APPENDICES AND BIBLIOGRAPHY

APPENDIX A: TABLES

WIRE RESISTANCE SOLID COPPER WIRE

AWG	Ω/FOOT (25°C)	DIAMETER (IN)
18	0.0065	0.040
20	0.0104	0.032
22	0.0165	0.0253
24	0.0262	0.0201
26	0.0416	0.0159
28	0.0662	0.0126
30	0.105	0.010
32	0.167	0.008

AVERAGE PROPERTIES OF SELECTED ENGINEERING MATERIALS
EXACT VALUES MAY VARY WIDELY

MATERIAL	POISSON'S RATIO, ν	MODULUS OF ELASTICITY, E psi X 10^6	ELASTIC STRENGTH (*) TENSION (psi)
ABS (unfilled)	—	0.2-0.4	4500-7500
Aluminum (2024-T4)	0.32	10.6	48000
Aluminum (7075-T6)	0.32	10.4	72000
Red Brass, soft	0.33	15	15000
Iron-Gray Cast	—	13-14	—
Polycarbonate	0. 285	0.3-0.38	8000-9500
Steel-1018	0.285	30	32000
Steel-4130/4340	0.28-0.29	30	45000
Steel-304 SS	0.25	28	35000
Steel-410 SS	0.27-0.29	29	40000
Titanium alloy	0.34	14	135000

(*) Elastic strength can be represented by proportional limit, yield point, or yield strength at 0.2 percent offset.

APPENDIX B: BRIDGE CIRCUITS

Equations compute strain from unbalanced bridge voltages:

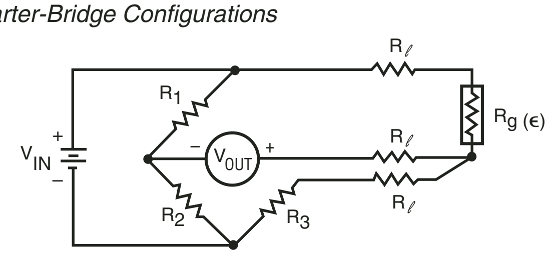
sign is correct for V_{IN} and V_{OUT} as shown

GF = Gage Factor ν = Poisson's ratio:

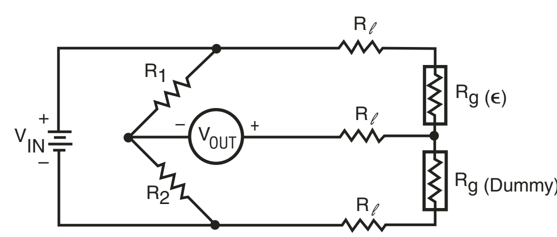
$V_r = [(V_{OUT}/V_{IN})\text{strained} - (V_{OUT}/V_{IN})\text{unstrained}]$:

ϵ = Strain: Multiply by 10^6 for microstrain: tensile is (+) and compressive is (–)

Quarter-Bridge Configurations

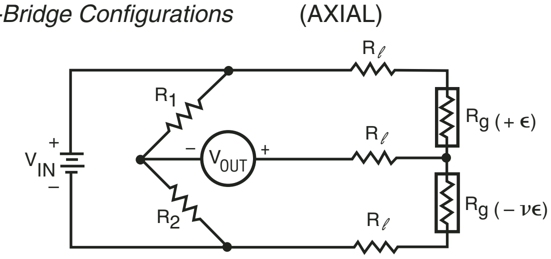


OR

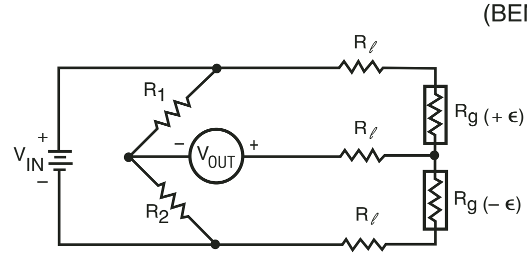


$$\epsilon = \frac{-4V_r}{GF(1 + 2V_r)} \bullet \left(1 + \frac{R_\ell}{R_g}\right)$$

Half-Bridge Configurations (AXIAL)



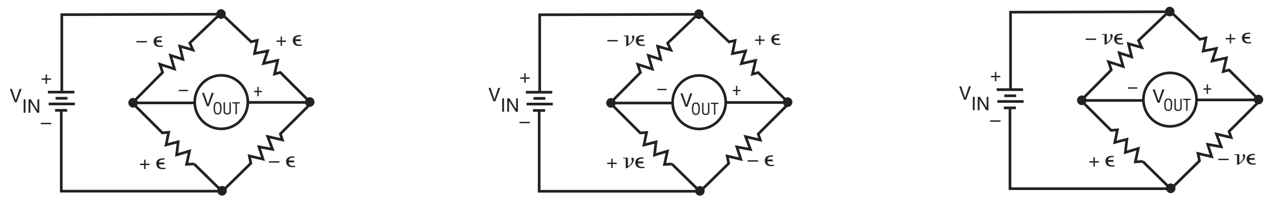
(BENDING)



$$\epsilon = \frac{-4V_r}{GF[(1 + \nu) - 2V_r(\nu - 1)]} \bullet \left(1 + \frac{R_\ell}{R_g}\right)$$

$$\epsilon = \frac{-2V_r}{GF} \bullet \left(1 + \frac{R_\ell}{R_g}\right)$$

Full-Bridge Configurations (BENDING) (AXIAL)



$\epsilon = \dfrac{-V_r}{GF}$	$\epsilon = \dfrac{-2V_r}{GF(\nu + 1)}$	$\epsilon = \dfrac{-2V_r}{GF[(\nu + 1) - V_r(\nu - 1)]}$

APPENDIX C: EQUATIONS

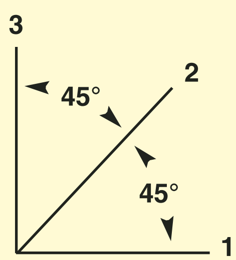
BIAXIAL STRESS STATE EQUATIONS

$$\epsilon_x = \frac{\sigma_x}{E} - \nu\frac{\sigma_y}{E} \qquad \epsilon_z = -\nu\frac{\sigma_x}{E} - \nu\frac{\sigma_y}{E} \qquad \sigma_y = \frac{E}{1-\nu^2}(\epsilon_x + \nu\,\epsilon_x)$$

$$\epsilon_y = \frac{\sigma_y}{E} - \nu\frac{\sigma_x}{E} \qquad \sigma_x = \frac{E}{1-\nu^2}(\epsilon_x + \nu\,\epsilon_y) \qquad \sigma_z = 0$$

ROSETTE EQUATIONS

Rectangular Rosette:

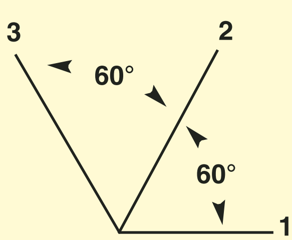


$$\epsilon_{p,q} = \frac{1}{2}\left[\epsilon_1 + \epsilon_3 \pm \sqrt{(\epsilon_1 - \epsilon_3)^2 + (2\epsilon_2 - \epsilon_1 - \epsilon_3)^2}\right]$$

$$\sigma_{p,q} = \frac{E}{2}\left[\frac{\epsilon_1 + \epsilon_3}{1-\nu} \pm \frac{1}{1+\nu}\sqrt{(\epsilon_1 - \epsilon_3)^2 + (2\epsilon_2 - \epsilon_1 - \epsilon_3)^2}\right]$$

$$\Theta_{p,q} = \frac{1}{2}\,\mathrm{TAN}^{-1}\,\frac{2\epsilon_2 - \epsilon_1 - \epsilon_3}{\epsilon_1 - \epsilon_3}$$

Delta Rosette:



$$\epsilon_{p,q} = \frac{1}{3}\left[\epsilon_1 + \epsilon_2 + \epsilon_3 \pm \sqrt{2\left[(\epsilon_1 - \epsilon_2)^2 + (\epsilon_2 - \epsilon_3)^2 + (\epsilon_3 - \epsilon_1)^2\right]}\right]$$

$$\sigma_{p,q} = \frac{E}{3}\left[\frac{\epsilon_1 + \epsilon_2 + \epsilon_3}{1-\nu} \pm \frac{1}{1+\nu}\sqrt{2\left[(\epsilon_1 - \epsilon_2)^2 + (\epsilon_2 - \epsilon_3)^2 + (\epsilon_3 - \epsilon_1)^2\right]}\right]$$

$$\Theta_{p,q} = \frac{1}{2}\,\mathrm{TAN}^{-1}\,\frac{\sqrt{3}\,(\epsilon_2\ \epsilon_3)}{2\epsilon_1 - \epsilon_2 - \epsilon_3}$$

WHERE:

ϵp,q = Principal strains

σp,q = Principal stresses

Θp,q = the acute angle from the axis of gage 1 to the nearest principal axis. When positive, the direction is the same as that of the gage numbering and, when negative, opposite.

NOTE: Corrections may be necessary for transverse sensitivity. Refer to gage manufacturer's literature.