



Worldwide:

F400A ^(6LB)

FL400A ^(6LC)

F450A ^(6KN)

FL450A ^(6KP)

USA, CAN, EUR, AUS, and NZL:

XF400 ^(6LB)

XF450 ^(6KN)

SERVICE MANUAL

6KN-28197-Z2-11 ●

LIT-18616-04-18


Preface

This manual has been prepared by Yamaha primarily for use by Yamaha dealers and their trained technicians when performing maintenance procedures and repairs to Yamaha equipment. It has been written to suit the needs of persons who have the Bronze Technical Certificate of the YTA (Yamaha Technical Academy) marine or the equivalent basic understanding of the mechanical and electrical concepts and procedures inherent in the work, for without such knowledge attempted repairs or service to the equipment could render it unsafe or unfit for use.

Because Yamaha has a policy of continuously improving its products, models may differ in detail from the descriptions and illustrations given in this publication. Use only the latest edition of this manual. Authorized Yamaha dealers are notified periodically of modifications and significant changes in specifications and procedures, and these are incorporated in subsequent editions of this manual. Also, up-to-date parts information is available on YMBS (Yamaha Marine Business System, USA only) or YPEC-web (except USA). Additional information and up-to-date information on Yamaha products and services are available on YMBS, YMPE (Yamaha Multimedia Product Encyclopedia, Canada only), or Yamaha Service Portal (except USA and Canada).

Important information

Particularly important information is distinguished in this manual by the following notations:

 : This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

WARNING

A WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

NOTICE

A NOTICE indicates special precautions that must be taken to avoid damage to the outboard motor or other property.

TIP:

A TIP provides key information to make procedures easier or clearer.

**F400A, FL400A, F450A, FL450A, XF400, XF450
SERVICE MANUAL
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Contents

General information	0
Specification	1
Technical feature and description	2
Rigging information	3
Troubleshooting	4
Electrical system	5
Fuel system	6
Power unit	7
Lower unit	8
Bracket unit	9
Maintenance	10
Appendix	A

General information

Model information	0-1
Applicable model	0-1
Model name designation	0-1
Important safety and service information	0-3
Rotating parts.....	0-3
Hot parts	0-3
Electric shock.....	0-3
Propeller	0-3
Handling of gasoline.....	0-3
Ventilation.....	0-3
Self-protection.....	0-3
Lifting outboard motors.....	0-4
Handling of gas torch	0-4
Parts, lubricants, and sealants	0-4
Handling of lubricants and sealants	0-4
Special service tools	0-5
Tightening torque	0-5
Non-reusable parts	0-5
Disassembly and assembly.....	0-5
Disposal of used components and chemicals	0-5
How to use this manual	0-6
Manual format	0-6
Conditions when testing and adjusting.....	0-7
Abbreviation	0-7
Color code.....	0-8
Specified tightening torque	0-9
General tightening torque.....	0-9
Symbol	0-10
Specification symbol.....	0-10
Lubricant, sealant, and thread locking agent symbol	0-10
Special service tool	0-12

Model information

Applicable model

This manual applies to the following models.

Worldwide

Model name	Approved model code	Starting serial No.
F450AVT	6KN	1000001-
FL450AVT	6KP	1000001-
F400AST	6LB	1000001-
FL400AST	6LC	1000001-

USA, CAN, EUR, AUS, and NZL

Model name	Approved model code	Starting serial No.
XF450SA	6KN	1000001-
XF400SA	6LB	1000001-

Model name designation

Worldwide

FL
450
A
VT
2
X

1
2
3
4
5
6

1	Model category	F: 4-stroke L: Counter rotating propeller
2	Output horsepower	400/450
3	Model generation	A: 1st change on motor B: 2nd change on motor C: 3rd change on motor Etc.
4	Model variation	Level 1: Starting method E: Electric start Level 2: Control method None: Remote control without tiller handle S: Built-in SBW and electric start V: Built-in SBW and electric start and power generation improvement or other additional functions Level 3: Trim and tilt method T: PT/T (Power trim and tilt)
5	Color code	None: Gray 2: White

Model information

6	Motor transom height	X (25 in) U (30 in) E (35 in)
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USA, CAN, EUR, AUS, and NZL

XF 450 N S A 2

1
2
3
4
5
6
7

1	Model category	X: XTO offshore series F: 4-stroke
2	Horsepower	400/450
3	Motor transom height	X: 25 in U: 30 in E: 35 in N: Without lower unit
4	Starting method/PTT	Blank: PTT and electric start
5	Control method	Blank: Remote control S: Built-in SBW and electric start
6	Generation	A: 1st change on motor B: 2nd change on motor C: 3rd change on motor Etc.
7	Color code	None: Gray 2: White

Important safety and service information

To prevent an accident or injury and to provide quality service, observe the following information.

Rotating parts

- Hands, feet, hair, jewelry, clothing, personal flotation device straps, and so on, can become entangled with internal rotating parts of the engine, resulting in serious injury or death.
- Keep the top cowling installed whenever possible. Do not remove or install the top cowling when the engine is running.
- Only operate the engine with the top cowling removed according to the specific instructions in the manual. Keep hands, feet, hair, jewelry, clothing, personal flotation device straps, and so on, away from any exposed moving parts.

Hot parts

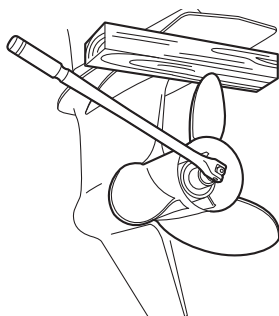
During and after operation, engine parts are hot enough to cause burns. Do not touch any parts under the top cowling until the engine has cooled.

Electric shock

Do not touch any electrical parts while starting or operating the engine. Otherwise, shock or electrocution could result.

Propeller

Do not hold the propeller with your hands when loosening or tightening the propeller nut. Sharp propeller edges can cause injury. Place a wood block between the gearcase and propeller to hold the propeller for removal and installation.



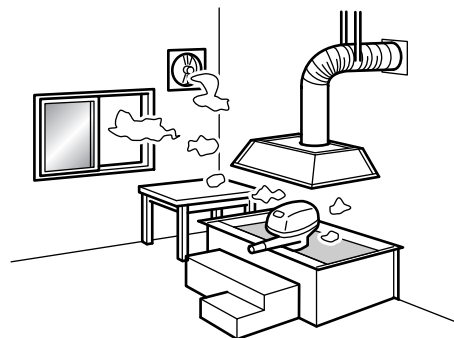
Handling of gasoline

- Gasoline is highly flammable. Keep gasoline and all flammable products away from heat, sparks, and open flames.
- Gasoline is poisonous and can cause injury or death. Handle gasoline with care. Never siphon gasoline by mouth. If you swallow some gasoline, inhale a lot of gasoline vapor, or get some gasoline in your eyes, see your doctor immediately. If gasoline spills on your skin, wash with soap and water. If gasoline spills on your clothing, change your clothes.



Ventilation

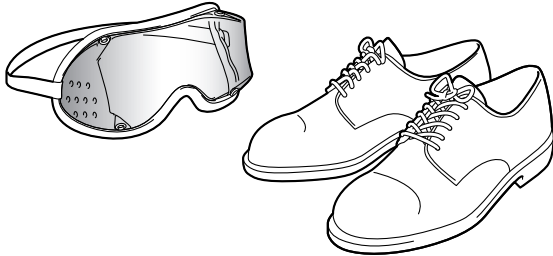
- Gasoline vapor and exhaust gases are heavier than air and extremely poisonous. If gasoline vapor or exhaust gases are inhaled in large quantities, it may cause loss of consciousness and death within a short time.
- When test running an engine indoors (for example, in a water tank), make sure to do so where adequate ventilation can be maintained.



Self-protection

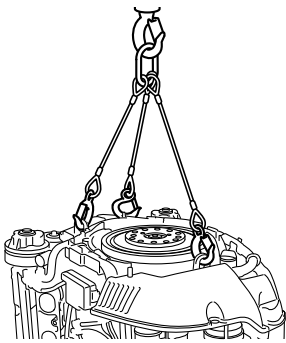
- Protect your eyes by wearing safety glasses or safety goggles during all operations involving drilling and grinding, or when using an air compressor.

- Protect your hands and feet by wearing protective gloves and safety shoes when necessary.



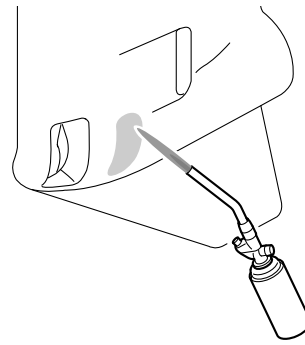
Lifting outboard motors

- Outboard motors weighing 18 kg (40 lb) and over must be carried by a crane or equivalent.
- Use a wire cable lifting harness of adequate strength to lift up the outboard motor in a stable manner.
- Lift and suspend the outboard motor in a stable manner using the designated lifting attachment points.
- Do not work on or under an outboard motor while it is suspended from a lifting device. Securely mount the motor on a suitable work stand or place it on a stable work surface as soon as possible.



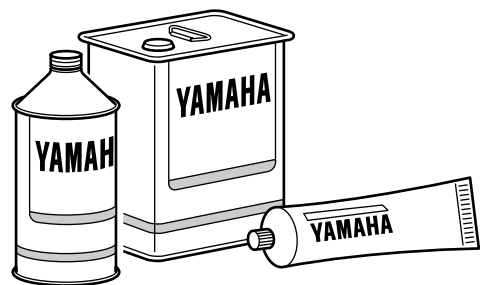
Handling of gas torch

- Improper handling of a gas torch may result in burns. For information on the proper handling of the gas torch, see the operation manual issued by the manufacturer.
- When using a gas torch, keep it away from gasoline and oil to prevent a fire.
- Components become hot enough to cause burns. Do not touch any hot components directly.



Parts, lubricants, and sealants

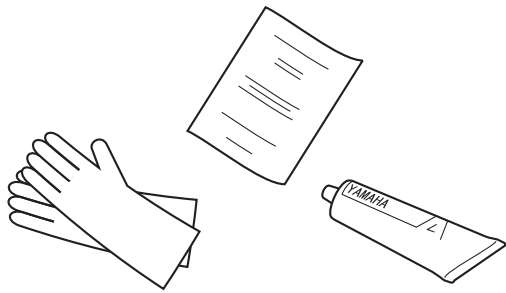
Use only genuine Yamaha parts, lubricants, and sealants, or those recommended by Yamaha, when servicing or repairing the outboard motor. Failures caused by the use of parts, lubricants, or sealants that are not equivalent in design and quality to genuine Yamaha parts, lubricants, or sealants will not be covered by warranty.



Handling of lubricants and sealants

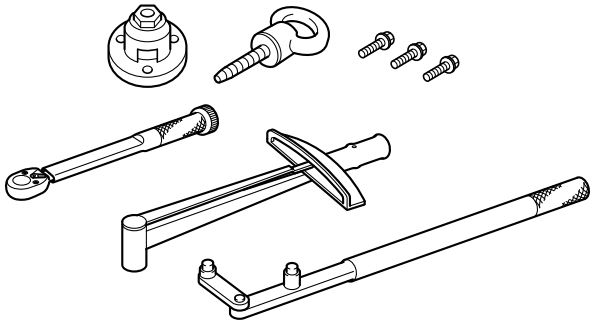
- Follow all instructions and safety precautions provided on the product label and the material safety data sheet (MSDS/SDS) for lubricants, sealants, and other shop chemicals.
- Wear impervious gloves, eye protection, or other protective apparel when required.
- Wash skin thoroughly after contact with lubricants, sealants, and other shop chemicals, and change clothing if contaminated with them.

Important safety and service information



Special service tools

For safety and to help protect parts from damage, use the recommended special service tools.

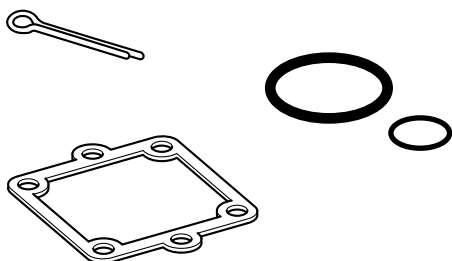


Tightening torque

When tightening nuts, bolts, and screws, follow the tightening instructions provided throughout the manual. If the tightening order is not specified, tighten the large sizes first, and then tighten the small sizes, starting from the center and moving outward.

Non-reusable parts

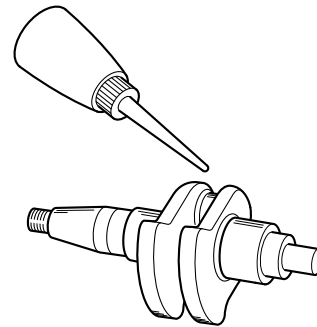
Always use new gaskets, seals, O-rings, cotter pins, and so on, when installing or assembling parts.



Disassembly and assembly

- Use compressed air to remove dust and dirt during disassembly.

- Apply engine oil to the contact surfaces of moving parts before assembly.



- During disassembly, cover all openings, such as intake and exhaust ports, to prevent foreign materials from entering the engine. Foreign materials could cause severe internal damage when the engine is started.
- Install bearings so that the bearing identification mark is facing in the direction indicated in the installation procedure. In addition, make sure to lubricate the bearings liberally.
- Apply a thin coat of water resistant grease to the lip and periphery of an oil seal before installation.
- Check that moving parts operate normally after assembly.
- When starting the engine after reassembly, check for fuel and water leaks from hoses and pipes that were disconnected or removed while servicing.
- When assembling the PTT/PT unit, do not use a rag. Otherwise, dust and particles could get on the PTT/PT unit components, causing poor performance.

Disposal of used components and chemicals

Obey all federal, state and local regulations when disposing of used components and/or chemicals such as crate frames, replaced parts, gaskets, oil, and so on.

How to use this manual

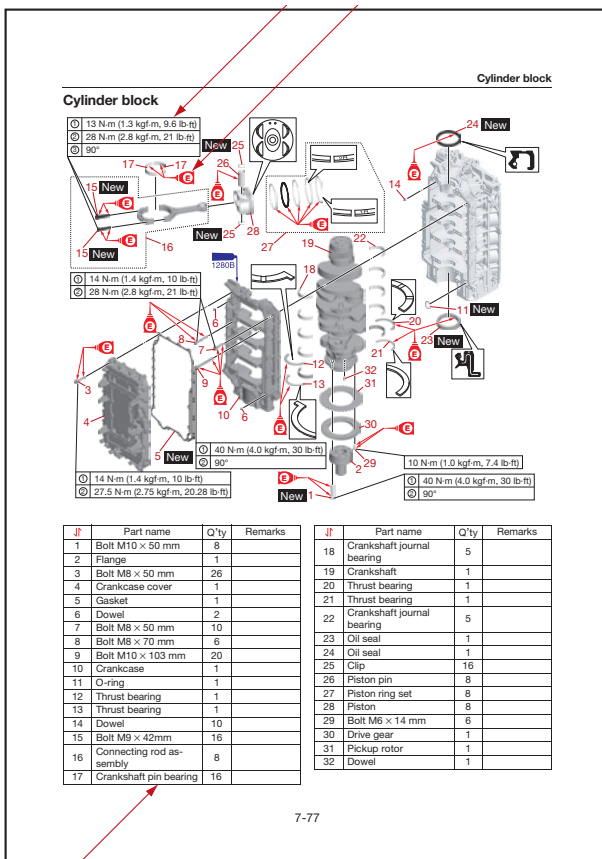
Manual format

The format of this manual has been designed to make service procedures clear and easy to understand. Use the following information as a guide for effective and quality service.

- Parts are shown and detailed in an exploded diagram and are listed in the component list (see “1” in the following figure for an example page).
- The component list consists of the basic removal or disassembly order (“↓”), part names, quantities, and remarks, which indicate the bolt and screw dimensions and other information (see “2” in the following figure). For the installation or assembly procedure, reverse the order.
- Symbols are used to indicate important aspects of a procedure, such as the grade of lubricant and the lubrication points (see “3” in the following figure).
- Tightening torque specifications are provided in the exploded diagrams (see “4” in the following figure), and in the related detailed instructions. Some torque specifications are listed in stages as torque values or angles in degrees.
- Separate procedures and illustrations are used to explain the details of removal, checking, and installation where necessary (see “5” in the following figure for an example page). Detailed explanations of the procedures are expressed by using lower case letters such as a, b, c, (see “6” in the following figure).
- Numbers enclosed in brackets are used to indicate the removal or tightening order of bolts, screws, and other parts (see “7” in the following figure).

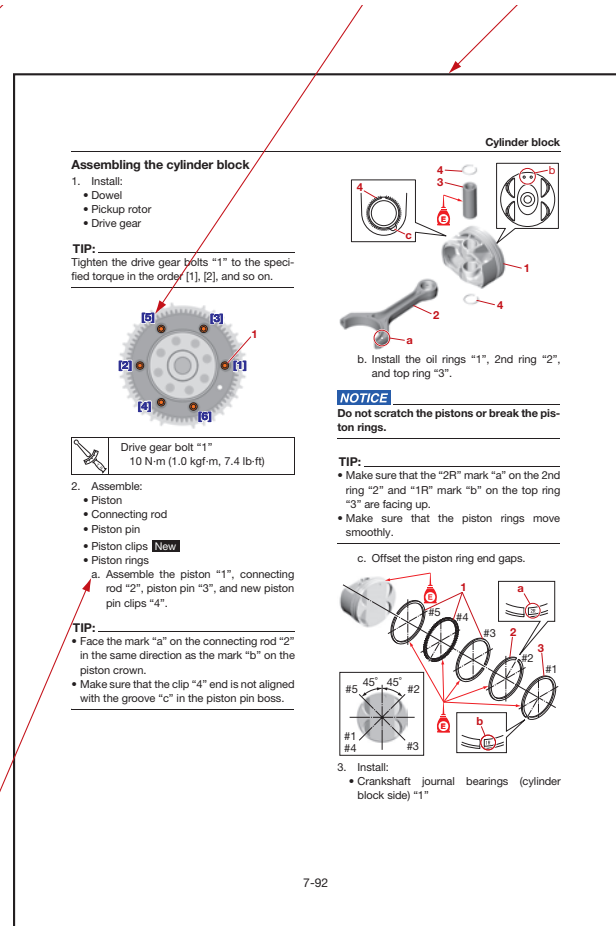
TIP:

For troubleshooting procedures, see Chapter 4, “Troubleshooting”.



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7-92

Conditions when testing and adjusting

Conditions can affect specifications when checking, measuring, and making certain adjustments. Service data in this manual was determined under the following conditions:

- Electrical resistance for components such as ignition coils and sensors was measured at 20 °C (68 °F).
- Engine compression was measured at:
 - Sea level
 - 20 °C (68 °F)
 - All spark plugs removed
 - Throttle valve at WOT (depending on model specification)
- Trim/tilt angles shown are when the transom angle is 12 degrees.

Abbreviation


The following abbreviations are used in this service manual.

Abbreviation	Description
ABYC	American Boat and Yacht Council
APS	Accelerator Position Sensor
ECM	Electronic Control Module
EN	European Norm (European standard)
EPA	Environmental Protection Agency
ETV	Electronic Throttle Valve
HCU	Helm Control Unit
ISC	Idle Speed Control
LPS	Lever Position Sensor
OCV	Oil Control Valve
OS	Offshore
PCU	Power-train Control Unit
PTT	Power Trim and Tilt
SBW	Steer by Wire
SCU	Steering Control Unit
SDS	Shift Dampener System
SPS	Shift Position Sensor
TPS	Throttle Position Sensor
VCT	Variable Camshaft Timing
Y-COP	Yamaha Customer Outboard Protection
YDIS	Yamaha Diagnostic System
XTO	Xtreme Thrust Output
WOT	Wide Open Throttle

Color code

B	Black 	Lg	Light green 	Sb	Sky blue 
Br	Brown 	Or	Orange 	W	White 
G	Green 	P	Pink 	Y	Yellow 
Gy	Gray 	Pu	Purple 		
L	Blue 	R	Red 		

TIP:

For example, "R/Y" stands for a Red with Yellow tracer stripe wire. 

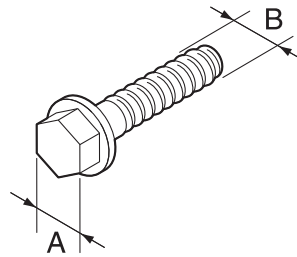
Specified tightening torque

Specified tightening torques are provided for specific nuts, bolts, and screws. Specified tightening torque specifications are provided in the exploded diagrams and in the related working instructions. When tightening these fasteners, follow the tightening torque specifications and procedures indicated throughout the manual to meet the design aims of the outboard motor.

General tightening torque

This chart indicates the tightening torques for standard fasteners with a standard ISO thread pitch.


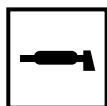






Width across flats (A)	Thread size (B)	General torque specifications		
		N·m	kgf·m	lb·ft
8 mm	M5	5	0.5	3.7
10 mm	M6	8	0.8	5.9
12 mm	M8	18	1.8	13
14 mm	M10	36	3.6	27
17 mm	M12	52	5.2	38



Symbol






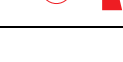



Specification symbol

Illustrated symbols are used to identify the specifications which appear.













Symbol	Definition	Symbol	Definition
	Filling fluid		Lubricant
	Special tool		Tightening torque
	Wear limit, clearance		Engine speed
	Electrical data		Replace the part with a new one.

Lubricant, sealant, and thread locking agent symbol

Symbols in an exploded diagram or illustration indicate the grade of lubricant and the lubrication points.

Symbol	Name	Application
	YAMALUBE 4 or YAMALUBE 4M FC-W	Lubricant
	YAMALUBE outboard gear oil or Yamalube Marine Gearcase Lube	Lubricant
	Water resistant grease (Yamalube grease A or Yamalube Marine Grease)	Lubricant
	Molybdenum disulfide grease (Yamalube Molybdenum Disulfide grease)	Lubricant
	Corrosion resistant grease (Yamaha grease D or Yamalube Marine Grease)	Lubricant
	Low temperature resistant grease (Yamaha grease C or Yamalube Molybdenum Disulfide grease)	Lubricant
	Epnoc grease AP #0	Lubricant
	YAMAHA WR-No.2 grease	Lubricant
	ThreeBond 1901	Lubricant

Symbols in an exploded diagram or illustration indicate the type of sealant or thread locking agent and the application points.




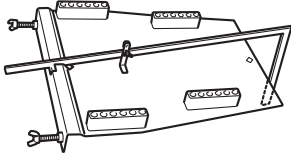
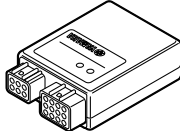

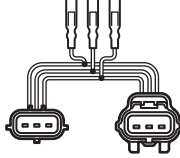
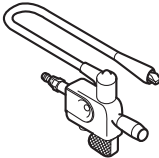
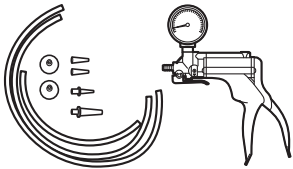

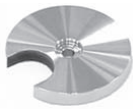



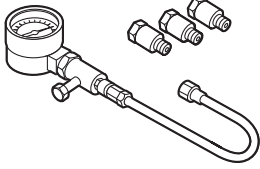
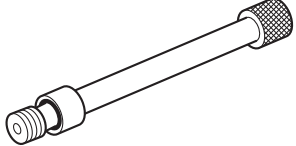


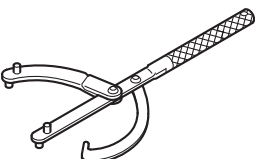
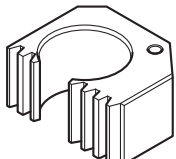
Symbol	Name	Application
	YAMAHA Gasket Maker	Sealant
	ThreeBond 1211*	
	ThreeBond 1280B (Yamabond 4 Marine)	Sealant
	ThreeBond 1322D	Thread locking agent
	ThreeBond 1386B	Sealant
	ThreeBond 1377B	Thread locking agent
	LOCTITE 1342H	Thread locking agent
	ThreeBond 1530D	Sealant
	ThreeBond 1303	Thread locking agent
	LOCTITE 271 (red)	Thread locking agent
	LOCTITE 241 (blue)	Thread locking agent
	LOCTITE 242 (blue)	Thread locking agent
	LOCTITE 572 (white)	Sealant

*. For white-colored parts.



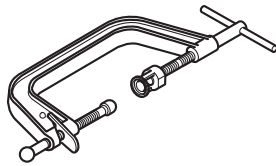
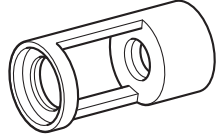


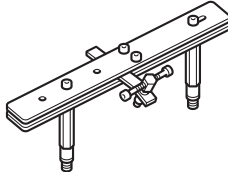
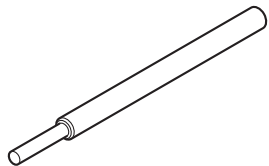
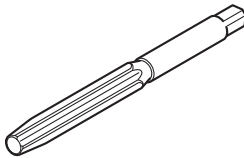
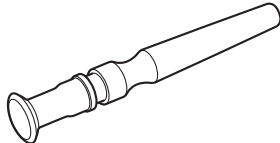
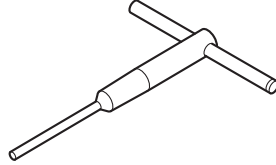

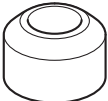
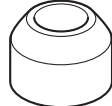

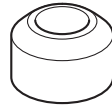
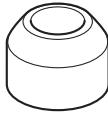
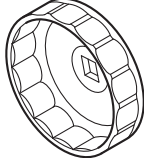
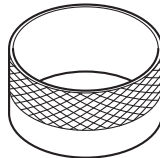
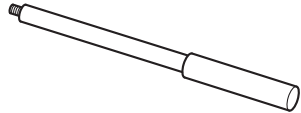
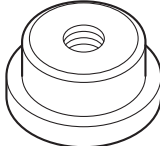
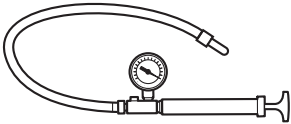


Special service tool

Special service tools with Yamaha part numbers (90890-*****) are distributed by the Parts Division. USA and Canada tool numbers (YB/YM/YS/YU-*****) are distributed by K&L Supply Co. Some of the special service tools are only available from the Marine Service Division.

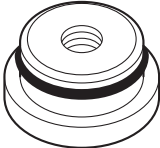

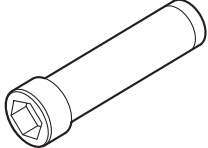
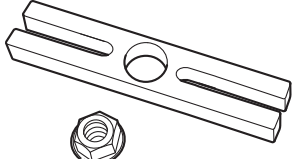
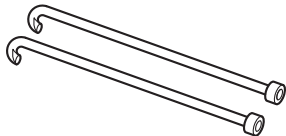
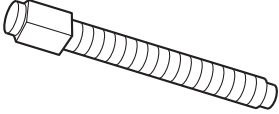
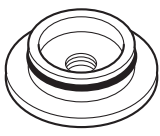
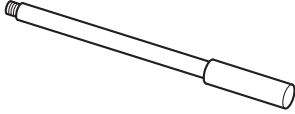

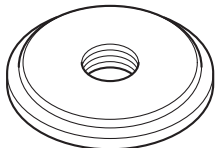
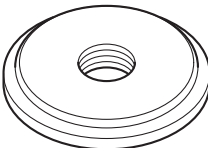
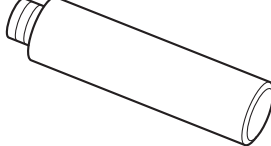
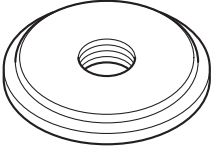

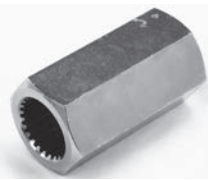





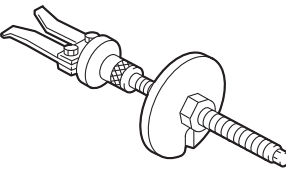

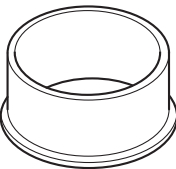
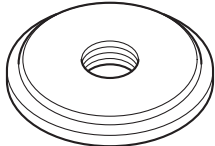
WW SST No.

<p>Lifting eye 90890-06953</p> 	<p>Bolt hexagon with washer 90890-06821</p> 	<p>Lifting hanger 90890-06951</p> 	<p>Drilling plate 90890-06783</p> 
<p>YDIS 2 HARDWARE KIT III 90890-06980</p> 	<p>Tester leads 90890-06976</p> 	<p>Test harness EJ-II-3 90890-06913</p> 	<p>Ignition checker (Spark gap tester) 90890-06754</p> 
<p>Vacuum/pressure pump gauge set 90890-06945</p> 	<p>Injector remover 90890-06696</p> 	<p>Stopper 90890-06699</p> 	<p>Seal fitter 90890-06708</p> 
<p>Nozzle cap 90890-06697</p> 	<p>Seal installer 90890-06698</p> 	<p>Compression gauge 90890-03160</p> 	<p>Compression gauge extension M10 90890-06582</p> 
<p>Balance hanger 90890-06460</p> 	<p>Bolt set 90890-06969</p> 	<p>Rotor holder 90890-01235</p> 	<p>Flywheel stopper 90890-06598</p> 


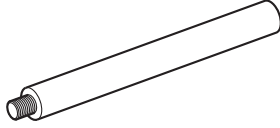
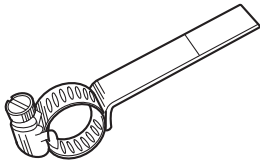
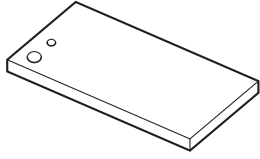
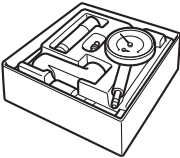
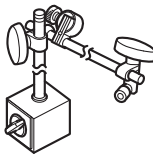

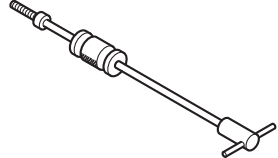
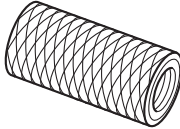
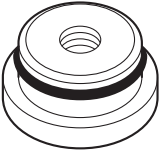

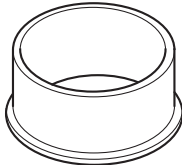
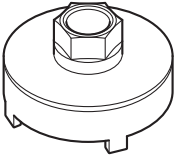
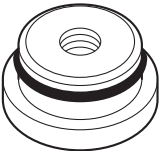
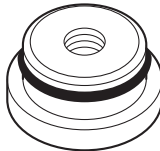
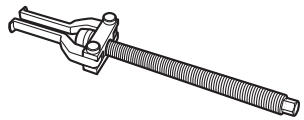
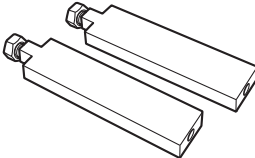






Special service tool

<p>Flywheel guide 90890-06955</p> 	<p>Shaft holder 90890-06949</p> 	<p>Valve spring compressor 90890-04200</p> 	<p>Valve spring compressor attachment 90890-06320</p> 
<p>Lever assy 90890-06956</p> 	<p>Support assy 3 90890-06952</p> 	<p>Valve spring compressor 90890-06689</p> 	<p>Valve guide remover/installer 90890-06801</p> 
<p>Valve guide reamer 90890-06804</p> 	<p>Valve lapper 90890-04101</p> 	<p>Valve seat cutter holder 90890-06316</p> 	<p>Valve seat cutter 30-38 90890-06817</p> 
<p>Valve seat cutter 45-38 90890-06816</p> 	<p>Valve seat cutter 60° 90890-06324</p> 	<p>Valve seat cutter 30° 90890-06326</p> 	<p>Valve seat cutter 45° 90890-06325</p> 
<p>Valve seat cutter 60° 90890-06323</p> 	<p>Oil filter wrench 90890-06874</p> 	<p>Piston slider 96 mm 90890-06684</p> 	<p>Driver rod L3 90890-06652</p> 
<p>Needle bearing attachment 90890-06608</p> 	<p>Leakage tester 90890-06840</p> 	<p>Shift rod socket 90890-06950</p> 	<p>Needle bearing attachment 90890-06614</p> 


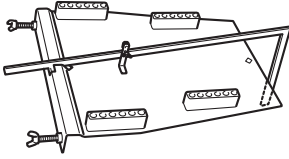
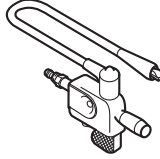
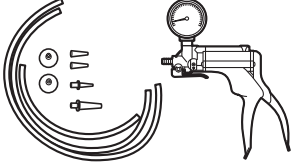

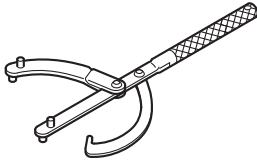
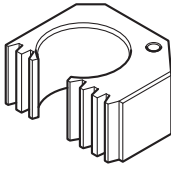
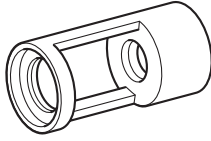
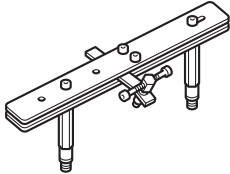
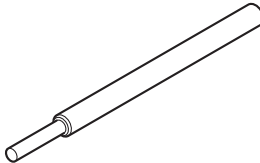
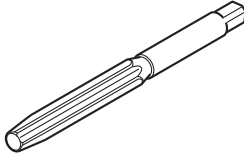
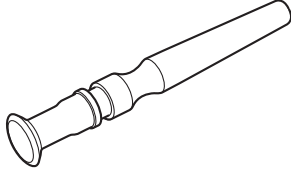
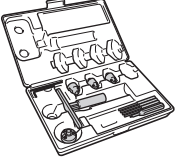
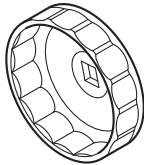
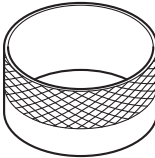
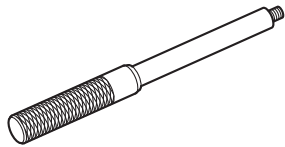
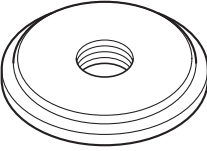
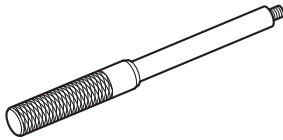
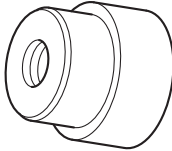
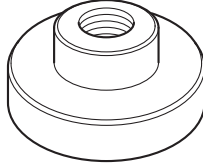
Special service tool

<p>Needle bearing attachment 90890-06609</p> 	<p>Ring nut wrench 90890-06932</p> 	<p>Ring nut wrench extension 2 90890-06784</p> 	<p>Stopper guide plate 90890-06501</p> 
<p>Bearing housing puller claw L 90890-06502</p> 	<p>Center bolt 90890-06504</p> 	<p>Ball bearing attachment 90890-06657</p> 	<p>Driver rod LL 90890-06605</p> 
<p>Needle bearing attachment 90890-06933</p> 	<p>Bearing inner race attachment 90890-06658</p> 	<p>Bearing outer race attachment 90890-06621</p> 	<p>Driver rod LS 90890-06606</p> 
<p>Bearing outer race attachment 90890-06623</p> 	<p>Ring nut wrench 90890-06934</p> 	<p>Drive shaft holder 90890-06935</p> 	<p>Pinion nut holder 90890-06451</p> 
<p>Socket adapter 90890-06936</p> 	<p>Holder guide 90890-06937</p> 	<p>Needle bearing attachment 90890-06967</p> 	<p>Needle bearing attachment 90890-06938</p> 
<p>Bearing outer race puller assembly 90890-06523</p> 	<p>Stopper guide plate 90890-06939</p> 	<p>Bearing inner race attachment 90890-06639</p> 	<p>Bearing outer race attachment 90890-06628</p> 

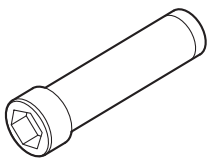

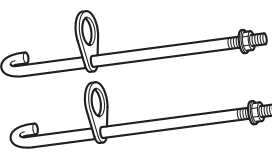
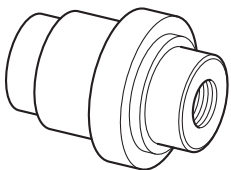
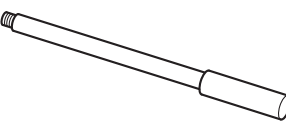
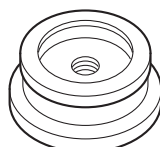
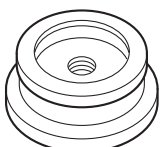
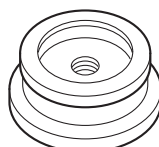
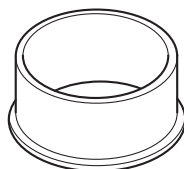

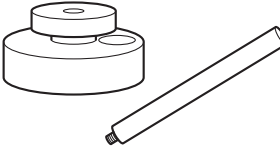
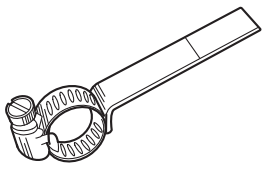
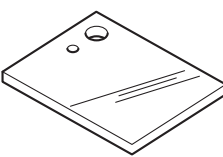

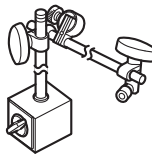
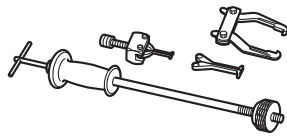
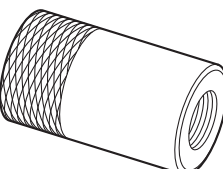

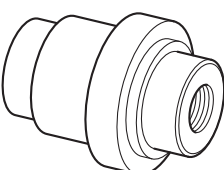
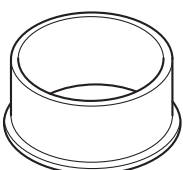
Special service tool

<p>Pinion shimming gauge 90890-06948</p> 	<p>Pinion shimming gauge rod 90890-06676</p> 	<p>Backlash indicator 90890-06836</p> 	<p>Magnet base plate 90890-07003</p> 
<p>Dial gauge set 90890-03238</p> 	<p>Magnet base B 90890-06844</p> 	<p>Ring nut extension 90890-06968</p> 	<p>Slide hammer handle 90890-06531</p> 
<p>Puller head 90890-06514</p> 	<p>Needle bearing attachment 90890-06616</p> 	<p>Ball bearing attachment 90890-06630</p> 	<p>Bearing inner race attachment 90890-06644</p> 
<p>Ring nut wrench 2 90890-06823</p> 	<p>Needle bearing attachment 90890-06654</p> 	<p>Ball bearing attachment 90890-06636</p> 	<p>Bearing puller assembly 90890-06535</p> 
<p>Stopper guide stand 90890-06538</p> 	<p>Cylinder end screw wrench 90890-06958</p> 	<p>Cylinder end screw wrench 90890-06959</p> 	<p>Gear oil attachment kit 90890-06963</p> 
<p>Oil socket 90890-06964</p> 	<p>Air socket 90890-06965</p> 	<p>Joint 90890-06966</p> 	

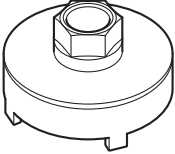
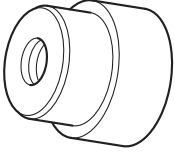
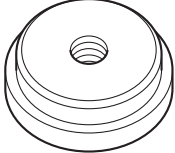
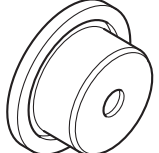
US SST No.

<p>Bolt hexagon with washer YB-06821</p> 	<p>Drilling plate YB-34465-A</p> 	<p>Spark checker YM-34487</p> 	<p>Pressure/vacuum tester YB-35956-B</p> 
<p>Compression gauge YU-33223</p> 	<p>Universal magneto and rotor holder YU-01235</p> 	<p>Flywheel stopper YB-06598</p> 	<p>Valve spring compressor adaptor YB-06320</p> 
<p>Valve spring compressor YB-06689</p> 	<p>Valve guide remover YB-06801</p> 	<p>Valve guide reamer YB-06804</p> 	<p>Valve lapping tool YM-A8998</p> 
<p>Neway valve seat kit YB-91044</p> 	<p>Oil filter wrench YB-06874</p> 	<p>Piston slider 96 mm YB-06684</p> 	<p>Driver handle (large) YB-06071</p> 
<p>Driveshaft bearing installer YB-06110</p> 	<p>Driver handle (small) YB-06229</p> 	<p>Oil seal installer reverse gear bearing housing YB-06021</p> 	<p>Driveshaft seal installer YB-06348</p> 

Special service tool

<p>Ring nut wrench extension YB-06784</p> 	<p>Universal Puller YB-06117</p> 	<p>Bearing housing puller YB-06207</p> 	<p>Prop end seal bearing driver YB-42227</p> 
<p>Driver rod LL YB-06605</p> 	<p>Taper roller bearing installer YB-06431</p> 	<p>Forward gear bearing installer YB-06276</p> 	<p>Forward gear bearing cup installer YB-06277-A</p> 
<p>Bearing inner race attachment YB-06639</p> 	<p>Bearing cup installer YB-06167</p> 	<p>Pinion shimming gauge YB-06835</p> 	<p>Backlash indicator YB-06836</p> 
<p>Backlash adjustment plate YB-07003</p> 	<p>Dial indicator gauge YU-03097</p> 	<p>Magnetic base stand YU-A8438</p> 	<p>Slide hammer YB-06096</p> 
<p>Propeller shaft and bearing housing remover YB-06335</p> 	<p>Oil seal installer YB-06023</p> 	<p>Forward gear needle bearing installer YB-06261</p> 	<p>Bearing inner race attachment YB-06644</p> 

Special service tool

<p>Ring nut wrench YB-06823</p> 	<p>Driveshaft needle bearing installer and remover YB-06196</p> 	<p>Needle bearing installer YB-06434</p> 	<p>Driveshaft needle bearing installer YB-06231</p> 
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Specification

Specification data 1-1

External dimensions 1-2

Clamp bracket dimensions 1-3

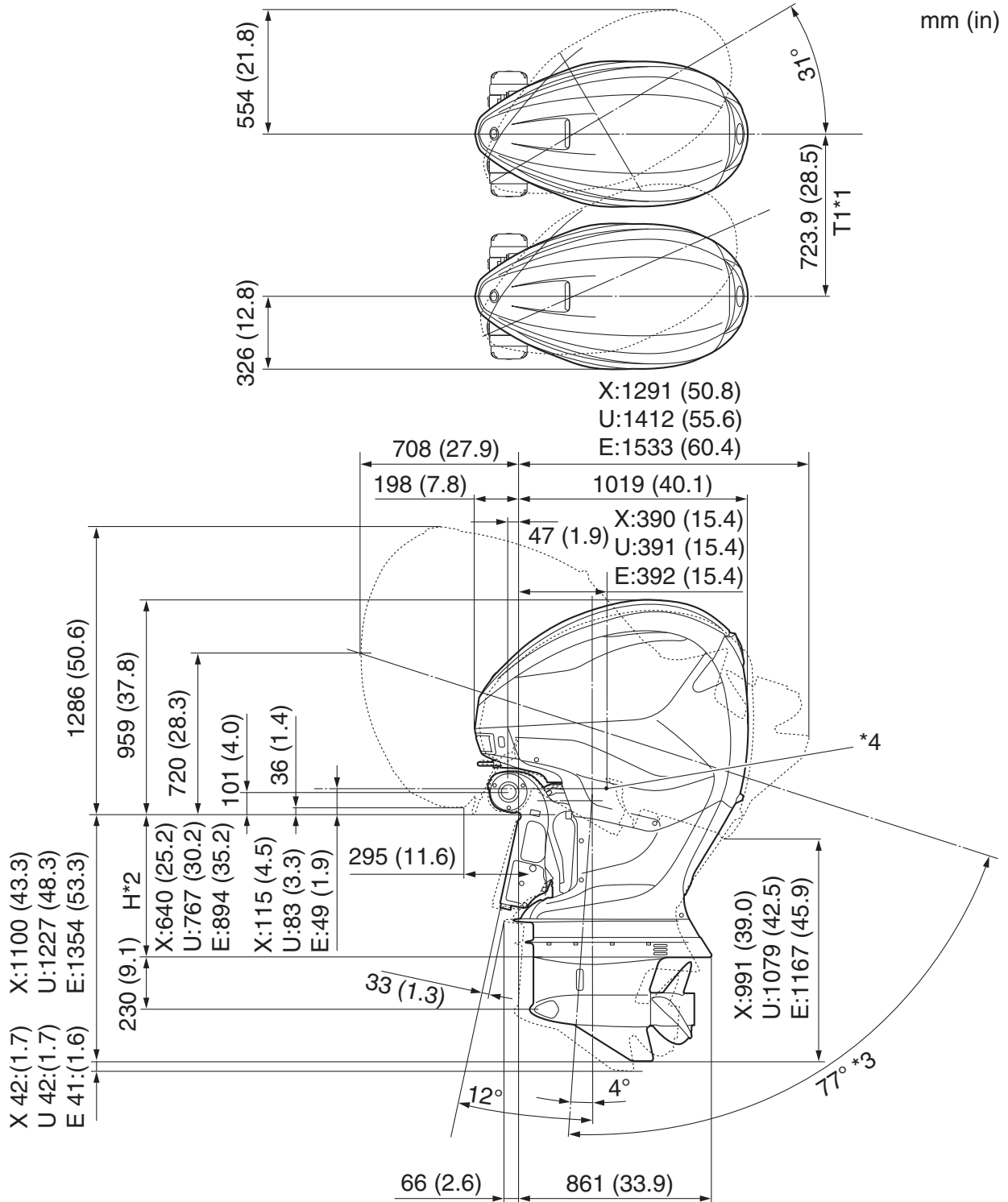
Specification data

For specification data, see Appendix, "Specification" (A-1).

External dimensions

TIP:

The dimension values may include reference values.



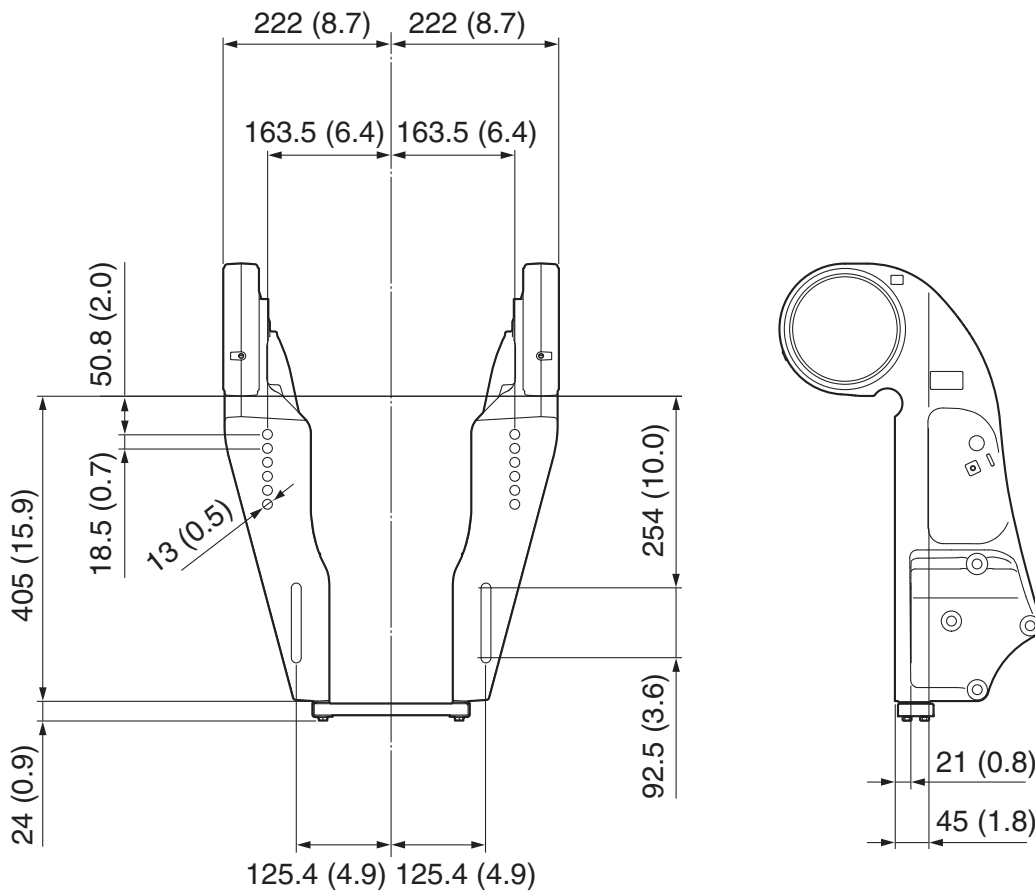
- *1. Minimum distance between the outboard motors in twin, triple, quad, or quint engine application
- *2. Motor transom height
- *3. Fully tilt-up angle (Not tilt support angle)
- *4. Gravity point

Clamp bracket dimensions

TIP: _____

The dimension values may include reference values.

mm (in)



Technical feature and description

Model feature	2-1
General feature.....	2-1
Model comparison table	2-2
Power unit.....	2-3
Intake silencer	2-4
Shift-shock reduction.....	2-4
Sleeveless cylinder.....	2-5
Heat exhaust fan and heat vent	2-5
Direct fuel injection.....	2-6
Crankshaft.....	2-7
Camshaft.....	2-8
Cowlings.....	2-9
Bracket unit	2-10
Upper mount	2-11
SBW (Steer by Wire) system	2-12
System diagram	2-13
Structure.....	2-15
Operation	2-16
Outboard motor manual steering method.....	2-17
PTT unit	2-18
PTT sensor	2-19
PTT lead	2-20
PTT TotalTilt™.....	2-20
Lower unit.....	2-23
Lower case.....	2-24
Gear oil changing method.....	2-25
Reverse thrust	2-27
Propeller (XTO-EC series).....	2-28
Engine ECM	2-28
Electrical system.....	2-29
Charging system (F400A/FL400A/XF400)	2-29
Charging system (F450A/FL450A/XF450)	2-30
Knocking detection	2-33
Overheat detection.....	2-33
Electronic control system	2-34
Electrical components.....	2-36
Fail-safe.....	2-38

Technical feature and description

Fuel system.....	2-42
Fuel diagram	2-42
High-pressure fuel pump control	2-45
Low-pressure fuel pump control	2-45
Vapor separator.....	2-46
Fuel strainer.....	2-47
Direct injection pump	2-48
Lubrication system	2-49
Lubrication diagram	2-49
Dual rotor oil pump	2-51
Oil drain plug	2-52
Cooling system.....	2-53
Cooling diagram	2-53
Dual water pump	2-56
Engine anode	2-57
Thermostat	2-58
Intake and exhaust system	2-59
Intake and exhaust diagram.....	2-59
Hose routing	2-60
Fuel hose and blowby hose	2-60
Cooling water hose	2-61

Model feature

General feature

- 4-stroke, V8, 5559 cm³ (339.2 cu. in) engine
- Various transom heights available for larger boats (X: 25", U: 30", E: 35")
- Enhanced reverse thrust at low speeds
- Higher-output engine with revised intake/exhaust system structure
- The intake silencer employed to reduce the noise
- Equipped with an automatic PTT tilt function (TotalTilt™)

a. Power unit

- Direct fuel injection
- Sleeveless cylinders
- Increased thrust strength of the crankshaft
- New camshaft layout
- Flywheel with a heat exhaust fan
- Top cowling with a heat vent
- Easier removal and installation of the top cowling
- Dual rotor oil pump

b. Electrical

- Electronic fuel injection control
- Digital ignition control
- ETV control
- VCT control (IN)
- Shift actuator control
- Twin sensor knock control
- Over-revolution control
- New three-phase simultaneous charging system (F450A/FL450A/XF450)
- High-capacity charging system at low r/min (F450A/FL450A/XF450)
- Built-in protection against accidental reverse polarity connections (F450A/FL450A/XF450)

c. Bracket unit

- Vibration-isolation upper mounts
- SBW (Steer by Wire) system
- PTT unit

d. Upper case

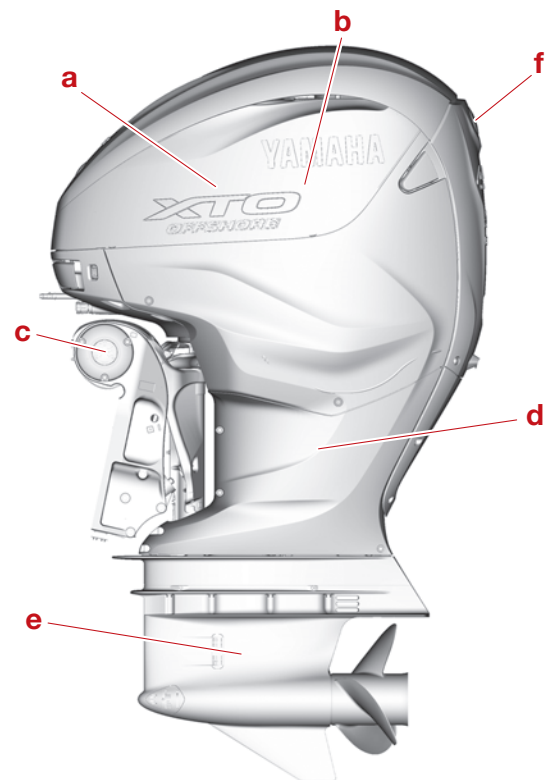
- Composite bottom cowling

e. Lower unit

- New lower case
- Dual water pump
- Gear oil changing system on the water
- XTO series propeller with SDS

f. Appearance

- Raised graphics on the cowling
- Art line added to the rear panel
- Improved external appearance by installing the flushing hose as an internal part
- Improved external appearance by changing the routing of PTT motor lead



Model comparison table

400- and 450-horsepower 4-stroke models have been newly added to the Yamaha outboard motor lineup.

The engine output powers of 400- and 450-horsepower models are controlled by their respective ECMs. Electricity generating capacity of 450-horsepower model is different from that of 400-horsepower model. The generator output and the charging capacity are also different.

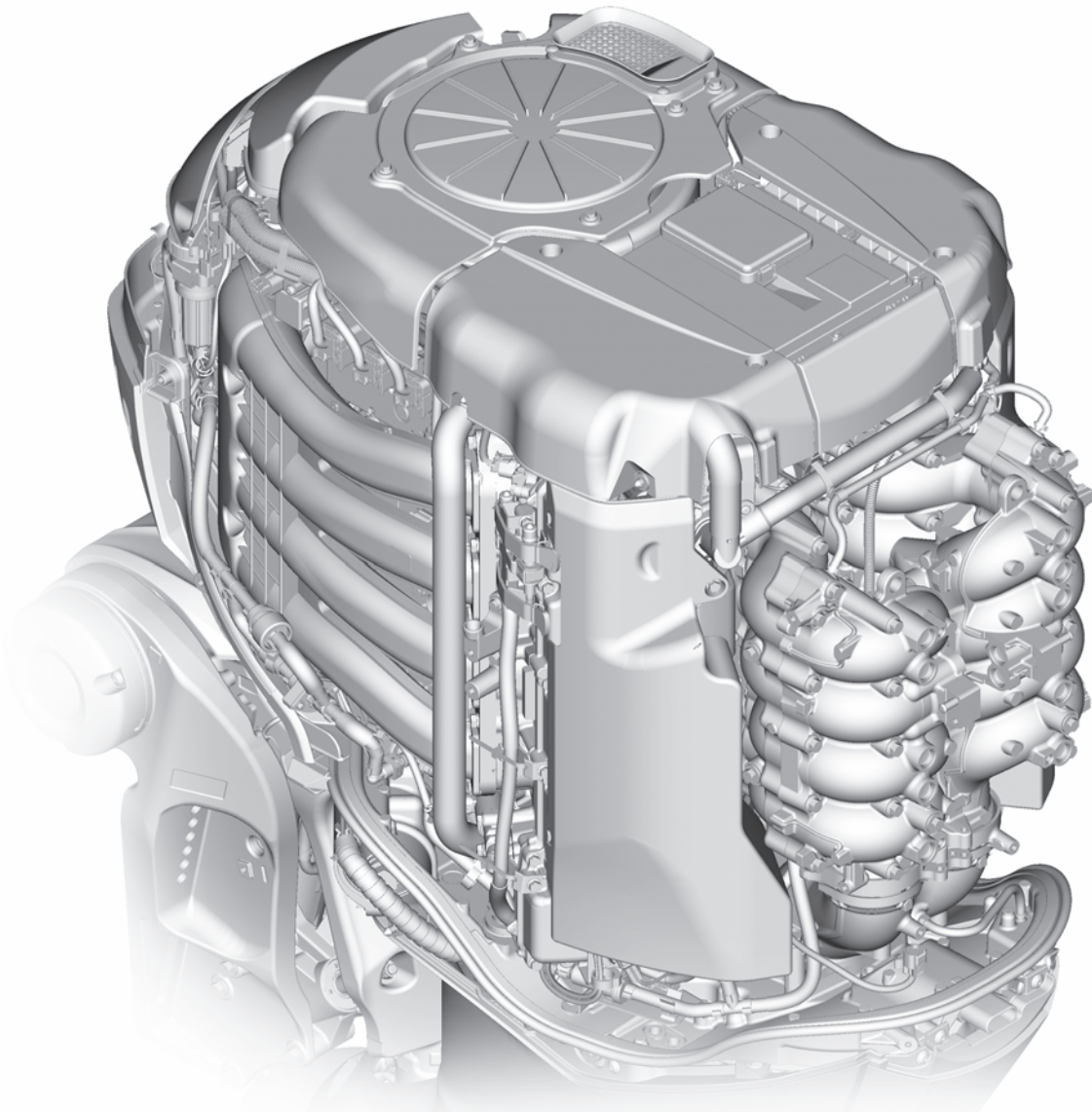
Appropriate wiring is required for the battery charging system. 400-horsepower model cannot be upgraded to 450-horsepower model.

	F400A/FL400A/XF400	F450A/FL450A/XF450
Type	4-stroke DOHC V8 32 valves	
Total displacement	5559 cm ³ (339.2 c.i.)	
Bore × stroke	96.0 × 96.0 mm (3.78 × 3.78 in)	
Compression ratio	12.3:1	
Maximum generator output	104 A	102 A
Maximum charging capacity	88 A	96 A
Rated power	294.2 kW (400 hp)	331.0 kW (450 hp)
Full throttle operating range	5000–6000 r/min	
Maximum fuel consumption at 6000 r/min (reference data)	130.6 L/h	144.8 L/h
Idle speed (in neutral)	650–750 r/min	

Power unit

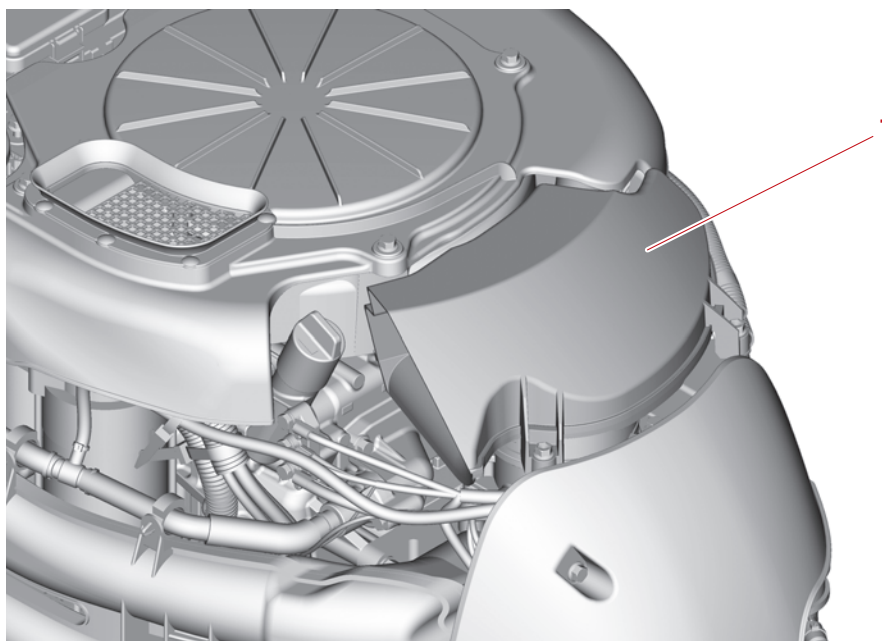
Outline

Electronically controlled, direct injection V8 engine, the flagship of the Yamaha Outboard Motor model line, is installed. An even higher output engine has been achieved through the optimization of intake/exhaust system structure, while the design features of F375/F425 (XF375/XF425) to obtain high output, high fuel efficiency, good serviceability, and so on are maintained.



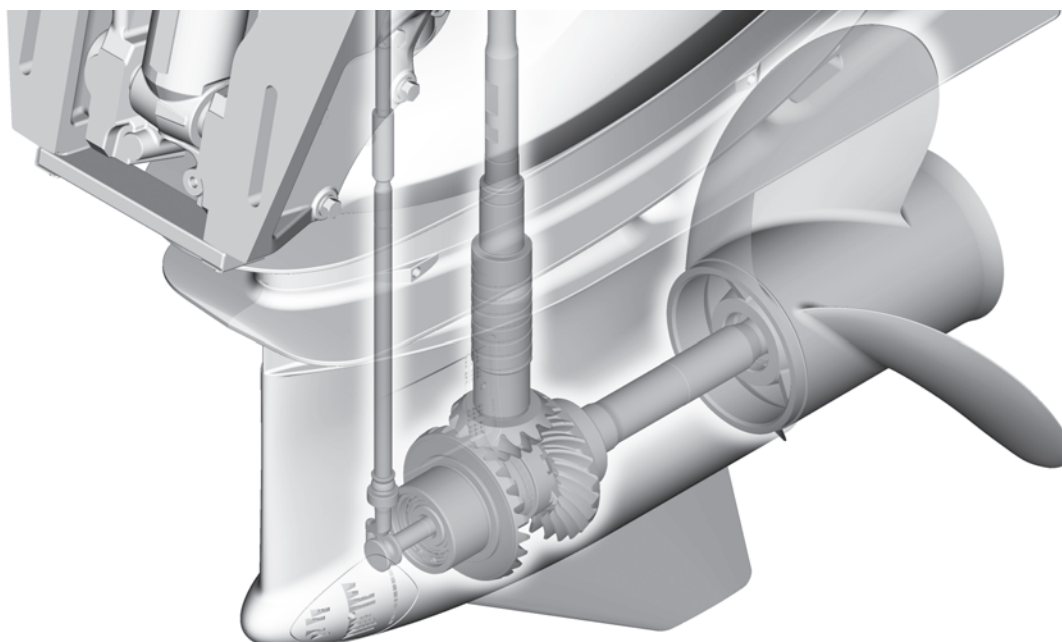
Intake silencer

Newly designed intake silencer “1” is employed. The space provided inside the silencer absorbs the intake air noise and the mechanical noise of the engine. This feature has greatly improved the quiet performance while the engine is in operation compared to F375/F425 (XF375/F425).



Shift-shock reduction

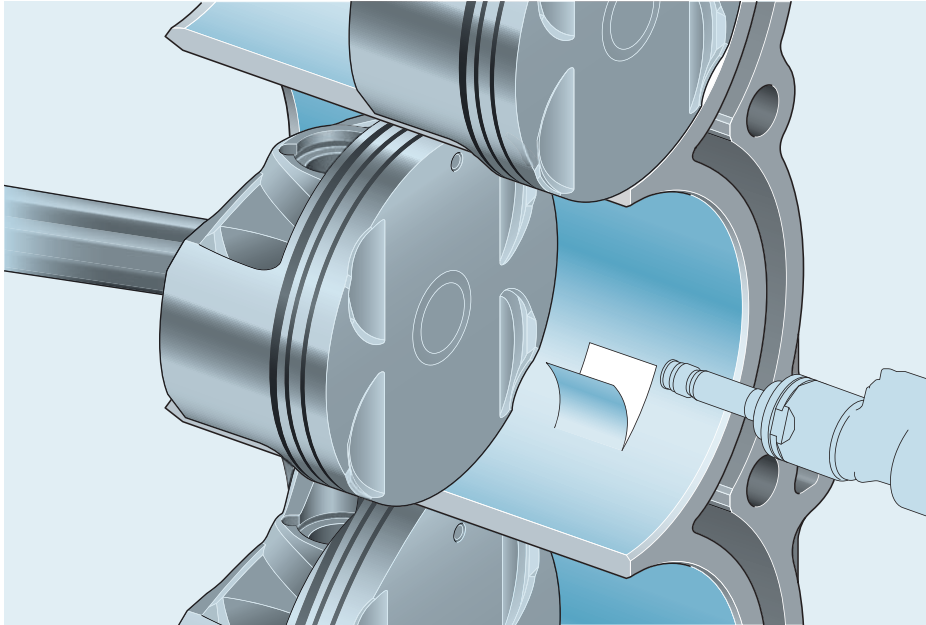
The gearshift shock has been reduced by the improved engine control program for the gearshift operation. Quietness has been improved relative to F375/F425 (XF375/XF425). The effect of the improvement is especially evident in multiple engine applications operated with joystick.



Sleeveless cylinder

The newly designed cylinder block has adopted spray-coated cylinders instead of sleeved cylinders. By using spray-coated cylinders, the weight of the cylinder block is decreased, cooling performance is increased, and so on.

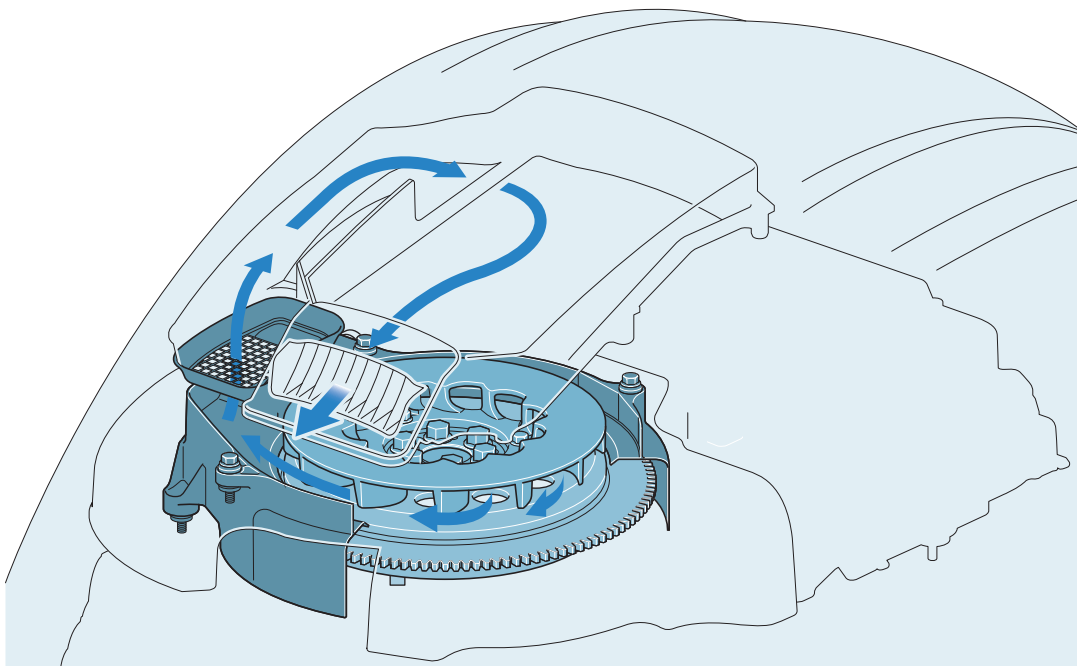
The inner walls of the cylinders are spray-coated using metal powder.



Heat exhaust fan and heat vent

The flywheel is equipped with a heat exhaust fan and the top cowling is equipped with a heat vent. By controlling the temperature increase in the top cowling due to the generation of a large amount of electricity and stabilizing the intake air temperature, high output can be produced.

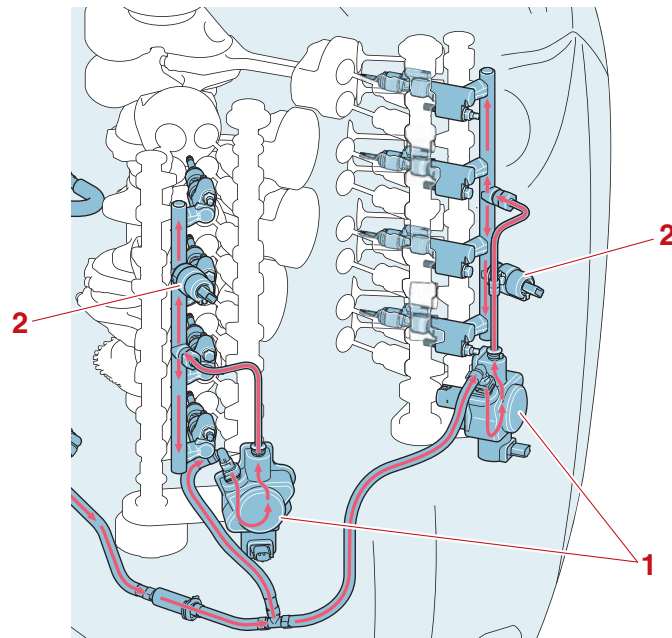
In addition, the heat vent is located on the front of the top cowling to prevent water from entering the cowling.



A. Warm air flow

Direct fuel injection

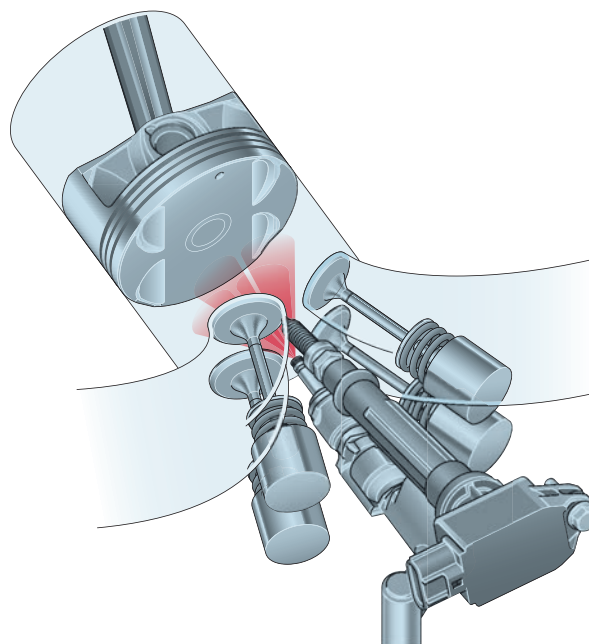
The direct injection pumps “1” further increase the pressure of the fuel from the fuel tank, low-pressure fuel pump, and vapor separator. The fuel pressure sensors (fuel rails) “2” are used to detect the fuel pressure in the fuel rails, and the injector drivers operate the direct injection pumps and fuel injectors based on information from the ECM to inject the optimum amount of fuel at the optimum timing.



A. Fuel flow

Because the intake air can be cooled, the output is increased due to the improved charging efficiency. In addition, the compression ratio can be increased because knocking is reduced, which increases the thermal efficiency and fuel economy.

Because the fuel injectors are located in the center of the combustion chambers, the size of the overall system is compact, and the overall width of the outboard motor and the distance between outboard motors for multiple engine applications is approximately the same as for previous models.

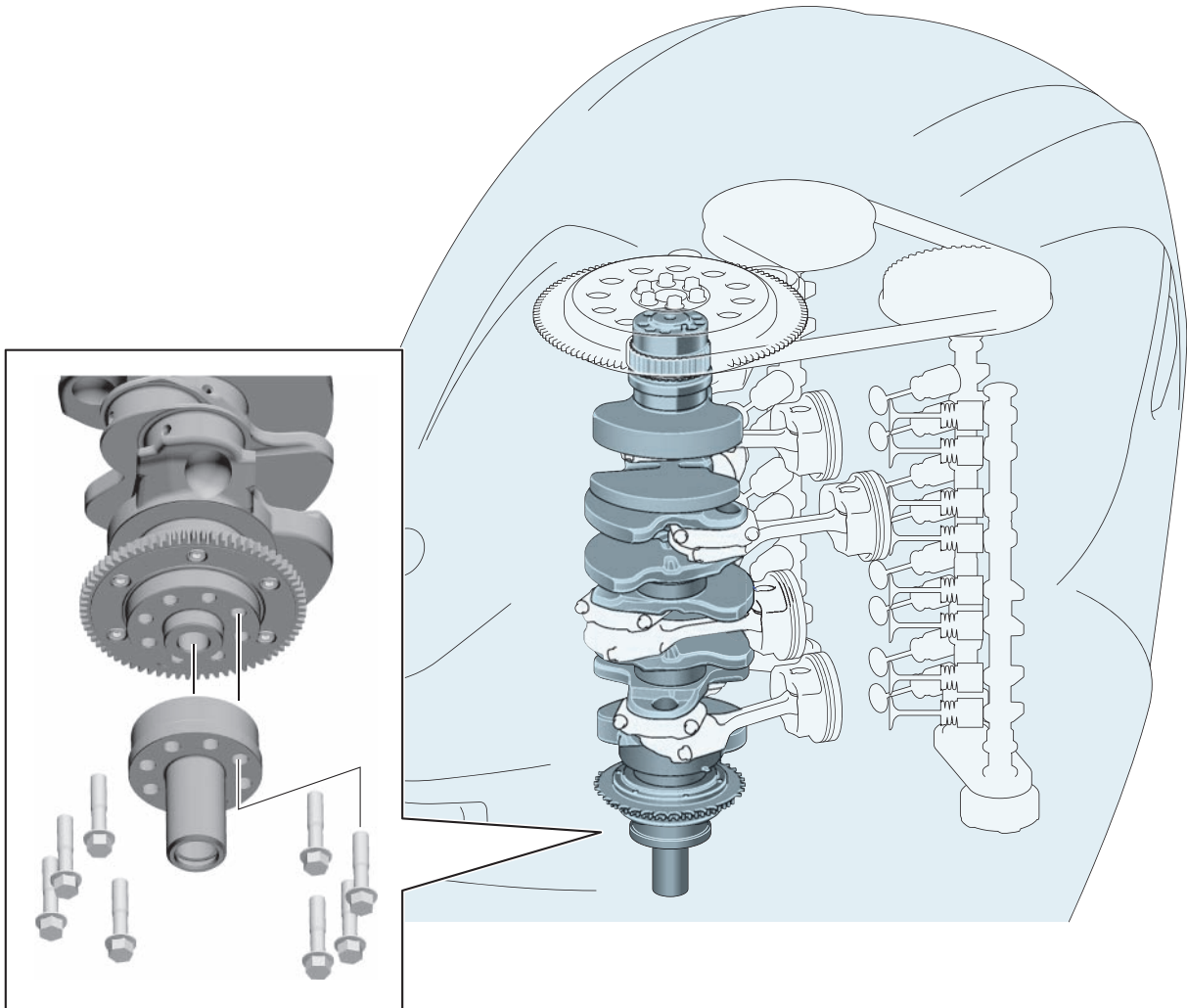


Crankshaft

The size of the journals is the same as for the F300B (F300CA) and the amount of overlap between the crankpins has been increased to ensure sufficient durability for offshore use.

In addition, by increasing the surface area of the thrust bearings and reducing the friction by adding a surface treatment to the portion that engages the drive shaft splines, the durability in the thrust direction is increased. By reducing the length of the crankshaft as much as possible, the height of the engine has also been kept low.

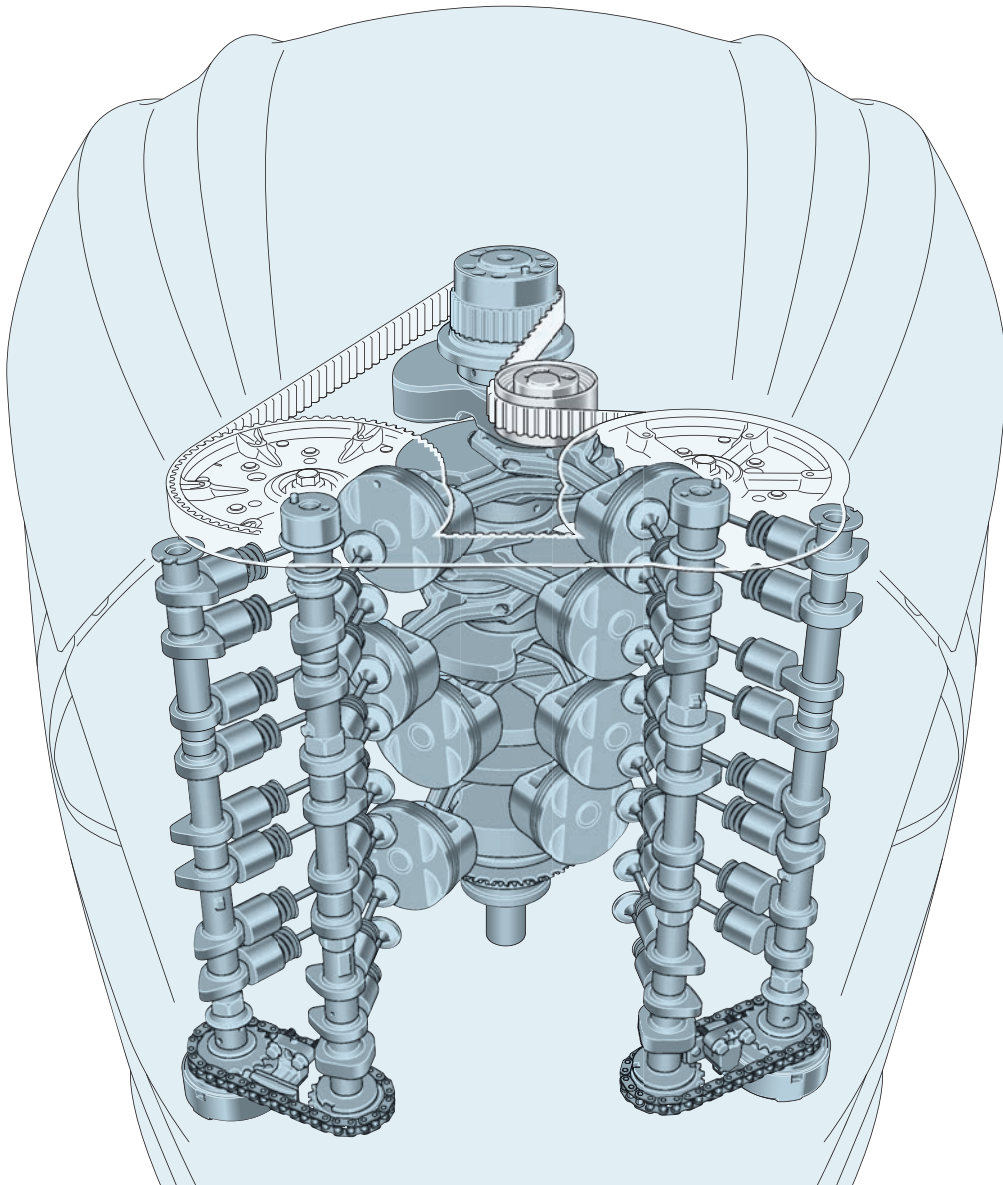
Also, the spline portion that engages the drive shaft can be removed and installed, which reduces the frequency of replacing the crankshaft.



Camshaft

The timing belt is located on the top of the engine and the timing chains and VCT assemblies are located at the bottom of the engine for increased engine reliability. In addition, the overall width of the outboard motor is compact and the distance between outboard motors for multiple engine applications is approximately the same as for previous models.

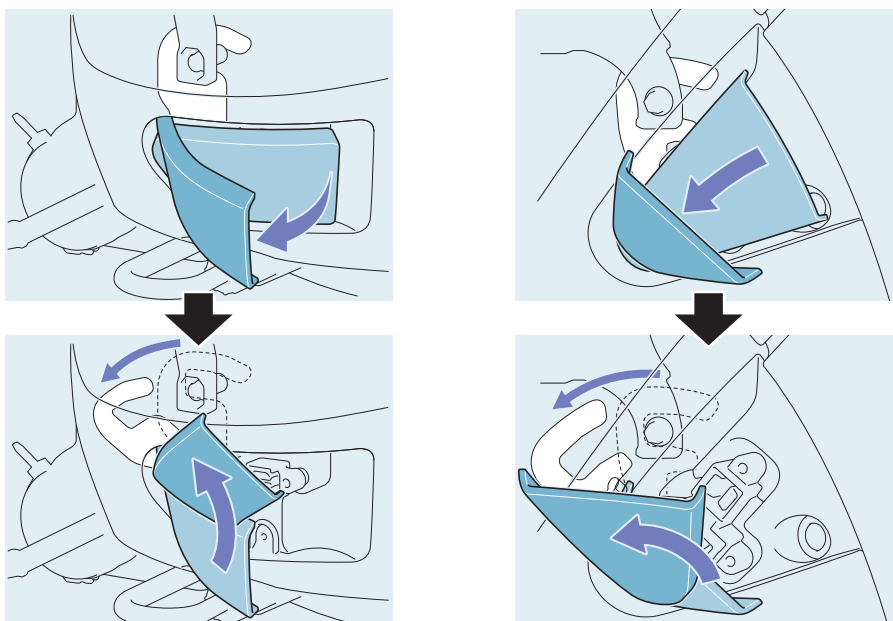
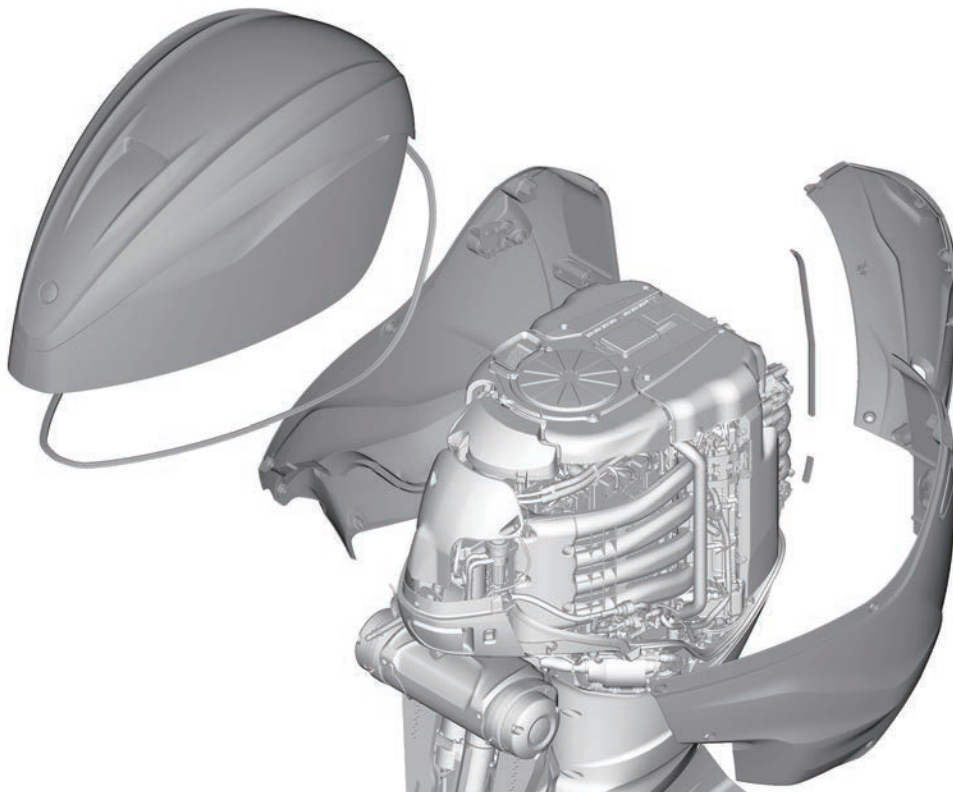
While the engine is running, the VCT assemblies advance or retard the intake camshafts according to the engine speed in order to control the opening and closing timing of the intake valves to improve the intake efficiency.



Cowlings

The cowling lock levers, which were located on the rear of the outboard motor for previous models, have been moved closer to the top of the top cowling and the rear portion of the top cowling is shorter. As a result, it is easier to access the cowling lock levers from the boat and remove and install the top cowling. In addition, the cowling lock levers can be released using a simple 2-step operation. By using a lightweight SMC (sheet molding compound) material, the weight of the cowlings has been reduced by 4.3 kg (9.5 lb) compared to the F350A (F350CC).

The bottom cowling cover and bottom cowlings can also be removed and installed while the boat is docked for improved serviceability. The bottom cowling cover and bottom cowlings use anti-detachment bolts except for 1 location at the front of each bottom cowling.

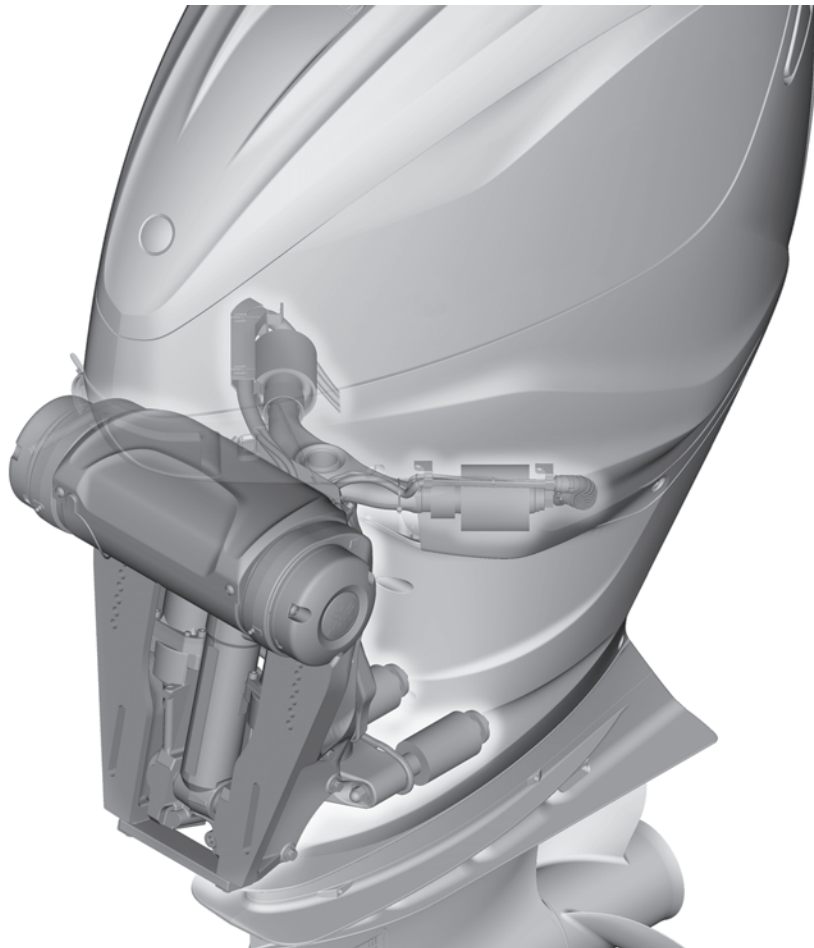


Bracket unit

Outline

The upper mounts use outward-positioned, vibration-isolation upper mounts. The swivel bracket is equipped with the SBW (Steer by Wire) system for easier operation at low to high speeds as well as easier rigging.

The PTT-related parts have also been newly designed for increased durability as well as easier removal and installation of the PTT unit itself.



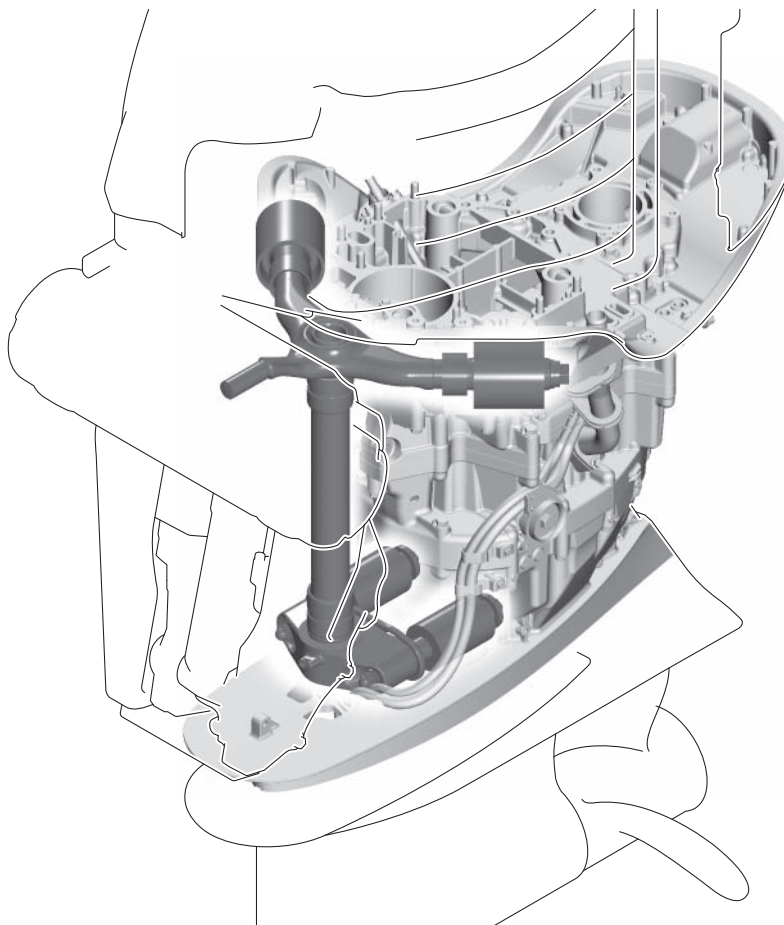
Upper mount

This model is the first Yamaha large outboard motor to use a layout with the vibration-isolation upper mounts positioned on the outside of the upper case.

The installation location of the upper mounts has been changed from being secured inside the exhaust guide to being secured to the left and right sides of the upper case. The upper mounts are positioned at a wider pitch and slightly lower toward the rear of the outboard motor compared to previous models.

As a result, the height of the outboard motor is minimized and the full tilt-up angle is increased. This helps to prevent the lower unit from being submerged when the outboard motor is tilted up while the boat is moored.

The upper mounts are also easier to replace and have a lighter weight.



SBW (Steer by Wire) system

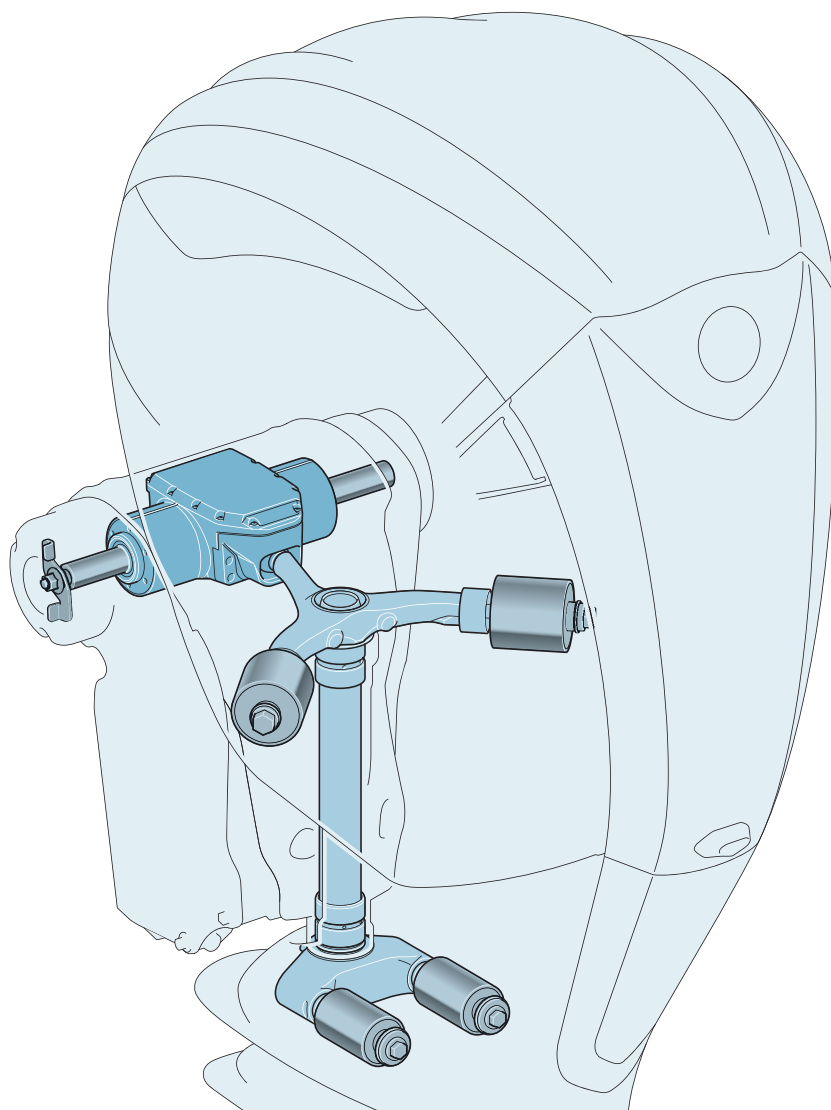
Outline

The steering system has been changed from a mechanical system that was used for previous models to an electronically controlled power-operated steering system. Because the steering system has been designed with a sufficient margin for use with large boats, the system is responsive and provides a stable feeling when steering the boat.

The system is comprised of an integrated unit that is simple and compact. Because the system has an easy-to-use design that can be used just by connecting the wiring, the time required for rigging is reduced and space is used more efficiently.

For multiple engine applications, because the system is always monitoring the positions of the outboard motors, the system controls the outboard motors to ensure that the appropriate distance is maintained between the outboard motors.

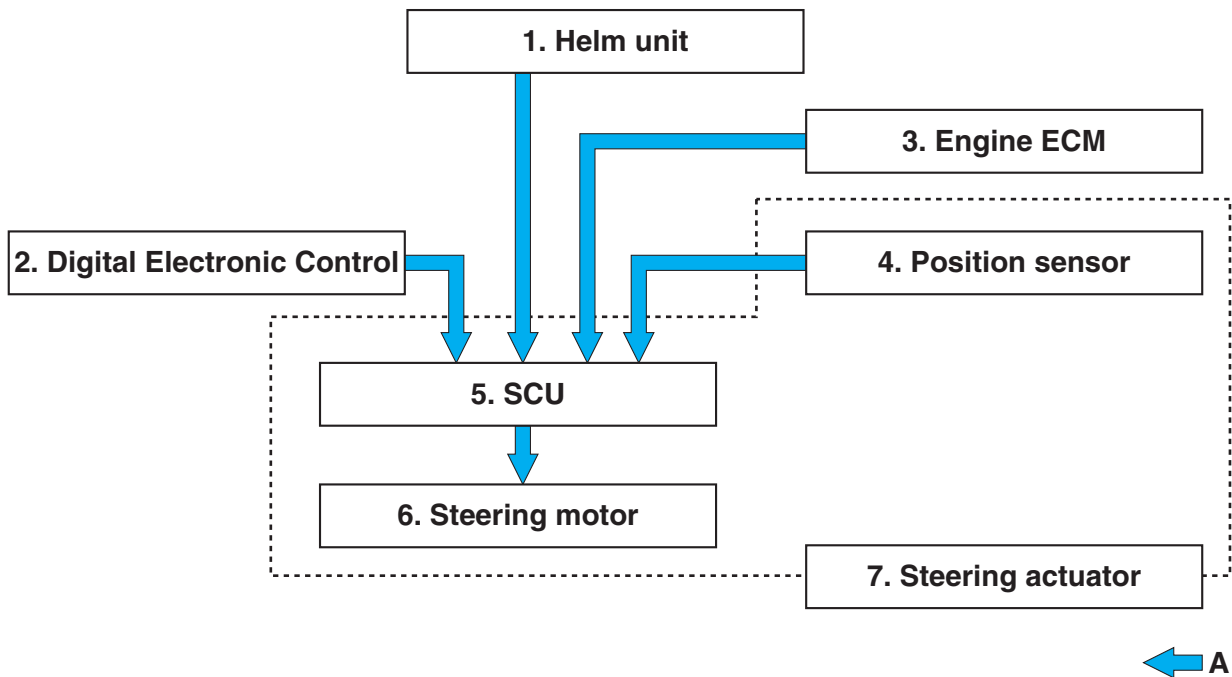
In addition, because the system includes a dual monitoring system, the boat can still be steered using the backup system if a malfunction occurs. Even if a malfunction occurs that prevents the power-operated steering of the boat, the system includes a mechanism for adjusting the steering angle manually.



System diagram

When the signals from the steering wheel and joystick are input into the steering control unit (SCU), the SCU uses that information together with the information from other sensors to calculate the optimal steering control and operates the steering motor to match the intended steering angle of the operator. For multiple engine applications, the system controls the steering angle of each outboard motor so that the boat moves in the intended direction.

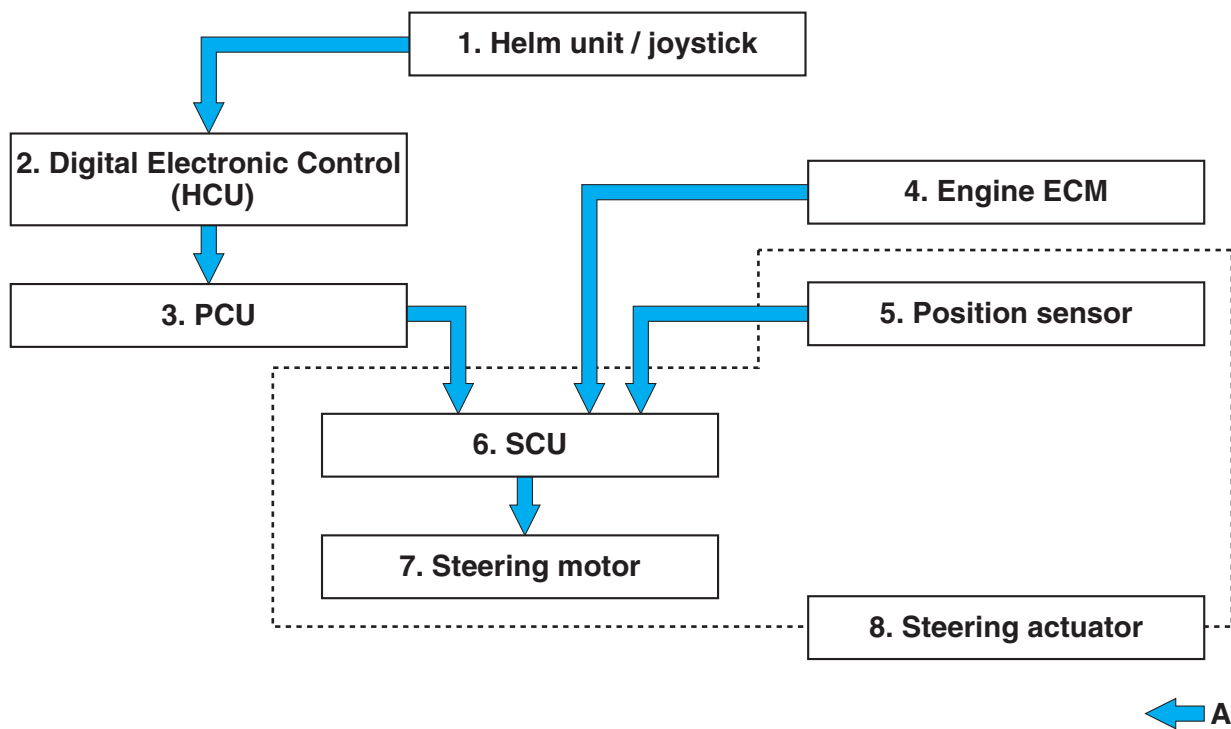
Digital Electronic Control model



1. Helm unit
2. Digital Electronic Control
3. Engine ECM
4. Position sensor
5. SCU
6. Steering motor
7. Steering actuator

A. Electronic signal

Helm Master model

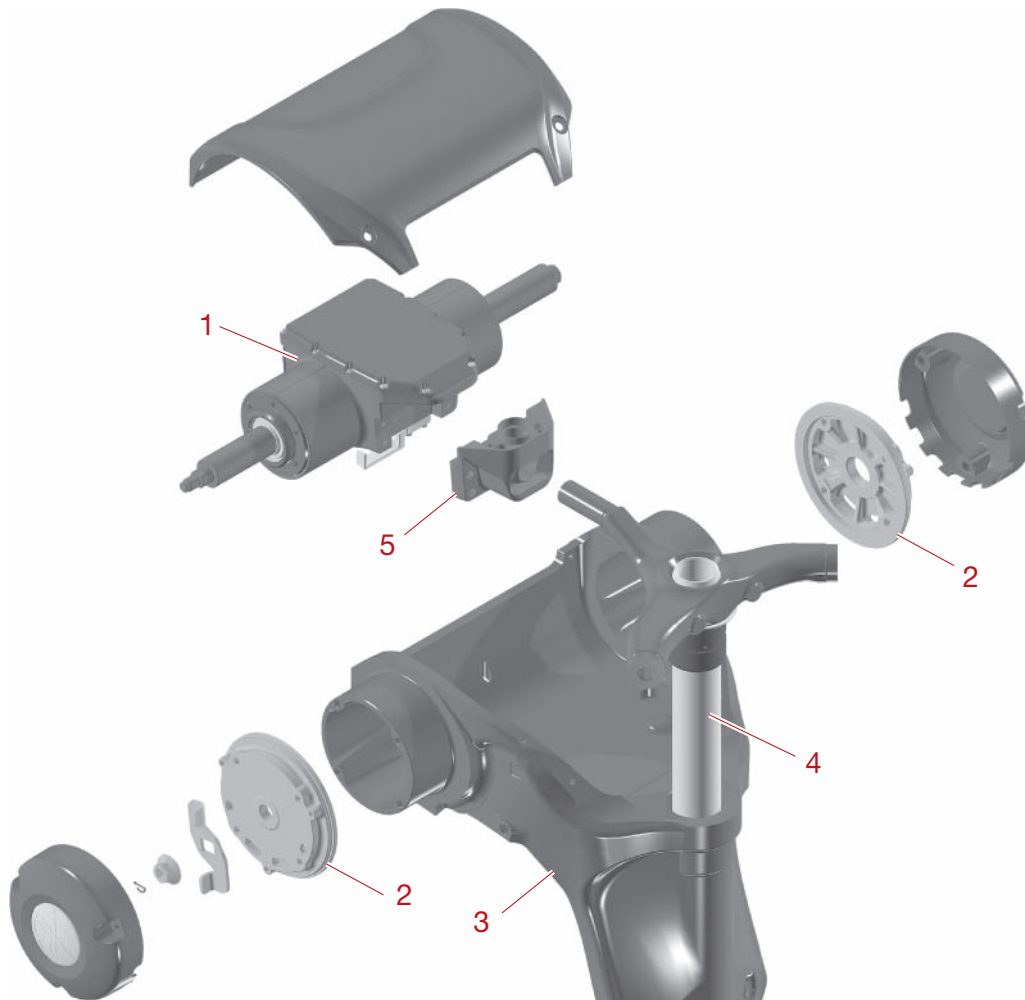


- 1. Helm unit/joystick
- 2. Digital Electronic Control (HCU)
- 3. PCU
- 4. Engine ECM
- 5. Position sensor
- 6. SCU
- 7. Steering motor
- 8. Steering actuator

A. Electronic signal

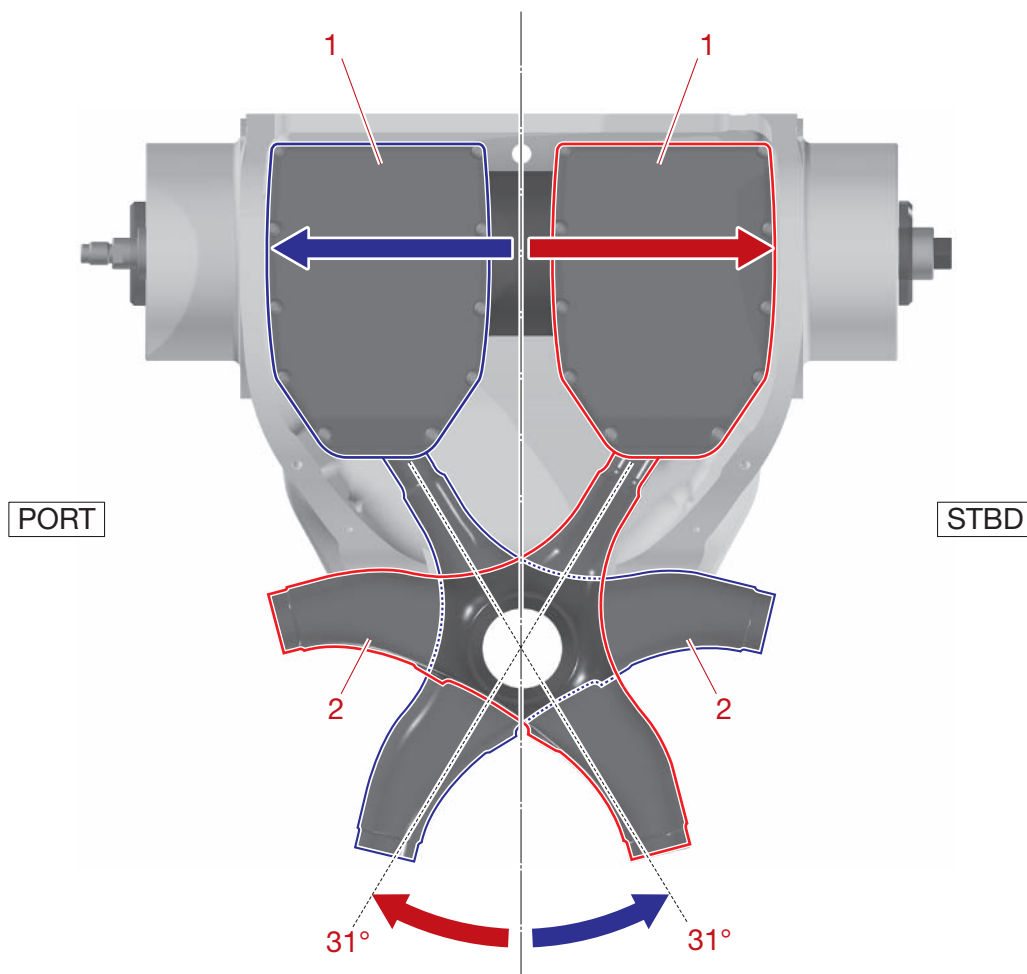
Structure

The steering actuator “1” is an integrated unit with a built-in steering control unit (SCU) and a built-in steering motor and cannot be disassembled. The steering motor, which has an integrated pipe, is located inside the actuator on one end and a shaft runs through the center of that pipe. The pipe is supported by a bearing on the other end. When the motor is supplied with power, the pipe turns inside the actuator. The inside of the pipe and the outside of the shaft have threads, which are engaged using planetary gears. The brackets “2” are installed to both ends of the shaft, and the steering actuator is suspended inside the swivel bracket “3”. In addition, the rear of the actuator is connected to the steering arm “4” through the ball joint “5”.



Operation

When power is supplied to the steering motor inside the steering actuator "1", the pipe integrated with the motor turns. The rotational speed of the pipe is reduced as it is transmitted through the planetary gears to the shaft in the center of the pipe. Because both ends of the shaft are secured to the swivel bracket, the steering actuator moves 2 mm (0.08 in), which is the internal thread pitch distance, in a straight line in the shaft direction for each turn of the pipe. The movement direction of the actuator changes according to the turning direction of the motor. When the steering actuator moves toward the starboard side, the outboard motor is steered to the port side and when the steering actuator moves toward the port side, the outboard motor is steered to the starboard side. Because the rear of the actuator is connected to the steering arm "2", the linear movement of the actuator is converted into turning movement (with the steering arm shaft as the axis) in order to steer the outboard motor.



Outboard motor manual steering method

If the SBW (Steer by Wire) system does not operate due to a malfunction, the outboard motor can be steered manually.

Usually, the pipe inside the steering actuator moves as it is turned by the motor force, but when the outboard motor is steered manually, the shaft is turned to move the pipe.

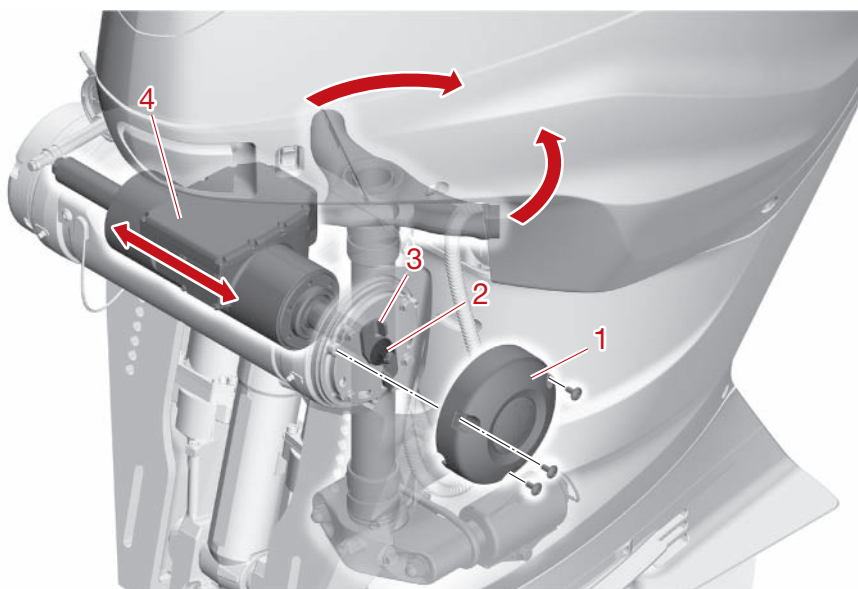
[Steering the outboard motor manually]

1. Remove the clamp bracket cover (PORT) "1" by removing the bolts.
2. Loosen the nut "2" until it contacts the cotter pin.
3. Turn the lever "3" that is installed to the shaft.

TIP:

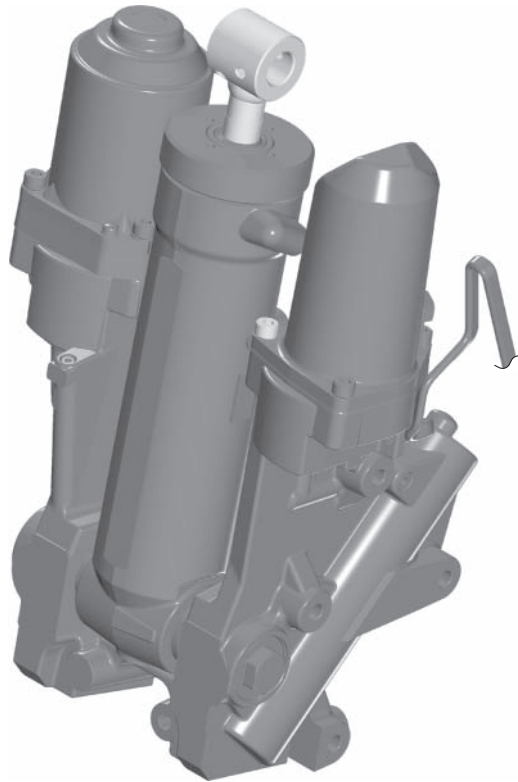
When the lever is turned clockwise, the steering actuator "4" moves toward the port side and the outboard motor is steered to the starboard side.

4. When the outboard motor is positioned at the desired steering angle, tighten the nut "2".



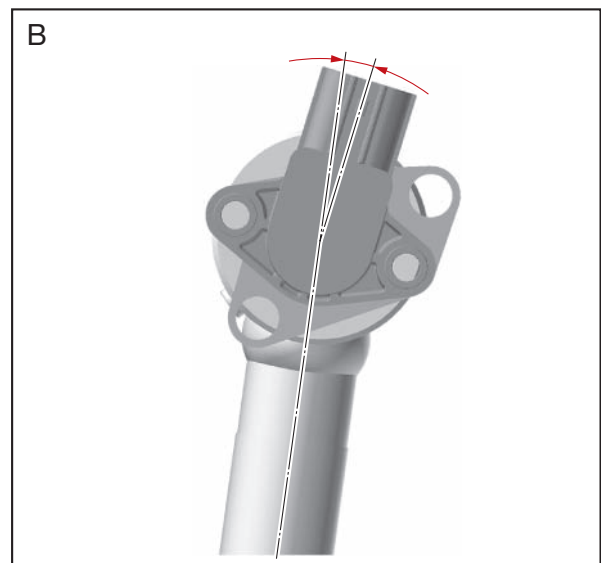
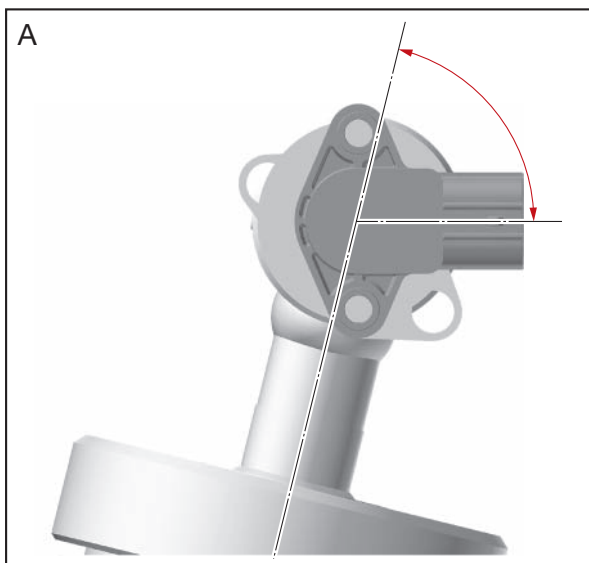
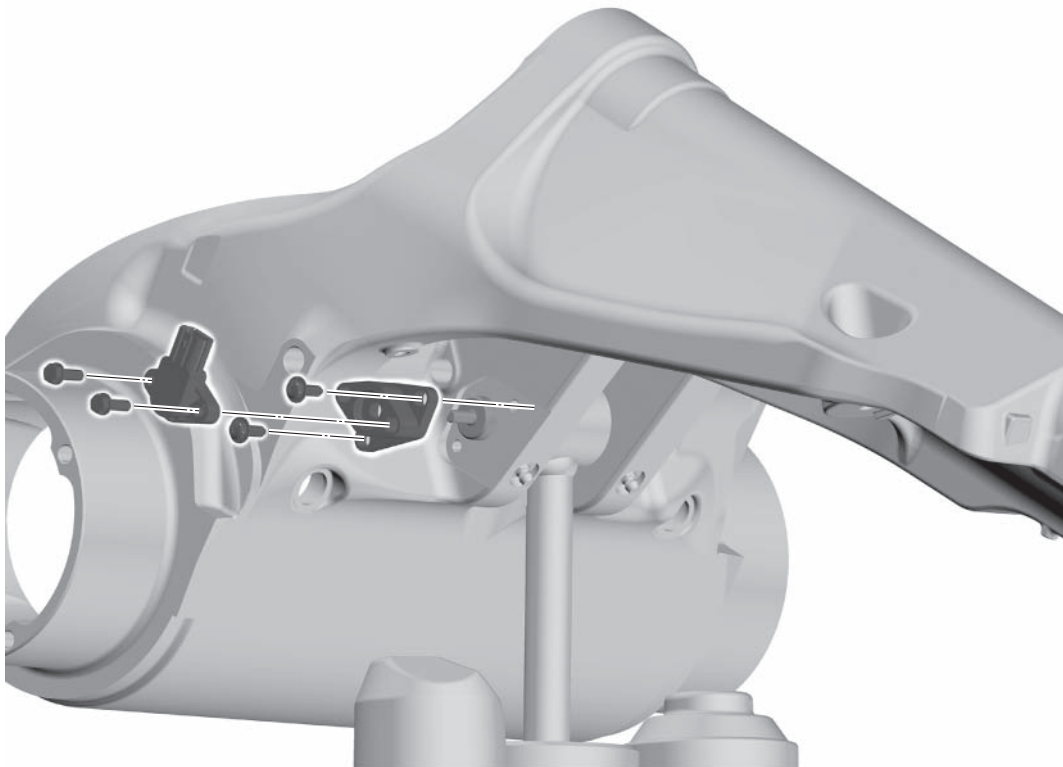
PTT unit

The material of the PTT motor has been changed to plastic to increase corrosion resistance. In addition, the PTT relay is a built-in component of the electrical management unit and is controlled by the microcomputer. As a result, the operation of the PTT motor can be controlled according to the trim and tilt angles. Malfunctions can also be determined easily and durability is increased.



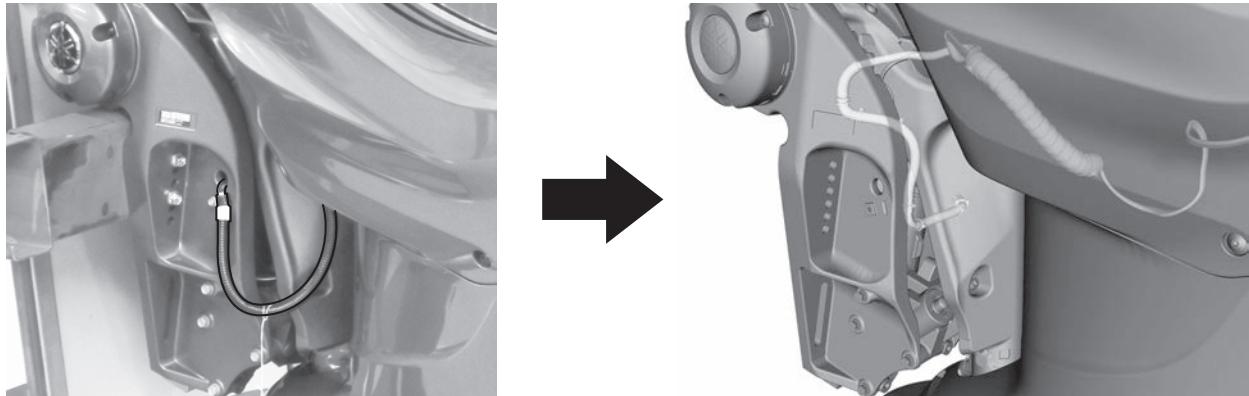
PTT sensor

This model is equipped with a PTT sensor that detects the trim and tilt angle of the outboard throughout the full range of movement from fully tilted down to fully tilted up. The end of the pin on the tilt rod fits into the PTT sensor that is installed to the swivel bracket. The pin is secured in the tilt rod and when the swivel bracket moves vertically, the relative angle between the pin and the sensor changes. This change is used to detect the trim and tilt angles of the outboard motor. While the outboard motor is tilted up from the fully tilted down position “A”, the relative angle becomes smaller. When the outboard motor is in the fully tilted up position “B”, the PTT sensor is almost parallel to the tilt rod. In addition, because the sensor is completely waterproof due to its mounting structure, durability is increased.



PTT lead

PTT lead routing has been changed to run inside the clamp bracket, compared to the routing on the outside of the clamp bracket in the previous models. The external appearance around the clamp bracket has been refined further to provide additional product value.



PTT TotalTilt™

This outboard motor is equipped with an automatic PTT tilt function. When this function is activated, you can tilt the outboard motor up/down automatically by pressing the switch twice quickly instead of keeping the PTT switch pushed.

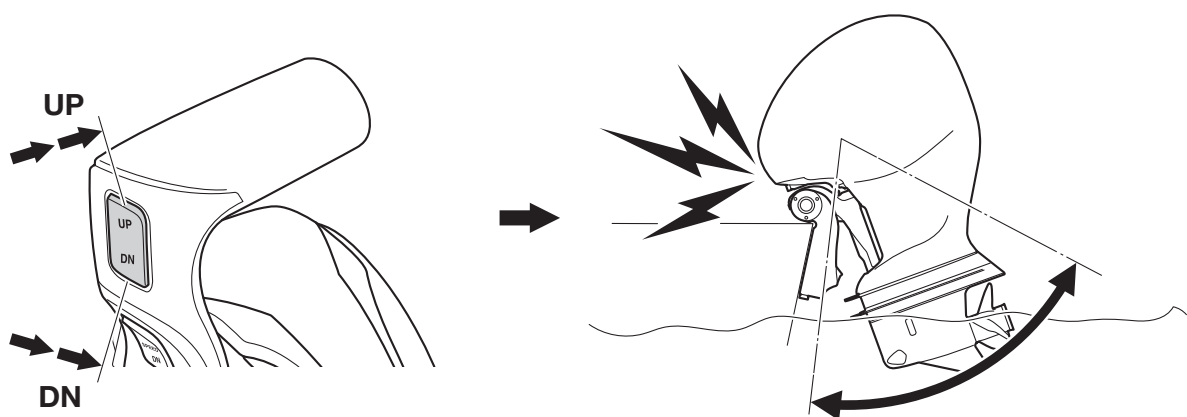
The PTT TotalTilt™ function is available only when the engine is stopped. To prevent danger, the PTT buzzer (power unit part) sounds to warn to the surrounding when the PTT TotalTilt™ function is operating.

When tilting up, the outboard motor stops at the set limiter position.

This function is deactivated by default. It can be activated or deactivated by changing the setting.

TIP:

The PTT switch can be used not only on the remote control lever side, but also on the bottom cowling side.

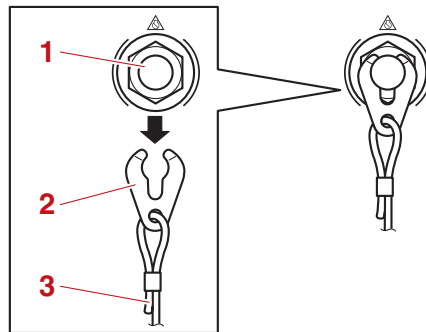


Activating and deactivating the PTT TotalTilt™ function

⚠ WARNING

Make sure that all people are clear of the outboard motor when tilting the outboard motor up and down. Body parts can be crushed between the outboard motor and the clamp bracket when the outboard motor is trimmed or tilted.

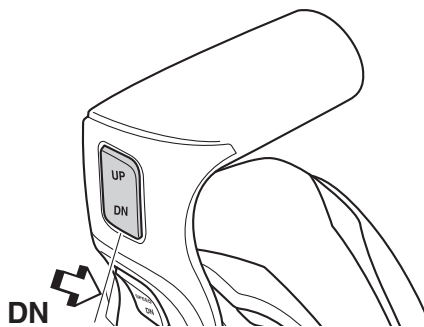
1. Fully tilt the outboard motor down.
2. Remove the clip from the engine shut-off switch.



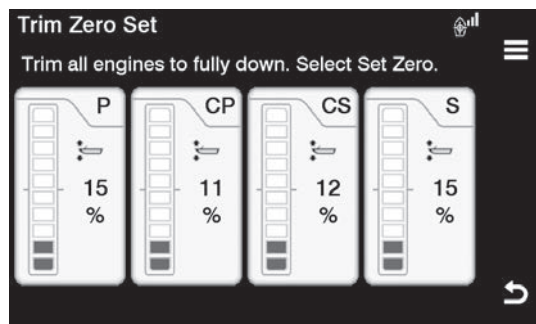
1. Engine shut-off switch
 2. Clip
 3. Engine shut-off cord (lanyard)
3. Hold the “DN” (down) side of the PTT switch pushed.

TIP:

The PTT switch can be used not only on the remote control lever side, but also on the bottom cowling side.



4. Operate the trim zero set while keeping the “DN” (down) side of the PTT switch pushed.



TIP:

- For how to operate the trim zero set, see the owner's manual included with the gauge.
- When the PTT TotalTilt™ function is activated, the PTT buzzer will sound once.
- When the PTT TotalTilt™ function is deactivated, the PTT buzzer will sound twice.

Automatic tilt-up**⚠ WARNING**

Make sure that all people are clear of the outboard motor when tilting the outboard motor up and down. Body parts can be crushed between the outboard motor and the clamp bracket when the outboard motor is trimmed or tilted.

1. Make sure that the PTT TotalTilt™ function is activated.
2. Push the "UP" (up) side of the PTT switch twice quickly.

TIP:

- This operation causes the outboard motor to automatically tilt up to the fully tilted-up position and stop.
- If the tilt limiter is installed, the auto tilt up operation causes the outboard motor to automatically tilt up to the angle set by the tilt limiter and stop.
- The PTT buzzer sounds before the automatic operation begins, and sounds intermittently during automatic tilting.
- Pushing the PTT switch briefly during the automatic operation, stops the operation.

Automatic tilt-down**⚠ WARNING**

Make sure that all people are clear of the outboard motor when tilting the outboard motor up and down. Body parts can be crushed between the outboard motor and the clamp bracket when the outboard motor is trimmed or tilted.

1. Make sure that the PTT TotalTilt™ function is activated.
2. Push the "DN" (down) side of the PTT switch twice quickly.

TIP:

- This function causes the outboard motor to automatically tilt down to the fully trimmed-out position and stop.
- The PTT buzzer sounds before the automatic operation begins, and sounds intermittently during automatic tilting.
- Pushing the PTT switch briefly during the automatic operation, stops the operation.

If automatic tilting does not operate

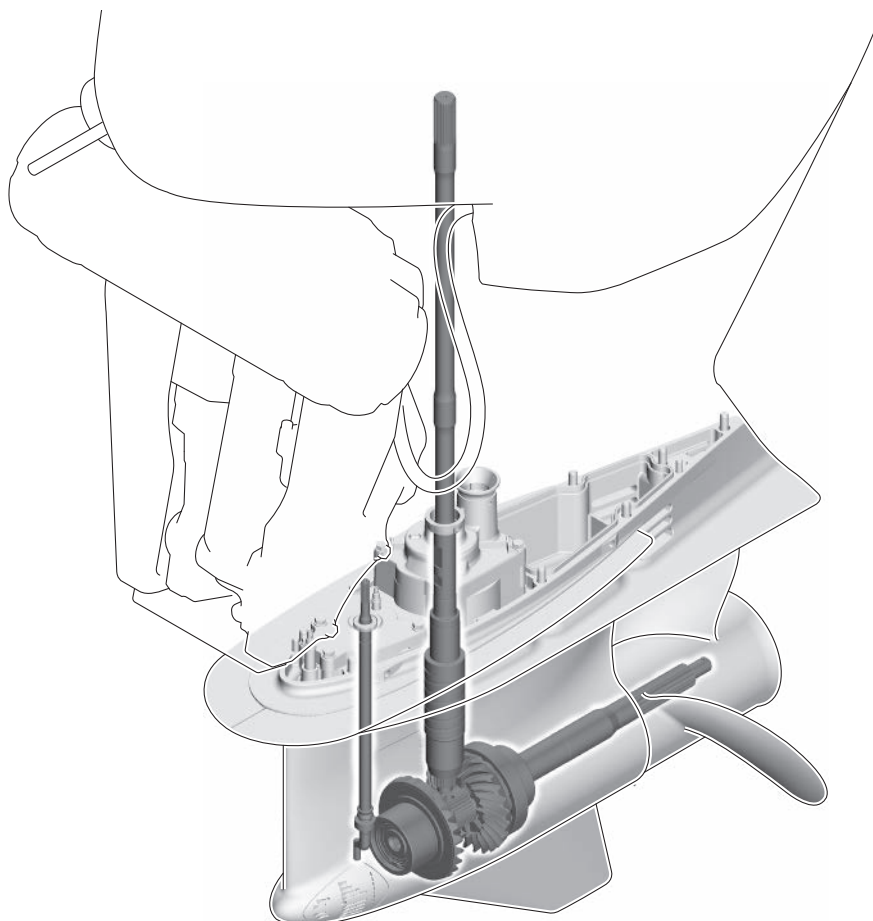
In the following situations, the PTT TotalTilt™ function is deactivated and does not operate. If a malfunction is suspected, check the PTT function.

- The PTT unit is stuck, or foreign matter is preventing the tilting operation. See "PTT unit" (9-45), "PTT motor" (9-52), "PTT gear pump" (9-57), "PTT cylinder" (9-62).
- The PTT buzzer is malfunctioning. See "Checking the PTT buzzer" (5-53).
- The tilt sensor is malfunctioning. See "Checking the PTT sensor" (5-53).

Lower unit

Outline

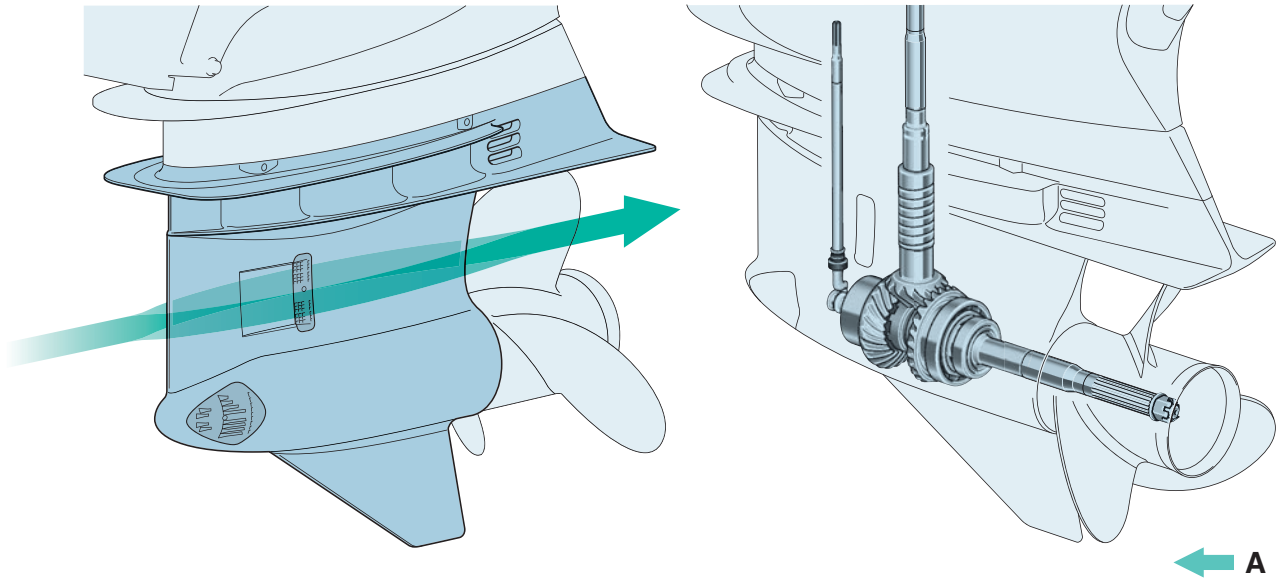
The lower case has been newly designed to increase the size of the case itself and increase the maximum speed and stability. The oil passages inside the case have also been revised and stainless steel parts with high strength and high corrosion resistance are used. In addition, because the lower unit is equipped with hoses for changing the gear oil, the gear oil can be changed even when the outboard motor is mounted to the boat for improved serviceability when the boat is docked.



Lower case

The lower case for this model has a new shape with low resistance. The maximum speed and stability are increased due to the newly shaped strut and skeg. In addition, by increasing the length of the anti-cavitation plate, the anti-cavitation performance of the propeller is increased.

Because the diameter of the torpedo is increased, there is sufficient space for the proper gear size inside the lower case.



A. Water flow

Gear oil changing method

There are 2 methods that can be used for changing the gear oil of this model. One method, which is similar to the method for previous models, uses the oil level plug, gear oil drain bolt, and oil filler bolt of the lower case, and one method uses a pump and the hoses on the side of the engine.

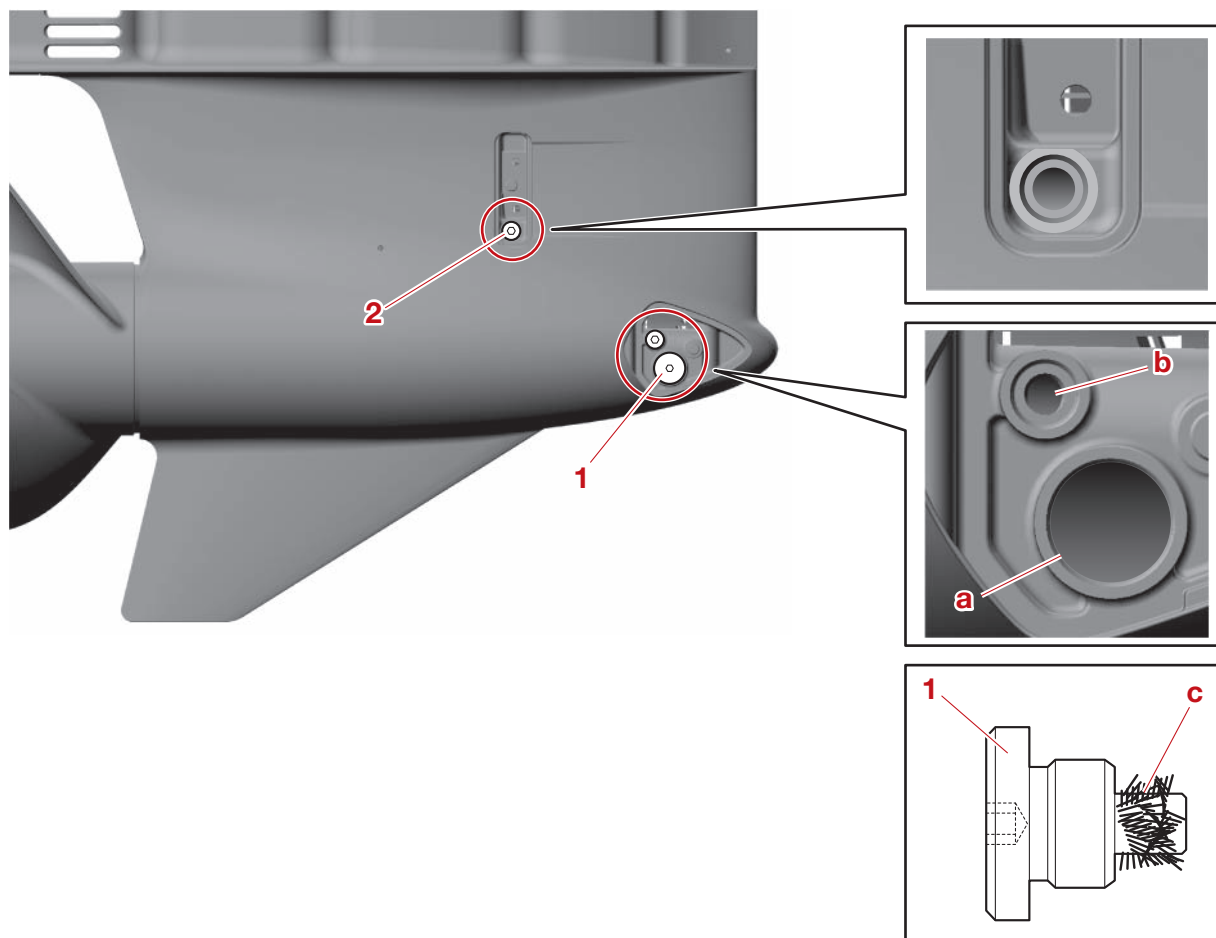
Changing the gear oil using the lower case

Although previous models used 1 bolt hole (M8) to drain and fill the lower unit with gear oil, this model is equipped with 2 holes: 1 hole (M18) "a" for draining the gear oil and 1 hole (M8) "b" for filling the lower unit with gear oil. Because the hole for draining the gear oil is larger, the time required to drain the gear oil is reduced and serviceability is improved.

Because the drain plug "1" is larger, the size of the magnet is also larger. A new type of magnet is used. Because the direction of the magnetic force of the magnet is different from that of previous models, a large amount of metal particles "c" become attached to the sides of this new type of magnet. As a result, this magnet is able to collect metal particles using a larger area than the type of magnet used for previous models.

The lower unit is filled with gear oil through the oil filler hole. Because the hole has the same diameter as the hole for previous models, the same gear oil pump can be connected to the hole. Because the oil surface level is lower than that for previous models, the oil level plug "2" was moved to a lower location compared to previous models.

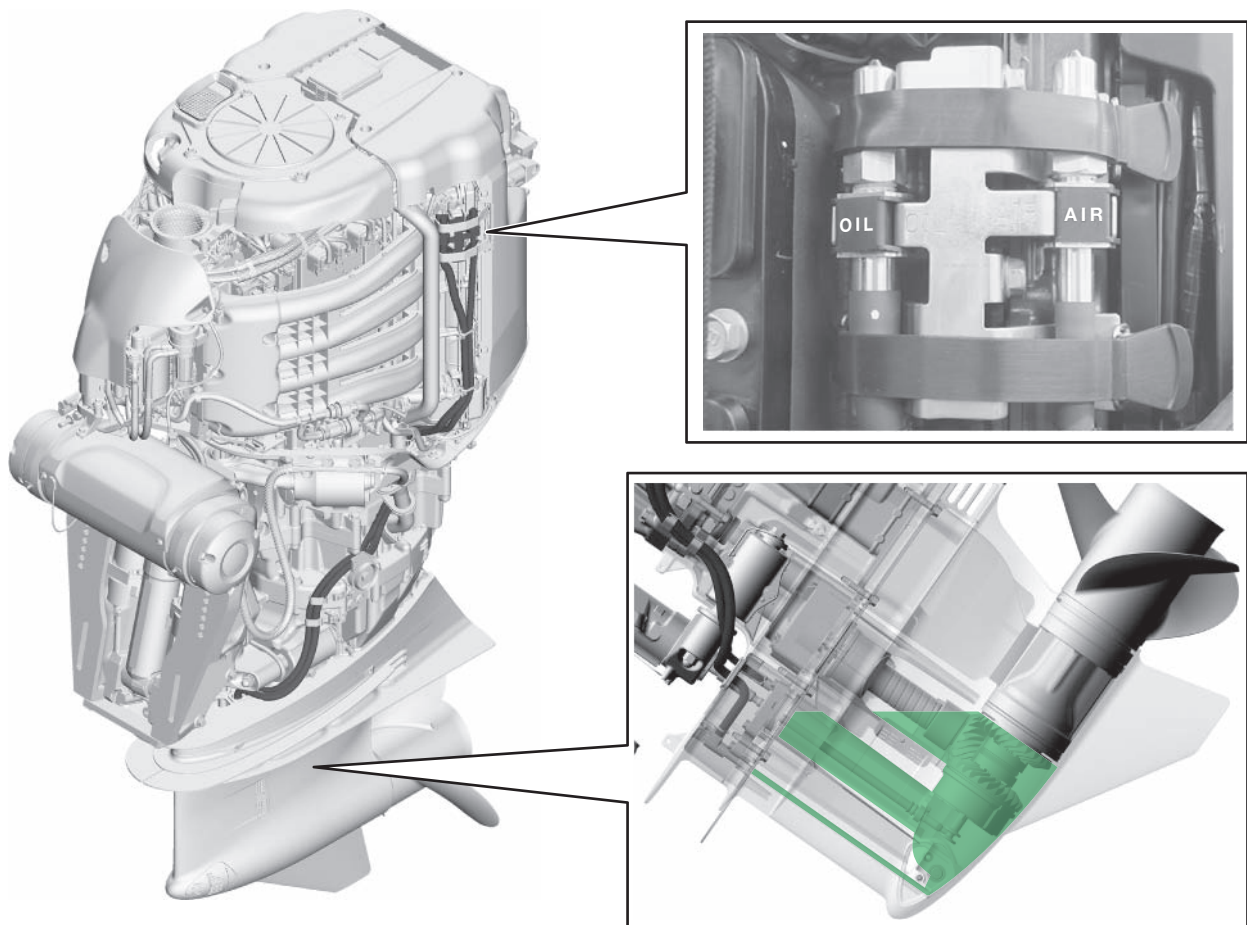
For the changing procedure, see "Changing the gear oil by removing the drain screw" (10-17).



Changing the gear oil using the hoses on the side of the engine

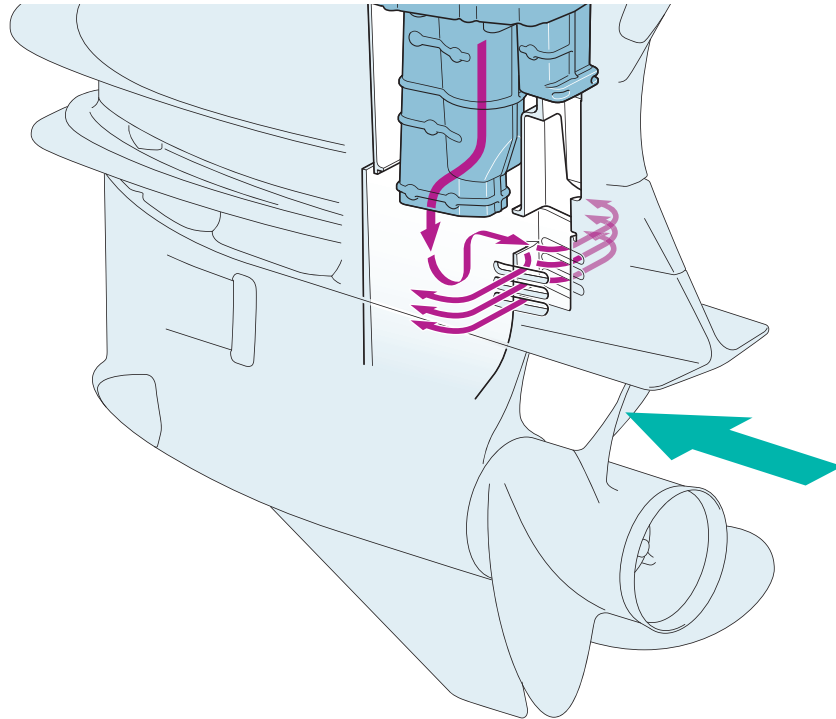
The gear oil can be changed using the hoses that are routed from the lower unit to the port side of the engine without removing the boat from the water, such as when the boat is docked. The “AIR” hose is connected to the upper portion of the lower case and the “OIL” hose is connected to the end of the torpedo from the front portion of the lower case. When the outboard motor is tilted up, the gear oil that collects in the end of the torpedo is extracted from this hose and the lower unit is filled with gear oil from this hose. When the lower unit is filled with gear oil while the outboard motor is tilted up 60° or more, the lower unit will be filled with gear oil up to the specified level. Therefore, if the outboard motor cannot be tilted up 60° or more, fill the lower unit with the specified amount of gear oil while being careful not to overfill the lower unit.

For the changing procedure, see “Changing the gear oil using an oil changer” (10-15).



Reverse thrust

The outboard motor has a structure that discharges the exhaust gas from above the anti-cavitation plate when the remote control lever is in the R position and the engine speed is 2000 r/min or less. As a result, propeller cavitation can be prevented when the outboard motor is operating in reverse. In addition, thrust when operating in reverse is increased, stopping performance is increased, and vibration and noise are lower. For boats that are equipped with Helm Master, performance when moving sideways is increased.

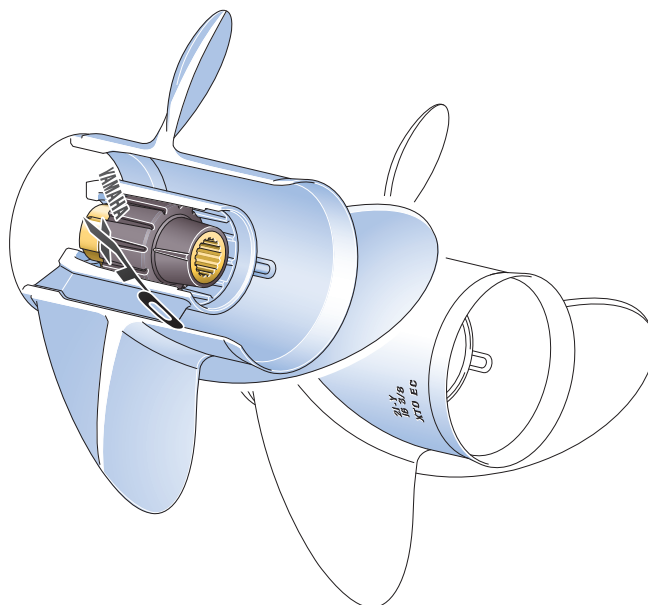


- A. Exhaust gas flow
- B. Water flow

Propeller (XTO-EC series)

New XTO-EC series is available in addition to the existing XTO-OS series compatible with large horsepower models.

XTO-EC series are high performance 3-blade stainless steel propellers having excellent anti-ventilation performance compared to the OS series. This allows more comfortable boat operation in the rough sea and on the heavily loaded boat.



Engine ECM

PTT protection control

PTT protection control system prevents damage to PTT unit, bracket and other related components when the engine speed becomes excessively high while the outboard motor is raised higher than its trim range. The engine speed is limited to the given rpm or below by the system if the PTT sensor output voltage exceeds the specification value.

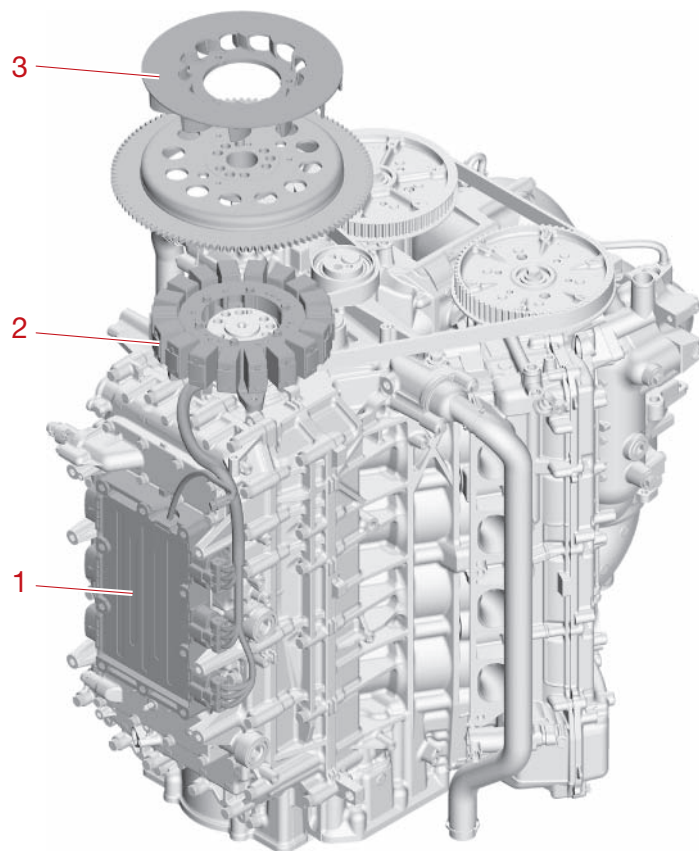
Model		PTT sensor output voltage (or higher)	RPM limitation
F450AVT, XF450SA	6KN	2.095 V	1551 r/min
FL450AVT	6KP		
F400AST, XF400SA	6LB		
FL400AST	6LC		

Electrical system

Charging system (F400A/FL400A/XF400)

This model is equipped with a 3-phase AC magneto type generator. In addition, because the cooling efficiency of the rectifier/regulator “1” is increased and the temperature increase is controlled by the fan “3” on top of the stator assembly “2”, the 400-horsepower models produce of up to 88 net amps per engine at 1500 r/min.

A circuit for detecting the battery voltage has been added to the rectifier/regulator. Because the charging of the house battery circuit is cut off when an instantaneous voltage drop occurs when the SBW (Steer by Wire) system or PTT unit is operated, stable power can be supplied to the electrical components of the engine. As a result, this model can use the same batteries as those of previous models. (This function operates when the boat is equipped with an engine battery and a house battery, and the isolator lead is connected.)



Charging system (F450A/FL450A/XF450)

Outline

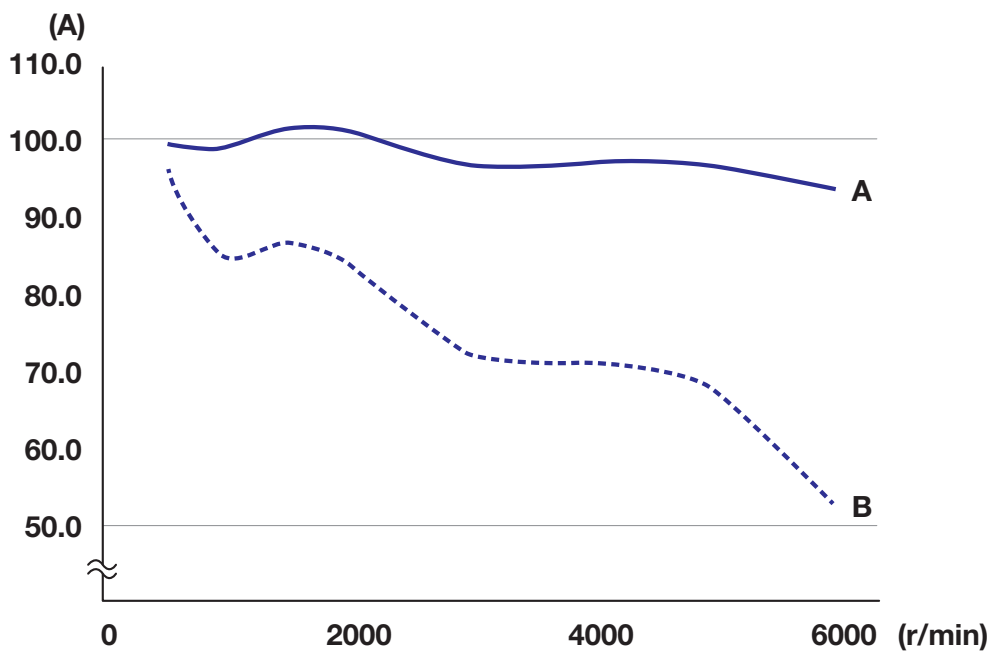
To help meet the extreme electrical demands of today’s larger boats, the 450-horsepower models now feature a new three-phase, simultaneous charging system that delivers more net amps and at lower r/min, where it’s needed most.

Using Phase Angle Control (PAC), which adjusts the intensity of the stator’s magnetic field, the 450-horsepower models produce of up to 96 net amps per engine at idle speed. Phase Angle Control (PAC) uses crank position sensor signals and built-in semi-conductors to control the magnetic field within the stator. This, paired with greater magnetism of the rotor, allows for increased output, especially at very low r/min.

Semi-conductors are now used in place of diodes to control output to the main and secondary charging leads while prioritizing charging of the starting battery(ies).

The 450-horsepower models provides more power for today’s popular on-board, high-demand devices like gyro stabilizers, air conditioning, sound systems, and more, all while keeping starting batteries constantly charged.

Generator output and charging performance



— A
 - - - B

A. Generator output
 B. Charge

Simultaneous charging

Traditionally outboard engines use a dedicated isolator lead to ensure that the start and house batteries are separated unless manually paralleled by the captain in an emergency. This allowed simultaneous charging of both the start and house batteries.

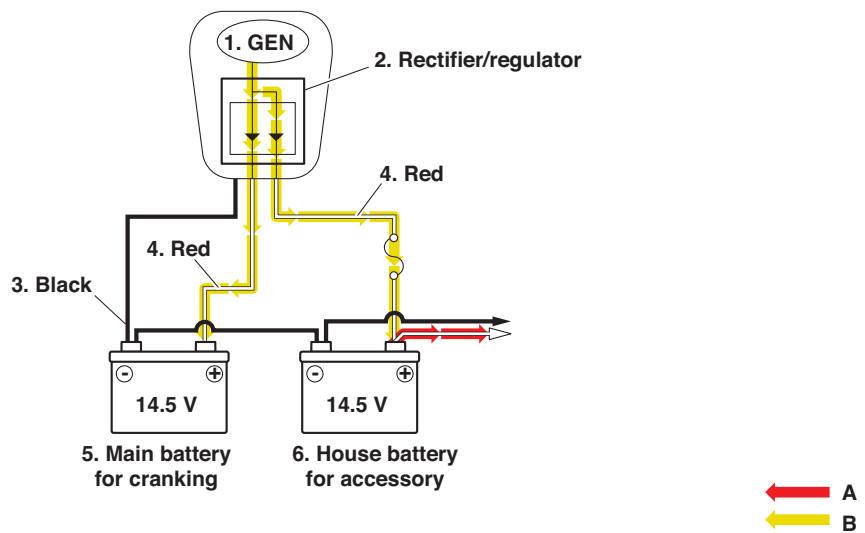
As boat-side electrical demand grew, boat side systems such as voltage sensing relays (VSR's) and diode-based isolator systems appeared.

The 450-horsepower models incorporate these modern systems while offering a significant increase in charging performance.

During periods of high consumption of the house battery, the 450-horsepower models new rectifier/regulator can supplement its isolator output by sourcing current from the starting battery.

If the starting battery voltage drops below 13.0 V, the system will turn off the isolator output and apply full charging current to the starting battery. Once the starting battery voltage reaches 14.0 V the isolator output will be switched back on.

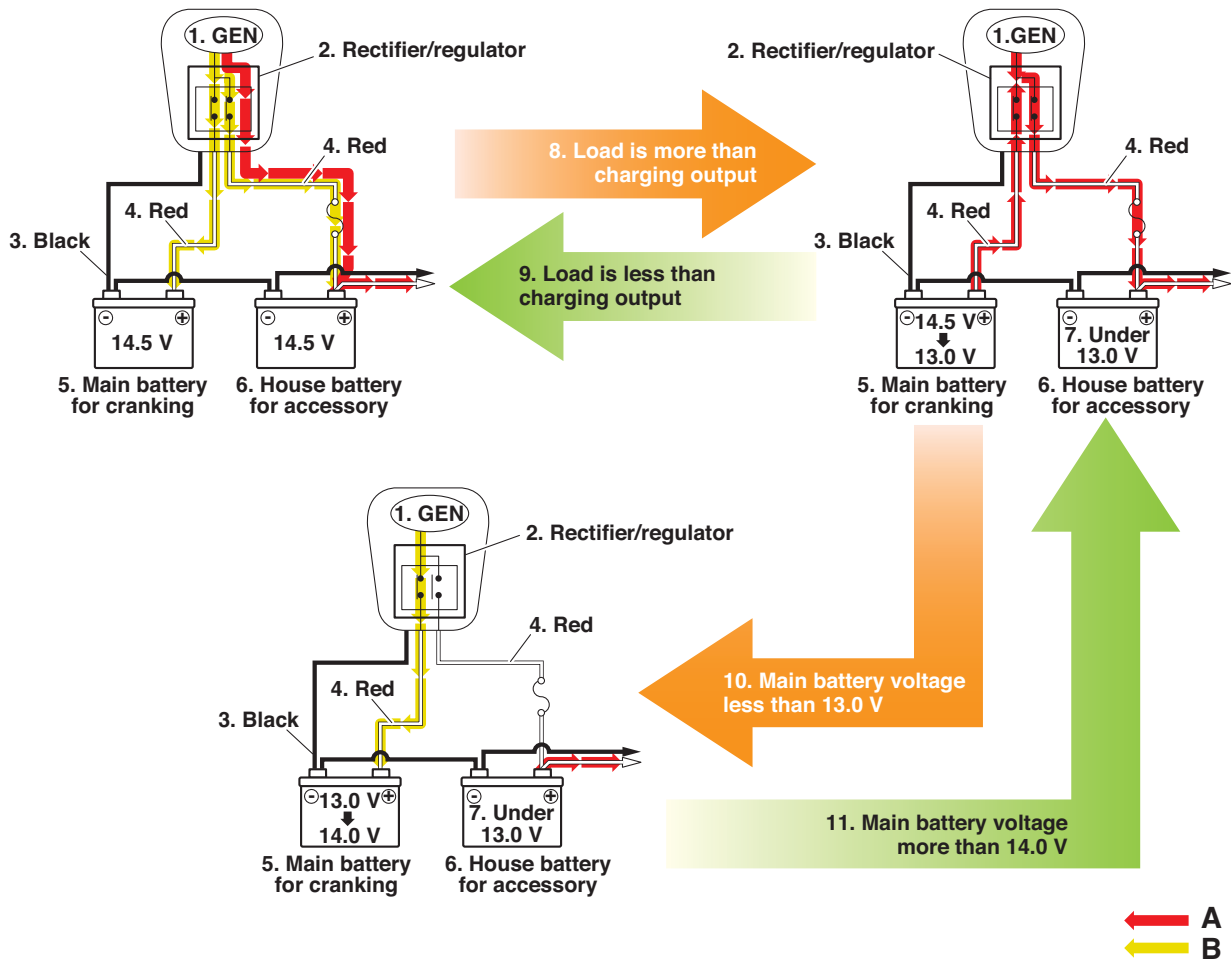
Isolator system (conventional)



- 1. GEN
- 2. Rectifier/regulator
- 3. Black
- 4. Red
- 5. Main battery for cranking
- 6. House battery for accessory

- A. Discharging current
- B. Charging current

Simultaneous charging system

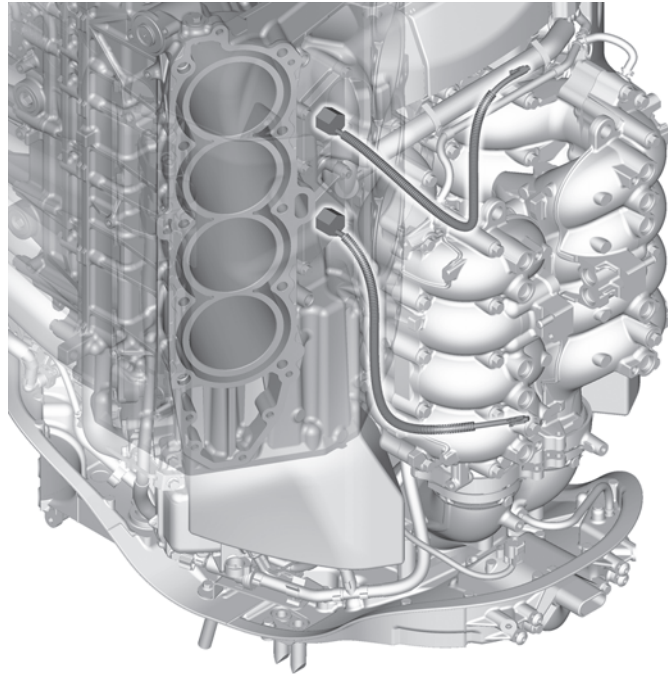


1. GEN
2. Rectifier/regulator
3. Black
4. Red
5. Main battery for cranking
6. House battery for accessory
7. Under 13.0 V
8. Load is more than charging output
9. Load is less than charging output
10. Main battery voltage less than 13.0 V
11. Main battery voltage more than 14.0 V

- A. Discharging current
- B. Charging current

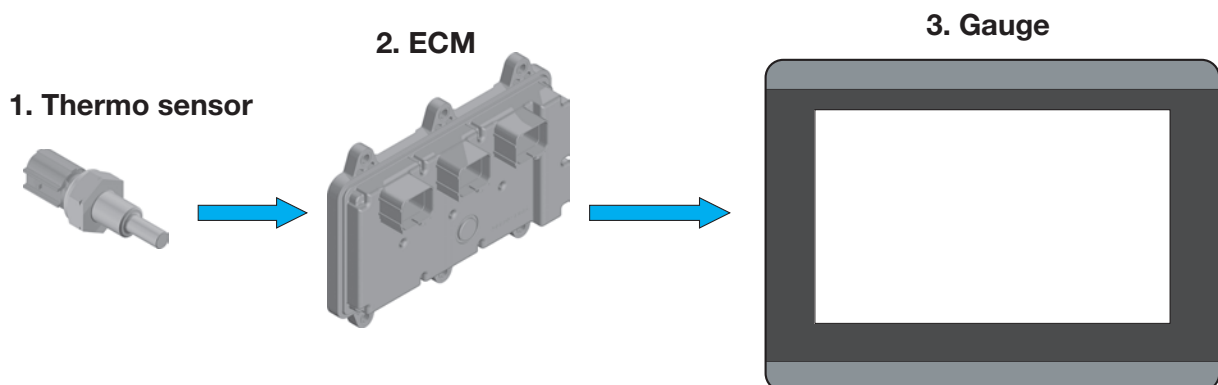
Knocking detection

Although previous models were equipped with 1 knock sensor, the number of sensors for this model was increased to 2 knock sensors. Because the sensitivity for detecting knocking is increased, the minimum amount of fuel within the range that does not produce knocking can be injected to generate the maximum output.



Overheat detection

Although previous models detected overheating using the engine temperature and thermo switch, this model detects overheating using the thermo sensor. As a result, the warning can be activated at an early stage.



- 1. Thermo sensor
- 2. ECM
- 3. Gauge

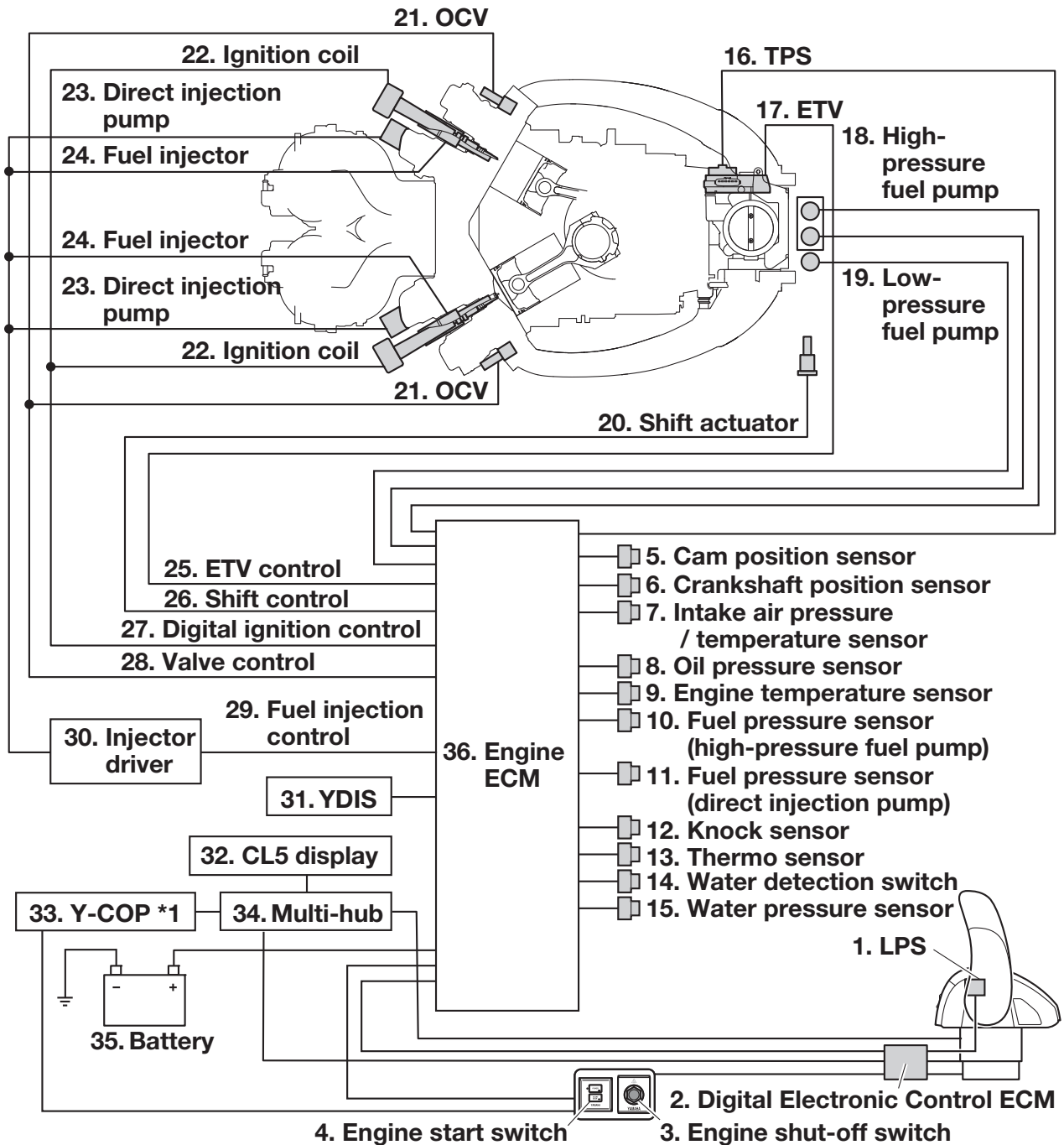
Electronic control system

This model uses an electronic direct injection control, digital ignition control, Digital Electronic Control, electronic shift control, ETV control, VCT control, knock control, over-revolution control, alert control, and fail-safe control.

The engine ECM performs these controls based on data received from each sensor and switch.

The engine ECM is equipped with a self-diagnosis function. This function can be used to check trouble codes on the YDIS.

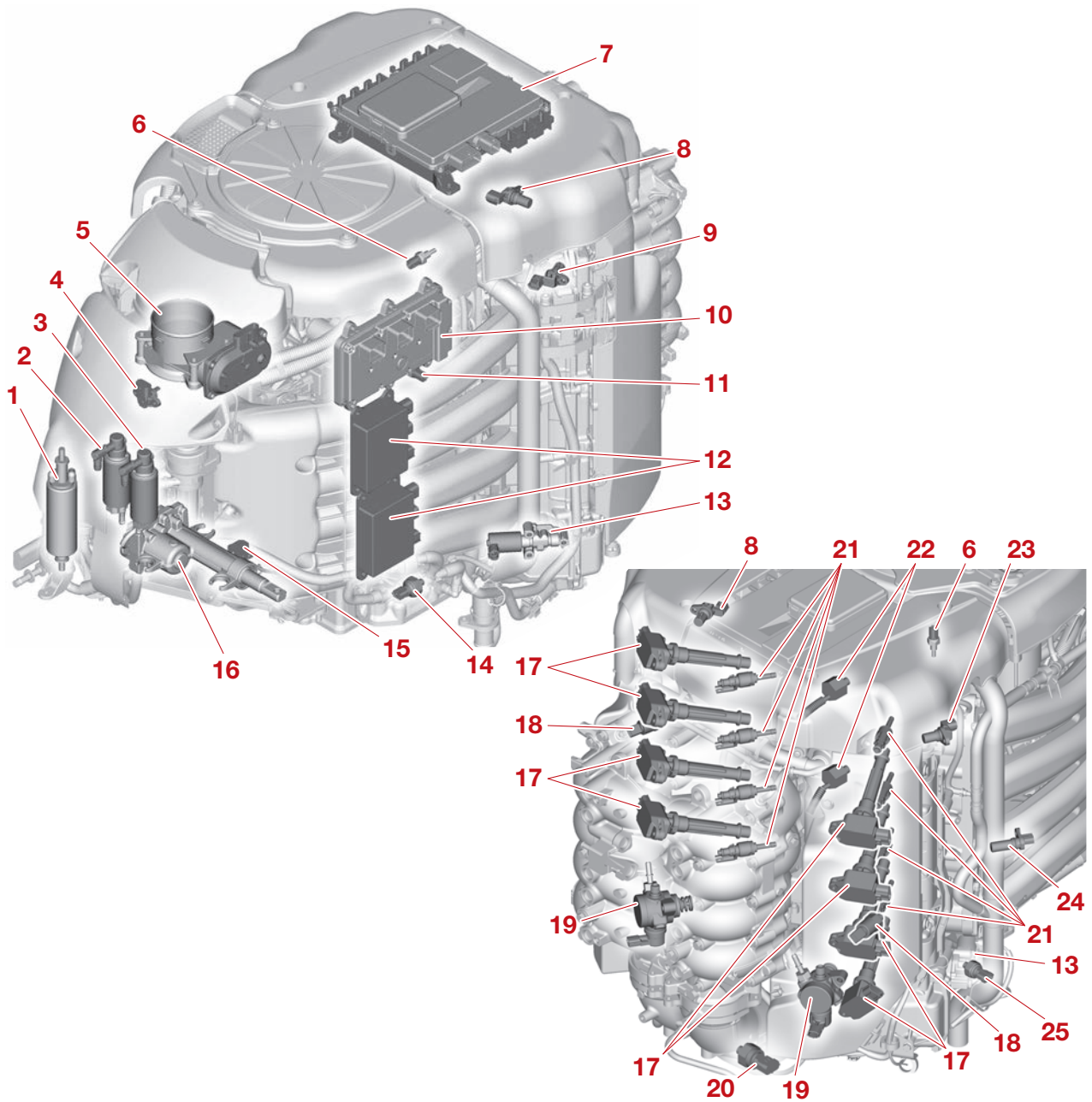
It is also equipped with Y-COP as an anti-theft measure (optional).



1. LPS
2. Digital Electronic Control ECM
3. Engine shut-off switch
4. Engine start switch
5. Cam position sensor
6. Crankshaft position sensor
7. Intake air pressure/temperature sensor
8. Oil pressure sensor
9. Engine temperature sensor
10. Fuel pressure sensor (high-pressure fuel pump)
11. Fuel pressure sensor (direct injection pump)
12. Knock sensor
13. Thermo sensor
14. Water detection switch
15. Water pressure sensor
16. TPS
17. ETV
18. High-pressure fuel pump
19. Low-pressure fuel pump
20. Shift actuator
21. OCV
22. Ignition coil
23. Direct injection pump
24. Fuel injector
25. ETV control
26. Shift control
27. Digital ignition control
28. Valve control
29. Fuel injection control
30. Injector driver
31. YDIS
32. CL5 display
33. Y-COP *1
34. Multi-hub
35. Battery
36. Engine ECM

*1. Optional

Electrical components



Part name		Function
1	Low-pressure fuel pump	Sends the fuel from the fuel tank to the vapor separator.
2	High-pressure fuel pump (sub)	Pressurizes the fuel and sends the fuel to the direct injection pump.
3	High-pressure fuel pump (main)	
4	Intake air pressure/temperature sensor	Detects the intake air pressure and intake air temperature.
5	ETV	Opens and closes the throttle valve using an electric motor.
6	Thermo sensor	Detects cooling water temperature.

Electronic control system

Part name		Function
7	Electrical management box	Contains various relays and fuses, and controls the power supply for the electrical components of the outboard motor.
8	Cam position sensor (PORT EX)	Determines the stroke of each cylinder according to the signals from both the crankshaft position sensor and the cam position sensor (PORT EX).
9	Cam position sensor (PORT IN)	Detects the advance angle on the intake camshaft.
10	Engine ECM	Determines the engine operating conditions according to the input signals from the sensors and switches which are installed at various locations on the engine, and sends output signals to operate the actuators to perform the various control functions.
11	Engine temperature sensor	Detects the engine temperature.
12	Injector driver	Controls the operation of the direct injection pumps and fuel injectors.
13	OCV	Advances or retards the intake camshaft timing by switching the oil passages through which the engine oil is sent into the advance chamber or the retard chamber in the rotor vane housing.
14	Fuel pressure sensor (high-pressure fuel pump)	Detects the fuel pressure between the vapor separator and the direct injection pump.
15	SPS 1 SPS 2	Detects the shift position. SPS 1 is the main sensor and SPS 2 is the sub sensor. SPS 1 and SPS 2 mutually monitor each other for malfunctions.
16	Shift actuator	Drives the motor according to the engine ECM command for engaging or disengaging the gearshift.
17	Ignition coil	Produces high voltage to ignite a spark plug.
18	Fuel pressure sensor (direct injection pump)	Detects the fuel pressure at the fuel rail.
19	Direct injection pump	Pressurize the fuel and sends the fuel to the fuel rail.
20	Water pressure sensor	Detects the cooling water pressure.
21	Fuel injector	Injects fuel.
22	Knock sensor	Detects engine knocking.
23	Cam position sensor (STBD IN)	Detects the advance angle on the intake camshaft.
24	Crankshaft position sensor	Detects the engine speed.
		Detects the crankshaft angle and piston positions.
25	Oil pressure sensor	Detects the oil pressure.

Fail-safe

In the fail-safe control, the engine ECM enters the fail-safe control mode when an electrical component malfunctions.

The fail-safe control system records the trouble codes according to the engine trouble conditions.

*: For applications with multiple outboard motors

Item	Trouble conditions to be detected	Controls performed by ECM
Crankshaft position sensor	There are 7 signals from cam position sensor (PORT EX), but no signal from crankshaft position sensor.	Set VCT in full retard position. Stop engine synchronization control.*
Cam position sensor (PORT EX)	No signal from cam position sensor (PORT EX) for 1 second.	High engine idle speed. Ignition timing advance angle is limited to BTDC 10°. Perform cylinder position identification using cam position sensor (PORT IN). Set VCT in full retard position. Stop engine synchronization control.*
Cam position sensor (STBD IN)	No signal from cam position sensor (STBD IN) for 1 second.	High engine idle speed. Set VCT in full retard position. Stop engine synchronization control.*
Cam position sensor (PORT IN)	No signal from cam position sensor (PORT IN) for 1 second.	High engine idle speed. Perform cylinder position identification using cam position sensor (PORT EX). Set VCT in full retard position. Stop engine synchronization control.*
TPS	TPS 1 output voltage is 0.35 V or less or 4.80 V or more. TPS 2 output voltage is 2.25 V or less or 4.80 V or more.	Engine speed is limited to 4200 r/min. Stop engine synchronization control.*
	Difference between TPS 1 and TPS 2 voltages is 1.7 V or less or 2.30 V or more.	Engine speed is limited to 1500 r/min. Stop engine synchronization control.*
Intake air pressure sensor	Output voltage is less than 0.20 V or more than 4.80 V.	High engine idle speed. Stop engine synchronization control.*
Engine temperature sensor	Output voltage is less than 0.20 V or more than 4.80 V.	Set to intake air temperature when starting. Set to 40 °C (104 °F) when running. High engine idle speed. Set VCT in full retard position. Stop engine synchronization control.*

Electronic control system

Item	Trouble conditions to be detected	Controls performed by ECM
Thermo sensor	Output voltage is less than 0.20 V or more than 4.65 V.	Set to 50 °C (122 °F) when running.
Intake air temperature sensor	Output voltage is less than 0.20 V or more than 4.65 V.	Set to 25 °C (77 °F). High engine idle speed. Stop engine synchronization control.*
Oil pressure sensor	Output voltage is less than 0.20 V, more than 4.80 V for 260 seconds, or more than 4.80 V when engine is stopped.	High engine idle speed.
Knock sensor	Output voltage is less than 0.20 V or more than 4.80 V.	High engine idle speed. Reduce engine speed approximately 300 r/min. Stop engine synchronization control.*
PTT sensor	Output voltage is less than 0.20 V or more than 4.80 V.	Deactivate tilt limiter.
Low power supply voltage under loaded condition	Battery voltage is less than 11.99 V, when the engine speed is 2000 r/min or more and running for 120 seconds.	High engine idle speed.
OCV	Open or short circuit.	Set VCT in full retard position. High engine idle speed. Stop engine synchronization control.*
Immobilizer (Y-COP)	Communication error occurs.	Stop engine synchronization control.*
Main relay	ECM input voltage is 3.99 V or more when the main relay is off.	—
Water pressure sensor	Output voltage is less than 0.20 V or more than 4.80 V.	—
Water detection switch	Water detection switch is turned on.	Operates the buzzer.
SPS	Output voltage is less than 0.20 V or more than 4.80 V.	Use value for SPS 2 when SPS 1 is malfunctioning and use value for SPS 1 when SPS 2 is malfunctioning. Stop engine synchronization control.*
	Output voltages of both SPS 1 and SPS 2 are less than 0.20 V or more than 4.80 V. Difference between SPS 1 and SPS 2 voltages is 0.3 V or more.	Engine speed is limited to 1500 r/min. Engine cannot be started. Stop engine synchronization control.*

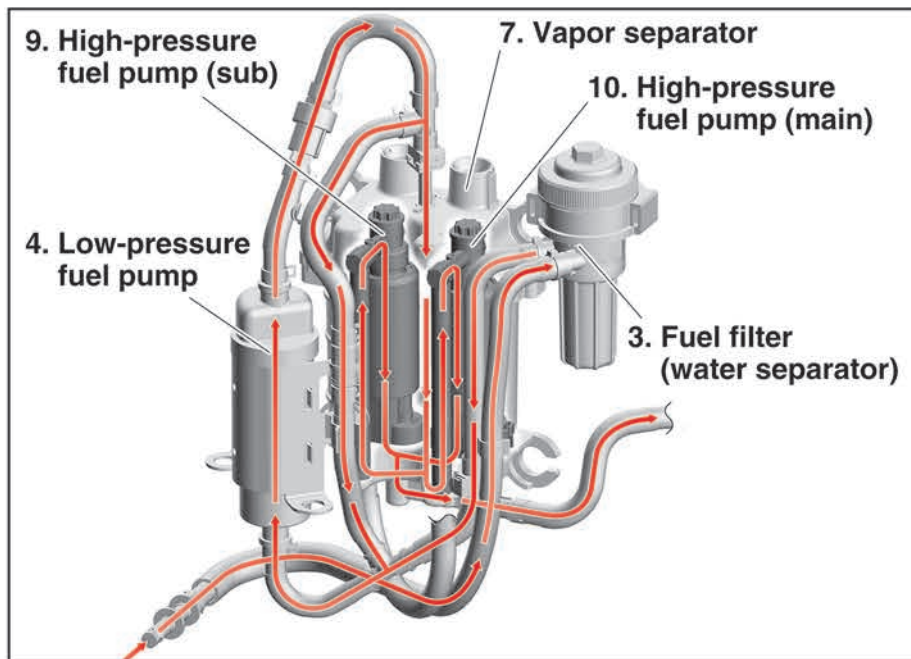
Electronic control system

Item	Trouble conditions to be detected	Controls performed by ECM
Shift actuator	Overcurrent or sticking is detected.	Stop engine synchronization control.*
Extension wire harness	Communication error between the engine ECM and Digital Electronic Control.	Engine speed is limited to 600 r/min. Stop engine synchronization control.*
LPS	LPS 1 is malfunctioning. LPS 2 is malfunctioning.	Engine speed is limited to 4200 r/min. Stop engine synchronization control.*
	LPS characteristics are abnormal. Both LPS 1 and LPS 2 are malfunctioning.	Engine speed is limited to 600 r/min. Stop engine synchronization control.*
Fuel injector	Open circuit in the fuel injector circuit.	Engine speed is limited to 2000 r/min. Injection to applicable cylinder is cut off. Stop engine synchronization control.*
Fuel pressure sensor (direct injection pump)	Output voltage is less than 0.20 V or more than 4.80 V.	Engine speed is limited to 2000 r/min. Use fixed start time for fuel injection. Stop engine synchronization control.*
Direct injection pump feedback	Signals to increase fuel pressure are sent continuously for approximately 6 minutes.	Engine speed is limited to 2000 r/min. Stop engine synchronization control.*
	Signals to decrease fuel pressure are sent continuously for approximately 8 minutes.	
	Feedback value is abnormal.	
Direct injection pump	Open circuit in the direct injection fuel pump circuit.	Engine speed is limited to 2000 r/min. Stop engine synchronization control.*
Fuel pressure sensor (high-pressure fuel pump)	Output voltage is less than 0.30 V or more than 4.75 V.	Engine speed is limited to 2000 r/min. Stop engine synchronization control.*

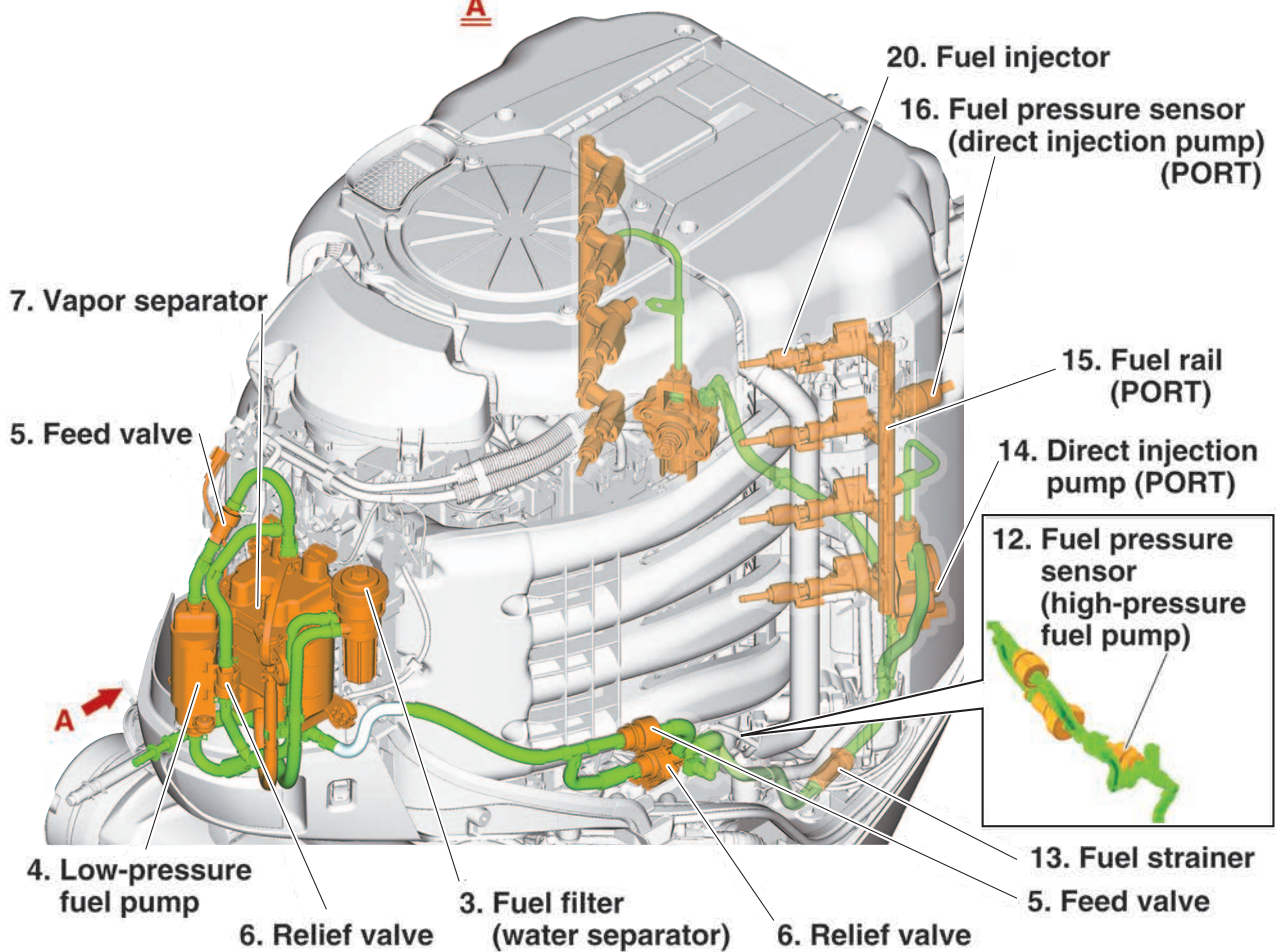
Electronic control system

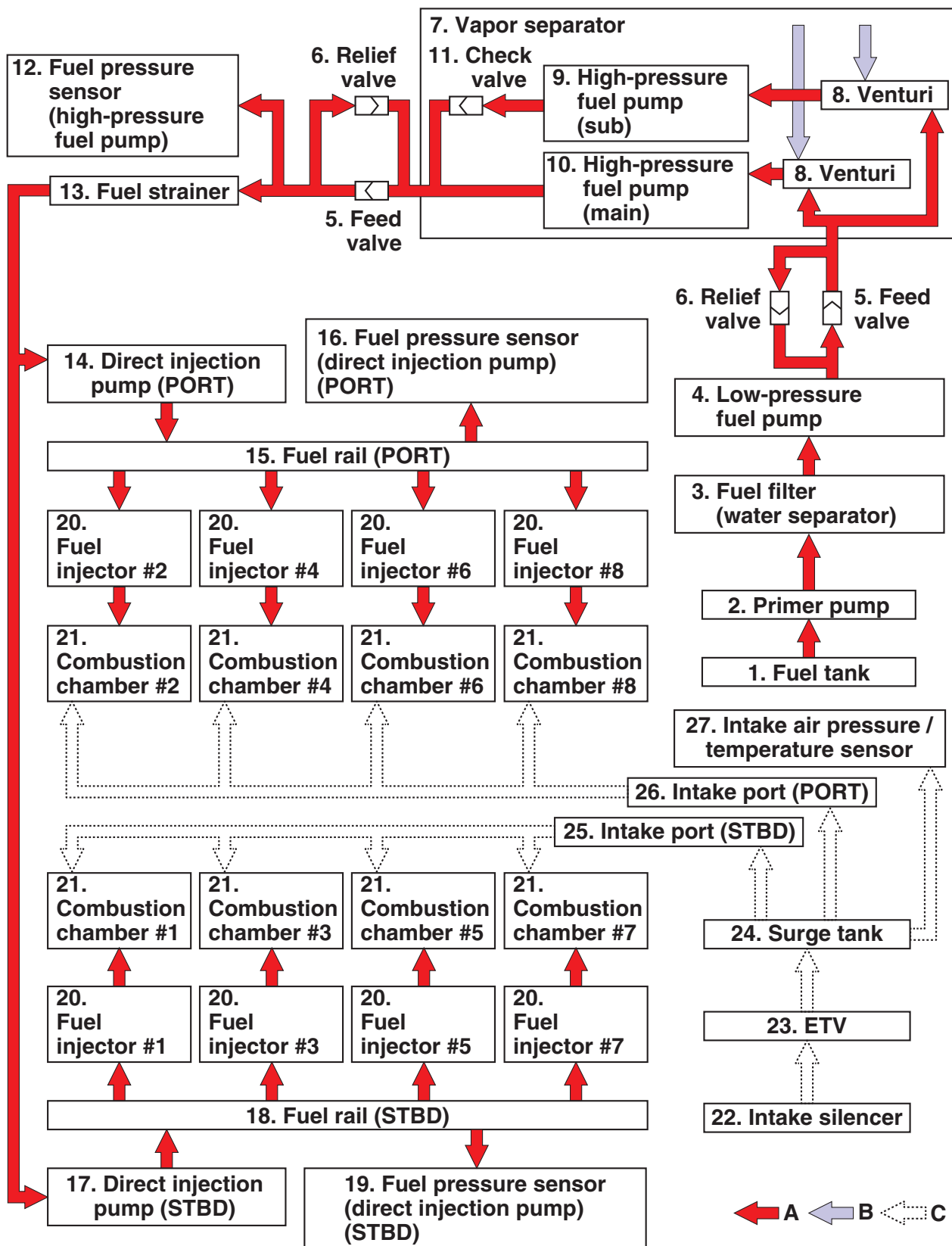
Item	Trouble conditions to be detected	Controls performed by ECM
High-pressure fuel pump supply abnormal	Insufficient fuel supply to vapor separator. High-pressure fuel pump is malfunctioning.	Message is displayed on gauge display when engine stops. “Check fuel supply. Outboard starter will not function for 7 sec. 10 or more restart attempts may be required. When the engine restarts, let it idle more than 5 min.”
Starter relay	Starter relay is malfunctioning.	—
PTT relay	PTT relay is malfunctioning.	—
PTT relay power supply	PTT relay and related parts are malfunctioning.	—
Shift relay	Shift relay is malfunctioning.	Stop engine synchronization control.*
High-pressure fuel pump relay	High-pressure fuel pump relay is malfunctioning.	Engine speed is limited to 2000 r/min Stop engine synchronization control.*
Fuel injector driver relay 1 Fuel injector driver relay 2	Fuel injector driver relay is malfunctioning.	Engine speed is limited to 2000 r/min Injection to applicable cylinder is cut off. Stop engine synchronization control.*
SBW	Abnormal information from the steering components is input using digital electronic control.	—
SCU	Abnormal information from the steering components is input using digital electronic control.	—
HELM	Abnormal information from the steering components is input using digital electronic control.	—

Fuel system
Fuel diagram



A





1. Fuel tank
 2. Primer pump
 3. Fuel filter (water separator)
 4. Low-pressure fuel pump
 5. Feed valve
 6. Relief valve
 7. Vapor separator
 8. Venturi
 9. High-pressure fuel pump (sub)
 10. High-pressure fuel pump (main)
 11. Check valve
 12. Fuel pressure sensor (high-pressure fuel pump)
 13. Fuel strainer
 14. Direct injection pump (PORT)
 15. Fuel rail (PORT)
 16. Fuel pressure sensor (direct injection pump) (PORT)
 17. Direct injection pump (STBD)
 18. Fuel rail (STBD)
 19. Fuel pressure sensor (direct injection pump) (STBD)
 20. Fuel injector
 21. Combustion chamber
 22. Intake silencer
 23. ETV
 24. Surge tank
 25. Intake port (STBD)
 26. Intake port (PORT)
 27. Intake air pressure/temperature sensor
-
- A. Fuel flow
 - B. Vapor gas flow
 - C. Air flow

High-pressure fuel pump control

The vapor separator contains 2 high-pressure fuel pumps: a main pump without a check valve and a sub pump with a check valve. When the engine load is low, only the main pump operates, and when the engine load is high, the sub pump also operates.

The high-pressure fuel pumps are controlled by the ECM using feedback based on information from the fuel pressure sensor (high-pressure fuel pump). The drive force of the fuel pumps changes dynamically and the fuel pumps may stop when the engine load is small. This prevents vapor gas from collecting in the vapor separator and contributes to more efficient operation.

Low-pressure fuel pump control

When the engine load is low, the pump will cycle ON for 10 seconds and OFF for 20 seconds.

When the engine load is high, the pump is ON continuously.

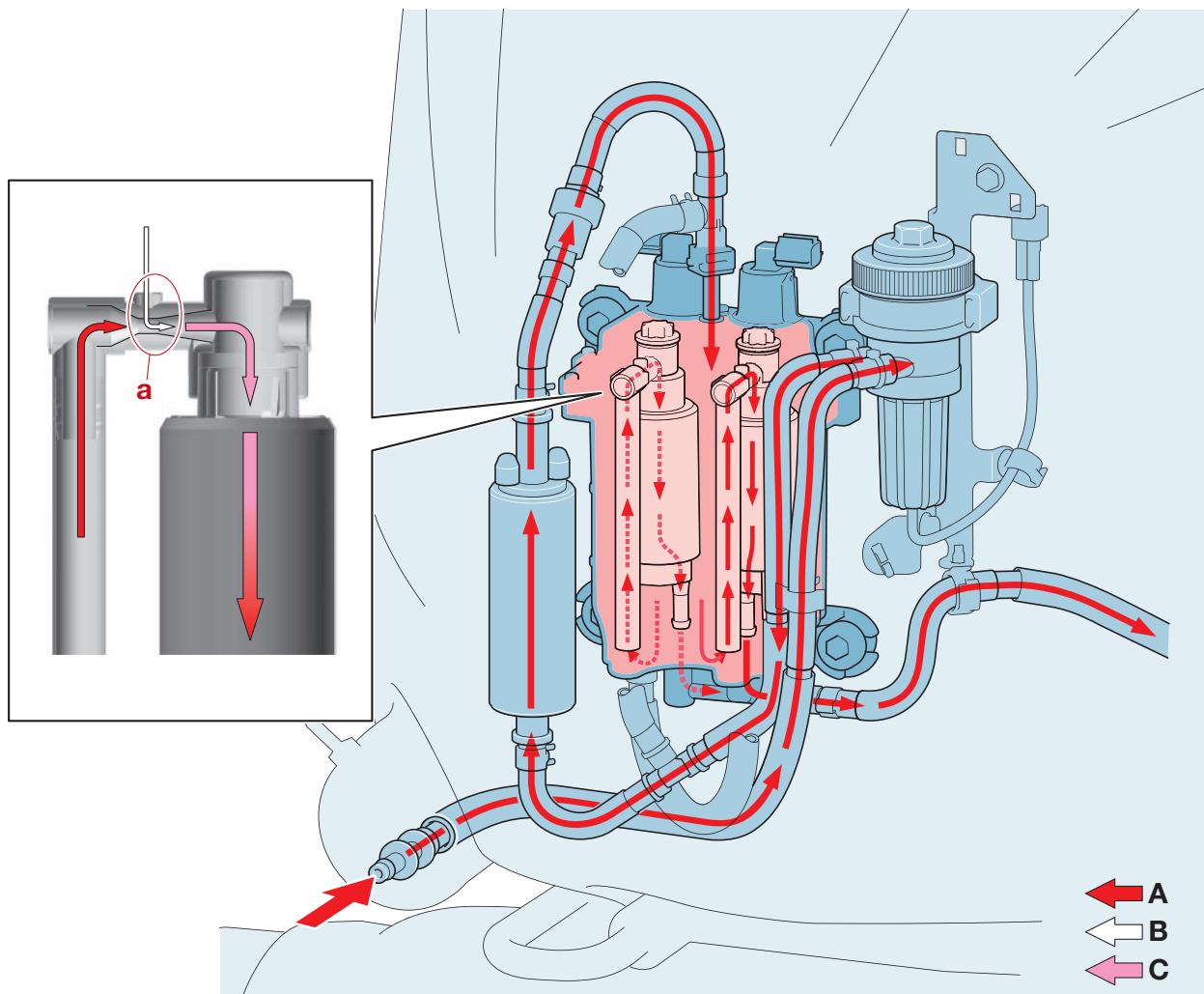
Vapor separator

This model is equipped with a newly designed vapor separator, which has been changed to a sealed type that eliminates the structure for discharging the vapor gas. Because venturi tubes “a” were added to control the amount of vapor gas so that it does not exceed a certain level, the vapor gas can be handled inside the vapor separator. When the liquid fuel is drawn from below the high-pressure fuel pumps, the pressure of the fuel decreases when it passes through the venturi tubes because its flow rate increases. As a result, it draws in the vapor gas from the passage at the top of each venturi tube. Although this mixture of liquid fuel and vapor gas is drawn into the high-pressure fuel pumps in this state, the vapor gas is compressed by the high-pressure fuel pumps into a liquid state and is discharged as a liquid.

In addition, because the fuel pressure after the vapor separator is stabilized using feedback control, the fuel return passage was eliminated.

As a result, the canister, return hoses, and other parts were eliminated, which reduced the number of parts and improved serviceability.

Also, because the vapor gas is not released into the atmosphere, the outboard motor is friendlier on the environment.

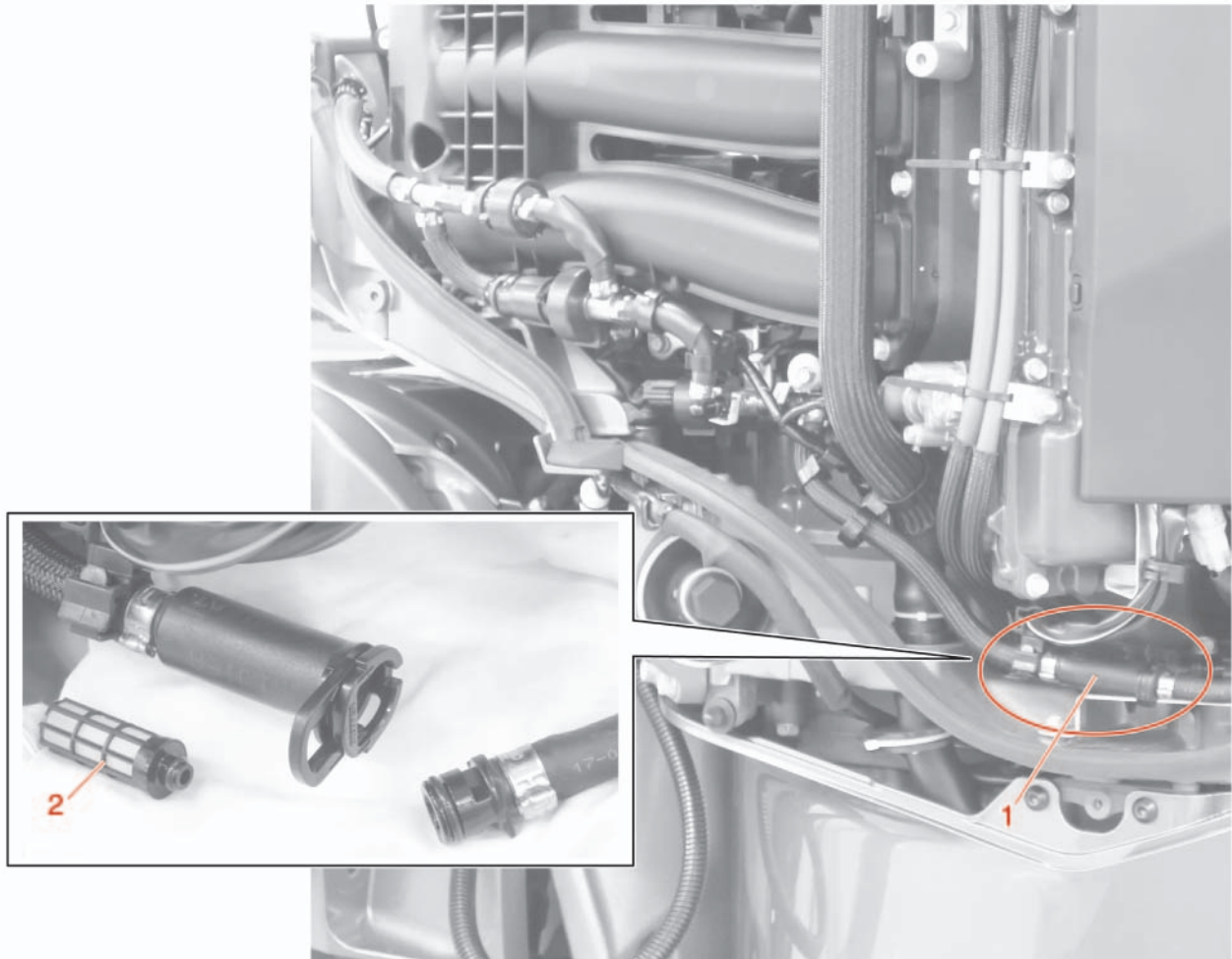


- A. Liquid fuel flow
- B. Vapor gas flow
- C. Mixture of liquid fuel and vapor gas

Fuel strainer

This model is equipped with a fuel strainer “1” between the vapor separator and the direct injection pumps.

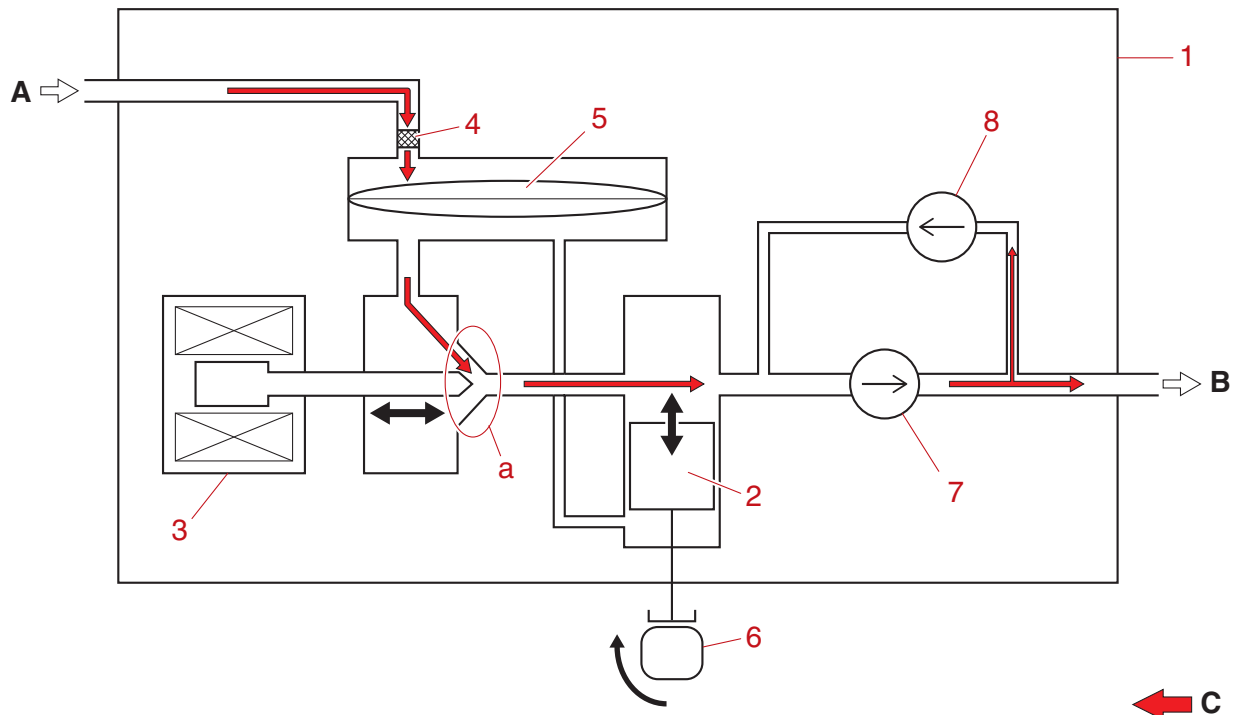
The strainer prevents clogging of the filters in the direct injection pumps and fuel injectors, extending the replacement intervals for the parts. In addition, because the fuel strainer element “2” can be replaced easily without removing the fuel hose, serviceability is improved.



Direct injection pump

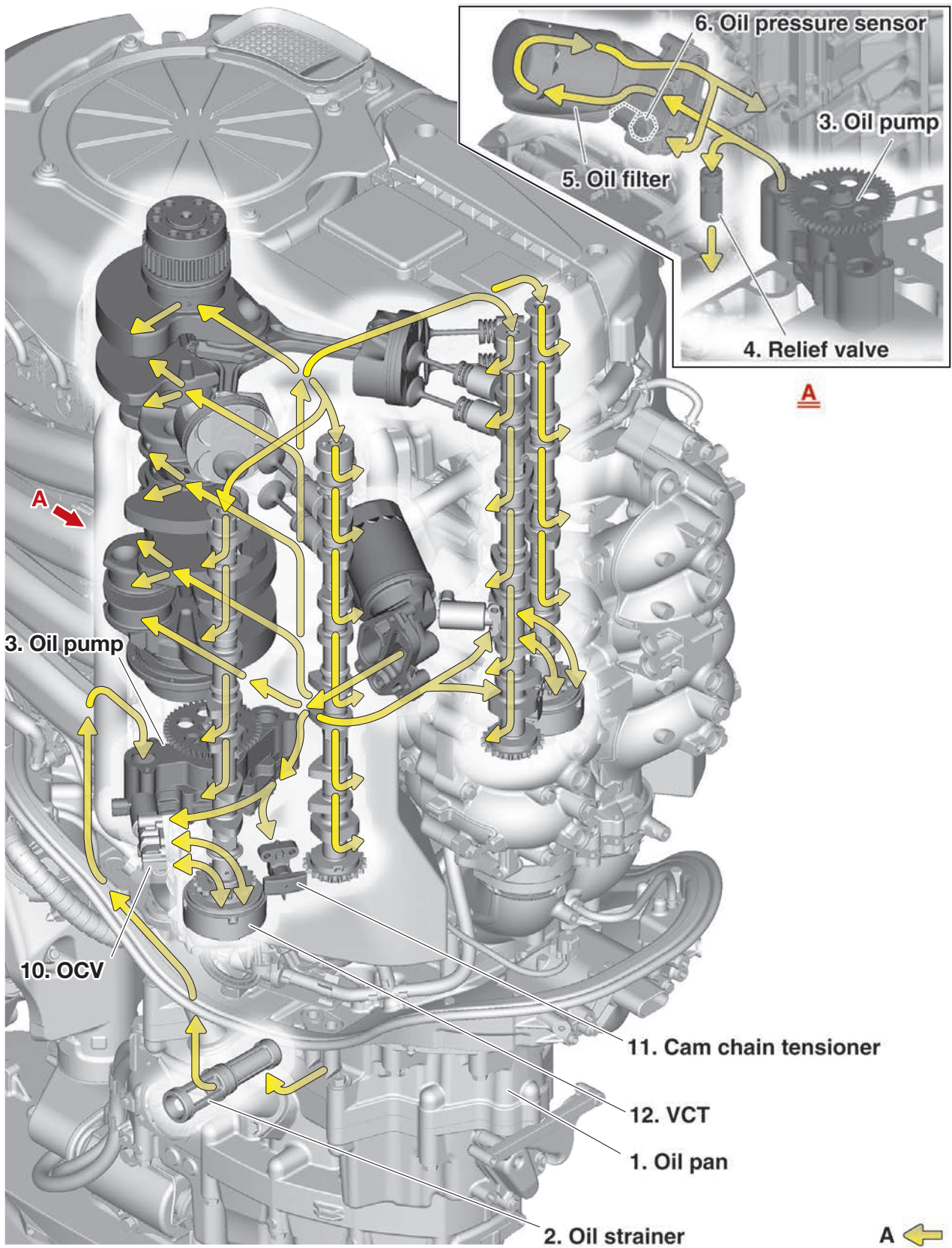
Each direct injection pump “1”, which has a mechanically driven built-in plunger “2” and an electrically driven built-in solenoid “3”, pressurizes the fuel to the high pressure required for direction injection. The fuel inside the pump is sent through the mesh filter “4” and damper “5” to the solenoid chamber and plunger chamber. The pressure of the fuel is increased by the plunger that is driven by the camshaft “6” and the fuel is sent to the fuel rail through the check valve “7”. To prevent the fuel from flowing back from the inlet of the plunger chamber at this time and reducing the pressure, the solenoid blocks the passage at the inlet “a” of the plunger chamber while the fuel is being pressurized. During 1 turn of the camshaft, the fuel is pressurized 4 times and the solenoid repeatedly opens and closes the passage each time. Conversely, if the fuel pressure in the fuel rail is too high, the fuel returns through the return valve “8”.

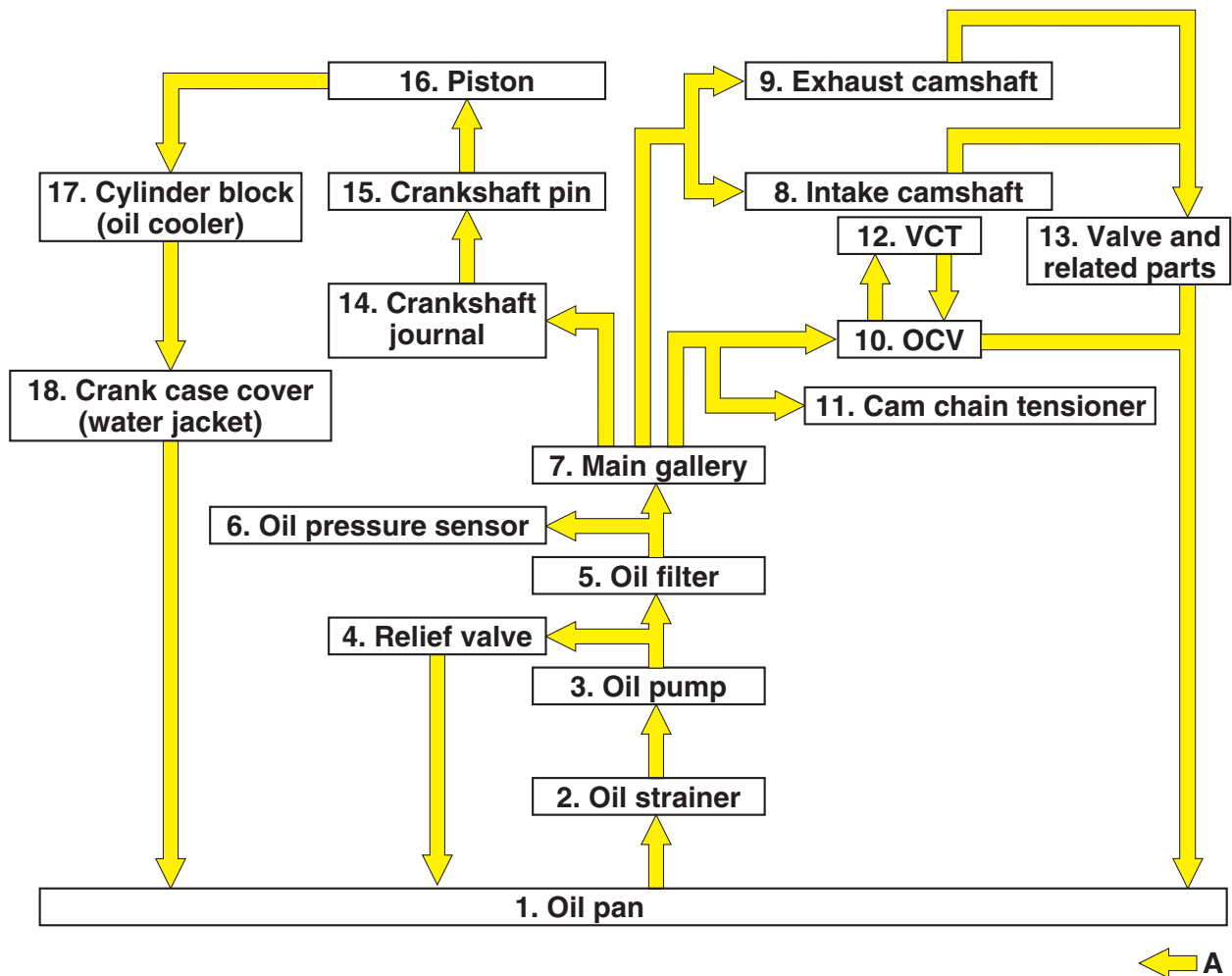
In addition, feedback control is carried out based on the information from the fuel pressure sensor (direct injection pump), and the operation of the solenoid is controlled to change the flow volume and adjust the fuel pressure.



- A. From vapor separator
- B. To fuel rail
- C. Fuel flow

Lubrication system
Lubrication diagram





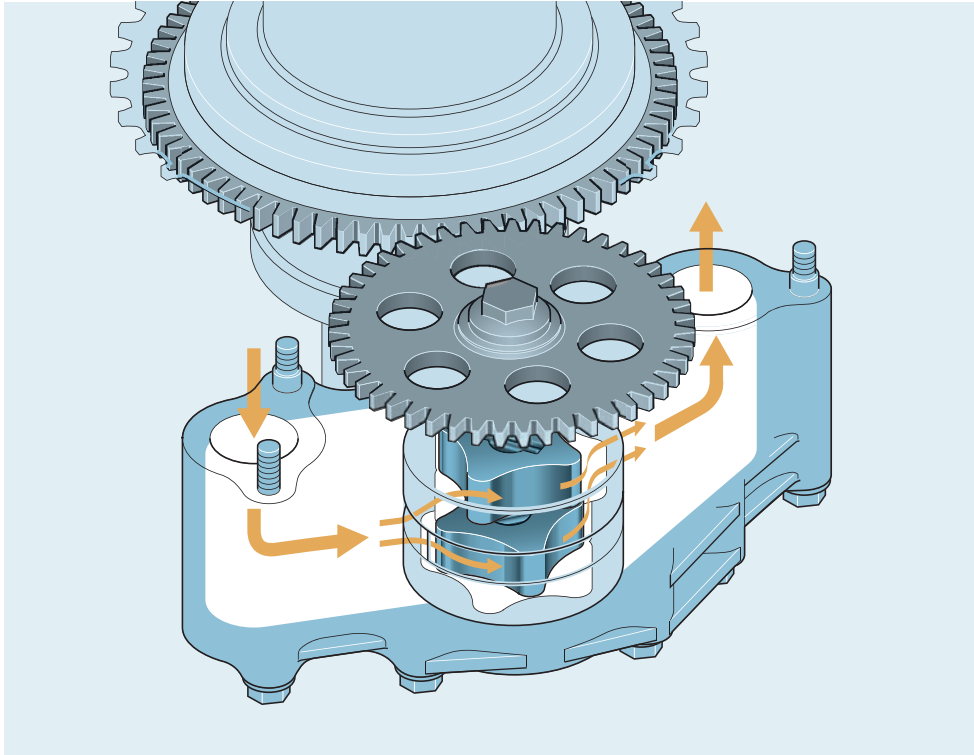
- 1. Oil pan
- 2. Oil strainer
- 3. Oil pump
- 4. Relief valve
- 5. Oil filter
- 6. Oil pressure sensor
- 7. Main gallery
- 8. Intake camshaft
- 9. Exhaust camshaft
- 10. OCV
- 11. Cam chain tensioner
- 12. VCT
- 13. Valve and related parts
- 14. Crankshaft journal
- 15. Crankshaft pin

- 16. Piston
- 17. Cylinder block (oil cooler)
- 18. Crank case cover (water jacket)

A. Engine oil flow

Dual rotor oil pump

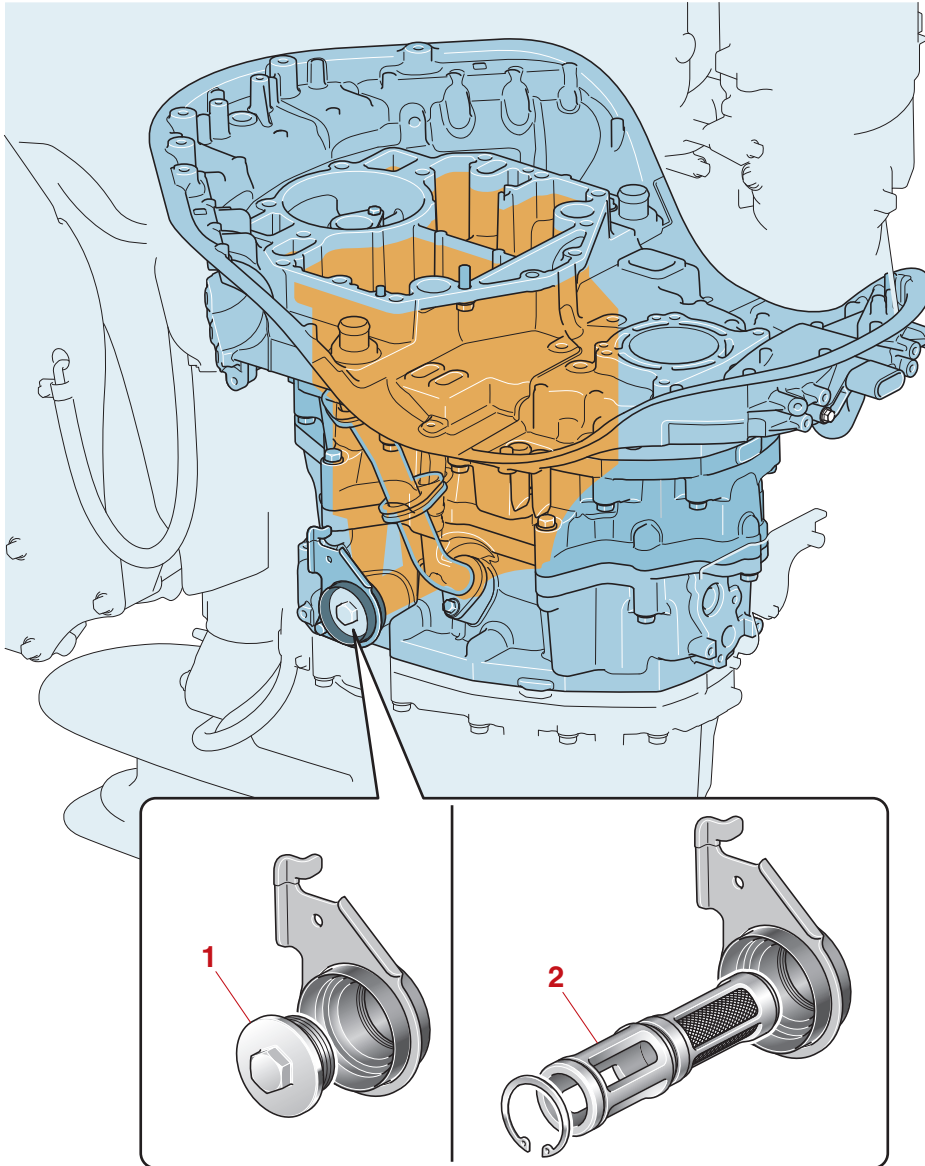
The dual rotor oil pump is driven using the crankshaft gear. The pump has 2 built-in rotors and while maintaining its compact size, the flow volume has been increased from 100 L/min to 140 L/min compared to previous models.



A. Engine oil flow

Oil drain plug

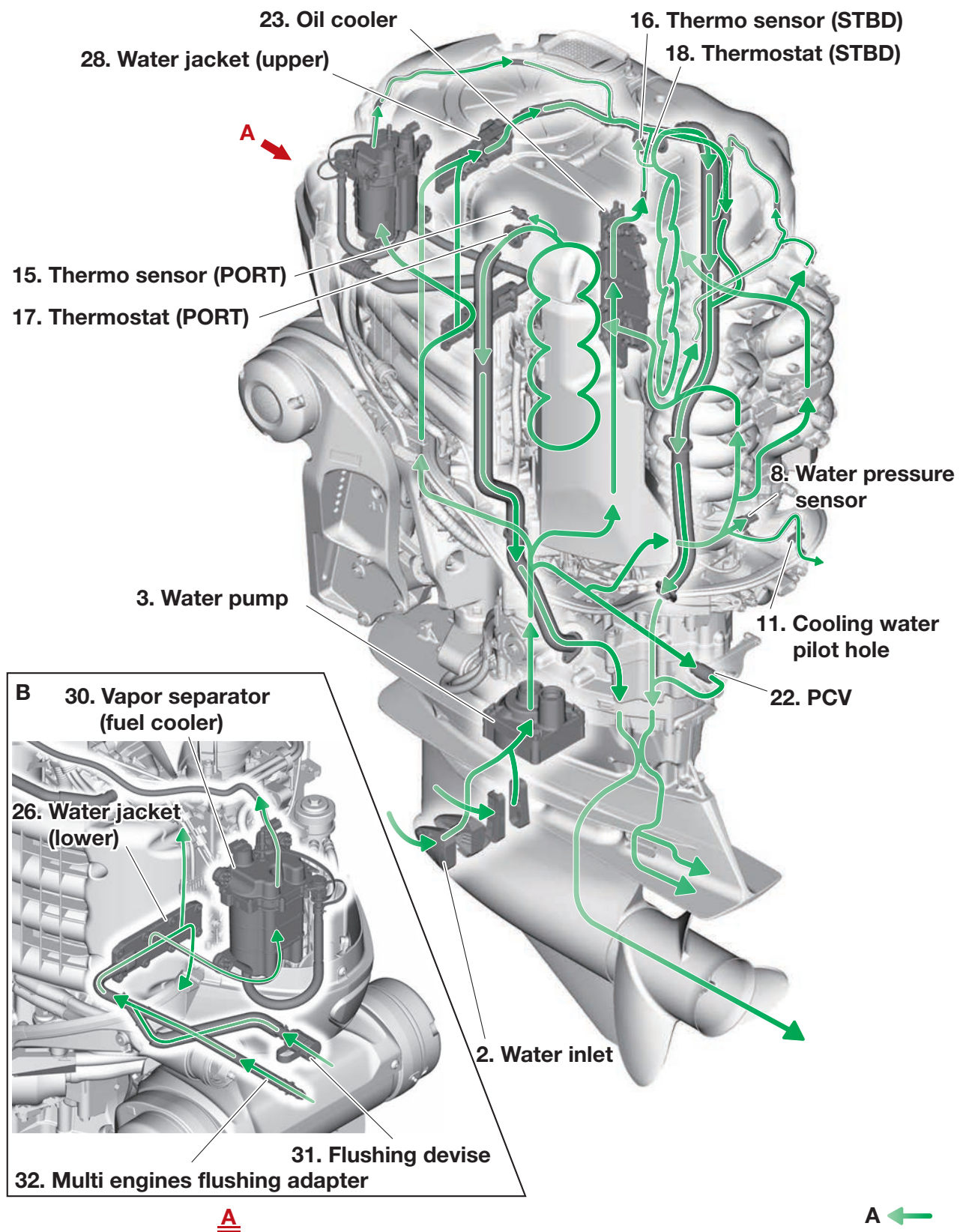
The diameter of the oil drain plug “1” has been increased, and the oil strainer “2” can be removed from and installed in the drain hole. As a result, the oil strainer can be checked and cleaned without disassembling the upper case.

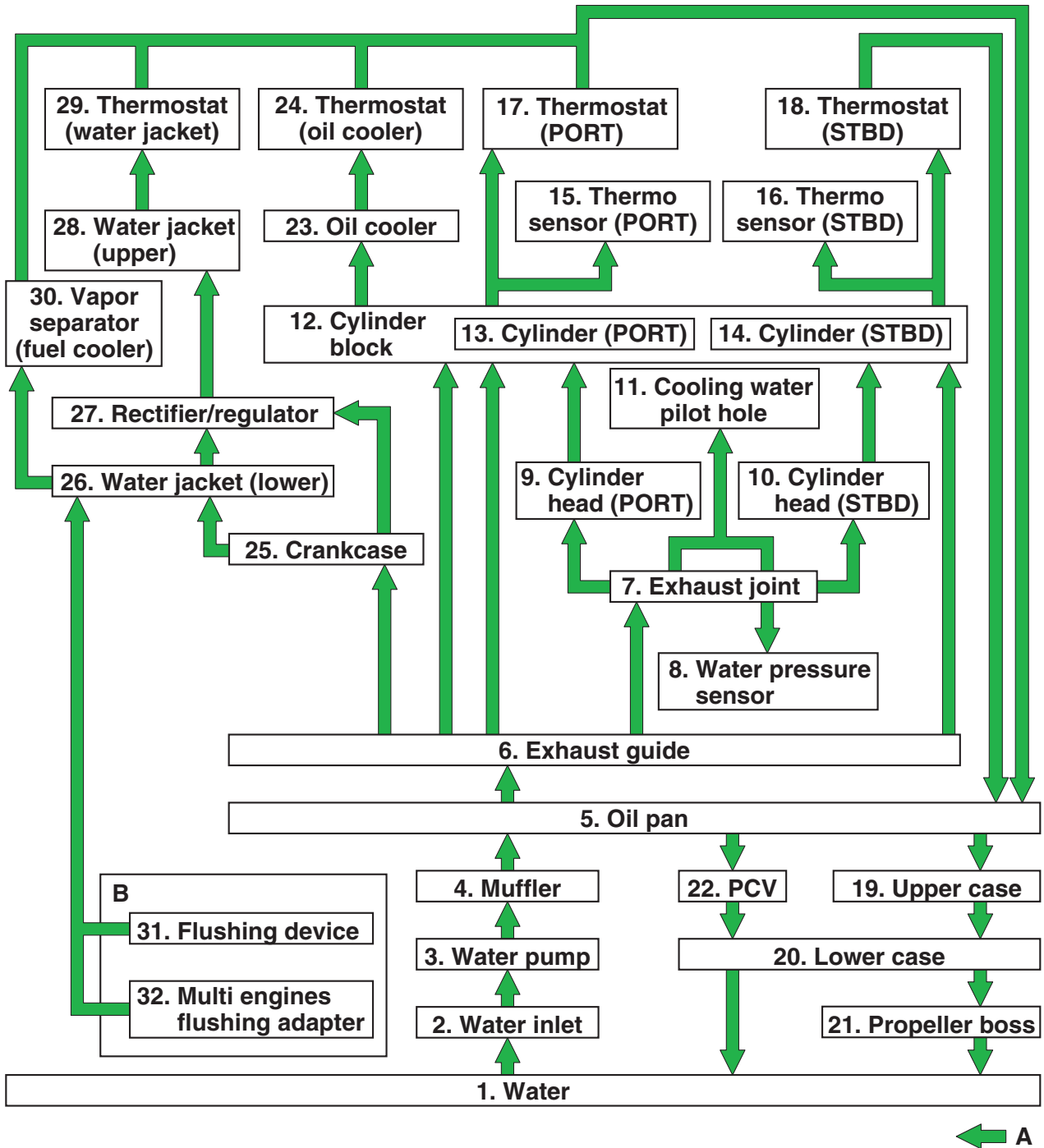


A. Engine oil

Cooling system

Cooling diagram

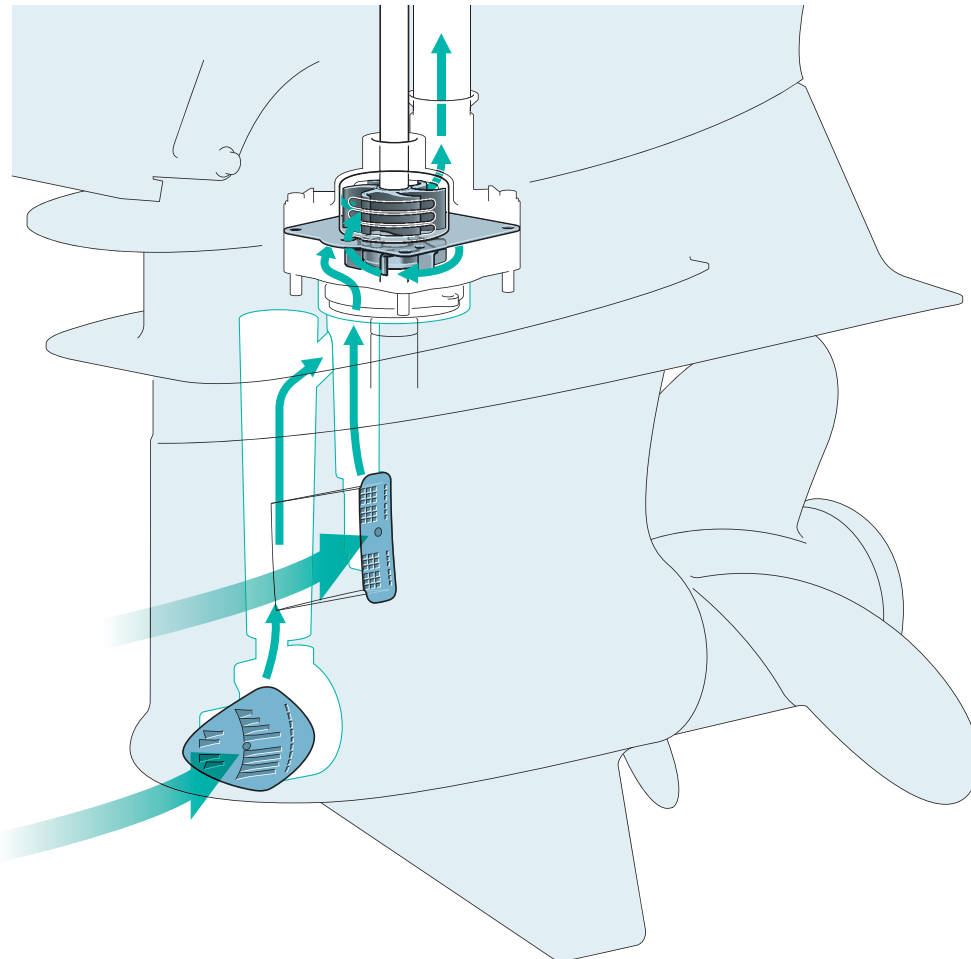




1. Water
 2. Water inlet
 3. Water pump
 4. Muffler
 5. Oil pan
 6. Exhaust guide
 7. Exhaust joint
 8. Water pressure sensor
 9. Cylinder head (PORT)
 10. Cylinder head (STBD)
 11. Cooling water pilot hole
 12. Cylinder block
 13. Cylinder (PORT)
 14. Cylinder (STBD)
 15. Thermo sensor (PORT)
 16. Thermo sensor (STBD)
 17. Thermostat (PORT)
 18. Thermostat (STBD)
 19. Upper case
 20. Lower case
 21. Propeller boss
 22. PCV
 23. Oil cooler
 24. Thermostat (oil cooler)
 25. Crankcase
 26. Water jacket (lower)
 27. Rectifier/regulator
 28. Water jacket (upper)
 29. Thermostat (water jacket)
 30. Vapor separator (fuel cooler)
 31. Flushing device
 32. Multi engines flushing adapter
-
- A. Cooling water flow
 - B. When flushing the cooling water passages

Dual water pump

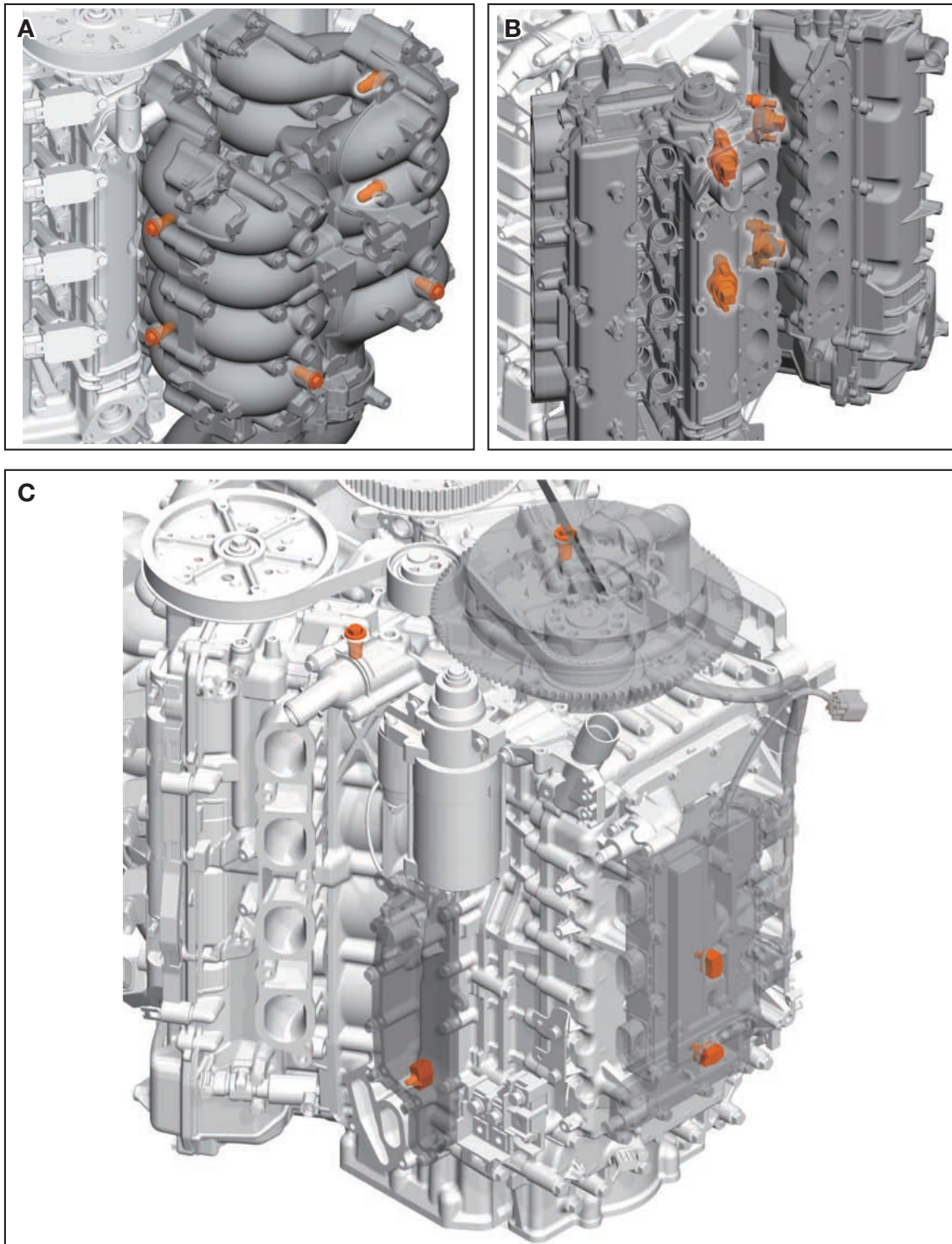
This model is equipped with a dual water pump to ensure sufficient cooling water for the higher output engine. The water pump can discharge 1.3 times the water that the pump for the F350A (F350CC) could discharge, which helps to control the increase in engine temperature when the outboard motor is operating under a high load. In addition, although the amount of cooling water has increased, the durability is equivalent to or higher than that of the F350A (F350CC).



A. Cooling water flow

Engine anode

The locations of the anodes in the engine cooling water passages have been optimized. As a result, checking the anodes at 1000 hours is no longer necessary and the anodes must be replaced only during major maintenance work.



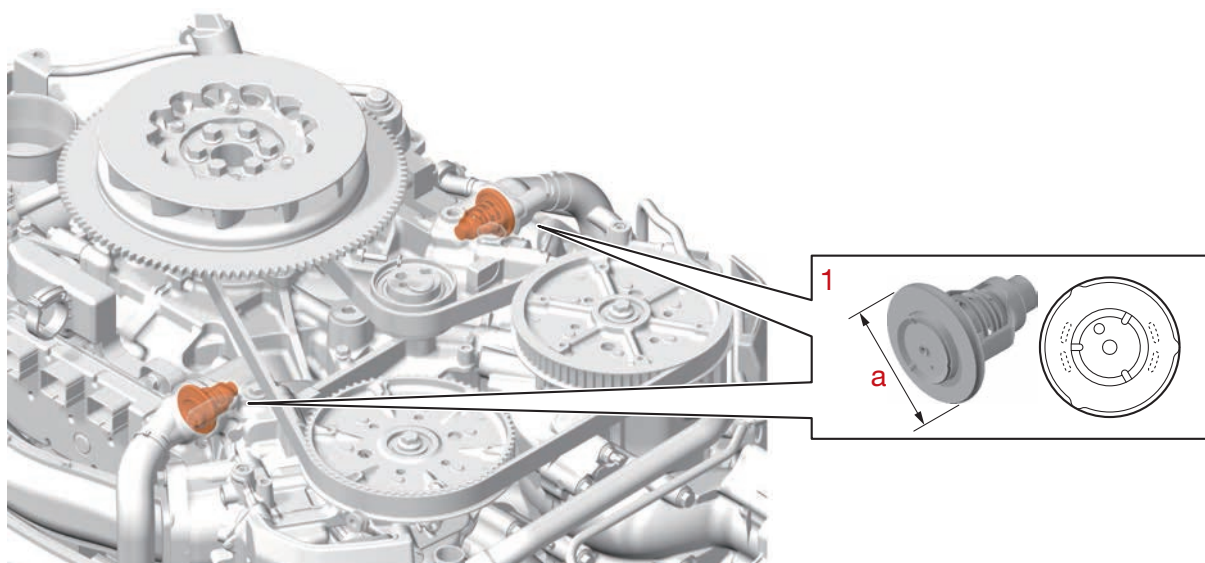
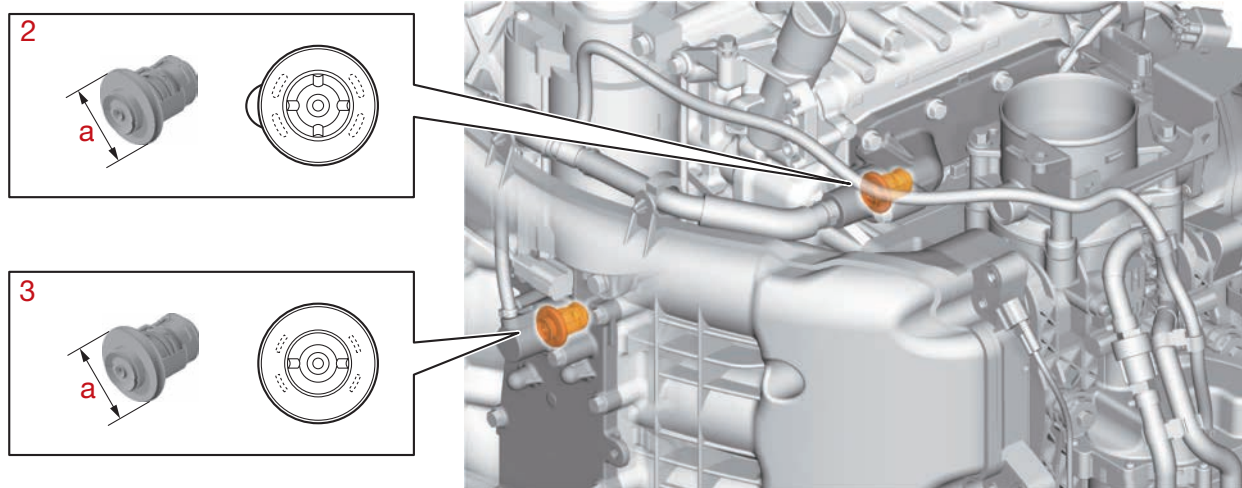
- A. Exhaust joint
- B. Cylinder head
- C. Cylinder block and water jacket

Thermostat

In addition to the thermostat in each cylinder bank of the F350A (F350CC), a thermostat has been added to the crankcase and cylinder block for a total of 4 thermostats.

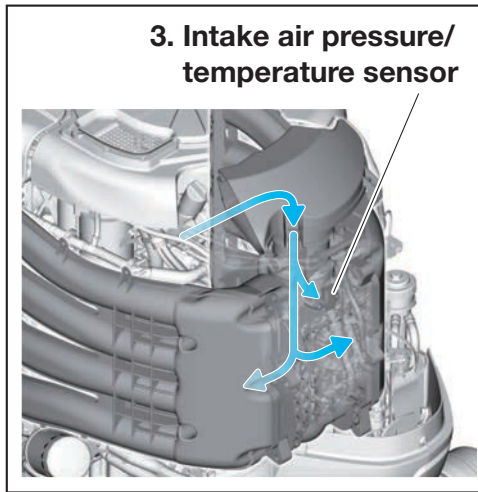
Because the cooling water passages have been divided into 2 sections that are controlled separately, the engine temperature and output are stabilized, the warming-up time is reduced, the fuel consumption is lower, and condensation in the lubrication system is prevented.

In addition, the high-temperature water that passes through the thermostats is discharged instead of flowing through the cooling water passages, which reduces the amount of corrosion.

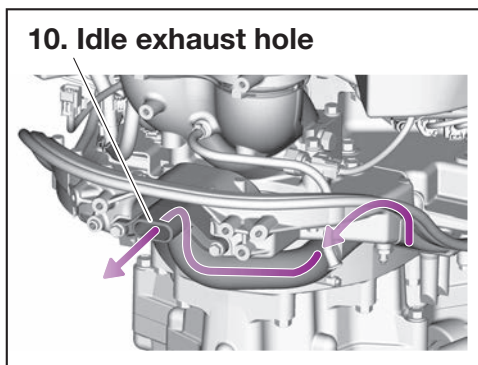


Specifications	1	2	3
Valve opening temperature	58–62 °C (136–143 °F)	58–62 °C (136–143 °F)	58–62 °C (136–143 °F)
Fully open temperature	70 °C (158°F)	70 °C (158°F)	70 °C (158°F)
Fully open stroke	5.0 mm (0.20 in)	3.0 mm (0.12 in)	3.0 mm (0.12 in)
Diameter “a”	45.65 mm (1.797 in)	27.3 mm (1.075 in)	27.3 mm (1.075 in)
Flow rate at a pressure difference of 19.6 kPa (0.196 kgf/cm ² , 2.8 psi)	2.8 L/min	0.3–0.4 L/min	0.1–0.2 L/min

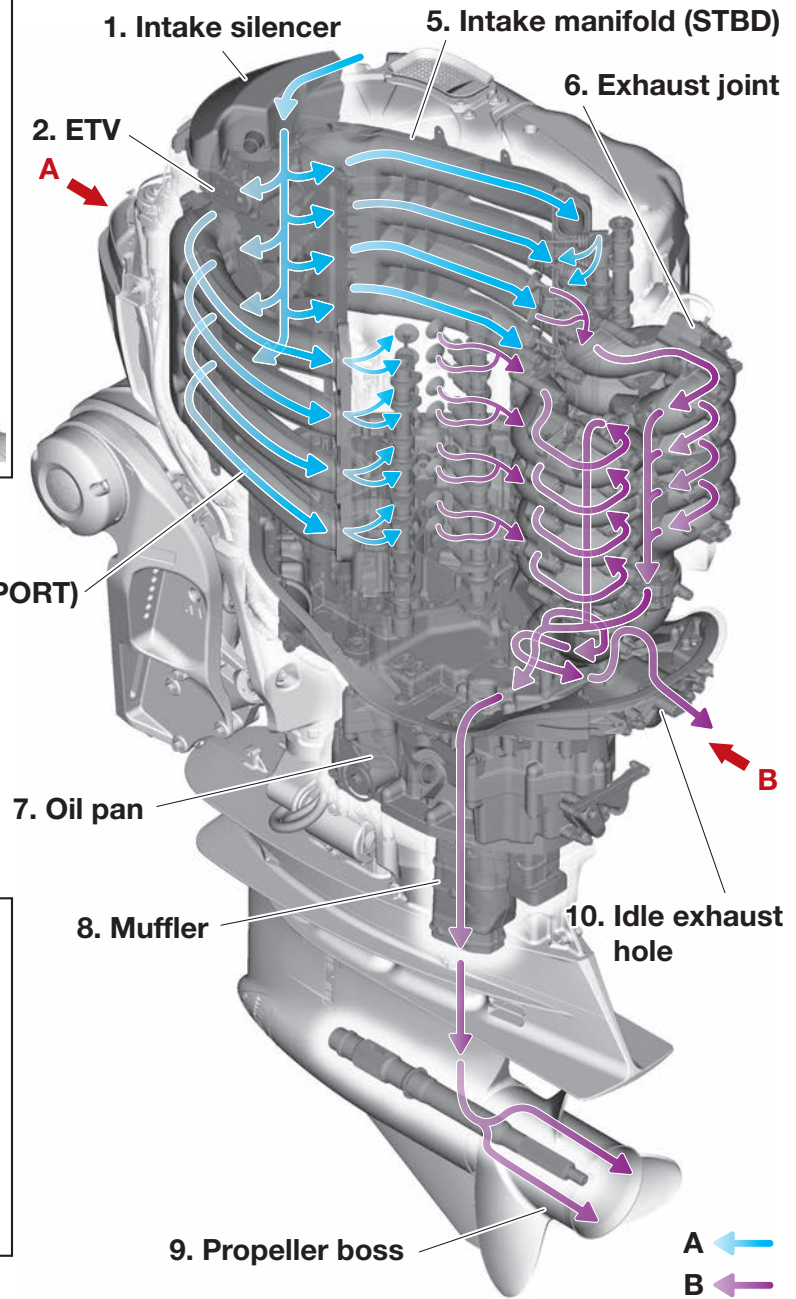
Intake and exhaust system
Intake and exhaust diagram



A



B



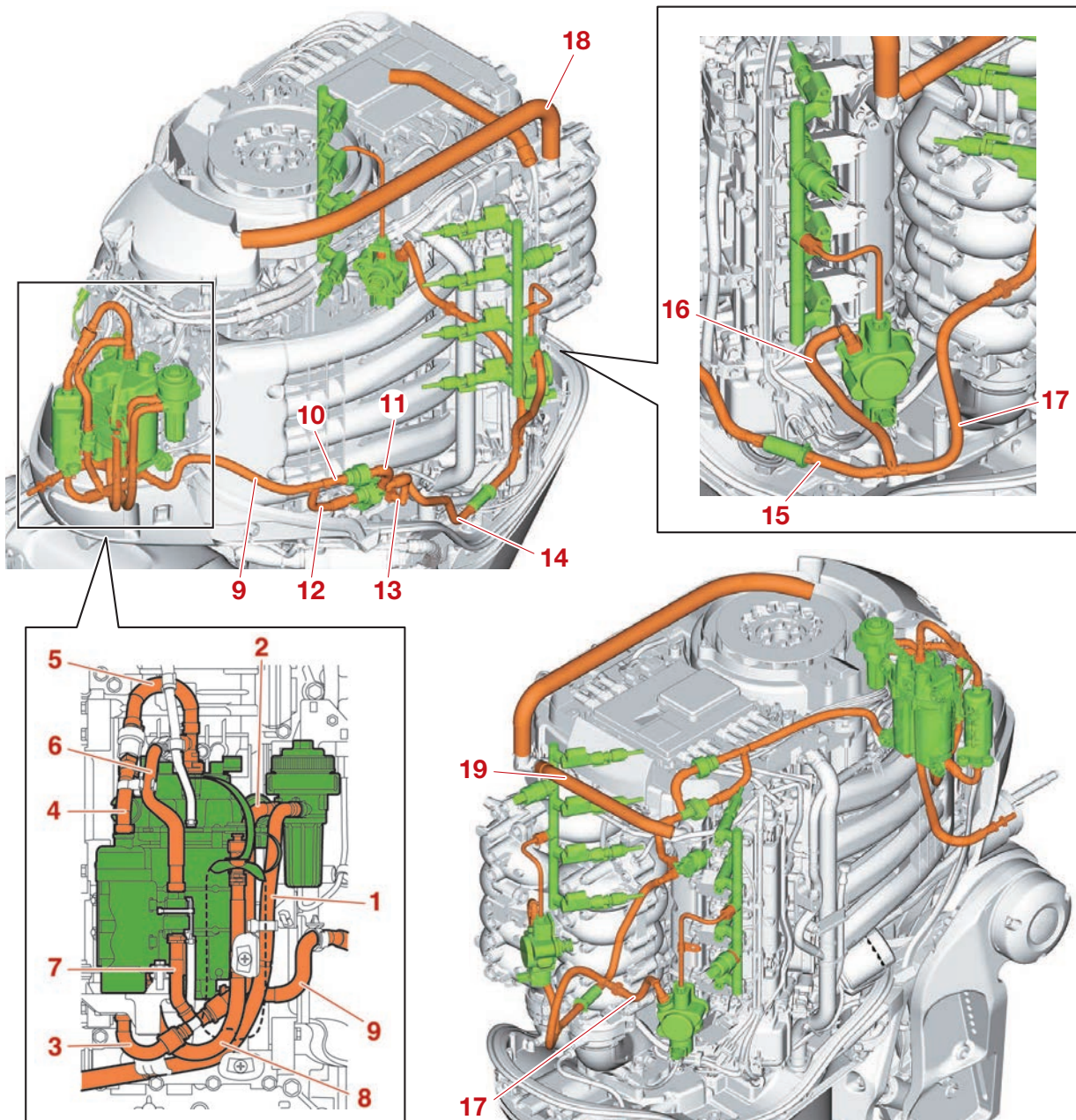
A ←
 B ←

A. Intake air flow
 B. Exhaust gas flow

1. Intake silencer
2. ETV
3. Intake air pressure/temperature sensor
4. Intake manifold (PORT)
5. Intake manifold (STBD)
6. Exhaust joint
7. Oil pan
8. Muffler
9. Propeller boss
10. Idle exhaust hole

Hose routing

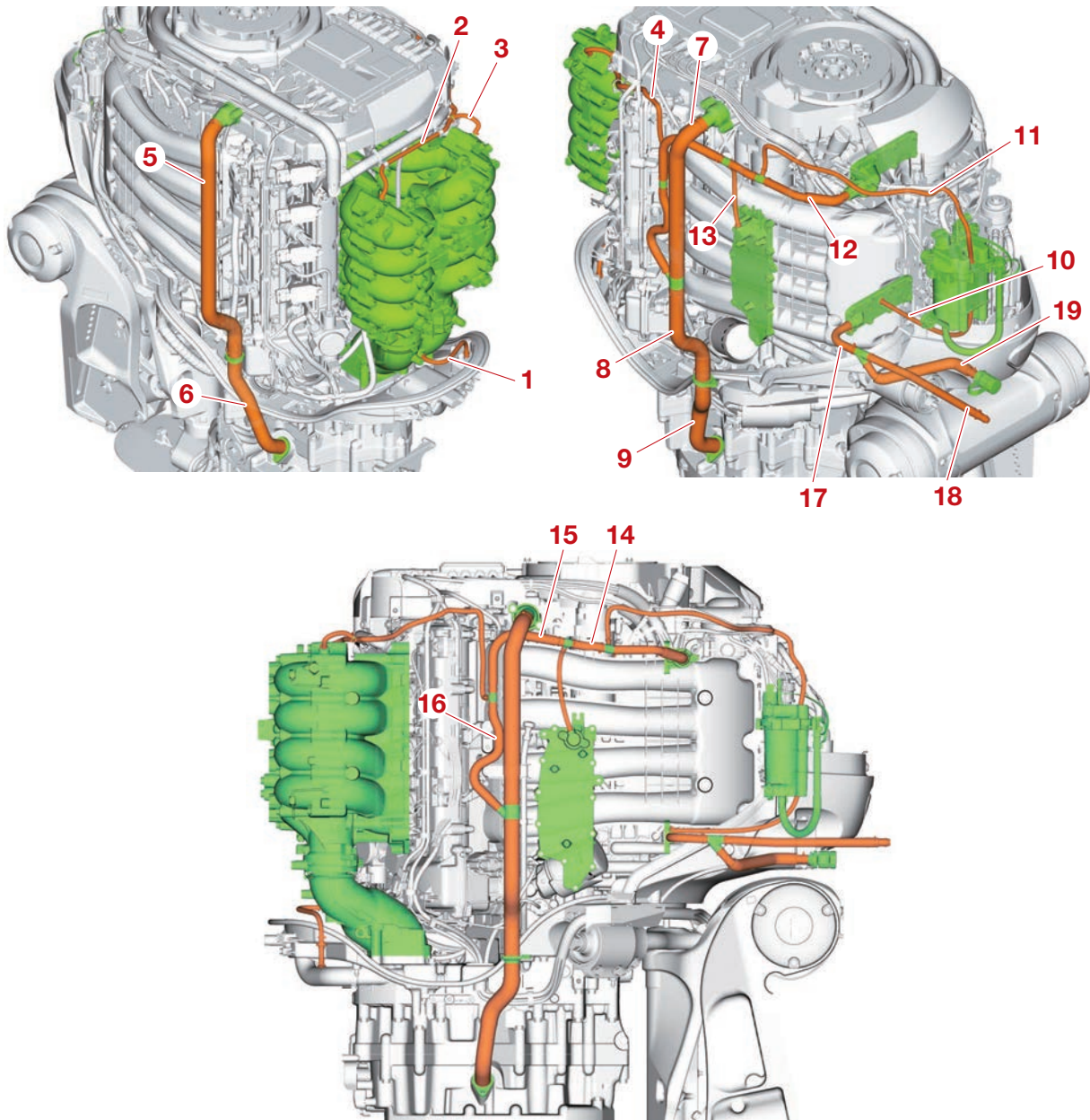
Fuel hose and blowby hose



1. Joint to fuel filter assembly
2. Fuel filter assembly to joint
3. Joint to low-pressure fuel pump
4. Low-pressure fuel pump to fuel feed valve
5. Fuel feed valve to vapor separator
6. Vapor separator to relief valve
7. Relief valve to joint
8. Vapor separator to drain joint
9. Vapor separator to joint
10. Joint to fuel feed valve
11. Fuel feed valve to relief valve

12. Relief valve to joint
13. Relief valve to fuel pressure sensor
14. Fuel pressure sensor to fuel strainer
15. Fuel strainer to joint
16. Joint to direct injection pump (PORT)
17. Joint to direct injection pump (STBD)
18. Cylinder head cover (PORT) to intake silencer
19. Cylinder head cover (STBD) to cylinder head cover (PORT)

Cooling water hose



- | | |
|------------------------------------------------|------------------------------------|
| 1. Exhaust joint to cooling water pilot hole | 14. Joint to joint |
| 2. Exhaust joint to joint | 15. Joint to joint |
| 3. Exhaust joint to joint | 16. Joint to joint |
| 4. Joint to joint | 17. Water jacket cover to joint |
| 5. Thermostat housing to joint | 18. Joint to joint |
| 6. Joint to upper case | 19. Flushing hose adapter to joint |
| 7. Thermostat housing to joint | |
| 8. Joint to joint | |
| 9. Joint to upper case | |
| 10. Crankcase to vapor separator (fuel cooler) | |
| 11. Vapor separator (fuel cooler) to joint | |
| 12. Thermostat housing to joint | |
| 13. Thermostat housing (oil cooler) to joint | |

Rigging information

Important reminder on rigging	3-1
Outboard motor mounting instructions.....	3-1
Crate handling	3-2
Crate top cover symbol description.....	3-2
Uncrating	3-3
Uncrating procedure (outboard motor without lower unit).....	3-3
Uncrating procedure (outboard motor with lower unit).....	3-4
Outboard motor mounting	3-8
Installing the outboard motor	3-8
Outboard motor mounting height.....	3-12
Rigging grommet mounting	3-13
Rigging grommet description.....	3-13
Installing the battery cable	3-13
Installing the main wire harness.....	3-13
Installing the rigging grommet.....	3-13
Connecting the fuel hose	3-14
Optional equipment	3-15
Installing the isolator lead.....	3-15
Installing the SCU communication lead	3-15
Installing Y-COP.....	3-16
Battery installation	3-17
Battery wiring	3-19
System diagram	3-25
Single outboard motor application (single station).....	3-25
Twin outboard motor application (single station)	3-28
Triple outboard motor application (single station).....	3-31
Quad outboard motor application (single station).....	3-35
Quint outboard motor application (single station).....	3-39
Single outboard motor application (dual station)	3-43
Twin outboard motor application (dual station)	3-46
Triple outboard motor application (dual station)	3-50
Quad outboard motor application (dual station)	3-54
Quint outboard motor application (dual station)	3-58

Rigging information

Digital Electronic Control	3-62
Digital Electronic Control system reset	3-62
Tilt limiter	3-63
Setting the tilt limiter	3-63
Clearing the tilt limiter	3-64
Deactivating the tilt limiter	3-64
Calibration (6X9 Digital Electronic Control)	3-66
CL5 display calibration	3-67
Configuring the number of outboard motors	3-67
Accessing the calibration menu	3-67
Steering sensor	3-68
Toe Adjust	3-70
Lock to Lock	3-72
Friction Set	3-74
Rigging recommendation	3-76
Battery cable length	3-76
Extension length recommendation for battery cable	3-76
Propeller selection	3-78
Propeller size	3-78
Selection	3-79
Fuel line air purging	3-81
Air purging during initial priming	3-81

Important reminder on rigging

Outboard motor mounting instructions

⚠ WARNING

- Overpowering a boat could cause severe instability. Do not install an outboard motor with more horsepower than the maximum rating on the capacity plate of the boat. If the boat does not have a capacity plate, consult the boat manufacturer.
 - Improper mounting of the outboard motor could result in hazardous conditions, such as poor handling, loss of control, or fire hazards.
-

⚠ WARNING

Too much weight on the transom can change the center of gravity, buoyancy, operating balance, or performance of the boat, which could cause loss of control or swamping. Consult the boat manufacturer for the maximum engine weight allowable on the transom, which is different from the overall boat capacity. Overloading the transom with an outboard motor that is too heavy could also damage the hull, transom, deck, or helm area, as well as the outboard motor and other equipment.

⚠ WARNING

Before mounting the outboard motor, consult the manufacturer of the engine jack plates or brackets. Excessive loads could damage the engine jack plates, brackets, boat transom, steering system, or engine. These damages could cause loss of control.

NOTICE

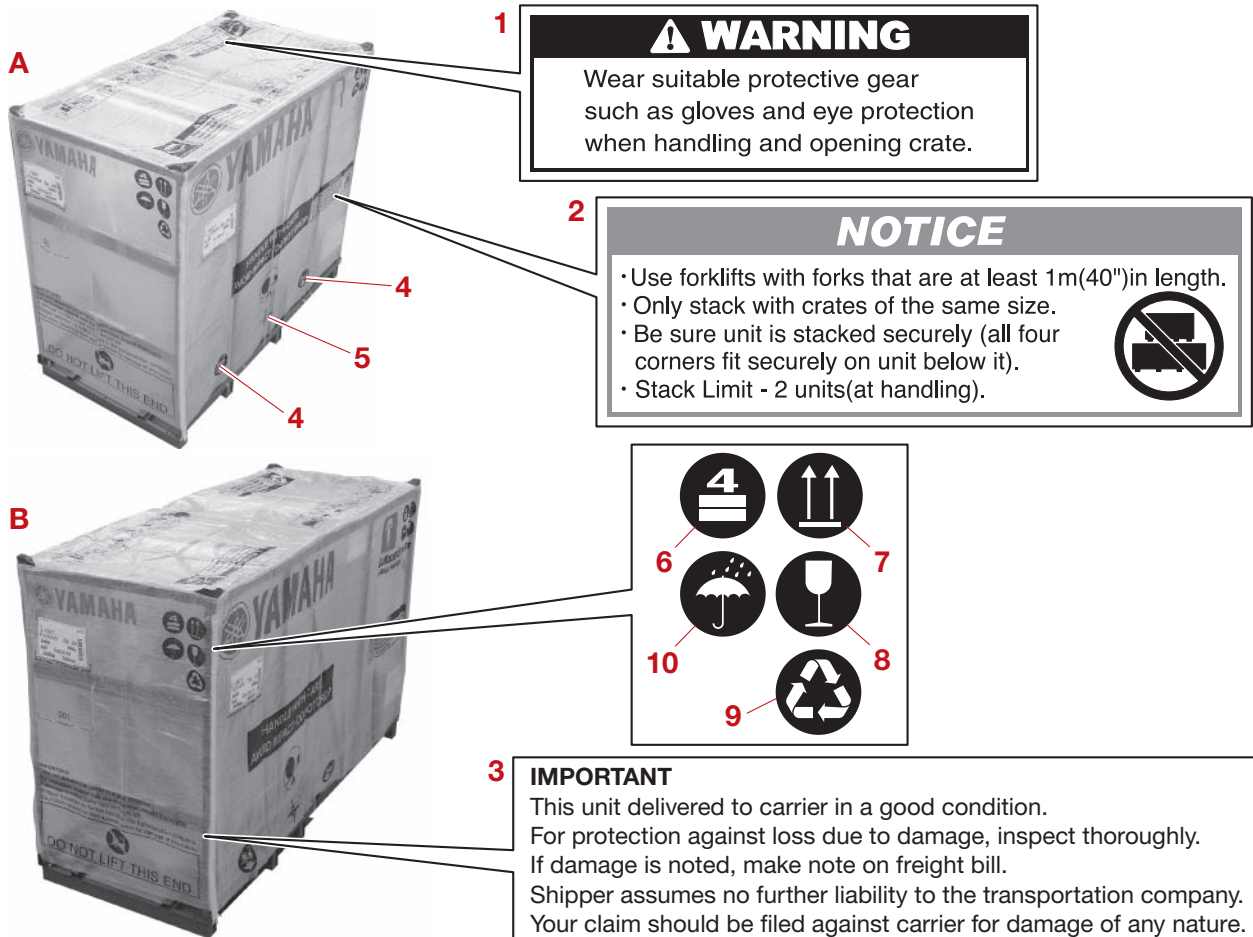
This outboard motor is designed exclusively for use with the Digital Electronic Control and CL5 Display/CL7 Display. Do not use this outboard motor with other control equipment or measuring devices.

Crate handling

Crate top cover symbol description

The following symbol are important when handling the crate.

Read the notice and understand what each symbol means to prevent damage to the outboard motor when handling, transporting, and storing the crate.



A. Outboard motor without lower unit

B. Outboard motor with lower unit

1. **WARNING**

Wear suitable protective gear such as gloves and eye protection when handling and opening crate.

2. **NOTICE**

- Use forklifts with forks that are at least 1 m (40 in) in length.
- Only stack with crates of the same size.
- Be sure unit is stacked securely (all four corners fit securely on unit below it).
- Stack Limit - 2 units (at handling).

3. **IMPORTANT**

This unit delivered to carrier in a good condition.

For protection against loss due to damage, inspect thoroughly.

If damage is noted, make note on freight bill.

Shipper assumes no further liability to the transportation company.

Your claim should be filed against carrier for damage of any nature.

4. Lifting fork insert position

5. Crate barycentric position

6. Stack limit: Maximum 4 units for storage

7. Upward indication

8. Care handling indication

9. Recycling indication

10. Water avoidance indication

Uncrating

Uncrating procedure (outboard motor without lower unit)

⚠ WARNING

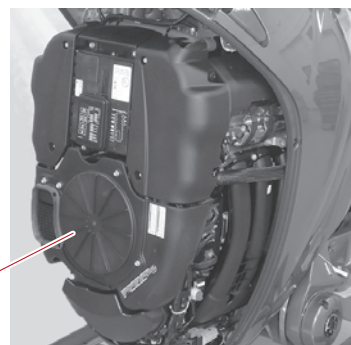
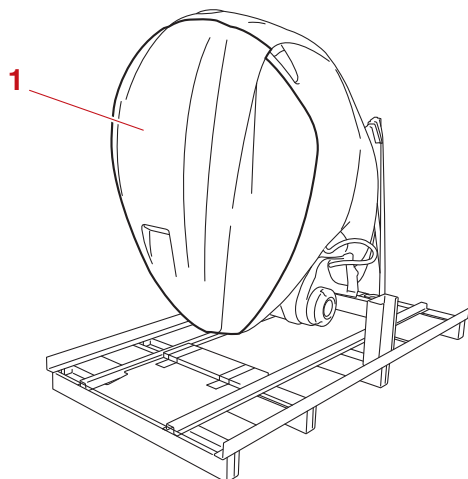
Wear gloves to avoid injury from sharp steel edges while uncrating.

1. Check:
 - Crate for shipping damage
If any damage is found, consult your Yamaha distributor.
2. Remove:
 - Top cover
 - Frame
 - Wrapping

NOTICE

Be careful not to damage the outboard motor.

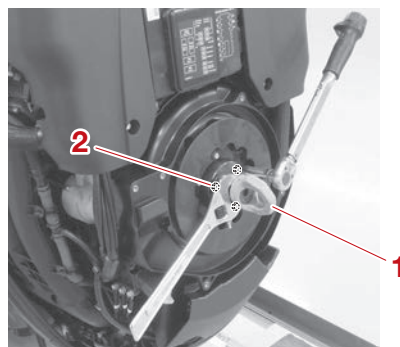
3. Check:
 - Outboard motor for concealed damage
If any damage is found, consult your Yamaha distributor.
4. Remove:
 - Top cowling "1"
 - Shroud cover "2"





5. Install:
 - Special service tool

NOTICE

When lifting the outboard motor, make sure to use the specified special service tool. Other bolts and hanging jigs could bend or break, causing the outboard motor to fall.



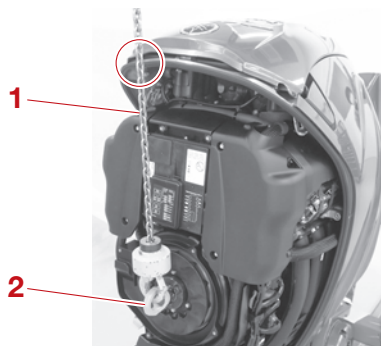
	Lifting eye "1" 90890-06953 Bolt hexagon with washer "2" 90890-06821 Bolt hexagon with washer "2" YB-06821
-------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------------------------------------------

	Lifting eye bolt 36 N·m (3.6 kgf·m, 27 lb·ft)
-------------------------------------------------------------------------------------	--------------------------------------------------

6. Install:
 - Lifting harness "1"
(to the lifting eye "2")
7. Apply tension to the lifting harness.

NOTICE

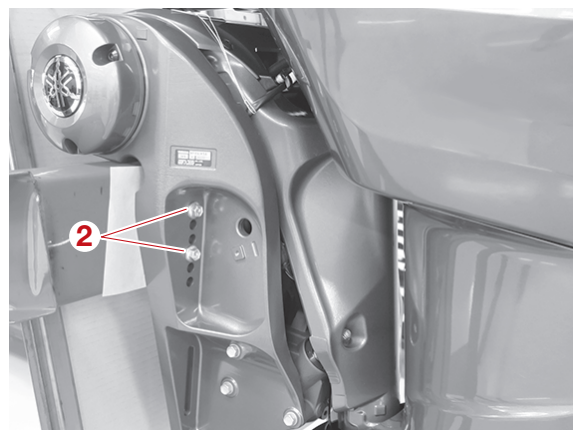
Make sure that the lifting harness does not contact the bottom cowling rear cover.



8. Lift up the outboard motor carefully along with the bottom frame "1".

NOTICE

Make sure that the lifting harnesses do not damage any parts of the outboard motor.

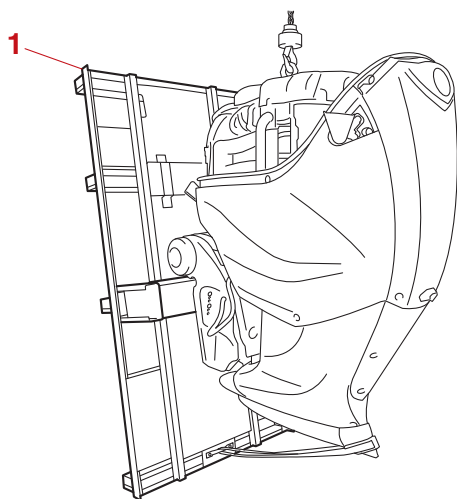


Uncrating procedure (outboard motor with lower unit)

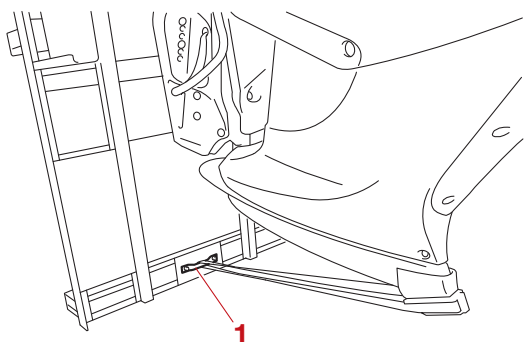
This procedure includes only the information that is different from the information in the procedure for the outboard motor without the lower unit. For the procedure of unpacking and lifting up the outboard motor, see "Uncrating procedure (outboard motor without lower unit)" (3-3).

WARNING

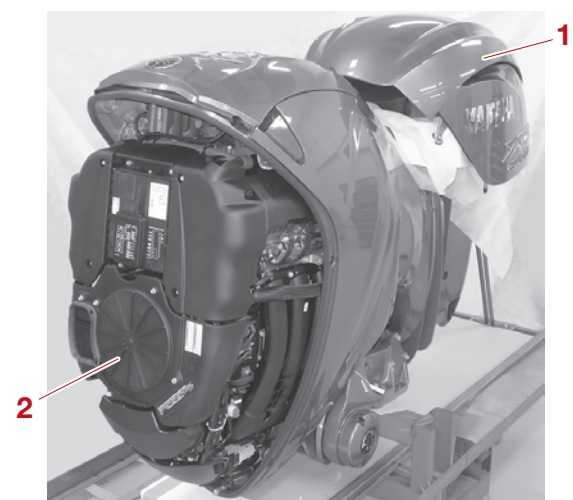
Wear gloves to avoid injury from sharp steel edges while uncrating.



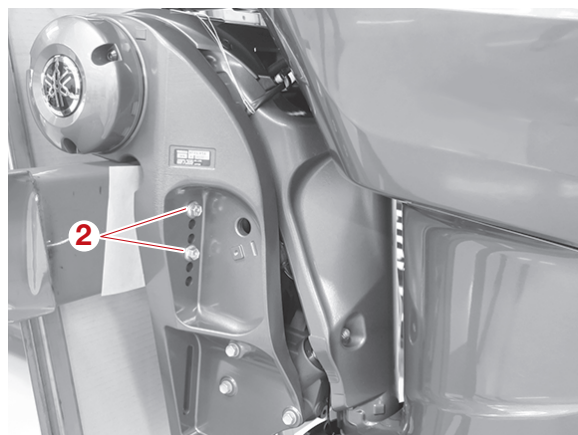
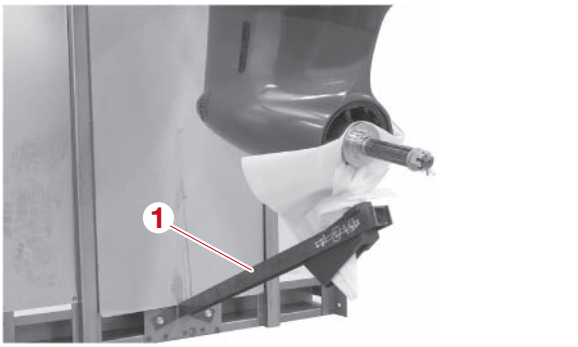
9. Remove:
- Skag holder "1"
 - Mount bolt "2"
 - Bottom frame



1. Remove:
- Top cowling "1"
 - Shroud cover "2"



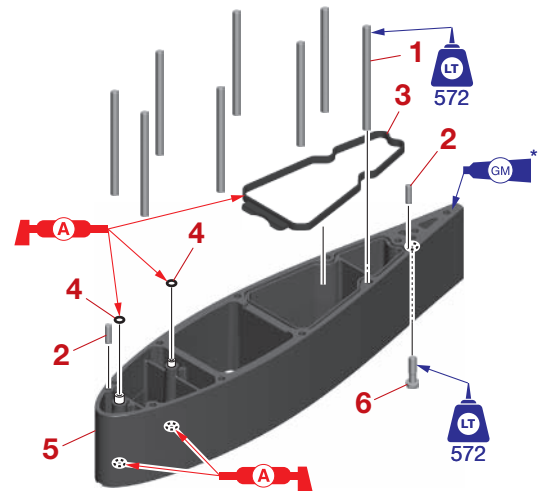
2. Remove:
- Skag holder "1"
 - Mount bolts "2"
 - Bottom frame



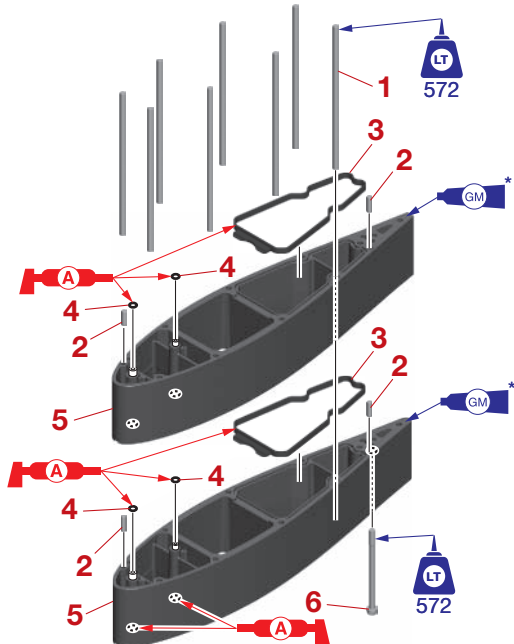
3. Mount:
 - Outboard motor
(to the boat or maintenance stand)
See "Installing the outboard motor" (3-8).
4. Remove:
 - Lifting harness
 - Special service tool
5. Install (for U- or E-transom model):
 - Stud bolts "1"
 - Dowels "2"
 - Rubber seal "3"
 - O-rings "4"
 - Extension "5"
 - Extension mounting bolt "6"

TIP: _____
 Point the flat end of the stud bolt up.

A





B



A. U-transom model

B. E-transom model

*. Use white sealant for white-colored units.

	Stud bolt "1"
	23 N·m (2.3 kgf·m, 17 lb·ft)
	Extension mounting bolt "6"
	42 N·m (4.2 kgf·m, 31 lb·ft)

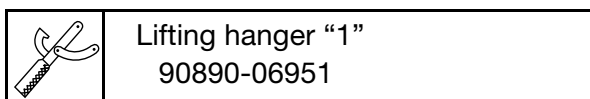
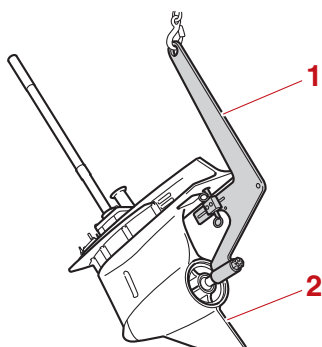
6. Install:
 - Water pipe
 - Dowel
 - Lower unit
 - Lower unit mounting bolts (for X-transom model)
 - Washers (for U- or E-transom model)

- Lower unit mounting nuts (for U- or E-transom model)
 - a. Install the water pipe.

TIP: _____

- Check that the rubber seal where the water pipe is inserted is installed properly, there is no foreign material on the rubber seal, and so on.
- Install the water pipe completely.

- b. Install the dowels to the lower unit.
- c. Install the special service tool "1" onto the lower unit "2".
- d. Hook a lifting harness onto the special service tool "1".
- e. Tilt the outboard motor up so that the mating surface of the outboard motor is parallel to the mating surface of the lower unit.



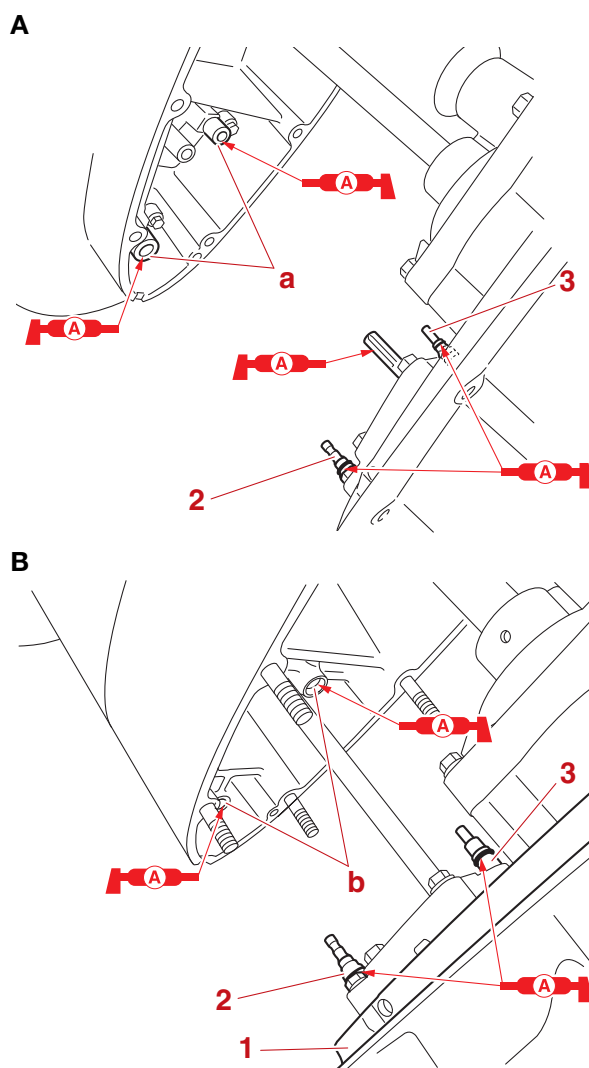
- f. Install the lower unit "1"

WARNING _____

- Make sure to disconnect the battery cables from the battery, and remove the clip from the engine shut-off switch.
- When removing or installing the lower unit with the power unit installed, make sure to suspend the outboard motor. Otherwise, the outboard motor could fall suddenly and result in severe injuries.

TIP: _____

- Align the check valves "2" and "3" with the holes "a" in the joint. (For X-transom model)
- Align the check valves "2" and "3" with the holes "b" in the extension. (For U- or E-transom model)
- If the lower unit cannot be installed properly to the outboard motor, check that the protruding portions are aligned properly with their corresponding openings.

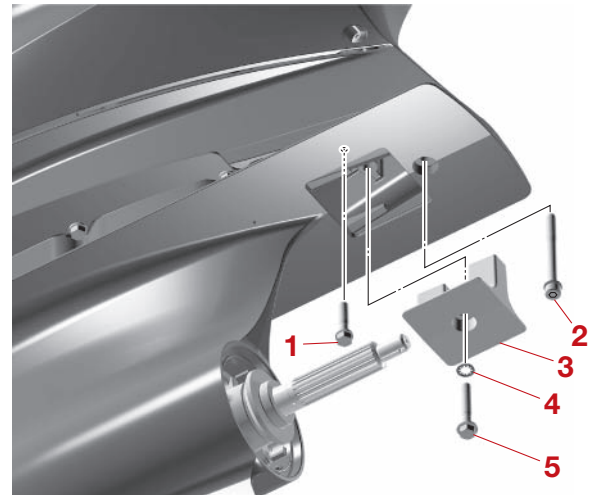
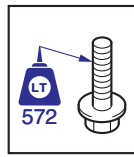
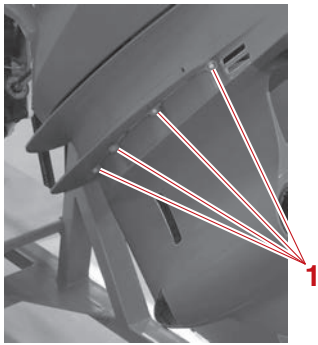


A. For X-transom model

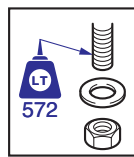
B. For U- or E-transom model


- g. Tighten the bolts "1". (For X-transom model)
Tighten the nuts "1". (For U- or E-transom model)

A




B



	Lower case mounting bolt 47 N·m (4.7 kgf·m, 35 lb·ft)
	Lower case anode bolt 42 N·m (4.2 kgf·m, 31 lb·ft)

A. For X-transom model

B. For U- or E-transom model

	Lower case mounting bolt (for X-transom model) 47 N·m (4.7 kgf·m, 35 lb·ft)
	Lower case mounting nut (for U- or E-transom model) 47 N·m (4.7 kgf·m, 35 lb·ft)
	Lower case mounting bolt (for X-transom model) 47 N·m (4.7 kgf·m, 35 lb·ft)

h. Remove the special service tool.

7. Install:

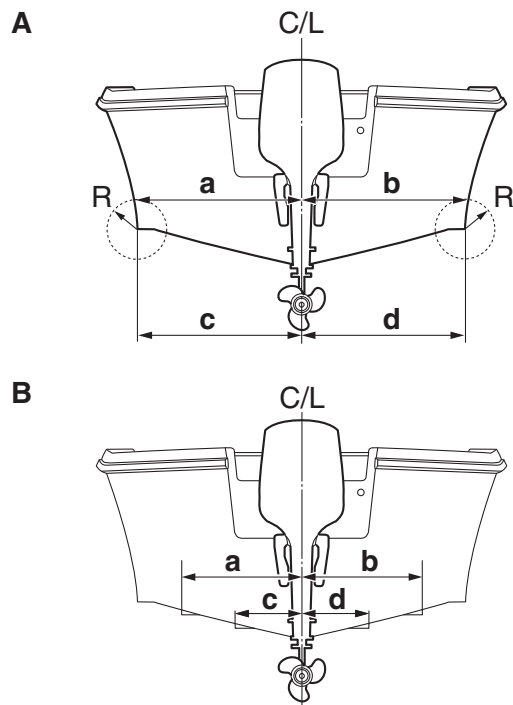
- Lower case mounting bolts “1”, “2”
- Anode “3”
- Washer “4”
- Anode bolt “5”

Outboard motor mounting
Installing the outboard motor

Properly mounting the outboard motor will result in better engine performance, product reliability, fuel economy, customer satisfaction, etc. This chapter provides a brief summary of the procedures for mounting the outboard motor. The first requirement is to make sure the outboard motor has clearance for full movement, from port to starboard, as well as during tilt operation. For the motor dimensions, see “External dimensions” (1-2).

1. For a single outboard motor application, place the outboard motor on the vertical centerline of the boat transom. For a hull without strakes, make the same radius (R) at both sides of the hull, and use another measurement point.

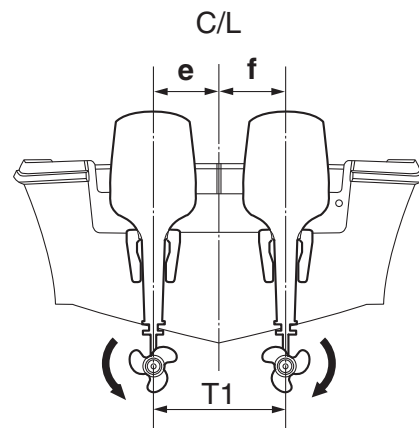
TIP: _____
 Make sure that distance “a” is equal to distance “b”, and distance “c” is equal to distance “d”.



A. Hull without strakes
 B. Hull with strakes
 C/L.Centerline of the transom

For a twin outboard motor application, place the outboard motors so that the distance from the C/L of each outboard motor to the C/L of the boat transom are equal on both sides.

TIP: _____
 • Make sure that the distance “e” is equal to distance “f”.
 • For the distance (T1), see “External dimensions” (1-2).

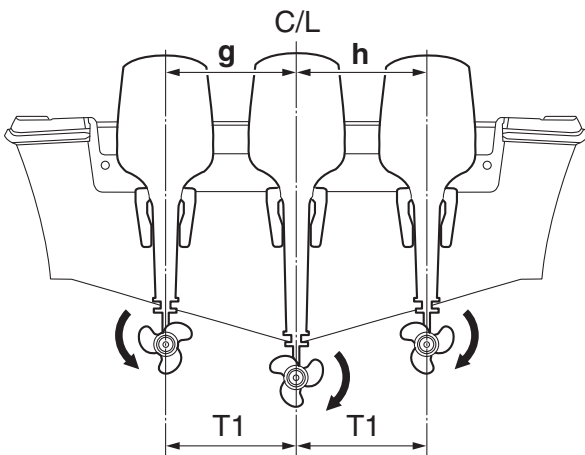


C/L.Centerline of the transom

For a triple outboard motor application, place the center outboard motor so that the C/L of the outboard motor is aligned with the C/L of the boat transom. Place the other two outboard motors on both sides so that the distance from the C/L of each outboard motor to the C/L of the boat transom are equal.

TIP: _____
 • Make sure that the distance “g” is equal to distance “h”.
 • If the boat has a V shape hull, the center outboard motor should have a longer transom height than the outboard motors on both sides.
 • For the distance (T1), see “External dimensions” (1-2).

Outboard motor mounting

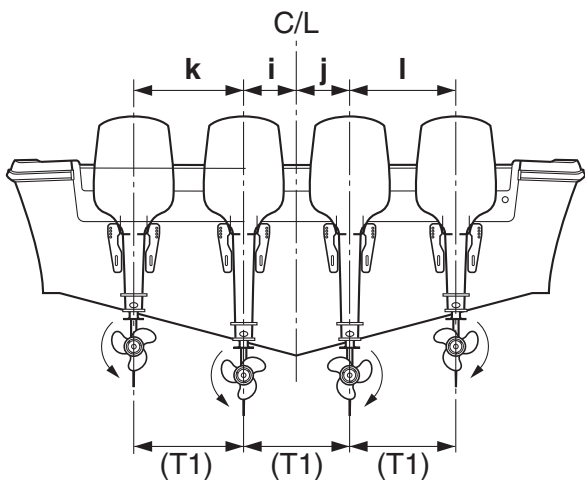


C/L.Centerline of the transom

For a quad outboard motor application, place the outboard motors so that the distance from the C/L of each outboard motor to the C/L of the boat transom are equal on both sides.

TIP:

- Make sure that the distance “i” is equal to distance “j”.
- Make sure that the distance “k” is equal to distance “l”.
- If the boat has a V shape hull, the center outboard motors should have a longer transom height than the outboard motors on both sides.
- For the distance (T1), see “External dimensions” (1-2).

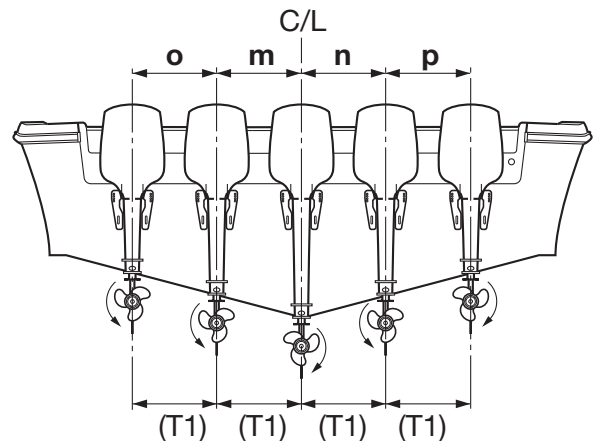


C/L.Centerline of the transom

For a quint outboard motor application, place the center outboard motor so that the C/L of the outboard motor is aligned with the C/L of the boat transom. Place the other four outboard motors so that the distance from the C/L of each outboard motor to the C/L of the boat transom are equal on both sides.

TIP:

- Make sure that the distance “m” is equal to distance “n”.
- Make sure that the distance “o” is equal to distance “p”.
- If the boat has a V shape hull, the center outboard motors should have a longer transom height than the outboard motors on both sides.
- For the distance (T1), see “External dimensions” (1-2).



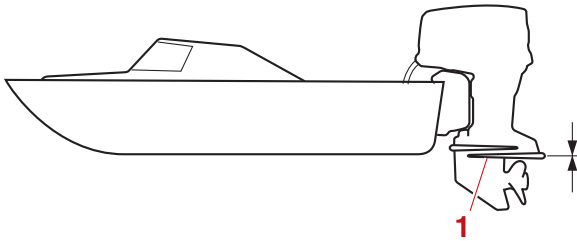
C/L.Centerline of the transom

2. Adjust the position of the outboard motor so that the height of the anti-cavitation plate “1” is equal to the bottom of the boat transom.

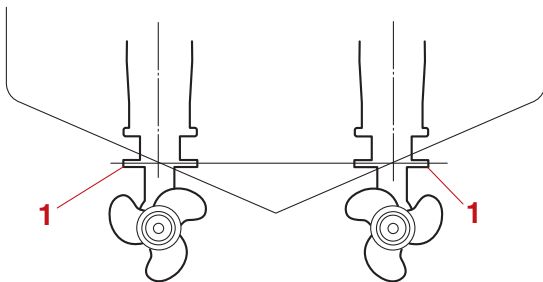
TIP:

This mounting height information is for reference only. It is impossible to provide complete instructions for every possible boat and outboard motor combination.

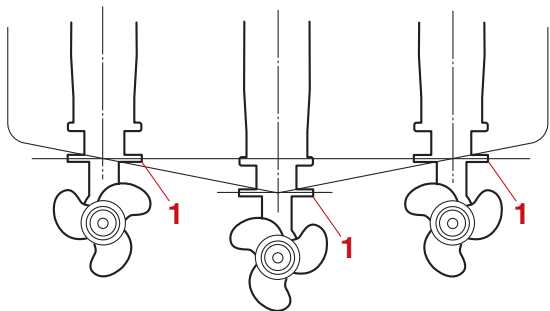
A



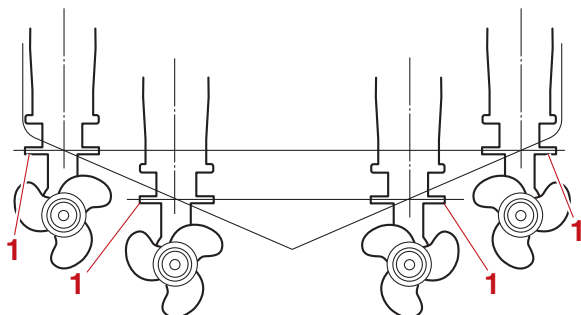
B



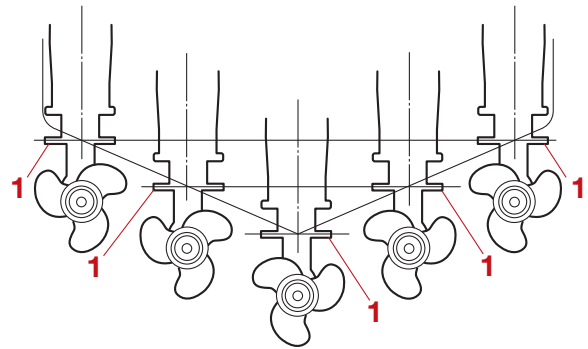
C



D



E



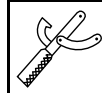
- A. Single outboard motor application
- B. Twin outboard motor application
- C. Triple outboard motor application
- D. Quad outboard motor application
- E. Quint outboard motor application

TIP: _____

The mounting height of an outboard motor varies based on the boat and engine model combination. For more information for your specific boat package, contact your boat manufacturer.

3. Install:

- Special service tool "1"



Drilling plate "1"
90890-06783
Drilling plate "1"
YB-34465-A

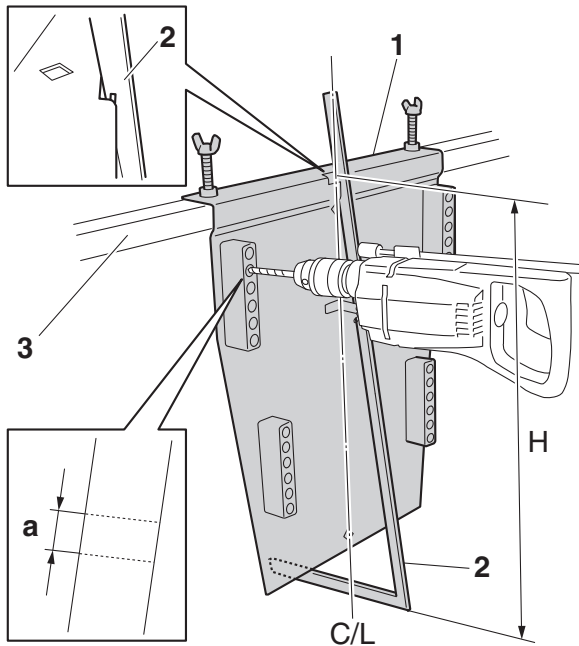
4. Adjust the height of the scale "2" to the transom height (H), and place it on the special service tool "1". Secure the special service tool "1" to the boat transom using screws or vises.

TIP: _____

For the transom height (H), see "External dimensions" (1-2).

5. When the outboard motor mounting position has been determined, mark the best suited 6 symmetrical mounting holes on the boat transom "3". Drill the mounting

holes perpendicular to the surface of the boat transom using a 13.0 mm (0.5 in) "a" drill bit.



C/L.Centerline of the transom

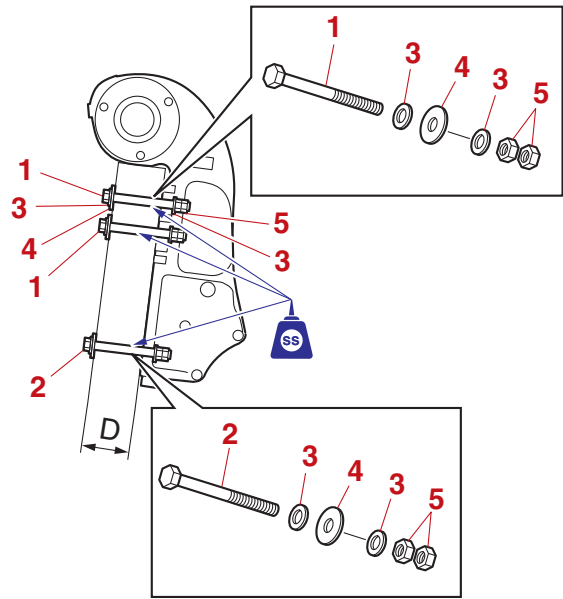
- Apply sealant to the mounting holes, and then secure the outboard motor using the included mounting bolts "1" and "2", small washers "3", large washers "4", and nuts "5".

NOTICE

Make sure that there is no clearance between the surfaces of the boat transom and the clamp brackets. Otherwise, the clamp brackets or boat transom may be damaged.

TIP:

The second hole from the top of each clamp bracket is recommended for the upper mounting bolt.



Upper mounting bolt "1"

Boat transom thickness (D)	Mounting bolt size	Part number
75–95 mm (3.0–3.7 in)	M12 × 170 mm (6.69 in)	90101-12068
	M12 × 180 mm (7.09 in)	90101-12073
95–115 mm (3.7–4.5 in)	M12 × 200 mm (7.87 in)	90101-12074
115 mm (4.5 in) or more	M12 × 210 mm (8.27 in)	90101-12069
	M12 × 230 mm (9.06 in)	90101-12070

Lower mounting bolt "2"

Boat transom thickness (D)	Mounting bolt size	Part number
75–95 mm (3.0–3.7 in)	M12 × 150 mm (5.91 in)	90101-12067

Outboard motor mounting

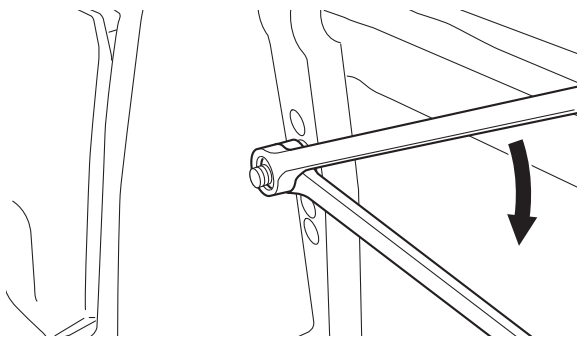
Boat transom thickness (D)	Mounting bolt size	Part number
95–115 mm (3.7–4.5 in)	M12 × 170 mm (6.69 in)	90101-12068
115 mm (4.5 in) or more	M12 × 180 mm (7.09 in)	90101-12073
	M12 × 200 mm (7.87 in)	90101-12074
	M12 × 210 mm (8.27 in)	90101-12069
	M12 × 230 mm (9.06 in)	90101-12070

- Install the mounting bolts, and then tighten the nuts firmly.

NOTICE

Make sure that the clamp brackets do not bite into the boat transom.

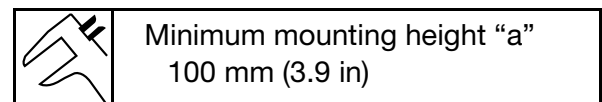
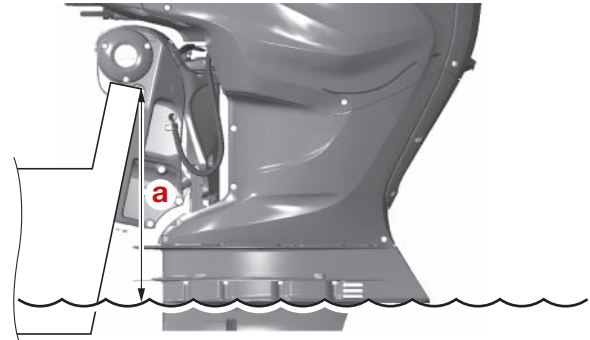
- Tighten the locknuts firmly.



Outboard motor mounting height

4-stroke engines are heavier than 2-stroke engines of the same horsepower. Therefore, if a 2-stroke outboard motor is replaced with a 4-stroke outboard motor, the boat will become “stern heavy”. Also, the water line will rise and become closer to the power unit. If the water line is too close to the power head, poor engine performance could result, and water could enter the cylinders and damage the engine.

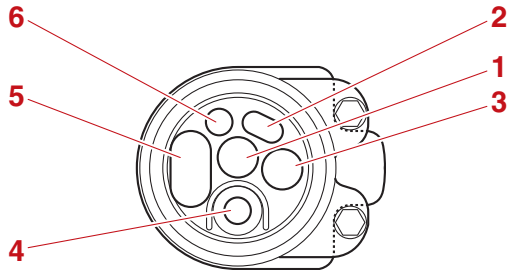
When mounting a 4-stroke outboard motor to a boat, make sure that the mounting height between the water surface and the clamp bracket seating point is not less than the specified minimum mounting height “a”. Measure the mounting height when the boat is moored and carrying the maximum load.



Rigging grommet mounting

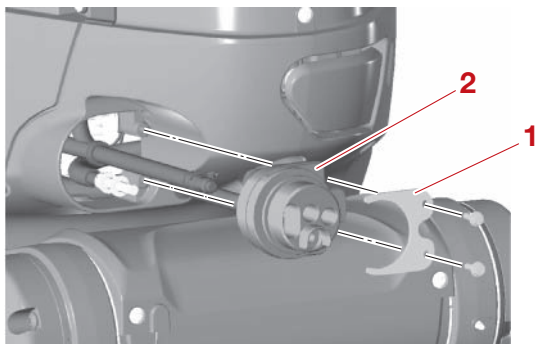
Rigging grommet description

Pass all the control components through the proper holes in the rigging grommet.



1. Main wire harness
2. SCU communication lead (for multiple engine applications)
3. Flushing hose
4. Fuel hose
5. Battery cable
6. Isolator lead (optional)

1. Remove the grommet holder "1" and rigging grommet "2".

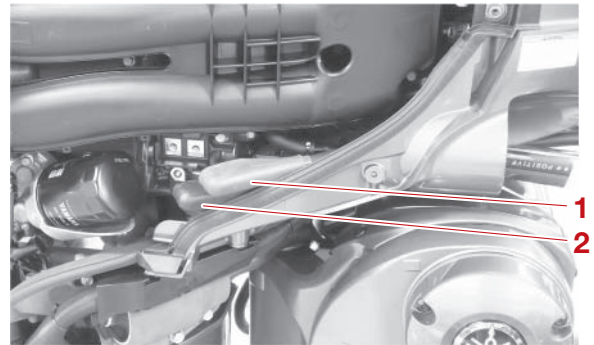


Installing the battery cable

1. Remove:
 - Bottom cowling cover
See "Bottom cowling cover and apron cover" (9-1).
 - Bottom cowling (STBD)
See "Bottom cowling (PORT and STBD)" (9-3).
2. Install
 - Battery cable
 - a. Insert the battery cables into the bottom cowling so that the positive battery cable "1" is routed above the negative battery cable "2".

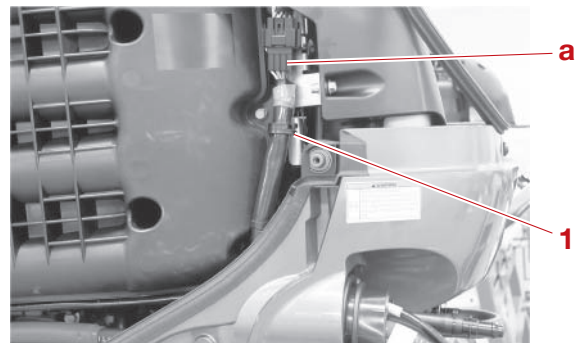
TIP:

Make sure that the hole in the end of the negative battery cable terminal fits over the projection.



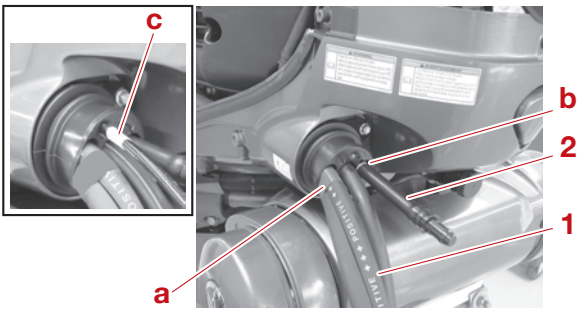
Installing the main wire harness

1. Install:
 - Main wire harness
 - a. Connect the main wire harness coupler "a", and then fasten it using the holder "1".

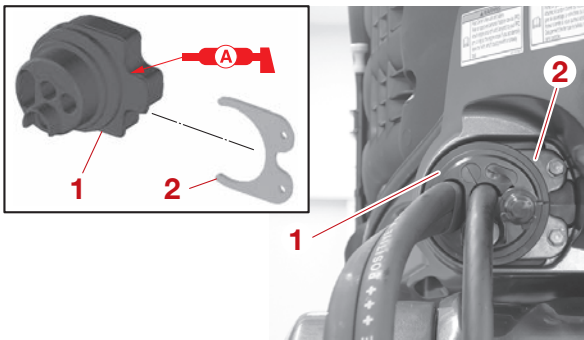


Installing the rigging grommet

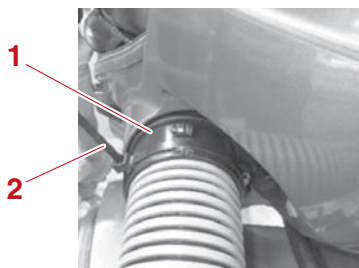
1. Install:
 - Rigging grommet
 - a. Route each harness through the proper hole in the rigging grommet. See "Rigging grommet description" (3-13).
 - b. Align the tape "a" on the battery cable "1" and mark "b" on the flushing hose "2" with the outer end of the rigging grommet.
 - c. Align the tape "c" on the SCU communication lead with the outer end of the rigging grommet. (For multiple engine applications)



d. Install the rigging grommet “1” along with the grommet holder “2”.



e. Install the rigging tube retainer “1”, and then fasten it using the plastic tie “2”.



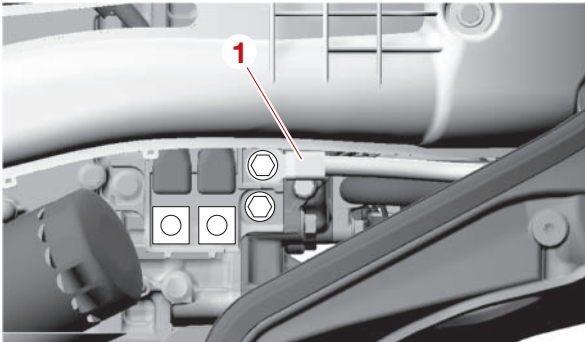
Connecting the fuel hose

- When connecting the fuel hose, bleed the boat fuel line.
See “Air purging during initial priming” (3-81).
- The engine idle speed may be unstable after the engine is started until the air is bled from the high-pressure line, but this is not a malfunction.

Optional equipment

Installing the isolator lead

1. Install
 - Isolator lead
 - a. Insert the isolator lead into the bottom cowling.
 - b. Remove the isolator terminal cover.
 - c. Install the isolator lead “1” and square washer to the isolator terminal.



- d. Install the rubber cap.

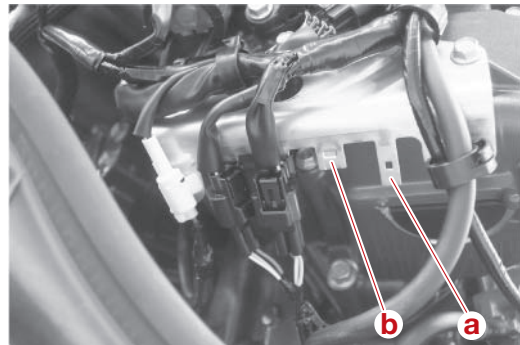
Installing the SCU communication lead

To improve working efficiency for the rigging of multiple engine applications, start from the outboard motor on the port side of the boat.

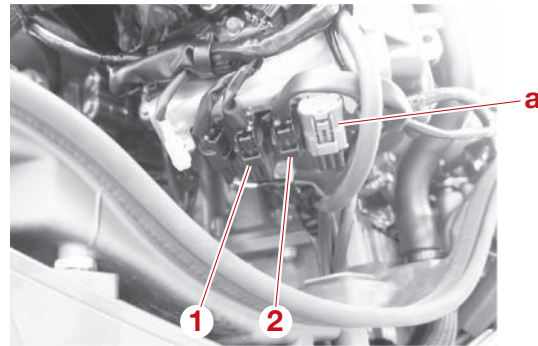
1. Install:
 - SCU communication lead
 - a. Insert the SCU communication lead into the bottom cowling.
 - b. Install the SCU communication lead coupler.

TIP:

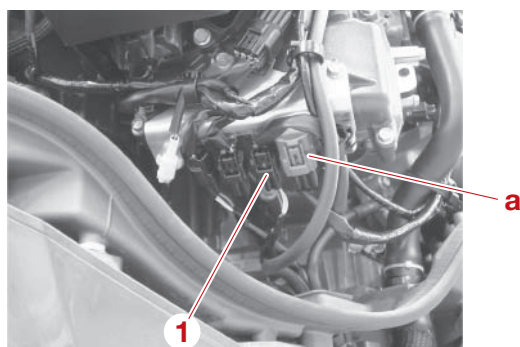
- For the port or starboard outboard motor of multiple engine applications, install the coupler (6 pins) onto the tab “a” and install the coupler (4 pins) onto the tab “b”.
- For the center outboard motor of multiple engine applications, install the coupler (4 pins) onto the tab “b”.



- c. Disconnect the SCU signal coupler “1”.
- d. Remove the coupler cap from the SCU communication lead coupler (4P) “2”, and then install the cap to the SCU signal coupler (4P) “1” (female section).



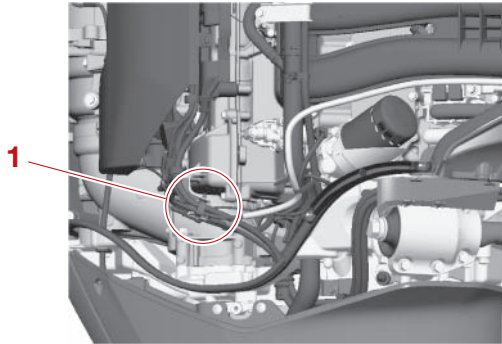
- a. For the port or starboard outboard motor of multiple engine applications only
- e. Connect the SCU signal coupler (male section) to the SCU communication lead coupler (4P) “1”.



- a. For the port or starboard outboard motor of multiple engine applications only
- f. Fasten the SCU communication lead using the holder “1” shown in the illustration.

TIP: _____

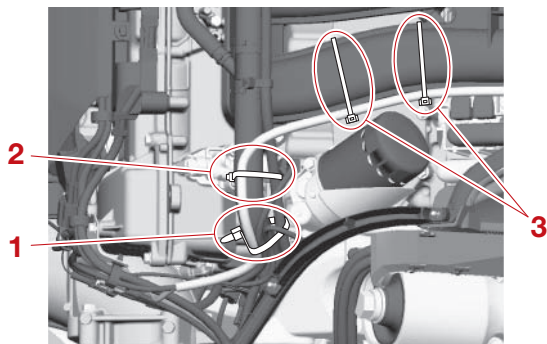
Make sure that there is no slack in the wire harness.



g. Fasten the SCU communication lead using the plastic ties “1”, “2”, and “3” at the 4 locations shown in the illustration.

TIP: _____

- Make sure that the SCU communication lead does not contact the oil filter.
 - Make sure that there is no slack in the wire harness.
-



Installing Y-COP

To install the Y-COP, see Helm Master Rigging Guide (6X9-28197-1*).

Battery installation

⚠ WARNING

- **Make sure to connect the battery properly and select the proper cable sizes. Otherwise, a fire could result.**
 - **If an optional isolator lead is installed and connected to a house battery, overcurrent protection in compliance with ABYC (E-11) or equivalent must be provided.**
-

NOTICE

- **Do not reverse the battery connections. Otherwise, the charging system could be damaged.**
 - **Route the positive battery cable and negative battery cable next to each other.**
 - **For excess portions of the battery cables, do not coil the cables more than is necessary.**
-

TIP:

- Always take care to never reverse battery connections. The rectifier/regulator itself is protected from damage by solid state semiconductors within the system, however other systems on the engine and on the boat may contain fuses or can be damaged by reverse polarity.
 - Wiring the starting battery to the 450-horsepower models are no different than 400-horsepower models. While Yamaha can not make recommendations about competitive engines wiring, most traditional wiring designs will work without issues with the 450-horsepower models. If using the isolator lead, please ensure that the wiring can handle the additional current that can be provided by the 450-horsepower models.
 - The motor cannot start using only the secondary charging lead. The current required to start the 450-horsepower models would exceed the 200-amp breaker capacity.
 - A 200-amp breaker is required when using the isolator lead. The Simultaneous Charging function has a much greater output than the 400-horsepower models when large current draws are placed on the house battery bank. This breaker is required to ensure that systems attached to the isolator lead do not exceed the rated capacity.
-

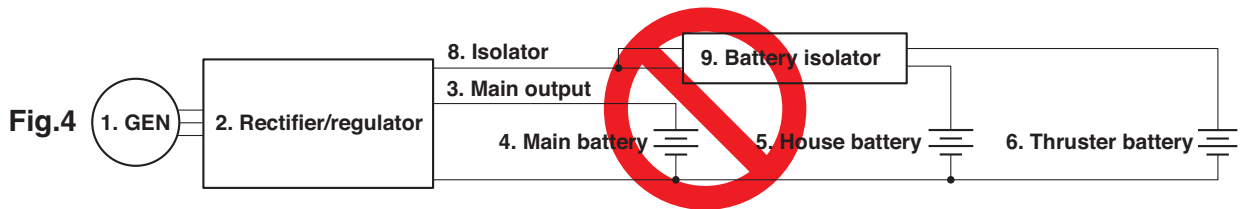
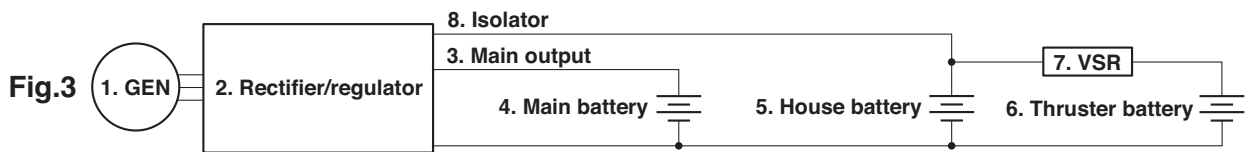
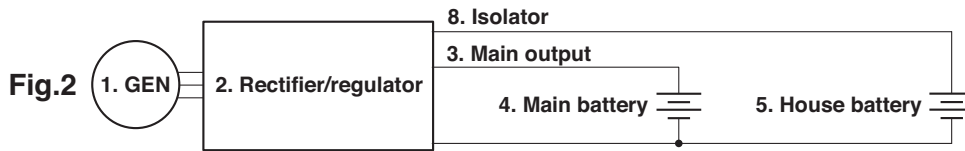
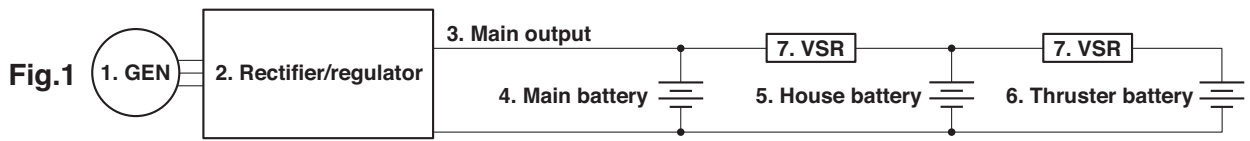
The increased charging output and the Simultaneous Charging function brings new options to integrating the 450-horsepower models into the electronics of a boat's power system.

To ensure that maximum performance is achieved, some simple guidelines should be followed.

Only the main output is used. Additional battery banks are connected with VSR's. This ensures priority charging of the starter battery (see Fig.1).

Main and isolator outputs are used. Additional battery banks are connected with VSR's. This ensures priority charging of the starter battery (see Fig.2 and Fig.3).

To function properly, the main and isolator leads must be in direct connection with the battery bank to be charged. Diode-based or other isolator systems inline will prevent the charging system from "seeing" the battery voltage of the house battery bank(s) and in that condition will not provide charging amperage to that lead (see Fig.4).

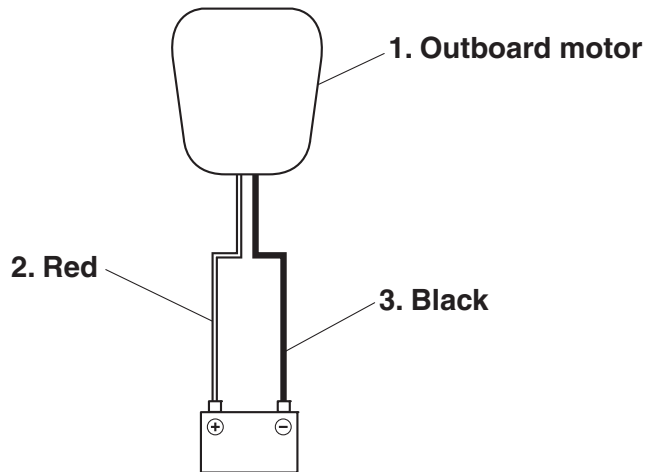


- 1. GEN
- 2. Rectifier/regulator
- 3. Main output
- 4. Main battery
- 5. House battery
- 6. Thruster battery
- 7. VSR
- 8. Isolator
- 9. Battery isolator

Battery wiring

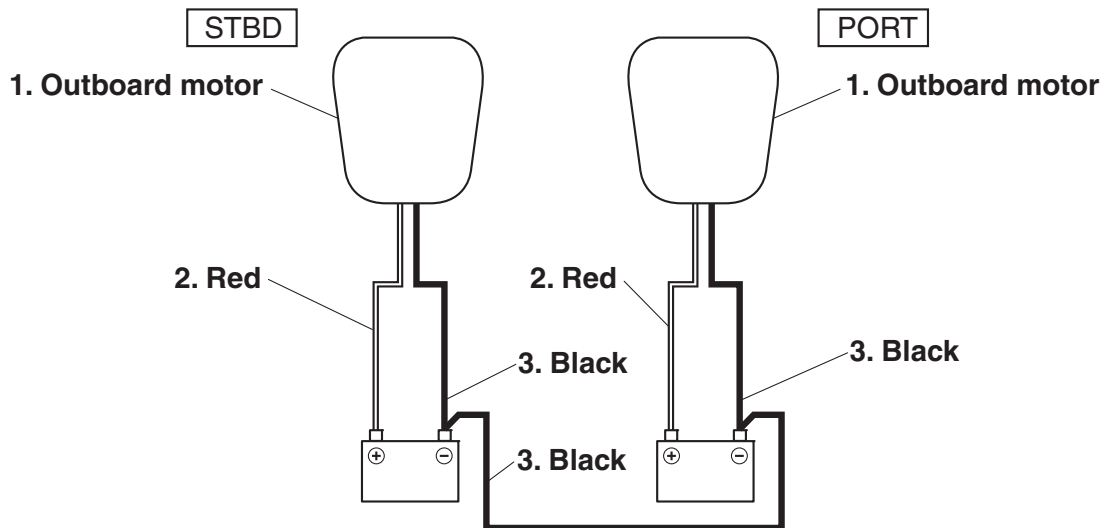
⚠ WARNING

When using a dual battery installation, a negative battery cable must be installed between both engine batteries. This cable must be sized equivalent to the engine battery cables or larger AWG cable size in accordance with ABYC specifications.

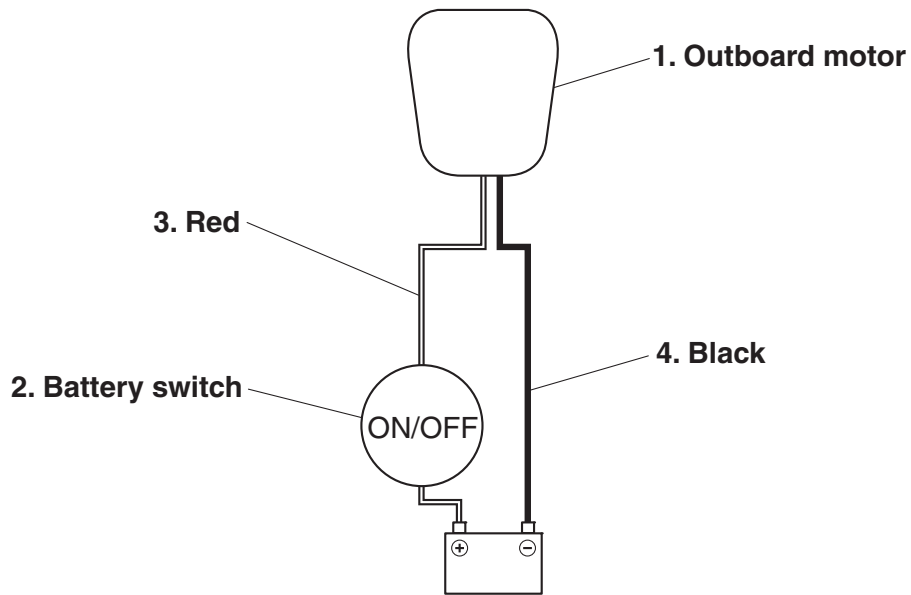


- 1. Outboard motor
- 2. Red

- 3. Black

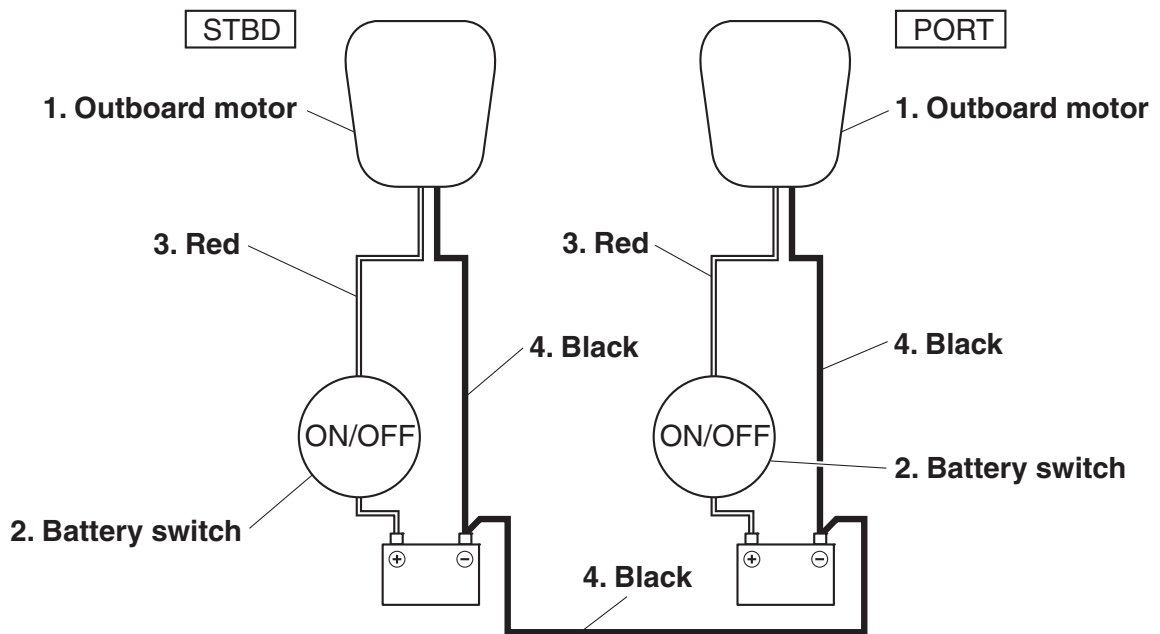


- 1. Outboard motor
- 2. Red
- 3. Black

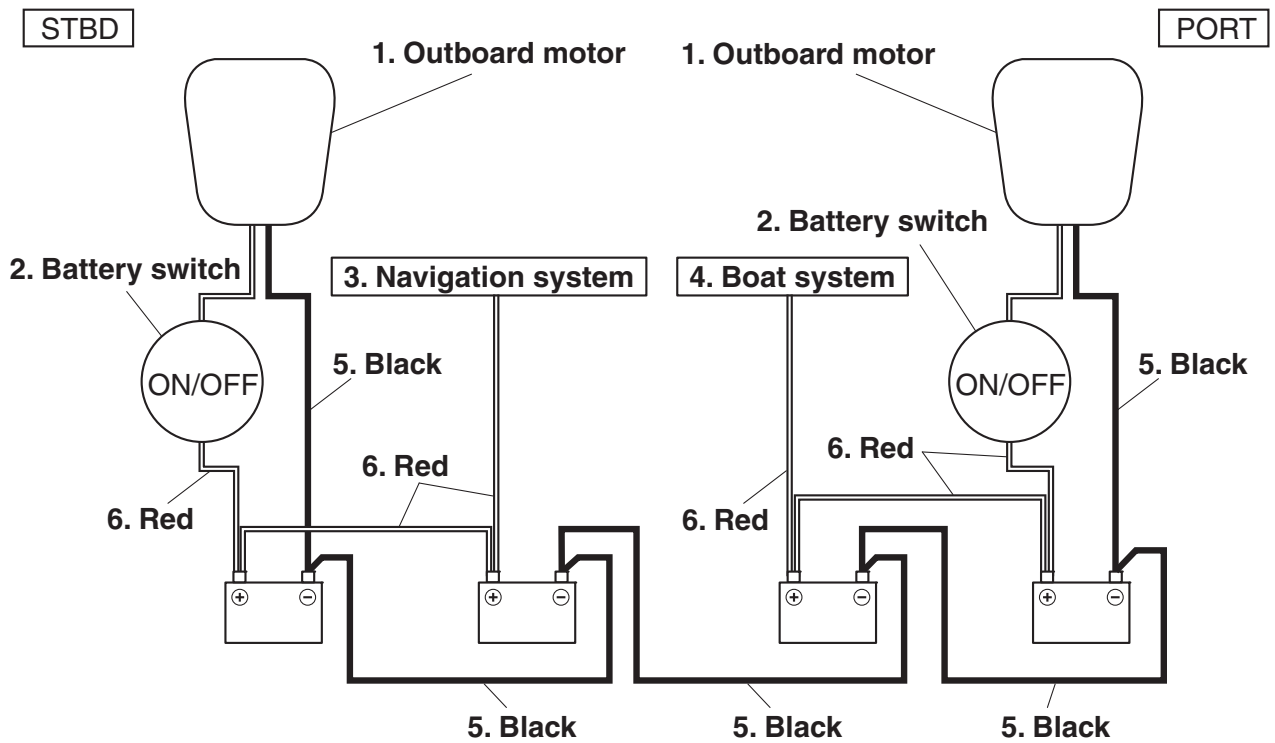


- 1. Outboard motor
- 2. Battery switch

- 3. Red
- 4. Black

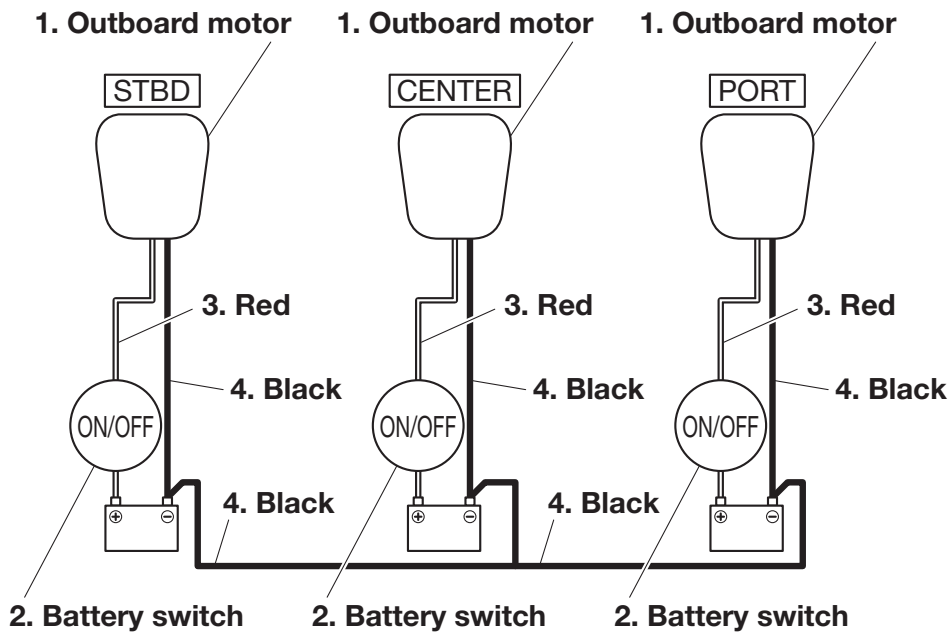


- 1. Outboard motor
- 2. Battery switch
- 3. Red
- 4. Black



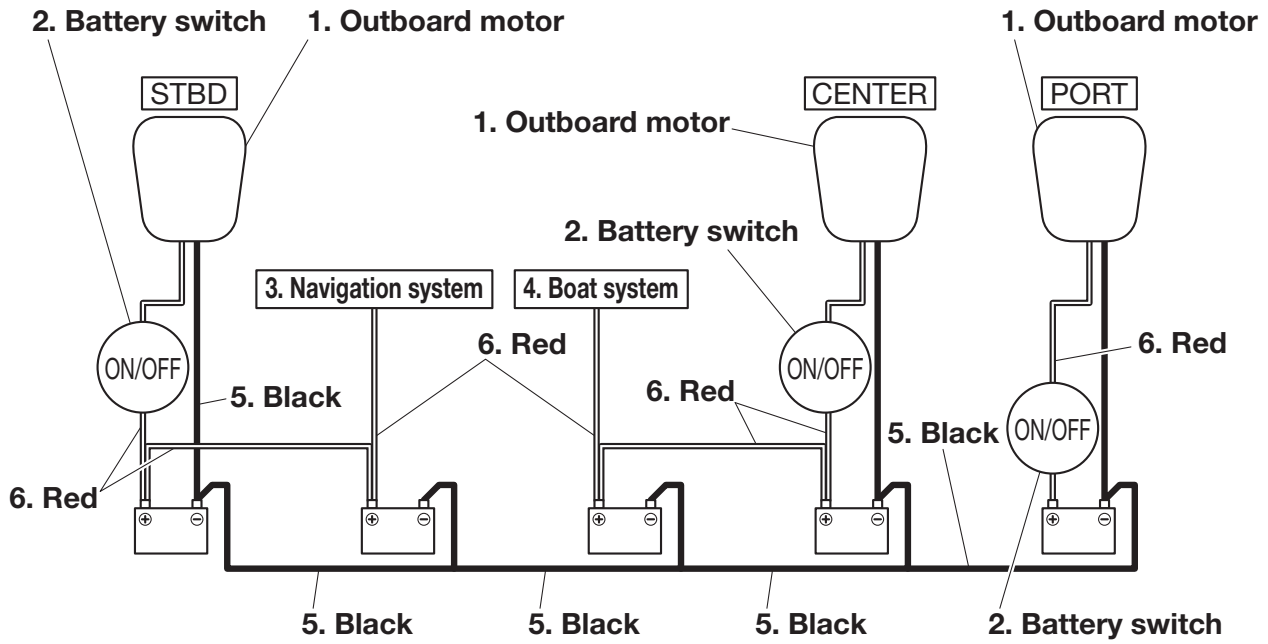
- 1. Outboard motor
- 2. Battery switch
- 3. Navigation system

- 4. Boat system
- 5. Black
- 6. Red

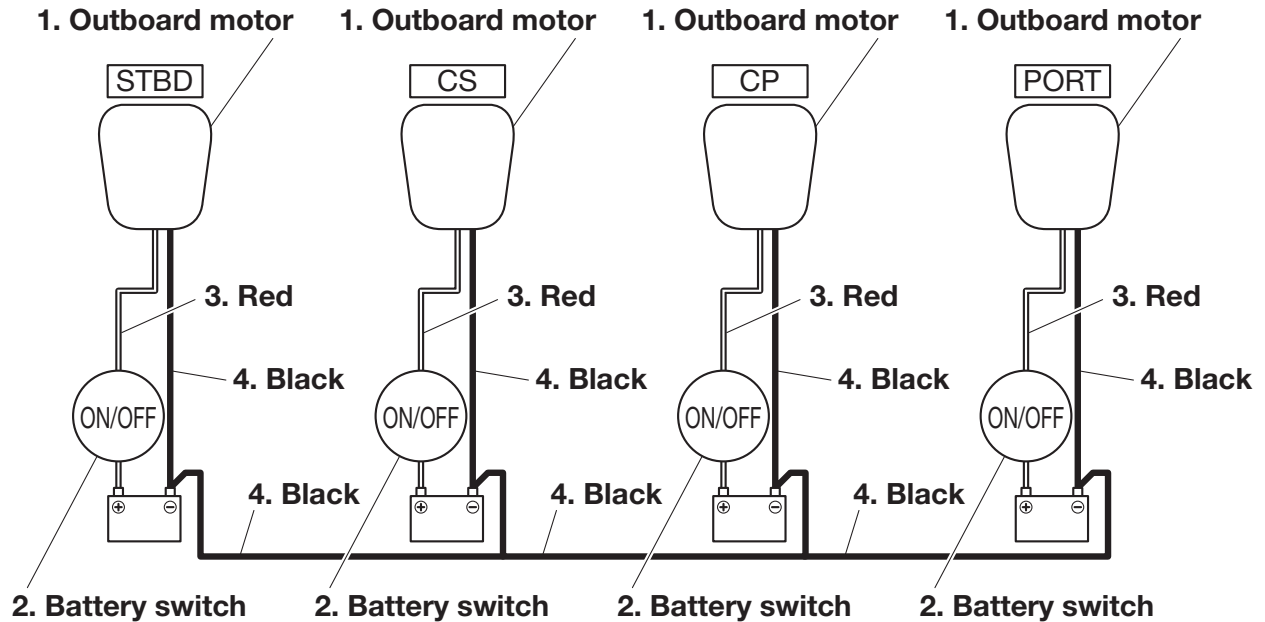


- 1. Outboard motor
- 2. Battery switch
- 3. Red

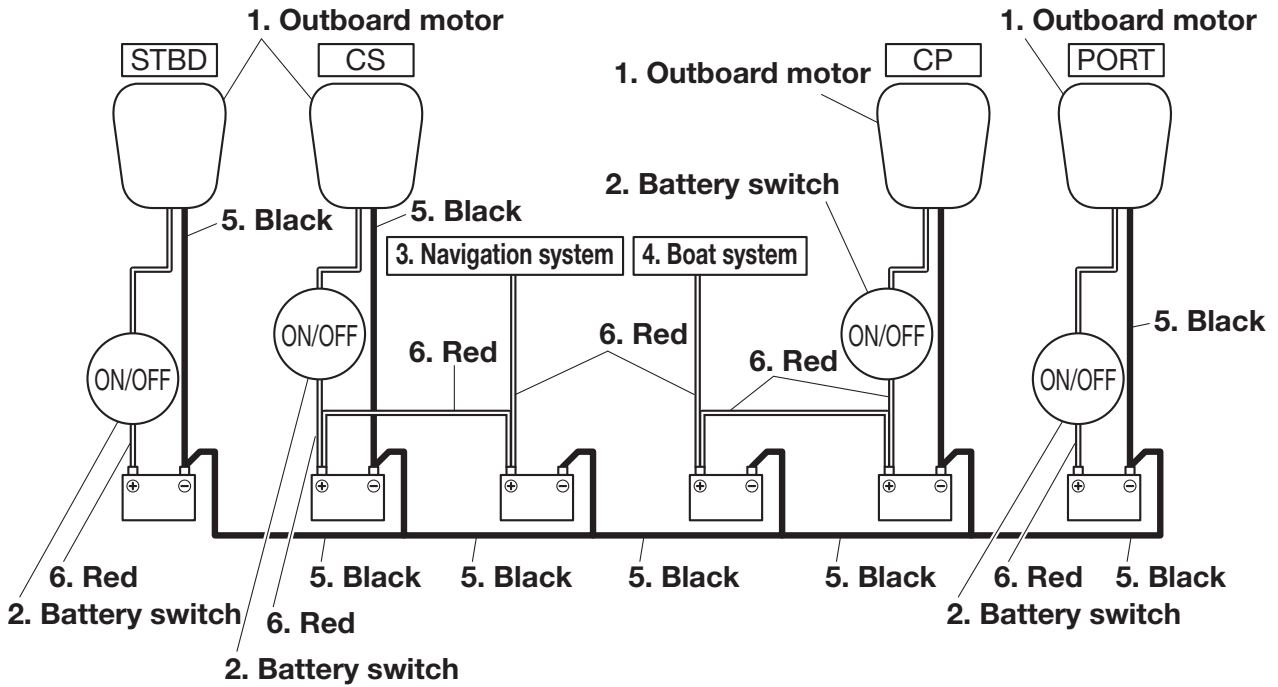
- 4. Black



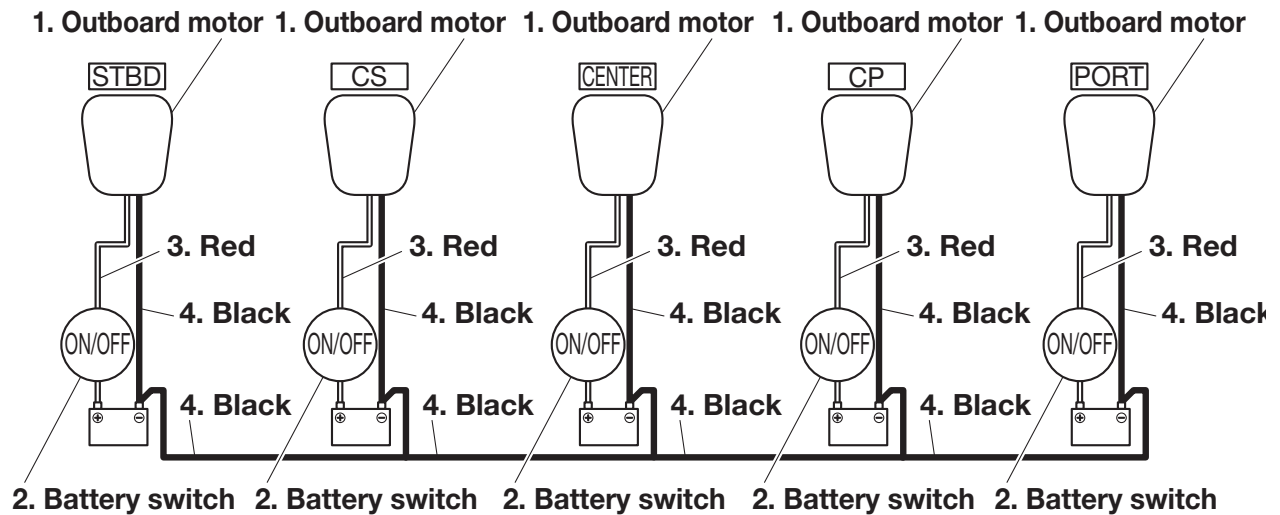
- 1. Outboard motor
- 2. Battery switch
- 3. Navigation system
- 4. Boat system
- 5. Black
- 6. Red



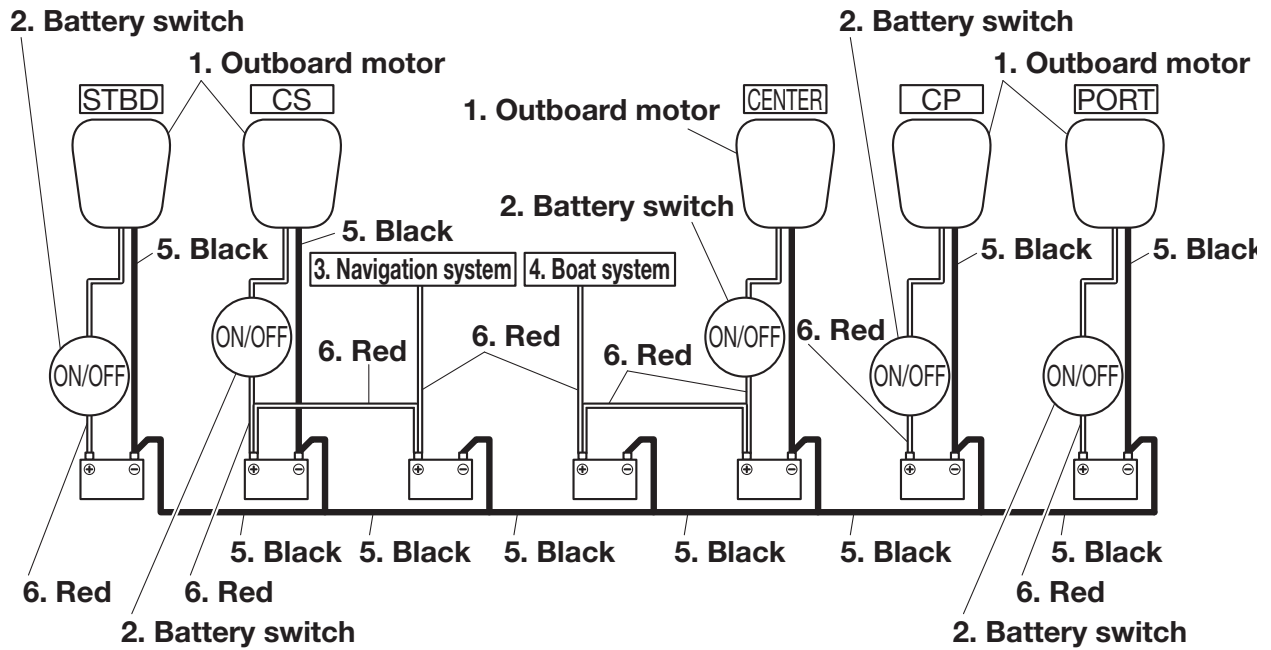
- 1. Outboard motor
- 2. Battery switch
- 3. Red
- 4. Black



- 1. Outboard motor
- 2. Battery switch
- 3. Navigation system
- 4. Boat system
- 5. Black
- 6. Red



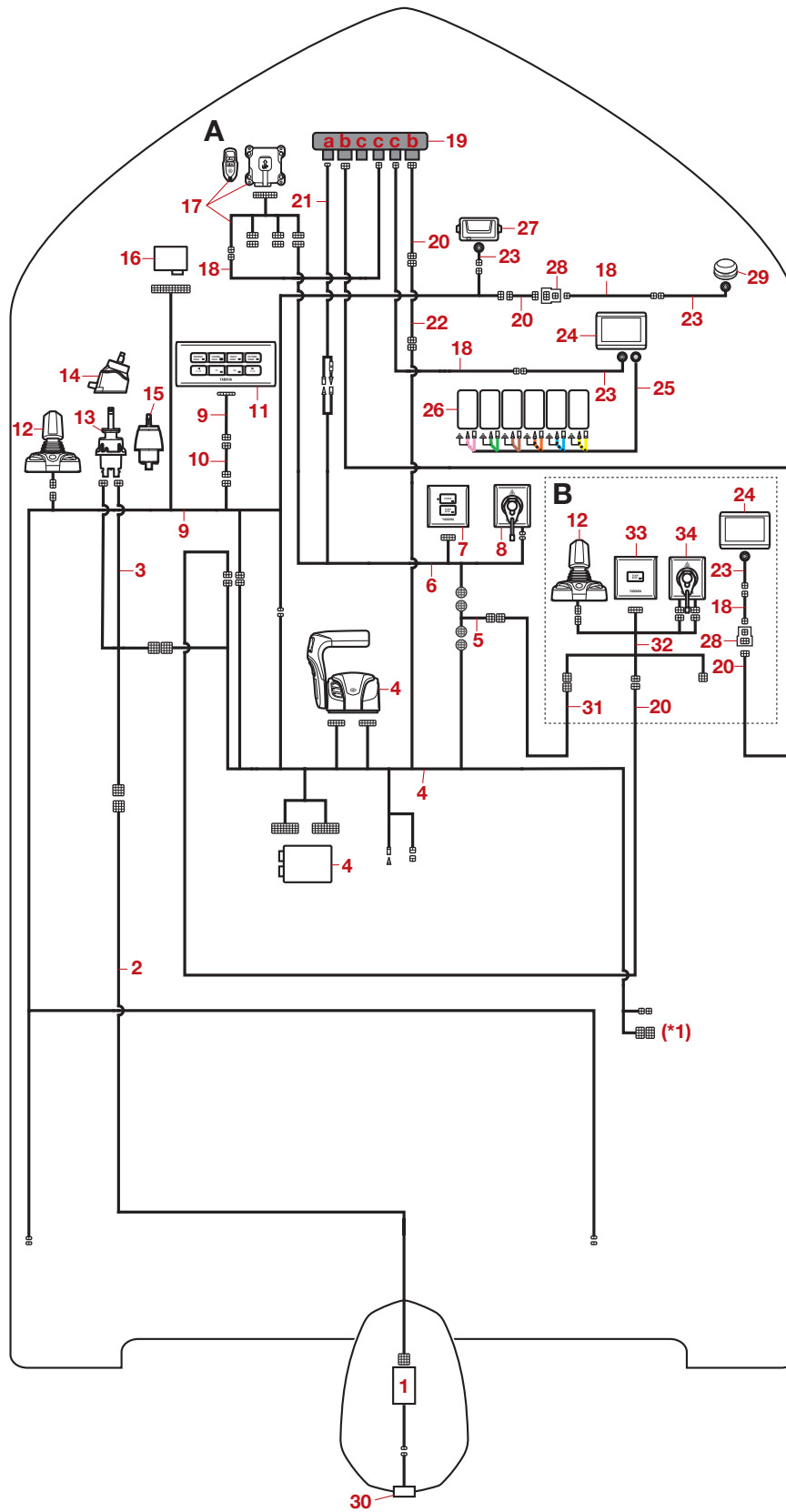
- 1. Outboard motor
- 2. Battery switch
- 3. Red
- 4. Black



- 1. Outboard motor
- 2. Battery switch
- 3. Navigation system
- 4. Boat system
- 5. Black
- 6. Red

System diagram

Single outboard motor application (single station)



System diagram

Ref. No.	Part name	Part No.	Remarks
1	Engine ECM	—	
2	Main wire harness (16P)	6X6-8258A-91	1.5 m (5 ft)
		6X6-8258A-51	3.7 m (12 ft)
		6X6-8258A-61	5.2 m (17 ft)
		6X6-8258A-01	6 m (19 ft)
		6X6-8258A-11	7 m (23 ft)
		6X6-8258A-21	8 m (26 ft)
		6X6-8258A-31	10 m (32 ft)
		6X6-8258A-41	12 m (39 ft)
		6X6-8258A-71	15 m (49 ft)
		6X6-8258A-81	24 m (79 ft)
3	Helm harness (Main/Single)	6GR-8258A-01	0.9 m (3 ft)
		6GR-8258A-41	1.8 m (6 ft)
4	Digital Electronic Control	6X9-48205-04	Main station
5	Split harness 1	6X9-8258A-C0	
6	EKS harness	6X9-82716-21	DEC to switch panel
7	Power switch	6X9-82570-01	
8	Engine shut-off switch	6X9-82570-70	Main station
9	BCU harness	6X9-82386-01	DEC to Autopilot/Joystick
10	Extension wire harness	6X9-82521-00	4.6 m (15 ft)
		6X9-82521-10	9.1 m (30 ft)
11	Autopilot panel	6X9-8253V-01	
12	Joystick	6X9-482A0-01	
13	Helm unit assembly	6GR-615A0-00	
14	Tilt helm unit	6GR-6154A-00	
15	Helm unit assembly	6X9-762H0-01	
16	BCU	6X9-8591T-13	
17	Key fob and receiver assembly	6X9-86254-04	Radio frequency 433 MHz, Key fob: 2 pcs.
		6X9-86254-13	Radio frequency 315 MHz, Key fob: 2 pcs.
18	Pigtail bus wire	6Y8-82521-01	0.3 m (1 ft)
		6Y8-82521-11	0.6 m (2 ft)
		6Y8-82521-21	0.9 m (3 ft)
		6Y8-82521-31	1.8 m (6 ft)
		6Y8-82521-41	2.7 m (9 ft)
		6Y8-82521-51	3.6 m (12 ft)

System diagram

Ref. No.	Part name	Part No.	Remarks
19	Multi-hub	6Y8-81920-01	w/ resistor cap, Gray
20	Main bus wire	6Y8-82553-01	0.3 m (1 ft)
		6Y8-82553-50	3.0 m (10 ft)
		6Y8-82553-11	4.6 m (15 ft)
		6Y8-82553-21	6.1 m (20 ft)
		6Y8-82553-31	7.6 m (25 ft)
		6Y8-82553-41	9.1 m (30 ft)
21	System power supply wire	6Y8-83553-02	w/ 10 A fuse, 2.4 m (8 ft)
22	Conversion harness	6Y9-83553-00	DEC to hub, 0.3 m (1 ft)
23	Conversion harness	6YM-83553-00	0.9 m (3 ft)
24	CL5 display	6YM-83710-14	No Wi-Fi
25	Tank wire	6YD-8356N-00	
26	Fuel tank	—	
27	Heading sensor	6X9-8A410-01	
28	Single (inline) hub	6Y8-81920-11	w/ resistor, 4-6P, White
29	GPS unit	6X9-88107-02	
30	Propeller light	6KA-83720-00	
31	Extension wire harness	6X9-83553-70	7 m (23 ft)
		6X9-83553-80	10 m (32 ft)
32	Aux joystick harness	6X9-82580-G0	
33	Start/stop switch	6X9-82570-B1	
34	Engine shut-off switch	6X9-82570-D1	Joystick station

(*1). Joint connector

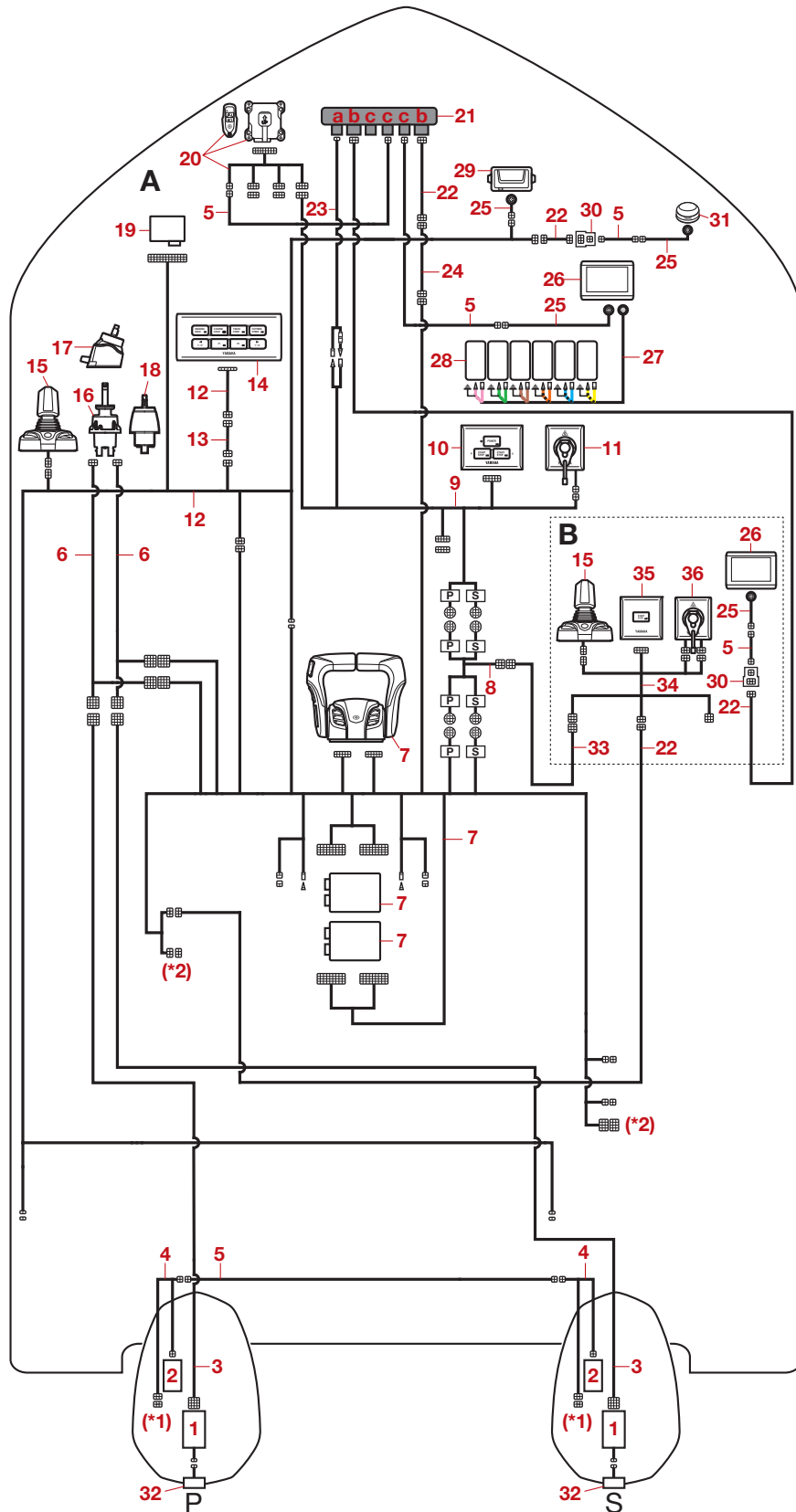
A. Main station
B. Joystick station

a. Power port
b. Bus port
c. Device port

TIP: _____

The part numbers are subject to change without notice. Make sure to confirm the latest part numbers.

Twin outboard motor application (single station)



System diagram

Ref. No.	Part name	Part No.	Remarks
1	Engine ECM	—	
2	SCU	—	
3	Main wire harness (16P)	6X6-8258A-91	1.5 m (5 ft)
		6X6-8258A-51	3.7 m (12 ft)
		6X6-8258A-61	5.2 m (17 ft)
		6X6-8258A-01	6 m (19 ft)
		6X6-8258A-11	7 m (23 ft)
		6X6-8258A-21	8 m (26 ft)
		6X6-8258A-31	10 m (32 ft)
		6X6-8258A-41	12 m (39 ft)
		6X6-8258A-71	15 m (49 ft)
		6X6-8258A-81	24 m (79 ft)
4	SCU communication lead (Starboard side/Port side)	6X9-81115-00	0.3 m (1 ft)
		6GR-81115-00	1.5 m (5 ft)
		6GR-81115-10	3.0 m (10 ft)
5	Pigtail bus wire	6Y8-82521-01	0.3 m (1 ft)
		6Y8-82521-11	0.6 m (2 ft)
		6Y8-82521-21	0.9 m (3 ft)
		6Y8-82521-31	1.8 m (6 ft)
		6Y8-82521-41	2.7 m (9 ft)
		6Y8-82521-51	3.6 m (12 ft)
6	Helm harness (Main/Multi)	6GR-8258A-11	0.9 m (3 ft)
		6GR-8258A-51	1.8 m (6 ft)
		6GR-8258A-61	2.7 m (9 ft)
7	Digital Electronic Control	6X9-48207-04	Main station
8	Split harness 2	6X9-8258A-D0	
9	EKS harness	6X9-82716-32	DEC to switch panel
10	Power switch	6X9-82570-11	
11	Engine shut-off switch	6X9-82570-80	Main station
12	BCU harness	6X9-82386-01	DEC to Autopilot/Joystick
13	Extension wire harness	6X9-82521-00	4.6 m (15 ft)
		6X9-82521-10	9.1 m (30 ft)
14	Autopilot panel	6X9-8253V-01	
15	Joystick	6X9-482A0-01	
16	Helm unit assembly	6GR-615A0-00	
17	Tilt helm unit	6GR-6154A-00	
18	Helm unit assembly	6X9-762H0-01	

System diagram

Ref. No.	Part name	Part No.	Remarks
19	BCU	6X9-8591T-23	
20	Key fob and receiver assembly	6X9-86254-04	Radio frequency 433 MHz, Key fob: 2 pcs.
		6X9-86254-13	Radio frequency 315 MHz, Key fob: 2 pcs.
21	Multi-hub	6Y8-81920-01	w/ resistor cap, Gray
22	Main bus wire	6Y8-82553-01	0.3 m (1 ft)
		6Y8-82553-50	3.0 m (10 ft)
		6Y8-82553-11	4.6 m (15 ft)
		6Y8-82553-21	6.1 m (20 ft)
		6Y8-82553-31	7.6 m (25 ft)
		6Y8-82553-41	9.1 m (30 ft)
23	System power supply wire	6Y8-83553-02	w/ 10 A fuse, 2.4 m (8 ft)
24	Conversion harness	6Y9-83553-00	DEC to hub, 0.3 m (1 ft)
25	Conversion harness	6YM-83553-00	0.9 m (3 ft)
26	CL5 display	6YM-83710-14	No Wi-Fi
27	Tank wire	6YD-8356N-00	
28	Fuel tank	—	
29	Heading sensor	6X9-8A410-01	
30	Single (inline) hub	6Y8-81920-11	w/ resistor, 4-6P, White
31	GPS unit	6X9-88107-02	
32	Propeller light	6KA-83720-00	
33	Extension wire harness	6X9-83553-70	7 m (23 ft)
		6X9-83553-80	10 m (32 ft)
34	Aux joystick harness	6X9-82580-G0	
35	All start/stop switch	6X9-82570-B1	
36	Engine shut-off switch	6X9-82570-D1	Joystick station

(*1). Resistor cap

(*2). Joint connector

A. Main station

B. Joystick station

a. Power port

b. Bus port

c. Device port

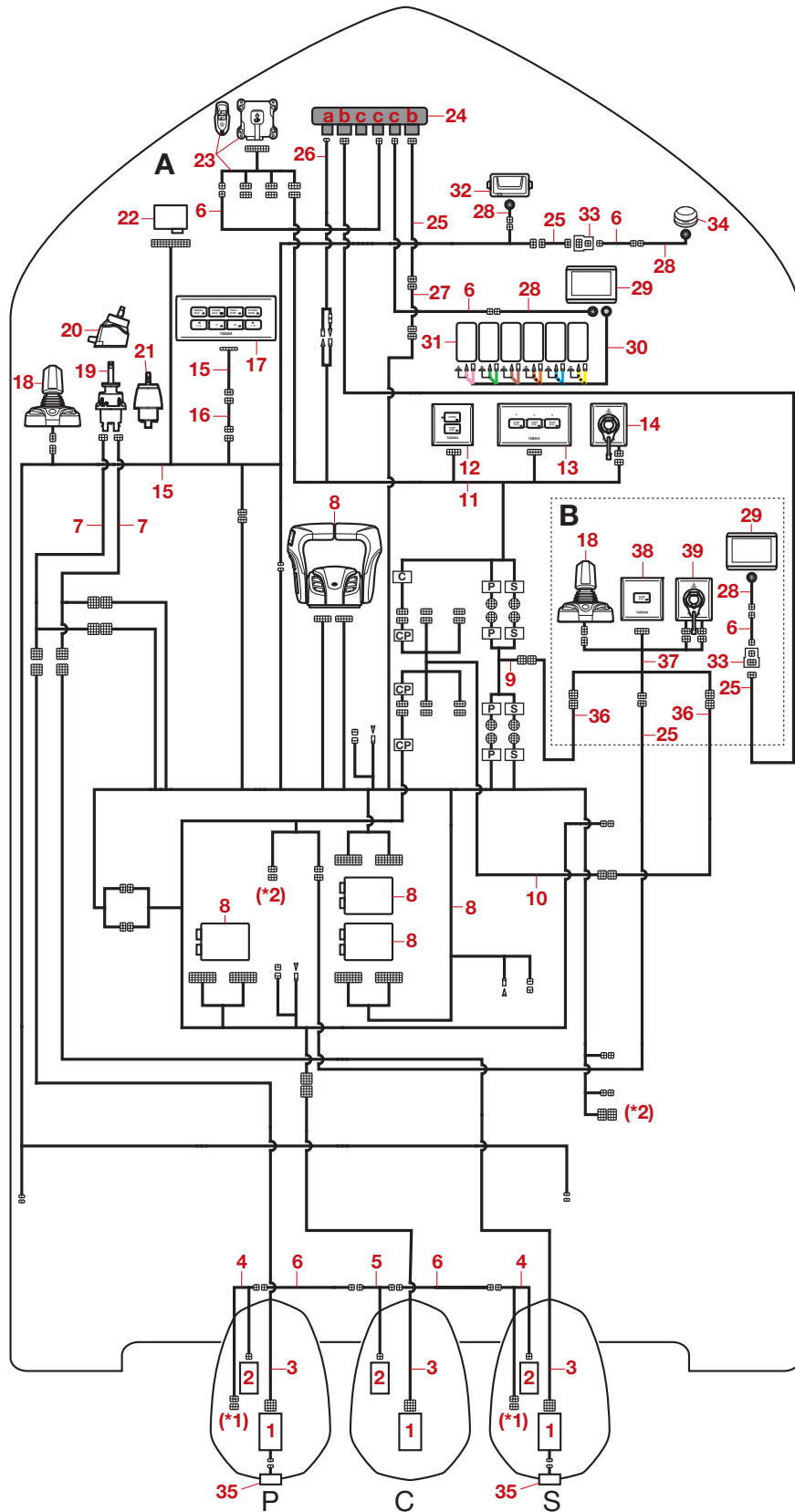
P. Port

S. Starboard

TIP: _____

The part numbers are subject to change without notice. Make sure to confirm the latest part numbers.

Triple outboard motor application (single station)



System diagram

Ref. No.	Part name	Part No.	Remarks
1	Engine ECM	—	
2	SCU	—	
3	Main wire harness (16P)	6X6-8258A-91	1.5 m (5 ft)
		6X6-8258A-51	3.7 m (12 ft)
		6X6-8258A-61	5.2 m (17 ft)
		6X6-8258A-01	6 m (19 ft)
		6X6-8258A-11	7 m (23 ft)
		6X6-8258A-21	8 m (26 ft)
		6X6-8258A-31	10 m (32 ft)
		6X6-8258A-41	12 m (39 ft)
		6X6-8258A-71	15 m (49 ft)
		6X6-8258A-81	24 m (79 ft)
4	SCU communication lead (Starboard side/Port side)	6X9-81115-00	0.3 m (1 ft)
		6GR-81115-00	1.5 m (5 ft)
		6GR-81115-10	3.0 m (10 ft)
5	SCU communication lead (Center)	6X9-81115-10	0.3 m (1 ft)
		6GR-81115-20	1.5 m (5 ft)
		6GR-81115-30	3.0 m (10 ft)
6	Pigtail bus wire	6Y8-82521-01	0.3 m (1 ft)
		6Y8-82521-11	0.6 m (2 ft)
		6Y8-82521-21	0.9 m (3 ft)
		6Y8-82521-31	1.8 m (6 ft)
		6Y8-82521-41	2.7 m (9 ft)
		6Y8-82521-51	3.6 m (12 ft)
7	Helm harness (Main/Multi)	6GR-8258A-11	0.9 m (3 ft)
		6GR-8258A-51	1.8 m (6 ft)
		6GR-8258A-61	2.7 m (9 ft)
8	Digital Electronic Control	6X9-48208-04	Main station
9	Split harness 2	6X9-8258A-D0	
10	Split harness 3	6X9-8258A-E0	
11	EKS harness	6X9-82716-41	DEC to switch panel
12	Power switch	6X9-82570-01	
13	Start/stop switch	6X9-82570-41	
14	Engine shut-off switch	6X9-82570-C0	Main station
15	BCU harness	6X9-82386-01	DEC to Autopilot/Joystick
16	Extension wire harness	6X9-82521-00	4.6 m (15 ft)
		6X9-82521-10	9.1 m (30 ft)

System diagram

Ref. No.	Part name	Part No.	Remarks
17	Autopilot panel	6X9-8253V-01	
18	Joystick	6X9-482A0-01	
19	Helm unit assembly	6GR-615A0-00	
20	Tilt helm unit	6GR-6154A-00	
21	Helm unit assembly	6X9-762H0-01	
22	BCU	6X9-8591T-33	
23	Key fob and receiver assembly	6X9-86254-04	Radio frequency 433 MHz, Key fob: 2 pcs.
		6X9-86254-13	Radio frequency 315 MHz, Key fob: 2 pcs.
24	Multi-hub	6Y8-81920-01	w/ resistor cap, Gray
25	Main bus wire	6Y8-82553-01	0.3 m (1 ft)
		6Y8-82553-50	3.0 m (10 ft)
		6Y8-82553-11	4.6 m (15 ft)
		6Y8-82553-21	6.1 m (20 ft)
		6Y8-82553-31	7.6 m (25 ft)
		6Y8-82553-41	9.1 m (30 ft)
26	System power supply wire	6Y8-83553-02	w/ 10 A fuse, 2.4 m (8 ft)
27	Conversion harness	6Y9-83553-00	DEC to hub, 0.3 m (1 ft)
28	Conversion harness	6YM-83553-00	0.9 m (3 ft)
29	CL5 display	6YM-83710-14	No Wi-Fi
30	Tank wire	6YD-8356N-00	
31	Fuel tank	—	
32	Heading sensor	6X9-8A410-01	
33	Single (inline) hub	6Y8-81920-11	w/ resistor, 4-6P, White
34	GPS unit	6X9-88107-02	
35	Propeller light	6KA-83720-00	
36	Extension wire harness	6X9-83553-70	7 m (23 ft)
		6X9-83553-80	10 m (32 ft)
37	Aux joystick harness	6X9-82580-G0	
38	All start/stop switch	6X9-82570-B1	
39	Engine shut-off switch	6X9-82570-D1	Joystick station

(*1). Resistor cap

(*2). Joint connector

A. Main station

B. Joystick station

a. Power port

b. Bus port

c. Device port

P. Port
C. Center
S. Starboard

TIP: _____
The part numbers are subject to change without notice. Make sure to confirm the latest part numbers.

System diagram

Ref. No.	Part name	Part No.	Remarks
1	Engine ECM	—	
2	SCU	—	
3	Main wire harness (16P)	6X6-8258A-91	1.5 m (5 ft)
		6X6-8258A-51	3.7 m (12 ft)
		6X6-8258A-61	5.2 m (17 ft)
		6X6-8258A-01	6 m (19 ft)
		6X6-8258A-11	7 m (23 ft)
		6X6-8258A-21	8 m (26 ft)
		6X6-8258A-31	10 m (32 ft)
		6X6-8258A-41	12 m (39 ft)
		6X6-8258A-71	15 m (49 ft)
		6X6-8258A-81	24 m (79 ft)
4	SCU communication lead (Starboard side/Port side)	6X9-81115-00	0.3 m (1 ft)
		6GR-81115-00	1.5 m (5 ft)
		6GR-81115-10	3.0 m (10 ft)
5	SCU communication lead (Center)	6X9-81115-10	0.3 m (1 ft)
		6GR-81115-20	1.5 m (5 ft)
		6GR-81115-30	3.0 m (10 ft)
6	Pigtail bus wire	6Y8-82521-01	0.3 m (1 ft)
		6Y8-82521-11	0.6 m (2 ft)
		6Y8-82521-21	0.9 m (3 ft)
		6Y8-82521-31	1.8 m (6 ft)
		6Y8-82521-41	2.7 m (9 ft)
		6Y8-82521-51	3.6 m (12 ft)
7	Helm harness (Main/Multi)	6GR-8258A-11	0.9 m (3 ft)
		6GR-8258A-51	1.8 m (6 ft)
		6GR-8258A-61	2.7 m (9 ft)
8	Digital Electronic Control	6X9-48209-04	Main station
9	Split harness 2	6X9-8258A-D0	
10	Split harness 3	6X9-8258A-E0	
11	EKS harness	6X9-82716-91	DEC to switch panel
12	Power switch	6X9-82570-01	
13	Start/stop switch	6X9-82570-51	
14	Engine shut-off switch	6X9-82570-D1	Main station/Joystick station
15	BCU harness	6X9-82386-01	DEC to Autopilot/Joystick
16	Extension wire harness	6X9-82521-00	4.6 m (15 ft)
		6X9-82521-10	9.1 m (30 ft)

System diagram

Ref. No.	Part name	Part No.	Remarks
17	Autopilot panel	6X9-8253V-01	
18	Joystick	6X9-482A0-01	
19	Helm unit assembly	6GR-615A0-00	
20	Tilt helm unit	6GR-6154A-00	
21	Helm unit assembly	6X9-762H0-01	
22	BCU	6X9-8591T-43	
23	Key fob and receiver assembly	6X9-86254-04	Radio frequency 433 MHz, Key fob: 2 pcs.
		6X9-86254-13	Radio frequency 315 MHz, Key fob: 2 pcs.
24	Multi-hub	6Y8-81920-01	w/ resistor cap, Gray
25	Main bus wire	6Y8-82553-01	0.3 m (1 ft)
		6Y8-82553-50	3.0 m (10 ft)
		6Y8-82553-11	4.6 m (15 ft)
		6Y8-82553-21	6.1 m (20 ft)
		6Y8-82553-31	7.6 m (25 ft)
		6Y8-82553-41	9.1 m (30 ft)
26	System power supply wire	6Y8-83553-02	w/ 10 A fuse, 2.4 m (8 ft)
27	Conversion harness	6Y9-83553-00	DEC to hub, 0.3 m (1 ft)
28	Conversion harness	6YM-83553-00	0.9 m (3 ft)
29	CL5 display	6YM-83710-14	No Wi-Fi
30	Tank wire	6YD-8356N-00	
31	Fuel tank	—	
32	Heading sensor	6X9-8A410-01	
33	Single (inline) hub	6Y8-81920-11	w/ resistor, 4-6P, White
34	GPS unit	6X9-88107-02	
35	Propeller light	6KA-83720-00	
36	Extension wire harness	6X9-83553-70	7 m (23 ft)
		6X9-83553-80	10 m (32 ft)
37	Aux joystick harness	6X9-82580-G0	
38	All start/stop switch	6X9-82570-B1	

(*1). Resistor cap

(*2). Joint connector

A. Main station

B. Joystick station

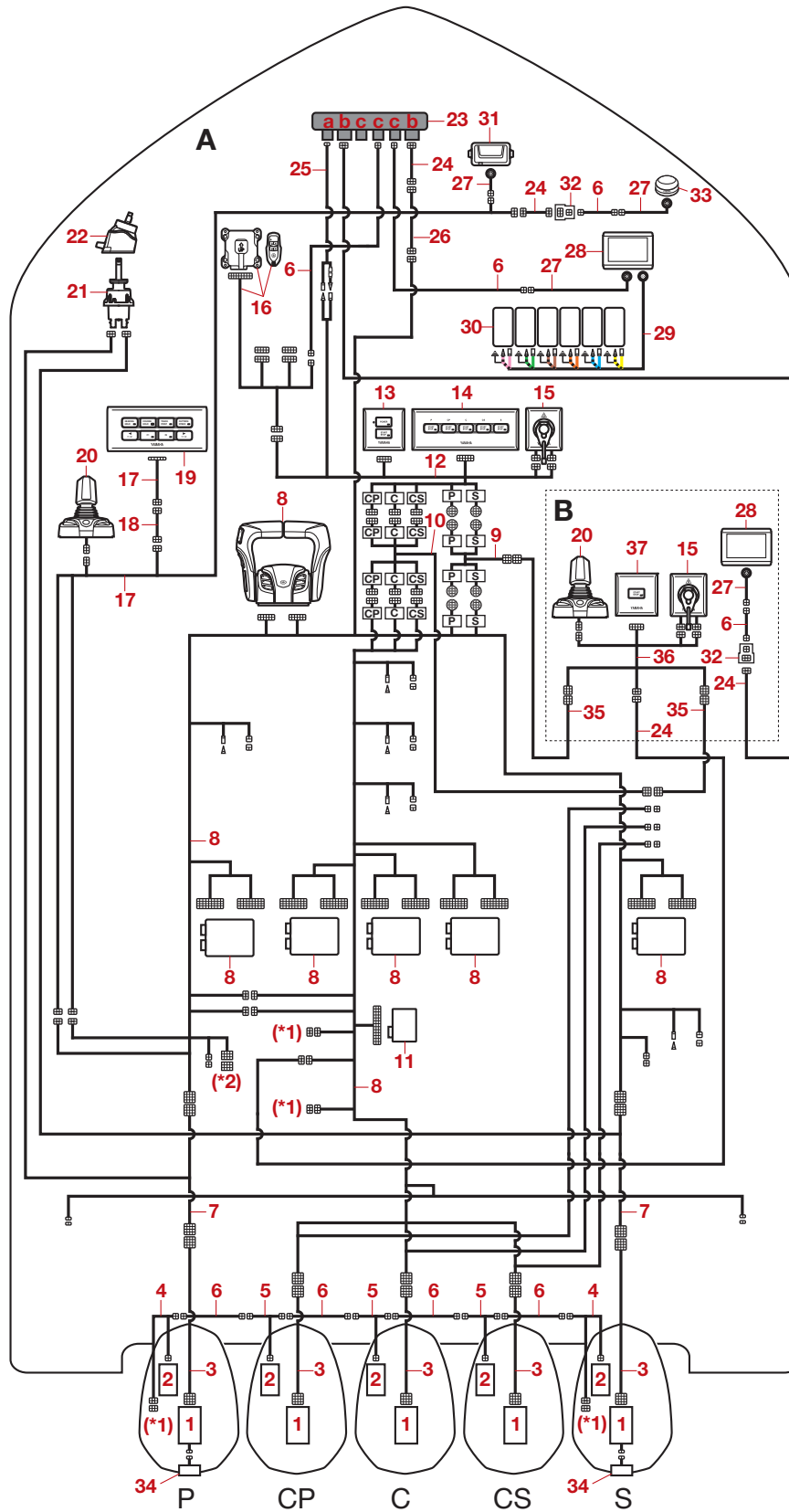
- a. Power port
- b. Bus port
- c. Device port

- P. Port
- CP. Center port
- CS. Center starboard
- S. Starboard

TIP:

The part numbers are subject to change without notice. Make sure to confirm the latest part numbers.

Quint outboard motor application (single station)



System diagram

Ref. No.	Part name	Part No.	Remarks
1	Engine ECM	—	
2	SCU	—	
3	Main wire harness (16P)	6X6-8258A-91	1.5 m (5 ft)
		6X6-8258A-51	3.7 m (12 ft)
		6X6-8258A-61	5.2 m (17 ft)
		6X6-8258A-01	6 m (19 ft)
		6X6-8258A-11	7 m (23 ft)
		6X6-8258A-21	8 m (26 ft)
		6X6-8258A-31	10 m (32 ft)
		6X6-8258A-41	12 m (39 ft)
		6X6-8258A-71	15 m (49 ft)
		6X6-8258A-81	24 m (79 ft)
4	SCU communication lead (Starboard side/Port side)	6X9-81115-00	0.3 m (1 ft)
		6GR-81115-00	1.5 m (5 ft)
		6GR-81115-10	3.0 m (10 ft)
5	SCU communication lead (Center)	6X9-81115-10	0.3 m (1 ft)
		6GR-81115-20	1.5 m (5 ft)
		6GR-81115-30	3.0 m (10 ft)
6	Pigtail bus wire	6Y8-82521-01	0.3 m (1 ft)
		6Y8-82521-11	0.6 m (2 ft)
		6Y8-82521-21	0.9 m (3 ft)
		6Y8-82521-31	1.8 m (6 ft)
		6Y8-82521-41	2.7 m (9 ft)
		6Y8-82521-51	3.6 m (12 ft)
7	Helm harness (Main/Multi)	6GR-8258A-11	0.9 m (3 ft)
		6GR-8258A-51	1.8 m (6 ft)
		6GR-8258A-61	2.7 m (9 ft)
8	Digital Electronic Control	6X9-48210-01	Main station
9	Split harness 2	6X9-8258A-D0	
10	Split harness 3	6X9-8258A-E0	
11	BCU	6X9-8591T-51	
12	EKS harness	6X9-82716-B0	DEC to switch panel
13	Power switch	6X9-82570-01	
14	Start/stop switch	6X9-82570-61	
15	Engine shut-off switch	6X9-82570-D1	Main station/Joystick station

System diagram

Ref. No.	Part name	Part No.	Remarks
16	Key fob and receiver assembly	6X9-86254-04	Radio frequency 433 MHz, Key fob: 2 pcs.
		6X9-86254-13	Radio frequency 315 MHz, Key fob: 2 pcs.
17	BCU harness	6X9-82386-20	DEC to Autopilot/Joystick
18	Extension wire harness	6X9-82521-00	4.6 m (15 ft)
		6X9-82521-10	9.1 m (30 ft)
19	Autopilot panel	6X9-8253V-01	
20	Joystick	6X9-482A0-01	
21	Helm unit assembly	6GR-615A0-00	
22	Tilt helm unit	6GR-6154A-00	
23	Multi-hub	6Y8-81920-01	w/ resistor cap, Gray
24	Main bus wire	6Y8-82553-01	0.3 m (1 ft)
		6Y8-82553-50	3.0 m (10 ft)
		6Y8-82553-11	4.6 m (15 ft)
		6Y8-82553-21	6.1 m (20 ft)
		6Y8-82553-31	7.6 m (25 ft)
		6Y8-82553-41	9.1 m (30 ft)
25	System power supply wire	6Y8-83553-02	w/ 10 A fuse, 2.4 m (8 ft)
26	Conversion harness	6Y9-83553-00	DEC to hub, 0.3 m (1 ft)
27	Conversion harness	6YM-83553-00	0.9 m (3 ft)
28	CL5 display	6YM-83710-14	No Wi-Fi
29	Tank wire	6YD-8356N-00	
30	Fuel tank	—	
31	Heading sensor	6X9-8A410-01	
32	Single (inline) hub	6Y8-81920-11	w/ resistor, 4-6P, White
33	GPS unit	6X9-88107-02	
34	Propeller light	6KA-83720-00	
35	Extension wire harness	6X9-83553-70	7 m (23 ft)
		6X9-83553-80	10 m (32 ft)
36	Aux joystick harness	6X9-82580-G0	
37	All start/stop switch	6X9-82570-B1	

(*1). Resistor cap

(*2). Joint connector

A. Main station

B. Joystick station

a. Power port

b. Bus port

c. Device port

P. Port

CP. Center port

C. Center

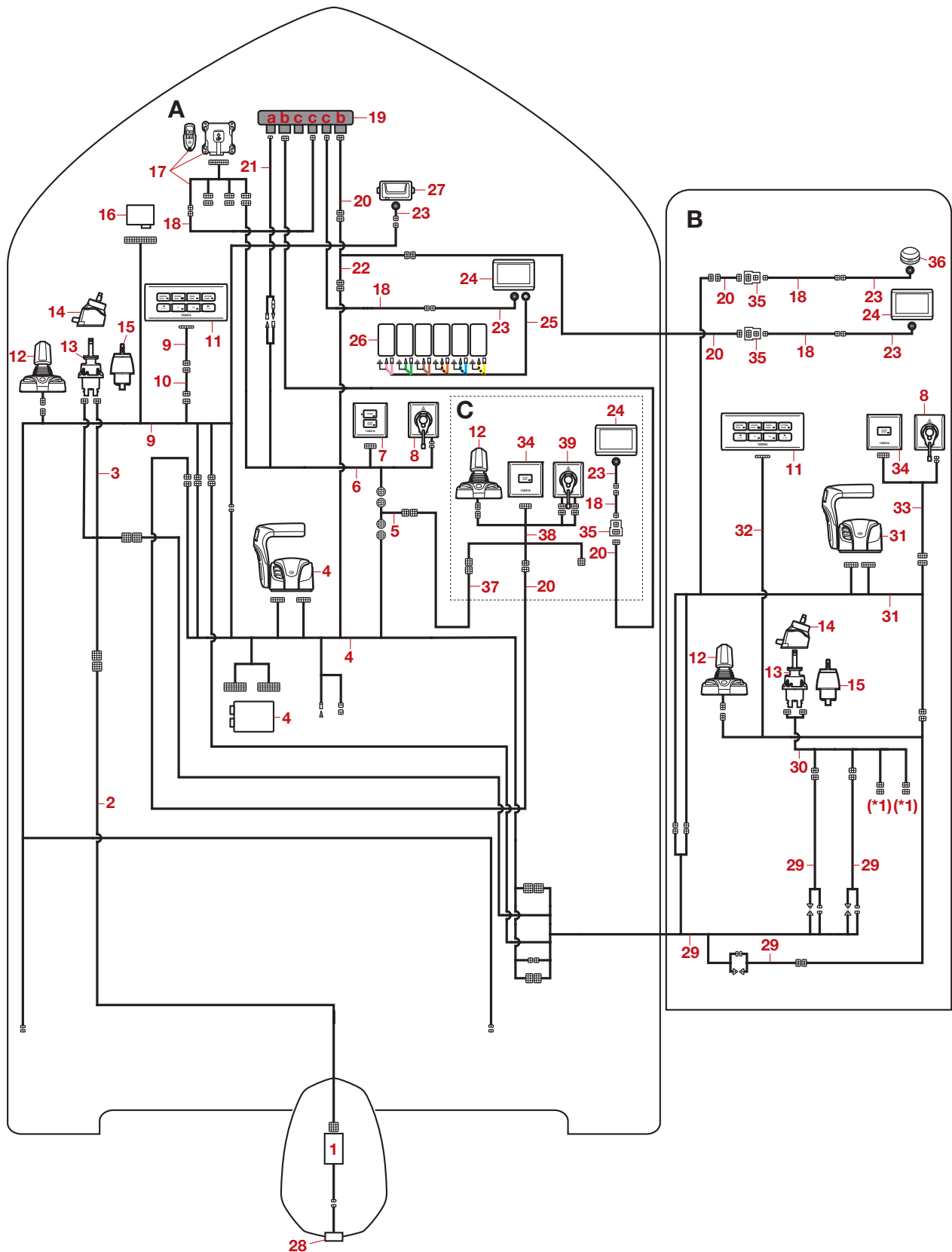
CS. Center starboard

S. Starboard

TIP:

The part numbers are subject to change without notice. Make sure to confirm the latest part numbers.

Single outboard motor application (dual station)



System diagram

Ref. No.	Part name	Part No.	Remarks
1	Engine ECM	—	
2	Main wire harness (16P)	6X6-8258A-91	1.5 m (5 ft)
		6X6-8258A-51	3.7 m (12 ft)
		6X6-8258A-61	5.2 m (17 ft)
		6X6-8258A-01	6 m (19 ft)
		6X6-8258A-11	7 m (23 ft)
		6X6-8258A-21	8 m (26 ft)
		6X6-8258A-31	10 m (32 ft)
		6X6-8258A-41	12 m (39 ft)
		6X6-8258A-71	15 m (49 ft)
		6X6-8258A-81	24 m (79 ft)
3	Helm harness (Main/Single)	6GR-8258A-01	0.9 m (3 ft)
		6GR-8258A-41	1.8 m (6 ft)
4	Digital Electronic Control	6X9-48205-04	Main station
5	Split harness 1	6X9-8258A-C0	
6	EKS harness	6X9-82716-21	DEC to switch panel
7	Power switch	6X9-82570-01	
8	Engine shut-off switch	6X9-82570-70	Main station/2nd station
9	BCU harness	6X9-82386-01	DEC to Autopilot/Joystick
10	Extension wire harness	6X9-82521-00	4.6 m (15 ft)
		6X9-82521-10	9.1 m (30 ft)
11	Autopilot panel	6X9-8253V-01	
12	Joystick	6X9-482A0-01	
13	Helm unit assembly	6GR-615A0-00	
14	Tilt helm unit	6GR-6154A-00	
15	Helm unit assembly	6X9-762H0-01	
16	BCU	6X9-8591T-13	
17	Key fob and receiver assembly	6X9-86254-04	Radio frequency 433 MHz, Key fob: 2 pcs.
		6X9-86254-13	Radio frequency 315 MHz, Key fob: 2 pcs.
18	Pigtail bus wire	6Y8-82521-01	0.3 m (1 ft)
		6Y8-82521-11	0.6 m (2 ft)
		6Y8-82521-21	0.9 m (3 ft)
		6Y8-82521-31	1.8 m (6 ft)
		6Y8-82521-41	2.7 m (9 ft)
		6Y8-82521-51	3.6 m (12 ft)

System diagram

Ref. No.	Part name	Part No.	Remarks
19	Multi-hub	6Y8-81920-01	w/ resistor cap, Gray
20	Main bus wire	6Y8-82553-01	0.3 m (1 ft)
		6Y8-82553-50	3.0 m (10 ft)
		6Y8-82553-11	4.6 m (15 ft)
		6Y8-82553-21	6.1 m (20 ft)
		6Y8-82553-31	7.6 m (25 ft)
		6Y8-82553-41	9.1 m (30 ft)
21	System power supply wire	6Y8-83553-02	w/ 10 A fuse, 2.4 m (8 ft)
22	Conversion harness	6Y9-83553-10	DEC to hub, 0.3 m (1 ft)
23	Conversion harness	6YM-83553-00	0.9 m (3 ft)
24	CL5 display	6YM-83710-14	No Wi-Fi
25	Tank wire	6YD-8356N-00	
26	Fuel tank	—	
27	Heading sensor	6X9-8A410-01	
28	Propeller light	6KA-83720-00	
29	2nd helm harness	6X9-8258A-00	5 m (16 ft)
		6X9-8258A-10	8 m (26 ft)
		6X9-8258A-20	12 m (38 ft)
30	Helm harness (2nd station)	6X9-8258A-A1	0.9 m (3 ft)
31	Digital Electronic Control	6X9-48205-12	2nd station
32	BCU harness	6X9-82386-10	DEC to Autopilot/Joystick
33	EKS harness	6X9-82716-60	
34	Start/stop switch	6X9-82570-B1	2nd station/Joystick station
35	Single (inline) hub	6Y8-81920-11	w/ resistor, 4–6P, White
36	GPS unit	6X9-88107-02	
37	Extension wire harness	6X9-83553-70	7 m (23 ft)
		6X9-83553-80	10 m (32 ft)
38	Aux joystick harness	6X9-82580-G0	
39	Engine shut-off switch	6X9-82570-D1	Joystick station

(*1). Resistor cap

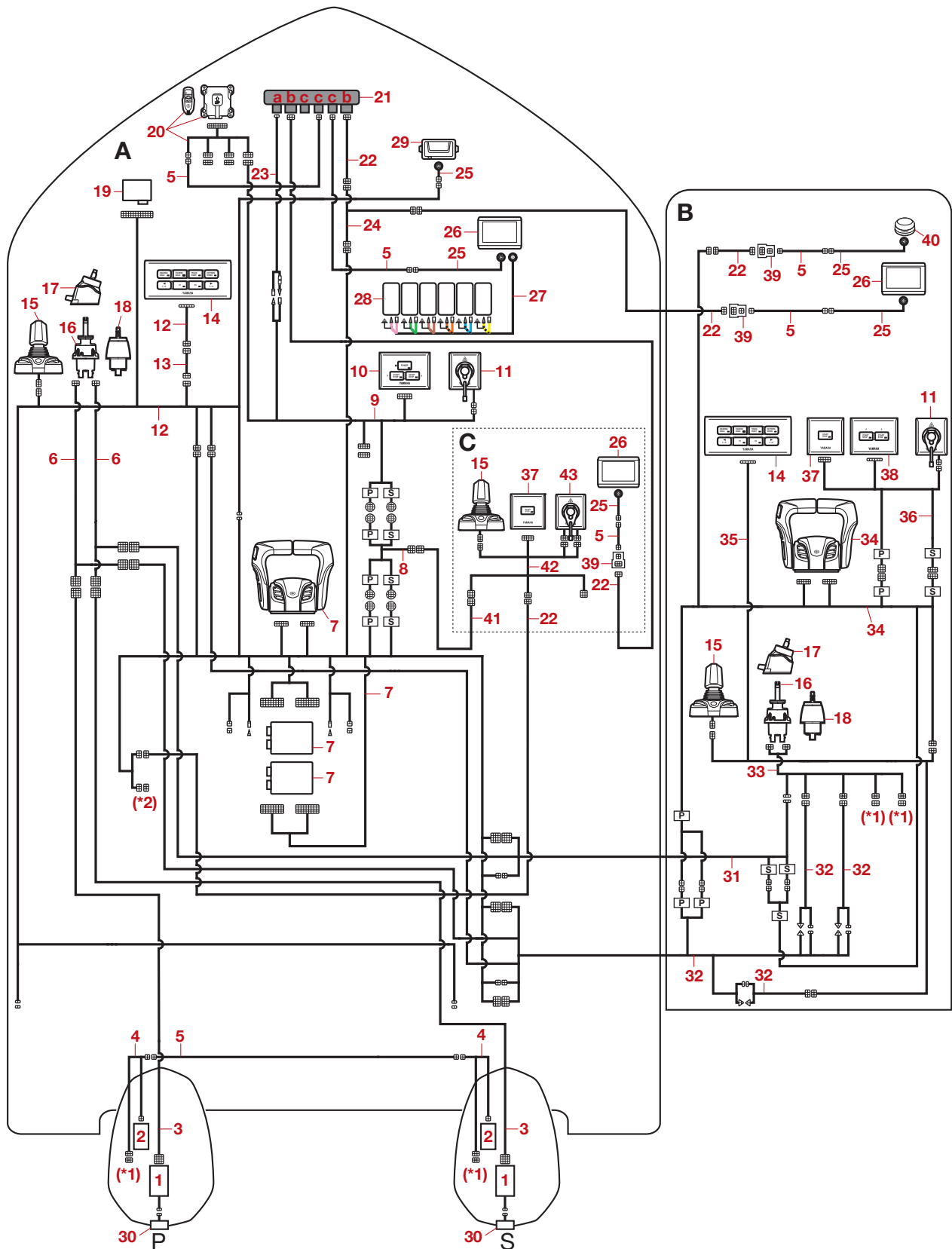
- A. Main station
- B. Sub station
- C. Joystick station

- a. Power port
- b. Bus port
- c. Device port

TIP: _____

The part numbers are subject to change without notice. Make sure to confirm the latest part numbers.

Twin outboard motor application (dual station)



System diagram

Ref. No.	Part name	Part No.	Remarks
1	Engine ECM	—	
2	SCU	—	
3	Main wire harness (16P)	6X6-8258A-91	1.5 m (5 ft)
		6X6-8258A-51	3.7 m (12 ft)
		6X6-8258A-61	5.2 m (17 ft)
		6X6-8258A-01	6 m (19 ft)
		6X6-8258A-11	7 m (23 ft)
		6X6-8258A-21	8 m (26 ft)
		6X6-8258A-31	10 m (32 ft)
		6X6-8258A-41	12 m (39 ft)
		6X6-8258A-71	15 m (49 ft)
		6X6-8258A-81	24 m (79 ft)
4	SCU communication lead (Starboard side/Port side)	6X9-81115-00	0.3 m (1 ft)
		6GR-81115-00	1.5 m (5 ft)
		6GR-81115-10	3.0 m (10 ft)
5	Pigtail bus wire	6Y8-82521-01	0.3 m (1 ft)
		6Y8-82521-11	0.6 m (2 ft)
		6Y8-82521-21	0.9 m (3 ft)
		6Y8-82521-31	1.8 m (6 ft)
		6Y8-82521-41	2.7 m (9 ft)
		6Y8-82521-51	3.6 m (12 ft)
6	Helm harness (Main/Multi)	6GR-8258A-11	0.9 m (3 ft)
		6GR-8258A-51	1.8 m (6 ft)
		6GR-8258A-61	2.7 m (9 ft)
7	Digital Electronic Control	6X9-48207-04	Main station
8	Split harness 2	6X9-8258A-D0	
9	EKS harness	6X9-82716-32	DEC to switch panel
10	Power switch	6X9-82570-11	
11	Engine shut-off switch	6X9-82570-80	Main station/2nd station
12	BCU harness	6X9-82386-01	DEC to Autopilot/Joystick
13	Extension wire harness	6X9-82521-00	4.6 m (15 ft)
		6X9-82521-10	9.1 m (30 ft)
14	Autopilot panel	6X9-8253V-01	
15	Joystick	6X9-482A0-01	
16	Helm unit assembly	6GR-615A0-00	
17	Tilt helm unit	6GR-6154A-00	

System diagram

Ref. No.	Part name	Part No.	Remarks
18	Helm unit assembly	6X9-762H0-01	
19	BCU	6X9-8591T-23	
20	Key fob and receiver assembly	6X9-86254-04	Radio frequency 433 MHz, Key fob: 2 pcs.
		6X9-86254-13	Radio frequency 315 MHz, Key fob: 2 pcs.
21	Multi-hub	6Y8-81920-01	w/ resistor cap, Gray
22	Main bus wire	6Y8-82553-01	0.3 m (1 ft)
		6Y8-82553-50	3.0 m (10 ft)
		6Y8-82553-11	4.6 m (15 ft)
		6Y8-82553-21	6.1 m (20 ft)
		6Y8-82553-31	7.6 m (25 ft)
		6Y8-82553-41	9.1 m (30 ft)
23	System power supply wire	6Y8-83553-02	w/ 10 A fuse, 2.4 m (8 ft)
24	Conversion harness	6Y9-83553-10	DEC to hub, 0.3 m (1 ft)
25	Conversion harness	6YM-83553-00	0.9 m (3 ft)
26	CL5 display	6YM-83710-14	No Wi-Fi
27	Tank wire	6YD-8356N-00	
28	Fuel tank	—	
29	Heading sensor	6X9-8A410-01	
30	Propeller light	6KA-83720-00	
31	2nd helm harness (Starboard side)	6X9-8258A-30	5 m (16 ft)
		6X9-8258A-40	8 m (26 ft)
		6X9-8258A-50	12 m (38 ft)
32	2nd helm harness (Port side)	6X9-8258A-00	5 m (16 ft)
		6X9-8258A-10	8 m (26 ft)
		6X9-8258A-20	12 m (38 ft)
33	Helm harness (2nd station)	6X9-8258A-B1	0.9 m (3 ft)
34	Digital Electronic Control	6X9-48207-12	2nd station
35	BCU harness	6X9-82386-10	DEC to Autopilot/Joystick
36	EKS harness	6X9-82716-71	
37	All start/stop switch	6X9-82570-B1	2nd station/Joystick station
38	Start/stop switch	6X9-82570-31	
39	Single (inline) hub	6Y8-81920-11	w/ resistor, 4-6P, White
40	GPS unit	6X9-88107-02	
41	Extension wire harness	6X9-83553-70	7 m (23 ft)
		6X9-83553-80	10 m (32 ft)

System diagram

Ref. No.	Part name	Part No.	Remarks
42	Aux joystick harness	6X9-82580-G0	
43	Engine shut-off switch	6X9-82570-D1	Joystick station

(*1). Resistor cap

(*2). Joint connector

A. Main station

B. Sub station

C. Joystick station

a. Power port

b. Bus port

c. Device port

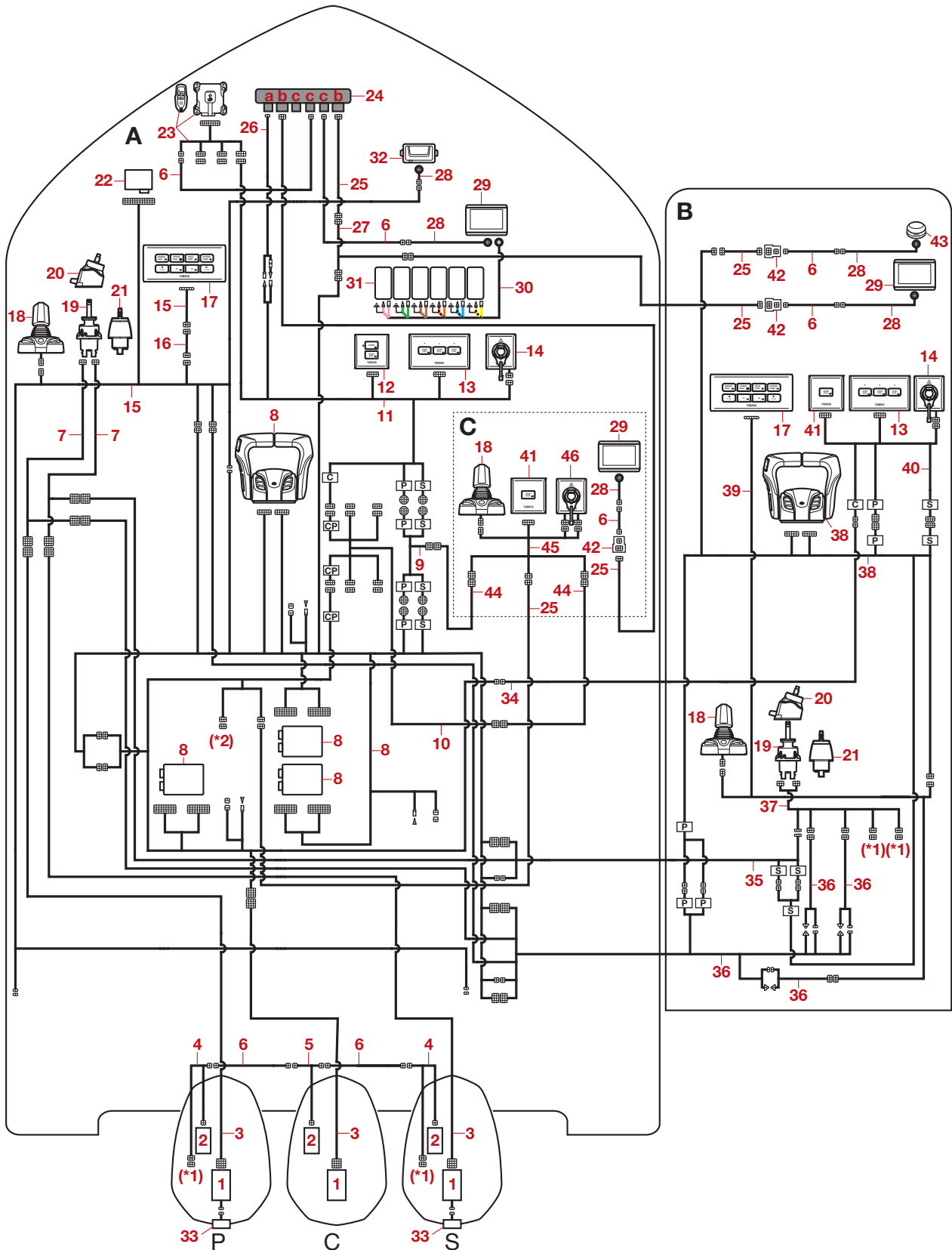
P. Port

S. Starboard

TIP:

The part numbers are subject to change without notice. Make sure to confirm the latest part numbers.

Triple outboard motor application (dual station)



System diagram

Ref. No.	Part name	Part No.	Remarks
1	Engine ECM	—	
2	SCU	—	
3	Main wire harness (16P)	6X6-8258A-91	1.5 m (5 ft)
		6X6-8258A-51	3.7 m (12 ft)
		6X6-8258A-61	5.2 m (17 ft)
		6X6-8258A-01	6 m (19 ft)
		6X6-8258A-11	7 m (23 ft)
		6X6-8258A-21	8 m (26 ft)
		6X6-8258A-31	10 m (32 ft)
		6X6-8258A-41	12 m (39 ft)
		6X6-8258A-71	15 m (49 ft)
		6X6-8258A-81	24 m (79 ft)
4	SCU communication lead (Starboard side/Port side)	6X9-81115-00	0.3 m (1 ft)
		6GR-81115-00	1.5 m (5 ft)
		6GR-81115-10	3.0 m (10 ft)
5	SCU communication lead (Center)	6X9-81115-10	0.3 m (1 ft)
		6GR-81115-20	1.5 m (5 ft)
		6GR-81115-30	3.0 m (10 ft)
6	Pigtail bus wire	6Y8-82521-01	0.3 m (1 ft)
		6Y8-82521-11	0.6 m (2 ft)
		6Y8-82521-21	0.9 m (3 ft)
		6Y8-82521-31	1.8 m (6 ft)
		6Y8-82521-41	2.7 m (9 ft)
		6Y8-82521-51	3.6 m (12 ft)
7	Helm harness (Main/Multi)	6GR-8258A-11	0.9 m (3 ft)
		6GR-8258A-51	1.8 m (6 ft)
		6GR-8258A-61	2.7 m (9 ft)
8	Digital Electronic Control	6X9-48208-04	Main station
9	Split harness 2	6X9-8258A-D0	
10	Split harness 3	6X9-8258A-E0	
11	EKS harness	6X9-82716-41	DEC to switch panel
12	Power switch	6X9-82570-01	
13	Start/stop switch	6X9-82570-41	
14	Engine shut-off switch	6X9-82570-C0	Main station/2nd station
15	BCU harness	6X9-82386-01	DEC to Autopilot/Joystick
16	Extension wire harness	6X9-82521-00	4.6 m (15 ft)
		6X9-82521-10	9.1 m (30 ft)

System diagram

Ref. No.	Part name	Part No.	Remarks
17	Autopilot panel	6X9-8253V-01	
18	Joystick	6X9-482A0-01	
19	Helm unit assembly	6GR-615A0-00	
20	Tilt helm unit	6GR-6154A-00	
21	Helm unit assembly	6X9-762H0-01	
22	BCU	6X9-8591T-33	
23	Key fob and receiver assembly	6X9-86254-04	Radio frequency 433 MHz, Key fob: 2 pcs.
		6X9-86254-13	Radio frequency 315 MHz, Key fob: 2 pcs.
24	Multi-hub	6Y8-81920-01	w/ resistor cap, Gray
25	Main bus wire	6Y8-82553-01	0.3 m (1 ft)
		6Y8-82553-50	3.0 m (10 ft)
		6Y8-82553-11	4.6 m (15 ft)
		6Y8-82553-21	6.1 m (20 ft)
		6Y8-82553-31	7.6 m (25 ft)
		6Y8-82553-41	9.1 m (30 ft)
26	System power supply wire	6Y8-83553-02	w/ 10 A fuse, 2.4 m (8 ft)
27	Conversion harness	6Y9-83553-10	DEC to hub, 0.3 m (1 ft)
28	Conversion harness	6YM-83553-00	0.9 m (3 ft)
29	CL5 display	6YM-83710-14	No Wi-Fi
30	Tank wire	6YD-8356N-00	
31	Fuel tank	—	
32	Heading sensor	6X9-8A410-01	
33	Propeller light	6KA-83720-00	
34	2nd helm harness (Center)	6X9-8258A-60	5 m (16 ft)
		6X9-8258A-70	8 m (26 ft)
		6X9-8258A-80	12 m (38 ft)
35	2nd helm harness (Starboard side)	6X9-8258A-30	5 m (16 ft)
		6X9-8258A-40	8 m (26 ft)
		6X9-8258A-50	12 m (38 ft)
36	2nd helm harness (Port side)	6X9-8258A-00	5 m (16 ft)
		6X9-8258A-10	8 m (26 ft)
		6X9-8258A-20	12 m (38 ft)
37	Helm harness (2nd station)	6X9-8258A-B1	0.9 m (3 ft)
38	Digital Electronic Control	6X9-48207-12	2nd station
39	BCU harness	6X9-82386-10	DEC to Autopilot/Joystick

System diagram

Ref. No.	Part name	Part No.	Remarks
40	EKS harness	6X9-82716-80	
41	All start/stop switch	6X9-82570-B1	2nd station/Joystick station
42	Single (inline) hub	6Y8-81920-11	w/ resistor, 4-6P, White
43	GPS unit	6X9-88107-02	
44	Extension wire harness	6X9-83553-70	7 m (23 ft)
		6X9-83553-80	10 m (32 ft)
45	Aux joystick harness	6X9-82580-G0	
46	Engine shut-off switch	6X9-82570-D1	Joystick station

(*1). Resistor cap

(*2). Joint connector

A. Main station
 B. Sub station
 C. Joystick station

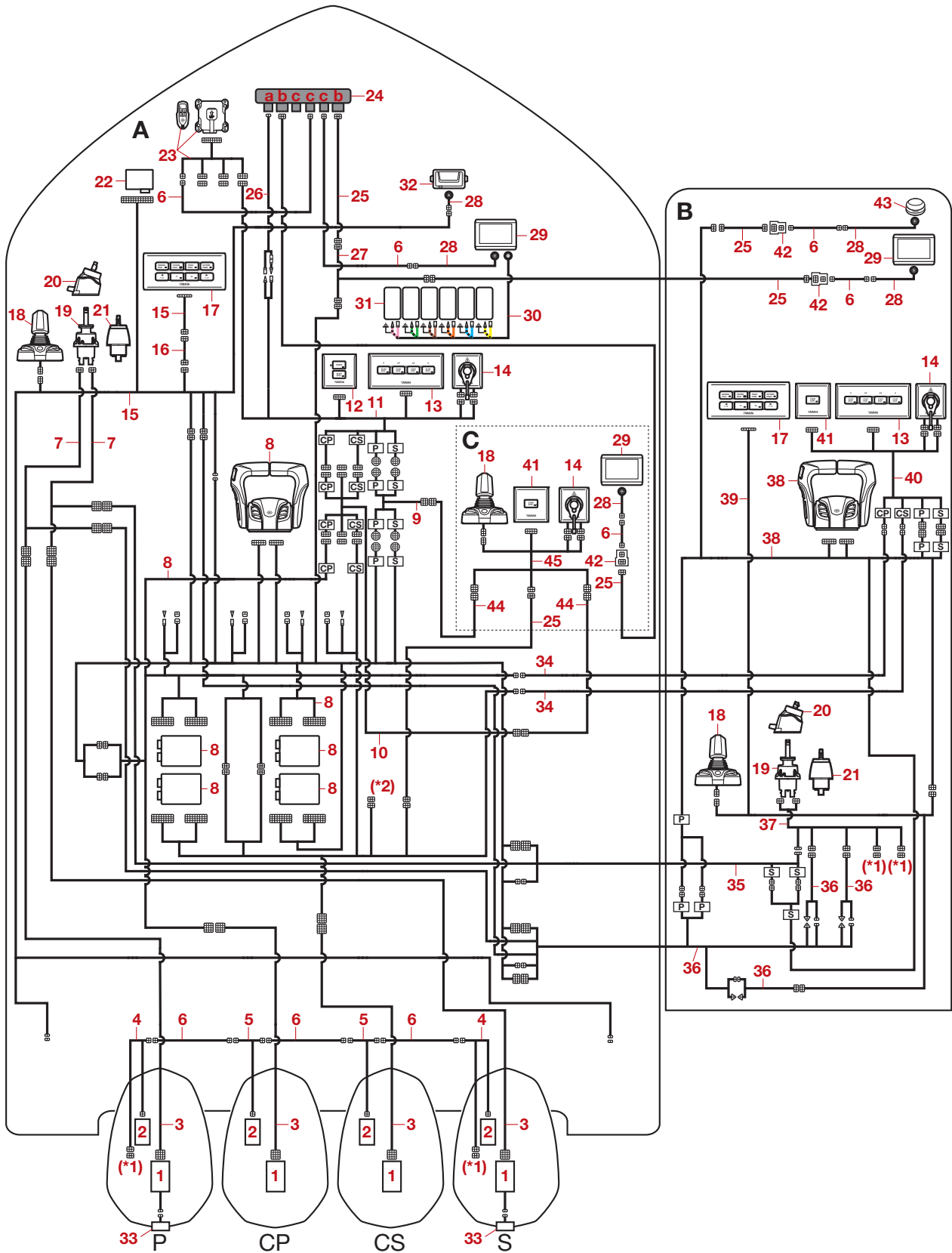
a. Power port
 b. Bus port
 c. Device port

P. Port
 C. Center
 S. Starboard

TIP: _____

The part numbers are subject to change without notice. Make sure to confirm the latest part numbers.

Quad outboard motor application (dual station)



System diagram

Ref. No.	Part name	Part No.	Remarks
1	Engine ECM	—	
2	SCU	—	
3	Main wire harness (16P)	6X6-8258A-91	1.5 m (5 ft)
		6X6-8258A-51	3.7 m (12 ft)
		6X6-8258A-61	5.2 m (17 ft)
		6X6-8258A-01	6 m (19 ft)
		6X6-8258A-11	7 m (23 ft)
		6X6-8258A-21	8 m (26 ft)
		6X6-8258A-31	10 m (32 ft)
		6X6-8258A-41	12 m (39 ft)
		6X6-8258A-71	15 m (49 ft)
		6X6-8258A-81	24 m (79 ft)
4	SCU communication lead (Starboard side/Port side)	6X9-81115-00	0.3 m (1 ft)
		6GR-81115-00	1.5 m (5 ft)
		6GR-81115-10	3.0 m (10 ft)
5	SCU communication lead (Center)	6X9-81115-10	0.3 m (1 ft)
		6GR-81115-20	1.5 m (5 ft)
		6GR-81115-30	3.0 m (10 ft)
6	Pigtail bus wire	6Y8-82521-01	0.3 m (1 ft)
		6Y8-82521-11	0.6 m (2 ft)
		6Y8-82521-21	0.9 m (3 ft)
		6Y8-82521-31	1.8 m (6 ft)
		6Y8-82521-41	2.7 m (9 ft)
		6Y8-82521-51	3.6 m (12 ft)
7	Helm harness (Main/Multi)	6GR-8258A-11	0.9 m (3 ft)
		6GR-8258A-51	1.8 m (6 ft)
		6GR-8258A-61	2.7 m (9 ft)
8	Digital Electronic Control	6X9-48209-04	Main station
9	Split harness 2	6X9-8258A-D0	
10	Split harness 3	6X9-8258A-E0	
11	EKS harness	6X9-82716-91	DEC to switch panel
12	Power switch	6X9-82570-01	
13	Start/stop switch	6X9-82570-51	
14	Engine shut-off switch	6X9-82570-D1	
15	BCU harness	6X9-82386-01	DEC to Autopilot/Joystick
16	Extension wire harness	6X9-82521-00	4.6 m (15 ft)
		6X9-82521-10	9.1 m (30 ft)

System diagram

Ref. No.	Part name	Part No.	Remarks
17	Autopilot panel	6X9-8253V-01	
18	Joystick	6X9-482A0-01	
19	Helm unit assembly	6GR-615A0-00	
20	Tilt helm unit	6GR-6154A-00	
21	Helm unit assembly	6X9-762H0-01	
22	BCU	6X9-8591T-43	
23	Key fob and receiver assembly	6X9-86254-04	Radio frequency 433 MHz, Key fob: 2 pcs.
		6X9-86254-13	Radio frequency 315 MHz, Key fob: 2 pcs.
24	Multi-hub	6Y8-81920-01	w/ resistor cap, Gray
25	Main bus wire	6Y8-82553-01	0.3 m (1 ft)
		6Y8-82553-50	3.0 m (10 ft)
		6Y8-82553-11	4.6 m (15 ft)
		6Y8-82553-21	6.1 m (20 ft)
		6Y8-82553-31	7.6 m (25 ft)
		6Y8-82553-41	9.1 m (30 ft)
26	System power supply wire	6Y8-83553-02	w/ 10 A fuse, 2.4 m (8 ft)
27	Conversion harness	6Y9-83553-10	DEC to hub, 0.3 m (1 ft)
28	Conversion harness	6YM-83553-00	0.9 m (3 ft)
29	CL5 display	6YM-83710-14	No Wi-Fi
30	Tank wire	6YD-8356N-00	
31	Fuel tank	—	
32	Heading sensor	6X9-8A410-01	
33	Propeller light	6KA-83720-00	
34	2nd helm harness (Center)	6X9-8258A-60	5 m (16 ft)
		6X9-8258A-70	8 m (26 ft)
		6X9-8258A-80	12 m (38 ft)
35	2nd helm harness (Starboard side)	6X9-8258A-30	5 m (16 ft)
		6X9-8258A-40	8 m (26 ft)
		6X9-8258A-50	12 m (38 ft)
36	2nd helm harness (Port side)	6X9-8258A-00	5 m (16 ft)
		6X9-8258A-10	8 m (26 ft)
		6X9-8258A-20	12 m (38 ft)
37	Helm harness (2nd station)	6X9-8258A-B1	0.9 m (3 ft)
38	Digital Electronic Control	6X9-48207-12	2nd station
39	BCU harness	6X9-82386-10	DEC to Autopilot/Joystick

System diagram

Ref. No.	Part name	Part No.	Remarks
40	EKS harness	6X9-82716-A0	
41	All start/stop switch	6X9-82570-B1	2nd station/Joystick station
42	Single (inline) hub	6Y8-81920-11	w/ resistor, 4-6P, White
43	GPS unit	6X9-88107-02	
44	Extension wire harness	6X9-83553-70	7 m (23 ft)
		6X9-83553-80	10 m (32 ft)
45	Aux joystick harness	6X9-82580-G0	

(*1). Resistor cap

(*2). Joint connector

A. Main station

B. Sub station

C. Joystick station

a. Power port

b. Bus port

c. Device port

P. Port

CP. Center port

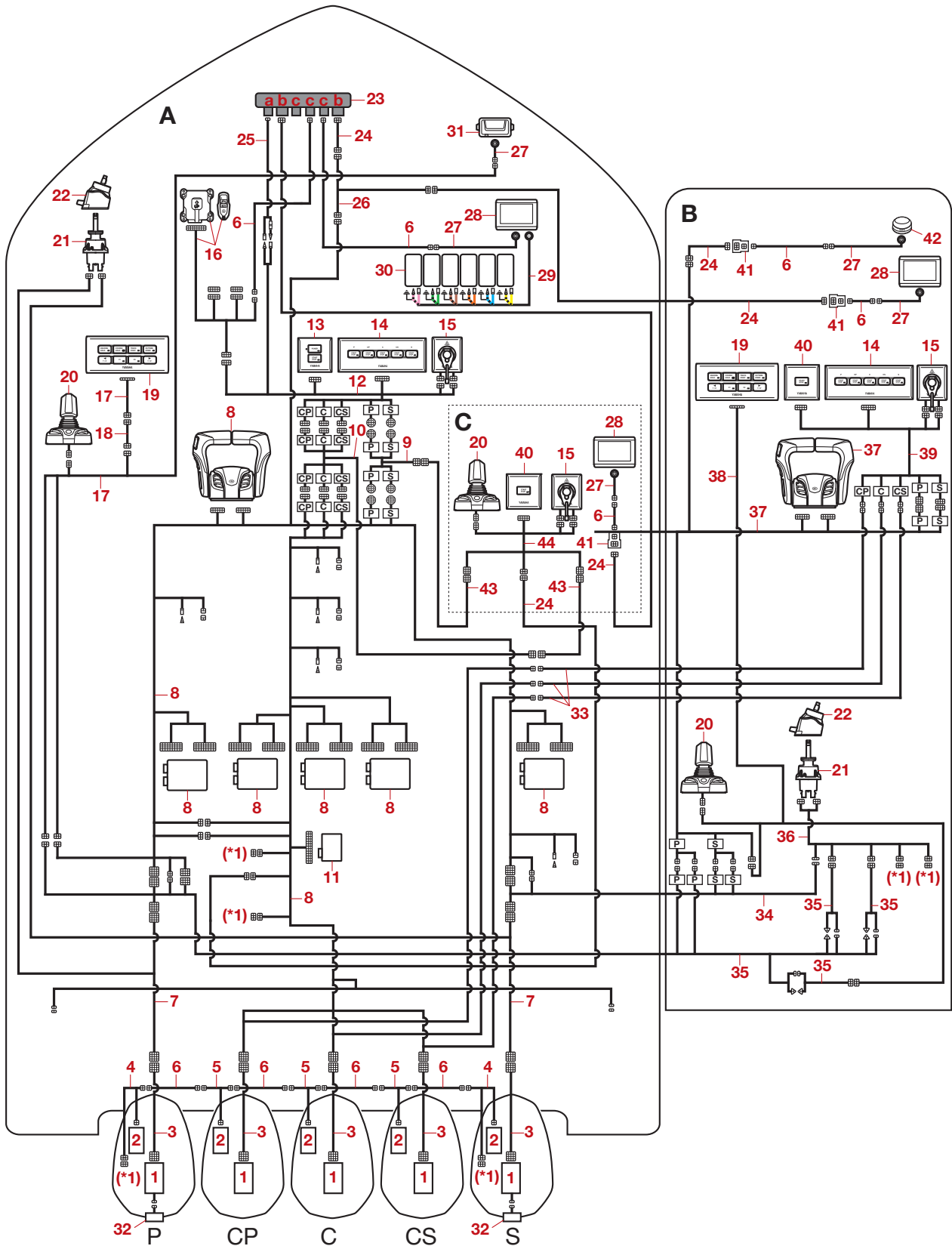
CS. Center starboard

S. Starboard

TIP:

The part numbers are subject to change without notice. Make sure to confirm the latest part numbers.

Quint outboard motor application (dual station)



System diagram

Ref. No.	Part name	Part No.	Remarks
1	Engine ECM	—	
2	SCU	—	
3	Main wire harness (16P)	6X6-8258A-91	1.5 m (5 ft)
		6X6-8258A-51	3.7 m (12 ft)
		6X6-8258A-61	5.2 m (17 ft)
		6X6-8258A-01	6 m (19 ft)
		6X6-8258A-11	7 m (23 ft)
		6X6-8258A-21	8 m (26 ft)
		6X6-8258A-31	10 m (32 ft)
		6X6-8258A-41	12 m (39 ft)
		6X6-8258A-71	15 m (49 ft)
		6X6-8258A-81	24 m (79 ft)
4	SCU communication lead (Starboard side/Port side)	6X9-81115-00	0.3 m (1 ft)
		6GR-81115-00	1.5 m (5 ft)
		6GR-81115-10	3.0 m (10 ft)
5	SCU communication lead (Center)	6X9-81115-10	0.3 m (1 ft)
		6GR-81115-20	1.5 m (5 ft)
		6GR-81115-30	3.0 m (10 ft)
6	Pigtail bus wire	6Y8-82521-01	0.3 m (1 ft)
		6Y8-82521-11	0.6 m (2 ft)
		6Y8-82521-21	0.9 m (3 ft)
		6Y8-82521-31	1.8 m (6 ft)
		6Y8-82521-41	2.7 m (9 ft)
		6Y8-82521-51	3.6 m (12 ft)
7	Helm harness (Main/Multi)	6GR-8258A-11	0.9 m (3 ft)
		6GR-8258A-51	1.8 m (6 ft)
		6GR-8258A-61	2.7 m (9 ft)
8	Digital Electronic Control	6X9-48210-01	Main station
9	Split harness 2	6X9-8258A-D0	
10	Split harness 3	6X9-8258A-E0	
11	BCU	6X9-8591T-51	
12	EKS harness	6X9-82716-B0	DEC to switch panel
13	Power switch	6X9-82570-01	
14	Start/stop switch	6X9-82570-61	
15	Engine shut-off switch	6X9-82570-D1	

System diagram

Ref. No.	Part name	Part No.	Remarks
16	Key fob and receiver assembly	6X9-86254-04	Radio frequency 433 MHz, Key fob: 2 pcs.
		6X9-86254-13	Radio frequency 315 MHz, Key fob: 2 pcs.
17	BCU harness	6X9-82386-20	DEC to Autopilot/Joystick
18	Extension wire harness	6X9-82521-00	4.6 m (15 ft)
		6X9-82521-10	9.1 m (30 ft)
19	Autopilot panel	6X9-8253V-01	
20	Joystick	6X9-482A0-01	
21	Helm unit assembly	6GR-615A0-00	
22	Tilt helm unit	6GR-6154A-00	
23	Multi-hub	6Y8-81920-01	w/ resistor cap, Gray
24	Main bus wire	6Y8-82553-01	0.3 m (1 ft)
		6Y8-82553-50	3.0 m (10 ft)
		6Y8-82553-11	4.6 m (15 ft)
		6Y8-82553-21	6.1 m (20 ft)
		6Y8-82553-31	7.6 m (25 ft)
		6Y8-82553-41	9.1 m (30 ft)
25	System power supply wire	6Y8-83553-02	w/ 10 A fuse, 2.4 m (8 ft)
26	Conversion harness	6Y9-83553-10	DEC to hub, 0.3 m (1 ft)
27	Conversion harness	6YM-83553-00	0.9 m (3 ft)
28	CL5 display	6YM-83710-14	No Wi-Fi
29	Tank wire	6YD-8356N-00	
30	Fuel tank	—	
31	Heading sensor	6X9-8A410-01	
32	Propeller light	6KA-83720-00	
33	2nd helm harness (Center)	6X9-8258A-60	5 m (16 ft)
		6X9-8258A-70	8 m (26 ft)
		6X9-8258A-80	12 m (38 ft)
34	2nd helm harness (Starboard side)	6X9-8258A-30	5 m (16 ft)
		6X9-8258A-40	8 m (26 ft)
		6X9-8258A-50	12 m (38 ft)
35	2nd helm harness (Port side)	6X9-8258A-00	5 m (16 ft)
		6X9-8258A-10	8 m (26 ft)
		6X9-8258A-20	12 m (38 ft)
36	Helm harness (2nd station)	6X9-8258A-B1	0.9 m (3 ft)
37	Digital Electronic Control	6X9-48207-12	2nd station

System diagram

Ref. No.	Part name	Part No.	Remarks
38	BCU harness	6X9-82386-10	DEC to Autopilot/Joystick
39	EKS harness	6X9-82716-C0	
40	All start/stop switch	6X9-82570-B1	2nd station/Joystick station
41	Single (inline) hub	6Y8-81920-11	w/ resistor, 4-6P, White
42	GPS unit	6X9-88107-02	
43	Extension wire harness	6X9-83553-70	7 m (23 ft)
		6X9-83553-80	10 m (32 ft)
44	Aux joystick harness	6X9-82580-G0	

(*1). Resistor cap

- A. Main station
- B. Sub station
- C. Joystick station

- a. Power port
- b. Bus port
- c. Device port

- P. Port
- CP. Center port
- C. Center
- CS. Center starboard
- S. Starboard

TIP: _____

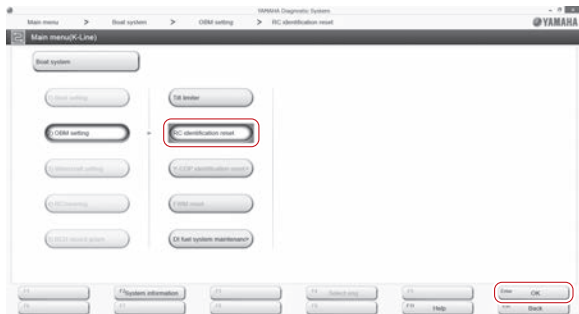
The part numbers are subject to change without notice. Make sure to confirm the latest part numbers.

Digital Electronic Control

Digital Electronic Control system reset

A Digital Electronic Control system reset is required after the replacement of the Digital Electronic Control ECM or the engine ECM.

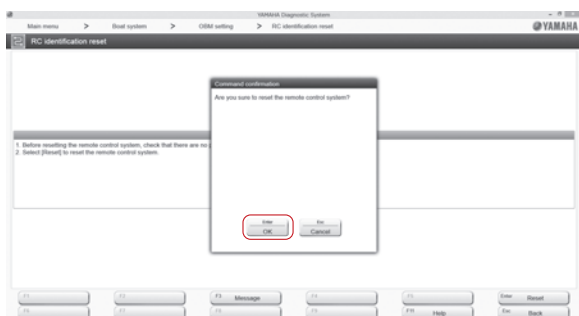
1. Connect the YDIS to display “Boat System” menu. To connect and operate the YDIS, see the YDIS (Ver. 2.49 or later) instruction manual.
2. Click the “R/C identification reset” button or “OK” button, or select “R/C identification reset” using the arrow keys, and then press the Enter key on the keyboard.



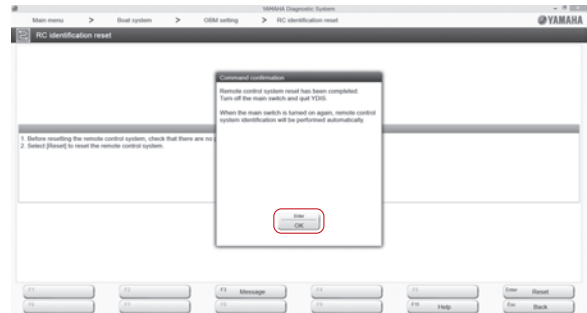
3. Click the “Reset” button or press the Enter key on the keyboard.



4. Click the “OK” button or press the Enter key on the keyboard.



5. Click the “OK” button or press the Enter key on the keyboard.



6. Turn the main switch or power switch to OFF, and then remove the extension wire harness of the Digital Electronic Control.

TIP:

The outboard motor will automatically identify the newly connected Digital Electronic Control under any of the following conditions:

- When the extension wire harness is connected and the engine start switch is turned to ON again.
- When the engine start switch is turned to OFF, and then turned to ON again after waiting for about 10 seconds until the power to the engine ECM is shut off.

Tilt limiter

Setting the tilt limiter

WARNING

- Check that the outboard motor is mounted on the boat or on a stand securely.
- Never get under the outboard motor while it is tilted.

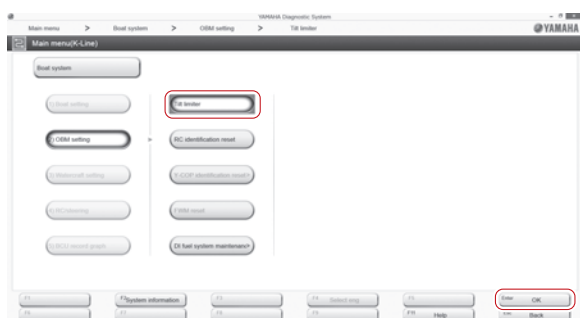
If there is interference between the top cowling and the motor well when the outboard motor is tilted up, adjust the setting angle of the tilt limiter using the following procedures.

1. Fully tilt the outboard motor down.
2. Connect the YDIS to display “Boat System” menu. To connect and operate the YDIS, see the YDIS (Ver. 2.49 or later) instruction manual.

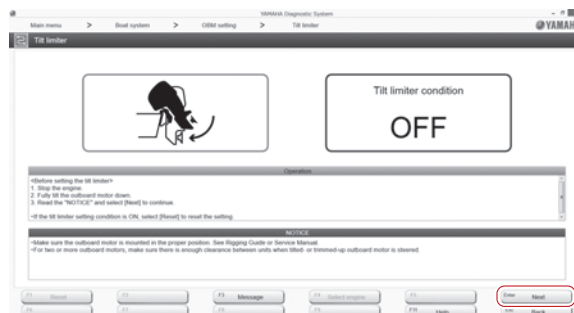
TIP:

It is not possible to set or clear the tilt limiter if there is any problem with the PTT sensor or the wiring. In that case, correct the problem first, and then set or clear the tilt limiter.

3. Click the “Tilt limiter” button or “OK” button, or select the “Tilt limiter” using the arrow keys, and then press the Enter key on the keyboard.



4. Click the “Next” button or press the Enter key on the keyboard.



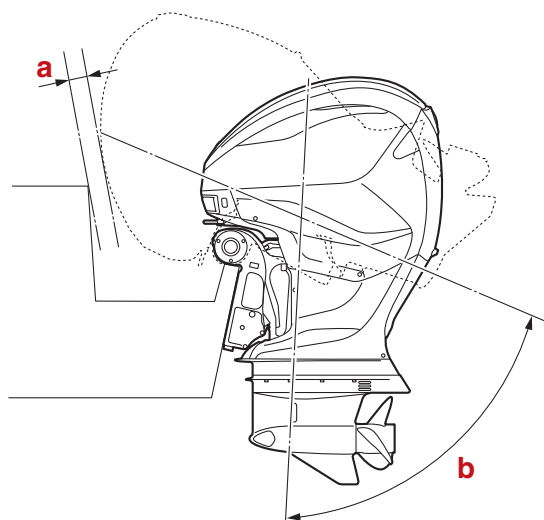
5. Operate the PTT switch on the bottom cowling to tilt the outboard motor up to the position where the tilt limiter is to be activated.

NOTICE

- Do not use the PTT switch on the Digital Electronic Control during the tilt limiter setting to avoid interference between the motor well and the top cowling.
- Make sure to keep the clearance “a” of 50.8 mm (2.0 in) or more between the outboard motor and the motor well.

TIP:

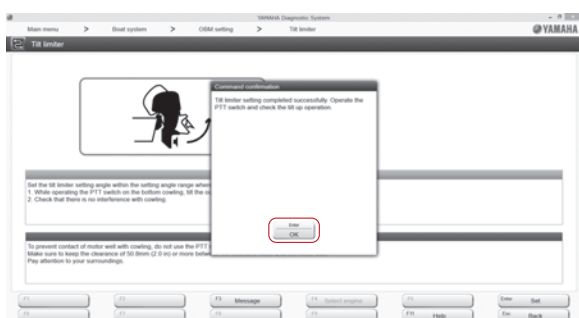
The tilt up angle can be set at any tilt setting range “b”.



- Click the “Set” button or press the Enter key on the keyboard.



- Click the “OK” button or press the Enter key on the keyboard.



- Check that the outboard motor stops at the set position.

TIP:

- If the tilt limiter does not operate at the set position, or to change the setting position, clear the tilt limiter setting, and then reset it.
- If the tilt limiter is set to a position where the tilt support lever cannot be engaged, or if the outboard motor is tilted up with the tilt support lever released for a long time, the outboard motor can fall under its own weight.

Clearing the tilt limiter

- Connect the YDIS to display “Boat System” menu. To connect and operate the YDIS, see the YDIS (Ver. 2.49 or later) instruction manual.

TIP:

It is not possible to set or clear the tilt limiter if there is any problem with the PTT sensor or the wiring. In that case, correct the problems before setting or clearing the tilt limiter.

- Click the “Reset” button or press the F1 key on the keyboard.



- Click the “OK” button or press the Enter key on the keyboard.



- Click the “OK” button or press the Enter key on the keyboard.

TIP:

To reset the tilt limiter setting, see “Setting the tilt limiter” (3-63).



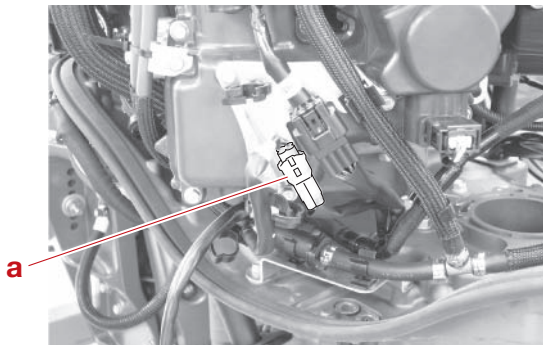
Deactivating the tilt limiter

The tilt limiter can be deactivated temporarily without using the YDIS for services or maintenance. Deactivate the tilt limiter using the following procedure.

1. Disconnect the PTT sensor (sub lead) coupler "a".

TIP:

When the engine start switch is turned to ON with the PTT sensor coupler disconnected, diagnosis code 83 (PTT sensor malfunction) will be recorded in the engine ECM. Make sure to connect the PTT sensor coupler and delete the diagnosis code after services or maintenance is complete.



Calibration (6X9 Digital Electronic Control)

- If the steering actuator is removed, the steering sensor must be calibrated after the unit is installed.
- Check that the battery is fully charged before performing the calibration. Otherwise, the calibration cannot be performed properly.
- Do not turn the steering wheel while the calibration is being performed.

TIP: _____

Steering calibration is not required with the factory default setting.

CL5 display calibration

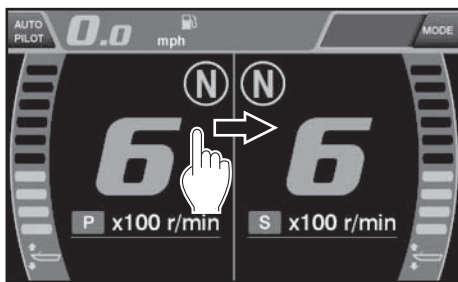
- If the steering actuator is removed, the steering sensor must be calibrated after the unit is installed.
- Check that the battery is fully charged before performing the calibration. Otherwise, the calibration cannot be performed properly.
- Do not turn the steering wheel while the calibration is being performed.

TIP: _____

Steering calibration is not required with the factory default setting.

Configuring the number of outboard motors

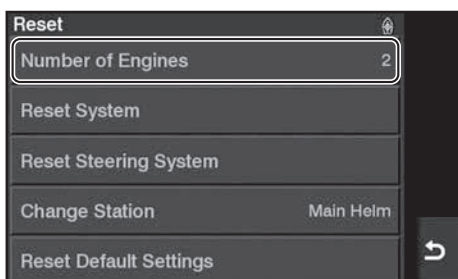
1. Turn the power switch to "ON".
2. Open the menu screen by swipe.



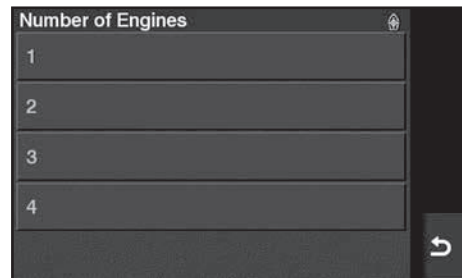
3. Tap "Reset".



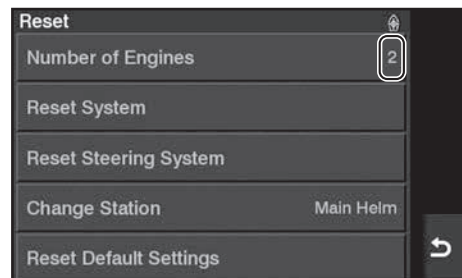
4. Tap "Number of Engines".



5. Select the number of outboard motors mounted on the boat.

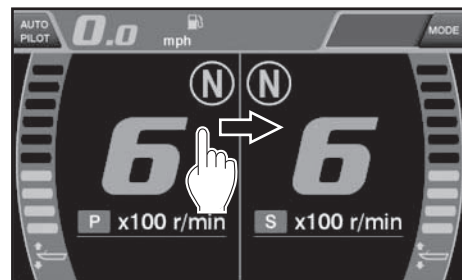


6. Tap "Reset" to confirm that the number of outboard motors has been changed.



Accessing the calibration menu

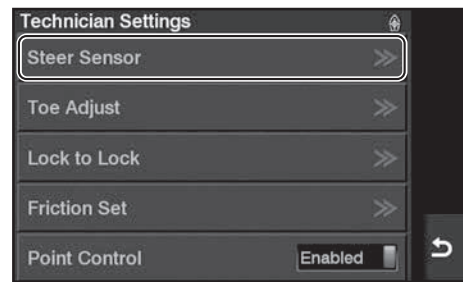
1. Open the menu screen by swipe.



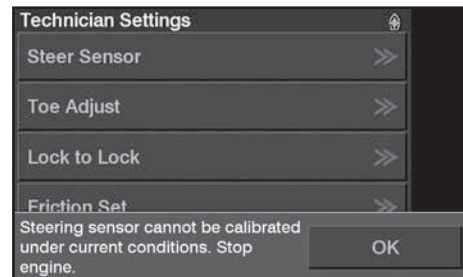
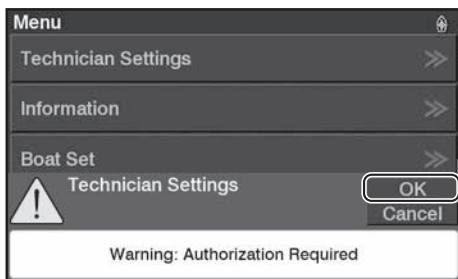
2. Tap and hold the "Menu" bar for 10 seconds. The "Technician Settings" menu will be added to the menu.

TIP: _____

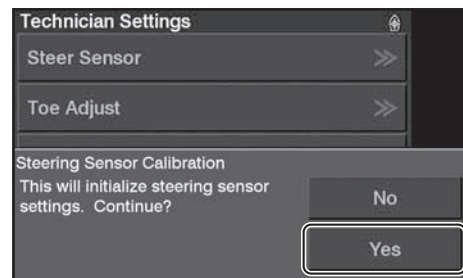
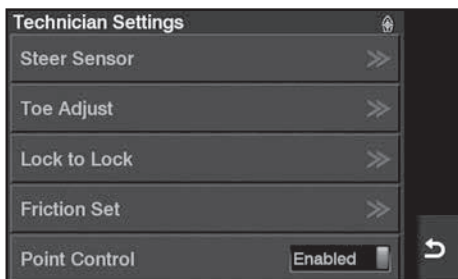
Tap while the screen is scrolled all the way to the top.



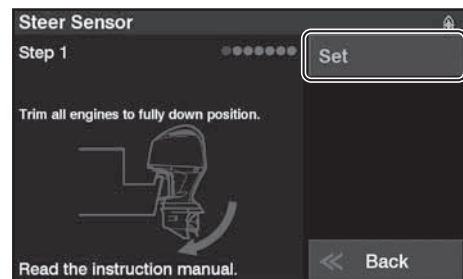
- When the “Technician Settings” message appears, tap “OK”.



- The “Technician Settings” menu will appear.



- Tap “Set” to trim all engines to the fully down position.



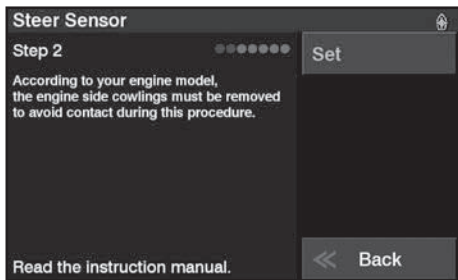
Steering sensor

During this process, only the corresponding steering actuator will operate as the steering sensor is being calibrated.

- Before performing this menu, switch the battery switch(es) to the “ALL” position.
- From the “Technician Settings” menu, select “Steer Sensor”, and then tap “Yes”.

TIP: _____
When the engine is running, this function is not available.

4. Check the contents of the display and proceed to the next step.

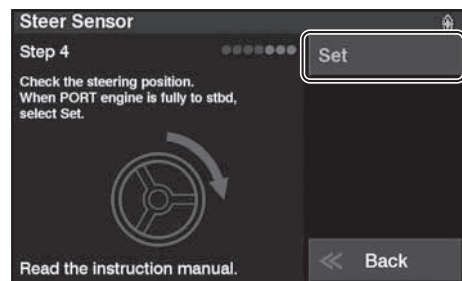
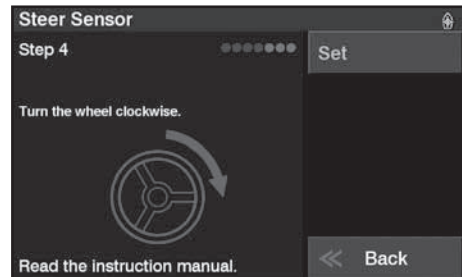


5. Turn the steering wheel clockwise until starboard outboard motor reaches full STBD lock and the message appears. Confirm the starboard outboard motor is at full STBD lock, and then tap “Set”.

TIP:

- For triple engine applications, after this step, do the center outboard motor, and then do the port outboard motor.
- For quad engine applications, after this step, do the center starboard outboard motor, then the center port outboard motor, and then do the port outboard motor.
- For quint engine applications, after this step, do the C STBD engine, then the CENTER engine, then the C PORT engine, and then do the PORT engine.

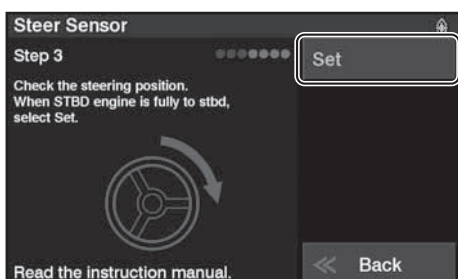
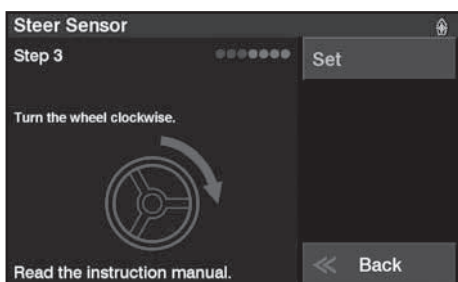
6. Turn the steering wheel clockwise until the port outboard motor reaches full STBD lock and the message appears. Confirm the port outboard motor is at full STBD lock, and then tap “Set”.

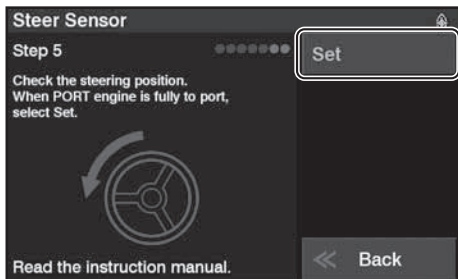
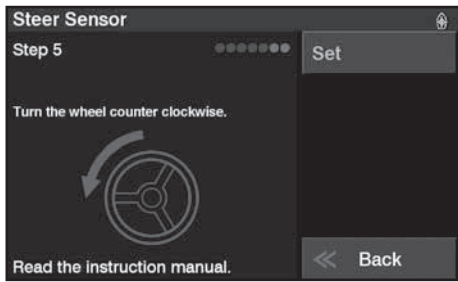


7. Turn the steering wheel counterclockwise until the port outboard motor reaches full PORT lock and the message appears. Confirm the port outboard motor is at full PORT lock, and then tap “Set”.

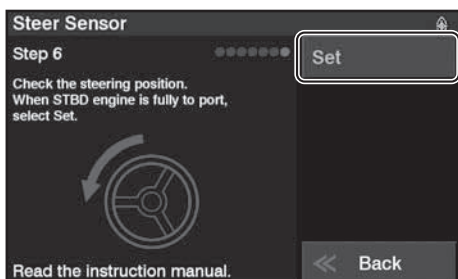
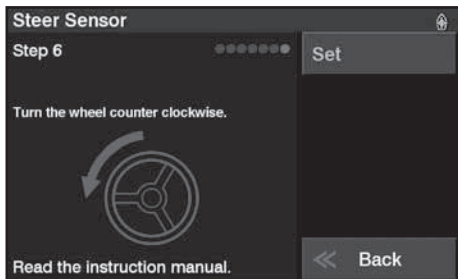
TIP:

- For triple engine applications, after this step, do the center outboard motor, and then do the port outboard motor.
- For quad engine applications, after this step, do the center port outboard motor, then the center starboard outboard motor, and then do the starboard outboard motor.
- For quint engine applications, after this step, do the C PORT engine, then the CENTER engine, then the C STBD engine, and then do the STBD engine.

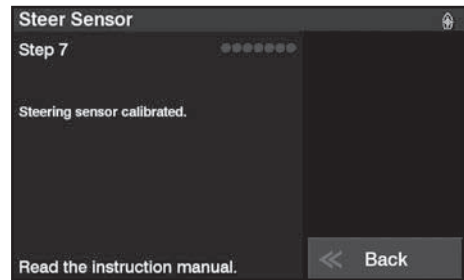




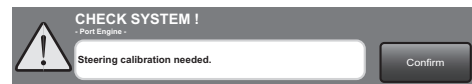
8. Turn the steering wheel counterclockwise until the starboard outboard motor reaches full PORT lock and the message appears. Confirm the starboard outboard motor is at full PORT lock, and then tap "Set".



9. Once the calibration is complete, a message will appear verifying the procedure is completed.



10. If there is an invalid value when calibrating the steering sensor, a notification will appear. Perform the complete calibration procedure again.
11. If the steering system still requires calibration, a warning notification will appear. The engine will not start until calibration is performed again.



Toe Adjust

You can freely adjust the toe angle of outboard motors according to the structure of the hull on which they are mounted.

This should be determined by on-water testing.

TIP: _____

- For twin engines without BCU, triple engines (Toe Adjust: numerical value input)
- For twin engines with BCU (Wedge/Toe: numerical value input, adjust up and down)
- For quad engines (Inner/Outer: numerical value input)

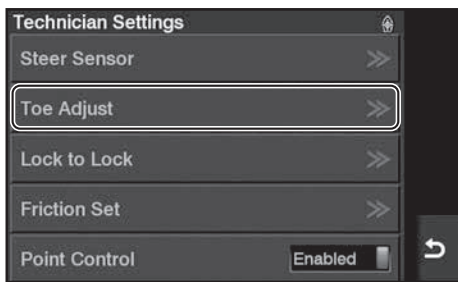
Wedge/Toe settings

Do this setting for “Wedge/Toe” only if the adjustment width of the toe angle is insufficient due to the shape of the transom.

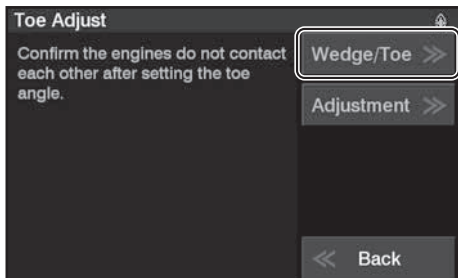
TIP:

Single engine application: No setting
 Twin engine application: Wedge and Toe
 Triple/quad/quint engine application: Toe Adjust only

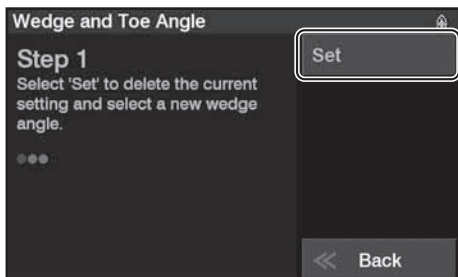
1. From the “Technician Settings” menu, select “Toe Adjust”.



2. Tap “Wedge/Toe”.



3. Select “Set” to delete the current setting and select a new wedge angle.

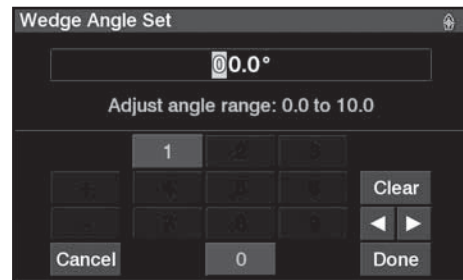


4. Adjust the wedge angle. Tap “Done” to confirm.

TIP:

The Helm Master EX control system comes with the toe set at 00.0°. The adjustment range is:

- 0.0° to +10.0° in 0.1° increments.
- Plus (+) degrees equals toe-out.



5. Select “Set” to adjust the toe angle.



6. Adjust the toe angle. Tap “Done” to confirm.

TIP:

The Helm Master EX control system comes with the toe set at 0.0°. The adjustment range is:

- -2.0° to +2.0° in 0.2° increments (up to 0.2 in).
- Minus (-) degrees equals toe-in.
- Plus (+) degrees equals toe-out.

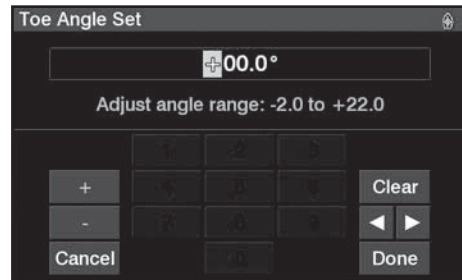
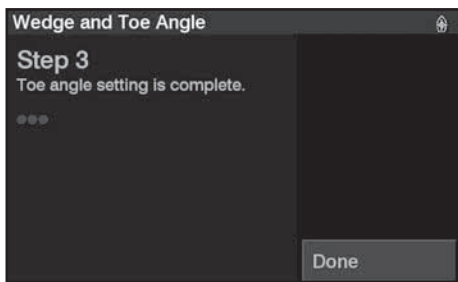


TIP: _____

The Helm Master EX control system comes with the toe set at 00.0°. The adjustment range is:

- -2.0° to +22.0° in 0.2° increments.
- Minus (-) degrees equals toe-in.
- Plus (+) degrees equals toe-out.

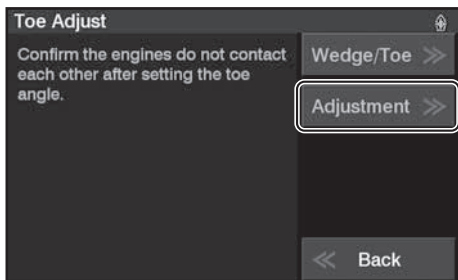
7. When the Wedge/Toe calibration is completed, a message will appear.



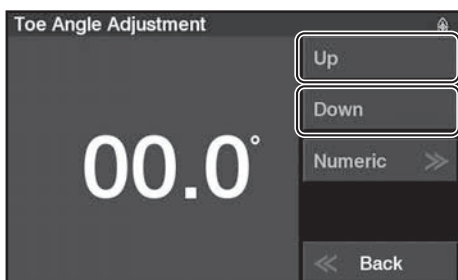
Adjustment settings

If you are adjusting only the toe angle, do the setting in "Adjustment".

1. Tap "Adjustment".



2. Tap "Up" or "Down" to adjust the toe angle.



Tap "Numeric" to adjust the toe angle.

Lock to Lock

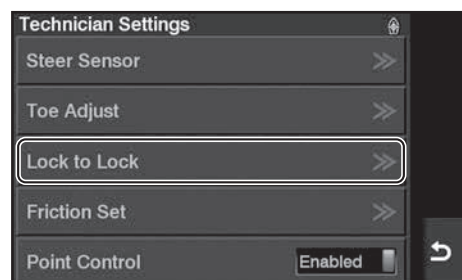
You can freely adjust the number of turns of the steering wheel lock to lock.

Constant

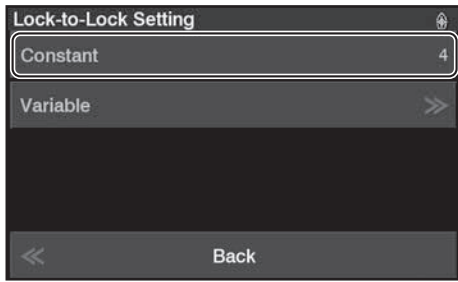
1. From the "Technician Settings" menu, select "Lock to Lock".

TIP: _____

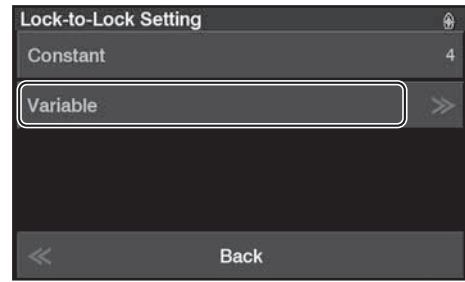
When the engine is running, this function is not available.



2. Tap “Constant”.



2. Tap “Variable”.

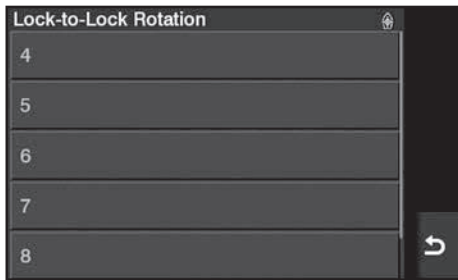


3. Select the steering wheels’ rotation range. Tap to confirm your setting.

TIP:

This setting allows you to adjust the number of turns from “Lock to Lock”.

- Minimum: 4 turns
- Maximum: 9 turns
- Default: 4 turns



3. Select the positions, 1 to 4, to set.

Position	RPM	LTL
1	0	4
2	500	5
3	600	6
4	5000	7

4. Tap “Set RPM” to adjust the RPM of engines 1 to 4.

TIP:

You can adjust this to any value in a range of 0 to 6000 r/min.

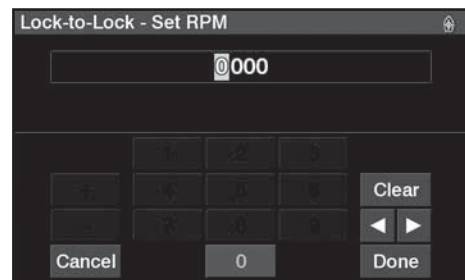
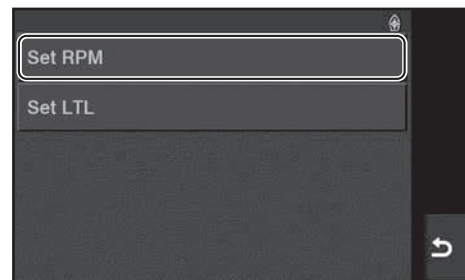
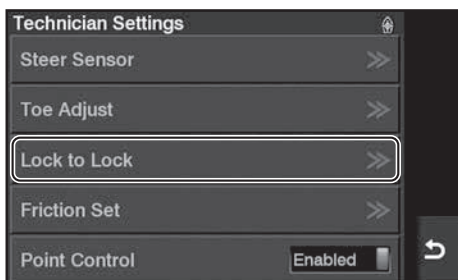
Variable

Select the rotational angle of the steering wheel according to the engine speed.

1. From the “Technician Settings” menu, select “Lock to Lock”.

TIP:

When the engine is running, this function is not available.

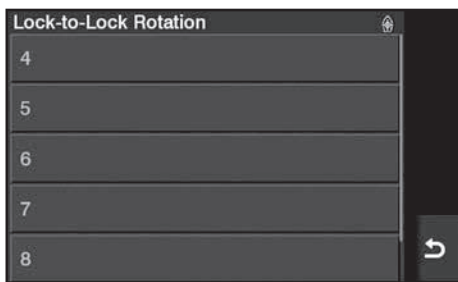


5. Tap “Set LTL” and then select a rotational angle, from 1 to 9, for the steering wheel.

TIP:

This setting allows you to adjust the number of turns from “Lock to Lock”.

- Minimum: 4 turns
- Maximum: 9 turns
- Default: 4 turns



Friction Set

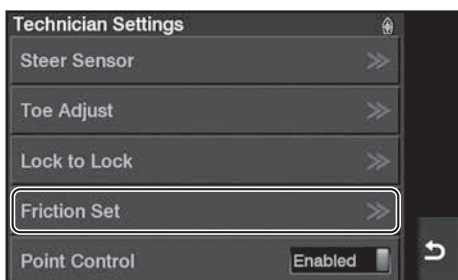
The Helm Master EX control steering system has a unique function related to the friction of the steering system. The steering will automatically adjust the friction setting depending on engine speed. At higher engine speeds, the friction increases. At lower engine speeds, the friction decreases.

Regardless of the setting chosen, the steering still increases and decreases the friction based on the engine speed.

1. From the “Technician Settings” menu, select “Friction Set”.

TIP:

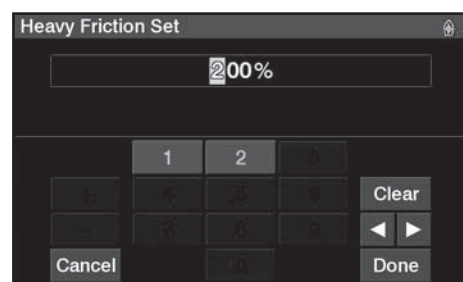
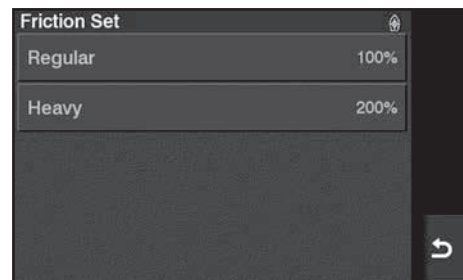
When the engine is running, this function is not available.

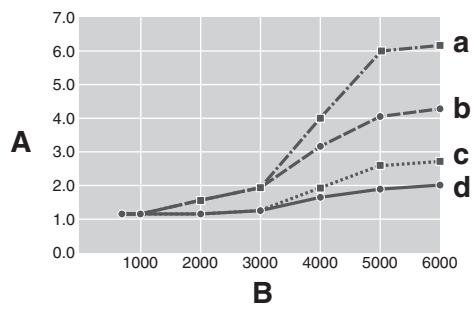


2. First choose “Regular” or “Heavy”, then adjust the percentage of friction. Tap “Done” to confirm.

TIP:

The setting choices allow you to choose between “Regular” and “Heavy”. In each of those settings, it is adjustable between 100% and 200% in 10% increments. The default setting is 100%.

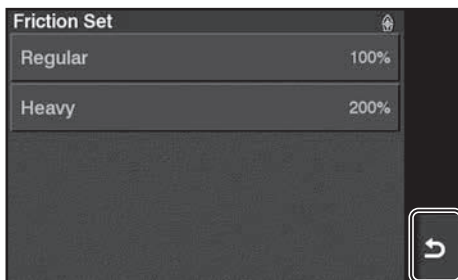




- a. Heavy 200%
- b. Regular 200%
- c. Heavy 100%
- d. Regular 100%

- A. Steering friction (N·m)
- B. Engine speed (r/min)

3. When the “Friction Set” setting is completed, tap “return mark” to return to the “Technician Settings” menu.



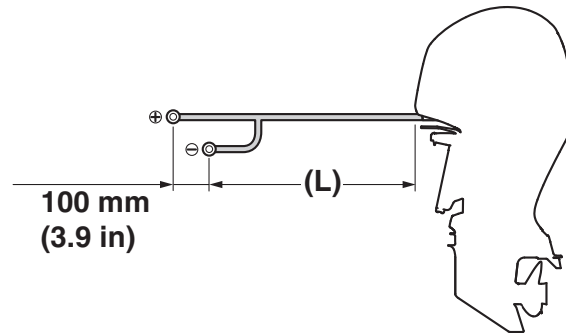
Rigging recommendation

Battery cable length

The table below shows the battery cable length from the negative terminal of the battery cable to the rigging grommet.

The positive battery cable is 100 mm (3.9 in) longer than the negative battery cable.

Length (L)
3.55 m (11.6 ft)



Extension length recommendation for battery cable

NOTICE

Do not exceed the recommended extension length for the battery cable. Otherwise, the electrical system could be damaged or operate improperly.

To extend the length of battery cables, follow the requirements in the tables for battery capacity, cable size, and ambient temperature.

The maximum total extension length is the total combined length of the positive and negative battery cables.

Select an extension battery cable and terminal that meet ABYC requirements or the equivalent.

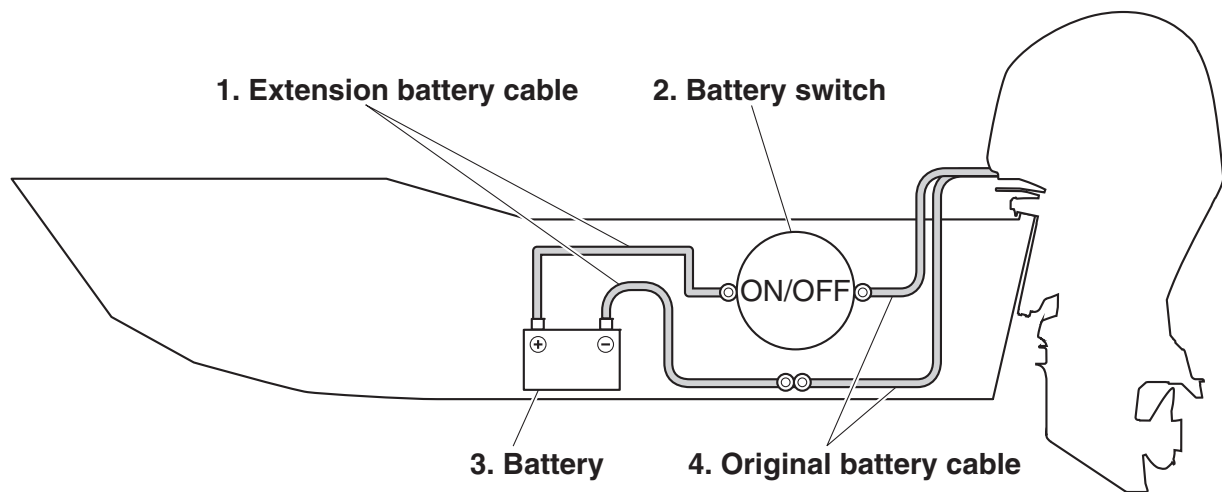
Select the battery stud that is best-suited to the terminal size.

Solder the cable and terminal connections to prevent them from corroding.

Ambient temperature is 0 °C (32 °F) and above					
Battery requirements		Cable specifications			
Unit	Rating	Maximum total extension length (Positive battery cable + Negative battery cable)			
		20 mm ² (AWG4)	30 mm ² (AWG2)	50 mm ² (AWG1/0)	60 mm ² (AWG2/0)
CCA/SAE	700 A	-	6.4 m (21 ft)	10.0 m (33 ft)	11.8 m (39 ft)
MCA/ABYC	900 A				
RC/SAE	170 minutes				
CCA/EN	670 A				
20HR/IEC	110 Ah				
JIS	120E41				

Rigging recommendation

Ambient temperature is below 0 °C (32 °F)					
Battery requirements		Cable specifications			
Unit	Rating	Maximum total extension length (Positive battery cable + Negative battery cable)			
		20 mm ² (AWG4)	30 mm ² (AWG2)	50 mm ² (AWG1/0)	60 mm ² (AWG2/0)
CCA/SAE	700 A	-	2.9 m (9 ft)	4.4 m (15 ft)	5.2 m (16 ft)
MCA/ABYC	900 A				
RC/SAE	170 minutes				
CCA/EN	670 A				
20HR/IEC	110 Ah				
JIS	120E41				
CCA/SAE	800 A	-	3.1 m (10 ft)	4.7 m (15 ft)	5.7 m (18 ft)
MCA/ABYC	960 A				
RC/SAE	230 minutes				
CCA/EN	750 A				
20HR/IEC	120 Ah				
JIS	130E41				



1. Extension battery cable
2. Battery switch
3. Battery
4. Original battery cable

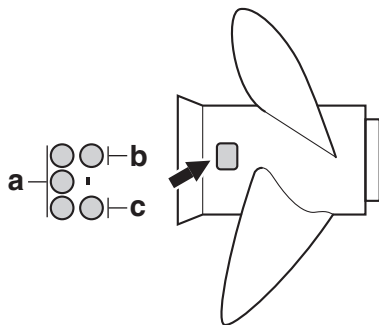
Propeller selection

The size and type of propeller that is used will affect the performance of a boat and outboard motor critically. Propellers greatly affect boat speed, acceleration, engine life, fuel economy, and even boat-ing and steering capabilities. An incorrect choice could adversely affect performance and could also damage the engine seriously.

Use the following information as a guide for selecting a propeller that meets the operating conditions of the boat and outboard motor.

Propeller size


The size of the propeller is indicated on the side of the propeller boss.



- a. Propeller diameter (in inches)
- b. Propeller pitch (in inches)
- c. Propeller type (propeller mark)

Selection

With the engine speed at full throttle operating range and under a maximum boat load, the engine speed should be within the upper half of the full throttle operating speed range.

	Full throttle operating range 5000–6000 r/min
-----------------------------------------------------------------------------------	--------------------------------------------------

Regular rotation model

Blade	Dia. (in)	Pitch (in)	Mark	Material	Part number	Remarks
3	17 1/8	15	Y2	Stainless steel	6GR-45970-20	*1, *2
3	16 7/8	16	Y2	Stainless steel	6GR-45D70-20	*1, *2
3	16 7/8	17	Y2	Stainless steel	6GR-45972-20	*1, *2
3	16 7/8	17	Y	Stainless steel	6KN-45970-00	*1, *3
3	16 5/8	18	Y2	Stainless steel	6GR-45938-20	*1, *2
3	16 5/8	19	Y2	Stainless steel	6GR-45974-20	*1, *2
3	16 3/8	20	Y2	Stainless steel	6GR-45936-20	*1, *2
3	16 5/8	20	Y	Stainless steel	6KN-45976-00	*1, *3
3	16 3/8	21	Y2	Stainless steel	6GR-45976-20	*1, *2
3	16 3/8	21	Y	Stainless steel	6KN-45978-00	*1, *3
3	16 1/8	22	Y2	Stainless steel	6GR-45934-20	*1, *2
3	16 1/8	23	Y2	Stainless steel	6GR-45978-20	*1, *2
3	16	24	Y2	Stainless steel	6GR-45932-20	*1, *2
3	16 1/8	24	Y	Stainless steel	6KN-45972-00	*1, *3
3	16	25	Y2	Stainless steel	6GR-45930-20	*1, *2
3	16 1/8	25	Y	Stainless steel	6KN-45974-00	*1, *3
3	16	26	Y2	Stainless steel	6GR-45D72-20	*1, *2
3	16 1/8	26	Y	Stainless steel	6KN-45B70-00	*1, *3
3	16	27	Y2	Stainless steel	6GR-45D74-20	*1, *2

*1. Shift Dampener System (SDS) propellers

*2. XTO offshore series propellers (“XTO OS” is indicated on the side of the propeller boss.)

*3. XTO-EC series propellers (“XTO EC” is indicated on the side of the propeller boss.)

TIP: _____

The part numbers are subject to change without notice. Make sure to confirm the latest part numbers.

Counter rotation model

Blade	Dia. (in)	Pitch (in)	Mark	Material	Part number	Remarks
3	17 1/8	15	YL2	Stainless steel	6GS-45970-20	*1, *2
3	16 7/8	16	YL2	Stainless steel	6GS-45D70-20	*1, *2
3	16 7/8	17	YL2	Stainless steel	6GS-45972-20	*1, *2
3	16 7/8	17	YL	Stainless steel	6KP-45970-00	*1, *3
3	16 5/8	18	YL2	Stainless steel	6GS-45938-20	*1, *2
3	16 5/8	19	YL2	Stainless steel	6GS-45974-20	*1, *2
3	16 3/8	20	YL2	Stainless steel	6GS-45936-20	*1, *2
3	16 5/8	20	YL	Stainless steel	6KP-45976-00	*1, *3
3	16 3/8	21	YL2	Stainless steel	6GS-45976-20	*1, *2
3	16 3/8	21	YL	Stainless steel	6KP-45978-00	*1, *3
3	16 1/8	22	YL2	Stainless steel	6GS-45934-20	*1, *2
3	16 1/8	23	YL2	Stainless steel	6GS-45978-20	*1, *2
3	16	24	YL2	Stainless steel	6GS-45932-20	*1, *2
3	16 1/8	24	YL	Stainless steel	6KP-45972-00	*1, *3
3	16	25	YL2	Stainless steel	6GS-45930-20	*1, *2
3	16 1/8	25	YL	Stainless steel	6KP-45974-00	*1, *3
3	16	26	YL2	Stainless steel	6GS-45D72-20	*1, *2
3	16 1/8	26	YL	Stainless steel	6KP-45B70-00	*1, *3
3	16	27	YL2	Stainless steel	6GS-45D74-20	*1, *2

*1. Shift Dampener System (SDS) propellers

*2. XTO offshore series propellers (“XTO OS” is indicated on the side of the propeller boss.)

*3. XTO-EC series propellers (“XTO EC” is indicated on the side of the propeller boss.)

TIP:

The part numbers are subject to change without notice. Make sure to confirm the latest part numbers.

Fuel line air purging

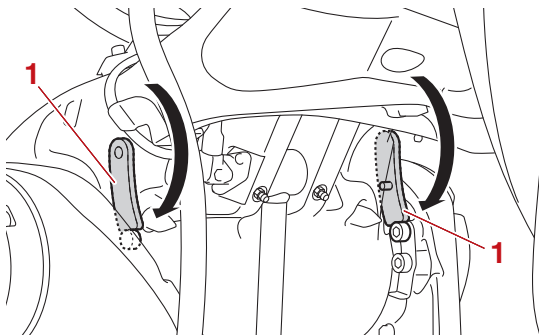
Air purging during initial priming

- When mounting a new outboard motor to a new boat, the fuel line must be bled.
- Cover the fuel components using a rag to prevent fuel from spilling out.

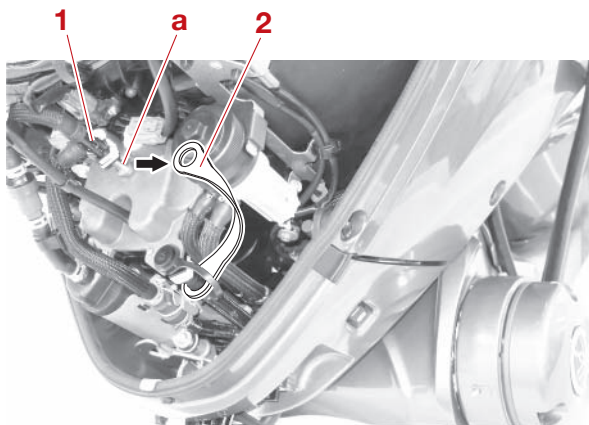
⚠ WARNING

Never get under the outboard motor while it is tilted.

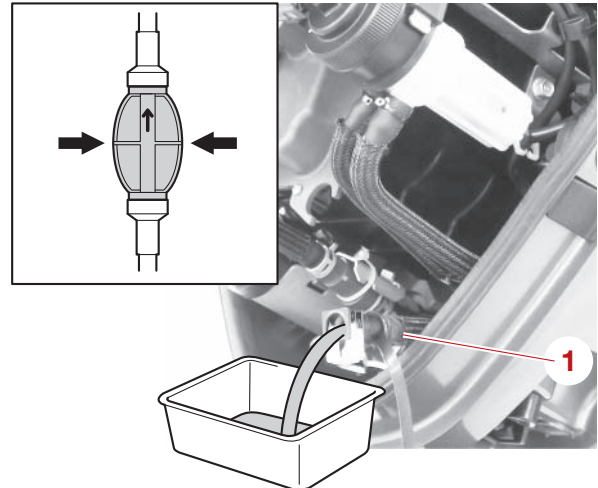
1. Fully tilt the outboard motor up, and then support it using the tilt support lever "1".



2. Disconnect the quick connector "1". See "Disconnecting the quick connector" (6-1).
3. Remove the band "2" from the fuel pipe "a", and then connect the quick connector "1".



4. Remove the drain hose "1" from the holder on the vapor separator cover.
5. Remove the plug from the drain hose, and then squeeze the primer pump until fuel flows from the drain hose.



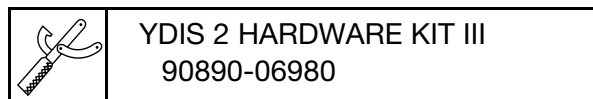
6. Install the plug into the drain hose, and then fasten the drain hose using the holder on the vapor separator cover.
7. Disconnect the quick connector. See "Disconnecting the quick connector" (6-1).
8. Install the band to the fuel pipe, and then connect the quick connector.
9. Squeeze the primer pump until it becomes firm.

Troubleshooting

YDIS	4-1
Connecting the communication cable	4-1
ECM reprogramming.....	4-3
Outboard motor troubleshooting	4-4
Troubleshooting procedure.....	4-4
Troubleshooting the power unit using the YDIS	4-4
Trouble code and checking step.....	4-8
Troubleshooting procedure (trouble code not detected)	4-25
Troubleshooting the power unit	4-25
Troubleshooting the PTT unit.....	4-33
Troubleshooting the lower unit.....	4-35

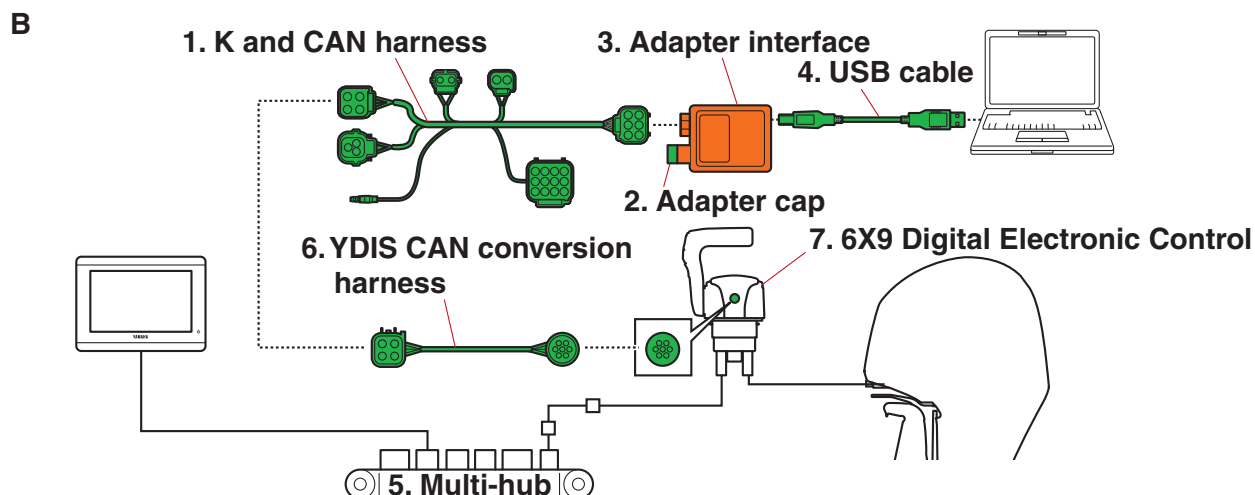
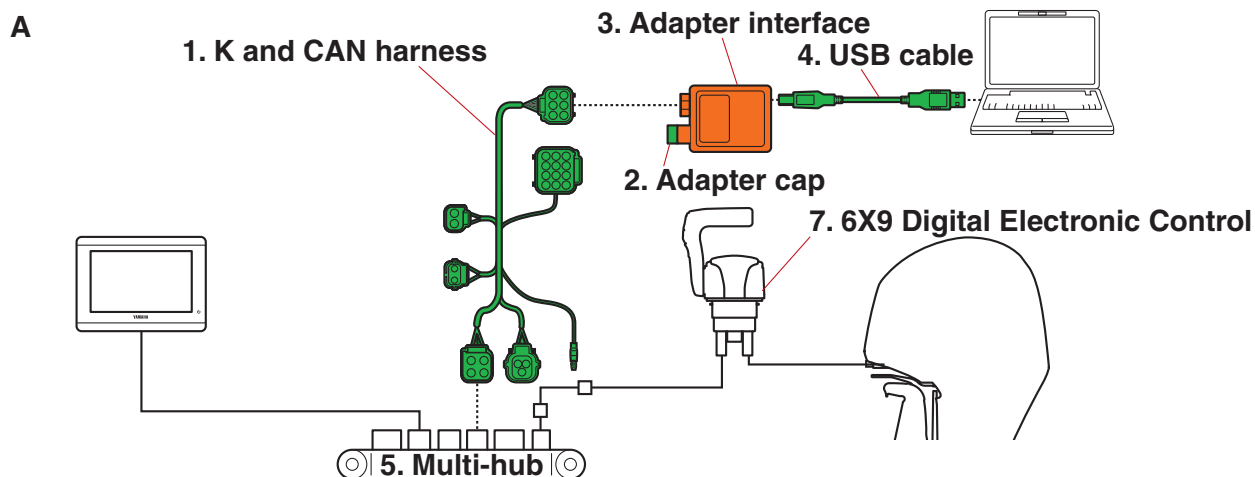
YDIS

The Yamaha Diagnostic System uses precision fault diagnosis to offer better serviceability at a time when there is increasing demand for service tools for electronically controlled products. It provides quick, reliable, safe, and reasonable service, and is intended to obtain customer satisfaction. The Yamaha Diagnostic System features updated software and expanded tool functions that allow it to respond to new models and technologies, maintaining compatibility with regulations. See YDIS (Ver. 2.49 or later) instruction manual for detailed information.



Connecting the communication cable

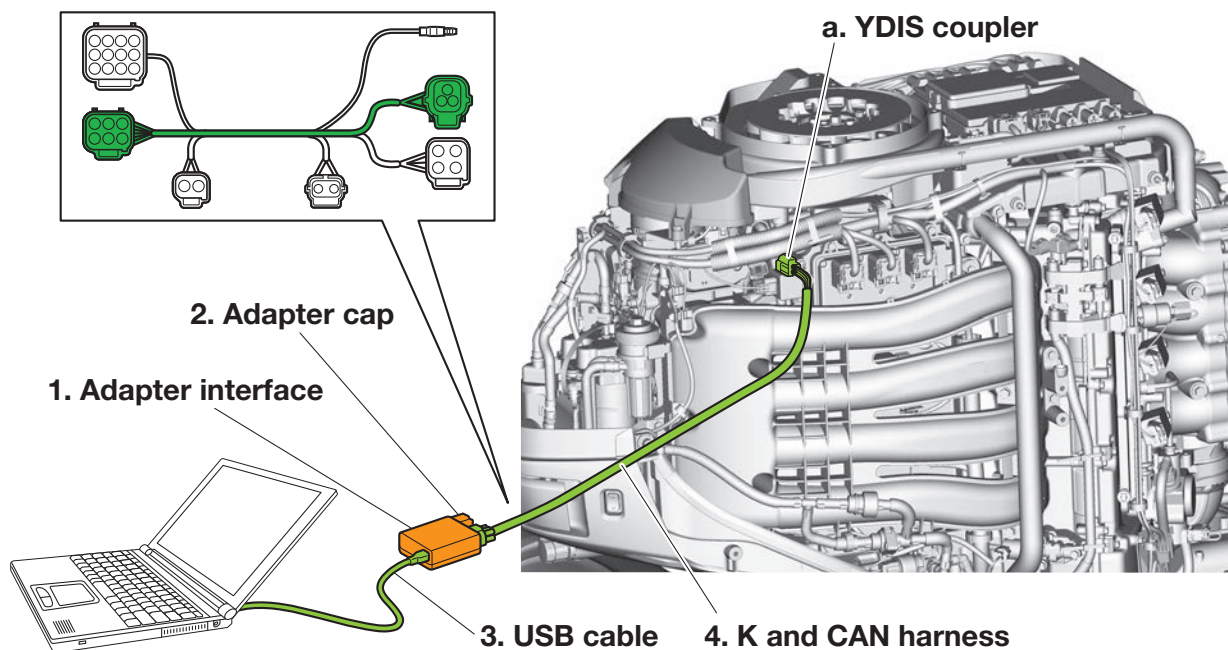
CAN-Line



1. K and CAN harness
2. Adapter cap
3. Adapter interface
4. USB cable
5. Multi-hub
6. YDIS CAN conversion harness
7. 6X9 Digital Electronic Control

- A. When connecting to multi-hub
- B. When connecting to 6X9 Digital Electronic Control

K-Line



- 1. Adapter interface
- 2. Adapter cap
- 3. USB cable
- 4. K and CAN harness

- a. YDIS coupler (gray)

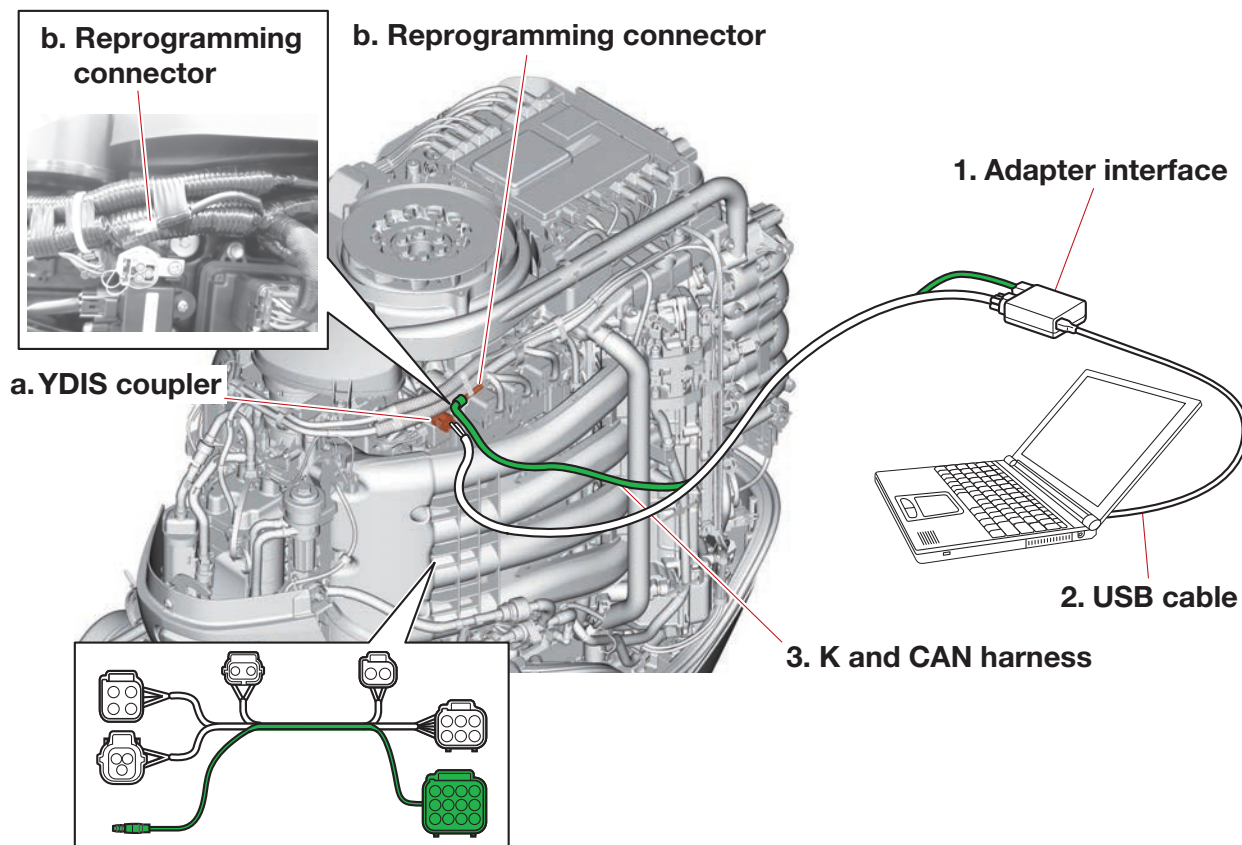
ECM reprogramming

Program update function

This function allows you to update the engine ECM program to the latest version using a K and CAN harness (VPP harness).

Writing function of engine serial numbers

A new function enables you to write an engine serial number to a new, replacement part engine ECM (supplied by the Part Division). With this new function, it will be possible to reprogram engine ECMs that are supplied as replacement parts by communicating with YMAN.



1. Adapter interface
2. USB cable
3. K and CAN harness

- a. YDIS coupler (gray)
- b. Reprogramming connector (green/orange)

Outboard motor troubleshooting

Troubleshooting procedure

1. Before troubleshooting the outboard motor, check that fresh fuel of the specified type has been used.
2. Check that all electrical connections are secure and free from corrosion, and that the battery is fully charged.
3. Check the trouble code using the YDIS first, and then check the electronic control system following the trouble code chart.
4. When a trouble code is detected, check the data logger of the engine ECM record graph as well.
5. If a trouble code is not detected, check the power unit according to “Troubleshooting the power unit” (4-25).
6. Before using the YDIS to check the power unit, check the engine ECM circuit. See “Checking the engine ECM circuit” (5-19).

TIP:

- When deleting the diagnosis record on the YDIS, make sure to check the time that the trouble codes were detected.
 - When checking the input voltage of a part, the coupler or connector must be disconnected. As a result, the engine ECM determines that the part is disconnected and a trouble code is detected. Therefore, make sure to delete the diagnosis record after checking the input voltage.
 - Since the main relay comes on for approximately 10 seconds after the engine start switch is turned to OFF, the power of the engine ECM cannot be turned off. Therefore, if the engine start switch is turned to ON within 10 seconds after it was turned to OFF, the trouble codes cannot be deleted.
 - When the battery is fully charged, the voltage value at low engine speed may fluctuate due to the influence of voltage control.
-

Troubleshooting the power unit using the YDIS

1. Use the trouble codes, displayed by the YDIS, to check each part according to the table of “Trouble code and checking step” (4-8).
2. Delete the trouble codes after checking, repairing, or replacing a part and check that the trouble codes are not detected again. If the same trouble codes are detected, the engine ECM may be faulty.
3. Check the items listed in the table. If all of the items are in good condition, delete the trouble codes, and then check the trouble codes again. If the same trouble codes are detected again, the engine ECM is faulty.

TIP:

When using a K-Line connection, trouble codes for code number 300 and higher are not displayed.

Trouble code table

To display trouble codes (code number 300 and higher) for the SBW system, connect using the CAN-Line harness.

*1: Crankshaft position sensor

*2: Fuel pressure sensor (high-pressure fuel pump)

✓: Indicated

—: Not indicated

Code No.	Item	YDIS diagnosis	YDIS diagnosis record
13	Pulser coil *1	✓	✓
15	Engine temperature sensor	✓	✓
17	Knock Sensor 1	✓	✓
19	Battery voltage	✓	✓
20	Knock Sensor 2	✓	✓
23	Air temperature sensor	✓	✓
24	Cam position sensor (EX)	✓	✓
27	Water in fuel filter	✓	✓
29	Air pressure sensor	✓	✓
39	Oil pressure sensor	✓	✓
42	Thermo sensor (P)	✓	✓
43	Thermo sensor (S)	✓	✓
44	Engine shut-off switch	✓	—
56	Main power supply	✓	✓
57	Starter magnet power supply	✓	✓
60	Generator system	✓	✓
71	Cam position sensor (S bank IN)	✓	✓
72	Cam position sensor (P bank IN)	✓	✓
73	OCV (S bank)	✓	✓
74	OCV (P bank)	✓	✓
83	PTT sensor	✓	✓
84	PTT buzzer	✓	✓
86	Immobilizer	—	✓
112, 113, 114, 115, 116, 117, 119, 123, 138, 141, 142, 143, 144, 145	ETV	✓	✓
124, 125, 126, 127, 128	TPS	✓	✓

Outboard motor troubleshooting

Code No.	Item	YDIS diagnosis	YDIS diagnosis record
146, 147, 148, 149, 150, 153, 154, 155	SPS	✓	✓
156, 157	Engine-R/C communication	✓	✓
160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 183, 184, 186, 187	Remote control system	✓	✓
190	PTT relay	✓	✓
191	PTT relay power	✓	✓
192	Shift actuator power supply	✓	✓
193	VST fuel pump power supply	✓	✓
194	Water pressure sensor	✓	✓
195	Medium pressure fuel pressure sensor *2	✓	✓
196	Fuel system	✓	✓
210	Engine-FuseBox communication	✓	✓
213	EDU power supply 1	✓	✓
214	EDU power supply 2	✓	✓
215	DI fuel pressure sensor (P)	✓	✓
216, 217	DI fuel pressure (P)	✓	✓
218	DI fuel pump (P) (DI fuel pressure pump P)	✓	✓
219	DI fuel pressure sensor (S)	✓	✓
220, 221	DI fuel pressure (S)	✓	✓
222	DI fuel pump (S)	✓	✓
223	Steering system	✓	✓
224	Steering system–Outboard (SCU)	✓	✓
225	Steering system–Helm (HELM)	✓	✓

Outboard motor troubleshooting

Code No.	Item	YDIS diagnosis	YDIS diagnosis record
241, 242, 243, 244, 245, 246, 247, 248	Injector#1–Injector#8	✓	✓
320	Trim drive	✓	✓
321	R/C to Steering Communication	✓	✓
322, 323	Remote Control System	✓	✓
324	RC to steering system comm. (BC)	✓	✓
325	RC to BC system communication	✓	✓
326	Main RC unit communication	✓	✓
327	2nd ST. RC unit communication	✓	✓
328	RC to BCU communication	✓	✓
512, 513	System Voltage Low	✓	✓
514	System Voltage High	✓	✓
515, 517, 518, 519, 520, 521	Steering System–Position Sensor	✓	✓
516	Steering Sensor(s) Calibration	✓	✓
522	Steering System–Actuator Temp.	✓	✓
523, 524	Steering System–Temperature Sensor	✓	✓
525, 526, 527	Steering System–Actuator Current	✓	✓
528, 529	Steering System–Control Unit	✓	✓
530	Steering System–Current Sensor	✓	✓
531	Steering System–Brake Current	✓	✓
532, 533	Steering System–Actuator	✓	✓
534	R/C to Steering Communication	✓	✓
535	Steering to Steering Communication	✓	✓
536	Steering System Communication	✓	✓
537, 538	Steering System–Main Helm	✓	✓
539, 540	Steering System–2nd Helm	✓	✓
541	Steering System–Control Unit	✓	✓
542	Incompatible Hardware	✓	✓
543	Steering System–Control Unit	✓	✓
544	Steering to R/C Communication	✓	✓
545	Incompatible Software	✓	✓
546	Steering System–Configuration	✓	✓
547	Outboard to Steering Communication	✓	✓

Trouble code and checking step

For code number 300 and higher checking steps, see the Helm master EX rigging guide (6X9-28197-**).

The descriptions enclosed by < > are applicable to multiple engine installations.

*1: Crankshaft position sensor

*2: See the Helm Master EX rigging guide.

—: Not applicable

Trouble code	Item (Condition)	Symptom	Checking steps	See page
13	Pulser coil *1 (Irregular signal)	“Check Engine” is displayed. Engine does not restart. <Engine speeds do not synchronize>	Measure the crankshaft position sensor input voltage.	5-35
			Check for wiring continuity between the crankshaft position sensor and the engine ECM.	A-14
			Check the protrusions on the pickup rotor for damage.	7-77
15	Engine temperature sensor (Out of specification)	“Check Engine” is displayed. Degraded acceleration performance. Declining maximum engine speed. <Engine speeds do not synchronize>	Measure the engine temperature sensor input voltage.	5-37
			Measure the engine temperature sensor resistance.	5-37
			Check for wiring continuity between the engine temperature sensor and the engine ECM.	A-14
17	Knock Sensor 1 (Irregular signal)	“Check Engine” is displayed. High engine idle speed. Reduce engine speed approximately 300 r/min. <Engine speeds do not synchronize>	Measure the knock sensor resistance.	5-39
			Check for wiring continuity between the knock sensor and the engine ECM.	A-14
19	Battery voltage (Below specified voltage)	Battery voltage and battery alert are displayed. High engine idle speed. Engine does not restart (depends on battery condition).	Check the battery capacity and specific gravity.	10-9
			Check the fuse.	5-10 A-16
			Check the battery cable and terminals for proper connection.	10-9
			Measure the lighting coil resistance.	5-34
			Measure the rectifier/regulator output voltage.	5-34
			Check the rectifier/regulator for continuity.	5-34

Outboard motor troubleshooting

Trouble code	Item (Condition)	Symptom	Checking steps	See page
20	Knock Sensor 2 (Irregular signal)	“Check Engine” is displayed. High engine idle speed. <Engine speeds do not synchronize>	Measure the knock sensor resistance.	5-39
			Check for wiring continuity between the knock sensor and the engine ECM.	A-14
23	Air temperature sensor (Out of specification)	“Check Engine” is displayed. High engine idle speed. <Engine speeds do not synchronize>	Check the intake air temperature using the YDIS.	5-36
			Measure the intake air temperature sensor input voltage.	5-36
			Measure the intake air temperature sensor resistance.	5-36
			Check for wiring continuity between the intake air temperature sensor and the engine ECM.	A-14
24	Cam position sensor (EX) (Irregular signal)	“Check Engine” is displayed. High engine idle speed. Degraded acceleration performance. Declining maximum engine speed. <Engine speeds do not synchronize>	Measure the cam position sensor input voltage.	5-23
			Measure the cam position sensor output voltage.	5-23
			Check for wiring continuity between the cam position sensor and the engine ECM.	A-10
			Check the brim of the camshaft.	7-50
27	Water in fuel filter (Water in fuel filter)	“Water in fuel” is displayed. Alert buzzer comes on while the shift is in the N position.	Check the fuel filter for water.	—
			Measure the water detection switch input voltage.	5-28
			Check the water detection switch for continuity.	5-28
			Check for wiring continuity between the water detection switch and the engine ECM.	A-12
29	Air pressure sensor (Out of specification)	“Check Engine” is displayed. High engine idle speed. Declining maximum engine speed. <Engine speeds do not synchronize>	Measure the intake air pressure sensor input voltage.	5-36
			Measure the intake air pressure sensor output voltage.	5-36
			Check for wiring continuity between the intake air pressure sensor and the engine ECM.	A-14

Outboard motor troubleshooting

Trouble code	Item (Condition)	Symptom	Checking steps	See page
39	Oil pressure sensor (Out of specification)	“Check Engine” is displayed. High engine idle speed. Declining maximum engine speed.	Check the oil pressure using the YDIS.	7-1
			Measure the oil pressure sensor input voltage.	5-26
			Measure the oil pressure sensor output voltage.	5-26
			Check for wiring continuity between the oil pressure sensor and the engine ECM.	A-10
42	Thermo sensor (P) (Out of specification)	“Check Engine” is displayed. Set to 50 °C (122 °F) when running. <Engine speeds do not synchronize>	Check the thermo sensor using the YDIS.	5-38
			Measure the thermo sensor input voltage.	5-38
			Measure the thermo sensor resistance.	5-38
			Check for wiring continuity between the thermo sensor and the engine ECM.	A-14
43	Thermo sensor (S) (Out of specification)	“Check Engine” is displayed. Set to 50 °C (122 °F) when running. <Engine speeds do not synchronize>	Check the thermo sensor using the YDIS.	5-38
			Measure the thermo sensor input voltage.	5-38
			Measure the thermo sensor resistance.	5-38
			Check for wiring continuity between the thermo sensor and the engine ECM.	A-14
56	Main power supply (Irregular signal)	“Check Engine” is displayed. Main relay is not turned off even if the engine start switch is OFF. Battery discharges.	Check for wiring short between the engine start switch and the engine ECM.	A-16
			Check for wiring short between the electrical management box and the engine ECM.	A-16
			Replace the electrical management box.	7-22

Outboard motor troubleshooting

Trouble code	Item (Condition)	Symptom	Checking steps	See page
57	Starter magnet power supply (Irregular signal)	“Check Engine” is displayed. Engine does not crank. Starter motor cannot be turned on or off.	Check the fuse.	5-10
			Check for wiring open or short between the engine start switch and the engine ECM.	A-16
			Check for wiring continuity between the engine start switch and the electrical management box.	A-16
			Check for wiring open or short between the electrical management box and the ground.	A-16
			Check for wiring open or short between the electrical management box and the engine ECM.	A-16
			Replace the electrical management box.	7-22
60	Generator system (rectifier/regulator)	“Check Engine” is displayed. Degraded charging performance.	Measure the crankshaft position sensor input voltage.	5-35
			Check for wiring continuity between the rectifier/regulator and the ECM.	A-16
71	Cam position sensor (S bank IN) (Irregular signal)	“Check Engine” is displayed. High engine idle speed. Degraded acceleration performance. Declining maximum engine speed. <Engine speeds do not synchronize>	Measure the cam position sensor input voltage.	5-23
			Measure the cam position sensor output voltage.	5-23
			Check for wiring continuity between the cam position sensor and the engine ECM.	A-10
			Check the brim of the camshaft.	7-50
72	Cam position sensor (P bank IN) (Irregular signal)	“Check Engine” is displayed. High engine idle speed. Degraded acceleration performance. Declining maximum engine speed. <Engine speeds do not synchronize>	Measure the cam position sensor input voltage.	5-23
			Measure the cam position sensor output voltage.	5-23
			Check for wiring continuity between the cam position sensor and the engine ECM.	A-10
			Check the brim of the camshaft.	7-50

Outboard motor troubleshooting

Trouble code	Item (Condition)	Symptom	Checking steps	See page
73	OCV (S bank) (Irregular load current value)	"Check Engine" is displayed. High engine idle speed. Degraded acceleration performance. Declining maximum engine speed. <Engine speeds do not synchronize>	Check the OCV operation using the YDIS.	5-25
			Measure the OCV input voltage.	5-25
			Measure the OCV resistance.	5-25
			Check for wiring continuity between the OCV and the main relay.	A-10
			Check for wiring continuity between the OCV and the engine ECM.	A-10
			Check the OCV filter.	7-58
74	OCV (P bank) (Irregular load current value)	"Check Engine" is displayed. High engine idle speed. Degraded acceleration performance. Declining maximum engine speed. <Engine speeds do not synchronize>	Check the OCV operation using the YDIS.	5-25
			Measure the OCV input voltage.	5-25
			Measure the OCV resistance.	5-25
			Check for wiring continuity between the OCV and the main relay.	A-10
			Check for wiring continuity between the OCV and the engine ECM.	A-10
			Check the OCV filter.	7-58
83	PTT sensor (Out of specification)	"Check Engine" is displayed.	Check the PTT sensor using the YDIS.	5-53
			Measure the PTT sensor input voltage.	5-53
			Measure the PTT sensor output voltage.	5-53
			Check for wiring continuity between the PTT sensor and the engine ECM.	A-18
84	PTT buzzer	When setting the PTT TotalTilt™, the PTT buzzer does not sound even if the PTT switch is pressed twice quickly.	Check the PTT buzzer.	5-53
			Check for continuity between the PTT buzzer and the engine ECM.	A-18

Outboard motor troubleshooting

Trouble code	Item (Condition)	Symptom	Checking steps	See page
86	Immobilizer (Communication error)	“Check Engine” is displayed. Declining maximum engine speed. <Engine speeds do not synchronize>	Check that Y-COP is connected properly.	3-25
			Measure the remote control receiver input voltage.	—
			Check the Y-COP circuit.	—
112	ETV (Engine ECM internal circuit malfunction)	“Check Engine” is displayed. High engine idle speed. Throttle does not operate. Engine speed is set at approximately 1500 r/min.	Replace the engine ECM.	7-37
113	ETV (Throttle valve malfunction)	“Check Engine” is displayed. High engine idle speed. Throttle does not operate. Engine speed is set at approximately 1500 r/min.	Measure the TPS output voltage using the YDIS.	5-21
			Check the ETV circuit.	A-10
			Check the fuse.	5-10
			Check the ETV motor relay.	5-22
114	ETV (Engine ECM internal circuit malfunction)	Engine will not start.	Replace the engine ECM.	7-37
115 116	ETV (Throttle valve malfunction)	“Check Engine” is displayed. High engine idle speed. Throttle does not operate. Engine speed is set at approximately 1500 r/min.	Check the ETV circuit.	A-10
			Check the ETV.	6-29
117	ETV (Throttle valve malfunction)	“Check Engine” is displayed. High engine idle speed. Throttle does not operate. Engine speed is set at approximately 1500 r/min.	Check the ETV circuit.	A-10
			Check the fuse.	5-10
			Check the ETV motor relay.	5-22
			Check the ETV.	6-29
119	ETV (Throttle valve malfunction)	“Check Engine” is displayed. High engine idle speed. Throttle does not operate. Engine speed is set at approximately 1500 r/min.	Check the ETV circuit.	A-10
123	ETV (Out of specification)	“Check Engine” is displayed. High engine idle speed. Throttle does not operate. Engine speed is set at approximately 1500 r/min.	Check the ETV circuit.	A-10
			Check the fuse.	5-10
			Check the ETV motor relay.	5-22

Outboard motor troubleshooting

Trouble code	Item (Condition)	Symptom	Checking steps	See page
124 125	TPS (Out of specification)	“Check Engine” is displayed. High engine idle speed. Degraded acceleration performance. Declining maximum engine speed.	Measure the TPS output voltage using the YDIS.	5-21
			Check the ETV circuit.	A-10
126	TPS (Out of specification)	“Check Engine” is displayed. High engine idle speed. Throttle does not operate. Engine speed is set at approximately 1500 r/min.	Measure the TPS output voltage using the YDIS.	5-21
			Measure the TPS input voltage.	5-21
			Check the ETV circuit.	A-10
127 128	TPS (Out of specification)	“Check Engine” is displayed. Degraded acceleration performance. Declining maximum engine speed.	Measure the TPS output voltage using the YDIS.	5-21
			Check the ETV circuit.	A-10
138	ETV (Engine ECM internal circuit malfunction)	“Check Engine” is displayed. High engine idle speed. Throttle does not operate. Engine speed is set at approximately 1500 r/min.	Replace the engine ECM.	7-38
141	ETV (Throttle valve malfunction)	“Check Engine” is displayed. High engine idle speed. Throttle does not operate. Engine speed is set at approximately 1500 r/min.	Check the ETV circuit.	A-10
142	ETV (Throttle valve malfunction)	“Check Engine” is displayed. Declining maximum engine speed.	Check the throttle valve operation.	6-29
			Replace the ETV.	6-28
143	ETV system (Engine ECM internal circuit malfunction)	“Check Engine” is displayed. High engine idle speed. Throttle does not operate. Engine speed is set at approximately 1500 r/min.	Replace the engine ECM.	7-38

Outboard motor troubleshooting

Trouble code	Item (Condition)	Symptom	Checking steps	See page
144	ETV (Throttle valve malfunction)	“Check Engine” is displayed. High engine idle speed. Throttle does not operate. Engine speed is set at approximately 1500 r/min.	Check the battery cable and terminals for proper connection.	10-9
			Check the fuse.	5-10
			Measure the lighting coil resistance.	5-34
			Measure the rectifier/regulator output voltage.	5-34
			Check the rectifier/regulator for continuity.	5-34
145	ETV (Throttle valve malfunction)	High engine idle speed.	Check that other trouble codes (112–144) are detected.	4-4
			Check the throttle valve operation.	6-29
146 147	SPS (Out of specification)	“Check Engine” is displayed. Engine operates normally unless it is stopped. Engine does not restart (No cranking). Alert indicator is ON. <Engine speeds do not synchronize>	Measure the SPS input voltage.	5-22
			Measure the SPS output voltage.	5-22
			Check for wiring continuity between the SPS and the engine ECM.	A-10
			Measure the shift actuator rod stroke.	5-23
148 149	SPS (Center outboard motor [Out of specification])	“Check Engine” is displayed. Normal operation is possible. Shift actuator does not operate. (When either one of the trouble codes 146 and 147, and either one of the trouble codes 148 and 149 took place simultaneously) Alert indicator is ON. <Engine speeds do not synchronize>	Measure the SPS input voltage.	5-22
			Measure the SPS output voltage.	5-22
			Check for wiring continuity between the SPS and the engine ECM.	A-10
			Measure the shift actuator rod stroke.	5-23

Outboard motor troubleshooting

Trouble code	Item (Condition)	Symptom	Checking steps	See page
150	SPS (Out of specification)	<p>“Check Engine” is displayed. High engine idle speed. Engine does not restart (In a shift-in position). Shift actuator does not operate. Alert indicator is ON. <Engine speeds do not synchronize></p>	Measure the SPS input voltage.	5-22
			Measure the SPS output voltage.	5-22
			Check for wiring continuity between the SPS and the engine ECM.	A-10
153	SPS (Out of specification)	<p>“Check Engine” is displayed. High engine idle speed. Engine does not restart (In a shift-in position). Throttle does not operate. Alert indicator is ON. <Engine speeds do not synchronize></p>	Check the fuse.	5-10 A-10
			Measure the shift actuator motor resistance.	5-23
			Check for wiring continuity between the shift actuator and the engine ECM.	A-10
			Check that the gear shift operates properly.	10-14
			Measure the shift actuator rod stroke.	5-23
			Check the shift mechanism.	9-13
			Check the lower unit.	8-5
154	SPS (Out of specification)	<p>“Check Engine” is displayed. Engine does not restart. Shift does not disengage from the shift-in position. Alert indicator is ON.</p>	Check the fuse.	5-10 A-14
			Measure the shift actuator relay input voltage.	5-22
			Measure the shift actuator motor resistance.	5-23
			Check for wiring continuity between the shift actuator and the engine ECM.	A-14
			Check the shift actuator relay.	5-23
			Check for wiring continuity between the shift actuator relay and the engine ECM.	A-14
			Measure the shift actuator rod stroke.	5-23
			Check the shift mechanism.	9-13
Check the lower unit.	8-11 8-18 8-48			

Outboard motor troubleshooting

Trouble code	Item (Condition)	Symptom	Checking steps	See page
155	SPS (Out of specification)	<p>“Check Engine” is displayed. Engine does not restart (In a shift-in position). Gear shift does not operate. Alert indicator is ON. <Engine speeds do not synchronize></p>	Check the fuse.	5-10 A-14
			Measure the shift actuator relay input voltage.	5-23
			Measure the shift actuator motor resistance.	5-23
			Check for wiring continuity between the shift actuator and the engine ECM.	A-14
			Check the shift actuator relay.	5-23
			Check for wiring continuity between the shift actuator relay and the engine ECM.	A-14
			Measure the shift actuator rod stroke.	5-23
			Check the shift mechanism.	9-13
		Check the lower unit.	8-11	
156 157	Engine-R/C communication (Communication error)	<p>“Check Engine” is displayed. Alert indicator is ON. <Engine speeds do not synchronize></p>	Check the extension wire harness proper connection and damage.	—
			Check for wiring continuity between the engine ECM and the engine main harness.	A-14
			Check the Digital Electronic Control circuit.	*2
		<p>Engine does not restart. Fully closed throttle. Shift actuator rod returns to the N position. CL7 gauge does not operate. Trouble codes 156 and 157 detected simultaneously. Alert indicator is ON. <Engine speeds do not synchronize> Unable to switch the active station in the case of dual station arrangement (trouble code 186).</p>	Check that the extension wire harness is connected properly and that there is no damage.	—
			Check for wiring continuity between the engine ECM and engine main harness.	A-14
			Check the Digital Electronic Control circuit.	*2

Outboard motor troubleshooting

Trouble code	Item (Condition)	Symptom	Checking steps	See page
160 161 162 163	Remote control system (Main station [LPS Irregular signal])	<p>“Check Engine” is displayed. Alert indicator is ON. <Engine speeds do not synchronize></p> <p>Locked at engine idle speed. Shift actuator rod returns to the N position. Alert indicator is ON. <Engine speeds do not synchronize></p> <p>When either one of the trouble codes 160 and 161, and either one of the trouble codes 162 and 163 took place simultaneously.</p>	<p>Measure the LPS output voltage using the YDIS.</p> <p>Check for wiring continuity between the LPS and the Digital Electronic Control ECM.</p> <p>Measure the LPS output voltage using the YDIS.</p> <p>Check for wiring continuity between the LPS and the Digital Electronic Control ECM.</p>	*2
164	Remote control system (Main station LPS Irregular signal [Digital Electronic Control ECM internal circuit malfunction])	<p>“Check Engine” is displayed. Locked at engine idle speed. Shift actuator rod returns to the N position. Shift actuator can be operated manually. Alert indicator is ON.</p>	<p>Replace the Digital Electronic Control ECM. (When replacing the Digital Electronic Control ECM with a new one, resetting of Digital Electronic Control ECM is necessary)</p>	*2
165	Remote control system (Main station [LPS Irregular signal])	<p>“Check Engine” is displayed. Locked at engine idle speed. Shift actuator rod returns to the N position. Alert indicator is ON. <Difference in engine idle speeds> <Engine speeds do not synchronize></p>	<p>Measure the LPS output voltage using the YDIS.</p> <p>Check for wiring continuity between the LPS and the Digital Electronic Control ECM.</p>	*2

Outboard motor troubleshooting

Trouble code	Item (Condition)	Symptom	Checking steps	See page
166 167 168 169	Remote control system (Main station, center outboard motor [LPS Irregular signal])	“Check Engine” is displayed. Locked at engine idle speed. Alert indicator is ON.	Measure the LPS output voltage using the YDIS.	*2
			Check for wiring continuity between the LPS and the Digital Electronic Control ECM.	
		Locked at engine idle speed. Shift actuator rod returns to the N position. Alert indicator is ON. When either one of the trouble codes 166 and 167, and either one of the trouble codes 168 and 169 took place simultaneously.	Measure the LPS output voltage using the YDIS.	
			Check for wiring continuity between the LPS and the Digital Electronic Control ECM.	
170	Remote control system (Main station [LPS Irregular signal])	“Check Engine” is displayed. Locked at engine idle speed. Shift actuator rod returns to the N position. Alert indicator is ON.	Measure the LPS output voltage using the YDIS.	*2
			Check for wiring continuity between the LPS and the Digital Electronic Control ECM.	
171 172 173 174	Remote control system (Sub station [LPS Irregular signal])	“Check Engine” is displayed. Locked at engine idle speed. Alert indicator is ON.	Measure the LPS output voltage using the YDIS.	*2
			Check for wiring continuity between the LPS and the Digital Electronic Control ECM.	
		Locked at engine idle speed. Shift actuator rod returns to the N position. Alert indicator is ON. When either one of the trouble codes 171 and 172, and either one of the trouble codes 173 and 174 took place simultaneously.	Measure the LPS output voltage using the YDIS.	
			Check for wiring continuity between the LPS and the Digital Electronic Control ECM.	
175	Remote control system (LPS Irregular signal [Sub station Digital Electronic Control ECM internal circuit malfunction])	“Check Engine” is displayed. Locked at engine idle speed. Shift actuator rod returns to the N position. Alert indicator is ON.	Replace the Digital Electronic Control ECM. (When replacing the Digital Electronic Control ECM with a new one, resetting of Digital Electronic Control ECM is necessary.)	*2

Outboard motor troubleshooting

Trouble code	Item (Condition)	Symptom	Checking steps	See page
176	Remote control system (Sub station, center outboard motor [LPS Irregular signal])	“Check Engine” is displayed. Locked at engine idle speed. Shift actuator rod returns to the N position. Alert indicator is ON.	Measure the LPS output voltage using the YDIS.	*2
			Check for wiring continuity between the LPS and the Digital Electronic Control ECM.	
177 178 179 180	Remote control system (Sub station, center outboard motor [LPS Irregular signal])	“Check Engine” is displayed. Locked at engine idle speed. Alert indicator is ON.	Measure the LPS output voltage using the YDIS.	*2
			Check for wiring continuity between the LPS and the Digital Electronic Control ECM.	
		Locked at engine idle speed. Shift actuator rod returns to the N position. Alert indicator is ON.	Measure the LPS output voltage using the YDIS.	
		When either one of the trouble codes 177 and 178, and either one of the trouble codes 179 and 180 took place simultaneously.	Check for wiring continuity between the LPS and the Digital Electronic Control ECM.	
181	Remote control system (Sub station [LPS Irregular signal])	“Check Engine” is displayed. Locked at engine idle speed. Throttle does not operate. Shift actuator rod returns to the N position. Alert indicator is ON.	Measure the LPS output voltage using the YDIS.	*2
			Check for wiring continuity between the LPS and the Digital Electronic Control ECM.	
183	Remote control system (LPS Irregular signal [Digital Electronic Control ECM internal circuit malfunction])	“Check Engine” is displayed. Station selection is impossible. Alert indicator is ON.	Replace the Digital Electronic Control ECM of the main station. (When replacing the Digital Electronic Control ECM with a new one, resetting of Digital Electronic Control ECM is necessary.)	*2
184	Remote control system (LPS Irregular signal [Digital Electronic Control ECM internal circuit malfunction])	“Check Engine” is displayed. Engine selection is impossible. Alert indicator is ON.	Replace the Digital Electronic Control ECM of the main station. (When replacing the Digital Electronic Control ECM with a new one, resetting of Digital Electronic Control ECM is necessary.)	*2

Outboard motor troubleshooting

Trouble code	Item (Condition)	Symptom	Checking steps	See page
186	Remote control system (Main station [LPS Irregular signal])	Sub station Digital Electronic Control does not operate. Unable to change to the sub station Digital Electronic Control Locked at engine idle speed. Shift actuator rod returns to the N position. Alert indicator is ON.	Turn off the engine start switch once, and turn it on again.	—
			Check the extension wire harness for proper connection and damage.	—
187	Remote control system (LPS Irregular signal [Digital Electronic Control ECM internal circuit malfunction])	“Check Engine” is displayed. Engine does not restart. Alert indicator is ON.	Replace the Digital Electronic Control ECM. (When replacing the Digital Electronic Control ECM with a new one, resetting of Digital Electronic Control ECM is necessary.)	*2
190	PTT relay (—)	“Check Engine” is displayed. Stop engine synchronization control.	—	—
191	PTT relay power (—)	“Check Engine” is displayed. Stop engine synchronization control.	Check the wiring is connected properly and that there is no damage.	A-12
			Check the PTT motor.	9-46 9-53
			Check the power supply and electrical management box.	A-12
192	Shift actuator power supply (—)	“Check Engine” is displayed. Stop engine synchronization control.	Check the fuse of shift actuator relay.	5-23
			Check the wiring is connected properly and that there is no damage.	A-12
			Check the shift actuator relay.	5-23
193	VST fuel pump power supply (—)	“Check Engine” is displayed. Engine speed is limited to 2000 r/min.	Check the fuse of high-pressure fuel pump relay.	5-31
			Check the wiring is connected properly and that there is no damage.	A-12
			Check the high-pressure fuel pump relay.	5-31

Outboard motor troubleshooting

Trouble code	Item (Condition)	Symptom	Checking steps	See page
194	Water pressure sensor (Out of specification)	“Check Engine” is displayed. Stop engine synchronization control.	Check the water pressure sensor using the YDIS.	—
			Measure the water pressure sensor output voltage.	5-26
			Check the wiring is connected properly and that there is no damage.	A-12
195	Fuel pressure sensor (Out of specification)	“Check Engine” is displayed. Engine speed is limited to 2000 r/min.	Check the fuel pressure sensor (high-pressure fuel pump) using the YDIS.	—
			Check the wiring is connected properly and that there is no damage.	A-12
196	Fuel system (Low-pressure fuel pump malfunction)	“Check Engine” is displayed. Can not start 7 seconds after engine stall.	Check the fuel pressure sensor using the YDIS.	—
			Check the wiring and fuel pipe for damage or bends.	—
			Check the operation of fuel pump in the YDIS “Stationary test”.	5-29
210	Engine-Fuse-Box communication (Communication error)	“Check Engine” is displayed. Stop engine synchronization control.	Check the wiring is connected properly and that there is no damage.	A-12
			Check the input voltage to electrical management box.	5-20
213	EDU power supply 1 (—)	“Check Engine” is displayed. Engine speed is limited to 2000 r/min.	Check the fuse of injector driver relay.	A-12
			Check the wiring is connected properly and that there is no damage.	
			Check the injector driver relay.	
214	EDU power supply 2 (—)	“Check Engine” is displayed. Engine speed is limited to 2000 r/min.	Check the fuse of injector driver relay.	A-12
			Check the wiring is connected properly and that there is no damage.	
			Check the injector driver relay.	

Outboard motor troubleshooting

Trouble code	Item (Condition)	Symptom	Checking steps	See page
215	DI fuel pressure sensor (P) (Out of specification)	“Check Engine” is displayed. Engine speed is limited to 2000 r/min.	Check the fuel pressure sensor (direct injection pump) (PORT) using the YDIS.	—
			Check the wiring is connected properly and that there is no damage.	A-12
216	DI fuel pressure (P) (DI fuel pressure drop P) (Out of specification)	“Check Engine” is displayed. Engine speed is limited to 2000 r/min.	Check fuel pipe for damage or bends.	—
			Check the operation of the direct injection pump (PORT) in the YDIS “Stationary test”.	5-30
217	DI fuel pressure (P) (DI fuel pressure rise P) (Out of specification)	“Check Engine” is displayed. Engine speed is limited to 2000 r/min.	Check fuel pipe for be clogged.	—
			Check the operation of the injector in the YDIS “Stationary test”.	5-29
218	DI fuel pump (P) (Irregular signal)	“Check Engine” is displayed. Engine speed is limited to 2000 r/min.	Check the wiring is connected properly and that there is no damage.	A-12
			Check the injector driver input voltage.	5-28
			Check the operation of the direct injection pump (PORT) in the YDIS “Stationary test”.	5-30
219	DI fuel pressure sensor (S) (Out of specification)	“Check Engine” is displayed. Engine speed is limited to 2000 r/min.	Check the fuel pressure sensor (direct injection pump) (STBD) using the YDIS.	—
			Check the wiring is connected properly and that there is no damage.	A-12
220	DI fuel pressure (S) (DI fuel pressure drop S) (Out of specification)	“Check Engine” is displayed. Engine speed is limited to 2000 r/min.	Check fuel pipe for damage or bends.	—
			Check the operation of the direct injection pump (STBD) in the YDIS “Stationary test”.	5-30

Outboard motor troubleshooting

Trouble code	Item (Condition)	Symptom	Checking steps	See page
221	DI fuel pressure (S) (DI fuel pressure rise S) (Out of specification)	“Check Engine” is displayed. Engine speed is limited to 2000 r/min.	Check fuel pipe for be clogged.	—
			Check the operation of the injector in the YDIS “Stationary test”.	5-29
222	DI fuel pump (S) (Irregular signal)	“Check Engine” is displayed. Engine speed is limited to 2000 r/min.	Check the wiring is connected properly and that there is no damage.	A-12
			Check the injector driver input voltage.	5-28
			Check the operation of the direct injection pump (STBD) in the YDIS “Stationary test”.	5-30
223	Steering system (Irregular signal)	Stop engine synchronization control.	Check detail by using YDIS CAN communication cable.	—
224	Steering system—Outboard (SCU) (Irregular signal)	Stop engine synchronization control.	Check detail by using YDIS CAN communication cable.	—
225	Steering system—Helm (HELM) (Irregular signal)	Stop engine synchronization control.	Check detail by using YDIS CAN communication cable.	—
241, 242, 243, 244, 245, 246, 247, 248	Injector#1—Injector#8 (Irregular signal)	“Check Engine” is displayed. Engine speed is limited to 2000 r/min.	Check the wiring is connected properly and that there is no damage.	A-12
			Check the operation of the injector in the YDIS “Stationary test”.	5-29
			Check the injector driver.	5-28

Troubleshooting procedure (trouble code not detected)

Troubleshooting consists of the following 5 items:

Symptom 1: Specific trouble conditions

Symptom 2: Trouble conditions of an area or individual part

Cause: Trouble causes of symptom 2

Checking steps: Method for checking

See page: Reference page

—: Not applicable

Troubleshooting the power unit

Symptom 1: Engine does not crank.

Symptom 2	Cause	Checking steps	See page
Starter motor does not operate	Gear shift not in the N position	Set the gear shift to the N position.	5-22
	Blown fuse	Check the fuse.	5-10
	Engine start switch malfunction	Check the engine start switch.	5-41
		Check the engine start/stop button.	5-41
	LPS malfunction	Check the LPS.	—
	Short, open, or loose connection in starter motor circuit	Check the wire harness for continuity.	A-16
	Starter motor malfunction	Disassemble and check the starter motor.	5-46
Y-COP is locked	Unlock Y-COP.	—	
Starter motor operates, but the engine does not crank	Stuck piston or crankshaft	Disassemble and check the power unit.	7-77
	Stuck drive shaft	Check the drive shaft bushing.	9-29
		Disassemble and check the lower unit.	8-27 8-54

Symptom 1: Engine will not start (engine cranks).

Symptom 2	Cause	Checking steps	See page
Engine ECM does not operate	Blown fuse	Check the fuse.	5-10
	Main relay malfunction	Check the electrical management box.	5-19
	Short, open, or loose connection in the engine ECM circuit	Check for wire harness continuity between the electrical management box and the engine ECM.	A-10
		Check for continuity between the engine ECM and ground.	5-19
	Engine ECM ID and Digital Electronic Control ECM ID do not match.	Reset the Digital Electronic Control system using the YDIS.	—
	Engine ECM malfunction	Replace the engine ECM.	7-37
	Extension wire harness malfunction	Check the extension wire harness for continuity.	5-50
Spark plug does not produce a spark (all cylinders)	Crankshaft position sensor malfunction	Measure the crankshaft position sensor input voltage.	5-35
	Short, open, or loose connection in the pulser coil circuit	Check the wire harness continuity between the crankshaft position sensor and the engine ECM.	A-12
	Y-COP is locked	Unlock Y-COP.	—

Outboard motor troubleshooting

Symptom 2	Cause	Checking steps	See page
Fuel not supplied (all cylinders)	—	Measure the fuel pressure.	6-2
	Pinched or kinked fuel hose	Check the fuel hose.	2-60
	Fuel leakage	Check the fuel line for leakage.	2-60
	Clogged fuel filter element	Check the fuel filter element for dirt and obstructions.	6-4
	Clogged fuel strainer	Check the fuel strainer for dirt and obstructions.	6-14
	Blown fuse	Check the fuse.	5-10
	Direct injection pump malfunction	Check the direct injection pump.	6-19
	High-pressure fuel pump malfunction	Check the high-pressure fuel pump operation using the YDIS.	5-29
		Measure the high-pressure fuel pump resistance.	5-29
	Short, open, or loose connection in high-pressure fuel pump circuit	Check the high-pressure fuel pump input voltage.	5-29
		Check for wiring continuity between the high-pressure fuel pump and the engine ECM.	A-12
		Check for wiring continuity between the high-pressure fuel pump and the electrical management box.	A-12
	Short, open, or loose connection in low-pressure fuel pump circuit	Check the low-pressure fuel pump input voltage.	5-29
		Check for wiring continuity between the low-pressure fuel pump and the engine ECM.	A-12
		Check for wiring continuity between the low-pressure fuel pump and the electrical management box.	A-12
	Low pressure fuel pump malfunction	Check the low-pressure fuel pump operation using the YDIS.	5-29
		Check the low-pressure fuel pump resistance.	5-29
Relief valve malfunction	Check the relief valve.	6-14	
Feed valve malfunction	Check the feed valve.	6-15	
Injector driver malfunction	Check the injector driver circuit.	5-28	

Outboard motor troubleshooting

Symptom 2	Cause	Checking steps	See page
Compression pressure is low	Improper valve timing	Check the valve timing.	7-43
		Check the timing belt.	7-43
		Check the cam chain.	7-49
		Check the chain tensioner.	7-49
		Check the VCT for sticking.	7-48
	Compression leakage	Check the valve for bends and sticking.	7-61
		Check the piston and piston rings for damage.	7-77
		Check the cylinder for scratches.	7-79

Symptom 1: Unstable engine idle speed, poor acceleration, poor performance, or limited engine speed.

Symptom 2	Cause	Checking steps	See page
Spark plug does not produce a spark (some cylinders)	Spark plug malfunction	Check the spark plug.	7-41
	Short, open, or loose connection in ignition coil circuit	Measure the ignition coil input voltage.	5-35
		Check for wiring continuity between the ignition coil and the engine ECM.	A-14
		Check for wiring continuity between the ignition coil and the electrical management box.	A-14
	Ignition coil malfunction	Exchange the ignition coil with a different one, and then check the ignition spark.	5-35
	Engine ECM malfunction	Replace the engine ECM.	7-38

Outboard motor troubleshooting

Symptom 2	Cause	Checking steps	See page
Fuel pressure is low	Fuel leakage	Check for fuel leakage.	2-60
	Clogged fuel filter	Check the fuel filter for dirt and obstructions.	6-4
	Clogged fuel strainer	Check the fuel strainer for dirt and obstructions.	6-14
	Direct injection pump malfunction	Check the direct injection pump.	6-19
	Cam lobe (direct injection pump) wear	Check the cam shaft.	7-50
	High-pressure fuel pump malfunction	Measure the high-pressure fuel pump resistance.	5-29
	Relief valve malfunction	Check the relief valve.	6-14
	Feed valve malfunction	Check the feed valve.	6-15
	Injector driver malfunction	Check the injector driver circuit.	5-28
	Fuel pressure sensor malfunction	Check the fuel pressure sensor.	5-32
Fuel not supplied (some cylinders)	Fuel injector malfunction	Check the fuel injector operation using the YDIS.	5-29
		Measure the fuel injector resistance.	5-29
	Short, open, or loose connection in fuel injector circuit	Check for wiring continuity between the fuel injector and the electrical management box.	A-12
		Check for wiring continuity between the fuel injector and the engine ECM.	A-12
	Clogged fuel injector	Replace the fuel injector.	6-18
	Relief valve malfunction	Check the relief valve.	6-14
	Feed valve malfunction	Check the feed valve.	6-15
	Injector driver malfunction	Check the injector driver circuit.	5-28
	Engine ECM malfunction	Replace the engine ECM.	7-38

Outboard motor troubleshooting

Symptom 2	Cause	Checking steps	See page
Compression pressure is low	Improper valve timing	Check the valve timing.	7-43
		Check the timing belt.	7-43
		Check the cam chain.	7-49
		Check the chain tensioner.	7-49
		Check the VCT for sticking.	7-48
	Compression leakage	Check the valve for bends and sticking.	7-61
		Check the piston and piston rings for damage.	7-77
		Check the cylinder for scratches.	7-79

Symptom 1: High engine idle speed.

Symptom 2	Cause	Checking steps	See page
—	Air leakage (ETV–cylinder head)	Check the gaskets of the intake manifolds, surge tank, and ETV.	6-24 6-28

Symptom 1: Engine stalls, unstable engine idle speed, or poor acceleration.

Symptom 2	Cause	Checking steps	See page
Improper intake cam timing	Stuck OCV plunger	Check the OCV operation using the YDIS.	5-25
		Check the OCV plunger.	5-25
	Clogged OCV filter	Replace the OCV filter.	7-58
	Clogged oil passage	Check the oil passage.	2-49
	Stuck VCT	Replace the VCT assembly.	7-46
	Cam chain wear Cam chain stretch	Check the cam chain.	7-49
	Cam chain tension	Check the cam chain tensioner.	7-49

Symptom 1: Limited engine speed (below 2000–3000 r/min).

Symptom 2	Cause	Checking steps	See page
Buzzer comes on. Overheat alert indicator comes on	Thermo sensor malfunction	Measure the thermo sensor input voltage.	5-38
		Measure the thermo sensor resistance.	5-38
		Check for continuity between the thermo sensor and the engine ECM.	A-14
	Engine temperature sensor malfunction	Measure the engine temperature sensor input voltage.	5-37
		Check the engine temperature sensor resistance.	5-37
		Check for continuity between the engine temperature sensor and the engine ECM.	5-37
	Water pressure sensor malfunction	Measure the water pressure sensor input voltage.	5-26
		Check the water pressure sensor output voltage.	5-26
		Check for continuity between the water pressure sensor and the engine ECM.	5-26
	Clogged cooling water inlet	Check the cooling water inlet.	2-53
	Water pump malfunction	Check the impeller.	8-13
		Check the impeller key.	8-13
		Check the water pump housing.	8-13
		Check the insert cartridge.	8-13
		Check the outer plate cartridge.	8-13
Clogged cooling water passage	Check the cooling water passage.	2-53	
Open PCV	Check the PCV.	9-29	
Thermostat malfunction	Check the thermostat.	7-73	

Outboard motor troubleshooting

Symptom 2	Cause	Checking steps	See page
Buzzer comes on. Oil pressure alert indicator comes on	Insufficient engine oil	Check the engine oil level.	10-10
		Check for engine oil leakage.	2-49
		Check the valve stem seals and valves.	7-63
		Check the piston rings.	7-79
	—	Measure the oil pressure.	7-1
	Engine oil pressure decrease	Check the oil pump.	7-70
		Check the oil strainer.	9-29
		Check the relief valve.	7-77
		Check the oil passage (power unit and oil pump).	2-49
		Replace the oil filter.	10-13
Engine speed cannot increase when tilt up	PTT is raised too high while cruising	Check the numerical value of PTT protection control range.	2-28
PTT protection control is not deactivated when the trim is lowered	No change in the PTT sensor output voltage when the PTT is operated	Check the PTT sensor.	5-53

Symptom 1: Discharged battery.

Symptom 2	Cause	Checking steps	See page
Low voltage indicator activates on the gauge	Battery performance decrease	Check the battery capacity and specific gravity.	10-9
		Check the proper connection of battery cables and terminals.	—
	Short, open, or loose connection in charging circuit	Check the proper connection of the charging circuit and for damage.	A-16
	Stator assembly malfunction	Measure the lighting coil resistance.	5-34
	Rectifier/regulator malfunction	Check the rectifier/regulator for continuity.	5-34
	Electrical management box malfunction	Check the rectifier/regulator output voltage.	5-34
		Check the electrical management box terminal and wire harness.	A-16

Symptom 1: Y-COP lock and unlock do not function.

Symptom 2	Cause	Checking steps	See page
There is an answer-back (beep)	Y-COP remote control transmitter malfunction	Check the button cell battery voltage.	—
		Replace with a spare remote control transmitter.	—
	Short, open, or loose connection of the wire harness	Check the Y-COP circuit.	—

Symptom 1: Y-COP lock and unlock function, but there is no answer-back (beep).

Symptom 2	Cause	Checking steps	See page
—	Buzzer malfunction	Check the buzzer.	—
	Short, open, or loose connection of the wire harness	Measure the buzzer input voltage.	—
		Check the Y-COP circuit.	—

Troubleshooting the PTT unit

Symptom 1: PTT unit does not operate.

Symptom 2	Cause	Checking steps	See page
PTT relay does not operate	Blown fuse	Check the fuse.	5-10 A-18
	PTT switch malfunction	Check the PTT switch.	5-53
	PTT relay malfunction	Check the electrical management box.	5-20
	Short, open, or loose connection of the wire harness	Measure the PTT switch input voltage.	5-53
		Measure the electrical management box input voltage.	5-53
		Check for continuity between the PTT switch and the electrical management box.	A-18
		Check for wiring continuity between the PTT switch and the ECM.	A-18

Outboard motor troubleshooting

Symptom 2	Cause	Checking steps	See page
PTT motor does not operate	PTT motor malfunction	Check the PTT motor.	9-52
	Short, open, or loose connection of the PTT motor lead	Check for wiring continuity between the PTT motor and the electrical management box.	A-18
	Electrical management box malfunction	Check the electrical management box.	A-18
	Bent tilt ram or trim ram	Check the tilt ram and trim ram.	9-62
	Stuck tilt ram or trim ram	Disassemble and check the PTT unit.	9-62
PTT fluid pressure does not increase	Open manual valve	Check the manual valve.	9-48
	Insufficient PTT fluid	Add sufficient PTT fluid.	10-20
	PTT fluid leakage	Check for PTT fluid leakage.	10-20
	Clogged fluid passage	Disassemble and check the PTT unit.	9-57 9-62
		Check the filter for dirt and obstructions.	9-54 9-59
		Check the valves for damage.	9-59
		Check the fluid passages for obstructions.	9-57 9-62
	PTT motor malfunction	Check the PTT motor.	9-52
Gear pump malfunction	Check the gear pump assembly.	9-59	

Symptom 1: PTT unit does not hold the outboard motor up.

Symptom 2	Cause	Checking steps	See page
Decrease in PTT fluid pressure in lower chamber of PTT cylinders	Open manual valve	Check the manual valve.	9-48
	Insufficient PTT fluid	Add sufficient PTT fluid.	10-20
	PTT fluid leakage	Check for PTT fluid leakage.	10-20
	Clogged or open fluid passage	Disassemble and check the PTT unit.	9-57 9-62
		Check the valves for damage.	9-59
		Check the fluid passages for obstructions.	9-57 9-62

Troubleshooting the lower unit

Symptom 1: Shift mechanism of the forward gear and reverse gear does not operate properly.

Symptom 2	Cause	Checking steps	See page
—	Shift rod does not operate properly	Check the shift actuator operation.	5-23
		Check that the shift rod, shift actuator bracket, and shift actuator are installed properly.	9-14
			8-15
			8-16
	Shift mechanism malfunction (in lower unit)	Check the shift rod for wear.	8-13
		Check the shift rod connection.	8-13
		Check the dog clutch and related parts.	8-21
Check the forward gear, reverse gear, and pinion for damage and wear.	8-30		
	8-22		
		8-30	

Electrical system

Electrical component and wire harness routing	5-1
Port.....	5-1
Starboard	5-3
Rear.....	5-5
Front.....	5-7
Top	5-8
Fuse holder (Electrical management box).....	5-10
Bottom cowling	5-11
ECM circuit diagram	5-12
ECM coupler layout.....	5-15
Checking the electrical component	5-18
Using the YDIS.....	5-18
Using the digital tester	5-18
Engine control unit and component	5-19
Checking the main relay.....	5-19
Checking the engine ECM circuit.....	5-19
Checking the electrical management box.....	5-20
Checking the ETV and TPS.....	5-21
Checking the ETV motor relay.....	5-22
Checking the SPS	5-22
Checking the shift actuator relay	5-23
Checking the shift actuator	5-23
Checking the cam position sensor.....	5-23
Checking the OCV.....	5-25
Checking the oil pressure sensor.....	5-26
Checking the water pressure sensor	5-26
Fuel control unit and component	5-28
Checking the injector driver circuit	5-28
Checking the water detection switch.....	5-28
Checking the fuel injector.....	5-29
Checking the low-pressure fuel pump and high-pressure fuel pump	5-29
Checking the direct injection pump	5-30
Checking the low-pressure fuel pump relay	5-31
Checking the high-pressure fuel pump relay	5-31
Checking the fuel pressure sensor.....	5-32

Electrical system

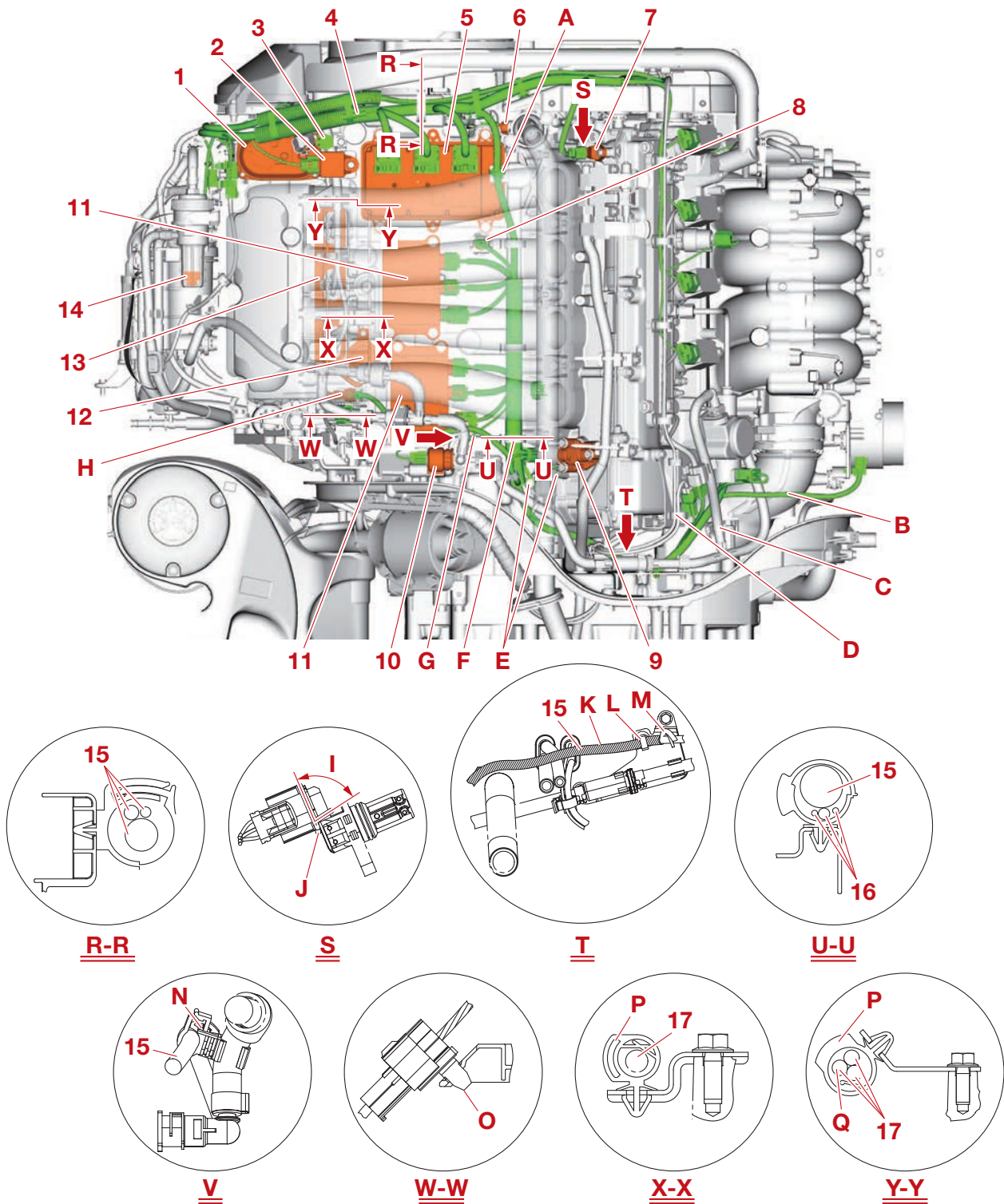
Charging unit and component	5-34
Checking the lighting coil (stator assembly).....	5-34
Checking the rectifier/regulator.....	5-34
Ignition unit and component	5-35
Checking the ignition spark.....	5-35
Checking the ignition coil	5-35
Checking the crankshaft position sensor.....	5-35
Checking the intake air pressure/temperature sensor	5-36
Checking the engine temperature sensor	5-37
Checking the thermo sensor	5-38
Checking the knock sensor.....	5-39
Checking the engine shut-off switch (6X6)	5-39
Checking the engine shut-off switch (EKS).....	5-39
Starting unit and component	5-41
Checking the starter relay	5-41
Checking the engine start switch and main switch (6X6).....	5-41
Checking the engine start/stop button (6X6)	5-41
Checking the power switch (EKS).....	5-42
Checking the start/stop button (EKS)	5-43
Checking Y-COP	5-44
Starter motor	5-45
Removing the starter motor	5-46
Checking the starter motor pinion.....	5-46
Disassembling the starter motor	5-46
Checking the armature (starter motor)	5-47
Checking the brush holder	5-47
Assembling the starter motor	5-48
Installing the starter motor	5-49
Outboard motor and Digital Electronic Control	
connection	5-50
Checking the extension wire harness	5-50
Checking the main harness.....	5-50
Steering unit	5-52
Checking the steering actuator	5-52

Electrical system

PTT system	5-53
Checking the PTT switch (on bottom cowling)	5-53
Checking the PTT sensor	5-53
Checking the PTT buzzer	5-53

Electrical component and wire harness routing

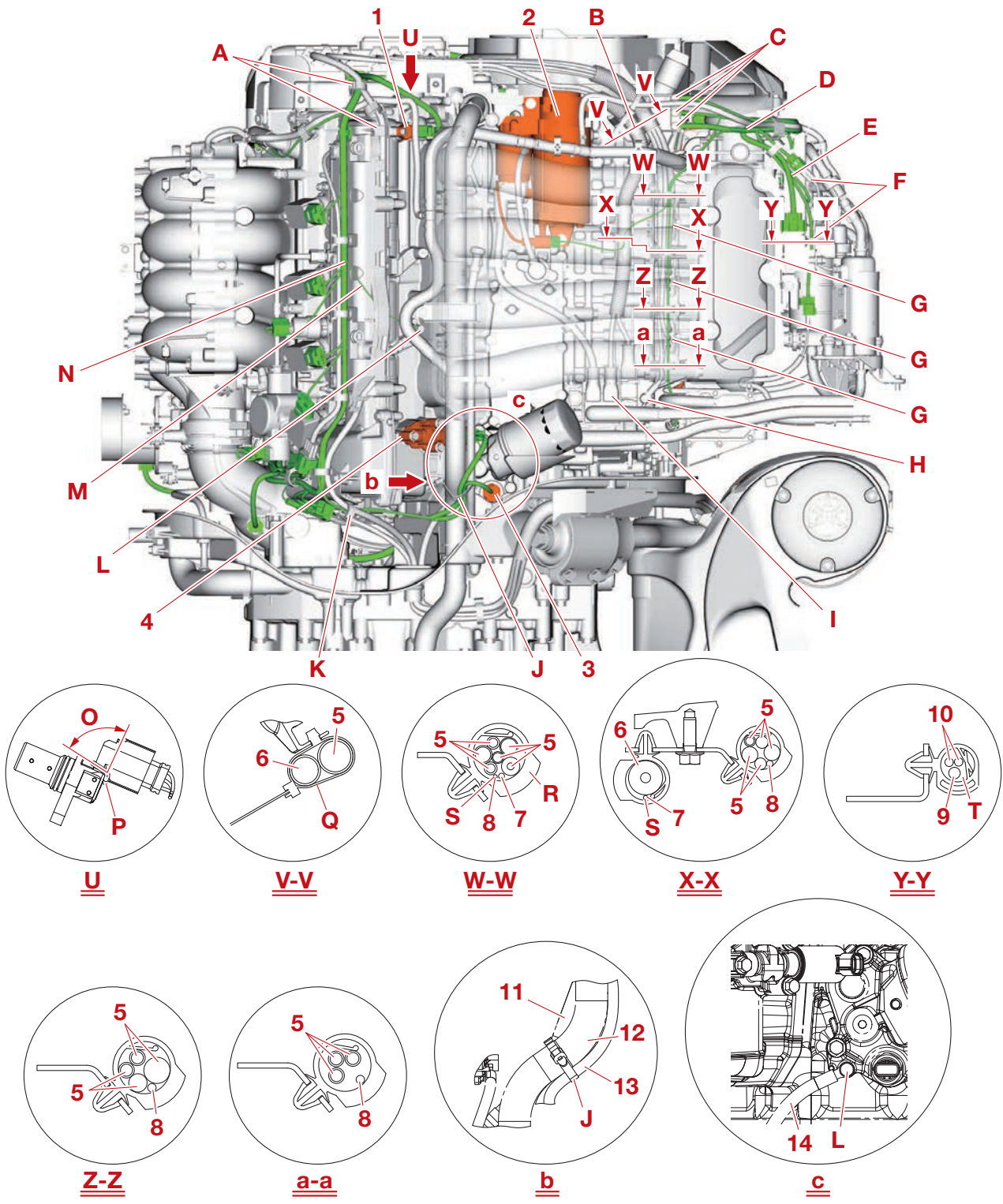
Port



Electrical component and wire harness routing

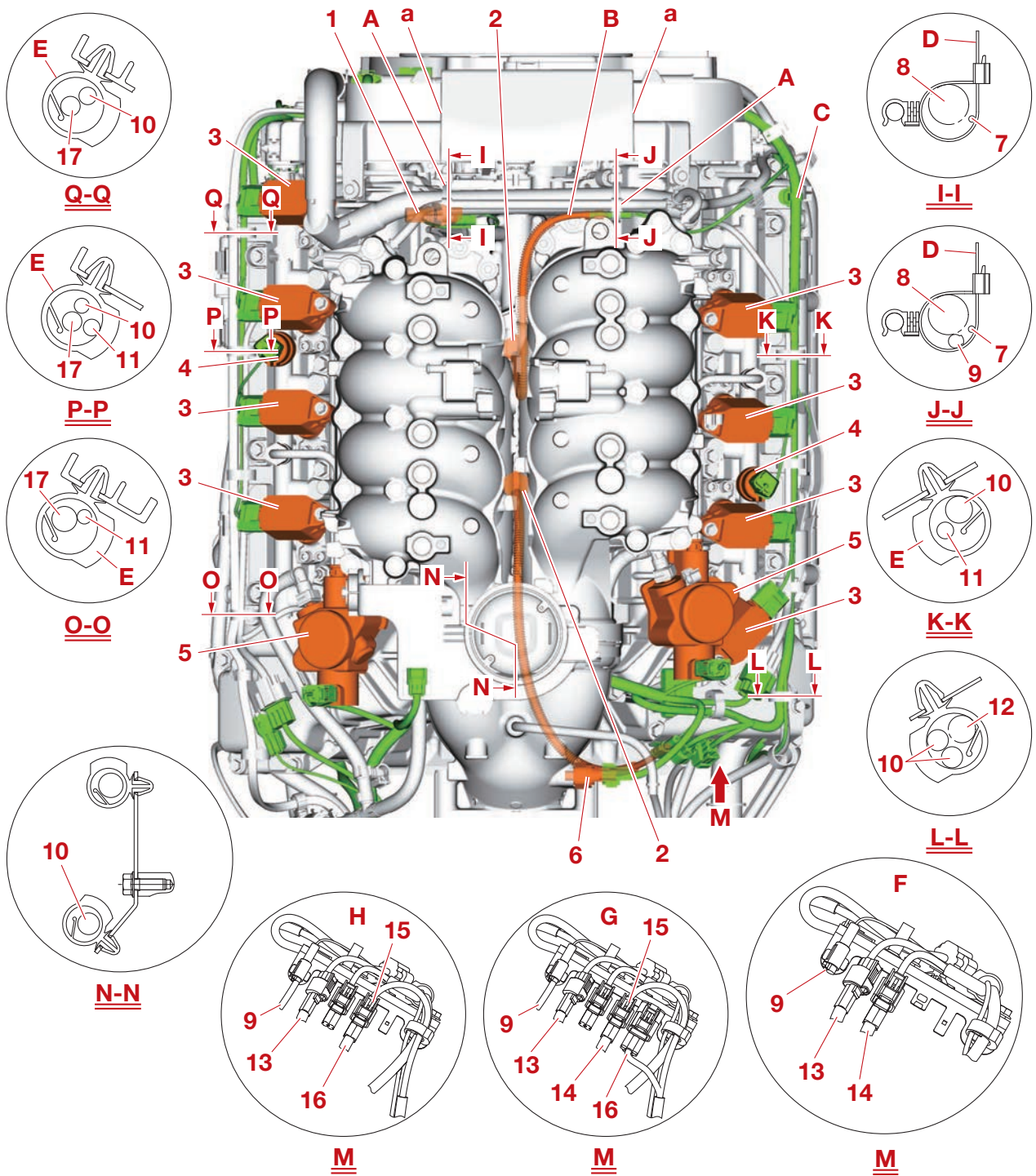
1. ETV (TPS)
 2. Low-pressure fuel pump relay
 3. YDIS coupler
 4. Reprogramming connector
 5. ECM
 6. Thermo sensor (PORT)
 7. Cam position sensor (PORT IN)
 8. Engine temperature sensor
 9. OCV (PORT)
 10. Fuel pressure sensor (high-pressure fuel pump)
 11. Injector driver
 12. PTT buzzer
 13. Rectifier/regulator
 14. Water detection switch
 15. Wire harness
 16. Ground lead
 17. Lighting coil lead
- A. Install the holder on the wire harness to the bracket.
 - B. Route the wire harness to the outside of the fuel hose.
 - C. Install the holder to the white tape on wire harness, and then install the holder to the fuel hose.
 - D. Fasten the wire harness at the white tape with the holder.
 - E. Install the ground lead terminals so that they contact the stoppers.
 - F. Make sure that the ground leads are not pinched between the intake manifold and the cylinder head.
 - G. Install the ground lead terminal so that it contacts the stopper.
 - H. Install the PTT buzzer coupler onto the bracket in the direction shown in the illustration.
 - I. Position the O-ring within the range shown in the illustration.
 - J. Install the O-ring to the cam position sensor coupler, and then install the wire harness to the cam position sensor. Make sure that the O-ring is pinched between the cam position sensor and wire harness coupler.
 - K. Route the wire harness to the inside of the gear oil change hose.
 - L. Install the holder on the wire harness to the bracket.
 - M. Do not route the PTT sensor lead and injector lead between the wire harness and the fuel hose.
 - N. Fasten the wire harness with the fuel hose using the holder.
 - O. Insert the protrusion on the SPS coupler into the hole of the bracket.
 - P. Install the holder in the direction shown in the illustration.
 - Q. Route the short lighting coil lead to the front of the other leads.

Starboard



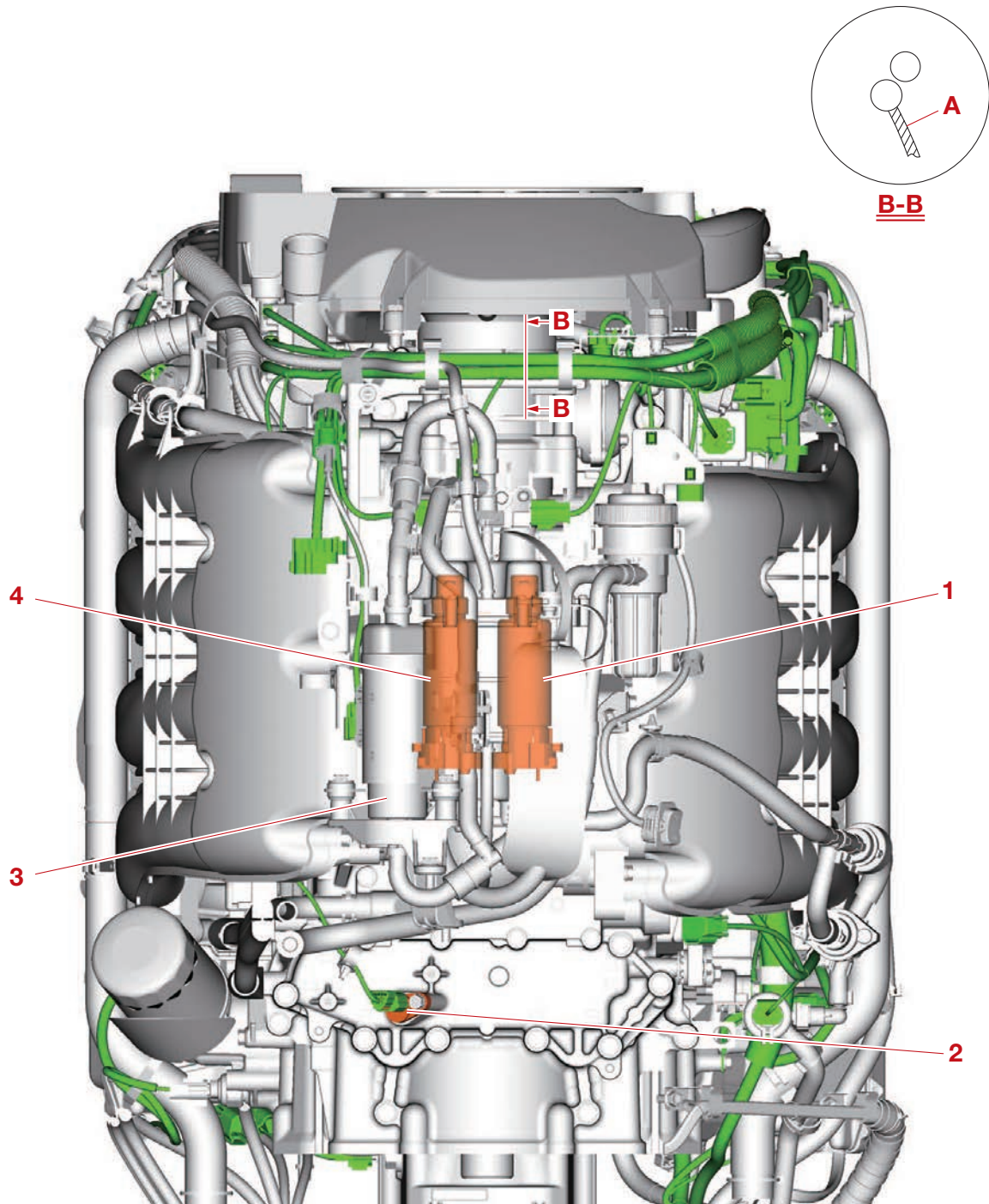
1. Cam position sensor (STBD IN)
 2. Starter motor
 3. Oil pressure sensor
 4. OCV (STBD)
 5. Extension wire harness (rectifier/regulator side)
 6. Extension wire harness (battery cable terminal side)
 7. Starter motor lead
 8. Crankshaft position sensor lead
 9. Shift actuator lead
 10. Low-pressure fuel pump lead
 11. Dipstick
 12. Cooling water hose
 13. OCV lead
 14. SCU negative lead
- A. Fasten the SCU positive lead at the white tape using the holder at the top of the guide plate, and then fasten the leads using the other holder as shown.
 - B. Install the lead terminals to the electrical management box, and then fasten the leads using the plastic tie. Point the end of the plastic tie in the direction shown. Do not cut off the excess end of the plastic tie.
 - C. Install the ground lead terminals so that they contact the stoppers. Make sure to match the numbers on the ground leads to the numbers on the bracket terminals.
 - D. Route the wire harness to the inside of the ground lead.
 - E. Route the high-pressure fuel pump lead under the low-pressure fuel pump coupler.
 - F. Position the slack in the fuel pump lead between the holder and the coupler.
 - G. Install the ground lead terminal, and then connect the rectifier/regulator couplers.
 - H. Fit the protrusions on the wire harness holders into the holes in the brackets, and then install the ground lead terminal. Make sure that the crimped sections of the terminals that secure the rectifier/regulator leads are facing away from each other and that the terminals contact the stopper.
 - I. Install the extension wire harness terminal that is identified by white tape on the lead to the center terminal.
 - J. Fasten the cooling water hose, OCV lead, oil pressure sensor lead, and dipstick guide at the location shown using the plastic tie. Do not cut off the excess end of the plastic tie.
 - K. Position the slack in the SCU positive lead between the exhaust guide and the holder.
 - L. Install the ground lead terminal so that it contacts the stopper.
 - M. Route the ground lead through the opening in the wire harness guide.
 - N. Route the wire harness so that the split where the ground lead branches off from the harness is facing to starboard.
 - O. Position the O-ring within the range shown in the illustration.
 - P. Install the O-ring to the cam position sensor coupler, and then install the wire harness to the cam position sensor. Make sure that the O-ring is pinched between the cam position sensor and wire harness coupler.
 - Q. Fasten the extension wire harness with the plastic tie. Route the harness in the order shown.
 - R. Install the holder in the direction shown in the illustration.
 - S. Route the starter motor lead to the outside of the extension wire harness.
 - T. Route the leads in the order shown.

Rear



1. Cam position sensor (PORT EX)
2. Knock sensor
3. Ignition coil
4. Fuel pressure sensor (direct injection pump)
5. Direct injection pump
6. Water pressure sensor
7. Cam position sensor lead
8. Blowby hose
9. Knock sensor coupler
10. Wire harness
11. Fuel injector sub-wire harness
12. SCU positive lead
13. SCU coupler (3P)
14. SCU coupler (4P)
15. SCU communication lead coupler (4P)
16. SCU communication lead coupler (6P)
17. PTT lead
 - a. Wire harness guide edge
 - A. Position the plastic tie within 20 mm (0.79 in) of the wire harness guide edge.
 - B. Route the knock sensor lead so that it does not protrude above the blowby hose.
 - C. Fit the protrusion on the wire harness holder into the hole in the guide plate.
 - D. Cut off the excess end of the plastic tie at a point below the wire harness guide.
 - E. Install the holder in the direction shown in the illustration.
 - F. For single outboard motor.
 - G. For port outboard motor and starboard outboard motor.
 - H. For center outboard motor.

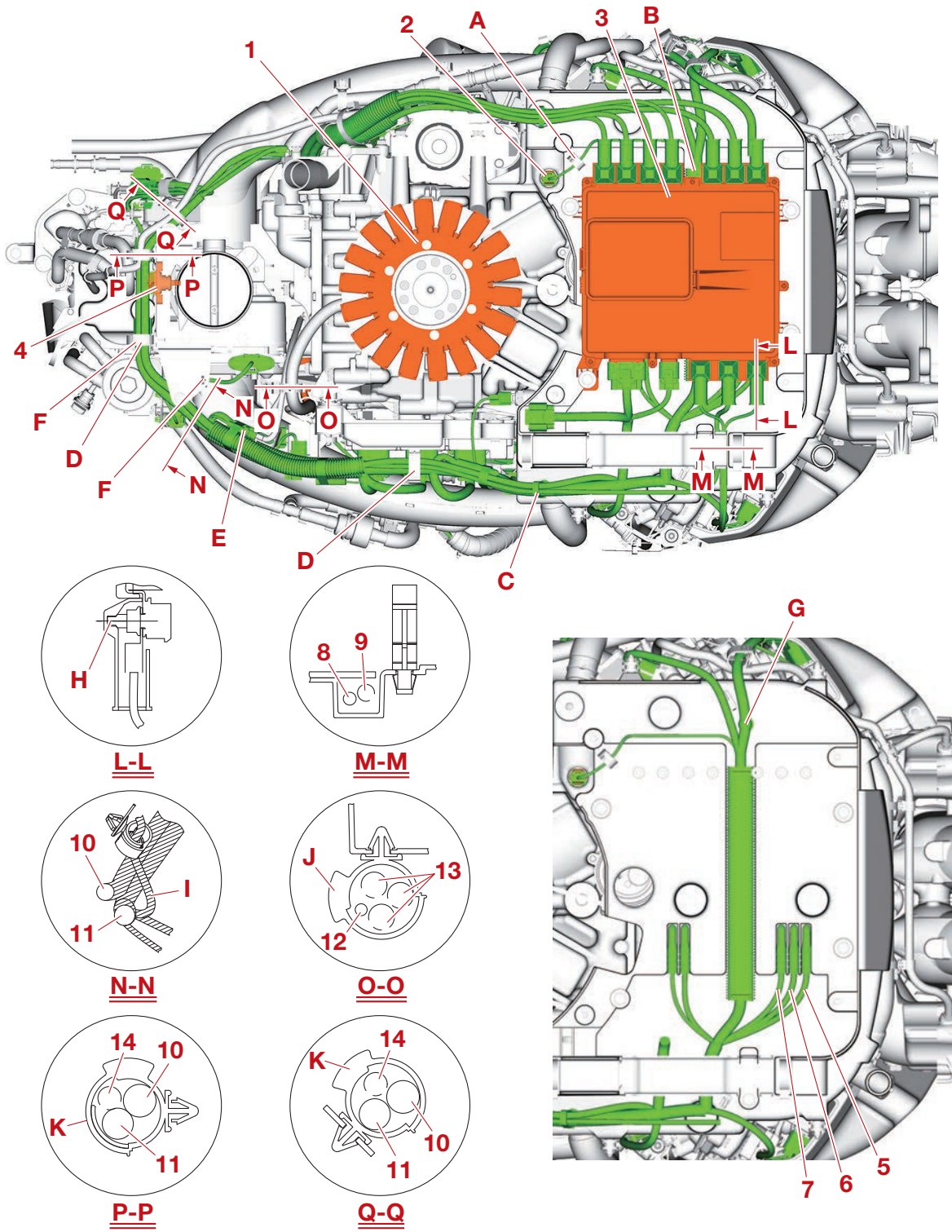
Front



1. High-pressure fuel pump (main)
2. Crankshaft position sensor
3. Low-pressure fuel pump
4. High-pressure fuel pump (sub)

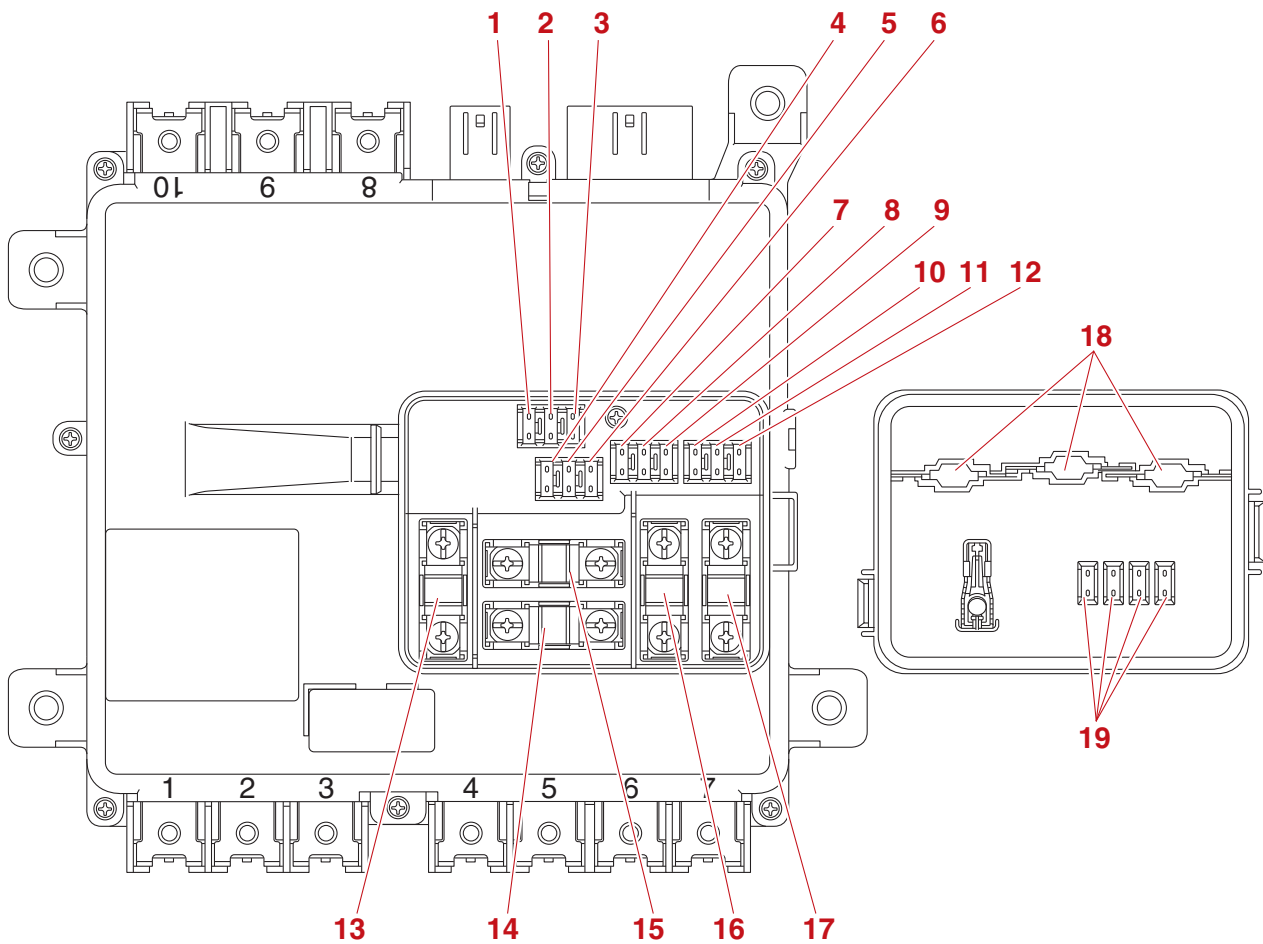
A. Do not route the intake air pressure/temperature sensor lead between the 2 main portions of the wire harness.

Top



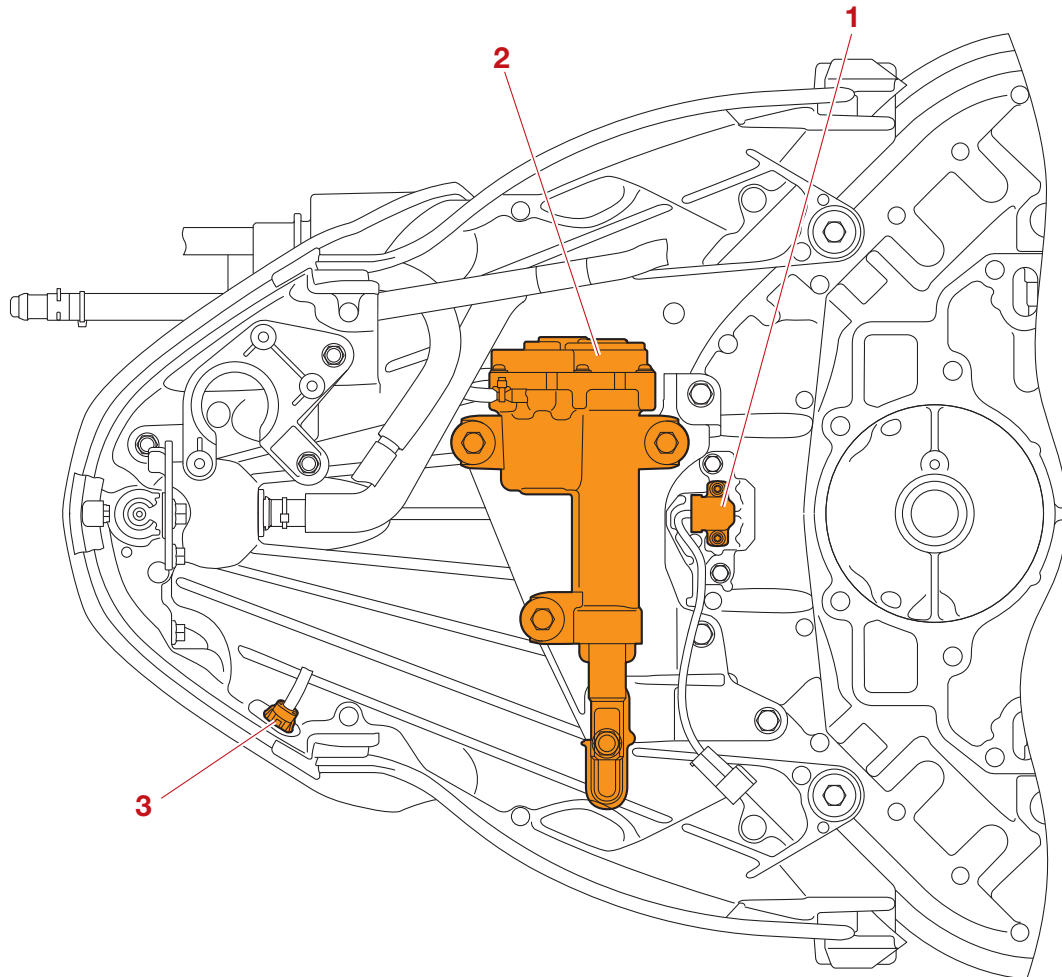
1. Lighting coil (stator assembly)
 2. Thermo sensor (STBD)
 3. Electrical management box
 4. Intake air pressure/temperature sensor
 5. Bonder (black leads with white tape)
 6. Bonder (orange leads)
 7. Bonder (black leads)
 8. PTT ground lead
 9. PTT lead
 10. Wire harness (to the main wire harness)
 11. Wire harness (to the PTT switch lead)
 12. Rectifier/regulator lead
 13. Lighting coil lead
 14. Cooling water hose
-
- A. Fit the protrusion on the wire harness holder into the hole in the wire harness guide, and then install the lead terminals to the electrical management box.
 - B. Route the wire harness under the electrical management box.
 - C. Fit the protrusion on the wire harness holder into the hole in the wire harness guide.
 - D. Position the slack in the wire harness between these holders.
 - E. Position the coupler and lead of the rectifier/regulator inside of the corrugated tube.
 - F. Fasten the wire harness at the white tape using the holder.
 - G. Fit the protrusion on the wire harness holder into the hole in the wire harness guide.
 - H. Install the lead terminal into the groove of the electrical management box, and then, fit the internal groove of the lead cover into the stud bolt head on the electrical management box.
 - I. Route the TPS lead under the wire harness (to the main wire harness) and wire harness (to the PTT switch lead).
 - J. Route the leads in the order shown. Position the slack in the lighting coil leads between the rectifier/regulator and the holder.
 - K. Route the hose and leads in the order shown.

Fuse holder (Electrical management box)



- | | |
|----------------------------------------|-------------------------------------------|
| 1. Fuse (15A) (fuel pump 2) | 11. Fuse (30A) (engine ECU/ignition coil) |
| 2. Fuse (15A) (fuel pump 1) | 12. Fuse (10A) (fuel feed pump) |
| 3. Fuse (30A) (fuel pumps) | 13. Fuse (100A) (power STRG) |
| 4. Fuse (10A) (RC-ECU) | 14. Fuse (70A) (engine main 1) |
| 5. Fuse (20A) (main switch/PTT switch) | 15. Fuse (70A) (engine main 2) |
| 6. Fuse (10A) (ETV) | 16. Fuse (70A) (isolator 2) |
| 7. Fuse (15A) (shift actuator) | 17. Fuse (70A) (isolator 1) |
| 8. Fuse (30A) (starter relay) | 18. Fuse (100A, 70A, 70A) (spare) |
| 9. Fuse (20A) (DI system 2) | 19. Fuse (30A, 20A, 15A, 10A) (spare) |
| 10. Fuse (20A) (DI system 1) | |

Bottom cowling

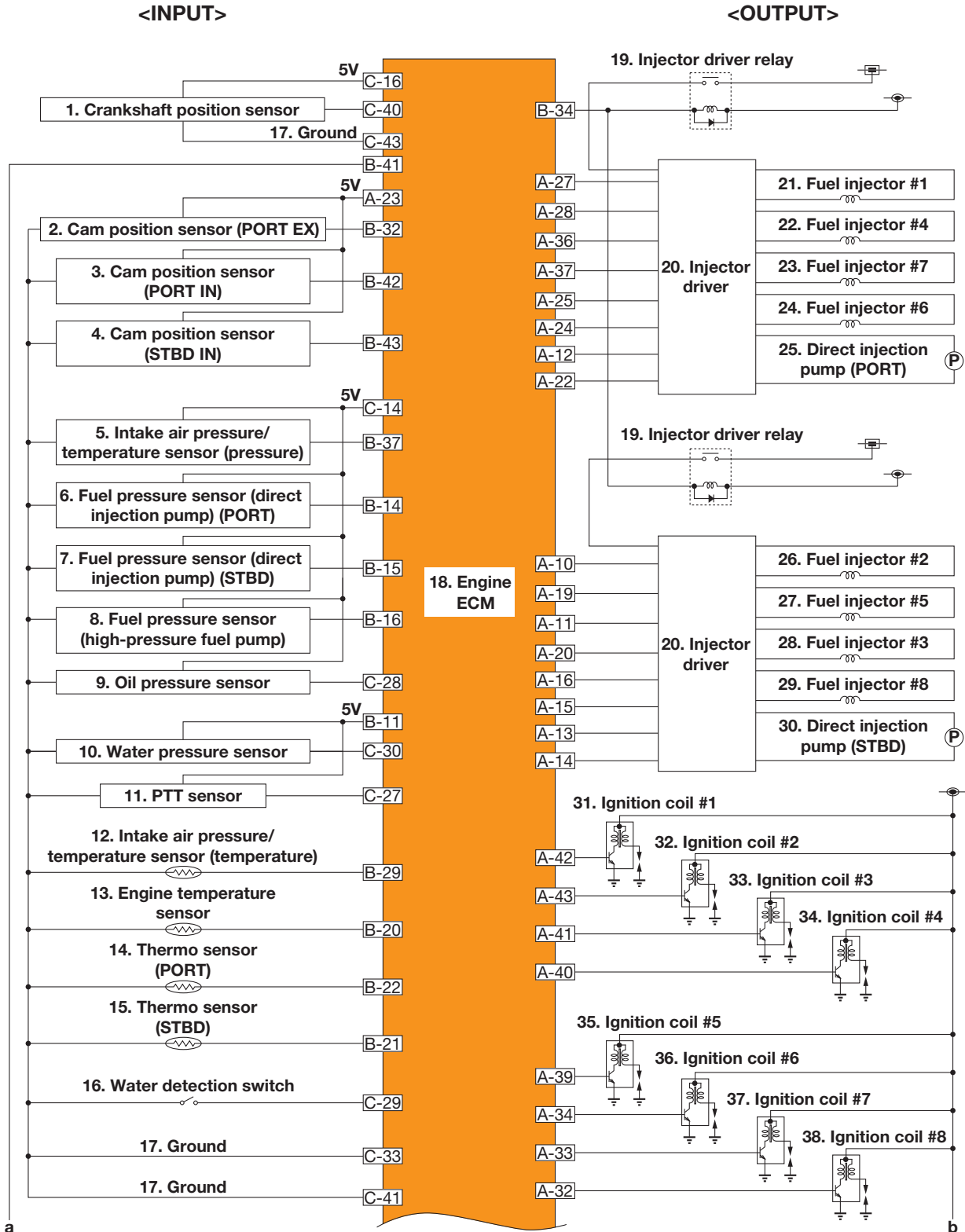


1. SPS
2. Shift actuator
3. PTT switch

ECM circuit diagram

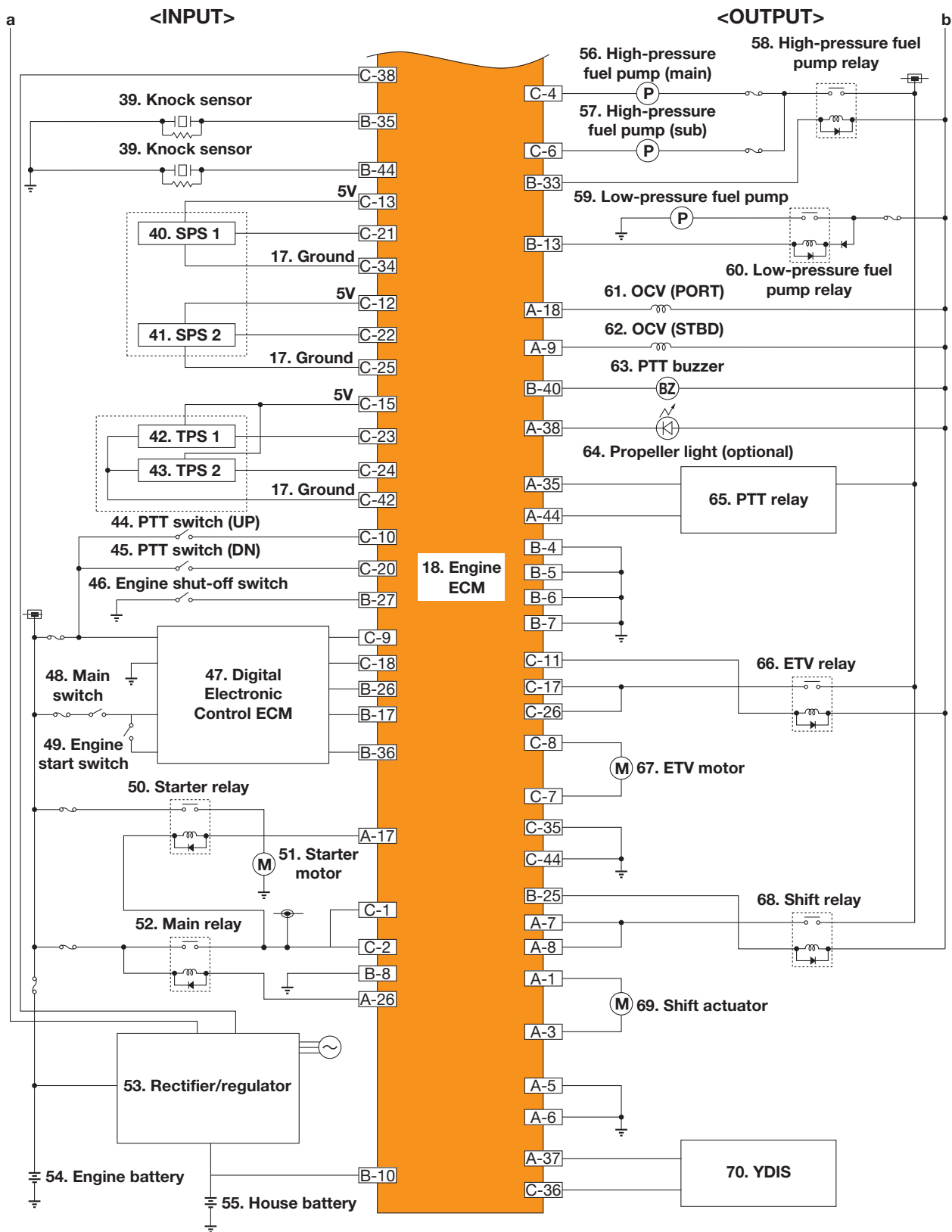
⊕, ⊖, a: Indicate a connection between the symbols.

The numbers in a square indicate the engine ECM terminal numbers.



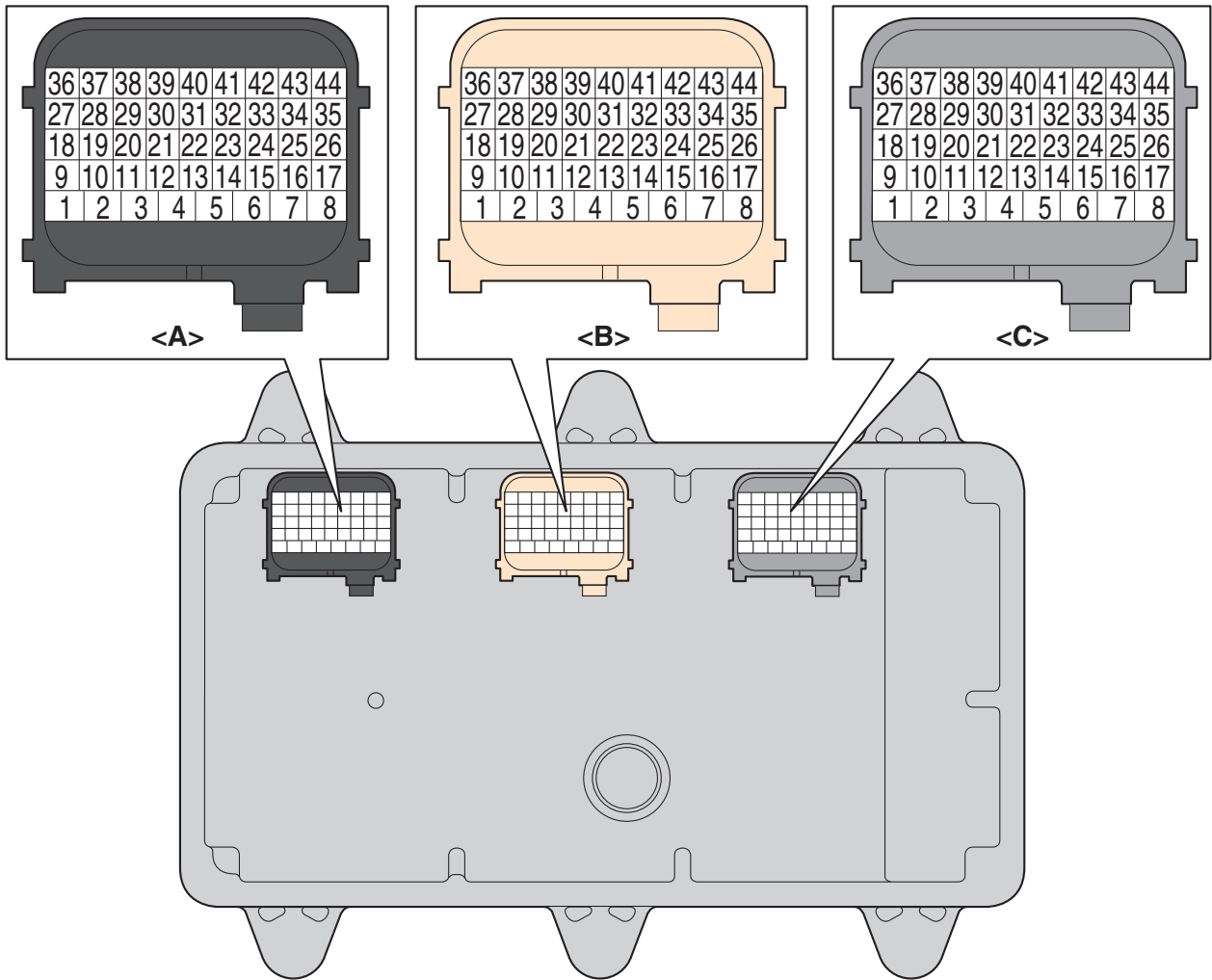
ECM circuit diagram

⊕, ⊖, a: Indicate a connection between the symbols.
 The numbers in a square indicate the engine ECM terminal numbers.



1. Crankshaft position sensor
2. Cam position sensor (PORT EX)
3. Cam position sensor (PORT IN)
4. Cam position sensor (STBD IN)
5. Intake air pressure/temperature sensor (pressure)
6. Fuel pressure sensor (direct injection pump) (PORT)
7. Fuel pressure sensor (direct injection pump) (STBD)
8. Fuel pressure sensor (high-pressure fuel pump)
9. Oil pressure sensor
10. Water pressure sensor
11. PTT sensor
12. Intake air pressure/temperature sensor (temperature)
13. Engine temperature sensor
14. Thermo sensor (PORT)
15. Thermo sensor (STBD)
16. Water detection switch
17. Ground
18. Engine ECM
19. Injector driver relay
20. Injector driver
21. Fuel injector #1
22. Fuel injector #4
23. Fuel injector #7
24. Fuel injector #6
25. Direct injection pump (PORT)
26. Fuel injector #2
27. Fuel injector #5
28. Fuel injector #3
29. Fuel injector #8
30. Direct injection pump (STBD)
31. Ignition coil #1
32. Ignition coil #2
33. Ignition coil #3
34. Ignition coil #4
35. Ignition coil #5
36. Ignition coil #6
37. Ignition coil #7
38. Ignition coil #8
39. Knock sensor
40. SPS 1
41. SPS 2
42. TPS 1
43. TPS 2
44. PTT switch (UP)
45. PTT switch (DN)
46. Engine shut-off switch
47. Digital Electronic Control ECM
48. Main switch
49. Engine start switch
50. Starter relay
51. Starter motor
52. Main relay
53. Rectifier/regulator
54. Engine battery
55. House battery
56. High-pressure fuel pump (main)
57. High-pressure fuel pump (sub)
58. High-pressure fuel pump relay
59. Low-pressure fuel pump
60. Low-pressure fuel pump relay
61. OCV (PORT)
62. OCV (STBD)
63. PTT buzzer
64. Propeller light (optional)
65. PTT relay
66. ETV relay
67. ETV motor
68. Shift relay
69. Shift actuator
70. YDIS

ECM coupler layout



No.	Connecting part	Color
A-1	Shift actuator +	Green/Yel-low
A-2	—	—
A-3	Shift actuator -	Green/Black
A-4	—	—
A-5	Shift ground	Black
A-6	Shift ground	Black
A-7	Shift power source	Red/Blue
A-8	Shift power source	Red/Blue
A-9	OCV (STBD)	Purple
A-10	Injector driver (fuel injector #2)	Black
A-11	Injector driver (fuel injector #3)	White

No.	Connecting part	Color
A-12	Injector driver (direct injection pump [PORT])	Red
A-13	Injector driver (direct injection pump [STBD])	Red
A-14	Injector driver (direct injection pump fail [STBD])	Green
A-15	Injector driver (fuel injector fail #3, #8)	Green
A-16	Injector driver (fuel injector fail #2, #5)	Red
A-17	Starter relay	Brown/White
A-18	OCV (PORT)	Purple
A-19	Fuel injector #5	White
A-20	Fuel injector #8	Black

ECM coupler layout

No.	Connecting part	Color
A-21	—	—
A-22	Injector driver (direct injection pump fail [PORT])	Green
A-23	Sensor power source	Orange
A-24	Injector driver (fuel injector fail #6, #7)	Green
A-25	Injector driver (fuel injector fail #1, #4)	Red
A-26	Main relay	Yellow/ Green
A-27	Fuel injector #1	Black
A-28	Fuel injector #4	White
A-29	—	—
A-30	—	—
A-31	—	—
A-32	Ignition coil #8	Black/White
A-33	Ignition coil #7	Black/Orange
A-34	Ignition coil #6	Black/Red
A-35	PTT relay (UP)	Sky blue
A-36	Fuel injector #7	White
A-37	Fuel injector #6	Black
A-38	Propeller light (optional)	Pink/Black
A-39	Ignition coil #5	Black/Blue
A-40	Ignition coil #4	Black/Blue
A-41	Ignition coil #3	Black/Yellow
A-42	Ignition coil #1	Black/Orange
A-43	Ignition coil #2	Black/White
A-44	PTT relay (DN)	Light green
B-1	—	—
B-2	—	—
B-3	—	—
B-4	Ground	Black
B-5	Ground	Black
B-6	Ground	Black
B-7	Ground	Black

No.	Connecting part	Color
B-8	Unit ground	Black
B-9	—	—
B-10	House battery power source	Red
B-11	Sensor power source	Orange
B-12	—	—
B-13	Low-pressure fuel pump relay	Blue/Yellow
B-14	Fuel pressure sensor (direct injection pump) (PORT)	White
B-15	Fuel pressure sensor (direct injection pump) (STBD)	White
B-16	Fuel pressure sensor (high-pressure fuel pump)	White
B-17	Digital Electronic Control 2 (L)	Blue
B-18	—	—
B-19	—	—
B-20	Engine temperature sensor	Black/Yellow
B-21	Thermo sensor (STBD)	Black/Yellow
B-22	Thermo sensor (PORT)	Black/Yellow
B-23	—	—
B-24	—	—
B-25	Shift relay	Yellow/ Green
B-26	Digital Electronic Control 2 (H)	White
B-27	Engine shut-off switch	White
B-28	—	—
B-29	Intake air pressure/temperature sensor (temperature)	Black/Yellow
B-30	—	—
B-31	—	—

ECM coupler layout

No.	Connecting part	Color
B-32	Cam position sensor (PORT EX)	White/Blue
B-33	High-pressure fuel pump relay	Yellow/Green
B-34	Injector driver relay	Yellow/Red
B-35	Knock sensor	Green
B-36	Wake up pulse (Digital Electronic Control)	Yellow
B-37	Intake air pressure/temperature sensor (pressure)	Yellow/Green
B-38	—	—
B-39	—	—
B-40	PTT buzzer	Pink
B-41	Crankshaft position sensor output	White
B-42	Cam position sensor (PORT IN)	White/Green
B-43	Cam position sensor (STBD IN)	White/Black
B-44	Knock sensor	Green/White
C-1	Battery power source	Red/Yellow
C-2	Battery power source	Red/Yellow
C-3	—	—
C-4	High-pressure fuel pump (main)	Blue/Red
C-5	—	—
C-6	High-pressure fuel pump (sub)	Blue/Red
C-7	ETV motor (-)	Green/Black
C-8	ETV motor (+)	Green/Red
C-9	Digital Electronic Control 1 (H)	White
C-10	PTT switch (UP)	Sky blue
C-11	ETV relay	Yellow/Green
C-12	SPS 2 power source	Orange
C-13	SPS 1 power source	Orange
C-14	Sensor power source	Orange
C-15	TPS power source	Orange

No.	Connecting part	Color
C-16	Sensor power source	Orange
C-17	ETV power source	Red/Green
C-18	Digital Electronic Control 1 (L)	Blue
C-19	—	—
C-20	PTT switch (DN)	Light green
C-21	SPS 1	Pink/Blue
C-22	SPS 2	Pink
C-23	TPS 1	Pink
C-24	TPS 2	Pink/Blue
C-25	SPS 2 ground	Black
C-26	ETV power source	Red/Green
C-27	PTT sensor	Pink
C-28	Oil pressure sensor	Pink/Blue
C-29	Water detection switch	Blue/White
C-30	Water pressure sensor	Blue/Black
C-31	—	—
C-32	—	—
C-33	Sensor ground	Black
C-34	SPS 1 ground	Black
C-35	ETV ground	Black
C-36	DIS (VPP)	Green/Orange
C-37	YDIS (communication)	White/Black
C-38	Rectifier/regulator fail	Blue
C-39	—	—
C-40	Crankshaft position sensor	White/Black
C-41	Sensor ground	Black
C-42	TPS ground	Black
C-43	Crankshaft position sensor ground	Black
C-44	ETV ground	Black

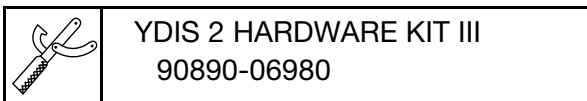
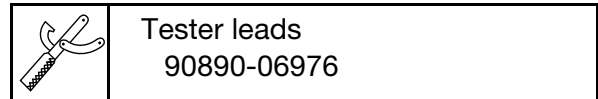
Checking the electrical component

Using the YDIS

When checking the ETV, TPS, SPS, OCV, ignition spark, high-pressure fuel pump, fuel injector, and related sensors, use the YDIS.

TIP:

- When deleting the diagnosis record in the YDIS, make sure to check the time that the trouble codes were detected.
- When checking the input voltage of a part, the coupler or connector must be disconnected. As a result, the engine ECM determines that the part is disconnected and a trouble code is detected. Therefore, make sure to delete the diagnosis record after checking the input voltage.
- To connect and operate the YDIS, see the YDIS (Ver. 2.49 or later) instruction manual.
- The software is available through YMAN (Yamaha Marine Associate Network).



Using the digital tester

The electrical technical data applies to the measurements taken using the Yamaha recommended tester.

The resistance values shown are the values taken before the engine is started. The actual resistance may vary depending on the environmental conditions and ambient temperature.

The input voltage changes depending on the battery voltage. Check the battery and wire harness if the input voltage is less than the specified value. Check the components between the battery and the input voltage measuring point if there is no problem with the battery and wire harness.

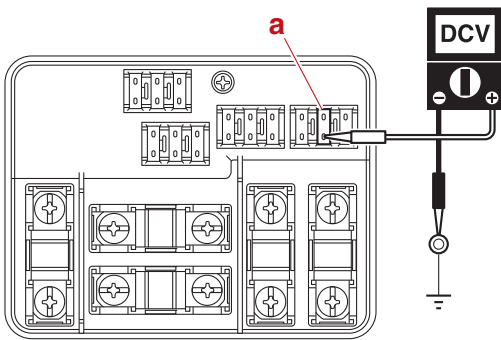
If the tester probe cannot be inserted into the coupler, prepare a test lead suitable for the measurement.

Engine control unit and component

Checking the main relay

The main relay cannot be removed for testing or replaced as a single unit because it is a component part of the electrical management box.

1. Check:
 - Main relay
 - a. Connect the YDIS to display “Main relay”.
 - b. Turn the main switch or power switch to ON, and then check that “ON” is displayed for the main relay on the YDIS screen.
 - c. Measure the input voltage between the main fuse “a” and ground.

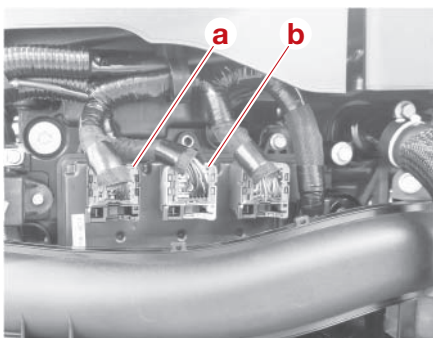


Input voltage
12 V
Main fuse “a”–Ground

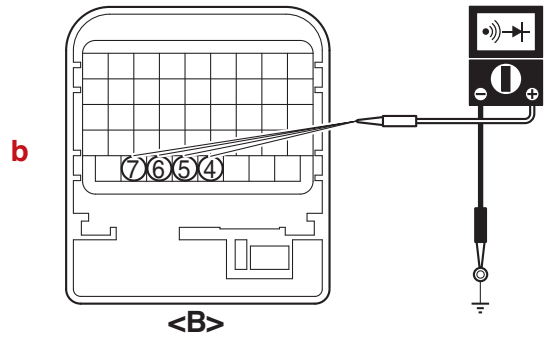
- d. Turn the main switch or power switch to OFF.
- e. Install the fuse cover.

Checking the engine ECM circuit

1. Check:
 - Engine ECM
 - a. Disconnect the engine ECM couplers “a” and “b”.



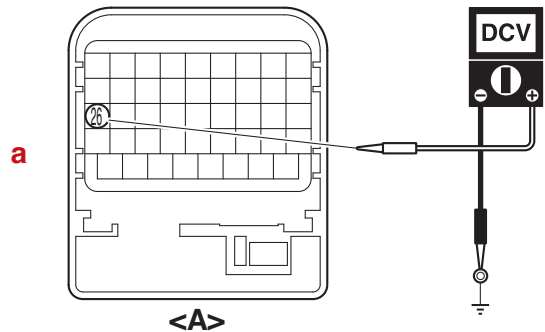
- b. Check the wire harness for continuity.



Continuity between the engine ECM coupler “b” and ground:

Terminal of coupler “b”		
4	–	Ground
5	–	Ground
6	–	Ground
7	–	Ground

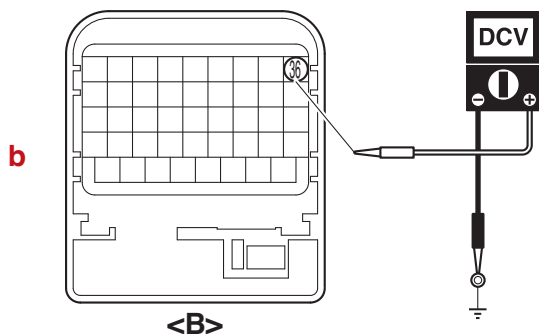
- c. Measure the input voltage between the terminal 26 of engine ECM coupler “a” and ground.



Input voltage
12 V
Terminal 26 of engine ECM coupler “a”–Ground

- d. Turn the main switch or power switch to ON, and then measure the input voltage between the terminal 36 of engine ECM coupler “b” and ground.

Engine control unit and component



Input voltage
12 V
Terminal 36 of engine ECM coupler "b"–Ground

- e. Turn the main switch or power switch to OFF.
- f. Connect the engine ECM couplers.

Checking the electrical management box

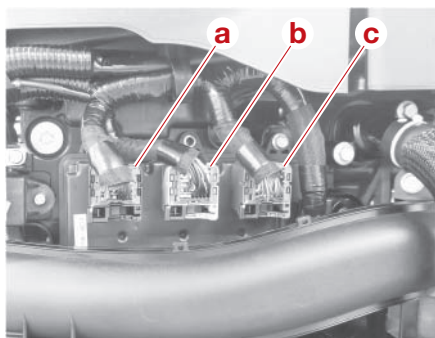
1. Check:
 - Electrical management box
 - a. Connect the YDIS and check that trouble codes for code number 190 and higher are not displayed.

Trouble codes for code number 190 and higher are displayed → See "Trouble code and checking step" (4-8).

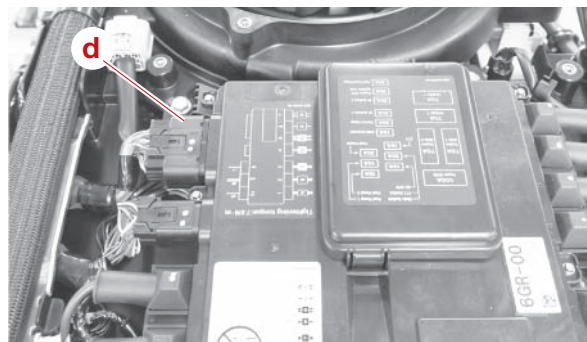
Trouble codes for code number 190 and higher are not displayed → Check the engine ECM and electrical management box for continuity.

TIP: _____
To connect the YDIS, use the CAN-Line.

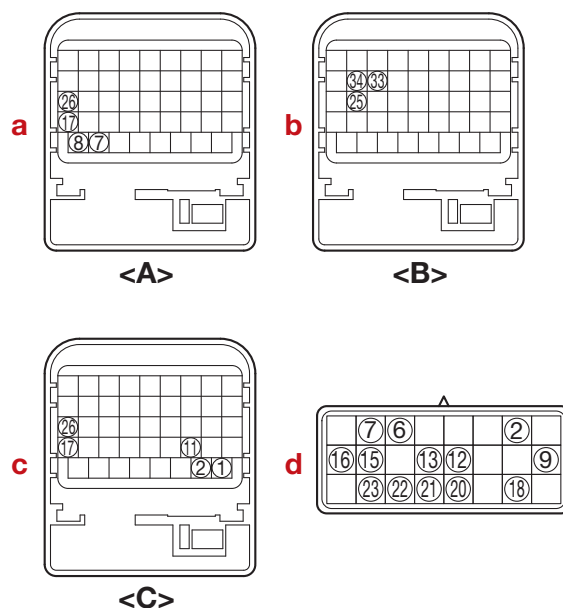
- b. Disconnect the engine ECM couplers "a", "b", and "c".



- c. Disconnect the electrical management box coupler "d".



- d. Check the wire harness for continuity.



Continuity between the engine ECM coupler "a" and the electrical management box coupler "d":

Terminal of coupler "a"		Terminal of coupler "d"
8	–	13
7	–	6
17	–	12
26	–	21

Continuity between the engine ECM coupler "b" and the electrical management box coupler "d":

Engine control unit and component

Terminal of coupler "b"		Terminal of coupler "d"
25	–	22
34	–	2
34	–	20
33	–	16

Continuity between the engine ECM coupler "c" and the electrical management box coupler "d":

Terminal of coupler "c"		Terminal of coupler "d"
1	–	18
2	–	9
17	–	7
11	–	23
26	–	15

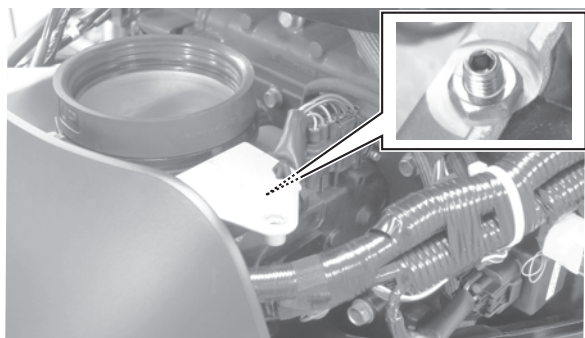
- e. Measure the input voltage at the engine ECM.
See "Checking the engine ECM circuit" (5-19).
- f. No problems were found in the preceding step → Replace the electrical management box.

Checking the ETV and TPS

TPS 1 and TPS 2 are components of the ETV, which cannot be disassembled.


NOTICE

Do not loosen the throttle stop screw nut or turn the throttle stop screw.

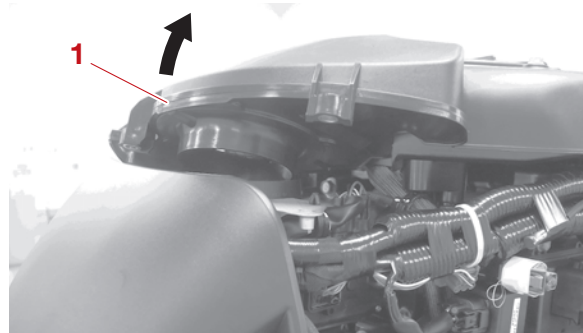


1. Check:
 - TPS 1 and TPS 2
 - a. Connect the YDIS to display "TPS 1" and "TPS 2".

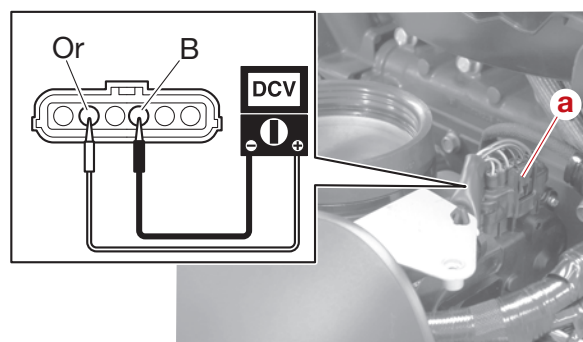
- b. Start the engine, warm it up for 5–10 minutes, and then stop it.
- c. Turn the main switch or power switch to ON, and then measure the TPS output voltages when the Digital Electric Control lever is at the fully closed position.

	TPS 1 output voltage at throttle valve fully closed (reference data)	0.850 V
	TPS 2 output voltage at throttle valve fully closed (reference data)	2.840 V
	TPS 1 output voltage at throttle valve fully open (reference data)	4.340 V
	TPS 2 output voltage at throttle valve fully open (reference data)	4.640 V


- d. Turn the main switch or power switch to OFF.
- e. Disconnect the intake silencer "1" from the ETV.



- f. Disconnect the ETV coupler "a".
- g. Turn the main switch or power switch to ON, and then measure the TPS input voltage at the ETV coupler.



Engine control unit and component



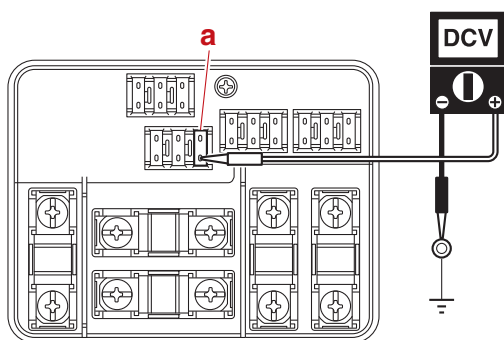
Input voltage
5 V
Orange (Or)–Black (B)


- h. Turn the main switch or power switch to OFF.
- i. Connect the ETV coupler.
- j. Connect the intake silencer to the ETV.

Checking the ETV motor relay

The ETV motor relay cannot be removed for testing or replaced as a single unit because it is a component part of the electrical management box.

1. Check:
 - ETV relay
 - a. Connect the YDIS to display “ETV relay”.
 - b. Turn the main switch or power switch to ON, and then check that “ON” is displayed for “ETV relay” on the YDIS screen.
 - c. Remove the fuse cover.
 - d. Measure the input voltage between the ETV relay fuse “a” and ground.





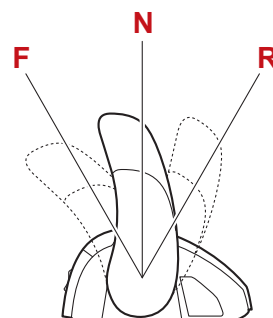
Input voltage
12 V
ETV fuse “a”–Ground

- e. Turn the main switch or power switch to OFF.
- f. Install the fuse cover.

Checking the SPS

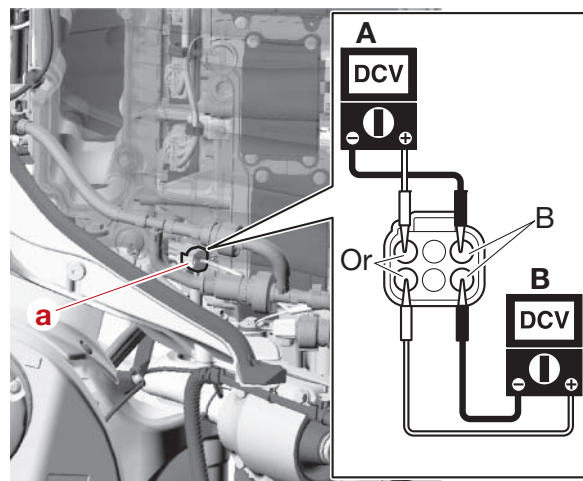
1. Check:
 - SPS
 - a. Connect the YDIS to display “SPS”.


- b. Operate the Digital Electronic Control lever to measure the output voltage at the F, N, and R positions.



SPS output voltage (reference data)	
F	1.17 V
N	2.54 V
R	3.78 V

- c. Turn the main switch or power switch to OFF, and then disconnect the SPS coupler “a”.
- d. Turn the main switch or power switch to ON, and then measure the input voltage at the SPS coupler.





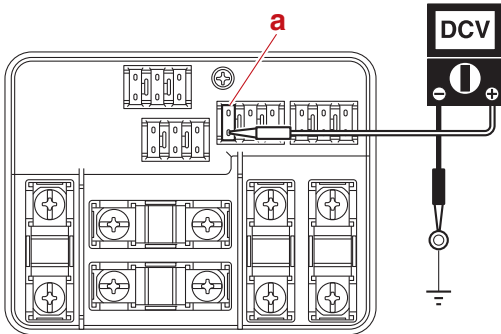
Input voltage
5 V

- A. SPS 1
- B. SPS 2
- e. Turn the main switch or power switch to OFF, and then connect the SPS coupler.

Checking the shift actuator relay

The shift actuator relay cannot be removed for testing or replaced as a single unit because it is a component part of the electrical management box.

1. Check:
 - Shift actuator relay
 - a. Connect the YDIS to display “Shift actuator relay”.
 - b. Turn the main switch or power switch to ON, and then check that “ON” is displayed for “Shift actuator relay” on the YDIS screen.
 - c. Remove the fuse cover.
 - d. Measure the input voltage between the shift fuse “a” and ground.

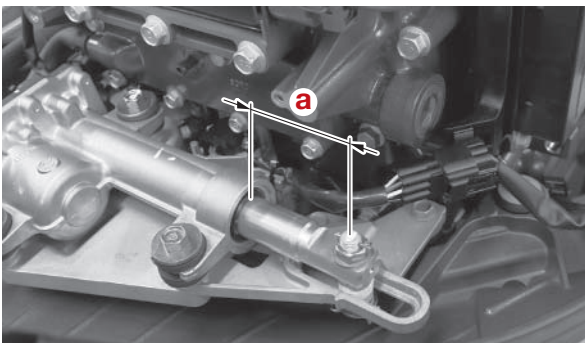


	Input voltage 12 V Shift fuse “a”–Ground
--	------------------------------------------------

- e. Turn the main switch or power switch to OFF.
- f. Install the fuse cover.

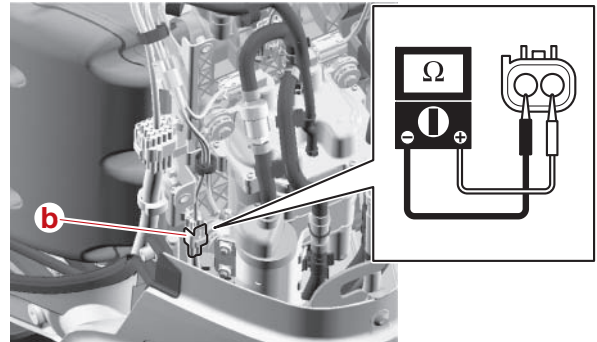
Checking the shift actuator

1. Check:
 - Shift actuator
 - a. Operate the Digital Electronic Control to check the shift actuator rod stroke “a” at the positions F, N, and R.



Shift actuator rod stroke “a”	
F	82.0 mm (3.23 in)
N	60.0 mm (2.36 in)
R	37.0 mm (1.46 in)

- b. Disconnect the shift actuator coupler “b”, and then measure the shift actuator motor resistance.

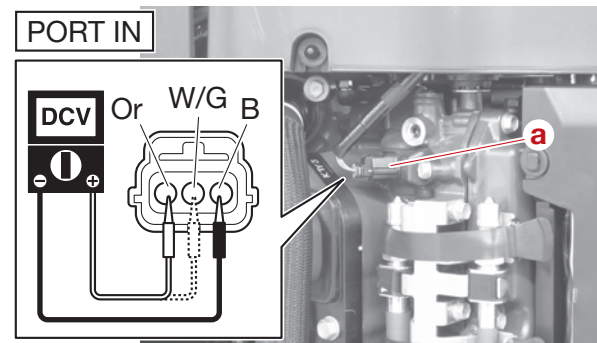


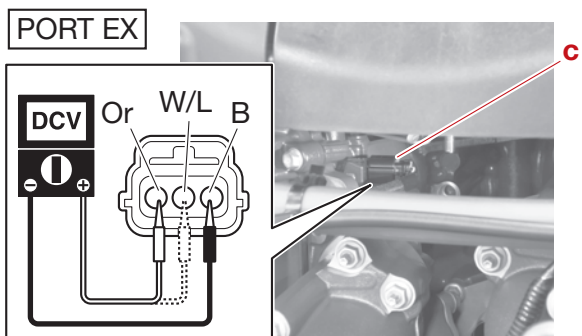
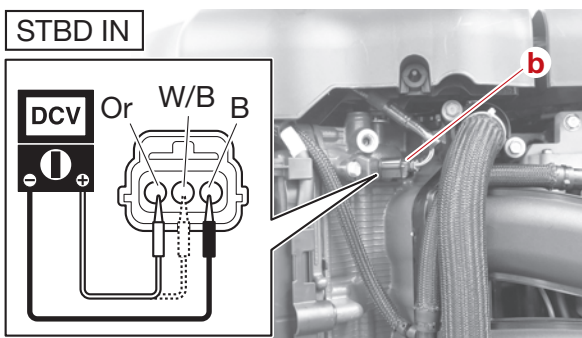
	Motor resistance (reference data) 1.2 Ω
--	--------------------------------------------


- c. Connect the shift actuator coupler.

Checking the cam position sensor

1. Check:
 - Cam position sensor
 - a. Disconnect the cam position sensor couplers “a”, “b”, and “c”.
 - b. Turn the main switch or power switch to ON, and then measure the input voltage at the cam position sensor coupler.

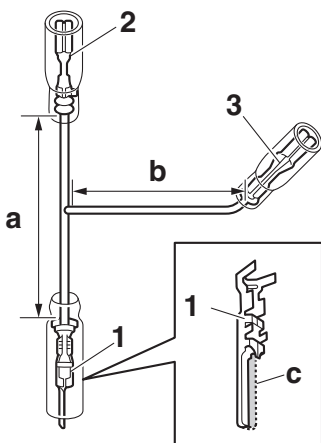




 Input voltage
5 V

- Orange (Or)–Black (B)
White/Green (W/G)–Black (B)
(PORT IN)
- Orange (Or)–Black (B)
White/Black (W/B)–Black (B)
(STBD IN)
- Orange (Or)–Black (B)
White/Blue (W/L)–Black (B)
(PORT EX)

- c. Turn the main switch or power switch to OFF.
- d. Make 3 test leads.



Test lead

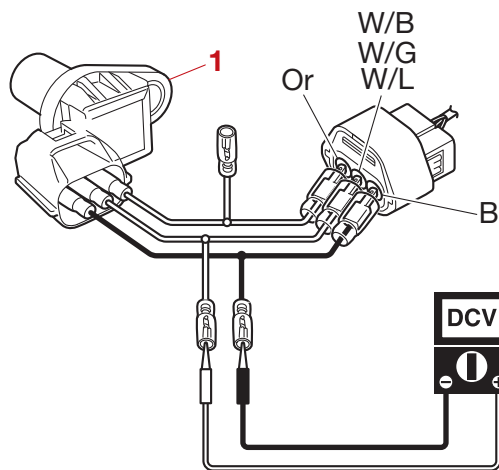
- Terminal, male "1"
9E212-10303
- Terminal, female "2"
9E212-11303
- Terminal, female "3"
(commercially available)
- "a" = 100 mm (3.94 in)
- "b" = 50 mm (1.97 in)
- "c" = Cutout area

- e. Remove the cam position sensors "1".
- f. Connect the test leads to the cam position sensor "1" and cam position sensor coupler.

NOTICE

Make sure that the test leads do not contact each other and cause a short circuit. Otherwise, the fuse could blow when the power is supplied.

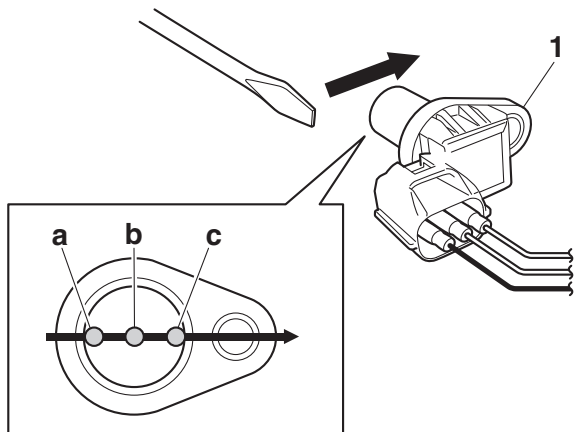
- g. Connect the tester probes to the test leads.



- h. Turn the main switch or power switch to ON, and then measure the output voltage when moving a screwdriver close to the cam position sensor "1".
Out of specification → Replace.

TIP:

Using an analog circuit tester is recommended.



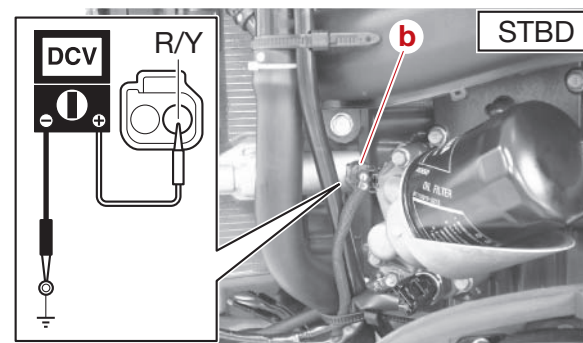
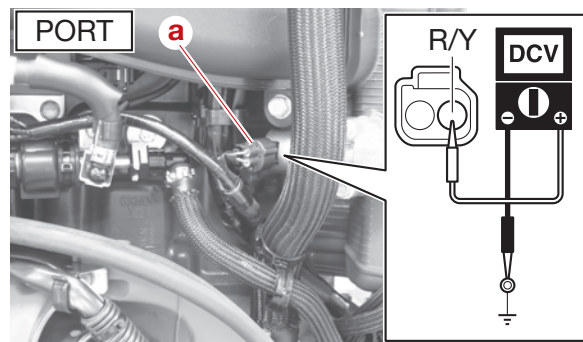
Output voltage	
White/Black (W/B)–Black (B) (STBD IN)	
White/Green (W/G)–Black (B) (PORT IN)	
White/Blue (W/L)–Black (B) (PORT EX)	
Position	Voltage
“a”, “c”	More than 4.8
“b”	Less than 1.0

- i. Turn the main switch or power switch to OFF.
- j. Disconnect the test leads, and then install the cam position sensors.
- k. Connect the cam position sensor couplers.

TIP: _____
For connection of cam position sensor coupler, see “Electrical component and wire harness routing” (5-1).

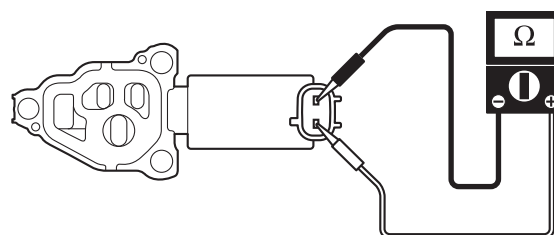
Checking the OCV

1. Check:
 - OCV
 - a. Check the operation of the OCV using the YDIS “Stationary test” and check the operating sound.
 - b. Disconnect the OCV couplers “a” and “b”.
 - c. Turn the main switch or power switch to ON, and then measure the input voltage between the OCV coupler and ground.



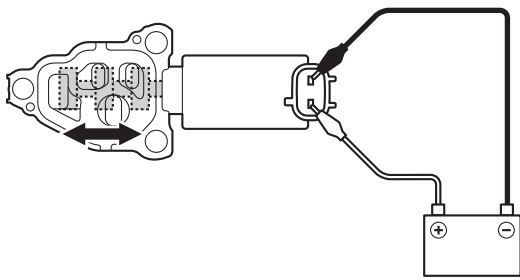
	Input voltage
	12 V
	Red/Yellow (R/Y)–Ground

- d. Turn the main switch or power switch to OFF.
- e. Remove the OCVs.
- f. Measure the OCV resistance.



	Resistance
	6.7–7.7 Ω

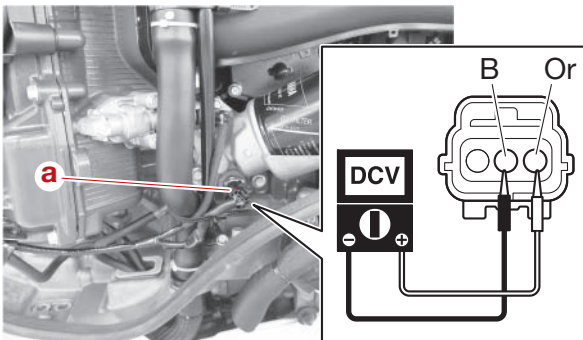
- g. Connect the battery leads to the terminals and check the operation of the spool valve.
Does not operate → Replace the OCV.



- h. Disconnect the battery leads.
- i. Install new gaskets and OCVs, and then connect the OCV couplers.

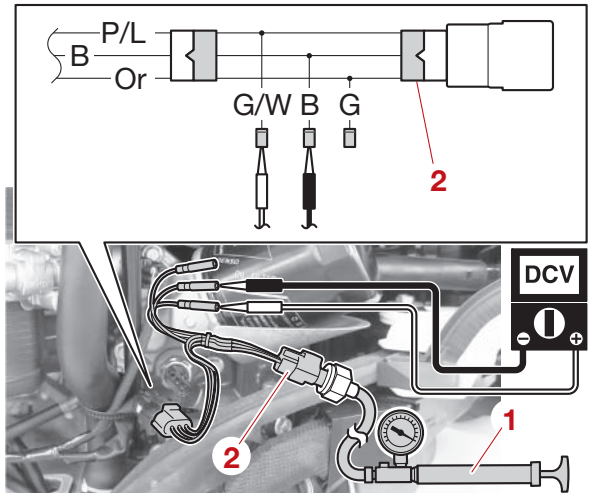
Checking the oil pressure sensor

1. Check:
 - Oil pressure sensor
 - a. Disconnect the oil pressure sensor coupler “a”.
 - b. Turn the main switch or power switch to ON, and then measure the input voltage at the oil pressure sensor coupler.



	Input voltage 5 V Orange (Or)–Black (B)
--	-----------------------------------------------

- c. Remove the oil pressure sensor, and then connect a pressure pump “1” and the special service tool “2”.
- d. Apply positive pressure to the oil pressure sensor slowly, and then measure the output voltage at the specified pressures.



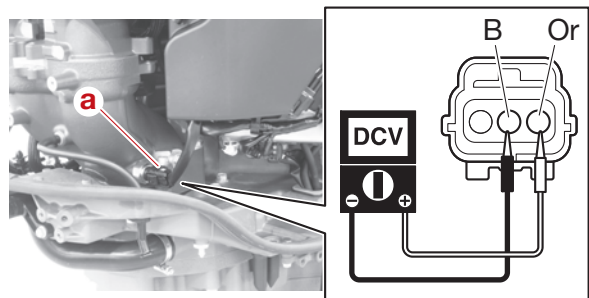
	Pressure pump “1” (commercially available) Test harness EJ-II-3 “2” 90890-06913
--	------------------------------------------------------------------------------------------

	Output voltage at 392 kPa (3.92 kgf/cm ² , 56.8 psi) 2.5 V Output voltage at 784 kPa (7.84 kgf/cm ² , 113.7 psi) 4.5 V Pink/Blue (P/L)–Black (B)
--	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------


- e. Turn the main switch or power switch to OFF, and then disconnect the special service tool and pressure pump.

Checking the water pressure sensor

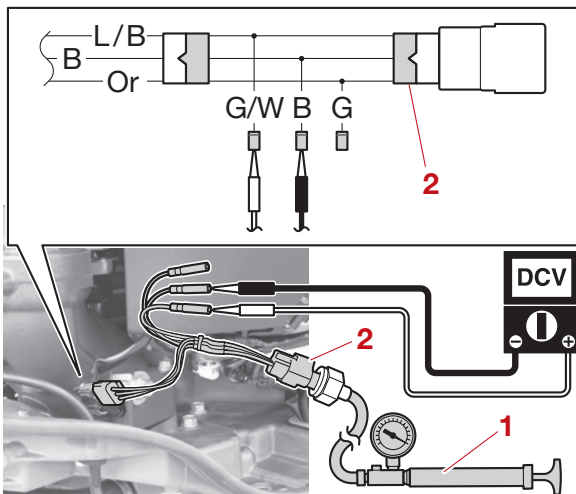
1. Check:
 - Water pressure sensor
 - a. Disconnect the water pressure sensor coupler “a”.





- b. Turn the main switch or power switch to ON, and then measure the input voltage at the water pressure sensor coupler.

	Input voltage 5 V Orange (Or)–Black (B)
-----------------------------------------------------------------------------------	-----------------------------------------------

- c. Remove the water pressure sensor, and then connect a pressure pump “1” and the special service tool “2”.
- d. Apply positive pressure to the water pressure sensor slowly, and then measure the output voltage at the specified pressures.



	Pressure pump “1” (commercially available) Test harness EJ-II-3 “2” 90890-06913
-------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------

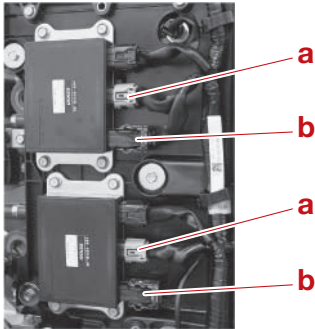
	Output voltage at 392 kPa (3.92 kgf/cm ² , 56.8 psi) (reference data) 2.5 V Output voltage at 784 kPa (7.84 kgf/cm ² , 113.7 psi) (reference data) 4.5 V Blue/Black (L/B)–Black (B)
-------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

- e. Turn the main switch or power switch to OFF, and then disconnect the special service tool and pressure pump.

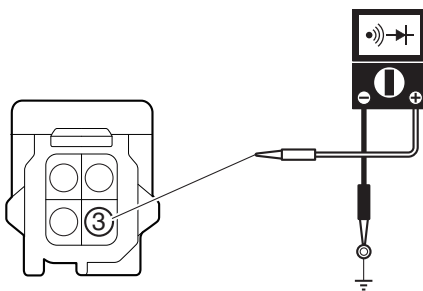
Fuel control unit and component


Checking the injector driver circuit

1. Remove:
 - Intake manifold (PORT)
See "Intake manifold" (6-24).
2. Check:
 - Injector driver
 - a. Disconnect the injector driver couplers "a" and "b".

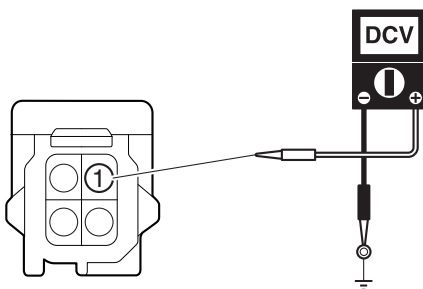


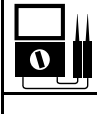
b. Check the wire harness for continuity.



	Wire harness continuity Terminal 3–Ground
-------------------------------------------------------------------------------------	----------------------------------------------

- c. Turn the main switch or power switch to ON, and then measure the input voltage between the injector driver coupler terminal 1 and ground.

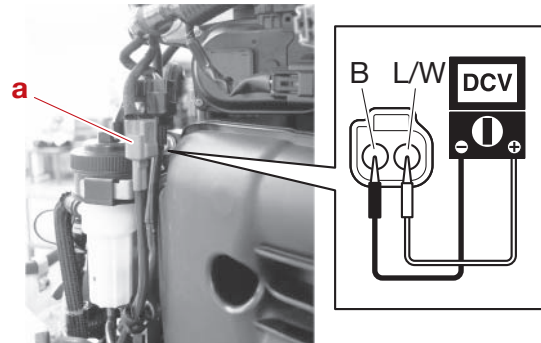


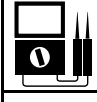
	Input voltage 12 V Terminal 1–Ground
-----------------------------------------------------------------------------------	--------------------------------------------

- d. Turn the main switch or power switch to OFF.
- e. Connect the injector driver couplers.

Checking the water detection switch

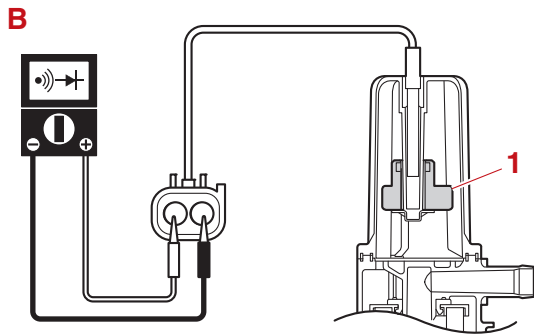
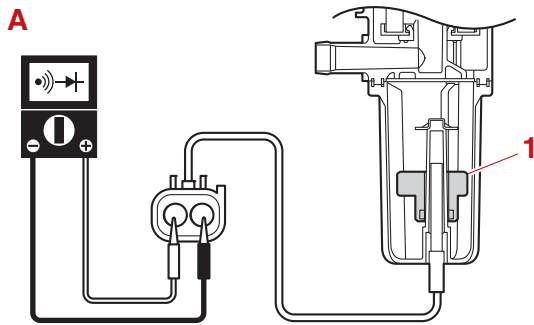
1. Check:
 - Water detection switch
 - a. Disconnect the water detection switch coupler "a".
 - b. Turn the main switch or power switch to ON, and then measure the input voltage at the water detection switch coupler.

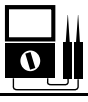


	Input voltage 5 V Blue/White (L/W)–Black (B)
-------------------------------------------------------------------------------------	----------------------------------------------------

- c. Turn the main switch or power switch to OFF, and then remove the fuel filter assembly.
- d. Check that the float "1" moves smoothly.
- e. Check the water detection switch for continuity when the float "1" is in positions "A" and "B".
Out of specification → Replace the fuel cup assembly.

NOTICE
Do not remove the clip and float.

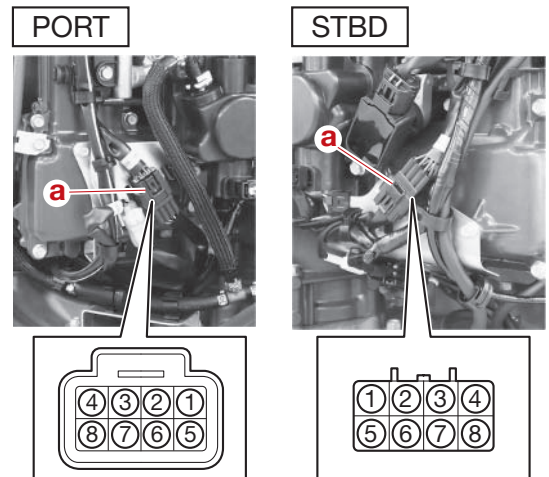



 Water detection switch continuity
 No continuity
 Float position "A"
 Continuity
 Float position "B"

- f. Install the fuel filter assembly. See "Fuel filter assembly" (6-3).
- g. Connect the water detection switch coupler.

Checking the fuel injector

1. Check:
 - Fuel injector
 - a. Check the operation of the fuel injector using the YDIS "Stationary test" and check the operating sound.
 - b. Disconnect the fuel injector sub-wire harness couplers "a".
 - c. Measure the fuel injector resistance.
 Out of specification → Replace the fuel injector.

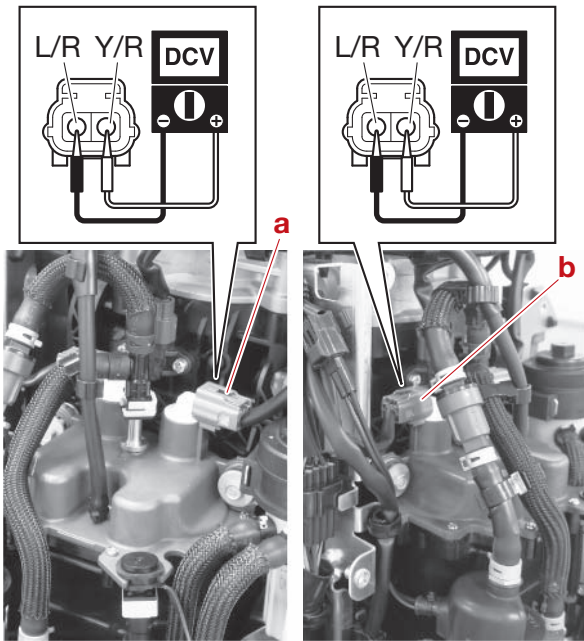



	Resistance (reference data)
	1.74–2.04 Ω
	Fuel injector #1, #2 terminal 4–8
	Fuel injector #3, #4 terminal 3–7
	Fuel injector #5, #6 terminal 2–6
	Fuel injector #7, #8 terminal 1–5

- d. Connect the fuel injector sub-wire harness couplers.

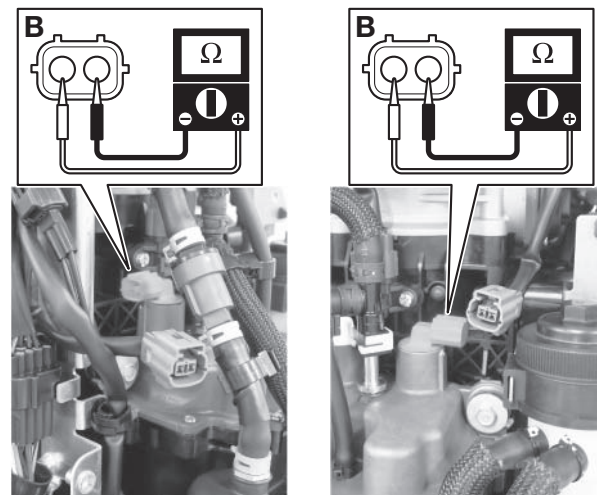
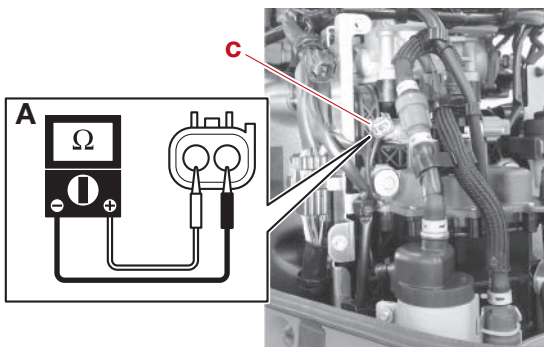
Checking the low-pressure fuel pump and high-pressure fuel pump

1. Check:
 - Low-pressure fuel pump
 - High-pressure fuel pump
 - a. Check the operation of the low-pressure fuel pump and high-pressure fuel pump using the YDIS "Stationary test" and check the operating sound.
 - b. Disconnect the high-pressure fuel pump couplers "a" and "b".
 - c. Connect the tester probes to the terminals of the high-pressure fuel pump couplers, and then measure the input voltage.

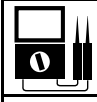


 High-pressure fuel pump
 Input voltage
 12 V
 Yellow/Red (Y/R)–Blue/Red (L/R)

- d. Disconnect the low-pressure fuel pump coupler “c”.
- e. Measure the resistance of the fuel pump motors.
 Out of specification → Replace.



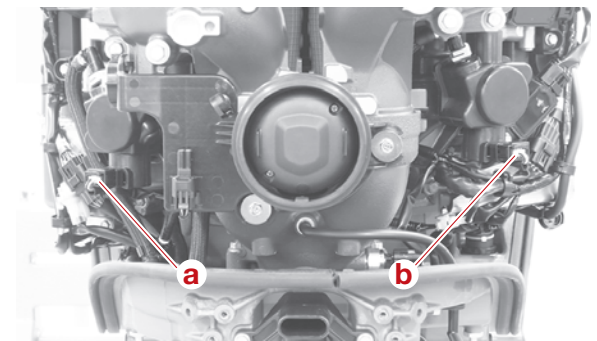
- A. Low-pressure fuel pump
- B. High-pressure fuel pump

 Low-pressure fuel pump
 Resistance (reference data)
 0.6 Ω
 High-pressure fuel pump
 Resistance (reference data)
 0.3 Ω

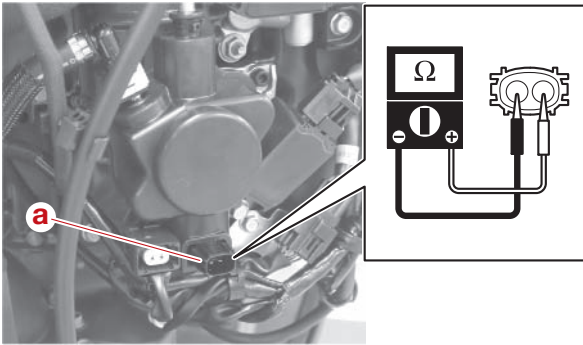
- f. Connect the low-pressure fuel pump coupler and high-pressure fuel pump couplers.

Checking the direct injection pump

1. Check:
 - Direct injection pump
 - a. Check the operation of the direct injection pump using the YDIS “Stationary test” and check the operating sound.
 - b. Disconnect the direct injection pump couplers “a” and “b”.



- c. Measure the resistance of the fuel pump solenoid.
 Out of specification → Replace the direct injection pump.

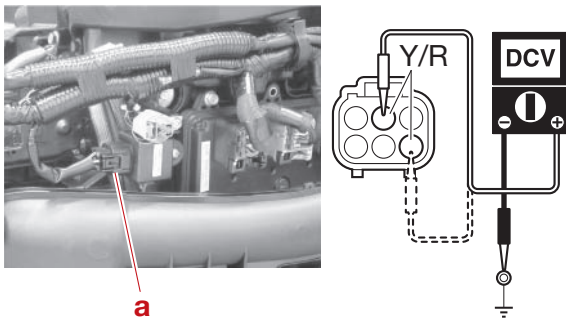


	Direct injection pump Resistance (reference data) 0.45-0.55 Ω
--	---------------------------------------------------------------------

d. Connect the direct injection pump couplers.

Checking the low-pressure fuel pump relay

- Check:
 - Low-pressure fuel pump relay
 - Disconnect the low-pressure fuel pump relay coupler “a”.
 - Turn the main switch or power switch to ON, and then measure the low-pressure fuel pump relay input voltage.

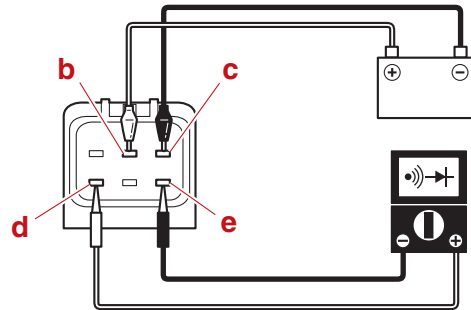


	Input voltage 12 V Yellow/Red (Y/R)–Ground
--	--------------------------------------------------

- Turn the main switch or power switch to OFF.
 - Remove the low-pressure fuel pump relay.
 - Connect the positive battery lead to the terminal “b” and the negative battery lead to the terminal “c”, and then check for continuity between the terminals “d” and “e”.
- If there is no continuity → Replace.

NOTICE

Do not reverse the battery leads.

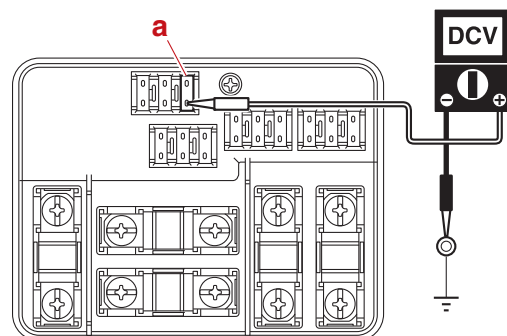


Battery lead	Terminal	
	d	e
Connect	○————○	
Disconnect		

Checking the high-pressure fuel pump relay

The high-pressure fuel pump relay cannot be removed for testing or replaced as a single unit because it is a component part of the electrical management box.

- Check:
 - High pressure fuel pump relay
 - Connect the YDIS to display “VST fuel pump relay”.
 - Turn the main switch or power switch to ON, and then check that “ON” is displayed for “VST fuel pump relay” on the YDIS screen.
 - Remove the fuse cover.
 - Measure the input voltage between the high-pressure fuel pump fuse “a” and ground.



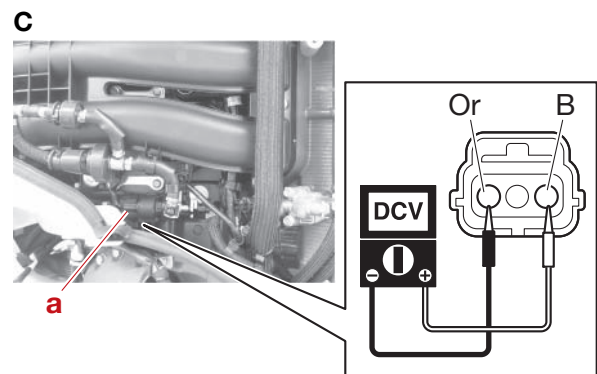
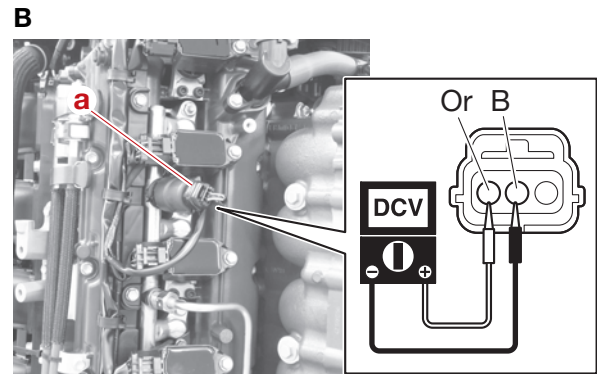
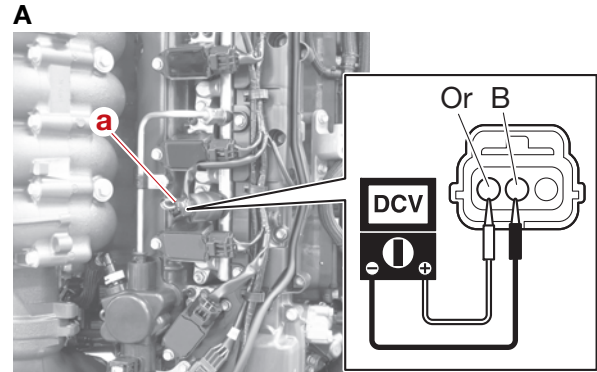
	Input voltage
	12 V
	High-pressure fuel pump fuse “a”–Ground

- e. Turn the main switch or power switch to OFF.
- f. Install the fuse cover.

Checking the fuel pressure sensor

Before checking the fuel pressure sensor, make sure that there are no other problems in the fuel system.

1. Check:
 - Fuel pressure sensor (high-pressure fuel pump)
 - Fuel pressure sensor (direct injection pump)
 - a. Stop the engine, and then disconnect the fuel pressure sensor couplers “a”.
 - b. Turn the main switch or power switch to ON, and then measure the fuel pressure sensor input voltage.



- A. Fuel pressure sensor (direct injection pump [STBD])
- B. Fuel pressure sensor (direct injection pump [PORT])
- C. Fuel pressure sensor (high-pressure fuel pump)

	Fuel pressure sensor (direct injection pump)
	Input voltage
	5 V
	Orange (Or)–Black (B)
	Fuel pressure sensor (high-pressure fuel pump)
	Input voltage
	5 V
	Orange (Or)–Black (B)

- c. Turn the main switch or power switch to OFF, and then connect the fuel pressure sensor couplers.
- d. Measure the fuel pressure.
See "Measuring the fuel pressure" (6-2).
Out of specification → Replace the fuel rail assembly.



Fuel pressure at idle speed (high-pressure fuel pump)

330-400 kPa (3.3-4.0 kgf/cm²,
47.9-58.0 psi)

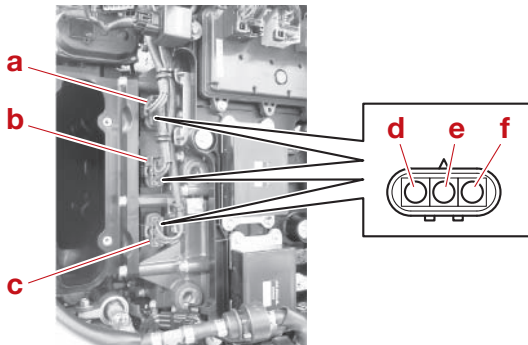
Fuel pressure at idle speed (DI pump)


8.00 Mpa (80.0 kgf/cm², 1160.0
psi)

Charging unit and component

Checking the lighting coil (stator assembly)

1. Check:
 - Lighting coil
 - a. Remove the intake manifold (PORT). See "Intake manifold" (6-24).
 - b. Disconnect the lighting coil couplers "a", "b" and "c".
 - c. Measure the lighting coil resistance at each coupler.



	Resistance (reference data)
	0.0904–0.1356 Ω
	Terminal "d"–Terminal "e"
	Terminal "d"–Terminal "f"
	Terminal "e"–Terminal "f"

- d. Connect the lighting coil couplers.
- e. Install the intake manifold (PORT). See "Intake manifold" (6-24).

Checking the rectifier/regulator

1. Check:
 - Rectifier/regulator (trigger leads)
 - a. Connect the YDIS to display "Battery voltage" and "Accessory battery voltage".
 - b. Start the engine, and measure the battery charging voltages.

Engine battery charging voltage is out of specification → Check the lighting coil and rectifier/regulator continuity.

House battery (accessory battery) charging voltage is low → Replace the rectifier/regulator.

TIP: _____

When the battery is fully charged, the voltage value at low engine speed may fluctuate due to the influence of voltage control.

Charging voltage	
Engine battery	More than 13.0 V
House battery (Accessory battery)	More than 14.0 V

- c. Turn the main switch or power switch to OFF.
2. Remove:
 - Intake manifolds
See "Intake manifold" (6-24).
 - Surge tank
See "ETV" (6-28).
3. Check:
 - Rectifier/regulator continuity
Out of specification → Replace the rectifier/regulator.
 - a. Disconnect the rectifier/regulator couplers.
 - b. Set the digital circuit tester to the diode mode.
 - c. Check the rectifier/regulator for continuity.

See "Rectifier/regulator continuity table (F400A/FL400A/XF400A)" (A-20) or "Rectifier/regulator continuity table (F450A/FL450A/XF450A)" (A-22).

Ignition unit and component

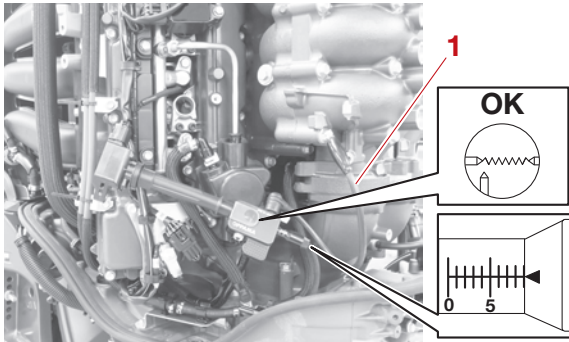
Checking the ignition spark

1. Check:
 - Ignition coil
 - a. Remove the ignition coils.
 - b. Connect the special service tool "1" to the ignition coil.

TIP: _____
Repeat steps (b)–(d) for each ignition coil.

- c. Check the ignition spark using the YDIS "Stationary test".

WARNING _____
Do not touch any of the connections of the special service tool.

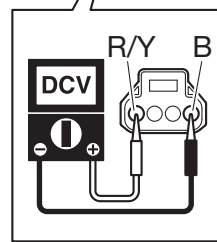
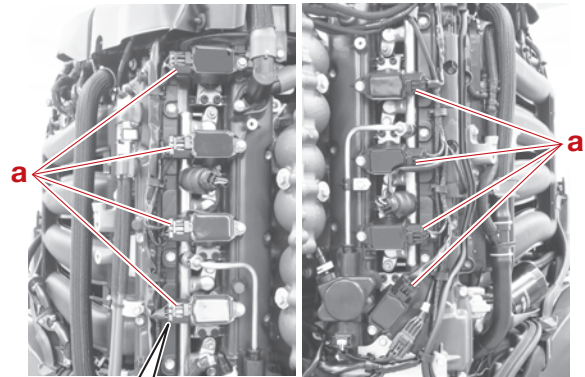


	Ignition checker (Spark gap tester) "1"
	90890-06754
	Spark checker "1"
	YM-34487

- d. Disconnect the special service tool.
- e. Install the ignition coils.

Checking the ignition coil

1. Check:
 - Ignition coil
 - a. Disconnect the ignition coil couplers "a".
 - b. Turn the main switch or power switch to ON, and then measure the input voltage at the ignition coil coupler.

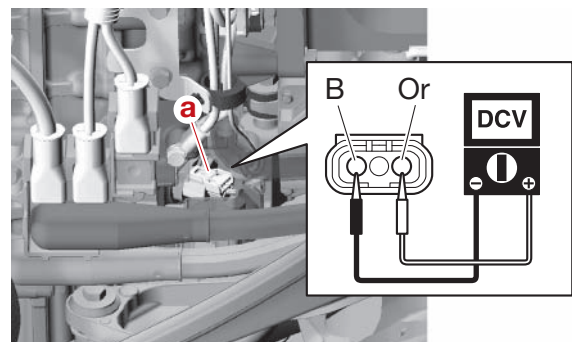


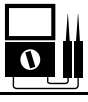
	Input voltage
	12 V
	Red/Yellow (R/Y)–Black (B)

- c. Turn the main switch or power switch to OFF.
- d. Connect the ignition coil couplers.

Checking the crankshaft position sensor

1. Remove:
 - Intake manifold (STBD)
See "Intake manifold" (6-24).
2. Check:
 - Crankshaft position sensor
 - a. Disconnect the crankshaft position sensor coupler "a".
 - b. Turn the main switch or power switch to ON, and then measure the input voltage at the crankshaft position sensor coupler.





Input voltage
5 V
Orange (Or)–Black (B)

- c. Turn the main switch or power switch to OFF.
- d. Connect the crankshaft position sensor coupler.

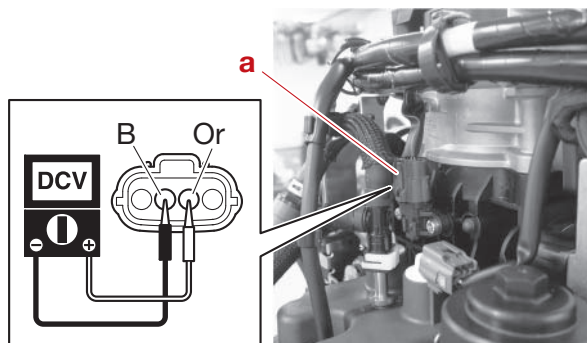
Checking the intake air pressure/temperature sensor


1. Check:
 - Intake air pressure/temperature sensor
 - a. Measure the ambient temperature.
 - b. Connect the YDIS to display “Intake air temperature”.
 - c. Check that the difference between the ambient temperature and the displayed intake air temperature is within $\pm 5\text{ }^{\circ}\text{C}$ ($\pm 9\text{ }^{\circ}\text{F}$).

TIP:

- Check the intake air pressure/temperature sensor when the engine is cold.
- When checking the intake air pressure/temperature sensor, remove the top cowling and do not start the engine.

- d. Disconnect the intake air pressure/temperature sensor coupler “a”.
- e. Turn the main switch or power switch to ON, and then measure the input voltage at the intake air pressure/temperature sensor coupler.

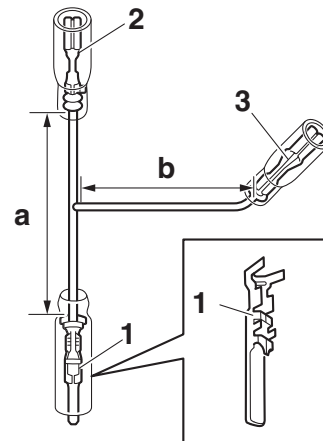




Input voltage
5 V
Orange (Or)–Black (B)

- f. Turn the main switch or power switch to OFF.

g. Make 3 test leads.



Test lead

Terminal, male “1”
8100-1466

Terminal, female “2”
8100-2567

Terminal, female “3”
(commercially available)

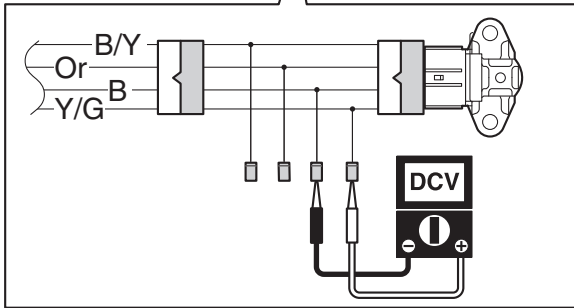
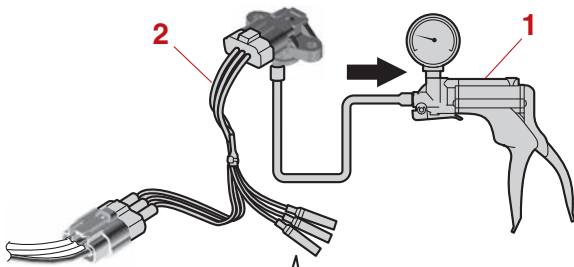
“a” = 100 mm (3.94 in)


“b” = 50 mm (1.97 in)

NOTICE


Make sure that the test leads do not contact each other and cause a short circuit. Otherwise, the fuse could blow when the power is supplied.

- h. Remove the intake air pressure/temperature sensor.
See “ETV” (6-28).
- i. Connect the special service tool “1” and test leads “2” to the intake air pressure/temperature sensor.

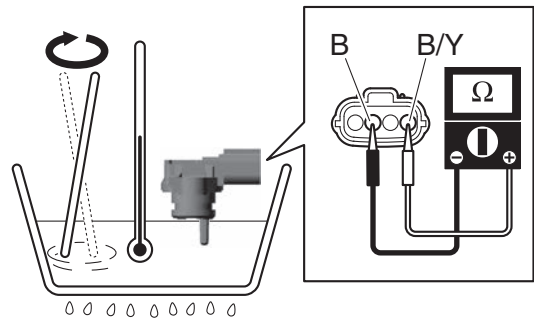


 Vacuum/pressure pump gauge set "1"
90890-06945
Pressure/vacuum tester "1"
YB-35956-B

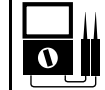
- j. Turn the main switch or power switch to ON.
- k. Apply negative pressure to the intake air pressure/temperature sensor slowly, and then measure the output voltage at the specified pressure.

 Output voltage at -20.0 kPa (-0.20 kgf/cm², -2.9 psi)
0.79 V
Output voltage at -46.7 kPa (-0.47 kgf/cm², -6.8 psi)
1.84 V
Yellow/Green (Y/G)–Black (B)

- l. Turn the main switch or power switch to OFF.
- m. Disconnect the test leads and special service tool.
- n. Place the intake air pressure/temperature sensor in a container of water and heat the water slowly.



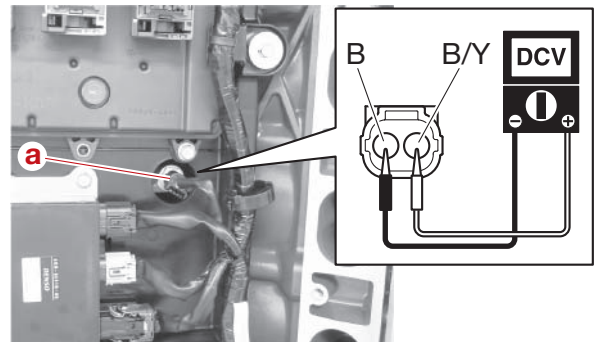
- o. Measure the intake air pressure/temperature sensor resistance.


 Resistance at 0 °C (32 °F)
5.4-6.6 kΩ
Resistance at 80 °C (176 °F)
0.28-0.38 kΩ
Black/Yellow (B/Y)–Black (B)

- p. Install the intake air pressure/temperature sensor and connect the coupler. See "ETV" (6-28).

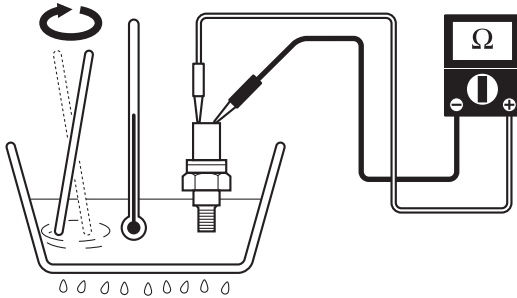
Checking the engine temperature sensor


1. Remove:
 - Intake manifold (PORT)
See "Intake manifold" (6-24).
2. Check:
 - Engine temperature sensor
 - a. Disconnect the engine temperature sensor coupler "a".
 - b. Turn the main switch or power switch to ON, and then measure the input voltage at the engine temperature sensor coupler.



 Input voltage
5 V
Black/Yellow (B/Y)–Black (B)

- c. Turn the main switch or power switch to OFF.
- d. Remove the engine temperature sensor.
- e. Place the engine temperature sensor in a container of water and heat the water slowly.
- f. Measure the engine temperature sensor resistance.

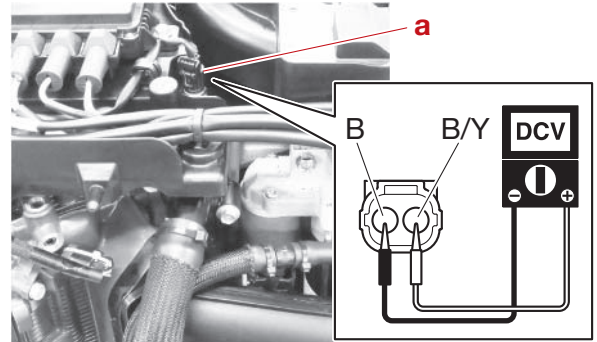
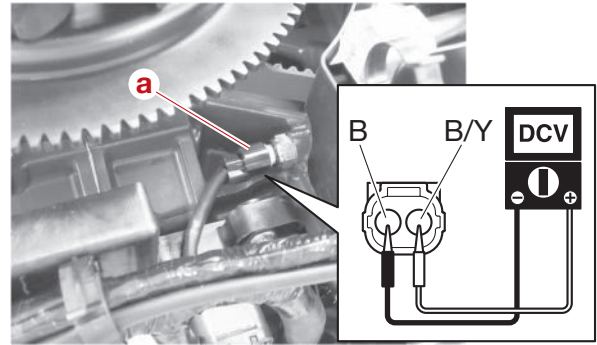



	Resistance at 20 °C (68 °F) (reference data)
	2.51–2.77 kΩ
	Resistance at 100 °C (212 °F) (reference data)
	0.21–0.22 kΩ

- g. Install the engine temperature sensor and connect the coupler.

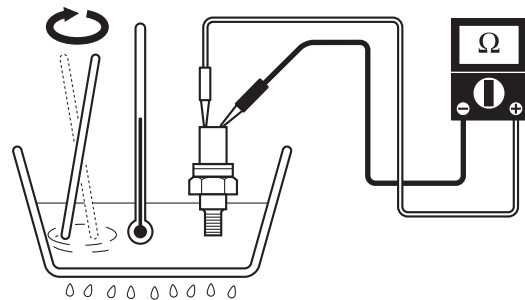
Checking the thermo sensor

1. Remove:
 - Shroud cover
 - Terminal covers
 See “Shroud cover and terminal cover” (7-5).
2. Check:
 - Thermo sensor
 - a. Disconnect the thermo sensor couplers “a”.
 - b. Turn the main switch or power switch to ON, and then measure the input voltage at the thermo sensors coupler.




	Input voltage
	5 V
	Black/Yellow (B/Y)–Black (B)

- c. Turn the main switch or power switch to OFF.
- d. Remove the thermo sensors.
- e. Place the thermo sensors in a container of water and heat the water slowly.



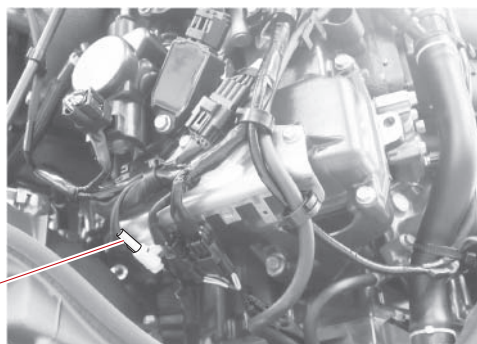
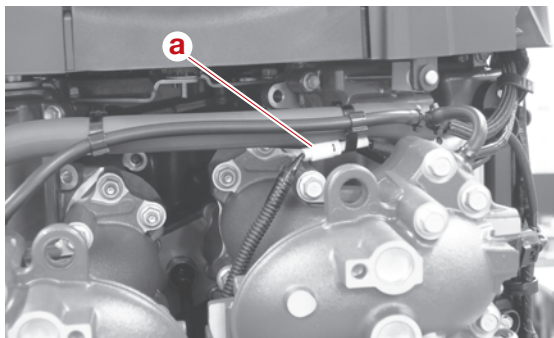
- f. Measure the thermo sensor resistance.

	Resistance at 20 °C (68 °F)
	2.25–2.65 kΩ
	Resistance at 80 °C (176 °F)
	0.31–0.33 kΩ

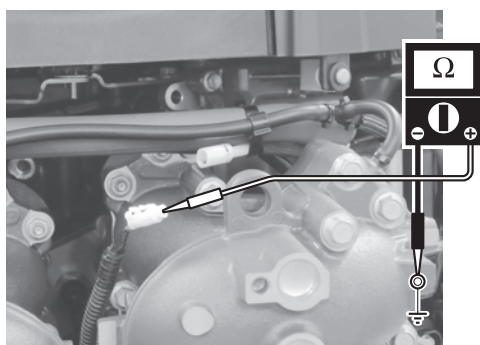
- g. Install the thermo sensors and connect the couplers.
See “Shroud cover and terminal cover” (7-5).


Checking the knock sensor

1. Check:
 - Knock sensor
 - a. Disconnect the knock sensor couplers “a” and “b”.



- b. Measure the knock sensor resistance. Replace if out of specification.

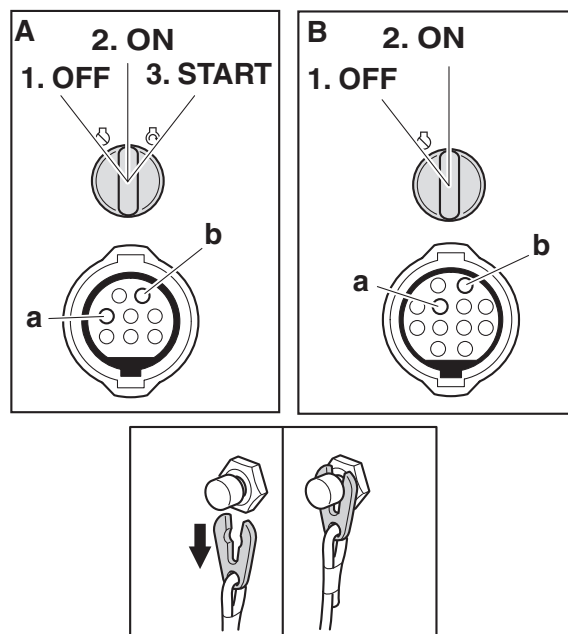


	Resistance 504–616 kΩ
-------------------------------------------------------------------------------------	--------------------------

Checking the engine shut-off switch (6X6)

1. Check:
 - Engine shut-off switch
 - a. Disconnect the main switch coupler or engine start switch coupler.

- b. Turn the main switch to ON, and then check the engine shut-off switch for continuity. Replace if out of specification.




A. Engine start switch
B. Main switch

Switch position	Terminal	
	a	b
Clip removed	○ ————— ○	
Clip installed		

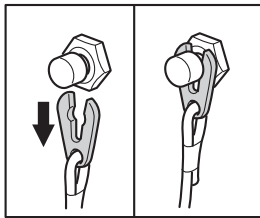
- c. Turn the main switch to OFF.
 - d. Connect the main switch coupler or engine start switch coupler.

Checking the engine shut-off switch (EKS)

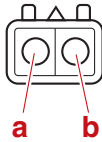
1. Check:
 - Engine shut-off switch continuity
Out of specification → Replace.

	Engine shut-off switch continuity Clip removed: Terminal “a”–Terminal “b” Terminal “c”–Terminal “d” Terminal “e”–Terminal “f” Terminal “g”–Terminal “h” Terminal “i”–Terminal “j”
-------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

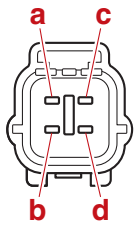
- a. Disconnect the engine shut-off switch couplers.
- b. Check the engine shut-off switch for continuity.



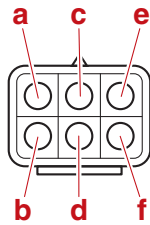
A



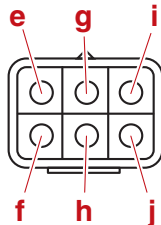
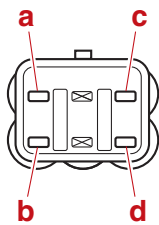
B



C



D



- A. Single type
- B. Twin type
- C. Triple type
- D. Quad/Quint type

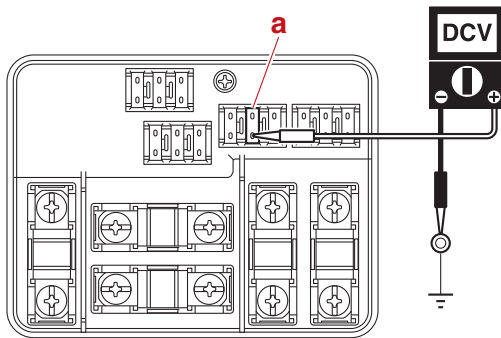
- c. Connect the engine shut-off switch couplers.

Starting unit and component

Checking the starter relay

The starter relay cannot be removed for testing or replaced as a single unit because it is a component part of the electrical management box.

1. Check:
 - Starter relay
 - a. Connect the YDIS to display “Starter relay”.
 - b. Turn the main switch or power switch to ON, and then check that “ON” is displayed for “Starter relay” on the YDIS screen.
 - c. Remove the fuse cover.
 - d. Measure the input voltage between the starter fuse “a” and ground.

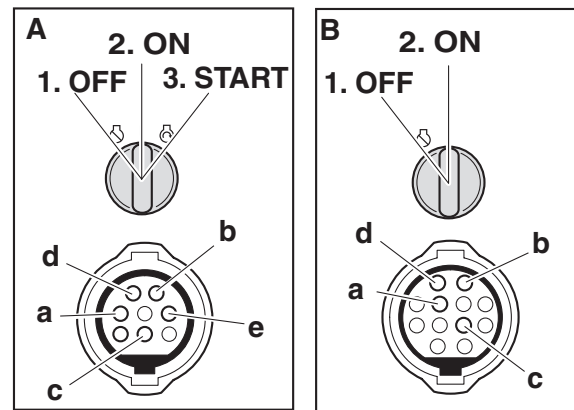


	Input voltage
	12 V
	Starter motor fuse “a”– Ground

- e. Turn the main switch or power switch to OFF.
- f. Install the fuse cover.

Checking the engine start switch and main switch (6X6)

1. Check:
 - Engine start switch
 - Main switch
 - a. Disconnect the engine start switch coupler or main switch coupler.
 - b. Check the engine start switch or main switch for continuity at the engine start switch coupler or main switch coupler.



A. Engine start switch
B. Main switch

Switch position	Terminal				
	a	b	c	d	e
OFF	○—○				
ON			○—○		
START *1			○—○—○		

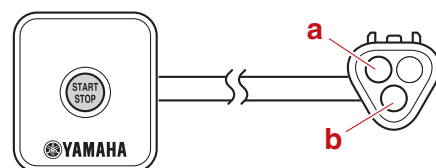
*1. Engine start switch only

- c. Connect the engine start switch coupler or main switch coupler.

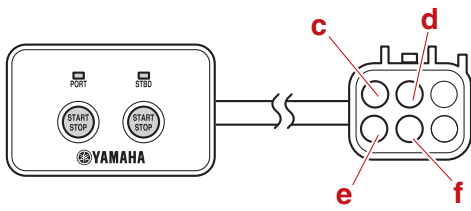
Checking the engine start/stop button (6X6)

1. Check:
 - Engine start/stop button
 - a. Disconnect the engine start/stop button coupler.
 - b. Check the engine start/stop button for continuity at the engine start/stop button coupler.

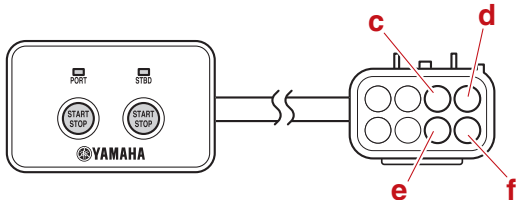
A



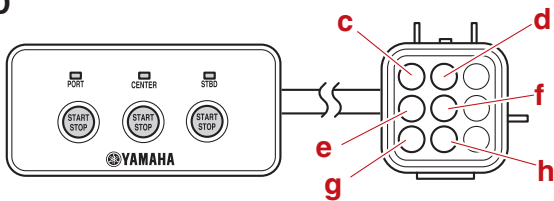
B



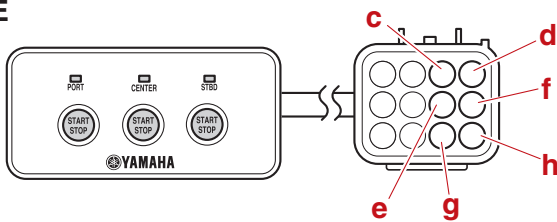
C



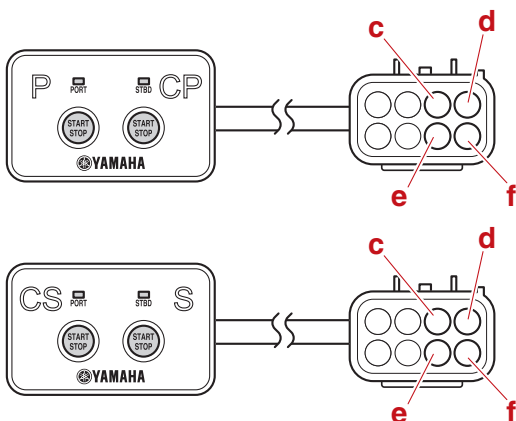
D



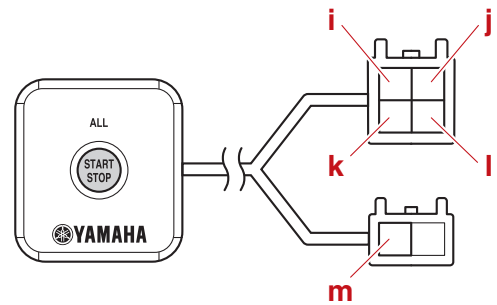
E




F



G



- A. Single type (sub station)
- B. Twin type (main station)
- C. Twin type (sub station)
- D. Triple type (main station)
- E. Triple type (sub station)
- F. Quad type (main station)
- G. All start/stop button




Engine start/stop button continuity
 Button pushed in:
 Terminal a–Terminal b
 Terminal c–Terminal d
 Terminal e–Terminal f
 Terminal g–Terminal h
 Terminal l–Terminal i
 Terminal l–Terminal j
 Terminal l–Terminal k
 Terminal l–Terminal m

c. Connect the engine start/stop button coupler.

Checking the power switch (EKS)

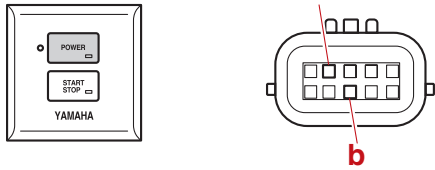
1. Check:
 - Power switch continuity
 Out of specification → Replace the power switch.



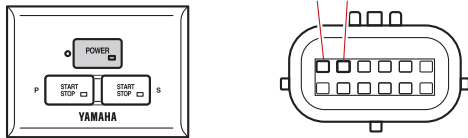
Power switch continuity
 Button pushed in:
 Terminal “a”–Terminal “b”

- a. Disconnect the power switch coupler.
- b. Check the power switch for continuity at the power switch coupler.

A



B



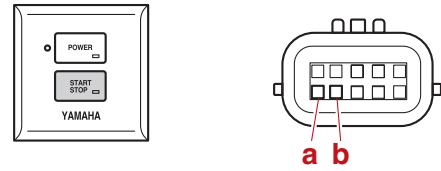
A. Single/triple/quad/quint type

B. Twin type

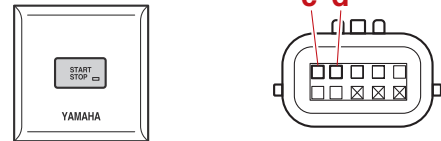
c. Connect the power switch coupler.

b. Check the engine start/stop button for continuity at the engine start/stop button coupler.

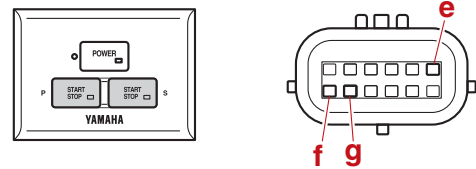
A



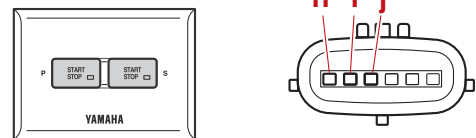
B



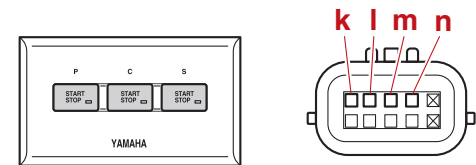
C



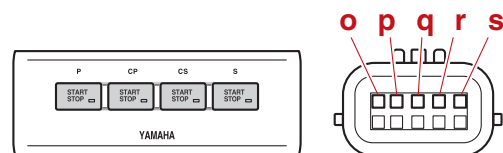
D



E



F



Checking the start/stop button (EKS)

1. Check:

- Start/stop button continuity
Out of specification → Replace the power switch, all start/stop button, or start/stop button.



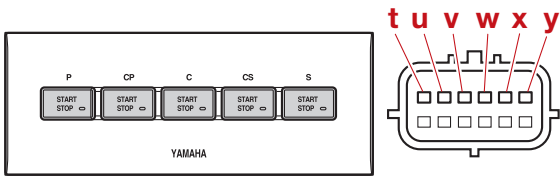
Start/stop button continuity

Button pushed in:

- Terminal "a"–Terminal "b"
- Terminal "c"–Terminal "d"
- Terminal "e"–Terminal "f"
- Terminal "e"–Terminal "g"
- Terminal "h"–Terminal "i"
- Terminal "h"–Terminal "j"
- Terminal "k"–Terminal "l"
- Terminal "k"–Terminal "m"
- Terminal "k"–Terminal "n"
- Terminal "o"–Terminal "p"
- Terminal "o"–Terminal "q"
- Terminal "o"–Terminal "r"
- Terminal "o"–Terminal "s"
- Terminal "t"–Terminal "u"
- Terminal "t"–Terminal "v"
- Terminal "t"–Terminal "w"
- Terminal "t"–Terminal "x"
- Terminal "t"–Terminal "y"

a. Disconnect the power switch, all start/stop button, or start/stop button coupler.

G



	Input voltage
	12 V
	Red (R)–Black (B)

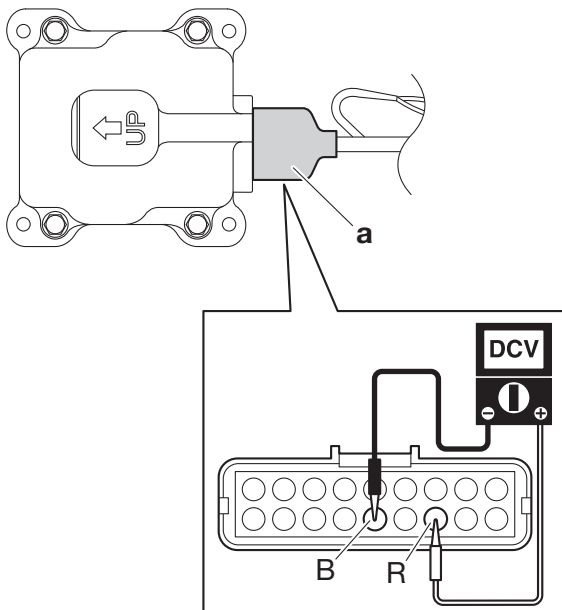
b. Connect the Y-COP coupler “a”.

- A. Power switch (single type)
- B. All start/stop button (sub station/joystick station)
- C. Power switch (twin type)
- D. Start/stop button (twin type/sub station)
- E. Start/stop button (triple type)
- F. Start/stop button (quad type)
- G. Start/stop button (quint type)

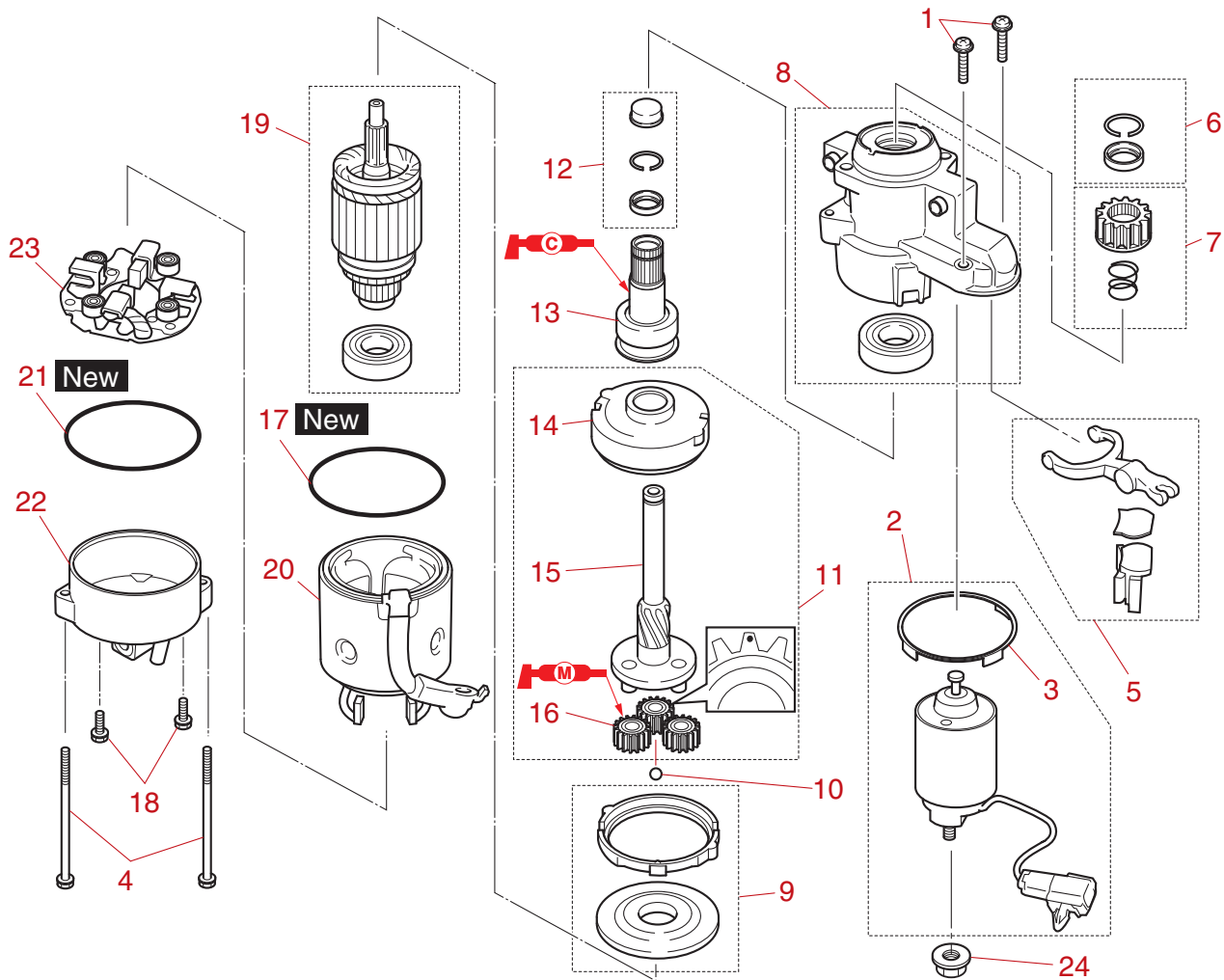
c. Connect the power switch, all start/stop button, or start/stop button coupler.

Checking Y-COP

1. Check:
 - Y-COP
 - a. Disconnect the Y-COP coupler “a”, and then measure the Y-COP input voltage.



Starter motor



↑↓	Part name	Q'ty	Remarks
1	Screw set M6 × 25 mm	2	
2	Magnet switch assembly	1	
3	Shim	1	Shim for pinion gap adjustment
4	Bolt M6 × 150 mm	2	
5	Lever assembly	1	
6	Pinion stopper set	1	
7	Pinion set	1	
8	Cover assembly	1	
9	Center bracket	1	
10	Ball 6.33 mm (0.25 in) (reference data)	1	
11	Starting motor gear assembly	1	
12	Stopper set	1	
13	Clutch assembly	1	
14	Bracket M4 × 16 mm	1	

↑↓	Part name	Q'ty	Remarks
15	Pinion shaft M5 × 127 mm	1	
16	Planetary gear	3	
17	O-ring	1	
18	Screw set M5 × 11 mm	1	
19	Armature	1	
20	Stator	1	
21	O-ring	1	
22	Bracket	1	
23	Brush holder	1	
24	Nut	1	

Removing the starter motor

NOTICE

Before removing the starter motor, make sure to disconnect the negative battery terminal.

Checking the starter motor pinion

1. Check:
 - Teeth of the pinion
Crack/wear → Replace the pinion.
 - Turn the pinion counterclockwise to check that it operates smoothly and turn it clockwise to check that it locks in place.
Not smooth → Replace the pinion.

Disassembling the starter motor

1. Remove:
 - Magnet switch assembly

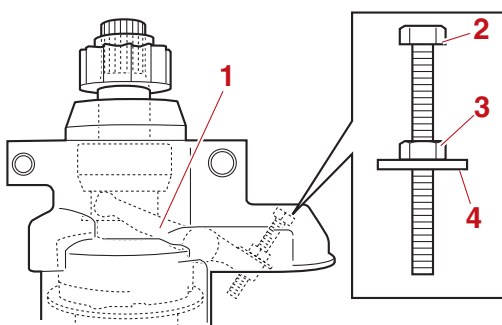
TIP:

Some starter motors do not have a shim.

2. Remove:
 - Pinion
 - Lever
 - Starting motor gear assembly
 - a. Fix the lever "1" in the pulled-out position using the bolt "2".

NOTICE

Be careful not to break the lever.



Bolt "2"

M5 × 35 mm

Nut "3"

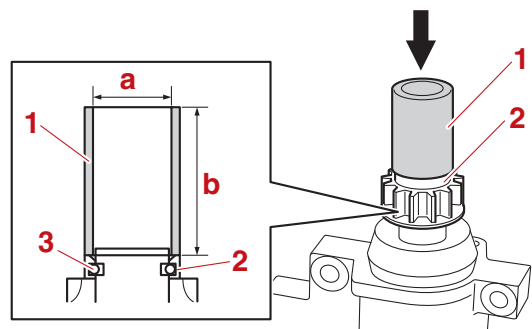
M5

Washer "4"

Inside diameter = 6.5 mm (0.24 in)

Outside diameter = 16.0 mm (0.63 in)

- b. Place a pipe "1" on the pinion stopper "2". Tap the pipe "1" using a plastic hammer to push down the pinion stopper "2", and then remove the clip "3".



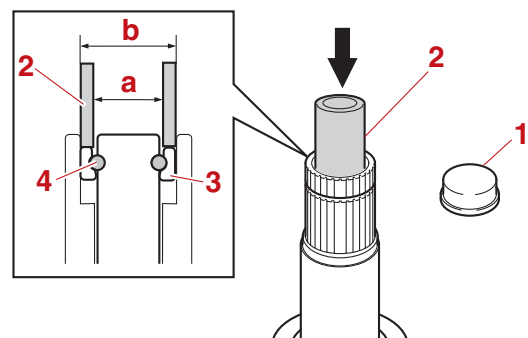
Pipe "1"

(commercially available)

"a" = 22.0 mm (0.87 in)

"b" = 50.0 mm (1.97 in)

3. Remove:
 - Clutch assembly
 - Bracket
 - a. Remove the cap "1".
 - b. Place a pipe "2" on the pinion shaft stopper "3". Tap the pipe "2" using a plastic hammer to push down the pinion shaft stopper "3", and then remove the clip "4".



Pipe "2"
 (commercially available)
 "a" = 12.0 mm (0.47 in)
 "b" = 17.0 mm (0.67 in)

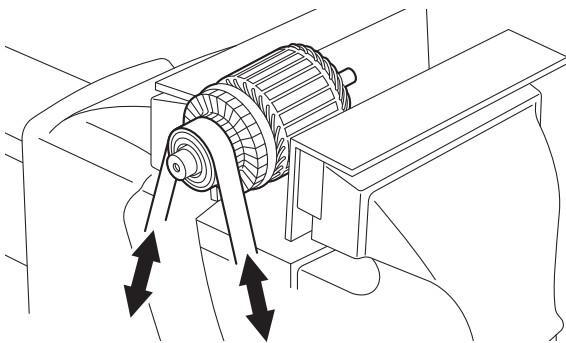
4. Remove:
- Bracket
 - Armature
 - Brush holder

NOTICE

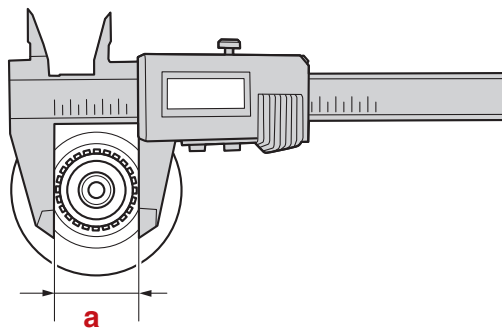
Do not scratch or damage the brushes when removing the armature.



Checking the armature (starter motor)

1. Check the commutator for dirt. Clean with 600-grit sandpaper and compressed air if necessary.

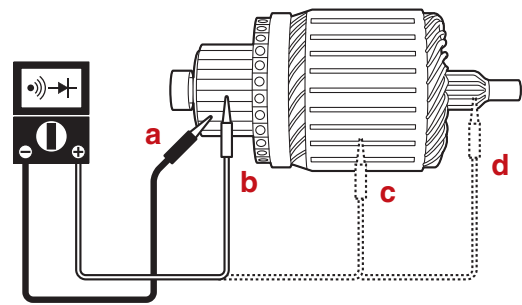


2. Check:
- Armature
 Out of specification → Replace.
- a. Measure the commutator diameter "a".



	Standard commutator diameter
	32.0 mm (1.26 in)
	Wear limit
	31.4 mm (1.24 in)

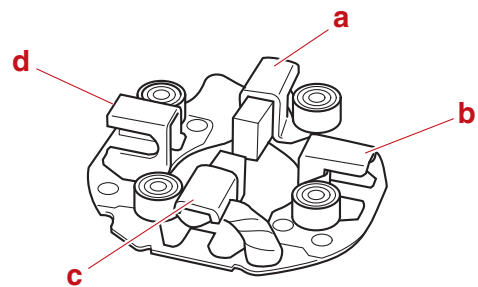
- b. Check the armature for continuity.



Armature for continuity			
"a"	"b"	"c"	"d"
○ — ○			

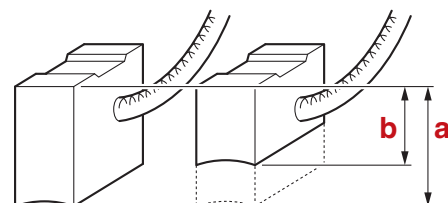
Checking the brush holder

1. Check:
- Brush holder continuity
 Out of specification → Replace.



Armature for continuity			
"a"	"b"	"c"	"d"
○ — ○			

2. Measure:
- Brush length "a"
 Out of specification → Replace.



- a. Standard brush length
 b. Wear limit



Standard brush length
18.0 mm (0.71 in)
Wear limit
11.0 mm (0.43 in)

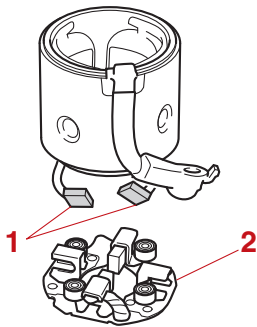
Assembling the starter motor

1. Install:
 - Brushes
 - Brushes holder
 - Armature
 - Stator
 - Bracket
 - O-ring **New**

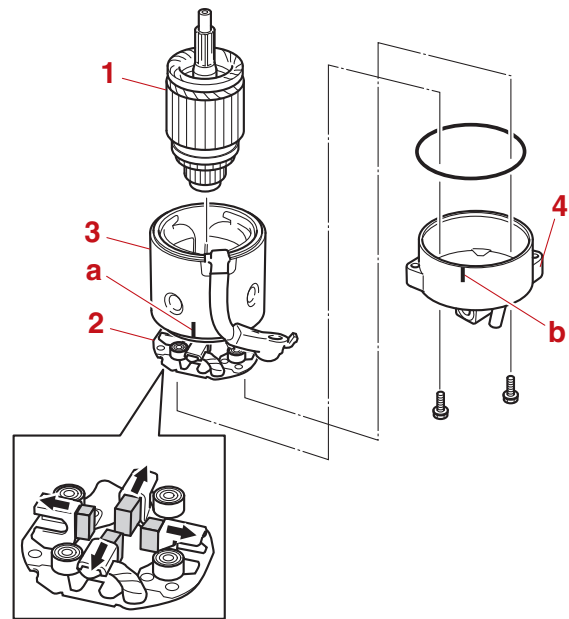
NOTICE

Do not apply grease or oil to the commutator of the armature.

- a. Install the brushes "1" of the stator to the brush holder "2".



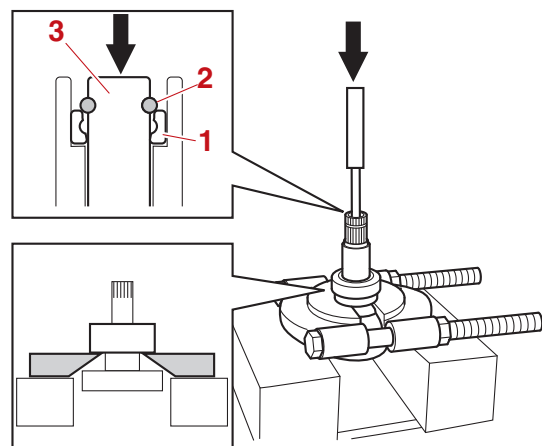
- b. Push the brushes into the holders, and then install the armature "1" to the brush holder "2".
- c. Align the protrusion "a" on the stator "3" with the protrusion "b" in the bracket "4", and then install the bracket "4".



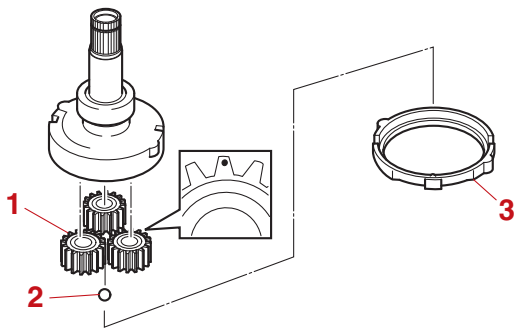
2. Assemble:

- Bracket
- Clutch assembly
- Pinion shaft
- Stopper
- Clip
- Planetary gear
- Ball
- Center bracket

- a. Install the stopper "1" and clip "2" to the pinion shaft "3".
- b. Set the bearing separator on the bottom face of the clutch, and then insert the clip "2" into the groove in the stopper "1" by tapping the pinion shaft "3".



- c. Install the planetary gear "1", ball "2", and center bracket "3".

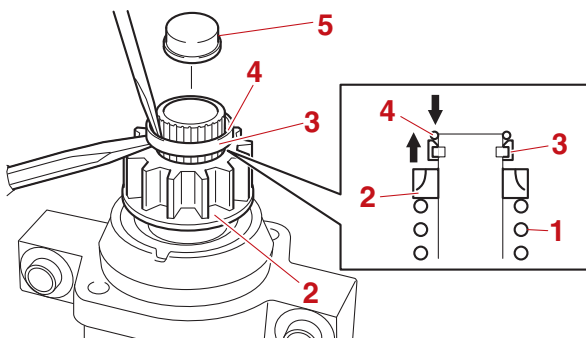


2. Install:
 - Intake manifolds
 - See “Intake manifold” (6-24).

3. Assemble:
 - Starting motor gear assembly
 - Lever assembly
 - Cover
 - Starting motor body

• O-ring **New**

4. Install:
 - Spring
 - Pinion
 - Pinion stopper
 - Clip
 - Cap
 - a. Install the spring “1”, pinion “2”, pinion stopper “3”, and clip “4”.
 - b. Insert a flat-head screwdriver between the pinion “2” and the pinion stopper “3” to raise the pinion stopper “3” and push in the clip “4”.
 - c. Install the cap “5”.



5. Install:
 - Magnet switch assembly

TIP: _____

Some starter motors do not have a shim.

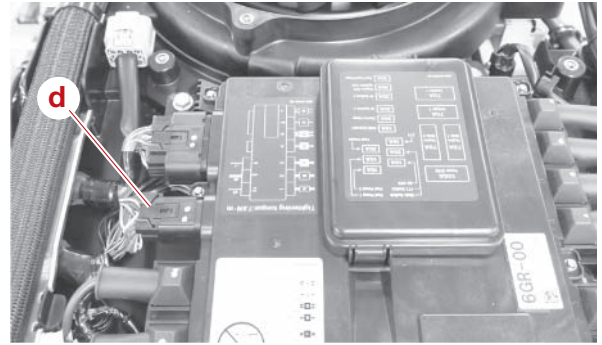
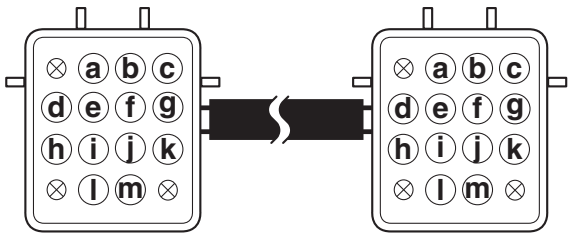
Installing the starter motor

1. Install:
 - Starter motor
 - See “Installing the starter motor” (7-29).

Outboard motor and Digital Electronic Control connection

Checking the extension wire harness

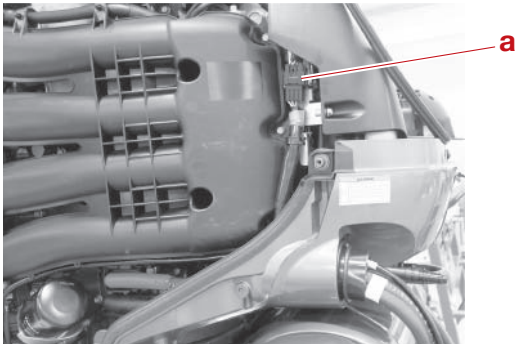
1. Check:
 - Extension wire harness
 - a. Check the extension wire harness for continuity. Check the wire terminal numbers from “a” to “m”.



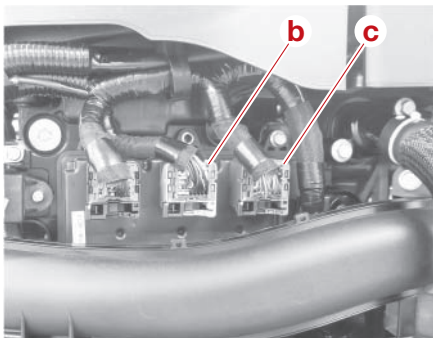
d. Check the wire harness for continuity.

Checking the main harness

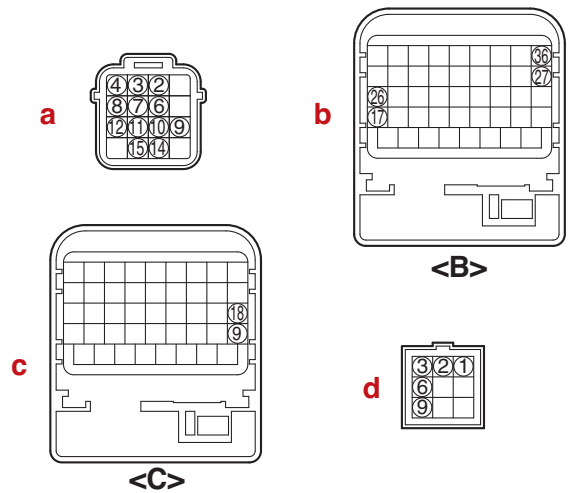
1. Check:
 - Main harness
 - a. Disconnect the main wire harness coupler “a”.



b. Disconnect the engine ECM couplers “b” and “c”.



c. Disconnect the electrical management box coupler “d”.



Continuity between the main wire harness coupler “a” and the engine ECM coupler “b”:

Terminal of coupler “a”		Terminal of coupler “b”
4	–	27
8	–	36
14	–	17
15	–	26

Continuity between the main wire harness coupler “a” and the engine ECM coupler “c”:

Terminal of coupler “a”		Terminal of coupler “c”
2	–	18
3	–	9

Continuity between the main wire harness coupler “a” and the electrical management box coupler “d”:

Outboard motor and Digital Electronic Control connection

Terminal of coupler "a"		Terminal of coupler "d"
2	-	2
3	-	1
7	-	3
10	-	6
12	-	9

Continuity between the main wire harness coupler "a" and the ground:

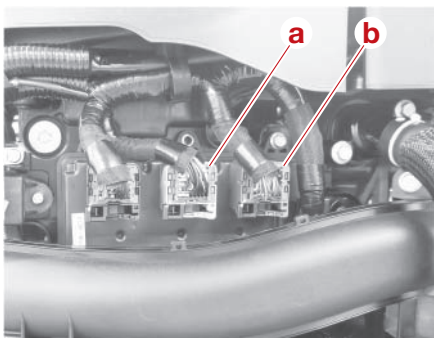
Terminal of coupler "a"		
6	-	Ground
9	-	Ground
11	-	Ground

- e. Connect the electrical management box coupler, the engine ECM couplers, and main wire harness coupler.

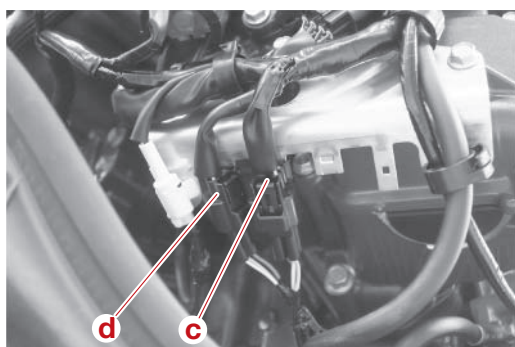
Steering unit

Checking the steering actuator

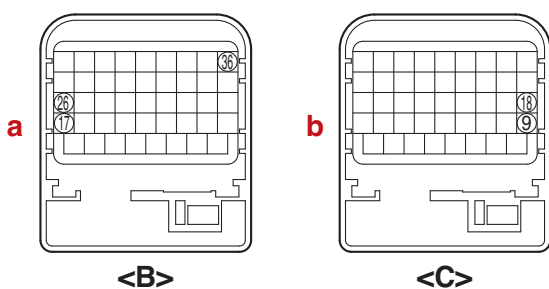
1. Check:
 - Steering actuator
 - a. Disconnect the engine ECM couplers "a" and "b".



- b. Disconnect the SCU signal couplers "c" and "d".



- c. Check the wire harness for continuity.



Continuity between the engine ECM coupler "a" and the SCU signal coupler "c":

Terminal of coupler "a"		Terminal of coupler "c"
17	–	4
26	–	3
36	–	1

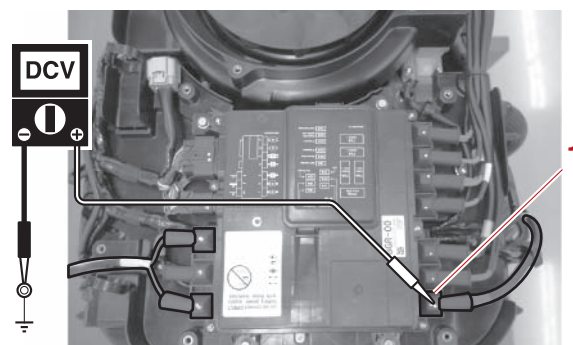
Continuity between the engine ECM coupler "a" and the SCU signal coupler "d":

Terminal of coupler "a"		Terminal of coupler "d"
36	–	3

Continuity between the engine ECM coupler "b" and the SCU signal coupler "d":

Terminal of coupler "b"		Terminal of coupler "d"
9	–	2
18	–	1

- d. Turn the main switch or power switch to ON, and then measure the input voltage between the electrical management box terminal "1" and ground.



	Input voltage
	12 V
	Terminal 1–Ground

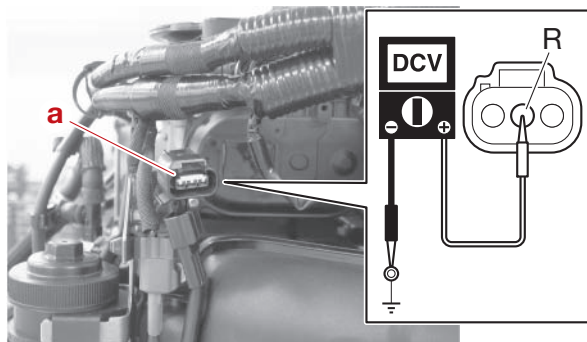
- e. Turn the main switch or power switch to OFF.
 - f. Connect the engine ECM couplers and SCU signal couplers.


PTT system

Checking the PTT switch (on bottom cowling)

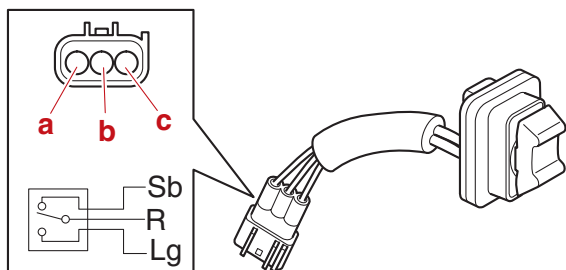
1. Check:

- PTT switch
 - a. Disconnect the PTT switch coupler “a”.
 - b. Measure the input voltage between the PTT switch coupler terminal and ground.



	PTT switch input voltage 12.0 V Red (R)–Ground
------------------------------------------------------------------------------------	------------------------------------------------------

- c. Check the PTT switch for continuity. Replace if out of specification.



Switch position	Terminal		
	“a”	“b”	“c”
UP		○ — ○	
Free			
DN	○ — ○		

Checking the PTT sensor

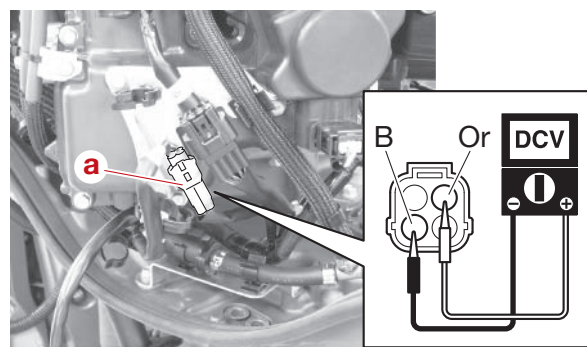
1. Check:


- PTT sensor
 - a. Connect the YDIS to display “PTT sensor”.

- b. Tilt the outboard motor up and down, and measure the PTT sensor output voltage at the specified positions.

Output voltage	
Position	Voltage
Tilt support lever upper position	4.07
Tilt support lever lower position	3.57
Fully tilted-down position	0.93

- c. Disconnect the PTT sensor (sub lead) coupler “a”.
- d. Turn the main switch or power switch to ON, and then measure the input voltage at the PTT sensor coupler.



	PTT sensor input voltage 5 V Orange (Or)–Black (B)
-------------------------------------------------------------------------------------	----------------------------------------------------------

- e. Turn the main switch or power switch to OFF, and then connect the PTT sensor (sub lead) coupler.

Checking the PTT buzzer

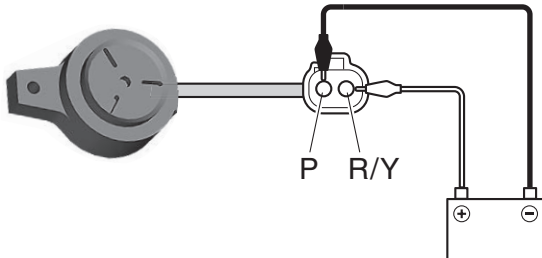
1. Remove:

- Intake manifold (PORT)
See “Intake manifold” (6-24).

2. Check:

- PTT buzzer continuity
Out of specification → Replace the PTT buzzer.
 - a. Remove the PTT buzzer.

- b. Connect the battery leads to the PTT buzzer coupler, and check that the PTT buzzer comes on. Replace the PTT buzzer if it does not come on.



- c. Install the PTT buzzer.

Fuel system

Fuel system basic procedure	6-1
Starting the engine after running out of fuel.....	6-1
Reducing the fuel pressure	6-1
Disconnecting the quick connector	6-1
Measuring the fuel pressure.....	6-2
Fuel filter assembly	6-3
Checking the fuel filter assembly	6-4
Checking the fuel filter element.....	6-4
Checking the fuel cup assembly	6-4
Checking the primer pump	6-4
Assembling the fuel filter	6-5
Installing the fuel filter	6-5
Low-pressure fuel pump	6-6
Checking the low-pressure fuel pump	6-7
Checking the feed valve (low-pressure fuel pump).....	6-7
Checking the relief valve (low-pressure fuel pump)	6-7
Installing the low-pressure fuel pump	6-8
Vapor separator and high-pressure fuel pump	6-9
Draining the fuel	6-10
Removing the vapor separator.....	6-10
Checking the high-pressure fuel pump.....	6-10
Assembling the vapor separator	6-10
Installing the vapor separator.....	6-11
Fuel hose assembly	6-12
Fuel hose, feed valve, relief valve, and fuel strainer	6-13
Disassembling the fuel hose assembly	6-14
Checking the fuel strainer	6-14
Checking the relief valve (high-pressure fuel pump).....	6-14
Checking the feed valve (high-pressure fuel pump).....	6-15
Checking the fuel pressure sensor (high-pressure fuel pump)	6-16
Assembling the fuel hose assembly.....	6-16
Installing the fuel hose assembly	6-17

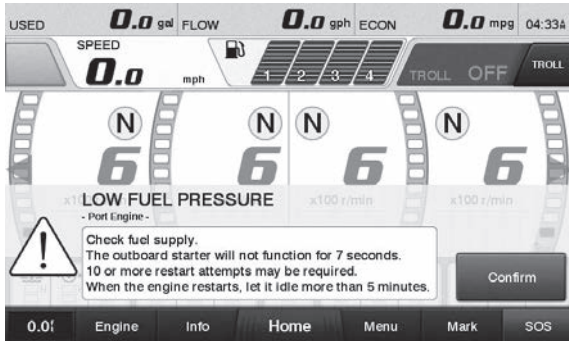
Fuel system

Direct injection pump and fuel injector.....	6-18
Removing the fuel rail.....	6-19
Removing the fuel injector.....	6-19
Checking the fuel pressure sensor (direct injection pump).....	6-19
Checking the direct injection pump	6-19
Checking the fuel rail and fuel injector	6-19
Installing the fuel injector and fuel rail.....	6-20
Intake manifold.....	6-24
Checking the intake manifold.....	6-26
Installing the intake manifold.....	6-26
ETV	6-28
Checking the ETV.....	6-29
Checking the intake air pressure/temperature sensor	6-29
Installing the ETV and surge tank.....	6-29

Fuel system basic procedure

Starting the engine after running out of fuel

Use the following procedure to start the engine after running out of fuel.



1. Check:
 - Fuel supply
Fuel is not supplied → Check and repair the fuel system.
2. Start the engine and let it idle for 5 minutes.

TIP: _____

- After the engine stops due to a lack of fuel, it cannot be cranked for 7 seconds.
- To start the engine, it may be necessary to crank the engine 10 or more times.
- The engine idle speed may be unstable after the engine is started until the air is bled from the high-pressure line, but this is not a malfunction.

Reducing the fuel pressure

⚠ WARNING _____

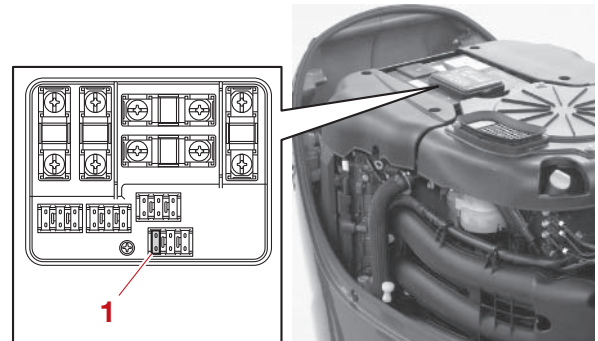
Before servicing the high-pressure fuel line or vapor separator, make sure to reduce the fuel pressure in the fuel line. Otherwise, pressurized fuel could spray out.

1. Connect the YDIS to display “DI fuel pressure P”, “DI fuel pressure S”, and “VST fuel pressure”.
2. Remove:
 - Fuse cover
 - Fuse (30 A) (high-pressure fuel pump system) “1”

3. Start the engine.

TIP: _____

Wait until the engine stalls.



4. After the engine stalls, crank the engine 2 or 3 times.
5. Reduce the fuel rail fuel pressure using the YDIS “Stationary test” or “Reduce DI fuel pressure”. See the YDIS (Ver. 2.49 or later) instruction manual.

TIP: _____

When using “Stationary test”, activate the injector for 1 cylinder on each side of the engine.

6. Check:
 - Fuel pressure
Does not decrease → Repeat steps 4 and 5.
7. Install:
 - Fuse (30 A) (high-pressure fuel pump system)
 - Fuse cover

Disconnecting the quick connector

⚠ WARNING _____

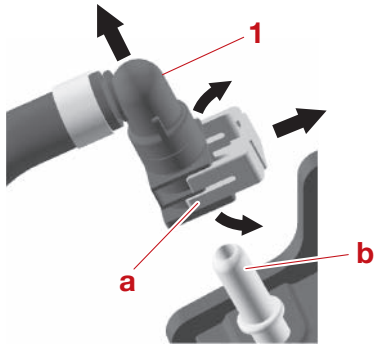
Before disconnecting the quick connector, reduce the fuel pressure. Otherwise, pressurized fuel could spray out.

1. Reduce the fuel pressure. See “Reducing the fuel pressure” (6-1).
2. Disconnect:
 - Quick connector
 - a. Wrap a rag around the quick connector “1”.
 - b. Spread apart the ends of the retainer “a”, and then pull the retainer.

- c. Disconnect the quick connector “1” from the fuel pipe “b” directly.

TIP:

Cover the quick connector and fuel pipe with a plastic bag to prevent damage and to prevent dirt from entering them.



Measuring the fuel pressure

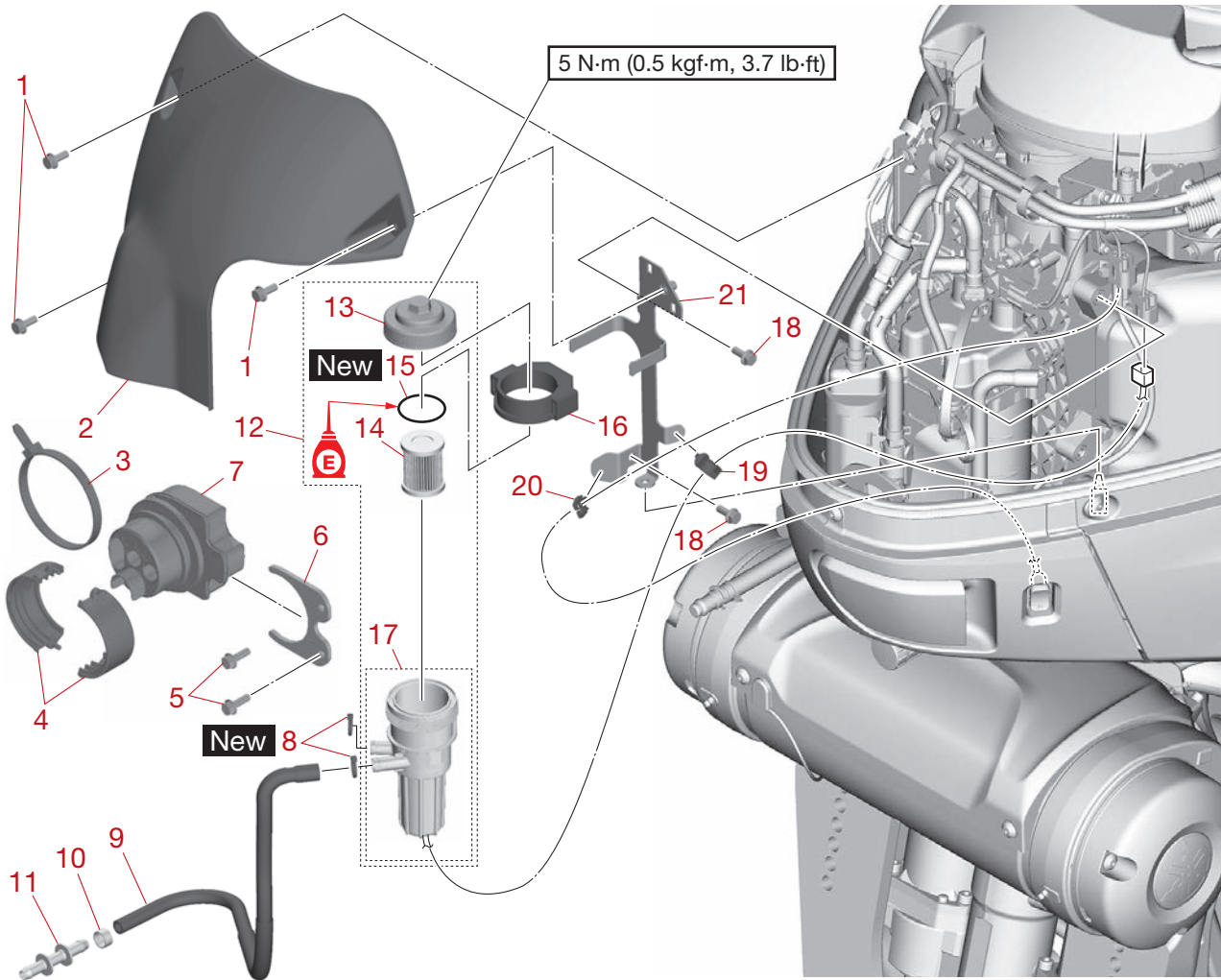
1. Connect the YDIS to display “DI fuel pressure P”, “DI fuel pressure S” and “VST fuel pressure”.
2. Measure:
 - Fuel pressure
 - a. Start the engine and warm it up until the engine idle speed stabilizes at the specified engine idle speed range.

	Idle speed (in neutral) 650–750 r/min
--	------------------------------------------

- b. Measure the fuel pressure.

	Fuel pressure at idle speed (high-pressure fuel pump) 330-400 kPa (3.3-4.0 kgf/cm ² , 47.9-58.0 psi) Fuel pressure at idle speed (DI pump) 8.00 Mpa (80.0 kgf/cm ² , 1160.0 psi)
--	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Fuel filter assembly




↑↓	Part name	Q'ty	Remarks
1	Bolt M6 × 16 mm	3	
2	Cover	1	
3	Plastic tie	1	
4	Retainer	1	
5	Bolt M6 × 20 mm	2	
6	Grommet holder	1	
7	Rigging grommet	1	
8	Plastic tie	2	
9	Hose	1	
10	Clamp	1	
11	Joint	1	
12	Fuel filter assembly	1	
13	Cap	1	
14	Fuel filter element	1	
15	O-ring	1	
16	Holder	1	
17	Fuel cup assembly	1	
18	Bolt M6 × 16 mm	2	
19	Holder	1	

↑↓	Part name	Q'ty	Remarks
20	Clamp	1	
21	Bracket	1	

Checking the fuel filter assembly

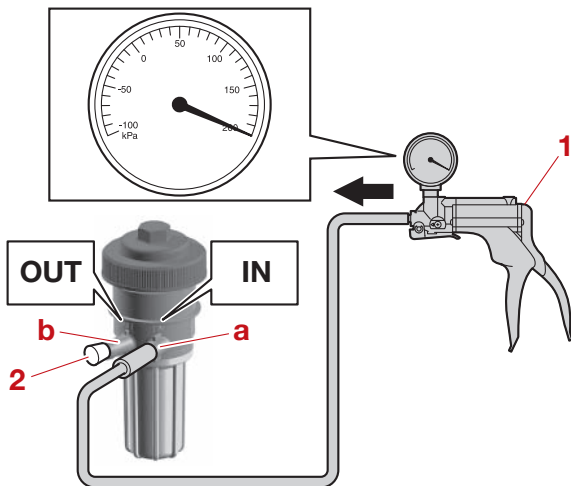
1. Check:


- Fuel inlet holding pressure
Out of specification → Replace the O-ring, cup assembly, or fuel filter assembly.



Fuel inlet holding pressure (positive pressure)
200.0 kPa (2.00 kgf/cm², 29.0 psi)

- Connect the special service tool “1” to the fuel inlet “a”.
- Block the fuel outlet “b” using a rubber plug “2”, and then apply the specified positive pressure for 15 seconds or more.






Vacuum/pressure pump gauge set “1”
90890-06945
Pressure/vacuum tester “1”
YB-35956-B

2. Check:

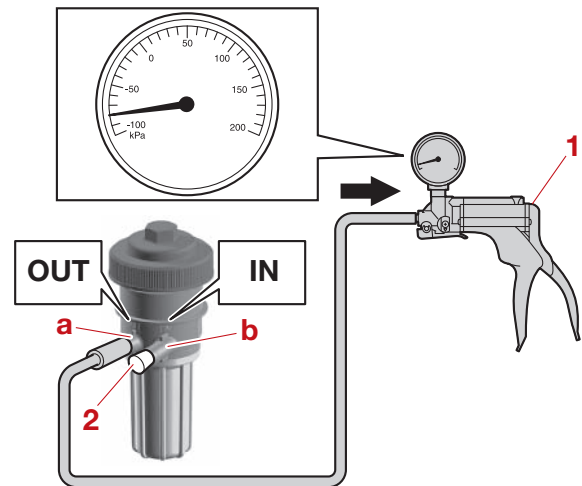
- Fuel outlet holding pressure (negative pressure)
Out of specification → Replace the O-ring, cup assembly, or fuel filter assembly.




Fuel outlet holding pressure (negative pressure)
-80.0 kPa (-0.80 kgf/cm², -11.6 psi)

- Connect the special service tool “1” to the fuel outlet “a”.

- Block the fuel inlet “b” using a rubber plug “2”, and then apply the specified negative pressure for 15 seconds or more.





Vacuum/pressure pump gauge set “1”
90890-06945
Pressure/vacuum tester “1”
YB-35956-B

Checking the fuel filter element

1. Check:

- Fuel filter element
Dirt/residue → Replace.

Checking the fuel cup assembly

1. Check:

- Fuel filter cup assembly
Foreign material → Clean.
Cracked → Replace.


2. Check:

- Electrical performance of the water detection switch.
See “Checking the water detection switch” (5-28).

Checking the primer pump

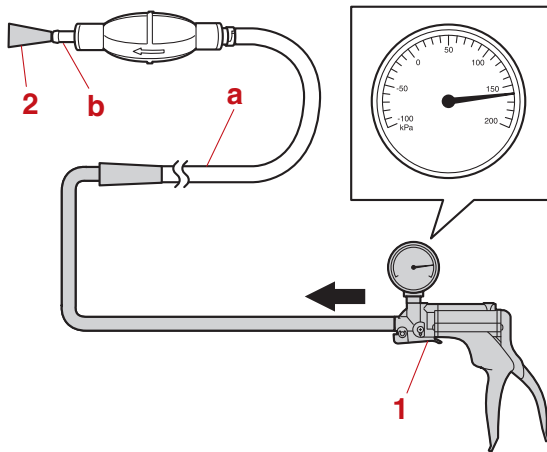
1. Check:


- Primer pump holding pressure
Out of specification → Replace the primer pump.



Positive pressure
166.7 kPa (1.67 kgf/cm², 24.2 psi)

- a. Connect the special service tool "1" to the fuel inlet "a".
- b. Block the fuel outlet "b" using a rubber plug "2", and then apply the specified positive pressure for at least 30 seconds.




	Vacuum/pressure pump gauge set "1" 90890-06945 Pressure/vacuum tester "1" YB-35956-B
------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------

2. Check:
 - Pump operation
Fuel is not sent to the outboard motor even after priming the pump → Replace the primer pump.

Assembling the fuel filter

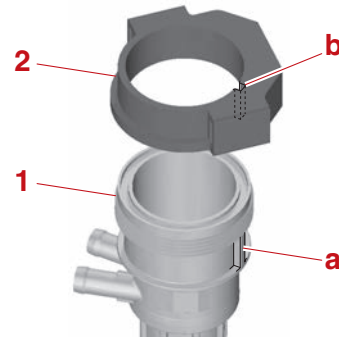
1. Install:
 - Fuel cup assembly
 - Fuel filter element
 - O-ring **New**
 - Fuel filter cap

	Fuel filter cap 5 N·m (0.5 kgf·m, 3.7 lb·ft)
-------------------------------------------------------------------------------------	-------------------------------------------------

Installing the fuel filter

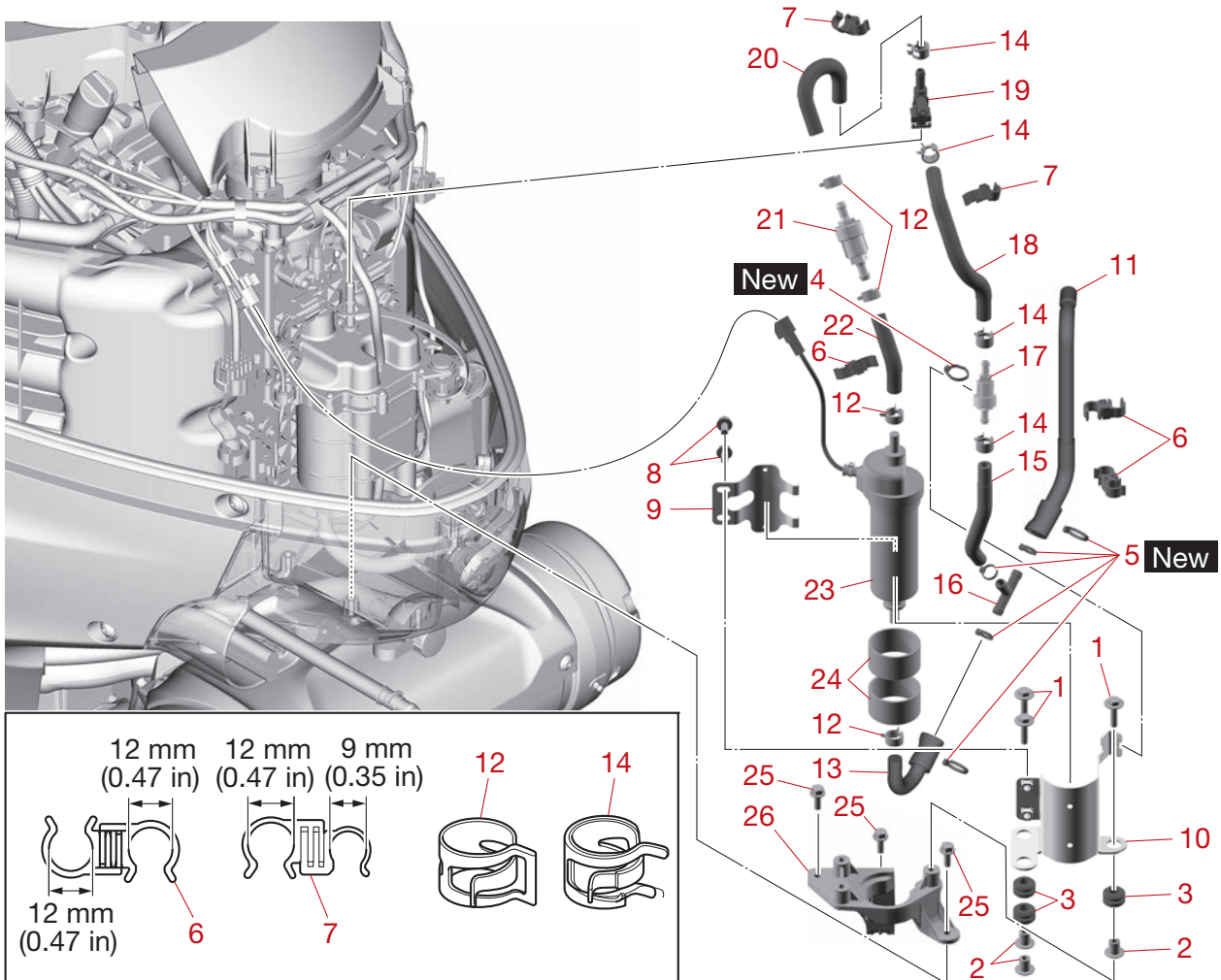
1. Install:
 - Fuel filter bracket
 - Clamp
 - Holder
 - Fuel filter assembly
 - Fuel hose
See "Hose routing" (2-60).

TIP: Fit the rib "a" on the fuel cup "1" into the slit "b" in the holder "2".



2. Check:
 - Fuel flow
Leak/clog → Replace the fuel filter assembly.

Low-pressure fuel pump



↑↓	Part name	Q'ty	Remarks
1	Bolt M6 × 25 mm	3	
2	Collar	3	
3	Grommet	3	
4	Plastic tie	1	
5	Plastic tie	5	
6	Holder	3	
7	Holder	2	
8	Bolt M6 × 12 mm	2	
9	Holder	1	
10	Holder	1	
11	Hose	1	
12	Clamp	4	
13	Hose	1	
14	Clamp	4	
15	Hose	1	
16	Joint	1	
17	Relief valve	1	
18	Hose	1	
19	Quick connector	1	

↑↓	Part name	Q'ty	Remarks
20	Hose	1	
21	Feed valve	1	
22	Hose	1	
23	Low-pressure fuel pump	1	
24	Bushing	2	
25	Bolt M6 × 16 mm	3	
26	Bracket	1	

Checking the low-pressure fuel pump

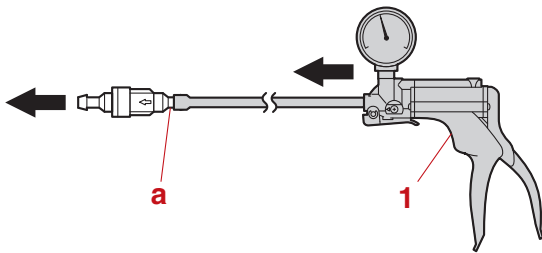
1. Check:
 - Electrical performance of the low-pressure-fuel pump

See “Checking the low-pressure fuel pump and high-pressure fuel pump” (5-29).

Checking the feed valve (low-pressure fuel pump)

1. Check:
 - Feed valve air flow
 - a. Connect the special service tool “1” to the fuel inlet “a”.
 - b. Apply positive pressure and check that air comes out of the opposite end of the feed valve.

No air comes out → Replace.

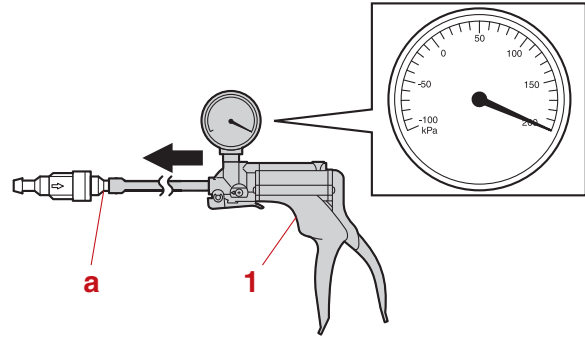


	Vacuum/pressure pump gauge set “1” 90890-06945 Pressure/vacuum tester “1” YB-35956-B
--	-----------------------------------------------------------------------------------------------

2. Check:
 - Feed valve holding pressure

	Holding pressure (positive pressure) 200.0 kPa (2.00 kgf/cm ² , 29.0 psi)
--	-----------------------------------------------------------------------------------------

- a. Connect the special service tool “1” to the fuel outlet “a”.
- b. Apply the specified positive pressure. Cannot be maintained for 15 seconds or more → Replace.



	Vacuum/pressure pump gauge set “1” 90890-06945 Pressure/vacuum tester “1” YB-35956-B
--	-----------------------------------------------------------------------------------------------

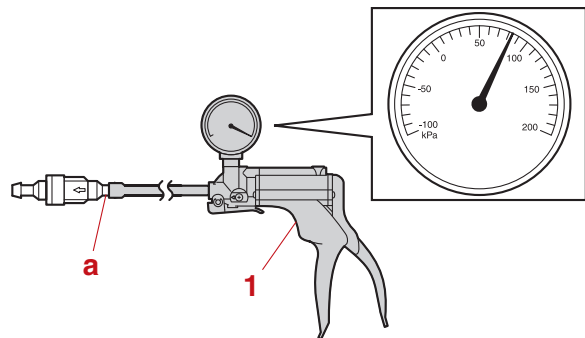
Checking the relief valve (low-pressure fuel pump)

1. Check:
 - Relief valve opening pressure

Out of specification → Replace.

	Opening pressure (positive pressure) 72.5-93.5 kPa (0.73-0.94 kgf/cm ² , 10.5-13.6 psi)
--	-------------------------------------------------------------------------------------------------------

- a. Connect the special service tool “1” to the relief valve inlet “a”.
- b. Apply the positive pressure, and check that the relief valve opens at the specified pressure.




	Vacuum/pressure pump gauge set “1” 90890-06945 Pressure/vacuum tester “1” YB-35956-B
--	-----------------------------------------------------------------------------------------------

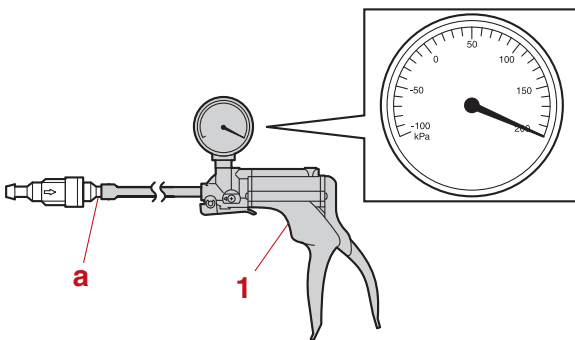
Low-pressure fuel pump


2. Check:

- Relief valve holding pressure
Out of specification → Replace.

	Holding pressure (positive pressure) 200.0 kPa (2.00 kgf/cm ² , 29.0 psi)
-----------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------

- a. Connect the special service tool "1" to the relief valve outlet "a".
- b. Apply the specified positive pressure, and check that the specified pressure is maintained.

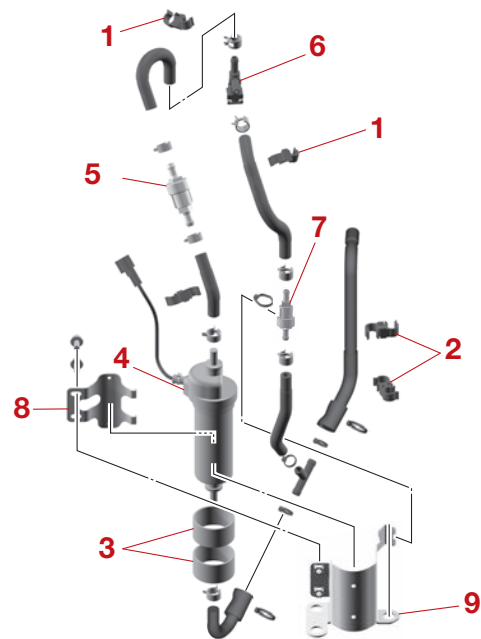


	Vacuum/pressure pump gauge set "1" 90890-06945 Pressure/vacuum tester "1" YB-35956-B
-------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------

Installing the low-pressure fuel pump

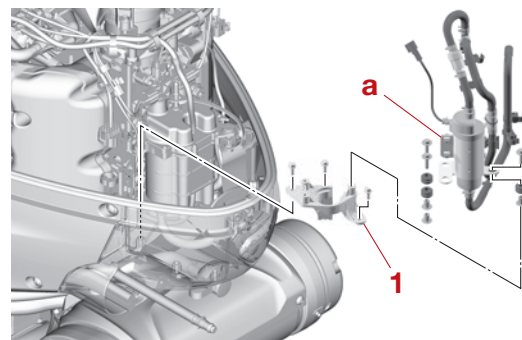
1. Assemble:

- Holder "1", "2"
- Bushing "3"
- Low-pressure fuel pump "4"
- Feed valve "5"
- Fuel hose
- Quick connector "6"
- Relief valve "7"
- Low-pressure fuel pump holder "8", "9"
- Clamp
- Plastic tie **New**

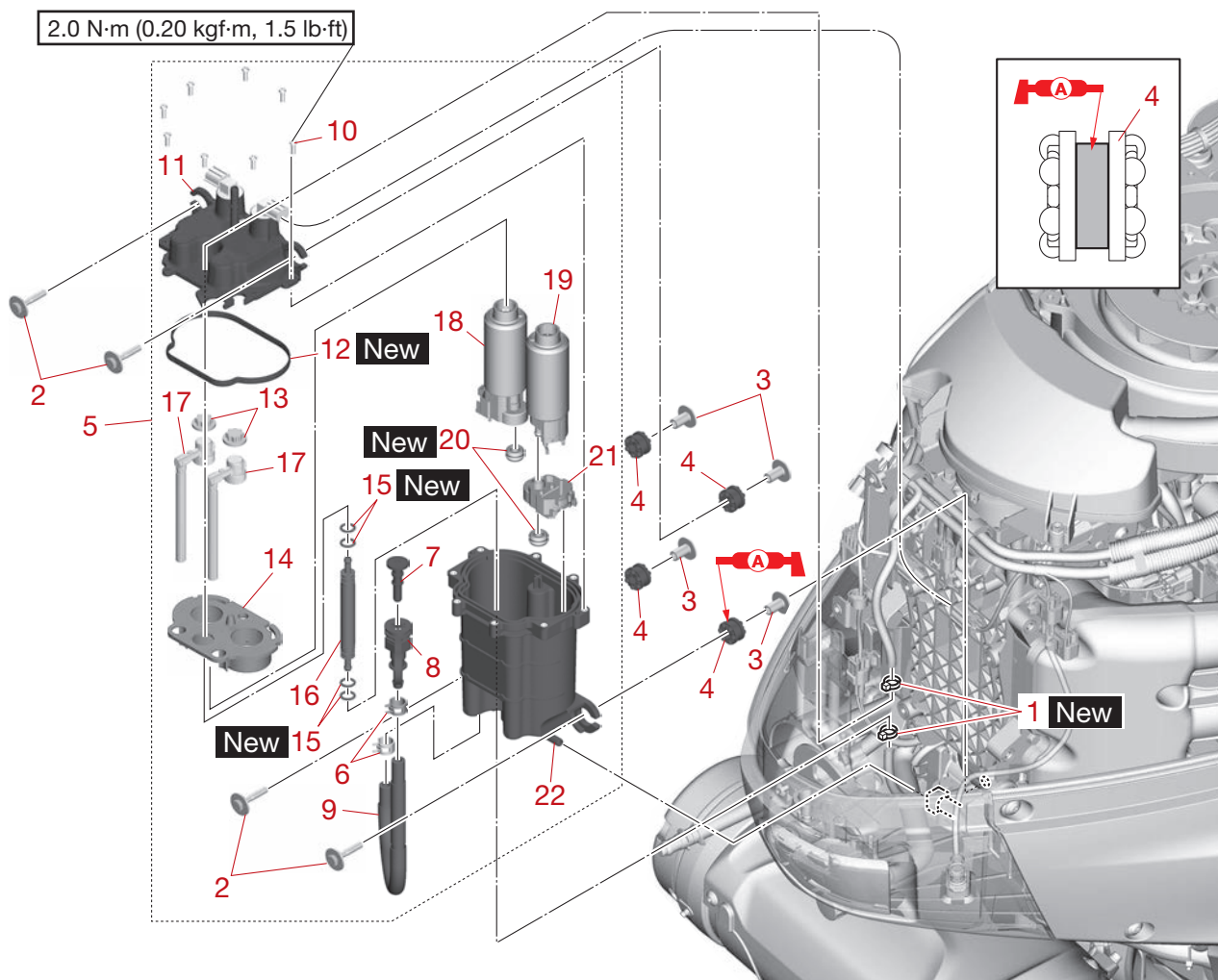


2. Install:

- Low-pressure fuel pump bracket "1"
- Low-pressure fuel pump assembly "a"
(along with feed valve, relief valve, and fuel hoses)



Vapor separator and high-pressure fuel pump



↑↓	Part name	Q'ty	Remarks
1	Plastic tie	2	
2	Bolt M6 × 35 mm	4	
3	Collar	4	
4	Grommet	4	
5	Vapor separator	1	
6	Clamp	2	
7	Plug	1	
8	Quick connector	1	
9	Hose	1	
10	Screw M4 × 12 mm	8	
11	Cover	1	
12	Gasket	1	
13	Rubber damper	2	
14	Bracket	1	
15	O-ring	4	
16	Pipe	1	
17	Pipe	2	
18	High-pressure fuel pump	1	Sub, white inlet

↑↓	Part name	Q'ty	Remarks
19	High-pressure fuel pump	1	Main, gray inlet
20	Damper	2	
21	Bracket	1	
22	Case	1	

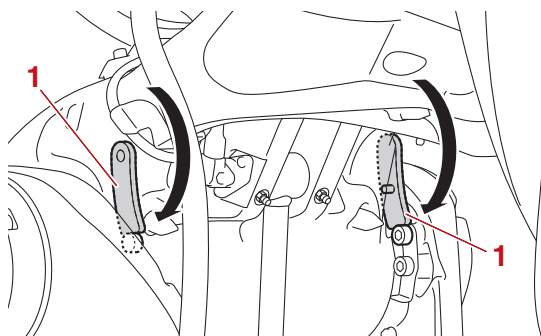
Draining the fuel

Cover the fuel components using a rag to prevent fuel from spilling out.

⚠ WARNING

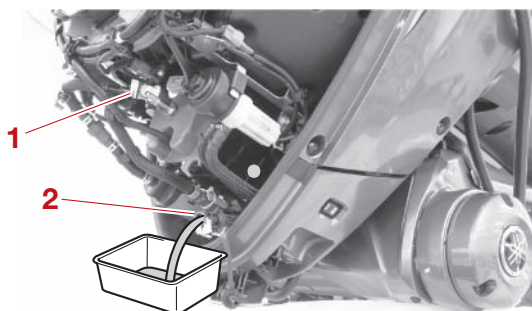
Never get under the outboard motor while it is tilted.

1. Fully tilt the outboard motor up, and then support it using the tilt support lever "1".



2. Disconnect:
 - Quick connector "1"

See "Disconnecting the quick connector" (6-1).
3. Remove:
 - Band
 - Drain hose (from the holder on the vapor separator cover)
4. Set the drain hose "2" into a drain pan.
5. Remove the plug in the drain hose, and then drain the fuel into the drain pan.



6. Install:
 - Plug
 - Drain hose (onto the holder on the vapor separator cover)
 - Band
7. Connect:
 - Quick connector

Removing the vapor separator

Cover the fuel components using a rag to prevent fuel from spilling out.

1. Reduce:
 - Fuel pressure

See "Reducing the fuel pressure" (6-1).

Checking the high-pressure fuel pump


1. Check:
 - Electrical performance of the high-pressure fuel pump

See "Checking the low-pressure fuel pump and high-pressure fuel pump" (5-29).

Assembling the vapor separator

1. Install:
 - Pump bracket
 - Damper
 - High-pressure fuel pump cover (to the sub pump)
 - High-pressure fuel pump (main) "1" (gray inlet)
 - High-pressure fuel pump (sub) "2" (white inlet)
 - Pipe
 - O-ring **New**
 - Fuel cooler pipe
 - High-pressure fuel pump bracket
 - Rubber damper
 - Vapor separator cover gasket **New**
 - Vapor separator cover
 - Vapor separator drain hose
 - Quick connector
 - Plug

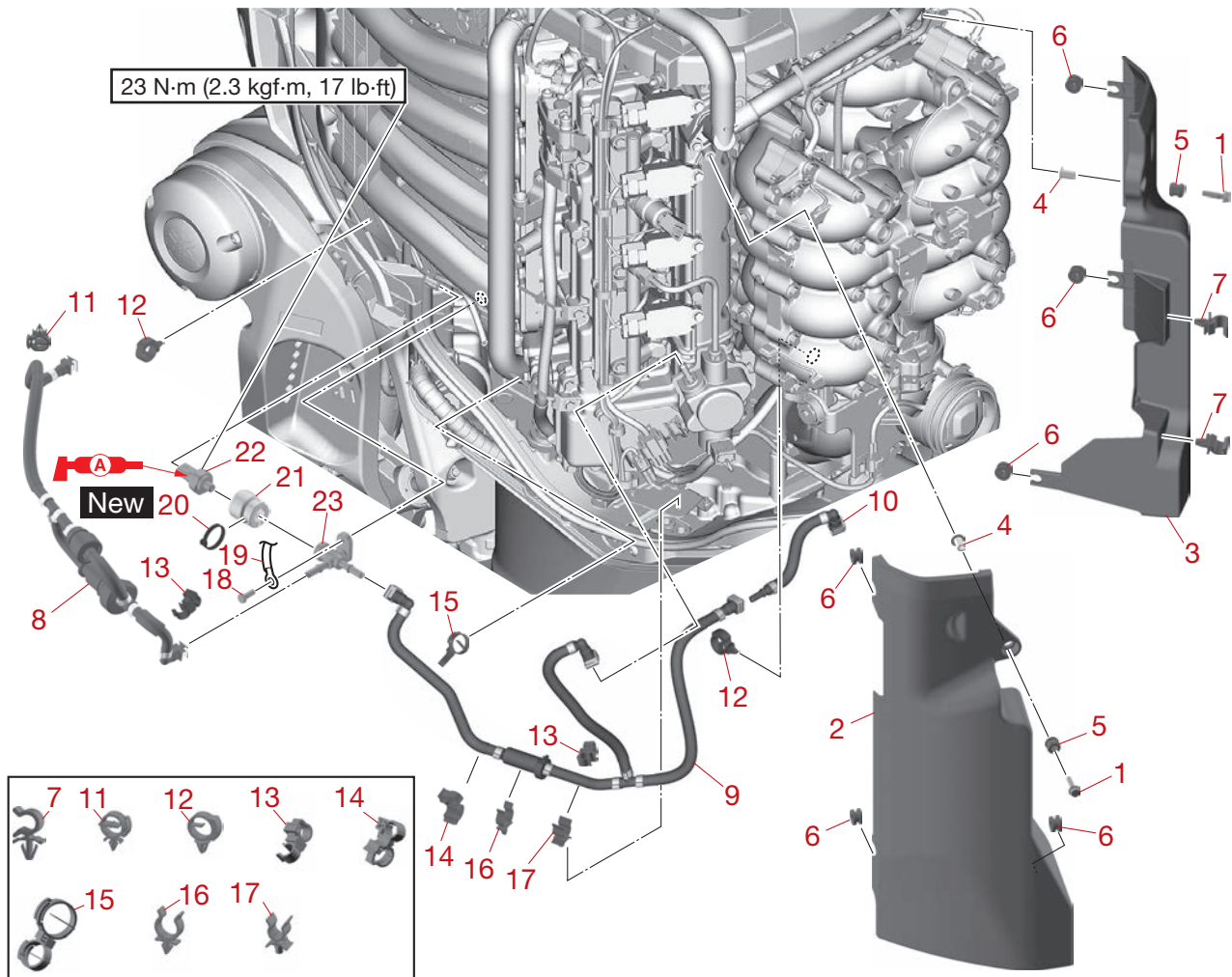


	Vapor separator cover screw 2.0 N·m (0.20 kgf·m, 1.5 lb·ft)
-------------------------------------------------------------------------------------	----------------------------------------------------------------

Installing the vapor separator

1. Install:
 - Vapor separator
2. Connect:
 - Quick connector
 - Cooling water hose
 - High-pressure fuel pump coupler

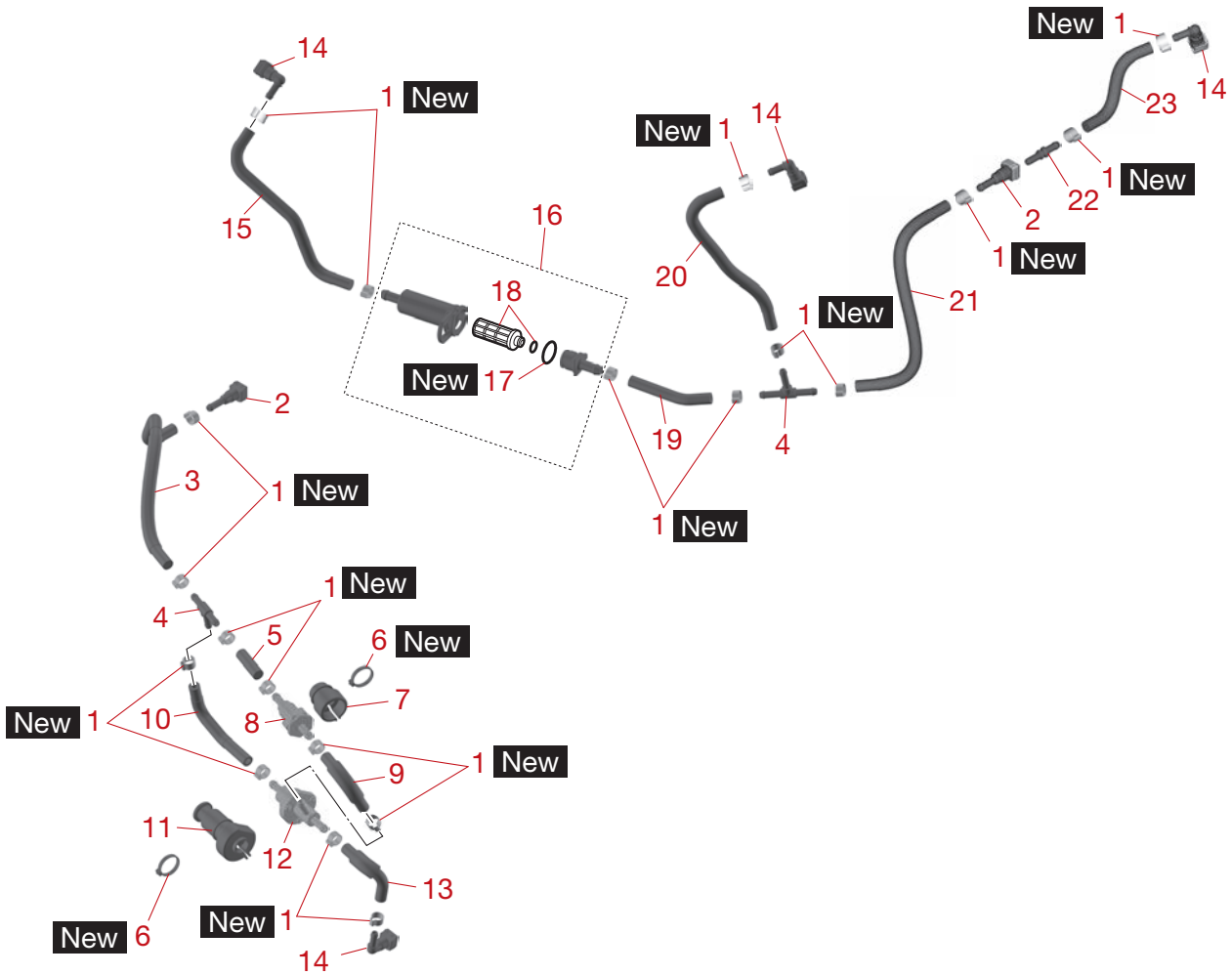
Fuel hose assembly



↑↓	Part name	Q'ty	Remarks
1	Bolt M6 × 25 mm	2	
2	Cover (PORT)	1	
3	Cover (STBD)	1	
4	Collar	2	
5	Grommet	2	
6	Grommet	6	
7	Holder	2	
8	Fuel hose assembly	1	
9	Fuel hose assembly	1	
10	Fuel hose assembly	1	
11	Holder	1	
12	Holder	2	
13	Holder	2	
14	Holder	1	
15	Holder	1	
16	Holder	1	
17	Holder	1	
18	Bolt M6 × 16 mm	1	
19	Ground lead	1	Disconnect.

↑↓	Part name	Q'ty	Remarks
20	Plastic tie	1	
21	Cover	1	
22	Sensor	1	Fuel pressure
23	Joint	1	

Fuel hose, feed valve, relief valve, and fuel strainer



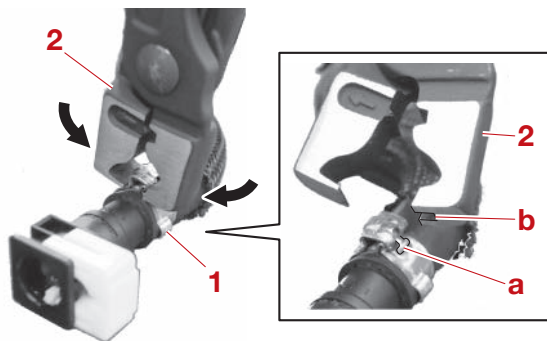
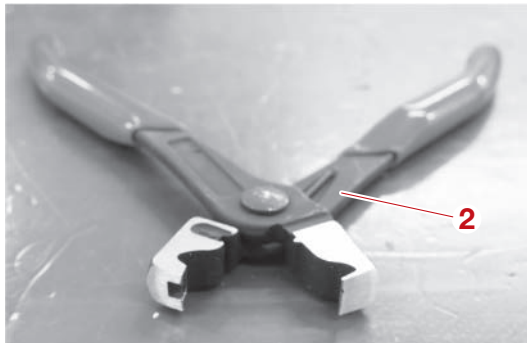
↑↓	Part name	Q'ty	Remarks
1	Clamp	20	
2	Quick connector	2	
3	Hose	1	
4	Joint	2	
5	Hose	1	
6	Plastic tie	2	
7	Cover	1	
8	Feed valve	1	
9	Hose	1	
10	Hose	1	
11	Cover	1	
12	Relief valve	1	
13	Hose	1	
14	Quick connector	4	
15	Hose	1	
16	Fuel strainer	1	
17	O-ring	1	
18	Element	1	
19	Hose	1	

↑↓	Part name	Q'ty	Remarks
20	Hose	1	
21	Hose	1	
22	Joint	1	
23	Hose	1	

Disassembling the fuel hose assembly

- Remove:
 - Clamp "1"

TIP: _____
 Make sure that the protrusion "a" on the clamp fits in the slot "b" in the tool "2".

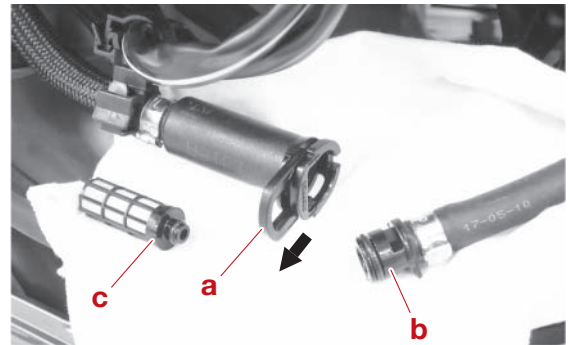


Checking the fuel strainer

- Check:
 - Fuel strainer
Cracked/damaged → Replace.
- Check:
 - Strainer element
Dirt/residue → Replace.

TIP: _____
 It is not necessary to remove the fuel strainer from the fuel hose when checking the strainer element.

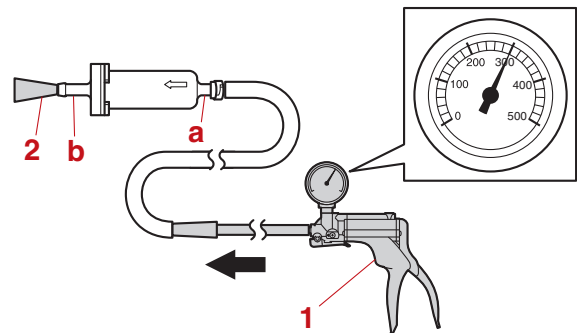
- Slide the retainer "a" outward.
- Remove the cap "b", and then remove the strainer element "c".



- Check:
 - Holding pressure
Out of specification → Replace the fuel strainer.

	Holding pressure (positive pressure) 300.0 kPa (3.00 kgf/cm ² , 43.5 psi)
--	-----------------------------------------------------------------------------------------

- Connect a pressure pump "1" to the fuel inlet "a".
- Block the fuel outlet "b" using a rubber plug "2", and then apply the specified positive pressure.



	Pressure pump "1" (commercially available)
--	-----------------------------------------------

Checking the relief valve (high-pressure fuel pump)

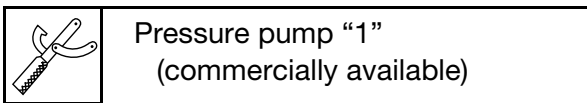
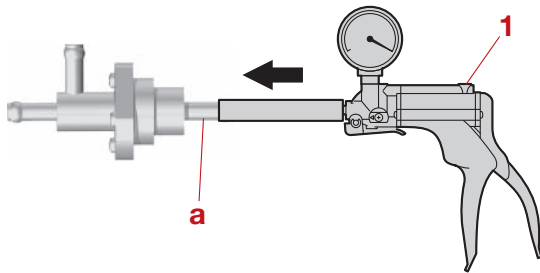
- Check:
 - Relief valve holding pressure
Out of specification → Replace.

	Holding pressure (positive pressure) 490.0 kPa (4.90 kgf/cm ² , 71.1 psi)
--	-----------------------------------------------------------------------------------------

- Connect a pressure pump "1" to the fuel outlet "a".

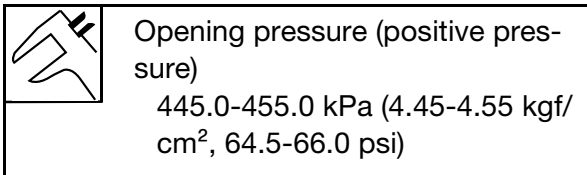
Fuel hose, feed valve, relief valve, and fuel strainer

- b. Apply the specified positive pressure for 15 seconds or more.

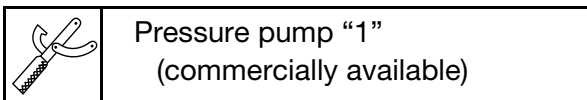
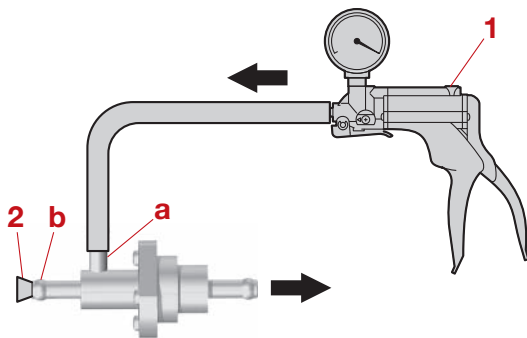


2. Check:

- Relief valve opening pressure
Out of specification → Replace.



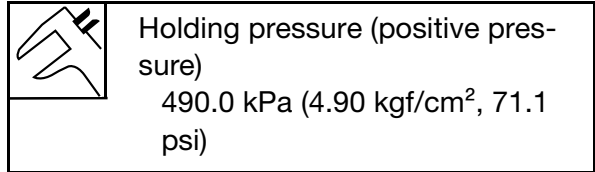
- Connect a pressure pump "1" to the fuel inlet "a".
- Block the fuel outlet "b" using a rubber plug "2".
- Apply the specified positive pressure, and check that the relief valve opens at the specified pressure.



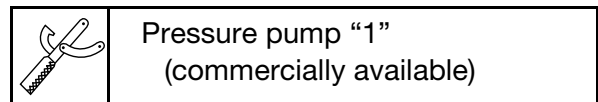
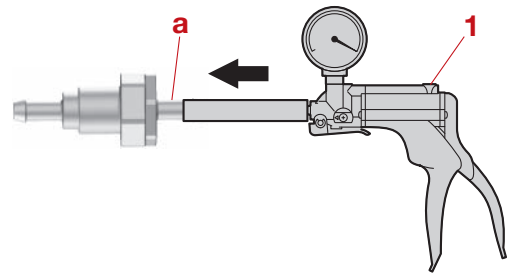
Checking the feed valve (high-pressure fuel pump)

1. Check:

- Feed valve holding pressure
Out of specification → Replace.

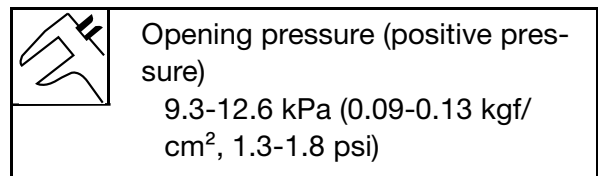


- Connect a pressure pump "1" to the fuel outlet "a".
- Apply the specified positive pressure for 15 seconds or more.

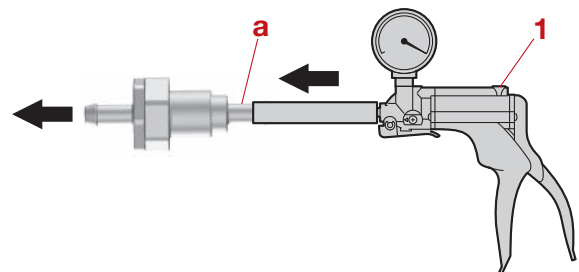


2. Check:

- Feed valve opening pressure
Out of specification → Replace.



- Connect a pressure pump "1" to the fuel inlet "a".
- Apply the specified positive pressure and check that the feed valve opens at the specified pressure.





Vacuum/pressure pump gauge set "1"
90890-06945
Pressure/vacuum tester "1"
YB-35956-B

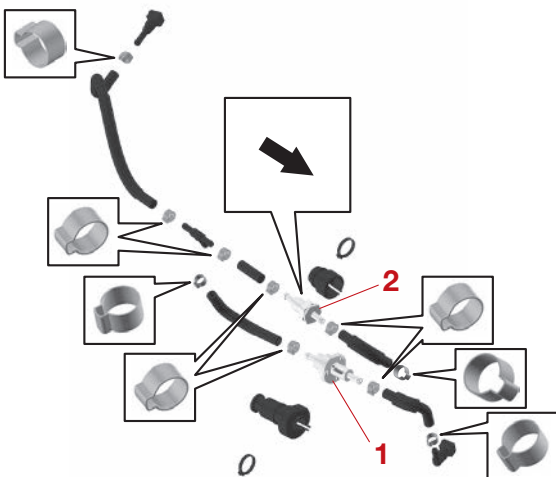
Checking the fuel pressure sensor (high-pressure fuel pump)

1. Check:
 - Electrical performance of the fuel pressure sensor (high-pressure-fuel pump). See "Checking the fuel pressure sensor" (5-32).

Assembling the fuel hose assembly

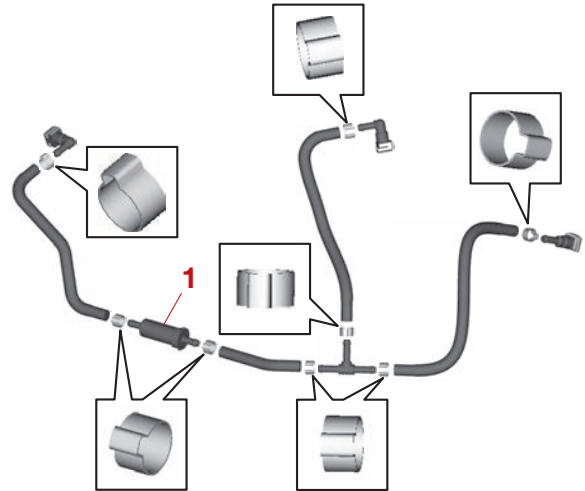
1. Assemble:
 - Fuel hose
 - Clamp **New**
 - Joint
 - Quick connector
 - Relief valve "1"
 - Fuel feed valve "2"
 - Cover
 - Plastic tie **New**

TIP: _____
Make sure to face the crimped section of the clamp in the direction shown in the illustration.



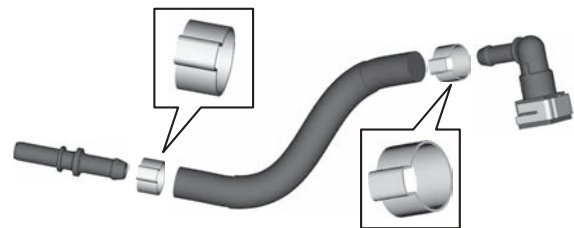
2. Assemble:
 - Fuel hose
 - Clamp **New**
 - Fuel strainer "1"
 - Joint
 - Quick connector

TIP: _____
Make sure to face the crimped section of the clamp in the direction shown in the illustration.



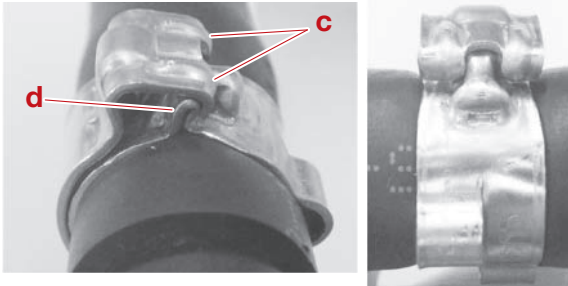
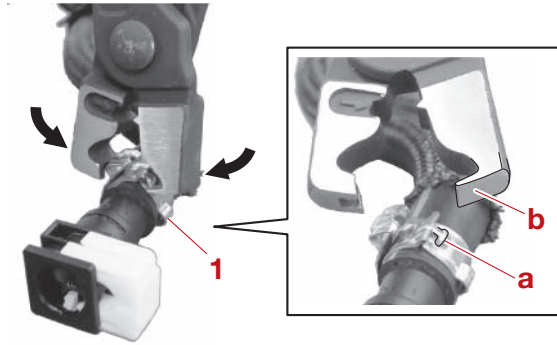
3. Assemble:
 - Fuel hose
 - Clamp **New**
 - Joint

TIP: _____
Make sure to face the crimped section of the clamp in the direction shown in the illustration.



4. Tighten:
 - Clamp "1"

TIP: _____
 • Push the protrusion "a" on the clamp using the side "b", which does not have a slot, of the tool.
 • Make sure that the ends "c" of the clamp are hooked securely onto the portion "d" of the clamp.



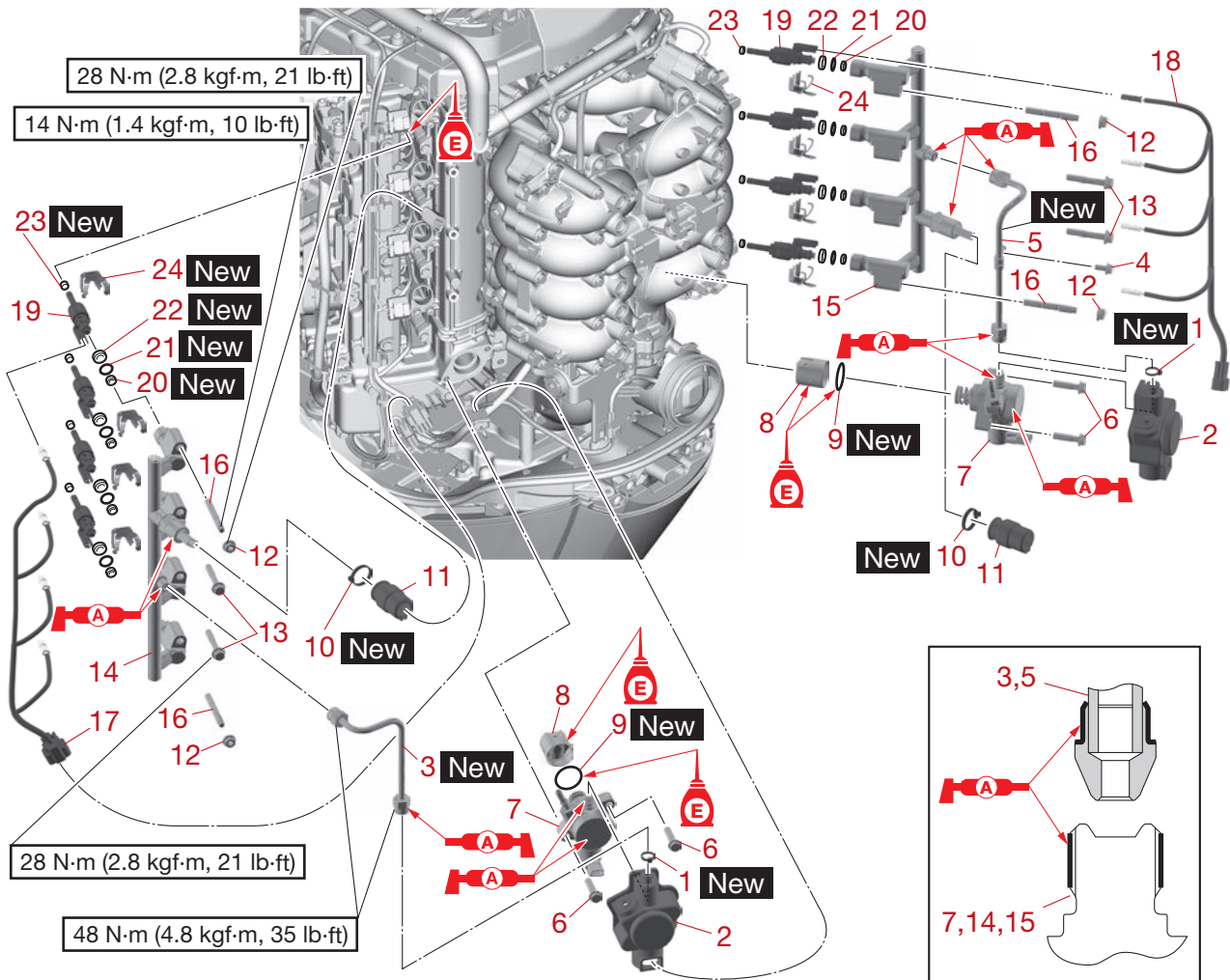
Installing the fuel hose assembly

1. Install:
 - Fuel pressure sensor (high-pressure fuel pump)
 - Fuel hose assembly
 - Holder
 - Fuel rail cover



Fuel pressure sensor (high-pressure fuel pump)
23 N·m (2.3 kgf·m, 17 lb·ft)

Direct injection pump and fuel injector



↑↓	Part name	Q'ty	Remarks
1	Plastic tie	2	
2	Cover	2	
3	Fuel pipe (PORT)	1	
4	Bolt M6 × 14 mm	1	
5	Fuel pipe (STBD)	1	
6	Bolt M6 × 35 mm	4	
7	Direct injection pump	2	
8	Lifter	2	
9	O-ring	2	
10	Plastic tie	2	
11	Cover	2	
12	Nut M6	4	
13	Bolt M6 × 50 mm	4	
14	Fuel rail (PORT)	1	With fuel pressure sensor
15	Fuel rail (STBD)	1	With fuel pressure sensor

↑↓	Part name	Q'ty	Remarks
16	Stud bolt M8 × 65 mm	4	
17	Sub-wire harness (PORT)	1	
18	Sub-wire harness (STBD)	1	
19	Fuel injector	8	
20	Stopper	8	
21	O-ring	8	
22	Backup ring	8	
23	Seal	8	
24	Spring	8	

Removing the fuel rail

WARNING

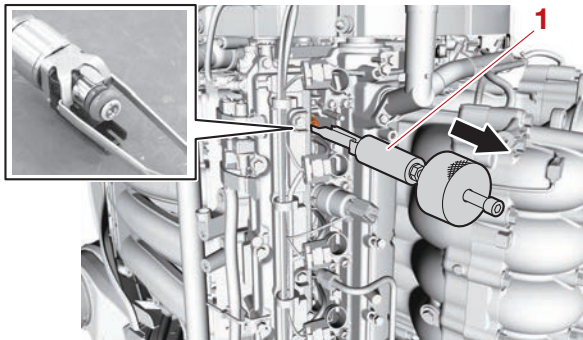
Do not remove the fuel pressure sensor from the fuel rail. Otherwise, fuel could leak when the fuel pressure sensor is reinstalled to the fuel rail.

Removing the fuel injector

1. Remove:
 - Fuel injector

TIP:

- Remove the fuel injector along with the fuel rail.
- If the fuel injectors remain installed to the cylinder head, remove them using the special service tool.

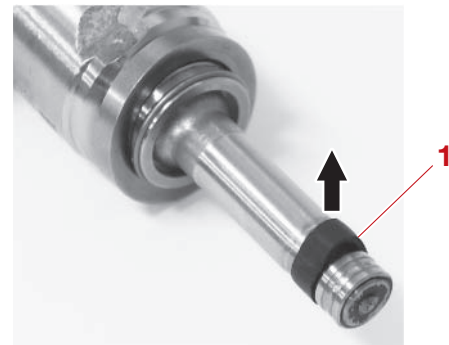


Injector remover "1"
90890-06696

2. Remove:
 - Nozzle seal
 - a. Stretch the nozzle seal "1" by pulling it away from the nozzle using needle-nose pliers.
 - b. Cut the nozzle seal.

NOTICE

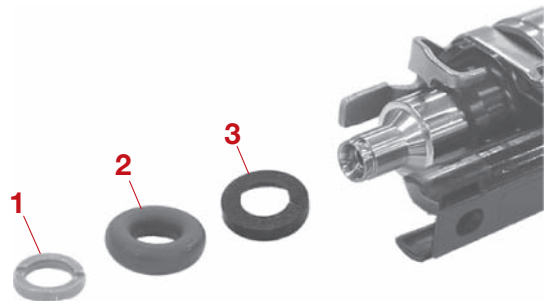
If the nozzle seal is cut without pulling it, the fuel injector could be damaged.



3. Remove:
 - Stopper "1"
 - O-ring "2"
 - Backup ring "3"

NOTICE

Be careful not to scratch the installation area of the O-ring.



Checking the fuel pressure sensor (direct injection pump)

1. Check:
 - Electrical performance of the fuel pressure sensor (direct injection pump). See "Checking the direct injection pump" (5-30).

Checking the direct injection pump

1. Check:
 - Electrical performance of the direct injection pump. See "Checking the direct injection pump" (5-30).

Checking the fuel rail and fuel injector

1. Check:
 - Fuel rail
Crack/deformed → Replace.

2. Check:
 - Electrical performance of the fuel injectors. See “Checking the fuel injector” (5-29).

Installing the fuel injector and fuel rail

NOTICE

Be careful not to scratch the installation area of the O-ring or the nozzle.

1. Clean the fuel injector and special service tool to remove any foreign material.
2. Install:
 - Spring **New**
 - Backup ring **New**
 - O-ring **New**
 - Stopper **New**
 - a. Install a new backup ring “1” and O-ring “2”.

TIP:

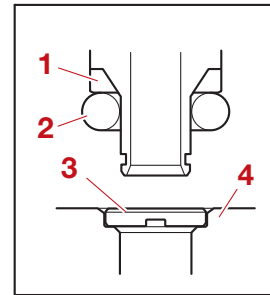
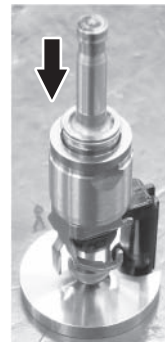
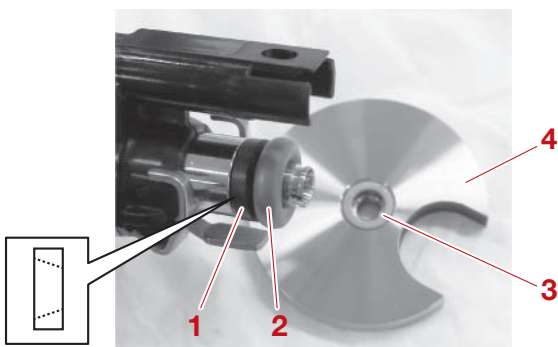
Make sure to face the tapered end of the backup ring “1” toward the O-ring.

- b. Put a new stopper “3” into the hole in the special service tool “4”.

TIP:

Install the stopper so that the side of the stopper with the notch is facing toward the special service tool.

- c. Fit the injector end into the stopper, and then push the injector down to install it.

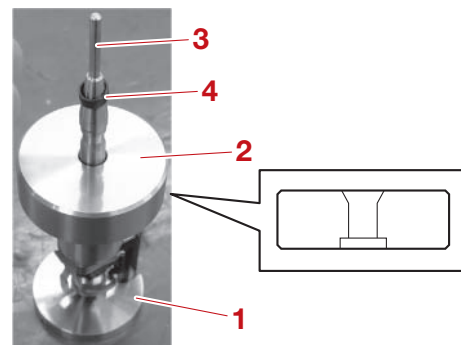


	Stopper “4” 90890-06699
--	----------------------------

3. Install:
 - Nozzle seal **New**
 - a. Set the fuel injector onto the special service tool “1”.
 - b. Install the special service tools “2” and “3” and a new nozzle seal “4”.

TIP:

- Make sure to face the stepped section of special service tool “2” toward the injector body.
- Make sure that the special service tool “3” does not contact the end of the nozzle.
- Make sure that the nozzle seal “4” is not deformed.



	Stopper “1” 90890-06699 Seal fitter “2” 90890-06708 Nozzle cap “3” 90890-06697
--	-----------------------------------------------------------------------------------------------

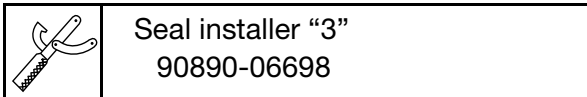
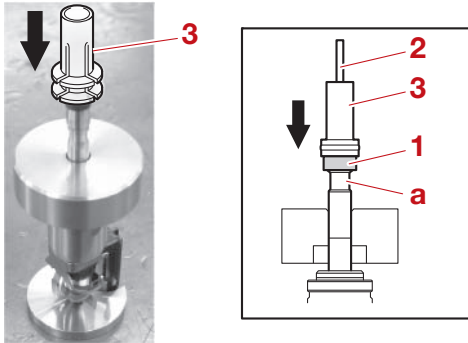
- c. Install the nozzle seal “1” onto the special service tool “2” up to the bottom of the tool using the special service tool “3”.

Direct injection pump and fuel injector

- d. Push the nozzle seal into the groove “a” using your fingers.

TIP:

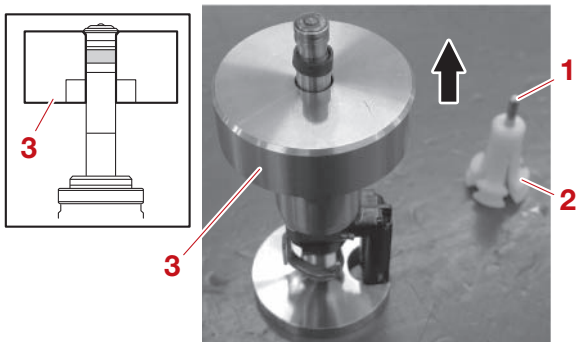
At this time, the nozzle seal is larger than its original size.



- e. Remove the special service tools “1” and “2”, and then pull up the special service tool “3” gradually.
- f. Keep the special service tool “3” for 30 seconds or more.
- g. Remove the special service tool “3”.

NOTICE

Make sure that the nozzle seal has returned to its original size. Otherwise, the seal could be pinched when the fuel injector is installed.




4. Install:
- Stud bolt
 - Fuel injector
(to the fuel rail)
 - Fuel injector sub-wire harness
(to the fuel injector)
 - Fuel rail
 - Fuel pressure sensor cover

- Plastic tie **New**

⚠ WARNING

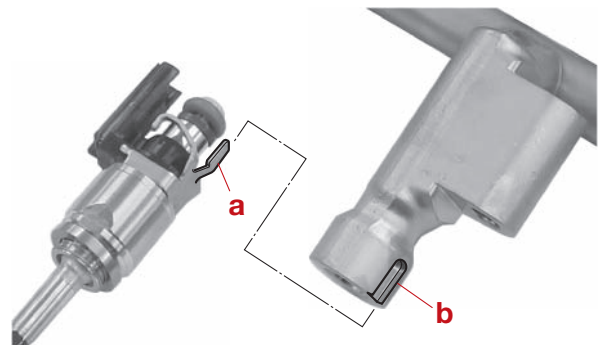
- If a fuel injector is dropped, replace it.
- Make sure that there is no foreign material or damage on the installation area of the fuel injector.

	Fuel rail stud bolt
	14 N·m (1.4 kgf·m, 10 lb·ft)
	Fuel rail bolt
	28 N·m (2.8 kgf·m, 21 lb·ft)
	Fuel rail nut
	28 N·m (2.8 kgf·m, 21 lb·ft)

- a. Install the fuel injector to the fuel rail so that the protrusion “a” on the fuel injector spring is aligned with the slot “b” in the fuel rail.

⚠ WARNING

- Install the fuel injector straight into the fuel rail so that it is not positioned at an angle.
- Be careful not to damage the O-ring on the fuel injector.



- b. Connect the sub-wire harness to the fuel injector.
- c. Apply engine oil to the fuel injector hole in the cylinder head.
- d. Install the fuel rail onto the stud bolts by pushing in the fuel rail until the threads of the bolts for the nuts are visible.

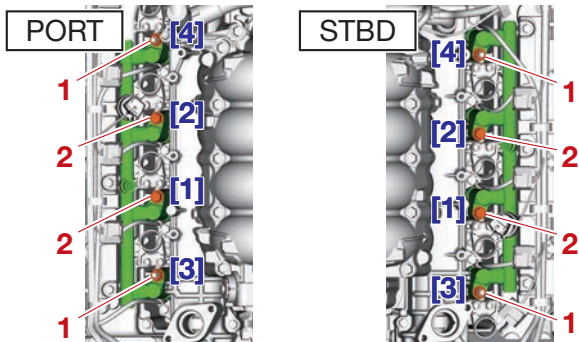
⚠ WARNING

- Push in the fuel rail gradually and evenly so that the fuel rail is not positioned at an angle.
- Be careful not to damage the end of the fuel injector nozzle or the nozzle seal.


e. Tighten the fuel rail nuts “1” and fuel rail bolts “2” to the specified torque evenly in the order [1], [2], and so on.

⚠ WARNING

Make sure that the fuel rail is not positioned at an angle.



5. Install:
- Lifter
 - O-ring **New**
 - Direct injection pump
 - Fuel pipe **New**
 - Direct injection pump cover
 - Plastic tie **New**

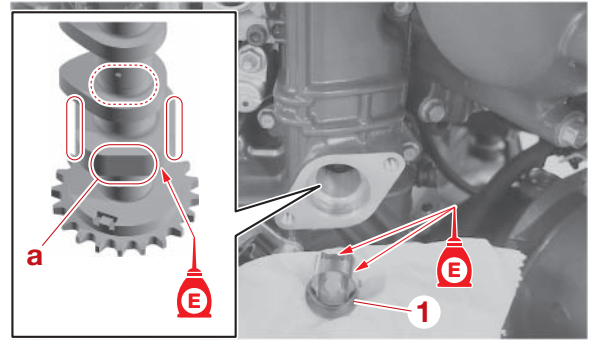
	Fuel pipe flare nut 48 N·m (4.8 kgf·m, 35 lb·ft)
-------------------------------------------------------------------------------------	-----------------------------------------------------

a. Turn the crankshaft so that the flat portion “a” of the fuel pump cam on the camshaft is facing toward the direct injection pump hole in the cylinder head cover.

TIP:

Because the fuel pump cams for the left and right cylinder banks have different positions, rotate the crankshaft to position each camshaft separately.

b. Install the lifter “1”.



c. Install a new O-ring and the direct injection pump, and tighten the bolts temporarily.

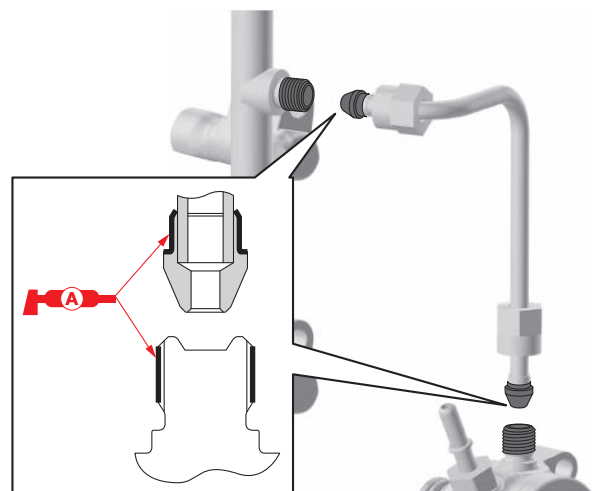
TIP:

Tighten the bolts temporarily to a level that does not compress the direct injection pump spring.

d. Install a new fuel pipe.

NOTICE

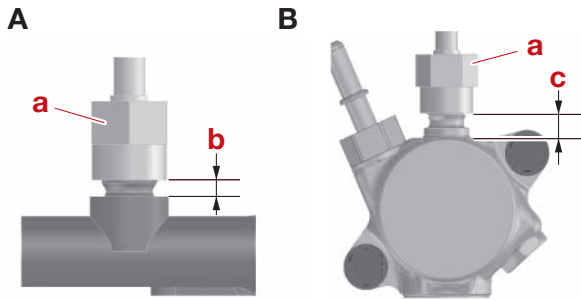
- Make sure that there is no foreign material or damage on the mating surfaces of the fuel rail, direct injection pump, and fuel pipe.
- Apply grease to the fuel pipe nipples, and all around the threaded portions of the direct injection pump and fuel rail. Otherwise, the parts could seize when tightened, causing fuel to leak.




e. Tighten the flare nuts “a” on both ends of the fuel pipe temporarily until the distances are within specification.

TIP: _____

- It is easier to perform the work by gradually tightening the nuts on both ends of the pipe alternately.
- If the nuts cannot be tightened temporarily until the distances are within specification, the fuel pipe may be connected improperly.

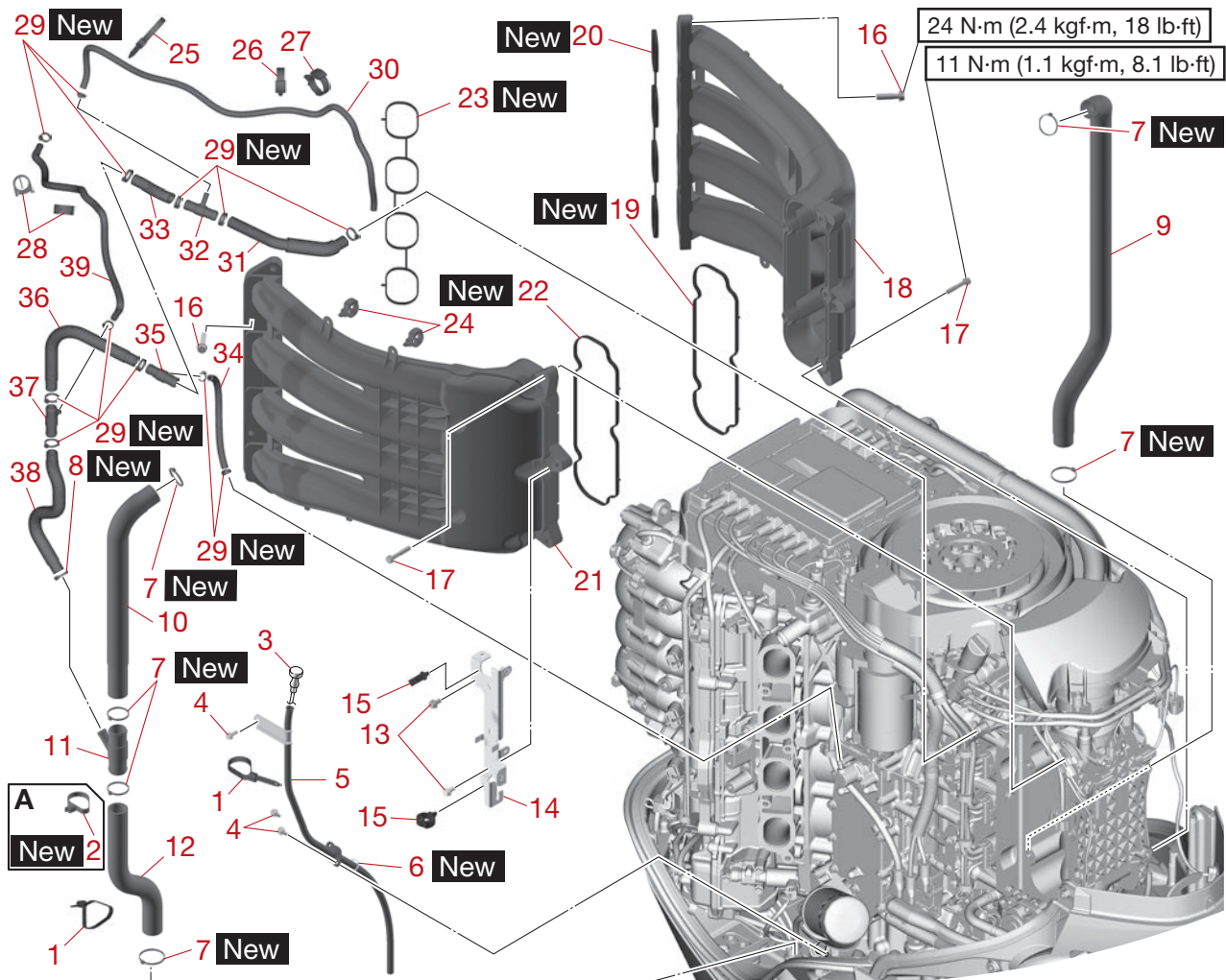


- A. Fuel rail end of the fuel pipe
B. Direct injection pump end of the fuel pipe

	Distance "b" 5.0 mm (0.20 in) or less
	Distance "c" 9.5 mm (0.37 in) or less

- f. Tighten the direct injection pump bolts evenly.
- g. Tighten the fuel pipe bolt (starboard fuel pipe).
- h. Tighten the flare nuts on both ends of the fuel pipe to the specified torque.

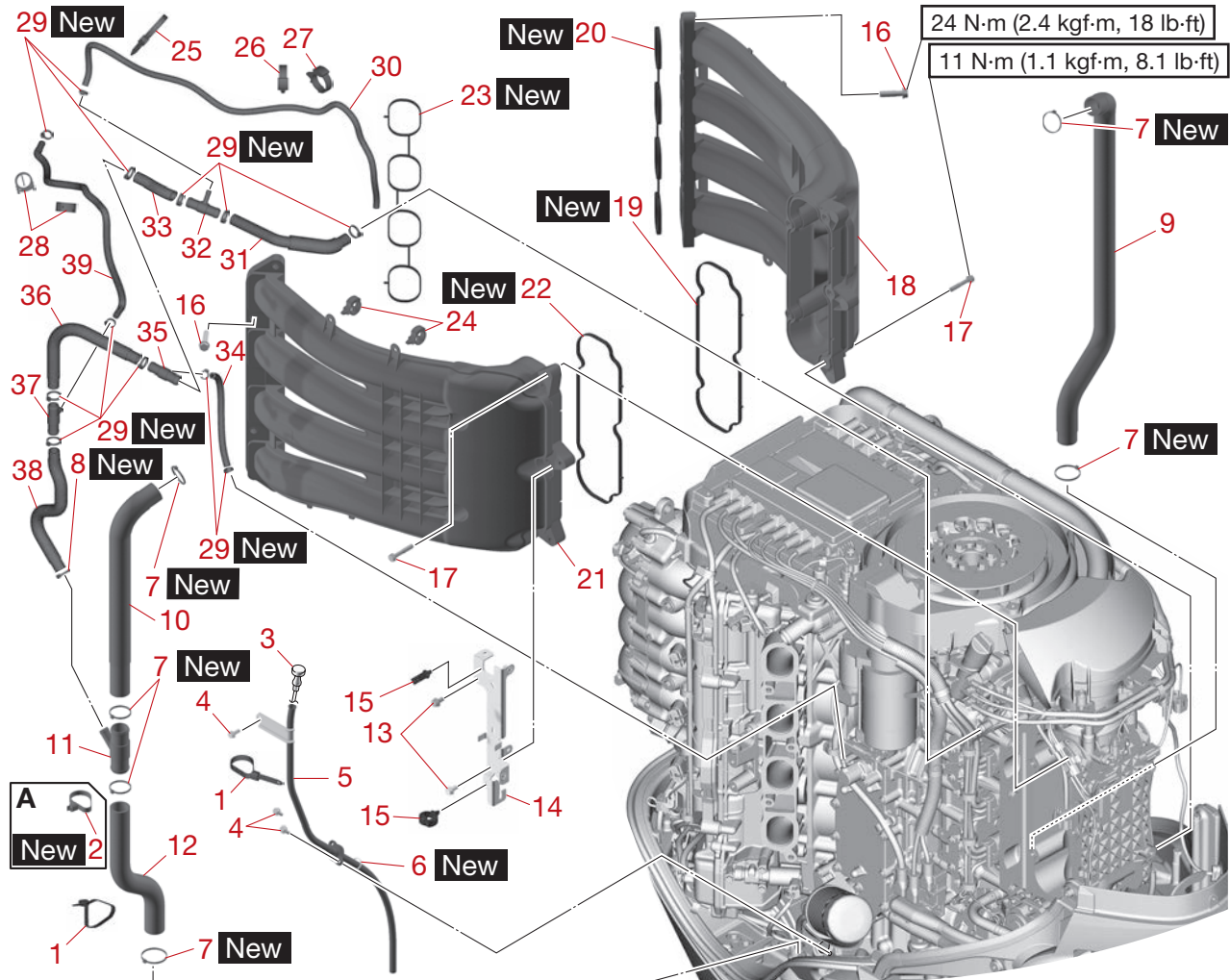
Intake manifold



↑↓	Part name	Q'ty	Remarks
1	Plastic tie	2	
2	Plastic tie	1	
3	Oil dipstick	1	
4	Bolt M6 × 16 mm	3	
5	Dipstick guide	1	
6	O-ring	1	
7	Plastic tie	6	
8	Plastic tie	1	
9	Hose	1	
10	Hose	1	
11	Joint	1	
12	Hose	1	
13	Bolt M6 × 12 mm	2	
14	Bracket	1	
15	Holder	2	
16	Bolt M8 × 35 mm	10	
17	Bolt M6 × 40 mm	10	
18	Intake manifold (PORT)	1	

↑↓	Part name	Q'ty	Remarks
19	Gasket	1	
20	Gasket	1	
21	Intake manifold (STBD)	1	
22	Gasket	1	
23	Gasket	1	
24	Holder	2	
25	Plastic tie	1	
26	Holder	1	
27	Holder	1	
28	Holder	2	
29	Plastic tie	12	
30	Hose	1	
31	Hose	1	
32	Joint	1	
33	Hose	1	
34	Hose	1	
35	Joint	1	
36	Hose	1	

Intake manifold



↕	Part name	Q'ty	Remarks
37	Joint	1	
38	Hose	1	
39	Hose	1	

A. For multiple engine applications

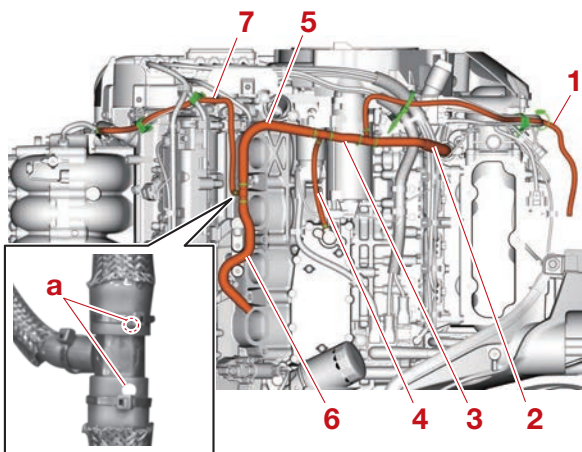
Checking the intake manifold

1. Check:
 - Intake manifold
 - Cracked/damaged → Replace.

Installing the intake manifold

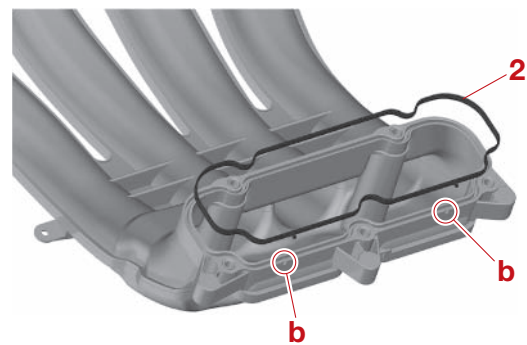
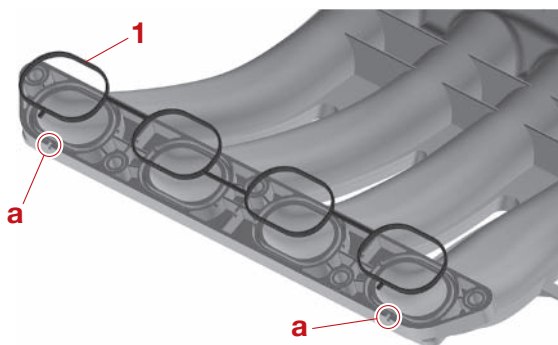
1. Install:
 - Cooling water hose “1”, “2”, “3”, “4”, “5”, “6”, “7”
 - Joint
 - Plastic tie **New**

TIP: _____
 Make sure that the paint marks “a” on the cooling water hoses face outward.



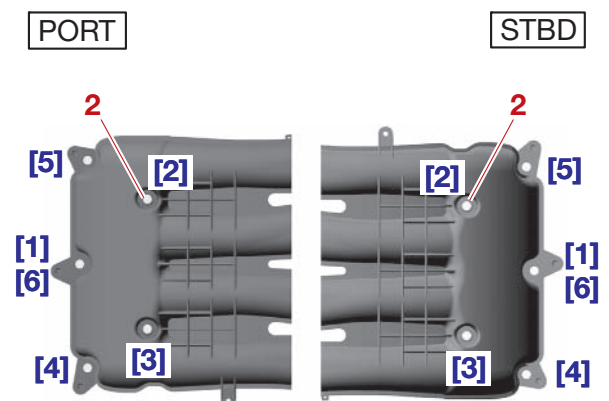
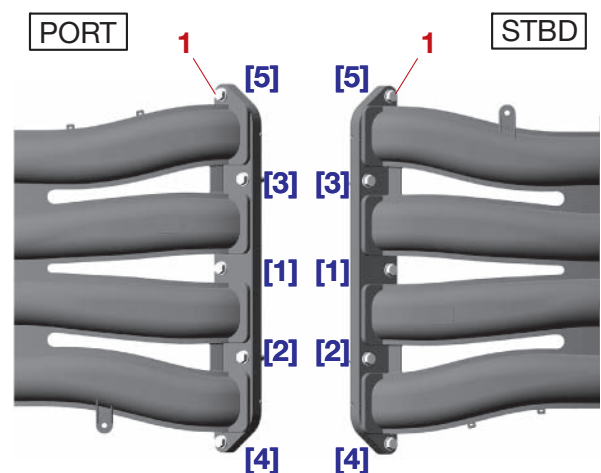
2. Install:
 - Gasket **New**

TIP: _____
 Make sure to fit the tabs on the gaskets “1” and “2” properly and firmly with the grooves “a” and “b” in the intake manifold.



3. Install:
 - Intake manifold (temporarily)
4. Tighten:
 - Intake manifold bolt

TIP: _____
 Tighten the intake manifold bolts “1” and “2” to the specified torque in the order [1], [2], and so on.





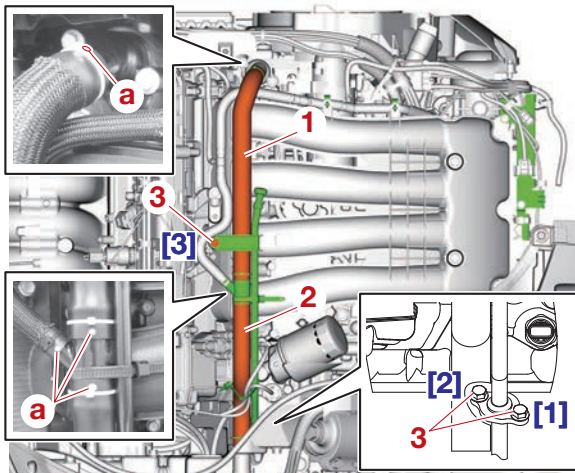
Intake manifold bolt "1" (M8)
 24 N·m (2.4 kgf·m, 18 lb·ft)
 Intake manifold bolt "2" (M6)
 11 N·m (1.1 kgf·m, 8.1 lb·ft)

5. Install:

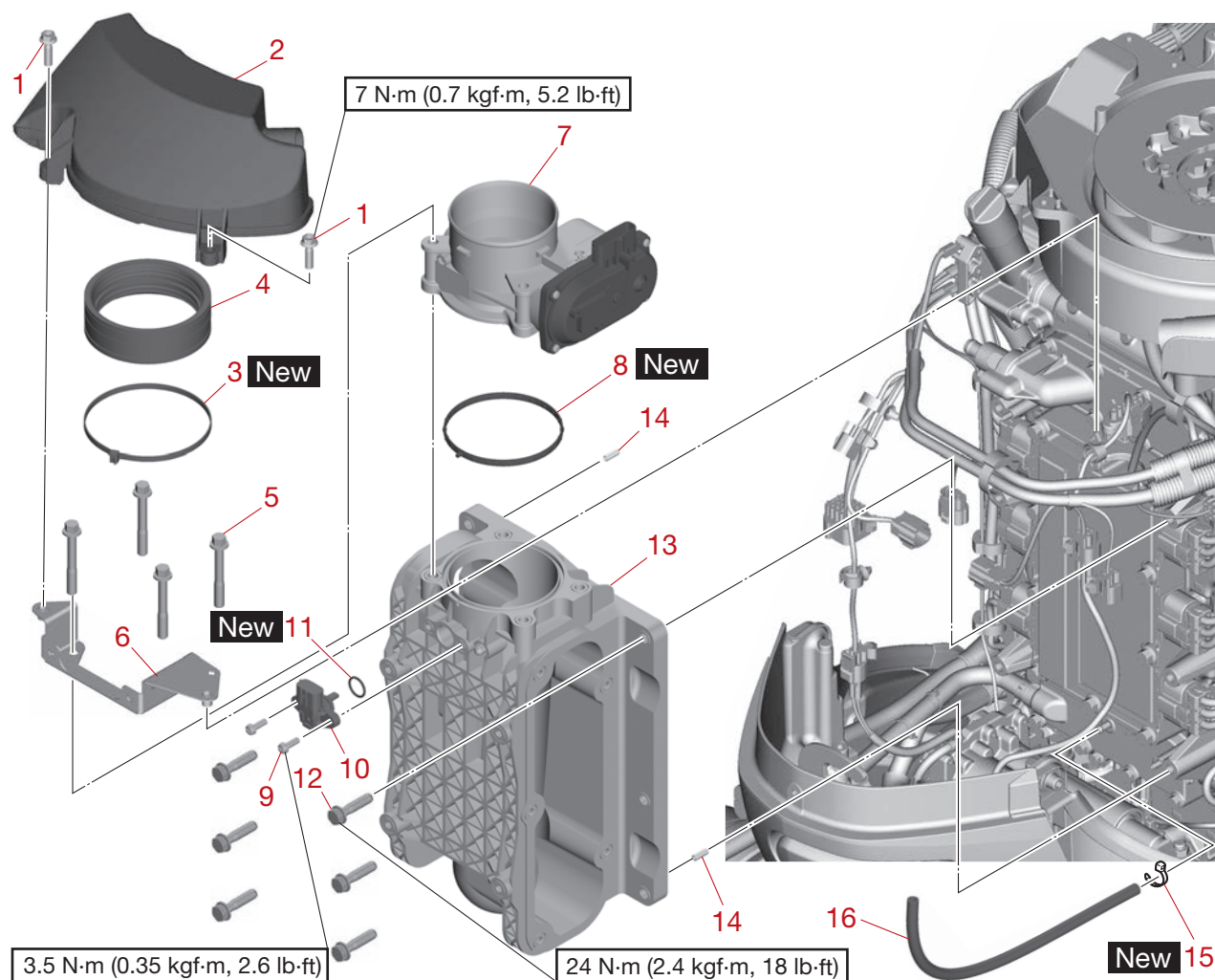
- Holder
- Bracket
- Hose "1", "2"
- Joint
- Plastic tie **New**
- O-ring **New**
- Dipstick guide
- Oil dipstick

TIP:

- Make sure that the paint marks "a" on the cooling water hoses face outward.
- Tighten the dipstick guide bolts "3" in the order [1], [2], and so on.



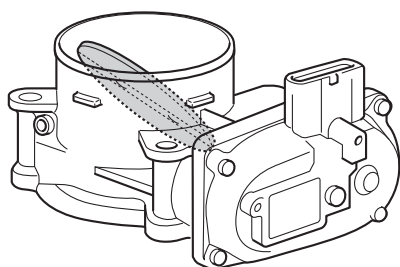
ETV



↑↓	Part name	Q'ty	Remarks
1	Bolt M6 × 25 mm	2	
2	Intake silencer	1	
3	Plastic tie	1	
4	Joint	1	
5	Bolt M8 × 60 mm	4	
6	Bracket	1	
7	ETV	1	
8	Gasket	1	
9	Screw M5 × 16 mm	2	
10	Sensor	1	Intake air pressure/temperature
11	O-ring	1	
12	Bolt M8 × 35 mm	6	
13	Surge tank	1	
14	Dowel	2	
15	Plastic tie	1	
16	Hose	1	

Checking the ETV

1. Check:
 - ETV
Cracked → Replace.
2. Check:
 - Throttle valve movement
 - Rough movement → Replace the ETV.



3. Check:
 - Electrical performance of the TPS.
See “Checking the ETV and TPS” (5-21).

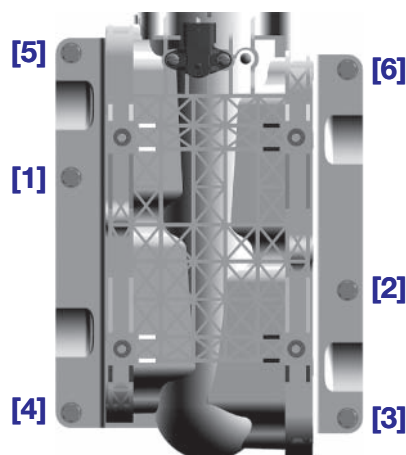
Checking the intake air pressure/temperature sensor

1. Check:
 - Intake air pressure/temperature sensor
Cracked → Replace.
2. Check:
 - Electrical performance of the intake air pressure/temperature sensor.
See “Checking the intake air pressure/temperature sensor” (5-36).

Installing the ETV and surge tank

1. Install:
 - Dowel
 - Surge tank
 - O-ring **New**
 - Intake air pressure/temperature sensor

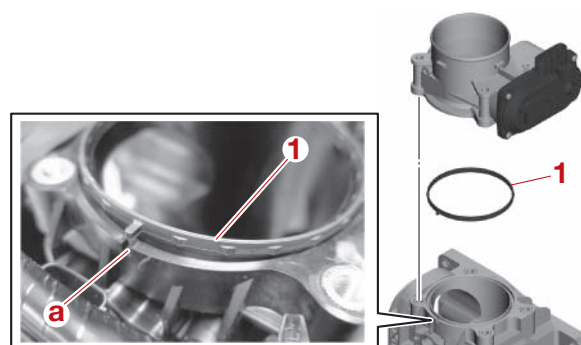
TIP: _____
Tighten the surge tank bolts to the specified torque in the order [1], [2], and so on.



	Surge tank bolt
	24 N·m (2.4 kgf·m, 18 lb·ft)
	Intake air pressure/temperature sensor bolt
	3.5 N·m (0.35 kgf·m, 2.6 lb·ft)

2. Install:
 - Gasket **New**
 - ETV
 - Bracket
 - Joint
 - Plastic tie **New**
 - Intake silencer

TIP: _____
Make sure to fit the tab on the ETV gasket “1” properly and firmly with the groove “a” in the surge tank.



	Intake silencer bolt
	7 N·m (0.7 kgf·m, 5.2 lb·ft)

Power unit

Power unit (check and adjustment)	7-1
Checking the compression pressure	7-1
Checking the oil pressure.....	7-1
Checking the valve clearance	7-1
Adjusting the valve clearance	7-3
Shroud cover and terminal cover	7-5
Installing the shroud cover and terminal cover	7-6
Exhaust joint (outside)	7-7
Removing the exhaust joint assembly	7-8
Disassembling the exhaust joint assembly	7-8
Checking the exhaust joint.....	7-8
Checking the exhaust joint anode.....	7-8
Checking the water pressure sensor	7-8
Installing the exhaust joint assembly	7-8
Exhaust joint (inside).....	7-11
Removing the exhaust joint.....	7-12
Checking the exhaust joint.....	7-12
Checking the exhaust joint anode.....	7-12
Installing the exhaust joint.....	7-12
Power unit assembly.....	7-13
Removing the power unit	7-15
Installing the power unit	7-17
Electrical management box	7-22
Installing the electrical management box.....	7-23
Flywheel magneto	7-24
Removing the flywheel magneto	7-25
Installing the flywheel magneto	7-25
Starter motor and extension wire harness	7-28
Installing the starter motor	7-29
Installing the extension wire harness	7-29

Power unit

Wire harness	7-30
Removing the wire harness.....	7-31
Installing the wire harness.....	7-33
ECM, injector driver, and rectifier/regulator	7-37
Removing the rectifier/regulator.....	7-38
Checking the rectifier/regulator anode.....	7-38
Installing the ECM and injector driver	7-38
Installing the rectifier/regulator.....	7-38
Ignition coil and spark plug	7-40
Checking the spark plug	7-41
Installing the ignition coil and spark plug.....	7-41
Timing belt	7-42
Removing the timing belt	7-43
Checking the timing belt	7-43
Installing the timing belt	7-43
Camshaft	7-46
Removing the camshaft, VCT assembly, and driven sprocket	7-48
Checking the sprocket	7-49
Checking the cam chain.....	7-49
Checking the cam chain tensioner.....	7-49
Checking the valve lifter	7-50
Checking the camshaft	7-50
Checking the camshaft journal oil clearance	7-51
Checking the camshaft journal outside diameter and camshaft journal inside diameter	7-52
Installing the camshaft, VCT assembly, and driven sprocket	7-53
Cylinder head	7-58
Removing the cylinder head.....	7-59
Disassembling the cylinder head	7-59
Checking the cylinder head.....	7-59
Checking the cylinder head bolt	7-60
Checking the valve spring	7-60
Checking the valve	7-61
Checking the valve guide	7-61
Replacing the valve guide	7-62

Power unit

Checking the valve seat	7-63
Refacing the valve seat	7-63
Checking the cylinder head anode.....	7-66
Checking the cam position sensor.....	7-66
Checking the OCV.....	7-66
Assembling the cylinder head	7-66
Installing the cylinder head.....	7-68
Oil pump assembly.....	7-70
Removing the oil pump assembly	7-71
Removing the oil filter.....	7-71
Installing the oil filler neck and relief valve	7-71
Installing the oil pump assembly.....	7-71
Installing the oil filter.....	7-71
Oil cooler and water jacket	7-72
Checking the thermostat.....	7-73
Checking the oil cooler cover anode and water jacket anode	7-73
Installing the cylinder block thermostat	7-73
Installing the water jacket cover.....	7-73
Installing the oil cooler cover.....	7-74
Cylinder block sensor	7-75
Checking the cylinder block anode.....	7-76
Installing the cylinder block anode.....	7-76
Installing the cylinder block sensor.....	7-76
Cylinder block.....	7-77
Disassembling the cylinder block.....	7-78
Checking the piston diameter	7-78
Checking the cylinder bore	7-79
Checking the piston clearance.....	7-79
Checking the piston ring	7-79
Checking the piston ring end gap	7-80
Checking the piston ring groove	7-80
Checking the piston ring side clearance	7-81
Checking the piston pin boss inside diameter	7-81
Checking the piston pin diameter	7-81
Checking the connecting rod small end inside diameter and big end inside diameter.....	7-82
Checking the connecting rod big end side clearance.....	7-82
Checking the crankshaft	7-82
Checking the crankcase bolt.....	7-83

Power unit

Checking the big end oil clearance	7-83
Selecting the crankshaft pin bearing.....	7-85
Crankshaft pin bearing selection table.....	7-87
Checking the journal oil clearance	7-88
Selecting the crankshaft journal bearing.....	7-89
Crankshaft journal bearing selection table.....	7-91
Assembling the cylinder block	7-92

Power unit (check and adjustment)

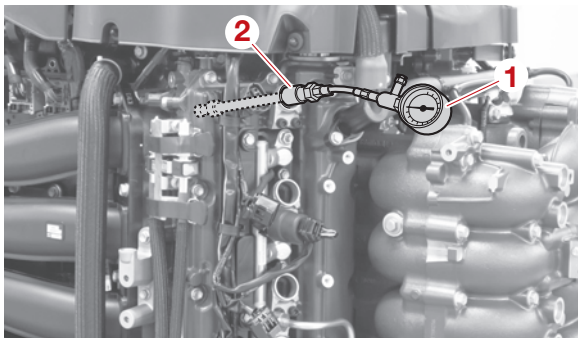
Checking the compression pressure


1. Start the engine, warm it up for 5–10 minutes, and then stop it.
2. Remove:
 - Clip (from the engine shut-off switch)
 - Fuel rail covers
See “Fuel hose assembly” (6-12).
 - Ignition coils
 - Spark plugs
See “Ignition coil and spark plug” (7-40).

NOTICE

Before removing the spark plugs, remove any dirt or dust in the spark plug wells that could fall into the cylinders.

3. Install:
 - Special service tools



	Compression gauge “1” 90890-03160
	Compression gauge extension M10 “2” 90890-06582
	Compression gauge “1” YU-33223

4. Measure:
 - Compression pressure
Below specification → Check the engine internal parts.

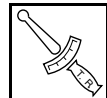
TIP:

Crank the engine until the reading on the compression gauge stabilizes.



Compression pressure Minimum (reference data) 947.9 kPa (9.48 kgf/cm ² , 137.4 psi)

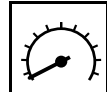
5. Remove:
 - Special service tools
6. Install:
 - Spark plugs
 - Ignition coils
See “Ignition coil and spark plug” (7-40).
 - Clip (to the engine shut-off switch)



Spark plug 11 N·m (1.1 kgf·m, 8.1 lb·ft)
Ignition coil bolt 10 N·m (1.0 kgf·m, 7.4 lb·ft)

Checking the oil pressure

1. Connect the YDIS to display “Oil pressure”.
2. Start the engine and warm it up until the engine idle speed stabilizes at the specified engine idle speed range.



Idle speed (in neutral) 650–750 r/min

3. Measure:
 - Oil pressure
Below specification → Check the engine internal parts.



Engine oil pressure at idle speed (reference data) 492.0 kPa (4.92 kgf/cm ² , 71.3 psi)
Engine oil pressure at 3000 r/min (reference data) 676.0 kPa (6.76 kgf/cm ² , 98.0 psi)

Checking the valve clearance

Measure the valve clearances when the engine is cold.

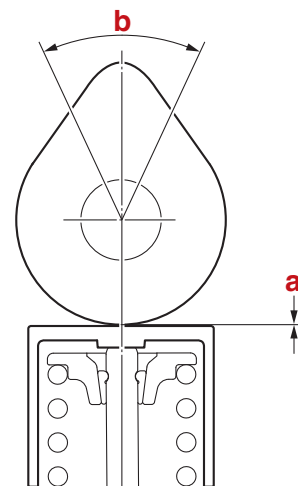
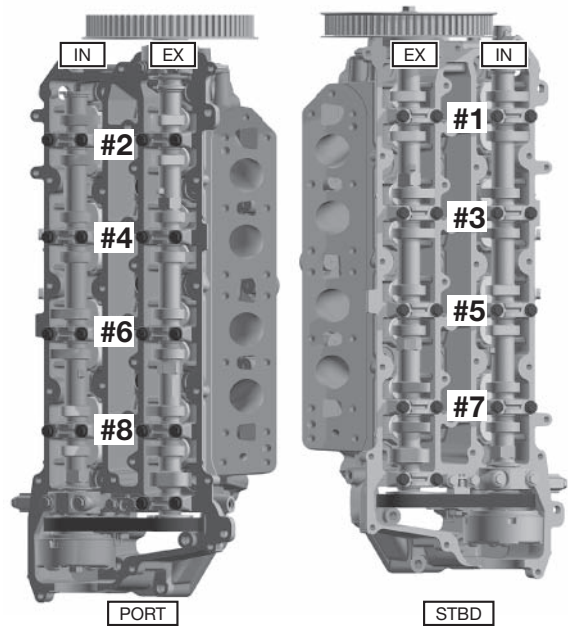
NOTICE

Do not turn the flywheel magneto counter-clockwise. Otherwise, the water pump impeller could be damaged.

1. Reduce:
 - Fuel pressure
See “Reducing the fuel pressure” (6-1).
2. Remove:
 - Bottom cowling cover
See “Bottom cowling cover and apron cover” (9-1).
 - Bottom cowling
See “Bottom cowling (PORT and STBD)” (9-3).
 - Shroud cover and terminal cover
See “Shroud cover and terminal cover” (7-5).
 - Electrical management box
See “Electrical management box” (7-22).
 - Fuel rail cover
See “Fuel hose assembly” (6-12).
 - Exhaust joint
See “Exhaust joint (outside)” (7-7) and “Exhaust joint (inside)” (7-11).
 - Ignition coil
 - Spark plug
See “Ignition coil and spark plug” (7-40).
 - Fuel hose
(from the direct injection pump)
 - Fuel rail
See “Direct injection pump and fuel injector” (6-18).
 - Wire harness guide
See “Timing belt” (7-42).
 - Cylinder head cover
See “Camshaft” (7-46).
3. Measure:
 - Valve clearance “a”
Out of specification → Adjust.
See “Adjusting the valve clearance” (7-3).

TIP:

- Turn the crankshaft gradually until the cam nose for each valve is positioned within the range “b”, and then measure the valve clearance for that valve.
- Write down the measurement data.



b. 60°

	Valve clearance IN (cold engine) 0.17–0.24 mm (0.0067–0.0094 in)
	Valve clearance EX (cold engine) 0.37–0.44 mm (0.0146–0.0173 in)

4. Install:
 - Cylinder head cover
See “Camshaft” (7-46).
 - Wire harness guide
See “Timing belt” (7-42).
 - Fuel rail
 - Fuel hose
(from the direct injection pump)

Power unit (check and adjustment)

- See "Direct injection pump and fuel injector" (6-18).
- Spark plug
- Ignition coil
See "Ignition coil and spark plug" (7-40).
- Exhaust joint
See "Installing the exhaust joint" (7-12) and "Installing the exhaust joint assembly" (7-8).
- Fuel rail cover
See "Fuel hose assembly" (6-12).
- Electrical management box
See "Installing the electrical management box" (7-23).
- Shroud cover and terminal cover
See "Shroud cover and terminal cover" (7-5).
- Bottom cowling
See "Bottom cowling (PORT and STBD)" (9-3).
- Bottom cowling cover
See "Bottom cowling cover and apron cover" (9-1).

Adjusting the valve clearance

Adjust the valve clearances when the engine is cold.

NOTICE

- **Do not turn the flywheel magneto counterclockwise. Otherwise, the water pump impeller could be damaged.**
- **Do not turn the flywheel magneto, VCT assembly or driven sprocket when the timing belt is not installed. Otherwise, the pistons and valves, or intake and exhaust valves will collide with each other and be damaged.**

1. Remove:
 - Fuel hose assembly
See "Fuel hose assembly" (6-12).
 - Intake manifold (PORT)
See "Intake manifold" (6-24).
 - Flywheel magneto
See "Removing the flywheel magneto" (7-25).
 - Timing belt
See "Removing the timing belt" (7-43).
 - Chain tensioner

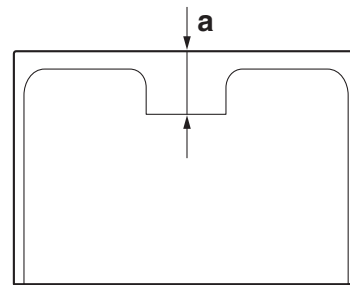
- Camshaft
(with driven sprocket and VCT assembly)
- Valve lifter
See "Removing the camshaft, VCT assembly, and driven sprocket" (7-48).

2. Measure:

- Valve lifter thickness "a"

TIP:

- Make sure to keep the parts in the order of removal.
- Write down the measurement data.



3. Select:

- Valve lifter
 - a. Select the necessary valve lifter by calculating its thickness using the following formula.

Calculation formula:

Necessary valve lifter thickness =
Removed valve lifter thickness +
Measured valve clearance –
Specified valve clearance

Example:

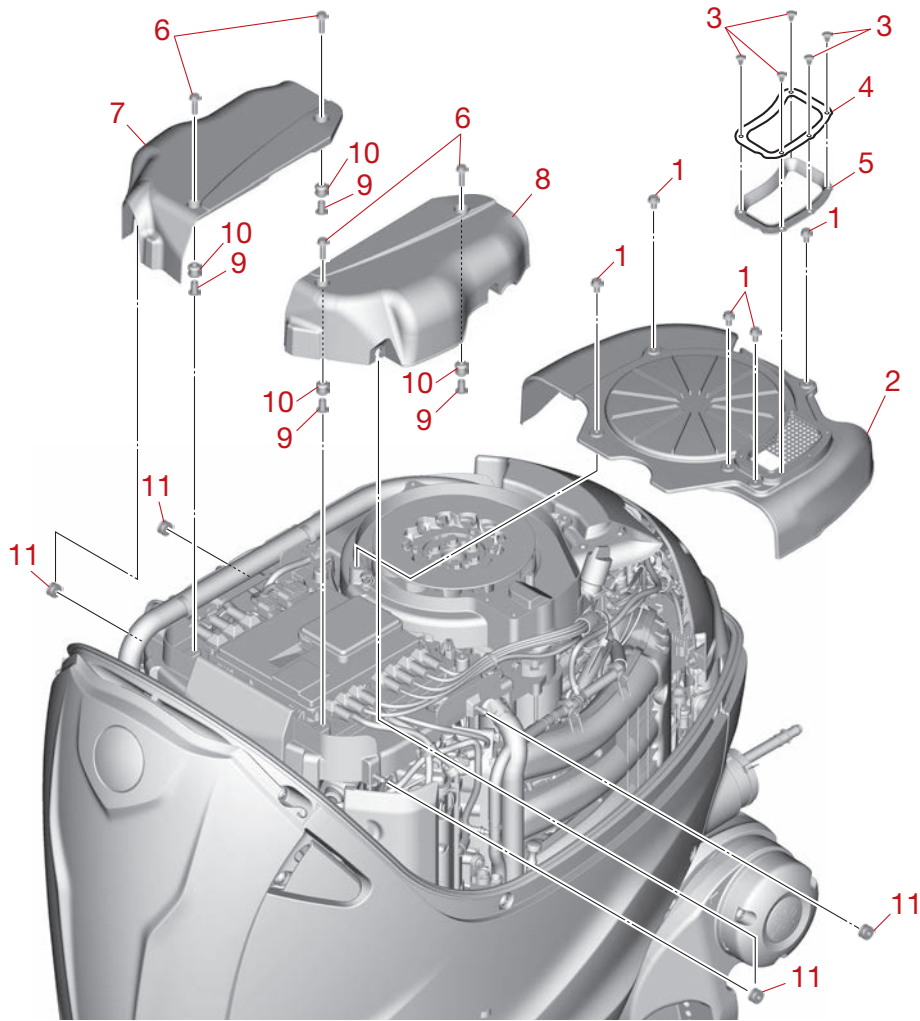
Removed valve lifter thickness = 3.000 mm
Measured valve clearance = 0.255 mm
Specified valve clearance = 0.205 mm
Necessary valve lifter thickness
= 3.000 mm + 0.255 mm – 0.205 mm
= 3.050 mm

4. Install:

- Valve lifter
- Camshaft
- Chain tensioner
See "Installing the camshaft, VCT assembly, and driven sprocket" (7-53).
- Timing belt
See "Installing the timing belt" (7-43).

- Flywheel magneto
See “Installing the flywheel magneto”
(7-25).
- Intake manifold (PORT)
See “Intake manifold” (6-24).
- Fuel hose assembly
See “Fuel hose assembly” (6-12).

Shroud cover and terminal cover

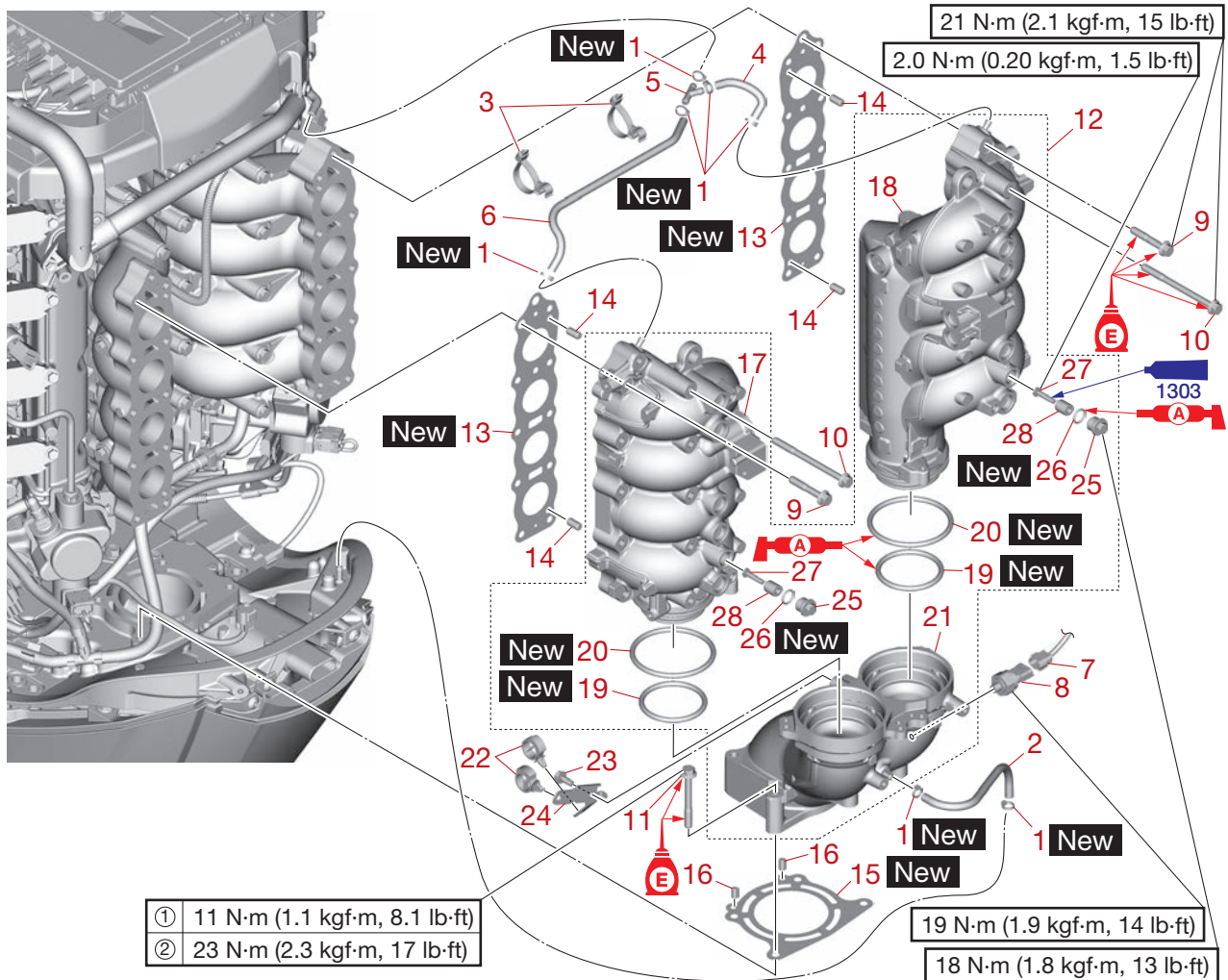


↑↓	Part name	Q'ty	Remarks
1	Bolt M6 × 12 mm	5	
2	Shroud cover	1	
3	Rivet	5	
4	Plate	1	
5	Damper	1	
6	Bolt M6 × 25 mm	4	
7	Terminal cover (PORT)	1	
8	Terminal cover (STBD)	1	
9	Collar	4	
10	Grommet	4	
11	Grommet	4	

Installing the shroud cover and terminal cover

1. Install:
 - Grommets
 - Terminal cover grommet
 - Terminal cover collar
 - Terminal cover
 - Shroud cover damper
 - Shroud cover damper plate
 - Shroud cover

Exhaust joint (outside)

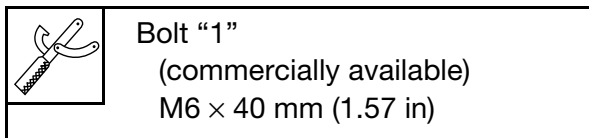
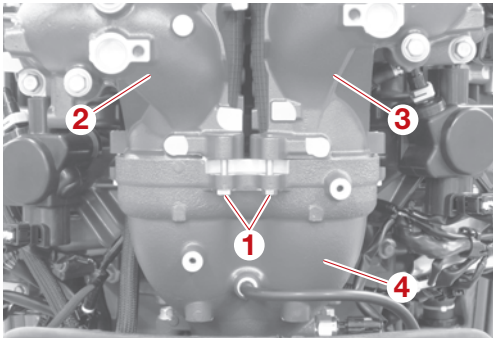


↑↓	Part name	Q'ty	Remarks
1	Plastic tie	7	
2	Hose	1	
3	Holder	2	
4	Hose	1	
5	Joint	1	
6	Hose	1	
7	Coupler	1	Disconnect.
8	Sensor	1	Water pressure
9	Bolt M8 × 50 mm	12	
10	Bolt M8 × 110 mm	10	
11	Bolt M8 × 70 mm	4	
12	Exhaust joint assembly	1	
13	Gasket	2	
14	Dowel	4	
15	Gasket	1	
16	Dowel	2	
17	Exhaust joint	1	PORT

↑↓	Part name	Q'ty	Remarks
18	Exhaust joint	1	STBD
19	O-ring	2	
20	O-ring	2	
21	Exhaust joint	1	Lower
22	Holder	2	
23	Bolt M6 × 16 mm	1	
24	Bracket	1	
25	Plug M16 × 11 mm	2	
26	O-ring	2	
27	Screw M5 × 25 mm	2	
28	Anode	2	

Removing the exhaust joint assembly

When not disassemble the exhaust joint assembly, use suitable bolts "1" to secure the exhaust joints "2", "3", and "4" so that they do not become misaligned, and then remove the exhaust joint assembly.

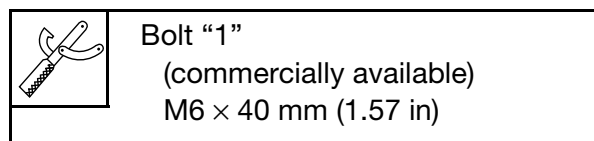
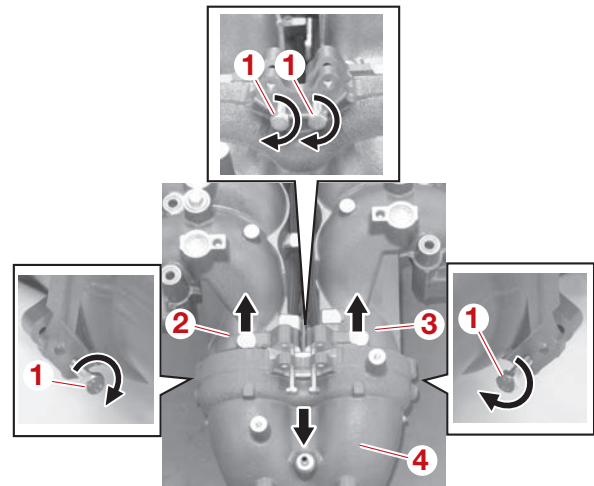


1. Remove:
 - Bottom cowling cover
See "Bottom cowling cover and apron cover" (9-1).
 - Bottom cowling
See "Removing the bottom cowling" (9-5).
 - Fuel rail cover
See "Fuel hose assembly" (6-12).

Disassembling the exhaust joint assembly

1. Disassemble:
 - Exhaust joint assembly

TIP: Use suitable bolts "1" to separate the exhaust joint (PORT) "2", exhaust joint (STBD) "3", and exhaust joint (lower) "4". Screw in the bolts "1" evenly.



Checking the exhaust joint

1. Check:
 - Exhaust joint
Corroded/cracked → Replace.

Checking the exhaust joint anode

1. Check:
 - Anode
Eroded (1/2 or more worn out) → Replace.
Adhered grease, oil, or scales → Clean.

NOTICE

Do not apply grease, oil, or paint to the anodes.

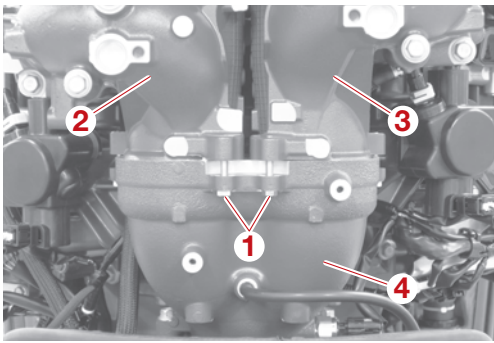
Checking the water pressure sensor

1. Check:
 - Exterior
Cracked → Replace.
 - Electrical performance
See "Checking the water pressure sensor" (5-26).

Installing the exhaust joint assembly

If the exhaust joint assembly is not disassembled, skip step 1. After tighten the exhaust joint assembly bolts temporarily, remove the bolts "1" that was used to secure the exhaust joints "2", "3", and "4".

Exhaust joint (outside)

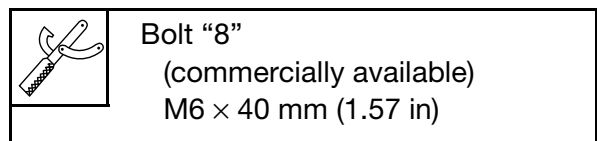
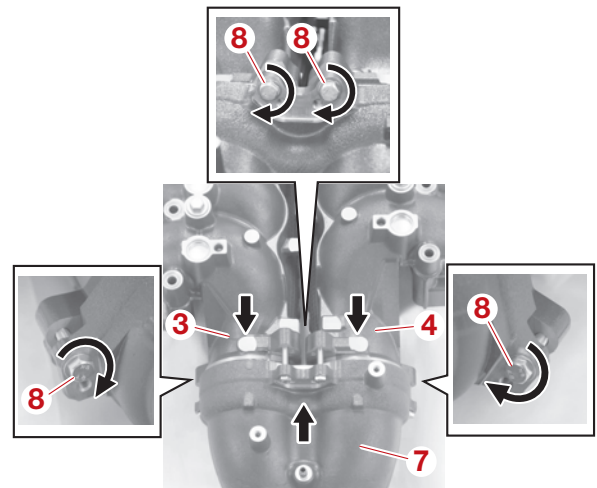


1. Assemble:

- Holder
- Holder bracket
- O-ring **New**
- Exhaust joint
 - a. Install new O-rings “1” and “2” to the exhaust joint (PORT) “3” and exhaust joint (STBD) “4”.
 - b. Install the holders “5” and holder bracket “6” to the exhaust joint (lower) “7”.
 - c. Install the exhaust joint (PORT) “3” and exhaust joint (STBD) “4” to the exhaust joint (lower) “7”.

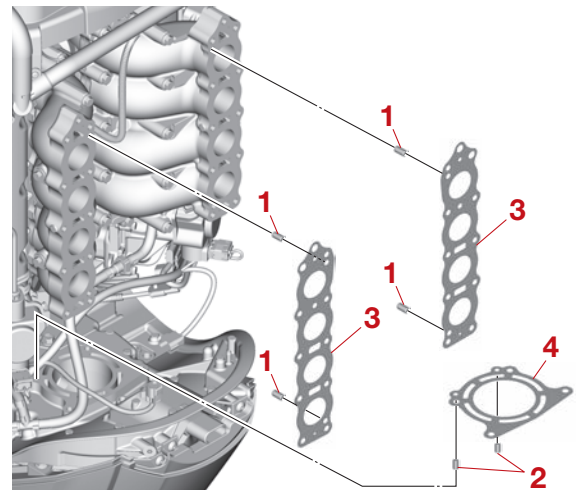
TIP:

- Use suitable bolts “8” to install the exhaust joint (PORT) “3” and exhaust joint (STBD) “4” to the exhaust joint (lower) “7”. Screw in the bolts “8” evenly.
- Do not remove the bolts “8” until the exhaust joint assembly bolts are temporarily tightened.

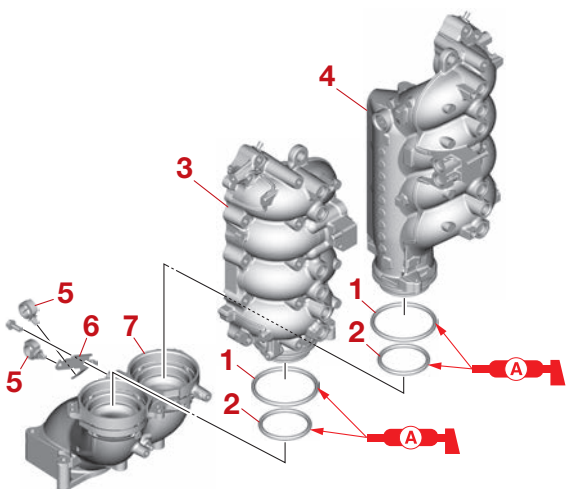


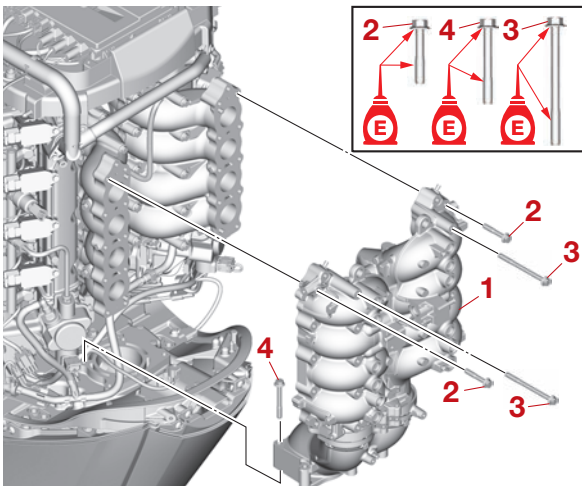
2. Install:

- Dowel
- Gasket **New**
- Exhaust joint assembly
 - a. Install the Dowels “1” and “2” and new gaskets “3” and “4”.

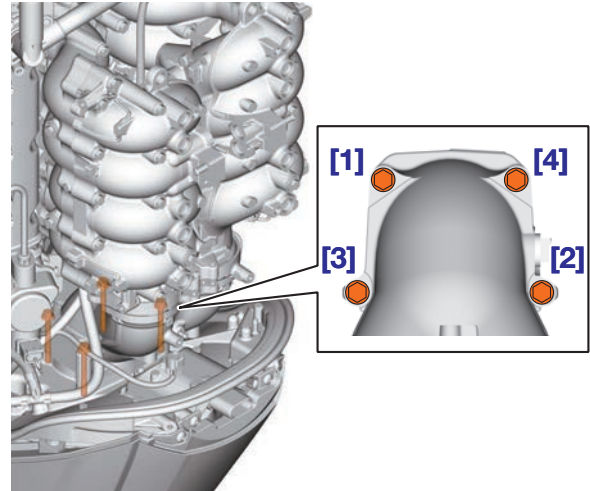



- b. Install the exhaust joint assembly “1”, and then tighten the exhaust joint assembly bolts “2”, “3”, and “4” temporarily.






c. Tighten the exhaust joint assembly bolts (PORT and STBD) to the specified torque in the order [1], [2], and so on.




	Exhaust joint assembly bolt (lower)
	1st: 11 N·m (1.1 kgf·m, 8.1 lb·ft) 2nd: 23 N·m (2.3 kgf·m, 17 lb·ft)


- Install:
 - Exhaust joint anode
 - O-ring **New**
 - Exhaust joint anode plug

	Exhaust joint anode screw
	2.0 N·m (0.20 kgf·m, 1.5 lb·ft)
	Exhaust joint anode plug
	18 N·m (1.8 kgf·m, 13 lb·ft)

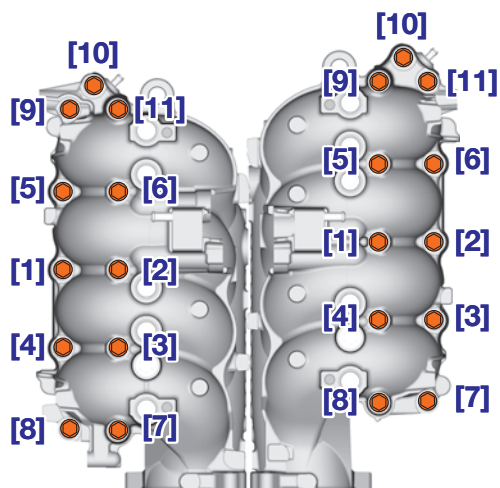
- Install:
 - Water pressure sensor
 - Pilot hose
 - Pilot hose joint
 - Plastic tie **New**
 - Pilot hose holder

	Water pressure sensor
	19 N·m (1.9 kgf·m, 14 lb·ft)

d. Tighten the exhaust joint assembly bolts (lower) to the specified torques in 2 stages and in the order [1], [2], and so on.

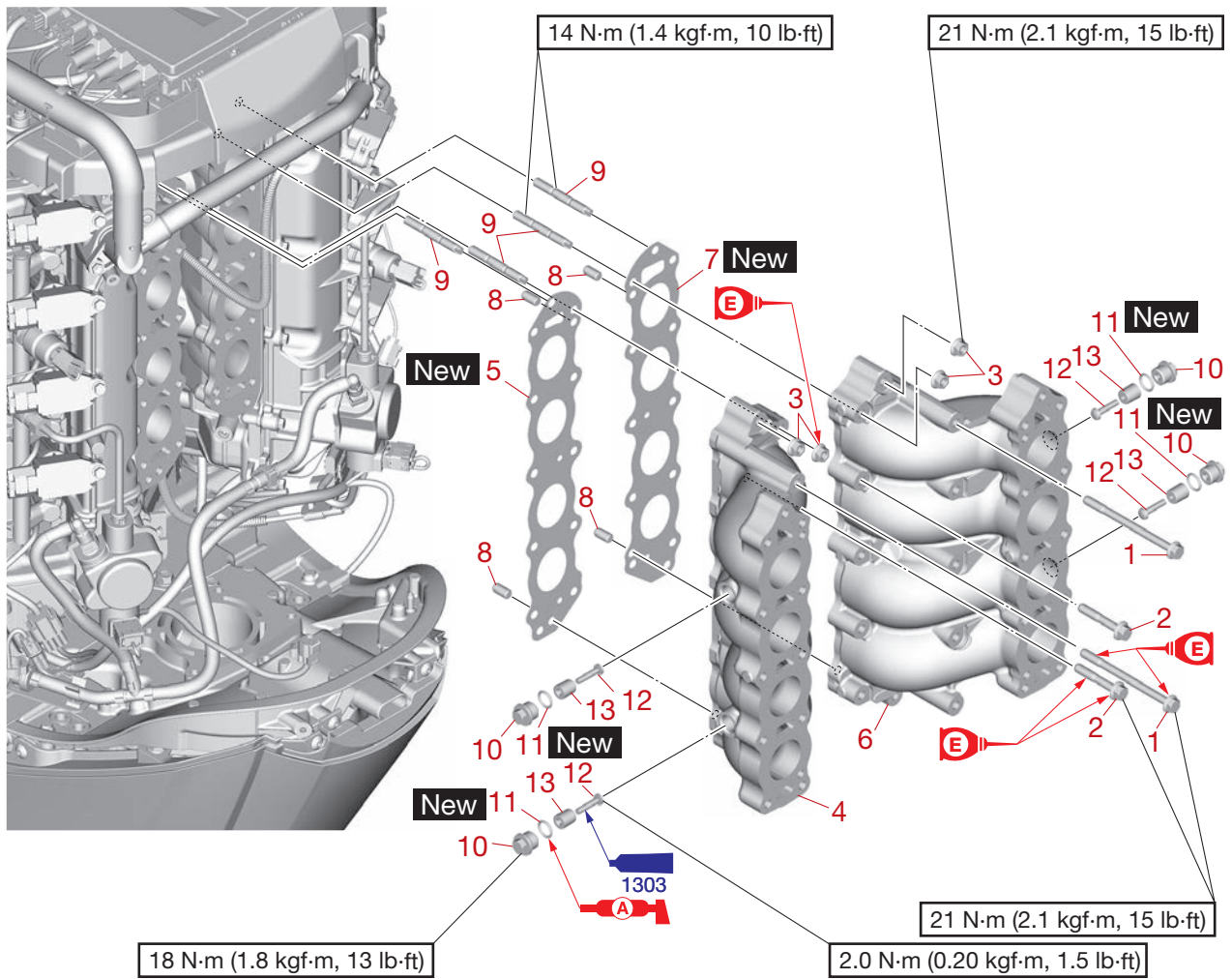
	Exhaust joint assembly bolt (PORT and STBD)
	21 N·m (2.1 kgf·m, 15 lb·ft)

d. Tighten the exhaust joint assembly bolts (lower) to the specified torques in 2 stages and in the order [1], [2], and so on.



- Connect:
 - Water pressure sensor coupler
- Install:
 - Fuel rail cover
See "Fuel hose assembly" (6-12).
 - Bottom cowling
See "Installing the bottom cowling" (9-7).
 - Bottom cowling cover
See "Bottom cowling cover and apron cover" (9-1).

Exhaust joint (inside)



↑↓	Part name	Q'ty	Remarks
1	Bolt M8 × 120 mm	10	
2	Bolt M8 × 50 mm	10	
3	Nut M8	4	
4	Exhaust joint	1	PORT
5	Gasket	1	
6	Exhaust joint	1	STBD
7	Gasket	1	
8	Dowel	4	
9	Stud bolt M8 × 65 mm	4	
10	Plug M16 × 11 mm	4	
11	O-ring	4	
12	Screw M5 × 25 mm	4	
13	Anode	4	

Removing the exhaust joint

- Remove:
 - Exhaust joint assembly
See "Exhaust joint (outside)" (7-7).

Checking the exhaust joint

- Check:
 - Exhaust joint
Corroded/cracked → Replace.

Checking the exhaust joint anode


- Check:
 - Anode
Eroded (1/2 or more worn out) → Replace.
Adhered grease, oil, or scales → Clean.

NOTICE

Do not apply grease, oil, or paint to the anodes.

Installing the exhaust joint

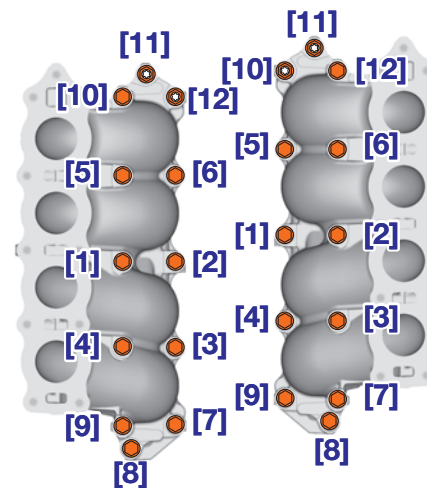
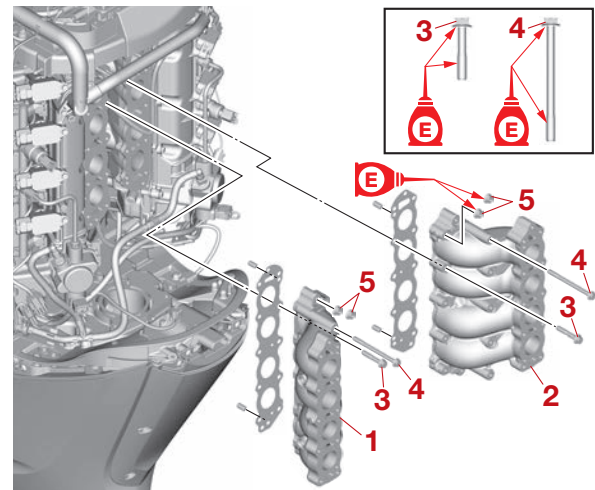
- Install:
 - Stud bolt


	Stud bolt 14 N·m (1.4 kgf·m, 10 lb·ft)
-------------------------------------------------------------------------------------	-------------------------------------------

- Install:
 - Dowel
 - Gasket **New**
 - Exhaust joint (PORT) "1"
 - Exhaust joint (STBD) "2"


TIP:

Tighten the exhaust joint bolts "3" and "4" and exhaust joint nuts "5" in the order [1], [2], and so on.



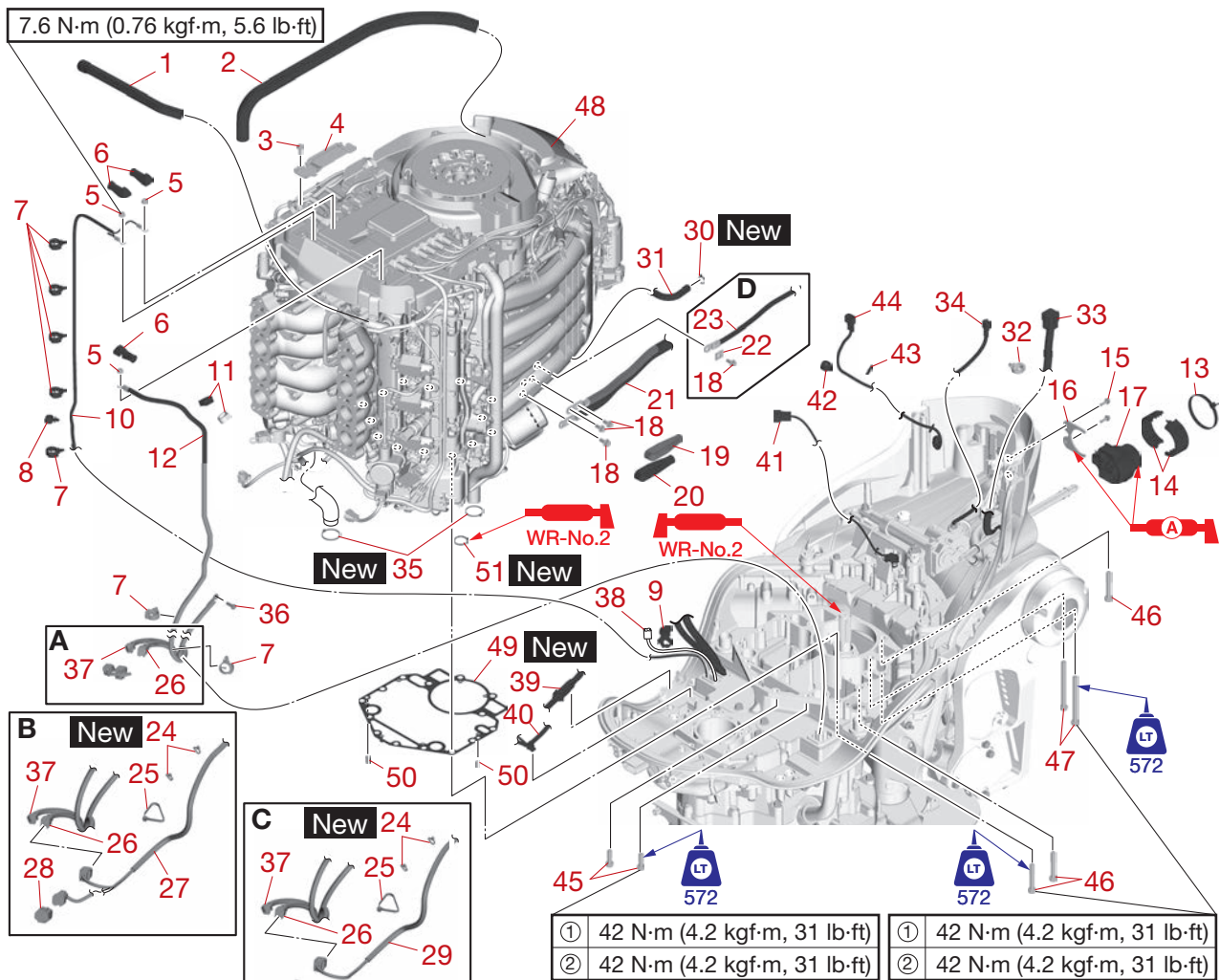
	Exhaust joint bolt "3", "4" 21 N·m (2.1 kgf·m, 15 lb·ft)
	Exhaust joint nut "5" 14 N·m (1.4 kgf·m, 10 lb·ft)

- Install:
 - Exhaust joint anode
 - O-ring **New**
 - Exhaust joint anode plug

	Exhaust joint anode screw 2.0 N·m (0.20 kgf·m, 1.5 lb·ft)
	Exhaust joint anode plug 18 N·m (1.8 kgf·m, 13 lb·ft)

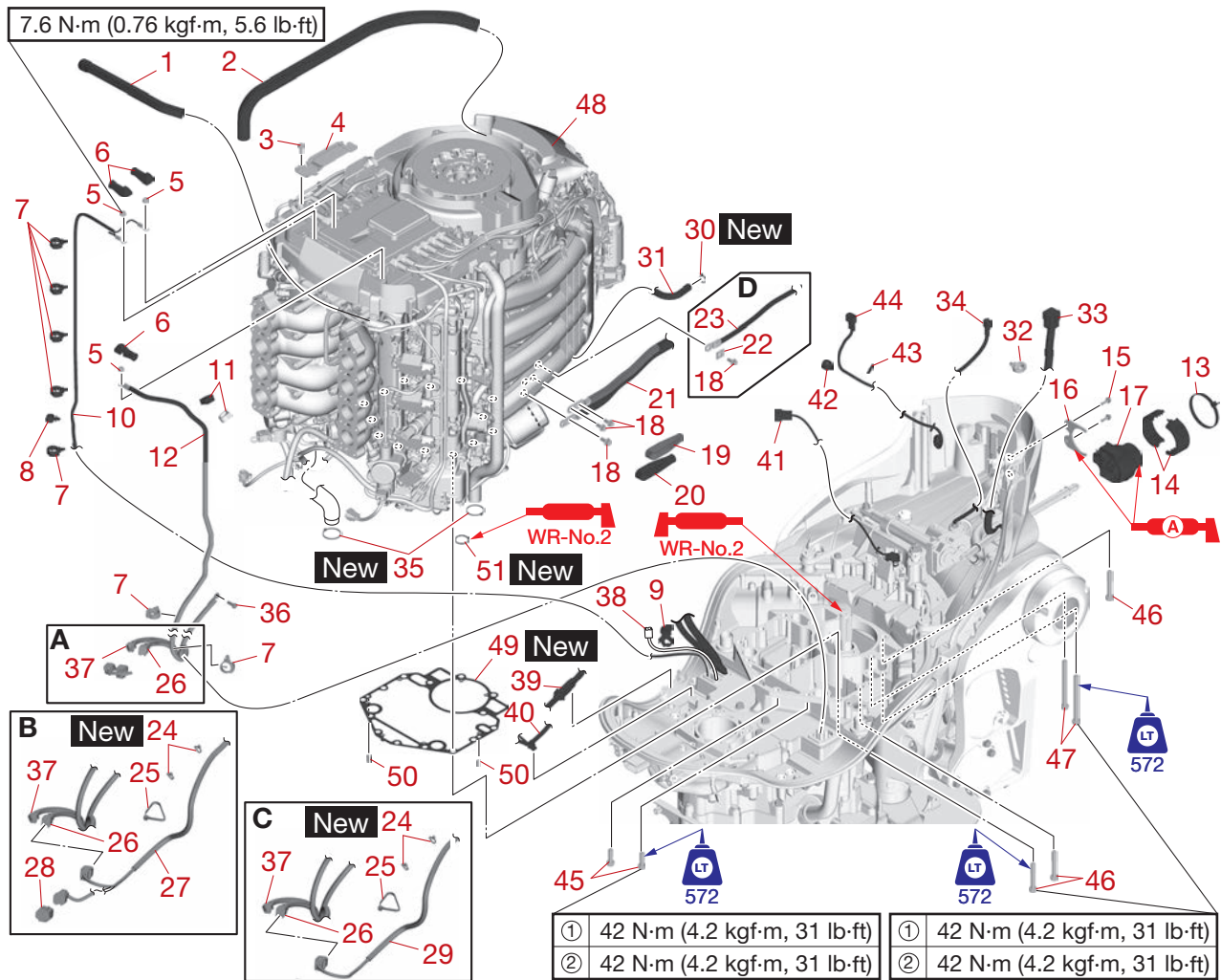
- Install:
 - Exhaust joint assembly
See "Installing the exhaust joint assembly" (7-8).

Power unit assembly



↑↓	Part name	Q'ty	Remarks
1	Hose	1	
2	Hose	1	
3	Bolt M6 × 16 mm	1	
4	Guide	1	
5	Nut M6	3	
6	Cap	3	
7	Holder	7	
8	Holder	1	
9	Holder	1	
10	Lead	1	
11	Holder	2	
12	Lead	1	
13	Plastic tie	1	
14	Retainer	1	
15	Bolt M6 × 20 mm	2	
16	Grommet holder	1	
17	Grommet	1	
18	Bolt M8 × 16 mm	4	
19	Cap	1	

↑↓	Part name	Q'ty	Remarks
20	Cap	1	
21	Battery cable	1	
22	Washer	1	
23	Lead	1	
24	Plastic tie	2	
25	Plastic tie	1	
26	Coupler	1	
27	Lead	1	
28	Cap	1	
29	Lead	1	
30	Plastic tie	1	
31	Hose	1	
32	Holder	1	
33	Coupler	1	
34	Coupler	1	
35	Plastic tie	2	
36	Bolt M6 × 16 mm	1	
37	Coupler	1	
38	Coupler	1	



↑↓	Part name	Q'ty	Remarks
39	Fuel hose	1	
40	Wire harness	1	
41	Coupler	1	
42	Holder	1	
43	Holder	1	
44	Coupler	1	
45	Bolt M10 × 35 mm	4	
46	Bolt M10 × 70 mm	6	
47	Bolt M10 × 130 mm	4	
48	Power unit assembly	1	
49	Gasket	1	
50	Dowel	2	
51	O-ring	1	

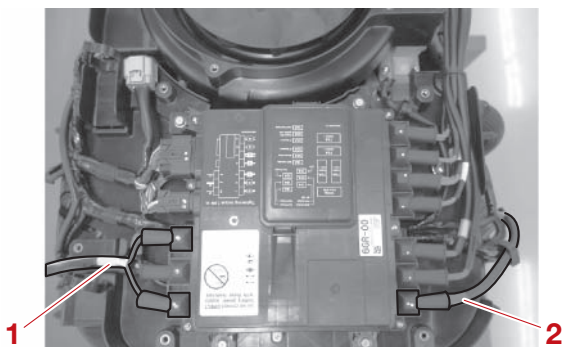
- A. For the single engine applications
- B. For the port or starboard outboard motor of multiple engine applications
- C. For the center outboard motor of multiple engine applications
- D. Optional (isolator lead)

Removing the power unit

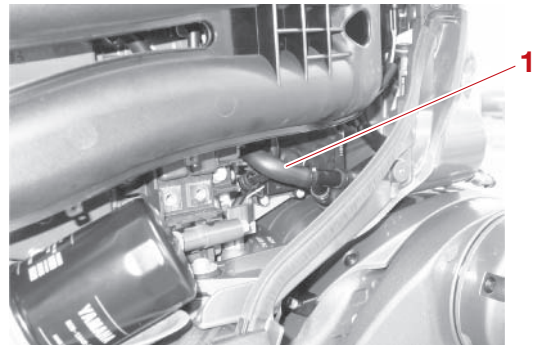
1. Remove:
 - Bottom cowling cover and apron cover
See “Bottom cowling cover and apron cover” (9-1).
 - Bottom cowlings
See “Bottom cowling (PORT and STBD)” (9-3).
 - Aprons
See “Apron” (9-8).
 - Dipstick
See “Intake manifold” (6-24).
 - Gear oil changing system hoses
See “Cooling water hose and gear oil changing hose” (9-9).
 - Fuel rail covers
See “Fuel hose assembly” (6-12).
 - Low-pressure fuel pump holder
(from the low-pressure fuel pump bracket)
See “Low-pressure fuel pump” (6-6).

TIP: _____
After removing the low-pressure fuel pump holder, support the low-pressure fuel pump, such as by securing it to the power unit assembly using a string, and so on.

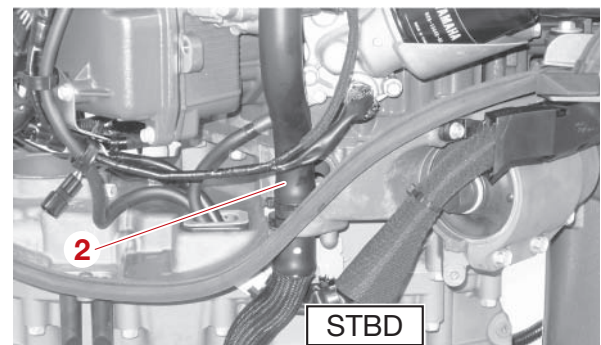
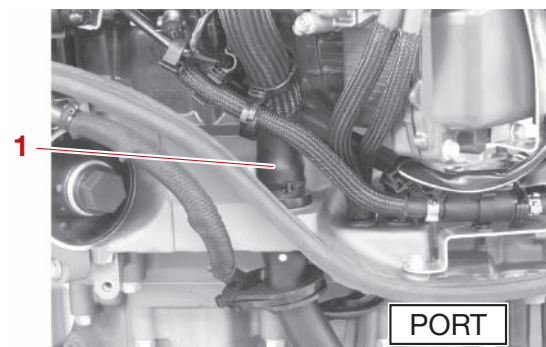
2. Remove:
 - Exhaust joint assembly
See “Exhaust joint (outside)” (7-7).
3. Remove:
 - PTT motor lead “1”
 - SCU positive lead “2”



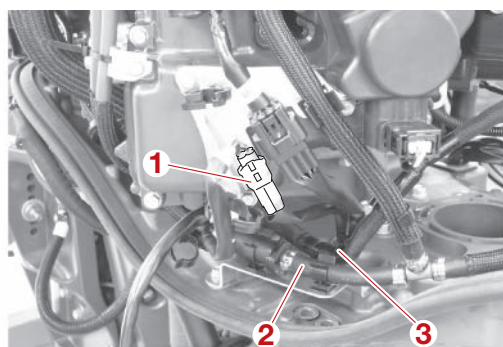
4. Disconnect:
 - Flushing hose “1”
(from the joint)



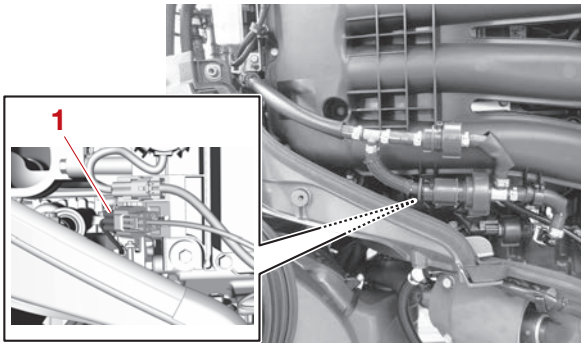
5. Disconnect:
 - Cooling water hoses “1”, “2”
(from the joint)



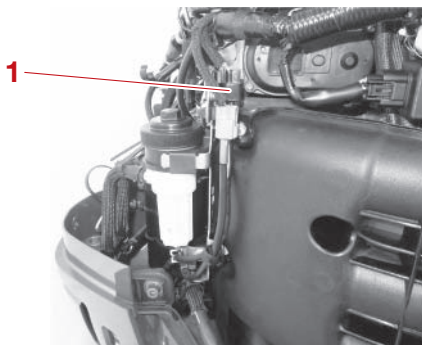
6. Disconnect:
 - PTT sensor coupler “1”
 - Fuel hose “2”
(from the holder bracket)
 - Wire harness “3”
(from the holder bracket)



7. Disconnect:
 - SPS lead coupler “1”



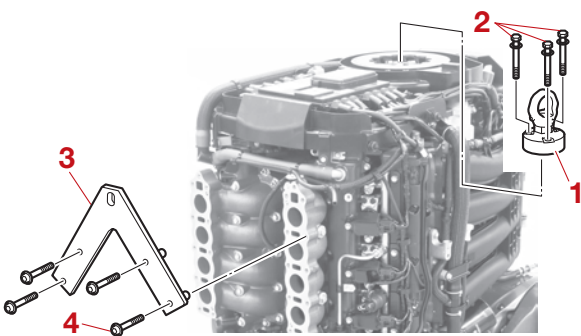
8. Remove:
- PTT switch lead “1”



9. Install:
- Special service tool

NOTICE

When lifting the outboard motor, make sure to use the specified special service tool. Other bolts and hanging jigs could bend or break, causing the outboard motor to fall.

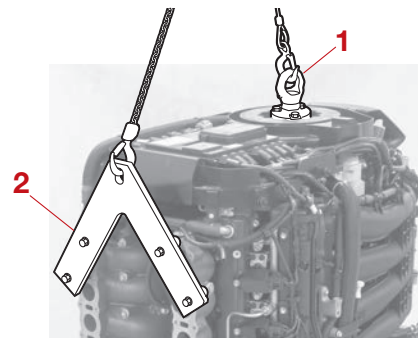


- Lifting eye “1”
90890-06953
- Bolt hexagon with washer “2”
90890-06821
- Balance hanger “3”
90890-06460
- Bolt set “4”
90890-06969
- Bolt hexagon with washer “2”
YB-06821

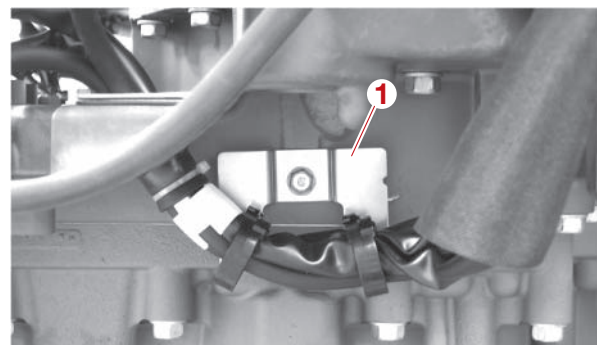


- Lifting eye bolt
36 N·m (3.6 kgf·m, 27 lb·ft)
- Balance hanger bolt
18 N·m (1.8 kgf·m, 13 lb·ft)

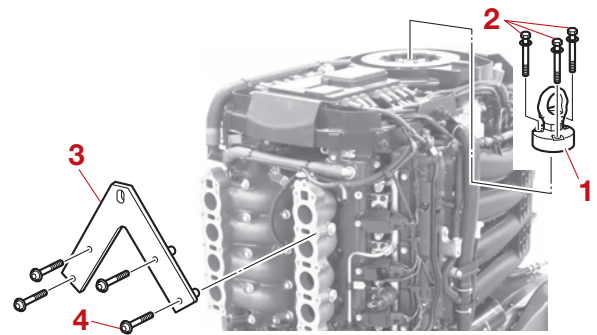
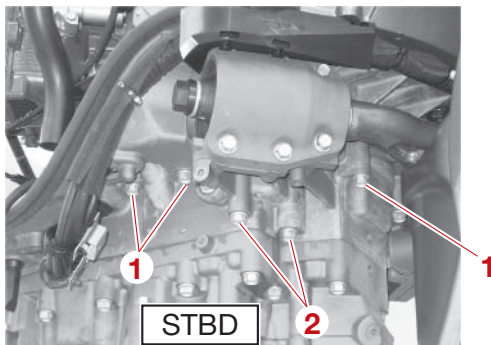
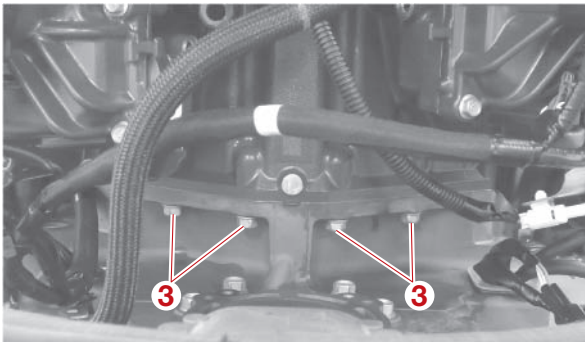
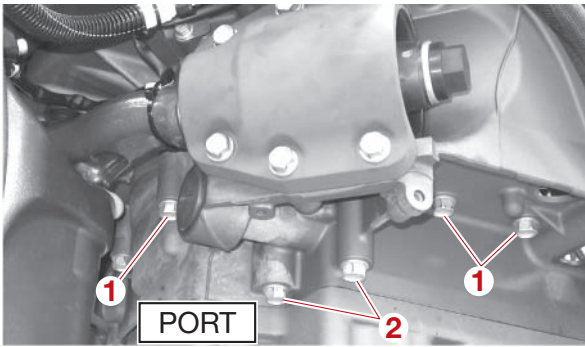
10. Install:
- Lifting harness
(onto the special service tool “1” and “2”)





11. Remove:
- Power unit
 - Remove the bracket “1”.



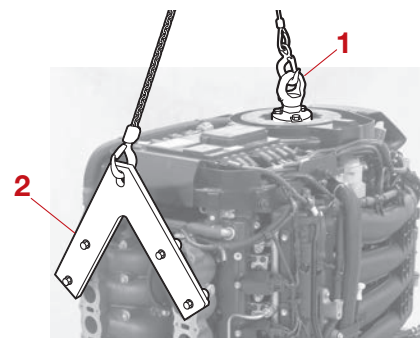
- Remove the power unit mounting bolts “1”, “2”, and “3”, and then remove the power unit.



- | | |
|-----------------------------------------------------------------------------------|---------------------------------------------|
|  | Lifting eye "1"
90890-06953 |
| | Bolt hexagon with washer "2"
90890-06821 |
| | Balance hanger "3"
90890-06460 |
| | Bolt set "4"
90890-06969 |
| | Bolt hexagon with washer "2"
YB-06821 |

- | | |
|-------------------------------------------------------------------------------------|-----------------------------------------------------|
|  | Lifting eye bolt
36 N·m (3.6 kgf·m, 27 lb·ft) |
| | Balance hanger bolt
18 N·m (1.8 kgf·m, 13 lb·ft) |

3. Install:
 - Lifting harness
(onto the special service tool "1" and "2")



Installing the power unit

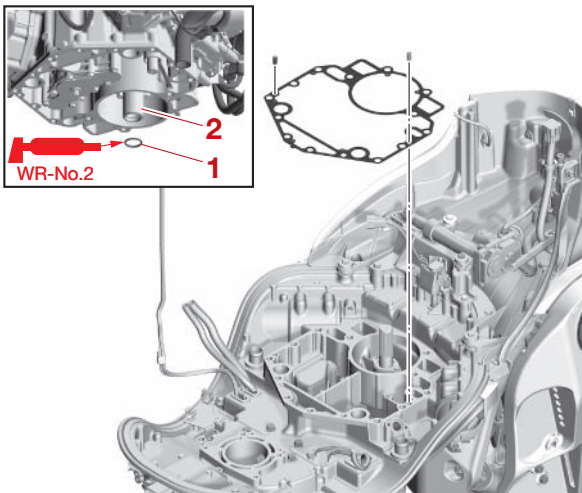
1. Clean:
 - Power unit matching surface
2. Install:
 - Special service tool

NOTICE

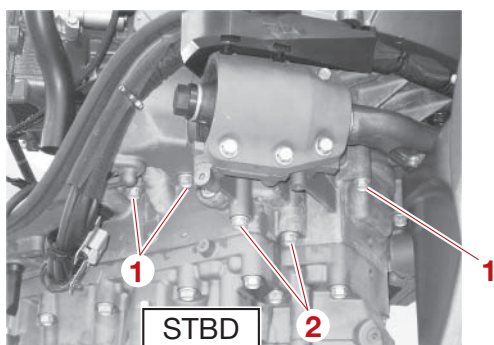
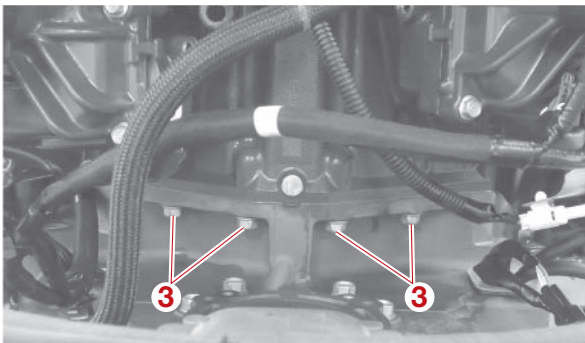
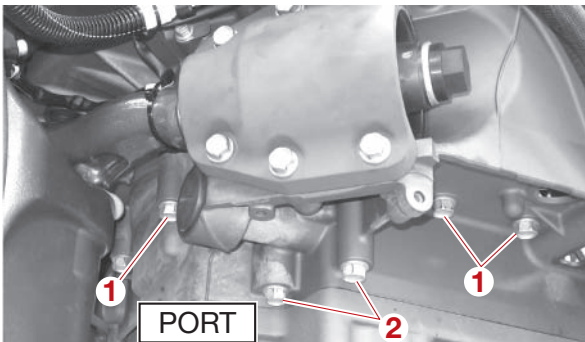
When lifting the outboard motor, make sure to use the specified special service tool. Other bolts and hanging jigs could bend or break, causing the outboard motor to fall.

4. Install:
 - O-ring **New**
 - Dowels
 - Gasket **New**
 - Power unit
 - a. Install a new O-ring "1" into the flange "2" and install the dowels and new gasket onto the exhaust guide.

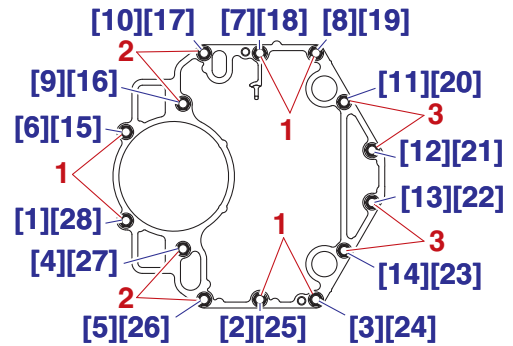
Power unit assembly



- b. Install the power unit, and then tighten the power unit mounting bolts "1", "2" and "3" temporarily.

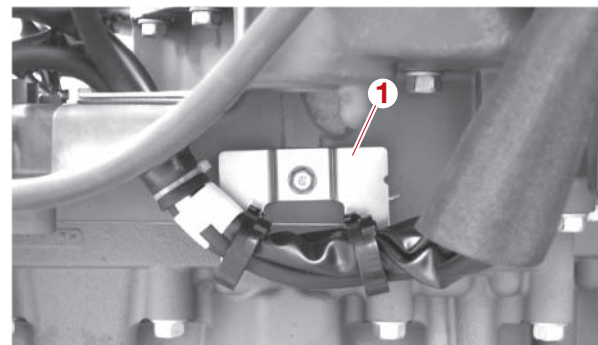


- c. Tighten the power unit mounting bolts "1", "2" and "3" to the specified torques in 2 stages and in the order [1], [2], and so on.

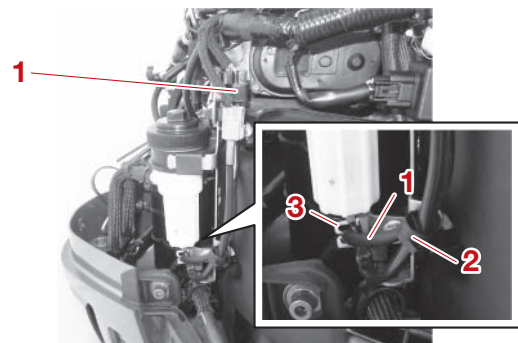


	Power unit mounting bolt "1", "2", "3"
	1st: 42 N·m (4.2 kgf·m, 31 lb·ft)
	2nd: 42 N·m (4.2 kgf·m, 31 lb·ft)

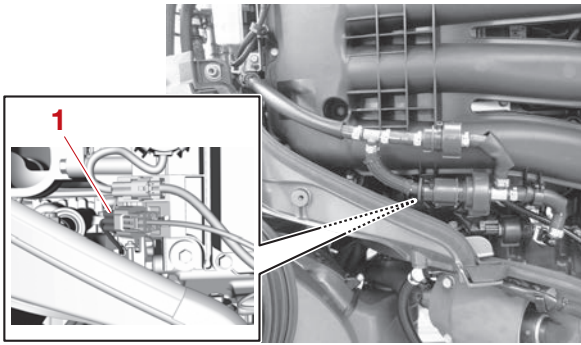
- d. Install the bracket "1"



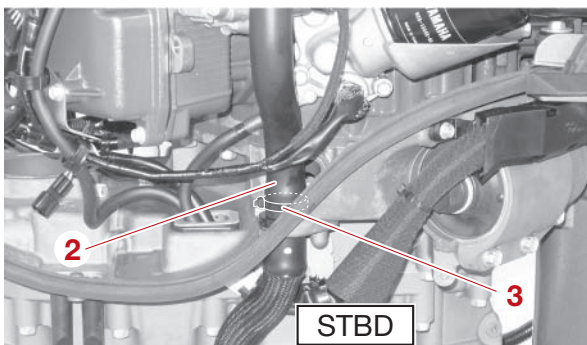
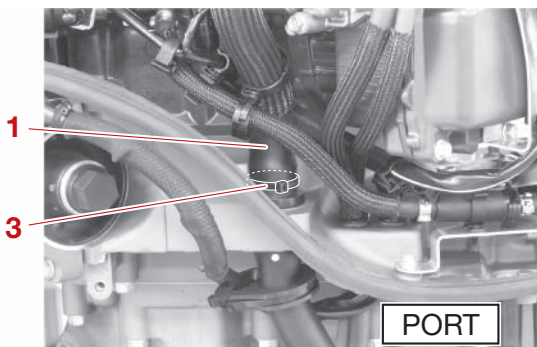
5. Install:
- PTT switch lead "1"
 - Holders "2", "3"



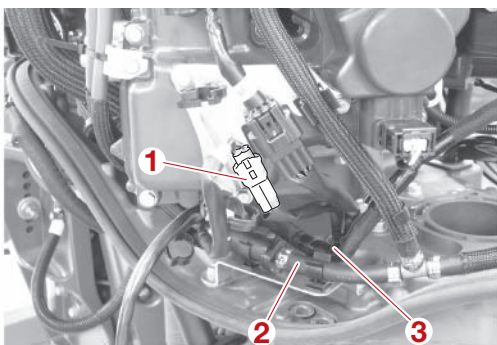
6. Connect:
- SPS lead coupler "1"



7. Connect:
- Cooling water hoses “1”, “2” (to the joint)
 - Plastic ties “3” **New**



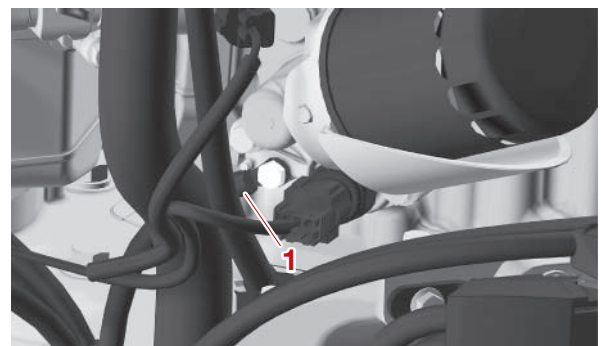
8. Connect:
- PTT sensor coupler “1”
 - Fuel hose “2” (to the holder bracket)
 - Wire harness “3” (to the holder bracket)



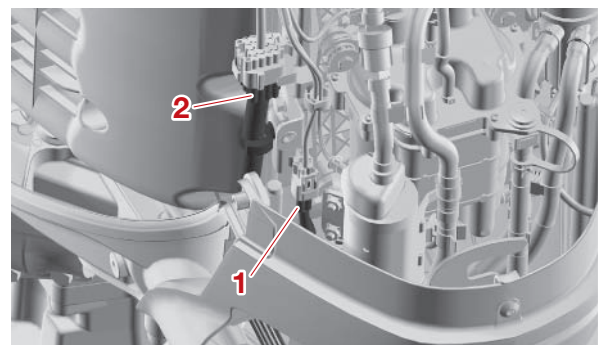
9. Install:
- SCU signal coupler (4 pins)
 - SCU signal coupler (3 pins)

TIP: _____
 For single engine applications, connect the SCU signal coupler (4 pins) to the wire harness, and for multiple engine applications, connect the coupler to the SCU communication lead (optional). See “Electrical component and wire harness routing” (5-1).

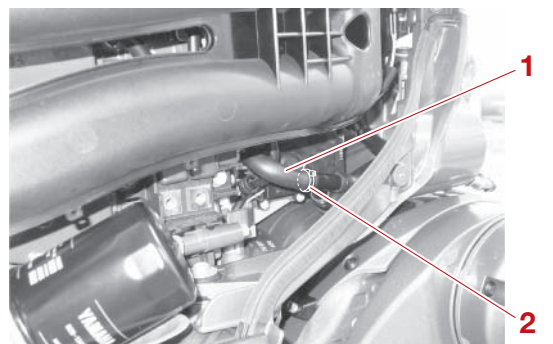
10. Connect:
- SCU negative terminal “1”



11. Install:
- Shift actuator motor coupler “1”
 - Main wire harness coupler “2”

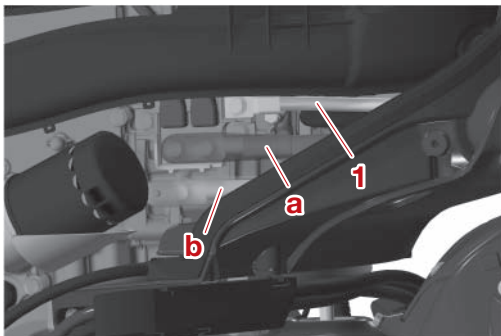


12. Connect:
- Flushing hose “1” (to the joint)
 - Plastic tie “2” **New**



13. Install:
- Isolator lead “1”
 - Washer (equipped with optional isolator lead)
 - Positive battery cable “a”
 - Negative battery cable “b”

TIP: _____
 When installing the battery cables, make sure that the flushing hose is not pulled or twisted and does not contact other parts.



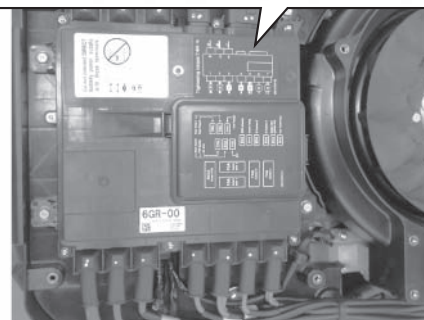
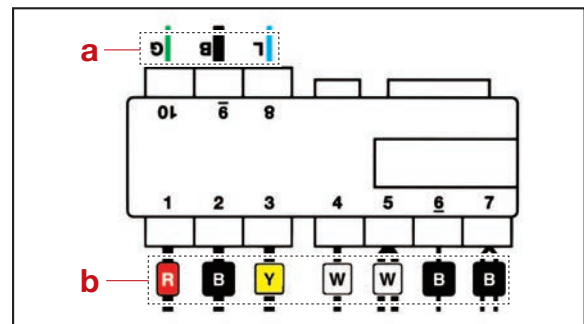
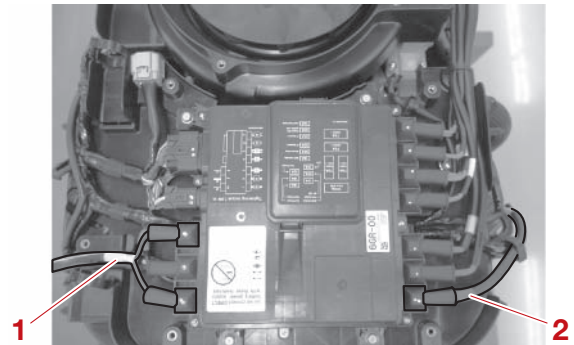
14. Install (for multiple engine applications):
- SCU communication lead
 - Plastic tie **New**
 See “Installing the SCU communication lead” (3-15).
15. Install:
- Rigging grommet
 - Rigging grommet holder
 - Rigging grommet retainer
 See “Installing the rigging grommet” (3-13).

TIP: _____
 Route each harness through the proper hole in the rigging grommet. See “Rigging grommet description” (3-13).


16. Install:
- Caps
 - PTT motor lead “1”
 - SCU positive lead “2”

NOTICE _____
When tightening the electrical management box terminal nuts, do not exceed the specified torque. Otherwise, the base of the electrical management box could be damaged.

- TIP:** _____
- Route the PTT lead and SCU lead. See “Electrical component and wire harness routing” (5-1).
 - Connect the specified leads to the terminals of the electrical management box.



a. Lead color
 b. Tape color

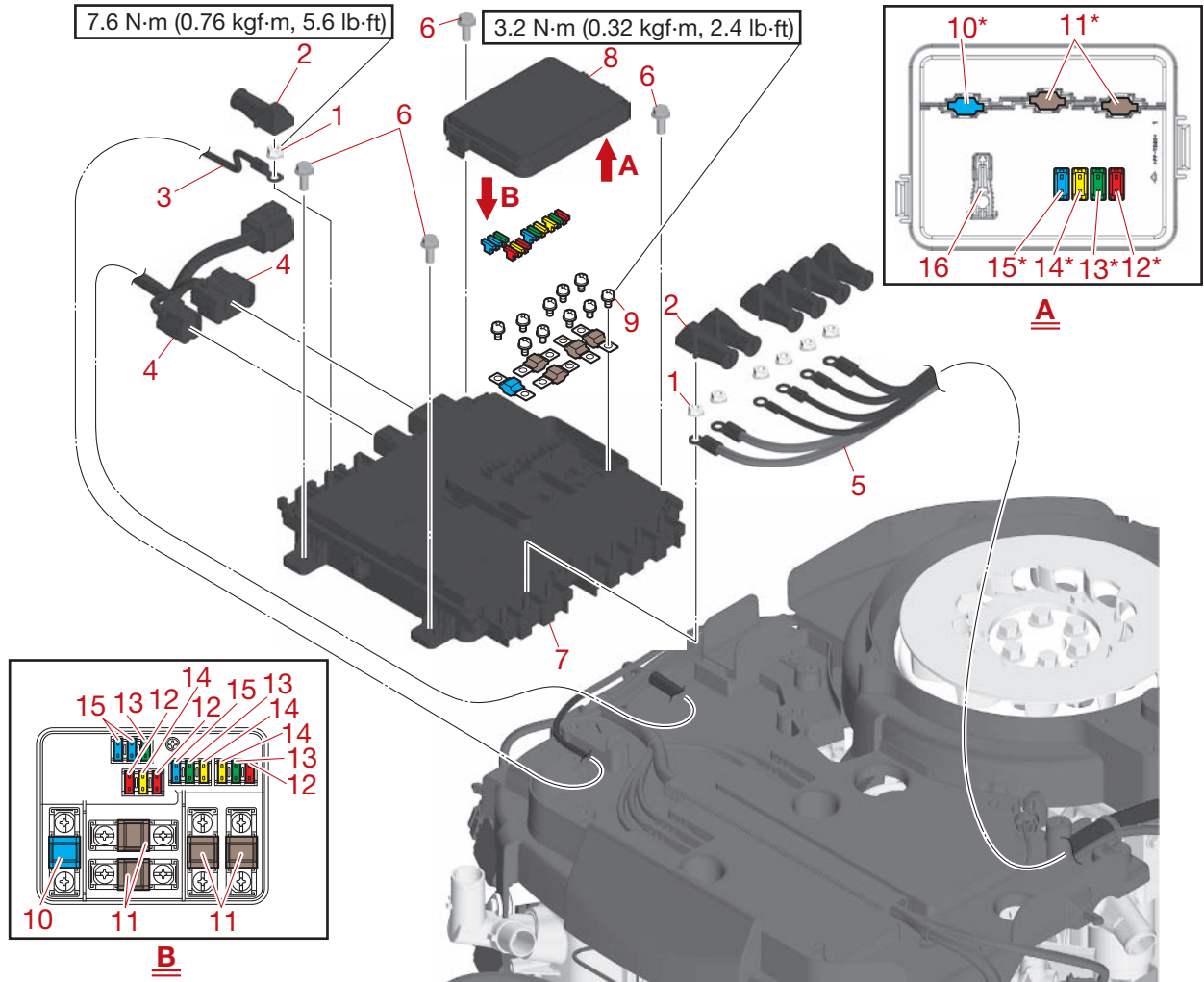
	Electrical management box terminal nut
	7.6 N·m (0.76 kgf·m, 5.6 lb·ft)

17. Install:
- Blowby hose guide
 - Holders
 - Blowby hoses
18. Install:
- Exhaust joint assembly
 See “Installing the exhaust joint assembly” (7-8).

19. Install:

- Low-pressure fuel pump holder
(to the low-pressure fuel pump bracket)
See “Low-pressure fuel pump” (6-6).
- Fuel rail covers
See “Fuel hose assembly” (6-12).
- Gear oil changing system hoses
See “Cooling water hose and gear oil
changing hose” (9-9).
- Dipstick
See “Intake manifold” (6-24).
- Aprons
See “Apron” (9-8).
- Bottom cowlings
See “Bottom cowling (PORT and STBD)”
(9-3).
- Bottom cowling cover and apron cover
See “Bottom cowling cover and apron
cover” (9-1).

Electrical management box

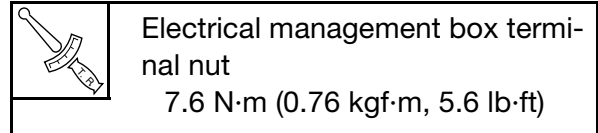
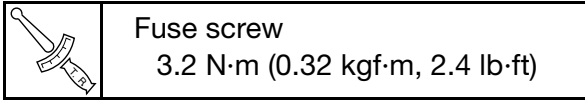


↑↓	Part name	Q'ty	Remarks
1	Nut M6	7	
2	Cap	7	
3	Lead	1	
4	Coupler	2	
5	Extension wire harness	1	
6	Bolt M6 × 16 mm	4	
7	Electrical management box	1	
8	Cover	1	
9	Screw M5 × 10 mm	10	
10	Fuse	2	100 A
11	Fuse	6	70 A
12	Fuse	4	10 A
13	Fuse	4	30 A
14	Fuse	4	20 A
15	Fuse	4	15 A
16	Fuse puller	1	

*The locations of the spare fuses are not specified.

Installing the electrical management box

1. Install:
 - Fuses



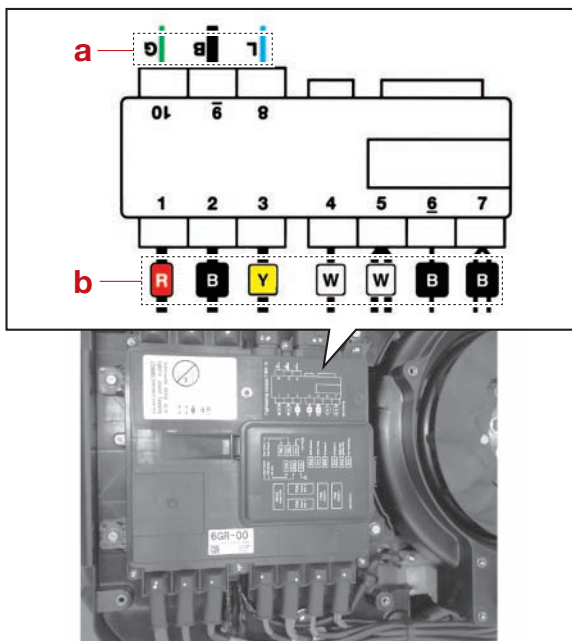
2. Install:
 - Fuse cover
 - Electrical management box
 - Caps
 - Extension wire harness
 - PTT ground lead (wire harness)
 - Couplers

NOTICE

When tightening the electrical management box terminal nuts, do not exceed the specified torque. Otherwise, the base of the electrical management box could be damaged.

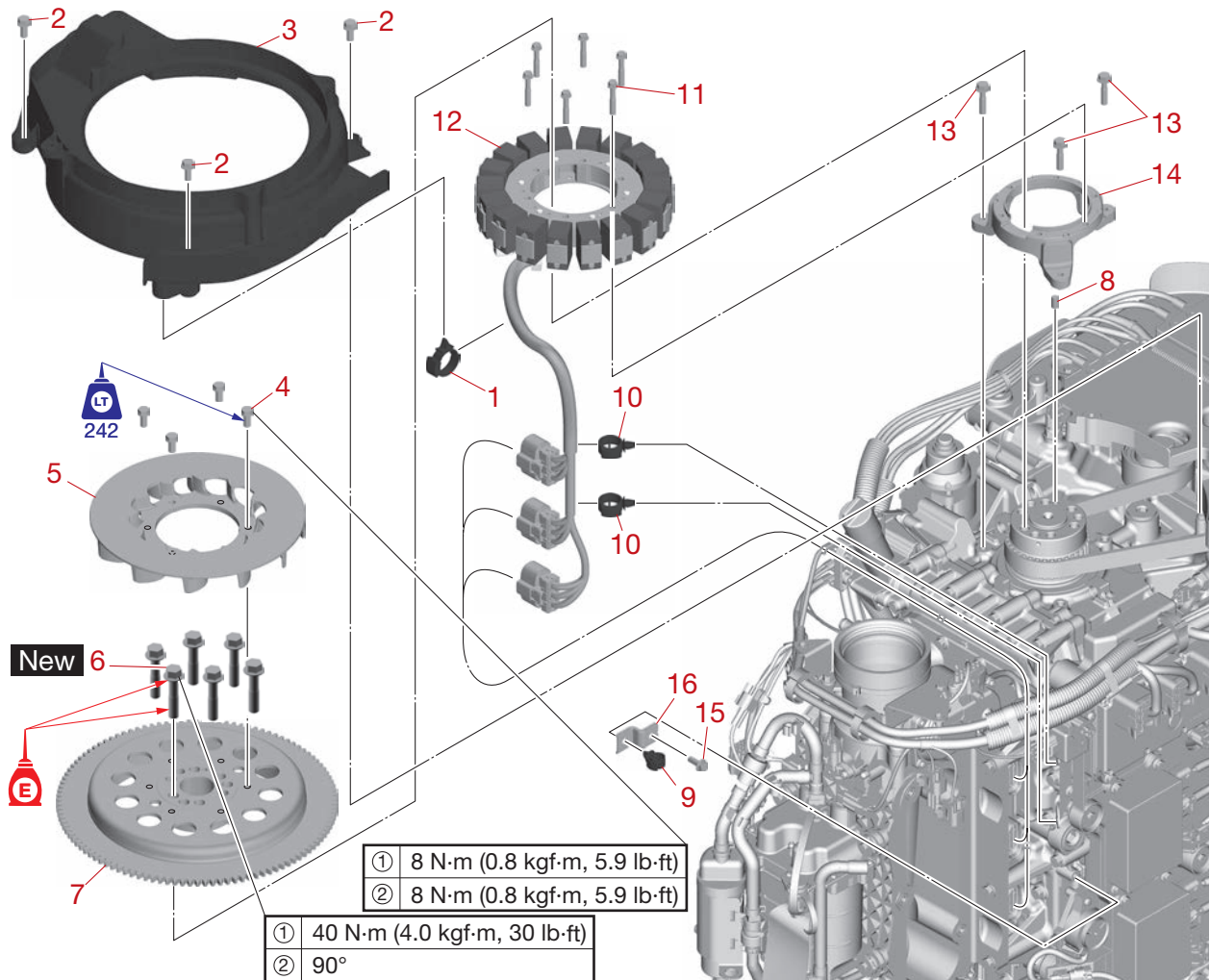
TIP:

Connect the specified leads to the terminals of the electrical management box.



- a. Lead color
- b. Tape color

Flywheel magneto



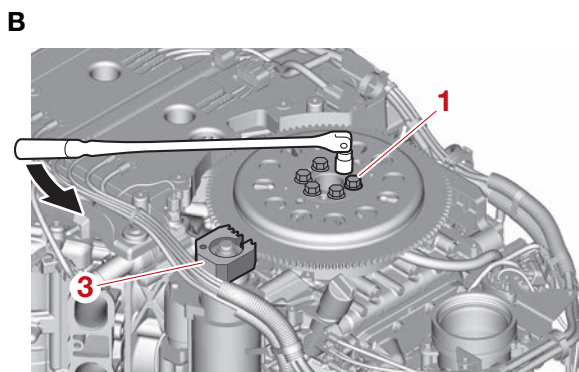
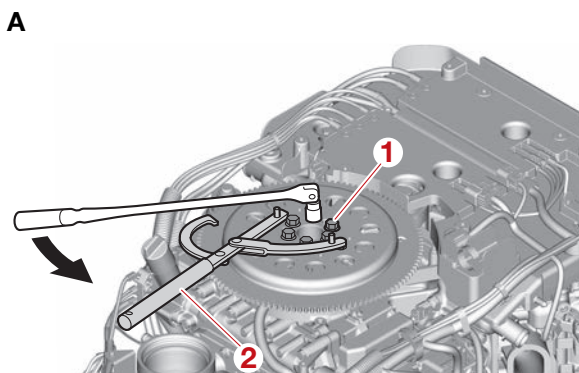
↕	Part name	Q'ty	Remarks
1	Holder	1	
2	Bolt M6 × 16 mm	3	
3	Air shroud	1	
4	Bolt M6 × 16 mm	4	
5	Fan	1	
6	Bolt M10 × 50 mm	6	
7	Flywheel magneto	1	
8	Dowel	1	
9	Holder	1	
10	Holder	2	
11	Bolt M6 × 35 mm	6	
12	Stator assembly	1	
13	Bolt M6 × 30 mm	3	
14	Base assembly	1	
15	Bolt M6 × 16 mm	1	
16	Bracket	1	

Removing the flywheel magneto

1. Remove:
 - Intake silencer
See "ETV" (6-28).
 - Fuel hose assembly
See "Fuel hose assembly" (6-12).
 - Intake manifold (PORT)
See "Intake manifold" (6-24).
2. Remove:
Flywheel magneto bolts "1"

NOTICE

Apply force in the direction of the arrow to prevent the special service tool "2" from slipping off easily.



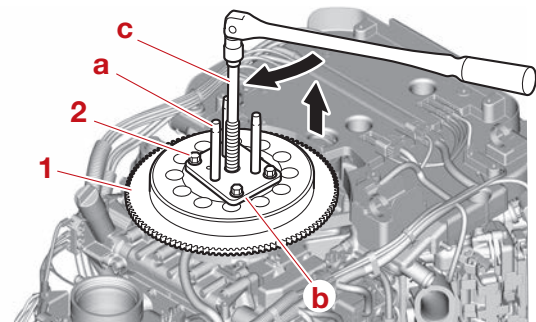
A. Conventional special service tool
B. New special service tool

	Rotor holder "2"
	90890-01235
	Flywheel stopper "3"
	90890-06598
	Universal magneto and rotor holder "2"
YU-01235	
Flywheel stopper "3"	
YB-06598	

3. Remove:
 - Flywheel magneto

TIP:

Install the guide bolts "a" to the crankshaft, and then install the guide plate "b" to the flywheel magneto "1" using the flywheel magneto fan bolts "2". Turn the center bolt "c" clockwise using a wrench to remove the flywheel magneto "1".



	Flywheel guide 90890-06955
--	-------------------------------

Installing the flywheel magneto

1. Install:
 - Holder bracket
 - Base assembly
 - Holders
 - Stator assembly

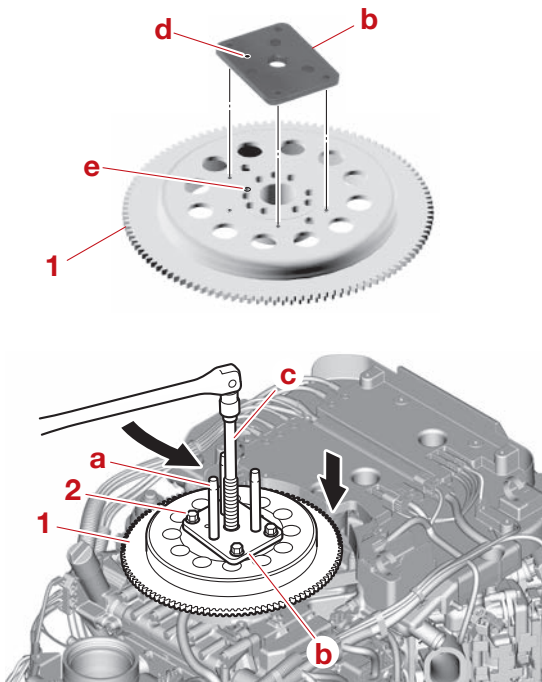
TIP:

Route the stator assembly leads. See "Electrical component and wire harness routing" (5-1).

2. Install:
 - Dowel
 - Flywheel magneto
 - Flywheel magneto bolts **New**
 - a. Check the mating surfaces of the flywheel magneto and crankshaft for dirt and other foreign material. Clean if there is dirt or other foreign material.
 - b. Install the flywheel magneto using the special service tool.

TIP: _____

- Install the guide bolts “a” to the crankshaft, and then install the guide plate “b” to the flywheel magneto “1” using the flywheel magneto fan bolts “2”. Turn the center bolt “c” counterclockwise using a wrench to install the flywheel magneto “1”.
- Align the hole “d” in the guide plate “b” with the dowel hole “e” in the flywheel magneto “1”.



	<p>Flywheel guide 90890-06955</p>
--	---------------------------------------

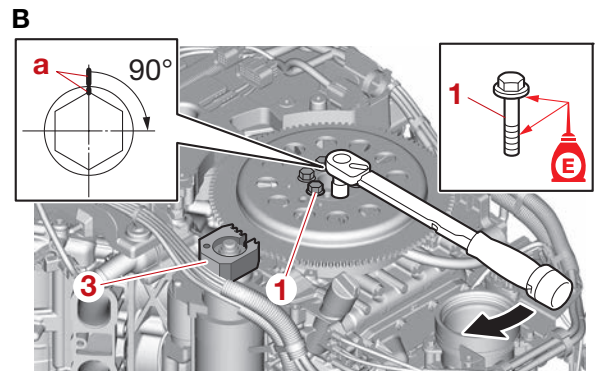
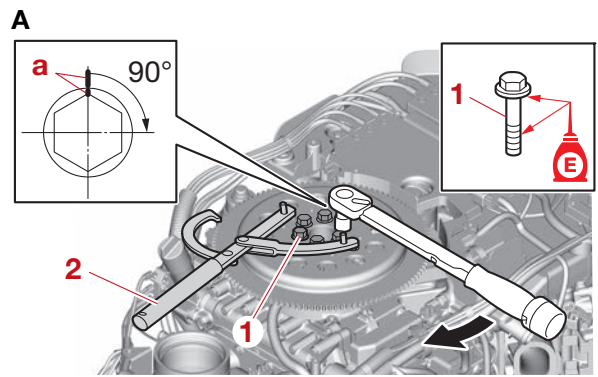
- Remove the special service tool and flywheel magneto fan bolts.
- Install new flywheel magneto bolts “1”, and then tighten the bolts to the specified torques in 2 stages and in the order [1], [2], and so on.

NOTICE _____

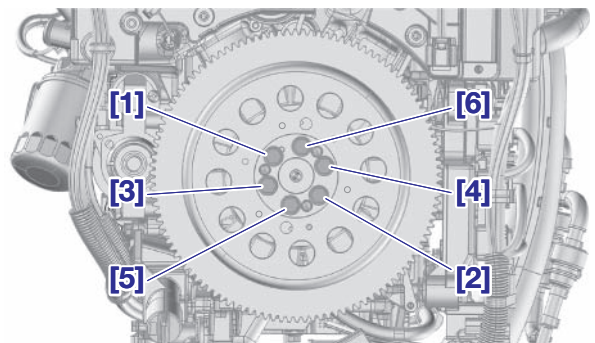
Apply force in the direction of the arrow to prevent the special service tool “2” from slipping off easily.

TIP: _____

In the second tightening stage for the flywheel magneto bolts “1”, mark the bolts and flywheel magneto with identification marks “a”, and then tighten the bolts 90° from the marks on the flywheel magneto.



A. Conventional special service tool
B. New special service tool





Rotor holder "2"
90890-01235
Flywheel stopper "3"
90890-06598
Universal magneto and rotor holder "2"
YU-01235
Flywheel stopper "3"
YB-06598



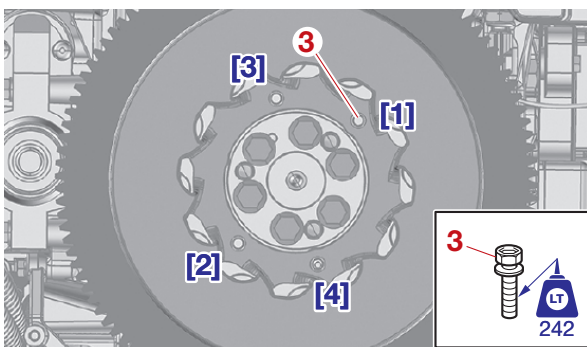
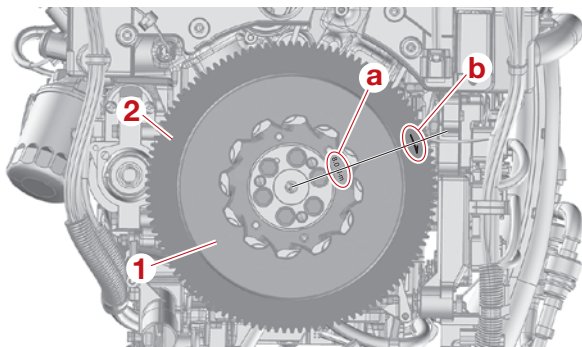
Flywheel magneto bolt "1"
1st: 40 N·m (4.0 kgf·m, 30 lb·ft)
2nd: 90°

3. Install:

- Flywheel magneto fan "1"
- Air shroud

TIP:

- Align the "8.0 N·m" mark "a" on the flywheel magneto fan "1" with the mark "b" on the flywheel magneto "2".
- Tighten the flywheel magneto fan bolts "3" to the specified torques in 2 stages and in the order [1], [2], and so on.

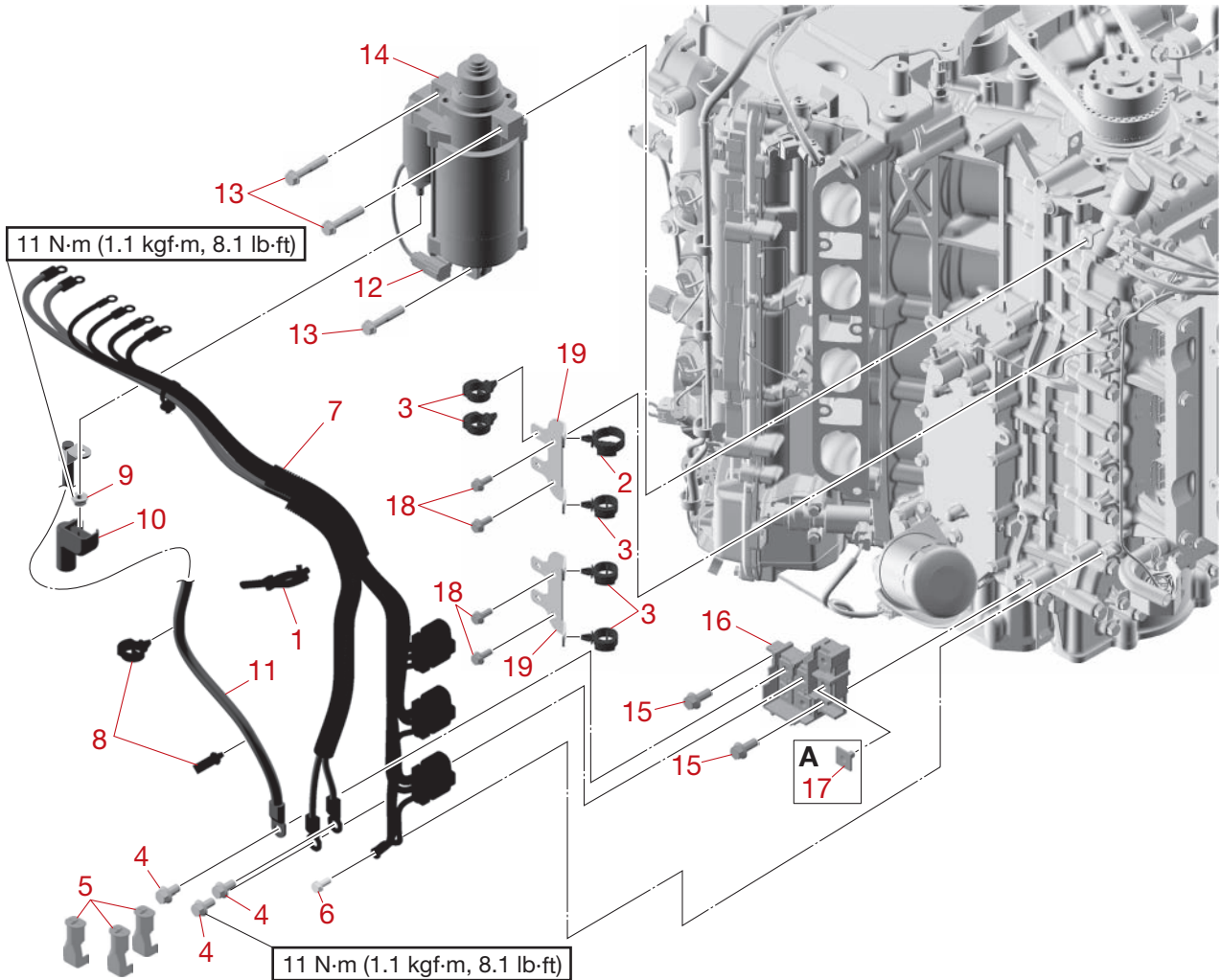


Flywheel magneto fan bolt "3"
1st: 8 N·m (0.8 kgf·m, 5.9 lb·ft)
2nd: 8 N·m (0.8 kgf·m, 5.9 lb·ft)

4. Install:

- Intake manifold (PORT)
See "Intake manifold" (6-24).
- Fuel hose assembly
See "Fuel hose assembly" (6-12).
- Intake silencer
See "ETV" (6-28).

Starter motor and extension wire harness




↑↓	Part name	Q'ty	Remarks
1	Plastic tie	1	
2	Holder	1	
3	Holder	5	
4	Bolt M8 × 16 mm	3	
5	Cap	3	
6	Bolt M6 × 16 mm	1	
7	Extension wire harness	1	
8	Holder	2	
9	Nut M8	1	
10	Cap	1	
11	Cable	1	
12	Coupler	1	
13	Bolt M8 × 45 mm	3	
14	Starter motor	1	
15	Bolt M8 × 20 mm	2	
16	Terminal	1	
17	Cover	1	
18	Bolt M6 × 16 mm	4	

↑↓	Part name	Q'ty	Remarks
19	Bracket	2	

A. When an isolator lead is not installed.

Installing the starter motor


1. Install:
 - Holder brackets
 - Battery cable terminal
 - Terminal cover
(when an isolator lead is not installed)
 - Starter motor
 - Holders
 - Cap
 - Starter motor cable
 - Starter motor coupler

	Starter motor cable nut 11 N·m (1.1 kgf·m, 8.1 lb·ft)
	Starter motor cable bolt 11 N·m (1.1 kgf·m, 8.1 lb·ft)

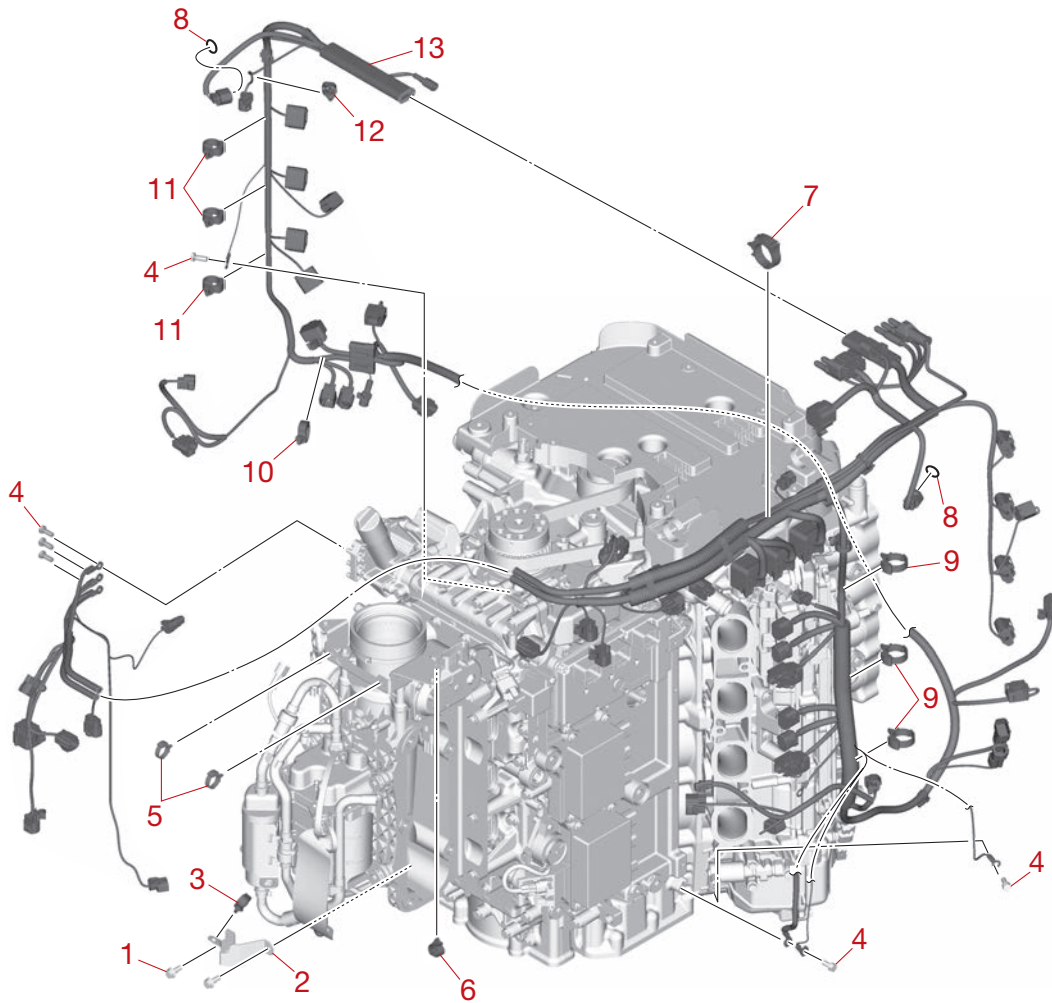
Installing the extension wire harness

1. Install:
 - Holders
 - Extension wire harness
 - Caps
 - Extension wire harness bolts
 - Ground lead
(extension wire harness)
 - Plastic tie

TIP: _____
Route the extension wire harness. See “Electrical component and wire harness routing” (5-1).

	Extension wire harness bolt 11 N·m (1.1 kgf·m, 8.1 lb·ft)
-------------------------------------------------------------------------------------	--------------------------------------------------------------

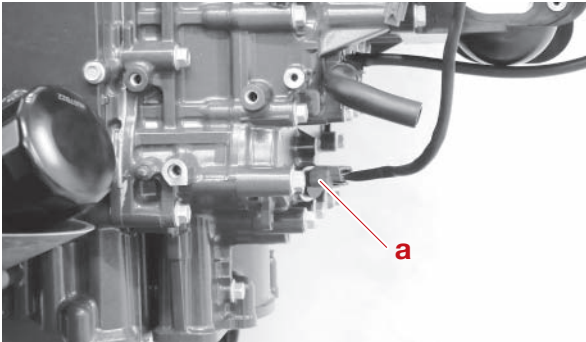
Wire harness



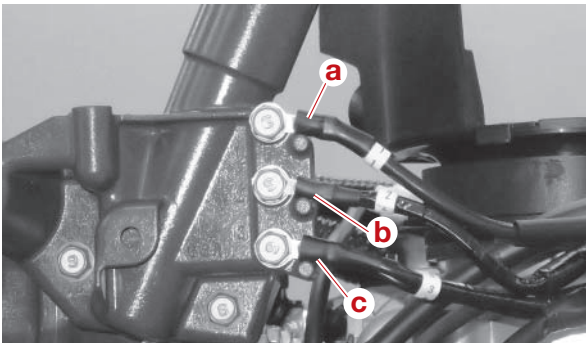
↑↓	Part name	Q'ty	Remarks
1	Bolt M6 × 16 mm	2	
2	Bracket	1	
3	Holder	1	
4	Bolt M6 × 16 mm	6	
5	Holder	2	
6	Holder	1	
7	Holder	1	
8	O-ring	2	
9	Holder	3	
10	Holder	1	
11	Holder	3	
12	Holder	1	
13	Wire harness	1	

Removing the wire harness

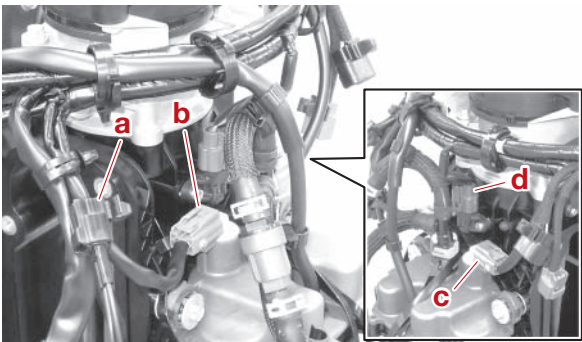
1. Disconnect:
 - Crankshaft position sensor coupler “a”



2. Disconnect:
 - Ground lead “a”, “b”, “c”

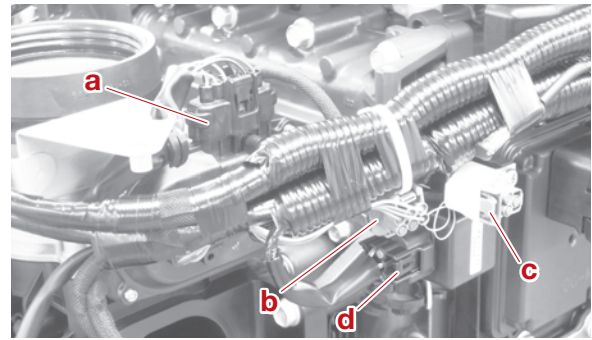


3. Disconnect:
 - Low-pressure fuel pump coupler “a”
 - High-pressure fuel pump coupler “b”, “c”
 - Intake air pressure/temperature sensor coupler “d”

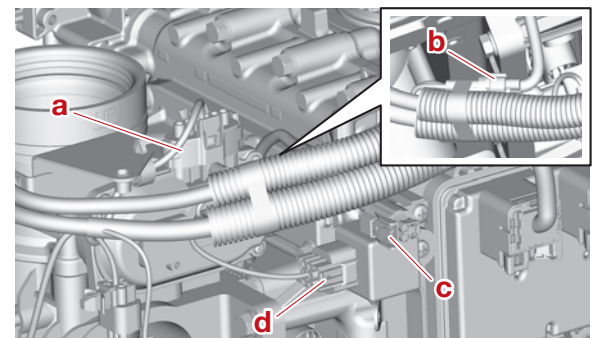


4. Disconnect:
 - ETV coupler “a”
 - Rectifier/regulator coupler “b”
 - YDIS coupler “c”
 - Low-pressure fuel pump relay coupler “d”

A



B

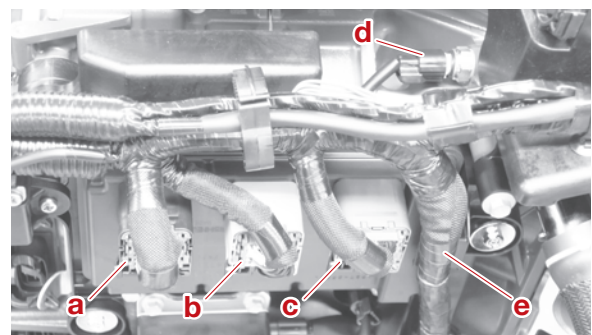


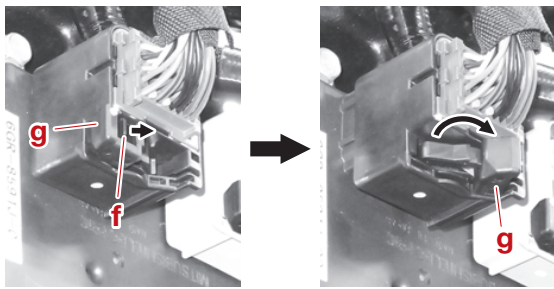
- A. F450A/FL450A/XF450
- B. F400A/FL400A/XF400

5. Disconnect:
 - ECM coupler “a”, “b”, “c”
 - Thermo sensor coupler (PORT) “d”
 - Wire harness “e” (from the bracket)

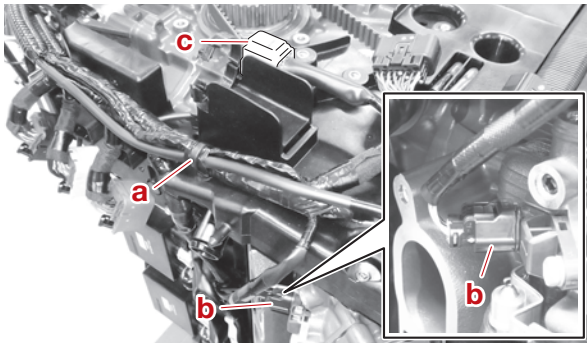
TIP:

While pushing the tab “f” of the ECM coupler, move the lock lever “g” in the direction shown to disengage the coupler.

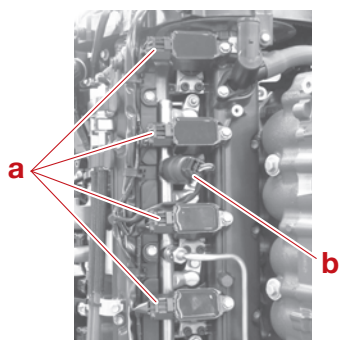




6. Disconnect:
- Wire harness “a” (from the guide)
 - Cam position sensor coupler (PORT IN) “b”
 - Joint connector “c” (from the guide)

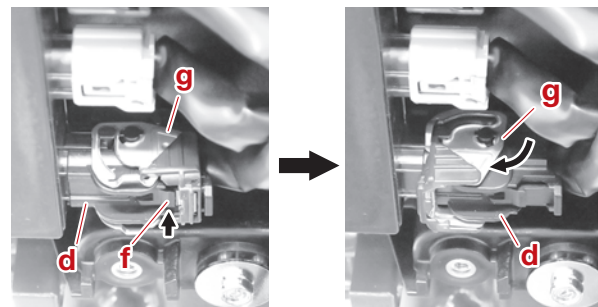
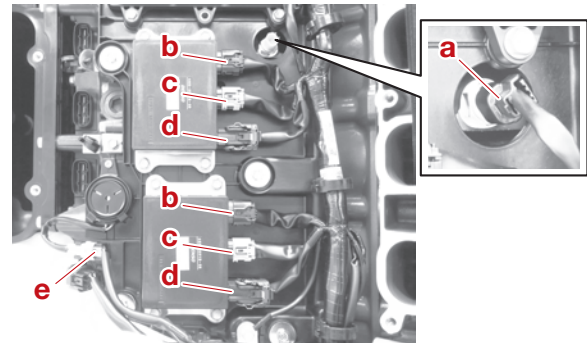


7. Disconnect:
- Ignition coil coupler (PORT) “a”
 - Fuel pressure sensor (direct injection pump) coupler (PORT) “b”

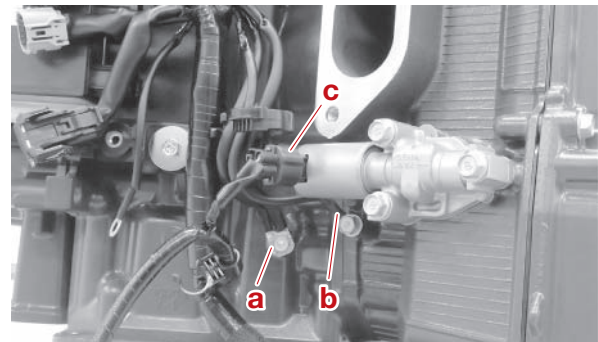


8. Disconnect:
- Engine temperature sensor coupler “a”
 - Injector driver coupler “b”, “c”, “d”
 - PTT buzzer coupler “e”

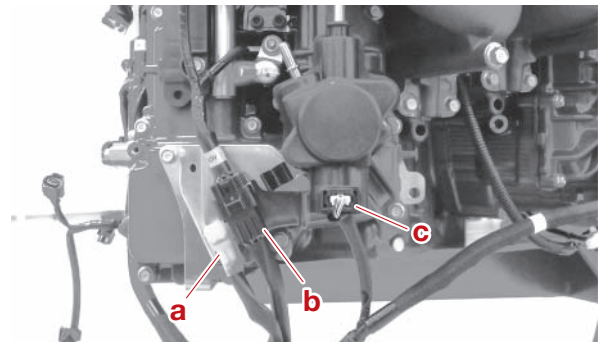
TIP: _____
 While pushing the tab “f” of the injector driver coupler “d”, move the lock lever “g” in the direction shown to disengage the coupler.



9. Disconnect:
- Ground lead “a”, “b”
 - OCV coupler (PORT) “c”

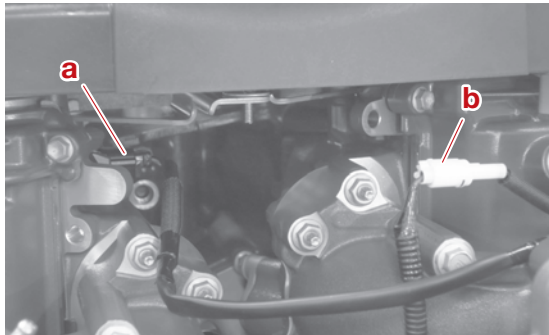


10. Disconnect:
- PTT sensor coupler “a” (from the bracket)
 - Sub-wire harness coupler (PORT) “b”
 - Direct injection pump coupler (PORT) “c”

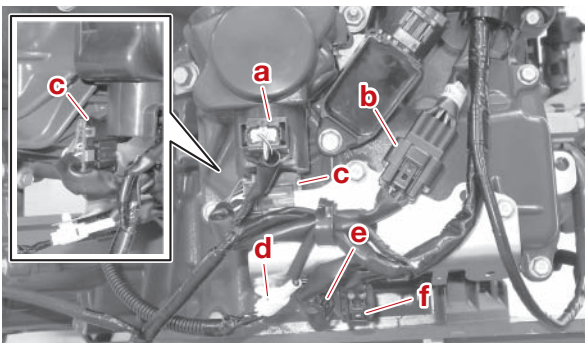


11. Disconnect:
- Cam position sensor coupler (PORT EX) “a”

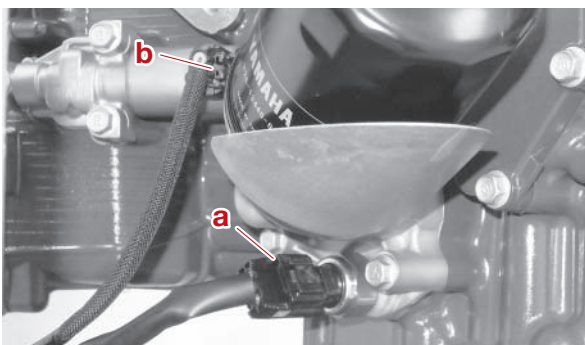
- Knock sensor coupler (upper) "b"



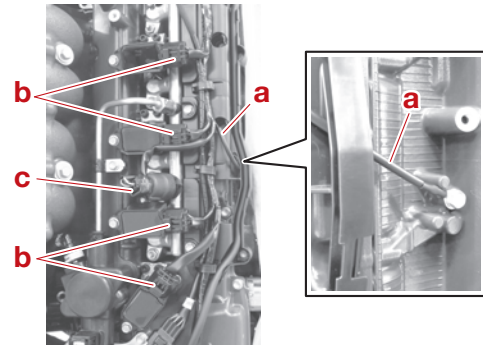
12. Disconnect:
- Direct injection pump coupler (STBD) "a"
 - Sub-wire harness coupler (STBD) "b"
 - Joint connector "c"
(from the bracket)
 - Knock sensor coupler (lower) "d"
 - SCU coupler "e", "f"
(from the bracket)



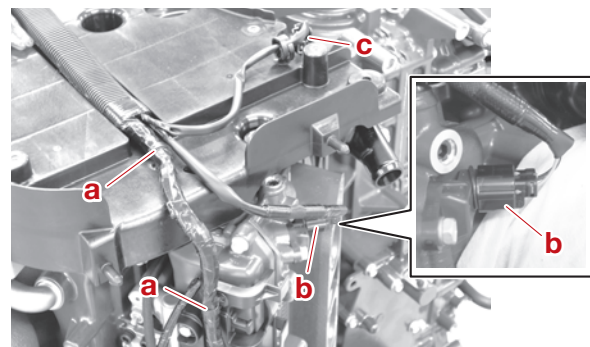
13. Disconnect:
- Oil pressure sensor coupler "a"
 - OCV coupler (STBD) "b"



14. Disconnect:
- Ground lead "a"
 - Ignition coil coupler (STBD) "b"
 - Fuel pressure sensor (direct injection pump) coupler (STBD) "c"



15. Disconnect:
- Wire harness "a"
(from the guides)
 - Cam position sensor coupler (STBD IN) "b"
 - Thermo sensor coupler (STBD) "c"



Installing the wire harness

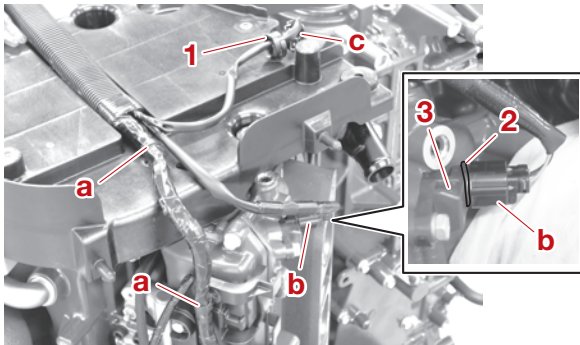
Route the wire harness.

See "Electrical component and wire harness routing" (5-1).

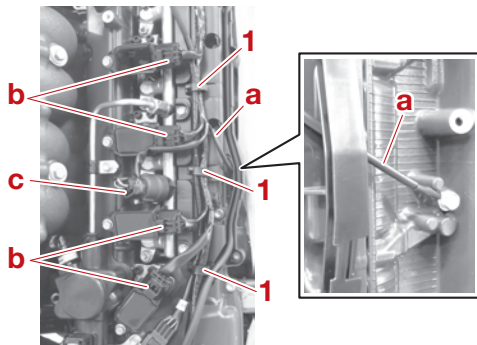
1. Connect:
- Holder "1"
 - Wire harness "a"
(to the guides)
 - O-ring "2"
 - Cam position sensor coupler (STBD IN) "b"
 - Thermo sensor coupler (STBD) "c"

TIP:

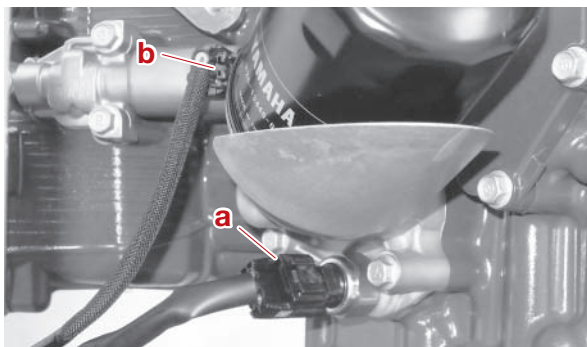
Check that the O-ring "2" is inserted between the cam position sensor "3" and the cam position sensor coupler "b". See "Electrical component and wire harness routing" (5-1).



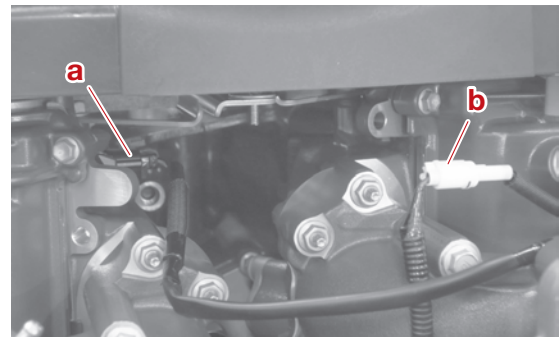
2. Connect:
- Holder "1"
 - Ground lead "a"
 - Ignition coil coupler (STBD) "b"
 - Fuel pressure sensor (direct injection pump) coupler (STBD) "c"



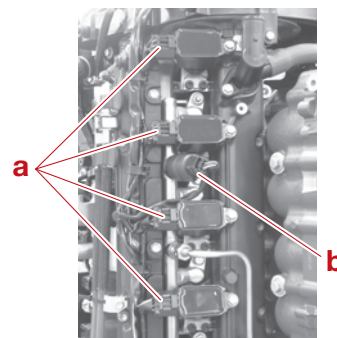
3. Connect:
- Oil pressure sensor coupler "a"
 - OCV coupler (STBD) "b"



4. Connect:
- Cam position sensor coupler (PORT EX) "a"
 - Knock sensor coupler (upper) "b"



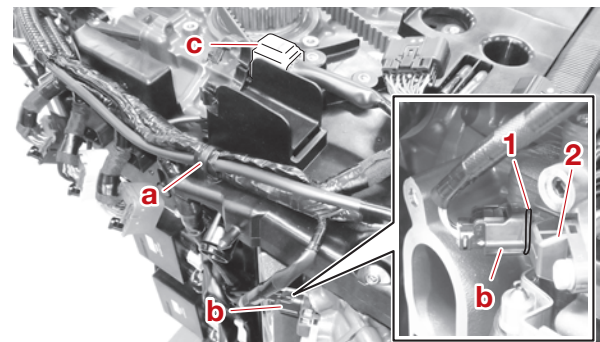
5. Connect:
- Ignition coil coupler (PORT) "a"
 - Fuel pressure sensor (direct injection pump) coupler (PORT) "b"



6. Connect:
- Wire harness "a" (to the guide)
 - O-ring "1"
 - Cam position sensor coupler (PORT IN) "b"
 - Joint connector "c"

TIP:

Check that the O-ring "1" is inserted between the cam position sensor "2" and the cam position sensor coupler "b". See "Electrical component and wire harness routing" (5-1).

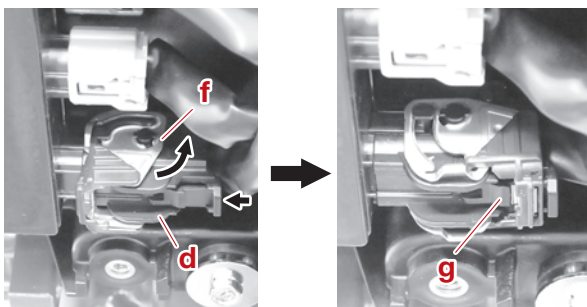
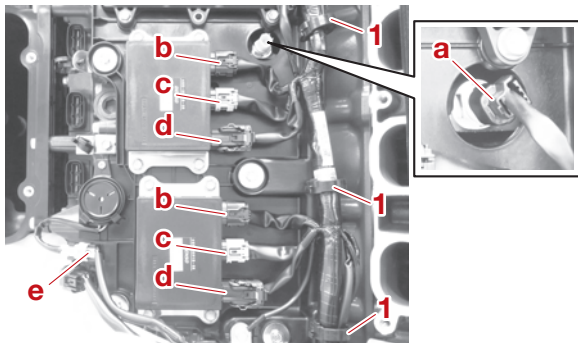


7. Connect:
- Holder "1"
 - Engine temperature sensor coupler "a"

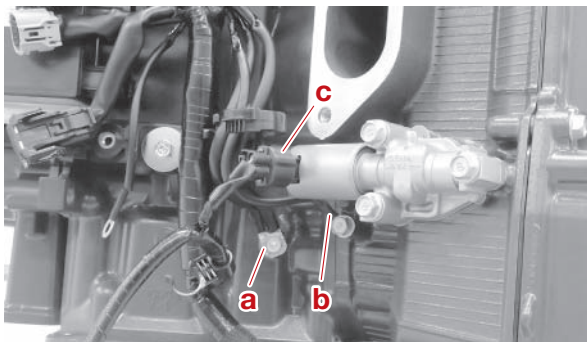
- Injector driver coupler “b”, “c”, “d”
- PTT buzzer coupler “e”

TIP:

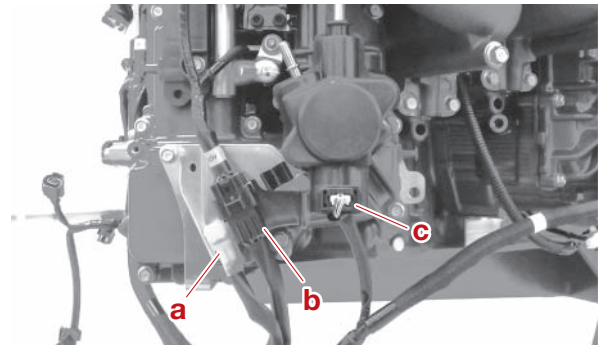
Fit the injector driver coupler “d” onto the injector driver, and then move the lock lever “f” in the direction shown to engage the coupler. Make sure that the tab “g” is securely locked in place.



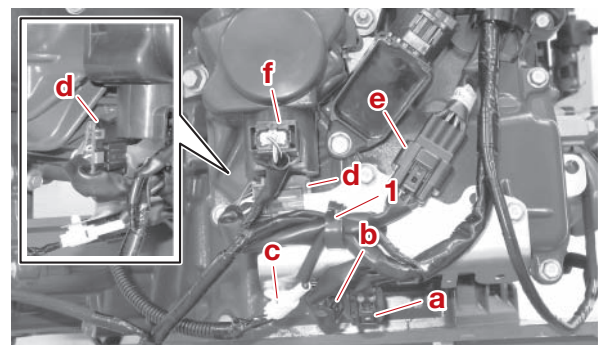
8. Connect:
- Ground lead “a”, “b”
 - OCV coupler (PORT) “c”



9. Connect:
- PTT sensor coupler “a” (to the bracket)
 - Sub-wire harness coupler (PORT) “b”
 - Direct injection pump coupler (PORT) “c”



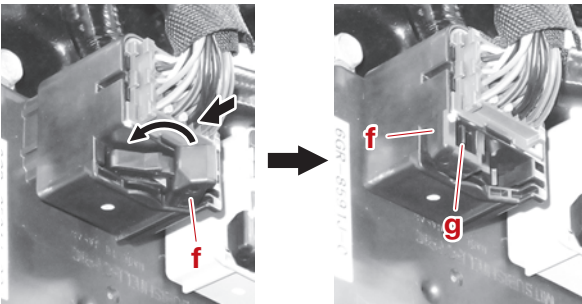
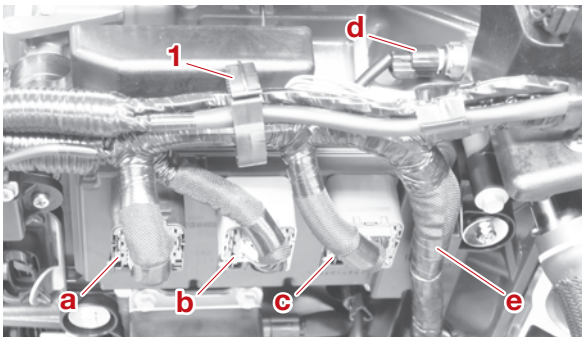
10. Connect:
- Holder “1”
 - SCU coupler “a”, “b” (to the bracket)
 - Knock sensor coupler (lower) “c”
 - Joint connector “d” (to the bracket)
 - Sub-wire harness coupler (STBD) “e”
 - Direct injection pump coupler (STBD) “f”



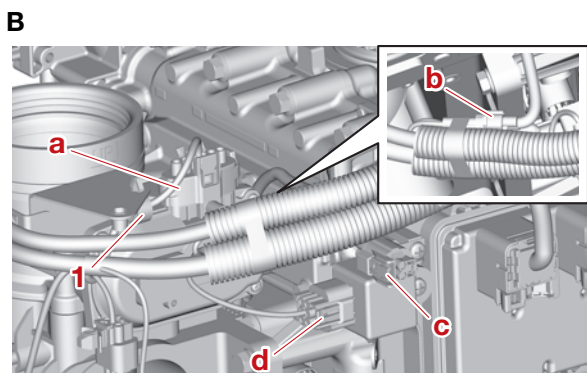
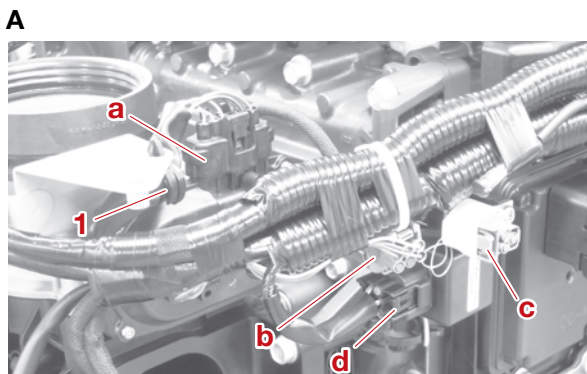
11. Connect:
- Holder “1”
 - ECM coupler “a”, “b”, “c”
 - Thermo sensor coupler (PORT) “d”
 - Wire harness “e” (to the bracket)

TIP:

Fit the ECM coupler onto the ECM, and then move the lock lever “f” in the direction shown to engage the coupler. Make sure that the tab “g” is securely locked in place.

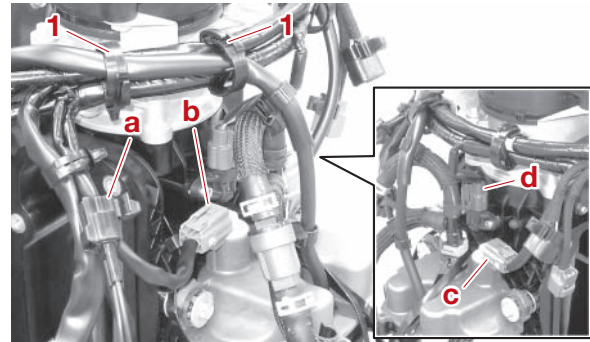


12. Connect:
- Holder "1"
 - ETV coupler "a"
 - Rectifier/regulator coupler "b"
 - YDIS coupler "c"
 - Low-pressure fuel pump relay coupler "d"



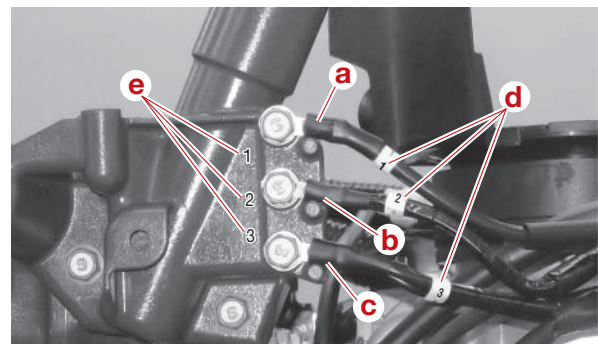
A. F450A/FL450A/XF450
 B. F400A/FL400A/XF400

13. Connect:
- Holder "1"
 - Low-pressure fuel pump coupler "a"
 - High-pressure fuel pump coupler "b", "c"
 - Intake air pressure/temperature sensor coupler "d"

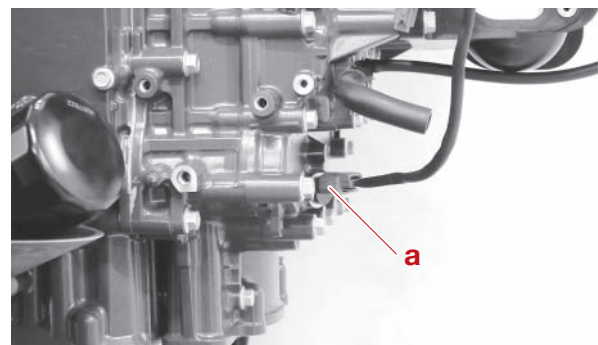


14. Connect:
- Ground lead "a", "b", "c"

TIP: Connect the ground leads so that they contact the stoppers. Make sure to match the numbers "d" on the ground leads to the numbers "e" on the oil filler neck.

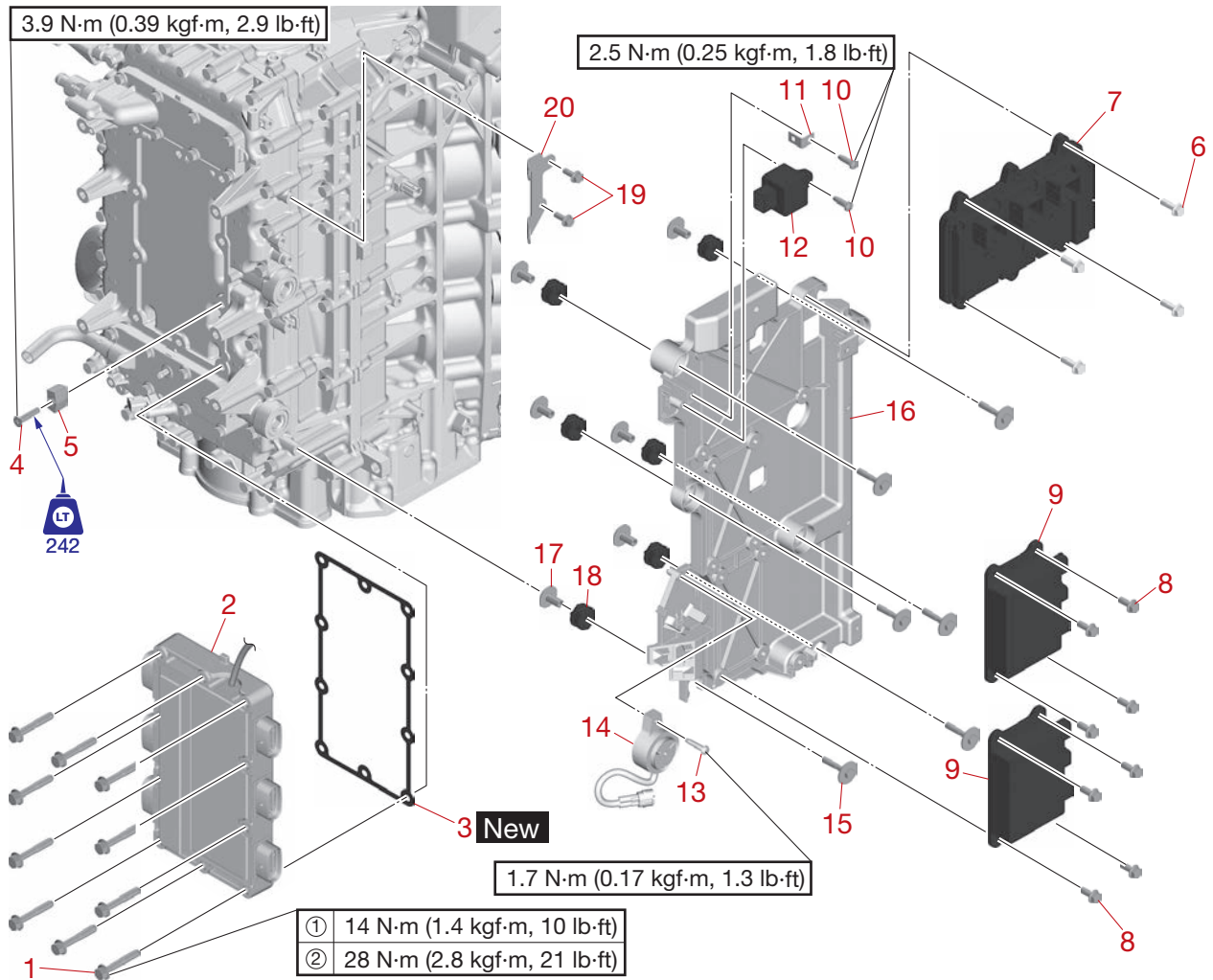


15. Connect:
- Crankshaft position sensor coupler "a"



16. Install:
- Holder bracket
 - Holder

ECM, injector driver, and rectifier/regulator



↑↓	Part name	Q'ty	Remarks
1	Bolt M8 × 50 mm	10	
2	Rectifier/regulator	1	
3	Gasket	1	
4	Screw M6 × 25 mm	1	
5	Anode	1	
6	Bolt M6 × 20 mm	4	
7	ECM	1	
8	Bolt M6 × 16 mm	8	
9	Injector driver	2	
10	Screw M6 × 20 mm	2	
11	Bracket	1	
12	Relay	1	
13	Screw M6 × 25 mm	1	
14	Buzzer	1	
15	Bolt M6 × 35 mm	6	
16	Bracket	1	
17	Collar	6	
18	Grommet	6	
19	Bolt M6 × 16 mm	2	

↑↓	Part name	Q'ty	Remarks
20	Bracket	1	

Removing the rectifier/regulator

- Remove:
 - Low-pressure fuel pump
See "Low-pressure fuel pump" (6-6).
 - Vapor separator assembly
See "Removing the vapor separator" (6-10).
 - Surge tank
See "ETV" (6-28).

Checking the rectifier/regulator anode


- Check:
 - Anode
Eroded (1/2 or more worn out) → Replace.
Adhered grease, oil, or scales → Clean.

NOTICE

Do not apply grease, oil, or paint to the anodes.

Installing the ECM and injector driver

- Install:
 - Holder bracket
 - Grommets
 - Collars
 - ECM/injector driver bracket
 - Coupler bracket
 - Low-pressure fuel pump relay
 - Injector drivers
 - ECM

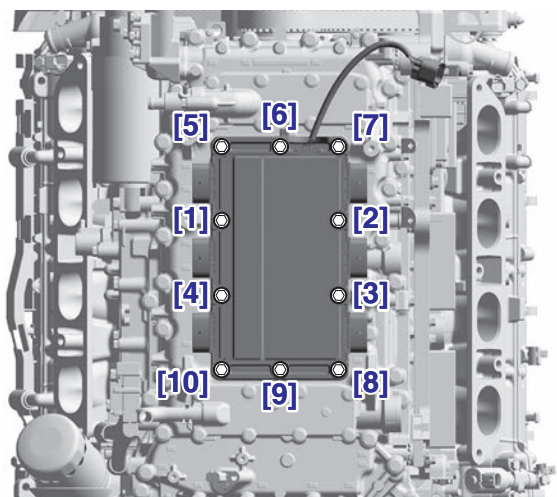
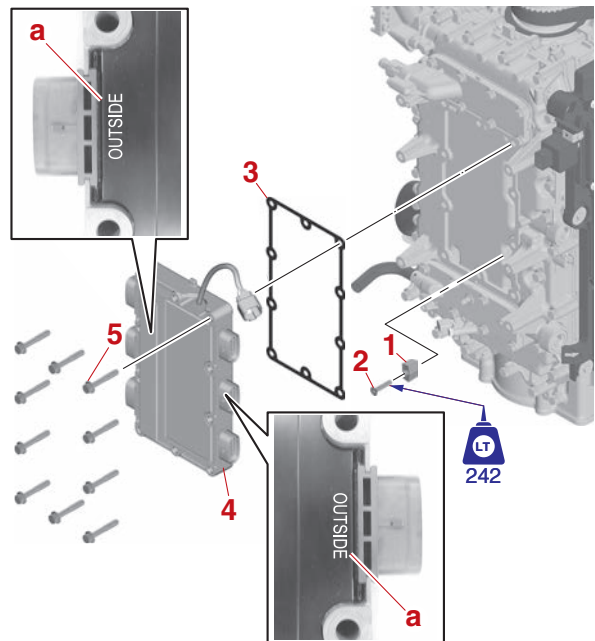
	Coupler bracket screw 2.5 N·m (0.25 kgf·m, 1.8 lb·ft)
	Low-pressure fuel pump relay screw 2.5 N·m (0.25 kgf·m, 1.8 lb·ft)


Installing the rectifier/regulator

- Install:
 - Rectifier/regulator anode "1"
 - Rectifier/regulator anode screw "2"
 - Gasket "3" **New**
 - Rectifier/regulator "4"
 - Rectifier/regulator bolts "5"

TIP:

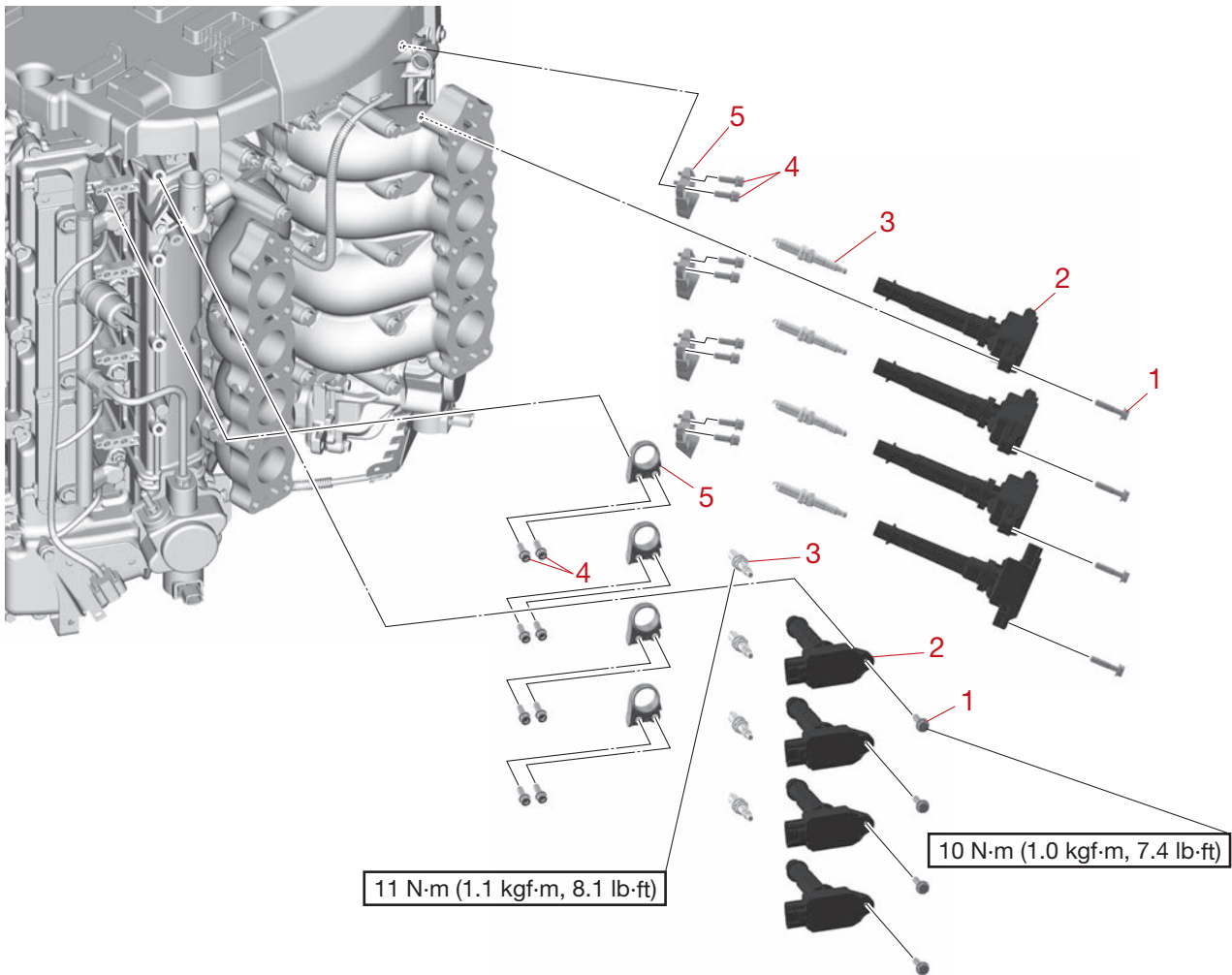
- Install the rectifier/regulator "4" so that its side with the "OUTSIDE" mark "a" is facing outward.
- Tighten the rectifier/regulator bolts "5" to the specified torques in 2 stages and in the order [1], [2], and so on.
- The rectifier/regulator shown is for F450A/FL450A/XF450.



	Rectifier/regulator anode screw "2" 3.9 N·m (0.39 kgf·m, 2.9 lb·ft)
	Rectifier/regulator bolts "5" 1st: 14 N·m (1.4 kgf·m, 10 lb·ft) 2nd: 28 N·m (2.8 kgf·m, 21 lb·ft)

2. Install:
- Surge tank
See “Installing the ETV and surge tank” (6-29).
 - Vapor separator assembly
See “Installing the vapor separator” (6-11).
 - Low-pressure fuel pump
See “Installing the low-pressure fuel pump” (6-8).

Ignition coil and spark plug



↕	Part name	Q'ty	Remarks
1	Bolt M6 × 30 mm	8	
2	Ignition coil	8	
3	Spark plug	8	
4	Bolt M6 × 20 mm	16	
5	Bracket	8	

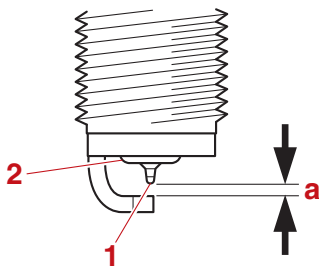
Checking the spark plug

1. Check:
 - Electrode “1”
Damaged/worn → Replace.
 - Insulator “2”
Abnormal color → Replace.
(Normal color: Medium-to-light tan)
2. Clean:
 - Spark plug
(with a spark plug cleaner)

NOTICE

Do not use a wire brush to clean the spark plugs, as it will damage the iridium coating on the electrode.

3. Measure:
 - Spark plug gap “a”
(with a wire thickness gauge)
Out of specification → Replace.



Spark plug (NGK)
ILMAR7H-9
Spark plug gap
0.8–0.9 mm (0.031–0.035 in)

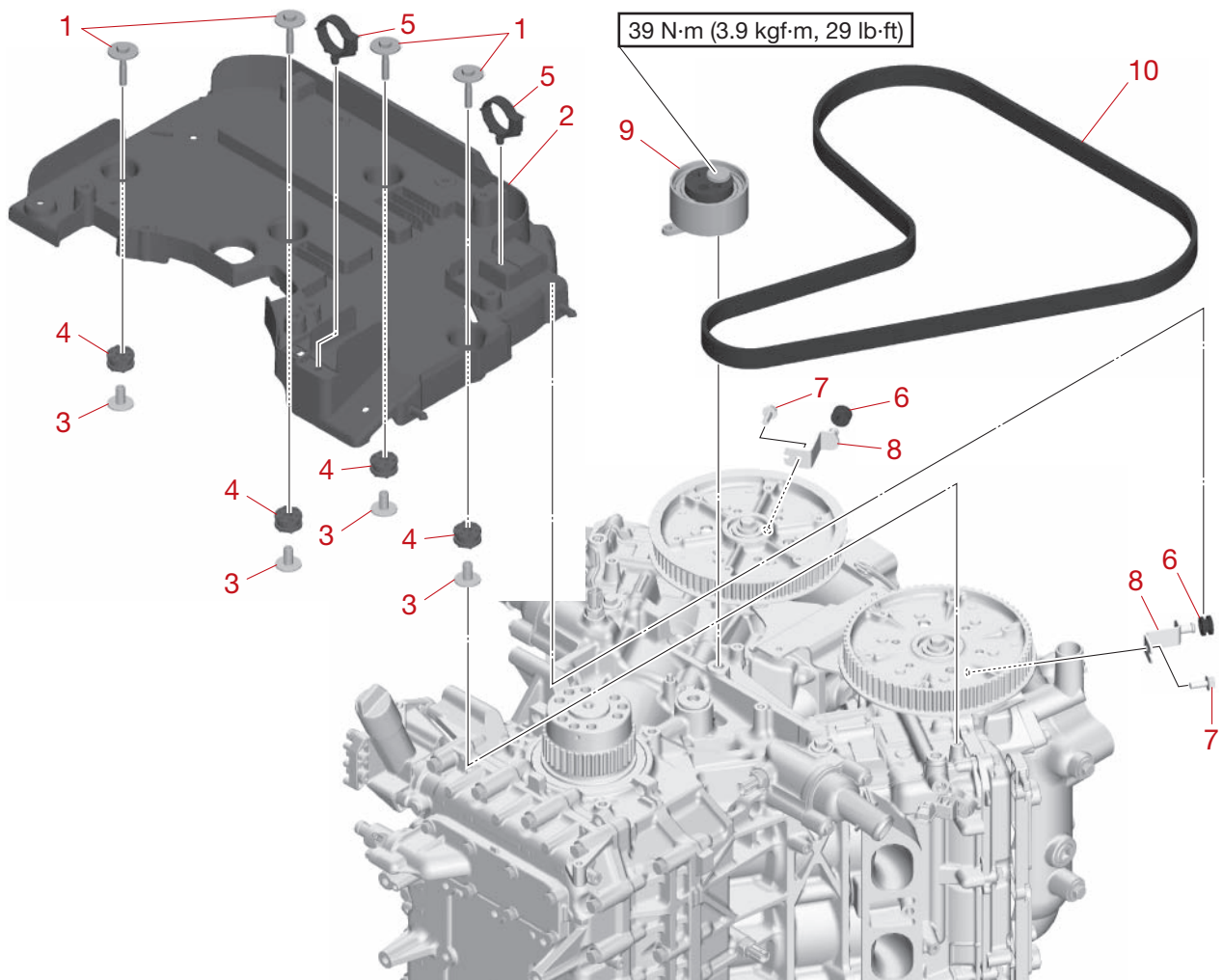
Installing the ignition coil and spark plug

1. Install:
 - Spark plugs
 - Ignition coil brackets
 - Ignition coils



Spark plug
11 N·m (1.1 kgf·m, 8.1 lb·ft)
Ignition coil bolt
10 N·m (1.0 kgf·m, 7.4 lb·ft)

Timing belt



↑↓	Part name	Q'ty	Remarks
1	Bolt M6 × 35 mm	4	
2	Wire harness guide	1	
3	Collar	4	
4	Grommet	4	
5	Holder	2	
6	Grommet	2	
7	Bolt M6 × 16 mm	2	
8	Bracket	2	
9	Tensioner	1	
10	Timing belt	1	

Removing the timing belt

NOTICE

When the timing belt is not installed, do not turn the crankshaft or driven sprocket. Otherwise, the pistons and valves could collide with each other and be damaged.

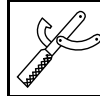
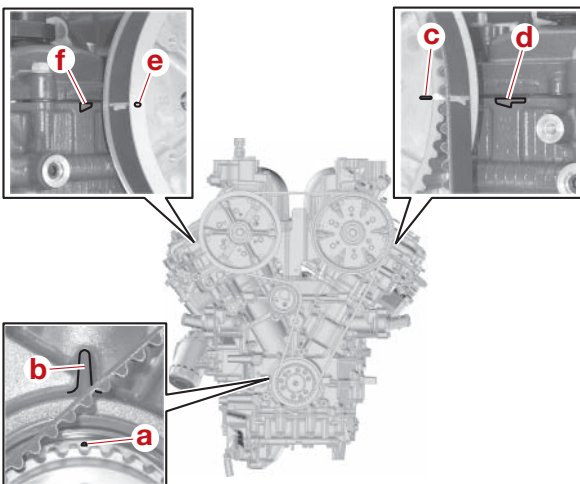
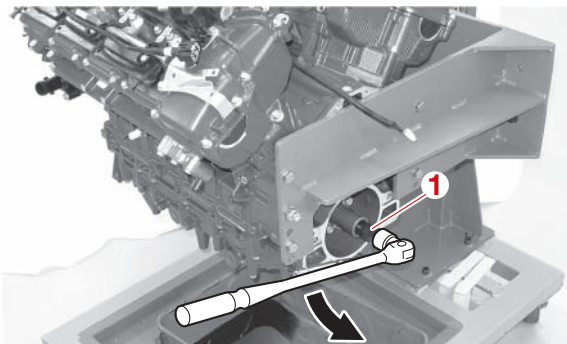
1. Remove:

- Timing belt
 - a. Align the “▲” mark “a” on the crankshaft with the protrusion “b” on the cylinder block.

TIP:

Turn the crankshaft clockwise using the special service tool “1”.

- b. Check that the “I” mark “c” on the driven sprocket (PORT) and the “←” mark “d” on the cylinder head (PORT) are aligned, and check that the “I” mark “e” on the driven sprocket (STBD) and the “→” mark “f” on the cylinder head (STBD) are aligned.

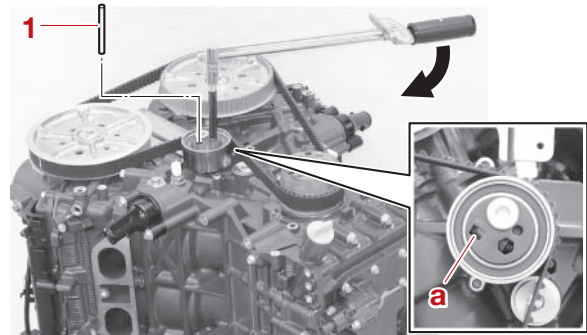


Shaft holder “1”
90890-06949

- c. Turn the timing belt tensioner gradually clockwise using a hexagon wrench, and then insert a 5.0 mm (0.2 in) diameter pin “1” into the hole “a”.

TIP:

- When turning the timing belt tensioner, apply a force of 15 N·m (1.5 kgf·m, 11 lb·ft) or less.
- Leave the pin “1” inserted into the hole “a” of the timing belt tensioner until the timing belt is installed again.



- d. Remove the timing belt.

Checking the timing belt

1. Check:
- Interior and exterior of the timing belt
Cracked/damaged/worn → Replace.

Installing the timing belt

NOTICE

When the timing belt is not installed, do not turn the crankshaft or driven sprocket. Otherwise, the pistons and valves could collide with each other and be damaged.

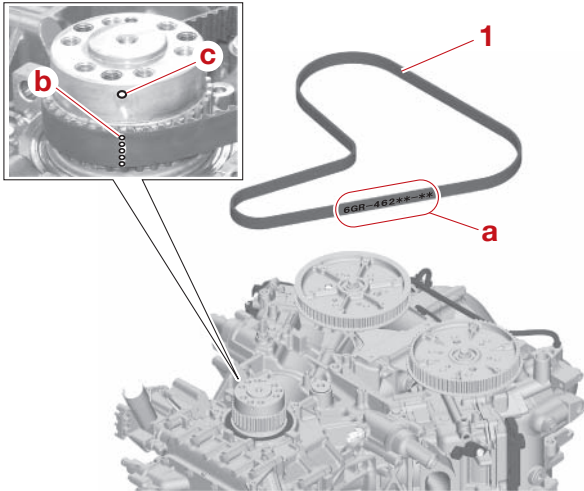
1. Install:
- Timing belt
 - Timing belt tensioner

TIP:

Check that the alignment marks on the crankshaft and driven sprockets are positioned in the proper locations. See “Removing the timing belt” (7-43).

Timing belt

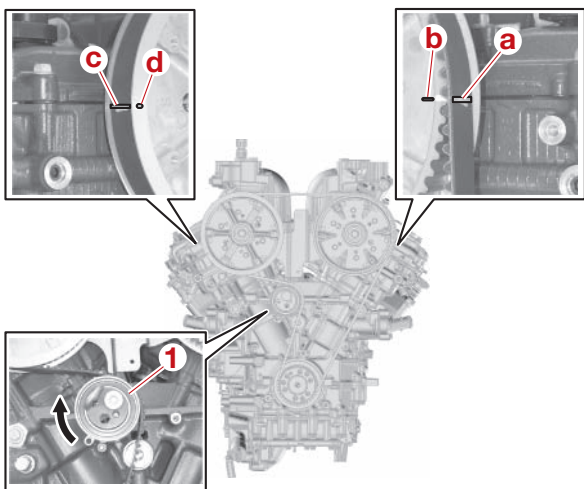
- a. Install the timing belt "1" onto the crankshaft so that the part number "a" is in the upright position and the belt position mark "b" is aligned with the mark "c" on the crankshaft.



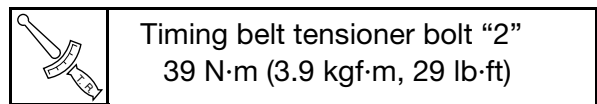
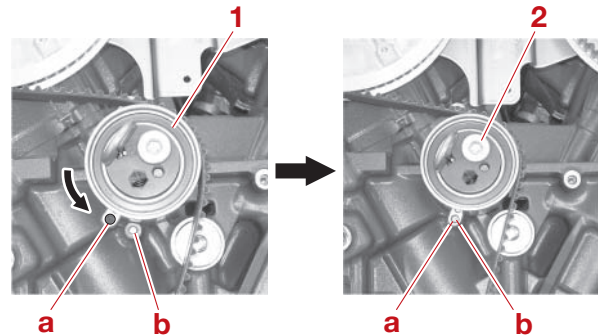
- b. Working in a counterclockwise manner, install the timing belt by aligning the belt position mark "a" with the "I" mark "b" on the driven sprocket (PORT) and aligning the belt position mark "c" with the "I" mark "d" on the driven sprocket (STBD).

TIP:

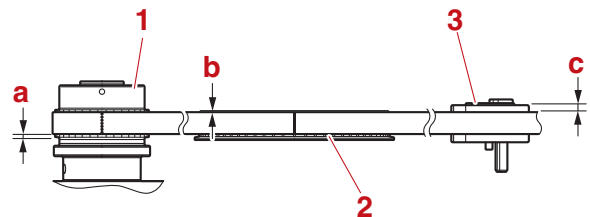
After installing the timing belt, temporarily install the timing belt tensioner "1" to remove the slack in the timing belt. Do not pull out the pin that was inserted when removing the timing belt tensioner "1".



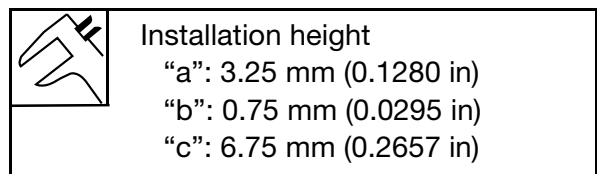
- c. Turn the timing belt tensioner "1" so that the hole "a" in the timing belt tensioner fits onto the protrusion "b" on the cylinder block, and then tighten the timing belt tensioner bolt "2".



- d. Adjust the timing belt installation heights "a", "b", and "c" to specification.



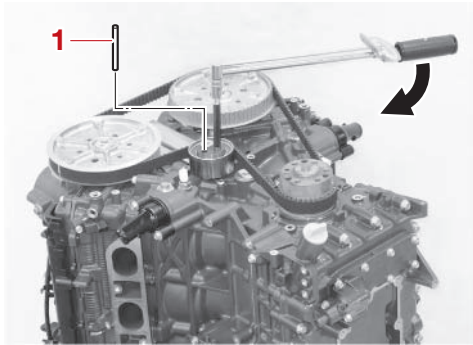
1. Crankshaft
2. Driven sprocket (PORT)
3. Timing belt tensioner



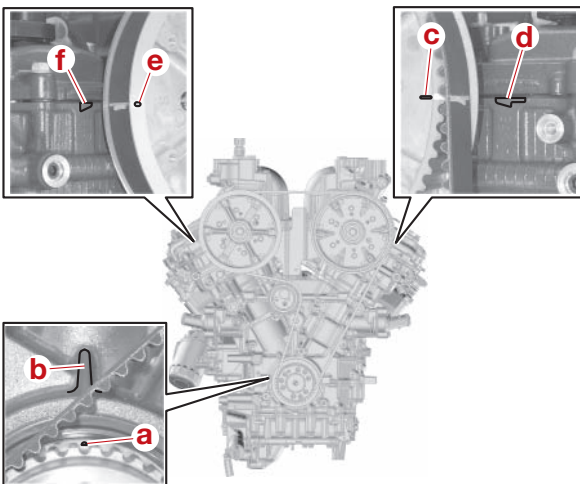
- e. Turn the timing belt tensioner gradually clockwise using a hexagon wrench, and then remove the pin "1". After removing the pin, slowly move the timing belt tensioner back to its original position.

TIP: _____

- When turning the timing belt tensioner, apply a force of 15 N·m (1.5 kgf·m, 11 lb·ft) or less.
- Make sure that the belt position marks are aligned with the marks on the crankshaft and driven sprockets. See steps (a) and (b).

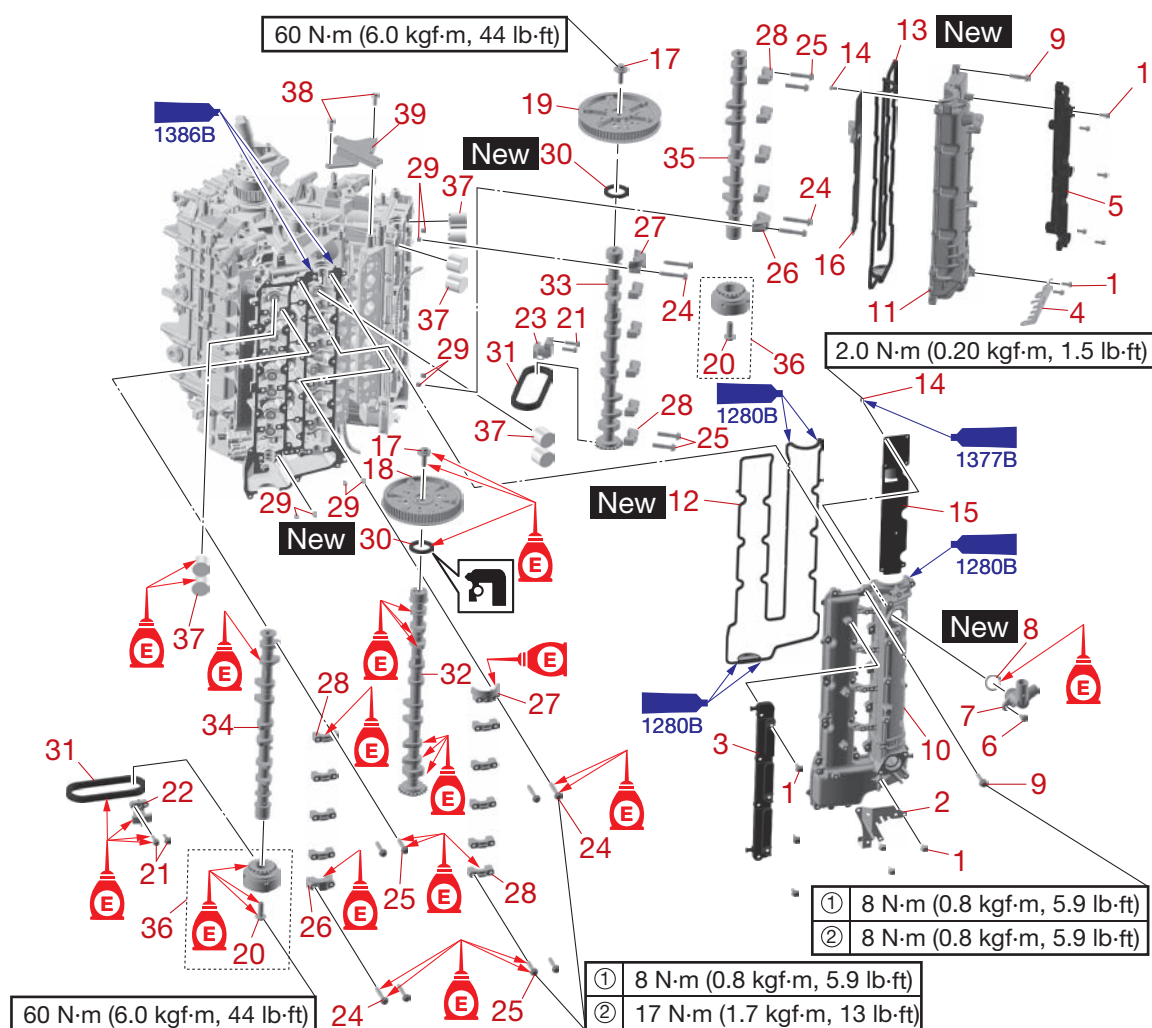


- f. Turn the crankshaft clockwise 2 full turns until the “▲” mark “a” on the crankshaft is aligned with the protrusion “b” on the cylinder block. Check that the “i” mark “c” on the driven sprocket (PORT) and the “└” mark “d” on the cylinder head (PORT) are aligned, and check that the “i” mark “e” on the driven sprocket (STBD) and the “└” mark “f” on the cylinder head (STBD) are aligned.



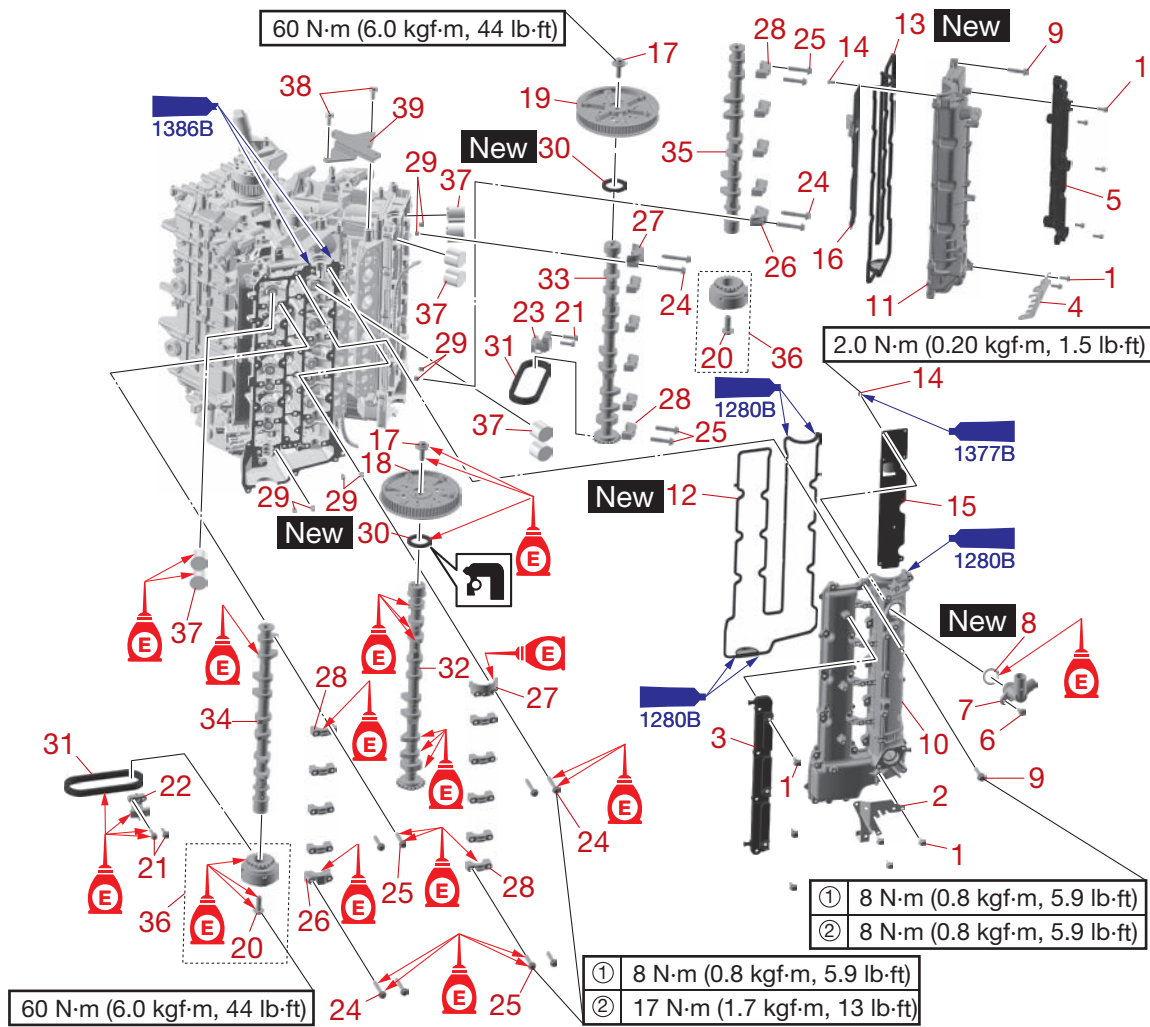
2. Install:
- Brackets
 - Grommets
 - Collars
 - Wire harness guide

Camshaft



↑↓	Part name	Q'ty	Remarks
1	Bolt M6 × 16 mm	13	
2	Bracket	1	
3	Guide	1	
4	Bracket	1	
5	Guide	1	
6	Bolt M6 × 25 mm	1	
7	Hose nipple	1	
8	O-ring	1	
9	Bolt M6 × 30 mm	44	
10	Cover	1	
11	Cover	1	
12	Gasket	1	
13	Gasket	1	
14	Screw M4 × 7 mm	16	
15	Plate	1	
16	Plate	1	
17	Bolt M10 × 35 mm	2	
18	Driven sprocket (PORT)	1	

↑↓	Part name	Q'ty	Remarks
19	Driven sprocket (STBD)	1	
20	Bolt M12 × 35 mm	2	Left-hand threads
21	Bolt M6 × 25 mm	4	
22	Tensioner (PORT)	1	
23	Tensioner (STBD)	1	
24	Bolt M7 × 48 mm	8	
25	Bolt M7 × 37 mm	36	
26	Camshaft cap	2	
27	Camshaft cap	2	
28	Camshaft cap	18	
29	Dowel	8	
30	Oil seal	2	
31	Chain	2	
32	Camshaft (PORT EX)	1	
33	Camshaft (STBD EX)	1	
34	Camshaft (PORT IN)	1	
35	Camshaft (STBD IN)	1	



↕↗	Part name	Q'ty	Remarks
36	VCT assembly	2	
37	Valve lifter	32	
38	Bolt M8 × 20 mm	2	
39	Bracket	1	

Removing the camshaft, VCT assembly, and driven sprocket

NOTICE

When the timing belt is not installed, do not turn the crankshaft or camshaft. Otherwise, the pistons and valves could collide with each other and be damaged.

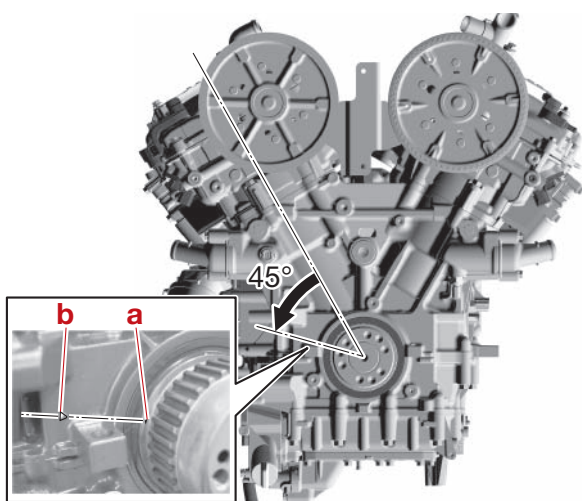
- Remove:
 - Exhaust joint
See "Exhaust joint (inside)" (7-11).
 - Direct injection pump
 - Fuel rail
 - Fuel injector
See "Direct injection pump and fuel injector" (6-18).
- Turn:
 - Crankshaft

NOTICE

Do not turn the crankshaft counterclockwise more than 45°. Otherwise, the pistons and valves could collide with each other and be damaged.

TIP:

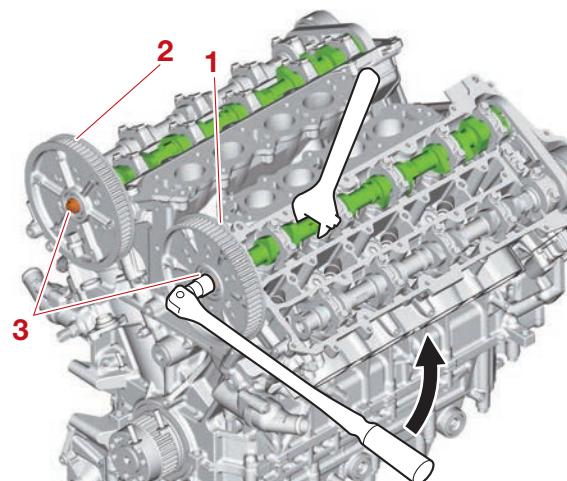
Turn the crankshaft counterclockwise 45° gradually until the "▲" mark "a" on the crankshaft is aligned with the "▲" mark "b" on the cylinder block.



- Remove:
 - Driven sprocket (PORT) "1"
 - Driven sprocket (STBD) "2"

TIP:

After removing the timing belt, secure the camshaft using a wrench, and then remove the driven sprocket bolts "3".



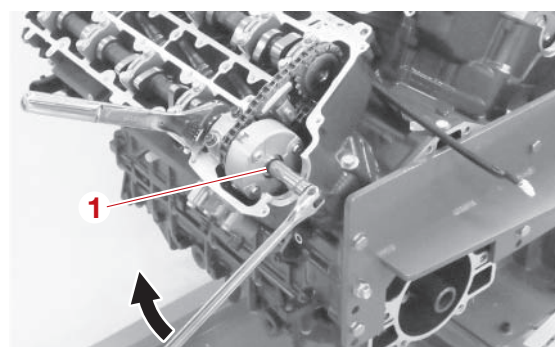
- Loosen:
 - VCT bolts "1"

NOTICE

When loosening or tightening the VCT bolt, do not secure the VCT assembly. Otherwise, the VCT assembly could be damaged.

TIP:

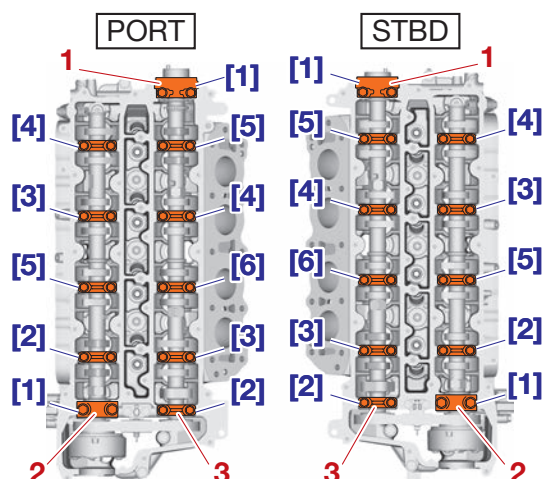
Secure the camshaft using a wrench, and then loosen the VCT bolt "1".



- Remove:
 - Cam chain tensioners
- Remove:
 - Camshaft caps

TIP:

Remove the camshaft caps "1", "2", and "3" in the order [1], [2], and so on.



7. Remove:
- Camshafts
 - Valve lifters

TIP: _____
 Make sure to keep the parts in the order of removal.

Checking the sprocket

1. Check:
- Driven sprocket
 - Camshaft (EX)
 - VCT assembly
- Cracked/damaged/worn → Replace the driven sprocket, camshaft (EX), or VCT assembly.

Checking the cam chain

1. Check:
 Chain length
 Above specification → Replace.

	Limit 114.85 mm (4.5216 in)
--	--------------------------------

- a. Measure the distances “a” and “b” for a 12-link section of the cam chain, and then calculate the chain length using the following formula.

TIP: _____
 When measuring the chain length, make sure that the chain is sufficiently taut without any slack.

Calculation formula:

Chain length of the measured section = (Distance “a” between the inner edges of the rollers + Distance “b” between the outer edges of the rollers)/2

Example:

Distance “a” between the inner edges of the rollers = 108.25 mm

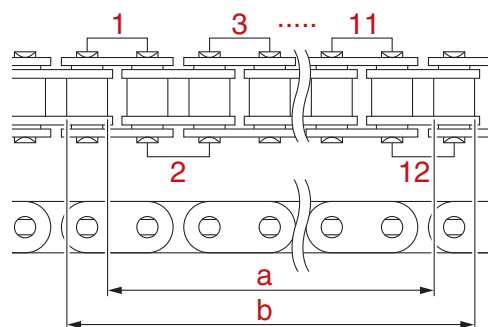
Distance “b” between the outer edges of the rollers = 120.55 mm

Chain length of the measured section = (108.25 mm + 120.55 mm)/2 = 114.40 mm

- b. Measure the distances of 3 different sections of the cam chain, and then calculate the average chain length.

Example:
 (mm)

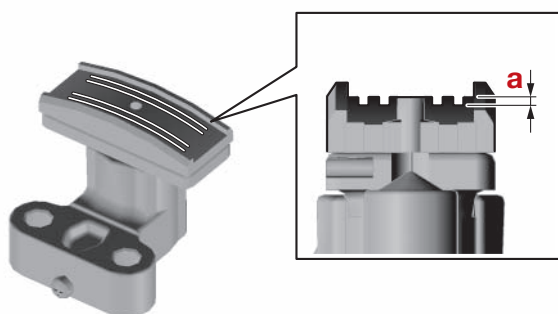
Chain length of measured section 1	114.40
Chain length of measured section 2	114.50
Chain length of measured section 3	114.45
Average	114.45




Checking the cam chain tensioner

1. Measure:
- Wear depth
- Above specification → Replace.

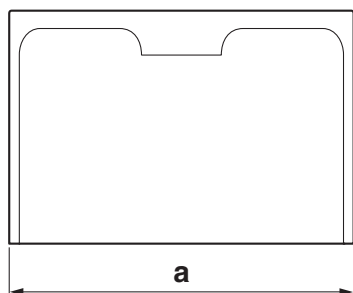
TIP: _____
 Measure the wear depth “a” on the guide surface of the cam chain tensioner.




 Maximum wear depth
1.00 mm (0.0394 in)

Checking the valve lifter

1. Check:
 - Valve lifter
Damaged/scratched/worn → Replace.
2. Measure:
 - Valve lifter outside diameter “a”
Out of specification → Replace.



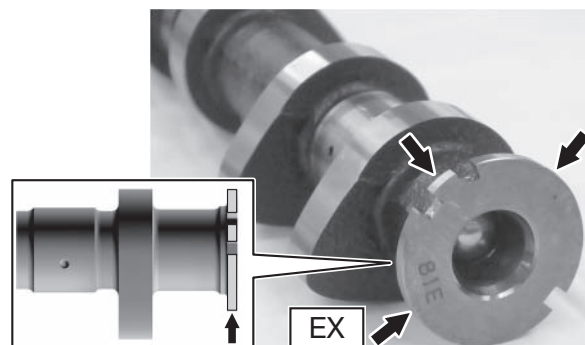
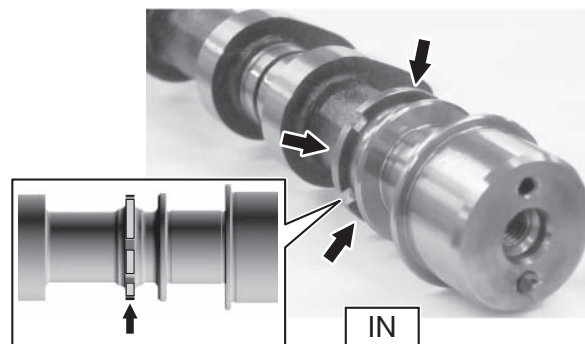
 Outside diameter
30.964–30.980 mm (1.2191–
1.2197 in)

Checking the camshaft

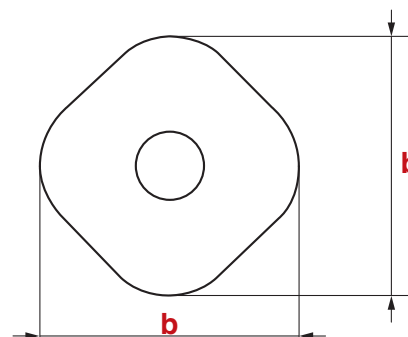
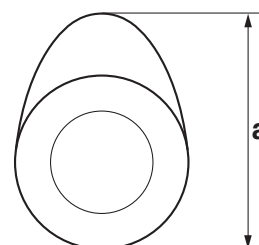
1. Check:
 - Pulser rotor
Damaged/rough/scratched → Replace.

TIP: _____

- Be careful not to scratch or damage the face of the flange.
- If there is a scratch that is more than 0.2 mm (0.008 in) deep or more than 0.5 mm (0.020 in) wide on the surface of the flange, an error may occur in the cam position sensor signal.



2. Measure:
 - Cam lobe height “a”
 - Fuel pump cam width across corners (direct injection pump) “b”
Out of specification → Replace.

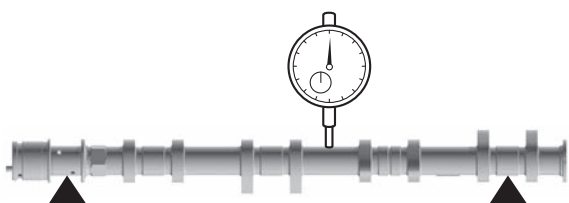




Cam lobe height IN
47.311–47.411 mm (1.8626–1.8666 in)
Limit
47.261 mm (1.8607 in)
Cam lobe height EX
46.600–46.700 mm (1.8346–1.8386 in)
Limit
46.550 mm (1.8327 in)
Fuel pump cam width across corner (DI pump)
49.350–49.450 mm (1.9429–1.9468 in)

3. Measure:

- Camshaft runout
Out of specification → Replace.



Runout
0.030 mm (0.0012 in)

Checking the camshaft journal oil clearance

1. Install:

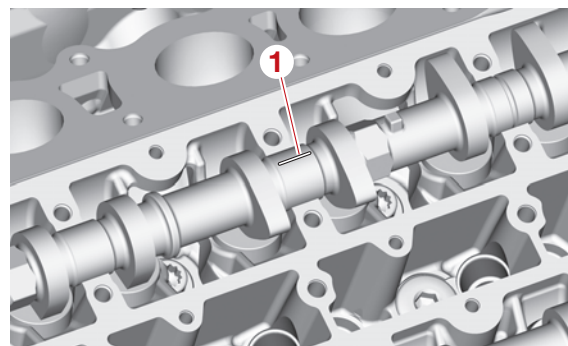
- Camshafts
- Plastigauge (PG-1) “1”

NOTICE

Do not place the Plastigauge (PG-1) over the oil hole in each camshaft journal.

TIP:

Place the camshafts onto the cylinder head, and then place a piece of Plastigauge (PG-1) “1” onto each camshaft journal, parallel to the camshaft.

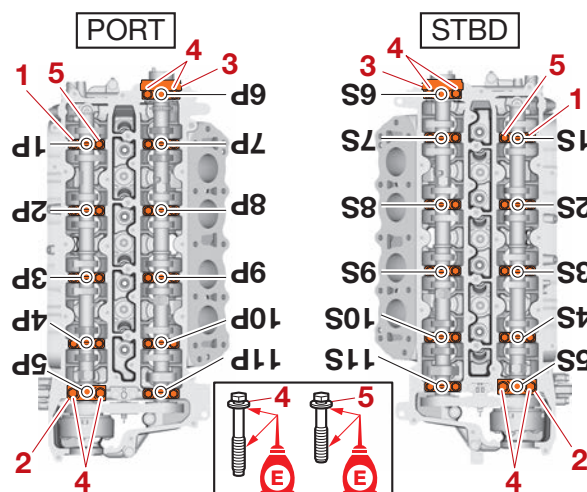


2. Install:

- Dowels
- Camshaft caps “1”, “2”, “3”
- Camshaft cap bolts (M7 × 48 mm) “4” (temporarily)
- Camshaft cap bolts (M7 × 36 mm) “5” (temporarily)

TIP:

Install the camshaft caps “1”, “2”, and “3” in their proper positions so that the stamped numbers are upside down.

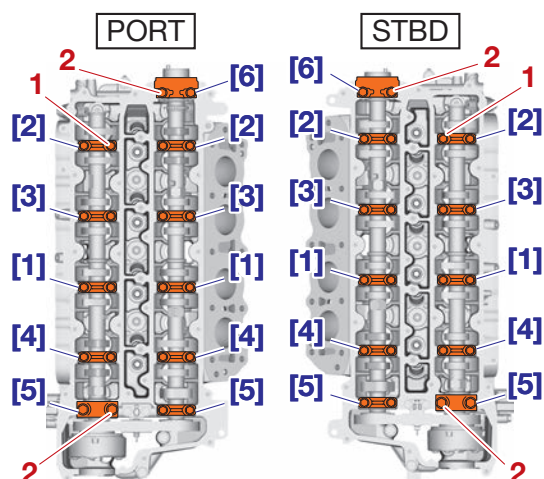



3. Tighten:

- Camshaft cap bolts “1”, “2”

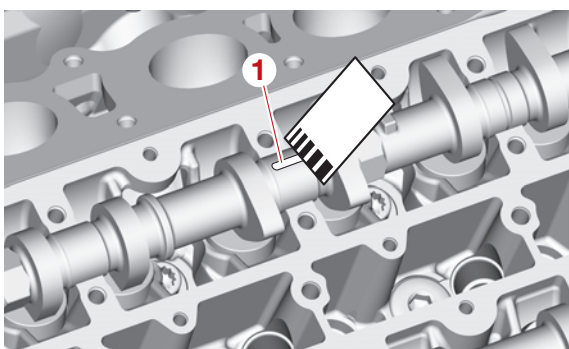
TIP:


- Tighten the camshaft cap bolts “1” and “2” to the specified torques in 2 stages and in the order [1], [2], and so on.
- Do not turn the camshafts when measuring the camshaft journal oil clearance using the Plastigauge.



	<p>Camshaft cap bolt "1", "2"</p> <p>1st: 8 N·m (0.8 kgf·m, 5.9 lb·ft)</p> <p>2nd: 17 N·m (1.7 kgf·m, 13 lb·ft)</p>
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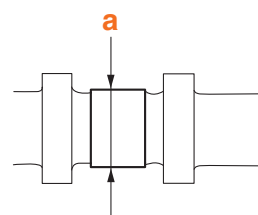
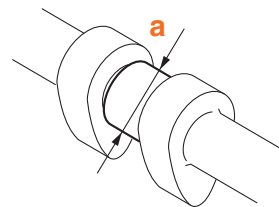
4. Remove:
 - Camshaft caps
See step 6 in "Removing the camshaft, VCT assembly, and driven sprocket" (7-48).
5. Measure:
 - Width of the Plastigauge "1"
Out of specification → Check the camshaft journal outside diameter and camshaft journal inside diameter. See "Checking the camshaft journal outside diameter and camshaft journal inside diameter" (7-52).




	<p>Camshaft journal oil clearance</p> <p>0.020–0.061 mm (0.0008–0.0024 in)</p> <p>Limit</p> <p>0.080 mm (0.0032 in)</p>
-------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------

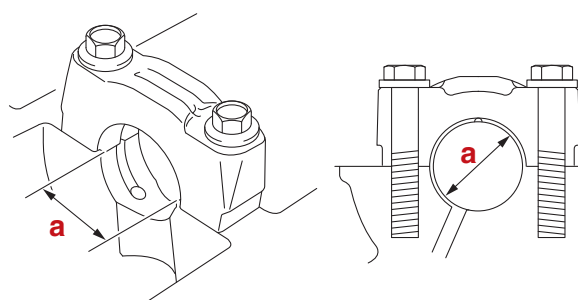
Checking the camshaft journal outside diameter and camshaft journal inside diameter


1. Measure:
 - Camshaft journal outside diameter "a"
Out of specification → Replace.



	<p>Journal diameter</p> <p>24.960–24.980 mm (0.9827–0.9835 in)</p>
------------------------------------------------------------------------------------	--------------------------------------------------------------------

2. Install:
 - Camshaft caps
See steps 2–3 in "Checking the camshaft journal oil clearance" (7-51).
3. Measure:
 - Camshaft journal inside diameter "a"
Out of specification → Replace the cylinder head and camshaft cap as a set.



	<p>Journal inside diameter</p> <p>25.000–25.021 mm (0.9843–0.9851 in)</p>
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Installing the camshaft, VCT assembly, and driven sprocket

If the valve clearances are adjusted or any parts related to valve movement are replaced after installing the timing belt, check the valve clearances. See “Checking the valve clearance” (7-1).

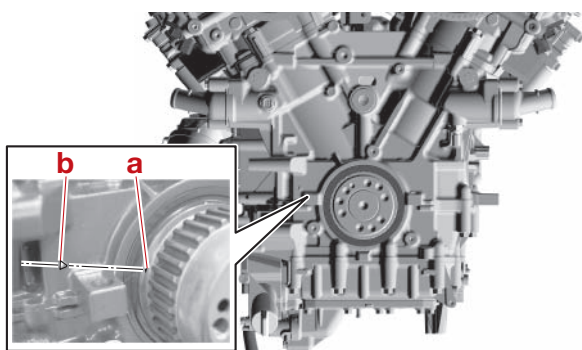
NOTICE

When the timing belt is not installed, do not turn the crankshaft or camshaft. Otherwise, the pistons and valves could collide with each other and be damaged.

1. Install:
 - Wire harness guide bracket
2. Check:
 - Crankshaft position

TIP:

Check that the “▲” mark “a” on the crankshaft is aligned with the “▲” mark “b” on the cylinder block.



3. Install:
 - Valve lifters

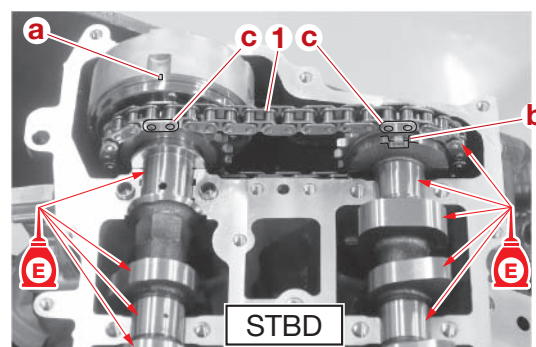
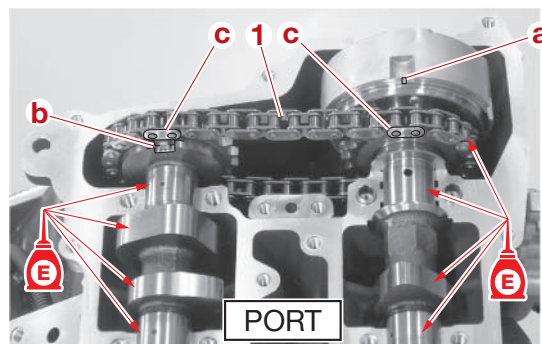
TIP:

Install the valve lifters in their original positions.

4. Assemble:
 - VCT assemblies
 - VCT bolts (temporarily)
 - Camshafts (IN)
5. Install:
 - Oil seals **New**
 - Camshafts (IN) (along with cam chain)
 - Camshafts (EX)

TIP:

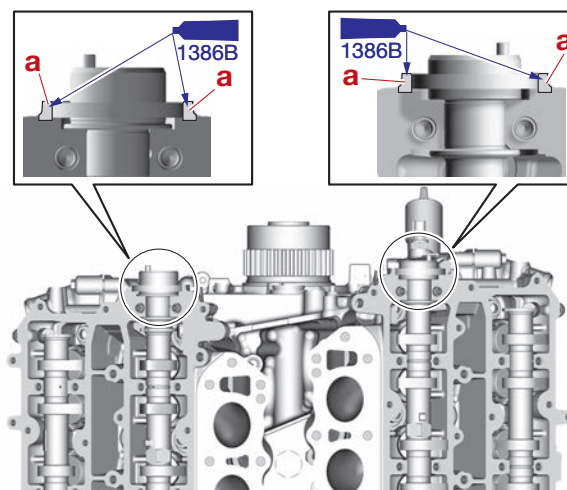
Align the mark “a” on the VCT assembly and the big slot “b” on the camshaft (EX) with the gold-colored plates “c” on the cam chain “1”.



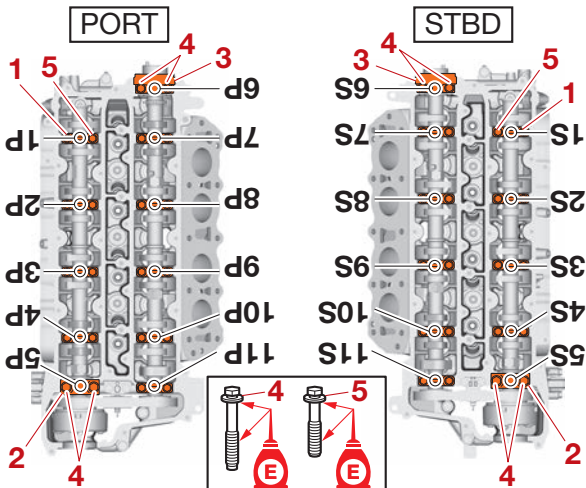
6. Install:
 - Camshaft caps
 - Camshaft cap bolts
 - a. Apply a thin, even coat of sealant to the mating surfaces “a” of the camshaft caps and cylinder heads.

TIP:

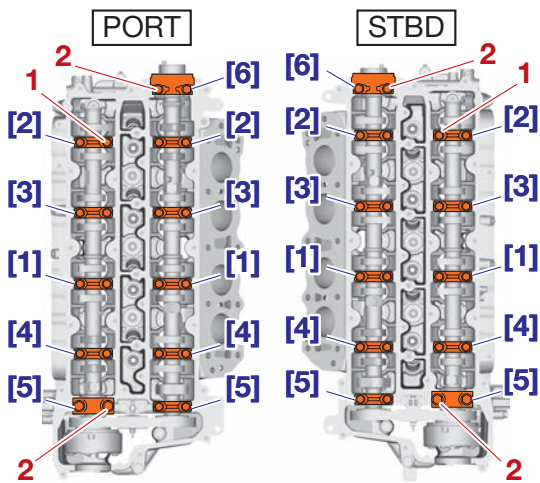
Do not block the oil passages or oil holes with the sealant.




- b. Install the camshaft caps “1”, “2”, and “3” in their proper positions so that the stamped numbers are upside down, and then install the camshaft cap bolts “4” and “5” temporarily.



- c. Tighten the camshaft cap bolts “1” and “2” to the specified torques in 2 stages and in the order [1], [2], and so on.



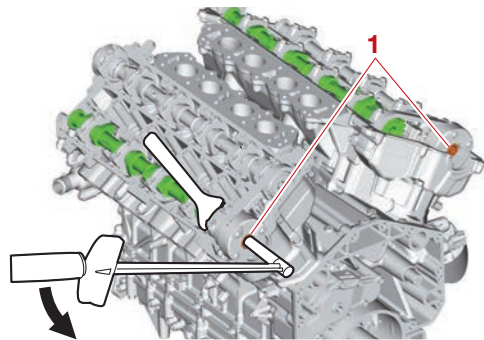
	Camshaft cap bolt “1”, “2” 1st: 8 N·m (0.8 kgf·m, 5.9 lb·ft) 2nd: 17 N·m (1.7 kgf·m, 13 lb·ft)
-------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------


7. Tighten:
- VCT bolts

NOTICE

When loosening or tightening the VCT bolt, do not secure the VCT assembly. Otherwise, the VCT assembly could be damaged.

TIP: _____
Secure the camshaft using a wrench, and then tighten the VCT bolt “1” to the specified torque.

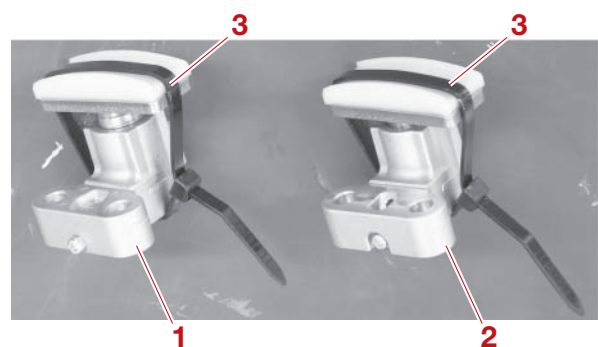


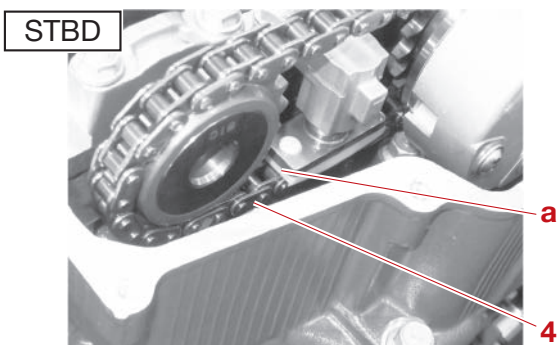
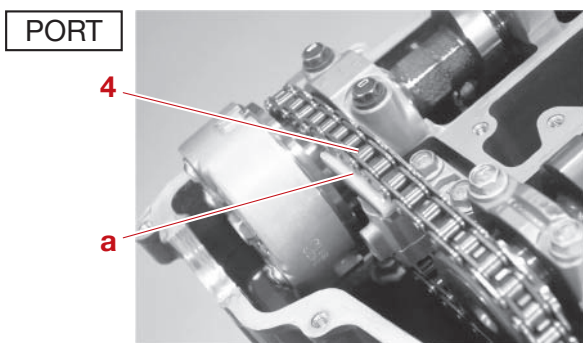
	VCT bolt “1” 60 N·m (6.0 kgf·m, 44 lb·ft)
-----------------------------------------------------------------------------------	----------------------------------------------

8. Install:
- Cam chain tensioner (PORT) “1”
 - Cam chain tensioner (STBD) “2”

TIP: _____

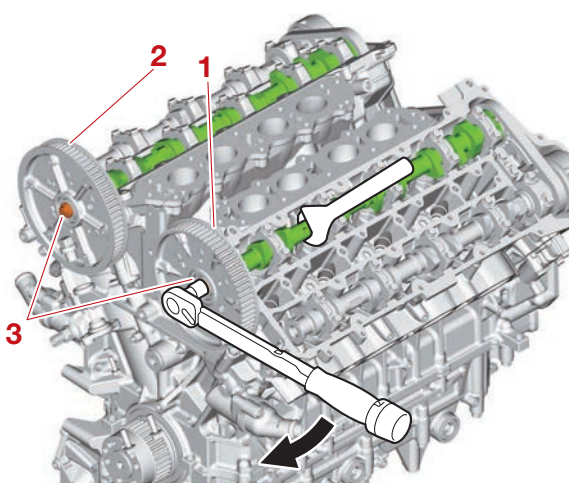
- Use plastic ties “3” to hold the cam chain tensioners in the retracted position. Remove the plastic ties “3” after installing the cam chain tensioners.
- Make sure that the cam chain “4” is properly positioned on the guide surface “a” of the cam chain tensioner.






9. Install:
- Driven sprocket (PORT) "1"
 - Driven sprocket (STBD) "2"

TIP: _____
 Secure the camshaft using a wrench, and then tighten the driven sprocket bolts "3" to the specified torque.

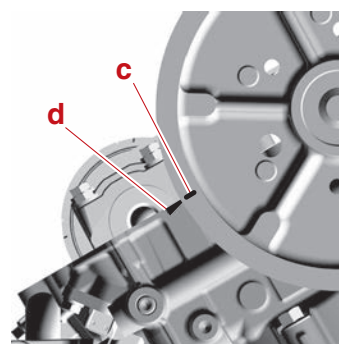
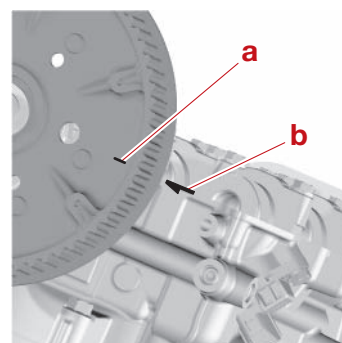


	Driven sprocket bolt "3" 60 N·m (6.0 kgf·m, 44 lb·ft)
-------------------------------------------------------------------------------------	----------------------------------------------------------

10. Check:
- Camshaft positions

TIP: _____

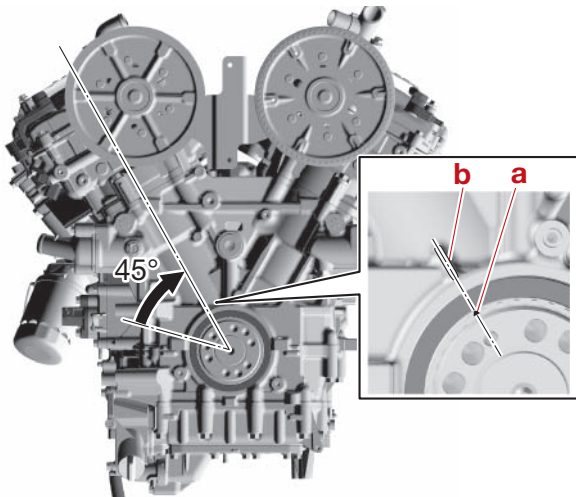
- Check that the "I" mark "a" on the driven sprocket (PORT) is aligned with the "◄" mark "b" on the cylinder head (PORT).
- Check that the "I" mark "c" on the driven sprocket (STBD) is aligned with the "►" mark "d" on the cylinder head (STBD).



11. Turn:
- Crankshaft

NOTICE _____
 Do not turn the crankshaft clockwise more than 45°. Otherwise, the pistons and valves could collide with each other and be damaged.

TIP: _____
 Turn the crankshaft clockwise 45° gradually until the "▲" mark "a" on the crankshaft is aligned with the protrusion "b" on the cylinder block.



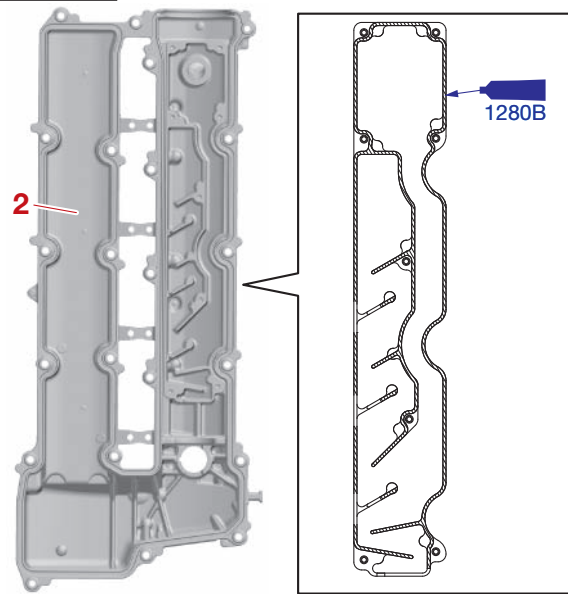
12. Install:


- Breather plate (PORT)
- Breather plate (STBD)

TIP:

- Apply a thin, even coat of sealant onto the cylinder head covers “1” and “2”.
- Make sure to apply sealant only to the portions of the cylinder head covers that will contact the breather plates.

STBD



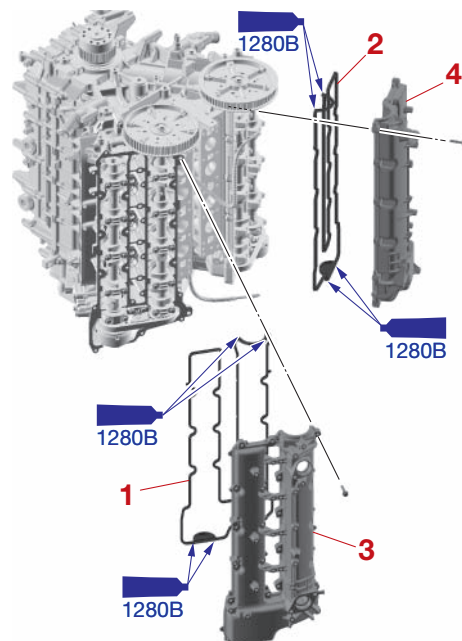
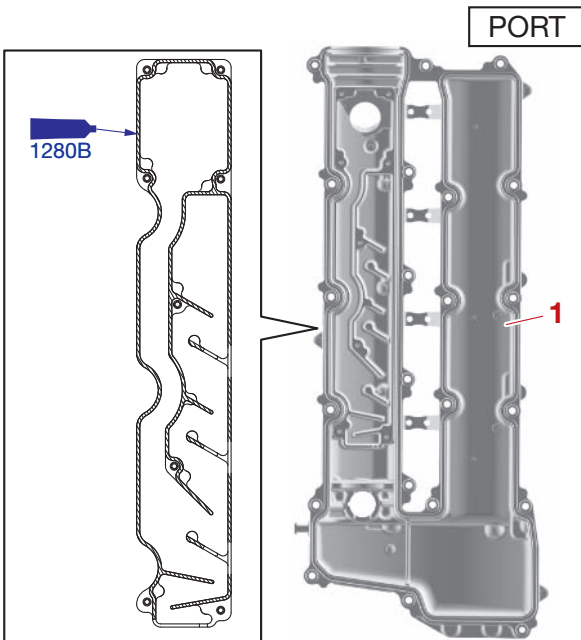
	<p>Breather plate screw 2.0 N·m (0.20 kgf·m, 1.5 lb·ft)</p>
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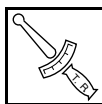
13. Install:

- Gaskets “1”, “2” **New**
- Cylinder head cover (PORT) “3”
- Cylinder head cover (STBD) “4”

TIP:

Tighten the cylinder head cover bolts to the specified torques in 2 stages.

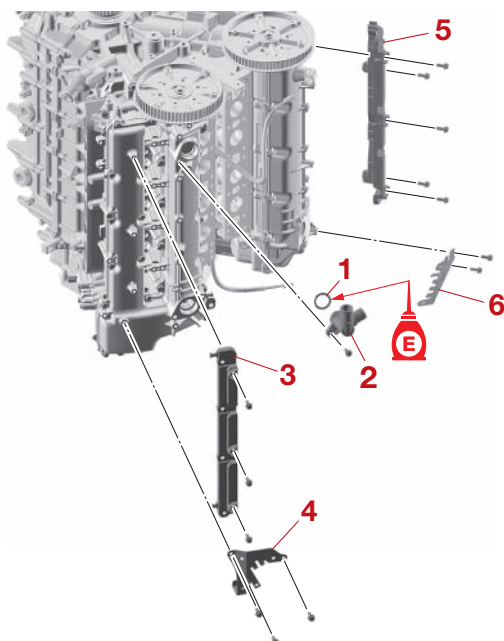




Cylinder head cover bolt
1st: 8 N·m (0.8 kgf·m, 5.9 lb·ft)
2nd: 8 N·m (0.8 kgf·m, 5.9 lb·ft)

14. Install:

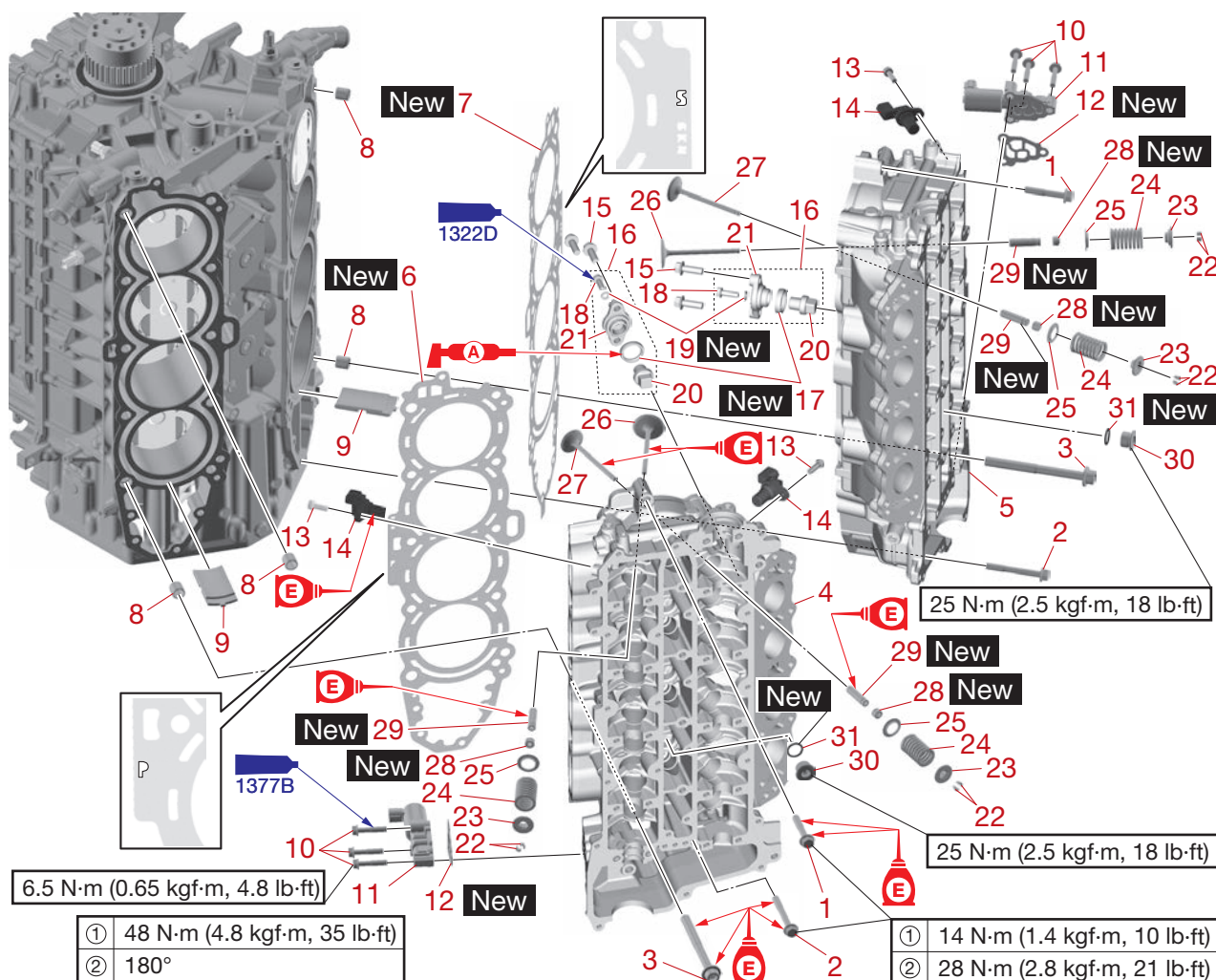
- O-ring “1” **New**
- Hose nipple “2”
- Guide (PORT) “3”
- Bracket (PORT) “4”
- Guide (STBD) “5”
- Bracket (STBD) “6”



15. Install:

- Fuel injectors
- Fuel rails
- Direct injection pumps
See “Installing the fuel injector and fuel rail” (6-20).
- Exhaust joint
See “Installing the exhaust joint” (7-12).

Cylinder head



↑↓	Part name	Q'ty	Remarks
1	Bolt M8 × 50 mm	2	
2	Bolt M8 × 70 mm	8	
3	Bolt M11 × 120 mm	20	
4	Cylinder head (PORT)	1	
5	Cylinder head (STBD)	1	
6	Gasket (PORT)	1	
7	Gasket (STBD)	1	
8	Dowel	4	
9	Grommet	2	
10	Bolt M6 × 35 mm	6	
11	OCV assembly	2	
12	Gasket	2	
13	Bolt M6 × 20 mm	3	
14	Cam position sensor	3	
15	Bolt M8 × 25 mm	8	
16	Anode assembly	4	
17	Grommet	4	
18	Bolt M6 × 20 mm	4	
19	Gasket	4	

↑↓	Part name	Q'ty	Remarks
20	Anode	4	
21	Cover	4	
22	Valve cotter	64	
23	Spring retainer	32	
24	Valve spring	32	
25	Spring seat	32	
26	Intake valve	16	
27	Exhaust valve	16	
28	Valve seal	32	
29	Valve guide	32	
30	Plug M21 × 14 mm	6	
31	O-ring	6	

Removing the cylinder head

- Remove:
 - Cylinder head

NOTICE

Do not scratch or damage the mating surfaces of the cylinder head and cylinder block.

TIP:

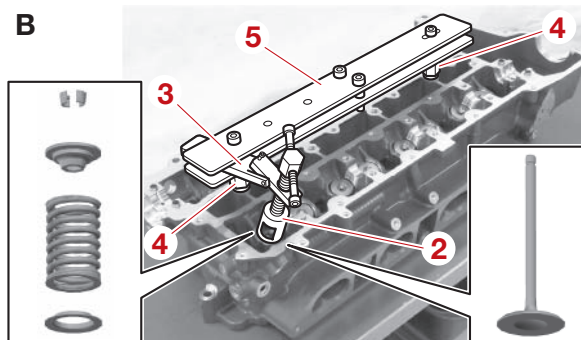
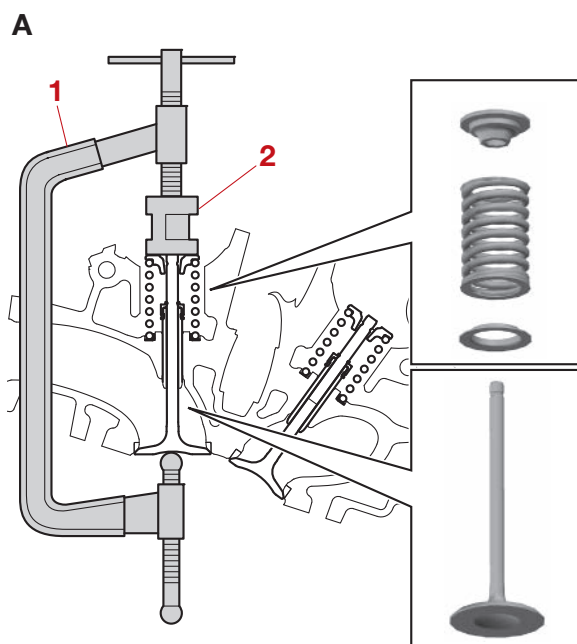
Remove the M11 cylinder head bolts using a triple square socket.

Disassembling the cylinder head

- Remove:
 - Intake valves
 - Exhaust valves


TIP:

Make sure to keep the parts in the order of removal.




- A. Conventional special service tool
B. New special service tool

Conventional special service tools

	Valve spring compressor "1" 90890-04200
	Valve spring compressor attachment "2" 90890-06320
	Valve spring compressor adaptor "2" YB-06320

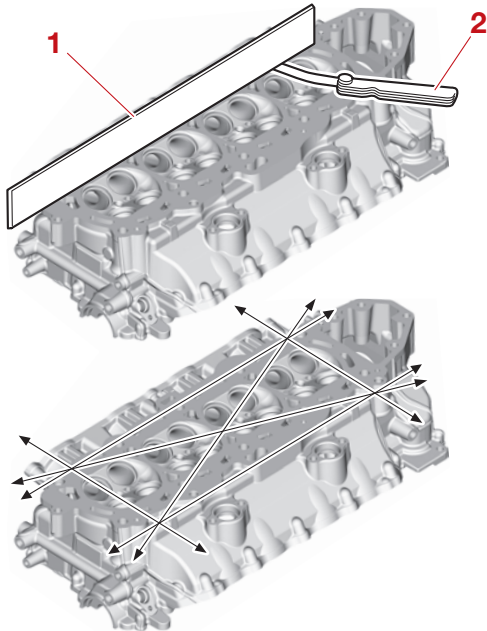
New special service tools


	Valve spring compressor attachment "2" 90890-06320
	Lever assy "3" 90890-06956
	Support assy 3 "4" 90890-06952
	Valve spring compressor "5" 90890-06689
	Valve spring compressor adaptor "2" YB-06320
	Valve spring compressor "5" YB-06689

Checking the cylinder head

- Remove:
 - Combustion chamber carbon deposits
- Check:
 - Cylinder head
Damaged/scratched → Replace.
 - Cylinder head warpage
Above specification → Replace.

TIP: _____
 Check the cylinder head warpage using a straightedge "1" and a thickness gauge "2" in 6 directions.

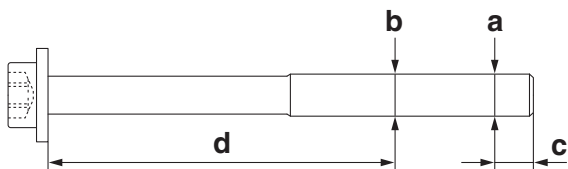



 Warpage limit
 0.10 mm (0.0039 in)

Checking the cylinder head bolt

- Measure:
 - Cylinder head bolt diameter
 Above specification → Replace.

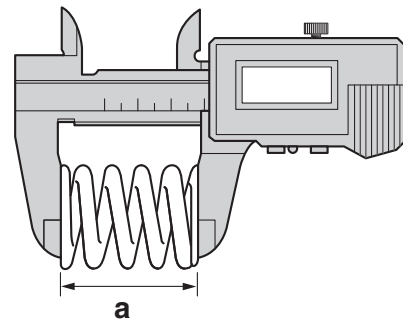
TIP: _____
 Measure the diameters "a" and "b" of the cylinder head bolt (M11) at the specified measuring points "c" and "d".




 Cylinder head bolt (M11) diameter difference limit
 "a" – "b" = Less than 0.20 mm (0.0079 in)
 Measuring point "c": 10.0 mm (0.39 in)
 Measuring point "d": 85.0 mm (3.35 in)

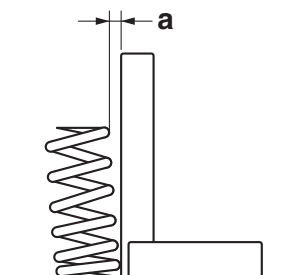
Checking the valve spring


- Measure:
 - Free length "a"
 Below specification → Replace.



 Free length IN
 48.08 mm (1.89 in)
 Limit
 45.68 mm (1.80 in)
 Free length EX
 48.08 mm (1.89 in)
 Limit
 45.68 mm (1.80 in)

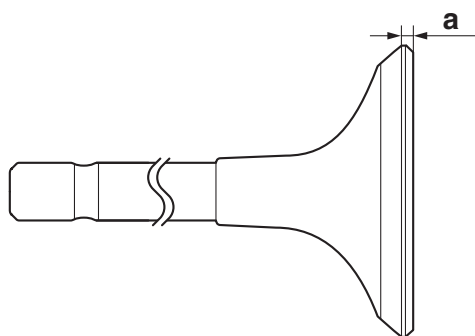
- Measure:
 - Spring tilt "a"
 Above specification → Replace.




	Tilt limit IN
	1.7 mm (0.07 in)
	Tilt limit EX
	1.7 mm (0.07 in)

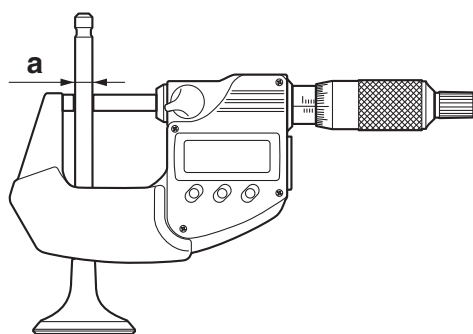
Checking the valve


1. Check:
 - Valve face
Pitted/worn → Replace.
2. Measure:
 - Margin thickness “a”
Out of specification → Replace.



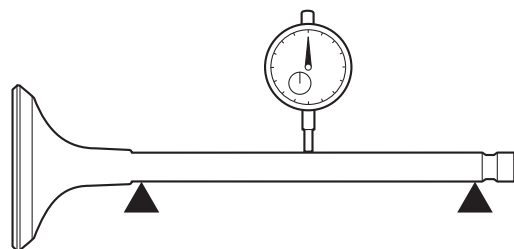
	Margin thickness IN
	0.50–0.90 mm (0.0197–0.0354 in)
	Margin thickness EX
	0.90–1.30 mm (0.0354–0.0512 in)


3. Measure:
 - Stem diameter “a”
Out of specification → Replace.



	Diameter IN
	5.477–5.492 mm (0.2156–0.2162 in)
	Limit
	5.447 mm (0.2144 in)
	Diameter EX
	5.464–5.479 mm (0.2151–0.2157 in)
	Limit
	5.434 mm (0.2139 in)

4. Measure:
 - Stem runout
Above specification → Replace.

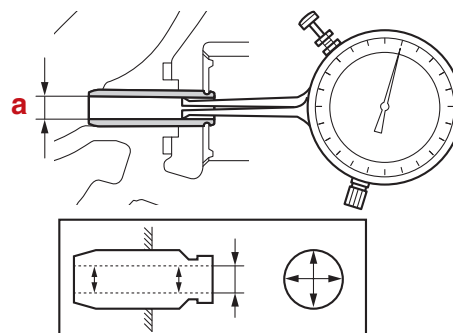



	Runout limit IN
	0.01 mm (0.0004 in)
	Runout limit EX
	0.01 mm (0.0004 in)

Checking the valve guide


Before checking the valve guides, make sure that the valve stem diameter is within specification.

1. Measure:
 - Inside diameter “a”
Out of specification → Replace.



	Inside diameter IN 5.504–5.522 mm (0.2167– 0.2174 in)
	Inside diameter EX 5.504–5.522 mm (0.2167– 0.2174 in)

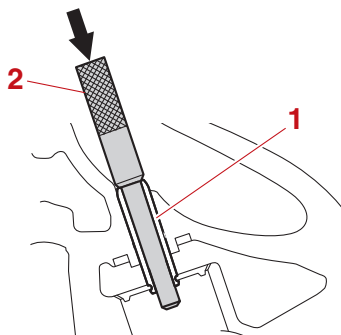
2. Calculate:
- Valve stem to valve guide clearance
Out of specification → Replace the valve
and valve guide.


	Valve stem to valve guide clear- ance = valve guide inside diameter – valve stem diameter
	Clearance IN 0.012–0.045 mm (0.0005– 0.0018 in)
	Limit 0.070 mm (0.0028 in)
	Clearance EX 0.025–0.058 mm (0.0010– 0.0023 in)
	Limit 0.080 mm (0.0032 in)

Replacing the valve guide

After replacing a valve guide, check the valve seat contact area.

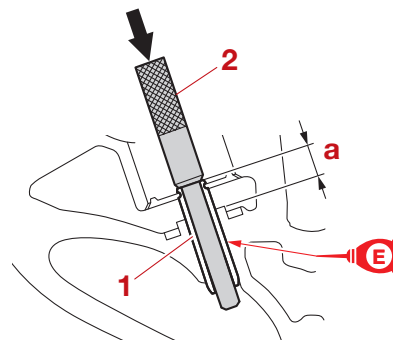
1. Remove:
- Valve guide “1”
(from the combustion chamber side)





	Valve guide remover/installer “2” 90890-06801
	Valve guide remover “2” YB-06801

2. Install:
- Valve guide “1” **New**
(from the camshaft side)

TIP: _____
Make sure that the valve guide installation height “a” is within specification.



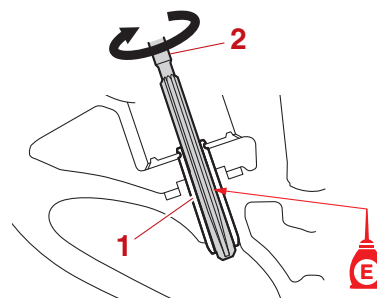
	Valve guide remover/installer “2” 90890-06801
	Valve guide remover “2” YB-06801


	Installation height 11.30–11.70 mm (0.4449– 0.4606 in)
-------------------------------------------------------------------------------------	--------------------------------------------------------------

3. Ream:
- Valve guide “1”


TIP: _____

- To ream the valve guide “1”, turn the valve guide reamer “2” clockwise.
- When removing the valve guide reamer “2”, do not turn it counterclockwise.
- After reaming the valve guide “1”, make sure to clean it.



	Valve guide reamer "2" 90890-06804
	Valve guide reamer "2" YB-06804

4. Measure:
- Inside diameter

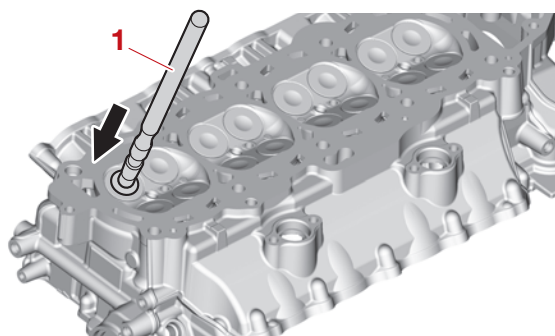
	Inside diameter IN 5.504–5.522 mm (0.2167– 0.2174 in)
	Inside diameter EX 5.504–5.522 mm (0.2167– 0.2174 in)


Checking the valve seat

1. Remove:
 - Carbon deposit
2. Measure:
 - Valve seat contact width

Not seated properly/out of specification
→ Reface the valve seat.
Uneven → Check the valve guide.

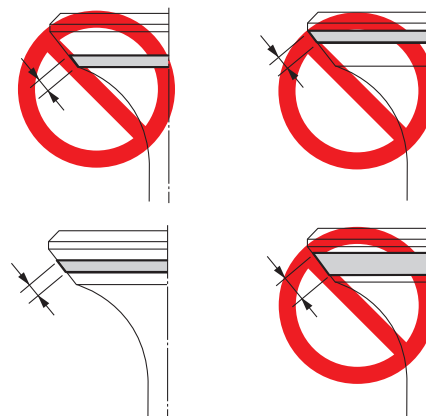
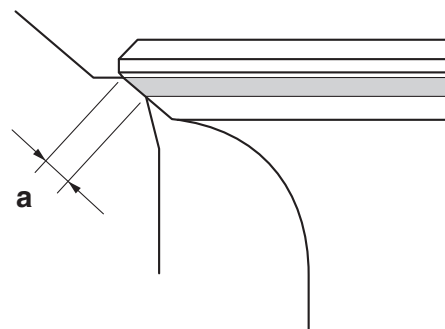
 - a. Remove the carbon deposits from the valve.
 - b. Apply a thin, even layer of blue layout fluid (Dykem) onto the valve seat.
 - c. Press the valve lightly against the valve seat using the special service tool "1".




	Valve lapper "1" 90890-04101
	Valve lapping tool "1" YM-A8998

- d. Measure the valve seat contact width "a" where the blue layout fluid is adhered to the valve face.

TIP: Reface the valve seat if the valve is not seated properly or if the valve seat contact width is out of specification. Check the valve guide if the valve seat contact width is uneven.



	Seat contact width IN 1.10–1.40 mm (0.0433–0.0551 in)
	Limit 1.850 mm (0.0728 in)
	Seat contact width EX 1.40–1.70 mm (0.0551–0.0669 in)
	Limit 2.150 mm (0.0846 in)

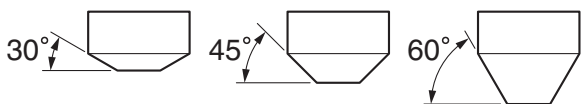
Refacing the valve seat

NOTICE After every lapping procedure, make sure to clean off any remaining lapping compound from the cylinder head and valves.

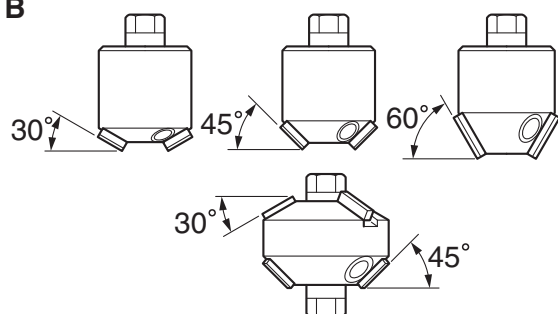
1. Reface:

- Valve seat
 - a. Reface the valve seat using the special service tools.


A



B



- A. Worldwide
- B. USA and Canada

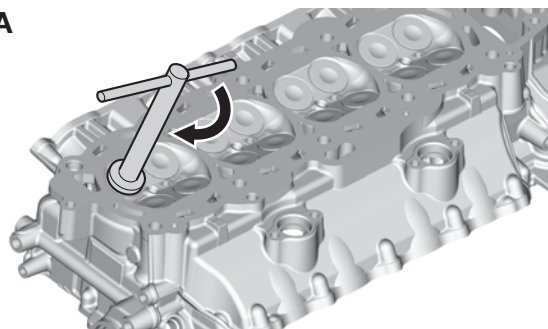
	Valve seat cutter holder 90890-06316 Intake: Valve seat cutter 30–38 90890-06817 Valve seat cutter 45–38 90890-06816 Valve seat cutter 60° 90890-06324 Exhaust: Valve seat cutter 30° 90890-06326 Valve seat cutter 45° 90890-06325 Valve seat cutter 60° 90890-06323 Neway valve seat kit YB-91044
-------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

- b. Cut the surface of the valve seat using a 45° cutter by turning the cutter clockwise until the valve seat face has become smooth.

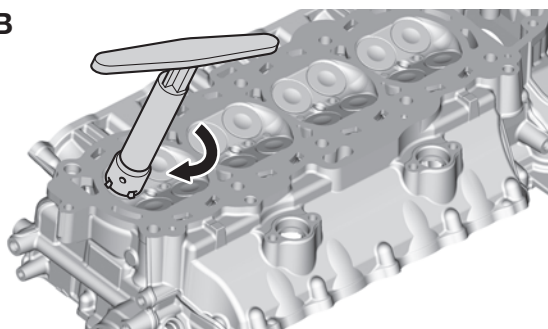
NOTICE

Do not overcut the valve seat. To prevent chatter marks, make sure to turn the cutter evenly using a downward force of 40–50 N (4.0–5.0 kgf, 8.8–11.0 lbf).

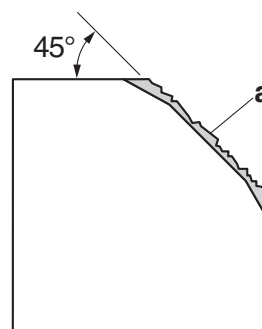
A



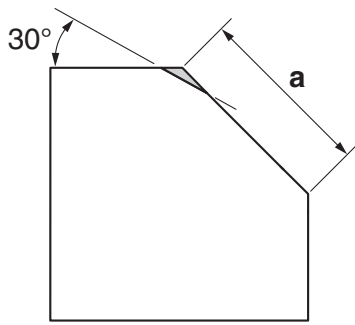
B



- A. Worldwide
- B. USA and Canada

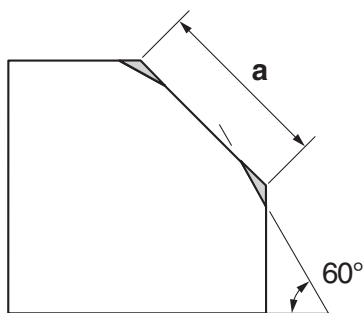


- a. Slag or rough surface
- c. Adjust the top edge of the valve seat contact width using a 30° cutter.



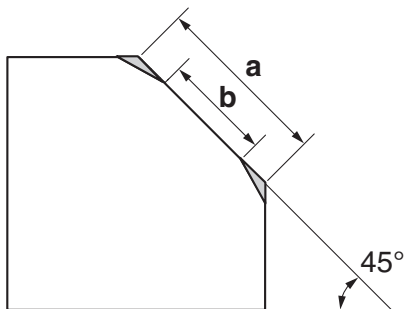
a. Previous contact width

d. Adjust the bottom edge of the valve seat contact width using a 60° cutter.



a. Previous contact width

e. Adjust the valve seat contact width to specification using a 45° cutter.



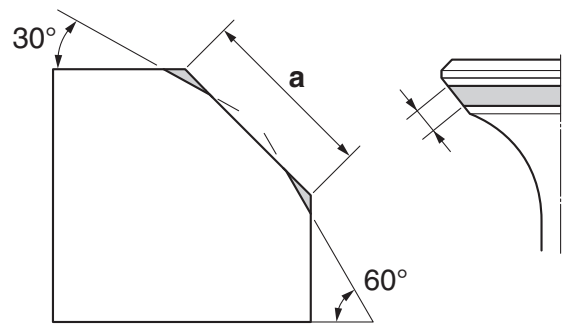
a. Previous contact width

b. Specified contact width

f. Check the valve seat contact area of the valve. See “Checking the valve seat” (7-63).

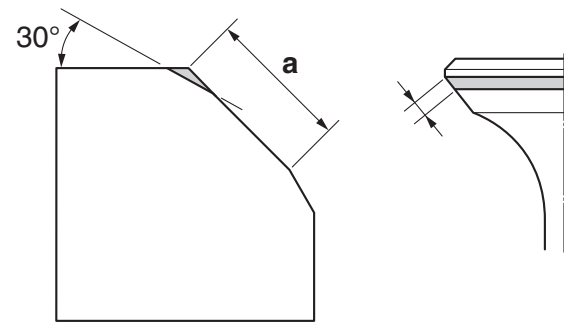
Example:

- If the valve seat contact area is too wide and situated in the center of the valve face, cut the top edge of the valve seat using a 30° cutter, and then cut the bottom edge using a 60° cutter to center the area and set its width.



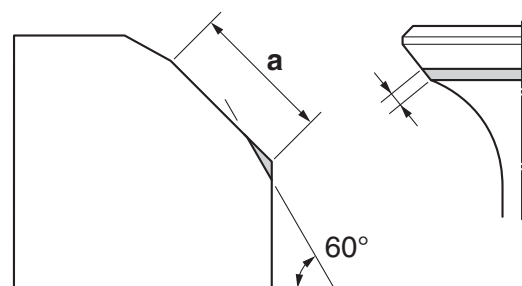
a. Previous contact width

- If the valve seat contact area is too narrow and situated near the top edge of the valve face, cut the top edge of the valve seat using a 30° cutter to center the area, and then set its width using a 45° cutter.



a. Previous contact width

- If the valve seat contact area is too narrow and situated near the bottom edge of the valve face, cut the bottom edge of the valve seat using a 60° cutter to center the area, and then set its width using a 45° cutter.



a. Previous contact width

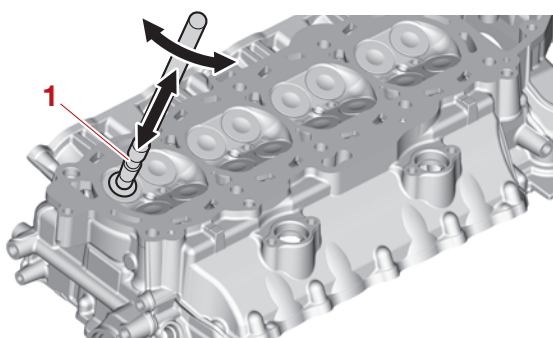
2. Lap:
 - Valve

NOTICE

Do not get the lapping compound on the valve stem and valve guide.

TIP:

After refacing the contact width of the valve seat to specification, apply a thin, even layer of lapping compound onto the valve seat, and then lap the valve using the special service tool "1".



Valve lapper "1"
90890-04101
Valve lapping tool "1"
YM-A8998

3. Measure:

- Valve seat contact width
See step 2 in "Checking the valve seat" (7-63).

Checking the cylinder head anode

1. Check:

- Anode
Eroded (1/2 or more worn out) → Replace.
Adhered grease, oil, or scales → Clean.

NOTICE

Do not apply grease, oil, or paint to the anodes.

Checking the cam position sensor

1. Check:

- Electrical performance
See "Checking the cam position sensor" (5-23).

Checking the OCV

1. Check:

- Electrical performance
See "Checking the OCV" (5-25).

Assembling the cylinder head

1. Install:

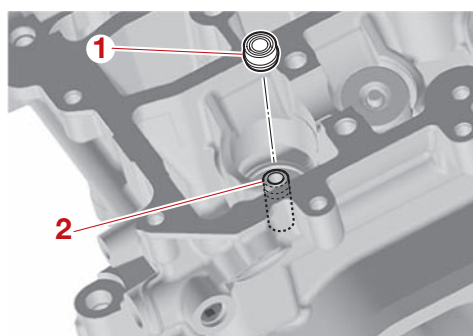
- O-rings **New**
- Plugs
- Cam position sensors
- OCV gaskets **New**
- OCV assemblies



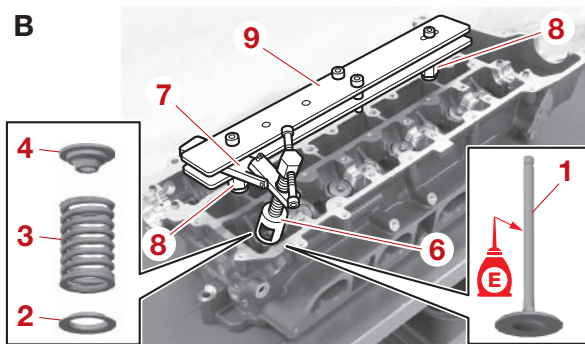
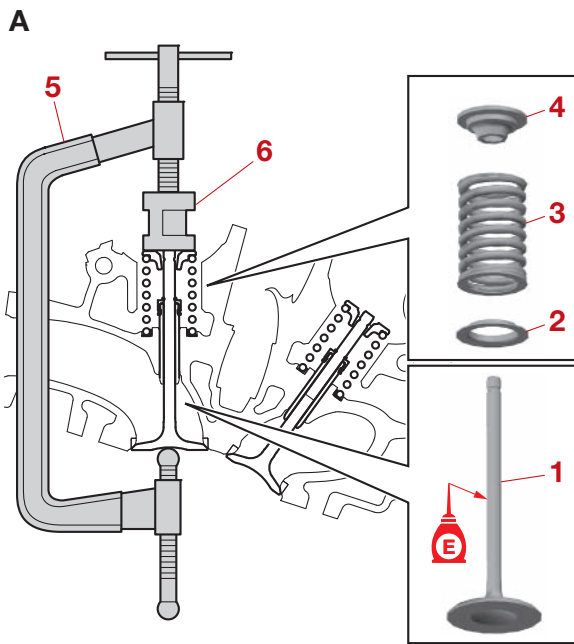
Plug
25 N·m (2.5 kgf·m, 18 lb·ft)
OCV bolt
6.5 N·m (0.65 kgf·m, 4.8 lb·ft)

2. Install:

- Valve stem seals **New**
 - Exhaust valves
 - Intake valves
 - Spring seats
 - Valve springs
 - Spring retainers
 - Valve cotters
- a. Install a new valve seal "1" onto the valve guide "2".



- b. Install the valve "1", valve spring seat "2", valve spring "3", and valve spring retainer "4" in this order, and then install the special service tools.

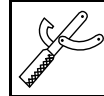


A. Conventional special service tool
 B. New special service tool

Conventional special service tools

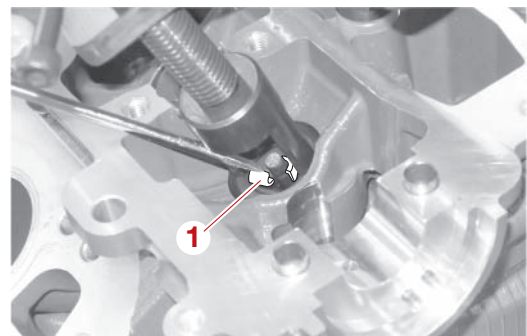
	Valve spring compressor "5" 90890-04200
	Valve spring compressor attachment "6" 90890-06320
	Valve spring compressor adaptor "6" YB-06320

New special service tools

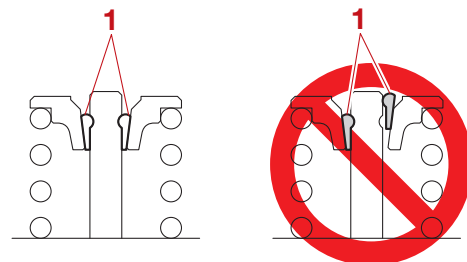
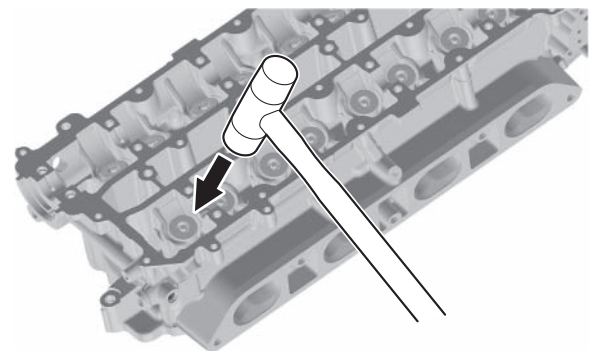


- Valve spring compressor attachment "6"
90890-06320
- Lever assy "7"
90890-06956
- Support assy 3 "8"
90890-06952
- Valve spring compressor "9"
90890-06689
- Valve spring compressor adaptor "6"
YB-06320
- Valve spring compressor "9"
YB-06689

c. Compress the valve spring, and then install the valve cotters "1".



d. Tap the valve spring retainer lightly using a plastic hammer to seat the valve cotters "1" securely.



3. Assemble:
- Anode cover

- Anode
- Gasket **New**
- Anode cover grommet **New**

4. Install:

- Anode assembly

NOTICE

Do not apply grease, oil, or paint to the anodes.

Installing the cylinder head

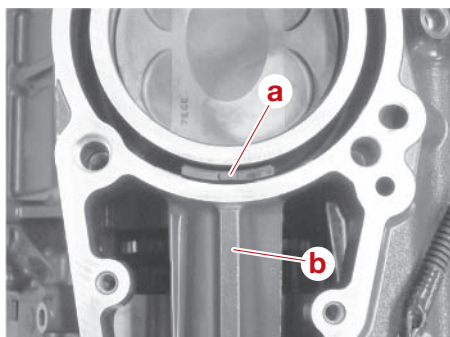
Before assembling the cylinder head, check the cylinder head bolts. See “Checking the cylinder head bolt” (7-60).

1. Install:

- Grommet

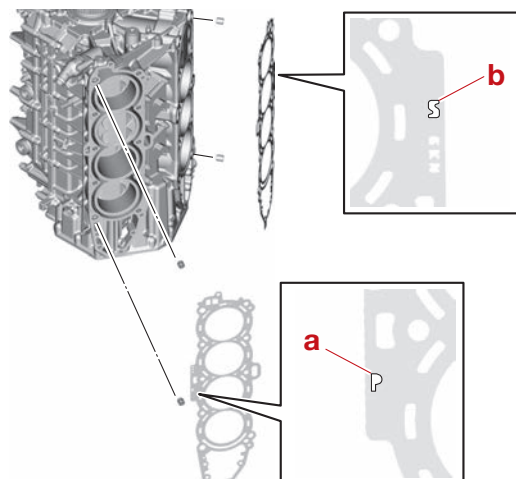
TIP:

Align the protrusion “a” on the grommet with the rib “b” on the cylinder block. Make sure that no portion of the grommet, except the protrusion, protrudes above the mating surface of the cylinder block.



2. Install:

- Dowel
- Gaskets **New**
- Cylinder head (PORT)
- Cylinder head (STBD)
- Cylinder head bolts (M11)
- Cylinder head bolts (M8)
 - Install a new gasket with the “P” mark “a” on port side, and a new gasket with the “S” mark “b” on starboard side.

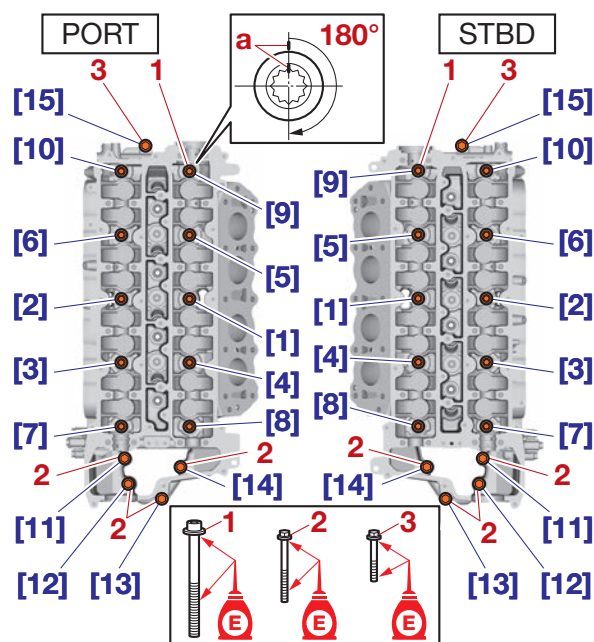


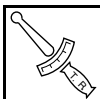
- Tighten the cylinder head bolts (M11) “1” to the specified torques in 2 stages and in the order [1], [2], and so on.

TIP:

- Tighten the M11 bolts using a triple square socket.
- In the 2nd stage, mark the M11 bolts and cylinder head with paint marks “a”, and then tighten the M11 bolts 180° from the marks on the cylinder head.

- Tighten the cylinder head bolts (M8) “2” and “3” to the specified torques in 2 stages and in the order [11], [12], and so on.





Cylinder head bolt (M11) "1" [1]-
[10]

1st: 48 N·m (4.8 kgf·m, 35 lb·ft)

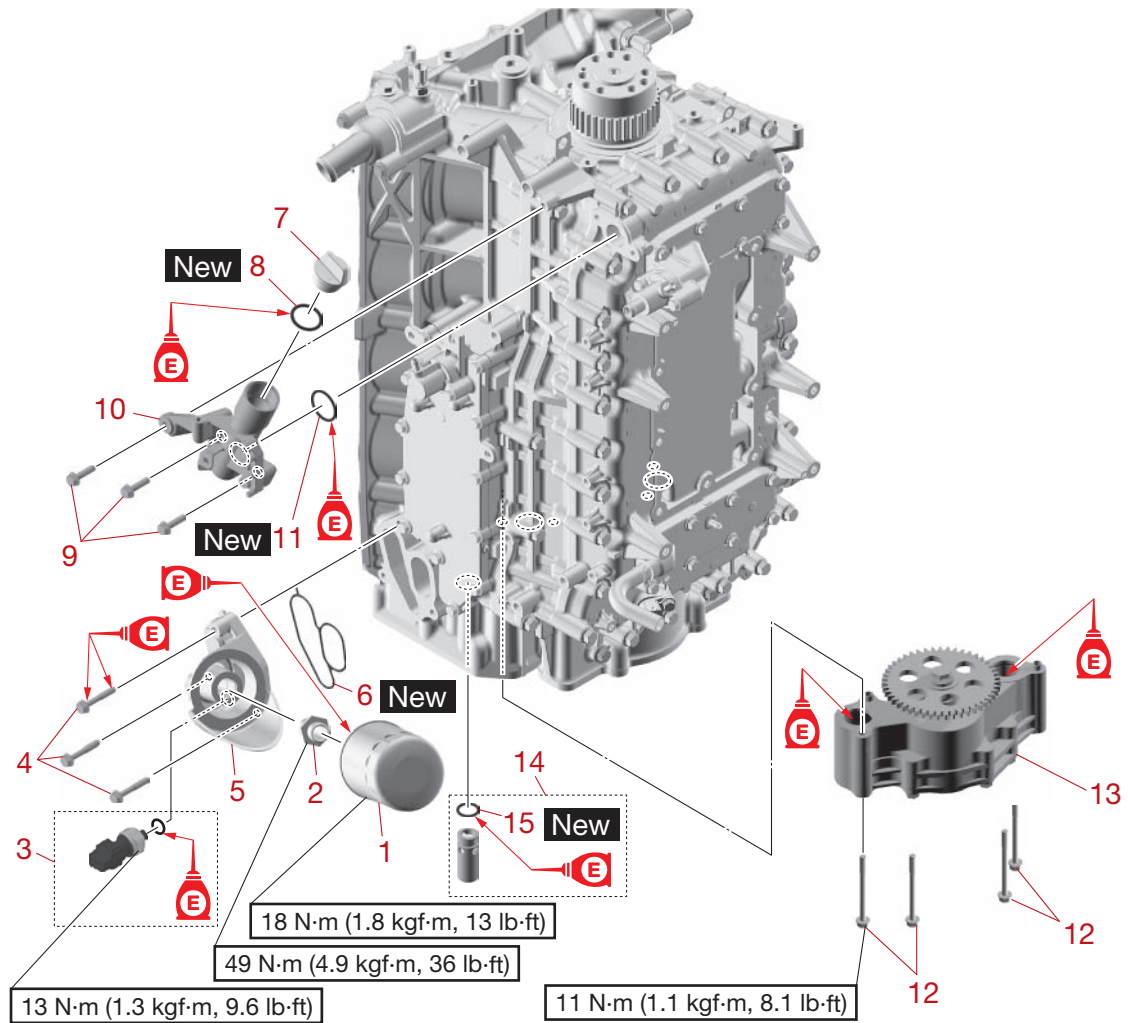
2nd: 180°

Cylinder head bolt (M8) "2", "3"
[11]-[15]

1st: 14 N·m (1.4 kgf·m, 10 lb·ft)

2nd: 28 N·m (2.8 kgf·m, 21 lb·ft)

Oil pump assembly



↕	Part name	Q'ty	Remarks
1	Oil filter	1	
2	Union bolt	1	
3	Sensor	1	Oil pressure
4	Bolt M6 × 40 mm	3	
5	Bracket	1	
6	Gasket	1	
7	Oil filler cap	1	
8	O-ring	1	
9	Bolt M6 × 25 mm	3	
10	Oil filler neck	1	
11	O-ring	1	
12	Bolt M6 × 75 mm	4	
13	Oil pump assembly	1	
14	Relief valve	1	
15	O-ring	1	

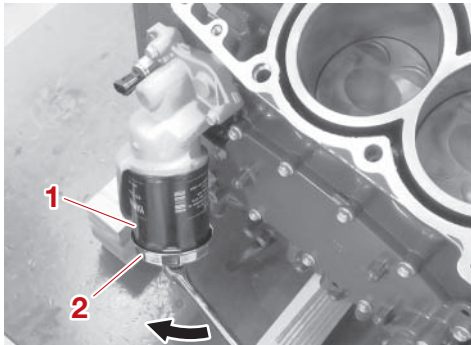
Removing the oil pump assembly

NOTICE

Do not disassemble the oil pump assembly.

Removing the oil filter

- Remove:
 - Oil filter "1"



Oil filter wrench "2"
90890-06874
Oil filter wrench "2"
YB-06874

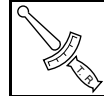
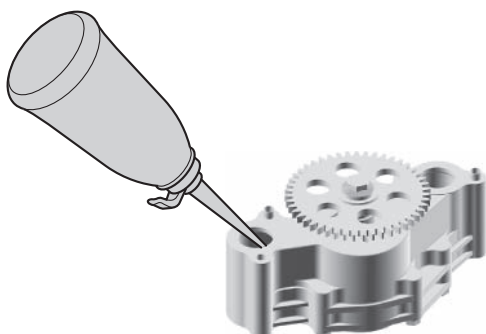
Installing the oil filler neck and relief valve

- Install:
 - O-rings **New**
 - Oil filler neck
 - Oil filler cap
 - Relief valve

Installing the oil pump assembly

- Install:
 - Oil pump assembly

TIP: Fill the oil pump assembly with engine oil through both the inlet hole and outlet hole.

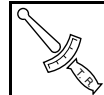
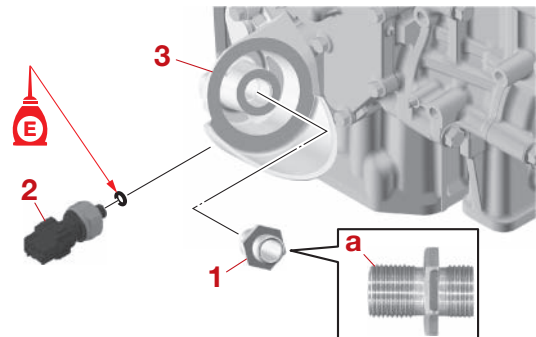


Oil pump assembly bolt
11 N·m (1.1 kgf·m, 8.1 lb·ft)

Installing the oil filter

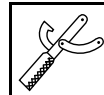
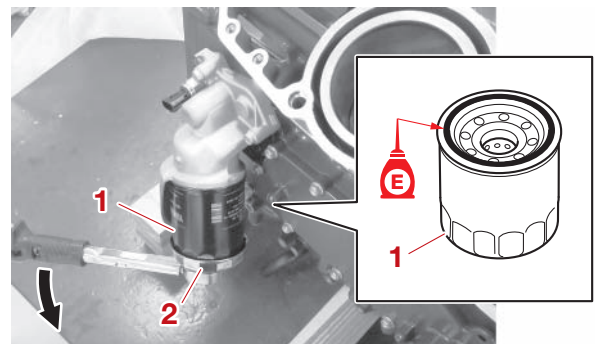
- Install:
 - Gasket **New**
 - Oil filter bracket
 - Union bolt "1"
 - Oil pressure sensor "2"

TIP: Install the longer threaded portion "a" of the union bolt "1" into the oil filter bracket "3".

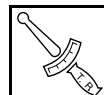


Union bolt "1"
49 N·m (4.9 kgf·m, 36 lb·ft)
Oil pressure sensor "2"
13 N·m (1.3 kgf·m, 9.6 lb·ft)

- Install:
 - Oil filter "1"

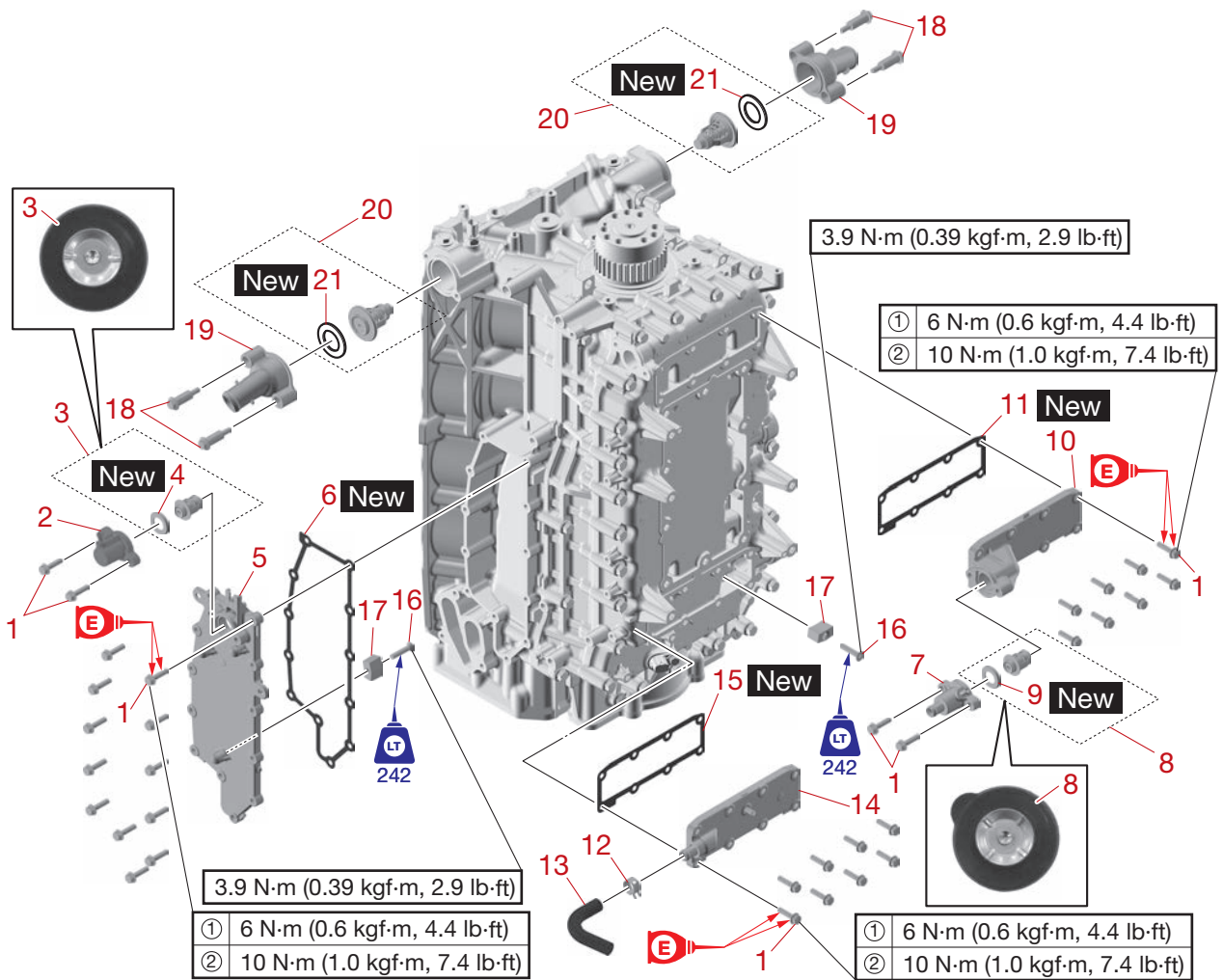


Oil filter wrench "2"
90890-06874
Oil filter wrench "2"
YB-06874



Oil filter
18 N·m (1.8 kgf·m, 13 lb·ft)

Oil cooler and water jacket



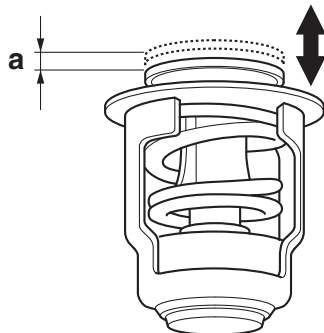
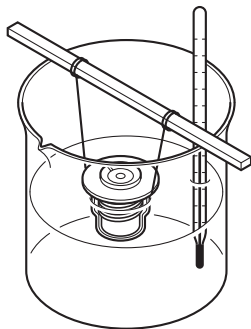
↑↓	Part name	Q'ty	Remarks
1	Bolt M6 × 25 mm	32	
2	Thermostat cover	1	
3	Thermostat	1	
4	Gasket	1	
5	Cover	1	
6	Gasket	1	
7	Thermostat cover	1	
8	Thermostat	1	
9	Gasket	1	
10	Cover	1	
11	Gasket	1	
12	Clamp	1	
13	Hose	1	
14	Cover	1	
15	Gasket	1	
16	Screw M6 × 25 mm	2	
17	Anode	2	
18	Bolt M6 × 40 mm	4	
19	Thermostat cover	2	

↑↓	Part name	Q'ty	Remarks
20	Thermostat	2	
21	Gasket	2	

Checking the thermostat

- Measure:
 - Valve opening "a"
(at the specified water temperatures)
Out of specification → Replace.

- TIP:** _____
- Suspend the thermostat in a container of water.
 - Place a thermo meter in the water, and then heat the water slowly.



Cylinder block thermostat

Water temperature	Valve opening "a"
58–62 °C (136–144 °F)	Starts opening
above 70 °C (158 °F)	5.0 mm (0.20 in) or above

Oil cooler thermostat and water jacket thermostat

Water temperature	Valve opening "a"
58–62 °C (136–144 °F)	Starts opening
above 70 °C (158 °F)	3.0 mm (0.12 in) or above

Checking the oil cooler cover anode and water jacket anode

- Check:
 - Anode
Eroded (1/2 or more worn out) → Replace.
Adhered grease, oil, or scales → Clean.

NOTICE _____
Do not apply grease, oil, or paint to the anodes.


Installing the cylinder block thermostat

- Install:
 - Gaskets **New**
 - Cylinder block thermostats
 - Thermostat housings

Installing the water jacket cover

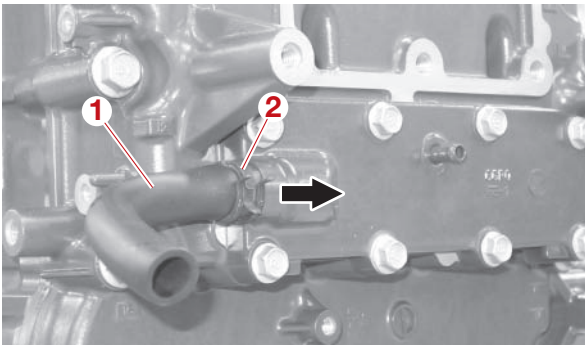
- Install:
 - Water jacket anode
 - Gasket **New**
 - Water jacket cover (lower)

TIP: _____
Tighten the water jacket cover (lower) bolts to the specified torques in 2 stages.

	Water jacket anode screw 3.9 N·m (0.39 kgf·m, 2.9 lb·ft)
	Water jacket cover (lower) bolt 1st: 6 N·m (0.6 kgf·m, 4.4 lb·ft) 2nd: 10 N·m (1.0 kgf·m, 7.4 lb·ft)

- Install:
 - Hose "1"
 - Clamp "2"

TIP: _____
Point the end of the clamp forward.



3. Install:

- Gasket **New**
- Water jacket cover (upper)

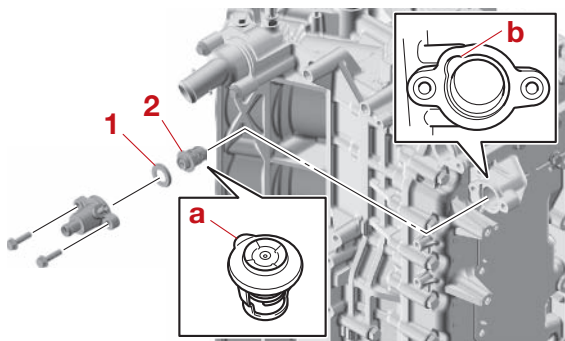
TIP: _____
Tighten the water jacket cover (upper) bolts to the specified torques in 2 stages.

	Water jacket cover (upper) bolt 1st: 6 N·m (0.6 kgf·m, 4.4 lb·ft) 2nd: 10 N·m (1.0 kgf·m, 7.4 lb·ft)
--	------------------------------------------------------------------------------------------------------------

4. Install:

- Gasket “1” **New**
- Water jacket thermostat “2”
- Water jacket thermostat housing

TIP: _____
Fit the protrusion “a” on the thermostat into the cut-out “b” in the water jacket cover (upper).



Installing the oil cooler cover

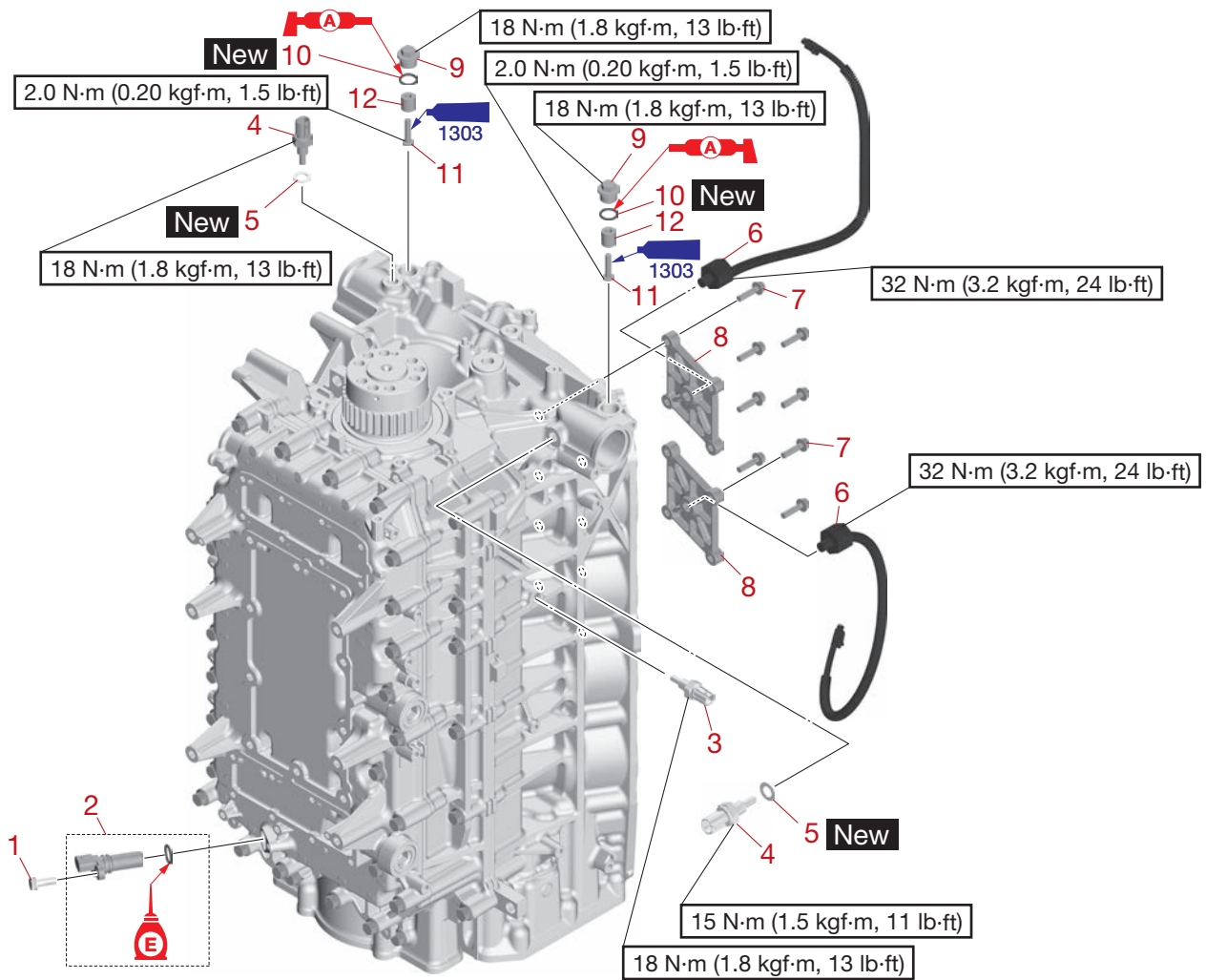
1. Install:

- Oil cooler cover anode
- Gasket **New**
- Oil cooler cover
- Gasket **New**
- Thermostat
- Thermostat cover

TIP: _____
Tighten the oil cooler cover bolts to the specified torques in 2 stages.

	Oil cooler cover anode screw 3.9 N·m (0.39 kgf·m, 2.9 lb·ft)
	Oil cooler cover bolt 1st: 6 N·m (0.6 kgf·m, 4.4 lb·ft) 2nd: 10 N·m (1.0 kgf·m, 7.4 lb·ft)

Cylinder block sensor



↑↓	Part name	Q'ty	Remarks
1	Bolt M6 × 20 mm	1	
2	Sensor	1	Crankshaft position
3	Sensor	1	Engine temperature
4	Sensor	2	Thermo
5	Gasket	2	
6	Knock sensor	2	
7	Bolt M6 × 25 mm	8	
8	Bracket	2	
9	Plug M16 × 11 mm	2	
10	O-ring	2	
11	Screw M5 × 25 mm	2	
12	Anode	2	

Checking the cylinder block anode

- Check:
 - Anode
 - Eroded (1/2 or more worn out) → Replace.
 - Adhered grease, oil, or scales → Clean.

NOTICE

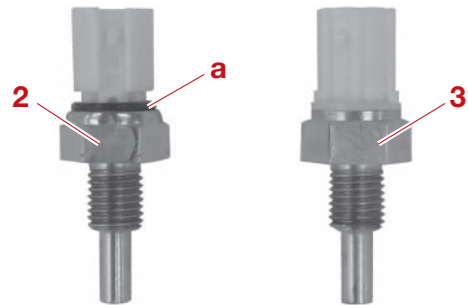
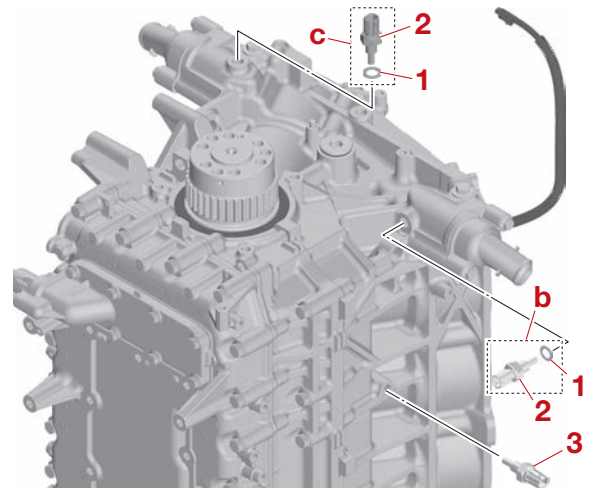
Do not apply grease, oil, or paint to the anodes.

Installing the cylinder block anode

- Install:
 - Cylinder block anodes
 - O-rings **New**
 - Anode plugs



Cylinder block anode screw
2.0 N·m (0.20 kgf·m, 1.5 lb·ft)
Anode plug
18 N·m (1.8 kgf·m, 13 lb·ft)

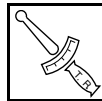


Installing the cylinder block sensor

- Install:
 - Knock sensor brackets
 - Knock sensors
 - Gaskets "1" **New**
 - Thermo sensors "2"
 - Engine temperature sensor "3"
 - O-ring **New**
 - Crankshaft position sensor

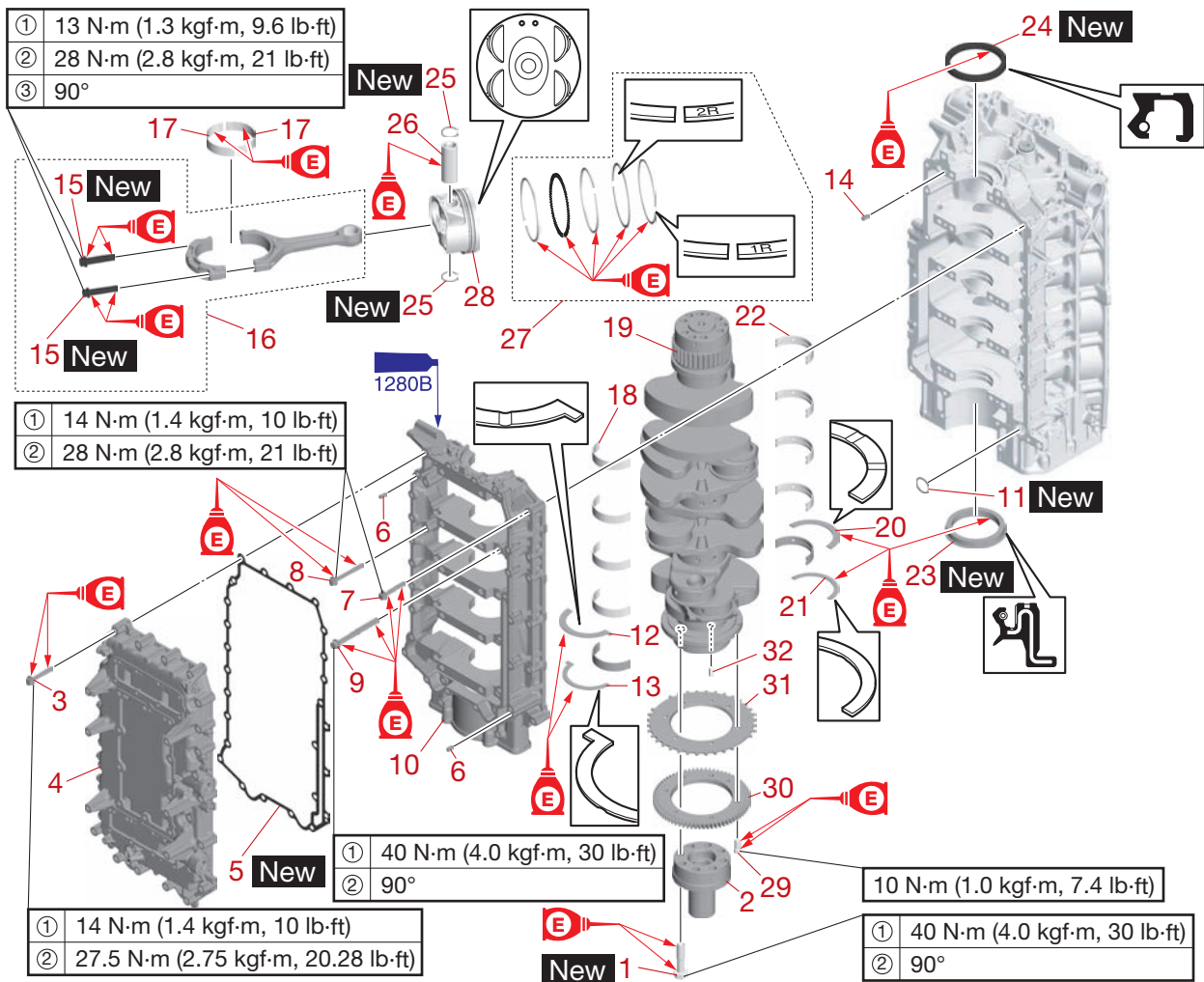
TIP:

Be sure to install the thermo sensor (with the O-ring "a") "2" and engine temperature sensor (without O-ring) "3" in the proper locations.



Knock sensor
32 N·m (3.2 kgf·m, 24 lb·ft)
Thermo sensor (PORT) "b"
15 N·m (1.5 kgf·m, 11 lb·ft)
Thermo sensor (STBD) "c"
18 N·m (1.8 kgf·m, 13 lb·ft)
Engine temperature sensor
18 N·m (1.8 kgf·m, 13 lb·ft)

Cylinder block



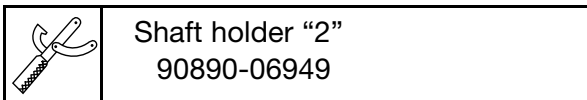
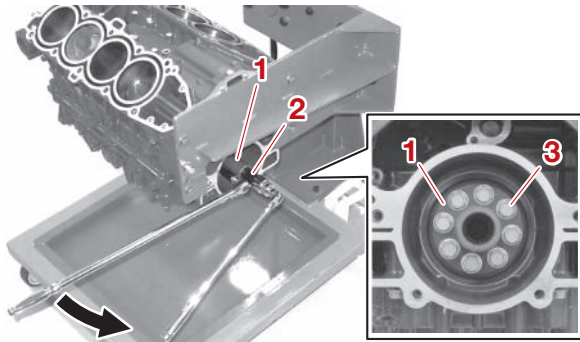
↑↓	Part name	Q'ty	Remarks
1	Bolt M10 × 50 mm	8	
2	Flange	1	
3	Bolt M8 × 50 mm	26	
4	Crankcase cover	1	
5	Gasket	1	
6	Dowel	2	
7	Bolt M8 × 50 mm	10	
8	Bolt M8 × 70 mm	6	
9	Bolt M10 × 103 mm	20	
10	Crankcase	1	
11	O-ring	1	
12	Thrust bearing	1	
13	Thrust bearing	1	
14	Dowel	10	
15	Bolt M9 × 42mm	16	
16	Connecting rod assembly	8	
17	Crankshaft pin bearing	16	

↑↓	Part name	Q'ty	Remarks
18	Crankshaft journal bearing	5	
19	Crankshaft	1	
20	Thrust bearing	1	
21	Thrust bearing	1	
22	Crankshaft journal bearing	5	
23	Oil seal	1	
24	Oil seal	1	
25	Clip	16	
26	Piston pin	8	
27	Piston ring set	8	
28	Piston	8	
29	Bolt M6 × 14 mm	6	
30	Drive gear	1	
31	Pickup rotor	1	
32	Dowel	1	

Disassembling the cylinder block

1. Remove:
 - Flange "1"

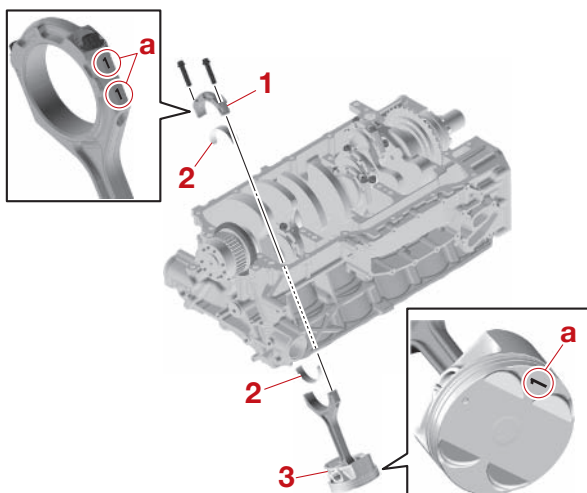
TIP: _____
 Install the special service tool "2" to the flange "1", secure the tool using a wrench, and then remove the flange bolts "3".



2. Remove:
 - Connecting rod assemblies
 - a. Remove the connecting rod caps "1", and then remove the crankshaft pin bearings "2" and connecting rods (along with the piston) "3".

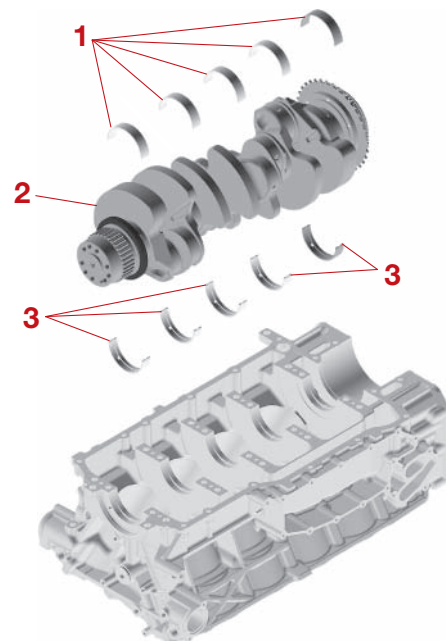
TIP: _____

- To prevent mixing the piston, connecting rod assemblies "3", and connecting rod caps "1", mark each with an identification number "a" of the corresponding cylinder.
- Make sure to keep the crankshaft pin bearings in the order of removal.



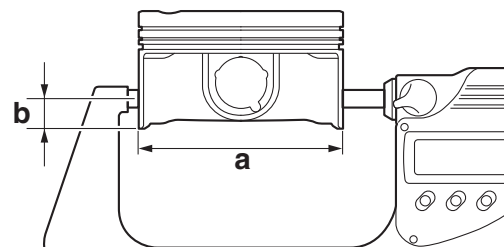
3. Remove:
 - Crankshaft journal bearings (crankcase side) "1"
 - Crankshaft "2"
 - Crankshaft journal bearings (cylinder block side) "3"


TIP: _____
 Make sure to keep the crankshaft journal bearings in the order of removal.



Checking the piston diameter

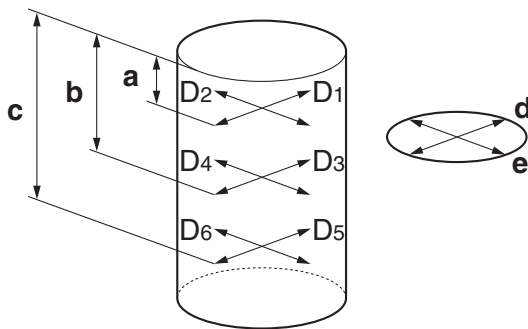
1. Measure:
 - Piston diameter "a" (at the specified measuring point "b")
 Out of specification → Replace.




	Piston Diameter
	95.945–95.960 mm (3.7774–3.7779 in)
	Limit
	95.905 mm (3.7758 in)
	Measuring point
	14.5 mm (0.57 in)

Checking the cylinder bore

- Measure:
 - Cylinder bore (D1–D6) (at measuring points “a”, “b”, and “c”, and in directions “d” [D1, D3, D5] and “e” [D2, D4, D6])
 Out of specification → Replace the cylinder block.




- 7.0 mm (0.28 in)
- 52.0 mm (2.05 in)
- 111.0 mm (4.37 in)
- Parallel to the crankshaft
- At a right angle to the crankshaft

	Cylinder Bore
	96.000–96.012 mm (3.7795–3.7800 in)
	Limit
	96.072 mm (3.7824 in)

Checking the piston clearance

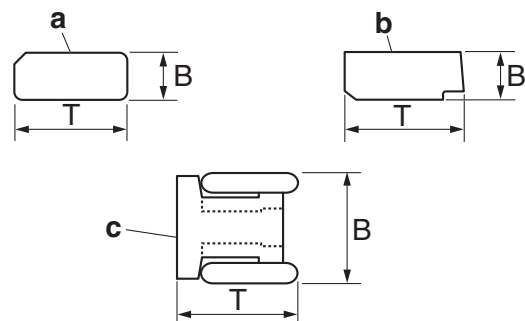
- Measure:
 - Piston diameter
See “Checking the piston diameter” (7-78).
 - Cylinder bore
See “Checking the cylinder bore” (7-79).

- Calculate:
 - Piston clearance
Out of specification → Replace the piston or cylinder block.


	Piston clearance = maximum cylinder bore – piston outside diameter
	Piston clearance
	0.040–0.067 mm (0.0016–0.0026 in)
	Limit
	0.167 mm (0.0066 in)


Checking the piston ring

- Measure:
 - Piston ring dimension
Out of specification → Replace.



- Top ring
- 2nd ring
- Oil ring

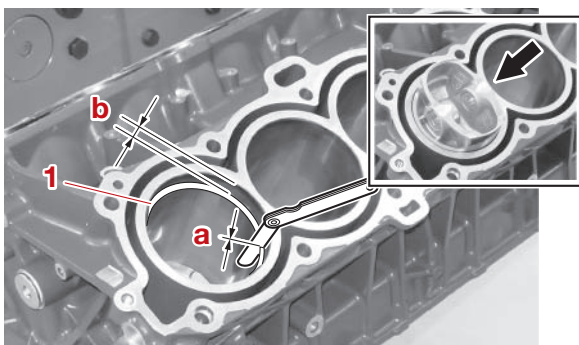
	Piston ring dimensions	
	Top ring	
	Height (B)	1.170–1.185 mm (0.0461–0.0467 in)
	Width (T)	2.800–3.000 mm (0.1102–0.1181 in)
	2nd ring	
	Height (B)	1.170–1.190 mm (0.0461–0.0469 in)
	Width (T)	3.800–4.000 mm (0.1496–0.1575 in)
	Oil ring	
	Height (B)	2.410–2.470 mm (0.0949–0.0972 in)
	Width (T)	2.350–2.750 mm (0.0925–0.1083 in)

	Piston ring end gap	
	Measuring point	
	10.0 mm (0.39 in)	
	Top ring	
	End gap	0.20–0.30 mm (0.0079–0.0118 in)
	Limit	0.470 mm (0.0185 in)
	2nd ring	
	End gap	0.60–0.75 mm (0.0236–0.0295 in)
	Limit	0.900 mm (0.0354 in)
	Oil ring	
	End gap	0.15–0.60 mm (0.0059–0.0236 in)

Checking the piston ring end gap

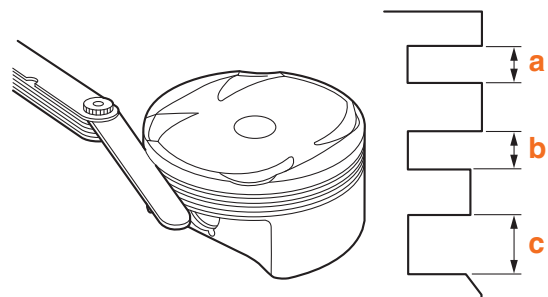
- Measure:
 - Piston ring end gap “a”
 Out of specification → Replace.

TIP: _____
 Level the piston ring “1” in the cylinder using a piston crown at the specified measuring point “b”.




Checking the piston ring groove

- Measure:
 - Piston ring groove
 Out of specification → Replace.

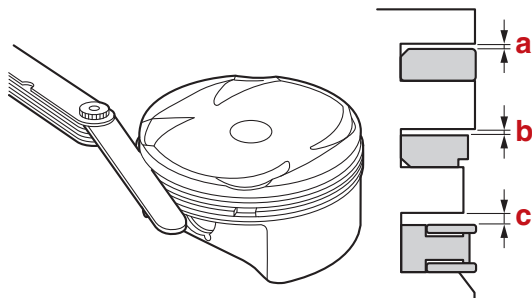


- a. Ring groove (Top)
- b. Ring groove (2nd)
- c. Ring groove (Oil)

	Piston ring groove	
	Ring groove (Top)	
		1.22–1.25 mm (0.0480–0.0492 in)
	Ring groove (2nd)	
		1.22–1.24 mm (0.0480–0.0488 in)
	Ring groove (Oil)	
	2.51–2.53 mm (0.0988–0.0996 in)	

Checking the piston ring side clearance

- Measure:
 - Piston ring side clearance
Out of specification → Check the piston ring grooves and piston ring.
See “Checking the piston ring groove” (7-80) and “Checking the piston ring” (7-79).



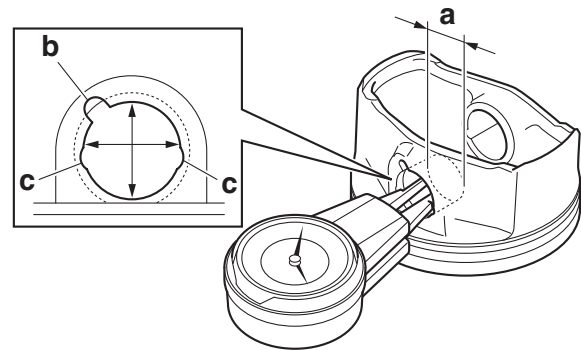
- Top ring side clearance
- 2nd ring side clearance
- Oil ring side clearance

	Piston ring side clearance
	Top ring
	Side clearance
	0.03–0.08 mm (0.0014–0.0032 in)
	Limit
	0.130 mm (0.0051 in)
2nd ring	
Side clearance	
0.03–0.07 mm (0.0012–0.0028 in)	
Limit	
0.110 mm (0.0043 in)	
Oil ring	
Side clearance	
0.04–0.12 mm (0.0016–0.0047 in)	

Checking the piston pin boss inside diameter

- Measure:
 - Piston pin boss inside diameter “a”
Out of specification → Replace.

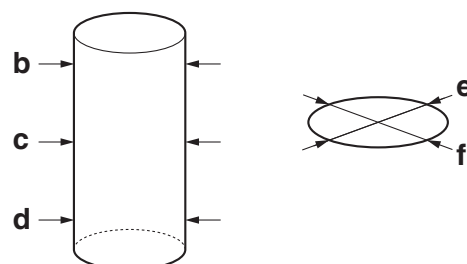
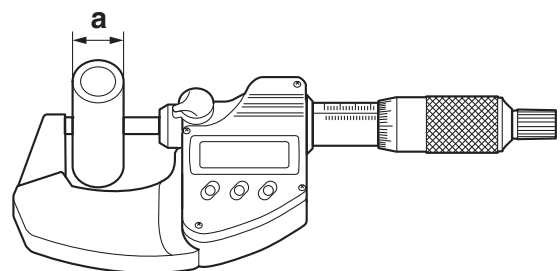
TIP: _____
When measuring the piston pin boss inside diameter, do not measure it at the ring groove “b” or oil groove “c”.



	Pin boss inside diameter
	22.011–22.018 mm (0.8666–0.8668 in)
	Limit
	22.038 mm (0.8676 in)

Checking the piston pin diameter

- Measure:
 - Piston pin outside diameter “a”
(at measuring points “b”, “c”, and “d”, and in directions “e” and “f”)
Below specification → Replace.





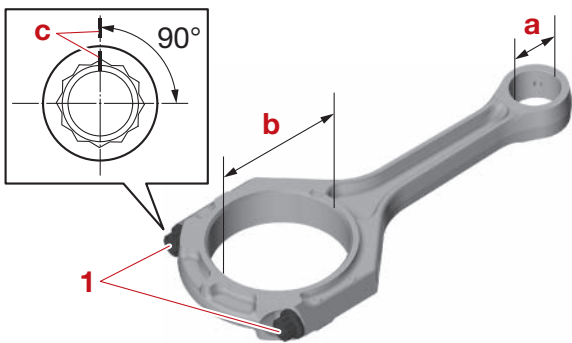
Pin outside diameter
21.996–22.005 mm (0.8660–
0.8663 in)
Limit
21.986 mm (0.8656 in)

Checking the connecting rod small end inside diameter and big end inside diameter

- Measure:
 - Small end inside diameter “a”
 - Big end inside diameter “b”
 Out of specification → Replace the connecting rod assembly.

TIP:

- When checking the big end inside diameter, reuse the removed connecting rod bolt.
- Tighten the connecting rod bolts “1” to the specified torques in 3 stages.
- In the third tightening stage for the connecting rod bolts “1”, mark the connecting rod bolts and the connecting rod cap with identification marks “c”, and then tighten the bolts 90° from the marks on the connecting rod cap.



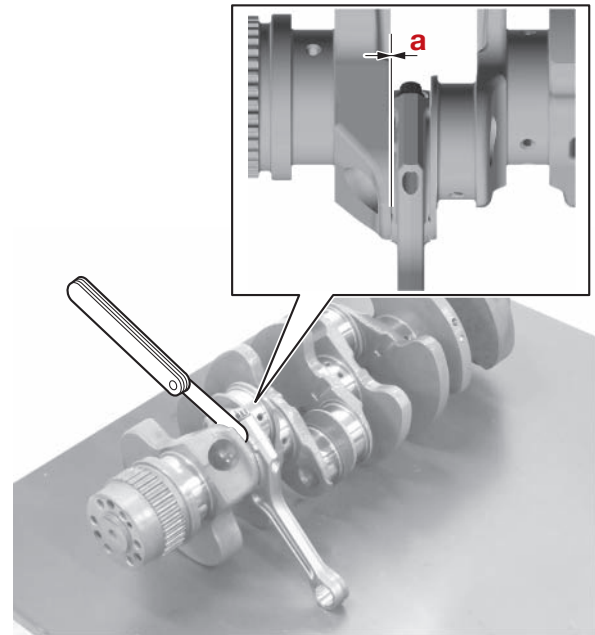
Connecting rod bolt “1”
1st: 13 N·m (1.3 kgf·m, 9.6 lb·ft)
2nd: 28 N·m (2.8 kgf·m, 21 lb·ft)
3rd: 90°



Small end inside diameter
22.008–22.025 mm (0.8665–
0.8671 in)
Big end inside diameter
65.990–66.010 mm (2.5980–
2.5988 in)

Checking the connecting rod big end side clearance

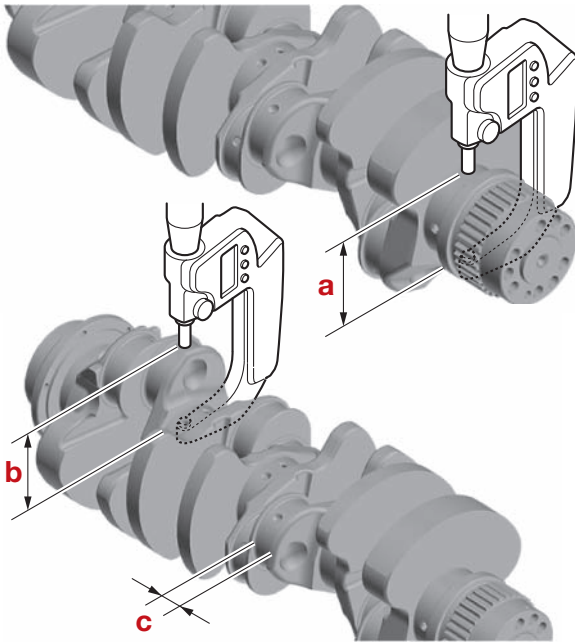
- Measure:
 - Big end side clearance “a”
 Out of specification → Check the crankshaft pin width.
See “Checking the crankshaft” (7-82).



Big end side clearance
0.140–0.310 mm (0.0055–
0.0122 in)
Limit
0.36 mm (0.0142 in)

Checking the crankshaft

- Measure:
 - Journal diameters “a”
 - Crankshaft pin diameters “b”
 - Crankshaft pin widths “c”
 Out of specification → Replace the crankshaft.

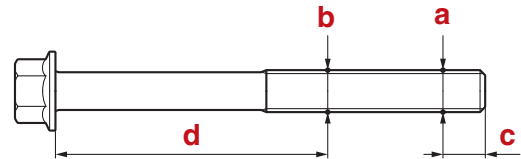


Checking the crankcase bolt

1. Measure:
 - Diameter
 Above specification → Replace.

TIP: _____

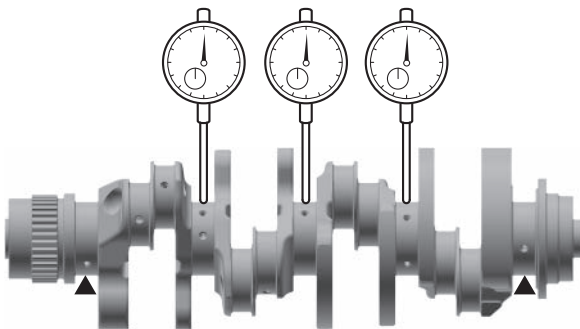
Measure the diameters “a” and “b” of the crankcase bolt (M10) at the specified measuring points “c” and “d”.



	Journal diameter 72.976–72.996 mm (2.8731–2.8739 in)
	Crankshaft pin diameter 62.980–63.000 mm (2.4795–2.4803 in)
	Crankshaft pin width 21.00–21.10 mm (0.8268–0.8307 in)

	Crankcase bolt diameter difference limit “a” – “b” = Less than 0.20 mm (0.0079 in)
	Measuring point “c”: 10.0 mm (0.39 in)
	Measuring point “d”: 65.0 mm (2.56 in)

2. Measure:
 - Runout
 Out of specification → Replace the crankshaft.



	Runout 0.03 mm (0.0012 in)
	Limit 0.04 mm (0.0016 in)

Checking the big end oil clearance

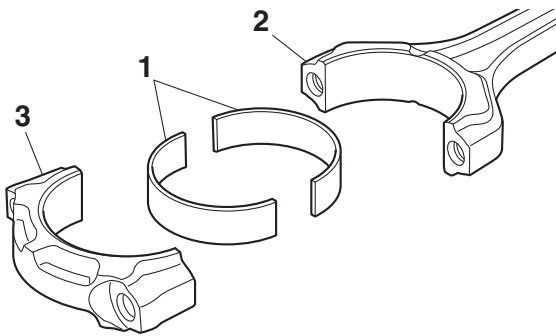
TIP: _____

Clean the mating surfaces of the parts in advance.

1. Install:
 - Crankshaft pin bearings “1” (into the connecting rod “2” and connecting rod cap “3”)

TIP: _____

Install the crankshaft pin bearings in their original positions.



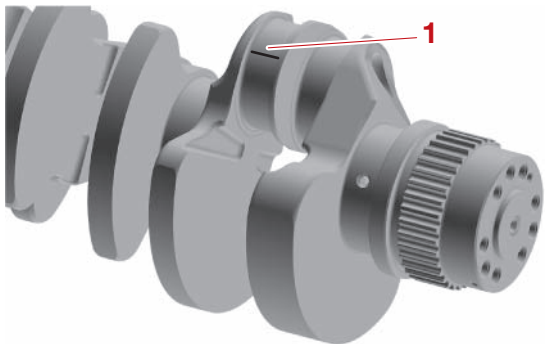
2. Install:
- Plastigauge (PG-1) “1”

NOTICE

Do not place the Plastigauge (PG-1) over the oil hole in the crankshaft pin of the crankshaft.

TIP:

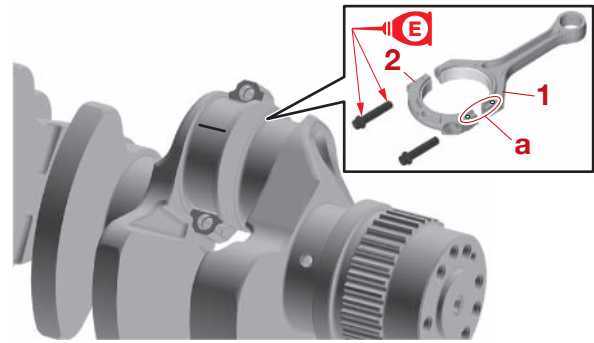
Place a piece of Plastigauge (PG-1) “1” onto the crankshaft pin, parallel to the crankshaft.



3. Install:
- Connecting rod “1”
 - Connecting rod cap “2”
 - Connecting rod bolts (temporarily)

TIP:

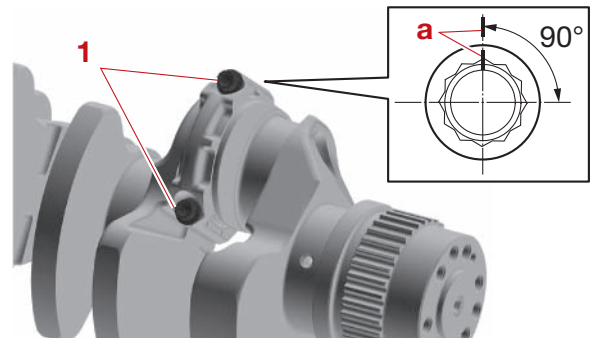
- When checking the oil clearance, reuse the removed connecting rod bolts.
- Make sure that the marks “a” on the connecting rod “1” and connecting rod cap “2” face toward the flywheel magneto end of the crankshaft.
- Do not turn the connecting rod until the big end oil clearance measurement has been completed.




4. Tighten:
- Connecting rod bolts “1”

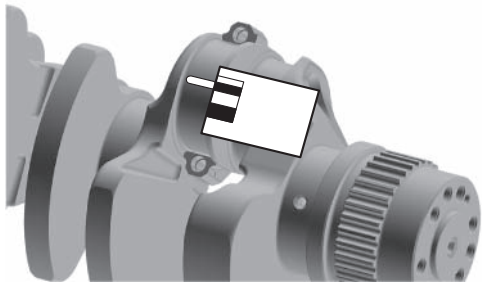
TIP:

- Tighten the connecting rod bolts “1” to the specified torques in 3 stages.
- In the third tightening stage for the connecting rod bolts “1”, mark the connecting rod bolts and the connecting rod cap with identification marks “a”, and then tighten the bolts 90° from the marks on the connecting rod cap.



	Connecting rod bolt “1”
	1st: 13 N·m (1.3 kgf·m, 9.6 lb·ft)
	2nd: 28 N·m (2.8 kgf·m, 21 lb·ft)
	3rd: 90°

5. Remove:
- Connecting rod bolts
 - Connecting rod cap
6. Measure:
- Width of the compressed Plastigauge (PG-1)
- Out of specification → Replace the crankshaft pin bearing.

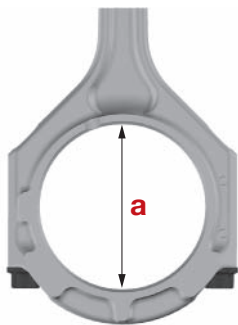


	Big end oil clearance
	0.026–0.049 mm (0.0010–0.0019 in)
	Limit
	0.079 mm (0.0031 in)

Selecting the crankshaft pin bearing

When replacing the crankshaft pin bearing, select the bearing as follows.

- Measure:
 - Connecting rod big end inside diameter “a”

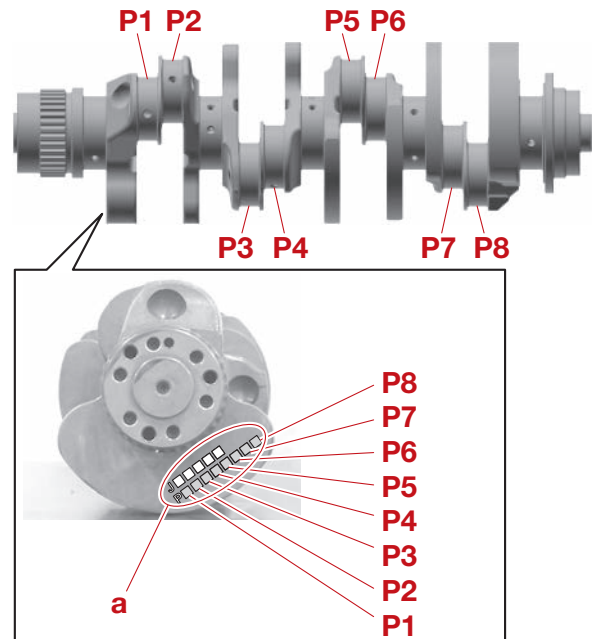


	Big end inside diameter
	65.990–66.010 mm (2.5980–2.5988 in)

Example:

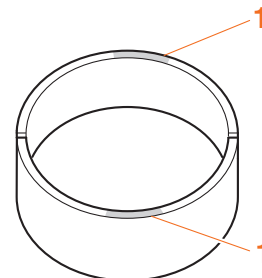
Connecting rod big end inside diameter “a”	Number in table
66.0 <u>05</u> mm	<u>05</u>

- Check:
 - Stamped mark “a” (on the crank web)



- Select:
 - Crankshaft pin bearing

TIP: Select the suitable colors “1” for the crankshaft pin bearing from the “Crankshaft pin bearing selection table” (7-87).



	Rod side bearing color	Cap side bearing color
“a”	Yellow	Yellow
“b”	Yellow	Green
“c”	Green	Green
“d”	Blue	Green
“e”	Blue	Blue

Example:

If the connecting rod big end inside diameter is "05" and the crankshaft pin mark is "81", select the bearing colors in "e". The rod side bearing color is blue and the cap side bearing color is blue.

		90	91	04	05	06	07
	80						
	81						
	82						e

Crankshaft pin bearing selection table

		A																				
		90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
B	80	Green	Green	Green	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	81	Green	Green	Green	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	82	Green	Green	Green	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	83	Green	Green	Green	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	84	Green	Green	Green	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	85	Green	Green	Green	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	86	Green	Green	Green	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	87	Green	Green	Green	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	88	Green	Green	Green	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	89	Green	Green	Green	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	90	Green	Green	Green	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	91	Green	Green	Green	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	92	Green	Green	Green	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	93	Green	Green	Green	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	94	Green	Green	Green	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	95	Green	Green	Green	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	96	Yellow	Yellow	Yellow	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	97	Yellow	Yellow	Yellow	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	98	Yellow	Yellow	Yellow	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	99	Yellow	Yellow	Yellow	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	00	Yellow	Yellow	Yellow	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue

- A. Connecting rod big end inside diameter
- B. Crankshaft pin mark

Checking the journal oil clearance

TIP: _____

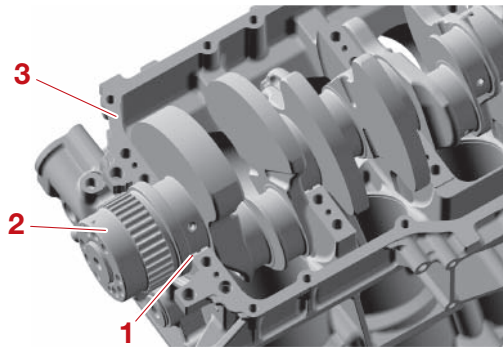
- After checking the journal oil clearance, check the crankcase bolts. See “Checking the crankcase bolt” (7-83).
- Clean the mating surfaces of the parts in advance.

1. Install:

- Crankshaft journal bearings “1”
- Crankshaft “2”
(into the cylinder block) “3”

TIP: _____

Install the crankshaft journal bearings “1” in their original positions.



2. Install:

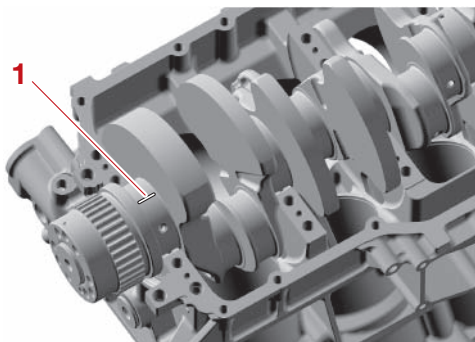
- Plastigauge (PG-1) “1”

NOTICE

Do not place the Plastigauge (PG-1) over the oil hole in each crankshaft journal.

TIP: _____

Place a piece of Plastigauge (PG-1) “1” onto the crankshaft journal, parallel to the crankshaft.



3. Install:

- Crankshaft journal bearings
(into the crankcase)

TIP: _____

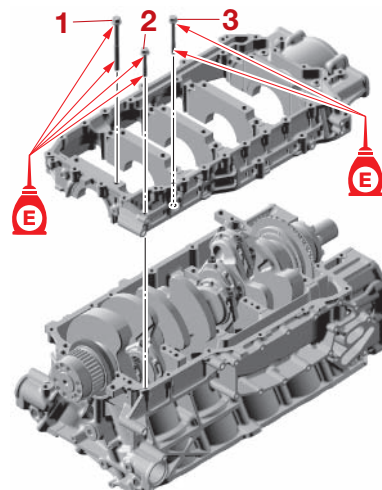
Install the crankshaft journal bearings in their original positions.

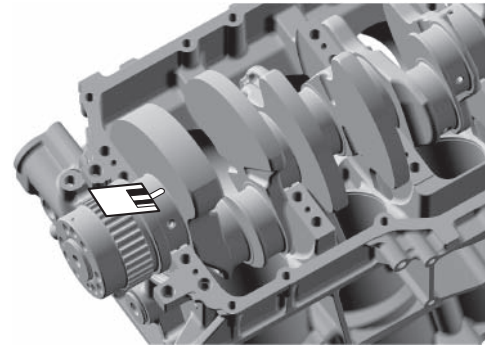
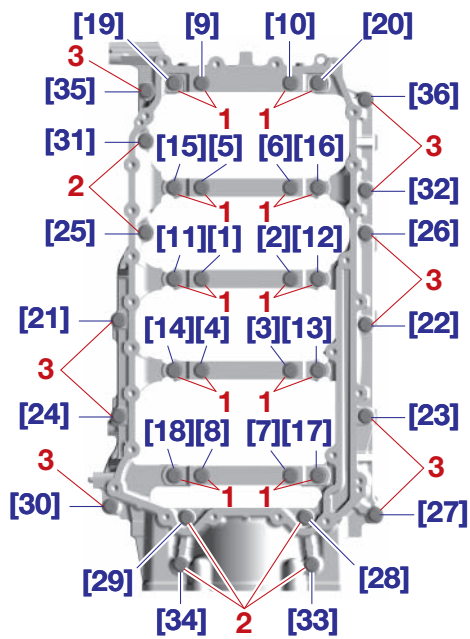
4. Install:


- Crankcase
 - Tighten the crankcase bolts (M10) “1” to the specified torques in 2 stages and in the order [1], [2], and so on.
 - Tighten the crankcase bolts (M8) “2” and “3” to the specified torques in 2 stages and in the order [21], [22], and so on.

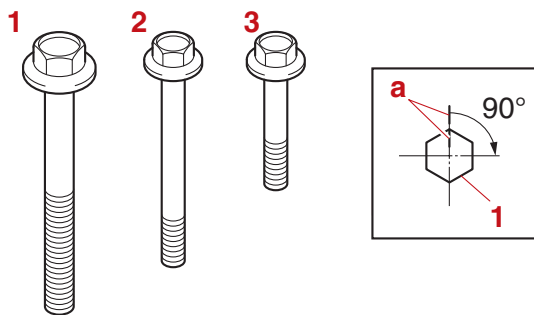
TIP: _____


- When checking the oil clearance, reuse the removed crankcase bolts.
- Do not turn the crankshaft until the journal oil clearance measurement has been completed.
- In the second tightening stage for the M10 crankcase bolts “1”, mark the M10 bolts and the crankcase with identification marks “a”, and then tighten the bolts 90° from the marks on the crankcase.





 Journal oil clearance
 0.029–0.053 mm (0.0011–0.0021 in)
 Limit
 0.073 mm (0.0029 in)



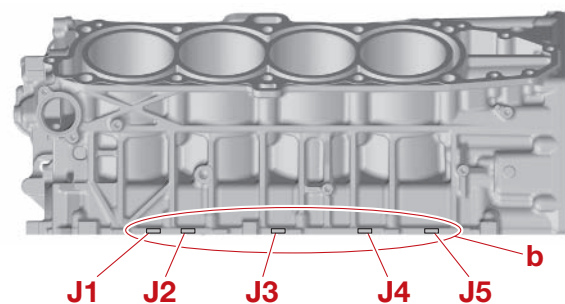
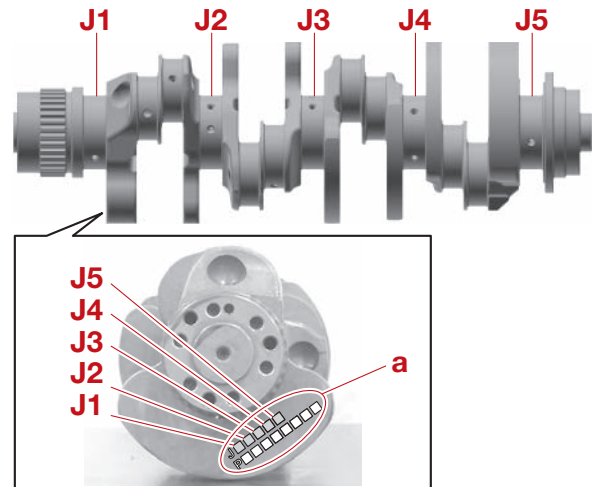
 Crankcase bolt (M10) “1” [1]–[20]
 1st: 40 N·m (4.0 kgf·m, 30 lb·ft)
 2nd: 90°
 Crankcase bolt (M8) “2”, “3” [21]–[36]
 1st: 14 N·m (1.4 kgf·m, 10 lb·ft)
 2nd: 28 N·m (2.8 kgf·m, 21 lb·ft)

5. Remove:
 - Crankcase
6. Measure:
 - Width of the compressed Plastigauge (PG-1)
 Out of specification → Replace the crankshaft journal bearing.

Selecting the crankshaft journal bearing

When replacing the crankshaft journal bearing, select the bearing as follows.

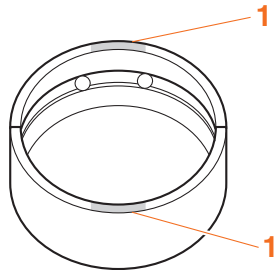
1. Check:
 - Stamped mark “a” (on the crank web)
 - Stamped mark “b” (on the cylinder block)



2. Select:
 - Crankshaft journal bearing

TIP: _____

Select the suitable colors “1” for the crankshaft journal bearing from the “Crankshaft journal bearing selection table” (7-91).



	Block side bearing color	Crankcase side bearing color
“a”	Black	Black
“b”	Blue	Blue
“c”	Pink	Pink
“d”	White	White

Example:

If the crankshaft journal mark is “77” and the cylinder block mark is “17”, select the bearing colors in “d”. The block side bearing color is white and the crankcase side bearing color is white.

		00	01	16	17	18	19	20
76								
77								
78							d	

Crankshaft journal bearing selection table

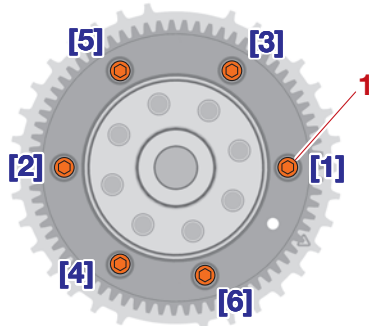
		A																														
		00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20										
B	76	Pink																														
	77	Pink										Pink																				
	78	Pink										Pink											d									
	79	Blue	Pink										Pink																			
	80	Blue	Blue	Pink										Pink																		
	81	Blue	Blue	Blue	Pink										Pink																	
	82	Blue	Blue	Blue	Blue	Pink										Pink																
	83	Blue	Blue	Blue	Blue	Blue	Pink										Pink															
	84	Blue	Blue	Blue	Blue	Blue	Blue	Pink										Pink														
	85	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Pink										Pink													
	86	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Pink										Pink												
	87	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Pink										Pink											
	88	Grey	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Pink										Pink										
	89	Grey	Grey	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Pink										Pink									
	90	Grey	Grey	Grey	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Pink										Pink								
	91	Grey	Grey	Grey	Grey	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Pink										Pink							
	92	Grey	Grey	Grey	Grey	Grey	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Pink										Pink						
93	Grey	Grey	Grey	Grey	Grey	Grey	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Pink										Pink						
94	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Pink										Pink					
95	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Pink										Pink					
96	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Pink										Pink					


- A. Cylinder block mark
- B. Crankshaft journal mark

Assembling the cylinder block

1. Install:
 - Dowel
 - Pickup rotor
 - Drive gear

TIP: _____
Tighten the drive gear bolts "1" to the specified torque in the order [1], [2], and so on.

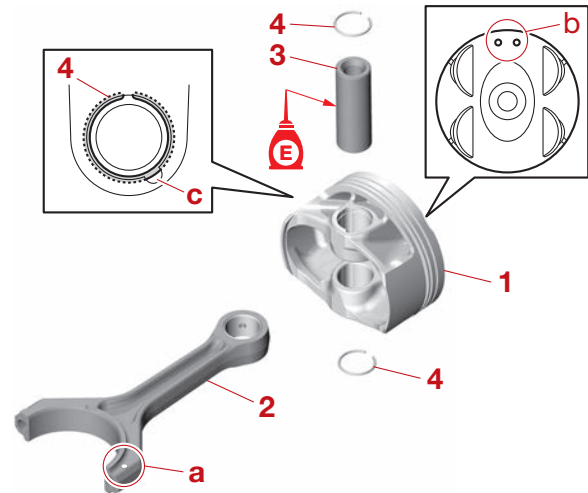


	Drive gear bolt "1" 10 N·m (1.0 kgf·m, 7.4 lb·ft)
------------------------------------------------------------------------------------	------------------------------------------------------

2. Assemble:
 - Piston
 - Connecting rod
 - Piston pin
 - Piston clips **New**
 - Piston rings
 - a. Assemble the piston "1", connecting rod "2", piston pin "3", and new piston pin clips "4".

TIP: _____

- Face the mark "a" on the connecting rod "2" in the same direction as the mark "b" on the piston crown.
- Make sure that the clip "4" end is not aligned with the groove "c" in the piston pin boss.



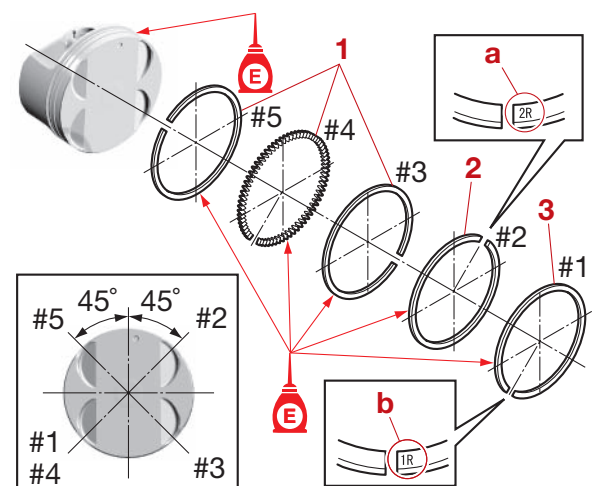
b. Install the oil rings "1", 2nd ring "2", and top ring "3".

NOTICE _____
Do not scratch the pistons or break the piston rings.

TIP: _____

- Make sure that the "2R" mark "a" on the 2nd ring "2" and "1R" mark "b" on the top ring "3" are facing up.
- Make sure that the piston rings move smoothly.

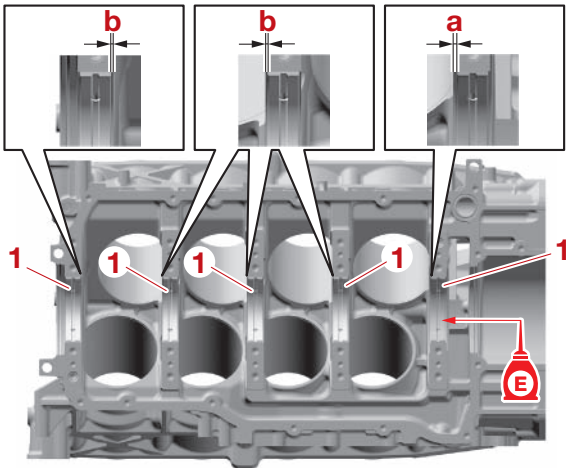
c. Offset the piston ring end gaps.




3. Install:
 - Crankshaft journal bearings (cylinder block side) "1"

TIP: _____

- Install the crankshaft journal bearings “1” in their original positions.
- Install the crankshaft journal bearings “1” according to the specified dimensions.



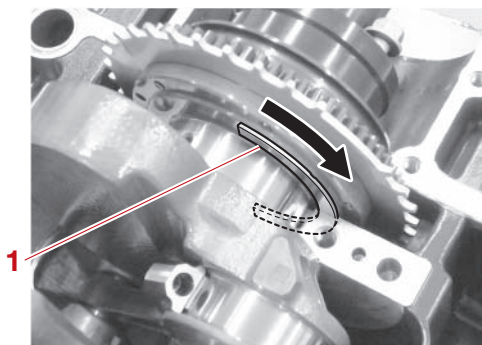
	Distance “a”
	0.65–1.25 mm (0.026–0.049 in)
	Distance “b”
	0.95–1.55 mm (0.037–0.061 in)

4. Install:

- Oil seal (upper) **New**
- Oil seal (lower) **New**
- Crankshaft
- Thrust bearings (cylinder block side) “1”

TIP: _____

- Install each thrust bearing with its grooves facing outward.
- Slide the thrust bearing between the crankshaft and the cylinder block.



5. Install:

- Crankshaft pin bearings (into the connecting rod and connecting rod cap)

TIP: _____

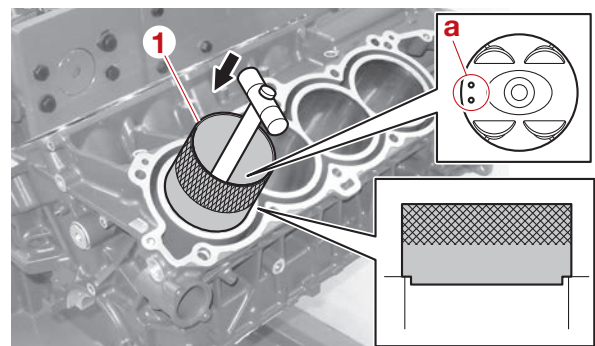
Install the crankshaft pin bearings in the original positions.


6. Install:

- Pistons

TIP: _____

- Apply engine oil to the side of the piston, piston rings, and cylinder wall.
- Install the piston so that the mark “a” on the piston crown is facing toward the flywheel magneto end of the crankshaft.



	Piston slider 96 mm “1”
	90890-06684
	Piston slider 96 mm “1”
	YB-06684

7. Install:

- Connecting rod caps
- Connecting rod bolts **New**
 - Install the connecting rod caps “1” to the connecting rods.

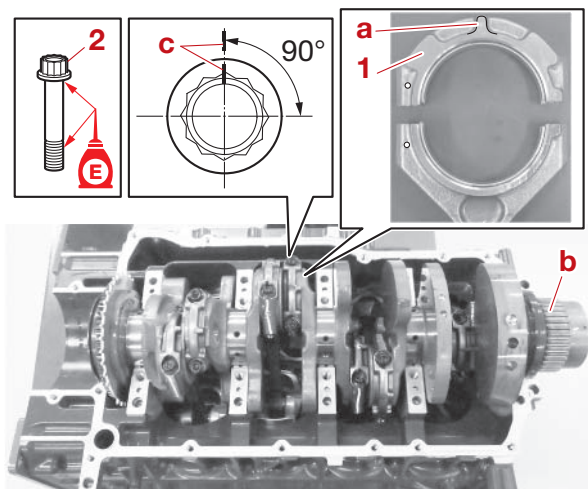
TIP: _____


Make sure that the protrusion “a” on the connecting rod caps “1” is facing toward the flywheel magneto end “b” of the crankshaft.

- Tighten new connecting rod bolts “2” to the specified torques in 3 stages.

TIP: _____

- In the third tightening stage for the connecting rod bolts “2”, mark the connecting rod bolts and connecting rod cap with paint marks “c”, and then tighten the bolts 90° from the marks on the connecting rod cap.
- After tightening the connecting rod bolts “2”, make sure that the crankshaft turns smoothly.



	Connecting rod bolt “2”
	1st: 13 N·m (1.3 kgf·m, 9.6 lb·ft)
	2nd: 28 N·m (2.8 kgf·m, 21 lb·ft)
	3rd: 90°

8. Install:
- Crankcase
 - Install the thrust bearings (crankcase side).

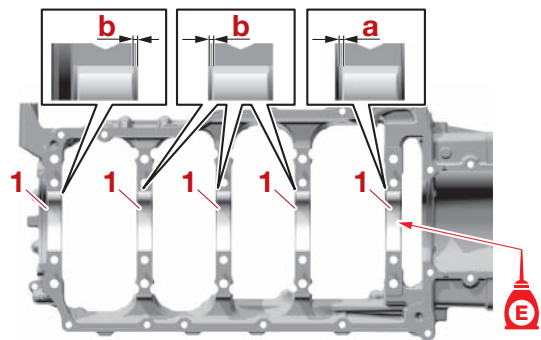
TIP: _____


Install each thrust bearing with its grooves facing outward.

- Install the crankshaft journal bearings (crankcase side) “1”.

TIP: _____

Install the crankshaft journal bearings “1” in their original positions.

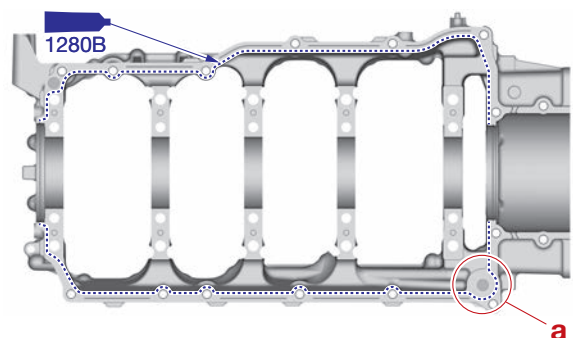


	Distance “a”
	0.65–1.25 mm (0.026–0.049 in)
	Distance “b”
	0.95–1.55 mm (0.037–0.061 in)

- Apply a thin, even layer of sealant onto the mating surface of the crankcase.

TIP: _____

- Do not apply any sealant to the crankshaft journal bearings.
- When applying sealant to the portion “a” of the mating surface, be careful not to apply sealant to an area that will contact the O-ring.
- Install the crankcase within 3 minutes after applying the sealant. Tighten the crankcase bolts to the specified torque within 15 minutes after applying the sealant.



- Install a new O-ring, dowels, and the crankcase, and then tighten the crankcase bolts (M10) “1” to the specified torques in 2 stages and in the order [1], [2], and so on.

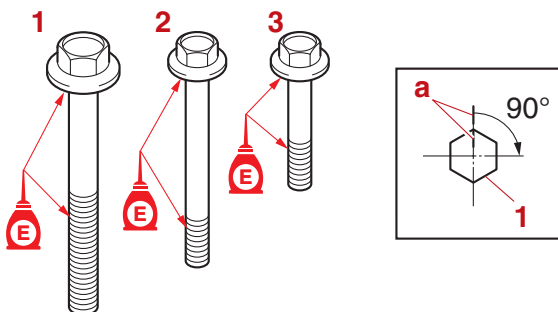
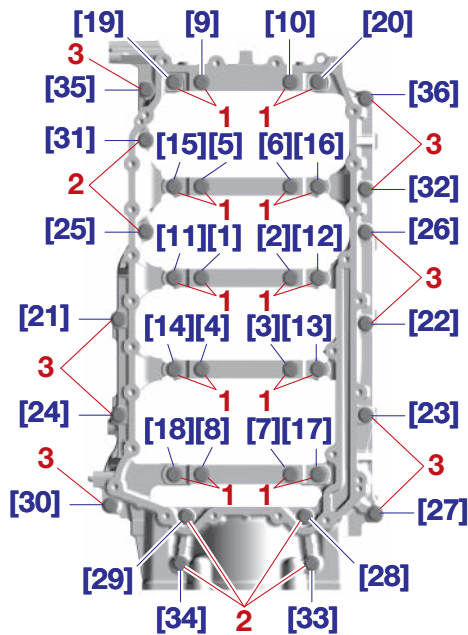
TIP: _____

In the second tightening stage for the M10 bolts “1”, mark the M10 bolts and the crankcase with identification marks “a”, and then tighten the bolts 90° from the marks on the crankcase.

- e. Tighten the crankcase bolts (M8) “2” and “3” to the specified torques in 2 stages and in the order [21], [22], and so on.

TIP: _____

After tightening the crankcase bolts “1”, “2” and “3”, make sure that the crankshaft turns smoothly.

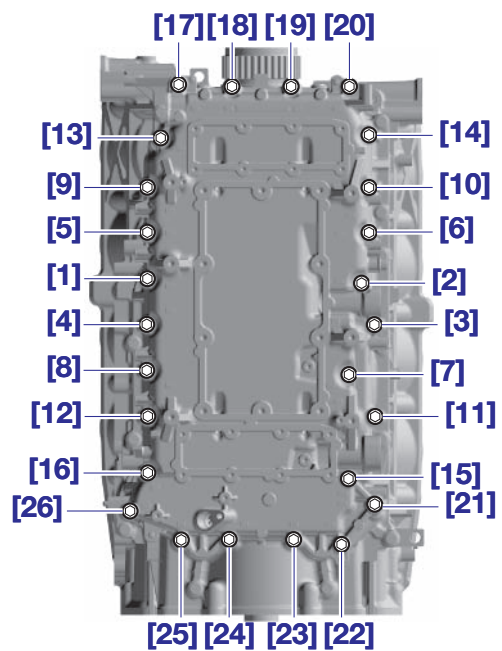


	Crankcase bolt (M10) “1” [1]–[20]
	1st: 40 N·m (4.0 kgf·m, 30 lb·ft)
	2nd: 90°
	Crankcase bolt (M8) “2”, “3” [21]–[36]
	1st: 14 N·m (1.4 kgf·m, 10 lb·ft)
	2nd: 28 N·m (2.8 kgf·m, 21 lb·ft)

9. Install:
 - Dowels
 - Gasket **New**
 - Crankcase cover
 - Crankcase cover bolts

TIP: _____

Tighten the crankcase cover bolts to the specified torques in 2 stages and in the order [1], [2], and so on.

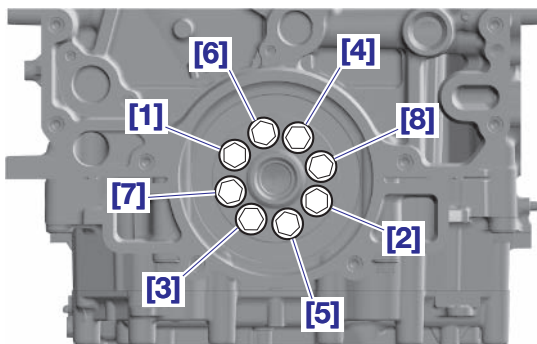
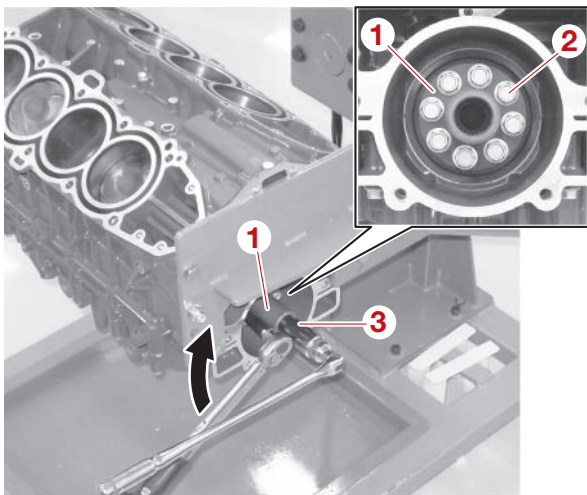



	Crankcase cover bolt [1]–[26]
	1st: 14 N·m (1.4 kgf·m, 10 lb·ft)
	2nd: 27.5 N·m (2.75 kgf·m, 20.28 lb·ft)


10. Install:
 - Flange “1”
 - Flange bolts “2” **New**

TIP: _____

- Clean the mating surface of the crankshaft and flange.
- Tighten new flange bolts “2” to the specified torques in 2 stages and in the order [1], [2], and so on.
- Install the special service tool “3” to the flange, secure the tool using a wrench, and then tighten the flange bolts “2”.



	<p>Shaft holder “3” 90890-06949</p>
-------------------------------------------------------------------------------------	-----------------------------------------

	<p>Flange bolt “2” 1st: 40 N·m (4.0 kgf·m, 30 lb·ft) 2nd: 90°</p>
-------------------------------------------------------------------------------------	---------------------------------------------------------------------------

Lower unit

Propeller and water inlet cover.....	8-1
Removing the propeller	8-2
Disassembling the propeller (Shift Dampener System [SDS] propeller)	8-2
Checking the propeller	8-2
Assembling the propeller (Shift Dampener System [SDS] propeller)	8-2
Installing the water inlet.....	8-3
Installing the propeller	8-3
Lower unit	8-5
Removing the lower unit.....	8-6
Checking the lower unit anode	8-6
Checking the gear oil passage check valve	8-6
Checking the lower unit for leakage.....	8-6
Installing the lower unit	8-7
Extension (except for X-transom model)	8-9
Checking the extension.....	8-10
Assembling the extension	8-10
Installing the extension.....	8-10
Water pump and shift rod.....	8-11
Removing the shift rod (regular rotation model).....	8-12
Removing the shift rod (counter rotation model).....	8-12
Removing the gear oil passage check valve	8-12
Checking the water pump	8-13
Checking the shift rod	8-13
Installing the gear oil passage check valve.....	8-13
Assembling the shift rod guide plate.....	8-13
Assembling the water pump housing.....	8-14
Installing the water pump and shift rod (regular rotation model)	8-15
Installing the water pump and shift rod (counter rotation model)	8-16
Propeller shaft housing (regular rotation model)	8-18
Removing the propeller shaft housing assembly	8-19
Disassembling the propeller shaft assembly.....	8-20
Disassembling the reverse gear	8-20
Disassembling the propeller shaft housing assembly	8-20
Checking the propeller shaft	8-21
Checking the dog clutch	8-21

Lower unit

Checking the propeller shaft housing	8-21
Checking the reverse gear	8-22
Assembling the propeller shaft assembly	8-22
Assembling the reverse gear	8-22
Assembling the propeller shaft housing assembly.....	8-23
Installing the propeller shaft housing assembly	8-25

Drive shaft and lower case (regular rotation model) 8-27

Removing the drive shaft	8-28
Disassembling the drive shaft	8-28
Disassembling the forward gear	8-29
Disassembling the lower case.....	8-29
Checking the pinion	8-30
Checking the forward gear.....	8-30
Checking the drive shaft	8-30
Checking the lower case.....	8-30
Assembling the lower case	8-30
Assembling the forward gear	8-31
Assembling the drive shaft.....	8-31
Assembling the oil seal housing.....	8-33
Installing the forward gear.....	8-34
Installing the drive shaft	8-34

Shimming (regular rotation model)..... 8-36

Shimming workflow.....	8-36
Shimming check sheet.....	8-37
Shimming procedure.....	8-38
Shim location	8-38
Selecting the forward gear shim (T1) and reverse gear shim (T2).....	8-39
Selecting the pinion shim (T3).....	8-39
Measuring the forward gear backlash and reverse gear backlash	8-41
Selecting the propeller shaft shim (T4).....	8-45

Propeller shaft housing (counter rotation model) 8-48

Removing the propeller shaft housing assembly	8-49
Disassembling the propeller shaft housing assembly	8-49
Disassembling the forward gear	8-50
Checking the propeller shaft	8-50
Checking the dog clutch	8-51
Checking the propeller shaft housing	8-51
Checking the forward gear.....	8-51
Assembling the propeller shaft housing and forward gear	8-51
Installing the propeller shaft housing assembly	8-52

Lower unit

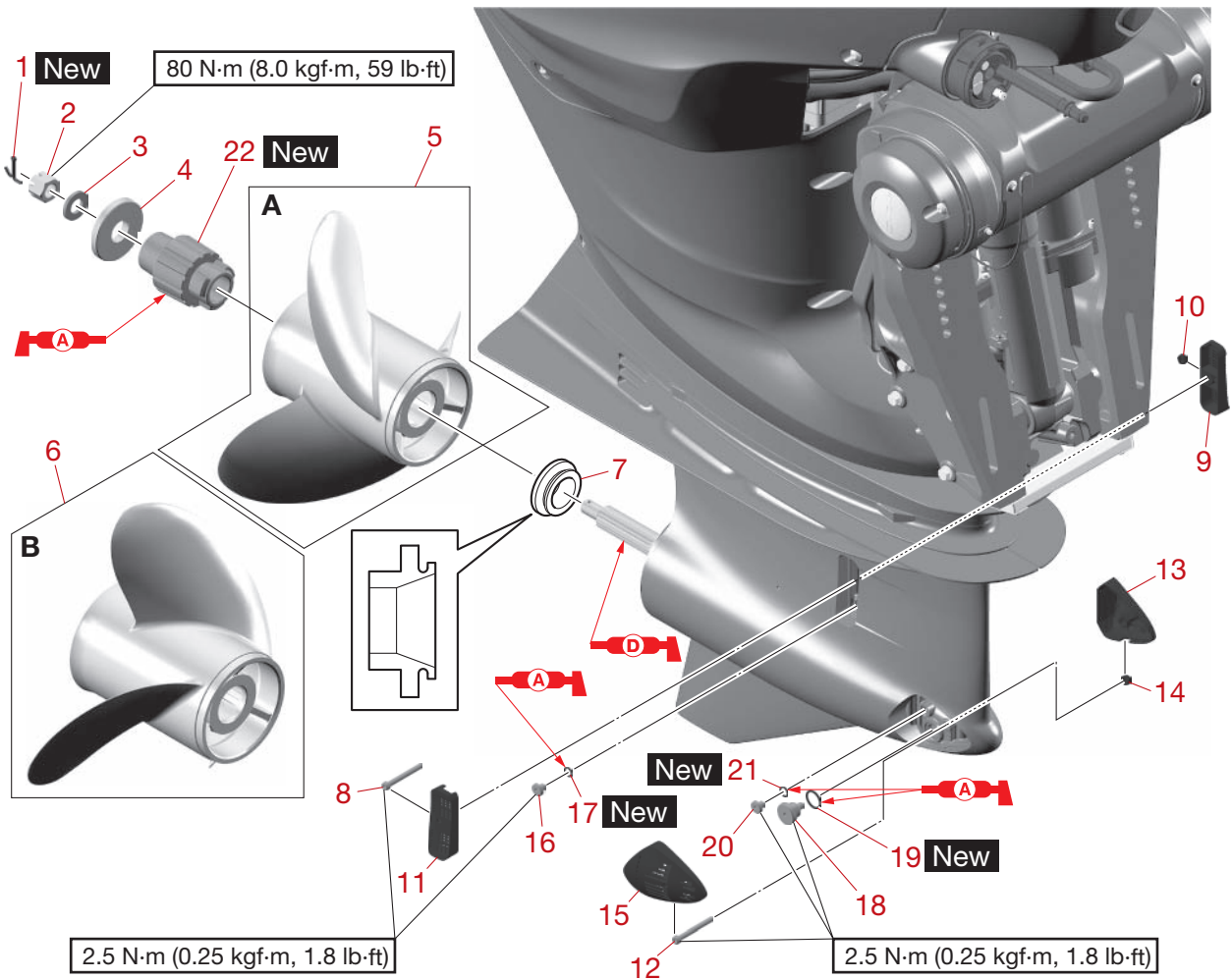
Drive shaft and lower case (counter rotation model) ... 8-54

Removing the drive shaft	8-55
Disassembling the drive shaft	8-55
Disassembling the reverse gear	8-55
Disassembling the lower case.....	8-55
Checking the pinion	8-55
Checking the reverse gear	8-55
Checking the drive shaft	8-55
Checking the lower case	8-55
Assembling the lower case	8-55
Assembling the reverse gear.....	8-55
Assembling the drive shaft.....	8-56
Assembling the oil seal housing.....	8-56
Installing the reverse gear	8-56
Installing the drive shaft	8-56

Shimming (counter rotation model)..... 8-57

Shimming workflow.....	8-57
Shimming check sheet.....	8-58
Shimming procedure.....	8-59
Shim location	8-59
Selecting the reverse gear shim (T1) and forward gear shim (T2).....	8-60
Selecting the pinion shim (T3)	8-60
Selecting the propeller shaft shim (T4).....	8-60
Measuring the forward gear backlash and reverse gear backlash	8-62

Propeller and water inlet cover



↑↓	Part name	Q'ty	Remarks
1	Cotter pin	1	
2	Propeller nut M18	1	
3	Washer	1	
4	Spacer	1	
5	Propeller	1	
6	Propeller	1	
7	Spacer	1	
8	Bolt M6 × 57 mm	1	
9	Water inlet cover (PORT)	1	
10	Self-locking nut M6	1	
11	Water inlet cover (STBD)	1	
12	Bolt M6 × 57 mm	1	
13	Water inlet cover (PORT)	1	
14	Self-locking nut M6	1	
15	Water inlet cover (STBD)	1	

↑↓	Part name	Q'ty	Remarks
16	Oil level plug M8 × 8 mm	1	
17	O-ring	1	
18	Drain screw M18 × 12 mm	1	
19	O-ring	1	
20	Oil filler plug M8 × 8 mm	1	
21	O-ring	1	
22	Damper	1	

A. For regular rotation model
 B. For counter rotation model

Removing the propeller

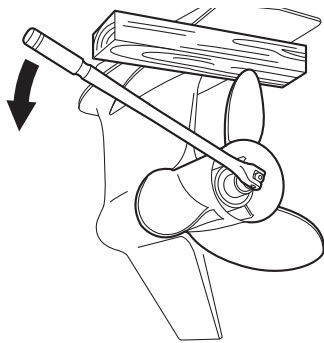
⚠ WARNING

- Make sure to disconnect the battery cables from the battery, and remove the clip from the engine shut-off switch.
- When removing or installing the lower unit with the power unit installed, make sure to suspend the outboard motor. Otherwise, the outboard motor could fall suddenly and result in severe injuries.

1. Remove:
 - Cotter pin
 - Propeller nut
 - Washer
 - Spacer
 - Propeller

TIP:

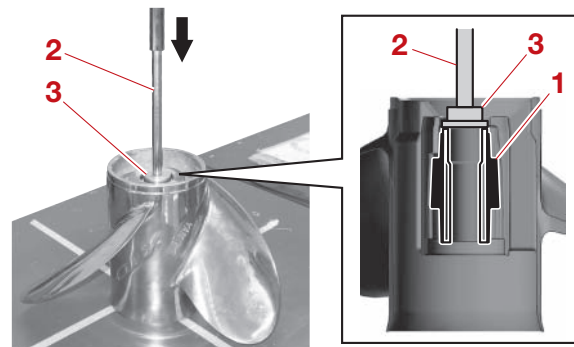
- Set the gear shift to the N position.
- Place a block of wood between the anticavitation plate and the propeller to prevent the propeller from turning, and then remove the propeller nut and propeller.



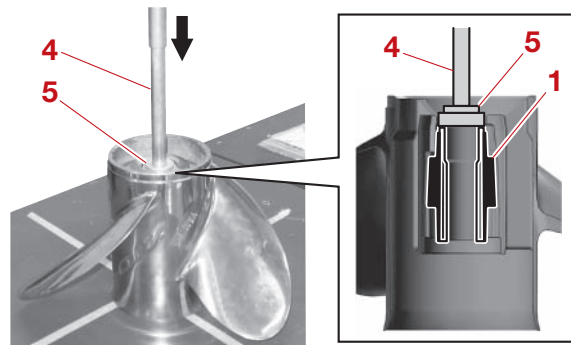
Disassembling the propeller (Shift Dampener System [SDS] propeller)

1. Remove:
 - Damper "1"

A



B



A. Worldwide

B. USA and Canada



Driver rod L3 "2"
90890-06652
Needle bearing attachment "3"
90890-06608
Driver handle (large) "4"
YB-06071
Driveshaft bearing installer "5"
YB-06110

Checking the propeller

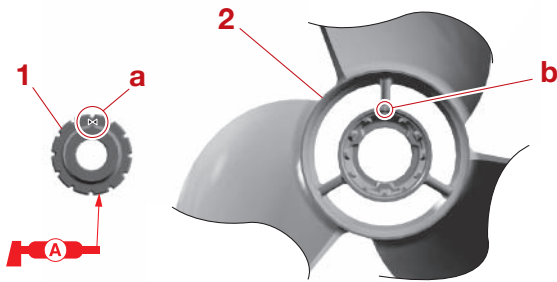
1. Check:
 - Propeller blade
 - Damper rubber spline
Cracked/damage/worn → Replace the propeller.

Assembling the propeller (Shift Dampener System [SDS] propeller)

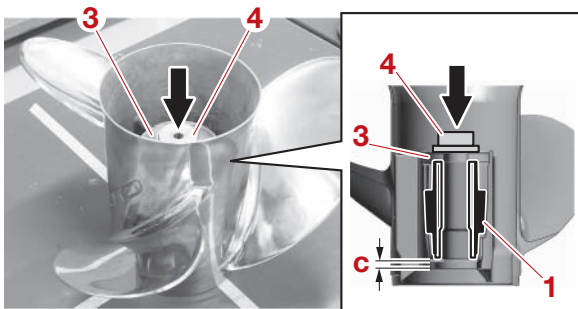
1. Install:
 - Damper "1" (into the propeller "2")

TIP: _____

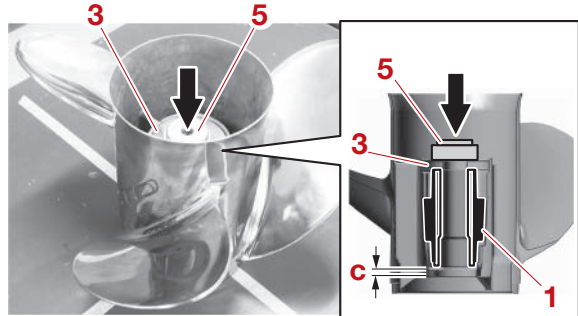
- Align the mark “a” on the damper “1” with the mark “b” on the propeller “2”.
- Install the damper “1” using the special service tools and spacer “3” to the specified installation depth “c”.



A



B



- A. Worldwide
- B. USA and Canada

	Needle bearing attachment “4” 90890-06608 Driveshaft bearing installer “5” YB-06110
--	----------------------------------------------------------------------------------------------

	Installation depth “c” 13.5–16.3 mm (0.53–0.64 in)
--	-------------------------------------------------------

Installing the water inlet

1. Install:

- O-ring **New**
- Drain screw

	Drain screw 2.5 N·m (0.25 kgf·m, 1.8 lb·ft)
--	------------------------------------------------

2. Fill:

- Gear oil
See step 5 in “Changing the gear oil by removing the drain screw” (10-17).

3. Install:

- O-rings **New**
- Oil level plug
- Oil filler plug
- Lower water inlet covers
- Upper water inlet covers

	Oil level plug 2.5 N·m (0.25 kgf·m, 1.8 lb·ft)
	Oil filler plug 2.5 N·m (0.25 kgf·m, 1.8 lb·ft)
	Lower water inlet cover bolt 2.5 N·m (0.25 kgf·m, 1.8 lb·ft)
	Upper water inlet cover bolt 2.5 N·m (0.25 kgf·m, 1.8 lb·ft)

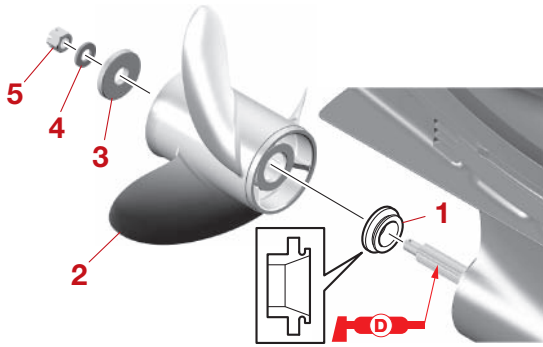
Installing the propeller

⚠ WARNING _____

- **Make sure to disconnect the battery cables from the battery, and remove the clip from the engine shut-off switch.**
- **When loosening or tightening the propeller nut, do not hold the propeller using your hands.**

1. Install:

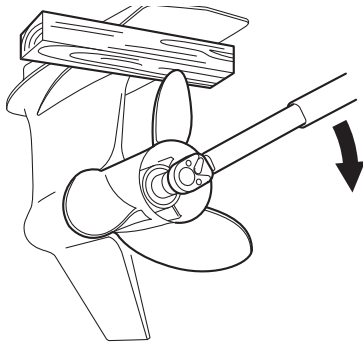
- Spacer “1”
- Propeller “2”
- Spacer “3”
- Washer “4”
- Propeller nut “5”




2. Tighten:
- Propeller nut

TIP:

Place a block of wood between the anticavitation plate and the propeller to prevent the propeller from turning, and then tighten the propeller nut.

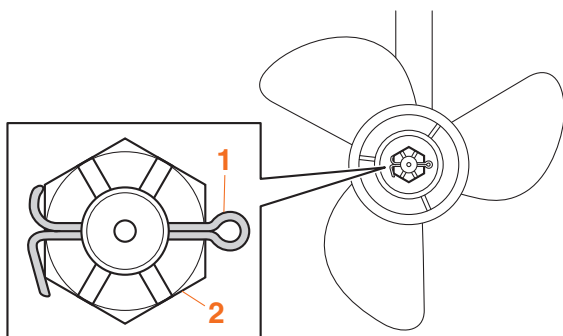


	Propeller nut 80 N·m (8.0 kgf·m, 59 lb·ft)
-------------------------------------------------------------------------------------	-----------------------------------------------

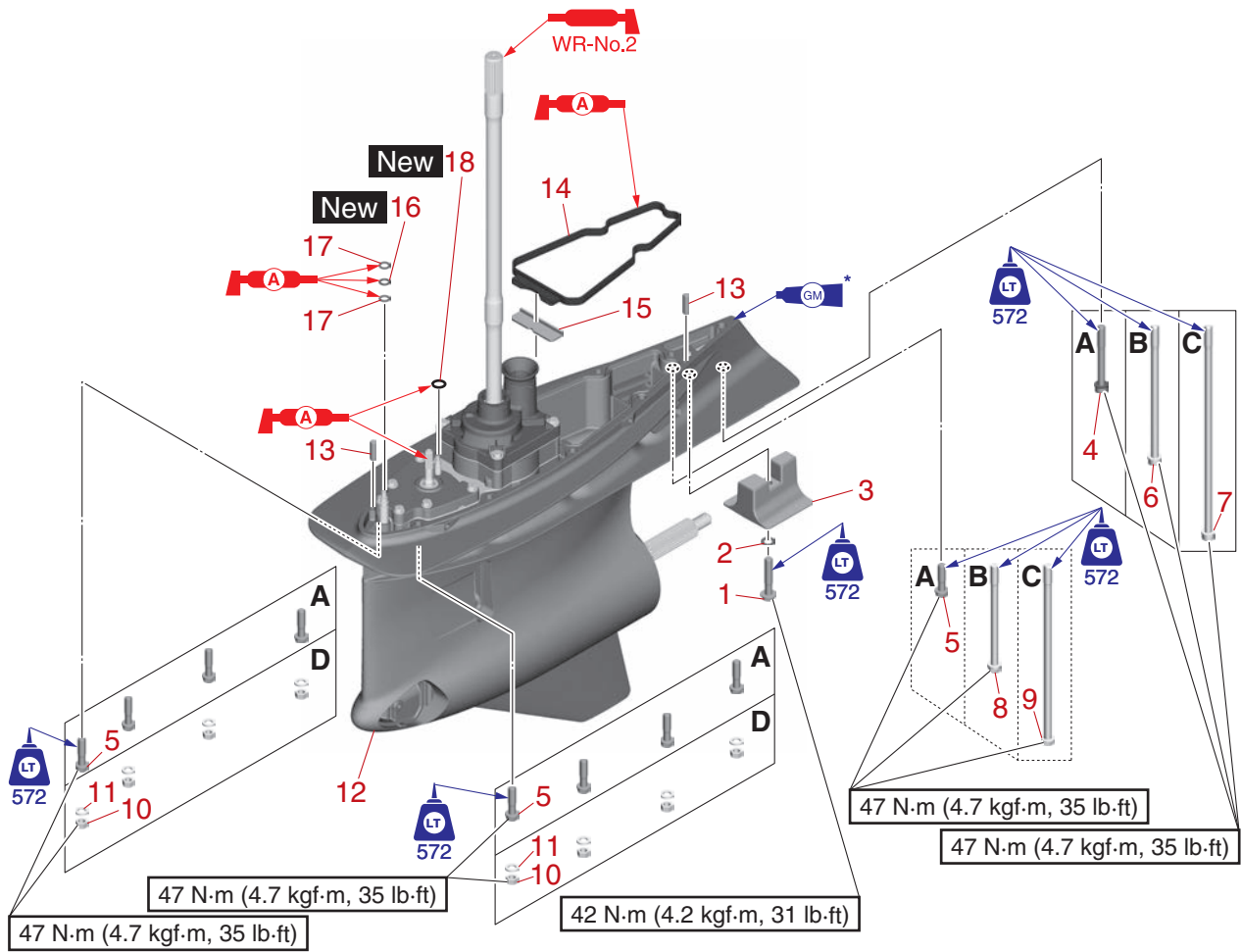
3. Install:
- Cotter pin “1” **New**

TIP:

If the slots in the propeller nut “2” are not aligned with the cotter pin hole, tighten the propeller nut until they are aligned.



Lower unit



↑↓	Part name	Q'ty	Remarks
1	Bolt M10 × 60 mm	1	
2	Washer	1	
3	Anode	1	
4	Bolt M10 × 100 mm	1	
5	Bolt M10 × 45 mm	9	
6	Bolt M10 × 225 mm	1	
7	Bolt M10 × 355 mm	1	
8	Bolt M10 × 174 mm	1	
9	Bolt M10 × 299 mm	1	
10	Nut M10	8	
11	Washer	8	
12	Lower unit	1	
13	Dowel	2	
14	Rubber seal	1	
15	Plate	1	
16	O-ring	1	
17	Backup ring	2	
18	O-ring	1	

- A. For X-transom model
- B. For U-transom model
- C. For E-transom model
- D. Except for X-transom model

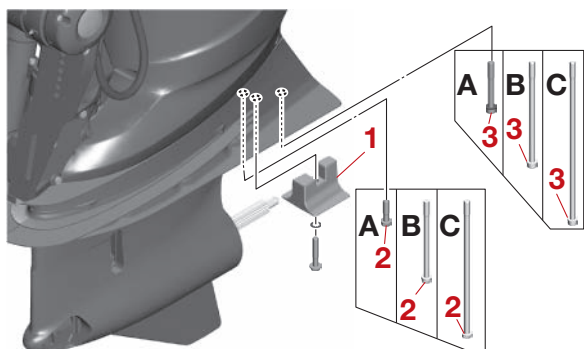
*. Use white sealant for white-colored units.

Removing the lower unit

⚠ WARNING

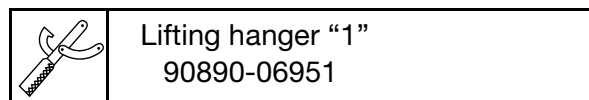
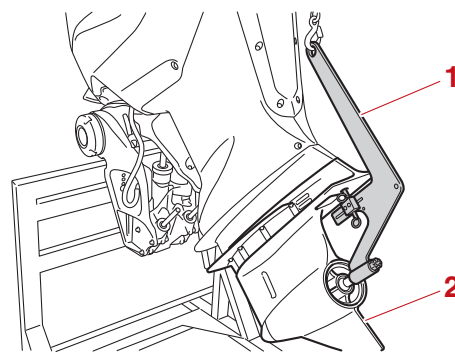
- Make sure to disconnect the battery cables from the battery, and remove the clip from the engine shut-off switch.
- When removing or installing the lower unit with the power unit installed, make sure to suspend the outboard motor. Otherwise, the outboard motor could fall suddenly and result in severe injuries.

1. Drain:
 - Gear oil
See steps 1 and 2 in “Changing the gear oil by removing the drain screw” (10-17).
2. Remove:
 - Anode
 - Lower case mounting bolts
 - Lower case mounting nuts (except for X-transom model)
 - Lower unit
 - a. Place the outboard motor in an upright position.
 - b. Remove the anode “1” and lower case mounting bolts “2” and “3”.



- A. X-transom model
- B. U-transom model
- C. E-transom model

- c. Tilt the outboard motor up, and then install the special service tool “1” to the lower unit “2”.
- d. Hook a lifting harness onto the special service tool.



- e. Remove the lower unit.

Checking the lower unit anode

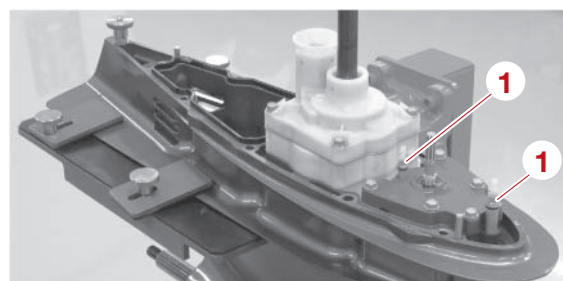
1. Check:
 - Anode
Eroded (1/2 or more worn out) → Replace.
Adhered grease, oil, paint, or scales → Clean.

NOTICE

Do not apply grease, oil, or paint to the anode.

Checking the gear oil passage check valve

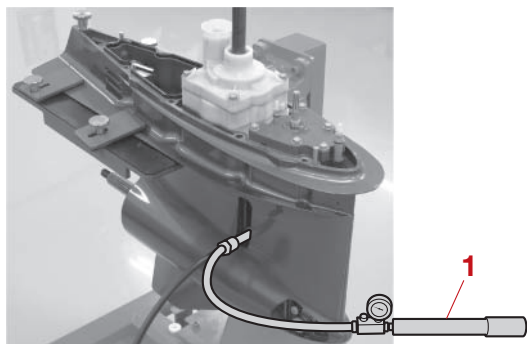
1. Check:
 - Gear oil passage check valves “1”
Cracked/damaged → Replace the check valve.
See “Water pump and shift rod” (8-11).




Checking the lower unit for leakage

1. Install:
 - O-rings **New**
 - Drain screw
 - Oil filler plug

- Special service tool “1” (to the oil level plug hole)



	Leakage tester “1” 90890-06840 Leakage tester “1” (commercially available)
-----------------------------------------------------------------------------------	-------------------------------------------------------------------------------------


2. Check:
 - Holding pressure
Pressure is not maintained → Repair the location of the leak.

NOTICE

Do not overpressurize the lower unit. Otherwise, the oil seals could be damaged.

TIP:

Apply the specified pressure and check that the pressure is maintained in the lower unit for 10 seconds or more.

	Holding pressure 68.6 kPa (0.69 kgf/cm ² , 9.9 psi) (F400ASTU, F400ASTX, F450AVTU, F450AVTX)
-------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------------------

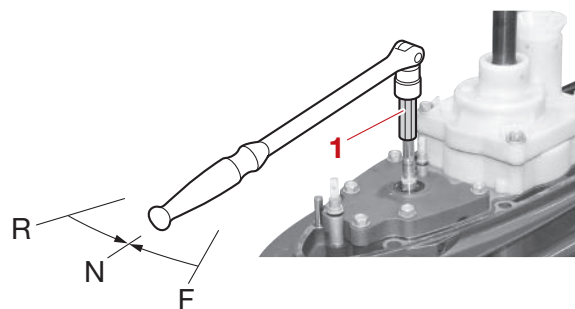
Installing the lower unit


WARNING

- Make sure to disconnect the battery cables from the battery, and remove the clip from the engine shut-off switch.
- When removing or installing the lower unit with the power unit installed, make sure to suspend the outboard motor. Otherwise, the outboard motor could fall suddenly and result in severe injuries.

1. Install:

- O-rings **New**
- Backup rings
- Plate
- Rubber seal
- Dowels
- Lower unit
- Splash plates
- Anode
 - a. Set the gear shift to the N position.



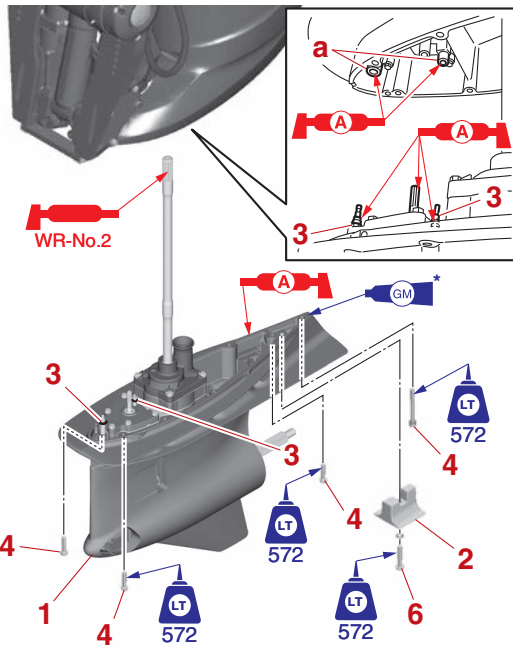
	Shift rod socket “1” 90890-06950
------------------------------------------------------------------------------------	-------------------------------------


- b. Install the dowels, lower unit “1”, and anode “2”.

TIP:

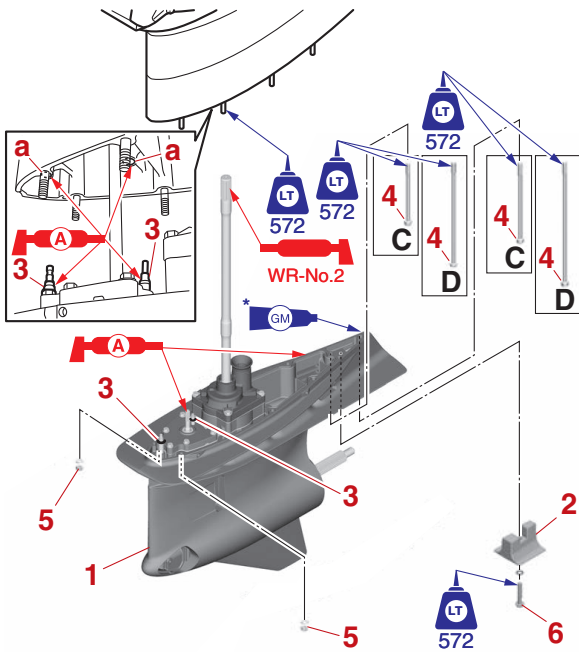
- To install the lower unit using the lifting hanger, see step 6 in “Uncrating procedure (outboard motor with lower unit)” (3-4).
- Align the check valves “3” with the holes “a”.

A



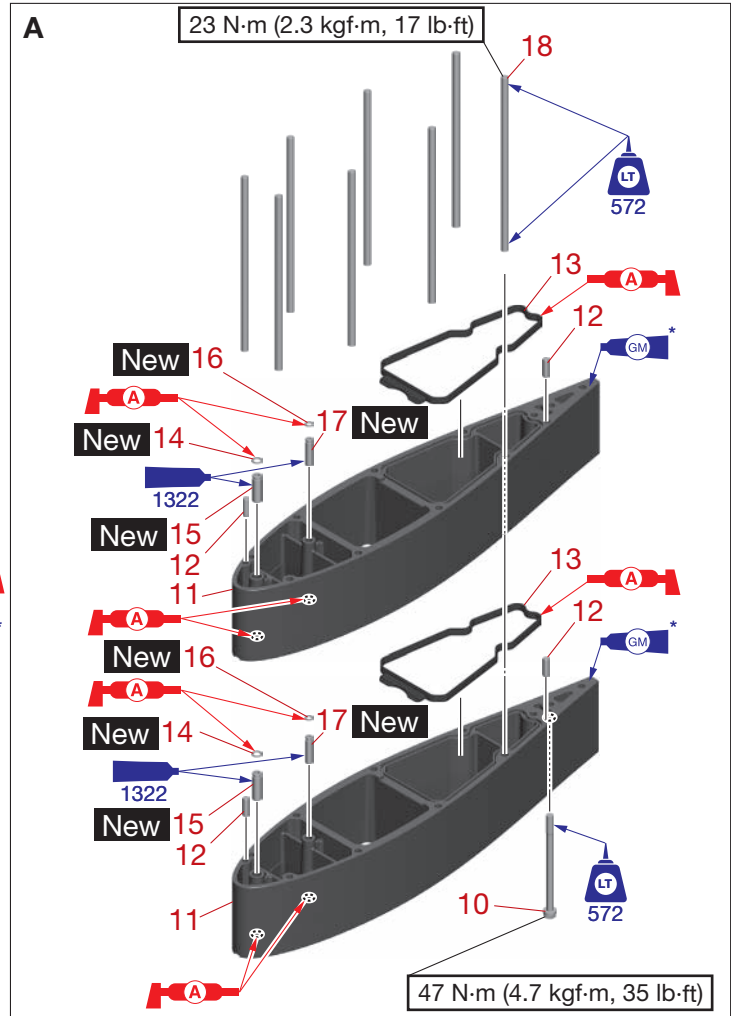
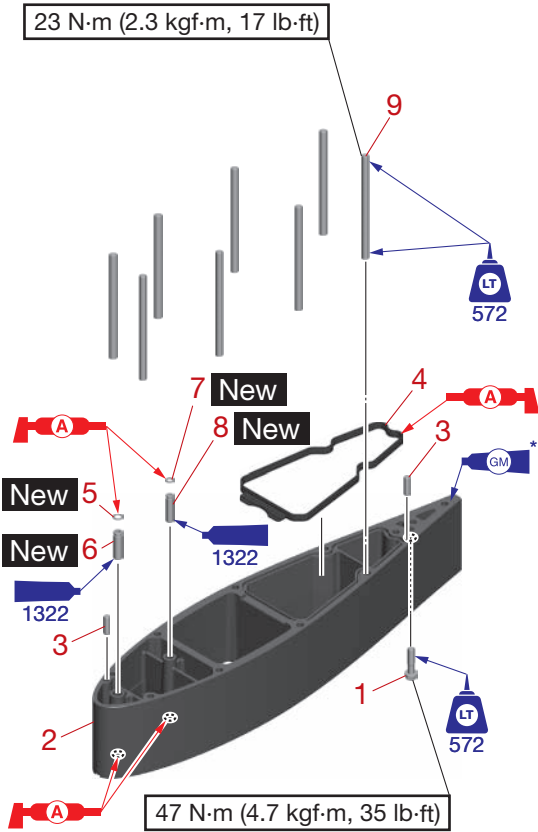
	Lower case mounting bolt "4"
	47 N·m (4.7 kgf·m, 35 lb·ft)
	Lower case mounting nut "5"
	47 N·m (4.7 kgf·m, 35 lb·ft)
	Lower case anode bolt "6"
	42 N·m (4.2 kgf·m, 31 lb·ft)

B



- A. X-transom model
- B. U-transom and E-transom model
- C. U-transom model
- D. E-transom model
- *. Use white sealant for white-colored units.

Extension (except for X-transom model)



↑↓	Part name	Q'ty	Remarks
1	Bolt M10 × 45 mm	1	
2	Extension	1	
3	Dowel	2	
4	Rubber seal	1	
5	O-ring	1	
6	Nipple	1	
7	O-ring	1	
8	Nipple	1	
9	Stud bolt M10 × 185 mm	8	Point the flat end of the stud bolt up.
10	Bolt M10 × 174 mm	1	
11	Extension	2	
12	Dowel	4	
13	Rubber seal	2	
14	O-ring	2	
15	Nipple	2	
16	O-ring	2	
17	Nipple	2	

↑↓	Part name	Q'ty	Remarks
18	Stud bolt M10 × 312 mm	8	Point the flat end of the stud bolt up.

A. For E-transom model

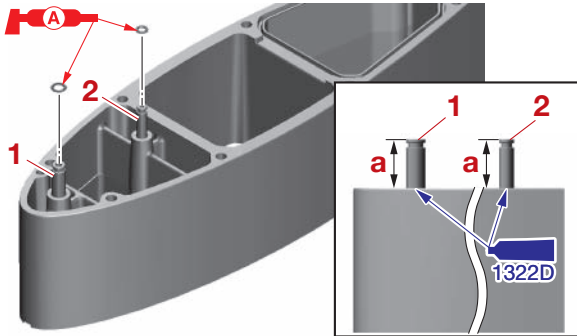
*. Use white sealant for white-colored units.


Checking the extension

1. Check:
 - Extension
Cracked/damaged → Replace.

Assembling the extension

1. Install:
 - Nipples “1”, “2” **New**
 - O-rings **New**




	Installation height “a” 32.2–32.8 mm (1.27–1.29 in)
------------------------------------------------------------------------------------	--------------------------------------------------------


Installing the extension

1. Install:
 - Stud bolts

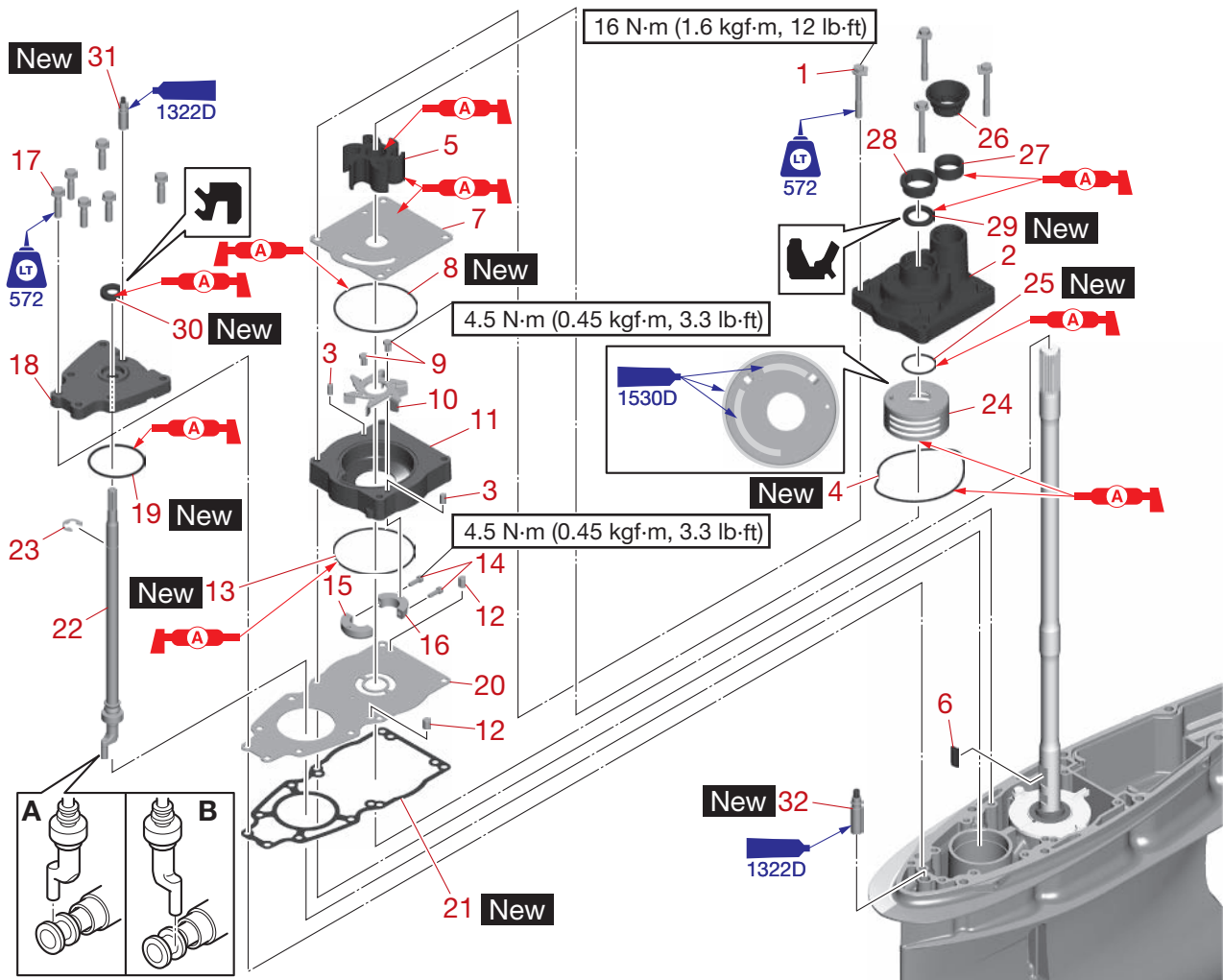
TIP: _____
Point the flat end of the stud bolt up.

	Stud bolt (lower case mounting) 23 N·m (2.3 kgf·m, 17 lb·ft)
-------------------------------------------------------------------------------------	-----------------------------------------------------------------

2. Install:
 - Rubber seal(s)
 - Dowels
 - Extension(s)

	Extension mounting bolt 47 N·m (4.7 kgf·m, 35 lb·ft)
-------------------------------------------------------------------------------------	---------------------------------------------------------

Water pump and shift rod



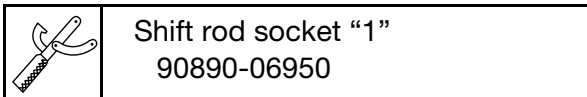
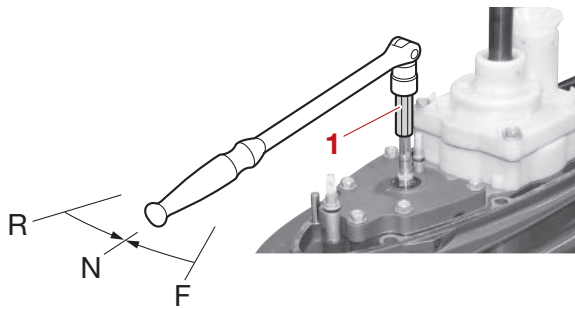
↑↓	Part name	Q'ty	Remarks
1	Bolt M8 × 70 mm	4	
2	Water pump housing	1	
3	Dowel	2	
4	O-ring	1	
5	Impeller	1	
6	Impeller key	1	
7	Outer plate cartridge	1	
8	O-ring	1	
9	Bolt M5 × 10 mm	2	
10	Impeller	1	
11	Water pump housing	1	
12	Dowel	2	
13	O-ring	1	
14	Bolt M5 × 16 mm	2	
15	Spacer	1	
16	Spacer	1	
17	Bolt M8 × 35 mm	6	
18	Plate	1	
19	O-ring	1	

↑↓	Part name	Q'ty	Remarks
20	Plate	1	
21	Gasket	1	
22	Shift rod	1	
23	E-clip	1	
24	Insert cartridge	1	
25	O-ring	1	
26	Guide	1	
27	Seal	1	
28	Cover	1	
29	Oil seal	1	
30	Oil seal	1	
31	Check valve	1	
32	Check valve	1	

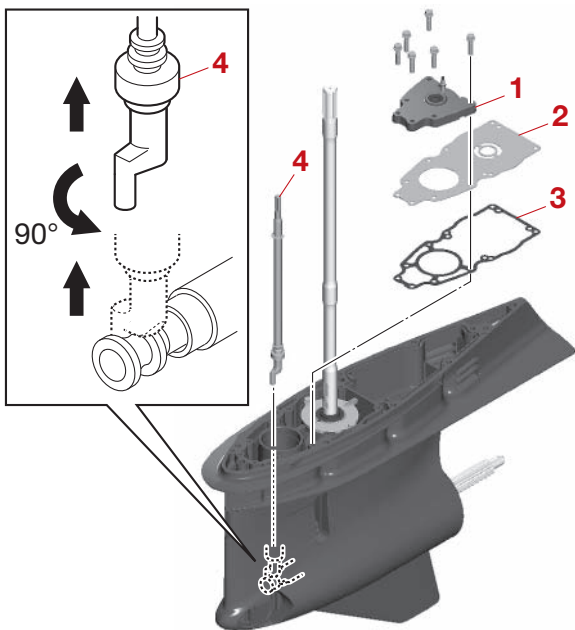
A. For regular rotation model
 B. For counter rotation model

Removing the shift rod (regular rotation model)

- Remove:
 - Shift rod guide plate
 - Plate
 - Gasket
 - Shift rod
 - Set the gear shift to the N position.

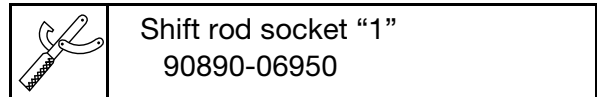
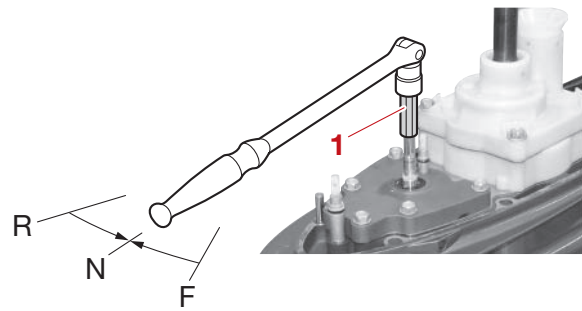


- Remove the shift rod guide plate "1", plate "2", gasket "3", and shift rod "4".

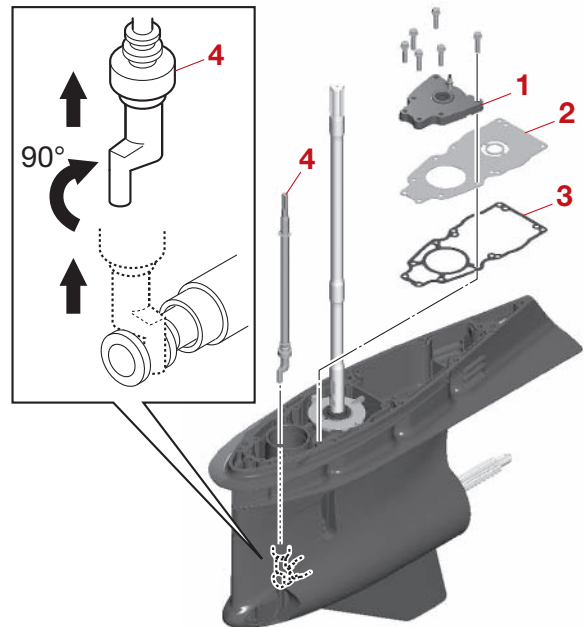


Removing the shift rod (counter rotation model)

- Remove:
 - Shift rod guide plate
 - Plate
 - Gasket
 - Shift rod
 - Set the gear shift to the N position.



- Remove the shift rod guide plate "1", plate "2", gasket "3", and shift rod "4".



Removing the gear oil passage check valve

⚠ WARNING

- Use heat-resistant gloves. Otherwise, burns could result.
- To prevent fires, remove any flammable substances, such as gasoline and oil, around the working area.
- Keep good ventilation while working.

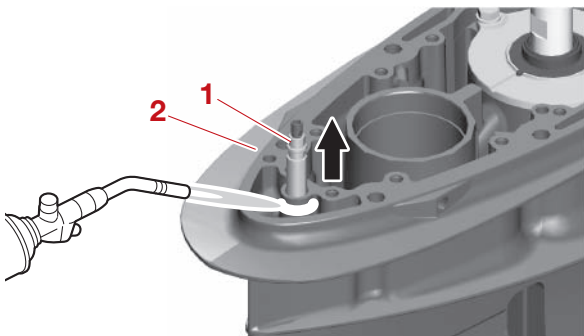
- Remove:
 - Gear oil passage check valve (lower case) "1"

NOTICE

When heating the lower case, heat the entire installation area evenly. Otherwise, the paint on the lower case could be burned.

TIP:

Heat the installation area of the check valve in the lower case "2" using a gas torch, and then remove the check valve "1".



Checking the water pump

1. Check:
 - Upper water pump housing
Deformed → Replace.

TIP:

If the engine overheats, the inside of the water pump housing may be deformed. Therefore, make sure to remove the insert cartridge when checking the upper water pump housing.

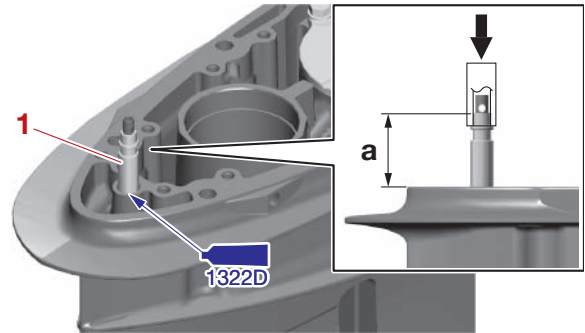
2. Check:
 - Upper impeller
 - Insert cartridge
Cracked/worn → Replace.
3. Check:
 - Lower impeller
 - Lower water pump housing
Cracked/damaged → Replace.
4. Check:
 - Impeller key
 - Keyway in the drive shaft
Deformed/worn → Replace.

Checking the shift rod

1. Check:
 - Shift rod
Bent/cracked/worn → Replace.

Installing the gear oil passage check valve

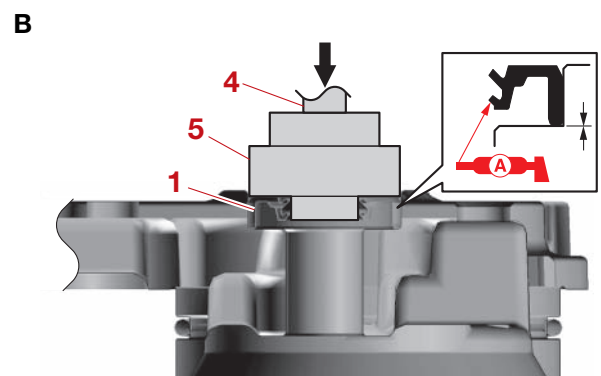
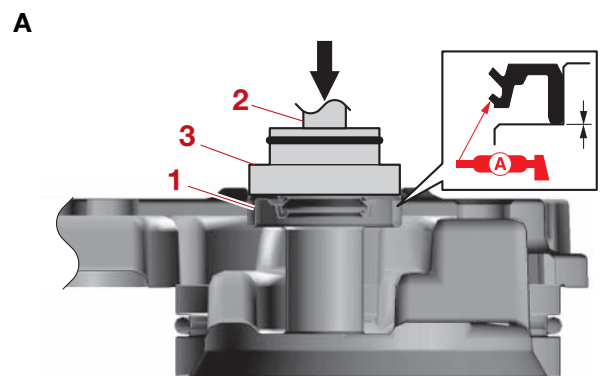
1. Install:
 - Gear oil passage check valve (lower case)
"1" **New**




Installation height "a"
40.7–41.3 mm (1.60–1.63 in)

Assembling the shift rod guide plate

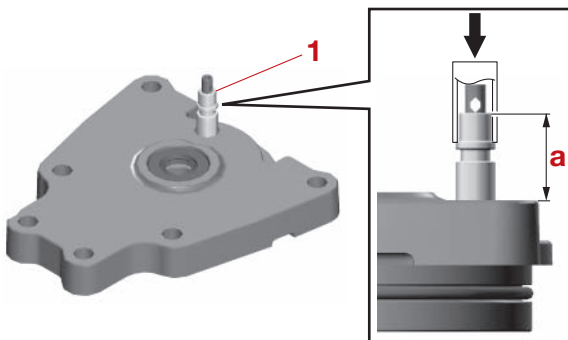
1. Install:
 - Oil seal "1" **New**
 - O-ring **New**




A. Worldwide
B. USA and Canada

	Driver rod L3 "2"
	90890-06652
	Needle bearing attachment "3"
	90890-06614
	Driver handle (small) "4"
YB-06229	
Oil seal installer reverse gear	
bearing housing "5"	
YB-06021	

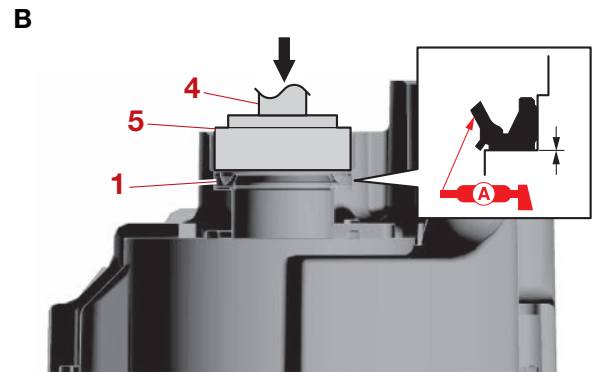
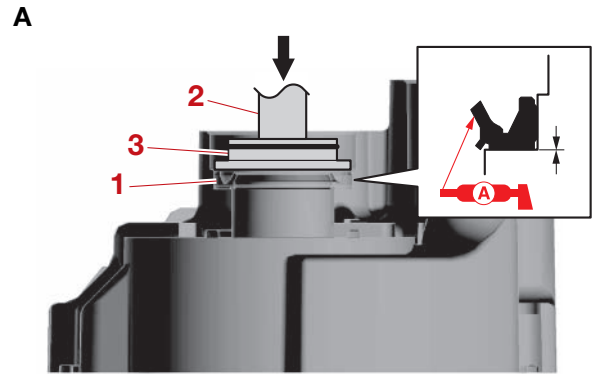
2. Install:
- Gear oil passage check valve (shift rod guide plate) "1" **New**




	Installation height "a"
	21.2–21.8 mm (0.83–0.86 in)

Assembling the water pump housing

1. Install:
- Oil seal "1" **New**
 - Seal

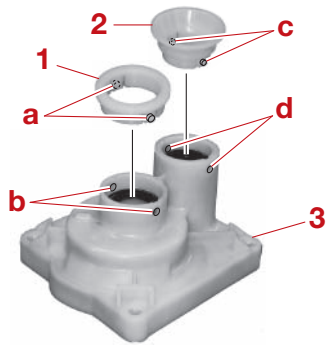


- A. Worldwide
B. USA and Canada

	Driver rod L3 "2"
	90890-06652
	Needle bearing attachment "3"
	90890-06609
	Driver handle (small) "4"
	YB-06229
Driveshaft seal installer "5"	
YB-06348	

2. Install:
- Cover "1"
 - Guide "2"

- TIP:**
- Fit the protrusions "a" on the cover "1" into the holes "b" in the upper water pump housing "3".
 - Fit the protrusions "c" on the guide "2" into the holes "d" in the upper water pump housing "3".

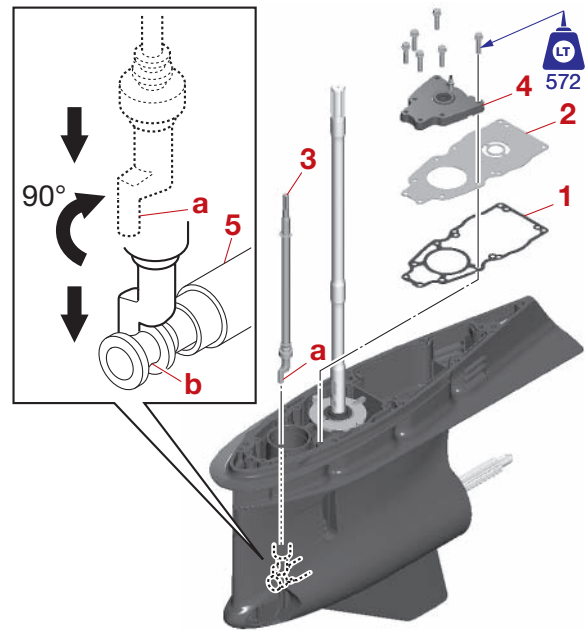


3. Install:

- O-ring **New**
- Insert cartridge "1"

TIP:

- Fit the protrusions "a" on the insert cartridge "1" into the slots "b" in the upper water pump housing "2".
- Do not apply sealant to the slot "c" in the upper water pump housing "2".

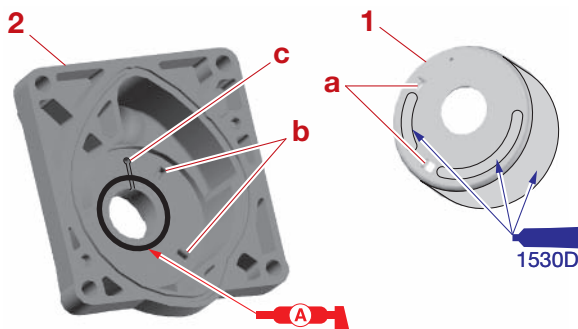


2. Install:

- Spacers
 - a. Install the spacers "1" and "2".

TIP:

- Install the spacers "1" and "2" so that the punch marks "a" on the spacers are facing up.
- Align the flat portion "b" of the spacer "1" with the cutout "c" in the drive shaft "3".



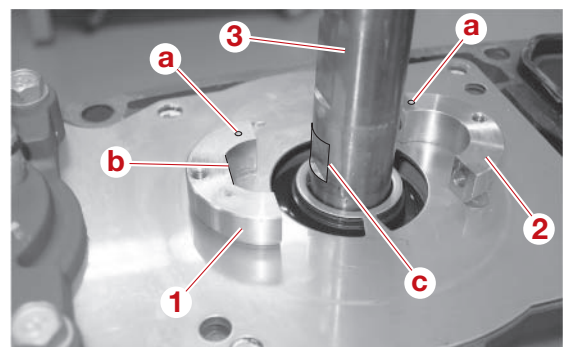
Installing the water pump and shift rod (regular rotation model)

1. Install:

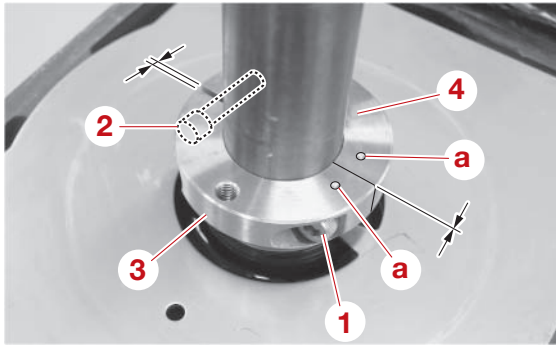
- Dowels
- Gasket "1" **New**
- Plate "2"
- E-clip
- Shift rod "3"
- Shift rod guide plate "4"


TIP:

Turn the shift rod "3" clockwise 90°, and then push it down so that the tip "a" of the shift rod "3" fits into the groove "b" in the shift slider "5".



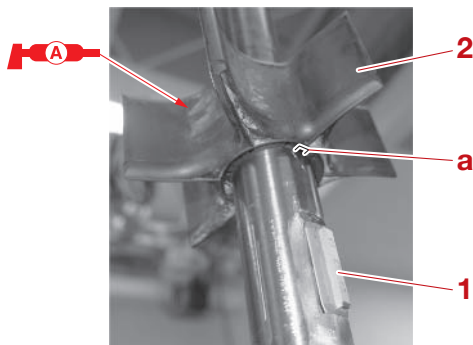
- b. Install the spacer bolts "1" and "2".
- c. Tighten the spacer bolt "1" temporarily until the mating surfaces (the ends with the punch marks "a" of the spacers "3" and "4" are contacting, and then tighten the spacer bolt "2" temporarily.
- d. Tighten the spacer bolt "1", then the spacer bolt "2".




 Spacer bolt "1", "2"
4.5 N·m (0.45 kgf·m, 3.3 lb·ft)

3. Install:
- O-rings **New**
 - Lower water pump housing
 - Lower impeller
 - Dowels
 - Outer plate cartridge
 - Impeller key "1"
 - Upper impeller "2"

TIP: _____
Align the slot "a" in the upper impeller "2" with the impeller key "1".

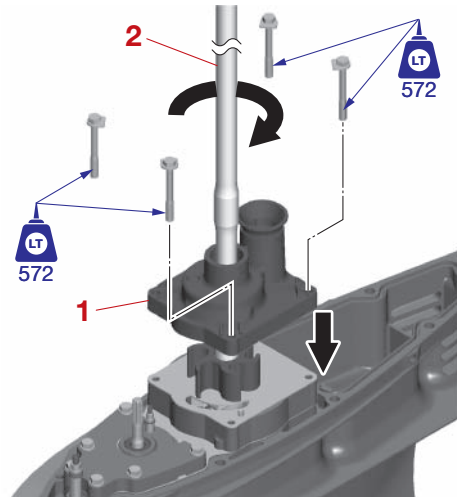



 Lower impeller bolt
4.5 N·m (0.45 kgf·m, 3.3 lb·ft)

4. Install:
- O-ring **New**
 - Upper water pump housing "1"

NOTICE _____
Do not turn the drive shaft counterclockwise. Otherwise, the water pump impeller could be damaged.

TIP: _____
While turning the drive shaft "2" clockwise, push the upper water pump housing "1" down to install it.

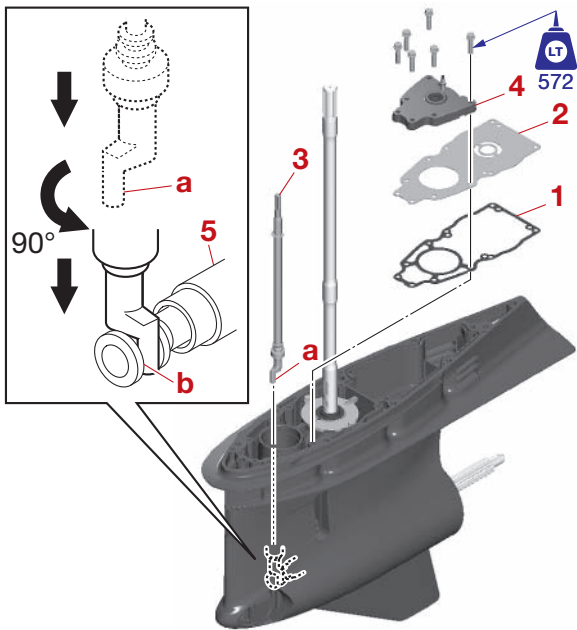


 Upper water housing bolt
16 N·m (1.6 kgf·m, 12 lb·ft)

Installing the water pump and shift rod (counter rotation model)

1. Install:
- Dowels
 - Gasket "1" **New**
 - Plate "2"
 - E-clip
 - Shift rod "3"
 - Shift rod guide plate "4"

TIP: _____
Turn the shift rod "3" counterclockwise 90°, and then push it down so that the tip "a" of the shift rod fits into the groove "b" in the shift slider "5".

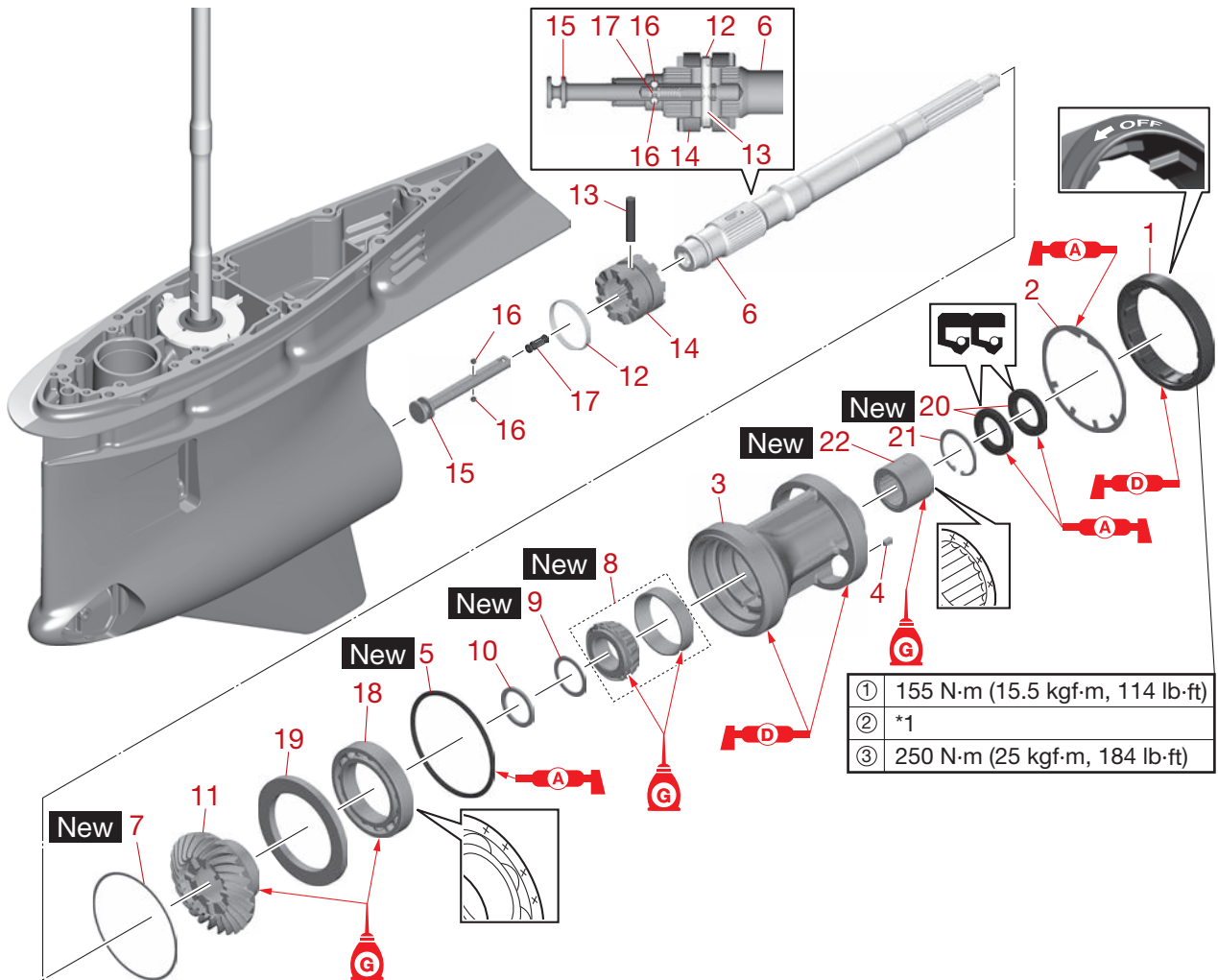


2. Install:

- Spacers
 - O-rings **New**
 - Lower water pump housing
 - Lower impeller
 - Dowels
 - Outer plate cartridge
 - Impeller key
 - Upper impeller
 - Upper water pump housing
- See steps 2–4 in “Installing the water pump and shift rod (regular rotation model)” (8-15).

Propeller shaft housing (regular rotation model)

Propeller shaft housing (regular rotation model)



↑↓	Part name	Q'ty	Remarks
1	Ring nut M142	1	
2	Claw washer	1	
3	Propeller shaft housing	1	
4	Key	1	
5	O-ring	1	
6	Propeller shaft	1	
7	Reverse gear shim (T2)	—	
8	Tapered roller bearing	1	
9	Propeller shaft shim (T4)	—	
10	Washer	1	
11	Reverse gear	1	
12	Spring	1	
13	Cross pin	1	
14	Dog clutch	1	
15	Slider	1	

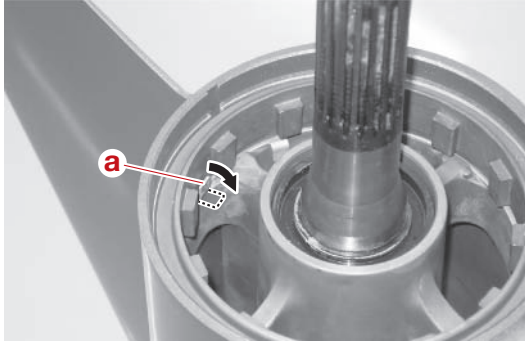
↑↓	Part name	Q'ty	Remarks
16	Ball	2	6.33 mm (0.25 in) (reference data)
17	Shift plunger	1	
18	Ball bearing	1	
19	Thrust washer	1	
20	Oil seal	2	
21	Circlip	1	
22	Needle bearing	1	

*1. Rotate the drive shaft by 10 turns or more.

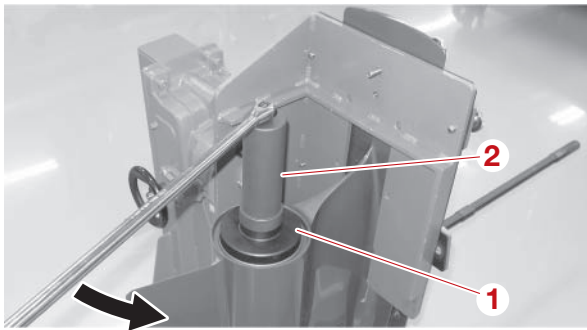
Propeller shaft housing (regular rotation model)


Removing the propeller shaft housing assembly

1. Remove:
 - Ring nut
 - Claw washer
 - a. Straighten the bent tab "a" on the claw washer.



b. Loosen the ring nut.

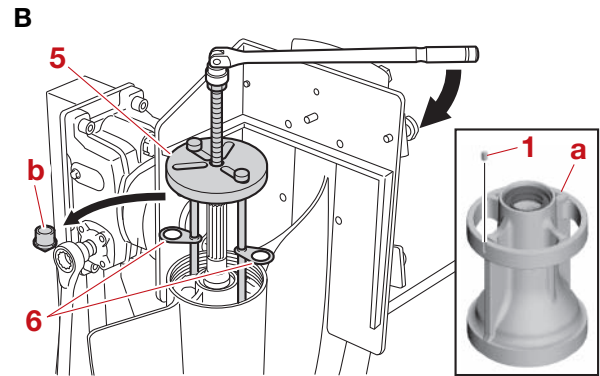
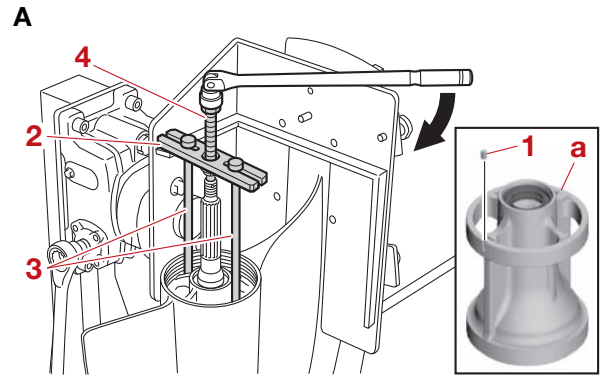


	Ring nut wrench "1" 90890-06932
	Ring nut wrench extension 2 "2" 90890-06784
	Ring nut wrench extension "2" YB-06784

c. Remove the ring nut and claw washer.


2. Remove:
 - Propeller shaft housing assembly "a"
 - Key "1"

TIP: _____
Without the attachment "b".

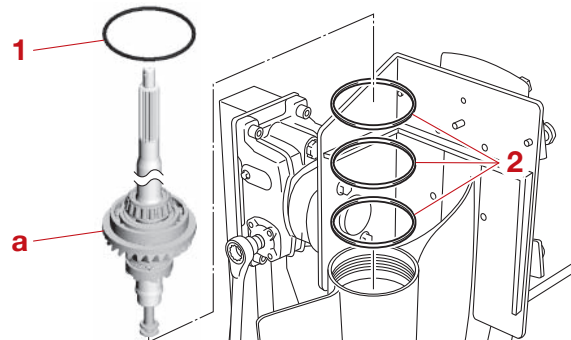


A. Worldwide

B. USA and Canada

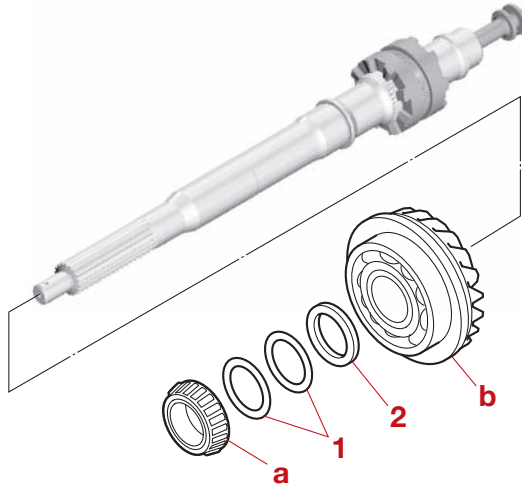
	Stopper guide plate "2" 90890-06501
	Bearing housing puller claw L "3" 90890-06502
	Center bolt "4" 90890-06504
	Universal Puller "5" YB-06117
	Bearing housing puller "6" YB-06207

3. Remove:
 - O-ring "1"
 - Propeller shaft assembly "a"
 - Reverse gear shims "2"



Propeller shaft housing (regular rotation model)

4. Remove:
 - Tapered roller bearing inner race "a"
 - Propeller shaft shims "1"
 - Washer "2"
 - Reverse gear assembly "b"

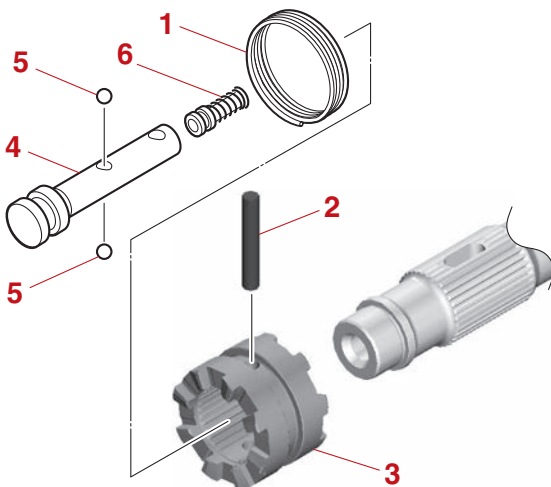


Disassembling the propeller shaft assembly

1. Remove:
 - Spring "1"
 - Cross pin "2"
 - Dog clutch "3"
 - Slider "4"
 - Balls "5"
 - Shift plunger "6"

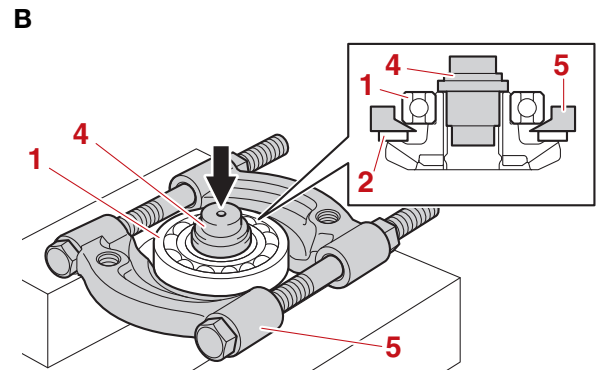
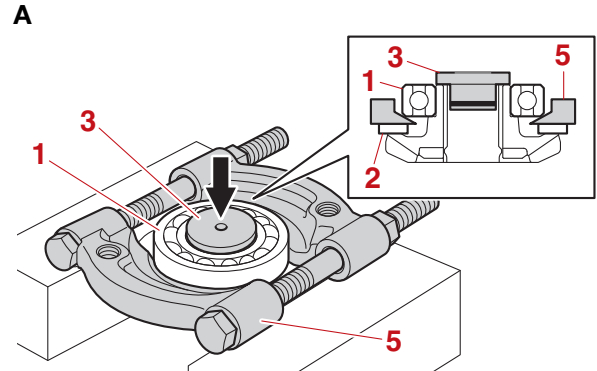
TIP:

When removing the slider "4", make sure that the balls "5" do not fall out of position.



Disassembling the reverse gear

1. Remove:
 - Ball bearing "1"
 - Thrust washer "2"



A. Worldwide

B. USA and Canada



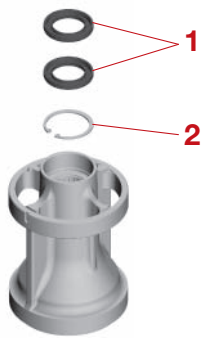
Ball bearing attachment "3"
90890-06657
Prop end seal bearing driver "4"
YB-42227
Bearing splitter plate "5"
(commercially available)

Disassembling the propeller shaft housing assembly

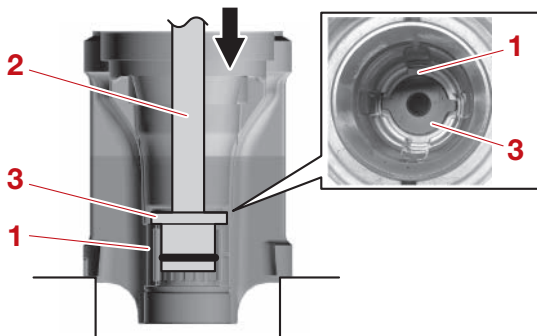
⚠ WARNING

- Use heat-resistant gloves. Otherwise, burns could result.
- To prevent fires, remove any flammable substances, such as gasoline and oil, around the working area.
- Keep good ventilation while working.

1. Remove:
 - Oil seals "1"
 - Circlip "2"



2. Remove:
- Needle bearing "1"



	Driver rod LL "2" 90890-06605
	Needle bearing attachment "3" 90890-06933
	Driver rod LL "2" YB-06605

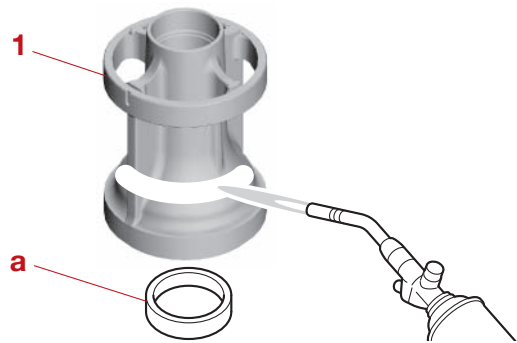
3. Remove:
- Tapered roller bearing (outer race) "a"

WARNING

When heating the propeller shaft housing, heat the entire installation area evenly. Otherwise, the propeller shaft housing could be damaged.

TIP:

Heat the installation area of the tapered roller bearing outer race in the propeller shaft housing "1" using a gas torch, and then remove the tapered roller bearing outer race "a".



Checking the propeller shaft

1. Check:
 - Propeller shaft
Damaged/worn → Replace.
2. Measure:
 - Propeller shaft runout
Above specification → Replace.



	Runout 0.02 mm (0.0008 in) (F400AS-TU, F400ASTX, F450AVTU, F450AVTX)
--	-------------------------------------------------------------------------

Checking the dog clutch

1. Check:
 - Dog clutch
 - Shift plunger
 - Cross pin
 - Spring
 - Balls
 - Slider
Cracked/worn → Replace.

Checking the propeller shaft housing

1. Check:
 - Propeller shaft housing
Cracked/damaged → Replace.

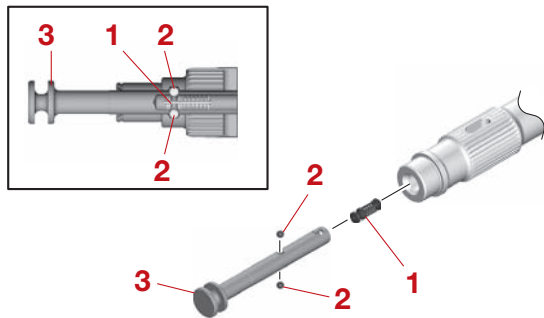
Checking the reverse gear

1. Check:
 - Teeth and dogs of the reverse gear Cracked/worn → Replace.

Assembling the propeller shaft assembly

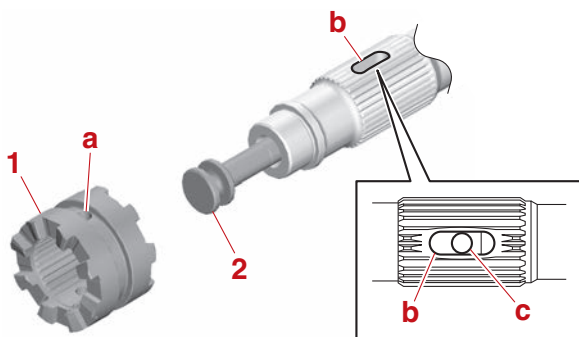
1. Install:
 - Shift plunger "1"
 - Balls "2"
 - Slider "3"

TIP: _____
 When installing the slider "3", make sure that the balls "2" do not fall out of position.

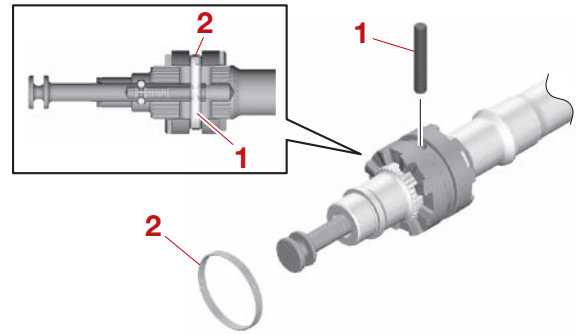


2. Install:
 - Dog clutch "1"

TIP: _____
 Install the dog clutch "1" so that the hole "a" in the dog clutch "1" and the hole "b" in the propeller shaft are aligned with the hole "c" in the slider "2".



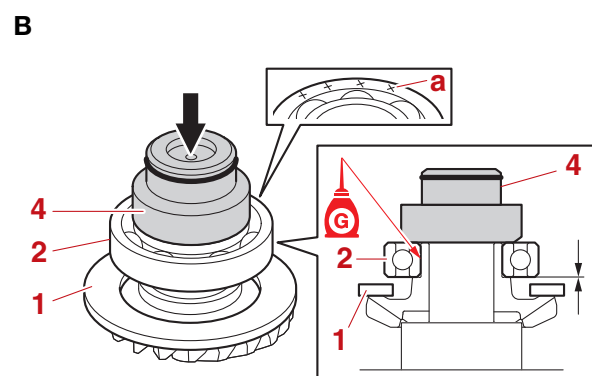
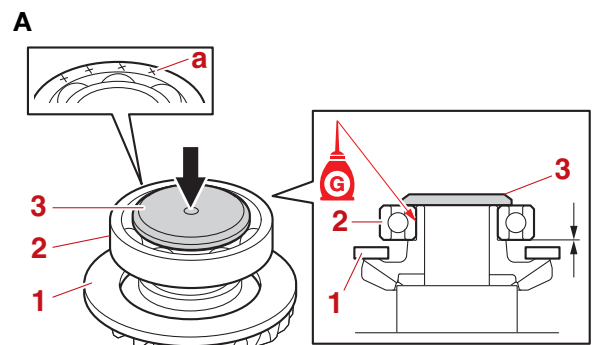
3. Install:
 - Cross pin "1"
 - Spring "2"



Assembling the reverse gear

1. Install:
 - Thrust washer "1"
 - Ball bearing "2" **New**

TIP: _____
 Face the bearing identification mark "a" on the ball bearing toward the propeller shaft housing.



- A. Worldwide
- B. USA and Canada

	Bearing inner race attachment "3" 90890-06658
	Taper roller bearing installer "4" YB-06431

Assembling the propeller shaft housing assembly

⚠ WARNING

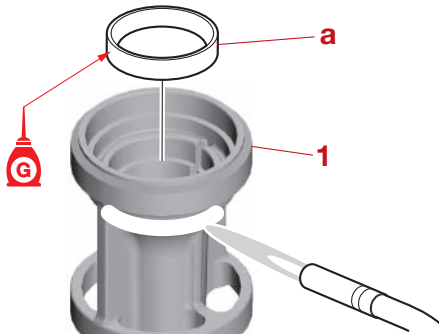
- Use heat-resistant gloves. Otherwise, burns could result.
- To prevent fires, remove any flammable substances, such as gasoline and oil, around the working area.
- Keep good ventilation while working.

1. Install:

- Tapered roller bearing (outer race) **New**
 - a. Heat the installation area of the tapered roller bearing outer race in the propeller shaft housing “1” using a gas torch, and then install a new tapered roller bearing outer race “a”.

⚠ WARNING

When heating the propeller shaft housing, heat the entire installation area evenly. Otherwise, the propeller shaft housing could be damaged.

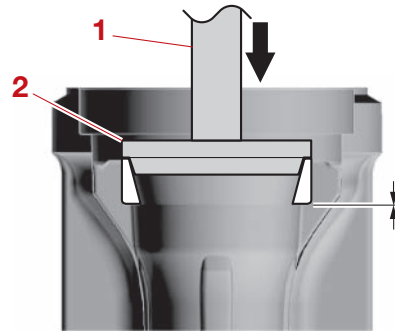


- b. While holding the special service tools, strike the tool to check that the tapered roller bearing outer race is installed properly.

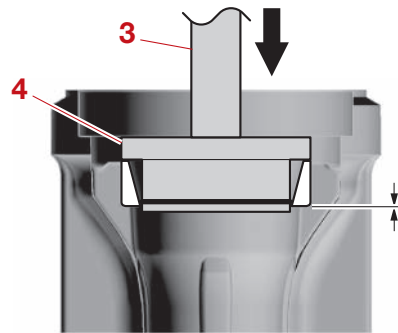
TIP:

If a high-pitched metallic sound is produced when the special service tool is struck, the outer race is installed properly.

A



B



A. Worldwide

B. USA and Canada



Driver rod LL “1”

90890-06605

Bearing outer race attachment
“2”

90890-06621

Driver handle (large) “3”

YB-06071

Forward gear bearing installer “4”

YB-06276

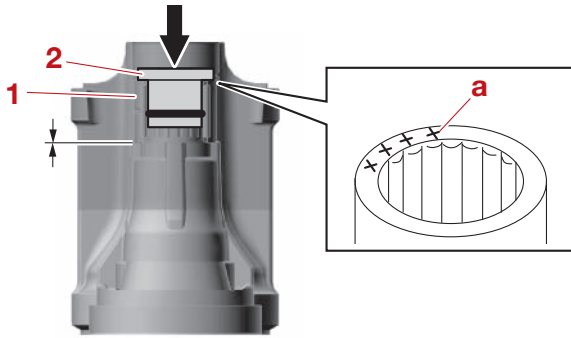
2. Install:


- Needle bearing “1” **New**
- Circlip


TIP:


Face the bearing identification mark “a” on the needle bearing toward the propeller.

Propeller shaft housing (regular rotation model)



	Needle bearing attachment "2" 90890-06933
-----------------------------------------------------------------------------------	----------------------------------------------

	Driver rod LS "2" 90890-06606
	Bearing outer race attachment "3" 90890-06623
	Driver handle (large) "4" YB-06071
	Forward gear bearing cup install- er "5" YB-06277-A

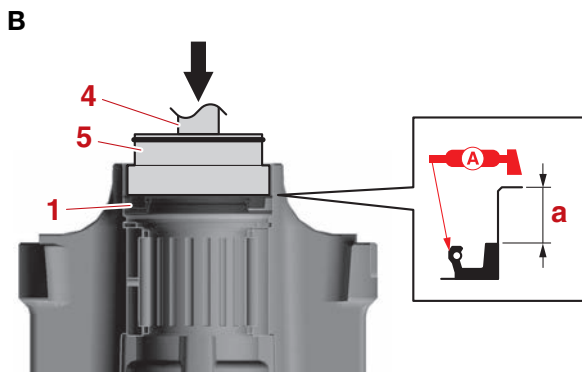
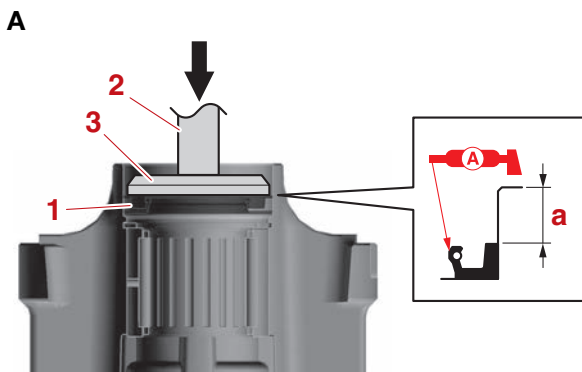
	Installation depth "a" 12.25–12.75 mm (0.482–0.502 in)
-----------------------------------------------------------------------------------	--------------------------------------------------------------

3. Install:

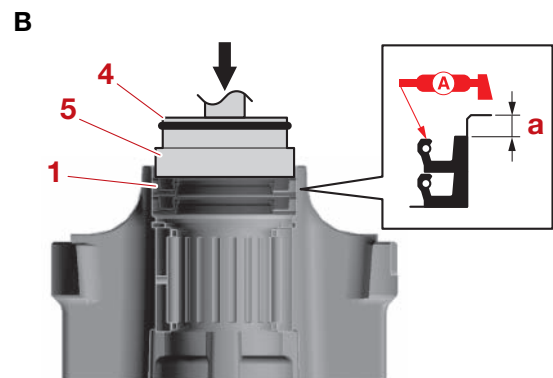
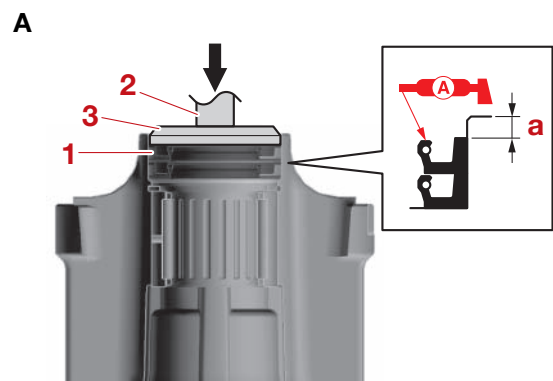
- Oil seals **New**

a. Install a new oil seal "1" in the propeller shaft housing at the specified installation depth "a".

b. Install a new oil seal "1" in the propeller shaft housing at the specified installation depth "a".



A. Worldwide
B. USA and Canada



A. Worldwide
B. USA and Canada

Propeller shaft housing (regular rotation model)



Driver rod LS "2"
90890-06606
Bearing outer race attachment
"3"
90890-06623
Driver handle (large) "4"
YB-06071
Forward gear bearing cup install-
er "5"
YB-06277-A



Installation depth "a"
4.75–5.25 mm (0.187–0.207 in)

Installing the propeller shaft housing assembly

- Assemble:
 - Propeller shaft assembly
 - Reverse gear assembly
 - Washer
 - Propeller shaft shim **New**
 - Tapered roller bearing (inner race) **New**
 - O-ring **New**
 - Propeller shaft housing assembly

TIP:

Position the thickest propeller shaft shim toward the propeller shaft housing.

- Install:
 - Reverse gear shim **New**
 - Propeller shaft/propeller shaft housing assembly
 - Key

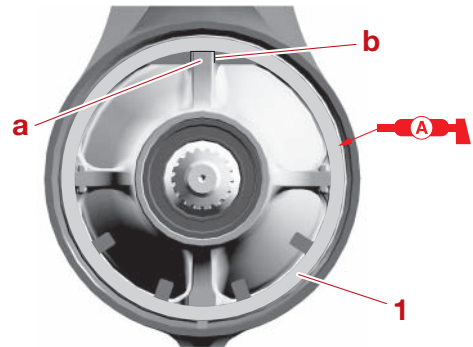
TIP:

- Position the thickest reverse gear shim toward the lower case.
- Turn the drive shaft and check that the propeller shaft/propeller shaft housing assembly is installed securely.

- Install:
 - Claw washer "1"

TIP:

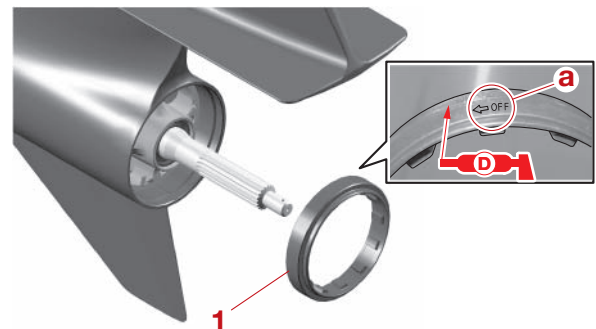
Make sure to fit the protrusion "a" on the propeller shaft housing into the slot "b" in the claw washer "1".



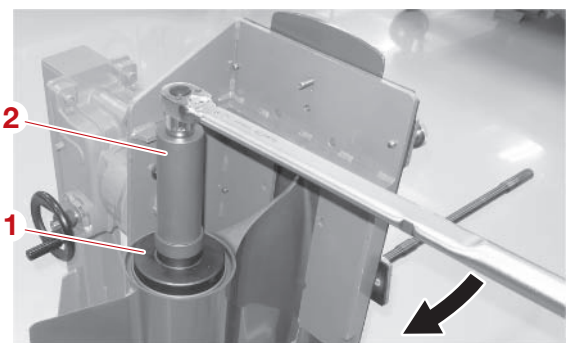
- Install:
 - Ring nut "1"

TIP:

Install the ring nut "1" so that the side with the mark "a" is toward the propeller.



- Tighten:
 - Ring nut
 - Tighten the ring nut to the specified torque.



Propeller shaft housing (regular rotation model)

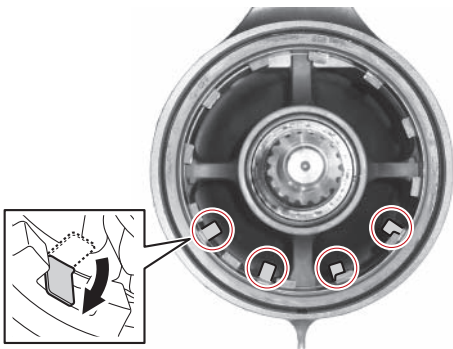


Ring nut wrench "1"
90890-06932
Ring nut wrench extension 2 "2"
90890-06784
Ring nut wrench extension "2"
YB-06784

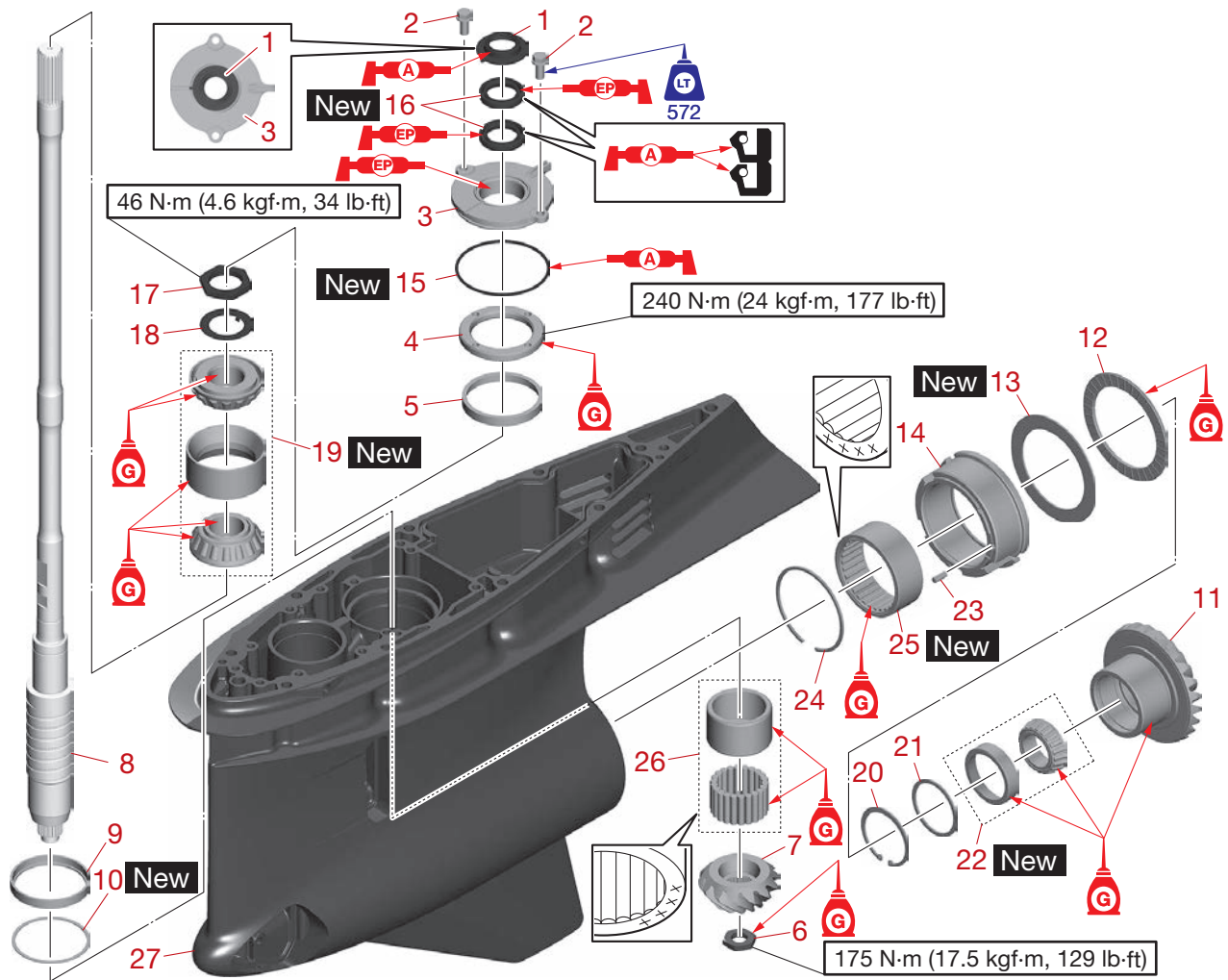


Ring nut
1st: 155 N·m (15.5 kgf·m, 114 lb·ft)
2nd: Rotate the drive shaft by 10 turns or more.
3rd: 250 N·m (25 kgf·m, 184 lb·ft)

- b. Bend one of the 4 tabs on the claw washer outward, and then bend the other 3 tabs inward.



Drive shaft and lower case (regular rotation model)

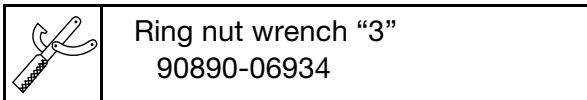
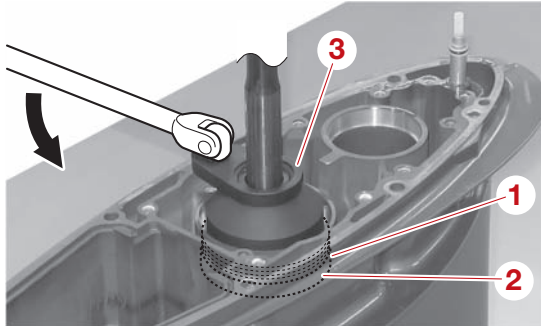


↑↓	Part name	Q'ty	Remarks
1	Cover	1	
2	Bolt M8 × 20 mm	2	
3	Housing	1	
4	Ring nut M86	1	
5	Spacer	1	
6	Pinion nut M18	1	
7	Pinion	1	
8	Drive shaft	1	
9	Spacer	1	
10	Pinion shim (T3)	—	
11	Forward gear	1	
12	Thrust bearing	1	
13	Forward gear shim (T1)	1	
14	Adapter	1	
15	O-ring	1	
16	Oil seal	2	
17	Nut M35	1	
18	Claw washer	1	

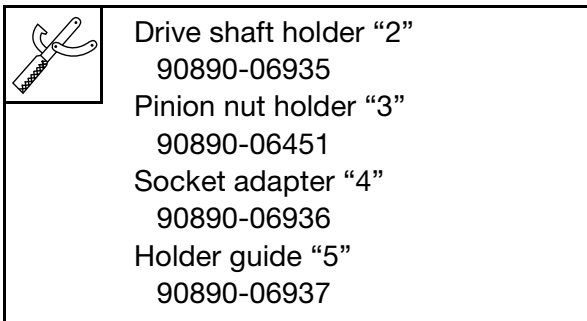
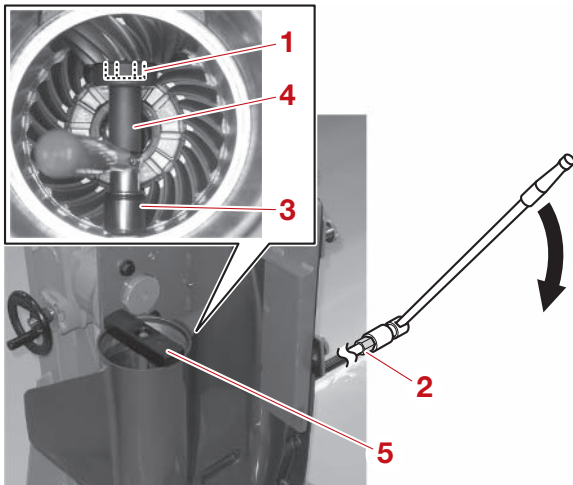
↑↓	Part name	Q'ty	Remarks
19	Tapered roller bearing	1	
20	Circlip	1	
21	Washer	1	
22	Tapered roller bearing	1	
23	Dowel	1	
24	Circlip	1	
25	Roller bearing	1	
26	Needle bearing	1	
27	Lower case	1	

Removing the drive shaft

- Remove:
 - Cover
 - Oil seal housing
 - Ring nut "1"
 - Spacer "2"

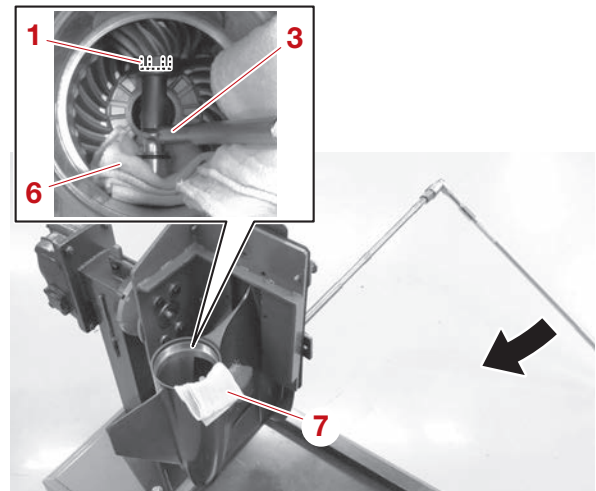


- Loosen:
 - Pinion nut "1"



TIP:

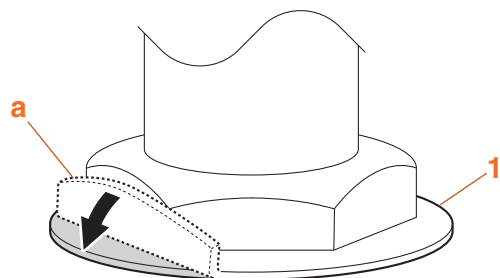
- When the pinion nut "1" is hard to loosen, remove the holder guide, insert a thick rag "6" between the pinion nut holder "3" and the lower case, and press the special service tool against the pinion nut "1".
- When the holder guide is not used, place a rag "7" where the special service tool contacts the lower case.



- Remove:
 - Pinion
 - Drive shaft assembly
 - Pinion shims
 - Spacer

Disassembling the drive shaft

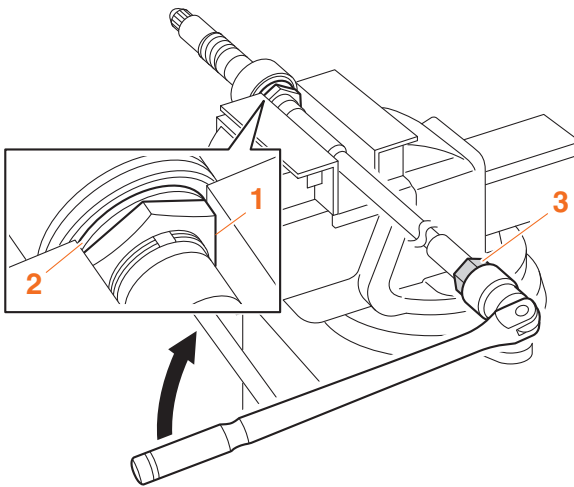
- Remove:
 - Drive shaft nut
 - Claw washer
 - a. Straighten the tab "a" on the claw washer "1".



- b. Secure the drive shaft nut "1" on the drive shaft.

Drive shaft and lower case (regular rotation model)

- c. Loosen the drive shaft nut "1", and then remove the drive shaft nut "1" and claw washer "2".

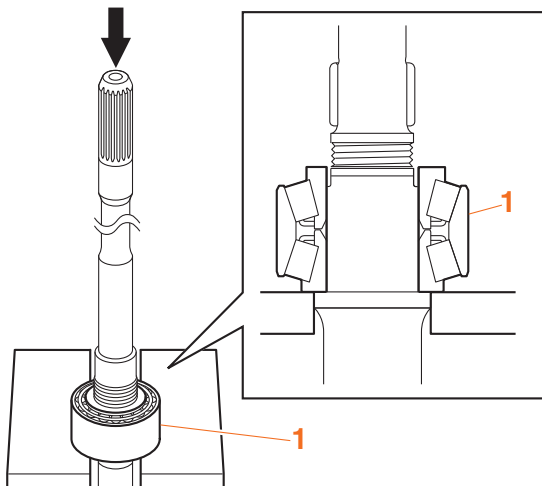


Drive shaft holder "3"
90890-06935

2. Remove:
- Tapered roller bearing "1"

NOTICE

Make sure that the inner race of the tapered roller bearing is placed properly on the blocks.



Disassembling the forward gear

WARNING

- Use heat-resistant gloves. Otherwise, burns could result.
- To prevent fires, remove any flammable substances, such as gasoline and oil, around the working area.
- Keep good ventilation while working.

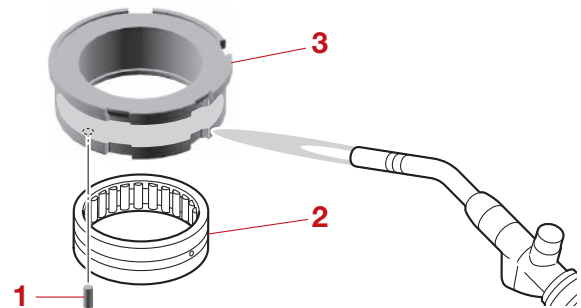
1. Remove:
- Circlip
 - Dowel "1"
 - Roller bearing "2"

NOTICE

When heating the adapter, heat the entire installation area evenly. Otherwise, the adapter could be damaged.

TIP:

Heat the installation area of the roller bearing in the adapter "3" using a gas torch, and then remove the roller bearing "2".



Disassembling the lower case

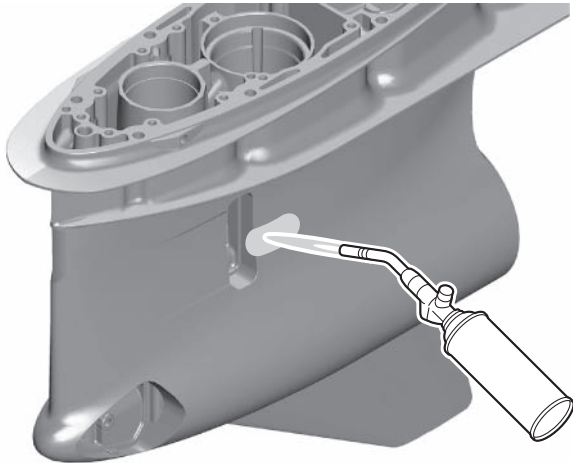
WARNING

- Use heat-resistant gloves. Otherwise, burns could result.
- To prevent fires, remove any flammable substances, such as gasoline and oil, around the working area.
- Keep good ventilation while working.

1. Remove:
- Needle bearing
 - a. Heat the installation area of the needle bearing in the lower case using a gas torch.

NOTICE

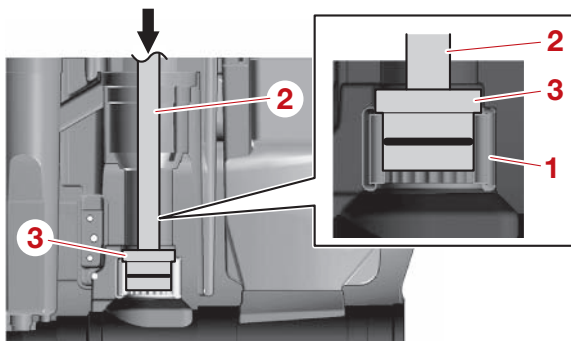
When heating the lower case, heat the entire installation area evenly. Otherwise, the paint on the lower case could be burned.



b. Remove the needle bearing "1".

TIP:

- Before removing the needle bearing, make sure to remove the forward gear assembly.
- Before installing the special service tool, make sure that the rollers are installed in the needle bearing outer race.



	Driver rod LL "2" 90890-06605
	Needle bearing attachment "3" 90890-06967
	Driver rod LL "2" YB-06605

Checking the pinion

1. Check:
 - Teeth of the pinion
Cracked/worn → Replace.

Checking the forward gear

1. Check:
 - Teeth and dogs of the forward gear
Cracked/worn → Replace.

Checking the drive shaft

1. Check:
 - Drive shaft
Damaged/worn → Replace.
2. Measure:
 - Drive shaft runout
Above specification → Replace.



	Runout 1.0 mm (0.039 in) (F400ASTU, F400ASTX, F450AVTU, F450AVTX)
--	----------------------------------------------------------------------------

Checking the lower case

1. Check:
 - Lower case
Cracked/damaged → Replace.

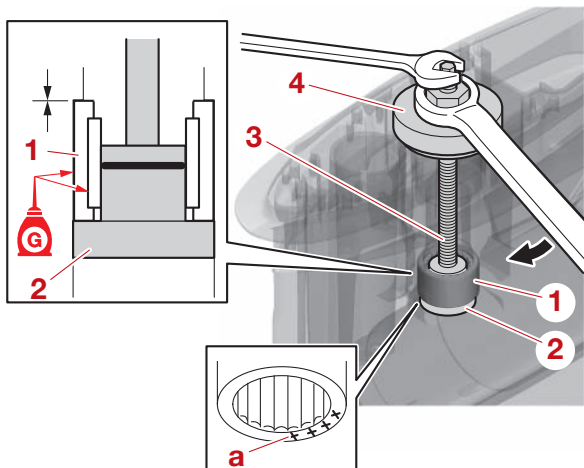
Assembling the lower case


1. Install:
 - Needle bearing "1" **New**

TIP:

- Make sure to face the bearing identification mark "a" on the needle bearing toward the pinion.
- The needle bearing contains 22 rollers.

Drive shaft and lower case (regular rotation model)



	Needle bearing attachment "2" 90890-06938
	Bearing outer race puller assembly "3" 90890-06523
	Stopper guide plate "4" 90890-06939
	Double ended bolt "3" (commercially available) 5/8-18 UNF, 350 mm (13.8 in)

Assembling the forward gear

WARNING

- Use heat-resistant gloves. Otherwise, burns could result.
- To prevent fires, remove any flammable substances, such as gasoline and oil, around the working area.
- Keep good ventilation while working.

1. Install:
 - Adapter
 - Roller bearing **New**
 - Dowel
 - Circlip

a. Heat the installation area of the roller bearing in the adapter "1" using a gas torch, and then install a new roller bearing "2".

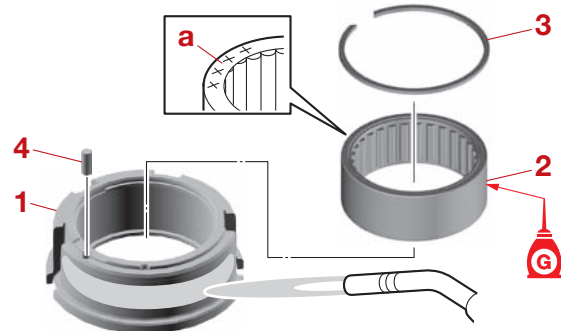
NOTICE

When heating the adapter, heat the entire installation area evenly. Otherwise, the adapter could be damaged.

- b. Install the circlip "3" and dowel "4".

TIP:

Face the bearing identification mark "a" on the roller bearing toward the circlip.



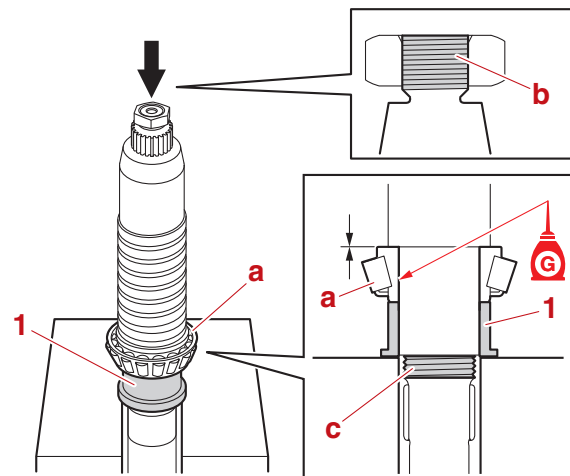
2. Install:
 - Tapered roller bearing **New**
 - Washer
 - Circlip

Assembling the drive shaft

1. Install:
 - Tapered roller bearing **New**
 - Claw washer
 - Drive shaft nut
 - a. Install a new tapered roller bearing inner race "a".

NOTICE

Do not press the threads "b" of the drive shaft directly. Make sure that the special service tool and blocks do not contact the threads "c" of the drive shaft.



Drive shaft and lower case (regular rotation model)



Bearing inner race attachment "1"
90890-06639
Bearing inner race attachment "1"
YB-06639

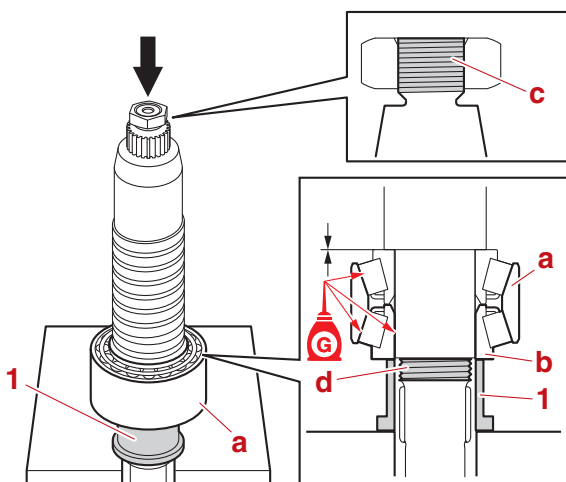


Press load (bearing)
 50×10^3 N (5000 kgf)

- b. Install a new tapered roller bearing outer race "a" and the tapered roller bearing inner race "b".

NOTICE

Do not press the threads "c" of the drive shaft directly. Make sure that the special service tool and blocks do not contact the threads "d" of the drive shaft.



Bearing inner race attachment "1"
90890-06639
Bearing inner race attachment "1"
YB-06639



Press load (bearing)
 50×10^3 N (5000 kgf)

- c. Turn the tapered roller bearing 10 turns or more to seat the bearing, and then press the drive shaft again using the specified load.



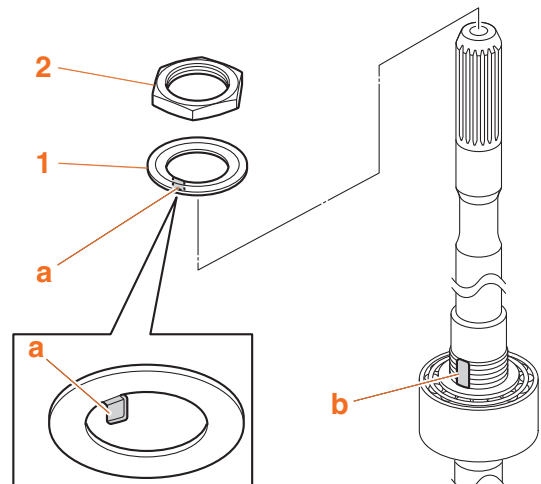
Press load (bearing)
 50×10^3 N (5000 kgf)

- d. Turn the tapered roller bearing 10 turns or more to seat the bearing.

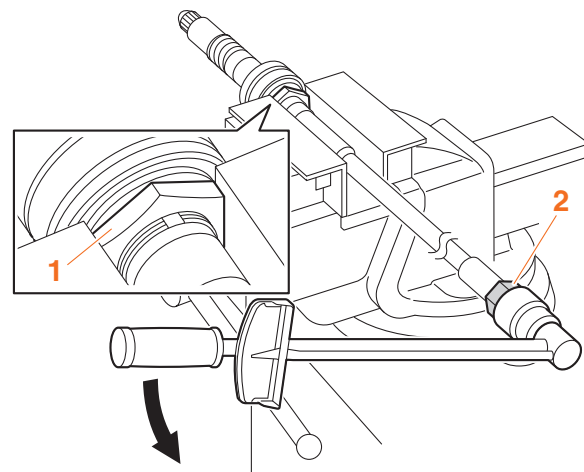
- e. Install the claw washer "1", and then tighten the drive shaft nut "2" temporarily.

TIP:

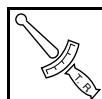
Make sure to fit the tab "a" on the claw washer "1" into the slot "b" in the drive shaft.



- f. Secure the drive shaft nut "1" on the drive shaft.
g. Tighten the drive shaft nut "1" to the specified torque.



Drive shaft holder "2"
90890-06935



Drive shaft nut "1"
46 N·m (4.6 kgf·m, 34 lb·ft)

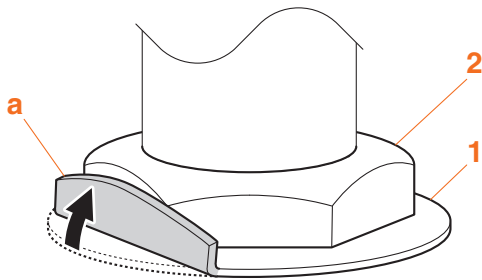
- h. Hold the tapered roller bearing outer race, and then measure the motive torque of the drive shaft.

Drive shaft and lower case (regular rotation model)



Motive torque
0.3–3.0 N·m (0.03–0.31 kgf·m,
0.2–2.2 lb·ft) (F400ASTU,
F400ASTX, F450AVTU,
F450AVTX)

- i. Bend the tab “a” on the claw washer “1” to secure the drive shaft nut “2”.



Driver rod LL “2”
90890-06605
Bearing outer race attachment
“3”
90890-06628
Driver handle (large) “4”
YB-06071
Bearing cup installer “5”
YB-06167



Installation depth “a”
8.25–8.75 mm (0.325–0.344 in)

- b. Install a new oil seal “1” in the oil seal housing at the specified installation depth “a”.

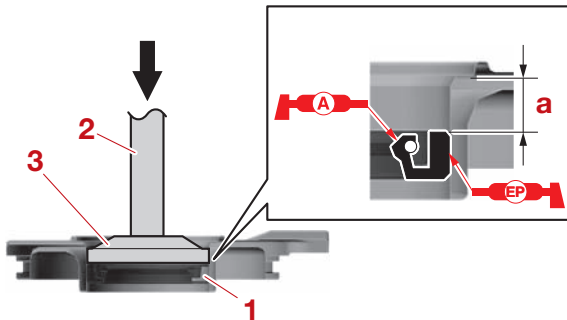
Assembling the oil seal housing

1. Install:

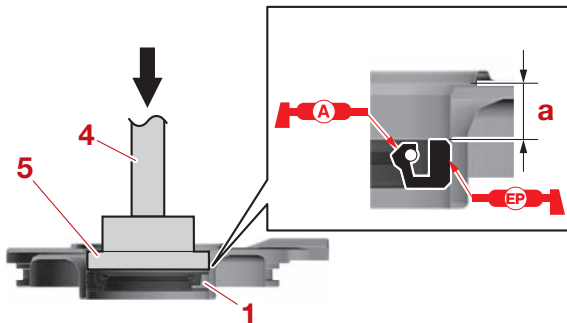
- Oil seals **New**
- O-ring **New**

- a. Install a new oil seal “1” in the oil seal housing at the specified installation depth “a”.

A

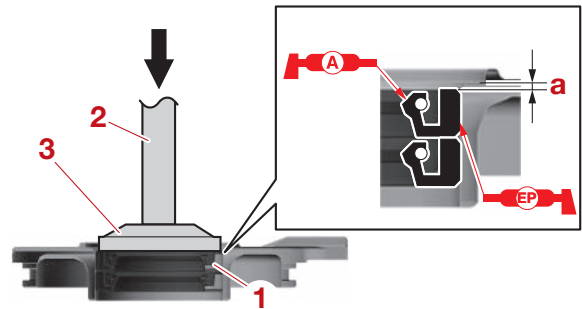


B

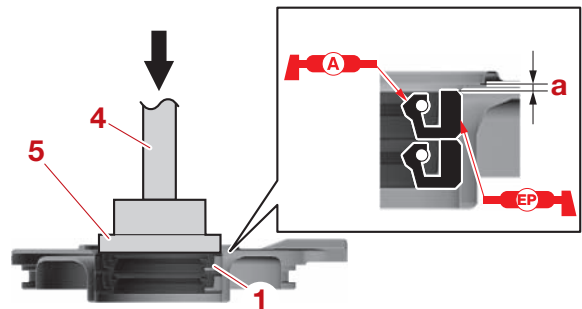


- A. Worldwide
B. USA and Canada

A



B



- A. Worldwide
B. USA and Canada



Driver rod LL “2”
90890-06605
Bearing outer race attachment
“3”
90890-06628
Driver handle (large) “4”
YB-06071
Bearing cup installer “5”
YB-06167

Drive shaft and lower case (regular rotation model)



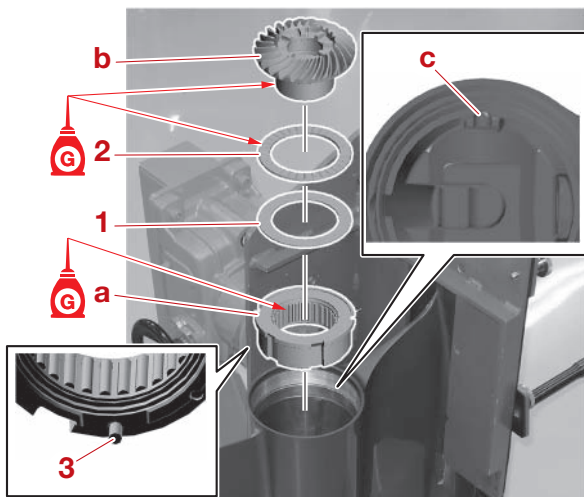
Installation depth "a"
0.75–1.25 mm (0.030–0.049 in)

Installing the forward gear

- Install:
 - Adapter assembly "a"
 - Forward gear shim "1" **New**
 - Thrust bearing "2"
 - Forward gear assembly "b"

TIP:

Make sure to fit the dowel "3" into the slot "c" in the lower case.

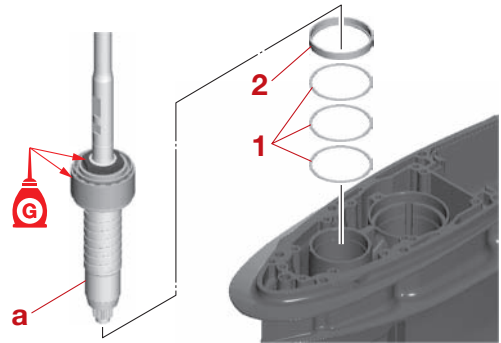


Installing the drive shaft

- Install:
 - Pinion shims **New**
 - Spacer
 - Drive shaft assembly
 - Pinion
 - Pinion nut
 - Install new pinion shims "1", spacer "2", and drive shaft assembly "a".

TIP:

Position the thickest shim on the bottom.

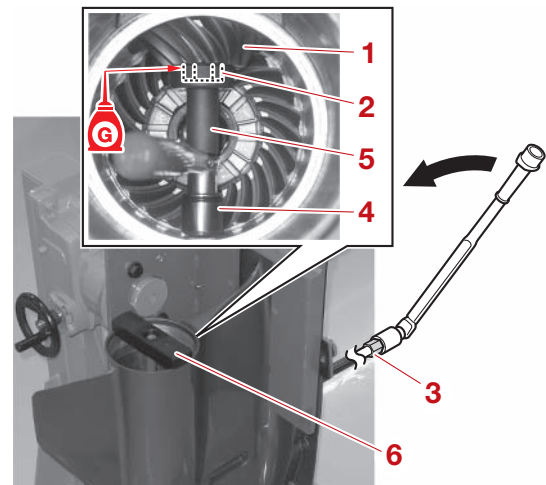


- Install the pinion "1" and pinion nut "2" temporarily.

TIP:

- When installing the pinion, lift up the drive shaft slightly and align the splines on the drive shaft with the splines on the pinion.
- Tighten the pinion nut "2" temporarily until the tapered portion of the pinion "1" contacts the tapered portion of the drive shaft.


- Tighten the pinion nut "2" to the specified torque.



Drive shaft holder "3"
90890-06935
Pinion nut holder "4"
90890-06451
Socket adapter "5"
90890-06936
Holder guide "6"
90890-06937

Drive shaft and lower case (regular rotation model)

TIP: _____
When the pinion nut “2” is hard to tighten, refer to the step 2 in “Removing the drive shaft” (8-28) that indicates the procedure using a rag.

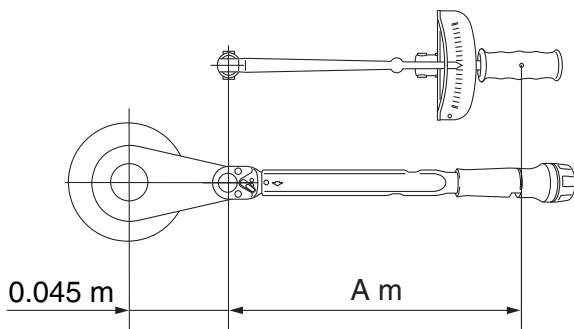
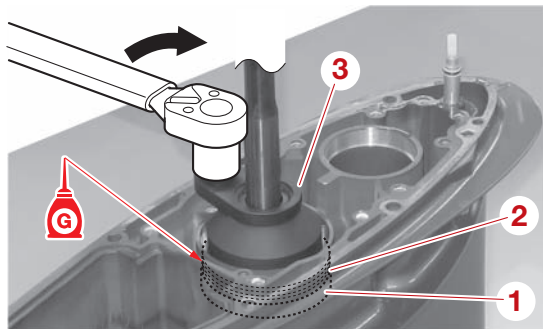
	Pinion nut “2” 175 N·m (17.5 kgf·m, 129 lb·ft)
-----------------------------------------------------------------------------------	---------------------------------------------------


d. Check that the drive shaft turns smoothly.

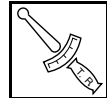
2. Install:
- Spacer “1”
 - Drive shaft ring nut “2”

NOTICE

The correct setting value of the torque wrench varies depending on its length. When tightening the drive shaft ring nut to the specified torque, use the following calculation formula to obtain the correct setting value.



	Ring nut wrench “3” 90890-06934
-------------------------------------------------------------------------------------	------------------------------------

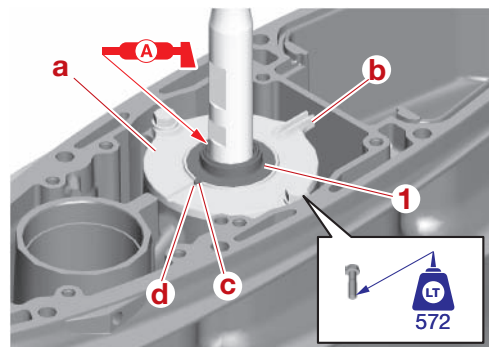


Torque wrench setting value =
 $240 \text{ N}\cdot\text{m} \div (A + 0.045) \times A$
 Specified tightening torque for
 the drive shaft ring nut
 0.045 m
 Ring nut wrench length
 A m
 Torque wrench length

3. Install:
- Oil seal housing assembly “a”
 - Cover “1”

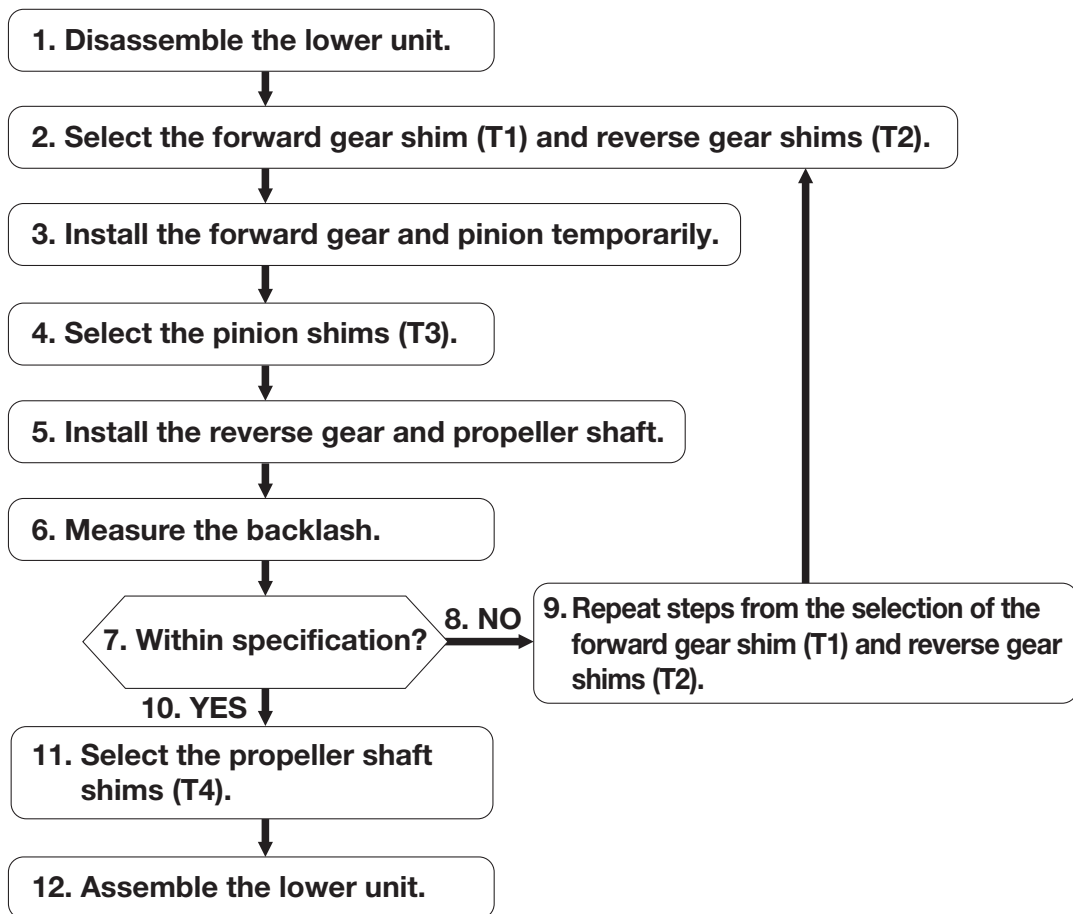
TIP:

- Make sure to install the oil seal housing “a” so that the protrusion “b” is facing rearward.
- Align the protrusion “c” on the cover “1” with the slot “d” in the oil seal housing “a”.



Shimming (regular rotation model)

Shimming workflow



1. Disassemble the lower unit.
2. Select the forward gear shim (T1) and reverse gear shims (T2).
3. Install the forward gear and pinion temporarily.
4. Select the pinion shims (T3).
5. Install the reverse gear and propeller shaft.
6. Measure the backlash.
7. Within specification?
8. No
9. Repeat steps from the selection of the forward gear shim (T1) and reverse gear shims (T2).
10. YES

11. Select the propeller shaft shims (T4).
12. Assemble the lower unit.

TIP: _____

- Make sure to drain the gear oil before measuring the backlash.
 - If the backlash is within specification, shimming is not required.
 - When assembling the original inner parts and a new lower case, shimming is required.
 - When replacing the pinion, forward gear, reverse gear, bearings, drive shaft, or propeller shaft housing, shimming is required.
-

Shimming check sheet

Lower case deviation

Serial number	P	F	R	Remarks
		—	—	

Pinion height

	Measurements (mm)
Measuring point "a"	
Measuring point "b"	
Measuring point "c"	
Measuring point "d"	
Average	
Round-down average	

Forward gear backlash

	Measurements (mm)
Measuring point "a"	
Measuring point "b"	
Measuring point "c"	
Measuring point "d"	
Average	
Round-down average	

Reverse gear backlash

	Measurements (mm)
Measuring point "a"	
Measuring point "b"	
Measuring point "c"	
Measuring point "d"	
Average	
Round-down average	

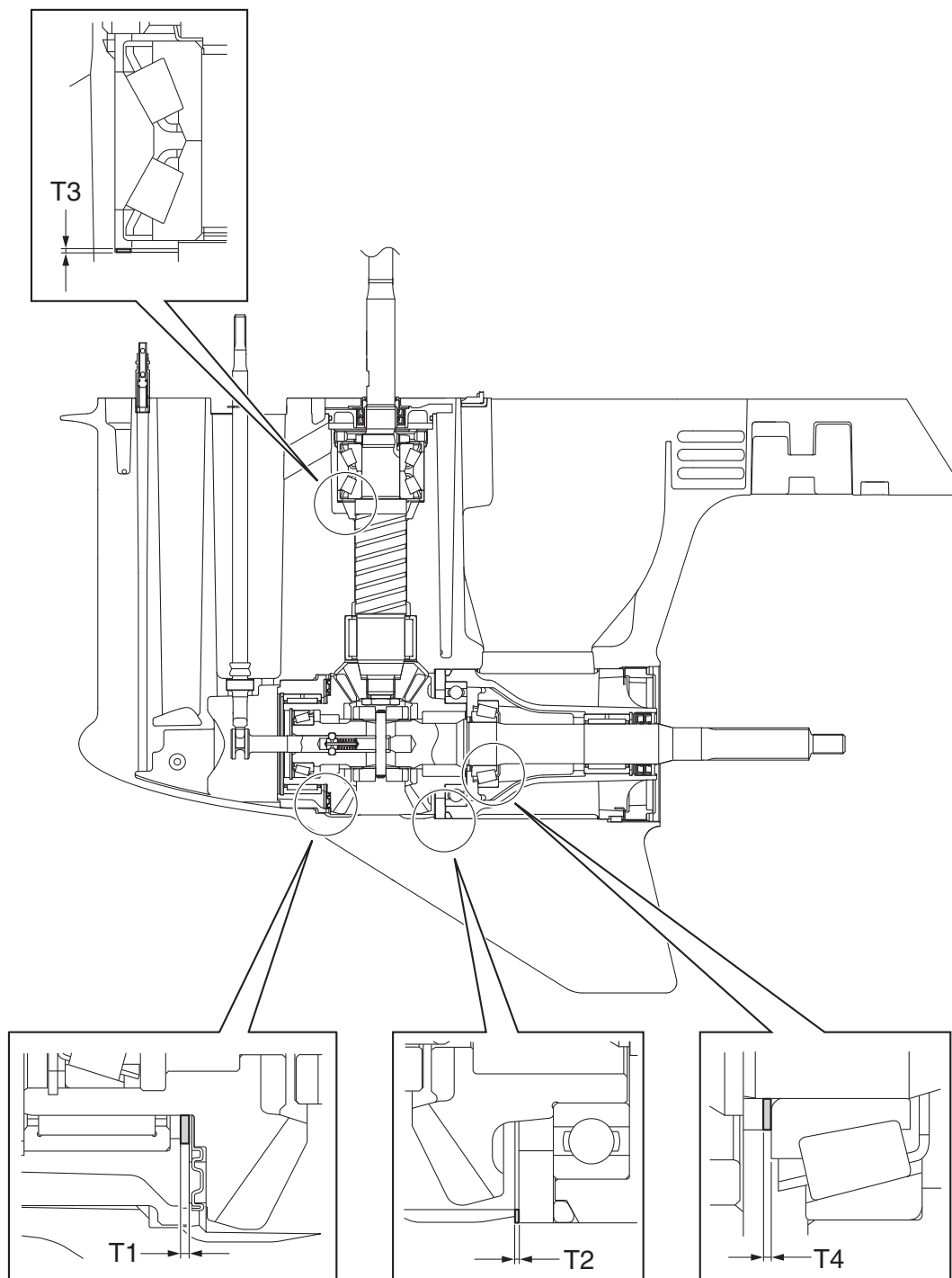
Propeller shaft motive torque

Measurement (N·m)	
-------------------	--

Shimming procedure

- Shim thickness is specified for the forward gear shim (T1) and reverse gear shims (T2).
- After selecting the pinion shims (T3), do not apply gear oil, grease, or sealant to the lower unit parts to measure the backlash.
- When the backlash adjustment is completed for the forward gear and reverse gear, make sure to select the propeller shaft shims (T4).
- When assembling the lower unit after shimming is completed, make sure to apply gear oil, grease, and sealant to the specified areas.

Shim location




Selecting the forward gear shim (T1) and reverse gear shim (T2)

- Select:
 - Forward gear shim (T1)
 - Reverse gear shim (T2)

TIP: _____

- Do not reuse shims.
- For forward gear shim (T1), use only 1 shim to obtain the specified shim thickness.
- For reverse gear shim (T2), use up to 3 shims to obtain the specified shim thickness.

	Shim thickness (T1)
	2.15 mm
	Shim thickness (T2)
	0.75 mm

Selecting the pinion shim (T3)

- Spray anti-rust lubricant on the gears and bearings before installation. Do not apply gear oil to the parts. Otherwise, correct measurements cannot be obtained.
- Keep the parts free of foreign material, such as dirt and lint.

NOTICE _____

Be careful not to damage the measurement plane surface of the special service tool. Otherwise, correct measurements cannot be obtained.

- Disassemble:
 - Lower unit
See “Water pump and shift rod” (8-11), “Propeller shaft housing (regular rotation model)” (8-18), and “Drive shaft and lower case (regular rotation model)” (8-27).
- Install:
 - Adapter assembly
 - Specified forward gear shim (T1) **New**
 - Forward gear assembly
See “Installing the forward gear” (8-34).
- Install:
 - Original pinion shim (T3)
 - Spacer
 - Drive shaft assembly
 - Pinion
 - Pinion nut

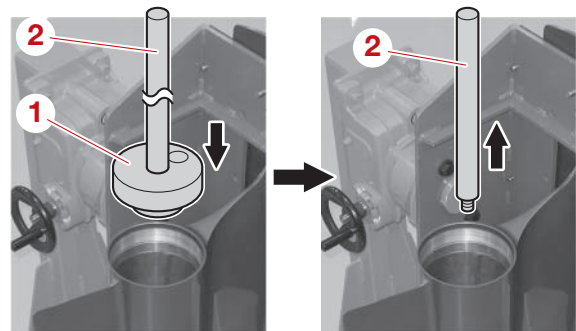
- Spacer
- Drive shaft ring nut
See steps 1 and 2 in “Installing the drive shaft” (8-34).


TIP: _____

- If the original shims (T3) are missing, install new shims with a combined thickness of 0.95 mm.
- Do not reuse shims (T3) if deformed or scratched.

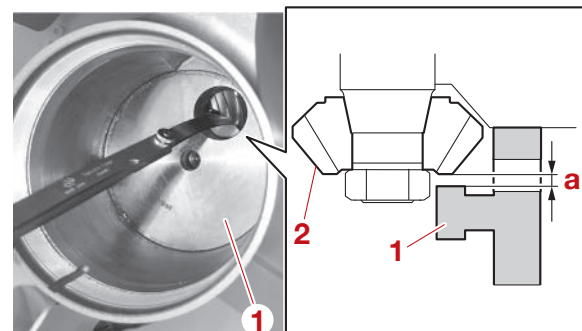
- Measure:

- Distance “a”
 - Check that the drive shaft turns smoothly.
 - Set up the special service tools “1” and “2”, and then remove the special service tool “2”.



	Pinion shimming gauge “1”
	90890-06948
	Pinion shimming gauge rod “2”
	90890-06676
	Pinion shimming gauge “2”
	YB-06835

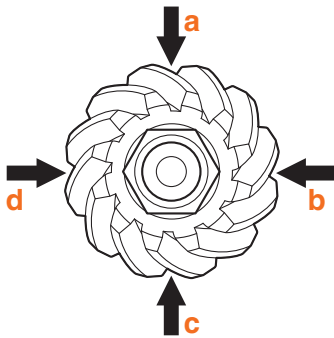
- Measure the distance “a” between the special service tool “1” and the pinion “2”.



- Turn the drive shaft 90° clockwise and measure the distance again.

TIP: _____

- Measure the distance at 4 points: “a”, “b”, “c”, and “d”, turning the drive shaft 90° clockwise after each measurement.
- Write down the measurement data in the shimming check sheet.



e. Determine the distance average, and then round down the average to the 1/100 place.

Example:
(mm)

Measuring point “a”	0.70
Measuring point “b”	0.71
Measuring point “c”	0.71
Measuring point “d”	0.69
Average	0.7025
Round-down average	0.70

5. Select:

- Pinion shim (T3)
 - Determine the pinion shim (T3) thickness adjustment using the pinion shim (T3) selection table. See “Pinion shim (T3) selection table” (A-25).

TIP: _____

Adjust the shim thickness to obtain the pinion distance of 0.75 mm.

Example:
Pinion distance measurement = 0.70 mm “a”
Pinion shim (T3) thickness adjustment = 0.05 mm “b”
The current shim thickness must be increased by 0.05 mm.

	(mm)		
A	0.69	0.70	0.71
B	+0.06	+0.05	+0.04

- Pinion distance measurement
- Shim thickness adjustment

b. Calculate the new pinion shim (T3) thickness.

TIP: _____

- Use up to 3 shims to obtain the required shim thickness. However, if the pinion shim thickness is 1.21 mm or more, 4 shims may be used.
- If the calculated shim thickness cannot be obtained with a combination of the available shims, increase or decrease the pinion distance measurement by 0.01 mm.

Calculation formula:

New pinion shim (T3) thickness = Current pinion shim thickness + Shim thickness adjustment

Example:

Use the following formula when the shim thickness adjustment value is positive.

Current pinion shim thickness = 0.70 mm

Shim thickness adjustment = 0.18 mm

New pinion shim (T3) thickness = 0.70 mm + 0.18 mm = 0.88 mm

Use the following formula when the shim thickness adjustment value is negative.

Current pinion shim thickness = 0.70 mm

Shim thickness adjustment = -0.09 mm

New pinion shim (T3) thickness = 0.70 mm + (-0.09) mm = 0.61 mm

Shimming (regular rotation model)



Available shim thicknesses

Pinion shims

0.10/0.12/0.15/0.18/0.30/0.40/
0.50 mm (F400ASTU,
F400ASTX, F450AVTU,
F450AVTX)

6. Remove:

- Special service tool

7. Install:

- Determined pinion shims (T3) **New**

Measuring the forward gear backlash and reverse gear backlash

- Spray anti-rust lubricant on the gear and bearings before installation. Do not apply gear oil to the parts. Otherwise, correct measurements cannot be obtained.
- Keep the parts free of foreign material, such as dirt and lint.
- When measuring the forward gear or reverse gear backlash, use the shims of the specified thickness for the forward gear shim (T1) and reverse gear shims (T2), and use the shims of the selected thickness for the pinion shims (T3).

1. Install:

- Adapter assembly
- Specified forward gear shim (T1) **New**
- Thrust bearing
- Forward gear assembly
See “Installing the forward gear” (8-34).
- Determined pinion shim (T3) **New**
- Spacer
- Drive shaft assembly
- Pinion
- Pinion nut
- Spacer
- Drive shaft ring nut
See steps 1 and 2 in “Installing the drive shaft” (8-34).

TIP:

- Do not reuse shims.
- Check that the drive shaft turns smoothly.

2. Install:

- Specified reverse gear shim (T2) **New**

- Propeller shaft/propeller shaft housing assembly
- Key
- Claw washer (do not bend the tabs)
- Ring nut
See steps 2–5 in “Installing the propeller shaft housing assembly” (8-25).

TIP:

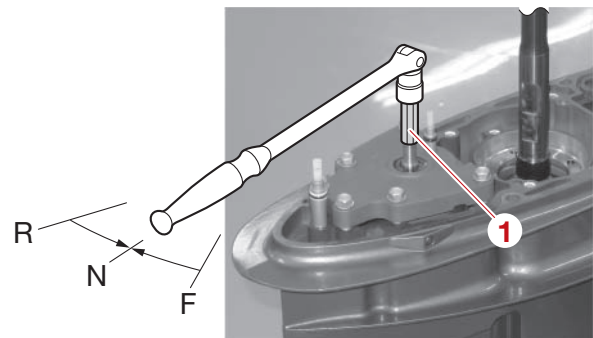
- Do not reuse shims.
- Check that the drive shaft turns smoothly.

3. Install:

- Shift rod
- Shift rod guide plate (temporarily)
See step 1 in “Installing the water pump and shift rod (regular rotation model)” (8-15).

4. Measure:

- Forward gear backlash
Out of specification → Repeat steps from the selection of the forward gear shim (T1) and reverse gear shims (T2).
 - a. Install the shift rod and shift rod guide plate temporarily, and then set the gear shift to the N position.



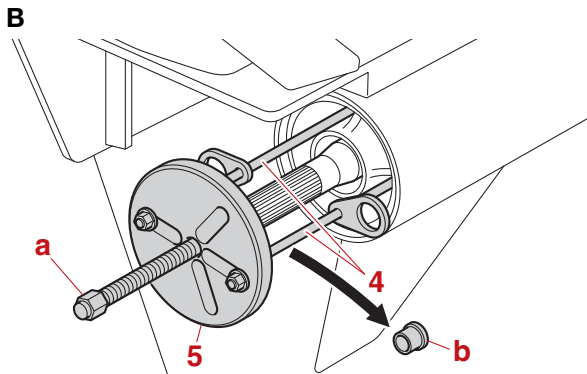
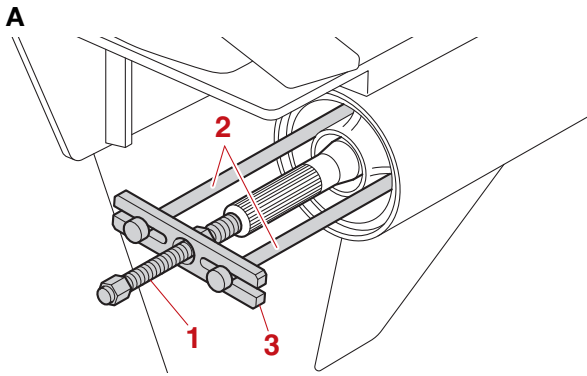
Shift rod socket “1”
90890-06950

- b. Set up the special service tools, and then tighten the center bolt “1” or “a” to the specified torque.

TIP:

Without the attachment “b”.

Shimming (regular rotation model)

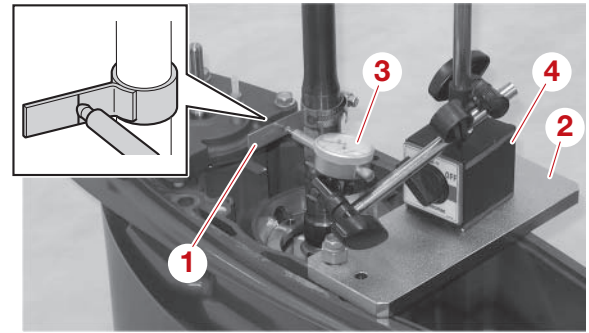


A. Worldwide
B. USA and Canada

	Center bolt "1" 90890-06504
	Bearing housing puller claw L "2" 90890-06502
	Stopper guide plate "3" 90890-06501
	Bearing housing puller "4" YB-06207
	Universal Puller "5" YB-06117

	Center bolt "1" or "a" (shimming) 4.9 N·m (0.49 kgf·m, 3.6 lb·ft)
--	----------------------------------------------------------------------

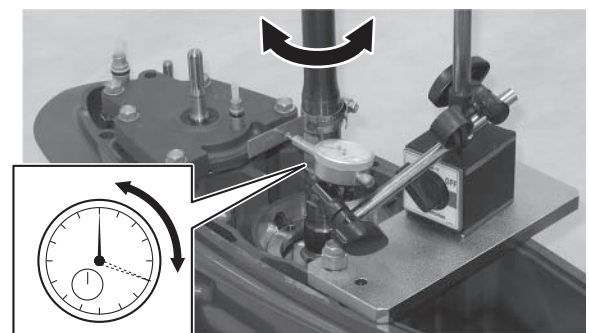
c. Install the special service tool "1" onto the drive shaft at the lowest possible position where the shaft diameter is 26.0 mm (1.024 in), and then set up the special service tools "2", "3", and "4".



	Backlash indicator "1" 90890-06836
	Magnet base plate "2" 90890-07003
	Dial gauge set "3" 90890-03238
	Magnet base B "4" 90890-06844
	Backlash indicator "1" YB-06836
	Backlash adjustment plate "2" YB-07003
	Dial indicator gauge "3" YU-03097
	Magnetic base stand "4" YU-A8438

d. Turn the drive shaft slowly clockwise and counterclockwise, and then measure the backlash between where the drive shaft stops in each direction.

TIP: Do not turn the drive shaft using too much force. Otherwise, the forward gear will turn, leading to incorrect measurements.

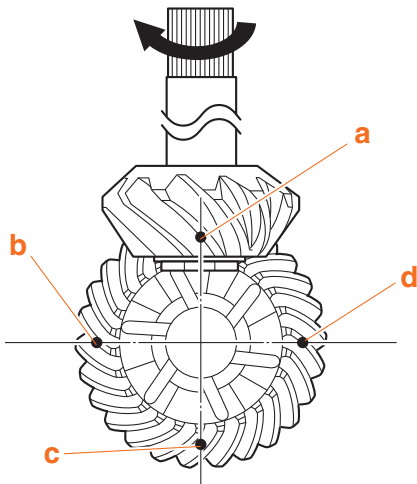


e. Turn the drive shaft 180° clockwise, and then measure the backlash again.

Shimming (regular rotation model)

TIP: _____

- Measure the backlash at 4 points: “a”, “b”, “c”, and “d”, turning the drive shaft 180° clockwise after each measurement.
- Write down the measurement data in the shimming check sheet.



- f. Determine the backlash average, and then round down the average to 2 decimal places.

Example:
(mm)

Measurement point “a”	0.25
Measurement point “b”	0.26
Measurement point “c”	0.26
Measurement point “d”	0.24
Average	0.2525
Round-down average	0.25

- g. Check that the forward gear backlash average is within specification.

TIP: _____

Repeat steps from the selection of the forward gear shim (T1) and reverse gear shims (T2) if the forward gear backlash is out of specification.



Forward gear backlash
0.13–0.50 mm (0.0051–0.0197 in)
(F400ASTU, F400ASTX,
F450AVTU, F450AVTX)

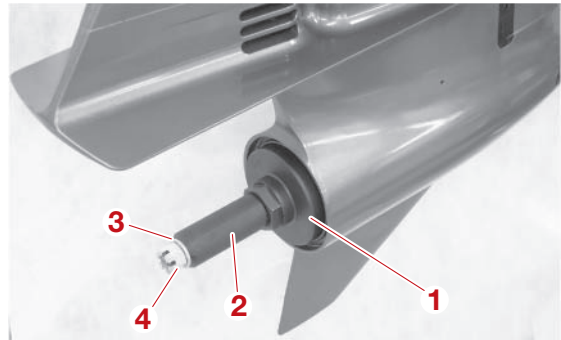
- h. Remove the special service tools.

5. Measure:

- Reverse gear backlash

Out of specification → Repeat steps from the selection of the forward gear shim (T1) and reverse gear shims (T2).

- a. Install the special service tools “1”, “2” washer “3”, and propeller nut “4”.



Ring nut wrench “1”
90890-06932
Ring nut extension “2”
90890-06968

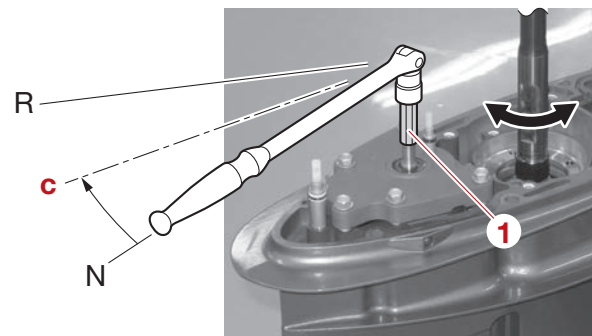


Propeller nut “4” (shimming)
50 N·m (5.0 kgf·m, 37 lb·ft)

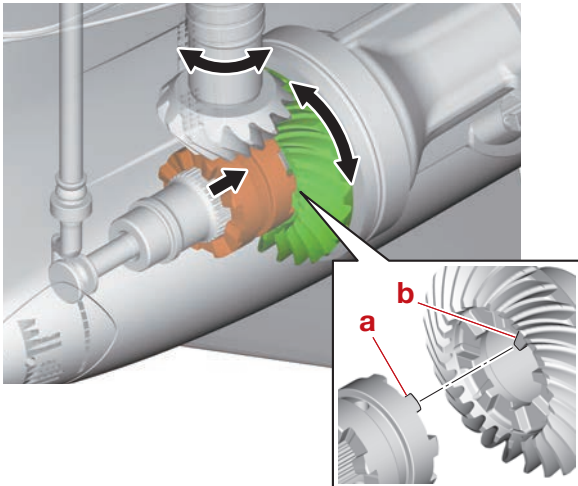
- b. While turning the drive shaft, move the gear shift toward the R position. Set the shift rod at the position where the protrusion “a” on the dog clutch hits the protrusion “b” on the reverse gear.


TIP: _____

When the protrusion on the dog clutch hits the protrusion on the reverse gear, the shift rod is fixed at the position “c” which is in between the N position and the R position.



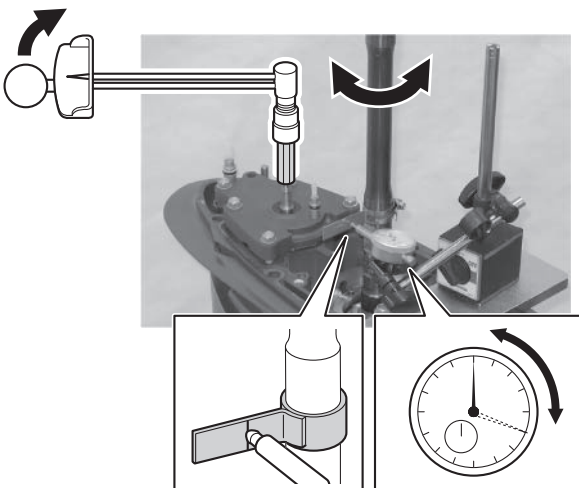
Shimming (regular rotation model)




 Shift rod socket "1"
90890-06950

- c. While turning the shift rod toward the R position using the specified torque, turn the drive shaft slowly clockwise and counterclockwise and measure the backlash between where the drive shaft stops in each direction.

TIP: Do not turn the drive shaft using too much force. Otherwise, the reverse gear will turn, leading to incorrect measurements.

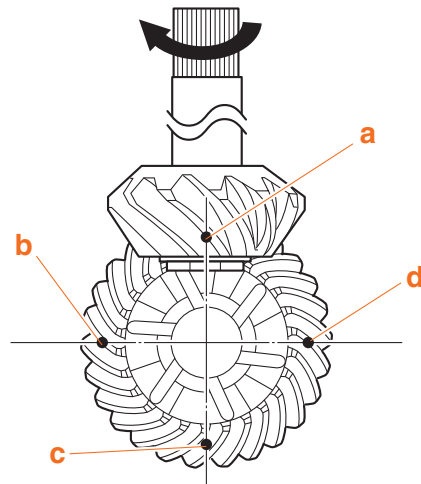


 Specified torque
10 N·m (1.0 kgf·m, 7.4 lb·ft)

- d. Turn the drive shaft 180° clockwise, and then measure the backlash again.

TIP:

- Measure the backlash at 4 points: "a", "b", "c", and "d", turning the drive shaft 180° clockwise after each measurement.
- Write down the measurement data in the shimming check sheet.



- e. Determine the backlash average, and then round down the average to 2 decimal places.


Example:
(mm)

Measurement point "a"	0.45
Measurement point "b"	0.46
Measurement point "c"	0.46
Measurement point "d"	0.44
Average	0.4525
Round-down average	0.45

- f. Check that the reverse gear backlash average is within specification.

TIP:

Repeat steps from the selection of the forward gear shim (T1) and reverse gear shims (T2) if the reverse gear backlash is out of specification.

 Reverse gear backlash
0.39–0.83 mm (0.0154–0.0327 in)
(F400ASTU, F400ASTX, F450AVTU, F450AVTX)

- g. Remove the special service tools.

Shimming (regular rotation model)

6. Install:
- Oil seal housing
 - Cover
 - See step 3 in “Installing the propeller shaft housing assembly” (8-25).
 - Shift rod
 - Dowel
 - Gasket **New**
 - Plate
 - Shift rod guide plate
 - Spacer
 - Lower water pump housing
 - Lower impeller
 - Outer plate cartridge
 - Upper impeller
 - Upper water pump housing
 - See “Installing the water pump and shift rod (regular rotation model)” (8-15).

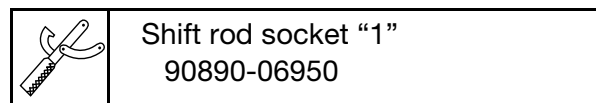
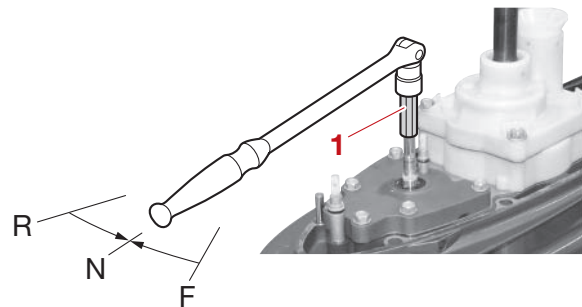
Selecting the propeller shaft shim (T4)

1. Install:
- Propeller shaft assembly
 - Reverse gear assembly
 - Washer
 - Original propeller shaft shim (T4)
 - Tapered roller bearing
 - Specified reverse gear shim (T2) **New**
 - O-ring
 - Propeller shaft housing assembly
 - Claw washer (do not bend the tabs)
 - Ring nut
 - See “Installing the propeller shaft housing assembly” (8-25).
2. Install:
- Shift rod
 - Shift rod guide plate (temporarily)
 - See step 1 in “Installing the water pump and shift rod (regular rotation model)” (8-15).

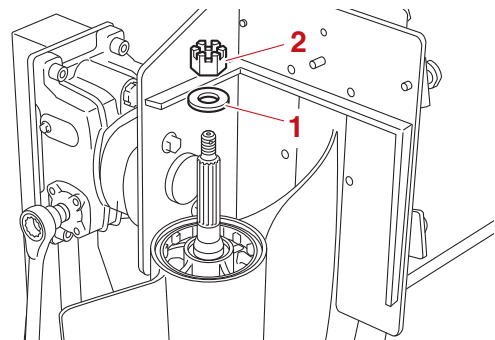
TIP:

- If the original shims (T4) are missing, install new shims with a combined thickness of 1.20 mm.
- Do not reuse shims (T4) if deformed or scratched.
- Check that there is no free play in the propeller shaft.

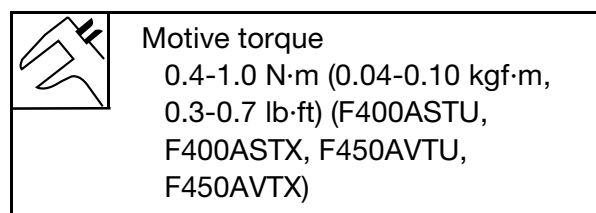
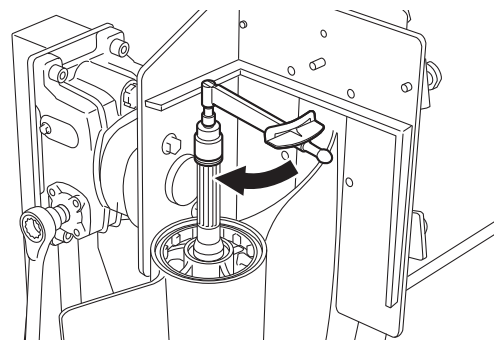
3. Measure:
- Propeller shaft motive torque
 - Set the gear shift to the N position.



- Turn the propeller shaft 5 turns or more.
- Install the washer “1” and propeller nut “2”.



- Measure the motive torque of the propeller shaft.



4. Select:
- Propeller shaft shim (T4)

Shimming (regular rotation model)

TIP: _____

- Measure the thickness of original propeller shaft shim (T4) in 2 places.
- Do not reuse shims.

a. Determine the propeller shaft shim (T4) thickness adjustment using the “Propeller shaft shim (T4) selection chart” according to the propeller shaft motive torque.

See “Propeller shaft shim (T4) selection chart” (A-26).

TIP: _____

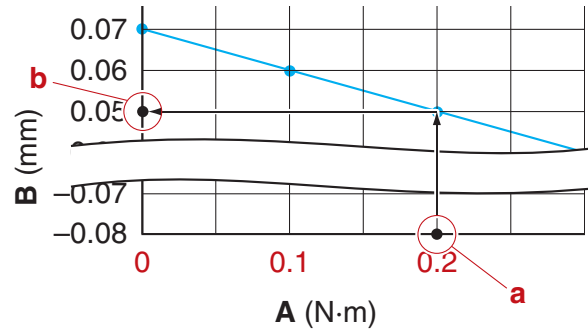
- If the shim thickness adjustment value is positive, increase the current shim thickness by that amount and, if the value is negative, decrease the current shim thickness by that amount.
- The blue-colored area on the selection chart indicates the range of the specified motive torque. Shimming is not required if the measured motive torque is within the blue-colored area.
- The values for the shim thickness adjustments specified in the selection chart are intended to obtain the median value within the range for the specified motive torque.
- The table that follows the selection chart shows the shim thickness adjustments for the points marked on the chart.

Example:

Propeller shaft motive torque measurement = 0.2 N·m “a”

Propeller shaft shim (T4) thickness adjustment = 0.05 mm “b”

The current shim thickness must be increased by 0.05 mm.



A	0	0.1	0.2	
B	0.07	0.06	0.05	

b. Calculate the new propeller shaft shim (T4) thickness.

TIP: _____

- Use up to 4 shims to obtain the required shim thickness. However, if the propeller shaft shim thickness is 2.32 mm or more, 5 shims may be used.
- If the calculated shim thickness cannot be obtained with a combination of the available shims, increase or decrease the shim thickness by 0.01 mm.

Calculation formula:

New propeller shaft shim (T4) thickness = Current propeller shaft shim thickness + shim thickness adjustment

Example:

Use the following formula when the shim thickness adjustment value is positive.

Current propeller shaft shim thickness = 1.20 mm

Shim thickness adjustment = 0.04 mm

New propeller shaft shim (T4) thickness = 1.20 mm + 0.04 mm = 1.24 mm

Use the following formula when the shim thickness adjustment value is negative.

Current propeller shaft shim thickness = 1.30 mm

Shim thickness adjustment = -0.05 mm

New propeller shaft shim (T4) thickness = 1.30 mm + (-0.05 mm) = 1.25 mm

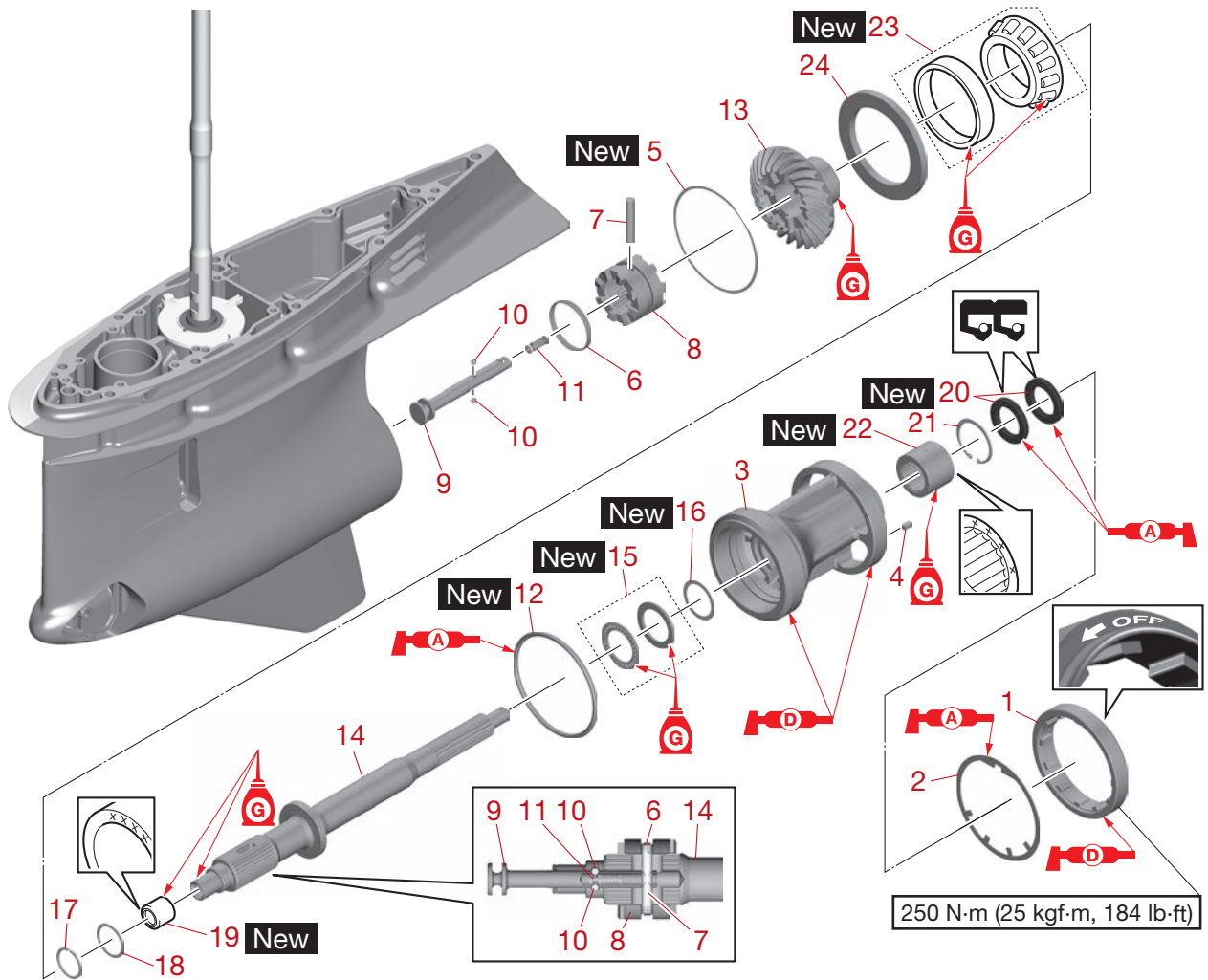


Available shim thicknesses

Propeller shaft shims

0.10/0.12/0.15/0.18/0.30/0.40/
0.50/1.00 mm (F400ASTU,
F400ASTX, F450AVTU,
F450AVTX)

Propeller shaft housing (counter rotation model)

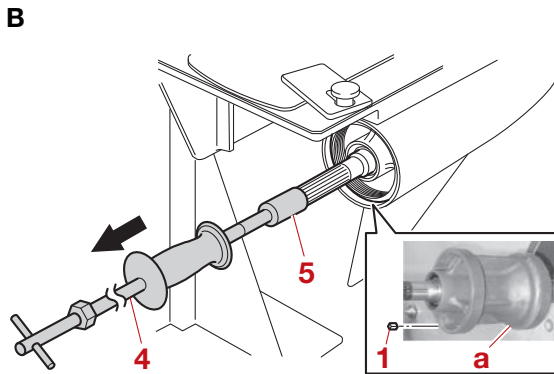
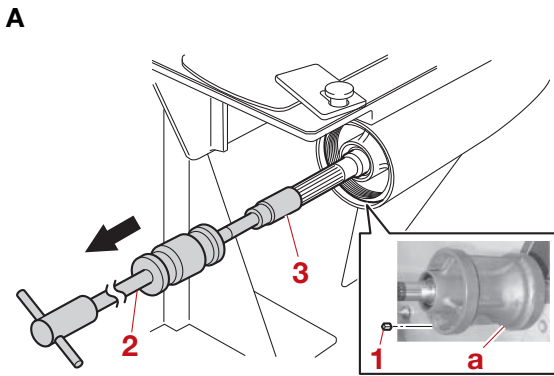


↑↓	Part name	Q'ty	Remarks
1	Ring nut M142	1	
2	Claw washer	1	
3	Propeller shaft housing	1	
4	Key	1	
5	Forward gear shim (T2)	—	
6	Spring	1	
7	Cross pin	1	
8	Dog clutch	1	
9	Slider	1	
10	Ball	2	6.33 mm (0.25 in) (reference data)
11	Shift plunger	2	
12	O-ring	1	
13	Forward gear	1	
14	Propeller shaft	1	


↑↓	Part name	Q'ty	Remarks
15	Thrust bearing	1	
16	Propeller shaft shim (T4)	—	
17	Circlip	1	
18	Washer	1	
19	Roller bearing	1	Inner race
20	Oil seal	2	
21	Circlip	1	
22	Needle bearing	1	
23	Tapered roller bearing	1	
24	Thrust washer	1	

Removing the propeller shaft housing assembly

1. Remove:
 - Ring nut
 - Claw washer
 See step 1 in “Removing the propeller shaft housing assembly” (8-19).
2. Remove:
 - Propeller shaft/propeller shaft housing assembly “a”
 - Key “1”



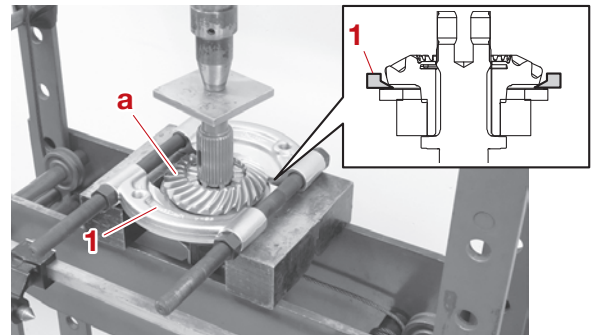
A. Worldwide
 B. USA and Canada


	Slide hammer handle “2” 90890-06531
	Puller head “3” 90890-06514
	Slide hammer “4” YB-06096
	Propeller shaft and bearing housing remover “5” YB-06335

3. Remove:
 - Forward gear shim
 - O-ring

Disassembling the propeller shaft housing assembly

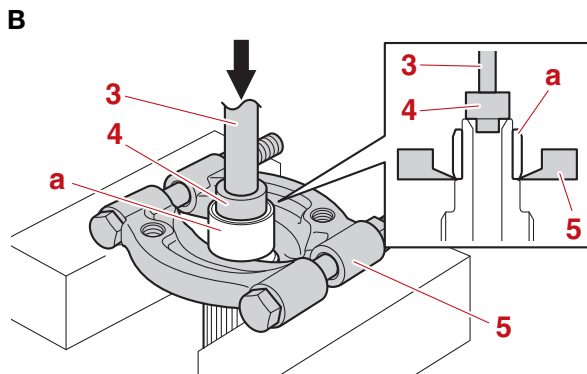
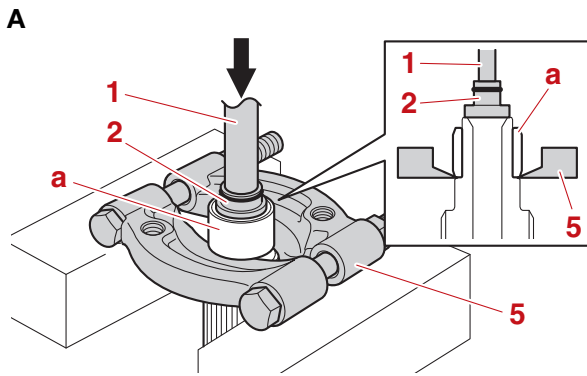
1. Remove:
 - Spring
 - Cross pin
 - Dog clutch
 - Slider
 - Balls
 - Shift plunger
 See “Disassembling the propeller shaft assembly” (8-20).
2. Remove:
 - Forward gear assembly “a”



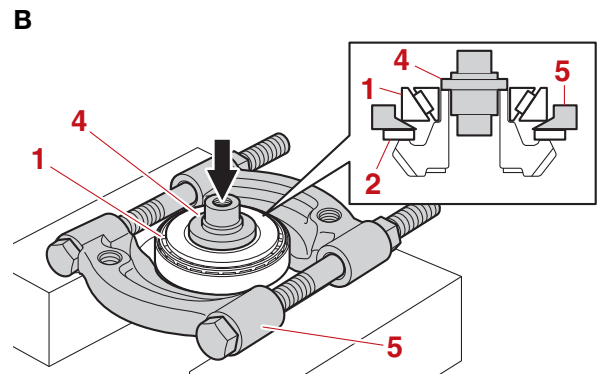
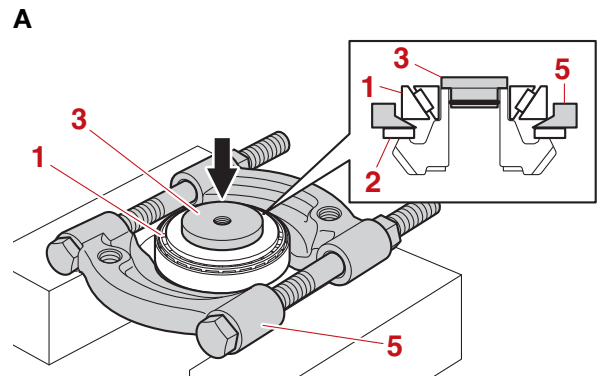
	Bearing splitter plate “1” (commercially available)
-------------------------------------------------------------------------------------	--------------------------------------------------------

3. Remove:
 - Propeller shaft
 - Thrust bearing
 - Propeller shaft shims
 - Circlip
 - Washer
 - Roller bearing (inner race) “a”


Propeller shaft housing (counter rotation model)




A. Worldwide
B. USA and Canada



A. Worldwide
B. USA and Canada

	Driver rod L3 "1" 90890-06652
	Needle bearing attachment "2" 90890-06616
	Driver handle (small) "3" YB-06229
	Oil seal installer "4" YB-06023
	Bearing splitter plate "5" (commercially available)

	Ball bearing attachment "3" 90890-06630
	Forward gear needle bearing installer "4" YB-06261
	Bearing splitter plate "5" (commercially available)

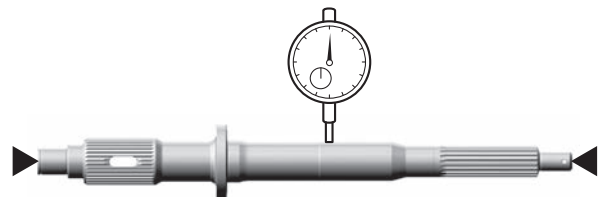
4. Remove:
- Oil seals
 - Circlip
 - Needle bearing
- See "Disassembling the propeller shaft housing assembly" (8-20).

Disassembling the forward gear

1. Remove:
- Tapered roller bearing "1"
 - Thrust washer "2"

Checking the propeller shaft

1. Check:
 - Propeller shaft
Damaged/worn → Replace.
2. Measure:
 - Propeller shaft runout
Above specification → Replace.



Propeller shaft housing (counter rotation model)



Runout
0.02 mm (0.0008 in) (FL400AS-
TU, FL400ASTX, FL450AVTU,
FL450AVTX)

Checking the dog clutch

See “Checking the dog clutch” (8-21).

Checking the propeller shaft housing

See “Checking the propeller shaft housing” (8-21).

Checking the forward gear

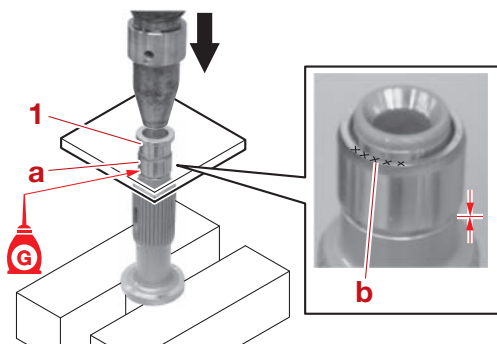
1. Check:
 - Teeth and dogs of the forward gear
Cracked/worn → Replace.

Assembling the propeller shaft housing and forward gear

1. Install:
 - Roller bearing (inner race) “a” **New**
 - Washer
 - Circlip

TIP:

Face the bearing identification mark “b” on the roller bearing inner race “a” up.



Bearing inner race attachment “1”
90890-06644
Bearing inner race attachment “1”
YB-06644

2. Install:
 - Needle bearing **New**
 - Circlip
 - Oil seals **New**

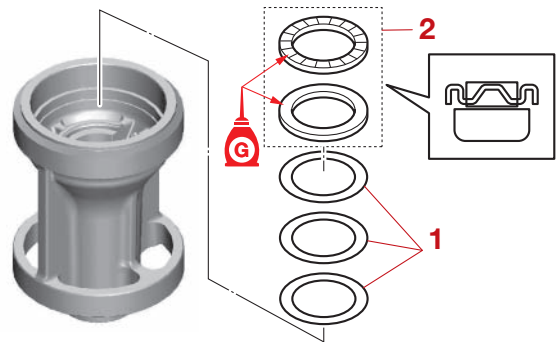
See steps 2 and 3 in “Assembling the propeller shaft housing assembly” (8-23).

3. Install:

- Propeller shaft shims “1” **New**
- Thrust bearing “2”

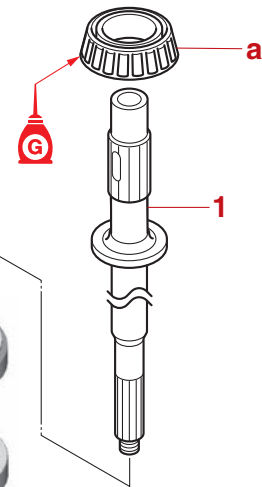
TIP:

Position the thickest propeller shaft shim toward the propeller shaft housing.

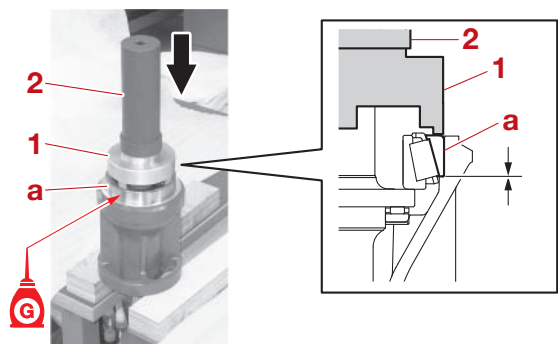


4. Install:

- Propeller shaft
- Tapered roller bearing
 - a. Install the propeller shaft “1” and tapered roller bearing inner race “a”.



- b. Install the tapered roller bearing outer race “a” using the special service tools.

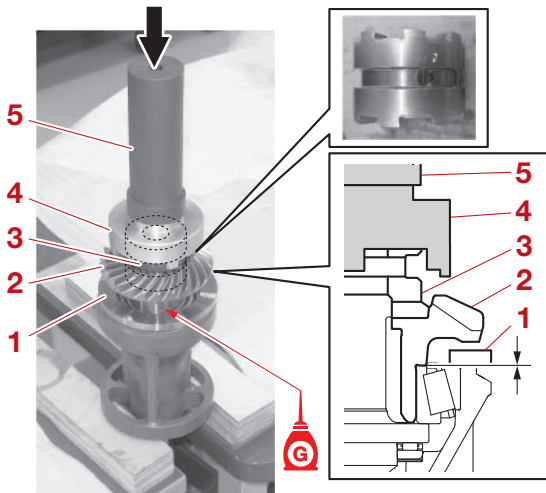


Propeller shaft housing (counter rotation model)



Ring nut wrench 2 "1"
90890-06823
Ring nut wrench extension 2 "2"
90890-06784
Ring nut wrench "1"
YB-06823
Ring nut wrench extension "2"
YB-06784

5. Install:
- Thrust washer
 - Forward gear
 - Install the thrust washer "1" and forward gear "2" using the dog clutch "3" and special service tools.

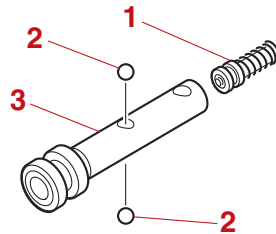
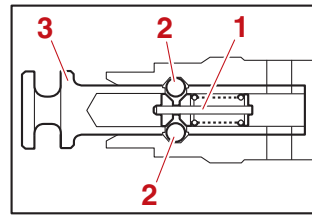


Ring nut wrench 2 "4"
90890-06823
Ring nut wrench extension 2 "5"
90890-06784
Ring nut wrench "4"
YB-06823
Ring nut wrench extension "5"
YB-06784

6. Install:
- Shift plunger "1"
 - Balls "2"
 - Slider "3"

TIP:

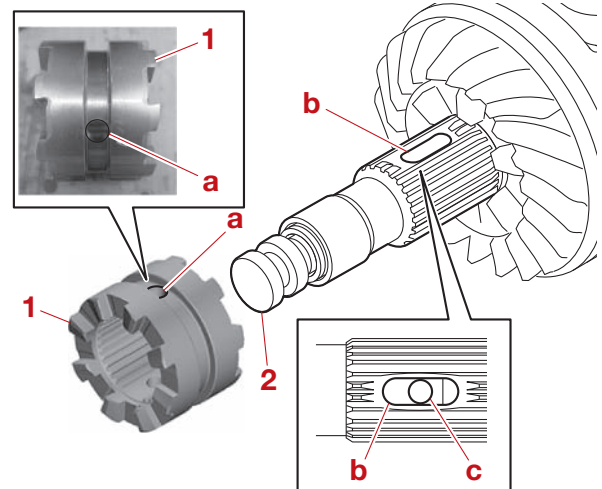
When installing the slider "3", make sure that the balls "2" do not fall out of position.



7. Install:
- Dog clutch "1"

TIP:

Make sure that the hole "a" in the dog clutch "1" and the hole "b" in the propeller shaft are aligned with the hole "c" in the slider "2".



8. Install:
- Cross pin
 - Spring
 - O-ring **New**

Installing the propeller shaft housing assembly


1. Install:
- Forward gear shims **New**
 - Propeller shaft/propeller shaft housing assembly
 - Key

TIP: _____

Position the thickest forward gear shim toward the lower case.

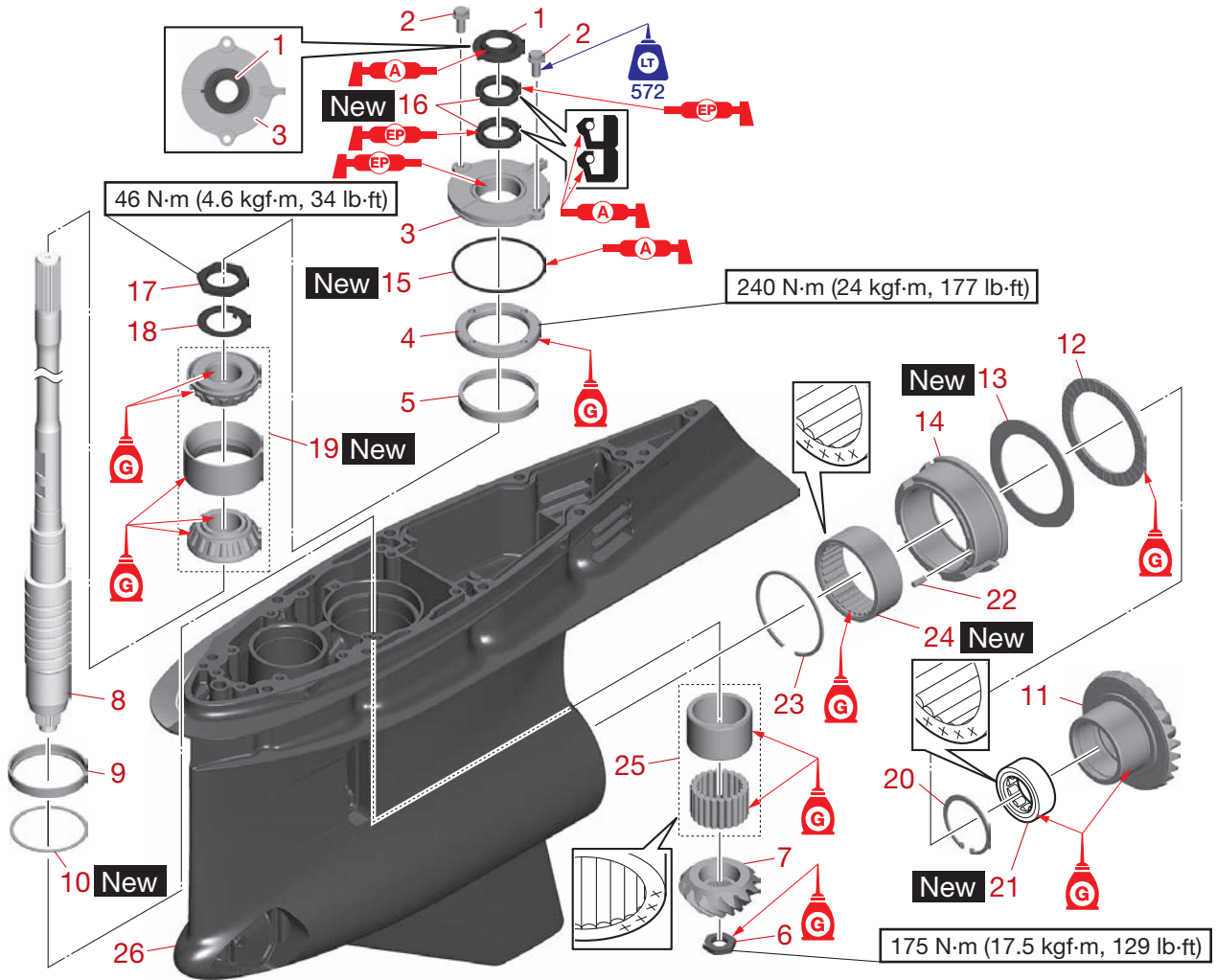
2. Install:

- Claw washer
- Ring nut

	Ring nut 250 N·m (25 kgf·m, 184 lb·ft)
-----------------------------------------------------------------------------------	-------------------------------------------

See steps 3–5 in “Installing the propeller shaft housing assembly” (8-25).

Drive shaft and lower case (counter rotation model)



↑↓	Part name	Q'ty	Remarks
1	Cover	1	
2	Bolt M8 × 20 mm	2	
3	Housing	1	
4	Ring nut M86	1	
5	Spacer	1	
6	Pinion nut M18	1	
7	Pinion	1	
8	Drive shaft	1	
9	Spacer	1	
10	Pinion shim (T3)	—	
11	Reverse gear	1	
12	Thrust bearing	1	
13	Reverse gear shim (T1)	1	
14	Adapter	1	
15	O-ring	1	
16	Oil seal	2	
17	Nut M35	1	
18	Claw washer	1	

↑↓	Part name	Q'ty	Remarks
19	Tapered roller bearing	1	
20	Circlip	1	
21	Roller bearing	1	Outer race
22	Dowel	1	
23	Circlip	1	
24	Roller bearing	1	
25	Needle bearing	1	
26	Lower case	1	

Removing the drive shaft

See “Removing the drive shaft” (8-28).

Disassembling the drive shaft

See “Disassembling the drive shaft” (8-28).

Disassembling the reverse gear

1. Remove:
 - Circlip
 - Roller bearing (outer race) “a”

TIP:

When removing the roller bearing, make sure that the reverse gear shim “1” is installed to the reverse gear. Do not reuse the reverse gear shim.

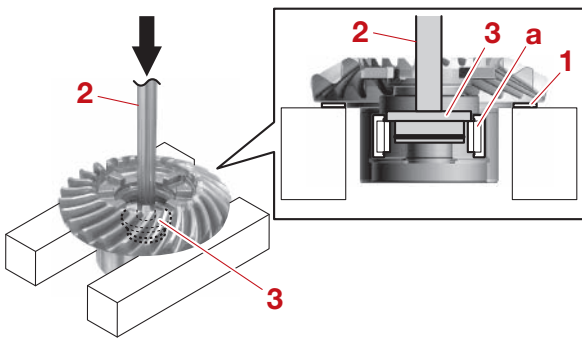


- Driver rod L3 “2”
90890-06652
- Needle bearing attachment “3”
90890-06609
- Driver handle (large) “4”
YB-06071
- Driveshaft needle bearing installer
and remover “5”
YB-06196

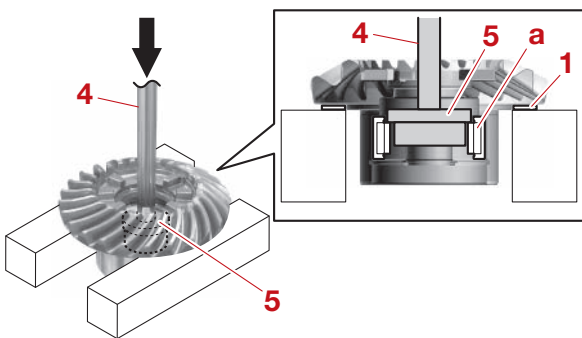
2. Remove:
 - Dowel
 - Circlip
 - Roller bearing

See “Disassembling the forward gear” (8-29).

A



B



- A. Worldwide
- B. USA and Canada

Disassembling the lower case

See “Disassembling the lower case” (8-29).

Checking the pinion

See “Checking the pinion” (8-30).

Checking the reverse gear

1. Check:
 - Teeth and dogs of the reverse gear

Cracked/worn → Replace.

Checking the drive shaft

See “Checking the drive shaft” (8-30).

Checking the lower case

See “Checking the lower case” (8-30).

Assembling the lower case

See “Assembling the lower case” (8-30).

Assembling the reverse gear

1. Install:
 - Adapter
 - Roller bearing **New**
 - Dowel

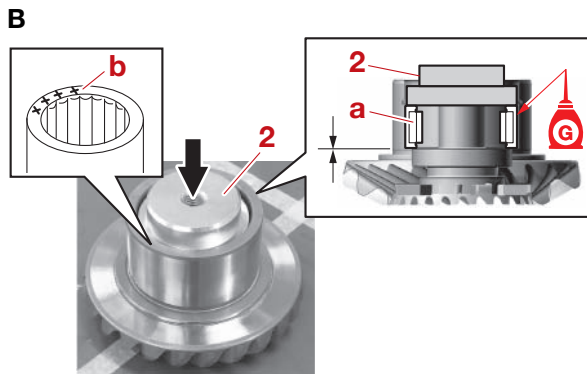
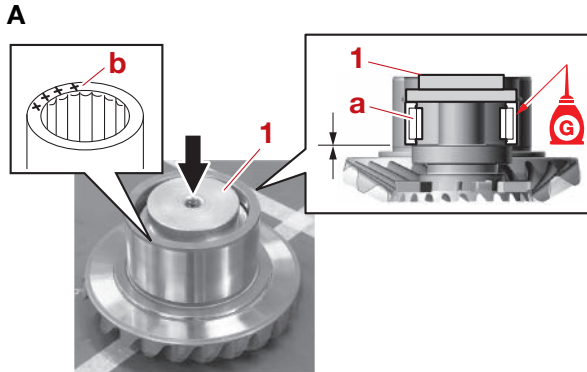
See step 1 in “Assembling the forward gear” (8-31).
2. Install:
 - Roller bearing (outer race) “a” **New**
 - Reverse gear
 - Circlip

TIP: _____

Face the bearing identification mark “b” on the roller bearing (outer race) “a” up.

Installing the drive shaft

See “Installing the drive shaft” (8-34).



- A. Worldwide
- B. USA and Canada



Needle bearing attachment “1”
90890-06654
Needle bearing installer “2”
YB-06434

Assembling the drive shaft

See “Assembling the drive shaft” (8-31).

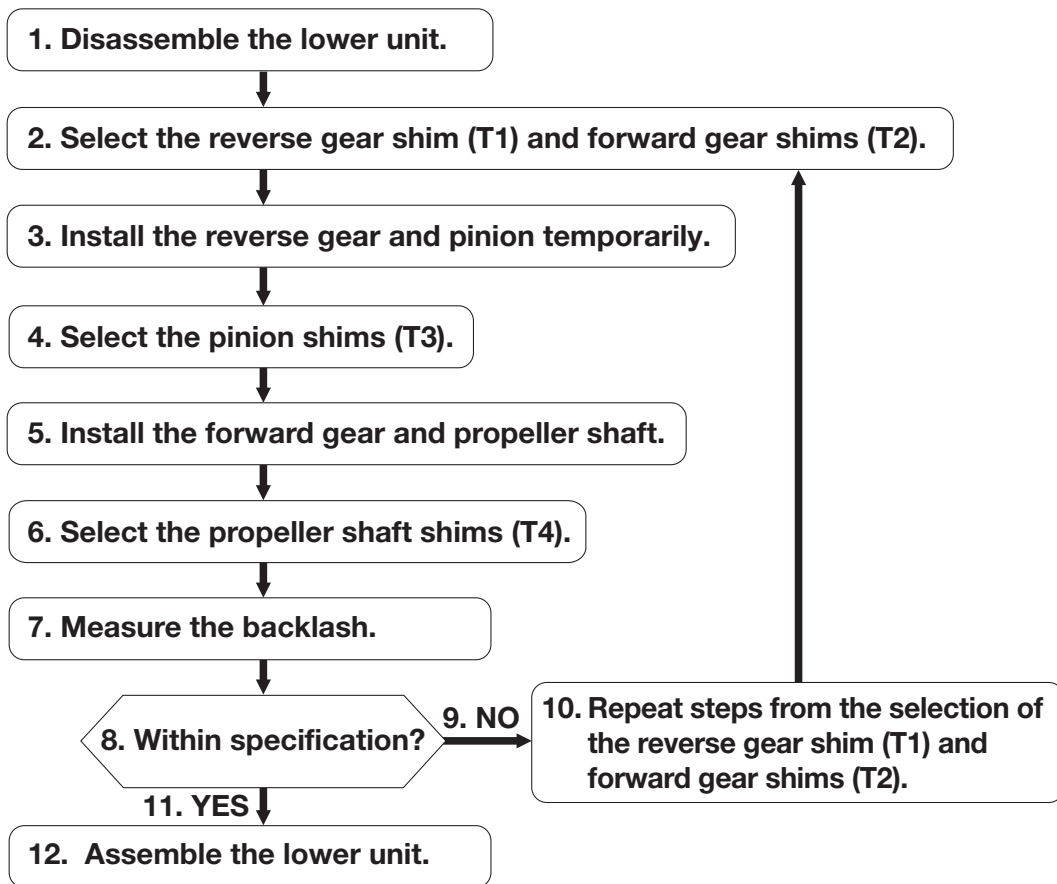
Assembling the oil seal housing

See “Assembling the oil seal housing” (8-33).

Installing the reverse gear

1. Install:
 - Adapter assembly
 - Reverse gear shim **New**
 - Thrust bearing
 - Reverse gear assemblySee “Installing the forward gear” (8-34).

Shimming (counter rotation model)
Shimming workflow



1. Disassemble the lower unit.
2. Select the reverse gear shim (T1) and forward gear shims (T2).
3. Install the reverse gear and pinion temporarily.
4. Select the pinion shims (T3).
5. Install the forward gear and propeller shaft.
6. Select the propeller shaft shims (T4).
7. Measure the backlash.
8. Within specification?
9. No
10. Repeat steps from the selection of the reverse gear shim (T1) and forward gear shims (T2).

11. YES
12. Assemble the lower unit.

TIP: _____

- Make sure to drain the gear oil before measuring the backlash.
 - If the backlash is within specification, shimming is not required.
 - When assembling the original inner parts and a new lower case, shimming is required.
 - When replacing the pinion, forward gear, reverse gear, bearings, drive shaft, or propeller shaft housing, shimming is required.
-

Shimming check sheet

Lower case deviation

Serial number	P	F	R	Remarks
		—	—	

Pinion height

	Measurements (mm)
Measuring point "a"	
Measuring point "b"	
Measuring point "c"	
Measuring point "d"	
Average	
Round-down average	

Forward gear backlash

	Measurements (mm)
Measuring point "a"	
Measuring point "b"	
Measuring point "c"	
Measuring point "d"	
Average	
Round-down average	

Reverse gear backlash

	Measurements (mm)
Measuring point "a"	
Measuring point "b"	
Measuring point "c"	
Measuring point "d"	
Average	
Round-down average	

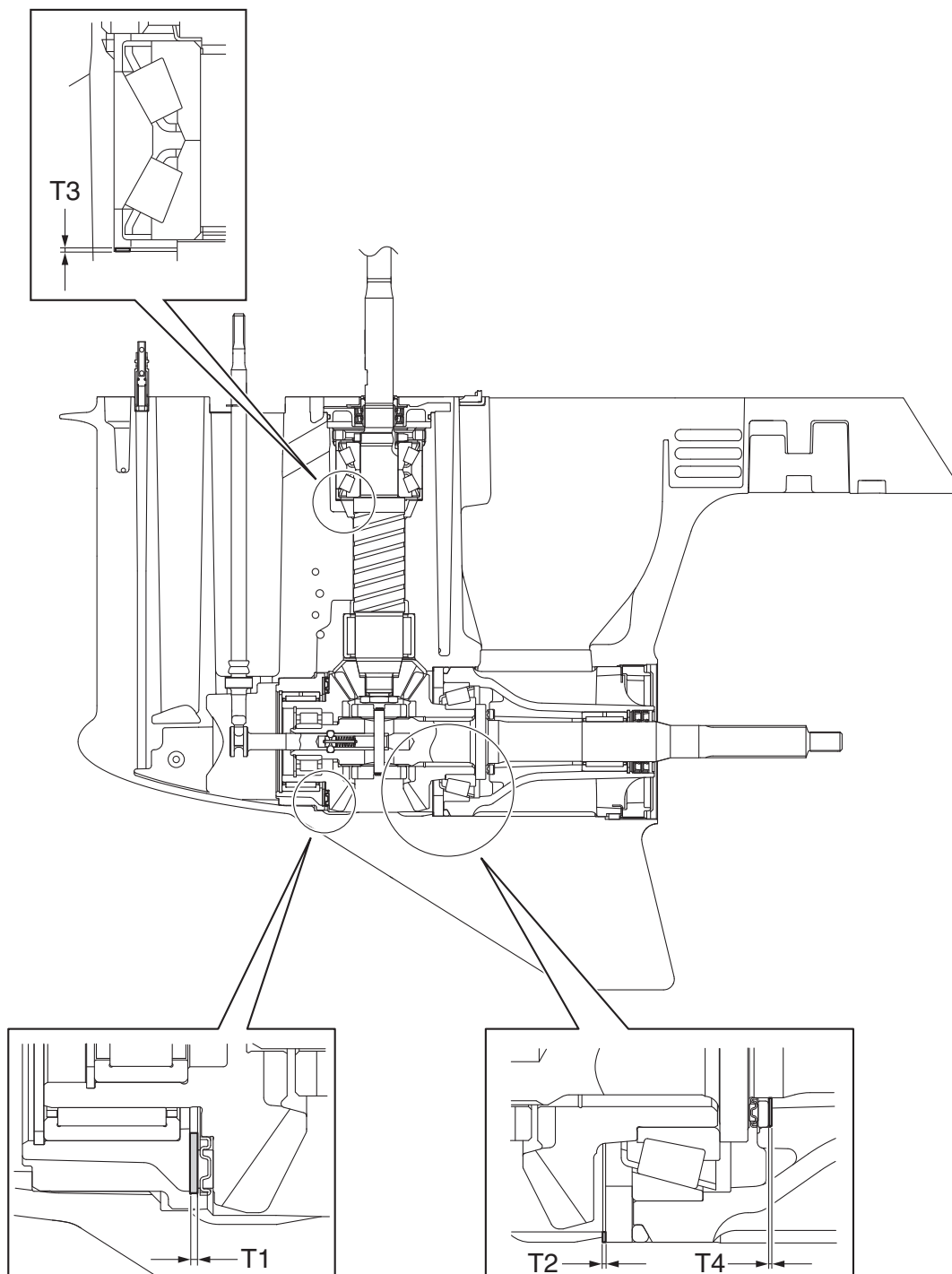
Propeller shaft free play

Measurement (mm)	
------------------	--

Shimming procedure

- Shim thickness is specified for the reverse gear shim (T1) and forward gear shims (T2).
- After selecting the pinion shims (T3), do not apply gear oil, grease, or sealant to the lower unit parts to measure the backlash.
- When the backlash adjustment is completed for the reverse gear and forward gear, make sure to select the propeller shaft shims (T4).
- When assembling the lower unit after shimming is completed, make sure to apply gear oil, grease, and sealant to the specified areas.

Shim location




Selecting the reverse gear shim (T1) and forward gear shim (T2)

- Select:
 - Reverse gear shim (T1)
 - Forward gear shim (T2)

TIP: _____

- Do not reuse shims.
- For reverse gear shim (T1), use only 1 shim to obtain the specified shim thickness.
- For forward gear shim (T2), use up to 3 shims to obtain the specified shim thickness.

	Shim thickness (T1)
	2.15 mm
	Shim thickness (T2)
	0.67 mm

Selecting the pinion shim (T3)

- Spray anti-rust lubricant on the gears and bearings before installation. Do not apply gear oil to the parts. Otherwise, correct measurements cannot be obtained.
- Keep the parts free of foreign material, such as dirt and lint.


NOTICE _____

Be careful not to damage the measurement plane surface of the special service tool. Otherwise, correct measurements cannot be obtained.

- Disassemble:
 - Lower unit
 - See “Water pump and shift rod” (8-11), “Propeller shaft housing (counter rotation model)” (8-48), and “Drive shaft and lower case (counter rotation model)” (8-54).
- Install:
 - Adapter assembly
 - Specified reverse gear shim (T1) **New**
 - Reverse gear assembly
 - See “Installing the forward gear” (8-34).
- Select:
 - Pinion shim (T3)
 - See steps 3–7 in “Selecting the pinion shim (T3)” (8-39).

Selecting the propeller shaft shim (T4)

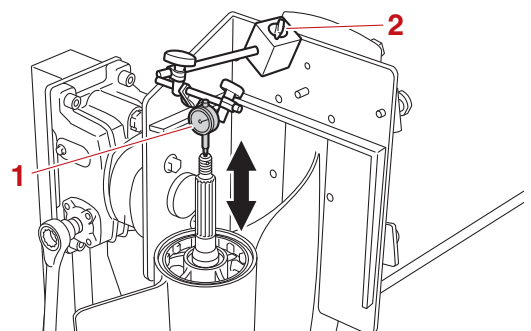
- Assemble:
 - Propeller shaft housing assembly
 - Original propeller shaft shim (T4)
 - Thrust bearing
 - Propeller shaft
 - Tapered roller bearing
 - Thrust washer
 - Forward gear
 - Shift plunger
 - Balls
 - Slider
 - Dog clutch
 - Cross pin
 - Spring
 - O-ring
 - See “Assembling the propeller shaft housing and forward gear” (8-51).
- Install:
 - Propeller shaft/propeller shaft housing assembly
 - Key
 - Claw washer (do not bend the tabs)
 - Ring nut

	Ring nut
	250 N·m (25 kgf·m, 184 lb·ft)

See steps 2–5 in “Installing the propeller shaft housing assembly” (8-25).

TIP: _____

- If the original shims (T4) are missing, measure the free play without any shims.
 - Do not reuse shims (T4) if deformed or scratched.
- Measure:
 - Propeller shaft free play



Shimming (counter rotation model)



Dial gauge set “1”
90890-03238
Magnet base B “2”
90890-06844
Dial indicator gauge “1”
YU-03097
Magnetic base stand “2”
YU-A8438



Free play
0.42–0.52 mm (0.0165–0.0205
in) (FL400ASTU, FL400ASTX,
FL450AVTU, FL450AVTX)

4. Select:
- Propeller shaft shim (T4) thicknesses
 - a. Select the propeller shaft shim (T4) thicknesses if out of specification.

TIP: _____

Use the rounded measurement value for the free play measurement.

- b. Determine the value of propeller shaft shim (T4) thickness adjustment using the “Propeller shaft shim (T4) selection table” according to the free play measurement. See “Propeller shaft shim (T4) selection table” (A-27).

TIP: _____

- If the shim thickness adjustment value is positive, the current shim thickness must be increased by that amount and, if the value is negative, the current shim thickness must be decreased by that amount.
- The blue-colored cell on the selection table indicates the specified propeller shaft free play. Shimming is not required if the measured propeller shaft free play is 0.42–0.52 mm.
- The values for the shim thickness adjustments specified in the selection table are intended to obtain the specified propeller shaft free play of 0.50 mm.

Example:

Free play measurement = 1.1 mm “a”
Propeller shaft shim (T4) thickness adjustment = 0.6 mm “b”

The current shim thickness must be increased by 0.6 mm.

		a	(mm)
A	1.0	1.1	
B	+0.5	+0.6	

- A. Free play measurement
- B. Shim thickness adjustment
- c. Calculate the new propeller shaft shim (T4) thickness.

TIP: _____

Use up to 3 shims to obtain the required shim thickness.

Calculation formula:

New propeller shaft shim (T4) thickness
= Current propeller shaft shim thickness + Shim thickness adjustment

Example:

Use the following formula when the shim thickness adjustment value is positive.

Current propeller shaft shim thickness
= 0.8 mm

Shim thickness adjustment = 0.2 mm

New propeller shaft shim (T4) thickness
= 0.8 mm + 0.2 mm = 1.0 mm

Use the following formula when the shim thickness adjustment value is negative.

Current propeller shaft shim thickness
= 0.8 mm

Shim thickness adjustment = -0.1 mm

New propeller shaft shim (T4) thickness
= 0.8 mm + (-0.1) mm = 0.7 mm



Available shim thicknesses

Propeller shaft shims

0.10/0.12/0.15/0.18/0.30/0.40/
0.50 mm (FL400ASTU,
FL400ASTX, FL450AVTU,
FL450AVTX)

5. Remove:
 - Special service tools
6. Install:
 - Determined propeller shaft shim **New**

Measuring the forward gear backlash and reverse gear backlash

- Spray anti-rust lubricant on the gears and bearings before installation. Do not apply gear oil to the parts. Otherwise, correct measurements cannot be obtained.
- Keep the parts free of foreign material, such as dirt and lint.
- When measuring the forward gear or reverse gear backlash, use the shims of the specified thickness for the reverse gear shim (T1) and forward gear shims (T2), and use the shims of the selected thickness for the pinion shims (T3).

1. Install:
 - Adapter assembly
 - Specified reverse gear shim (T1) **New**
 - Thrust bearing
 - Reverse gear assembly
See “Installing the forward gear” (8-34).
 - Determined pinion shim (T3) **New**
 - Spacer
 - Drive shaft assembly
 - Pinion
 - Pinion nut
 - Spacer
 - Drive shaft ring nut
See steps 1 and 2 in “Installing the drive shaft” (8-34).

TIP: _____

- Do not reuse shims.
- Check that the drive shaft turns smoothly.

2. Install:
 - Specified forward gear shim (T2) **New**
 - Propeller shaft/propeller shaft housing assembly
 - Key
 - Claw washer (do not bend the tabs)
 - Ring nut
See steps 2–5 in “Installing the propeller shaft housing assembly” (8-25).

TIP: _____

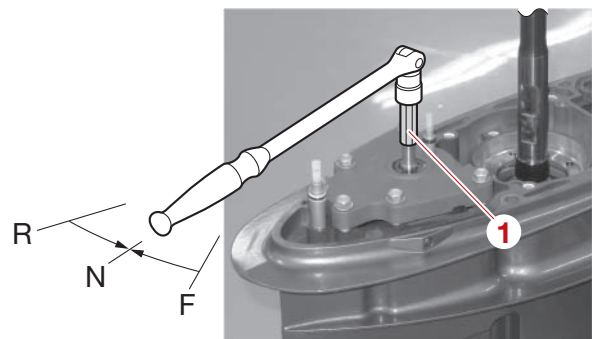
- Do not reuse shims.
- Check that the drive shaft turns smoothly.


3. Install:
 - Shift rod
 - Shift rod guide plate (temporarily)
See step 1 in “Installing the water pump and shift rod (counter rotation model)” (8-16).
4. Measure:
 - Forward gear backlash
Out of specification → Repeat steps from the selection of the reverse gear shim (T1) and forward gear shims (T2).

TIP: _____

When measuring the forward gear backlash on the counter rotation model, the torpedo of the lower unit should point upward.

- a. Install the shift rod and shift rod guide plate temporarily, set the gear shift to the N position.



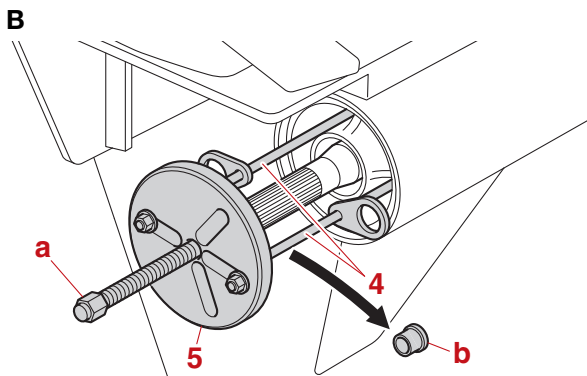
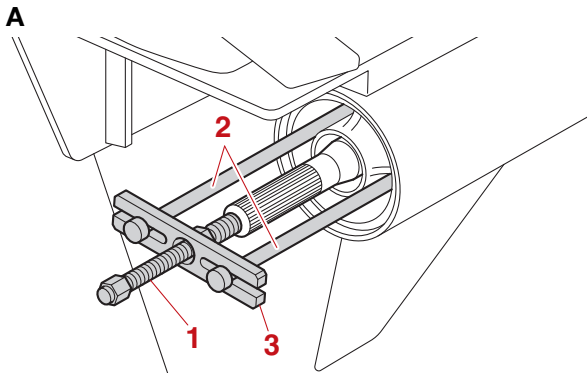
	Shift rod socket “1” 90890-06950
-------------------------------------------------------------------------------------	-------------------------------------

- b. Set up the special service tools, and then tighten the center bolt “1” or “a” to the specified torque.


TIP: _____


Without the attachment “b”.

Shimming (counter rotation model)

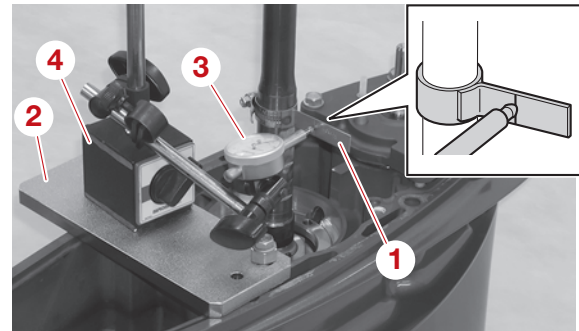



A. Worldwide
B. USA and Canada

	Center bolt "1" 90890-06504
	Bearing housing puller claw L "2" 90890-06502
	Stopper guide plate "3" 90890-06501
	Bearing housing puller "4" YB-06207
	Universal Puller "5" YB-06117

	Center bolt "1" or "a" (shimming) 4.9 N·m (0.49 kgf·m, 3.6 lb·ft)
-------------------------------------------------------------------------------------	----------------------------------------------------------------------

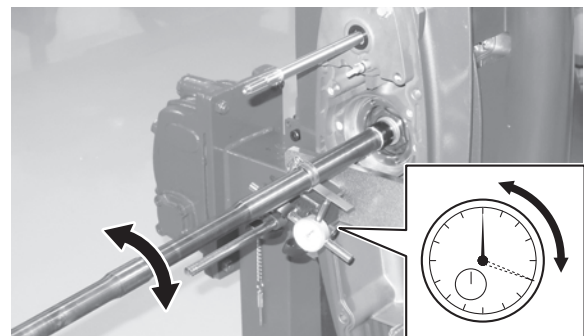
c. Install the special service tool "1" onto the drive shaft at the lowest possible position where the shaft diameter is 26.0 mm (1.024 in), and then set up the special service tools "2", "3", and "4".



	Backlash indicator "1" 90890-06836
	Magnet base plate "2" 90890-07003
	Dial gauge set "3" 90890-03238
	Magnet base B "4" 90890-06844
	Backlash indicator "1" YB-06836
	Backlash adjustment plate "2" YB-07003
	Dial indicator gauge "3" YU-03097
	Magnetic base stand "4" YU-A8438

- d. Face the lower unit torpedo upward.
- e. Turn the drive shaft slowly clockwise and counterclockwise, and then measure the backlash between where the drive shaft stops in each direction.

TIP: Do not turn the drive shaft using too much force. Otherwise, the forward gear will turn, leading to incorrect measurements.

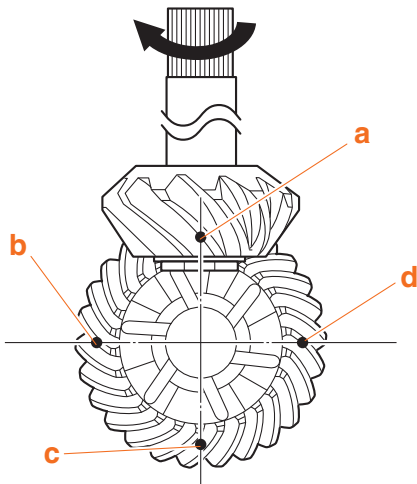


f. Turn the drive shaft 180° clockwise, and then measure the backlash again.

Shimming (counter rotation model)

TIP: _____

- Measure the backlash at 4 points: “a”, “b”, “c”, and “d”, turning the drive shaft 180° clockwise after each measurement.
- Write down the measurement data in the shimming check sheet.



- g. Determine the backlash average, and then round down the average to 2 decimal places.

Example:
(mm)

Measurement point “a”	0.25
Measurement point “b”	0.26
Measurement point “c”	0.26
Measurement point “d”	0.24
Average	0.2525
Round-down average	0.25

- h. Check that the forward gear backlash average is within specification.

TIP: _____

Repeat steps from the selection of the reverse gear shim (T1) and forward gear shims (T2) if the forward gear backlash is out of specification.

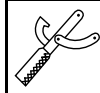
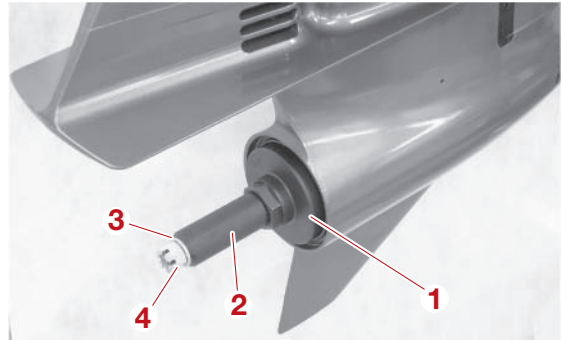


Forward gear backlash
0.20–0.61 mm (0.0079–0.0240 in)
(FL400ASTU, FL400ASTX,
FL450AVTU, FL450AVTX)

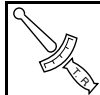
- i. Remove the special service tools from the propeller shaft.

5. Measure:

- Reverse gear backlash
Out of specification → Repeat steps from the selection of the reverse gear shim (T1) and forward gear shims (T2).
- a. Install the special service tools “1”, “2” washer “3”, and propeller nut “4”.



Ring nut wrench “1”
90890-06932
Ring nut extension “2”
90890-06968

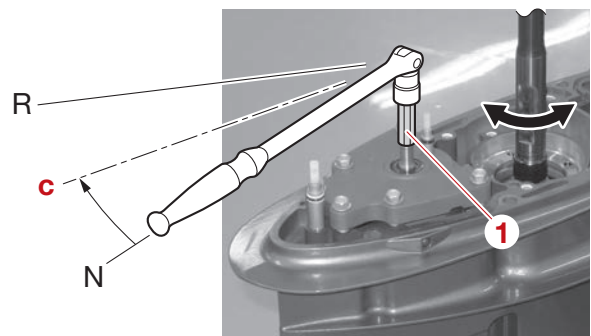


Propeller nut “4” (shimming)
10 N·m (1.0 kgf·m, 7.4 lb·ft)

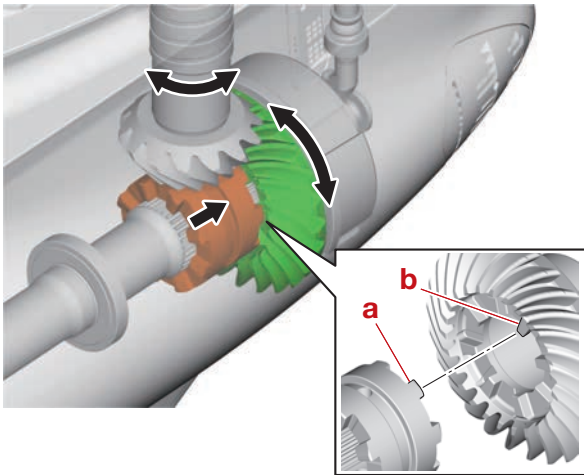
- b. While turning the drive shaft, move the gear shift toward the R position. Set the shift rod at the position where the protrusion “a” on the dog clutch hits the protrusion “b” on the reverse gear.


TIP: _____

When the protrusion on the dog clutch hits the protrusion on the reverse gear, the shift rod is fixed at the position “c” which is in between the N position and the R position.



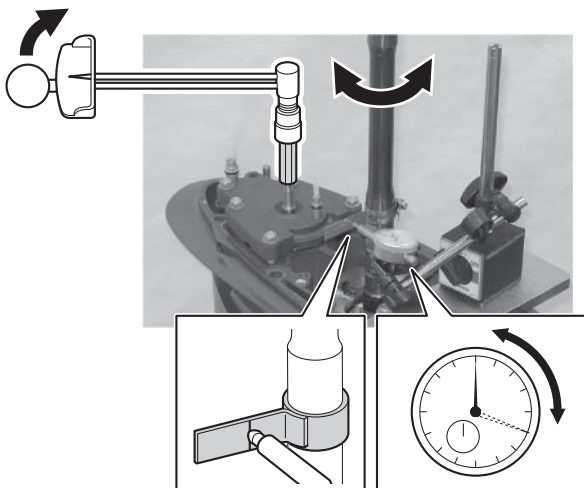
Shimming (counter rotation model)




 Shift rod socket "1"
90890-06950

- c. While turning the shift rod toward the R position using the specified torque, turn the drive shaft slowly clockwise and counterclockwise and measure the backlash between where the drive shaft stops in each direction.

TIP: Do not turn the drive shaft using too much force. Otherwise, the reverse gear will turn, leading to incorrect measurements.

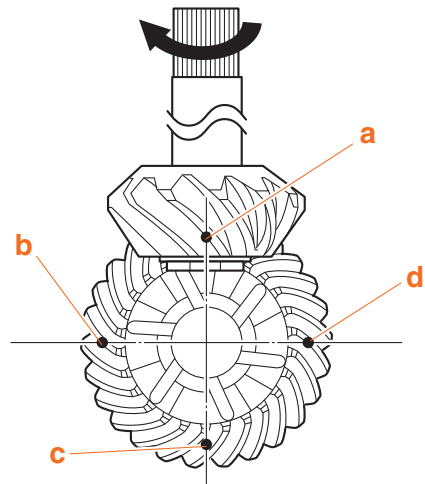


 Specified torque
10 N·m (1.0 kgf·m, 7.4 lb·ft)

- d. Turn the drive shaft 180° clockwise, and then measure the backlash again.

TIP:

- Measure the backlash at 4 points: "a", "b", "c", and "d", turning the drive shaft 180° clockwise after each measurement.
- Write down the measurement data in the shimming check sheet.



- e. Determine the backlash average, and then round down the average to 2 decimal places.


Example:
(mm)

Measurement point "a"	0.45
Measurement point "b"	0.46
Measurement point "c"	0.46
Measurement point "d"	0.44
Average	0.4525
Round-down average	0.45

- f. Check that the reverse gear backlash average is within specification.

TIP:

Repeat steps from the selection of the reverse gear shim (T1) and forward gear shims (T2) if the reverse gear backlash is out of specification.

 Reverse gear backlash
0.40–0.81 mm (0.0157–0.0319 in)
(FL400ASTU, FL400ASTX, FL450AVTU, FL450AVTX)

6. Install:
- Oil seal housing
 - Cover
See step 3 in “Installing the drive shaft” (8-34).
 - Shift rod
 - Plate
 - Shift rod guide plate
 - Spacer
 - Lower water pump housing
 - Lower impeller
 - Outer plate cartridge
 - Upper impeller
 - Upper water pump housing
See “Installing the water pump and shift rod (counter rotation model)” (8-16).

Bracket unit

Bottom cowling cover and apron cover.....	9-1
Installing the bottom cowling cover	9-2
Bottom cowling (PORT and STBD).....	9-3
Removing the bottom cowling	9-5
Assembling the bottom cowling.....	9-5
Installing the propeller light bracket	9-6
Installing the bottom cowling	9-7
Apron.....	9-8
Cooling water hose and gear oil changing hose.....	9-9
Removing the cooling water hose (oil pan side)	9-10
Installing the gear oil changing hose.....	9-10
Installing the cooling water hose.....	9-12
Shift actuator and shift rod	9-13
Installing the shift actuator and shift rod.....	9-14
Bottom cowling (front) and flushing hose.....	9-16
Assembling the bottom cowling (front)	9-17
Installing the bottom cowling (front).....	9-17
Installing the flushing hose and PTT switch.....	9-17
Upper case assembly and mount.....	9-20
Removing the upper case assembly	9-21
Installing the upper case assembly.....	9-21
Exhaust guide	9-25
Checking the exhaust guide.....	9-26
Installing the exhaust guide.....	9-26
Upper case, muffler, and oil pan.....	9-28
Disassembling the upper case.....	9-29
Checking the upper case	9-29
Checking the muffler	9-29
Checking the PCV	9-29
Checking the oil pan and oil strainer.....	9-29
Assembling the oil pan.....	9-29

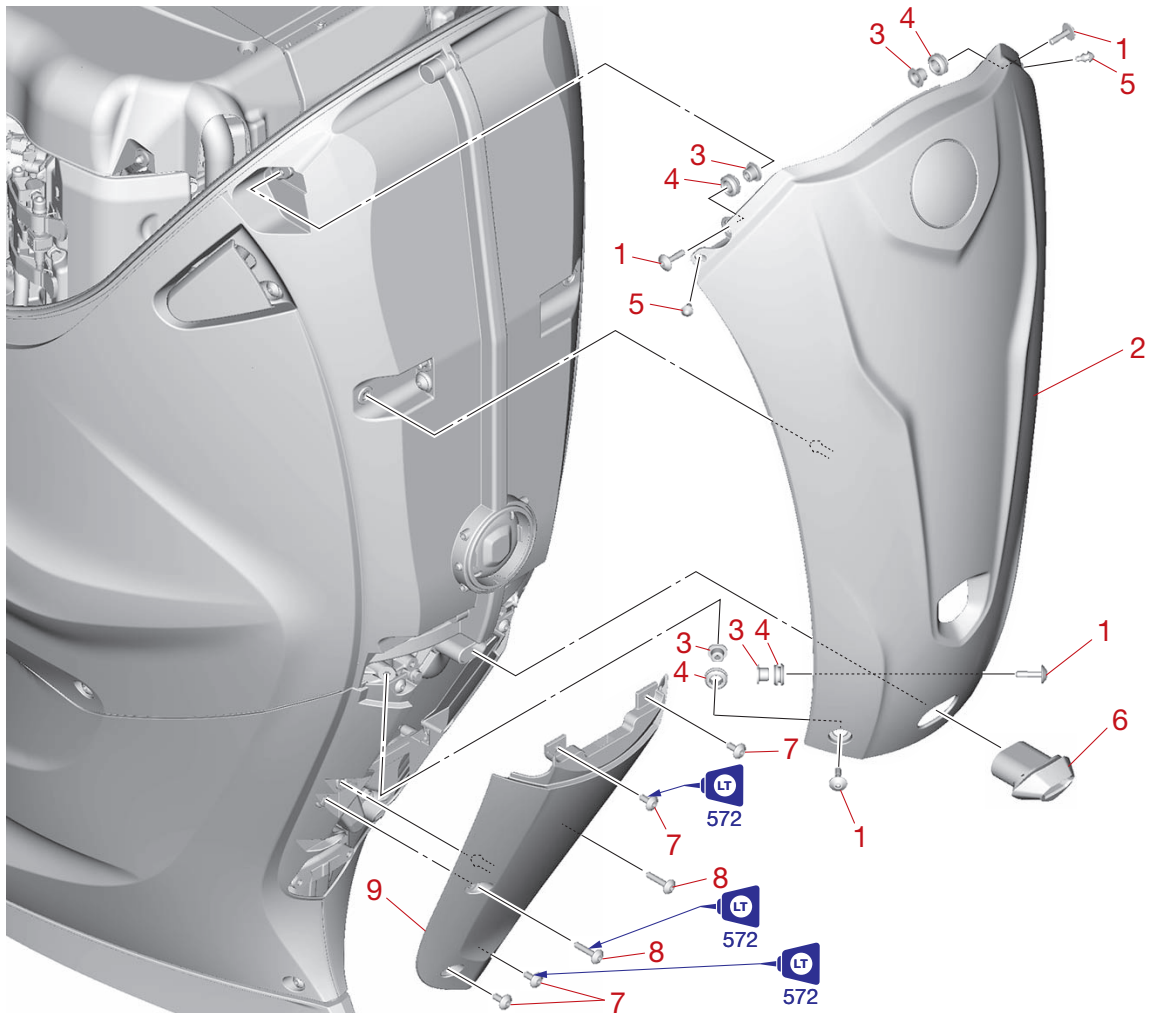
Bracket unit

Assembling the upper case.....	9-30
Installing the muffler and upper case	9-30
Steering actuator and steering arm	9-32
Removing the steering actuator (with the power unit installed)	9-33
Removing the power steering unit (with the power unit removed)	9-34
Removing the steering arm	9-35
Checking the steering arm and steering arm joint	9-36
Installing the steering arm	9-36
Installing the steering actuator (with the power unit removed)	9-37
Installing the steering actuator (with the power unit installed)	9-39
Clamp bracket and swivel bracket.....	9-42
Removing the clamp bracket	9-43
Checking the clamp bracket anode	9-43
Assembling the swivel bracket.....	9-43
Installing the clamp bracket	9-43
PTT unit.....	9-45
Removing the PTT unit.....	9-46
Checking the PTT motor electric current when the relief valve operates	9-46
Bleeding the PTT unit.....	9-48
Installing the PTT unit.....	9-49
PTT motor	9-52
Removing the reservoir	9-53
Disassembling the PTT motor	9-53
Checking the PTT motor	9-53
Checking the brush	9-54
Checking the reservoir	9-54
Checking the filter	9-54
Assembling the PTT motor.....	9-54
Installing the reservoir	9-55
Installing the PTT motor	9-55

Bracket unit

PTT gear pump	9-57
Disassembling the gear pump assembly	9-59
Checking the gear pump.....	9-59
Checking the gear pump housing	9-59
Checking the filter	9-59
Assembling the gear pump assembly	9-59
Installing the gear pump assembly	9-61
PTT cylinder	9-62
Removing the tilt ram	9-64
Removing the trim ram.....	9-64
Checking the tilt cylinder and trim cylinder.....	9-65
Checking the absorber valve.....	9-65
Assembling the trim ram	9-65
Assembling the tilt ram.....	9-65
Installing the tilt cylinder.....	9-66
Installing the trim ram.....	9-66
Installing the tilt ram	9-67

Bottom cowling cover and apron cover

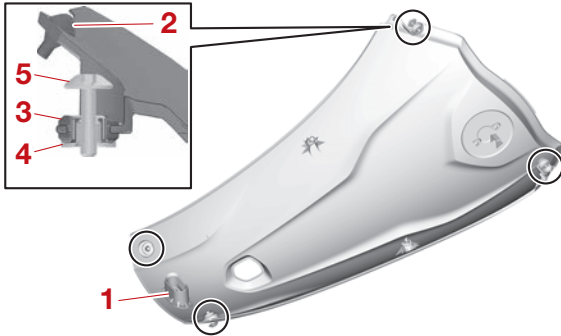


↕↗	Part name	Q'ty	Remarks
1	Bolt M6 × 25 mm	4	
2	Cover	1	
3	Collar	4	
4	Grommet	4	
5	Damper	2	
6	Grommet	1	
7	Bolt M6 × 14 mm	4	
8	Bolt M6 × 30 mm	2	
9	Cover	1	

Installing the bottom cowling cover

1. Assemble:

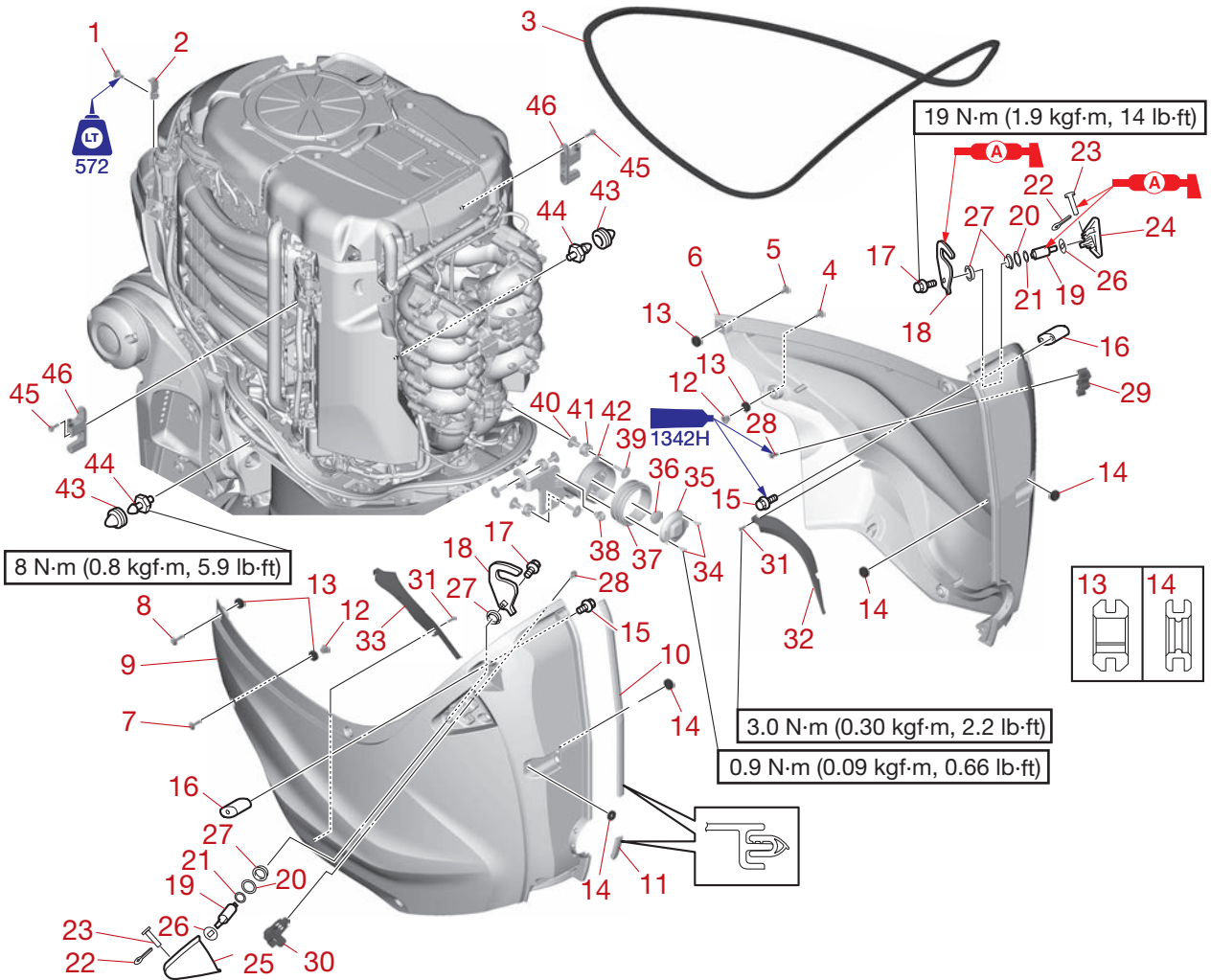
- Grommet "1"
- Damper "2"
- Grommet "3"
- Collar "4"
- Bolt "5"



2. Install:

- Apron cover
- Bottom cowling cover

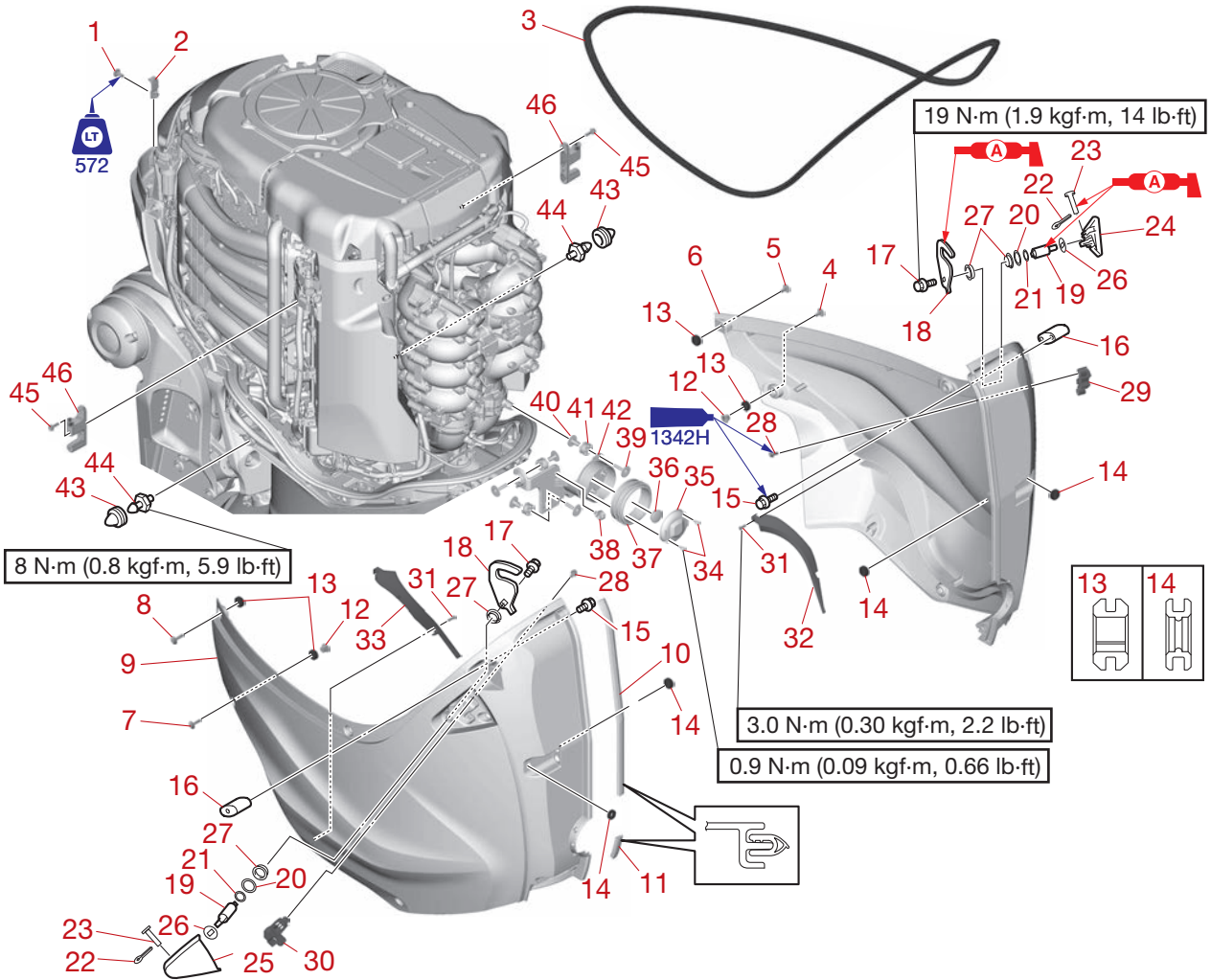
Bottom cowling (PORT and STBD)



↑↓	Part name	Q'ty	Remarks
1	Bolt M6 × 14 mm	1	
2	Plate	1	
3	Rubber seal	1	
4	Bolt M6 × 25 mm	7	
5	Bolt M6 × 14 mm	1	
6	Bottom cowling (STBD)	1	
7	Bolt M6 × 25 mm	5	
8	Bolt M6 × 14 mm	1	
9	Bottom cowling (PORT)	1	
10	Rubber seal	1	
11	Rubber seal	1	
12	Collar	12	
13	Grommet	14	
14	Grommet	4	
15	Bolt M6 × 12 mm	4	
16	Bracket	2	
17	Bolt M8 × 12 mm	2	

↑↓	Part name	Q'ty	Remarks
18	Clamp lever	2	
19	Shaft	2	
20	Washer	2	
21	Wave washer	2	
22	Retaining clip	2	
23	Pin	2	
24	Lock lever (STBD)	1	
25	Lock lever (PORT)	1	
26	Washer	2	
27	Bushing	4	
28	Bolt M6 × 12 mm	4	
29	Clamp plate (STBD)	1	
30	Clamp plate (PORT)	1	
31	Screw M5 × 16 mm	4	
32	Damper (STBD)	1	
33	Damper (PORT)	1	
34	Screw M4 × 12 mm	2	
35	Cover	1	
36	Grommet	1	

Bottom cowling (PORT and STBD)



↕	Part name	Q'ty	Remarks
37	Grommet	1	
38	Holder	1	
39	Bolt M6 × 35 mm	3	
40	Collar	3	
41	Grommet	3	
42	Bracket	1	
43	Damper	2	
44	Stay	2	
45	Bolt M6 × 20 mm	4	
46	Bracket	2	

Removing the bottom cowling

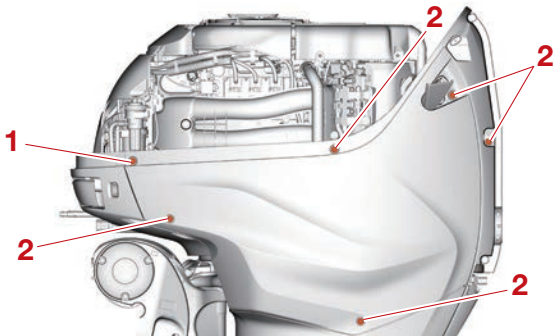
1. Remove:
 - Bolts (M6 × 14 mm)
 - Bottom cowlings
 - a. Remove the bolts (M6 × 14 mm) “1”, and then loosen the bolts (M6 × 25 mm) “2”.

TIP: _____

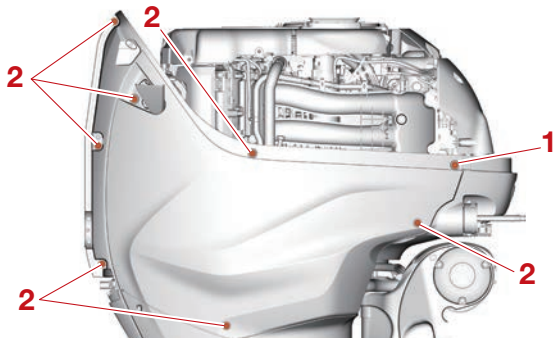
Although the bolts (M6 × 25 mm) “2” will remain in the bottom cowlings when the bolts are loosened, make sure that the bolts (M6 × 14 mm) “1” do not fall from the bottom cowlings because those bolts are removed.

- b. Remove the bottom cowlings.

A



B




A. PORT
B. STBD

2. Remove:
 - Plate
 - Rubber seal
 - Bottom cowlings
 - Dipstick guide
See “Intake manifold” (6-24).
 - Cowling brackets

Assembling the bottom cowling

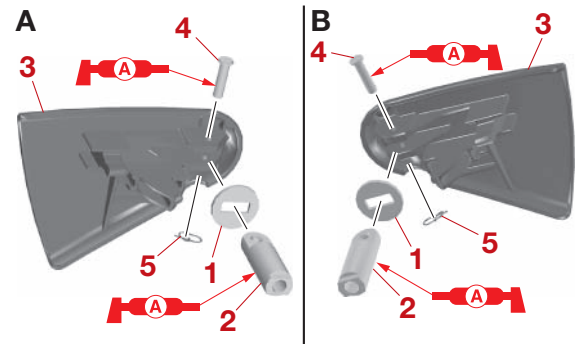
1. Install:
 - Dampers
 - Clamp plates

	Damper screw 3.0 N·m (0.30 kgf·m, 2.2 lb·ft)
-----------------------------------------------------------------------------------	-------------------------------------------------

2. Assemble:
 - Washers “1”
 - Lever shafts “2”
 - Cowling lock levers “3”
 - Pins “4”
 - Retaining clips “5”


TIP: _____

Install the pins “4” in the direction shown.



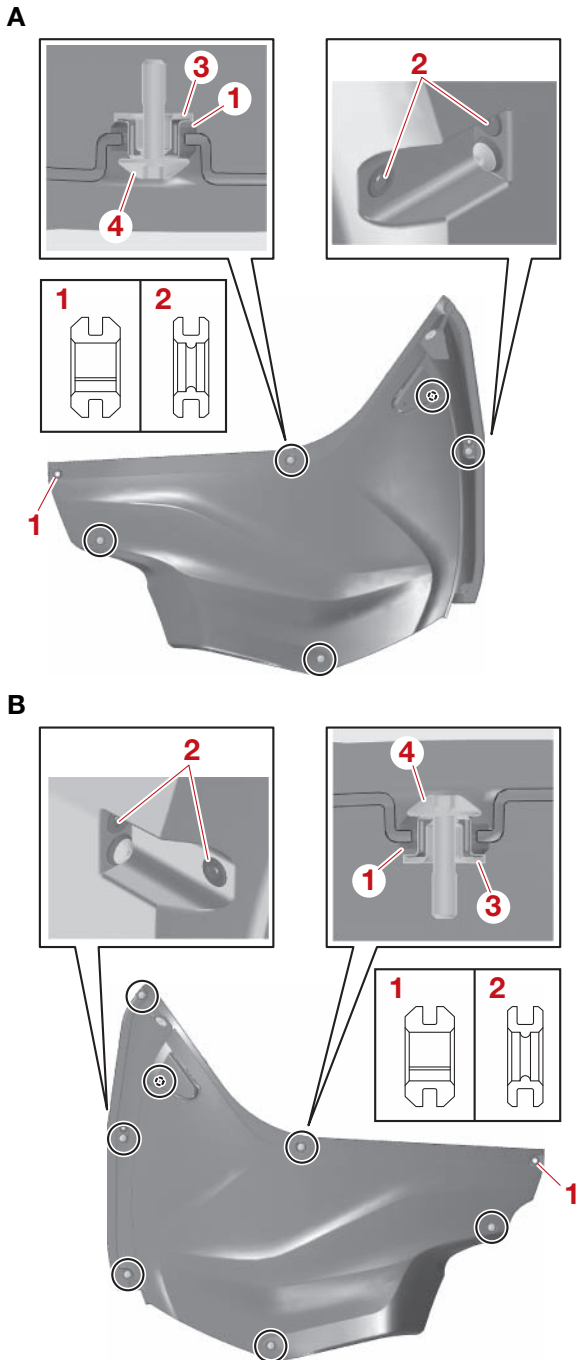
A. PORT
B. STBD

3. Install:
 - Bushings
 - Wave washers
 - Washers
 - Cowling lock lever assemblies
 - Clamp levers
 - Bottom cowling cover brackets

	Clamp lever bolt 19 N·m (1.9 kgf·m, 14 lb·ft)
-------------------------------------------------------------------------------------	--------------------------------------------------

4. Install:
 - Grommets “1”, “2”
 - Collars “3”
 - Bolts (M6 × 25 mm) “4” (to the collars “3”)

Bottom cowling (PORT and STBD)

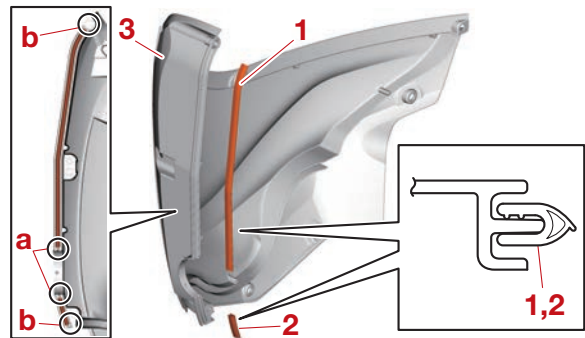


A. PORT
B. STBD

5. Install:
- Rubber seal “1”, “2”

TIP: _____

- Align end of the rubber seals “1” and “2” with the portion “a” of the bottom cowling (PORT) “3”.
- Make sure that the rubber seals “1” and “2” are not installed on the portion “b” of the bottom cowling (PORT) “3”.
- Install the rubber seals “1” and “2” so that the lip on the seal is pointing in the direction shown.

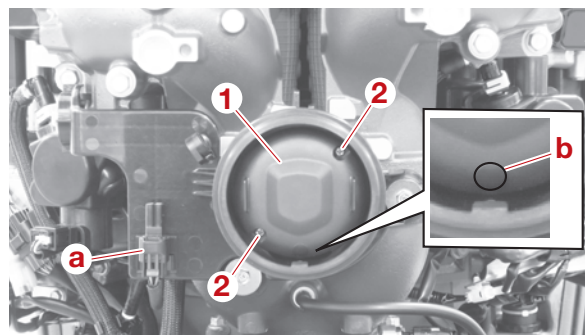


Installing the propeller light bracket

1. Install:
- Bracket
 - Holder
 - Wire harness “a”
 - Grommet
 - Grommet
 - Cover “1”

TIP: _____


Install the cover “1” so that the mark “b” is facing downward.



Cover screw “2”
0.9 N·m (0.09 kgf·m, 0.66 lb·ft)

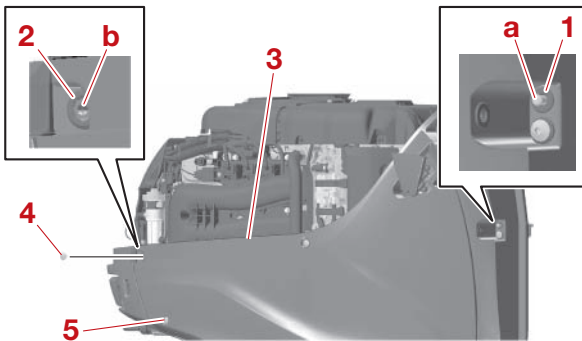
Installing the bottom cowling

1. Install:
 - Cowling brackets
 - Dipstick guide
See "Intake manifold" (6-24).
 - Cowling stays
 - Dampers

	Cowling stay 8 N·m (0.8 kgf·m, 5.9 lb·ft)
-----------------------------------------------------------------------------------	----------------------------------------------

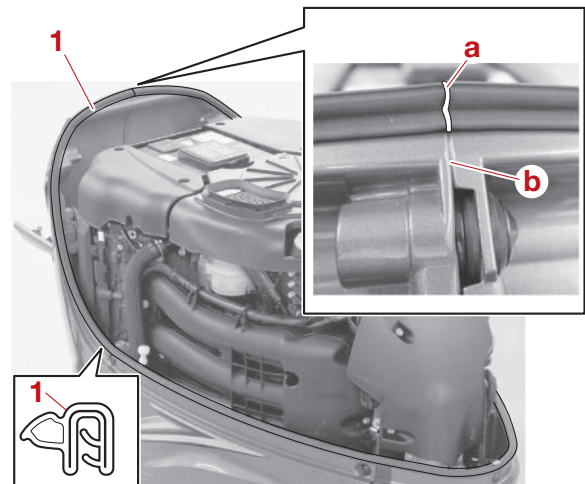
2. Install:
 - Bottom cowlings
 - Bolts (M6 × 14 mm)
 - a. Install the grommet "1" onto the protrusion "a" on the exhaust joint.
 - b. Install the grommet "2" onto the protrusion "b" on the bottom cowling (front) "3", and then install the bolts (M6 × 14 mm) "4".

TIP: _____
 Install the bolts (M6 × 14 mm) "4", and then install the bolts "5".

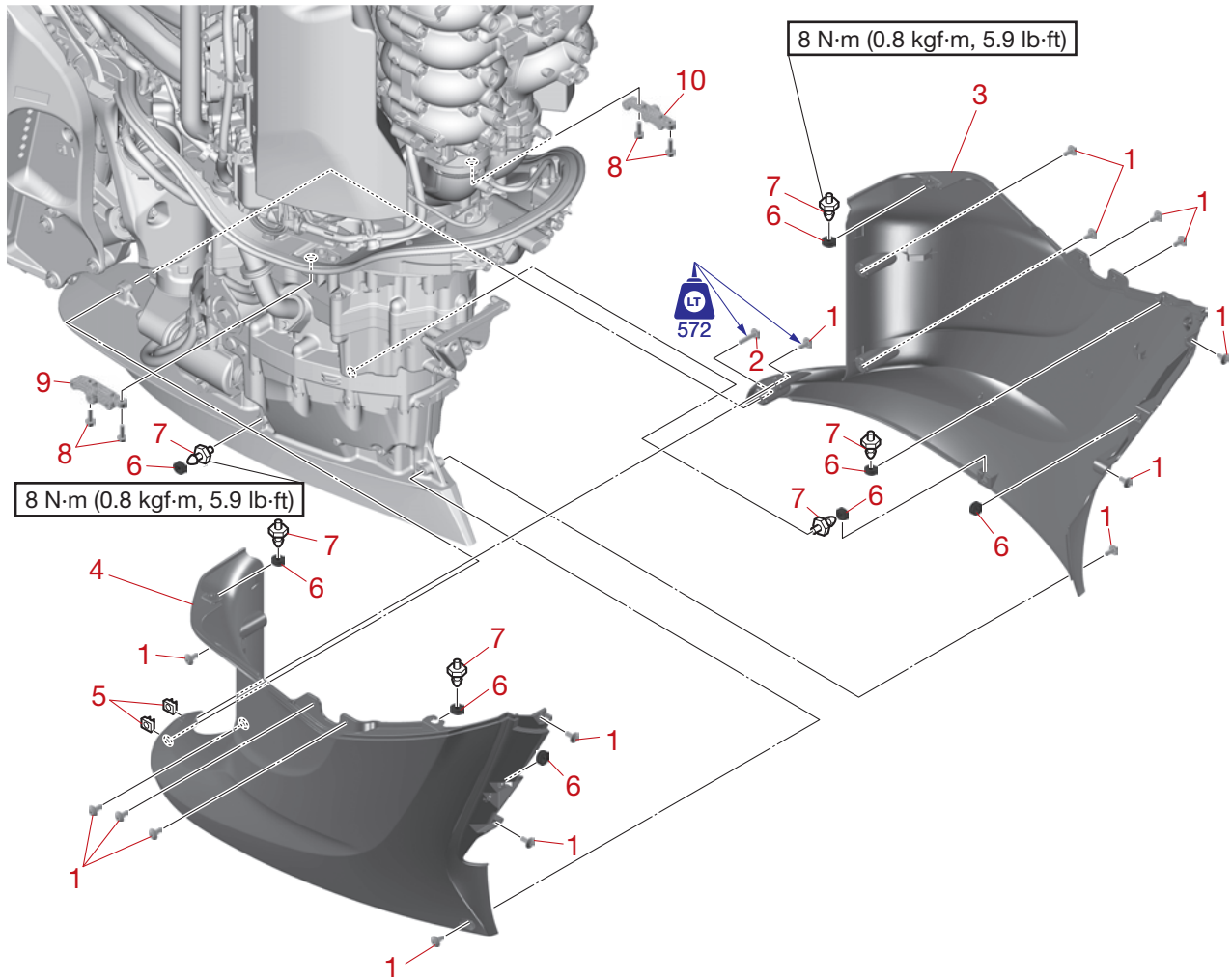


3. Install:
 - Rubber seal "1"
 - Plate

TIP: _____
 • Align the seam "a" of the rubber seal "1" with the mating surface "b" of the bottom cowling.
 • After installing the rubber seal "1", make sure that there are no wavy areas of the seal.

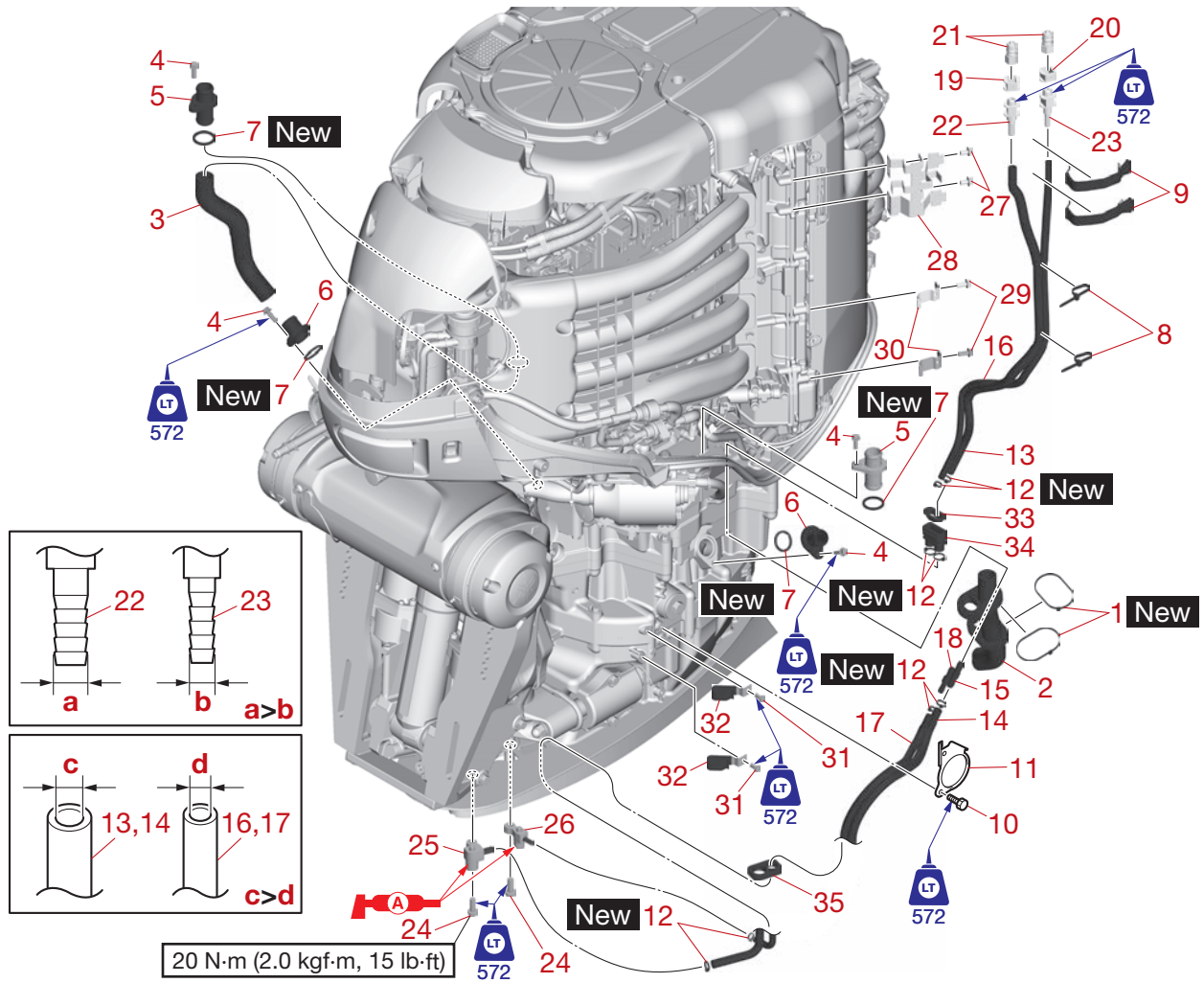


Apron



↑↓	Part name	Q'ty	Remarks
1	Bolt M6 × 14 mm	15	
2	Bolt M6 × 30 mm	1	
3	Apron (STBD)	1	
4	Apron (PORT)	1	
5	Nut M6	2	
6	Grommet	8	
7	Stay	6	
8	Bolt M6 × 20 mm	4	
9	Bracket (PORT)	1	
10	Bracket (STBD)	1	

Cooling water hose and gear oil changing hose



↑↓	Part name	Q'ty	Remarks
1	Plastic tie	2	
2	Hose	1	
3	Hose	1	
4	Bolt M6 × 20 mm	4	
5	Joint	2	
6	Joint	2	
7	Rubber seal	4	
8	Plastic tie	2	
9	Band	2	
10	Bolt M6 × 12 mm	1	
11	Cover	1	
12	Plastic tie	8	
13	Hose (gear oil)	1	
14	Hose (gear oil)	1	
15	Joint (gear oil)	1	
16	Hose (air)	1	
17	Hose (air)	1	
18	Joint (air)	1	
19	Cover (gear oil)	1	"OIL"

↑↓	Part name	Q'ty	Remarks
20	Cover (air)	1	"AIR"
21	Quick connector	2	
22	Hose fitting (gear oil)	1	
23	Hose fitting (air)	1	
24	Bolt M8 × 25 mm	2	
25	Joint (gear oil)	1	
26	Joint (air)	1	
27	Bolt M6 × 12 mm	2	
28	Hose holder	1	
29	Bolt M6 × 16 mm	2	
30	Holder	2	
31	Bolt M6 × 12 mm	2	
32	Holder	2	
33	Cap	1	
34	Grommet	1	
35	Rubber seal	1	

Removing the cooling water hose (oil pan side)

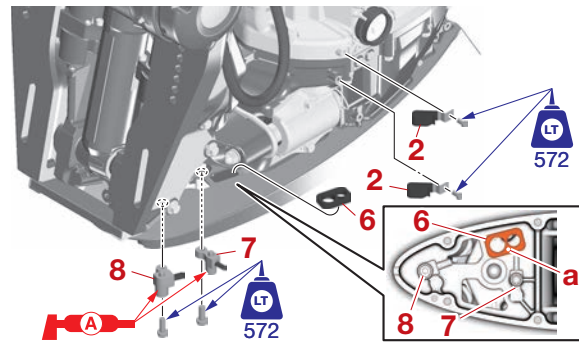
1. Remove:
 - Cooling water hose (engine side)
See "Intake manifold" (6-24).
2. Remove:
 - Plastic ties
 - Cooling water hoses (oil pan side)
 - Joints (exhaust guide side)
 - Joints (oil pan side)
 - Rubber seals


Installing the gear oil changing hose

1. Install:
 - Holders "1", "2"
 - Hose holder "3"
 - Grommet "4"
 - Cap "5"
 - Rubber seal "6"
 - Joint (air) "7"
 - Joint (gear oil) "8"

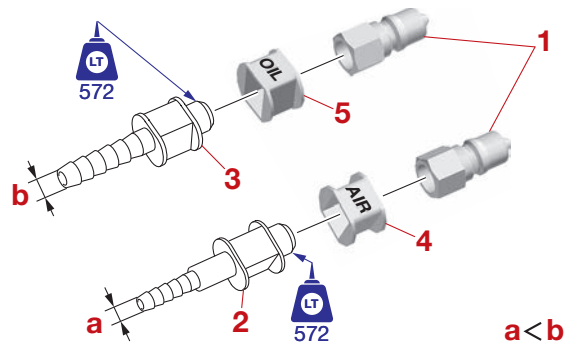
TIP:

Make sure to face the paint mark "a" on the rubber seal "6" in the direction shown in the illustration.

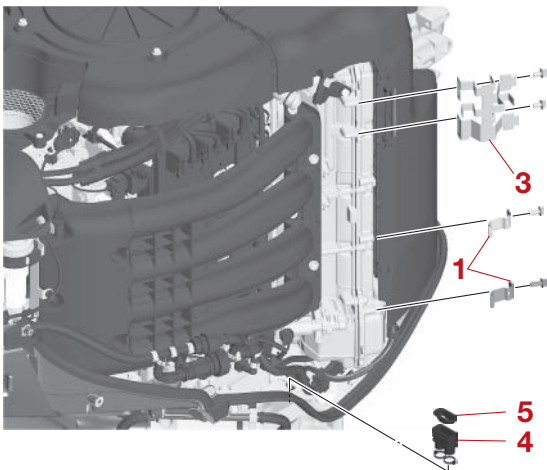


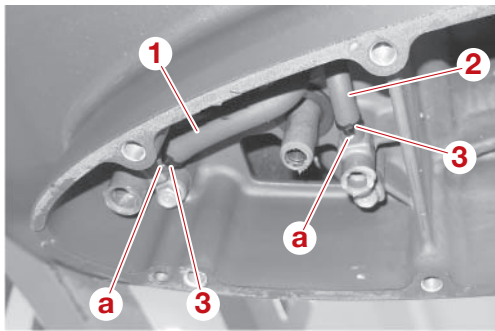
	Joint bolt 20 N·m (2.0 kgf·m, 15 lb·ft)
-----------------------------------------------------------------------------------	--------------------------------------------

2. Assemble:
 - Quick connectors "1"
 - Hose fitting (air) "2"
 - Hose fitting (gear oil) "3"
 - Cover (air) "4"
 - Cover (gear oil) "5"

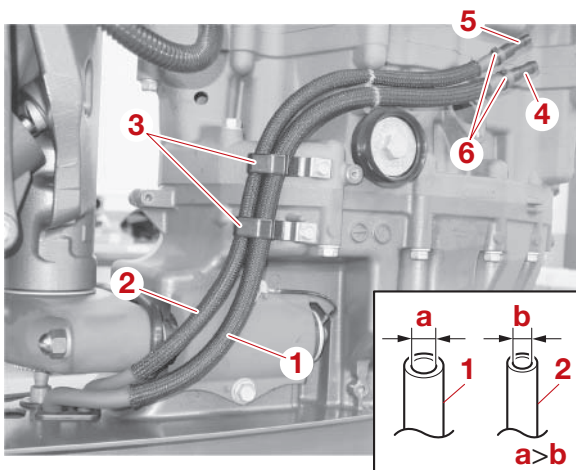


3. Install:
 - Hoses (air)
 - Hoses (gear oil)
 - Plastic ties **New**
 - Joint (air)
 - Joint (gear oil)
 - Hose fitting assembly (air)
 - Hose fitting assembly (gear oil)
 - Bands
 - Plastic ties **New**
 - Plastic ties
 - Cover
 - a. Install the hose (gear oil) "1" and hose (air) "2" onto the hose fitting on the joint. Face the paint mark "a" on the hoses downward.
 - b. Fasten the hose (gear oil) "1" and hose (air) "2" using new plastic ties "3".





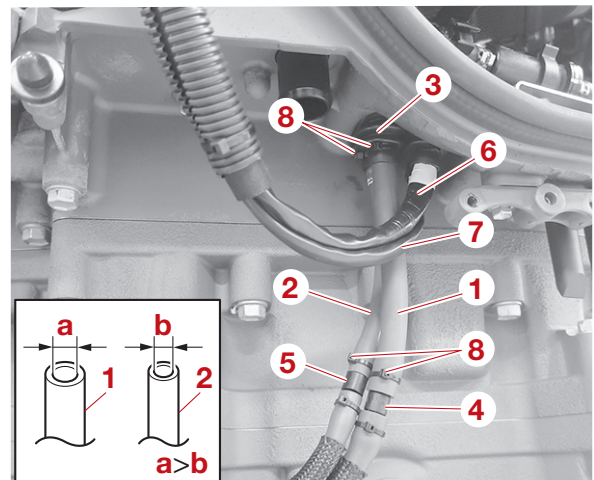
- c. Fasten the hose (gear oil) "1" and hose (air) "2" using the holders "3".
- d. Install the joints "4" and "5" into the hose (gear oil) "1" and hose (air) "2", and then fasten the hoses using new plastic ties "6".



- e. Route the hose (gear oil) "1" and hose (air) "2" through the grommet "3", and then connect the joints "4" and "5".

TIP: Route the hose (gear oil) "1" and hose (air) "2" to the inside of the PTT motor lead "6" and PTT sensor lead "7".

- f. Fasten the hose (gear oil) "1" and hose (air) "2" using new plastic ties "8".



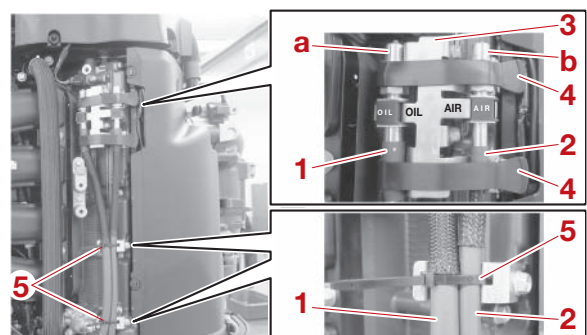
- g. Install the hose fitting assemblies "a" and "b" into the hose (gear oil) "1" and hose (air) "2", and then install the hose fitting assemblies "a" and "b" onto the hose holder "3".

TIP:

- Install the hose fitting assemblies "a" and "b" and hoses "1" and "2" so that the "AIR" and "OIL" marks are facing outward.
- Make sure that the "AIR" and "OIL" marks on the hose fitting assemblies "a" and "b" are positioned next to the corresponding "AIR" and "OIL" marks on the hose holder "3".

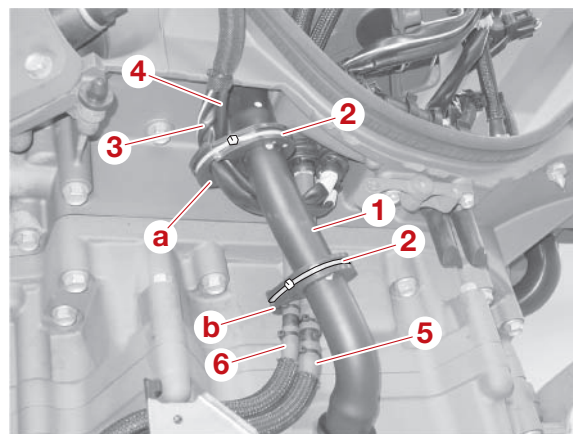
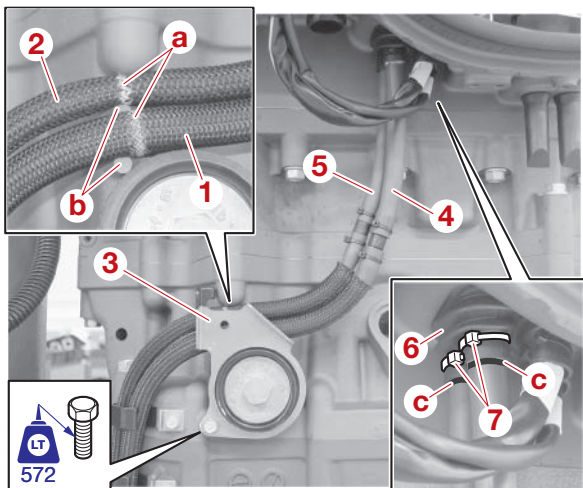
- h. Install the bands "4".
- i. Fasten the hoses "1" and "2" using the plastic ties "5" as shown.

TIP: Do not cut off the excess end of the plastic ties.



- j. Align the white paint marks "a" on the hose (gear oil) "1" and hose (air) "2" with the projections "b" on the oil pan (lower), and then install the cover "3".

- k. Align the white paint marks “c” on the hose (gear oil) “4” and hose (air) “5”, and then fasten the grommet “6” using new plastic ties “7”.



2. Install:
 - Cooling water hose (engine side)
See “Intake manifold” (6-24).

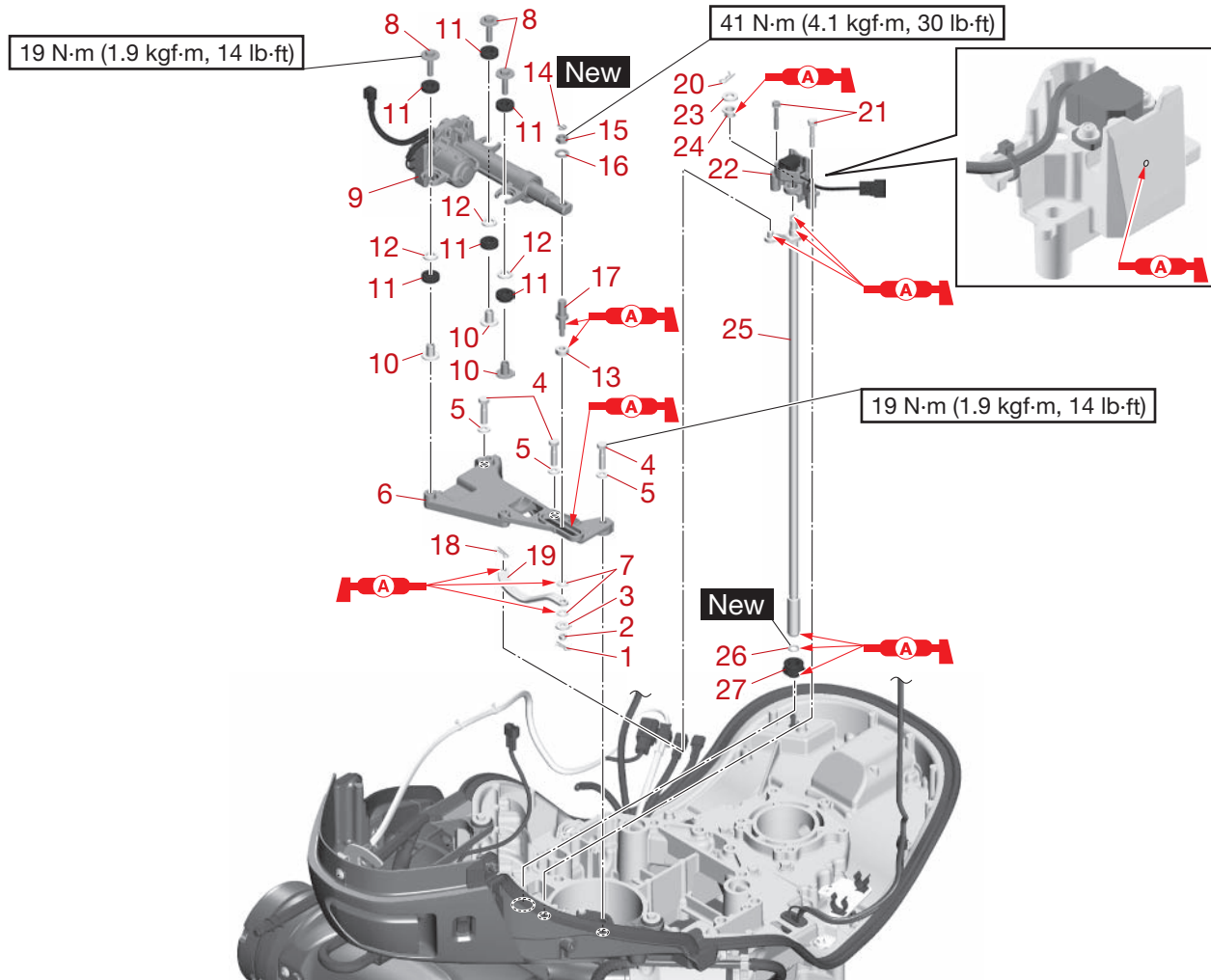
Installing the cooling water hose

1. Install:
 - Rubber seals **New**
 - Joints (oil pan side)
 - Joints (exhaust guide side)
 - Cooling water hose (oil pan side) (STBD)
 - Cooling water hose (oil pan side) (PORT) “1”
 - Plastic ties “2” **New**

TIP:

- Route the PTT motor lead “3” and PTT sensor lead “4” through the grommet “a” on the cooling water hose (oil pan side) (PORT) “1”.
- Route the hose (gear oil) “5” and hose (air) “6” through the grommet “b” on the cooling water hose (oil pan side) (PORT) “1”.
- Install new plastic ties “2” as shown.

Shift actuator and shift rod



↑↓	Part name	Q'ty	Remarks
1	Clip	1	
2	Self-locking nut M6	1	
3	Washer	1	
4	Bolt M8 × 35 mm	3	
5	Washer	3	
6	Bracket	1	
7	Bushing	2	
8	Bolt M8 × 35 mm	3	
9	Shift actuator	1	
10	Collar	3	
11	Grommet	6	
12	Washer	3	
13	Bushing	1	
14	Cotter pin	1	
15	Nut M10	1	
16	Washer	1	
17	Joint pin	1	
18	Clip	1	
19	Shift lever	1	

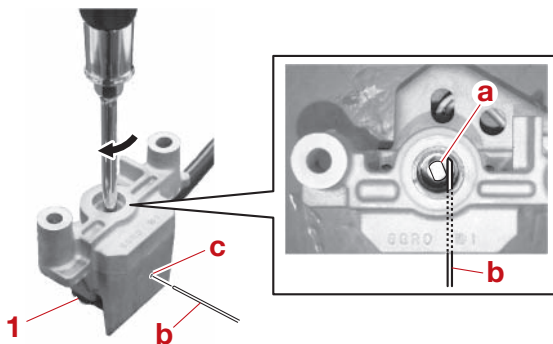
↑↓	Part name	Q'ty	Remarks
20	Clip	1	
21	Bolt M6 × 40 mm	2	
22	SPS	1	
23	Washer	1	
24	Bushing	1	
25	Shift rod	1	
26	O-ring	1	
27	Grommet	1	

Installing the shift actuator and shift rod

1. Assemble:

- SPS
- Bushing
- Washer
- Shift rod
- Clip

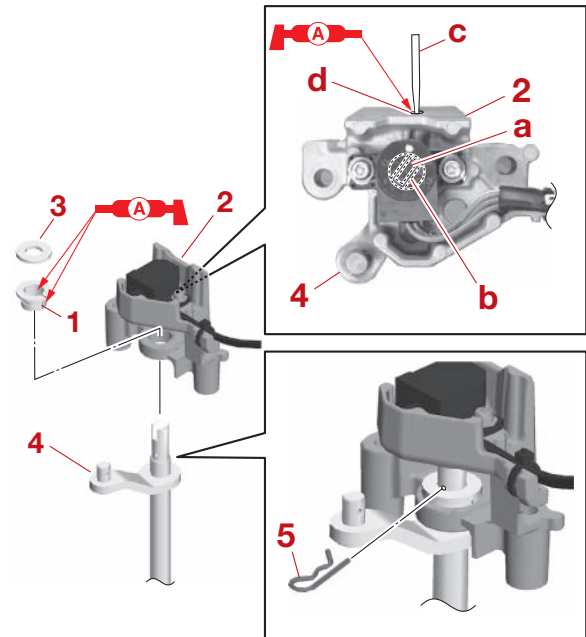
a. Turn the protrusion “a” on the SPS “1” in the direction of the arrow using a slotted screwdriver, and then insert a suitable pin “b” into the hole “c” to secure the protrusion.



- b. Install the bushing “1” into the SPS “2”.
- c. Install the washer “3” onto the SPS “2”.
- d. Fit the protrusion “a” on the SPS “2” into the slot “b” in the tip of the shift rod “4”, and then install the clip “5” in the direction shown.
- e. Remove the pin “c”.

TIP: _____

After removing the pin “c”, fill the hole “d” with a small amount of grease.

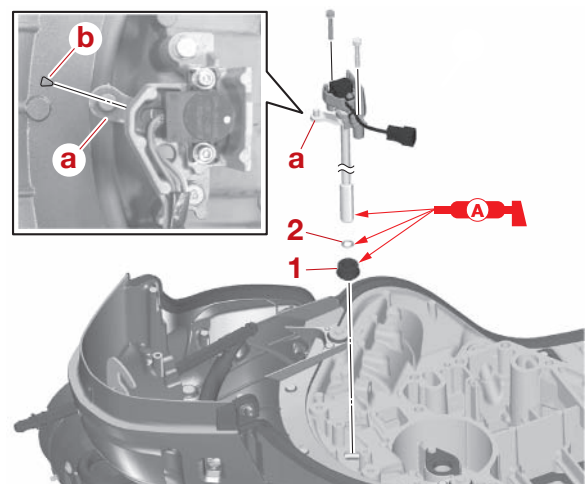


2. Install:

- Grommet “1”
- O-ring “2” **New** (into the shift rod)
- Shift rod assembly “a”

TIP: _____

Install the shift rod assembly “a” so that it is aligned with the mark “b” on the bottom cowl- ing (front) as shown.



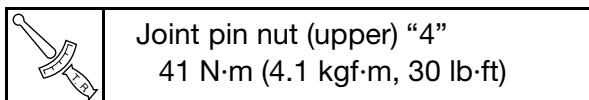
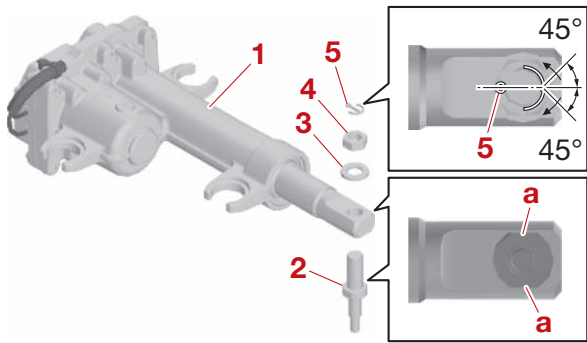
3. Assemble:

- Shift actuator “1”
- Joint pin “2”
- Washer “3”
- Joint pin nut (upper) “4”
- Cotter pin “5” **New**

Shift actuator and shift rod

TIP:

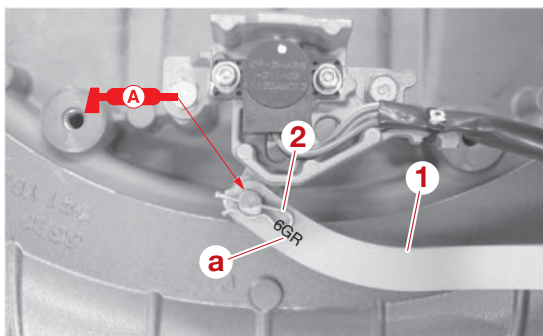
- Install the joint pin “2” so that the flat sides “a” of the pin are parallel to the sides of the rod of the shift actuator “1”.
- Install a new cotter pin “5” in the direction shown and bend the ends 45° or more from the centerline of the joint pin “2”.



4. Install:
 - Shift lever “1”
 - Clip “2”

TIP:

- Make sure that the “6GR” mark “a” on the shift lever “1” is facing up.
- Install the clip “2” in the direction shown.

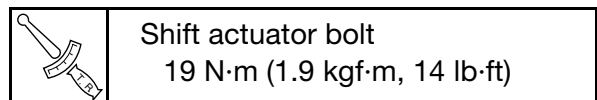
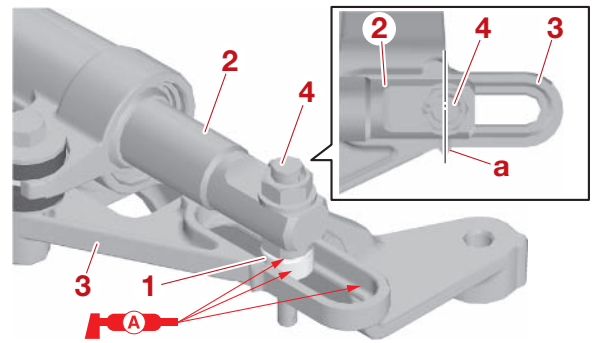


5. Assemble:
 - Bushing
 - Washers
 - Grommets
 - Collars
 - Shift actuator
 - Shift bracket
 - Bushings
 - Washers
 - Joint pin nut (lower)

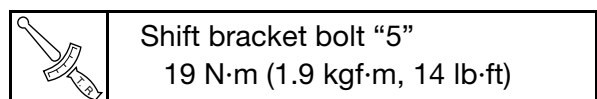
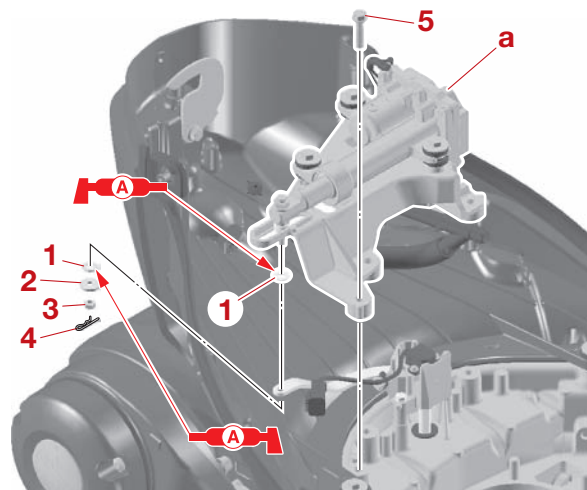
- Clip
 - a. Install the bushing “1” and shift actuator “2” onto the shift bracket “3”.

TIP:

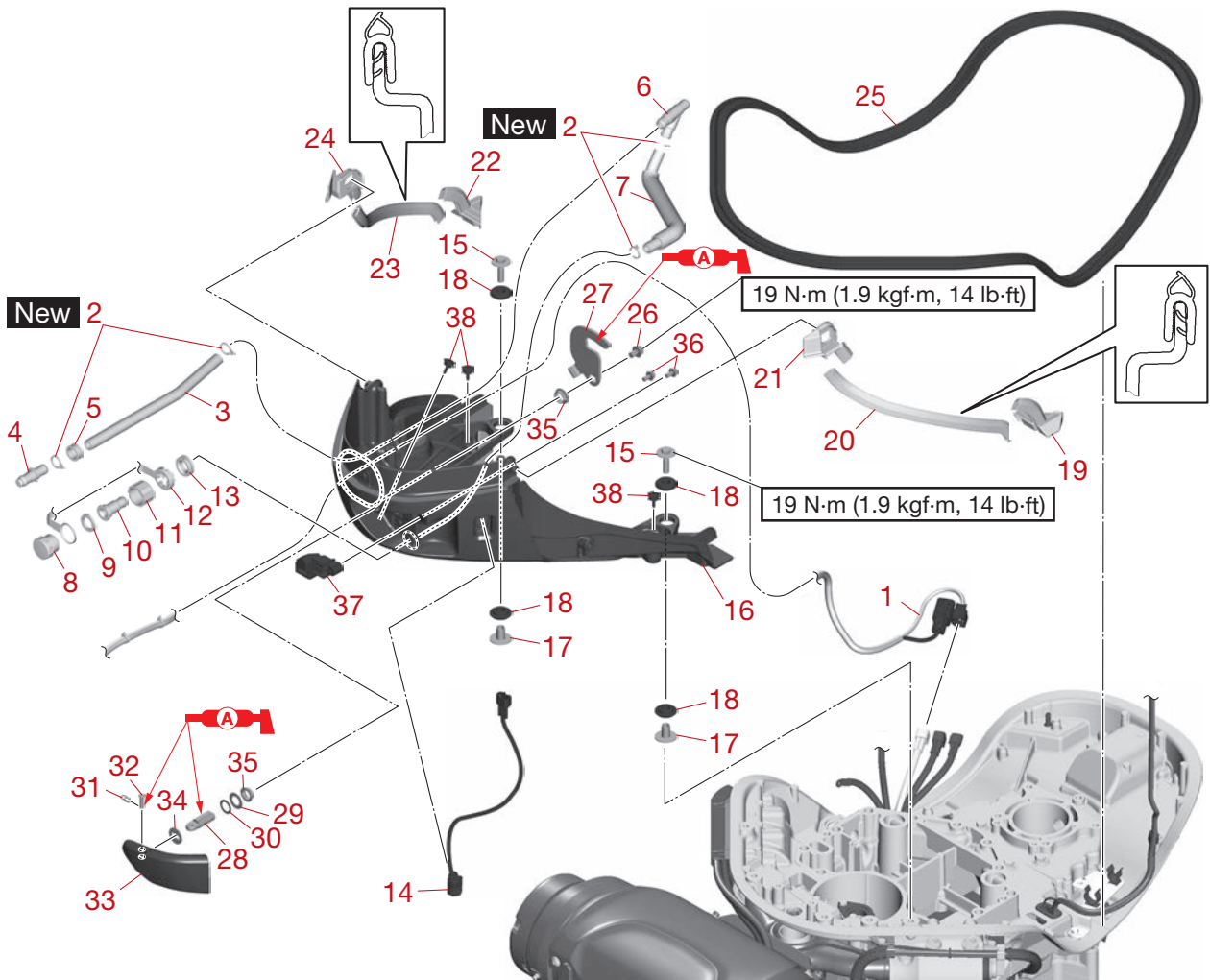
Install the shift actuator “2” so that the center of the joint pin “4” is aligned with the protrusion “a” on the shift bracket “3”.



- b. Install the bushings “1”, shift actuator assembly “a”, washer “2”, and joint pin nut (lower) “3”.
- c. Install the clip “4” in the direction shown.



Bottom cowling (front) and flushing hose



↑↓	Part name	Q'ty	Remarks
1	Lead	1	*1
2	Plastic tie	4	
3	Hose	1	
4	Nipple	1	
5	Grommet	1	
6	Joint	1	
7	Hose	1	
8	Flushing plug	1	
9	Gasket	1	
10	Joint	1	
11	Joint	1	
12	Holder	1	
13	Grommet	1	
14	Switch	1	PTT
15	Bolt M8 × 35 mm	2	
16	Bottom cowling	1	
17	Collar	2	
18	Grommet	4	
19	Rubber seal (PORT)	1	
20	Rubber seal (PORT)	1	

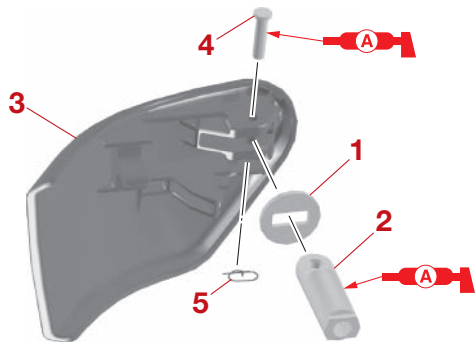
↑↓	Part name	Q'ty	Remarks
21	Grommet	1	
22	Rubber seal (STBD)	1	
23	Rubber seal (STBD)	1	
24	Grommet	1	
25	Rubber seal	1	
26	Bolt M8 × 12 mm	1	
27	Clamp lever	1	
28	Shaft	1	
29	Washer	1	
30	Wave washer	1	
31	Retaining clip	1	
32	Pin	1	
33	Lock lever	1	
34	Washer	1	
35	Bushing	2	
36	Bolt M6 × 12 mm	2	
37	Clamp plate	1	
38	Grommet	3	

*1. For the multiple engines.

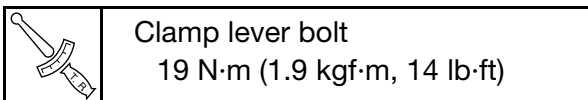
Assembling the bottom cowling (front)

1. Install:
 - Grommets
 - Clamp plate
2. Assemble:
 - Washer "1"
 - Lever shaft "2"
 - Cowling lock lever "3"
 - Pin "4"
 - Retaining clip "5"

TIP: _____
Install the pin "4" in the direction shown.



3. Install:
 - Bushings
 - Wave washer
 - Washer
 - Cowling lock lever assembly
 - Clamp lever

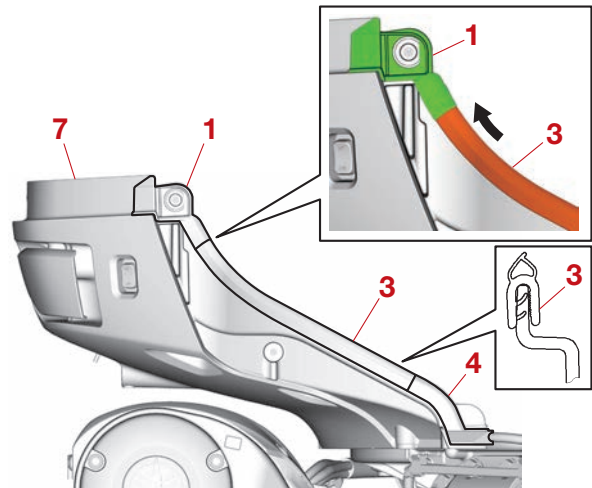


Installing the bottom cowling (front)

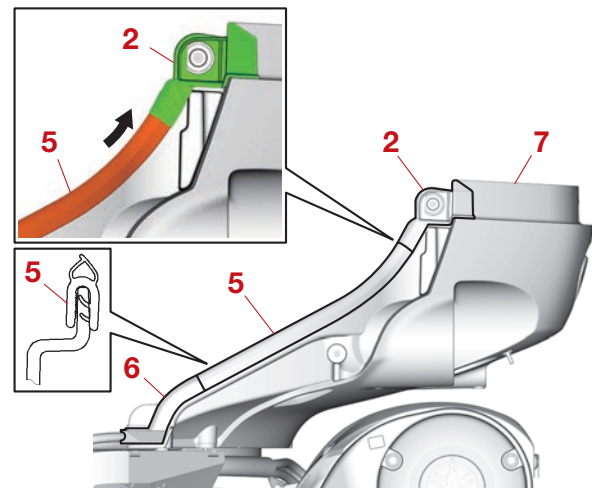
1. Install:
 - Rubber seal (onto the exhaust guide)
 - Grommet "1", "2"
 - Rubber seal (PORT) "3", "4"
 - Rubber seal (STBD) "5", "6"
 - Bottom cowling (front) "7"

TIP: _____
• Attach the grommets "1" and "2" to the bottom cowling (front) "7".
• Install the rubber seals "3" and "5" so that they are pushed against the grommets "1" and "2".

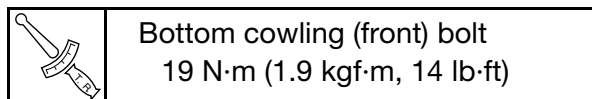
A



B



A. PORT
B. STBD



Installing the flushing hose and PTT switch

1. Install:
 - PTT switch

TIP: _____
Install the PTT switch so that the side with the "UP" mark is facing up.

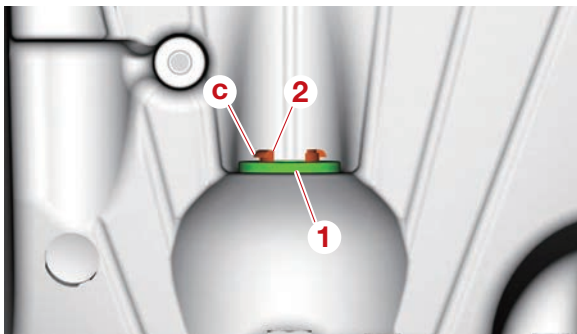
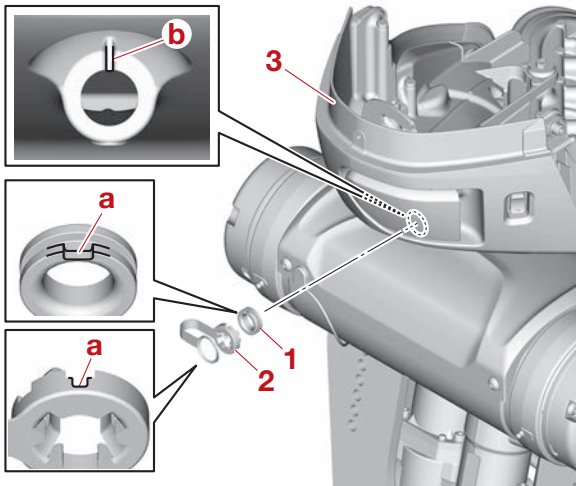
2. Install:
 - Grommet
 - Holder
 - Joint
 - Gasket
 - Flushing plug

Bottom cowling (front) and flushing hose

a. Install the grommet "1" and holder "2".

TIP:

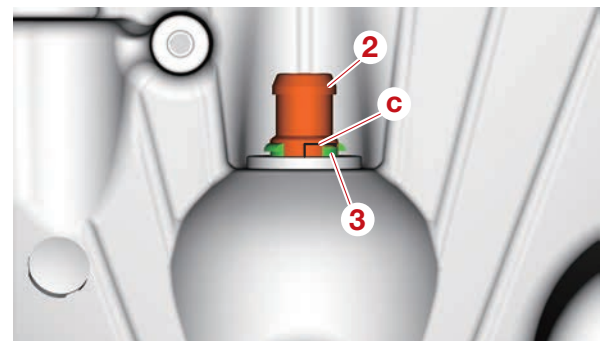
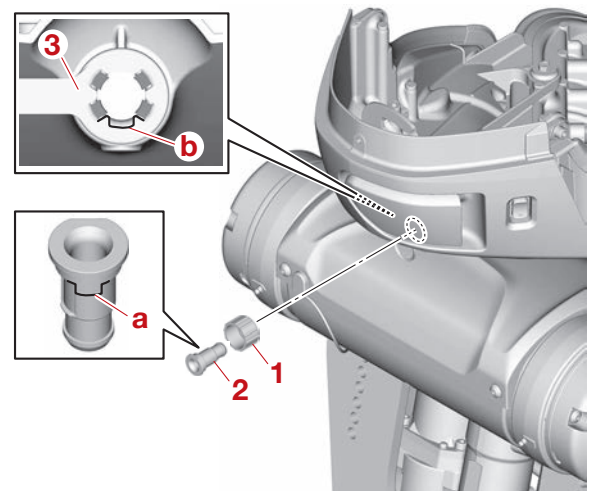
- Align the slots "a" on the grommet "1" and holder "2" with the protrusion "b" on the bottom cowling (front) "3".
- Confirm that the claw "c" of the holder "2" sticks out from the grommet "1".



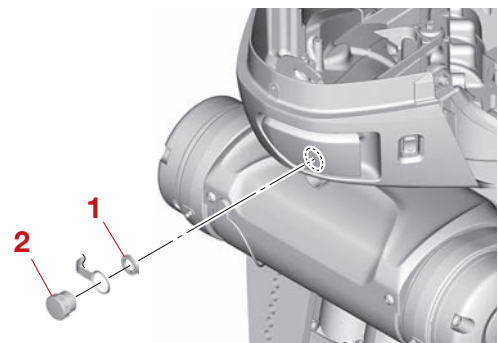
b. Install the joints "1" and "2".

TIP:

- Align the protrusion "a" on the joint "2" with the slot "b" on the holder "3".
- Confirm that the holder "3" is fitted into the groove "c" of the joint "2".



c. Install the gasket "1" and flushing plug "2".



3. Install:

- Grommets
- Hoses
- Joint
- Plastic ties **New**
- Nipple

a. Install the grommet "1" onto the hose "2" so that the grommet is aligned with the edge of the white paint mark "a" toward the white mark "b" as shown.

TIP:

Apply instant glue to the indicated points "c" to affix the grommet "1" to the hose "2".

- b. Install the nipple “3” into the hose “2”, and then fasten the hose “2” using a new plastic tie “4”.

TIP: _____

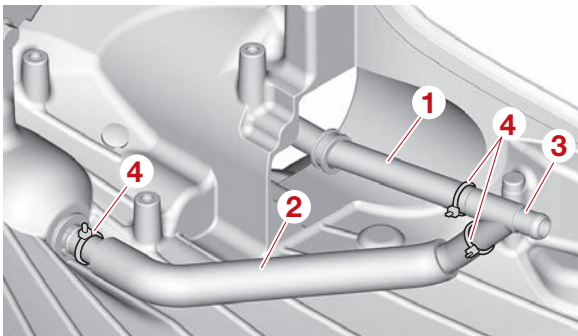
Cut off the excess end of the new plastic tie to 3 mm (0.12 in) or less.



- c. Install the hoses “1” and “2”, and then install the joint “3”.
- d. Fasten the hoses “1” and “2” using new plastic ties “4” as shown.

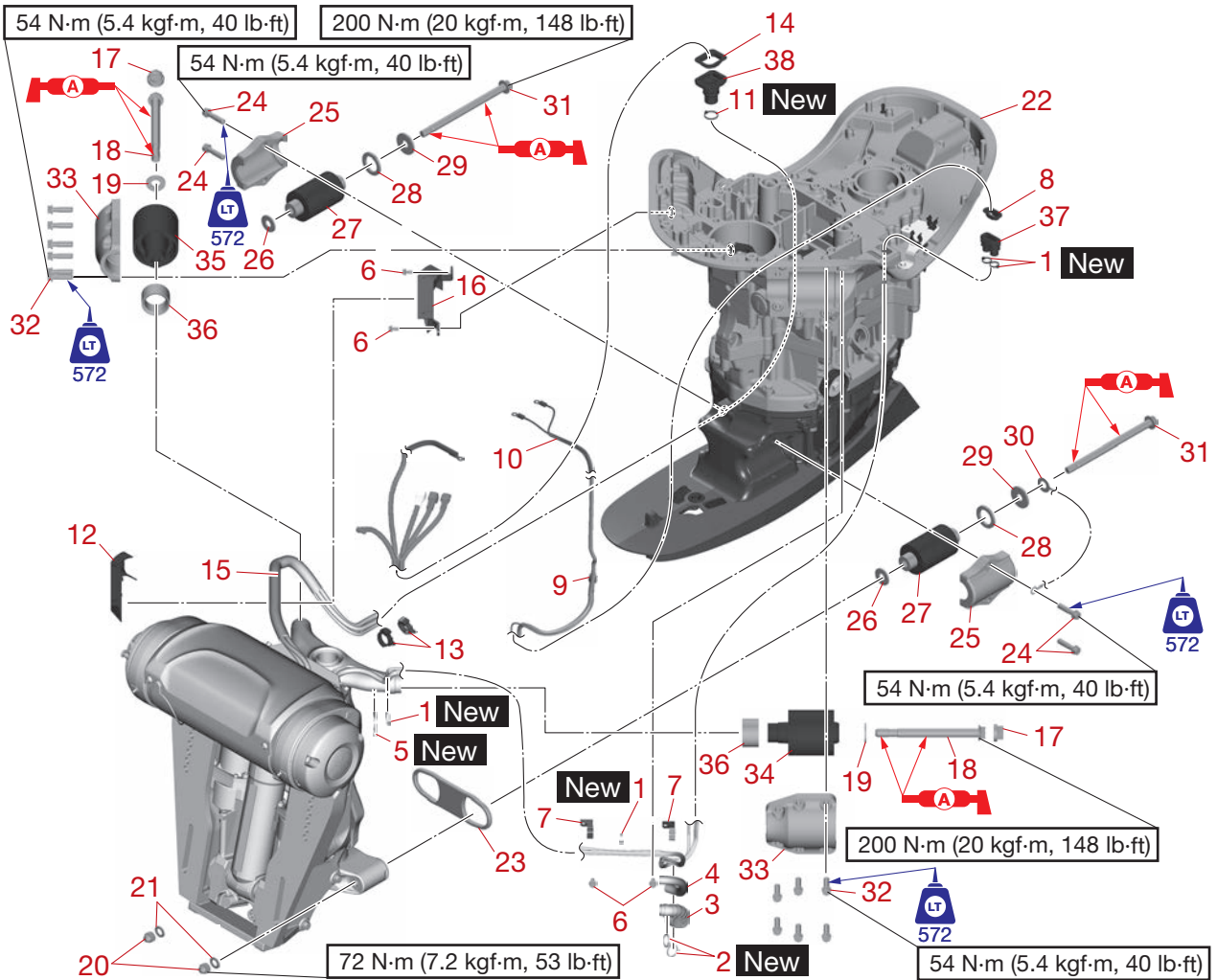
TIP: _____

Cut off the excess end of each plastic tie to 3 mm (0.12 in) or less.



4. Connect:
- SCU communication lead (for the multiple engines)

Upper case assembly and mount

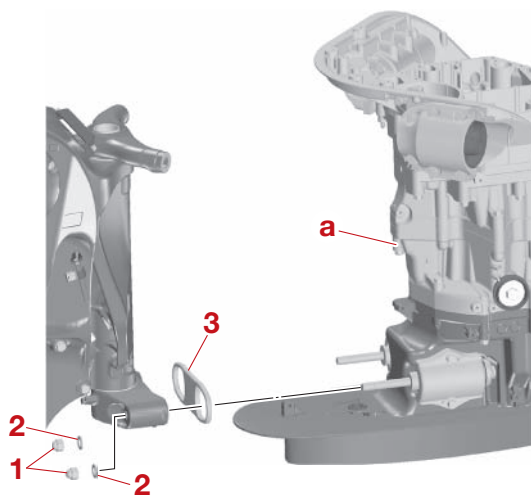


↑↓	Part name	Q'ty	Remarks
1	Plastic tie	4	
2	Plastic tie	2	
3	Corrugated tube	1	
4	Protective tube	1	
5	Plastic tie	1	
6	Bolt M6 × 12 mm	4	
7	Holder	2	
8	Cap seal	1	
9	Lead	1	
10	Lead	1	
11	Plastic tie	1	
12	Protector cover	1	
13	Holder	2	
14	Cap seal	1	
15	Lead	1	
16	Protector	1	
17	Cap	2	
18	Bolt M16 × 202 mm	2	
19	Washer	2	
20	Nut M14	2	

↑↓	Part name	Q'ty	Remarks
21	Washer	2	
22	Upper case assembly	1	
23	Damper	1	
24	Bolt M10 × 45 mm	4	
25	Bracket	2	
26	Washer	2	
27	Lower mount	2	
28	Washer	2	
29	Washer	2	
30	Ground lead	1	
31	Bolt M14 × 227 mm	2	
32	Bolt M10 × 40 mm	12	
33	Bracket	2	
34	Upper mount (PORT)	1	Red paint marks
35	Upper mount (STBD)	1	Green paint marks
36	Damper	2	
37	Grommet	1	
38	Grommet	1	

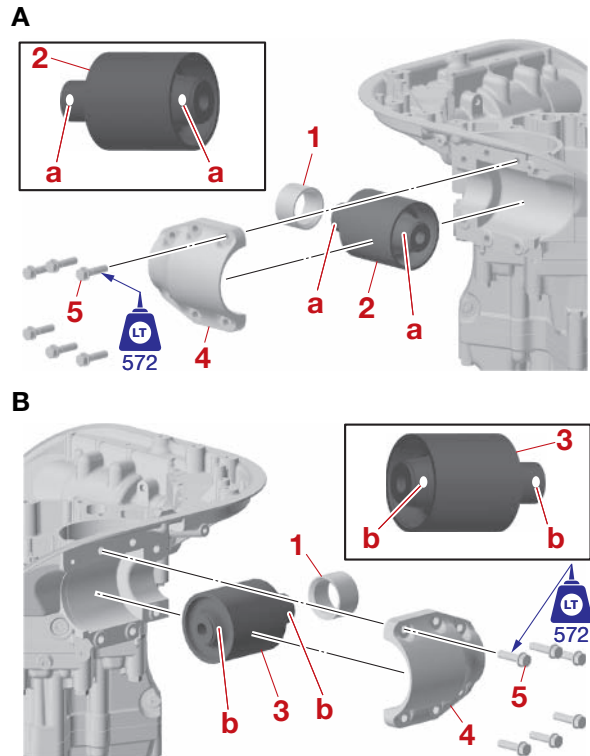
Removing the upper case assembly

1. Drain:
 - Engine oil
 - See step 5 in “Changing the engine oil by removing the drain bolt” (10-11).
2. Suspend:
- Upper case assembly
3. Remove:
- Caps
- Upper mount bolts
- Washers
4. Loosen:
- Lower mount bracket bolts
5. Remove:
- Lower mount nuts “1”
- Washers “2”
- Upper case assembly “a”
- Damper “3”



Installing the upper case assembly

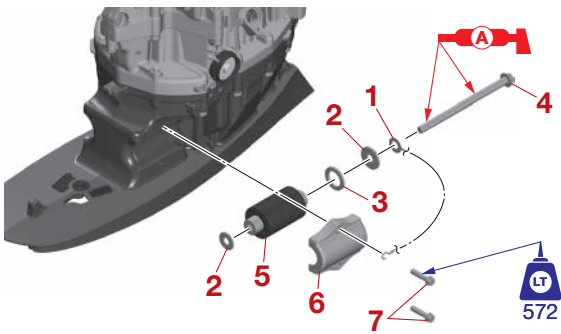
1. Install:
 - Grommets
 - Dampers “1” (into the upper mount bracket)
 - Upper mount (PORT) “2”
 - Upper mount (STBD) “3”
 - Upper mount brackets “4”
 - Upper mount bracket bolts “5” (temporarily tighten)



A. PORT
B. STBD

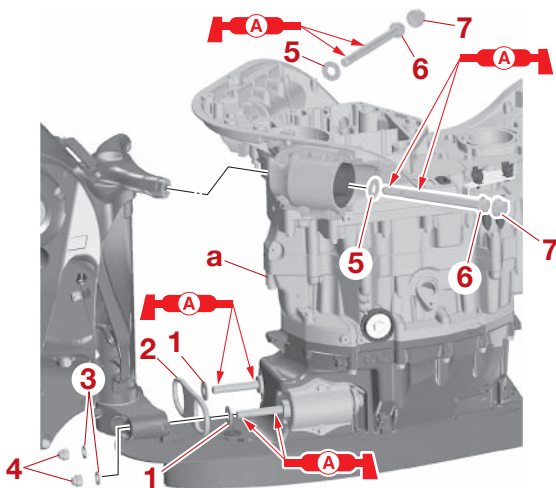
- a. Red paint marks
- b. Green paint marks
2. Install:
 - Ground lead (PORT only)
 - Washers
 - Lower mount bolts
 - Lower mounts
 - Lower mount brackets
 - Lower mount bracket bolts (temporarily tighten)
 - a. Install the ground lead “1” and washers “2” and “3” onto the lower mount bolt “4”.
 - b. Install the lower mount bolt “4” into the lower mount “5”.
 - c. Install the lower mount “5” and lower mount bracket “6”, and then tighten the lower mount bracket bolt “7” temporarily.

TIP: _____
The ground lead “1” should be installed on the same side as originally installed.



3. Install:

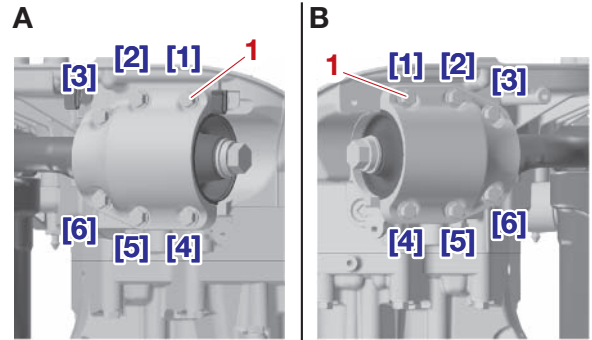
- Washers “1”
- Damper “2”
- Upper case assembly “a”
- Washers “3”
- Lower mount nuts “4”
- Washers “5”
- Upper mount bolts “6”
- Caps “7”



	Lower mount nut “4”
	72 N·m (7.2 kgf·m, 53 lb·ft)
	Upper mount bolt “6”
	200 N·m (20 kgf·m, 148 lb·ft)

4. Tighten:

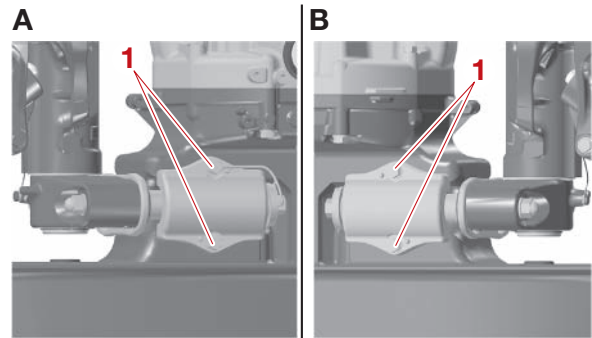
- Upper mount bracket bolts
- Lower mount bracket bolts
 - a. Tighten the upper mount bracket bolts “1” to the specified torque in the order [1], [2], and so on.



- A. PORT
B. STBD

	Upper mount bracket bolt “1”
	54 N·m (5.4 kgf·m, 40 lb·ft)

- b. Tighten the lower mount bracket bolts “1”.



- A. PORT
B. STBD

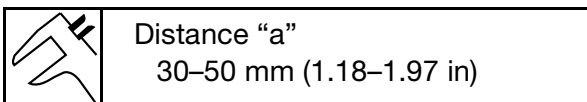
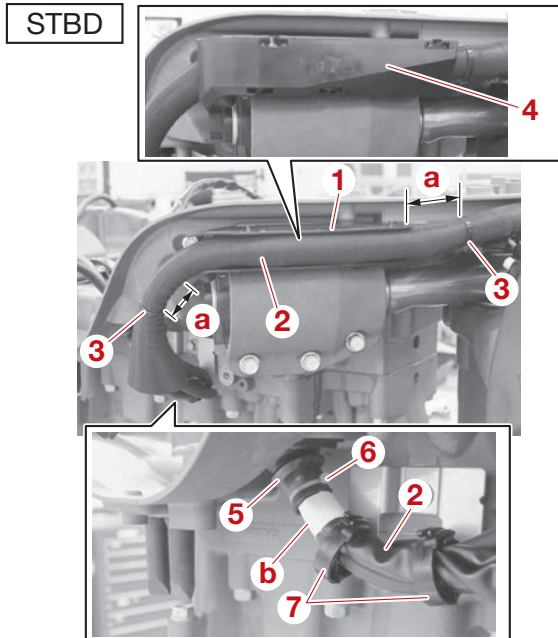
	Lower mount bracket bolt “1”
	54 N·m (5.4 kgf·m, 40 lb·ft)

5. Install:

- Protector
- SCU lead
- Holders
- Protector cover
- Grommet
- Plastic ties **New**
 - a. Install the protector “1”
 - b. Install the SCU lead “2” to the protector “1” so that the plastic ties “3” on the lead are positioned within the specified distances “a” shown from the ends of the protector.
 - c. Install the protector cover “4”.

Upper case assembly and mount

- d. Fasten the grommet "5" and SCU lead "2" using a new plastic tie "6" so that the lower edge of the grommet overlaps the white tape "b" on the lead.
- e. Fasten the SCU lead "2" using the holders "7".

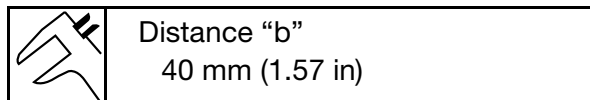
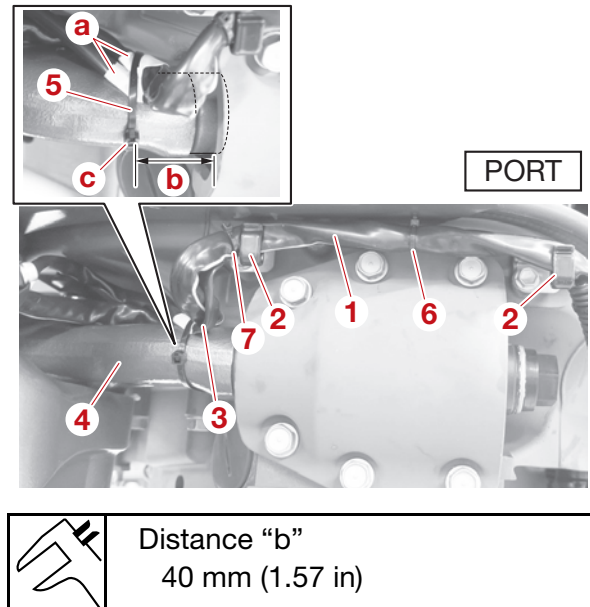


6. Install:
 - PTT motor lead
 - Holders
 - PTT sensor lead
 - Protective tube
 - Corrugated tube
 - Plastic ties **New**
 - Cap seal
 - a. Fasten the PTT motor lead "1" using the holders "2".
 - b. Fasten the PTT sensor lead "3" and PTT motor lead "1" at the white tape "a" to the steering arm "4" using a new plastic tie "5".

TIP:

- Position the plastic tie "5" the specified distance "b" from the end of the steering arm "4", and position the buckle "c" of the plastic tie at the location shown.
- Route the PTT sensor lead "3" to the inside of the holders "2".

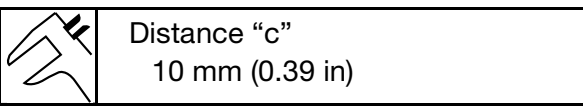
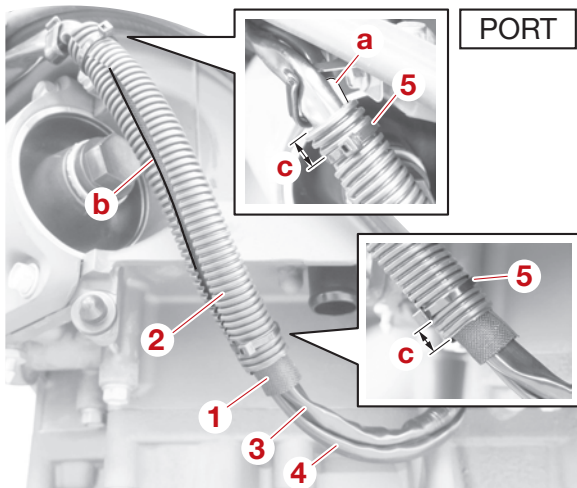
- c. Fasten the PTT motor lead "1" and PTT sensor lead "3" using a new plastic tie "6" between the holders "2" as shown.
- d. Fasten the PTT motor lead "1" and PTT sensor lead "3" using a new plastic tie "7".



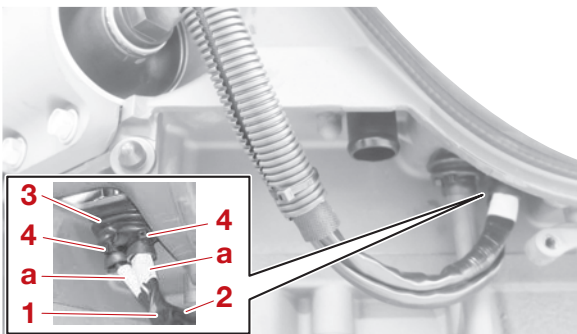
- e. Wrap the protective tube "1" and corrugated tube "2" around the PTT motor lead "3" and PTT sensor lead "4", and then fasten the tubes using new plastic ties "5" so that the end of the tube is aligned with the white tape "a" on the PTT sensor lead.

TIP:

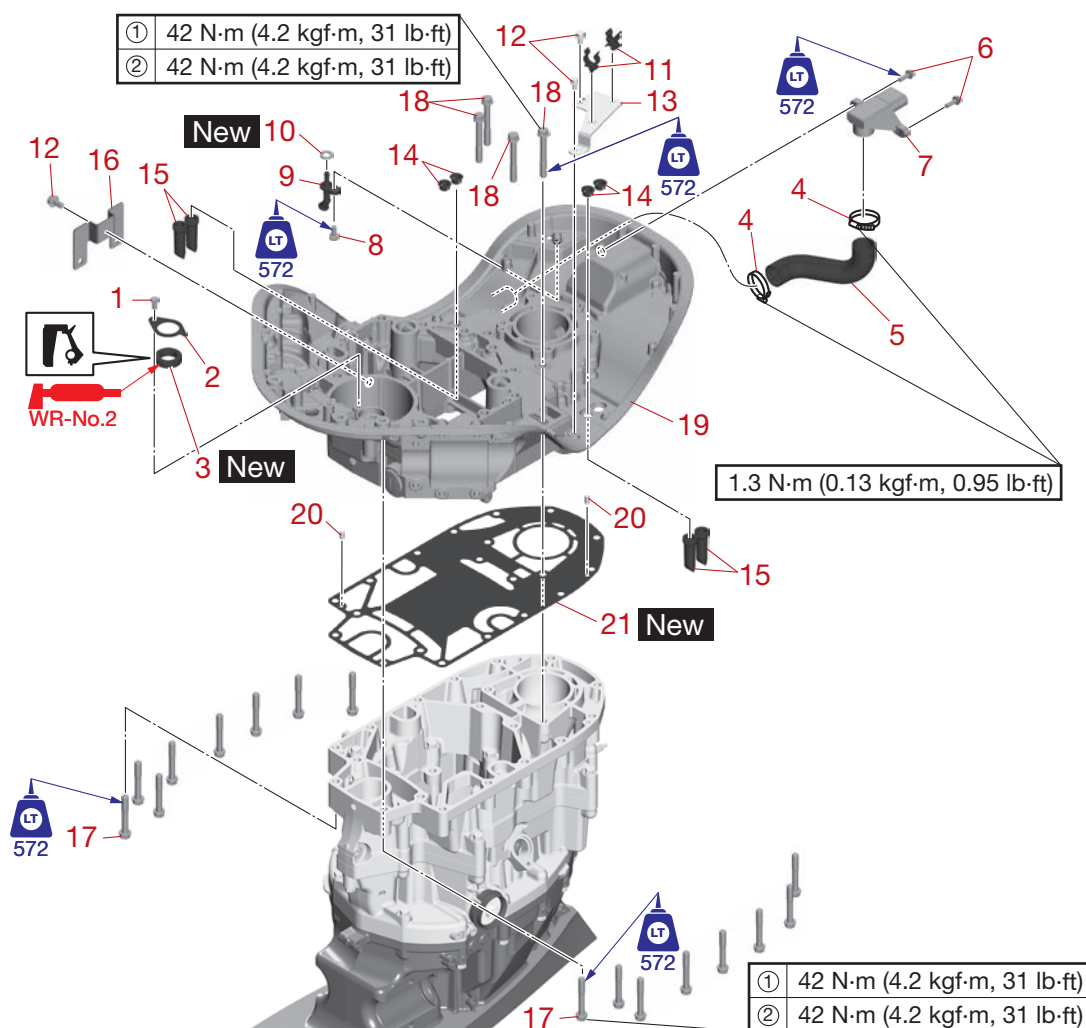
- Face the slit "b" of the corrugated tube "2" in the direction shown.
- Position the plastic ties "5" within the specified distance "c" shown from the ends of the corrugated tube.



- f. Route the PTT motor lead "1" and PTT sensor lead "2" through the grommet "3", and then fasten the leads and grommet using new plastic ties "4" so that the white tape "a" on the leads is aligned with the grommet.



Exhaust guide



↑↓	Part name	Q'ty	Remarks
1	Bolt M6 × 12 mm	1	
2	Plate	1	
3	Oil seal	1	
4	Clamp	2	
5	Hose	1	
6	Bolt M6 × 20 mm	2	
7	Silencer	1	
8	Bolt M6 × 16 mm	1	
9	Nipple	1	
10	Gasket	1	
11	Holder	2	
12	Bolt M6 × 12 mm	3	
13	Bracket	1	
14	Cap seal	4	
15	Grommet	4	
16	Bracket	1	
17	Bolt M10 × 70 mm	16	
18	Bolt M10 × 80 mm	4	
19	Exhaust guide	1	

↑↓	Part name	Q'ty	Remarks
20	Dowel	2	
21	Gasket	1	

Checking the exhaust guide

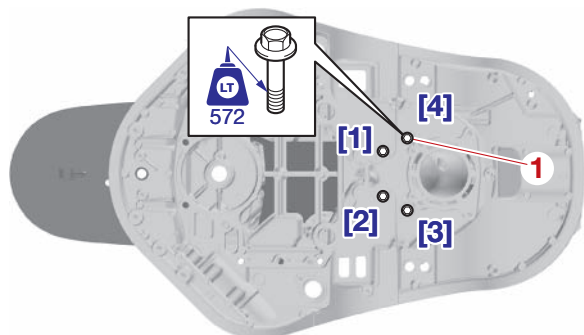
1. Clean:
 - Removed parts
2. Check:
 - Exhaust guide
 - Corroded/cracked → Replace.


Installing the exhaust guide

1. Install:
 - Dowels
 - Gasket **New**
 - Exhaust guide
2. Tighten:
 - Exhaust guide bolts (M10 × 80 mm) “1”

TIP: _____

Tighten the bolts “1” to the specified torques in 2 stages and in the order [1], [2], and so on.



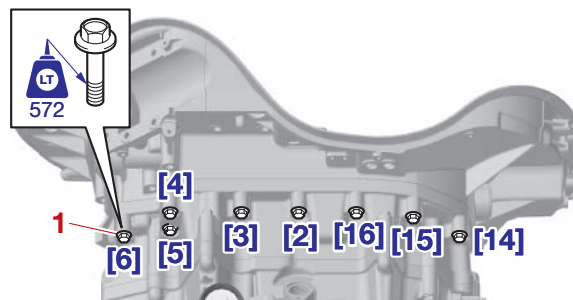
	Exhaust guide bolt (M10 × 80 mm) “1” 1st: 42 N·m (4.2 kgf·m, 31 lb·ft) 2nd: 42 N·m (4.2 kgf·m, 31 lb·ft)
-------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------

3. Tighten:
 - Exhaust guide bolts (M10 × 70 mm) “1”

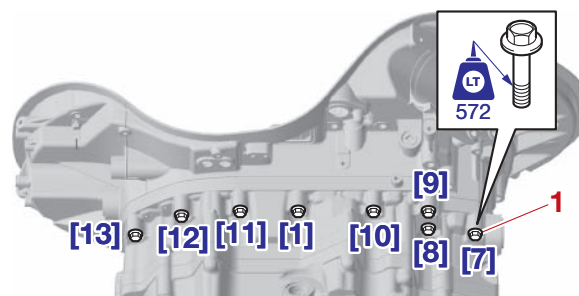
TIP: _____

Tighten the bolts “1” to the specified torques in 2 stages and in the order [1], [2], and so on.


A



B



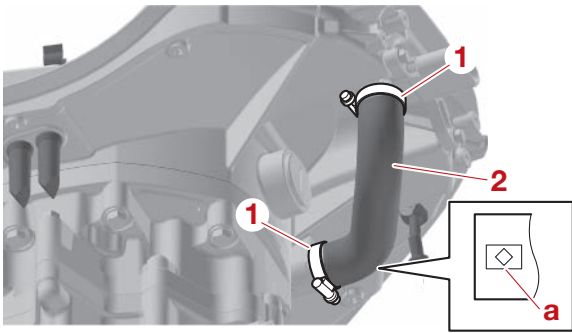
- A. PORT
B. STBD


	Exhaust guide bolt (M10 × 70 mm) “1” 1st: 42 N·m (4.2 kgf·m, 31 lb·ft) 2nd: 42 N·m (4.2 kgf·m, 31 lb·ft)
-------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------

4. Install:
 - Bracket
 - Grommets
 - Cap seals
 - Bracket
 - Holder
 - Gasket **New**
 - Nipple
 - Silencer
 - Clamps “1”
 - Hose “2”

TIP: _____

- Face the mark “a” on the hose “2” to star-board.
- Install each clamp “1” in the direction shown.

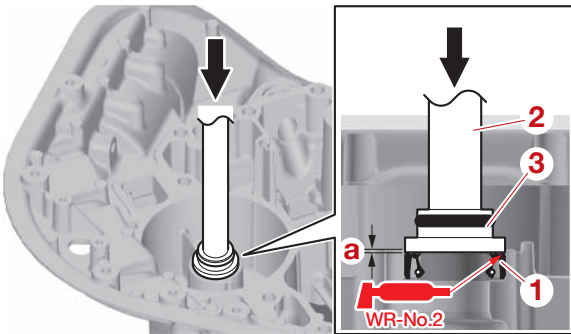


 Clamp screw
1.3 N·m (0.13 kgf·m, 0.95 lb·ft)

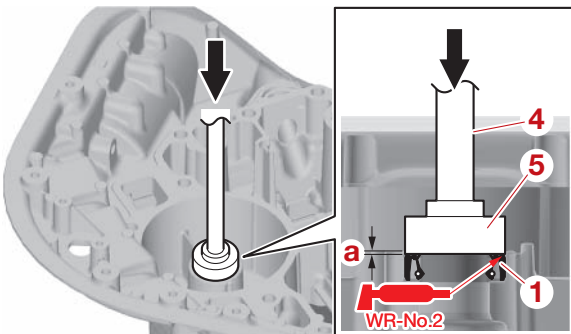
5. Install:

- Oil seal “1” **New**

A




B



A. Worldwide

B. USA and Canada

 Driver rod LL “2”
90890-06605
Ball bearing attachment “3”
90890-06636
Driver handle (small) “4”
YB-06229
Driveshaft seal installer “5”
YB-06348



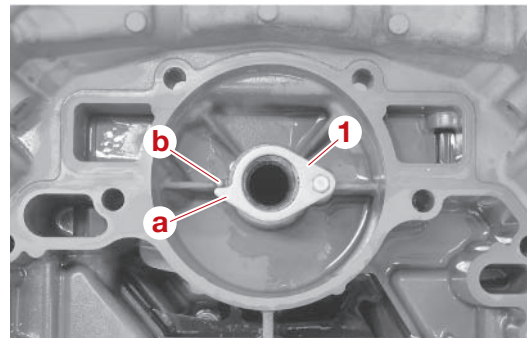
Installation depth “a”
0.30–0.90 mm (0.0118–0.0354
in)

6. Install:

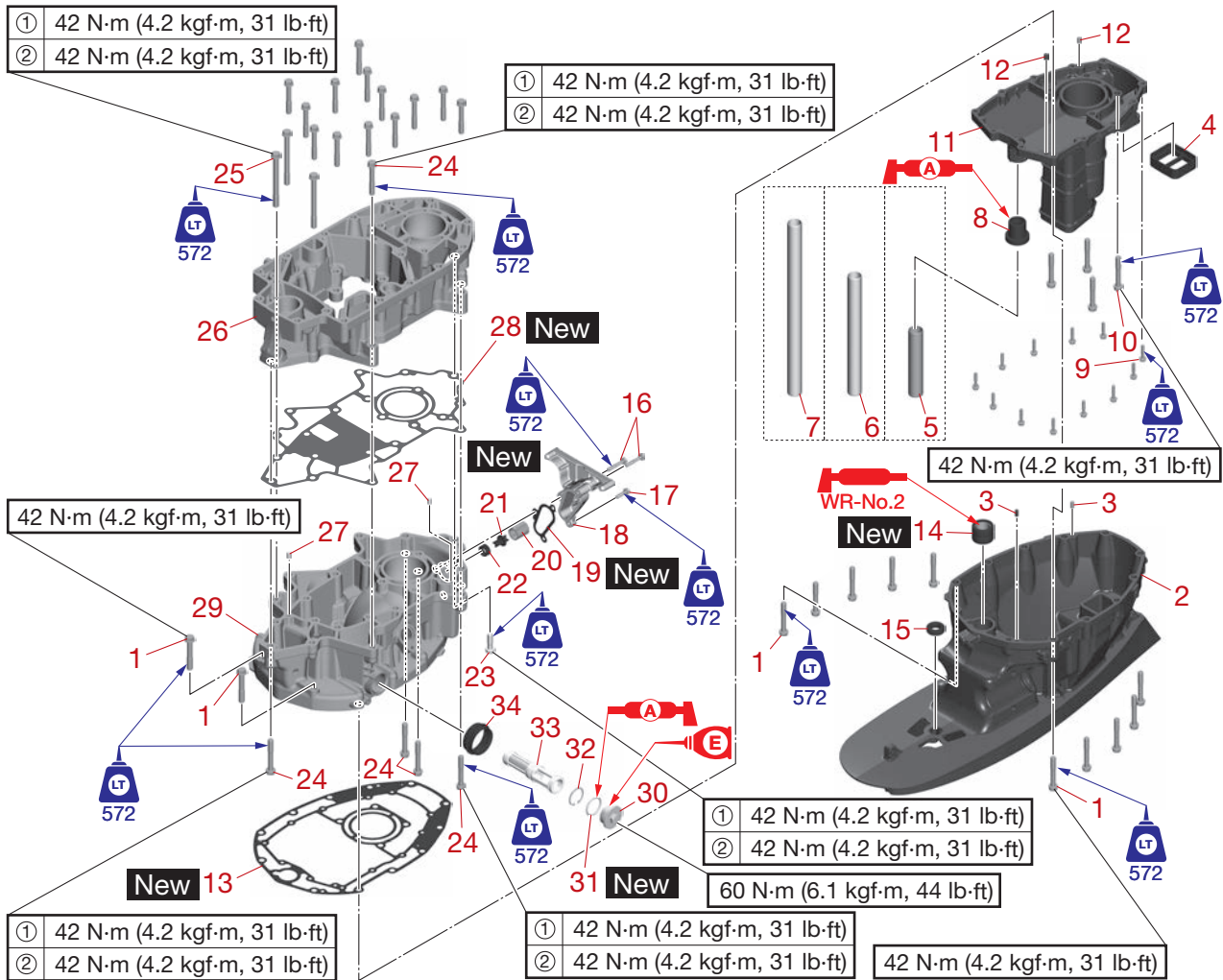
- Plate “1”

TIP:

Install the plate “1” so that the portion “a” of the plate contacts the protrusion “b”.



Upper case, muffler, and oil pan

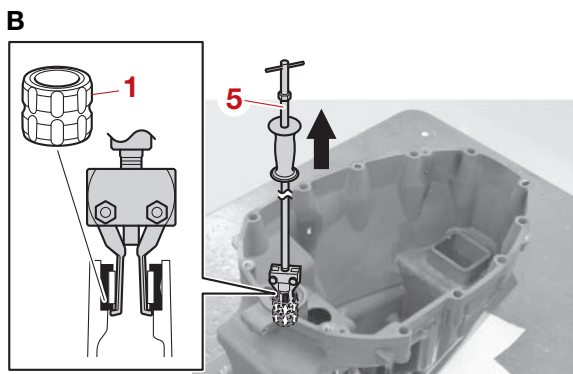
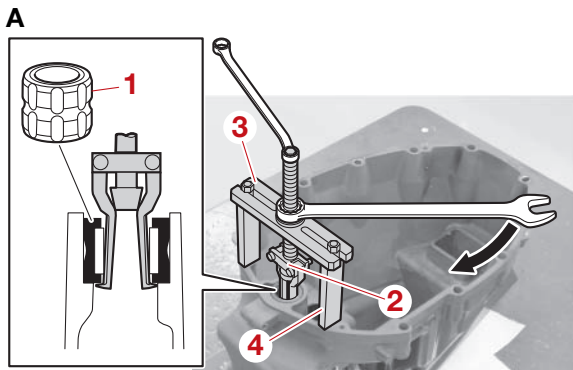


↑↓	Part name	Q'ty	Remarks
1	Bolt M10 × 70 mm	12	
2	Upper case	1	
3	Dowel	2	
4	Rubber seal	1	
5	Pipe 151 mm (5.9 in)	1	For X-transom model
6	Pipe 278 mm (10.9 in)	1	For U-transom model
7	Pipe 405 mm (15.9 in)	1	For E-transom model
8	Rubber seal	1	
9	Bolt M6 × 30 mm	12	
10	Bolt M10 × 70 mm	4	
11	Muffler	1	
12	Dowel	2	
13	Gasket	1	
14	Bushing	1	
15	Grommet	1	
16	Bolt M6 × 40 mm	2	

↑↓	Part name	Q'ty	Remarks
17	Bolt M6 × 25 mm	1	
18	Cover	1	
19	Gasket	1	
20	Spring	1	
21	PCV	1	
22	Grommet	1	
23	Bolt M10 × 35 mm	1	
24	Bolt M10 × 70 mm	18	
25	Bolt M10 × 120 mm	3	
26	Oil pan (upper)	1	
27	Dowel	2	
28	Gasket	1	
29	Oil pan (lower)	1	
30	Drain bolt M38	1	
31	O-ring	1	
32	Circlip	1	
33	Strainer	1	
34	Damper	1	

Disassembling the upper case

1. Remove:
 - Drive shaft bushing “1”



- A. Worldwide
B. USA and Canada

	Bearing puller assembly “2” 90890-06535
	Stopper guide plate “3” 90890-06501
	Stopper guide stand “4” 90890-06538
	Slide hammer “5” YB-06096

Checking the upper case

1. Clean:
 - Removed parts
2. Check:
 - Drive shaft bushing
Cracked/worn → Replace.
3. Check:
 - Upper case
Corroded/cracked → Replace.

Checking the muffler

1. Clean:
 - Removed parts

2. Check:
 - Muffler
Corroded/cracked → Replace.

Checking the PCV

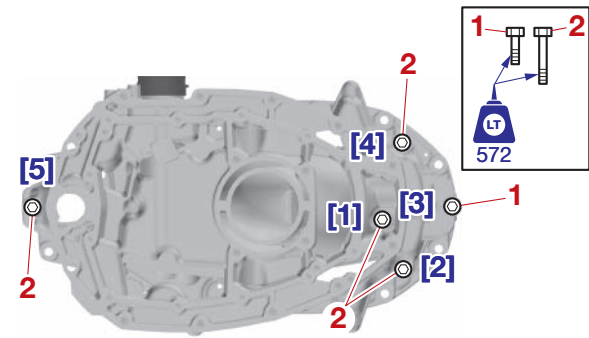
1. Check:
 - PCV
Damaged → Replace.
 - Grommet
Deformed → Replace.
 - Spring
Corroded/deformed/fatigued → Replace.


Checking the oil pan and oil strainer

1. Clean:
 - Removed parts
2. Check:
 - Oil strainer
Dirt/residue → Clean.
Cracked/damaged → Replace.
3. Check:
 - Oil pan (upper and lower)
Corroded/cracked → Replace.

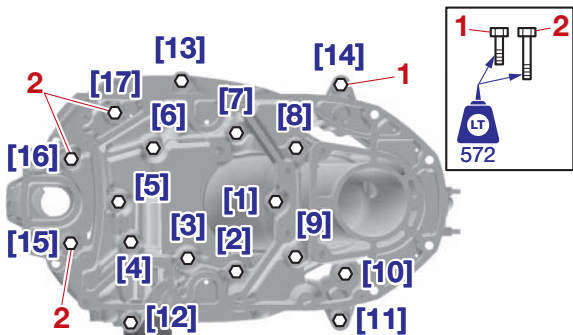
Assembling the oil pan


1. Install:
 - Damper
 - Strainer
 - Circlip
 - O-ring **New**
 - Drain bolt
 - Dowels
 - Gaskets **New**
 - Oil pan (upper and lower)
 - Grommet
 - PCV
 - Spring
 - Cover
 - a. Install the bolt (M10 × 35 mm) “1” and bolts (M10 × 70 mm) “2”, and then tighten the bolts “1” and “2” to the specified torques in 2 stages and in the order [1], [2], and so on.



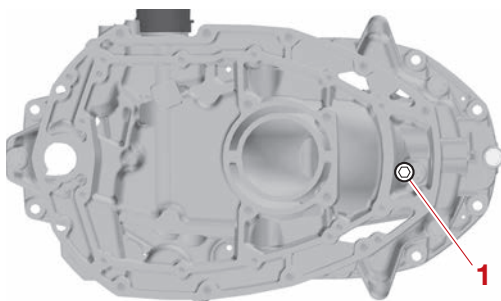
 Oil pan bolt "1", "2"
 1st: 42 N·m (4.2 kgf·m, 31 lb·ft)
 2nd: 42 N·m (4.2 kgf·m, 31 lb·ft)


b. Install the bolts (M10 × 70 mm) "1" and bolts (M10 × 120 mm) "2", and then tighten the bolts to the specified torques in 2 stages and in the order [1], [2], and so on.



 Oil pan bolt "1", "2"
 1st: 42 N·m (4.2 kgf·m, 31 lb·ft)
 2nd: 42 N·m (4.2 kgf·m, 31 lb·ft)

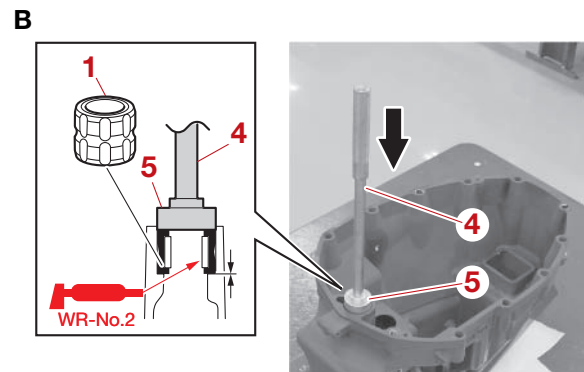
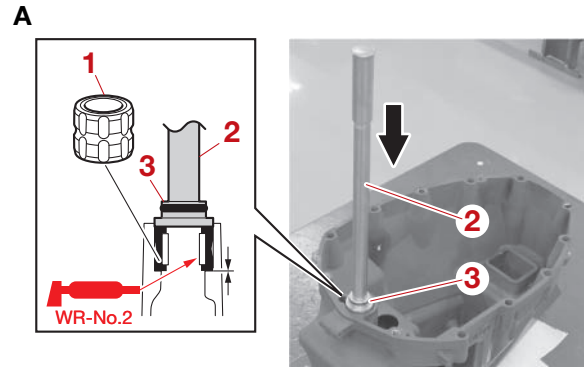
c. Tighten the bolt "1" to the specified torque.




 Oil pan bolt "1"
 42 N·m (4.2 kgf·m, 31 lb·ft)

Assembling the upper case

1. Install:
 - Grommet
 - Drive shaft bushing "1" **New**



- A. Worldwide
 B. USA and Canada

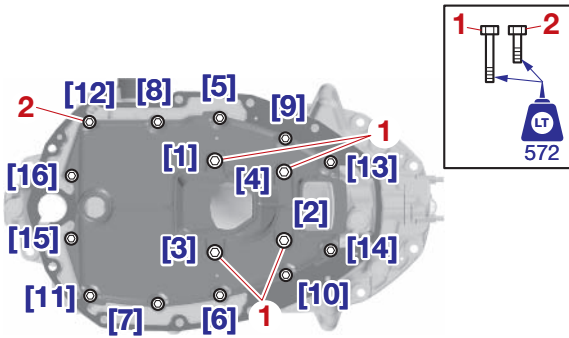
 Driver rod LL "2"
 90890-06605
 Ball bearing attachment "3"
 90890-06636
 Driver handle (small) "4"
 YB-06229
 Driveshaft seal installer "5"
 YB-06348


Installing the muffler and upper case

1. Install:
 - Dowels
 - Gasket **New**
 - Muffler
 - Muffler bolts (M10 × 70 mm) "1"
 - Muffler bolts (M6 × 30 mm) "2"
 - Rubber seals
 - Water pipe

TIP: _____

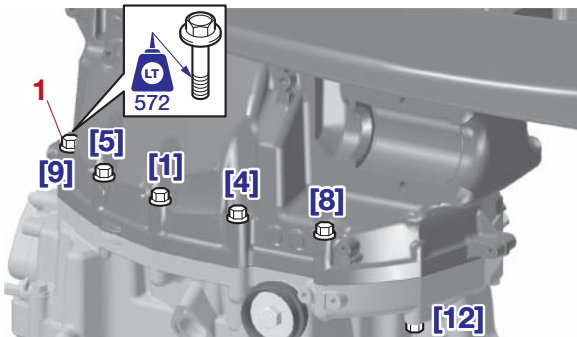
- Check that the rubber seal where the water pipe is inserted is installed properly, there is no foreign material on the rubber seal, and so on.
- Install the water pipe completely.



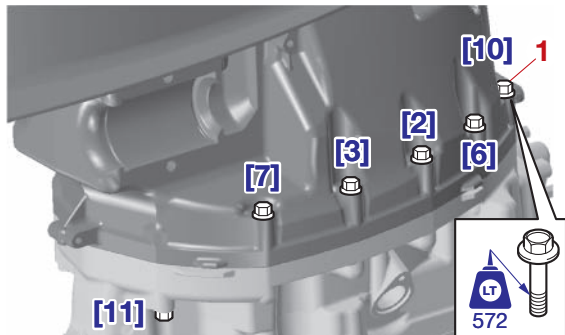
	<p>Muffler bolt "1"</p> <p>42 N·m (4.2 kgf·m, 31 lb·ft)</p>
-----------------------------------------------------------------------------------	-------------------------------------------------------------

2. Install:
- Dowels
 - Upper case


A



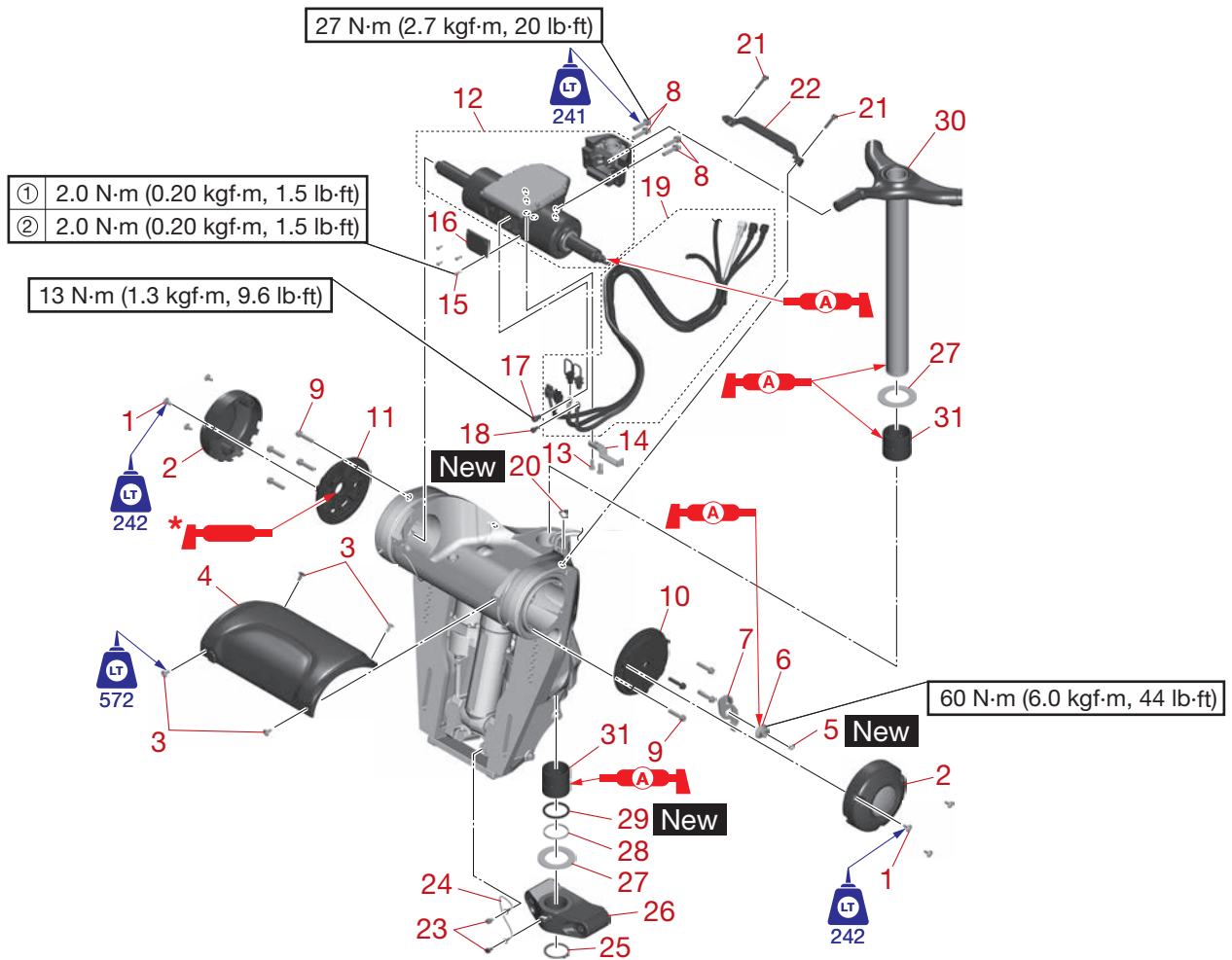
B



- A. PORT
B. STBD

	<p>Upper case bolt "1"</p> <p>42 N·m (4.2 kgf·m, 31 lb·ft)</p>
-------------------------------------------------------------------------------------	----------------------------------------------------------------

Steering actuator and steering arm



↑↓	Part name	Q'ty	Remarks
1	Bolt M6 × 14 mm	6	
2	Cover	2	
3	Bolt M6 × 14 mm	4	
4	Cover	1	
5	Cotter pin	1	
6	Nut M14	1	
7	Lever	1	
8	Bolt M8 × 35 mm	4	
9	Bolt M8 × 40 mm	8	
10	Bracket (PORT)	1	
11	Bracket (STBD)	1	
12	Steering actuator	1	
13	Bolt M6 × 18 mm	2	
14	Holder	1	
15	Bolt M4 × 10 mm	4	
16	Cover	1	
17	Bolt M8 × 8 mm	1	Positive terminal

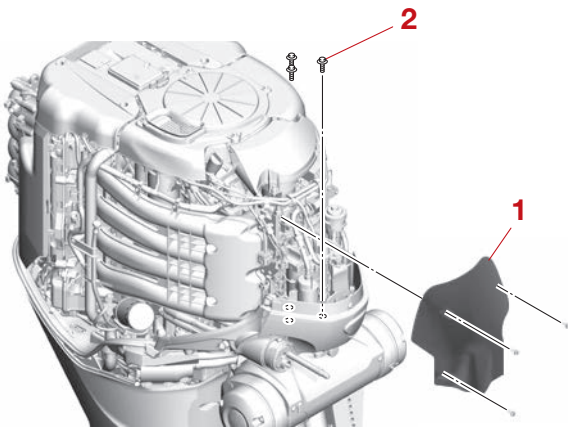
↑↓	Part name	Q'ty	Remarks
18	Bolt M6 × 8 mm	1	Negative terminal
19	Lead	1	
20	Plastic tie	1	
21	Bolt M6 × 30 mm	2	
22	Guide	1	
23	Bolt M6 × 10mm	2	
24	Ground lead	1	
25	Circlip	1	
26	Steering yoke	1	
27	Washer	2	
28	Washer	1	
29	O-ring	1	
30	Steering arm	1	
31	Bushing	2	

*. Apply Valvoline X-ALL.

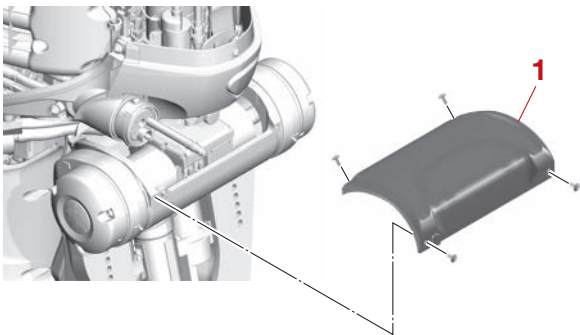
Removing the steering actuator (with the power unit installed)

The steering actuator can be removed even when the power unit is installed.

1. Remove:
 - Top cowling
 - Bottom cowling cover
 - Apron cover
See "Bottom cowling cover and apron cover" (9-1).
 - Bottom cowlings (PORT and STBD)
See "Bottom cowling (PORT and STBD)" (9-3).
 - Apron (STBD)
See "Apron" (9-8).
2. Disconnect:
 - Battery cables
3. Remove:
 - Cover "1"
 - Low-pressure fuel pump bracket bolts "2"

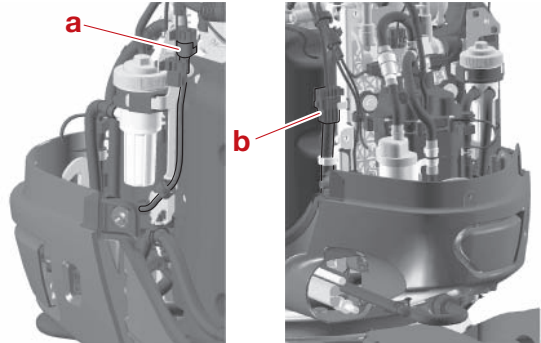


4. Remove:
 - Swivel bracket top cover "1"

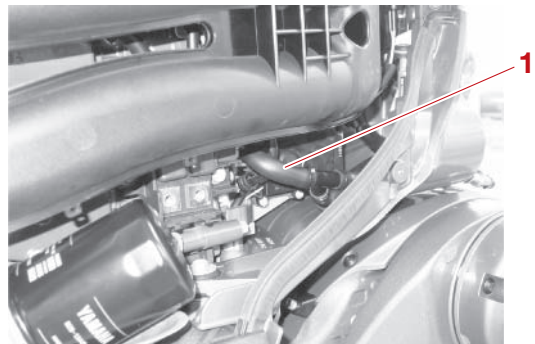


5. Remove:
 - Plastic tie
 - Grommet holder

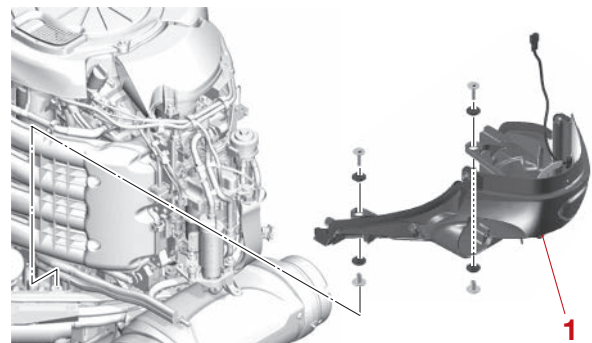
- Rigging grommet
See "Power unit assembly" (7-13).
6. Disconnect:
 - PTT switch coupler "a"
 - Main wire harness coupler "b"



7. Disconnect:
 - Flushing hose "1"
(from the joint)

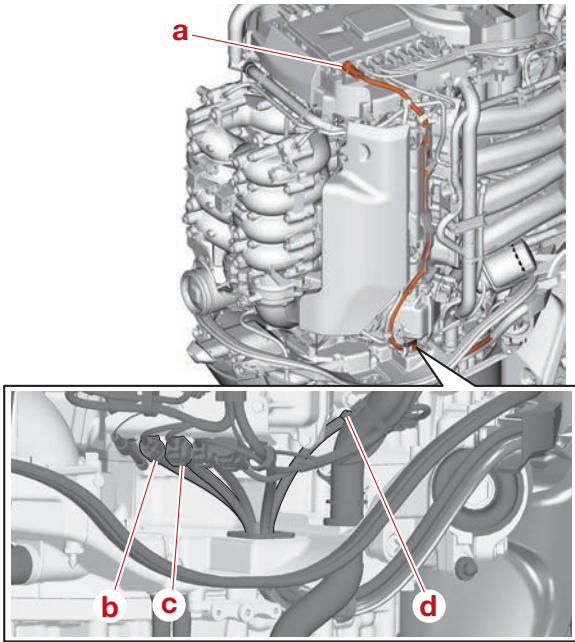


8. Remove:
 - Bottom cowling (front) "1"



9. Remove:
 - Dipstick guide
See "Intake manifold" (6-24).
 - Shroud cover
See "Shroud cover and terminal cover" (7-5).
10. Disconnect:
 - SCU positive terminal "a"
 - SCU couplers "b", "c"
 - SCU ground terminal "d"

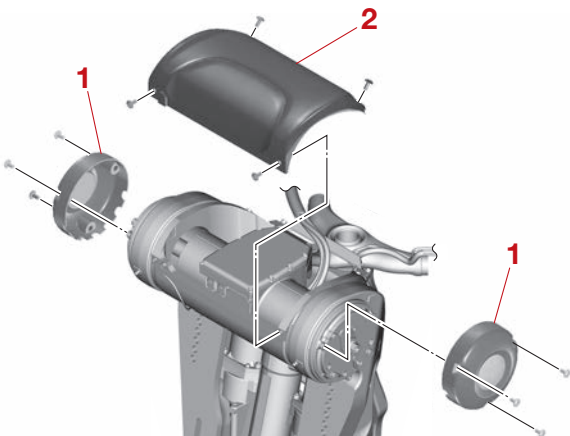
Steering actuator and steering arm



11. Remove:
 - Protector cover
 - SCU lead
(from the holders and exhaust guide)
See "Upper case assembly and mount" (9-20).
12. Remove:
 - Steering actuator
See "Removing the power steering unit (with the power unit removed)" (9-34).

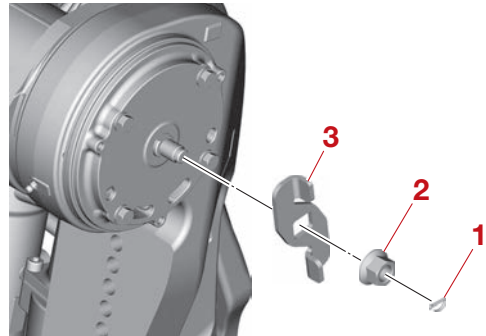
Removing the power steering unit (with the power unit removed)

1. Remove:
 - Clamp bracket side covers "1"
 - Swivel bracket top cover "2"

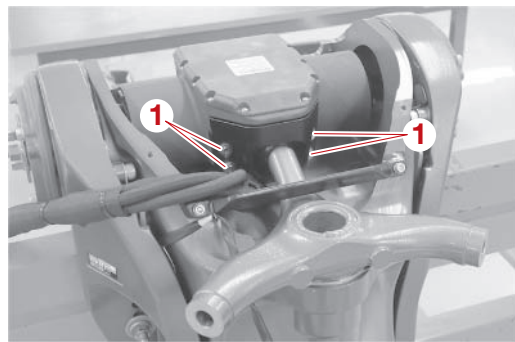


2. Remove:
 - Steering actuator

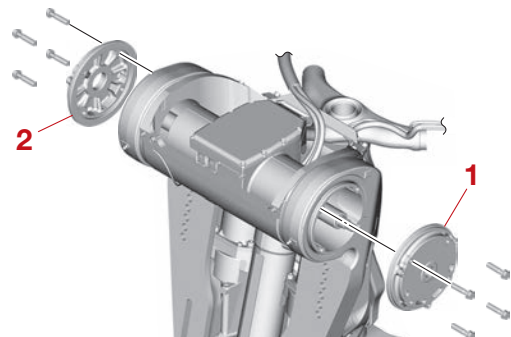
- a. Remove the cotter pin "1", nut "2", and manual steering lever "3".



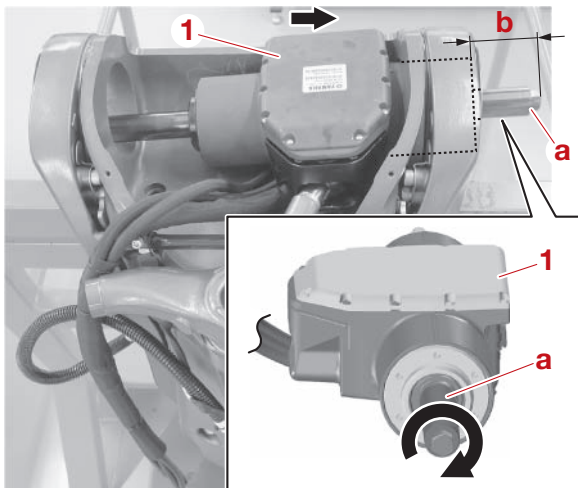
- b. Remove the bolts "1".




- c. Remove the steering actuator brackets "1" and "2".

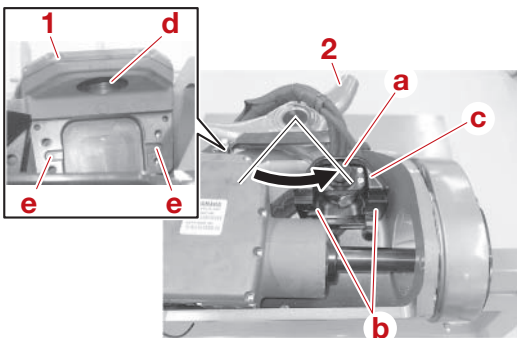


- d. Turn the shaft "a" of the steering actuator "1" clockwise until the starboard end of the shaft is the specified length "b", and then move the steering actuator to the starboard side as shown.

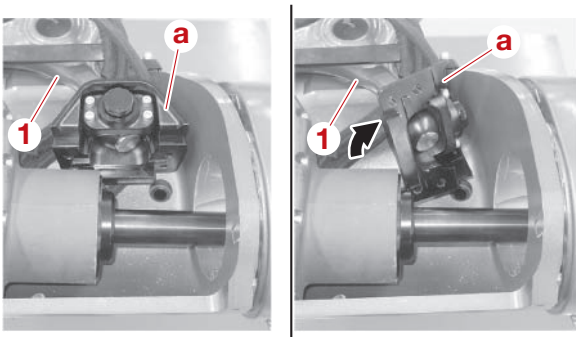


 Length "b"
50 mm (1.97 in)

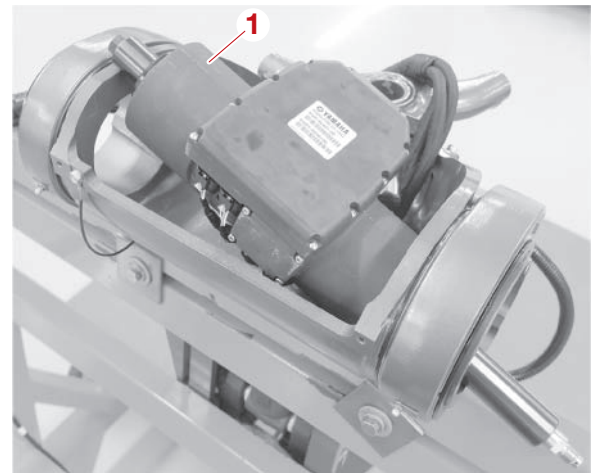
e. Remove the protrusions "a" and "b" on the steering arm joint "c" from the hole "d" and slots "e" in the steering actuator "1", and then move the steering arm "2" in the direction of the arrow.



f. Turn the steering arm joint "a" as shown and remove the joint from the steering arm "1".



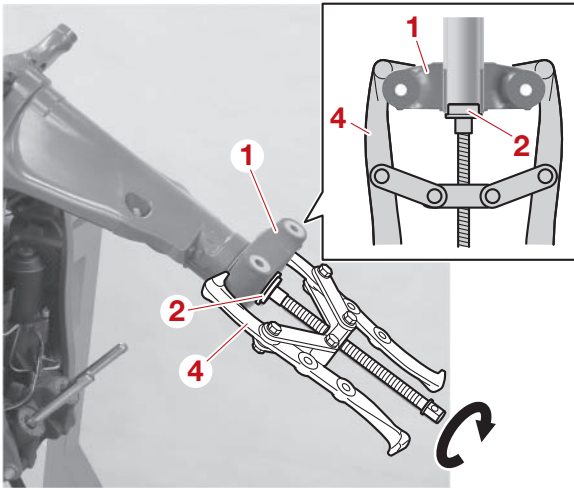
g. Remove the steering actuator "1".



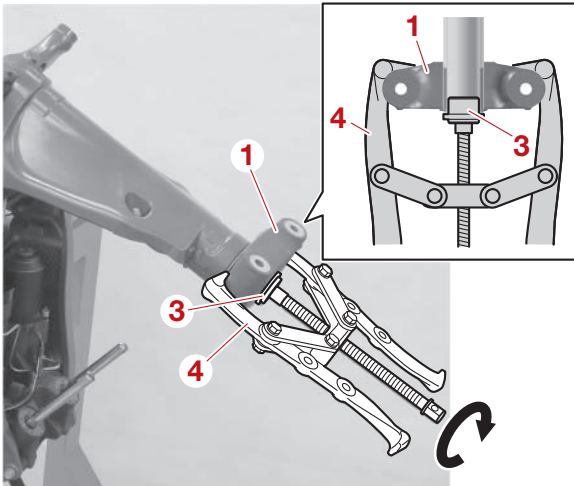
Removing the steering arm

1. Remove:
 - Ground lead
 - Circlip
 - Steering yoke "1"
 - Washers
 - Steering arm
 - O-ring
 - Steering arm bushings

A



B



A. Worldwide
B. USA and Canada



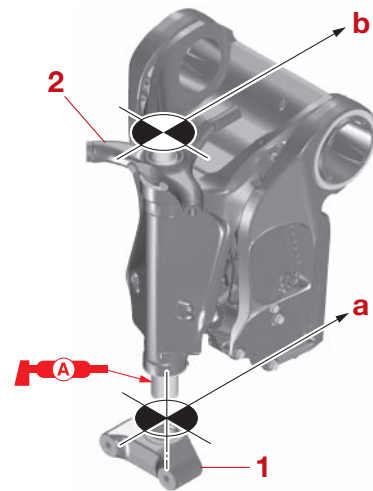
Needle bearing attachment "2"
90890-06608
Driveshaft needle bearing installer
"3"
YB-06231
Gear puller "4"
(commercially available)

Checking the steering arm and steering arm joint

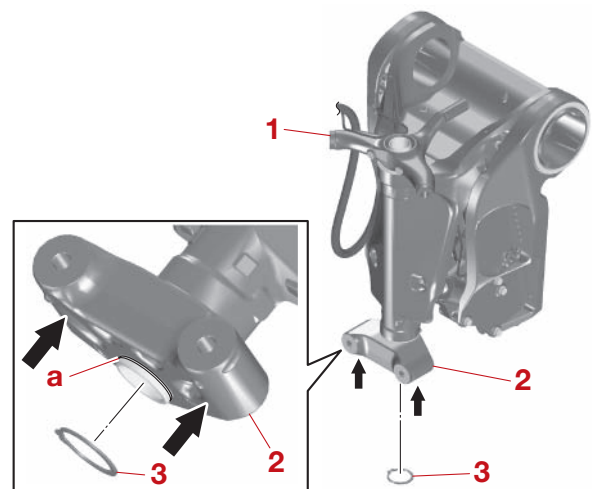
- Check:
 - Steering arm
Worn → Replace.
 - Steering arm joint
Cracked/worn → Replace the steering actuator.

Installing the steering arm

- Install:
 - Steering arm bushings (into the swivel bracket)
 - Washers
 - Steering arm
 - O-ring **New**
 - Steering yoke
 - Circlip
 - Ground lead
 - Install the steering yoke "1" so that it faces the same direction as the steering arm "2" (aligning "a" with "b").

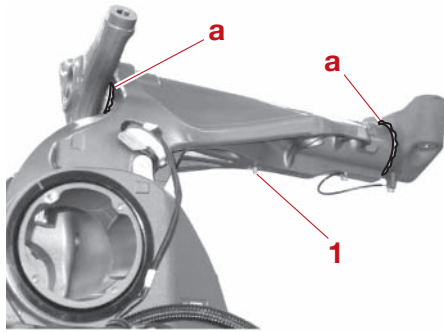


- Hold the steering arm "1", and then strike the steering yoke "2" using a copper hammer until the groove "a" for installing the circlip is visible.
- Install the circlip "3"



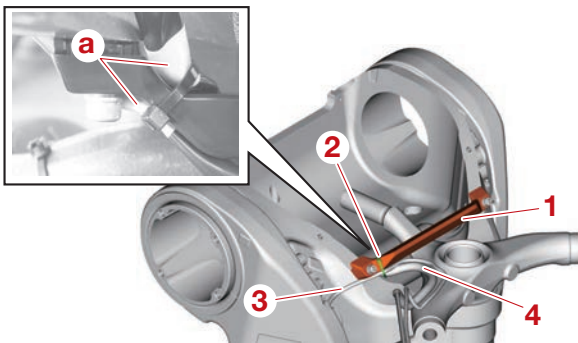
- Inject:
 - Grease

TIP: _____
 Inject grease into the grease nipple “1” until grease “a” comes out from both the upper and lower bushings.



3. Install:
 - Guide “1”
 - Plastic tie “2” **New**

TIP: _____
 Route the PTT sensor lead “3” under the guide “1”, and then fasten the PTT sensor lead “3” and PTT motor lead “4” at the white tape “a” using a new plastic tie “2”.



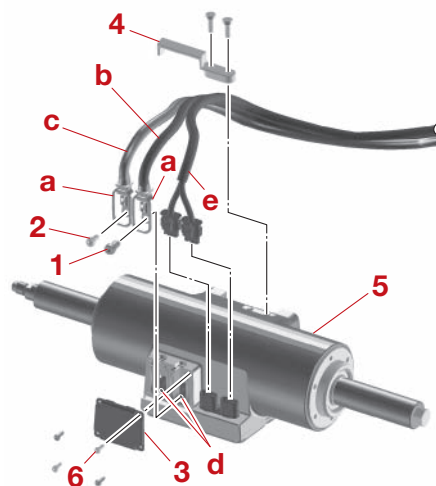
Installing the steering actuator (with the power unit removed)

If the steering actuator is removed, the calibration is required after installation. See “Calibration (6X9 Digital Electronic Control)” (3-66).

1. Install:
 - SCU lead (to the steering actuator)
 - SCU positive terminal bolt “1”
 - SCU negative terminal bolt “2”
 - Terminal cover “3”
 - Holder “4”

TIP: _____

- Fit the grommets “a” on the SCU positive lead “b” and SCU negative lead “c” into the slots “d” in the steering actuator “5”, and then install the terminal cover “3” to the steering actuator.
- Position the SCU negative lead “c”, SCU positive lead “b”, and SCU signal lead “e” in the order listed from port to starboard so that the leads do not overlap, and then fasten the leads using the holder “4”.

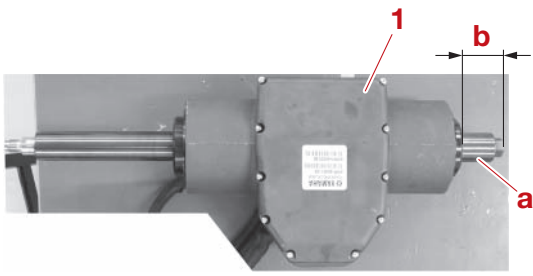


	SCU positive terminal bolt “1”
	13 N·m (1.3 kgf·m, 9.6 lb·ft)
	Terminal cover bolt “6”
	1st: 2.0 N·m (0.20 kgf·m, 1.5 lb·ft)
	2nd: 2.0 N·m (0.20 kgf·m, 1.5 lb·ft)

2. Install:
 - Steering actuator
 - a. Turn the shaft “a” of the steering actuator “1” until the starboard end of the shaft is the specified length “b”.

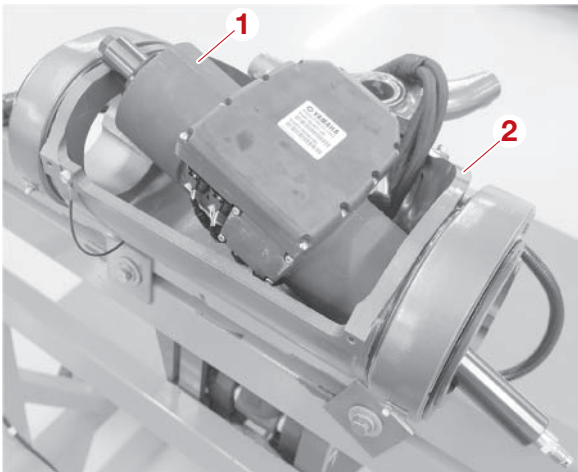
TIP: _____
 To decrease the shaft length “b”, turn the shaft “a” clockwise.
 To increase the shaft length “b”, turn the shaft “a” counterclockwise.

Steering actuator and steering arm



Length "b"
50 mm (1.97 in)

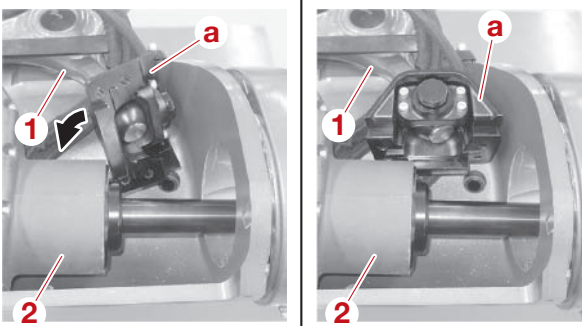
- b. Install the steering actuator "1" to the swivel bracket "2".



- c. Install the steering arm joint "a" onto the steering arm "1", and then turn the steering arm joint "a" as shown.

TIP:

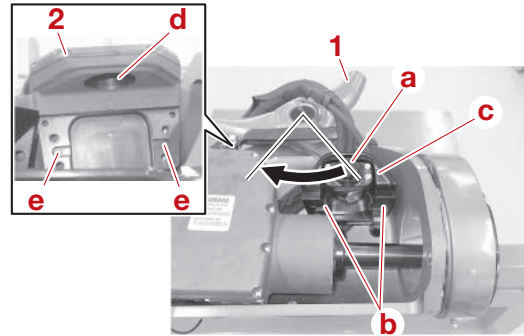
Move the steering actuator "2" to the starboard side as shown to create space for installing the steering arm joint "a".



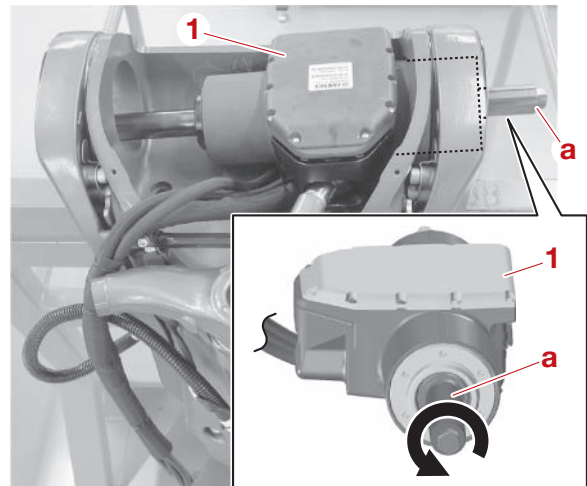
- d. Move the steering arm "1" in the direction of the arrow, fit the protrusions "a" and "b" on the steering arm joint "c"

into the hole "d" and slots "e" in the steering actuator "2", and install the steering arm joint to the steering actuator.

- e. Install the steering arm joint bolts temporarily.



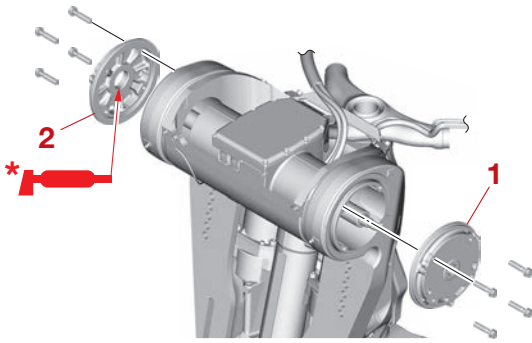
- f. Turn the shaft "a" of the steering actuator "1" counterclockwise to position the shaft in the center steering position.



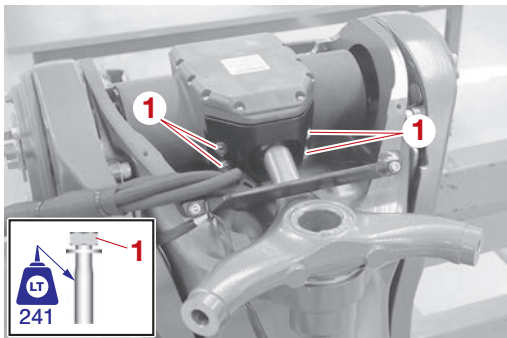
- g. Install the steering actuator brackets "1" and "2".

TIP:

Install the steering actuator bracket "1" with the smaller center hole on the port side, and install the steering actuator bracket "2" with the larger center hole on the starboard side.



- *. Apply Valvoline X-ALL.
h. Tighten the steering arm joint bolts "1".

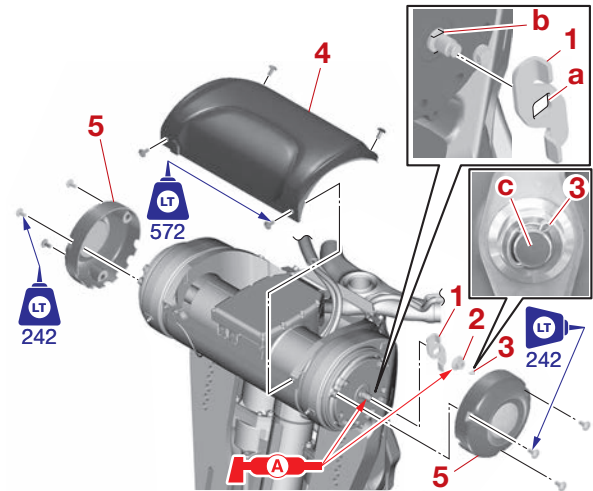


	Steering arm joint bolt "1" 27 N·m (2.7 kgf·m, 20 lb·ft)
--	-------------------------------------------------------------

3. Install:
- Manual steering lever "1"
 - Steering shaft end nut "2"
 - Cotter pin "3" **New**
 - Swivel bracket top cover "4"
 - Clamp bracket side covers "5"

TIP: _____

- Align the hole "a" in the manual steering lever "1" with the flat sides "b" of the steering shaft.
- Bend the ends of the cotter pin "3" along the shaft "c" as shown.



	Steering shaft end nut "2" 60 N·m (6.0 kgf·m, 44 lb·ft)
--	------------------------------------------------------------

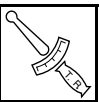
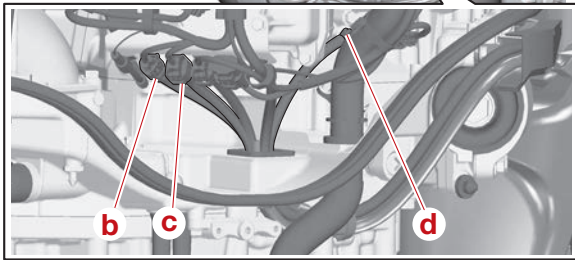
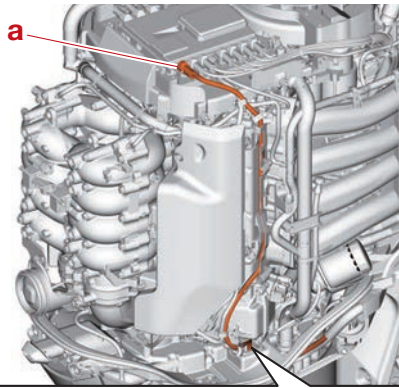
Installing the steering actuator (with the power unit installed)

If the steering actuator is removed, the calibration is required after installation. See "Calibration (6X9 Digital Electronic Control)" (3-66).

1. Install:
 - SCU lead
 - Steering actuator
See "Installing the steering actuator (with the power unit removed)" (9-37).
2. Connect:
 - SCU positive terminal "a"
 - SCU couplers "b", "c"
 - SCU ground terminal "d"

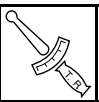
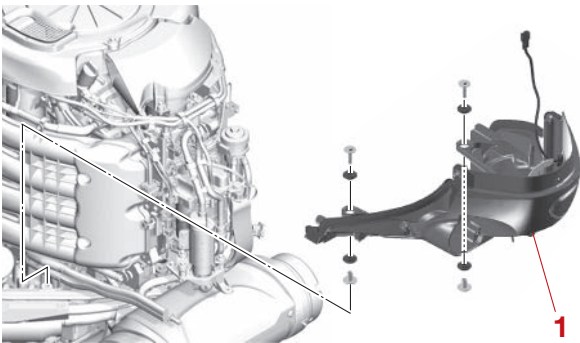
NOTICE _____

When tightening the electrical management box terminal nuts, do not exceed the specified torque. Otherwise, the base of the electrical management box could be damaged.



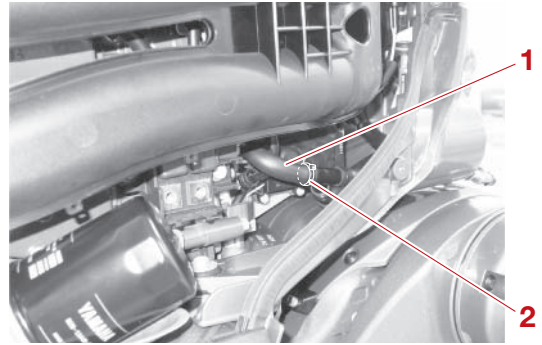
Electrical management box terminal nut
7.6 N·m (0.76 kgf·m, 5.6 lb·ft)

3. Install:
 - Protector cover
 - SCU lead (to the holders)
See step 5 in “Installing the upper case assembly” (9-21).
 - Dipstick guide
See “Intake manifold” (6-24).
4. Install:
 - Bottom cowling (front) “1”

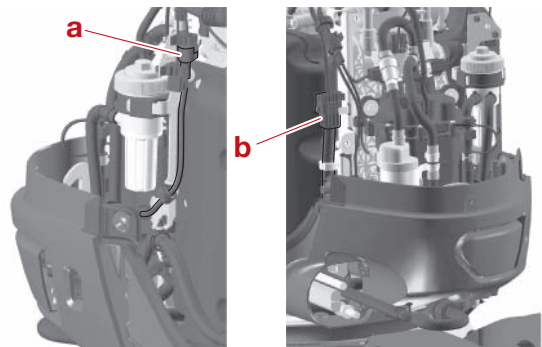


Bottom cowling (front) bolt
19 N·m (1.9 kgf·m, 14 lb·ft)

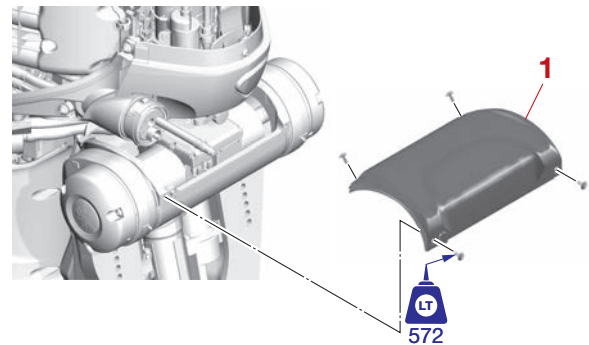
5. Connect:
 - Flushing hose “1” (to the joint)
 - Plastic tie “2” **New**



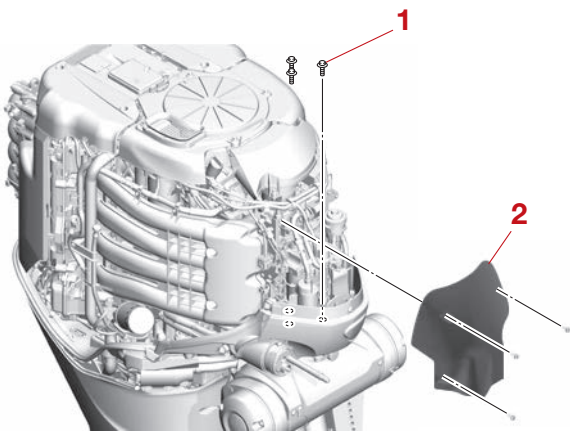
6. Connect:
 - PTT switch coupler “a”
 - Main wire harness coupler “b”



7. Install:
 - Rigging grommet
 - Grommet holder
 - Plastic tie
See “Rigging grommet mounting” (3-13).
8. Install:
 - Swivel bracket top cover “1”



9. Install:
 - Low-pressure fuel pump bracket bolts “1”
 - Cover “2”



10. Connect:

- Battery cables

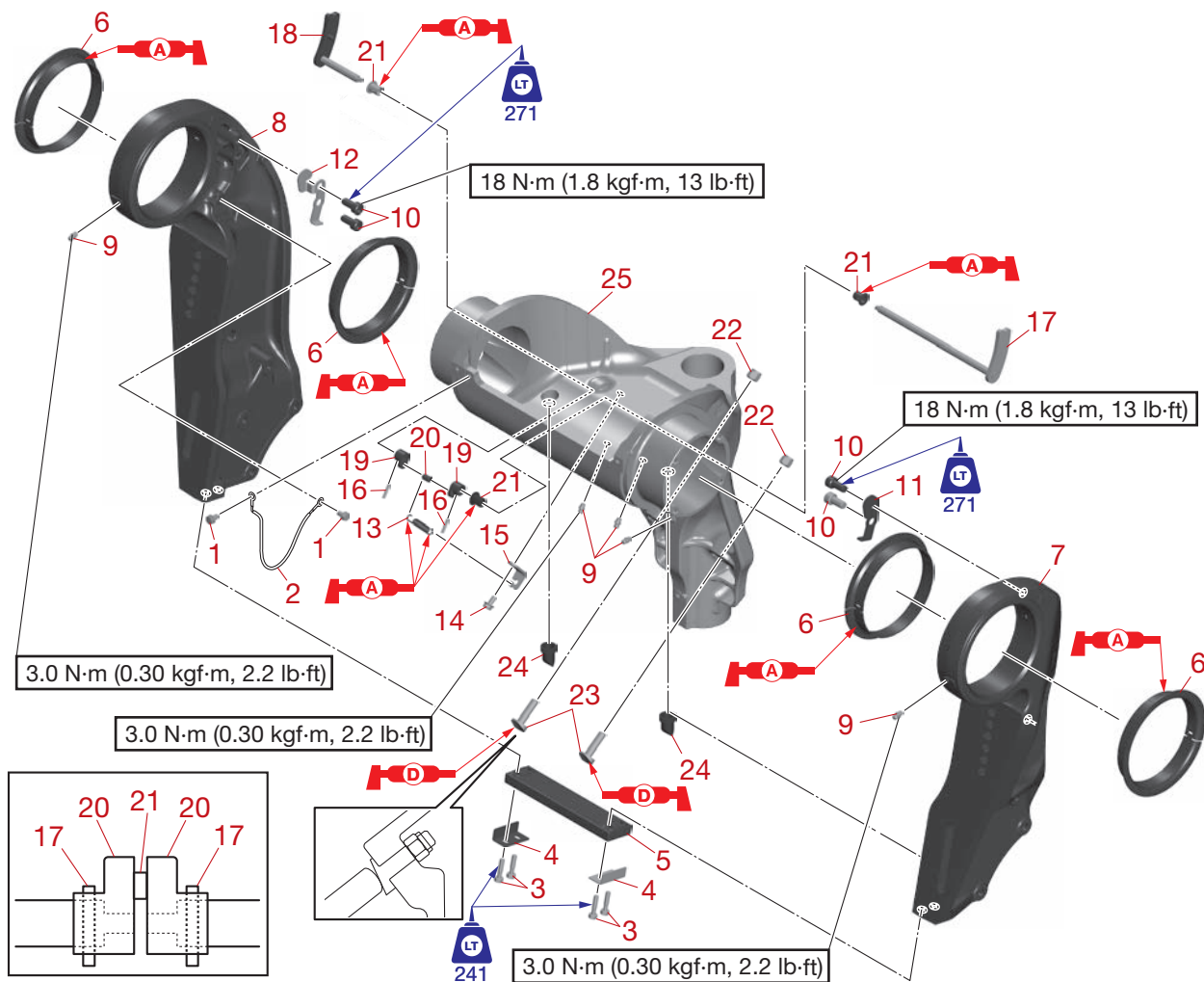
11. Install:

- Apron (STBD)
See “Apron” (9-8).
- Bottom cowlings (PORT and STBD)
See “Bottom cowling (PORT and STBD)”
(9-3).
- Apron cover
- Bottom cowling cover
- Top cowling
See “Bottom cowling cover and apron
cover” (9-1).

TIP: _____

After the steering actuator replaced or removed, the steering sensor must be calibrated after the unit installed.

Clamp bracket and swivel bracket



↑↓	Part name	Q'ty	Remarks
1	Bolt M6 × 10 mm	2	
2	Ground lead	1	
3	Bolt M6 × 30 mm	4	
4	Plate	2	
5	Anode	1	
6	Bushing	4	
7	Clamp bracket (PORT)	1	
8	Clamp bracket (STBD)	1	
9	Grease nipple M6	5	
10	Bolt M10 × 20 mm	4	
11	Bracket (PORT)	1	
12	Bracket (STBD)	1	
13	Spring	1	
14	Bolt M6 × 12 mm	1	
15	Hook	1	
16	Pin	2	
17	Tilt support lever (PORT)	1	

↑↓	Part name	Q'ty	Remarks
18	Tilt support lever (STBD)	1	
19	Distance collar	2	
20	Pin	1	
21	Bushing	3	
22	Nut M10	2	
23	Trim stopper	2	
24	Grommet	2	
25	Swivel bracket	1	

Removing the clamp bracket

- Remove:
 - PTT unit
See "Removing the PTT unit" (9-46).

Checking the clamp bracket anode

- Check:
 - Anode
Eroded (1/2 or more worn out) → Replace.
Adhered is grease, oil, paint, or scales → Clean.

NOTICE

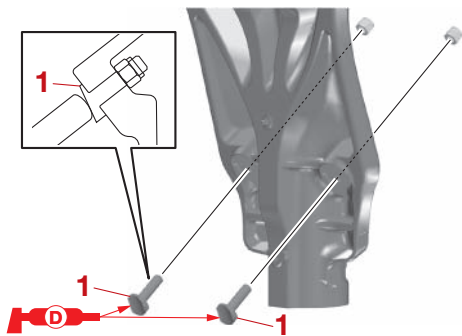
Do not apply grease, oil, or paint to the anode.


Assembling the swivel bracket

- Install:
 - Grommets
 - Grease nipples
 - Trim stoppers "1"

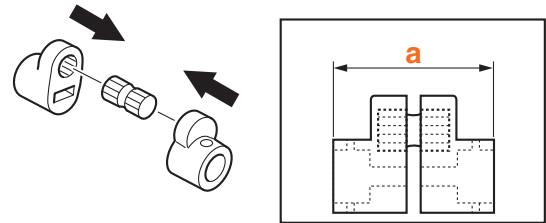
TIP:


Install the trim stoppers "1" in the direction shown.



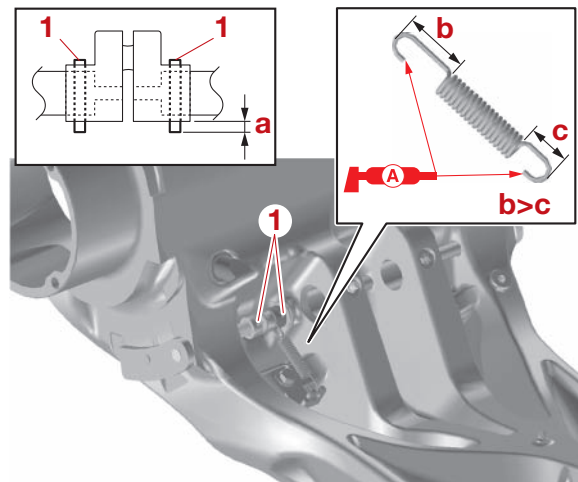
	Grease nipple 3.0 N·m (0.30 kgf·m, 2.2 lb·ft)
-------------------------------------------------------------------------------------	--------------------------------------------------


- Assemble:
 - Pin
 - Distance collars



	Distance "a" 30.3–30.6 mm (1.19–1.20 in)
-----------------------------------------------------------------------------------	---------------------------------------------

- Install:
 - Bushings
 - Tilt support levers
 - Distance collar assembly
 - Pins "1"
 - Hook
 - Spring



	Distance "a" 2.5–3.5 mm (0.10–0.14 in)
-------------------------------------------------------------------------------------	-------------------------------------------

Installing the clamp bracket

- Install:
 - Brackets
 - Grease nipples
 - Clamp brackets
 - Bushings
 - Clamp bracket anode
 - Plates
 - Ground lead



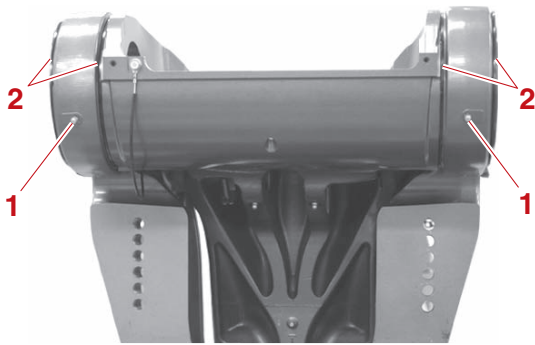
Bracket bolt
18 N·m (1.8 kgf·m, 13 lb·ft)
Grease nipple
3.0 N·m (0.30 kgf·m, 2.2 lb·ft)

2. Inject:

- Grease

TIP: _____

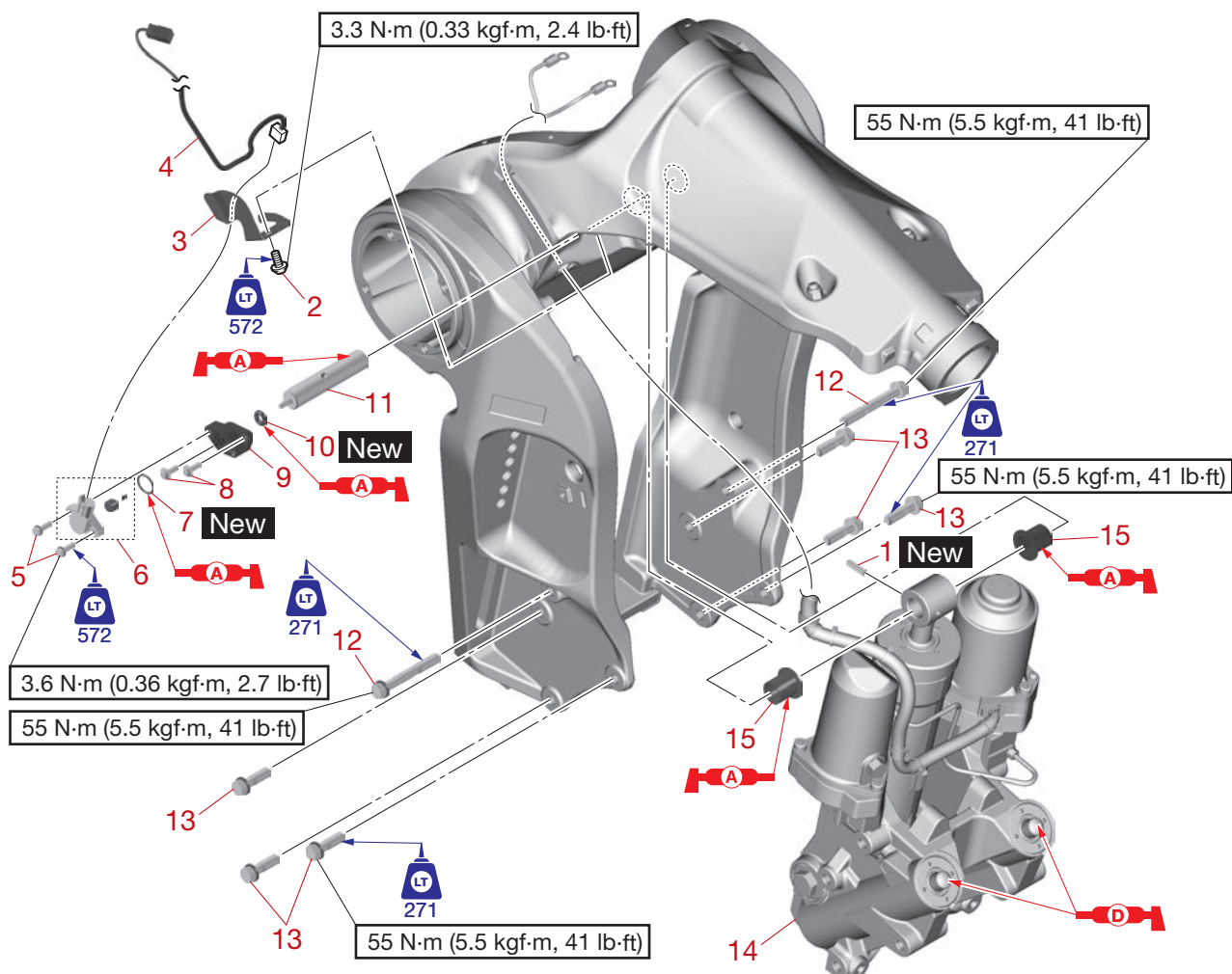
Inject grease into the grease nipples “1” until grease comes out from both the port and starboard bushings “2”.



3. Install:

- PTT unit
See “Installing the PTT unit” (9-49).

PTT unit



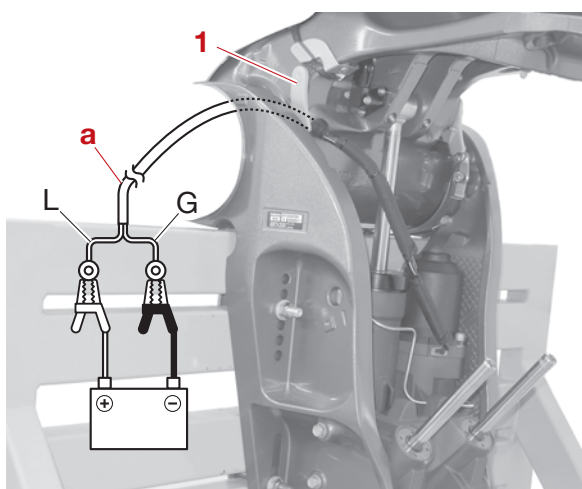
↑↓	Part name	Q'ty	Remarks
1	Pin	1	
2	Bolt M6 × 14 mm	1	
3	Plate	1	
4	Lead	1	
5	Bolt M5 × 16 mm	2	
6	Sensor	1	PTT
7	O-ring	1	
8	Bolt M5 × 16 mm	2	
9	Adapter	1	
10	O-ring	1	
11	Shaft	1	
12	Bolt M10 × 75 mm	2	
13	Bolt M10 × 35 mm	6	
14	PTT unit	1	
15	Bushing	2	

Removing the PTT unit

WARNING

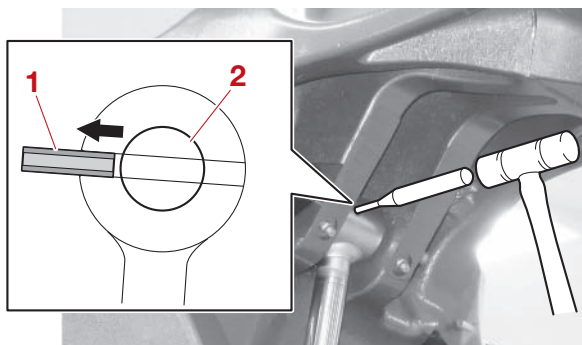
When removing or installing the PTT unit with the power unit or upper case assembly installed, make sure to suspend the out-board motor.

1. Remove:
 - PTT unit
 - a. Connect the battery jumper leads to the PTT motor lead “a” to fully tilt the swivel bracket up, and then support it using the tilt support lever “1”.

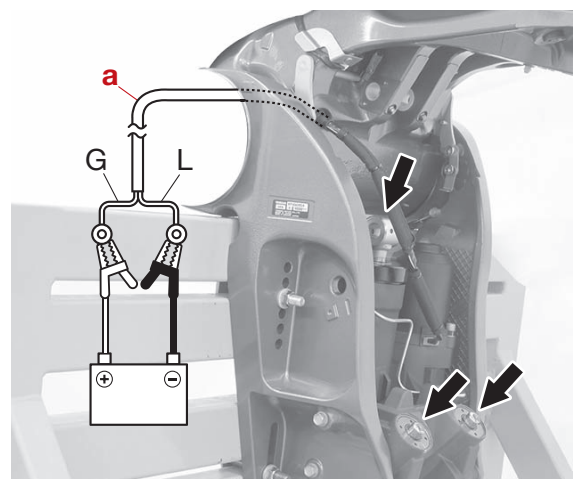


Ram	PTT motor lead	Battery
Extend	Blue (L)	(+)
	Green (G)	(-)

- b. Push in the pin “1” past the upper mount shaft “2”, and then remove the shaft.



- c. Connect the battery jumper leads to the PTT motor lead “a” to fully retract the PTT rams.



Ram	PTT motor lead	Battery
Retract	Green (G)	(+)
	Blue (L)	(-)

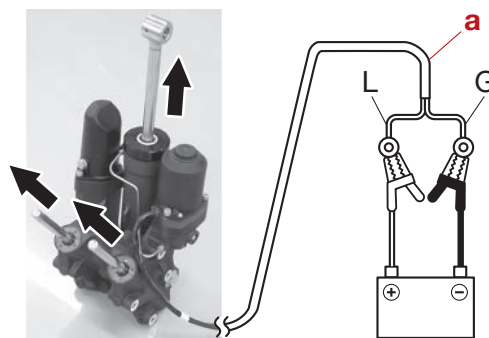
- d. Remove the holder, and then pull the PTT motor lead inward to remove it from the hole in the clamp bracket.
 - e. Remove the PTT unit.

NOTICE

When removing or installing the PTT unit, do not hold the PTT unit using the tilt cylinder. Otherwise, the pipe could break, causing PTT fluid to leak.

Checking the PTT motor electric current when the relief valve operates

1. Check:
 - PTT fluid level
 - a. Place the PTT unit in an upright position.
 - b. Connect the battery jumper leads to the PTT motor lead “a” to fully extend the PTT rams.



Ram	PTT motor lead	Battery
Extend	Blue (L)	(+)
	Green (G)	(-)

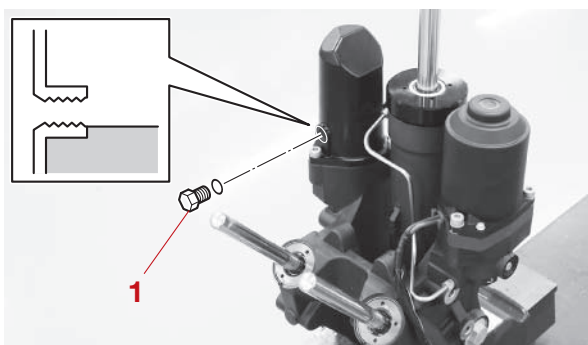
c. Remove the reservoir cap “1”, and then check the fluid level in the reservoir.

WARNING


Before removing the reservoir cap “1”, make sure that the PTT rams are fully extended. Otherwise, fluid could be expelled forcefully from the PTT unit due to internal pressure.

TIP:

If the fluid is at the proper level, a small amount of fluid should flow out of the filler hole.



d. If the fluid is below the proper level, add the recommended fluid.
e. Install the reservoir cap.

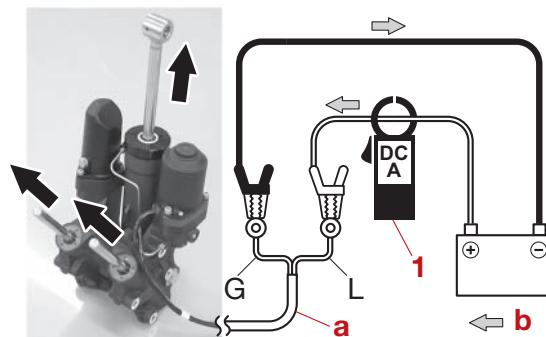
	Reservoir cap 7 N·m (0.7 kgf·m, 5.2 lb·ft)
-------------------------------------------------------------------------------------	-----------------------------------------------

2. Measure:

- PTT motor electric current when the up-relief valve operates
 - PTT motor electric current when the down-relief valve operates
- Out of specification → Check the PTT motor or PTT gear pump.
See “Checking the PTT motor” (9-53) or “Checking the gear pump” (9-59).
- a. Connect the battery jumper leads to the PTT motor lead “a” to fully extend the PTT rams, and then measure the PTT motor electric current using a clamp meter “1”.


TIP:


Use a clamp meter “1” that can measure DC 100 A or more.



b. Electric current direction

Ram	PTT motor lead	Battery
Extend	Blue (L)	(+)
	Green (G)	(-)

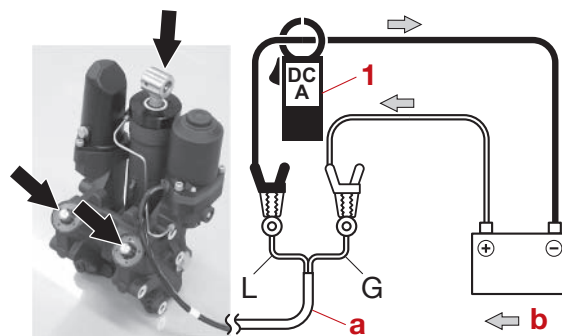
	Clamp meter “1” (commercially available)
------------------------------------------------------------------------------------	---------------------------------------------

	Electric current Up 69-93 A
-------------------------------------------------------------------------------------	-----------------------------------

b. Connect the battery jumper leads to the PTT motor lead “a” to fully retract the PTT rams, and then measure the PTT motor electric current using the clamp meter “1”.


TIP:


Use a clamp meter “1” that can measure DC 100 A or more.



b. Electric current direction

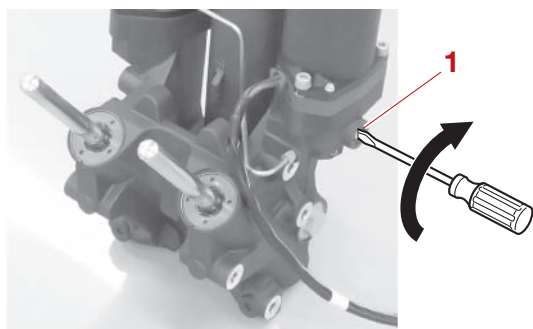
Ram	PTT motor lead	Battery
Retract	Green (G)	(+)
	Blue (L)	(-)


	Clamp meter "1" (commercially available)
-----------------------------------------------------------------------------------	---------------------------------------------

	Electric current Down 43-59 A
-----------------------------------------------------------------------------------	-------------------------------------

Bleeding the PTT unit

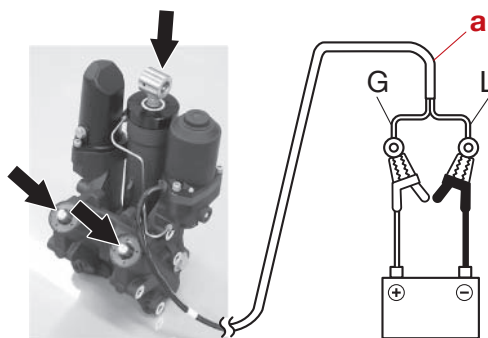
1. Bleed:
 - PTT unit
 - a. Place the PTT unit in an upright position.
 - b. Turn the manual valve "1" clockwise to close it.



	Manual valve "1" 2.0 N·m (0.20 kgf·m, 1.5 lb·ft)
-------------------------------------------------------------------------------------	-----------------------------------------------------

- c. Check the fluid level.
See step 1 in "Checking the PTT motor electric current when the relief valve operates" (9-46).
- d. Connect the battery jumper leads to the PTT motor lead "a" to fully retract the PTT rams.

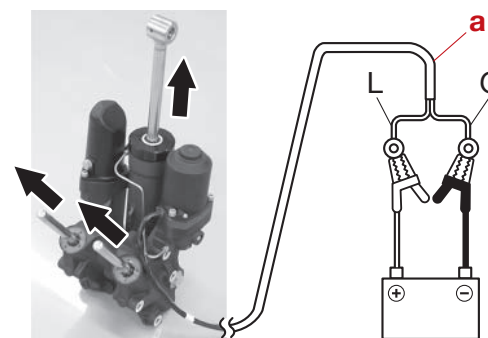
TIP: _____
If the PTT rams do not move down easily, push on the PTT rams to assist operation.



Ram	PTT motor lead	Battery
Retract	Green (G)	(+)
	Blue (L)	(-)

- e. Reverse the connection between battery jumper leads and the PTT motor lead "a" to fully extend the PTT rams.

TIP: _____
If the PTT rams do not move up easily, pull on the PTT rams to assist operation.



Ram	PTT motor lead	Battery
Extend	Blue (L)	(+)
	Green (G)	(-)


- f. Repeat steps (d) and (e) to fully extend and retract the PTT rams 4 or 5 times.
- g. Fully extend the PTT ram.
- h. Remove the reservoir cap, and then check the fluid level in the reservoir.

⚠ WARNING _____
Before removing the reservoir cap, make sure that the PTT rams are fully extended. Otherwise, fluid could be expelled forcefully from the PTT unit due to internal pressure.

TIP: _____

If the fluid is below the proper level, add the recommended PTT fluid. Repeat steps (c)–(g) until the fluid remains at the proper level.

- i. Install a new O-ring and the reservoir cap.

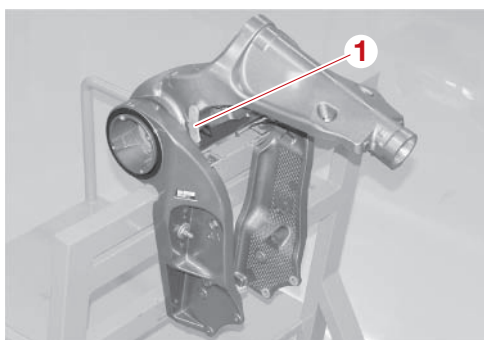
	Reservoir cap 7 N·m (0.7 kgf·m, 5.2 lb·ft)
-----------------------------------------------------------------------------------	-----------------------------------------------

Installing the PTT unit

⚠ WARNING _____

When removing or installing the PTT unit with the power unit or upper case assembly installed, make sure to suspend the out-board motor.

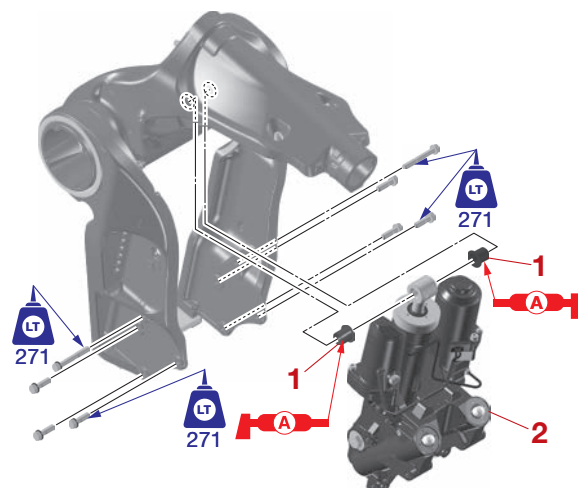
1. Install:
 - Bushing (into the swivel bracket)
 - PTT unit
 - a. Fully tilt the swivel bracket up, and then support it using the tilt support lever “1”.




- b. Install the bushings “1” and PTT unit “2”.

NOTICE _____

When removing or installing the PTT unit, do not hold the PTT unit using the tilt cylinder. Otherwise, the pipe could break, causing PTT fluid to leak.

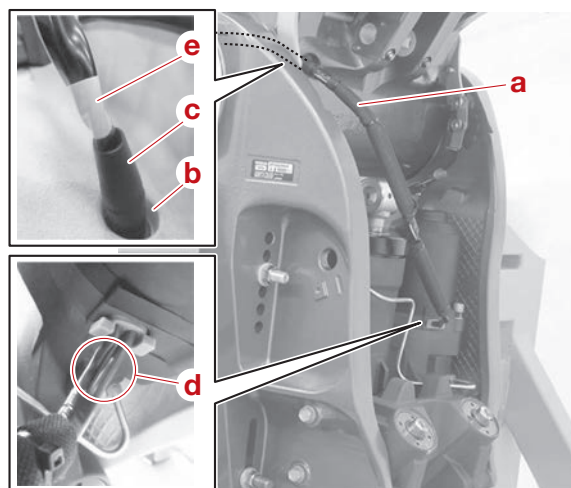


	PTT unit mounting bolt 55 N·m (5.5 kgf·m, 41 lb·ft)
-----------------------------------------------------------------------------------	--------------------------------------------------------

- c. Route the PTT motor lead “a” through the hole “b” in the swivel bracket, and then install the grommet “c” on the PTT motor lead to the hole “b”.

TIP: _____

- Confirm that there is no torsion in the base “d” of the PTT motor lead “a”.
- After the grommet “c” is installed, confirm that the end of the white tape “e” on the PTT motor lead is aligned with the end of the grommet “c”.



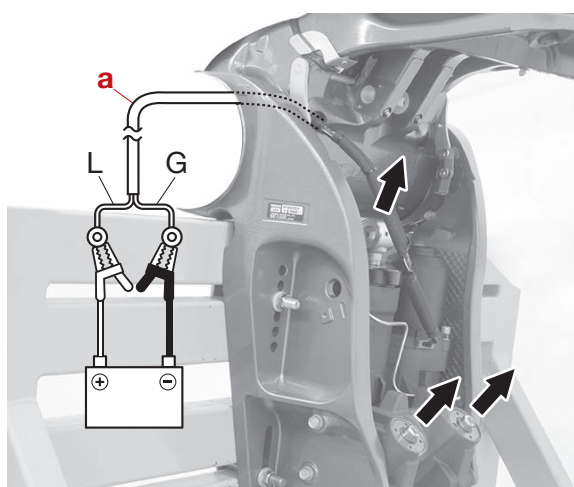
2. Install:
 - O-ring **New**
 - Adapter
 - Upper mounting shaft
 - PTT sensor
 - Pin

- PTT sensor lead
- Plate

NOTICE

Do not install the PTT sensor to the upper mounting shaft while the sensor is installed to the adapter. Otherwise, the PTT sensor could be damaged.

- Connect the battery jumper leads to the PTT motor lead “a” to extend the PTT rams until the end of the tilt ram is aligned with the mounting position hole.



Ram	PTT motor lead	Battery
Extend	Blue (L)	(+)
	Green (G)	(-)

- Install a new O-ring “1” into the adapter “2”.
- Install the upper mounting shaft “3” completely into the adapter “2”, and then install the magnet “a” to the shaft.

TIP:

Align the flat portion “b” of the magnet “a” with the flat portion “c” of the upper mounting shaft “3”.

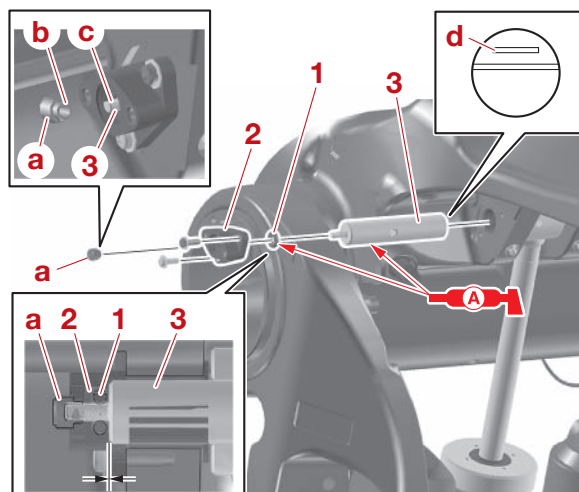
- Install the upper mounting shaft assembly into the swivel bracket.

NOTICE

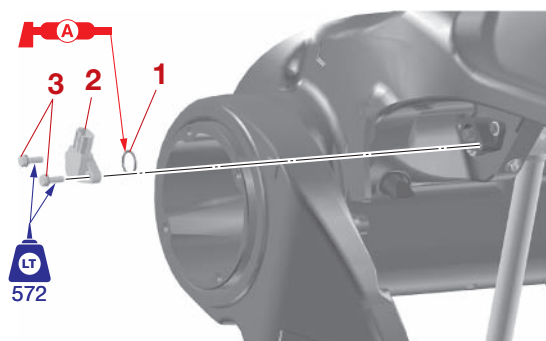
Do not strike or tap the upper mounting shaft to install it. Otherwise, the bushing could be damaged.

TIP:

Install the upper mount shaft “3” into the swivel bracket so that the groove “d” in the shaft is facing in the direction shown.

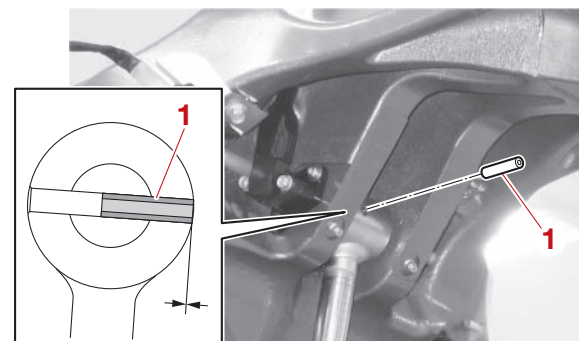


- Install a new O-ring “1” and the PTT sensor “2”.



	PTT sensor bolt “3” 3.6 N·m (0.36 kgf·m, 2.7 lb-ft)
--	--------------------------------------------------------

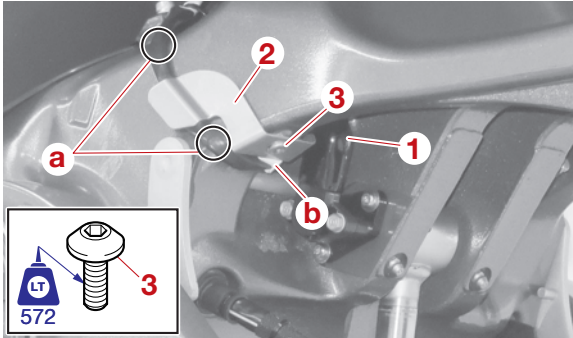
- Align the hole in the upper mounting shaft and hole in the tilt rod, and then install a new pin “1”.




- Install the PTT sensor lead “1” and plate “2”.

TIP: _____

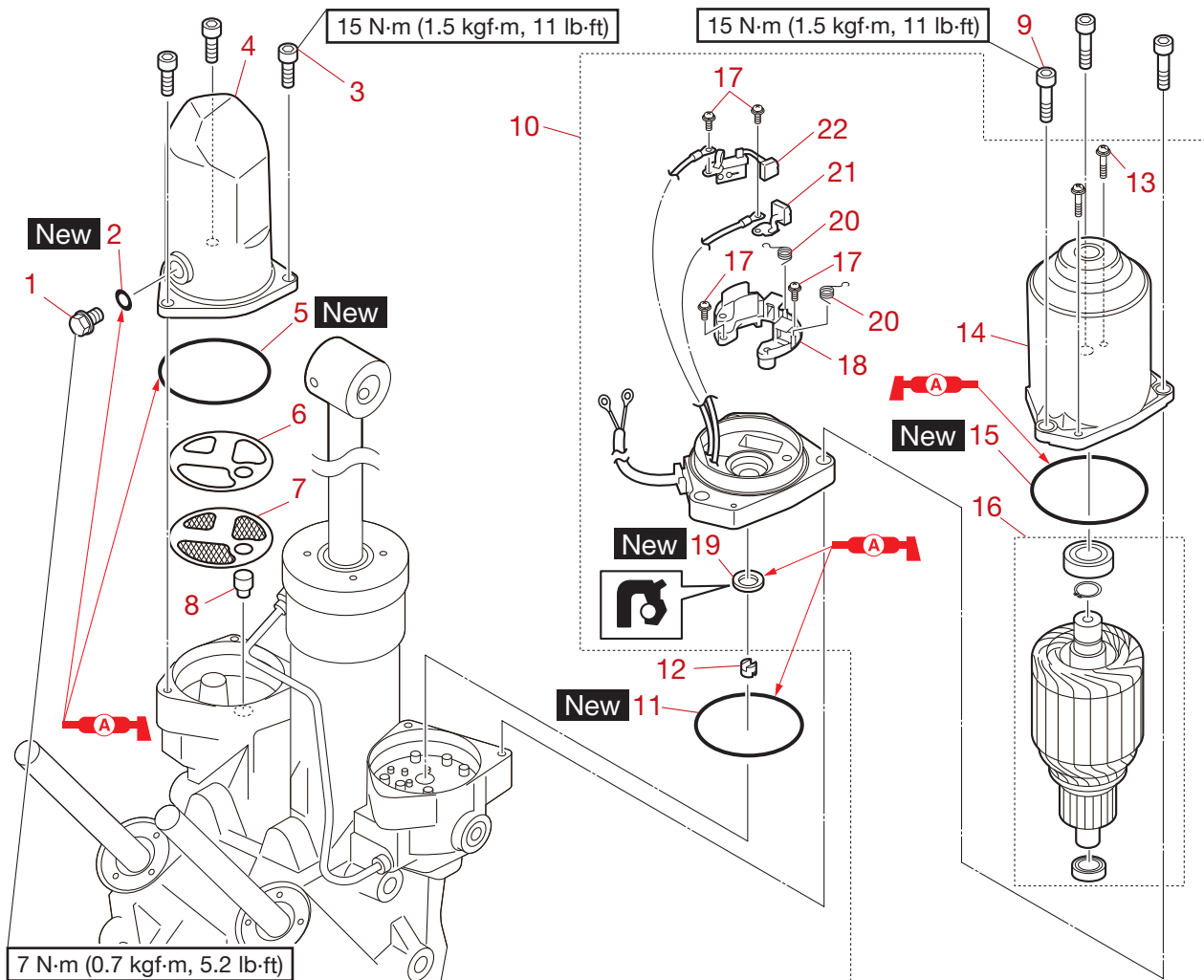
- Route the PTT sensor lead so that they contact the points “a” of the swivel bracket.
- Align the white tape “b” on the PTT sensor lead “1” with the plate “2”.



	Plate bolt “3” 3.3 N·m (0.33 kgf·m, 2.4 lb·ft)
-----------------------------------------------------------------------------------	---------------------------------------------------

h. Fully tilt the swivel bracket down.

PTT motor



↑↓	Part name	Q'ty	Remarks
1	Reservoir cap M12 × 10 mm	1	
2	O-ring	1	
3	Bolt M8 × 20 mm	3	
4	Reservoir	1	
5	O-ring	1	
6	Sheet	1	
7	Filter	1	
8	Spacer	1	
9	Bolt M8 × 35 mm	3	
10	PTT motor assembly	1	
11	O-ring	1	
12	Joint	1	
13	Screw M4 × 17 mm	2	
14	Stator	1	
15	O-ring	1	
16	Armature assembly	1	
17	Screw M4 × 10 mm	4	
18	Brush holder	1	

↑↓	Part name	Q'ty	Remarks
19	Oil seal	1	
20	Spring	2	
21	Brush	1	
22	Circuit breaker	1	

Removing the reservoir

⚠ WARNING

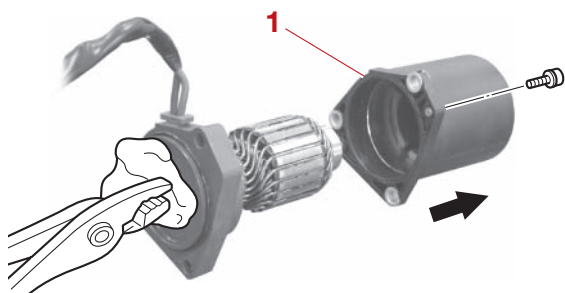
Before removing the reservoir, make sure that the PTT rams are fully extended. Otherwise, fluid could be expelled forcefully from the PTT unit due to internal pressure.

Disassembling the PTT motor

1. Remove:
 - Stator "1"

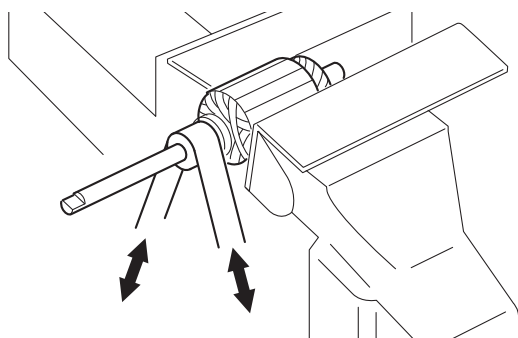
NOTICE

When removing or installing the armature along with the motor base assembly, secure the end of the armature shaft using a pair of pliers. Otherwise, the armature could separate from the motor base assembly due to the magnetic force of the stator and damage the brushes.

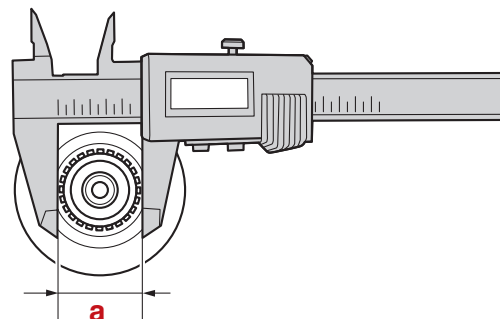



Checking the PTT motor

1. Check:
 - Commutator
Dirty → Clean using 600-grit sandpaper and compressed air.

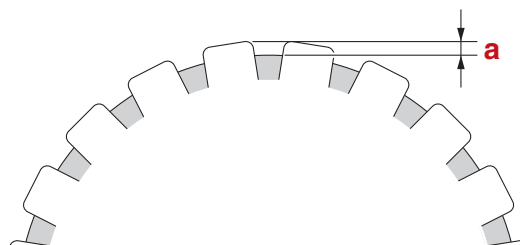



2. Measure:
 - Commutator diameter "a"
Out of specification → Replace the armature.



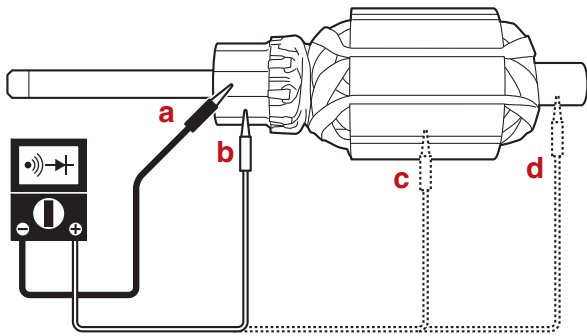
	Standard commutator diameter
	28.00 mm (1.1024 in)
	Wear limit
	27.00 mm (1.0630 in)

3. Measure:
 - Commutator undercut "a"
Out of specification → Replace the armature.



	Standard commutator undercut
	1.00 mm (0.0394 in)
	Wear limit
	0.50 mm (0.0197 in)

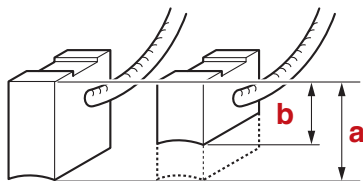
4. Check:
 - Armature for continuity
Out of specification → Replace the armature assembly.



Armature for continuity			
"a"	"b"	"c"	"d"
○ — ○			

Checking the brush

- Measure:
 - Brush length



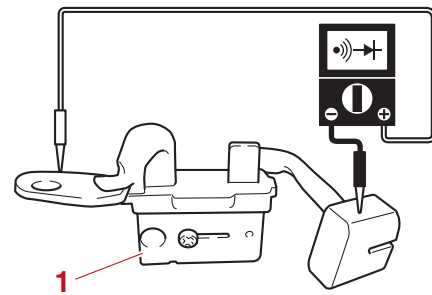
- Standard brush length
- Wear limit

	Standard brush length
	12.00 mm (0.4724 in)
	Wear limit
	4.3 mm (0.17 in)

- Check:
 - Circuit breaker for continuity
 No continuity → Replace.

NOTICE

Do not touch the bimetal "1". Otherwise, the operation of the circuit breaker can be affected.



- Check:
 - PTT motor base assembly
 Cracked/damaged → Replace the PTT motor assembly.

Checking the reservoir

- Check:
 - Reservoir
 Cracked/damaged → Replace.

Checking the filter

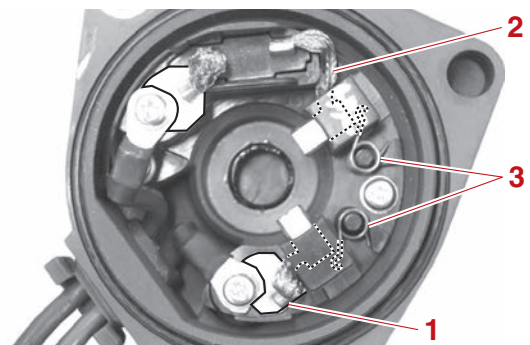
- Check:
 - Filter
 Dirt/residue → Clean.
 Clogged/damaged → Replace.

Assembling the PTT motor

NOTICE

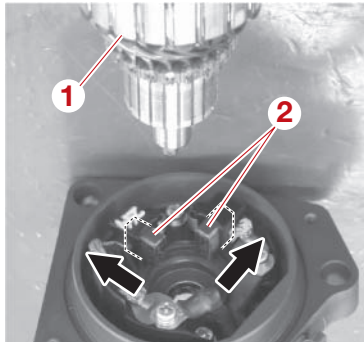
Do not apply grease or oil to the commutator of the armature.

- Assemble:
 - Brush holder
 - Oil seal **New**
 - Brush "1"
 - Circuit breaker "2"
 - Springs "3"



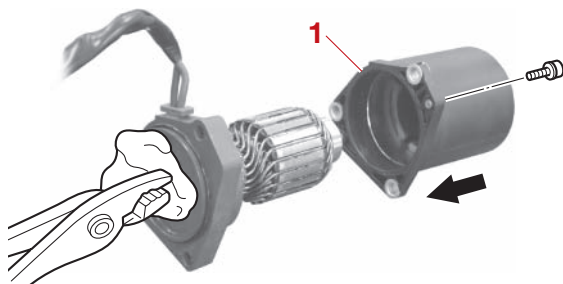
- Install:
 - Armature "1"

TIP: _____
 Push the brushes “2” into the holders, and then install the armature “1”.




3. Install:
- O-ring **New**
 - Stator “1”

NOTICE _____
 When removing or installing the armature along with the motor base assembly, secure the end of the armature shaft using a pair of pliers. Otherwise, the armature could separate from the motor base assembly due to the magnetic force of the stator and damage the brushes.



Installing the reservoir

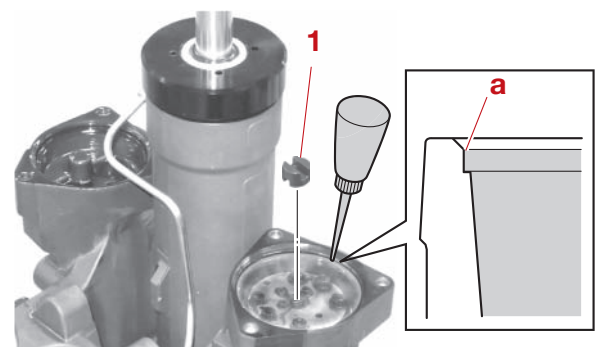
1. Install:
- Spacer
 - Filter
 - Sheet
 - O-rings **New**
 - Reservoir
 - Reservoir cap

	Reservoir mounting bolt
	15 N·m (1.5 kgf·m, 11 lb·ft)
	Reservoir cap
	7 N·m (0.7 kgf·m, 5.2 lb·ft)

Installing the PTT motor

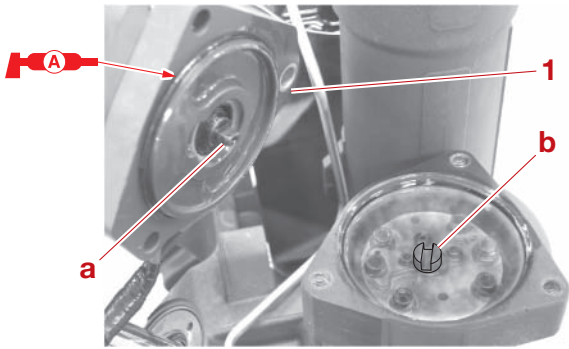
NOTICE _____
 When assembling the PTT unit, do not use a rag. Otherwise, dust and particles could get on the PTT unit components, causing poor performance.

1. Install:
- Joint
2. Fill:
- PTT fluid
 - a. Fill the gear pump housing with the recommended fluid up to the proper level “a”.
 - b. Turn the joint “1” using a screwdriver to remove any air between the pump gear teeth.



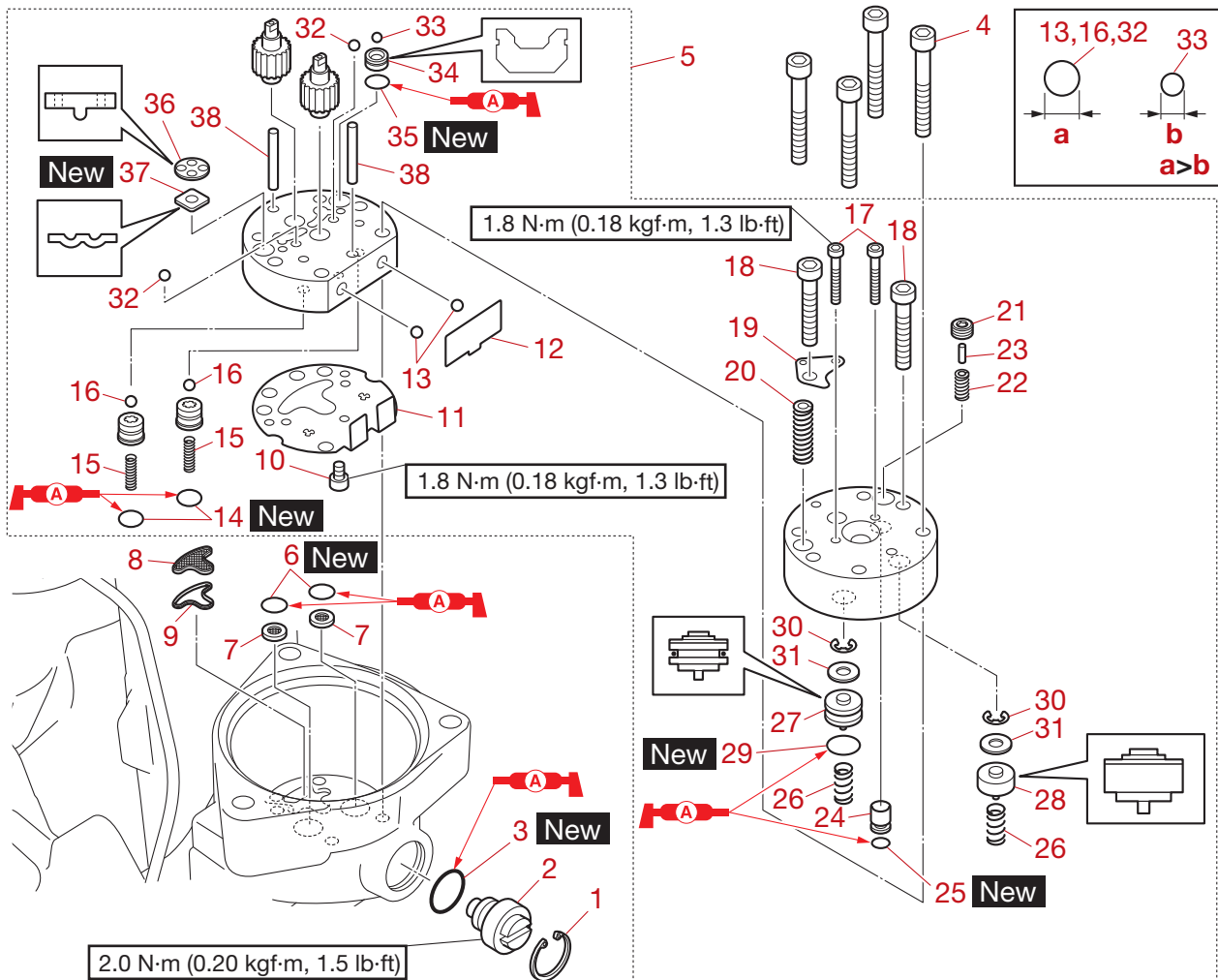
- c. Remove all of the air bubbles using a syringe or suitable tool.
3. Install:
- O-ring **New**
 - PTT motor assembly “1”

TIP: _____
 Align the protrusion “a” on the armature shaft with the slot “b” in the joint.



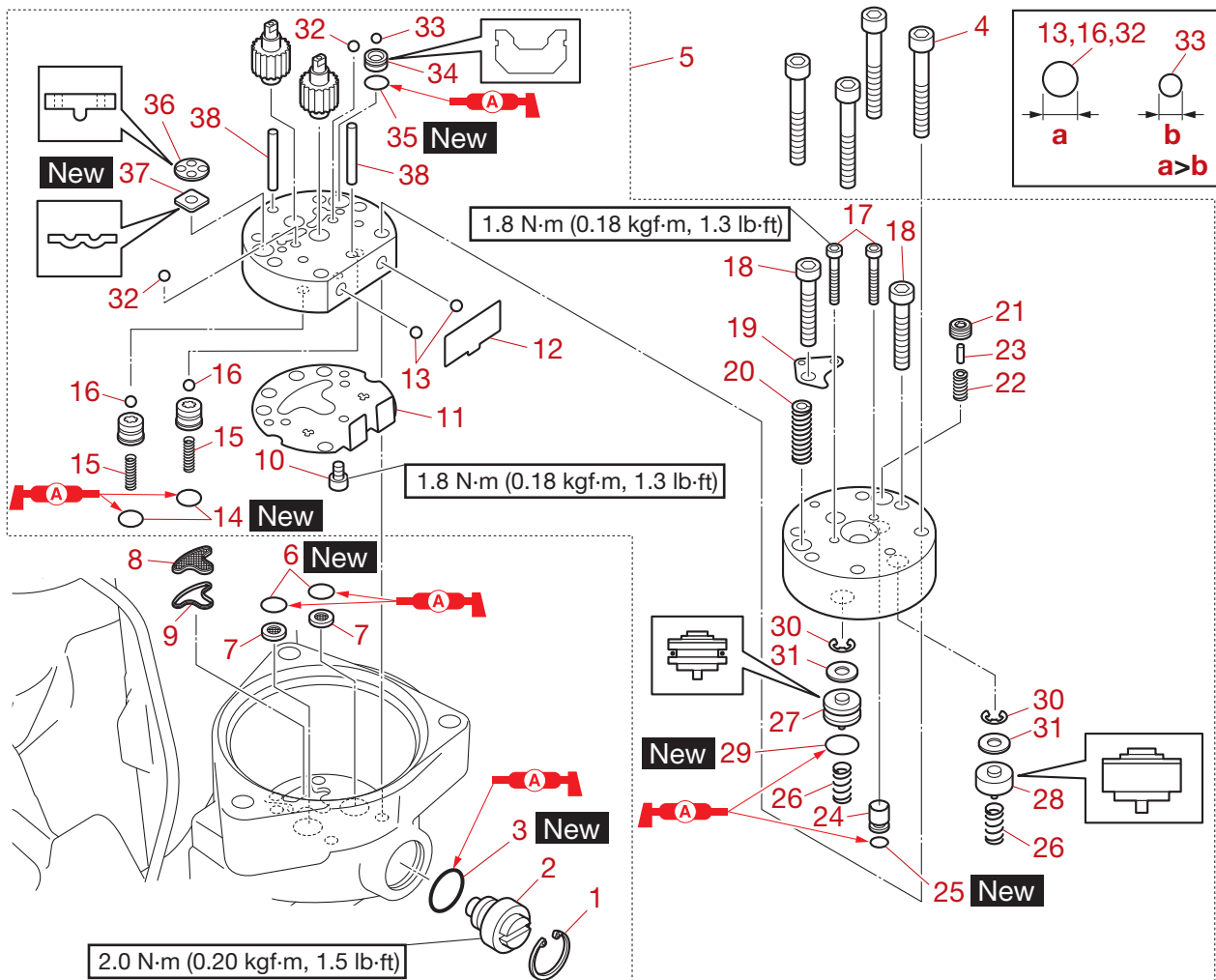
PTT motor mounting bolt
15 N·m (1.5 kgf·m, 11 lb·ft)

PTT gear pump



↑↓	Part name	Q'ty	Remarks
1	Circlip	1	
2	Manual valve	1	
3	O-ring	1	
4	Bolt M5 × 45 mm	4	
5	Gear pump assembly	1	
6	O-ring	2	
7	Filter	2	
8	Filter	1	
9	Plate	1	
10	Bolt M3 × 5 mm	1	
11	Relief valve seat	1	
12	Manual release plate	1	
13	Ball	2	3.92 mm (0.15 in) (reference data)
14	O-ring	2	
15	Spring	2	

↑↓	Part name	Q'ty	Remarks
16	Ball	2	3.92 mm (0.15 in) (reference data)
17	Bolt M3 × 25 mm	2	
18	Bolt M5 × 30 mm	2	
19	Cap	1	
20	Spring	1	
21	Valve lock screw	1	
22	Spring	1	
23	Pin	1	
24	Valve support pin	1	
25	O-ring	1	
26	Spring	2	
27	Down-main valve	1	
28	Up-main valve	1	
29	O-ring	1	
30	E-clip	2	
31	Main valve seal	2	

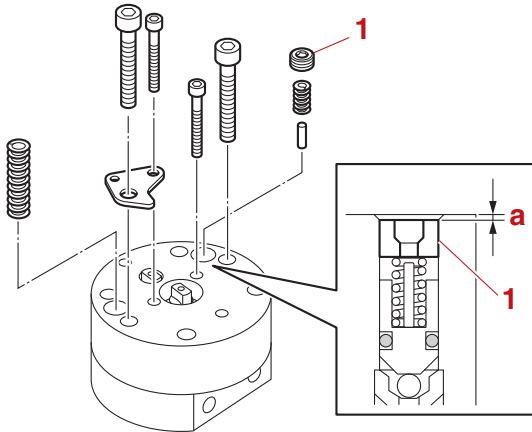


↕	Part name	Q'ty	Remarks
32	Ball	2	3.92 mm (0.15 in) (reference data)
33	Ball	1	3.13 mm (0.12 in) (reference data)
34	Relief valve seat	1	
35	O-ring	1	
36	Valve pin	1	
37	Valve seal	1	
38	Pin	2	

Disassembling the gear pump assembly

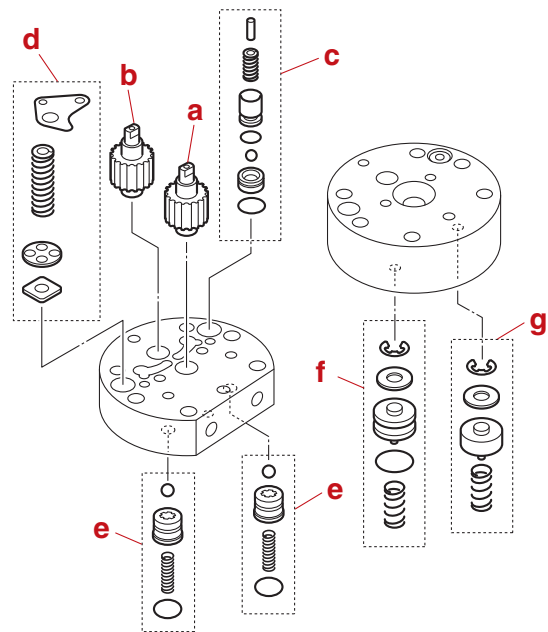
- Remove:
 - Valve lock screw "1"

TIP: Before removing the valve lock screw "1", measure and write down the screw depth "a".



Checking the gear pump

- Check:
 - Drive gear "a"
 - Driven gear "b"
 - Damaged/worn → Replace the gear pump assembly.
 - Up-relief valve "c"
 - Down-relief valve "d"
 - Main valves "e", "f", "g"
 - Dirt/residue → Clean.



Checking the gear pump housing

- Check:
 - Gear pump housing
 - Corroded/cracked → Replace the PTT unit.

Checking the filter

- Check:
 - Filters
 - Dirt/residue → Clean.

Assembling the gear pump assembly

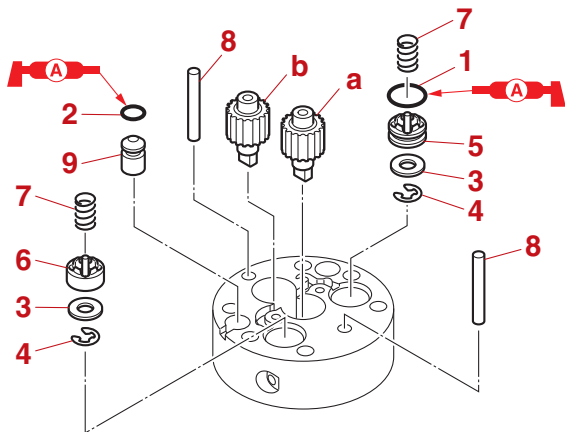
Lubricate the parts using recommended fluid during assembly.

NOTICE

When assembling the PTT unit, do not use a rag. Otherwise, dust and particles could get on the PTT unit components, causing poor performance.

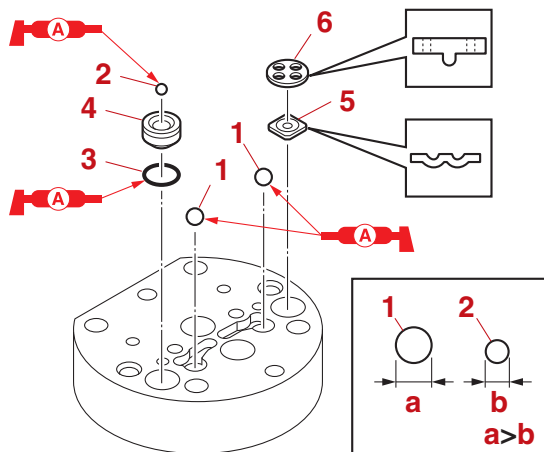
- Install:
 - Drive gear "a"
 - Driven gear "b"
 - O-rings "1", "2" **New**
 - Main valve seals "3"
 - E-clips "4"
 - Down-main valve "5"
 - Up-main valve "6"
 - Springs "7"
 - Pins "8"

- Valve support pin “9”



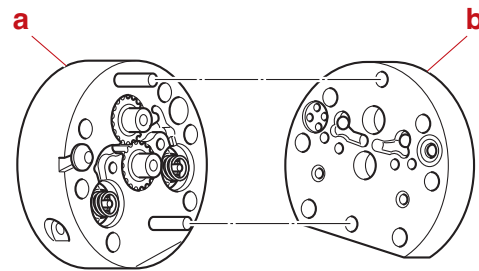
2. Install:
- Balls “1”, “2”
 - O-ring “3” **New**
 - Relief valve seat “4”
 - Valve seal “5” **New**
 - Valve pin “6”

TIP: _____
 To prevent the balls “1” and “2” from falling out of the gear housing assembly, apply a small amount of grease to the balls.



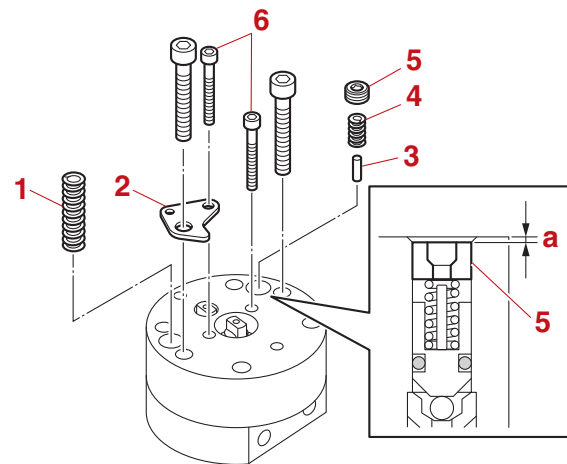
3. Assemble:
- Gear housing assemblies “a”, “b”


NOTICE _____
Make sure that there is no gap between the gear housings. If there is a gap, parts between them may not be installed properly.




4. Install:
- Spring “1”
 - Plate “2”
 - Pin “3”
 - Spring “4”
 - Valve lock screw “5”

TIP: _____
 • Install the valve lock screw “5” to the depth “a” that was measured before removing it.
 • When installing a new part, install it according to the preceding reference data.

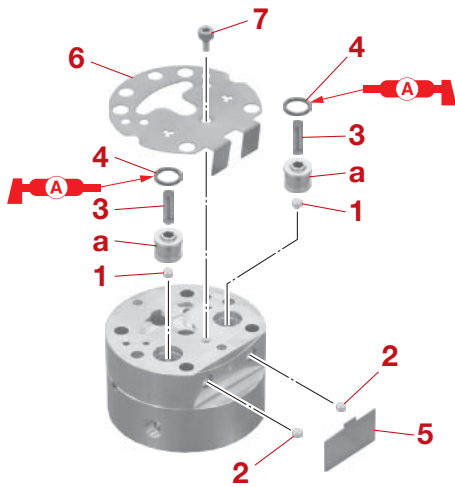



	Installation depth “a” (reference data) 1.35 mm (0.053 in)
-------------------------------------------------------------------------------------	---------------------------------------------------------------

	Gear pump bolt “6” 1.8 N·m (0.18 kgf·m, 1.3 lb·ft)
-------------------------------------------------------------------------------------	-------------------------------------------------------

5. Install:
- Balls “1”, “2”
 - Adapters “a”
 - Springs “3”
 - O-rings “4” **New**
 - Manual release plate “5”


- Relief valve seat “6”



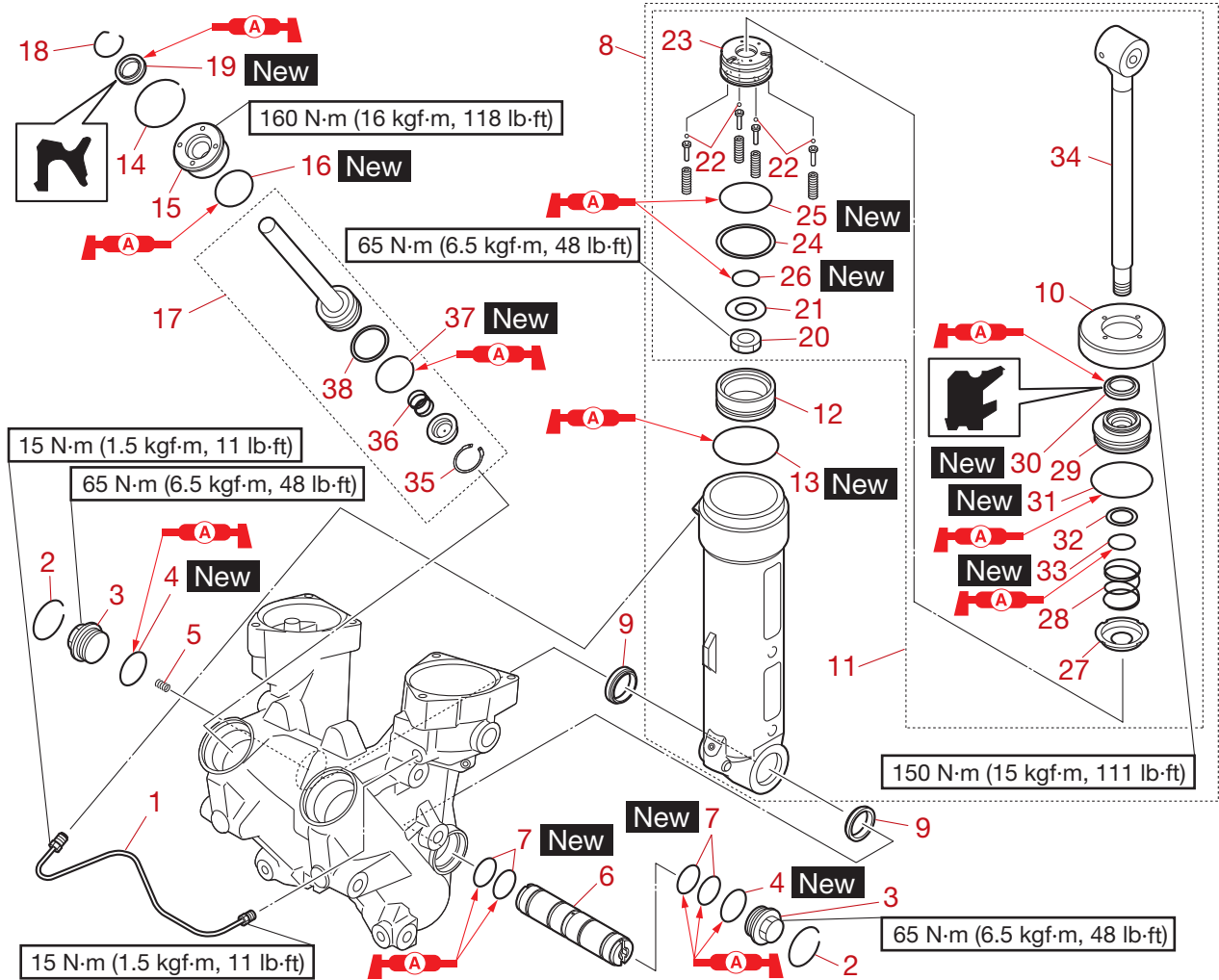
	<p>Relief valve seat bolt “7” 1.8 N·m (0.18 kgf·m, 1.3 lb·ft)</p>
-----------------------------------------------------------------------------------	-----------------------------------------------------------------------

Installing the gear pump assembly

1. Install:
 - Plate
 - Filters
 - O-rings **New**
 - Gear pump assembly
 - Manual valve
 - Circlip

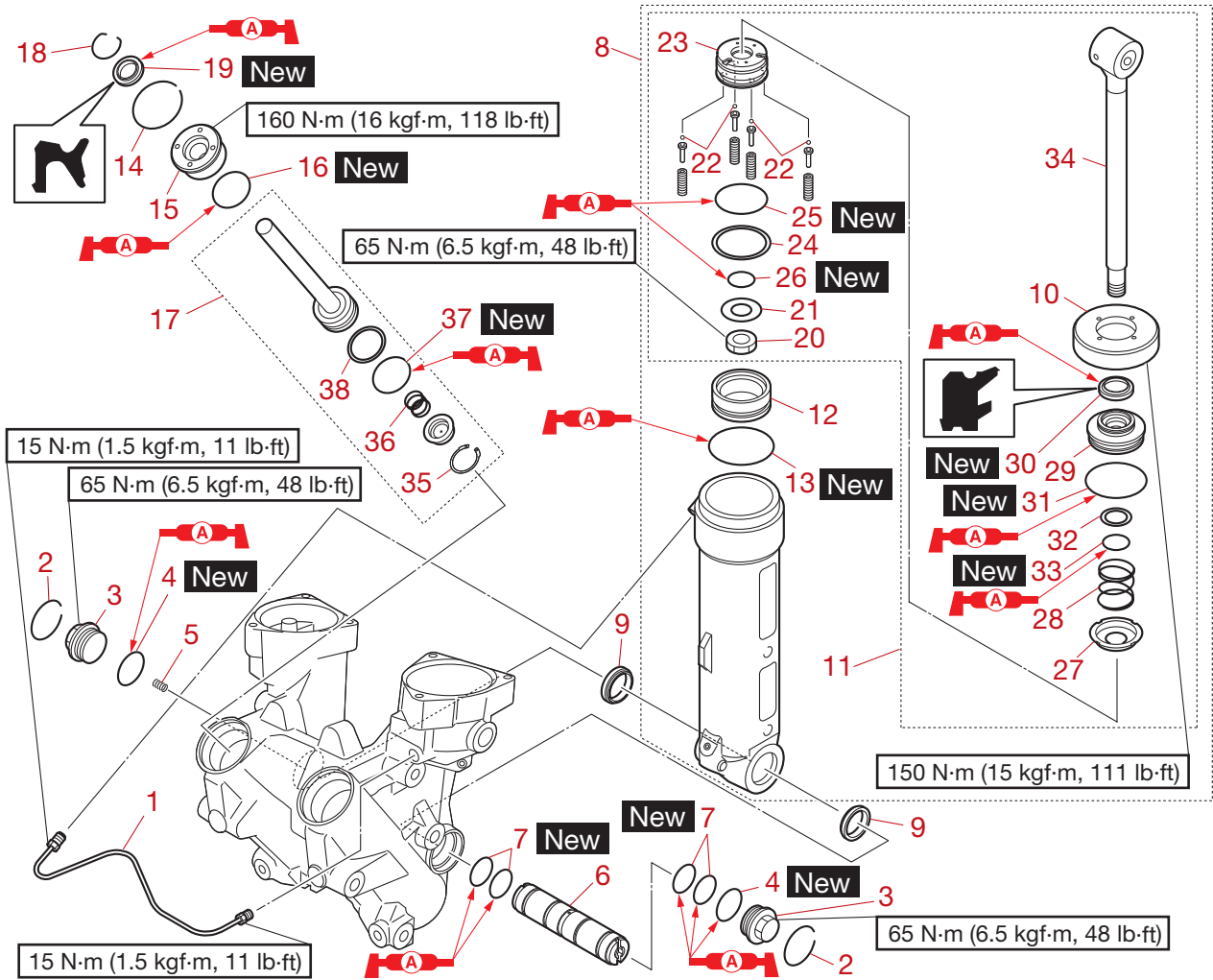
	<p>Manual valve 2.0 N·m (0.20 kgf·m, 1.5 lb·ft)</p>
-------------------------------------------------------------------------------------	---------------------------------------------------------

PTT cylinder



↑↓	Part name	Q'ty	Remarks
1	Pipe	1	
2	Circlip	2	
3	Cap	2	
4	O-ring	2	
5	Spring	1	
6	Shaft	1	
7	O-ring	4	
8	Tilt cylinder assembly	1	
9	Spacer	2	
10	Tilt cylinder end screw	1	
11	Tilt ram assembly	1	
12	Free piston	1	
13	O-ring	1	
14	Circlip	1	
15	Trim cylinder end screw	2	
16	O-ring	2	
17	Trim ram assembly	2	
18	Circlip	2	

↑↓	Part name	Q'ty	Remarks
19	Dust seal	2	
20	Nut	1	
21	Washer	1	
22	Ball	4	3.92 mm (0.15 in) (reference data)
23	Tilt piston	1	
24	Backup ring	1	
25	O-ring	1	
26	O-ring	1	
27	Adapter	1	
28	Spring	1	
29	Tilt cylinder end	1	
30	Dust seal	1	
31	O-ring	1	
32	Backup ring	1	
33	O-ring	1	
34	Tilt rod	1	
35	Circlip	2	



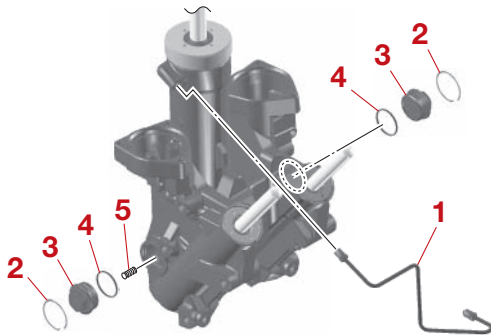
↕	Part name	Q'ty	Remarks
36	Spring	2	
37	O-ring	2	
38	Backup ring	2	

Removing the tilt ram

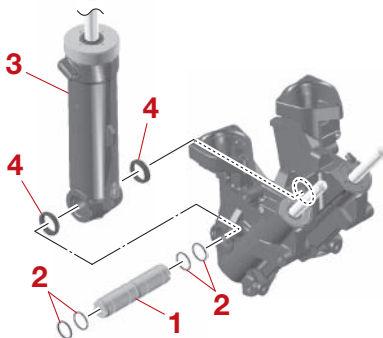
⚠ WARNING

Before removing the tilt cylinder end screw, make sure that the PTT rams are fully extended. Otherwise, fluid could be expelled forcefully from the PTT unit due to internal pressure.

- Remove:
 - Pipe "1"
 - Circlips "2"
 - Lower mounting shaft caps "3"
 - O-rings "4"
 - Spring "5"



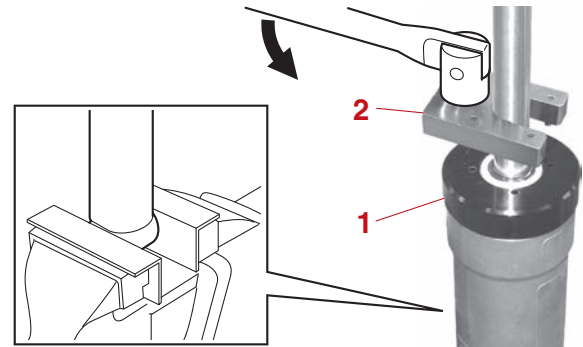
- Remove:
 - Lower mounting shaft "1"
 - O-rings "2"
 - Tilt cylinder assembly "3"
 - Spacers "4"



- Drain:
 - Fluid
- Loosen:
 - Tilt cylinder end screw "1"



Cylinder end screw wrench "2"
90890-06958



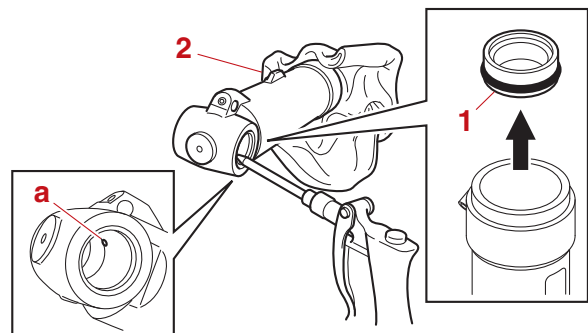
- Remove:
 - Free piston "1"

⚠ WARNING

When removing the free piston, never look into the tilt cylinder opening because the free piston and PTT fluid could be expelled forcefully.

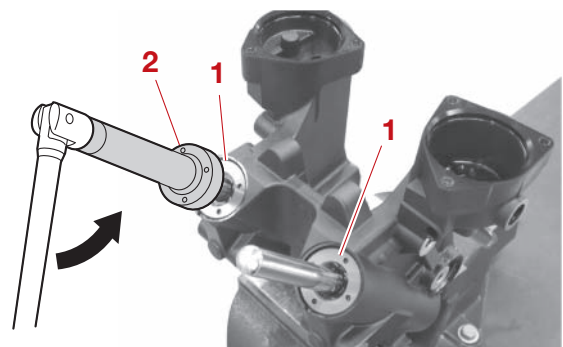
TIP:

Cover the tilt cylinder using a rag "2", and then blow compressed air through the hole "a" to remove the free piston "1".



Removing the trim ram

- Loosen:
 - Trim cylinder end screws "1"



Cylinder end screw wrench "2"
90890-06959

2. Drain:
 - Fluid

Checking the tilt cylinder and trim cylinder

1. Check:
 - PTT body
 - Tilt cylinder
Corroded/cracked → Replace.
2. Check:
 - Inner surface of the PTT body
 - Inner surface of the tilt cylinder
Scratched → Replace.
3. Check:
 - Outer surfaces of the tilt piston
 - Outer surfaces of the trim piston
 - Outer surfaces of the free piston
Scratched → Replace.
4. Check:
 - Backup rings
Damaged/worn → Replace.
5. Check:
 - Trim rams
 - Tilt ram
Rust → Clean using 400–600-grit sandpaper.
Bent/corroded → Replace.
6. Check:
 - Pipe
Corroded/cracked → Replace.

Checking the absorber valve

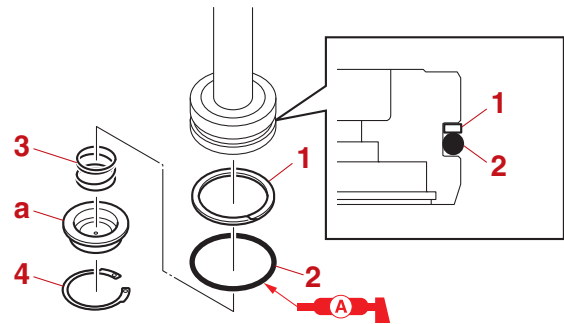
1. Check:
 - Tilt piston absorber valves
Dirt/residue → Clean.

Assembling the trim ram

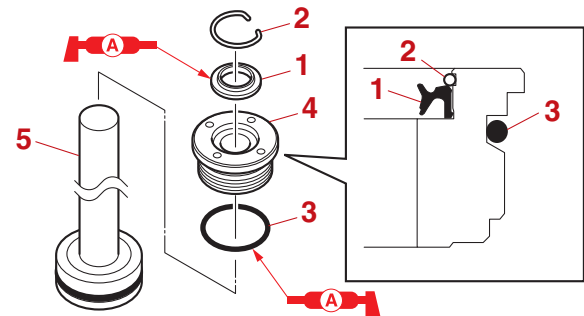
NOTICE

When assembling the PTT unit, do not use a rag. Otherwise, dust and particles could get on the PTT unit components, causing poor performance.

1. Install:
 - Backup ring “1”
 - O-ring “2” **New**
 - Spring “3”
 - Adapter “a”
 - Circlip “4”



2. Install:
 - Dust seal “1” **New**
 - Circlip “2”
 - O-ring “3” **New**
 - Trim cylinder end screw “4”
(onto the trim ram “5”)

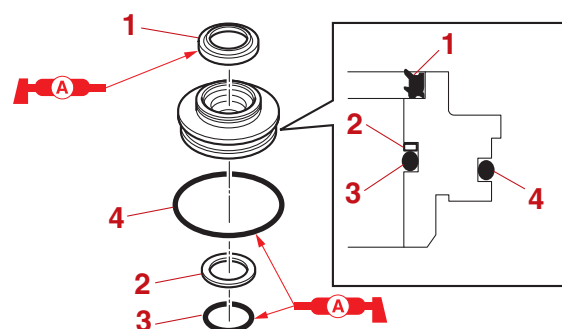


Assembling the tilt ram

NOTICE

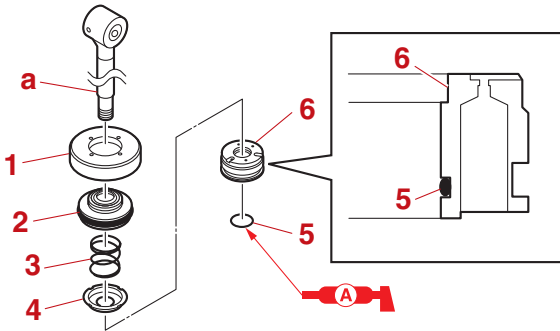
When assembling the PTT unit, do not use a rag. Otherwise, dust and particles could get on the PTT unit components, causing poor performance.

1. Install:
 - Dust seal “1”
 - Backup ring “2”
 - O-rings “3”, “4” **New**



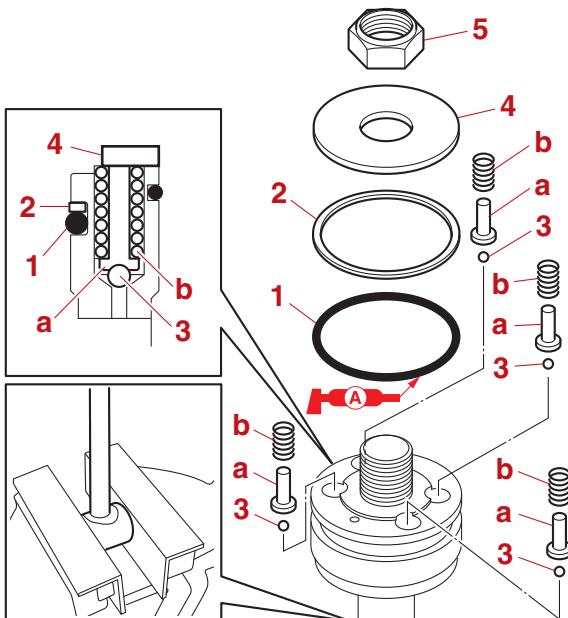
2. Install:
 - Tilt ram “a”


- Tilt cylinder end screw “1”
- Tilt cylinder end “2”
- Spring “3”
- Adapter “4”
- O-ring “5” **New**
- Tilt piston “6”



3. Install:

- O-ring “1” **New**
- Backup ring “2”
- Balls “3”
- Absorber valve pins “a”
- Springs “b”
- Washer “4”
- Tilt piston nut “5”



 Tilt piston nut “5”
65 N·m (6.5 kgf·m, 48 lb·ft)

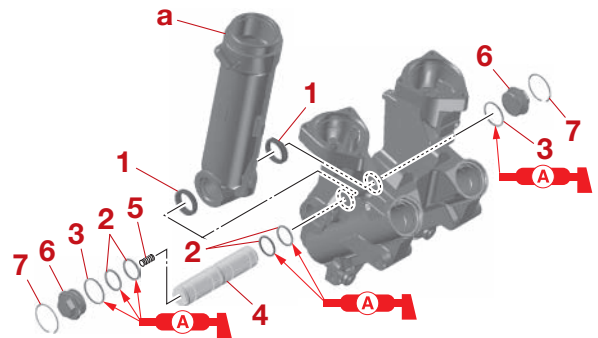
Installing the tilt cylinder


NOTICE

When assembling the PTT unit, do not use a rag. Otherwise, dust and particles could get on the PTT unit components, causing poor performance.

1. Install:

- Spacers “1”
- Tilt cylinder “a”
- O-rings “2”, “3” **New**
- Lower mounting shaft “4”
- Spring “5”
- Lower mounting shaft caps “6”
- Circlips “7”



 Lower mounting shaft cap “6”
65 N·m (6.5 kgf·m, 48 lb·ft)

Installing the trim ram

NOTICE

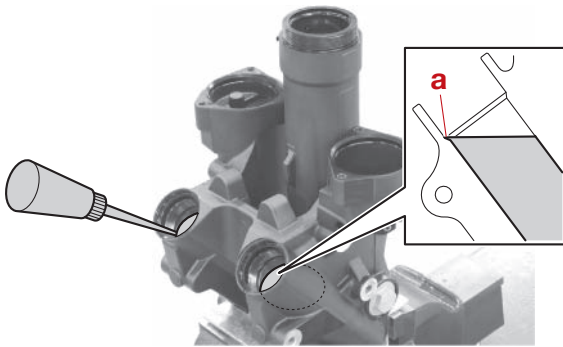
When assembling the PTT unit, do not use a rag. Otherwise, dust and particles could get on the PTT unit components, causing poor performance.

1. Fill:

- PTT fluid

TIP:

Fill the trim cylinders with the recommended fluid up to the proper level “a”.

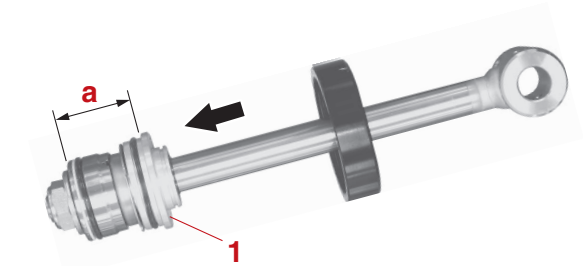
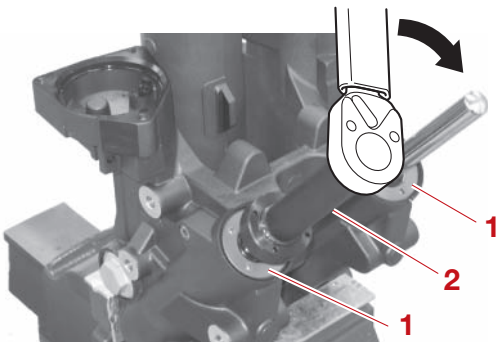



TIP: _____


- Fill the tilt cylinder and PTT body with the recommended fluid up to the proper level “a”.
- Place the tilt cylinder end “1” at the bottom of the tilt ram assembly.

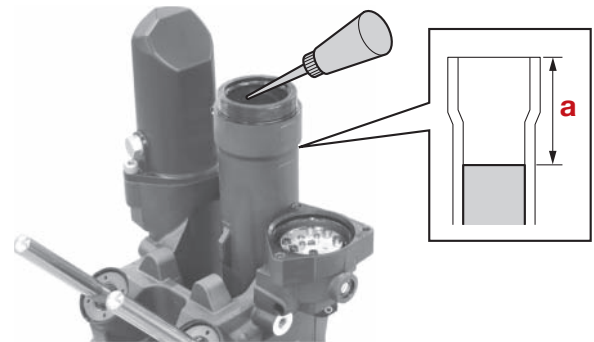
2. Install:

- Trim ram assemblies “1”



	Cylinder end screw wrench “2” 90890-06959
-------------------------------------------------------------------------------------	----------------------------------------------

	Trim cylinder end screw 160 N·m (16 kgf·m, 118 lb·ft)
-------------------------------------------------------------------------------------	----------------------------------------------------------



Installing the tilt ram

NOTICE _____

When assembling the PTT unit, do not use a rag. Otherwise, dust and particles could get on the PTT unit components, causing poor performance.

1. Install:

- Gear pump assembly
See “Installing the gear pump assembly” (9-61).

2. Install:

- Reservoir
See “Installing the reservoir” (9-55).

3. Install:

- O-ring **New**
- Free piston

4. Fill:

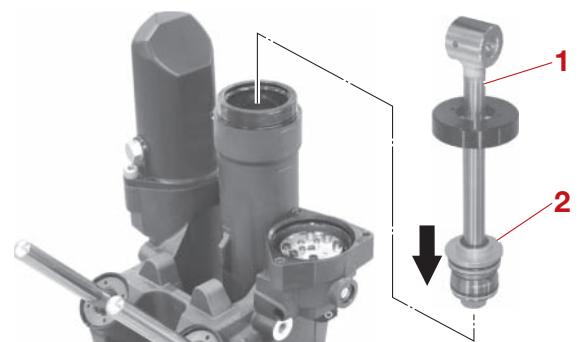
- PTT fluid

5. Install:

- Tilt ram assembly “1”

TIP: _____

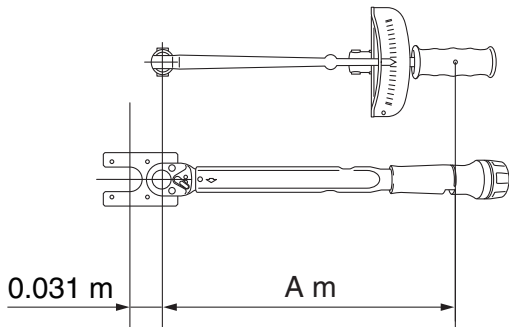
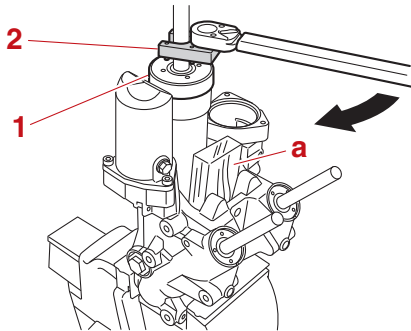
Place the tilt cylinder end “2” at the bottom of the tilt ram assembly “1”.





6. Tighten:

- Tilt cylinder end screw “1”

TIP: _____
 Place a block of wood “a” between the tilt cylinder and the PTT body to secure the tilt cylinder when tightening the tilt cylinder end screw “1”.




	Cylinder end screw wrench “2” 90890-06958
-------------------------------------------------------------------------------------	----------------------------------------------

	Torque wrench setting value = $150 \text{ N}\cdot\text{m} \div (A + 0.031) \times A$ 150 N·m (15 kgf·m, 111 lb·ft) Specified tightening torque for the tilt cylinder end screw 0.031 m Cylinder end screw wrench length A m Torque wrench length
-------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

7. Install:

- Pipe

	Pipe joint 15 N·m (1.5 kgf·m, 11 lb·ft)
-------------------------------------------------------------------------------------	--------------------------------------------

8. Install:

- PTT motor
 See “Installing the PTT motor” (9-55).

Maintenance

Outline	10-1
Maintenance interval chart 1	10-1
Maintenance interval chart 2	10-4
General periodic maintenance.....	10-5
Checking the battery	10-9
Checking the cooling water pilot hole.....	10-9
Checking the engine idle speed.....	10-9
Checking the engine oil level.....	10-10
Changing the engine oil using an oil changer	10-10
Changing the engine oil by removing the drain bolt	10-11
Replacing the oil filter.....	10-13
Checking the gear oil level	10-14
Changing the gear oil using an oil changer.....	10-15
Changing the gear oil by removing the drain screw.....	10-17
Greasing points	10-19
Checking the PTT fluid level.....	10-20
Checking the PTT unit operation.....	10-20
Checking the top cowling fitting	10-21
Predelivery check.....	10-22
Checking the outboard motor mounting height	10-25

Outline

- To obtain long product life, Yamaha strongly recommends that the specified periodic checks and maintenance be performed according to the maintenance interval charts.
- If replacement parts are necessary, use only genuine Yamaha parts of equivalent design and quality. Any parts of inferior quality may cause a malfunction, and the resulting loss of control could endanger the operator and passengers. Yamaha genuine parts and accessories are available from Yamaha dealers.
- The service intervals provided in the maintenance interval charts are based upon “typical” operating conditions that include speed variations, sufficient time for engine warm up and cool-down, medium to light load, and an average cruising speed in the 3000–4000 r/min range. If your normal operating conditions are more intensive, more frequent servicing will be required, especially the engine oil and gear oil changes. Examples of the intensive operation will be: wide-open-throttle, trolling, or idling operation for extended periods of time, carrying heavy loads, and frequent starting and stopping or shifting. In most cases, the frequent maintenance pays off in increased engine life and greater owner satisfaction.
- The maintenance cycle on these charts is based on usage of 100 hours per year and regular flushing of the cooling water passages. Adjust the maintenance frequency when operating the engine under adverse conditions, such as extended trolling.
- Disassembly or repairs may be necessary depending on the outcome of maintenance checks.
- Expendable or consumable parts and lubricants will lose their effectiveness over time and through normal usage regardless of the warranty period.
- When operating the outboard motor in salt water, or in muddy, turbid (cloudy), or acidic water, flush the engine using clean water after each use.

Maintenance interval chart 1

The “●” symbol indicates the check-ups which the owners or operators may carry out themselves. The “○” symbol indicates work to be carried out by a Yamaha dealer.

Item	Actions	Initial	Every			See
		20 hours (3 months)	100 hours (1 year)	300 hours (3 years)	500 hours (5 years)	
Anode(s) (external)	Inspection or replacement as necessary		●/○			8-6 9-43
Battery (electrolyte level, terminal)	Inspection	●/○	●/○			10-9
Battery (electrolyte level, terminal)	Fill, charging or replacing as necessary		○			
Cooling water leakage	Inspection or replacement as necessary	○	○			2-61
Cowling lock lever	Inspection		●/○			10-21
Engine starting condition/noise	Inspection	●/○	●/○			—
Engine idle speed/noise	Inspection	●/○	●/○			10-9

Item	Actions	Initial	Every			See
		20 hours (3 months)	100 hours (1 year)	300 hours (3 years)	500 hours (5 years)	
Engine oil	Replacement	○	○			10-10 10-11
Engine oil filter (cartridge)	Replacement		○			10-13
Fuel filter (can be disassembled)	Inspection or replacement as necessary	●/○	●/○			6-4
Fuel line (Direct injection pressure)	Inspection	●				—
Fuel line (Direct injection pressure)	Inspection or replacement as necessary	○				6-18
Fuel line (High pressure)	Inspection	●	●			—
Fuel line (High pressure)	Inspection or replacement as necessary	○	○			6-12 6-13
Fuel line (Low pressure)	Inspection	●	●			—
Fuel line (Low pressure)	Inspection or replacement as necessary	○	○			6-6
Fuel pump	Inspection or replacement as necessary			○		5-29 5-30
Fuel/engine oil leakage	Inspection	○	○			2-42 2-49
Gear oil	Replacement	●/○	●/○			10-15 10-17
Greasing points	Greasing	●/○	●/○			10-19
Impeller/water pump housing	Inspection or replacement as necessary		○			8-13
Impeller/water pump housing	Replacement			○		8-11
OCV (Oil Control Valve) filter	Replacement				○	7-58
Power trim and tilt unit	Inspection	●/○	●/○			10-20 10-20
Propeller/propeller nut/cotter pin	Inspection or replacement as necessary	●/○	●/○			8-2 8-1
PCV (Pressure Control Valve)	Inspection or replacement as necessary		○			9-28 9-29

Outline

Item	Actions	Initial	Every			See
		20 hours (3 months)	100 hours (1 year)	300 hours (3 years)	500 hours (5 years)	
Spark plug(s)	Inspection or replacement as necessary		○			7-41
Water from the cooling water pilot hole	Inspection	●/○	●/○			2-53
Thermostat	Inspection or replacement as necessary		○			7-73
Timing belt	Inspection or replacement as necessary		○			7-43
Cooling water inlet	Inspection	●/○	●/○			2-53
Main switch/stop switch	Inspection or replacement as necessary	○	○			5-41 5-42
Wire harness connections/wire coupler connections	Inspection or replacement as necessary	○	○			5-1
(Yamaha) Meter/gauge	Inspection	○	○			—
SBW	Inspection or replacement as necessary	○	○	○	○	9-32 9-42

Maintenance interval chart 2

Item	Actions	Every	See
		1000 hours	
Exhaust guide/exhaust manifold	Inspection or replacement as necessary	○	7-7 7-11 9-26
Timing belt	Replacement	○	7-42
Cam chain	Inspection or replacement as necessary	○	7-49
Cam chain tensioner	Inspection or replacement as necessary	○	7-12
Valve clearance	Inspection and adjustment	○	7-1
Fuel strainer	Inspection or replacement as necessary	○	6-14
Fuel line (Direct injection pressure)	Inspection	●	—
Fuel line (Direct injection pressure)	Inspection or replacement as necessary	○	6-18
Anode(s) (internal) *1	Inspection or replacement as necessary	○	7-8 7-12 7-38 7-66 7-73
Anode(s) (Under the timing belt)	Inspection or replacement as necessary	○	7-76
SBW	Inspection or replacement as necessary	○	9-32 9-42

*1 cylinder head, cylinder block, oil cooler, water jacket cover (lower), exhaust joint, rectifier/regulator

General periodic maintenance

Item	Procedures	See
Anodes	Check the anodes. Eroded (1/2 or more worn out) → Replace. Adhered grease, oil, paint, or scales → Clean.	7-8 7-12 7-38 7-66 7-73 7-76 8-6 9-43
Battery	Check the battery electrolyte level. Below the minimum level mark → Add distilled water.	10-9
	Check the specific gravity of the electrolyte. Below specification → Fully charge the battery.	
Cooling water inlets	Check the cooling water inlets. Clogged → Clean.	2-53
Cooling water pilot hole	Start the engine.	—
	Check that the cooling water is discharged from the cooling water pilot hole. Not discharged → Check the cooling system.	2-53 10-9
Engine idle speed	Check the engine idle speed.	10-9
Engine oil	Check the oil level using the dipstick. Not at the proper level → Add or extract the engine oil.	10-10
	Check the engine oil. Replacement interval has been exceeded/deterioration → Change. Milky → Overhaul the outboard motor.	10-10 10-11
Oil filter	Replace the oil filter.	10-13
Engine start switch (Single application)	Check that the engine starts when the engine start switch is turned to START. Out of specification → Check the engine start switch.	5-41 5-43
	Check that the engine stops when the engine start switch is turned to OFF. Out of specification → Check the engine start switch.	

General periodic maintenance

Item	Procedures	See
Main switch (or "POWER" switch) Engine start/stop button	Turn the main switch (or "POWER" switch) to ON, and then push the engine start/stop button. Check that the engine starts. Out of specification → Check the main switch (or "POWER" switch) or engine start/stop button.	5-41 5-41 5-42 5-43
	Start the engine. Check that the engine stops when the main switch (or "POWER" switch) is turned to OFF. Out of specification → Check the main switch (or "POWER" switch).	5-41 5-42
	Start the engine. Check that the engine stops when the engine start/stop button is pushed. Out of specification → Check the engine start/stop button.	5-43
Engine shut-off switch	Check that the engine stops when the clip is removed from the engine shutoff switch. Out of specification → Check the engine shut-off switch.	5-39 5-39
Exhaust joint Exhaust guide	Check the exhaust joint and exhaust guide. Corroded/cracked/damaged → Replace.	7-7 7-11 9-26
Fuel filter	Check the fuel filter element. Dirt/residue → Replace. Water accumulated → Drain.	6-4
	Checking the fuel cup assembly. Foreign material → Clean. Cracked → Replace.	
	Checking the fuel inlet or fuel outlet holding pressure. Out of specification → Replace the O-ring, fuel cup assembly, or fuel filter assembly.	
Fuel strainer	Check the fuel strainer Cracked/damage → Replace. Check the fuel strainer element. Dirt/residue → Clean.	6-14
	Check the fuel strainer holding pressure. Out of specification → Replace.	
Fuel pump	Check the operation of the fuel pump using the YDIS "Stationary test" and check the operating sound. Abnormal sound → Check the fuel pump internal parts.	5-29 5-30
Fuel leakage	Check the fuel line. Leaking → Check the related parts.	2-42
Engine oil leakage	Check the engine oil line. Leaking → Check the related parts.	2-49

General periodic maintenance

Item	Procedures	See
Gear oil	Check the gear oil level. Below the proper level → Add the recommended gear oil.	10-14
	Check the gear oil. Replacement interval has been exceeded/deterioration → Change. Milky → Overhaul the lower unit.	10-15 10-17
OCV filter	Replace the OCV gasket.	7-58
Greasing	Apply lubricants.	10-19
Propeller Propeller nut Cotter pin	Check the propeller blade and damper rubber spline. Cracked/damaged/worn → Replace.	8-2
	Check the installed condition of propeller nut and cotter pin. Improperly installed → Reinstall.	8-1
PCV (Pressure Control Valve)	Check the PCV. Corroded/damaged/deformed/fatigued → Replace the PCV, grommet, or spring.	9-29
PTT fluid level	Check that a small amount of fluid flows out of the filler hole. Below the proper level → Add the recommended fluid.	10-20
PTT unit operation	Check the PTT unit operation. PTT operation is not smoothly → Check the PTT fluid level.	10-20
	Check the tilt support lever. Tilt support lever locks in place not properly → Check the related parts.	10-20 9-42
	Check the PTT fluid leakage. Leaking → Check the related parts.	10-20 9-52 9-62
Spark plug	Clean the electrodes using a spark plug cleaner.	—
	Check the spark plug. Electrodes are damaged/worn or insulator is abnormal color → Replace.	7-41
	Check the spark plug gap. Out of specification → Replace.	
Ignition coil	Check the ignition spark. Out of specification → Replace.	5-35
Timing belt	Check the timing belt. Cracked/damaged/worn → Replace.	7-43
Cam chain	Check the cam chain. Damaged/stiffness → Replace the cam chain, camshaft (EX), and VCT assembly as a set.	7-49
Cam chain tensioner	Check the cam chain tensioner. Cracked/damaged/rough movement/worn → Replace.	7-49
Thermostat	Measure the thermostat valve opening. Out of specification → Replace.	7-73

General periodic maintenance

Item	Procedures	See
Cowling lock lever	Check the fitting by pushing the top cowling. Looseness/rattling → Adjust or replace the top cowling stopper.	10-21
Valve clearance	Check the valve clearance. Out of specification → Adjust.	7-1
Water pump	Check the upper water pump housing. Deformed → Replace.	8-13
	Check the upper impeller, insert cartridge, and outer plate cartridge. Cracked/worn → Replace.	
	Check the lower impeller and lower water pump housing. Cracked/damaged → Replace.	
	Check the impeller key and keyway in the drive shaft. Deformed/worn → Replace.	
Wire harness	Check the wire harness coupler and lead coupler connections.	—
Yamaha Gauge	Check the gauge display.	—
SBW	Check that the steering operates smoothly. Not smooth → Check the steering arm, swivel bracket, steering actuator, helm unit, or related parts.	9-32 9-42
	Check whether the steering responds immediately when the steering wheel is turned. Slow response → Check the steering control system components for tightness, looseness, and wear.	9-32 9-42
	Check the steering control system components. Looseness → Tighten. Worn/corroded → Replace.	9-32 9-42
	Check the trouble code using the YDIS. Trouble code is detected → Perform the troubleshooting procedures.	4-8
	Check the wire harness coupler and lead coupler.	—

Checking the battery

⚠ WARNING

Battery electrolyte is dangerous; it contains sulfuric acid, which is poisonous and highly caustic. Always follow these preventive measures:

- Avoid bodily contact with electrolyte as it can cause severe burns or permanent eye injury.
- Wear protective eye gear when handling or working near batteries.

Antidote (EXTERNAL):

- SKIN - Wash with water.
- EYES - Flush with water for 15 minutes and get immediate medical attention.

Antidote (INTERNAL):

- Drink large quantities of water or milk followed with milk of magnesia, beaten egg, or vegetable oil. Get immediate medical attention.

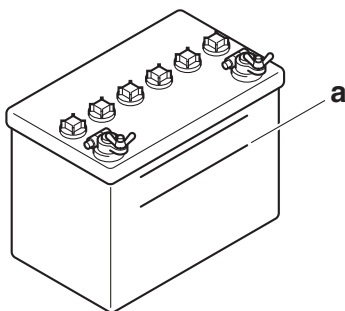
Batteries generate explosive, hydrogen gas. Always follow these preventive measures:

- Charge batteries in a well-ventilated area.
- Keep batteries away from fire, sparks, or open flames (for example, welding equipment and lighted cigarettes).
- DO NOT SMOKE when charging or handling batteries.

KEEP BATTERIES AND ELECTROLYTE OUT OF REACH OF CHILDREN.

1. Check:

- Battery electrolyte level
Below the minimum level mark "a" → Add distilled water until the level is between the maximum and minimum level marks.



2. Check:

- Specific gravity of the electrolyte
Below specification → Fully charge the battery.

TIP:

- Batteries vary depending on the manufacturer. The procedures mentioned in this manual may not always apply. Therefore, see the instruction manual of the battery.
- Disconnect the negative battery cable first, and then disconnect the positive battery cable.

	Recommended battery capacity
	Battery rating
	700 A (CCA/SAE)
	900 A (MCA/ABYC)
	170 minutes (RC/SAE)
670 A (CCA/EN)	
110 Ah (20 HR/IEC)	

Checking the cooling water pilot hole

1. Place the lower unit in water, and then start the engine.

2. Check:

- Cooling water is discharged from the cooling water pilot hole.
Not discharged → Check the cooling passages for clog.



Checking the engine idle speed

1. Check:

- Engine idling speed
Out of specification → Perform the troubleshooting procedures. See "Troubleshooting procedure" (4-4).
a. Check the engine idle speed using the YDIS. See the YDIS (Ver. 2.49 or later) instruction manual.



Idle speed (in neutral)
650–750 r/min

Checking the engine oil level

NOTICE

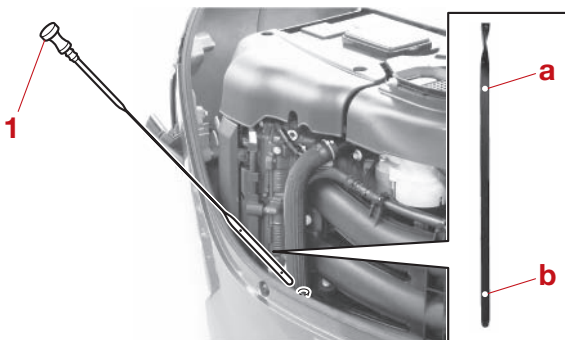
Make sure that the engine is filled with engine oil before operating the outboard motor for the first time. Otherwise, the engine could be damaged severely.

1. Check:
 - Engine oil level
Not at the proper level → Add or extract the engine oil.
 - a. Place the outboard motor in an upright position.

NOTICE

If the outboard motor is not level, the oil level indicated on the dipstick may not be correct.

- b. Start the engine and warm it up for 5–10 minutes.
- c. Stop the engine and leave it off for 5–10 minutes.
- d. Remove the top cowling.
- e. Remove the dipstick “1” and wipe it clean.
- f. Insert the dipstick “1” completely for a correct measurement and remove it again.
- g. Check that the oil level indicated on the dipstick “1” is between the upper mark “a” and the lower mark “b”. If the engine oil is not at the proper level, add or extract engine oil.



Changing the engine oil using an oil changer

NOTICE

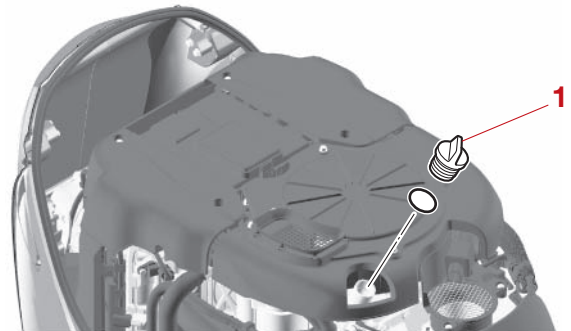
Change the engine oil after the first 20 hours of operation or 3 months, and every 100 hours or at 1-year intervals thereafter.

1. Warm up:
 - Engine
 - a. Place the outboard motor in an upright position.

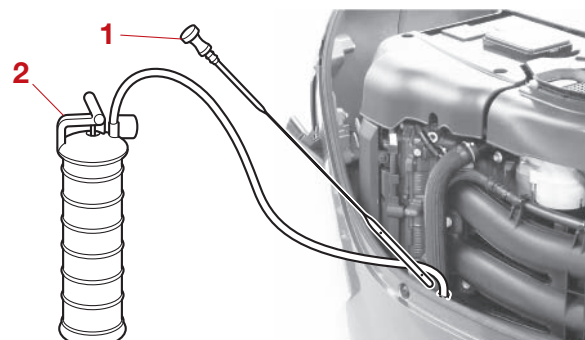
NOTICE

If the outboard motor is not level, the oil level indicated on the dipstick may not be correct.

- b. Start the engine and warm it up for 5–10 minutes.
- c. Stop the engine and leave it off for 5–10 minutes.
2. Remove:
 - Top cowling
3. Drain:
 - Engine oil
 - a. Remove the oil filler cap “1”.



- b. Remove the dipstick “1” and extract the engine oil using the oil changer “2”.



4. Fill:
 - Engine oil

- a. Fill the engine with the specified amount of the recommended engine oil through the oil filler hole. Install the oil filler cap and dipstick.

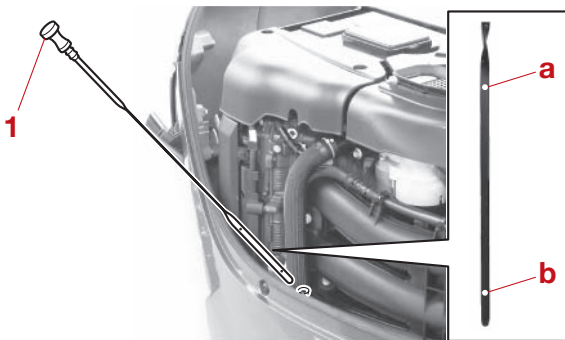
NOTICE

Do not overfill the engine with engine oil. Otherwise, the engine could be damaged or oil could leak. If the engine oil is above the upper level, extract the excess engine oil until the oil is at the proper level.



Engine oil quantity (without oil filter replacement)
7.5 L (7.93 US qt, 6.60 Imp.qt)

- b. Leave the outboard motor off for 5–10 minutes.
- c. Remove the dipstick “1” and wipe it clean.
- d. Insert the dipstick “1” completely for a correct measurement and remove it again.
- e. Check that the oil level indicated on the dipstick “1” is between the upper mark “a” and the lower mark “b”.



- f. Start the engine and check that the oil pressure alert indicator does not come on. Also, check that there is no oil leakage.

NOTICE

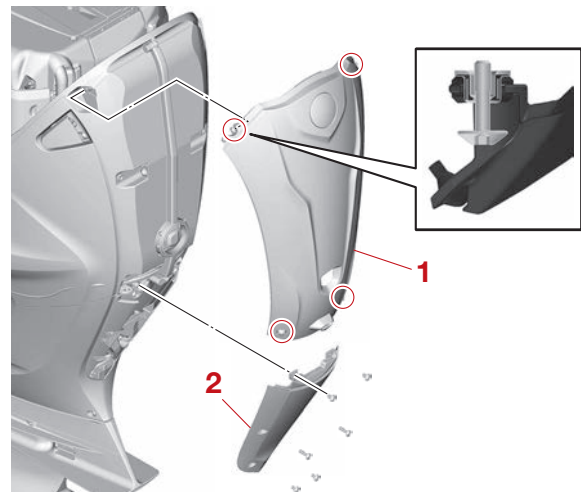
If the oil pressure alert indicator comes on or if there is oil leakage, stop the engine and find the cause. Continued operation with a problem could cause severe engine damage.

Changing the engine oil by removing the drain bolt

NOTICE

Change the engine oil after the first 20 hours of operation or 3 months, and every 100 hours or at 1-year intervals thereafter.

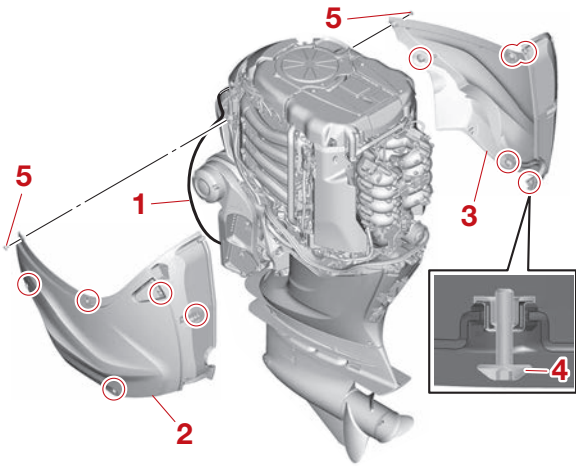
1. Warm up:
 - Engine
See step 1 in “Changing the engine oil using an oil changer” (10-10).
2. Remove:
 - Top cowling
 - Bottom cowling cover “1”
 - Apron cover “2”



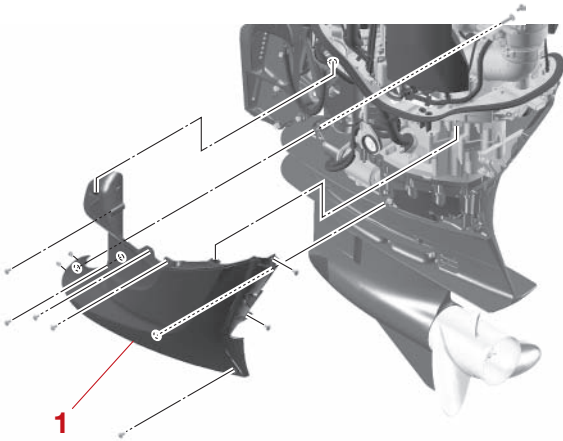
3. Remove:
 - Rubber seal “1”
 - Bottom cowling “2”, “3”

TIP:

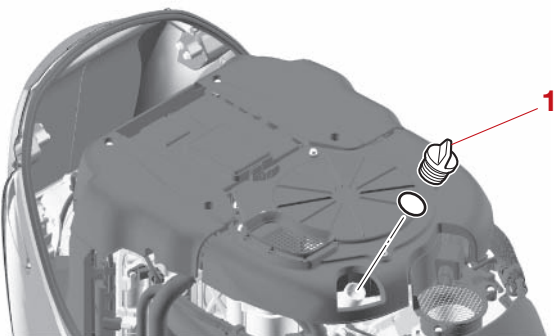
Although the bolts (M6 × 25 mm) “4” will remain in the bottom cowlings when the bolts are loosened, make sure that the bolts (M6 × 14 mm) “5” do not fall from the bottom cowlings because those bolts are removed.



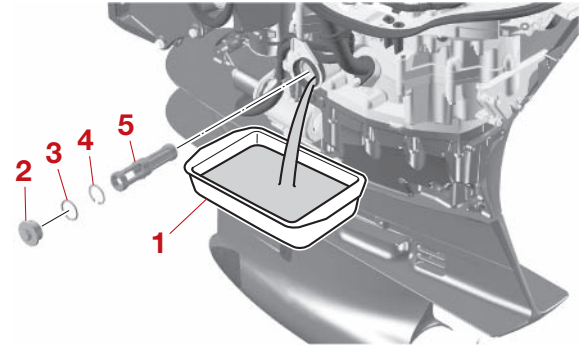
4. Remove:
- Apron (PORT) "1"



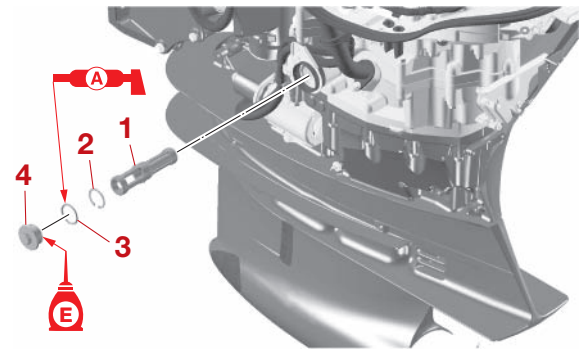
5. Drain:
- Engine oil
 - a. Remove the oil filler cap "1".




- b. Place a drain pan "1" under the engine oil drain hole.
- c. Remove the drain bolt "2", O-ring "3", circlip "4", and oil strainer "5" and let the oil drain completely.



6. Check:
- Oil strainer
See "Checking the oil pan and oil strainer" (9-29).
7. Install:
- Oil strainer "1"
 - Circlip "2"
 - O-ring "3" **New**
 - Drain bolt "4"




	Drain bolt 60 N·m (6.1 kgf·m, 44 lb·ft)
-------------------------------------------------------------------------------------	--------------------------------------------

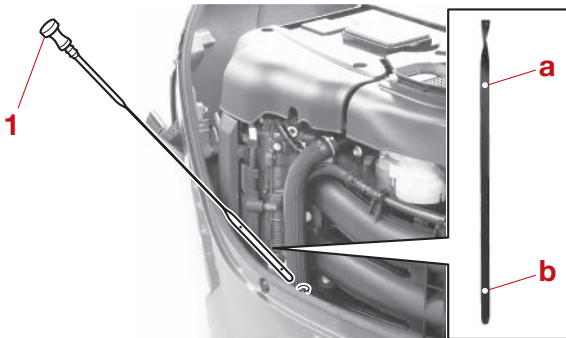
8. Fill:
- Recommended engine oil
 - a. Fill the engine with the specified amount of the recommended engine oil through the oil filler hole. Install the oil filler cap.

NOTICE

Do not overfill the engine with engine oil. Otherwise, the engine could be damaged or oil could leak. If the engine oil is above the upper level, extract the excess engine oil until the oil is at the proper level.

	Engine oil quantity (without oil filter replacement) 7.5 L (7.93 US qt, 6.60 Imp.qt)
-------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------

- b. Leave the outboard motor off for 5–10 minutes.
- c. Remove the dipstick “1” and wipe it clean.
- d. Insert the dipstick “1” completely for a correct measurement and remove it again.
- e. Check that the oil level indicated on the dipstick “1” is between the upper mark “a” and the lower mark “b”.

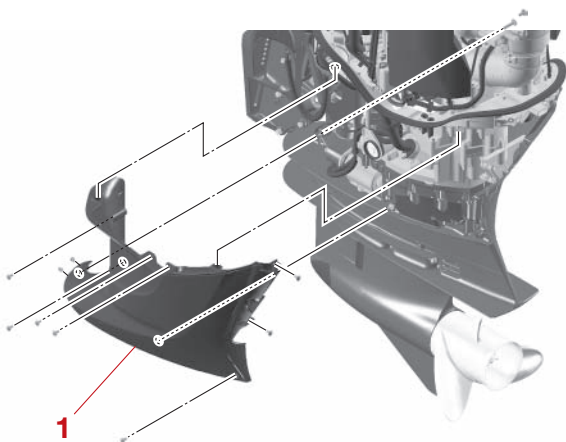


- f. Start the engine and check that the oil pressure alert indicator does not come on. Also, check that there is no oil leakage.

NOTICE

If the oil pressure alert indicator comes on or if there is oil leakage, stop the engine and find the cause. Continued operation with a problem could cause severe engine damage.

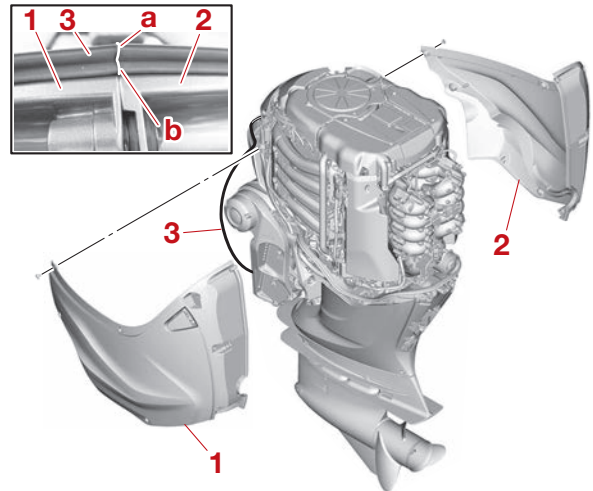
9. Install:
 - Apron (PORT) “1”



10. Install:
 - Bottom cowling “1”, “2”
 - Rubber seal “3”

- Top cowling

TIP: Align the seam “a” of the rubber seal “3” with the mating surface “b” of the bottom cowling.



Replacing the oil filter

1. Warm up:
 - Engine
 - See step 1 in “Changing the engine oil using an oil changer” (10-10).
2. Remove:
 - Top cowling
 - Bottom cowling cover
 - Apron cover
 - Rubber seal
 - Bottom cowlings
 - Apron (PORT)
 - See steps 2–4 in “Changing the engine oil by removing the drain bolt” (10-11).
3. Drain:
 - Engine oil
 - See step 3 in “Changing the engine oil using an oil changer” (10-10) or step 5 in “Changing the engine oil by removing the drain bolt” (10-11).

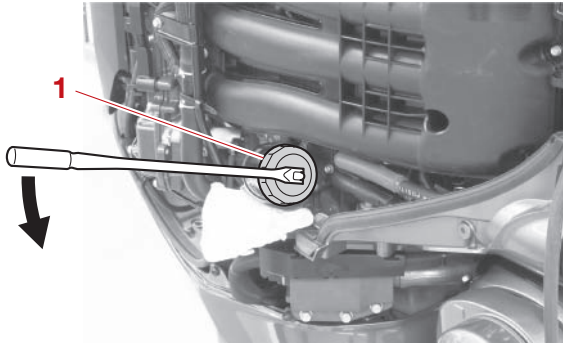
TIP: If the engine oil was changed by removing the drain bolt, install the drain bolt. See step 7 in “Changing the engine oil by removing the drain bolt” (10-11).


4. Replace:
 - Oil filter

- a. Place a rag under the oil filter, and then remove the oil filter.

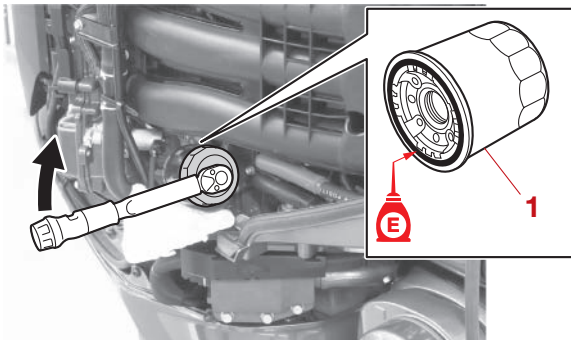
TIP:


Make sure to clean up any oil spills.



	Oil filter wrench "1" 90890-06874
	Oil filter wrench "1" YB-06874

- b. Install a new oil filter "1".



	Oil filter "1" 18 N·m (1.8 kgf·m, 13 lb·ft)
-------------------------------------------------------------------------------------	------------------------------------------------

5. Fill:

- Recommended engine oil
 - a. Fill the engine with the specified amount of the recommended engine oil through the oil filler hole. Install the oil filler cap.

NOTICE

Do not overfill the engine with engine oil. Otherwise, the engine could be damaged or oil could leak. If the engine oil is above the upper level, extract the excess engine oil until the oil is at the proper level.



Engine oil quantity (with oil filter replacement)
7.8 L (8.24 US qt, 6.86 Imp.qt)

- b. Install the oil filler cap and dipstick, and then start the engine and warm it up for 5–10 minutes.
 - c. Stop the engine, and then leave it off for 5–10 minutes.
 - d. Check the oil level.
6. Install:
- Apron (PORT)
 - Bottom cowlings
 - Rubber seal
 - Apron cover
 - Bottom cowling cover
 - Top cowling
- See steps 9–10 in "Changing the engine oil by removing the drain bolt" (10-11).

Checking the gear oil level

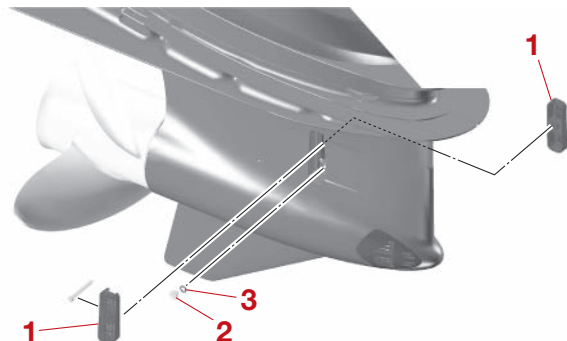
1. Check:
 - Gear oil level

Below the proper level → Add the recommended gear oil.

 - a. Place the outboard motor in an upright position.
 - b. Remove the upper water inlet covers "1", oil level plug "2", and O-ring "3", and then check the gear oil level.

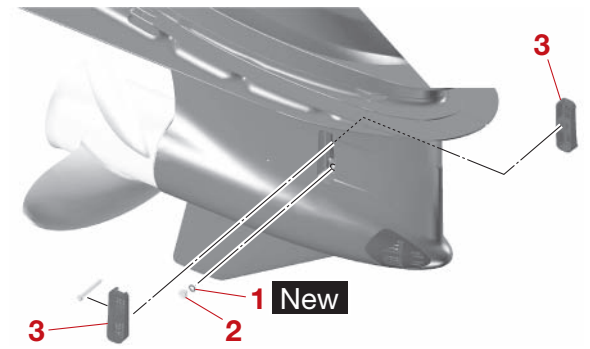
TIP:


If the oil is at the proper level, a small amount of oil should flow out of the check hole.



- c. Install a new O-ring "1" and the oil level plug "2".
- d. Install the upper water inlet covers "3".

General periodic maintenance

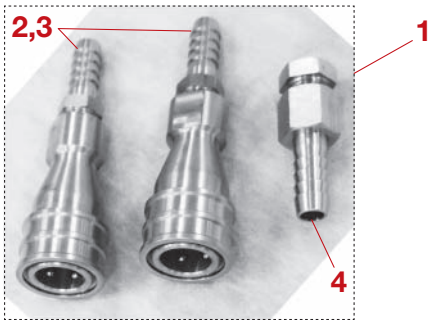



	Oil level plug 2.5 N·m (0.25 kgf·m, 1.8 lb·ft)
	Upper water inlet cover bolt 2.5 N·m (0.25 kgf·m, 1.8 lb·ft)

Changing the gear oil using an oil changer

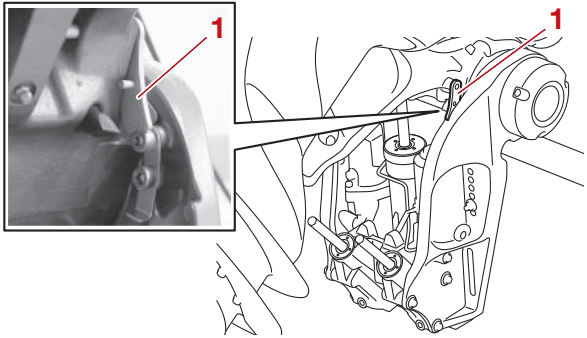
If the outboard motor cannot be tilted up 60° or more due to the boat on which the outboard motor is mounted, this method cannot be used to change the gear oil. Use the usual method for changing the gear oil, or place the outboard motor in an upright position and fill the lower unit with the specified gear oil quantity.

1. Remove:
 - Top cowling
2. Drain:
 - Gear oil

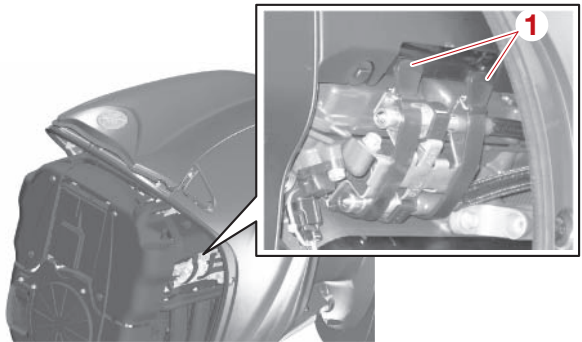


	Gear oil attachment kit "1" 90890-06963
	Oil socket "2" 90890-06964
	Air socket "3" 90890-06965
	Joint "4" 90890-06966

- a. Fully tilt the outboard motor up, and then support it using the tilt support lever "1".

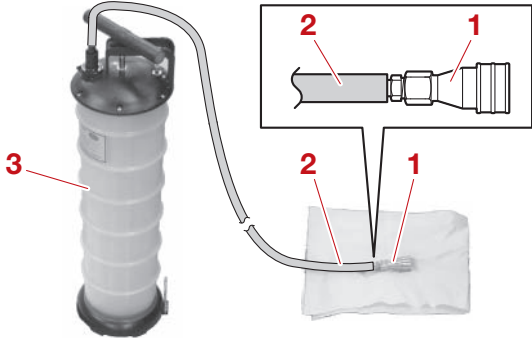


- b. Remove the bands "1".



- c. Connect the oil socket "1", hose "2", and oil changer "3".

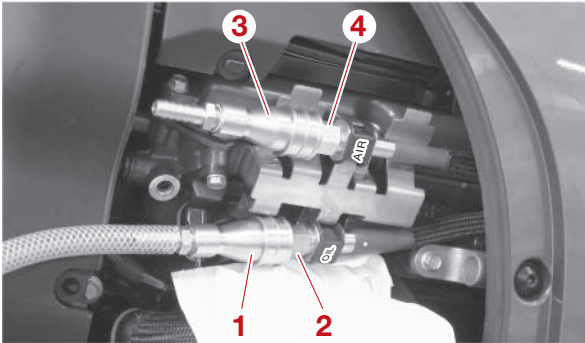
TIP: _____
A hose with an inner diameter of 6 mm (0.24 in) or more is recommended.



- d. Connect the oil socket "1" that is connected to the oil changer to the quick connector "2" with the "OIL" mark and connect the air socket "3" to the quick connector "4" with the "AIR" mark.
- e. Extract the gear oil using the oil changer.

NOTICE

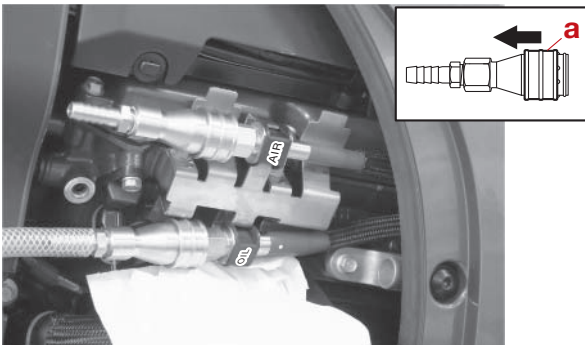
After the gear oil has been drained, check the used oil. If the oil is milky, water is getting into the lower case, which can cause gear damage.



- f. Disconnect oil socket and air socket by wrapping a rag around the socket, and then sliding the portion "a" of the socket in the direction of the arrow.

TIP:

Make sure to clean up any oil spills.



3. Fill:
- Gear oil



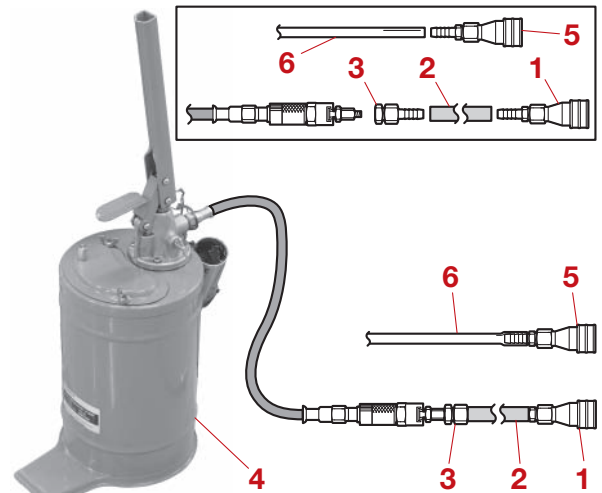
- Gear oil attachment kit "1"
90890-06963
- Oil socket "2"
90890-06964
- Air socket "3"
90890-06965
- Joint "4"
90890-06966

- a. Connect the oil socket "1", hose "2", joint "3", and gear oil pump "4".

TIP:

A hose with an inner diameter of 6 mm (0.24 in) or more is recommended.

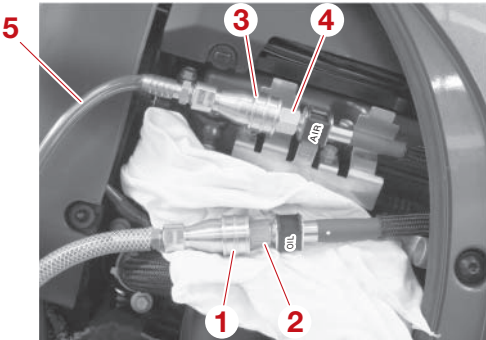
- b. Connect the air socket "5" to a clear hose "6".



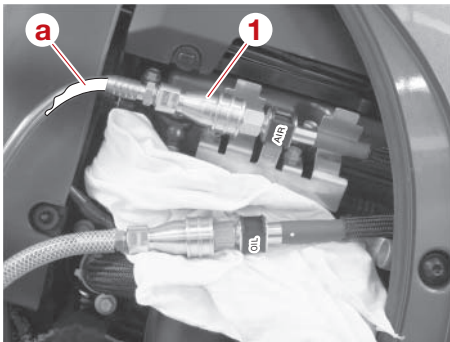
- c. Connect the oil socket "1" that is connected to the gear oil pump to the quick connector "2" with the "OIL" mark and connect the air socket "3" to the quick connector "4" with the "AIR" mark.

TIP:

Place a container under the end of the hose "5" that is connected to the air socket "3" to catch the oil.



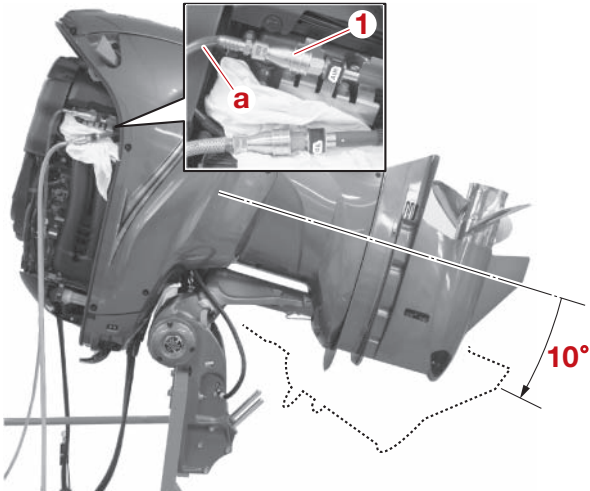
d. Fill the lower unit slowly with gear oil until oil “a” flows out of the air socket “1”.



Gear oil quantity (regular rotation model)
 1.950 L (2.061 US qt, 1.716 Imp.qt)
 Gear oil quantity (counter rotation model)
 1.830 L (1.934 US qt, 1.610 Imp.qt)

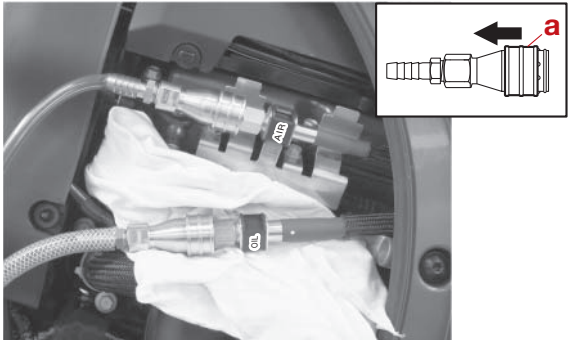
e. Release the tilt support lever, and then tilt the outboard motor down 10° to release the pressure in the lower case.

TIP: Leave the outboard motor in this position until gear oil “a” stops flowing out of the oil socket “1”.



f. Disconnect oil socket and air socket by wrapping a rag around the socket, and then sliding the portion “a” of the socket in the direction of the arrow.

TIP: Make sure to clean up any oil spills.



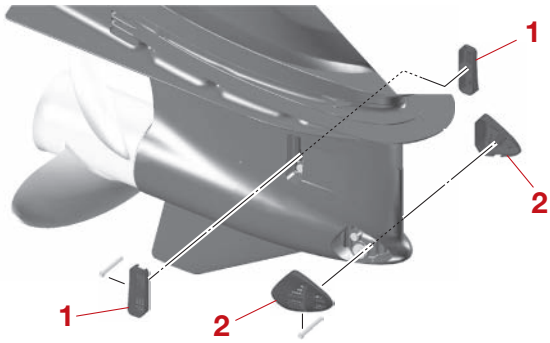
g. Install the hose fitting assemblies onto the hose holder, and then install the bands.

- 4. Install:
 - Top cowling

Changing the gear oil by removing the drain screw

WARNING Never get under the lower unit while it is tilted.

- 1. Remove:
 - Upper water inlet covers “1”
 - Lower water inlet covers “2”



2. Drain:
- Gear oil
 - a. Tilt the outboard motor so that the drain screw is at the lowest point.
 - b. Place a drain pan "1" under the gear oil drain hole.
 - c. Remove the drain screw "2" and O-ring "3".

NOTICE

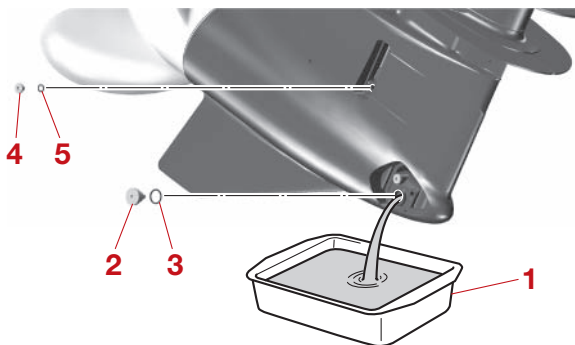
If there is a significant amount of metal particles on the magnetic drain screw, the lower unit may have a problem.

- d. Remove the oil level plug "4" and O-ring "5" and let the oil drain completely.

NOTICE

After the gear oil has been drained, check the used oil. If the oil is milky, water is getting into the lower case, which can cause gear damage.

- e. After the gear oil has been drained, check the used oil. Pressure test the lower case and inspect the oil seal for damage if the oil is milky. See "Checking the lower unit for leakage" (8-6).

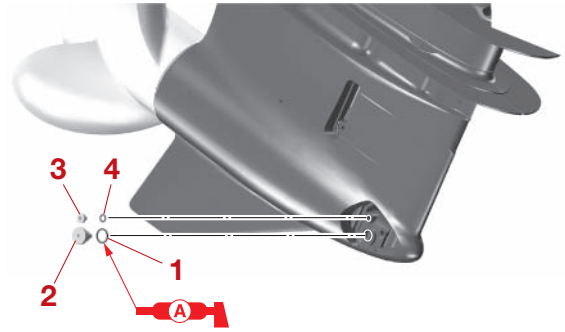



3. Install:
- O-ring "1" **New**
 - Drain screw "2"

TIP:

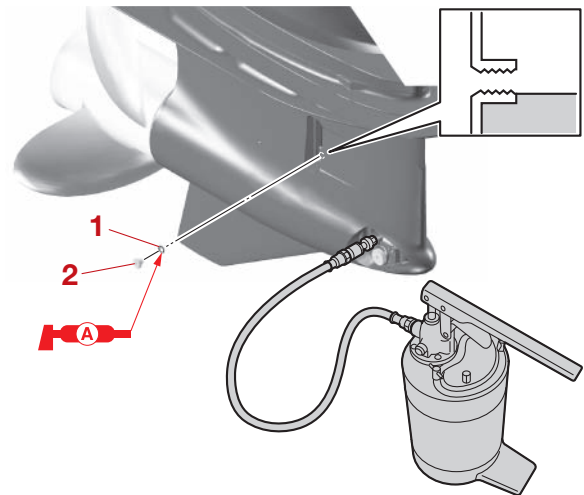
Before installing the magnetic drain screw, make sure to remove all metal particles.


4. Remove:
- Oil filler plug "3"
 - O-ring "4"



	Drain screw "2" 2.5 N·m (0.25 kgf·m, 1.8 lb·ft)
-----------------------------------------------------------------------------------	----------------------------------------------------

5. Fill:
- Gear oil
 - a. Place the outboard motor in an upright position.
 - b. Insert the gear oil pump into the filler hole, and then fill the lower unit slowly with gear oil until oil flows out of the check hole and no air bubbles are visible.
 - c. Install a new O-ring "1" and the oil level plug "2".

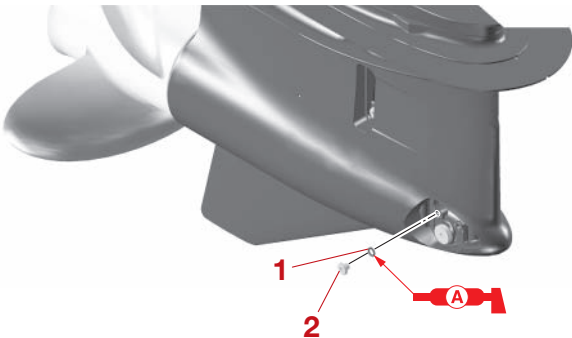


	Oil level plug "2" 2.5 N·m (0.25 kgf·m, 1.8 lb·ft)
-------------------------------------------------------------------------------------	-------------------------------------------------------



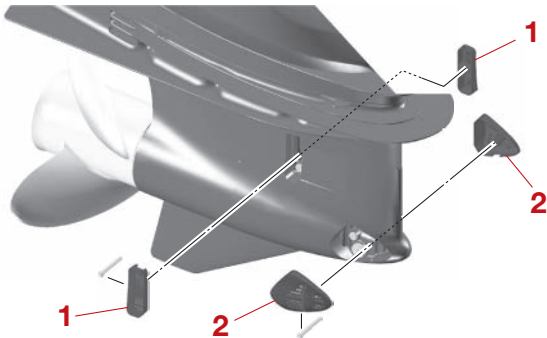
Gear oil quantity (regular rotation model)
 1.950 L (2.061 US qt, 1.716 Imp.qt)
 Gear oil quantity (counter rotation model)
 1.830 L (1.934 US qt, 1.610 Imp.qt)

d. Remove the gear oil pump, and then install a new O-ring "1" and the oil filler plug "2".



Oil filler plug "2"
 2.5 N·m (0.25 kgf·m, 1.8 lb·ft)

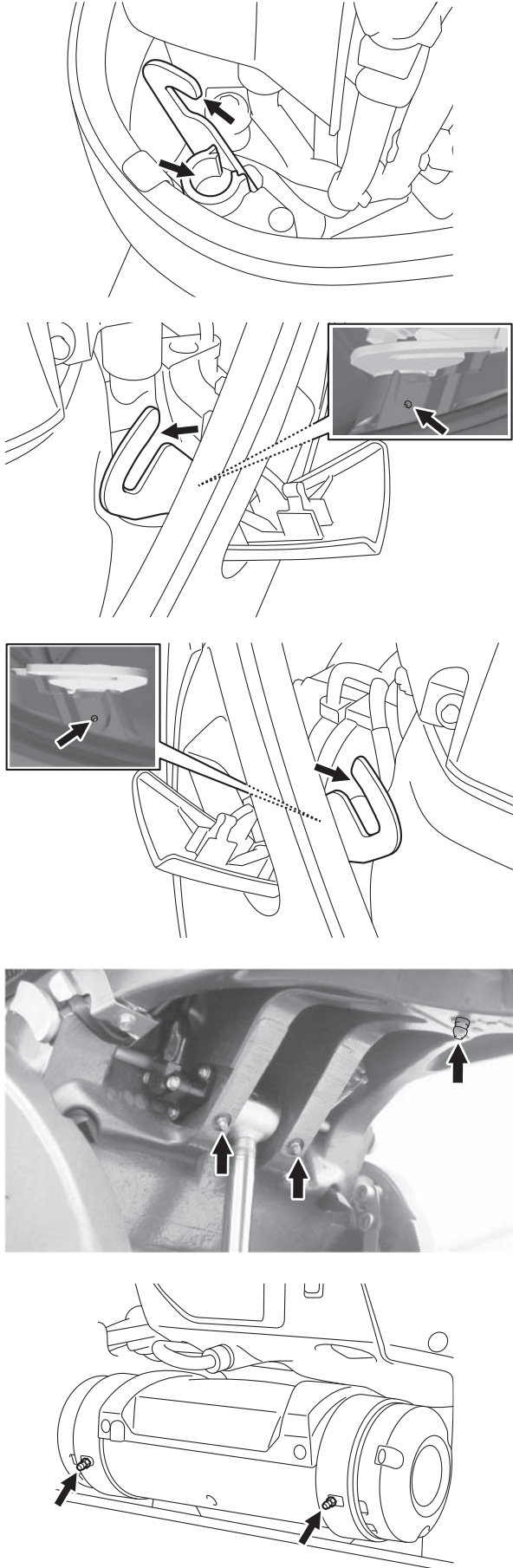
6. Install:
- Upper water inlet covers "1"
 - Lower water inlet covers "2"



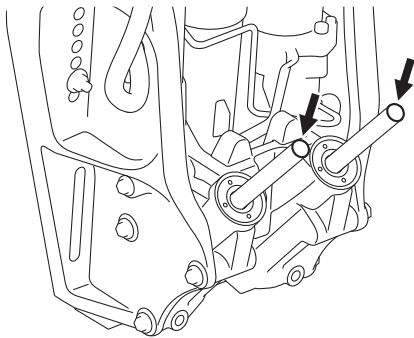
Upper water inlet cover bolt
 2.5 N·m (0.25 kgf·m, 1.8 lb·ft)
 Lower water inlet cover bolt
 2.5 N·m (0.25 kgf·m, 1.8 lb·ft)

Greasing points

1. Apply:
- Specified lubrication points
 - a. Apply water resistant grease to the specified lubrication points.



- b. Apply corrosion resistant grease to the specified lubrication point.

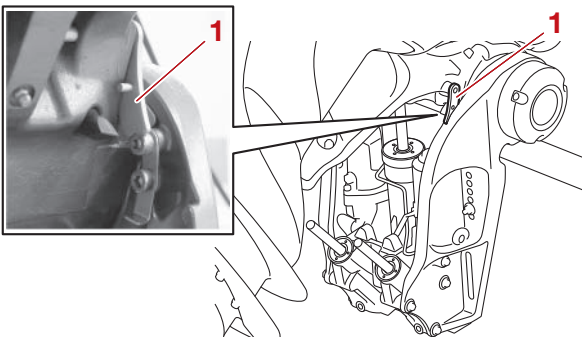


Checking the PTT fluid level

WARNING

Never get under the outboard motor while it is tilted.

1. Check:
 - PTT fluid level
Below the proper level → Add the recommended fluid.
 - a. Fully tilt the outboard motor up, and then support it using the tilt support lever "1".



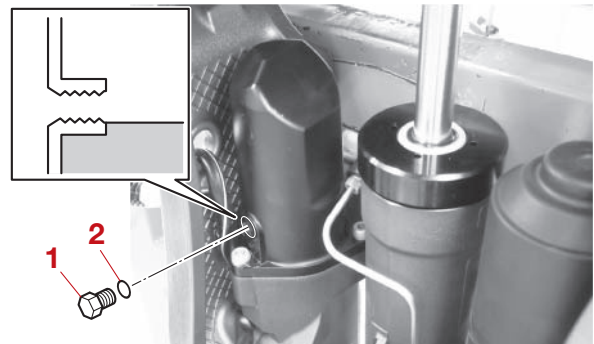
- b. Remove the reservoir cap "1" and O-ring "2", and then check the fluid level in the reservoir.

WARNING

Before removing the reservoir cap, make sure that the PTT ram is fully extended. Otherwise, fluid could be expelled forcefully from the unit due to internal pressure.

TIP:

- If the fluid is at the proper level, a small amount of fluid should flow out of the filler hole when the reservoir cap is removed.
- If the fluid is below the proper level, add the recommended fluid.

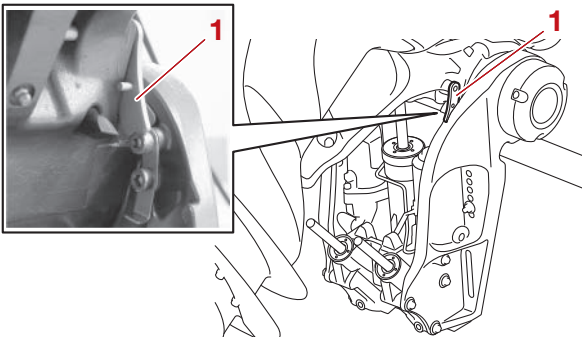


- c. Install a new O-ring and the reservoir cap.

	Reservoir cap 7 N·m (0.7 kgf·m, 5.2 lb·ft)
--	-----------------------------------------------

Checking the PTT unit operation

1. Check:
 - PTT unit operation
PTT operation is not smooth → Check the PTT fluid level.
See "Checking the PTT fluid level" (10-20).
 - a. Fully tilt the outboard motor up and down a few times and check that it tilts up and down smoothly.
 - b. Check the PTT motor makes a winding sound when it is operating smoothly.
2. Check:
 - Tilt support lever
Tilt support lever does not lock in place properly → Check the related parts.
See "Clamp bracket and swivel bracket" (9-42).
 - a. Fully tilt the outboard motor up, and then support it using the tilt support lever "1".



3. Check:
- Fluid leakage
Leaking → Check the related parts.
See “PTT motor” (9-52), “PTT gear pump” (9-57), or “PTT cylinder” (9-62).

Checking the top cowling fitting

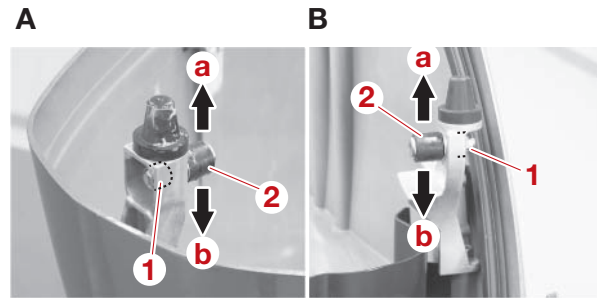
1. Check:
- Top cowling fitting
Looseness or rattling → Adjust or replace the top cowling stopper.

TIP: _____
Check the fitting by pushing the top cowling.
Adjust if there is looseness or rattling.



2. Adjust:
- Top cowling fitting
 - a. Loosen the cowling stopper nut “1”.
 - b. Move the stopper “2” up or down slightly to adjust its position.

TIP: _____
• To loosen the fitting, move the stopper in direction “a”.
• To tighten the fitting, move the stopper in direction “b”.



- A. Front
B. PORT and STBD

c. Tighten the cowling stopper nut.

	Cowling stopper nut 17 N·m (1.7 kgf·m, 13 lb·ft)
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d. Recheck the fitting. Replace the rubber seal if looseness or rattling cannot be adjusted.

Predelivery check

To make the delivery process smooth and efficient, complete the predelivery checks as explained in the following procedures.

Item	Procedures	See
Engine oil level	Check the oil level using the dipstick. Oil is not at the proper level → Add or extract engine oil.	10-10
Battery	Check the battery electrolyte level. Below the minimum level mark → Add distilled water.	10-9
	Check the specific gravity of the electrolyte. Below specification → Fully charge the battery.	
Cooling water pilot hole	Start the engine.	—
	Check that the cooling water is discharged from the cooling water pilot hole. Not discharged → Check the cooling passage for clog.	10-9 2-53
Communication between the engine and the Digital Electronic Control	Check that the digital electronic control-active indicator light or DEC alert indicator light comes on in blue. Light does not come on in blue → Check the wire harness for proper connections, the main wire harness (16 pins) for continuity, and the Digital Electronic Control circuit.	3-25 5-50
Engine start switch (Single application)	Check that the engine starts when the engine start switch is turned to START. Out of specification → Check the engine start switch.	5-41
	Check that the engine stops when the engine start switch is turned to OFF. Out of specification → Check the engine start switch.	5-43
Main switch (or "POWER" switch) Engine start/stop button	Turn the main switch (or "POWER" switch) to ON, and then push the engine start/stop button. Check that the engine starts. Out of specification → Check the main switch (or "POWER" switch) or engine start/stop button.	5-41 5-41 5-42 5-43
	Start the engine. Check that the engine stops when the main switch (or "POWER" switch) is turned to OFF. Out of specification → Check the main switch (or "POWER" switch).	5-41 5-42
	Start the engine. Check that the engine stops when the engine start/stop button is pushed. Out of specification → Check the engine start/stop button.	5-43
Engine shut-off switch	Check that the engine stops when the clip is removed from the engine shut-off switch. Out of specification → Check the engine shut-off switch.	5-39 5-39
Fuel line	Check the fuel line connection. Disconnect → Connect.	2-42
	Check all the fuel lines for leakage. Leaking → Check the related parts.	
Gear oil	Check the gear oil level. Below the proper level → Add the recommended gear oil.	10-14

Predelivery check

Item	Procedures	See
Shift and throttle operation	Check that the gear shift operates properly when the remote control lever is moved from the N position to the F or R position. Not properly → Check the shift actuator and related parts.	8-11 8-18 8-48 9-13
	Check that the throttle operates properly when the remote control lever is moved from the F or R position to the fully open position. Not properly → Check the ETV and/or LPS.	6-29
Outboard motor mounting height	Check the outboard motor mounting height. Improper → Adjust.	10-25
PTT unit	Check the PTT unit operation. Not smooth → Check the PTT fluid level and PTT motor electric current when the relief valve operate.	10-20
	Check that there is no abnormal noise produced when the outboard motor is tilted up or down. Abnormal noise → Overhaul PTT unit.	9-45 9-52 9-57 9-62
	Steer the tilted-up outboard motor. Interference → Check the hose and wire harness routing, or mounting of the outboard motor.	3-13 5-1 1-2
Steering system	Check that the steering operates smoothly. Not smooth → Check the steering arm, swivel bracket, steering actuator, helm unit or related parts.	9-32 9-42
	Check that there is no interference with hose or leads when the outboard motor is steered. Interference → Check the hose and wire harness routing.	3-13 5-1
Test run	Start the engine, and then check that the gear shift operates properly.	—
	Warm up the engine, and then check the engine idle speed. Out of specification → Perform the troubleshooting procedures.	10-9 4-25
	Operate the boat at trolling speed.	—
	Operate the outboard motor according to the break-in procedure.	—
	Check that the outboard motor does not tilt up when reverse operation. Tilt up → Check the PTT unit.	9-45
	Check that the power trim operates smoothly while cruising. Not smooth → Check the PTT unit.	9-45

Predelivery check

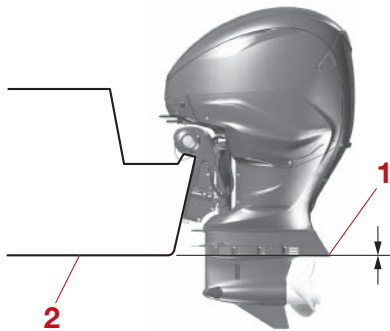
Item	Procedures	See
Break-in	Operate the engine under load (in gear with a propeller installed) for 10 hours.	—
	For the first hour of operation: Operate the engine at varying speeds up to 2000 r/min or approximately 1/2 throttle.	—
	For the second hour of operation: Increase the engine speed until the boat is on plane (but do not fully open the throttle), and then back off on the throttle while keeping the boat at a planing speed.	—
	For the remaining 8 hours of operation: Operate the engine at any engine speed. However, do not operate the engine at full throttle for more than 5 minutes at a time.	—
	After the first 10 hours of operation: Operate the engine normally.	—
After test run	Check for water in the gear oil. Oil is milky → Check the lower case for airtightness and oil seal.	8-6
	Check all the fuel lines for leakage. Leaking → Check the connection or replace affected parts.	2-42
	Flush the cooling water passages using fresh water. When using the equipped flashing device, flush the cooling water passages without starting the engine.	—

Checking the outboard motor mounting height

1. Check:
 - Outboard motor mounting height
Improper → Adjust.
 - a. Check that the anti-cavitation plate “1” is aligned with the bottom of the boat “2”.

TIP: _____

- If the mounting height is too high, cavitation will occur and propulsion will decrease. Besides, the engine speed will increase abnormally and cause the engine to overheat.
 - If the mounting height is too low, water resistance will increase, which will decrease engine efficiency and performance.
 - The appropriate mounting height depends on the combination of the boat and outboard motor. To determine the appropriate mounting height, test run the outboard motor at different heights.
-



2. Check:
 - Mount bolts
Loosen → Tighten.

Appendix

Specification	A-1
Model data	A-1
Electrical system technical data.....	A-3
Fuel system technical data.....	A-5
Power unit technical data.....	A-5
Lower unit technical data	A-7
Bracket unit technical data	A-8
Wiring diagram	A-9
How to use the wiring diagram	A-9
Engine control unit	A-10
Fuel unit.....	A-12
Ignition unit.....	A-14
Charging unit and starting unit.....	A-16
PTT unit and steering unit	A-18
Rectifier/regulator continuity table (F400A/FL400A/XF400A)	A-20
Rectifier/regulator continuity table (F450A/FL450A/XF450A)	A-22
Shim selection table and chart (regular rotation model)	A-25
Pinion shim (T3) selection table.....	A-25
Propeller shaft shim (T4) selection chart	A-26
Shim selection table and chart (counter rotation model)	A-27
Pinion shim (T3) selection table.....	A-27
Propeller shaft shim (T4) selection table	A-27

Specification

Model data

Dimension and weight

Model	F450A/XF450	FL450A/XF450	F400A/XF400	FL400A/XF400
Overall length	1217 mm (47.9 in)			
Overall width	652 mm (25.7 in)			
Overall height X	2059 mm (81.1 in) (F450AVTX)	2059 mm (81.1 in) (FL450AVTX)	2059 mm (81.1 in) (F400ASTX)	2059 mm (81.1 in) (FL400ASTX)
Overall height U	2186 mm (86.1 in) (F450AVTU)	2186 mm (86.1 in) (FL450AVTU)	2186 mm (86.1 in) (F400ASTU)	2186 mm (86.1 in) (FL400ASTU)
Overall height E	2313 mm (91.1 in) (F450AVTE)	2313 mm (91.1 in) (FL450AVTE)	2313 mm (91.1 in) (F400ASTE)	2313 mm (91.1 in) (FL400ASTE)
Motor transom height X	640 mm (25.2 in) (F450AVTX)	640 mm (25.2 in) (FL450AVTX)	640 mm (25.2 in) (F400ASTX)	640 mm (25.2 in) (FL400ASTX)
Motor transom height U	767 mm (30.2 in) (F450AVTU)	767 mm (30.2 in) (FL450AVTU)	767 mm (30.2 in) (F400ASTU)	767 mm (30.2 in) (FL400ASTU)
Motor transom height E	894 mm (35.2 in) (F450AVTE)	894 mm (35.2 in) (FL450AVTE)	894 mm (35.2 in) (F400ASTE)	894 mm (35.2 in) (FL400ASTE)
Dry weight (SUS) X	447 kg (985 lb) (F450AVTX)	447 kg (985 lb) (FL450AVTX)	447 kg (985 lb) (F400ASTX)	447 kg (985 lb) (FL400ASTX)
Dry weight (SUS) U	458 kg (1010 lb) (F450AVTU)	458 kg (1010 lb) (FL450AVTU)	458 kg (1010 lb) (F400ASTU)	458 kg (1010 lb) (FL400ASTU)
Dry weight (SUS) E	468 kg (1032 lb) (F450AVTE)	468 kg (1032 lb) (FL450AVTE)	468 kg (1032 lb) (F400ASTE)	468 kg (1032 lb) (FL400ASTE)

* Dry weight: With SUS (stainless steel) propeller

Performance	
Rated power	331.0 kW (450 HP) 294.2 kW (400 HP)
Full throttle operating range	5000–6000 r/min
Maximum fuel consumption (reference data)	144.8 L/h at 6000 r/min (38.2 US gal/h at 6000 r/min, 31.9 Imp.gal/h at 6000 r/min) 130.6 L/h at 6000 r/min (34.5 US gal/h at 6000 r/min, 28.7 Imp.gal/h at 6000 r/min)
Idle speed (in neutral)	650–750 r/min

Power unit	
Type	4-stroke DOHC V8 32 valves
Total displacement	5559 cm ³ (339.2 c.i.)
Bore x stroke	96.0 x 96.0 mm (3.78 x 3.78 in)
Compression ratio	12.3 : 1

Model	F450A/XF450	FL450A/XF450	F400A/XF400	FL400A/XF400
Throttle & shift control system	Remote control			
Starting system	Electric starter			
Fuel system	Fuel injection			
Starting carburetion system	Fuel injection			
Ignition system	TCI			
Advance type	Microcomputer			
Maximum generator output	102 A		104 A	
Maximum charging capacity	96 A		88 A	
Spark plug (NGK)	ILMAR7H-9			
Firing order	1-2-7-3-4-5-6-8			
Steering system	Remote steering			
Cooling system	Water			
Exhaust system	Through propeller boss			
Lubrication system	Wet sump			

Lower unit				
Gear shift positions	Forward-neutral-reverse			
Gear ratio	1.79 (25/14)			
Gear type	Spiral bevel gear			
Clutch type	Dog clutch			
Propeller fitting mechanism	Spline			
Propeller direction (rear view)	Clockwise	Counterclockwise	Clockwise	Counterclockwise
Propeller mark	Y	YL	Y	YL

Bracket unit	
Trim angle	-4 ~ +16 °
Full Tilt-up angle	77 °
Tilt support angle	69, 56 °
Steering angle	31 °
Trim and tilt system	Power trim and tilt

Model	F450A/XF450	FL450A/XF450	F400A/XF400	FL400A/XF400
Fuel and oil				
Recommended fuel	Premium unleaded gasoline			
Min. research octane number (RON)	94 (F450AVTE, F450AVTU_*EC3/*EC4/*EE/*NC/OTH, F450AVTX_*EC1/*EC2/*EE/*NC1/*NC2/OTH)	94 (FL450AVTE, FL450AVTU_*EC3/*EC4/*EE/*NC/OTH, FL450AVTX_*EC1/*EC2/*EE/*NC/OTH)	94	
Min. pump octane number (PON)	89 (F450AVTE_*NC, F450AVTU_*EC3/*EC4/*NC, F450AVTX_*EC1/*EC2/*NC1/*NC2)	89 (FL450AVTE_*NC, FL450AVTU_*EC3/*EC4/*NC, FL450AVTX_*EC1/*EC2/*NC)	—	
Recommended engine oil	YAMALUBE 4 or 4-stroke outboard motor oil (except for USA and CAN) YAMALUBE 4M FC-W or 4-stroke outboard motor oil (for USA and CAN)		YAMALUBE 4 or 4-stroke outboard motor oil	
Recommended engine oil grade 1	SAE 10W-30/10W-40/5W-30 API SG/SH/SJ/SL			
Recommended engine oil grade 2	SAE 15W-40/20W-40/20W-50 API SH/SJ/SL			
Engine oil quantity (without oil filter replacement)	7.5 L (7.93 US qt, 6.60 Imp.qt)			
Engine oil quantity (with oil filter replacement)	7.8 L (8.24 US qt, 6.86 Imp.qt)			
Recommended gear oil	YAMALUBE outboard gear oil or Hypoid gear oil (except for USA and CAN) Yamalube Marine Gearcase Lube HD or Hypoid gear oil (for USA and CAN)		YAMALUBE outboard gear oil or Hypoid gear oil	
Recommended gear oil grade	SAE 80W API GL-5 / SAE 90 API GL-5			
Gear oil quantity	1.950 L (2.061 US qt, 1.716 Imp.qt)	1.830 L (1.934 US qt, 1.610 Imp.qt)	1.950 L (2.061 US qt, 1.716 Imp.qt)	1.830 L (1.934 US qt, 1.610 Imp.qt)

* Recommended engine oil and gear oil grade: Meeting both API and SAE requirements.

Model	F450A/XF450	FL450A/XF450	F400A/XF400	FL400A/XF400
Battery requirement				
Battery rating (CCA/SAE)	700 A (F450AVTE_*NC, F450AVTU_*EC3/*EC4/*NC, F450AVTX_*EC1/*EC2/*NC1/*NC2)	700 A (FL450AVTE_*NC, FL450AVTU_*EC3/*EC4/*NC, FL450AVTX_*EC1/*EC2/*NC)	—	
Battery rating (MCA/ABYC)	900 A (F450AVTE_*NC, F450AVTU_*EC3/*EC4/*NC, F450AVTX_*EC1/*EC2/*NC1/*NC2)	900 A (FL450AVTE_*NC, FL450AVTU_*EC3/*EC4/*NC, FL450AVTX_*EC1/*EC2/*NC)	—	
Battery rating (RC/SAE)	170 minutes (F450AVTE_*NC, F450AVTU_*EC3/*EC4/*NC, F450AVTX_*EC1/*EC2/*NC1/*NC2)	170 minutes (FL450AVTE_*NC, FL450AVTU_*EC3/*EC4/*NC, FL450AVTX_*EC1/*EC2/*NC)	—	
Battery rating (CCA/EN)	670 A (F450AVTE, F450AVTU_*EC3/*EC4/*EE/*NC/BRA/OTH, F450AVTX_*EC1/*EC2/*EE/*NC1/*NC2/BRA/OTH)	670 A (FL450AVTE, FL450AVTU_*EC3/*EC4/*EE/*NC/OTH, FL450AVTX_*EC1/*EC2/*EE/*NC/BRA/OTH)	670 A	
Battery rating (20HR/IEC)	110 Ah (F450AVTE, F450AVTU_*EC3/*EC4/*EE/*NC/BRA/OTH, F450AVTX_*EC1/*EC2/*EE/*NC1/*NC2/BRA/OTH)	110 Ah (FL450AVTE, FL450AVTU_*EC3/*EC4/*EE/*NC/OTH, FL450AVTX_*EC1/*EC2/*EE/*NC/BRA/OTH)	110 Ah	
Battery rating (JIS)	120E41-195G51 (F450AVTU_*JK3/*JK4, F450AVTX_*JK1/*JK2)	120E41-195G51 (FL450AVTU_*JK3/*JK4, FL450AVTX_*JK1/*JK2)	—	

Model	F450A/XF450	FL450A/XF450	F400A/XF400	FL400A/XF400
Battery cable length	3.55 m (11.6 ft)			
Battery cable conductor cross sectional area	60 mm ² (AWG 2/0)			
PTT system				
Recommended fluid	ATF Dexron II (except for USA and CAN) Yamalube Marine Power Trim and Tilt fluid or ATF Dexron II (for USA and CAN)		ATF Dexron II	

Electrical system technical data

Ignition timing control system

Spark plug	
Spark plug gap	0.8–0.9 mm (0.031–0.035 in)
Ignition coil	
Input voltage	12 V
Cam position sensor	
Input voltage	5 V
Crank position sensor	
Input voltage	5 V
Intake air pressure/temperature sensor	
Input voltage	5 V
Output voltage at -20.0 kPa (-0.20 kgf/cm ² , -2.9 psi)	0.79 V
Output voltage at -46.7 kPa (-0.47 kgf/cm ² , -6.8 psi)	1.84 V
Resistance at 0 °C (32 °F)	5.4–6.6 kΩ
Resistance at 80 °C (176 °F)	0.28–0.38 kΩ
Engine temperature sensor	
Input voltage	5 V
Resistance at 20 °C (68 °F) (reference data)	2.51–2.77 kΩ
Resistance at 100 °C (212 °F) (reference data)	0.21–0.22 kΩ
Thermo sensor	
Input voltage	5 V

Model	F450A/XF450	FL450A/XF450	F400A/XF400	FL400A/XF400
Resistance at 20 °C (68 °F)	2.25–2.65 kΩ			
Resistance at 80 °C (176 °F)	0.31–0.33 kΩ			
Knock sensor				
Resistance	504–616 kΩ			

Fuel injection control system

Water detection switch	
Input voltage	5 V
Fuel injector	
Input voltage	14 V
Resistance (reference data)	1.74–2.04 Ω
Low-pressure fuel pump	
Resistance (reference data)	0.6 Ω
High-pressure fuel pump	
Input voltage	12 V
Resistance (reference data)	0.3 Ω
Direct injection pump	
Resistance (reference data)	0.45–0.55 Ω
Fuel pressure sensor (high-pressure fuel pump)	
Input voltage	5 V
Fuel pressure sensor (direct injection pump)	
Input voltage	5 V

Engine speed control system

TPS	
TPS 1 output voltage at throttle valve fully closed (reference data)	0.850 V
TPS 2 output voltage at throttle valve fully closed (reference data)	2.840 V
TPS 1 output voltage at throttle valve fully open (reference data)	4.340 V

Model	F450A/XF450	FL450A/XF450	F400A/XF400	FL400A/XF400
TPS 2 output voltage at throttle valve fully open (reference data)	4.640 V			
Throttle valve opening angle at throttle valve fully closed (reference data)	7.5 °			
Throttle valve opening angle at throttle valve fully open (reference data)	80.7 °			
Input voltage	5 V			
SPS				
Output voltage at gear shift in the F position (reference data)	1.17 V			
Output voltage at gear shift in the N position (reference data)	2.54 V			
Output voltage at gear shift in the R position (reference data)	3.78 V			
Input voltage	5 V			
Oil pressure sensor				
Input voltage	5 V			
Output voltage at 392 kPa (3.92 kgf/cm ² , 56.8 psi)	2.5 V			
Output voltage at 784 kPa (7.84 kgf/cm ² , 113.7 psi)	4.5 V			

VCT system

OCV	
Input voltage	12 V
Resistance	6.7–7.7 Ω

Shift system

Shift actuator	
Rod stroke at gear shift in the F position (reference data)	62.0 mm (2.44 in)

Model	F450A/XF450	FL450A/XF450	F400A/XF400	FL400A/XF400
Rod stroke at gear shift in the N position (reference data)	82.0 mm (3.23 in)			
Rod stroke at gear shift in the R position (reference data)	41.0 mm (1.61 in)			
Motor resistance (reference data)	1.2 Ω			

PTT system

PTT sensor	
Input voltage	5 V
Output voltage at tilt support lever upper position (reference data)	4.07 V
Output voltage at tilt support lever lower position (reference data)	3.57 V
Output voltage at full trim-down position	0.93 V

Charging system

Lighting coil	
Resistance (reference data)	0.0904–0.1356 Ω

Starting system

Starter motor	
Type	Sliding gear
Output	2.00 kW
Cranking time limit	30 sec
Standard brush length	18.0 mm (0.71 in)
Wear limit	11.0 mm (0.43 in)
Standard commutator diameter	32.0 mm (1.26 in)
Wear limit	31.4 mm (1.24 in)

Y-COP

Receiver	
Input voltage	12 V

Model	F450A/XF450	FL450A/XF450	F400A/XF400	FL400A/XF400
Buzzer				
Input voltage	12 V			
Button cell battery - CR2016				
Battery voltage (reference data)	3 V			

Gauge/sensor

Water pressure sensor				
Input voltage	5 V			
Output voltage at 392 kPa (3.92 kgf/cm ² , 56.8 psi) (reference data)	2.5 V			
Output voltage at 784 kPa (7.84 kgf/cm ² , 113.7 psi) (reference data)	4.5 V			

Fuel system technical data

Fuel system

Fuel line	
Fuel pressure at idle speed (high-pressure fuel pump)	330–400 kPa (3.3–4.0 kgf/cm ² , 47.9–58.0 psi)
Fuel pressure at idle speed (DI pump)	8.00 Mpa (80.0 kgf/cm ² , 1160.0 psi)
Primer pump	
Positive pressure	166.7 kPa (1.67 kgf/cm ² , 24.2 psi)
Feed valve (low-pressure fuel pump)	
Holding pressure (positive pressure)	200.0 kPa (2.00 kgf/cm ² , 29.0 psi)
Relief valve (low-pressure fuel pump)	
Opening pressure (positive pressure)	72.5–93.5 kPa (0.73–0.94 kgf/cm ² , 10.5–13.6 psi)
Holding pressure (positive pressure)	200.0 kPa (2.00 kgf/cm ² , 29.0 psi)
Fuel strainer	
Holding pressure (positive pressure)	300.0 kPa (3.00 kgf/cm ² , 43.5 psi)

Model	F450A/XF450	FL450A/XF450	F400A/XF400	FL400A/XF400
Relief valve (high-pressure fuel pump)				
Holding pressure (positive pressure)	490.0 kPa (4.90 kgf/cm ² , 71.1 psi)			
Opening pressure (positive pressure)	445.0–455.0 kPa (4.45–4.55 kgf/cm ² , 64.5–66.0 psi)			
Feed valve (high-pressure fuel pump)				
Holding pressure (positive pressure)	490.0 kPa (4.90 kgf/cm ² , 71.1 psi)			
Opening pressure (positive pressure)	9.3–12.6 kPa (0.09–0.13 kgf/cm ² , 1.3–1.8 psi)			
Fuel filter assembly				
Fuel inlet holding pressure (positive pressure)	200.0 kPa (2.00 kgf/cm ² , 29.0 psi)			
Fuel outlet holding pressure (negative pressure)	-80.0 kPa (-0.80 kgf/cm ² , -11.6 psi)			

Power unit technical data

Power unit

Compression pressure	
Minimum (reference data)	947.9 kPa (9.48 kgf/cm ² , 137.4 psi)
Engine oil	
Engine oil pressure at idle speed (reference data)	492.0 kPa (4.92 kgf/cm ² , 71.3 psi)
Engine oil pressure at 3000 r/min (reference data)	676.0 kPa (6.76 kgf/cm ² , 98.0 psi)

* For the checking method, see "Checking the oil pressure" (7-1). The figures are for reference only.

Thermostat	
Valve opening temperature	58–62 °C (136–144 °F)
Fully open temperature	70 °C (158 °F)
Fully open stroke	3.0 mm (0.12 in) (oil cooler and water jacket)
Fully open stroke	5.0 mm (0.20 in) (cylinder block)

Model	F450A/XF450	FL450A/XF450	F400A/XF400	FL400A/XF400
Timing belt				
Installation height (bottom of drive sprocket [crankshaft] to bottom of timing belt)	3.25 mm (0.1280 in)			
Installation height (top of driven sprocket to top of timing belt)	0.75 mm (0.0295 in)			
Installation height (top of belt tensioner to top of timing belt)	6.75 mm (0.2657 in)			

Cylinder head assembly

Cylinder head	
Warpage limit	0.10 mm (0.0039 in)
Journal inside diameter	25.000–25.021 mm (0.9843–0.9851 in)
Camshaft journal oil clearance	0.020–0.061 mm (0.0008–0.0024 in)
Limit	0.080 mm (0.0032 in)
Cam chain	
Chain length	114.33–114.58 mm (4.5012–4.5110 in)
Limit	114.85 mm (4.5216 in)
Cam chain tensioner	
Maximum wear depth	1.00 mm (0.0394 in)
Camshaft	
Cam lobe height IN	47.311–47.411 mm (1.8626–1.8666 in)
Limit	47.261 mm (1.8607 in)
Cam lobe height EX	46.600–46.700 mm (1.8346–1.8386 in)
Limit	46.550 mm (1.8327 in)
Journal diameter	24.960–24.980 mm (0.9827–0.9835 in)
Runout	0.030 mm (0.0012 in)
Fuel pump cam width across corner (DI pump)	49.350–49.450 mm (1.9429–1.9468 in)
Valve clearance	
Valve clearance IN (cold engine)	0.17–0.24 mm (0.0067–0.0094 in)
Valve clearance EX (cold engine)	0.37–0.44 mm (0.0146–0.0173 in)

Model	F450A/XF450	FL450A/XF450	F400A/XF400	FL400A/XF400
Valve				
Margin thickness IN	0.50–0.90 mm (0.0197–0.0354 in)			
Margin thickness EX	0.90–1.30 mm (0.0354–0.0512 in)			
Seat contact width IN	1.10–1.40 mm (0.0433–0.0551 in)			
Limit	1.850 mm (0.0728 in)			
Seat contact width EX	1.40–1.70 mm (0.0551–0.0669 in)			
Limit	2.150 mm (0.0846 in)			
Valve lifter				
Outside diameter	30.964–30.980 mm (1.2191–1.2197 in)			
Clearance IN (reference data)	0.020–0.061 mm (0.0008–0.0024 in)			
Clearance EX (reference data)	0.020–0.061 mm (0.0008–0.0024 in)			
Valve stem				
Diameter IN	5.477–5.492 mm (0.2156–0.2162 in)			
Limit	5.447 mm (0.2144 in)			
Diameter EX	5.464–5.479 mm (0.2151–0.2157 in)			
Limit	5.434 mm (0.2139 in)			
Runout limit IN	0.01 mm (0.0004 in)			
Runout limit EX	0.01 mm (0.0004 in)			
Valve guide				
Inside diameter IN	5.504–5.522 mm (0.2167–0.2174 in)			
Clearance IN	0.012–0.045 mm (0.0005–0.0018 in)			
Limit	0.070 mm (0.0028 in)			
Inside diameter EX	5.504–5.522 mm (0.2167–0.2174 in)			
Clearance EX	0.025–0.058 mm (0.0010–0.0023 in)			
Limit	0.080 mm (0.0032 in)			
Installation height	11.30–11.70 mm (0.4449–0.4606 in)			
Valve spring				
Free length IN	48.08 mm (1.89 in)			
Limit	45.68 mm (1.80 in)			
Tilt limit IN	1.7 mm (0.07 in)			
Free length EX	48.08 mm (1.89 in)			
Limit	45.68 mm (1.80 in)			
Tilt limit EX	1.7 mm (0.07 in)			

Crankcase assembly

Model	F450A/XF450	FL450A/XF450	F400A/XF400	FL400A/XF400
Cylinder				
Bore	96.000–96.012 mm (3.7795–3.7800 in)			
Limit	96.072 mm (3.7824 in)			
Piston				
Diameter	95.945–95.960 mm (3.7774–3.7779 in)			
Limit	95.905 mm (3.7758 in)			
Measuring point	14.5 mm (0.57 in)			
Piston clearance	0.040–0.067 mm (0.0016–0.0026 in)			
Limit	0.167 mm (0.0066 in)			
Ring groove (Top)	1.22–1.25 mm (0.0480–0.0492 in)			
Ring groove (2nd)	1.22–1.24 mm (0.0480–0.0488 in)			
Ring groove (Oil)	2.51–2.53 mm (0.0988–0.0996 in)			
Pin boss inside diameter	22.011–22.018 mm (0.8666–0.8668 in)			
Limit	22.038 mm (0.8676 in)			
Pin outside diameter	21.996–22.005 mm (0.8660–0.8663 in)			
Limit	21.986 mm (0.8656 in)			
Piston ring (Top)				
Type	Barrel			
Height (B)	1.170–1.185 mm (0.0461–0.0467 in)			
Width (T)	2.800–3.000 mm (0.1102–0.1181 in)			
End gap	0.20–0.30 mm (0.0079–0.0118 in)			
Limit	0.470 mm (0.0185 in)			
Side clearance	0.03–0.08 mm (0.0014–0.0032 in)			
Limit	0.130 mm (0.0051 in)			
Piston ring (2nd)				
Type	Taper			
Height (B)	1.170–1.190 mm (0.0461–0.0469 in)			
Width (T)	3.800–4.000 mm (0.1496–0.1575 in)			
End gap	0.60–0.75 mm (0.0236–0.0295 in)			
Limit	0.900 mm (0.0354 in)			
Side clearance	0.03–0.07 mm (0.0012–0.0028 in)			
Limit	0.110 mm (0.0043 in)			
Piston ring (Oil)				
Height (B)	2.410–2.470 mm (0.0949–0.0972 in)			
Width (T)	2.350–2.750 mm (0.0925–0.1083 in)			

Model	F450A/XF450	FL450A/XF450	F400A/XF400	FL400A/XF400
End gap	0.15–0.60 mm (0.0059–0.0236 in)			
Side clearance	0.04–0.12 mm (0.0016–0.0047 in)			
Connecting rod				
Small end inside diameter	22.008–22.025 mm (0.8665–0.8671 in)			
Big end inside diameter	65.990–66.010 mm (2.5980–2.5988 in)			
Big end side clearance	0.140–0.310 mm (0.0055–0.0122 in)			
Limit	0.36 mm (0.0142 in)			
Big end oil clearance	0.026–0.049 mm (0.0010–0.0019 in)			
Limit	0.079 mm (0.0031 in)			
Crankshaft				
Journal diameter	72.976–72.996 mm (2.8731–2.8739 in)			
Crankshaft pin diameter	62.980–63.000 mm (2.4795–2.4803 in)			
Runout	0.03 mm (0.0012 in)			
Limit	0.04 mm (0.0016 in)			
Crankshaft pin width	21.00–21.10 mm (0.8268–0.8307 in)			
Journal oil clearance	0.029–0.053 mm (0.0011–0.0021 in)			
Limit	0.073 mm (0.0029 in)			

Lower unit technical data

Lower unit assembly (regular rotation model)

Lower unit				
Holding pressure	68.6 kPa (0.69 kgf/cm ² , 9.9 psi)	—	68.6 kPa (0.69 kgf/cm ² , 9.9 psi)	—
Gear backlash				
Forward gear backlash	0.13–0.50 mm (0.0051– 0.0197 in)	—	0.13–0.50 mm (0.0051– 0.0197 in)	—
Reverse gear backlash	0.39–0.83 mm (0.0154– 0.0327 in)	—	0.39–0.83 mm (0.0154– 0.0327 in)	—
Available shim thicknesses				
Pinion shims	0.10/0.12/0.15/ 0.18/0.30/0.40/ 0.50 mm	—	0.10/0.12/0.15/ 0.18/0.30/0.40/ 0.50 mm	—
Forward shims	2.00/2.03/2.06/ 2.09/2.12/2.15/ 2.18/2.21 mm	—	2.00/2.03/2.06/ 2.09/2.12/2.15/ 2.18/2.21 mm	—

Model	F450A/XF450	FL450A/XF450	F400A/XF400	FL400A/XF400
Reverse shims	0.10/0.12/0.15/ 0.18/0.30/0.40/ 0.50 mm	—	0.10/0.12/0.15/ 0.18/0.30/0.40/ 0.50 mm	—
Propeller shaft shims	0.10/0.12/0.15/ 0.18/0.30/0.40/ 0.50/1.00 mm	—	0.10/0.12/0.15/ 0.18/0.30/0.40/ 0.50/1.00 mm	—
Propeller shaft				
Motive torque	0.4–1.0 N·m (0.04–0.10 kgf·m, 0.3–0.7 lb·ft)	—	0.4–1.0 N·m (0.04–0.10 kgf·m, 0.3–0.7 lb·ft)	—
Runout	0.02 mm (0.0008 in)	—	0.02 mm (0.0008 in)	—
Drive shaft				
Motive torque	0.3–3.0 N·m (0.03–0.31 kgf·m, 0.2–2.2 lb·ft)	—	0.3–3.0 N·m (0.03– 0.31 kgf·m, 0.2– 2.2 lb·ft)	—
Runout	1.0 mm (0.039 in)	—	1.0 mm (0.039 in)	—

* Figures obtained using the special service tools.

Lower unit assembly (counter rotation model)

Lower unit				
Holding pressure	—	68.6 kPa (0.69 kgf/cm ² , 9.9 psi)	—	68.6 kPa (0.69 kgf/cm ² , 9.9 psi)
Gear backlash				
Forward gear backlash	—	0.20–0.61 mm (0.0079– 0.0240 in)	—	0.20–0.61 mm (0.0079– 0.0240 in)
Reverse gear backlash	—	0.40–0.81 mm (0.0157– 0.0319 in)	—	0.40–0.81 mm (0.0157– 0.0319 in)
Available shim thicknesses				
Pinion shims	—	0.10/0.12/0.15/ 0.18/0.30/0.40/ 0.50 mm	—	0.10/0.12/0.15/ 0.18/0.30/0.40/ 0.50 mm
Forward shims	—	0.10/0.12/0.15/ 0.18/0.30/0.40/ 0.50 mm	—	0.10/0.12/0.15/ 0.18/0.30/0.40/ 0.50 mm
Reverse shims	—	2.00/2.03/2.06/ 2.09/2.12/2.15/ 2.18/2.21 mm	—	2.00/2.03/2.06/ 2.09/2.12/2.15/ 2.18/2.21 mm

Model	F450A/XF450	FL450A/XF450	F400A/XF400	FL400A/XF400
Propeller shaft shims	—	0.10/0.12/0.15/ 0.18/0.30/0.40/ 0.50 mm	—	0.10/0.12/0.15/ 0.18/0.30/0.40/ 0.50 mm
Propeller shaft				
Free play	—	0.42–0.52 mm (0.0165– 0.0205 in)	—	0.42–0.52 mm (0.0165– 0.0205 in)
Runout	—	0.02 mm (0.0008 in)	—	0.02 mm (0.0008 in)
Drive shaft				
Motive torque	—	0.3–3.0 N·m (0.03–0.31 kgf·m, 0.2–2.2 lb·ft)	—	0.3–3.0 N·m (0.03–0.31 kgf·m, 0.2–2.2 lb·ft)
Runout	—	1.0 mm (0.039 in)	—	1.0 mm (0.039 in)

* Figures obtained using the special service tools.

Bracket unit technical data

PTT system

Hydraulic pressure	
Up	15.00 Mpa (150.0 kgf/cm ² , 2175.0 psi)
Down	7.70 Mpa (77.0 kgf/cm ² , 1116.5 psi)
Electric current	
Up	69–93 A
Down	43–59 A
Motor	
Standard commutator diameter	28.00 mm (1.1024 in)
Wear limit	27.00 mm (1.0630 in)
Standard commutator undercut	1.00 mm (0.0394 in)
Wear limit	0.50 mm (0.0197 in)
Standard brush length	12.00 mm (0.4724 in)
Wear limit	4.3 mm (0.17 in)







Wiring diagram

How to use the wiring diagram

Composition of the wiring diagrams

The wiring diagram consists of five categories: “Engine control unit”, “Fuel unit”, “Ignition unit”, “Charging unit and starting unit”, and “PTT unit and steering unit”.

Legend symbols in the wiring diagrams

1	2	3
		
4	5	6
		

1. Double-colored wire
2. Not used (vacant)
3. A wire is not included in the selected wiring unit
4. Alert buzzer
5. Optional parts
6. Continuity

Terminal numbers

- Terminal numbers are indicated for cases where terminal locations of wires are unclear.
- In the coupler illustrations, only the rightmost and leftmost terminal numbers are indicated, and terminal numbers between them are omitted.

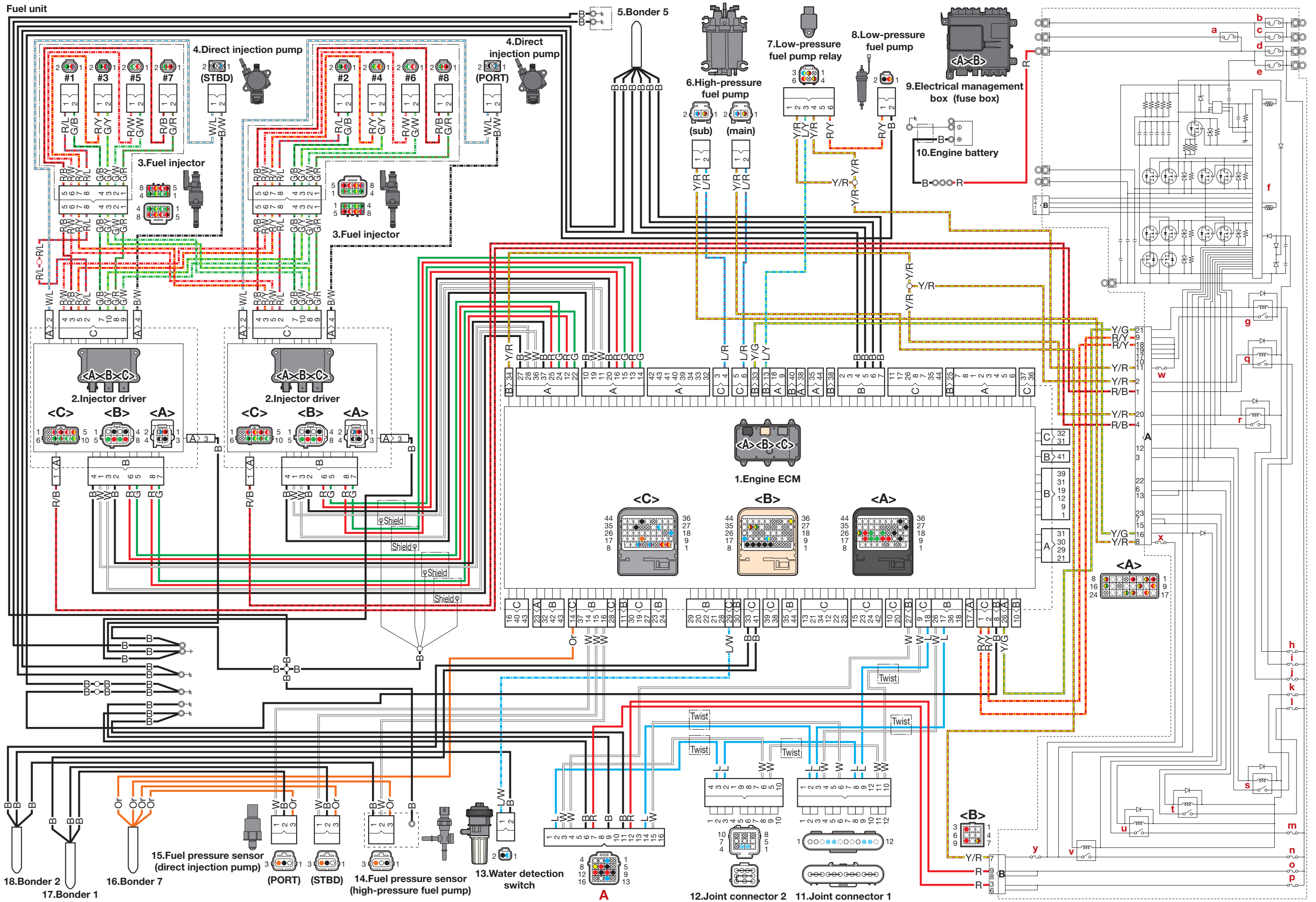


1. Engine ECM
2. BONDER 5
3. BONDER 8
4. BONDER 6
5. OCV
6. Shift actuator
7. Engine battery
8. Electrical management box (fuse box)
9. Joint connector 1
10. Joint connector 2
11. ETV
12. SPS
13. Water pressure sensor
14. Oil pressure sensor
15. Cam position sensor
16. BONDER 7
17. BONDER 1
18. BONDER 2

B. To Digital Electronic Control

- a. Fuse (100A) (SCU)
- b. Fuse (70A) (house battery)
- c. Fuse (70A) (house battery)
- d. Fuse (70A) (engine battery)
- e. Fuse (70A) (engine battery)
- f. PTT relay
- g. Main relay
- h. Fuse (30A) (main)
 - i. Fuse (20A) (injector driver)
 - j. Fuse (20A) (injector driver)
- k. Fuse (30A) (starter motor)
- l. Fuse (15A) (shift actuator)
- m. Fuse (10A) (ETV)
- n. Fuse (30A) (high-pressure fuel pump system)
- o. Fuse (20A) (Digital Electronic Control)
- p. Fuse (10A) (Digital Electronic Control ECM)
- q. Injector driver relay
- r. Injector driver relay
- s. Starter relay
- t. Shift actuator relay
- u. ETV motor relay
- v. High-pressure fuel pump relay
- w. Fuse (10A) (low-pressure fuel pump)
- x. Fuse (15A) (high-pressure fuel pump [main])
- y. Fuse (15A) (high-pressure fuel pump [sub])

A. To YDIS



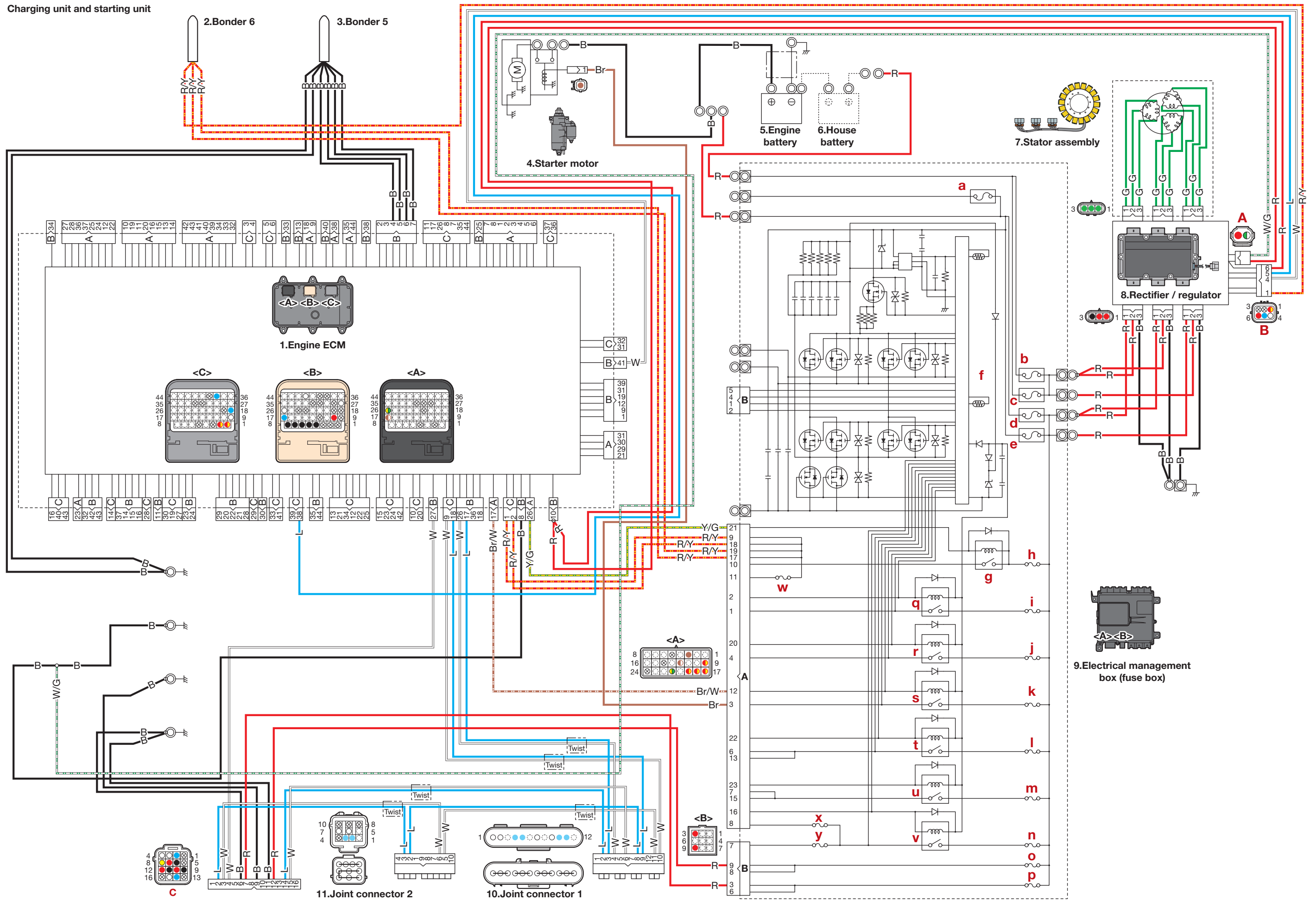
1. Engine ECM
2. Injector driver
3. Fuel injector
4. Direct injection pump
5. BONDER 5
6. High-pressure fuel pump (main), (sub)
7. Low-pressure fuel pump relay
8. Low-pressure fuel pump
9. Electrical management box (fuse box)
10. Engine battery
11. Joint connector 1
12. Joint connector 2
13. Water detection switch
14. Fuel pressure sensor (high-pressure fuel pump)
15. Fuel pressure sensor (direct injection pump)
16. BONDER 7
17. BONDER 1
18. BONDER 2

A. To Digital Electronic Control

- a. Fuse (100A) (SCU)
- b. Fuse (70A) (house battery)
- c. Fuse (70A) (house battery)
- d. Fuse (70A) (engine battery)
- e. Fuse (70A) (engine battery)
- f. PTT relay
- g. Main relay
- h. Fuse (30A) (main)
 - i. Fuse (20A) (injector driver)
 - j. Fuse (20A) (injector driver)
- k. Fuse (30A) (starter motor)
 - l. Fuse (15A) (shift actuator)
- m. Fuse (10A) (ETV)
 - n. Fuse (30A) (high-pressure fuel pump system)
 - o. Fuse (20A) (Digital Electronic Control)
 - p. Fuse (10A) (Digital Electronic Control ECM)
- q. Injector driver relay
- r. Injector driver relay
- s. Starter relay
- t. Shift actuator relay
- u. ETV motor relay
- v. High-pressure fuel pump relay
- w. Fuse (10A) (low-pressure fuel pump)
- x. Fuse (15A) (high-pressure fuel pump [main])
- y. Fuse (15A) (high-pressure fuel pump [sub])

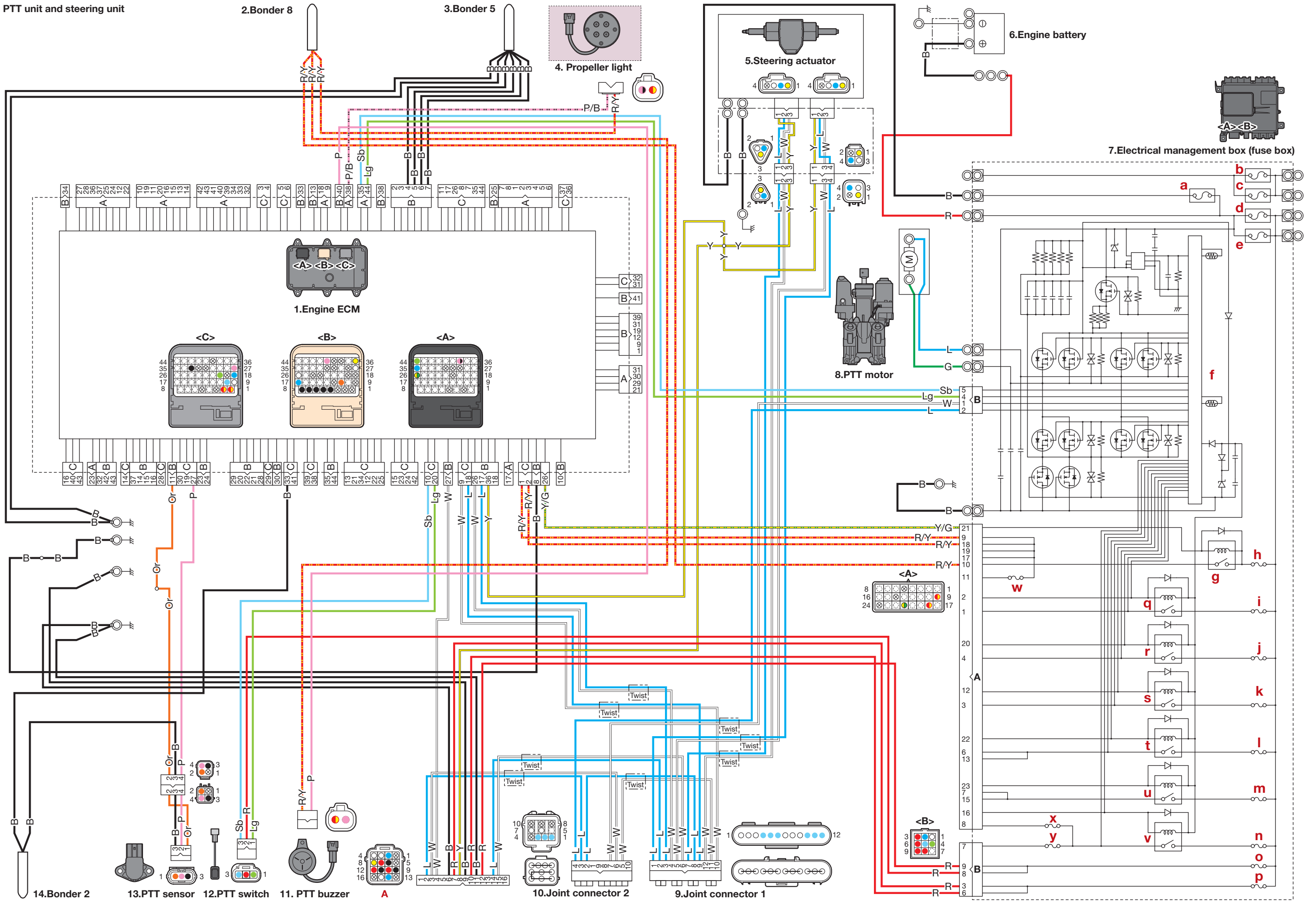
1. Engine ECM
 2. Ignition coil
 3. BONDER 6
 4. BONDER 4
 5. BONDER 5
 6. Engine battery
 7. Electrical management box (fuse box)
 8. Joint connector 1
 9. Joint connector 2
 10. Knock sensor
 11. Thermo sensor
 12. Engine temperature sensor
 13. Intake air pressure/temperature sensor
 14. Crankshaft position sensor
 15. BONDER 7
 16. BONDER 1
 17. BONDER 2
-
- a. Fuse (100A) (SCU)
 - b. Fuse (70A) (house battery)
 - c. Fuse (70A) (house battery)
 - d. Fuse (70A) (engine battery)
 - e. Fuse (70A) (engine battery)
 - f. PTT relay
 - g. Main relay
 - h. Fuse (30A) (main)
 - i. Fuse (20A) (injector driver)
 - j. Fuse (20A) (injector driver)
 - k. Fuse (30A) (starter motor)
 - l. Fuse (15A) (shift actuator)
 - m. Fuse (10A) (ETV)
 - n. Fuse (30A) (high-pressure fuel pump system)
 - o. Fuse (20A) (Digital Electronic Control)
 - p. Fuse (10A) (Digital Electronic Control ECM)
 - q. Injector driver relay
 - r. Injector driver relay
 - s. Starter relay
 - t. Shift actuator relay
 - u. ETV motor relay
 - v. High-pressure fuel pump relay
 - w. Fuse (10A) (low-pressure fuel pump)
 - x. Fuse (15A) (high-pressure fuel pump [main])
 - y. Fuse (15A) (high-pressure fuel pump [sub])
-
- A. To Digital Electronic Control

Charging unit and starting unit



1. Engine ECM
 2. BONDER 6
 3. BONDER 5
 4. Starter motor
 5. Engine battery
 6. House battery
 7. Stator assembly
 8. Rectifier/regulator
 9. Electrical management box (fuse box)
 10. Joint connector 1
 11. Joint connector 2
-
- a. Fuse (100A) (SCU)
 - b. Fuse (70A) (house battery)
 - c. Fuse (70A) (house battery)
 - d. Fuse (70A) (engine battery)
 - e. Fuse (70A) (engine battery)
 - f. PTT relay
 - g. Main relay
 - h. Fuse (30A) (main)
 - i. Fuse (20A) (injector driver)
 - j. Fuse (20A) (injector driver)
 - k. Fuse (30A) (starter motor)
 - l. Fuse (15A) (shift actuator)
 - m. Fuse (10A) (ETV)
 - n. Fuse (30A) (high-pressure fuel pump system)
 - o. Fuse (20A) (Digital Electronic Control)
 - p. Fuse (10A) (Digital Electronic Control ECM)
 - q. Injector driver relay
 - r. Injector driver relay
 - s. Starter relay
 - t. Shift actuator relay
 - u. ETV motor relay
 - v. High-pressure fuel pump relay
 - w. Fuse (10A) (low-pressure fuel pump)
 - x. Fuse (15A) (high-pressure fuel pump [main])
 - y. Fuse (15A) (high-pressure fuel pump [sub])
-
- A. For F400A/FL400A/XF400
 - B. For F450A/FL450A/XF450
 - C. To Digital Electronic Control

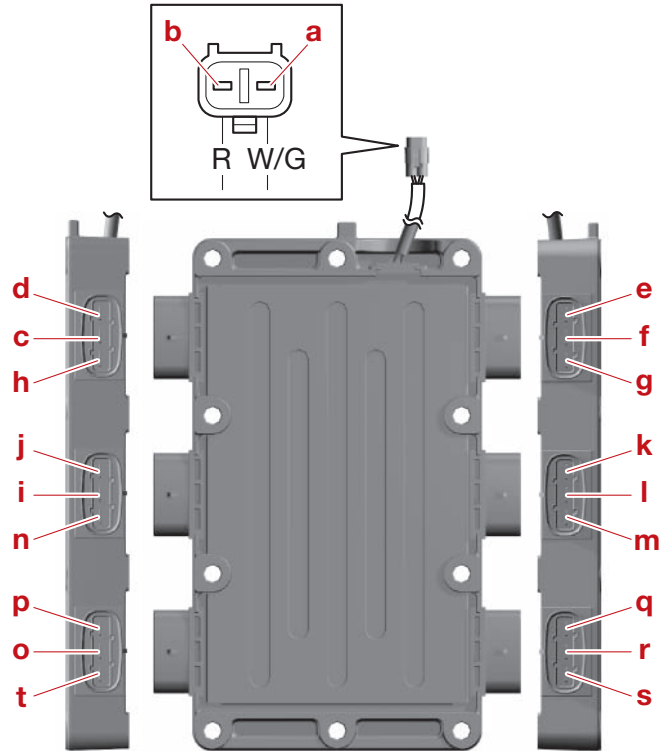
PTT unit and steering unit



1. Engine ECM
2. BONDER 8
3. BONDER 5
4. Propeller light
5. Steering actuator
6. Engine battery
7. Electrical management box (fuse box)
8. PTT motor
9. Joint connector 1
10. Joint connector 2
11. PTT buzzer
12. PTT switch
13. PTT sensor
14. BONDER 2

- a. Fuse (100A) (SCU)
 - b. Fuse (70A) (house battery)
 - c. Fuse (70A) (house battery)
 - d. Fuse (70A) (engine battery)
 - e. Fuse (70A) (engine battery)
 - f. PTT relay
 - g. Main relay
 - h. Fuse (30A) (main)
 - i. Fuse (20A) (injector driver)
 - j. Fuse (20A) (injector driver)
 - k. Fuse (30A) (starter motor)
 - l. Fuse (15A) (shift actuator)
 - m. Fuse (10A) (ETV)
 - n. Fuse (30A) (high-pressure fuel pump system)
 - o. Fuse (20A) (Digital Electronic Control)
 - p. Fuse (10A) (Digital Electronic Control ECM)
 - q. Injector driver relay
 - r. Injector driver relay
 - s. Starter relay
 - t. Shift actuator relay
 - u. ETV motor relay
 - v. High-pressure fuel pump relay
 - w. Fuse (10A) (low-pressure fuel pump)
 - x. Fuse (15A) (high-pressure fuel pump [main])
 - y. Fuse (15A) (high-pressure fuel pump [sub])
- A. To Digital Electronic Control

Rectifier/regulator continuity table (F400A/FL400A/XF400A)



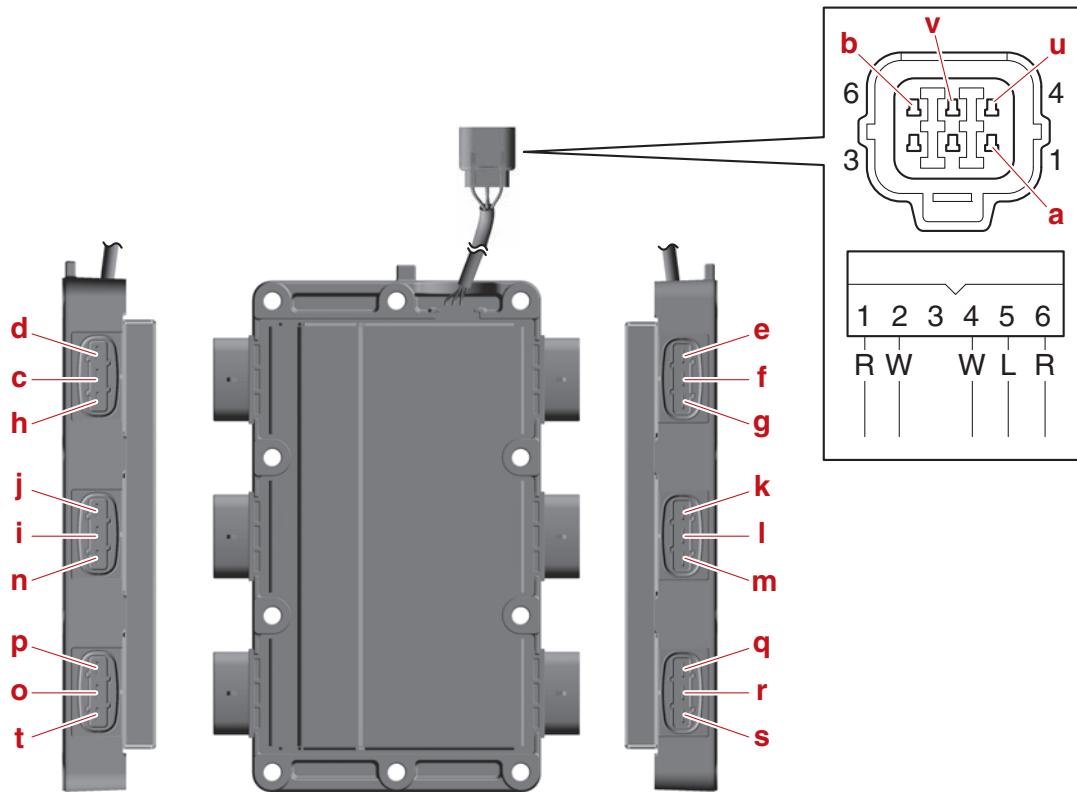
OL: Indicates an overload

Rectifier/regulator for continuity		
Tester probe		Display value (reference data)
(+)	(-)	
"a"	All terminals	OL
"b"	"c"	0
	Except for "c"	OL
"c"	"b"	0
	Except for "b"	OL
"d"	All terminals	OL
"e"	"d"	0.22–0.43
	Except for "d"	OL
"f"	"d"	0.48–0.69
	Except for "d"	OL
"g"	"d"	0.22–0.43
	Except for "d"	OL
"h"	"d"	0.48–0.69
	"e", "f", and "g"	0.22–0.43
	Except for "d", "e", "f", and "g"	OL
"i"	All terminals	OL

Rectifier/regulator continuity table (F400A/FL400A/XF400A)

Rectifier/regulator for continuity		
Tester probe		Display value (reference data)
(+)	(-)	
"j"	All terminals	OL
"k"	"j"	0.22–0.43
	Except for "j"	OL
"l"	"j"	0.22–0.43
	Except for "j"	OL
"m"	"j"	0.22–0.43
	Except for "j"	OL
"n"	j	0.48–0.69
	"k", "l", "m"	0.22–0.43
	Except for "j", "k", "l", and "m"	OL
"o"	All terminals	OL
"p"	All terminals	OL
"q"	"p"	0.22–0.43
	Except for "p"	OL
"r"	"p"	0.22–0.43
	Except for "p"	OL
"s"	"p"	0.22–0.43
	Except for "p"	OL
"t"	"p"	0.48–0.69
	"q", "r", and "s"	0.22–0.43
	Except for "p", "q", "r", and "s"	OL

Rectifier/regulator continuity table (F450A/FL450A/XF450A)



OL: Indicates an overload

Rectifier/regulator for continuity		
Tester probe		Display value (reference data)
(+)	(-)	
"a"	"e", "f" and "g"	1.83 V
	"h"	1.35 V
	"n"	1.89 V
	"t"	1.90 V
	"v"	1.82 V
	Except for "e", "f", "g", "h", "n", "t" and "v"	OL
"b"	"c"	0.08 mV
	Except for "c"	OL
"c"	"b"	0.08 mV
	Except for "b"	OL
"d"	All terminals	OL
"e"	All terminals	OL
"f"	All terminals	OL
"g"	All terminals	OL

Rectifier/regulator continuity table (F450A/FL450A/XF450A)

Rectifier/regulator for continuity		
Tester probe		Display value (reference data)
(+)	(-)	
"h"	"e", "f" and "g"	0.48 V
	"k", "l", "m", "q", "r" and "s"	1.08 V
	"n" and "t"	0.61 V
	"v"	0.47 V
	Except for "e", "f", "g", "k", "l", "m", "n", "q", "r", "s", "t" and "v"	OL
"i"	All terminals	OL
"j"	All terminals	OL
"k"	All terminals	OL
"l"	All terminals	OL
"m"	All terminals	OL
"n"	"e", "f" and "g"	1.17 V
	"h"	0.69 V
	"k" and "m"	0.48 V
	"l"	0.47 V
	"q" and "r"	1.77 V
	"s"	1.78 V
	"t"	1.30 V
	"v"	1.16 V
Except for "e", "f", "g", "h", "k", "l", "m", "q", "r", "s", "t" and "v"	OL	
"o"	All terminals	OL
"p"	All terminals	OL
"q"	All terminals	OL
"r"	All terminals	OL
"s"	All terminals	OL
"t"	"e", "f" and "g"	1.17 V
	"h"	0.69 V
	"k" and "m"	1.78 V
	"l"	1.77 V
	"n"	1.30 V
	"q" and "s"	0.48 V
	"r"	0.47 V
	"v"	1.16 V
	Except for "e", "f", "g", "h", "k", "l", "m", "n", "q", "r", "s" and "v"	OL

Rectifier/regulator continuity table (F450A/FL450A/XF450A)

Rectifier/regulator for continuity		
Tester probe		Display value (reference data)
(+)	(-)	
"u"	All terminals	OL
"v"	All terminals	OL

Shim selection table and chart (regular rotation model)

Pinion shim (T3) selection table

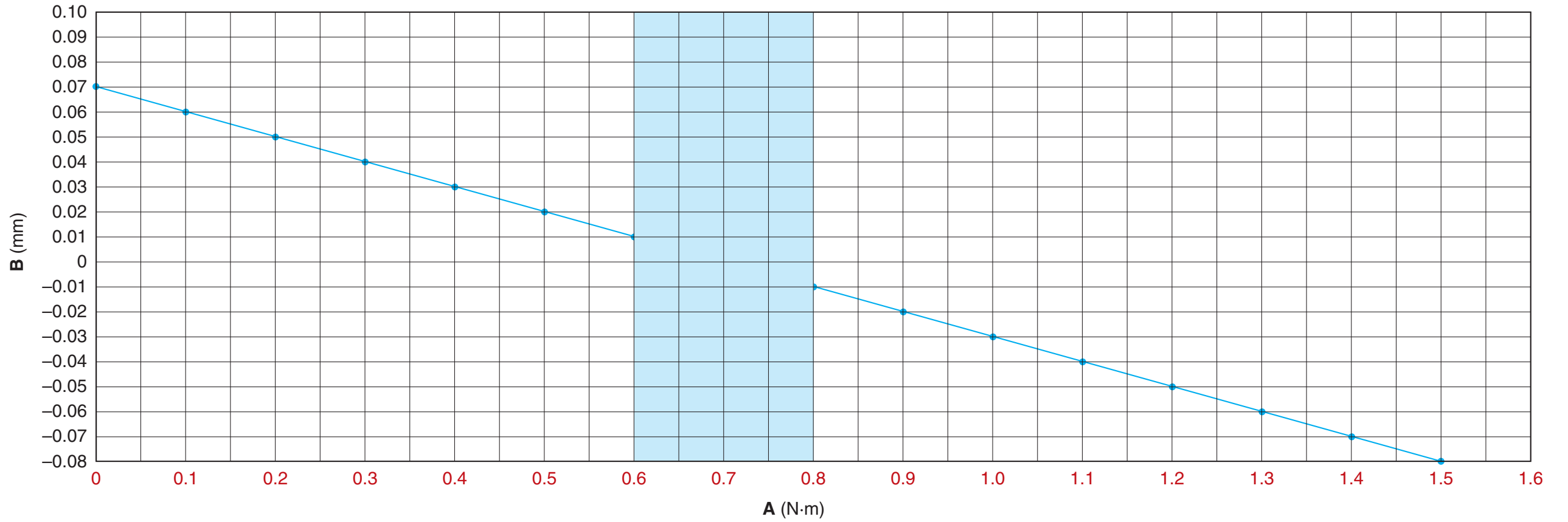
The shim thickness does not have to be adjusted for the blue-colored cells.

																							(mm)
A	0.38	0.39	0.40	0.41	0.42	0.43	0.44	0.45	0.46	0.47	0.48	0.49	0.50	0.51	0.52	0.53	0.54	0.55	0.56	0.57	0.58	0.59	0.60
B	+0.37	+0.36	+0.35	+0.34	+0.33	+0.32	+0.31	+0.30	+0.29	+0.28	+0.27	+0.26	+0.25	+0.24	+0.23	+0.22	+0.21	+0.20	+0.19	+0.18	+0.17	+0.16	+0.15
A	0.61	0.62	0.63	0.64	0.65	0.66	0.67	0.68	0.69	0.70	0.71	0.72	0.73	0.74	0.75	0.76	0.77	0.78	0.79	0.80	0.81	0.82	0.83
B	+0.14	+0.13	+0.12	+0.11	+0.10	+0.09	+0.08	+0.07	+0.06	+0.05	+0.04	+0.03	+0.02	+0.01		-0.01	-0.02	-0.03	-0.04	-0.05	-0.06	-0.07	-0.08
A	0.84	0.85	0.86	0.87	0.88	0.89	0.90	0.91	0.92	0.93	0.94	0.95	0.96	0.97	0.98	0.99	1.00	1.01	1.02	1.03	1.04	1.05	1.06
B	-0.09	-0.10	-0.11	-0.12	-0.13	-0.14	-0.15	-0.16	-0.17	-0.18	-0.19	-0.20	-0.21	-0.22	-0.23	-0.24	-0.25	-0.26	-0.27	-0.28	-0.29	-0.30	-0.31
A	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.21	1.22	1.23	1.24	1.25	1.26	1.27	1.28	1.29
B	-0.32	-0.33	-0.34	-0.35	-0.36	-0.37	-0.38	-0.39	-0.40	-0.41	-0.42	-0.43	-0.44	-0.45	-0.46	-0.47	-0.48	-0.49	-0.50	-0.51	-0.52	-0.53	-0.54
A	1.30	1.31	1.32	1.33	1.34	1.35	1.36	1.37	1.38	1.39	1.40	1.41	1.42										
B	-0.55	-0.56	-0.57	-0.58	-0.59	-0.60	-0.61	-0.62	-0.63	-0.64	-0.65	-0.66	-0.67										

A. Pinion distance measurement

B. Shim thickness adjustment

Propeller shaft shim (T4) selection chart



A	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6
B	0.07	0.06	0.05	0.04	0.03	0.02				-0.02	-0.03	-0.04	-0.05	-0.06	-0.07	-0.08	-0.09

A. Motive torque measurement
 B. Shim thickness adjustment

Shim selection table and chart (counter rotation model)

Pinion shim (T3) selection table

See "Pinion shim (T3) selection table" (A-25).

Propeller shaft shim (T4) selection table

The shim thickness does not have to be adjusted for the blue-colored cell.

(mm)

A	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5
B	-0.5	-0.4	-0.3	-0.2	-0.1	0.0	+0.1	+0.2	+0.3	+0.4	+0.5	+0.6	+0.7	+0.8	+0.9	+1.0

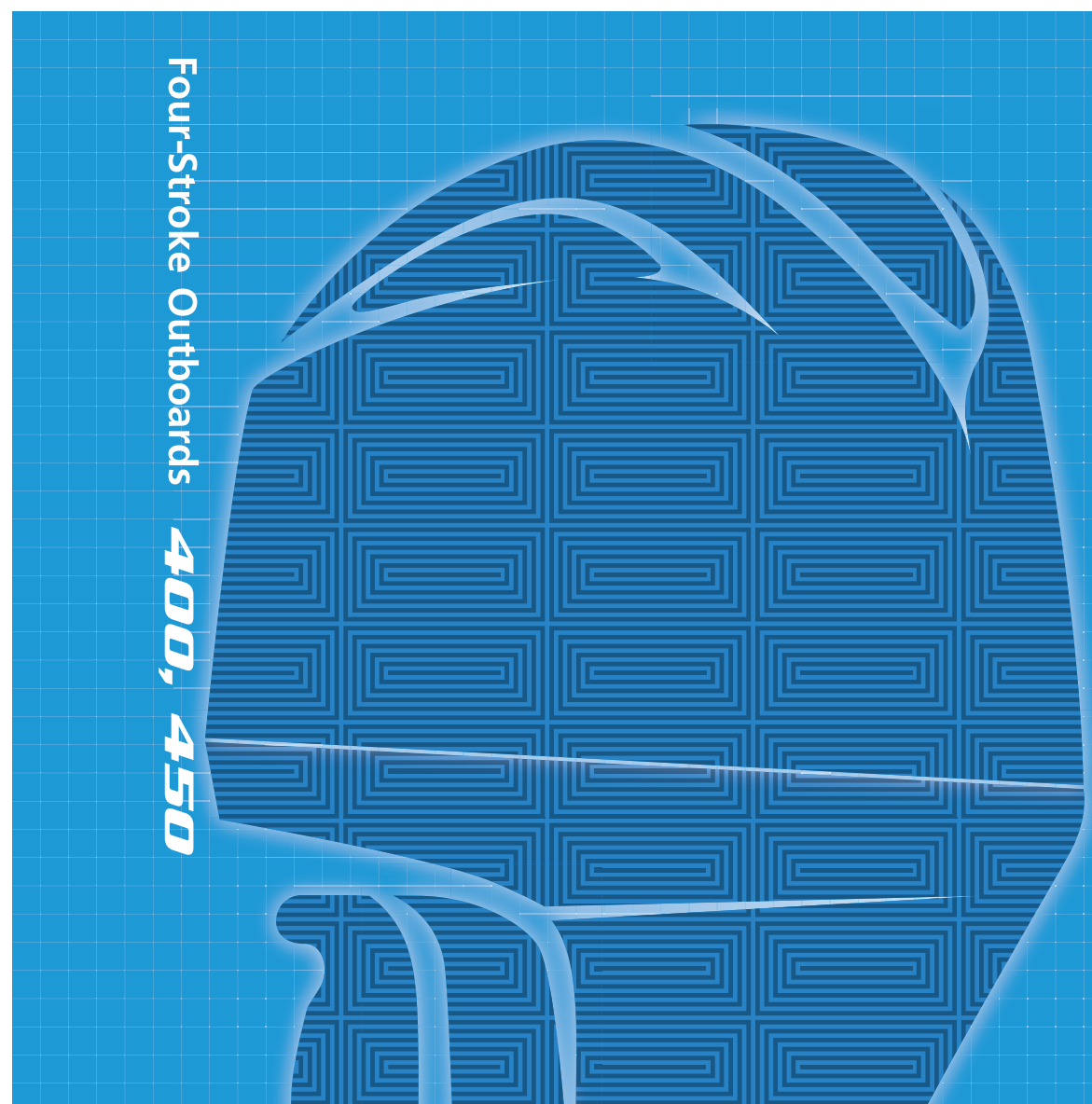
A. Free play measurement

B. Shim thickness adjustment





SERVICE
MANUAL



Worldwide:

F400A ^(6LB)

FL400A ^(6LC)

F450A ^(6KN)

FL450A ^(6KP)

USA, CAN, EUR, AUS, and NZL:

XF400 ^(6LB)

XF450 ^(6KN)

SERVICE MANUAL

6KN-28197-Z2-11 ●
LIT-18616-04-18

6KN-28197-Z2-11 ●
LIT-18616-04-18

