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 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.

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

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.

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 Ltd, Coppen Road, Dagenham, Essex, RM8 1NU

Gunson's

LAMBDA SYSTEM TESTER
PART NO 4128

HANDBOOK

- **Tests operation of Lambda sensor.**
- **Tests E.C.U. fuel injection control system.**
- **Works off vehicle's own 12V battery.**

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

- 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.

7. SPECIFICATION

Voltage range:	0 - 1V
Accuracy	± 0.05V
Input Impedance:	Greater than 500 K Ohm.
Display:	LED Bargraph 20 segment.

1. INTRODUCTION

Engines fitted with a lambda sensor use the output of the sensor to constantly monitor oxygen levels in the exhaust. The output is used by the Electronic Control Unit (ECU) to control the fuel injection system, to ensure that, as far as possible, undesirable exhaust emissions are minimised while economic engine operation is maintained. These emissions may be further reduced by a catalytic convertor if fitted, and in such engines the lambda sensor is also used to ensure that the catalytic convertor is not damaged by incorrect exhaust gas composition entering the convertor. Under some engine operating conditions, such as when the engine is cold, or when acceleration is demanded, the ECU may ignore the output from the lambda sensor, allowing emissions to temporarily reach levels that would otherwise be considered unacceptable.

The output of a Lambda sensor is a voltage, typically in the range 0 to 1 volt. It is high (typically 0.8V) in exhaust gas containing no oxygen, and low (typically 0V) in the presence of even a small percentage of oxygen. The bargraph display of the Lambda System Tester has a measurement range of 0 to 1 volt, and hence it can show graphically the output of the lambda sensor over its full operating range.

In normal engine operation, for example in a fully warmed up engine running at idle speed, the output of the lambda sensor will be observed to oscillate or fluctuate quite rapidly, often between near its full limits. The Lambda System Tester has a fast response which can show all these fluctuations.

These oscillations/fluctuations in the output of a lambda sensor occur because the composition of the exhaust gas from the engine is under the control of the engine ECU (which controls the rate at which petrol is injected to the engine), and the ECU uses "feedback" from the lambda sensor, in order to "decide" how much petrol to inject. This so-called "closed-loop" operation is what gives the oscillating voltage normally seen at the lambda sensor terminal.

However, as mentioned above, under some normal or fault conditions, the ECU is not using "feedback" from the lambda sensor, (it is said to be working "open loop"), and under these conditions the output from the sensor will usually be steady or constant. Normal conditions which can show a constant voltage include engine operation when the lambda sensor and/or engine are cold (the output is normally high, typically around 0.8V), or under acceleration or power (eg engine full throttle) when the output is also high. During "over-run" ie engine deceleration from high speeds, the voltage output of the lambda sensor may be constant and low (around 0.1V). Apart from these conditions, a constant or steady lambda sensor output voltage generally indicates a fault. The level of this output may help diagnosis of the problem although the ECU may well override the sensor and impose a mid level voltage.

Where there is a fault, the ECU may rely on recently learned and/or originally programmed information to give a less accurate control. Many ECU's will then indicate a fault by displaying a warning light to the driver so that repairs can be made before the exhaust catalyst is irreparably damaged by contamination or burn out.

Lambda sensors are either heated or non-heated and can generally be recognised from the wiring. Non-heated sensors are often referred to as EGO (Exhaust Gas Oxygen) and have a single cable (output) connection with an earth return through the exhaust manifold, or alternatively two wires, one output and one earth connection. Heated sensors HEGO

c. TESTS SHOW A STEADY DISPLAY EXCEPT ON RAPID ACCELERATION /DECELERATION WHEN A NORMAL OUTPUT IS BRIEFLY OBSERVED (I.E. BRIEFLY ABOVE O.7 V THEN BELOW 0.3 V).

Lambda sensor appears to be working. Check for normal sensor output during rapid acceleration/deceleration without connections to ECU.

No output indicates a Lambda sensor fault, normal output indicates ECU or connection fault.

The ECU may be operating in "Limp Home" mode, due to a failure elsewhere in another system.

d. TESTS SHOW A LOW OR STEADY DISPLAY EXCEPT ON RAPID ACCELERATION / DECELERATION, WHEN A SMALL CHANGE IS BRIEFLY OBSERVED. LESS THAN 0.4 V TOTAL CHANGE

Lambda output is low. Most likely cause is faulty sensor.

e. DISPLAY RESPONSE IS SLOW / SLUGGISH EVEN AT HIGH ENGINE SPEEDS.

Suspect Lambda sensor: check manufacturers specification.

If the vehicle system is found to be faulty a cross check on the ECU and lambda sensor can be performed as follows:

1. Identify the lambda sensor output wire, and follow this to identify the connector. One side of this connector will lead to the sensor, and the other side to the ECU.

2. Connect the tester to the sensor side of this connector.

3. With engine fully heated and running disconnect the Lambda sensor at this connector. Connect the ECU side of the connector to a Gunson's Sensor Simulator. Vary the Simulator output repeatedly between 0.1V and 0.9V and then reduce the output to 0.1V to give the ECU the indication of a lean fuel/air mixture.

4. Observe the tester display and note any change to engine idle quality.

The tester display should indicate high as the ECU recognises a lean mixture and increases fuel supply. A change in engine idle quality with no change to the tester display suggests a faulty sensor only. No change in engine idle quality suggests an ECU fault.

Lambda sensor life is often greater than 50,000 miles but leaded petrol causes permanent damage to lambda sensors and exhaust catalyst.

Leaded petrol pump nozzles are too large for petrol tank inlets intended for unleaded petrol, but beware of filling a petrol tank from a reserve can which could contain leaded petrol.

WIRE PIERCING CONNECTOR. Used to pierce a wire where the signal probe lead can not be readily connected to a terminal. (Not illustrated).

TERMINAL PROBE. Used to slide along a wire into the back of a connector. (Method of use illustrated opposite).

3. INSTRUCTIONS

Before use, read the Precautions section of this Handbook.

Higher Lambda sensor outputs are indicated by a greater number of segments being illuminated. This specialist instrument provides a rapid response high resolution display without loading the sensitive Lambda sensor output. This combination of features can not be found on general purpose analogue or digital instruments.

The basic procedure is as follows:

1. With the engine off, connect the RED and BLACK power connections to the car battery.

2. Connect the Blue connector to the lambda signal (eg the output terminal of the lambda sensor, or as described below). In difficult cases it may be necessary to use the special connectors included (Wire Piercing Connector, Terminal Probe).

3. Start the engine, and carry out any required tests.

   Further information on this procedure is given below.

3.2. LAMBDA SYSTEM TESTER - ELECTRICAL CONNECTIONS

THE TWO POWER CONNECTIONS TO THE VEHICLE BATTERY, RED/POSITIVE AND BLACK/NEGATIVE SHOULD ALWAYS BE CONNECTED BEFORE CONNECTING THE LAMBDA SIGNAL PROBE LEAD. WHEN DISCONNECTING, ALWAYS REMOVE THE LAMBDA PROBE BEFORE THE POWER LEADS

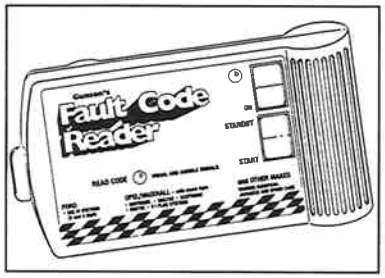
With the power connections in place the display will self test by initially illuminating (ie showing 1.00V). When the probe lead (coloured blue) is connected to earth the display will extinguish (ie indicate 0.00V). The display may be affected during testing if the earth connection is poor, direct battery connection is advised as wiring inside the passenger compartment may not be at exact earth voltage.

With the blue probe lead connected to a working lambda sensor the display will follow the fluctuating output of the Lambda sensor over the range zero to one volt, or will display a steady reading when the lambda sensor is not operating. i.e. open loop conditions and as described above

CONTENTS

Other products in Gunson's "AUTO DIAGNOSIS" Range

FAULT CODE READER

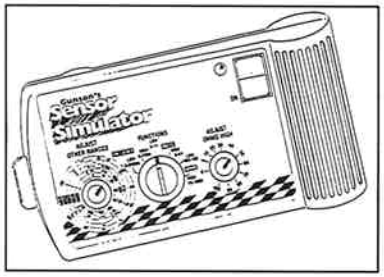


Provides access to vehicle's "Black Box" computer diagnosis Fault Code information, to help fault finding and service procedures.

With some vehicles, can initiate and control onboard diagnostic procedures, such as "Wiggle Test", Power Balance Test, Relays and Solenoid test, etc.

Base unit suitable for cars with Ford EECIV ECU, and many Vauxhall. Adaptor Kits now or ready soon for Audi, Citroen, Peugeot, Saab, Volkswagen, Diahatsu, Hyundai, Mitsubishi, Isuzu, Mazda, Nissan Subaru, Suzuki, Toyota.

SENSOR SIMULATOR



Simulates output from vehicle/engine sensors.

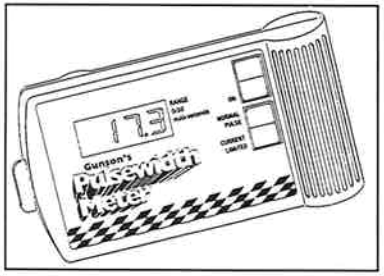
Enables effect of replacing sensor to be tested.

Enables ECU to be "driven" by artificial sensor.

Resistance, Voltage and Frequency outputs, fully variable.

Ranges: Ohms Low: 180 - 10K, Ohms High: 1K - 100K,
Volts low: 0 - 1, Volts High: 0 - 5,
Freq Low: 0 - 200Hz, Freq High: 0 - 2KHz.

PULSEWIDTH METER



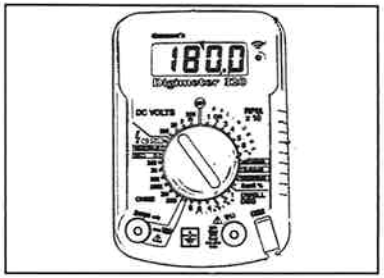
Measures pulsewidth (in milliseconds) for petrol injection and Electronic ignition waveforms.

Suitable for various complex waveforms including "Current Limited" types, ie current limited ignition coil current, and oscillating type petrol injector waveform (eg Weber, Rover). Measures both basic pulsewidth and current-limited pulsewidth.

Digital LCD display, accurately measuring from 0 - 50 mS.

Switch for waveform type.

DIGIMETER: 32 FUNCTION DIGITAL MULTIMETER

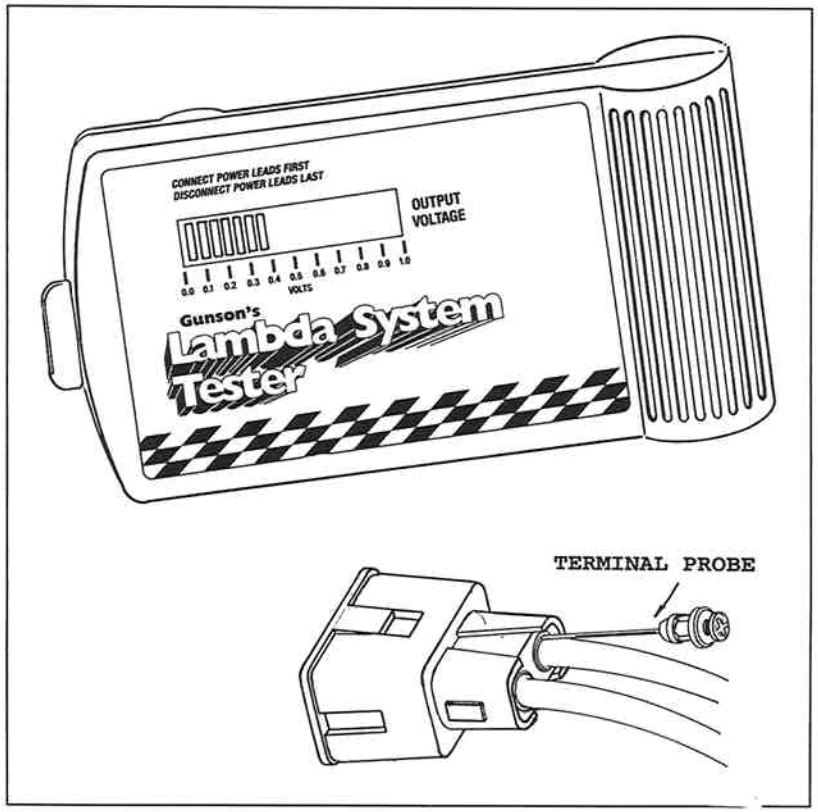


Designed for use with modern cars. Ranges:
DC Voltage: 2V, 20V, 200V. (All 10 MOhm impedance)
AC Voltage: 0 - 250V
Current: 20A
Resistance: 200, 2K, 20K, 200K, 2M, 20M.
RPM: 20,000 max (Switch for 1, 2, (DIS), 3, 4, 5, 6, 8 Cyl)
Dwell %: 0 - 100% for all engines
Dwell °: Switch for 1, 2, 3, 4, 6, 8 Cyl.
Pulsewidth (Millisecond dwell): 0 - 50mS, (basic pulsewith).
Waveform Period: 0 - 50mS
Frequency: 0 - 200 Hz
Continuity (LED/Bleep)
Diode test.

(Heated Exhaust Gas Oxygen) normally have four cables, two to the heater and two to the sensor (output / earth). As heaters use heavy currents separate earth return wires are usual but the earth return for the sensor can be through the manifold.

The Lambda System Tester has a very high internal impedance, and hence is perfectly safe for use on all systems when used as described.

2. DESCRIPTION



DISPLAY. 20 segment quick response LED segment, measuring voltage in the range 0 to 1 volt (ie each segment represents 0.05 volts)

POWER CONNECTION LEADS. Coloured RED and BLACK. Red to be connected to vehicle battery (+) terminal and BLACK to battery (-) terminal.

SIGNAL PROBE LEAD. Coloured BLUE. To be connected to the lambda sensor signal.

6. PRECAUTIONS

- Do not allow the product to get wet, and store it in a dry frost-free environment.
- Using this product necessarily involves 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 the Lambda System Tester 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 setting up, maintenance work and adjustments 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.
- 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 this product 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.

3.3. IDENTIFICATION OF VEHICLE ELECTRICAL CONNECTIONS

If connections are not identified from a wiring diagram or wiring colour code the following method may be used.

NOTE- Tests may be made without disconnecting the sensor wiring connections. Usually the easiest method is to pass the thin probe between the connector seal and the cable insulation where it enters the connector An electrical contact will then be made. (It is acceptable to pierce low voltage cable insulation with the sharp probe but in most cases this can be avoided by using the former method).

Unheated sensors - If there is a single cable this is the output. For two cable systems connect the blue connector to each terminal in turn, with the ignition on, to see which has an output (the earth lead will not illuminate the display). Alternatively, with ignition off, check the resistance between each wire and battery negative or chassis earth with a digital meter (200k ohms range) such as Gunson's Digimeter 320. The earth wire has a low resistance to earth, whereas the sensor output wire will have a high resistance to earth.

Heated sensors - Connect the blue connector to each cable in turn, and turn on the ignition. The sensor output will partially illuminate the display (ie a voltage between 0 and 1); the heater input will totally illuminate the display (ie a voltage greater than 1); and earth connections will not illuminate the display at all (voltage will be 0). Alternatively, with ignition off, check resistance between each wire and battery negative or chassis earth with a digital meter (200k ohms range) the cable with a high resistance to earth is the sensor output. A low resistance is earth (< 0.5 ohm) or the heater input (e.g. 4 ohms).

3.4. TEST METHOD

Testing for normal lambda sensor output can be most easily carried out at idle / steady speeds with the engine hot. Before connecting the Terminal Probe to the lambda sensor electrical connector, switch off the engine, and ensure that the power leads to the tester are correctly connected. Restart the engine and observe the display for correct sensor operation as below.

Idle / Steady speeds - Engine Hot. Sufficient heating of the Lambda sensor can be assured by driving the vehicle for a few minutes. Connection of the Lambda system tester should then reveal closed loop Lambda system operation. This is recognised by a rapidly oscillating or **fluctuating voltage which should vary between about 0.15 volt to 0.8volts**, the rate of fluctuation is normally is normally around 8 cycles in 10 seconds at idle speeds and can be seen to increase in frequency to perhaps double the rate, when engine speed is raised and held at 3000 rpm for example. Heated sensors installed in the exhaust pipe may respond slightly slower than unheated types installed in the engine exhaust manifold due to the distance of the sensor from the engine exhaust valves.

CONFIRMATION OF THIS BEHAVIOUR ON THE L.E.D. DISPLAY SHOWS THAT THE LAMBDA SYSTEM, BOTH SENSOR AND ECU CONTROL ARE FUNCTIONING. (THERE IS AN OUTPUT FROM THE SENSOR AND WHEN THE ECU RESPONDS TO CONTROL THE INJECTION SYSTEM THIS APPEARS AS A CHANGE IN SENSOR OUTPUT.)

Rapid acceleration - deceleration. If engine speed is rapidly increased a mixture with a greater proportion of fuel is required. When the throttle is closed from a high engine speed

the fuel proportion is reduced. This can be observed as the output from the Lambda sensor will swing high and hold momentarily at 0.8volts before swinging low and holding at less than 0.2 volts. Observe the display for response during several rapid openings of the throttle. The rise of the display should immediately follow the throttle opening without discernable delay (response is rapid with high exhaust flow rates which occur at open throttle).

CONFIRMATION OF THIS BEHAVIOUR ON THE L.E.D. DISPLAY SHOWS THAT THE LAMBDA SYSTEM, BOTH SENSOR AND ECU CONTROL OF THE INJECTION SYSTEM IS WORKING.

4. FURTHER NOTES

Output with cold engine. With the engine started from cold the display will initially indicate a steady level. The Lambda sensor will not be producing an output but, a voltage will normally be present from the ECU terminal.

This voltage may well reduce as the engine warms up and runs on a weaker mixture, or may remain steady until the ECU recognises an output from the sensor, and a warm engine, and turns to "closed loop" operation. This is recognised as a fluctuating voltage which should reach from 0.15 volt to 0.8 volts during normal operation, as mentioned above.

Heating of the sensor. This will be assisted by raising the engine speed. This applies particularly to unheated sensor types and/or cold weather. With unfavourable conditions of low engine speed and cold climate a sensor may eventually cool down again and run too cold to give a normal output but increased engine speed will restore operation.

Cold starting problems. Cold starting and initial running problems are not assisted by examination of Lambda sensor output. Fuel Injector duration and temperature sensor operation should be examined instead.

Catalytic Convertor operation. A lambda sensor and ECU working correctly will not guarantee correct catalytic convertor performance: an exhaust emission check is required to verify low emission levels.

5. FAULT DIAGNOSIS

5.1 SYMPTOMS AND DIAGNOSIS

a. ALL TESTS SHOW A STEADY DISPLAY FULL RANGE (all segments on): Check probe connection to the vehicle.

b. ALL TESTS SHOW A STEADY DISPLAY OF UNDER FULL RANGE (Some segments on) DURING ALL OPERATING CONDITIONS:

Engine is running open loop. Lambda sensor is faulty, or there is a broken connection, or a circuit fault exists. The ECU may be operating in "Limp Home" mode, due to a failure elsewhere in another system.