Hypex Electronics BV
Kattegat 8
9723 JP Groningen, The Netherlands
+31 50 526 4993
sales@hypex.nl
www.hypex.nl

Application note

UcD and earth/Insulation

Earth/Insulation.

The reasoning behind single and double insulation is that there should always be one extra line of defence between the user and live voltages when something fails. This on the premise that two unrelated faults do not occur simultaneously.

Counted as a single insulation is:

- One layer of insulating material around a conductor
- 3mm of air between an uninsulated live part and any externally accessible part (includes the ground connection). You should be able to guarantee these 3mm even with reasonable force exerted on all internal wiring.

Single insulation is acceptable if the apparatus is connected to safety earth. The second line of defence is the differential circuit breaker.

Counted as a double insulation is:

- Two separate layers of insulating material. If one layer is damaged, there should always be a second one.
- One layer of insulating material plus 3mm of air. Again, you should be able to guarantee this even when tugging at the wiring. If the insulation fails, there is still 3mm of air. If something is severely forced and the wire contacts the chassis, there's still the insulation.
- 6mm of air.

You can buy double-insulated wires for the primary wiring. This is recognizable when you cut the wire, you get an inner layer of insulation which is white and another one which is coloured. You'll find that the first layer can separate from the second one so that a superficial cut in the insulation doesn't propagate all the way to the conductor when the cable is bent sharply.

Now, I would like to stress that I don't want to force anyone to disconnect the chassis from mains earth. The point is, I can't recommend separating the audio ground from the chassis ground, because that's a recipe for making a radio receiver. However, **if one insists on using unbalanced (RCA) inputs** or if the ancillary equipment is sensitive to ground loops, tying the audio ground to mains earth causes hum problems or more subtle sonic issues. In other words, the fact that tying chassis and audio grounds together is the only correct solution implies that earthing the chassis creates ground loops. Correctly designed balanced connections are completely insensitive to ground loops (which is why they're universally used in pro audio although not all pro gear is correctly done, see "pin 1 problem"). One should not go around trying to avoid ground loops, because in any system more complicated than a home stereo, ground loops are a fact of life. Instead, one should design their equipment to be impervious to ground loops.

So if everyone would design their gear according to *AES48*, all equipment could be earthed with no adverse effects. Until that's the case, there'll always be equipment that'll produce hum when connected to another piece of gear that is grounded.

So, there's the choice:

A) If you want to use RCA inputs, disconnect the mains earth and employ double insulated construction techniques.
B1) Use balanced (XLR) inputs. This allows the whole thing to be earthed unless the ancillary equipment has problems.
B2) Make a "pseudo-differential" RCA input. I still haven't figured out whether or not I should post a detailed description of how to do this, because unless I manage to explain with perfect clarity it's almost certain to generate large volumes of mail.
C) Anything else (e.g. floating the amps inside a grounded chassis), but then you're on your own if you hear your mobile through the speakers.

Bruno Putzeys