Miscellaneous Sensors and Actuators Waveforms

In this topic we will be looking miscellaneous sensors and actuators found on the motor vehicle. The waveforms that will be covered are:

- Cranking current
- Alternator ripple
- Diesel glow plugs
- ABS sensors
- Road speed sensor

Cranking Current

The purpose of this particular waveform is two-fold: to measure the amperage required to crank the engine and to evaluate the relative compressions.

The amperage required to crank the engine will largely depend on many factors, including the capacity of the engine, the number of cylinders, the viscosity of the oil, the condition of the starter motor, the condition of the starter's wiring circuit and the compressions in the cylinders. The current for a typical 4 cylinder petrol engine is in the region of 80 - 180 amps.

The compressions can be compared against each other by monitoring the current required to push each cylinder up on its compression stroke. The better the compression the higher the current demand and vice versa. It is therefore important that the current draw on each cylinder is equal. This test is only a comparison against each cylinder and is not a substitute for a physical compression test with a suitable gauge. An example can be seen in Fig 1.0

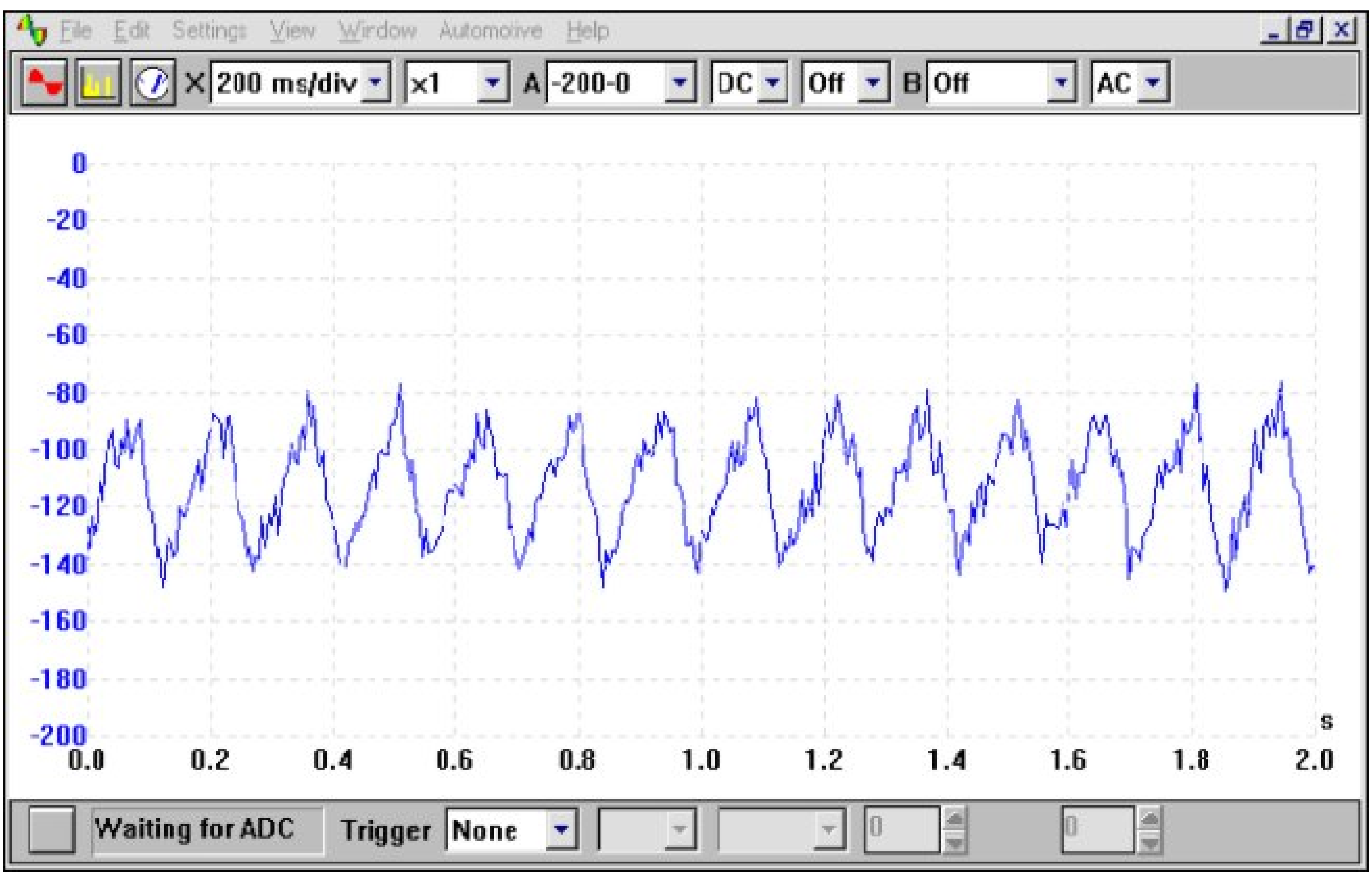

Figure 1.0

Alternator Ripple

The ripple on this waveform (Fig 1.1) shows that the output is correct and that there is no fault within the phase windings or the diodes (rectifier pack), also illustrating that the three phases from the alternator have been rectified to Direct Current (DC) from its original Alternating Current (AC) and that the three phases that contribute towards the alternator's output are all functioning.

If the alternator is suffering from a diode fault, long downward 'tails' will appear from the trace at regular intervals and 33% of the total current output will be lost. A fault within one of the three phases will show a similar picture to the one illustrated but is three or four times the height, with the base to peak voltage in excess of 1 volt. The voltage scale at the side of the oscilloscope is not representative of the charging voltage, but is representative of the upper and lower limits of the DC ripple. The 'amplitude' of the waveform will vary under different conditions with a fully charged battery showing a 'flatter' picture, while a discharged battery will show an exaggerated amplitude until the battery is charged.

The example waveform below (Fig 1.1) illustrates the rectified output from the alternator.

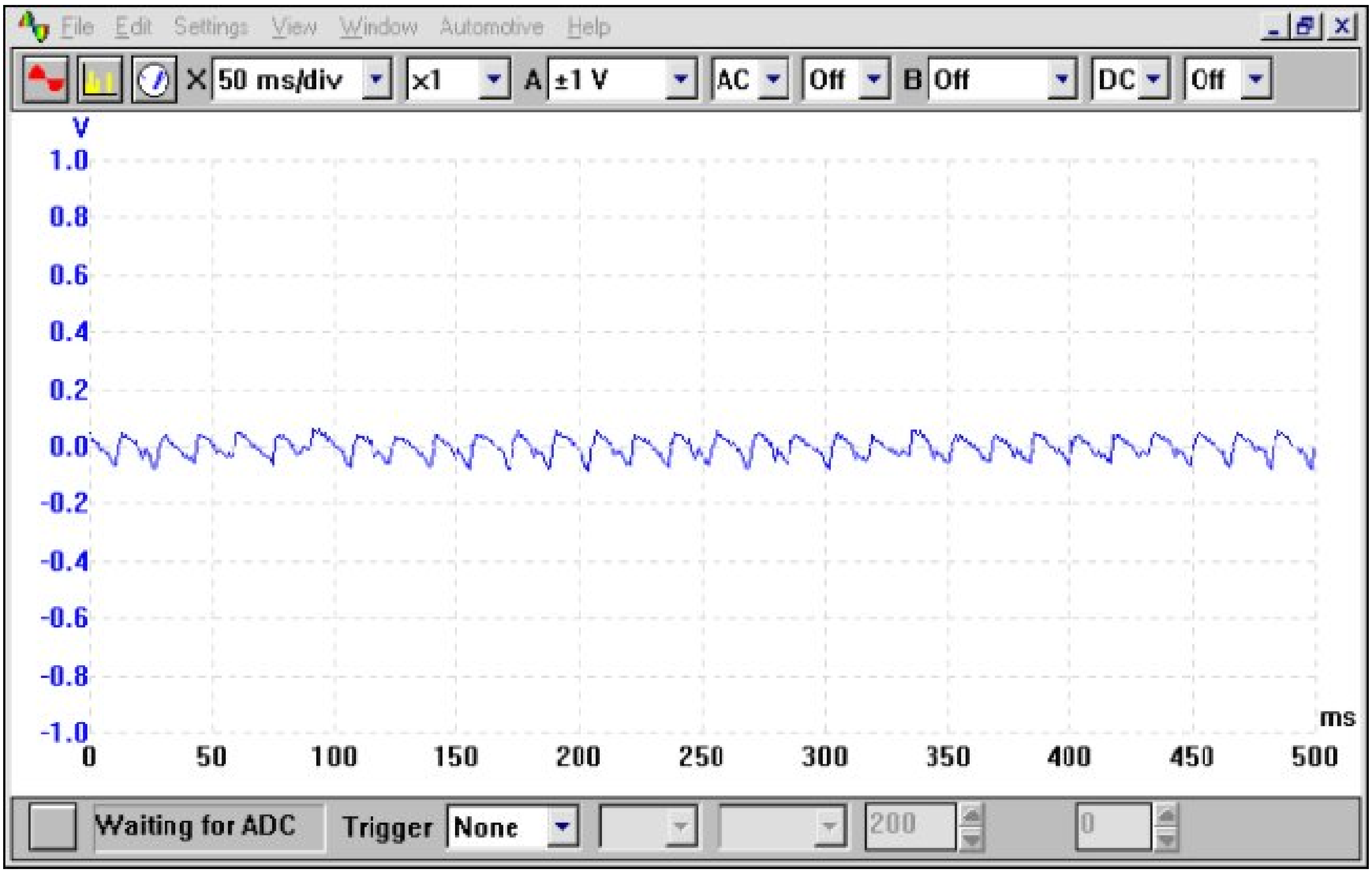

Figure 1.1

Diesel Glow Plugs

This test is conducted to evaluate the condition of the glow plugs (this example is a 4 cylinder engine) and to measure the 'on time', which is controlled by the timer relay. A typical glow (or heater) plug will have a high initial current draw that will gradually drop, stabilising at a constant amperage. The current draw will be dependent on the wattage rating of the glow plug. This data is available in the appropriate diesel data books.

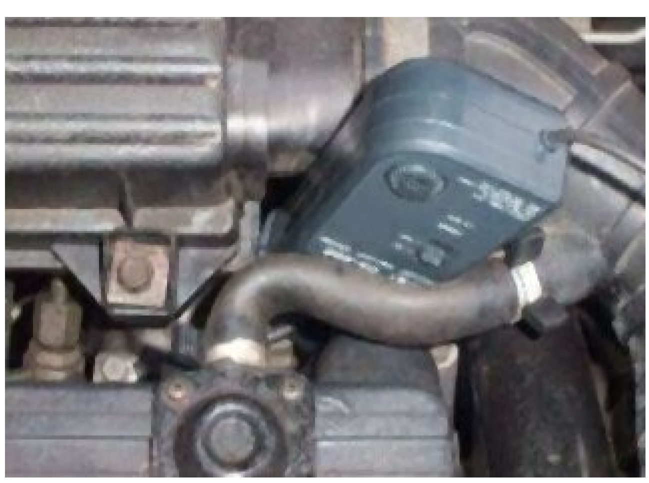

Figure 1.2

The length of time that the glow plugs are operational can be measured from the initial drop in current to the switch off point; in this case it is around 17 seconds. Fig 1.2 shows the current clamp around the common feed to the glow plugs. Fig 1.3 shows the current fall-off and the time period involved**.**

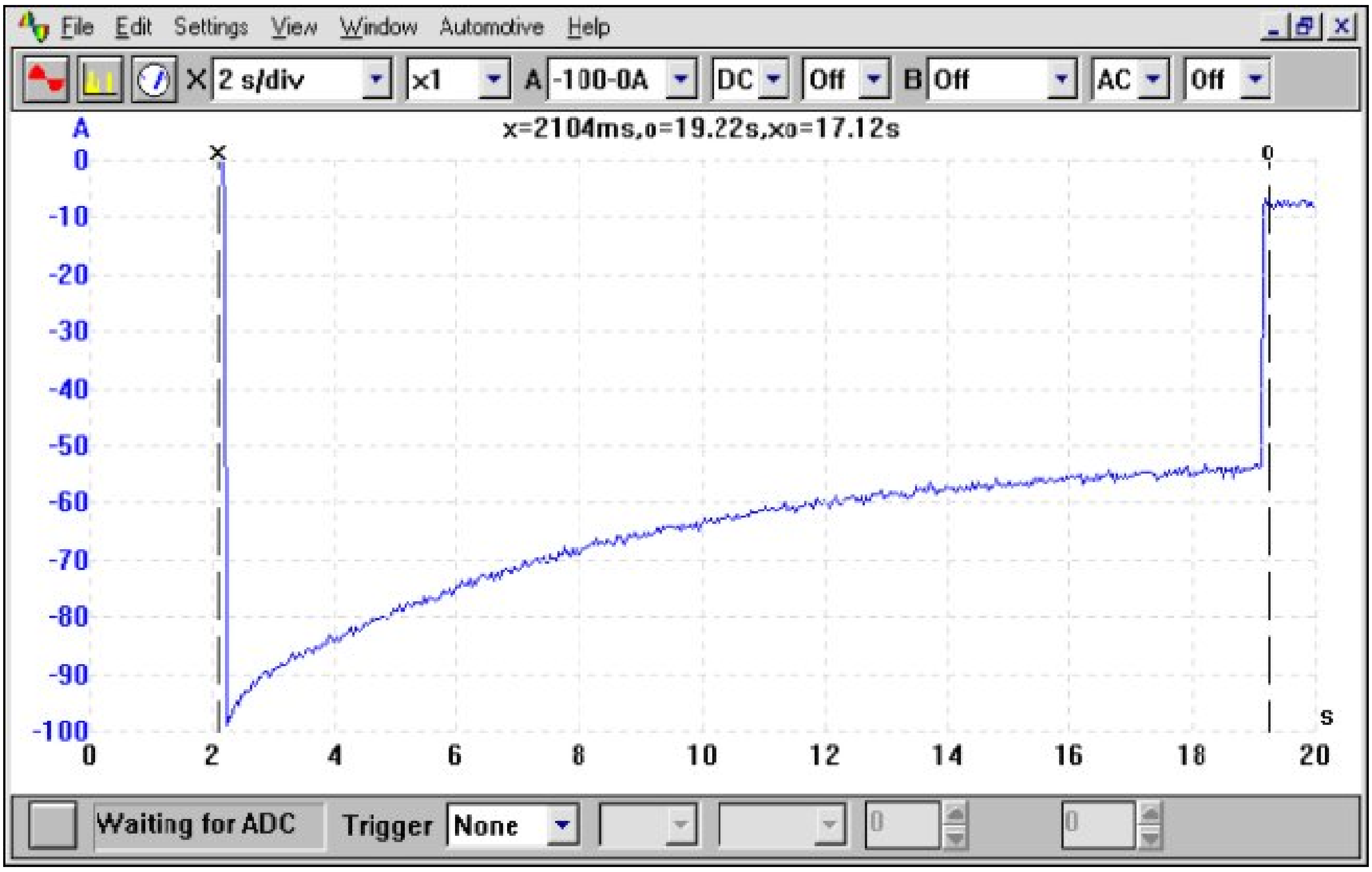

Figure 1.3

ABS Sensors

The Anti-lock Braking System (ABS) relies upon information coming in from the sensors fitted to the hub assemblies.

If under heavy braking the ABS Electronic Control Module (ECM) loses a signal from one of the road wheels, it assumes that the wheel has locked and releases that brake for a moment until it sees the signal return. It is therefore imperative that the sensors are capable of providing a signal to the ABS ECM.

The operation of an ABS sensor is like that of a crank angle sensor, using a small pick-up that is affected by the movement of a phonic wheel, moving in close proximity. The relationship between the phonic wheel and the sensor results in the production of a continuous Alternating Current (AC) 'sine wave' that can be monitored on an oscilloscope.

The sensor, recognisable by its two electrical connections (some may have a coaxial braided outer shield), will produce an output that can be monitored and measured on the oscilloscope.

Figure 1.4

Fig 1.4 shows the four connections made to the ABS electronic control module in order that the two front speed sensors could be monitored. The resultant waveform is shown below. Whilst on road test you will notice the frequencies change as you corner.

Fig 1.5 is a perfect illustration of the generated AC voltage produced by the ABS sensors.

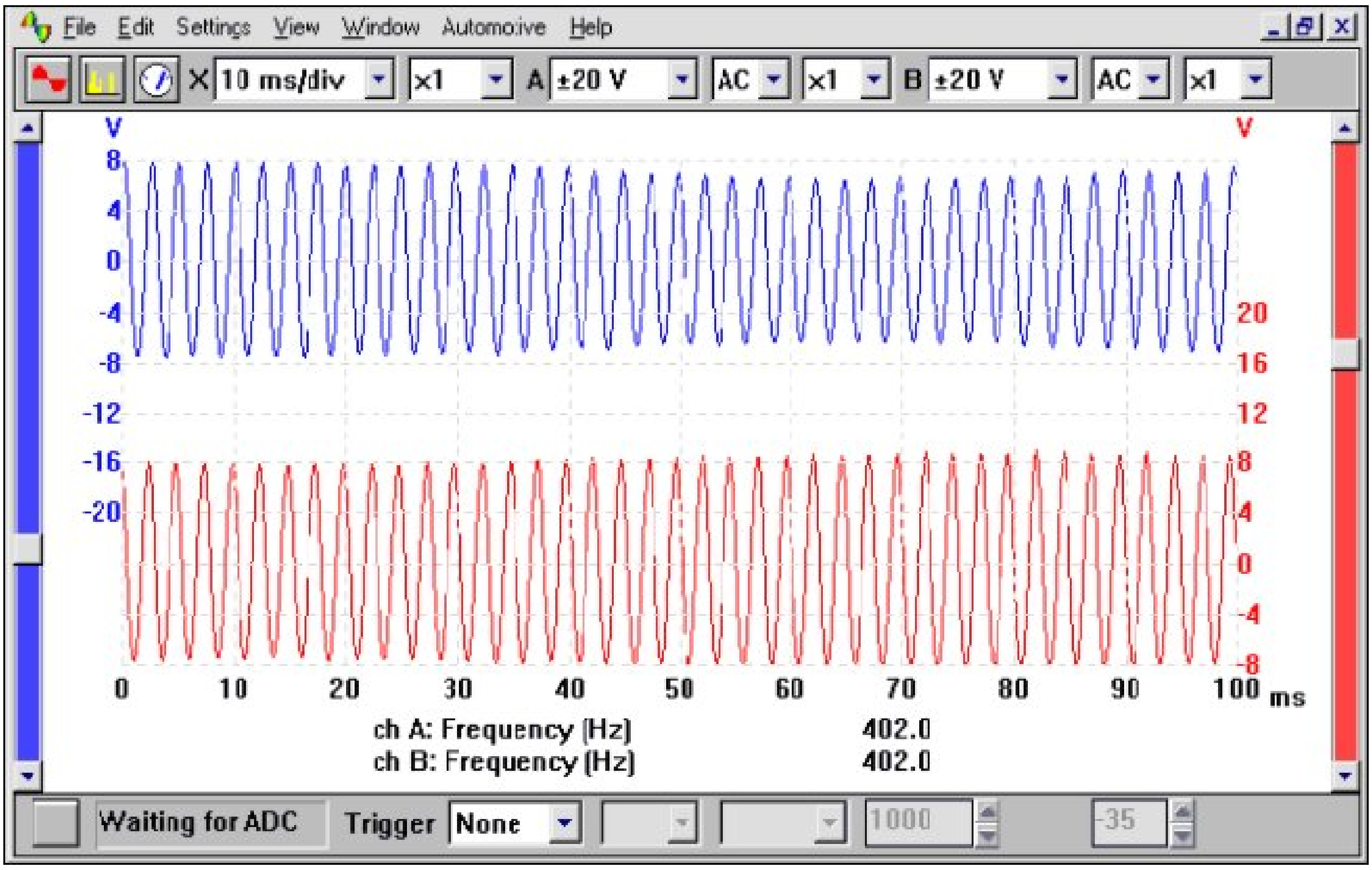

Figure 1.5

Road Speed Sensor

The Electronic Control Module (ECM) has the ability to adjust the engine's idle speed when the vehicle is slowing or stationary by using information from the Road Speed Sensor (RSS). The sensor is a 3 wire device and will have a supply at battery voltage, an earth and a digital square wave output also switching at 12 volts.

With the appropriate electrical connection made to the RSS output, raise one wheel with a trolley and place an axle stand under the suspension unit. Start the engine, select a gear, and a waveform switching from 12 volts to zero should be seen. As the road speed is increased the frequency of the switching should be seen to increase. This change can also be measured on a multimeter with frequency capabilities.

The RSS is an often underrated sensor as it also provides information to the vehicle's on-board computer, speed sensed audio systems and speed sensed power steering. The sensor will be located on either the speedometer drive output from the gearbox or to the rear of the speedometer head.

Fig 1.6 shows a typical road speed sensor output.

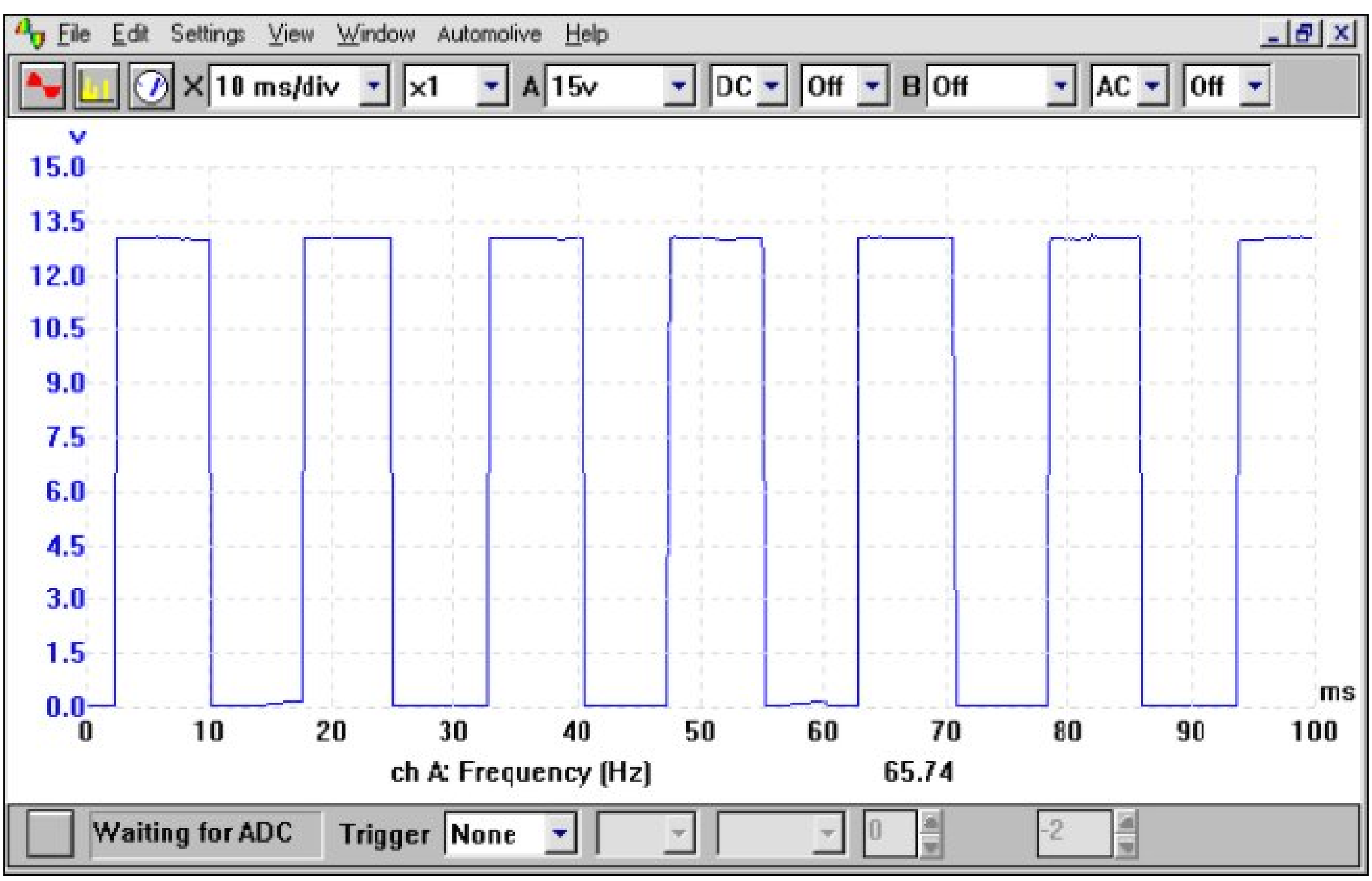

Figure 1.6

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