Autronic

FUEL INJECTION — ADVANCED CONTROLS

INSTRUCTION MANUAL

KNOCK1 PROCESSOR MODULE FOR PLUG-IN ECU

1.0 GENERAL WARNINGS

If your engine type is unable to withstand knock, or you are unwilling to subject your engine to knock, or you are not experienced with detection of engine knock, or do not have instruments for the detection of knock, or do not have a good understanding of AUTRONIC SM4 ECU operation and ECU set up software you SHOULD NOT install this product. You should seek help from an experienced AUTRONIC installer.

These engine specific modules MUST only be applied for use with the intended engine types as listed on the product labeling. Also these modules are designed to use ONLY the OEM vibration sensor/s mounted in the OEM position/s. Failure to observe these restrictions will result in unreliable knock detection and/or inoperative fail safe protection leading to serious engine damage or destruction.

This manual should be thoroughly read and clearly understood before installation is commenced.

2.0 INSTALLATION

CAUTION:- Installation should only be performed by qualified personnel in an ELECTROSTATIC DISCHARGE SAFE environment. Installation MUST not be attempted while the ECU is installed in the vehicle. Failure to observe these precautions will result in permanent damage or destruction of the Knock Processor and/or the ECU. Such damage is NOT covered by warranty.

2.1 Prepare Knock Processor PCB for installation. Check ribbon cable and JP21 jumper configuration as per Fig 1 & 2 below

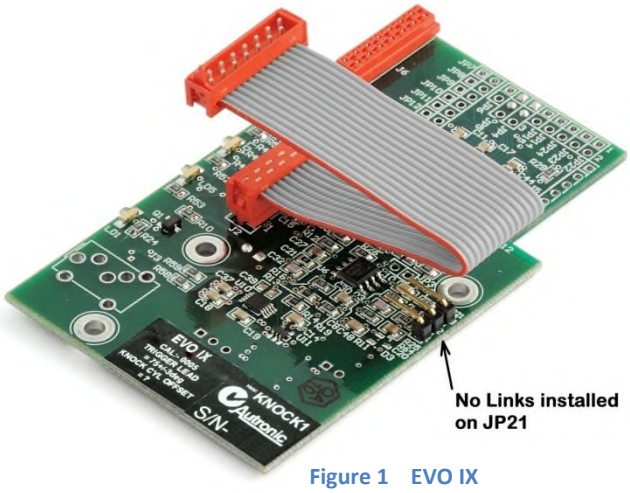


Figure 1 EVO IX

Figure 2 WRX

2.2 Special preparation of EVO IX PCB. Some PCBs have component ZD100 fitted. This MUST BE REMOVED from the PCB. See Fig 3. Its removal should only be attempted by skilled technicians using proper desoldering techniques

Figure 3 EV0 IX ZD100 Location

2.3 The Knock Processor mounts face down on the top of the ECU, above the Pressure Sensor, using longer Pressure Sensor attachment screws (supplied). Prepare ECU by replacing the Pressure Sensor attachment screws with the supplied M3 x 25mm screws (2off). To avoid Pressure Sensor damage, replace one screw at a time and only moderately tighten the sensor retaining nuts to avoid crushing the sensor mounting lugs. Install a second nut on each screw, positioning it 6 to 6.5 mm from the screw end (see Fig 4). Plug red ribbon cable connector into ECU socket and mount the Knock Processor, using flat washers then shake proof washers before fitting and tightening the retaining nuts. Ensure that the ribbon cable is neither pinched nor likely to be subjected to chafing.

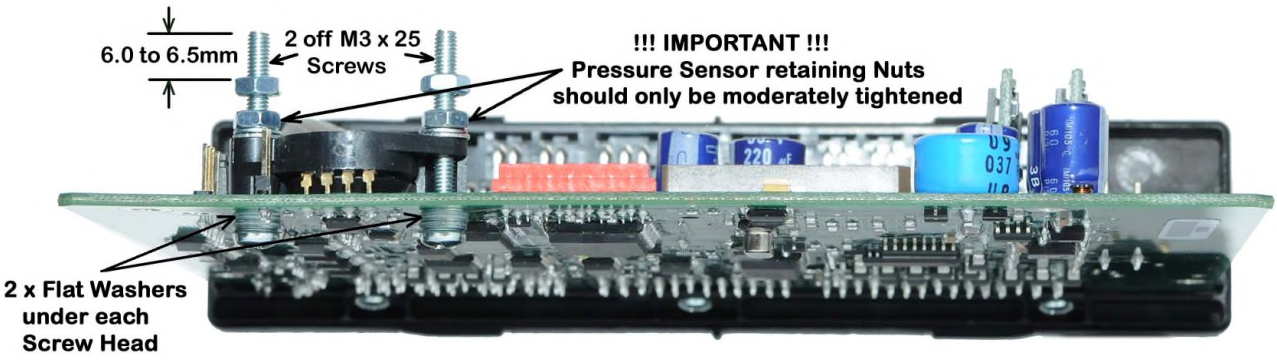


Figure 4 Mounting screw replacement

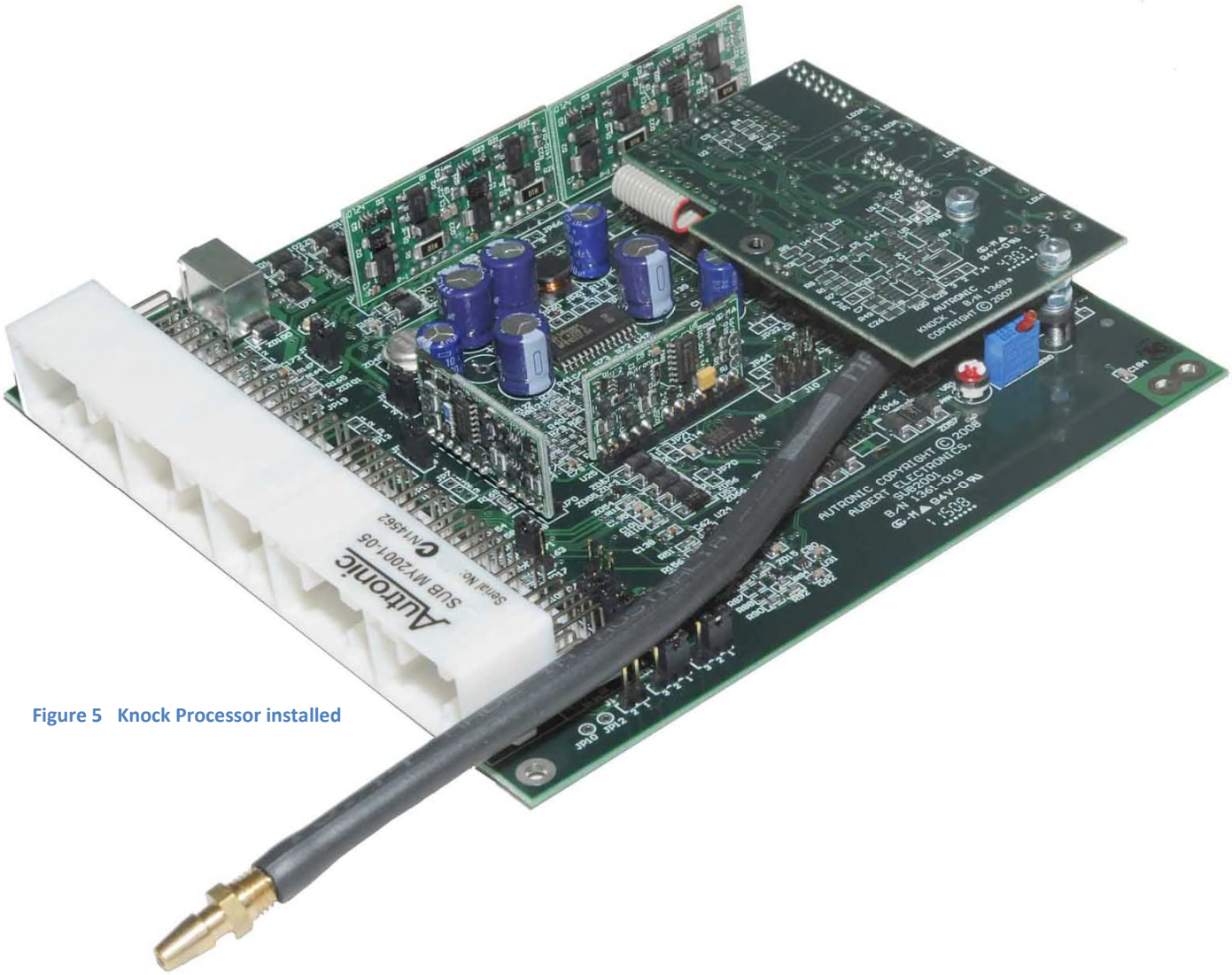


Figure 5 Knock Processor installed

3.0 ECU CALIBRATION

3.1 Menu M1 – O/P Setup - O/P Tacho **MUST** be enabled. O/P pulse duration can be either 0.5 or 1mSEC.

AUTRONIC [S/N-][Cal for Knock Pro]-KNOCK_MAN.CAL

OFF LINE COM1 19.2kbps

FileCal Edit-Window M0 -M1- M2 M3 M4 M5 M6 Logger Win Help(F1)

O/P setup

	O/P type	H-Bridge setup	O/P	Pin	Properties
O/P IAC control	Disabled				
O/P Boost	Disabled				
O/P Anti lag	Disabled				
O/P Air con	Disabled				
O/P GPC 1	Disabled				
O/P GPC 2	Disabled				
O/P GPC 3	Disabled				
O/P GPC 4	Disabled				
O/P GPC 5	Disabled				
O/P GPC 6	Disabled				
O/P GPC 7	Disabled				
O/P GPC 8	Disabled				
O/P GPC 9	Disabled				
O/P GPC 10	Disabled				
O/P GPC 11	Disabled				
O/P GPC 12	Disabled				
O/P GPC 13	Disabled				
O/P NOS	Disabled				
O/P Knock	Disabled				
O/P Fan 1	Disabled				
O/P Fan 2	Disabled				
O/P Water spray	Disabled				
O/P Tumble valve 1	Disabled				
O/P Tumble valve 2	Disabled				
O/P Error light	Disabled				
O/P Fuel used	Disabled				
O/P Fuel pump	Disabled				
O/P Tacho	DIRECT to pin		[ ] Output 8	C09	1.0 msec pulse
O/P TC	Disabled				
O/P Force 1	Disabled				
O/P Force 2	Disabled				
I/O Switch to var 1	Disabled				
I/O Switch to var 2	Disabled				
I/O Switch to var 3	Disabled				
I/O Switch to var 4	Disabled				

Figure 6 Enable Tacho O/P

3.2 Menu M1 – I/P Switches – I/P Knock **MUST** be enabled. Select from following modes:-

3.2.1 Cyl by Cyl

Individual cylinder Knock detection and retard action.

3.2.2 Cyl by Cyl / Record

Individual cylinder Knock detection and retard action plus reporting of prevailing Engine operating conditions (RPM, MAP and Coolant temp) when full protective measures failed to stop engine knocking. (**Recommended for Advanced user ONLY**)

3.2.3 Group retard

Knock detection on any cylinder causes retard action on all cylinders.

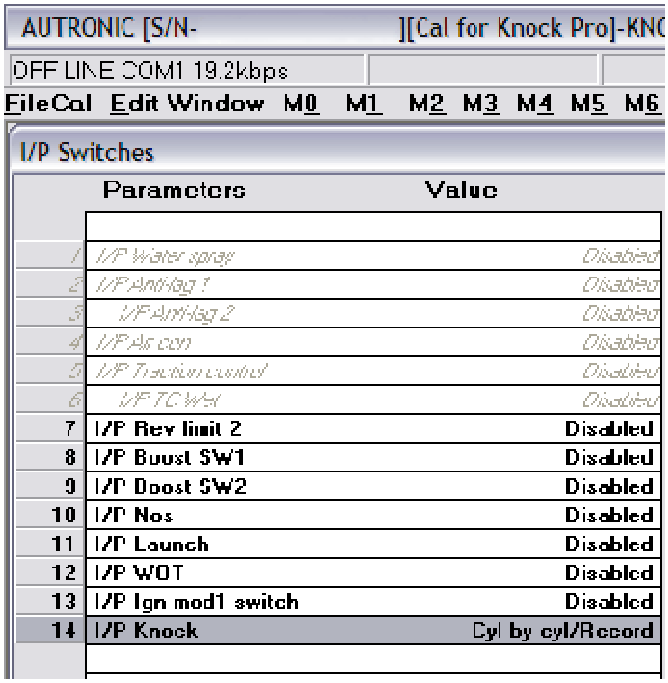


Figure 7 Knock I/P Mode selection

3.2.4 Group retard / Record

Knock detection on any cylinder causes retard action on all cylinders plus reporting of prevailing Engine operating conditions (RPM, MAP and Coolant temp) when full protective measures failed to stop engine knocking. **(Safest method. Recommended for Inexperienced user**)

The Cyl by Cyl mode results in the best engine output and lowest EGT (Exhaust Gas Temperature) however incorrect selection of ECU "Knock Cyl Offset" parameter will totally negate Knock protective action. The Group retard mode is easiest to setup since the ECU "Knock Cyl Offset" parameter is not required to be determined for the mode to produce full Knock protective action. **Important**:- See below for method to set and check ECU "Knock Cyl Offset" setting.

3.3 The menu M1 – I/P Cylinder & Sync – Cylinder I/P Lead Angle MUST be set within the Trigger lead angle range specified on the Knock Processor ID label. This requires that crank trigger wheel position & corresponding ECU trigger pattern decoding selection must produce correct Ignition timing when Cylinder I/P lead angle is within this allowed setting range.

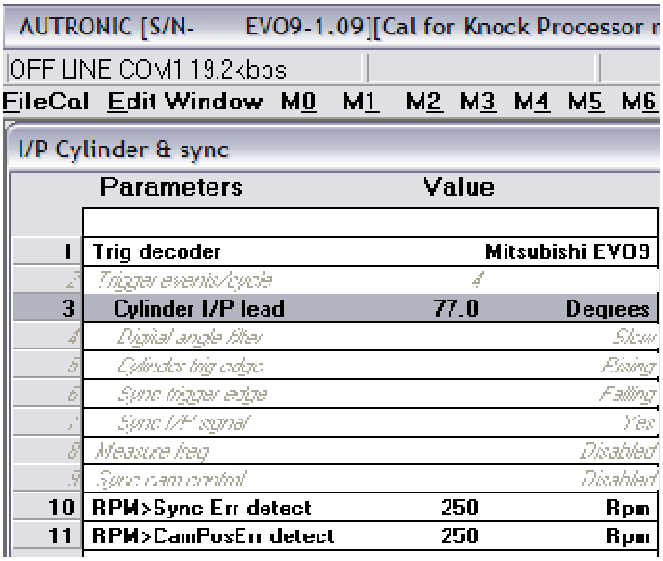
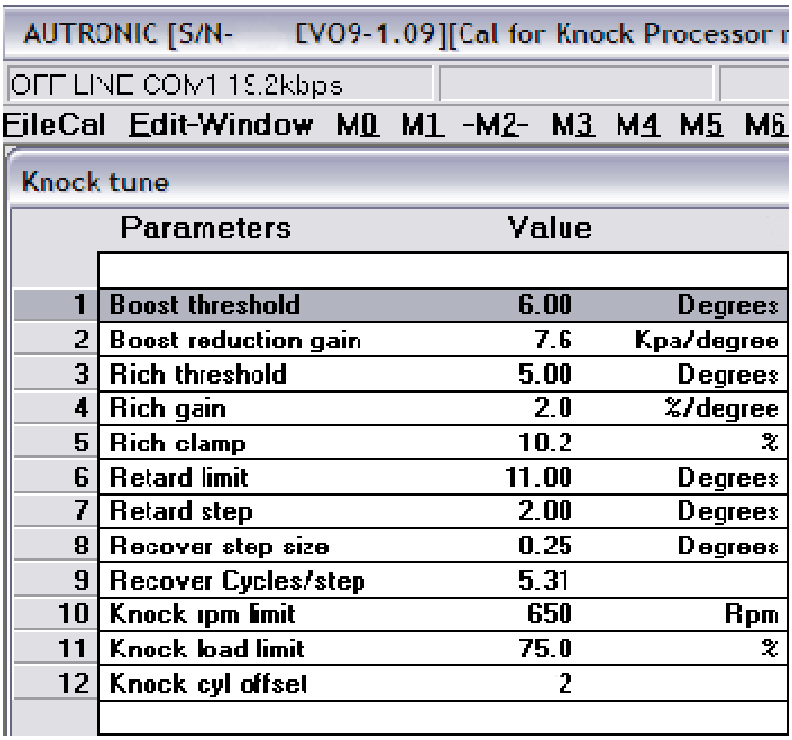


Figure 8 Cylinder I/P Lead

IE:- EVO IX — Trigger lead Angle = 75± 3 deg
WRX 01-04 — Trigger Lead Angle = 88± 3 deg
WRX 01-04a alternate trigger decode — Trigger Lead Angle = 628± 3 deg (is 540 + 88)

To ensure that this requirement is met unmodified factory trigger wheels & sensors should be used, the correct Trig decoder pattern selected and the specified Cylinder I/P lead angle set. Confirmation of the correct setup MUST be performed by using a simple timing light (timing light without any advance dial back adjustment) to check that actual ignition timing matches the PC screen live data "Ignition angle" display variable for any chosen cylinder. The Cylinder I/P lead angle MUST only be adjusted within the specified range (±3deg) in order to make the actual ignition point observed with the timing light, match the live ignition timing display. Adjustment outside this range MUST NOT be used to correct the ignition timing; the cure is to rectify a trigger selection error or engine assembly error.
See NOTE 3 below for Alternate Trigger Lead Angles (For Advanced users ONLY).

3.4 Knock corrective action



	Parameters	Value	
1	Boost threshold	6.00	Degrees
2	Boost reduction gain	7.6	Kpa/degree
3	Rich threshold	5.00	Degrees
4	Rich gain	2.0	%/degree
5	Rich clamp	10.2	%
6	Retard limit	11.00	Degrees
7	Retard step	2.00	Degrees
8	Recover step size	0.25	Degrees
9	Recover Cycles/step	5.31	
10	Knock rpm limit	650	Rpm
11	Knock load limit	75.0	%
12	Knock cyl offset	2	

Figure 9 Configure Knock Protection Strategy

3.4.1 Settings 6 thru 11 control the retard step at each detected knock event and the recovery of ignition timing after knock events.

3.4.1a **Retard limit** (setting 6) sets the maximum ignition retard allowed during knock control. It prevents extreme ignition retard elevating exhaust gas temperature to levels that are damaging to exhaust valves, exhaust system components or turbocharger turbine. If this retard limit is reached the ECU will report a "Knock Control Error" and record current Engine RPM, Manifold Pressure and Coolant in menu M0 – ECU Telltales for diagnostic purposes. The value chosen should be large enough to ensure a retard range that

can control knock under all engine operating conditions but not so large that destructive exhaust temperatures occur. (**Recommended 11 deg**)

3.4.1b **Retard step (setting** 7) sets the additional ignition retard applied upon detection of each knock event. A smaller value results in more frequent knocking while too large a value results in power loss. Values in range 1.5 to 3 deg are suggested. (**Recommended 2.0 deg**)

3.4.1c **Recover step size & Recover Cycles/step (s**ettings 8 & 9) set the rate at which knock ignition retard diminishes when knock is absent. **Recover step size** sets the increment of each retard reduction and **Recover Cycles/step** sets the period between each reduction measured in engine cycles (Note:- 1 engine cycle = 2 rev for a 4 cycle engine). Settings that slowly reduce knock retard give reduced knocking intensity and frequency and prolong engine life. (**Recommended Recover step size = 0.25 deg Recover Cycles/step = 5.31**)

3.4.1d **Knock rpm limit** (setting 10) sets the lower limit of engine rpm for knock detection. Set above cranking rpm and below rpm that destructive knocking can occur. (**Recommended 1000 Rpm**)

3.4.1e **Knock load limit** (setting 11) sets the lower limit of engine load for knock detection. Use to prevent false knock reporting that some engines exhibit when lightly loaded. It can also be used to prevent false knock reporting during anti-lag operation. Ensure that the value selected is lower than all load levels that produce damaging knock. (**Recommended 75% for Super/Turbo-charged engines**)

3.4.1f **Knock cyl offset** (setting 12) assigns ignition retard corrective action to individual cylinder ignition timing when "Cyl by Cyl" ignition retard mode is selected. If the selected mode is "Group retard" mode, this setting is non critical and should be set to 0.

MOST IMPORTANT !!! if "Cyl by Cyl" mode is selected, this setting must be set correctly so that the individual cylinder knock corrective action is applied to the correct cylinder. Incorrect setting choice will confuse the knock processors protective actions and will almost certainly result in engine damage. The installer MUST check that this setting is correct. Allowed setting range is 0 to number of (cylinders – 1). (eg:- 0 to 3 for 4 cyl engines)

The choice of **Knock cyl offset** is affected by the following ECU calibration settings (I/P Cyl & Sync pattern, I/P Cylinder Lead Angle and Ignition Advanced tabs). Changes to any of these ECU settings will affect the **Knock cyl offset** value required.

Because of the importance of this setting we recommend that the installer check its correctness using the following procedure.

Checking can be done by running the engine with an ECU calibration that lightly knocks only one cylinder. Set a base ignition map that does NOT cause any cylinders to knock. Apply an individual cylinder trim (advance) to only a single cylinder of your choice. This trim must be large enough to induce light knock when the engine is moderately loaded. The resulting calibration should only cause light knock on the selected cylinder.

Use extreme CAUTION when performing tests that induce knock since heavy and/or prolonged knocking, especially at high RPM will rapidly cause permanent engine damage. Momentary engine operation with light knock at moderate RPMs and moderate loads is all that should be allowed. If

your engine type is unable to withstand knock, you are unwilling to subject your engine to knock or you do not have sufficient training to conduct these tests we recommend you select "Group retard" mode & set Knock cyl offset = 0.

Once the appropriate calibration is setup in the ECU, carefully increase engine load until light knocking momentarily occurs on the chosen cylinder. Confirm by watching the PC screen live data or data logging that the chosen cylinder is retarded by the Knock Processor. If the incorrect cylinder is retarded adjust the **Knock cyl offset** calibration and then repeat the test. As stated previously use extreme **CAUTION** when performing this test, heavy and/or prolonged knocking, especially at high RPM will rapidly cause permanent engine damage. Recommended individual cylinder advance should be in the range 4 to 10 deg and test RPM in the range 3500 to 4000 RPM, with only sufficient load to cause light knocking for up to one second total duration. When testing is finished do not forget to remove the individual cylinder ignition trim. **(Typical settings:- EVO IX use 2, WRX 01-04 trigger decode use 3) CORRECTNESS OF SETTING MUST BE CHECKED.**

See NOTE 2 below for additional caution regarding application to Mitsubishi EVO IX.

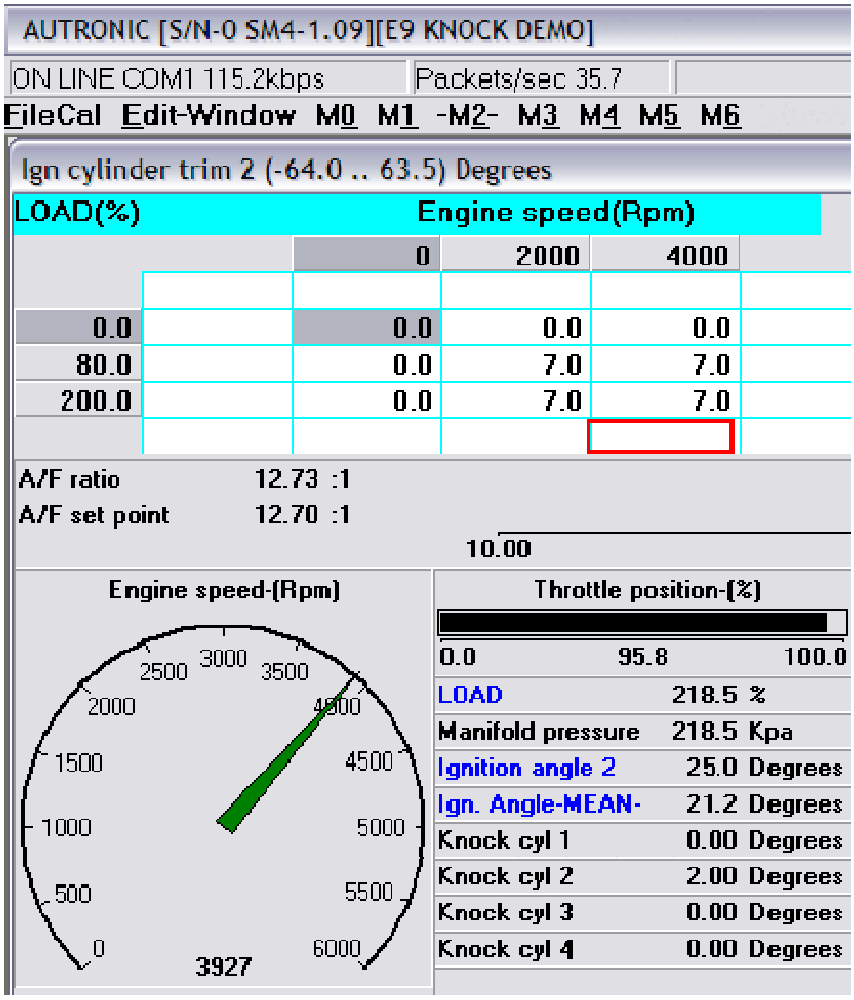


Figure 10 Typical Test cylinder trim table (Cyl 2 Advanced)

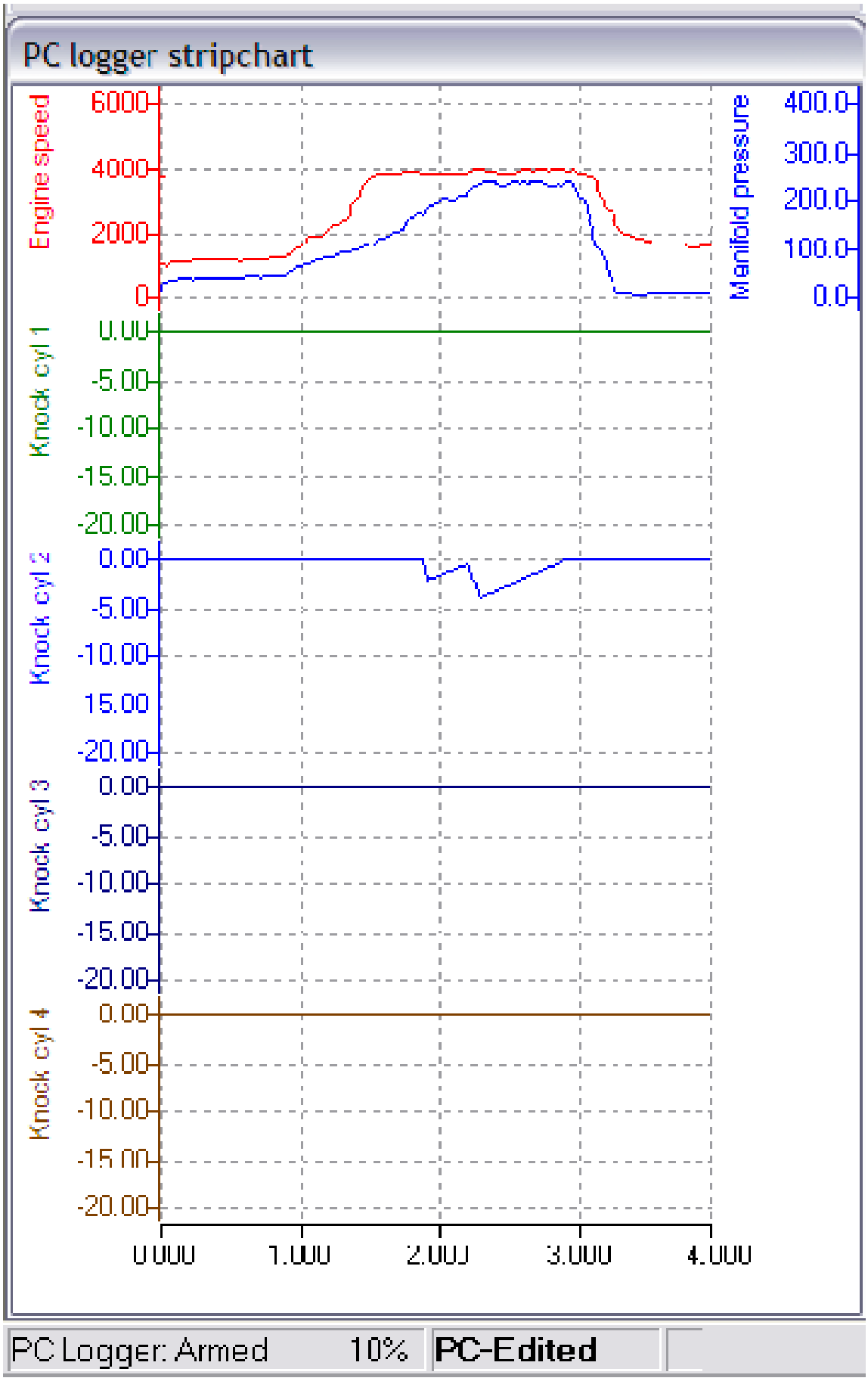


Figure 11 Result of correctly set "Knock cyl offset"
(Cyl 2 advanced & Graph shows only Cyl 2 Knocking)

3.4.2 Settings 1 thru 5 are for Boost reduction and/or additional fueling during excessive knock retard action. They control the introduction of desirable protective measures that combat the dangerous rise in exhaust temperature associated with sustained ignition retard.

3.4.2a **Boost threshold & Boost reduction gain** (settings 1&2) in conjunction with Setting 6 **Retard limit** control the boost reduction feature. Reduction of boost reduces the tendency to knock and also reduces the thermal load on the engine. These settings determine the relationship between knock retard and reduction of boost control set point.

Boost threshold sets the retard angle that initiates boost reduction. Values between 1/3 and 2/3 of Setting 6 **Retard limit** are typical. (**Recommended 6 deg**) Be aware that the consequence of selecting a small threshold value is premature reduction of boost and unnecessary reduction of engine output.

Boost reduction gain sets the Boost reduction (in kPa) for each degree of additional retard beyond the **Boost reduction gain**. Choose a setting that gives a moderate reduction of boost if knock retard reaches the **Retard limit**. Do not choose large values that force the boost set point below levels that can be controlled by the engine's boost control hardware. Doing so may result in the ECU sensing a loss of boost control and reporting an over boost error. (**Recommended 7.6 kPa/deg**)

3.4.2b **Rich threshold, Rich gain & Rich clamp** (setting 3, 4 & 5) in conjunction with setting 6 **Retard limit** set the characteristic of the fuel enrichment feature. Use this feature to supply additional fuel to combat the engine's tendency to knock. Be aware that enrichment beneficially reduces the thermal stress on the engine and reduces the tendency to knock, but beyond 0.73 λ may offer no improvement or even make knocking more severe. This feature can also be used to counter mixture leaning that is seen in applications where fuel pump sizing is marginal and moderate leaning is seen at low battery voltage and/or elevated ambient temperatures. This measure will only be effective if the injector sizing includes sufficient reserve capacity.

Rich threshold sets the retard angle that commencement of enrichment occurs. Values between 1/3 and 2/3 of Setting 6 **Retard limit** are typical.

Rich gain sets the additional fueling added per degree of knock retard beyond the **Rich threshold**. (**Recommended 2%/deg**)

Use the **Rich clamp** to limit enrichment if the amount provided at **Retard limit** is excessive. **(Recommended 10%)**

4.0 DIAGNOSTICS

Both the ECU and Knock processor include integrated diagnostic and protective limp home features.

4.1 ECU DIAGNOSTICS

The ECU can detect and report two knock error conditions:-

ECU ERROR CODE	ERROR	CAUSE	CORRECTIVE ACTION
24	Knock Error	Knock Processor disconnected, faulty or in error (see diagnostics for Knock processor below)	Applies maximum allowed retard, enrichment & boost reduction
32	Knock Control Error	ECU applied full knock corrective measures without eliminating Knock	Applies maximum allowed retard, enrichment & boost reduction. Records RPM, MAP & Coolant temperature of last occurrence in ECU Telltales.

See ECU software and documentation for general information

4.2 KNOCK PROCESSOR DIAGNOSTICS

The Knock Processor is fitted with 4 Knock indicators and an Error Indicator.

The 4 Knock indicators flash with an intensity dependent upon the severity of detected knock. They operate in a sequence corresponding to the firing order of the engine. The correspondence of a particular indicator to particular cylinder is determined randomly at engine start-up and remains fixed while the engine is running. With the use of these indicators judgment of knocking severity is possible, but actual cylinder identification is impossible. Use PC interrogation of the ECU in order to identify the knocking cylinder/s.

The Error indicator displays error history followed by real time error conditions as they are detected. At ignition switch on, the error history is displayed, followed 10 seconds later by “real time” error reporting. Detected errors are retained and reported as Error history for 20 engine starts after detection. Each error code comprises a 2 digit code, signaled as 2 groups of flashes. The digit groups are separated by a 2.5 second gap. Each code is separated by a 5 second gap.

Example:- 2 flashes, 2 sec gap, 3 flashes, 5 sec gap, 8 flashes, 10 sec gap, 2 flashes, 2 sec gap, 3 flashes = Error History contains Errors 23 and 58 and Error 23 detected now.

At ignition switch on, Error free condition is indicated 2 error indicator flashes and 1 single flash on each Knock indicator in sequence.

Some Knock Processor models are fitted with an Error History reset push button. Depression of this button after ignition on for at least 5 seconds in the first 50 seconds of operation will clear any stored error history.

Continuous illumination of any indicator or continuous flashing of the error indicator signifies a malfunction that can only be remedied at the manufacturer’s repair facility.

The Knock Processor is able to report the following:-

FLASH CODE	CAUSE	ECU SIGNAL
1-1	NO ERRORS	
4-1	EVENT BUFFER OVERFLOW (Contact Manufacturer)	E
2-3	EVENT START OVERFLOW (Contact Manufacturer)	E
3-2	TRIGGER TO FAST (> 16,000 RPM)	E
9-9	EEROM ERROR (Contact Manufacturer)	
1-10	KNOCK SENSOR DISCONNECTED, FAULTY OR NOT SECURELY ATTACHED TO ENGINE	EL
1-13	KNOCK SENSOR DISCONNECTED OR FAULTY	EL
1-14	KNOCK SENSOR SHORT CIRCUIT	EL
1-12	SIGNAL I/P OVERLOAD	K
3-11	DSP OVERLOAD	K
1- 4	BG OVERLOAD	

E = Reports Error to ECU as momentary Signal Knock Processor malfunction K = Reports Error to ECU as a Knock Event
L = Reports Error to ECU as Signal Knock Processor malfunction until Ignition Switch Off

5.0 OPERATION CHECK

Knock Processor operation can be verified by setting an aggressive ignition timing table using up to 5 **deg more timing than would normally be considered safe. Then RPM ramp testing with gradually increasing engine load should demonstrate knock retard when the knock limit of the** engine is reached. EXTREME caution must be exercised when performing this test, since incorrect ECU calibration may render the Knock Processor and ECU failsafe features inoperative. It is recommended that a knock listening device be used to ascertain that safe engine operation is maintained and that the Knock Processor is operative. Correct operation is indicated by occasional knock of low intensity when excessively advanced ignition is applied. Further advancing of ignition timing should not result in increased frequency or intensity of knocking until the **"KNOCK RETARD LIMIT"** is reached.

NOTE 1:- **FALSE KNOCK**

These modules have been exhaustively tested in their intended applications and found to be highly resistant to the false reporting of knock when no knock is present. False knock detection will unnecessarily retard ignition timing resulting in needless engine power reduction. False knock may also result in the ECU reporting a Knock Control Error (code 32) when the protective measures applied to control "real" knock fail to have any significant effect on the reduction of "false" knock.
In most instances false knock reporting can be attributed to a mechanical problem. The likely causes include erroneous engine noise resulting from excessive valve lash, bent valves, sticking valves, worn or damaged camshaft, insufficient piston to valve, piston to cylinder head or piston to crankshaft counter weight clearance, excessive piston to bore clearance or excessive crankshaft bearing clearance.

NOTE 2:- **MITSUBISHI EVO IX - ADDITIONAL CAUTION**

For Mitsubishi 4G63 engine installations with standard crank and cam triggers, it is possible, and quite a common occurrence, to have the cam sensor trigger incorrectly installed on the exhaust camshaft but have the engine appear to run correctly. In an ECU without the Knock Processor, incorrect installation of the cam trigger results in the fuel injection timing being in error by 360 degrees. This is not always apparent in operation of the engine but is detectable if specifically checked for.

The consequence of having the cam trigger incorrectly installed is that the Knock Cylinder Offset parameter is different to the expected value. If this is NOT checked and the Knock Control strategy is Cyl by Cyl then serious engine damage will occur.

It cannot be determined from examination of a calibration file if the cam trigger installation is correct as the engine will run with correct or incorrect installation. Also, the calibration file can accommodate the trigger installation error in a number of different menu options such as I/P Cyl & Sync pattern, I/P Cylinder Lead Angle, Injection & Ignition Advanced tabs and Injection Phasing 1 table. Some of these parameters affect the Knock Cylinder Offset parameter.

In Summary:- **For Cyl by Cyl control method, the Knock Cylinder Offset parameter MUST be confirmed as correct. If any changes are made to I/P Cyl & Sync pattern, Cylinder I/P Lead Angle or Ignition Advanced screens the Knock Cylinder offset parameter MUST be reconfirmed as correct. The importance of checking the "Knock cyl offset" parameter when Cyl by Cyl mode is selected CANNOT BE OVER STRESSED.**

NOTE 3:- **ALTERNATE TRIGGER LEAD ANGLES** (For Advanced users ONLY).

The **Cylinder I/P Lead Angle** range specified on the Knock1 Processor label is the preferred angle range. This angle range is actually one of 4 possible allowed angle ranges that are valid for 4 cylinder engines. The angle range specified plus multiples of 180deg are all valid angle settings. For example a Mitsubishi EVO IX could use 75± 3 deg, 255± 3 deg, 435± 3 deg or 615± 3 deg. A different **Knock cyl offset** setting would be required for each of these possible angle ranges.