

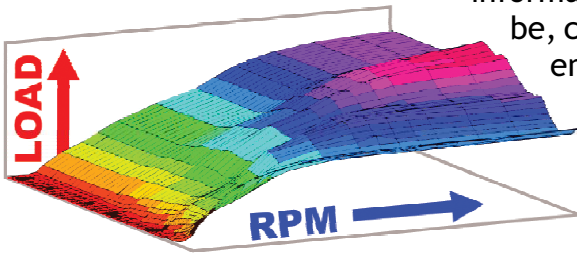
Diesel Control ECU

OPERATOR MANUAL



Few people would disagree that a diesel tuning box is no match for a properly executed remap.

To map an engine properly, in accordance with engine speed (rpm) and load, it is essential to know what the engine speed and load values actually are at any given moment. Devoid of such information, diesel tuning boxes, however sophisticated they may be, can't compete with a professional diesel engine remap. A full engine remap, performed by a professional remap specialist, will always be able to out-perform any diesel tuning box in terms of performance, economy and drive-ability.



Despite this, diesel tuning boxes remain popular for a number of reasons, not least because they're often simple to install and can quickly be uninstalled should a potential warranty issue arise. Another likely factor is price; diesel tuning boxes can be less expensive than a professional remap, at least in the short term. Of course this perspective does not take into account the cost of any damage resulting from poor fuel control, especially where vehicles are fitted with Diesel Particulate Filters that can quickly become blocked when using a diesel tuning box due to frequent excessive fuelling.

There are, however, a growing number of vehicles for which a diesel tuning box is the only practical option. Improvements in vehicle engine management technologies, especially in recent years, have brought about an increase in processor sophistication and code protection securities that put conventional ECU remapping under threat.

While such complications do not necessarily make ECU remapping an impossibility, the increased difficulties and risks associated with such procedures can make the work extremely specialised and prohibitively expensive.

Even if it is practical to carry out an ECU remap, there are a number of potential issues to consider. If a remap can be performed without opening the vehicle's ECU:

- Will remapping be detected by dealer equipment and will it affect the vehicle's warranty?
- If an error should occur during reprogramming, could the ECU be rendered inoperable?
- Could the new map be overwritten during routine servicing and dealer firmware updates?

If a remap cannot be performed without opening the vehicle's ECU:

- Can the ECU be opened without risk of damage?
- Will the vehicle warranty be affected by opening the ECU?
- Can successful remapping be guaranteed once the ECU has been opened?

The Diesel Control ECU addresses all of these issues by combining most of the benefits of a full fuel remap with the ease of installation & removal of a diesel tuning box. Unique, patented injection sensing technology enables it to measure injection duration and frequency which, when combined with fuel rail pressure sensor readings, allows it to instantly and continuously calculate engine speed and load.

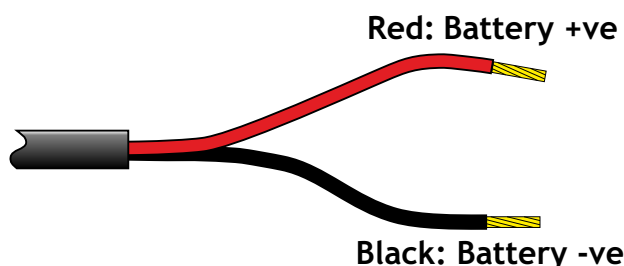


Innovative calibration and mapping processes make the Diesel Control ECU highly universal and able to accurately map the fuelling of most common rail diesel engines easily and non-intrusively.

In addition, the Diesel Control ECU provides a host of other features that are not available in any other product, including LPG/CNG dual-fuel control and (with the addition of an optional driver) nitrous control.

NOTE: The installer must have access to an OBD scan tool capable of reading manufacturer-specific data and it is recommended that the engine management system is checked for fault codes before proceeding with the installation.

CONNECTION 1 2 3 *Power Supply*



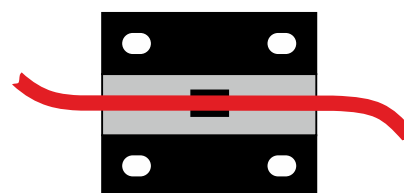
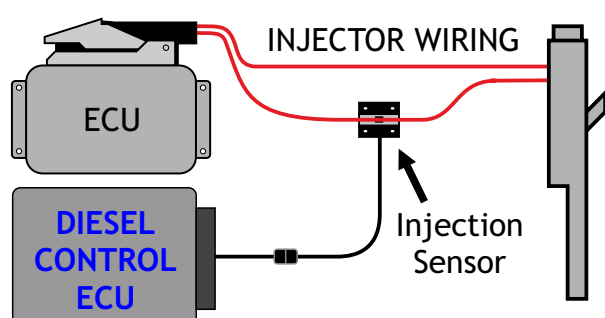
The unit requires a single, fused 12 volt power connection. Ignition on/off states are determined automatically so a permanent (battery +ve) supply may be used for convenience.

For more power configuration options, please refer to the technical manual.

CONNECTION 1 2 3 *Injector Sensor*

The patented injector sensor technology employs a non-intrusive clamp-over design that can sense injector current (and therefore determine injector duration and frequency) without the need to cut injector wires or make any direct connections to the injector circuitry.

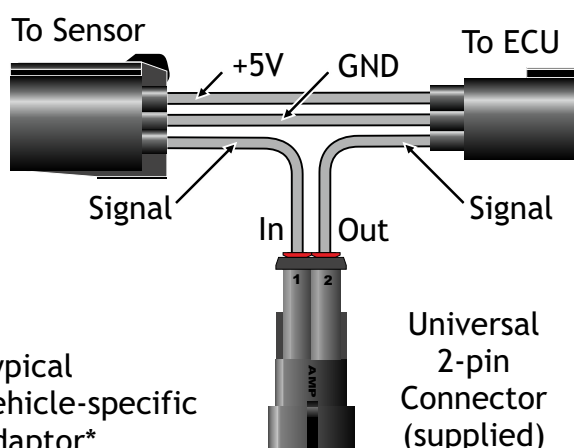
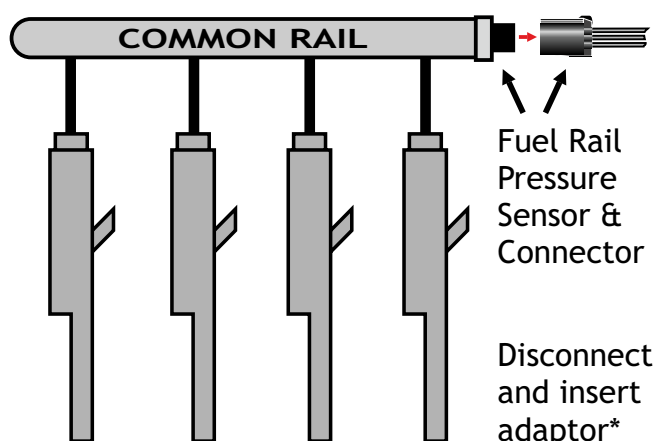
The injection sensor (supplied) should be securely clamped over any one of the two injector wires (of any injector). Please ensure that the wire is positioned centrally and directly over the sensor chip. A unique, patented signal processing system automatically determines the injector signal type (eg piezo or inductive) and polarity, regardless of sensor position or orientation.



Lay the injector wire over the sensor and secure the cover with cable ties

CONNECTION 1 2 3 *Fuel Rail Pressure*

The fuel rail pressure sensor signal must be intercepted to enable manipulation of fuel rail pressure. A vehicle-specific adaptor* can be used to avoid the need to cut wires and to allow for quick removal and refitting. The adaptor should be used in conjunction with the universal 2-pin connector (supplied).



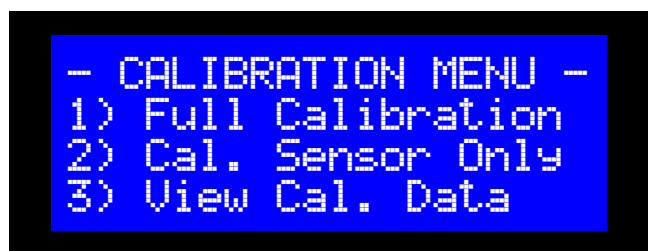
* Where available (optional item).

Introduction

The calibration process is one of the most innovative and unique features of the Diesel Control ECU. It allows the operator to easily calibrate the device, quickly and automatically, to work with most diesel engine management systems and injector types.

During calibration, the Diesel Control ECU learns engine characteristics and fuelling parameters, so it is important to complete each of the calibration steps to ensure that the full range of engine operating conditions are met, measured and recorded.

The full calibration procedure consists of 3 distinct steps; **Sensor Calibration**, **Idle Calibration** and **Drive Calibration**. Following installation, or when performing a calibration for the first time, a full calibration is required. If subsequent sensor adjustment or repositioning becomes necessary, a sensor-only calibration (menu option 2) may be performed.



Full Calibration will automatically commence after the initial installation (or following a full factory reset) as soon as power is applied. To start the calibration process manually, select **3** from the **Main Menu** then select the required option from the **Calibration Menu** (shown left). The calibration process can be aborted at any time by pressing *****.

NOTE: For correct and accurate operation, please ensure that the engine is at normal operating temperature and that the engine has no management or mechanical faults before proceeding with the calibration process.

STAGE 1 **Sensor Calibration**

Sensor Calibration enables the Diesel Control ECU to optimise the injector signal levels and automatically determine the injector type, sensor orientation and signal quality. It does this by repeatedly analysing and adjusting the sensor signal, while at a constant engine running state (idle), until it is able to derive a stable and consistent injection pulse.

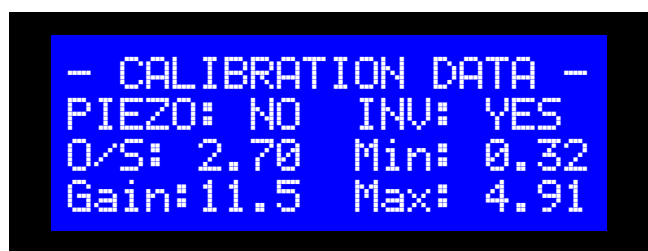


Sensor Calibration in progress (typical values)

NOTES:

- Engine must be running at a steady idle speed.
- Fully automatic - No operator intervention.
- Process takes approximately 25 seconds.

The Diesel Control ECU will adjust the signal level (gain) and offset throughout, until the signal has been successfully detected and optimised.



Sensor Calibration complete (typical values)

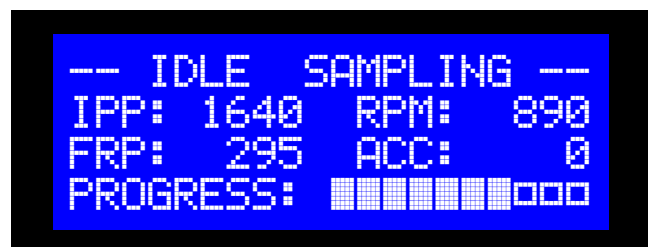
NO SIGNAL will be displayed in the bottom left of the display if the engine is not running or there is a problem with the injector sensor. If this occurs, please check that the engine is at idle and the sensor is correctly positioned on the injector wire. Recheck or relocate the injector sensor if necessary.

When sensor calibration is complete, the calibration data is briefly displayed before calibration continues.

The information this data provides can be useful in helping to resolve any sensor position related issues. See the troubleshooting guide for more information.

STAGE 1 2 3 *Idle Calibration*

Idle Calibration provides the Diesel Control ECU with baseline reference data and allows it to learn more about the type of system it is installed on. The process takes just a few seconds to sample the injection input pulses (IPP), the RPM and the Fuel Rail Pressure (FRP). ACC measures engine acceleration rate and therefore should remain close to zero throughout, indicating a steady engine idle state. If idle is insufficiently stable an unstable warning will be displayed and calibration may restart.



Idle Calibration in progress (typical values)

NOTES:

- Engine must be running at a steady idle speed.
- Fully automatic - No operator intervention.
- Process takes approximately 10 seconds.

The progress bar indicates the time remaining, while idle data such as injector pulse width, fuel rail pressure and engine speed are sampled.



Idle Calibration complete (typical values)

The Diesel Control ECU uses the sampled data to calculate the typical idle state, a summary of which is displayed briefly (approximately 5 seconds) when Idle Sampling is complete.

This data is displayed for information and diagnostic purposes only.

STAGE 1 2 3 *Drive Calibration*

This is a semi-automatic stage that captures the upper parameters of the engine and its management system. It is important to ensure that maximum values are reached to allow the system to properly determine the control parameters.

The vehicle should be driven to capture the maximum injector input pulse (IPP) duration and fuel rail pressure (FRP) - these are generally largest during moments of sudden, short bursts of acceleration or under heavy load.



Drive Calibration in progress (typical values)

To capture maximum engine acceleration (ACC) and speed (RPM), on most manual vehicles this can be achieved by quickly revving the engine to the red-line two or more times while stationary. On some automatics, it may be necessary to drive the vehicle in 1st gear, accelerating the engine as quickly as possible to the red-line limit.



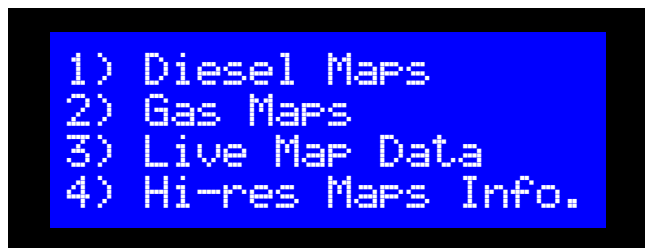
Drive Calibration complete (typical values)

The data values displayed are the maximum values recorded (not the live data). Continue with the drive calibration procedure until no further increases are observed. When the maximum values have been captured, press the # key to continue. The Diesel Control ECU will respond with the message 'COMPLETE' and the recorded maximum values will display briefly before returning to the menu system.

To review calibration data at a later time, select option 3 from the calibration menu.

Fuel Map Menus

The Diesel Control ECU's fuel maps allow the operator to accurately increase or decrease fuel delivery at specific engine speed/load points, while intermediate points are automatically calculated using interpolation. There are 10 fuel maps in total, switchable in 5 pairs; 5 diesel fuel maps and 5 'gas' fuel maps. The gas fuel maps can be used for dual-fuel applications (eg Diesel-LPG/CNG) or Nitrous Oxide control (using an optional driver). For diesel-only applications, the gas fuel maps can be ignored.



The Fuel Maps Menu (Main Menu item #1)

The **Fuel Maps** menu (Main Menu item 1) gives access to the diesel and gas map menus, live map data and hi-resolution map information (for advanced users).

The live map data screen can be used to monitor fuelling while adjusting maps. Press 3 to toggle between live data and the help screen information.



A Diesel Map Menu (Fuel Map Menu item #1)

The **Diesel Map** and **Gas Map** menus provide access to map and band editing features. The first line indicates the map to be edited (Diesel Map #1 in the example).

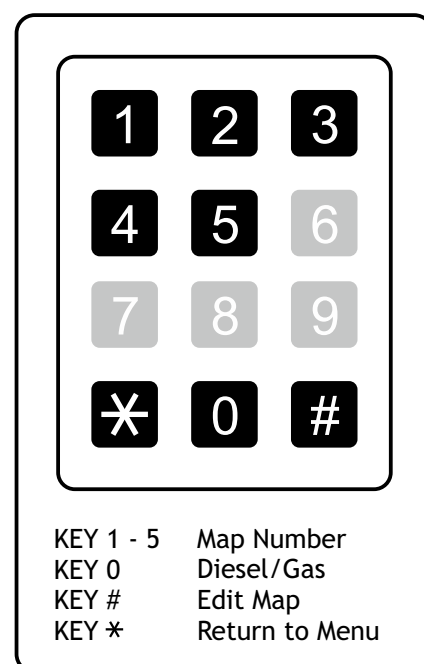
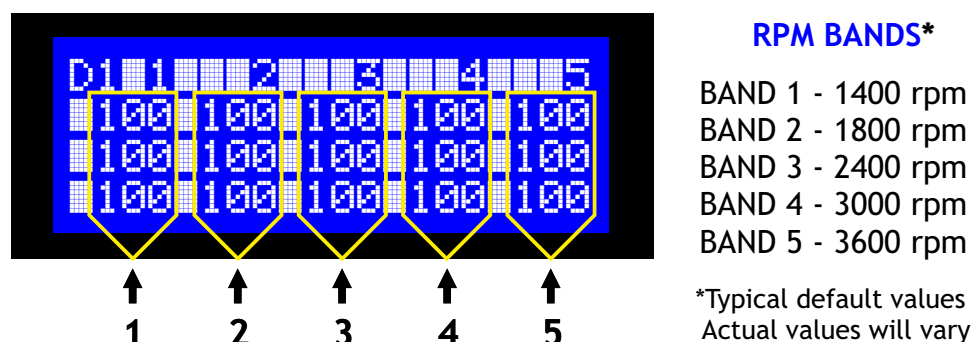
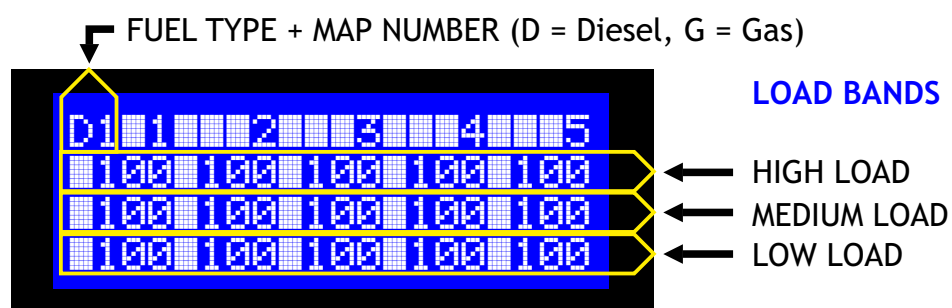
Use option 2 to select a different map number.

TIP: Press zero to quickly toggle between the diesel and gas map menus.

Fuel Maps

The fuel map view/edit screen is divided into fifteen fuel map cells, comprising of three load bands and five rpm bands. Intermediate values are automatically interpolated to provide a smooth transition between bands. Values in the left-most column control fuelling when the engine speed is near that of the lowest rpm band, while values in the bottom row control fuelling when the engine load is near that of the lowest load band.

The top row contains the fuel type and number of the selected map (top left) and the column numbers of the rpm bands. A value of 100 (100%) = standard (i.e. no fuel increase or decrease).



Fuel Map Bands

During initial calibration, the Diesel Control ECU gathers information, including idle data and maximum rpm and load which it uses to generate vehicle-specific fuel map bands. Although in many cases these bands will not require any adjustment, if greater control is needed at a particular engine speed or load, the bands can easily be moved to suit.

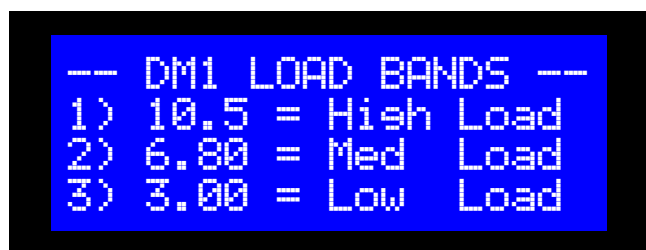
NOTE: After adjusting bands, the relevant fuel map should be reset and recreated to re-align it.



Diesel Map 1 RPM Bands (typical default values)

To adjust the bands for any of the fuel maps, select Fuel Map Bands (option 3) from the relevant diesel or gas map menu. Select the number that corresponds with the band you wish to edit then press 2 to increase the value or 8 to decrease the value. Press # to save.

RPM Bands include a 'start' value that sets the rpm at which fuel control begins.



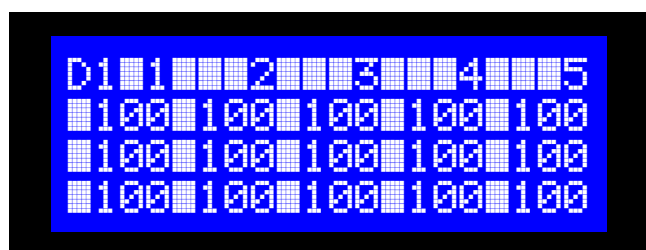
Diesel Map 1 Load Bands (typical default values)

NOTE: Band value adjustment is limited to prevent overlap. To increase or decrease a value beyond its limit it may be necessary to adjust the adjacent value first.

To reset the bands back to their calculated default values, select option 3 from the Fuel Map Bands menu and select the bands that are to be reset.

Editing Fuel Maps

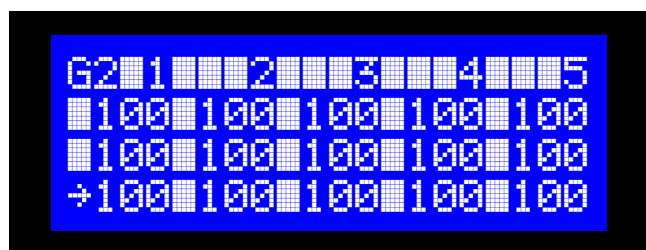
To view or edit a fuel map, first select option 1 from any fuel map menu to view the map data.



Viewing Map Data (Diesel Map 1 - All cells 100%)

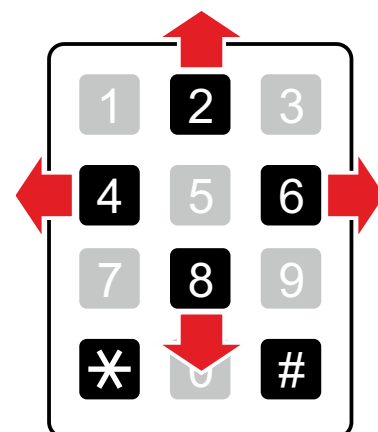
The map data is initially displayed in view-only mode.

In the example (left) the current map is indicated in the top left of the screen, D1 (diesel map number 1) and all map cells have been reset to 100%. To select a different map, press the corresponding keypad number from 1 to 5. To switch from a diesel map to a gas map (or vice versa), press key 0 (zero).



Cell Selection Mode (Showing G2 - Gas Map 2)

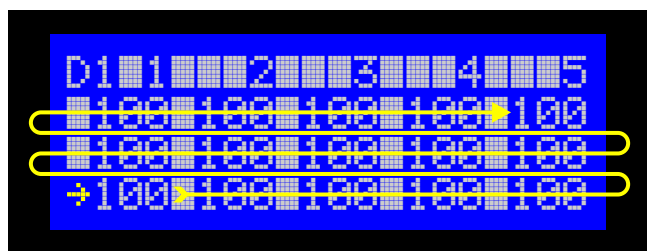
KEY 2	Move Up
KEY 4	Move Left
KEY 6	Move Right
KEY 8	Move Down
KEY #	Edit/Save
KEY *	Back/Cancel



To begin editing the fuel map, press the # key to enter cell selection mode. An arrow appears, indicating the cell to edit. To select a different cell, move the arrow using the keypad as shown. To edit the selected cell, press the # key. A flashing cursor appears, indicating cell edit mode is active.

Creating Fuel Maps

If a block of cells or an entire fuel map is to be created or edited, it may be edited consecutively by starting at the lowest and left-most cell. As each digit is entered the cursor will automatically move to the next digit and then on to the next cell along after 3 digits have been entered. At the end of each row, the cursor will move up to the first (left-most) cell of the row above.



Consecutive Editing: Direction of cursor travel

Press # to finish editing and confirm the changes.

Press * to finish editing and cancel the changes.

After confirming or cancelling cell edits, the display returns to cell selection mode. To remove the arrow and return to fuel map view mode, press *.

Press * again to return to the fuel map menus. If edits have been made, you will be asked to confirm the changes upon exit.

TIPS:

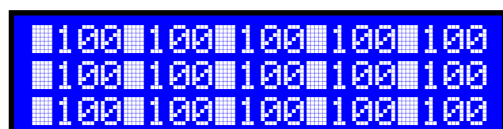
- To ensure standard fuelling at idle, retain a value of 100 in the lower-left cell.
- To leave a cell's data unchanged when editing consecutively, simply re-enter the same value.
- To enter values less than 100, precede with zeros. Eg: For 80, enter 080; for 6, enter 006.
- To reset all cells of a map to 100%, press and hold zero for 5 seconds in Map View mode.

NOTES:

- A cell data value of 100 represents 100% (ie no increase or decrease of fuel)
- The valid cell data range is 0 (zero) to 255.

Fuel Map Examples

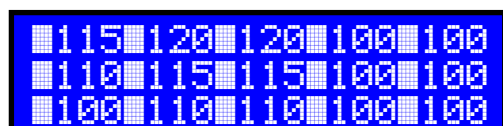
The examples below provide a good fuel map selection that will work well on most vehicles.



Example Fuel Map #1

Standard (unmodified)

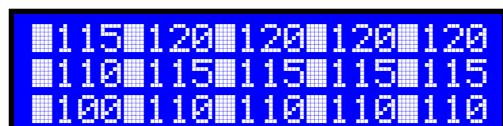
STANDARD TORQUE, STANDARD BHP



Example Fuel Map #2

Economy

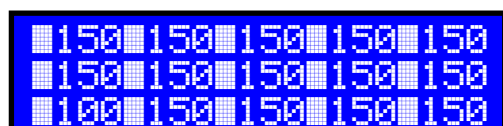
INCREASED TORQUE, STANDARD BHP



Example Fuel Map #3

Fast Road Use

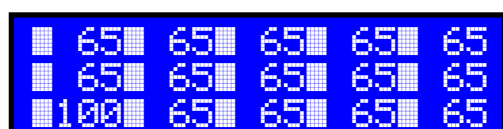
INCREASED TORQUE, INCREASED BHP



Example Fuel Map #4

Occasional Fast Road Use

HIGHEST TORQUE, HIGHEST BHP



Example Fuel Map #5

Low Power / Valet Mode

REDUCED TORQUE, REDUCED BHP

To change which fuel map the Diesel Control ECU defaults to after ignition-off, go to Fuel Map Defaults: Main Menu -> Setup (option 4) -> Next (#) -> Next (#) -> Fuel Map Defaults (Option 1).

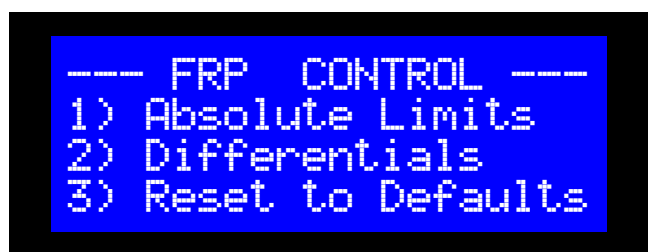
NOTE: Manual selection of Fuel Map 5 is persistent (default fuel map settings will be ignored).

Fuel Rail Pressure Control

Manipulating fuel rail pressure sensor voltages in order to control fuel rail pressure (and therefore engine performance) is nothing new. Most diesel tuning boxes employ this technique because it helps to make installation simpler and more universal. In fact, any modern common rail diesel engine, whether it is running a standard fuel map or it has been professionally remapped, ultimately relies on fuel pressure modulation for most of the fuelling control.

The main problem with diesel tuning boxes of course is not that they modulate fuel pressure but that they do so independently of engine speed or load, making any fuel adjustments one-dimensional, resulting in poor fuel control that inevitably leads to frequent over-fuelling. And even when emissions or DPF blockages are not a concern, such indiscriminate fuel control means that fuel adjustment limitations at some engine speed and load combinations will compromise performance at others.

The Diesel Control ECU not only provides precise fuel control based on engine speed and load, in the form of fuel maps, it also provides several other fuel rail pressure control and monitoring features that enhance and simplify the mapping features, such as FRP limits and Acceleration Control.



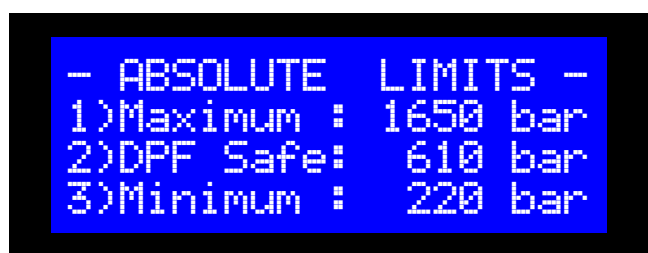
Fuel Rail Pressure (FRP) Control Menu

The FRP Control menu (accessible from the first page of the Setup Menu) provides access to a number of different fuel rail pressure limits. Once set, these limits will not be exceeded, making it possible to eliminate the risk of triggering engine management fault detection, no matter how extreme the fuel map adjustments are, simply by setting limit values that are well within the engine management's detection parameters.

NOTE:

The fuel rail pressure control limits are automatically set during calibration to values that have shown to work well with the majority of vehicles. For some vehicles it may be possible to widen the limits and therefore increase the range of fuel control available (to further increase performance, for example). Widening these limits will increase the risk of triggering engine management warning lights or fault codes however, so some experimentation, and a suitable OBD scan tool, will be required.

Absolute FRP Limits



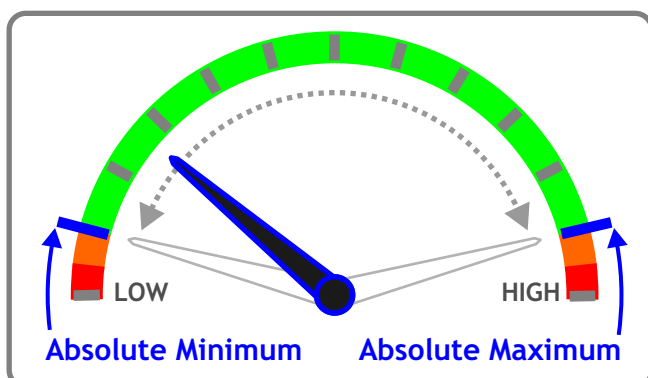
Absolute FRP Limits (typical values)

The Absolute FRP Limits are pressure-based values that automatically limit any further fuel rail pressure modifications if an attempt is made to exceed them.

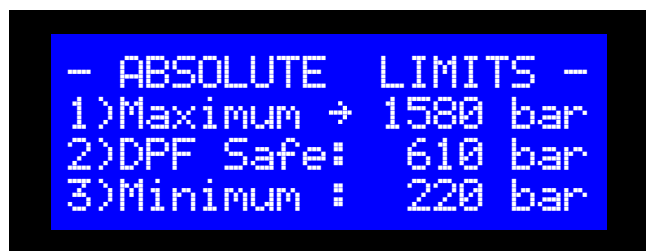
The Minimum and Maximum limits define the extremities, beyond which no fuel rail pressure modifications will be made, regardless of fuel map configuration.

The minimum limit can be used when setting economy maps (such as reducing fuel at idle on commercial vehicles) by helping to set an absolute minimum fuel reduction that prevents stalling.

See also: *DPF Safe* and *Differential FRP Limits*.



Modifying FRP Control Limits



Absolute FRP Limits - Editing Maximum (Limit #1)

To modify any FRP Control limit, press the number on the keypad that corresponds to the limit number. An arrow appears, indicating edit mode is active.

To change the value press 2 to increase it or 8 to decrease it, then press the # key to save or the * key to cancel the changes.

DPF Safe

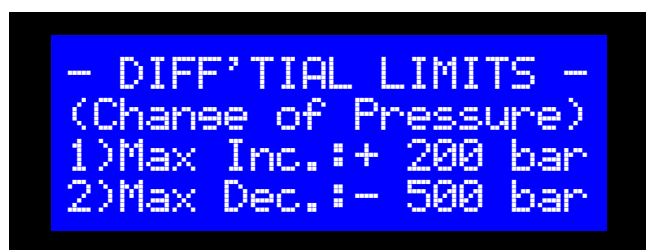
When remapping a turbo-charged vehicle, it can sometimes be necessary to limit the injection of any extra fuel during initial acceleration until boost pressure has had sufficient time to develop. Too much fuel too early can cause fuel wastage, resulting in visibly poorer emissions or Diesel Particulate Filter (DPF) saturation.

While this issue could be resolved by creating a complex fuel map or by adding a boost signal input to the installation, the Diesel Control ECU simplifies both mapping and installation with the addition of the DPF Safe feature.

DPF Safe is a special absolute limit that restricts fuel rail pressure control only when fuel pressure is below the configured pressure and only when fuelling is being increased, leaving any reduction in fuelling unaffected. This allows simple fuel maps to be produced quickly and easily, without any need to compensate for lack of boost pressure.

The DPF Safe parameter is automatically configured during calibration, based on idle calibration data, but it can easily be adjusted for best performance. To find the optimum value, select a high-power fuel map and gradually reduce DPF Safe until there is no more performance gain or until emissions are noticeably worse. Now increase DPF Safe again to the point that emissions improve or just before the performance (more specifically the initial acceleration) begins to decline.

Differential FRP Limits

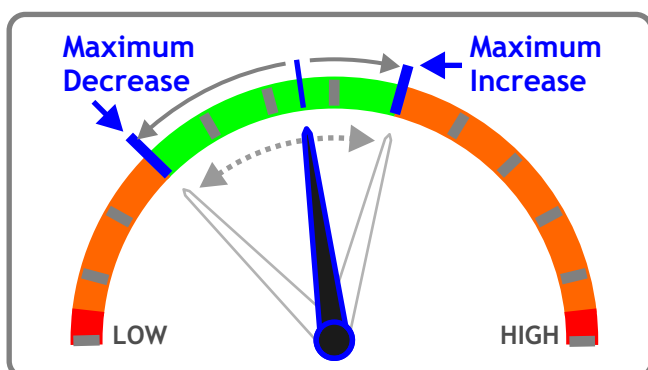


Differential FRP Limits (typical values)

While the Absolute Limits prevent fuel rail pressure from exceeding fixed-value extremities, on most common rail diesel systems it is equally important to limit the change in fuel pressure too. If the engine management system determines that the fuel rail pressure is much higher or much lower than expected it may report an engine management fault.

The Differential Limits allow fuel pressure changes to be limited relative to the fuel pressure the engine management system is expecting, effectively delaying the requested changes in pressure until the actual pressure has had sufficient time to catch up.

The default values are determined during calibration but may easily be modified to suit. See *Modifying FRP Control Limits* for details.



High-Resolution Fuel Maps (advanced users)

For convenience, simplicity and speed of use, fuel maps are displayed and manipulated with the hand control display using just fifteen 8-bit cells, called Quick Maps, and arranged as 5 rpm columns and 3 load rows. Internally, however, the fuel maps are much higher resolution, consisting of 1024 16-bit cells, arranged as 32 rpm columns and 32 load rows.

When a Quick Map is created or modified using the hand control, the data is automatically translated, using interpolation, into a high-resolution map and stored internally on a removable 25LC512 EEPROM. This allows maps to be created quickly using the hand control and later, if required, edited and refined by reading and modifying the high-resolution map data stored on the EEPROM.

Quick Map Relationship

The Quick Map bands represent a selection of high-resolution map bands. The fuel map data cells to which they refer relate directly to 15 of the 1024 high-resolution map cells. The distribution and position of the 15 cells is determined by the Quick Map bands.

For example: Suppose during calibration idle is determined to be 1000rpm, and the maximum rpm and load are measured at 4100rpm and 15.5 respectively. Based on this data, the high-resolution map is automatically divided up, by creating equally spaced map bands, like this:

RPM BAND 0 = 1000rpm (idle)

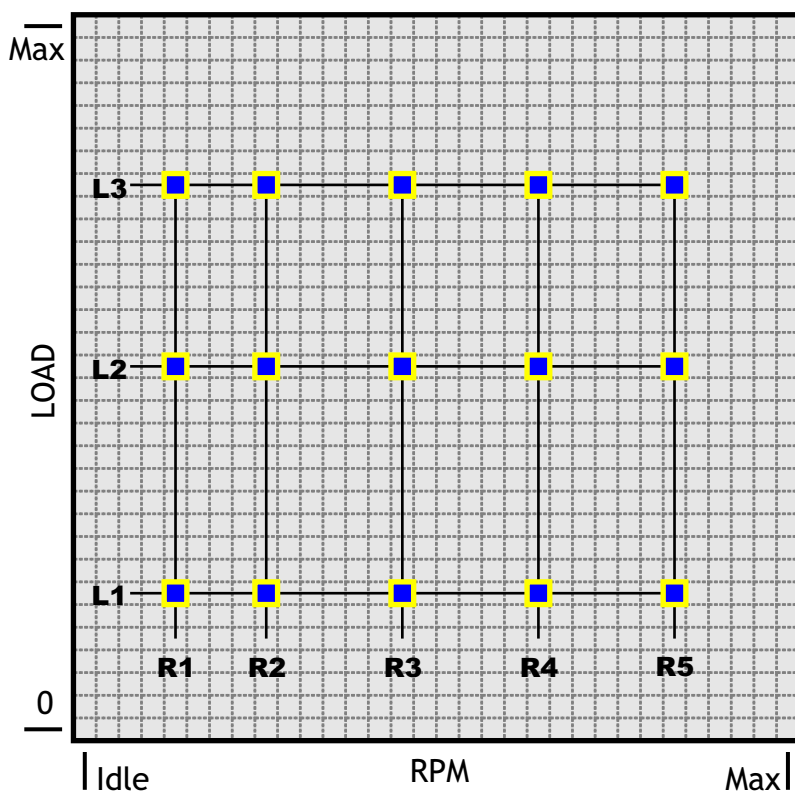
RPM BAND 31 = 4100rpm (max rpm)

RPM BAND INTERVAL = $(4100 - 1000) / 31 = 100\text{rpm}$

LOAD BAND 0 = 0

LOAD BAND 31 = 15.5 (max load)

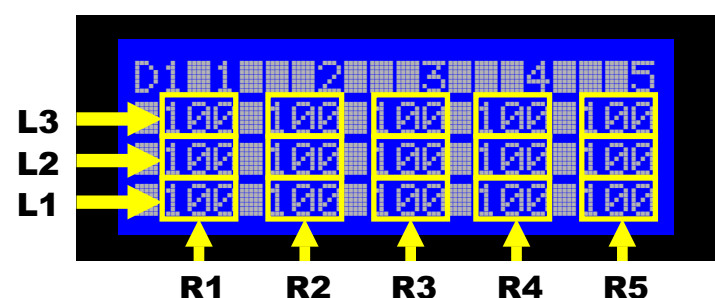
LOAD BAND INTERVAL = $15.5 / 31 = 0.5$



The illustration (left) represents a high-resolution fuel map, with each square of the grid representing a map cell.

Using the above example, the RPM axis would start at 1000rpm, increasing in 100rpm steps, ending at 4100rpm. The LOAD axis would start at 0 (zero), increasing in 0.5 steps, ending at 15.5.

When a Quick Map is created, its cells directly coincide with 15 of the high-resolution maps cells, indicated here in blue. By changing the Quick Map rpm bands (R1 to R5) or load bands (L1 to L3) using the hand control, it is possible to 'reposition' the Quick Map within the high-resolution map.



In the present example, the Quick Map rpm and load bands would be:

R1 = 1400rpm

R2 = 1800rpm

R3 = 2400rpm

R4 = 3000rpm

R5 = 3600rpm

L1 = 3.0

L2 = 8.0

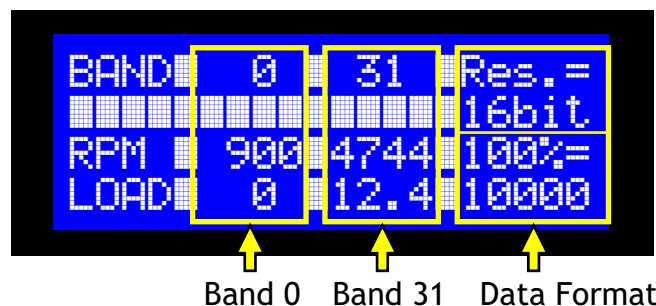
L3 = 12.0

Mapping Information

Using the hand control, enter the Fuel Maps menu (Main Menu option 1) then select option 4, Hi-res Maps Info. Press # to cycle forward through the information screens. Press * to go back or exit.

NOTE: Where the information displayed differs from information presented in this or any other publication, the information displayed on the hand control should be taken as the most current.

High-Resolution Fuel Map Info. (typical data)



The first screen displays information about the serial EEPROM. Press # to move forward to the first of the fuel map information screens (see screenshot left).

This screen consists of 3 columns of information; band 0, band 31 and map data format information.

The two band columns provide the first (0) and last (31) map band values for both rpm and load.

The first load band value will usually be 0 (zero), the first rpm band will usually be idle (900 in the example above) and the last band (31) values will usually be equal to the maximum load and rpm data captured during the drive calibration process.

From this information it is possible to calculate the band interval and therefore any band value. Using the example above:

RPM BAND 0 = 900rpm
 RPM BAND 31 = 4744rpm
 $\text{RPM BAND INTERVAL} = (4744 - 900) / 31 = 124\text{rpm}$

Calculating the value of RPM BAND 14:
 $\text{BAND\#} \times \text{INTERVAL} + \text{BAND 0} = 14 \times 124 + 900 = 2636\text{rpm}$

LOAD BAND 0 = 0
 LOAD BAND 31 = 12.4
 $\text{LOAD BAND INTERVAL} = 12.4 / 31 = 0.4$

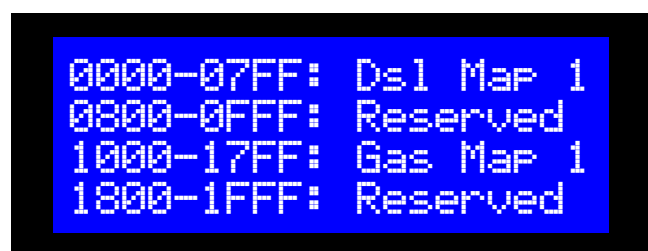
Calculating the value of LOAD BAND 20:
 $\text{BAND\#} \times \text{INTERVAL} = 20 \times 0.4 = 8$

The third column provides information about the formatting of the map data; the resolution (usually 16 bit) and the map data value used to represent no change of fuelling or 100% (usually 10,000).

The high-resolution (16 bit) fuel map data is converted from the Quick Map format (8 bit) by a simple x100 multiplication. The Quick Map data range is 0 to 255 (0% to 255%), therefore when modifying the high-resolution map data, the map data should be kept within the range of 0 to 25,500 (255 x 100).

EEPROM Memory Allocation

Moving forward on the hand control through the high-resolution map information, the next series of screens provide EEPROM address locations, one screen for each of the 5 map groups.



EEPROM Memory Allocation - Map Group 1

Allocation details of each fuel map memory are displayed as a hexadecimal start and end address. Each fuel map occupies 2048 bytes, consisting of a 32 x 32 array of pairs of 8-bit bytes (with each pair of bytes acting as a 16-bit word).

The map data is stored using the 'little-endian' method, ie the least significant byte is stored at the lower address.

Map data storage example:

If 10,000 (Decimal) is stored as 16 bit integer (2710 in Hex) starting at address 0x0000, the resulting byte order will be: Address 0x0000 Data = 0x10, Address 0x0001 Data = 0x27

Acceleration Control

In addition to providing a means to accurately measure engine speed and load, the injector sensing technology used by the Diesel Control ECU enables engine acceleration rate to be instantly and continuously calculated. This information is used internally by the Diesel Control ECU to allow it to profile and predict fuel timing but also as an input to a number of other functions.

One such function is Acceleration Control; an innovative feature, unique to the Diesel Control ECU, that provides a simple but effective means of limiting performance, independently of the fuel maps.

Acceleration Control can be used whenever there is a requirement to restrict a vehicle's acceleration rate, without affecting its power at steady speeds or gentle acceleration. For example, this feature could be used to restrict the acceleration rate of a goods vehicle in order to improve fuel consumption.

While it's trivial to reduce a vehicle's acceleration rate by altering fuel maps, any such modifications would have no direct correlation with engine acceleration and therefore their effectiveness would be largely dependant on engine load. Any fuel map able to provide the desired effect with the vehicle unladen, could leave the vehicle lacking in power or unable to climb hills when carrying a heavy load.

Since the Acceleration Control feature only reduces power when an attempt is made to accelerate the vehicle more quickly than the chosen threshold allows, the vehicle's top speed remains unaffected and full power is always available during gentle, steady acceleration, regardless of load. This removes the ability to accelerate hard and encourages the driver to drive the vehicle in a more fuel-efficient manner.

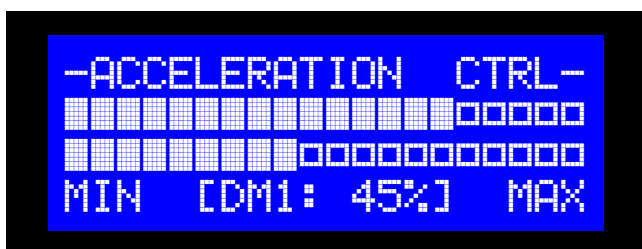
To access the Acceleration Control feature, select option 2 from the first page of the Setup Menu.



Acceleration Control (showing Diesel Map 1 OFF)

Shown here (left) in the initial OFF state, two moving bars display the Acceleration Control status, moving from left (0% or MIN) to right (100% or MAX).

The lower bar is controlled by the operator to set the desired level of acceleration restriction. The upper bar provides live feedback, indicating when acceleration is being restricted and by how much.



Acceleration Control (showing Diesel Map 1 at 45%)

In the example (left), Diesel Map 1 (indicated by the notation *DM1*) has been set to 45% (represented by the lower bar). As the vehicle attempts to accelerate beyond the set limit, the upper bar shows instantly that a restriction is taking place and that the rate of acceleration has been significantly limited.

Key 2 - Increase the Acceleration Control limit

Key 8 - Decrease Acceleration Control limit

Acceleration Control adjustments take effect immediately. Simply increase the limit, while monitoring the feedback bar during acceleration, until the desired level of control is reached.

NOTES: There are 5 Acceleration Controls; one for each of the 5 diesel fuel maps. Acceleration Control can be disabled (reduced to 0%) or restricted independently for each fuel map. Acceleration Control always relates to the currently selected fuel map; to adjust the limit for a different fuel map, select the relevant map first.

To exit Acceleration Control and return to the Setup Menu, press **✱**. Changes are automatically saved.

Remote Control

With the addition of the optional radio receiver module and a remote control key fob transmitter, the Diesel Control ECU allows any of the 5 fuel maps to be selected, easily and instantly, by the end user. Each remote control must first be 'paired' with the Diesel Control Unit using the operator hand control. This is a simple authentication process that stores the identity of each remote control to be used with the system.

Enter the Setup Menu, press # (Next) to move to page 2 then select option 2 (Remote Control).

NOTE:

If the remote control receiver module is not installed, the Remote Control menu will be unavailable.



Remote Control Menu

To add a new remote control transmitter, select option 1 and follow the prompts. The Diesel Control ECU will ask three times for a button to be pressed. This can be any button but it must be the same button each time.

When three button presses have been successfully received and identified, the remote control's ID will be saved, after which time the display will automatically switch to the remote control test page (menu option 2). Press each of the three buttons on the remote control to test it.

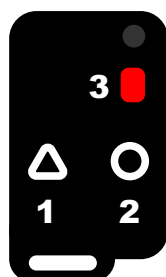
To remove a remote control from memory, first unpair all remote controls (menu option 3) then reinstate any remote controls that are still in use by pairing them again (menu option 1).



Pairing a new Remote Control

Switching using the remote control

Press * to exit the Remote Control menu.



NOTE: Remote Control map switching is disabled if the Remote Control menu is selected (on the operator hand control) or the vehicle's engine speed is above idle.

A brief press of buttons 1 to 3 selects fuel maps 1 to 3 respectively. To select fuel map 4, press and hold button 3 for 3 seconds. To select fuel map 5, press and hold button 3 for 5 seconds. Confirmation of the chosen map is provided by the external sounder/LED (if fitted) with the number of bleeps/flashes corresponding with the fuel map number.

Other Features

Fuel Map Defaults (Option 1) sets the default map behaviour for power-on or ignition-on. The Diesel Control ECU can remember the last map selected or default to any of the 5 fuel maps.

LED/Sounder Mode (Option 2) sets the map selection confirmation behaviour of the external sounder or a resisted LED (optional). It can be configured to confirm repeatedly, on map selection only or disabled completely.

Swap Displays (Option 3) exchanges the roles of the upper and lower operator hand control displays.

NOTE: More features can be found in the dual fuel sections of the manual.



Setup Menu - Page 3

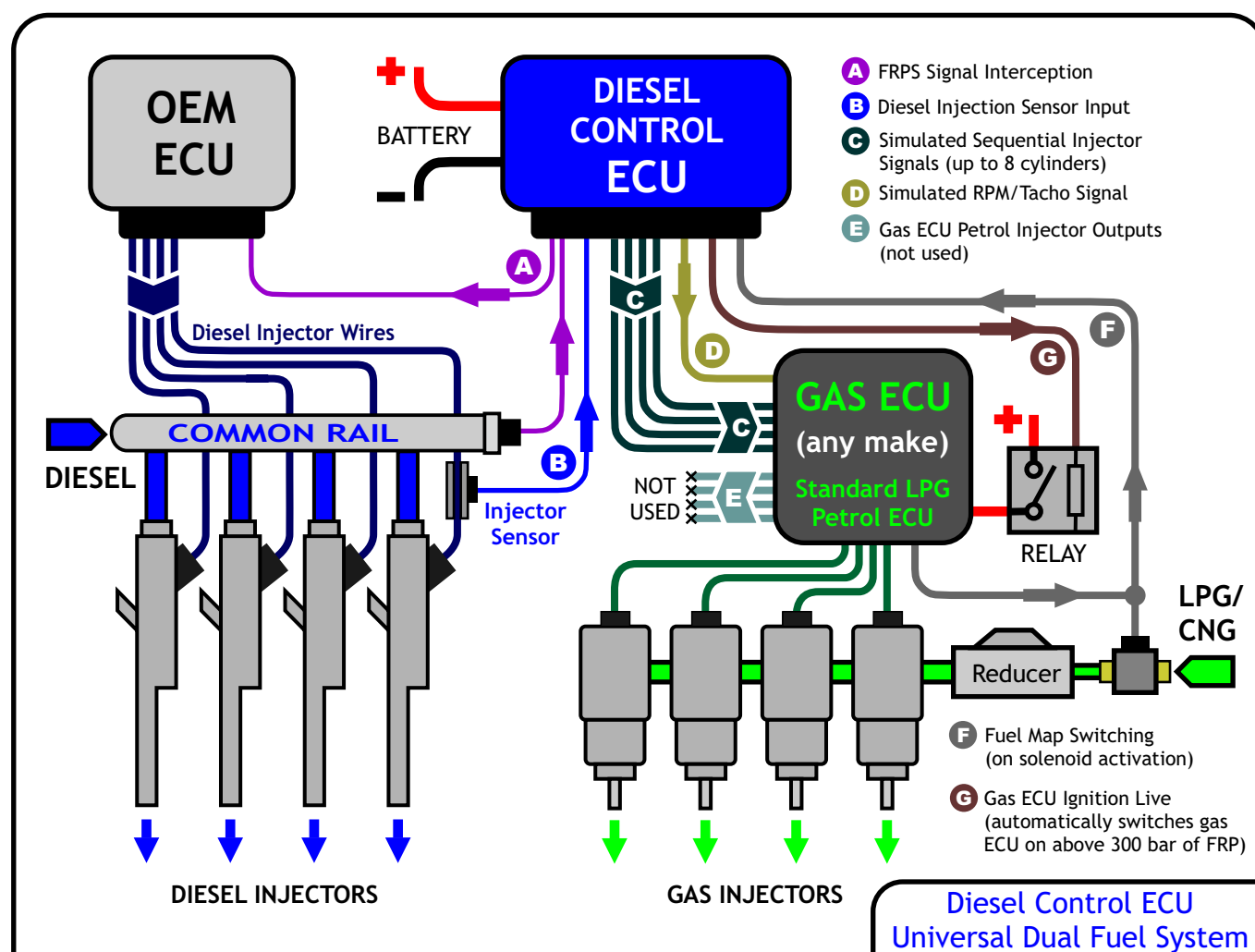
IMPORTANT: This section of the manual assumes the operator has a good understanding of how the Diesel ECU Controller works, how it is calibrated and configured and how to create and edit fuel maps. **Please ensure that you have read and fully understood all previous sections of this manual before proceeding.**

Introduction

There are a number of technical difficulties to overcome when converting a common rail diesel vehicle to run on a mixture of diesel and gas. Conventional petrol injection systems maintain a relatively low, constant fuel pressure, using low voltage injector pulses that are easily intercepted and monitored. CRD systems, by comparison, operate at much higher fuel rail pressures and inject fuel using high-voltage, high-current injectors that can deliver a multiple of high-precision, high-speed injections of diesel with every engine power-stroke. Additionally, on many diesel vehicles, just finding a reliable ignition-switched live in the engine bay can be difficult; a tachometer/rpm signal may be impossible where CAN bus systems are used.

To complicate matters, because there are a variety of different techniques and technologies in common use (such as systems based on piezo or inductive injectors) CRD systems can vary greatly from vehicle to vehicle, making it difficult for vehicle gas equipment manufacturers to make their systems universal. As a result, any such systems are usually expensive and developed to be very vehicle-specific.

Thanks to its unique, patented diesel injection sensing technology and innovative approach to monitoring, measuring and controlling a common rail diesel system, the Diesel Control ECU is able to provide a solution that now makes it possible to convert most modern diesel engines universally and inexpensively.



With just a permanent supply, a FRPS connection and an injector sensor, the Diesel Control ECU provides the gas system with (up to 8) sequential injection inputs and an rpm/tacho signal. It is even able to automatically power-up the gas system, via a relay, when diesel fuel rail pressure is detected.

CNG / LPG System Basic Requirement

The universal diesel control unit can be used with most multipoint CNG / LPG vapour or liquid front-end systems; there are however a few basic requirements. Most popular systems (for example Prins) work on a 'following' principle and, as such, monitor incoming petrol injector opening times (millisecond duration) and allow the installer to make percentage output adjustments (either up or down) to the gas injectors in order to achieve closed-loop fuel control. When blending gas with diesel, closed-loop no longer applies; the percentage blending of the 2 fuels is adjustable, even though the diesel control ECU follows the amount of diesel injected.

Some gas systems (for example BRC or AEB-based systems) however, use an auto calibration programme that switches both petrol and gas injectors on consecutively until similar fuelling is achieved and closed loop status is reached using the secondary fuel. These type of systems may still be used but will require a pre-configured petrol base-map to be used as a starting point that can be further refined. Ideally, the system should have the ability to output gas without any delay as soon as it receives incoming injector signals from the diesel control ECU. During engine overrun injector signals aren't present but are immediately restored when the CRD injectors start to operate.

The RPM at which gas injection starts (normally slightly above idling speed) is also dictated by the diesel control ECU. The gas system should be set to full-sequential, group start and, any features normally used to assist a smooth changeover from petrol to gas over a few seconds, set to their minimum. The BHP/KW rating of the gas system should be about 50% of the engine's total power output and, ideally, the gas injectors used should be available with different flow rates or have drillable nozzles to allow map refinement.

When using LPG, the reducer should be mapped for boost compensation, ensuring that the pressure of gas is always higher than that of inlet manifold pressure. On CNG applications this is not always necessary due to the higher natural gas pressure from the storage tank and reducer. When using a front-end LPG system for CNG applications the only necessary change is that of the reducer for a CNG type. It is also usual to use slightly larger injectors than when on LPG.

Diesel CNG/LPG Blending

Because of CNG's higher octane value (130-140, compared to LPG's 105), it is possible to substitute more diesel with CNG than with LPG. During development of the diesel control ECU, mainly on small, high compression, high-revving diesels, around 50% CNG and 35% LPG substitution rates were achievable without any detonation. On some larger, low-revving commercial vehicle engines it is possible to substitute larger percentages, especially when using the diesel control ECU to limit the gas at selected engine speeds and at maximum load, high boost conditions.

There are 3 ways to blend any gas with the diesel:

The engine's diesel injected quantity can be left unchanged and gas injected as an additional fuel. This method works very well due to the abundance of unused air inside a diesel engine, especially under cruising conditions. Although the engine's power is obviously increased, overall horse power at higher engine speeds can be kept standard if required by adjusting the map bands of the diesel control ECU. This method gives excellent driveability and fuel savings and, at light throttle and load, gives a substitution ratio of diesel saved to gas used of around 1:1.

Alternatively, the diesel control ECU can be used to reduce the diesel quantity by lowering the diesel common rail pressure and then restoring the engines power by adding the appropriate quantity of gas. Using this method retains standard power and benefits tailpipe emissions whilst giving a substitution ratio of diesel saved to gas used of around 1:1.3 with LPG or 1:1.45 with CNG. What has to be remembered is that using this method, maximum fuel pressure reduction may vary from vehicle to vehicle as any adjustments are always limited by the ECU's parameters.

Diesel CNG/LPG Blending (continued)

A further option that produces excellent results (provided that remapping the vehicle's ECU is possible and doing so does not raise manufacture warranty issues) is to reduce CRD injector opening times instead of reducing fuel rail pressure. A remap can also be used to remove the injector pilot pulses above idle to enable greater gas substitution at low speeds. Again, gas is used to restore engine power back to standard.

The latter method probably gives the best results for both emissions and fuel savings and can still be employed if there is a frequent requirement for the vehicle to operate on diesel only, e.g. from cold or when gas is not available. A unique feature of the diesel control ECU is that a high fuel rail pressure map can be automatically selected when running on diesel only, allowing normal power to be restored. Where there is no requirement to run on diesel alone, the vehicle's ECU remap can be fully utilised or smaller diesel injectors can be fitted to achieve even greater substitution rates.

Engine Safety Precautions

To reduce cost, the diesel control ECU does not incorporate any means of monitoring engine knock (detonation) or exhaust gas temperature. Since the unit is based on a 'following' system, once correctly calibrated, the quantities of gas injected into the engine should remain consistent under all conditions. Any gas front-end system employed should also have built-in safety features and compensations for both gas temperature and pressure.

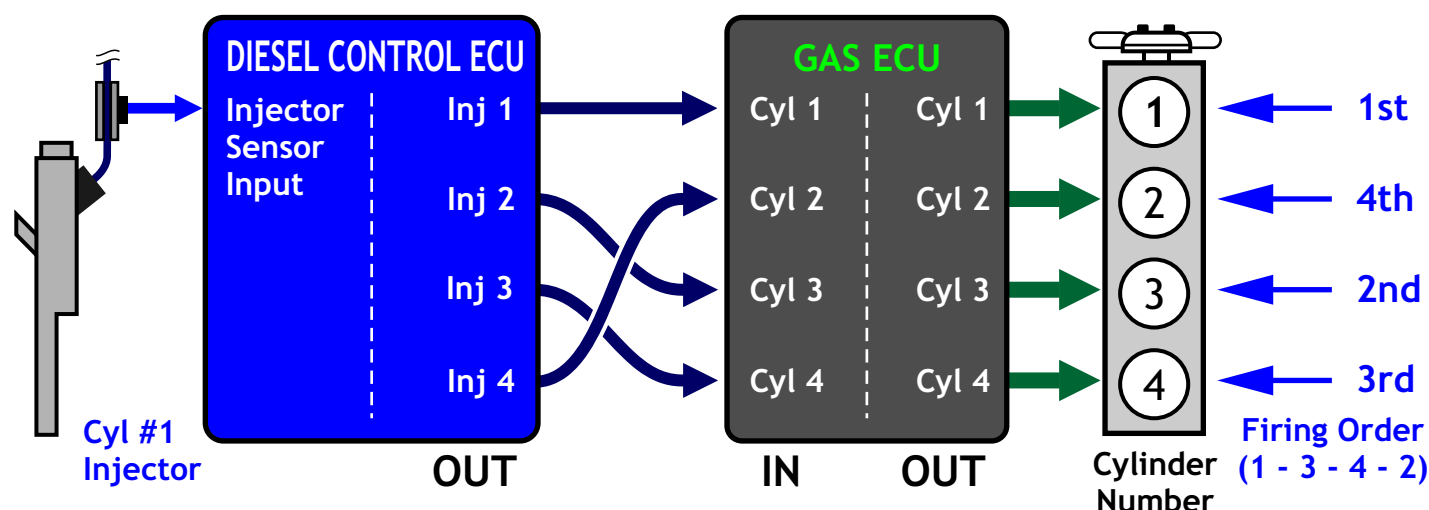
High exhaust gas temperatures normally only occur when too much gas is injected under very high loads; it's under these conditions that engine knock or detonation can also be heard. If the diesel control ECU and gas system are correctly installed and calibrated, excessive gas injection should never occur, which is not true of some commonly available single point systems.

If an installer wishes to fit additional monitoring equipment for both exhaust gas temperature and engine knock detection, this can easily be configured to immediately cease gas injection (therefore returning the engine to diesel-only power) by interrupting the diesel control unit's power supply or the gas system's RPM input. When the connection is reinstated, gas injection resumes automatically without the need to restart the engine.

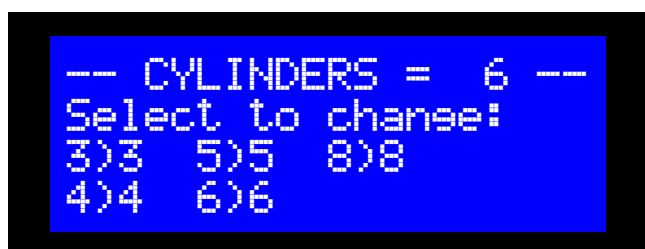
Sequential Gas Injection

For ease and speed of installation, the Diesel Control ECU monitors only one diesel injector, from which it is able to calculate the timing of the remaining diesel injectors (given the number of cylinders). These timings are used to generate simulated sequential conventional petrol injection pulses that provide the gas ECU with precise injection timing information. To prevent gas passing through the engine during exhaust valve overlap and to achieve optimum emissions and performance, it is therefore important to match injection order with engine firing order.

Since firing order is not the same for all engines, the Diesel Control ECU generates outputs in ascending numeric order (1, 2, 3, 4, 5, 6, 7, 8). These outputs should be wired to match the engine's firing order.



The illustration above shows a 4 cylinder configuration, with a common firing order of 1, 3, 4, 2. The diesel ECU injector pulse outputs are connected to the gas ECU's inputs in firing order, such that the first cylinder to fire (#1) uses the first output, the second cylinder to fire (#3) uses the second output, the third cylinder to fire (#4) uses the third output and so on.



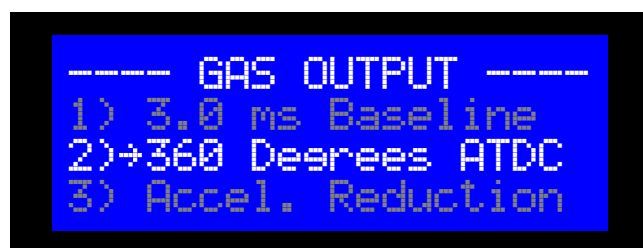
Cylinders Selection (showing 6 cyl configuration)

To enable the Diesel Control ECU to calculate and generate each injector output pulse from a single input, it needs to know how many cylinders the engine has. To configure this setting, select Cylinders (option 1) from the second page of the Setup Menu and press the keypad number corresponding to the correct number of cylinders. The unit will automatically reboot and reconfigure, confirming the change.

Gas Output Timing

By default, the first gas injection pulse occurs 360 degrees After Top Dead Centre (ATDC), to coincide with the start of the induction stroke. Gas pulses for the remaining cylinders will be equally spaced over the full cycle of 720 degrees (ie 2 engine revolutions), such that the pulses will be spaced 180 degrees apart for a 4 cylinder engine, 120 degrees apart for a 6 cylinder engine and so on.

The default value of 360 degrees can be easily modified, allowing the operator to precisely control when the gas output pulses occur, with respect to the diesel injection pulses. From the Setup Menu, select Gas Output (option 3) then select option 2 to adjust the number of degrees ATDC. The value can be increased (key 2) or decreased (key 8) from 0 to 720 degrees.



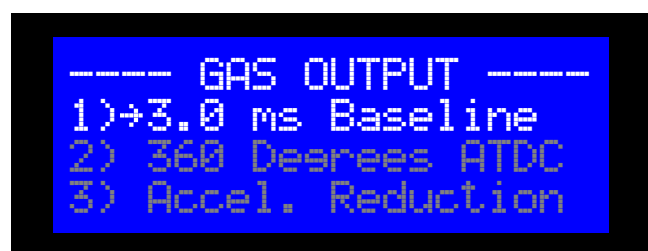
Gas Output Menu (editing degrees ATDC)

NOTE: The value set will automatically be advanced, slightly, as engine speed increases, to compensate for the time it takes the gas to reach the cylinder.

Gas Baseline Adjustment

The primary source of information the Diesel Control ECU uses to determine the gas output duration is the live injection data it gathers while monitoring diesel injection duration and pressure. Before any fuel map or other adjustments take place, this information forms the basis of every gas output calculation and creates a proportional relationship between the two fuels, the ratio of which is determined by the gas baseline value.

During idle calibration, the Diesel Control ECU measures diesel fuelling and configures the fuel ratios such that, when idle conditions are present, the gas output pulse will be equal to 3 milliseconds. Even if gas is to be disabled at idle, this establishes an essential reference point that will be used as a factor for gas output pulse calculations at all engine speeds and loads. Since the baseline value affects the overall quantity of gas injected under all conditions, and for all fuel maps, it is important to ensure that it is correctly configured before any other any other fuelling adjustments are made.



Gas Output Menu (editing gas baseline)

Gas baseline adjustments should be performed using an unmodified, default fuel map (all cells at 100%).

To modify the gas baseline value select option 1 from the Gas Output menu (accessible from Setup page 1) then press key 2 to increase the value or key 8 to decrease the value. Press # to save the changes or press * to cancel.

At 100% gas map fuelling, the default value of 3 milliseconds will, for most engines and injectors, represent a moderate amount of gas. When the correct size injectors are fitted, the gas baseline value should typically be around 5 to 10 milliseconds. Adjust the setting until a sufficient quantity of gas is being injected.

DPF Safe

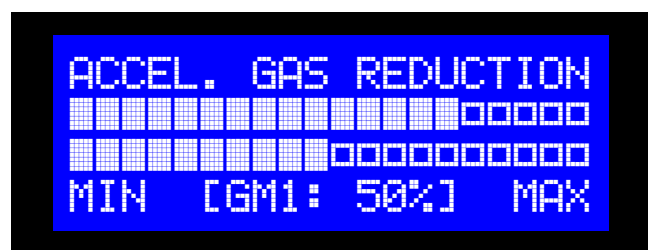
When the Diesel Control ECU is used as a dual fuel controller, the DPF Safe parameter serves to limit the injection of both fuels during initial acceleration, helping prevent fuel wastage or poor emissions caused by insufficient oxygen or boost pressure. No gas will be injected when the diesel pressure is below the limit set by this parameter. For more information, see DPF Safe in the FRP Control section.

Acceleration Gas Reduction

Acceleration Gas Reduction is another unique Diesel Control ECU feature that simplifies gas injection optimisation, to help improve emissions, reduce fuel wastage and prevent DPF problems.

When a CRD vehicle is subjected to sudden acceleration, the engine management system responds by quickly and sharply increasing the amount of diesel being injected, resulting in a brief increase in engine load as it overcomes the vehicle's inertia. Because this load increase can occur at any engine speed it can be difficult to compensate using fuel mapping alone without compromising the maximum amount of fuel substitution available at constant, higher loads.

During acceleration, the Diesel Control ECU monitors the rate of increase in engine power, which can be used to detect sharp acceleration and reduce the gas output accordingly.



Acceleration Reduction (showing Gas Map 1 at 50%)

Selecting option 3 of the Gas Output menu displays the acceleration reduction setting for the current fuel map. The default value of 50% works well on most engines and is recommended for vehicles equipped with DPFs. For vehicles without DPFs, where the effects on emissions are more visible, a lower setting may provide good results.

(Press key 2 to increase or key 8 to decrease)

Fuel Maps

NOTE: The procedure for creating and editing gas fuel maps is identical to that of the diesel fuel maps. For more information, please refer to the diesel fuel maps section of this manual.

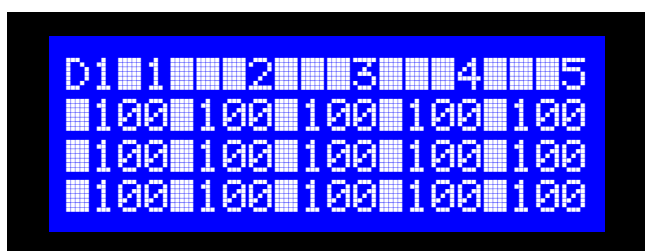
The Diesel Control ECU contains 10 fuel maps, switchable as 5 pairs of diesel and gas maps. Each map has its own rpm and load bands and can be created and adjusted independently of the others.

Fuel Map Examples

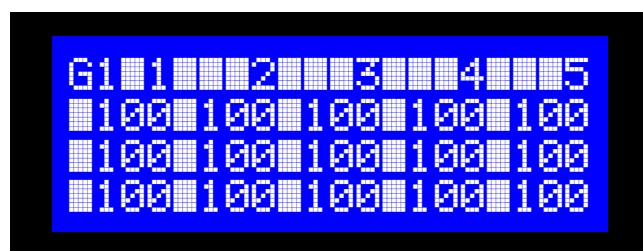
The examples below show how the fuel map pairs make it easy to blend the 2 fuels in the required ratios. A pair of maps is defined as any 2 maps of the same number (eg Diesel Map 1 and Gas Map 1).

Example Fuel Map Pair #1

Standard (unmodified) diesel with gas injected as additional fuel.



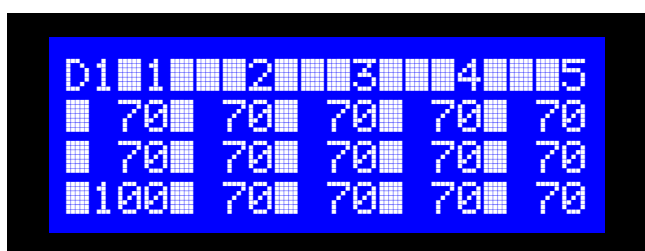
Diesel Map



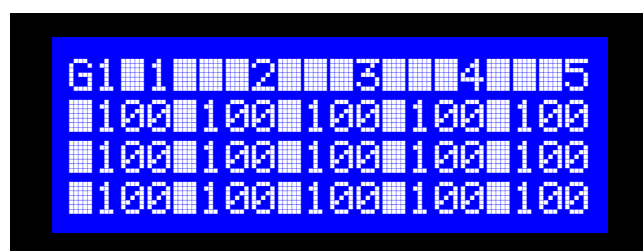
Gas Map

Example Fuel Map Pair #2

Reduced diesel with gas injected substitutionally.



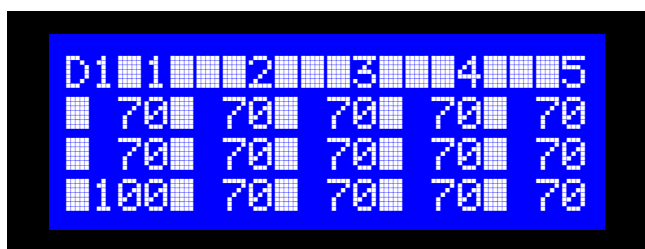
Diesel Map



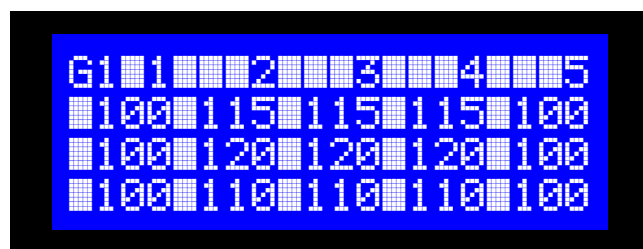
Gas Map

Example Fuel Map Pair #3

Reduced diesel with increased gas at cruising speeds.



Diesel Map



Gas Map

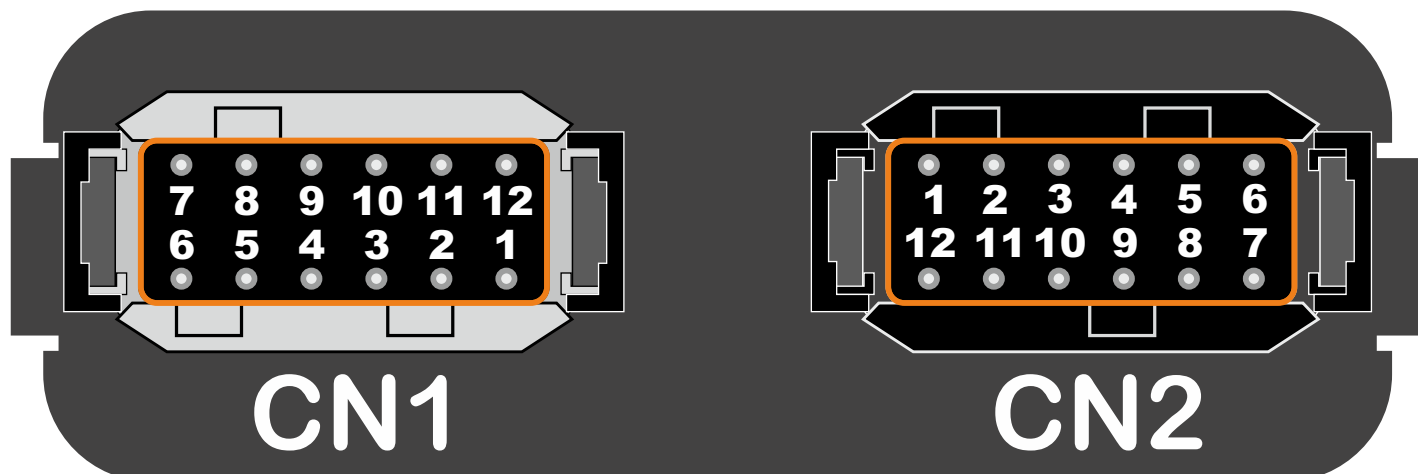
Automatic Map Switching

Using Control Input #1 (pin 11 of external connector CN1) fuel maps can be automatically selected. By connecting the control input to the gas solenoid, the Diesel Control ECU can be configured to select the diesel-gas map pair when gas is enabled, switching back to a standard diesel map when gas is disabled.

Control Input #1

Connected to +12 Volts: Fuel Map Pair #4 selected
 Connected to Ground: Fuel Map Pair #5 selected

External Connections



Connector 1 (CN1)

1. +Batt
2. O2 SENSOR IN
3. SCREEN (GND)
4. FRPS IN
5. FRPS OUT
6. INJ CURRENT SENSOR SIGNAL
7. 5V OUT
8. I2C1 BUFF DATA
9. I2C1 BUFF CLK
10. SOUNDER
11. CONTROL IN 1
12. -Batt (GND)

Connector 2 (CN2)

1. INJECTOR OUT 1
2. INJECTOR OUT 2
3. INJECTOR OUT 3
4. INJECTOR OUT 4
5. INJECTOR OUT 5
6. INJECTOR OUT 6
7. INJECTOR OUT 7
8. INJECTOR OUT 8
9. TACHO OUT
10. PROGRAMMABLE
11. CONTROL IN 2
12. GND