

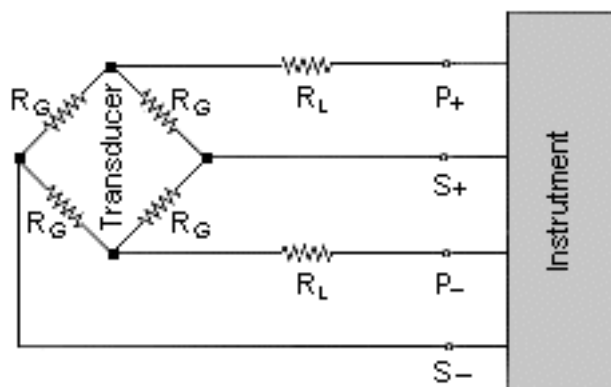
# TECHNIQUE

## Remote Sense

Remote sense or, more correctly, remote sensing of excitation voltage, is commonly recommended for use with precision, commercial transducers to prevent leadwire resistance changes (due to changes in either temperature or length) from affecting transducer span, or sensitivity. This feature is less frequently used with "homemade" transducers, and is seldom used in strain gage test applications.

### Transducer Applications

Leadwire attenuation presents a potentially significant error source in transducers utilizing a Wheatstone bridge circuit. The leadwires represent a parasitic resistance, and a portion of the excitation voltage intended for the bridge circuit is dropped in the leadwire system, reducing the voltage actually present at the transducer, and effectively reducing the transducer sensitivity. If the temperature remains constant during the setup and measurement process, then correctly applying shunt calibration, or a physical calibration of the transducer, is all that is necessary to correct for the effects of leadwire attenuation.



However, if the temperature of the leadwire system changes during the measurement process, the resistance will change correspondingly, changing the amount of attenuation, and again resulting in a calibration error. The resulting error is typically a fraction of one percent, but with commercial transducers, which demand the highest possible accuracy, or when attempting to obtain the best

possible performance from a homemade transducer, even that small error may not be acceptable. In those instances, if the measuring instrument is provided with remote sense capability, the error can be effectively eliminated.

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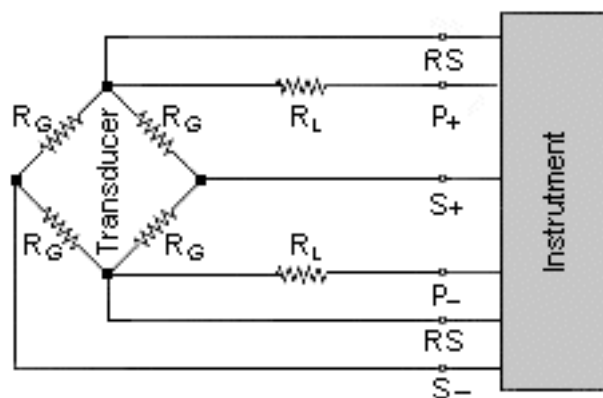
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For remote-sense operation, in addition to the pair of leadwires supplying excitation voltage to the transducer, another pair of wires would be connected between the excitation terminals on the transducer and the remote sense terminals at the instrumentation. The remote sensing circuit in the instrumentation is designed to continuously monitor the excitation voltage actually present at the transducer and, depending upon the instrument design, to respond in one of two ways if that voltage attempts to change.

1. Change the instrument sensitivity inversely with the voltage monitored at the transducer. In other words, if the voltage at the transducer were to drop due to an increase in leadwire resistance, reducing the output signal from the transducer, the instrument gain would effectively be increased by a corresponding percentage; and if the voltage increased, sensitivity would be reduced. The Measurements Group [Model P-3500 Portable Strain Indicator](#) employs this design.
2. Increase or decrease the excitation supply voltage to maintain a constant voltage at the transducer, regardless of changes in leadwire resistance. The Measurements Group [Model 3800 Wide-Range Strain Indicator](#) is representative of this design.



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### Stress Analysis Applications

Leadwire attenuation is directly dependent upon the ratio of wire resistance to strain gage bridge resistance, and by keeping the wire resistance to no more than a few percent of the bridge resistance, the error will be on the same order of magnitude. For example, for a three-wire quarter-bridge circuit, if the leadwire resistance is one percent of the gage resistance, the uncorrected error due to attenuation will be approximately one percent and can easily be eliminated by proper application of shunt calibration. In a three-wire quarter-bridge circuit, this is generally accomplished by applying the shunt calibration resistor across the dummy arm of the Wheatstone bridge, and adjusting the instrument gage factor or gain control to display the proper synthesized strain value. For a half- or full-bridge circuit, remote shunt calibration can be employed, and the instrument adjusted as for the quarter-bridge circuit.

As noted earlier, remote sense is generally not used in strain gage measurement applications. The leadwire temperature effects can greatly affect bridge balance (and that is why the three-wire hookup is strongly recommended for quarter-bridge circuits), but the effect of leadwire temperature change on sensitivity is generally very small, and normally can be ignored in stress analysis applications.

In those cases where the leadwire resistance is a significant percentage of the gage resistance, or if the wire temperature will vary more than perhaps 200°F (110°C), remote sense can be employed to advantage in half- or full-bridge circuits. For a half bridge, the remote sense wires would be connected at the remote half bridge; and for a full bridge, the connections would be made as for a transducer. Remote sense is not practicable with a quarterbridge circuit.



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### Special Applications

While the subject of constant-current excitation is beyond the scope of this article, it is worth noting that in some special applications, constant-current (rather than constant-voltage and remote sensing) can be used effectively to reduce or eliminate temperature-dependent leadwire effects. It may sometimes be used with commercial or homemade transducers having long leadwires with appreciable resistance; but it should be borne in mind that the transducer must be designed for constant-current excitation. For example, if a constant-voltage transducer is used with constant-current excitation, it may defeat any built-in compensation for changes in elastic modulus (of the transducer) with temperature. And, constant-current excitation can offer an advantage in high-temperature strain measurement testing where copper wire (with its inherent low resistance) cannot be used. In these applications, a uniaxial gage would typically be employed with a four-wire constant current hookup, eliminating the Wheatstone bridge circuit, and the need for remote sensing. The Measurements Group [Model 2200 Signal Conditioning Amplifier System](#) offers both constant-voltage excitation with remote sensing and constant-current excitation.

