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With

Auto-Solve

Topic 1

Ignition Primary Circuits

The primary ignition is so called as it forms the first part of the ignition circuit. The primary circuit is used to provide the initial stage towards the secondarys High Tension (HT) output.
The primary circuit has evolved from the basic contact breaker points and condenser, to the distributorless and coil per cylinder systems in common use today. The basic origin of all of these systems evolves around the magnetic inductance principal. The only system to differ from this principal is capacitive discharge, whose operation will be detailed in a later topic.

This principle is based around a magnetic field (or flux) being produced when the coil's earth circuit is completed by either the contacts or the amplifier providing the coil negative terminal with a path to earth. When this circuit is complete, a magnetic field is produced and builds until the coil's magnetic field becomes maximised or saturated. At the predetermined point of ignition, the coil's earth is removed and the magnetic field or flux collapses across the coils 250 to 350 primary windings, which in turn induces a voltage of 200 to 350 volts.

This induced voltage will be determined by the following factors:

- The number of turns in the coils primary winding
- The strength of the magnetic field
- The rate of collapse, which is determined by the speed of the switching of the earth path

The number of turns within the coils primary is preset from manufacture, however the strength of the magnetic field which is proportionate to the current within the circuit and the speed of the switching, can be seen in **Fig 1.0**

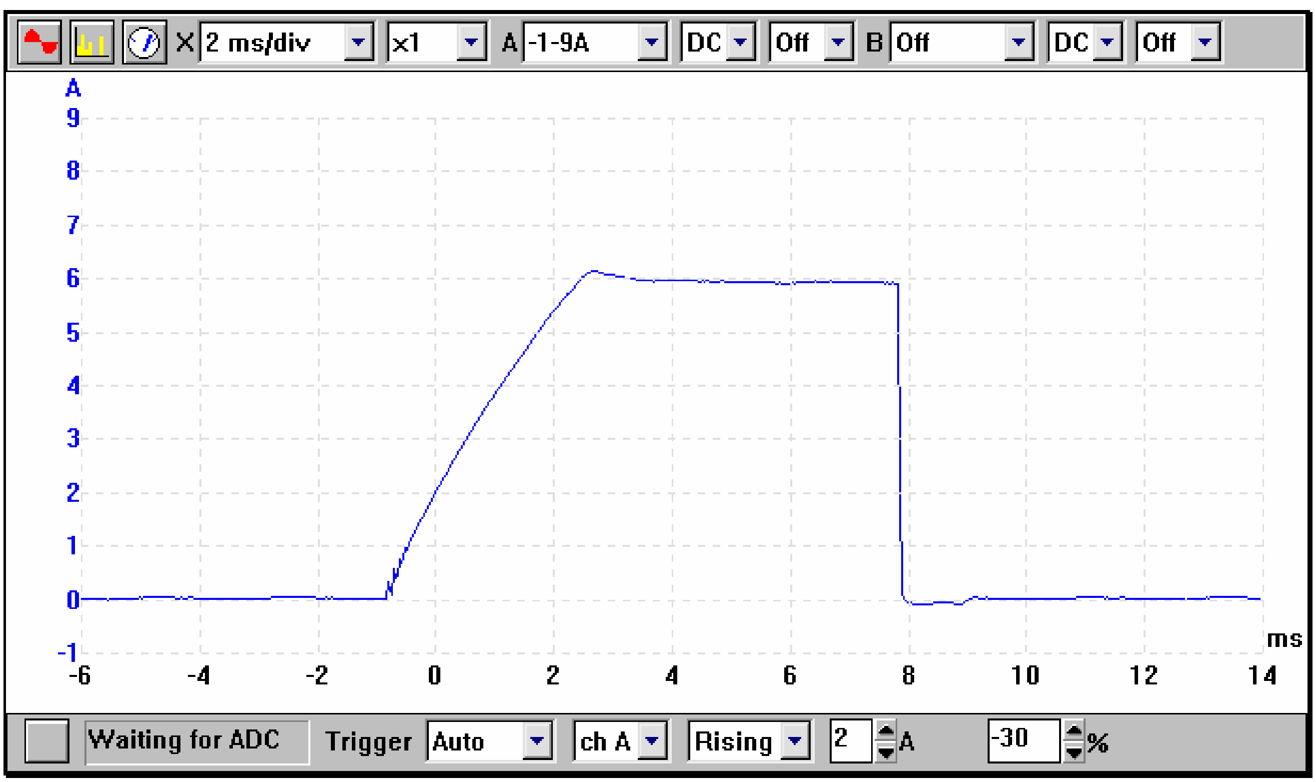

Fig 1.0

The current within the electronic ignition example shown sharply rises to 6 amps, at which point the current is held until the earth circuit is removed. The switching speed can be seen by the angle of the vertical line at the end of the trace, any delay or slow switching will be seen as a sloping line. Any compromise in the switching speed will result in a lower induced voltage.

The height of the induced voltage line can be seen in **Fig 1.1**, in this particular instance its maximum voltage is 326 volts. This is a result of the magnetic flux passing quickly across the coils primary windings. It is important to test this voltage as a low secondary HT output could result from a low primary voltage.

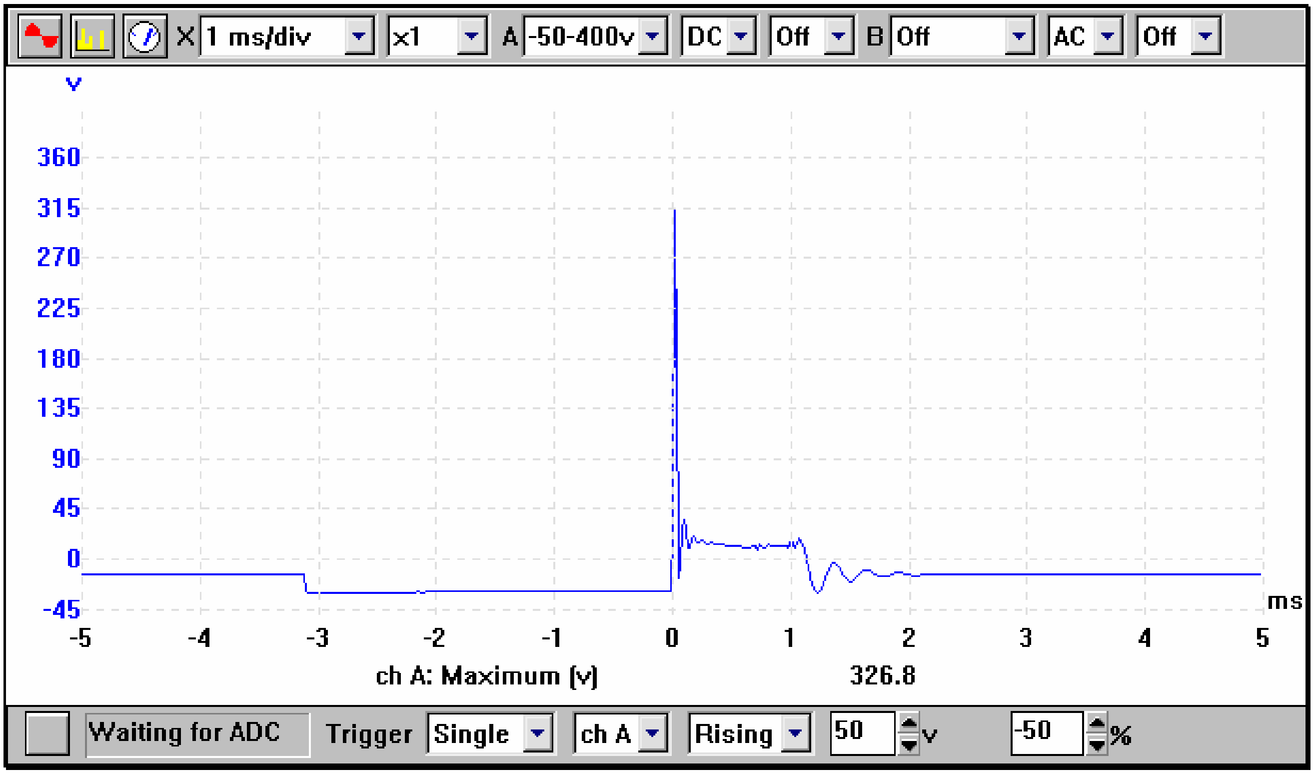

Fig 1.1

Dwell Period

Dwell is measured as an angle: with contact ignition, the points gap determines the dwell angle. The definition of contact ignition dwell is: 'the number of degrees of distributor rotation with the contacts in the closed position'.
As an example, a 4 cylinder engine will have a dwell of approximately 45 degrees, which is 50% of one cylinders complete primary cycle.

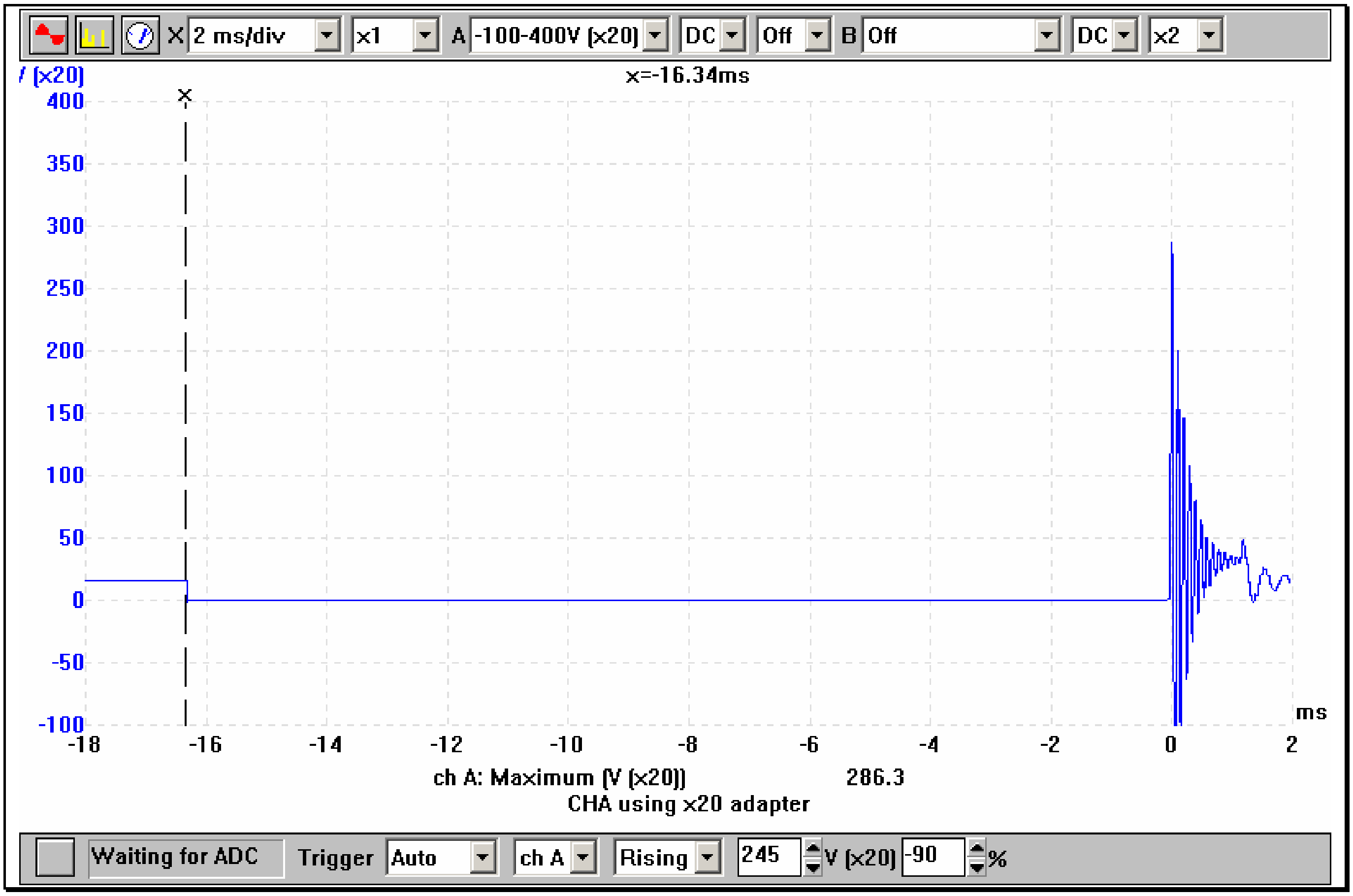

Fig 1.2

One of the many compromises with contact ignition is the fact that the coils saturation time will reduce with increasing engine speed. In the illustration shown in **Fig 1.2**, the engine is running at approximately 1000 rpm and the points are closed for 16.3 milliseconds. This results in an induced voltage of 286.3 volts. As the engine speed is increased to 3000 rpm the coils available time to fully 'saturate' will be reduced pro-rata. Illustration **Fig 1.3** shows that the time available to charge the coil has now been reduced to 5.6 milliseconds. As a result, the induced voltage has been reduced to 275.4 volts and the coils HT output reduced accordingly.

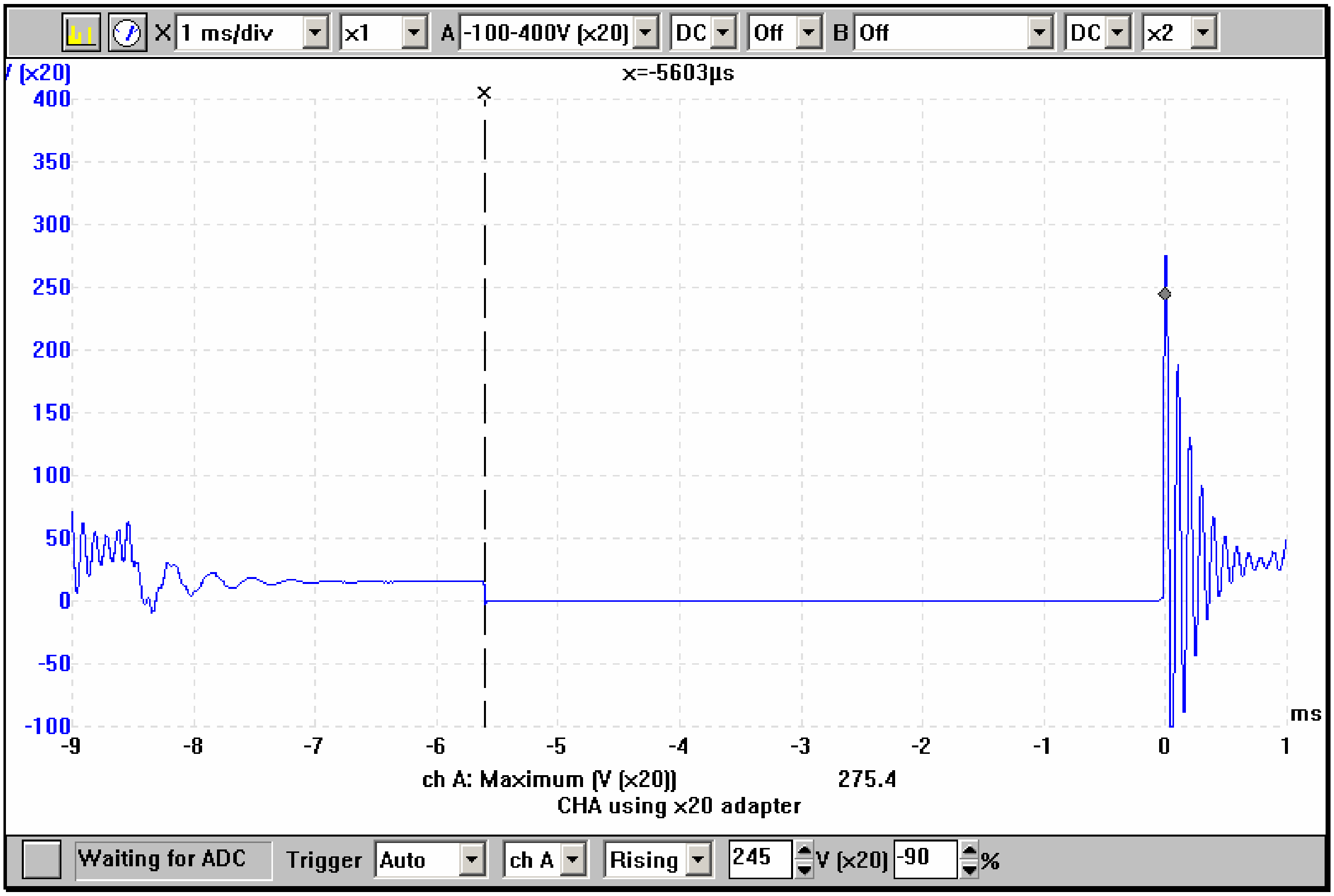

Fig 1.3

The dwell period on an engine with electronic ignition is controlled by the current limiting circuit within the amplifier or Electronic Control Module (ECM). The dwell on a variable dwell or constant energy system will be seen to expand as the engine speed increases, compensating for the shorter time period. The term 'constant energy' refers to the available voltage produced by the coil. This, regardless of engine speed, will remain constant as opposed to contact ignition where an increase in engine speed means the contacts are closed for a shorter time period. The coils saturation time can be seen in **Fig 1.4**, where the time available to saturate the coil is a constant 3.0 milliseconds regardless of the engine speed. The saturation time is considerably lower than that of a contact system due to the coils supply voltage being approximately double that of a ballasted contact system and the coils primary resistance approximately halved. This will result in a far higher current, saturating the coil with amperage that would not be possible on a contact system.

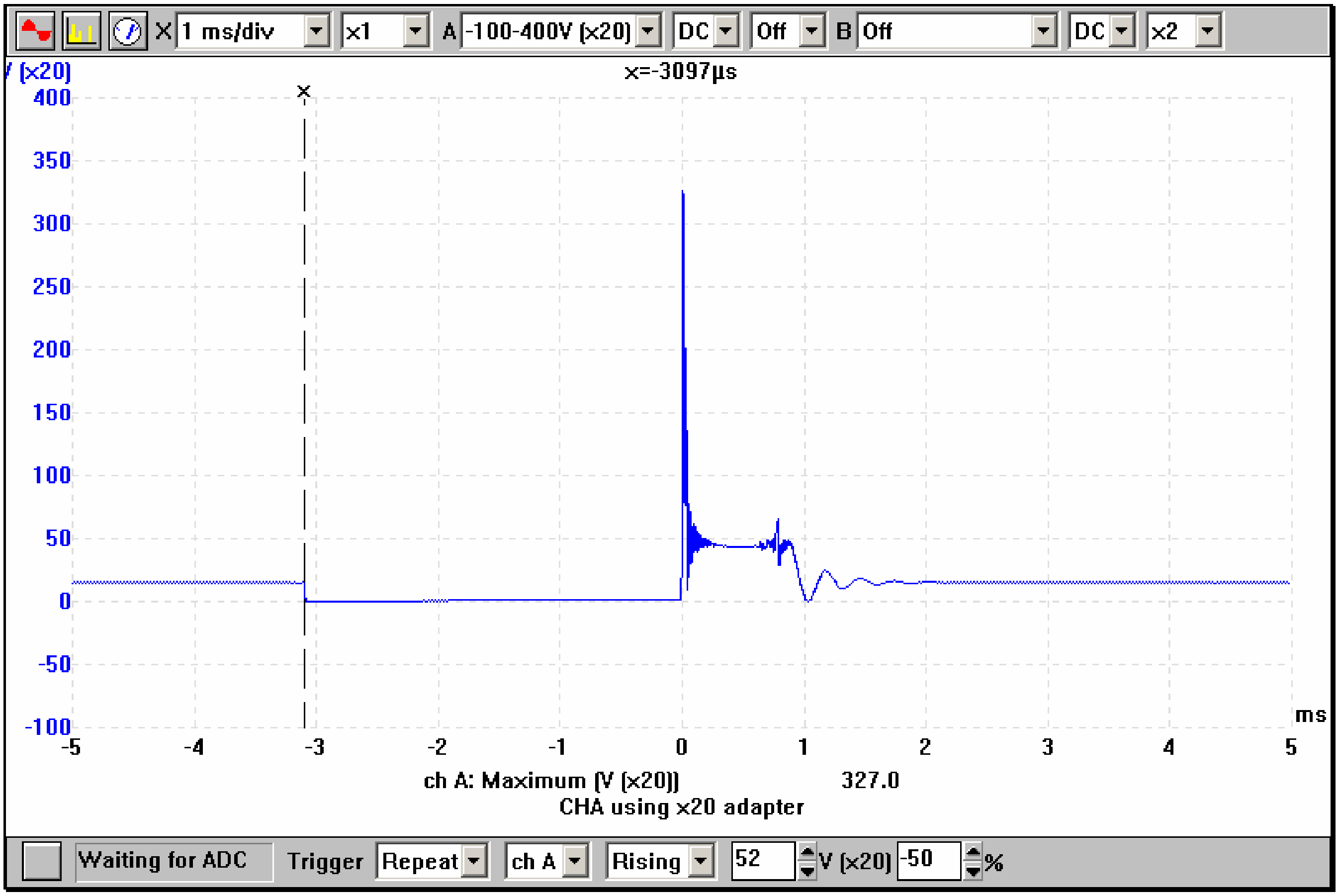

Fig 1.4

As with all electrical circuits it is important for the technician to check the condition of the earth circuit, this cannot however be done by simply checking for good continuity using a multimeter. As an example, imagine an earth wire that has broken and is down to the last strand of copper wire. When testing for continuity it will show next to zero resistance, pass a current along the wire and the result is a different matter. This simple example shows the importance of testing any switching circuit's earth path with the aid of an oscilloscope. An ideal earth would show an almost flat line, however in practical terms the voltage may creep up as high as 0.3 volts. An old electrical *law* stated that we can loose up to 0.5 volts on any live circuit while the earth must remain below 0.25 volts. In all practicality, common sense must prevail so try to minimise the dynamic resistance in any important earth return circuit.

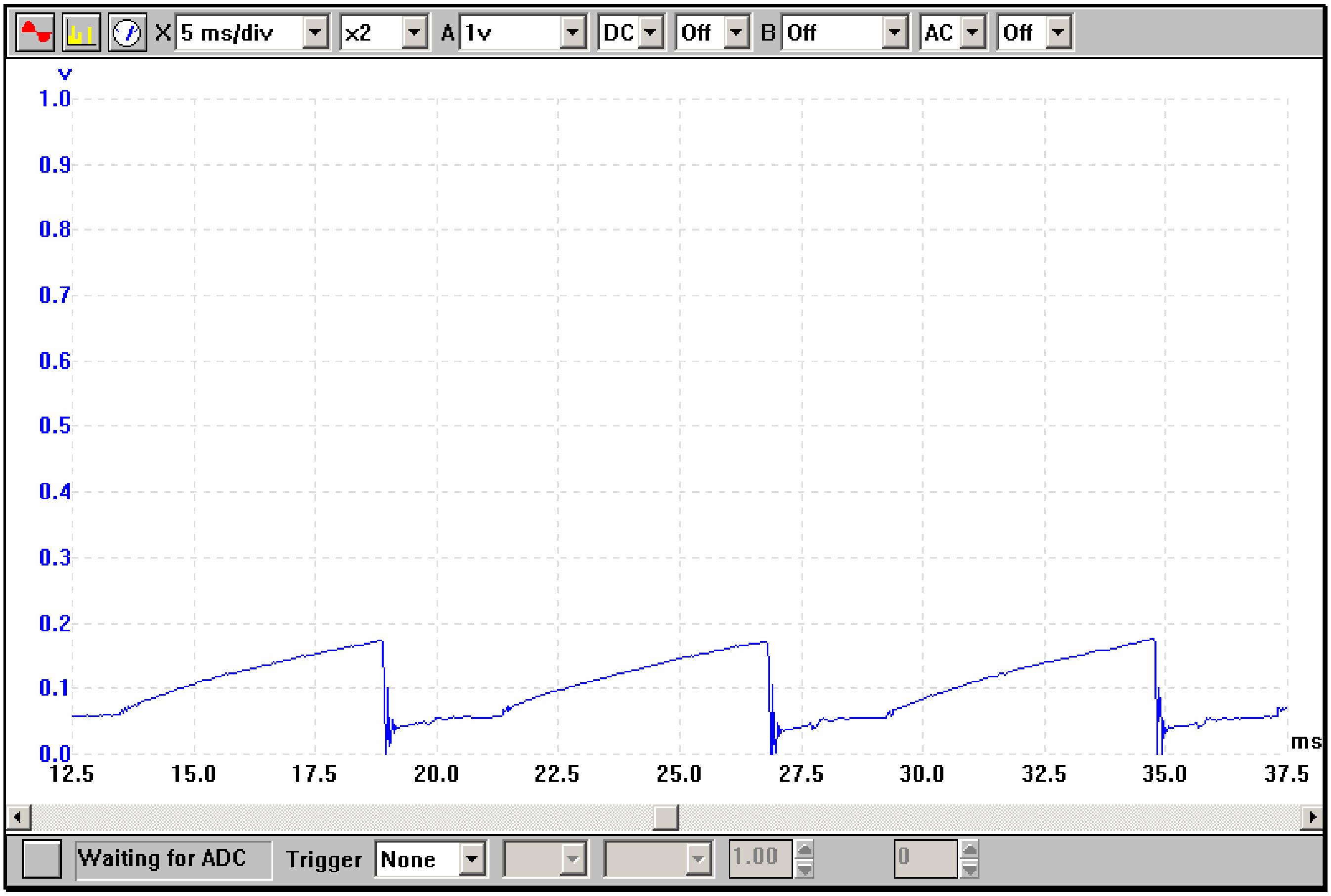

Fig 1.5

In Fig **1.5** we can see that while the coils earth circuit is complete (the length of the dwell period) there is a small volt drop that increases as the current builds, in this example the circuit is increasing in current until the earth is removed. A poor earth will result in an increase in height to the earth 'ramps' and a decision must be made as to whether the earth circuit requires and remedial rectification.

All the example waveforms used were recorded using a PC based oscilloscope loaned by www.picotech.com. Other manufacturers equipment will have different voltage ranges but the resultant picture should be very similar. Please remember that using a higher voltage range will result in the waveform appearing to have a lower amplitude, although the overall voltage will be the same.

In the next issue we will be looking at the components that initiate the coils primary circuit, being the pick-up, crank angle sensor or an output signal from the ECM. We will look at the waveforms required from the different components and the way in which they are formed.