Guidelines – IDRANet Wiring Structure & Testing

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Overview of IDRANet Structure

IDRANet consists of 3 buses each typically carried by a pair of twisted wires within a CAT5 style cable. The Power bus (12-15V) delivers power to the modules, the Data Bus carries differential digital data signals, the Audio bus carries analogue audio signals to and from audio capable modules.

The IDRANet structure is 'free topology'. A single cable can provide a connection to several modules and can itself branch out into other cable sections (tree structure). However there is a limit to the number of modules that can be connected to one cable which depends on the current capacity of that cable, the individual module power consumption requirements and, to some extent, cable length.

Power delivery considerations

Typical CAT5 cable is rated to carry 1A per pair, but it is not wise to operate cables at full capacity continuously, so a de-rated value of 750mA is a better design guide limit. Where the power bus uses two pairs in parallel this figure can be doubled. However it should also be noted that lowering cable resistance is not only useful to increase current capacity but also a way to reduce voltage drop across very long cable runs. This is especially important if powering relay type modules since the relays are driven directly from the power bus and are thus more susceptible to such voltage drops.

Present IDRATEK supply units limit current to any one spur to a value of no greater than 1A. As a rough guide most sensory only modules consume less than 15mA. This implies that more than 60 such modules could be connected to one spur. On the other hand a QRH module (4 high power relays) can consume 150mA, meaning that only about 7 can accommodated (assuming that we cater for all 28 relays being on at the same time).

Total number of modules

There is also a limit to the overall number of modules that can be connected to a single IDRANet structure before a data bus repeater is required. This number is approximately (but not less than) 250 modules irrespective of module type and is imposed by the Data bus driver characteristics – not the power delivery.

Cable length

IDRANet is capable of variable bit rate communications, however the present products typically operate at around 10Kbaud. At these baud rates cable lengths of several hundred meters pose no problems to the communication signals, the main consideration being the effects of voltage drop on power delivery if large loads are used at the end of such lengths.

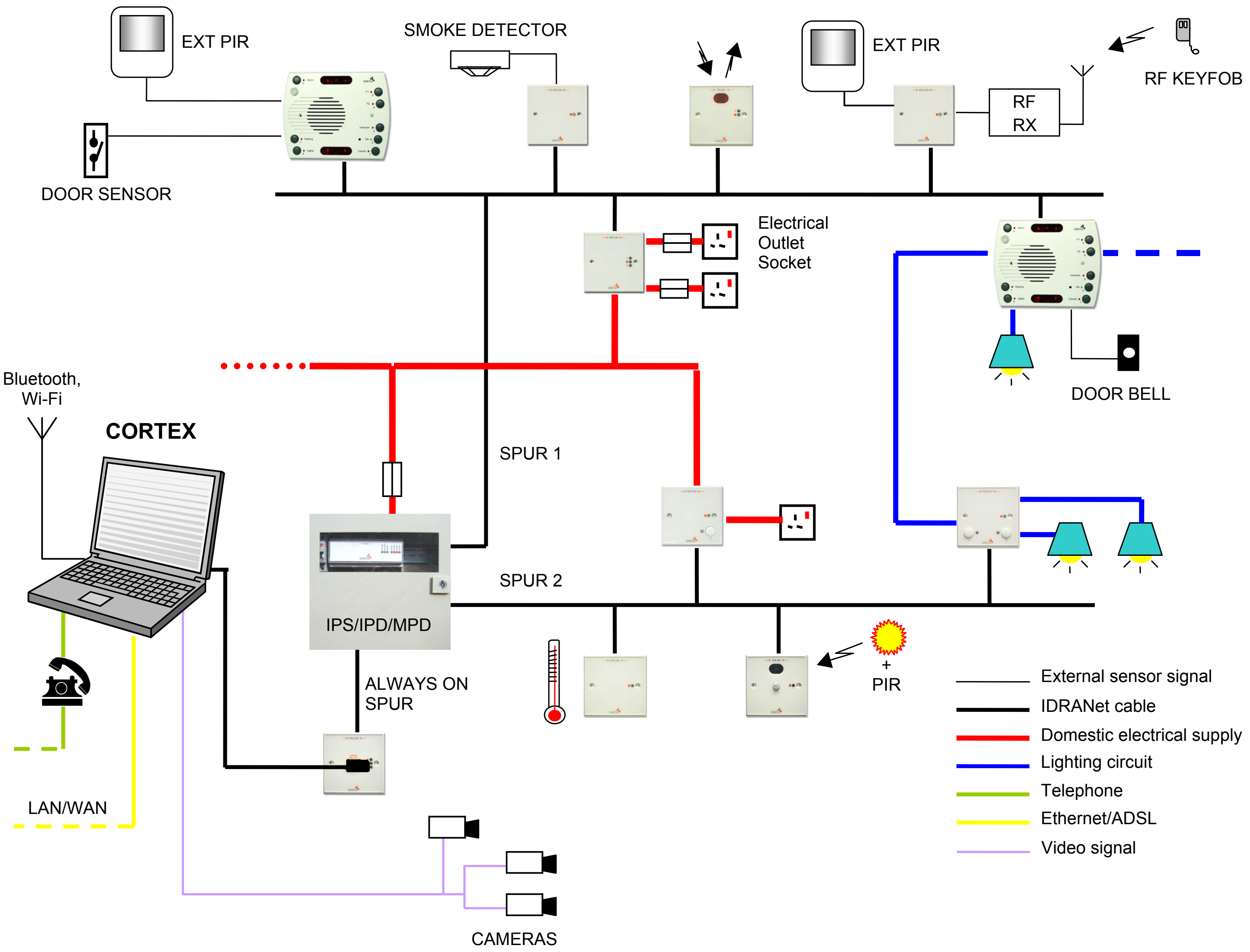
Cable type

It is important that a twisted pair cable type is used since this improves noise immunity/emissions characteristics. Generally speaking 4 pair CAT5 cable provides a suitable and low cost solution. Although the IDRANet data bus does not require a shielded cable, using a shielded cable variant is preferred for installations with longer cable runs and to improve noisy immunity of the audio bus. Furthermore although single cored CAT5 cable is more common and lower cost, stranded cable is less prone to breakages during installation – particularly when fitting to the IDRANet terminal block plugs and is also therefore the preferred option.

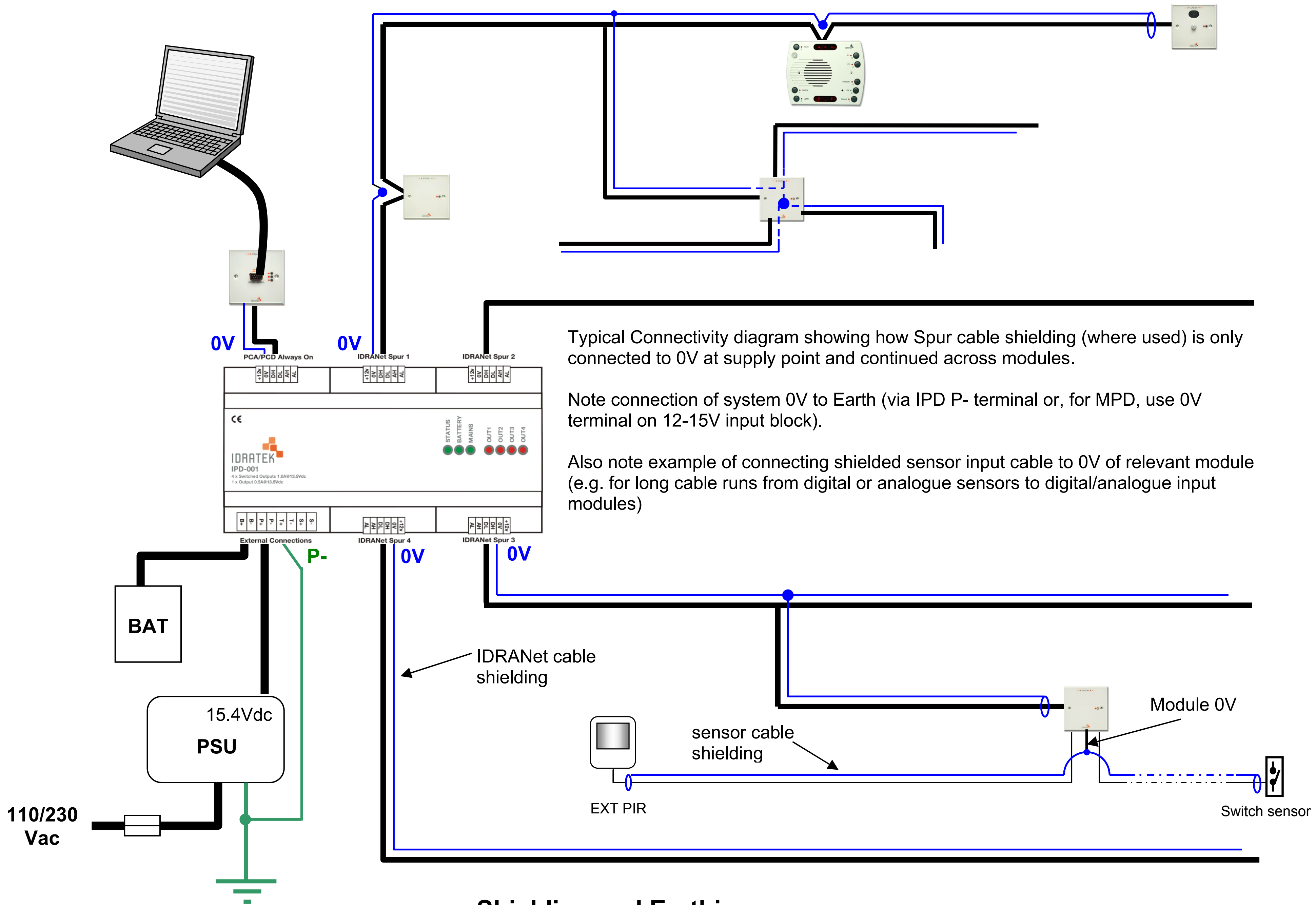
Special environments

Though it always to be avoided, if the IDRANet cable has to be run in close proximity and in the same enclosure as an electrical supply cable (e.g. 110-230Vac) then it is necessary to ensure that the cables cannot come into contact (by using some form of physical barrier whose own isolation rating is better than the highest voltage) or to use a suitably rated CAT5 cable type (i.e. whose specification states that the insulation is rated to withstand electrical supply voltages). It is possible to mix cable types such that the higher rated cable is only used where necessary rather than across the installation.

If significant lengths of IDRANet cable are to be run outdoors then it is highly recommended that shielded types are used and that the shields are correctly grounded at the supply point as shown in the following diagrams. It is also wise to protect such cables from mechanical damage and to some extents weathering where possible. Certainly running a cable under ground will require some form of resilient conduit. Garden hosepipe can offer a low cost protective covering for some protection applications. Always bear in mind the ability of outdoor cabling to accumulate moisture and to siphon rain water along its length. A 'U' shaped section in the cable run will help to trap such siphoning effects.



Example of structure



Typical Connectivity diagram showing how Spur cable shielding (where used) is only connected to 0V at supply point and continued across modules.

Note connection of system 0V to Earth (via IPD P- terminal or, for MPD, use 0V terminal on 12-15V input block).

Also note example of connecting shielded sensor input cable to 0V of relevant module (e.g. for long cable runs from digital or analogue sensors to digital/analogue input modules)

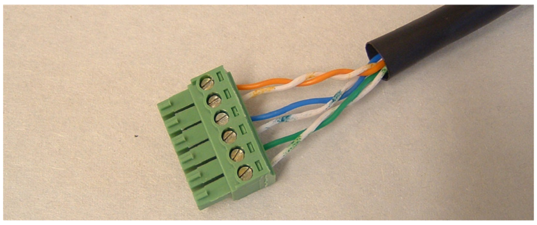
Shielding and Earthing

Inspection & Testing

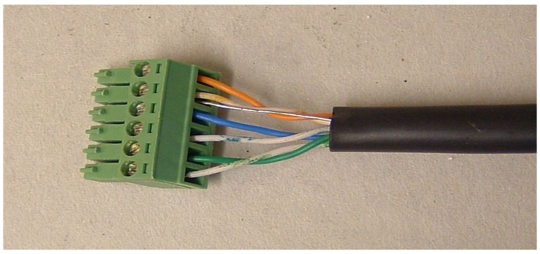
Before plugging modules into an IDRANet wiring installation it is **essential** that the installer carries out both visual and electrical checks to ensure that no wiring faults exist (such as shorts, open circuits, transposed connections etc.)

This document provides some simple guidelines for the electrical testing of an IDRANet wiring installation for users who do not have access to dedicated cable testing instruments (such as CAT5/6 analysers). By following these guidelines, it should be possible to detect most wiring related faults thus making the commissioning stage easier.

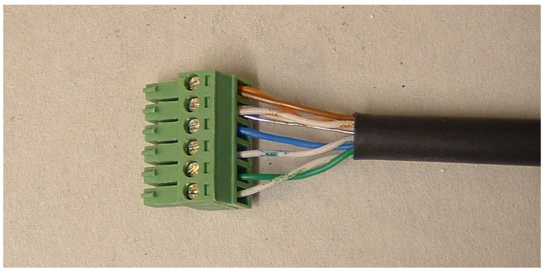
The procedure assumes you have read and implemented the guidelines "How to Wire IDRANet Connectors" and have terminations such as those below.



Module end (no drain connection)



Power bus Node 0 end (drain connected to PL/0V)



Power bus Node 0 end power bus doubled up (drain connected to PL/0V)

Basic termination at the module end of a spur does not connect the drain wire. This should also be the case where the spare brown pair has been doubled up across the orange power pair. Where spurs are returned to a central point (node 0), typically an IDRANet power supply, the drain wire should be connected to PL/0V at the power supply to improve noise immunity.

Faults

There are 4 typical fault conditions that can occur with this wiring scheme :

Open Circuit (most common)
- cores may be broken when the cables were pulled/bent
- cores may not be fitted properly into the IDRANet plug
- screw may not be tightened
- cores may still have the insulating sheath
- cores from a pair may be swapped with others

Short Circuit (less likely)
- cores may be inserted into the same terminal at the IDRANet plug (this may affect measurements across all terminations)

- stray wiring strands touching other bare sections of wire at the connector block

Swapped Pairs (common)
- core may be swapped with another colour at one end
- core may be swapped with another colour at both ends
- core may be swapped within the same pair at both ends (although wrong, it may not affect operation)
- core may be swapped within the same pair at one end only

High impedance (rare)
- usually caused by poor termination or dirt

Visual Inspection

Visual inspection is not sufficient to discover all faults on a wiring installation since it is prone to human error. However it is a good starting point and may be made easier if the installer carries a note detailing the colour scheme used in relation to the wiring at the plug terminals.

Electrical Testing

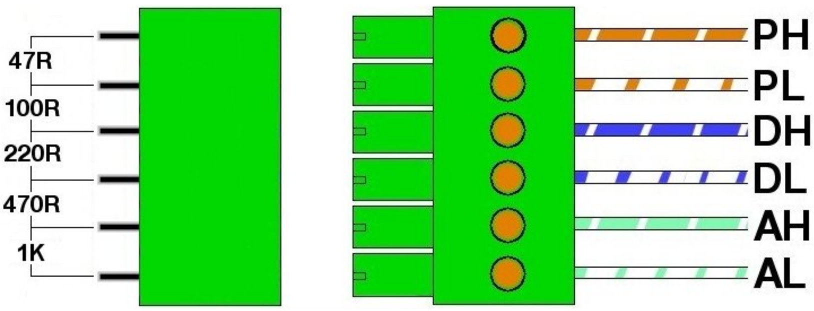
Following a visual check of each IDRANet plug for the above conditions, the wiring should be checked electrically.

Simple continuity/short circuit testing, whilst better than nothing at all, cannot discover all fault conditions. On the other hand specialist cable test equipment may not be in everyone's toolkit. Two methods which mainly require a multimeter can provide better diagnostics and are outlined below:

Method 1
By connecting a set of known resistances across adjoining pairs at one plugging point on a spur (typically at the node 0 plug) then testing for these resistance values at each plug connected to that spur, a more accurate diagnosis of fault conditions can be obtained. This procedure requires 5 resistors and a multimeter (preferably digital) with a capability to resolve the different resistor values comfortably. Most modern multimeters should be capable of doing this easily. The procedure is more complex than simply using shorting links across pairs, but provides a much better ability to spot faults.

A convenient 'test header' can be used which comprises 5 resistors soldered across adjoining terminals on a loose header as shown below. Alternatively the 5 resistors can be wired into an IDRANet plug and this can then be plugged into one of the sockets of a multi-way adaptor such as 3WA-001 or 6WA-001 then the spur to be tested plugged into one of the other sockets.

The known resistance thus placed across each adjoining pair allows for effective but simple testing using a multi-meter capable of measuring DC resistance. The resistance values are chosen such that various combinations cannot result in any one value (including a small margin for cable resistance).



Note: PH = +12V
PL = 0V

As the cabling itself has a resistance of approximately 100mΩ / metre, a cable run of 20m (40m for total path on both cores) will add 4Ω to any measurement. This cable resistance is normally negligible compared with the known resistance for each pair but can be taken into account for known long cable runs. If the spare pair has been doubled up for whatever reasons, the CAT5 resistance will be halved again (resistors in parallel).

Test Procedure

All spurs must be unplugged from any IPD or MPD unit throughout the testing process.

1. Select one branch/spur to test.

2. Fit the resistance header onto a spur connected plug (preferably the spur plug which would normally be plugged into the IPD/MPD), or if using a test plug then plug the test plug and the spur to be tested into a multiway adaptor. Now take measurements at the next closest node first. Check the resistance across each adjoining pair of terminals on that node plug (ie. between 1&2, 2&3, 3&4, 4&5, 5&6). The measurements can be made by touching the meter probes firmly across the screw heads. If the 5 readings match the test resistances (allowing tolerance for cable lengths) then that node termination can be considered a PASS. Repeat this measurement process for each node in turn down that particular branch/spur.

3. Repeat the entire procedure (from step 1) for each spur. Once all spurs have passed this testing, further system commissioning can then proceed.

Potential fault symptoms and possible causes:

1. If a test on a pair results in an open circuit reading, then check the:
   - cores have insulation removed at both ends
   - cores are inserted properly into the IDRANet plug
   - screws are tightened correctly
   - cores are in the correct order, i.e. not swapped with a neighbour

If these are visually correct, then a core in that loop may have been damaged when installed. It may be possible to isolate the fault and investigate further, but that is beyond the scope of these guidelines.

2. If a test on a pair results in a short circuit reading, then check:
   - the cores are not inserted in the same terminal at either end
   - there is no stray wiring across the pair of cores at either end

If the fault still persists, the fault may be across another node due to the “daisy chain” structure of IDRANet. A thorough inspection of each node termination should find this but if the fault remains, isolate each node in turn until the fault is removed.

3. If a test on a pair results in a incorrect reading such as 100Ω when 220Ω is expected :
   - the likelihood is that one or more pairs have been transposed at one or more of the nodes

As every installation is likely to be different, it is impossible to provide answers to every detected fault. These notes are mainly intended to provide a starting point guide.

Method 2

This is a *limited* method which simply relies on characteristics of the IDRANet bus loads provided by an MPD or IPD unit. It is a somewhat better test than simple short circuit / continuity testing but can only discover a limited set of faults. In particular it cannot easily determine pair reversal.

Testing with MPD

1. Unplug any power source to the MPD
2. Unplug all Spurs from MPD
3. Plug in spur to be tested
4. At each plug connected to that spur measure resistance across terminal:
   0V & 12V (+ red probe to 12V, black to 0V): Should read very high resistance eg. Megaohms when stablised
   DH & DL (+ red probe to DH, black to DL): Should read ~ 100 ohms (+ any intervening cable resistance)
   AH & AL (+ red probe to AH, black to AL): Should read ~220 ohms (+ any intervening cable resistance)

AL & 0V: Should read ~0 ohms (+ any intervening cable resistance)

If the multimeter has a diode test setting then:
0V & 12V (+ red probe to 0V, black to 12V): Should read ~ 0.5-0.6V
0V & 12V (+ red probe to 12V, black to 0V): Should read > 1V
This test enables line reversal check on power supply pair

Testing with IPD(IPS)

1. Unplug any power source to the IPD/IPS
2. Disconnect battery
3. Place DC switch (IPS) in OFF position
4. Unplug all Spurs
5. Plug spur to be tested into 'Always ON' header on IPD
6. At each plug connected to that spur measure resistance across terminal:

0V & 12V (+ red probe to 12V, black to 0V): Should read very high resistance eg. Megaohms when stablised
DH & DL (+ red probe to DH, black to DL): Should read ~ 100 ohms (+ any intervening cable resistance)
AH & AL (+ red probe to AH, black to AL): Should read ~220 ohms (+ any intervening cable resistance)
AL & 0V: Should read ~0 ohms (+ any intervening cable resistance)