10. SPECIFICATION

Ohms Low:	150 Ohms to 1K Ohms, Linear.
Ohms High:	1K Ohms to 100K Ohms Linear
Volts High:	0 to 5 Volts DC linear, 5% line resistance min 1k Ohm
5V power supply:	5V regulated 5%, 100mA max, with automatic overload thermal shutdown.
Volts Low:	0 to 1 volt DC linear, 5% line resistance min 10K Ohm
Frequency High:	0 to 2000 Hz, square wave, amplitude 0-5V line resistance:
Frequency Low:	0 to 200 Hz, square wave, amplitude 0-5V Line resistance:

(THIS PRODUCT REQUIRES A PP3 (9V) BATTERY (NOT SUPPLIED)

WARRANTY

Gunson have made every effort to ensure that this product is of the highest quality and value to the customer. However, Gunson accept no responsibility for any loss or damage arising from the use of this product.

All technical enquiries regarding this product should be accompanied by a stamped self-addressed envelope. Telephone enquiries may be made on the Gunson Helpline 0181-592 1967. Please note that Gunson can not provide technical advice or information on motor cars.

If this product should require service or repair, it should be returned to Gunson Ltd (Service Dept), Coppen Road, Dagenham, Essex RM8 1NU.

Postage may be refunded (UK only) and repairs will be completed free of charge for manufacturing defects within one year of purchase.

This Warranty does not affect the Statutory Rights of the user.

Defects due to other than manufacturing faults may be charged for.

When sending goods for service or repair, please give full details of faults requiring attention.

Gunson's

SENSOR SIMULATOR

PART NO 4130

HANDBOOK

INCLUDING TECHNICAL INFORMATION ON SENSORS AND METHODS OF TESTING

GUNSON LTD ● COPPEN ROAD ● DAGENHAM ● ESSEX ● RM8 1NU

- Take care to avoid placing metal tools where they may cause an electrical short, such as near the car battery.
- Take care not to place tools etc where they may be dislodged by engine vibration.
- Treat High Tension components with respect, remembering that electrical shocks can cause involuntary movement which may result in secondary injury. Remember that sparks can jump quite a distance. Also remember that severe unexpected HT shocks can be received from old, worn, damaged or wet components (eg HT leads, coil, distributor).
- Keep Sensor Simulator away from HT voltages, such as spark plug leads.
- Take care not to inhale exhaust gas. Never run the engine inside a garage or in a confined space. When running the engine, always ensure that there is adequate circulation of fresh air. Ensure that there are no leaks in the exhaust system near where you are working.
- When carrying out tests on a motor vehicle, remember NEVER run the engine with the car battery disconnected (either + or -) since the alternator would then run at a damaging over-voltage.
- Keep children and pets away from the car while work is being carried out.

9. GENERAL WARNING

This equipment has been designed to operate in the harsh environment close to spark ignition engines but the user should be aware of the following:

1. Spark ignition engines and related electronics can emit high levels of interference which could effect test and maintenance equipment together with other electrical items such as radio or television receivers, computers etc.

2. Any interference emitted from the engine area could be increased by:
(a) Opening the engine cover.
(b) Making an electrical connections to the vehicle wiring loom or the vehicle battery.
(c) Any faulty components particularly if those associated with the ignition system.

3. If this equipment has any display which behaves in an erratic nature the user is advised to refer to the advice given in the detailed instructions to minimise the possibility of interference. In cases of difficulty the user is advised to check for the following.
(a) A faulty vehicle battery or poor connections to it.
(b) Poor ground connection to engine or other electrical equipment
(c) Faulty ignition components particularly rotor arms, ignition coils or HT leads with an internal break or with a resistance outside vehicle manufacturers limits.

The user is therefore advised, due to the potential emitting of interference, that vehicle maintenance and testing should be undertaken with due care and not in an area close to sensitive electronic equipment.

1. INTRODUCTION

A sensor is a device which measures an environmental variable, such as air temperature, coolant water temperature, throttle position, engine speed, inlet mass air flow etc, and feeds this information into the vehicle's engine control computer (often called an ECU, or MAP system), so that the engine computer can correctly set the operating condition of the engine, such as the amount of petrol to inject into the cylinders, and the degrees of advance to apply to the ignition spark.

Modern vehicles require and utilise many sensors (eg refer to section 7), and if any sensor is faulty, then the engine will not operate correctly, and may not even operate at all. Any faulty sensor which affects emissions may cause damage to a catalytic convertor.

A faulty sensor may be indicated by the engine computer via a "fault code reader", or the user may suspect that a sensor is faulty himself, because of incorrect engine operation (ie over-rich or over-lean running, misfiring, difficult starting, failure to idle at cold, etc.

One way of testing a faulty sensor in a car is to substitute a new sensor and see if that cures the fault. In other cases a suspect sensor may be removed and tested. These procedures can be expensive and/or involve a lot of effort. This cost and effort can be avoided in some cases by the use of a Sensor Simulator. Gunson's Sensor Simulator can be substituted for a faulty sensor, and if the fault appears to be cured when the simulator is set at the correct value, or operated in a way that a correct sensor would be expected to work, then a faulty sensor is indicated or confirmed.

Most sensors provide as output a resistance, a voltage, or a frequency signal, and Gunson's Sensor Simulator can be used to simulate most of these types of sensor. Such sensors include various types, eg coolant temperature sensor (CTS), throttle position sensor (TPS), exhaust oxygen sensor (lambda sensor), manifold air temperature (MAT), outside air temperature (OAT), manifold absolute pressure (MAP), barometric pressure, mass air flow (MAF), knock (pre-ignition), ABS wheel speed, oil temperature, oil level, fuel tank level, engine RPM, and more.

This product is intended to complement, rather than replace, other methods and tools for identifying faulty sensors. For instance, it can be used in conjunction with a fault code reader (eg Gunson's Fault Code Reader), to see if a persistently occurring fault code could be eliminated by a replacement of a particular sensor, and what value of simulation would cause the fault to be eliminated. It can also be used as an alternative to an electrical test meter (eg Gunson's Autoranger, Testune, Digimeter, or Multitest), where the use of a test meter is impractical. It can be used in conjunction with an injector pulsewidth meter (eg Gunson's Pulsewidth Meter), to observe the effect of changing the value of a sensor output on injector pulsewidth duration, or with an emmissions tester, (eg Gunson's Gastester, and Lambda System Tester) to see the effect on exhaust emissions. It could be used with a timing light to observe any sensor that is used to vary ignition timing.

Not all these applications are possible with all cars, since a feature of modern motor car design is the proliferation of many different technical features. In some cars, the effect of a lambda sensor in the exhaust is to over-rule and mask any effect a faulty sensor may otherwise have on injector pulsewith (ie "closed loop" operation). (Note: Lambda sensors can be tested with Gunson's Lambda System Tester). In most such cars the lambda sensor may be disconnected, at least for a brief time, in order to see the true effect of the sensor

This voltage changes as the air flow is varied. The airflow can be varied by varying the engine speed.

Test the output of the airflow meter with the ignition on, at idle, at 1500 RPM, at 3000 RPM and during a rapid acceleration and compare to the typical values below:

Ignition on	0.25v-0.5v
Idle	0.5v-1.5v
1500 RPM	0.7v-2v
3000 RPM	1.1v-3v
rapid Acceleration	3v-4.5v

Typical Air Flow sensor output

Some systems produce a fall in the output voltage relative to an increase in air flow.

A sensor simulator can be used to provide a voltage to the ECU to simulate the output of the airflow sensor and positively diagnose a faulty airflow meter.

8. **<u>PETROL TEMPERATURE SENSOR:</u>** This measures the fuel temperature in the fuel manifold/pipe. If the temperature exceeds 90°C the ECU will richen the mixture by increasing the injection duration, as fuel evaporation is likely above 90°C.

9. **<u>LAMBDA OR OXYGEN SENSOR</u>**: This sensor is positioned in the exhaust system. It provides a voltage signal to the ECU which is used to vary the injection duration to maintain an air/fuel ratio of 14 parts air to 1 part of fuel.

A Lambda sensor tester (such as Gunson's Lambda System Tester) is required to test the operation of this sensor.

On vehicles with a catalytic converter the Lambda sensor is essential as the sensor enables the ECU to maintain an oxygen content of about 2% in the exhaust. The catalytic converter requires the 2% of oxygen to perform its function.

The Sensor Simulator (set to 0 - 1V range) may be used as a substitute for a suspect Lambda Sensor, to check for correct ECU response

to 100K Ohms

ADJUST OTHER RANGES. Controls the level of the simulations Volts High, Volts Low, Frequency High, Frequency Low and Ohms Low, as set by the FUNCTION KNOB. The level of the simulation is increased by turning the knob clockwise, with the approximate level shown on the scale indications. For a more accurate setting or measurement of the set values (Volts, Frequency or Ohms), use Gunson's Digimeter in conjunction with the Sensor Simulator.

OUTPUT LEADS. The simulated electrical setting/signal will appear at the output leads.

WIRE PIERCING CONNECTOR. This is used to pierce leads in the circuit being tested, the crocodile clip is then connected to the screw head. Only minor marking of the insulation is caused and this is not a problem with low voltage wiring. Piercing the insulation can be avoided by using the terminal probe.

TERMINAL PROBE. A long thin probe is included in the kit. This is used to make a connection with a terminal by insertion in a plug or socket connector alongside the lead. Take care to avoid injury from the sharp point.

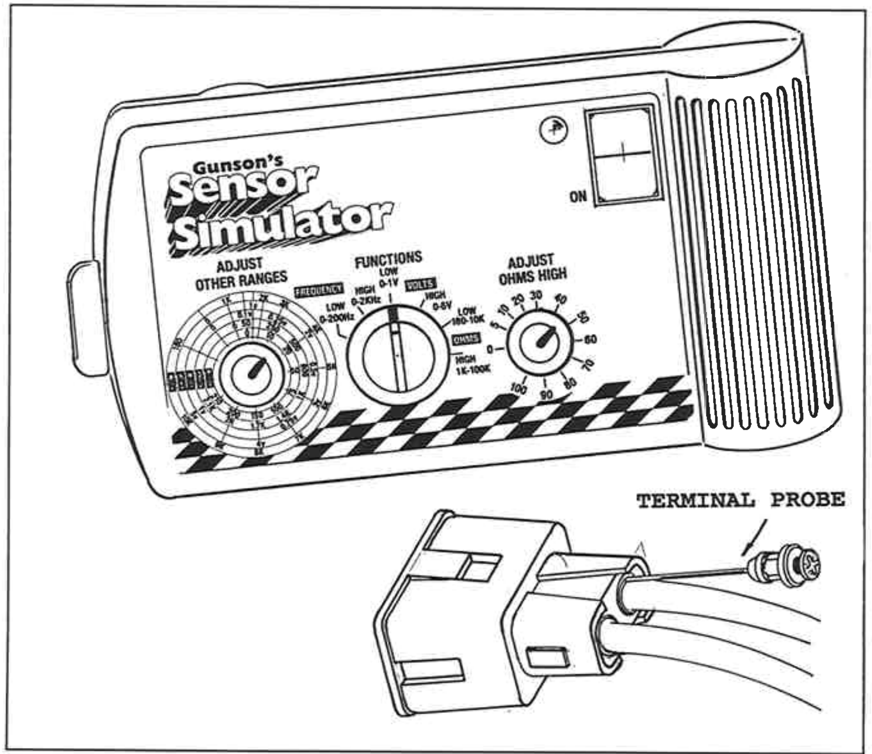


Figure 1

A sensor simulator that can simulate resistance (such as Gunson's Sensor Simulator), can be used to simulate the resistance value of the sensor and positively identify a defective sensor.

3. **AIR TEMPERATURE SENSOR**: This may be tested by connecting an ohms meter across the sensor and checking against the typical values given below:

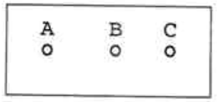
	Most systems	Exceptions	
Cold	5k	500R	@ 0°C
Warm	2k5	200R	@ 20°C

Typical Air Temperature Sensor Resistance

Exceptions - KE,L,LE2 and LE3 Jetronic Lucas P Digital

The sensor is intended for fine-tuning the petrol/air mixture. Therefore dynamic tests while observing the injection duration are inconclusive. The use of a sensor simulator to simulate extreme temperature variations is useful to show the injection duration can be affected by air temperature and therefore that the circuit is fully operational.

4. **THROTTLE SWITCH**: This is a switch which connects two terminals at idle (or closed throttle), and connect two other terminals when the throttle is open.



At idle A+B

Open throttle B+C

Typical throttle position switch

Therefore to test a throttle switch, connect an ohms meter across A + B. If the throttle is closed then there should be 0 ohms across A+B. With the throttle open, the reading should be open circuit or infinity. Connect the ohms meter across B + C. Vary the throttle positions and the opposite should be true.

Typical throttle switch resistance

Throttle closed A+B 0 ohms
Throttle open A+B infinity
Throttle closed B+C infinity
Throttle open B+C 0 ohms

5. **THROTTLE POTENTIOMETER**. This is variable resistor with a reference voltage supplied to the resistor. As the throttle position changes the voltage on the output of the potentiometer varies. This voltage informs the ECU of the exact position of the throttle. In some cases the ECU measures the rate of change of throttle position, and so a "clean" potentiometer track can be very important.

Note that the Sensor Simulator can not simulate a resistance as low as zero ohms, on either range. This limitation is intentional, and is to provide a degree of protection to the instrument should the user inadvertently connect the simulator to a high power source, such as a connector which leads to the battery plus terminal. In general, resistive sensors do not have a resistance which can be zero, and so this protection device does not impose a limitation on the use of the product.

Further information is given in Section 7 on some common resistance-based sensors.

5. VOLTAGE SIMULATION

The Sensor Simulator has 2 voltage ranges, VOLTS HIGH and VOLTS LOW, and it is necessary to consult the vehicle/sensor specifications to determine the voltage level of the sensor that it is required to simulate. If the maximum possible voltage of the sensor is above 1 Volt but less than 5 Volts, then set the Function switch to VOLTS HIGH. If the maximum possible voltage is less than 1 V, then set the central Function Switch to VOLTS LOW.

The voltage level is controlled by the knob to the left labelled ADJUST OTHER RANGES. Note that this knob indicates on a scale the approximate voltage that is set. This setting can be confirmed, or set more precisely, by the use of a good voltmeter such as Gunson's DIGIMETER.

Disconnect the leads from the sensor, and connect the Sensor Simulator in its place. Note that where the socket that connects to the sensor has 2 pins, then the Sensor Simulator is connected with a lead to each pin. In difficult cases it may be necessary to pierce the cable using the enclosed piercing connectors, or use the side connectors. For Voltage simulation, it is important to have correct polarity, the RED lead of the Simulator being connected to the positive (+) pin, and the BLACK lead of the Simulator to the negative (-) or earth pin.

Switch the Sensor Simulator ON at the ON/OFF switch.

Observe from the operation of the vehicle whether the fault has been cured by substituting the Sensor Simulator for the sensor.

Further information on some voltage based sensors is included in Section 7 of this handbook.

5.1 5 VOLT POWER SUPPLY

An extra feature of the Sensor Simulator is that it can be used as a regulated power supply for systems that require a 5 volt supply, which applies to various systems on modern vehicles. For instance, three pin resistive sensors, such as petrol tank level gauges, are often supplied with a 5V power supply.

To use the Sensor Simulator as a 5V power supply, set the main FUNCTION SWITCH to VOLTS HIGH, and rotate the left level control knob, labelled ADJUST OTHER RANGES, fully clockwise, where it will indicate 5V on the VOLTS HIGH scale.

When the Sensor Simulator is switched ON, the output leads will carry 5V.

This power supply can provide up to 100mA at 5V. The source resistance is 180 Ohms. This source is protected against overload by current limiting to 100mA, and by automatic thermal shutdown.

Clearly, care should be taken in the use of this feature, and the user should not connect the leads of the instrument to any circuits that might be damaged by 5V.

This power supply feature is provided only at 5V, ie with the ADJUST knob rotated fully clockwise. At other voltage settings the source resistance is considerably greater than 180 Ohms.

6. FREQUENCY SIMULATION

The Sensor Simulator has 2 frequency ranges, 0 to 200 Hz and 0 to 2000 Hz, as set by the central FUNCTION SWITCH. In either case the waveform is a square wave, amplitude 5V, with a source resistance of 10 KOhms. It is necessary to consult the vehicle/sensor specifications to determine the frequency of the sensor that it is required to simulate. The actual frequency is set by adjusting the knob to the left labelled ADJUST OTHER RANGES.

Note that this knob indicates on a scale the approximate frequency that is set. This setting can be confirmed, or set more precisely, by the use of a good frequency meter such as Gunson's DIGIMETER.

With the engine off, disconnect the leads from the sensor, and connect the Sensor Simulator in its place. Note that where the socket that connects to the sensor has 2 pins, then the Sensor Simulator is connected with a lead to each pin. For Frequency Simulation it is important to have correct polarity, the RED lead of the Simulator carries the frequency signal, the BLACK lead being earth. Note that, as with other applications of this product, in difficult cases it may be necessary to pierce the cable using the enclosed piercing or use the side connectors.

Switch the Sensor Simulator ON at the ON/OFF switch.

Observe from the operation of the vehicle whether the fault has been cured by substituting the Sensor Simulator for the sensor.

7. SENSORS AND METHODS OF TESTING

1. **VANE AIR FLOW METER** This is positioned in the airstream and is opened by the flow of the air intake. The greater the airflow, the more the flap/plate opens. The flap/plate is connected a potentiometer that will produce a voltage reading proportional to the position of the flap/plate.

To test a Vane Air Flow Meter, probe the airflow meter connector with a voltage meter until the sensor output is identified. The output will be a voltage of 0.5v to 4.5v, or 4.5v to 9v. The reading changes as the air flow is varied. The airflow can be varied by varying the engine speed.

Test the output of the airflow meter with the ignition on, at idle, at 1500 RPM, at 3000 RPM, and during a rapid acceleration, and compare to typical values given below:

Ignition on	0.25v-0.5v	3.5v
Idle	0.5v-1.5v	4.5v-5.0v
1500 RPM	0.7v-2v	5.0v-5.5v
3000 RPM	1.1v-3v	6-7v
Rapid Acceleration	3v-4.5v	>8v

Typical Air Flow sensor output

Most systems give an increase in voltage with air flow rate, but some systems give a fall in voltage.

Gradually increase engine speed from idle to 3000 RPM, observing the voltage change. If the voltage becomes 0v or 5v at any point, repeat the test. If the same result is obtained, the resistive track of the airflow meter is damaged. If the voltage stays at a particular value as the engine speed changes it indicates a sticking flap/plate.

2. **COOLANT TEMPERATURE SENSOR:** This should be tested by an ohms meter when the engine is cold, and also when warm (with any connections to the sensor disconnected). The results should be checked against manufacturer's specifications, or typical values as given below:

	Most systems	Exception	
Cold	3-5k	50k	@ 15°C
Warm	300-400R	3.5k	@ 80°C

Typical Coolant Temperature Sensor Resistance

Exceptions - KE Jetronic, EEC1V.

3. BEFORE USE

Before use, fit a battery, 9v PP3 type. Access to the battery compartment is achieved by unscrewing the 4 screws on the back of the case. Note that the battery is only required for Volts and Frequency simulation.

The ON/OFF switch need only be switched ON for Volts and Frequency simulation. For OHMS simulation, the switch may be left in the OFF position.

Before simulating a sensor, it is necessary to ascertain the type of sensor, whether it is resistive, voltage or frequency, and what the expected value is. Information on common sensors is included in Section 7 of this handbook, and the vehicle workshop manual may also be consulted.

Connection with the terminals of the sensor is made by means of the connectors on the leads of the Sensor Simulator. These connectors will be found adequate for many types of sensor. However, in difficult cases it may be necessary to pierce the cable using the cable piercing connectors, or use the side connectors to slide into a plug or socket alongside the cable. (These adaptors are includes with the Kit, see section 2)

4. RESISTANCE SIMULATION

The Sensor Simulator has 2 resistance ranges, OHMS HIGH and OHMS LOW, and it is necessary to consult the vehicle/sensor specifications to determine the resistance level of the sensor that it is required to simulate. If the maximum possible resistance of the sensor is above 1000 Ohms, but less than 100 KOhms, then set the Function switch to OHMS HIGH. If the maximum possible resistance is less than 1000 Ohms, then set the central Function Switch to OHMS LOW.

Note that if the FUNCTION SWITCH is set to OHMS HIGH, then the Ohms level is controlled by the knob to the right labelled "ADJUST OHMS HIGH". If the FUNCTION SWITCH is set to OHMS LOW then the Ohms level is controlled by the knob to the left labelled ADJUST OTHER RANGES.

Set the appropriate LEVEL knob to the correct resistance that the sensor should have. Note that each ADJUST LEVEL knob has a corresponding scale of resistance, which may be used to set the resistance value. This setting can be confirmed, or set more precisely, by the use of a good ohm-meter such as Gunson's DIGIMETER.

Disconnect the leads from the sensor, and connect the Sensor Simulator in its place. Note that where the socket that connects to the sensor has 2 pins, then the Sensor Simulator is connected with a lead to each pin. It does not matter which lead is connected to which pin. Where the sensor connector socket has only one pin, then this should be connected to one lead of the Sensor Simulator, the other lead being connected to the vehicle earth (eg the car bodywork). Here again, it does not matter which lead of the simulator is connected to the connector socket or to earth.

Start the vehicle, and observe from the operation of the vehicle whether the fault has been cured by substituting the Sensor Simulator for the sensor.


```
A   B   C
o   o   o
```

A = Variable Voltage - 0.5 to 4.5v

B+C = Resistor - fixed : 3k - 10k

Typical throttle potentiometer

To test the throttle potentiometer disconnect the connector to the sensor and connect an ohms meter to terminals B and C. This is usually the fixed resistance of the potentiometer. A resistance of between 3k-10k should be observed. Re-connect the ohms meter to terminals A and B. A resistance of 0Ω-1k to 5k-10k should be observed between throttle closed and throttle open. From throttle closed, slowly open the throttle, observing the steady change in resistance. A rapid change in resistance or an open/closed circuit reading indicates a faulty sensor.

To further test the sensor, reconnect the connector to the sensor and start the engine. Connect a voltage meter between terminal A and earth. Observe the voltage at idle. Slowly open the throttle observing the change in voltage. The voltage is typically O.5v to 4.5v. A rapid change in the voltage, or a loss of the voltage, indicates a faulty sensor.

If the sensor is not producing a voltage, or the tests are inconclusive, the use of a sensor simulator (to simulate the sensor output), should be used to provide a voltage to the ECU. If symptoms persist while using a sensor simulator, then the fault is not with the Throttle Position sensor. If the system works correctly while the sensor is being simulated (replaced) the sensor is positively identified as faulty.

6. **MANIFOLD ABSOLUTE PRESSURE SENSOR**: This produces a voltage of 0.5 to 4.5v dependant upon the pressure/vacuum in the inlet manifold. The connector usually has three terminals. Use a voltage meter to identify the 5 volt supply, the ground, and the output voltage of the sensor.

Test the response of the sensor output relative to engine speed as for (1) (Vane Air-Flow Meter).

If there is little or no response, disconnect the vacuum pipe from the sensor and apply a vacuum directly to the sensor. If the voltage now varies, check the vacuum pipe for leaks or blockages. If the voltage does not vary with a direct vacuum, it is likely that the sensor is defective.

To positively identify the MAP sensor as faulty, use a sensor simulator to simulate the output of the sensor.

7. **MASS AIR FLOW SENSOR**: This is a hot wire positioned in the air stream. The air flow through the air intake has a cooling effect on the hot wire, and the greater the flow, the greater the cooling effect. A control unit regulates the temperature of the hot wire, and provides a voltage signal to the ECU relative to the air flow.

To test a mass air flow sensor, probe the airflow meter connector with a voltage meter until the sensor output is identified. The output will be a voltage of 0.5v to 4.5v, or 4.5v to 9v.

on, say, the injector pulsewidth, but in other cars disconnection of the lambda sensor (ie reverting to "open loop" operation) may not be advised, or may cause the ECU (engine control unit) to switch to a "limp home" mode. Most cars with lambda sensors operate in the "open loop" mode when the engine is cold. Some cars now have no DIY means for measuring ignition timing, since there is no exposed fan belt pulley. Some vehicles have no ready means of sampling CO upstream of the Catalytic convertor. This Sensor Simulator is not therefore a product that has universal application to all sensors on all cars, but rather should be viewed as another useful tool in the armoury of service tools which further assists the user to cope with the increasing diversity and sophistication of modern motor vehicles.

Care needs to be taken in all work on vehicles, and the user is particularly advised to read the "Precautions" section of this handbook before using this product. This product has been designed with built-in protection so that, as far as is reasonably practical, it can not be damaged by misconnection or misuse, and neither will it damage the circuits of the motor car when used as directed. However, special care needs to be taken with some modern vehicles, particularly those with catalytic convertors and lambda sensors (as mentioned above), and the user is advised to heed the vehicle manufacturer's precautions and follow manufacturer's service procedures if available.

The user is also advised to consult specific vehicle workshop manuals, where available, and to consult relevant specialist magazines and other publications, for service information, technical data and operating principles of vehicles. Some information is given later in this manual on the characteristics of many commonly encountered vehicle and engine sensors, and how to test them, but this information does not necessarily indicate how the sensor will interact with a particular car. That section of this manual is therefore intended to supplement rather than to replace manufacturer's data.

2. DESCRIPTION

BATTERY COMPARTMENT. Access to the battery compartment is by removing the 4 screws on the back of the instrument. A 9V (PP3) battery must be fitted by the user before using the product to simulate Volts or Frequency. The product can be used to simulate Ohms (High or Low) with no battery fitted.

ON/OFF SWITCH. This switches on the power for Volts and Frequency simulations. Simulation of Ohms can be carried out irrespective of the position of the ON/OFF switch. This switch should be set to OFF whenever the product is not in use, and it may be set to OFF when Ohms (High or Low) is being simulated.

LED INDICATOR. Illuminated when a battery is fitted and the instrument is switched ON. The LED indicator will be out or dim when the battery is low.

FUNCTION KNOB. Sets the type of simulation. It has 6 positions, corresponding to Volts High, Volts Low, Ohms High, Ohms Low, Frequency High, Frequency Low.

ADJUST OHMS HIGH. Controls the level of the OHMS HIGH simulation. Rotate clockwise to increase resistance. The resistance that is set is indicated approximately on the scale. For a more accurate measurement of the set resistance, use a multimeter such as Gunson's Digimeter in conjunction with the Sensor Simulator. The limits of possible settings are as follows: Ohms High: 1k

8. PRECAUTIONS

- Before using Sensor Simulator it is necessary to fit a battery. For battery type, and how to fit, see Section 1 DESCRIPTION (above).
- Before connecting the leads of Sensor Simulator, always ensure that the function switch is switched to the appropriate range that is to be used. This avoids any possibility of damaging Sensor Simulator (although circuit protection is provided within Sensor Simulator), or damaging the circuits of the car. When set to VOLTS or FREQUENCY Sensor Simulator produces a voltage at its leads, which may be enough to damage certain sensitive circuits.
- After using Sensor Simulator, first disconnect the leads from the circuit being tested, then set the FUNCTION switch to the OFF position. Doing things in this order ensures protection of Sensor Simulator and the circuits of the car. Remember to switch the Sensor Simulator off at the ON/OFF switch after use, to protect the life of Sensor Simulator's internal battery.
- Do not allow Sensor Simulator to get wet, and store it in a dry frost-free environment.
- Using Sensor Simulator can involve working on a car while the engine is running. This is a potentially hazardous situation, and the user should take every precaution to avoid any possibility of damage or injury. The following guidance should always be followed:
- Always ensure that Sensor Simulator is located in a secure place, so that it can not be dislodged by, for example, engine vibration.
- Never wear loose clothing, particularly ties, long sleeves etc that can catch in moving engine parts, and always tie-up or cover long hair.
- Ensure that the car is on firm level ground, and is out of gear and the handbrake firmly applied at all times.
- If for any reason the car is jacked up or the wheels removed, always ensure that the car is well supported, and never rely on a car jack alone: always also use ramps or axle stands. Be wary of axle stands and jacks sinking into soft ground, and remember that asphalt and road surfaces may appear firm, but may give way after a short time under the concentrated load of a jack or axle stand.
- Do as much of the work as possible with the engine not running.
- Always route cables well away from hot or moving parts, (particularly the exhaust pipe and cooling fan) and check that the meter and leads are in a safe position before starting the engine.
- Always guard against getting equipment or fingers too close to moving, hot or electrical parts. Be especially wary of the fan, fanbelt, fanbelt pulley, exhaust manifold, exhaust pipe, and HT parts of the ignition system. Remember that thermostatically controlled fans may suddenly start with no warning.

CONTENTS