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ISIS practice
For BT people

EPT/PPS/B062

Issue 24, 26-Mar-2020
Use until 26-Mar-2021

Published by Technical Documentation - Openreach

Privacy- Internal

Cabinets Cross-Connection and Other Extnl Cabinets

Containing Equipment Using Mains Power - Safety Aspects

About this document ...

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Content approval

This is the Issue 24 of this document.
The information contained in this document was approved on 26-Mar-2020 by Desmond Silvera, Senior Technical Power Manager

Version History

Version No.	Date	Author	Comments
Issue 24	26-Mar-2020	Chief Engineer's Office Technical Documentation Team	Updated Section 8.5 Re Shelling of a PCP and DSLAM.
Issue 23	15-Jul-2019	Chief Engineer's Office Technical Documentation Team	New Section 8.5 Re Shelling of a PCP and DSLAM.
Issue 22	26-Feb-2019	Chief Engineer's Office Technical Documentation Team	Section 8.4.4 updated with new notes.
Issue 21	01-Jan-2019	Chief Engineer's Office Technical Documentation Team	RCD testing updated to 6 monthly. References to the new 18th ed updated.
Issue 20	13-Apr-2018	Chief Engineer's Office Technical Documentation Team	Correction to section 9.2 link
Issue 20	09-Apr-2018	Chief Engineer's Office Technical Documentation Team	Correction to section 9.2 link
Issue 19	05-Apr-2018	Chief Engineer's Office Technical Documentation Team	Section 9.2 updated with the new Non-contact voltage/proving tool and process.
Issue 18	05-Jul-2017	Chief Engineer's Office Technical Documentation Team	Number of section rewritten to align with current edition of BS7671. Testing of the AutoRCD updated and table in section 9 changed to show what training is needed to access the power compartment of street cabinets.
Issue 17	06-Mar-2017	Chief Engineer's Office Technical Documentation Team	Change regarding who can enter the power section of the cabinet.
Issue 16	16-Jan-2017	Chief Engineer's Office Technical Documentation Team	Introduction change regarding testing of the cabinet case before touching the cabinet.
Issue 15	23-Dec-2016	Chief Engineer's Office Technical Documentation Team	Approver change
Issue 14	04-Jan-2016	Chief Engineer's Office Technical Documentation Team	Approver change
Issue 13	03-Mar-2015	Document Manager T	Document migrated onto new platform with no content change

Issue 13	1-Mar-2013	Chief Engineer's Office Technical Documentation Team	Options for cabinet bonding expanded and more detail provided. History log added. Crimp connector detail added
Issue 12	27-Jul-2011	Chief Engineer's Office Technical Documentation Team	Clarification added for RCD functional testing in sections 3.4/3.4.1 and Electricity at Work Regulations requirement added to section 1
Issue 11	4-Feb-2011	Chief Engineer's Office Technical Documentation Team	Section 3.4.1. spelling mistakes corrected. DCC1197/SH.
Issue 10	2-Nov-2010	Chief Engineer's Office Technical Documentation Team	Section 3.4.1. Updated and RCD document added. DCC1057/SH.
Issue 9	10-Sep-2010	Chief Engineer's Office Technical Documentation team	Sections 3.4. and 3.4.1. Updated. DCC974/SH.
Issue 8	24-Aug-2010	Chief Engineer's Office Technical Documentation team	Document reviewed.New Section 3.4.1 added.Change of author (DCC977PD)
Issue 7	14-Jun-2010	Chief Engineer AEI Technical Documentation team	Change to Section 3.4 table. DCC839/SH.
Issue 6	4-May-2010	Chief Engineer AEI Technical Documentation team	All sections revised. DCC772/SH.
Issue 5	24-Feb-2009	Chief Engineer AEI Technical Documentation team	Document reviewed with minor changes
Issue 4	13-Jan-2009	Chief Engineer AEI Technical Documentation team	Change of author and approver
Issue 3	24-Feb-2006	Pete Whelan	Change of author and approver, and minor amendments
Issue 2	6-Apr-2004	Keri Thomas	Change of owner & approver
Issue 1	1-Apr-1993	Bob Ruddock	Amendment

Table of Content

1 *Introduction*

This document describes the design and installation features necessary to safeguard BT personnel and the general public where mains powered equipment is installed in external cabinets. It applies to all external cabinets, whether owned by BT or not, to which BT people have access. Protection from accidental contact with dangerous voltages is required under both normal and fault conditions.

Whilst the this document specifies IET Wiring Regulations 18th Edition/BS 7671:2018, the most current edition of the wiring regulations in force at the time of use must always be used.

Note: IET – was previously known as IEE.

There is special mention of cabinets used for FTTC/NGA when fitted with an RCD. The fitting of the RCD is now within EPT/ANS/A036.

- Anyone working in cabinets containing mains power must have completed either 'Working on Electrical cabinet' course (ORWPP01) or 'The Electricity at Work Regulations' CBT available on Route2Learn – course code DLT142074 and have the relevant product knowledge to enable safe working on cabinet internal components. Section 9, Appendix 1 of this instruction details minimum training requirements for anyone working within the cabinet power compartment.
- Upon accessing any cabinet containing mains power a visual risk assessment must be conducted in order to determine the structural condition i.e. whether the cabinet has been damaged by a vehicle strike. From your assessment, if the cabinet is undamaged then proceed with your work task. Upon accessing the cabinet to work on electronic apparatus, refer to AC-DC Connectivity for NGA Huawei and ECI cabinets contained at section 9.1 of this instruction and carry out the prescribed checks on AC/DC connections installed in the Power Supply Unit (PSU).
- If the cabinet is damaged and you are a qualified power engineer then investigate further to confirm if the cabinet is safe to work on. From your investigation, if you find a fault/s then correct the fault/s if possible. If it cannot be repaired report to AOC.
- If you are a non-power engineer then report the damage to the AOC (0800-6816672), they will instruct you to the next step. **Do not touch the cabinet.**

Caution: If a cabinet has been involved in a vehicle collision or other event to cause it to be dislodged from the plinth then do not touch the cabinet or the

associated PCP if it is within the 3m Open Door rule distance. Guarding should be erected at least 1m ('arms reach') from the cabinets to avoid the public contacting the metalwork. The AOC (Access Operations Centre) should be contacted to arrange for the power to be made safe by the DNO.

Note: None of the courses in this document gives you the ability to work as an electrician; they only give you an awareness of the hazards that can be expected within these locations and how to avoid them.

If you are not trained to work on power, then you must not attempt to correct any faults to the power system apart from testing an RCD (manual button push and reset), resetting an MCB or reconnecting an equipotential bonding conductor.

If attaching or replacing bond wires, avoid contact with other cabinets or external metalwork at the same time as making the repair. If in doubt or it is unavoidable, then check for the presence of voltage on cabinets using the voltage detector detailed above before making the repair.

If a theft of the copper bonding conductors has been made, then the Openreach Power team should be informed to affect the repair as it may mean new cable needs to be fitted between the FTTC and PCP. Until the A1024 process is able to deal with this, the power team should be contacted directly.

If a PCP is being re-shelled and is associated with a FTTC cabinet, then make sure all bond wires have been connected correctly as described in this document.

2 *Electrical System Types*

In order to ensure that the correct method of protection for safety is used, it is necessary to know the type of electrical earthing system being used at the cabinet.

An electrical system consists of a single source of electrical energy and an installation. Types of system are identified as described below, according to the relationship of the source, and the exposed conductive parts of the installation to earth.

Whilst the values listed in 2.1 & 2.2 are the typical earth impedances associated with TN type systems for general installations (Ze) the DNO (Distribution Network Operator) policy insists on a secondary earth also being fitted to satisfy safety requirements for metallic street furniture, which for systems up to 2kW load will be a 20 Ohm maximum irrespective of the DNO earth impedance. TT earthing systems are not affected by this requirement, when the required earth impedance is governed by the residual tripping current of the installation according to BS 7671.

The DNO may deliver a system which has a higher than expected earth fault loop impedance, as they tend to work to a higher value (0.5 Ohm for TN-C-S). This can either be referred back to the DNO for possible rectification (improve earthing or heavier gauge cable or the system converted to TT earth system.

2.1 TN-S System

In this system, the electricity supplier (DNO) provides an earth terminal with a separate connection to the earthed point of the supply transformer. The armouring of the power supply cable is normally used for this purpose; but a separate conductor may be used. See Figure 2.1 (a).

BS 7671 states that the earth fault loop impedance of a TN-S system up to the origin of the installation (Ze) will typically be less than 0.8 Ohms.

2.2 TN-C-S System

In this system, the DNO provides a protective earth terminal which is derived from the neutral conductor. The neutral and protective earth functions are combined in a single conductor up to the origin of the installation. See Figure 2.1 (b).

This type of distribution is also known as Protective Multiple Earthing (PME). The combined neutral and earth conductor is earthed at several points and may require an earth electrode near the consumer's installation.

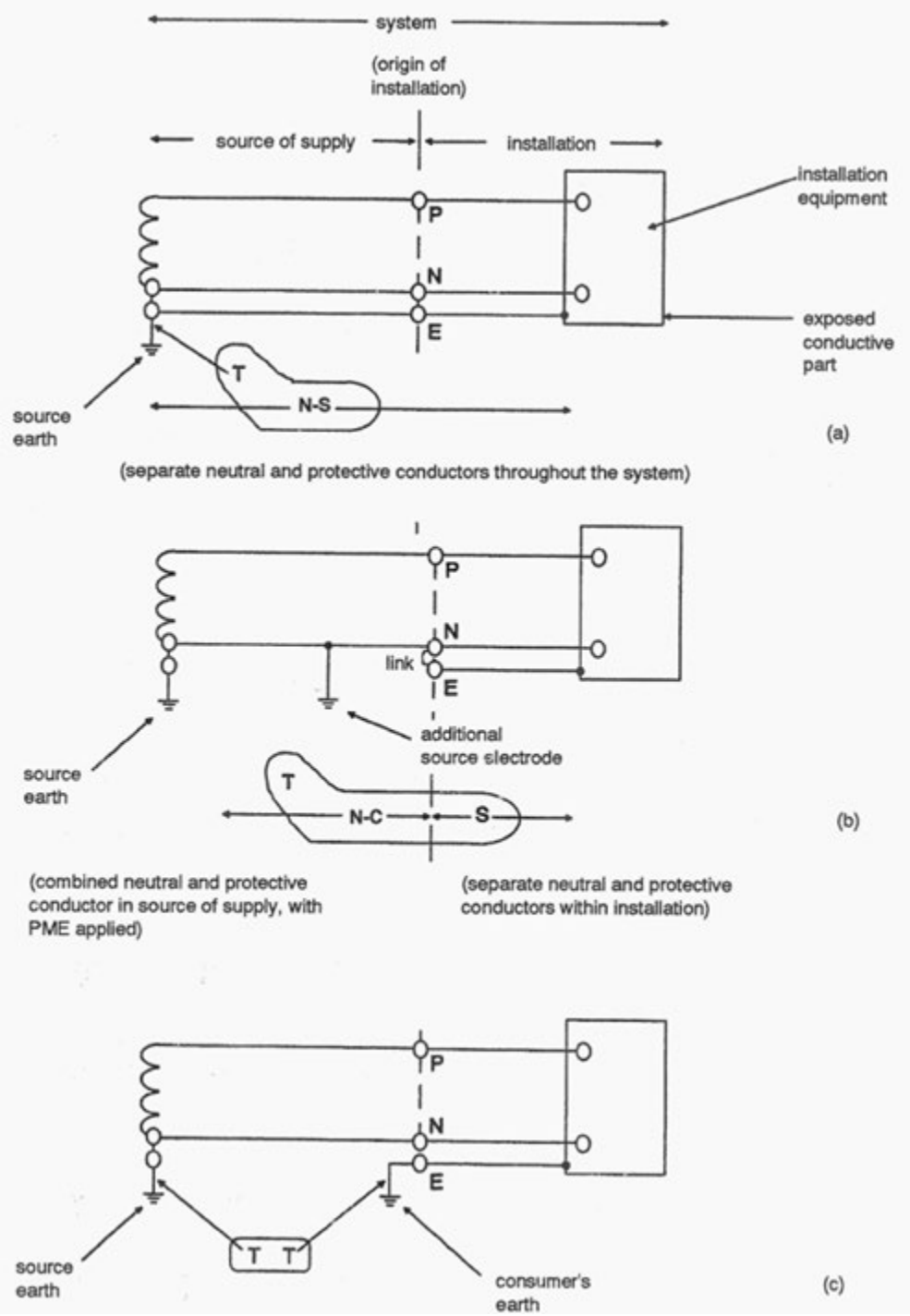
BS 7671 states the earth fault loop impedance of a TN-C-S system up to the origin of the installation (Ze) will typically be less than 0.35 Ohms. Some DNOs work to a 0.5 Ohm limit which is above that of BS 7671 and will need to be referred back to the DNO for improving or converting to a TT system.

2.3 TT System

In this system, the DNO provides only a phase and neutral connection. The exposed conductive parts of the installation are connected to an independent earth electrode. See Figure 2.1 (c).

The earth fault loop impedance of a TT system will generally be in excess of 20 Ohms, which is greater than the values permitted for fuses or circuit breakers to operate without presenting a hazard to life. Therefore, it is necessary to use a residual current device (RCD) in this situation; for example, an earth leakage circuit breaker.

Figure 2.1 Electrical System Types



Designers should ensure that when the use of an RCD is made that there are procedures in place to provide both the necessary functional testing of the RCD (once every three months according to BS 7671) and also that call-out staffing is in place in the event of it tripping. To only test the RCD when the cabinet is visited for other reasons, e.g. once per year or longer, could prove dangerous as the RCD mechanical components needs to operate, to stop

seizing and to provide protection for the public at all times, hence the 3 month guideline.

The residual operating current value should be determined to cause the least inconvenience to customers and provide the relevant degree of safety (30mA is recommended). The earth impedance will need to be kept below the level stipulated in BS 7671 for the rated residual operating current of the device being used. If power sockets exist within the cabinet, then these **must** be protected with a 30mA RCD.

If attending a 3rd party cabinet, then identify the last time the RCD was tested (possibly via a test result in the cabinet or by enquiry to the owner). If no test data is available to prove it has been tested within the last 3 months, then the RCD must be tested before any other work commences. Notify the appropriate people (e.g. AOC or cabinet owner) that AC power is to be interrupted for the test.

2.4 Identification of Power System type

As indicated in the above sections, TN-C-S, also described as PME, is the most common form of power distribution in mainland UK and derives the earth from the neutral; TN-S, most common used in Northern Ireland, and uses a separate earth, e.g. the armoured sheath of the power cable; TT, more common in rural areas of the UK, and uses an earth electrode at the customers premises.

The easy answer on how to identify the power system is to ask to look at a copy of the Electrical Installation Certificate for the wiring from the end-user or equipment owner. This would immediately identify the circuit type on the first or second page of the certificate.

It is not expected that an Openreach engineer would remove any protective covers of the power system unless fully qualified, trained and competent to do so (i.e. trained in power work) when trying to identify the power system type. At all times, safe working practices must be followed (Electricity at Work Regulations1989).

The document below shows diagrams of how the incoming supply is connected to the premises from the main fuse to the meter and consumer unit. From this you should be able to identify the supply type at the EU premises without the need to remove protective covers.

Whilst the diagrams in the attachment generally show a domestic type situation, they can be applied equally well to a power system found within a

Please click here

cabinet.

TN-C-S: - The live and neutral come into the DNO fuse (100Amp in figures 3 & 4 of the attachment). On route to the premises, the neutral may be earthed at intervals to give an earthing value within the regulation limits. The earth connection will be made from the neutral off the side of the DNO fuse – this is the prime identifier of the TN-C-S system.

TN-S: - The live and neutral come into the DNO fuse (100Amp in figures 1 & 2 of the attachment). The earth connection will be made from the metallic outer sheath of the incoming power cable. Very occasionally this would be a separate cable coming in with the power cable. A separate earth bar is generally used as a common connection point.

TT: - The live and neutral come into the DNO fuse (100Amp in figures 5 & 6 of the attachment). There will not be any other form of earth connection from the DNO fuse area. The earth will come from a separate earth cable to a connection block (main earth terminal), and if followed should lead to an earth spike, generally fitted externally to the premises. This earth spike may be protected from the elements with tape, but more often is left exposed. This connection can suffer from corrosion or mechanical damage and so lead to a poor earth connection. Using the earth spike itself as an earth reference for line test should prove if the earth within the building is at fault. A poor earth value could also be due to the earth electrode in the ground being corroded or badly fitted, and again this would be evident when testing at the electrode.

If an Earth Loop Impedance tester is available to the engineer, then this can be used to test the earth loop impedance at a socket within the EU premises. Some testers allow a test lead to be used, so it may be possible to prove to the earth electrode at the premises.

Note: In a cabinet, this test must only be performed by a power trained engineer as it is not possible to have pluggable equipment in the cabinet, though 3rd party cabinets may have sockets, BT/Openreach cabinets do not.

3 *Mains Electrical Installation*

The installation should be in accordance with BS 7671, The Requirements for Electrical Installations; (BS 7671:2018 is identical to the 18th Edition of the IET Wiring Regulations). Section 714, covering some aspects of Highway Power Supplies and Street Furniture, is particularly relevant.

3.1 Protection against Electric Shock

Protection against direct contact must be provided by insulation and barriers & enclosures.

Protection against indirect contact must be provided by earthed equipotential bonding and automatic disconnection of supply.

The means of disconnection must be by fuses or miniature circuit breakers for a TN-S or TN-C-S system and an RCD and MCB for a TT earthing system. The earthing resistance required for a TT earthing system to be safe without an RCD is impossibly low to achieve.

If the DNO elects not to provide an earth or the earth fault loop impedance (Ze) of the TN-C-S or TN-S is higher than the BS 7671 specification, an earth electrode and a Main Earth Terminal (MET) must be provided in accordance with BS 7671 to achieve the required values.

Without this extra earth electrode the DNO will only offer a TT earthing supply. The Earthing Manual, ISIS document EPT/PPS/B025, gives guidance to BT/Openreach people on the provision of earthing systems.

The shell and doors of the powered cabinet, if metal, plus its internal metalwork and any metallic cable sheaths must be bonded to the main earth terminal of the powered cabinet (minimum 6mm^2 green/yellow insulated cable within the cabinet, but 10mm2 if possible, note: 6mm2 fine stranded cable for door bonds, so preserving flexibility of the cable). FTTC DSLAM cabinets are fully bonded at manufacture.

Any adjacent cabinet, e.g. active PCP, associated (i.e. owned by Openreach) with the powered cabinet and less than 3m (open door distance) away must also be equipotential bonded to the powered cabinet earth terminal (minimum 10mm^2 green/yellow insulated cable from the PCP to the powered cabinet). This associated cabinet must also have all metallic elements (e.g. doors and shell) bonded together to a common point (minimum 6mm^2 green/yellow, fine stranded, insulated cable and flexibility maintained). Fixing frames for Strip Cross Connect need not be bonded unless the strips contain lightning protection.

Bonding is not required for the following metallic items in proximity to the cabinet:-

- Telephone kiosks do not require bonding to adjacent cabinets (either powered or PCP);
- Powered cabinets belonging to 3rd parties do not require bonding to Openreach PCPs. (we have no power of entry to maintain any bonding);
- Other metallic structures (powered or unpowered) not belonging to Openreach e.g. bus shelters or metal railings do not need to be bonded to Openreach cabinets (powered or PCP);
- Unpowered, but associated cabinets further than 3m away (between open doors) do not need equipotential bonding;
- A redundant PCP that is fully decommissioned (no cables) and can be removed within 30 days of the FTTC cabinet being electrically certified;
- Fibre-glass or other composite plastic cabinets cannot be bonded.

Note: All bonding & earthing cables within the cabinets are to be terminated via crimped eyelets of a suitable size to match both the cable and the retaining bolts, e.g. 10mm2 x M6. Fastening to painted surfaces will require the use of serrated washers and abrasives to give the required metallic contact. The point the cable is to be attached should first be abraded to expose the base metal, and then bolted using serrated washers, etc. There are generally sufficient points to fasten to on doors, etc. Drilling must be avoided.

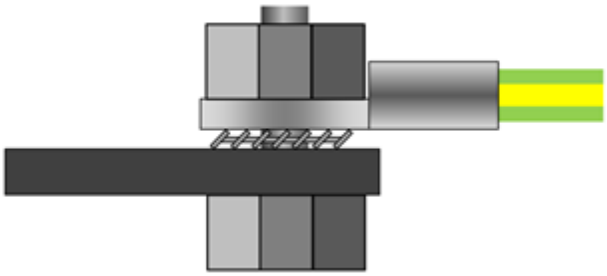


Figure 3.1: Shows bolt through panel/stay mount and serrated washer under crimp connector.

Caution: Do not bond to a door stay if it means there is no way the door can be safely closed, at least one door stay point must be available on each door. If door stays are damaged, then the normal A1024 process should be followed for repair or replacement of the door. Alternative means of bonding, such as to document pockets on the door may be used (see Section 8).

The whole installation must meet the standard required by BS 7671:2008 for electrical continuity, i.e. paint and debris to be removed to enable good electrical contact to be obtained. See Section 8 for examples.

Safety labels must be attached either to or near each cable (e.g. Safety Electrical Connection – Do Not Remove) as per BS 7671:2008. This will generally be:-

1. At every earthing conductor to an earth electrode, and
2. At every protective bonding conductor to extraneous conductive parts.

For the FTTC & PCP earth bonding cable the above label will be provided on the 10mm2 cable at the connection point in both the PCP and FTTC cabinets.

For the PCP extraneous conductive parts the labels supplied with the earth bonding kit (e.g. Important Safety Requirement - the earth bonding lead must be reconnected after refitting) will be provided at the connection points e.g. PCP doors.

The general rule is that if there is a green/yellow bond wire, then make sure it is connected at both ends. If you remove a bond wire for maintenance purposes e.g. door removal, then make sure it is correctly put back in place

afterwards. Any bond wire with a broken connection should either be fixed at the time or referred via A1024 process for correction.

3.2 Wiring

The incoming mains supply must be fitted with a means of isolation which complies with BS EN 60947-3, in accordance with BS 7671. This should be installed as close as possible to the DNO cut-out and permanently connected to it; but positioned so that it is readily evident whether or not the supply has been isolated. In instances where the power requirements are above that agreed for an unmetered supply (generally 500W or more) a meter shall be fitted between the cut-out and the circuit breaker/isolator.

The DNO cut-out fuse cannot be used as an isolator as it is only single pole (i.e. the fuse only isolated the live conductor). It is recommended that a 2-pole isolator be fitted before the circuit breaker/RCD to avoid the need to have the DNO fuse pulled if the RCD or MCB need to be replaced. Certain RCD and MCB are able to function as isolators. Refer to BS7671 for details.

The distribution must be permanently wired to the fuse, MCB or RCD, and then be either permanently wired or connected via a suitably protected connector to the equipment.

Socket outlets **must not** be provided in the cabinet in order to inhibit the use of mains powered tools and test equipment at the cabinet, and also to aid compliance with BS 7671 and avoid the need for additional RCDs of low current tripping ability.

3rd party cabinets may have sockets fitted for equipment use. Sockets must be protected via an RCD of 30mA or less earth leakage tripping current. Any RCD in a 3rd Party must be tested before use as we do not know the test regime of the cabinet owner.

Note: Check with the cabinet owner that this will not cause service issues.

3.3 Mains Power Units

Mains power units must be housed within an enclosure or a cover which is entered or removed only by the use of a tool. The enclosure or cover will be in addition to the shell/door of the cabinet i.e. there should be no exposed conductive parts at mains potential accessible without the use of a tool by someone who is trained and competent in electrical power.

A warning notice stating the greatest voltage present within the equipment, e.g. 230V ac, must be displayed on the cover (Fig: 3.2). If possible, an additional notice should be placed adjacent to the internal components concerned being fed with the power.

If battery back-up facilities are available within the cabinet, then a warning label that the cabinet operates at dual voltages should be prominently displayed within the cabinet. Only those people trained to work on DC power systems should work with back-up batteries.

You must only access areas that you have been trained and are licenced to work on.

Figure 3.2 Example of Dual Voltage label and Danger 230 Volts

For cabinets belonging to Openreach, then authorised people entering the power area should have completed ORWPP001 CBT on Route2Learn or be a qualified electrician (see Section 9). Only access those areas that you need to, e.g. telemetry socket. Use voltage detection tools to determine what cables and equipment are live, etc. and so need to be avoided.

3.4 Residual Current Devices (RCDs)

The use of RCDs is not preferred as they impose a maintenance burden and they can be subject to spurious operation (nuisance tripping) from operating close to the imbalance current limit due to filters etc. in the equipment. Road vibration from passing traffic is unlikely to cause false tripping. Stray ground currents due to faults or surges from other equipment in the vicinity or atmospheric conditions could give rise to false tripping.

Where it is necessary to provide an RCD it must comply with either BS 4293 or BS EN 61008-1 and have an operating current preferably of 30 mA or less. A 200 Ohms maximum earth resistance is allowed at 30mA (refer to BS 7671 for limits). A notice regarding testing, as described in BS 7671, must be fixed near the RCD. Manual tested RCD's must have a record sheet of when the unit was last functionally tested and should be kept within the cabinet. If in doubt of when last tested, then perform a test.

Warning: RCDs must be functionally tested quarterly by pressing the button marked 'T' or 'Test' to prevent the mechanism from sticking (A requirement of BS 7671). A full characterisation test must be performed at least once every six years. A note of the functional test date should be logged at the installation.

It is possible to use a higher current RCD, but it does require lower earth loop impedance. E.g. a 16A TT mains power supply will need a breaker time of 0.4s, which can be achieved with a 300mA RCD and an earth loop impedance of less than 167 Ohms. Full details and limits are defined in BS 7671.

Note: Power sockets must be protected via a maximum of a 30mA RCD

Where an RCD is used for earth fault current protection, the following conditions shall be fulfilled before installing it:-

$$R_A \times I\Delta_n = 50$$

Where:-

R_A is the sum of the resistances of the earth electrode and the protective conductor connecting it to the exposed conductive parts (in Ohms)

$I\Delta_n$ is the rated residual operating current of the RCD

Next Generation Access (NGA) FTTC cabinets may be fitted with an RCD in areas where it has proven difficult to achieve the maximum supplementary earth value. Due to the special nature of these cabinets the procedure for fitting the RCD is detailed separately within EPT/ANS/A036, which also gives details of the full electrical testing required to enable electrical certification. For basic functional testing of the RCD, please see section 3.4.1.

3.4.1 Functional Testing of RCDs

A requirement of the Wiring Regulations (BS 7671) is that an RCD shall be functionally tested every three months, and the test date noted. This applies to all RCD protected equipment / wiring that is within buildings and cabinets. Any competent person (completed Electricity at Work Regs CBT) may perform this test. It is important that the engineer performing this test completes the test certificate within the cabinet (date & signature). There is no requirement for the person completing this task to dismantle any live parts to safely access the test button. If when servicing a cabinet the last functional test date cannot be determined as being within the last three months, then it should be tested before any other work is carried out. Consultation with the cabinet owner may be required before turning off the power if no battery back-up is present, etc.

The following process shall be followed:-

- A visual inspection of the RCD and its immediate surroundings shall be made. There should be no indication of overheating (scorching, etc.)

- The button marked ‘T’ or TEST shall be pushed. The breaker should switch with a clean, crisp click and not give rise to any arcing sounds.
- The RCD breaker switch shall then be reset and remain in the ON position.
- The test date shall be logged on the relevant data system (i.e. whichever system that the operational team are using to log data) and it will also be noted on the functional test sheet (RCD 3 Monthly Test Certificate) that resides within the cabinet (in a plastic wallet).

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A copy of the RCD 6 Monthly Test Certificate is available

The RCD can be distinguished from a normal miniature circuit breaker (MCB), as indicated in figure 3.3, as the RCD has a TEST button, whereas the circuit breaker does not. Note, only the central section of these components will be visible on both items when installed on the switch panel.

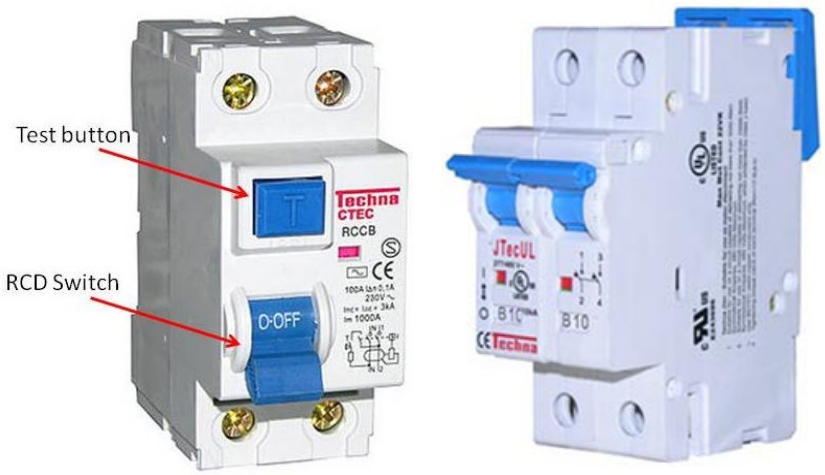


Figure 3.3: Examples - [left] Residual Current Device (RCD) and [right] Miniature Circuit Breaker (MCB).

Some RCDs and MCBs, when tripped, require that they be pushed down into the fully off position before they can be reset. (E.g. they may have 1 = On, 0 = Off and + = trip position. The switch would need pushing to the 0 position and then reset to 1)

You must verify that the AC power has been restored by checking available indicators for power or similar alarms.

If there are any issues with any of the above points, then the cabinet must be reported as faulty via the engineering control.

Note: AutoRCD functional tests are logged by the element controller.

4 Functional Earth

The equipment in the cabinet may require a separate functional earth for signalling or heavy duty over-voltage surge protection purposes. This should be provided in addition to the protective earth and should be installed in accordance with the Earthing Manual, EPT/PPS/B025.

The resistance of this earth should not normally exceed 50 Ohms. Equipment manufacturers may specify a lower earth electrode resistance so as to prevent electrical noise problems or to meet other requirements of the equipment. The Earthing Manual describes how to measure the earth impedance independently of the mains power system (3 point method).

The functional earth must be bonded to the main earth terminal.

Note: The functional earth may be in addition to any supplementary earth required by the DNO. Depending on the power requirement of the cabinet the DNO supplementary earth value will depend on the maximum load.

5 Electrical Testing

Warning: Only qualified personnel (accredited to the current edition of BS 7671 regulations) may perform activities listed in this section of the document. Health and safety regulations must be adhered to at all times.

5.1 Initial Certification

Upon completion of the electrical installation, the following tests must be carried out and a Completion and Inspection Certificate provided in accordance with BS 7671 by a competent and qualified person:

- Visual inspection.
- Continuity of circuit protective conductors and equipotential bonding conductors.
- Polarity of supply.
- Insulation resistance.
- Earth fault loop impedance.
- Operation of RCDs, if fitted.

Model certification forms can be found in BS 7671and ISIS EPT/ANS/A036.

5.2 Periodic Inspection and Testing

A notice regarding periodic inspection and testing should be fixed to the installation in accordance with BS 7671. This will normally be required every 2.5 years after initial certification.

The installation should be tested at least once every 2.5 years; including a full characterisation test of the RCD if appropriate. See ISIS EPT/ANS/A036. Any DNO required earths or functional earths should also be characterised at this time and the results recorded on the certificate.

Cabinets fitted with an RCD should have the RCD functionally tested every three months (via the Test button) and the test date noted within the cabinet, as per section 3.4.1.

6 *Cabinets Shared with Other Equipment*

Where BT/Openreach equipment using voltages below 120V dc or 50V ac is installed in a cabinet which also houses mains powered equipment, the owner of the mains powered equipment should ensure that it is adequately enclosed and identified to prevent danger to BT/Openreach staff and equipment either by accident or by mistaken identity. Cabling shall be tidy and the need to move cables avoided. Equipment shall be mounted to avoid ingress of water.

It is recommended that engineers entering such cabinets make themselves aware of what items are operating at mains voltage by using the voltage detector and proving tool, item code 093746.

7 *Customer/End-user's Cabinets*

These must be carefully checked for compliance with this document before they are used to house BT/Openreach equipment. Any customer or end-user cabinet already containing mains power shall only be entered by a competent and authorised person trained to a minimum G39/1 or skilled and trained as an electrician. A non-contact voltage detector test is undertaken before touching or entering the cabinet (as they are not maintained by Openreach we do not know the health of the cabinet). The link on how to use the voltage detector is in Section 9. Test labels within the cabinet should be valid/in date. If it is raining and no suitable tent is available, then do not work in the cabinet.

If an RCD is used as part of the circuit protection, this must have been functionally tested within the last 3 months (section 3.4.1). If it hasn't, then the cabinet owner must be contacted and informed that an RCD functional test will be performed and that total loss of power may be experienced for the duration of the test (depending on there being suitable battery back-up or not).

If the owner does not agree to this, then do not proceed until the RCD can be functionally tested.

8 *Equipotential Bonding PCP Cabinets Connected to FTTC Systems.*

8.1 When is Bonding Required

Bonding is required for any metallic cross connection cabinet (PCP) within 3m (doors open distance) of an FTTC cabinet containing mains power. If it is possible for someone to touch both cabinets then they need to be bonded if not then they do not. GRP (i.e. fibreglass, plastic) cabinets do not need to be bonded.

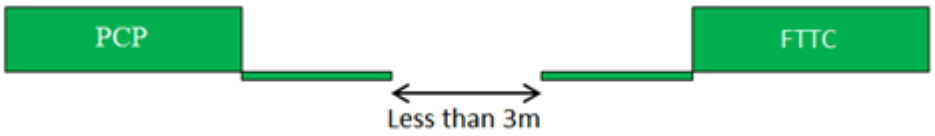


Figure 8.1: Cabinet Spacing

8.2 What needs to be bonded

In short, the cross connection cabinet needs to be bonded to the FTTC/DSLAM and all parts of the cross connection cabinet itself need to be bonded to make sure there is good electrical contact with each part, i.e. doors to shell.

8.3 Bonding between FTTC cabinet and PCP

8.3.1 Bonding Cable Requirements

The bond cable between the FTTC cabinet and the PCP shall be a minimum of 10mm2 cross section and have terminal lugs crimped onto both ends. If the cable routing between the two cabinets is via a distant footway box, i.e. circuitous route, then the total length of the 10mm2 cable should be less than 27m (i.e. to be less than 0.05 Ohm). If the cable length is longer than 27m, then either shorter route needs to be used or the cable increased to 16mm2, where the maximum length is now 43m. The cable should be routed in standard cable duct between the cabinets.

8.3.2 Connection Points

The FTTC cabinet connection point is to the main earth bonding bar (ISIS EPT/ANS/A036). In the PCP, it shall be terminated onto the PCP shell using an available, existing nut/bolt and having any paint abraded before fastening.

8.4 Bonding of Cross Connection Cabinet

All metallic components i.e. doors and shell must be bonded. Other metallic components in the PCP need not be bonded e.g. connection strip mounting bars. This generally means a bonding wire will need to be connected between the doors and shell only. The rest of the shell is assumed to be in good electrical contact with its component parts.

Note: The FTTC cabinet will have been fully bonded at manufacture and not need any retrospective bonding. There is a common bonding point that shall be connected to the main earth electrode and also to the equipotential bonding cable for the PCP. This is all documented in the appropriate FTTC install documents, ISIS EPT/ANS/A036

Warning: After PCP bonding has taken place the door stays must continue to function as intended. Not having a door functional door stay is a safety failure.

8.4.1 Bonding Method

The bonding cable from door to shell shall be 6mm2 fine strand Green/Yellow insulation wire. This is to help prevent breakage due to fatigue of the cable. A terminal lug shall be crimped onto each end of the cable. The length of the cable needs to be long enough to prevent excess strain on the cable or impediment to the full opening of the door yet short enough that it will not get caught in the door. Creating a pig-tail (coiled wire) can help give the cable free movement when the door is moved and also helps avoid it getting trapped in the hinge or door seal.

The terminal must be attached to bare metal. This means that the area must be free of paint and rust to allow good electrical contact. Serrated washers must be used between the metalwork and the eyelet crimp terminal, to ensure a good electrical connection.

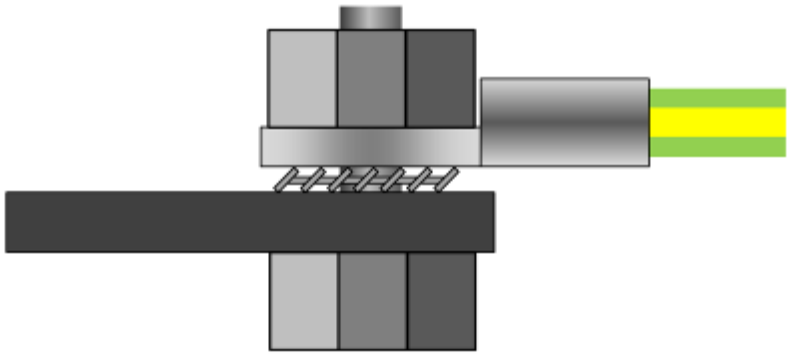


Figure 8.2: Arrangement of serrated washer and terminal.

Figure 8.3: Coiled Cable.

Choose the mounting point on the door to minimise any issues with staying the door, etc. If the cable runs a risk of being trapped when the door is closed it is possible to coil the cable by wrapping it tightly around a screwdriver to form a pig-tail. This means the cable will act as a spring and will be out of the way when the door is closed.

This should never be done for earthing cables providing lighting protection. It is okay to do in this case because the cable is not there for lightning protection.

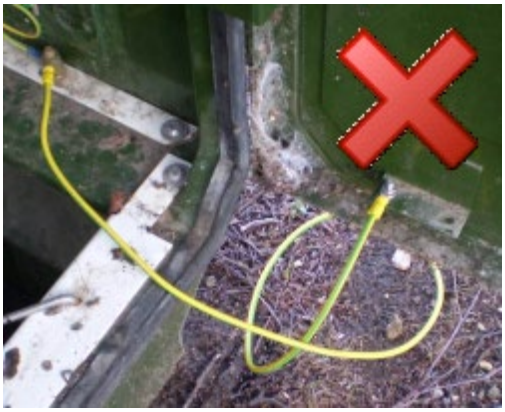


Figure 8.4: Cable too short and cable too long. (Risk of damage to cable from door opening too far or catching in door seal when closed)

Figure 8.5: Long cable that has been shortened by coiling.

8.4.2 Cast Iron Cabinets

This covers cabinet types CCC1, CCC2 and CCC3 with the original cast iron doors or the newer steel universal replacement doors. The bonding methods are listed in order of preference. Holes should not be drilled in the cabinet as suitable bonding points already exist. Some lugs may have the holes filled with paint, which a 6mm drill should be used to aid removal and then scrapping to expose bare metal. A cable crimp termination of size 6-8 is required i.e. crimps for 6mm2 cable with an 8mm diameter hole, for bonding to the internal shells bolts from the door bond. The 10mm2 FTTC bonding cable to the FTTC cabinet should be connected to the most convenient point on the cast iron shell using a size 10-8 crimp terminal (10mm2 cable to M8 bolt).

8.4.2.1 Bonding doors using top lug

Both the original cast iron doors and the newer steel replacement doors have a lug at the top of the door. If this is available then a bonding cable shall be connected between the lug shown below, Figure 8.6, and the internal shell bolt.

Figure 8.6: CCC3 with universal replacement door lug and shell bolt.

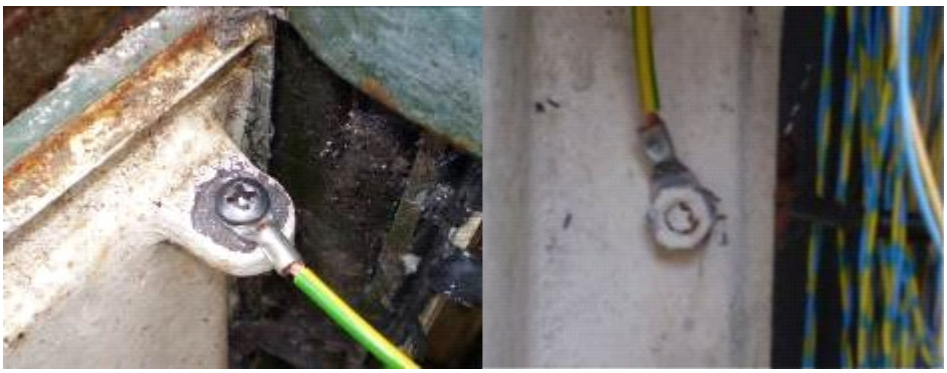


Figure 8.7: Left Image, Cast iron door with top lug used as bonding point. Right Image, Internal shell bolt used as bonding point.

Note: There are some door/cabinet combinations that may place the lugs very close to the door seal and so trap the cable. Take care when providing the cable that cables cannot become trapped due to the proximity of the lug. Alternative bonding points may need to be used.

8.4.2.2 Bonding doors using bottom lug

If the top lug has broken off a cast iron door, the cable can be bonded to the door stay at the bottom, but only if it still allows the door stay to be operated correctly.

The top locknut needs to be removed; the bolt can be removed to allow paint removal. Typically there is enough space to attach the terminal between the locknut and lug, however, if there is not then a longer bolt will need to be purchased locally. The standard bolt is 5/16" BSW thread. An alternative using extra nuts would be to use an M8 bolt. When the bolt is tightened the door stay must still move freely. Some doors may have a lug that is not threaded and so will require the use of a longer bolt. The locknut and terminal must be tightened securely against the lug as shown in Figure 8.8. The stay must continue to function after this has been performed, whilst the bond is tight against the lug.

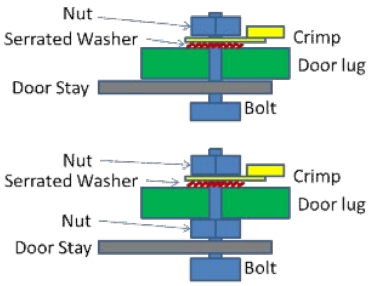


Figure 8.8: Bonding wire attached to bottom lug on cabinet.

If the bottom lug is missing then the door must be replaced as it is unsafe, i.e. cannot be stayed safely. Use the A1024 process to report defective doors.

8.4.3 Steel Cabinets

There is an earth bonding kit available on eASC, item code 052511, which is suitable for bonding CCC7 cabinets and some of the CCC6 and CCC5 cabinets.

If a document holder with a hole is available this if the preferred connection point, failing this, most of the steel cabinets have a two door stay holes and one can be used as a bonding point. The internal connection point for the bonding cable depends on the cabinet. CCC5, CCC6 and CCC7 all have bonding bars. FTTC cable must be connected to a bonding bar if available and the door bonding cable terminated also connected to the bonding bar.

Figure 8.9: Door with spare hole used for bonding

If there is not an extra door stay hole that can be used then it is probably a CCC6b with wrap around doors. This can be bonded using a 'radiator' earthing clip – locally purchased.

Figure 8.10: Radiator earthing clip used to bond CCC6b

The bottom of the clip has a screw that needs to be tightened onto the terminal before it is attached to the hinge. In Figure 8.10 the terminal is obscured because it needs to point into the hinge to prevent the cable being pinched. The paint needs to be removed then the grub screw must be tightened firmly against the hinge.

8.4.4 Other bonding methods

If the door cabinet combination is one that cannot be bonded using the suggested methods above, then the list below can be considered. The

document owner should also be notified with accompanying pictures as the previous methods should cover all the cabinets in the network. These are in no particular order and only for doors and cabinets that cannot be bonded in the suggested way.

1. Use an existing bolt/stud that may exist on the door, that does not compromise the operation of the door;

2. Use Clip Earth 3; item code 011550 instead of the radiator clip in Figure 8.10 on a CCC6b. Note: this clip must not be used in the FTTC cabinet as it has the wrong current rating. It must only be used in the PCP.

Figure 8.11 Alternatives to Radiator Clip for CCC6b

3. Use a ‘radiator clip’ to fasten to the sheet metal of a document pocket on the door;

4. Use an adaptor plate on a single door hole to provide an additional door stay point.

5. Have a mounting point added to the door (a door stay lug can be fitted to the door by one of the cabinet maintenance companies);

(a) Where a PCP or FTTC cabinet has been re-shelled or the bonding has been removed. The person/engineer instructed to re-shelling the cabinet must make sure that all the bonding cables (listed above) have been correctly installed to the instruction in this ISIS, This can be done by the power engineer or a competent copper engineer. (b) If the PCP has a DSLAM or G-Fast connected and the earth bonded cables have been disconnected or disturbed then both the DSLAM and PCP will need to be re-tested using an Electrical Inpection Condition Report (this can be found in ISIS EPT/ANS/A036).

8.5 Re Shelling of a PCP

Where a PCP cabinet has to be re-shelled for build or damage replacement, and there is no equipotential bond to another DSLAM or cabinet, it is the responsibility of the person/engineer instructed to complete the re-shelling to ensure that all the bonding cables have been correctly installed and terminated. This activity can be done by either a power engineer or a competent engineer on the day of the reshell (see table 1 below).

If the PCP that is being re-shelled has a DSLAM (5 meter rule) or G-Fast unit electrically connected (either AC or DC), the main earth can only be disconnected by a skilled person (**electrically qualified, trained and with practical electrical skills who is able to perceive risks and avoid hazards which electricity can create**) as it is part of the electrical insulation within the DSLAM.

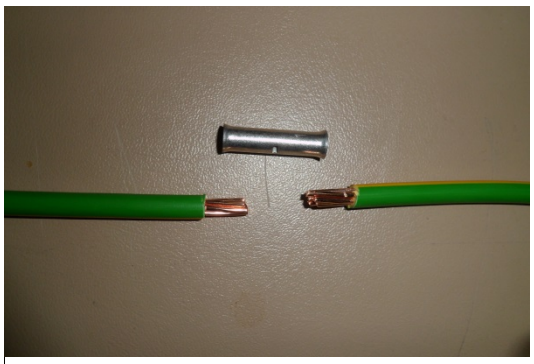
Where the main earth in the PCP has been disconnected or disturbed then both the Main DSLAM and PCP earth connections must be checked, re-terminated if disconnected, re-tested and an Electrical Installation Condition Report must be produced (this can be found in ISIS EPT/ANS/A036). The activity must be undertaken by a skilled person only. The retesting of the cabinet earth must be completed on the same day of the cabinet being re-shelled or on the same day of the disconnection of the earth. The cabinet earth cannot be left unterminated or left un-tested as this would not conform to BS 7671 which underpins the 'Electricity at Work Regulation 1989'.

Remember to install the BS951 safety label on both the main earth cable in the DSLAM and the main earth cable in the PCP., then the earth tag/label must be removed and relocated to the correct position (by the termination point i.e. bolt/screw).

	PCP Shells without any external earth connection	PCP shell bonded to a DSLAM	PCP with G-Fast	DSLAM Earth Connections	Electrical Installation Condition Report
Competent Engineer	√	X	X	X	X
Skilled Person	√	√	√	√	√

Table 1: Outlines who must carry out the activity.

If the existing main earth bonding cable from the DSLAM to the new PCP shell is not long enough to reach the main earth terminate (MET) on the PCP. The cable can be extended by installing a new length of earth cable with the same 'Cross Section Area' (CSA) as the earth cable already installed in the cabinet. Cut back the earth cable PVC outer insulation and crimp one end on to the copper tube butt splice. Then cut back the installation on the new earth cable, crimp the end on to the copper tube butt splice and then cover the copper tube butt splice with green/yellow insulation tape.



Cut back the PVC insulation 1.5cm

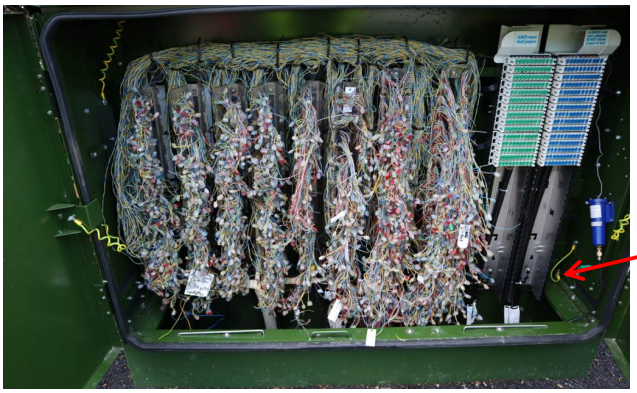
Crimp both ends into the copper tube butt splice.

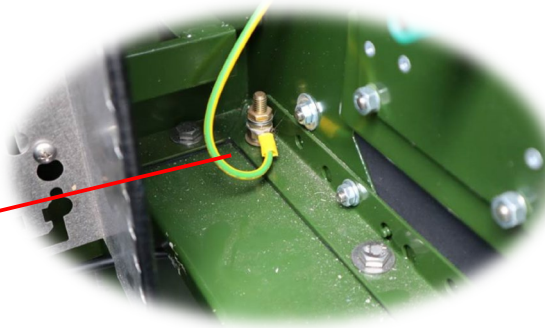
Using earth insulation tape, tape the full length of the copper tube butt splice.

1. If the eyelet lugs are broken, missing or damaged follow the instruction in section 11. to replace the lug.
2. Where an earth bonding cable connection has been disconnected it must be reconnected. Who can reconnect are outlines in table 1 in section 8.5.
3. All earth bonding cables and connection must be checked for tightness. As a guide the bolts/screw should be torqued between 1.7 Nm and 2.1Nm.
4. In the PCP, (when connected to the DSLAM) and on the Gfast MET, the main earth cable must be fitted with an earth bonding label BS951. If the cable has been extended, then the earth tag/label must be removed and relocated to the correct position (by the termination point i.e. bolt/screw)

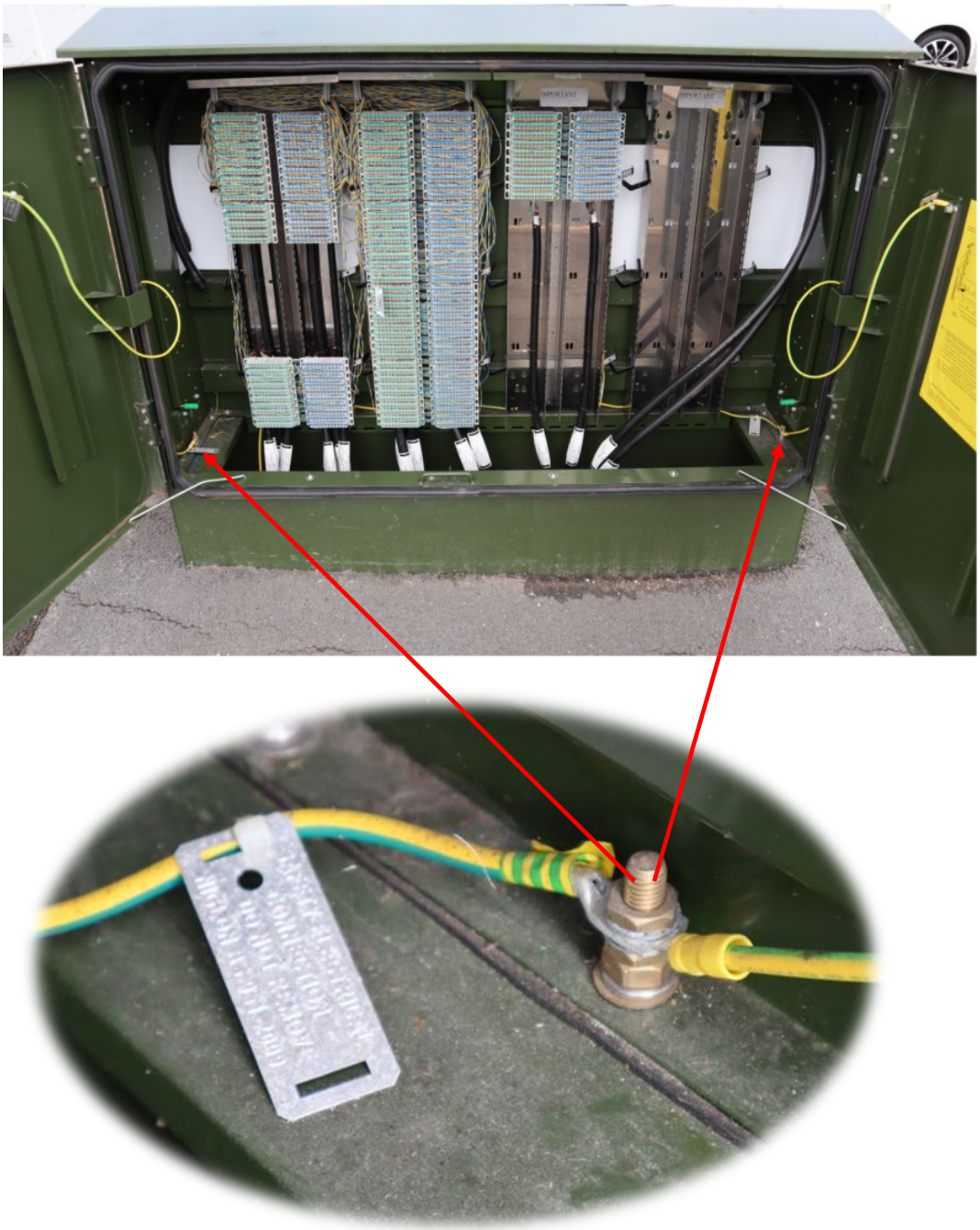
Earth bonding bar in PCP is 8mm with a 13mm nut

New 7/7 with pre bonded doors and panels





Old Style 7/7 (with MET on both sides of the cabinet)



8.6 Tools and Consumables for performing bonding

It is not necessary to use insulated crimp terminals. Plain copper tube crimps for earthing & equipotential bonding are sufficient.

eASC Item Code	Item Description
052511	Earth Bonding Kits for CCC7
011550	Clip Earth 3 (earth bonding strap)
791555	6mm2 G/Y cable ELP 6491
791551	10mm2 G/Y cable ELP 6491
791556	16mm2 G/Y cable ELP 6491
533961	Copper tube Crimp eyelet 16 x 6

Note: Crimps are specified by the cable cross sectional area (mm2) and then eyelet hole diameter (mm)

TW Item Code	Item Description
TW1736	Crimping tool suitable for 0.3 to 16mm2 cable crimps £30.87 each
TW1856	Copper tube Crimp eyelet 16 x 10 (bag 100) £15.81
TW1855	Copper tube Crimp eyelet 16 x 6 (bag 100) £17.04
TW1853	Copper tube Crimp eyelet 10 x 6 (bag 100) £14.18
TW1852	Copper tube Crimp Butt Splice 10mm2 (bag 100) (In-line splice) £20.20
TW1854	Copper tube Crimp Butt Splice 16mm2 (bag 100) (In-line splice) £24.21
TW1861	Copper tube Crimp eyelet 6 x 6 (bag 100) £12.87

The items from TW Engineering are not generally used in great quantity, and so do not warrant being a standard stores item. Prices are approximate and will be confirmed at time of order. They should also be available from general electrical wholesalers such as CEF, Denman's, Newey & Eyre.

9 *Appendix 1: Requirements for Working in Mains Powered FTTC Cabinets*

9.1 AC-DC Connectivity for NGA Huawei and ECI cabinets.

AAA-AC connectivity for NGA cabinets ver

9.2 Working in the RDSLAM Cabinet

- Always undertake a local risk assessment of the cabinet and surrounding area before opening or touching the cabinet.
- If you are not a qualified power engineer, then you can only access the power sections of the cabinet if you have completed ORWPP001 CBT course. This CBT course does not allow you to work on any power equipment.


Toolbox Talk -
Working in Mains Pow

- The Kewtech tools can be ordered from the Stores Ordering System (eASC).
  - Kewtech Combined kit (Non-Contact voltage detector 90-600V AC and Proving Tool) – IC 093746
  - Kewtech Non-Contact voltage detector 90-600V AC – IC 095290
  - Kewtech Proving tool for Non-Contact voltage detector -IC 095291

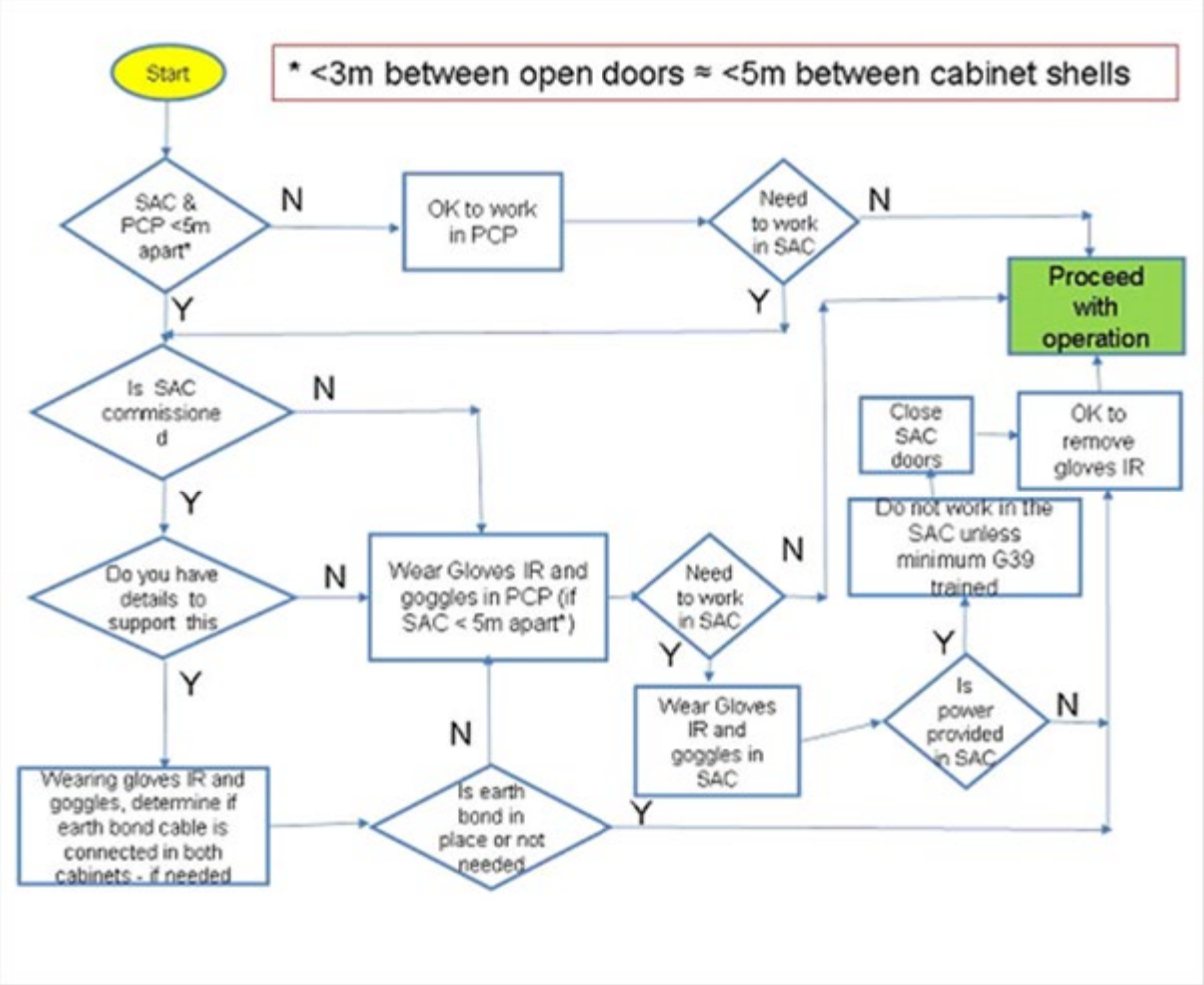
Note: The table above explains the minimum training requirement to access the cabinet.


Toolbox Talk - Non
Contact Voltage Dete

- The RDSLAM should be verified as safe to touch with a Non-Contact Voltage detector.
- If entering the power side before the BS 7671:2018 testing has been completed, wear Goggles and Gloves IR before opening the power door. Look, but don't touch wiring or equipment. G39/1 procedure may also be used.
- If the active side is powered, as indicated by equipment lights being on, the electrical test certification will have been completed and the cabinet considered safe to work at.
- If the power cable is provided, but not terminated or protected, do not work in the power side unless ORWPP001 or G39/1 or power trained and only on the NTE. Carefully close the door and make the cabinet secure.
- Nominated electricians will check for the provision of earth bonding cable and PCP bonding during the BS 7671:2018 wiring tests, if necessary. The earth bonding cable will be terminated in the appropriate side (normally passive side) of the FTTC cabinet.

9.3 Risk Assessment for when FTTC and PCP Cabinets are in Close Proximity.

The following local risk assessment should be completed when the RDSLAM stand-alone cabinet (SAC) and PCP are close together, i.e. less than 3m between open doors of SAC and PCP and the commissioning status is unknown.



10 *Appendix 2: Requirements for Working on Mains Power Systems within Cabinets.*

Each DNO supply to a FTTC cabinet will be provided via a cut-out fuse, a meter and then a MCB. The DNO will only cable and terminate as far as the

cut-out. **Cabling from the cut-out to the equipment must only be performed by qualified and accredited MOCCOP engineer.**

Caution: Only **skilled, trained and authorised** people are allowed to remove the cut-out fuse (a minimum of **G39/1** training) – this is only expected to be necessary in an **emergency situation**. Before entering the cabinet/power cubicle, safety checks in accordance with G39/1 shall be performed. If an MCB is fitted it shall be switched to the OFF position before removal of the cut-out. Internal electrical safety checks at the cabinet shall also be made before and after removal of the cut-out in accordance with G39/1.

Wiring of meters, circuit breakers, earths and the equipment can only be performed by qualified and trained electricians. The whole installation will be certified in accordance with the IET Wiring Regulations 18th Edition /BS 7671:2018.

Model certification forms can be found in IET Wiring Regulations 18th Edition/BS 7671:2018 and in BT ISIS EPT/ANS/A036.

11 *Appendix 3: Examples of good and bad crimping*

11.1 Correct Crimping Tools

(a)

(b)

Figure 11.1: (a) Ratcheting tool for non-insulated crimps; (b) Ratcheting tool for insulated crimps.

Two types of crimping tool are generally available, those for plain (non-insulated) copper tube crimps and those for insulated crimps. Those suitable for insulated crimps generally have colour coding on the jaw slots.

Red 0.5mm2 – 1.5mm2

Blue 0.75mm2 – 2.5mm2

Yellow 4mm2 – 6mm2

Do not use the wrong tool as it will not give the correct compression joint and could damage the crimp.

With insulated crimps, the crimp should be made close to the eye end of the crimp, such that it compresses all the metal. Note, the insulation is a lot longer than the metal within it.

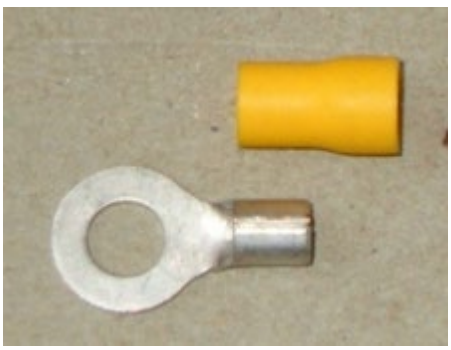


Figure 11.2: Insulated crimp with the insulation removed, to show how short the metal section is.

11.2 Good Crimp

Figure 11.3: Correct length of copper exposed with no cut strands.

Figure 11.4: Cable in terminal with insulation butting against terminal and a little copper showing at the end confirming copper is long enough.

Figure 11.5: Good quality crimp performed on ring terminal, and cable insulation butted up to crimp

Figure 11.6: Good quality Insulated crimp. Cable insulation butts up inside to metal of crimp.

A pull test should result in the cable being held tight, and not show any sign of movement of the strands in the crimp. Any indication of failure means a new termination is required.

11.3 Poor Quality Crimp

Figure 11.7: Not enough copper exposed to go fully inside crimp, resulting in either wire pulling out or insulation preventing good electrical contact.

Figure 11.8: Crimp made with that from Figure 11.7 and insulation pushed hard into crimp. .

Whilst the crimp in Figure 11.8 may look OK externally, it may not conduct correctly and may fail mechanically. A pull test and electrical test should reveal the poor quality.

Figure 11.9: Terminal crimped with tool other than correct crimpers

The crimp in figure 11.9 may work short term but is more likely to fail mechanically or due to corrosion and cables fracturing.

Figure 11.10: Fewer strands of wire to be crimped

In a cable where some strands of the copper wires have been cut when removing insulation it will result in the crimp not being as mechanically sound as it should be. Crimping tools and crimps are designed to function correctly with the correct wire/number of strands. Do not be tempted to use a smaller crimp to correct for cut strands. Equally, do not use a larger crimp and compress using a smaller crimp setting or fold the wire to compensate.

END OF DOCUMENT