DITEX

Automotive sensor simulator

Operating manual

AutoSim

Contents

Introduction

The automotive tester and simulator AutoSim is used for making diagnostics and test of the electronical automotive systems. The simulator imitates the signals coming from different sensors and ECM.

AutSim tester can be used in all automobiles with ECM either independently, or very often together with different types of auto diagnostic scanners. These scanners are connected directly to the ECU by means of diagnostic connector. Through their values the codes of the faults are recognized, as the sensors data, imitated at the same time by the simulator, are observed.

AutoSim simulator is mainly used for simulation of the signals generated by different types of sensors in case of some doubt about their accuracy and the entirety of the connecting wires.

Through simulation of the output signals from the sensors, the ECU response as well as its efficiency can be estimated.

Attention!

The automotive tester - simulator has built-in power supply protection against overhead power supply and negative power supply. A built-in electronical protection against output short-circuit to ground and to positive terminal supply is also available. The trigger pulse output is limited to 0.15 amperes maximum. In other words, this device is well protected against occasional damages. But in order to avoid troubles on the ECU input terminals or the sensors, the below listed requirements must be kept:

- **Never turn off the sensors or automotive connectors if the ignition switch is ON.** This can provoke short overhead power supplies in the electronical circuits and damage on the electronical components.

- **The grounding of the sensors output terminals or connector's terminals is not allowed. Do not connect the outputs each to other except if it is especially indicated in the service documentation.**

- **Erase the fault codes from ECU memory after having done the automobile repair.**

Technical specifications:

Power:	12V DC
Power supply range:	9V DC – 40V DC
Power consumption:	5W max
Output connector:	BNC output connector
Trigger pulse output:	0.15A
Dimensions:	176mm x 100mm x 30mm
Weight:	0.7 kg

Typical applications of AutoSim simulator

- **Simulates the output signals of the most automotive sensors,** such as ABS sensor, Crankshaft sensor, Camshaft sensor etc. AutoSim can generate output periodical rectangular shape AC signal as all the parameters of this signal will be changed: frequency, amplitude, duty cycle as a DC offset can be added also.

- **Simulates all the sensors which output signal is DC voltage.** On the output of AutoSim tester a DC voltage in the range of 0.2V to 12V can be generated. In the range of 0.2V to 5V the min. resolution of setting is 0.2V, in the range of 5V to 12V - 1V.

- **Simulates O2 sensor signal;**

- **Checks ECU inputs accuracy;**

- **Activates the actuators and mechanisms;**

- **Imitates the signals from the sensors at different working modes of the engine.** It is done by means of sensors real working conditions simulation without the sensors to be disassembled: ABS, CKP, CMP, Coolant, Lambda, MAP, MAF, VSS etc. During the sensor operation simulation, the ECU response is observed.   In this way the wiring entirely to ECU is checked. This test can be made in combination with a diagnostic scanner. The scanner must be set in the mode of following the real data coming from the sensors.

AutoSim

## Device appearance and buttons location

Operation of AutoSim simulator

The device doesn't have built-in supply unit. It is fed either by automobile battery, other outside battery or by DC adaptor. For this purpose, it is necessary the red crocodile clip of the supply cable to be connected to +12V, and the black crocodile clip - to chassis ground (negative supply).

As soon as the device is power supplied, its operation starts. The initial working mode is mode "Generator" as on the output a periodical AC signal with rectangular waveform is generated.

The modification of the main working mode, as well as the change in the parameters of generated variable periodical signal is made by means of 4 push buttons.
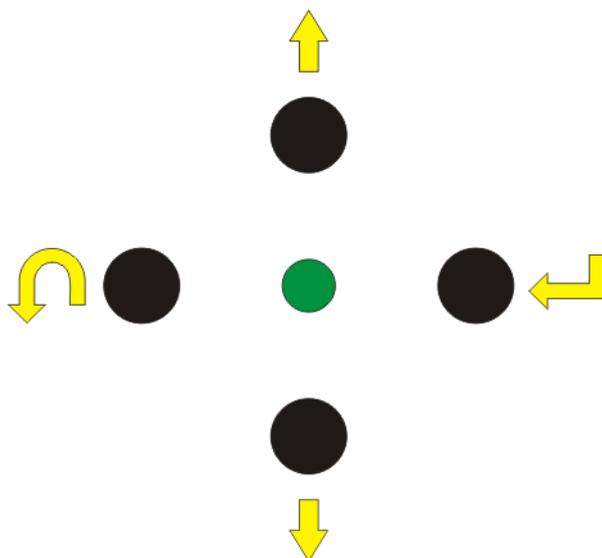
Use the arrows ↑ and ↓ to go through the menu and to change the value of the parameter already chosen.

Use the button ↵Enter to enter the submenu or to confirm the choice.

Use the button ↻ Esc to go back into the pervious menu. If after the choice of the parameter the button ↵Enter is not pushed, but only button ↻ Esc, the new value will be also kept.

The green holding button in the middle is used for interruption and start of the signal towards the output of the simulator.

Note, that during the change of some of the signal parameters (Frequency, Amplitude, Duty cycle, DC offset and DC magnitude) there is always a voltage on the output.

Moreover, the output signal changes together with the parameter modification and if it is required it can be controlled with oscilloscope or other measuring tool.

In case during the operation of the simulator the output signal should be interrupted, this can be done through the holding button located in the middle of the keyboard. The green LED of the device box indicates the active condition of this button. This LED will be switched on till the signal is available on the output, if this LED is not lightened - that means the signal is interrupted.

The blinking of the red LED on the device box indicates that the device is power supplied and the microprocessor of the device is in order.

As soon as the work is over and the supply of AutoSim simulator tester is turn off, all the settings, previously done are lost. There is no possibility the tester to remember the settings. At second turn on of the device, the adjustments as per its internal program are activated.

Working modes

1. Periodical signal generation

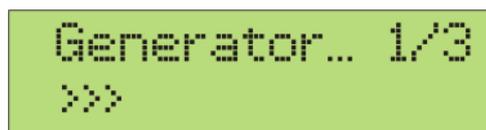|	
Waveform	Rectangular
Frequency	0.1Hz ~ 10000Hz
Output amplitude	0.2V ~ 12V
Duty cycle	10% ~ 90%
DC offset	0.2V ~ 5V
Trigger pulse output	150mA

```
Generator… 1/3
>>>
```

Fig.1 Mode Generator – Main screen

```
>Freq=1000Hz 1/2
 Ampl= 6.0V
```

Fig.2 Mode Generator – Frequency adjustment

```
 Freq= 600Hz 1/2
>Ampl= 5.0V
```

Fig.3 Mode Generator – Amplitude adjustment

```
>Duty=50%     2/2
 Offset=0.0V
```

Fig.4 Mode Generator – Duty cycle adjustment

```
 Duty=50%     2/2
>Offset=0.8V
```

Fig.5 Mode Generator – DC offset adjustment

2. DC source

Output range	0 ~ 12V
Adjustment resolution	0.2V
Max output current	150mA

```
 DC Output   2/3
>U= 5.0V
```

Fig.6 DC source – Main screen

In mode DC source there is no additional screen for settings. When this mode is chosen, the cursor for adjustment implicitly is located on the row, showing the input magnitude. Through buttons ▲ and ▼ the required output voltage is set.

3. Lambda Sensor Zirconia simulator

Output signal   vary between 0.2V and 0.8V

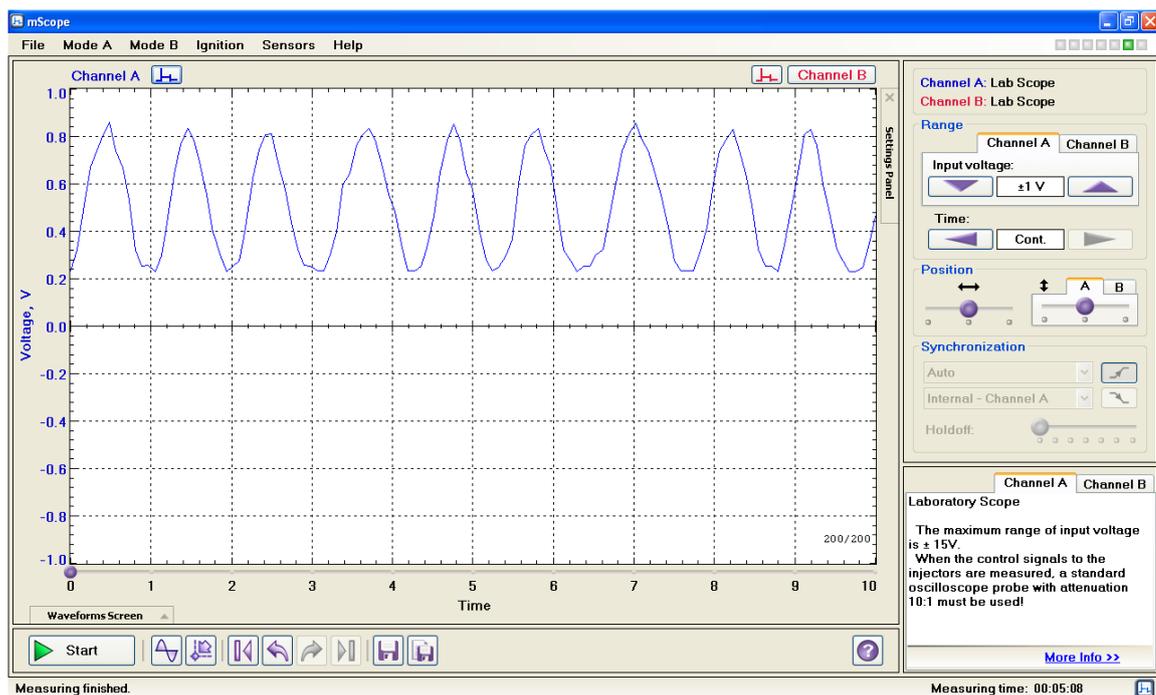I output max   150mA

Fig.7 O2 Sensor Zirconia

Fig.8 Output Waveform of Oxygen Sensor Zirconia

4. Lambda Sensor Titania simulator

Output signal   vary between 0.5V and 4V

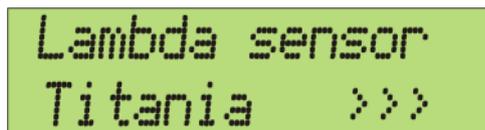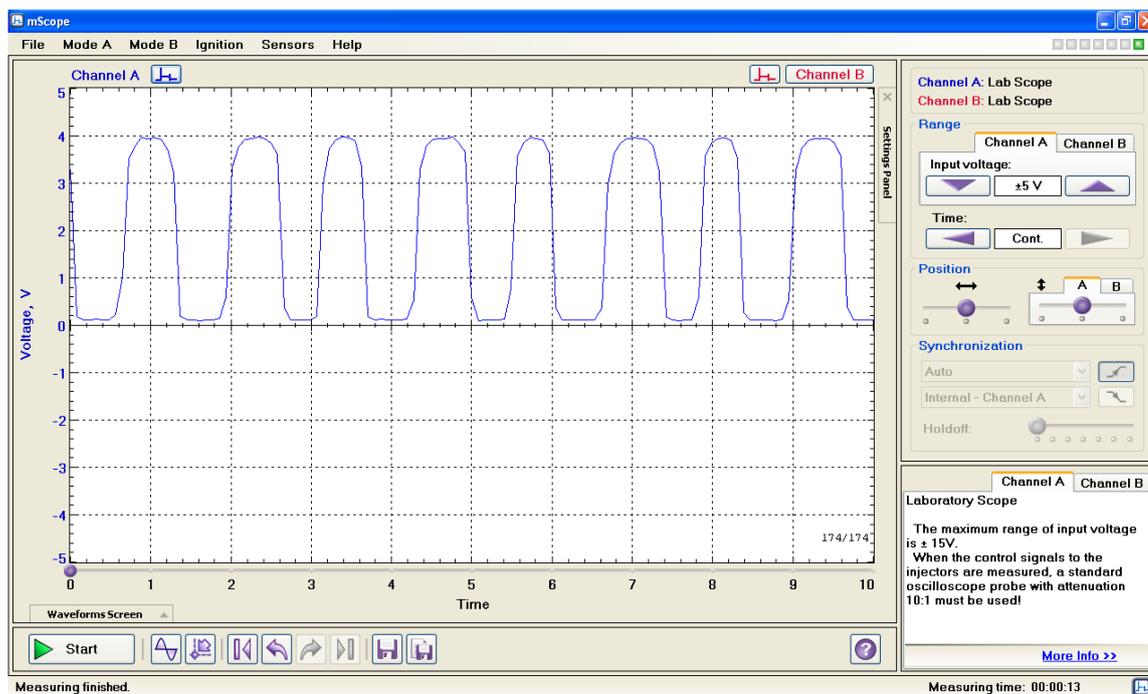I output max   150mA
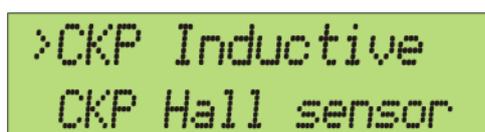

Fig.9 O2 Sensor Titania

Fig.10 Output Waveform of Oxygen Sensor Titania

5. CKP Inductive and CKP Hall sensors simulator

In modes CKP Inductive and CKP Hall the cursor is located against the selected type sensor. At this mode there is an additional screen for adjusting required number of the active teeth and required number of the missing teeth. The adjustment menu of the teeth is accessed by pressing the ↵ **Enter** button, when the cursor is located against the selected type sensor.

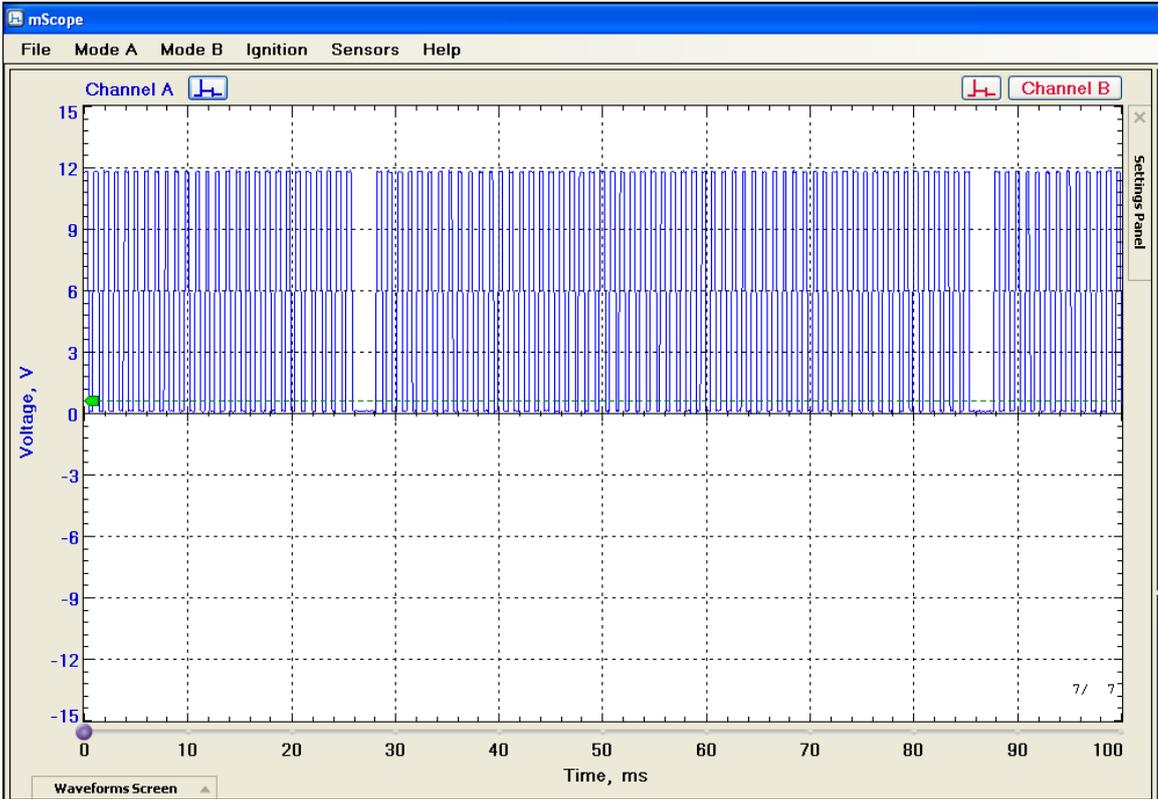Fig.11 CKP Setup Menu – Adjust the number of teeth

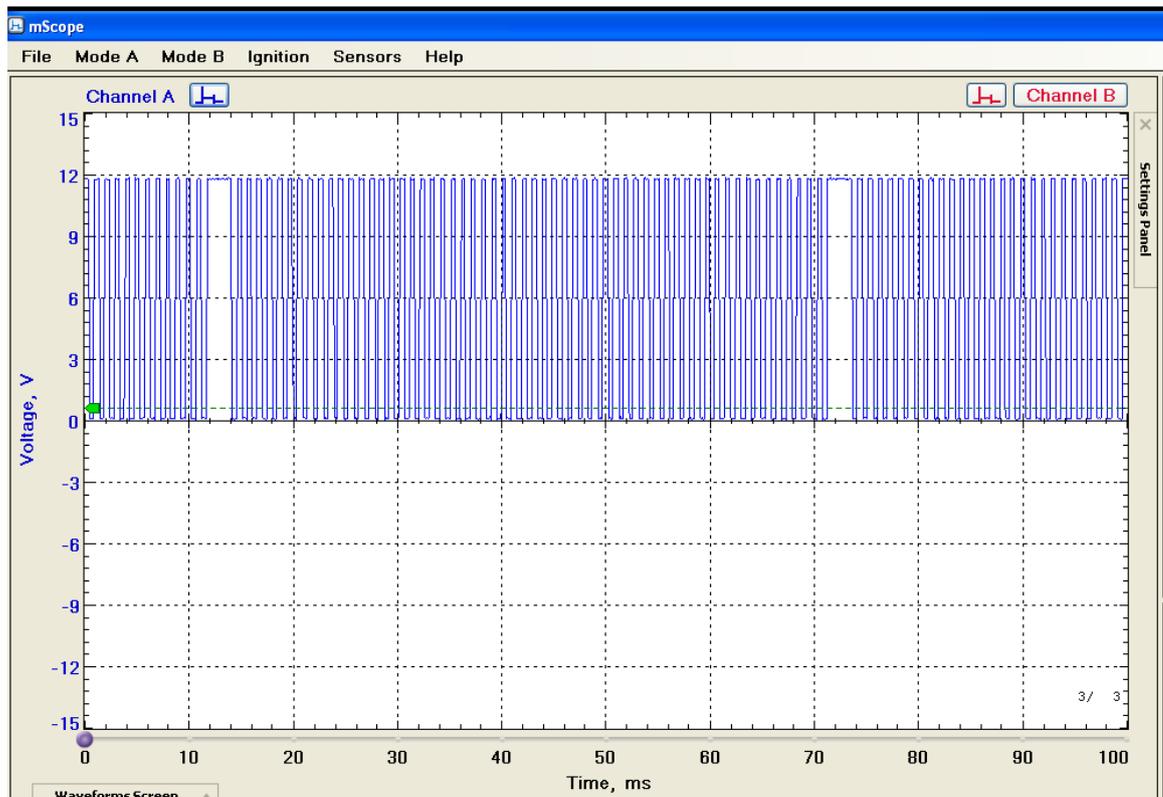Fig.12 Output Waveform of CKP Inductive Sensor

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Fig.13 Output Waveform of CKP Hall Sensor

Definition of terms

Freq (Frequency)

Frequency is a measurement of the numbers of repetition of electrical signal period for 1 sec. Usually the frequency is marked with F as the measurement unit is Hertz (Hz). Frequency of 1 Hz means, that the event occurs once per second.

In the practice the device used for frequency measurement is the oscilloscope. It measures the period and not the frequency directly.
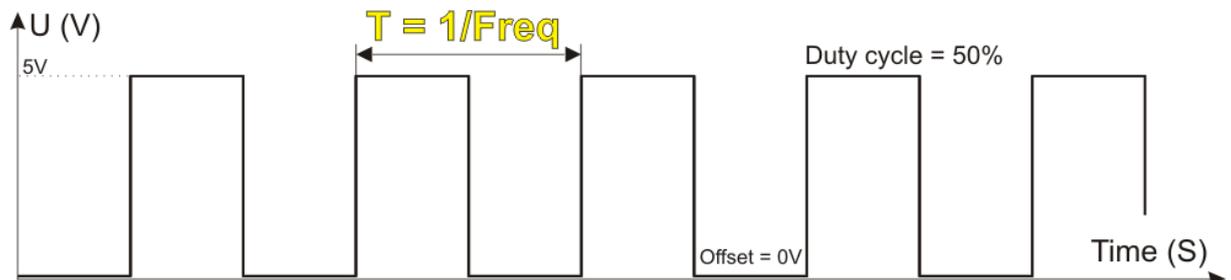
Interval of time in which some event repeats is called period. In the SI system the period is marked with T and it is measured in seconds [s]. The period T is inversely proportional to the frequency and the formula for calculation is T = 1 / f.
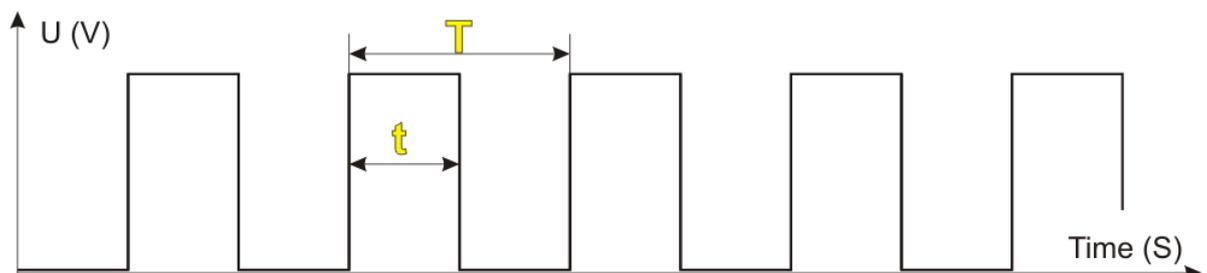
Ampl (Amplitude)

Amplitude measures the magnitude of electrical oscillations. The output signal of AutoSim simulator is a voltage and it is measured in Volt.
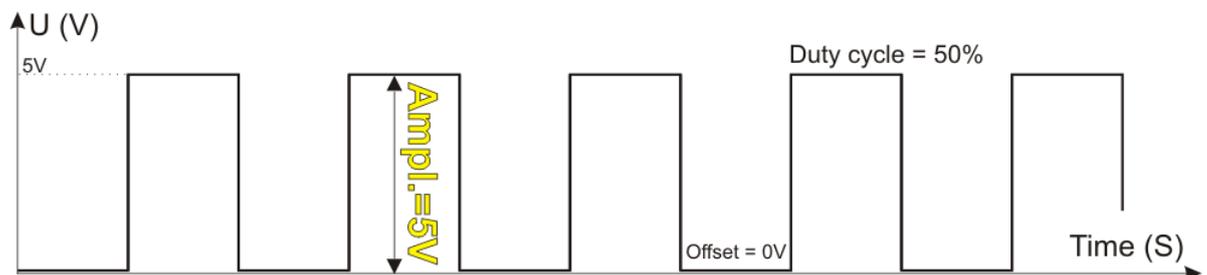

Duty (Duty cycle)

Duty cycle specifies the duration of the period in which the signal is active. Usually the active condition of impulses series is the one in which the signal is with maximum amplitude.

Duty cycle = t / T, when t is the half of the entire period Duty cycle=0.5 (50%). This case is shown on the figure above. The Duty cycle equal to 50% is the most common case in the practice when the signals from different sensors are simulated.

Some other examples of Duty cycle of periodical signal are shown below:

Duty cycle = 20%   Duty cycle = 80%
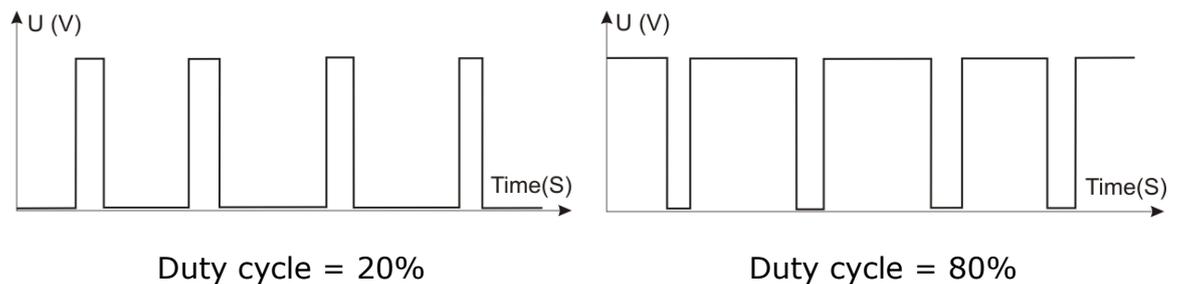
Offset (DC offset)

Positive DC offset of variable electrical signal towards OV.
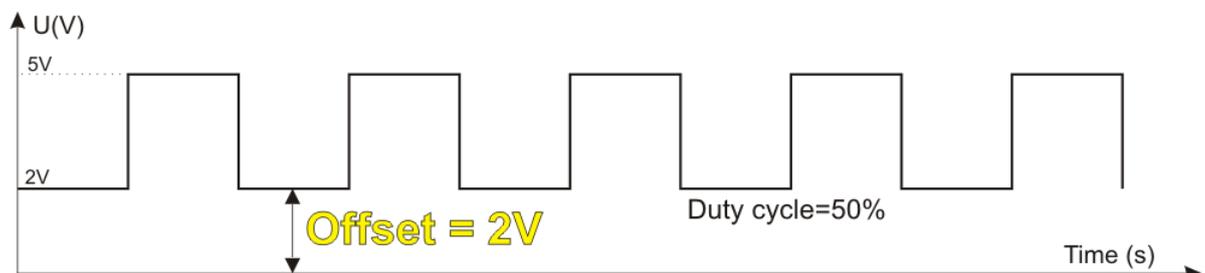
During the simulation of the signal from O2 sensor it is necessary DC offset to be used.

What types of sensors exist?

Resistance type sensors - Very often they are called 2-wired sensors, because they are connected to the ECU through a couple of wires. These types of sensors are all the sensors used for temperature measurement: cooling liquid temperature, intake collector air temperature, environmental air temperature etc. These sensors can be simulated with an automotive resistance substitution box.

Sensors with output signal voltage.

There are two types:

● Position pick-up sensors. Very often these are resistor sensors based on potentiometer. The potentiometer sensors are also called 3-wired, because they are connected to the ECU through 3 wires: supply wire (usually 5V), signal wire (the middle point of potentiometer) and ground wire. Such types of sensors are the sensor for positioning of the throttle valve, position sensor of the accelerator gas pedal, some of the old version MAF sensors etc.

● Pressure sensors. Usually they are supplied by ECU with voltage of 5V. The output voltage varies from 0V to 5V. Very often there is a correspondence between the lower pressure and lower input voltage of the sensor. At normal working conditions and idle mode, the output signal of such sensor is in the middle of the range (app. 2.5V).
All types of sensors which output signal is voltage can be simulated through supplying a DC from the AutoSim simulator.

O_2 **sensor -** The output signal of O2 sensor is a variable voltage with positive offset towards OV. It operates by measuring the oxygen quantity difference in the exhaust gas and the external air, and generates a voltage or changes its resistance depending on the difference between the both quantities. As smaller as this quantity is, as bigger the voltage on the output of O2 sensor will be. The alteration range of the sensor output voltage is from 0.1V to 1.0V. O_2 sensor can be designed with 1, 2, 3 or 4 wires for connection to ECU. The number of the wires depends on the type of the O2 sensor i.e. if it has its own heating or not.

By means of AutoSim the signal of all types O2 sensors can be simulated. Use the mode Generator with appropriate frequency adjustment (0.5Hz-2Hz), amplitude (0.2V-0.5V), Duty cycle (50%) and DC offset (0.3V-0.8V).

Sensors with frequency-modulated output signal. This
type is common for all up-to-date automobiles, such as Hall sensors, Crankshaft sensors, Camshaft sensors etc. At some automotive models - MAF, MAP и BARO the sensors can be with frequency-modulated output signal. The frequency range of all these sensors is between 0.5 Hz and 5000 Hz. The most common Duty cycle of impulses range is 50%.

How the simulation of sensor signal is done?

○ The ignition is switch off.

○ Disconnect the sensor from ECU's circuit.

○ AutoSim simulator is adjusted to imitate the required signal type.

○ The output test leads of the AutoSim simulator should be connected to the ground (black wire) and the red wire is connected to the correspondent terminal of the sensor. For the purpose, please refer the electrical scheme of the automobile in order to be sure for the correct connection.

○ A diagnostic scanner and / or other type of diagnostic device is connected in order to control the system operation.

○ Ignition switch is ON and an analysis of the engine operation is held.

○ When the AutoSim signal is present to the ECU input, if there is no change in the fault symptom, the most probable reasons for the defect are the following: sensor's wires are not connected properly to the ECU, ECU's inputs are damaged, defected driving module (actuator, solenoid or other driving unit). In such case a multimeter must be used in order to check the interrupted electrical circuit, short circuit between some wires, short to the ground or to the positive supply.

○ If after the checking procedure the electrical circuit and ECU inputs, as well as the different driving modules are in normal operational condition, the defect is probably in the sensor and it has to be replaced.

How the working mode of the engine can be changed?

The engine working mode can be changed through simulation of some sensors` signals (for example the "closed-loop mode" to be changed to "open-loop mode" and back). For the purpose, the ECU must be "deceived" in order to consider the engine as not working (cold). It is done by imitating a

convenient signal from the Coolant Temperature Sensor, so the ECU will change its working mode from mode of closed-loop to mode open-loop.

Other examples:

- The composition of the fuel mixture can be modified as the signal coming from the Throttle Position Sensor is changed (the duration of the impulses to the injectors are modified).

- Changing the sensor signal for barometric atmosphere pressure, the fuel mixture composition can be modified as well as the "advanced spark time before top dead center" (BTDC) and thus "high above sea-level" and "normal sea-level" modes are imitated.

 - The composition of fuel mixture can be modified though change of signal from O2 sensor. In this case the ECU will modify the period when the injectors are open.

- Changing the absolute pressure sensor signal in the input collector, the time that a spark will occur in the combustion chamber before top dead center can be modified and the fuel mixture composition also.

Attention: During the simulation of the operation of different types of sensors in the ECU can be registered digital trouble codes. In order to avoid it, do not forget to erase all the fault codes from ECU memory.

Standard package list:

AutoSim Main Unit	1 piece
AutoSim Main Signal Cable	1 piece
Power Cable - 2.5mm DC Plug to Crocodile Clips	1 piece