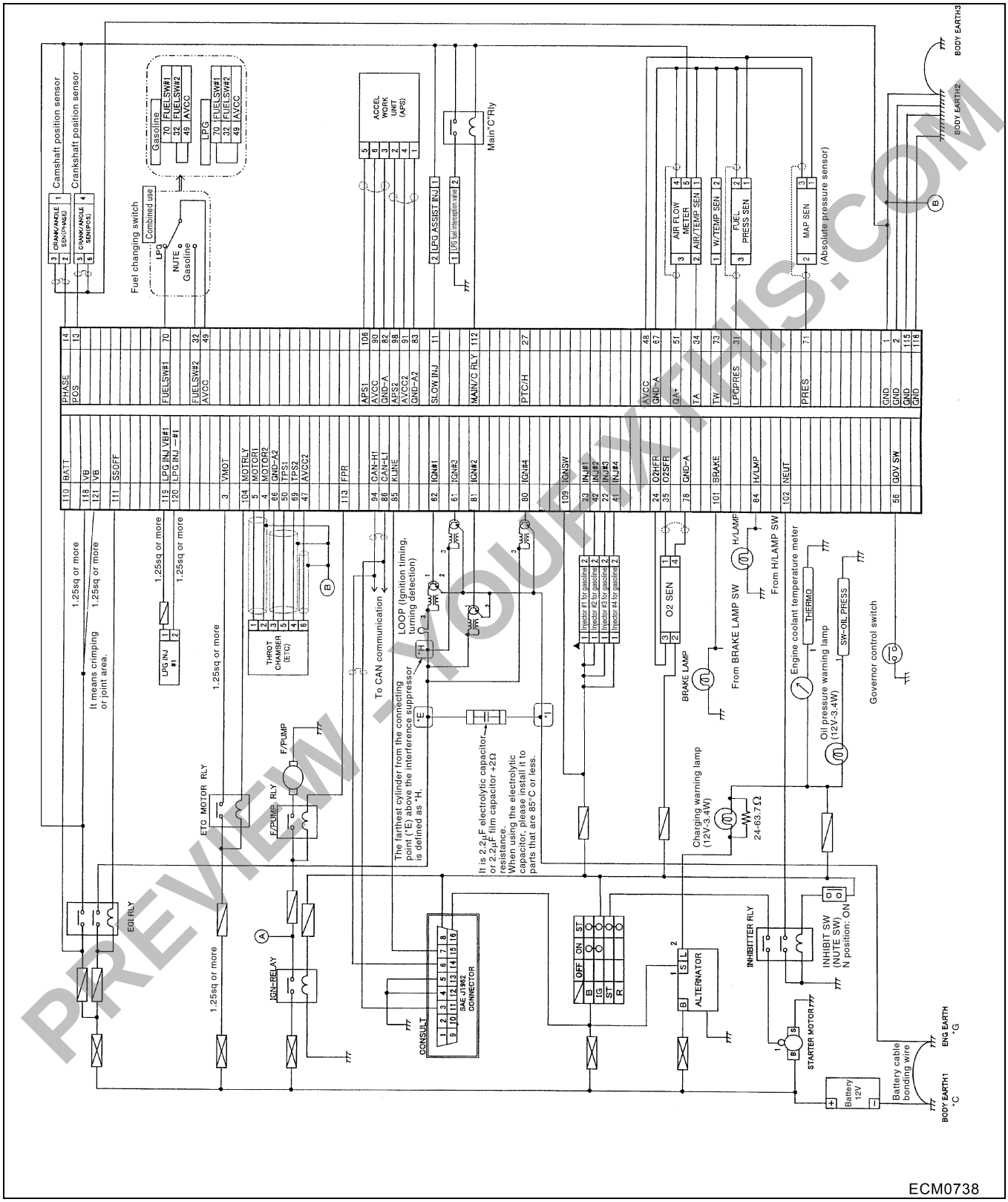
Circuit Diagram

GK-ENGINE ELECTRONIC CONTROLLED ECM CIRCUIT DIAGRAM (DUAL, GASOLINE AND LPG)



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Maintenance Schedule

Make sure to perform appropriate maintenance and service work to maintain the initial performances of the GCT, GK Engine forklift.

PERFORM INSPECTION

Make sure to perform the periodical inspections at appropriate times, according to the month basis or the operating hour basis, whichever comes first. ..... Inspection period

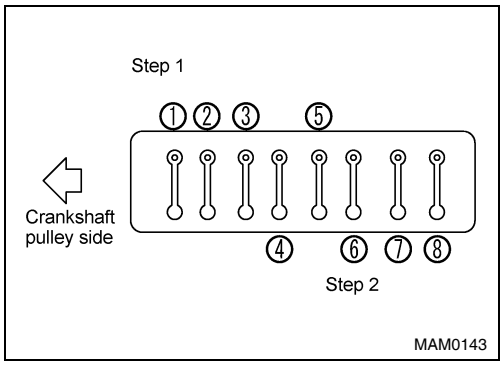
Refer to the following notes for values in ( )

No.	Inspection items	Applicable control system	Engine system inspection (except LPG fuel system)																		
			Months of use	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
			Operation hours (x 100 hours)	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
1	Intake/exhaust valve clearance	Electronic controls		A		A			A			A			A			A			A
2	Engine drive belt tension	Electronic controls		I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
3	Cylinder head bolt and manifold nut	Electronic controls		T																	
4	Engine oil	Electronic controls	(1)	R´	R´			R´		R´			R´		R´			R´		R´	
5	Oil filter	Electronic controls	(1)	R´	R´			R´		R´			R´		R´			R´		R´	
6	Engine coolant	Electronic controls													R						
7	Air cleaner element	Electronic controls	(1)	C	C	C	C	C	C	C	C	C	C	C	R	C	C	C	C	C	R
8	Spark plug	Electronic controls	(1)	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	R
9	PCV valve	Electronic controls	(1)			I			I			I			I			I			I
10	PCV hose	Electronic controls				I			I			I			I			I			I

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On Board Inspection and Service (Cont'd)



4. Set the piston for the No. 1 cylinder to the compression TDC and adjust the valves of (1), (2), (3), and (5) in the figure.
5. Set the piston for the No. 4 cylinder to the compression TDC by rotating crank again and adjust the valves of (4), (6), (7), and (8) in the figure.

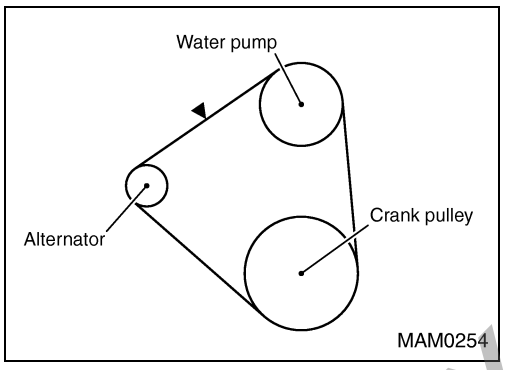
Intake/exhaust valve clearance (Hot) Unit: mm (in)

Intake	Exhaust
0.38 (0.015)	0.38 (0.015)

INSPECTION AND ADJUSTMENT OF ENGINE DRIVE BELT

⚠ CAUTION:
- **Make sure that engine stops. Wash hands.**
- **Wash hands.**

1. Visually check fan belt for wear, damage, and cracks. Do not contact the belt with pulley groove bottom.
2. Push the belt between pulleys. Check tension.



Unit: mm (in)

Item	Specification	Belt deflection (Force 98 N (10 kgf, 22 lb)		
		New belt	Adjusting	Deflection limit
Alternator belt	Low edge type	10 - 12 (0.39 - 0.47)	11 - 13 (0.43 - 0.51)	14 (0.55)

REPLACEMENT OF OIL AND OIL FILTER

1. Warm engine.
2. Remove oil pan drain plug and oil filler cap, and discharge all oil.

⚠ CAUTION:
- **Be careful not to get burned when engine or engine oil is heated.**
- **It shows the mixing of coolant so that oil looks likes milk. Repair if necessary.**
- **It shows the mixing of gasoline so that oil viscosity is too lean. Repair if necessary.**

3. Wipe around drain hole. Install drain plug.
   Tightening torque for oil pan drain plug:
   29.4 - 39.2 N·m (3.0 - 4.0 kgf-m, 22 - 29 ft-lb)

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Table of DTC

SELF-DIAGNOSIS RESULTS

When a malfunction occurs in ECM input/output signal circuit, the malfunctioning circuit is recorded and displayed. Also, the malfunction item that is occurred is displayed.
Display sample [Example: When there is a malfunction in mass air flow sensor] Display DTC and the malfunction item in the alarm monitor screen.

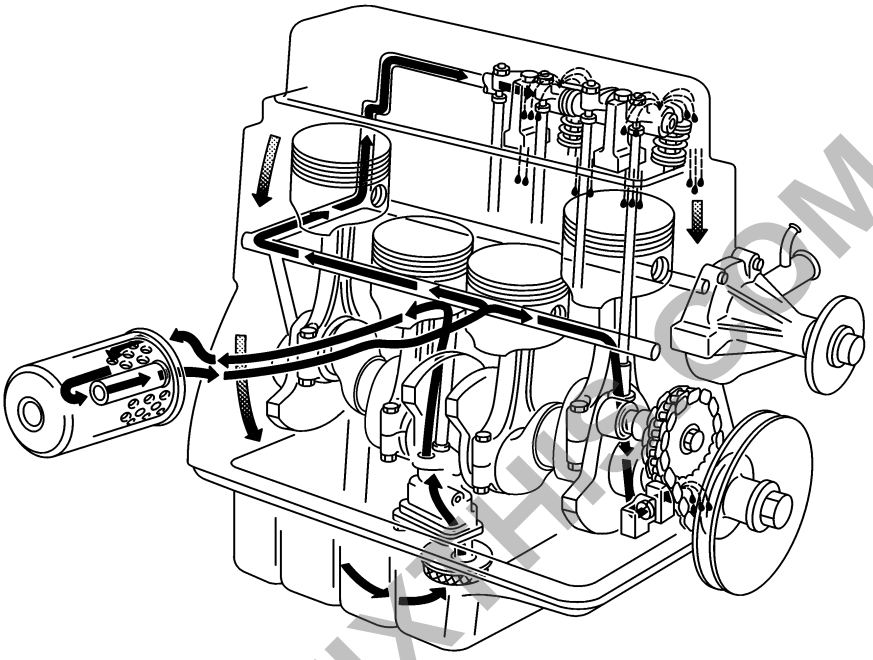
DTC	Name	Engine warning lamp	DTC for GST	Malfunction return condition	Diagnosis outline	Trip
—	NO DTC	—	—	—	—	—
E-03	VCM communication signal circuit malfunction	—	U1001	• Malfunction occurs in CAN communication transmit/receive data or in VCM, and data transmission/reception cannot be confirmed. • CAN communication data is transmitted/ received for predetermined period.	—	2
E-04	ECM communication signal circuit malfunction	—	U1001	• Malfunction occurs in CAN communication transmit/receive data or in ECM, and data transmission/reception cannot be confirmed. • CAN communication data is transmitted/ received for predetermined period.	—	2
E-05	DCM communication signal circuit malfunction	—	U1001	• Malfunction occurs in CAN communication transmit/receive data or in DCM, and data transmission/reception cannot be confirmed. • CAN communication data is transmitted/ received for predetermined period.	—	2
E-07	MP communication signal circuit malfunction	—	U1001	• Malfunction occurs in CAN communication transmit/receive data or in MP, and data transmission/reception cannot be confirmed. • CAN communication data is transmitted/ received for predetermined period.	—	2
E-21	Mass air flow sensor signal circuit malfunction	ON	P0102	When the engine is running and the mass air flow sensor output voltage has been 0.5V or less (open or shorted) for a predetermined period.	Detect disconnection and short circuit and make MIL go on.	1
			P0103	When the engine is stopped (ignition switch ON) and the mass air flow sensor output voltage has been approx. 4.9V or more (open or shorted) for a predetermined period.		
E-22	Engine coolant temperature signal circuit malfunction	ON	P0117	Engine coolant temp. sensor output voltage has been less than 0.06V (open or shorted) for a predetermined period.	Detect disconnection and short circuit and make MIL go on.	1
			P0118	Engine coolant temp. sensor output voltage has been approx. 4.8V or more (open or shorted) for a predetermined period.		

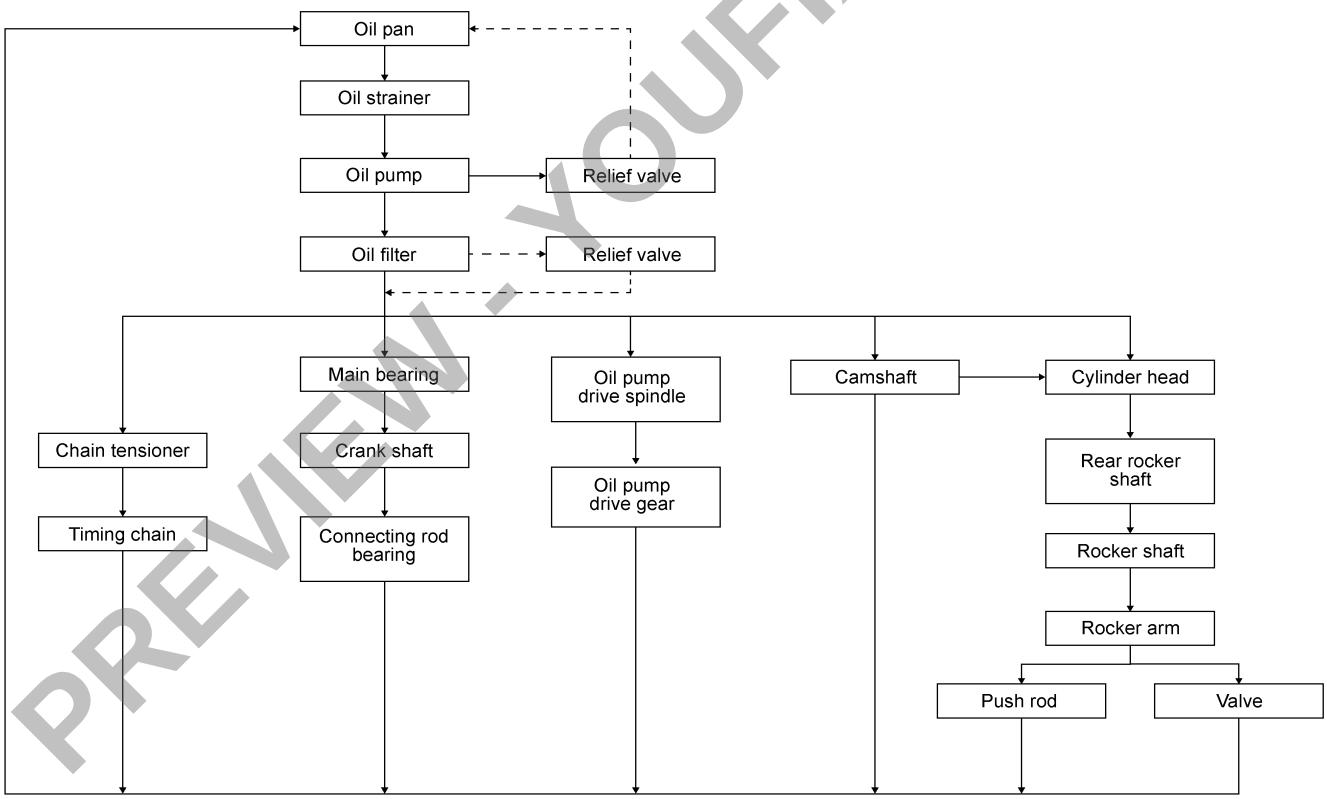
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Lubrication Schematic Diagram

LUBRICATION CIRCUIT



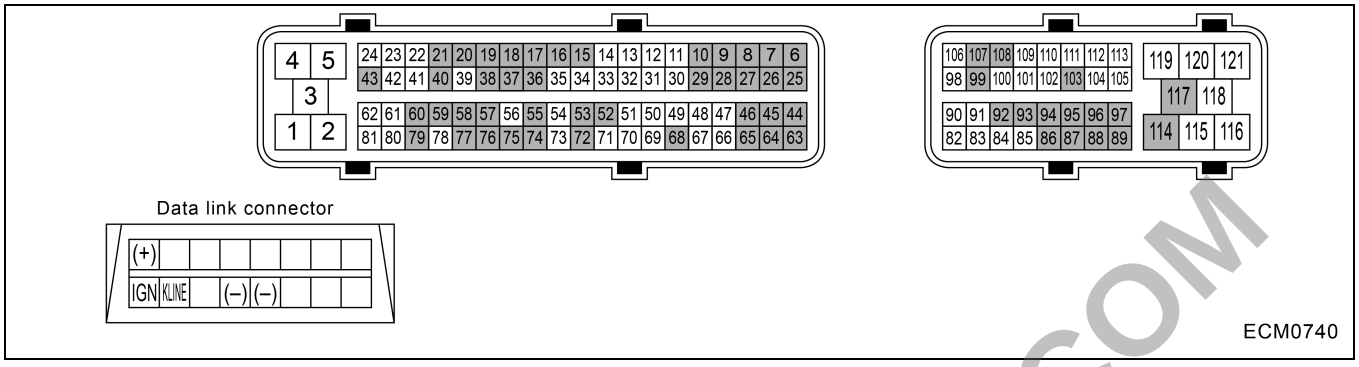


LCM0093

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ECM Terminal



REFERENCE VALUE LIST

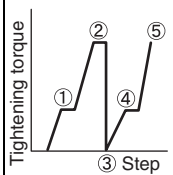
Voltage is measured with a circuit tester, and the sample waveforms obtained with an oscilloscope are shown below for each ECM terminal. Measurement data varies depending on variation in parts as well as many other factors. Such factors include vehicle history, driving conditions, environmental conditions, maintenance status, measuring instrument/method, etc. Data shown below are reference values.

Terminal signal	Description	Measurement condition	Measured value
1 2 115 116	ECM ground	Always	Approx. 0V
12	Snow switch	Snow switch OFF	Approx. 0V
		Snow switch ON	Approx. 5V
66	Sensor ground (Throttle position sensor)	At idle after warming up	Approx. 0V
		At approx. 2,000 rpm	
67	Mass air flow sensor ground	Always	Approx. 0V
78	Heated oxygen sensor ground	Always	Approx. 0V
82	Accelerator pedal position sensor 1 ground	Always	Approx. 0V
83	Accelerator pedal position sensor 2 ground	Always	Approx. 0V
32	Fuel changing switch 2 (Gasoline)	Changing switch ON (At gasoline side)	Approx. 5V
		Changing switch ON (At LPG side)	Approx. 0V
56	Governor control switch	At normal speed setting	Approx. 0V
		At low speed setting	Battery voltage
70	Fuel changing switch 1 (LPG)	Changing switch ON (At LPG side)	Approx. 5V
		Changing switch ON (At GAS side)	Approx. 0V
84	Headlamp switch	Lighting switch OFF	Approx. 0V
		Lighting switch ON	Battery voltage
101	Brake switch	Brake pedal released	Approx. 0V
		Brake pedal depressed	Battery voltage
102	Neutral switch	N position	Approx. 0V
		Other than above	Battery voltage
109 (IGN)	Ignition switch	Ignition switch OFF	Approx. 0V
		Ignition switch ON	Battery voltage
71	Map sensor	Ignition switch ON and at idle after warming up	Approx. 0.08 - 4.82V

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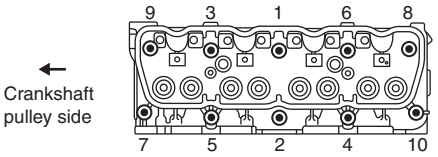
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Tightening procedure



Tightening torque (Reference) N•m (kgf-m, ft-lb)		
①	19.6 - 23.5 (2.0 - 2.3, 14 - 17)	Tightening for brake-in
②	68.6 (7.0, 51)	
③	0 (0, 0)	Return
④	19.6 - 23.5 (2.0 - 2.3, 14 - 17)	Retightening
⑤	90˚ - 92˚	

Assembly sequence



Precautions before assembling

- Do not allow oil or dust to get on cylinder head, mounting surface of cylinder block, and head gasket.
- Apply anticorrosive oil onto head bolt thread and surface under the head.

MAM0318

On Board Inspection and Service

TIGHTENING OF HEAD BOLT

Tighten head bolts from inside to outside as shown in the figure.
Tighten bolts gradually as shown in the figure.
Tightening torque: 68.6 N·m (7.0 kgf-m, 51 ft-lb) (This tightening torque can be used in step (5) as shown in the figure for service.)

⚠ CAUTION:
Check tightening angle with an angle wrench (SST) or a protractor. Do not simply estimate tightening angle.

RETIGHTENING OF MANIFOLD NUT AND BOLT

⚠ CAUTION:
Do not retighten nut and bolt until manifold components get cold. It may cause to get burned.

Tightening torque for manifold and nut

N·m	kgf-m	ft-lb
41.2 - 48.1	4.2 - 4.91	30.4 - 35.5

(Do not use power tools such as air runner to tighten.)

INTAKE/EXHAUST VALVE CLEARANCE ADJUSTMENT

- Adjustment must be made with the vehicle in hot condition.

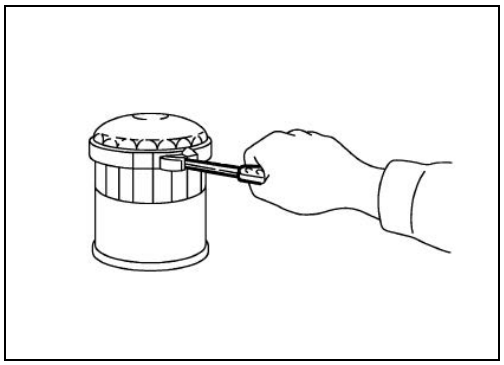
1. Warm up engine until engine coolant temperature gauge shows nearly center, and then stop it.
2. Remove rocker cover.
3. Turn the crankshaft.

⚠ CAUTION:
Disconnect high-tension cable from ignition coil when rotating crankshaft with starter motor.

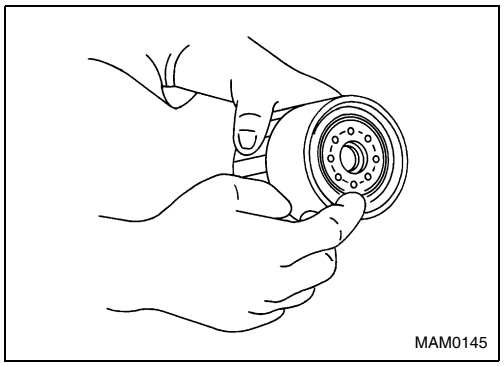
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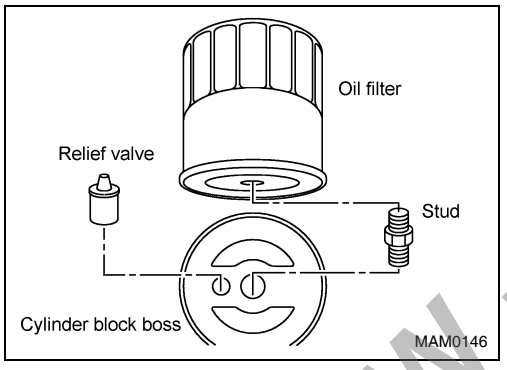
On Board Inspection and Service (Cont'd)



4. Replace oil filter.
- Remove oil filter using an oil filter wrench (SST).
- Wipe oil filter mounting surface with a clean shop cloth.



- Apply a small amount of engine oil to the lip of the new oil filter.



- Screw in the oil filter by hand until it contacts cylinder block boss, and then screw in another 2/3 of a turn.

5. Fill the oil according to the specified lubricant amount.

Standard oil amount Unit: ℓ (Imp qt)

Including filter	3.8 (3-3/8)
Not including filter	3.5 (3)

6. Start engine, and make sure that there is no leakage around drain plug and oil filter. Replace drain plug and oil filter if there is some leakage.
7. Run engine, and stop it after engine coolant temperature gauge is in nearly center position. Check oil level after waiting for a few minutes. Refill oil if necessary.

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Table of DTC (Cont'd)

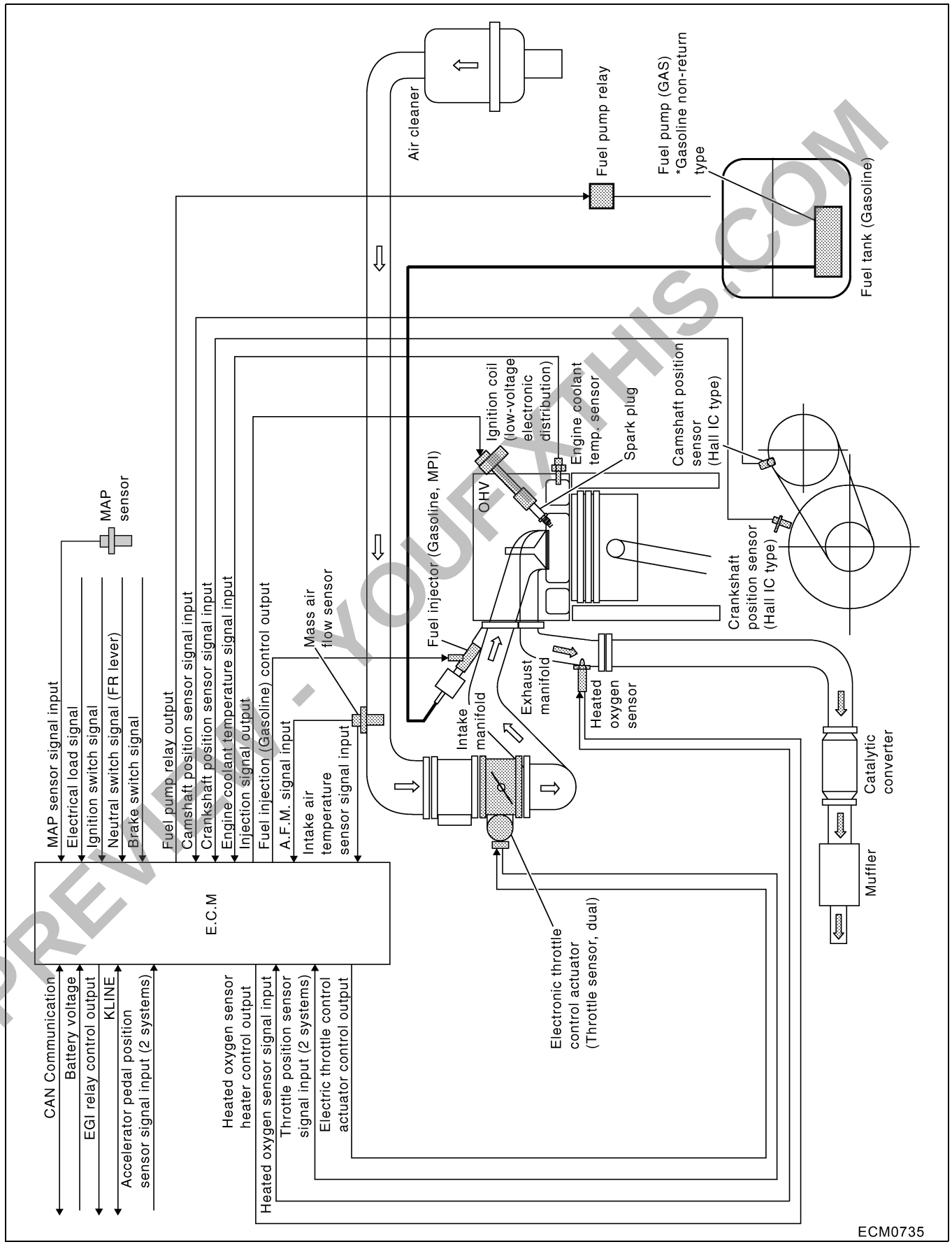
DTC	Name	Engine warning lamp	DTC for GST	Malfunction return condition	Diagnosis outline	Trip
E-23	Throttle position sensor signal circuit malfunction	ON*	P0122	Throttle position sensor 2 output voltage has been approx. 0.3V or less (open) for a predetermined period.	Detect disconnection and short circuit and make MIL go on.	1
			P0123	Throttle position sensor 2 output voltage has been approx. 4.8V or more (shorted) for a predetermined period.		
			P0222	Throttle position sensor 1 output voltage has been approx. 0.3V or less (open) for a predetermined period.		
			P0223	Throttle position sensor 1 output voltage has been approx. 4.8V or more (shorted) for a predetermined period.		
			P1225	When the throttle valve closed position learning value is excessively low.	Compare inconsistency between two separate circuits which are installed for redundancy and judges abnormal condition and make MIL go on.	
			P1226	When the throttle valve closed position learning cannot be performed.		
			P2135	A malfunction occurs in the relation between throttle position sensors 1 and 2.		
E-24	Accelerator pedal position sensor signal circuit malfunction	—	P2122	Accelerator pedal position sensor 1 output voltage has been approx. 0.15V or less (open) for a predetermined period.	Detect disconnection and short circuit and make MIL go on.	1
			P2123	Accelerator pedal position sensor 1 output voltage has been approx. 5V or more (shorted) for a predetermined period.		
			P2127	Accelerator pedal position sensor 2 output voltage has been approx. 0.15V or less (open) for a predetermined period.		
			P2128	Accelerator pedal position sensor 2 output voltage has been approx. 5V or more (shorted) for a predetermined period.		
			P2138	A malfunction occurs in the relation between accelerator pedal position sensors 1 and 2.	Compare inconsistency between two separate circuits which are installed for redundancy and judges abnormal condition and make MIL go on.	
E-25	Heated oxygen sensor signal circuit malfunction	—	P0132	Heated oxygen sensor output voltage is higher than normal (1.4V or more).	Detect disconnection and short circuit and make MIL go on.	2
			P0134	Heated oxygen sensor signal circuit is open.		
E-26	Heated oxygen sensor heater signal malfunction	—	P0031	Heated oxygen sensor heater control voltage has been approx. less than 0.12V (open or shorted) for a predetermined period.	Detect disconnection and short circuit of an oxygen sensor heater circuit and make MIL go on.	2
			P0032	Heated oxygen sensor heater control voltage has been approx. 4.7V or more (shorted) for a predetermined period.		

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Description (Cont'd)

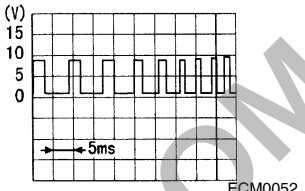
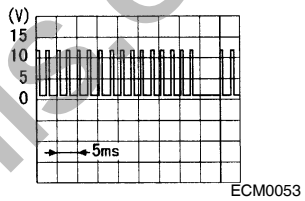
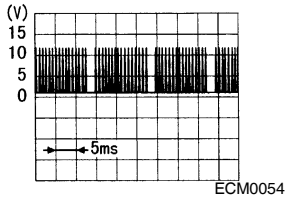
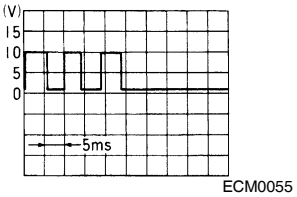
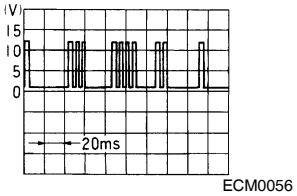
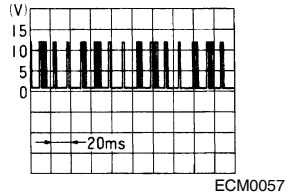
GK-ENGINE ELECTRONIC CONTROLLED SYSTEM DIAGRAM (GASOLINE)



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ECM Terminal (Cont'd)

Terminal signal	Description	Measurement condition	Measured value
13	Crankshaft position sensor (POS)	At cranking	Approx. 2.6V  ECM0052
		At idle after warming up	Approx. 3V  ECM0053
		At approx. 2,000 rpm	Approx. 3V  ECM0054
14	Camshaft position sensor (PHASE)	At cranking	Approx. 0.15V  ECM0055
		At idle after warming up	Fluctuates between approx. 1.5 - 2V.  ECM0056
		At approx. 2,000 rpm	Approx. 2V  ECM0057
24	Heated oxygen sensor heater	At idle after warming up	Approx. 0.3V
31	LPG fuel pressure sensor	At idle after warming up	Approx. 0.78V

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Engine Part Tightening Torque

TIGHTENING TORQUE AT VARIOUS POINTS OF ENGINE

Tightening point	Unit	Standard	Max. value
Cylinder head (lubricated)	Separately given		
Main bearing cap (lubricated)	Separately given		
Crankshaft pulley bolt (lubricated)	N•m	220.5	240.1
	kgf-m	22.5	24.5
	ft-lb, in-lb*	163	177
Flywheel bolt (lubricated)	N•m	132	142
	kgf-m	13.47	14.49
	ft-lb, in-lb*	97	105
Connecting rod nut (lubricated)	N•m	31.4	37.3
	kgf-m	3.2	3.81
	ft-lb, in-lb*	23	28
Rear plate bolt	N•m	44.1	58.8
	kgf-m	4.5	6.0
	ft-lb, in-lb*	33	43
Camshaft sprocket bolt	N•m	39.2	49
	kgf-m	4.0	5.0
	ft-lb, in-lb*	29	36
Oil filter stud	N•m	29.4	39.2
	kgf-m	3.0	4.0
	ft-lb, in-lb*	22	29
Oil filter element	N•m	14.7	20.6
	kgf-m	1.5	2.1
	ft-lb, in-lb*	11	15
Spark plug	N•m	19.6	29.4
	kgf-m	2.0	3.0
	ft-lb, in-lb*	14	22
Engine slinger bolt	N•m	22.6	25.5
	kgf-m	2.31	2.6
	ft-lb, in-lb*	17	22
Rocker cover nut	N•m	13.7	15.7
	kgf-m	1.4	1.6
	ft-lb, in-lb*	10	12
Water temperature gauge	N•m	15.7	19.6
	kgf-m	1.6	2.0
	ft-lb, in-lb*	12	14
Oil pressure switch	N•m	15.7	21.6
	kgf-m	1.6	2.2
	ft-lb, in-lb*	12	16
Exhaust manifold nut	N•m	41.2	48.1
	kgf-m	4.2	4.91
	ft-lb, in-lb*	30	36
Straight screw plug (For head top face)	N•m	44.1	58.9
	kgf-m	4.5	5.5
	ft-lb, in-lb*	33	40
Oil pan drain plug	N•m	29.4	39.2
	kgf-m	3.0	4.0
	ft-lb, in-lb*	22	29
Mass air flow sensor mounting screw	N•m	1.27	1.67
	kgf-m	0.13	0.17
	ft-lb, in-lb*	11*	15*
Fuel tube flare nut	N•m	16.0	23.0
	kgf-m	1.63	2.35
	ft-lb, in-lb*	12	17
Crankshaft position sensor plug bolt	N•m	6.37	7.45
	kgf-m	0.65	0.76
	ft-lb, in-lb*	56*	66*
Thermo-housing relief plug	N•m	6.37	7.45
	kgf-m	0.65	0.76
	ft-lb, in-lb*	56*	66*

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