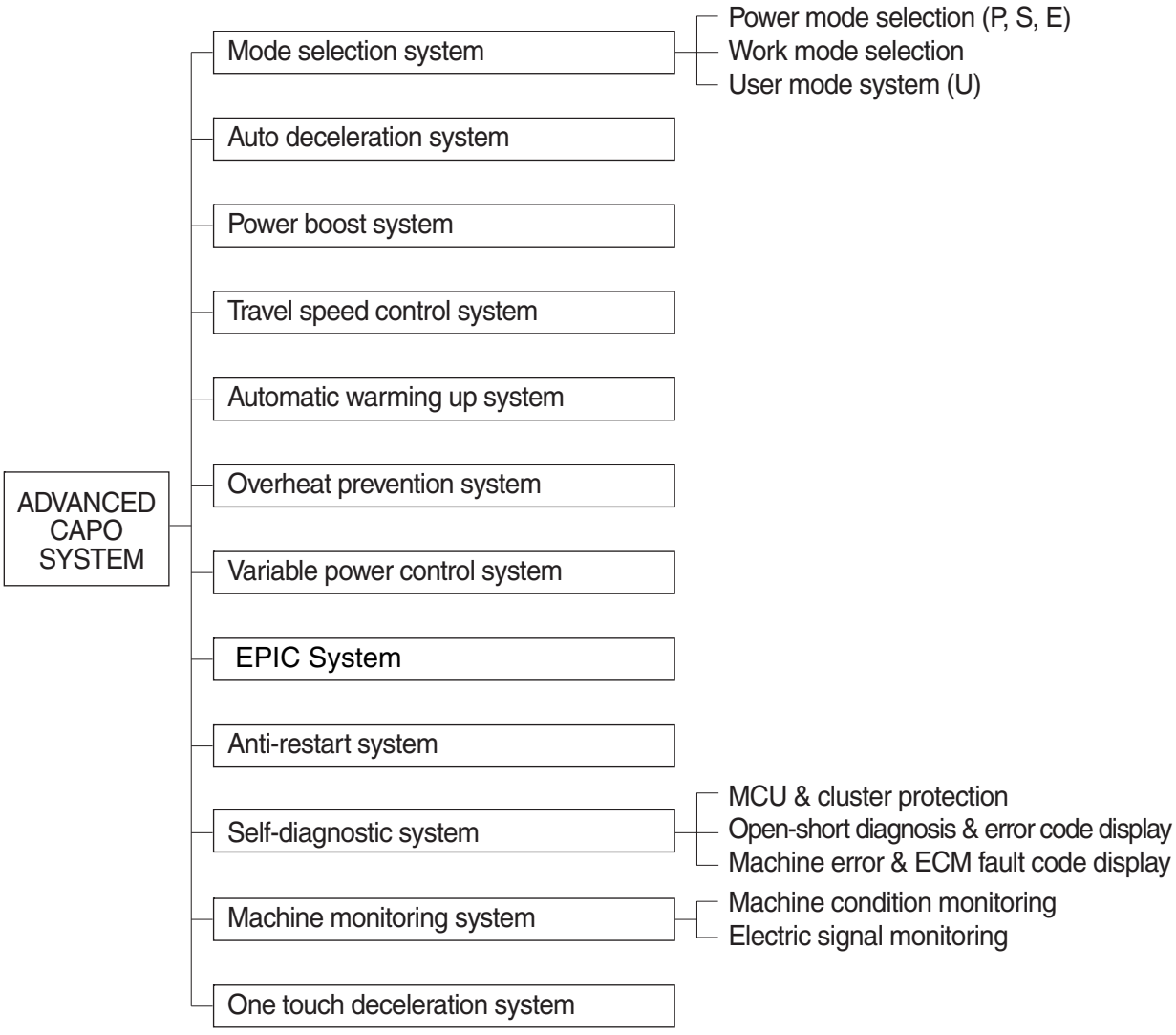
SECTION 5 MECHATRONICS SYSTEM

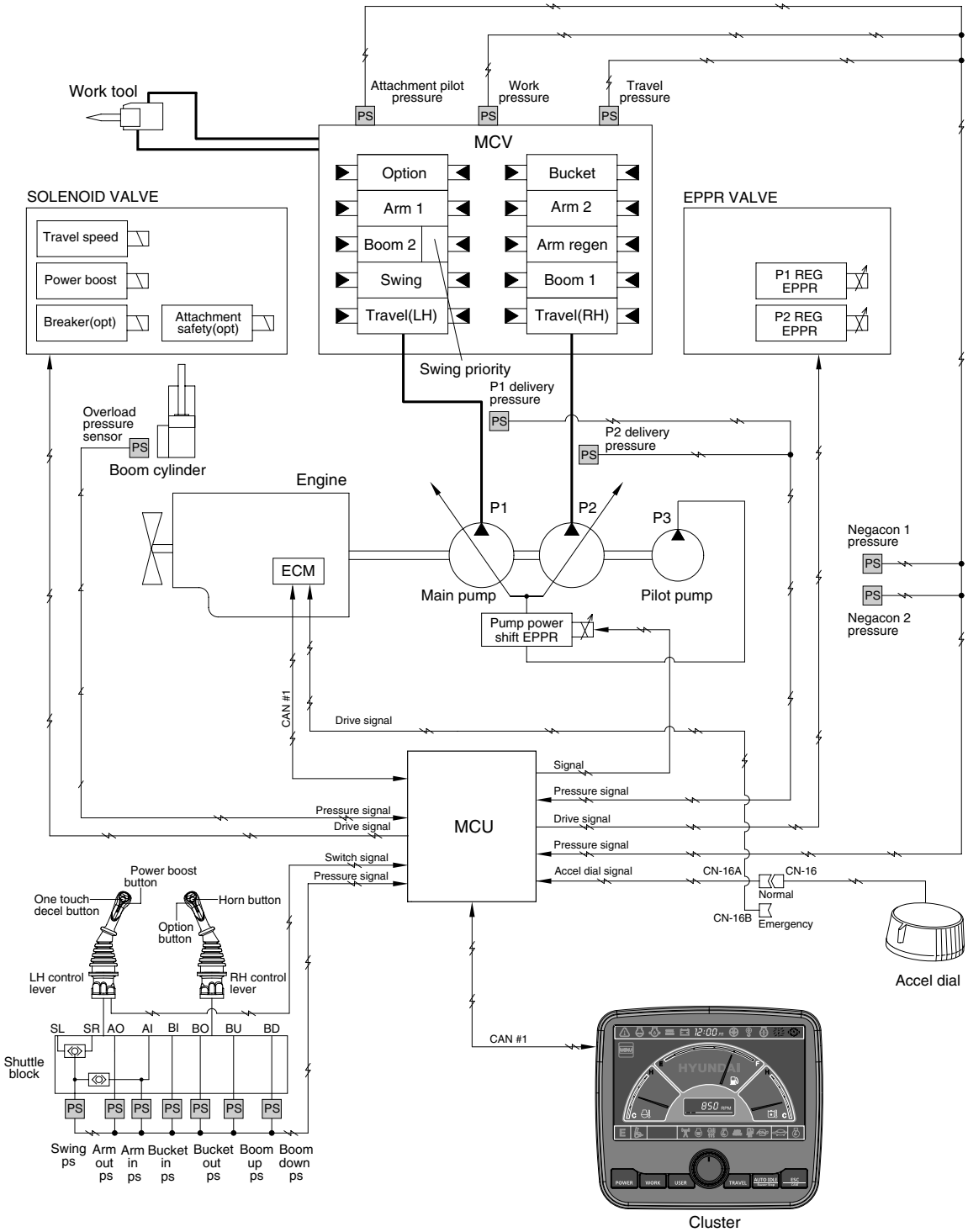
SECTION 5 MECHATRONICS SYSTEM

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.

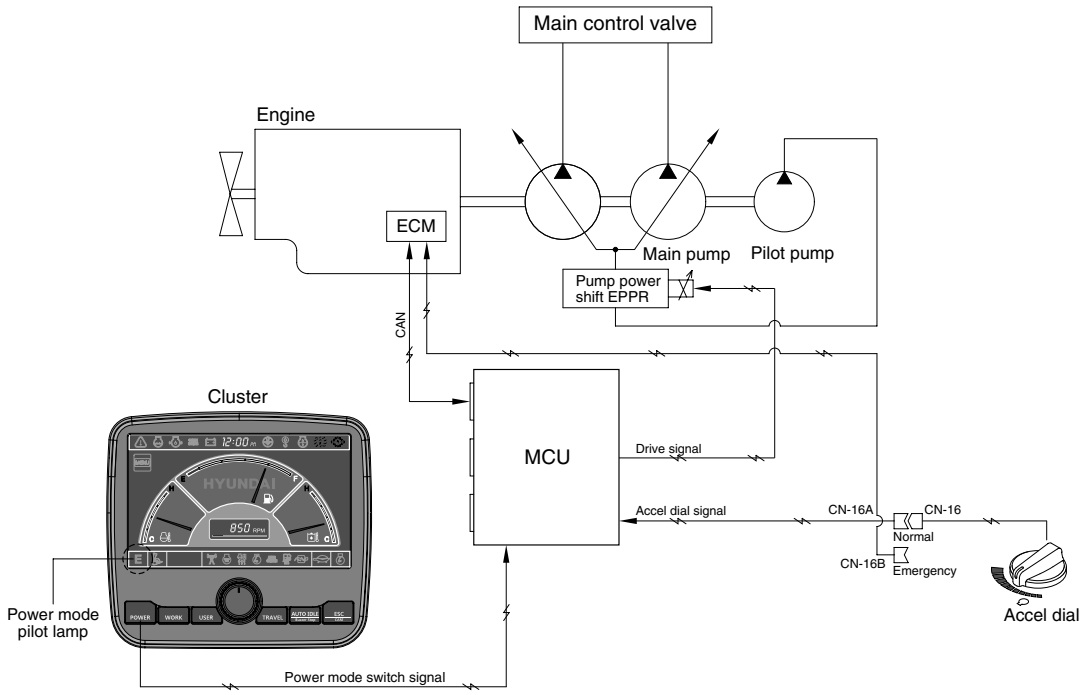


SYSTEM DIAGRAM



GROUP 2 MODE SELECTION SYSTEM

1. POWER MODE SELECTION SYSTEM



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

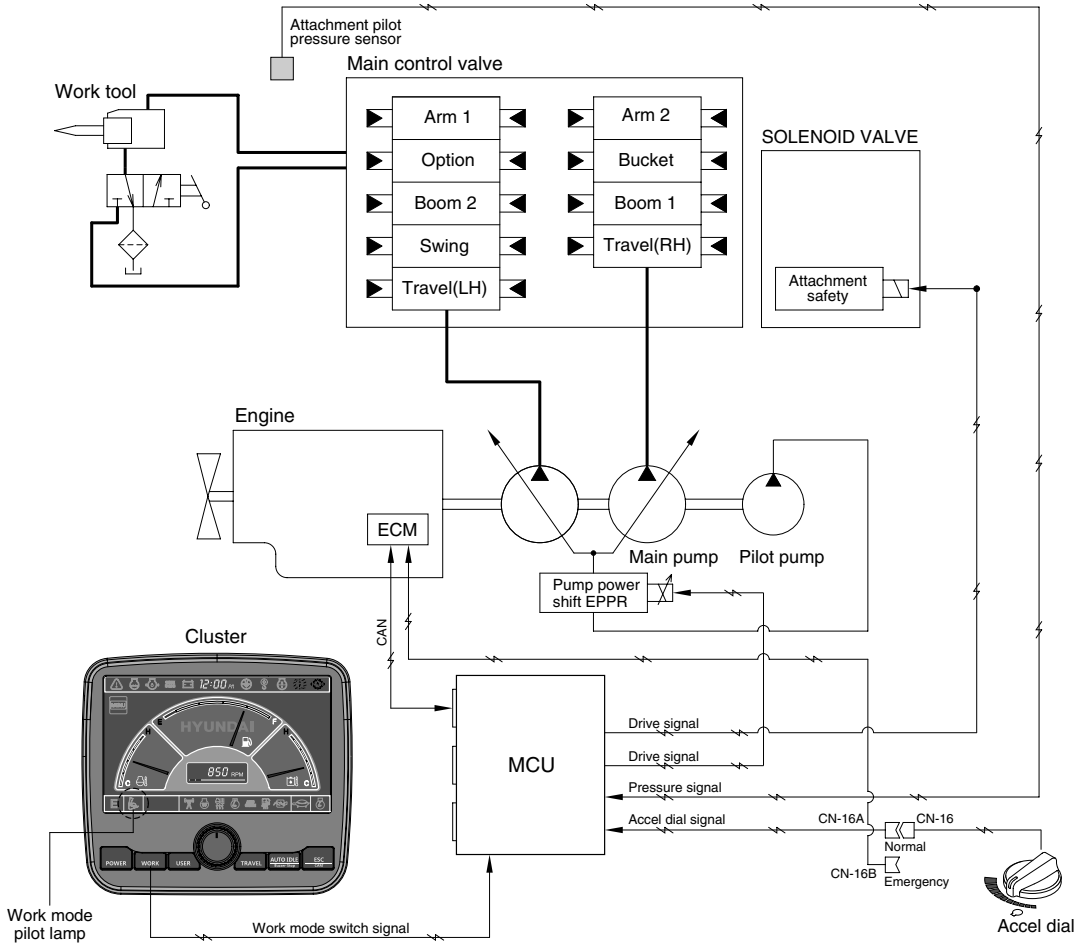
The combination of 3 power modes (P, S, E) and accel dial position (10 set) makes it possible to use the engine and pump power more effectively corresponding to the work conditions from a heavy and great power requesting work to a light and precise work.

Power mode	Application	Engine rpm				Power shift by EPPR valve			
		Standard		Option		Standard		Option	
		Unload	Load	Unload	Load	Current (mA)	Pressure (kgf/cm²)	Current (mA)	Pressure (kgf/cm²)
P	Heavy duty power	1750±50		1800±50			7(~4)		7(~4)
S	Standard power	1650±50		1700±50			9(~6)		9(~6)
E	Economy operation	1600±50		1600±50			10(~7)		12(~9)
AUTO DECEL	Engine deceleration	1000±50					40±2		
One touch decel	Engine quick deceleration	900±50					40±2		
KEY START	Key switch start position	900±50					40±2		

※ 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).



1) GENERAL WORK MODE (bucket)

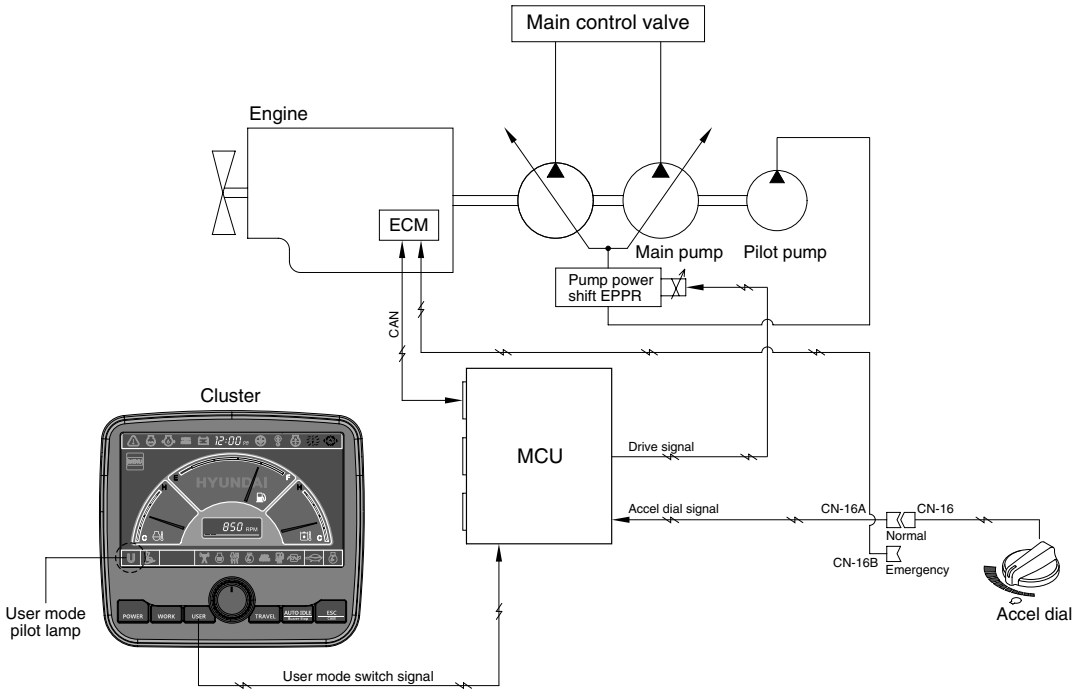
This mode is used to general digging work.

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

3. USER MODE SELECTION SYSTEM

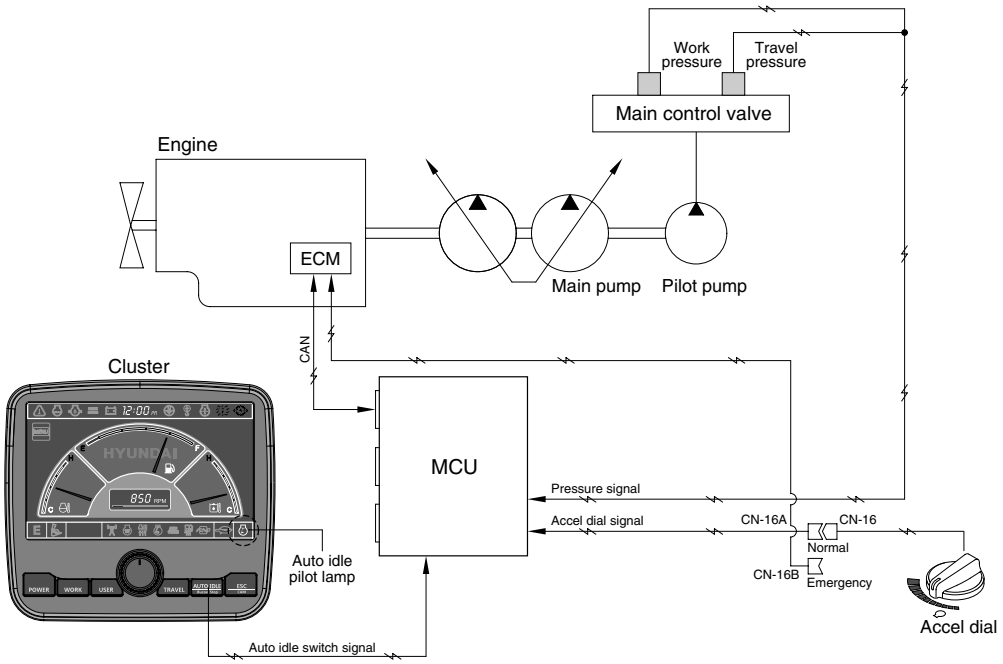


1) High idle rpm, auto idle rpm and EPPR pressure can be adjusted and memorized in the U-mode.

2) LCD segment vs parameter setting

Step (▮)	Engine speed (rpm)	Idle speed (rpm)	Power shift (bar)
1	1400	850	0
2	1450	900	3
3	1500	950	6
4	1550	1000	9
5	1600	1050	12
6	1650	1100	16
7	1700	1150	20
8	1750	1200	26
9	1800	1250	32
10	1850	1300	38

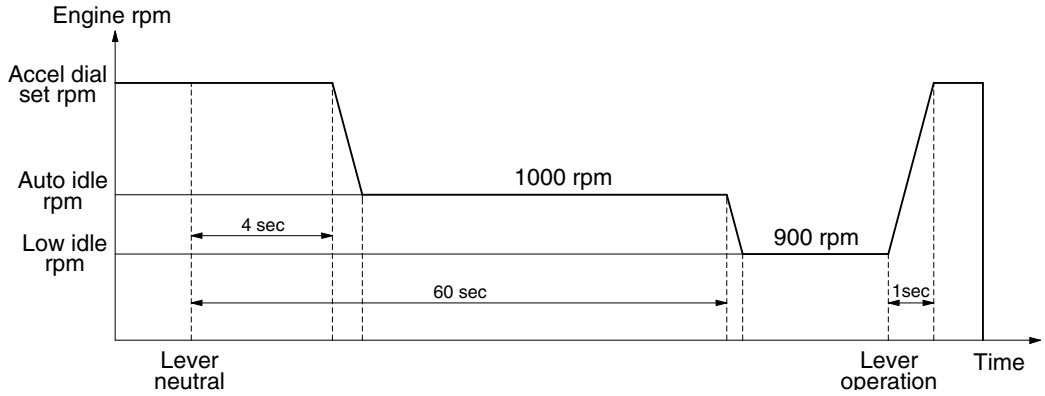
GROUP 3 AUTOMATIC DECELERATION SYSTEM



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 1000 rpm. If the control levers are at neutral for 1 minute, MCU reduces the engine speed to 950 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 upto the speed before deceleration in a second.

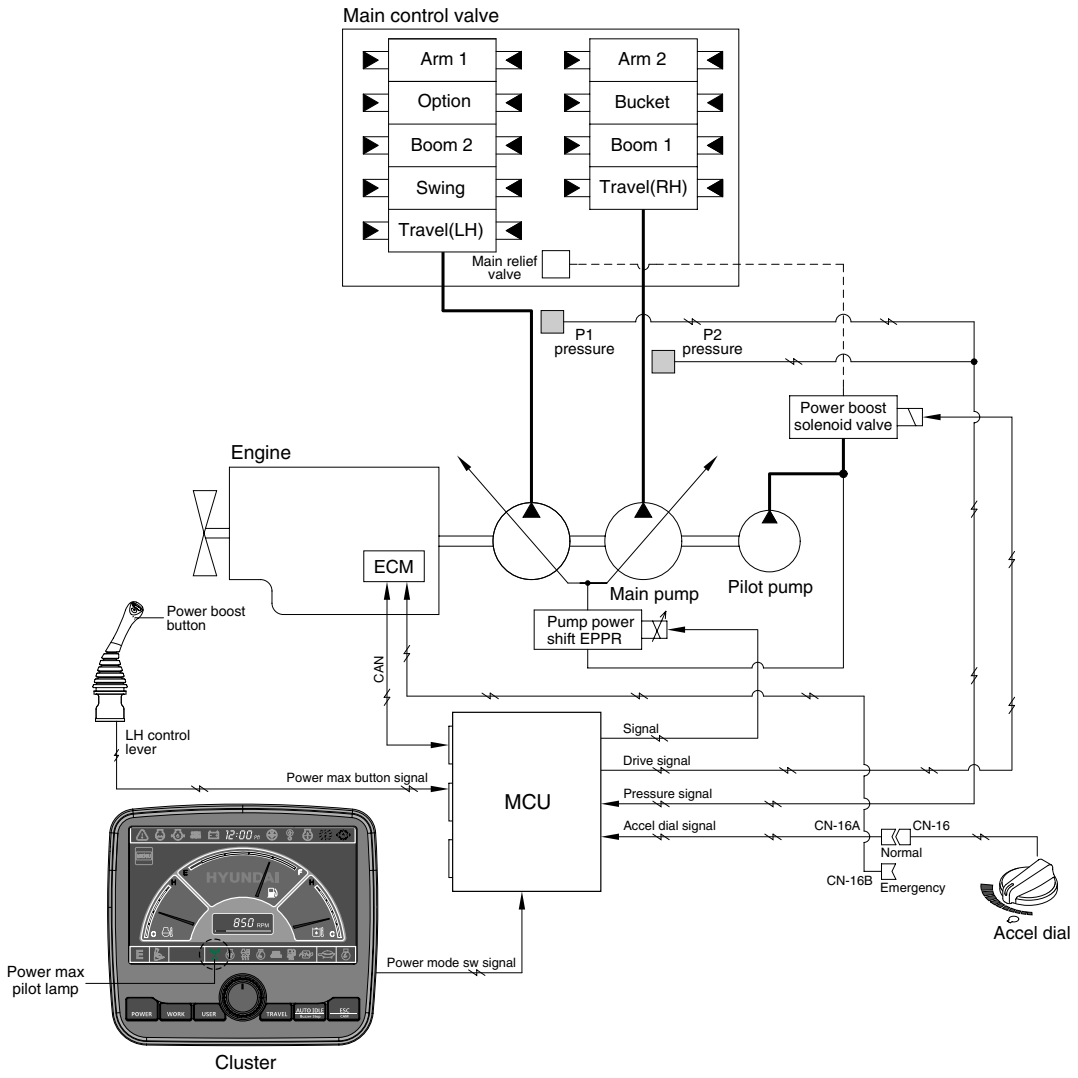


2. WHEN AUTO IDLE PILOT LAMP OFF

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



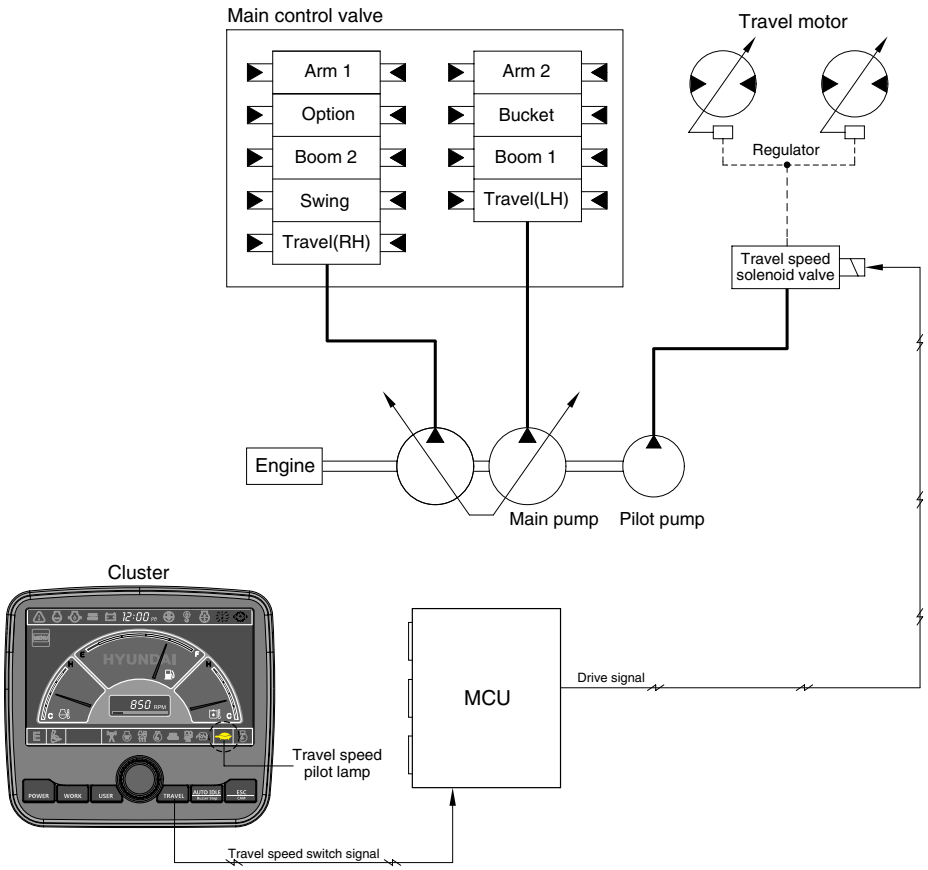
· When the power boost switch on the left control lever knob is pushed ON, the power mode is set P mode and maximum digging power is increased by 10 %.

· 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

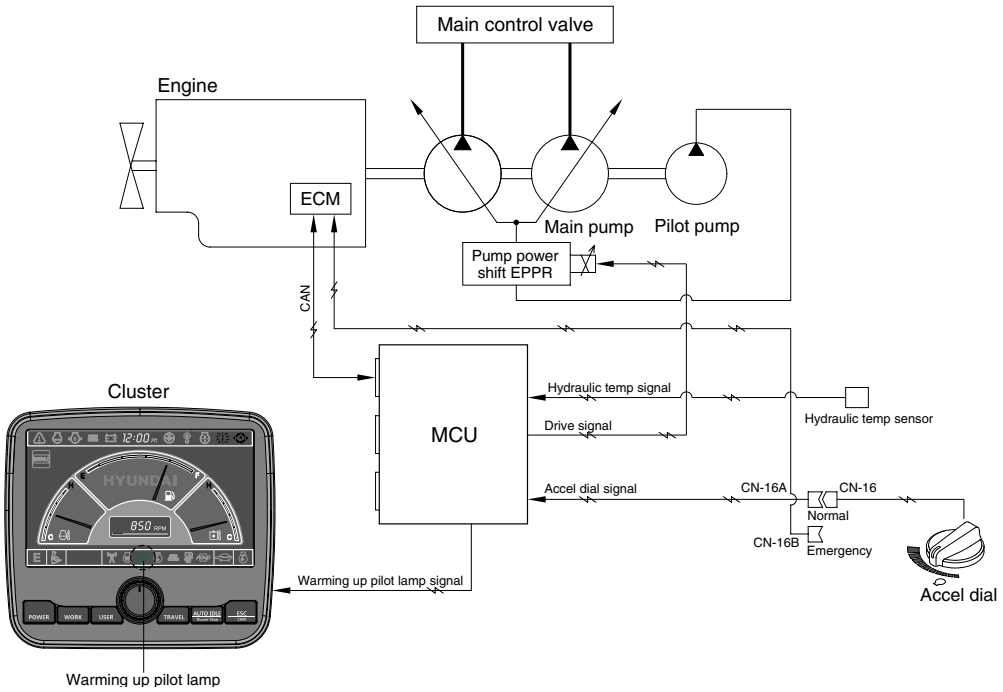


Travel speed can be switched manually by pressing the travel speed switch on the cluster.

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

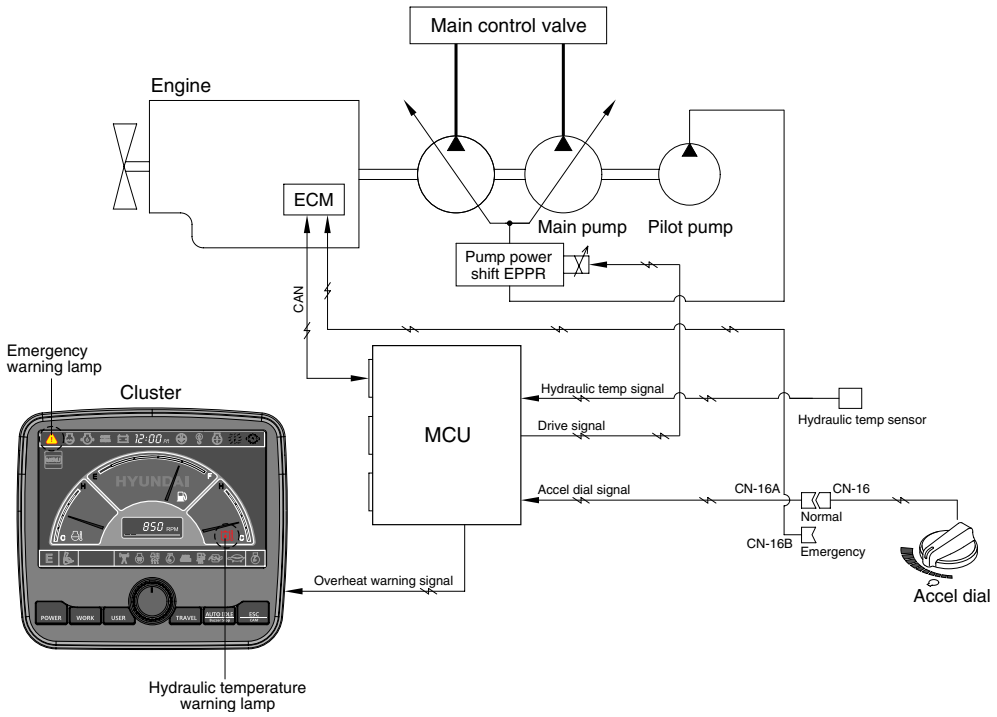


1. The MCU receives the engine coolant temperature from the ECM, and if the coolant temperature is below 30˚C, it increases the engine speed from key start rpm to 1200rpm. At this time the mode does not change. If the coolant temperature sensor has fault, the hydraulic oil temperature signal is substituted.
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

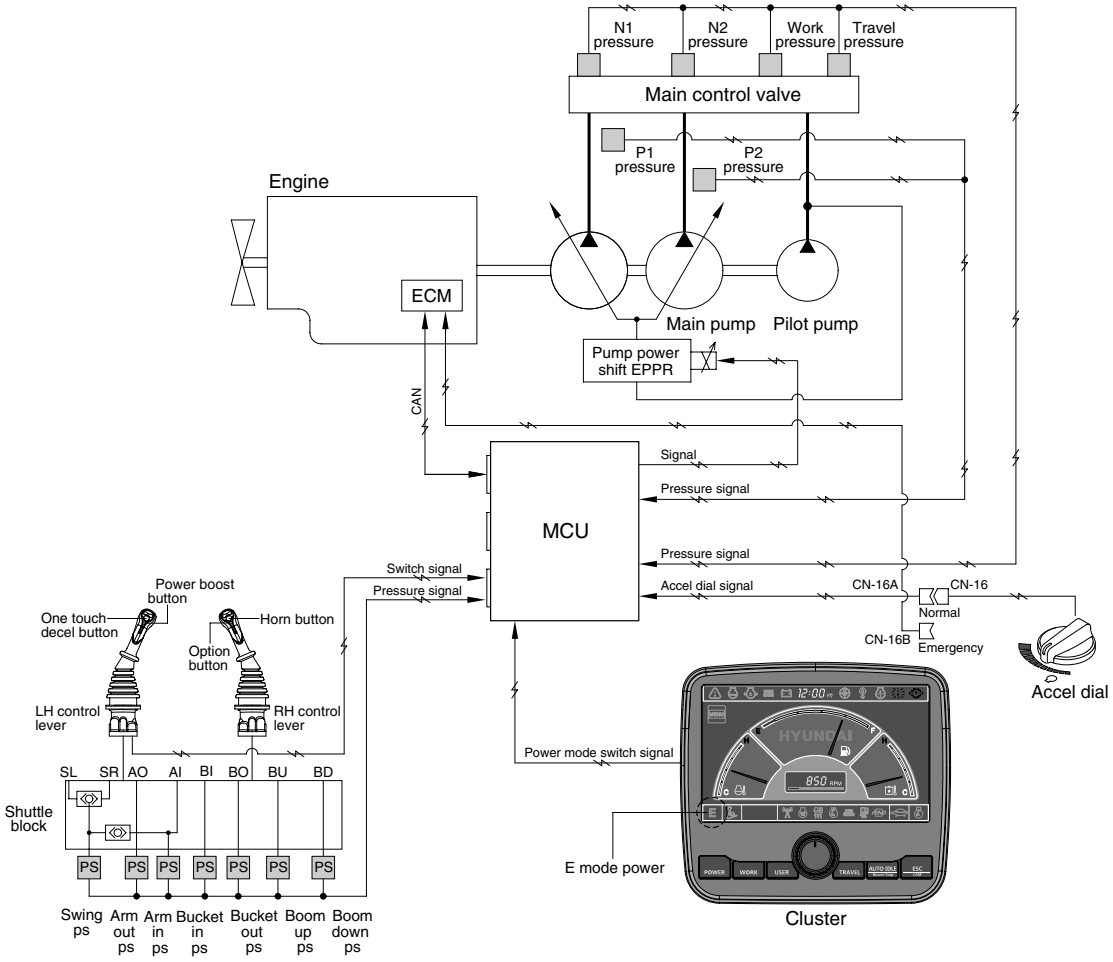


1. The engine coolant temperature or the hydraulic oil temperature is overheated over 100˚C, the warning lamp is ON and the pump input torque or the engine speed is reduced as below logic table.

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.
			- Warning lamp & buzzer : ON - Pump input torque is reduced.
	Canceled	- Coolant temperature : Less than 100˚C - Hydraulic oil temperature : Less than 95˚C	- Return to pre-set the pump absorption torque.
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

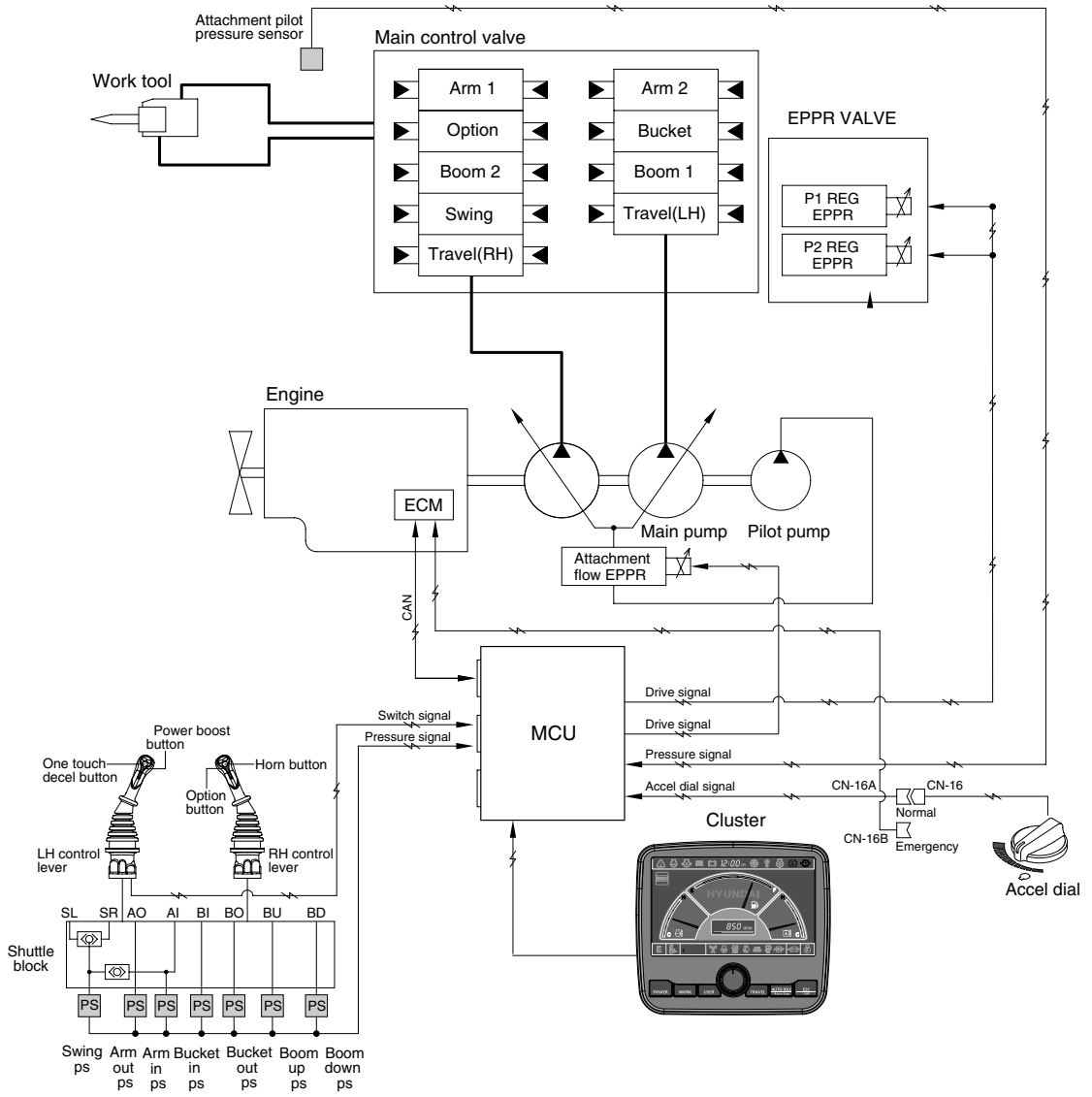


· The variable power control system controls the engine and pump mutual power according to RCV lever stroke and pump load.
It makes fuel saving and smooth control at precise work.

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.

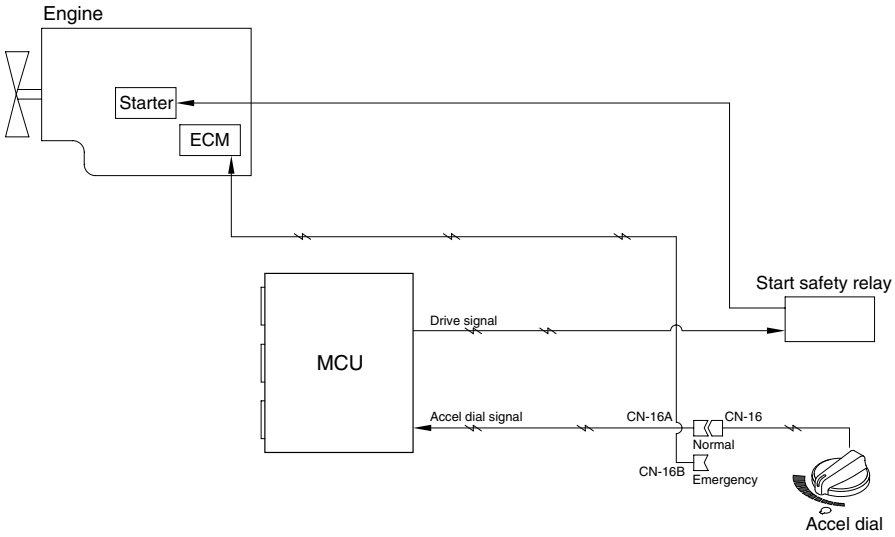
GROUP 9 ELECTRONIC PUMP INDEPENDENT CONTROL SYSTEM (EPIC)



· When the requirement operate in Composite actions，auto idle， EPIC function controls pump flow rate to improve fuel efficiency.

Condition	Function
boom up + arm in swing & boom up + swing boom down + arm out auto idle Operating at lower engine speed	Limitation of pump flow rate : Activated (p1 reg eppr or p2 reg eppr)
None of upper condition	Limitation of pump flow rate : Canceled

GROUP 10 ANTI-RESTART SYSTEM



1. ANTI-RESTART FUNCTION

After a few seconds from the engine starts to run, MCU turns off the start safety relay to protect the starter from inadvertent restarting.

2. When a replacement or taking-off of the MCU is needed, connect CN-16 and CN-16B to ensure the engine start without the MCU.

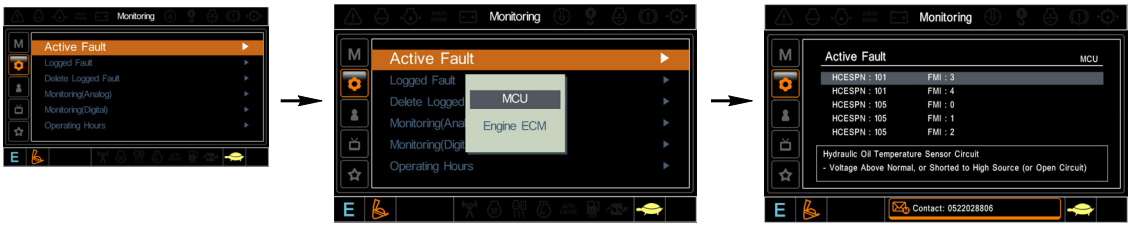
GROUP 11 SELF-DIAGNOSTIC SYSTEM

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.

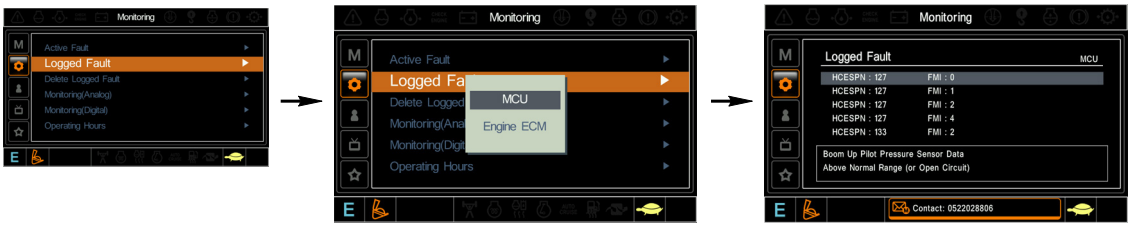
2. MONITORING

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.
128	0	Boom down Pilot Pressure Data sensor valid but above normal operational range.
	1	Boom down Pilot Pressure Data sensor Data valid but below normal operational range.
	2	Boom down Pilot Pressure Data sensor Data erratic, intermittent or incorrect.
	4	Boom down Pilot Pressure Data sensor Voltage below normal, or shorted to low source

※ Some error codes are not applied to this machine.

Error code		Description
HCESPN	FMI	
129	0	Arm in Pilot Pressure data valid but above normal operational range.
	1	Arm in Pilot Pressure data valid but below normal operational range.
	2	Arm in Pilot Pressure data erratic, intermittent or incorrect.
	4	Arm in Pilot Pressure Voltage below normal, or shorted to low source.
130	0	Arm out Pilot Pressure data valid but above normal operational range.
	1	Arm out Pilot Pressure data valid but below normal operational range.
	2	Arm out Pilot Pressure data erratic, intermittent or incorrect.
	4	Arm out Pilot Pressure Voltage below normal, or shorted to low source.
131	0	Bucket in Pilot Pressure data valid but above normal operational range.
	1	Bucket in Pilot Pressure data valid but below normal operational range.
	2	Bucket in Pilot Pressure data erratic, intermittent or incorrect.
	4	Bucket in Pilot Pressure Voltage below normal, or shorted to low source.
132	0	Bucket out Pilot Pressure data valid but above normal operational range.
	1	Bucket out Pilot Pressure data valid but below normal operational range.
	2	Bucket out Pilot Pressure data erratic, intermittent or incorrect.
	4	Bucket out Pilot Pressure Voltage below normal, or shorted to low source.
133	0	Arm In/Out & Bucket In Pilot Pressure data valid but above normal operational range.
	1	Arm In/Out & Bucket In Pilot Pressure data valid but below normal operational range.
	2	Arm In/Out & Bucket In Pilot Pressure data erratic, intermittent or incorrect.
	4	Arm In/Out & Bucket In Pilot Pressure Voltage below normal, or shorted to low source.
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.

Error code		Description
HCESPN	FMI	
139	0	Option pilot pressure sensor data above normal range.
	1	Option pilot pressure sensor data below normal range.
	2	Option pilot pressure sensor data error.
	4	Option 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.
188	5	Attachment flow EPPR 1 valve - Current below normal, or open circuit.
	6	Attachment flow EPPR 1 valve - Current above normal.
189	5	Attachment flow EPPR 2 valve - Current below normal, or open circuit.
	6	Attachment flow EPPR 2 valve - 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 ECM voltage supply circuits.	Engine will not start.
115 190 2	No engine speed signal detected at both engine position sensor circuits.	Engine will die and will not start.
121 190 10	No engine speed signal detected from one of the engine position sensor circuits.	None on performance.
122 102 3	High voltage detected on the intake manifold pressure circuit.	Derate in power output of the engine.
123 102 4	Low voltage detected on the intake manifold pressure circuit.	Derate in power output of the engine.
131 91 3	High voltage detected at the throttle position signal circuit.	Severe derate (power and speed). Limp home power only.
132 91 4	Low voltage detected at the throttle position signal circuit.	Severe derate (power and speed). Limp home power only.
133 974 3	High voltage detected at the remote throttle position signal circuit.	None on performance if remote throttle is not used.
134 974 4	Low voltage detected at the remote throttle position signal circuit.	None on performance if remote throttle is not used.
135 100 3	High voltage detected at the oil pressure circuit.	No engine protection for oil pressure.
141 100 4	Low voltage detected at the oil pressure circuit.	No engine protection for oil pressure.
143 100 18	Oil pressure signal indicates oil pressure below the low oil pressure engine protection limit.	Progressive power and speed derate with increasing time after alert. If engine protection shutdown feature is enable, engine will shut down 30 seconds after red lamp starts flashing.
144 110 3	High voltage detected at the coolant temperature circuit.	Possible white smoke. Fan will stay on if controlled by the electronic control module (ECM). No engine protection for coolant temperature.
145 110 4	Low voltage detected at the coolant temperature circuit.	Possible white smoke. Fan will stay on if controlled by electronic control module (ECM). No engine protection for coolant temperature.
147 91 8	A frequency of less then 100Hz was detected at the frequency throttle signal pin of the actuator harness connector at the ECM.	Calibration dependent power and speed derate.
148 91 8	A frequency of more than 100Hz was detected at the frequency throttle signal pin of the actuator harness connector at the ECM.	Calibration dependent power and speed derate.
151 110 0	Coolant temperature signal indicates coolant temperature above 104˚C (220˚F).	Progressive power derate with increasing time after alert. If engine protection shutdown feature is enabled, engine will shut down 30 seconds after red lamp starts flashing.

※ Some fault codes are not applied to this machine.

111Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
153 105 3	High voltage detected at the intake manifold temperature circuit.	Possible white smoke. Fan will stay on if controlled by electronic control module (ECM). No engine protection for coolant temperature.
154 105 4	Low voltage detected at the intake manifold temperature circuit.	Possible white smoke. Fan will stay on if controlled by electronic control module (ECM). No engine protection for coolant temperature.
155 105 0	Intake manifold temperature signal indicates temperature above 87.8˚C (190˚F).	Progressive power derate with increasing time after alert. If engine protection shutdown feature is enabled, engine will shut down 30 seconds after red lamp starts flashing.
187 620 4	Low voltage detected on the ECM voltage supply line to some sensors (VSEN2 supply).	Engine will run derated. No engine protection for oil pressure and coolant level.
198 612 3	High voltage detected at the ICON lamp circuit when low voltage was expected by the ECM.	The ICON system will be disabled. Only mandatory shutdown will be enabled.
199 612 4	Less than 6 VDC (low voltage) detected at the ICON lamp circuit when high voltage was expected by the ECM.	The ICON system will be disabled. Only mandatory shutdown will be enabled.
211 1484 31	Additional machine diagnostic codes have been logged. Check other ECM's for diagnostic codes.	None on engine performance.
212 175 3	High voltage detected at the oil temperature circuit.	No engine protection for oil temperature.
213 175 4	Low voltage detected at the oil temperature circuit.Low voltage detected at the oil temperature circuit.	No engine protection for oil temperature.
214 175 0	Oil temperature signal indicates oil temperate above 123.9˚C (225˚F).	Progressive power derate with increasing time after alert. If engine protection shutdown feature is enabled, engine will shut down 30sec after the red lamp starts flashing.
219 1380 17	Low oil level was detected in the CentinelTM makeup oil tank.	None on performance. CentinelTM deactivated.
221 108 3	High voltage detected at the ambient air pressure circuit.	Derate in power output of the engine.
222 108 4	Low voltage detected at the ambient air pressure circuit.	Derate in power output of the engine.
223 1265 4	Incorrect voltage detected at the CentinalTM actuator circuit by the ECM.	None on performance. CentinelTM deactivated.
227 620 3	High voltage detected on the ECM voltage supply line to some sensors (VSEN2 supply).	Engine will run derated. No engine protection for oil pressure and coolant level.
234 190 0	Engine speed signal indicates engine speed is greater than 2650 rpm.	Fuel shutoff valve is closed unit the engine speed drops. The fuel shutoff valve will open when engine speed falls below 2000 rpm.
235 111 1	Coolant level signal indicates coolant level is below the normal range.	Progressive power derate with increasing time after alert. If engine protection shutdown feature is enabled, engine will shut down 30 seconds after red lamp starts flashing.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
237 644 2	Duty cycle of the throttle input signal to the primary or secondary engine for multiple unit synchronization is less than 3 percent or more than 97 percent.	All engines(primary and secondary) are shut down with increasing time after alert if hard-coupled. Only secondary engines are shut down with increasing time after alert if soft-coupled.
241 84 2	The ECM lost the vehicle speed signal.	Engine speed limited to maximum engine speed without vehicle speed sensor parameter value Cruise Control. Gear-Down Protection and Road Speed Governor will not work (automotive only).
242 84 10	Invalid or inappropriate vehicle speed signal detected. Signal indicates an intermittent connection or VSS tampering.	Engine speed limited to maximum engine speed without vehicle speed sensor parameter value Cruise Control. Gear-Down Protection and Road Speed Governor will not work (automotive only).
245 632 4	Less than 6 VDC detected at fan clutch circuit when on. Indicates an excessive current draw from the ECM or faulty ECM output circuit.	The fan may stay on at all times.
254 647 4	Less than 6 VDC detected at FSO circuit when on. Indicates an excessive current draw from the ECM or a faulty ECM output circuit.	The ECM turns off the FSO supply voltage. The engine will shut down.
255 632 3	Externally supplied voltage detected going to the fuel shutoff solenoid supply circuit.	None on performance. Fuel shutoff valve stays open.
285 639 9	The ECM expected information from a multiplexed device but did not receive it soon enough or did not receive it at all.	At least one multiplexed device will not operate properly.
286 639 13	The ECM expected info from a multiplexed device but only received a portion of the necessary information.	At least on multiplexed device will not operate properly.
287 91 19	The machine vehicle electronic control unit (VECU) detected a fault with its throttle pedal.	The engine will only idle.
288 974 19	The machine vehicle electronic control unit (VECU) detected a fault with its remote throttle.	The engine will not respond to the remote throttle.
293 1083 3	High voltage detected at the machine temperature sensor signal pin of the 31-pin machine connector.	No engine protection for machine temperature.
294 1083 4	Low voltage detected at the machine temperature sensor signal pin of the 31-pin machine connector.	No engine protection for machine temperature.
295 108 2	An error in the ambient air pressure sensor signal was detected by the ECM.	Engine is derated to no air setting.
297 1084 3	High voltage detected at the machine pressure sensor signal pin of the 31-pin machine connector.	No engine protection for machine pressure.
298 1084 4	Low voltage detected at the machine pressure sensor signal pin of the 31-pin machine connector.	No engine protection for machine pressure.
299 1384 31	Engine shutdown by device other than key switch before proper engine cool down resulting in filtered load factor above maximum shutdown threshold.	No action taken by the ECM.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
311 651 6	Current detected at No.1 injector when voltage is turned off.	The injector for cylinder number 1 is turned off.
312 655 6	Current detected at No.5 injector when voltage is turned off.	The injector for cylinder number 5 is turned off.
313 653 6	Current detected at No.3 injector when the voltage is turned off	The injector for cylinder number 3 is turned off.
314 656 6	Current detected at No 6 injector when the voltage is turned off.	The injector for cylinder number 6 is turned off.
315 652 6	Current detected at No.2 injector when the voltage is turned off.	The injector for cylinder number 2 is turned off.
319 251 2	Real time clock lost power.	None on performance. Data in the ECM will not have accurate time and date information.
321 654 6	Current detected at No.4 injector when the voltage is turned on.	The injector for cylinder number 4 is turned off.
322 656 5	Injector solenoid driver cylinder 1 circuit-current below normal, or open circuit. Current detected at injector number 1 when voltage is turned off.	The current to the injector is shut off. The engine can possibly misfire or run rough.
323 656 5	Injector solenoid driver cylinder 5 circuit-current below normal, or open circuit. Current detected at injector number 5 when voltage is turned off.	The current to the injector is shut off. The engine can possibly misfire or run rough.
324 656 5	Injector solenoid driver cylinder 3 circuit-current below normal, or open circuit. Current detected at injector number 3 when voltage is turned off.	The current to the injector is shut off. The engine can possibly misfire or run rough.
325 656 5	Injector solenoid driver cylinder 6 circuit-current below normal, or open circuit. Current detected at injector number 6 when voltage is turned off.	The current to the injector is shut off. The engine can possibly misfire or run rough.
331 656 5	Injector solenoid driver cylinder 2 circuit-current below normal, or open circuit. Current detected at injector number 2 when voltage is turned off.	The current to the injector is shut off. The engine can possibly misfire or run rough.
332 656 5	Injector solenoid driver cylinder 4 circuit-current below normal, or open circuit. Current detected at injector number 4 when voltage is turned off.	The current to the injector is shut off. The engine can possibly misfire or run rough.
341 630 2	Severe loss of data from the ECM.	Possible no noticeable performance effects OR engine dying OR hard starting. Fault information, trip information and maintenance monitor data may be inaccurate.
343 629 12	Internal ECM error.	Possible none on performance or severe derate.
349 191 16	A frequency greater than calibrated threshold was detected at the tail shaft governor signal pin of the 31-pin machine connector.	Calibration dependent power and speed derate.
352 620 4	Low voltage detected on the ECM voltage supply line to some sensors (VSEN 1 supply).	Engine is derated to no air setting.
386 620 3	High voltage detected on the ECM voltage supply line to some sensors (VSEN 1 supply).	Engine is derated to no air setting.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
387 1043 3	High voltage detected on the ECM voltage supply line to the throttle (VTP supply)	Engine will only idle.
388 1072 11	Less than 6 VDC detected at the engine brake circuit 1 when on indicates an excessive current draw from the electronic control module (ECM) or faulty ECM output circuit.	Engine brake 1 can not be activated.
392 1073 11	Less than 6 VDC detected at the engine brake circuit 2 when on indicates an excessive current draw from the electronic control module (ECM) or faulty ECM output circuit.	Engine brake 2 can not be activated.
415 100 1	Oil pressure signal indicates oil pressure below the very low oil pressure engine protection limit.	Progressive power derate with increasing time from alert. If engine protection shutdown feature is enabled, engine will shut down 30 seconds after red lamp starts flashing.
418 097 15	Water has been detected in the fuel filter.	Possible white smoke, loss of power, or hard starting.
419 1319 2	An error in the intake manifold pressure sensor signal was detected by the ECM.	Engine is derated to no air setting.
422 111 2	Voltage detected simultaneously on both the coolant level high and low signal circuits OR no voltage detected on both circuits.	No engine protection for coolant level.
426 639 2	Communication between the ECM and the J1939 data link has been lost.	None on performance. J1939 devices may not operate.
428 97 3	High voltage detected at water-in-fuel sensor.	None on performance.
429 97 4	Low voltage detected at water-in-fuel sensor.	None on performance.
431 558 2	Voltage detected simultaneously on both the idle validation off-idle and on-idle circuits.	None on performance.
432 558 13	Voltage detected at idle validation on-idle circuit when voltage at throttle position circuit indicates the pedal is not at idle OR voltage detected at idle validation off-idle circuit when voltage at throttle position circuit indicates the pedal is at idle.	Engine will only idle.
433 102 2	Voltage signal at intake manifold pressure circuit indicates high intake manifold pressure but other engine characteristics indicate intake manifold pressure must be low.	Derate to no air setting.
434 627 2	Supply voltage to the ECM fell below 6.2 VDC for a fraction of a second OR the ECM was not allowed to power down correctly (retain battery voltage for 30 seconds after key off).	Possible no noticeable performance effects OR possibility of engine dying OR hard starting. Fault information, trip information and maintenance monitor data may be inaccurate.
435 100 2	An error in the oil pressure sensor signal was detected by the ECM.	None on performance. No engine protection for oil pressure.
441 168 18	Battery voltage below normal operating level.	Possible no noticeable performance effects OR possibility of rough idle.

※ Some fault codes are not applied to this machine.

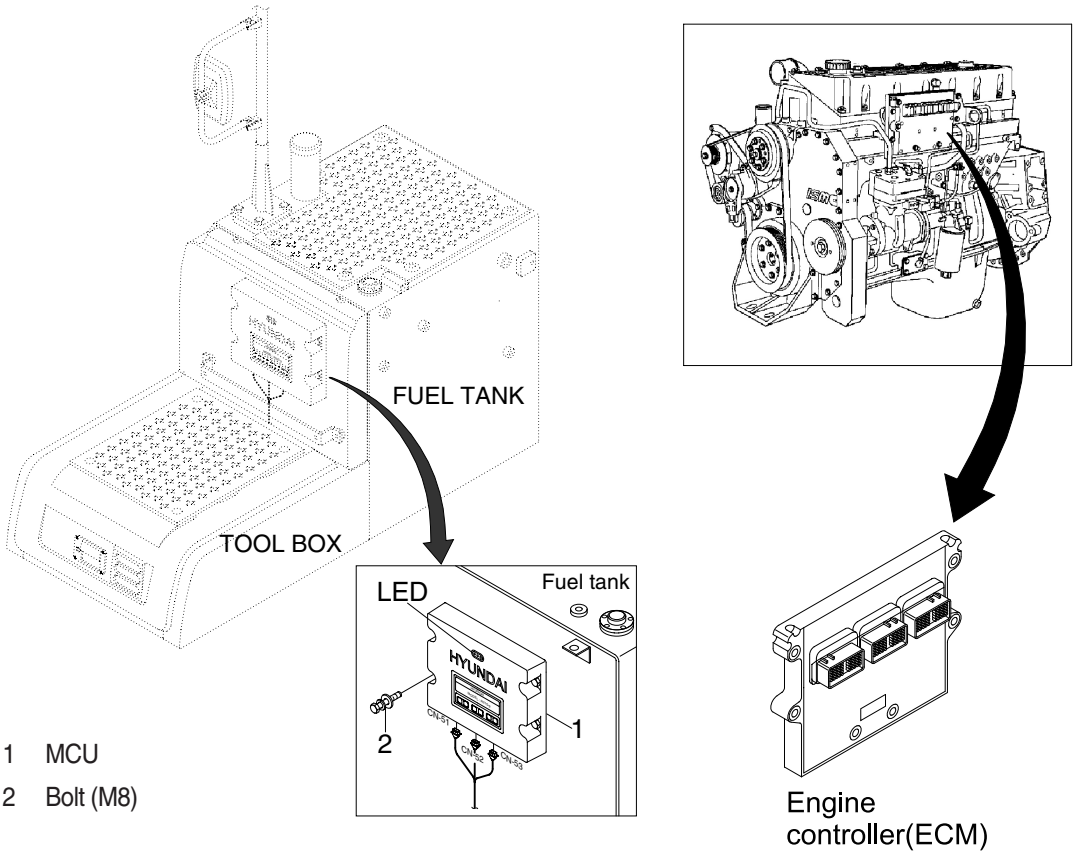
Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
442 168 16	Battery voltage below normal operating level.	None on performance.
443 1043 4	Low voltage detected on the ECM voltage supply line to the throttle(s) (VTP supply).	Engine will only idle.
465 1188 3	High voltage detected at the wastegate actuator number 1 circuit when no voltage was being supplied by the electronic control module (ECM).	Engine will run derated.
466 1188 4	Less than +6 VDC detected at the wastegate actuator number 1 circuit when on indicates an excessive current draw from the electronic control module (ECM) or faulty ECM output circuit.	Engine will run derated.
472 1380 2	Either high or low voltage detected on the crankcase oil level sensor circuit by the electronic control module (ECM).	None on performance. Centinel system deactivated.
474 1321 2	Either low voltage detected when +12 VDC are commanded or voltage detected when no voltafe is commanded.	Either the engine will not start or the engine will not have starter lockout protection.
475 1351 4	Low voltage was detected on the electronic air compressor circuit when high voltage was expected.	Air compressor will not shut off.
476 1351 3	High voltage or an open circuit detected at the electronic air compressor governor actuator circuit.	Air compressor runs continuously or not at all.
489 191 18	Auxiliary speed frequency on input pin indicated that the frequency is below a calibration dependent threshold.	Engine will only idle.
491 1189 3	High voltage detected at the wastegate actuator number 2 circuit when no voltage was being supplied by the electronic control module (ECM).	Engine will run derated.
492 1189 4	Less than +6 VDC detected at the wastegate actuator number 2 circuit when activated indicates an excessive current draw from the electronic control module (ECM) or faulty ECM output circuit.	Engine will run derated.
527 702 3	Less than 17.0 VDC detected at the dual output A signal pin of the 31-pin machine connector.	No action taken by the ECM.
528 093 2	Less than 17.0 VDC detected at the dual output B signal pin of the 31-pin machine connector.	No action taken by the ECM.
529 703 3	Less than 17.0 VDC detected at the dual output B signal pin at the ECM.	No action taken by the ECM.
536 718 11	Either low voltage detected on autoshift low gear actuator circuit when +12 VDC are commanded or voltage detected when no voltage is commanded.	Top 2 lockout solenoid will not function properly. Transmission will not shift properly.
537 717 11	Either low voltage detected on autoshift high gear actuator circuit when (+) 12 VDC are commanded or voltage detected when no voltage is commanded.	Top 2 shift solenoid will not function properly. Transmission will not shift properly.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
538 719 11	Either low voltage detected on autoshift neutral gear actuator circuit when +12 VDC are commanded or voltage detected when no voltage is commanded.	Top 2 neutral actuator will not function properly. Transmission will not shift properly.
544 611 7	Autoshift failure ; at least three shift attempts were missed.	Top 2 transmission will not be controlled correctly. Transmission remains in manual mode.
551 558 4	No voltage detected simultaneously on both the idle validation off-idle and on-idle circuits.	Engine will only idle.
581 1381 3	High voltage detected at the fuel inlet restriction sensor signal pin.	Fuel inlet restriction monitor deactivated.
582 1381 4	Low voltage detected at the fuel inlet restriction sensor signal pin	Fuel inlet restriction monitor deactivated.
583 1381 18	Restriction has been detected at the fuel pump inlet.	Fuel inlet restriction monitor warning is set.
588 611 3	High voltage detected at the alarm circuit when low voltage was expected by the ECM.	The ICON system will be disabled. Only mandatory shutdown will be enabled. Engine can be started normally.
589 611 4	Less than +6 VDC detected at the engine start alarm circuit when high voltage was expected by the ECM.	The ICON idle control system will be disabled. Only mandatory shutdown will be enabled. Engine can be started normally.
596 167 16	High battery voltage detected by the battery voltage monitor feature.	Yellow lamp will be lit until high battery voltage condition is corrected.
597 167 16	ICONTM has restarted the engine three times within three hours due to low battery voltage (automotive only) OR low battery voltage detected by the battery voltage monitor feature.	Yellow lamp will be lit until low battery voltage condition is corrected. The ECM may increase idle speed and deactivate idle decrement switch if idle speedup is enabled. The engine will run continuously if ICONTM is active (automotive only).
598 167 1	Very low battery voltage detected by the battery voltage monitor feature.	Red lamp lit until very low battery voltage condition is corrected.
611 1383 31	Engine shutdown by operator before proper engine cool down resulting in filtered load factor above maximum shutdown threshold.	No action taken by the ECM.
951 166 2	A power imbalance between cylinders was detected by the ECM.	Engine may have rough idle or misfire.

※ Some fault codes are not applied to this machine.

1. MCU and Engine ECM (Electronic Control Module)



1 MCU
2 Bolt (M8)

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.

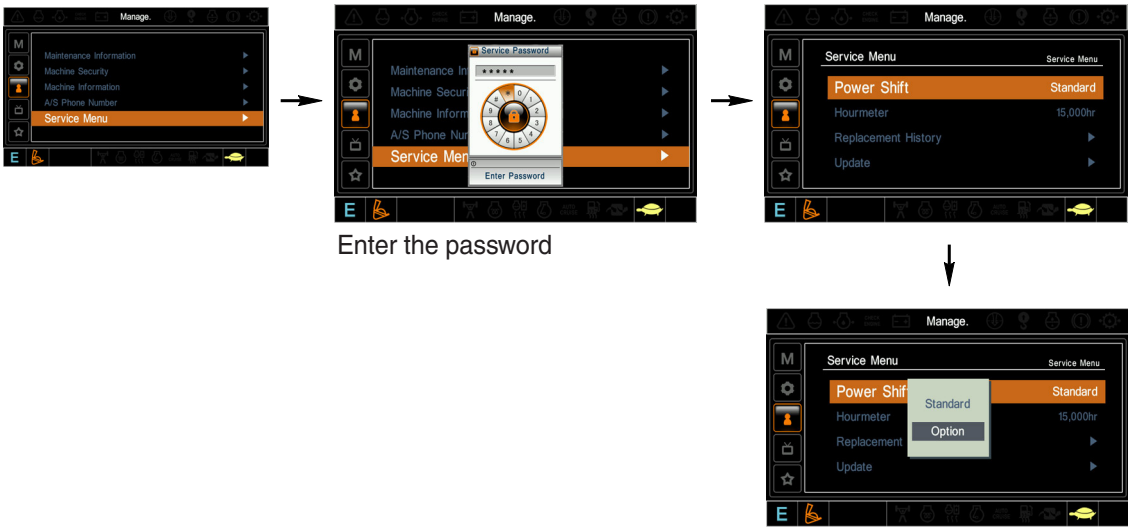
(3) Pressure and electric current value for each mode

Mode		Pressure		Electric current (mA)	Engine rpm (at accel dial 10)
		kgf/cm²	psi		
Standard (Stage : 1.0)	P	7(~4)	101 (~58)	-	1750 ± 50
	S	9(~6)	130 (~87)	-	1650 ± 50
	E	10(~7)	145 (~101)	-	1600 ± 50
Option (Stage : 2.0)	P	7(~4)	101 (~58)	-	1800 ± 50
	S	9(~6)	130 (~87)	-	1700 ± 50
	E	12(~9)	174 (~130)	-	1600 ± 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



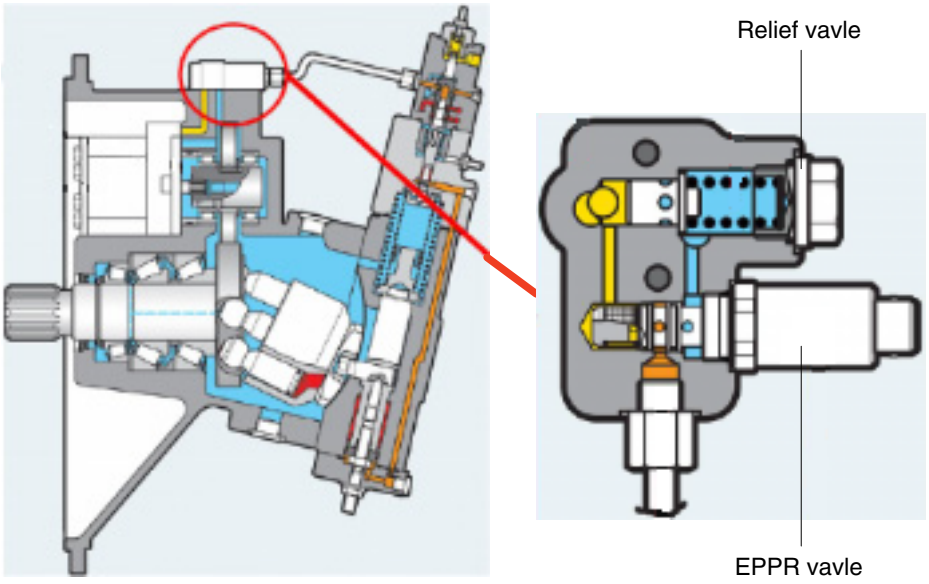
Enter the password

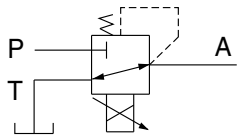
· Power shift (standard/option) : Power shift pressure can be set by option menu.

3) OPERATING PRINCIPLE (pump EPPR valve)

(1) Structure

(1) Structure

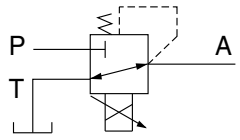


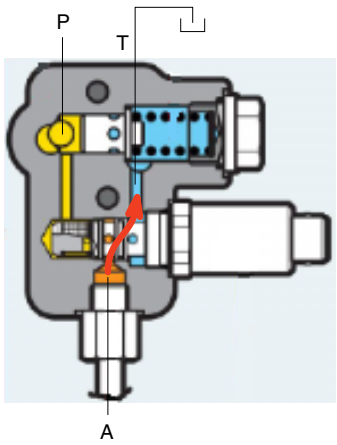


P Pilot oil supply line (pilot pressure)
T Return to tank
A Negative control pressure to main pump

(2) Neutral

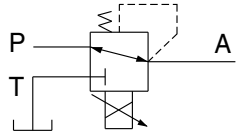
Pressure line is blocked and A oil returns to tank.

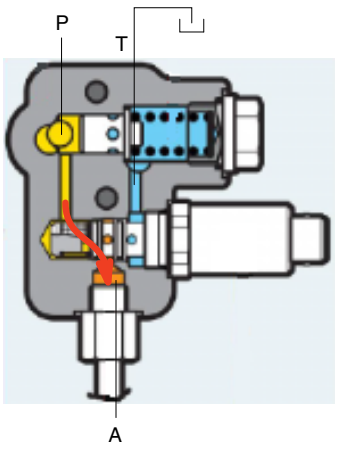




(3) Operating

Negative control pressure enters into A.





4) EPPR VALVE CHECK PROCEDURE

(1) Check electric current value at EPPR valve

① Disconnect connector CN-75 from EPPR valve.

② Insert the adapter to CN-75 and install multimeter as figure.

③ Start engine.

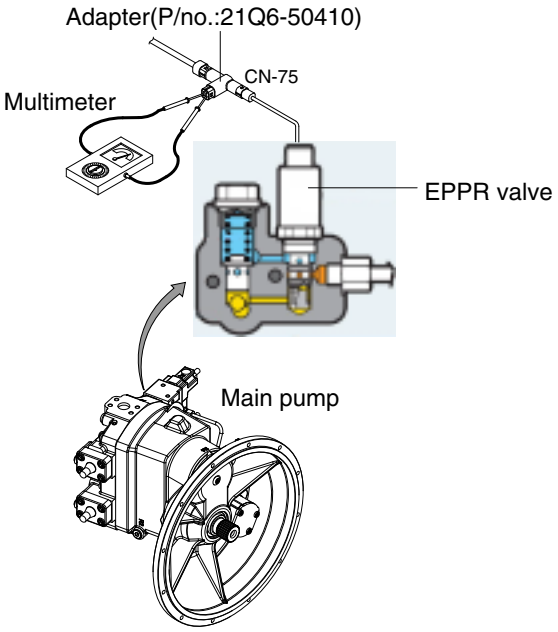
④ Set S-mode and cancel auto decel mode.

⑤ Position the accel dial at 10.

⑥ If rpm display show approx 1750±50 rpm check electric current at bucket circuit relief position.

⑦ Check electric current at bucket circuit relief position.

Spec : 100~700 mA



(2) Check pressure at EPPR valve

① Start engine.

② Set S-mode and cancel auto decel mode.

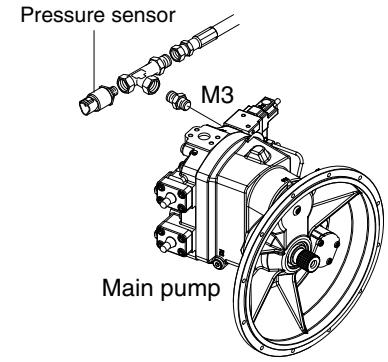
③ Position the accel dial at 10.

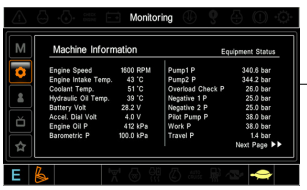
④ If tachometer show approx 1750±50 rpm check pressure at relief position of bucket circuit by operating bucket control lever.

⑤ If pressure is not correct, adjust it.

⑥ After adjust, test the machine.

Spec : 2~40 kgf/cm^2 (30~580 psi)





Cluster

2. EPIC EPPR VALVE

1) COMPOSITION

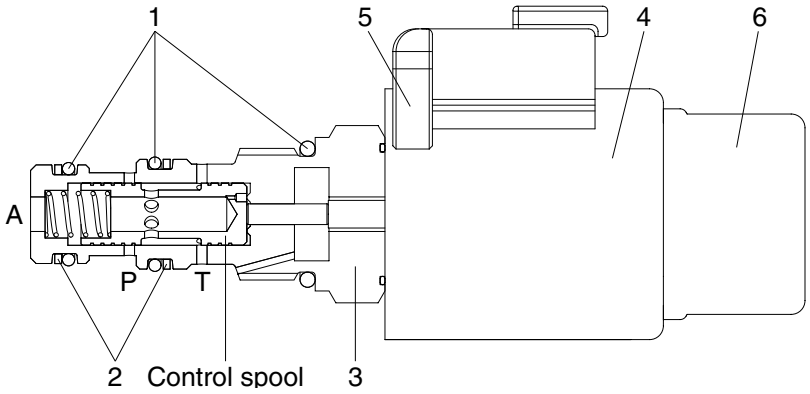
The boom priority EPPR valve is built in a manifold and mainly consisting of valve body and coil. This EPPR valve installed under the solenoid valve.

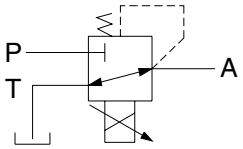
2) CONTROL

The boom priority EPPR valve has to be controlled by a specific electronic amplifier card, which is supplying the coil with a current 580 mA at 30 Ω and 24 V.

3) OPERATING PRINCIPLE

(1) Structure





P : Pilot supply line
T : Return to tank
A : Secondary pressure to flow MCV

1	O-ring	3	Valve body	5	Connector
2	Support ring	4	Coil	6	Cover cap

(2) Operation

In de-energized mode the inlet port (P) is closed and the outlet port (A) is connected to tank port (T).

In energized mode the solenoid armature presses onto the control spool with a force corresponding to the amount of current. This will set a reduced pressure at port A. The setting is proportional to the amount of current applied.

(3) Maximum pressure relief

If a pressure from outside is applied on port A the valve may directly switch to tank port (T) and protect the system before overload.

2) EPPR VALVE CHECK PROCEDURE

(1) Check electric current value at EPPR valve

① Disconnect connector CN-242,243 from EPPR valve.

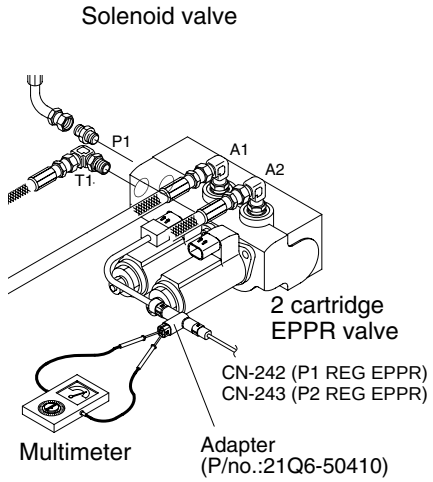
② Insert the adapter to CN-242,243 and install multimeter as figure.

③ Start engine.

④ If rpm display approx 1750±50 rpm disconnect one wire harness from EPPR valve.

⑤ Check electric current in case of combined boom up and swing operation.

Spec : 0~600 mA



(2) Check pressure at EPPR valve

① Remove hose from A5 port and connect pressure gauge as figure.
- Gauge capacity : 0 to 50 kgf/cm² (0 to 725 psi)

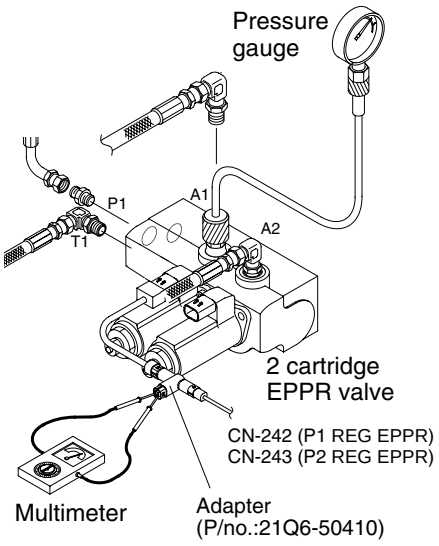
② Start engine.

③ If rpm display approx 1750±50 rpm check pressure at relief position of bucket circuit by operating bucket control lever.

④ If pressure is not correct, adjust it.

⑤ After adjust, test the machine.

Spec : 0~38 kgf/cm² (0~530 psi)



GROUP 14 MONITORING SYSTEM

1. OUTLINE

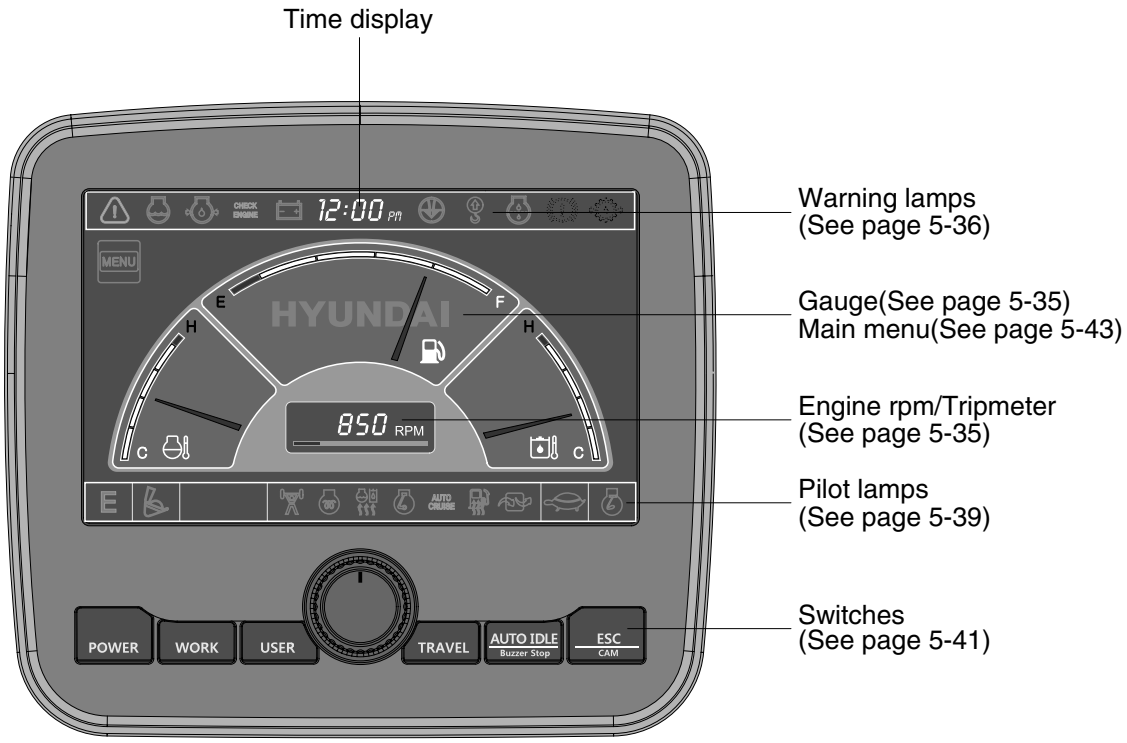
Monitoring system consists of the monitor part and switch part.

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



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 1200 rpm.

※ Others same as above.

③ When abnormal condition

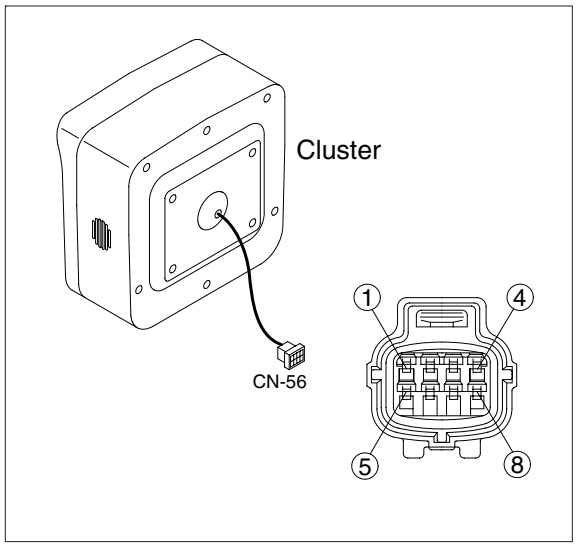
a. The warning lamp lights up and the buzzer sounds.
b. If BUZZER STOP switch is pressed, buzzer sound is canceled but the lamp warning lights up until normal condition.

※ 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

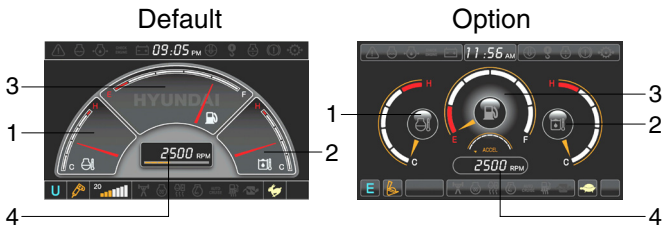
No.	Name	Signal
1	Battery 24V	20~32V
2	Signal 3	NTSC
3	GND	-
4	Serial + (TX)	0~5V
5	Power IG (24V)	20~32V
6	Signal 2	NTSC
7	Camera signal	NTSC
8	Serial - (RX)	0~5V

※ NTSC : the united states National Television Systems Committee



2) GAUGE

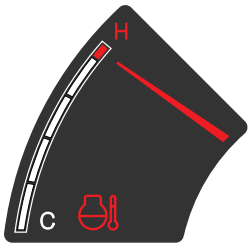
(1) Operation screen



1 Engine coolant temperature gauge
2 Hydraulic oil temperature gauge
3 Fuel level gauge
4 RPM / Tripmeter display

※ **Operation screen type can be set by the screen type menu of the display. Refer to page 5-54 for details.**

(2) Engine coolant temperature gauge

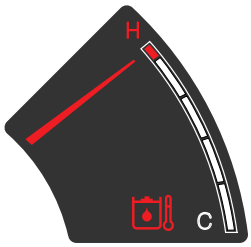


① This gauge indicates the temperature of coolant.
- White range : 40-107˚C (104-225˚F)
- Red range : Above 107˚C (225˚F)

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.

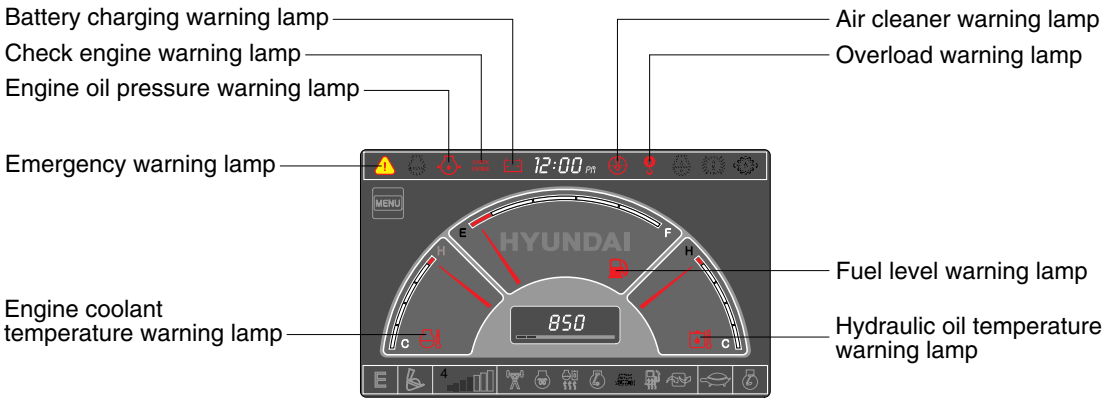
※ **If the gauge indicates the red range or lamp blinks in red even though the machine is on the normal condition, check the electric device as that can be caused by the poor connection of electricity or sensor.**

(5) RPM / Tripmeter display

① This displays the engine speed or the tripmeter.

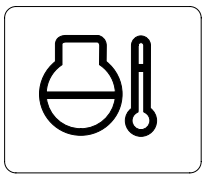
※ **Refer to page 5-53 for details.**

3) WARNING LAMPS



※ **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.**

(1) Engine coolant temperature

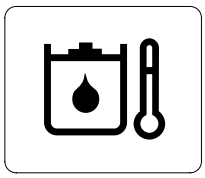


① Engine coolant temperature warning is indicated two steps.
- 103˚C over : The lamp blinks and the buzzer sounds.
- 107˚C over : The lamp pops up on the center of LCD and the buzzer sounds.

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



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

① This warning lamp blinks and the buzzer sounds when the level of fuel is below 61 ℓ (16.1 U.S. gal).

② Fill the fuel immediately when the lamp blinks.

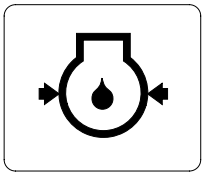
(4) Emergency warning lamp

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.

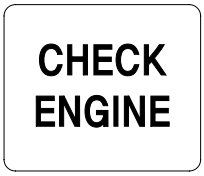
(5) Engine oil pressure warning lamp



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

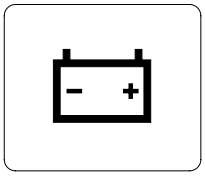


① This lamp blinks when the communication between MCU and engine ECM on the engine is abnormal, or if the cluster received any fault code from engine ECM.

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.

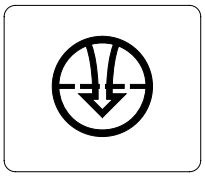
(7) Battery charging warning lamp



① This lamp blinks when the battery charging voltage is low.

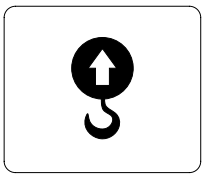
② Check the battery charging circuit when this lamp blinks.

(8) Air cleaner warning lamp



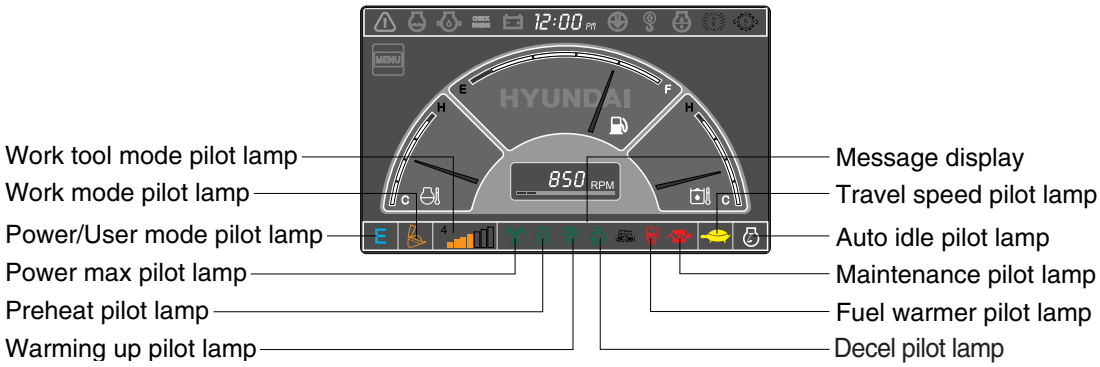
① This lamp blinks when the filter of air cleaner is clogged.
② Check the filter and clean or replace it.

(9) Overload warning lamp (opt)



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



(1) Mode pilot lamps

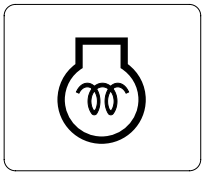
No	Mode	Pilot lamp	Selected mode
1	Power mode	P	Heavy duty power work mode
		S	Standard power mode
		E	Economy power mode
2	User mode	U	User preferable power mode
3	Work mode		General operation mode
			Breaker operation mode
			Crusher operation mode
4	Travel mode		Low speed traveling
			High speed traveling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

(2) Power max pilot lamp

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

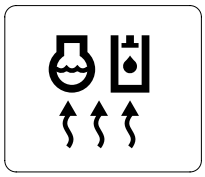
② The power max function is operated maximum 8 seconds.

(3) Preheat pilot lamp



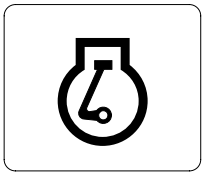
① Turning the start key switch ON position starts preheating in cold weather.
② Start the engine after this lamp is OFF.

(4) Warming up pilot lamp



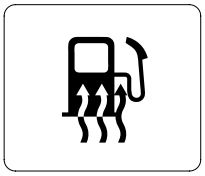
① This lamp is turned ON when the coolant temperature is below 30˚C(86˚F).
② The automatic warming up is cancelled when the engine coolant temperature is above 30˚C, or when 10 minutes have passed since starting the engine.

(5) Decel pilot lamp



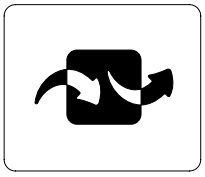
① Operating one touch decel switch on the RCV lever makes the lamp ON.
② Also, the lamp will be ON and engine speed will be lowered automatically to save fuel consumption when all levers and pedals are at neutral position, and the auto idle function is selected.
※ **One touch decel is not available when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

(6) Fuel warmer pilot lamp



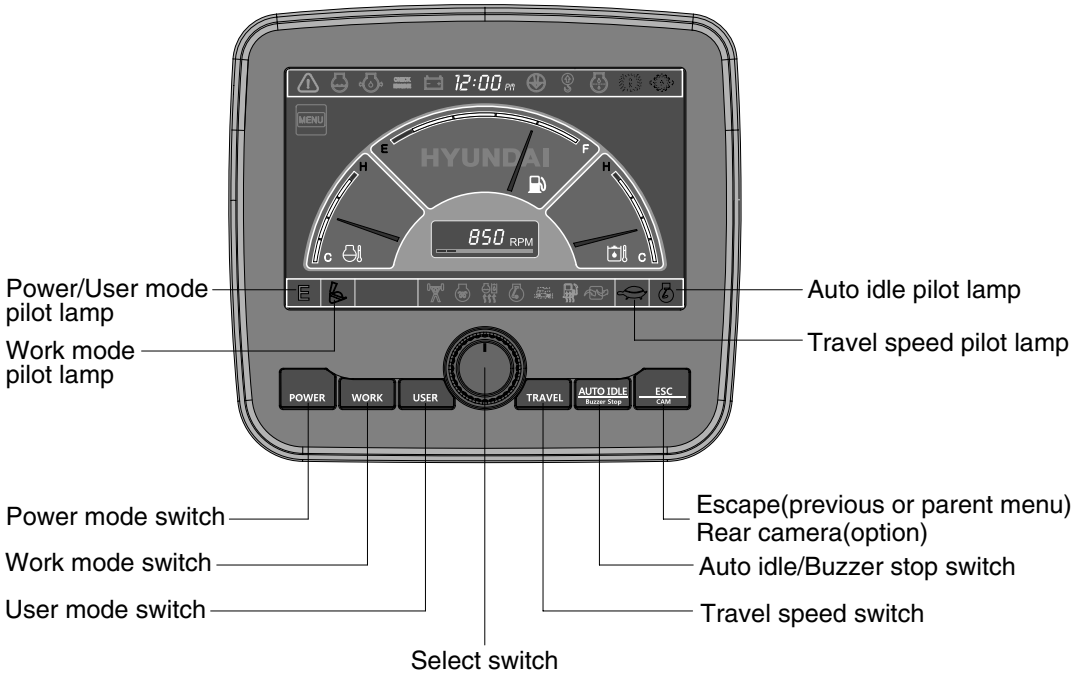
① This lamp is turned ON when the coolant temperature is below 10˚C (50˚F) or the hydraulic oil temperature 20˚C (68˚F).
② The automatic fuel warming is cancelled when the engine coolant temperature is above 60˚C, or the hydraulic oil temperature is above 45˚C since the start switch was ON position.

(7) Maintenance pilot lamp



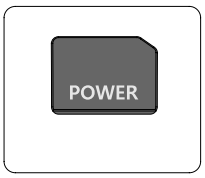
① This lamp will be ON when the consuming parts are needed to change or replace. It means that the change or replacement interval of the consuming parts remains below 30 hours.
② Check the message in maintenance information of main menu. Also, this lamp lights ON for 3 minutes when the start switch is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

5) SWITCHES



※ **When the switches are selected, the pilot lamps are displayed on the LCD. Refer to the page 5-40 for details.**

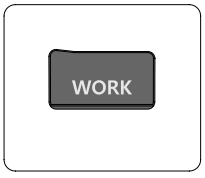
(1) Power mode switch



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.

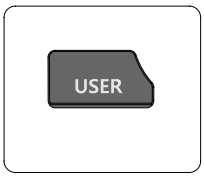
② The pilot lamp changes E → S → P → E in order.

(2) Work mode switch



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.

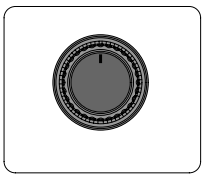
(3) User mode switch



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 5-44 for another set of user mode.

(4) Select switch

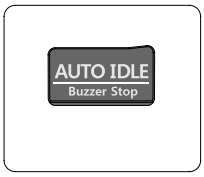


① This switch is used to select or change the menu and input value.

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

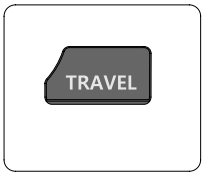
(5) Auto idle/ buzzer stop switch



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.

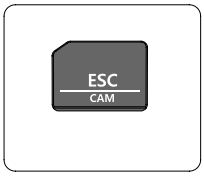
② The buzzer sounds when the machine has a problem.
In this case, push this switch and buzzer stops, but the warning lamp blinks until the problem is cleared.

(6) Travel speed control switch



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

(7) Escape/Camera switch

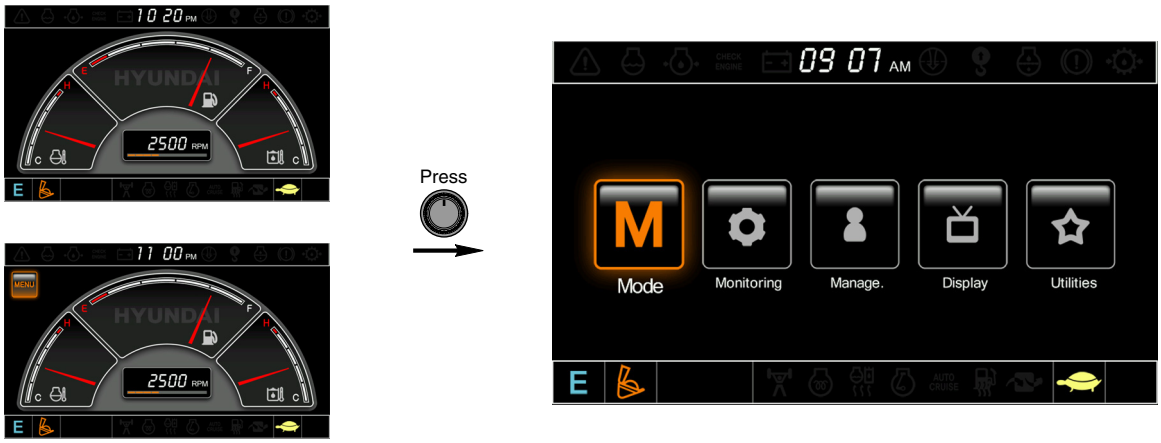


① This switch is used to return to the previous menu or parent menu.

② In the operation screen, pushing this switch will display the view of the camera on the machine (if equipped).
Please refer to page 5-54 for the camera.

③ If the camera is not installed, this switch is used only ESC function.

6) MAIN MENU



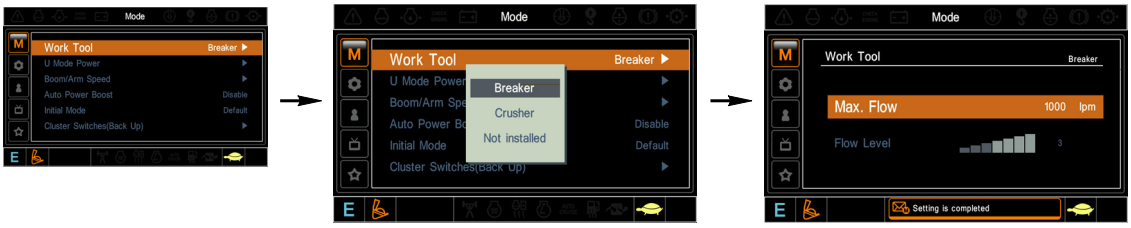
※ **Please refer to select switch, page 5-43 for selection and change of menu and input value.**

(1) Structure

No	Main menu	Sub menu	Description
1	M 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

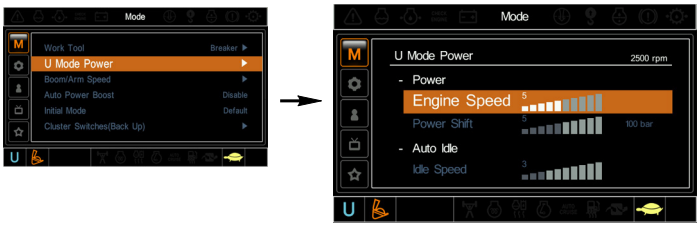


A B

· 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.**

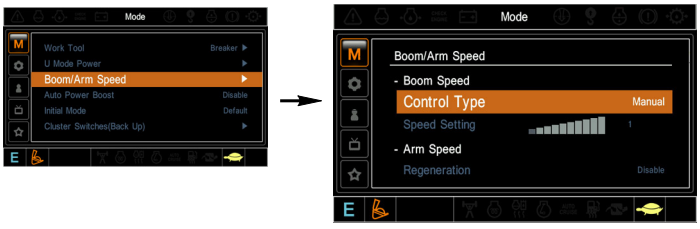
② U mode power



· 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 (▮)	Engine speed (rpm)	Idle speed (rpm)	Power shift (bar)
1	1400	850	0
2	1450	900	3
3	1500	950	6
4	1550	1000	9
5	1600	1050	12
6	1650	1100	16
7	1700	1150	20
8	1750	1200	26
9	1800	1250	32
10	1850	1300	38

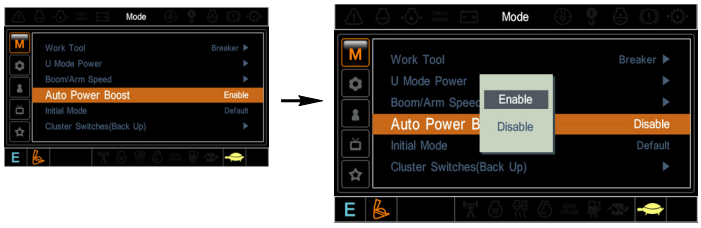
③ Boom/Arm speed



· **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.

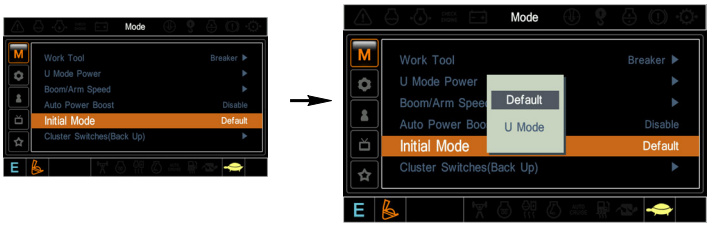
· **Arm speed**
- Regeneration - Arm regeneration function can be activated or cancelled.
Enable - Arm in speed is up.
Disable - Fine operation.

④ Auto power boost



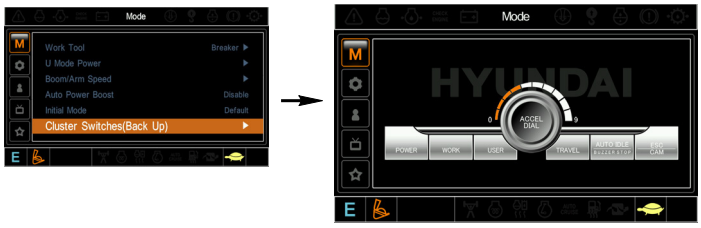
· The power boost function can be activated or cancelled.
· Enable - The digging power is automatically increased as working conditions by the MCU.
It is operated max 8 seconds.
· Disable - Not operated.

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.

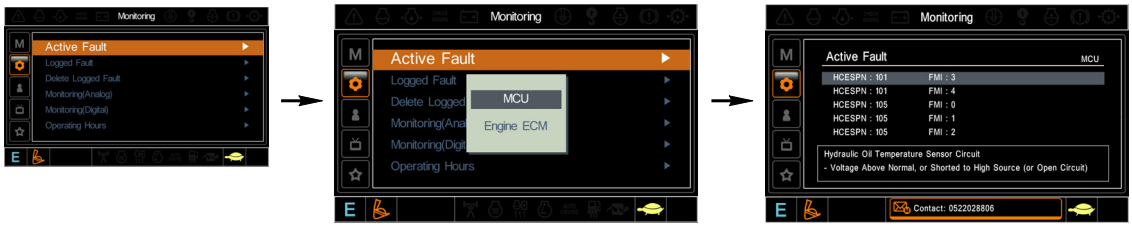
⑥ Cluster switch (back up)



- 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.

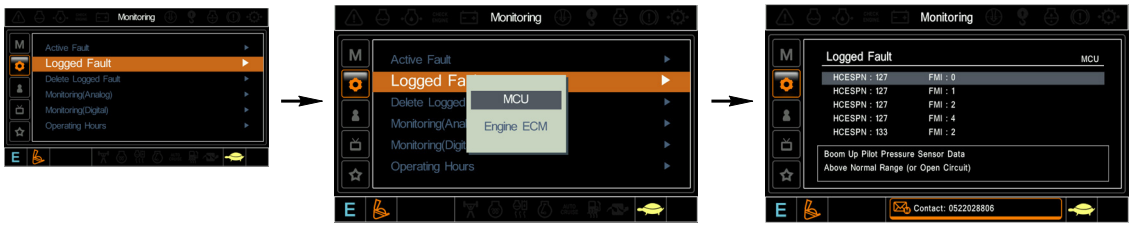
(3) Monitoring

① Active fault



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

② Logged fault

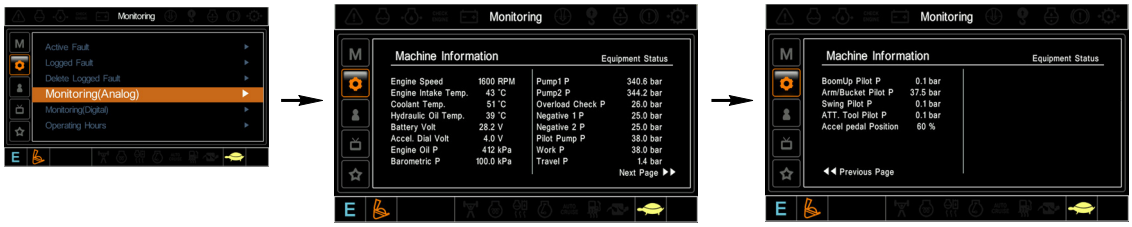


· The logged faults of the MCU or engine ECM can be checked by this menu.

③ Delete logged fault

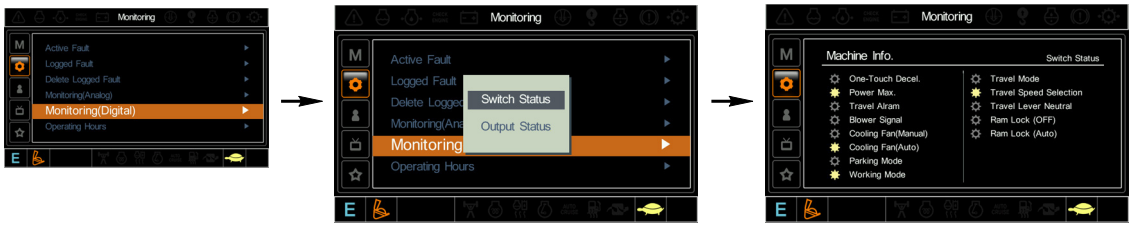
· The logged faults of the MCU or engine ECM can be deleted by this menu.

④ Monitoring (analog)



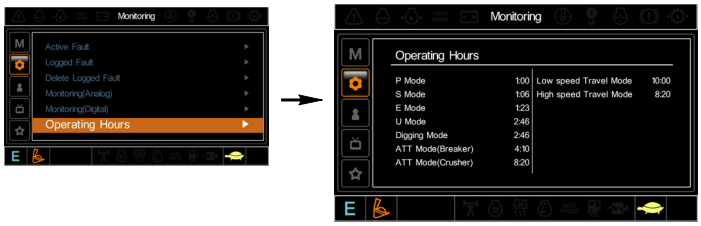
· The machine status such as the engine rpm, oil temperature, voltage and pressure etc. can be checked by this menu.

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.

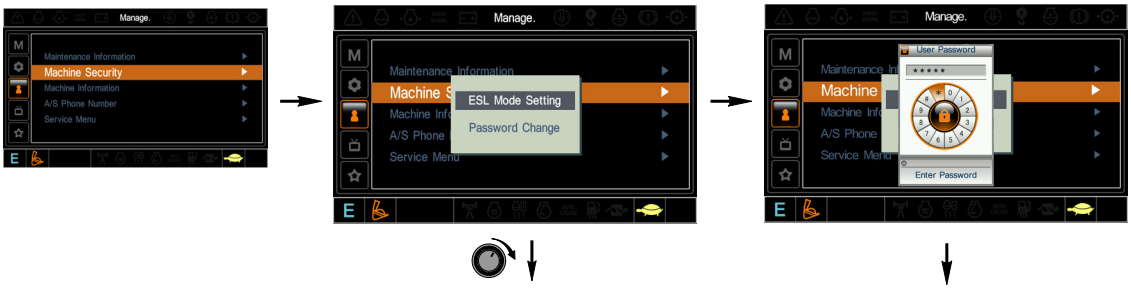
(4) Management

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	2000
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	Pre-filter	500
11	Hydraulic tank breather(filter)	1000
12	Air cleaner (inner)	500
13	Radiator coolant	2000
14	Swing gear pinion grease	1000

② Machine security

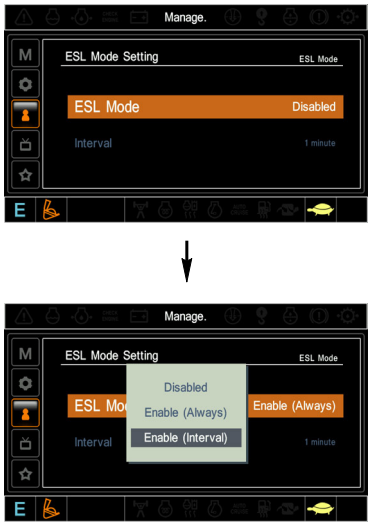


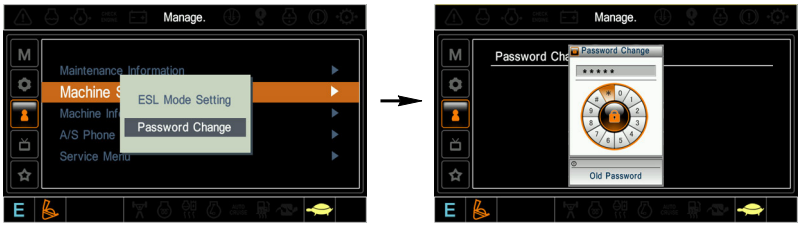
· **ESL mode**

- 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.

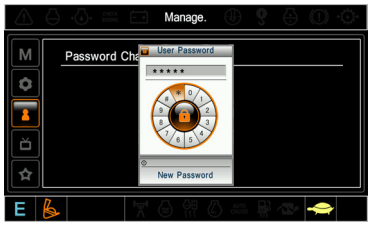




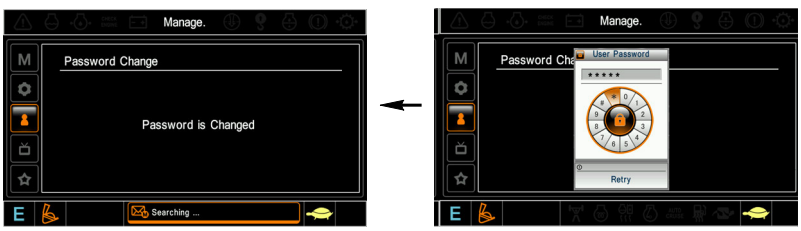
Enter the current password

· **Password change**

- The password is 5~10 digits.



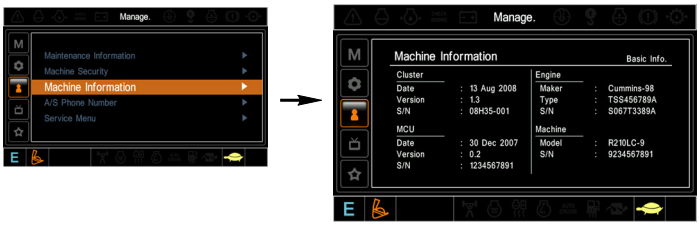
Enter the new password



The new password is stored in the MCU.

Enter the new password again

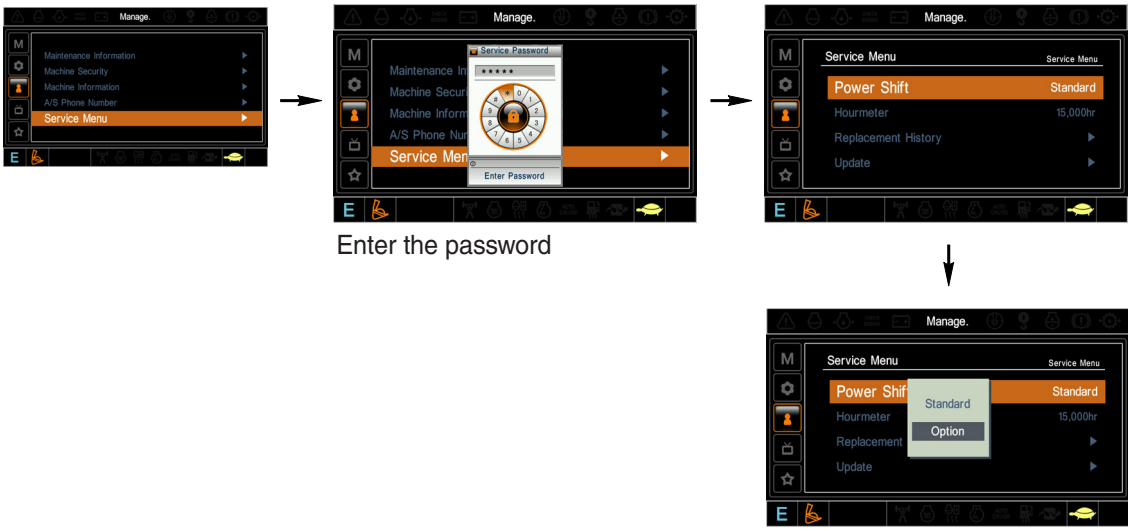
③ Machine Information



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

④ A/S phone number

⑤ Service menu

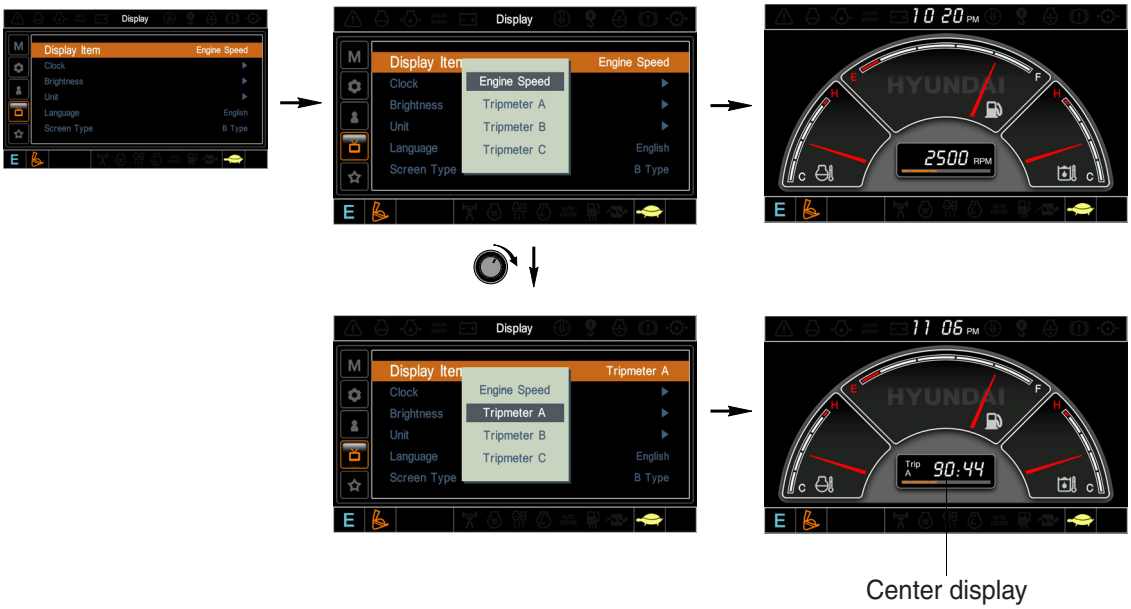


Enter the password

· 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)

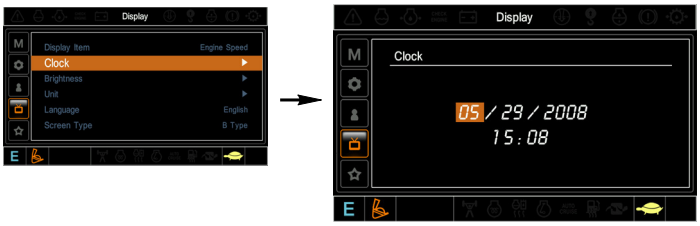
(5) Display

① Display item



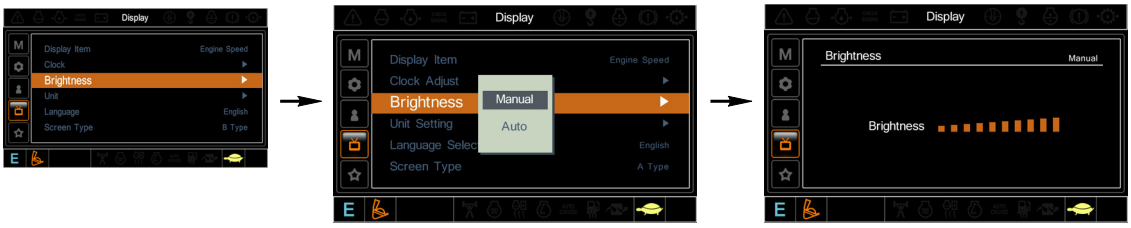
- The center display type of the LCD can be selected by this menu.
- The engine speed or each of the tripmeter (A,B,C) is displayed on the center display.

② Clock

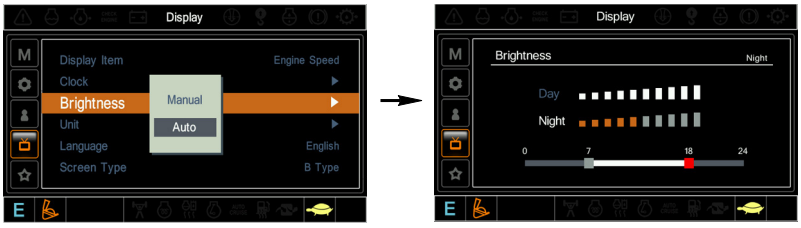


- The first line's three spots "**/**/****" represent Month/Day/Year each.
- The second line shows the current time. (0:00~23:59)

③ Brightness



Manual (1st~10th step)



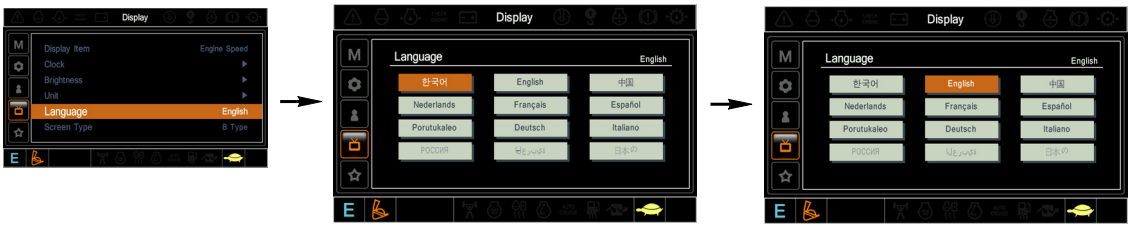
Auto (day/night)

※ 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

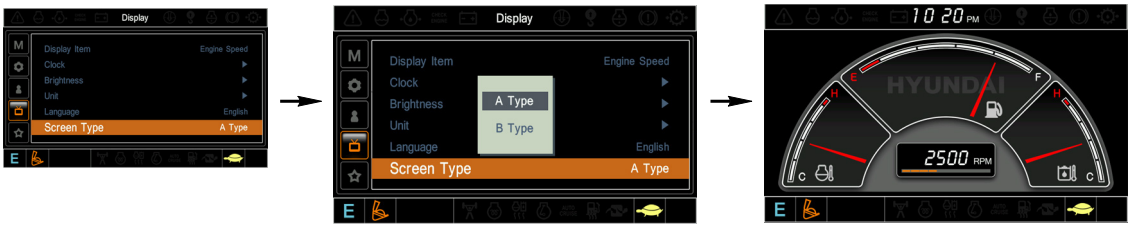
- Temperature : ˚C ↔ ˚F
- Pressure : bar ↔ MPa ↔ kgf/cm²
- Flow : lpm ↔ gpm
- Date format : yy/mm/dd ↔ mm/dd/yy ↔ dd-Mar-yy

⑤ Language



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

⑥ Screen type



A Type

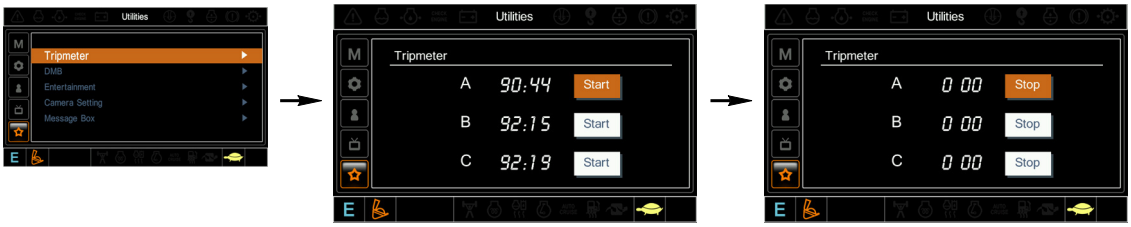
Standard

B Type

Option

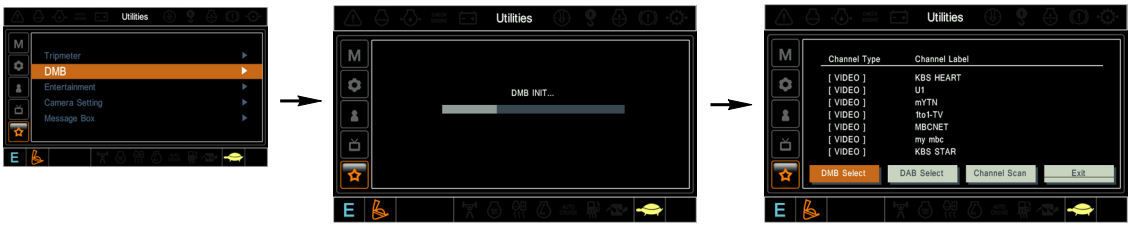
(6) Utilities

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.

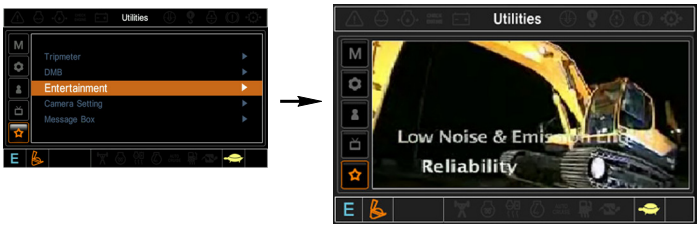
② DMB



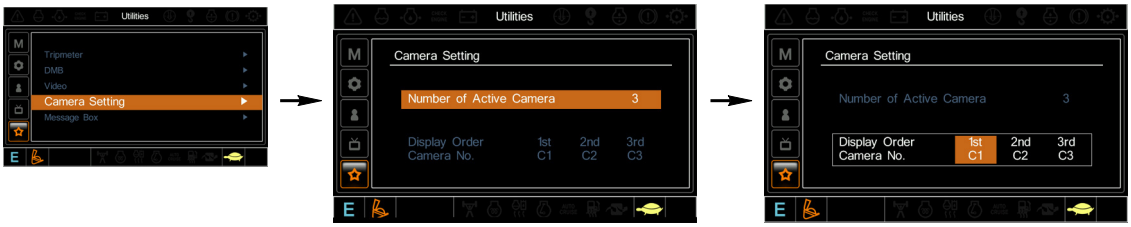
- DMB select : TV channel can be selected by this menu.
- DAB select : Audio channel can be selected by this menu.
- Channel scan : This menu can be used other region for TV/Audio.
- Exit : Exit DMB menu

③ Entertainment

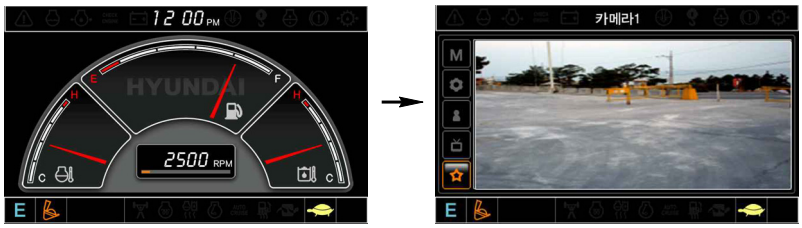
· Play MP4 or codec file of external hard disk through USB port.
· The USB port is located under the cluster.



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.**