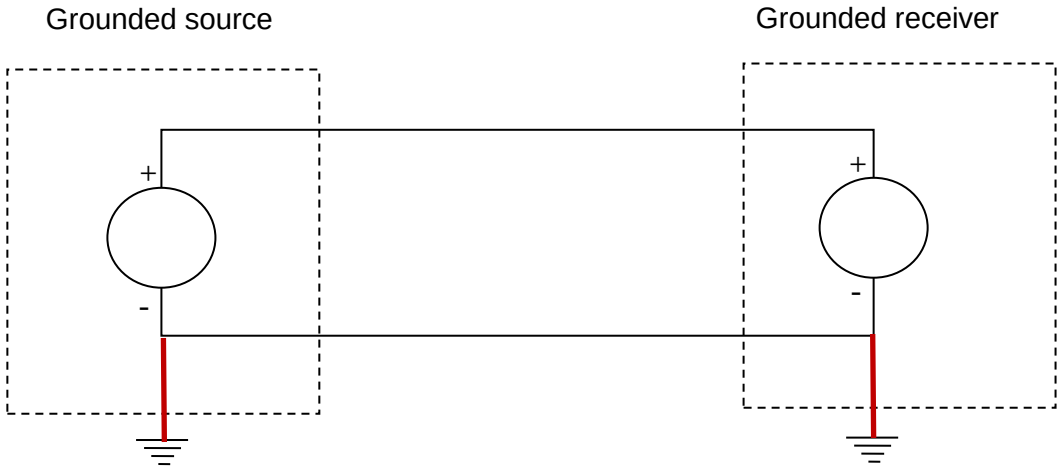
Avoiding ground loops in radar signal connections

When connecting an HPx-series radar interface card to a radar or simulator, the possibility arises of ground loops. These can introduce noise into the signals, but more seriously they can permit large currents to flow into sensitive devices causing card failure (on either the radar side or the HPx side). This note explains the issues and describes the best practice for connections.

There are typically several signals associated with a radar interface and these signals may be of different types. The specific situation that needs careful consideration is when a *grounded* signal source is used with a *grounded* signal receiver. The situation is shown below. The ground connection on the source and receiver is shown in red. In this configuration, the signal from the source has its –ve side connected to the chassis ground. On the receiver, the –ve input is also connected to chassis ground. The two separate ground points provides a path for spurious currents through induced voltages in the cable connecting the –ve signals, and also in the ground path of each side.



The signal being shown here could be video, trigger, ACP or ARP (or any other signal being used). It is the same consideration for each signal. Each one needs to be considered separately.

- **Video**

  The radar video inputs to the HPx card are always single ended with the –ve connected to ground, and hence the chassis. Therefore, if the source of the radar video signal is also grounded (as in the above diagram) the double grounded situation arises.

- **Trigger, ACP and ARP**

  If RS422 (differential) connections are used, there is no grounding issue.

  If opto-coupled connections are used, there is no grounding issue.

If programmable threshold input is used, the –ve input is connected to chassis ground. Therefore if the source of the signal is also grounded, the double grounded situation arises.

The grounding situation in the source

It will typically not be documented whether the source output is isolated or grounded.

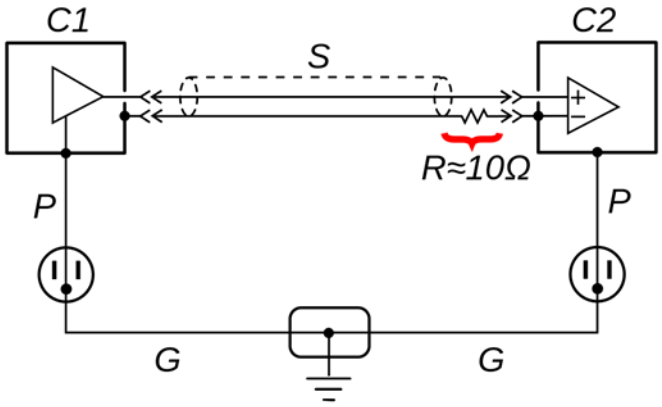
A simple test is to measure the impedance from the –ve output to the chassis ground. If this is 1 Ohm or less, then the –ve output is grounded.

What to do if both the source and the receiver are grounded

If it is established that the source and the receiver for a signal are both grounded, then further consideration is needed. If the source and the receiver are close (less than 3m) and driven from the same power supply, then it is likely that there will be no problem. It will be more of a concern if there is a long cable run and the source and receiver are on different mains power circuits with a significant length of earth cable.

It is possible to fit a video isolating transformer inline of the signal. This provides isolation between the source and receiver. The input and output signals are connected through BNCs. The unit is passive (requires no power). The example shown below (Jepsen VBH-1BB has a 3dB frequency response from 10 Hz to over 500 MHz with about 0.3dB loss at 10MHz (approx. 4% signal loss).

Another possible solution is to fit a resistor in the ground lead (see following picture). The resistor needs to be small enough to avoid significantly changing the input impedance. A value of 5R to 10R is suggested. The larger value is better from the point of view of protection, but then there will be more impedance mismatch and therefore more effect of signal quality.



Shielding

If a conducting shield is used around several signals, it must be connected to the chassis only at one end. It must not be connected at both ends, as that would cause shield currents to flow and induce voltages in the enclosed signals.

Summary Recommendations

Use differential or opto-coupled signal connections for trigger, ACP and ARP where possible.

Consider whether the source of the radar video signal is grounded to chassis earth. If it is and the cable connection length is long, or the source and receiver are using different power sources, use a video isolating transformer or a current-limiting resistor.

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