

MoTeC**3D****V4.2****2 Group****Engine Management System****Sections**

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Overview

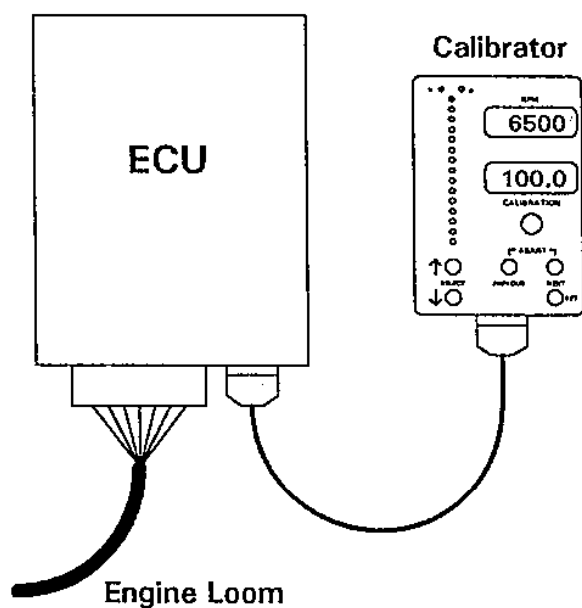
ECU

The Electronic Control Unit (ECU) is the heart of the *MoTeC* Engine Management System. The ECU analyses signals from the engine sensors then controls the Fuel Injectors, Ignition Coil and other actuators according to the Calibration and Setup data which is stored in its programmable memory.

Calibrator

The *MoTeC* Hand Held Calibrator may be used to adjust the ECU Setup and Calibration data, it may also be used to view the sensor readings, diagnostic errors and various operating parameters such as injector pulse width etc. See the Calibrator Operation and ECU Calibration Sections for details.

The Calibrator is not required for normal operation of the ECU.



Calibration Tables

The Calibration Tables determine how the output devices should be controlled for various sensor readings. e.g. The Fuel calibration table determines the pulse width for the Fuel Injectors for all combinations of RPM and Load.

The table below shows a typical Fuel Calibration Table.

LOAD	RPM													
	0	500	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	6500
100	38.0	40.0	41.0	43.0	45.5	55.0	53.0	55.0	56.5	58.0	59.5	60.5	62.0	64.0
90	38.0	39.0	40.0	42.0	42.0	50.0	50.5	51.0	52.5	52.5	55.5	57.5	59.5	61.5
80	38.0	39.0	39.5	41.5	40.5	45.5	48.0	45.5	46.5	49.0	51.5	53.5	55.5	56.0
70	38.0	38.5	39.0	40.0	38.5	42.5	43.5	43.0	43.0	43.5	46.5	44.5	44.0	44.5
60	38.0	38.0	39.0	39.5	37.5	38.0	41.0	41.0	41.5	41.0	43.5	42.5	41.5	42.0
50	38.0	38.0	38.5	39.0	37.0	36.0	39.0	39.5	39.0	40.0	41.0	39.0	38.0	38.0
40	32.0	31.5	32.0	33.0	32.0	31.0	33.0	34.0	33.5	34.5	35.5	34.5	33.5	33.5
30	25.5	26.0	25.5	27.0	26.0	27.0	28.0	29.0	28.5	28.0	28.0	28.0	28.0	27.0
20	20.5	21.0	29.5	20.5	21.5	22.5	22.5	25.5	27.5	27.0	26.0	27.0	26.0	25.0
10	18.0	17.5	17.0	18.5	18.5	19.5	19.5	22.0	24.0	24.5	24.5	24.5	24.5	22.5
0	14.0	14.0	14.5	15.0	15.5	16.5	18.0	20.0	20.0	21.0	20.5	20.0	20.0	19.5

The various RPM points are referred to as RPM Sites, similarly the various LOAD points are referred to as LOAD Sites.

The ECU determines the amount of fuel to inject by first calculating the RPM and Load then extracting the corresponding value from the table. If the RPM and Load do not match an RPM and LOAD point exactly then the values from the closest sites are mathematically interpolated to arrive at an in-between value. e.g. If the engine RPM is exactly 4250 then the interpolated value will be half way between the value from the 4000 RPM and 4500 RPM sites.

Note that when the engine RPM (or Load) is between table sites then the current fuel value is effected by the sites to either side. For this reason when changing the calibration values it is important that the engine RPM (and Load) are very close to the current adjustment site to ensure that the values from the adjacent sites have minimal influence on the value being adjusted.

Setup Parameters

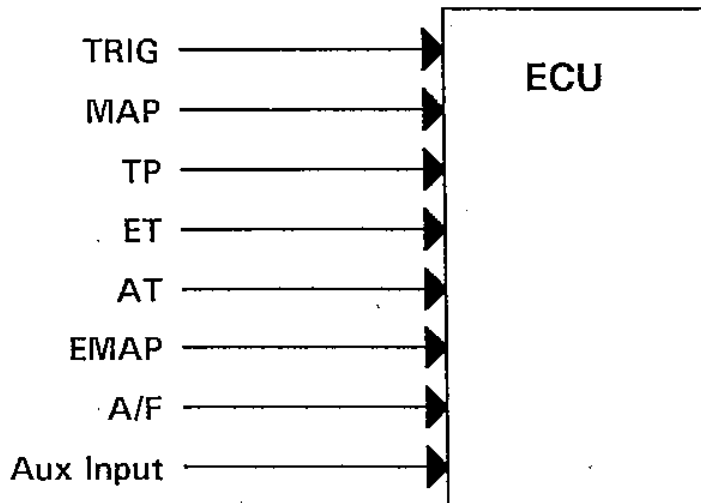
The Setup parameters allow the ECU to be configured for almost any engine. The Setup Parameters include Number of Cylinders, Ignition Type, Sensor Types, Injector Current, Auxiliary Output Function etc.

MAP or TP Load Control

The Load for the Fuel and Ignition tables may be based either Manifold Pressure (MAP) or Throttle Position (TP). Throttle Position is recommended for normally aspirated engines and Manifold Pressure for Turbo Charged engines.

Engine Sensors

The engine sensors provide the ECU with the information necessary to perform its various control tasks.

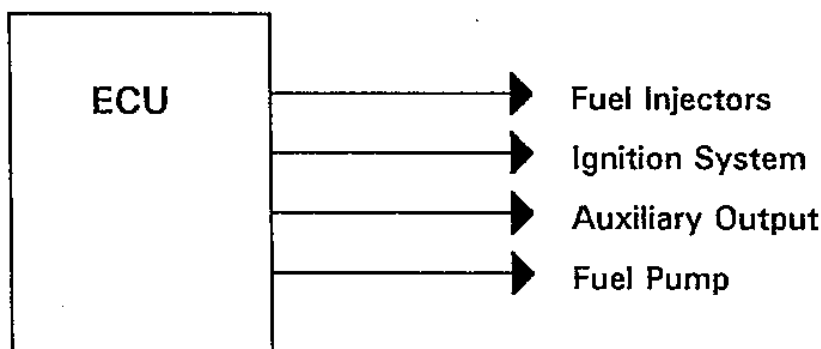


TRIG	Crank Trigger	Generates a signal to tell the ECU when the crank passes particular degree marks. Normally a signal is generated at approx. 10 deg BTDC for each cylinder i.e. 4 reference marks per engine rev on an 8 cylinder. The Engine RPM is also determined from this signal.
MAP	Manifold Absolute Pressure	Measures the Intake Manifold pressure if * Manifold Pressure controlled. Optionally measures barometric pressure if Throttle Position controlled.
TP	Throttle Position	Measures the current Throttle Position. Optional if Manifold Pressure controlled.
ET	Engine Temperature	Measures the current Engine Temperature. Normally placed to measure the water temperature.
AT	Air Temperature	Measures the current Air Temperature. Should placed to measure the air temperature before the butterfly (Between the inter cooler and the butterfly on Turbo charged engines)
EMAP	Exhaust Pressure (Optional)	Measures the Exhaust Manifold back pressure on Turbo Charged engines. (Not normally required)

A/F	Air Fuel Ratio (Optional)	Measures either Narrow band O ₂ or Wide band Air Fuel Ratio (Using the <i>MotEC</i> Air Fuel Ratio Meter).
Aux In	Auxiliary Input (Optional)	Used either to synchronise the Injectors or to signal that Nitrous Enrichment and Retard is required.

Output Signals

The ECU output signals are used to control the Fuel Injectors, Ignition System etc.



Fuel Injector Outputs

Two groups of injectors may be driven by the ECU. The amount of current delivered to the injectors may be programmed to suit the number and type of injectors. The two injector groups may be fired either once per engine rev at the same time, once per engine rev on alternate half revs or once per two engine revs on alternate revs.

Ignition System Output

The Ignition System Output drives an Ignition Module which then drives the Ignition Coil.

This output may be configured to drive a number of different types of ignition modules.

Auxiliary Output

The Auxiliary Output may be used for a number of different functions including, Turbo Waste Gate Control, Idle Speed Control, Electric Cooling Fan Control, Air Conditioner Cut Out, Fuel Used Pulse, RPM Activated Output or Tacho Output.

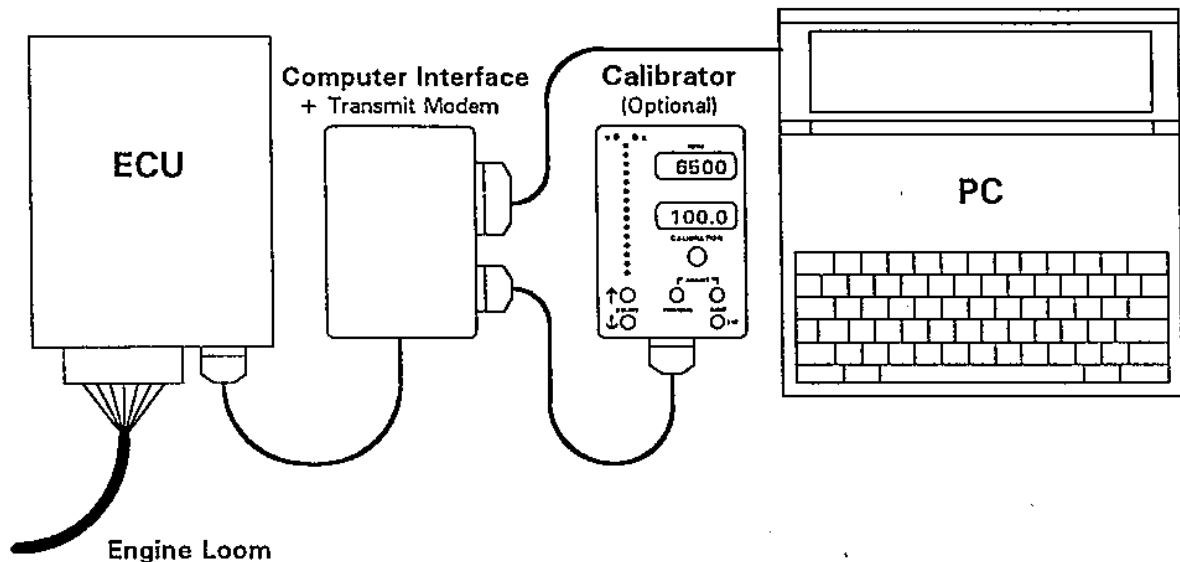
Fuel Pump Output

The Fuel Pump output may be used to control the Fuel Pump Relay. This ensures that the Fuel Pump is off whenever the engine RPM is zero.

Personal Computer (PC)

A PC may be connected to the ECU in one of two ways :

1. *Direct Connection*



An IBM PC compatible computer may be direct connected to the ECU via the *MoTeC* Computer Interface as shown above. See the Computer Interface section for more detail.

The E.M.P. and MONITOR Software (Detailed below) may be used when the PC is connected in this manner.

2. *Telemetry Link Connection*

The ECU may connect to a PC via either the 1200 Baud or 9600 Baud Telemetry Links. The 9600 Baud Link can transmit data four times faster than the 1200 Baud link. The 1200 Baud link can transmit all engine parameters 3 times per second whereas the 9600 baud link can transmit all engine parameters 20 times per second.

See the 1200 Baud Telemetry Link or 9600 Baud Telemetry Link sections for details.

Only the MONITOR Software (Detailed below) may be used when the PC is connected in this manner.

E.M.P. Software

The *MoTeC* Engine Management Program (E.M.P.) provides an alternative method of calibrating the ECU.

E.M.P. provides additional facilities not available when using the calibrator alone, including the following :

- Storage of the Calibration Data on disk.
- Printing of the Calibration Data.
- Viewing of the Calibration data in tabular form.
- 3 Dimensional Graphing of the Calibration Data.
- Transfer of the Calibration Data from disk to the ECU.
- Viewing of all Engine Sensor Values and other ECU Operating Parameters on one screen.
- Graphical RPM and Load Indicators.
- Table Interpolation.
- Injector Test and Ignition Test modes.
- Context Sensitive Help.

See the E.M.P. Software section for more detail.

MONITOR Software

The *MoTeC* MONITOR Program allows Monitoring and Data Logging of various ECU sensors and parameters.

MONITOR may be used for direct monitoring of the ECU or for monitoring over a Telemetry Link.

See the MONITOR Software section for more detail.

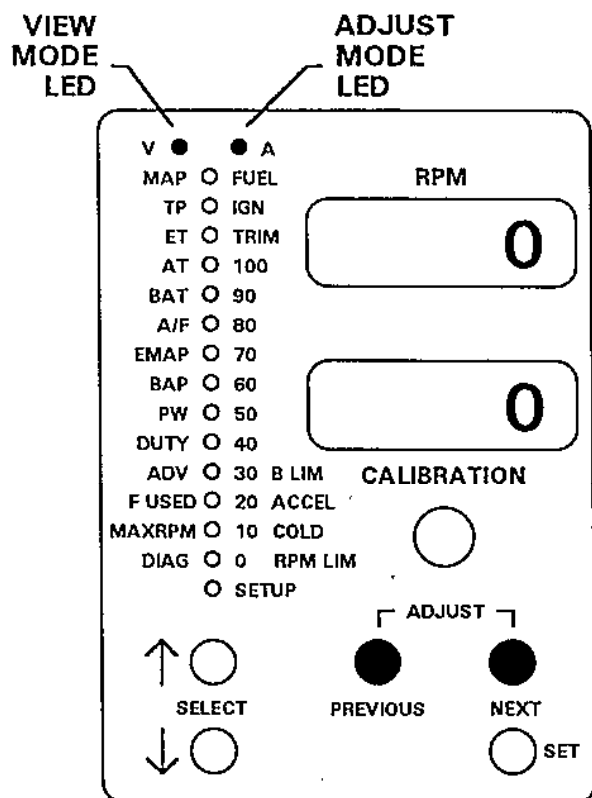
VIEW Software

The *MoTeC* VIEW Program allows viewing and printing of the logged data produced by the MONITOR Program.

See the VIEW Software section for more detail.

Calibrator Operation

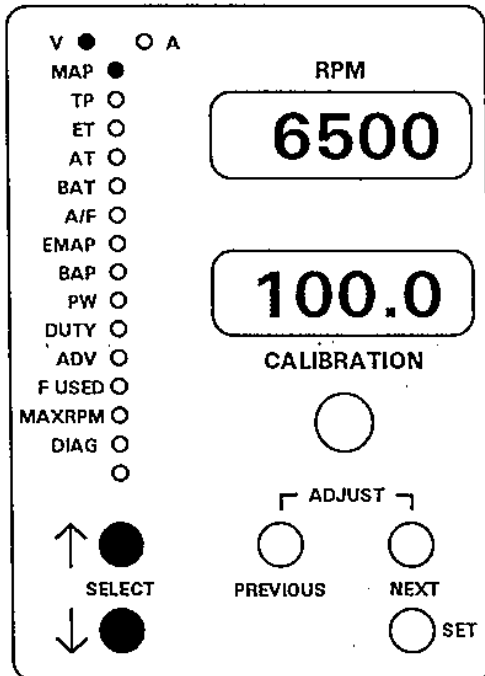
SELECTING VIEW OR ADJUST MODE



- The LEDs at the top of the calibrator indicate the current mode.
- To change between **VIEW** mode and **ADJUST** mode press the **PREVIOUS** and **NEXT** buttons simultaneously.
- **Note** If the Password has been set the calibrator will not enter Adjust Mode until the password is entered.
- At power up the calibrator will be in **VIEW** mode.

VIEW MODE

Selecting the View Item



- Switch to VIEW Mode then press the SELECT buttons until the LED next to the desired item is illuminated.
- The text to the left of the LEDs indicates the selected item.
- The top display shows the current engine RPM except if viewing the Diagnostic Errors or Software Version.
- The bottom display shows the value for the selected item.
- In the example the selected item is MAP (Manifold Pressure), it's value is 100.0 kPa and the current RPM is 6500.

View - MAP (Manifold Absolute Pressure)

Use the SELECT buttons to select MAP.

The bottom display shows the MAP sensor value in kPa.

The MAP sensor may be vented to atmospheric or connected to the intake manifold depending on whether the system is Throttle Position or Manifold Pressure controlled.

Note 100 kPa = 1 Bar = 14.5 PSI = 29.5 in Hg.

View - TP (Throttle Position)

Use the SELECT buttons to select TP.

The bottom display shows the Throttle Position.

Range : 0 to 100.

If the SETUP parameters *TPLO* and *TPHI* have been set correctly then the value should be 0 when the throttle is closed and should graduate smoothly towards 100 when the throttle is fully open.

View - ET (Engine Temperature)

Use the SELECT buttons to select ET.

The bottom display shows the Engine Temperature in degrees C.

Note $100\text{ deg C} = 212\text{ deg F}$.

View - AT (Air Temperature)

Use the SELECT buttons to select AT.

The bottom display shows the Air Temperature in degrees C.

Note $25\text{ deg C} = 77\text{ deg F}$.

View - BAT (Battery Voltage)

Use the SELECT buttons to select BAT.

The bottom display shows the Battery Voltage in Volts.

If the charging system is working correctly and the engine RPM is high enough then the battery voltage should be between 13.5 and 14.5 Volts.

View - A/F (Air Fuel Ratio)

Use the SELECT buttons to select A/F.

If a Narrow Band A/F sensor is fitted and the Setup is set for Narrow Band control then the bottom display shows the sensor voltage in milli Volts.

If the *MoTeC* Wide Band Air Fuel Ratio Meter is connected to the ECU then the bottom display shows Lambda x 100, i.e. 0.85 Lambda is shown as 85.

View - EMAP (Exhaust Manifold Absolute Pressure)

Use the SELECT buttons to select EMAP.

If an EMAP sensor is fitted then the bottom display will show the Exhaust Absolute Manifold Pressure in kPa.

The Barometric Pressure (BAP) is shown if the EMAP sensor is not used.

Note $100\text{ kPa} = 1\text{ Bar} = 14.5\text{ PSI} = 29.5\text{ in Hg}$.

Note Fluctuations in readings greater than 5 kPa are undesirable and should be dampened by restricting the line.

View - BAP (Barometric Absolute Pressure)

Use the SELECT buttons to select BAP.

The bottom display shows the Barometric Pressure in kPa.

The BAP value is determined by reading the MAP sensor value when the ECU is powered up and the engine RPM is zero. If the engine RPM is not zero then the default BAP value is used. To set the default BAP value, turn the ECU on (with the engine off), select BAP, wait till the value stabilises then press the SET button.

Note 100 kPa = 1 Bar = 14.5 PSI = 29.5 in Hg.

View - PW (Injector - Pulse Width)

Use the SELECT buttons to select PW.

The bottom display shows the Injector Pulse Width in msec.

NEXT Button If the NEXT button is held down then the Acceleration Enrichment contribution will be displayed.

View - Acceleration Enrichment

Use the SELECT buttons to select PW then hold the NEXT button down.

The bottom display shows the Acceleration Enrichment in msec.

View - DUTY (Injector - Duty Cycle)

Use the SELECT buttons to select DUTY.

The bottom display shows the Injector Duty Cycle in %

The Injector duty cycle must typically not exceed 85 % (depending on the Injector type and the RPM). This ensures that the Injectors are working in the linear range. If the Injectors exceed their maximum duty then larger injectors or higher fuel pressure is needed.

NEXT Button If the NEXT button is held down then the Auxiliary Output Duty Cycle will be shown.

View - Auxiliary Output Duty Cycle

Use the SELECT buttons to select DUTY then hold the NEXT button down.

The bottom display shows the Auxiliary Output Duty Cycle in %.

View - ADV (Ignition Advance)

Use the SELECT buttons to select ADV.

The bottom display shows the Ignition Advance in degrees Before Top Dead Center (deg BTDC).

The value does not include the Ignition Trim value as this is normally used to account for the static timing offset which is used as the timing point during cranking and is normally set to approximately 10 deg BTDC. The Ignition Trim can be adjusted to ensure that the displayed value agrees with a Timing Light.

View - F USED (Fuel Used)

Use the SELECT buttons to select F USED.

The bottom display shows the Fuel Used value.

If the SETUP Fuel Used calibration parameter is zero then the Fuel Used is displayed in total effective pulse widths since power on, measured in seconds.

If the SETUP Fuel Used Calibration parameter has been set then the units are dependant on the calibration value. Typically it may read in 0.1 Litres or 0.1 Gallons.

The value may be reset to zero by pressing the SET button.

Note If the ECU power is removed then the value will be reset to zero.

View - MAXRPM (Maximum RPM)

Use the SELECT buttons to select MAXRPM.

The bottom display shows the maximum RPM reached since power on.

The value may be reset to zero by pressing the SET button.

Note If the ECU power is removed then the value will be reset to zero.

View - DIAG (Diagnostics)

Use the SELECT buttons to select DIAGS

The errors are divided into two groups which are shown on either display. More than one error may be shown on either display.

The Diagnostics Errors record momentary errors as well as permanent errors. If the ECU power is interrupted the momentary errors will be lost.

Non current errors may be cleared by pressing the SET button. Errors that are still current cannot be cleared.

Note Sensors that are not fitted (e.g. EMAP) will show a diagnostics error permanently.

Top Display

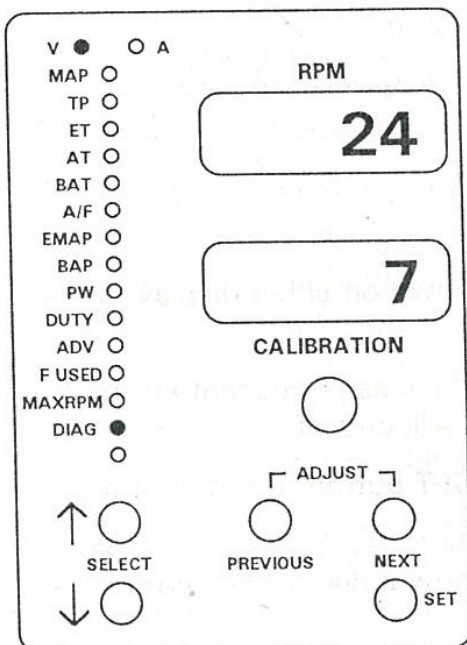
- 0 No Errors
- 1 Crank Sensor Error
- 2 RPM Limit Exceeded
- 3 ECU Reset while Engine Running
- 4 Injector Maximum Duty Exceeded
- 5 Synchronisation Pulse Error
- 6 Battery Voltage below 10V while engine above 2000 RPM
- 7 Internal Memory Error
- 8 Overboost

Bottom Display

- 0 No Errors
- 1 Ignore
- 2 MAP Sensor Error
- 3 TP Sensor Error
- 4 AT Sensor Error
- 5 ET Sensor Error
- 6 Battery Voltage Error
- 7 EMAP Sensor Error
- 8 A/F Sensor Error

The Diagnostics Errors also appear in Appendix L - Diagnostics Errors.

Example



The example shows the following Diagnostics Errors.

Top Display

- 2 RPM Limit Exceeded.
- 4 Injector Maximum Duty Exceeded.

Bottom Display

- 7 EMAP Sensor Error.

Setting the View Power Up Item

To select an item as the power up item, first select the item then press the SET button. On power up this item will be selected.

Exceptions :

When viewing MAXRPM or DIAG or FUEL USED pressing the SET button once will clear the current value, pressing the SET button again will select the item as the power up item.

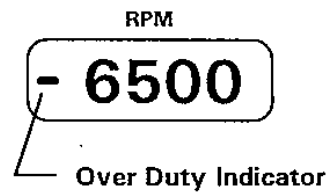
When viewing BAP pressing the SET button once will set the default BAP value, pressing the SET button again will select the item as the power up item.

Over Duty Indicator

If the maximum injector duty cycle is exceeded the Diagnostics Error and Over Duty Indicator are set .

The indicator will stay set until the Diagnostic Errors are Reset. (Press the SET button while viewing DIAGS).

The Over Duty Indicator is shown at the left of the top display.



View - Software Version

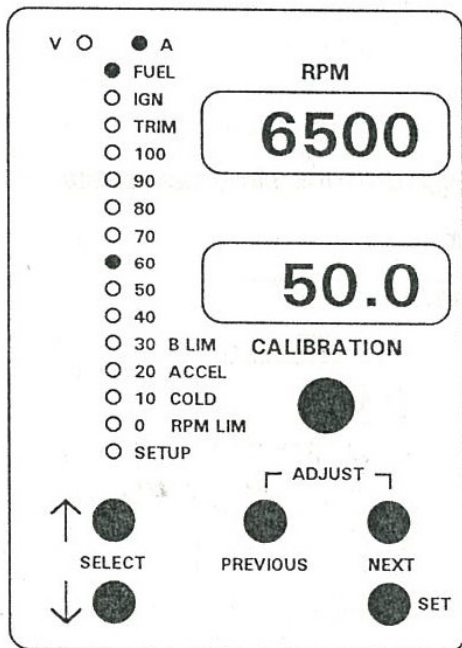
To view the ECU Software Version press both SELECT buttons simultaneously.

The top display shows the Software Version number.

The bottom display shows the software creation date.

ADJUST MODE

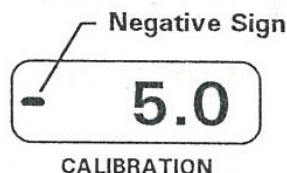
Selecting the Adjust Item



- Switch to ADJUST Mode then press the **SELECT** buttons until the LED next to the desired item is illuminated.
- The text to the Right of the LEDs indicates the selected item.
- Use the **PREVIOUS** and **NEXT** Keys to select the desired RPM site or Parameter Abbreviation (if any) (shown on the top display).
- If the table has Load Sites an additional LED will show the current site (0 to 100). Use the **SELECT** buttons to change the current Load Site.
- The bottom display shows the calibration value for the current table item. The **KNOB** is used to change the calibration value and the **SET** button is used to lock in the new calibration value. The **SET** button must be pressed before pressing any other buttons otherwise the calibration value will revert to its previous value.
- In the example the selected table is **FUEL**. The current Load Site is 60, the current RPM Site is 6500 and the calibration value is 50.0.
- Refer to The ECU Calibration Section for more detail on each Adjust item.

Negative Calibration Values

Some adjustments allow negative values to be entered e.g. Fuel Trim. To enter a negative value turn the **KNOB** anti clockwise past zero. A bar at the left of the bottom display indicates a negative calibration value.

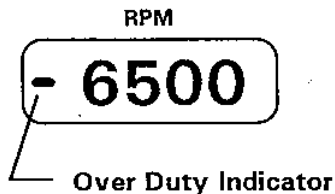


Over Duty Indicator

If the maximum injector duty cycle is exceeded the Diagnostics Error and Over Duty Indicator are set.

The indicator will stay set until the Diagnostic Errors are Reset. (Switch to VIEW mode then press the SET button while viewing DIAGS).

The Over Duty Indicator is shown at the left of the top display.

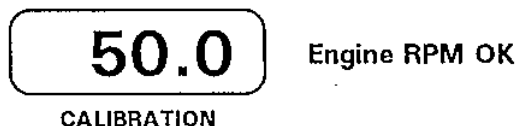


RPM Cursors

The RPM Cursors show if the current engine RPM is close to the currently selected RPM Site.

The current Engine RPM must be close to the current RPM Site to ensure that changes to the calibration value change the current engine tuning and any influence from the adjacent sites is minimised.

The RPM Cursors are shown at the left of the bottom display.



Load Cursors

The Load Cursors show if the current engine Load is close to the currently selected Load Site.

The current Engine Load must be close to the current Load Site to ensure that changes to the calibration value change the current engine tuning and any influence from the adjacent sites is minimised.

The Load Cursors are shown at the left of the bottom display.

, 50.0

CALIBRATION

Engine Load too Low

50.0

CALIBRATION

Engine Load OK

' 50.0

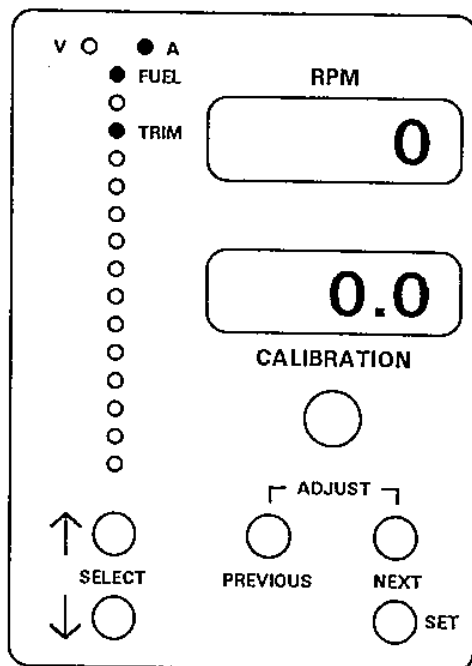
CALIBRATION

Engine Load too High

ECU Calibration

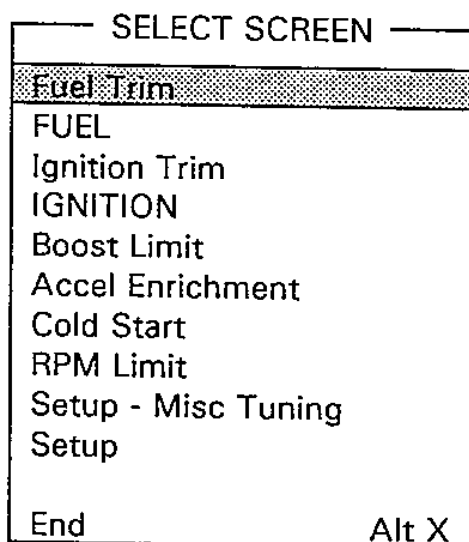
FUEL TRIM

Calibrator Operation



- Enter Adjust Mode
- Select FUEL & TRIM using the SELECT buttons.
- Use the KNOB to change the calibration value (shown in the bottom display).
- Press the SET button to Lock in the new calibration value.
- Refer to the Calibrator Operation section for more detail.

E.M.P. Software Operation



- Select Adjust from the Main Menu
- Select Fuel Trim from the Select Screen Menu.
- Use the Page Up & Page Down Keys or the Calibrator KNOB to change the calibration value. Press Ctrl for fast adjustments.
- Press the Enter key to Lock in the new calibration value.
- Refer to the E.M.P. Software section for more detail.