Association For
Audio Visual Professionals

Code of Practice

Electrical Safety Requirements for Signal Reception Systems (excluding CATV)

CAI COP 3: January 2019

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- To unite the Industry on its common aims.
- To keep abreast of technological change.
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Association For Audio Visual Professionals

CAI Ltd
Communications House
41a Market Street, Watford, Hertfordshire, WD18 0PN
Tel: 01923 803030 **Twitter:** /cailtd **Facebook:** /cailimited
Email: office@cai.org.uk **Website:** www.cai.org.uk

Contents

1 Introduction

This document is the Code of Practice of CAI Ltd on Electrical Safety Requirements for Signal Reception Systems (excluding CATV).

CAI Codes of Practice are created by CAI's Technical Committee to provide an interpretation of current British and IEC Standards and best practice. In creating such a Code consideration is given to all the relevant standards and EC Directives covering the subject in question as well as current practice. The standards considered in this Code are listed within the Scope and Purpose and Appendix 7.

This particular Code of Practice originates from requirements in the Low Voltage Directive 2006 (LVD) and The Electricity at Work Regulations 1989.

The LVD states that; "...without prejudice to any other form of proof, the proof of compliance with these requirements may be established by reference to harmonised standards which incorporate these conditions", and Article 2 states "... equipment may be placed on the market only if having been constructed in accordance with good engineering practice in safety matters in force in the Community, it does not endanger the safety of persons, domestic animals or property when properly installed and maintained and used in the application for which it was made."

Regulation 4.1 of The Electricity at Work Regulations states; "All *(electrical)* systems shall at all times be of such construction as to prevent, so far as is reasonably practicable, danger."

Reference to actual aerial systems assumes that CAI benchmarked cable is used throughout.

While a stated aim of CAI is to raise standards within the industry, it is not their intention to overburden members with requirements which are not always necessary, nor is it the intention to cause consumers to pay for work which is not necessary. Specifically in the case of SDUs while the following Code makes safe all currently perceived events it is appropriate to consider the safety of the system from a risk assessment point of view [1] where previous experience as well as the current system requirements will determine the necessity of following all the safety items detailed herein.

Compliance with this Code would meet the requirements of the Electricity at Work Regulations, the IET Wiring Regulations 17th Edition and the Heath and Safety at Work Act. It is the responsibility of members to install safe systems and to this end they should comply with the Electricity at Work Regulations, the Wiring Regulations and the Heath and Safety at Work Act.

[1] An example of such an assessment could include the lower limit for reaction from an electric current being 0.5mA rms. However, susceptibility to this level of current varies from person to person and also to the conditions under which contact is made with the source. Significant differences in the reaction level depends upon, amongst others, contact area and damaged or wet skin. When taking into account 100% of the population, the physiological threshold for muscular reactions such as; immobilization, difficulty in breathing or the inability to let-go, the current can be as low as 5mA rms. However, as far as HSE are concerned, no recorded cases of 'can't let go' have occurred and therefore from a risk assessment point of view it may be concluded on SDUs that the risk is small. In all cases the user of the system should be advised of the issues involved and information left with the householder advising of the risks of Class II equipment leakage current and limits thereof.

1.1 Scope and Purpose

This Code of Practice is intended to provide requirements to ensure adequate electrical safety provision for Signal Reception Systems (excluding CATV); these requirements are based on BS EN 60728-11:2005, BS EN 60065:2002, BS EN 60950-1:2006, BS EN 60990:2000, BS EN 62305-4:2006, TS 60479-1:2005, IEC 62368-1 Ed 1.0 and other overriding safety standards such as BS EN 7671:2008 (wiring regulations), Directive 2006/95/EC, Electricity at Work Regulations 1989 and the Health and Safety Directive (Health and Safety at Work etc Act 1974 (HSW Act) in Great Britain or the Health and Safety at Work (Northern Ireland) Order 1978 in Northern Ireland). As this is only a summary document it is recommended that an up to date copy of the Standards are available for reference.

The premise of these requirements is the prevention of serious injury either to a system user or any maintenance personnel due to the risk of hazardous voltages becoming present on that distribution system.

The two basic options to ensure adequate system safety are outlined below:

Systems with fully isolated outlets.

Electrical safety is provided by double capacitive isolation of the aerial system from the equipment. Due to the poor EMC performance of these isolators the use of isolated outlets is seldom applicable on new installations. These outlets rely on isolating components, usually capacitors, in series with both the inner and outer conductors throughout the network. These isolating components shall comply with BS EN 60065:2002 and the complete isolated outlet to BS EN 60728-11:2005 for safety purposes and BS EN 50083-2:2001 for EMC.

Non-isolated Systems using earthing and Main Protective Bonding (Equipotential).

Where the aerial system may be associated with Class I equipment any earthing shall conform with BS 7671:2008 to prevent any fault condition from making the system hazardous.

With Class II equipment the provision of isolation or of equipotential bonding is intended to provide protection by minimising the touch voltages to conform with BS 7671:2008 and provide a signal reference (EMC) for the aerial system.

1.2 Definitions and Glossary of Terms in relation to this document

Bonding Point: A point where a connection may be made for equipotential bonding and/or earthing.

"Can't let go" (Threshold of let-go): The maximum value of touch current at which a person holding electrodes can let go of the electrodes.

CATV: Community Antenna Television. A master antenna and distribution system capable of receiving, amplifying and distributing a television signal via a coaxial or fibre cable to television receivers in a large community. Also known as "Cable Television".

Class I Equipment: Equipment in which protection against electric shock does not rely on basic insulation only, but which includes means for the connection of exposed-conductive-parts to a protective conductor in the fixed wiring of the installation. Examples of this equipment are: Plasma and LCD Televisions and Desk-top Computers.

Class II Equipment: Equipment in which protection against electric shock does not rely on basic insulation only, but in which additional safety precautions such as supplementary insulation are provided, there being no provision for the connection of exposed metalwork of the equipment to a protective conductor, and no reliance upon precautions to be taken in the fixed wiring of the installation. Class II equipment normally carries the symbol ⧈. Examples of this equipment are: Televisions, Set Top Boxes, DVDs, PVRs, VCRs, Games Consoles and Audio Equipment etc.

Note: It does not necessarily follow that the examples given are exclusively of that class. For example some LCD televisions are Class II.

Competent Person (electrical): A person with technical knowledge or experience (Electricity at Work Regulations 1989). See Appendix 6.

Dish Sharing: A signal reception system that delivers satellite signals only, via a network, to multiple outlets as if connected to own dish.

EMC: Electro-Magnetic Compatibility.

Equipotential Bonding: Electrical connection maintaining various exposed-conductive-parts and extraneous-conductive-parts at substantially the same potential.

Engineer: Person competent to work on installation or maintenance of a signal reception system according to CAI Codes of Practice.

Interconnected Buildings: (In the context of Figs. 4a and 4b), single dwelling units that are connected together via a signal distribution system.

IRS: Integrated Reception System. A signal reception system that delivers terrestrial and satellite signals to multiple outlets as if connected to own dish and aerial array.

Leakage Current: Electric current in an unwanted conductive path under normal operating conditions.

LPS: Lightning Protection System.

MATV: Master Antenna Television. A signal reception system that feeds terrestrial signals to multiple points via a network. If in multiple buildings this would be restricted to a local area.

MDU: Multiple Dwelling Unit.

MET: Main Earth Terminal.

Protective Earthing: Earthing of a point or points in a system or in an installation or in equipment for the purposes of safety.

RF: Radio Frequency.

SDU: Single Dwelling Unit, be it detached, semi-detached or terraced. This would also include an individual apartment, flat or maisonette etc.

SMATV: Satellite Master Antenna Television. Similar to MATV with the addition of locally modulated signals, commonly satellite programmes.

Supplementary Bond: A connection to earth in order to minimise touch currents from Class II equipment.

System: A network that feeds RF signals to multiple points. See CATV, MATV, SMATV and IRS.

Touch Current: Electric current through a human body or through an animal's body when it touches one or more accessible parts of an installation or equipment.

Touch Reaction (Threshold of reaction): The minimum value of touch current which causes involuntary muscular contraction.

2 Responsibilities

Any design, installation or maintenance work undertaken on a system is the responsibility of those that carry out the work. They are therefore responsible for ensuring that the system is safe and that any work carried out is to the correct standards.

If a system is found to have inadequate electrical safety protection, then it is the responsibility of the person identifying this deficiency to notify the appropriate body in writing, for example, the landlord.

3 Earthing and Equipotential Bonding

All systems shall be connected to the building's main earth terminal, with the exception of very simple systems in SDUs (See section 8).

Generally, there will be a Main Earth Terminal (MET) to which the system can be connected, this has been the case since 1937. (It may be difficult to find, but only in exceptional circumstances will there be no main earth terminal). A typical installation is shown in Fig. 2. Where no MET is evident then advice should be sought from an electrical professional.

A competent person shall install a bonding point, or confirm the suitability of an existing point, to which the system shall be connected.

Where a route back to the main earth is difficult to achieve, it is acceptable to use other bonded metalwork providing that it is connected back to the main earth in a robust, permanent and continuous manner. The competent person shall confirm this. The path shall also have adequate current carrying capacity. This may be checked by measuring the resistance of the earth path using a wander lead on a multimeter (with accuracy to 0.1Ω). The resistance of this lead should be subtracted from the total resistance of the earth path plus the wander lead and should be no greater than 4Ω, including an allowance for the coaxial cable. All bonding points shall be labelled "Safety electrical connection do not remove" and comply with BS 951. It is acceptable to use bonded cable trays and the metal structure of the building, but not gas pipes for example. It is not permitted to bond using a mains plug. In a MDU the bond must not be via a ring or radial circuit.

4 Safety Provision

Summary of relevant requirements for the different approaches to providing system safety.

4.1 Safety Isolation

It is unlikely that a new system would use fully isolated outlets to provide electrical safety as the industry standard isolated outlet plates do not meet the screening requirements defined for EMC compliance.

On older systems that rely on isolation, fully isolated outlets shall be used for maintenance.

Regardless whether isolation is used, the headend and mast shall be connected to a bonding point.

4.2 Earth Systems

Safety is provided by ensuring that the system is connected to the main earth terminal of the building, the same earth that all other services are connected to, and relies on the connection of the aerial system to the building's protective earth to minimise any dangerous voltages.

Operation of the appropriate circuit protection device is essential during a fault condition, hence the requirement for a low resistance path (See 9.2 below).

4.2.1 Headend

The screen of all coaxial cables feeding signals to or from a headend and the headend equipment shall be connected to a bonding point. (See Figs. 7, 8, 9)

4.2.2 Repeater Amplifiers, Multiswitches and Other Active Components

Repeater amplifiers, multiswitches etc either mains or line powered, shall be separately connected to the protective bonding point where installed within a single building. This may be achieved by connection of the earth terminal of the equipment (method 2) or via the incoming and outgoing coaxial signal cables (method 1) and shall be connected such that removal of the equipment leaves the system earth intact (See Fig. 3). With method 2, a temporary bond shall be employed when equipment is removed.

4.2.3 Taps and Splitters and Other Passive Devices

Taps and splitters need not be separately bonded, i.e. bonding may be achieved by the coaxial cables to which they are connected providing their removal leaves the bonding system intact. This will mean using a bridging connection as explained in Appendix 2.

4.2.4 Connectors

All terminations shall be made in a sound and reliable manner; this is necessary for both RF signals and electrical bonding. Where used, connectors are performing a dual function, as well as providing well matched cable terminations they shall also present a low resistance path to earth. In preference, crimp or compression connectors shall be used. 'Screw-on' connectors should not be used on MDU or commercial systems. See Appendix 1 for correct method of termination for connectors.

Select the termination method appropriate to the connector used. Check with the cable supplier for confirmation of dimensional requirements and correct tool.

5 Interconnected Buildings

5.1 Multiple Houses *

Where a number of houses have a common signal feed and common earth, equipotential bonding shall be made via the coaxial cable or protective conductor (coloured green and yellow) back to the headend (See Fig. 4a). Where the common earth cannot be guaranteed it is possible that balancing currents may exceed those given in Table 1. In this instance each dwelling shall be galvanically isolated from the distribution point (See Fig. 4b) and any switches required shall be located within the dwelling after the isolation and bonded to the MET of that building.

5.2 Interconnected Blocks *

Where differing earth potentials will cause a significant balancing current to flow between two or more parts of the system then the interconnecting coaxial cables shall be galvanically isolated. If there is any doubt then galvanic isolation shall be used (See Fig. 5).

5.3 Multiple Outlets

When multiple outlets are within each dwelling, additional safety connections shall be made as described in section 8.2.

* See also section 9.3.

6 Equipment Disconnection Procedure

The removal of some system components may break bonding continuity and thereby increase the risk to maintenance personnel. To negate this risk it is essential that maintenance personnel are made aware of the risk and that, prior to the removal of a component, provision is made to ensure continuity is retained. This can be achieved by strapping across the disconnected cables with suitable conductors or with the provision of a bonding bar (See Fig. 6 and Appendix 2). On no account should any coaxial cable be removed from a permanent or temporary bonding bar, nor should the earth cable. In order to remove/test a piece of equipment the whole bar should be removed with all cables connected.

7 Lightning Protection System (LPS)

Reference is made in BS EN 60728-11:2005 to the connection of the system to the building's lightning protection system, where fitted.

Work on lightning protection systems is a specialised task and shall only be carried out by or with the guidance of a competent and qualified person. Before any work is conducted on, or connections made to the LPS, permission from the client and specialist advice shall be sought.

Provision of a LPS is beyond the installer's responsibility as is the integrity of any such system already installed, however the installer shall advise the client of the possible requirements.

Where a LPS is to be installed or already exists it may be necessary to fit Surge Protection Devices (SPDs) on the incoming antenna feeder cables where they enter the building as defined in BS EN 62305-4:2006. This requirement will normally be detailed by the LPS specialist.

With reference to BS EN 60728-11:2005, it is prohibited to affix an antenna to a building with a thatched roof.

8 Single Dwelling Units

Where the system includes Class II equipment a voltage will be present on the screen of the coaxial cable which will be minimised by the use of a supplementary bond. Where rooms are rented out in a SDU, this should be considered as a MDU and treated accordingly.

8.1 Protecting the Engineer

The touch current is minimised by the supplementary bond. This is particularly important when the engineer is working off a ladder in wet conditions. Engineers working on a SDU installation shall apply one of the following:

Satisfy themselves of the continuity and integrity* of a local mains earth and then use that earth connection to minimise any voltage that may be found on the antenna installation by making a temporary bond to the outer screen of the coaxial cable.

or

Isolate from the mains supply all devices connected and interconnected with the antenna installation such that there is no possibility of the presence of a voltage and no touch currents.

or

Apply a supplementary bond to the system in accordance with 8.2 detailed below.

8.2 Protecting the End User

The maximum permissible touch current, taking into account contact area and skin condition is 3.5mA which is the lowest touch current at which it can be ensured that any human may "let go" of the conductor. This level is the same as the maximum touch current leakage from a Class I item of equipment with the earth removed and this is the upper limit of the sum of all potential touch currents from a number of interconnected items of Class II equipment. The maximum amount of leakage current from a single piece of Class II equipment under BS EN 60065 is 0.5mA. However BS EN 60950-1:2006 (IT equipment) only allows a leakage of 0.25mA. IEC 62368-1 Ed 1.0 combines these two standards and uses the higher limit of 0.5mA. For safety CAI is using the upper limit for worst case scenario.

The cumulative touch current from a number of interconnected Class II items shall not exceed 3.5mA. Where touch current in excess of 3.5mA is likely, a supplementary bond shall be provided to conduct the touch current to earth. The agreed industry advisory note, or Certificate of Conformity (see Appendix 3) shall always be left with the user of the equipment offering guidance on how to reduce or eliminate touch current.

Typically seven units would be the maximum recommended number of interconnected Class II units in order to keep below the 3.5mA maximum allowable touch current.

In the case of a SDU with more than one viewing position the total number of Class II units across all viewing positions must be taken into account.

Before starting the installation, installers shall satisfy themselves of the continuity and integrity* of a local mains earth, then the supplementary bond shall be connected by one of the following:

Provide a supplementary bond to the distribution amplifier and / or each of the coaxial cables at a central location.

or

Provide a supplementary bond to one of the coaxial cables at a convenient location providing that there is a low impedance path from the coaxial cable chosen to all other coaxial cables in the installation. See section 9.2. This should be tested at each outlet on the system to a known local earth.

The supplementary bond used may be via the earth of a radial (including a lighting circuit), or a ring final circuit or directly from a building main earth terminal.

For robustness, the conductor used for the interconnection from the aerial system to the radial or ring circuit shall have a minimum cross sectional area of 2.5mm^2 and shall be insulated (See Fig. 7). If made directly to the MET the connecting cable shall have a minimum CSA of 4mm^2. Any cable less than 4mm^2 shall be protected in trunking.

A suitable label should be affixed next to the bond stating **"SAFETY ELECTRICAL CONNECTION DO NOT REMOVE".**

Where part of the supplementary bond relies on the connector of a coaxial cable that connector shall be terminated in a permanent and robust manner. (See Appendix 1).

A suitable certificate should be left with the customer advising them of the conformity of this work. (See Appendix 3).

* See Appendix 4 – maximum permissible earth fault loop impedance values.

9 Supplementary Notes

Relating to BS EN 60728-11:2005.

9.1 Mains Connection

Connection to both the mains and protective earth shall be carried out in accordance with BS7671 (current edition). For new buildings and refurbishments etc. this shall be considered at the planning stage.

9.2 Bonding Resistance

The resistance allowed between the screen of any coaxial socket and the main bonding point shall be no more than 4Ω. Where equipotential bonding conductors are used they shall be copper and have a minimum cross-sectional area of 4mm^2 and shall be continuous. (See also Appendix 1 for connection techniques that provide lowest resistance termination).

9.3 Remote Equipment

Where equipment is housed in separate detached buildings or street cabinets, they shall be housed in an enclosure. If a metallic enclosure is used, then the enclosure shall be bonded to the local protective earth. Figures (10.1a to 10.2b) represent either metallic or non-metallic enclosures. They do not imply that a metallic enclosure, such as a street cabinet, should be enclosed within a non-metallic outer enclosure. Both are shown to illustrate the different earthing arrangements between the two types of enclosure. The non-metallic inner enclosure in Fig. 10.2b is to protect the engineer from balancing currents created because of different earth potentials between the active component within the cabinet and the trunk lines that will be earthed remotely.

9.3.1 Locally Powered Equipment

Galvanic isolators shall be fitted to all trunk/distribution cables that feed other buildings, unless the balancing current is less than shown in Table 1, and all local active and passive equipment shall be bonded to the local earth (See Fig. 10.1a). If balancing currents greater than those allowable are present on subscriber feeds then galvanic isolation must be used in those feeds and any required switches must be located in the subscriber premises (See Fig. 10.1b). Isolation at each end of subscriber feeds is recommended.

9.3.2 Line Powered Equipment

Where power is being supplied via coaxial cables from a remote source and balancing currents do not exceed those given in Table 1 no galvanic isolation is required (See Fig. 10.2a). If balancing currents greater than those allowable are present on subscriber feeds then galvanic isolation must be used in those feeds and any required switches must be located in the subscriber premises. Any equipment within the enclosure shall be fitted within a separate non-metallic enclosure bearing a label stating, "Removal of this cover may expose potentially dangerous voltages" (See Fig. 10.2b). Isolation at each end of subscriber feeds is recommended.

Advisory note: Should balancing currents be present greater than those in Table 1 then the local electricity supplier should be informed.

10. Installation of Electrical Outlets

Extra sockets or fused connector units for televisions or distribution amplifiers shall only be fitted by a competent person as defined in section 1.2. If the work only involves the modification of an existing circuit and not the installation of a new circuit then this may be done under a minor works certificate (Appendix 4). Please note that electrical works in bathrooms/kitchens/communal areas and outside is 'notifiable' to the local council and will need inspecting by them or an electrician within a self-certification scheme.

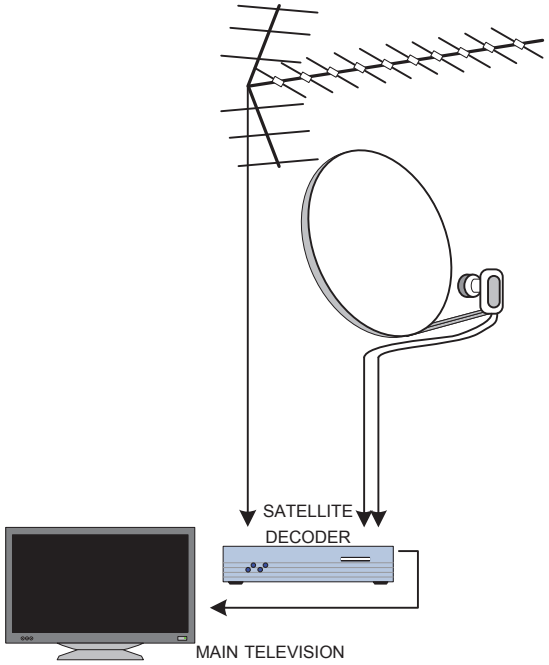


Fig. 1 Simple installation in single dwelling unit.

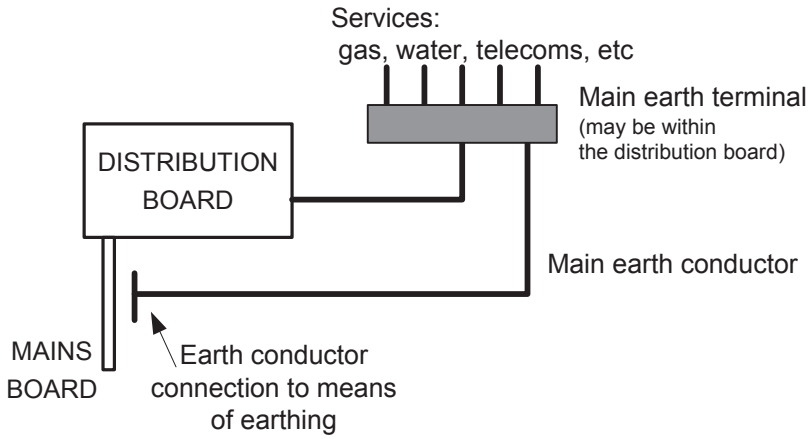


Fig. 2 Typical main earth terminal and bonding arrangement.

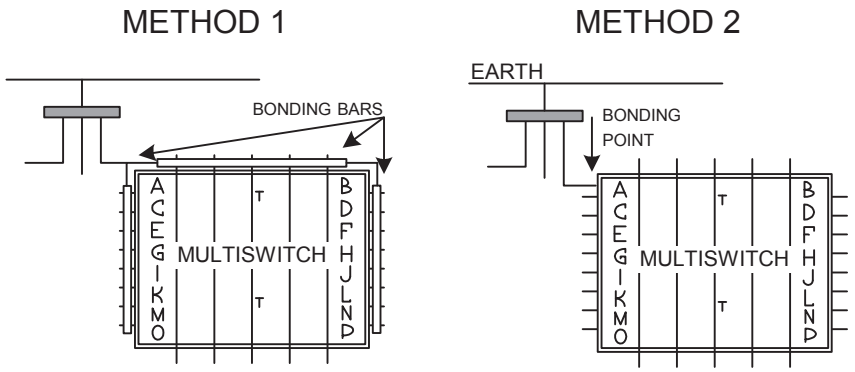


Fig. 3 Multiswitch equipotential bonding.

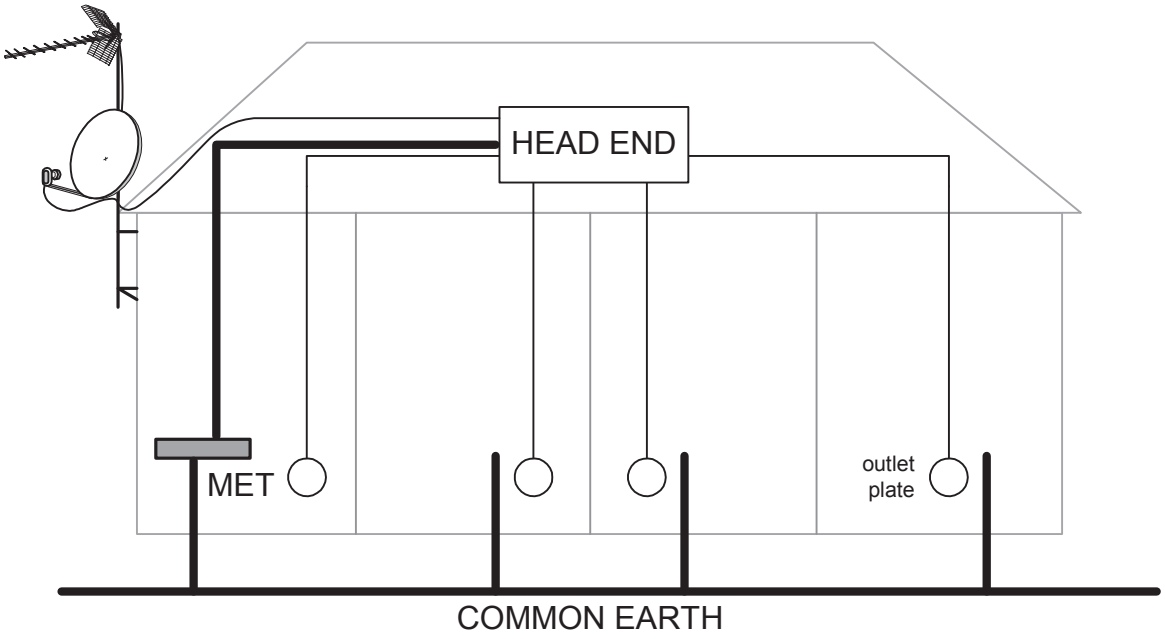


Fig. 4a Main protective (equipotential bonding) multiple interconnected houses with common earth.

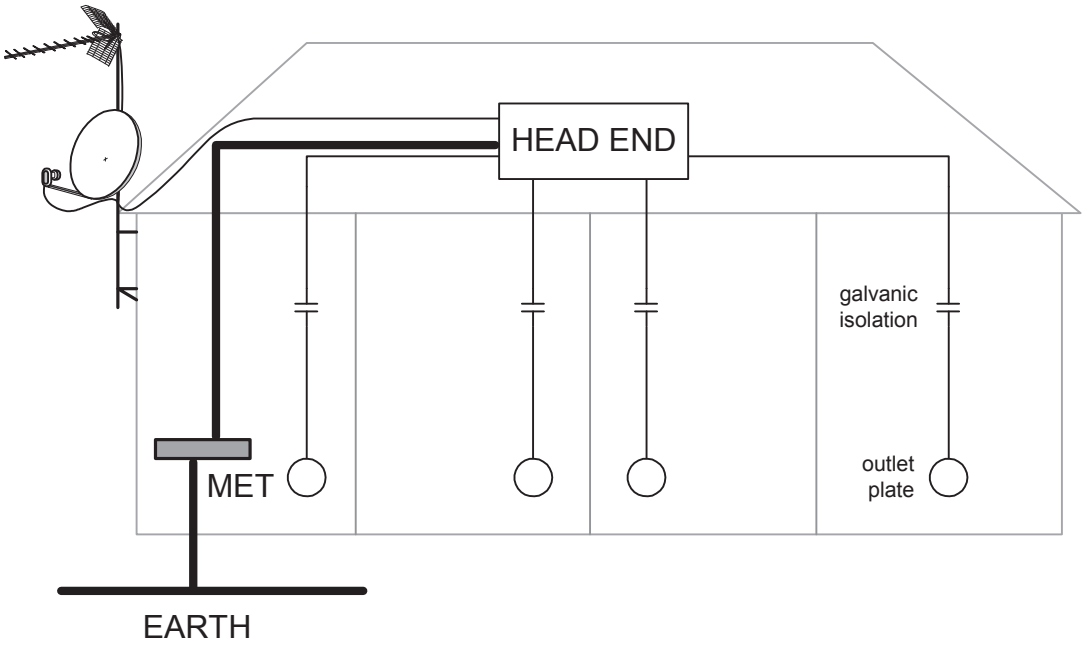


Fig. 4b Main protective (equipotential bonding) multiple interconnected houses with no common earth.

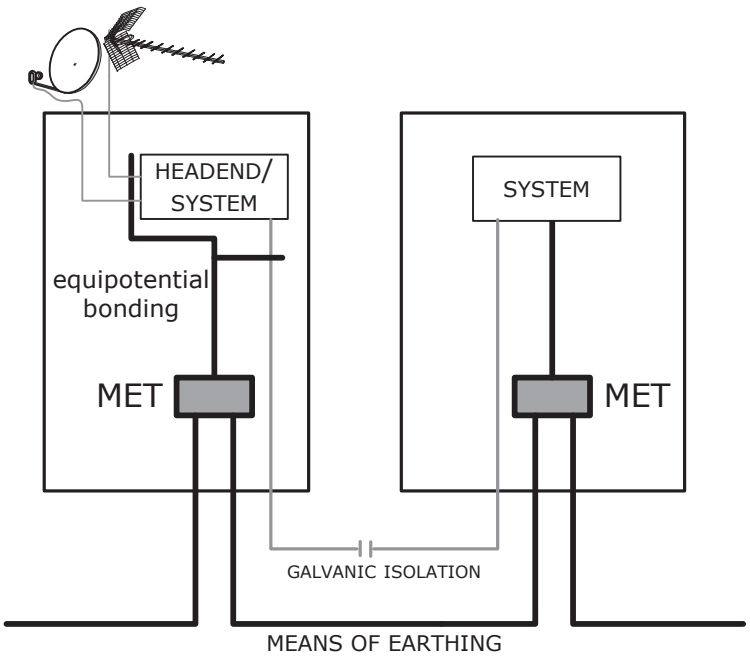


Fig. 5 Equipotential bonding multiple interconnected blocks.

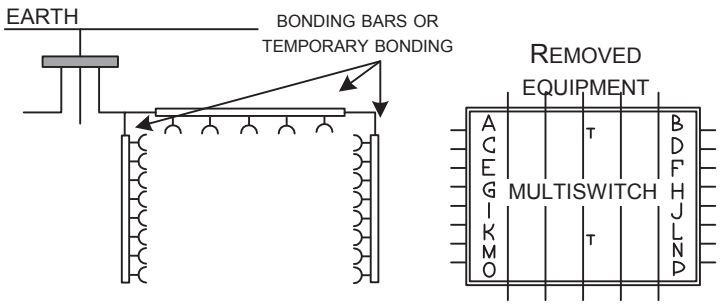


Fig. 6 Disconnection procedure retaining bonding continuity.

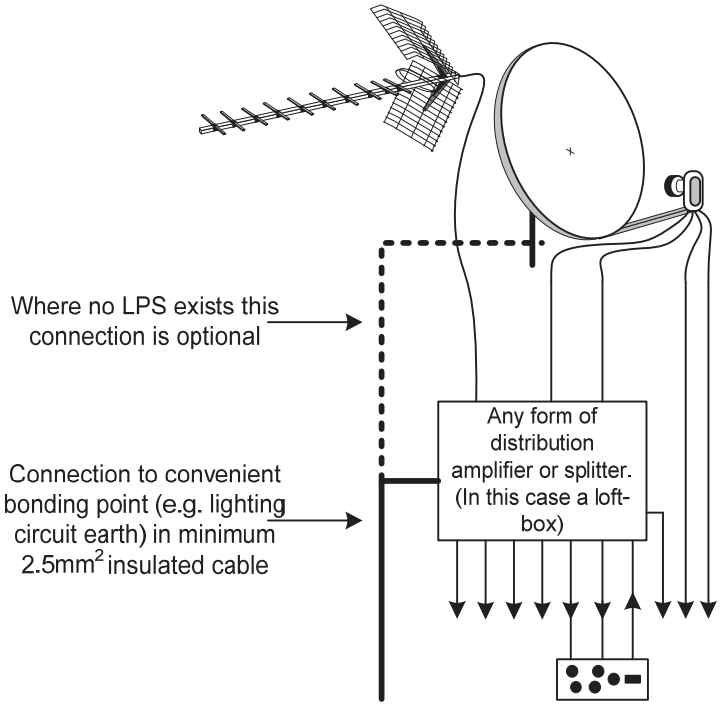


Fig. 7 Safety bonding for a multipoint system within a single dwelling unit.

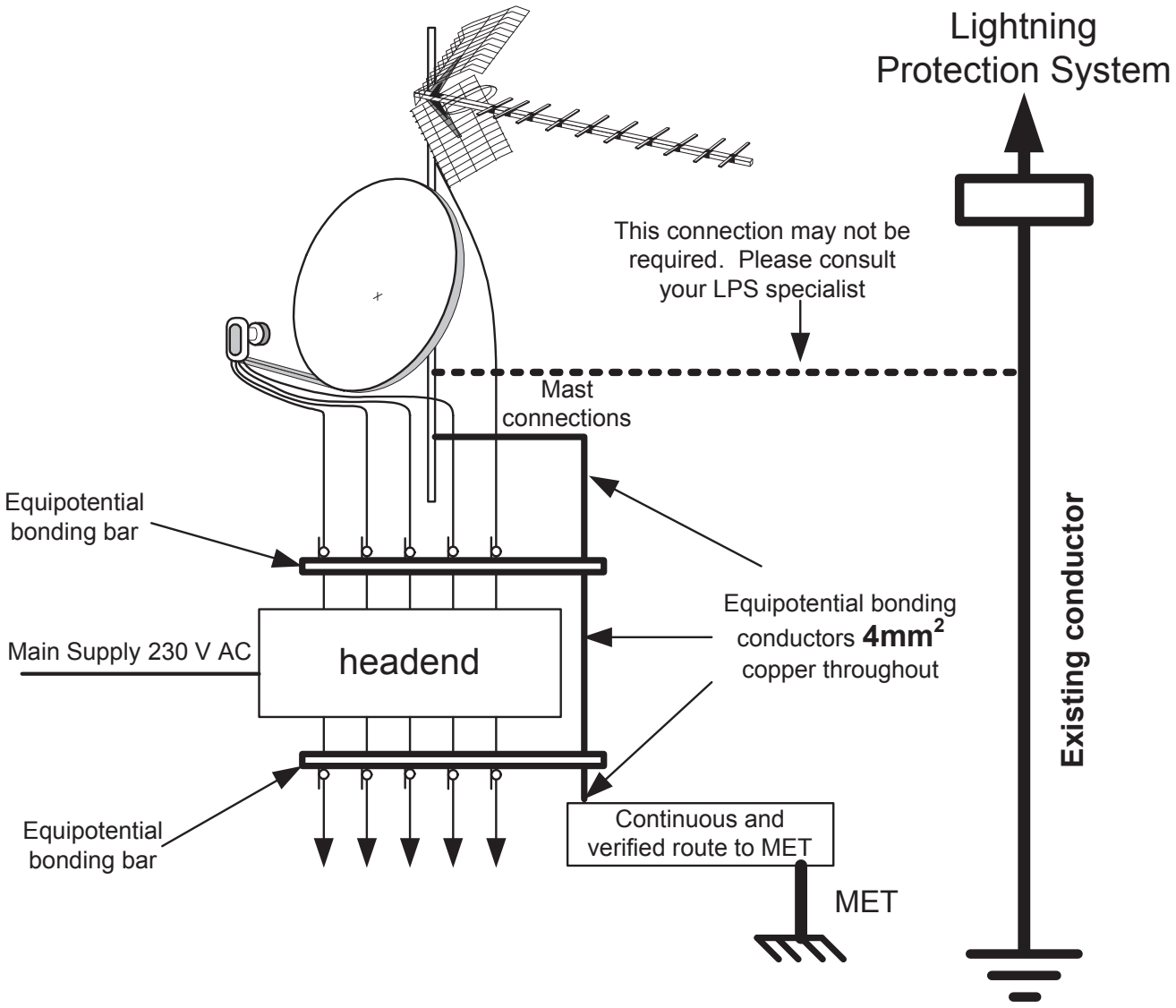


Fig. 8 Main protective (equipotential) bonding arrangement for non SDU headend equipment. Method 1 shown using bonding bars (See Fig. 3).

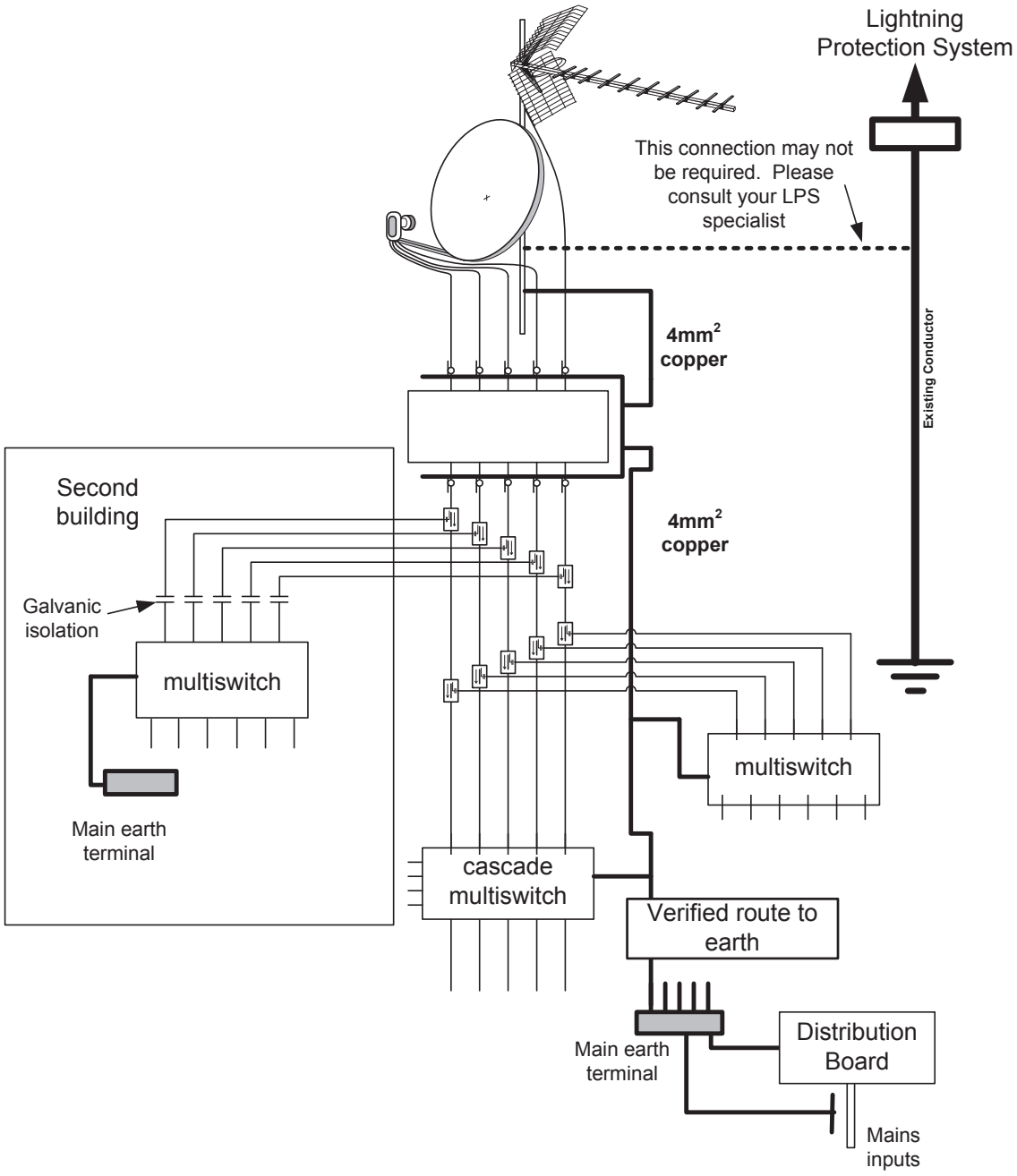


Fig. 9 Main protective (equipotential) bonding arrangement for IRS headend. Both methods shown (See Fig. 3).

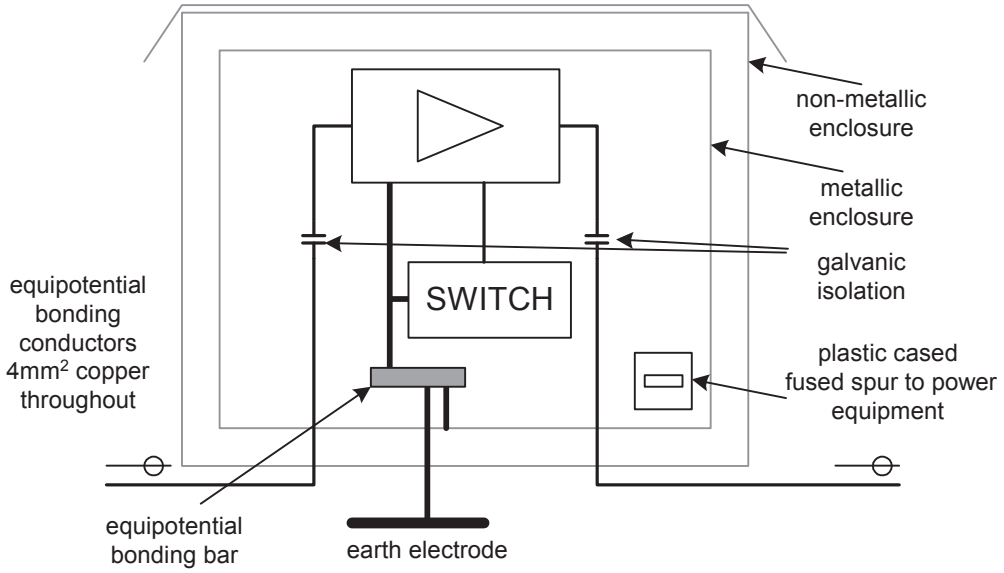


Fig. 10.1a Street cabinet with amplifier and switch (Local Power).

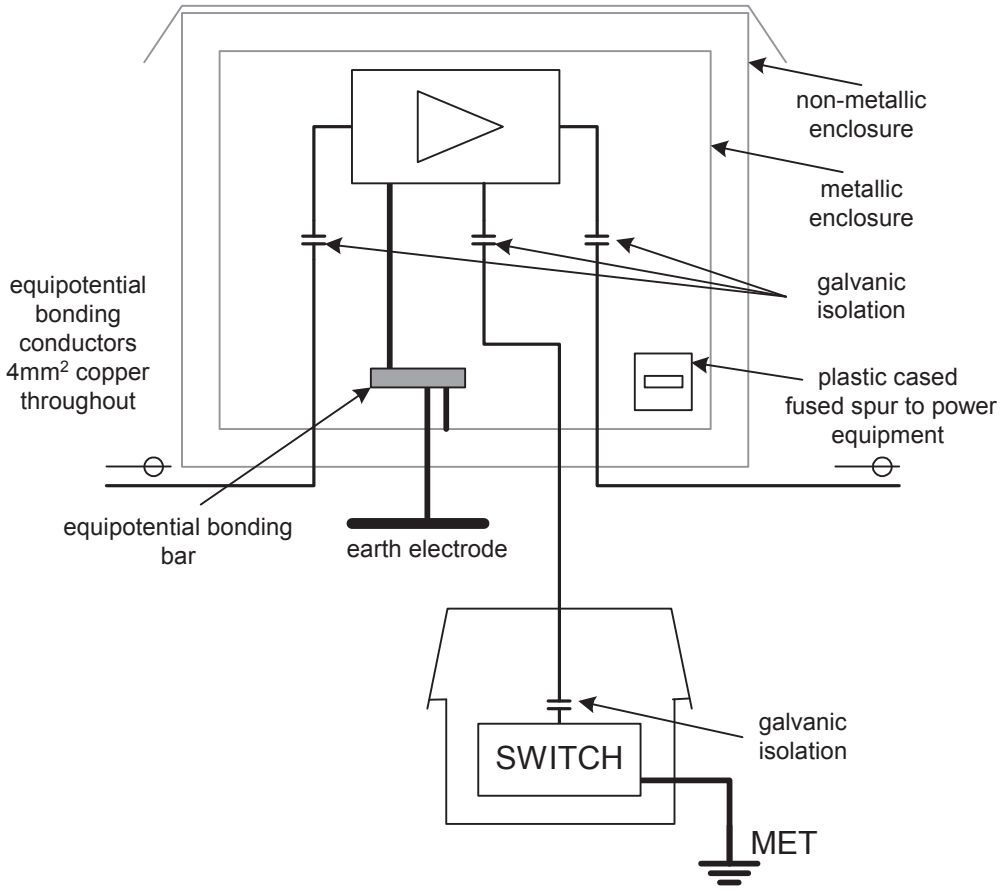


Fig. 10.1b Street cabinet with amplifier and remote switch (Local Power).

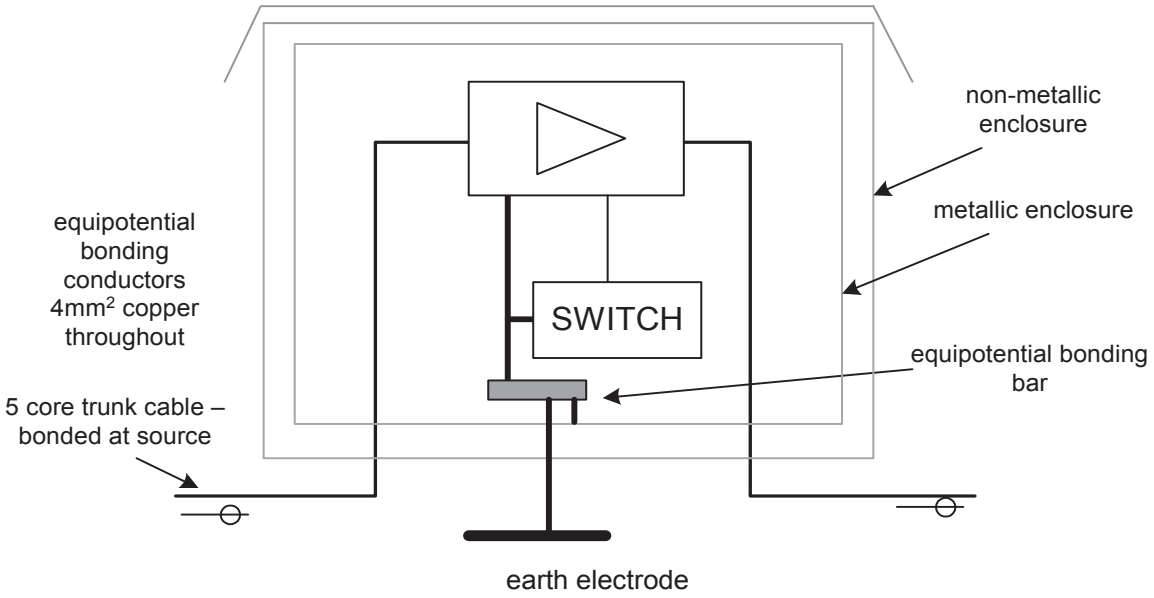


Fig. 10.2a Street cabinet with amplifier and switch (Line Power).

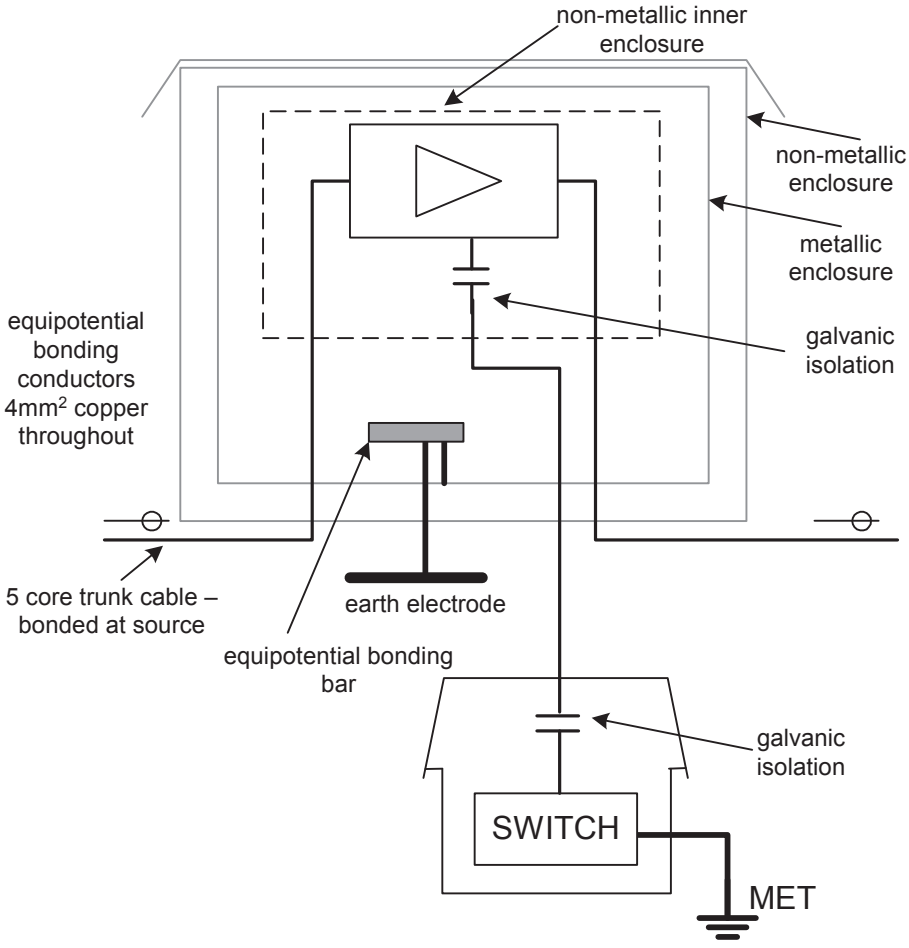


Fig. 10.2b Street cabinet with amplifier and remote switch (Line Power).

Table 1

Cable Type	Maximum allowable balancing current
100	3.5A
125	4.0A
165	4.5A
233	8.0A
340	12.0A

Maximum allowable balancing current* values beyond which galvanic isolation becomes mandatory.

* In individual coaxial cables, or a summation of balancing currents at any point where the screens of multiple cables are connected together, for example at a switching point.

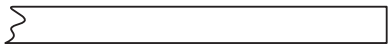
APPENDIX 1:

CORRECT FITTING OF 'F' CONNECTORS

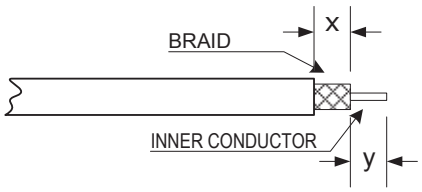
This Appendix shows example installation details for 'f' connectors to CAI benchmarked cable types '100' & '125', and '165/167'.

As explained in clause 9.2 it is of paramount importance that the 'f' connection on the subscriber cables in MDUs exhibits the lowest possible resistance (as well as good EMC and return loss ratio performance) to ensure that total resistance between subscriber outlet and the protective earth is no more than 4Ω.

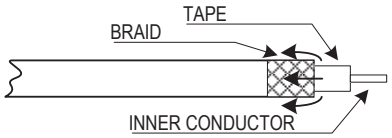
"100/125" cable fitting details for crimp and compression plug



1 Cut the cable squarely.

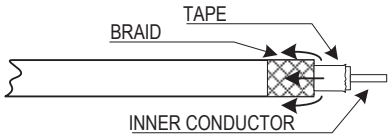


2 Use a preparation tool to expose the correct amount of centre core and screen as defined by the plug manufacturer.

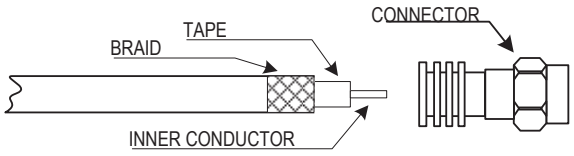


3a Pull the braid back over the sheath and ensure that the tape is snug on the dielectric.

OR (depending upon the connector being used)

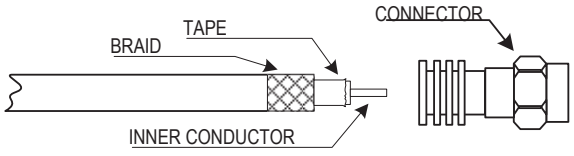


3b Pull the braid back over the sheath and tease the exposed tape that it is loose on the dielectric.

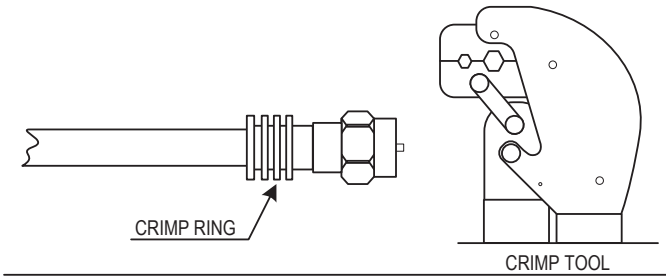


4a Install the connector with the throat of the connector between the tape and the braid of the outer conductor. Push and twist the connector until the dielectric is flush with the inner face of the connector. A "f" mounting tool can help with this procedure.

OR



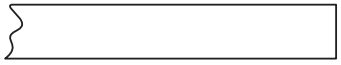
4b Install the connector with the throat of the connector between the dielectric and the tape. Push and twist until the dielectric is flush with the inner face of the connector. A "f" mounting tool can help with this procedure.



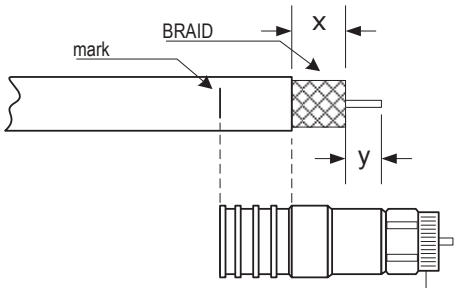
5 Crimp the crimp ring with an appropriately sized crimp tool ensuring that the crimp tool is level with the back of the connector. Trim the centre core to expose 2mm from the end of the plug.

The procedure for fitting compression fittings is much the same as crimp, except a different tool is used to fix the plug to the cable.

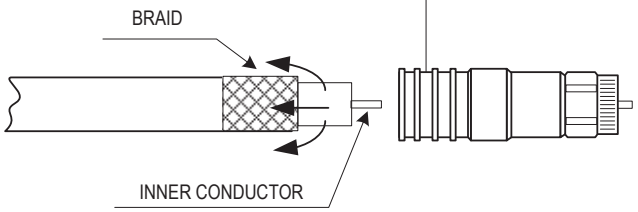
“165/167” cable fitting details for crimp plug



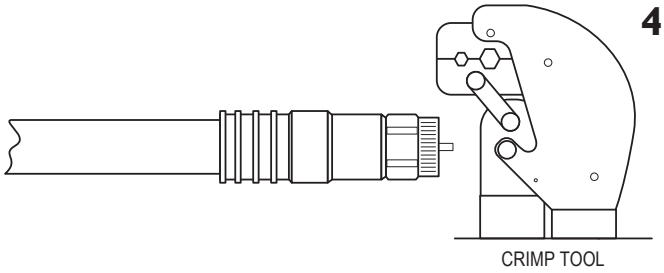
1 Cut the cable squarely



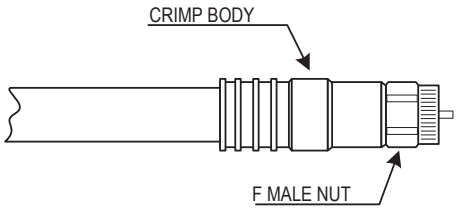
2 Use a preparation tool to expose the correct amount of centre core and screen as defined by the plug manufacturer.



3 Pull the braid back over the sheath and ensure that the tape is snug on the dielectric.



4 Offer the connector to the cable, slipping the inner tube over the foil and under the braid of the outer conductor.
Install the connector by pushing and twisting until the back of the crimp ring is level with the mark.
You may find a ‘f’ mounting tool will help with this procedure.

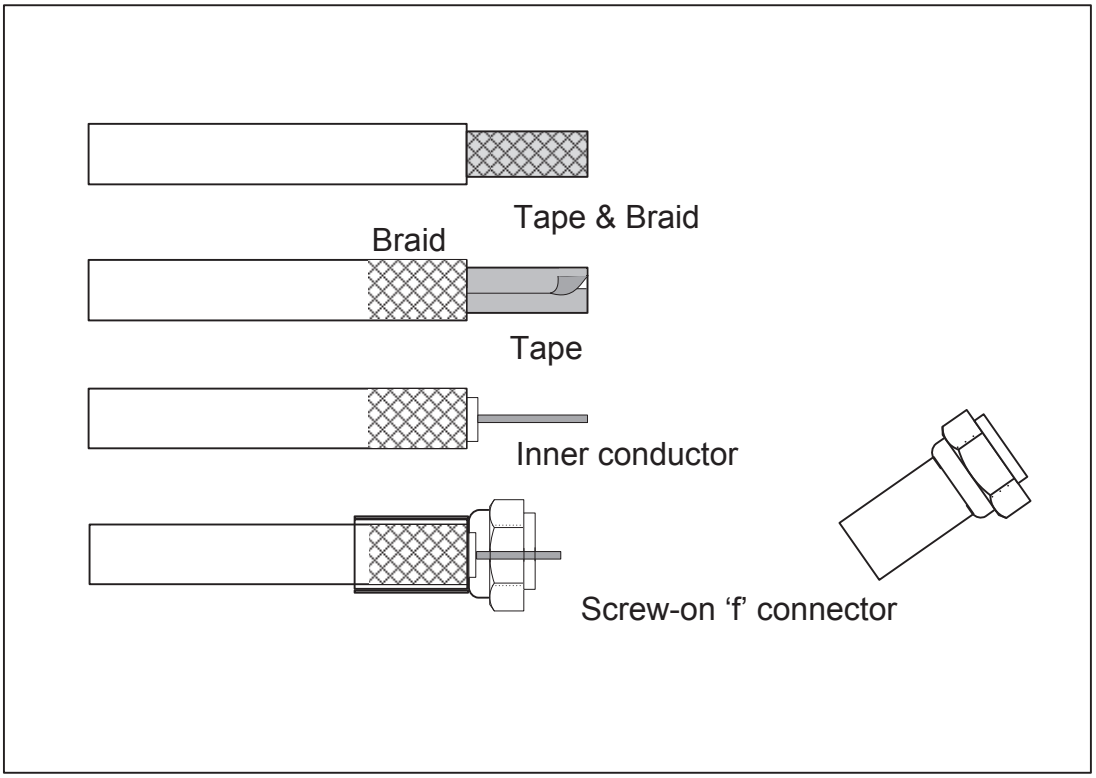


5 Crimp the crimp ring with an appropriately sized crimp tool ensuring that the crimp tool is level with the back of the connector.

Correct fitting for screw-on ‘f’ connectors. Single Domestic Unit only.

Screw-on ‘f’ connectors shall only be used in a single dwelling unit and never on an Integrated Reception System or other multiple dwelling or commercial signal reception system. It is imperative that the correct sized connector is employed for the cable being used.

The cable shall be cut square and then trimmed with an appropriate tool to expose the correct amount of dielectric, centre core and screen for the plug being used. The braid shall then be pulled back over the outer sheath of the cable and the plug carefully screwed on. Any excess in the length of the centre core shall be trimmed back so that 2mm protrudes from the end of the plug.



APPENDIX 2:

SAFE DISCONNECTION PROCEDURE FOR MULTISWITCHES, AMPLIFIERS ETC WITHOUT BONDING BARS FITTED.

Applicable to equipment with 'f' connectors. It is recommended that equipment with saddle and clamp connections etc be fitted with earth bars (See 4.2.2 - method 1) unless an earth terminal is provided.

EQUIPMENT REQUIRED

- Loop impedance test instrument.
- Length of 4mm^2 earth cable to check integrity of safety bond.
- Length of 4mm^2 earth cable with crocodile clip attached to one end.
- Bonding bar (or similar) with equivalent number of connections as equipment (input and output).
- Appropriate tool for loosening and tightening 'f' connectors.

METHOD

Note: This procedure shall only be carried out by a competent person trained to perform this task.

1. Locate a local earth point and verify the earth loop impedance with a test instrument. Maximum values may be found in On-Site Guide, BS7671:2008, reproduced in Appendix 4. This could be the earth point on a 13A socket.
2. Use the above identified earth point to confirm the continuity and integrity of the safety earth on the TV distribution system.
3. Use the identified earth point as a temporary connection.
4. Connect bonding bar and a length of 4mm^2 earth cable to the temporary bonding point. The length of the cable shall be long enough to reach the furthest connection on the equipment being removed and have a crocodile clip fixed to the free end.
5. Loosen the connection with a suitable tool and connect the crocodile clip to the outer conductor of the first connection. Without removing the clip, fully remove the connection and attach it to the bonding bar with an appropriate tool.
6. Remove the crocodile clip and repeat the process with all other connections.
7. Remove bonding cable from equipment and fit the replacement.
8. Re-attach bonding cable to equipment and verify earth connection as before.
9. Re-attach the connections using the above procedure in the reverse order.
10. Perform final continuity check between equipment and identified earth point.

APPENDIX 3:

NOTICE FOR INSTALLER TO ISSUE TO END USERS REGARDING THE INTERCONNECTION OF AUDIO-VISUAL EQUIPMENT IN THE HOME.

Electrical Safety in Aerial Systems

Information for the End User and Certificate of Conformity

Most audio-visual equipment (such as televisions, DVDs, satellite receivers, Freeview set top boxes, game consoles, radio tuners, audio amplifiers, surround sound systems, aerial distribution amplifiers) relies upon double insulation for electrical safety and has no separate earth wire. However, this equipment does have a small amount of electrical leakage. With a few pieces of equipment this is not dangerous and is acceptable under law.

As consumers add more and more equipment to their homes this electrical leakage could become dangerous and steps need to be taken to minimise the hazard. The amount of leakage will vary between types of equipment and manufacturers, but in the worst case situation typically seven pieces of equipment may be interconnected to keep the leakage below an acceptable level defined under British Standards. The equipment does not have to be in the same room as it could be interconnected via the aerial cables for example. CAI Ltd has recognised this risk and qualified members will advise on this and fit the necessary safety connection to overcome this hazard.

Please be aware that:

☐ At present you do not have more than seven pieces of interconnected audio-visual equipment. No safety connection has been made. Should you add more equipment please contact your installer who will be pleased to advise you.

☐ You have more than seven pieces of interconnected audio-visual equipment, or you have requested the connection be made. The necessary connection has been made, the earth continuity checked and found to be satisfactory.

☐ A risk assessment has been carried out, by the engineer named below, who has reasoned that the risk is minimal and no connection has been made.

Address of property: .....

Location of supplementary bond: .....

Signed: ..... (for '*insert company name*')

Name: .....

Signed: ..... (customer)

Name: .....

Date: .....

Reference invoice number: .....

Insert company details, including address and 'phone details here

Association For Audio Visual Professionals

Mem. No.

Guidance for Recipients

This Notice/Certificate has been issued to confirm that the supplementary bonding of the aerial installation to which it relates has been designed, constructed, inspected and tested in accordance with British Standard BS7671 and CAI Code of Practice 03. You should have received an 'original' and the contractor should have retained a duplicate. If you were the person ordering the work, but not the owner of the installation, you should pass this Notice/Certificate, or a copy of it, to the owner.

This Notice/Certificate should be retained in a safe place and shown to any person inspecting or undertaking further work on the aerial or electrical installations in the future. If you later vacate the property, this Notice/Certificate will demonstrate to the new owner that the installation complied with the requirements of all relevant standards at the time the Notice/Certificate was issued.

APPENDIX 4:

MINOR ELECTRICAL INSTALLATION WORKS CERTIFICATE

(REQUIREMENTS FOR ELECTRICAL INSTALLATION – BS 7671 [IEE WIRING REGULATIONS])
To be used only for electrical work which does not include the provision of a new circuit.
See Guidance for completing this form in "Checklist for Minor Electrical Work".

PART 1 : Description of minor works

1. Description of the minor works .....
2. Location/Address .....
3. Date minor works completed .....
4. Details of departures, if any, from BS 7671:2008 .....

PART 2 : Installation details

1. System earthing arrangement: TN-C-S ❑ TN-S ❑ TT ❑
2. Method of fault protection: ADS
3. Protective device for the modified circuit : ……..Type, BS ....., Rating ..... A

   Comments on existing installation, including adequacy of earthing and bonding arrangements:

   .....

PART 3 : Essential Tests (see checklist for guidance)

1. Earth continuity : Satisfactory? ❑
2. Insulation resistance :

   "Method 2": Measured between Line-and-Neutral-combined, and Earth ..... MΩ
   Satisfactory? ❑ (1MΩ minimum value. Preferably maximum measurable by instrument such as >200MΩ)

3. Earth fault loop impedance ..... Ω Satisfactory? ❑ (See max. permissible values overleaf.)
4. Polarity : Satisfactory? ❑
5. RCD/RCCB/RCBO operation (if applicable):

   Test at 0° and 180° for each test: All devices at 15mA: No trip after 2 seconds, at 0° and 180°? ❑

At $I_{\Delta n}$ = 30mA, tripping time: BS 4293 devices – 200 millisec max BS EN 61008 and 61009 devices - 300 millisec max	Enter longest tripping time for 30mA, after testing at 0° and 180°: …….. mSec Satisfactory? ❑
All devices at 150mA – 40 millisec max	Enter longest tripping time for 150mA, after testing at 0° and 180°: …….. mSec Satisfactory? ❑

PART 4 : Declaration

I/We CERTIFY that the said works do not impair the safety of the existing installation, that the said works have been designed, constructed, inspected and tested in accordance with BS 7671:2008 (IEE Wiring Regulations), amended to …… (date) and that the said works, to the best of my/our knowledge and belief, at the time of my/our inspection, complied with BS 7671 except as detailed in Part 1 above.

Name:..... Signature:.....

For and on behalf of: Position: .....

Address:

Tel: ..... Mem. No. Date: .....

MINOR ELECTRICAL INSTALLATION WORKS CERTIFICATE

GUIDANCE FOR RECIPIENTS

This Certificate has been issued to confirm that the electrical installation work to which it relates has been designed, constructed, inspected and tested in accordance with British Standard 7671 (the IEE Wiring Regulations).

You should have received an 'original' Certificate and the contractor should have retained a duplicate. If you were the person ordering the work, but not the owner of the installation, you should pass this Certificate, or a copy of it, to the owner. A separate Certificate should have been received for each existing circuit on which minor works have been carried out. This Certificate is not appropriate if you requested the contractor to undertake more extensive installation work, for which you should have received an Electrical Installation Certificate.

This Certificate should be retained in a safe place and shown to any person inspecting or undertaking further work on the electrical installation in the future. If you later vacate the property, this Certificate will demonstrate to the new owner that the minor electrical installation work carried out complied with the requirements of British Standard 7671 at the time the Certificate was issued.

GUIDANCE FOR ENGINEER

See "Checklist for Minor Electrical Work" or consult the IEE On-Site Guide, IEE Guidance Note 3 or other national guidance given by the NICEIC, ECA, NAPIT, BSI. Before any work is started which involves connection to the building's electrical supply, be it for power or earthing, the integrity of the earth shall be confirmed by measuring the earth fault loop impedance. Before this can be done the type and size of the protective device should be ascertained for the circuit being checked and the tables below used to give the maximum permissible values.

Maximum permissible measured earth fault loop impedance values (Ohms) for commonly used protective devices are shown below. These are taken from the On-Site Guide, BS7671:2008.

Circuit breaker to BS3871-1 or BS EN 60898 or RCBO to BS EN 61009

Circuit-breaker type	Circuit-breaker rating (A)								
	5	6	10	15	16	20	25	30	32
1	9.27	7.73	4.64	3.09	2.90	2.32	1.85	1.55	1.45
2	5.3	4.42	2.65	1.77	1.66	1.32	1.06	0.88	0.83
B	7.42	6.18	3.71	2.47	2.32	1.85	1.48	1.24	1.16
3&C	3.71	3.09	1.85	1.24	1.16	0.93	0.74	0.62	0.58

Fuses to BS1361

Protective conductor (mm^2)	Fuse rating (A)			
	5	15	20	30
1.0	8.4	2.6	1.4	0.81
1.5	8.4	2.6	1.4	0.93
2.5 to 16.0	8.4	2.62	1.4	0.93

Semi-enclosed fuse to BS3036

Protective conductor (mm^2)	Fuse rating (A)			
	5	15	20	30
1.0	7.7	2.1	1.4	Not permitted
≥1.5	7.7	2.1	1.4	0.9

Fuses to BS 88

Protective conductor (mm^2)	Fuse rating (A)					
	6	10	16	20	25	32
1.0	6.9	4.1	2.2	1.4	1.2	0.66
1.5	6.9	4.1	2.2	1.4	1.2	0.84
≥2.5	6.9	4.1	2.2	1.4	1.2	0.84

CHECKLIST FOR MINOR ELECTRICAL WORK

ADDING A NEW SPUR FOR A FUSED CONNECTION UNIT OR SOCKET OUTLET

Note: If the electrical installation is not in good condition or any measured values are out of limits, stop work and recommend to the Client that a thorough Periodic Inspection is carried out in accordance with the Wiring Regulations.

No.	Action	Observed value	Permitted value or limit	Pass? Yes/ No	Done ✓
1.	Obtain PERMISSION from the premises responsible person to carry out the work and to turn off the whole distribution board (consumer unit).	N/A	N/A	N/A	
2.	IDENTIFY THE CIRCUIT to be used (such as the nearest convenient socket outlet or light fitting) and determine which fuse or circuit breaker (CB) at the distribution board supplies it.	Circuit number or name: ……..….	N/A	N/A	
3.	If a SOCKET OUTLET circuit is chosen to supply the new spur, perform earth fault loop impedance test to establish a baseline for comparison when task complete. This also confirms earth continuity. Connect to the socket outlet using a 13 Amp moulded plug and flexible cord to the test instrument. WARNING: Only use a no-trip low-current test because a traditional high-current test will trip RCD-protected circuits.	……Ω	1.16Ω MAXIMUM for a 32 Amp breaker Type 'B'. Check tables for other devices.		
	After completing the test, ISOLATE and LOCK OFF circuit at distribution board, or remove and retain fuse. Prove circuit dead at point of work.	……V	Zero voltage		
	If socket outlet is on a ring final circuit, remove completely leaving bare conductor ends exposed. To prove the existing circuit is truly a ring with no breaks, perform Stage 1 test by carrying out CONTINUITY TEST of each loop: the Line loop, neutral loop and cpc (earth) loop.	Line loop ……Ω	2.0Ω max.		
		Neutral loop ……Ω	2.0Ω max.		
		cpc loop ……Ω	2.0Ω max.		
4.	If a NON-SOCKET OUTLET circuit is chosen to supply the new spur, ISOLATE and LOCK OFF circuit at distribution board, or remove and retain fuse. Prove circuit dead at point of work.	……V	Zero voltage		
	Prove correct earth connection by measuring continuity between earth at point of work and a known earth, such as the earth pin of a nearby socket outlet. Use "wander lead" method.	……Ω	2.0Ω max.		
5.	Create NEW SPUR. Ensure no nicks in insulation and no bare wire, including the earth wire green/yellow sleeved. If metal back-box, ensure earthed to face plate. Comply with all BS7671 wiring regulations, such as conductor sizing, fuse rating, protection of cables if concealed in walls etc. Comply with all relevant building regulations such as drilling through joists, chasing into solid walls, sealing of holes, heights of accessories above the floor.	N/A	All Regulations		
6.	Perform EARTH CONTINUITY TEST at furthest point of new spur.	……Ω	2.0Ω max.		

Cont...

7.	INSULATION RESISTANCE TESTING. SAFETY: The test instrument will apply a test voltage to the circuit. DO NOT TOUCH. WARN other personnel in the vicinity. After reminding the premises responsible person, turn off the main isolator at the distribution board to remove power from the whole installation. LOCK OFF. On the newly modified circuit, switch all switches ON, such as light switches and fused connection units. DAMAGE to equipment: The test voltage may damage electronic equipment such as dimmer switches, some types of RCD, electronic equipment such as PCs, audio visual systems etc. To avoid this, use "TEST METHOD 2" and where practicable disconnect/unplug all connected equipment.	N/A	N/A	N/A	
	"TEST METHOD 2". At the new spur, short together the Line and Neutral conductors. Connect one test instrument lead to the CPC, the other to the Line/Neutral combined. Select the appropriate test voltage, 500 Volts for 230 Volt AC circuits.	N/A	N/A	N/A	
	Press the Test button and record the reading. If "OL" is shown, this means the measured value is over the maximum value measurable by the test instrument. For a 200MΩ maximum limit, this should be recorded as >200MΩ.	……..MΩ	1.0MΩ MINIMUM for 230 Volt AC circuits		
8.	POLARITY. Visually check that all conductors are correctly terminated: each conductor to be connected into the appropriately marked terminations - Line to "L", Neutral to "N", cpc to "E". For a new fused connection unit, ensure the supply conductors are terminated into the "Supply" terminations (later, the equipment will be connected to the "Load" side.)	N/A	N/A	N/A	
9.	EARTH FAULT LOOP IMPEDANCE TESTING. This is a LIVE test. Do NOT probe onto LIVE PARTS. For testing on bare terminations, such as the rear of a new fused connection unit, clip on ONLY when the circuit is dead. Before re-energising, ensure that all socket outlets, lighting accessory covers etc have been refitted securely. For a new fused connection unit, leave the terminations exposed and clip the test instrument leads onto the L, N and E terminations at the back. For a new socket outlet, connect to the socket outlet using a 13 Amp moulded plug and flexible cord to the test instrument and switch on at the socket outlet. Inform premises occupants that power is being re-applied. Remove lock-off devices, turn on the main isolator and switch on the circuit breaker.	N/A	N/A	N/A	
	Set the test instrument to measure LOOP IMPEDANCE on the no-trip low-current setting. Check the display to confirm presence of voltage and correct polarity. Press the test button, record the measured ohmic value and check this does not exceed the maximum permitted figure. For an addition to a ring final circuit, check this figure for consistency with the value measured before starting work.	……Ω	1.16Ω MAXIMUM for a 32 Amp breaker Type 'B'. Check tables for other devices.		
10.	RCD TESTING. Set the test instrument mode to 30 mA RCD testing.	.....mS	15mA for 2 sec, no trip		
	Carry out the tests at 15 mA (no trip), 30 mA and 150 mA, re-setting after each trip and repeating every test to ensure RCD is tested on each half-cycle, at 0° and 180°.	.....mS	30mA trip within 200mS		
	Make a note of each measurement worst case – slowest for each test current.	.....mS	150mA trip within 40mS		
	Finally, press the test button on the RCD, check it trips and re-set it.	Press button	Trip		

Cont...

11.	If a new FUSED CONNECTION UNIT is being fitted, isolate the circuit at the distribution board as before, lock off and prove dead. Remove the test instrument leads. Connect the equipment flexible cord into the connection unit, making sure that: a. The flex connections are connected into the correct "Load" terminations. b. The cord grip is secured firmly into place. c. A final visual inspection is carried out. d. The connection unit is fixed securely into its enclosure taking care not to trap any of the conductors or screw through conductor insulation. Check that the correct fuse is fitted into the connection unit, appropriate for the flex size, such as a red 3 Amp fuse for a 0.5 mm^2 flex. Put the circuit into service by switching on the supply, or replacing the fuse, at the distribution board.	N/A	N/A	N/A	
12.	Complete the MINOR ELECTRICAL INSTALLATION WORKS CERTIFICATE for this task, including signing the certificate at the bottom.	N/A	N/A	N/A	
13.	INFORM the premises responsible person that the task is complete and hand over the Certificate, keeping a copy for your records.	N/A	N/A	N/A	

Operative name: . . . . . .

Signature: . . . . . .

Date: . . . . . .

APPENDIX 5:

DANGEROUS SITUATION REPORT

To be used by an engineer to inform a customer of a dangerous situation that the engineer feels needs rectifying, either by himself or a third party. This form enables the engineer to complete his work and also exonerates him if the customer does not wish the situation to be made safe. A copy of this form should be kept for your records and a further copy sent to CAI's office.

Association For Audio Visual Professionals

CAI ***Dangerous Situation*** Report

For reporting an observed dangerous situation.
Please complete all the unshaded areas.

Job No.
Page of

Owner/Occupier		Date	
Address		Postcode	
Inspector	Member No.	Signature	

To the owner/occupier: A dangerous situation has been observed. It is recommended that it is made safe until remedial works can be undertaken. Details of the dangerous situation are recorded below.

Defect details

I have been informed of this dangerous situation Yes No
I give my permission to make the dangerous situation safe Yes No
(In not agreeing to make safe I understand that I take responsibility)

Owner/Occupier Signature

Method of making safe

CAI Ltd, Communications House, 41a Market Street, Watford, WD18 0PN

APPENDIX 6:

ELECTRICITY AT WORK REGULATIONS 1989

All electrical work is governed by these regulations and it is assumed that anybody working on an electrical installation is competent to do so. Regulation 16 states the following:

Persons to be competent to prevent danger and injury.

No person shall be engaged in any work activity where technical knowledge or experience is necessary to prevent danger or, where appropriate, injury, unless he possesses such knowledge or experience, or is under such degree of supervision as may be appropriate having regard to the nature of the work.

The whole document may be viewed at :
www.opsi.gov.uk/si/si1989/uksi_19890635_en_1.htm

APPENDIX 7:

NORMATIVE REFERENCES

BS EN 7671:2008	Requirements for Electrical Installations.
	IEE Wiring Regulations 17th Edition.
BS EN 60065:2002	Audio, video and similar electronic apparatus. Safety requirements.
BS EN 60728-11:2005	Cable networks for television signals, sound signals and interactive services. Safety.
BS EN 60950-1:2006	Information technology equipment. Safety. General requirements.
BS EN 60990:2000	Methods of measurement of touch current and protective conductor current.
BS EN 62305-4:2006	Protection against lightning.
	Electrical and electronic systems within structures.
IEC 62368-1 Ed 1.0	Audio/Video, Information and Communication Technology Equipment - Part 1: Safety requirements.
TS 60479-1:2005	Effects of current on human beings and livestock. General aspects.
Electricity at Work Regulations 1989.	
Directive 2006/95/EC	Low Voltage Directive.
Health and Safety Directive.	(Health and Safety at Work etc Act 1974 (HSW Act) in Great Britain or the Health and Safety at Work (Northern Ireland) (Order 1978 in Northern Ireland).

Setting the Standard for the Future

Association For
Audio Visual Professionals

CAI Ltd
Communications House,
41a Market Street, Watford, Herts, WD18 0PN UK
+44 (0)1923 803030 office@cai.org.uk /cailimited /cailtd

www.cai.org.uk