Integrated Design Project

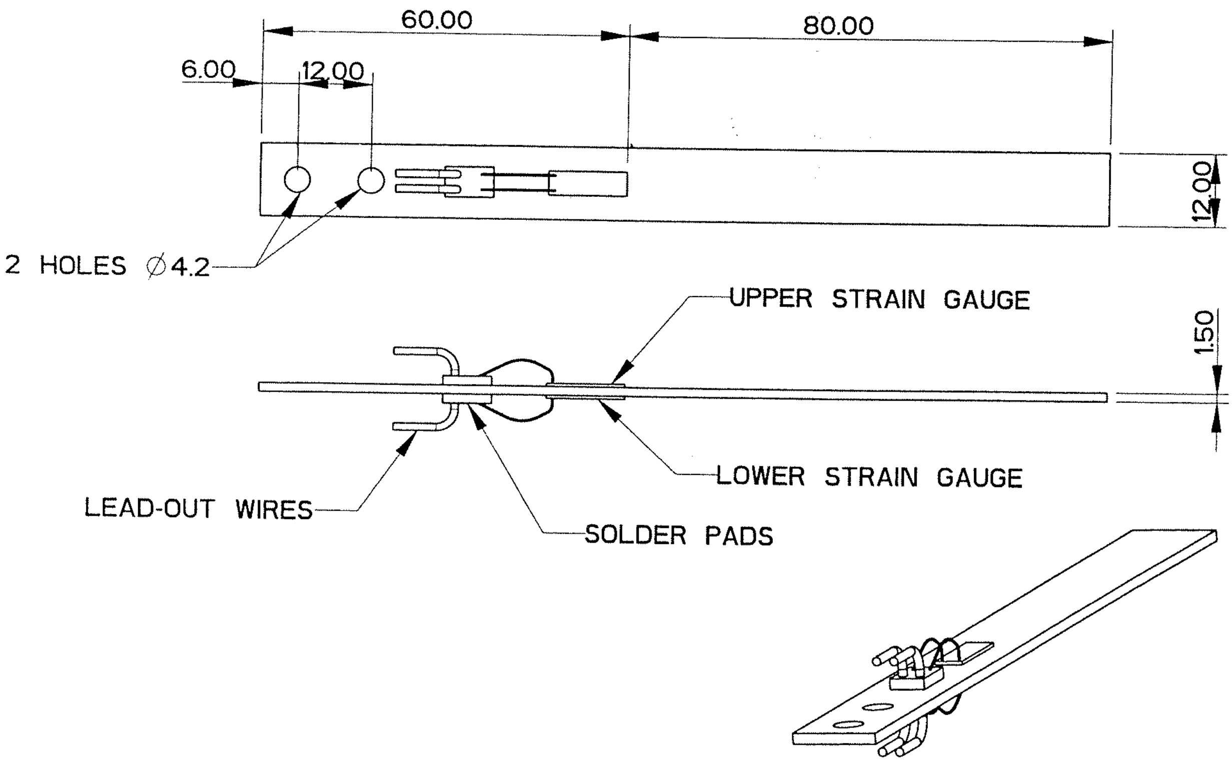
The Use of Strain Gauges

A strain gauge is made up of a long conductor folded back on itself many times, mounted on a backing surface. When it is stretched, the conductor length increases and its electrical resistance increases. When it is compressed, the decreased conductor length results in a lowered resistance. The resistance change is approximately proportional to the mechanical strain producing it. The constant of proportionality is known as the *gauge factor* and is typically 2.0 or 2.1.

When a strain gauge is bonded to the surface of a stressed member then its resistance change will be proportional to the stress carried, thus it can be used to measure an applied load or even supported weight.

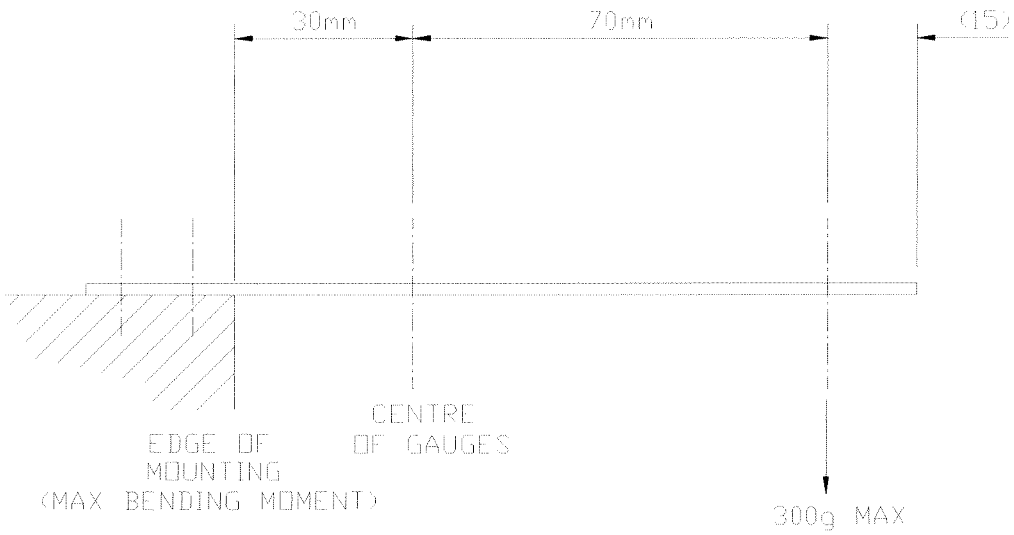
Resistance changes tend to be small and traditionally strain gauges exhibit a temperature coefficient due to thermal expansion of the test piece (although modern gauges often have temperature compensation built-in). For these reasons gauges are often connected in bridge circuits. If two gauges are mounted on opposite sides of a beam in bending then one will contract and the other compress thus giving double the resistance change whilst cancelling temperature effects.

Strain gauge pairs have been ready-mounted on beams as shown below. The beam dimensions have been chosen to give a reasonable strain for the load envisaged while avoiding the onset of plastic deformation.



Dimensions of given Strain Gauge Beam

Remember:- $M/I = \sigma/y = Es/y$,
where M is bending moment,
I is 2^{nd} moment of area, $= 3.4 \times 10^{-12}$
σ is stress,
y is ½ thickness = 0.75mm,
E is Young's modulus $= 76 \times 10^{9}\ Nm^{-2}$,
and s is strain ($\delta L/L$).



The diagram above shows the maximum practical lengths and thus maximum bending moments achievable with the given beam.

Mmax = 0.29 Nm
Therefore σ max $= 64\ MNm^{-2}$

Mgauge = 0.21 Nm
Therefore s at gauge $= 600 \times 10^{-6}$

Electrical Considerations

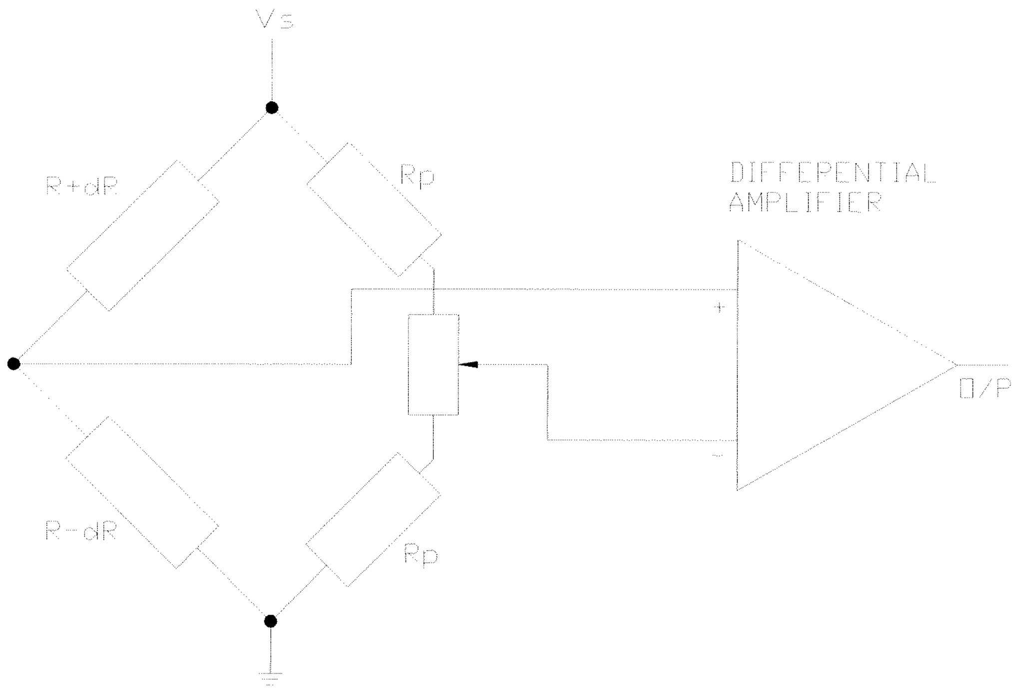
Shown below is a suggested bridge and amplifier circuit. The gauge labelled R + δR is in tension and the gauge labelled R – δR is in compression.

The potentiometer allows the bridge to be balanced, giving a null signal under no-load conditions.

For the strain gauges provided :–

R = 120 Ω

δR/R = 2.1 x s



Strain Gauge Test Boxes are available in the EIETL to allow you to simulate the working conditions and optimise values for gain and passive resistors (it is expected that gains of between 100 and 1000 will be selected, with values of passive resistors of between 100 and 1000 Ω).

N.B. Be careful not to induce plastic deformation into strain gauge beams. Provide strain-relief for lead-out wires close to the solder pads.

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