Implementing good grounding practices is always key in achieving optimal measurement results when integrating instruments, controllers, monitoring devices, sensors, DUTs (devices under test), etc. into a test and measurement system. Any small ground potential differences between devices in the test and measurement system could couple into the sensitive signal path and cause undesirable interference, unwanted noise, or error in measurement due to the inherent stray capacitance between signal conductors and the chassis of the system.

DEFINITIONS

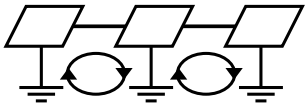
Signal Ground is an analog or digital ground that is attached to every signal that is transmitted between devices in a system.

Power Ground is the low side (0V or power return) of the power input.

Chassis Ground is a protective ground that connects all metal parts to the earth ground.

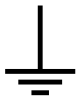
Earth Ground is a ground that is physically and electrically connected to earth via a conductive material such as copper, steel, aluminum, or aluminum alloy.

Ground Loop is an unwanted condition in an electrical system that contains multiple conductive paths for the flow of electrical current between two or more nodes. It causes noise and interference that disrupts the signal quality.



Each of the ground types is defined by where and how they are placed, and they serve as a return path for current that flows through the electronics.

Please pay attention to the function of each terminology as the symbols used by other manufacturers may look different than what has been presented in this document (depending on their geographical locations and the standards that they comply with). The following symbol is used to designate Chassis Ground on FUTEK products to ensure that customers connect Chassis Ground to Earth Ground where possible.



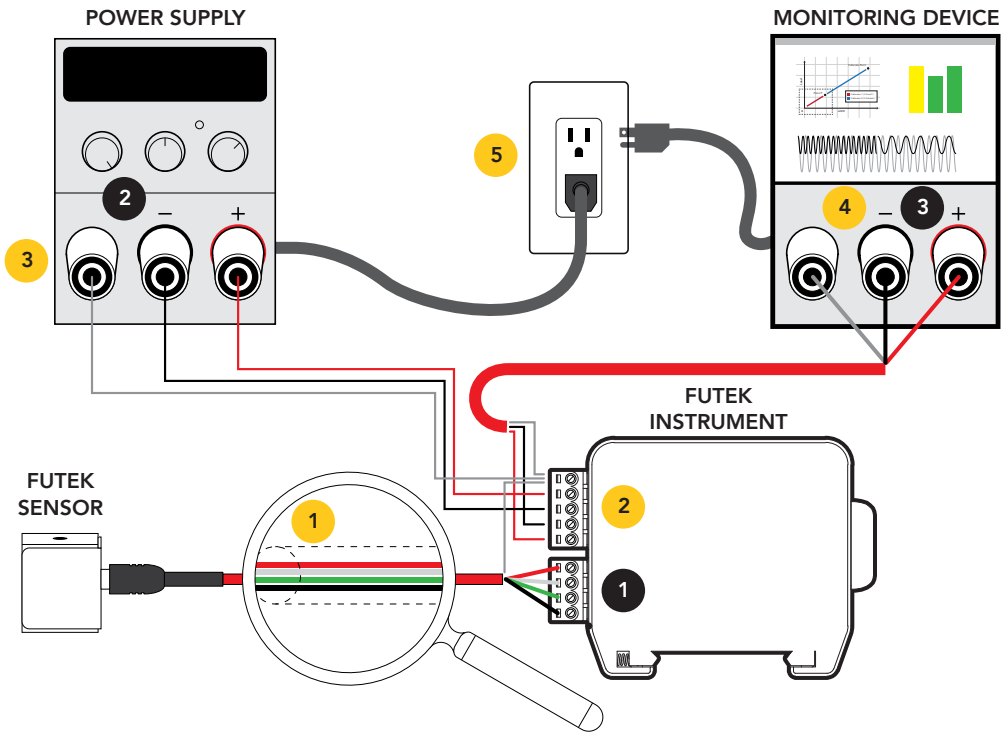
CHASSIS GROUND

WHAT GROUNDING TECHNIQUE SHOULD BE USED BETWEEN VARIOUS DEVICES IN A SYSTEM?

STAR GROUNDING

The most effective grounding method for a system that includes multiple devices is Star Grounding, where each device in the system is connected to the measurement instrument ground (single point).

In this configuration, all devices have their signal grounds connected to the same point on the FUTEK instrument. All chassis ground connections go to the earth ground of the outlet.

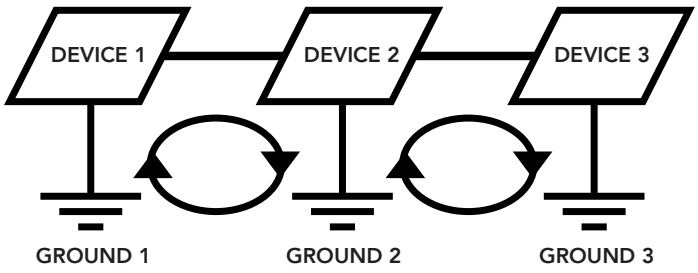


1. Sensor cable shield.
2. Sensor cable shield connected to IAA105 Chassis pin.
3. If Chassis pin of power supply is accessible, connect to IAA105 Chassis pin.
4. IAA105 output cable shield connected to instrument chassis.
5. Chassis connected outlet ground.

1. Sensor –Excitation connected to IAA105 where all grounds are connected together.
2. Supply signal ground connected to IAA105 GND.
3. Monitoring Device signal ground to IAA105.

1. Ground loop can introduce interference due to small electromagnetic fields generated by excess current that circulates in a system. Hence, it is crucial to ensure that only a single point ground connection is used within a system. For multiple systems, all ground connections should be connected to a single point, as well.
2. It is recommended to ensure that the enclosure is not left floating even if it's designated as a chassis ground. If possible, **connect the chassis ground to the earth ground via a single point** within the system so that the excess current can safely travel to earth; this protects the device from unwanted current surges, ESD events, and EMI disruption. Additionally, it could improve the overall noise immunity of the system. For a portable device that contains its own power supply, consider the power supply return as the earth ground, and use a single connection from the internal circuits for grounding.

AVOID GROUNDING LOOPS

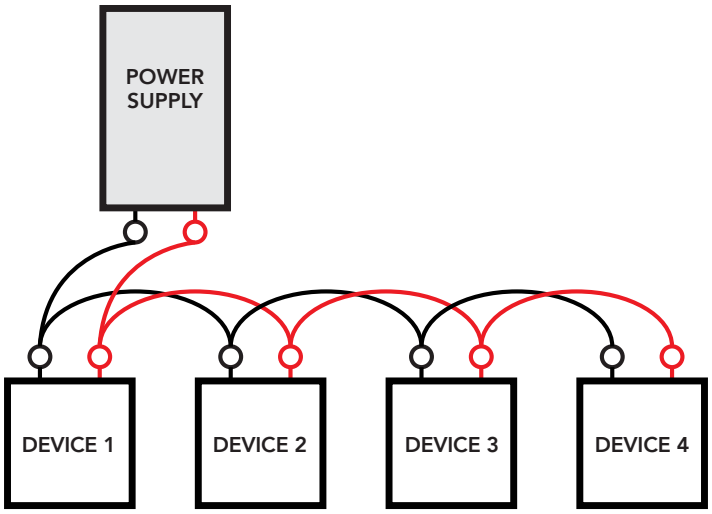


In this example, each device is connected to its own separate ground source which results in a different ground potentials. This creates grounding loops and leads to error in measurement.

DAISY CHAINING OR BUS GROUNDING

Daisy chaining or bus grounding is where several devices are grounded in a series to a ground bus or a low-impedance conductor.

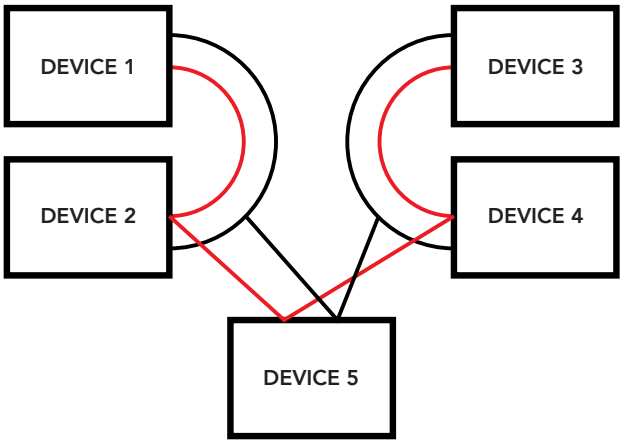
We **DO NOT** recommend this technique as it could put the devices at different ground potentials and introduce ground loops.



COMBINATION OF STAR AND BUS GROUNDING

When the serial conductors are very short, the combination of star and bus grounding techniques may provide a decent grounding performance if the power bus has a very low impedance.

This is recommended ONLY if implementing the star grounding technique is not possible.



Device 1 and Device 2 are connected together and then go to a common connection to Device 5.

Device 3 and Device 4 are connected together as well and go to the same common connection to Device 5.

For further consideration:

- The sensor's body or the shield of the cable should be tied to the chassis ground if it is floating or not connected to the ground internally.
- The enclosure of devices with no access to the chassis could be left floating.
- Different grounding techniques must be used if the system is plugged into a GFCI outlet.
- The use of an isolated power supply may be sufficient in some applications to prevent ground loops at the tradeoff of a potentially higher noise floor and lower power efficiency.
- The potential difference between the signal/power ground and the chassis ground should be kept within a reasonably low range. Otherwise, this may trigger the protection circuitry of some devices or cause other issues.

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