Autronic
FUEL INJECTION — ADVANCED CONTROLS

Knock1 - Engine Sound Signature Recording Procedure

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1.0 GENERAL WARNINGS

This procedure is performed with the engine's knock sensor/s connected only to an audio capture device. Protective knock control functionality is not available. It is therefore the responsibility of the operator to control engine operation in such a manner that avoids damaging or destructive engine knock.
The procedure requires the sound recording of short duration light knock. If your engine type is unable to withstand short bursts of light intensity 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 SM3/SM4 ECU product family operation or set up software or digital sound recording, you SHOULD NOT undertake this procedure. You should seek help from an AUTRONIC installer who has experience with this procedure.

2.0 ABOUT

The following outlines the method for making the audio recordings that are required to develop a knock processor calibration for an engine. With this information, Autronic can develop a calibration to suit Knock1 products. Knock1-1CH is only suitable for single knock sensor equipped engines. Knock1-2CH is suitable for single or twin knock sensor equipped engines.

3.0 EQUIPMENT REQUIRED

1. Digital audio capture device: Either standalone device or P.C. hosted using a P.C. card or a USB connected module
   - Minimum audio bandwidth: 100 Hz to 20 kHz
   - Minimum analog conversion standard: 16 bit @ 44 kHz (48 or 96 kHz preferred)
   - Audio capture file format: Uncompressed .wav
   - Simultaneous audio channels required: 2 channels (if engine fitted with a single knock sensor) 4 channels (if engine fitted with twin knock sensors.
2. P.C. software to view .wav files
3. Audio Signal Generator
4. Oscilloscope (optional)

4.0 SETUP

4.1 AUDIO CAPTURE DEVICE SETUP

The minimum audio quality setting should be 16 bit @ 44 kHz. The audio file format must be uncompressed .wav format.
Ensure any AGC (automatic gain control), peak clipper or dynamic range compression functions are disabled.
Piezo ceramic vibration sensors require an electrical load that is > 100k ohm. Most audio capture devices have an input impedance of 2k ohm. Therefore a series resistor must be connected between the sensor and the audio input. In most cases a 100k ohm resistor should be used. This may require an increase if signal overload cannot be prevented by reducing the gain setting of the capture device.

4.2 CONNECTIONS

The sound recording must include 1 or 2 channels for knock sensor/s signals and 1 or 2 channels for engine rotation position sensor/s signal/s. Connection options are as follows:

a. Single Knock sensor applications

Two channel (stereo) capture with I/P channel 1 (left) connected via series resistor to knock sensor and I/P channel 2 (right) connected to the ECU Tachometer O/P.

b. Twin Knock sensor applications

Option 1: Two channel (1 x stereo) capture with I/P channel 2 (right) connected to the Knock 1-2CH trigger O/P (Knock1-2CH J1 Pin 4). I/P channel 1 (left) connected via series resistor to Engine Bank 1 (e.g.: front ½ half of inline engine or left side of Vee engine) knock sensor to record background noise and the trace knock. Connection is then moved to Engine Bank 2 (e.g.: rear ½ half of inline engine or right side of Vee engine) to record signals from this bank.

Option 2: (Preferred) Four channel (2 x stereo) capture with I/P channel 1 (front left) connected via series resistor to Engine Bank 1 (e.g.: front ½ half of inline engine or left side of Vee engine). I/P channel 2 (front right) connected via series resistor to Engine Bank 2 (e.g.: rear ½ half of inline engine or right side of Vee engine). I/P channel 3 (rear left) connected to the Knock1-2CH trigger O/P (Knock1-2CH J1 Pin 4, 0.1" 4 way header. Requires installation of Knock1-2CH hardware.

Option 3: Four channel (2 x stereo) capture I/P channel 1 (left front) connected via series resistor to Engine Bank 1 (e.g.: front ½ half of inline engine or left side of Vee engine). I/P channel 2 (right front) connected via series resistor to Engine Bank 2 (e.g.: rear ½ half of inline engine or right side of Vee engine). I/P channel 3 (left rear) connected to the Hall Effect crank trigger and I/P channel 4 (right rear) connected to the Hall Effect camshaft trigger. Only compatible with Hall Effect triggers.

4.3 CAUTION!!!

This procedure is normally performed without any knock processor installed. If a Knock processor has installed into the ECU, it must be disabled during these tests, since it will report malfunction while disconnected from the knock sensor/s. Protective knock control functionality is not available. It is the responsibility of the operator to control engine operation in such a manner that avoids damaging or destructive engine knock. Protective measures to be applied include conservative engine calibration and short duration heavy load operation.

4.4 SIGNAL LEVEL CALIBRATION

Record the audio during a very brief engine free revving to its intended maximum RPM. Ensure that no knock occurs during the free rev. Check that the captured audio signal/s do not exceed 35% of the full scale signal range (25% to 30% is recommended). Use device gain adjustment/s and/or series resistor/s to set the correct signal level. When two knock sensor signals are being simultaneously captured (twin sensor options 2 or 3) ensure that the resistors and gain settings are the same for both sensor I/P channels.
The trigger signal/s (Tacho or Trigger O/P or Crankshaft & Camshaft) level/s should be set by adjusting gain setting/s and/or series resistor/s for greater than 25% of full scale and not overloading the audio channel/s.

5.0 PROCEDURE

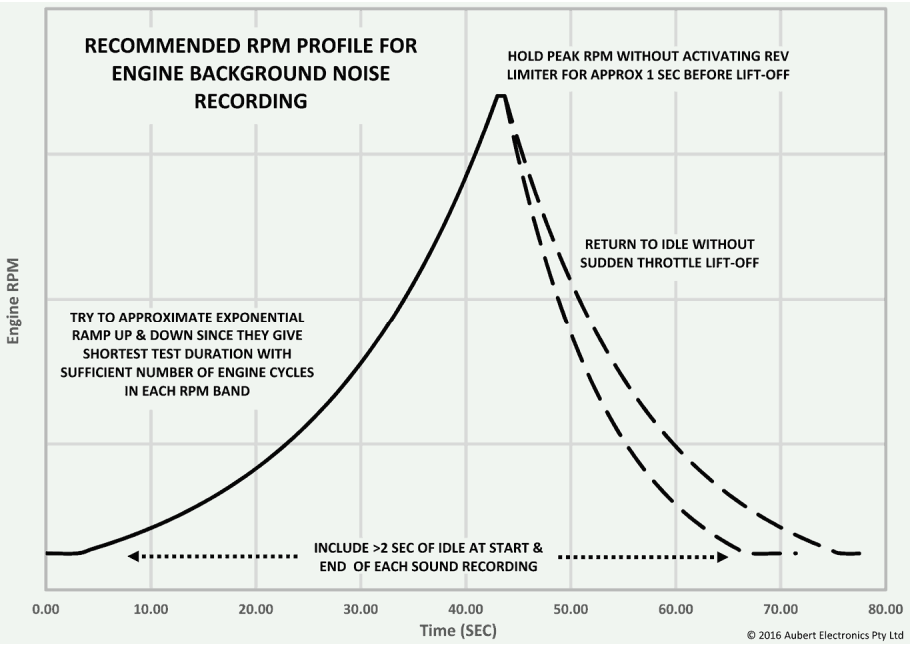
5.1 RECORD ENGINE TRACE KNOCK

Heavy load engine knock noise must be recorded at low RPM, peak torque RPM and high RPM. Only momentary trace knock (light knock) should be induced otherwise engine damage could result. Use caution especially at high RPM where engine damage can occur very rapidly. Separate recordings can be done for each RPM region or all regions can be tested in one recording provided the engine is rested between each region test. The normal procedure is to apply islands of aggressive ignition timing to the ignition map table in the operating regions that require knock imitation. The engine is momentarily driven into each region for just sufficient time to produce several light knock events per cylinder. A rest should be applied before returning to a region of engine knock. Each sound recording should commence, and then return to finish with a brief period of engine idle. These tests should be conducted using smooth throttle movements and smooth adjustments to dynamometer load.

Twin knock sensor applications using a 2 channel digital audio capture device (Option 1) will require duplication of recordings. One of each is required for each knock sensor.

Examine all knock signal files and check for signal overload during knock. If overload is observed, reduce the gain of the signal I/P/s by 50% using the gain adjustment or by increasing the input series resistor to 2X original value. Repeat the process of recording, checking and 2X gain reduction until overload is eliminated.

5.2 RECORD ENGINE BACKGROUND NOISE



Background recordings should be made using the RPM profile shown in the opposite diagram. The acceleration ramp has an exponential profile (acceleration is proportional to RMP).This profile provides an equal number of engine revolutions in each RPM band and allows the ramp to be conducted in the shortest possible time. A linear RPM ramp profile can be used, but is undesirable since the slow ramp rate required to allow the capture of sufficient engine revolutions at lower RPMs results in excessive time being spent at dangerously high RPMs. RPM ramps comprising RPM steps are UNSUITABLE for engine noise analysis and MUST NOT BE USED. In all phases of the RPM profile throttle movements MUST BE GRADUAL. The recordings MUST be conducted using engine ignition timing and fueling settings, and with fuel of sufficient octane rating to exclude all engine combustion knock. The recording should start with several seconds of idling, then 30 to 40 seconds of acceleration (suitable time for an exponential acceleration), a short pause at peak RPM, then a 15 to 40 second smooth deceleration back to idle and finish with several seconds of idle. Make one recording with the engine operating in the unloaded condition and a second recording with it moderately loaded.
Twin Knock sensor applications using a 2 channel sound capture device (Option 1) will require duplication of recordings. One of each is required for each knock sensor.

5.3 RECORD REFERENCE SIGNAL

Remove the signal connection/s from the knock sensor/s and reconnect to an audio signal generator. Record several seconds of 5 or 10 kHz sinewave of known amplitude that does not overload the signal I/P of the digital audio capture device. Take note of the signal size and method of measurement (i.e.: Peak to Peak, RMS or average).

5.4 SUBMISSION TO AUTRONIC

Submit the following to Autronic:

1. Sound Files: Background, Knock & reference signal recordings.
2. Reference signal: Frequency & amplitude
3. Engine: Make, year manufactured, manufacturers designation, donor vehicle, application vehicle
4. Fuel specification:
5. RPM maximum:
6. Forced Induction: Yes/No, maximum manifold pressure
7. Cylinder: Compression ratio, Bore size & number
8. Camshaft: OEM or performance
9. Valves: Number, position & actuation method.
10. Spark Plugs: Number & position.
11. Knock sensor/s: Number, position & type (broad/narrow band).
12. ECU: ‘Trigger lead’ calibration setting for this engine
13. ECU: Serial number & firmware revision