APPLICATION MANUAL

TNV Series

YANMAR®

TNV series

ELECTRONIC CONTROL SYSTEM

Complies with EPA Tier3

3TNV84T-Z
4TNV84T-Z
4TNV98-Z・4TNV98-E
4TNV98T-Z

Complies Optionally

3TNV82A-Z
3TNV88-Z・3TNV88-E
4TNV88-Z・4TNV88-E

INDUSTRIAL ENGINES

Section 14

ELECTRONIC CONTROL SYSTEM

Page

This chapter describes a Yanmar second-generation electronic governor (herein referred to as the "Gen2 Eco-governor") that conforms to the third EPA regulation by controlling Exhaust Gas Recirculation (EGR). The Gen2 Eco-governor is standard equipped on NV3 and supercharged engines. It is also available as an option for other engines. Contact Yanmar for details.

The engine electronic control unit (E-ECU) controls the speed and power of the engine by adjusting the rack position of the fuel injection pump depending on the signal from the accelerator sensor.

The opening of the EGR valve is adjusted depending on the engine speed and load factor so as to ensure conformance to exhaust emission standards.

The Gen2 Eco-governor provides control to the engine depending on the throttle position, coolant temperature, external-switch positions, signals through CAN or other parameters and is superior to a mechanical governor in versatility.

This manual provides overall description of the Gen2 Eco-governor. Optional setting of the E-ECU must be done by Yanmar. Contact Yanmar for details.

By combination of the machine, these application functions may come into contact with the third party's industrial property.Yanmar disclaims any responsibility for the violation of the third party's industrial property caused by the customer's machine use in combination with the engine application functions provided by Yanmar.

PRECAUTIONS ON THE USE OF ELECTRONIC CONTROL COMPONENTS

Controller and wire harness

Read **Control system (P.7)** carefully before designing an engine control system comprising the engine electronic control unit (E-ECU) and other control components in order to ensure correct application of the components.

Observe precautions in **Harness (P.25)** when designing wire harnesses.

Be sure to perform installation assessment as specified by Yanmar to ensure applicability of the E-ECU and other control components to the intended machine.

At the first power-up, the E-ECU is initialized and cannot be used to start the engine. See **Check for power-up of the E-ECU (P.15)** for details.

Be sure to use the E-ECU in conjunction with engines, the type and serial number of which are specified by Yanmar. Failure to do so will result in no assurance that the engine develops the intended performance.

Never use the E-ECU in failure condition (the trouble monitor lamp flashes, as described later).Doing so will result in no assurance that the engine develops the intended performance and may cause serious damage to the engine. Never keep running the engine, while the trouble monitor lamp is flashing.

Place the trouble monitor lamp and other indictors so that they are readily visible to personnel.

When replacing the E-ECU, be sure to contact Yanmar in advance. The fuel injection quantity data must be transferred from the old E-ECU to the new unit. See **Control software (P.31)** for details. If the fuel injection quantity data is not transferred to the new E-ECU, the engine is not assured to develop the intended performance.

Updating the fuel injection quantity data in the E-ECU requires a Yanmar genuine engine diagnosis tool. See the manual for the engine diagnosis tool for the maintenance procedure.

The customer must not perform tasks that are specified to be done by Yanmar, including replacement of the E-ECU, rewriting or modification of data in the E-ECU and removal of sensors or actuators. Such tasks done by the customer may be deemed an infringement of exhaust emission control laws and regulations. Yanmar assumes no responsibility for any loss or damage caused by incompliance with instructions or suggestions in this chapter.

Fuel injection pump

Be sure to perform installation assessment as specified by Yanmar to ensure applicability of the fuel injection pump to the intended machine.

Take special precaution on temperature and vibration.Do not expose it to an ambient temperature exceeding 80½C. Make measurement or adjustment by engine leg for vibration.When vibration displacement exceeds the specified value, trouble such as hunting and disconnection of wire harness may occur.

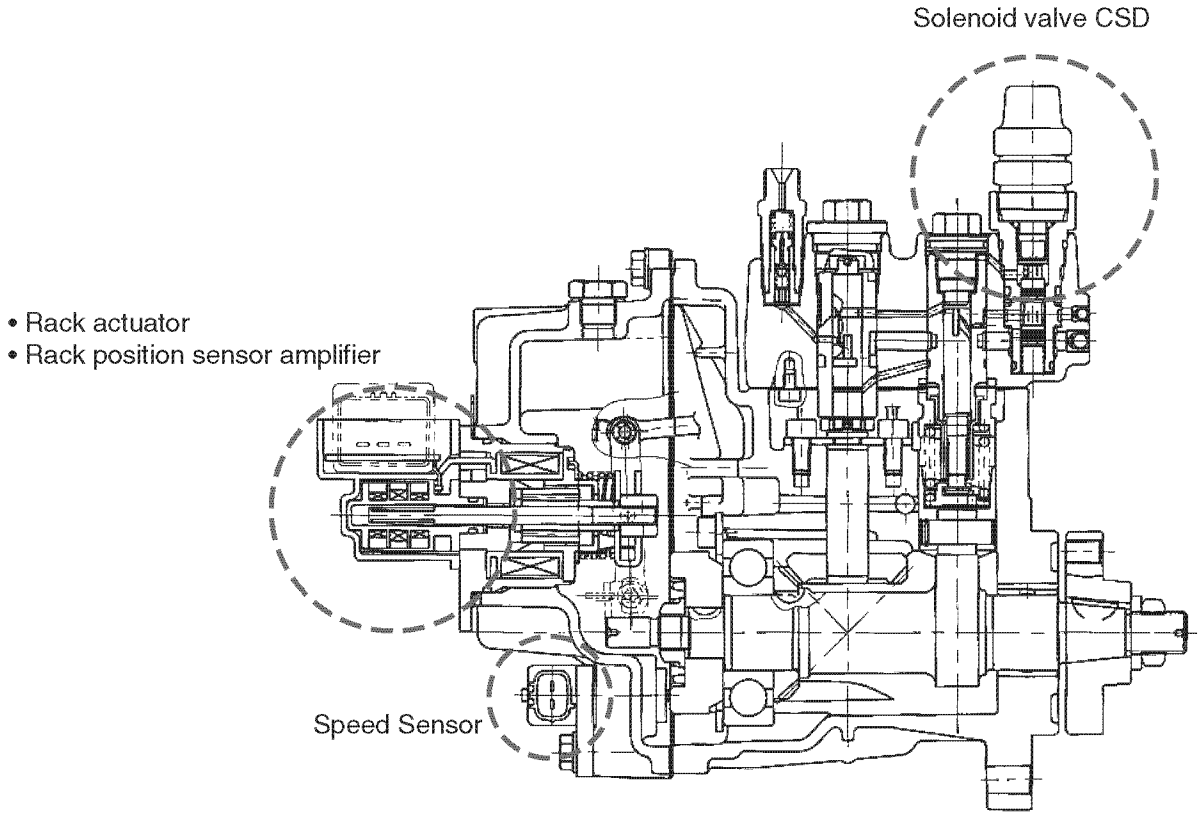


Fig. 14-1 **MP fuel injection pump of the Eco-governor**

Supply power to the rack position sensor via terminal AVB (E43) of the E-ECU. The rack position sensor may cause malfunction in surge voltage.

The fuel injection pump requires its specific injection quantity data. When replacing the fuel injection pump, be sure to use the attached fuel injection quantity data to update the memory in the E-ECU. Failure to do so will result in no assurance that the engine develops the intended performance.

Updating the fuel injection quantity data in the E-ECU requires a Yanmar genuine engine diagnosis tool. See the manual for the engine diagnosis tool for the maintenance procedure.

EGR valve

Be sure to perform installation assessment as specified by Yanmar to ensure applicability of the EGR valve to the intended machine.

Do not expose EGR valve motor to an ambient temperature exceeding 80½C. Make measurement or adjustment by engine leg for vibration.

Accelerator sensor

Connect the accelerator sensor according to the recommended connection diagram. Make sure the accelerator sensor and the E-ECU have a common reference potential (GND potential) as shown in example [A] of Fig. 2. If the E-ECU is connected to a machine controller as shown in example [B] or [C], the difference between the E-ECU and the machine comptroller in reference potential (V1 V2) may cause excess voltage to be applied to the APS input of the E-ECU or excess current to flow through GND-A, and result in malfunction or damage.

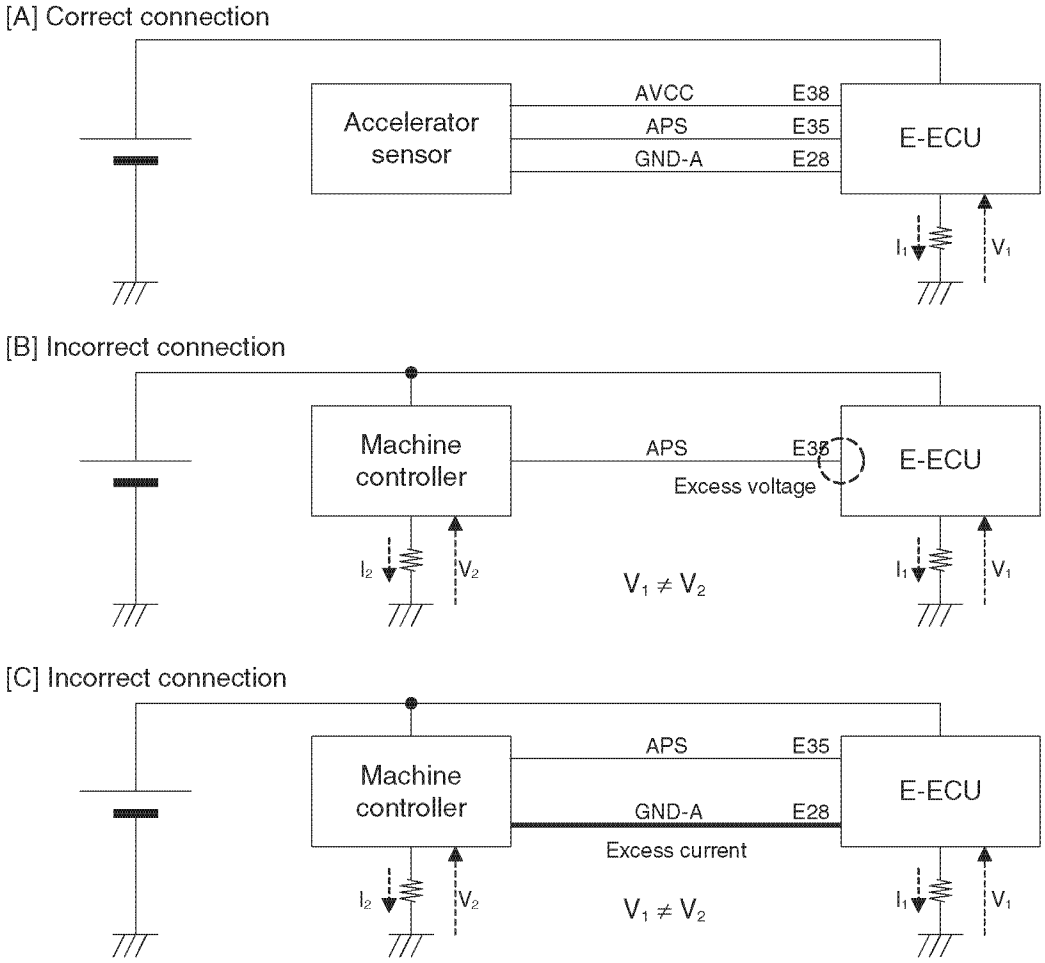


Fig. 14-2 **Accelerator sensor connection examples**

Read **Accelerator sensor (P.86)** carefully before utilizing a Yanmar genuine accelerator sensor in order to ensure correct use of the sensor.

Be sure to perform installation assessment as specified by Yanmar to ensure applicability of the accelerator sensor to the intended machine.

Relay

Be sure to perform installation assessment as specified by Yanmar to ensure applicability of the relay to the intended machine.

Engine diagnosis tool

Install the connector shown in **Fig. 14-3** at a convenient position on the intended machine in order to permit connection of the Yanmar genuine engine diagnosis tool.

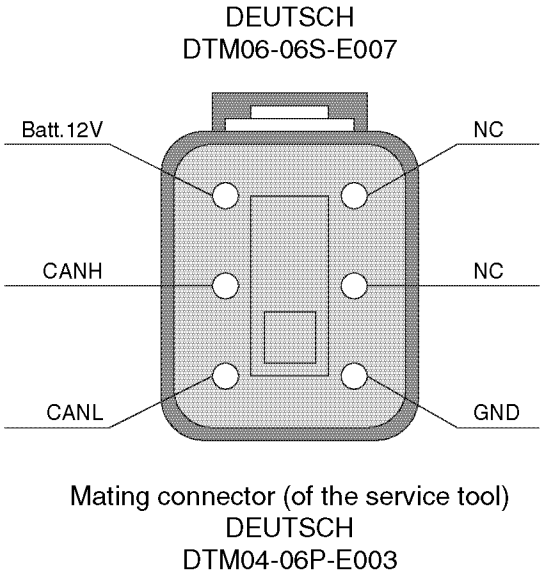


Fig. 14-3 **Diagnosis tool connector**

CONTROL SYSTEM

System outline

Fig. 14-4 shows the standard electrical connection diagram of the Gen2 Eco-governor.

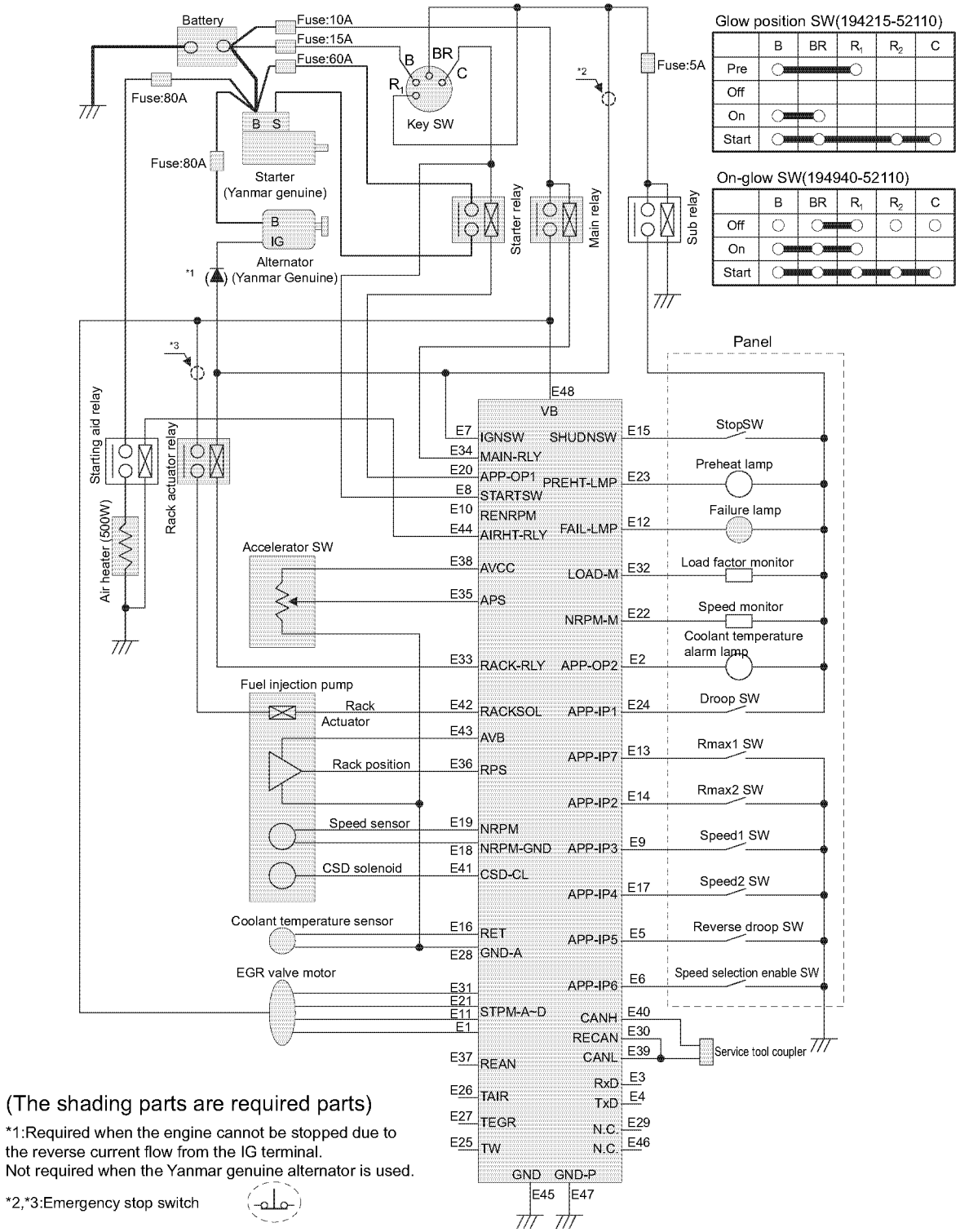


Fig. 14-4 **The standard electrical connection diagram of the Eco-governor system**

The following describes each of the components shown in Fig. 14-4

(1) Main relay

- Not using the key switch allows avoiding a long electrical wiring between the battery and E-ECU terminal VB.
- Allows self-holding of the E-ECU power and logging of engine events including faults and running time when the key switch is off.
- A diode contained in the excitation coil prevents reverse current from being applied to the E-ECU or rack actuator in case of reverse connection of battery terminals.

(2) Rack actuator relay

- Cuts off the power to the actuator to stop the engine when the key switch is turned off, regardless whether or not the main relay causes self-holding of the E-ECU power.
- Cuts off the power to the rack actuator to stop the engine when overspeed is detected.

(3) Sub relay

- By separating engine electrical circuit - which is essential to running engine - from the panel electrical circuit, panel electrical failure to stop running engine is avoided.
- Avoids turning the leaked current to the E-ECU's terminal IGNS (E7) from panel load, when the key switch is turned off.
- A diode contained in the excitation coil prevents reverse current from being applied to the I/O terminals of the E-ECU panel in case of reverse connection of battery terminals.

(4) Starting aid relay

- Not using the key switch allows avoiding a long electrical wiring between the battery and starting aid (air heater or glow plug). As a large current is not flowed to the key switch, the small capacity key switch can be used.
- Enables the E-ECU to provide ON-glow control, simultaneous energization or after heating to the starting aid (air heater or glow plug).
- In the standard electrical connection diagram, both the key switch with a ìglowî position and the key switch without a ìglowî position (ON-glow key switch) can be used.

(5) Starter relay

- Prevents the starter motor from starting until the rack self-diagnostics on power-on is completed (for approx. 0.7 second).
- Prevents failure caused by starter overrun.
- Limits the starter-on time to prevent failure caused by starter overcranking (optional feature).
- Synchronizes the starter operation with the crutch pedal switch position or the like (optional feature).

(6) Failure lamp

- Alerts the operator to a fault occurring in the Eco-governor system or a start of energization of the E-ECU.

(7) Service tool coupler

- By using the engine diagnosis tool, control information and history information in the E-ECU can be checked.These information is used when troubleshooting is done by the service manual.
- Enables maintenance of data, programs, parameters etc. in the E-ECU by using the engine diagnosis tool. These are required at the time of changing pump and E-ECU in the market.

(8) Accelerator sensor

- In the Eco-governor, there is no mechanical governor like governor lever.Accelerator sensor is required to set the target engine speed in place of the governor lever. The target speed is in proportion to the accelerator output voltage.
- If the engine speed is changed stepwise to constant values as in the case of generator engines, a panel switch can be used to change the engine speed.In such a case, the accelerator sensor is not needed.
- Using CAN communication permits a target engine speed to be specified from the ECU of the intended machine. In such a case, the accelerator sensor is not needed.

(9) Coolant temperature sensor

- Detects the coolant temperature to control CSD for low-temperature start and EGR for exhaust reduction.Using the Yanmar genuine sensor eliminates the possibility of using other devices in parallel.
- By using the coolant temperature sensor, coolant temperature high alarm can be generated.At the time of coolant temperature high alarm, it's possible to turn on the alarm lamp (APP-OP2 terminal) and limit the engine operation. Therefore, the conventional coolant temperature switch (121250-44901) is not featured in the Eco-governor specification TNV.

(10) Panel switches and lamps

- Enables options of the E-ECU to be used. If optional features are not needed, the panel does not require to be connected.

(11) About a diode to be inserted in alternator terminal IG

- The engine may be impossible to stop because the current generated by the alternator flows reversely from alternator terminal IG to the harness circuit. To avoid such a trouble, you should separate alternator terminal IG from the rack actuator excitation circuit or insert a diode (marked with an asterisk in **Fig. 14-4**) into alternator terminal IG in order to prevent reverse current from the terminal.
- Insertion of diode is not required when the Yanmar genuine alternator (119620-77201, 129423-77200, 119626-77210, 129612-77290) is used.

When the key switch with a ìglowî position is used in the standard connection diagram, preheat lamp is illuminated both at ìglowî position and ON (accessory) position.However, when preheated at ìglowî position, it's not necessary to preheat again at ON position.

Fig. 14-5 is the referential electrical connection diagram for not using starting aid by the E-ECU.Starting aid relay is used in the diagram, but if the total length of the starting aid (air heater or glow plug) cable doesnít exceed 5 m, it is possible to drive the starting aid directly from the key switch.

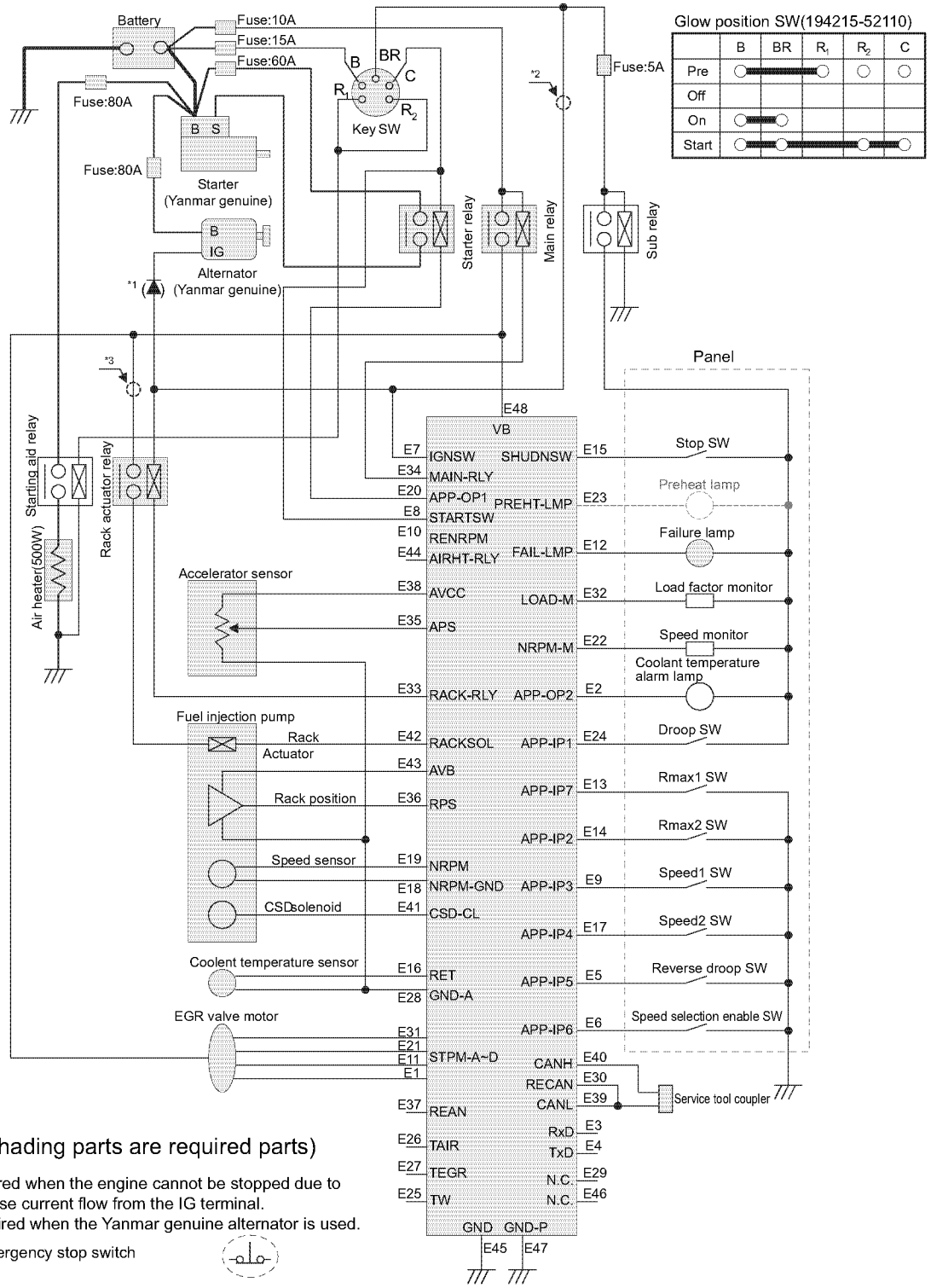


Fig. 14-5 **The referential electrical connection diagram of the Eco-governor system**

Timing of the E-ECU

The timing concerning start and end of the E-ECU control at the time of turning on and turning off the key switch of the Gen2 Eco-governor control system is described in **Fig. 14-6**.

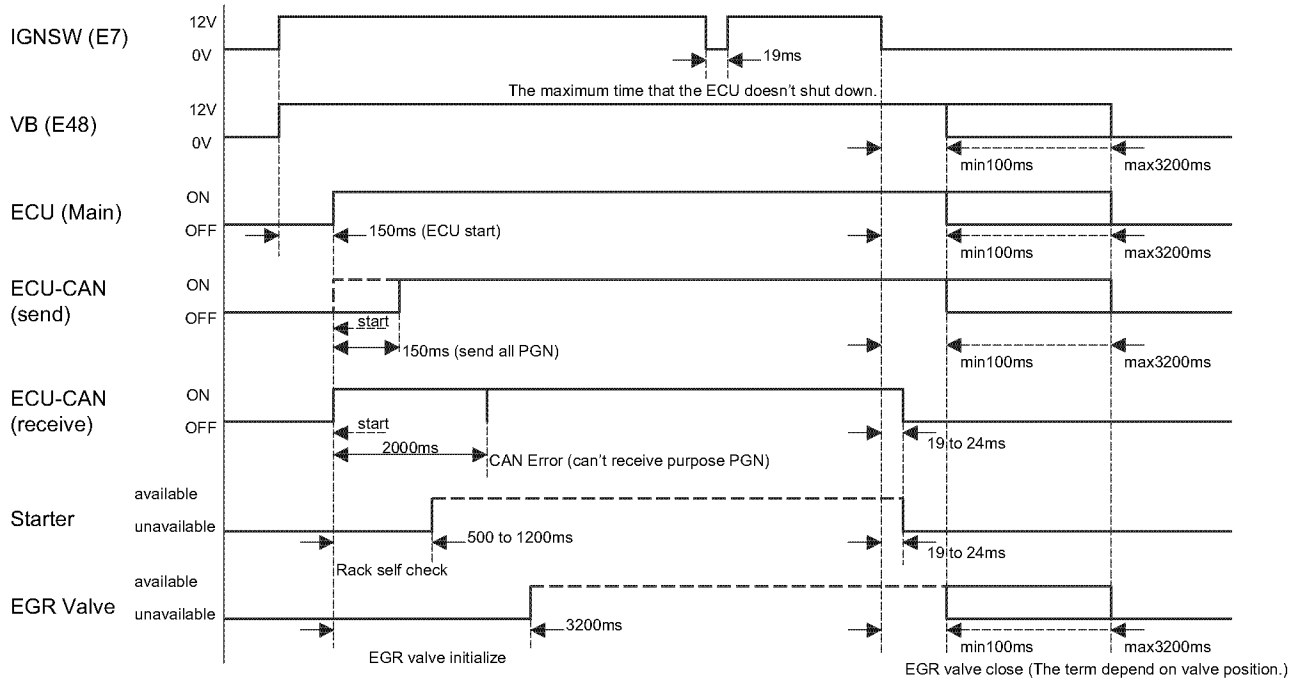


Fig. 14-6 **Timing of the E-ECU control**

E-ECU

Outline

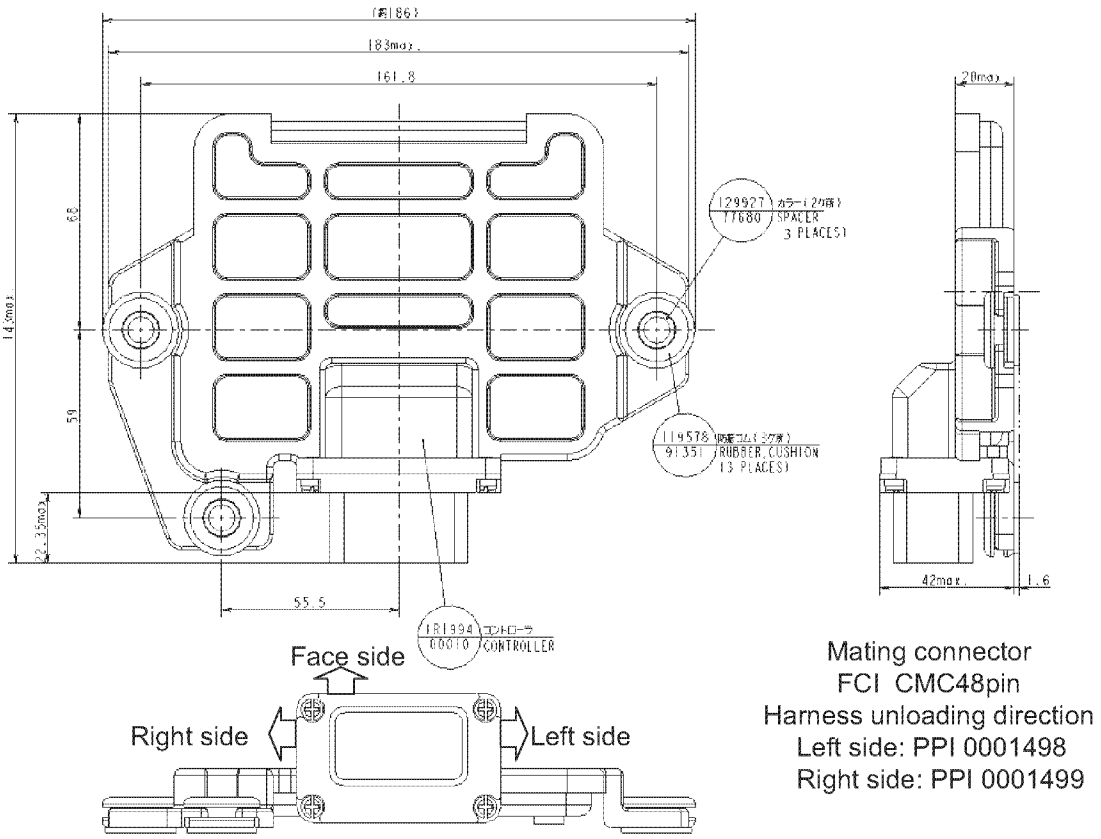
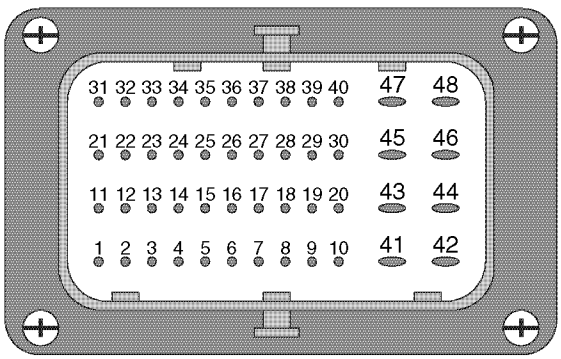


Fig. 14-7 **E-ECU Outline**

The specified grommets (119578-91351) and spacers (129927-77680) are installed in the E-ECU.Do not use grommets and spacers other than the Yanmar specified.Vibrations of the engine or machine could cause malfunction of the E-ECU.

Fig. 14-8 shown the connector pin numbers of the E-ECU. Note that the connection diagram in **Fig. 14-4** uses the pin numbers with a prefix of "E" as circuit symbols.



Circuit symbols: Pin number with prefix "E"

Fig. 14-8 **E-ECU connector pin No.**

Requirement

Table 14-1 shows the operating conditions of the E-ECU.

Table 14-1 E-ECU Specification

I/O		Requirement
Regulation	Rated voltage	12 VDC
	Operating ambient temperature	-30°C ~ 80°C
	Storage ambient temperature	-40°C ~ 110 °C
Basic Performance	Operating voltage range	10.0 ~ 16.0 VDC
	Minimum operating voltage	6.0 VDC Min.
Vibration	Severity level	To be installed on a place of 45 or lower in severity level
	The acceleration, speed, and displacement of the ECU mount must conform to the requirements shown to the right in an overall range of 5 - 1000 Hz.	70.4m/s (rms) Max.
		44.6 mm/s (rms) Max.
		0.283 mm (rms) Max. 0.800 mm (p.p) Max.
Waterproofness	Waterproofness (of connector)	JIS D0203 S2 compliant The ECU must not be installed with its connector facing upward.

Precautions:

- Install the E-ECU in a location that is not subject to steam or high-pressure water for cleaning.
- Install the E-ECU in a location that is well ventilated and not subject to direct sunlight.
- Install the E-ECU so that the connector faces downward. Failure to do so may trap water in the connector, resulting in corrosion of connector pins.
- Do not plug or unplug the connector for at least 6 seconds after the E-ECU is turned on or off.
- Do not touch connector pins with bare hands. Doing so may corrode or statically charge connector pins, resulting in damage to electronic components in the E-ECU.
- Do not force a measuring or testing probe into the female coupler of the connector. Repeated plugging/unplugging may cause contact failure of connector pins, resulting in malfunction of the E-ECU.
- Ensure no water is trapped inside the coupler when plugging or unplugging the connector. Water inside the coupler may corrode connector pins, resulting in malfunction of the E-ECU.
- Avoid plugging/unplugging the connector more than ten times. Repeated plugging/unplugging may cause contact failure of connector pins, resulting in malfunction of the E-ECU.
- Do not use the ECU that has suffered drop impact.
- When the machine is used in areas where a cryoprotectant/salt is distributed or near the seashore, the aluminum case of the E-ECU may corrode, resulting in malfunction of the E-ECU. Use a cover to protect the E-ECU against salt intrusion.

Current consumption

The engine control-related components including ECU, rack actuator, EGR valve, CSD, main relay, rack actuator relay, starter relay, starting aid relay, lamp, and switch require the current consumption of 4.6 [A] in measurement. Among these, the cold starter such as CSD requires the current consumption of 1A, so select the alternator capacity of 5A for frequent cold starts or 4A for otherwise.

Minimum operating voltage

The minimum operating voltage of the E-ECU is 6.0 VDC. Decreasing the E-ECU power supply voltage to less than the above causes the ECU to stop. When the power supply voltage is recovered, it restarts from the initial condition.

When the battery voltage decreases to less than 6.0 V repeatedly at compression steps during cranking in cold start conditions, for example, the engine may not be able to start. To avoid such a trouble, check the battery and E-ECU power supply for correct voltage.

Fig. 14-9 provides the transition of the E-ECU power supply voltage at engine start.

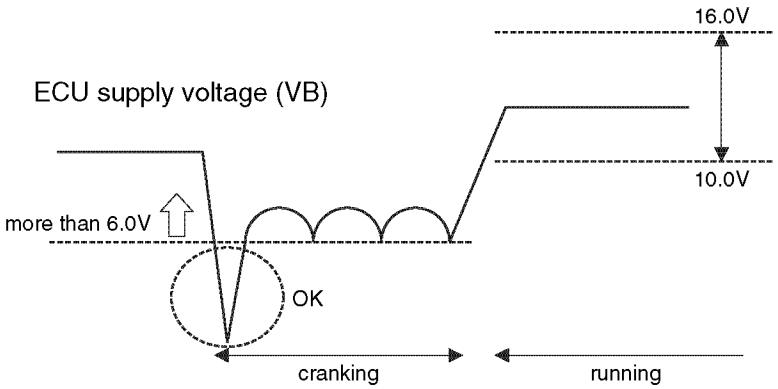


Fig. 14-9 **Transition of E-ECU power supply voltage at engine start**

Minimum detectable speed

The minimum detectable speed of the engine that can detect E-ECU and fuel injection pump (speed sensor) is set lower than the minimum cranking speed (average engine speed = 75min^{-1}) required for starting the engine. However, when the engine speed is reduced at the starting time and not reaching the minimum detectable speed due to having drastically increased engine start load at the time of extremely low temperature or having the reduced battery capacity because of deterioration and electrical discharge, the E-ECU may indicate the speed sensor failure.For this case, increase the starter start current to decrease the engine start load.

Number of start/stop cycles and duration of energization

The E-ECU saves engine logs in the internal EEPROM and updates them every time the power turns off if the power self-holding feature (described later) is enabled, or at regular intervals if the power self-holding feature is disabled. The design service life of the E-ECU is therefore dependent on the maximum number of EEPROM write cycles.

The service life of EEPROM is limited to the order of 105 key-on operations if the power self-holding feature is enabled, or 104 key-on duration hours if the power self-holding feature is disabled.

EEPROM is a nonvolatile storage; data stored in EEPROM is not lost if the E-ECU power turns off.

Safety features

The E-ECU has the following safety features:

- The function called watchdog timer monitors whether the engine control microcomputer program process is working properly or not.When the microcomputer program failure is detected, the watchdog timer restarts the microcomputer to help recover the program process.
- The other detector also monitors the engine speed besides the engine control microcomputer. If this detector detects an overspeed condition of the engine, it turns off the rack actuator relay to cut off the engine. (On overspeed condition occurs when the engine speed reaches High Idling Speed plus 600 min^{-1} by default).
- The power supply terminal (VB) of the E-ECU has a zener diode for protection against dump surge. As the rack actuator and the rack position sensor must be protected by the zener diode, the power lines for these components should be branched at a point as close to terminal VB as practicable.

About battery reverse connection

- Battery reverse connection will cause damage to the E-ECU and the rack position sensor.
- To protect the E-ECU and the rack position sensor against inadvertent reverse connection, main and sub relays fitted with a reverse connection prevention diode (198461-52950) should be arranged as indicated on the standard connection diagrams (E3-29927-0041).

Check for power-up of the E-ECU

The E-ECU is factory set so that the internal EEPROM is reset at the first power-up of the E-ECU. At the power-up, check for power-up of the E-ECU (EEPROM) as follows:

When the trouble monitor lamp illuminates at the first power-up, initialization is complete. The engine cannot be started in succession to the initialization process. To enable starting the engine, turn off the power to the E-ECU; then turn on the power again. If the trouble monitor lamp remains off, the harness or the E-ECU is probably out of order. See “Troubleshooting” for details.

When the trouble monitor lamp illuminates for two seconds and then goes out after the second power-up, the E-ECU works normally. If the trouble monitor lamp remains off or flashes, the harness or the E-ECU is probably out of order. See ìTroubleshootingî for details.

I/O layout

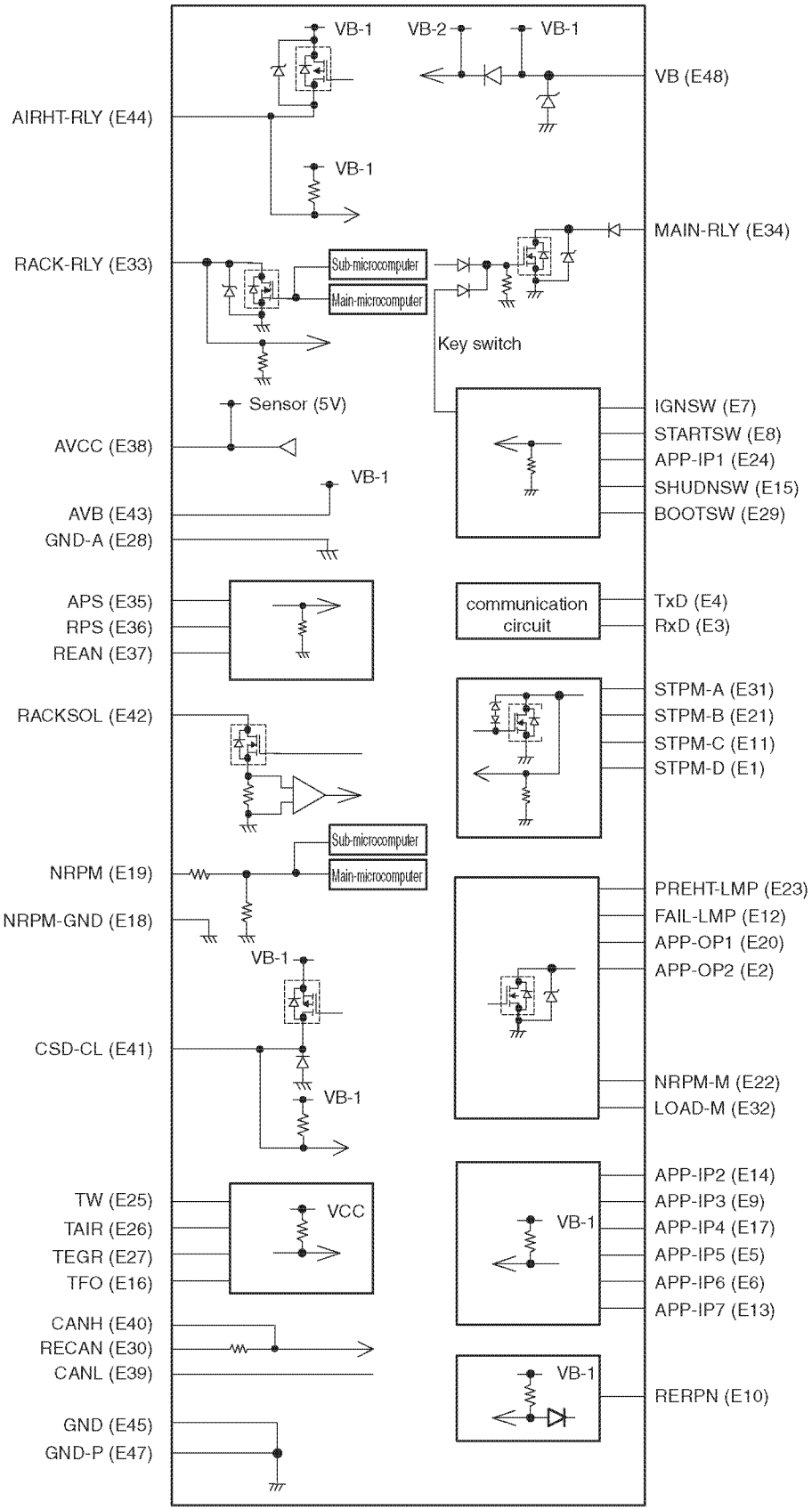


Fig. 14-10 **E-ECU I/O layout**

I/O description

Table 14-2 E-ECU I/O description

I/O	Type	Pin function/name	Symbol	No.	Description
Input	Analog	Accelerator position sensor	APS	E35	Recommended load: Potentiometer (5 kΩ) Range: 0 ~ 5 V Accuracy: 512±13 (@2.5 V) Input resistance: 200 kΩ
		Rack position sensor	RPS	E36	Specified load: Rack position sensor Range: 0 ~ 5 V Accuracy after adjustment: 716±2 (@3.5 V/25 ~ 30°C) Input resistance: 100 kΩ
		Coolant temperature (Unused)	TW	E25	Specified load: Thermistor (119254-44910) Range: -30 ~ 120°C Accuracy after adjustment: 3°C (@0°C/5.88 kΩ) Output resistance: 1.5 kΩ
		Intake air temperature (reserve)	TAIR	E26	Specified load: Thermistor (124399-12750) Range: -30 ~ 120°C Accuracy: 5°C (@20°C/2.45 kΩ) Output resistance: 1.5 kΩ
		EGR temperature (reserve)	TEGR	E27	Specified load: Thermistor (not defined) Range: 0 ~ 200°C Accuracy: ±5°C (@100°C/1.10kΩ) Output resistance: 1.5 kΩ
		Backup temperature	RET	E16	Specified load: Thermistor (129927-44900) Range: -30 ~ 120°C Accuracy: ±2°C (@20°C/2.45 kΩ) Accuracy: ±2°C (@110°C/0.1417 kΩ) Output resistance: 1.5 kΩ
		Backup analog (Optional)	REA N	E37	Recommended load: Backup accelerator sensor Range: 0 ~ 5 V Accuracy: 512±13 (@2.5 V) Input resistance: 100 kΩ
	Contact	Engine start recognition	STARTSW	E8	Circuit: High side Pull-down resistance: 1.2 kΩ (10 mA@12 V)
		Engine emergency stop	SHUDNSW	E15	Circuit: High side Pull-down resistance: 1.2 kΩ (10 mA@12 V)
		Key switch	IGNSW	E7	Circuit: High side Pull-down resistance: 1.2 kΩ (10 mA@12 V)
		Application input 1	APP-IP1	E24	Circuit: High side Pull-down resistance: 1.2 kΩ (10 mA@12 V)
		Application input 2	APP-IP2	E14	Circuit: Low side Pull-up resistance: 1.2 kΩ (10 mA@12 V)
		Application input 3	APP-IP3	E9	Circuit: Low side Pull-up resistance: 1.2 kΩ (10 mA@12 V)
		Application input 4	APP-IP4	E17	Circuit: Low side Pull-up resistance: 1.2 kΩ (10 mA@12 V)
		Application input 5	APP-IP5	E5	Circuit: Low side Pull-up resistance: 1.2 kΩ (10 mA@12 V)
		Application input 6	APP-IP6	E6	Circuit: Low side Pull-up resistance: 1.2 kΩ (10 mA@12 V)
		Application input 7	APP-IP7	E13	Circuit: Low side Pull-up resistance: 1.2 kΩ (10 mA@12 V)

Table 14-2 E-ECU I/O description

I/O	Type	Pin function/name	Symbol	No.	Description
Input	Pulse	Speed input (-)	NRPM-GND	E18	Specified load: Electromagnetic pickup (158557-61720) Range: 10Hz, 0.4Vp-p - 400Hz, 60Vp-p
		Speed input (+)	NRPM	E19	
		Backup speed sensor	RENRPM	E10	Circuit: Low side Pull-up resistance: 1.2 k (10 mA@12 V)
Output	Contact	Rack actuator	RACKSOL	E42	Circuit: High side, PWM port Output: 6.0 A Max. (@12 V)
		Main relay	MAIN-RLY	E34	Circuit: High side Output: 200mA Max. (@12 V)
		Rack actuator relay	RACK-RLY	E33	Circuit: High side Output: 200mA Max. (@12 V)
		Air heater relay	AIRHT-RLY	E44	Circuit: Low side Output: 1.2A Max. (@12 V)
		CSD solenoid coil	CSD-CL	E41	Circuit: Low side Output: 2.41A Max. (@12 V)
		Trouble Monitor Lamp	FAIL-LMP	E12	Circuit: High side Output: 300mA Max. (@12 V) Lamp load: 12 V/3.4 W Max. Rush current: 12V/3 A-10ms Max.
		Preheat lamp	PREHT-LMP	E23	Circuit: High side Output: 300mA Max. (@12 V) Lamp load: 12 V/3.4 W Max. Rush current: 12V/3 A-10ms Max.
		Application output 1	APP-OP1	E20	Circuit: High side Output: 300mA Max. (@12 V) Lamp load: 12 V/3.4 W Max. Rush current: 12V/3 A-10ms Max. Relay load: 40 Min., 200 mH Max.
		Application output 2	APP-OP2	E2	Circuit: High side Output: 300mA Max. (@12 V) Lamp load: 12 V/3.4 W Max. Rush current: 12V/3 A-10ms Max. Relay load: 40 Min., 200 mH Max.
	Pulse	Speed monitor	NRPM-M	E22	Circuit: High side, direct-coupled to speed input Output: 200mA Max. (@12 V) ON voltage: 1.5 V Max. OFF voltage: Load power supply voltage Output withstand voltage: 200 V
		Load factor monitor	LOAD-M	E32	Circuit: High side, PWM port Output: 200 mA (@12 V) ON voltage: 1.5 V Max. OFF voltage: Load power supply voltage Output withstand voltage: 200 V
		Stepping motor phase A	STPM-A	E31	Circuit: High side Output: 1.0A Max. (@12 V)
		Stepping motor phase B	STPM-B	E21	Circuit: High side Output: 1.0A Max. (@12 V)
		Stepping motor phase C	STPM-C	E11	Circuit: High side Output: 1.0A Max. (@12 V)
		Stepping motor phase D	STPM-D	E1	Circuit: High side Output: 1.0A Max. (@12 V)

Table 14-2 E-ECU I/O description

I/O	Type	Pin function/name	Symbol	No.	Description
Com-munication	Network	CANL	CANL	E39	ISO 11898 (Ver2.0B), 250/500 kbps
		CANH	CANH	E40	
		CAN terminator	RECA N	E30	CAN terminator resistance: 120 when E30 is coupled to CANL (E39)
	Serial	RxD1	RxD	E3	TTL level (Disabled)
		TxD1	TxD	E4	
Power supply	Output	Sensor 5V	AVCC	E38	Voltage: Vcc0.02 V (Vcc = 5.00.1 V) Output: 25 mA Max.
		Sensor GND	GND-A	E28	
		Sensor 12V	AVB	E43	Voltage: Internally coupled to VB Protection against dump surge
	Input	Power supply 12V	VB	E48	Connected to main relay
		Power supply GND	GND	E45	Connected to battery negative terminal
		Power GND	GND-P	E47	
Misc.	Misc.	Boot mode	BOOTSW	E29	(Disabled)
		-	-	E46	

Notes:

- The function of each pin is described later. Do not use the pins for other purposes than intended.
- Serial communication terminal (E3, E4) cannot be used.
- As required, jumper E30 to E39 to activate the CAN terminal resistor. See **Harness (P.25)** for details.
- E25, E26, E27, E29, and E46 are unused terminals.Wiring is not required.

Electrical parts

Table 14-3 The Electrical parts list of the Eco-governor system

Part name	Functional description	Setting *1	Interchangeability *2
E-ECU (Part No.: Model dependant)	Engine control	◉	Non
FO pump (Part No.: Model dependant)	• Fuel injection - Rack actuator • Rack position sensor • Speed sensor • CSD solenoid	◉	Non
Coolant temperature sensor (129927-44900)	Engine control (Do not use for other purposes than engine control).	◉	Non
EGR valve (37 kW Min.) (129927-13900)	Emission control	◉	Non
Alternator (129423-77200, etc.)	• Battery charging • Battery low alarm/indication (connection to ECU is optional service) • Reserved speed detection (pin P)	◉	Yes
Starter (129900-77010, etc.)	Engine start	◉	Yes
Starting aid (129915-77050, etc.)	Cold start	◉	Non
Accelerator sensor (129938-77800)	• Engine target speed direction • May be omitted for generator applications	○*6)	Yes
Main relay (198461-52950)	Power self-holding and battery reverse connection protection	◉	Non
Rack actuator relay (198461-52950)	• Overspend prevention • Emergency stop	◉	Yes
Starter relay (129927-77920)*4)	• Starter motor start prevention • Recommended connector: Yazaki 7223-6146-30 Bracket for the above connector: 129927-77910	◉	Yes
Trouble monitor lamp (124732-77720)	• E-ECU operation indication (illuminates for 2 sec after power-on) • E-ECU trouble indication (illuminates when a problem occurs)	○*7)	Yes
Sub relay (198461-52950)	Panel power supply and battery reverse connection protection	△	Yes
Starting aid relay (129927-77920, etc.)*4)	• ON-glow control and the like • Recommended connector: Yazaki 7223-6146-30 • Bracket for the above connector: 129927-77910	○	Yes
Preheat lamp (Part No.: Non)	ON-glow indication, pre-heat indication	△	Yes
Oil pressure switch (119761-39450)	• Oil pressure alarm/indication (actuated when a problem occurs) • Use an alarm lamp or equivalent device too.	◉	Non
Air cleaner (with sensor) (129601-12610, etc.)	• Air cleaner blockage alarm/indication (actuated when a problem occurs) • Use an alarm lamp too.	△Sensor attached on user's request	Yes

Table 14-3 The Electrical parts list of the Eco-governor system

Part name	Functional description	Setting *1	Interchangeability *2
Oily water separator (with sensor) (129245-55700 Availability pending)	Oily water alarm/indication (actuated when a problem occurs)	◉ Sensor attached on user's request	Yes
Harness (129927-91040,129927-91050)	• Electrical part connection • Engine checker connection (Deutsch DTM connector)	○*8)	Yes
Key switch (194215-52110)	• Glow position control • ON-glow is optional feature	○	Yes
Fuel feed pump (119225-52102)	• Fuel feed • Auto bleeding	◉	Non
Oil pressure sensor (119773-91501)	Oil gauge pressure indication	△	Yes
Coolant temperature sensor (124250-49351)	Coolant temperature indication	△	Yes

*1 The electrical part of the Eco-governor system is set as the following:
◉: Standard part
○: Recommended optional part
△: Optional part

*2 "Interchangeability" refers to whether or not commercially available parts can be used in place of Yanmar genuine parts.
Non: Use Yanmar genuine parts. Otherwise, the intended engine performance will not assured.
Yes: Commercially available parts can be used.Commercially available parts can be used provided that the parts meet requirements specified by Yanmar.

*3 Shading means that the electrical part or component is specific to the Eco-governor (is not required for a mechanical governor).

*4 Yanmar genuine starting aid relay and starter relay have no mounting bracket.ISO relay connector (Yazaki: 7223-6146-30) bracket (129927-77910) is set.

*5 The alternator with pin P can be used as a backup speed sensing means, but it cannot be used to start the engine.

*6 E-ECU for generator engine application is not standard equipped with the accelerator sensor. The engine speed can be changed using a switch connected to terminals APP-IP3/IP4 of the E-ECU.

*7 Be sure to locate the trouble monitor lamp so as to be easily visible to the operator.

*8 The custom development of harness is not conducted.

The Eco-governor does away with the need for the following electrical parts in **Table 14-4** that are used for mechanical governors:

Table 14-4 List of electrical parts not required for the Eco-governor

Part name	Part number	Remarks
Coolant temperature switch	121250-44901, etc.	Replace when coolant temperature alarm is generated
Safety relay	119802-77200, etc.	-
Stop solenoid	119653-77950, etc.	-
Timer	129211-77920	1-sec timer for stop solenoid
Relay	119650-77910	-
Diode	119643-66900	-
Timer	128300-77920	15-sec timer for stop solenoid (similar for glow)
QHS controller	129457-77900	In the Eco-governor, starting aid relay is required (similar for glow)

Commercially available electrical parts used instead of Yanmar genuine parts must meet the minimum requirements specified in **Table 14-5**. Failure to meet these requirements may affect the engine performance or cause malfunction of the E-ECU.

Table 14-5 Electrical requirements of the commercially available electrical parts used for the Eco-governor

Part name	Electrical requirements	
Accelerator sensor	• Sensor output voltage: 0 ~ 5V (0.7 V Min., and 3.0 V Max. as standard) • Resistive potentiometer (2.0 kΩ Min.) or thru-hole potentiometer • When a thru-hole potentiometer is used, its current consumption must not exceed 5 V/10 mA. • When the sensor input voltage is lower than 0.2 V or higher than 4.6 V, the sensor is assumed to fail. The input voltage therefore recommends to be held within a range of 0.5 ~ 4.0 V (the sensor's operating range is 10 ~ 80% of the actual effective electrical travel).	
Rack actuator relay Sub relay	Contact Rated voltage Rated load current Coil current Coil inductance Switching durability Other features must be compliant with applicable specifications.	Normally open (a-contact) 12 VDC 12 VDC/20 A Min., continuous 12 VDC/200 mA or lower 200 mH Max. 10^6 times or more
Starter relay	Contact Rated voltage Rated load current Instantaneous load current Coil current Coil inductance Operation delay time Switching durability Other features must be compliant with applicable specifications.	Normally open (a-contact) 12 VDC 12 VDC/40 A Min., 30 sec. 12 VDC/100 A Min.. 12 VDC/300 mA or lower 200 mH Max. 20 ms or lower 10^6 times or more

Table 14-5 Electrical requirements of the commercially available electrical parts used for the Eco-governor

Part name	Electrical requirements
Starting aid relay	Contact: Normally open (a-contact) Rated voltage: 12 VDC Rated load current: 400 W: 12 VDC/40 A Min., 4 min. (@ 30°C) 500 W: 12 VDC/50 A Min., 4 min. (@ 30°C) 800 W: 12 VDC/80 A Min., 4 min. (@ 30°C) 1000 W: 12 VDC/90 A Min., 4 min. (@ 30°C) Coil current: 12 VDC/1.0 A or lower Coil inductance: 200 mH Max. Switching durability: 106 times or more Other features must be compliant with applicable specifications.
Trouble monitor lamp Preheat lamp	Lamp load 12 V-3.4 W Max. Rush current 12V/3A-10ms Max.
Harness	Must meet the requirements shown on the standard connection diagrams. (E3-29927-0031, E3-29927-0041)
Air cleaner (with sensor switch) Oily water separator (with sensor switch)	Contact: Normally open (a-contact) When connected to E-ECU: Max. current 20mA or higher Min. current 10 mA or lower
Key switch	When the switch is moved from the ON position to the START position, no instantaneous power interruption must occur.
Oil pressure sensor	Not to be connected to the E-ECU.
Coolant temperature sensor	Not to be connected to the E-ECU.

The fulfillment of the requirements shown in the table above does in no way constitute a warranty by Yanmar of user-selected commercially available parts.

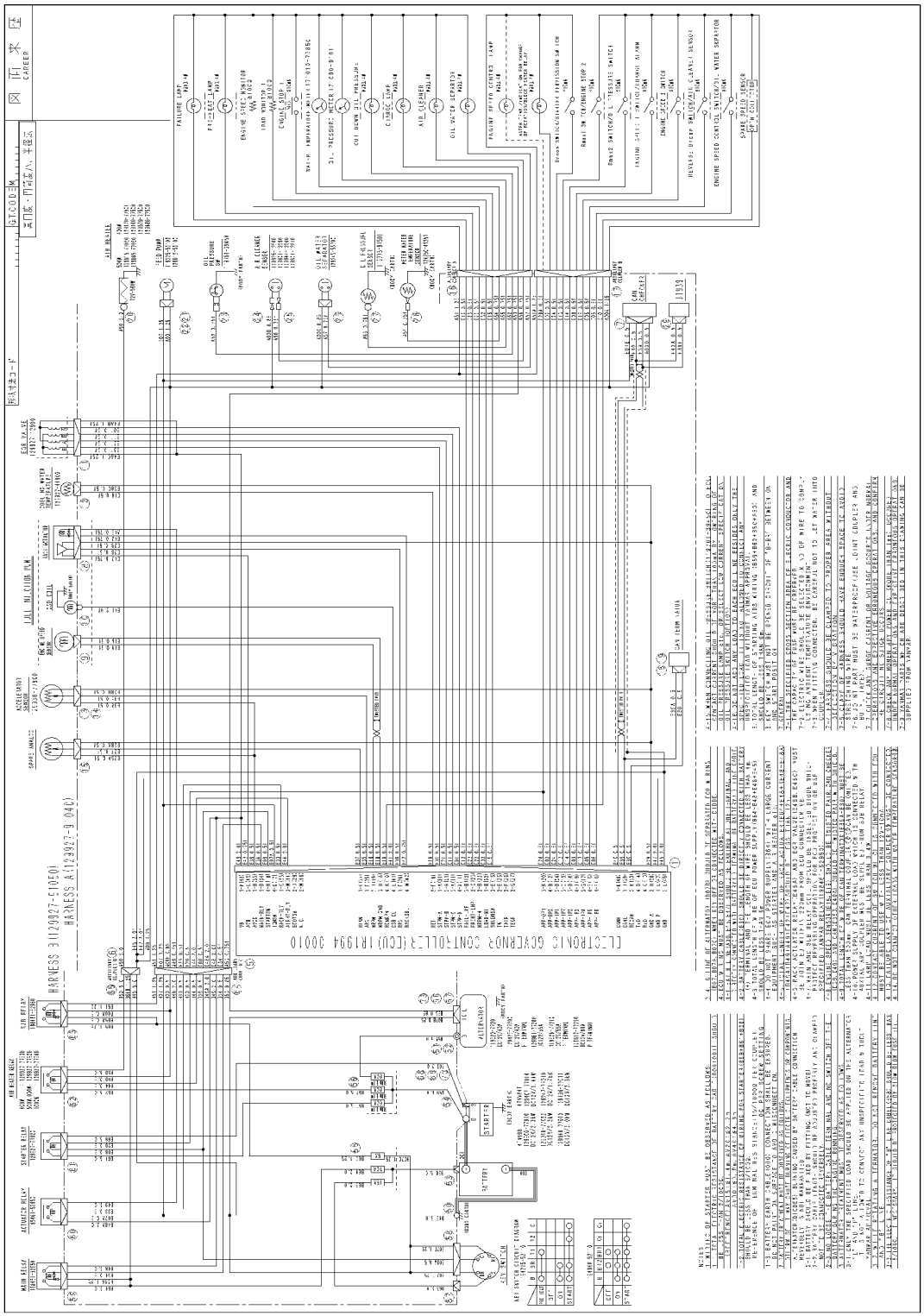
Table 14-6 Requirements of user-selected electrical parts

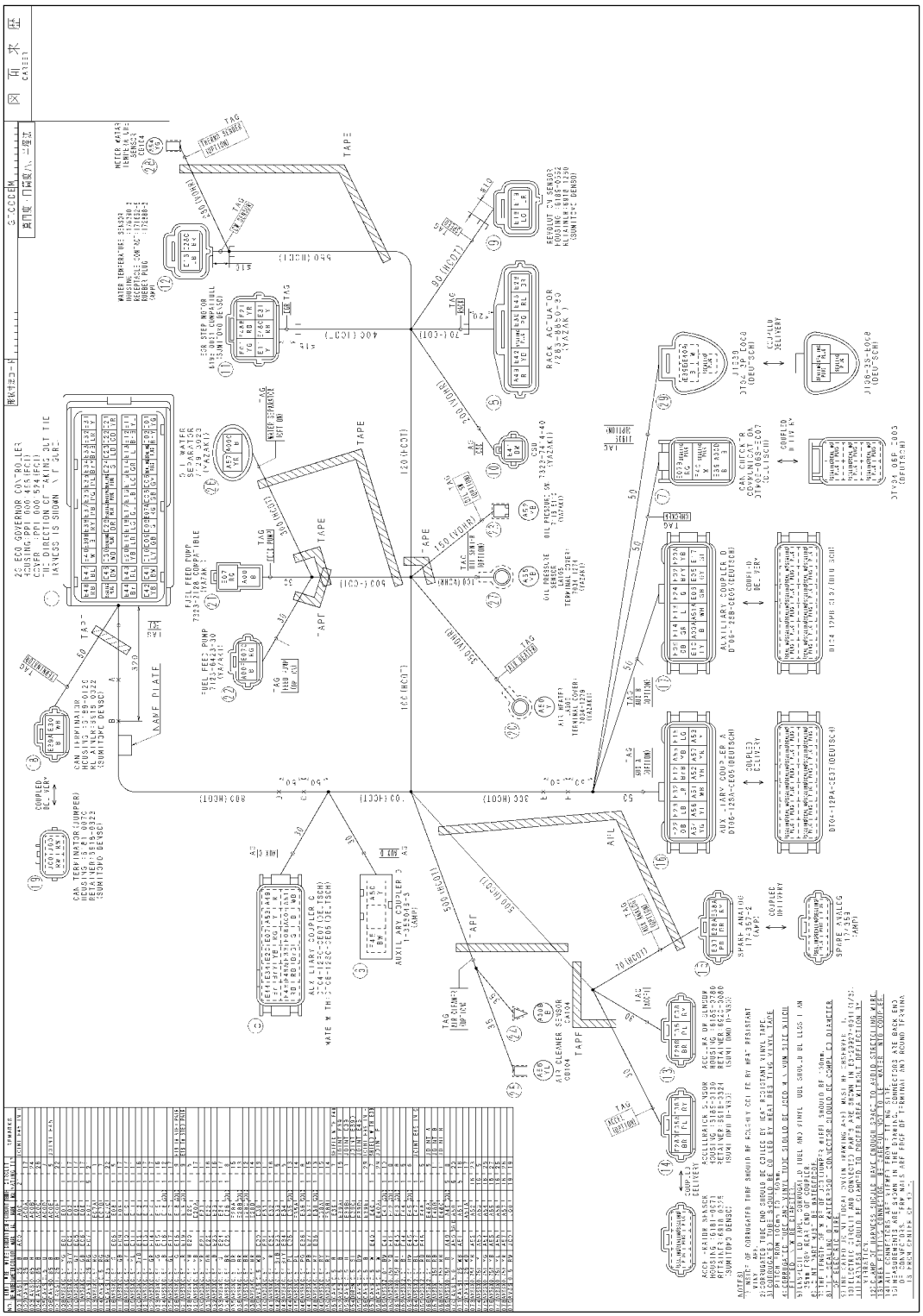
Part name	ECU connection Terminal number	Requirements	
Backup speed sensor	RENRPM (E10)	Output Rated voltage Max. current	Open connector type 12 VDC 20 mA or higher
Stop switch	SHUDNSW (E15)	Contact NC Max. current Min. current	Normally open (a-contact) Optional 12 VDC/20 mA or higher 12 VDC/10 mA or lower
Load factor monitor	LOAD-M (E32)	Resistive load Max. current ON voltage OFF voltage	Pulled up to 12 VDC 12 VDC/200 mA or lower 1.5 V Max. power supply voltage
Speed monitor	NRPM-M (E22)		
Coolant temperature alarm lamp (Eco-mode lamp) (Speed change indication lamp)	APP-OP2 (E2)	Lamp load Rush current	12 VDC/-3.4 W Max. 12VDC/3 A-10ms Max.
Block heater relay		Contact Rated voltage Rated load current Coil current Coil inductance Switching durability Other features must be compliant with applicable specifications. When the block heater is connected to the commercial power supply, observe standards and regulations concerning the dielectric withstand voltage and insulation resistance of relay contacts.	Normally open (a-contact) 12 VDC 100V: 115 VAC/4 A Min., continuous 200V: 210 VAC/2 A Min., continuous 12 VDC/300 mA or lower 200 mH Max. 10^6 times or more
Droop switch Starter enable switch	APP-IP1 (E24)	Contact	Normally open (a-contact): standard Normally closed (b-contact): optional
Foot pedal switch (NC)	APP-IP7 (E13)	Max. current Min. current	12 VDC/20 mA or higher 12 VDC/10 mA or lower
Foot pedal switch (NO)	APP-IP2 (E14)		
Speed1 switch	APP-IP3 (E9)		
Speed2 switch Backup starter enable switch	APP-IP4 (E17)		
Optional switch	APP-IP5 (E5)		
Speed selection enable switch	APP-IP6 (E6)		

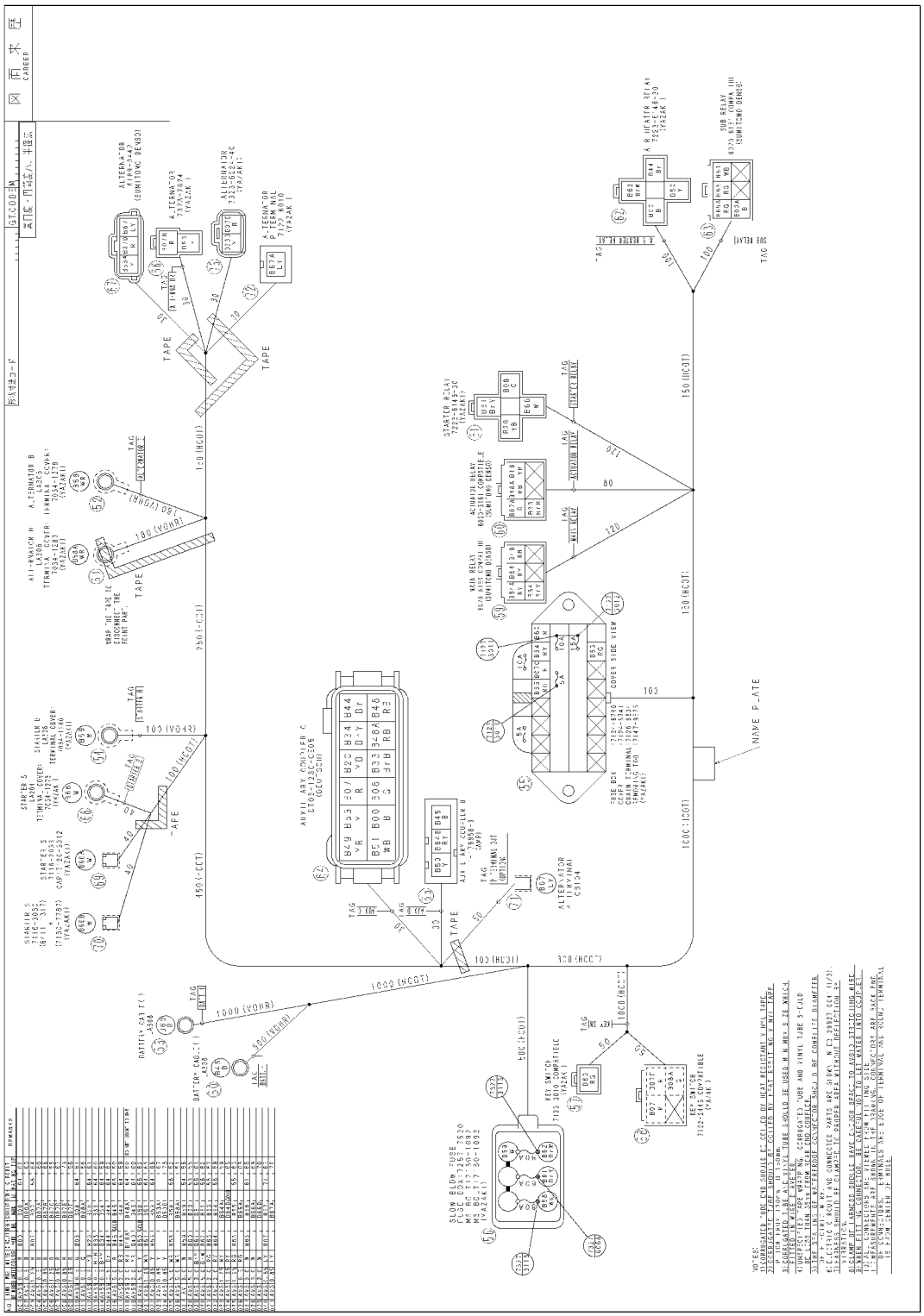
HARNESS

See the standard connection diagram (E3-29927-0041) for harness arrangement. Yanmar has verified the engine performance with the standard harness. If you want to use a harness other than the standard harness, consult the standard connection diagram for harness design.

Yanmar has made available the standard harness (E-ECU side: 12997-91040, Power supply side: 129927-91050), but cannot supply customized harnesses to individual customers.







Harness design requirements

Design and implement the harness according to the following instructions. Neglecting these instructions may affect the engine performance or result in malfunction of or damage to the E-ECU. See 13 "Electrical System" for wiring of the battery and starter. See the standard connection diagram (E3-29927-0041) for harness arrangement.

[Wiring of the ECU]

1. Connect GND directly to the battery negative terminal or battery negative terminal cable by single-point grounding.
2. Supply the main relay with power directly from the battery positive terminal using a cable having a length of 4 m or less. Failure to do so may affect the noise immunity or cold-start resetting process of the E-ECU.
3. The total length of the ECU power supply line must not exceed 5 m.
4. Avoid common impedance between the power supply circuit of the ECU and that of a large current device such as the starter or air heater. Otherwise, the E-ECU could be reset at cold start.
5. The total length of the rack actuator line must not exceed 10 m.
6. Place the branch of the power supply line for the rack actuator and the ERG valve as close to ECU terminal VB as practicable. Otherwise, transmission noise may be developed.
7. Install a reverse connection prevention diode into the main and sub relays or use the Yanmar specified relay (198461-52950) in order to protect the E-ECU rack position sensor. Otherwise, the E-ECU is damaged at the time of battery reverse connection.
8. Use a twisted-pair cable for the speed sensor. Use a shielded twisted-pair cable for CAN communication. Otherwise, noise may cause malfunction.
9. When using the CAN terminal resistor inside the E-ECU, connect E30 and E39 with a jumper as short as possible.
10. Do not connect to the main relay other loads than the engine parts such as the E-ECU (E48), rack actuator, and EGR valve. Supply the extended load power supply such as E-ECU external switches and indicator lamps with power through other circuit. Avoids the malfunction including stopping the engine from the extended load circuit trouble and turning the leaked current to the E-ECU from the extended load
11. Do not connect to the E-ECU's IGNSW (E7) terminal other loads than the indicated in **Fig. 14-4**.Turning current may cause the E-ECU power supply to not shutdown.
12. Do not connect 12-volt/3.4-watt or higher lamps directly to the E-ECU.
13. The minimum contact capacity of switches directly connecting to the E-ECU must not exceed 10 mA.
14. Be sure to locate the trouble monitor lamp so as to be easily visible to the operator.
15. Do not connect unintended loads to the coolant temperature sensor of the E-ECU. Doing so may cause CSD or EGR malfunction and deteriorate durability of the engine.
16. When connecting the oil pressure switch (11976-39450) directly to the E-ECU in order to prevent a trouble due to an abnormal oil pressure, insert a dummy load so as to ensure a 0.1-A or higher contact current, or use an oil pressure switch with low contact current (124298-39450).
17. Do not connect to E-ECU terminals loads other than intended or specified.

[Wiring of the starting aid]

1. The total length of the starting aid (air heater or glow plug) cable must not exceed 5 m.

[Key switch]

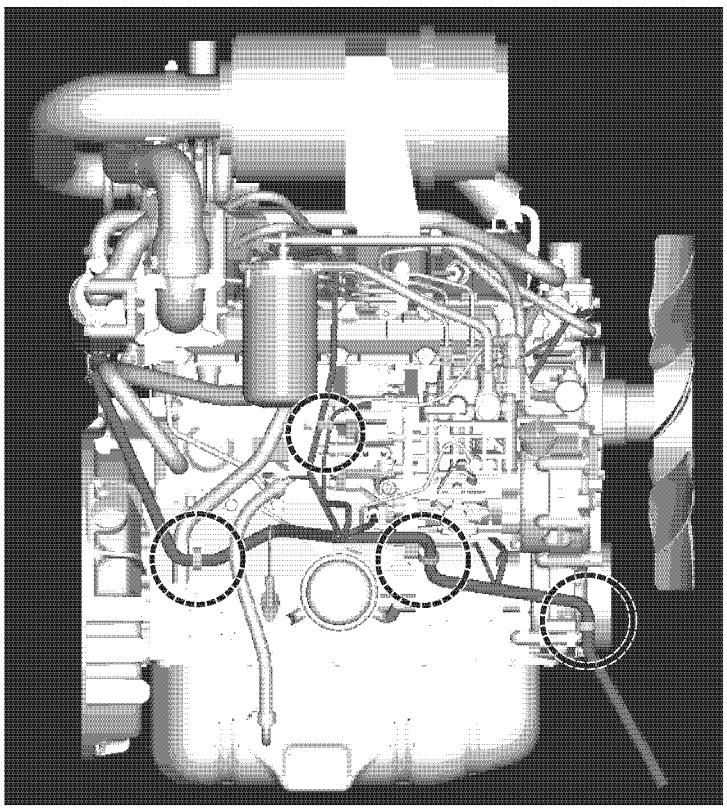
1. Select a key switch whose B-to-BR circuit (E-ECU power supply circuit) is not open between the ON and START positions. An instantaneous power interruption of 1 ms or longer of the E-ECU power supply may cause trouble including changing the engine speed and hindering the engine from starting.Be noted that the above-mentioned trouble tends to occur easily to the key switch at cold start.

[General]

1. Observe the cable and fuse requirements specified on the standard connection diagram.
2. Use electric cables whose heat resistance is appropriate to surrounding thermal conditions.
3. Ensure no water is trapped inside the coupler when plugging the connector.
4. Clamp the harness to appropriate structures so as to prevent vibrations.
5. Do not strain the harness clamp.
6. Use joint couplers or butyl tape to ensure waterproofness at joints.
7. Check that no surge current or voltage occurs in normal working conditions or expectedly abnormal conditions.
8. Check that no instantaneous power interruption (6.0 V or lower for 1 ms or more) occurs in normal working conditions or expectedly abnormal conditions.
9. Do not force a measuring or testing probe into the female coupler of the connector.

Harness clamping

A typical harness clamping method is shown in **Fig. 14-11** below:



Clamp the harness at at least 4 locations as shown in the figure above

Fig. 14-11 **Typical harness clamping**

CAN bus termination

As the E-ECU contains a 120 CAN terminator resistor, jumpering RECAN (E30) to CANL (E39) as scheme (b) in **Fig. 14-12**. enables the CAN signal to be terminated.

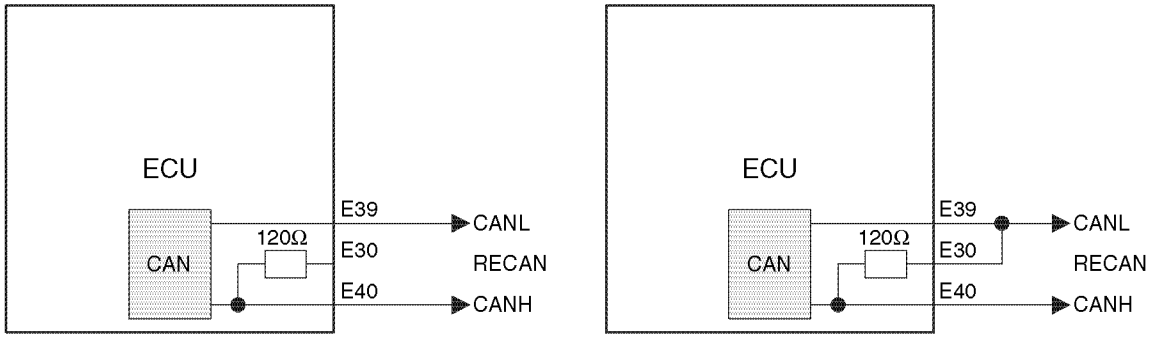


***Fig. 14-12* CAN terminator resistor**

When the CAN bus is not used by any devices other than the E-ECU, select scheme (b) in **Fig. 14-12** to permit a service tool to be connected to the terminator.

When the CAN bus is used by any devices other than the E-ECU, configure the harness according to the devices used.

Table 14-7 CAN terminator resistor

		CAN terminator resistor
When the CAN bus is not used by the other devices.		Per scheme (b) in **Fig. 14-12**
When the CAN bus is used by the other devices.	There are terminator resistor in the other devices.	Per scheme (a) in **Fig. 14-12**
	There are no terminator resistor in the other devices.	Per scheme (b) in **Fig. 14-12**

CONTROL FUNCTIONS

Control software

The functions of the E-ECU software can be divided into the mentioned categories. See **Fig. 14-13**:

1. Driver: Interface between hardware and software
2. Diagnostics: Troubleshooting and event logging of the engine and control hardware
3. Communication: Data exchange among the checker and other ECU communication features
4. Engine control: Control of the engine
5. Application: Application interface

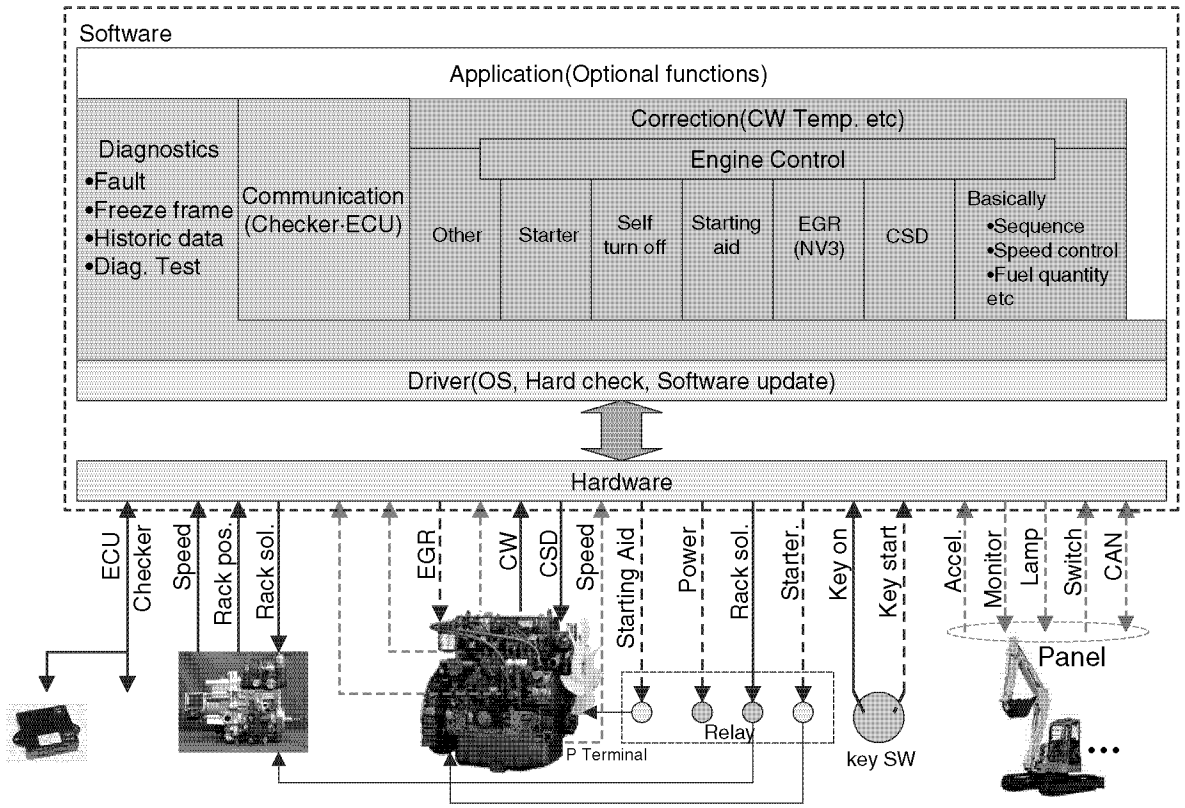


Fig. 14-13 **E-ECU software configuration**

The E-ECU software consists primarily of the following sections:

1. Control program: Engine control logic
2. Engine model-specific control map: Torque characteristics and optional settings
3. Individual data: Correction values of fuel injection rate, power output etc.

The control program and the engine model-specific control map are maintained as prime constituents by engine models. The individual data is created per each injection pump and engine and maintained as CS data. **Fig. 14-14** illustrates constituents of the E-ECU data.

The control program is common to all engine models and cannot be customized per customers.

The engine model-specific control map is composed of two areas: the base area (unchangeable) that defines engine performance including torque characteristics, and the option area that can be customized per customers.

The individual data is injection pump and engine specific and, when the E-ECU is replaced, the data must be copied to a new E-ECU. When the fuel injection pump is replaced, the E-ECU must be updated according to settings of a new pump. The individual data are stored on EEPROM. Loading new individual data to EEPROM automatically refreshes the map from the Flash memory area to the EEPROM area.

Flash memory is a nonvolatile storage, the maximum number of write cycles of which is usually 100, and data stored in this memory is not lost if the E-ECU power turns off. Flash memory differs from EEPROM in that the former does not accept write cycles during engine operation while the latter can be written to, irrespective of whether or not the engine runs. A special device is needed to write data to Flash memory.

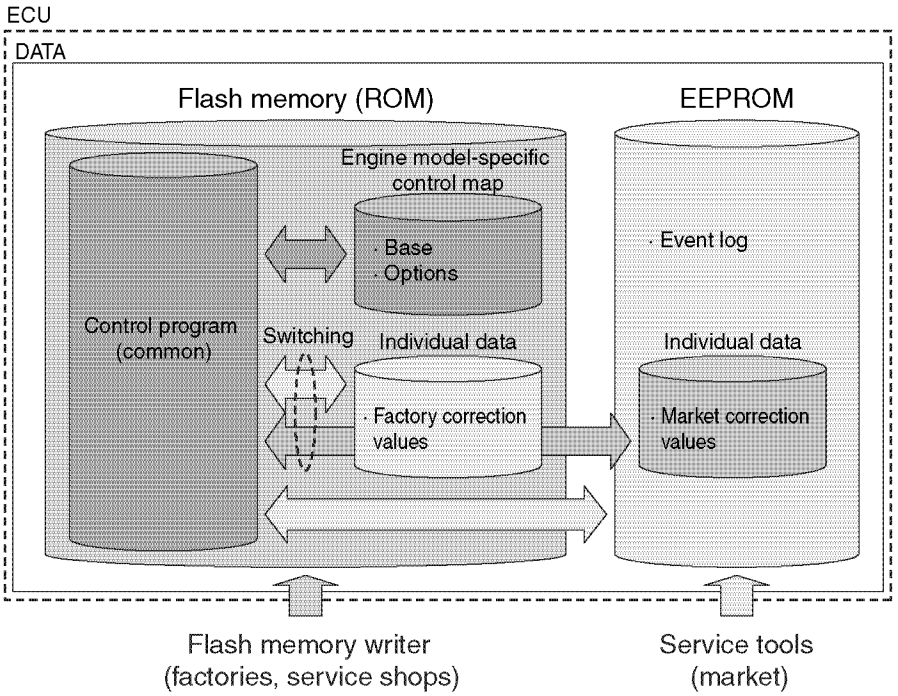


Fig. 14-14 **E-ECU data configuration**

General

Speed sensor input

The Eco-governor detects the engine speed with 12 pulsers attached to the camshaft. See **Fig. 14-15**.

Assuming that the frequency of pulses provided by the pulsers is fp [Hz], the engine speed N rpm min^{-1}] is given by. (See **Fig. 14-15 a)** for details.)

Nrpm [min^{-1}] = (fp x 2/12) x 60 = 10 x fp [Hz]

The engine speed fluctuates periodically due to compression and explosion strokes. As to a 4-cylinder engine, 3 pulses represent cyclic fluctuation for one cylinder. As to a 3-cylinder engine, 4 pulses represent cyclic fluctuation for one cylinder.

The Eco-governor averages cyclic fluctuations for one cylinder, thus minimizing the effect of cyclic fluctuations in engine speed and ensuring stable measurement. (See **Fig. 14-15 b)** for details.)

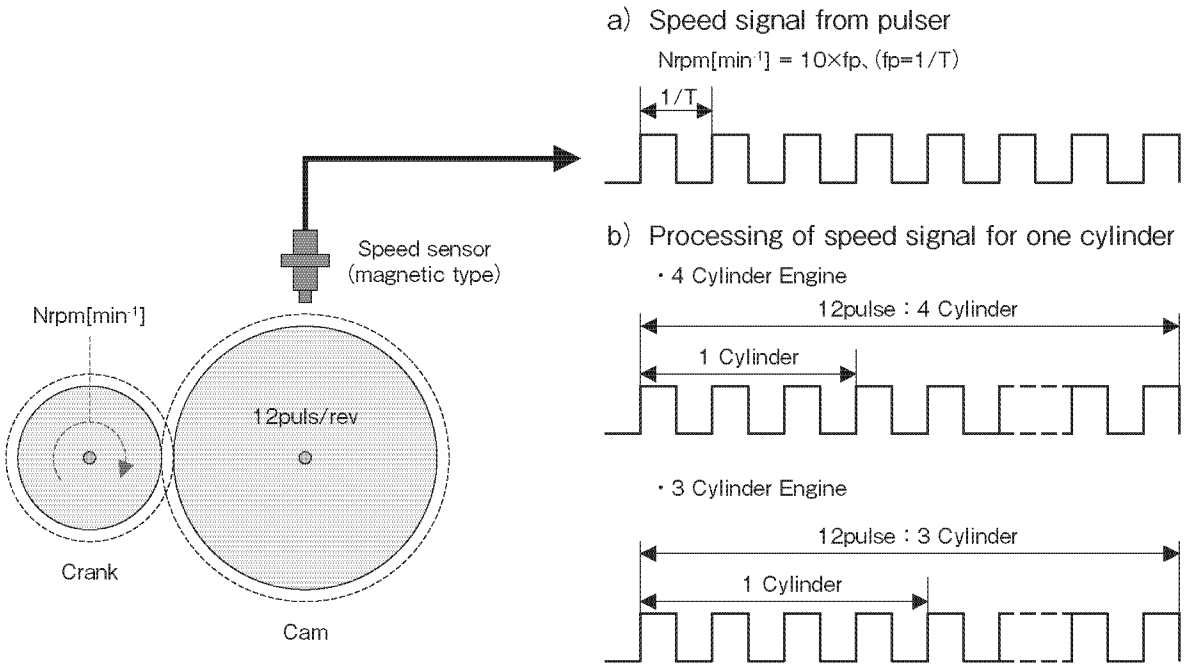


Fig. 14-15 **Detection of engine speed**

Rack position sensor input

The Eco-governor controls the fuel injection quantity by adjusting the rack position of the fuel injection pump. The rack position is converted into voltage by the rack position sensor, and the voltage signal is applied to E-ECU terminal RPS and sent to an AD converter. The AD converter converts the input voltage of 0 to 5 volt into an AD value of 0 to 1023. See **Fig. 14-16.**The Eco-governor controls the maximum and minimum rack positions and calculates the load factor on the basis of this AD value.

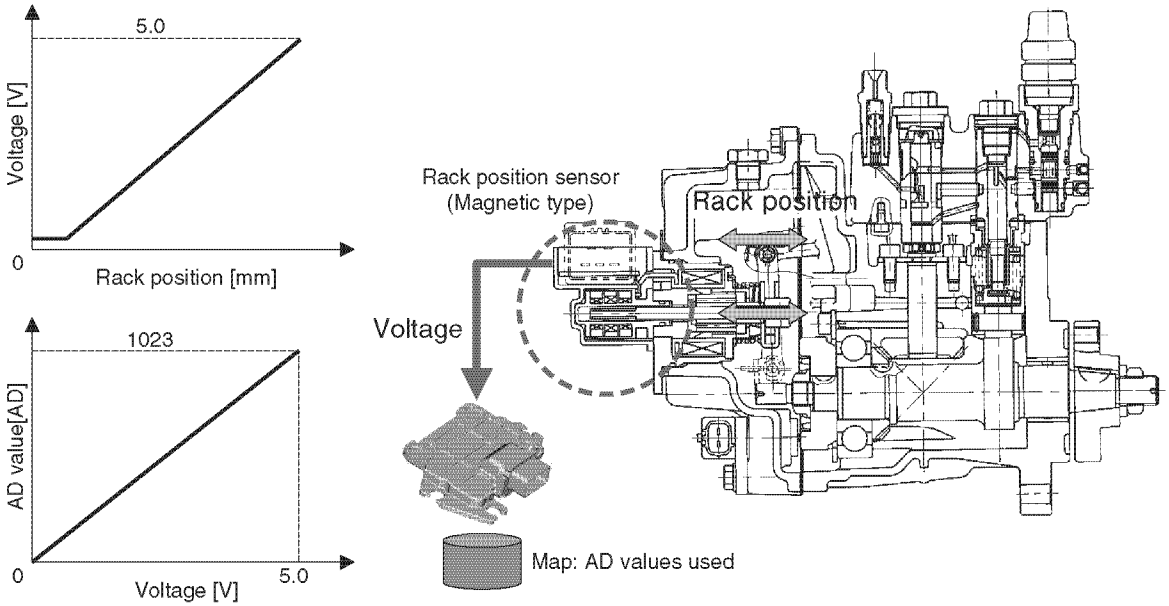


Fig. 14-16 **Detection of rack position**

Coolant temperature sensor input

The input characteristics of the coolant temperature sensor are shown in **Fig. 14-17** below. As in the case of the rack position sensor, the input voltage of 0 to 5 volt is converted into an AD value of 0 to 1023. As is clear from the figure, the thermistor resistance decreases with increasing temperatures. The measurement error of the coolant temperature sensor (129927-44900) newly adopted in the Gen2 Eco-governor is approximately ±3°C at 0°C, ±2°C at 20°C, and ±2°C at 110°C. Therefore, the conventional coolant temperature switch (121250-44901, etc.) is not featured in the Gen2 Eco-governor specification TNV as a standard coolant temperature high alarm function. The E-ECU coverts the input voltage into temperature by mapping. Connecting a thermistor with different characteristics to the sensor or connecting an unintended load to the thermistor circuit will affect the relationship between input voltage and temperature, resulting in failure to perform correct temperature measurement. Do not connect a coolant temperature sensor other than the Yanmar genuine sensor to terminal RET (E16 – E28) of the E-ECU.

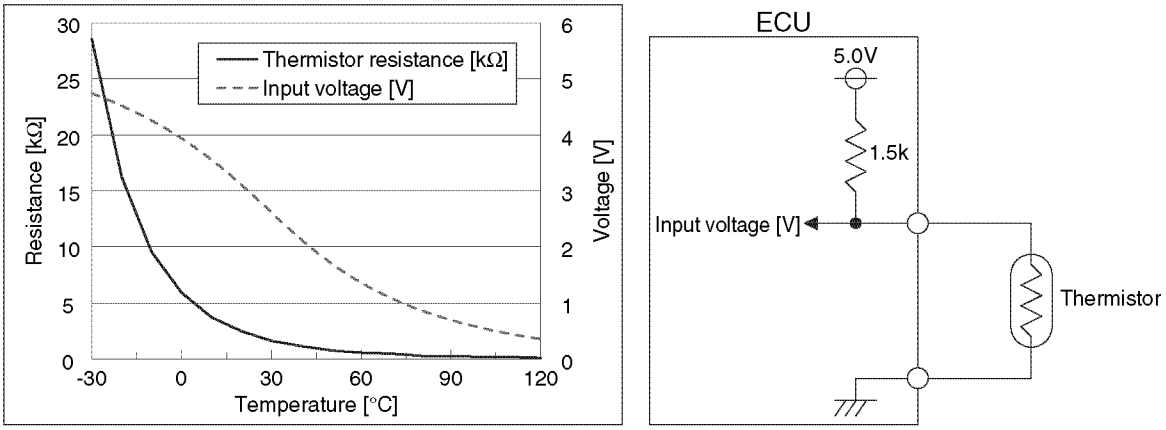


Fig. 14-17 **Characteristics of the coolant temperature sensor**

Accelerator sensor input

The Eco-governor uses the input voltage from the accelerator sensor or the input value through CAN communication to calculate the target engine speed, which is to become the standard of control. (The actual engine speed is decided by the relationship between maximum engine torque and load torque, so it doesnít necessarily match the target engine speed)

The input voltage from the accelerator sensor is converted into a speed value between the low idling speed and the high idling speed. See **Fig. 14-18**. By default, 0.7 V signal is converted into the low idling speed and 3.0V signal into the high idling speed. Input voltages corresponding to the low and high idling speeds can be adjusted in the range where the later described accelerator sensor failure cannot be detected.The input voltages can also be selected so that the gradient of the input voltage line segment between the high and low idling speed points is reversed.

See "Application interface outline" for details on accelerator sensor setting.

If the input voltage from the accelerator sensor is lower than 0.2 V or higher than 4.6 V, the E-ECU detects an accelerator sensor failure.

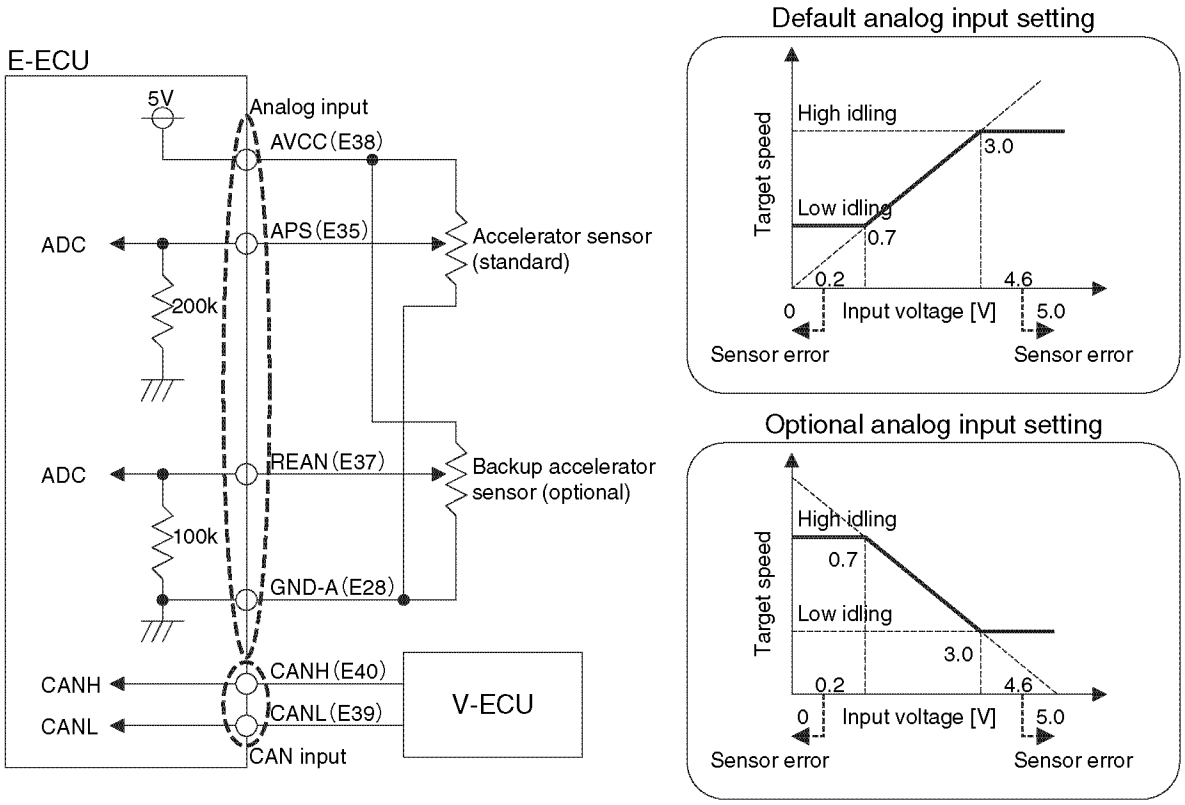


Fig. 14-18 **Accelerator sensor input**

The E-ECU has detection error on the electrical circuit and hysteresis characteristics on the software for the input voltage from the accelerator sensor. The total of these is 0.125 V. When the accelerator sensor voltage is used in default setting (0.7 - 3.0 V), voltage from the accelerator sensor must be in the range of **Fig. 14-19** at least.

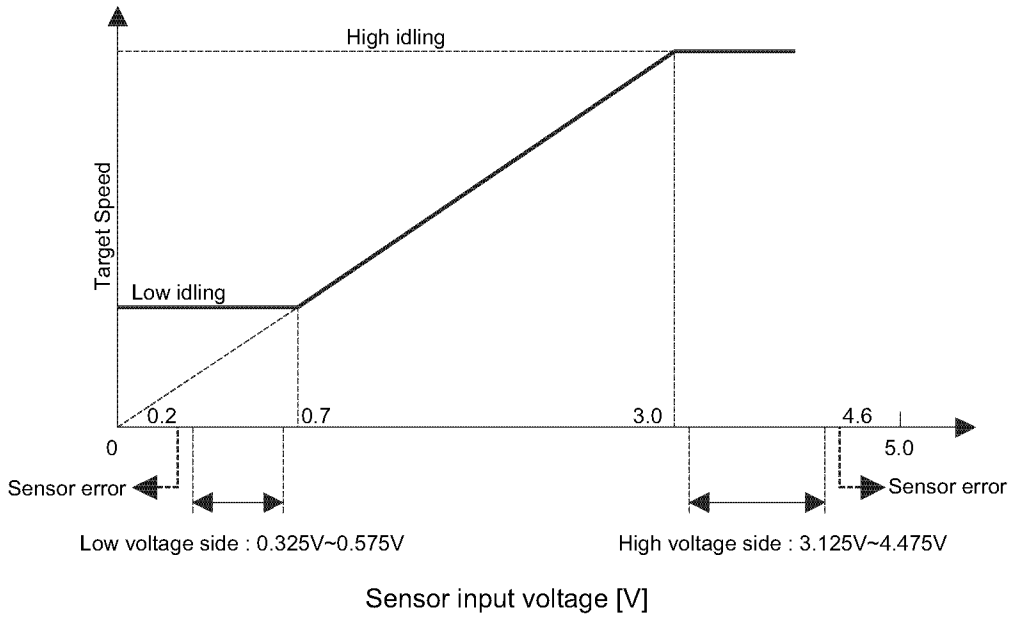


Fig. 14-19 **Request accuracy of accelerator sensor**

Contact input

There are two schemes for contact input of the E-ECU: high-side input and low-side input. See **Fig. 14-20**. The contact input of the Eco-governor E-ECU has been designed with the same sink current and source current of 1.0 mA typ. See **Fig. 14-10** and **Table 14-2** for the details of the Eco-governor E-ECU contact input circuit specifications.

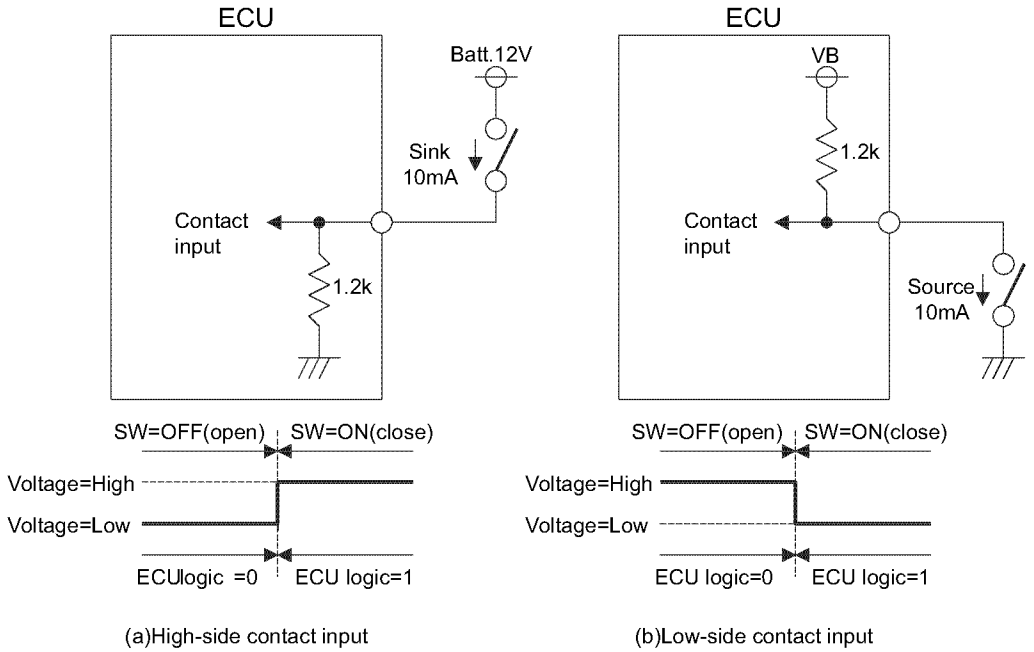


Fig. 14-20 **Contact input schemes and input logics**

There are two types of switch contacts connected to contact inputs: Normally open (NO) contact and normally closed (NC) contact.

Fig. 14-21 illustrates the voltage levels at the input terminal for the high-side contact input. When the switch turns on, the input terminal goes high for the switch with NO contact and goes low for the switch with NC contact.

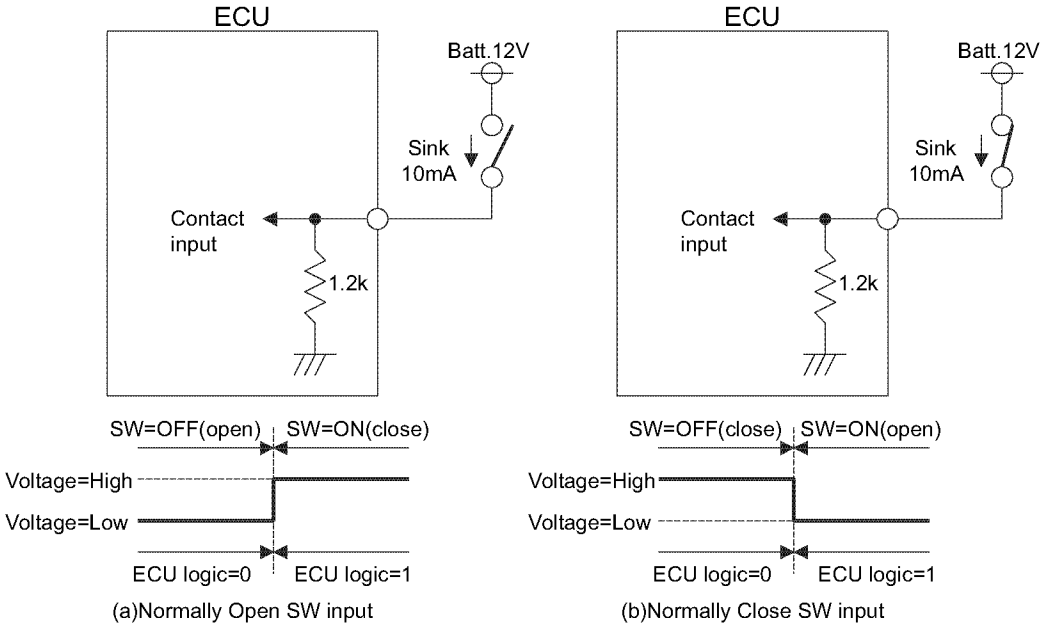


Fig. 14-21 **Switches for high-side contact input**

Fig. 14-22 illustrates the voltage levels at the input terminal for the low-side contact input. When the switch turns on, the input terminal goes low for the switch with NO contact and goes high for the switch with NC contact.

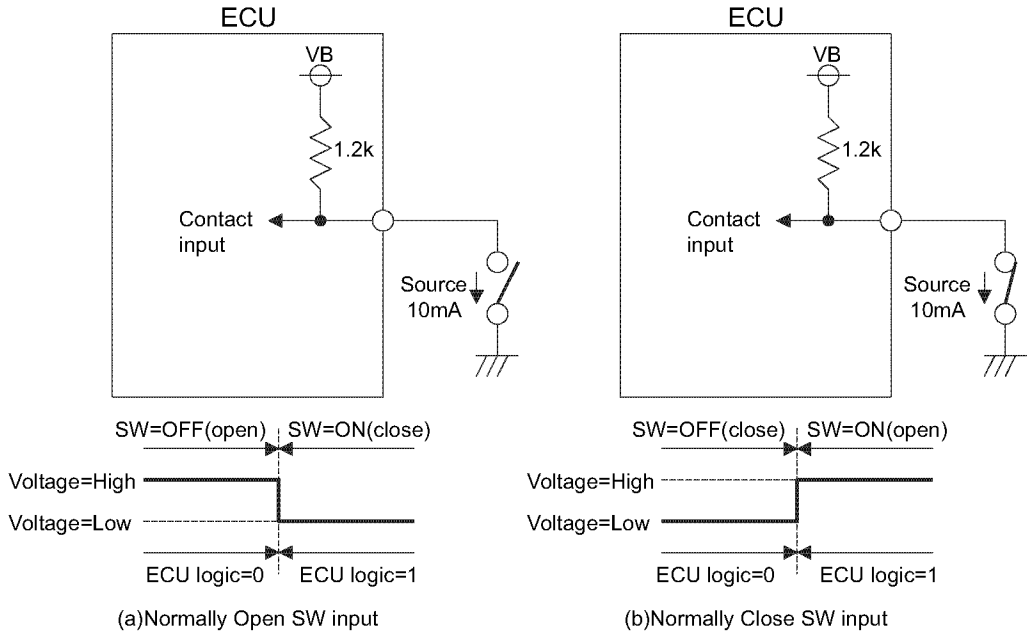


Fig. 14-22 **Switches for low-side contact input**

Unless otherwise specified, this manual assumes that switches with NO contact are used. This means that turning on the switch activates the corresponding function.

Selection of NO switch or NC switch is allowed by using mapping plug-ins. **Table 14-17** lists contact input terminals for which a NO or NC switch can be selected.

Contact output

There are two schemes for contact output of the E-ECU: high-side output and low-side output. See **Fig. 14-23**. See **Fig. 14-10** and **Table 14-2** for the details of the Eco-governor E-ECU contact output's sink/source and allowable current.

In this manual, output transistor ON is referred to as logical "1" and output transistor OFF as logical "0". In the high-side output scheme, the output terminal goes high when the transistor turns off. In the low-side output scheme, the output terminal goes low when the transistor turns off.

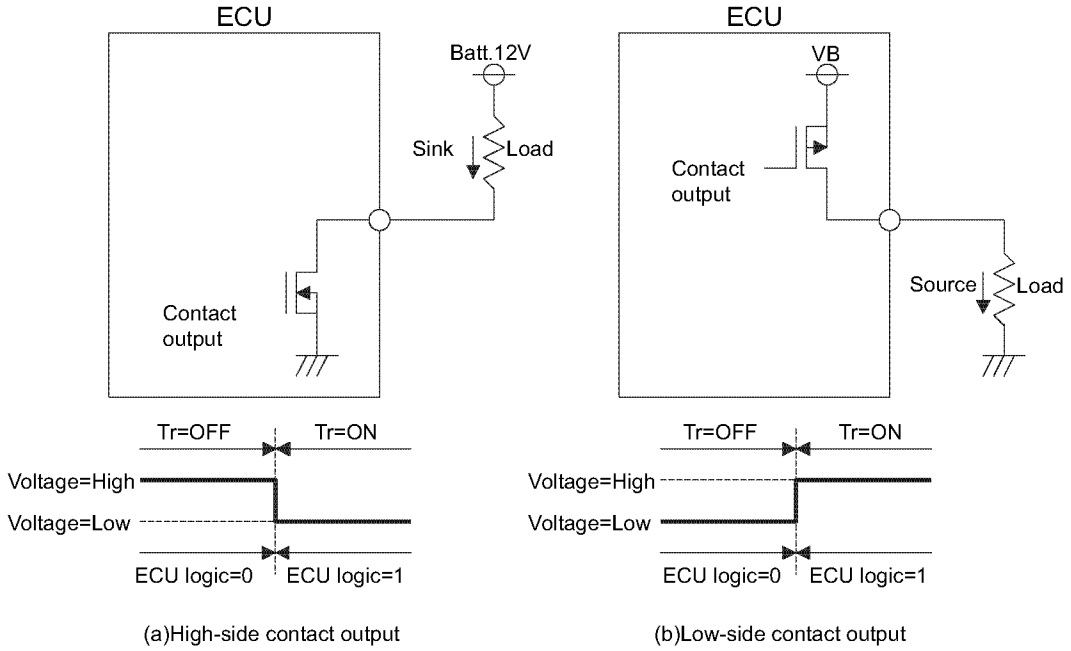


Fig. 14-23 **Contact output schemes and output logics**

Rack actuator output

The rack actuator output is a high side output as shown in **Fig. 14-24**.

The E-ECU adjust the magnitude of current flowing through the rack actuator solenoid by shortening or lengthening the ON-duration of the output transistor. The rack position of the fuel injection pump varies depending on the magnitude of current flowing through the rack actuator.

This technique where the ON duration of the transistor is changed to provide current control is called PWM (Pulse Width Modulation).

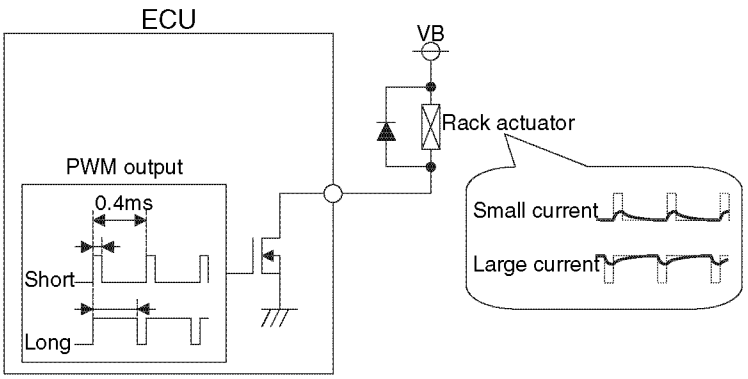


Fig. 14-24 **Rack actuator output**

EGR valve output

The EGR valve output is a high-side output as shown in **Fig. 14-25**.

The EGR valve is driven by a stepping motor. This stepping motor adopts two-phase excitation and requires holding current to keep the valve stopped. "Two-phase excitation" means that the solenoid is supplied with two-phase current and "holding current" does that the solenoid is always energized. The motor of the EGR valve is consequently approx. 24 watt (12 watt x 2 phase) heated even while the engine is at rest be warned that touching it could burn you.

The E-ECU turns on or off the output transistors in the sequence shown in **Fig. 14-25**, thereby driving the solenoids for the stepping motor and opening/closing the EGR valve.

In the EGR valve, the full-close position is 0 step and the full-open position is 54 steps.

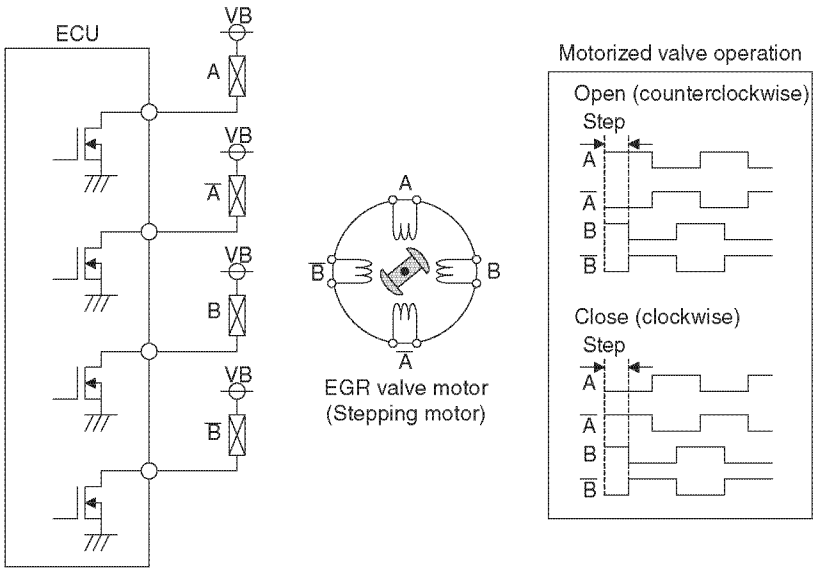


Fig. 14-25 **EGR valve driving mechanism**

Engine control - General

Self-holding of the E-ECU power

The E-ECU saves engine logs including faults and running hours in the internal EEPROM. And it has a power self-holding feature that allows the power supply to be held until the engine logs are completely saved in EEPROM.

In the E-ECU, the EGR valve is moved to the full-close condition at engine stop to ensure starting the engine start sequence from the full-close condition. Therefore, the power self-holding feature holds the power supply until the EGR valve is cutoff completely after the key switch is turned off.

To implement the power self-holding feature, the main relay and the rack actuator relay must be connected as shown in **Fig. 14-4**.

This feature can also be activated through CAN communication. See “CAN communication specifications” for details.

Start control

The engine start sequence is shown in the figure below. The E-ECU performs rack self-diagnostics directly after power on. The rack self-diagnostics checks the rack motion alone without turning on the engine. So, the starter relay prevents the starter motor from starting until the rack self-diagnostics is completed.

Next, when ON-glow control is alive (default), the time of energization of the starting aid relay is adjusted according to the coolant temperature. The preheat lamp should illuminate while ON-glow control is in progress.

After ON-glow control is complete, the E-ECU waits until the key switch is moved to the START position.

When the key switch is moved to START or the engine speed reaches 240 min^{-1}, rack position control on start takes place to move the rack to a predefined position.

Having detected that the engine speed reaches 600 min^{-1}, the E-ECU goes to speed control mode. In this mode, the rack position is controlled so that the engine runs at a speed that matches the speed command from the accelerator.

When the engine speed is reduced to less than 240 min^{-1} or the key switch is turned off, the engine will stop.

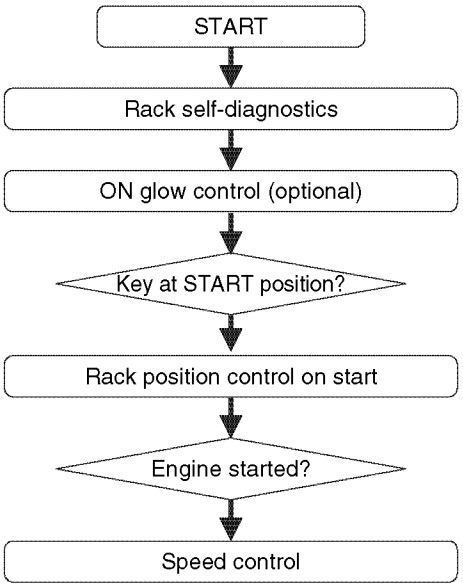


Fig. 14-26 **Start sequence**

Torque curve and engine regulation

Standard engine torque curves are outlined in **Fig. 14-27**, **Fig. 14-28**. The figure is an image. Details of the curves vary depending on the engine models. When the engine load or speed is changed instantaneously, there is some delay until the engine speed is set to the specified regulations.

For the Eco-governor, engine regulations are available in the following variations:

(a) Isochroous
The engine speed is constant, regardless of the load (regulation 0%).

(b) Virtual droop (torque curve of base engine)
Approx. 7% regulation regardless of the engine speed.
The engine speed is kept until a torque equivalent to a load factor of approx. 30% is reached, in order that the idling (non load) speed does not fluctuate even if installation of the engine on a machine causes some power loss.
Even when virtual droop is active, it is possible that the engine speed does not decrease to lower than the low-idling speed. (Optional)

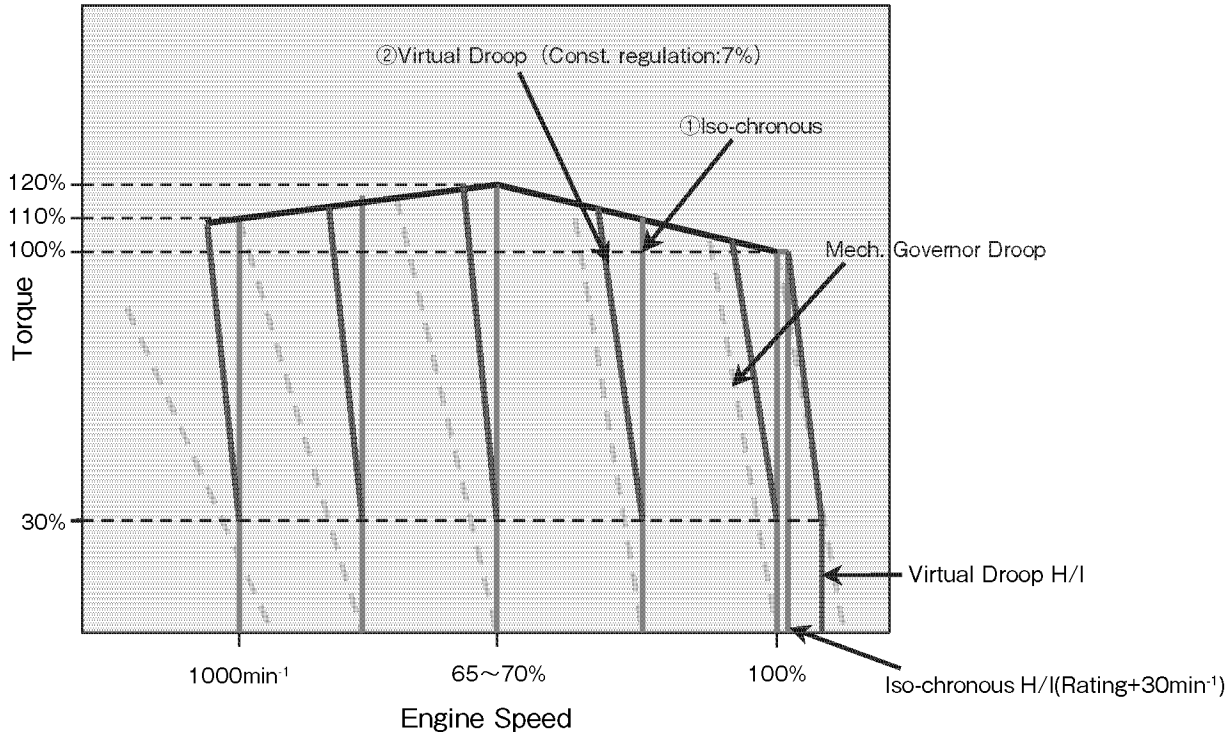


Fig. 14-27 **Standard torque curves (image figure of 4TNV98-E, 4TNV98-Z)**

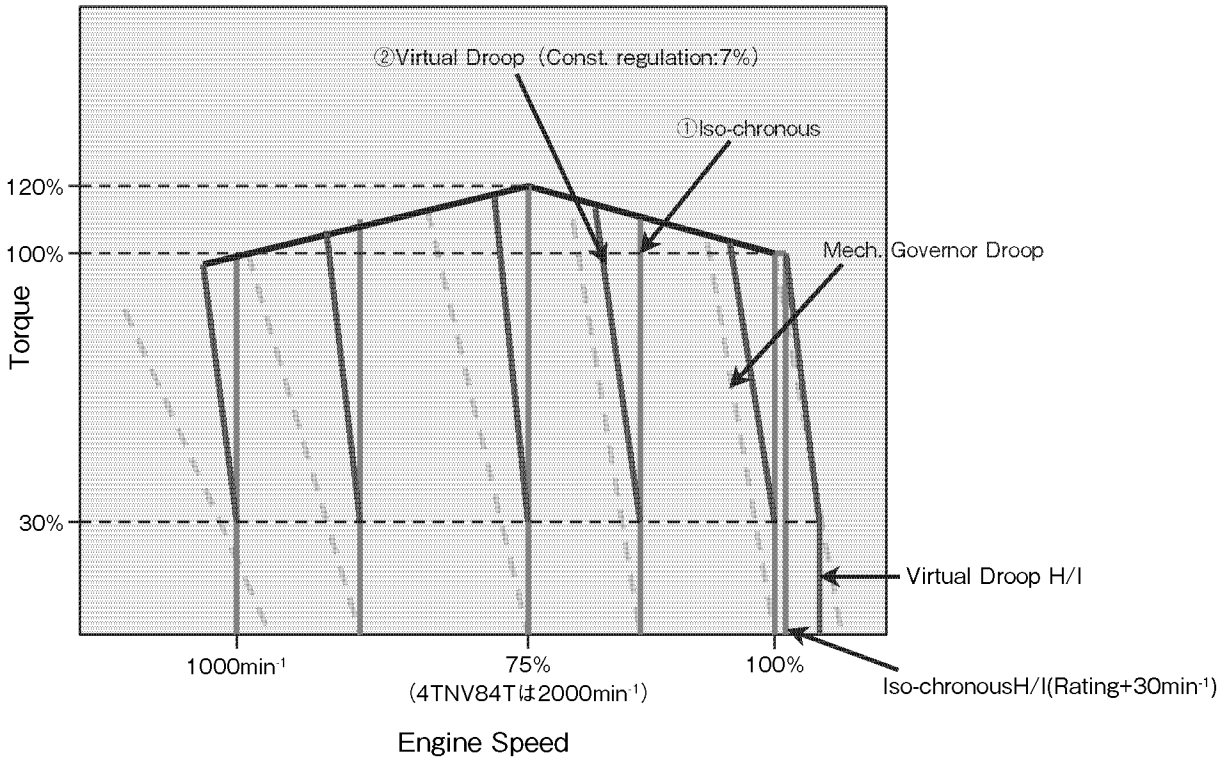


Fig. 14-28 **Standard torque curves (image figure of 4TNV98T, 4TNV84T)**

For the NV2 Eco optional engine, torque curve and engine regulation are set to the same specification as a standard mechanical governor specification engine.

Switching between "isochroous" and "virtual droop" can be done with an external switch or through CAN communication, while the engine is running. Selection of either one as default is allowed on customer's request. Whichever is set as default, the high idle speed on application is the high idle speed at droop.

Switching between "isochroous" and "virtual droop" can be done even while the engine is running. Switching between "isochroous" and "virtual droop" while the engine is running can change the engine speed.

The Isochroous-Virtual droop switching by external switch connection diagram is shown in **Fig. 14-29**.

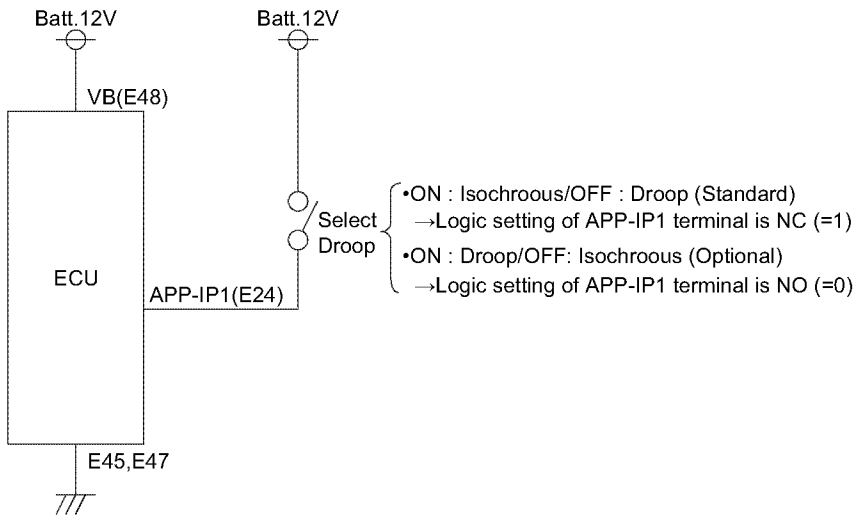


Fig. 14-29 **Isochroous-Droop switching and reverse droop enabling/disabling connection**

Note: We cannot accept an order for the change of torque curves.

Speed control

The target engine speed is defined by input signals from the accelerator sensor or through CAN communication. **Fig. 14-30** shows the flow of defining the target engine speed. Elements and optional settings in the flow will be described later.

The accelerator input selection feature allows certain accelerator sensors to be selected as input source among others depending on the setting and status of accelerator sensors. (See *14-48* for details).

The engine speed selection feature allows the target speed to be changed depending on the status of external switches APP-IP3/IP4/IP6. (See *14-56* for details).

The idling speed up feature allows the low idling speed of the engine to be raised depending on the coolant temperature. (See *14-64* for details).

The blue and white smoke suppression feature allows the high idling speed of the engine to be reduced depending on the coolant temperature. (See *14-65* for details).

The governor control feature calculates the target engine speed for virtual droop. (See *14-41* for details).

The accelerator filter suppresses fluctuations in target engine speed, minimizing overshoot or undershoot. (See *14-66* for details).

The low/high idling speed limiting feature checks if the target engine speed is in the range of the low idling speed to the high idling speed and adjusts it if required.

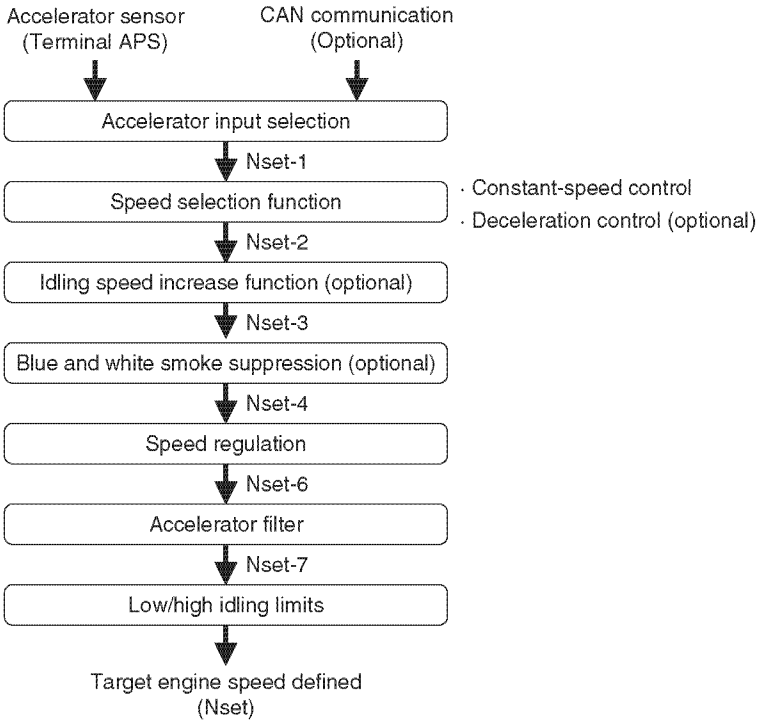


Fig. 14-30 **Flow of defining the target engine speed**

Fig. 14-31 shows the engine speed control block diagram.

[Speed control]

The deviation of the actual engine speed (Nrpm) from the target engine speed (Nset) is used to determine the target rack position (Rset) with PID control. The target rack position is the basis for providing torque limitation or rack motion delay adjustment for transition control (described later).

[Rack position control]

The deviation of the actual rack position (Ract) from the target rack position (Rset) is used to determine the target current (Iset) with PID control. To check that the control system of the Eco-governor works properly, use the engine diagnosis tool to make sure that Ract is approximately equal to Rset while the engine is running.

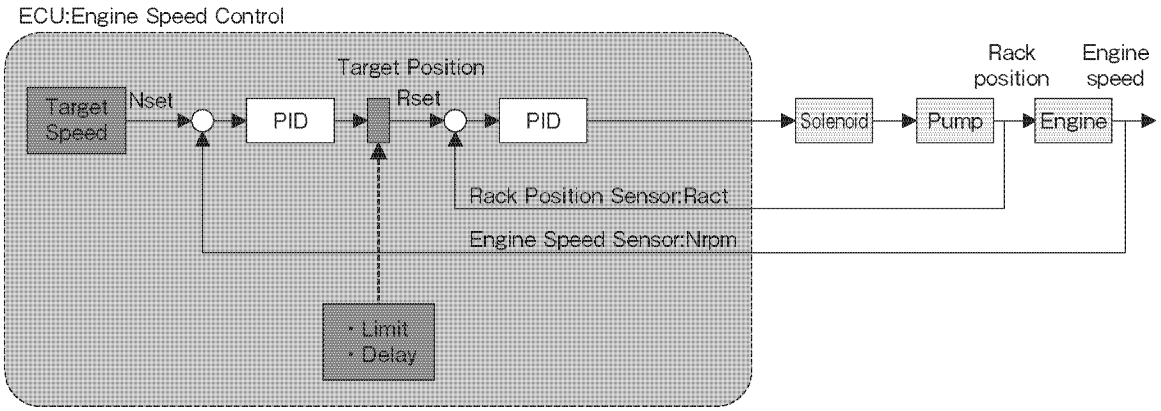


Fig. 14-31 **Engine speed control block diagram**

Transition control

The Eco-governor delays the rack motion at engine start or during acceleration in order to minimize the emission of black smoke. See **Fig. 14-32**. Surplus fuel injection control during acceleration is adopted only in the supercharged engines.

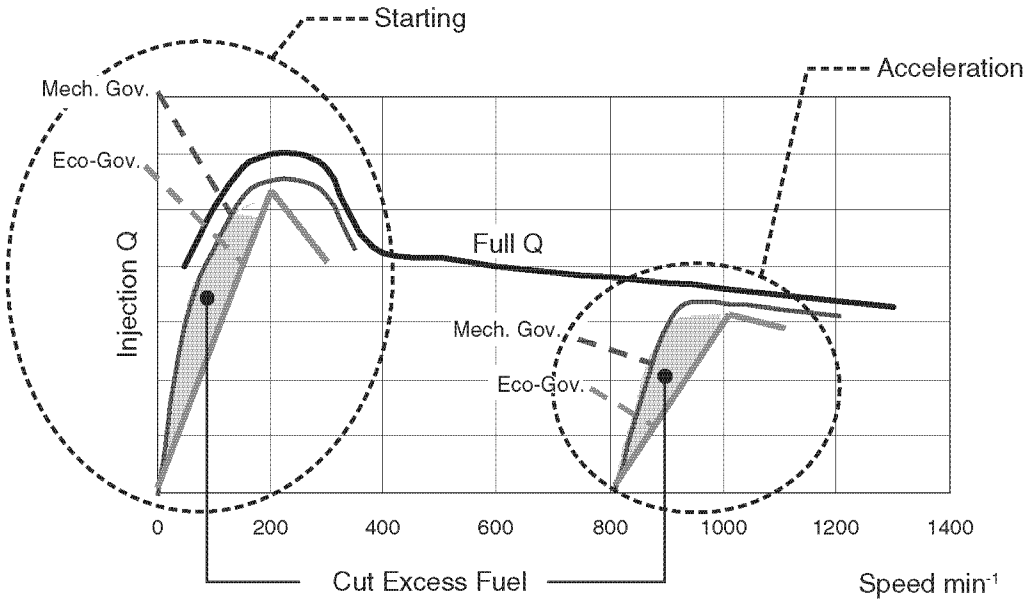


Fig. 14-32 **Transition control**

EGR control

The Eco-governor uses an electronic-controlled EGR valve to reduce the emission of NOx from the rated power 37 kW or more engines.

The EGR valve is driven by a stepping motor. The opening (0 ~ 54 steps) of the EGR valve is adjusted depending on the engine speed and load factor so as to control recirculation of exhaust gas. **Fig. 14-33** outlines the relationship between the number of steps and the flow rate.

The EGR valve does not open when the coolant temperature is lower than 60°C. This is because low temperature corrosion due to condensation of exhaust gas components must be prevented.

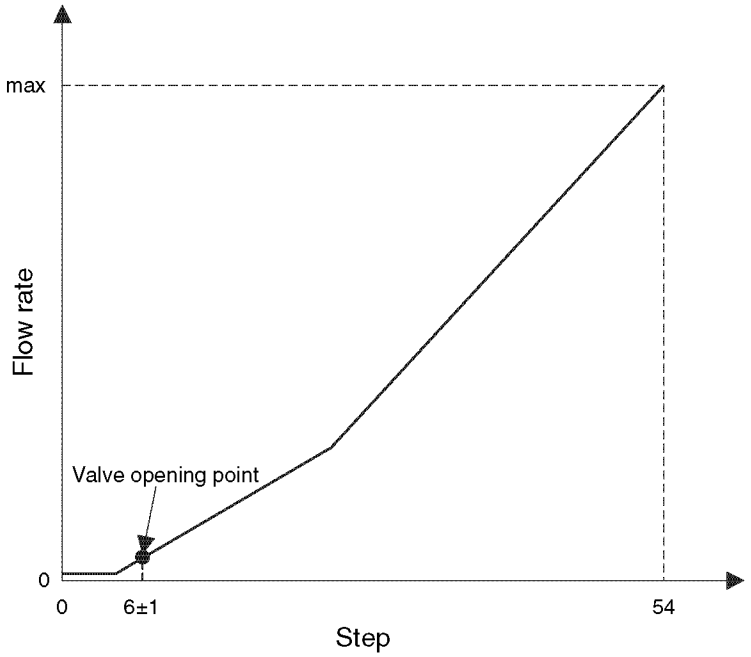


Fig. 14-33 **EGR valve characteristics**

CSD control

The fuel injection pump (MP pump) has a CSD valve mechanism that allows the fuel injection timing to advance, thereby improving the cold start performance of the engine.

The Eco-governor has a solenoid valve CSD where the CSD can be opened or closed with a solenoid. The E-ECU opens the CSD valve when the coolant temperature sensor detects that the coolant temperature is 5°C or lower in case of the NV2 engine and 10°C or lower in case of the NV3 engine at cold start. The CSD stops when the coolant temperature is 5°C or higher in case of the NV2 engine and 10°C or higher in case of the NV3, or five minutes have elapsed. Once the CSD is stopped from the actuation state, it doesn't re-actuate until the temperature is reduced by 5°C from the above-mentioned actuation stop temperature.

In the Eco-governor, the engine speed is increased 50min^{-1} in case of the NV2 engine and 75min^{-1} in case of the NV3 engine during CSD actuation in order to check the CSD actuation.However, the high idling speed isn't exceeded during CSD actuation. After the completion of CSD actuation, the engine speed is automatically reduced to the normal speed.

When the idling speed up feature (described later) is used, the added value of the idling speed up speed increase and the CSD actuation speed increase to the speed command from the accelerator become the target speed.

Target speed = speed command from the accelerator + idling speed up speed increase + the CSD actuation speed increase. The CSD control action is summarized in **Table 14-8**.

Table 14-8 CSD control action

	CSD actuation stop temperature	CSD actuation maximum time	CSD actuation speed increase
NV2 engine	5°C or lower	5 minutes	$50min^{-1}$
NV3 engine	10°C or lower	5 minutes	$75min^{-1}$

Calculation of load factor

The load factor of the engine is determined as a percentage from the rack position at idling (Ridl), maximum rack position (Rmax), minimum rack position (Rmin) and actual rack position relative to Rmin (Ract). See **Fig. 14-34**.

The calculated load factor is delivered as a PWM signal from an E-ECU terminal or through CAN communication.

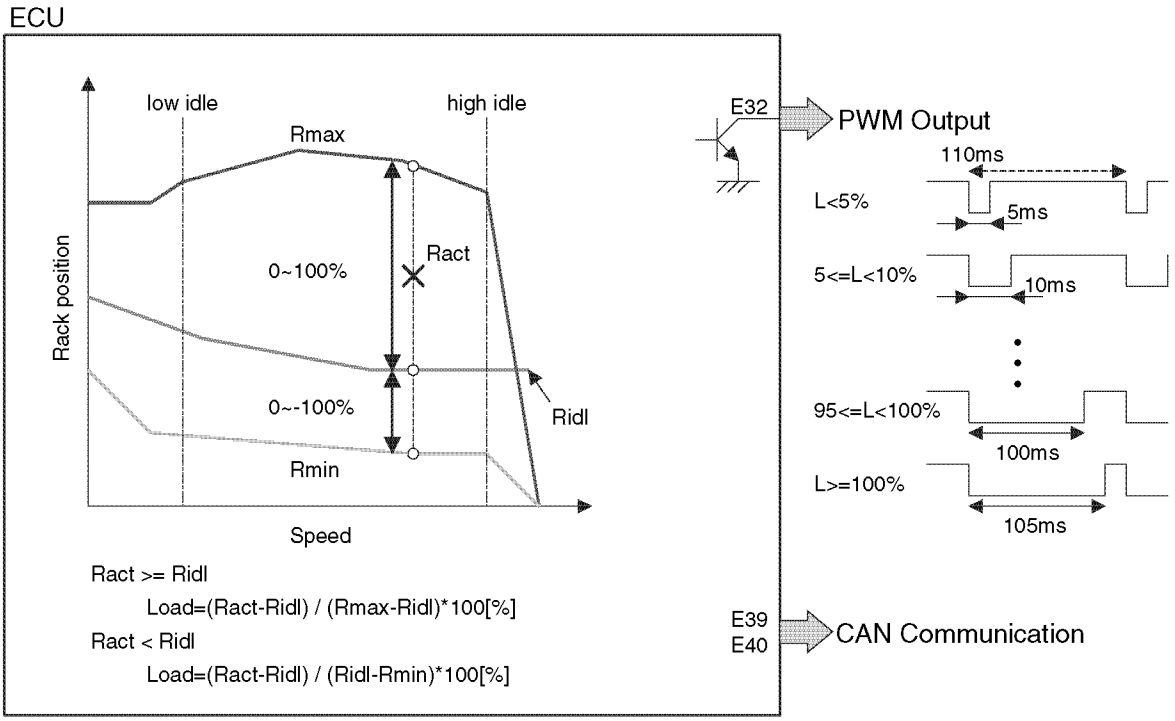


Fig. 14-34 **Detection of load factor**

Application interface outline

Droop selection feature (switching droop-isochroous control)

The Eco-governor can switch the Isochroous control and the virtual droop control by external switch. By default, when external switch is not connected (when ECUterminal APP-IP1 [E24] is open), it is set that it becomes the virtual droop control.By option, changing the logic setting of APP-IP1 terminal enables the isochroous control to be set when external switch isn't connected.See **Fig. 14-29** for details.

Isochroous control at low idling

As shown in **Fig. 14-35**, it's possible to make the engine speed (target speed) not go below the low idling speed even when virtual droop is selected. (Optional)

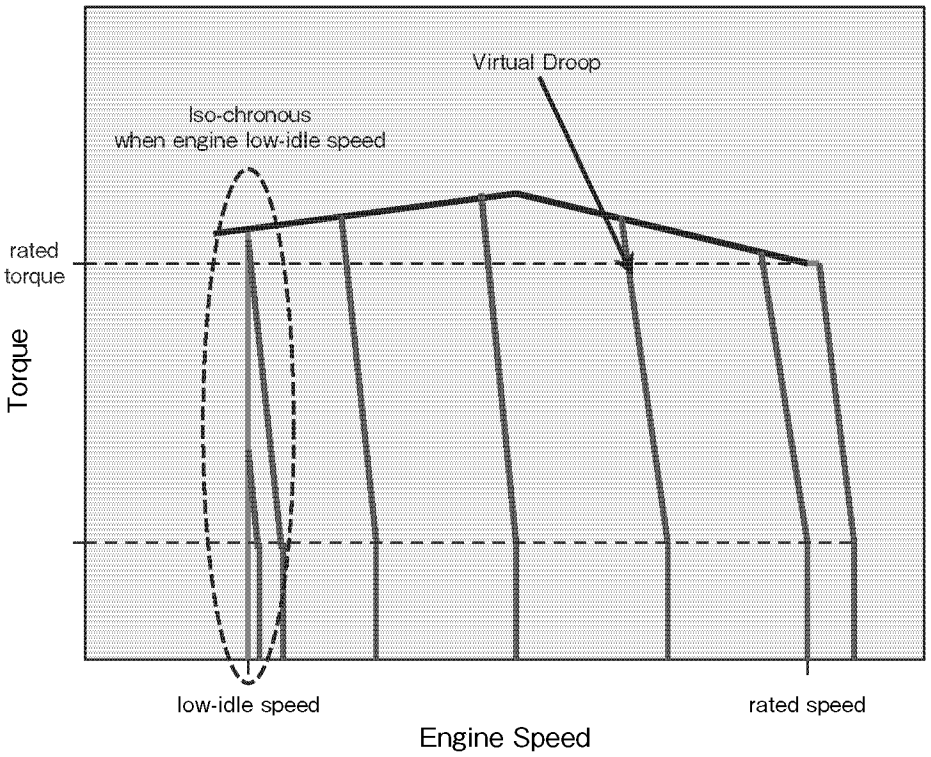


Fig. 14-35 **Isochroous control at low idling**

Accelerator input selection

Accelerator sensors are available in three types: standard (analog voltage), backup (analog voltage) and CAN communication (communication command) types. See **Fig. 14-18**. Using accelerator sensor setting flags allows combined use of these sensors.

In standard mapping (1), the main accelerator sensor is solely used. In generator standard mapping (O), selecting a contact input can switch the engine speed without the use of accelerator sensors.

In option mapping (2), a higher speed setting is selected from the main accelerator sensor input and the backup sensor input. If one of the two sensors fails, the other is used to control the engine speed.

In option mapping (3), the engine target speed is commanded via CAN communication.

In option mapping (4), the engine target speed is commanded via CAN communication, and if CAN communication fails, the main accelerator sensor input is used for engine speed control.

In option mapping (6), the lastly used speed setting is selected from the main accelerator sensor input and the backup sensor input.
Initially, the main accelerator sensor is prioritized. If one of the two sensors fails, the other is used to control the engine speed.

When an accelerator sensor failure is detected while the engine is running, either (1) a value immediately before the failure is used for engine speed control, or (2) a value set in the accelerator sensor failure flag is used for engine speed control, can be selected.

1. A value immediately before the failure is used for engine speed control (standard)
   When an accelerator sensor fails while the engine is running, a value immediately before the failure is used for engine speed control. When an accelerator sensor fails while the engine is at rest, a value set in the accelerator sensor failure flag is used for engine speed control.

Note: When an accelerator sensor fails due to the gradual change of the accelerator sensor value to the acceleration side, there are cases in which the target speed is held at the high idling speed.Oppositely, when an accelerator sensor fails due to the gradual change of the accelerator sensor value to the deceleration side, there are cases in which the target speed is held at the low idling speed.

2. The engine runs at a speed determined by the accelerator sensor failure flag (optional).
   The engine always runs at a speed determined by the accelerator sensor failure flag. When an accelerator fails while the engine is running, the engine target speed changes until the speed setting at the rate of $100min^{-1}/s$ (default is $1500min^{-1}$ but it can be changed optionally).

Note: Depending on the operation conditions, an accelerator sensor failure may cause the engine to accelerate. Because the speed setting is a target speed, the actual speed is decided by the load factor of the engine.

The speed determined as an accelerator sensor failure flag can be selected from (1) low idling, (2) $1500min^{-1}$(standard), (3) $1800min^{-1}$, and (4) engine stop.

Table 14-9 Accelerator sensor setting flags

Map setting	Main Accelerator sensor APS (E35)	Reserve Accelerator sensor REAN (E37)	CAN input (E39, E40)	Priority operation
0 (Generator standard)	×	×	×	By the following contact input • APP-IP6 (E6) • APP-IP3 (E9) • APP-IP4 (E17)
1 (Standard)	○	×	×	-
2	○	○	×	• Priority in the high-speed side sensor • Priority in the normal operation sensor
3	×	×	○	-
4	○	×	○	Priority in the CAN input
6	○	○	×	• Priority in the lastly used sensor (initially main) • Priority in the normal operation sensor

The accelerator position sensor input (APS: E35) and the backup analog sensor input (REAN: E37) can be flagged so that the corresponding sensor types are changed. See **Table 14-10**. These inputs have been flagged so that accelerator sensor signals (flag setting: 1) and foot pedal signals per SAE J1843 (flag setting: 2 - 4) can be applied.

When these inputs are open, they must be flagged to 0 to disable sensor failure detection.

Table 14-10 Analog input assignment

ECU terminal setting flag		Connection sensor type
APS: E35	REAN: E37	
0(Generator standard)	0(Standard)	No connection (failure detection disabled)
1(Standard)	1	Normal accelerator sensor
2	2	Foot pedal (SAE J1843 configuration) Analog + APP-IP2: NO & APP-IP7:NC)
3	3	Foot pedal (SAE J1843 configuration) Analog + APP-IP2: NO
4	4	Foot pedal (SAE J1843 configuration) Analog + APP-IP7: NC
-	5	(reserve)

To connect the accelerator position sensor input (APS: E35) and the backup analog sensor input (REAN: E7) to the foot pedal (flag setting: 2 - 4), APP-IP2: E14 and APP-IP7: E13 must be configured to enable reception of signals from the foot pedal switch. In addition, APP-IP2: E14 and APP-IP7: E13 must be configured to enable connection with an NO switch and NC switch respectively. Åi(Set APP-IP2 to NO and APP-IP7 to NC. See **Table 14-17**).

[Example]

- When ECU terminal setting flag setting = 2, set APP-IP2 to NO and APP-IP7 to NC.
- When ECU terminal setting flag setting = 3, set APP-IP2 to NO.
- When ECU terminal setting flag setting = 4, set APP-IP7 to NC.

When the foot pedal connection is selected, it's recommended that you set the low idling voltage and the high idling voltage of ASP terminal and REAN terminal to 1.0 V and 3.5 V.

Fig. 14-36 shows the foot pedal operation and engine speed. When the flag is set to 2, the input voltage at APS terminal or REAN terminal is effective only when APP-IP2: NO is low and APP-IP7: NC is high. Otherwise, the engine runs at the voltage input of 0.83 V (when the recommended setting is selected, the engine runs at the low idling speed).

When the flag is set to 3, the input voltage at APS terminal or REAN terminal is effective only when APP-IP2: NO is low. Otherwise, the engine runs at the voltage input of 0.83 V (when the recommended setting is selected, the engine runs at the low idling speed).

When the flag is set to 4, the input voltage at APS terminal or REAN terminal is effective only when APP-IP7: NC is high. Otherwise, the engine runs at the voltage input of 0.83 V (when the recommended setting is selected, the engine runs at the low idling speed).

When 2 foot pedals are connected, it's necessary to set that APS and REAN donít require the same foot pedal switch.

[Example]

- APS: E35 for 3 (APP-IP2 pedal switch), REAN: E37 for 4 (APP-IP7 pedal switch)
- APS: E35 for 4 (APP-IP7 pedal switch), REAN: E37 for 3 (APP-IP2 pedal switch)

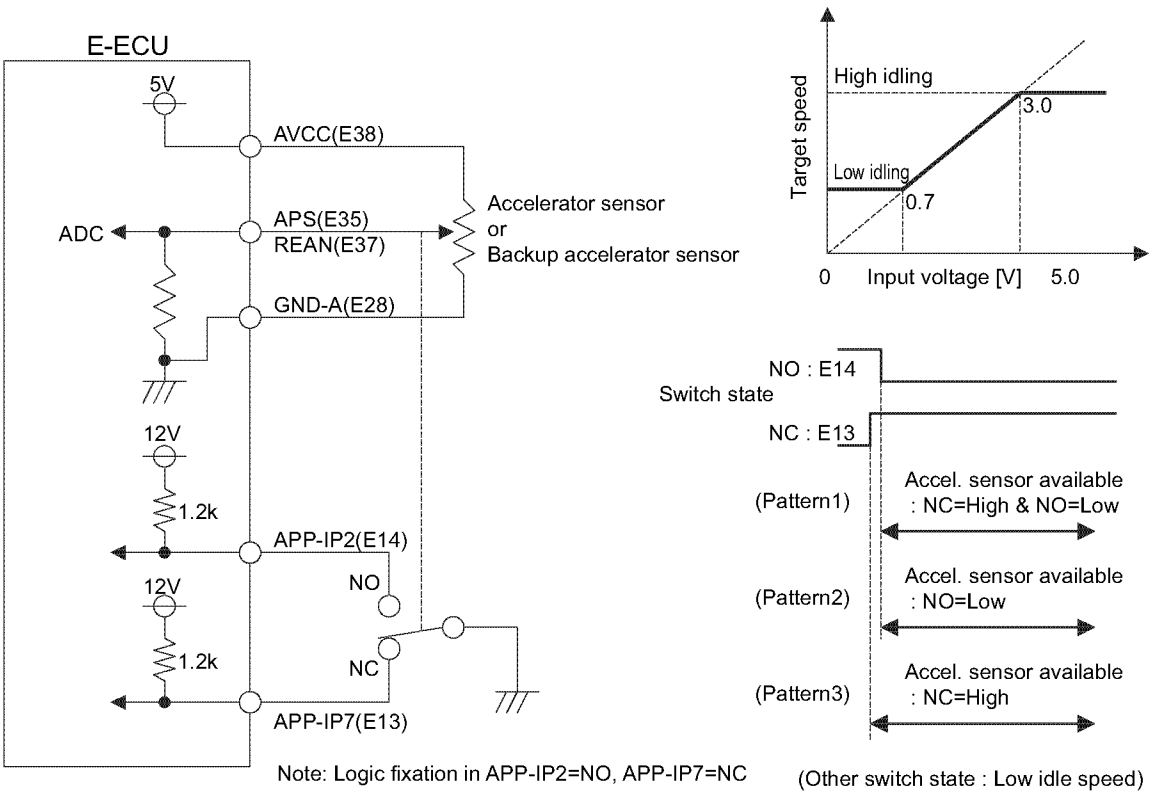


Fig. 14-36 **Operation of foot pedal**

Fig. 14-37 shows the foot pedal failure detection scheme. When either of the following is approved, the sensor fails.

The E-ECU has an error of ±0.125 V for the following detection voltage.Therefore, be noted that the pedal switch must switch in between 0.775 V and 0.975 V.
The operation while the sensor failure is in detection is same as the normal accelerator sensor.
When the foot pedal is selected, interrupting the E-ECU power supply by turning off the key switch is

required to meet the cancellation condition of sensor failure.In case of the normal acceleration sensor, the sensor failure is automatically cancelled when the sensor signal is returned to normal.

- As in the case of the acceleration sensor, when the input voltage reaches below 0.2V or above4.6 V, the sensor failure is detected
- When APP-IP2: NO becomes high or APP-IP7: NC becomes low and the input voltage is above1.1 V, the sensor failure is detected.(depending on the status of the active switch when the flag is set to3 or 4).
- When APP-IP2: NO becomes low or APP-IP7: NC becomes high and the input voltage is above0.65 V, the sensor failure is detected.(depending on the status of the active switch when the flag is set to3 or 4).

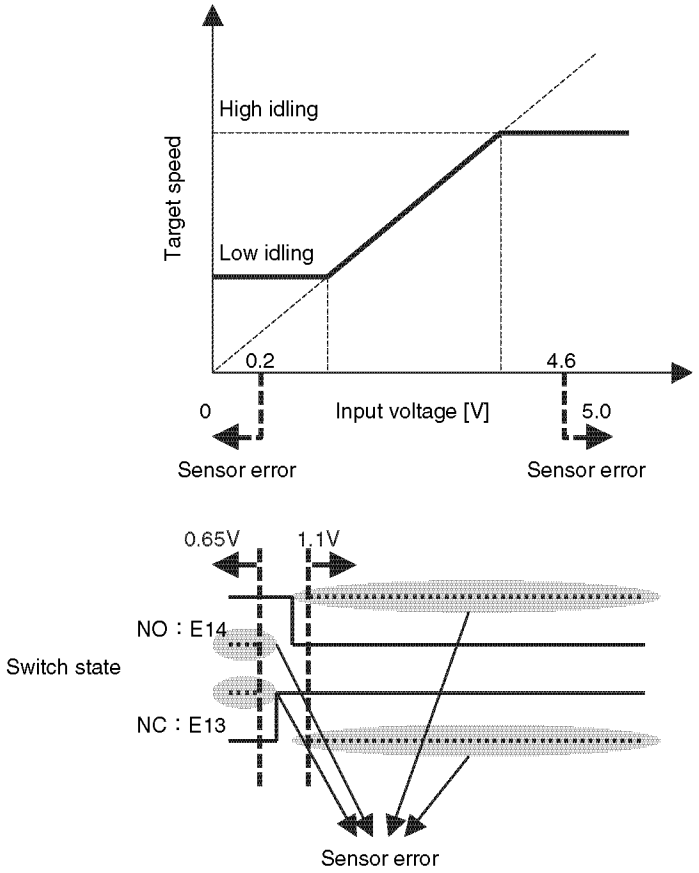


Fig. 14-37 **Failure detection of foot pedal**

Starting aid

Using a standard starting aid relay allows the starting aid (air heater or glow plug) to be controlled as follows. The starting aid relay permits the E-ECU to check for disconnection or short-circuit. (Standard)

1. ON-glow control (standard feature)
   When the key switch is moved to the "ON" position, the starting aid relay is automatically energized for a duration that depends on the coolant temperature. The preheat lamp can be on during energization. (The same feature as QHS controller 129457-77900. QGS controller 119650-77900 has a two-stage temperature control feature).
   The preheat time for ON-glow control differs for an air heater and a glow plug used as the starting aid. See **Fig. 14-38**.
2. Simultaneous energization (standard feature)
   This feature allows energizing the starting aid relay while energizing the starter when the key switch is in the START position, facilitating cold start. (This feature is the same as provided by QHS controller 129457-77900 and QGS controller 119650-77900).
   When the voltage at the power supply terminal of the E-ECU decreases to 6.5 V, the starting aid relay is de-energized to prevent the E-ECU from being reset due to "supply voltage low" (the E-ECU is reset when the supply voltage lowers to 6.0 V).
   For reduction of the battery power consumption and voltage drop control of the starter in use, it's possible to make the starting aid relay de-energized, but in this case the cold start check with installation of the engine on a machine is requested.
3. After heating (optional feature)
   This feature allows the starting aid relay to be energized for 80 seconds after engine start or as long as the coolant temperature is lower than 10½C, thereby reducing the time required for self-extinguishing of blue and white smoke. (This feature is the same as provided by QHS controller 129457-77900 except for temperature and time settings. QGS controller 119650-77900 has no after glow feature).
   The after heating feature is disabled by default to avoid a heavy burden on the battery. Use this feature in due consideration to the battery charging/discharging cycle.

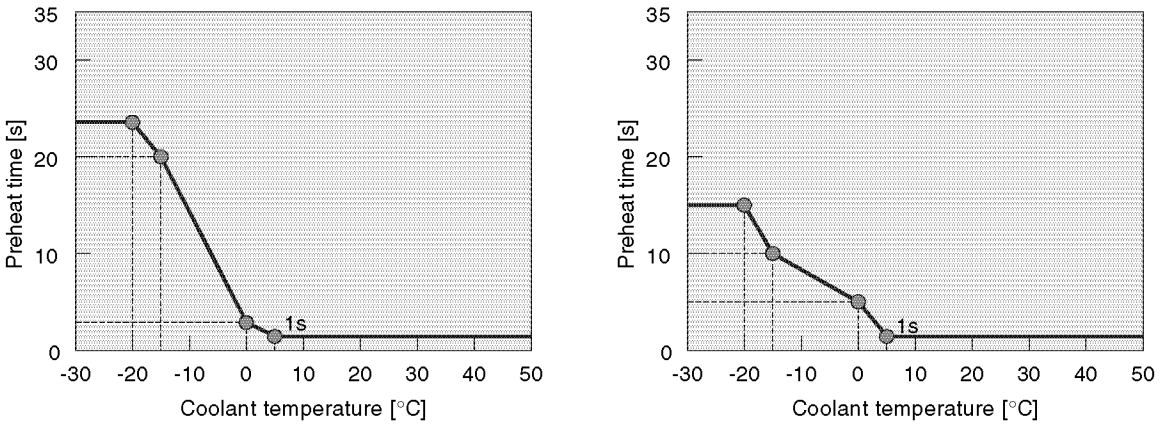


Fig. 14-38 **Preheat time for ON-glow control**

Note When the key switch with a ìglowî position is used in the standard connection diagram, preheat lamp is illuminated for a duration that depends on the coolant temperature, and the starting aid is automatically energized at the same time.
However, when the key switch is moved from the OFF position to the ON position to start the engine after the completion of preheat, preheat lamp is illuminated again. Be noted that it's not necessary to preheat again at this time.

Starter motor start prevention

When the key switch is turned on, the Eco-governor performs rack self-diagnostics before starting the engine in order to check the fuel injection pump rack operation. Starter motor staring prevention can be implemented by connecting a starter relay to the E-ECU. As shown in **Fig. 14-39**, the starter motor start prevention is done by connecting the E-ECU to the starter relay.

The starter motor start prevention factor is checked by connecting the engine diagnosis tool to see the prevention factor flag. (**Table 14-28** (Reference))

In addition to rack self-diagnostics, the E-ECU has the following features:

1. Safety relay (standard feature)
   This feature turns the starter off when the engine speed reaches 675 min^{-1}, and disables the starter to start until the engine speed decreases to 325 min^{-1} or less. (This feature is the same as provided by 119802-77200 when the pulley ratio is 2).

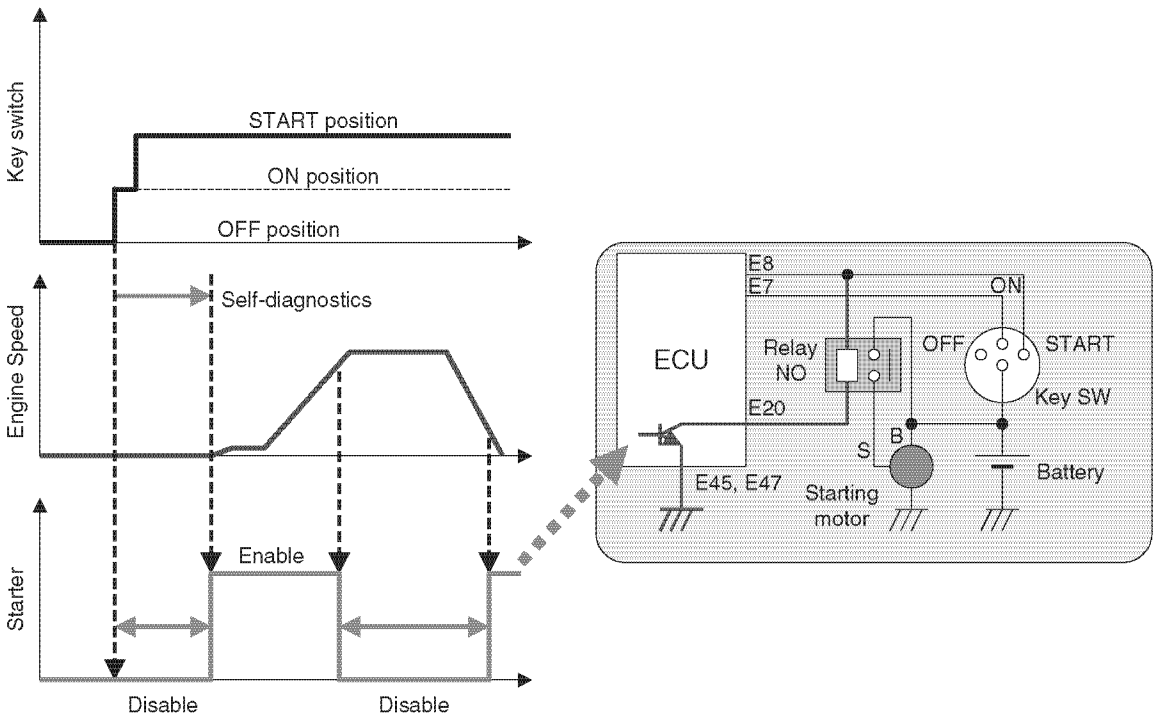


Fig. 14-39 **Timing chart of stator motor start prevention**

2. Starter disable (optional feature)
   This feature turns off the starter when it is energized continuously for 30 seconds, and disables it to be energized for 30 seconds, thereby providing protection to the starter.
3. External switch control (optional feature)
   This feature allows the starter to be disabled until an external switch turns on. This can be used for creating a safety system where the starter cannot start unless a safety pedal is depressed.
   Like**Fig. 14-40**, the external switch can be connected to APP-IP1 terminal (E24: in common use for droop selection). Also, the starter can be enabled via CAN communication in place of contact input at APP-IP1 terminal. Furthermore, the starter can also be enabled by the AND of the APP-IP1 contact input and the CAN communication input.
   When the coexistence of droop selection feature and starter prevention external switch feature is desired, the external switch can be connected to the APP-IP4 terminal (E17: in common use with SW2), as shown in**Fig. 14-41**.In this case, the switch input becomes low-side input.
   The conditions that enable the starter can be changed using map flags for setting E-ECU applications.

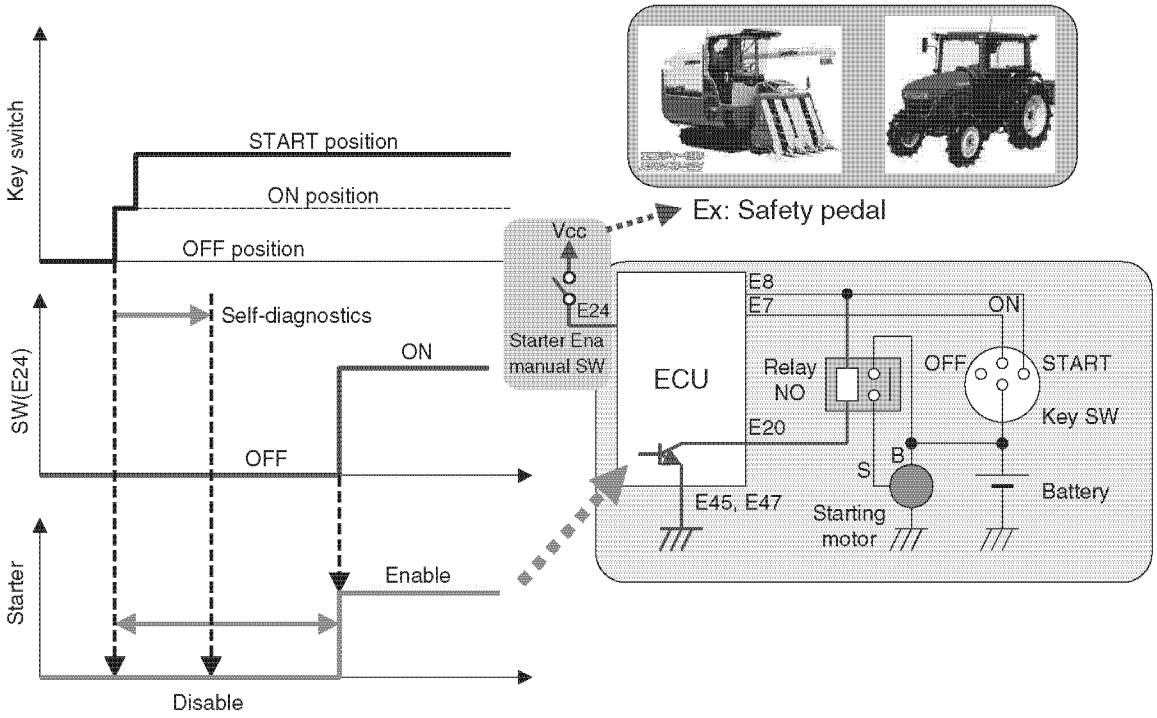


Fig. 14-40 **External switch 1 and starter disable/enable circuit**

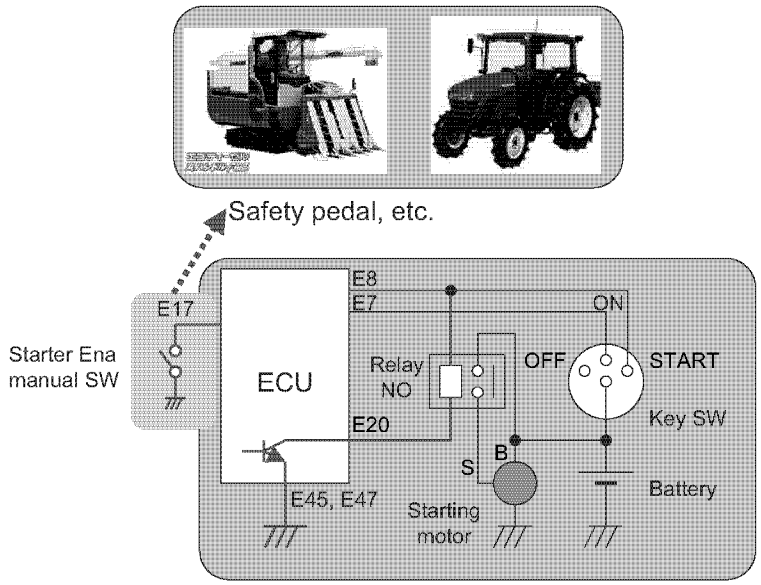


Fig. 14-41 **External switch 2 and starter disable/enable circuit**

Utilizing features 1 and 2 above permits establishing a remote (auto) start/stop system that can be operated through an external sequence. See **Fig. 14-42** for details. In the figure, a machine start recognition signal (E8) is given from an external control device in place of the key switch.

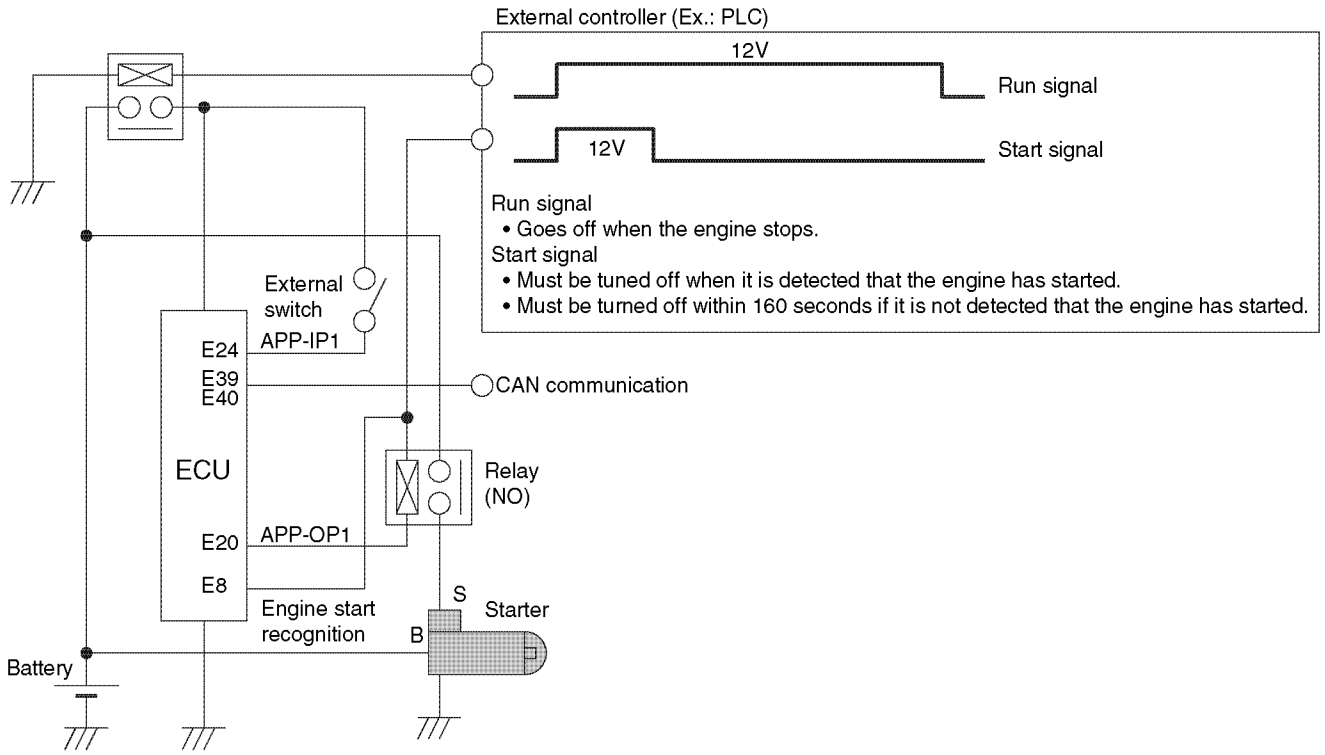


Fig. 14-42 **Connection diagram of a remote (auto) start/stop system**

The engine run signal goes on at engine start and goes off at engine stop. The start signal must be turned off within160seconds as a guideline.Otherwise, the starter tries to start the engine repeatedly in intervals of 30 seconds when the engine may not be able to start for some reason.

Speed selection

The Eco-governor has a speed selection feature that allows the engine speed to be changed with external switch inputs. The speed selection feature includes three modes: (1) Constant speed mode where the engine speed is kept constant, (2) Constant deceleration mode where the engine speed is reduced from a specified value with a constant deceleration, and (3) Auto deceleration mode where the engine speed is set to a specified value after a specified time has elapsed.

Table 14-11shows the relationship between the position of external switches and the engine speed in the three modes.

Table 14-11 Engine speed and external switch position

Map setting	External switches			Engine speed
	Speed selection enable SW (E6)	Speed 1 SW (E9)	Speed 2 SW (E17)	
(1) Constant speed 0 or 1 (Standard)	Disabled (OFF)	-	-	Per accelerator command
	Enabled (ON)	OFF	OFF	1500min^{-1} *1)
		OFF	ON	Low idling
		ON	OFF	1800min^{-1} *2)
		ON	ON	High idling
(2) Constant deceleration 2 or 3 (Optional)	Disabled (OFF)	-	-	Per accelerator command
	Enabled (ON)	OFF	OFF	Deceleration 70% *3)
		OFF	ON	Per accelerator command
		ON	OFF	Deceleration 85% *4)
		ON	ON	Per accelerator command
(3) Auto deceleration 5 (Optional)	Disabled (OFF)	-	-	Per accelerator command
	Enabled (ON)	OFF	OFF (delay: 4s *))	Low idling
		OFF	ON	Per accelerator command
		ON	OFF (delay: 4s *))	1800min^{-1} *2)
		ON	ON	Per accelerator command

Values marked with an asterisk (*1-*4) can be changed by map setting.(Optional)
Values marked with an asterisk (*2) is used in map as well.
External switch's ON/OFF can be commanded via CAN communication.

(1) Constant speed mode

Fig. 14-43shows the connection diagram for constant speed mode. Do not connect the indicator lamp power supply to the IGNSW (E7) terminal.Turning current from the APP-IP terminal to the IGNSW terminal may cause the E-ECU power supply to not shutdown.
The indicator lamp can be connected to the APP-OP2 (E2) terminal optionally, but in this case the coolant temperature alarm indication and block heater control cannot be done.Åi**Table 14-16**(Reference)

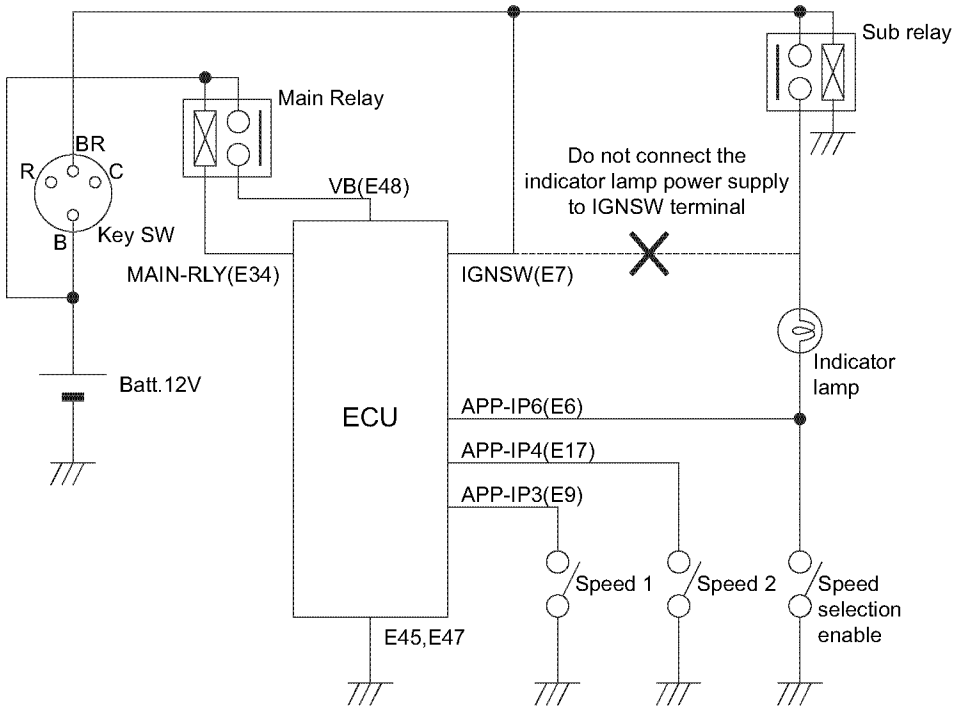


***Fig. 14-43* Connection diagram for constant speed mode**

Fig. 14-44shows the operation timing for constant speed mode. The speed selection enable switch (E6) is available in two types: toggle and momentary.

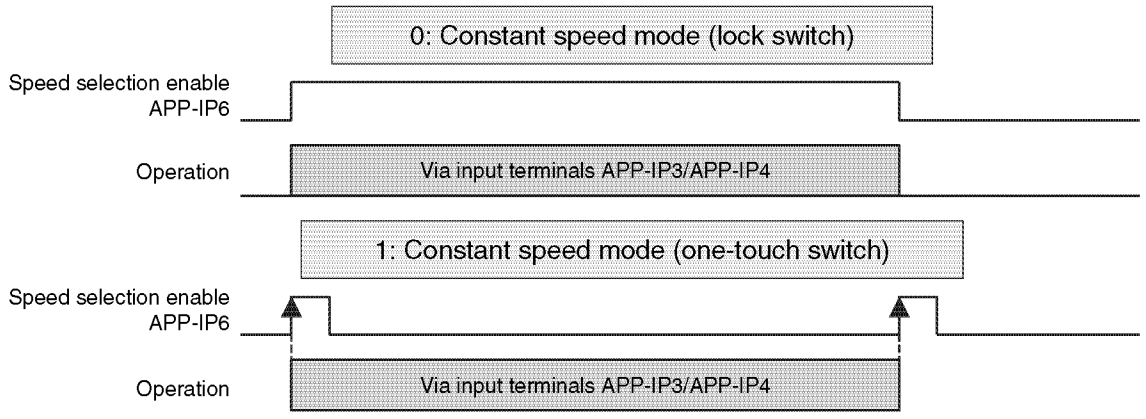


***Fig. 14-44* Operation timing for constant speed mode**

Note: The type of the speed selection enable switch: APP-IP6 (toggle or momentary) is mapped. As a momentary switch involves the possibility of a fluctuation in engine speed if the E-ECU is reset, it is recommended to use a toggle switch.

The input voltage from the accelerator sensor (or the input value through CAN communication) is not depended during the constant speed mode in operation, and the target speed is fixed.
The speed of constant speed mode of speed1 switch: APP-IP3 and speed2 switch: APP-IP4 can be selected from (1) speed is set to a specified value1 (standard: 1800min^{-1}), (2) speed is set to a specified value2 (standard: 1500min^{-1}), (3) low idling, and (4) high idling.(**Table 14-11**(Reference))
The speed of specified value1 and value2 can be changed (optional).

(2) Constant deceleration mode

Fig. 14-45shows the connection diagram for constant deceleration. Do not connect the indicator lamp power supply to the IGNSW (E7) terminal.Turning current from the APP-IP terminal to the IGNSW terminal may cause the E-ECU power supply to not shutdown.
The indicator lamp can be connected to the APP-OP2 (E2) terminal optionally, but in this case the coolant temperature alarm indication and block heater control cannot be done. (**Table 14-16**(Reference))

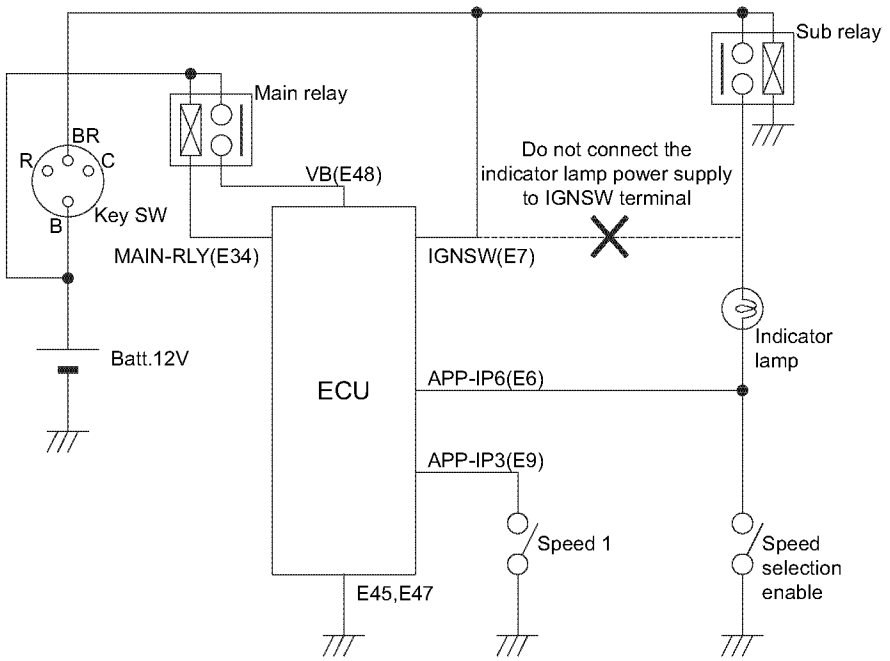


Fig. 14-45 **Connection diagram for constant deceleration**

Fig. 14-46shows the operation timing for constant decelerationThe speed selection enable switch (E6) is available in two types: toggle and momentary.

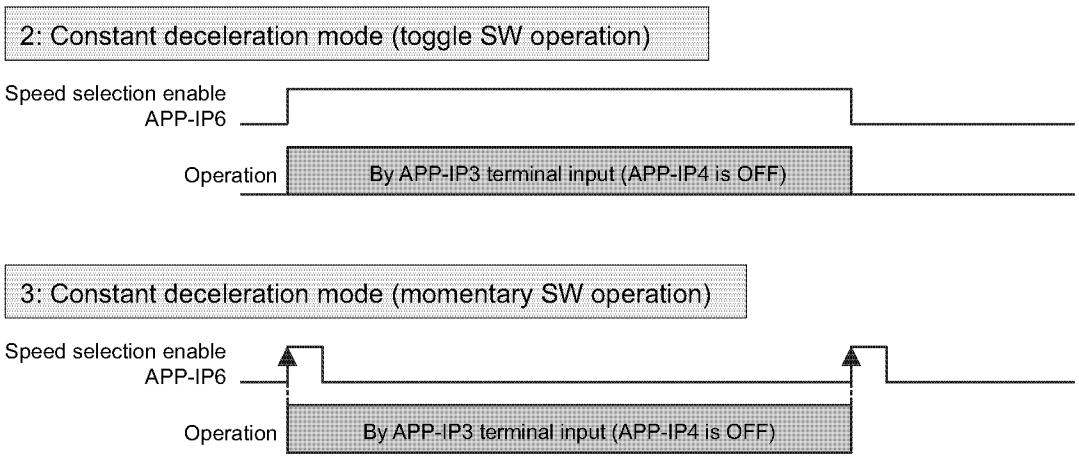


Fig. 14-46 **Operation timing for constant deceleration mode**

Note: The type of the speed selection enable switch: APP-IP6 (toggle or momentary) is mapped. As a momentary switch involves the possibility of a fluctuation in engine speed if the E-ECU is reset, it is recommended to use a toggle switch.

As shown in **Fig. 14-47** the engine target speed in constant deceleration operation is decelerated (see **Table 14-11**) for the input voltage from the accelerator sensor (or the input value through CAN communication).

The before-mentioned indicator lamp (APP-OP2) isn't illuminated even in deceleration operation when the target speed is below the deceleration start speed.

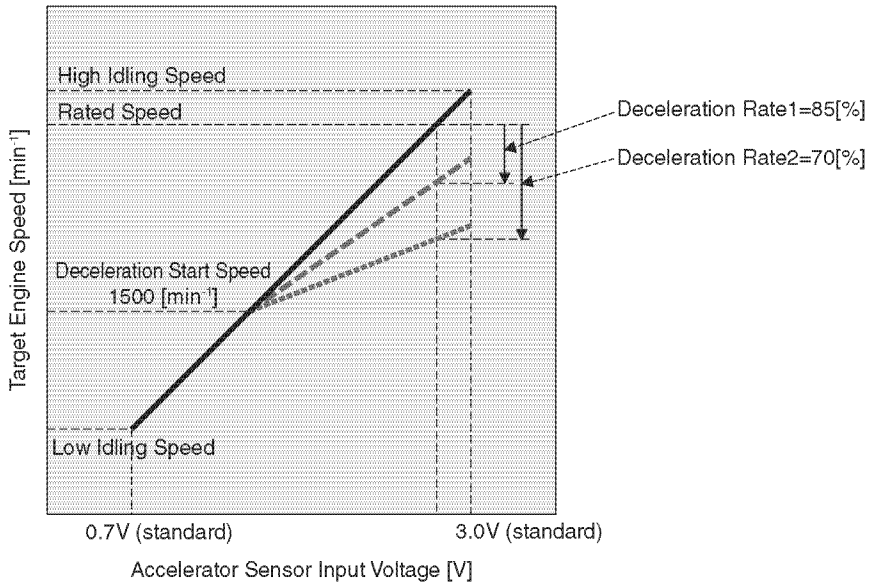


Fig. 14-47 **Operation of constant deceleration**

The deceleration ratio of constant deceleration in the APP-IP3 condition can be selected from (1) deceleration ratio1 (standard: 85%), and (2) deceleration ratio2 (standard: 70%).(Speed2 switch is: APP-IP4=OFF. See **Table 14-11**).
The speed of deceleration ratio1, deceleration ratio2, and deceleration start speed (standard: 1500min^{-1}) can be changed.(Optional)

(3) Auto deceleration mode

Fig. 14-48shows the connection diagram for auto deceleration mode. The indicator lamp is connected to illuminate when the auto deceleration is permitted.There is no influence in control action even if it's omitted.

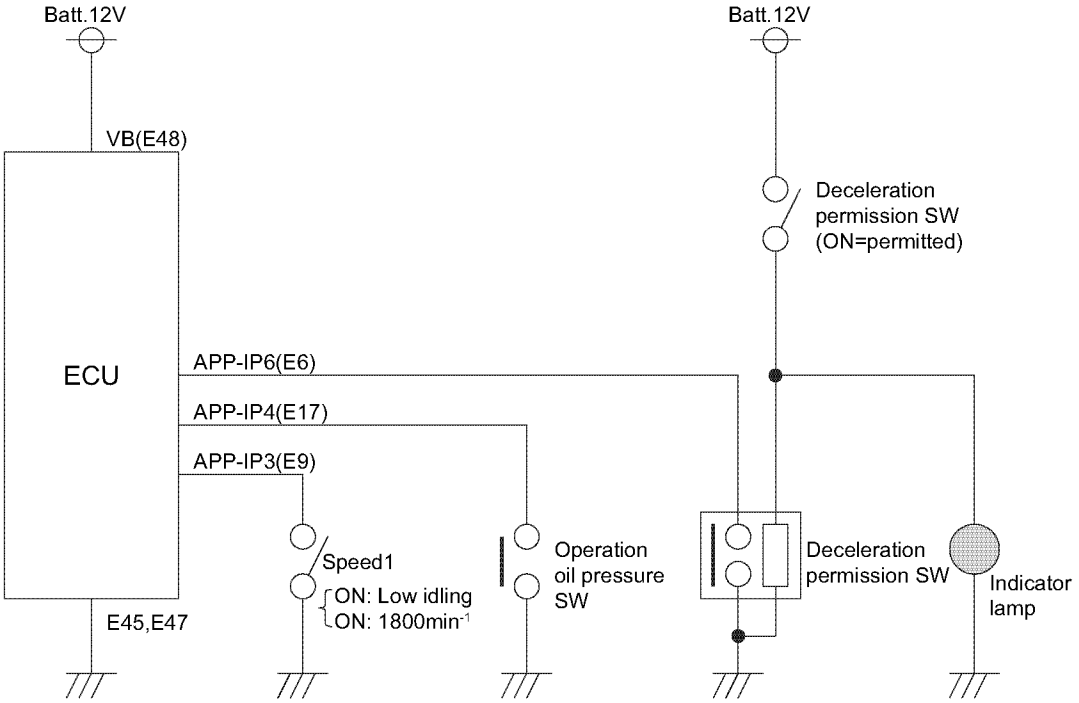


***Fig. 14-48* Connection diagram for auto deceleration**

Fig. 14-49shows the operation timing for auto deceleration mode.

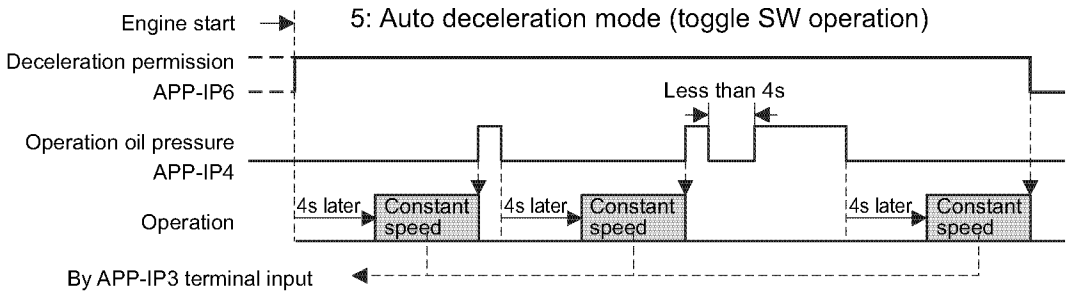


***Fig. 14-49* Operation timing for auto deceleration mode**

Deceleration permission switch: when APP-IP6=ON, operation oil pressure switch: APP-IP4=OFF (in non-operational condition) is continued over 4s, the auto deceleration is affected and the engine target speed is fixed without depending on the accelerator sensor input voltage (or the input value through CAN communication).

The speed of auto deceleration of speed1 switch: in the APP-IP3 condition can be selected from (1) constant speed1 (standard: 1800min^{-1}), or (2) low idling. (**Table 14-11**(Reference))

The speed of constant speed11 in common use with constant speed mode can be changed. The duration of operation oil pressure switch OFF (standard: 4s) can also be changed.(Optional)

Constant speed by the auto deceleration mode can be temporarily released by acceleration use even the operation oil pressure switch is: APP-IP4=OFF, as shown in **Fig. 14-50**. The operated accelerator's target speed is followed during the deceleration release. (Optional)

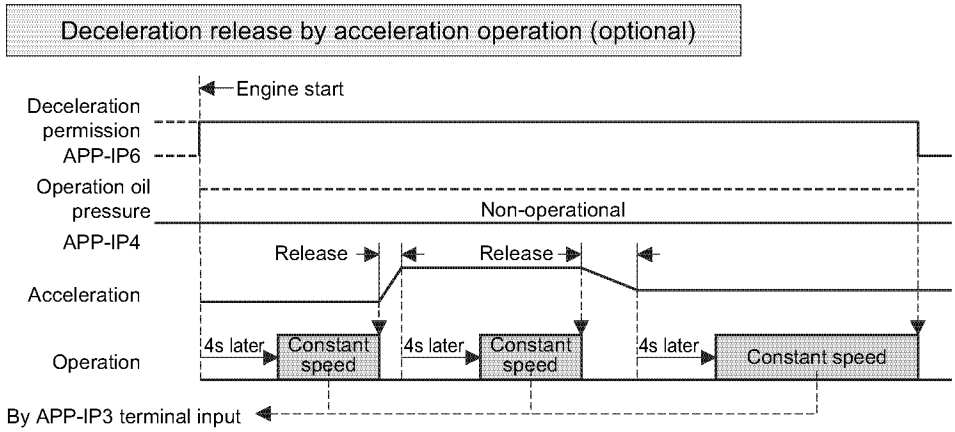


Fig. 14-50 **Deceleration release by acceleration operation**

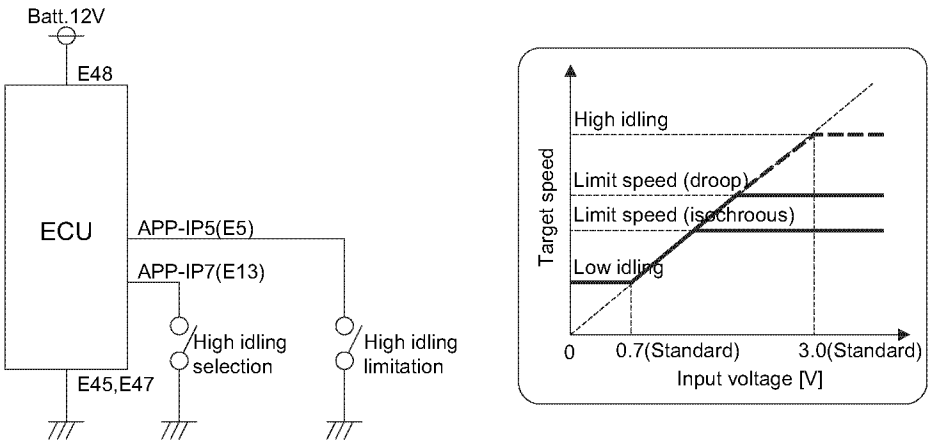
High idling limitation feature

When the high idling limitation control is enabled, the Eco-governor has a feature which temporarily reduces the high idling speed by the external switch input (APP-IP5).

Like **Fig. 14-51**, the maximum target speed can be limited by the accelerator input voltage by connecting the high idling limitation switch to the APP-IP5 terminal. The switch used can be selected from the following 2types: normal open type and normal close type.By default, normal open type is set, so the maximum speed is limited when the APP-IP5 terminal is GND connected.

The speed for high idling limitation can be switched by the condition of high idling limitation speed switch, or droop or isochroous drives.Also, the settings of the limitation speed can be changed. (The default settings can be switched by the high idling limitation speed switch condition of 1900min^{-1} or 1700min $^{-1}$).

The speed of limitation is the target speed at no load.The actual maximum speed is decided by the size of load.



High idling limitation SW APP-IP5(E5)	High idling selection SW APP-IP7(E13)	Limit speed (standard set value)	
		Droop	Isochroous
OFF	-	Speed command from the accelerator	
ON	OFF	1900 [min^{-1}]	1900 [min^{-1}]
	ON	1700 [min^{-1}]	1700 [min^{-1}]

Fig. 14-51 **High idling limitation feature**

Engine cutoff

Besides the engine stop caused by overload and out of fuel, the factor for stopping the engine is as follows.

The engine stop factor is checked by connecting the engine diagnosis tool to see the stop factor flag. (**Table 14-28**(Reference))

[Method by key switch]

When the key switch is turned off and the rack actuator is shut off, the engine is cut off. (No stop solenoid is required).

[Method by SHUDNSW terminal]

The engine can also be cut off by turning on terminal SHUDNSW to which an engine stop switch has been connected. The engine stop switch is available in two types: NC (normally closed) and NO (normally open - standard). The connection method of the engine stop switch is shown in **Fig. 14-52**.By default, NO type switch is set, so if the switch is not connected, it's possible for the engine to run.

Once the engine stop switch is turned on, the engine stop condition is held; it's required to turn off the switch in order to re-start.While the engine stop switch is turned on, it cannot be started with the starter.

The operation by the SHUDNS terminal during the engine stop is summarized in **Table 14-12**.

By setting the NC type for the engine stop switch, this feature is suitable for the utilization as a connection port for immobilizer key; it has high protection to stop the engine drive for disconnection and short of the switch harness, as shown in **Fig. 14-53**.

Note: Be noted that when the NC type is set for the engine stop switch, the engine cannot run with the switch circuit unconnected.

[Method by APP-IP7 terminal]

By connecting the APP-IP7 terminal to the engine stop 2 switch, the engine can be stopped when the terminal input is turned on.The engine stop switch is available in two types: NC (normally closed) and NO (normally open - standard). The connection method of the engine stop switch is shown in **Fig. 14-52**.By default, NO type switch is set, so if the switch is not connected, it's possible for the engine to run.

Once the engine stop switch is turned on, the engine stop condition is held; it's required to turn off the switch in order to re-start.While the engine stop switch is turned on, it cannot be started with the starter.

Such an engine stop switch can be utilized as a safety switch that stops the engine when the engine cover is opened, for example. The input signal to the engine stop2 switch can also be given through CAN communication instead of from terminal APP-IP7.

The operation by the APP-IP7 terminal during the engine stop is summarized in **Table 14-12**.

[Control failure]

A failure detected by the E-ECU may cause the engine to stop. For details see "Engine/control failure detection" sections.

Table 14-12 Comparison of engine cutoff means

Terminal	switch		CAN input stop	Engine stop conditions			
	[Circuit]	Momentary		Rack actuator relay	Rack	Starter	Recovery
SHUDNSW	High side	OK	NG	OFF	Halt	Disabled	Key off
APP-IP7	Low side	OK	OK	OFF	Halt	Disabled	Key off

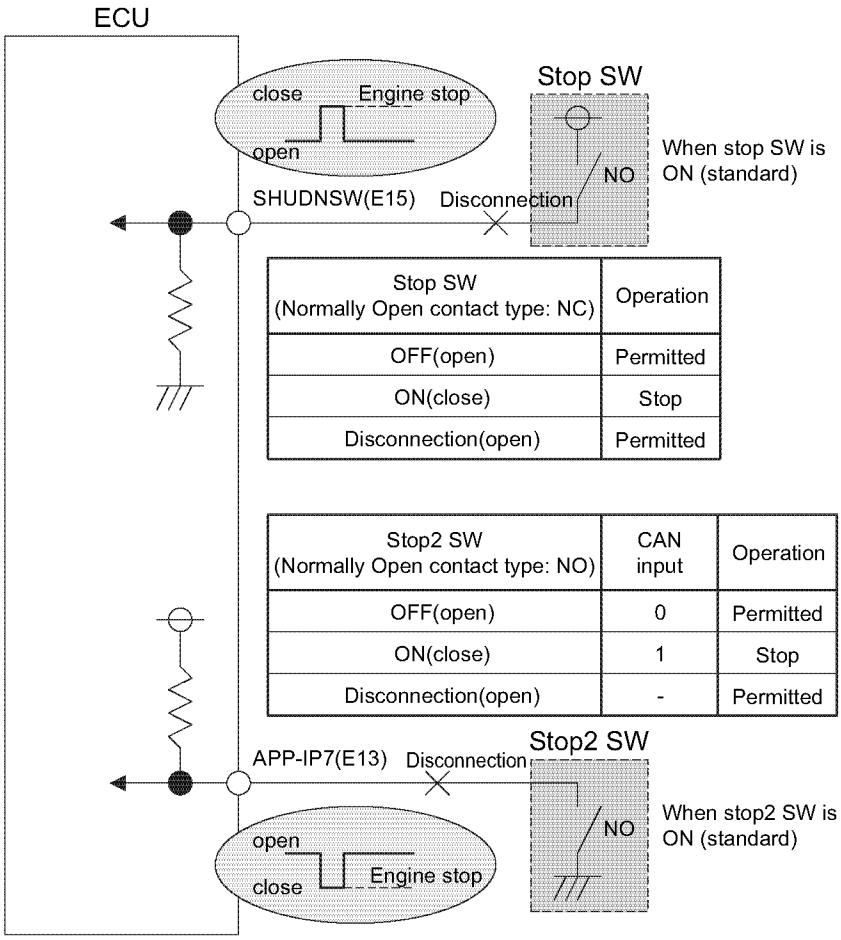


Fig. 14-52 **Engine cutoff with external switch**

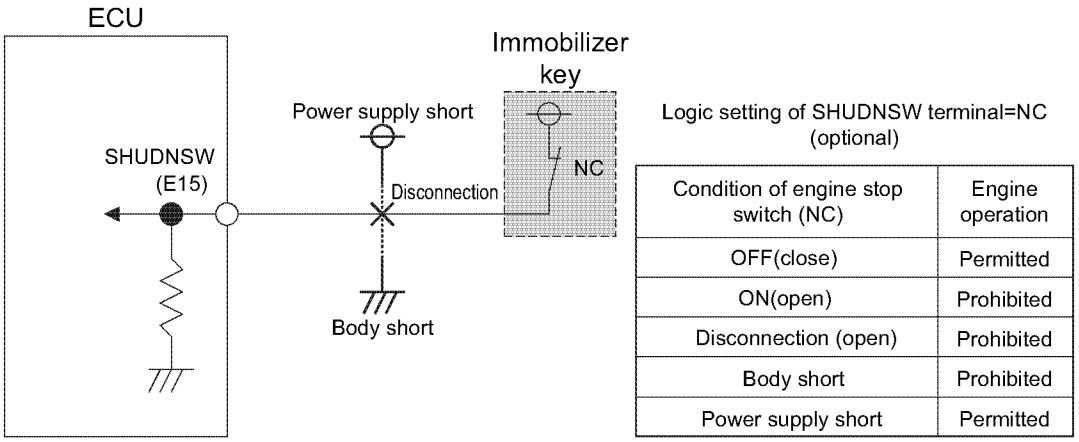


Fig. 14-53 **Connection of immobilizer**

Emergency stop feature

By installing the emergency stop switch in either *2 or *3 position of **Fig. 14-4**, the engine can be stopped.

Table 14-13 Comparison of emergency stop feature

Switch installation position	Advantage	Disadvantage
*2 of **Fig. 14-4** (recommended)	• The failure log isn't left in the ECU. • Even if the rack actuator relay contact is fastened, the E-ECU cuts off the rack actuator output, so that it's possible to stop the engine.	• When the rack actuator relay contact is fastened, the stop operation is by the E-ECU control.
*3 of **Fig. 14-4** (recommended)	• The engine can be stopped without relying on the rack actuator relay. • The engine can be stopped without using the E-ECU.	• The rack actuator failure remains in the ECU. • Be noted that the total length of the rack actuator line must not exceed 10 m.

Idling speed up

The feature allows the low idling speed to increase gradually until the coolant reaches a specified temperature, helping the engine warm up quickly. See the figure below. See **Fig. 14-54**. In case of the standard engine with the low idling speed of 600min^{-1}, this feature is set by default to keep the minimum speed above 1000min^{-1} to stabilize the engine speed fluctuation in low temperature with the coolant temperature below 10°C. See **Fig. 14-55**.

As in the case of the before-mentioned CSD actuation speed increase, the speed is increased at the same time.

Target speed = speed command from the accelerator + idling speed up speed increase + the CSD actuation speed increase.

For example, the target speed becomes 1075min^{-1} (800+200+75) in case of the NV3 engine with the low idling speed of 800min^{-1} in the coolant temperature 10°C.

With the setting of the low idling speed above 1000min^{-1}, this feature isn't required.Be noted that by keeping this feature effective, the engine speed of the NV2 engine increases to 250min^{-1}; the engine speed of the NV3 increases to 275min^{-1} in the coolant temperature below 10, as mentioned before.

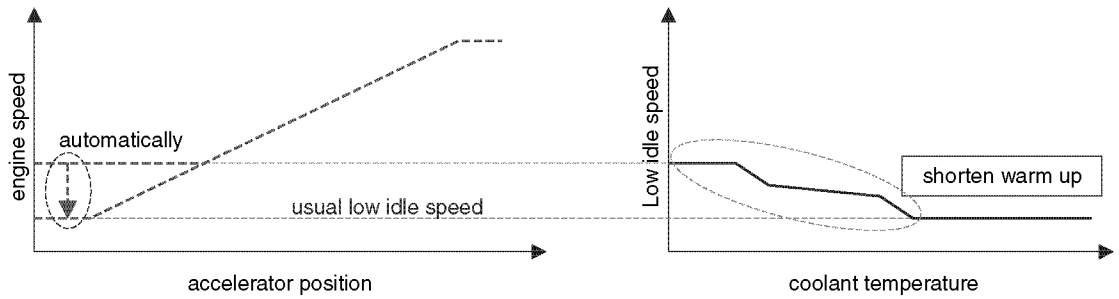


Fig. 14-54 **Low Idling speed in cold conditions**

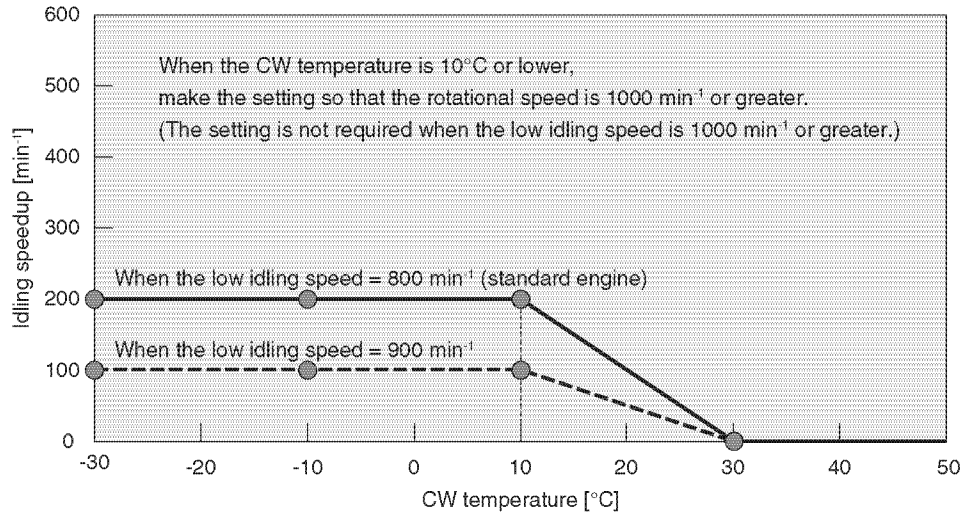


Fig. 14-55 **The standard setting of idling speed up (low idling speed = 800min^{-1})**

By utilizing this feature, the duration in cold conditions can be limited with the optional setting as shown in **Fig. 14-56**.In this manner, the idling speed up speed can be changed. (Optional)

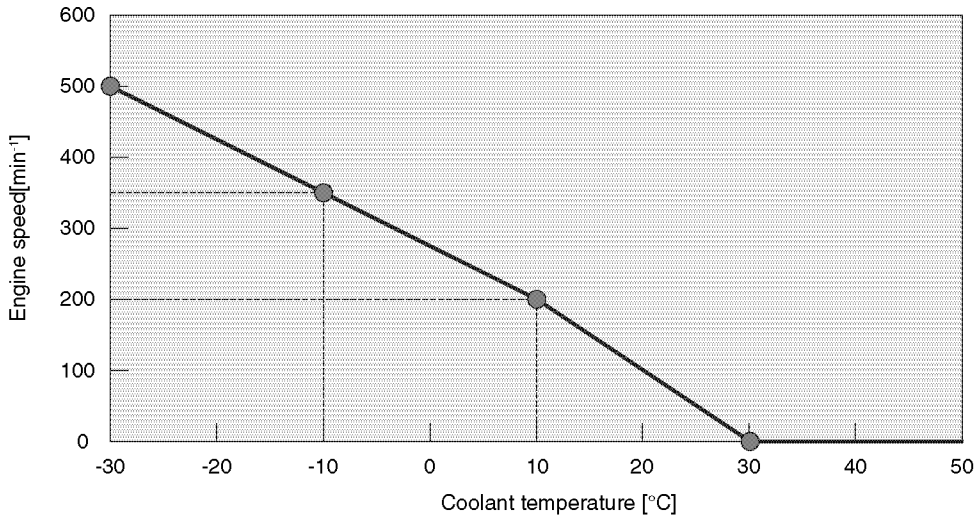


Fig. 14-56 **The speed for idling speed up**

Blue and white smoke suppression

The feature allows the high idling speed to be limited when the coolant is lower than a prescribed temperature, thus reducing the time required for vanishing the emission of blue and white smoke in cold start conditions. See **Fig. 14-57**. By default, the "blue and white smoke suppression" feature is disabled.

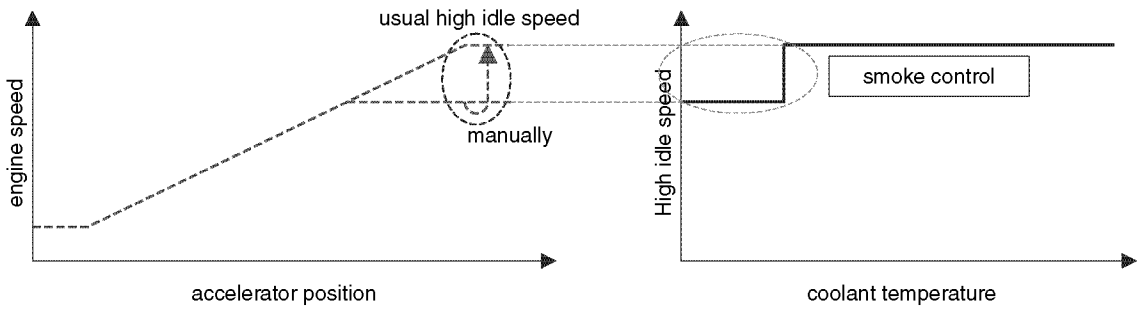


Fig. 14-57 **High idling speed limitation in cold conditions**

Blue and white smoke suppression is effective in limiting the time required for vanishing the blue and white smoke for the engines with the rated speed of 2300min^{-1} or above by reducing the high idling speed to around 150min^{-1} in the coolant temperature below 30°C when optionally set.

Accelerator filter

The accelerator filter regulates the trade-off between acceleration/deceleration time and overshoot/ undershoot during acceleration or deceleration. This feature is factory set appropriately at Yanmar, but a higher priority may have to be given to either the reduction of acceleration/deceleration time or the suppression of overshoot/undershoot depending on the engine applications.

Fig. 14-58shows the effect of the accelerator filter. The accelerator filter delays reaching the engine target speed, thereby avoiding overshoot and undershot while trading off the speed responsibility of the engine.

By advancing the engine target speed change, the motion responsiveness at the time of engine acceleration/deceleration can be improved.

When the adjustment requirement is admitted in the engine application test in regard to the stabilization and responsiveness of engine speed mentioned above, Yanmar makes the adjustment to change the model-specific control map by this adjustment.

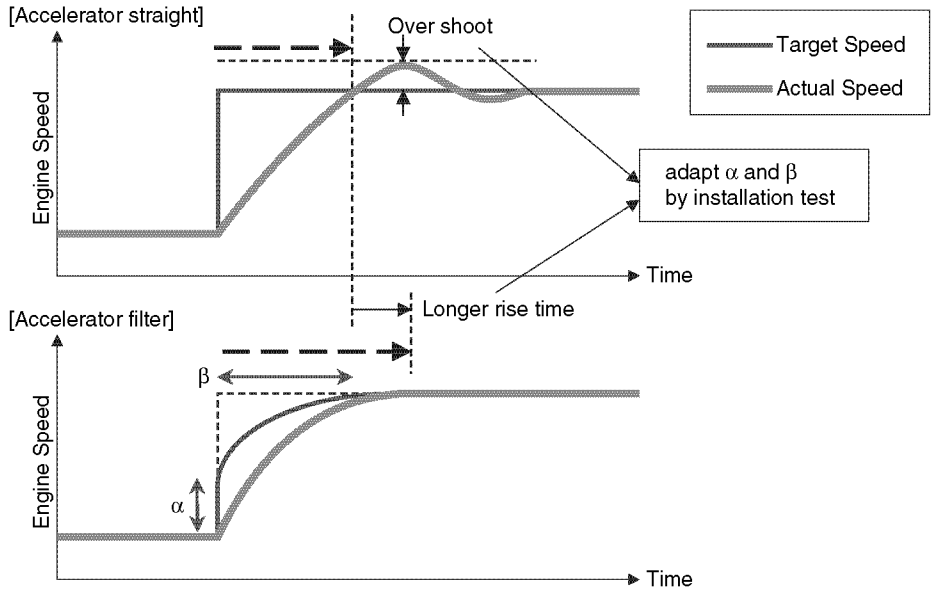


Fig. 14-58 **Effect of the accelerator filter**

Block heater control

This feature allows the block heater to be turned on or off by an external block heater relay as long as the E-ECU power supply is on. By default, the block heater relay turns on when the coolant temperature decreases to 15°C, and turns off to disable the block heater when the coolant temperature increases to 50°C. By default, the "block heater control" feature is disabled. When the “block heater control” feature is enabled, the coolant temperature alarm indication and block heater control cannot be done. (**Table 14-16**(Reference))

Fig. 14-59 shows a typical connection diagram for block heater control.

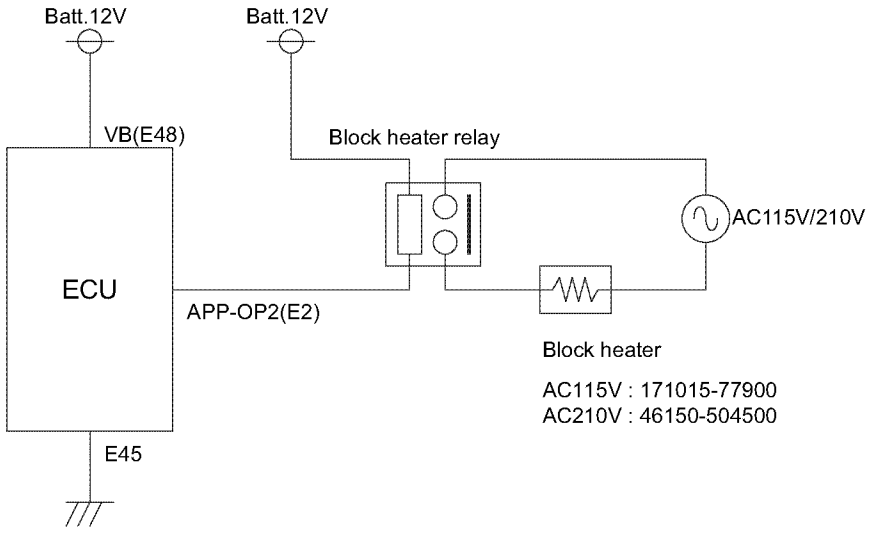


Fig. 14-59 **Connection diagram for block heater control**

Engine failure detection

The E-ECU accepts the connection of engine failure detection sensors as shown in **Fig. 14-60** besides electronic control sensor. Actions to be taken depending on the status of sensors can be programmed. The sensor status can also be sent via CAN communication.

In order to take in each sensor signal to the E-ECU, the E-ECU terminal function setting of APP-IP2, APP-IP3, APP-IP5, and APP-IP6 must be changed.When the sensor connection is enabled by the optional setting, some applications can no longer be used.See **Table 14-16** for details. A failure lamp can be connected to each sensor as shown in **Fig. 14-60**. In this case, do not connect the indication lamp to the IGNSW (E7) terminal. See **Fig. 14-60**.Turning current from the APP-IP terminal to the IGNSW terminal may cause the E-ECU power supply to not shutdown.

Note: Be sure to connect a lamp or load resistance (120Ω) to the pressure switch so that the contact current is 100mA or higher for the oil pressure switch (119761-39450, etc.). Due to the impurity of lube oil, contact failure of oil pressure switch may be caused.

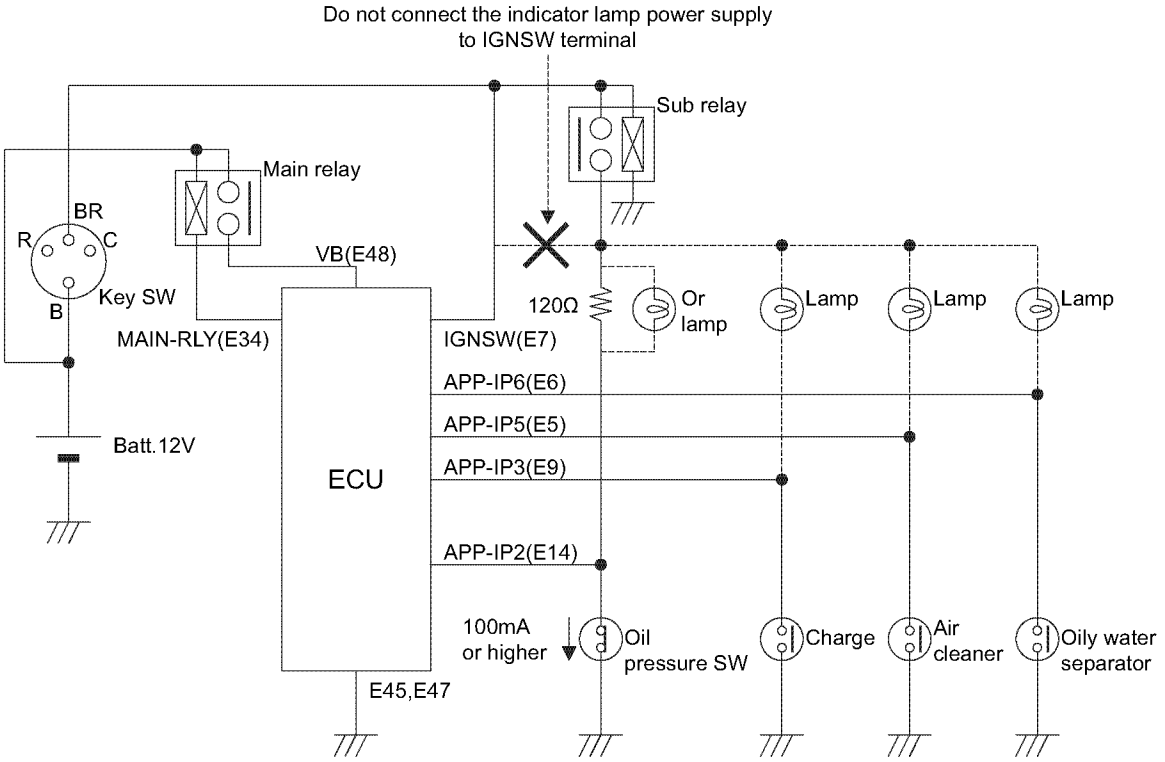


Fig. 14-60 **Connection of sensors for engine failure detection**

Control failure detection

The E-ECU performs various self-diagnostics as shown in **Table 14-14**.

Diagnostic items are divided into "Always enable", "Default to enable" and "Default to disable" in the table.

Standard : The failure detected in all specifications

Default : The failure that can be disabled by the customer's setting though the initial detection is enabled.

Optional : The failure that can be enabled by the customer's setting though the initial detection is disabled.

Table 14-14 The detected failure list

No.	Item	Failure detection conditions	Operation when failure occurs	Action/ condition for recovery	Setting	Lamp Number of flash
1	Coolant temperature sensor failure	Sensor voltage is 4.8 V or more, or 0.2 V or less.	• Continued operation in the coolant temperature condition of 30°C (EGR valve is not in operation) • The same limited operation is performed as the EGR vale failure	Key off	Always enable	4
2	Accelerator sensor failure	Sensor voltage is 4.6 V or more, or 0.2 V or less.	[Without optional backup accelerator sensor: standard] • The speed immediately before is held (standard) • The engine operation in 1500min^{-1}*) [With optional backup accelerator sensor: optional] Select backup accelerator sensor: No limitation Backup accelerator sensor failure: • The speed immediately before is held (standard) • The engine operation in 1500min^{-1}*)	Correct failure.	Default	5
3	Speed sensor failure	Engine start signal (E8) is on, but the engine speed cannot be detected. When the engine speed is reduced lower than the rated speed instantaneously	[Without optional backup speed sensor: standard] Engine stop [With optional backup speed sensor: optional] • Switching backup speed sensor (speed is limited to 1800 min^{-1}*)). • Backup speed sensor failed: Engine stops.	Key off	Always enable	6
4	Rack position sensor failure	When the rack position sensor voltage is raised above the rated value by rack self-diagnostics When the rack position relationship for the rack actuator output is raised above the rated value When the rack position relationship for the rack actuator output is reduced below the rated value	The engine operation with output/speed limitation (Rack position control is inactive and speed control is active).	Key off	Always enable	7

Table 14-14 The detected failure list

No.	Item	Failure detection conditions	Operation when failure occurs	Action/ condition for recovery	Setting	Lamp Number of flash
5	Rack actuator failure	When the rated rack doesnít operate by rack self-diagnostics	Engine stop	Key off	Always enable	8
		When the rack actuator output is raised above the rated value				
		When the rack actuator output is reduced below the rated value				
		When the engine accelerates rapidly even with minimum rack actuator output.				
		When engine stalls while rack position sensor is in failed operation.				
6	Overspeed	Idling engine speed exceeds high idling speed + 600 min^{-1}.	Engine stop caused by independent curcuit	Key off	Always enable	9
7	Backup speed sensor failure	Engine start signal (E8) is on, but the engine speed cannot be detected.	• Engine continues to run while main speed sensor is used. • Main speed sensor failed: Engine stops.	Key off	Optional	1-1
		When the engine speed is reduced lower than the rated speed instantaneously				
8	CAN communication failure	CAN communication packets cannot be received.	• Last value is retained. • Switch to backup sensor • The failure isn't indicated during the engine start or the power supply voltage is below 10.5 V	Correct failure.	Optional	1-2
9	EGR valve failure (37 kW Min.)	Low status is detected even through port is off.	The limited engine operation in output 92% and speed 1800min^{-1}	Key off	Always enable	1-3
		High status is detected even through port is on.				
10	CSD solenoid valve failure	High status is detected even through port is off.	Engine continues to run with CSD being off.	Key off	Always enable	1-4
		Low status is detected even through port is on.				
11	Starting aid relay failure	High status is detected even through port is off.	Engine continues to run with starting aid relay being off.	Key off	Optional	1-5
		Low status is detected even through port is on.				

Table 14-14 The detected failure list

No.	Item	Failure detection conditions	Operation when failure occurs	Action/ condition for recovery	Setting	Lamp Number of flash
12	Main relay failure	ECU power is not shut off even though main relay is off.	Engine runs normally.	Retained until correct failure	Default	1-6
13	Rack actuator relay failure	Low status is detected even through port is off.	Engine stop	Key off	Always enable	1-7
		High status is detected even through port is on.				
14	Backup accelerator sensor failure	Sensor voltage is 4.6 V or more, or 0.2 V or less.	Engine continues to run while main accelerator sensor is used. Main accelerator sensor failure: • The speed immediately before is retained (standard) • The engine operation in 1500min^{-1}*)	Correct failure.	Optional	1-8
15	reserve	-	-	-	-	1-9
16	Oil pressure switch failure	Oil pressure switch fails to turn on when engine is off.	Engine runs normally*)	Key off	Optional	2-1
17	Charge switch failure	Charge switch fails to turn on when engine is off.	Engine runs normally.	Key off	Optional	2-2
18	Power supply voltage failure	ECU supply voltage exceeds 10.0 V.	Engine runs normally.	Correct failure.	Always enable	2-3
		ECU supply voltage exceeds 16.0 V.				
19	Sensor 5V failure	Monitoring voltage is approx. 0 V.	Engine runs normally.	Key off	Always enable	2-4
		Monitoring voltage is 4.5 V or less.				
		Monitoring voltage is 5.5 V or more.				
20	ECU overheat alarm	Detected when ECU temperature exceeds 105°C*) or above Canceled when ECU temperature decreases to 100°C*) or below (Optional change is possible)	Engine runs normally*)	Correct failure.	Optional	2-5
21	Oil pressure low	Oil pressure switch fails to turn off when engine is running.	Engine runs normally*)	Correct failure.	Optional	3-1
22	Charge failure	Charge switch fails to turn off when engine is running.	Engine runs normally.	Key off	Optional	3-2
23	reserve	-	-	-	-	3-3
24	Air cleaner blockage alarm	Air cleaner switch turns on.	Engine runs normally*)	Key off	Optional	3-4
25	Oily water separator alarm	Oily water separator switch turns on.	Engine runs normally*)	Key off	Optional	3-5

Table 14-14 The detected failure list

No.	Item	Failure detection conditions	Operation when failure occurs	Action/ condition for recovery	Setting	Lamp Number of flash
26	Coolant temperature high alarm	Coolant temperature is 110°C*) or higher Alarm is canceled when Coolant temperature decreases to 105°C*) or below	Engine runs normally*)	Correct failure.	Default	3-6
27	ECU failure [ROM error]	Flash ROM's EEPROM checksum error.	Engine stop	Key off	Always enable	4-1
28	ECU failure [EEPROM error]	Reading/Writing fails. EEPROM suffers checksum error.	Engine runs normally.	Key off	Always enable	4-1
29	ECU failure [Sub CPU failure]	ECU fails to communicate with sub CPU.	Engine runs normally.	Key off	Always enable	4-1
30	ECU failure [Mapping error]	Map format is invalid.	Engine stop	Key off	Always enable	4-1
31	ECU failure [ECU temperature sensor failure]	Sensor voltage is 4.6 V or more, or 1.0 V or less.	Engine runs normally.	Correct failure.	Always enable	4-1

*) The items in which the setting can be changed optionally

When detecting these failures, the E-ECU flashes the trouble monitor lamp to alert the operator to the occurrence of failure conditions. The trouble monitor lamp will illuminate for 2 sec. when the E-ECU is power on. This allows operator to check if the E-ECU is supplied with power normally. (The trouble monitor lamp is an essential means for checking or diagnosing the ECU).

Fig. 14-61shows the flash method of trouble monitor lamp. When accelerator sensor failure (flashing 5 time) and ERG valve failure (flashing 1 – 3 times) occur, the failure lamp flashes as shown in **Fig. 14-61**. When two or more failures have occurred simultaneously, the failure lamp indicates all the failures in order of increasing number of flashes cyclically.

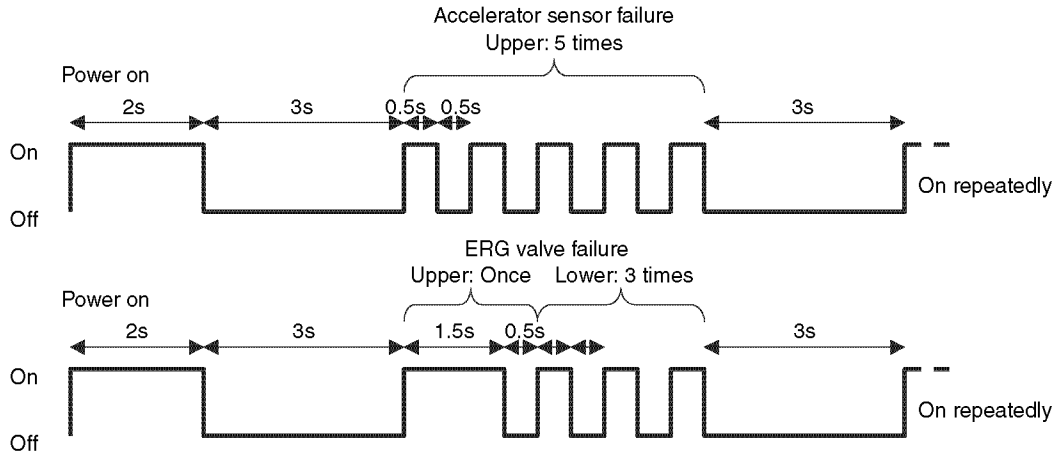


***Fig. 14-61* Flash method of trouble monitor lamp**

Connecting the Yanmar genuine engine self-diagnosis tool to the E-ECU as shown **Fig. 14-62** allows status monitoring or diagnostic testing as well as the indication of detailed failure information, failure log and freeze frame data.

Failure log indications can include time stamps. The following lists attribute available for time stamps

Table 14-15 Attributes of time stamps

Flag	Attribute
0 (Standard)	Accumulated engine run time
1	Accumulated E-ECU energization time
2	CAN acquision time

See the engine diagnosis tool manual or troubleshooting chart for details.

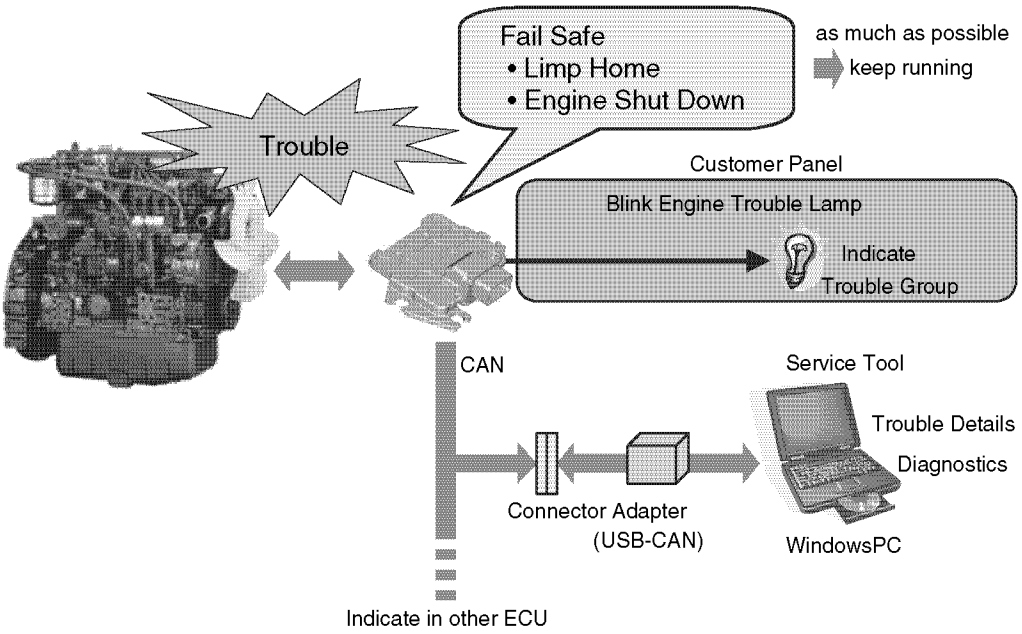


***Fig. 14-62* Diagnostics of the Eco-governor**

CAN communication

The E-ECU is equipped with a CAN communication port that can be used to communicate with the engine diagnosis tool and another common use communication port that can be used to communicate with other controller (for the inter-ECU communication use). The physical layer for CAN communication conforms to ISO 11898 Ver2.0B and uses 29-bit CAN arbitration ID. Baud rates of 250 kbps (standard) and 500 kbps are available. (**Fig. 14-63**(Reference))

The ECU supports communication protocols conforming to ISO 15765 and KWP 2000 for engine diagnosis tool and ASE J1939 for inter-ECU communication.

The engine diagnosis tool can perform the engine monitoring/diagnostics/setting.See the manual for the engine diagnosis tool for details.

For the inter-ECU communication, various control commands including target speed indication can be sent from the machine ECU to the engine ECU (E-ECU).Also, various information including control conditions such as actual engine speed and failure codes can be printed from the E-ECU to the machine ECU.The inter-ECU communication is enabled optionally. See the CAN communication manual for details.

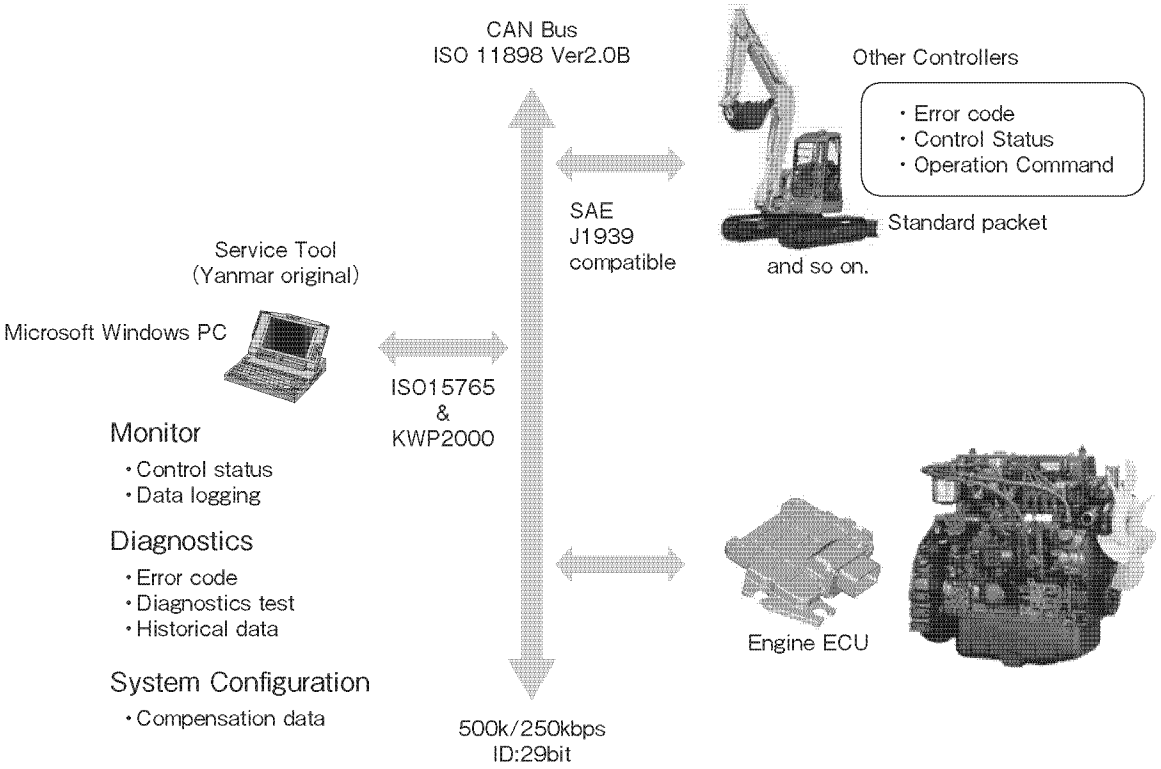


Fig. 14-63 **CAN communication outline**

Terminal assignment

Each of the E-ECU terminals listed in **Table 14-16** is assigned multiple functions. The active function for each terminal can be changed by mapping.

Contact Yanmar for setting change.

Table 14-16 E-ECU terminals assigned multiple functions

Terminal No.	Terminal name	Map setting				
		0	1	2	3	4
E24	APP-IP1	No setting	Droop selection *)	Starter enable1	Starter enable1	Reserve
E14	APP-IP2	No setting	Reserve *)	ñ°àŠSW	Reserve	Foot pedal NO
E9	APP-IP3	No setting	Speed 1 *)	Charge	Reserve	Reserve
E17	APP-IP4	No setting	Speed 2 *)	Reserve	Reserve	Starter enable2
E5	APP-IP5	No setting	Reserve	Air cleaner *)	Reserve	High idling limitation
E6	APP-IP6	No setting	Speed selection enable *)	Oily water separator	Reserve	Reserve
E13	APP-IP7	No setting	Reserve	Engine stop2 *)	High idling selection	Foot pedal NC
E20	APP-OP1	Starter relay *)	Reserve	Disabled	Disabled	Disabled
E2	APP-OP2	Reserve	Block heater relay	Speed change indication lamp	Coolant temperature alarm lamp *)	Disabled

*) default is indicated.

Contact input terminal switches are available in two types: NC (normally closed) and NO (normally open). **Table 14-17** lists contact input terminals for which a NO or NC switch can be selected. Table 15 lists contact input terminals for which a NO or NC switch can be selected.

Table 14-17 Contact input terminal switches available in NC and CO types

Terminal No.	Terminal name	Default function	Default input logic
E24	APP-IP1	Droop selection	NC
E14	APP-IP2	Reserve	NO
E9	APP-IP3	Speed 1	NO
E17	APP-IP4	Speed 2	NO
E5	APP-IP5	Air cleaner	NO
E6	APP-IP6	Speed selection enable	NO
E13	APP-IP7	Engine stop2	NO
E15	SHUDNSW	Engine stop	NO

Table 14-18 lists E-ECU terminals whose functions must be mapped depending on whether or not the specific devices are connected to the terminals.

Table 14-18 E-ECU terminals to be assigned a function

Terminal No.	Terminal name	Device connected	Setting
E35	APS	Accelerator sensor	0: No accelerator sensor (Generator standard) 1: Analog sensor (default) 2: Foot pedal + APP-IP2/IP7 switches 3: Foot pedal + APP-IP2 switch 4: Foot pedal + APP-IP2 switch (See "Accelerator sensor" for details).
E10	RENRPM	Backup speed sensor	0: Without backup speed sensor (default) 1: With backup speed sensor (default)
E44	AIRHT-RLY	Starting aid relay	0: Starting aid relay failure detection disabled 1: Starting aid relay failure detection enabled (default)
E34	MAIN-RLY	Main relay	Power supply self-holding feature 0: Disabled 1: Enabled (default)
E37	REAN	Backup analog	0: Without accelerator sensor (default) 1: Analog sensor 2: Foot pedal + APP-IP2/IP7 switches 3: Foot pedal + APP-IP2 switch 4: Foot pedal + APP-IP2 switch (See "Accelerator sensor" for details).
E16	RET	Backup coolant temperature sensor	0: Non 1: High-accuracy coolant temperature sensor (default)

Table 14-18 E16 can also be used as a backup coolant temperature sensor input. When terminal TFO is assigned as a coolant temperature sensor input as shown in **Table 14-19**, TFO (E16) must be flagged to 1.

Table 14-19 Selection of the terminal for coolant temperature input

Flag	Input terminal	Sensor to be used
Coolant temperature sensor selection	0: From TW (E25) terminal	Conventional type (119254-44910)
	1: From RET (E16) terminal (default)	High-accuracy type (129927-44900)

Operational limitations in failure situations

Operational limitations are applied to the engine when alarms or failures shown in **Table 14-21** occur. These limitations can be changed depending on properties of the machine to which the engine is installed.

Table 14-20 shows mapping flags to be used for limiting the engine operation.

Table 14-20 Operational limitations and map settings

Flag setting	Limitation	
	Speed limit	Output limit
6	Engine stop	
5	1800min^{-1}	92%
4	1500min^{-1}	92%
3	No limit	92%
2	1800min^{-1}	No limit
1	1500min^{-1}	No limit
0	No limit	No limit

Table 14-21 shows alarms and failures at which operational limitations are applied to the engine, and flags for the limitations.

Table 14-21 Default flag setting for operational limitations

No. *2)	Failure item	Default flag
2	Accelerator sensor failure *1)	1
7	Backup speed sensor activation	2
9	EGR valve failure	5 (Unchangeable)
20	ECU overheat alarm	0
21	Oil pressure low alarm	0
23	Reserve	Âl
24	Air cleaner blockage alarm	0
25	Oily water separator alarm	0
26	Coolant temperature alarm	0

*1) See "Application interface outline" for details on accelerator sensor setting. The applied speed limit at the time of accelerator sensor failure has the different map from the other failure speed limit, so that the special speed at the time of accelerator sensor failure can be set.

*2) **Table 14-14** shows the number inside.

Alarm/failure detection conditions depend on the setting of the flags shown in **Table 14-22**.

Table 14-22 Alarm/failure detection condition setting flags

No. *1)	Failure item	Failure detection conditions
2	Accelerator sensor failure	APS terminal function assignment flag
7	Backup speed sensor failure	RENRPM terminal function assignment flag
8	CAN communication failure	Application function assignment flag
11	Starting aid relay failure	Starting aid relay failure detection setting flag
12	Main relay failure	Power supply self-holding feature assignment flag
14	Backup accelerator sensor failure	REAN terminal function assignment flag
15	Reserve	
16	Oil pressure switch failure	APP-IP2 terminal function assignment flag
17	Charge switch failure	APP-IP3 terminal function assignment flag
20	ECU overheat alarm	ECU overheat alarm setting flag
21	Oil pressure low	APP-IP2 terminal function assignment flag
22	Charge failure	APP-IP3 terminal function assignment flag
23	Reserve	Ål
24	Air cleaner blockage alarm	APP-IP5 terminal function assignment flag
25	Oily water separator alarm	APP-IP6 terminal function assignment flag
26	Coolant temperature high alarm	Cool temperature alarm setting flag

*1) **Table 14-14** shows the number inside.

Lamp check functional description

All lamps will illuminate for approx. 2 seconds for lamp disconnection check when the E-ECU's power supply is turned on (at the time of turning on the key switch). Check the lamp, when lamp isn't illuminated at the time of turning on the key switch.

Table 14-23 Lamp output of the Eco-governor

Lamp name	E-ECU I/O name	E-ECU I/O number
Failure lamp	FAIL-LMP	E12
Preheat lamp	PREHT-LAMP	E23
Coolant temperature alarm lamp	APP-OP2	E2
Speed change indication lamp		

Engine diagnosis tool function outline

The Yanmar genuine engine diagnosis tool can perform the E-ECU monitoring/diagnostics/setting of Gen2 Eco-governor. The engine diagnosis tool function is described in the tool manual. The following is supplementation of some functions.

Data monitor and logging functions

Table 14-24 shows the data that can be monitored/logged. The data that can be monitored/logged by default is shown in **Table 14-24** (17 types of freeze flame data shown in the left half side in the middle). In addition to these 17 items, 8 items can be selected from the 19 items shown in the right half side in the middle of **Table 14-24**.

Table 14-24 lists the monitor/logging enabled data

Freeze flame date (FFD) *1)			Optional logging data *2)		
I/O		Symbol	I/O		Symbol
1	Standard engine target speed	RES	21	Accelerator sensor position	APP
2	Final engine target speed	ERSF	22	Camshaft speed	CMRS
3	Actual engine speed	ES	23	Backup speed	AUXRSS
4	Target rack position	REQRP	24	EGR target opening	REVCV
5	Actual rack position	ACTRP	25	Maximum rack position	RMAX
6	EGR actual opening	AEVCV	26	Idling rack position	RIDLE
7	Coolant temperature	ECT	27	Minimum rack position	RMIN
8	Gross engine load factor	ELRG	28	Net engine load factor	LOAD
9	Engine start recognition	ESSS	29	Speed control P gain	GCPG
10	Target rack current	RCV	30	Speed control I gain	GCIG
11	ECU temperature	EET	31	Speed control D gain	GCDG
12	Battery voltage	BV	32	Rack circuit	RAC
13	Accumulated engine run time	ERH	33	Rack position control conditions	RCS
14	Contact input1	DIS1	34	Virtual droop correction amount	DCV
15	Contact input2	DIS2	35	Reverse droop correction amount	RDCV
16	Contact output1	DOS1	36	Engine acceleration flag	EAF
17	Contact output2	DOS2	37	Engine deceleration flag	EDF
18	-	-	38	Engine stop factor flag	ESWS
19	-	-	39	Sensor 5V voltage	SSV
20	-	-	40	-	-

*1) The 17 items data recorded by FFD function is also recorded by data logging function.

*2) In the data logging function, 8 types of the optional logging data can be selected and recorded in addition to the 17 FFD items.

Logging function

The E-ECU saves engine logs inside the internal EEPROM. The Yanmar genuine engine diagnosis tool can indicate these logs. See the Yanmar engine diagnosis tool instruction manufal for details.

The E-ECU saves engine logs in the internal EEPROM by utilizing power supply self-holding feature (default) when the E-ECU's power is turned off. When the power supply self-holding feature isn't used, the logging function data cannot be guaranteed.

Table 14-25 List of logging function

I/O	Instruction	Record accuracy
Accumulated E-ECU energization	Time connected to the E-ECU.	Record: 1s unit
Accumulated engine run	Time for engine run	Record: 1s unit
Accumulated engine run time at alarm (total)	Fixed error condition*1) for the engine run time at (deletion impossible)	Record: 1s unit
Accumulated engine run time at alarm (trip)	Fixed error condition*1) for the engine run time at (deletion impossible)	Record: 1s unit
Number of engine start	Number for engine run	Number of start completion:
Load factor profile	Average value of 1-minute engine speed and engine load factor in 10 minutes interval is calculated. Calculated corresponding frequency is recorded in the cell of the speed and load factor frequency map*2) separately regulated.	Record: 0.167 hour unit (Indication: 0.2 hour unit)
Error log	for each error code, first time of occurrence, latest time of occurrence, number of all occurrence and FMI at the latest occurrence are recorded. By default, time of occurrence is engine run time*3)	Number of occurrence: maximum 127 times First time of occurrence: 0.05 hour Latest time of occurrence: 0.05 hour FMI at the latest occurrence
Freeze flame date (FFD)	Two-times data ñ 1s and 2s before the error occurrence is recorded Record subject error *4) is 4 items Number of FFD data *5) is 17 items	10 times (Disappearance after the 10th time)
Engine stop factor	Engine's stop factor *6) and accumulated engine run time at occurrence are recorded	Latest 50 times
Starter motor start prevention factor	Starter's stop factor *7) and accumulated engine run time at occurrence are recorded	Latest 50 times

*1) Fixed error indicates coolant temperature high alarm, EGR failure, oil pressure low, and ECU overheat alarm.
*2) See **Table 14-26** for details of frequency map.
*3) Selection is possible from accumulated engine run time, ECU total time, and CAN acquisition time (optional)
*4) See **Table 14-27** for details of the subject error recorded in the FFD record
*5) See **Table 14-24** for details of the data types included in the FFD
*6) See **Table 14-28** for details of engine stop factor.
*7) See **Table 14-28** for details of starter motor start prevention factor.

Table 14-26 The use frequency map of engine speed vs. load factor use

		Engine speed [min^{-1}]							
		Less than 1000	Less than 1200	Less than 1500	Less than 1800	Less than 2000	Less than 2300	Less than 2500	More than 2500
Engine load factor [%]	Less than 20%	Frequency	Frequency	Frequency	Frequency	Frequency	Frequency	Frequency	Frequency
	Less than 40%	Frequency	Frequency	Frequency	Frequency	Frequency	Frequency	Frequency	Frequency
	Less than 50%	Frequency	Frequency	Frequency	Frequency	Frequency	Frequency	Frequency	Frequency
	Less than 60%	Frequency	Frequency	Frequency	Frequency	Frequency	Frequency	Frequency	Frequency
	Less than 70%	Frequency	Frequency	Frequency	Frequency	Frequency	Frequency	Frequency	Frequency
	Less than 80%	Frequency	Frequency	Frequency	Frequency	Frequency	Frequency	Frequency	Frequency
	Less than 90%	Frequency	Frequency	Frequency	Frequency	Frequency	Frequency	Frequency	Frequency
	More than 90%	Frequency	Frequency	Frequency	Frequency	Frequency	Frequency	Frequency	Frequency

Note: Frequency is the result of speed and load factor 1-minute average over 10 minutes interval

Table 14-27 List of errors for the FFD record

Item	DTC code
Engine overspeed	P0219
Rack position sensor failure	P1202, P1203
Rack actuator failure	P1211, P1212, P1213
Rack actuator relay failure	P1222, P1223

Table 14-28 List of engine stop factor and starter motor start prevention factor

Engine stop factor flag		Starter motor start prevention factor flag	
Factor	Flag position	Factor	Flag position
Engine stall	bit0	Safety relay function	bit0
Key switch	bit1	In rack self-diagnosis	bit1
Engine stop switch (E15)	bit2	External switch (E24, E17)	bit2
Engine stop2 switch (E13)	bit3	Immobilizer (CAN message)	bit3
Speed sensor failure	bit4	Control for duration of energization	bit4
Rack actuator system failure	bit5	ICAN message	bit5
E-ECU trouble - ROM	bit6	Engine stop switch (E15, E13)	bit6
Engine overspeed	bit7	Key switch off	bit7
E-ECU trouble - MAP	bit8	Rack self-diagnosis defection	bit8
Engine run at failure flag *)	bit9	E-ECU trouble	bit9
In EEPROM initialization	bit10	Engine overspeed Engine run at failure flag *)	bit10
E-ECU trouble - EEPROM	bit11	In performing service maintenance	bit11
ICAN message	bit12	E-ECU trouble - EEPROM	bit12
-	bit13	Rack actuator system failure	bit13
-	bit14	-	bit14
-	bit15	-	bit15

*) At the time of engine stop by the operation flag setting (=6) in **Table 14-21**

Tuning function

Tuning at the time of machine installation is possible for the E-ECU's engine control. In this kind of tuning is basically not needed. However, only when Yanmar judges the necessity of the matching with the machine, it will be implemented by Yanmar.

This tuning is done by the engine diagnosis tool to change the EEPROM data on each individual E-ECU. Therefore, changing the E-ECU's engine model-specific control map is required in order to apply to the mass-produced engines.

Table 14-29 Tuning function outline

I/O		Instruction
1	Start degradation measurement control	This adjustment is used to increase the start injection amount provisionally from the engine diagnosis tool for testing, when the start is reduced due to the wear out of fuel injection pump plunger.
2	Accelerator filter change	The adjustment is used to change the responsiveness of target engine speed for testing, when there is a problem in engine speed control of the Eco-governor. See **Accelerator filter (P.14-66)** for details.
3	Governor gain simple adjustment	The adjustment is used to change the control gain of engine speed control for testing, when there is a problem in engine speed control of the Eco-governor.
4	Rack position control adjustment	If the engine vibration mount is inappropriate, there are cases in which the engine vibration may influence the rack position control. The adjustment is used to change the control gain of rack position control for testing, when there is a problem in engine speed control of the Eco-governor.

FUEL INJECTION PUMP

At the time of harness creation, watch for the polarity of rack actuator solenoid and speed sensor.

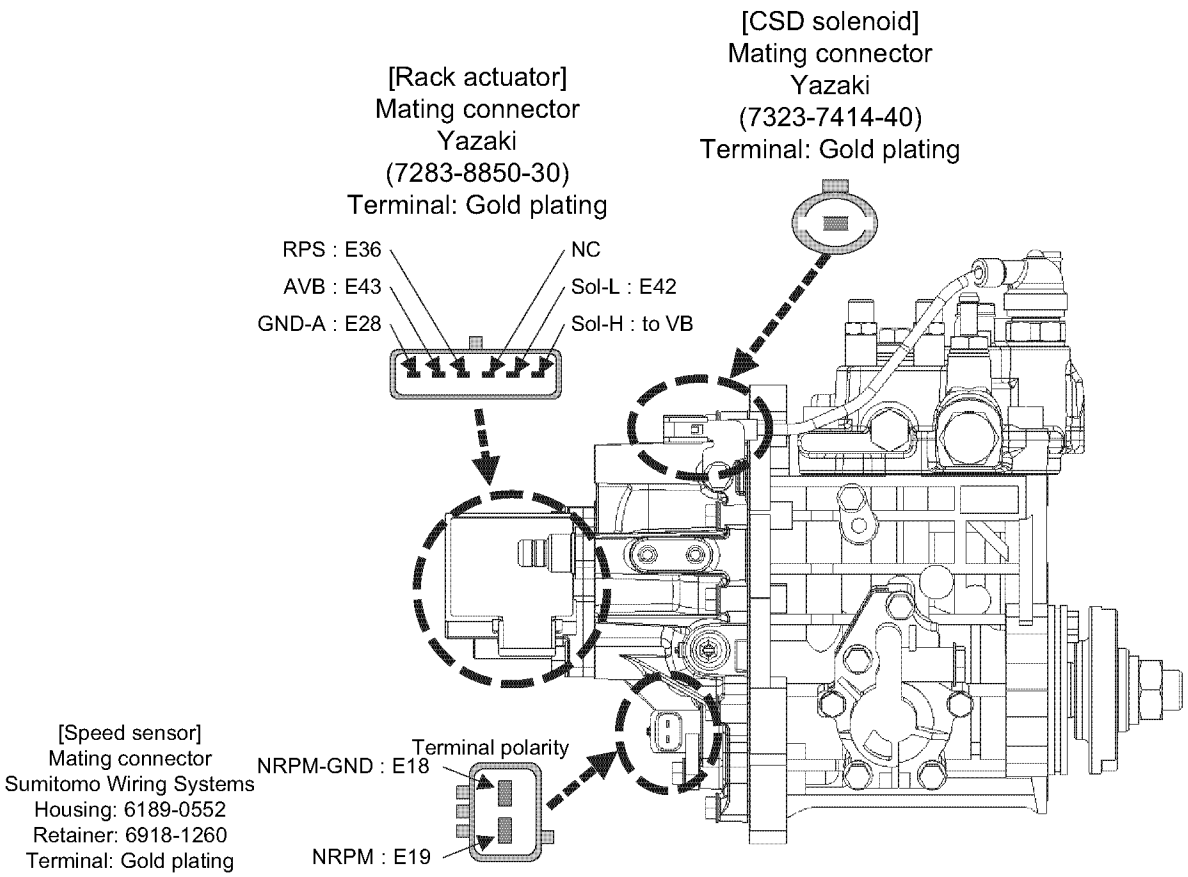
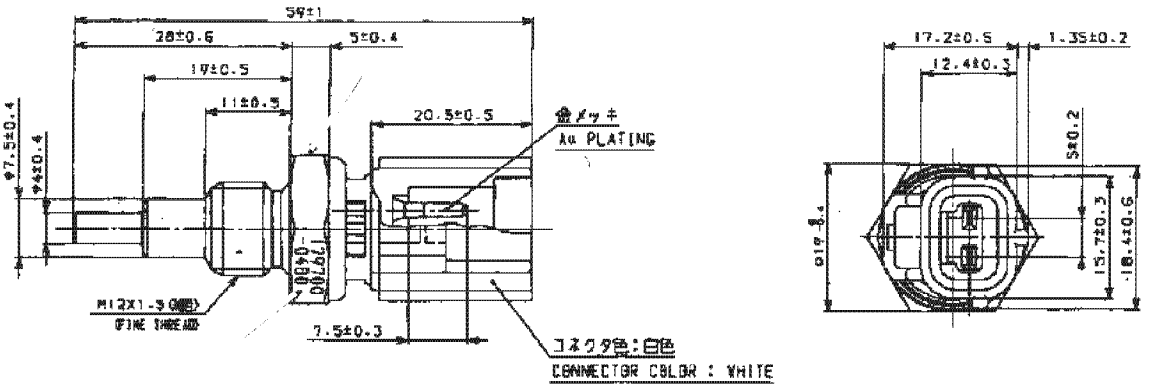


Fig. 14-64 **Connectors applicable to the fuel injection pump**

COOLANT TEMPERATURE SENSOR

The coolant temperature sensor comprises a thermister and provides control to the Eco-governor.



Mating connector
Tyco Electronics AMP
Housing: 178390-2
Reset contact: 171662-5
Rubber plug: 172888-2
Terminal: Gold plating

Fig. 14-65 **Coolant temperature sensors (129927-44900)**

EGR VALVE

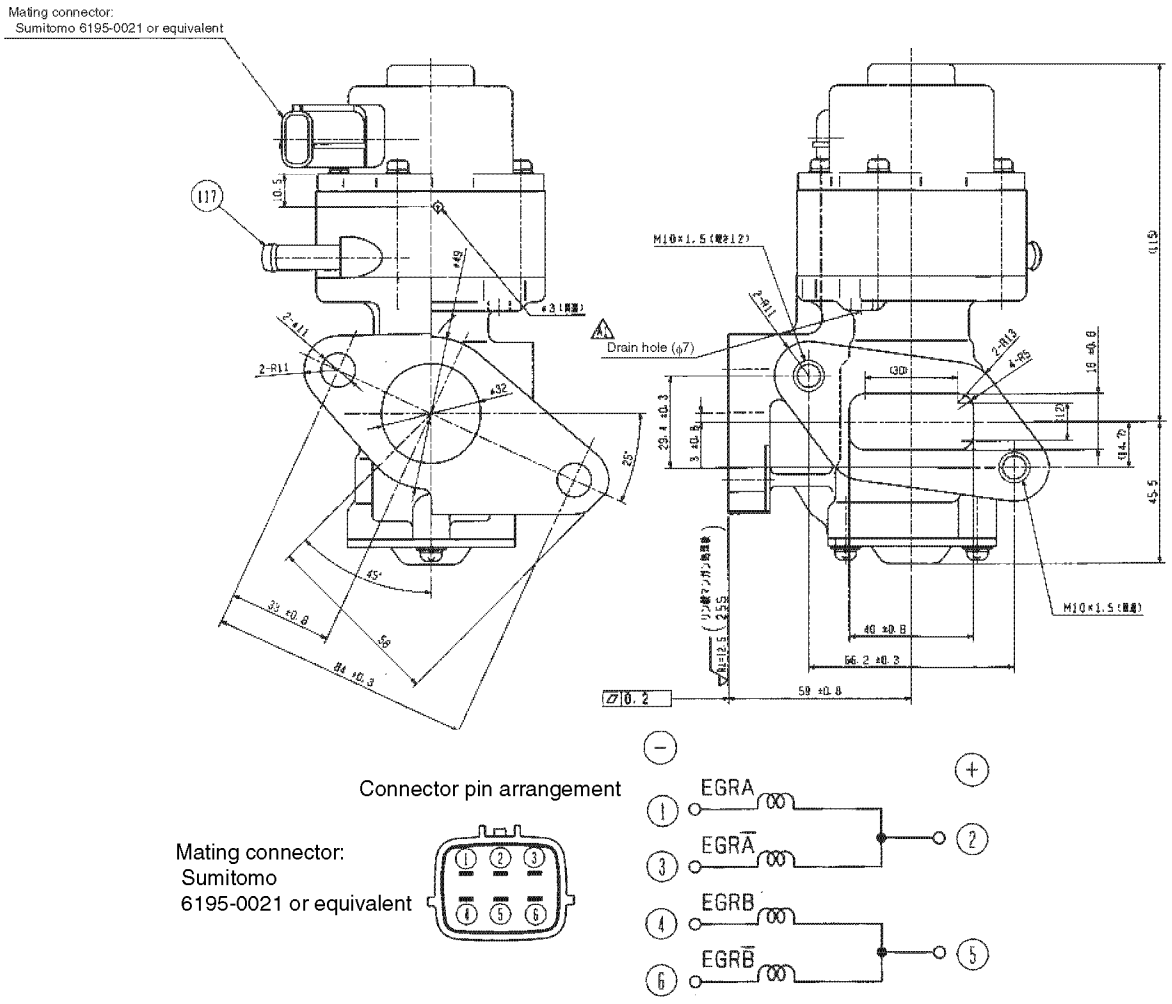
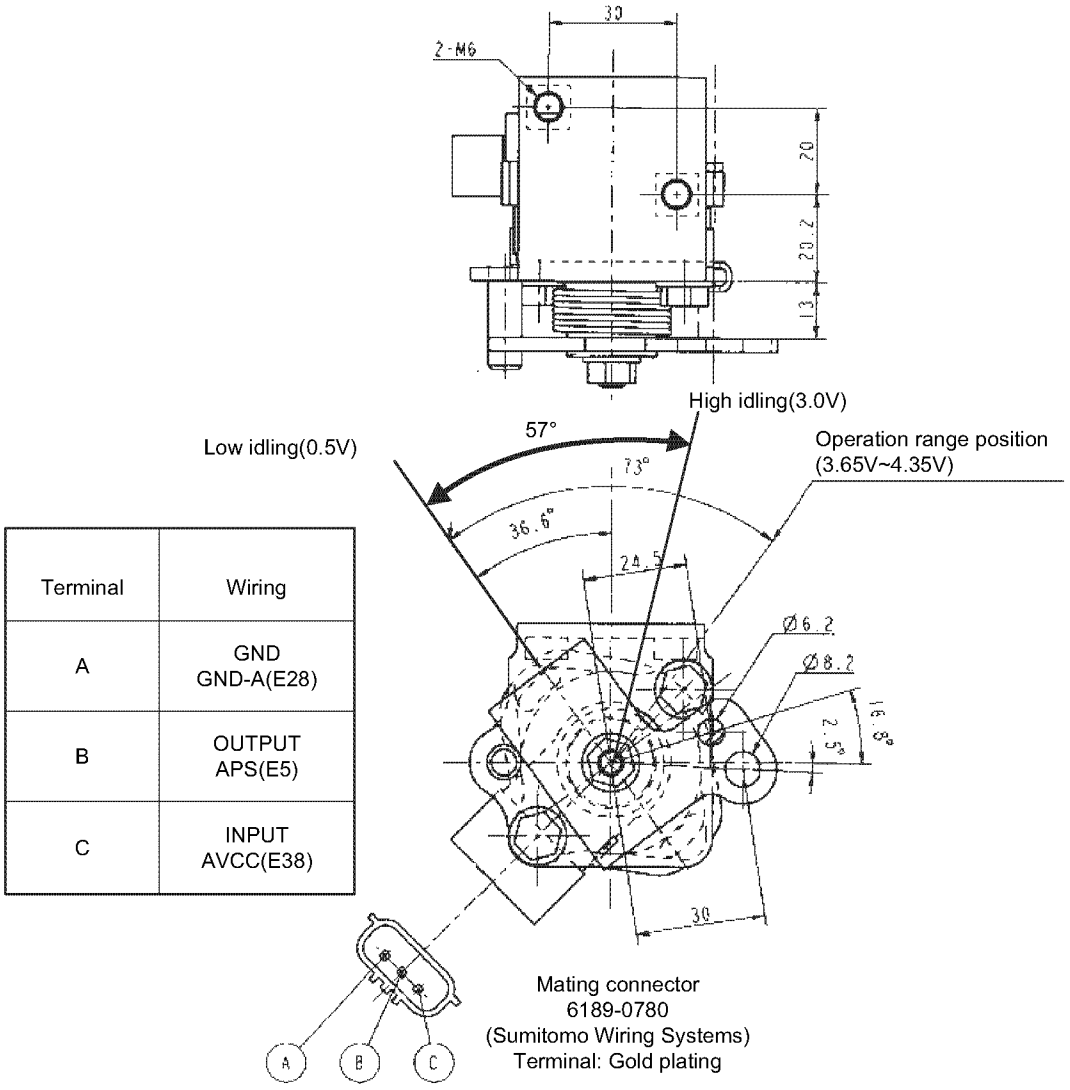


Fig. 14-66 **EGR valve outline**

ACCELERATOR SENSOR

The Eco-governor has no governor lever unlike a mechanical governor and requires an accelerator sensor to set the engine speed. Use a Yanmar standard accelerator sensor (see **Fig. 14-67**) or equivalent. See **Fig. 14-2**, **Table 14-5**, **Accelerator sensor (P.14-86)**, **Accelerator input selection (P.14-48)** for general requirements on accelerator.

Constant speed engines for generators may require no accelerator sensor. Contact Yanmar for details.



Terminal	Wiring
A	GND GND-A(E28)
B	OUTPUT APS(E5)
C	INPUT AVCC(E38)

Fig. 14-67 **Yanmar standard accelerator sensor (129938-77800)**

Installation requirements of the Yanmar standard accelerator sensor:

(1) Waterproofness

In order to avoid water suction, water infiltration, and terminal corrosion, watch out for the following:

- Ensure no water is trapped inside the sensor axis or connector of the sensor.
- Install the sensor in such an area that is not subject to steam or high-pressure water for cleaning.
- Do not strain the harness. Doing so may damage waterproof seals, causing water to intrude into the harness.

(2) To protect against vibrations

To prevent abrasion or deterioration of potentiometer resistance elements and disconnection of the harness, observe the following:

- Install the sensor in such an area that is not subject to vibration of more than 2.4 Grms (5 to 1000 Hz in all directions).
- Install the sensor so that no resonance is produced.
- Install the sensor so that the sensor lever arm does not suffer vibration due to vibrations of the accelerator lever or wire cable. (Secure the accelerator lever and wire cable to the same member, for example). Ensure the fluctuation in output voltage of the accelerator sensor due to vibrations falls within a range of 1.6 mVp-p or less.

(3) To protect against noise

In order to prevent voltage fluctuation, watch out for the following:

- Ensure the cable length between the E-ECU and the accelerator sensor does not exceed 5 m.
- Do not lay the cable near noise sources such as large power devices. If it is inevitable to install the cable near noise sources, use a twisted or shielded cable.
- Ensure the fluctuation in output voltage falls within a range of 50 mVp-p or less.

(4) Others

- Do not use sensors that have suffered drop impact or visible damage.

Table 14-30 Accelerator sensor specifications

Rated voltage	5 VDC 0.01 V
Part Number	129938-77800
Total resistance (sensor alone)	5 ± 1.5kΩ
Working temperature range (sensor alone)	-30°C ~ 110°C
Storage temperature range (sensor alone)	-40°C ~ 130°C

MAIN RELAY

The main relay provides power to the E-ECU, rack actuator, EGR valve etc. It contains a diode that prevents contact operation in case of reverse connection of the excitation coil. See **Fig. 14-4** for electrical connection of the starting aid relay.

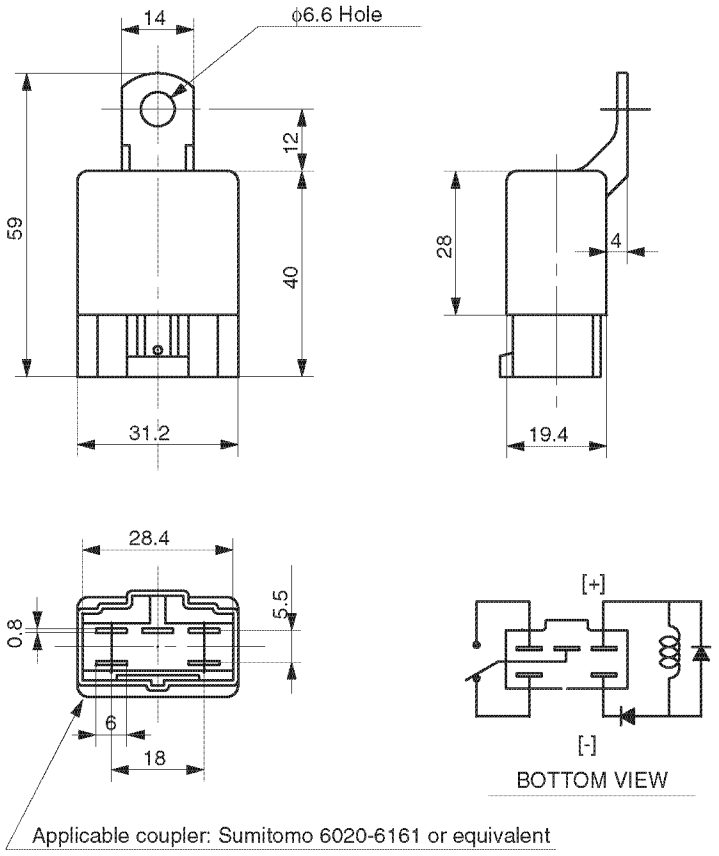


Fig. 14-68 **CA relay**

Table 14-31 CA relay specifications

Part Number	198461-52950
Coil rated voltage	12 VDC
Rated excitation current	150mA
Contact type	c-contact
Contact rated voltage	12 VDC
Contact rated current	20 A continuous/100a-0.1s

RACK ACTUATOR RELAY

The rack actuator relay provides power to the rack actuator. The standard sub relay is the same as the main relay. It also contains a diode that prevents contact operation in case of reverse connection of the excitation coil. But this diode is not necessarily required for the rack actuator relay. See **Fig. 14-4** for electrical connection of the starting aid relay.

SUB RELAY

The sub relay provides power to the trouble monitor lamp on the panel or external switches. The standard sub relay is the same as the main relay. It contains a diode that prevents contact operation in case of reverse connection of the excitation coil. See **Fig. 14-4** for electrical connection of the starting aid relay.

STARTER RELAY

The starter relay controls power to terminal S of the starter. See **Fig. 14-4** for electrical connection of the starting aid relay.

This starter relay is applicable to 12 VDC/2.3 kW starters (129900-77010, 129910-77022) and 12 VDC/3.0 kW starter (129940-77010). Contact Yanmar for confirmation on application for the other starters.

As ISO relays have no bracket, a metal bracket compatible with the mating connector (Yazaki 7223-6146-30) is available. See **Fig. 14-70**.

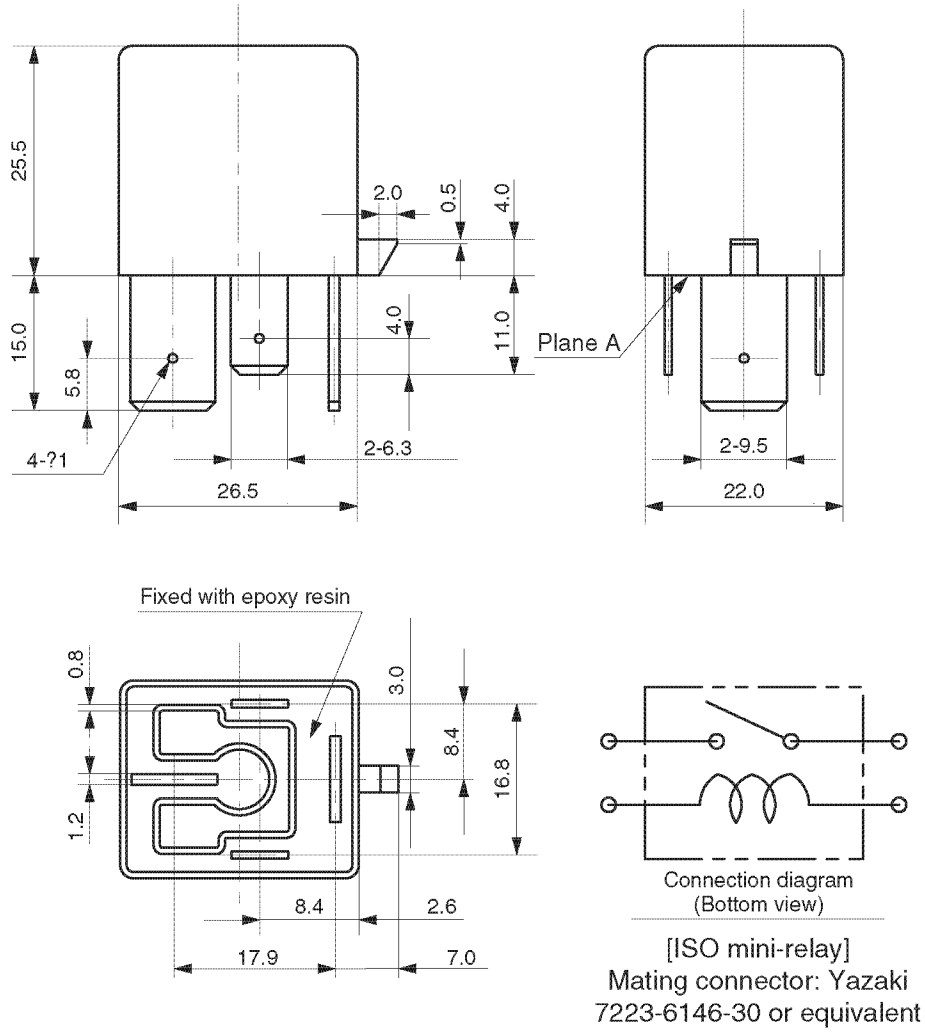


Fig. 14-69 **ISO relay (70A)**

Table 14-32 Specifications of ISO relay (70A)

Part Number	129927-77920
Coil rated voltage	12 VDC
Rated excitation current	117mA
Contact type	a-contact
Contact rated voltage	12 VDC
Contact rated current	70A
Operation delay time	15ms Max.
Recovery delay time	15ms Max.

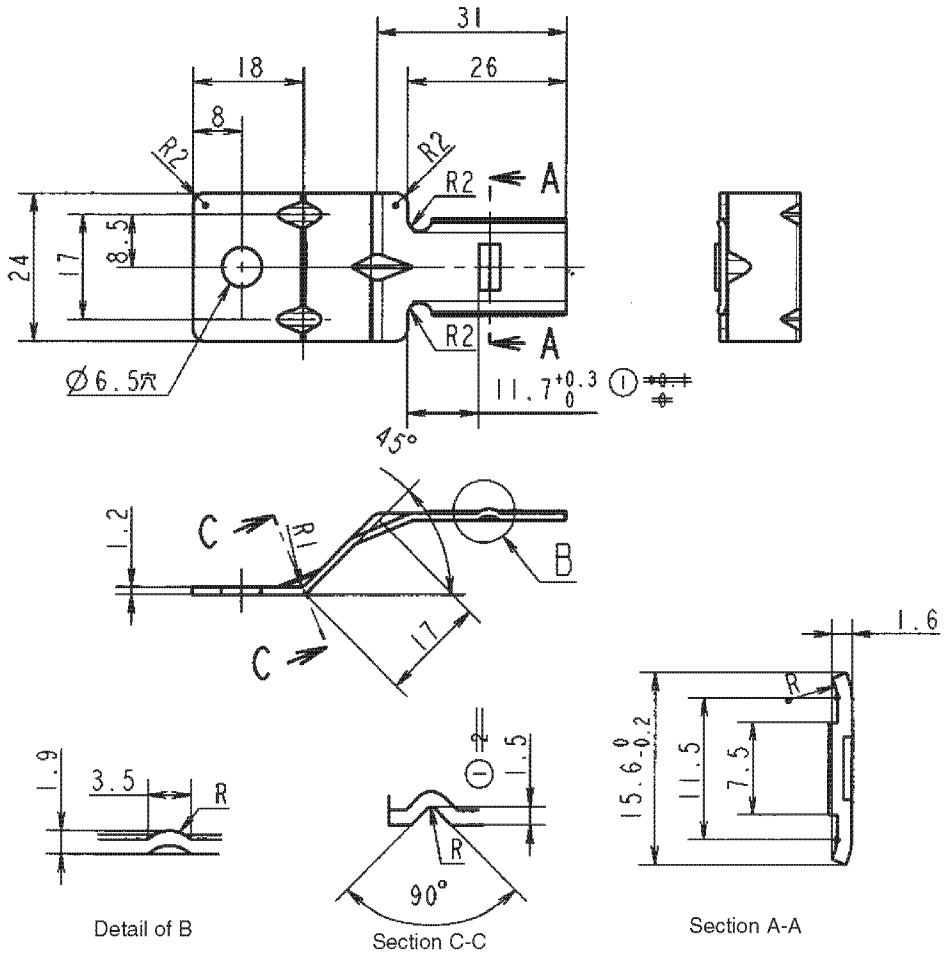


Fig. 14-70 **Bracket for ISO relay (129927-77910)**

STARTING AID RELAY

The starting aid relay controls power to the air heater or glow plug. See **Fig. 14-4** for electrical connection of the starting aid relay. Three types of starting aid relays are available depending on the load capacity.

For 400 W air heater (glow plug)

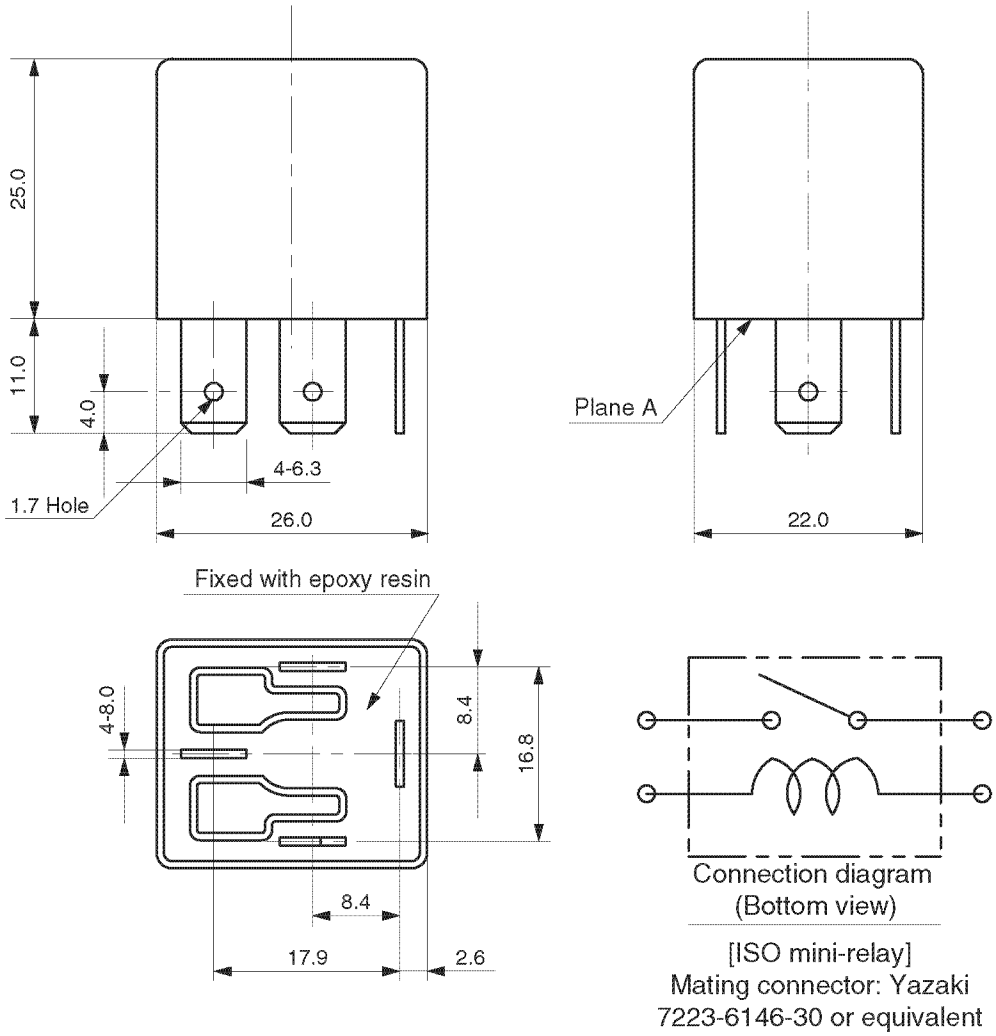


Fig. 14-71 **ISO relay (40A)**

Table 14-33 Specifications of ISO relay (40A)

Part Number	129927-77930
Coil rated voltage	12 VDC
Rated excitation current	117mA
Contact type	a-contact
Contact rated voltage	12 VDC
Contact rated current	40A-continuous

As ISO relays have no bracket, a metal bracket compatible with the mating connector (Yazaki 7223-6146-30) is available. See **Fig. 14-70**.

For 500/800 W air heater

The relay for 500/800 W air heater is the same as the starter relay (129927-77920).

For 1000 W air heater

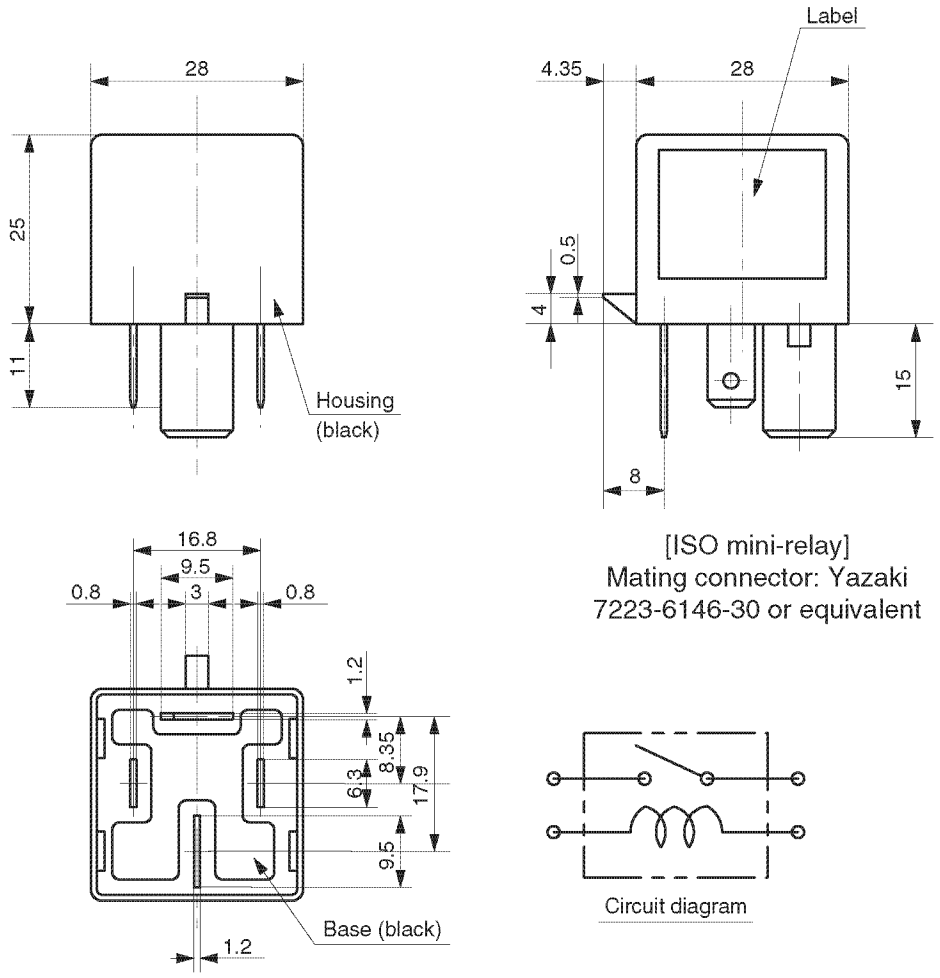


Fig. 14-72 **ISO relay (90A)**

Table 14-34 Specifications of ISO relay (90A)

Part Number	129927-77900	
Coil rated voltage	12 VDC	
Rated excitation current	200mA	
Contact type	a-contact	
Contact rated voltage	12 VDC	24 VDC
Contact rated current	Resistive load: 90A for 4 minutes	Resistive load: 55A for 4 minutes Inductive load: 19A for 30 seconds

THE ECO-GOVERNOR CHECKLIST

No.	I/O	Result		
		Design	Installation	Remarks
Control system design and check				
1	Is alternator's charging capacity enough? Besides starting aid, E-ECU, Eco-governor (pump, CSD), EGR valve, E-ECU lamp, and E-ECU relay require 4 - 5A consumption current for the engine control.	OK/NG (A)	-	
2	Is the E-ECU's connector installed facing downward? Avoid the installation method that makes water trapped inside coupler in ECU side or water trapped in coupler in harness side ? it may cause the connector terminal to rust.	OK/NG (deg)	OK/NG (deg)	
3	Is the E-ECU installed in a location that is well ventilated and not subject to direct sunlight? it will result in malfunction by high temperature and discoloration by sunlight.	OK/NG	OK/NG	
4	Is the E-ECU installed in a location that is not subject to steam or high-pressure water for cleaning? It will result in connection malfunction and make connector terminal to rust.	OK/NG	OK/NG	
5	When the salt damage is thought, is the salt damage prevention cover installed in the E-ECU? When the aluminum part of the E-ECU becomes rusty, it will result in malfunction such as flaking off molding.	OK/NG	OK/NG	
6	Is the engine trouble indication means (the trouble monitor lamp, etc.) located so as to be easily visible to the operator. The engine performance is not assured at the trouble conditions (flash of the trouble monitor lamp, etc.).	OK/NG	OK/NG	
7	Is the connector for the engine diagnosis tool located so as to be easily maintained? The connector for the engine diagnosis tool is essential for the E-ECU's maintenance.	OK/NG	OK/NG	
8	Is the E-ECU located where the regulatory environmental conditions are satisfied? (See the installation assessment report for environmental requirements).	-	OK/NG	
9	Is the accelerator sensor located where the regulatory environmental conditions are satisfied? (See the installation assessment report for environmental requirements). Never install the Yanmar genuine accelerator sensor (129938-77800) to engine or fuel injection pump body.	-	OK/NG	
10	Are the engine type and manufacturing number matching the engine nameplate and E-ECU label? The engine performance is not assured except the regulated combination.	-	OK/NG	
11	Is the trouble monitor lamp flashing after the 2 seconds illumination at the time of turning on the key switch? (When the other engine trouble indication means besides the trouble monitor lamp are utilize, is there the trouble indication by that means?) The engine performance is not assured at the trouble conditions (flash of the trouble monitor lamp, etc.).	-	OK/NG	
12	Is the engine diagnosis tool in operation?	-	OK/NG	
13	Is the E-ECU power voltage at the time of getting over cranking increase to more than 6.0 V by measuring between the VB terminal (E48) and the GND terminal (E45)? Especially, the evaluation at cold start and battery degradation is requested.	-	OK/NG (V)	

No.	I/O	Result		
		Design	Installation	Remarks
14	In the engine run conditions, low idling, high idling, rated load, middle load, check the following. Check is conducted by using the engine diagnosis tool. • Engine speed fluctuation: the difference between maximum and minimum value of the engine speed in 10s. • Rack deviation: the difference in average value of target rack position and actual rack position in 10s. • Rack deviation: the difference in average value as well as maximum and minimum value of target rack position and actual rack position in 10s. (Report the result to Yanmar. The judgment is made by Yanmar).	-	Speed fluctuation = (min^{-1}) Rack deviation = (AD) Rack fluctuation = (AD)	
Electrical component design and check				
15	Is the E-ECU's lamp load such as the trouble monitor lamp lower than 12 V/3.4 W?	OK/NG (W)	-	
16	Is the minimum working current of switches directly connecting to the E-ECU not exceeding 10 mA? The contact input current of the E-ECU is 10mA at the rated voltage of 12 V. Do not use the switches that require more contact current.	OK/NG (mA)	-	
17	Is the Yanmar genuine coolant temperature sensor used for the E-ECU? Also, is the load besides the E-ECU connected to the E-ECU's TW terminal (E25)?	OK/NG	-	
18	When the oil pressure switch (such as 119761-39450) is connected to the E-ECU's APP-IP2 terminal (E14), is resistance or lamp connected to enable the contact circuit of the oil pressure switch to become more than 100mA? An instantaneous power interruption of 1 ms or longer of the E-ECU power supply may cause trouble including changing the engine speed and hindering the engine from starting.	OK/NG (mA)	-	
19	Is the alternator'sIG terminal independent from the circuit of the E-ECU's IGNSW terminal (E7) and the E-ECU's RACK-RLY terminal (E33) from the rack actuator relay? In some alternators, the generated current flows in reverse from the IG terminal.In this case, the engine may not stop even the key switch is turned off.When the circuit cannot be made independent, install diode in the IG terminal to avoid the current to flow in reverse from the IG terminal. When the Yanmar genuine alternator is used, this check isn't required.	OK/NG	-	
20	The key switch: the E-ECU power supply current not open between the ON and Start positions ñ is this kind of key switch used? Having more than 10ms momentary power failure at the time of returning the key switch from the Start to ON positions may cause trouble including changing the engine speed and hindering the engine from starting.Be noted that the above-mentioned trouble tends to occur easily to the key switch at cold temperature.	OK/NG	OK/NG (ms)	
21	When using the CAN terminal resistor inside the ECU, are E30 and E39 connected with a jumper as short as possible? When using the CAN terminal resistor inside the ECU, are E30 and E39 connected with a jumper as short as possible?	Short/ Open	-	
22	Are the E-ECU terminals loads other than intended or specified connected?	OK/NG	-	
Wiring harness design				
23	Is the E-ECU's GND terminal (E45, E47) earthed one point as closely as possible to the battery minus terminal?	OK/NG	OK/NG	
24	Is the main relay fuse's power supply side circuit directly branched from the battery plus terminal? If the main relay's power supply circuit is branched from the starter B terminal and other large current device, it will be difficult to maintain the E-ECU power supply voltage of more than 6.0 V due to the voltage drop.	OK/NG	-	

No.	I/O	Result		
		Design	Installation	Remarks
25	Is the capacity of main relay fuse 10A and connected besides the E-ECU, rack actuator relay, and EGR valve? The main relay circuit (E-ECU, rack actuator relay, EGR valve) is an important function.Have an independent fuse circuit from the other electrical devices.	OK/NG (A)	-	
26	Is the main relay power supply circuit connected with the E-ECU's power supply self-holding feature? Is the main relay's connection in accordance with the referential electrical connection diagram?	OK/NG	-	
27	Is branching of the E-ECU, rack actuator relay, and EGR valve made as closely as possible to the E-ECU's VB terminal (E48)? (within 220mm from the VB terminal is recommended).	OK/NG (mm)	-	
28	Is the rack actuator relay connected with contact off (rack actuator power supply interruption) by the key switch? Is the rack actuator relay's connection in accordance with the referential electrical connection diagram? Even if some trouble is occurred in the main relay and power supply self-holding feature, the engine can be stopped by shutting off the rack actuator's power supply by the key switch.	OK/NG	-	
29	Is the connection enable the starter motor start prevention by starter relay? Is the starter relay's connection in accordance with the referential electrical connection diagram? During the rack self-diagnosis at the E-ECU's power on, the starter movement must be prevented.	OK/NG	-	
30	Is the key switch's start position signal connected to the E-ECU's STARTSW terminal? Is the engine start signal (E8) connected in accordance with the referential electrical connection diagram? In the E-ECU, the engine start signal (E8) must be entered for injection to start even when the starter is working.Also, be noted that when the starter start isn't checked by the speed sensor (E18, E19) even with the STARTSW terminal (E8) entered in the E-ECU, the speed sensor failure is detected.	OK/NG	-	
31	Is the Yanmar genuine relay (198461-52950) used for the main relay and sub relay, or diode for the protection against reverse connection installed? Diode is required to protect the E-ECU from the reverse connection of battery cable.	OK/NG	-	
32	Is the cable length from battery to main relay fuse less than 4m? The numerical value is the length that confirms the engine performance by Yanmar.	OK/NG (m)	-	
33	Is the total cable length from the main relay fuse to the E-ECU's VB terminal (E48), GND terminal (E45) to battery less than 5 m? The numerical value is the length that confirms the engine performance by Yanmar.	OK/NG (m)	-	
34	Is the total cable length from the main relay fuse to the main relay, from the main relay to the rack actuator relay, from the rack actuator relay to the rack actuator, from the rack actuator to the E-ECU's RACSOL terminal (E42), from the E-ECU's GND-P terminal (E47) to battery less than 10 m? The numerical value is the length that confirms the engine performance by Yanmar.	OK/NG (m)	-	
35	Is a twisted-pair cable used for the speed sensor?	OK/NG	-	
36	Is a shield + twisted-pair cable used for the CAN communication (E39, E49) connection?	OK/NG	-	
37	Is an appropriate fuse used to meet the load's requested current and the electric cableís allowable current? When design is inappropriate, fuse may often interrupted and cause the harness fire.	OK/NG	-	

No.	I/O	Result		
		Design	Installation	Remarks
38	Is the design allow to branch the circuit that requests a large current of more than 10 A (starter and starting aid, etc.) and a small current of a few A (E-ECU, fuel feed pump, etc.) from the same fuse circuit? Such a design may cause malfunction including widening the cable road of the small current circuit when combined with the large current circuit fuse capacity.Group the fuse circuit by function and requested electrical current.	OK/NG	-	
39	Are electric cables whose heat resistance is appropriate to surrounding thermal conditions used?. Heat resistant temperature of higher than 100°C is recommended for the harness surrounding the engine.	OK/NG (°C)	-	
Wiring harness installation				
40	Is the harness cramped to appropriate structures so as to prevent vibrations? Vibration may cause the inside of electrical cable to be disconnected, and short the cable.	-	OK/NG	
41	Is the harness cramp strained? The disconnection is caused.	-	OK/NG	
42	Is the harness installed in the location where it's not pinched or touching the edge part? The disconnection and short are caused.	-	OK/NG	
43	Is there infiltration of water from the non-waterproofed connector terminal and joints? When water is trapped, it may cause corrosion.The water proof processing is recommended, if it's a worrying factor.	-	OK/NG	

ECU APPLICATION MENU

I/O		Unit		Standard machine					
				Base Engine	Backhoe	Tractor	Loader	Generator	Customer's specifications
a) Engine control setting part									
1	Engine specification								
	2 Low idling speed	min^{-1}		-	-	-	-	-	
	5 Managed torque speed	min^{-1}		-	-	-	-	-	
9	Limited speed conditions								
	1 limited speed A speed			1500	1500	1500	1500	1500	
b) Application interface setting part									
1	Application interface outline setting		0: Standard contact 1: Standard CAN 2: Reserve 3: Reserve	0	0	0	0	0	
2	ECU Control function setting								
	Accelerator sensor input								
	1 Setting of accelerator sensor		0: No accelerator sensor 1: APS terminal 2: APS terminal + REAN terminal (high speed or normal side is prioritized) 3: CAN communication 4: CAN communication + APS terminal (CAN communication is prioritized) 5: CAN communication + APS ñ IP5 terminal (CAN communication is prioritized)	1	1	1	1	0	
	2 Low Idling voltage of APS terminal	V		0.7	0.7	0.7	0.7	0.7	
	3 High Idling voltage of APS terminal	V		3.0	3.0	3.0	3.0	3.0	
	4 Low Idling voltage of REAN terminal	V		0.7	0.7	0.7	0.7	0.7	
	5 High Idling voltage of REAN terminal	V		3.0	3.0	3.0	3.0	3.0	
	7 Droop selection input		0: Always isochroous control 1: by APP-IP1 or CAN input 2: Always droop control	1	1	1	1	1	
	8 Isochroous control at low idling		0: Disabled 1: Enabled	0	0	0	0	0	
	9 Reverse Droop selection		0: Always reverse droop disabled 1: by APP-IP5 or CAN input 2: Always reverse droop enabled	1	1	1	1	1	
	11 Power supply self-holding feature		0: Disabled (without failure detection) 1: Control by IGNSW terminal input 2: Control by CAN communication	1 (Essential)	1	1	1	1	
	12 Starter permission motor start prevention function		0: Disabled 1: Enabled - NO-Relay 2: Enabled - NC-Relay: Reseve	1 (Essential)	1	1	1	1	
	13 External switch control function		0: Disabled 1: Enabled	0	0	0	0	0	
	14 Starter duration of energization control function		0: Disabled 1: Enabled	0	0	0	0	0	
	15 Starting aid relay failure detection function		0: Disabled 1: Enabled	1	1	1	1	1	
	16 Starting aid function: ON-glow		0: Disabled 1: Enabled (Disabling is possible by CAN communication command)	1	1	1	1	1	
	17 Starting aid function: simultaneous energization		0: Disabled 1: Enabled (Disabling is possible by CAN communication command)	1 (Essential)	1	1	1	1	
	18 Starting aid function: after heating		0: Disabled 1: Enabled (Disabling is possible by CAN communication command)	0 (1: Recommended)	0	0	0	0	
	19 Speed selection setting		0: Constant speed control, APP-IP6 = toggle switch 1: Constant speed control, APP-IP6 = momentary switch 2: deceleration control, APP-IP6 = toggle switch 3: deceleration control, APP-IP6 = momentary switch 4: Reserve 5: Auto deceleration control, APP-IP6 = toggle switch	0	0	0	0	0	
	20 Auto deceleration waiting time			4	4	4	4	4	
	Constant speed control								
	21 Constant Speed 1	min^{-1}		1800	1800	1800	1800	1800	

I/O		Unit						Standard machine					
							Base Engine	Backhoe	Tractor	Loader	Generator	Customer's specifications
2	22 Constant Speed 2	min^{-1}					1500	1500	1500	1500	1500	
	Deceleration control											
	23 Deceleration start speed	min^{-1}					1500	1500	1500	1500	1500	
	24 Deceleration1	%					85	85	85	85	85	
	25 Deceleration2	%					70	70	70	70	70	
	27 Idling speed up		0: Disabled 1: Enabled				1 (Essential)	1	1	1	0	
	28 Blue and white smoke suppression (high idling speed limitation in cold conditions)		0: Disabled 1: Enabled				0 (1: Recommended)	0	0	0	0	
	37 Coolant temperature alarm setting		0: Disabled 1: Enabled				1	1	1	1	1	
	38 ECU overheat alarm setting		0: Disabled 1: Enabled				0	0	0	0	0	
3	ECU terminal setting											
	1 Logic setting of APP-IP1 terminal		0: Input for NO switch (High is 1) 1: Input for NC switch (Low is 1)				1	1	1	1	0	
	2 Input setting of APP-IP1 terminal function		Setting	Droop selection	Starter permission motor start prevention	Reserve	Reserve	1	1	1	1	1	
			0	Non	Non	-	-						
			1	APP-IP1	CAN	-	-						
			2	CAN	APP-IP1	-	-						
			3	CAN	APP-IP1/ CAN	-	-						
			4	CAN	CAN	-	-						
	3 Logic setting of APP-IP7 terminal		0: Input for NO switch (Low is 1) 1: Input for NC switch (High is 1)					0	0	0	0	0	
	4 Input setting of APP-IP7 terminal function		Setting	Rmax 1	Engine stop2	Reserve	Foot pedal switch-NC	1	1	1	1	1	
			0	Non	Non	-	Non						
			1	APP-IP7	CAN	-	Non						
			2	CAN	APP-IP7	-	Non						
			3	CAN	CAN	-	Non						
			4	CAN	CAN	-	APP-IP7						
			5	CAN	CAN	-	Non						
	5 Logic setting of APP-IP2 terminal		0: Input for NO switch (Low is 1) 1: Input for NC switch (High is 1)					0	0	0	0	0	
	6 Input setting of APP-IP2 terminal function		Setting	Rmax 2	Oil pressure switch	Reserve	Foot pedal switch-NO	1	1	1	1	2	
			0	Non	Non	-	Non						
			1	APP-IP2	CAN	-	Non						
			2	CAN	APP-IP2	-	Non						
			3	CAN	CAN	-	Non						
			4	CAN	CAN	-	APP-IP2						
			5	CAN	CAN	-	Non						
	7 Logic setting of APP-IP3 terminal		0: Input for NO switch (Low is 1) 1: Input for NC switch (High is 1)					0	0	0	0	0	
	8 Input setting of APP-IP3 terminal function		Setting	Speed selection1	Charge failure	Reserve	Reserve	1	1	1	1	1	
			0	Non	Non	-	-						
			1	APP-IP3	Non	-	-						
			2	CAN	APP-IP3	-	-						
			3	CAN	Non	-	-						
			4	CAN	Non	-	-						
	9 Logic setting of APP-IP4 terminal		0: Input for NO switch (Low is 1) 1: Input for NC switch (High is 1)					0	0	0	0	0	

I/O		Unit						Base Engine	Standard machine				Customer's specifications
									Backhoe	Tractor	Loader	Generator	
3	10 Input setting of APP-IP4 terminal function		Setting	Speed selection2	Reserve	Reserve	Reserve	1	1	1	1	1	
			0	Non	-	-	-						
			1	APP-IP4	-	-	-						
			2	CAN	-	-	-						
			3	CAN	-	-	-						
			4	CAN	-	-	-						
	11 Logic setting of APP-IP5 terminal		0: Input for NO switch (Low is 1) 1: Input for NC switch (High is 1)					0	0	0	0	0	
	12 Input setting of APP-IP5 terminal function		Setting	Reverse Droop selection	Air cleaner sensor	Reserve	Reserve	1	1	1	1	1	
			0	Non	Non	-	-						
			1	APP-IP5	Non	-	-						
			2	CAN	APP-IP5	-	-						
			3	CAN	Non	-	-						
			4	CAN	Non	-	-						
			5	CAN	Non	-	-						
	13 Logic setting of APP-IP6 terminal		0: Input for NO switch (Low is 1) 1: Input for NC switch (High is 1)					0	0	0	0	0	
	14 Input setting of APP-IP6 terminal function		Setting	Speed Selection enable	Oily water separator	Reserve	Reserve	1	1	1	1	1	
			0	Non	Non	-	-						
			1	APP-IP6	Non	-	-						
			2	CAN	APP-IP6	-	-						
			3	CAN	Non	-	-						
			4	CAN	Non	-	-						
	15 Logic setting of SHUDNS terminal		0: Input for NO switch (High is 1) 1: Input for NC switch (Low is 1)					0	0	0	0	0	
	16 Setting of APP-OP1 terminal function		0: Starter relay 1: Middle-speed lamp (YN track specifications)					0 (Essential)	0	0	0	0	
	17 Setting of APP-OP2 terminal function		0: Reserve 1: Block heater relay output (block heater is connected) 2: Speed change indication lamp output 0(illuminated during the speed selection permission) 3: Coolant temperature alarm lamp output					3	3	3	3	3	
	18 Input setting of APS terminal function		0: Disabled (without accelerator sensor failure detection) 1: Analog input 2: SAE Foot pedal (NO and NC switch synchronized) 3: SAE Foot pedal (NO switch synchronized) 4: SAE Foot pedal (NC switch synchronized)					1	1	1	1	0	
	19 Input setting of REAN terminal function		0: Disabled (without accelerator sensor failure detection) 1: Analog input 2: SAE Foot pedal (NO and NC switch synchronized) 3: SAE Foot pedal (NO switch synchronized) 4: SAE Foot pedal (NC switch) 5: Atmosphere pressure sensor					0	0	0	0	0	
	20 Setting of RENRPM terminal		0: Backup speed sensor disabled 1: Backup speed sensor enabled (P terminal alternator is connected)					0	0	0	0	0	
4	Operation in failure detection												
	1 Coolant temperature alarm		0: No limitation in operation 1: Speed limitation A 2: Speed limitation B 3: Output limitation 4: Speed limitation A + output limitation 5: Speed limitation B + output limitation 6: Engine stop					0	0	0	0	3	
	2 Coolant temperature start alarm	°C						110	110	100	100	100	
	3 Coolant temperature complete alarm	°C						105	105	105	105	105	

I/O		Unit		Standard machine					
				Base Engine	Backhoe	Tractor	Loader	Generator	Customer's specifications
4	4 Operation at accelerator sensor failure		0: No limitation in operation 1: Speed limitation A 2: Speed limitation B 3: Output limitation 4: Speed limitation A + output limitation 5: Speed limitation B + output limitation 6: Engine stop	1	1	1	1	1	
	6 ECU overheat alarm		0: No limitation in operation 1: Speed limitation A 2: Speed limitation B 3: Output limitation 4: Speed limitation A + output limitation 5: Speed limitation B + output limitation 6: Engine stop	0	0	0	0	0	
	7 ECU overheat start alarm	°C		105	105	105	105	105	
	8 ECU overheat complete alarm	°C		100	100	100	100	100	
	9 Oil pressure low alarm		0: No limitation in operation 1: Speed limitation A 2: Speed limitation B 3: Output limitation 4: Speed limitation A + output limitation 5: Speed limitation B + output limitation 6: Engine stop	0	0	0	0	6	
	11 Operation in air cleaner blockage		0: No limitation in operation 1: Speed limitation A 2: Speed limitation B 3: Output limitation 4: Speed limitation A + output limitation 5: Speed limitation B + output limitation 6: Engine stop	0	0	0	0	0	
	12 Oily water separator alarm		0: No limitation in operation 1: Speed limitation A 2: Speed limitation B 3: Output limitation 4: Speed limitation A + output limitation 5: Speed limitation B + output limitation 6: Engine stop	0	0	0	0	0	
	13 Backup speed sensor activation		0: No limitation in operation 1: Speed limitation A 2: Speed limitation B 3: Output limitation 4: Speed limitation A + output limitation 5: Speed limitation B + output limitation 6: Engine stop	2	2	2	2	2	
	14 Error occurrence time selection		0: Engine stop accumulation time 1: Accumulated E-ECU energization time 2: CAN communication reception time	0	0	0	0	0	
5	CAN setting								
	1 Communication speed		0: 500Kbps 1: 250Kbps	0	0	0	0	0	

Section 15

ON-VEHICLE COMMUNICATION CAN SPECIFICATION

Page

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SCOPE

This document outlines communication protocols of Y-LINK. CAN interface components of Y-LINK system are the serial communication links SAE J1939 and ISO 15765.

Y-LINK allows the following functionality via these communication links.

(a) ECU transmits engine data and active DTCs (Diagnostic Trouble Code) information at regular intervals and previously active DTCs information on request from the monitor equipment via J1939 data link.

(b) Y-LINK allows sharing engine data with electronic monitor displays and vehicle management information system via J1939 data link.

(c) ECU can receive the operation messages from the vehicle control unit via J1939 data link.

(d) ECU transmits and performs diagnostic procedures from TESTER via ISO 15765 data link.

(e) Y-LINK allows transmitting customer requested change to the ECU from the external equipment via ISO 15765 data link.

This document dose not includes communication protocols of ISO 15765.

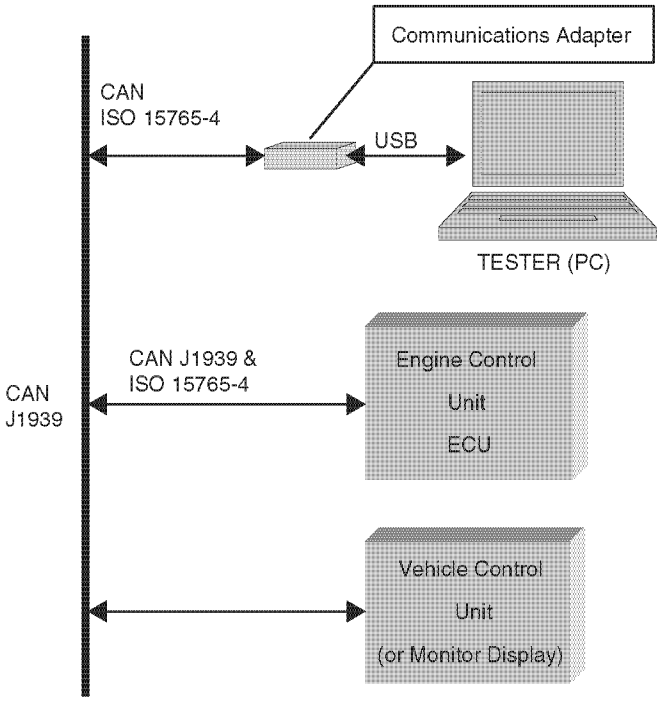

Fig. 15-1 **CAN-BUS Diagram**

COMMUNICATION PROTOCOLS

The following table shows a comparison between J1939 and ISO15765 in OSI Basic Reference Model. The Control column (Y-LINK) indicates the communication methods between the ECU and the vehicle control unit.

Table 15-1 The OSI Seven Layer Model of Y-LINK

Applicability	OSI 7 layer		Diag. on CAN	Vehicle	Y-LINK	
			ISO 15765	J1939	On Vehicle	Diagnostics
Seven layer according to ISO/IEC 7498 and ISO/IEC10731	Physical (layer 1)		ISO11898, ISO15765-4	J1939-13 (ISO11898)	ISO11898	ISO11898
	Data link (layer 2)		ISO11898, ISO15765-4	J1939-21	J1939-21 • Single frame • Multi-packet BAM • Request/Acknowledge • Proprietary B	ISO11898, ISO15765-4
	Network (layer 3)		ISO15765-2, ISO15765-4	J1939-31	-	ISO15765-2, ISO15765-4
	Transport (layer 4)		-	-	-	-
	Session (layer 5)		ISO15765-4	-	-	ISO15765-4
	Presentation (layer 6)		-	-	-	-
	Application (layer 7)	Diagnostics	ISO15031-5	SAE J1939-73	SAE J1939-73(DM1~3)	ISO 14230-3
		Implement	-	-	-	ISO 15765-3
		Drivetrain	-	SAE J1939-71	SAE J1939-71	-
		Management	-	SAE J1939-81	-	-

MESSAGE/FRAME FORMAT

"CAN 2.0B" Extended Frame Format

Nominal bitrate: 500kbps (250kbps is option)

NETWORK LAYER

Addressing

29bit CAN normal fixed addressing

Address mapping (SA)

Table 15-2 Physical addresses of ECU and other electronic equipment

Physical CAN identifier	Description
00H	Physical CAN identifier of ECU
01H	Physical CAN identifier of ECU (#2)
17 (11H)	Physical CAN identifier of Cruise Control Equipment
39 (27H)	Management Computer #1

COMMUNICATION METHODS

- Single frame message : data length =< 8bytes
- Multi-packet Broadcast message : data length > 8bytes
  (Not support Multi-packet RTS/CTS session)
- Multi-packet Broadcast message is used to send DTCs (Diagnostic Trouble Code) and component ID.

Table 15-3 indicates which service item is required which set of Request/Response procedure.

Table 15-3 Request and Response Requirements

No.	Item	Description	Data length	Request PGN 59904	Response	TP* Used
1	J1939-71 Application Layer Send/Receiv Message	Single frame message	≤8bytes	none	DA Global	NA
2	Active Diagnostic Trouble Code	Multi-packet Broadcast message	>8bytes	none	DA Global	BAM*
3	Previously Active Diagnostic Trouble Code, Component ID	On request, Multi-packet Broadcast message	>8bytes	DA Global	DA Global	BAM*
4	Diagnostic Data Clear/Reset of Previously Active DTCs	On request, Acknowledgement	≤8bytes	DA Global	DA Global	NA

* TP=Transport Protocol , BAM=Broadcast Announce Message

RECEIVE and SEND MESSAGE CAN ID SUMMARY

(See Appendix A)

MESSAGE FORMAT

J1939-71 Application Layer

(See Appendix B)

pgn0 - Torque/Speed Control #1 - TSC1 -

Transmission Repetition Rate:	when active; 10 ms to engine
Data Length:	8 bytes
Data Page:	0
PDU Format:	0
PDU Specific:	DA
Default Priority:	3
Parameter Group Number:	0 (0x000000)

Bit Start Position /Bytes	Length	SPN Description	SPN
1.1	2 bits	**Override Control Mode**	695
1.3	2 bits	Requested Speed Control Conditions<N/A>	696
1.5	2 bits	Override Control Mode Priority<N/A>	897
2-3	2 bytes	**Requested Speed/Speed Limit**	898
4	1 byte	Requested Torque/Torque Limit <N/A>	518

pgn61443 - Electronic Engine Controller #2 - EEC2 -

Transmission Repetition Rate:	50 ms
Data Length:	8 bytes
Data Page:	0
PDU Format:	240
PDU Specific:	3
Default Priority:	3
Parameter Group Number:	61443 (0x00F003)

Bit Start Position/Bytes	Length	SPN Description	SPN
1.1	2 bits	**Accelerator Pedal Low Idle Switch**	558
1.3	2 bits	Accelerator Pedal Kickdown Switch<N/A>	559
1.5	2 bits	Road Speed Limit Status<N/A>	1437
2	1 byte	**Accelerator Pedal Position**	91
3	1 byte	**Percent Load At Current Speed**	92
4	1 byte	Remote Accelerator<N/A>	974

pgn61444 - Electronic Engine Controller #1 - EEC1 -

Transmission Repetition Rate:	engine speed dependent
Data Length:	8 bytes
Data Page:	0
PDU Format:	240
PDU Specific:	4
Default Priority:	3
Parameter Group Number:	61444 (0x00F004)

Bit Start Position/Bytes	Length	SPN Description	SPN
1.1	4 bits	**Engine Torque Mode**	899
2	1 byte	Driver's Demand Engine - Percent Torque<N/A>	512
3	1 byte	Actual Engine - Percent Torque<N/A>	513
4-5	2 bytes	**Engine Speed**	190
6	1 byte	Source Address of Controlling Device for Engine Control<N/A>	1483
7.1	4 bits	**Engine Starter Mode**	1675

pgn65188 - Engine Temperature #2 - ET2 -

Transmission Repetition Rate:	1s
Data Length:	8 bytes
Data Page:	0
PDU Format:	254
PDU Specific:	164
Default Priority:	6
Parameter Group Number:	65188 (0x00FEA4)

Bit Start Position /Bytes	Length	SPN Description	SPN
1-2	2 bytes	Engine Oil Temperature 2<N/A>	1135
3-4	2 bytes	Engine ECU Temperature	1136
5-6	2 bytes	Engine Differential Pressure<N/A>	411
7-8	2 bytes	Engine EGR Temperature<N/A>	412

pgn65247 - Electronic Engine Controller #3 - EEC3 -

Transmission Repetition Rate:	250 msec
Data Length:	8 bytes
Data Page:	0
PDU Format:	254
PDU Specific:	223
Default Priority:	6
Parameter Group Number:	65247 (0x00FEDF)

Bit Start Position/Bytes	Length	SPN Description	SPN
1	1 byte	Nominal Friction - Percent Torque<N/A>	514
2-3	2 bytes	Engine's Desired Operating Speed	515
4	1 byte	Engine's Desired Operating Speed Asymmetry Adjustment<N/A>	519

pgn65253 - Engine Hours, Revolutions - HOURS -

Transmission Repetition Rate:	On request
Data Length:	8 bytes
Data Page:	0
PDU Format:	254
PDU Specific:	229
Default Priority:	6
Parameter Group Number:	65253 (0x00FEE5)

Bit Start Position /Bytes	Length	SPN Description	SPN
1-4	4 bytes	Total Engine Hours	247
5-8	4 bytes	Total Engine Revolutions<N/A>	249

pgn65255 - Vehicle Hours - VH -

Transmission Repetition Rate:	1000 ms
Data Length:	8 bytes
Data Page:	0
PDU Format:	254
PDU Specific:	231
Default Priority:	6
Parameter Group Number:	65255 (0x00FEE7)

Bit Start Position /Bytes	Length	SPN Description	SPN
1-4	4 bytes	Total Vehicle Hours	246
5-8	4 bytes	Total Power Takeoff Hours<N/A>	248

pgn65259 - Component Identification - CI -

Transmission Repetition Rate:	1000 ms
Data Length:	8 bytes
Data Page:	0
PDU Format:	254
PDU Specific:	235
Default Priority:	6
Parameter Group Number:	65262 (0x00FEEB)

Bit Start Position/Bytes	Length	SPN Description	SPN
1-5	5 bytes	Make (ASCII *5)	586
6-25	20 bytes	Engine Model Number (ASCII *20)	587
26	1 byte	Delimiter “*”	
27-32	6 bytes	Engine Serial Number (ASCII *6)	588
33	1 byte	Delimiter “*”	
34-47	14 bytes	ECU Model Number (ASCII *14)	233
48	1 byte	Delimiter “*”	

pgn65260 - Vehicle Identification - VI -

Transmission Repetition Rate:	On request
Data Length:	Variable bytes
Data Page:	0
PDU Format:	254
PDU Specific:	236
Default Priority:	6
Parameter Group Number:	65260 (0x00FEEC)

Bit Start Position /Bytes	Length	SPN Description	SPN
1	Variable - up to N characters (“*” delimited)	Vehicle Identification Number	237
Byte: 1-n		Vehicle Identification Number Delimiter (ASCII “*”)	

NOTE: n=< 32

pgn65262 - Engine Temperature #1 - ET1 -

Transmission Repetition Rate:	1000 ms
Data Length:	8 bytes
Data Page:	0
PDU Format:	254
PDU Specific:	238
Default Priority:	6
Parameter Group Number:	65262 (0x00FEEE)

Bit Start Position/Bytes	Length	SPN Description SPN	
1	1 byte	Engine Coolant Temperature	110
2	1 byte	Fuel Temperature<N/A>	174
3-4	2 bytes	Engine Oil Temperature 1 <N/A>	175
5-6	2 bytes	Turbo Oil Temperature<N/A>	176
7	1 byte	Engine Intercooler Temperature<N/A>	52
8	1 byte	Engine Intercooler Thermostat Opening<N/A>	1134

pgn65269 - Ambient Conditions - AMB -

Transmission Repetition Rate:	1000 ms
Data Length:	8 bytes
Data Page:	0
PDU Format:	254
PDU Specific:	245
Default Priority:	6
Parameter Group Number:	65269 (0x00FEF5)

Bit Start Position/Bytes	Length	SPN Description	SPN
1	1 byte	Barometric Pressure	108
2-3	2 bytes	Cab Interior Temperature<N/A>	170
4-5	2 bytes	Ambient Air Temperature<N/A>	171
6	1 byte	Air Inlet Temperature<N/A>	172
7-8	2 bytes	Road Surface Temperature<N/A>	79

pgn65271 - Vehicle Electrical Power - VEP -

Transmission Repetition Rate:	1000 ms
Data Length:	8 bytes
Data Page:	0
PDU Format:	254
PDU Specific:	247
Default Priority:	6
Parameter Group Number:	65271 (0x00FEF7)

Bit Start Position/Bytes	Length	SPN Description	SPN
1	1 byte	Net Battery Current<N/A>	114
3-4	2 bytes	Alternator Potential (Voltage) <N/A>	167
5-6	2 bytes	Electrical Potential (Voltage) <N/A>	168
7-8	2 bytes	Battery Potential (Voltage), Switched	158

J1939-21 Data Link Layer

(See Appendix B)

Acknowledgment

Definition: The Acknowledgment PG is used to provide a handshake mechanism between transmitting and receiving devices.

Transmission repetition rate:		Upon reception of a Parameter Group Number that requires this form of acknowledgment.
Data length:		8 bytes
Data Page:		0
PDU Format:		232
PDU Specific:		Destination address1 = Global (255)
Default priority:		6
Parameter Group Number:		59392 (0x00E800)
Data ranges for parameters used by this Message Type:		
Control byte:	0 to 3	See definitions below
	4 to 255	Reserved for assignment by SAE
Group Function Value	0-250	Definition is specific to the individual PGN, when applicable. Most often it is located as the first byte in the data field of the applicable Group Function PG.
	251-255	Follows conventions defined in J1939-71
Positive Acknowledgment: Control byte = 0		
Byte:	1	Control byte = 0, Positive Acknowledgment (ACK)
	2	Group Function Value (If applicable) <N/A> 0xFF
	3-5	Reserved for assignment by SAE, these bytes should be filled with 0xFF
	6	Parameter Group Number of requested information (8 LSB of parameter group number, bit 8 most significant)
	7	Parameter Group Number of requested information (2nd byte of parameter group number, bit 8 most significant)
	8	Parameter Group Number of requested information (8 MSBs of parameter group number, bit 8 most significant)
Negative Acknowledgment: Control byte = 1		
Byte:	1	Control byte = 1, Negative Acknowledgment (NACK)
	2	Group Function Value (if applicable) <N/A>0xFF
	3-5	Reserved for assignment by SAE, these bytes should be filled with 0xFF
	6-8	Parameter Group Number of requested information (see above)
Access Denied: Control byte = 2		
Byte:	1	Control byte = 2, Access Denied (PGN supported but security denied access)
	2	Group Function Value (if applicable) <N/A>0xFF
	3-5	Reserved for assignment by SAE, these bytes should be filled with 0xFF
	6-8	Parameter Group Number of requested information (see above)
Cannot Respond: Control byte = 3		
Byte:	1	Control byte = 3, Cannot Respond (PGN supported but ECU is busy and cannot respond now. Re-request the data at a later time.)
	2	Group Function Value (if applicable) <N/A> 0xFF
	3-5	Reserved for assignment by SAE, these bytes should be filled with 0xFF
	6-8	Parameter Group Number of requested information (see above)

Request

Definition:		Used to request a Parameter Group from a network device or devices.
Transmission repetition rate:		Per user requirements, generally recommended that requests occur no more than 2 or 3 times per second.
Data length:		3 bytes (The CAN frame for this PG shall set the DLC to 3.)
Data page:		0
PDU Format:		234
PDU specific field:		Destination Address (global or specific)
Default priority:		6
Parameter Group Number:		59904 (0x00EA00)
Byte:	1,2,3	Parameter Group Number being requested

Transport Protocol.Data Transfer (TP.DT)

Definition:		Used for the transfer of data associated with Parameter Groups that have more than 8 bytes of data
Transmission repetition rate:		Per the Parameter Group to be transferred
Data length:		8 bytes
Data Page:		0
PDU Format:		235
PDU specified field:		Destination address (Global (DA = 255) for TP.CM.BAM data transfers) (Global not allowed for RTS/CTS data transfers)
Default priority:		7
Parameter Group Number:		60160 (0x00EB00)
Data ranges for parameters used by this Group Function:		
Sequence Number:		1 to 255 (1 byte)
Byte:	1	Sequence Number
	2-8	Packetized Data (7 bytes). Note the last packet of a multipacket Parameter Group may require less than 8 data bytes. The extra bytes should be filled with 0xFF

Transport Protocol.Connection Management (TP.CM)

Definition:		Used for the transfer of Parameter Groups that have 9 bytes or more of data.
Transmission repetition rate:		Per the Parameter Group Number to be transferred
Data length:		8 bytes
Data Page:		0
PDU Format:		236
PDU Specific:		Destination Address
Default priority:		7
Parameter Group Number:		60416 (0x00EC00)
Data ranges for parameters used by this Group Function:		
Control byte:		0-15, 18, 20-31, 33-254 are Reserved for SAE Assignment
Total Message Size, number of bytes:		9 to 1785 (2 bytes), zero to 8 and 1786 to 65535 not allowed
Total Number of Packets:		2 to 255 (1 byte), zero not allowed
Maximum Number of Packets:		2 to 255 (1byte), zero through 1 are not allowed
Number of Packets that can be sent:		0 to 255 (1 byte)
Next Packet Number to be sent:		1 to 255 (1 byte), zero not allowed
Sequence Number:		1 to 255 (1 byte), zero not allowed
Broadcast Announce Message (TP.CM_BAM): Global Destination		
Byte:	1	Control byte = 32, Broadcast Announce Message
	2,3	Total message size, number of bytes
	4	Total number of packets
	5	Reserved for assignment by SAE, this byte should be filled with FF16
	6-8	Parameter Group Number of the packeted message

J1939-73 Diagnostic Layer

(See Appendix B)

ACTIVE DIAGNOSTIC TROUBLE CODES (DM1)

Transmission Rate: A DM1 message is transmitted whenever a DTC becomes an active fault and at a normal update rate of only once per second thereafter. If a fault has been active for 1 second or longer, and then becomes inactive, a DM1 message shall be transmitted to reflect this state change. If a different DTC changes state within the 1 second update period, a new DM1 message is transmitted to reflect this new DTC. To prevent a high message rate due to intermittent faults that have a very high frequency, it is recommended that no more than one state change per DTC per second be transmitted. Thus a DTC that becomes active/ inactive twice within a 1 second interval, such as shown in Example Case 1, would have one message identifying the DTC becoming active, and one at the next periodic transmission identifying it being inactive. This message is sent only when there is an active DTC existing or in response to a request.
Note that this Parameter Group will require using the "multipacket Transport" Parameter Group (reference SAE J1939-21) when more than one active DTC exists.

Data Length: Variable
Data page: 0
PDU Format: 254
PDU Specific: 202
Default Priority: 6
Parameter Group Number: 65226 (0x00FECA)

Byte: 1	bits 1-2	Protect Lamp(PL) <N/A>
	bits 3-4	Amber Warning Lamp Status(AWL)
	bits 5-6	Red Stop Lamp Status(RSL)
	bits 7-8	Malfunction Indicator Lamp Status(MIL)
Byte: 2	bits 1-2	Reserved for SAE assignment Lamp Status <N/A> 0xFF
	bits 3-4	Reserved for SAE assignment Lamp Status <N/A>
	bits 5-6	Reserved for SAE assignment Lamp Status <N/A>
	bits 7-8	Reserved for SAE assignment Lamp Status <N/A>
Byte: 3	bits 1-8	SPN, 8 least significant bits of SPN (most significant at bit 8)
Byte: 4	bits 1-8	SPN, second byte of SPN (most significant at bit 8)
Byte: 5	bits 6-8	SPN, 3 most significant bits (most significant at bit 8)
bits 1-5	FMI	(most significant at bit 5)
Byte: 6	bits 1-7	Occurrence Count
	bit 8	SPN Conversion Method

Version 4. Recommended Version

	DTC																													
	Byte 3 8 least significant bits of SPN (bit 8 most significant)								Byte 4 second byte of SPN (bit 8 most significant)								Byte 5 3 most significant bits of SPN and the FMI (bit 8 SPN msb and bit 5 FMI msb)								Byte 6							
	SPN																			FMI					CM	OC						
J1939 Frame Format	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
	1	0	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	1	0

EXAMPLE 1: The following illustrates the message format for when there is more than one diagnostic trouble code.

Given:

a=lamp status (LS)

b=SPN

c=FMI

d=CM and OC (Version.4 CM=0)

Message form will be as follows: a,b,c,d,b,c,d,b,c,d,b,c,d....etc. In this example, the transport protocol of SAE J1939-21 will have to be used to send the information because it requires more than 8 data bytes. Actually any time there is more than one fault the services of the transport protocol will have to be used.

EXAMPLE 2: The following illustrates the message format for when a request of the DM1 is made and there are zero active faults. In order for one of the currently defined lamps (Malfunction Indicator Lamp, Red Stop Lamp, Amber Warning Lamp, and Protect Lamp) to be on, an active DTC must be in existence.
The original publication of this recommended practice defined that bytes 6 through 3 should be set to all ones when there are zero faults. This particular implementation is permitted but not preferred. Therefore, this is the Grandfathered Setting. Implementations are preferred to set bytes 6 through 3 to all zeros. This is the Recommended Setting.

Given:

Byte 1 bits 8-7 = 00

bits 6-5 = 00

bits 4-3 = 00

bits 2-1 = 00

Byte 2 bits 8-7 = 11

bits 6-5 = 11

bits 4-3 = 11

bits 2-1 = 11

PREVIOUSLY ACTIVE DIAGNOSTIC TROUBLE CODES (DM2)

Transmission Rate:		On request using PGN 59904 See SAE J1939-21 A NACK is required if PG is not supported (see SAE J1939-21 PGN 59392)
Data Length:		Variable
Data page:		0
PDU Format:		254
PDU Specific:		203
Default Priority:		6
Parameter Group Number:		65227 (0x00FECB)
Byte: 1	bits 1-2	Protect Lamp (PL) <N/A>
	bits 3-4	Amber Warning Lamp Status (AWL)
	bits 5-6	Red Stop Lamp Status (RSL)
	bits 7-8	Malfunction Indicator Lamp Status(MIL)
Byte: 2	bits 1-2	Reserved for SAE assignment Lamp Status <N/A> 0xFF
	bits 3-4	Reserved for SAE assignment Lamp Status <N/A>
	bits 5-6	Reserved for SAE assignment Lamp Status <N/A>
	bits 7-8	Reserved for SAE assignment Lamp Status <N/A>
Byte: 3	bits 1-8	SPN, 8 least significant bits of SPN (most significant at bit 8)
Byte: 4	bits 1-8	SPN, second byte of SPN (most significant at bit 8)
Byte: 5	bits 6-8	SPN, 3 most significant bits (most significant at bit 8)
bits 1-5	FMI	 (most significant at bit 5)
Byte: 6	bits 1-7	Occurrence Count
	bit 8	SPN Conversion Method

EXAMPLE 1: The following illustrates the message format for when there is more than one diagnostic trouble code.

Given:

a=lamp status (LS)

b=SPN

c=FMI

d=CM and OC

Message form will be as follows: a,b,c,d,b,c,d,b,c,d,b,c,d....etc. In this example, the transport protocol of SAE J1939-21 will have to be used to send the information because it requires more than 8 data bytes. Actually any time there is more than one fault the services of the transport protocol will have to be used.

DIAGNOSTIC DATA CLEAR/RESET OF PREVIOUSLY ACTIVE DTCS (DM3)

Transmission Rate:	On request using PGN 59904 See SAE J1939-21 A NACK is required if PG is not supported (see SAE J1939-21 PGN 59392)
Data Length:	0
Data page:	0
PDU Format:	254
PDU Specific:	204
Default Priority:	6
Parameter Group Number:	65228 (0x00FECC)

YANMAR Proprietary PGN

(See Appendix C)

DIAGNOSTIC TROUBLE CODES (DTCS)

Listing of DTCs on ECU

J1939 *1			Description	Lamp Status			
SPN	SPN (hex)	FMI		MIL	RSL	AWL	PL
1210	4BA	4	Engine Fuel Rack Position Sensor Circuit Low			X	
		3	Engine Fuel Rack Position Sensor Circuit High			X	
91	5B	4	Pedal Position Sensor "A" Circuit Low			X	
		3	Pedal Position Sensor "A" Circuit High			X	
		2	Pedal Position Sensor "A" Circuit Intermittent				
		1	Pedal Position Sensor "A" Voltage Low			X	
		0	Pedal Position Sensor "A" Voltage High			X	
29	1D	4	Pedal Position Sensor "B" Circuit Low			X	
		3	Pedal Position Sensor "B" Circuit High			X	
		2	Pedal Position Sensor "B" Circuit Intermittent				
		1	Pedal Position Sensor "B" Voltage Low			X	
		0	Pedal Position Sensor "B" Voltage High			X	
		8	Pedal Position Sensor "B" Communication Error			X	
108	6C	4	Barometric Pressure Circuit Low	X			
		3	Barometric Pressure Circuit High	X			
		2	Barometric Pressure Circuit Intermittent				
1136	470	4	ECM Internal Temperature Sensor Circuit Low			X	
		3	ECM Internal Temperature Sensor Circuit High			X	
		2	ECM Internal Temperature Sensor Circuit Intermittent				
		0	ECM Internal Temperature Too High				X
110	6E	4	Engine Coolant Temperature Circuit Low Input			X	
		3	Engine Coolant Temperature Circuit High Input			X	
		2	Engine Coolant Temperature Circuit Intermittent				
		0	Engine Coolant Over Temperature Condition				X
1079	437	4	Sensor 5V Voltage "A" Circuit Low			X	
		3	Sensor 5V Voltage "A" Circuit High			X	
		2	Sensor 5V Circuit Intermittent				
168	A8	1	System Voltage Low				X
		0	System Voltage High				X
2209	8A1	4	Camshaft Position Sensor "A" Circuit		X	X	
2210	8A2	4	Auxiliary Rotation Speed Sensor Circuit		(Both)	(Ether)	
2049	801	4	Engine Fuel Rack Actuator Relay Circuit Open		X		
		3	Engine Fuel Rack Actuator Relay Circuit Shorted		X		
		2	Engine Fuel Rack Actuator Relay Circuit Intermittent				

ON-VEHICLE COMMUNICATION CAN SPECIFICATION

J1939 *1			Description	Lamp Status			
SPN	SPN (hex)	FMI		MIL	RSL	AWL	PL
729	2D9	4	Air Heater Relay Circuit Open	X			
		3	Air Heater Relay Circuit Shorted	X			
		2	Air Heater Relay Circuit Intermittent				
2050	802	4	Cold Start Device Circuit Open	X			
		3	Cold Start Device Circuit Shorted	X			
		2	Cold Start Device Circuit Intermittent				
2059	80B	4	EGR Stepping Motor "A" Circuit Open	X			
		3	EGR Stepping Motor "A" Circuit Shorted	X			
2060	80C	4	EGR Stepping Motor "B" Circuit Open	X			
		3	EGR Stepping Motor "B" Circuit Shorted	X			
2061	80D	4	EGR Stepping Motor "C" Circuit Open	X			
		3	EGR Stepping Motor "C" Circuit Shorted	X			
2062	80E	4	EGR Stepping Motor "D" Circuit Open	X			
		3	EGR Stepping Motor "D" Circuit Shorted	X			
100	64	4	Oil Pressure Switch Circuit Open			X	
		1	Oil Pressure Too Low				X
2125	84D	4	Battery Charge Switch Circuit Open			X	
		1	Battery Charge Warning				X
2122	84A	0	Engine Coolant Over Temperature Condition (Coolant Switch ON)				X
107	6B	0	Air Cleaner Blocking				X
97	61	0	Oily Water Separator not Responding				X
190	BE	0	Engine Over Speed Condition		X		
638	27E	4	Engine Fuel Rack Actuator Output Circuit Low		X		
		3	Engine Fuel Rack Actuator Output Circuit High		X		
		7	Engine Fuel Rack Actuator not Responding		X		
522725	7F9E5	12	High Speed CAN Communication Bus			X	
522726	7F9E6	12	Internal Control Module EEPROM Write Error			X	
2530	79E2	12	Internal Control Module Memory Check Sum Error		X		
1485	5CD	4	ECM Main Relay GND Shorted			X	
522727	7F9E7	12	Sub CPU Cyclic Redundancy Check Error			X	
		12	Sub CPU ACKnowledgement Error			X	
		12	Sub CPU Communication Error			X	
522728	7F9E8	12	ECM MAP Format Error		X		

REFERENCES

J1939/21 Data Link Layer

J1939/71 Vehicle Application Layer.

J1939/73 Application Layer - Diagnostics.

ISO 15765-1.3: 2001 : [Road vehicles - Diagnostics on CAN - Part 1: General information]

ISO 15765-2.4: 2002 : [Road vehicles - Diagnostics on CAN - Part 2: Network layer services]

ISO 15765-3.5: 2002 : [Road vehicles - Diagnostics on CAN - Part 3: implementation of diagnostic services]

ISO 15765-4.3: 2001 : [Road vehicles - Diagnostics on CAN - Part 4: Requirement for emission-related systems]

Appendix A : RECEIVE and SEND MESSAGE CAN ID SUMMARY

Appendix B : MESSAGE FORMAT(J1939-71, -73, -21)

Appendix C : MESSAGE FORMAT(YANMAR Prorietary PGN)

APPENDIX A

	PGN	ID	Description	P (3bit)	R (1bit)	DP (1bit)	PF (8bit)	PS (GE/DA) (8bit)	SA (8bit)	With period (ms)	Data Length (byte)	Acronym	R/S	Note
ISO 15765	55808	18DAF****	Reserved for 15765 (Physical Addressed)	6	0	0	218	DA	SA	100ms	Variable	KWP2	R/S	Diagnostics on CAN (Physical Addressed)
	56064	18DB****	Reserved for 15765 (Functional Addressed)	6	0	0	219	DA	SA	100ms	Variable	KWP1	R/S	Diagnostics on CAN (Functional Addressed)
J1939-71 Application Layer	0	0C0000**	Torque speed control	3	0	0	0	0	SA	10ms	8	TSC1	R	Override control mode,Requested speed
	61443	0CF00300	Electronic Engine Controller #2	3	0	0	240	3	0	50ms	8	EEC2	S	Accelerator pedal position, Load at current speed
	61444	0CF00400	Electronic Engine Controller #1	3	0	0	240	4	0	20ms	8	EEC1	S	Actual engine %torque, Engine speed
	65188	0CFEA400	Engine Temperature #2	3	0	0	254	164	0	1000ms	8	ET2	S	ECU temperature, EGR temperature
	65247	#NAME?	Electronic Engine Controller #3	3	0	0	254	223	0	250ms	8	EEC3	S	Nominal friction %torque, Engine's desired speed
	65253	18FEE500	Engine Hours, Revolutions	6	0	0	254	229	0	On request	8	HOURS	S	Total engine hours, Total engine revolution
	65255	18FEE700	Vehicle Hours	6	0	0	254	231	SA	1000ms	8	VH	R	Total vehicle hours
	65259	18FEEB00	Component Identification	6	0	0	254	235	0	On request	48	CI	S	ECU number, Engine serial number, Engine type,
	65260	18FEEC00	Vehicle Identification	6	0	0	254	236	0	On request		VI	S	Vehicle Identification number
	65262	18FEEE00	Engine Temperature #1	6	0	0	254	238	0	1000ms	8	ET1	S	Engine coolant temperature, fuel, oil,
	65269	18FEF500	Ambient conditions	6	0	0	254	245	0	1000ms	8	AMB	S	Barometric pressure
	65271	#NAME?	Vehicle Electrical Power	6	0	0	254	247	0	1000ms	8	VEP	S	Electrical potential
J1939-21 Application Layer (Yanmar Original)	65297	#NAME?	Port In/Out State	6	0	0	255	17	0	100ms	8	Y_I/OS	S	Port in/out
	65298	#NAME?	Rack Position Control	6	0	0	255	18	0	20ms	8	Y_RPC	S	Actual rack position, Request rack pos. Iset_raw
	65302	#NAME?	Overload Warning Setting	6	0	0	255	22	0	On request	8	Y_OLS	R	Over Load Setting
	65303	#NAME?	Percent Load	3	0	0	255	23	0	20ms	8	Y_LF	S	Related to percent load
	65306	#NAME?	Raw Analog Input Value	6	0	0	255	26	0	100ms	8	Y_AIN1	S	AD values (coolant temperature, rack position sensor, accelerator sensor, reserve analog)
	65307	#NAME?	Raw Analog Input Value 2	6	0	0	255	27	0	100ms	8	Y_AIN2	S	AD values (reserve thermistor, intake air temperature, EGR temperature)
	65308	#NAME?	Governing Related Command	6	0	0	255	28	SA	100ms	8	Y_EC	R	Rmax switching, etc (engine control)
	65309	#NAME?	Stop Command	3	0	0	255	29	SA	On request	8	Y_STP	R	Engine stop
	65310	#NAME?	Rotational Speed Selection Command	6	0	0	255	30	SA	10ms	8	Y_RSS	R	Rotational speed selection, rotation speedup
	65311	#NAME?	Starter Restraint Factor	6	0	0	255	31	0	20ms	8	Y_SRF	S	Starter restraint factor, engine stop factor
	65318	#NAME?	Set Rotational Speed Information	6	0	0	255	38	0	250ms	8	Y_SRSI	S	Low idling value, high idling value, etc (set rotational speed information)
	65319	#NAME?	Governing State Information	6	0	0	255	39	0	100ms	8	Y_ESI	S	Requested rack position control mode, etc (engine state information)
J1939-21 Data Link Layer	59392	18E8FF00	Acknowledge/Negative Acknowledge	6	0	0	232	255	0	On request	8	Ack/ Nack	S	Global Response
	59904	18EAFF**	Request	6	0	0	234	255	SA	As Needed	3		R	Global Request
	60160	18EBFF00	TRANSPORT PROTOCOL-DATA TRANSFER	7	0	0	235	255	0	As Required	8	TP.DT	S	
	60416	18ECFF00	TRANSPORT PROTOCOL-CONNECTION MANAGEMENT	7	0	0	236	255	0	As Required	8	TP.CM	S	Broadcast Announce Message Only
	61184	18EF****	PROPRIETARY A (Development Tool)	6	0	0	239	DA	SA					Yanmar Proprietary
J1939-73 Diagnostic Layer	65226	18FECA00	Active Diagnostic Trouble Code	6	0	0	254	202	0	1000ms	Variable	DM1	S	Multi-packet Broadcast message
	65227	18FECB00	Previously Active Diagnostic Trouble Code	6	0	0	254	203	0	On request	Variable	DM2	S	Multi-packet Broadcast message
	65228		Diagnostic Data Clear/Reset of Previously Active DTCs				254	204		On request		DM3		Positive response = ACK

APPENDIX B

PGN		Acronym		Developing									
0		TSC1											
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
	1	1	2	Override Control Mode						695			
R				Override Disabled (not implemented)	00								When "Requested Speed" is used
R				Speed Control (not implemented)	01								
N/A				Torque Control	10								
N/A				Speed/Torque Limit	11								
N/A	1	3	2	Requested Speed Control Condition					696				
N/A				Not available	11								
	1	5	2	Override Contorol Mode Priority						897			
N/A				Highest	00								
N/A				High	01								
N/A				Medium	10								
N/A				Low	11								
N/A	1	7	2	not defined									
R	2	1	16	Requested Speed / Speed Limit		U16	0.125	0	0	8031.875	rpm	898	Engine rotational speed value requested through CAN. Valid when the accelerator sensor flag of the OEM specification setting is set to CAN.) When the value is FE00h or more, the value of this function is not used.No error is generated; the error handling operation of this function is applied (for example, switching to the backup system).) <When a CAN reception error (initialization) occurs>As with the case when the value is FE00h or more, the error handling operation of this function is applied. <When a CAN reception error occurs>As with the case when the value is FE00h or more, the error handling operation of this function is applied. <When an error is removed>The value is applied.
R				Error Indicator	FE**								
R				Not available	FF**								
N/A	4	1	8	Requested Torque / Torque Limit		U8	1	-125	-125	125	%	518	
N/A				Error Indicator	FE**								
N/A				Not available	FF**								
N/A	5	1	32	Not defined									

PGN		Acronym											
61443		EEC2											
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
N/A	1	1	2	Accelerator Pedal Low Idle Switch					558				
N/A				Accelerator pedal not in low idle condition	00								
N/A				Accelerator pedal in low idle condition	01								
N/A				Error Indicator	10								
S				Not available	11								
N/A	1	3	2	Accelerator Pedal Kickdown Switch					559				
N/A				Kickdown passive	00								
N/A				Kickdown active	01								
N/A				Error Indicator	10								
S				Not available	11								
N/A	1	5	2	Road Speed Limit Status						1437			
N/A				Active	00								
N/A				Not active	01								
N/A				Error Indicator	10								
S				Not available	11								
N/A	1	7	2	not defined									
S	2	1	8	Accelerator Pedal Position		U8	0.4	0	0	100	%	91	The main accelerator sensor value expressed in percentage between low idling 0% and high idling 100%. (Note that, when the high idling value in isochronous is lower than the value in droop, the high idling value in droop is used as 100%.)
S				Error Indicator	FE								When an error occurs in the main accelerator sensor
S				Not available	FF								When the main accelerator sensor is disabled
S	3	1	8	Percent Load At Current Speed		U8	1	0	0	100	%	92	
S				Error Indicator	FE								When the percent load cannot be calculated due to one of the following errors (engine stop state, over rotation, rack position sensor error, rack actuator system error, rotation sensor error)
N/A				Not available	FF								
N/A	4	1	8	Remote Accelerator		U8	0.4	0	0	100	%	974	
N/A				Error Indicator	FE								
S				Not available	FF								
N/A	5	1	32	Not defined									

PGN		Acronym										
61444		EEC1										
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
N/A	1	1	4	Engine/Retarder Torque Mode						899			
N/A				Low idle governor/no request (default mode)	0000								
N/A				Accelerator pedal	0001								
N/A				Cruise control	0010								
N/A				PTO governor-N/A	0011								
N/A				Road speed governor	0100								
N/A				ASR control-N/A	0101								
N/A				Transmission control	0110								
N/A				ABS control-N/A	0111								
N/A				Torque limiting	1000								
N/A				High speed governor	1001								
N/A				Braking system-N/A	1010								
N/A				Remote Accelerator	1011								
N/A				not defined	1100								
N/A				not defined	1101								
N/A				Other	1110								
S				Not available	1111								
N/A	1	5	4	not defined									
N/A	2	1	8	Driver's Demand Engine - Percent Torque		U8	1	-125	-125	125	%	512	
N/A				Error Indicator	FE								
S				Not available	FF								
N/A	3	1	8	Actual Engine - Percent Torque		U8	1	-125	-125	125	%	513	
N/A				Error Indicator	FE								
S				Not available	FF								
S	4	1	16	Engine Speed		U16	0.125	0	0	8031.875	rpm	190	
S				Error Indicator	FE**								When an error occurs in the main rotation sensor
N/A				Not available	FF**								
N/A	6	1	8	Source Address of Controlling Device for Engine Control		U8	1	0	0	253		1483	
N/A				Error Indicator	FE								
S				Not available	FF								
	7	1	4	Engine Starter Mode								1675	
S				start not requested	0000								See Software Function Specification [OEM Specification].
S				starter active, gear not engaged	0001								See Software Function Specification [OEM Specification].
S				starter active, gear engaged	0010								See Software Function Specification [OEM Specification].
S				start finished	0011								See Software Function Specification [OEM Specification].
N/A				starter inhibited due to engine already running	0100								
N/A				starter inhibited due to engine not ready for start	0101								
N/A				starter inhibited due to driveline engaged	0110								
N/A				starter inhibited due to active immobilizer	0111								
N/A				starter inhibited due to starter over-temp	1000								
N/A				reserved	1001								
N/A				reserved	1010								
N/A				reserved	1011								
N/A				reserved	1100								
S				starter inhibited - reason unknown	1101								When the starter is inhibited due to an unknown reason (the reason is sent with PGN65311 separately)
N/A				error	1110								
N/A				Not available	1111								
N/A	7	5	4	Not defined									
N/A	8	1	8	Not defined									

PGN		Acronym											
65188		ET2											
	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
N/A	1	1	16	Engine Oil Temperature 2		U16	0.031	-273	-273	1735	deg C	1135	
N/A				Error Indicator	FE**								
S				Not available	FF**								
S	3	1	16	Engine ECU Temperature		U16	0.031	-273	-273	1735	deg C	1136	ECU temperature
S				Error Indicator	FE**								When an error occurs in the ECU temperature sensor
N/A				Not available	FF**								
N/A	5	1	16	Engine EGR Differential Pressure					411				
N/A				Error Indicator	FE**								
S				Not available	FF**								
N/A	7	1	16	Engine EGR Temperature		U16	0.031	-273	-273	1735	deg C	412	
N/A				Error Indicator	FE**								
S				Not available	FF**								

PGN		Acronym											
65247		EEC3											
	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
N/A	1	1	8	Nominal Friction - Percent Torque		U8	1	-125	-125	125	%	514	
N/A				Error Indicator	FE								
S				Not available	FF								
S	2	1	16	Engine's Desired Operating Speed		U16	0.125	0	0	8031.875	rpm	515	Final target engine rotational speed (NsetF)
N/A				Error Indicator	FE**								
N/A				Not available	FF**								
N/A	4	1	8	Engine's Desired Operating Speed Asymmetry Adjustment		U8	1	0	0	250		519	
N/A				Error Indicator	FE								
S				Not available	FF								
N/A	5	1	32	Not defined									

PGN		Acronym											
65253		HOURS											
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
S	1	1	32	Total Engine Hours		U32	0.05	0	0	210,554,061	hr	247	Operation hours measured by the engine ECU (when an EEPROM error occurs, 0 is sent)
N/A				Error Indicator	FE******								
N/A				Not available	FF******								
N/A	5	1	32	Total Engine Revolutions		U32	1,000	0	0	4,211,081,215,000	r	249	
N/A				Error Indicator	FE******								
S				Not available	FF******								

PGN		Acronym											
65255		VH											
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
R	1	1	32	Total Vehicle Hours		U32	0.05	0	0	210,554,061	hr	246	Total operation hours <When a CAN reception error (initialization) occurs>The ECU's initial value is set to 0.Continued even after an error occurs. <When a CAN reception error occurs>The previous value is held. <When an error is removed>The value is applied.
N/A				Error Indicator	FE******								Ignored for this value
N/A				Not available	FF******								Ignored for this value
N/A	5	1	32	Total Power Takeoff Hours		U32	0.05	0	0	210,554,061	hr	248	
N/A				Error Indicator	FE******								
R				Not available	FF******								

PGN		Acronym											
65259		CI											
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
S	1	1	40	Make "YDECO"		ASCII						586	
S	6	1	160	Engine Model Number(ASCII *20)		ASCII						587	Engine model (OEM)
S	26	1	8	Delimiter "*"		ASCII							
S	27	1	48	Engine Serial Number(ASCII *6)		ASCII						588	Engine serial number
S	33	1	8	Delimiter "*"		ASCII							
S	34	1	112	ECU Number(ASCII *14)		ASCII						233	ECU assy part number
S	48	1	8	Delimiter "*"		ASCII							

PGN		Acronym		061006: Under consideration									
65260		VI		(This PGN is not implemented)									
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
S	1	1	256	Vehicle Identification Number(ASCII)		ASCII						237	Engine model (printed name)
S	33	1	8	Delimiter "*"		ASCII							

PGN		Acronym											
65262		ET1											
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
S	1	1	8	Engine Coolant Temperature		U8	1	-40	-40	210	deg C	110	Coolant temperature
S				Error Indicator	FE								When an error occurs in the coolant temperature sensor
N/A				Not available	FF								
N/A	2	1	8	Fuel Temperature		U8	1	-40	-40	210	deg C	174	
N/A				Error Indicator	FE								
S				Not available	FF								
N/A	3	1	16	Engine Oil Temperature		U16	0.031	-273	-273	1735	deg C	175	
N/A				Error Indicator	FE00								
S				Not available	FF00								
N/A	5	1	16	Turbo Oil Temperature		U16	0.031	-273	-273	1735	deg C	176	
N/A				Error Indicator	FE00								
S				Not available	FF00								
N/A	7	1	8	Engine intercooler temperature		U8	1	-40	-40	210	deg C	52	
N/A				Error Indicator	FE								
S				Not available	FF								
N/A	8	1	8	Engine intercooler Thermostat Opening		U8	0.4	0	0	100	%	1134	
N/A				Error Indicator	FE								
S				Not available	FF								

PGN		Acronym											
65269		AMB											
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
S	1	1	8	Barometric Pressure		U8	0.5	0	0	125	kPa	108	
S				Error Indicator	FE								When an error occurs in the barometric pressure sensor
S				Not available	FF								When high altitude correction control is not applied
N/A	2	1	16	Cab Interior Temperature		U16	0.031	-273	-273	1735	degC	170	
N/A				Error Indicator	FE00								
S				Not available	FF00								
N/A	4	1	16	Ambient Air Temperature		U16	0.031	-273	-273	1735	degC	171	
N/A				Error Indicator	FE00								
S				Not available	FF00								
N/A	6	1	8	Air Inlet Temperature		U8	1	-40	-40	210	degC	172	
N/A				Error Indicator	FE								
S				Not available	FF								
N/A	7	1	16	Road Surface Temperature		U16	0.031	-273	-273	1735	degC	79	
N/A				Error Indicator	FE00								
S				Not available	FF00								

PGN		Acronym											
65271		VEP											
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
N/A	1	1	8	Net Battery Current		U8	1	-125	-125	125	A	114	
N/A				Error Indicator	FE								
S				Not available	FF								
N/A	2			Not defined									
N/A	3	1	16	Alternator Potential (Voltage)		U16	0.05	0	0	3212.75	V	167	
N/A				Error Indicator	FE00								
S				Not available	FF00								
N/A	5	1	16	Electrical Potential (Voltage)		U16	0.05	0	0	3212.75	V	168	
N/A				Error Indicator	FE00								
S				Not available	FF00								
S	7	1	16	Battery Potential (Voltage), Switched		U16	0.05	0	0	3212.75	V	158	ECU supply voltage
N/A				Error Indicator	FE00								
N/A				Not available	FF00								

PGN		Acronym											
65226		DM1											
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
N/A	1	1	2	Protect Lamp Status								987	a[1] Failure of machine
S				Lamp Off	00								
N/A				Lamp On	01								
S	1	3	2	Amber Warning Lamp Status								624	[2] Error that does not cause the engine to stop
S				Lamp Off	00								
S				Lamp On	01								
S	1	5	2	Red Stop Lamp Status								623	[3] Error that causes the engine to stop
S				Lamp Off	00								
S				Lamp On	01								
S	1	7	2	Malfunction Indicator Lamp Status								1213	Error that does not cause the engine to stop but affects exhaust emission
S				Lamp Off	00								
S				Lamp On	01								
N/A	2			Reserved									
S	3	1	8	SPN, 8 least significant bits of SPN		U19	1	0	0	524286		1214	b
S	4	1	8	SPN, 8 second byte of SPN									Version 4 Format
S	5	6	3	SPN, 3 most significant bits									
S	5	1	5	FMI		U5	1	0	0	30		1215	c
N/A				Not available	3F								
S	6	1	7	Occurrence count		U7	1	0	0	126		1216	d
N/A				Not available	7F								
S	6	8	1	Conversion Method	0							1706	
S	7	1	8	Not defined(Set to 0FFH) : Single Frame/SPN-H : Multi-packet									b
S	8	1	8	Not defined(Set to 0FFH) : Single Frame/SPN-M : Multi-packet									
S	9			(SPN-L)+(FMI) : Multi-packet									c
S	10			(OC)									d
S	11			(SPN-H)									b
S	12			(SPN-M)									
S	13			(SPN-L)+(FMI)									c
S	14			(OC)									d

PGN		Acronym											
65227		DM2											
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
N/A	1	1	2	Protect Lamp Status								987	a
S				Lamp Off	00								
N/A				Lamp On	01								
S	1	3	2	Amber Warning Lamp Status								624	
S				Lamp Off	00								
S				Lamp On	01								
S	1	5	2	Red Stop Lamp Status								623	
S				Lamp Off	00								
S				Lamp On	01								
S	1	7	2	Malfunction Indicator Lamp Status								1213	
S				Lamp Off	00								
S				Lamp On	01								
N/A	2			Reserved									
S	3	1	8	SPN, 8 least significant bits of SPN		U19	1	0	0	524286		1214	b
S	4	1	8	SPN, 8 second byte of SPN									Version 4 Format
S	5	6	3	SPN, 3 most significant bits									
S	5	1	5	FMI		U5	1	0	0	30		1215	c
N/A				Not available	3F								
S	6	1	7	Occurrence count		U7	1	0	0	126		1216	d
N/A				Not available	7F								
S	6	8	1	Conversion Method	0							1706	Version 4 Format
S	7	1	8	Not defined(Set to 0FFH) : Single Frame/SPN-H : Multi-packet									b
S	8	1	8	Not defined(Set to 0FFH) : Single Frame/SPN-M : Multi-packet									
S	9			(SPN-L)+(FMI) : Multi-packet									c
S	10			(OC)									d
S	11			(SPN-H)									b
S	12			(SPN-M)									
S	13			(SPN-L)+(FMI)									c
S	14			(OC)									d

PGN		Acronym											
59904		Requests											
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
R	1	1	8	Least Significant Byte of PGN			1	0	0	131071		2540	
R	2	1	8	Byre 2 of PGN									
R	3	1	8	Most Significant Byte of PGN									

PGN		Acronym											
59392		Ack/Nack											
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
	1	1	8	Control Byte			1	0	1	3		2541	
S				0: Positive Acknowledgment									
S				1: Negative Acknowledgment									
S				2: Access Denied (PGN supported but security access denied)									
S				3: Busy (PGN supported but ECU is busy and cannot respond now)									
N/A	2	1	8	Group Function					255	255		2542	
N/A	3	1	8	Not defined									
N/A	4	1	8	Not defined									
N/A	5	1	8	Not defined									
S	6	1	8	Least Significant Byte of PGN of Requested Information		U24	1	0	0	131071		2543	
S	7	1	8	Middle Byte 2 of PGN of Requested Information									
S	8	1	8	Most Significant Byte of PGN of Requested information									

PGN		Acronym										
60160		TP_DT										
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
S	1	1	8	Sequence Number		U8	1	0	1	255			
S	2	1	16	Packetized Data (7 bytes)									Note the last packet of a multipacket Parameter Group may require less than 8 data bytes. The extra bytes should be filled with 0xFF

PGN		Acronym										
60416		TP_CM_BAM										
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
S	1	1	8	Control Byte - set to 32 for CM_BAM		U8	1	32	32	32		2556	
S	2	1	16	Total Message Size, number of byte		U16	1	0	9	1785		2567	
S	4	1	8	Total number of packets		U8	1	0	2	255		2568	
S	5	1	8	Not Defined									
S	6	1	8	Least Significant Byte of PGN		U24	1	0	0	131071		2569	
S	7	1	8	Byre 2 of PGN									
S	8	1	8	Most Significant Byte of PGN									

APPENDIX C

PGN		Acronym											
65297		Y_I/OS											
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
	1	1	3	Contact Input 1 State								2160	Outputs ON (short) or OFF (open) of the contact input.OFF=0/ON=1
S		1	1	Engine Startup Recognition (Start SW)	XX1							2116	Note: Port input
S		2	1	Emergency Stop	X1X							2114	
S		3	1	Key Switch	1XX							2112	
N/A		4	5	not defined									
	2	1	7	Contact Input 2 State								2161	Outputs ON (short) or OFF (open) of the contact input.OFF=0/ON=1
S		1	1	APP-IP1	XXXXXX1								Droop selection, starter enable restraint
S		2	1	APP-IP2	XXXXX1X							2128	Rmax selection 2, oil pressure SW, rotation speedup, foot pedal SW-NO
S		3	1	APP-IP3	XXXX1XX								Rotational speed selection 1, charge warning, pulse accelerator sensor
S		4	1	APP-IP4	XXX1XXX							2122	Rotational speed selection 2, coolant temperature SW
S		5	1	APP-IP5	XX1XXXX							2131	Reverse droop selection, air cleaner sensor
S		6	1	APP-IP6	X1XXXXX								Rotational speed selection enable, oil water separator
S		7	1	APP-IP7	1XXXXXX								Rmax selection 1, engine stop 2, foot pedal SW-NC
N/A		8	1	not defined									
	3	1	8	Contact Output 1 State									Outputs ON (energized) or OFF (not energized) of the contact output.OFF=0/ON=1
S		1	1	Main Relay	XXXXXXX1							2048	
S		2	1	Rack Actuator Relay	XXXXXX1X							2049	
S		3	1	Air Heater Relay	XXXXX1XX							2051	
S		4	1	CSD Solenoid Valve	XXXX1XXX							2050	
S		5	1	Trouble Lamp	XXX1XXXX							2055	
S		6	1	Preheat Lamp	XX1XXXXX							2054	
S		7	1	APP-OP1	X1XXXXXX							701	
S		8	1	APP-OP2	1XXXXXXX							702	
N/A	4	1	40	not defined									

PGN		Acronym											
65298		Y_RPC											
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
S	1	1	16	ACTUAL RACK POSITION		U10	1	0	0	1023		2305	Actual rack position
S				Error Indicator	FE**								When an error occurs in the rack position sensor
N/A				Not available	FF**								
S	3	1	16	REQUEST RACK POSITION		U10	1	0	0	1023		2304	Requested rack position
S				Error Indicator	FE**								When an error occurs in the rack position sensor
N/A				Not available	FF**								
S	5	1	16	Iset_raw		U10	1	0	0	6000		2336	Rack Target Value
N/A				Error Indicator	FE**								
N/A				Not available	FF**								
N/A	7	1	16	not defined									
N/A				Error Indicator	FE**								
S				Not available	FF**								

PGN		Acronym											
65302		Y_OLS											
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
R	1	1	16	Rotational Speed-Down for Overload Detection		U16	0.125	0	0	8031.875	rpm		
N/A				Error Indicator	FE**								
N/A				Not available	FF**								
R	3	1	16	Rotational Speed-Down for Overload Removal		U16	0.125	0	0	8031.875	rpm		
N/A				Error Indicator	FE**								
N/A				Not available	FF**								
R	5	1	8	Percent Load for Overload Detection		U8	1	0	0	101	%		
N/A				Error Indicator	FE								
N/A				Not available	FF								
R	6	1	8	Percent Load for Overload Removal		U8	1	0	0	101	%		
N/A				Error Indicator	FE								
N/A				Not available	FF								
N/A	7	1	16	Not defined									

PGN		Acronym											
65303		Y_LF											
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
S	1	1	8	Gross Percent Load		U8	1	0	0	100	%		
S				Error Indicator	FE								When the percent load cannot be calculated
N/A				Not available	FF								
S	2	1	8	Net Percent Load		U8	1	0	0	100	%		
S				Error Indicator	FE								When the percent load cannot be calculated
N/A				Not available	FF								
S	3	1	8	UFO Percent Load		U8	1	0	0	100	%		
S				Error Indicator	FE								When the percent load cannot be calculated
N/A				Not available	FF								
S	4	1	8	Percent Load for Load Detection		U8	1	0	0	100	%		
S				Error Indicator	FE								When the percent load cannot be calculated
N/A				Not available	FF								
S	5	1	8	Net Percent Load (Held during Acceleration/Deceleration)		U8	1	0	0	100	%		
S				Error Indicator	FE								When the percent load cannot be calculated
N/A				Not available	FF								
S	6	1	2	Overload Warning									Initial value = OFF
S				OFF	00								
S				ON	01								
S				Error Indicator	10								When the percent load cannot be calculated
S				Not available	11								When the setting value for judgment has not been received
N/A			6	Not defined									
N/A	7		16	Not defined									

PGN		Acronym											
65306		Y_AIN1											
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
S	1	1	16	Coolant Temperature Sensor Voltage		U16	0	0	0	1,023		2189	AD data (the voltage of raw data is the raw value before averaging (after correction and adjustment))
N/A				Error Indicator	FE**								
N/A				Not available	FF**								
S	3	1	16	Rack Position Sensor Voltage		U16	0	0	0	1,023		2179	AD data (the voltage of raw data is the raw value before averaging (after correction and adjustment))
N/A				Error Indicator	FE**								
N/A				Not available	FF**								
S	5	1	16	Accel Position Sensor Voltage		U16	0	0	0	1,023		2176	AD data (the voltage of raw data is the raw value before averaging)
N/A				Error Indicator	FE**								
N/A				Not available	FF**								
S	7	1	16	Reserve Analog Sensor Voltage		U16	0	0	0	1,023			AD data (the voltage of raw data is the raw value before averaging)
N/A				Error Indicator	FE**								
N/A				Not available	FF**								

PGN		Acronym											
65307		Y_AIN2											
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
S	1	1	16	Reserve Thermistor Sensor Voltage		U16	0	0	0	1,023			AD data (the voltage of raw data is the raw value before averaging)
N/A				Error Indicator	FE**								
N/A				Not available	FF**								
S	3	1	16	Suction Temperature Sensor Voltage		U16	0	0	0	1,023			AD data (the voltage of raw data is the raw value before averaging) (Note: This terminal is not used)
N/A				Error Indicator	FE**								
N/A				Not available	FF**								
S	5	1	16	EGR Temperature Sensor Voltage		U16	0	0	0	1,023			AD data (the voltage of raw data is the raw value before averaging) (Note: This terminal is not used)
N/A				Error Indicator	FE**								
N/A				Not available	FF**								
S	7	1	16	Not defined		U16	0	0	0	1,023			
N/A				Error Indicator	FE**								
N/A				Not available	FF**								

PGN		Acronym											
65308		Y_EC											
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
	1	1	2	Rmax Selection Command (CAN)									Rmax curve selection command from CAN. 0=OFF, 1=ON <When a CAN reception error (initialization) occurs>The ECU's initial value is set to OFF.Continued even after an error occurs. <When a CAN reception error occurs>OFF is assumed. <When an error is removed>The value is applied.
R		1	1	Rmax selection 1 (APP-IP7)	X1								CAN version of contact input APP-IP7 (valid when the input setting flag of the APP-IP7 terminal function of the OEM specification setting is set to CAN.)
R		2	1	Rmax selection 2 (APP-IP2)	1X								CAN version of contact input APP-IP2 (valid when the input setting flag of the APP-IP2 terminal function of the OEM specification setting is set to CAN.)
	1	3	2	Governing Mode Selection Command (CAN)									0=OFF, 1=ON <When a CAN reception error (initialization) occurs>The ECU's initial value is set to OFF.Continued even after an error occurs. <When a CAN reception error occurs>The previous value is held. <When an error is removed>The value is applied.
R		3	1	Droop Selection (APP-IP1)	X1								CAN version of contact input APP-IP1 (valid when the input setting flag of the APP-IP1 terminal function of the OEM specification setting is set to CAN.)
R		4	1	Reverse Droop Selection (APP-IP5)	1X								CAN version of contact input APP-IP5 (valid when the input setting flag of the APP-IP5 terminal function of the OEM specification setting is set to CAN.)
	1	5	1	Starter Restraint (CAN)									0=Enable, 1=Disable <When a CAN reception error (initialization) occurs>The ECU's initial value is set to Disable.Enabled after an error occurs. <When a CAN reception error occurs>Enable is assumed. <When an error is removed>The value is applied.
R		5		Starter Enable Restraint (APP-IP1)	1								CAN version of contact input APP-IP1 (valid when the input setting flag of the APP-IP1 terminal function of the OEM specification setting is set to CAN.)
	1	6	2	High Idling Limit (CAN)									0=OFF, 1=ON <When a CAN reception error (initialization) occurs>The ECU's initial value is set to OFF.Continued even after an error occurs. <When a CAN reception error occurs>The previous value is held. <When an error is removed>The value is applied.
R		6		High Idling Limit (APP-IP5)	1								CAN version of contact input APP-IP5 (valid when the input setting flag of the APP-IP5 terminal function of the OEM specification setting is set to CAN.)
R		7		High Idling Limit (APP-IP5)	1								CAN version of contact input APP-IP7 (valid when the input setting flag of the APP-IP7 terminal function of the OEM specification setting is set to CAN.)
N/A	1	8	1	Not defined									
N/A	2	1	56	Not defined									

PGN		Acronym										
65309		Y_STP										
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
R	1	1	2	Engine Stop									0=OFF (operable), 1=ON (stop) This packet is an event, and not a CAN error.
R				Engine stop not requested	00								
R				Engine stop	01								
N/A				Error Indicator	10								This value is ignored.
N/A				Not available	11								This value is ignored.
N/A	1	3	6	not defined									
N/A	2	1	56	Not defined									

PGN		Acronym										
65310		Y_RSS										
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
	1	1	5	Rotational Speed Selection Command (CAN)									0=OFF, 1=ON <When a CAN reception error (initialization) occurs>The ECU's initial value is set to OFF.Continued even after an error occurs. <When a CAN reception error occurs>The previous value is held. <When an error is removed>The value is applied.
R		1	1	Rotational Speed Selection 1 (APPIP-3)	XXXX1								
R		2	1	Rotational Speed Selection 2 (APPIP-4)	XXX1X								
R		3	1	Working Machine (Up) (APPIP-5)	XX1XX								
R		4	1	Working Machine (Down) (APPIP-6)	X1XXX								
R		5	1	Rotational Speed Selection Enable (APPIP-6)	1XXXX								
N/A		6	3	Not defined									
R	2		16	Rotational Speed-Up Command (CAN)		U16	0.125	0	0	8031.875	rpm	2211	<When a CAN reception error (initialization) occurs>The ECU's initial value is set to 0.Continued even after an error occurs. <When a CAN reception error occurs>The previous value is held. <When an error is removed>The value is applied.
N/A				Error Indicator	FE**								
N/A				Not available	FF**								
N/A	4	1	40	Not defined									

PGN		Acronym											
65311		Y_SRF											
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
S	1	1	16	Starter Restraint Factor									
S		1	1	During Starter Restraint (during safety relay restraint operation)	1								Restraint = 1, No restraint = 0
S		2	1	During Starter Restraint (during rack actuator initialization, oil pressure SW, charge SW auto diagnosis)	1								Restraint = 1, No restraint = 0
S		3	1	During Starter Restraint (during external switch restraint operation)	1								Restraint = 1, No restraint = 0
S		4	1	During Starter Restraint (during immobilizer restraint operation)	1								Restraint = 1, No restraint = 0
S		5	1	During Starter Restraint (during energization time restraint operation)	1								Restraint = 1, No restraint = 0
S		6	1	During Starter Restraint (restraint command through CAN communication)	1								Restraint = 1, No restraint = 0
S		7	1	During Starter Restraint (during engine stop: stop SW1, stop SW2, CAN)	1								Restraint = 1, No restraint = 0
S		8	1	During Starter Restraint (key switch OFF)	1								Restraint = 1, No restraint = 0
S		9	1	During Starter Restraint (abnormal rack check operation at startup)	1								Restraint = 1, No restraint = 0
S		10	1	During Starter Restraint (ECU error)	1								Restraint = 1, No restraint = 0
S		11	1	During Starter Restraint (engine over-rotation)	1								Restraint = 1, No restraint = 0
S		12	1	During Starter Restraint (during EEPROM initialization, after executing active control)	1								Restraint = 1, No restraint = 0
N/A		13	1	reserved									0
N/A		14	1	reserved									0
N/A		15	1	reserved									0
N/A		16	1	reserved									0
S	3	1	16	Engine Stop Factor									
S		1	1	Engine Stalling	1								Stop due to this factor = 1, Other than stop = 0 (When the engine stalls (when, after the engine starts once, the engine rotational speed decreases to 240 min-1 or less))
S		2	1	Key Switch OFF	1								Stop due to this factor = 1, Normal = 0 (Key switch terminal of ECU is OFF (only when power self-retention control is enabled))
S		3	1	Stop SW1	1								Stop due to this factor = 1, Normal = 0 (Engine stop by Stop SW1 (SHUDNSW terminal))
S		4	1	Stop SW2	1								Stop due to this factor = 1, Normal = 0 Engine stop by Stop SW2 (APP-IP6 terminal or CAN input)
S		5	1	Rotation Sensor Error	1								Stop due to this factor = 1, Normal = 0 (When the engine stops due to a rotation sensor error)
S		6	1	Rack Actuator, Rack Actuator Relay Error	1								Stop due to this factor = 1, Normal = 0 (When a rack actuator error or relay error occurs)
S		7	1	ECU Error (FLASHROM)	1								Stop due to this factor = 1, Normal = 0 (When the ROM checksum is abnormal)
S		8	1	Over-Rotation Error	1								Stop due to this factor = 1, Normal = 0 (At stop due to an over-rotation error)
S		9	1	ECU Error (map format)	1								Stop due to this factor = 1, Normal = 0 (Mismatch of map version)
S		10	1	Engine Stop Due to Other Errors	1								Stop due to this factor = 1, Normal = 0 (When an error whose restraint operation when an error is detected is engine stop occurs)
S		11	1	reserved									0
S		12	1	reserved									0
N/A		13	1	reserved									0
N/A		14	1	reserved									0
N/A		15	1	reserved									0
N/A		16	1	reserved									0
N/A	5	1	32	Not defined									

PGN		Acronym											
65318		Y_SRSI											
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
S	1	1	16	No-Load Minimum Rotational Speed Setting Value		U16	0.125	0	0	8031.875	rpm	188	
S	3	1	16	No-Load Maximum Rotational Speed Setting Value (Droop)		U16	0.125	0	0	8031.875	rpm	532	
S	5	1	16	No-Load Maximum Rotational Speed Setting Value (Isochronous)		U16	0.125	0	0	8031.875	rpm		
S	7	1	16	No-Load Maximum Rotational Speed Setting Value (at Derate)		U16	0.125	0	0	8031.875	rpm		Maximum rotational speed for the current operation (the minimum value of operation such as rotational speed derate for error/alarm, high idling limit control, blue-white smoke limit control, isochronous/droop switching function, etc)

PGN		Acronym											
65319		Y_ESI											
R/S	Byte	Bit	Len	Description	States	Type	Res.	Offset	Min	Max	Unit	SPN	Note
S	1	1	8	Rack Position Mode		U8							Indicates the control state of the engine.The engine operation state is INJ_REG. INJ_ZERO, (0: Stop) INJ_START, (1: Startup) INJ_REG, (2: Startup completed (governing)) INJ_ERROR, (3: Error) INJ_STOP, (4: Stop) INJ_PRE, (5: Rack startup operation completed)
S	2		2	Derate State									
S		1	1	Rmax Derate	X1								During output restraint = 1, Normal = 0
S		2	1	Rotational Speed Derate	1X								During rotational speed restraint = 1, Normal = 0
N/A		3	6	Not defined									
S	3		3	Option Control State									
S		1	1	Idling Up Function	XX1								During idling up = 1 (both during idling up map and CSDON up), Normal = 0
S		2	1	Blue-White Smoke Limit Control Function	X1X								During blue-white smoke limit control = 1, Normal = 0 (displaying the reason why the requested rotational speed cannot be reached)
S		3	1	Rotation Speed-Up Control	1XX								During rotation speed-up control = 1 (when speed-up amount > 0), Normal = 0
N/A		4	5	Not defined									
S	4		3	Governing State									
S		1	1	Isochronous	*X1								During isochronous control = 1
S		2	1	Droop	X1X								During droop control = 1
S		3	1	Reverse Droop	1X*								During reverse droop control = 1
N/A		4	5	Not defined									
N/A	5	1	32	Not defined									

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