Gunson

FAULT CODE READER

Audi / Volkswagen
Vehicles with Fuel Injection or Electronic Control Units

PART NO G4155
HANDBOOK

Fault Code Reader

for Petrol Engines
Audi / Volkswagen

For vehicles with fuel injection or electronic control units

INDEX

1. SAFETY FIRST

General safety guidelines to follow when working on vehicles

- **Always operate the vehicle in a well ventilated area.**
- **Do not inhale exhaust gases - they are very poisonous.**
- **Always make sure the vehicle is in park (Automatic transmission) or neutral (manual transmission) and that the parking brake is firmly set. Block the drive wheels.**
- **Always keep yourself, tools and test equipment away from all moving or hot engine parts. Treat high tension ignition components with respect, remembering that electrical shocks can cause involuntary movement which may result in secondary injury.**
- **Wear approved eye protection.**
- **Never wear loose clothing that can catch in moving engine parts and always tie-up or cover long hair.**
- **Never lay tools on a vehicle battery. You may short the terminals together causing harm to yourself, the tools or the battery.**
- **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.**
- **Never smoke or have open flames near vehicle. Vapours from gasoline and charging battery are highly flammable and explosive. Always keep a suitable fire extinguisher handy.**
- **Never leave vehicle unattended while running tests.**
- **Keep children and animals out of the area.**
- **Always turn ignition key OFF when connecting or disconnecting electrical components, unless otherwise instructed.**
- **Always follow vehicle manufacturer's warnings, cautions and service procedures.**

CAUTION

Some vehicles are equipped with safety air bags. You must follow vehicle service manual cautions when working around the air bag components or wiring. If the cautions are not followed, the air bag may open up unexpectedly, resulting in personal injury. Note: The air bag may still open up several minutes after the ignition key is off (or even if the vehicle battery is disconnected) because of a special energy reserve module.

Precautions to be followed when using the Fault Code Reader

- **Before connecting the leads, ensure that the correct connector of the car has been identified.**

- **Using this product may cause vehicle systems to self test, items such as coolant fans to suddenly start with no warning, and engine speed to suddenly increase.**

- **Using this product can involve working on a car while the engine is running. This is a potential hazard and the user should take every precaution to avoid any possibility of damage or injury.**

2. HOW FAULT CODES MAKE IT EASY

Modern vehicles have electronic control units that are able to identify and remember faults which occur in the vehicle's equipment. This system was introduced on the higher specification electronic fuel injection vehicles around 1986 and was applied to other types of ECU a little later(ABS and Ignition) Its application is now virtually universal to all petrol engine vehicles. This is a great benefit to service and maintenance personnel as it can considerably simplify vehicle repair. The vehicle faults are stored in the vehicle's Electronic Control Unit (ECU) as "Fault Codes".

The system is so simple that retrieving vehicle fault codes does not require particular skill. However, in order to read these fault codes some equipment is necessary. (E.g. a Fault Code Reader), which is used to instruct the vehicle's ECU to download fault codes and/or present them to the user on a display. By far the most common system is to present the code as a "blink code". The Fault Code Reader will activate that part of the OBD programme which identifies the defective component and cause a code to be displayed, usually by a light on the Fault Code Reader or by an instrument panel "Check Engine" light. These provide a series of pulses to simply count a code number. Systems with an instrument panel "Check engine" light are able to illuminate this when the engine is running to warn of faults, other systems are more secretive and need to be interrogated.

The Fault Code Reader is an economical but very effective product. It is available for a wide range of vehicles and enables the user to instruct the vehicle to download stored fault codes. Having obtained the fault codes, the user then identifies the nature of faults by referring to a list of code numbers. Comprehensive lists of code numbers are included in this handbook.

NB Car manufacturers have in the past used a connector type unique to their own cars. Many manufacturers have used different types of connector at various times. Only recently have there been moves to standardise to a 16 pin socket.

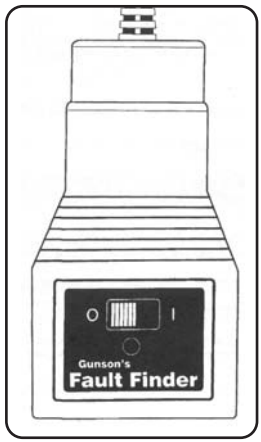
Makes and models of car also vary in the degree of testing and fault diagnosis that is possible. In general, the ECU will identify faults that exist at the time of the test, but the ECU may also have a memory that remembers faults that have occurred in the recent past, and these can also be read out from memory using the Fault Code Reader. For instance, in some vehicles, the readout consists of the faults that are present at that time, followed after a "separator" code, by the codes that are held in memory from some previous time.

In most vehicles, tests are carried out with the engine off (but ignition on). Occasionally additional tests may be carried out with the engine running (this depends on the sophistication of the ECU and is not available on all makes of vehicle).

Having identified the fault codes, and eliminated the faults, the user may then wish to erase the faults from the ECU's memory. With some cars this is possible using a special sequence of operations, or a sequence of switch operations on the Fault Code Reader. With other vehicles this is not possible and it may be necessary to erase the memory by disconnecting the battery (-) connection (with engine not running), this has the disadvantage that codes for radio/ security system and also some ECU memory settings are temporarily lost. Fault codes generally disappear anyway after the fault has not been present for a certain number of engine start cycles, but deletion of the codes followed by a short drive has the advantage that it allows the operator to check if the fault has truly been rectified. This is confirmed if the code does not re-occur.

Before using this product (or indeed carrying out any vehicle maintenance), the user is recommended to read the precautions presented in later sections of this manual. In particular, note that during the use of this product the vehicle's On Board Diagnostic programme (OBD) takes control of the vehicle, and may activate various vehicle systems (such as turning on the cooling fan), this can constitute a safety hazard and the user should keep fingers clear during tests.

3. THE FAULT CODE READER



Fault Code Reader is complete with the connections for the vehicle listed on the packaging. It is not suitable for use on any other vehicle

INSTRUCTIONS FOR USE please read carefully and it will help you to use the product and interpret the information it can provide

TEST SWITCH. Labelled "0" and "I". Moving from "0" to "I" starts a test or changes the way the vehicle's Electronic Control Unit (ECU) functions.

LED CODE INDICATOR. (If fitted), will transmit pulses which represent the fault codes. On models where this is not fitted the pulses will generally be seen on the engine check light on the vehicle instrument panel.

4. HOW TO USE YOUR FAULT CODE READER

NUMBER / CODE IDENTIFICATION

Identifying fault codes is in fact very easy and simple, though it may seem complicated at a first reading, the user will soon get accustomed to the technique.

Basically, the ECU communicates with the "Code Reader" in a series of pulses, and the user simply counts these pulses to identify particular numbers. For example, the number 6 would be transmitted as 6 pulses in rapid succession. If we use the symbol ☼ to indicate a pulse, then the number 6 will be transmitted as:

☼ ☼ ☼ ☼ ☼ ☼ **= 6**

If the number is a 2 digit number, then each digit is transmitted separately. For example, the number 25 would be represented as 2 pulses, followed by a brief pause, and then 5 more pulses.

☼ ☼ ☼ ☼ ☼ ☼ ☼

2 5 = 25

In practice, the ”Fault Code Reader” code will be output as a series of numbers one after the other, and the user has to recognise individual numbers, and recognise the gaps between numbers. This is made easy by the fact that the pause between two numbers is much greater than the pause between the individual digits of a number.

Similarly, there is an even greater pause between one series of code numbers (egg representing current faults), and another series of code numbers (e.g. representing faults stored in memory.

To make matters even easier, the ECU, in most instances, repeats a series of code numbers, so that the user has the opportunity to check the reading.

Each code has a particular meaning, which is identified by reference to the tables of Fault Codes which follow.

GENERAL NOTES

Before connecting “the Fault Code Reader” to the car, the user should ensure that the TEST SWITCH is set to "O" and the diagnostic socket has been correctly identified. Check that the car ignition is off, the car is out of gear, and that the handbrake is applied.

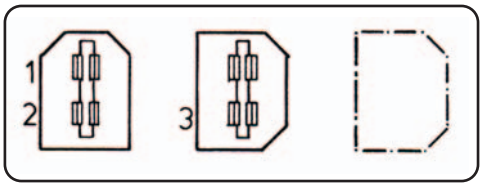
When a fault code appears, it does not necessarily mean that the component indicated is faulty. It could mean that the ECU has received a signal from the component or it's wiring, which is outside specification.
Therefore before tests are performed, (using the Test Procedure Notes later in this Manual), it is important
all of the connections and wiring associated with the indicated component are checked.

When multiple faults are indicated, it is possible that the fault on one component is causing incorrect readings from other components, but all the components will have to be checked to eliminate the true cause.

5. CONNECTION

DIAGNOSTIC SOCKET LOCATION

The diagnostic socket is usually located close to the ECU or the main relays in the engine compartment. It is a two pin socket with Female contacts, the moulding is usually green



Fault Code Reader connection:
Flat blade connector to socket A
Alligator Clip to battery earth

FAULT INDICATION AND DISPLAY TYPE

It is normal for Citroen / Peugeot vehicles to have an engine check light fitted to the instrument panel. If a significant continuous fault is present this light should be illuminated. An intermittent fault may record a code without setting the engine check light.
The engine check light is orange in appearance, has a small engine silhouette with a transistor symbol on it. It should illuminate with the ignition ON and engine not running to check the bulb and wiring.

FAULT STORAGE MEMORY

This facility is included. Intermittent fault detection will result in a code being set. After a number of repeat vehicle journeys without a fault, the code may be automatically deleted.

6. DISPLAY CODES

Carry out a basic inspection under the bonnet before proceeding, ensuring that all leads and connectors are secure and the ignition is turned off.

TEST PROCEDURE

1. **Set the "Code Reader" switch to the O position and connect the Code Scanner to the diagnostic socket (Fig 1)**

2. **Turn on the ignition ON but do not start the engine. The LED will be ON**

3. **Set the Code Reader switch in the I position for a period of approximately three seconds, then return it to the 0 position.**
   The LED will now come ON. After five seconds a further fault code may be transmitted

4. **After a further five seconds the LED will extinguish.**

5. **Set the switch into the I position again for three seconds and then return to the 0 position, the LED will now come on. After about five seconds the next code will be transmitted.**

6. **Wait for five seconds and the Code Reader LED will extinguish, if a fault code was transmitted, set the switch into the I position again for three seconds and then return to the 0 position. After about five seconds a further fault code may be transmitted.**

7. **This switch sequence must be repeated until code 1111, end of test, is transmitted.**

8. **The test can be repeated in order to confirm any codes or terminated by switching off the ignition and disconnecting the Code Reader.**

Reference should be made to the Fault Code Table to identify any codes and to assist in repair procedures.

CLEARING CODES (AFTER CORRECTING ANY VEHICLE FAULTS)

When the end of the test procedure is indicated by the end of code 11, there will be a pause of about five seconds and the LED will extinguish.

1. Put the switch into the I position for about ten seconds. Then put the switch into the 0 position, and switch off the ignition.

2. Perform the test procedure again to ensure that the fault codes have been deleted.

3. Drive the vehicle sufficient to warm the engine fully and then operate it under a variety of part and full load conditions.

4. Perform the test procedure again to ensure that the fault codes have not been reset.

Actuator Test (AUDI V8 MOTRONIC ONLY)

1. Set the Fault Finder switch to the O position and connect the Fault Finder to the diagnostic socket

2. Turn on the ignition but do not start the engine

3. Set the Fault Finder switch to the I position for a period of approximately ten seconds, then turn to the O position. Fault codes will be transmitted as a series of pulses.

4. Set the Fault Finder switch in the I position again for three seconds then return it to the O position. After five seconds a further fault code may be transmitted.

This switch sequence must be repeated until code 1111 End of test is transmitted.

After all codes have been transmitted fully open the throttle. When the throttle is returned to the closed position, the actuator test will start. Injector valve 1 will be activated 4 times, then injector valve 3 and so on. After all injector valves have been operated the idle speed control valve will be activated followed by the carbon filter solenoid.

7. Vehicle Applications

Audi	80	1.6/2.0	ABM/ABT	-1993
	100	2.6 V6	ABC	-1993
		4.2 V8	ABH	-1993
Volkswagen	Golf/Vento	1.4/1.8	ABD/AMM/ABS	
	Golf	2.0 16v	ABF	
	Golf/Vento	2.0 8v	2E	
	Golf/Vento	2.8 VR6	AAA	
	Passat	2.8 VR6	AAA	
	Passat	2.0 16v	9A	
	Passat	1.8	AAM	

8. Fault Codes - Audi/Volkswagen

1111	ECU faulty	
1231	Vehicle Speed Sensor	Test for speed signal to ECU
2111	RPM Sensor	Test for RPM signal to ECU
2112	TDC Sensor	Test for TDC signal to ECU
2113	Hall Effect pick-up	
2114	Hall effect sensor position	
2121	Throttle position sensor/idle switch	Refer to TPN 4/5
2123	Throttle position sensor/full load	Refer to TPN 4/5
2141	Knock control 1	
2142	Knock control 1	
2143	Knock control 2	
2144	Knock control 2	
2212	Throttle position sensor/full	Refer to TPN 4/5
2214	Max engine speed exceeded	
2221	Throttle position sensor idle	Refer to TPN 4/5
2222	MAP sensor	Refer to TPN 6
2223	Altitude sensor	
2224	Max boost pressure exceeded	
2231	Idle speed control outside control range	
2232	MAF potentiometer	Refer to TPN 7
2234	Power supply	
2242	CO potentiometer	
2312	Coolant temp sensor	Refer to TPN 2
2314	Engine/Gearbox switch circuit	
2322	Air temp sensor	Refer to TPN 3
2323	Mass air flow potentiometer	Refer to TPN 7
2324	Mass air flow sensor	Refer to TPN 7
2411	Exhaust gas recirculation	
2413	Mixture adaptive range exceeded	
4332	ECU faulty	
4343	Carbon filter solenoid valve	
4411	Injector valve 1	
4412	Injector valve 2	
4413	Injector valve 3	
4414	Injector valve 4	
4421	Injector valve 5	
4422	Injector valve 6	
4423	Injector valve 7	
4424	Injector valve 8	
4431	Idle speed control	
4444	No fault found	

9. TEST PROCEDURE NOTES (TPN)

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 to 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 value as the engine speed changes it indicates a sticking flap/plate.

A sensor simulator that can simulate a varying voltage, 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.

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 overleaf:

Typical Coolant Temperature Sensor Resistance

Most systems		Exception KE Jetronic, EEC1V.	
Cold	3-5 K Ω	50 K Ω	@ 15∞C
Warm	300-400 Ω	3.5 K Ω	@ 80∞C

A sensor simulator that can simulate resistance 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:

Typical Air Temperature Sensor Resistance

Most systems		Exceptions*	
Cold	5 K Ω	500 Ω	@ 0∞C
Warm	2.5 K Ω	200 Ω	@ 20∞C

***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 connected**

Open throttle B+C connected

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 to B = 0 Ω (closed circuit)
Throttle open	A to B = infinity (open circuit)
Throttle closed	B to C = infinity (open circuit)
Throttle open	B to C = 0 Ω (closed circuit)

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.

A = Variable Voltage : 0.5 to 4.5v
B+C = Resistor - fixed : 3K Ω - 10K Ω

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 0_-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 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). 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 which regulates the temperature of the hot wire 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. 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.PETROL TEMPERATURE SENSOR:
This measures the fuel temperature in the fuel manifold/pipe. If the temperature exceeds 90∞C the ECU will enrich the mixture by increasing the injection duration, as fuel evaporation is likely above 90∞C.

9.LAMBDA OR OXYGEN SENSOR:
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 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.

10. VALVES:
The ECU uses valves in the fuel system to pass or restrict fuel or gases according to engine load conditions. Use the relay test to ensure that the ECU is actuating the valve. Valves are mechanical devices which can be sticking or jammed, therefore, removal and testing when removed from the vehicle may be required.

10. COMMON TERMS

Many abbreviated terms are peculiar to a particular manufacturer and are explained in the relevant text. Some more common or universal ones appear below.

COMPUTER SYSTEMS

ECU **ELECTRONIC CONTROL UNIT** These units may control a separate function, for example fuel injection, ignition, ABS. Modern systems tend to be more multi- function as this saves cost, wiring complications and ensures greater resistance to interference and more control over emitted interference.

OBD **ON BOARD DIAGNOSTICS** The facility provided by modern ECU's to self diagnose and report faults in the ECU, sensors, wiring connections etc. Fault codes are used to differentiate faults.

KAM **KEEP ALIVE MEMORY** A system for maintaining a record of faults encountered to be accessed later. These may be intermittent or recorded only under particular conditions and therefore not accessible during no load testing.

IGNITION

DIS **DISTRIBUTOR LESS IGNITION SYSTEM.** These use one coil per cylinder or an arrangement which provides one coil per two cylinders and sparks every rotation of the engine instead of every two rotations (wasted spark). The net result is that H.T. voltages do not have to be mechanically distributed. Together with ignition advance "mapping" in the ECU this provides a high reliability and performance.

EDIS **ELECTRONIC DISTRIBUTOR LESS IGNITION SYSTEM**

CID **CYLINDER IDENTIFICATION (SIGNAL)** Determines which cylinder is not only receiving a spark but is also on the compression stroke.

RON Defines the **OCTANE NUMBER** of petrol. Multiple position plug/socket arrangements allow ignition requirements to be changed for different rated fuels. e.g. "octane multiplug"

INJECTION/FUEL

LAMBDA SENSOR See EGO and HEGO sensors.

EGO EXHAUST GAS OXYGEN (SENSOR) Sensitive to low concentrations of oxygen in hot exhaust gas. Essential for accurate "feedback" control of injection.

HEGO HEATED EGO (SENSOR)

MAP MANIFOLD ABSOLUTE PRESSURE (SENSOR) Manifold pressure sensor measures differential pressure with vacuum sealed capsule (not atmospheric pressure).

MAF MANIFOLD AIR FLOW (SENSOR) "Vane" or "hot wire" flow sensor.

SENSORS GENERAL

PTC TEMPERATURE SENSOR of POSITIVE TEMPERATURE COEFFICIENT type. Low resistance when cold. NTC (NEGATIVE TEMPERATURE COEFFICIENT)is low resistance hot.

ATS, FTS, CTS, TTS TEMPERATURE SENSORS Air, Fuel, Coolant, Transmission.

11. WARRANTY AND CUSTOMER SERVICE

This warranty is in addition to the statutory rights of the purchaser.
The Tool Connection has made every effort to ensure that this product is of the highest quality and value to the customer. However, The Tool Connection can accept no responsibility for consequential damage howsoever caused arising from the use of this product.
All technical enquiries regarding this product should be made to:

The Tool Connection Technical Service Department: ++44 (0) 1926 818181

Please note that The Tool Connection cannot provide technical information or advice or service data on particular motor vehicles.
If this product should require service or repair, it should be returned to:

The Tool Connection Technical Service Department,
Kineton Road,
Southam,
Warwickshire,
CV47 0DR,
England.

Please give full details of faults requiring attention when sending goods for service or repair