5 Gould Road, PO Box 2155
New London, NH 03257
Voice: (603) 526-9088
info@canarysystems.com
www.canarysystems.com

3-Wire ¼ Bridge Measurements

Sensor Application Note #9

Overview

This Sensor Application Note provides additional information to connect and configure a 3-wire 120ohm strain gage, to be read using a ¼ bridge technique with excitation lead compensation.

Strain gage measurements using bonded resistance strain gages are prone to error from a variety of sources often encountered in field environments. This Sensor Application Note is not intended to address these issues. Please review the following Tech Notes available from Micro-Measurements for more information on these potential sources of error:

- **TN-501 – Noise Control in Strain Gage Measurements**
- **TN-504 – Temperature Induced Strain Variation**
- **TN-507 – Errors due to Wheatstone Bridge Non-linearity**
- **TN-509 – Errors due to Transverse Sensitivity**
- **TN-502 – Errors due to Gage Self Heating**

This Sensor Application Note will assume a 120ohm strain gage element however, with an appropriate matching bridge resistor, any available gage resistance may be used, in fact higher resistance gages such as 350ohm are preferable due to reduced lead-loss and temperature effects.

Note: This measurement is only supported by a MultiSensor Interface that has been modified by Canary Systems. Contact Canary Systems or your hardware vendor to arrange for the required modifications to your MultiSensor Interface.

Wiring

Connection to the multiplexers is as follows:

Description	Non-MultiSensor Mux	MultiSensor Mux
Excitation	1H	1H
Analog Ground	1L	1L
Remote Sense	2H	2H
No Connection	2L	2L
Instrument Shield	S	S

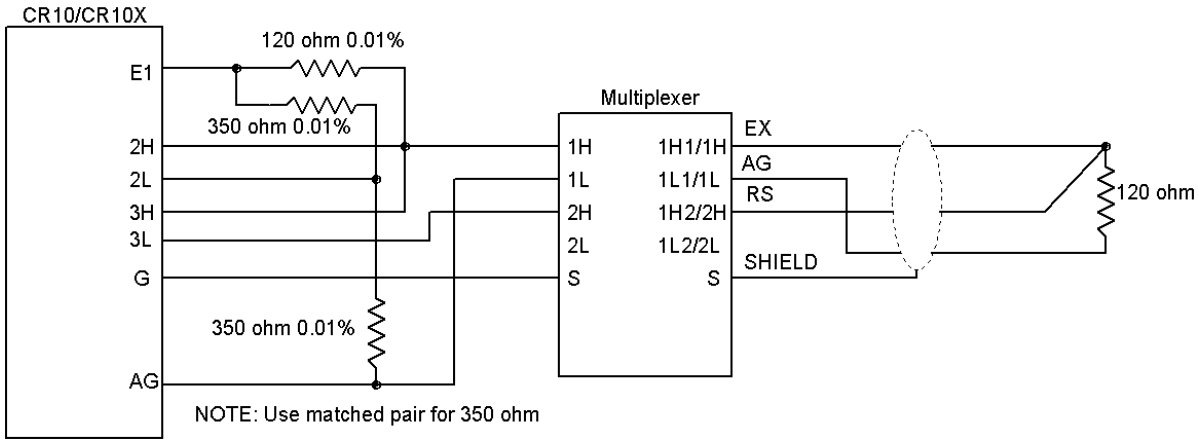
Refer to the wiring diagram supplied with the instrument to match the lead descriptions to wire colors or other designations.

Channel Configuration

Type	Make	Model	Instruction File	Description	Output Units
ResistanceSG	Generic	3Wire_1/4B1	3wire_14b1.ins	3-Wire ¼ Bridge narrow range	±15000 digits
		3Wire_1/4B2	3wire_14b2.ins	3-Wire ¼ Bridge wide range	±50000 digits

Note: Use **3Wire_1/4B1** when strains are expected to be within ±7500 (approximate, depends on gage factor), use **3Wire_1/4B2** when strains are expected to be within ±25000 (or when the bridge is significantly out-of-balance). The **3Wire_1/4Bn** sensor configurations are included in shipments of MultiLogger beginning with v2.1.5. Contact Canary Systems or your software vendor if you need to update your software.

Non-MultiSensor Multiplexer Wiring



Contact Canary Systems to obtain the required precision resistors. It is essential to use high accuracy low-temperature coefficient fixed resistors.

Data Reduction

The output equation for the Wheatstone bridge with a single active gage in uniaxial tension or compression (without correction for output nonlinearity) is as follows;

$$\frac{E_o}{E} = \frac{F\varepsilon \times 10^{-3}}{4}$$

where;
E_o is the output voltage (S+, S-) of the bridge in mV.
E is the input voltage (P+, P-) to the bridge in V.
F is the gage factor.
ε is the strain in microinches/inch ($\mu\varepsilon$).

This formula rearranges as follows;

$$\varepsilon = \frac{\frac{E_o}{E} \times 4000}{F}$$

The **3Wire_1/4Bn** Gage Type output, commonly referred to as “digits”;

$$\frac{E_o}{E} \times 4000$$

To convert the output to strain, divide by the gage factor or multiply (as can be entered into the Channel Configuration) by the inverse of the gage factor.

The magnitude of the initial readings and sign indicate the degree and direction of "unbalance" in the circuit. Usually, the non-linearity (or error) due to this "unbalance" is small and can be ignored. However, this error is a function of the magnitude of the "unbalance" and the strain being measured so for large strains (>10,000 με) may need to be considered. For additional information on this issue and other data reduction considerations see Micro-Measurements Tech Note TN-507. Increasing readings for this configuration indicate increasing compressive strains while decreasing readings indicate increasing tensile strains. Pay strict attention to the sign when reducing data.

Instruction File (wide range)

```
;Read bridge output
P6     Full Bridge   ;
1:[1                    ]    Reps   ;
2:[3                    ]    Range (25 mV Slow Range)   ;
3:[2                    ]    DIFF Channel  ;
4:[1                    ]    Ex Chan (Excite all reps w/Exchan 1)     ;
5:[2000                 ]    mV Excitation;
6:[ReadingLoc           ]    Loc    ;
7:[4000                 ]    Mult   ;
8:[0                    ]    Offset ;

;User Lower EX for Remote Sense measurement - provides approx 6.3ohms max resistance
;To increase loop resistance - reduce to 500mV then use factor of 8 in P37
P8     Ex-Del-Diff   ;
1:[1                    ]    Reps   ;
2:[3                    ]    New Range (25 mV Slow Range)      ;
3:[3                    ]    DIFF Channel  ;
4:[1                    ]    Ex Chan (Excite all reps w/Exchan 1)     ;
5:[10                   ]    Delay (units 0.01 sec)     ;
6:[1000                 ]    mV Excitation;
7:[ScratchLoc1          ]    Loc    ;
8:[.001                 ]    Mult   ;
9:[0                    ]    Offset ;

;Multiply for both ways and Vex
P37    Z=X*F  ;
1:[ScratchLoc1          ]    X Loc  ;
2:[4                    ]    F      ;
3:[ScratchLoc1          ]    Z Loc  ;

;Subtract VEx
P34    Z=X+F  ;
1:[ScratchLoc1          ]    X Loc  ;
2:[-2                   ]    F      ;
3:[ScratchLoc1          ]    Z Loc  ;

;Calculate correction factor
P37    Z=X*F  ;
1:[ScratchLoc1          ]    X Loc  ;
2:[-.5                  ]    F      ;
3:[ScratchLoc1          ]    Z Loc  ;

;Invert for multiplier
P42    Z=1/X  ;
1:[ScratchLoc1          ]    X Loc  ;
2:[ScratchLoc1          ]    Z Loc  ;

;Apply to reading
P36    Z=X*Y  ;
1:[ReadingLoc           ]    X Loc  ;
2:[ScratchLoc1          ]    Y Loc  ;
3:[ReadingLoc           ]    Z Loc  ;
```