PRÁCTICA #3 – MEDICIÓN DE FUERZA CON GALGAS EXTENSIOMÉTRICAS

LABORATORIO DE INSTRUMENTACIÓN

OBJETIVOS

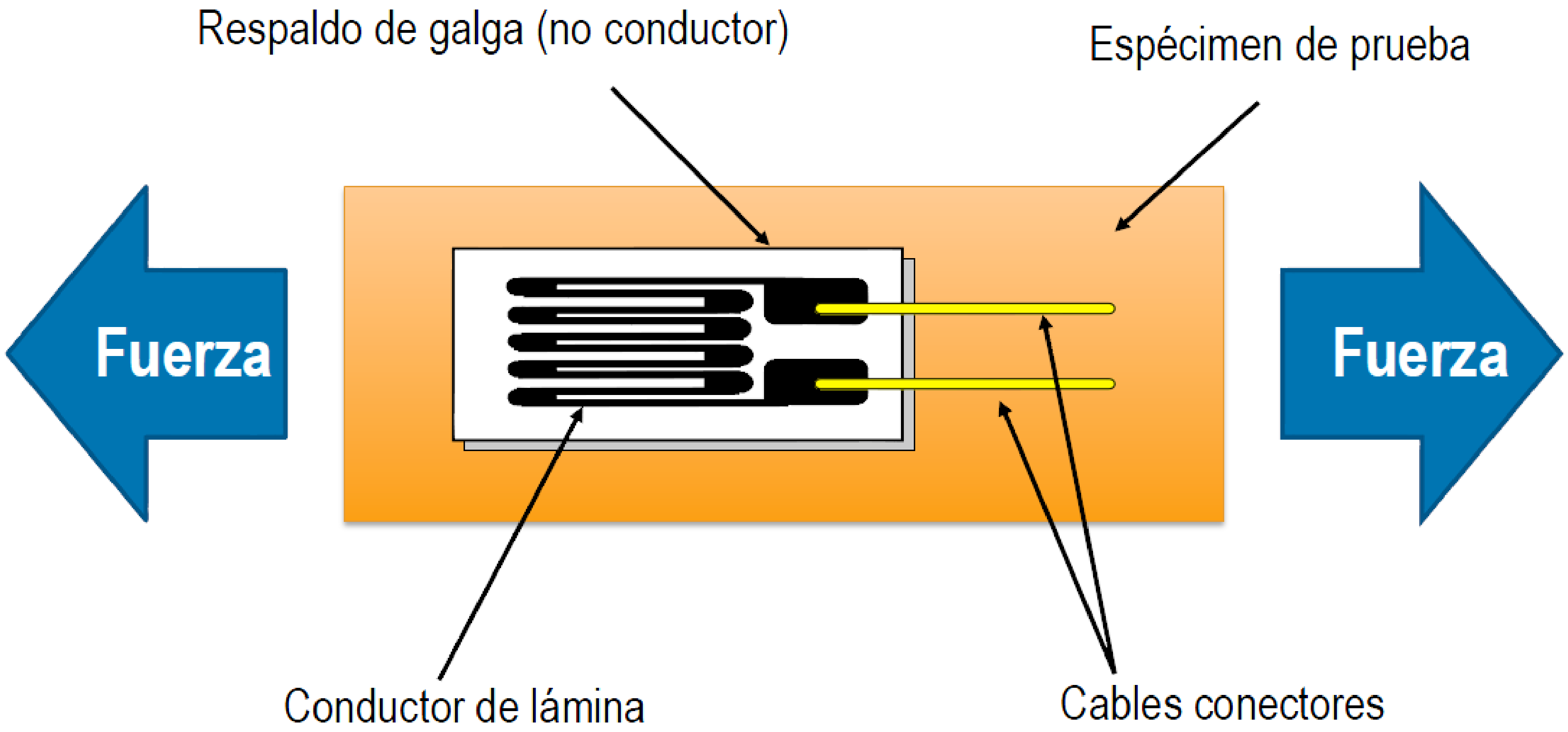
Usar una celda de carga para medición de fuerza aplicada por medios electrónicos (módulo HX711 y Arduino.

Entender el principio de funcionamiento de la galga extensiométrica en una celda de carga y sus diferentes configuraciones

Caracterizar la respuesta en estado estable del sistema de medición (análisis de histéresis, linealidad, sensibilidad, etc)

Comparar las mediciones hechas con una celda de carga industrial versus una balanza electrónica de bajo costo.

GALGA EXTENSIOMÉTRICA (PARTES)



GALGA EXTENSIOMÉTRICA (FUNCIONAMIENTO)

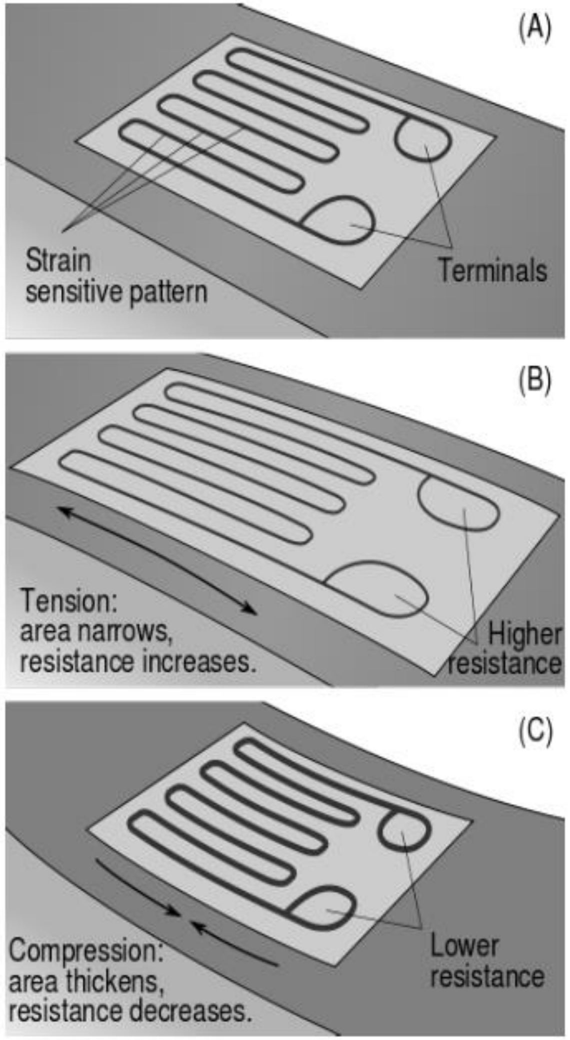
Sensores resistivos variables.

La resistencia varía con respecto a la deformación:

$$\varepsilon = \frac{\Delta L}{L}$$

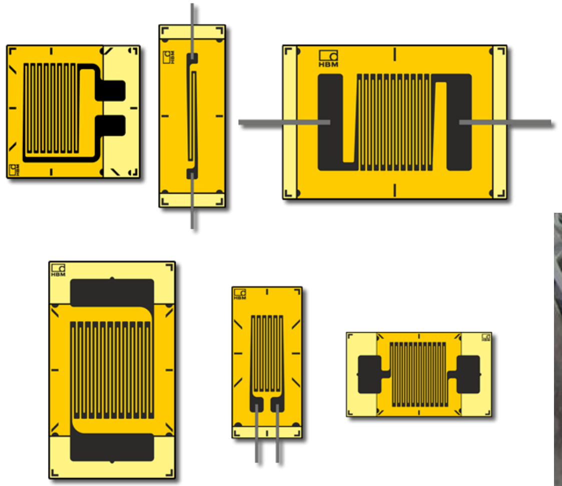
El factor de galga relaciona la tasa de cambio de la resistencia con respecto a la deformación:

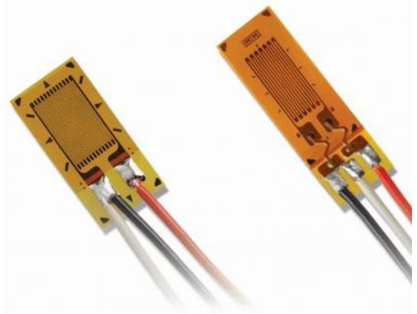
$$GF = \frac{\Delta R / R}{\Delta L / L}$$

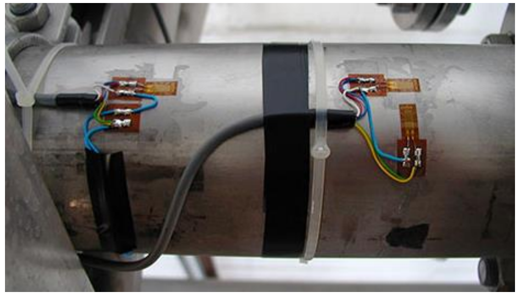


GALGA EXTENSIOMÉTRICA VS. CELDA DE CARGA

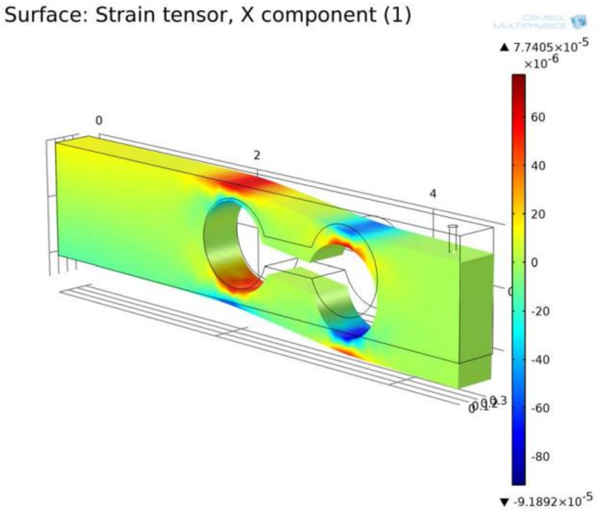
La galga es el transductor resistivo adherido a la probeta o estructura en que se quiere medir la deformación (o cargas que causan la deformación).



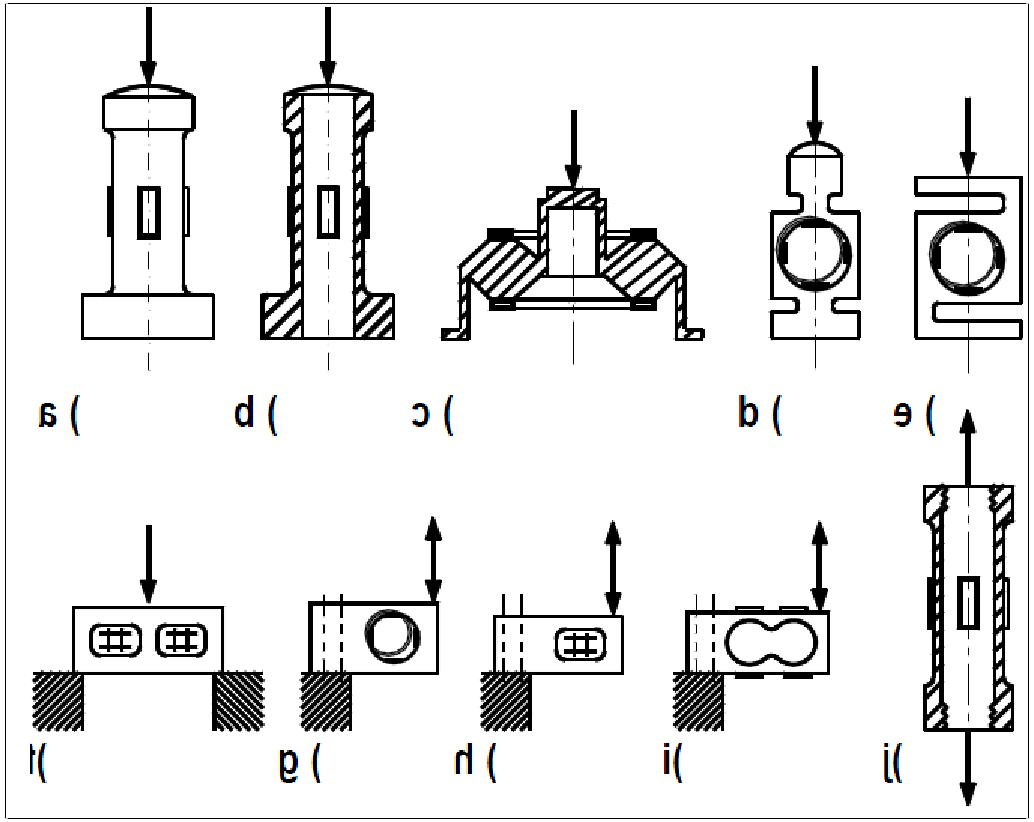




En la celda de carga la probeta (elemento elástico) se diseña para deformarse en cierta medida ante una carga determinada. Se instalan las galgas en las zonas de mayor deformación.



TIPOS DE CELDAS DE CARGA

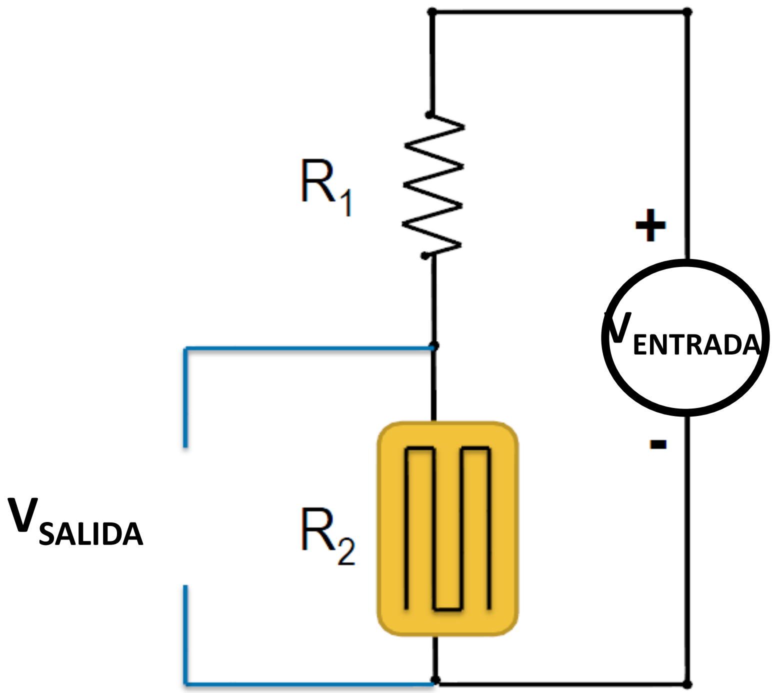


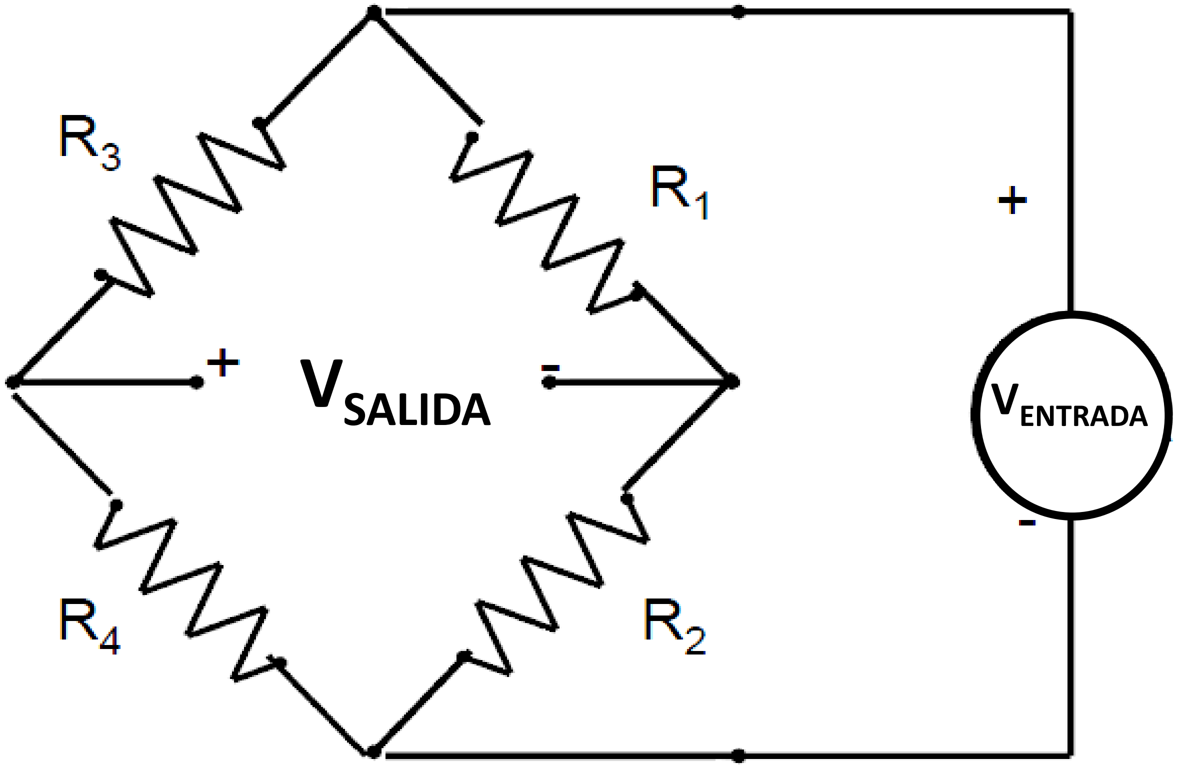
a) compression cylinder 50 kN to 50 MN
b) compression cylinder (hollow) 10 kN to 50 MN
c) toroidal ring 1 kN to 5 MN
d) ring 1 kN to 1 MN
e) S-beam (bending or shear) 50 N to 50 kN
f) double-ended shear beam 20 kN to 2 MN
g) double-bending beam (simplified) 500 N to 50 kN
h) shear beam 1 kN to 500 kN
i) double-bending beam 5 N to 10 kN
j) tension cylinder 50 kN to 50 MN

GALGA EXTENSIOMÉTRICA (DIVISOR DE VOLTAJE Y PUENTE DE WHEATSTONE)

$$V_{SALIDA} = V_{ENTRADA}\frac{R_2}{R_1 + R_2}$$

$$V_{SALIDA} = 0 \; si \; R_1/R_2 = R_3/R_4$$
$$V_{SALIDA} \neq 0 \; si \; R_1/R_2 \neq R_3/R_4$$





ERRORES ASOCIADOS A GALGAS

Ruido → Filtrado analógico o digital

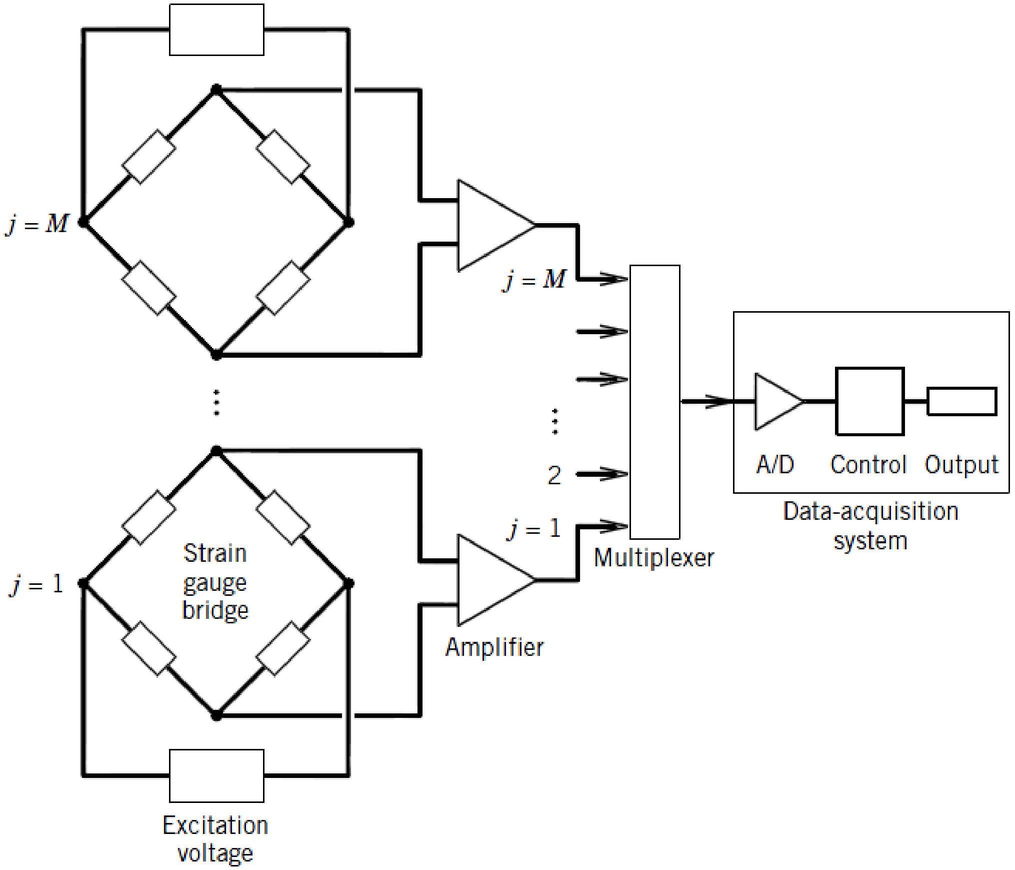
Auto-calentamiento → Selección de galga, material base, nivel de excitación, etc

Estabilidad de Voltaje de excitación → Monitoreo del voltaje de excitación

Resistencia de cables largos → Configuración de puente

Problemas de calibración → Calibración del cero y de derivación

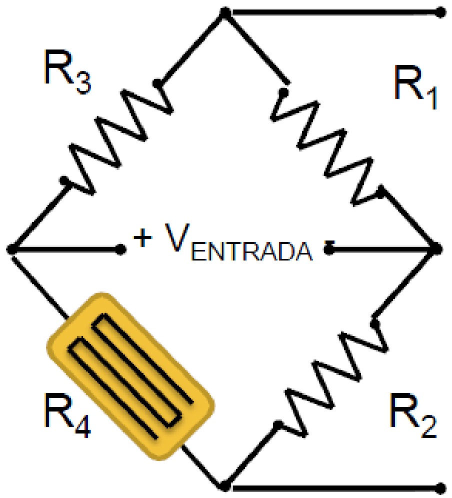
SISTEMA COMPLETO DE MEDICIÓN

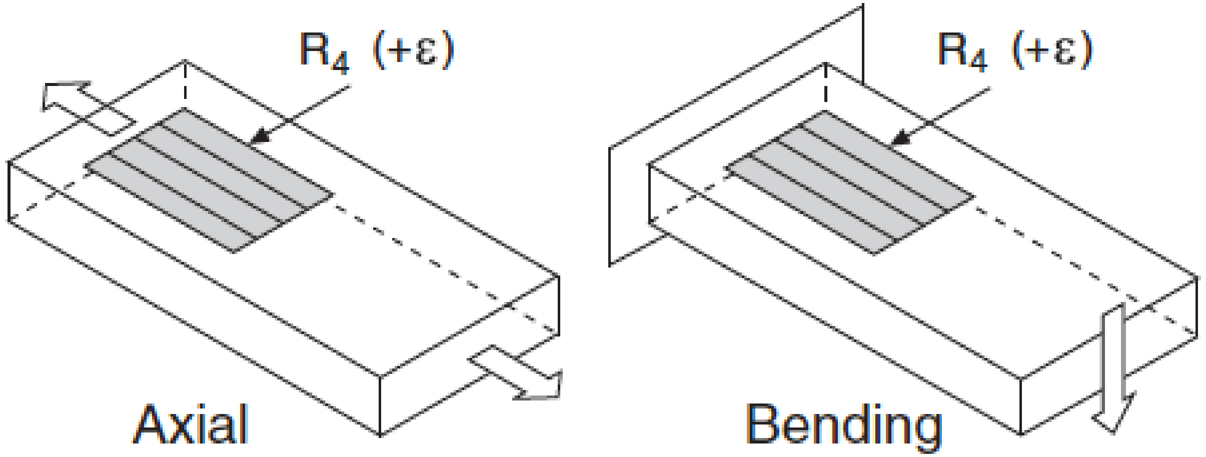


CUARTO DE PUENTE TIPO I

$$V_r = \frac{V_{O(strained)} - V_{O(unstrained)}}{V_{EX}}$$

$$strain(\varepsilon) = \frac{-4V_r}{GF(1+2V_r)} \bullet \left(1 + \frac{R_L}{R_G}\right)$$

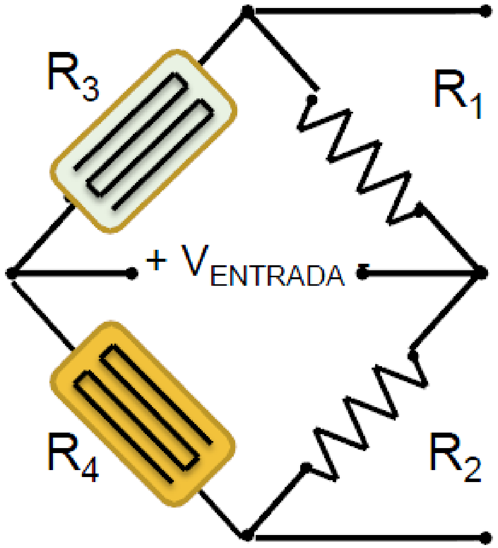


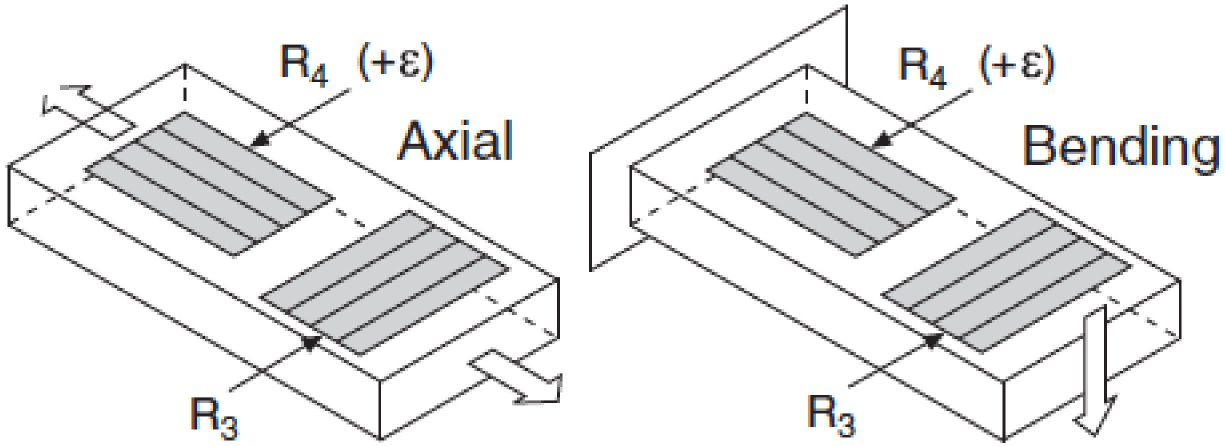


CUARTO DE PUENTE TIPO II

$$V_r = \frac{V_{O(strained)} - V_{O(unstrained)}}{V_{EX}}$$

$$strain(\varepsilon) = \frac{-4V_r}{GF(1+2V_r)} \bullet \left(1 + \frac{R_L}{R_G}\right)$$

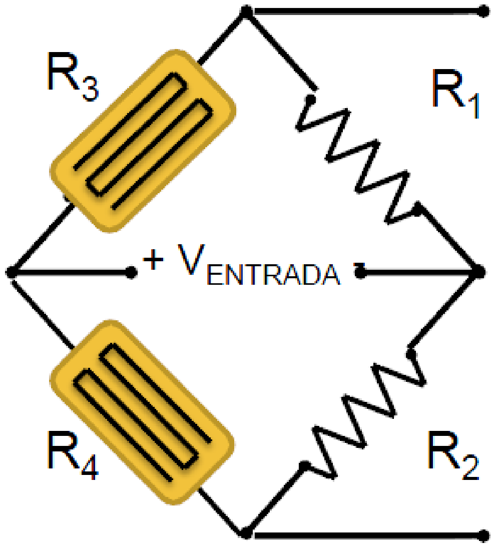


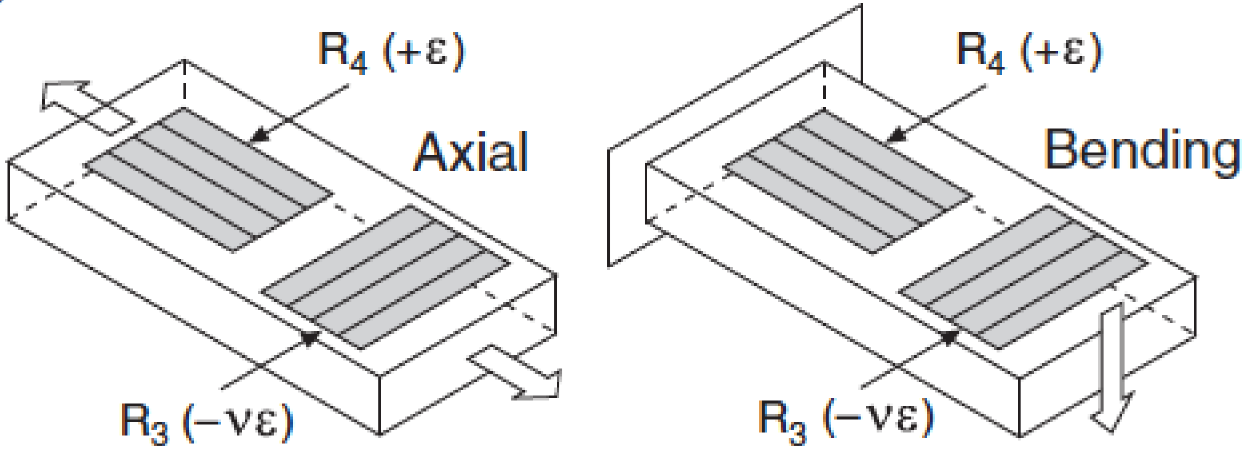


MEDIO PUENTE TIPO I

$$V_r = \frac{V_{O(strained)} - V_{O(unstrained)}}{V_{EX}}$$

$$strain(\varepsilon) = \frac{-4V_r}{GF[(1+\nu) - 2V_r(\nu - 1)]} \bullet \left(1 + \frac{R_L}{R_G}\right)$$

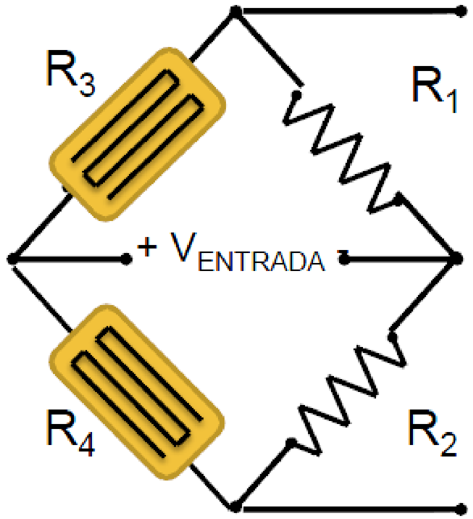


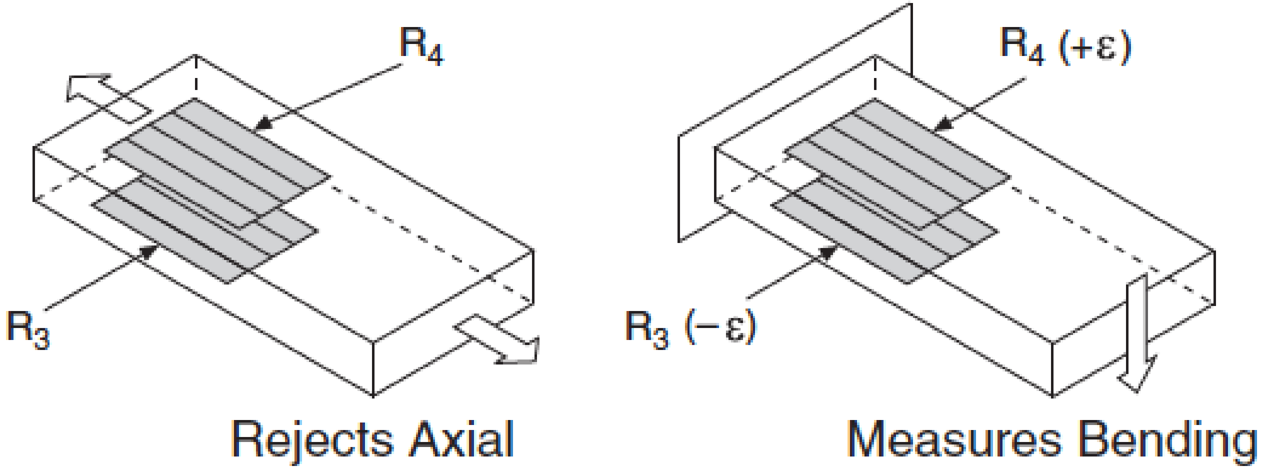


MEDIO PUENTE TIPO II

$$V_r = \frac{V_{O(strained)} - V_{O(unstrained)}}{V_{EX}}$$

$$strain(\varepsilon) = \frac{-2V_r}{GF} \bullet \left(1 + \frac{R_L}{R_G}\right)$$

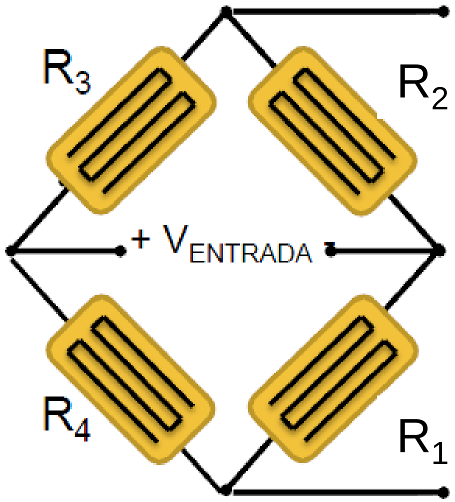


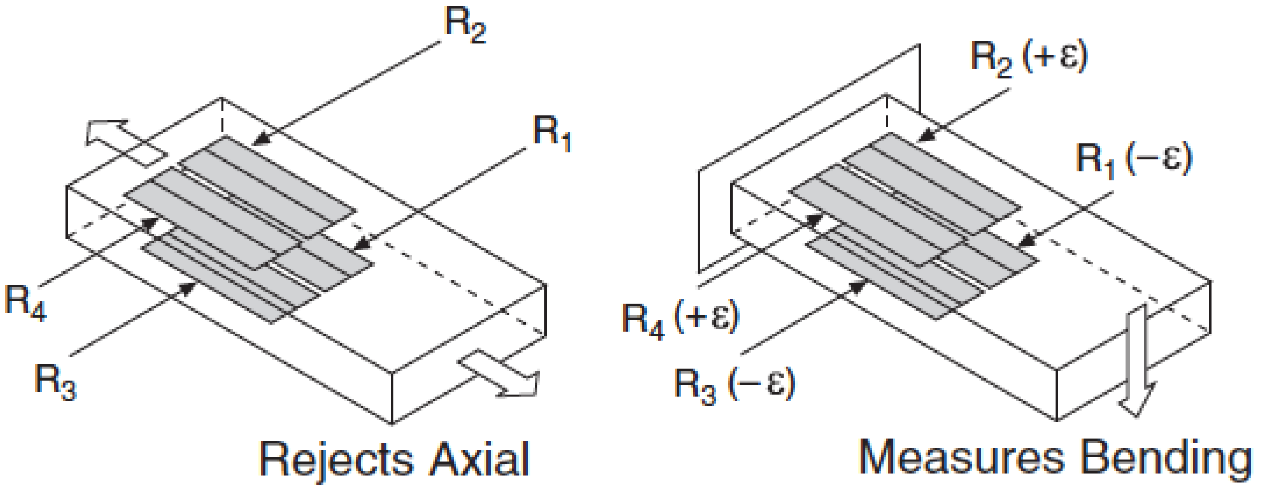


PUENTE COMPLETO TIPO I

$$V_r = \frac{V_{O(strained)} - V_{O(unstrained)}}{V_{EX}}$$

$$\text{strain}(\varepsilon) = \frac{-V_r}{GF}$$

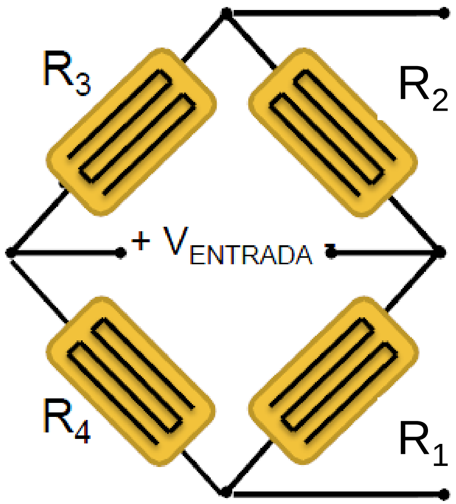


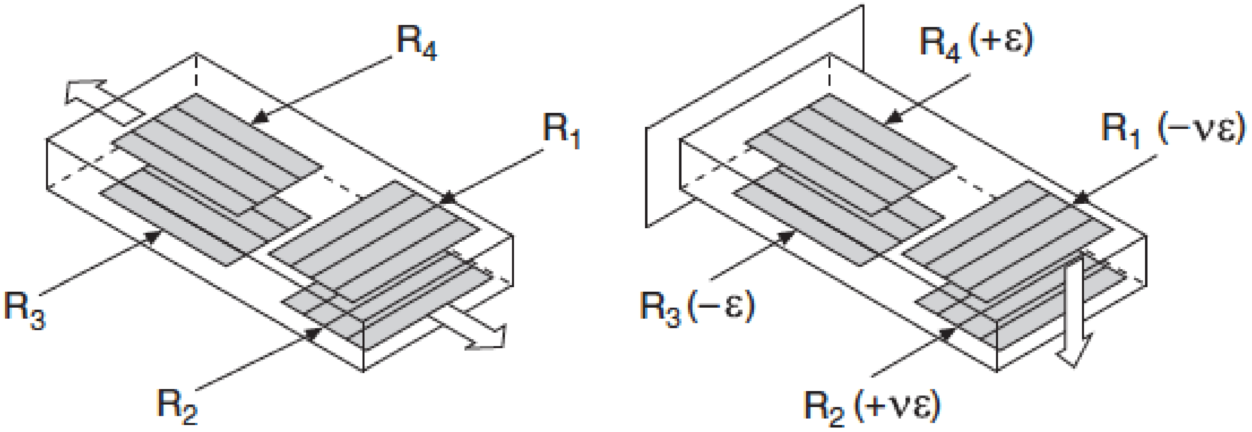


PUENTE COMPLETO TIPO II

$$V_r = \frac{V_{O(\text{strained})} - V_{O(\text{unstrained})}}{V_{EX}}$$

$$\text{strain}(\varepsilon) = \frac{-2V_r}{GF(\nu + 1)}$$





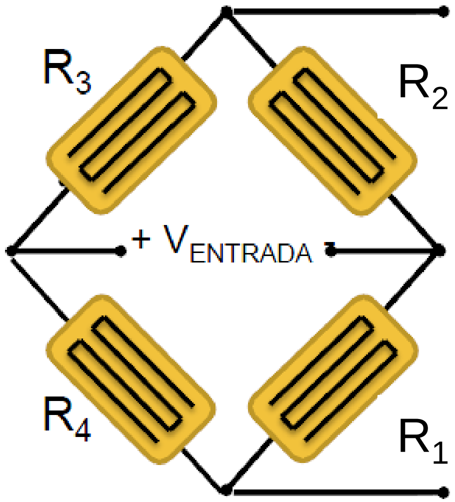
Rejects Axial

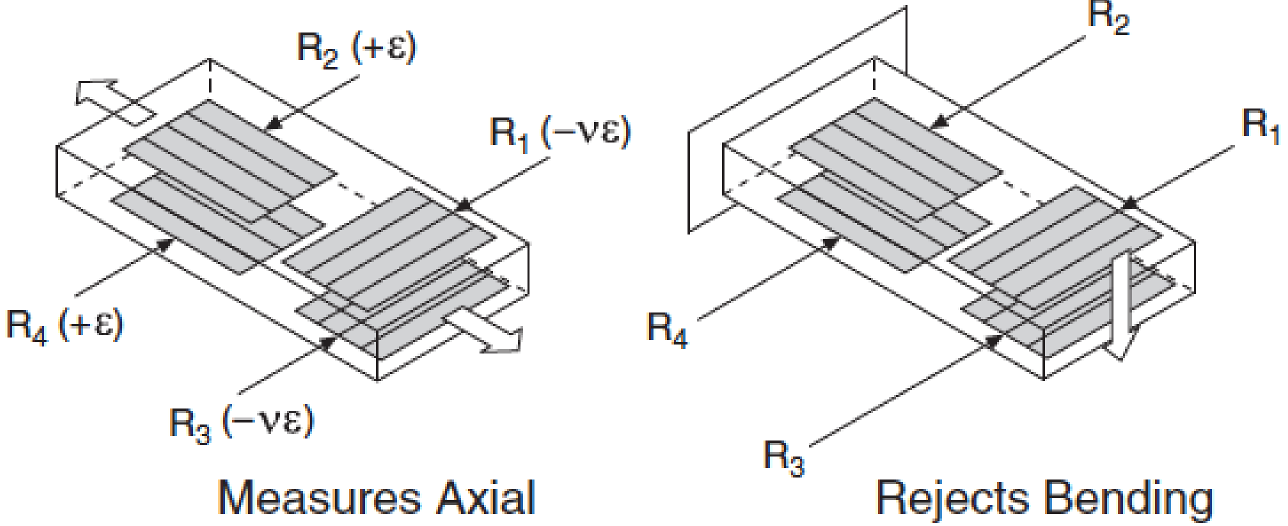
Measures Bending

PUENTE COMPLETO TIPO III

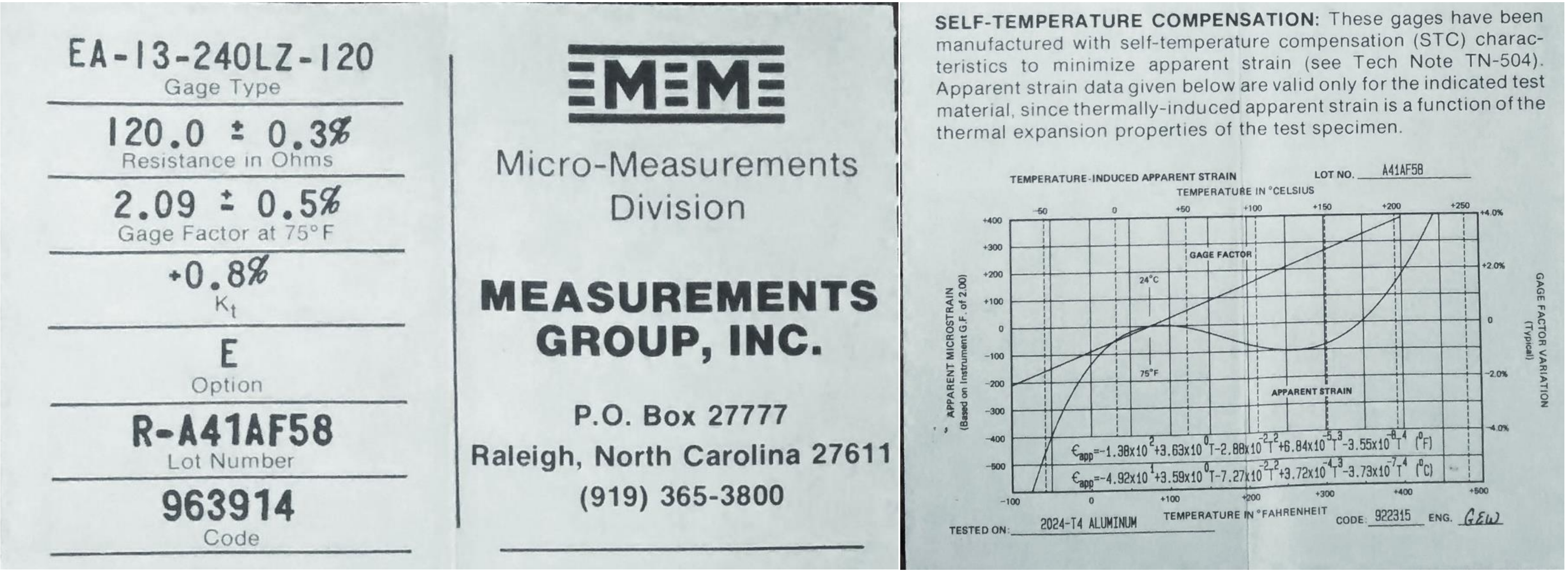
$$V_r = \frac{V_{O(strained)} - V_{O(unstrained)}}{V_{EX}}$$

$$strain(\varepsilon) = \frac{-2V_r}{GF[(\nu+1) - V_r(\nu-1)]}$$





HOJA DE DATOS DE GALGA EXTENSIOMÉTRICA



EA-13-240LZ-120
Gage Type

120.0 ± 0.3%
Resistance in Ohms

2.09 ± 0.5%
Gage Factor at 75° F

+0.8%
K_t

E
Option

R-A41AF58
Lot Number

963914
Code

MEASUREMENTS GROUP, INC.
Micro-Measurements Division

P.O. Box 27777
Raleigh, North Carolina 27611
(919) 365-3800

SELF-TEMPERATURE COMPENSATION: These gages have been manufactured with self-temperature compensation (STC) characteristics to minimize apparent strain (see Tech Note TN-504). Apparent strain data given below are valid only for the indicated test material, since thermally-induced apparent strain is a function of the thermal expansion properties of the test specimen.

TESTED ON: 2024-T4 ALUMINUM
CODE: 922315 ENG. GEW

HOJA DE DATOS DE CELDA DE CARGA

SPECIFICATIONS

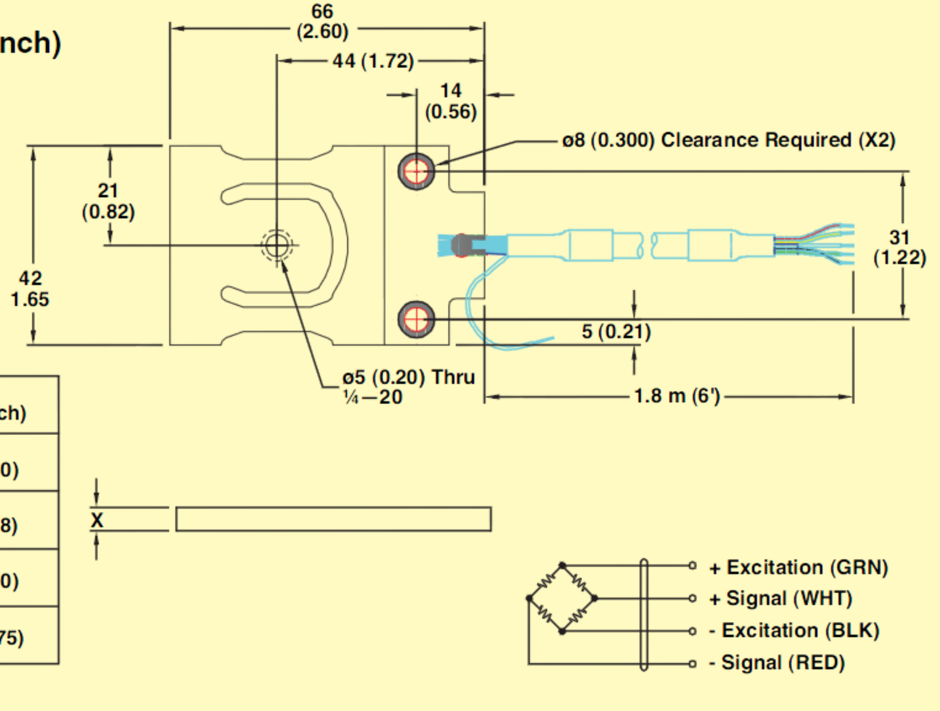
Excitation: 5 Vdc, 15 Vdc maximum
Output: 1 mV/V ± 0.1%
Linearity: ± 0.02% FS
Hysteresis: ± 0.01% FS
Zero Balance: ± 5% FS
Creep (in 30 minutes): ± 0.03% FS
Operating Temp Range: -10 to 100°C (14 to 212°F)
Compensated Temp Range: -10 to 100°C (14 to 212°F)
Thermal Effects:
- **Span:** ± 0.005% FS/°C (0.003/°F)
- **Zero:** ± 0.005% FS/°C (0.003/°F)

Safe Overload: 300% of capacity
Ultimate Overload: 400% of capacity

To Order *Visit omega.com/lcpb for Pricing and Details*

CAPACITY kg	CAPACITY lb	MODEL NO.	"X" DIMENSION mm (inch)	COMPATIBLE METERS
100	220	**LCPB-100**	9.53 (0.375)	DP25B-S, DP41-S, DPiS

Dimensions: mm (inch)



CAPACITY	X mm (inch)
5 kg	2 (0.080)
10 kg	3 (0.118)
20 kg	4 (0.160)
100 kg	10 (0.375)

¿PREGUNTAS?