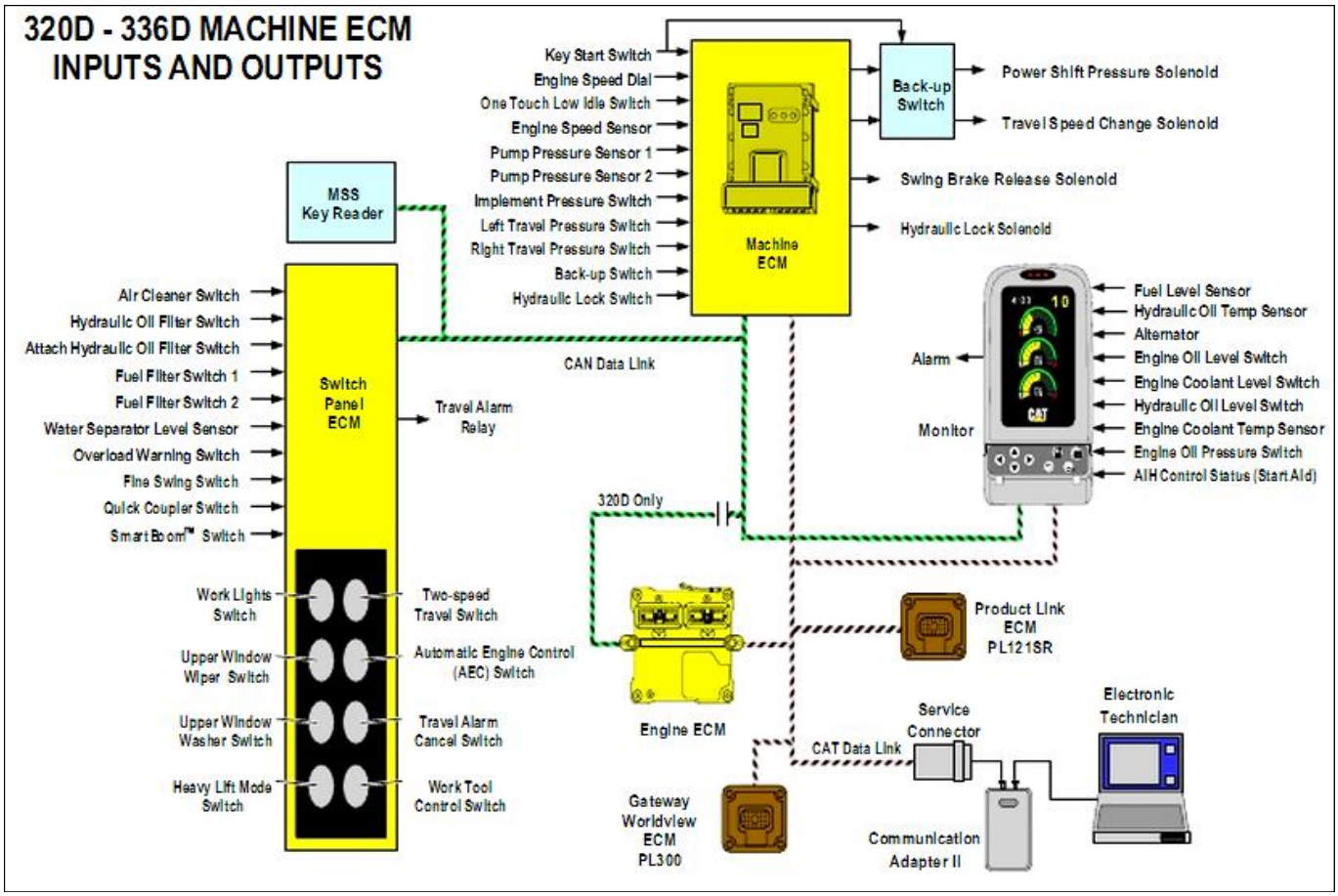


ELECTRONIC CONTROL SYSTEM

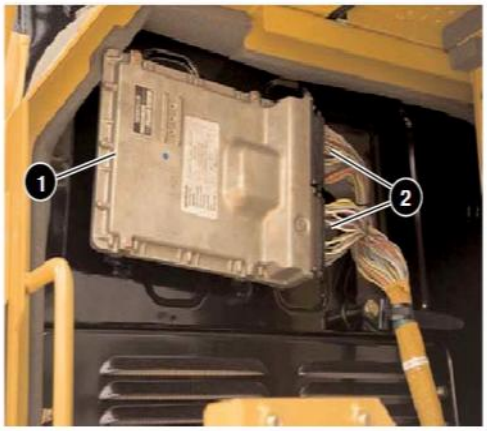
The Electronic Control System controls many of the functions of the 320D-336D Excavators and is pretty much the same system for the 311D to the 345D.

The electronic control system uses two data links to communicate:

- The Engine ECM, the Machine ECM, the monitor, Cat ET, the optional Product Link ECM (PL321SR) , and the Gateway WorldViewer ECM (PL300) communicate via the Cat Data Link.
- The soft switch panel communicates with the Machine ECM and the monitor on the J1939 CAN Data Link. The switch panel is not connected to the Cat Data Link.

For the Machine Security System, the software is part of the Machine ECM. A MSS keyreader provides input into the Machine ECM through the Can Data Link.

Cat ET is used to diagnose system problems via the Cat Data Link. Some of the input and output components of the Machine ECM are also shown in this illustration.



2

The Machine ECM (1) is located on the left side of the machine in the compartment behind the cab.

The inputs and outputs of the Machine ECM connect to the machine harness by two 54 pin connectors (2).

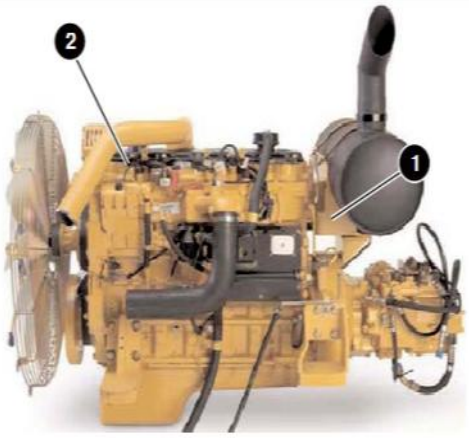
NOTE: The Gateway WorldViewer ECM or PL300 Network Adapter is the hardware that enables Health Watch on Caterpillar Machines equipped with Caterpillar Electronic Control Modules (ECMs). In addition, the 4 switch channels can be used on any machine, Cat or non-Cat, to monitor on board switches. It should also be noted that PL121 must be installed and used in combination with PL300 to enable Heath Watch subscriptions.

PL321 is a combination of the PL300 Network Adapter and the PL121SR Radio.

For some markets, factory installed standardization goes into effect for Product Link. PL321 will be listed as a "required optional attachment."

Health Watch provides:

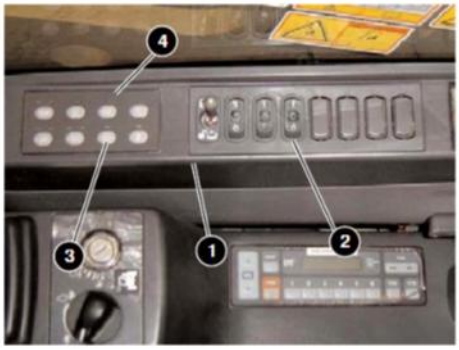
- *Event and Diagnostic Codes, History and Alerts*
- *Event and Diagnostic Code Troubleshooting Procedures*
- *Fuel Level, History and Alerts*
- *Fuel Used, History & Graphic Display*
- *Refueling History*
- *4 Digital Switch Channels*



3

The Engine ECM (1) is mounted to the engine (2).

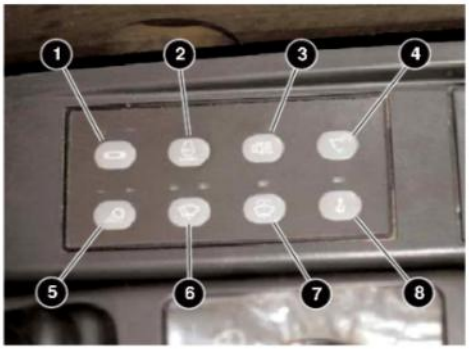
Accessibility to the Engine ECM with the engine in-chassis is limited.



4

The Switch Panel ECM is part of the right console. The Switch Panel ECM is non-flashable through Cat ET.

The Switch Panel ECM (1) receives inputs from rocker type switches (2) and from soft switches (3) in soft switch panel (4).



5

The soft switch panel includes switches that either turn a function ON/OFF or allow the operator to toggle through different modes of the selected function. The soft switches provide the operator with the following functions:

Two-speed travel switch (1): When the button is pushed the travel speed is toggled between low and auto.

- The rabbit indicator indicates auto speed.
- The tortoise indicator indicates low speed.

Automatic Engine Control (AEC) switch (2): The AEC function automatically reduces engine speed while there is no hydraulic demand, which reduces noise and fuel consumption.

- The AEC switch disables and enables the AEC function.
- Initially, AEC reduces the engine speed by 100 rpm after there has been no hydraulic demand for approximately three seconds.
- Then AEC reduces the engine rpm to approximately 1300 rpm after there has been no hydraulic demand for an additional three seconds.
- The additional three second AEC delay time and the low speed of 1300 rpm can be changed using the monitor or Caterpillar Electronic Technician (Cat ET).

Travel alarm cancel switch (3): The travel alarm cancel switch is a momentary two-position switch.

- The travel alarm sounds when travel is detected.
- The travel alarm stops immediately if the travel alarm cancel switch is depressed.
- The travel alarm switch is reset every time the travel pressure switch opens.

Work tool switch (4): The work tool switch will show the selected work tool on the monitor display. Press the switch repeatedly to change the selected work tool. When the desired work tool is highlighted in the monitor display press the "OK" button on the monitor to select the work tool shown.

Work lights switch (5): The work lights switch toggles between the different work light combinations. Two different work light patterns are available.

- **Pattern 1:** Chassis work lights and cab work lights
- **Pattern 2:** Chassis work lights, cab work lights, and boom work lights

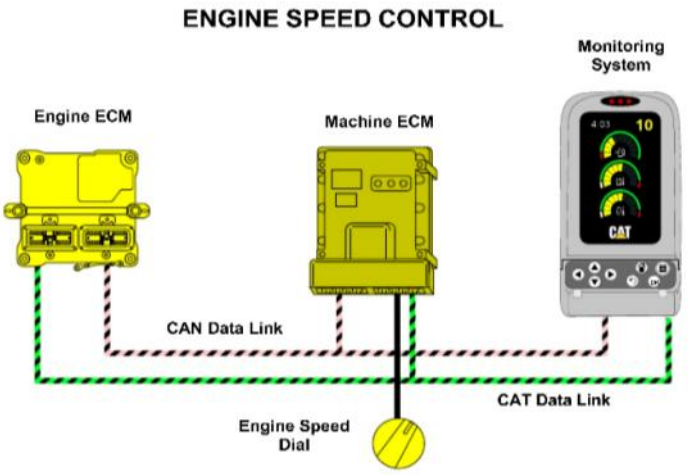
Upper window wipers switch(6): The wiper switch toggles between the following different modes of the wipers.

- six second delay
- three second delay
- continuous operation
- off

Upper window washer switch(7): The windshield washer fluid switch is an ON/OFF switch.

Heavy lift mode switch (8): The Heavy lift mode switch can be selected to increase lifting capability and provide improved controlability of heavy loads.

- When heavy lift is turned on, the main relief valve maximum pressure increases from 35,000 MPa (5080 psi) to 36,000 MPa (5225 psi), making it possible to operate at the system at a higher pressure.
- In Heavy Lift Mode, the maximum engine speed is limited to engine speed dial 6 (1510 ± 90 rpm).
- Hydraulic horsepower maximum output is reduced to 60%.

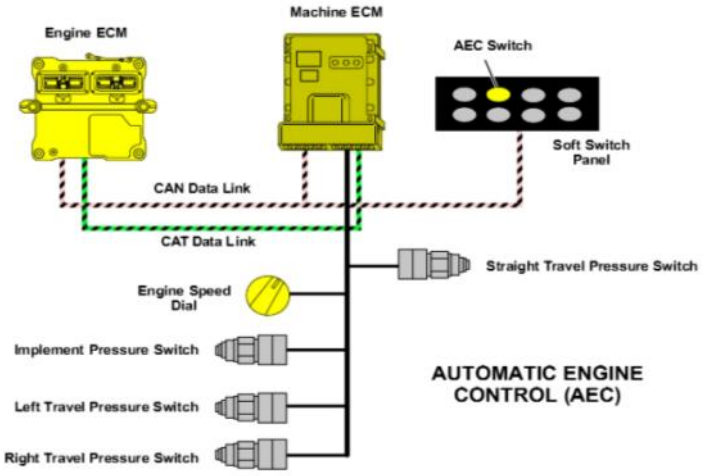


6

Engine Speed Control

The Machine ECM converts the signal from the engine speed dial into a pulse width modulated (PWM) signal. The information is then sent to the Engine ECM over the Cat Data Link.

The engine speed dial is divided into 10 positions. The dial position is displayed on the character display of the monitor panel.



7

Automatic Engine Speed Control (AEC)

The Automatic Engine Speed Control (AEC) automatically reduces engine speed when the machine is inactive or under low load. The AEC system is designed to reduce fuel consumption and noise. Lower engine speeds can also increase engine life.

The engine speed dial, the AEC switch, the implement pressure switch, the left travel pressure switch, the left right pressure switch, and the straight travel pressure switch send input signals to the Machine ECM. The Machine ECM processes the input signals and sends corresponding output signals to the Engine ECM to control the engine speed.

The AEC system will be inoperable while the backup switch of the electronic controller system is in the MAN position.

The engine rpm will recover automatically to the setting of the engine speed dial when any hydraulic function is activated. The AEC system operates in three modes

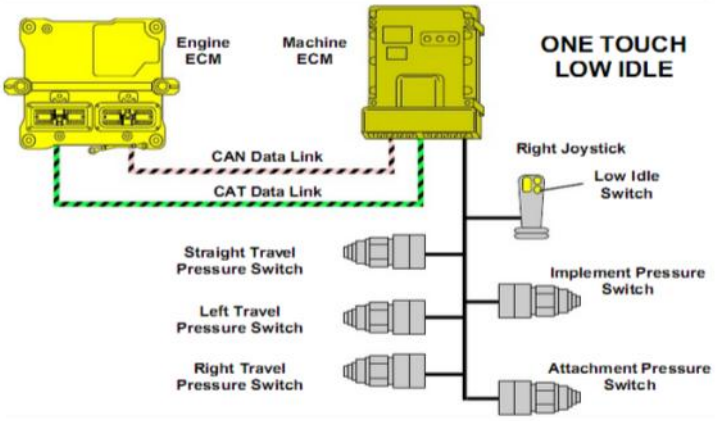
The AEC is set by the AEC switch. The switch indicator will illuminate during the second setting of the AEC. The second setting of the AEC is available immediately after the engine start switch is turned to the ON position. The AEC can be set in the first stage and the second stage by alternately pressing the switch.

- The First Stage Mode of the AEC will lower the speed setting of the engine speed dial by approximately 100 rpm in the "no load" condition. The speed setting dial must be between 5 and 10. The position of the AEC switch is OFF.

- The Second Stage Mode of the AEC will reduce the engine speed to approximately 1300 rpm in the "no load" condition. The speed setting dial must be between 5 and 10. The position of the AEC switch is ON.

- The Manual Low Idle Mode is also called one touch low idle and is explained in more detail on the next page. The speed setting dial must be between 3 and 10, while the position of the AEC switch can be either ON or OFF.

NOTE: *When the main back-up switch is turned to the ON position (Manual), the AEC function is disabled.*



One Touch Low Idle

When the one touch low idle switch is pressed and the machine is not under a load, the engine speed can be lowered by more than the speed setting of the AEC Second Stage Mode. When normal operations have resumed, the engine speed for the dial setting will return to the corresponding rpm.

The one touch low idle feature will activate during all "stopped" conditions of the implement, swing, travel, and tools.

The following components are in the OFF position: the implement pressure switch, the left travel pressure switch, the right travel pressure switch, the straight travel pressure switch, and the attachment pedal pressure switch. However, when the one touch low idle switch is pressed, the Machine ECM will signal the Engine ECM to lower the engine speed to engine speed dial setting 2 setting, which is approximately 1020 rpm.

The one touch low idle overrides the AEC.

The one touch low idle will be released when any of the following conditions occur:

- The one touch low idle switch is pressed again.
- The implement pressure switch is set to the ON position.
- The travel pressure switch is set to the ON position.
- A pressure switch that is related to a tool is set to the ON position.

The engine speed is different after the switch has been released. The different speed will depend on the conditions of the release.

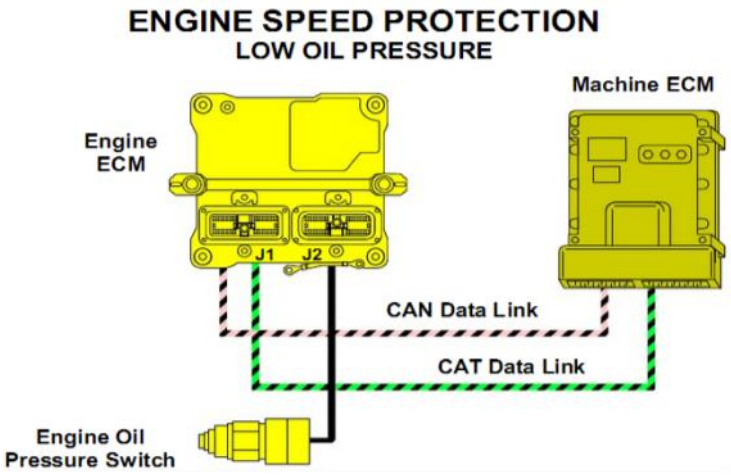
- The engine speed will be set to the setting of the engine speed dial, when the feature for one touch low idle has been released by an operation of the implement, swing, etc..

- The engine speed will be set by the AEC. The speed will be set when the one touch low idle has been released. The engine speed will be affected by the following conditions:

  - When the AEC First Stage Mode setting is selected, the engine speed is set to the speed of the AEC First Stage Mode. The engine speed is approximately 100 rpm lower than the setting of the engine speed dial.

  - When the AEC Second Stage Mode setting is selected, the engine speed will be set to the speed of the AEC Second Stage Mode setting. The engine speed is approximately 1300 rpm.

  - The engine speed will be set to the speed of the engine speed dial if the engine speed is lower than the AEC Second Stage Mode. The setting of this speed is not based on a setting of the AEC.



Engine Speed Protection

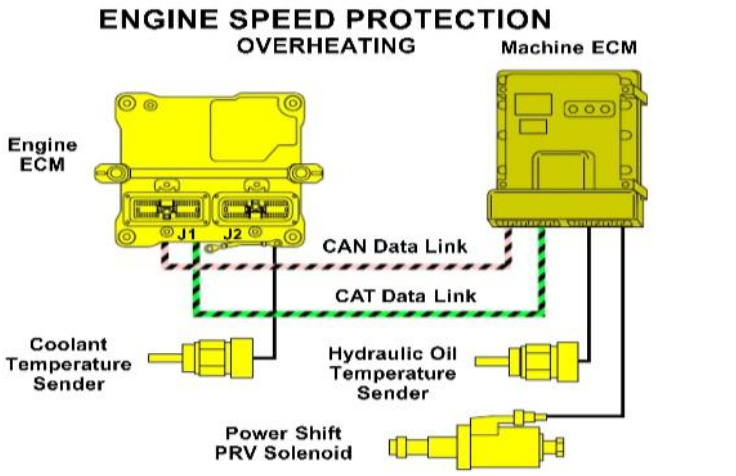
The electronic control system provides three different engine protection functions:

Engine speed protection due to low engine oil pressure: is designed to prevent the engine from starting at a high speed during a low oil pressure condition.

For example, after the engine oil filter is replaced, the engine may need to run for a short time to fill the engine oil filter. During this time the engine oil pressure will remain low. Engine damage may occur if the engine runs at a high speed dial position with low oil pressure.

The Engine ECM senses the status of the engine oil pressure switch. With low engine oil pressure the pressure switch is open.

The Engine ECM will automatically limit the engine speed to speed dial position 5.



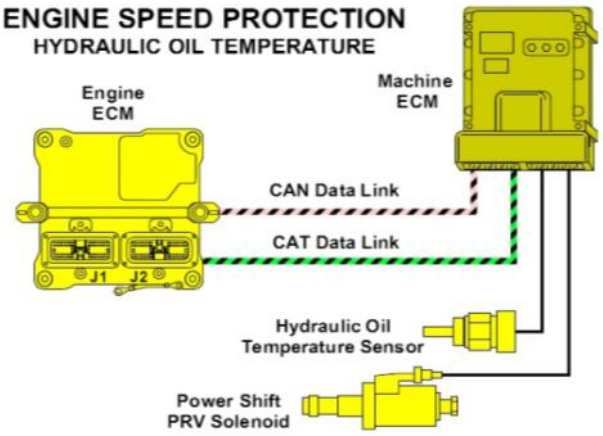
Engine speed protection during an overheating condition: prevents damage to the engine caused by overspeed during an overheating condition.

The Engine ECM receives input from the coolant temperature sender and communicates this information to the Machine ECM. The Machine ECM receives input from the hydraulic oil temperature sender.

If the Machine ECM senses on overheating condition has occurred, the Machine ECM will send a signal to the power shift PRV solenoid to destroke the pump and a signal to the Engine ECM to reduce the engine speed.

The engine speed will be decreased to the Second Stage Mode setting of the AEC (1300 rpm).

Work that requires high pressure will be restricted during an overheating condition. The engine and other components are protected during this condition.



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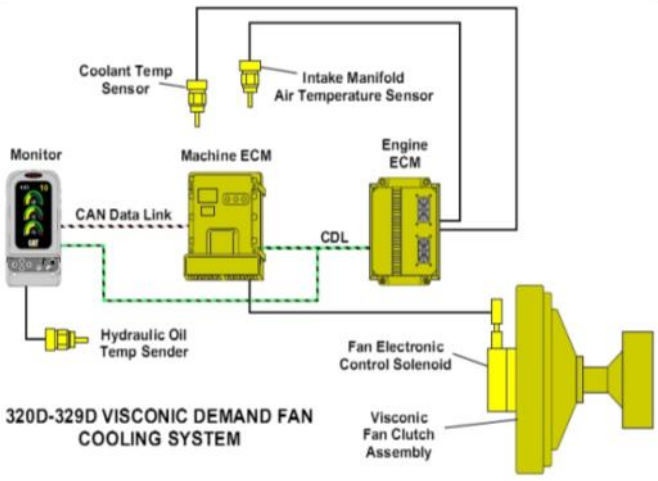
Control of the hydraulic oil at low temperatures: occurs when it is cold and the temperature of the hydraulic oil is low, the machine may not operate smoothly.

The hydraulic oil temperature sensor signals the Machine ECM as to the hydraulic oil temperature.

When the hydraulic oil temperature sensor has detected an oil temperature below 15° C (59° F) the Machine ECM sends a signal to the power shift PRV solenoid in order to limit the hydraulic pump output pressure to 80% of the maximum hydraulic horsepower. Engine speed is maintained.

This reduction allows for smoother machine operations until the temperature of the oil rises.

As the hydraulic oil temperature rises to above 20° C (68° F), the Machine ECM will allow for normal control of the main hydraulic pumps, by changing the signal to the power shift PRV solenoid.



12

Visconic Demand Fan Cooling System

The 320D-329D Hydraulic Excavators can be equipped with an electronically controlled, viscous coupled demand fan. The speed of the engine cooling fan is controlled by the Engine ECM in relation to engine coolant temperature, inlet manifold air temperature, and hydraulic fluid temperature.

A viscous coupling fan clutch is used between the engine mounted, belt driven fan drive hub and the fan assembly. Inside the visconic coupling, a high viscosity, temperature stable, silicon fluid provides a means of coupling and uncoupling the fan to the fan input hub.

When the machine is running, the hydraulic oil temperature sender and the engine coolant temperature sensor sends signals to the Engine ECM. The Engine ECM then sends this information to the Machine ECM. The Machine ECM picks up the hydraulic temperature through the monitor. The Machine ECM interprets the information from these inputs to send a PWM signal to the fan electronic control solenoid to control the demand fan clutch.

A higher temperature input will cause the Machine ECM to send a reduced PWM signal to the fan electronic control solenoid.

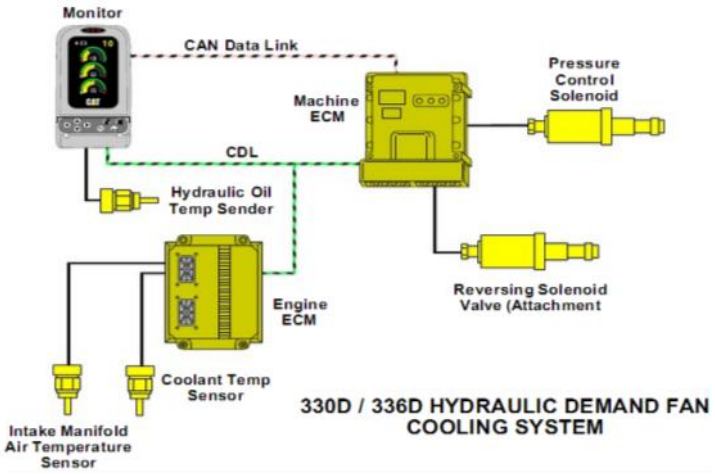
The reduced PWM signal causes the fan clutch to move toward full engagement to increase the fan speed for more cooling capacity. With the minimum PWM signal the fan will turn at the engine speed.

If only one sensor is reporting a high temperature, or need for increased cooling, the ECM will reduce the current to the fan control coil by a predetermined percentage of the fan speed map and the fan speed will increase.

The Engine ECM monitors the speed of the fan blade by use of a Hall Effect type sensor built into the center of the electronic fan control. A ring magnet and bolt is installed in the drive assembly at the center of the fan control coil. The ring magnet and bolt will rotate at fan speed and provide an input to the speed sensor. The fan speed sensor is supplied a 5 volt reference signal and returns a square wave frequency signal to the Engine ECM.

If no fan speed signal is supplied to the Engine ECM by the fan speed sensor the fan will default to maximum fan speed.

NOTE: The visconic demand fan can not rotate in reverse, even though Cat ET and the Monitor display parameters for a reversing fan.



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Hydraulic Demand Fan Cooling System

The hydraulic demand fan is standard on the 330D/336D Hydraulic Excavators. The fan is part of the hydraulic system, but it is controlled by the Machine ECM.

The intake manifold air temperature sensor and the coolant temperature sensor are inputs into the Engine ECM. The Engine ECM provides information to the Machine ECM from these two sensors. The Machine ECM also receives information from hydraulic temperature sensor through the monitor.

The Machine ECM evaluates these three sensor inputs for controlling the fan. A target speed for the cooling fan is assigned for each engine speed based on the output of the various temperature sensors. The target values for the maximum fan speeds are assigned by specific software designed for the 330D/336D machine models.

The Machine ECM sends a PWM signal to the fan pump proportional solenoid to control the flow from the pump. The pump flow is directed to the fan motor, to rotate the motor, which causes the fan to turn to provide engine cooling.

When engine coolant and/or hydraulic oil temperatures are high, the fan speed is increased. If the temperatures are low, the fan speed is decreased. The higher the ambient temperature, the higher the fan speed, as well.

For high temperature readings the Machine ECM sends the minimum software controlled PWM signal to the fan pump pressure control solenoid to upstroke the hydraulic pump to increase the pump flow.

When maximum pump flow is sent to the the fan motor, the fan rotates at the maximum software controlled rpm.

For lower temperature readings, such as machine startup or while idling, the Machine ECM will send higher PWM signals to the fan pump pressure control solenoid to cause the pump to destroked to produce pump flow, which results in lower fan speeds.

Cat ET or the monitor can be used to check or calibrate the fan speed. Refer to the 330D/336D Test and Adjust Manual for the calibration procedures.

Maximum mechanical pump pressure and maximum fan speed (high pressure cut-off) can be achieved by disconnecting the electrical connection to the solenoid or by using Cat ET to turn OFF the fan control (Engine ECM/Configuration screen).

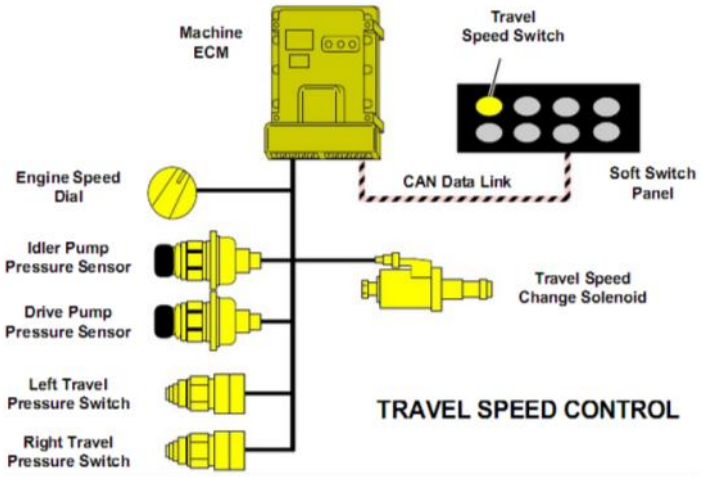
If communication is lost between the Engine ECM and the fan pump pressure control solenoid, the fan will default to the maximum mechanical pressure setting (high pressure cutoff). This action results in a higher system pressure. This pressure is higher than the maximum pressure controlled through the software. The fan speed is also higher than the maximum fan speed normally controlled by the software.

On machines equipped with the reversing fan attachment, the Machine ECM also controls the reversing fan solenoid valve.

A bi-directional fan motor will replace the standard fan motor with the reversing fan feature. Operation of the fan pump and motor makeup valve is as previously discussed.

The Machine ECM will automatically activate the fan reversing solenoid valve at predetermined intervals, if the machine is equipped with the optional reversing fan. Fan reversing duration may be re-configured using Cat ET or through the monitor.

When the reversing solenoid valve is energized, pilot oil is directed to the reversing spool. The reversing spool shifts causing the flow of oil to the fan motor to be reversed. The fan motor rotates in the opposite direction.



14

Travel Speed Control

There are two travel speed modes, Low Speed (Tortoise) and High Speed (Rabbit). By selecting the "Tortoise" Mode, travel speed is limited to the low travel speed. By selecting the "Rabbit" Mode, travel speed will change automatically between low/high speeds. The change in travel speed is dependent on the supply pressure of the pumps.

The travel speed switch, the implement pump pressure sensors, the engine speed dial, and the left and right travel pressure switches send input signals to the Machine ECM. The Machine ECM processes the input signals and sends a corresponding output signal to the travel speed change solenoid to control travel speed.

The travel mode selector switch and travel mode indicators (tortoise and rabbit) are located on the switch panel. When the travel mode selector switch is pressed, the travel mode can be set to the Rabbit Mode or set to the Tortoise Mode. The indicator (tortoise or rabbit) is illuminated to show the travel mode that is chosen.

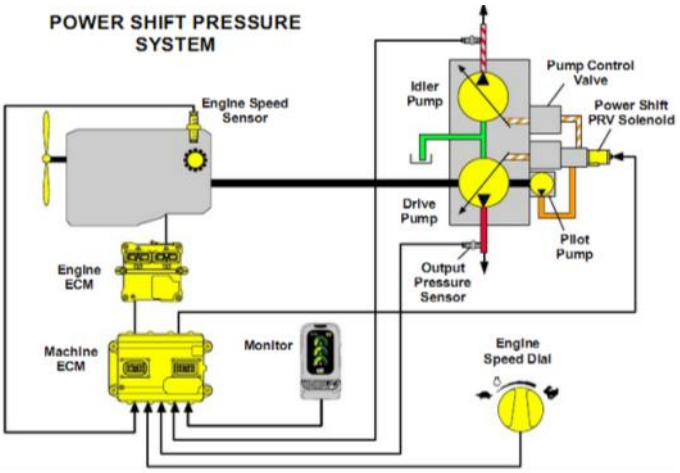
When the machine is first turned on the machine is in the Tortoise Mode. To select the Rabbit Mode, press the travel mode selector switch. While the circuit pressure at the pump output remains below a certain range, the machine will travel in HIGH (rabbit) speed.

The output pressure of the pump increases as the load on the machine increases. When the output pressure increases to a certain high level, the machine will automatically shift to travel in the Tortoise Mode and the machine will slow down. More torque will be available for traveling up slopes, for instance.

The machine will automatically return to the Rabbit Mode when the pump output pressure decreases to the predetermined range.

The automatic travel speed change function allows the machine to adjust speeds without direct operator input. The machine will travel at HIGH speed under a light load and travel at LOW speed under a heavy load. This function ensures that the machine has high mobility and a high drawbar pull.

When the travel is set to the Tortoise Mode, the travel is set at low speed and does not change.



15

Pump Regulation

Power shift pressure is controlled by the Machine ECM, and assists in pump regulation. Power shift pressure is one of three pressures to control the pump.

The pilot pump supplies the power shift PRV solenoid with pilot oil. The Machine ECM monitors the selected engine speed (from the engine speed dial), the actual engine speed (from the engine speed sensor and Engine ECM), and the pump output pressures (from the output pressure sensors). The power shift PRV solenoid valve regulates the pressure of the power shift oil depending upon the signal from the Machine ECM to the pump control valve groups.

When the engine speed dial is in position 10, the Machine ECM varies the power shift pressure in relation to the actual speed of the engine.

The power shift pressure is set to specific fixed values dependent upon the position of the engine speed dial. The fixed power shift pressures assist cross sensing pressure (not shown) with constant horsepower control.

When the engine speed dial is on position 10 and a hydraulic load is placed on the engine, this condition causes the engine speed to decrease below the engine's target rpm.

When this decrease occurs, the Machine ECM signals the power shift PRV solenoid valve to send increased power shift pressure to the pump control valve groups. The increased power shift signal causes the pumps to destroke, and reduce the horsepower demand placed on the engine. With a decreased load from the hydraulic pumps the engine speed increases. This function is referred to as engine underspeed control.

Engine underspeed control prevents the engine from going into a "stall" condition where engine horsepower cannot meet the demands of the hydraulic pumps. The power shift signal to the pump control valve groups enables the machine to maintain a desired or target engine speed for maximum productivity.

Power shift pressure has the following effect on the main hydraulic pumps:

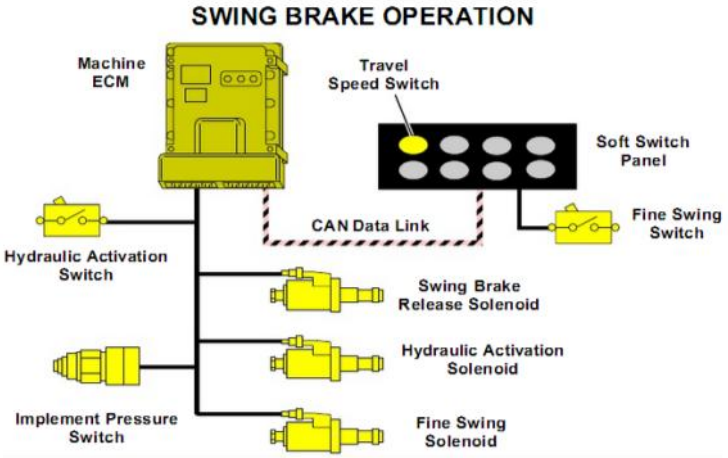
- As power shift pressure decreases, pump output increases.
- As power shift pressure increases, pump output decreases.

Power shift pressure ensures that the pumps can use all of the available engine horsepower for the hydraulic system at all times without exceeding the output of the engine.

NOTE: *The target rpm is the full load speed for a specific engine "no load" rpm. Engine target rpm is determined by the opening of one of the implement, swing, and/or travel pressure switches at the end of an operation. The Machine ECM then waits 2.5 seconds and records the engine speed. This specific rpm is the "new" no load rpm.*

The Machine ECM then controls the power shift pressure to regulate pump flow to maintain the full load (target) rpm for the recorded no load rpm.

Target rpm can change each time the pressure switches open for more than 2.5 seconds.



16

Swing Brake Operation

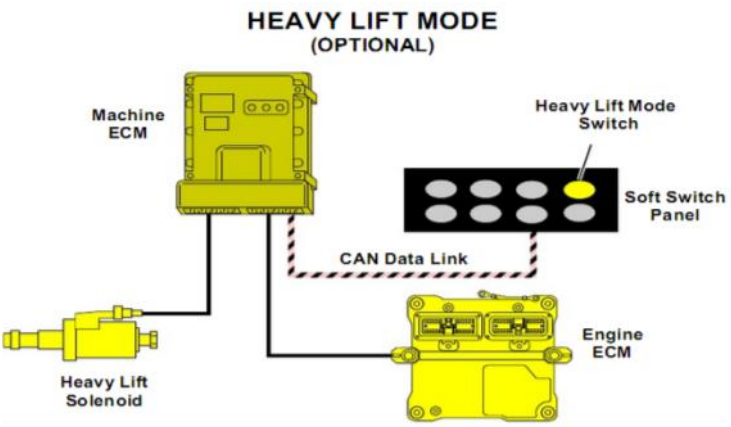
This machine is equipped with a swing lock system that is controlled by the Machine ECM. The swing lock system control circuit provides control for the swing motor, swing brake, fine swing function, and back-up system of the machine.

The swing brake solenoid is controlled by the implement pressure switch through the Machine ECM. When the implement pressure switch closes, the Machine ECM energizes the swing brake solenoid. When the implement pressure switch opens, the swing brake solenoid is de-energizesd by the Machine ECM 6.5 seconds later. The de-energized swing brake solenoid allows the machine upper structure to come to a complete stop before the swing brake is engaged. The hydraulic activation lever must be in the activated (UP) position before the spring brake solenoid will energize.

If the main back-up switch is placed in the Manual position, then the swing brake is electrically released.

The fine swing function (optional) provides smooth start and stop operation during swing movement.

When the fine swing switch is activated, a signal is sent to the soft switch panel which sends a signal to the Machine ECM. The Machine ECM energizes the fine swing solenoid to activate the fine swing feature.



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Heavy Lift Mode

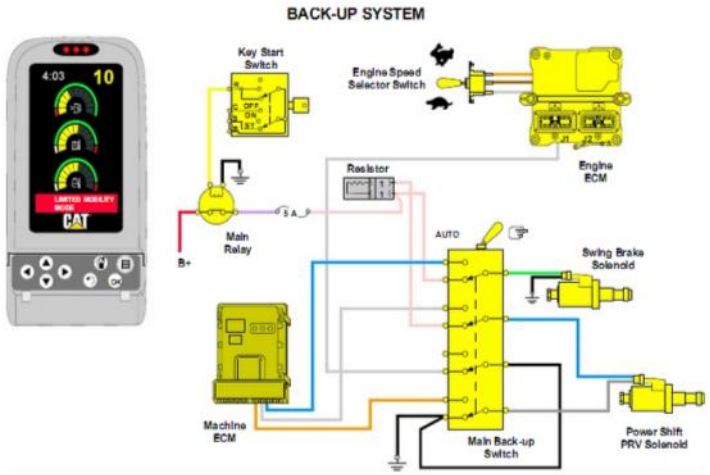
Press the heavy lift switch on the soft switch panel, in order to turn the Heavy Lift Mode ON or OFF. When the Heavy Lift Mode is turned ON, the indicator will illuminate and the Machine ECM will energize the heavy lift solenoid.

When the "Heavy Lift Mode is turned ON, the main relief pressure increases from 35 MPa (5100 psi) to 36 MPa (5200 psi).

The Machine ECM will send a signal to the Engine ECM to control the engine rpm.

However, due to the flow restriction, the maximum engine speed is limited to approximately 1600 rpm, which is equivalent to engine speed dial position "6".

The hydraulic output is restricted to 64% of the maximum flow.



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Backup System

The "Backup System" or The Limited Mobility Mode allows the operator to maneuver the machine to the shop when the Machine ECM has failed. Excavating operations are not possible if the machine is in the Limited Mobility Mode.

The main backup switch is located behind the right arm rest. When the main back-up switch is turned to the MAN position, the power to the Machine ECM is removed, and the "Limited Mobility Mode" is activated. In Limited Mobility Mode, the the joysticks and the engine speed dial do not function.

The engine speed can be adjusted by the engine speed selector switch which is located next to the main back-ups switch. The switch provides an input into the Engine ECM.

Also, the AEC switch and the low idle switch will not function. The Monitoring System will display the message "LIMITED MOBILITY MODE" and the Monitoring System will sound the action alarm.

When the main backup switch is moved to the MANUAL position, power from the main relay is directed through to the resistor and to send a reduced signal to the power shift PRV solenoid.

The power shift PRV solenoid is "double switched" to energize. The solenoid return is switched to ground.

Power through the resistor is directed to the swing brake solenoid valve to energize the solenoid. With the swing brake solenoid energized, the swing brake is released.

The change of the machine backup switch is sensed by the Engine ECM. When the Engine ECM senses this change in the state, the engine ECM will accept input from the engine speed selector switch. The switch is used to increase or decrease the engine speed.

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Behind the right armrest is the main backup switch (1) to select AUTO or MANUAL engine speed control and the engine speed selector switch (2) to adjust engine speed.

By utilizing these switches, the engine speed can be controlled manually by the operator or the engine speed can be controlled automatically by the ECMs.

When the Machine ECM is functioning properly the main backup switch should be in the down or Auto position.

If a problem occurs with the Machine ECM, move the main back-up switch to the up or Manual position in order to bypass the Machine ECM. In this condition, the machine can be operated at a reduced ratio of pump output on a temporary basis. "Limited Mobility Mode" will appear on the message display.

When the main backup switch is in Manual:

- Move the engine speed selector backup switch up to increase the engine rpm.

- Move the engine speed selector backup switch down to decrease the engine rpm.

When the switch is released the switch returns to the NEUTRAL position and the machine will maintain the engine speed. This switch overrides the function of the engine speed dial.

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MONITOR

The 300D monitor has been updated. The new monitor is used on the 308D, 311D, 312D, 314D,3 315D, 319D, 320D, 321D, 323D, 324D, 325D/329D, 328D, 330D/336D, 345C, 365C, and the 385C hydraulic excavators.

The monitor is a full color Liquid Crystal Display (LCD) that displays the various parameters of the machine. Shown above are the:

- alert indicator (1)

- clock (2)

- fuel gauge (3)

- hydraulic oil temperature gauge (4)

- engine speed dial indicator (5)

- engine coolant temperature gauge (6)

- operating hours (7)

- work tool indicator (8)

The monitor uses eight buttons to control navigation on the monitor screen. The four directional button are:

- left (1)

- up (2)

- down (3)

- right (4)

The directional buttons navigate the cursor through the various screens.

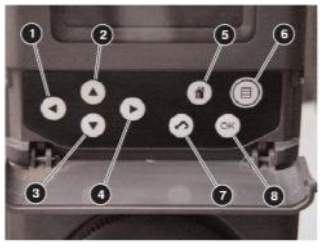
The four navigational buttons are:

- home (5)

- menu (6)

- back (7)

- OK (8)



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CONCLUSION

This presentation has provided information for the Caterpillar 320D-336D Hydraulic Excavators.

This presentation covered the electronic control system and the monitor.

Additional presentations are available for each system used on these machines.

When used in conjunction with the service manual, the information in this package should permit the technician to do a thorough job of analyzing a problem in these systems.

For service repairs, adjustments, and maintenance, always refer to the Operation and Maintenance Manual, Service Manuals, and other related service publications.