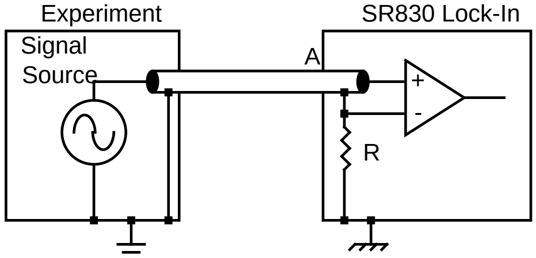
INPUT CONNECTIONS

In order to achieve the best accuracy for a given measurement, care must be taken to minimize the various noise sources which can be found in the laboratory. With intrinsic noise (Johnson noise, 1/f noise or input noise), the experiment or detector must be designed with these noise sources in mind. These noise sources are present regardless of the input connections. The effect of noise sources in the laboratory (such as motors, signal generators, etc.) and the problem of differential grounds between the detector and the lock-in can be minimized by careful input connections.

There are two basic methods for connecting a voltage signal to the lock-in - the single-ended connection is more convenient while the differential connection eliminates spurious pick-up more effectively.

Single-Ended Voltage Connection (A)

In the first method, the lock-in uses the A input in a single-ended mode. The lock-in detects the signal as the voltage between the center and outer conductors of the A input only. The lock-in does not force the shield of the A cable to ground, rather it is internally connected to the lock-in's ground via a resistor. The value of this resistor is selected by the user. Float uses 10 kΩ and Ground uses 10Ω. This avoids ground loop problems between the experiment and the lock-in due to differing ground potentials. The lock-in lets the shield 'quasi-float' in order to sense the experiment ground. However, noise pickup on the shield will appear as noise to the lock-in. This is bad since the lock-in cannot reject this noise. Common mode noise, which appears on both the center and shield, is rejected by the 100 dB CMRR of the lock-in input, but noise on only the shield is not rejected at all.

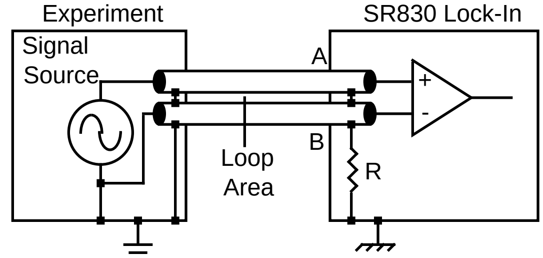


Grounds may be at different potentials

Differential Voltage Connection (A-B)

The second method of connection is the differential mode. The lock-in measures the voltage difference between the center conductors of the A and B inputs. Both of the signal connections are shielded from spurious pick-up. Noise pickup on the shields does not translate into signal noise since the shields are ignored.

When using two cables, it is important that both cables travel the same path between the experiment and the lock-in. Specifically, there should not be a large loop area enclosed by the two cables. Large loop areas are susceptible to magnetic pickup.



Grounds may be at different potentials

Common Mode Signals

Common mode signals are those signals which appear equally on both center and shield (A) or both A and B (A-B). With either connection scheme, it is important to minimize both the common mode noise and the common mode signal. Notice that the signal source is held near ground potential in both illustrations above. If the signal source floats at a nonzero potential, the signal which appears on both the A and B inputs will not be perfectly cancelled. The common mode rejection ratio (CMRR) specifies the degree of cancellation. For low frequencies, the CMRR of 100 dB indicates that the common mode signal is canceled to 1 part in 10^5. Even with a CMRR of 100 dB, a 100 mV common mode signal behaves like a 1 µV differential signal! This is especially bad if the common mode signal is at the reference frequency (this happens a lot due to ground loops). The CMRR decreases by about 6 dB/octave (20 dB/decade) starting at around 1 kHz.