COMPUTER AUDIO DESIGN

CAD Ground Controls : Passive high frequency noise absorption

GC1 (rear)

The CAD GC1 Ground Control is cased in acrylic, and has two 4mm banana connectors on the back. Weighing 5kg / 11 lbs, with a footprint of 11cm x 32 cm (4.5” x 13”) it can fit alongside components on most HiFi racks.

GC3

The CAD GC3 has six connectors and is roughly three times the size of a GC1, weighing 16kg (35 lbs). The footprint is similar to a typical HiFi component : while it can be placed on one side, best results will be achieved by placing it horizontally.

GC-R

The CAD Reference GC-R is made to order and weighs 50kg (110 lbs).

The CAD Ground Controls are passive (do not plug into a power source) and attach directly to audio components using the CAD ground cables.

CAD supplies a range of GC cables :

At one end of each cable is a 4mm banana to connect to the Ground Control. The other end can be a range of terminations to connect to an unused connector on the HiFi component :

RCA, XLR, 4mm banana, 4mm spade, BNC, USB.

In each case, only the ground terminal is connected.

The Ground Controls contain materials that absorb (and convert into heat) high frequency energy from 1MHz to the GHz range.

We recommend using GC1s to connect to “signal ground” (the “internal” Ground) of HiFi components.

There are two sockets on the GC1 : you can connect one GC1 to either one single component, or to two components at the same time. You can also link two GC1s together.

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

You access signal ground by connecting a GC Ground Cable to an unused socket on the back of the component. Some components have multiple available sockets; sometimes you have limited choice.

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.

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 independent chassis/earth connections : typically these are 4mm sockets or “posts” (to fit spade connectors).

Or, loosening a screw on the casework offers a connection.

Alternatively, earth on the whole system can be accessed by connecting to the earth of the mains power supply.

If using a power outlet strip or power conditioner which has an independent earth socket/post, a Ground Control can be connected to this. Or, CAD can supply Ground Control cables which terminate in a mains plug : only the “third pin” on the mains plug is connected.

Implementing Ground Controls : GCs and Signal Ground		
How and What to do – or not to do	**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 these digital devices generate the most "internal" high frequency noise and pollute the ground plane of all devices in the system. You may have more than one of these devices in your system (e.g. streamer and DAC). 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.

(5) 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!
Implementing Ground Controls : GCs and Earth		
Absorbing noise on earth	**Why**	**Exceptions**
(6) **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.
(7) **Attaching to each component in the system individually.** Some components, particularly amplifiers, have independent earth/chassis connections (4mm	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.	Many components do not have independent earth sockets, in which case loosening a screw on the case will provide an alternative.

sockets or posts) which should be clearly labelled. These can be used to attach GCs.	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.	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.