Crankshaft Sensor

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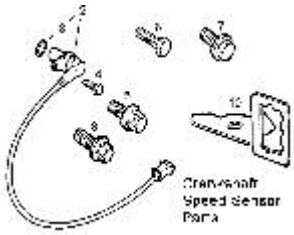

Figure 1
The Crankshaft speed sensor parts and bracket.

Figure 2
Location of CAS on the C20XE engine.

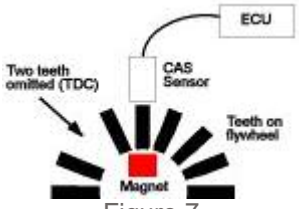

Figure 7
A CAS sensor reading the TDC position using permanent magnet.

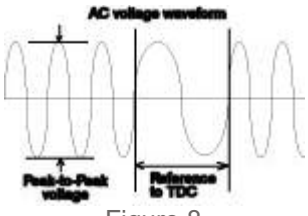

Figure 8
Typical AC voltage waveform produced by a CAS unit.

What is a 'Crankshaft Sensor'?

A Crankshaft Sensor (also known as a Crankshaft Angle Sensor - or CAS for short) watch's the position of the camshaft and its relationship with the piston position inside the engine. The CAS is an inductive signal generator, it measure reluctance. The CAS is typicality found on injection engines, and its an important sensor. Without it, the engine will not run at its optimum, and if faulty, the ECU warning light shall illuminate on the dash.

How does a CAS work?

The CAS is typically positioned beside the cam belt or crankshaft (**Figure 1**). A number of steel pegs or steps (i.e. different thickness of material) are set at regular intervals around the circumference of the flywheel or crankshaft (**Figure 7**). Typically a pin or a step may be set at every 10° (but this number does vary depending on what the engine is). The flywheel thus becomes a reluctor.

A permanent magnet, which acts as a inductive signal generator, is mounted in close proximity to the flywheel. This radiates a magnetic field. As the flywheel spins and the pins or steps are rotated in this magnetic field, an alternating (AC) waveform output signal is produced and the EMU (Engine Management Unit) uses this information to calculate the speed of rotation.

AC stands for **Alternating Current**. Its a term used in electronics to indicate a signal is varying its characteristics all the time and may go negative. In other words its the opposite to Direct Current (DC), which the 12v battery produces, which is a constant source.

If a pin is omitted at two points on the flywheel the signal also changes at these points, and a reference to TDC (Top Dead Centre) will be returned to the EMU. The location of the position signal is not TDC, but may be at 90° BTDC (or some other point fixed by the vehicle manufacture - depending on engine type).

TDC stands for **Top Dead Centre**. Its a termed used to express the position of the piston head within its stoke, i.e. its maximum compression stage. At TDC, the spark plug should be ready to ignite the fuel within. BTDC stands for **Before Top Dead Centre**.

In addition as the flywheel spins, the missing pins or double pins cause a variance of the signal which is returned to the ECU as reference to the TDC position.

Although most modern systems utilise a single CAS, some older systems use two CAS - one for the RPM (Revs per Minute) and one for the position. The 2L 16v C20XE engines commonly use this system (as found in the Cavalier, Calibra and Astra GTE's). The waveform

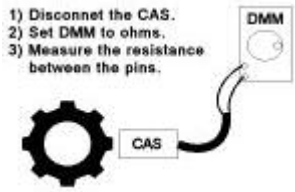

Figure 9
How to measure the resistance of a CAS using a DMM.

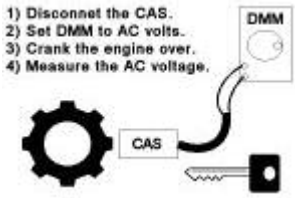

Figure 10
How to measure the AC output of a CAS using a DMM.

produced by each type of CAS will be slightly different.

The peak-to-peak voltage of the speed signal varies according to engine speed, the faster the rotation, the bigger increase in voltage produced (**Figure 8**). For example it can vary from 5 volts at idle to over 100 volts at 6000rpm. Because the EMU is a computer, its works on digital information (on or off signals). The output signal produced by a CAS is analogue, which isn't compatible with the EMU. So the EMU uses a ADC (Analogue to Digital Convertor) which transforms the AC pulse into a digital signal.

When used the CAS provides the primary signal to initiate both ignition and fuelling.

Is the CAS easy to replace?

Within reason, yes. The CAS sensor, as described above is a small reluctance sensor. This heavily depends on the position of the sensor for your particular engine.

For example the C20XE engines (2L 16v DOHC 'red -top' series as found in the Cavalier, Astra GTE and Calibra's for example) are one of the easiest to replace. The location and procedure is as follows:

- Open the bonnet of the car and look at the offside suspension turret, there should be a black cable form with a connector (**see Figure 2 item 3**). This is the connection point of the CAS, disconnect it. On some cars you may have to remove the air box of air tubing to the throttle body.
- Looking at the cambelt cover, follow this down to the bottom crank pulley wheel. There facing towards the radiator shall be a sensor screwed into the side of the bottom block (**see Figure 2 item 2**), this is the CAS.
- Remove the CAS by unscrewing the small bolt it from the bracket on the bottom block. Replace it with a new item from your dealer and ensure a new sealing O -ring is with the item (**see Figure 1 items 2 and 3**). Tighten the CAS up to 6 Nm.

Note: on some models the mounting bracket (**see Figure 1 item 10**) may have to be replaced, as there was a common fault that they got bent. This meant that the CAS was at the wrong distance from the teeth, hence sending false information back to the ECU, commonly resulting in the ECU warning lamp to be illuminated on the dash.

To check the bracket, do the following:

Inspect the engine accessories bracket to see if the has a small opening (**see Figure 2 item 1**). If so then remove and replace with new item. However if the bracket has a large opening ensure that the CAS cable routing does not touch the exhaust manifold or rotating parts. However the cost of a new bracket is small and a new bracket is often purchased when the CAS is changed.

How do I know if a CAS has malfunctioned?

As previously explained, the CAS is vital for the performance of the engine. It supplies a signal back to the ECU so it can calculate ignition timing and the correct fuelling. If the CAS is sending back incorrect data, the performance of the engine decreases significantly, even stop it from working.

However, to overcome this problem, the EMU can use a data map within its memory (which was set by the manufactures) which use some default values to regain correct fuelling and ignition.

But because this data is static and not true live data coming from a CAS, the performance isn't at its optimum. What this means is that the car may feel sluggish, but the car will still work. Also the ECU warning light will be illuminated on dash.

Is there any way of testing a CAS to see if its faulty?

Yes there several methods, but all involve electronic measuring equipment. If the ECU warning light is on, **read the ECU fault codes** off with a paper clip to see if the CAS has logged a fault (Note: if the engine is NOT running when reading the codes, then the ECU may log this as a fault straight away because its not getting a valid signal back - ignore this logged fault). Alternatively, use a TECH1 reader to obtain the logged fault codes.

If the CAS is likely to be faulty as this point, do the simple checks as listed below:-

- Locate the CAS and look at its plug for any damage, corroded pins or bad connections etc.
- Inspect the cable form for the CAS and look for any brakes, cuts or splits on the surface. The CAS cable usually incorporates a 'shield' which protects the signal from picking up stray electronic noise from the harsh environment of the engine bay.
- Remove the CAS from the engine and inspect the condition if its 'tip' at the point it measures. It should have no damage or be corroded in anyway.

If the above are OK, then it is possible to check the resistance of the sensor (**Figure 9**). However, the value depends heavily on what type of engine it is fitted to, i.e. there isn't a standard resistance value for all CAS sensors unfortunately. Also measuring the resistance isn't a compressive way of testing a CAS sensor, even if you do get a resistance value back, it doesn't mean that the CAS is capable of producing a acceptable signal for the ECU.

- Disconnect the CAS connector and with a DMM (Digital Multi - Meter) set to measure ohms (resistance) connect the two probes to the CAS unit. Note: some CAS have 3 pins, this is likely to be the 'shield' connection, ignore this pin for now.
- If the DMM measures 0 ohms then the CAS is likely to be at fault.
- The CAS resistance could measure anywhere between 500 ohm and 1500 ohms (depending on type).
- Locate the 'shield' pin on the CAS (if applicable) and the EMU equilvant pin on its multi-plug. Measure the resistance of the shield wire. It should be a short circuit (i.e.< 5 ohms). If its open circuit (infinity resistance) then there is a break in the shield wire. This could mean that the CAS signal being sent was picking up other electronic signals in the engine bay and changing the signal characteristics, hence upsetting the fuelling and ignition timing. Repair the cable.

It is possible to see if the CAS is producing a AC signal by using the AC volt function on the DMM (**Figure 10**). However, this will show the AC RMS (Root Mean Square) which means that it sees the average AC voltage source being produced. This method will not show if the

sinewave is regular or correct, it just means the CAS is producing a AC waveform to the EMU.

- Disconnect the plug to the CAS unit. Set the DMM to measure AC volts. Connect the DMM probes across the two pins of the CAS unit. If a third pin is present, this is most likely to be the 'shield' pin, ignore this for the time being.
- With the DMM secured in position, crank the engine over on the starter motor (starting the engine is unnecessary, but will be difficult as the CAS is unplugged).
- Note the AC voltage measured. A minimum of 0.7v should have been read back. But some sensors may produce a high voltage or up to 1.4v.

Again these tests don't really show if the AC voltage signal produced is correct. The only way of telling this is to use a oscilloscope, connected up to the CAS which can 'see' the voltage signal graphically. With this piece of equipment you can measure the frequency and peak -to-peak voltages produced over a period of time. However this is a expensive piece of equipment and won't be covered here.

Also, bearing in mind, if you have got this far and the CAS is producing a AC voltage source, then its unlikely to be anything wrong with it. The construction of the sensor is made in that, it either works or it doesn't. Its very rare to get an intermittent fault with these type or sensors. Its most like to be a cable form or plug connection problem at times.

Because testing these sensors is time consuming, and hence labour charges will be high, all garages will simply just replace the unit and see if that solves the problem or not. If it doesn't then the RPM sensor could also be at fault (if fitted).

*Article based on text in the **Haynes Books** series and peoples personal experiences.*