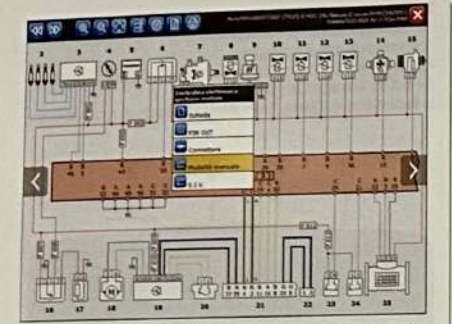

Figure 3: Accesso alla modalità manuale dallo schema elettrico

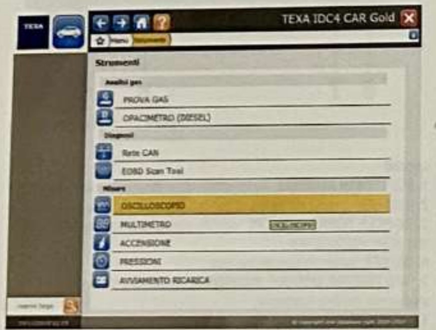

Figure 4: Access to manual mode from the Tool menu

1.1.1 Signal Peak, Signal "Peak to peak"

To make measurements in certain electronic devices, (such as a motor speed sensor) many times it becomes necessary to measure the peak voltage or "peak to peak". The peak voltage is the hight level (peak) between the maximum voltage and the highlighted zero line.
The signal peak - peak instead is the total potential within the highest and the lowest point of an alternating voltage of any waveform.

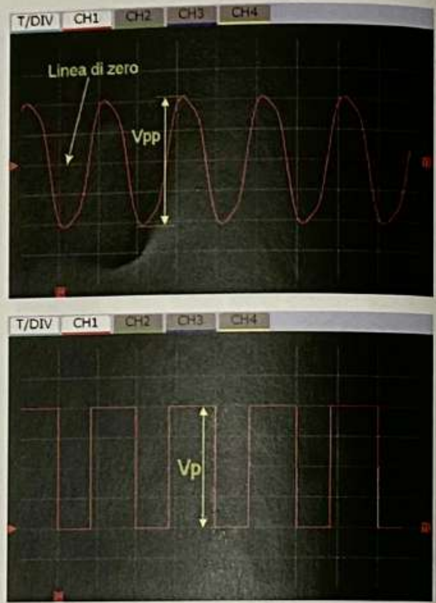

Figure 5: The signal is shown with the voltage peak to peak (Vpp) and peak (Vp)

1.1.2 Reading of the period and of the frequency

The period is a physical phenomenon (in our case an electric one) that is constantly repeated in the javascript:insert ('section2',1); it is the time that a signal is cyclically repeated. In the following picture, you can see that the period (T) has always the same value even when the reading points change.

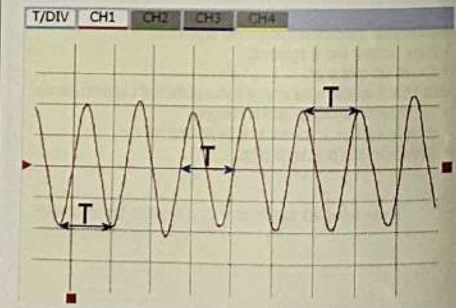

Figure 6

The frequency, as the period, is a dimension for periodic and repetitive processes. In physics, the frequency of a phenomenon presents an evolution which is formed by identically or nearly identically repeating events in time and it is given by the number of events which are repeated in a given time unit. A way to calculate a frequency is to set a time interval and count the number of times the event is repeated in that time interval and, thus, divide the result of this count by the time interval length. Alternatively, you can measure the time interval between the initial instants of two successive events (the period) and, thus, calculate the frequency as a reciprocal dimension of that duration, where T means the period.

$$f=\frac{1}{T}$$

Figure 7: Frequency formula derived from period

The result of f is given by the measurement unit called hertz (Hz), where 1 Hz characterises an event that occurs once in a second. This can also be defined as 1 period in a second.

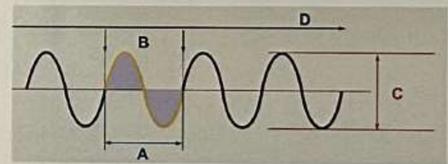

Figure 8

Legend:
A) Period
B) Frequency
C) Amplitude
D) Time

1.1.3 Duty-cycle percentage reading (PWM)

Computers check and manage, through manual commands modulated in **PWM** (**Pulse Width Modulation**), several actuators that can be the following:

- pressure and fuel flow regulators;
- EGR valve;
- some types of lambda sensor heaters;
- variable geometry regulation;
- fuel vapour solenoid valve (Canister);
- voltage regulator of modern alternators;
- rotation speed of the climate control fans.

Normally, all these parameters are displayed in self-diagnosis, if any, with the measurement unit expressed in percentage. In all cases, the control unit provides a fixed frequency (constant period) square wave signal to these actuators which is modulated in pulse width (also called **Duty-Cycle**); this signal (control voltage variation from +14 Volt to zero Volt) determines the modulation of the supply current intensity of the solenoid valve coils.

In most cases, the control modulated in PWM is managed by the ground line. This means that, normally, we will find at the other end of the actuator a fixed power supply line coming from the control unit or from the battery (usually by means of a relay).

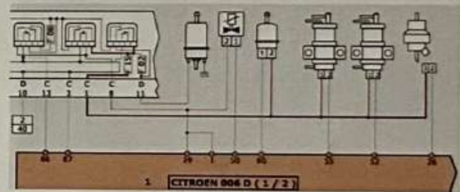

Figure 9: Fixed power supply line (in red)

A PWM control has two states: an active one (**ON**) and a passive one (**OFF**) that alternate in a set and constant time period chosen by the manufacturer.
ON = when the actuator is powered and its circuit is closed to ground.
OFF = when the actuator is not powered or its circuit is not closed to ground.

The task of the computer is to vary this value by modulating the power supply. As the active state duration, expressed in percentage (%) of the overall period, determines the "Duty-Cycle" it can be said that generally there are three characteristic operating moments:
1) Duty-Cycle at 50%

the active and passive areas of the diagram are equivalent (the control unit enables and removes the ground for the same times).

2) Duty-Cycle from 50% to 100%

the activated areas of the diagram are larger than the passive ones (the control unit enables the coil to ground for a longer period than the disabling one for the same cycle duration), high average voltage value and high absorbed current.

3)Duty-Cycle from 50% to 1%

the passive areas of the diagram are larger than the active ones (the control unit enables the coil to ground for a shorter period than the enabling one for the same cycle duration); low average voltage value, low absorbed current.

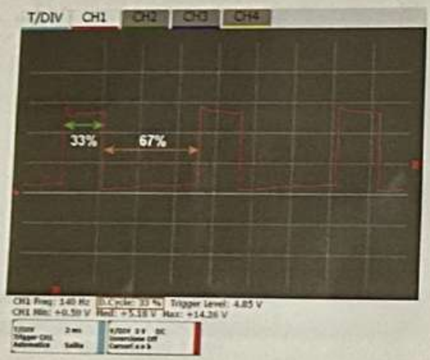

Figure 10

1.1.4 Check and analysis of a PWM signal

The variable geometry turbocharger is one of the most common components that are managed by the control system in PWM. The pneumatic valve managing the position of the blades inside the turbine is checked in turn by a by-pass solenoid valve that determines the depression inside the pneumatic valve.

The method used is the modulation of the air passage of the pneumatic valve between the external atmospheric air and the one in depression realized by the vacuum pump of the servo brake. The typical conditions of use of the turbine are the following:

Condition	Pneumatic valve pressure	Turbine pressure	Blades position
Rest	Atmospheric pressure	Minimum pressure	
Engine at idle or pressure-increasing phase	Tendency to maximum depression	Maximum pressure reaching	
Engine at high speeds or pressure-decreasing phase	Tendency to atmospheric pressure	Minimum pressure reaching	

Table 1

Before analysing the electric signal with the oscilloscope, you must check how the solenoid valve is connected using the electric diagram on the IDC4 (component 8). This check allows to verify whether the power supply of the solenoid valve comes from a fixed positive, that is common to other components too, while the wire coming from the control unit is a ground modulated in PWM.

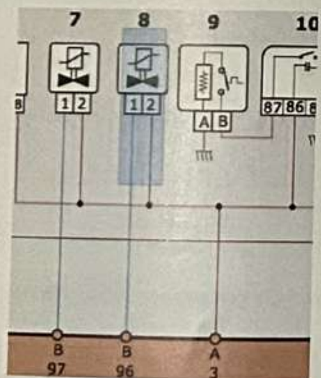

Figure 11

The signal we will find at pin 1 with the oscilloscope will be similar to the following picture, where the turbine is in relief/rest state.

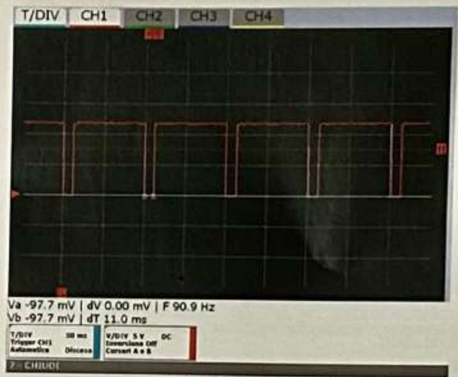

Figure 12: Turbine pressure relief state; PWM at 10%

On the contrary, the pressure-increasing phase determines an increase of the negative percentage of the control square wave which means a PWM value of about 40%.

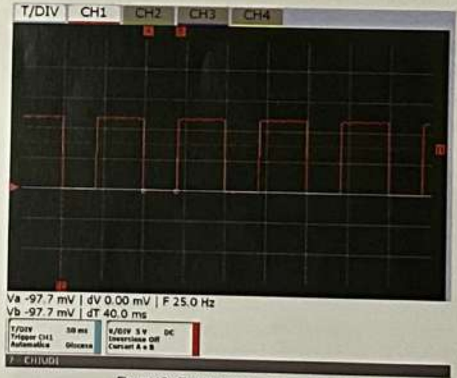

Figure 13: Turbine pressure-increasing phase; PWM at 40%

1.1.5 Check of the frequency of a signal

The frequency is considered as "periods in a second", thus, by analysing the time in which a period occurs we will be able to evaluate its frequency. This calculation is made easier by the automatic count of the UNIProbe oscilloscope software that gives us the already ready data.

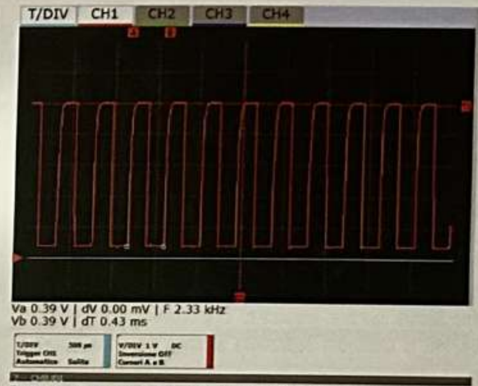

Figure 14: Signal of a digital air flow meter with the level trigger positioned for frequency evaluation

Note that to detect the frequency, the level trigger must be positioned in an useful space so that to detect the read signal. The analysis carried out in this way on a PWM signal will show the same frequency for all the semi-waves of any length, thus, enlarging the field of use and it can be very useful also for the signals in which the modulation occurs not only in frequency but also in PWM.

1.1.6 Use of the trigger function

As mentioned in the previous section, the Trigger task is to synchronize the beginning of the horizontal scan (time) with a precise threshold level of the voltage of the periodic signal to be analysed. The synchronisation, like a freeze frame, allows the stable displaying of the considered signal on the screen. The trigger options which are available in Uniprobe allow to set the device to three different levels.

- automatic;
- normal;
- single.

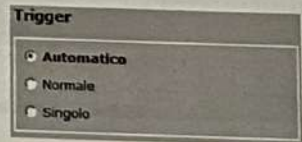

Figure 15