AFMLink

Air Flow Meter Control/Replacement

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Effective April 5,1992 5 p.m.

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By Link ElectroSystems Ltd.

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1.0 INTRODUCTION

The AFMLink is a product designed for vehicles using an Air Flow Meter (AFM) Engine Management System.
It will convert the factory ECU into an adjustable system by providing complete control over the engines mixture. This is achieved by removing the factory AFM and allowing the AFMLink to simulate this signal. By controlling this voltage the correct mixture can be set to match any load condition, allowing the optimisation of both engine performance and economy. The operating conditions of the engine are mapped using a Zone Table formed from the engines RPM and Manifold Air Pressure. The AFMLink offers two Operating Modes.

1.1 REPLACE Primary Mode

This mode allows the Air Flow Meter to be removed. It should be selected when the AFM is out of calibration or causing a restriction and a performance gain can be achieved by removing it. To simulate the characteristics of the original AFM, the AFMLink will form an initial estimate of this voltage, based on the engines Manifold Air Pressure (MAP) and RPM. As there are many AFM variations, the initial estimate must then be adjusted to matched to the orignal AFM. This is achieved by adjusting two coefficients labelled SPAN and ALIGN. These are only numbers, used by the AFMLink to control the shape of the AFM Voltage curve. Fine-tuning can then be done using the Zone Table allowing the voltage to be scaled at any load condition, to match the mixture requirements of the engine. In some situations the AFM can initially be retained to aid in the tuning of the engine. When connected the AFMLink can automatically determine the AFM type. It will also allow the user to compare the voltage produced by the AFMLink to the actual AFM Voltage and adjust the SPAN and ALIGN coefficients accordingly.

1.2 INTERCEPT Secondary Mode

An alternative to the Replace Mode is the Intercept Mode. The aim of this mode is to provide a quick tune-up tool for engines that require only a mild mixture adjustment. The AFM is therefore retained and must be in good working order. The system works by intercepting the AFM signal and allowing this voltage to be scaled before returning it to the factory ECU. Fuel corrections are made by scaling the AFM voltage at any load condition to match the mixture requirements of the engine. When the AFMLink is initially powered after the Calibration Process the AFM signal voltage is passed directly without scaling to the ECU. This has the advantage of allowing the engine to run as previously configured. The vehicle can then be taken for a test run and tuning can begin.

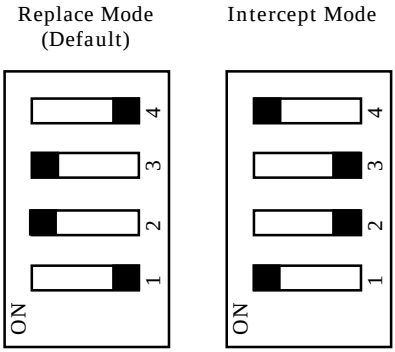
Both these modes offer the option of connecting a Throttle Position Sensor (TPS) to improve engine throttle response.

2.0 SYSTEM INSTALLATION

2.1 Initial Considerations

There are several factors to consideration before installing the AFMLink. These are controlled by one 4-way dip switch and one single way dip switch.

2.1.1 Firstly, the user must decide on the Operating Mode; REPLACE or INTERCEPT. Once decided the 4-Way dip switch inside the AFMLink must be set. To access this, remove the outer case and adjust as shown in Figure 1.0. The Default Mode is REPLACE and the AFMLink will be supplied in this mode.



Dip4	=	OFF	Dip4	=	ON
Dip3	=	ON	Dip3	=	OFF
Dip2	=	ON	Dip2	=	OFF
Dip1	=	OFF	Dip1	=	ON

Figure 1.

2.1.2 There are 2 options available when selecting the trigger signal used by the AFMLink, applicable to both operating modes. This is controlled by a 1 way Dip Switch located next to the main header pin.

Trigger High This uses the coil negative signal and the 10k Resistor supplied must be connected as close to the coil as possible. Set DIP1 switch to ON.

NOTE This trigger should only be selected in a Single Coil Ignition System.

Trigger Low This uses the Tacho signal derived by the factory ECU. This signal can be connected directly to the AFMLink. To achieve this, set DIP1 to OFF.

2.1.3 Lastly the AFMLink needs to know what AFM type to simulate. There are only two types, defined by their voltage swing.

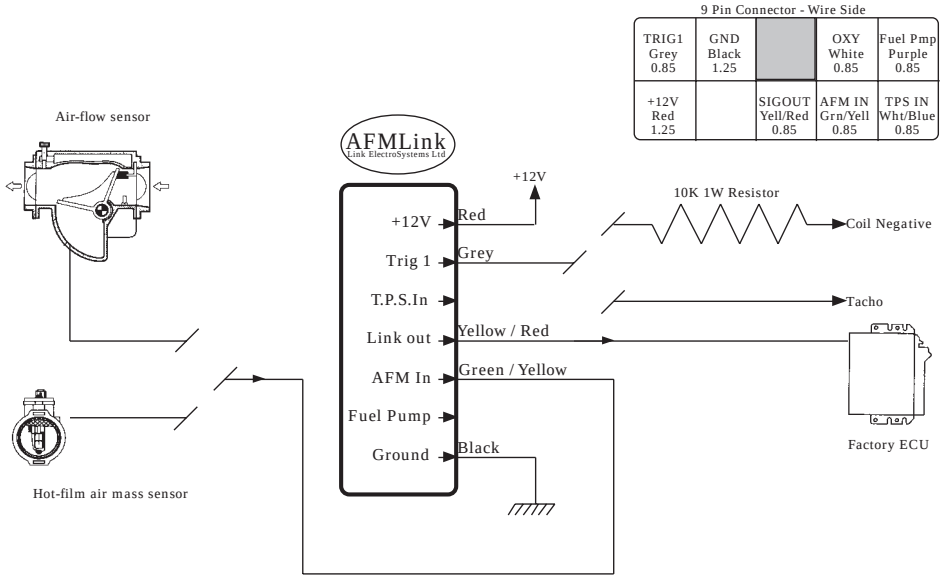
Type A AFM	Voltage at idle < voltage at Wide Open Throttle (WOT) (covers both hotwire & flap)
Type B AFM	Voltage at idle > voltage at WOT

A decision must be made on how the AFM type will be selected. The AFMLink can automatically determine the type independent of the Operating Mode. If this is selected the AFM must be connected to the engine. The other option is to select the AFM type manually. If the type is unknown, use the following simple test.

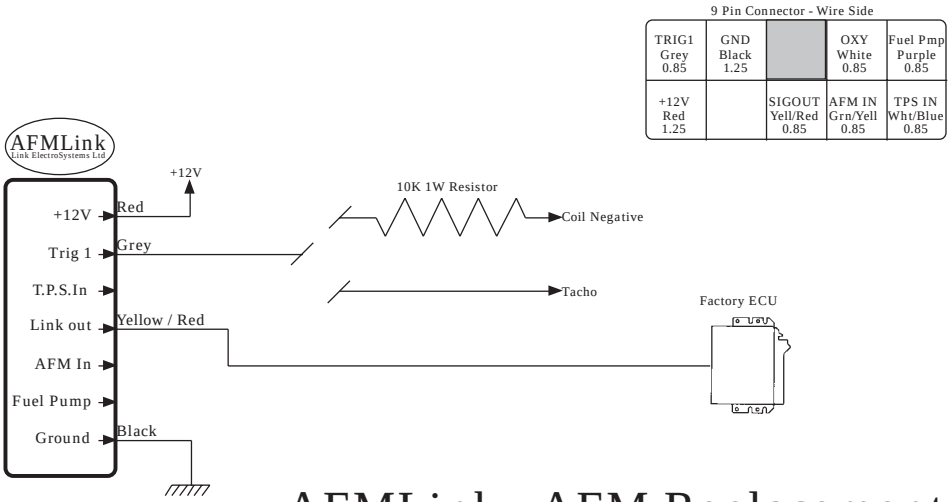
- Start the engine to determine the AFM voltage signal out. As the engine is revved this voltage will fluctuate. Once identified, let the engine return to idle.
- At idle take note of the voltage.
- Now Rev the engine and observe the voltage change. At this point it will either increase or decrease, indicating TYPE A or B. Once identified the AFMLink is ready to be installed.

2.2 INSTALLATION DIAGRAMS

There are three options available in the installation process. In each one, make sure the vacuum line is connected



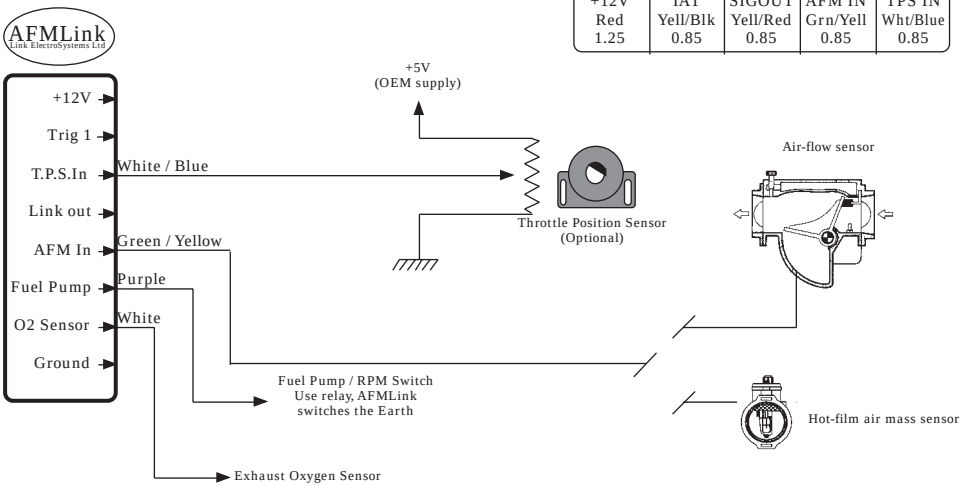
AFMLink - Intercept Mode



AFMLink - AFM Replacement

9 Pin Connector - Wire Side

TRIG1 Grey 0.85	GND Black 1.25		OXY White 0.85	FUEL PMP Purple 0.85
+12V Red 1.25	IAT Yell/Blk 0.85	SIGOUT Yell/Red 0.85	AFM IN Grn/Yell 0.85	TPS IN Wht/Blue 0.85



AFMLink - Ancillaries

White/Blue - A Throttle Position Sensor (TPS) can also be connected to improve throttle response or to select the zone rows for engines that have low vacuum at idle.

Purple - Can be configured to control a fuel pump relay or an RPM switch.

3.0 TUNING MODULE FUNCTIONS

TEST RPM - Read Only

Related Mode - REPLACE, INTERCEPT
This is the default display and indicates engine RPM. This reading should be stable and in accordance with the factory tachometer.

CYLINDER SETTING

Related Mode - REPLACE, INTERCEPT
Displays the current number of cylinders. Changes are made by pressing the ADJUST buttons and must be stored before the new settings become active.

MAP

Related Mode - REPLACE, INTERCEPT
Displays engine Manifold Air Pressure in units of kPa.

MASTER AFM

Related Mode - REPLACE, INTERCEPT
Controls the overall scaling on the voltage sent to the factory ECU and is effected throughout the entire operating range from idle to full power. The range is from -128% through to +128%.

INTERCEPT MODE

When the Intercept Mode is selected the MASTER is used to provide overall scaling on the Air Flow Meter voltage before it is sent to the factory ECU.

0% = no overall change. Air Flow Meter Voltage is passed with out scaling directly to ECU.

<0% = adjusts the entire Air Flow Meter Voltage range to produce a leaner mixture.

>0% = adjusts the entire Air Flow Meter Voltage range to produce a richer mixture.

REPLACE MODE

When the Replace Mode is selected, the MASTER will provide overall scaling on the Air Flow Meter Voltage estimate before it is sent to the factory ECU. This provides the fine mixture adjustment after the setting of both the SPAN and ALIGN Coefficients.

0% = no overall change, so the estimate of the Air Flow Meter Voltage is passed without scaling to the factory ECU.

<0% = the AFMLink will scale the estimated AFM Voltage over the entire range to produce a leaner mixture.

>0% = means the AFMLink will scale the estimated AFM Voltage over the entire range to produce a richer mixture.

The MASTER is adjusted by pressing the ADJUST buttons. When the scaled AFM voltage sent to the ECU reaches its Maximum value (5V), the symbol ">" will be displayed in this menu and ZN AFM menu. Likewise, when the Minimum voltage is reached the symbol "<" will be displayed.

ROW STEPS

The Zone Table rows can be selected using MAP or TPS. In TPS mode, the zone rows are selected by the TPS sensor to provide stable zoning if the MAP signal is fluctuating due to special cams etc. The TPS must be connected before selecting this mode.

ROW STEPS - MAP - Press the ADJUST DOWN Button

ROW STEPS - TPS - Press the ADJUST UP Button

TPS RANGE SELECT

When ROW STEPS = TPS this menu will be displayed. It allows the Zone Table span limits to be set according to the number of ROW/ZONES required. By providing two separate adjustable limits the operator can select which rows and the number of rows required for tuning. These limits are adjustable using the following buttons:-

- The ADJUST Buttons allow the lower limit to be changed ('MAP- xx'). This means when the Throttle fully closed it will point to 'xx' on the Load Axis(Vertical axis on Zone Table)
- The EDIT Buttons allow the upper Load Axis limit to be changed ('MAP+ yy'). This means when the Throttle is fully open it will point to 'yy' on the Load Axis

TPS

When ROW STEPS = TPS this menu will be displayed. This menu allows the TPS span to be set. The TPS voltage is displayed in brackets and percentage throttle is displayed on right hand side of the screen. Closed throttle is scaled to indicate 0% and WOT scaled to read 100%.

Setting TPS Span:

To set the span press and hold both edit buttons. The screen will show "TPS - CLOSED " At this point the throttle should be closed.

After a 3 seconds delay the screen will display "TPS - WOT". The throttle should now be fully depressed and left until the display returns to its normal menu.

A check should be performed to ensure the TPS span is set correctly. The display should read 0% with the throttle closed and approximately 100% with the throttle fully depressed. Note that when the TPS span setup is initiated, the ACCEL mode is automatically adjusted for TPS enrichment.

VOLTAGE

Related Mode - REPLACE, INTERCEPT
Used to monitor two important voltages. Vin represents the actual Air Flow Meter voltage and will only be displayed when the AFM is connected to the AFMLink. VECU represents the voltage the AFMLink sends to the factory ECU.

INTERCEPT MODE
Vin = Actual Air Flow Meter Voltage
VECU = Actual AFM Voltage sent to factory ECU after scaling

REPLACE MODE

VIN = Actual Air Flow Meter Voltage. The AFM should only be connected in this mode if the AFMLink is programmed to determine AFM type OR is required to aid in the tuning of the device. When the AFM is removed, Offline will replace the symbol Vin.

VECU = This display shows the AFM Voltage Estimate sent to the factory ECU. This is the voltage produced by the AFMLink to simulate the original AFM.

ADJUST buttons in this menu adjusts the SPAN Coefficient
EDIT buttons in the menu adjusts the ALIGN Coefficient.

STORE

Used to store any corrections to memory. STORE is initiated by pressing BOTH ADJUST buttons together until the display shows "**********" and then releasing. The process will take from 2..30 seconds depending on the number of corrections to be stored.

SPAN COEFFICIENT

Related Mode - REPLACE
This coefficient is used only in the REPLACE AFM mode. Its purpose is to adjust the span (range) of the estimated AFM voltage. Increasing this number will increase the voltage operating range produced by the AFMLink. Likewise decreasing this number will

reduce the voltage operating range. The SPAN coefficient is clamped between 1 & 25.5 and offers the choice of both fine and coarse adjustment.

Coarse Adjustment Alters the SPAN coefficient by ± 1%. The ADJUST buttons are used to change this. This adjustment should always be used when initially calibrating the AFMLink.

Fine Adjustment This will alter the SPAN coefficient by ± 0.1%. The EDIT buttons are used to change this. This adjustment will ONLY be necessary when dealing with a narrow AFM voltage range, typically less than 2V.

Refer to section 6.0 on Tuning Procedures for instructions on how to adjust this number.

ALIGN Coefficient

Related Mode - REPLACE

This coefficient is used only in the REPLACE AFM mode. Its purpose is to control the alignment of the estimated AFM voltage. The range is clamped between -128 & 128. Refer to section 6.0 on Tuning Procedures for instructions on how to adjust this number. Press the ADJUST buttons to change this value.

ZN AFM

Related Mode - REPLACE, INTERCEPT

There are 144 fuel zones arranged in a rectangular grid of 9 ROWS by 16 COLUMNS. The ROWS progress in steps of Manifold Air Pressure to provide the "load" axis and the COLUMNS progress in steps of RPM. Each zone therefore represents a unique engine operating condition, allowing fuel changes to be made in small, localised areas. The zone selection is automatic with the current zone displayed in the centre of the screen and its associated value to the right, represented as a percentage. Adjustments are made by operating the ADJUST buttons as required. Values range from -128% to +128%. All zones use Interpolation.

INTERCEPT MODE

0% -When using the INTERCEPT Mode, 0% allows the sampled AFM voltage to be returned to the factory ECU without scaling. This is the default number stored during a RELOAD. An increase in this number will enrichen the mixture, while a decrease will produce a leaner mixture.

REPLACE MODE

0% - When using the REPLACE Mode, 0% means the AFM voltage calculated by the AFMLink is sent to the factory ECU without scaling. If this number is increased the calculated AFM voltage is scaled to enrichen the mixture. Likewise, if the number is decreased the calculated AFM voltage is rescaled to achieve a leaner mixture.

As changes are made the AFM & ECU voltages can be viewed from the VOLTAGE Menu.

LGE ZN Z=x

Related Mode - REPLACE, INTERCEPT

The zone table has been divided into 23 large zones. The zone selection is automatic with the current zone (x) displayed in the centre of the screen and its associated value to the right, represented as a percentage. Adjustments are made by operating the ADJUST buttons as required. Values range from -128% - +128%. All zones use interpolation.

The adjustments have the same function as described in ZN AFM menu. An increase in this number will enrichen the mixture over the entire Large Zone x, while a decrease will produce a leaner mixture.

ACCEL MODE

Controls acceleration enrichment during abrupt opening of the throttle or rapid changes in Manifold Air Pressure. There are 4 zones covering a 2000-RPM span to allow optimum enrichment figures to be set for varying conditions. The current zone will be

displayed automatically with the transient fuel shown on the right side of the display. This can be changed by using the ADJUST buttons. By default these are reset to 0% which means no transient fuel.

Z=0	0	-	2000 Rpm
Z=1	2000	-	4000 Rpm
Z=2	4000	-	6000 Rpm
Z=3	6000	-	8000 Rpm

Two types of transient mode can be selected

TPS mode

This is selected by pressing the EDIT DN button. The display will indicate ACCEL TPS MODE and then return to its previous menu. The Symbol T will now be displayed to indicate this mode. Before selecting this, ensure the TPS is connected correctly and its span has been adjusted in the TPS Menu. This mode should be selected if the Map transient mode provides insufficient engine throttle response.

MAP mode (default)

This is selected by pressing the EDIT UP button. The display will indicate ACCEL MAP MODE and then return to the previous menu. The Symbol M will now be displayed to indicate this mode.

Note that ACCEL is only effective during the actual movement of the throttle or a sudden change in manifold pressure.

EDIT

Enables the zone editor function, which allows access to all 184 zones for viewing and editing. The EDIT function may be used at any time, with or without the engine running. Use the EDIT buttons to select the appropriate zone(s) and ADJUST buttons to change the selected zone. The zone is identified by a number displayed in the centre of the screen. Storing of edited values may be done by pressing BOTH EDIT buttons together until the display shows "**********" and then releasing. Alternatively, STORE may be selected.

AFM EQUATION

Selects the AFM Equation used to calculate the estimated AFM Voltage. This is adjusted by using the ADJUST buttons.

RELOAD

This process will reset all zones to typical values to allow a base for subsequent tuning. The AFMLink provides two RELOAD options

System Reload - Will allow the operator to enter the AFMLink Calibration Process and is activated by pressing both ADJUST buttons and released when the screen displays Calibration Mode . Refer to the section Calibration Process for more information.

Zone Reload - Will only reload zones 100 - 975 and is activated by pressing both EDIT buttons until the screen displays ********* and then releasing.

CAUTION: RELOAD will over-write all values currently stored in the memory and should only be used during the initial setup or if you wish to restart the tuning procedure.

RPM SWITCH

This is a low power drive which can be configured as an RPM Switch or Fuel Pump Drive. It provides an earth and MUST be used only to switch a relay.

When the menu displays 'RPM SW xxxx OFF' the RPM switch is off and the drive is configured to switch a fuel pump relay. This is selected by pressing hte EDIT DOWN Button.

When the menu displays 'RPM SW 4000 ON' the drive is configured as an RPM Switch. This is selected by pressing the EDIT UP Button. To adjust the switching RPM use the ADJUST Buttons.

OXYGEN

When a lambda sensor is connected to the AFMlink, this menu` can be used to view its output voltage and corresponding CO percentage.

VOLTAGE	%CO	A/F RATIO (approx)
< 0.6	< 1.0	> 15:1
0.72	1.0	14:1
0.76	2.0	
0.80	3.0	
0.84	5.0	13:1
0.86	6.0	12:1
0.88	8.0 +	11:1

MIMIMUM CLAMP VOLTAGE

This is an adjustable clamp and will prevent the voltage produced by the AFMLink going below this limit. It can be changed using the ADJUST Buttons.

MAXIMUM CLAMP VOLTAGE

This is an adjustable clamp and will prevent the voltage produced by the AFMLink going above this limit. It can be changed using the ADJUST Buttons.
In some situation a clamp voltage will be required to prevent idle surge or over-voltage on WOT Conditions.

4.0 CALIBRATION PROCESS

The Calibration Process allows the configuration of the AFMLink to be setup. It allows the user to select:

- Operating Mode
- How the AFM type is detected
- Manual AFM Type Select

Once completed the correct zone table will be loaded to match the configuration. With the remote connected, apply power to the AFMLink. Assuming the initial considerations have been taken into account from section 2 the Calibration Mode can be selected.

4.1 Starting Calibration Process

Firstly apply power and press the SELECT UP button until the RELOAD menu is displayed. The Calibration Mode is then started by pressing and holding both ADJUST buttons until the screen displays CALIBRATION MODE and then released Do NOT start the engine. The first menu (default) to appear will read MODE ‘ REPLACE. The blinking text indicates the current setting. To exit this process, recycle the power at any time or use SELECT DOWN to return to the default Calibration menu.

CAUTION

Never attempt to start the engine if power has been removed during any of the Calibration menus. Once started the calibration process MUST be completed.

4.2 Operating Mode.

This is the first menu and allows the user to select the operating mode.

MODE→ REPLACE (default) - Selected by ADJUST DOWN.
MODE → INTERCEPT. - Selected by ADJUST UP

To progress to the next menu press the SELECT UP button.

4.3 AFM Select

This mode allows the user to select how the AFMLink determines the AFM type. The two options available are:

4.3.1 AFM SEL ' MANUAL (default) - ADJUST UP

This will allow the manual selection of the AFM type. This should already be known before the Calibration process is selected. To progress to the next menu (section 4.4) press the SELECT UP button.

4.3.2 AFM SEL ' AUTOMATIC - ADJUST DOWN

This setting allows the AFMLink to automatically determine the AFM type. If this mode is selected the output of the existing AFM MUST be connected to the AFMLink. To progress to the next menu (section 4.5) press the SELECT UP button.

4.4 AFM Type

This mode allows the manual selection of the AFM type. There are two options:-

AFM → TYPE B Selected by ADJUST UP.
AFM → TYPE A Selected by ADJUST DOWN.

Type A AFM	Voltage at idle < voltage at WOT (covers both hotwire & flap)
Type B AFM	Voltage at idle > voltage at WOT (older style Flap AFM)

Pressing the SELECT UP button will now end the calibration process and load the correct zone table.

4.5 AUTOMATIC AFM Test

The display should read "TESTING AFM " indicating the AFMLink is ready to test the AFM. In this mode the AFMLink passes the AFM voltage without scaling directly to the factory ECU independent of the operating mode. The engine will therefore run as normal allowing the AFM to be identified. The following procedure should now be used:-

i) Start the engine

ii) Rev the engine slowly towards 2000 RPM and allow it to return to idle.

When the AFMLink has determined the AFM type, the display will show:

AFM ‘ TYPE A or B.

The AFM type will be flashing. If the display still reads TESTING AFM .. repeat the test procedure.

Note. Revving the engine too quickly may cause the AFMLink to incorrectly detect the AFM Type.

The AFM Type will be displayed for 3 seconds after which time a Zone Table will be loaded. At this point DO NOT switch the engine off.

4.6 Zone Loading

The Zone table matching the selected requirements will be loaded and stored in approximately 5 seconds. The display will show “LOADING ZONE.....” while this is taking place. If the Automatic AFM test was selected then the engine will be running on the original AFM and will continue to run during this process. When the display returns to TEST RPM the calibration process is complete. If the engine is running you will observe the engine RPM on the screen and at this point it can be switched off. The power MUST now be recycled to allow the AFMLink to run from its new configuration. Refer to the section on Tuning Procedures before the engine is started.

4.7 Cylinder Number

Scroll to the CYLINDERS menu and check the setting is correct. Use the ADJUST buttons to change the setting remembering to store the changes. Switch off the power.

4.8 Trigger Stability Check

Apply power to the AFMLink. This check will depend on the AFMLink Mode of Operation.

4.8.1 INTERCEPT MODE

After the calibration process the AFM Signal is passed directly without scaling to the factory ECU. At this point start the engine with the remote on TEST RPM. Check to ensure the RPM is stable by observing idle RPM and then revving the engine. In this mode RPM is used only for Zoning.

4.8.2 REPLACE MODE

If the AFM is connected press the SELECT DOWN button. While holding this button press the SELECT UP button. This will allow the AFMLink to replicate the AFM voltage and pass it to the factory ECU. Now start the engine with the display on TEST RPM. Check to ensure the RPM is stable by observing idle RPM and then revving the engine. This is important because the AFMLink uses RPM as a variable to calculate an estimate of the AFM Voltage. Once satisfied switch the engine off. If the AFM is not connected the voltage transferred to the factory ECU will be that produced by the AFMLink. At this initial stage the voltage may be incorrect and the engine may not idle smoothly, making it difficult to view TEST RPM. A quick adjustment of the ALIGN coefficient may therefore be required to check RPM stability.

The Calibration Process is now complete. The next step is to adjust the SPAN and ALIGN coefficients.

5.0 SPAN & ALIGN COEFFICIENTS

For the AFMLink to produce a signal that simulates an AFM, it must first form a voltage estimate using the engines RPM and MAP. The result forms a base number from which the user can fine-tune the calculation, allowing the voltage characteristics produced by the AFMlink to match those of the original AFM. The two coefficients used to control this are labeled SPAN & ALIGN. This section will define these coefficients and give examples on their use. A good understanding of the two coefficients is important before attempting to tune the AFMLink.

5.1 SPAN Coefficient

This controls the voltage span or range produced by the AFMLink. (Range = Difference between the maximum and minimum voltage produced)
This means the engines RPM and MAP are first combined to produce a base AFM estimate. This result is then scaled by the SPAN Coefficient with the following results:

- Increase SPAN Coefficient, will increase the voltage range of AFM Estimate (ie difference between the min and max voltage produced by the AFMlink will increase)
- Decrease SPAN Coefficient, will decrease the voltage range of AFM Estimate

The adjustment range is from 1- 25.5. The following examples will illustrate the SPAN properties. During these examples TYPE A Air Flow Meters will be used on a normally aspired engine. The shaded area indicates the AFM Voltage operating range, estimated by the AFMLink.

Example 1

The SPAN was initially set at 12 and ALIGN set to 0%. Figure 2(a) shows these default settings. This will produce a typical value of 1.3V at idle and 3.5V at Wide Open Throttle (WOT), giving a 2.2V operating range. To increase the voltage range, increase the SPAN coefficient to 24. Figure 2(b) can be used to view the result.

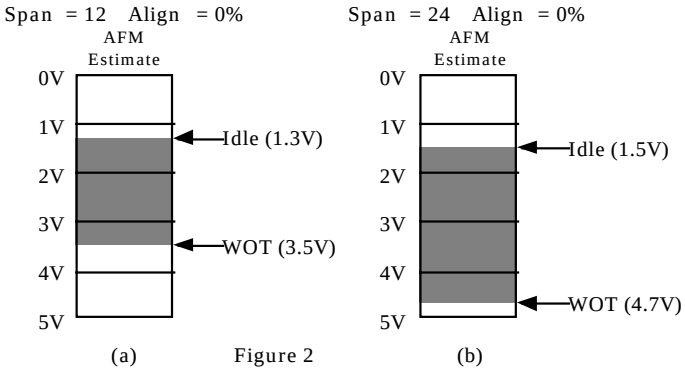


Figure 2

Summary - Example1:This example illustrates that increasing the SPAN Coefficient will increase the voltage range produced by the AFMLink. Increasing the range is achieved by allowing the WOT value to increase significantly more than the idle voltage. This is an inherent property of the calculation and MUST be realised when adjusting the SPAN coefficient.

Example 2

The SPAN was initially set at 12 using a TYPE A AFM. The result was an AFM Voltage range of 1.3- 3.5V (Figure 3(a). The voltage range was then reduced by decreasing the SPAN coefficient to 4. Figure 3(b) can be used to view the result, remembering the shaded area indicates the AFM Voltage range, estimated by the AFMLink.

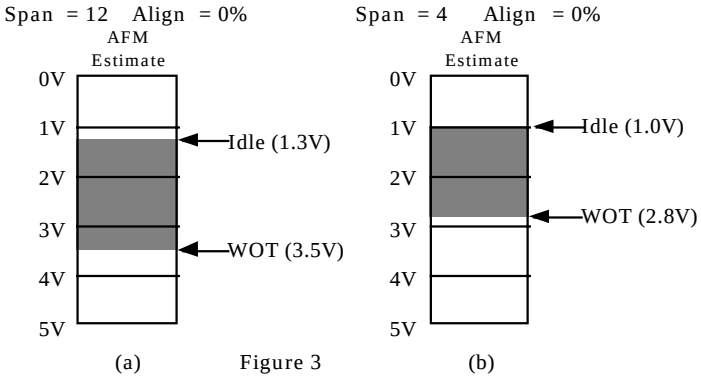


Figure 3

Summary - Example 2 This example illustrates that decreasing the SPAN Coefficient will decrease the voltage range estimated by the AFMLink. Decreasing the range is achieved by allowing the WOT value to decrease significantly more than the idle voltage. This is an inherent property of the calculation and MUST be realised when making adjustments to the SPAN coefficient.

Conclusion on SPAN

The SPAN controls the difference between the minimum and maximum voltage estimated by the AFMLink. Ideally when altering the voltage range, the minimum limit should be held constant while the maximum is changed. However the inherent properties of this calculation mean that the minimum voltage will always change slightly when the voltage range is changed.

Selecting the Correct SPAN

There is no one correct SPAN setting for an engine setup. Variations in MAP and AFM types mean the SPAN must be selected using trial and error. Information on the original AFM can be valuable by providing information on idle voltage and voltage range. The SPAN coefficient is shown to one decimal place. When operating from the SPAN menu, the ADJUST buttons control the coarse adjustment by changing the SPAN by 1, while pressing the EDIT buttons will cause the SPAN to change by 0.1, hence controlling the fine adjustment. The fine adjustment should only be required when operating on a narrow voltage span, typically less than 2V

5.2 ALIGN Coefficient

The ALIGN Coefficient is used to scale the voltage produced by the AFMLink at the end of its calculation. This means engine RPM and MAP are first used to produce a base AFM voltage estimate. This result is then scaled by the SPAN Coefficient. Lastly the ALIGN Coefficient is added or subtracted to ALL AFM Voltages estimates. A change of $\pm$ 1% will cause all estimates to be scaled by approximately 20mV. The ALIGN Coefficient has NO EFFECT on the voltage range produced by the AFMLink.

To obtain a better understanding of how this works, use example 3 to view the properties of the ALIGN coefficient.

Example 3

The SPAN was initially set at 12 and the ALIGN at 0% using a TYPE A AFM. The result was an AFM Voltage range of 1.3- 3.5V shown in Figure 4a. Figure 4b shows the result of decreasing the ALIGN by 15 while Figure 4c shows the result of increasing the ALIGN by 15.

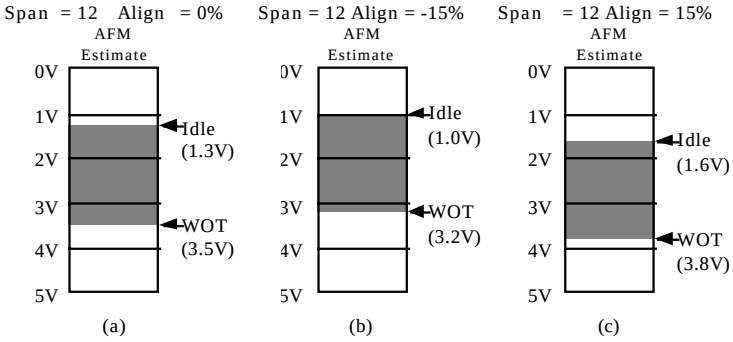


Figure 4

Summary

This example illustrates that increasing the ALIGN to +15% will add 0.3V (15*20mV) to all AFM estimates. Likewise, decreasing the ALIGN to 15% will subtract 0.3V from all AFM estimates. It can be through of as sliding the AFM estimate up or down the 5V scale.

5.3 Combining SPAN & ALIGN Coefficients

The following is an example of how to combine the SPAN and ALIGN Coefficients to produce the AFM Voltage required to meet the mixture requirements of the engine.

Example 4

The SPAN was initially set at 12 using a TYPE A AFM. The result was an AFM Voltage range of 1.3- 3.5V (Figure 5a). At this point the idle voltage produces the desired mixture but 3/4 to WOT is lean because the voltage estimate at this point is too small (i.e. the range is too narrow). This means the SPAN must be increased to allow a voltage range of approximately 1.3 (Idle) - 4.5V (WOT). To achieve this the SPAN coefficient was increased by trial and error to 24. Figure 5b shows to result:

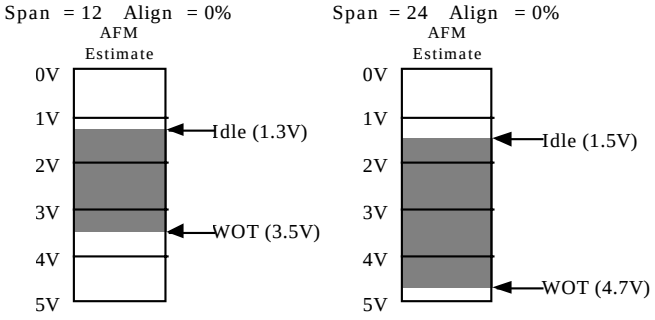


Figure 5

At this point the voltage operating range (WOT minus Idle) has increased from 2.2V to 3.2V. The inherent property of this calculation means the WOT value has increased significantly more than the idle value. At present the engine is running rich throughout the entire operating range. This is fixed by adjusting the ALIGN coefficient to 10% subtracting 0.2V (20mV*10) from all AFM Estimates. Figure 6 shows the result.

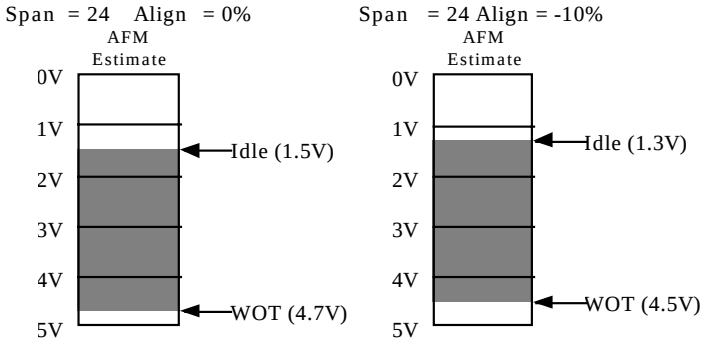


Figure 6

Summary

The engine is now idling at its original 1.3V and has a larger voltage operating range spanning to 4.5V. This example illustrates how the two coefficients can be used to simulate the charactoristics of the orignal AFM.. The important points to remember from this section are:

- The SPAN coefficient controls the range of the AFM voltage estimate. To achieve this, the WOT value will change significantly more than the Idle value. To compensate for this inherent property the ALIGN coefficient may require adjustment allowing the voltage range to be shifted either up or down the 5V axis.
- The ALIGN coefficient represents a voltage and this will be subtracted or added to all the AFM estimate before it is sent to the factory ECU.

An understanding of these two coefficients is vital in being able to achieve the correct AFM Estimate for the engine.

5.4 AFM EQUATION

The AFMLink offers the choice of 3 equations when calculating an estimate of the AFM Voltage. These are labelled LOW, MED, HI. The difference between these equations is the operating range of the estimated AFM Voltage, for the same Idle and WOT conditions. (Note: Range = WOT minus Idle voltage.)

Equation	Low	Medium	High
Operating Range	3.1V	2.2V	1.8V

This table shows that the equation LOW provides an estimate spanning the largest voltage range, while equation HI has the smallest range.

When To Change Equations

The default equation is MED and coefficient adjustment will be made initially using this equation. There are 2 situations that will require the AFM Equation to be changed.

- SPAN coefficient around 24-25. This means the range of the estimated AFM Voltage has been increased to about its maximum limit. An equation with a larger range should now be selected - Equation LOW. Once the new equation is selected reset the SPAN coefficient to 12 and try retuning the engine.
- SPAN coefficient around 3- 5. This means the range of the estimated AFM Voltage has been decreased to about its minimum limit. An equation with a smaller range should now be selected - Equation HI. Once the new equation is selected reset the SPAN coefficient to 12 and try retuning the engine.

6.0 TUNING PROCEDURE

It is assumed at this point that the configuration of the AFMLink has been setup as required using the Calibration Process and the coefficients are ready to be adjusted.

6.1 INTERCEPT MODE

When the engine is first run on INTERCEPT MODE the voltage produced by the AFM is passed directly without scaling to the factory ECU. This can be observed on the Tuning Module by scrolling to the VOLTAGE menu and noting that AFM Voltage and VECU (Voltage sent to ECU) are the same. This is also represented by 0% shown on the MASTER, ZN AFM, LGE ZN menus and will allow the engine to run as previously configured. Tuning in this mode is a simple procedure. An increase in the MASTER will enrichen the mixture over the entire operating range of the engine while a decrease will produce a leaner mixture. If a particular load condition requires a mixture change, simply go to the correct zone and adjust. This can either be done in ZN AFM allowing the engines current operating zone to be adjusted, or by using LGE ZN and adjusting the engines current large zone, or by using the Zone Editor. As adjustments are made the VOLTAGE menu can be used to observe the changes in the AFM and ECU voltages. REMEMBER to save any changes by using the STORE menu.
Note: The SPAN and ALIGN Coefficients have no function in this operating mode.

6.2 REPLACE MODE

Before Zone tuning can begin, both the SPAN and ALIGN Coefficients must be adjusted. If the orignal AFM is in working order it should be connected to the AFMLink. It will provide valuable information on Idle voltage, WOT voltage and AFM voltage range. With this information the AFMLink can be configured quicker and once setup the AFM can be removed from the engine. If the AFM is

not avaiable then the engines CO will require monitoring. The default settings are:

SPAN	=	12
ALIGN	=	0%
AFM EQUATION	=	Mid

giving the following typical results :

TYPE A AFM:

Idle Voltage = 1.35V (800rpm@35kP

WOT Voltage = 3.85V (6000RPM@ 100kPa) Non turbo Engine

WOT Voltage = 4.55V (6000RPM@ 180kPa) Turbo Engine

TYPE B AFM:

Idle Voltage = 3.72V (800rpm @35kPa)

WOT Voltage = 1.23V (6000rpm@ 100kPa) Non turbo Engine

WOT Voltage = 0.39V (6000rpm@ 180kPa) Turbo Engine

The following procedures should now be used when the engine is being started for the first time.

Switch on the ignition to supply power to the AFMLink. If the AFM is connected then use the SELECT UP button to scroll through to the VOLTAGE menu, otherwise scroll to the ALIGN menu.

Step A Idle Adjustment One

The first step is to achieve a smooth idle. Before starting the engine make sure the following procedure is understood.

The aim is to initially adjust the ALIGN coefficient to achieve the correct idle voltage. Two cases will arise:

- The AFM Voltage estimate (VECU) is too large. This means the estimated voltage needs to be reduced and this is achieved by decreasing the ALIGN Coefficient by the required voltage.
- The AFM Voltage estimate (VECU) is too small. This means the estimated voltage needs to be increased and this is achieved by increasing the ALIGN Coefficient by the required voltage

Now start the engine. If the VOLTAGE Menu is displayed use the EDIT buttons to change the ALIGN Coefficient until either the AFM Voltage & VECU are close OR the required CO level is achieved. If the ALIGN menu is displayed use the ADJUST buttons to change this value until the engine begins to idle smooth OR the required CO level is achieved. This is only an initial adjustment and is likely to change.

Example: SPAN = 12 ALIGN = 0%.
Engine idling at 1.4V, but running rough due to a rich mixture. The ALIGN coefficient is reduced to 18 (- 0.35V) allowing the engine to idle at 1.05V.
REMEMBER :- Changing the ALIGN coefficient by 18% will subtract 0.35V from all AFM Estimates

Step B Idle Adjustment Two

While the vehicle is stationary gradually increase the RPM. There are two ways to adjust the coefficients:

Step B.1 - Adjustment using orignal AFM

If the VOLTAGE menu is displayed observe the difference between the AFM and ECU Voltage. Two situations will arise:

- The ECU Voltage (Estimated AFM Voltage) will be LESS than the actual AFM Voltage and the difference will increase as the RPM is increased. This means the span (range) of the AFM estimate needs to be increased. From the VOLTAGE menu use the ADJUST UP button to increase the SPAN coefficient. This will increase the SPAN one unit at a time

NOTE Remembering from section 5.1, that increasing the SPAN not only increases the range, but also slightly increases the idle voltage. This means as the SPAN is increased the ALIGN coefficient may need to be reduced slightly.

- The ECU Voltage (Estimated AFM Voltage) will be GREATER than the actual AFM Voltage and the difference will increase as the RPM is increased. This means the span (range) of the AFM estimate needs to be reduced. From the VOLTAGE menu use the ADJUST buttons to decrease the SPAN coefficient.

NOTE Remembering from section 5.1, that decreasing the SPAN not only decreases the range, but also slightly decreases the idle voltage. This means as the SPAN is decreased the ALIGN coefficient may need to be increased slightly.

Step B.2 -Using Lambda Sensor

Scroll to the SPAN menu on the tuning module. As the engine is revved observe the response of the engine. At this point the engine will either feel lean or rich.

- If the engine is lacking response the mixture will be lean. This means the AFM Voltage range is too narrow and the SPAN coefficient should be increased.
- If the engine is running rich the estimated AFM Voltage range needs to be reduced by reducing the SPAN coefficient.

  Remembering that each time the SPAN is adjusted the ALIGN coefficient may require adjustment, to compensate for the inherent property of this calculation.

STEP C Medium to Light Throttle Adjustment

In this next phase the vehicle should be driven at medium to light throttle. The aim is to achieve a minimum difference between the estimated AFM voltage produced by the AFMLink and AFM voltage required by the engine. There are 2 ways of doing this:-

- If the AFM is connected then a good start is to scroll to the Voltage menu on the Tuning Remote and compare the AFM Voltage to the VECU while adjusting the SPAN coefficient
- Adjust the SPAN by monitoring the mixture using a LAMBDA LINK or by using some other device.

When adjusting the SPAN coefficient, the same rules apply as those outlined in STEP B.

CAUTION At this initial tuning stage, the engine may suffer from either a rich or lean mixture causing denotation or back-firing. It is therefore advised that the initial test run be done with caution while the SPAN Coefficient is adjusted.

Once satisfied, let the engine return to idle. When the SPAN and ALIGN coefficients are close to their final value, a compromise is

likely to be required between Idle and WOT conditions. For example if the ALIGN is reduced to achieve the correct Idle voltage (for TYPE A AFM) the engine may lack response on the road. This condition may be misdiagnosed as a SPAN problem, when in fact the ALIGN coefficient has been reduced too much. This solution is to increase the ALIGN coefficient which will improve engine response. However the compromise is the Idle mixture, which is slightly rich. Zone tuning should then be used to decrease the Idle voltage which will reduce the Idle mixture.

STEP D Full Throttle

The last check is full throttle and should done only when you are confident that the mid to light throttle settings are set correctly. REMEMBER to save these changes before removing power. At this point you can begin zone tuning the engine using ZN AFM, LGE ZN and MASTER to achieve the final desired mixture

AFMLink Zone Sheet

Settings

Master	CY	Mode	RPM Switch	Span	Align	Min Clamp	Max Clamp	AC C	AC C	AC C	AC C	EQ N		Span TPS	Min TPS
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

MAP (kPa)

	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
0															
20	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175
	0		4		8		12			16				20		
40	200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275
60	300	305	310	315	320	325	330	335	340	345	350	355	360	365	370	375
		1		5		9		13			17				21	
80	400	405	410	415	420	425	430	435	440	445	450	455	460	465	470	475
100	500	505	510	515	520	525	530	535	540	545	550	555	560	565	570	575
		2		6		10		14			18				22	
120	600	605	610	615	620	625	630	635	640	645	650	655	660	665	670	675
160	700	705	710	715	720	725	730	735	740	745	750	755	760	765	770	775
		3		7		11		15			19				23	
200	800	805	810	815	820	825	830	835	840	845	850	855	860	865	870	875
240	900	905	910	915	920	925	930	935	940	945	950	955	960	965	970	975

Large Zones

0	4	8	12	16	20	← Absolute Vacuum / ← Typical Idle
1	5	9	13	17	21	← Mid Power
2	6	10	14	18	22	← Atmosphere WOT Non Turbo
3	7	11	15	19	23	← Low Boost / ← High Boost