DIAGNOSCOPE DM-1

User manual

Read the user manual carefully before using this device. Ignorance of this user manual may cause damage to the device or components and subassemblies operated by it.

DeltaTech®
Electronics

Contents

1. Introduction

DM-1 Diagnoscope is an oscilloscope designed for fast diagnosis of vehicles as well as for educational purposes. Having predefined settings for most of currently used automotive sensors it is convenient and inexpensive tool for automobile workshops. Diagnoscope can be powered with AC adaptor (12V/500mA), built-in rechargeable batteries or directly from car's cigarette lighter socket (12V system).

Sealed ABS housing ensures safeguards internal electronics against moisture and dust while compact size makes it easy to operate.

2. Specifications

Maximum sampling rate	8MHz
Input bandwidth	1MHz (-3dB for 1V/div)
Input impedance	1MΩ/20pF
Input voltage range	-100V do 100V (without x10 probe)
Input signal type	DC, AC, GND
Resolution	8 bit (6 bit display resolution)
Linearity	±1 bit
Display:	LCD backlit, black-white 64 x 128 pix, 64x 96 pix waveform size
DC voltage measurement range	-80V do 80V (without x10 probe)
Peak-to-peak measurement range	0 do 160V (without x10 probe)
Time base	1,25us; 2,5us; 5us; 10us; 20us; 50us; 100us; 200us; 500us; 1ms; 2ms; 5ms; 10ms; 20ms; 50ms; 100ms; 200ms; 500ms; 1s; 2s; 5s; 10s; 20s; 30s; 1min; 2min; 5min; 10min; 20min; 30min; 1h per div
Amplifier gain (without x10 probe):	5mV; 10mV; 20mV; 50mV; 0,1V; 0,2V; 0,4V 1V; 2V; 4V; 8V; 20V per div
Number of memory cells	7
Supply voltage	11VDC do 15VDC/500mA
Battery	AA Type NiMH - 5 pcs pack
Maximum charge current	250mA
Maximum battery life	15h
Working temperature	-10°C do 50°C
Size	80x200x120mm
Weight	450g (without battery)

3. Operation

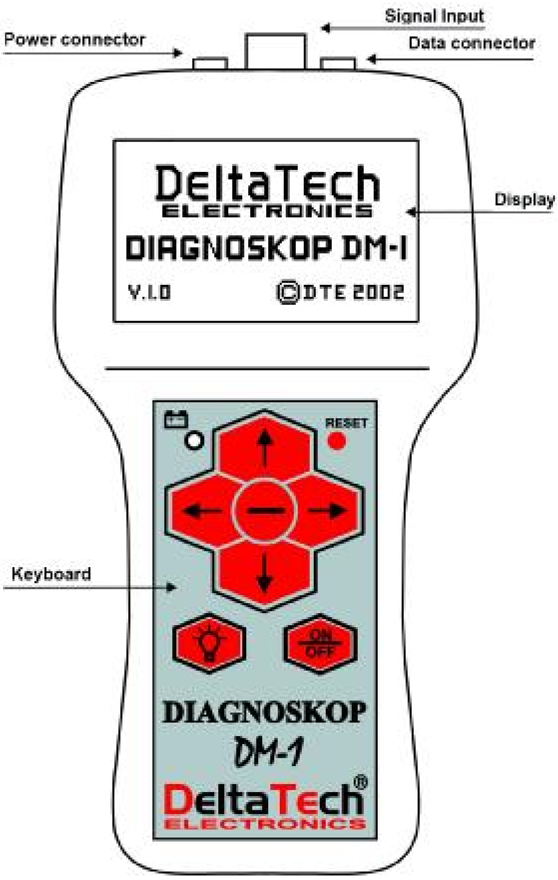


Fig. 2 DM-1 device.

To turn on the device press the **ON/OFF** button. The manufacturer logo will display for a moment.

Fig. 1 Welcome screen.

During this time no buttons are active except **RESET**. **RESET** button can be used in any time when a improper operation or freeze situation is encountered.

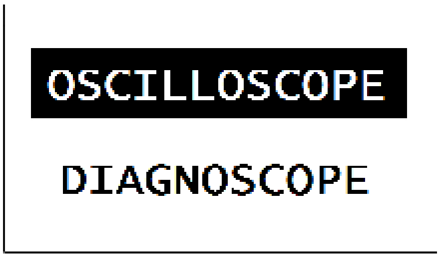


Fig. 3 Main menu.

The menu consist of two items: **OSCILLOSCOPE** and **DIAGNOSCOPE**. To change selection use arrow buttons ¯ or -. Use center accept button (—) to confirm selection.

4. Oscilloscope.

After selecting oscilloscope mode the acquisition will start with default settings. Since that moment the device is ready to perform measurements. The device will display connected signal waveform. Figure 4 shows an example of acquired waveform using default settings. The left part of the screen (¾ full) shows measured waveform. The right part of the display includes menu to change oscilloscope settings. Use arrow keys ¯ and - to move between menu items. Arrow keys ¬ ® and accept key (—) enables changing value of currently selected menu item.

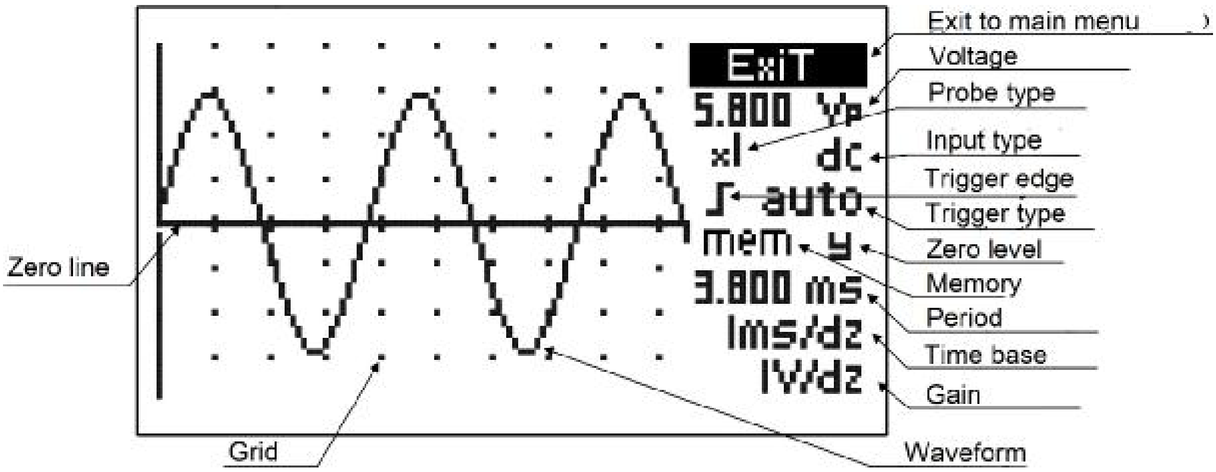


Fig. 4 Oscilloscope screen

4.1 Exit

When using **OSCILLOSCOPE** mode the first menu item is **ExiT**. This allows to exit measurement mode and return to main menu. To do this use arrow buttons ¬ and ® or accept button (—).

4.2 Input voltage

This item enables measurement of input voltage. The measurement can be performed in two modes: amplitude (peak-to-peak) value indicated with **VP** symbol or **mP** for milivolts and DC voltage (marked with **Vd** symbol for volts or **md** for milivolts). Use arrow buttons ¬ and ® to switch between these two modes. DC voltage measurement is only available when using **auto** trigger mode. Exceeding measurement range or inability to make measurement is indicated by four dashes - - - -.

4.3 x10 probe

Probe selection indicator shows if the x10 probe scaling is active or not. When not active the **x1** symbol is displayed meaning that the signal is connected directly to device. When using x10 probe use arrow button® to select **x10** mode. This will update measurement and setting values to work with x10 probe. When removing the probe remember to switch to normal mode by pressing the arrow key ¬ . The **x1** symbol will appear.

4.4 Input coupling selection

Oscilloscope allows measurement of signals with DC bias using **dc** coupling, measurement of voltage ripple only in **ac** mode or measurement of ground level when **Gnd** is selected. Use arrow keys ¬ and ® or accept button (**—**) to switch between different modes.

5.4 Edge and trigger level

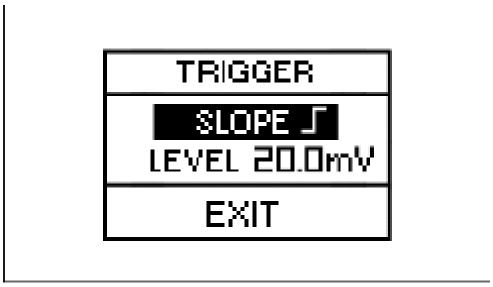


Fig. 6. TRIGGER submenu

To change edge type and trigger level use arrow keys ¯ and - to navigate to edge symbol and press accept button (**—**). The sub menu will pop up that allows to change both edge type and trigger level. Navigate to **SLOPE** and use arrow keys ¬ ® to switch edge type between rising and falling edge . To adjust trigger level navigate to **LEVEL 20.0mV** and use arrows ¬ ® to adjust level value.

Trigger level value is adapted to selected gain. For given gain there are 5 intermediate level values available per div. The minimum and maximum values are limited to 3/4 of the screen (+/-2.8 V for 1V/div).
To leave **TRIGGER** submenu use arrow keys ¯ and - to navigate to **EXIT** and press accept button (**—**) or one of the arrow buttons ¬ ® .

4.6 Trigger mode

The device can use the following trigger methods: **auto**, **norm**, **one**, **hold**. When **auto** is set, the waveform is triggered using defined level and signal edge. If does not occur in certain time, the waveform will be triggered nevertheless. When **norm** is set the trigger will happen when defined level and edge occur only. When set to **one** (once) the waveform will be triggered in defined way only once and then hold. When hold is selected the displayed waveform will not be updated.

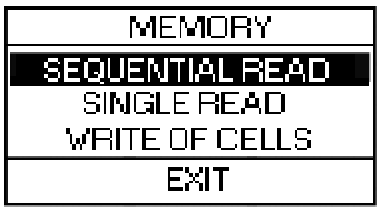
To switch between **auto**, **norm** and **one** use arrow keys ¬ ®. To select hold press the accept button (—) in any mode.

4.7 Waveform memory

The diagnoscope is capable of storing in its RAM memory up to 7 screens (waveforms). The writing method can be sequential or single.

Sequential write means that the each consecutive screen is automatically stored in the next memory location. If all cells are stored, the further writing starts from the first cell erasing its previous contents, and so on.

The single write means that the single waveform (screen) will be saved to memory cell selected by user.



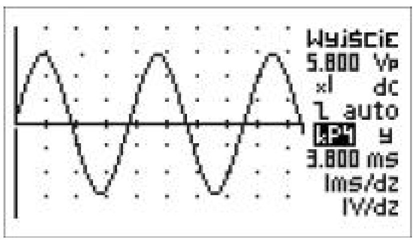
Memory entries persists until device is turned off or reset.

After the device is turn on or reset the sequential write method is selected by default.

To enter memory menu select **mem** using arrow keys ¯ and - and press accept key (—).

A. Sequential read

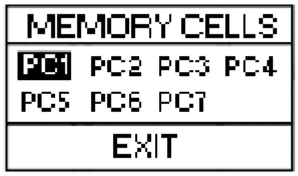
When this option is selected the device will display contents of the last saved memory cell. The waveform is displayed exactly as in oscilloscope mode. In the place of **mem** there will be number of the used memory cell, for example **PT4**.



All other menu items are inactive. To switch between different memory cells use arrow keys ¬ and ®. To return to memory menu use arrow keys ¯ or - to navigate to **ExiT** and press accept key (—) or one of the arrow keys ¬ ® .

B. Single read.

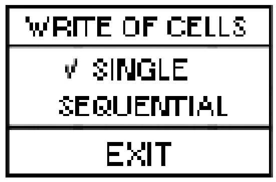
When this option is selected the menu will appear as in Figure 9. Then specify the memory cell using arrow keys ¯ or - and press accept key (—).
To exit navigate to **EXIT** and confirm selection using accept key (—).



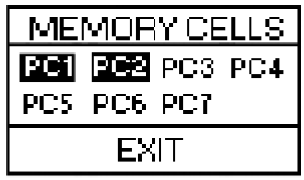
C. Write of cells

After this item is selected the menu will appear. If there is need to store only one waveform screen use **SINGLE** option. The symbol **√** indicates current selection.

Then select memory cell. To avoid mistakes last used cell is already marked off.

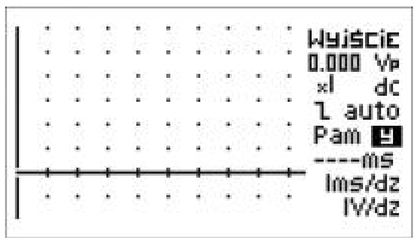


To exit this menu navigate to exit and press accept key (—).



4.8 Zero line.

The next menu item ( ) enables to move zero line. If the zero line is in the middle of screen, the user may move it up to two lines up or down. The left arrow ¬ lowers the zero line while the right arrow ® raises it. This adjustment can also be made using accept key (—).



4.9 Period, frequency, rpm.

The device calculates waveform period with an accuracy of one pixel of display. Therefore in order to achieve maximum accuracy the time base should be selected so that only few periods are visible (more than one).

It is possible to select instead of period, a frequency (**Hz**) or number of rotations per minute (**r|m**). Then the diagnoscope will calculate value required.

To switch between these modes use accept key (—) or arrow keys ¬ ® .

Exceeding the measuring range or impossibility of calculating the period is signaled by four dashes symbol instead of value **- - - -** .

4.10 Time base

To select time base (sweep time) use accept key (—) or arrow keys ¬ ®. Time base can be adjusted in broad range from 1.25us/div up to 1h/div.

The first three values 1.25us/div, 2.5us/div and 5us/div are suitable for periodic waveforms. Therefore when selected, the device switches trigger mode to **norm**.

4.11 Gain

Gain (sensitivity) value can be selected, just as time base using accept key (—) or arrow keys ¬ ®.

This value can be selected from number of predefined values from 5mV/div up to 20V/div.

4.12 Coordinates.

The next menu item is associated with the method of presenting waveform coordinates. There are three options available: **Grid**, **cross**, **marker**. Use accept key (—) or arrow keys ¬ ® to switch between these options.

A. <u>Grid.</u>

This way of presenting waveform coordinates (Fig. 13) consist of X Y zero lines as continuous lines and X Y divisions as dots.

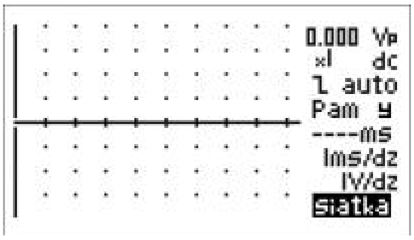


Fig. 13. Grid.

B. <u>Cross.</u>

In this mode zero lines of X and Y axis are shown as dotted lines and X Y divisions are visible on zero lines only.

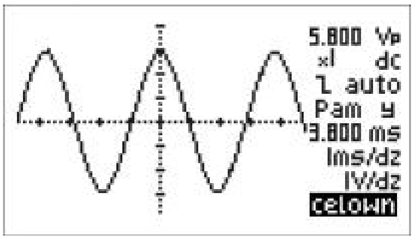


Fig. 14. Cross.

X. <u>Marker.</u>

Markers enable easy measurement making on displayed waveform. The user can determine voltage or time difference in waveform running, currently hold or stored in memory.

Selecting the **marker** will move the menu by two items upwards so that there are additional items visible. These items include four marker icons: left, right, bottom, upper. To move specific marker, select it using arrow keys ¯ or - Wand change its position using horizontal arrow keys: ¬ for moving left or downwards ® for moving right or upwards.

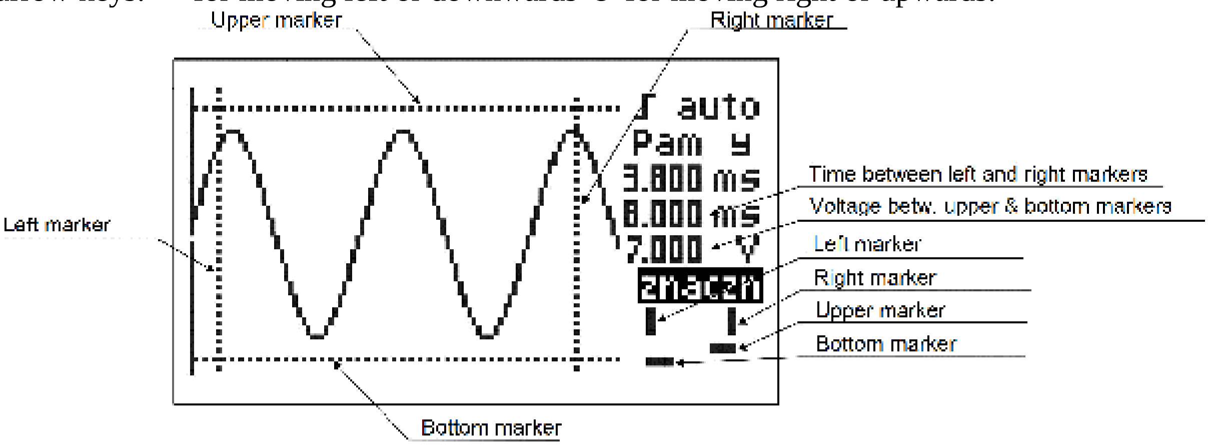


Fig. 15. Markers.

Now, the item which previously displayed time base will display time elapsing between left and right marker. The gain item will now display voltage difference between upper and bottom marker.

Changing **marker** parameter to **Grid** or **cross** will restore normal display.

4.13 Backlight and contrast adjustment

Every pressing of backlight key will switch on and off LCD display backlight.

Holding the backlight key and pressing arrow keys ¯ or - woul decrease or increase contrast respectively. There are 10 contrast settings below and over default setting.

4.14 Connecting to a PC computer.

DM-1 diagnoscope can be connected to PC computer. This enables observing waveforms on computer screen as well as storing and browsing recorded waveforms on PC.
For DM-1 to work with a computer please install DM-1 software (included).

Minimum hardware requirements:
- Intel Pentium 200 MMX class processor
- 32 MB RAM
- 10 MB disk space
- 800x600 screen resolution

- serial port available (or serial-to-usb converter)
- CD-ROM drive

Insert included CD-ROM to drive. An installation menu should appear. If does not, run '*start.exe*' from the CD-ROM drive. Click '*Install*' to run installation program.
After installation connect DM-1 to COM serial port using dedicated data cable (included).
When connected turn on DM-1 and run Diagnoscope DM-1 program on PC.
In the *Port* field select proper COM port and click *START* to start data transmission.

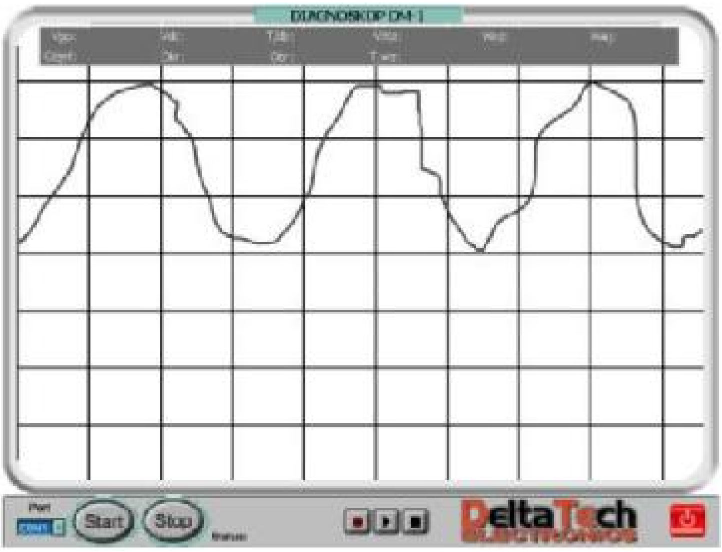


Fig. 4.13. DM-1 software running.

After completing work with DM-1, click *STOP* to end connection. Then you may disconnect cables.
To store waveforms on hard drive click record button (with red dot). The recording will last until stop button is pressed (with black square). When recording is complete a save file dialog will appear that will enable to name the file.
To open the file and browse waveforms click open button (with triangle symbol). The waveform will be replayed just as during measurement till end of file or stop button click.
When connecting DM-1 to a computer without serial port use serial-to-usb adapter. Always check whether specific converter works with DM-1 device.

4.15 Power and battery replacement

Use only AC adapter provided by the manufacturer. This power supply has the following parameters:

input voltage: 100-240V AC
output voltage: 12VDC stabilized
output current: 1000mA

Diagnoscope is designed to work with rechargeable NiMH battery pack (5 sealed AA cells).The need for charging the battery is indicated by low battery symbol in the upper left corner of the screen. To recharge the batteries plug in AC adapter. During charge process the battery indicator light (red) will light up. While the batteries are charged, indicator lights fades. Batteries are fully charged after approximately 14 hours.

If the battery fails to power the device despite fully charged replace the batteries. Contact manufacturer to obtain new battery pack In order to replace the batteries unscrew 6 screws from the bottom of device and replace the battery pack.

We recommend to perform all measurements using internal battery, and recharging after use by included power supply.

5. Diagnoscope

Diagnoscope is special oscilloscope mode with predefined measurement parameters. The list of defined measurements include most of automotive sensors currently in use. In almost all cases there are reference waveform included for comparison. This references as well as measurement parameters should be considered demonstrative.

After **DIAGNOSCOPE** is selected form device main menu the list of sensors will appear. Use arrow keys ¯ or - to navigate to specific sensor. Confirm selection using accept key (—).
The list ends with **EXIT**. Selecting this item will make device back to main menu. Other way to do this is to press left arrow key ¬ from any menu position.

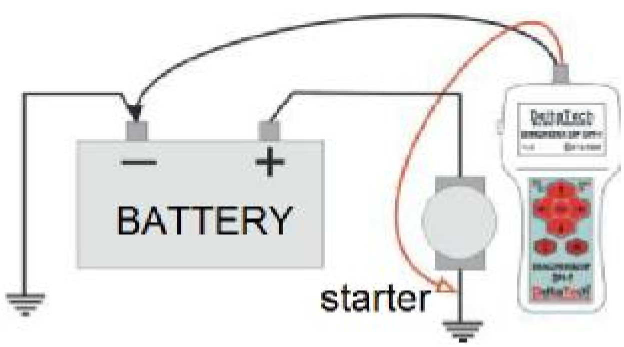
After selecting specific sensor the additional sensor variant submenu may appear if more than one sensor variant. Then the user may select MEASURE to make measurements or EXAMPLE for reference.

If there is not reference available the device will start measurement immediately.

5.1 Battery

Voltage measurement

Measurement set-up:



Menu selection: DIAGNOSCOPE>BATTERY>VOLTAGE>MEASURE

(If required adjust time base and gain value)

In modern vehicles battery is very important since many electronic systems are sensitive to power quality. One of the most frequent problem is situation when trying to start a car with faulty battery. Rapid drops of voltage often cause problems with controllers. In worst case scenario this may cause damage to the ECU.

Therefore battery maintenance is needed to avoid such problems. The table below shows how open circuit battery voltage relate to state of charge.

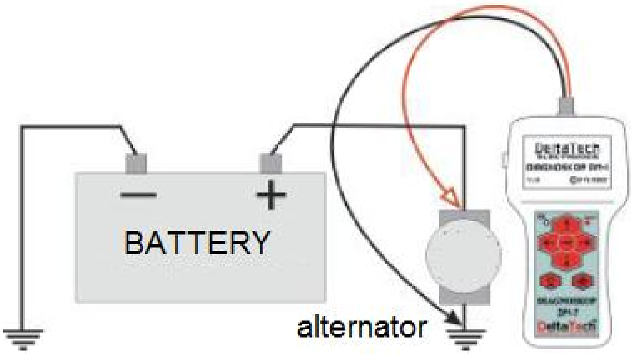
State of charge	Maintenance-free	Lead-Antimonium	Lead-Calcium
100%	13.0 V	12.6 V	12.7 V
75%	12.8 V	12.4 V	12.5 V
50%	12.5 V	12.1 V	12.2 V
25%	12.2 V	11.9 V	12.0 V
0%	12.0 V or less	11.8 V or less	12.9 V or less

To check battery voltage connect probes to its terminals and make measurement.

To measure charge voltage set by voltage regulator start the engine end hold the speed at 2000 rpm and then make voltage measurement.

<u>Ground measurement</u>

Measurement set-up:



Menu selection: DIAGNOSCOPE>BATTERY>GND>MEASURE

(If required adjust time base and gain value)

Vehicle electronic systems are very sensitive to faults in connection with battery ground. Excessive resistance of ground connections cause many problems and these problems are often hard to diagnose. Faulty ground connection affect readings of most sensors and also impair actuators such as injectors, relays, electric valves. These problems are common in cars which were repaired after accident as technicians tend to pay less attention to ground connections as these of less importance. This make the current to flow different, often undesirable ways.

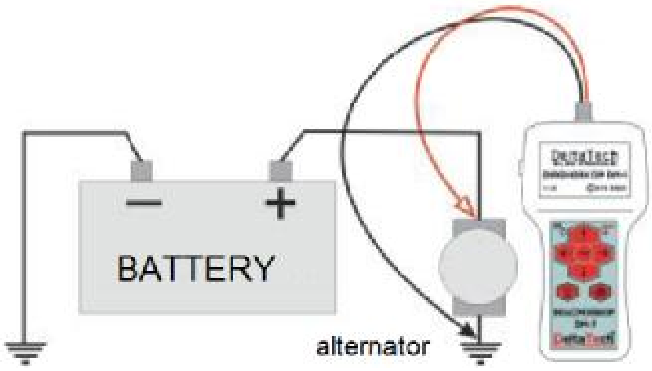
Therefore it is advised to check car's main ground connection – connection between engine and car's body. This is thick copper wire which is easy to find and check. Resistance measurement performed by ordinary millimeter is inaccurate as these devices are not intended for such measurement. Typical measurement error of 1 Ohm make all measurement futile as resistance increase of only 0.1 Ohm can make current change as large as 70%.

In order to perform more accurate measurement measure the voltage between negative battery terminal and diagnosed point of car electrical system. All measurements should be made under load. As a rule of the thumb can be stated that 0.5 V voltage difference is acceptable.

5.2 Alternator

Voltage ripple measurement

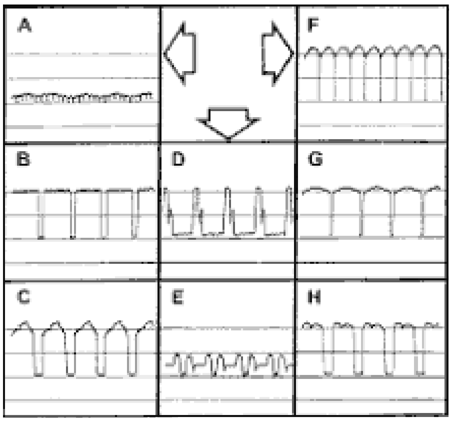
Measurement set-up:



Menu selection: DIAGNOSCOPE>ALTERNATOR>CURRENT RIPPLE>MEASURE

(If required adjust time base and gain value)

Alternator produces alternating current which is rectified by rectifier diodes. Rectifying process is not ideal and leaves a ripple in output current and voltage. Alternator diagnosis will be based on observing voltage ripple because this measure is easier available. Basic information on alternator performance can be get by observing charging indicator on the dashboard. When indicator fails to go out after starting the engine and keeps lighting or fades with changing intensity this usually means some kind of alternator problem. Basic diagnosis should include measuring charge voltage. This may vary but should be about 13.9 – 14.4 V in different models. Of course comprehensive diagnosis can be made on the test bed, but it is time consuming and expensive method. Easier is to use DM-1 diagnoscope. For results to be more accurate enable all current consuming systems such as lights, heated seats, air conditioning. Then run the engine at 2000 – 3000 RPM speed and make voltage measurement at alternator terminals. Compare result with provided reference waveform. Below there are sample waveforms that present typical alternator malfunctions.



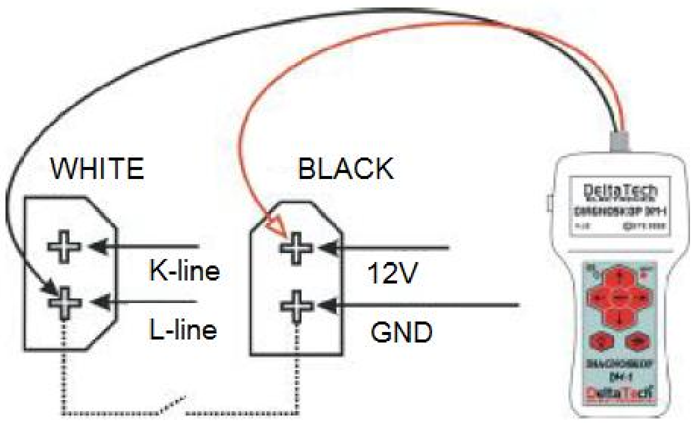
A – normal
B – stator diode open
C – stator diode shorted
D – positive diode open
E – positive diode shorted
F – faulty phase
G – negative diode open
H – negative diode shorted

During measurement ensure that alternator operates under load. When diagnosing alternator pay attention to brushes condition as well as bearings. The cause of improper charge voltage may be voltage controller circuit.

5.3 Codes

<u>Blink codes readout</u>

Measurement set-up:



Menu selection: DIAGNOSCOPE>CODES>MEASURE

(If required adjust time base and gain value)

DM-1 diagnoscope allows fault codes readout of blink codes, regardless of make or car model. To read the codes it is required to invoke code transmission in vehicle. This example covers blink codes readout in VW/ Audi cars.

Readout procedure:

1. Disable ignition.

2. Connect diagnoscope according to diagram above.

3. Start the engine and leave it on idling.

4. If engine fails to start, crank for 6 seconds and leave ignition turned on.

5. Connect L line to battery ground for 5 seconds (dotted line on above diagram)

6. Observe waveform appearing on screen. First series of pulses indicates first digit (e.g. 3 pulses means 3), second series second digit, and so on. To invoke next code hold L line shorted to ground for 5 seconds.

7. Wait until ECU stops transmitting fault codes. Code 0000 means all codes were invoked. Code 4444 means no fault codes in controller memory.

8. Turn off ignition.

Clearing fault codes.

1. Turn off ignition.

2. Disconnect negative battery terminal (ground) or disconnect ECU connector.

Warning!!!

Leaving ECU without supply voltage may cause loss of adaptation data. In this case there is need to make longer test drive.

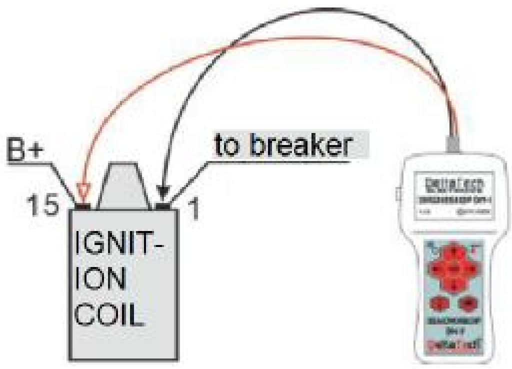
Disconnecting negative battery connector may cause loss of settings of various electronic devices such as car radio, clock, etc.

To make code readout easier the user may use storing to memory feature.

5.4 RPM

Engine RPM measurement

Measurement set-up:



Menu selection: DIAGNOSCOPE>RPM>(4 STROKE / 2 STROKE)>MEASURE

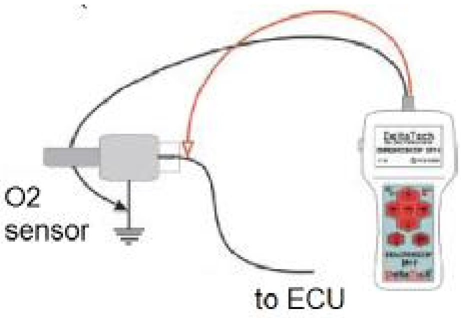
(If required adjust time base and gain value)

One method of getting engine speed is to connect the device to ignition coil and calculate rotational speed on the basis of pulses detected. Because there are many ignition system used in automotive industry, the device enable to set calculation method. Measured pulses can be divided by 2, 3, 4, 5, 6, 7, 8, 9, 10 or multiplied by 2 or directly taken as the number of revolutions. For example, in a four-stroke four-cylinder engine having single ignition coil, we need to divide the number of pulses by 2. To do this select **mtx1** option and set to **mtx1/2** . For other systems adjust correction parameter accordingly. RPM measurement can be also performed using inductive probe placed on high voltage cable of one cylinder. When not available the user may use a piece of isolated wire wrapped along high voltage cable. In this case set x1 correction parameter for two-stroke engines and x2 for four-stroke engines.

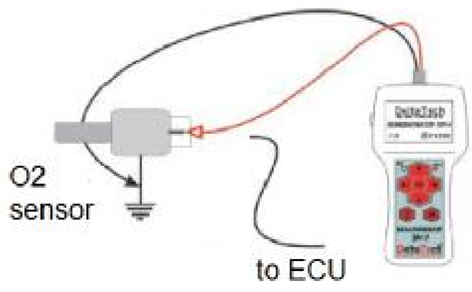
5.5 O2 sensor

Checking O2 sensor

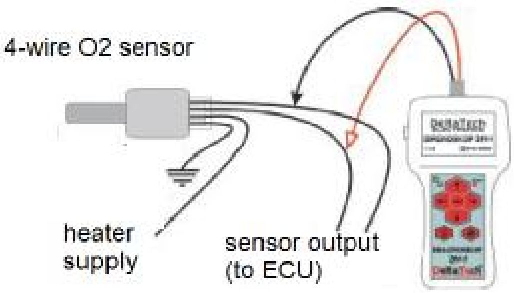
Measurement set-up:



(1)



(2)



(3)

Menu selection: DIAGNOSCOPE>O2 SENSOR>(1V SENSOR / 5V SENSOR)>MEASURE

(If required adjust time base and gain value).

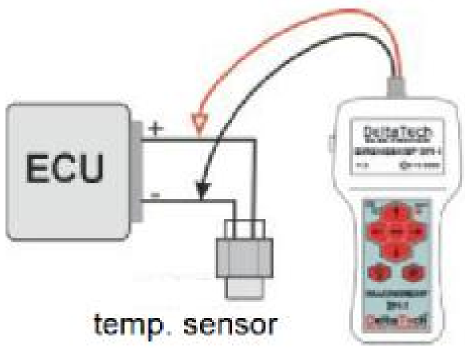
To test oxygen sensor (lambda sensor) first locate sensor signal wire and connect in parallel with a positive probe (red) terminal. In order to test sensor itself more independently the user may want to disconnect signal from ECU. Negative probe (black) should be connected to ground (car body in most cases, in some there is a special terminal in sensor connector). After starting and heating the engine (about 10 minutes at 1000 rpm) the sensor output should be 0.8V (for 5V sensors about 5V) amplitude at minimum 1 Hz. If the voltage does not exceed 0.5V (2.5V for 5V variant) the sensor is faulty and need replacement. Note that any short circuit in oxygen sensor circuit causes no output voltage even though the sensor itself can be in good condition. To check correct operation of oxygen sensor circuit and ECU response use dedicated hardware do simulate lean and rich air fuel ratio (such as TSL-3 tester by DeltaTech Electronics). It is assumed that border between lean and rich air fuel ratio is 0.45 V level (2.5 V for 5V sensors). This means that diagnoscope readings of 0.1 to 0.4 (0.1 – 2.5) indicates lean air fuel ratio while 0.5 to 1.0 (2.5 to 5.0) rich air fuel ratio.

Warning!!! Disconnecting oxygen sensor when ignition is turned on may cause fault codes to be appear.

5.6 Temperature

Checking temperature sensor

Measurement set-up:



Menu selection: DIAGNOSCOPE>TEMPERATURE>(LIQUID/CTS/ / AIR/AT/)>MEASURE

(If required adjust time base and gain value).

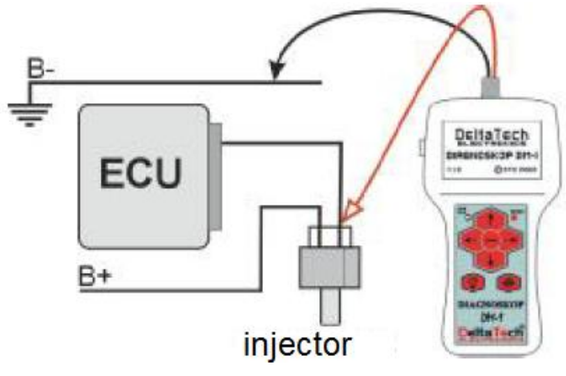
In modern cars coolant temperature sensor and sometimes oil temperature sensor readings have great importance. They provide ECU with information such as engine reached normal operating temperature or it is just warming up. In this way temperature sensor readings determines control of injection system. That is why it is important for these sensor circuits to work properly. Frequently the technician checks only sensor resistance, but it is not sufficient because also good sensor can cause problems when the contacts are poor or circuit open. Sensor diagnosis is straightforward: just connect diagnoscope as presented above. The only difficulty can be number of different temperature sensors. Find proper sensor using service manual. Most often this sensor is supplied with 5V while sensors powered by 12V usually powers dashboard indicator. Sometimes there are two sensors in one housing with four terminals. Most of sensor used are NTC sensors, that means the resistance decreases with temperature increase. Engine controller supplies sensor with constant current and 5V voltage. Below there is table with typical sensor readings:

Temperature (Celsius)	Resistance (Ohm)	Voltage (Volt)
0	4600 – 6600	4.00 – 4.50
10	4000	3.75 – 4.00
20	2200 – 2800	3.00 – 3.50
30	1300	3.25
40	1000 – 1200	2.50 – 3.00
50	1000	2.50
60	800	2.00 – 2.50
80	270 – 380	1.00 – 1.30
110	180 – 200	0.50
Open circuit	-	5.00
Short circuit	-	0

While diagnosing the sensor check whether output signal changes smoothly along with temperature and if these changes are proportional to engine temperature. In the same way other temperature sensors can be checked such as air, oil, etc. Always refer to service manual in case of specific make/model.

5.7 Injection

Measurement set-up:



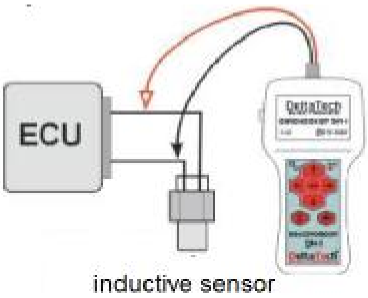
Menu selection: DIAGNOSCOPE>INJECTOR> MEASURE

(If required adjust time base and gain value).

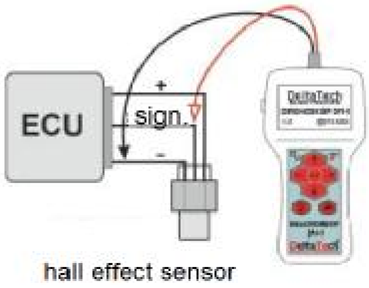
To measure injection signal time adjust time base so that there is only one complete pulse visible, in other case the measurement will be inaccurate. Alternatively the injection duration can be obtained by holding the waveform and using markers.

5.8 Crank /Ckp/

Measurement set-up:



(1)



(2)

Menu selection: DIAGNOSCOPE>CRANK /CKP/> MAGNETIC/HALL EFFECT/OPTICAL> MEASURE

(If required adjust time base and gain value)

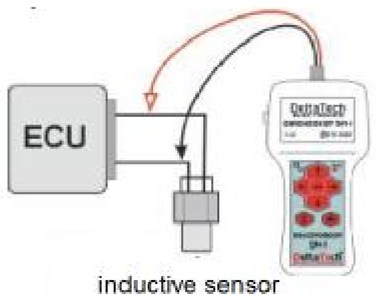
Crankshaft sensor can be made as inductive sensor that uses flywheel teeth to induce voltage pulses. One lacking tooth indicates reference position. Engine controller uses this sensor to obtain engine speed and to properly adjust ignition timing. Magnetic sensor (1) can be identified as it has always two output wires. Correct waveform of magnetic sensor is sine wave with one lacking pulse per crankshaft revolution.

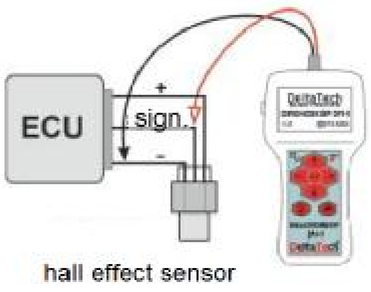
If the crankshaft sensor has three wires it may be Hall effect or optical sensor (2). These kinds of sensor have similar output waveform – it is square wave with one pulse lacking per crankshaft revolution.

It is worth mentioning that some self-diagnostic systems display fault code for this sensor when the engine is not running. It is clear that when the engine is not working there is no signal from this sensor and this should be considered as imperfection of such self-diagnostic system.

5.9 Cam /Cmp/

Measurement set-up:





(1) (2)

Menu selection: DIAGNOSCOPE>CAM /CMP/>MAGNETIC/HALL EFFECT/OPTICAL> MEASURE

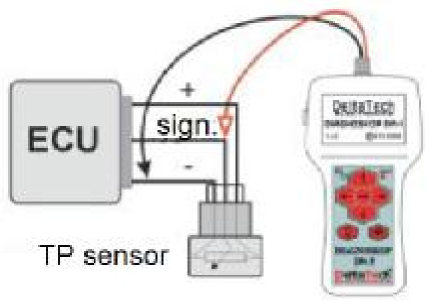
(If required adjust time base and gain value)

Camshaft sensor (CAM or CMP) is used to determine position of camshaft, and more specifically in which cylinder ignition should occur. Sometimes the name cylinder identification sensor is used. This sensor is found in vehicles with sequential injection system. Two variants of this sensor is used: inductive (1) and Hall-effect (2).

To diagnose the sensor check if the output signal is generated and observe the waveform. Sensor output should be uniform and steady.

5.10 TP Sensor

Measurement set-up:



Menu selection: DIAGNOSCOPE> TP SENSOR > MEASURE

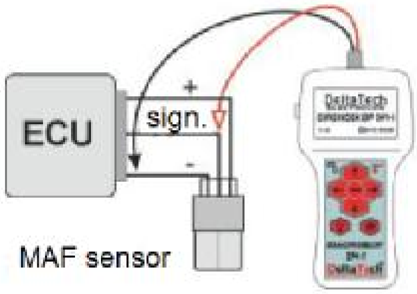
(If required adjust time base and gain value)

Throttle position sensor (TP Sensor) are usually made as a potentiometer. This potentiometer is connected to 5V and ground so that potentiometer output indicates throttle position. As sensing element is usually made of carbon track and movable slider it is prone to wear and dirt accumulation. After some usage, sensor deterioration can distort output signal and cause engine malfunction.

Use diagnoscope to observe if output is proportional to potentiometer movement. Pay attention to any rapid signal disturbances during slow, uniform motion. Along with TP sensor it is advised to check idle and full throttle switch if they are present.

5.11 MAF sensor

Measurement set-up:



Menu selection: DIAGNOSCOPE> MAF SENSOR > MEASURE

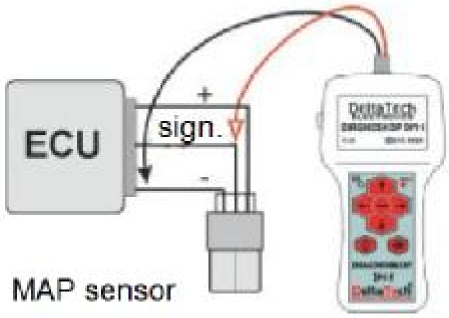
(If required adjust time base and gain value)

Mass flow sensor measures inlet air flow. There are many technologies used in MAFsensors. Older designs usually relied on potentiometer while newer tend to lack moving parts. A hot wire mass airflow sensor uses heated wire suspended in flowing air to indirectly measure air mass flowing through inlet manifold.

All MAF sensor variants have usually three wires. Two are for power supply while third is signal wire. First, check supply voltage - it should be 5V DC. Then connect negative probe to ground and positive to measured signal. Run the engine and check if sensor output changes with varying throttle positions. Response should be quick and regular. When diagnosing potentiometer sensor pay attention to any signal disturbances (spikes) while the engine is operating at speed that usually causes problems. Please note that without reference flow meter it is impossible to state about MAF accuracy. It is known that hot wire flow meters tend to underestimate flow rates over time. It often happens that despite no fault codes are present in ECU, the flow meter is giving erroneous readings.

5.12 MAP sensor

Measurement set-up:



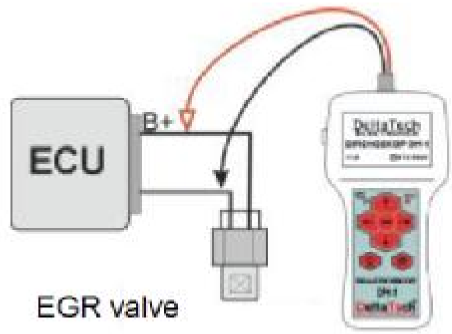
Menu selection: DIAGNOSCOPE> MAP SENSOR > MEASURE

(If required adjust time base and gain value)

Manifold absolute pressure sensor (MAP sensor)measures instantaneous pressure in intake manifold. Typical sensor has three wires. Two wires provide power while third is signal output. First, check supply voltage - it should be 5V DC. Then connect sensor as shown above and check if the signals change with vacuum level in manifold. To force pressure changes change throttle opening. Without pressure gauge only presence and uniformity of output signal can be verified.

5.13 EGR

Measurement set-up:



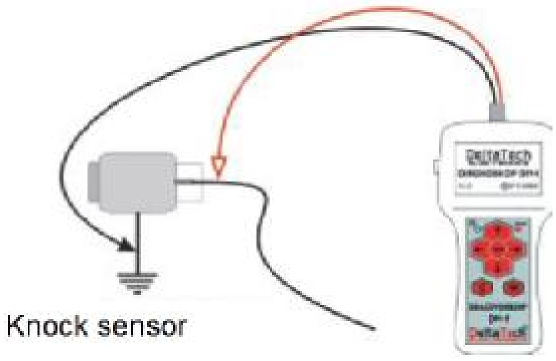
Menu selection: DIAGNOSCOPE> EGR > MEASURE

(If required adjust time base and gain value)

In order to reduce nitrogen oxides NOx emissions, some amount of exhaust are passing to inlet manifold. As proportion is precisely controlled by ECU, a solenoid valve is used to control flow rate. This solenoid is powered using PWM signal. The greater duty cycle, the more exhaust gases enter intake manifold. Diagnoscope examination is based on measuring PWM signal controlling the valve and observing how does it change with engine speed.

5.14 Knock sensor

Measurement set-up:



Menu selection: DIAGNOSCOPE> KNOCK SENSOR > MEASURE

(If required adjust time base and gain value)

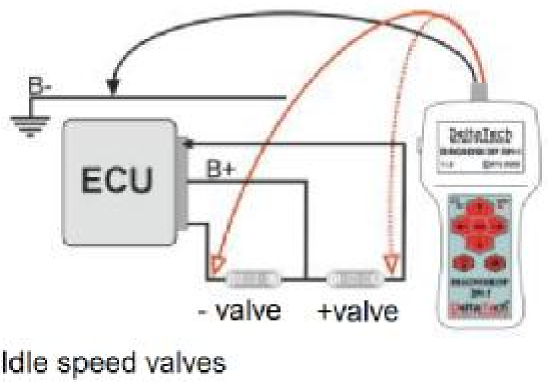
Nowadays many vehicle has so-called knock sensor. This sensor informs engine controller that air/fuel mixture explodes before time normal combustion process is intended to occur. This phenomenon occurs most often as a result of premature ignition. Best engine performance can be achieved when setting ignition timing near detonation limit.

ECU uses knock sensor to set a working point of engine just before detonation limit to achieve optimum performance. When knock sensor fails the controller switches to safe mode and sets spark advance timing too high to ensure proper combustion but this will lower engine performance.

Knock sensors are made as typical piezoelectric sensor that produces electric signal when exposed to shock and vibration. Diagnosis is relatively simple. Connect DM-1 diagnoscope as shown above and gently tap around the sensor. Chaotic waveform should appear as response to vibrations. No signal means faulty sensor. Signal presence does not guarantee sensor is fully operational as we do not know exactly what amplitude this sensor should produce.

5.15 Idle speed CTR

Measurement set-up:



Menu selection: DIAGNOSCOPE> IDLE SPEED CTR > MEASURE

(If required adjust time base and gain value)

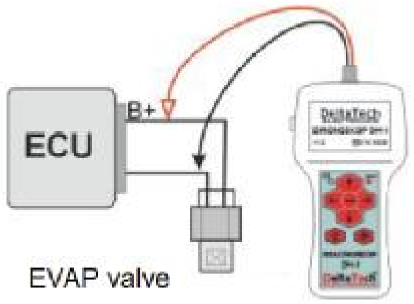
Vehicle engines operation take place under different conditions – they vary considerably every time the engine is starting. It is needed to control engine air supply. In older designs this is usually done by electrically driven vacuum systems. Two valves control little actuator that adjusts throttle position. Electric valve solenoids can be checked with multimeter, and operation with diagnoscope.

Different approach is to use small electric motor controlled by ECU to adjust throttle position. Some engines use special regulated electric valve controlling air supply.

When there is a problem in maintaining proper idle speed, use diagnoscope to check if control signal actually reaches actuating element, responsible for idle speed setting.

5.16 EVAP

Measurement set-up:



Menu selection: DIAGNOSCOPE > EVAP > MEASURE

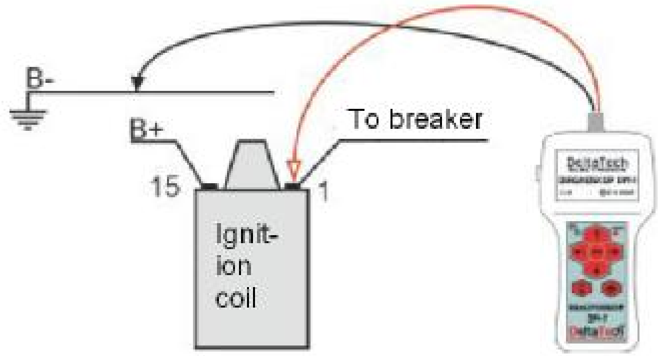
(If required adjust time base and gain value)

In the era of environmental awareness vehicle incorporate system to extract tank fuel vapors. Most often these vapors are sucked to inlet manifold through an active carbon filer. To ensure proper operation of the system a control valve is used. ECU opens and closes this valve at specific time to extract fuel vapors.

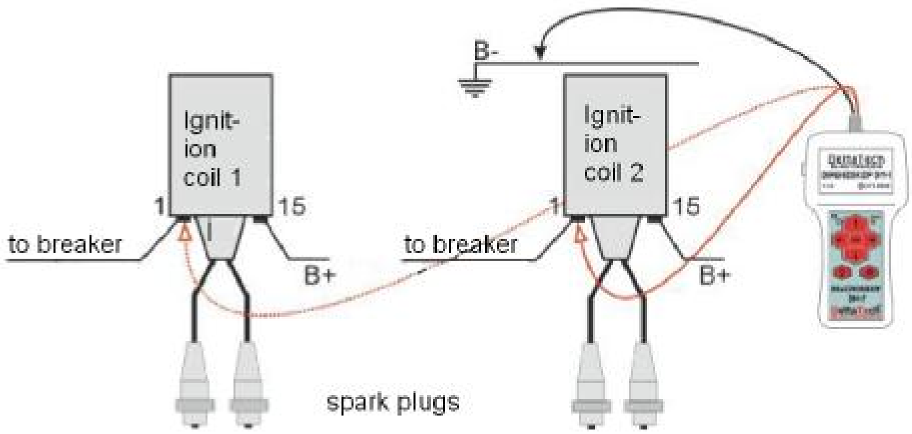
5.16 Ignition

Warning!!! When engine run unevenly or do not work after DM-1 is connected to primary circuit of ignition coil this means that there are voltages above 230V in primary circuit as a sign of high voltage breakdown.

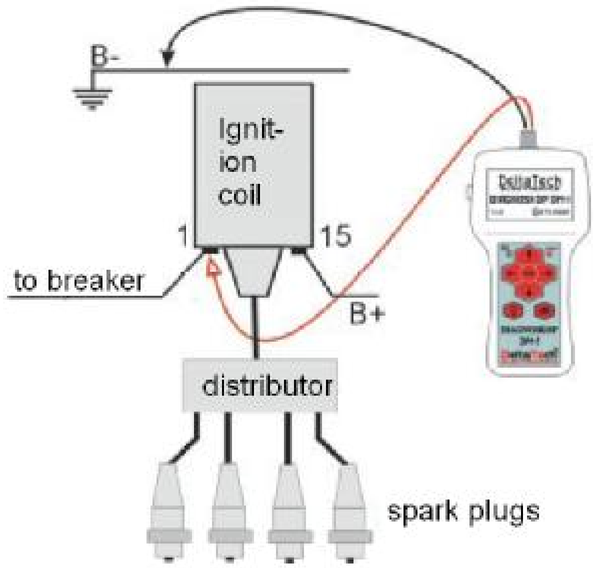
Measurement set-up:



(1) *Circuit with single spark per stroke*



(2) *Circuit without distributor with two sparks per stroke.*



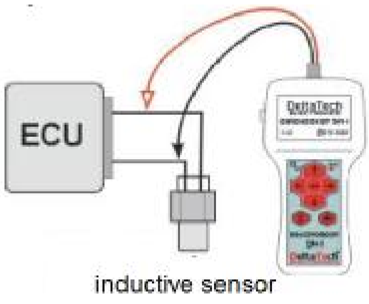
(3) *Traditional circuit with distributor.*

Menu selection: DIAGNOSCOPE > IGNITION > MEASURE

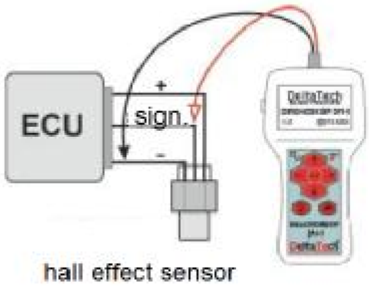
(If required adjust time base and gain value).

5.17 Distributor

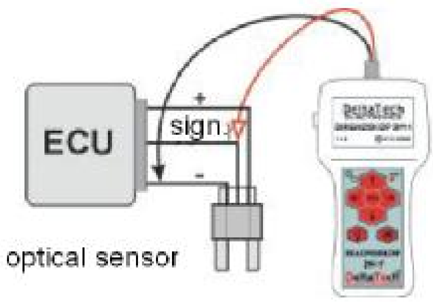
Measurement set-up:



(1)



(2)



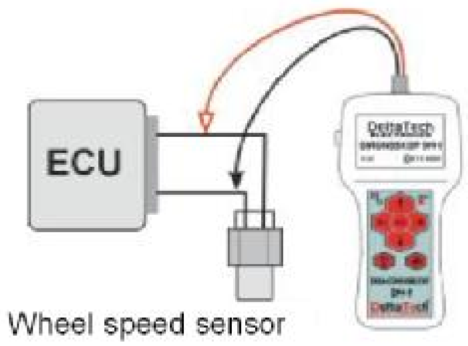
(3)

Menu selection: DIAGNOSCOPE > DISTRIBUTOR > MEASURE

(If required adjust time base and gain value).

5.18 ABS sensor

Measurement set-up:



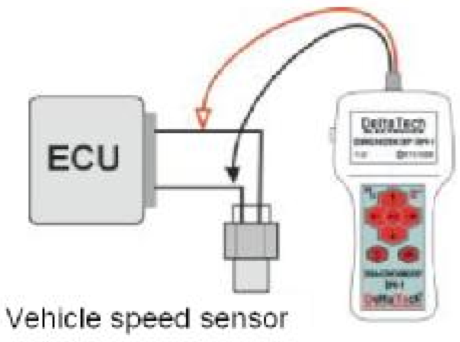
Menu selection: DIAGNOSCOPE > ABS SENSOR >MAGNETIC/HALL EFFECT> MEASURE

(If required adjust time base and gain value).

Most prone to damage part of ABS system is wheel speed sensor and its cable. Sensors mounted on front wheels fails more often than rear. To diagnose the sensors, disable the ignition, raise the vehicle using a lift, locate the sensor connector and unplug it. Then connect diagnoscope to sensor output according to diagram above. Most popular are magnetic sensors. Output should be sine wave, most important is that signal parameters should be equal for all wheels. To produce the output rotate the wheel. For easier comparison of four waveforms the user may want to use waveform storage option. If all signals are correct and fault codes persist to appear check sensor connections. The most reliable way is to connect probes directly to ECU connector.

5.19 Vehicle speed

Measurement set-up:



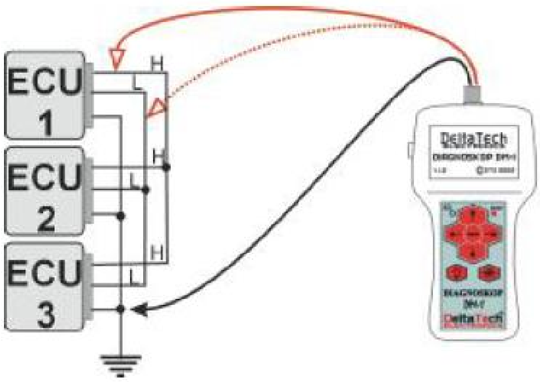
Menu selection: DIAGNOSCOPE > VEHICLE SPEED > MEASURE

(If required adjust time base and gain value).

Vehicle speed sensor is usually a typical inductive sensor located in gearbox. To diagnose it, connect to sensor with DM-1 and check if the signal output is sine wave with the frequency proportional to vehicle speed.

5.20 CAN/BUS

Measurement set-up:



Menu selection: DIAGNOSCOPE > CAN/BUS > MEASURE

(If required adjust time base and gain value).

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