

SECTION 5 MECHATRONICS SYSTEM

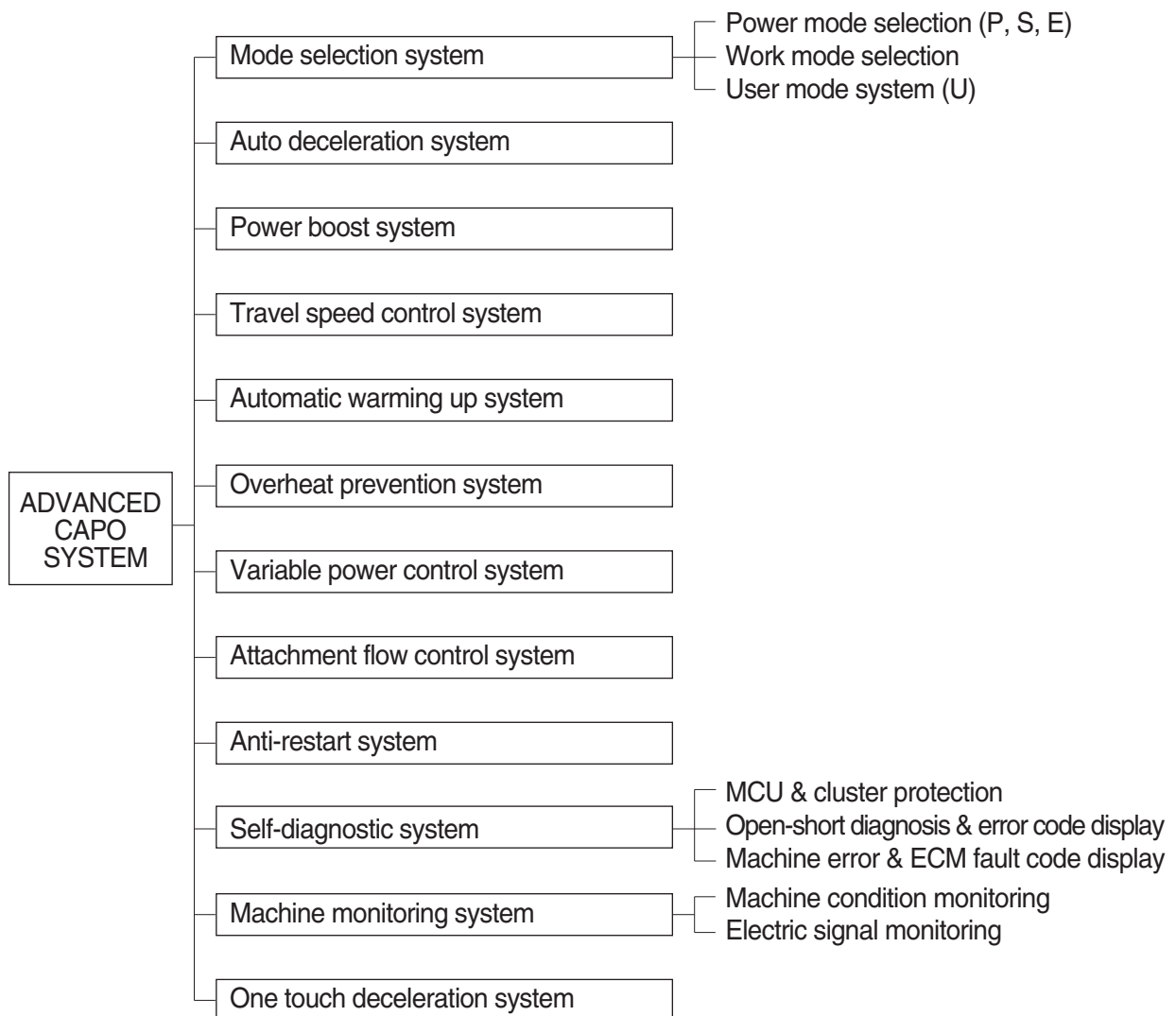
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SECTION 5 MECHATRONICS SYSTEM

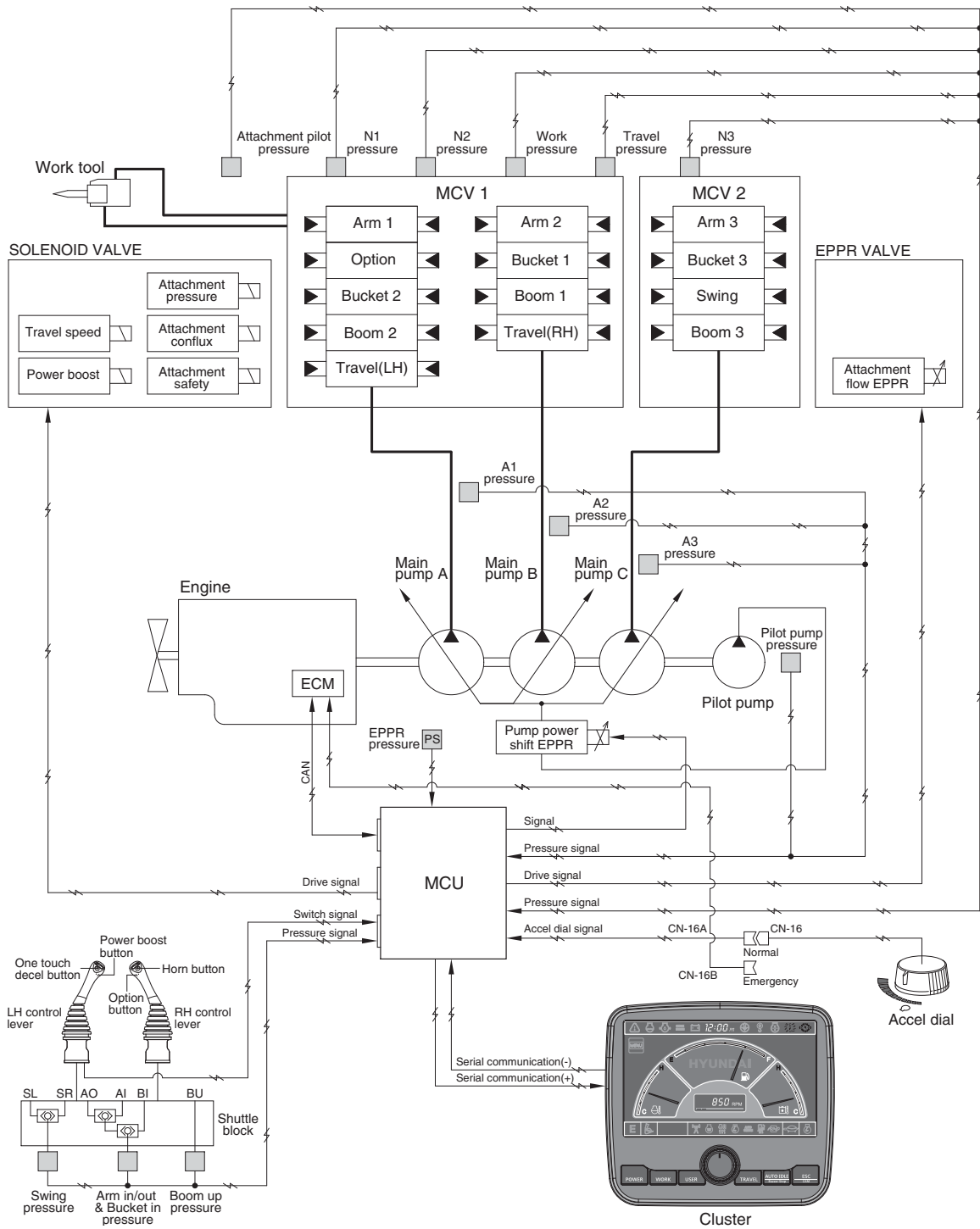
GROUP 1 OUTLINE

The ADVANCED CAPO (Computer Aided Power Optimization) system controls engine and pump mutual power at an optimum and less fuel consuming state for the selected work by mode selection, auto-deceleration, power boost function, etc. It monitors machine conditions, for instance, engine speed, coolant temperature, hydraulic oil temperature, and hydraulic oil pressure, etc.

It consists of a MCU, a cluster, an ECM, EPPR valves, and other components. The MCU and the cluster protect themselves from over-current and high voltage input, and diagnose malfunctions caused by short or open circuit in electric system, and display error codes on the cluster.



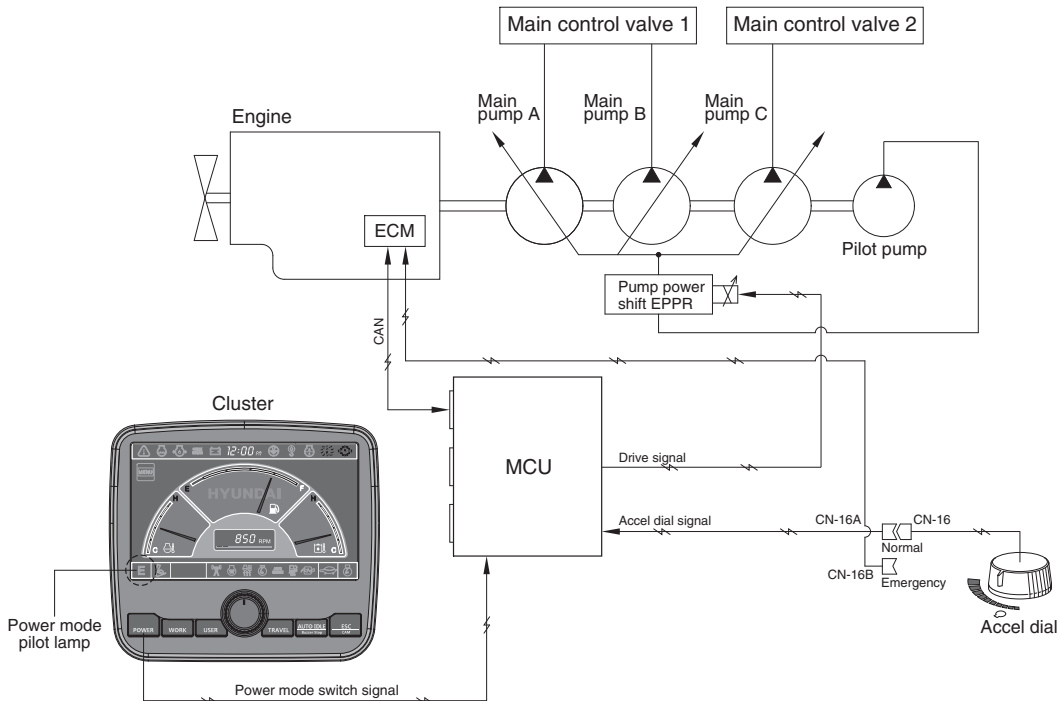
SYSTEM DIAGRAM



120095MS01

GROUP 2 MODE SELECTION SYSTEM

1. POWER MODE SELECTION SYSTEM



120095MS02

Mode selection system (micro computer based electro-hydraulic pump and engine mutual control system) optimizes the engine and pump performance.

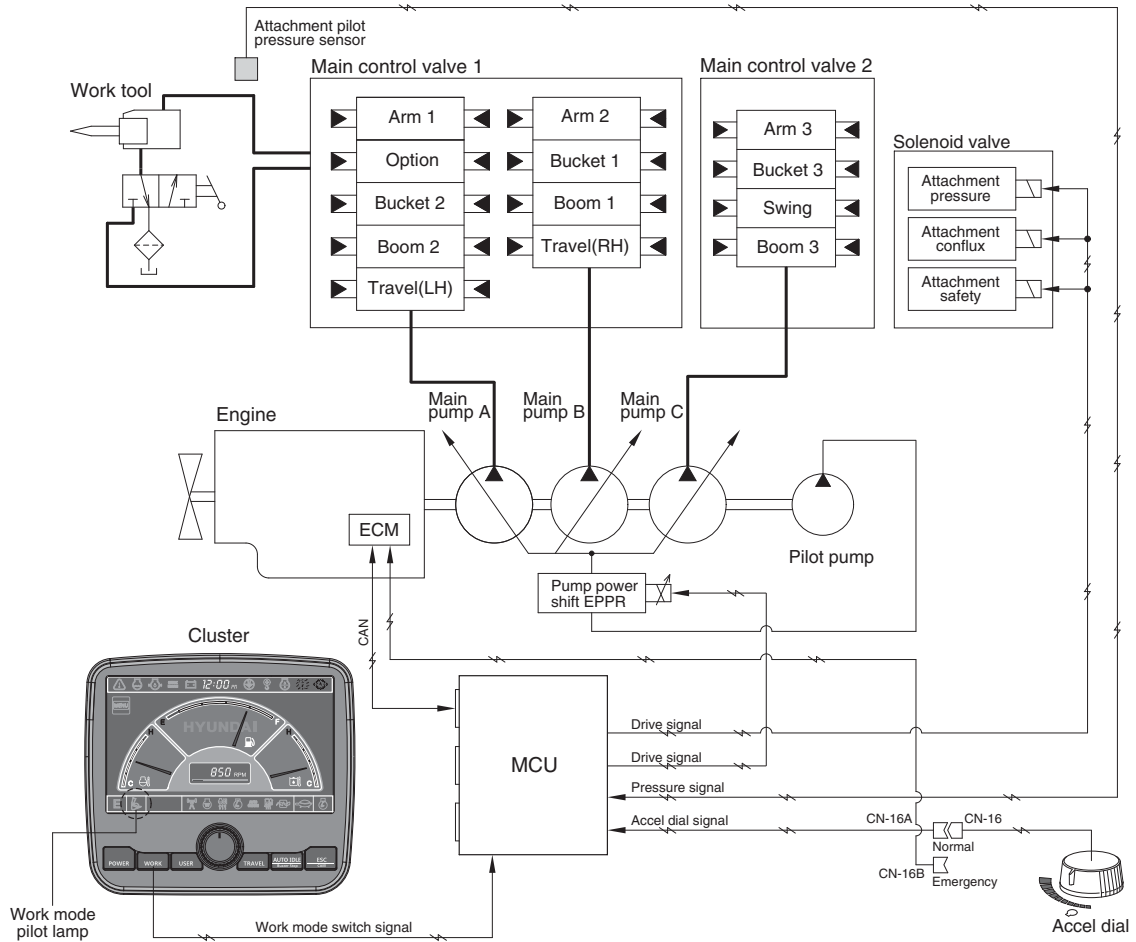
The combination of 3 power modes (P, S, E) and accel dial position (10 set) makes it possible to use the engine and pump power more effectively corresponding to the work conditions from a heavy and great power requesting work to a light and precise work.

Power mode	Application	Engine rpm				Power shift by EPPR valve			
		Standard		Option		Standard		Option	
		Unload	Load	Unload	Load	Current (mA)	Pressure (kgf/cm ²)	Current (mA)	Pressure (kgf/cm ²)
P	Heavy duty power	1800±50	1750±50	1850±50	1800±50	330±30	10	160±30	0
S	Standard power	1700±50	1650±50	1750±50	1700±50	330±30	10±3	280±30	7
E	Economy operation	1600±50	1650±50	1650±50	1700±50	400±30	15±3	360±30	12
AUTO DECEL	Engine deceleration	1100±100	-	1100±100	-	700±30	38±3	700±30	38±3
One touch decel	Engine quick deceleration	900±100	-	900±100	-	700±30	38±3	700±30	38±3
KEY START	Key switch start position	900±100	-	900±100	-	700±30	38±3	700±30	38±3

※ Power shift (Standard/Option) can be changed by "Service menu" in "Management" on the cluster.

2. WORK MODE SELECTION SYSTEM

Work mode consists of the general operation (bucket) and the optional attachment (breaker, crusher).



120095MS03

1) GENERAL WORK MODE (bucket)

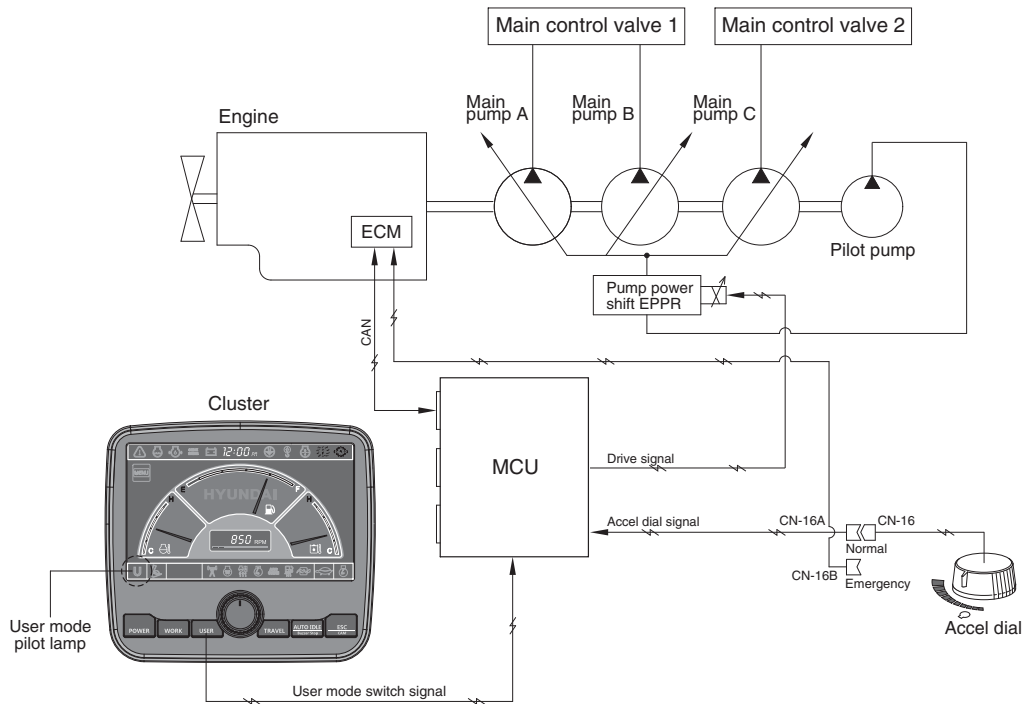
This mode is used to general digging work.

2) ATT WORK MODE (breaker, crusher)

It controls the pump flow and system pressure according to the operation of breaker or crusher.

Description	General mode	Work tool	
	Bucket	Breaker	Crusher
Attachment safety solenoid	OFF	ON	ON
Attachment pressure solenoid	OFF	OFF	ON
Attachment conflux solenoid	OFF	OFF	ON/OFF
Attachment flow EPPR current	100 mA	100~700 mA	100~700 mA

3. USER MODE SELECTION SYSTEM



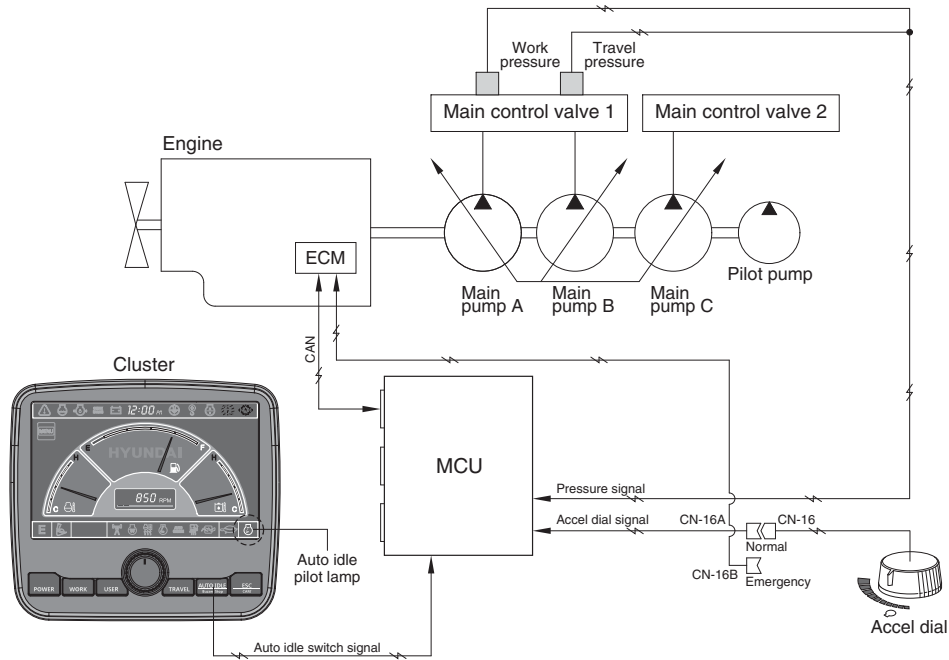
120095MS04

1) High idle rpm, auto idle rpm and EPPR pressure can be adjusted and memorized in the U-mode.

2) LCD segment vs parameter setting

Step ()	Engine speed (rpm)	Idle speed (rpm)	Power shift (bar)
1	1300	800	0
2	1400	850	3
3	1500	900 (low idle)	6
4	1550	950	9
5	1600	1000	12
6	1650	1050	16
7	1700	1100 (decel rpm)	20
8	1750	1150	26
9	1800	1200	32
10	1850	1250	38

GROUP 3 AUTOMATIC DECELERATION SYSTEM

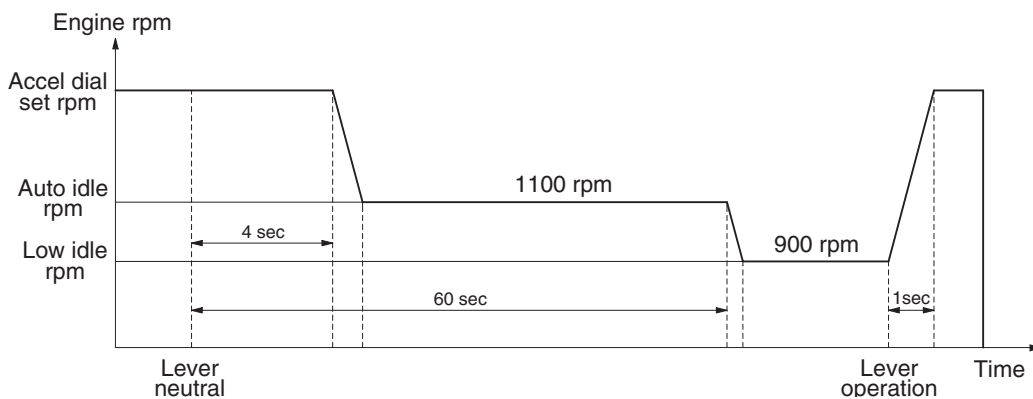


120095MS05

1. WHEN AUTO IDLE PILOT LAMP ON

When all of the work equipment control levers including swing and travel levers are at neutral for 4 seconds, MCU sends throttle command to ECM to reduce the engine speed to 1100 rpm. If the control levers are at neutral for 1 minute, MCU reduces the engine speed to 900 rpm. As the result of reducing the engine speed, fuel consumption and noise are effectively cut down during non-operation of the control levers.

When the Auto idle pilot lamp is turned off by pressing the switch or any control lever is operated, the reduced engine speed rises up to the speed before deceleration in a second.



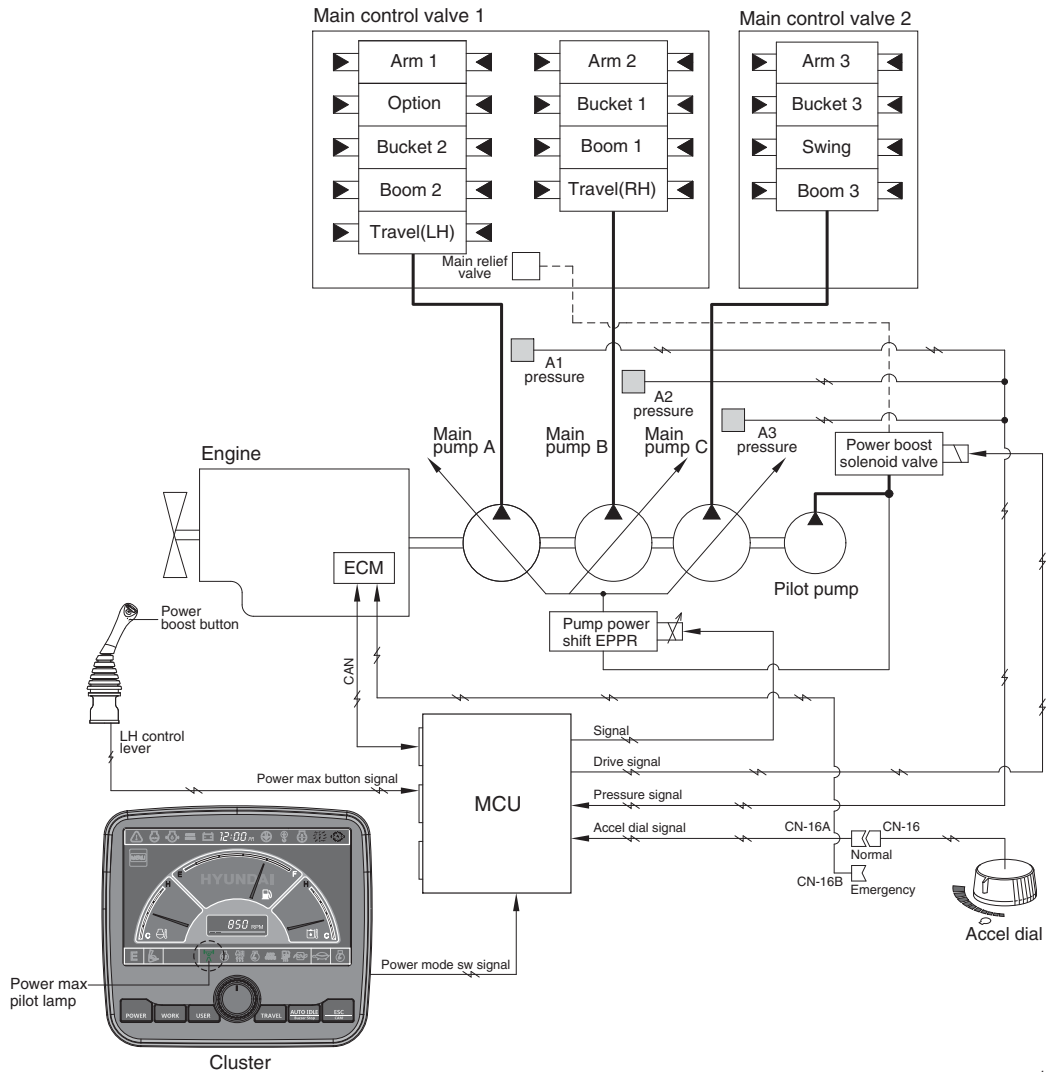
120095MS07

2. WHEN AUTO IDLE PILOT LAMP OFF

The engine speed can be set as desired using the accel dial switch, and even if the control levers are neutral, the engine speed is not reduced.

※ Auto idle function can be activated when accel dial position is over 4.

GROUP 4 POWER BOOST SYSTEM



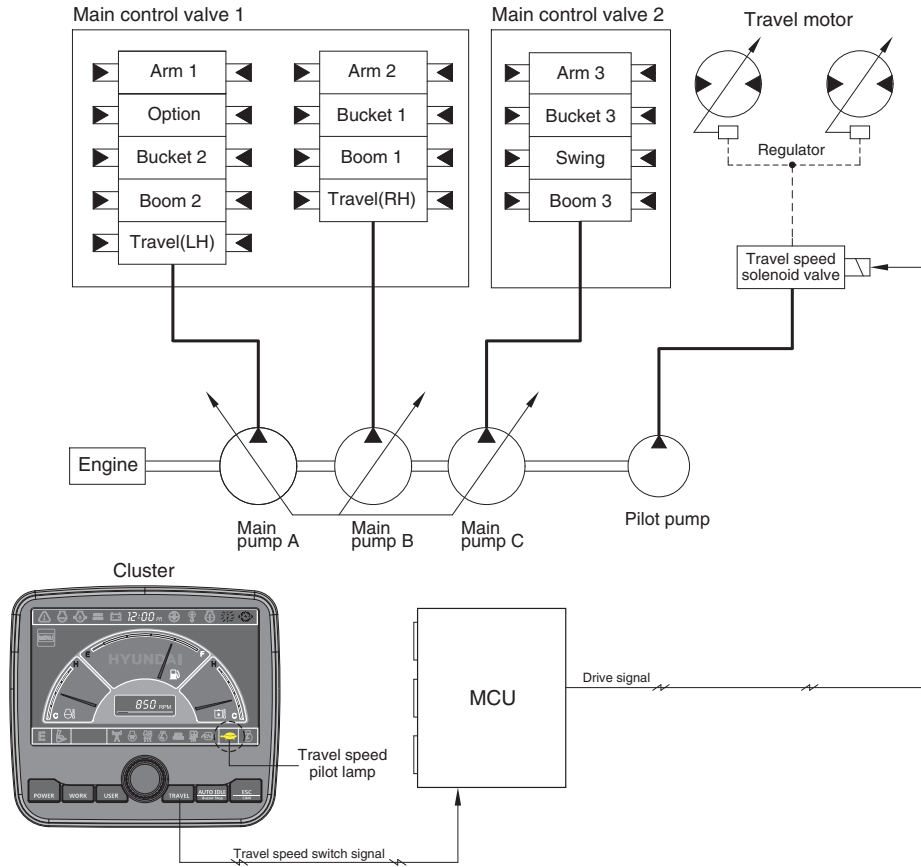
120095MS06

- When the power boost switch on the left control lever knob is pushed ON, the power mode is set P mode and maximum digging power is increased by 10 %.
- When the power boost function is activated, the power boost solenoid valve pilot pressure raises the set pressure of the main relief valve to increase the digging power.

Description	Condition	Function
Activated	Power boost switch : ON Accel dial : over 8	- Power mode : P - Accel dial power : 9 - Power boost solenoid : ON - Power boost pilot lamp : ON - Operating time : max 8 seconds
Canceled	Power boost switch : OFF	- Pre-set power mode - Power boost solenoid : OFF - Power boost pilot lamp : OFF

※ When the auto power boost is set to Enable and power mode is set to P mode on the cluster, the digging power is automatically increased as working conditions by the MCU. It is operated max 8 seconds.

GROUP 5 TRAVEL SPEED CONTROL SYSTEM



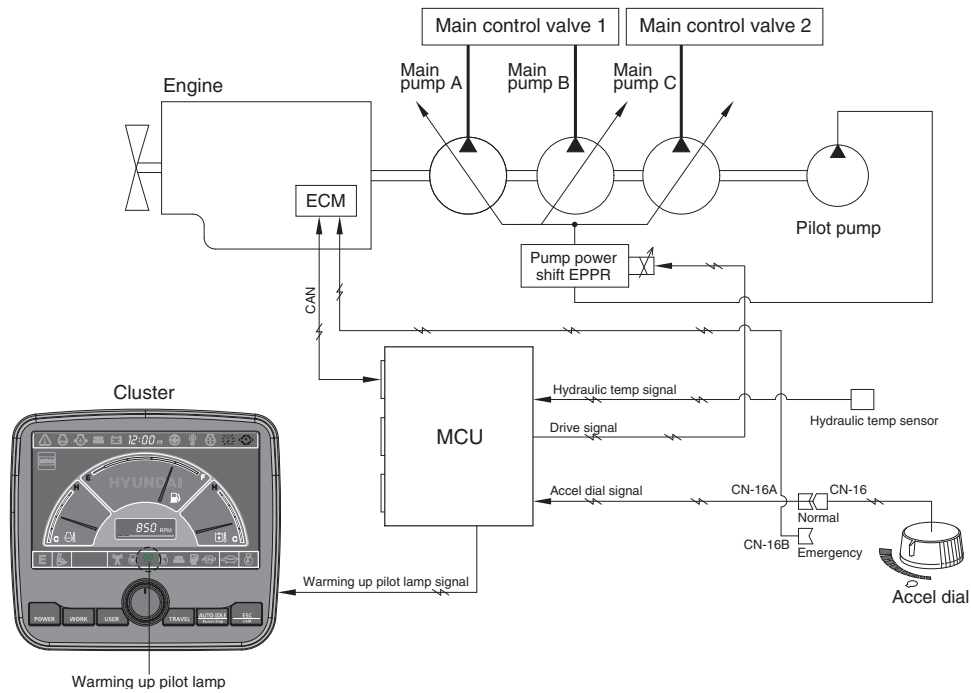
120095MS08

Travel speed can be switched manually by pressing the travel speed switch on the cluster.

Speed	Travel speed solenoid valve	Lamp on cluster	Operation
Low	OFF	Turtle	Low speed, high driving torque in the travel motor
High	ON	Rabbit	High speed, low driving torque in the travel motor

※ Default : Turtle (Low)

GROUP 6 AUTOMATIC WARMING UP SYSTEM



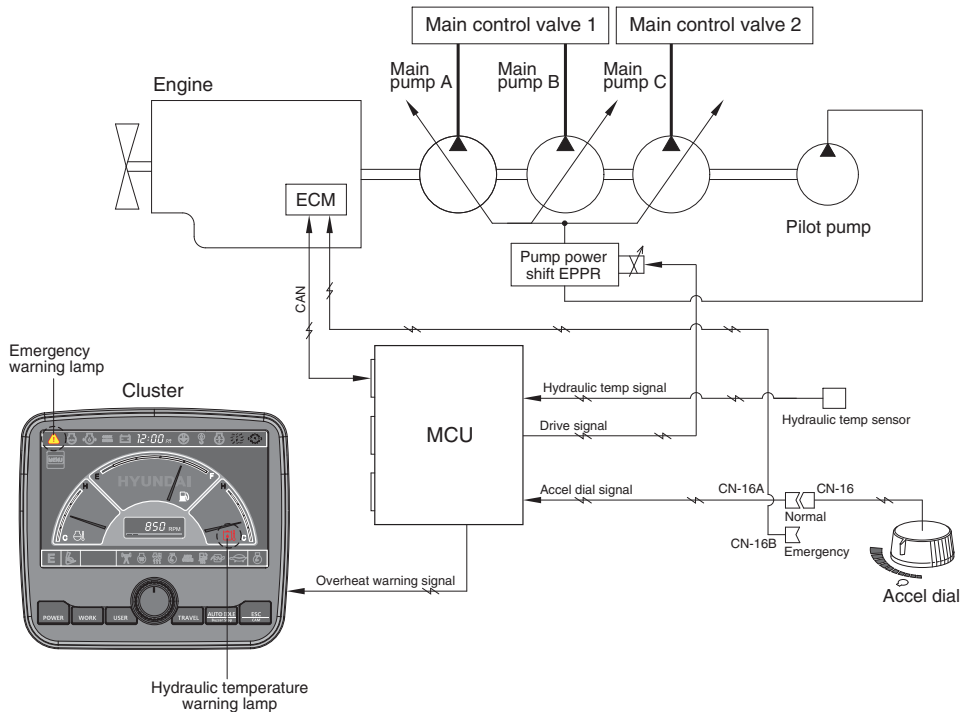
120095MS09

1. The MCU receives the engine coolant temperature from the ECM, and if the coolant temperature is below 30°C, it increases the engine speed from key start rpm to 1200rpm. At this time the mode does not change. If the coolant temperature sensor has fault, the hydraulic oil temperature signal is substituted.
2. In case of the coolant temperature increases up to 30°C, the engine speed is decreased to key start speed. And if an operator changes power mode set during the warming up function, the MCU cancels the automatic warming up function.

3. LOGIC TABLE

Description	Condition	Function
Actuated	- Coolant temperature : below 30°C (after engine run)	- Power mode : Default (E mode) - Warming up time : 10 minutes (max) - Warming up pilot lamp : ON
Canceled	- Coolant temperature : Above 30°C - Warming up time : Above 10 minutes - Changed power mode set by operator - RCV lever or pedal operating - Auto idle cancel ※ If any of the above conditions is applicable, the automatic warming up function is canceled	- Power mode : set mode - Warming up pilot lamp : OFF

GROUP 7 ENGINE OVERHEAT PREVENTION SYSTEM



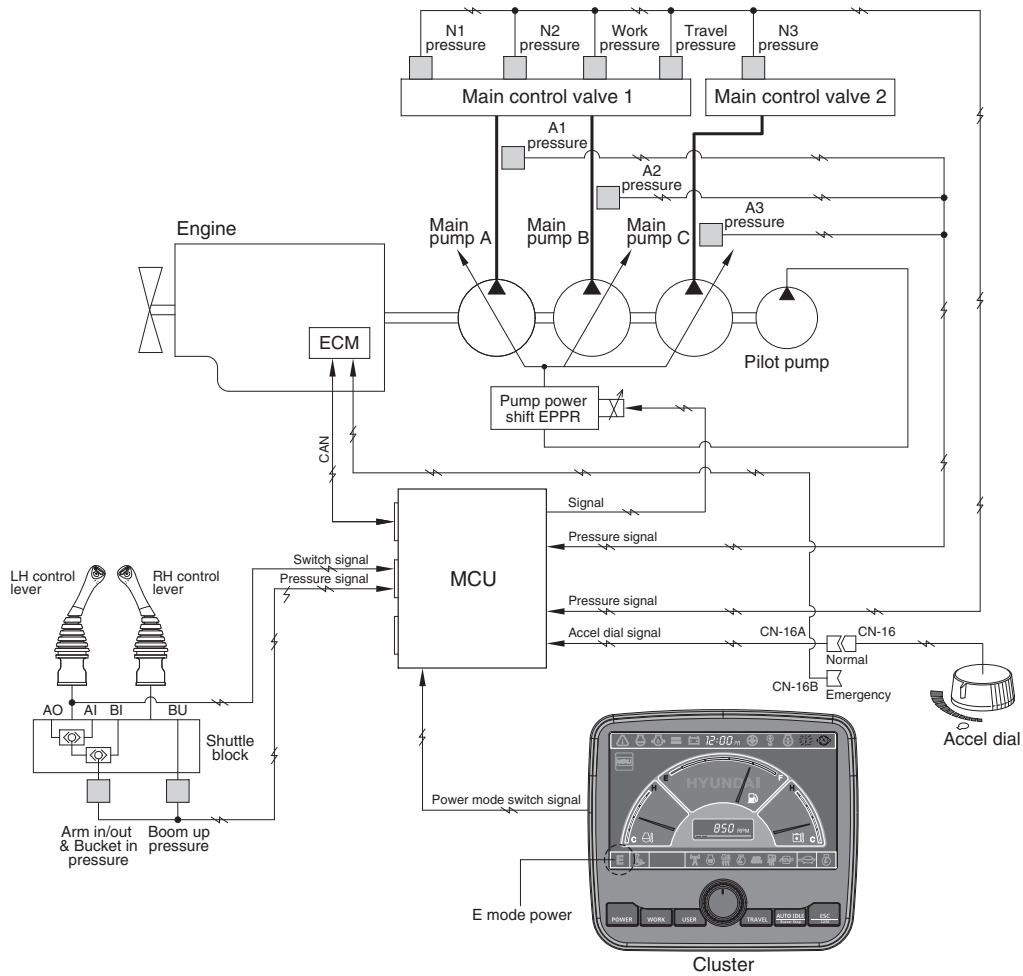
120095MS11

1. The engine coolant temperature or the hydraulic oil temperature is overheated over 100°C, the warning lamp is ON and the pump input torque or the engine speed is reduced as below logic table.

2. LOGIC TABLE

Description		Condition	Function
First step warning	Activated	- Coolant temperature : Above 103°C - Hydraulic oil temperature : Above 100°C	- Warning lamp : ON , buzzer : OFF - Pump input torque is reduced.
	Canceled	- Coolant temperature : Less than 100°C - Hydraulic oil temperature : Less than 95°C	- Warning lamp & buzzer : ON - Pump input torque is reduced.
Second step warning	Activated	- Coolant or hydraulic oil temperature : Above 105°C	- Emergency warning lamp pops up on the center of LCD and the buzzer sounds. - Engine speed is reduced after 10 seconds.
	Canceled	- Coolant temperature : Less than 103°C - Hydraulic oil temperature : Less than 100°C	- Return to pre-set the engine speed. - Hold pump absorption torque on the first step warning.

GROUP 8 VARIABLE POWER CONTROL SYSTEM



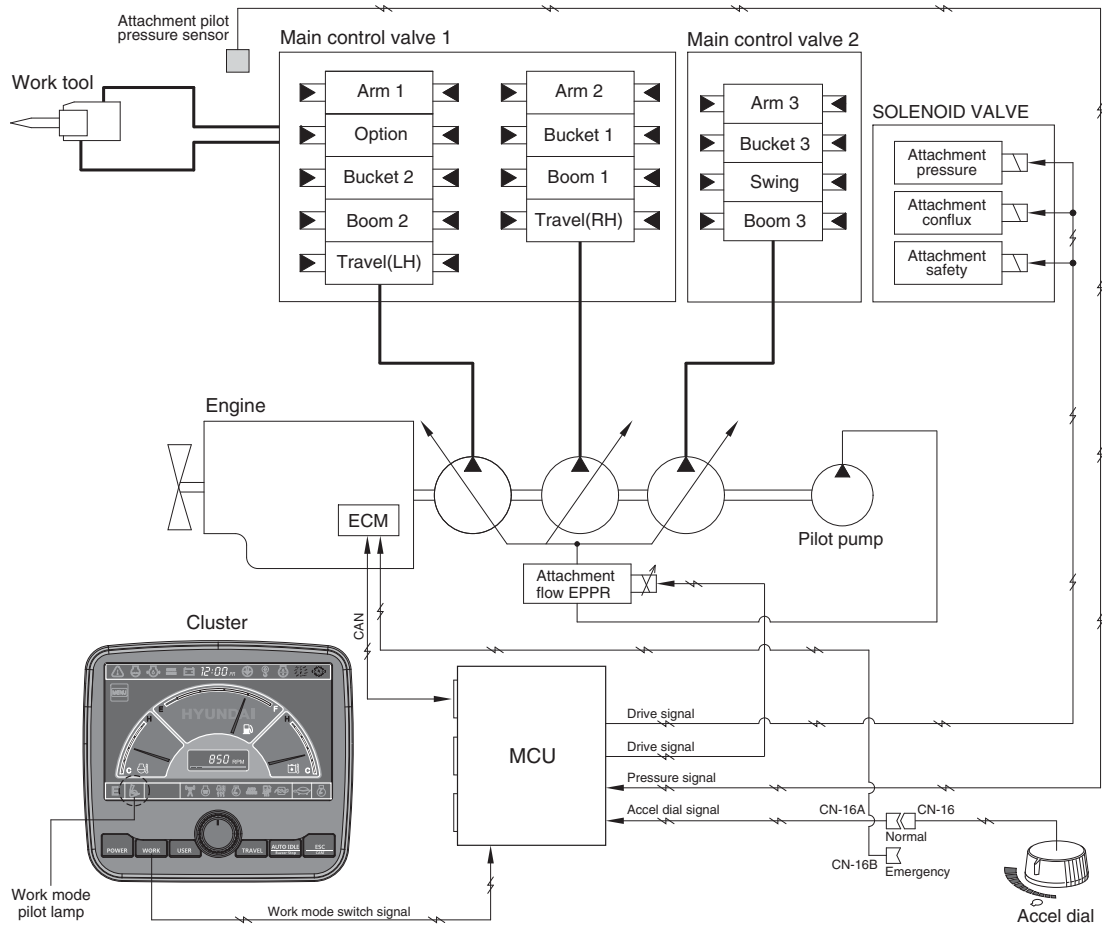
120095MS12

- The variable power control system controls the engine and pump mutual power according to RCV lever stroke and pump load. It makes fuel saving and smooth control at precise work.

Description	Working condition
Power mode	E
Work mode	General (bucket)
Pressure sensor	Normal

※ The variable power control function can be activated when the power mode is set to E mode.

GROUP 9 ATTACHMENT FLOW CONTROL SYSTEM



120095MS13

- The system is used to control the pump delivery flow according to set of the work tool on the cluster by the attachment flow EPPR valve.

Description	Work tool	
	Breaker	Crusher
Flow level	Max 7 step, reduced 10 lpm each step	Max 4 step, reduced 20 lpm each step
Attach safety solenoid	ON	ON
Attach pressure solenoid	OFF	ON
Attach conflux solenoid	OFF	ON/OFF

※ Refer to the page 5-42 for the attachment kinds and max flow.

GROUP 11 SELF-DIAGNOSTIC SYSTEM

1. OUTLINE

When any abnormality occurs in the ADVANCED CAPO system caused by electric parts malfunction and by open or short circuit, the MCU diagnoses the problem and sends the error codes to the cluster and also stores them in the memory.

2. MONITORING

1) Active fault



- The active faults of the MCU or engine ECM can be checked by this menu.

2) Logged fault



- The logged faults of the MCU or engine ECM can be checked by this menu.

3) Delete fault



- The logged faults of the MCU or engine ECM can be deleted by this menu.

3. MACHINE ERROR CODES TABLE

Error code		Description
HCESPN	FMI	
101	3	Hydraulic oil temperature sensor circuit - Voltage above normal, or shorted to high source.
	4	Hydraulic oil temperature circuit - Voltage below normal, or shorted to low source.
105	0	Working pressure sensor data above normal range.
	1	Working pressure sensor data below normal range.
	2	Working pressure sensor data error.
	4	Working pressure sensor circuit - Voltage below normal, or shorted to Low source.
108	0	Travel oil pressure sensor data above normal range.
	1	Travel oil pressure sensor data below normal range.
	2	Travel oil pressure sensor data error.
	4	Travel oil pressure sensor circuit - Voltage below normal, or shorted to low source.
120	0	Main pump 1 (P1) pressure sensor data above normal range.
	1	Main pump 1 (P1) pressure sensor data below normal range.
	2	Main pump 1 (P1) pressure sensor data error.
	4	Main pump 1 (P1) pressure sensor circuit - Voltage below normal, or shorted to low source.
121	0	Main pump 2 (P2) pressure sensor data above normal range.
	1	Main pump 2 (P2) pressure sensor data below normal range.
	2	Main pump 2 (P2) pressure sensor data error.
	4	Main pump 2 (P2) pressure sensor circuit - Voltage below normal, or shorted to low source.
122	0	Overhead pressure sensor data above normal range.
	1	Overhead pressure sensor data below normal range.
	2	Overhead pressure sensor data error.
	4	Overhead pressure sensor circuit - Voltage below normal, or shorted to low source.
123	0	Negative 1 pressure sensor data above normal range.
	1	Negative 1 pressure sensor data below normal range.
	2	Negative 1 pressure sensor data error.
	4	Negative 1 pressure sensor circuit - Voltage below normal, or shorted to low source.
124	0	Negative 2 Pressure sensor data above normal range.
	1	Negative 2 Pressure sensor data below normal range.
	2	Negative 2 Pressure sensor data error.
	4	Negative 2 Pressure sensor circuit - Voltage below normal, or shorted to low source.
125	0	Pilot pump (P3) pressure sensor data above normal range.
	1	Pilot pump (P3) pressure sensor data below normal range.
	2	Pilot pump (P3) pressure sensor data error.
	4	Pilot pump (P3) pressure sensor circuit - Voltage below normal, or shorted to low source.
127	0	Boom up pilot pressure sensor data above normal range.
	1	Boom up pilot pressure sensor data below normal range.
	2	Boom up pilot pressure sensor data error.
	4	Boom up pilot pressure sensor circuit - Voltage below normal, or shorted to low source.
133	0	Arm in/out & bucket in pilot pressure sensor data above normal range.
	1	Arm in/out & bucket in pilot pressure sensor data below normal range.
	2	Arm in/out & bucket in pilot pressure sensor data error.
	4	Arm in/out & bucket in pilot pressure sensor circuit - Voltage below normal, or shorted to low source.

※ Some error codes are not applied to this machine.

Error code		Description
HCESPN	FMI	
135	0	Swing pilot pressure sensor data above normal range.
	1	Swing pilot pressure sensor data below normal range.
	2	Swing pilot pressure sensor data error.
	4	Swing pilot pressure sensor circuit - Voltage below normal, or shorted to low source.
138	0	Attachment pilot pressure sensor data above normal range.
	1	Attachment pilot pressure sensor data below normal range.
	2	Attachment pilot pressure sensor data error.
	4	Attachment pilot pressure sensor circuit - Voltage below normal, or shorted to low source.
140	5	Pump EPPR valve circuit - Current below normal, or open circuit.
	6	Pump EPPR valve circuit - Current above normal.
141	5	Boom priority EPPR valve circuit - Current below normal, or open circuit.
	6	Boom priority EPPR valve circuit - Current above normal.
143	5	Travel EPPR valve circuit - Current below normal, or open circuit.
	6	Travel EPPR valve circuit - Current above normal.
144	5	Attachment flow EPPR valve circuit - Current below normal, or open circuit.
	6	Attachment flow EPPR valve circuit - Current above normal.
145	5	Remote cooling fan EPPR valve circuit - Current below normal, or open circuit.
	6	Remote cooling fan EPPR valve circuit - Current above normal.
150	5	Left rotate EPPR valve circuit - Current below normal, or open circuit.
	6	Left rotate EPPR valve circuit - Current above normal.
151	5	Right rotate EPPR valve circuit - Current below normal, or open circuit.
	6	Right rotate EPPR valve circuit - Current above normal.
152	5	Left tilt EPPR valve circuit - Current below normal, or open circuit.
	6	Left tilt EPPR valve circuit - Current above normal.
153	5	Right tilt EPPR valve circuit - Current below normal, or open circuit.
	6	Right tilt EPPR valve circuit - Current above normal.
166	5	Power max solenoid circuit - Current below normal, or open circuit.
	6	Power max solenoid circuit - Current above normal.
167	5	Travel speed solenoid circuit - Current below normal, or open circuit.
	6	Travel speed solenoid circuit - Current above normal.
168	5	Attachment pressure solenoid circuit - Current below normal, or open circuit.
	6	Attachment pressure solenoid circuit - Current above normal.
169	5	Attachment conflux solenoid circuit - Current below normal, or open circuit.
	6	Attachment conflux solenoid circuit - Current above normal.
170	5	Arm regeneration solenoid circuit - Current below normal, or open circuit.
	6	Arm regeneration solenoid circuit - Current above normal.
171	5	Attachment safety solenoid circuit - Current below normal, or open circuit.
	6	Attachment safety solenoid circuit - Current above normal.
181	5	Remote cooling fan reverse solenoid circuit - Current below normal, or open circuit.
	6	Remote cooling fan reverse solenoid circuit - Current above normal.
301	5	Fuel level sensor circuit - Voltage above normal, or shorted to high source.
	6	Fuel level sensor circuit - Voltage below normal, or shorted to low source.
304	3	Engine coolant temperature sensor circuit - Voltage above normal, or shorted to high source.
	4	Engine coolant temperature sensor circuit - Voltage below normal, or shorted to low source.
310	8	Engine speed signal error - Abnormal frequency or pulse width.
322	3	Engine preheat relay circuit - Voltage above normal, or shorted to high source.
	4	Engine preheat relay circuit - Voltage below normal, or shorted to low source.
325	3	Fuel warmer relay circuit - Voltage above normal, or shorted to high source.
	4	Fuel warmer relay circuit - Voltage below normal, or shorted to low source.

※ Some error codes are not applied to this machine.

Error code		Description
HCESPN	FMI	
340	3	Potentiometer (G/A) circuit - Voltage above normal, or shorted to high source.
	4	Potentiometer (G/A) circuit - Voltage below normal, or shorted to low source.
341	5	Governor actuator circuit - Current below normal, or open circuit.
	6	Governor actuator circuit - Current above normal.
501	0	Transmission oil pressure sensor data above normal range.
	1	Transmission oil pressure sensor data below normal range.
	2	Transmission oil pressure sensor data error.
	4	Transmission oil pressure sensor circuit - Voltage below normal, or shorted to low source.
503	0	Brake pressure sensor data above normal range.
	1	Brake pressure sensor data below normal range.
	2	Brake pressure sensor data error.
	4	Brake pressure sensor circuit - Voltage below normal, or shorted to low source.
505	0	Working brake pressure sensor data above normal range.
	1	Working brake pressure sensor data below normal range.
	2	Working brake pressure sensor data error.
	4	Working brake pressure sensor circuit - Voltage below normal, or shorted to low source.
506	3	Working brake lamp circuit - Voltage above normal, or shorted to high source.
	4	Working brake lamp circuit - Voltage below normal, or shorted to low source.
520	3	Ram lock lamp circuit - Voltage above normal, or shorted to high source.
	4	Ram lock lamp circuit - Voltage below normal, or shorted to low source.
525	5	Ram lock solenoid circuit - Current below normal, or open circuit.
	6	Ram lock solenoid circuit - Current above normal.
530	0	Travel F pilot pressure sensor data above normal range.
	1	Travel F pilot pressure sensor data below normal range.
	2	Travel F pilot pressure sensor data error.
	4	Travel F pilot pressure sensor circuit - Voltage below normal, or shorted to low source.
531	0	Travel R pilot pressure sensor data above normal range.
	1	Travel R pilot pressure sensor data below normal range.
	2	Travel R pilot pressure sensor data error.
	4	Travel R pilot pressure sensor circuit - Voltage below normal, or shorted to low source.
701	3	Hourmeter circuit - Voltage above normal, or shorted to high source.
	4	Hourmeter circuit - Voltage below normal, or shorted to low source.
705	0	MCU input voltage high.
	1	MCU input voltage low.
707	1	Alternator node I voltage low.
714	3	Acc. dial circuit - Voltage above normal, or shorted to high source.
	4	Acc. dial circuit - Voltage below normal, or shorted to low source.
715	3	Rotate signal input circuit - Voltage above normal, or shorted to high source.
	4	Rotate signal input circuit - Voltage below normal, or shorted to low source.
716	3	Tilt signal input circuit - Voltage above normal, or shorted to high source.
	4	Tilt signal input circuit - Voltage below normal, or shorted to low source.
722	3	Travel alarm (buzzer) circuit - Voltage above normal, or shorted to high source.
	4	Travel alarm (buzzer) circuit - Voltage below normal, or shorted to low source.
830	12	MCU internal memory error.
840	2	Cluster communication data error.
841	2	ECM communication data error.
843	2	Option #1 (CAN 2) communication data error.
850	2	RCM communication data error.

※ Some error codes are not applied to this machine.

4. ENGINE FAULT CODE

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
111 629 12	Error internal to the ECM related to memory hardware failures or internal processor communication failures.	Mission-disabling failure. Engine not allowed to start.
112 635 7	The error between estimated timing fueling and desired timing fueling is outside acceptable limits.	Depending on the calibration, the engine will shut down or speed-derate or no action by the ECM is taken.
113 635 3	Timing actuator circuit is open, or supply pin 1 is shorted to ground, or return pin 20 is shorted to battery voltage.	No action by the ECM is taken. Actuator is closed or partially closed. Engine exhausts white smoke and loses power. Fault code 112 can possibly be logged.
115 190 2	No engine speed signal detected at pins 27, 28, 37 and 38 of the engine harness.	Engine is shut down and can not be run.
116 156 3	More than 4.78 VDC detected at timing pressure sensor signal pin 33 of the engine harness.	Depending on the calibration, the engine will shut down or speed-derate, or no action by the ECM is taken.
117 156 4	Less than 0.15 VDC detected at timing pressure sensor signal pin 33 of the engine harness.	Depending on the calibration, the engine will shut down or speed-derate, or no action by the ECM is taken.
118 135 3	More than 4.78 VDC detected at fuel pump pressure sensor signal pin 32 of the engine harness.	No action by the ECM is taken.
119 135 4	Less than 0.30 VDC detected at fuel pump pressure sensor signal pin 32 of the engine harness.	No action by the ECM is taken.
121 190 10	No engine speed signal detected at one pair of pins, either pin 27, 28, 37 or 38 of the engine harness.	No action by the ECM is taken.
122 102 3	More than 4.72 VDC detected at the intake manifold air pressure sensor signal pin 35 of the engine harness.	Engine power derate to no-air setting.
123 102 4	Less than 0.33 VDC detected at the intake manifold air pressure sensor signal pin 35 of the engine harness.	Engine power derate to no-air setting.
131 091 3	More than 4.20 VDC detected at the accelerator pedal or lever position signal pin 29 of the OEM interface harness.	Calibration dependent power and speed derate.
132 091 4	Less than 0.13 VDC detected at the accelerator pedal or lever position signal pin 29 of the OEM interface harness ECM connector.	Calibration dependent power and speed derate.
133 029 3	More than 4.82 VDC detected at the remote throttle position signal pin 30 of the OEM interface harness.	Calibration dependent power and speed derate.
134 029 4	Less than 0.12 VDC detected at the remote accelerator pedal or lever position signal pin 30 of the OEM interface harness.	Calibration dependent power and speed derate.
135 100 3	More than 4.88 VDC detected at the engine oil pressure sensor signal pin 24 of the engine harness.	No engine protection for oil pressure. Centinel system is disabled.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
141 100 4	Less than 0.31 VDC detected at the engine oil pressure sensor signal pin 24 of the engine harness.	No engine protection for oil pressure. Centinel™ system is disabled.
143 100 1	Low oil pressure has been detected. Voltage signal at oil pressure signal pin 24 of the engine harness indicates oil pressure lower than 103 kPa (15 psi) at 600 rpm, 131 kPa (19 psi) at 800 rpm, 165 kPa (24 psi) at 1500 rpm, and 207 kPa (30 psi) above 2100 rpm.	Calibration dependent progressive power derate and engine shutdown with increasing time after alert. Centinel™ system is disabled.
144 110 3	More than 4.95 VDC detected at the coolant temperature signal pin 22 of the engine harness.	Possible white smoke. No engine protection for coolant temperature. Centinel™ system is disabled.
145 110 4	Less than 0.21 VDC detected at the coolant temperature signal pin 22 of the engine harness.	Possible white smoke. No engine protection for coolant temperature. Centinel™ system is disabled.
147 091 8	A frequency of less than 100Hz has been detected at the frequency accelerator signal pin 17 of the OEM interface harness.	Calibration dependent power and speed derate.
148 091 8	A frequency of more than 1500Hz has been detected at the frequency accelerator signal pin 17 of the OEM interface harness.	Calibration dependent power and speed derate.
151 110 0	High coolant temperature has been detected. Voltage signal at coolant temperature signal pin 22 indicates the coolant temperature is above 100°C (212°F).	Calibration dependent progressive power and speed derate and engine shutdown as temperature increases over thresholds. Centinel™ system is disabled.
153 105 3	More than 4.88 VDC detected at the intake manifold temperature sensor signal pin 23 of the engine harness ECM connector.	No engine protection for the intake manifold air temperature.
154 105 4	Less than 0.08 VDC detected at the intake manifold air temperature signal pin 23 of the engine harness.	No engine protection for the intake manifold air temperature.
155 105 0	High intake air manifold temperature has been detected. Voltage signal at intake manifold air temperature signal pin 23 indicates intake manifold air temperature above 104°C (219°F).	Calibration dependent progressive power and speed derate and engine shutdown as the temperature increases over thresholds.
219 1380 1	Low oil level detected in the remote oil reservoir used in the Centinel™ system.	Centinel™ system is disabled.
221 108 3	More than 4.78 VDC detected at the ambient air pressure sensor signal pin 34 of the engine harness.	Derate in power output of the engine.
222 108 4	Less than 0.20 VDC detected at the ambient air pressure sensor signal pin 34 of the engine harness.	Derate in power output of the engine.
223 1265 4	The Centinel™ burn valve solenoid circuit is open or shorted. Less than 18.0 VDC detected at the Centinel™ burn valve solenoid supply pin 8 of the OEM interface harness or resistance of the solenoid has dropped below 80 ohms.	ECM turns off the burn valve supply voltage and the Centinel™ system is disabled.
225 1266 4	The centinel™ make-up valve solenoid circuit is open or shorted. Less than 18.0 VDC detected at Centinel™ make-up valve solenoid supply pin 2 of the engine harness or resistance of the solenoid has dropped below 80 ohms.	ECM turns off the Centinel™ make-up valve supply voltage and the Centinel™ system is disabled.

111 Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
231 109 3	More than 4.72 VDC detected at the coolant pressure sensor signal pin 16 of the engine harness.	No engine protection for coolant pressure.
232 109 4	Less than 0.33 VDC detected at the coolant pressure sensor signal pin 16 of the engine harness.	No engine protection for coolant pressure.
233 109 1	Low coolant pressure has been detected. Voltage signal at coolant pressure signal pin 16 of the engine harness indicates coolant pressure lower than 28 kPa (4 psi) at 800 rpm, 41 kPa (6 psi) at 1300 rpm, 76 kPa (11 psi) at 1800 rpm, 96 kPa (14 psi) at 2000 rpm and 103 kPa (15 psi) above 2100 rpm.	Calibration dependent progressive power and speed derate and engine shutdown with increasing time after alert.
234 190 0	Engine speed signal on pin 27 and pin 28 and/or pin 37 and pin 38 of the engine harness indicates an engine speed greater than the safe operation rpm limit. The limit is 2450 rpm for the QSK19 and 2190 rpm for the QSK60.	Fuel shutoff valve deenergizes (valve closes). The valve reenergizes (fuel shut off valve opens) when engine speed falls below its upper rpm threshold.
235 111 1	Low coolant level has been detected. Voltage signal on the coolant level signal pin 23 of the OEM harness indicates low radiator coolant level on the vehicle	Calibration dependent progressive power and speed derate and engine shutdown with increasing time after alert.
237 644 2	Duty cycle of input throttle signal pin 17 of the OEM interface harness is less than 3 percent or more than 97 percent.	The primary engine and secondary engines are shut down with increasing time after alert if hard coupled. Only the secondary engines are shut down with increasing time after alert if soft coupled.
252 098 2	Oil level sensor error.	No engine protection for low oil level. Centinel™ system is disabled.
253 098 1	Low coolant level has been detected. Voltage signal on the oil level signal pin 12 of the engine harness indicates low oil level in the engine.	Calibration dependent progressive power derate and engine shutdown with increasing time after alert.
254 632 4	The fuel shutoff valve solenoid circuit is open or shorted. Less than 6.0 VDC detected at fuel shutoff valve solenoid supply pin 30 of the engine harness or resistance of the solenoid has dropped below 20 ohms.	ECM turns off fuel shutoff valve supply voltage. The engine dies.
259 632 7	Fuel shutoff valve is open and will not close.	No action by the ECM is taken.
261 174 0	High fuel temperature has been detected. Voltage signal at fuel temperature signal pin 26 of engine harness indicates fuel temperature above 71°C (160°F).	Calibration dependent progressive power and speed derate and engine shutdown with increasing time after alert.
263 174 3	More than 4.95 VDC detected at the fuel temperature signal pin 26 of the engine harness.	No engine protection for fuel temperature.
265 174 4	Less than 0.21 VDC detected at the fuel temperature signal pin 26 of the engine harness.	No engine protection for fuel temperature.
292 1083 14	OEM temperature out-of-range has been detected. Voltage signal at OEM temperature signal pin 27 indicates OEM temperature beyond the OEM specified threshold.	Calibration dependent progressive power and speed derate and engine shutdown with increasing time after alert.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
293 1083 3	VDC detected at the OEM temperature sensor signal pin 27 of the OEM interface harness indicates the sensor has failed high.	No engine protection for OEM temperature.
294 1083 4	VDC detected at the OEM temperature sensor signal pin 27 of the OEM interface harness indicates the sensor has failed low.	No engine protection for OEM temperature.
296 1084 14	OEM pressure out-of-range has been detected. Voltage signal at OEM pressure signal pin 27 indicates OEM pressure beyond OEM specified threshold.	OEM and calibration dependent progressive power and speed derate and engine shutdown with increasing time after alert.
297 1084 3	VDC detected at the OEM pressure sensor signal pin 15 of the OEM interface harness indicates the sensor has failed high.	No engine protection for OEM pressure.
298 1084 4	VDC detected at the OEM pressure sensor signal pin 15 of the OEM interface harness indicates the sensor has failed low.	No engine protection for OEM pressure.
299 - -	The engine was shutdown by device other than the key switch before proper engine cooldown, resulting in a load factor above the maximum shutdown threshold. Fault Code 299 will be logged if the engine is shut down while hot by the engine protection feature or other OEM devices.	No action taken by the ECM.
316 931 3	Fuel pump actuator circuit is open, or supply pin 11 is shorted to battery voltage or ground, or return pin 40 is shorted to battery voltage or ground in the engine harness.	No action by the ECM is taken. Actuator is open or close, or or partially closed.
318 931 7	The error between estimated fuel pump pressure and desired fuel pump pressure is outside acceptable limits.	No action by the ECM is taken.
343 629 12	Microprocessor communication error internal to the ECM.	Variable; performance will or will not be affected.
346 630 12	ECM powerdown internal data store error.	Powerdown data are lost. Powerdown data include maintenance monitoring, present ECM and engine delta times, and past fault dat.
349 191 0	A frequency of greater than a calibrated threshold has been detected at frequency accelerator signal pin 17 of the OEM interface harness.	Calibration dependent power and speed derate.
384 626 11	The ether injection solenoid circuit is open or shorted at pin 2 of the engine harness.	Ether injection feature is disabled.
415 100 1	Very low oil pressure has been detected. Voltage signal at oil pressure signal pin 24 of the engine harness indicates oil pressure lower than 83 kPa (12 psi) at 600 rpm, 110 kPa (16 psi) at 800 rpm, and 138 kPa (20 psi) at 1500 rpm and 172 kPa (25 psi) above 2100 rpm.	Calibration dependent progressive power and speed derate and engine shutdown with increasing time after alert.
422 111 2	Voltage detected simultaneously on both the coolant level high and low signal pins 14 and 23 of the OEM interface harness, or no voltage detected on either pin.	No engine protection for coolant level

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
423 156 2	More than 1.83 VDC detected at the timing temperature signal pin 33 of the engine harness at engine key on.	Calibration dependent power and speed derate.
426 - -	ECM can not transmit on J1939 datalink.	No action is taken by ECM.
427 - -	ECM can not transmit on J1939 datalink at acceptable rate.	No action is taken by ECM.
431 091 2	Voltage detected simultaneously on both the idle validation off idle and idle signal pins 12 and 13 of the OEM harness, or no voltage detected on either pin.	None on performance.
432 091 13	Voltage detected at the idle validation on idle signal pins 13 of the OEM harness when voltage at accelerator position signal pin 29 of the OEM harness indicates pedal is not at idle or voltage detected at idle validation off-idle signal pin 12 of the OEM harness when voltage at accelerator position signal pin 29 of the OEM harness indicates pedal is at rest.	Engine will default to 0 percent accelerator.
441 168 1	Less than 12.0 VDC battery voltage detected at the ECM.	ECM voltage supply approaching a level at which unpredictable operation will occur.
442 168 0	More than 38.0 VDC battery voltage detected at the ECM.	ECM damage will occur.
451 157 3	More than 4.78 VDC detected at the rail pressure sensor signal pin 31 of the engine harness.	Depending on the calibration, the engine will shut down or power derate, or no action is taken by the ECM.
452 157 4	Less than 0.15 VDC detected at the rail pressure sensor signal pin 31 of the engine harness.	Depending on the calibration, the engine will shut down or power derate, or no action is taken by the ECM.
455 633 3	Rail actuator circuit is open, or supply pin 3 is shorted to battery voltage or ground, or return pin 10 is shorted to battery voltage or ground in the engine harness.	No action by the ECM is taken. Actuator is closed, or partially closed. Engine will not run, or runs at one speed. Fault code 514 can be logged.
467 635 2	The timing current offset, used to adjust timing flow, has reached the maximum or minimum threshold.	No action taken by the ECM.
468 633 2	The rail current offset, used to adjust fueling flow, has reached the maximum or minimum threshold.	No action taken by the ECM.
471 098 1	Very low oil level is detected. Voltage signal on the oil level signal pin 12 of the engine harness indicates very low oil level in the engine.	Calibration dependent progressive power derate and engine shutdown with increasing time after alert. Centinel™ feature is disabled.
487 - -	The ether bottle for the ether injection system is empty.	The ether injection system is disabled.
489 191 1	Auxiliary speed frequency on input pin 17 indicates the frequency is below a calibration dependent threshold.	Engine will go to idle.

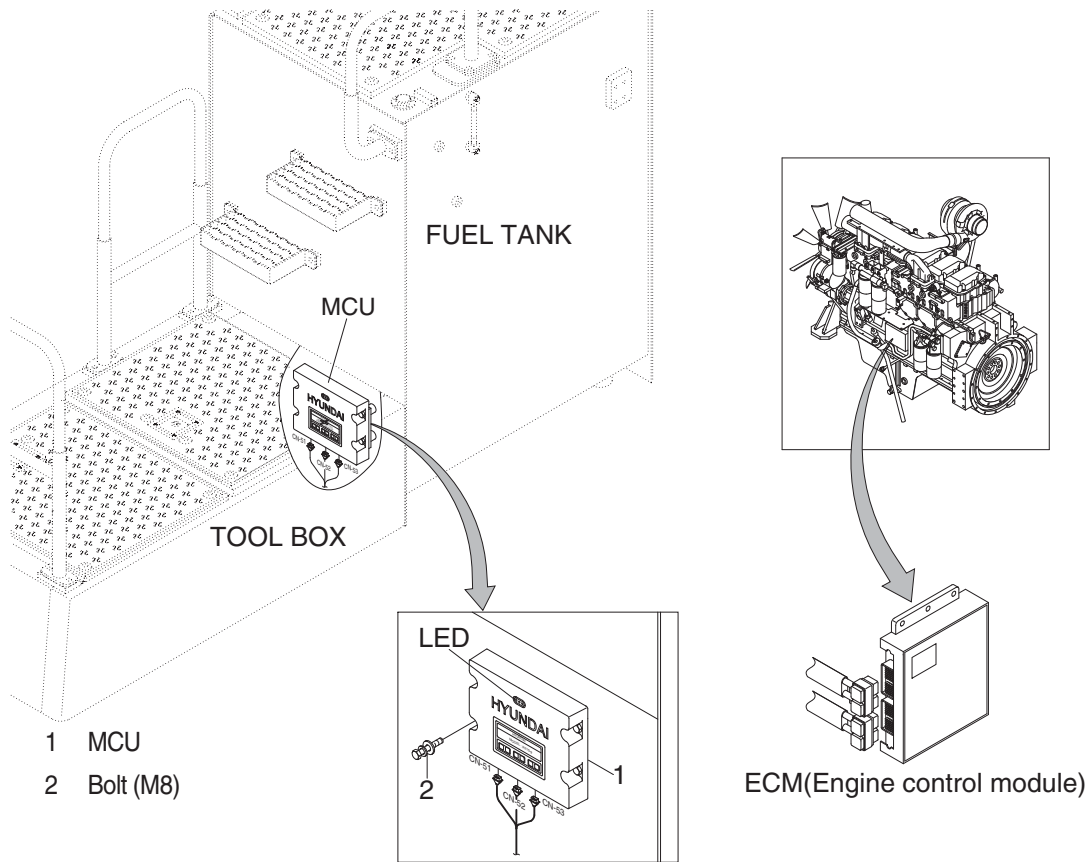
※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
497 1377 2	Multiunit synchronous on/off switch and multiunit synchronous complimentary on/off switch have different values at the ECM.	Multiunit synchronous feature is disabled.
498 - -	Engine oil level #1 sensor circuit-shortcd high.	No engine protection for low oil level. Centinel system is disabled.
499 - -	Engine oil level #1 sensor signal-shortcd high.	No engine protection for oil level. Centinel system is disabled.
514 633 7	The error between the estimated rail fueling and the desired rail fueling is outside the acceptable limits.	Calibration-dependent engine shutdown or power derate or no action by the ECM is taken. Engine will overspeed, or run at one speed, or not run.
527 702 3	The dual output A signal pin 1 of the OEM interface harness indicates an open or short circuit.	OEM dependent.
529 703 3	The dual output B signal pin 9 of the OEM interface harness indicates an open or short circuit.	OEM dependent.
551 091 4	No voltage detected simultaneously on both the idle validation off-idle and idle signal pins 12 and 13 of the OEM interface harness.	Engine will default to 0-percent accelerator.
553 157 0	Rail pressure exceeds a normal limit.	Fuel shutoff valve de-energized (valve closes). The valve reenergizes (valve opens) when rail pressure falls below acceptable limit for present engine speed.
554 157 2	More than 0.67 VDC detected at the rail pressure signal pin 31 of the engine harness at engine key-on.	Calibration dependent engine derate.
555 1264 0	High blowby pressure has been detected. Voltage signal at blowby pressure signal pin 25 indicates blowby pressure above 368 mm H ₂ O (14.5 in H ₂ O).	Calibration dependent. Progressive power and speed derate and engine shutdown as pressure increases over thresholds.
611 - -	Engine shut down with the keyswitch before proper engine cooldown.	No action is taken by ECM. Load factor above the maximum shutdown threshold. Fault code will be logged.
649 - -	The maintenance interval has been reached.	No action is taken by ECM.
719 1264 3	More than 4.94 VDC detected at the blowby pressure sensor signal pin 25 of the engine harness.	No engine protection for blowby pressure.
729 1264 4	Less than 0.29 VDC detected at the blowby pressure sensor signal pin 25 of the engine harness.	No engine protection for blowby pressure.
753 723 2	The engine speed signals detected on pins 27, 28, 37 and 38 of the ECM do not match.	No action by the ECM is taken.
777 - -	The turbocharger inlet air temperature has exceeded the standard ambient air temperature limit.	The engine will go into a derate mode until the turbocharger inlet air temperature drops to a normal level.

※ Some fault codes are not applied to this machine.

GROUP 12 ENGINE CONTROL SYSTEM

1. MCU and Engine ECM (Electronic Control Module)



120095MS10

2. MCU ASSEMBLY

- 1) To match the pump absorption torque with the engine torque, MCU varies EPPR valve output pressure, which control pump discharge amount whenever feedbacked engine speed drops under the reference rpm of each mode set.
- 2) Three LED lamps on the MCU display as below.

LED lamp	Trouble	Service
G is turned ON	Normal	-
G and R are turned ON	Trouble on MCU	• Change the MCU
G and Y are turned ON	Trouble on serial communication line	• Check if serial communication lines between controller and cluster are disconnected
Three LED are turned OFF	Trouble on MCU power	• Check if the input power wire (24 V, GND) of controller is disconnected • Check the fuse

G : green, R : red, Y : yellow

GROUP 13 EPPR VALVE

1. PUMP EPPR VALVE

1) COMPOSITION

EPPR (Electro Proportional Pressure Reducing) valve consists of electro magnet and spool valve installed at main pump.

(1) Electro magnet valve

Receive electric current from MCU and move the spool proportionally according to the specific amount of electric current value.

(2) Spool valve

Is the two way direction control valve for pilot pressure to reduce main pump flow.

When the electro magnet valve is activated, pilot pressure enters into flow regulator of main pump.

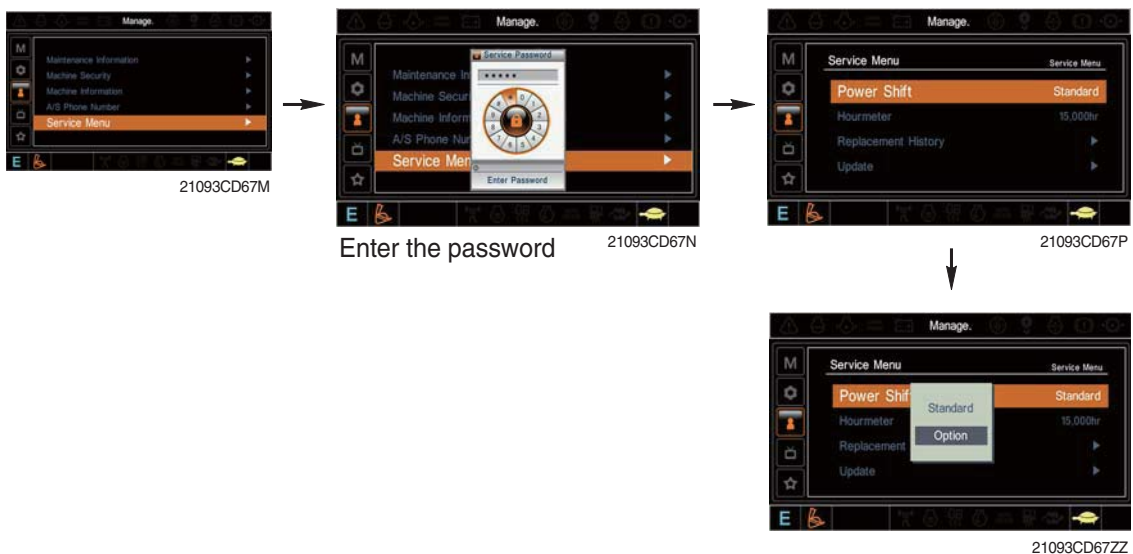
(3) Pressure and electric current value for each mode

Mode		Pressure		Electric current (mA)	Engine rpm (at accel dial 10)
		kgf/cm ²	psi		
Standard (Stage : 1.0)	P	10 ± 3	142 ± 40	330 ± 30	1800 ± 50
	S	10 ± 3	142 ± 40	330 ± 30	1700 ± 50
	E	15 ± 3	213 ± 40	400 ± 30	1600 ± 50
Option (Stage : 2.0)	P	0 ± 3	0 ± 40	160 ± 30	1850 ± 50
	S	7 ± 3	100 ± 40	280 ± 30	1700 ± 50
	E	12 ± 3	171 ± 40	360 ± 30	1700 ± 50

2) HOW TO SWITCH THE STAGE (1.0 ↔ 2.0) ON THE CLUSTER

You can switch the EPPR valve pressure set by selecting the stage (1.0 ↔ 2.0).

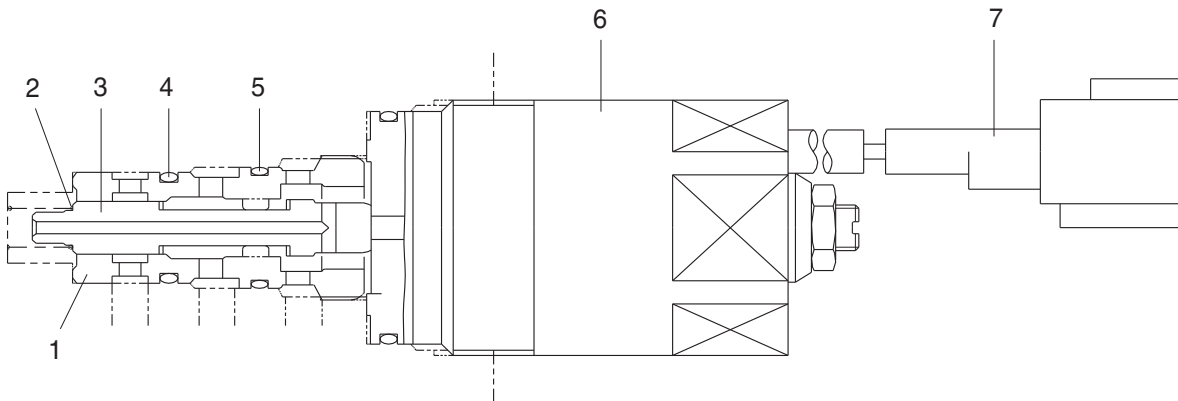
- Management
 - Service menu



- Power shift (standard/option) : Power shift pressure can be set by option menu.

3) OPERATING PRINCIPLE (pump EPPR valve)

(1) Structure

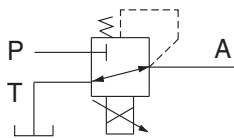


5-22(1)

- 1 Sleeve
- 2 Spring
- 3 Spool

- 4 O-ring
- 5 O-ring

- 6 Solenoid valve
- 7 Connector



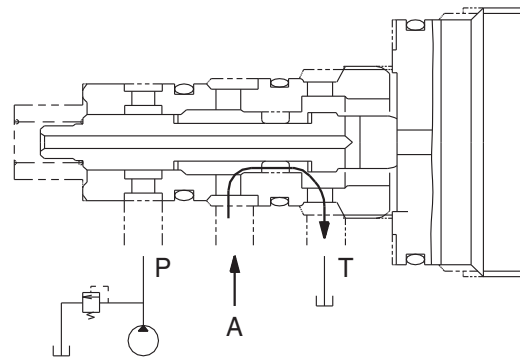
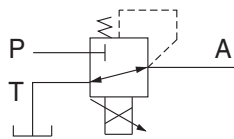
P Pilot oil supply line (pilot pressure)

T Return to tank

A Secondary pressure to flow regulator at main pump

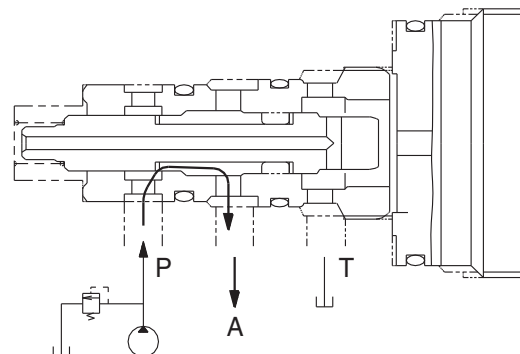
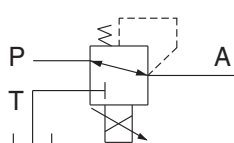
(2) Neutral

Pressure line is blocked and A oil returns to tank.



(3) Operating

Secondary pressure enters into A.

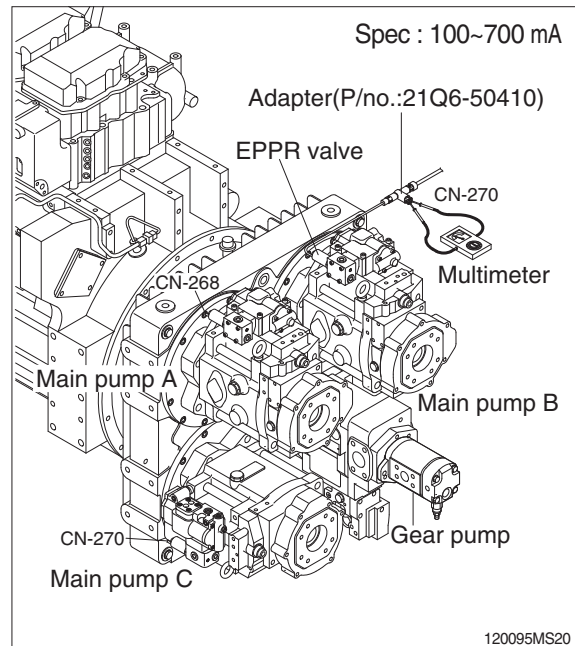


5-22(2)

4) EPPR VALVE CHECK PROCEDURE

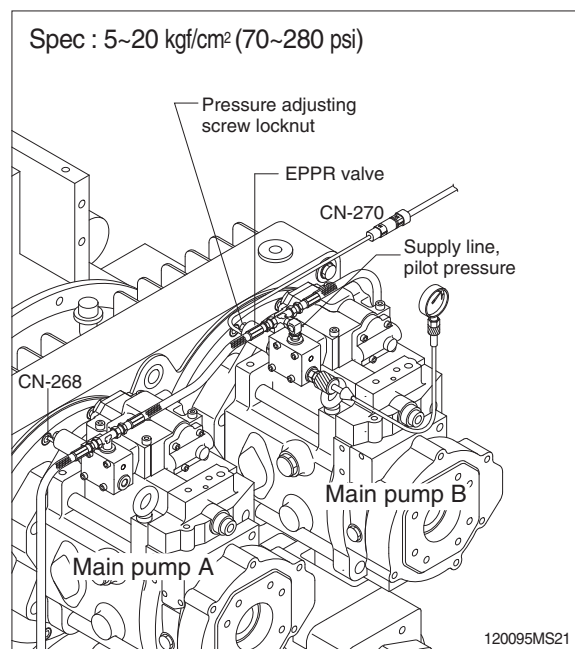
(1) Check electric current value at EPPR valve

- ① Disconnect connector CN-268, CN-270 from EPPR valve.
- ② Insert the adapter to CN-268, CN-270 and install multimeter as figure.
- ③ Start engine.
- ④ Set S-mode and cancel auto decel mode.
- ⑤ Position the accel dial at 10.
- ⑥ If rpm display show approx 1700 ± 50 rpm check electric current at bucket circuit relief position.
- ⑦ Check electric current at bucket circuit relief position.



(2) Check pressure at EPPR valve

- ① Remove plug and connect pressure gauge as figure.
 - Gauge capacity : 0 to 50 kgf/cm²
(0 to 725 psi)
- ② Start engine.
- ③ Set S-mode and cancel auto decel mode.
- ④ Position the accel dial at 10.
- ⑤ If tachometer show approx 1700 ± 50 rpm check pressure at relief position of bucket circuit by operating bucket control lever.
- ⑥ If pressure is not correct, adjust it.
- ⑦ After adjust, test the machine.



GROUP 14 MONITORING SYSTEM

1. OUTLINE

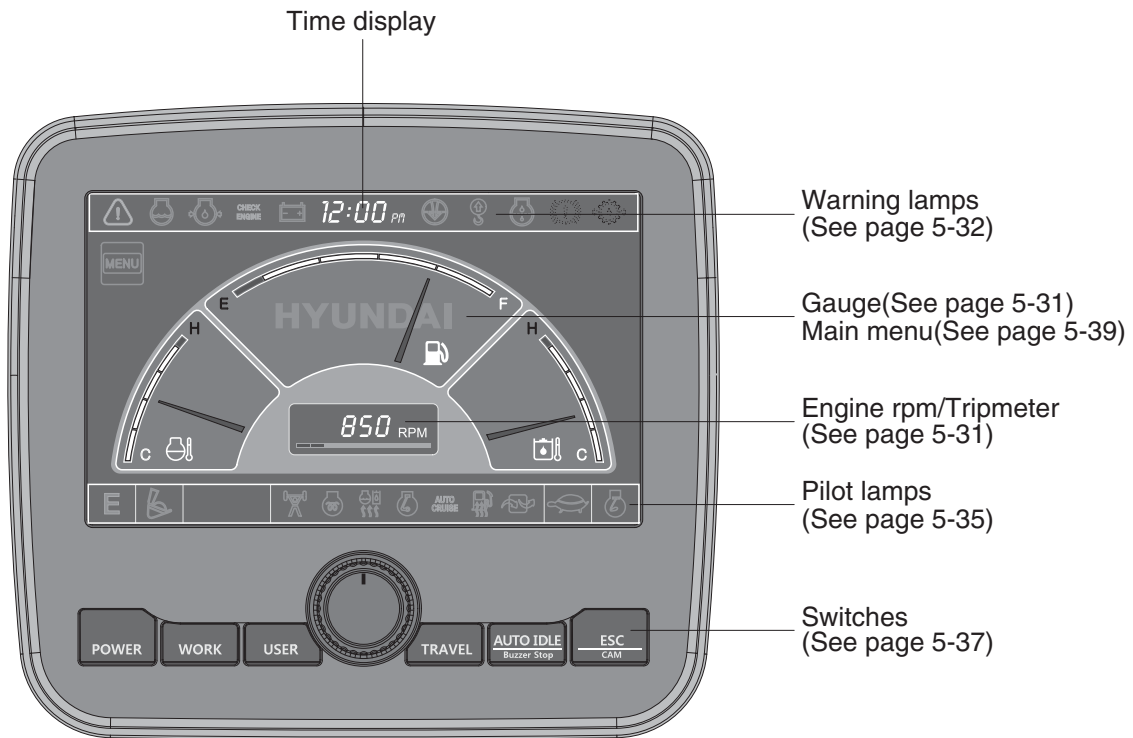
Monitoring system consists of the monitor part and switch part.

The monitor part gives warnings when any abnormality occurs in the machine and informs the condition of the machine.

Various select switches are built into the monitor panel, which act as the control portion of the machine control system.

2. CLUSTER

1) MONITOR PANEL



120095MS25

2) CLUSTER CHECK PROCEDURE

(1) Start key : ON

① Check monitor

a. Buzzer sounding for 4 seconds with HYUNDAI logo on cluster.

※ **If the ESL mode is set to the enable, enter the password to start engine.**

② After initialization of cluster, the operating screen is displayed on the LCD.

Also, self diagnostic function is carried out.

a. Engine rpm display : 0 rpm

b. Engine coolant temperature gauge : White range

c. Hydraulic oil temperature gauge : White range

d. Fuel level gauge : White range

③ Indicating lamp state

a. Power mode pilot lamp : E mode or U mode

b. Work mode pilot lamp : General operation mode (bucket)

c. Travel speed pilot lamp : Low (turtle)

(2) Start of engine

① Check machine condition

a. RPM display indicates at present rpm

b. Gauge and warning lamp : Indicate at present condition.

※ **When normal condition : All warning lamp OFF**

c. Work mode selection : General work

d. Power mode selection : E mode or U mode

e. Travel speed pilot lamp : Low (turtle)

② When warming up operation

a. Warming up pilot lamp : ON

b. After engine started, engine speed increases to 1200rpm.

※ **Others same as above.**

③ When abnormal condition

a. The warning lamp lights up and the buzzer sounds.

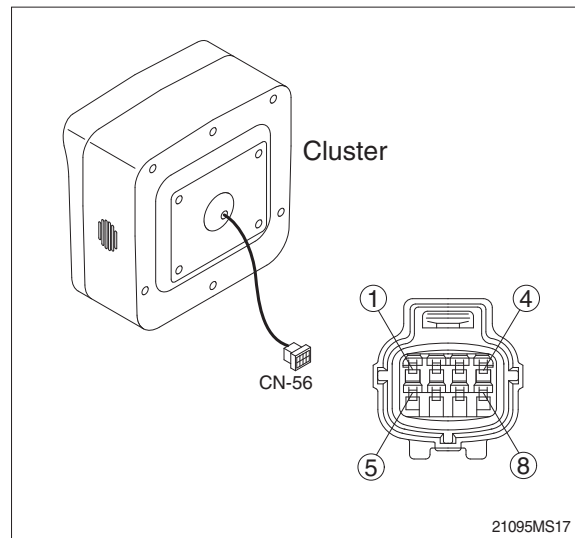
b. If BUZZER STOP switch is pressed, buzzer sound is canceled but the lamp warning lights up until normal condition.

※ **The pop-up warning lamp moves to the original position and blink when the select switch is pushed. Also the buzzer stops.**

3. CLUSTER CONNECTOR

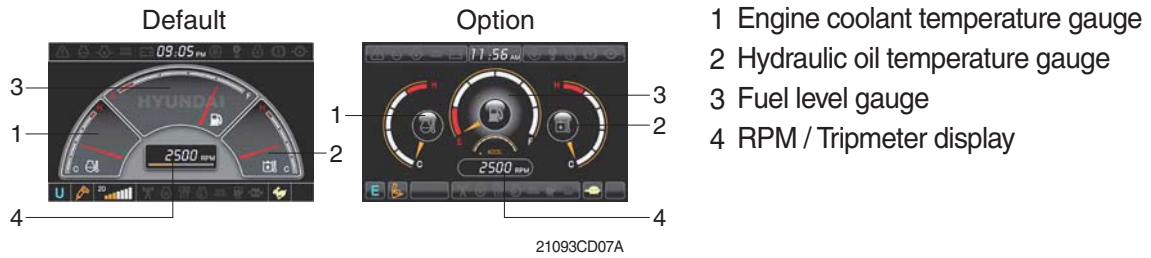
No.	Name	Signal
1	Battery 24V	20~32V
2	Signal 3	NTSC
3	GND	-
4	Serial + (TX)	0~5V
5	Power IG (24V)	20~32V
6	Signal 2	NTSC
7	Camera signal	NTSC
8	Serial - (RX)	0~5V

※ NTSC : the united states National Television Systems Committee



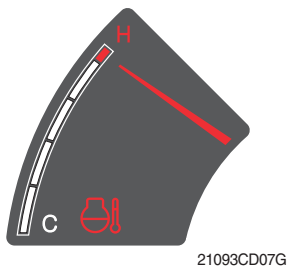
2) GAUGE



(1) Operation screen



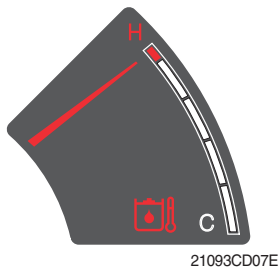
※ Operation screen type can be set by the screen type menu of the display.
Refer to page 5-49 for details.



(2) Engine coolant temperature gauge



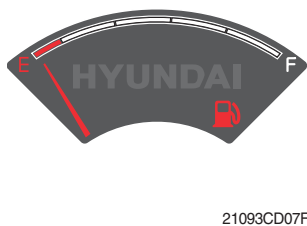
- ① This gauge indicates the temperature of coolant.
 - White range : 40-107°C (104-225°F)
 - Red range : Above 107°C (225°F)
 - ② If the indicator is in the red range or  lamp blinks in red, turn OFF the engine and check the engine cooling system.
- ※ If the gauge indicates the red range or  lamp blinks in red even though the machine is on the normal condition, check the electric device as that can be caused by the poor connection of electricity or sensor.



(3) Hydraulic oil temperature gauge



- ① This gauge indicates the temperature of hydraulic oil.
 - White range : 40-105°C(104-221°F)
 - Red range : Above 105°C(221°F)
 - ② If the indicator is in the red range or  lamp blinks is red, reduce the load on the system. If the gauge stays in the red range, stop the machine and check the cause of the problem.
- ※ If the gauge indicates the red range or  lamp blinks in red even though the machine is on the normal condition, check the electric device as that can be caused by the poor connection of electricity or sensor.

(4) Fuel level gauge



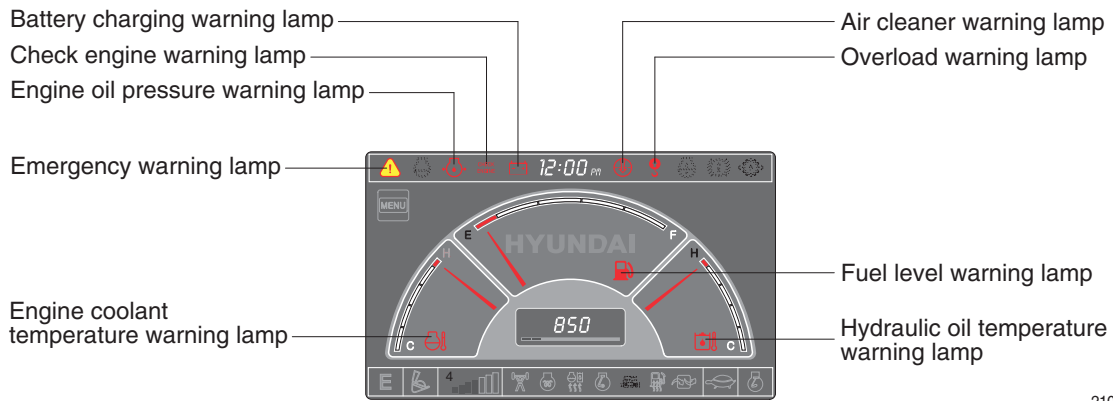
- ① This gauge indicates the amount of fuel in the fuel tank.
 - ② Fill the fuel when the red range, or  lamp blinks in red.
- ※ If the gauge indicates the red range or  lamp blinks in red even though the machine is on the normal condition, check the electric device as that can be caused by the poor connection of electricity or sensor.

(5) RPM / Tripmeter display



- ① This displays the engine speed or the tripmeter.
- ※ Refer to page 5-49 for details.

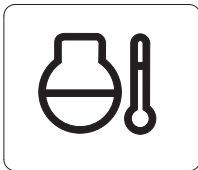
3) WARNING LAMPS



21093CD08D

- ※ Each warning lamp on the top of the LCD pops up on the center of LCD and the buzzer sounds when the each warning is happened. The pop-up warning lamp moves to the original position and blinks when the select switch is pushed. And the buzzer stops. Refer to page 5-38 for the select switch.

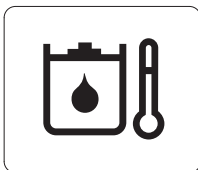
(1) Engine coolant temperature



21093CD08A

- ① Engine coolant temperature warning is indicated two steps.
 - 103°C over : The lamp blinks and the buzzer sounds.
 - 107°C over : The lamp pops up on the center of LCD and the buzzer sounds.
- ② The pop-up lamp moves to the original position and blinks when the select switch is pushed. Also, the buzzer stops and lamp keeps blink.
- ③ Check the cooling system when the lamp keeps ON.

(2) Hydraulic oil temperature



21093CD08C

- ① Hydraulic oil temperature warning is indicated two steps.
 - 100°C over : The lamp blinks and the buzzer sounds.
 - 105°C over : The lamp pops up on the center of LCD and the buzzer sounds.
- ② The pop-up lamp moves to the original position and blinks when the select switch is pushed. Also, the buzzer stops and lamp keeps blink.
- ③ Check the hydraulic oil level and hydraulic oil cooling system.

(3) Fuel level



21093CD08B

- ① This warning lamp blinks and the buzzer sounds when the level of fuel is below 131 l (34.6 U.S. gal).
- ② Fill the fuel immediately when the lamp blinks.

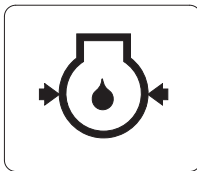
(4) Emergency warning lamp



21093CD30

- ① This lamp pops up and the buzzer sounds when each of the below warnings is happened.
 - Engine coolant overheating (over 107°C)
 - Hydraulic oil overheating (over 105°C)
 - Pump EPPR circuit abnormal or open
 - Attachment flow EPPR circuit abnormal or open
 - MCU input voltage abnormal
 - Accel dial circuit abnormal or open
 - Cluster communication data error
 - Engine ECM communication data error
- ※ **The pop-up warning lamp moves to the original position and blinks when the select switch is pushed. Also the buzzer stops. This is same as following warning lamps.**
- ② When this warning lamp blinks, machine must be checked and serviced immediately.

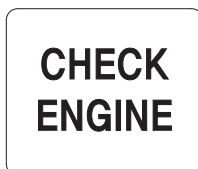
(5) Engine oil pressure warning lamp



21093CD32

- ① This lamp blinks when the engine oil pressure is low.
- ② If the lamp blinks, shut OFF the engine immediately. Check oil level.

(6) Check engine warning lamp



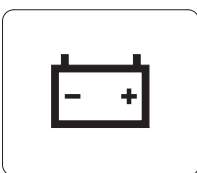
21093CD33



29093CD03

- ① This lamp blinks when the communication between MCU and engine ECM on the engine is abnormal, or if the cluster received any fault code from engine ECM.
- ② Check the communication line between them.
If the communication line is OK, then check the fault codes on the cluster.
- ③ This lamp blinks when "Engine check water in fuel" is displayed in the message box then check water separator.

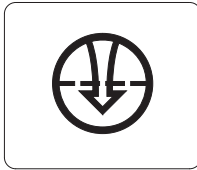
(7) Battery charging warning lamp



21093CD34

- ① This lamp blinks when the battery charging voltage is low.
- ② Check the battery charging circuit when this lamp blinks.

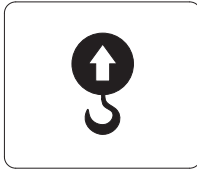
(8) Air cleaner warning lamp



21093CD35

- ① This lamp blinks when the filter of air cleaner is clogged.
- ② Check the filter and clean or replace it.

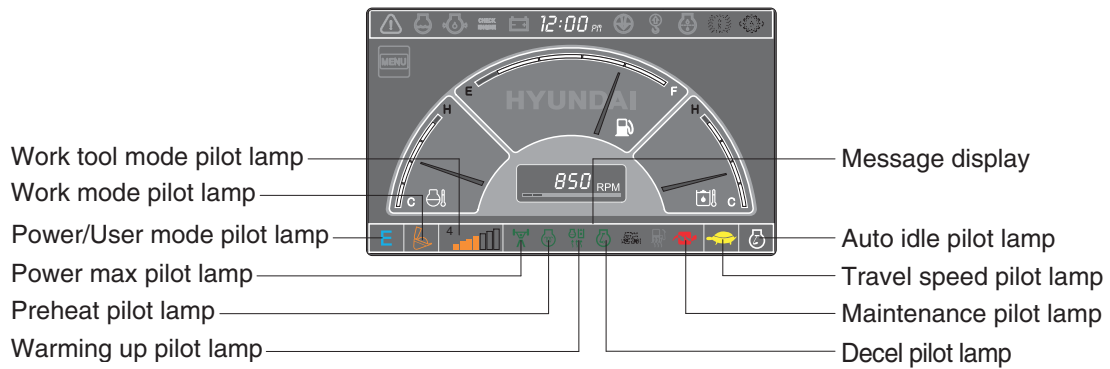
(9) Overload warning lamp (opt)



21093CD36

- ① When the machine is overload, the overload warning lamp blinks during the overload switch is ON. (if equipped)
- ② Reduce the machine load.

4) PILOT LAMPS



120093CD05

(1) Mode pilot lamps

No	Mode	Pilot lamp	Selected mode
1	Power mode		Heavy duty power work mode
			Standard power mode
			Economy power mode
2	User mode		User preferable power mode
3	Work mode		General operation mode
			Breaker operation mode
			Crusher operation mode
4	Travel mode		Low speed traveling
			High speed traveling
5	Auto idle mode		Auto idle
6	Work tool mode		Oil flow level of breaker or crusher mode
7	Message display		"Setting is completed" display after selection

(2) Power max pilot lamp



21093CD38

① The lamp will be ON when pushing power max switch on the LH RCV lever.

② The power max function is operated maximum 8 seconds.

※ Refer to the operator's manual page 3-26 for power max function.

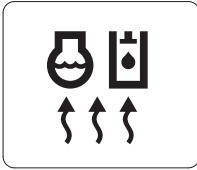
(3) Preheat pilot lamp



21093CD39

- ① Turning the start key switch ON position starts preheating in cold weather.
- ② Start the engine after this lamp is OFF.

(4) Warming up pilot lamp



21093CD40

- ① This lamp is turned ON when the coolant temperature is below 30°C (86°F).
- ② The automatic warming up is cancelled when the engine coolant temperature is above 30°C, or when 10 minutes have passed since starting the engine.

(5) Decel pilot lamp



21093CD41

- ① Operating one touch decel switch on the RCV lever makes the lamp ON.
 - ② Also, the lamp will be ON and engine speed will be lowered automatically to save fuel consumption when all levers and pedals are at neutral position, and the auto idle function is selected.
- ※ **One touch decel is not available when the auto idle pilot lamp is turned ON.**
- ※ **Refer to the operator's manual page 3-26.**

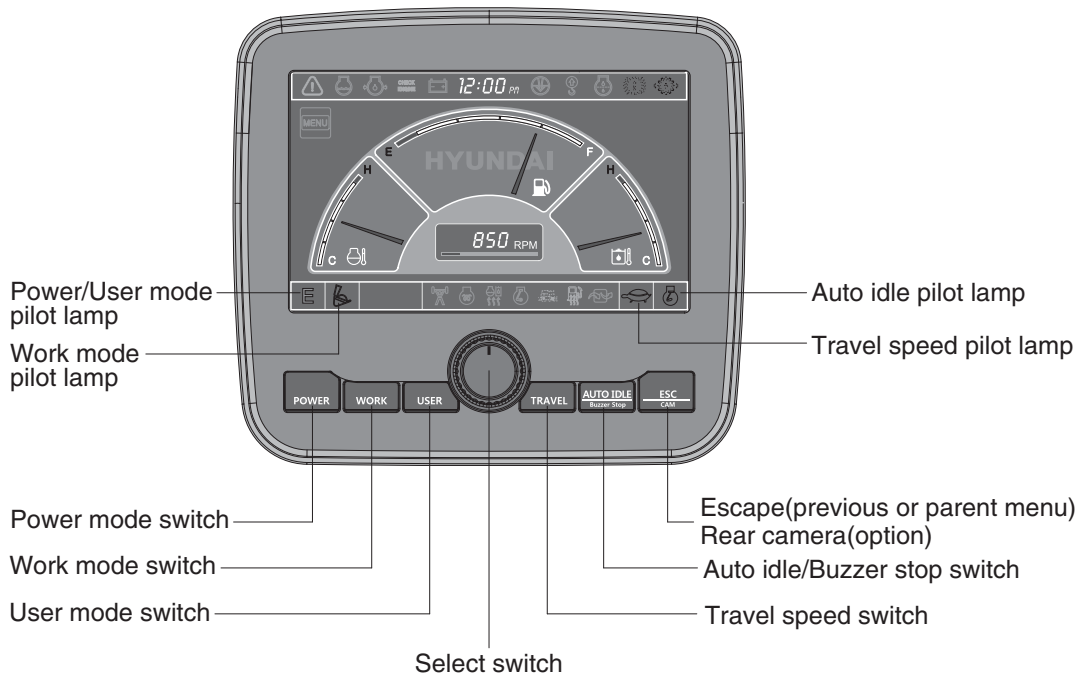
(6) Maintenance pilot lamp



21093CD44

- ① This lamp will be ON when the consuming parts are needed to change or replace. It means that the change or replacement interval of the consuming parts remains below 30 hours.
- ② Check the message in maintenance information of main menu. Also, this lamp lights ON for 3 minutes when the start switch is ON position.

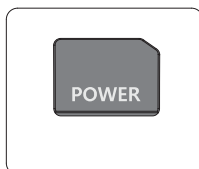
5) SWITCHES



21093CD45

※ When the switches are selected, the pilot lamps are displayed on the LCD. Refer to the page 5-35 for details.

(1) Power mode switch



21093CD45A

- ① This switch is to select the machine power mode and selected power mode pilot lamp is displayed on the pilot lamp position.
 - P : Heavy duty power work.
 - S : Standard power work.
 - E : Economy power work.
- ② The pilot lamp changes E → S → P → E in order.

(2) Work mode switch

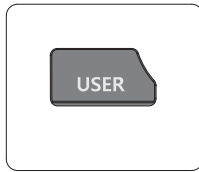


21093CD45C

- ① This switch is to select the machine work mode, which shifts from general operation mode to optional attachment operation mode.
 - : General operation mode
 - : Breaker operation mode (if equipped)
 - : Crusher operation mode (if equipped)
 - Not installed : Breaker or crusher is not installed.

※ Refer to the operator's manual page 4-6 for details.

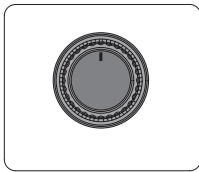
(3) User mode switch



21093CD45D

- ① This switch is used to memorize the current machine operating status in the MCU and activate the memorized user mode.
 - Memory : Push more than 2 seconds.
 - Action : Push within 2 seconds.
 - Cancel : Push this switch once more within 2 seconds.
- ② Refer to the page 5-40 for another set of user mode.

(4) Select switch



21093CD45E

- ① This switch is used to select or change the menu and input value.
- ② Knob push
 - Long (over 2 sec) : Return to the operation screen
 - Medium (0.5~2 sec) : Return to the previous screen
 - Short (below 0.5 sec) : Select menu
- ③ Knob rotation

This knob changes menu and input value.

 - Right turning : Down direction / Increase input value
 - Left turning : Up direction / Decreased input value

(5) Auto idle/ buzzer stop switch



21093CD45F



- ① This switch is used to activate or cancel the auto idle function.
 - Pilot lamp ON : Auto idle function is activated.
 - Pilot lamp OFF : Auto idle function is cancelled.
- ② The buzzer sounds when the machine has a problem.

In this case, push this switch and buzzer stops, but the warning lamp blinks until the problem is cleared.

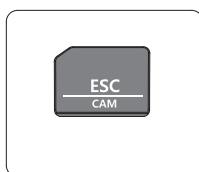
(6) Travel speed control switch



21093CD45G

- ① This switch is used to select the travel speed alternatively.
 -  : High speed
 -  : Low speed

(7) Escape/Camera switch



21093CD45H

- ① This switch is used to return to the previous menu or parent menu.
- ② In the operation screen, pushing this switch will display the view of the camera on the machine (if equipped).






Please refer to page 5-50 for the camera.
- ③ If the camera is not installed, this switch is used only ESC function.

6) MAIN MENU



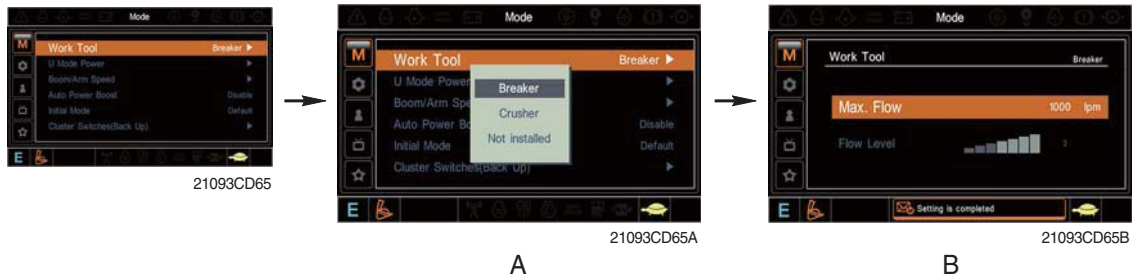
※ Please refer to select switch, page 5-38 for selection and change of menu and input value.

(1) Structure

No	Main menu	Sub menu	Description
1	 Mode 21093CD64D	Work tool U mode power Boom/Arm speed Auto power boost Initial mode Cluster switch (back up)	Breaker, Crusher, Not installed User mode only Boom speed, Arm speed Enable, Disable Default, U mode Switch function
2	 Monitoring 21093CD64E	Active fault Logged fault Delete logged fault Monitoring (analog) Monitoring (digital) Operating hours	MCU, Engine ECM MCU, Engine ECM All logged fault delete, Initialization canceled Machine information Switch status, Output status Operating hours for each mode
3	 Management 21093CD64F	Maintenance information Machine security Machine Information A/S phone number Service menu	Replacement, Change interval oils and filters ESL mode setting, Password change Cluster, MCU, Engine, Machine A/S phone number, A/S phone number change Power shift, Hourmeter, Replacement history, Update
4	 Display 21093CD64G	Display item Clock Brightness Unit Language Screen type	Engine speed, Tripmeter A, Tripmeter B, Tripmeter C Clock Manual, Auto Temperature, Pressure, Flow, Date format Korean, English, Chinese A type, B type
5	 Utilities 21093CD64H	Tripmeter DMB Entertainment Camera setting Message box	3 kinds (A, B, C) DMB select, DAB select, Channel scan, Exit Play MP4, codec. Basic direction, Display switching, Full screen Record for fault, attachment etc.

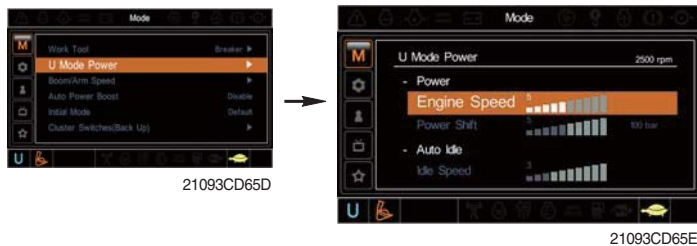
(2) Mode setup

① Work tool



- A : Select one installed optional attachment.
 - B : Max flow - Set the maximum flow for the attachment.
Flow level - Reduce the operating flow from maximum flow.
Breaker - Max 7 steps, Reduced 10 lpm each step.
Crusher - Max 4 steps, Reduced 20 lpm each step.
- ※ The flow level is displayed with the work mode pilot lamp.

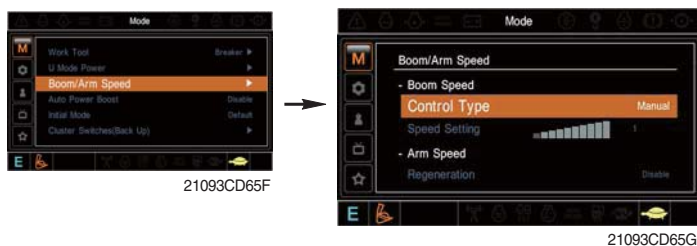
② U mode power



- Engine high idle rpm, auto idle rpm and pump torque (power shift) can be modulated and memorized separately in U-mode.
- U-mode can be activated by user mode switch.

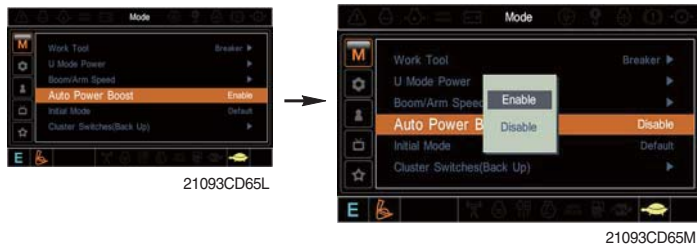
Step (I)	Engine speed (rpm)	Idle speed (rpm)	Power shift (bar)
1	1300	800	0
2	1400	850	3
3	1500	One touch decel low idle (900)	6
4	1550	950	9
5	1600	1000	12
6	1650	1050	16
7	1700	Auto decel rpm (1100)	20
8	1750	1150	26
9	1800	1200	32
10	1850	1250	38

③ Boom/Arm speed



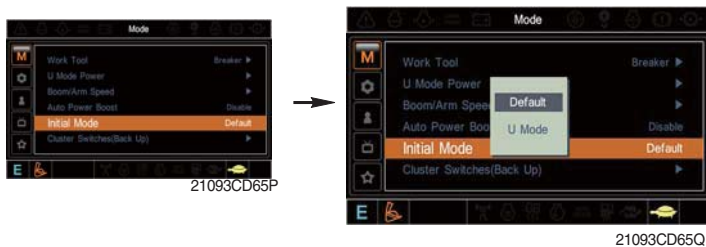
- **Boom speed**
 - Control type
 - Manual - Boom up speed is fixed as set steps.
 - Auto - Boom up speed is automatically adjusted as working conditions by the MCU.
 - Speed setting - Boom up speed is increased as much as activated steps.
- **Arm speed**
 - Regeneration - Arm regeneration function can be activated or cancelled.
 - Enable - Arm in speed is up.
 - Disable - Fine operation.

④ Auto power boost



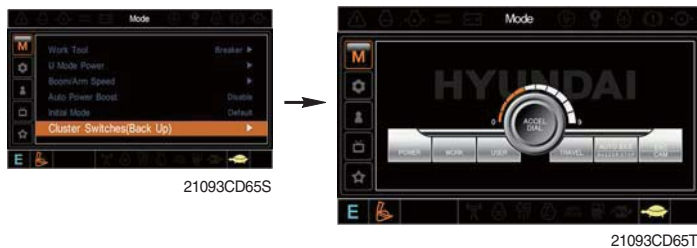
- The power boost function can be activated or cancelled.
- Enable - The digging power is automatically increased as working conditions by the MCU. It is operated max 8 seconds.
- Disable - Not operated.

⑤ Initial mode



- Default - The initial power mode is set E mode when the engine is started.
- U mode - The initial power mode is set U mode when the engine is started.

⑥ Cluster switch (back up)



- The cluster switch can be selected and changed by this menu when the switches are abnormal on the cluster.
- In order to exit "Cluster switch" mode, please put the cursor on the ESC/CAM switch by turning the select switch and push the select switch.
- In "Cluster switch", other switches except "Select switch" do not work.

(3) Monitoring

① Active fault



- The active faults of the MCU or engine ECM can be checked by this menu.

② Logged fault



- The logged faults of the MCU or engine ECM can be checked by this menu.

③ Delete logged fault



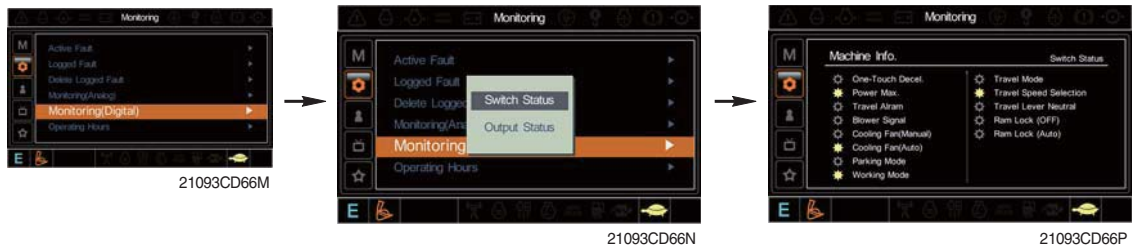
- The logged faults of the MCU or engine ECM can be deleted by this menu.


④ Monitoring (analog)



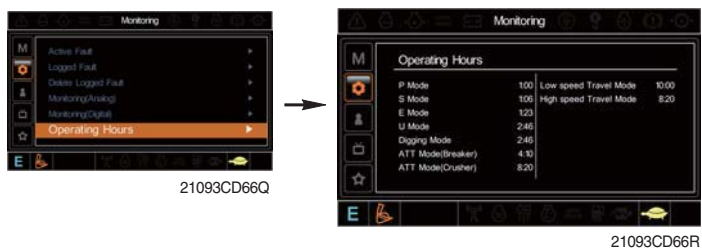
- The machine status such as the engine rpm, oil temperature, voltage and pressure etc. can be checked by this menu.

⑤ Monitoring (digital)



- The switch status or output status can be confirmed by this menu.
- The activated switch or output pilot lamps  are light ON.

⑥ Operating hours



- The operating hour of each mode can be confirmed by this menu.

(4) Management

① Maintenance information



- Alarm (⚙️ 🟡 🔴): Gray ⚙️ - Normal
Yellow 🟡 - First warning
Red 🔴 - Second warning
- Replacement : The elapsed time will be reset to zero (0).
- Change interval : The change or replace interval can be changed in the unit of 50 hours.
- OK : Return to the item list screen.
- Change or replace interval**

No	Item	Interval
1	Engine oil	500
2	Final gear oil	1000
3	Swing gear oil	1000
4	Hydraulic oil	5000
5	Pilot line filter	1000
6	Drain filter	1000
7	Hydraulic oil return filter	1000
8	Engine oil filter	500
9	Fuel filter	500
10	Hydraulic tank breather	250
11	Air cleaner (inner)	500
12	Radiator coolant	2000
13	Swing gear pinion grease	1000

② Machine security

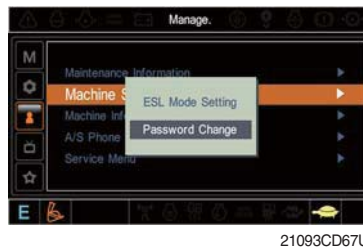
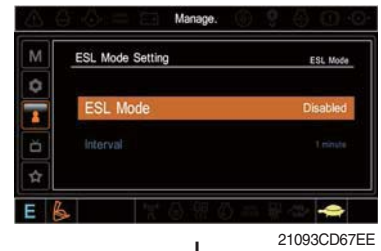


• ESL mode

- ESL : Engine Starting Limit
- ESL mode is designed to be a theft deterrent or will prevent the unauthorized operation of the machine.
- If the ESL mode was selected Enable, the password will be required when the start switch is turned ON.
- Disable : Not used ESL function

Enable (always) : The password is required whenever the operator start engine.

Enable (interval) : The password is required when the operator start engine first. But the operator can restart the engine within the interval time without in putting the password. The interval time can be set maximum 4 hours.



Enter the current password 21093CD67V

• Password change

- The password is 5~10 digits.



Enter the new password 21093CD67V

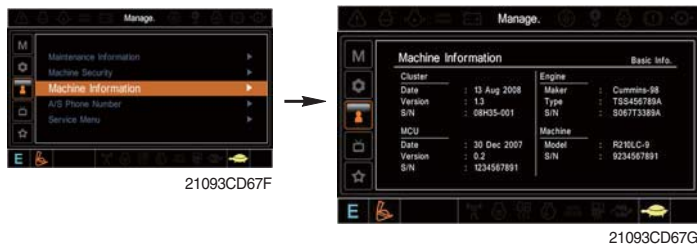


The new password is stored in the MCU. 21093CD67X



Enter the new password again 21093CD67XX

③ Machine Information

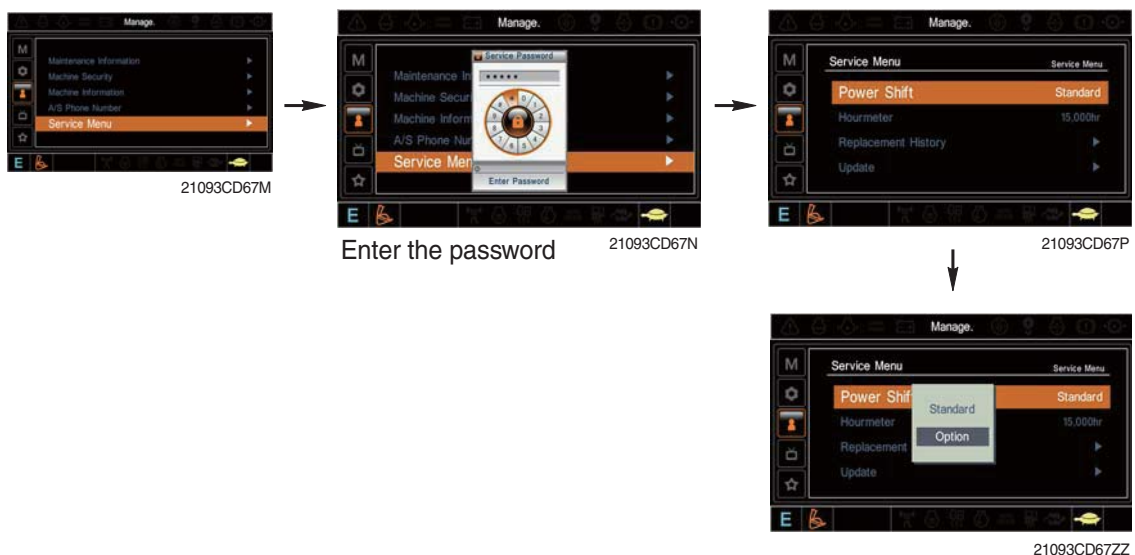


- This can confirm the identification of the cluster, MCU, engine and machine.

④ A/S phone number



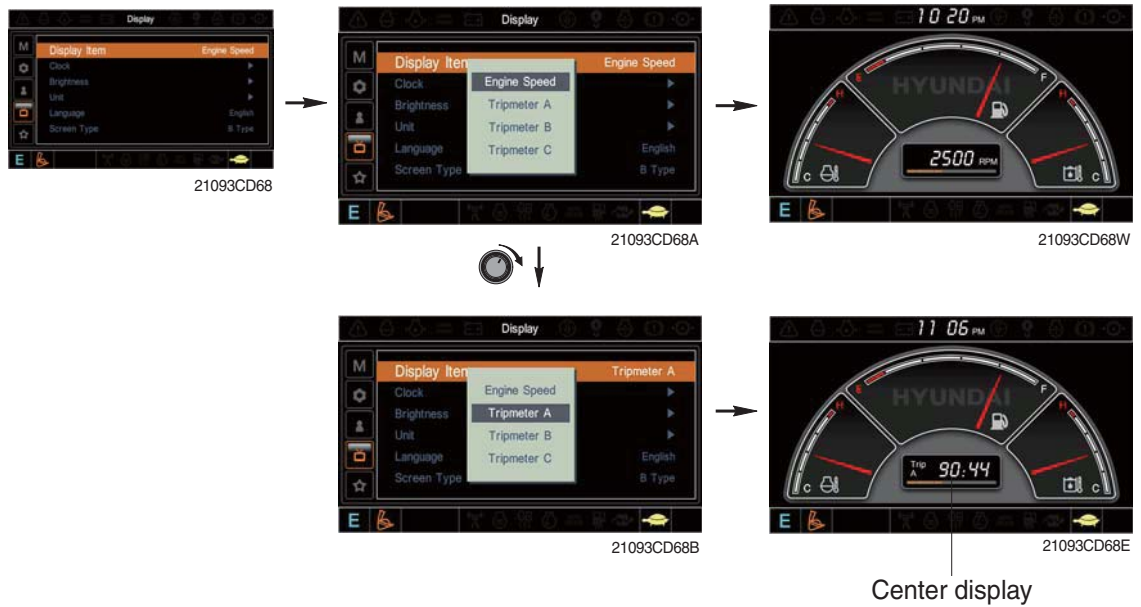
⑤ Service menu



- Power shift (standard/option) : Power shift pressure can be set by option menu.
- Hourmeter : Operating hours since the machine line out can be checked by this menu.
- Replacement history : Replacement history of the MCU and cluster can be checked by this menu.
- Update : Firm ware can be upgraded by this menu. (the USB port is located under the cluster)

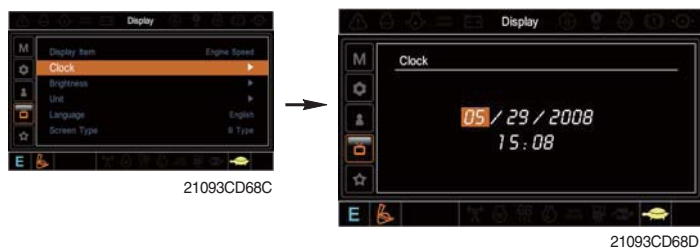
(5) Display

① Display item



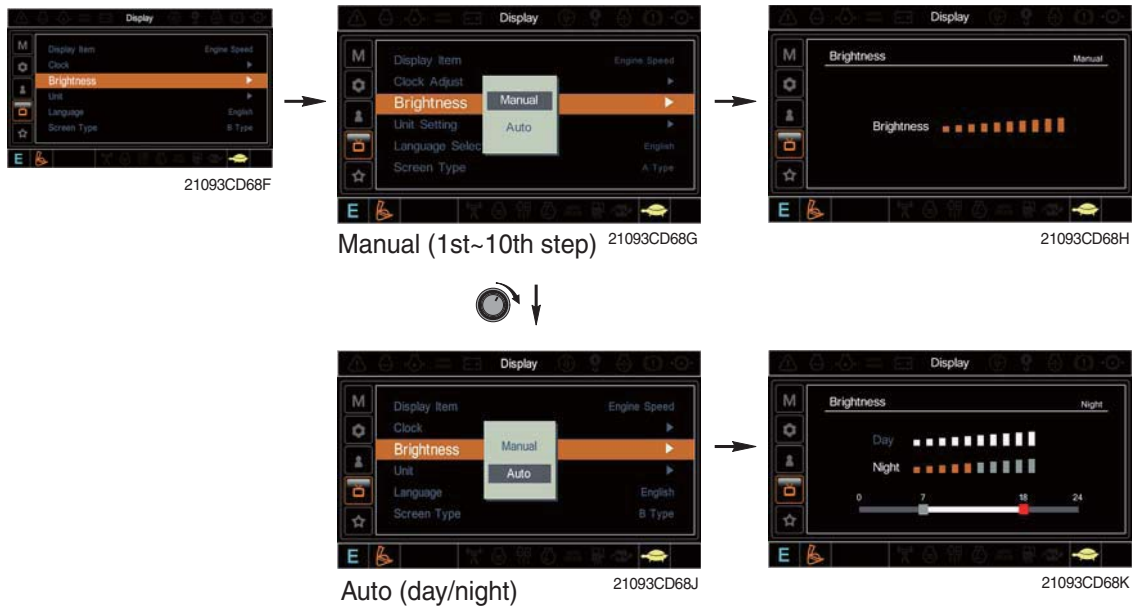
- The center display type of the LCD can be selected by this menu.
- The engine speed or each of the tripmeter (A,B,C) is displayed on the center display.

② Clock



- The first line's three spots "**/**/****" represent Month/Day/Year each.
- The second line shows the current time. (0:00~23:59)

③ Brightness



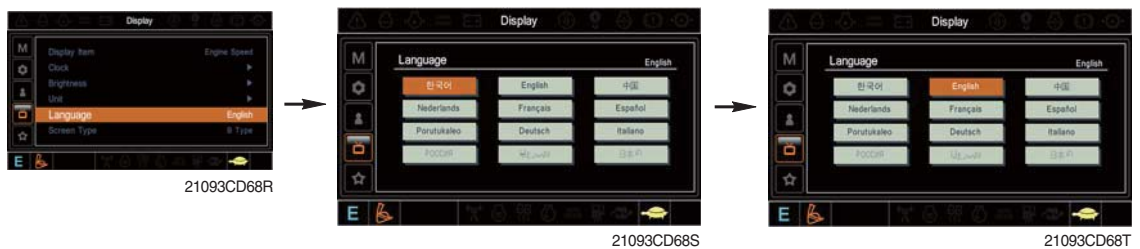
※ If "Auto" is chosen, brightness for day and night can be differently set up. Also by using the bar in lower side, users can define which time interval belongs to day and night. (in bar figure, gray area represents night time while white shows day time)

④ Unit



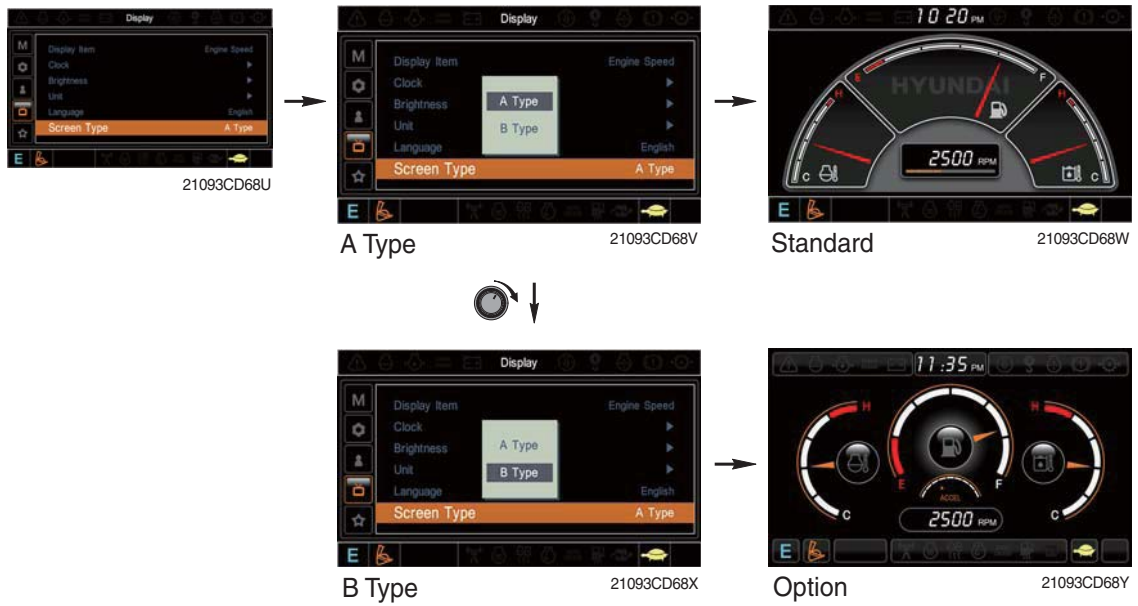
- Temperature : °C ↔ °F
- Pressure : bar ↔ MPa ↔ kgf/cm²
- Flow : lpm ↔ gpm
- Date format : yy/mm/dd ↔ mm/dd/yy ↔ dd-Mar-yy

⑤ Language



- User can select preferable language and all displays are changed the selected language.

⑥ Screen type



(6) Utilities

① Tripmeter



- Maximum 3 kinds of tripmeters can be used at the same time.
- Each tripmeter can be turned on by choosing "Start" while it also can be turned off by choosing "Stop".
- If the tripmeter icon is activated in the operation screen, it can be controlled directly there.

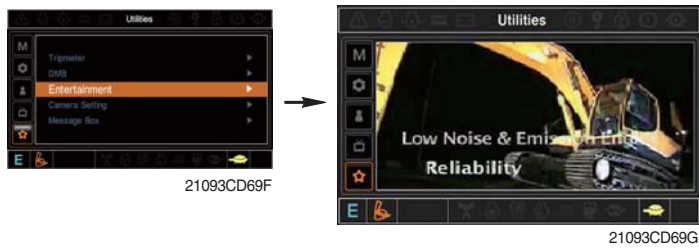
② DMB



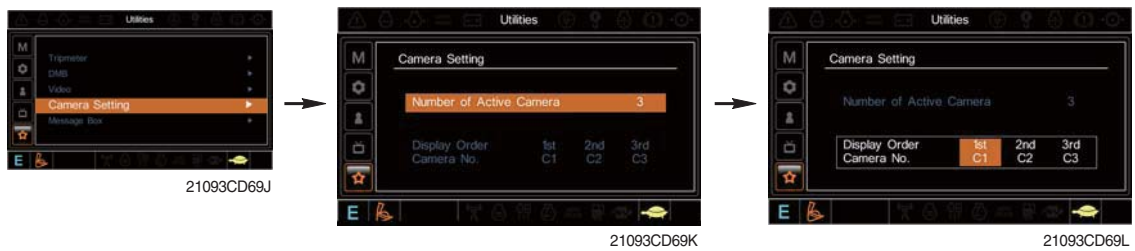
- DMB select : TV channel can be selected by this menu.
- DAB select : Audio channel can be selected by this menu.
- Channel scan : This menu can be used other region for TV/Audio.
- Exit : Exit DMB menu

③ Entertainment

- Play MP4 or codec file of external hard disk through USB port.
- The USB port is located under the cluster.



④ Camera setting



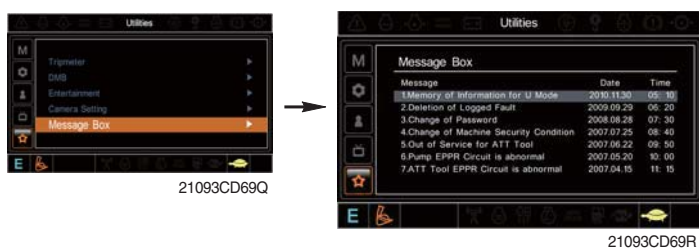
- Three cameras can be installed on the machine.
- The display order can be set by this menu.



- If the camera was not equipped, this menu is not useful.
- In the operation screen, if the ESC/CAM switch is pushed, the first ordered display camera will be viewed.
- Turning the select switch in clockwise direction, the next ordered will be shown and in counter-clockwise direction, the previously ordered will be shown.
- Push the select switch, the displayed screen will be enlargement.

⑤ Message box

- The history of the machine operating status can be checked by this menu.



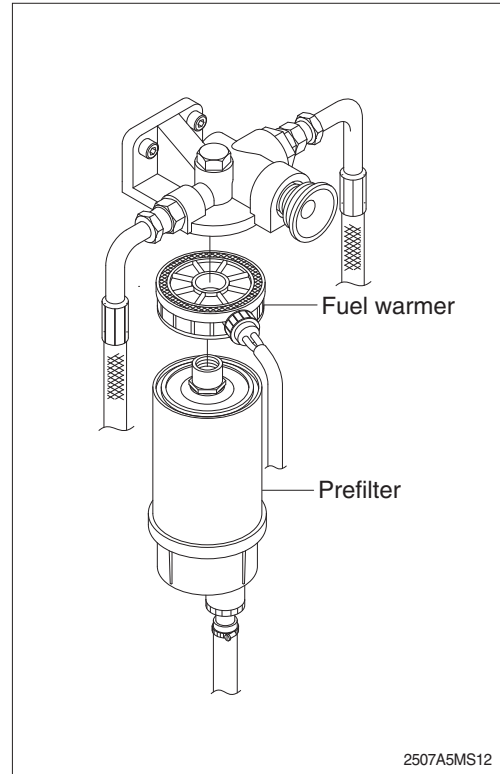
GROUP 15 FUEL WARMER SYSTEM

1. SPECIFICATION

- 1) Operating voltage : 24 ± 4 V
- 2) Power : 350 ± 50 W
- 3) Current : 15 A

2. OPERATION

- 1) The current of fuel warmer system is automatically controlled without thermostat according to fuel temperature.
 - 2) At the first state, the 15 A current flows to the fuel warmer and engine may be started in 5~6 minutes.
 - ※ More time may take according to ambient temperature.
 - 3) If the fuel starts to flow, ceramic-disk in the fuel warmer heater senses the fuel temperature to reduce the current as low as 1.5 A.
- So, fuel is protected from overheating by this mechanism.



3. ELECTRIC CIRCUIT

