C6.6 & C4.4 with ACERT® Technology

Name

Date

Company

E-mail

Tel.

From the library of Barrington Diesel Club
Important

- The product training information is distributed for informational purposes only. It is not to be construed as creating or becoming part of Cat contractual or warranty obligations.
- This presentation must be printed in notes page format, with the speaker notes showing, which contain essential additional information.
- The appropriate service literature, should always be the final authority and source of information.
C6.6 & C4.4 ACERT Benefits

- Installed Package
  - Engine Size
  - Cooling Pack

- Cost of Ownership
  - Fuel Economy
  - Service Period

- Environment
  - Emission compliant
  - Filtration

- Electronic Functionality
  - Machine Integration

- Refinement
  - 3 dBA Noise Reduction
  - Quality of Noise
  - Low Vibration

- Ratings
  - Power
  - Torque

- Product Functionality
  - Cold Start
  - Fuel Compatibility
  - PTO

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Electronically assisted

- To create....
  - Lower emissions
  - Better fuel consumption
  - Versatile control
<table>
<thead>
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<th>S/N Prefix Nomenclature</th>
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<tr>
<td>3054E</td>
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<tr>
<td>Ind.</td>
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• For ratings above 250hp see ERM for detail of applications and usage

• Ratings above 286hp/213kW are not currently planned with Stage 3a emissions certification

• Revise the slide for USA APA
Features

- 4 Valve Head
- ECM
- Timing
- Crankshaft
- Cylinder Block
- Fuel System
The 6 cylinder engine now has a capacity of 6.6 litres. The Bore and stroke of the engine is in line with 3054C at 127mm stroke and 105mm bore.

The new six cylinder block, which is 10.5mm longer than the 1106C, has a scalloped crank case with extra ribbing. These features give a more ridged structure with a lower noise attenuation. The block is of a closed top deck configuration with 120mm spaced, non siamese, bores.

The production block is liner less and has a new standard of bore finish (TD522). Oversized pistons will be the service solution for overhaul. (0.5 – 1.0 mm) Will be available after 2007.
Two types of piston are used, gallery cooled and non-gallery cooled. The squared boss on the inside of the piston is fitted facing towards the front of the engine. A new ring pack combined with the new bore finish (TD522) gives good oil control. Piston protrusion is controlled by use of graded rods. The piston is made of a low expansion aluminium incorporating a Quiescent bowl design. This design of combustion bowl allows the use of multiple injections.
There are three lengths of con rod to adjust the piston height. The con-rods are fracture split at an angle to facilitate their removal from the top end of the block. These fracture split con-rods have conjoined notches to locate the big end bearings shells. The bearing shells are therefore not interchangeable between cap and rod. It is recommended that the con-rod bolts are never reused. For torque method and load refer to the relevant workshop Manual. The conrod and cap have dimples on them to identify correct orientation.
The fully balanced crankshaft is a steel forging.

For increased power and improved bearing life, the following improvements have been made:

The main journals are now 84mm in diameter an increase of 8mm over 3054C.
The big end pins are 72mm an increase of 9mm over 3054C.
These increases in bearing diameters gives an increase of 15mm in bearing overlap over crankshafts on previous engines of this size.
All bearing surfaces are induction hardened as are the fillet radii.
All bearings are lead free.
The crank nose has been re designed to allow `100% power take off.
Thrust Bearing

- Crank Thrust Bearing
  - #5 Main
  - Fitted into the Block
    - Faces the Crank
  - Squared ends for proper installation
  - Aluminium Base - Lead Free

The crankshaft thrust washers are fitted either side of the No 5 main bearing position.

The thrust washers are fitted into the block ensuring the bearing face is towards the crankshaft.

The squared off ends fit into recesses in the main bearing saddle and bearing cap.

The thrust washer bearing face is of a lead free aluminium base.

The main bearing caps are tightened using the torque and angle method.

Refer to relevant workshop manual for details of load and angle.
Isolated Sump

- Sump connected to block via isolator plate.
- Gives benefits of noise reduction.

Isolator plate
Rear End Oil Seal Fitting
Main Bearing Caps

- Bearing Caps
  - Installation
    - Use Torque and Angle Method
    - Details in D&A Manual

The main bearing caps are tightened using the torque and angle method. Refer to relevant workshop manual for details of load and angle.
This close up shows -

- 4 valves per cylinder.
- The central position for the injector.
- The rocker pedestal location bolt holes.
- The valve stem seals are of the same material and design as the 3054C but of a smaller diameter to suit the smaller valve stems.
- Seals are colour coded for inlet & exhaust.
- The head design does not use serviceable valve guides or seats.
- The head face cannot be machined.
- An adaptor is required to be used with current valve spring compressor.
The tightening sequence is from the outside to the centre of the head, as shown above.
The cylinder head and MLS head gasket are dowel located to the cylinder block.
The head is tightened using the torque and angle method.
Refer to the relevant workshop manual for the torque and angle recommendations.
There are 14, 16mm bolts. The bolts are 118mm long.
Head

- Head
  - Multi-Layered-Steel (MLS) Head Gasket
  - Fourteen - 16mm bolts
    - Single Use
  - Torque and Angle Tightening Method
Rocker Assembly

- Bridge can be installed either way
- Single Bolt per Rocker Lever
- Lash settings the same for Inlet and Exhaust
- Injectors can be replaced without removing Rockers

The close up of the rocker levers and valve operating bridge piece.
The bridge pieces can be fitted either way round.
The bridge piece has one elongated hole. This allows for a variance in valve positioning in the head.
The rocker levers are located by a single bolt per rocker lever.
The longer lever operates the inlet valves
Valve clearances are set using a new method. Refer to the relevant manual.
Valve clearances are the same for inlet and exhaust.
Rockers need not be removed but can be manipulated to allow removal of injectors.
To move the oil filter option from the LHS to the RHS of the engine requires extra piping to be introduced into the crankcase area.
The oil flows to the cooler via internal galleries.
From the cooler the oil passes to the lube oil filter and then on into the oil feed galleries.
Timing Case

- Timing Case
  - Increased Clearance for Idler Hub access
  - PTFE Crank Seal with dust seal
  - New Seal Recommended if Timing Case is removed
  - Use “dummy” Sleeve when front Pulley is Removed

Cam locating position will be on the right hand side of the gear viewed from the front.

Idler hub location in timing case is larger for clearance of the hub and gear installation (an alignment tool is required to centralise the case).

Front oil seal mounted in the timing case for exact alignment to crank.

The front seal is of PTFE with dust seal.

The seal is supplied with a fitting sleeve, which must remain in the seal until fitted.

A dummy sleeve should be fitted in the seal when front pulley is removed.

The correct installation tool must be used to ensure correct alignment.

It is recommended that if the timing case is removed, a new oil seal is fitted.
• Timing Case Alignment Tool must be used
  – Allows Idler Gear and Hub to be installed as an assembly

• Tool aligns the timing case.
• This allows the idler gear and hub to be fitted as an assembly
Idler Gears

- Two Types
  - Bronze
  - Double Needle
  - Dependant on PTO requirements.
There are two camshaft thrust washers available.

One has two location notches, as shown, the other only has one.

The one notch washer is used where there is a requirement for a PTO mounted on the RHS requiring in excess of 35Nm torque.
To facilitate setting the engine to an accurate, No I cylinder, TDC a timing pin is available.
Remember to remove the pin and replace the blanking screw.
Camshaft Timing

- Camshaft Alignment Tool
  - Not a Tight Fit
  - Ease of Assembly

• Use the camshaft alignment tool to locate the camshaft.
• The tool is only used to locate the gear and is therefore not a tight fit.
• This allows the cam gear to move slightly when fitting the Idler gear easing the assembly.
The toothed timing disc is of a pressed steel manufacture. The design is different to that used on the previous electronically controlled engines.
Fuel System Overview

- Caterpillar Fuel System using common rail technology
  - Low Pressure
    - 300kPa (43 PSI)
    - 20 Micron Primary Filter
    - 2 Micron Secondary Filter
    - Fuel Cooler Required on some arrangements
  - High Pressure
    - Up to 160 MPa (1600bar - 23,200 PSI)
      - Fluid penetration safety hazard.
    - Hardened Fuel Lines
    - External Fuel Manifold
How small is a Micron?

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Electron Microscope  Microscope  Visible by Human Eye

2.0

Human Hair: .001 Inch
1 Micron: .000001 inch
.0254 mm
25.4 Micron

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Fuel System Handling

IMPORTANT!

• Cap all fuel passages *Immediately* after removal
• Do Not “Blow Out” or “Wash Out” any fuel passages
• Place removed parts in clean area
• Do Not pre-fill filters
• Remove packaging and protective caps *immediately* before installation
• Fuel Lines cannot be reused
The schematic above shows us the layout of the High pressure fuel system used by C4.4/C6.6 electronically controlled engines.

Fuel is placed through the primary filter, forwarded onto the transfer pump which moves fuel onwards into the cooling chamber of the ECM, (Where used).

For further and more substantial cleanliness, fuel is passed through a secondary filter and passed clean onto the High pressure pump.
The pressure of fuel is raised and transferred into the High pressure fuel rail.

Finally each Electronically actuated injector is branched from the rail.
The fuel pump comprises of the transfer pump and high pressure pump in one unit.

The high pressure fuel pump is lubricated by engine oil.
This gives an extended pump life compared to pumps lubricated with fuel.

The transfer pump does not require a lift pump but does require priming.
The method of priming is either by hand pump incorporated into the primary filter head or by an electric priming pump.
The high pressure fuel pump is mounted on the LHS of the engine. The pump is locked, for timing purposes, prior to being fitted to the engine. (If the pump is not locked, it should be returned to the authorised outlet.) This ensures that the delivery strokes from the pump are in phase with the injector deliveries. Always refer to the manual for the correct removal and re-fitting procedure. **The high pressure fuel system is self bleeding. Fuel lines must never be cracked to purge air.** When the pump is replaced the feed pipe to the fuel manifold must also be replaced. Fuel is directed to the fuel manifold and from there to the injectors.
Fuel Pump

- Stroke in phase with Injection
- Self Bleeding
  - Do Not Crack lines to bleed
- Lock Pump BEFORE removal
- Replace HP Fuel Line when Pump is removed
  - Check Clips
- Two Cams – 2 or 3 lobes each
- Solenoid adjusts rail pressure and return to tank
- Needs to be Timed
  - Lock in Place BEFORE Removal

The 6 cylinder high pressure pump has two three lobe cams.
The 4 has two two lobe cams.
This enables it to deliver six pumping strokes per pump revolution
The solenoid valve determines fuel rail pressure and fuel returned to tank.
Excess fuel is returned, via the pump leak off, to the fuel tank
Fuel enters the HP pump and is directed via non return valves to the two plungers
On the delivery stroke of a plunger a percentage of the fuel is delivered to the fuel manifold, again via a non return valve.
The volume of fuel delivered to the fuel manifold is dependant on the position of the solenoid valve.
Fuel in excess of that required to maintain the desired pressure in the fuel manifold is re-circulated.
Some re-circulation of fuel takes place within the pump,
The remainder of the fuel is returned back to the fuel tank.
As the injector solenoid is actuated a pressure drop occurs in the fuel manifold. This pressure drop is registered by the ECM from a signal sent by the pressure sensor in the fuel manifold.

The ECM sends a requirement for an increase in delivery volume from the pump to return the rail pressure to the desired pressure.

When the pressure sensor informs the ECM that the desired pressure is correct the ECM then causes the solenoid valve on the pump to reduce fuel volume.

This cycle takes place every time an injection takes place.

It is therefore important to phase the pump delivery to injection sequence and occurrence to ensure that fuel manifold pressure does not drop too much.
The transfer pump is driven from the rear of the High Pressure Pump drive shaft.

The pump has the capacity to create both negative and positive pressures.

It draws the fuel (negative pressure) into the pump, via a 20 micron primary fuel filter.

The pump then delivers the fuel, at between 300 – 400 kPa, to the secondary filter.
High pressure pipe connections must never be loosened when the engine is running or being cranked. High fuel pressure is always present throughout the high pressure system when the engine is running or being cranked.

All high pressure pipes must be replaced every time they are disturbed.

All pipes must be renewed when a new fuel manifold is fitted.

DO NOT bend the pipe for any reason as it has been internally hardened. Any attempt to bend the pipe could rupture this process which could lead to a very high pressure leak. Do not fit a fuel pipe which is damaged in any way.

New fuel pipes are supplied sealed in protective packaging. This protection should remain on the pipe until just before the moment of fitting.
High Pressure Fuel System

- **Do’s & Don’ts**
  - Do Remove HP Cap just before installation
  - Do Keep your Work Area Clean
  - Do Think about Cleanliness when working on HP System
  - Do Make Sure all Clips and Clamps are tight and in position

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The primary function of the fuel pressure sensor is to constantly monitor rail pressure.

If it detects rail pressure above 160 MPa diagnostic code 157-00 will be displayed and the engine will default to ‘limp home’ mode.

The high pressure relief valve protects the high pressure fuel system from excessive pressures.

The valve will operate with a constant pressure above 160 MPa.(1600 bar) but allow pressure spikes of up to 190 MPa.(1900bar)

The fuel passing the pressure valve will be returned to the tank and will be at a very high temperature.

After rectifying the cause of excessive pressure it will then be necessary to replace the pressure valve.
The injector leak off is a gallery return from the injectors in the cylinder head.
When the solenoid is energised, start of injection, the valve lifts.

The fuel manifold pressure now passes below the valve and down to the nozzle.

When the solenoid is de-energised the valve closes removing fuel manifold pressure from the nozzle.

The closing nozzle needle forces the fuel to pass the upper face of the valve into the leak off drilling in the injector body.

The leak off fuel then passes via the gallery in the head to the return to the fuel tank.
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Fuel Injector Connections

- Two Types
  - High Pressure Fuel
  - Electrical
    - Three Connectors thru Valve Cover Base

High pressure and electrical connections to the injectors.
Fuel Injector

- **Do’s and Don’ts**
  - Do Use Proper Torque on Electrical Connection
    - Service Tool Available
  - Do Finger Tighten all Clamps and HP Lines, First, then torque properly
  - Do Cap the Injector Immediately After Removing HP Fuel Line
  - Do Make Sure the O-Ring and Copper Washer are in place
    - Do Not Re-use O-Ring or Copper Washer

Electrical connections to the solenoid operated injectors can be easily damaged.

**Do not over-tighten. Use the correct tool and torque found in the manual.**

When replacing injectors, finger tighten the injector clamp, align the high pressure pipe and finger tighten the nut, tighten the injector clamp to its correct torque. Fully tighten the high pressure pipe nuts using the correct tooling and torque.

DO NOT bend the pipes.

Remember to ensure there is only one copper sealing washer on the injector nozzle.

Replace the injector pipe, copper injector washer and ‘O’ ring when replacing the injector.

The injector serial number and confirmation code will be used for trimming the injector. The 3d bar code in the center is used in production. More about injector trimming later on in the training.
Fuel Injector

- **Do’s and Don’ts**
  - Do Write down the Injector Serial Number and Confirmation Code before you install the Injector
  - Do use Cat ET to Program ECM with proper Injector Trim File
  - Do Look for the Trim File CD in the Injector Box

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Cleanliness

- Thoroughly clean equipment before disassembling
- Use only NEW protective caps to seal fuel connections
- Replace HP Fuel Lines if they have been loosened
Fuel Injection Serviceability

- NEVER loosen high pressure pipes when engine is running! 23,000 PSI
- Use Electronic Service Tool to Troubleshoot Injector Problems
- Injectors have no serviceable parts.
  - Warranty will only be paid with evidence of the correct tests.
- Pump Solenoid is non serviceable.
  - If the solenoid is removed the whole pump assembly must be replaced.
Fuel Injection Serviceability

- Transfer pump is a serviceable item, separate from High Pressure pump.
- Speed sensor is serviceable.
A smart wastegate is fitted to all variable speed engines. It controls the pressure applied to the mechanical wastegate actuator. Smart wastegate gives flexibility to match boost pressure requirements at both part load and full load conditions over the entire operating range. Optimised emissions for any torque curve. Optimised engine performance at non emissions points – i.e. reduced exhaust temp.

The controller is serviceable only as an assembly, there are different part numbers depending supply voltage (12 & 24volts).
Wastegate Actuator

- 1 mm Total Travel
- Refer to Service Manual for Adjustment Procedure

Care must be taken when setting up the Smart Wastegate actuator. The fitting of a new, adjusted or replacement actuator requires mandatory checking of settings as shown in the service manuals.

If the Wastegate does not operate at the correct pressure, it can effect the engine performance.

High pressure setting will result in engine de-rate.

Low pressure can cause black smoke and may also result in engine de-rate.
With a normal Wastegate turbocharger as the exhaust gas volume and temperature increase so does the turbo boost pressure.

At a predetermined pressure the boost air pressure overcomes the spring load and the Wastegate valve (D) opens venting the gas into the exhaust outlet, thus controlling the turbo boost pressure.

In the ‘Smart Wastegate’ the pressurised air passes to the Wastegate Actuator (C) via a control valve (B). This valve is normally open allowing the air to vent to atmosphere.

The spring in the Wastegate Actuator (C) is of a lower compressive load than in the standard Wastegate, therefore it is possible to overcome the spring and open the Wastegate at a lower pressure output from the turbo.

By operating under the control of the ECM (A), the boost pressure can be controlled throughout the operating range of the engine.
Glow plugs

- Installed on ALL Engines
- Improved
  - Sheathed Element
- 850 °C in 4 Seconds
- Controlled by ECM
  - Via OEM Relay

1 - Early Glow plug
2 - Improved version.
Engine Wiring Harness

- Both Connectors and Harness are serviceable
- Pump Connector Serviced by Pigtail

Harness serviceability

Entire harness only needs to be replaced if ECM connector is broken.
Individual connectors are available in the parts system.
Pump connector is serviced by pig tail.
Two general purpose connector kits are available. One for DT connectors and one for AMPSeal.
All connectors use a common crimp tool.
Connector seals are available as service items.
The harness ties/clips are available.
The three injector harnesses under valve cover are serviced separately as assemblies. It is essential these are properly secured.

Reminder – Do not connect wiring to injector lines.
Engine Wiring Harness

- Harness Do’s and Don’ts
  - Do clip the harness
  - Do Not Force Connectors
    ▪ Keyed to ensure Correct Connection
  - Do Not use “Electrical Grease”
  - Do make sure seals are in good condition

- Diagnostic Connector
  - Cat Machine Engines - No
  - Industrial Engines - Yes

We have a very ‘Fault Tolerant’ extremely robust and reliable system. Inevitably after many years service, faults may occur.

Traditionally, if the problem is ‘Electrical’, wiring / connectors are most likely to be the cause.

Shorts / open circuits / high resistance connections, can be caused by any combination of corrosion / abrasion / burning / vibration / fatigue and ‘liquid ingress’.

Make sure all seals are correctly positioned. Blanking plugs must be fitted on any unused pins, to prevent any liquid ingress.
Earth strap and anti-vibration mounts are serviced separately.
New anti-vibration mounts should be used when replacing the ECM.
Note: Air cooled ECM’s are also used.
A4-E2 Electronic Control Module (ECM)

- ECM Controls:
  - Fuel Pressure
  - Speed Governing
  - Air/Fuel Ratio
  - Start/Stop Sequence
  - Engine Protection Devices/ Diagnostics
A4-E2 ECM Voltages/Current

- Nominal battery supply voltage 9-32 volts
  - Expected voltage range/current draw...
    - 12V system / 9-16 volts / Max 30 Amps (8mA ‘Sleep’)
    - 24V system / 18-32 volts / Max 15 Amps (10mA ‘Sleep’)

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A4-E2 ECM

• Do Use the proper tools to tighten the ECM Connector Screws
  – 6 Nm (4.4 lb-ft)
• Do Use the ‘Test ECM’ Feature when troubleshooting the ECM
Temperature Sensors

- Intake Air
- Coolant
Temperature Sensors

- Thermistor sensing devices
  - Resistance varies with temperature
  - As temperature increases its resistance decreases
- Passive Sensor
  - Does not need its own power supply
Temperature Sensors

Negative Temperature Coefficient (NTC)

Ohms (Resistance)

- 2,500
- 1000

Increasing Temperature

20°C
Temperature Sensors

Thermistor

Ground Pin No 2

Signal Pin No 1

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Temperature Sensors

- Engine Coolant Temperature Sensor
  - Used for engine protection, Warning/Derate/Shutdown

- Intake Manifold Air Temperature Sensor
  - Used for engine protection, Warning/Derate
  - Smoke limiting

- Both Used for
  - Cold Start Strategy
  - Data Link Information
Example given is engine coolant temperature sensor.
Range, -40 to 150°C
Range, -40 to 300°F
Intake manifold temperature sensor has a different range and will give different diagnostic codes.
Pressure Sensors

- Oil
- Fuel Rail
- Intake Air
Pressure Sensors

Oil Pressure Sensor

Intake Manifold Pressure Sensor

Fuel Rail Pressure Sensor
Fuel Rail Pressure Sensors

- **Fuel Rail Pressure Sensor**
  - Determines Fuel Rail Pressure
  - Continuous Operating Pressure 200 Mpa
  - Maximum without damage, 260 Mpa (burst at 320 Kpa)
  - Temperature Range, -40º to +160ºC
  - Sensor has M12 x 1.5 Thread
  - Requires Special ‘Crush’ Washer for Sealing
  - Ensure there is no Rail Pressure before removal
  - Serviced as a Kit with ‘Crush’ Washer
IMA Pressure Sensors

- Intake Manifold Air Pressure Sensor
- Measures Manifold Air Pressure
  - Used to calculate air/fuel ratio
  - Used for smoke limiting strategy
  - Measures atmospheric pressure on “key-on”
  - Serviced as a Kit with O-ring

Atmospheric pressure is measured when the ignition is first switched on. If the atmospheric pressure changes (i.e., if the engine moves uphill), the engine will not de-rate until switched off and on again.
Oil Pressure Sensors

- Engine Oil Pressure Sensor
  - Used for engine protection, Warning/Shutdown
  - Provides signal for pressure gauge, via the ECM
  - Serviced as a Kit with O-Ring
Pressure Sensors

- Integrated circuit
- Capacitive sensor
- Voltage output varies with pressure
- Sensor conditions the signal voltage output to the ECM
- Active Sensor (Needs a external power supply)
Speed/Timing Sensors

Cam

Crank
The toothed timing disc is of a pressed steel manufacture.
The design is different to that used on the previous electronically controlled engines, in that now a wide tooth is used as the reference point.
The timing disc has 59 + 1 wide tooth. This gives 6° between teeth except where the gap has not been cut.

This larger tooth will generate a different signal in the speed sensor.

To re-fit a new disc pass it carefully over the rear seal face and engage it on the location dowel.

Ensure the teeth point toward the nose of the crankshaft.

The timing disc is secured with three setscrews. If these are to be re-used, the correct thread lock should be used as specified in the manual.
• When the pump is renewed the feed pipe to the fuel rail must also be renewed.
Hall Effect Sensor

- Produces a conditioned square-wave signal

Using a hall effect sensor gives a sharp, square wave form, giving more accurate positioning.
Injectors

6 EUI Injectors
Do’s and Don’ts

- Do make sure wires are properly routed
- Do make sure clips are used
  - Clips are available in the Parts System
- Do use the proper Service Tool to torque Injector Connectors

Spring Clip Retainer
Pump Solenoid Wiring

Service by pigtail
Smart Wastegate Solenoid

Smart Wastegate Solenoid
Wastegate Wiring

- Long fly lead used.
- Clipped to air line around back of engine.
- Route correctly to avoid chafing.
ECM J1 ‘Customer’ Connection

- New Connector
  - Available from Cat Parts System
  - New Removal Tool
  - Uses Standard Crimp Tool
OEM Connections

- Inputs
  - Power
  - Throttles
  - Switches

- Outputs
  - Lamps
  - Relay

- Datalink
  - J1939
ECM Inputs - Power

- Ten Power Wires REQUIRED
  - 4 Plus Battery
  - 5 Minus Battery
  - 1 Ignition Switch
- Beware of “In” Harness Power & Ground Splices
- Battery Minus should go directly to the Battery
  - Do Not Connect to Battery via the Chassis
- Use Correct Cable Size
  - Refer to A&I Guide for details.
Resistive track potentiometer type devices most common.
‘Hall’ effect type recommended, (non contact, longer life)
Provide linear voltage output (Approx 0.5v to 4.5v)
Should have a throttle movement detector, or Idle Validation Switch (IVS) on all applications for throttle failure detection.
Analogue Throttle Position Sensor.

The analogue pedal sends a voltage signal to the ECM depending on the pedal position. This voltage, as shown above, varies from 0.5v to 4.5v. The ECM then interprets this signal into a required engine speed. A comparison between actual engine speed and desired engine speed is made and the amount of fuel being delivered to the engine is adjusted to increase or decrease the RPM of the engine.
PWM Throttle Position Sensor.

Throttle incorporates conditioning electronics to provide Pulse Width Modulation (PWM) signal output.

More consistent than a analogue throttle type.

No need for Idle Validation Switch.

Only three wire connection.

Uses sensor 8v reference voltage.

Less susceptible to voltage supply Variations.

Less susceptible to outside noise/interference.

The PWM pedal sends a signal to the ECM depending on the pedal position. This signal varies from 10% duty cycle to 90% duty cycle. The ECM then interprets this signal into a required engine speed. A comparison between actual engine speed and desired engine speed is made and the amount of fuel being delivered to the engine is adjusted to increase or decrease the RPM of the engine.
PWM Signal.
At engine idle, duty cycle = 10 - 22%.
Average time on (Pulse Width) = average voltage.
Pulse runs at 500Hz.

The position sensor generates a PWM signal which is a square wave. A square wave signal is either full voltage or no voltage – on or off. The percent of time the signal is on versus the time off is called the duty cycle. Duty cycle at low idle pedal position is 10% to 22%. Duty cycle at high idle pedal position is 75% to 90%. The pedal position sensor transmits the signal to the ECM at a constant frequency. This type of sensor provides a very accurate signal to the ECM with a smooth transition between acceleration and deceleration. The ECM determines if the sensor is faulty by monitoring the duty cycle. If the duty cycle is greater than 90% or less than 10%, the ECM will log an active fault.
ECM Inputs - Switches

- 9 Switch Inputs
  - PTO
    - On/Off
    - Set/Lower
    - Raise/Resume
    - Speed 1
    - Disengage
  - Mode
    - Mode 1
    - Mode 2
  - Throttle
    - Throttle Select
  - Shutdown Switch
ECM Outputs - Lamps

- 5 Lamps
  - 2 Recommended
    - Warning
    - Stop
  - 3 Optional
    - PTO Mode
    - Wait to Start
    - Low Oil Pressure

+Battery

PTO Mode
STOP Lamp
Warning Lamp
Wait to Start
Low Oil Pressure
ECM Outputs - Relays

- OEM Installed
  - See A&I Guide for Relay Specifications
- Driven by ECM
  - Part of Cold Start Strategies

To glow plug relay

ECM J1 OEM Connector

40
Grounding & Welding

● Grounding
  – Always ensure the ground strap on the ECM
  – Prevent EMI, Electro Magnetic Interference

● Welding
  – Refer to A&I, OM&M or Troubleshooting Guide for details

Welding Precautions.
Turn off engine with Ignition Key.
Disconnect negative terminal from battery, open battery isolation switch.
If welding on the machine, ensure the welding earth clamp is placed close to the welding point.
Protect wiring harness against welding debris and 'splatter'

Electrostatic Paint Spraying Precautions.
Connect all 64 pins of the ECM directly to the spray booth ground.
Connect the engine block to the ground at two points on bright metal.

Jump Starting Precautions.
Jump starting an can cause higher voltages, make sure they do not exceed the ECM maximum.
Cylinder Block Grounding

- Engine Block must be properly grounded
  - Provide a good return path for Starter Motor, Alternator, Start Aids...
- Ground Cables should be minimum, 67.4 mm² (00 AWG)
- Starter Motor Stud, the first choice and directly back to battery
- Tapped Holes on Engine Block
  - Clean, Paint and dirt free
  - 10 mm zinc plated screw/washer
  - Tightened to 44 Nm
  - Conductive grease can be used
Cylinder Block Grounding

Options for Ground Connection to Tapped Holes on Engine Block

1  2

3
Battery Isolator Switches

- Installed in location, not normally accessible
- Not to be used for normal ‘Shutdown’
  - Looses Diagnostic information
- Disconnects battery during storage, transport and maintenance
- Improves Safety
  - Avoids battery discharge during storage
  - Protects ECM during welding
- Automatic Isolators
  - Must be controlled by a timer to allow normal ‘shutdown’ by the ‘Ignition’ switch
  - Removing power from ECM Ignition Switch Input
Warning & Diagnostic Lamps

- Strategy Change from 3054/6E
  - Amber Diagnostic Lamp
    - Active Diagnostic Present
  - Red Warning Lamp
    - Derate or Shutdown

- Lights Off: Everything is OK
### Warning Lamp Strategy

<table>
<thead>
<tr>
<th>Warning Lamp</th>
<th>Shutdown Lamp</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>On</td>
<td>Off</td>
<td>Both On - Lamp Check for 2 Second at key “On”</td>
</tr>
<tr>
<td>Off</td>
<td>Off</td>
<td>Both OFF - No Faults</td>
</tr>
<tr>
<td>On</td>
<td>Off</td>
<td>Warning ON - Active Fault</td>
</tr>
<tr>
<td>On</td>
<td>F</td>
<td>Warning ON / Shutdown Flashing - Engine Derate</td>
</tr>
<tr>
<td>F</td>
<td>Off</td>
<td>Warning Flashing / Shutdown OFF - Warning</td>
</tr>
<tr>
<td>F</td>
<td>F</td>
<td>Warning Flashing / Shutdown Flashing - Derate</td>
</tr>
<tr>
<td>On</td>
<td>On</td>
<td>Warning ON / Shutdown ON - Shutdown</td>
</tr>
</tbody>
</table>
Engine Warning and Protection

- Warn, Derate and Shutdown thresholds
- Read Only Screen

Monitoring System.

This screen provides all the warning, derate and shutdown levels that are currently set within the ECM.

NOTE: These cannot be altered. The only way to change the values is to alter the actual flash file program.
Electronic Diagnostics

- Electronic Technician (ET) PC based
  - Many functions, reading of temp, speed, pressures, switch positions, etc
  - For Installation work and full diagnostics
  - Configuration settings, Histograms, graphing, data log, etc
  - Programming the ECM, (Reflashing, Configuration)
  - Throttle Configuration, Analogue, PWM, MPTS, Variable Set Speed

Diagnostic Plug

A diagnostic plug is available on the engine harness (certain engines may not have this facility). This allows connection of diagnostic service tool to either the Cat Data Link (CDL) or the CAN J1939

The Diagnostic connector fitted to the engine harness is a 9 pin Deutsch. The pin allocations are as follows:

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Battery +</td>
</tr>
<tr>
<td>B</td>
<td>Battery -</td>
</tr>
<tr>
<td>C</td>
<td>CAN screen</td>
</tr>
<tr>
<td>D</td>
<td>PDL +</td>
</tr>
<tr>
<td>E</td>
<td>PDL -</td>
</tr>
<tr>
<td>F</td>
<td>CAN -</td>
</tr>
<tr>
<td>G</td>
<td>CAN +</td>
</tr>
<tr>
<td>H</td>
<td>Not connected</td>
</tr>
<tr>
<td>J</td>
<td>Not connected</td>
</tr>
</tbody>
</table>
Diagnostic Fault Codes

- Two Types of Codes
  - Faults
  - Events
- Faults
  - Problems with Components
- Events
  - The Parameter being Measured is Out of range
    - E.g. Oil Pressure, Coolant Temperature
Diagnostic Fault Codes

• 4 Code Categories
  – Active Diagnostic Codes
    • Any fault that is currently on the engine.
    • Usually an electrical problem, connections, etc
  – Logged Diagnostic Codes
    • Faults that have occurred and/or been repaired
  – Active Events Codes
    • Currently Active Events
  – Logged Event Codes
    • An engine history view
FMI DESCRIPTIONS

0  Data valid but above normal operating range
1  Data valid but below normal operating range
2  Data is erratic, intermittent or incorrect
3  Voltage above normal, or shorted to high source
4  Voltage below normal, or shorted to low source
5  Current below normal or open circuit
6  Current above normal or grounded circuit
7  Mechanical system not responding or out of adjustment
8  Abnormal frequency, pulse width or period
9  Abnormal update rate
10  Abnormal rate of change
11  Failure code not identifiable
12  Bad intelligent device or component
13  Out of calibration
14  Special instructions
15-31 Not available at present, for future use.
Active Codes.

This screen shows all the active diagnostic codes currently on the engine. i.e. any current faults with the engine.

These faults will appear and as the faults occur. There is no need to clear the faults manually as there will automatically disappear when the problem is rectified.
Logged Diagnostic Fault Codes

This screen shows a history of all the faults that have occurred on the engine. They are logged with how many times the fault has happened, the first time it happened and the last time it happens. These are all in ECM hours.
Logged Event Codes

- High Engine Coolant Temperature
- High Intake Air Temperature
- Low Engine Oil Pressure
- Engine Over-speed
- High System Supply Voltage (12/24Volt)

Faults That Could cause Engine Damage

---

**Event Codes for J1939.**

Events are not supported in J1939 as used on the Electronic Service Tool (EST). Rather than an 'E' code, we are transmitting them using a Suspect Parameter Numbers (SPN) and a Failure Mode Identifier (FMI)

<table>
<thead>
<tr>
<th>Event Code</th>
<th>SPN</th>
<th>FMI</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>168</td>
<td>018</td>
<td></td>
<td>Low system voltage warning</td>
</tr>
<tr>
<td>172</td>
<td>016</td>
<td></td>
<td>High engine inlet air temp de-rate</td>
</tr>
<tr>
<td>190</td>
<td>0 or 16</td>
<td></td>
<td>Engine over-speed warning</td>
</tr>
<tr>
<td>110</td>
<td>016</td>
<td></td>
<td>High engine coolant temp warning</td>
</tr>
<tr>
<td>100</td>
<td>018</td>
<td></td>
<td>Low engine oil pressure warning</td>
</tr>
<tr>
<td>110</td>
<td>000</td>
<td></td>
<td>High engine coolant temp de-rate</td>
</tr>
<tr>
<td>172</td>
<td>016</td>
<td></td>
<td>High engine inlet air temp warning</td>
</tr>
<tr>
<td>100</td>
<td>018</td>
<td></td>
<td>Low oil pressure</td>
</tr>
</tbody>
</table>

These Fault codes can only be removed/cleared with an Electronic Service Tool.
## Active Event Codes

In the diagnostic menu, select "Active Event Codes" to view active events and issues. The table below lists some of the codes and their descriptions:

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6.6</td>
<td>Injection Disabled</td>
</tr>
</tbody>
</table>

### Explanation

These codes are specific to Caterpillar equipment and help diagnose issues in real-time. Understanding these codes can aid in the quick resolution of equipment problems.
Logged Events.

These codes are generated when the engine has gone into a warning, de-rate or shutdown. They are logged in the same way as the logged diagnostic codes.
New Diagnostics

- 1-2 Injector Data Incorrect (CDL)
- 1-7 Injector Not Responding (CDL)
- CID Can be 1 to 24 to Identify Cylinder (CDL)

- 651 - 2 Injector Data Incorrect (J1939)
- 651 - 7 Injector Not Responding (J1939)
- CID 651 to 675 to Identify Cylinder (J1939)
ET Diagnostic Test

- Diagnostic Test
  - Injector Solenoid Test
    - “Click” Test
  - Override Parameters
  - Cylinder Cutout Test
    - Major Test for finding “Good” or “Bad” Injectors
  - Wiggle Test
  - Fuel Rail Pressure Test
  - Smart Wastegate Click Test
  - Injector Verification Test
Injector Installation

- Not Just a Mechanical Process
  - Physical installation
  - Electronic Installation
    - ET Required
    - E-Trim File Required
Injector Removal

- Rocker Arm
  - Loosen Set Screw
  - Slide Rocker to get access to Injector Hold
  - Down Bolt
Injector Installation

- **Mechanical Issues**
  - Make Sure Copper Washer is in Place
  - Make Sure the Old Washer is not still in the Injector Hole
  - Install Injector and Fuel Lines ‘finger tight’
    - Then tighten Injector Hold Down Bolt to the Proper Torque.
Injector Installation

- Electronic Issues
  - Remember to write down Injector Serial Number and Confirmation Code BEFORE you install the injector.
Injector Installation

• Installing the E-Trim File
  – Finding E-Trim File
    ▪ On CD with the replacement Injector
    ▪ On SIS Web

• Connect Cat ET
  – Service>Calibrations>Injector Trim Calibrations
**Injector Installation**

- Select Injector to be Programmed
- Click on ‘Change’ button

<table>
<thead>
<tr>
<th>Injector</th>
<th>Not Programmed</th>
<th>Serial Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injector 1</td>
<td>Not Programmed</td>
<td>0</td>
</tr>
<tr>
<td>Injector 2</td>
<td>Not Programmed</td>
<td>0</td>
</tr>
<tr>
<td>Injector 3</td>
<td>Not Programmed</td>
<td>0</td>
</tr>
<tr>
<td>Injector 4</td>
<td>Not Programmed</td>
<td>0</td>
</tr>
<tr>
<td>Injector 5</td>
<td>Not Programmed</td>
<td>0</td>
</tr>
<tr>
<td>Injector 6</td>
<td>Not Programmed</td>
<td>0</td>
</tr>
</tbody>
</table>

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C6.6
Injector Installation

- Find E-Trim File on your Computer
- Select it
- Click on ‘Open’ button
Injector Installation

- ET informs you that the file was successfully programmed into the ECM.
Injector Replacement

- If Injector is being replaced because of
  - “Injector Data Incorrect”
    Or
  - “Injector Not Responding” Diagnostics
- Injector Verification Test must be run from Service Tool
Troubleshooting Injectors

- Using Injector Swap Feature
  - Part of the Injector Calibration Screen
  - Swaps E-Trim Files for you
  - Click on ‘Exchange’ Button
  - Use only as directed from Troubleshooting Guide
C6.6 Quirks

- Fuel System Optimization Routine
  - Runs every hundred hours or so
  - *Audible changes when engine is running*
  - NO performance or Power Changes
  - Everything’s OK
  - Similar to HD ACERT engines
Throttle Configuration Screen (EST).
This screen capture shows where we can change the type of throttle and program its characteristics. Access to this screen is through the electronic service tool and will require a factory password to make changes to it.

Speed Demand (throttle) options, decided by customer.
Highest one wins
Manual switched throttle selection
Throttle one
Throttle two
**Why do we need an idle validation switch?**

An ‘Idle Validation Switch’ provides an extra level of safety. It’s a ‘throttle movement’ detector. A micro switch is configured to operate when the pedal is in its released position. If the idle validation switch tells the ECM that the pedal is released, but the voltage signal tells the ECM that there is a speed demand, then the ECM can detect that there must be a fault with the throttle sensor or its wiring.

**How is the idle validation switch applied**

A switch should be set up such that it closed (ON) when the pedal is released. It should open (OFF) when the pedal is depressed a little.

Like other components, there will be some variation due to manufacturing tolerances and wear of switches and switch mountings. We define 2 thresholds in the software, “Max ON” and “Min OFF”.

Operating the throttle, **forward, Max On Threshold**

If the ECM reads a value above this and the switch is still ON *(Closed)* then it will register a fault

Releasing the throttle, **returning, Min Off Threshold**

If the ECM reads a value below this and the switch is still OFF *(Open)* then it will register a fault
Idle Validation Switch

- Between Min OFF and Max ON Thresholds
  - When the ECM reads a raw signal higher than Min OFF but lower than Max ON, it does not care what the switch position is. This zone is to allow for tolerance of components.
- Typical Idle Validation Switch (IVS) settings
Idle Validation Switch (IVS)

Machine Interface Connection

Switch Open (off)
Switch Closed (on)

Min Off Threshold
Max On Threshold

0 Volts
Not Used
0 Volts
12 Volts

Idle Validation Minimum OFF Threshold
Idle Validation Maximum OFF Threshold

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C6.6
Diagnostic Limits.

In an analogue throttle, if we try to measure values too close to the supply voltage (5V) or to ground (0V) then it is possible that short circuit, open circuits or 'noise' events will be mistaken for valid signals.

In a PWM throttle, we cannot go as low as 0% or as high as 100% pulse width as both of these would be the same as no signal, or the full 8 volts.

If the ECM measures values close to 0% or 100% raw signal then it is considered as an sensor fault and a diagnostic code is sent or logged.

Example; 91-3, (Signal Voltage above normal or shorted to a higher voltage)
Example; 774-4, (Signal Voltage below normal or shorted to a lower voltage)

Position Limits.

A throttle pedal is designed so that when it is in the released position it will give a voltage output of approximately 1 volt. The sensor (potentiometer) used has a tolerance of 1% of full travel. The manufacturing tolerances of the pedal add a further 2% (of full travel) tolerance.

Pedals will be produced, therefore, which, when in the released position will give a voltage somewhere between 0.7 volts and 1.3 volt

For this pedal the ECM would be configured to give an initial lower position of 15% (equivalent to 1.3V) and a lower position limit of 10% (equivalent to 0.7V)

If a throttle pedal leaves the production line that gives an output of 1 volt, (when back). Then when the ignition is turned the ECM will see that this value is lower than the initial lower limit but greater than the lower position limit. It will now auto-calibrate to take 1volt to be the lower pedal position.

Dead Zone.

The lower Dead Zone will be a certain amount of throttle movement before the engine speed starts to rise.

The Dead Zone is defined as a percentage of the raw signal. If the throttle auto calibrates then the Dead Zone will also move.

Upper Diagnostic Limit, Initial Upper Position, Upper Position Limit and Upper Deadzone are defined in exactly the same way as the lower ones.
Flashing the ECM

- Re-programming the ECM will be required
  - ECM has been replaced
  - Flash File needs to be updated
- Two Types of Files
  - Flash File
    - Base Engine Data
      - Fueling/timing maps, cold start/governor strategies, set speedemode switching, default values, etc
  - Configuration File
    - Specific Customer Data
      - e.g. Configurable parameters, idle speed, droop, etc
Where do I get the Data?
- Extracted from Failed ECM
- SIS Web
  - Flash File
- TMI
  - Configuration
  - Being Moved to SIS Web
Extracting Data from ECM

- Extracting the Data from a Failed ECM
  - If Failed ECM can Communicate
    - Downloads ALL data to PC for upload to new ECM
- Service>Copy Configuration>Fleet Configuration
Extracting Data from ECM

- Loading Data from a Failed ECM
Extracting Data from ECM

- Saving Data to PC
Extracting Data from ECM

- Retrieve Data from PC
Extracting Data from ECM

- Program Data From PC
Flash Memory.
To begin the Flash process first click on the Flash Memory icon.
Factory Passwords

• C6.6/4.4 Requires fewer Factory Password
  – Only
    ▪ FLS/FTS
    ▪ Interlock (Changing Flash File)
  – No Passwords Required for:
    ▪ Throttles
    ▪ J1939 Communications (TSC 1)
    ▪ Highest Enabled Rating
Factory Passwords

- Password Input Screen will automatically appear when trying a Factory Password Protected Parameter change is attempted.
Additional Speed Demand Options

- Multi-Position Throttle Switch - (MPTS) Up to 16 speeds
- Power Take Off, PTO, (Variable Set Speed, Cruise Control)
- Torque Speed Control (TSC) via J1939 communication throttle
Multi-Position Throttle Switch (MPTS)
## Example of Multi-Position Throttle Switch operation

<table>
<thead>
<tr>
<th>Throttle Switch Input 4</th>
<th>Throttle Switch Input 3</th>
<th>Throttle Switch Input 2</th>
<th>Throttle Switch Input 1</th>
<th>Throttle Switch Position</th>
<th>Valid</th>
<th>Desired Engine Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open</td>
<td>Open</td>
<td>Open</td>
<td>Open</td>
<td>1</td>
<td>Yes</td>
<td>Idle</td>
</tr>
<tr>
<td>Open</td>
<td>Open</td>
<td>Open</td>
<td>Closed</td>
<td>2</td>
<td>Yes</td>
<td>1000</td>
</tr>
<tr>
<td>Open</td>
<td>Open</td>
<td>Closed</td>
<td>Open</td>
<td>3</td>
<td>Yes</td>
<td>1200</td>
</tr>
<tr>
<td>Open</td>
<td>Open</td>
<td>Closed</td>
<td>Closed</td>
<td>4</td>
<td>Yes</td>
<td>1250</td>
</tr>
<tr>
<td>Open</td>
<td>Closed</td>
<td>Open</td>
<td>Open</td>
<td>5</td>
<td>Yes</td>
<td>1400</td>
</tr>
<tr>
<td>Open</td>
<td>Closed</td>
<td>Closed</td>
<td>Open</td>
<td>6</td>
<td>Yes</td>
<td>1650</td>
</tr>
<tr>
<td>Open</td>
<td>Closed</td>
<td>Closed</td>
<td>Closed</td>
<td>7</td>
<td>Yes</td>
<td>1670</td>
</tr>
<tr>
<td>Closed</td>
<td>Open</td>
<td>Open</td>
<td>Open</td>
<td>9</td>
<td>Yes</td>
<td>2100</td>
</tr>
<tr>
<td>Closed</td>
<td>Open</td>
<td>Closed</td>
<td>Closed</td>
<td>10</td>
<td>Yes</td>
<td>2200</td>
</tr>
</tbody>
</table>
Power Take Off (PTO)Variable Set Speed Control

- Not Available if using the Multi Position Switch (MPTS) option
  - Gives Variable Set Speed/Power Take Off, Isochronous and droop control
  - Input Disable, provided for safety and protection systems
  - Provides simple, Set Speed increase / decrease
  - Warning Lamp indication available
  - One Set Speed available
  - Pre-programmed speed
Power Take Off (PTO) Variable Set Speed Control

- ON / OFF
- SET / LOWER
- RAISE / RESUME
- SPEED 1 / SPEED 2
- DISCONNECT SWITCH
- PWM THROTTLE SENSOR
- SENSOR SUPPLY

- 43 SENSOR SUPPLY 8V
- 52 PWM THROTTLE SENSOR INPUT
- 38 PTO MODE - SET / LOWER
- 51 PTO MODE - RAISE / RESUME
- 33 SENSOR RETURN

Diagram showing connections and labels for PTO control.
Torque Speed Control (TSC1)

- Controlled Via the Controller Area Network (CAN) link:
  - Use J1939 message Torque Speed Control 1 (TSC1)
  - This is a speed demand signal, also known as a communications 'comms' throttle
  - CAN is the communication network between intelligent electronic devices (several ECM's) used on an machine application
  - Uses a version of CAN that conforms to an international standard known as SAE J1939

- Application control, monitoring and diagnostics is possible using SAE J1939
## Mode Selection

- A mode defines a fuel limit map, a rated speed and a droop value for each throttle input
- This feature provides the ability to select up to four different modes of operation
- A mode defines:
  - one of 2 ratings
  - a droop value for each throttle input, 0 - 10%
- Mode selection is controlled by 2 switched inputs

---

**Mode Selection.**

Electronic control allows a signal mechanical specification to deliver different rating curves and droop characteristics. Each combinations of rating and droop is known as a mode. Each ECM may be configured to offer up to eight different operating modes.

**Torque/Fuel Limit Maps.**

A maximum of four of four pre defined torque/fuel limit (Rating) curves may be selected when ordering the engine and these will be embedded into the ECM. These curves may in multi-mode operation be toggled to provide different characteristics whilst the engine is running.

**Varying Droop.**

Speed droop is the rate at which an engine will increase in speed if the load is reduced for a given throttle setting. A drop slope of 10% would give a typical road driving feel. Some applications, however, require tighter governing with only small variations of speed against load. A droop of 2% may be suitable for a PTO mode, some applications may need isochronous governing where the droop is 0%. (variable set speed is Isochronous).
Mode Selection.

This feature provides the ability to select up to eight different modes of operation under operator control. A mode defines a fuel limit map, a rated speed and a droop value for each throttle input.

Different modes of operation may be used to aid particular working environments by offering characteristics suitable for the work in hand. Examples would be an economy mode, a ploughing mode or a PTO mode.

Up to three digital switch inputs may be used to determine which mode of operation is required. With three switches, a maximum of eight modes may be specified; with two switches, four modes; and with one switch, two modes. Each mode has a single defined fuel limit map, a rated speed and a individual droop values for throttle 1, throttle 2 and the comms throttle.
## Typical Mode Selection Examples

<table>
<thead>
<tr>
<th>Mode Selection Switch Input 1</th>
<th>Mode Selection Switch Input 2</th>
<th>Mode Selection Switch Input 3</th>
<th>Mode Selection Number</th>
<th>Valid</th>
<th>Rating Number</th>
<th>Throttle 1 Droop Percentage</th>
<th>Throttle 2 Droop Percentage</th>
<th>Comms Throttle Droop Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open</td>
<td>Open</td>
<td>Open</td>
<td>0</td>
<td>Yes</td>
<td>1</td>
<td>10</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Open</td>
<td>Open</td>
<td>Closed</td>
<td>1</td>
<td>Yes</td>
<td>1</td>
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J1939 Datalink

- Advantages:
  - Uses less wiring
    - Lower weight
    - Lower cost
  - Fewer connections
    - Increased Reliability
  - Easier to install
  - Improved quality of signal
  - Can transfer large amounts of Data

Types of messages.
Commands (Torque Speed Control 1).
Requests for data.

Types of addressing.
Point to point.
Broadcast.
Example of J1939 Wiring

Note. CAN wiring must be twisted

DCR, Diagnostic Code Reader
GEM, Generic Engine Monitor
TSC, Torque Speed Control

Nodes

Data Bus

120 Ohm

DCR, Address 249
GEM, Address 23
TSC1, Address 3

ECM
J1939 Datalink

- Example of J1939 CAN Communications
- Transmission ECM to engine ECM:
  - ‘Requests’ an engine speed change for a period of time while transmission changes gear.
- Engine ECM to machine ECM:
  - ‘Broadcasts’ engine parameters (eg engine speed, oil pressure, coolant temp)
J1939 Datalink Fault Finding

- Do make sure “CAN high” and “CAN low” are wired correctly
- Do use 120Ω terminating resistors
- Do Make sure that no short circuits are present
- Do Check for possible electrical interference