

Ohms Law
Less resistance more current





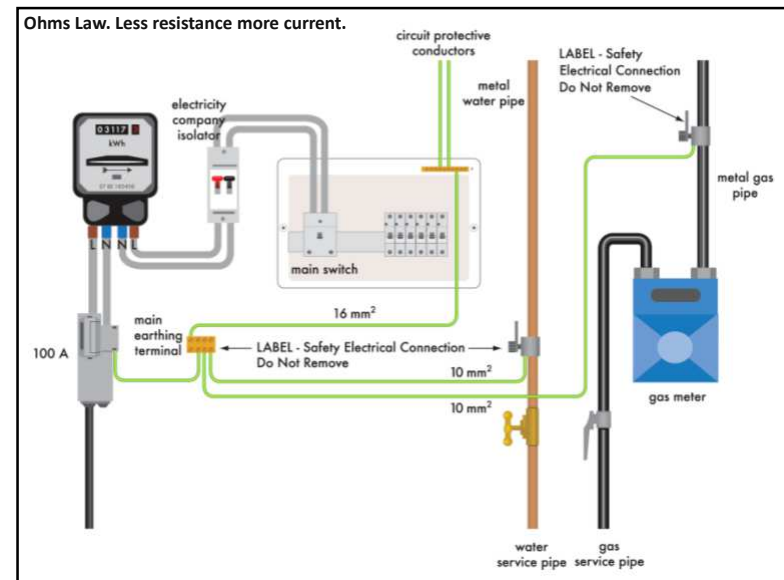
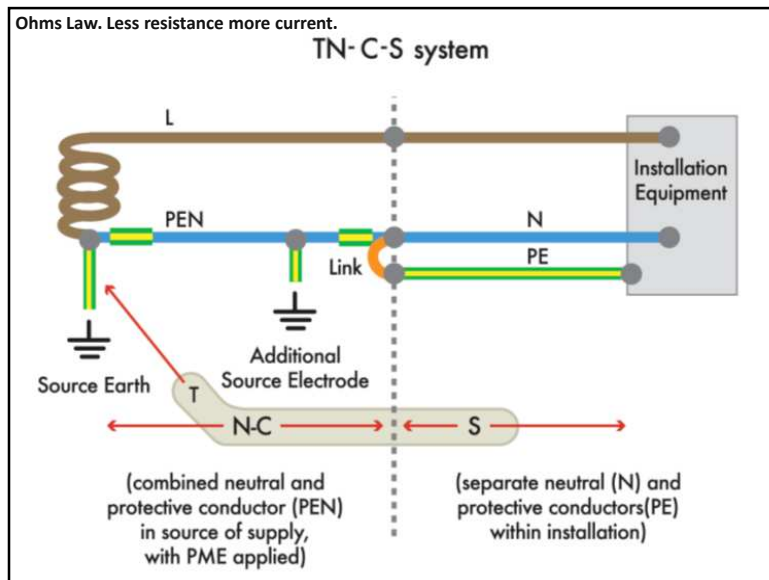

INSPECTION & TESTING



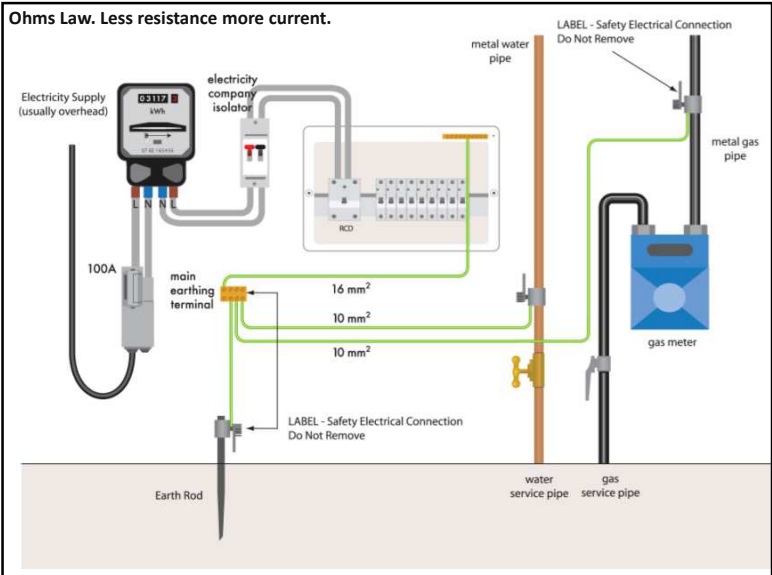
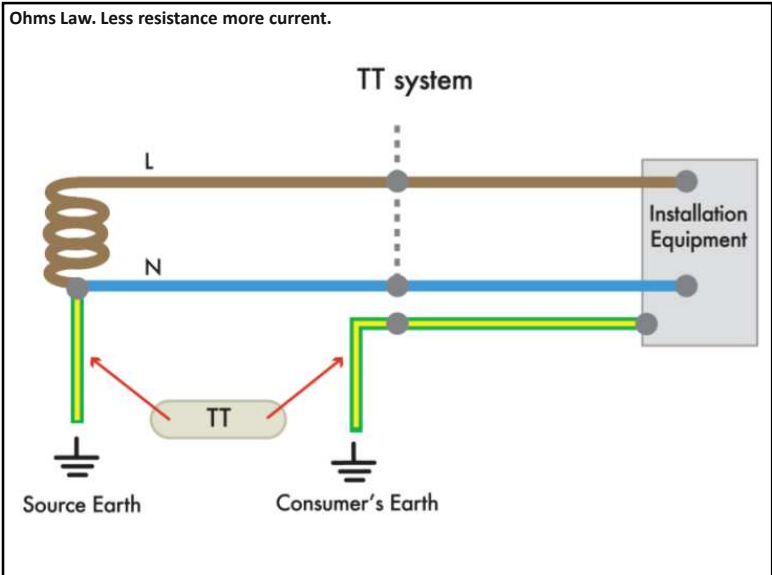
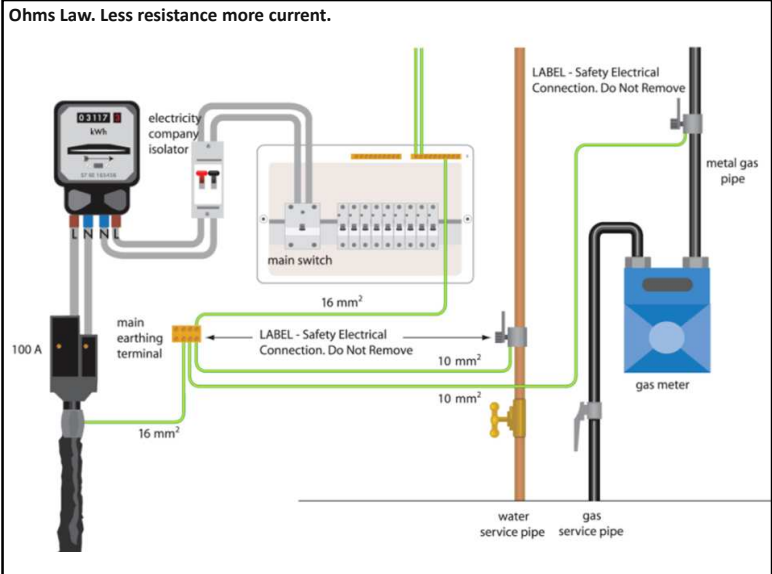
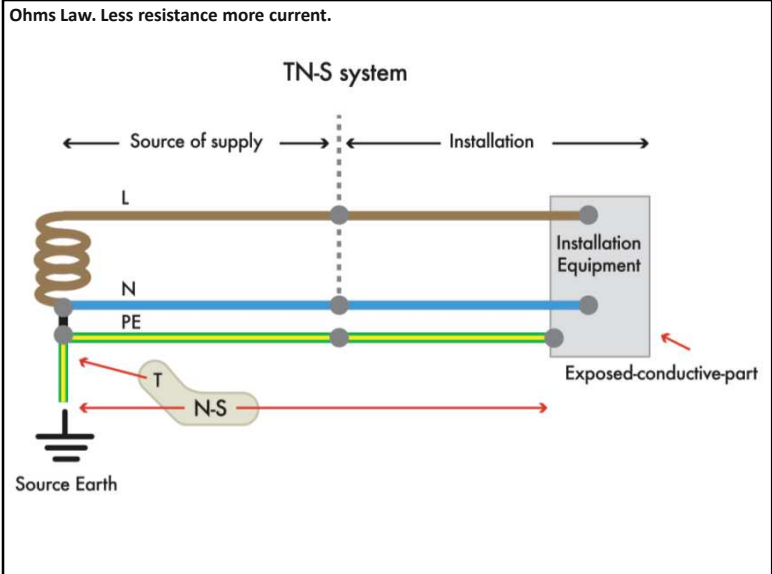
Reasons for Periodic Inspection

- Requirements of legislation
- Requirements of licensing authorities
- Change of owner/tenancy
- Change of use
- Alteration to original installation
- Significant change in loading
- When it has been damaged





Hamandy Electrician Inspection & Testing



Initial Verification

- Section **311** – Maximum demand
- Section **312** – Arrangement of live conductors and type of earthing
- **Regulation 514.9.1** – Charts, diagrams and tables and other technical information etc. should be available to the person carrying out the verification and testing



Statutory Regulations

- Electricity at Work Regulations (1989)
- Electricity Safety Quality and Continuity Regulations (2002)



Test sequence – New Installations

- **612.2 / 612.2.1 - Continuity of conductors including main and supplementary equipotential bonding**
- **612.2.2 – Continuity of ring final circuits**
- **612.3 – Insulation resistance**
- **612.6 – Polarity**
- **612.9 – Earth Fault Loop Impedance**
- **612.13 – Functional testing**
e.g., Operation of **RCD's**



Information required

- Type and disposition of each circuit
- Identification and location of protection, isolation and switching devices
- Circuits or equipment vulnerable to certain tests
- Protection devices for automatic disconnection, earthing arrangements and relevant impedances

Responsibilities for signing Electrical Installation Certificate

- The design
- The construction
- The inspection and testing



Ohmmeter



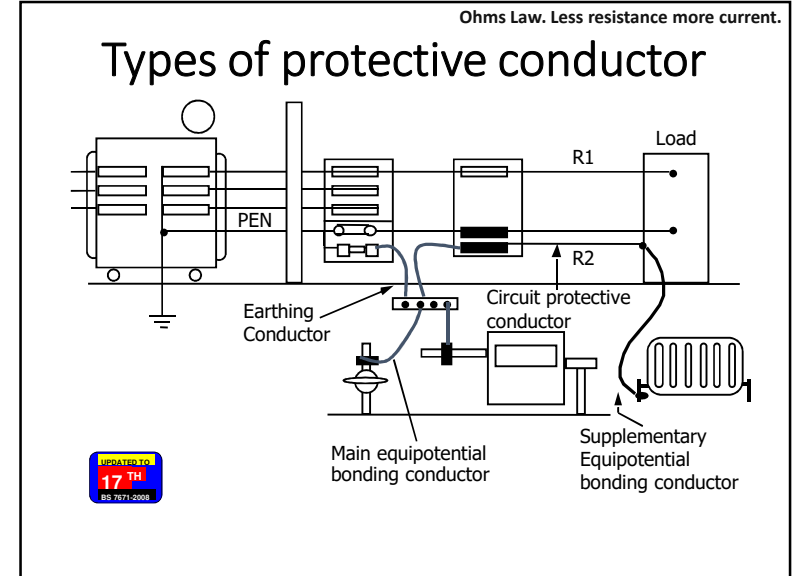
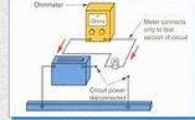
- Instruments to BSEN61557-4
- Test current A.C. or D.C., no-load voltage 4 - 24V
- Short-circuit current not less than 200mA (0.2A).
- Measuring range covers a span of at least 0.2Ω to 2Ω
- Digital resolution must be 0.01Ω



Ohms Law. Less resistance more current.

Ohmmeter

An Ohmmeter is used to measure Resistance...
Always – place across the device
Never – test while power is applied to circuit
Units – Ohms (Ω) 1.0
 Kilo-ohms (K Ω) 1,000
 Megaohms (M Ω) 1,000,000



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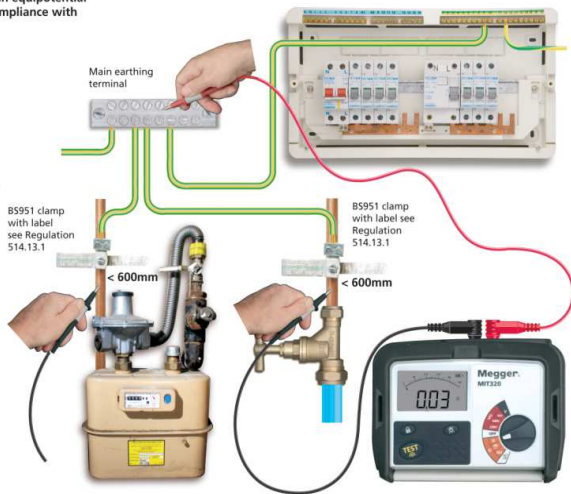
Checking continuity of main equipotential bonding conductors for compliance with Regulation 612.2

As required by Regulation 544.1.2, the main equipotential bonding connection to any gas, water or other service shall be made as near as practicable to the point of entry of that service into the premises.

Where there is an insulating section or insert at that point, or there is a meter, the connection shall be made to the consumer's hard metal pipework and before any branch pipework.

Where practicable the connection shall be made within 600 mm of the meter outlet union or at the point of entry to the building if the meter is external.

For copper or copper-equivalent, main equipotential bonding conductors the minimum cross-sectional area is 6 sq mm and subject to a maximum of 25 sq mm except for PME supplied installations where the minimum csa is in accordance with Table 54.8 of BS7671



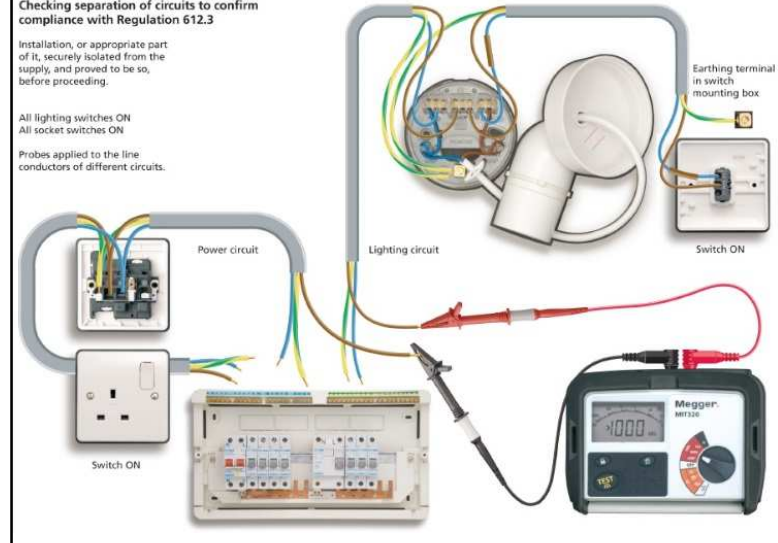
Checking separation of circuits to confirm compliance with Regulation 612.3

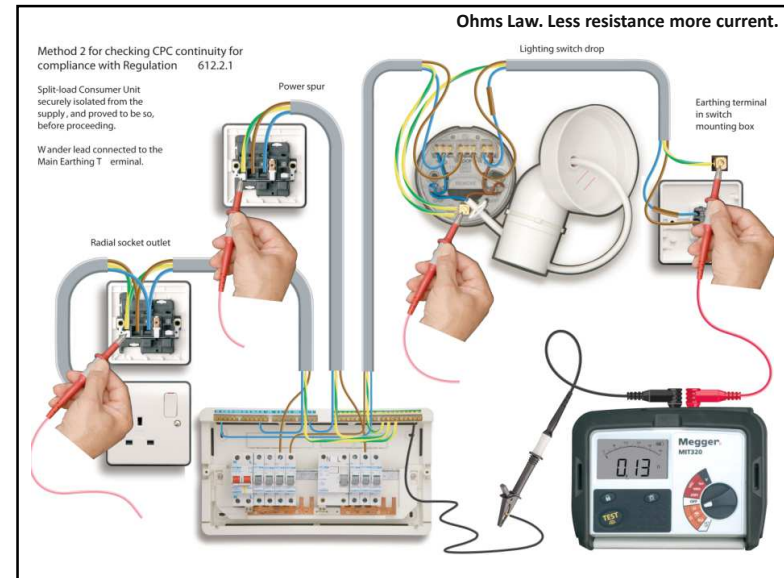
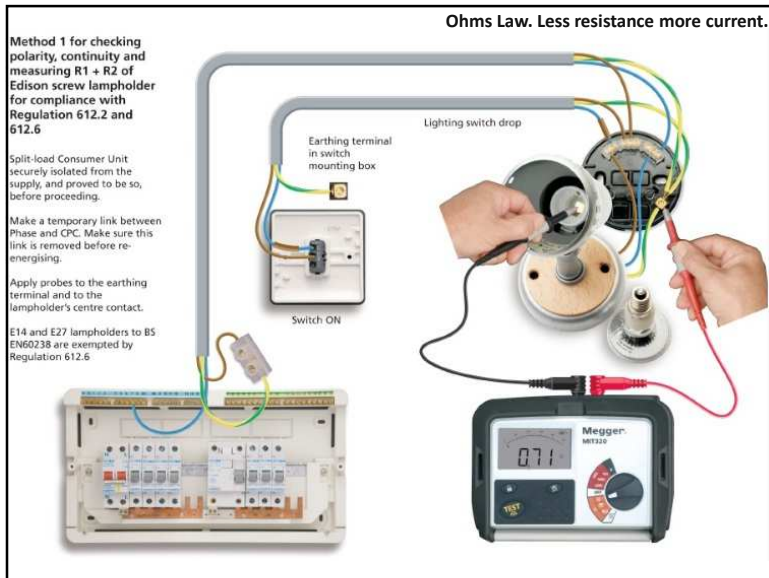
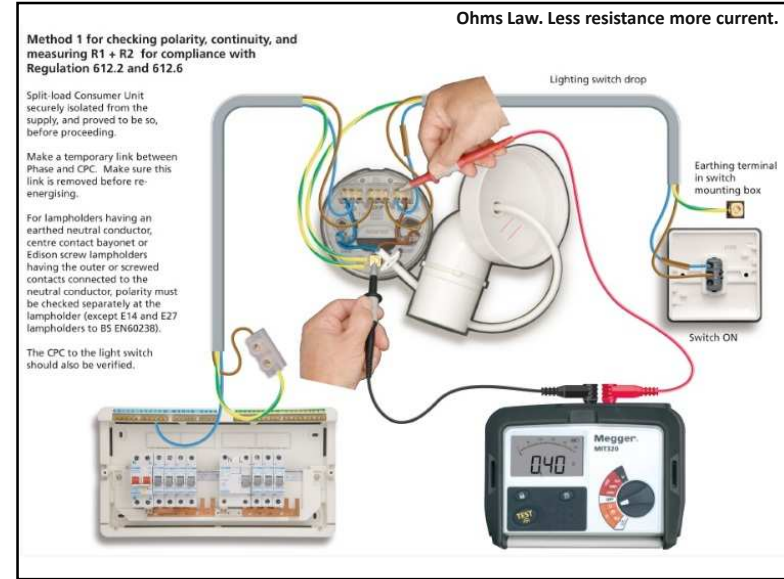
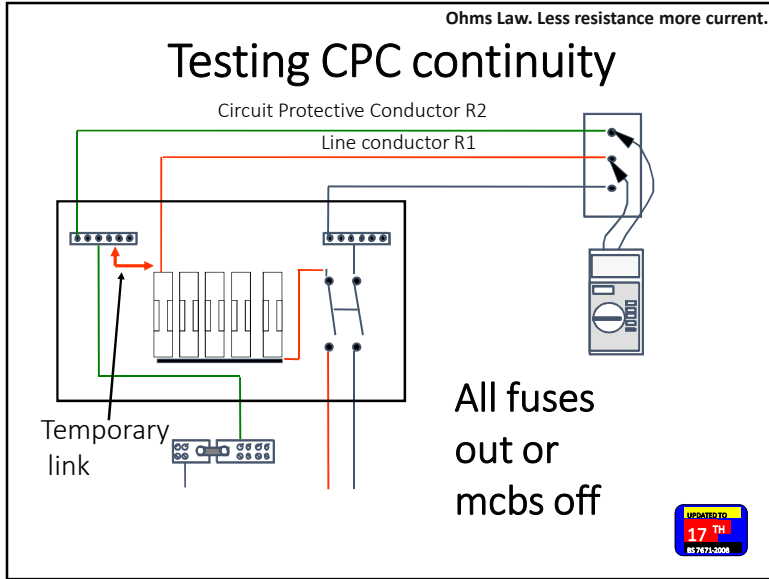
Installation, or appropriate part of it, securely isolated from the supply, and proved to be so, before proceeding.

All lighting switches ON

All socket switches ON

Probes applied to the line conductors of different circuits.





Checking continuity of live and protective conductors of a ring final circuit for compliance with Regulation 612.2.2 - Step 1

Installation, or appropriate part of it, securely isolated from the supply, and proved to be so, before proceeding

Measure resistance of each loop in turn of phase, neutral and circuit protective conductors and record measured data, r_1 , r_n and r_2 respectively.

Where the CPC is the same cross sectional area as the live conductors, the resistance values for the three conductors should be the same (within 50 mΩ). Where the CPC is 1.5 sq mm and the live conductors are 2.5 sq mm, the measured value of the CPC should be 1.67 times that of one of the live conductors.

For Steps 2, 3a and 3b see other diagrams.

Checking continuity of ring final circuit conductors for compliance with Regulation 612.2.2 - Step 2

Installation, or appropriate part of it, securely isolated from the supply, and proved to be so, before proceeding.

Cross-connect the incoming neutral conductor with the outgoing phase of the circuit, and vice versa. Measure the resistance phase to neutral and note the result which should be approximately half the measured value of the phase or neutral conductor measured separately as in Step 1

Alternatively the measured value at each socket-outlet should be substantially the same. This measurement would be $\frac{(r_1 + r_2)}{4}$ or $\frac{(r_1 + r_n)}{4}$

For Steps 1, 3a and 3b see other diagrams.

Open ring test (1)

Line

cpc

Neutral

Closed ring test (2)

Temporary links

Test at each Outlet

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Checking continuity and polarity of final circuit conductors for compliance with Regulation 612.2.2 - Step 3a - ring final circuit with no spur

Installation, or appropriate part of it, securely isolated from the supply, and proved to be so, before proceeding.

Cross-connect the incoming phase with the outgoing circuit protective conductor (CPC) of the circuit and vice versa. Measure the resistance of phase and CPC and note the result.

The measured value at each socket-outlet and at the consumer unit should be substantially the same. This measurement would be $\frac{r_1 + r_2}{4}$

Correct verification of rings also proves correct polarity but only on ring circuits.

For Steps 1, 2 and 3b, see other diagrams.

Use lead 6220-810
Connect red and green plugs

Ohms Law. Less resistance more current.

Checking continuity of ring final circuit conductors for compliance with Regulation 612.2.2 - Step 3b - ring final circuit with unintentional spurs

Installation, or appropriate part of it, securely isolated from the supply, and proved to be so, before proceeding.

Measurement to be taken at each and every socket-outlet. Measured values should be the same at each point including at the Consumer's Unit.

For Steps 1, 2 and 3a, see other diagrams.

Three sockets unintentionally connected as a spur and not within the ring.

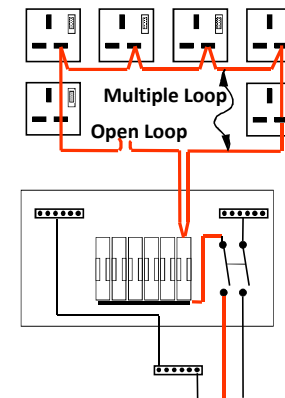
Use lead 6220-810
Connect red and green plugs

Ring circuit test – (3)

- The test is repeated using the Line and CPC
- The highest value is recorded and represents the maximum (R1 + R2) and can be used to determine the Zs
- $r_1 + r_2/4 = \text{Max } R_1 + R_2$
- i.e., $\frac{1}{2}$ length and double csa = $\frac{1}{4}$ resistance



Ring-circuit problems



Insulation resistance tester

- Instruments to BS EN 61557-2 / BS EN 61557-4
- This can take the form of the continuity range of an **Insulation resistance** / Continuity tester
- Output current 1mA / accuracy required +/-5%
- Must be capable of developing the test voltage across the load:
- 250v SELV-PELV
- 500v Circuits rated up to 500v excluding ELV
- 1000v Circuits rated between 500v & 1000v

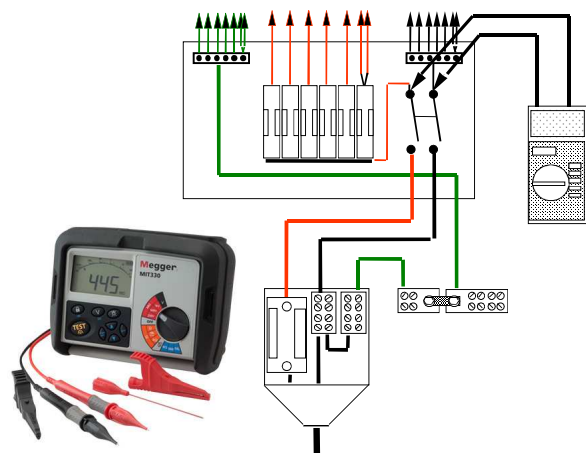


Preparation for Insulation Resistance testing

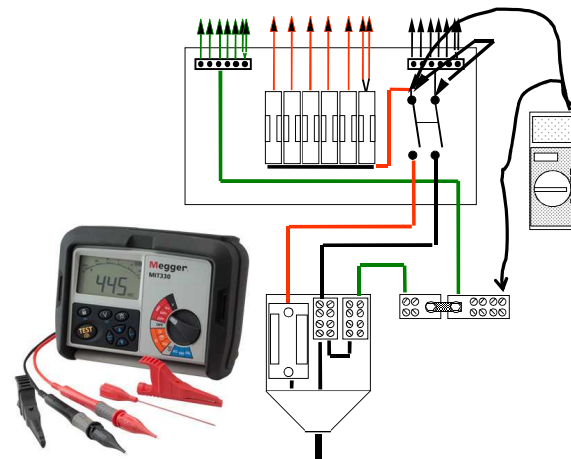
- Supply 'OFF'
- All switches 'ON'
- Remove all lamps and loads
- Disconnect all electronic equipment
- Identify and switch off all accessories with pilot lamps
- All fuses 'IN' / All MCBs 'ON'



Insulation testing-between live conductors



Insulation Testing between Live Conductors and CPC



Insulation resistance tester

- Instruments to BS EN 61557-2 / BS EN 61557-4
- This can take the form of the continuity range of an **Insulation resistance / Continuity tester**
- Output current 1mA / accuracy required +/-5%
- Must be capable of developing the test voltage across the load:
- 250v SELV-PELV
- 500v Circuits rated up to 500v excluding ELV
- 1000v Circuits rated between 500v & 1000v



UPDATED TO
17TH
BS 7671:2008

Checking insulation resistance between live conductors and protective conductor connected to the earthing arrangement, for compliance with Regulation 612.3.1

The Consumer Unit must be securely isolated from the supply, and proved to be so, before proceeding.

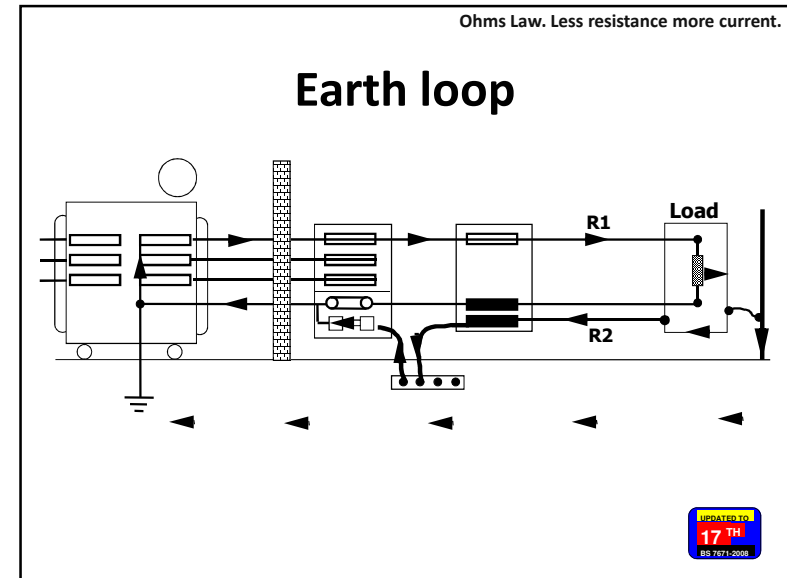
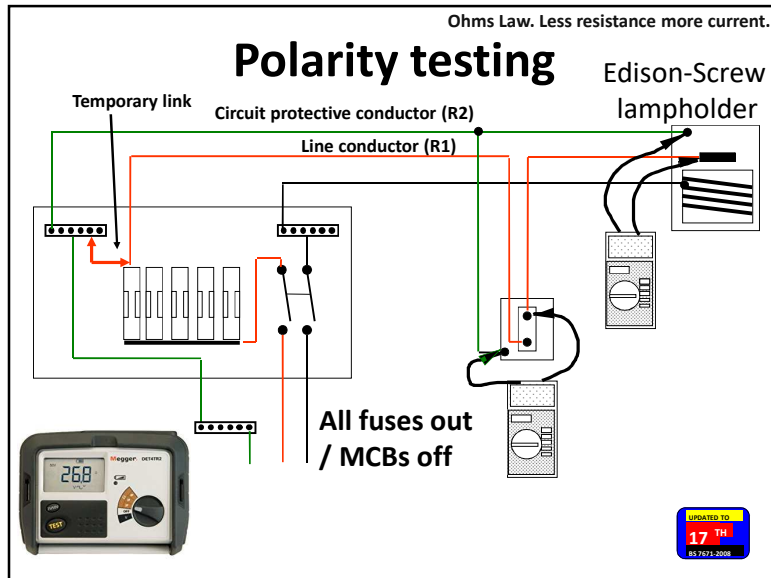
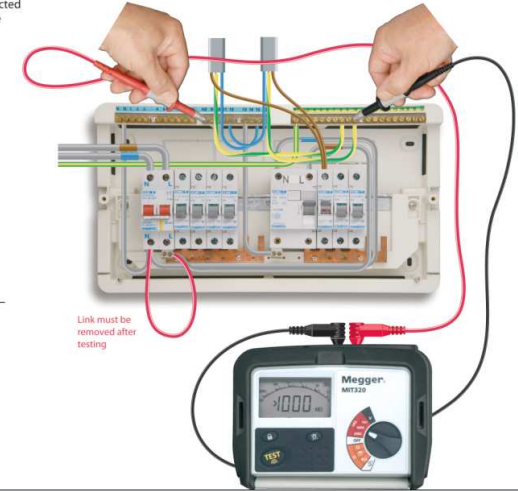
Live and neutral conductor may be connected, where appropriate, during measurement

Link must be removed after testing

Consumer Unit shown with the cover removed for illustration purposes. Normally all live parts would be behind barriers or an enclosure providing at least IP2X or IPXXB protection as appropriate.

Insulation test voltage and insulation resistance minimum values

	DC test voltage	Min insulation resistance
SELV & PELV	250 V	>= 0.5 Mohms
Up to 500V	500 V	>= 1.0 Mohms
Above 600V	1000 V	>= 1.0 Mohms



Loop Impedance tester

- Instruments to BSEN61557-3
- These circulate current from the Line conductor into the protective earth.
- This will therefore raise the potential of the protective earth system.
- Test duration should be within safe limits.
- Instrument should cut off the test after typically 40mS.
- Transient variations of mains voltage can introduce field errors during tests therefore the test should be repeated at least once.
- For circuits rated up to 50A a resolution of 0.01Ω is acceptable.
- **Can also provide function for measuring Prospective Short Circuit Current.**



On single phase installations PEFC is usually higher.

Note: Refer to manufacturer's instructions for correct connection

Fig 1b Line-to-earth test

Prospective Earth Fault Current test sequence

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Note: Refer to manufacturer's instructions for correct connection

Fig 1a Line-to-neutral test

Prospective Short Circuit Current test sequence

Ohms Law. Less resistance more current.

Measurement of earth fault loop impedance, Z_s , at lighting points for compliance with Regulation 612.9

Lighting circuit is fed from one side of the split-load Consumer Unit. The measurement is taken at the furthest point electrically from the Consumer Unit.

Consumer Unit shown with cover removed for illustration purposes. Normally all live parts would be behind barriers or an enclosure providing at least IP2X or IPXXB protection as appropriate.

Lighting switch drop

Earthing terminal in switch mounting box

Main switch ON
Circuit breaker ON
Light switch ON

Ohms Law. Less resistance more current.

Measurement of earth fault loop impedance of final ring circuits for compliance with Regulation 612.9

Socket outlet circuit is fed from one side of the split-load Consumer Unit protected by a RCD. Z_s is measured at every socket and the highest reading recorded.

Consumer Unit shown with cover removed for illustration purposes. Normally all live parts would be behind barriers or an enclosure providing at least IP2X or IPXXB protection as appropriate.

Socket outlets to BS1363

Switch on

Use lead 6220-810 Connect red (phase) and green (earth) plugs

Main switch ON
Circuit breaker ON
Outlet switch ON

Ohms Law. Less resistance more current.

Loop Impedance tester

- Instruments to BSEN61557-3
- These circulate current from the Line conductor into the protective earth.
- This will therefore raise the potential of the protective earth system.
- Test duration should be within safe limits.
- Instrument should cut off the test after typically 40mS.
- Transient variations of mains voltage can introduce field errors during tests therefore the test should be repeated at least once.
- For circuits rated up to 50A a resolution of 0.01Ω is acceptable.
- **Can also provide function for measuring Prospective Short Circuit Current.**



When testing Z_e you remove all parallel paths. Ohms Law. Less resistance more current.

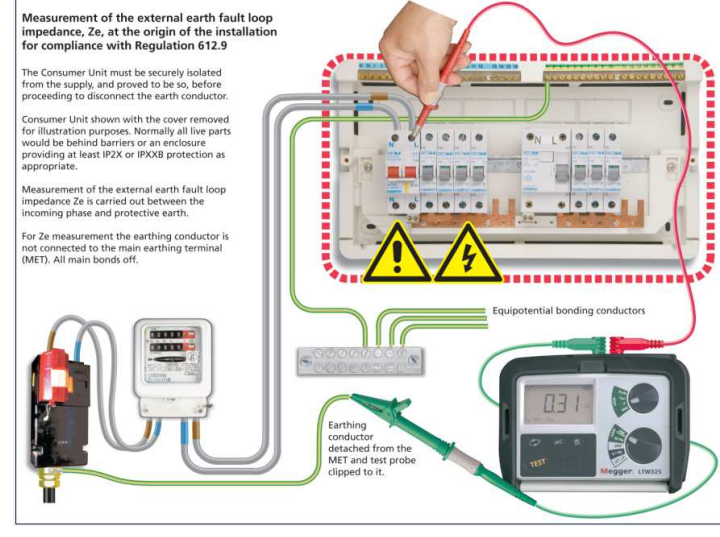
Measurement of the external earth fault loop impedance, Z_e , at the origin of the installation for compliance with Regulation 612.9

The Consumer Unit must be securely isolated from the supply, and proved to be so, before proceeding to disconnect the earth conductor.

Consumer Unit shown with the cover removed for illustration purposes. Normally all live parts would be behind barriers or an enclosure providing at least IP2X or IPXXB protection as appropriate.

Measurement of the external earth fault loop impedance Z_e is carried out between the incoming phase and protective earth.

For Z_e measurement the earthing conductor is not connected to the main earthing terminal (MET). All main bonds off.



PFC - Loop Impedance tester

- Instruments to BSEN61557-3
- **Prospective Fault Current...calculate up to 20 kA.**
- The LTW425 can calculate up to 40 kA using the 0.001 Ω high current, resolution test range.
- The calculation uses the measured loop impedance and the measured line voltage to calculate the appropriate PFC.



On three phase installations PSCC is usually higher because it's at 400v rather than 230v.

Measurement of the prospective short-circuit current (PSCC) at the origin of the installation for compliance with Regulation 612.12

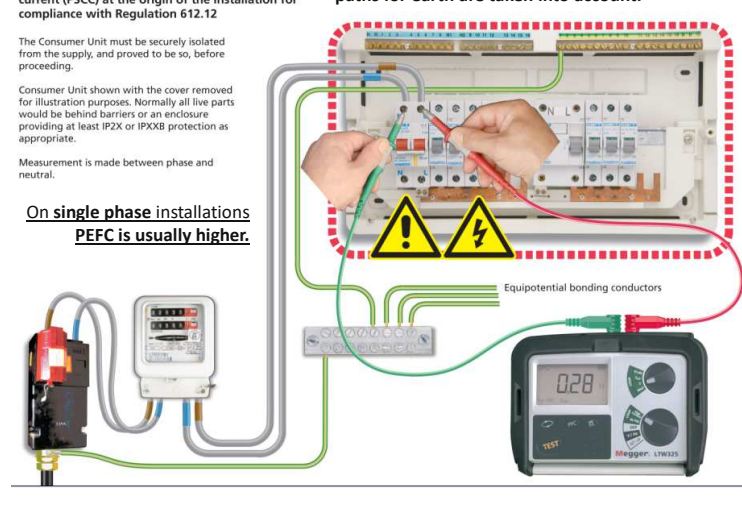
The Consumer Unit must be securely isolated from the supply, and proved to be so, before proceeding.


Consumer Unit shown with the cover removed for illustration purposes. Normally all live parts would be behind barriers or an enclosure providing at least IP2X or IPXXB protection as appropriate.

Measurement is made between phase and neutral.

On single phase installations PEFC is usually higher.

PFC should be tested because all parallel paths for earth are taken into account.





Instruments to BSEN61557-6

Test current applied for maximum 2 seconds

Accuracy 10%

A current of around **30 mA (0.030 amperes)** is potentially sufficient to cause cardiac arrest or serious harm if it persists for more than a small fraction of a second. RCDs are designed to disconnect the conducting wires quickly enough to prevent serious injury from such shocks, commonly described as the RCD being "tripped".

BS 4293 @1x-200ms if it incorporates a time delay it should trip within a range of 50% to 100% of the rated time delay plus 200ms.
 BSEN 61008 @1x-300ms with time delay within the range of 130ms to 500ms.

RCD tester

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RCD Testing

500mA - For agricultural/horticultural use, they are usually required (dependant on the installation complexity) even on a TN system. See Section 605 - BS 7671

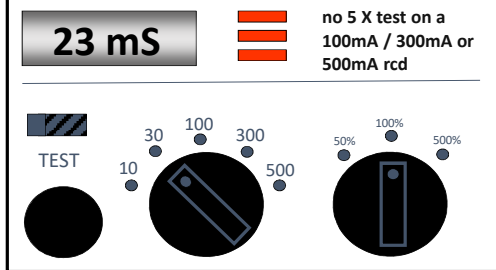
Testing should be done with...

A) 50% ; 100% and 500%

B) both 0° and 180°

RCDs having a rated residual operating current ($I_{\Delta n}$) not exceeding **30 mA** and an operating time not exceeding **40 ms** at a residual current of **5 I_{Δn}**

23 mS no 5 X test on a 100mA / 300mA or 500mA rcd



A **B**

300mA - will give no protection against electric shock, they are usually used in farm buildings for protection against fire

RCD maximum trip time			
Test current	BS 4293	BS EN 61008	BS EN 61009
50% I _n <	No trip	No trip	No trip
100% I _n	200ms	300ms	300ms
500% I _n	40ms	40ms	40ms

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Test results – 30mA RCD

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Repeat below for Positive side - 0 degrees;
 Then Negative side - 180 degrees


➤ **1/2 Trip – 15mA must not trip (stability check)**

➤ **Full-Trip – 30mA must trip within BS4293 200mS (0.2 secs)**

BS EN 61008 /61009 300ms (0.3 secs)

➤ **5 x - (150 mS) Supplementary protection use against Direct Contact, must trip within 40mS**

Record the highest value (longest time)



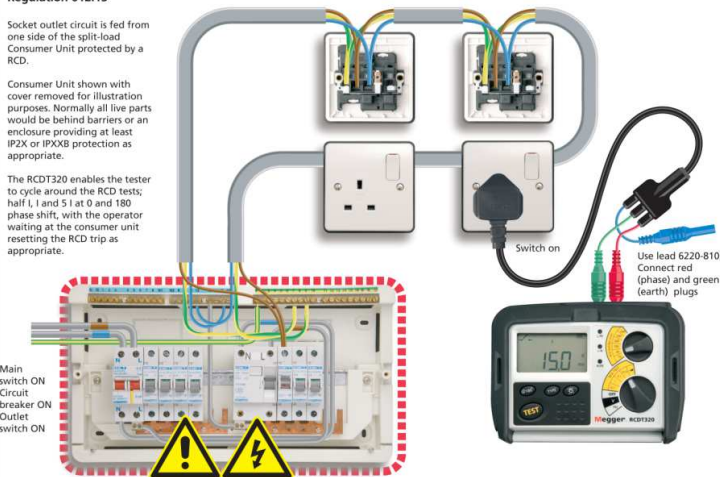
RCD testing for compliance with Regulation 612.13

Socket outlets to BS1363

Socket outlet circuit is fed from one side of the split-load Consumer Unit protected by a RCD.

Consumer Unit shown with cover removed for illustration purposes. Normally all live parts would be behind barriers or an enclosure providing at least IP2X or IPXXB protection as appropriate.

The RCD320 enables the tester to cycle around the RCD tests; half I_{Δn} and 5 I_{Δn} at 0 and 180 phase shift, with the operator waiting at the consumer unit resetting the RCD trip as appropriate.



Main switch ON
 Circuit breaker ON
 Outlet switch ON

Switch on

Use lead 6220-810
 Connect red (phase) and green (earth) plugs.