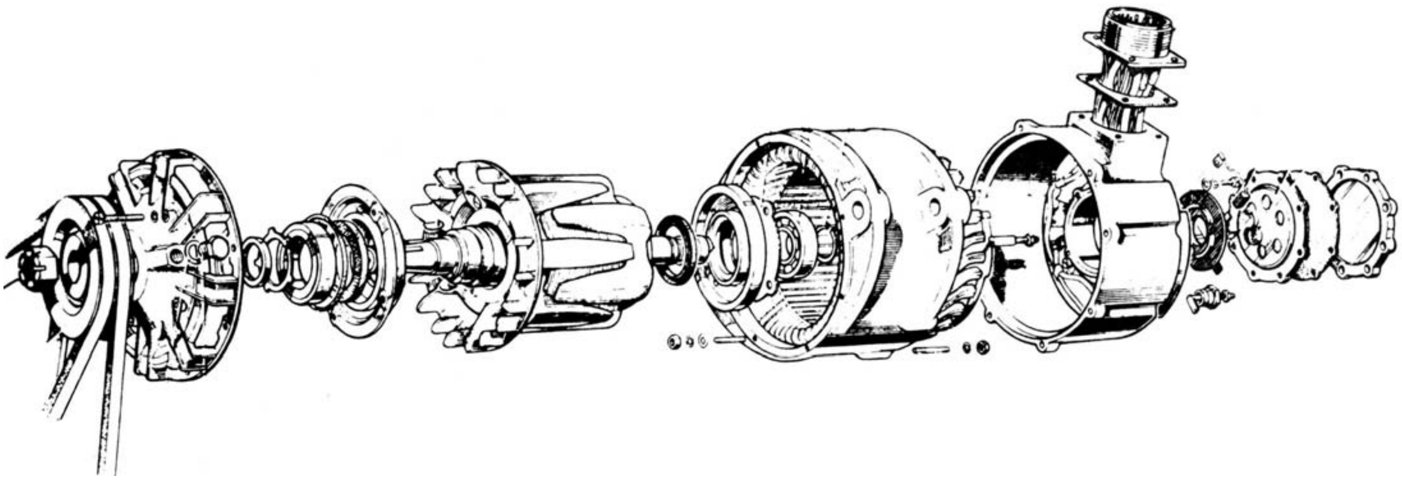
ALL CHARGED UP!

Clive Elliott continues his series on military alternators by giving some hints for fault finding in the 90-amp 24-volt system so widely used in post-war British vehicles.



The Generator No.10 and its Generator Panel No.9 form the 90-amp 24-volt system that was used in many FFR (Fitted For Radio) vehicles. These include:

Rover 1
Rover 8 & 9 (late models)
Rover 10 & 11
Rover Series III
Rover 1-Ton APGP
Rover 1-Tonne
Stalwart
AEC Recovery Vehicles
BV202E
Saracen (later upgrades)
Ferret (later upgrades)

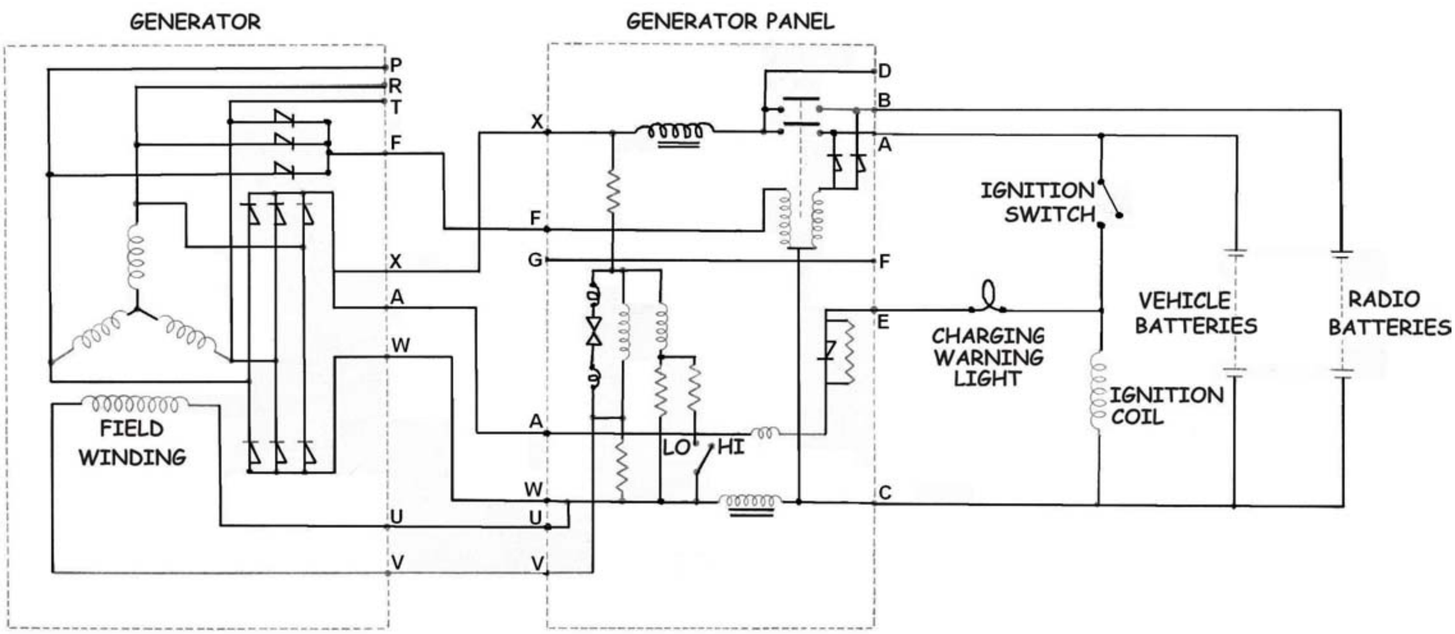
Although the generating system was described in detail *Windscreen* (Issue 101 pages 43-48), here is a summary of the types of generator and generator panel:

Generator No.10

Mk A and Mk 1 were produced in small numbers. Had a 3-phase AC outlet for power tools, used in Rover 1-Ton APGP and some early Stalwarts.
Mk 2 was produced in large numbers. Although it had a 3-phase AC outlet for power tools, this was not utilised in most applications.
Mk 3 was produced in more modest numbers. It did not have a 3-phase AC outlet. For installations that do not use power tools the Mk 2 and Mk 3 are interchangeable.

Generator Panel No.9

Mk A and Mk 1 were produced in small numbers and were used with the Generator No.10 Mk A and Mk 1.
Mk 2 was used with the Generator No.10 Mk 2 and was produced in relatively small numbers before being superseded by the Mk 3 panel.
Mk 3 was produced in large numbers and became the standard panel for the Generator No.10 Mk 2.
Mk 4 was produced in more modest numbers. It had a transistorised voltage regulator and became the standard panel for the Generator No.10 Mk 3.



The basic generating system, note that the filter capacitors are not shown

Fault-finding

What follows is based on a variety of official publications and from bitter experience. I make no apologies for the section on meggers, as this is a most useful instrument that deserves wider popularity! Last winter I spent a number of very cold Sunday mornings faultfinding on a Land Rover. I learnt three very important things:

1. When you have found a fault don't assume you have found 'the' fault, there may be others. On this particular occasion there were a total of eight faults.
2. Establish whether the charging system was working and then went wrong, or whether the system has never worked properly since owning the vehicle. If it is the latter it may well be that a previous owner has done all sorts of strange things to the wiring. It may be that the fault is a direct result of this meddling or the meddling was an attempt to correct a long established fault. If there has been inappropriate rewiring some of the diagnostic tests that following may give misleading results.
3. Documentation for the generator, the control panel and installation is a complete mess! Land Rover produced a very good workshop manual for their military products. It struck a good balance between technical description, faultfinding and repairs. Large sections of this manual were lifted and became part of EMER WHEELED VEHICLES Q 020.

This included sections covering both the 40-amp and 90-amp systems, which were partially re-written. This is arrangement of topics is contrary to the normal EMER structure where the generator, starter motor and engine are covered in EMER POWER. However further detail was described in the EMER POWER series. The Generator No.10 in EMER POWER W 100/13 and the Generator Panel No.9 in EMER POWER P 130/26 and P 130/27. Fault finding diagnosis was covered in EMER POWER W 133. Further complications arise from EMERs being upgraded in the form of AESPs (Army Equipment Supports Publications) and some information was only published in microfiche. All rather confusing!

General points

Given the vast amount of technical information available there is no space to reproduce many hundreds of pages of information here. In fact much of the faultfinding and repair information is only appropriate to a base workshop where test rigs can be set up to service large number of installations. For most of us this is wholly impractical and anyway life is too short! I have tried to include only tests that can be easily performed and if a unit fails the basic investigations then it is best to chuck the thing away and buy another, given their availability.

Many electrical faults are really mechanical faults. The most vulnerable item in the installation is the cable harness, which can be susceptible to crushing, fraying, corrosion and stretching. Check all harness plugs are correctly inserted. If there is doubt, unscrew and check that no plug pins have become misaligned or even broken off. If a pin has broken off, check whether it is a pin that carries a wire. It may not matter as not all the pins are utilised. Even if the harness looks in good condition the cable may have been stretched and lead pulled off, the end on the generator seems to be the most vulnerable.

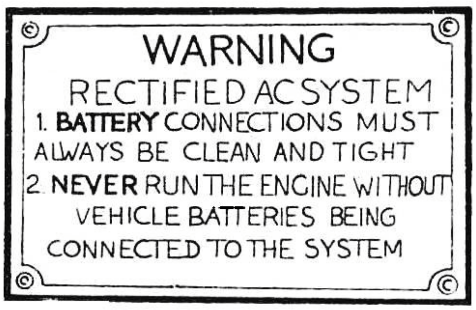
Inspection of the connector to the generator reveals no obvious fault

Gentle tugging on a lead reveals that it has come unsoldered

But there is a second fault!

And a third!

Pure electrical faults are often as the result of damage to diodes. The alternator has built-in silicon diodes for rectification. These diodes are destroyed by high voltages that are induced in the generator windings if the generator is disconnected with the engine running or the batteries are not properly connected. There is a warning plate fitted on the vehicle to that effect.



I would add to this warning to check that the connectors on the wiring harness at each end are firmly tightened, but not too tight, as it is easy to split the locking collar of the plug.

Remember that the use of an arc welder can also destroy diodes. An instruction in a 1967 EMER was to disconnect the batteries before welding. However this did not give adequate protection and the instruction was amended in 1976 to require the disconnection of the batteries, generator and control panel.

A further risk to the diodes takes place if using a stroboscopic timing light powered by the battery of the vehicle under test. Several hundred volts can be induced between the HT connection to the lamp and its supply leads, which can result in high voltage spikes in the charging system. This can be avoided by using a slave battery to power the timing light.

There are also diodes in the regulator panel, these provide protection against connecting batteries the wrong way round. However it is quite possible for the system to work despite these diodes having been blown open circuit, although there will be no protection for reverse connection errors.

Detailed fault finding

It should be possible to find a fault inside the generator and control panel by tracing through every wire and testing every component. Rather than spend a lot of time doing that, the fault-finding summaries that follow are intended to be used without necessarily understanding how individual components function.

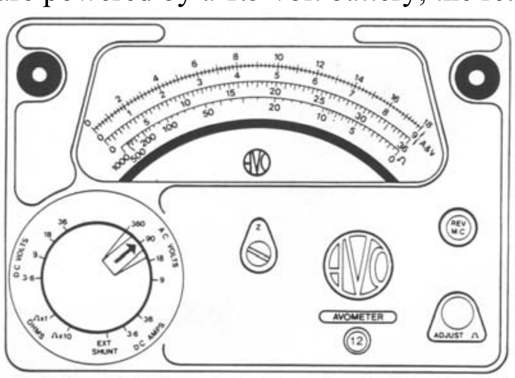
Test meters

A multimeter is essential for faultfinding; the instrument will have functions that include measurement of voltage, current and resistance. Any multimeter will have a DC voltage range capable of measuring 28 volts, which is needed here. The DC current range is often only up to 1 amp or at most 10 amps and is of little value in the following diagnostic tests.

The resistance range is extremely useful and is measured in ohms and kilohms (1 kilohm =1000 ohms). Continuity of a cable or circuit can be confirmed by a reading of 0 ohms (or thereabouts). Digital meters often incorporate an audible tone where the circuit resistance is only a few ohms. This facility can be very useful for rapid testing and particularly where you are trying to hold a test prod on a circuit with each hand and the meter cannot be seen. Where resistance tests are required to eliminate the possibility of short circuit between individual feeds in a harness, make sure the plug is removed from the other end of the harness! Remember a short circuit or direct connection will read 0 ohms on the meter. An open circuit will read infinity on the meter.

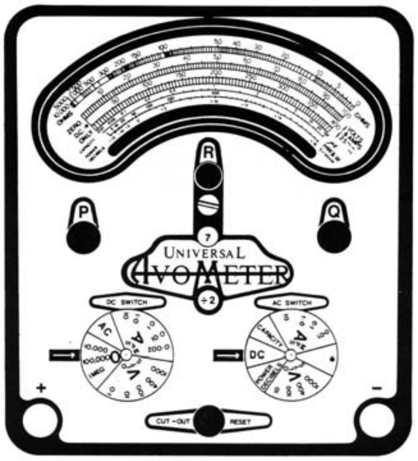
A Fluke digital multimeter Z4/6626-99-252-3606 well protected for military service

The testing of diodes requires resistance measurement in one direction across a diode and then in the opposite direction. There should be a low resistance usually in the order of 10–40 ohms in one direction and at least 10 kilohms in the opposite direction. If a diode reads low resistance in both directions it may not necessarily be defective. There may be some other circuitry through which the current is flowing e.g. the harness is still connected. Some EMERs quote precise values for readings obtained with a particular meter. These need to be viewed with caution as it depends on the characteristics of the multimeter you are using. Forward resistance of a diode might measure say 40 ohms on an Avo 7, but would measure about 120 ohms on an Avo 12. Although both instruments are powered by a 1.5 volt battery, the readings are influenced by the sensitivity of the meter (ohms per volt).

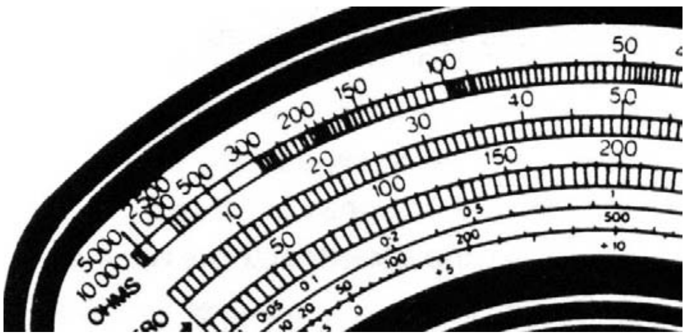


Avo Model 12, Z4/6625-99-109-3126

This confusion is fuelled by the fact that a few EMERs use a Z4/WY2440 Avometer, most of them use an Avo Model 7 and some a Multimeter CT497. In fact these are all the same instrument! Officially it is known as Multimeter, Avo, Model 7, Panclimatic Eqpt, CT497, part no Z4/6625-99-943-1523. In order to measure higher resistances an increase in voltage is needed. A 9-volt battery is used in the high resistance range of the Avo 7, but even so the scale is non-linear and difficult to interpret.



Avo Model 7

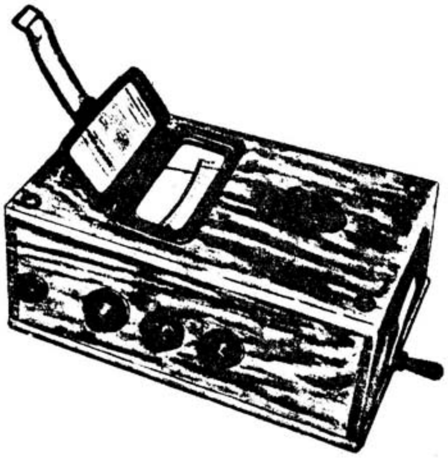


Note the cramped scale with 10 kilohms to the left and 50 ohms mid-scale.

The upper resistance range was improved in the Avo Model 8, which used a 15-volt battery.

Avo Model 8, Z4/6625-99-943-1532 with metal panclimatic case

To make measurements of higher resistances even higher voltages are needed, which is beyond the scope of normal multimeters. Resistances of several megohms (1 megohm = million ohms) require a voltage of at least 100 volts. Leakage between leads in a cable harness can be have a very high resistance, sufficient to cause a fault yet remain undetected by a multimeter. A meter that can be used to measure high resistance is called an insulation tester or a megohmmeter. During the war they were quite large devices weighing as much as 28lb for a teak case model. It was available in 100 volt, 250 volt, 500 volt and 2,500 volt models

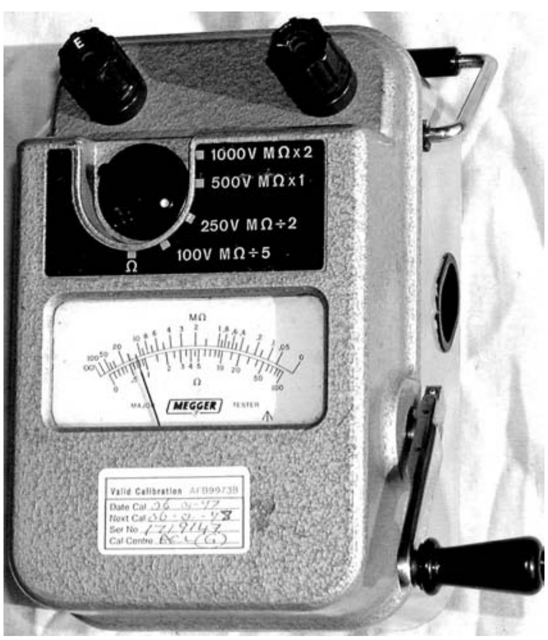


Tester, Insulation, No.1 in its teak box over 14 inches long

Although still a wartime development the most widely known of these instruments is the *Wee Megger* manufactured by Evershed and Vignoles, it weighed only 3lb. It was available in 100 volt, 250 volt and 500 volt models.

The 500 volt Wee Megger, Model 70003, less than 6 inches long

As a result of its popularity, the term megger is often used to describe any megohmmeter. The high voltage in a megger is achieved by turning a geared handle linked to a generator; there is a clutch arrangement so that the gears slip once the required voltage has been reached. Originally the generators were direct current (DC), but by using an alternating current (AC) generator it avoided the need for carbon brushes. It also meant that by using AC, voltage-multiplying circuits could be employed to give a choice of DC output voltages usually in the range of 50 to 1000 volts. Meggers turn up on stalls and carboot sales for £5 - £30.



Megohmmeter Type 70154 Mk 2, (Z4/6625-99-325-2217). Note that with increasing voltage, higher resistances can be measured.

A widely used megger is the Megohmmeter Type 70154. It is a hand driven megger geared up by 25.7 : 1 to drive a permanent magnet alternator. The maximum output of 500 volts RMS is tapped by the range switch and passes through a voltage doubler that rectifies the output to DC. Note that meggers are note exclusively for measuring high resistances, there is usually also a low resistance range. The effect of voltage on the instrument's ability to read higher resistances can be seen:

Test voltage	Range limits	
2V	0-100	ohms
100V	0-20	megohms*
250V	0-50	megohms*
500V	0-100	megohms*
1000V	0-200	megohms*

*Note that this is the upper practical limit that can be read, the maximum reading is 'infinity'.

To produce the desired output the handle must be turned at a speed between 180-240 rpm. This is not always easy, as it is two-hand job. The handle is not easy to turn and the instrument must be firmly gripped with the other hand, otherwise the instrument will slip and be damaged. It was prudent that most supplied for military service were in metal cases whereas the civilian models were plastic. This means that test prods must be firmly clipped in place on the circuit under test rather than held in place by hand, although this would be inadvisable in view of the voltages applied. Assuming the test prods stay in place, the megger cannot easily be held steady whilst being cranked. There is also vibration of the meter needle, which adds to the difficulty of use.

Modern meggers now use internal batteries to run an inverter to produce the high voltage. This is much easier to use because there is no handle to wind and meter readings are steady, but they are expensive. A new one costs about £250, although I have bought one for as little as £5.

Megger Type BM8/2 (Z4/6625-99-325-2217) with internal batteries

A further use of a megger is its ability to test a capacitor (condenser) used in a distributor. Capacitors will deteriorate with age and allow leakage through the internal insulation even if the capacitor has never been used! Testing with an ohmmeter will not usually show up these defects, but a megger can. A capacitor can be tested in two ways. One way is to connect the capacitor, run the megger up and watch the needle flip down to then creep up to the infinity reading as the capacitor charges up. A failed capacitor will show a sustained low reading. The alternative is to keep the megger running and carefully, not touching the output leads, disconnect the capacitor. After say 30 seconds, carefully short out the terminals of the capacitor whereupon a small spark will be seen. No spark shows that the charge has leaked away due to failure of the insulation in the capacitor. Remember a distributor capacitor is designed to withstand about 250 volts, so the megger on a low range will not harm it. It is permissible to test the capacitors in the generator panel with a 100-volt megger. But never use a megger to test a diode.

In EMERs it is stated that “under no circumstance must a megger rated at more than 100 volts be used when testing”. This is to prevent damage to the diodes. However the RAF test procedures permit the use of a 250-volt Wee Megger. As 250 volts is the lowest voltage model of Wee Megger and in itself is quite an old fashioned instrument so I can only assume that’s all RAF mechanics had available. But in the original Land Rover manual 500 volts is specified for testing the cable harness and for testing the diode heatsinks to earth leakage.

Test Preliminaries

1. Check fan belt is at correct tension.
2. Ensure battery connections are correct, and terminals are clean and secure.
3. If the radio battery leads are not connected ensure they are kept separate, well insulated and not able to touch each other or touch the bodywork.
4. Remove the cover from the generator panel and ensure the ‘HIGH / LOW’ link is in the ‘HIGH’ position.
5. Where a test requires the engine to be run, it must be at fast idling speed except where specifically stated.
6. Turn off engine before disconnecting leads or harness plugs.
7. Unless otherwise stated ‘Battery voltage’ refers to the vehicle battery voltage, measured at the inspection light sockets on the instrument panel.
8. Where tests are on the field winding of the generator the resistance will vary between 14.5-90 ohms, this measurement must be taken with the generator rotor in several different positions. The engine needs to be turned over by hand several times and the lowest reading noted.
9. When testing for leakage with a megger: If a single lead is specified it is a test between it and earth, if several leads are specified it is the leakage between the leads themselves and also each lead to earth. A reading of 5 megohms is the lowest acceptable reading.
10. Testing the continuity or circuit resistance of a lead means testing the full extent of the lead e.g. from one connector on the harness to the connector at the other end.

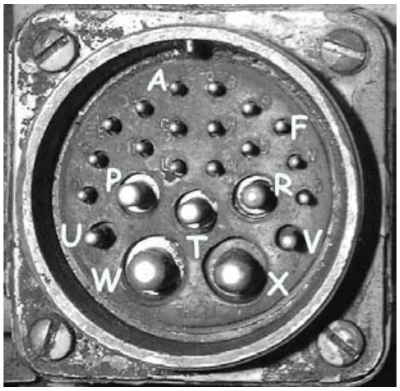
Tests

Read through the faults listed below to choose the appropriate test for your vehicle. The tests apply to either the transistorised or non-transistorised installations.

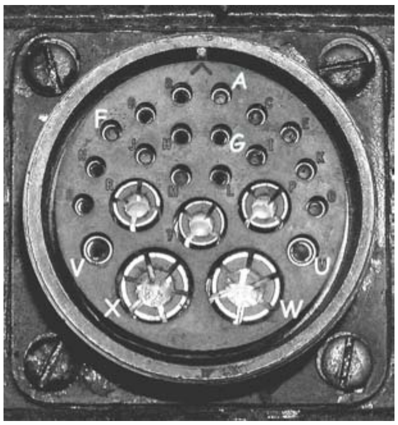
TEST 1. Engine stationary, ignition switch ‘ON’, ignition warning light ‘OFF’.
TEST 2. Engine running, ignition warning light ‘ON’, ammeter(s) read charge.
TEST 3. Engine running, ignition warning light ‘ON’, ammeter(s) read zero.
TEST 4. **Land Rover only.** Engine running, ignition warning light ‘ON’, vehicle ammeter reads charge, radio ammeter reads zero.
TEST 5. **Land Rover only.** Engine running, ignition warning light ‘ON’, vehicle ammeter reads zero, radio ammeter reads charge.
TEST 6. Engine running, ignition warning light ‘OFF’, ammeter(s) read zero.
TEST 7. **Land Rover only.** Engine running, ignition warning light ‘OFF’, vehicle ammeter reads charge, radio ammeter reads zero.
TEST 8. **Land Rover only.** Engine running, radio ammeter reads zero.
TEST 9. Engine running, batteries overheating or excessive topping up needed.
TEST 10. Engine running, low charging rate i.e. flat batteries
TEST 11. **AEC Recovery only.** Engine running, charge warning light remains ‘ON’.
TEST 12. **AEC Recovery only.** Engine stationary, charge warning light switch ‘ON’, charge warning light remains ‘OFF’.
TEST 13 Ignition switch ‘OFF’, ignition/warning light on DIM.

Abbreviations

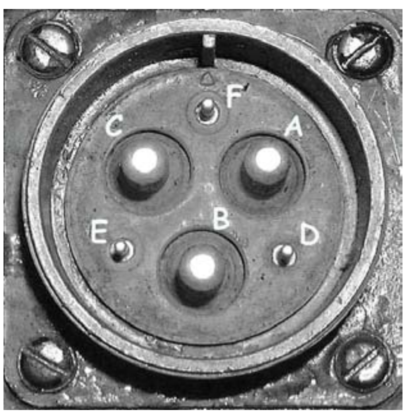
CR Continuity or circuit resistance (use multimeter)
Con Connector
Dist Distribution
Gen Generator
Ign Ignition
IR Insulation resistance (use megger, if you use a multimeter you may fail to diagnose leakage)
Skt Socket
W/L Warning light



Socket on generator, significant pins. The AC outlet for power tools from pins P, R & T is rarely used. This is identical to the connector that plugs into Socket 1 on Generator Panel.



Connection 1, socket on Generator Panel, significant sockets. This is identical to the connector on harness that plugs into generator.



Connection 2, plug on Generator Panel, supplying shunt box.

<u>TEST 1.</u>
Ignition switch 'ON', Ignition warning light 'OFF', engine stationary.

Does oil warning light come 'ON' or oil pressure gauge register?
NO – Land Rover TEST 1(b)
NO – Stalwart TEST 1(c)
YES – Check ign W/L bulb.
    Defective – Replace bulb
    OK - Switch 'OFF' ign switch. Disconnect con 2 from gen panel. Link pins E & C on disconnected harness with jumper lead. Switch 'ON' ign switch. Does ign W/L come 'ON'?
        YES – See TEST 1(a)
        NO – Land Rover TEST 1(d)
        NO – Stalwart TEST 1(e)

TEST 1(a)

Switch 'OFF' ign switch. Reconnect con 2 on gen. Disconnect con 1 on gen panel and link skts A & W on gen panel socket 1 with jumper lead. Switch 'ON' ign switch. Does ign W/L come 'ON'?

NO – Repair or replace gen panel

YES- Measure CR between pins A & X on disconnected harness (0 ohms)

> **Other than 0 ohms.** Disconnect harness at gen
>
> > Measure CR on gen between pins A & X (0 ohms) and pins U & V (14.5–90 ohms) (see note 8)
> >
> > > **OK** – Replace or repair harness
> > >
> > > **Fault** – Repair or replace generator
>
> **0 ohms.** Measure CR between pins U & V on disconnected harness (14.5–90 ohms) (see note 8)
>
> > **OK** – repair or replace generator panel (fault = open circuit in field circuit in panel)
> >
> > **Fault** - disconnect harness at generator, measure CR on generator between pins A & X (0 ohms) and also pins U & V (14.5–90 ohms) (see note 8)
> >
> > > **OK** – Replace or repair harness
> > >
> > > **Fault** – Repair or replace gen

TEST 1(b) (Land Rover)

Do other ignition switched circuits operate (fuel gauge, screen wipers)?

NO – check harness lead (white) from ignition switch controlled fuse A3 to six-way switch

> **Fault –** Repair lead
>
> **OK** – Check harness lead from terminal 1 on six-way switch to vehicle ammeter for open circuit.
>
> > **Fault** – Repair lead
> >
> > **OK** – Replace six-way switch

YES – disconnect lead (white) from double connector at rear of instrument panel

Check for open circuits between fuse A3 and disconnected lead

> **Fault** – Repair or replace harness
>
> **OK** – Check ignition & oil W/L bulbs
>
> > **Fault** – Replace bulbs
> >
> > **OK** - Means two faults could exist (i.e. oil warning & ignition warning circuits)
> >
> > > 1. Oil W/L – check for open circuit (commonly faulty engine sensor or its terminal)
> > > 2. Ignition W/L – switch 'OFF' ignition switch, disconnect con 2 from generator panel, link pins E & C on disconnected harness with jump lead, switch 'ON' ignition switch.
> > >
> > > Does ignition W/L come 'ON'?
> > >
> > > > **YES** – see TEST 1(a)
> > > >
> > > > **NO** – see TEST 1(d)

TEST 1(c) (Stalwart)

Check supply from ammeter shunt to con ign + below instrument panel

Fault – Repair harness lead ign + to ammeter shunt

OK – Disconnect ign sw lead from con R & F below instrument panel and check voltage supply

> > **Doesn't read battery voltage** – Measure CR from con ign + to disconnected lead at con R & F should read 0 ohms
> >
> > > **OK** – Check mating of supply lead to con ign +
> > >
> > > **Fault** – Replace ignition switch
> >
> > **Reads battery voltage** – Disconnect tacho lead from con R & F, measure CR from con R & F and con INS
> >
> > > **170 ohms** – Defective thermal magnetic circuit breaker in distribution panel
> > >
> > > **0 ohms –** Check circuit to ignition warning light via INS con (3) for open circuit
> > >
> > > **Infinity** - Disconnect con 7 from distribution panel, measure CR from con R & F & DP7A, should read 0 ohms
> > >
> > > > **Defective** – Repair lead

OK – Measure CR from ammeter INS & DPD should be 0 ohms
Defective – Repair lead
OK – Repair or replace distribution panel

<u>TEST 1(d) (Land Rover)</u>
Check for open circuit between double connector at rear of instrument panel (white lead) & gen panel con 2, pin E.

- **OK** – Check mating of white lead to double connector
- F**ault** – Check for open circuit from double connector to single connector (yellow Unipren)
  - **Fault** – Repair lead
  - **OK-** Check circuit from single con (blue lead) to generator panel plug 2, pin E
    - **Fault** – Repair lead
    - **OK** – Check mating of leads to single connector

<u>TEST 1(e) (Stalwart)</u>
Switch ON boiling vessel relay. Does ign W/L come on?

- **YES** – Repair or replace harness, gen panel con 2, lead E to P at con junction below instr panel
- **NO** – Check ign W/L circuit from P at con junction below instr panel to ign switch. Replace or repair defective harness lead or ign W/L holder

<u>TEST 2</u>
Engine running, ignition W/L 'ON', ammeter(s) read charge.

Stop engine, disconnect con 2 from gen panel, switch ignition 'ON', does ignition W/L come 'ON'?

- **YES** – Land Rover, see TEST 2(a)
  Stalwart, see TEST 2(b)
- **NO** – Switch 'OFF' ignition switch, reconnect con 2 to gen panel, disconnect con 1
  Switch 'ON' ignition switch. Does ignition W/L come 'ON'?
  - **YES** – Repair or replace gen panel (fault = earth problem pin 2E to pin 1A in panel)
  - **NO** – Switch 'OFF' ignition switch.
    Reconnect con 1 to gen. Disconnect harness at gen
    Switch 'ON' ignition switch. Does ignition W/L come 'ON'?
    - **NO** – Repair or replace generator
    - **YES** – Repair or replace harness (fault = gen con 1 to gen lead A to earth or W)

<u>TEST 2(a) (Land Rover)</u>
Check for earth fault from gen panel con 2, pin E on disconnected harness to ignition W/L (Unipren lead) – repair earth fault.

<u>TEST 2(b) (Stalwart)</u>
Switch 'OFF' ign switch. Disconnect P lead from ign W/L at con junction below instr panel. Switch 'ON' ign switch. Does ign W/L come 'ON' ?

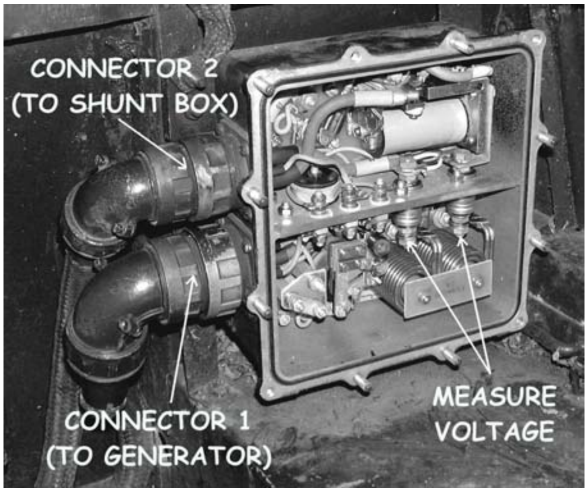
- **YES** – Defective ign W/L holder or earth fault on lead from ign W/L to con junction. Repair or replace W/L holder or harness lead
- **NO** – Switch 'OFF' ign switch. Reconnect P line at con junction. Disconnect lead to boiling vessel relay at con junc. Switch 'ON' ign switch. Does ign W/L come 'ON' ?
  - **YES** – Replace or repair harness gen panel con 2 to con junction lead E (earth fault)
  - **NO** – Switch 'OFF' ign switch. Reconnect lead to boiling vessel relay at con junction. Disconnect harness at boiling vessel relay. Switch 'ON' ign switch. Does ign W/L come 'ON' ?
    - **YES** – Replace or repair harness from con junction to boiling vessel relay (earth fault)
    - **NO** – Replace or repair boiling vessel relay box (earth fault)

TEST 3
Engine running, ignition W/L 'ON', ammeter(s) read zero

Stop engine, measure battery voltage at inspection sockets or batteries. Note voltage.
Run engine at fast idling speed. Does voltage at inspection sockets or batteries rise above previous reading?

YES –Land Rover, see TEST 3(a)
Stalwart, see TEST 3(b)

NO – Remove cover from gen panel & measure voltage between smoothing chokes.
(This measures generator output voltage)



Reads 0 volts – see TEST 3(c)
Reads 1 to 5 volts – see TEST 3(d)
Reads 5 to battery voltage – see TEST 3(e)
Reads above battery voltage – see TEST 3(f)

TEST 3(a) (Land Rover)
Stop engine, replace ammeter – see TEST 2

TEST 3(b) (Stalwart)
Stop engine. Check ammeter circuit from shunt to ammeter for open circuit.

OK – Replace ammeter, see Test 2
Fault – Replace or repair harness leads, see Test 2

TEST 3(c)
Generator voltage reads 0 volts - check generator drive belt tension

Fault – Adjust tension or renew driving belts
OK – Disconnect con 1 from gen panel. Measure CR between X & W on disconnected harness, (80-110 ohms on Avo 7, 285-315 ohms on Avo 12), reverse resistance should exceed 10,000 ohms

NO - Disconnect con from generator. Measure CR through each lead X, W, U & V. Measure IR between each lead X, W, U & V.
Should be no continuity between pins U & V on harness,
Should be no continuity between pins X & W on harness
Fault – Repair or replace harness
OK – Repair or replace generator

YES – (with generator con in place, con 1 off generator panel) measure CR between pin U & V on disconnected harness should be 14.5–90 ohms (see note 8)
OK – repair or replace generator panel (= fault between leads X & W, short or open circuit)
Fault – Disconnect con at gen. Measure CR between pins U & V (14.5–90 ohms) (see note 8)
Fault – Repair or replace generator
OK – Repair or replace harness from generator to plug 1 of generator panel

<u>TEST 3(d)</u>
Generator voltage reads between 1-5 volts, increase engine speed to max, does voltage rise to 28-29 volts?

Yes – Stop engine, replace generator
No – Stop engine, switch 'OFF' ignition switch, disconnect plug 1 from generator panel, measure CR between pins U & V on disconnected harness (14.5-90 ohms) (see note 8). Measure IR
- **OK** – Repair or replace harness generator to generator panel (fault = field circuit in panel)
- **Fault** – Disconnect harness at generator.
  Measure CR pins U & V on gen (14.5-90 ohms)(see note 8). Measure IR pins U & V
  - **OK** – Repair or replace harness (gen to gen panel)
  - **Fault** - Repair or replace generator

<u>TEST 3(e)</u>
Generator voltage reads between 5 – battery voltage, increase engine speed to max, does voltage rise to 28-29 volts?

Yes – Stop engine, replace generator
No – Adjust voltage regulator. Was regulator adjustment previously set correctly?
- **Yes** - see TEST 10
- **No –** Stop, engine, switch 'OFF' ignition switch, replace generator panel

<u>TEST 3(f)</u> (on completion of this test adjust voltage regulator)
Generator voltage reads above battery volts
Two possible faults. See TEST 2 or proceed. Does battery relay close?

YES – Stop engine, disconnect gen panel con 2, close the battery relay by hand, measuring resistance between pins 2A & 2B on generator panel, should read 0 ohms
- **Other than 0 ohms –** Clean relay contacts / replace relay / replace generator panel
- **0 ohms –** Fault = Open circuit between gen panel plug 2 and inspection socket or batteries

NO –Measure 'Generator only' voltage in generator panel between dividing bulkhead terminal (red lead, F) & earth
- **Above 21 volts** – Stop engine, repair relay coil circuit in generator panel or replace generator panel
- **Below 21 volts** – Stop engine, disconnect con 1 from gen panel, measure CR from gen panel, socket 1 pin F to dividing bulkhead terminal.
  - **Other than 0 ohms** – Repair faulty lead in gen panel or replace panel
  - **0 ohms** – Disconnect harness from generator
    Measure IR & CR of harness lead F
    - **Other than 0 ohms** – Repair or replace harness
    - **0 ohms** – Replace generator

<u>TEST 4 (Land Rover)</u>
Engine running, ignition warning light 'ON', vehicle ammeter reads charge, radio ammeter reads zero
Two possible faults. See TEST 2 or proceed. Measure voltage at radio battery terminals.

Correct voltage, 28-29 volts – Stop engine, replace radio ammeter
Same as vehicle battery voltage – Stop engine, disconnect con 2 from gen panel, measure CR of pin B on disconnected harness to radio battery positive lead
- **Other than 0 ohms** – Repair or replace harness
- **0 ohms** – Repair or replace gen panel (fault = battery relay contacts)

TEST 5 (Land Rover)
Engine running, ignition warning light 'ON', vehicle ammeter reads zero, radio ammeter reads charge
Two possible faults. See TEST 2 or proceed. Measure voltage at vehicle battery terminals

Correct voltage, 28-29 volts – Stop engine, replace vehicle ammeter
Battery voltage – Stop engine, disconnect con 2 from gen panel, measure resistance of pin A on disconnected harness to vehicle battery positive lead
- **Other than 0 ohms** – Repair or replace harness
- **0 ohms** – Repair or replace gen panel (fault = battery relay contacts)

TEST 6
Engine running, ignition warning light 'OFF', ammeter(s) read zero.

Stop engine, note battery voltage at inspection sockets or batteries, run engine, remove cover from generator panel & measure generator voltage between smoothing chokes (= generator voltage).
Reads 5 to battery volts – see TEST 3(e)
Reads above battery voltage – see TEST 3(f) starting from 'Does battery relay close?'

TEST 7 (Land Rover)
Engine running, ignition warning light 'OFF', vehicle ammeter reads charge, radio ammeter reads zero.

Measure voltage at radio battery terminals
Correct voltage 28-29 volts – Stop engine, replace radio ammeter
Radio battery voltage – See TEST 4 starting after 'Battery voltage'

TEST 8 (Land Rover)
Engine running, ignition warning light 'OFF', vehicle ammeter reads zero, radio ammeter reads charge.

Measure voltage at vehicle battery terminals
Correct voltage 28-29 volts – Stop engine, replace vehicle ammeter
Vehicle battery voltage – See TEST 5 starting after 'Battery voltage'

TEST 9
Engine running – batteries over-heating / gassing. Measure voltage at inspection light socket.

Temperate climate should be 28-29 volts
- **Incorrect voltage –** Adjust voltage regulator
- **Correct voltage -** Replace batteries

Tropical climate should be 26-27 volts
- **Incorrect voltage –** Adjust voltage regulator
- **Correct voltage –** Stop engine, put 'High / Low' link in 'Low' position, run engine, measure voltage at inspection light socket.
  - **Incorrect voltage** – Repair or replace generator panel
  - **Correct voltage** – Replace batteries

TEST 10
Engine running – low charging rate, i.e. 'flat' batteries.

Remove cover from gen panel & measure voltage between smoothing chokes (= generator voltage)
Correct voltage (28-29 volts) - Got to TEST 10(a)
Incorrect voltage – Adjust voltage regulator
- **Adjustment gives correct voltage** – Go to TEST 10(a)
- **Adjustment fails to give correct voltage** – Repair or replace generator panel

TEST 10(a)
Engine running – low charging rate but correct voltage (28-29 volts)

Increase engine speed to 1,700 rpm (generator 3,000 rpm)

Increase load on generating system by connecting additional batteries & turning on equipment until ammeter(s) read 40-60 amps. (On AEC Recovery Vehicle connect an ammeter in main charging line). Does generator voltage fall below 28-29 volts?

NO – Stop engine, replace batteries

YES – Stop engine, disconnect con 1 on gen panel. Disconnect harness on gen. Check in turn CR between pins P & R, P & T, R, & T. (These leads are not used in transistorised regulator)

No circuit (i.e. harness good) – Replace generator

Yes (i.e. some shorting or leakage) – Repair or replace harness

TEST 11 (AEC Recovery Vehicle)
Engine running, charge W/L remains 'ON'

Measure voltage across battery terminals. Note voltage.
Run engine. Does voltage rise above previous value?

NO – see Test 3 after 'NO'

YES – Stop engine, switch 'OFF' charging W/L switch. Disconnect con 2 from gen panel. Switch charge W/L 'ON'. Does charge W/L come 'ON'?

NO – see Test 2 after first 'NO' (for ign switch read W/L switch & ign W/L read charge W/L)

YES - Switch 'OFF' charge W/L switch. Disconnect lead from charge W/L at Fuse & Dist panel, terminal ALT W/L. Does W/L come 'ON'?

NO – Repair or replace harness lead, gen panel 2, socket E to ALT/W/L terminal on Fuse & Distribution panel.

YES – Defective charge W/L holder or earth fault on lead from terminal ALT/W/L to charge W/L holder.

TEST 12 (AEC Recovery Vehicle)
Engine stationary, charge W/L switch 'ON', charge W/L 'OFF'.

Does starter operate?
NO - see Test 12(a)
YES – check charge W/L bulb

Defective – Replace bulb

Serviceable – Switch 'OFF' charge W/L switch. Disconnect connector 2 from gen panel. Link skts E & C on disconnected harness with jumper lead. Switch 'ON' charge W/L switch. Does charge W/L come 'ON'?

YES – See Test 1(a) (for ign switch read W/L switch & ign W/L read charge W/L)

NO – Switch 'OFF' charge W/L switch. Link ALT/W/L terminal to neg at Fuse & Dist panel with jumper lead. Switch 'ON' charge W/L switch. Does charge W/L come 'ON'?

NO – See Test 12(b)

YES – Check CR & IR of lead ALT/W/L top gen panel con 2, skt E

Defective – Replace or repair harness

TEST 12(a) (AEC Recovery Vehicle)
Measure voltage between B+ and negative terminals on Fuse & Dist Panel

Reads 0 volts – Check for break in supply from B+ terminal to battery via isolating switch

Reads battery voltage – Check CR & IR of lead from B+ terminal on Fuse & Dist Panel to 6-way switch

Defective - Replace or repair lead

Serviceable - Replace or repair defective 6-way switch or connection at B+ terminal

TEST 12(b) (AEC Recovery Vehicle)
Does fuel gauge register?

NO – Check CR & IR of lead from aux 1 terminal on Fuse & Dist Panel to 6-way switch
- **Defective** - Replace or repair lead

YES – Check CR of lead from aux 1 terminal on Fuse & Dist Panel to charge W/L
- **Defective** - Replace or repair lead
- **Serviceable** - Check CR & IR of lead from ALT/W/L terminal on Fuse & Dist Panel to charge W/L
  - **Defective** - Replace or repair lead
  - **Serviceable** – Replace or repair charge W/L bulb holder

TEST 13
Ignition switch 'OFF', ignition warning light glows dim
Disconnect con 2 from gen panel. Check battery relay contacts. Are they open?

YES – Check IR between skts A & E on disconnected harness
- **No circuit (i.e. harness good)** – Replace gen panel
- **Shorting or leakage** – Repair or replace harness

NO – Are the relay contacts welded together?
- **NO** – Repair or replace gen panel
- **YES** – Disconnect vehicle & radio battery negative leads. Measure IR between pins A to C and B to 6 on disconnected harness
  - **No circuit (i.e. harness good)** – Repair or replace gen panel
  - **Shorting or leakage** – Repair or replace harness or radio battery lead stowage box. If still a problem replace or repair gen panel

Given the vulnerability of the loom and its connectors it is surprising that there is such little enthusiasm to purchase a spare loom for substitution tests. I have seen one loom priced at £5 remain on a dealers stall for over a year! Substitution of a pre-tested loom requires very little effort compared with the work required removing the generator. So any tests that give additional confirmation of where a fault may lie helps reduce the frustration of removing large components unnecessarily.

A spare loom is useful for faultfinding and to have as a replacement.

Trivia
Something for EMER fetishists. EMERs are divided into part, section and regulation. Meggers have had a varied EMER part classification over the years. During WW2 meggers were put in EMER TEST & MEASUREMENT which seems logical enough. Some were put in EMER SEARCHLIGHTS & INSTRUMENTS, although this EMER part was later to absorb principally optical instruments. Even so, during the war some meggers were also put in EMER TELECOMMUNICATIONS. After the war this practice continued but with the vast expansion of radio and electronic equipment, the part series became overloaded and some sections re-designated several times. Eventually all such instruments were put in EMER TEST & MEASUREMENT. Details are also given in the Compendium of Army Electronic Test Equipment (CAETE).

Although Evershed and Vignoles manufactured Meggers, they were later manufactured under the brand name Megger. They continue to be manufactured together with Avometers under the banner of Avo Megger Instruments Ltd.