Making the Bond

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After many man hours of deliberation and consultation the Code of Practice 'Electrical Safety Requirements for Signal Reception Systems (excluding CATV)' has finally been published. You now need satisfy yourself that you fully understand why the CAI has felt it necessary to produce this code and then know how to implement its recommendations.

The background to this code comes from many British, European and Worldwide standards:-

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)

From reading and interpreting these documents, the CAI realised that there was a risk to the consumer in Single Dwelling Units (SDUs) from the cumulative effect of touch currents on interconnected class II equipment such as TVs, DVDs, set-top boxes etc.

Class I and Class II Electrical Equipment

At the risk of teaching my grandmother how to suck eggs, it is probably worth reminding ourselves what class II electrical equipment is and how it differs from class I equipment. Class I equipment has a three core mains cable that includes a protective conductor (or earth wire). Should a fault arise on the equipment and exposed metalwork become live this protective conductor takes the current to earth and causes the protective device (fuse etc) to operate thus rendering the equipment safe. Class II equipment, on the other hand, only has a flat twin mains cable that carries a line and neutral conductor. This type of equipment relies on separation and double insulation for protection. Most modern AV equipment falls within this category, although some flat panel TVs are class I. Due to how the equipment is

made a standing voltage can be present on exposed metalwork of this equipment (even if the case is non-metallic, connectors will be metal). Should that metalwork be touched, whilst the equipment is switched on, a current will flow through the person touching it. This current is known as a touch current and under BS EN 60065:2002 can be up to 0.5mA. However IT equipment, including set-top boxes that contain a modem, under BS EN 60950:2006 can only have a touch current up to 0.25mA, although both of these documents are to be combined under a new standard, IEC 62368-1, when the higher value will be applicable to all equipment.

So why may aerial systems in SDUs need to be earthed?
The small values of touch current associated with one piece of class II equipment are considered safe and will not create a problem to the consumer, but we have to consider not just one piece of equipment but many pieces of interconnected equipment in one household and not necessarily in the same room (in my sitting room alone I have 14 items taking into account the surround sound and the audio system that is all interconnected, add to that the TVs and ancillary equipment in bedrooms, kitchen and office!).

People differ in their sensitivity to electric currents and to the situation, for example in a damp environment the contact resistance between the body and the conductor will be less as it will if the contact area is larger or contact is made with greater pressure and this will increase the touch current. While some people can take quite large currents without distress others will have an involuntary reaction to currents as low as 0.25mA.

The other consideration is how safe are you on a ladder when working on the aerial? A touch current of 0.25mA can cause a reaction in adverse weather conditions. So, in this instance, even one piece of equipment could be a hazard. The easiest thing to do here would be to switch off the whole TV system whilst working on it, and this is good practice. However this may not be possible and you may need to either provide a temporary bond whilst working or make a permanent one before you start work.

3.5mA is the amount of touch current allowed on a single piece of class I equipment should the earth become disconnected and is the level at which it can be assured that 100% of the population can let go of a conductor when taking into account things like skin damage and moisture. This is why the CAI say make the bond if the customer has more than seven pieces of interconnected equipment (3.5 divided by 5 = 7, if all equipment is at its maximum allowed touch current value). If the bond is not made you must inform the customer of the possible danger and recommend they contact a suitably qualified person who can do this for them. An industry document is being prepared to cover this scenario, but by making the bond you cover yourself and fulfil any requirements concerning touch currents in the standards listed above.

What is involved in making the connection?
Before any connection is made to the house earth you need to know that the earth system is in good condition and the easiest way to do this is by performing an earth fault loop impedance test. If you have a multifunction tester, which you will need if you are a Competent Person (as defined under the Electricity at Work Regulations) engaged in putting in fused connector units or extra sockets for things like distribution amplifiers or flat panel TVs, then you can do the test with that. If not you can buy a simple device such as the *MARTINDALE EZ150*. This is a plug in device that measures the EFLI and gives an indication of the value by a series of LEDs. This is a live test, i.e. the power needs to be switched on at the position where the

test is being made. When measuring the EFLI on a circuit with RCD protection it is important to have an instrument with a 'no-trip' facility enabled as if this test is performed without this feature enabled it will cause the RCD to trip and as the test has to be done under live conditions no reading will be possible.

MARTINDALE EZ150.

Using a multifunction meter to check Earth Fault Loop Impedance

The maximum value of the EFLI depends upon the type of earth system in place and also the type and value of protective device in the consumer unit.

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

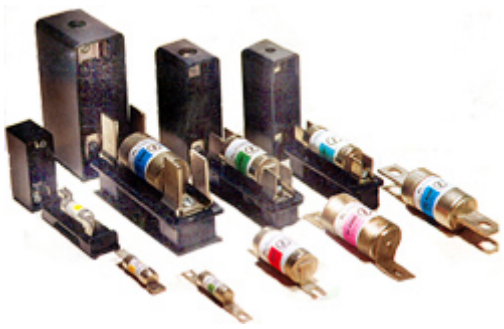
Protective conductor (mm^2)	Fuse rating (A)					
	6	**10**	**16**	**20**	**25**	**32**
1.0	6.9	4.1	2.2	1.4	1.2	0.66
1.5	6.9	4.1	2.2	1.4	1.2	0.84
≥2.5	6.9	4.1	2.2	1.4	1.2	0.84

If you are using the MARTINDALE plug in device you will be plugging this in to a 13A socket which, in a modern house will be protected by either a 30 or 32A circuit breaker of type B. Using the above charts you can see that the maximum EFLI is 1.24 and 1.16 Ω respectively. Experience will tell you how to recognise each type of device, but below are a few examples.

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

BS1361 fuse

BS3036 Semi-enclosed fuse



BS88 type fuses – not normally found in a domestic situation

If the property has a TT type earth (i.e. an earth rod outside) you may well get readings of many hundred Ohms. This is not a problem providing the supply is protected with RCD devices. A 100mA device should be in the main tails between the meter and consumer unit, and with 17th Edition regulations the sockets should also be protected with a 30mA device. If you find this not to be the case then you should issue the customer with a report stating that the system may not comply with regulations and suggest a qualified electrician should look at the system.

Making the Connection

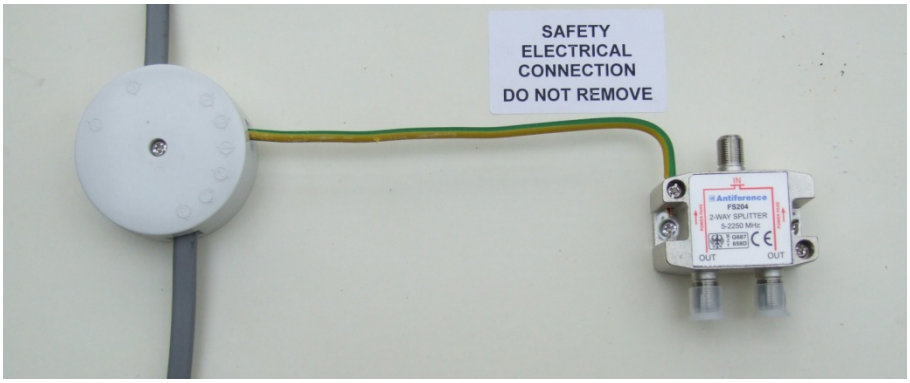
You are now in a position to make the supplementary bond and remove any touch current from the aerial system. This connection may be made anywhere on the aerial system, providing the maximum resistance between any outlet and earth is less than 4Ω. Probably the most convenient place is at or near the distribution amplifier, but it doesn't have to be.

You first need to identify the earth you are going to use, be it an earth off the lighting circuit, a ring or radial main or even a piece of bonded metalwork such as a water pipe. Many will say that pipes shouldn't be used because a plumber may remove a section and replace it with plastic. Whilst this is a very possible scenario it is down to the plumber as the last man working on the 'system' to make sure the integrity is still there. Providing you make the bond and you have issued a certificate to say that the bond was made AND TESTED, you have no liability should anything happen. The other argument we hear is that a 4mm^2 copper cable should be used and a ring main is no where near this size and a lighting circuit is of an even smaller CSA. The 4mm^2 size comes about from TV aerial systems in MDUs where, for other reasons, this size of conductor must be used. This article is purely regarding SDUs and the bond is to remove small touch currents only.

Once the earth location is identified turn off any electrical circuit that you are going to attach to and then run a supplementary bond with a minimum CSA of 2.5mm^2 from that location to the aerial system equipment. However, any conductor less than 4mm^2 should be protected in conduit. A 4mm^2 conductor has sufficient strength to be physically robust enough, although it should still be clipped, or stapled, in place on long runs.

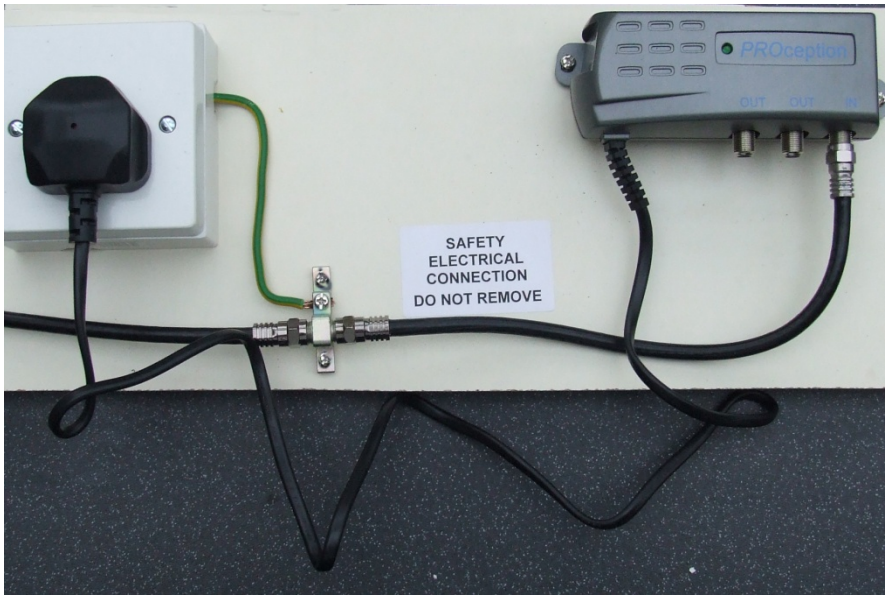
Many manufacturers are now putting earth tags on amplifiers; this makes the job much easier and a little cheaper. There is also no reason why the tag on a passive splitter can't be used. If the equipment you use doesn't have an earth tag a simple earth bar system can be used in one of the legs, or even connect to the earth tag of the fully screened aerial socket.

Examples of how you could make the connection - this is not exhaustive!



A simple connection off a lighting circuit junction box onto a passive device.

Connecting to the earth tag on an amplifier from a fused connector unit



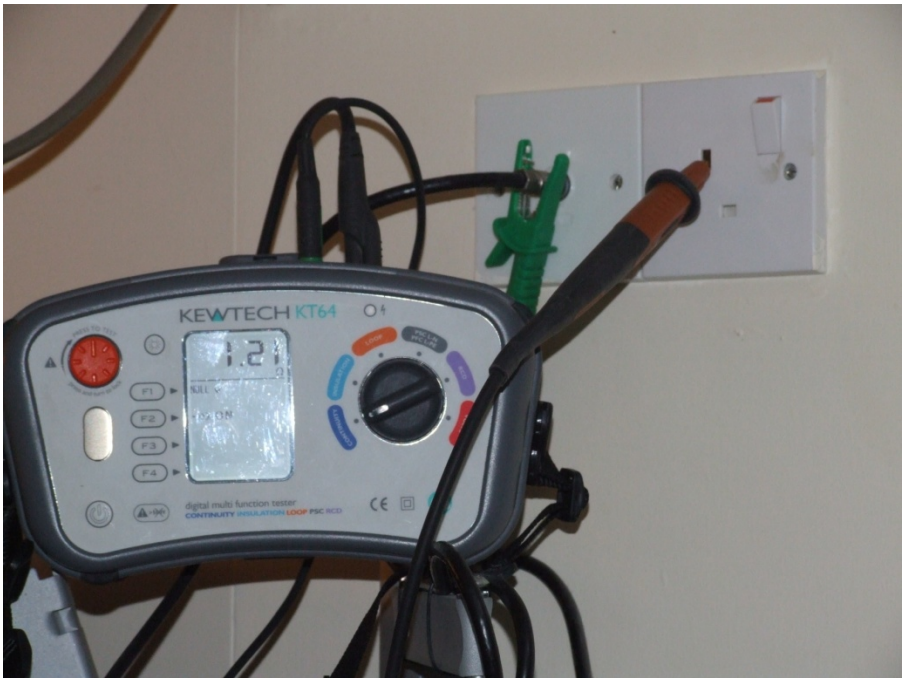
When the amplifier has no earth tag then use an earth connector block

In a situation, such as when using an external amplifier or if no earth can be located near to the distribution point, the earth could be taken off the socket behind a TV for example.

You will also note that at in each example a label is fixed saying 'SAFETY ELECTRICAL CONNECTION DO NOT REMOVE'. Such a label must be attached by any bonding point that you make.

Final Checks

Once you have made the connection use a multimeter, or multifunction tester, to test the resistance between each outlet and a known earth (the adjacent mains socket earth would be sufficient). This reading should be a maximum of 4Ω and the meter should have a minimum accuracy of 0.1Ω. Switch back on the power and do a final test of the EFLI.



Doing a final resistance test between the outlet and a convenient local earth.

All that remains is to fill in the certificate and explain to the customer that they should keep their copy in a safe place so that if an electrician enquires as to why the bond has been made they have the information. It will also form part of any Home Information Pack (HIP) should they sell the house.

Frequently Asked Questions.

Q. If there is one piece of class I equipment on the system does this make the system safe?

A. Yes it does, but only whilst that equipment is plugged in. What happens if that equipment is sent away for repair or simply gets unplugged?

Q. Could I make the connection by simply going in to a plug top with the earth wire and plugging it in to a socket outlet?

A. Again, whilst this would serve the purpose it could still get unplugged and leave the system in a possible unsafe condition. This method is a good idea as a temporary bond whilst working on the system.

Q. What do I have to do on an IRS or MATV?

A. Nothing has changed with systems in MDUs or commercial premises. You still have to use a minimum 4mm^2 copper conductor to the Main Earth Terminal (MET) of the building. This does not mean that you have to run a conductor from your equipment to the MET, but verify that the earth you are bonding to has a permanent and robust route back to the MET.