COMPUTER AUDIO DESIGN

Implementing Ground Controls : GCs and Signal Ground

The CAD GC1 Ground Control has two 4mm banana connectors on the back and weighs 4.7kg / 11 lbs. With a footprint of 11cm x 32 cm (just over 4" x 12") it will fit alongside many components on a HiFi rack.
The CAD GC3 has six connectors and is approximately three times the size with a weight of 16kg (35 lbs) and the footprint of a typical HiFi component. While it can be placed on one side, best results will be achieved by placing it horizontally.
The CAD GC-R is made to order and weighs 50kg (110 lbs).

CAD supplies a choice of Ground cables.

On each GC cable, one end of each cable is a 4mm banana to connect to the Ground Control.
The other end can be a range of terminations : standards are RCA, XLR, 4mm banana, 4mm spade, BNC, or USB.
In each case, only the ground terminal is connected.

We recommend using GC1s to connect to "signal ground" (the "internal" Ground) of HiFi components. You access signal ground by connecting to a spare socket on the back of the component. SOME components have dedicated (usually 4mm banana) sockets to connect to signal ground. The CAD 1543 DAC and the CAD Audio Transport (CAT) have these sockets.
You can connect one GC1 to either one single component, or to two components at the same time.

The GC3 was designed to connect to "mains earth": since earth is a "big place" the larger mass and surface area of the GC3 will get improved results relative to using a GC1 on mains earth.
However, the GC1 and GC3 can be used interchangeably – it is a question of value, space and weight.

We have compiled our suggestions of how to get the best results, starting with GC1s / signal ground and then addressing mains earth.

Absorbing noise on signal ground	**Why**	**Exceptions**
(1) **In a digital system**, connect a GC to an unused connector (signal ground) on the "noisiest" (most digital) device in the chain: - "Server"/"streamer" or laptop - DAC - CD player - All-in-one music players e.g NAIM 272 - Class D pre-amplifiers / integrated amps - Active speakers – often contain Class D amps (but you may find you have no spare sockets…..)	Because this device is generating the most "internal" noise and polluting the ground plane of all devices in the system. You want to look for a connector that is as close as possible to the digital board….maybe a second USB, or a spare SPDIF, BNC….. depends on the brand.	Streamers/servers connected to a DAC by ETHERNET (RJ45), rather than USB or SPDIF. Ethernet cable has no ground wire, just two pairs of differential signals : so ethernet acts as a bit of a barrier to noise pollution *on ground* (you are kind of wasting the absorption of the GC). If you have an ethernet cable connected to a DAC, the best results will likely come from connecting to the DAC, rather than to the server/streamer.
(2) **Try not to mix signal ground (internally generated noise) with Earth (externally generated Earth).** Avoid connecting a single ground control to both an unused outlet on a device and to mains earth at the same time.	Most high-end audio components isolate internal signal ground from earth. So, if you connect a GC to both, you connect / short signal ground to mains earth. This undoes the designer's intention and allows external earth noise to pollute the system. It is likely to sound worse.	Almost all servers / computers are designed so that the signal ground is directly connected to mains earth. So, with any computer/server you should get the best result connecting one GC to signal AND to mains earth at the same time.
(3) **In an analogue system, connect to the earth post on the phono pre-amplifier.**	Because the voltage gain here is very high, even small amounts of high frequency noise will affect the sound quality.	We would avoid additionally attaching the same GC1 to Mains Earth – because you then provide a direct bridge, albeit an absorbent one – for mains earth noise to get into your phono stage.
(4) **Connecting the same GC to the "player" (DAC, CD etc) and the pre-amplifier or input of an integrated amplifier usually has a good result.**	You are absorbing noise on the ground planes of the two components – which are already connected by the analogue cables – AND you are providing a super-solid ground connection. This often improves "PRAT".	This is always worth a try - just give it a listen. We would generally do this as a secondary step, having first tried connecting a GC1 to each one independently.

DO NOT connect to outputs of balanced / balanced bridge design power amplifiers or integrated amplifiers or to speakers, and then also to mains earth / another device. The output sockets should have a warning label : "do not connect to earth" - but in our experience, not all of them do. So, take care!	Doing this can cause damage to the device. It is in any case more effective to connect to source devices (where high frequency noise is being created) The "negative" output of a balanced amp is NOT ground, so if you connect a GC to "negative" and then to something else, you can short the amplifier out.	You can "float" GCs safely but since even a GC1 has two connectors on it, this area is fraught with risk. We just avoid it unless we have the manufacturer in the room, and they want to take responsibility!

The GC3 was designed to absorb high frequency noise on mains earth. It contains a larger mass of absorbent material than the GC1 and has a greater surface area. If space and budget allow, GC1s and GC3s can be used interchangeably.

Most HiFi components have metal casework. In the USA and the EU, it is a legal requirement that any metal case containing an electronic device must be connected to mains earth as a safety feature. This is to reduce the risk of injury/death from electric shock should internal wires become disconnected, and the metal casework (which is conductive) become "live".
Therefore, any metal case (chassis) will provide a means to connect a Ground Control to "earth".
Some components have chassis/earth sockets or "posts" (for spade connectors). Or, loosening a screw on the casework offers a connection.

More simply, earth on the whole system can be accessed if using a power outlet strip or power conditioner that has an independent earth socket. Or, CAD can supply Ground Control cables which connect only the "third pin" on a mains plug.

Below we set out our standard approach to absorbing high frequency noise on mains earth.

Absorbing noise on earth	**Why**	**Exceptions**
(1) **Attaching via mains power outlet strips or conditioners.** In case all the HiFi components in a system are connected to a single outlet strip, or to a mains power conditioner, it may be most convenient to attach a GC3 to this. Some outlet strips or conditioners have dedicated independent earth sockets or posts.	Attaching via the power supply can be a quick and convenient way to access the earth of the whole system with the minimal number of cables. In cases where a system has been arranged to use separate mains power supplies for the digital and analogue components, using one Ground Control for both circuits / supplies will connect the earths. This may or may not improve sound quality. Try each independently and then try both together and see what you think.	If there is no independent earth socket/post, CAD can supply a custom GC cable connecting only the third pin (earth) of a mains plug, which can be used in a spare outlet. If you do not use outlet strips or conditioners, then a mains earth cable plugged into the wall next to your power cables can also work well if it is on the same circuit.
(2) **Attaching to each component in the system individually.** Some components, particularly amplifiers, have independent earth/chassis connections (4mm sockets or posts) which should be clearly labelled. These can be used to attach GCs.	Attaching each device directly to a GC3, which provides up to six connections, will give a very solid earth connection, AND ensure the earths of the components are all at the same potential. This can have a secondary benefit of reducing "hum" due to ground loops - *because* it ensures the "earth" of each component is at the same potential. It is not as convenient as using a power strip but can have very good results.	Many components do not have independent earth sockets, in which case loosening a screw on the case will provide an alternative. Some manufacturers offer the option to connect signal ground to earth or not, via an external switch. Which works best is normally a function of the local power supply quality and the ambient noise in the locality – high tech homes, or built up areas being typically "noisier" than isolated homes with few devices on the domestic circuit.