System	Component	Model	Thread	Comments	Specification
Crankshaft and Bearings	Main Bearing Cap Replace Bolts Lightly oil threads	4BY 6BY	M10x80 Grade 12.9 PHR	Initial Torque Torque Angle	22 N·m (195 in.-lb) Plus 90°
Oil Pump	Oil Pick-Up to Oil Pump	4BY 6BY	M6x20	-	10 N·m (89 in.-lb)
	Reinforcement Shell	4BY 6BY	M6x16	-	10 N·m (89 in.-lb)
Oil Filter	Oil Filter Cap to Oil Filter Housing	4BY 6BY	-	-	25 N·m (221 in.-lb)
Thermostat and Connections	Coolant Return to Cylinder Head and Oil Filter Housing	4BY 6BY	M8x18	-	10 N·m (89 in.-lb)

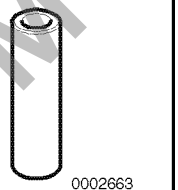
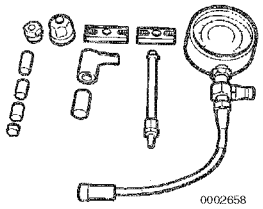
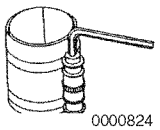
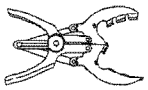
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SPECIAL SERVICE TOOLS

Note: The tool numbers used in this section are either Yanmar or BMW part numbers. Yanmar part numbers are referred to as **Yanmar Part No.** and BMW part numbers are referred to as **OEM Part No.** Tools not having part numbers must be obtained locally.

No.	Tool Name	Applicable Model and Tool Size	Illustration
1	Valve Spring Compressor	OEM Part No. 11 9 000	
2	Valve Stem Seal Installer	OEM Part No. 11 6 370 Remover, 11 1 960 Protector, and 11 6 380 Installer	 0002663
3	Cylinder Compression Tester	OEM Part No. 11 0 222 and 11 0 236	 0002658
4	Piston Ring Compressor (For Installing Piston)	Obtain Locally	 0000824
5	Piston Ring Tool (For Removing/ Installing Piston Rings)	Obtain Locally	 0000825

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Electrical Panel Components

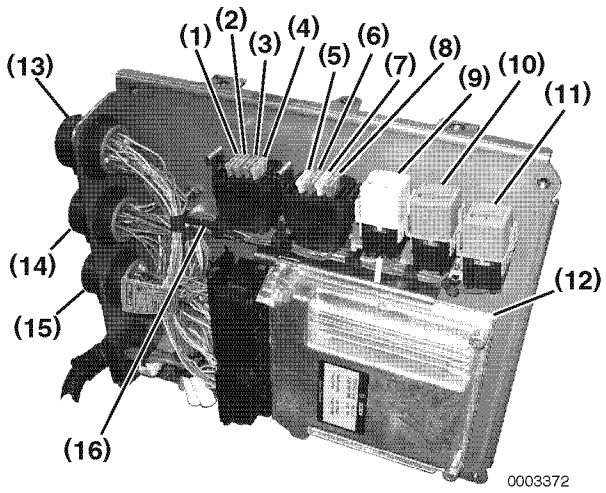


Figure 12-3

1 – Fuse F1 (3 A) - Switched B+ to CAN
2 – Fuse F2 (10 A) - B+ to Key Switch
3 – Fuse F3 (15 A) - Fuel Supply Pump
4 – Fuse F4 (30 A) - Switched B+ to ECU
5 – Fuse F5 (20 A) - Power to Sensors and Actuators
6 – Fuse F6 (10 A) - Auxiliary Power
7 – Jumper Fuse F7 (3 A) - Single / Port Selection, default is single / port (fuse in). Remove fuse for starboard configuration.
8 – Jumper Fuse F8 (3 A) - CAN / Analog Throttle Selection, default is analog (fuse out). Insert 3 A fuse to configure for CAN.
9 – K1 - Starter Relay
10 – K3 - Fuel Supply Pump Relay
11 – K2 - Main Power Relay
12 – ECU
13 – Connector X1 - Communication to Helm Display
14 – Connector X21/1 - Engine Wiring Harness
15 – Connector X22/1 - Fuel Injector Wiring Harness
16 – Blocking Diode V1

NOTICE: The electrical panel cables must be connected directly to the battery, and must have a circuit breaker installed in the B+ (red) lead.

Electrical Panel Connector (X1) Connections

The ECU is connected to other components and systems via connector X1 **(Figure 12-4)**. The graphic and table show the pin locations and assignments.

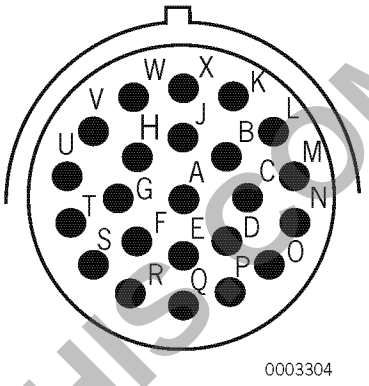


Figure 12-4

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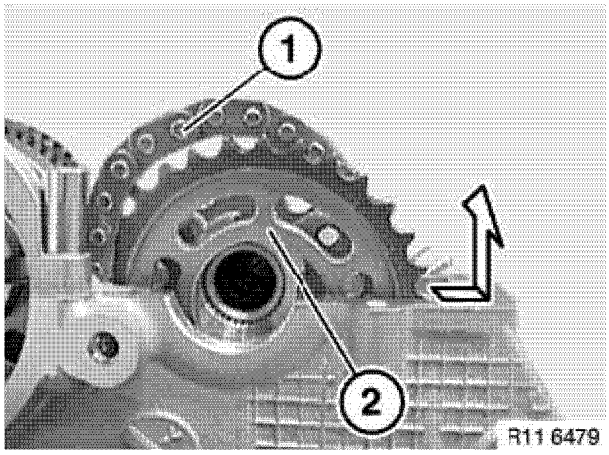


Figure 5-98

18. Remove camshaft sprocket **(Figure 5-98, (2))** from chain **(Figure 5-98, (1))** as shown by arrow.

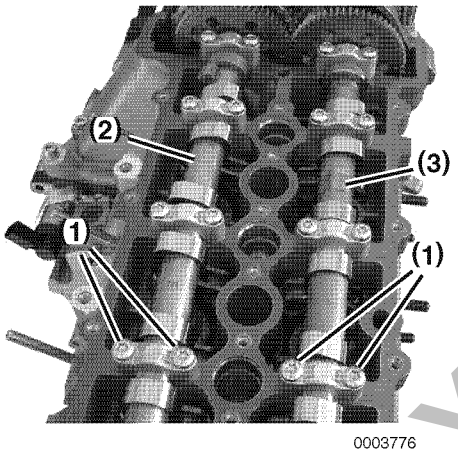


Figure 5-99

19. Evenly loosen all camshaft bearing cap bolts **(Figure 5-99, (1))** in 1/2-turn increments, working from each end towards the center.
20. Remove all bearing caps. *NOTICE: Camshaft bearing caps are numbered and must be installed in their original locations.*
21. Remove the intake **(Figure 5-99, (2))** and exhaust **(Figure 5-99, (3))** camshafts.

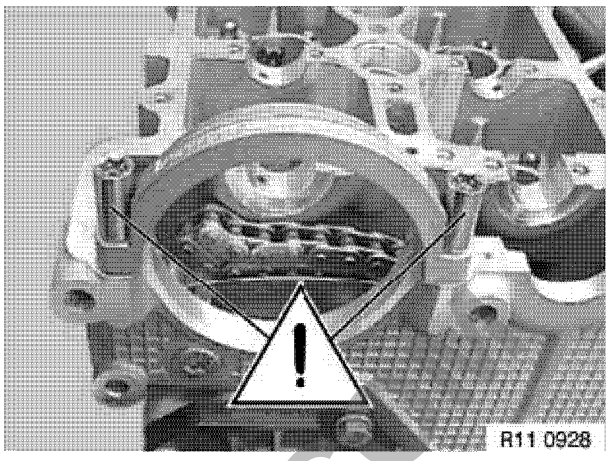


Figure 5-100

22. Do not remove loop casting bolts. *NOTICE: NEVER remove bolts retaining loop casting **(Figure 5-100)**.*

Install Camshafts

1. Lubricate all camshaft bearings, caps and journals with clean engine oil.

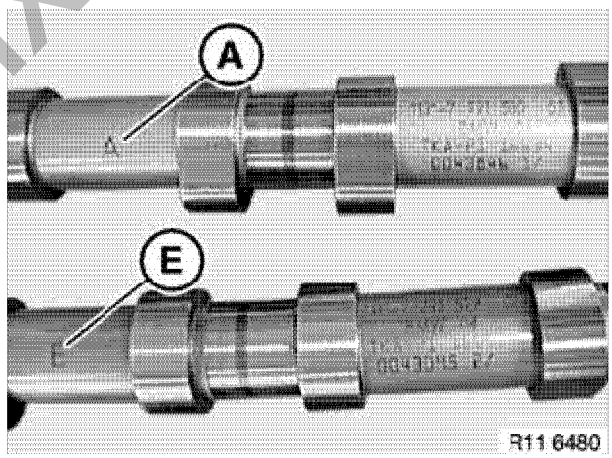


Figure 5-101

2. Identify the intake **(Figure 5-101, (E))** and exhaust **(Figure 5-101, (A))** camshafts.

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Remove and Install Fuel Rail

1. Disconnect the battery negative (-) cable.
2. Shut off all valves in the fuel supply system.
3. Remove intake manifold. *See Intake Manifold on page 5-66.*

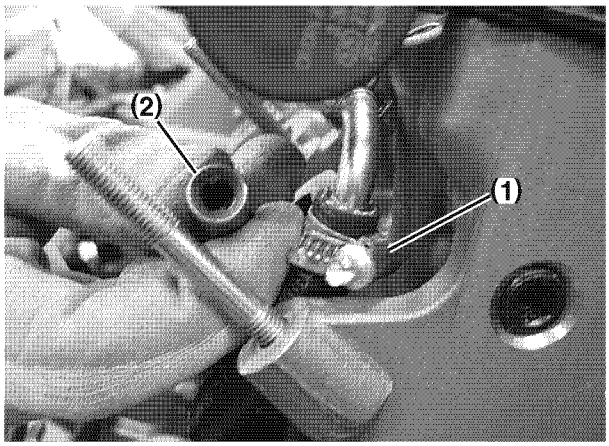


Figure 6-37

4. Use special socket **(Figure 6-37, (2))** to loosen clamp **(Figure 6-37, (1))**. Remove the hose.

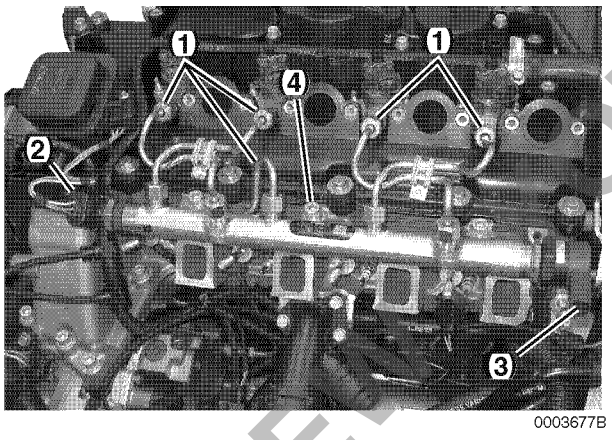


Figure 6-38

5. Remove all high-pressure fuel lines **(Figure 6-38, (1))**. *See Remove and Install High-Pressure Fuel Lines on page 6-13.*
6. Disconnect electrical connectors from fuel pressure sensor **(Figure 6-38, (2))** and fuel pressure regulator **(Figure 6-38, (3))**.
7. Remove bolts **(Figure 6-38, (4))** and remove fuel rail from engine.
8. If removed, install fuel return hose fitting with new seal washers. Tighten banjo bolt to 25 N·m (221 in.-lb).
9. Install fuel rail on engine. Install and tighten bolts.
10. Connect return hose and tighten clamp using special socket.
11. Connect electrical connectors to fuel pressure sensor and fuel pressure regulator.
12. Install high-pressure lines. *See Remove and Install High-Pressure Fuel Lines on page 6-13.*
13. Install intake manifold. *See Intake Manifold on page 5-66.*
14. Open all fuel supply valves.
15. Connect the battery negative (-) cable.
16. Bleed fuel system. *See Bleed the Fuel System on page 6-21.*
17. Start engine and check for fuel leaks.

Replace Injector Return Fuel Line

1. Disconnect the battery negative (-) cable.
2. Shut off all valves in the fuel supply system.
3. Remove intake manifold. *See Intake Manifold on page 5-66. NOTICE: When working on the oil, coolant or fuel systems, you must protect the alternator against contamination. Cover alternator with suitable materials.*

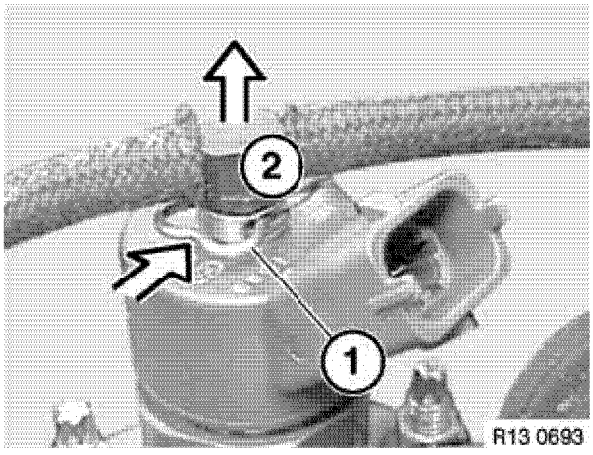


Figure 6-39

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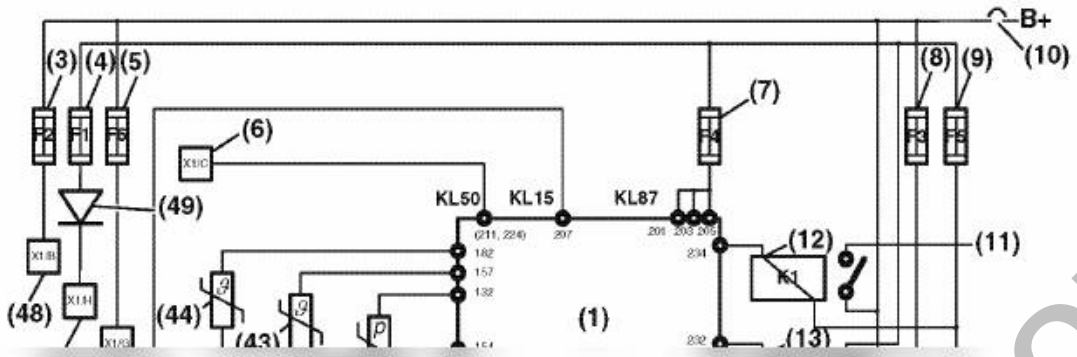
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Engine Control Unit (ECU) Assignments



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INTRODUCTION

This section of the *Service Manual* describes the procedures for proper care and maintenance of the engine.

The Importance of Periodic Maintenance

Engine deterioration and wear occurs in proportion to length of time the engine has been in service and the conditions the engine is subject to during operation. Periodic maintenance prevents

EPA REQUIREMENTS

The EPA emission regulation is applicable only in USA.

Conditions to Ensure Compliance with EPA Emission Standards

This product is an EPA-approved engine.

The following are the conditions that must be met in order to ensure that the emissions during operation meet the EPA standards:

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5. Remove high-pressure pump sprocket using special tool OEM No. 13 5 191. *See Replace High-Pressure Fuel Pump on page 6-14.*
6. Remove sprockets and timing chains.
7. Install lower chain on sprockets and install as an assembly.
8. Install nut **(Figure 5-86, (2))** and tighten to 65 N·m (48 ft-lb).
9. Install tensioner rail and guide rail. Remove retainer **(Figure 5-86, (1))**.
10. Install timing case cover. *See Install Timing Case Cover on page 5-49.*

Install Timing Case Cover

Note: The front crankshaft seal must be installed with the timing case cover installed.

1. Thoroughly clean all old gasket material from mating surfaces.
2. Check condition and location of alignment dowel sleeves.

Note: Only a one-piece gasket is available for timing case cover and water pump. When repairing timing chain cover only, detach seal at marked points.

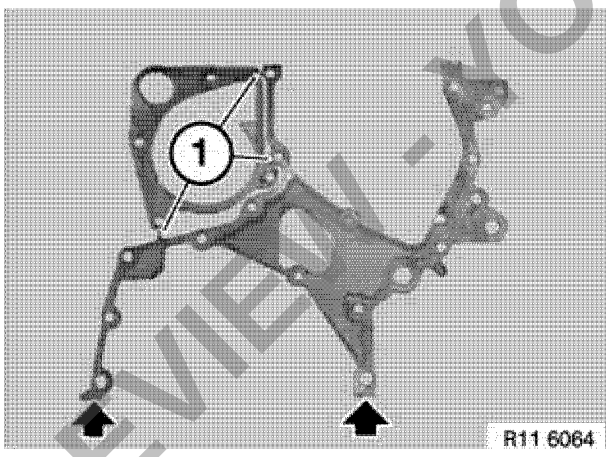


Figure 5-87

3. If coolant pump was not removed, cut gasket at three locations **(Figure 5-87, (1))**. Install gasket and apply a thin coat of Three Bond 1207F (Yanmar part No. 977770-1207F) sealing agent to gasket at ends (arrow) on both sides.
4. Install timing case cover.
5. Install all bolts and tighten to an initial torque of 5 N·m (44 in.-lb), then tighten in an alternating sequence to final torque specification of 14 N·m (124 in.-lb).
6. After all bolts have been tightened to final specification, check the torque and tighten again if necessary.
7. Install front crankshaft seal. *See Replace Front Crankshaft Seal on page 5-64.*
8. Install vibration dampener. *See Remove and Install Vibration Damper - 4BY on page 5-46 or Remove and Install Vibration Damper - 6BY on page 5-47.*
9. Install alternator belt tensioner.
10. Install cylinder head. *See Install Cylinder Head on page 5-27.*
11. Install oil sump. *See Remove and Install Oil Sump on page 8-11.*
12. **4BY:** Install alternator. *See Remove and Install Alternator on page 11-5.*
13. Install alternator belt and belt guard. *See Remove and Install Alternator on page 11-5 and Replace Seawater Pump Belt on page 7-19.*
14. Add engine oil. *See Change Engine Oil and Replace Engine Oil Filter Element on page 8-8.*
15. Fill engine with coolant. *See Drain and Fill Closed Cooling System on page 7-10.*
16. Connect battery negative (-) cable.

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Section 2

SAFETY

Yanmar is concerned for your safety and the condition of your marine engine. Safety statements are one of the primary ways to call your attention to the potential hazards associated with Yanmar marine engines. Follow the precautions listed throughout the manual before operation, during operation and during periodic maintenance procedures for your safety, the safety of others and to protect the performance of your marine engine. Keep the decals from becoming dirty or torn and replace them if they are lost or damaged. Also, if you need to replace a part that has a decal attached to it, make sure you order the new part and decal at the same time.



This safety alert symbol appears with most safety statements. It means attention, become alert, your safety is involved! Please read and abide by the message that follows the safety alert symbol.

⚠ DANGER

Indicates a hazardous situation which, if not avoided, *will* result in death or serious injury.

⚠ WARNING

Indicates a hazardous situation which, if not avoided, *could* result in death or serious injury.

⚠ CAUTION

Indicates a hazardous situation which, if not avoided, *could* result in minor or moderate injury.

NOTICE

Indicates a situation which can cause damage to the machine, personal property and / or the environment or cause the equipment to operate improperly.

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