



Seção de Ensino de Engenharia de Fortificação e Construção – SE/2
Curso de Pós-Graduação em Engenharia de Transportes

Instrumentação, Aquisição e Processamento de Sinais para Medições de Engenharia

Prof. Luiz Augusto C. Moniz de Aragão Filho

Unidade III:

Extensometria III: Ponte Completa

Abril 2012



Extensometria

- Referências -

National Instruments: Measuring Strain with Strain Gages:

<http://zone.ni.com/devzone/cda/tut/p/id/4172>

Experimental stress analysis, 1978, Dally, J.N., Riley, W.F.

Biblioteca do IME - Número de Chamada: 620.1124 D147

Experimental Stress Analysis: Principles and Methods, 1967, G. S. Holister

<http://books.google.com.br/books?id=zjk8AAAAIAAJ&pg=PA138&dq=RILEY+Experimental+stress+analysis&hl=pt-BR&sa=X&ei=dT-GT9y1AaOF8AHt8ImcCA&ved=0CFgQ6AEwBw#v=onepage&q=RILEY%20Experimental%20stress%20analysis&f=false>

How to Form Strain-gage Bridges

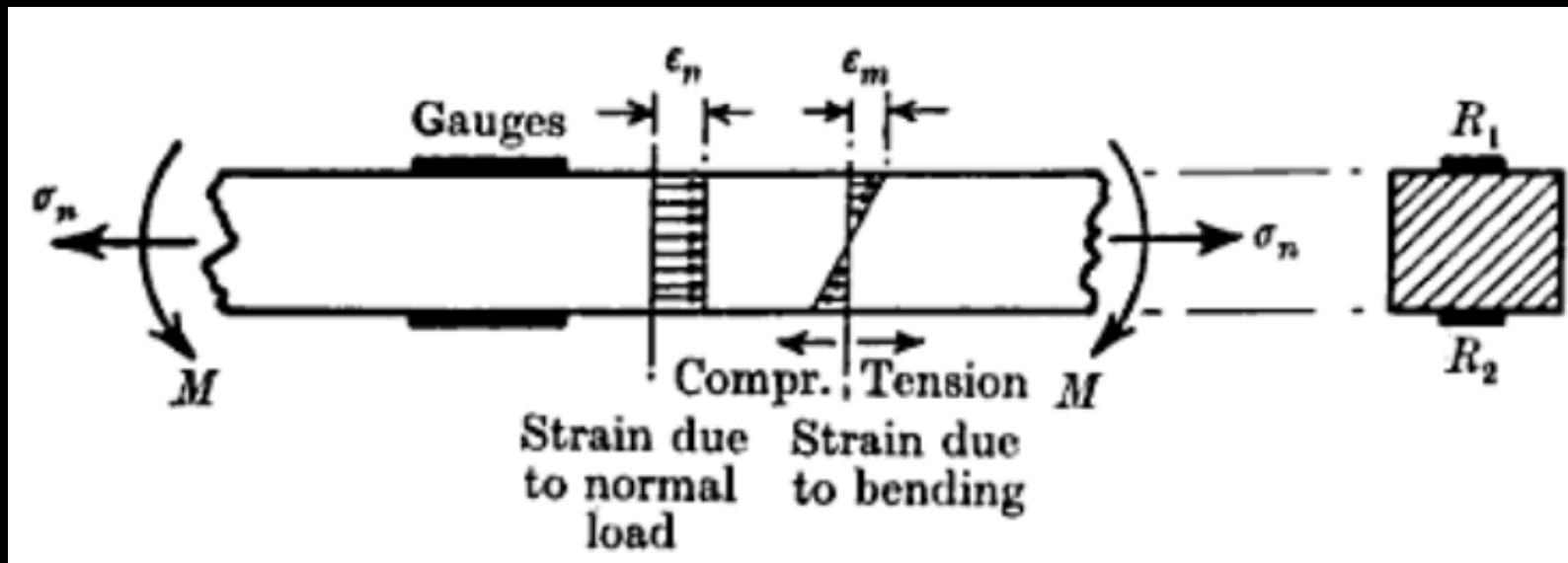
<http://www.kyowa-ei.co.jp/english/products/gages/pdf/bridge.pdf>



Extensometria

Ponte completa – Procedimento

Medindo deformações da Flexão Composta

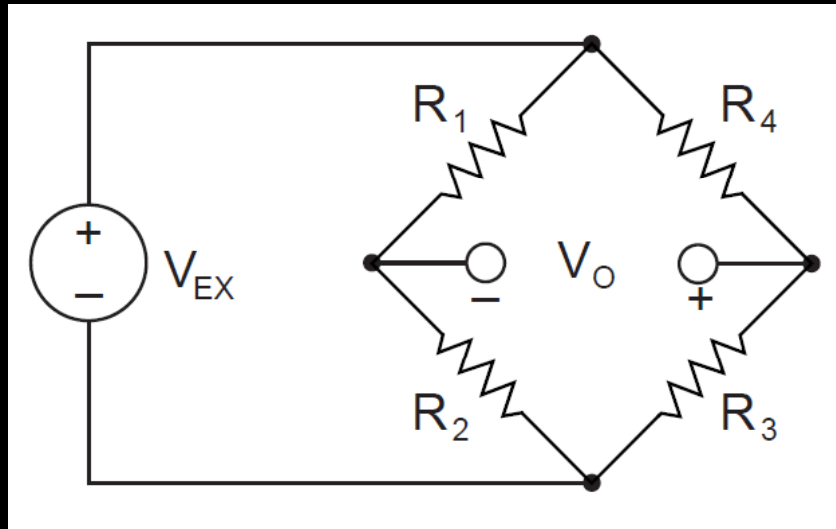




Extensometria

Ponte completa – Procedimento

Medindo deformações na Ponte Completa



$$V_0 = \left[\frac{R_3}{R_3 + R_4} - \frac{R_2}{R_1 + R_2} \right] \cdot V_{EX}$$

$$\varepsilon = \frac{1}{G} \cdot \frac{\Delta R}{R}$$

Razão de voltagem:

$$V_r = \frac{\Delta V_0}{V_{Ex}} = \frac{V_0 \text{ deformada} - V_0 \text{ indeformada}}{V_{Ex}} \left[\frac{\text{mV}}{\text{V}} \right]$$



Extensometria

Ponte completa – Procedimento

Partindo-se da ponte balanceada: $\Rightarrow R_1 R_3 = R_2 R_4$

Tem-se:

$$\Rightarrow \frac{\Delta V_0}{V_{Ex}} = \frac{R_1 R_2}{(R_1 + R_2)^2} \left(\frac{\Delta R_1}{R_1} - \frac{\Delta R_2}{R_2} + \frac{\Delta R_3}{R_3} - \frac{\Delta R_4}{R_4} \right)$$

Se os strain-gages forem todos iguais:

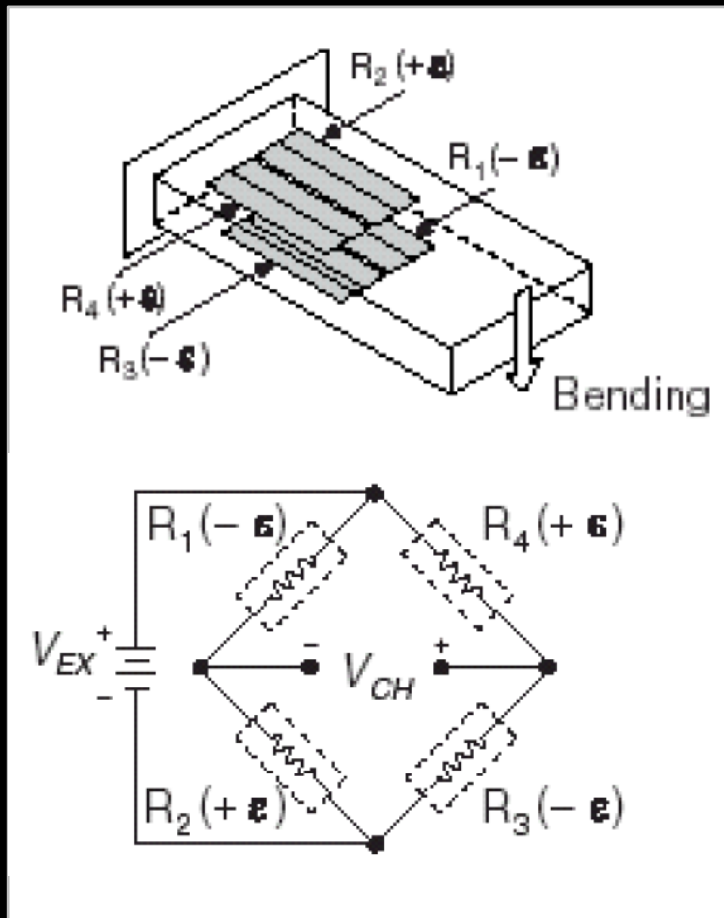
$$\Rightarrow \frac{\Delta V_0}{V_{Ex}} = \frac{G}{4} (\varepsilon_1 - \varepsilon_2 + \varepsilon_3 - \varepsilon_4)$$



Extensometria

Ponte completa – Procedimento

Medindo deformações da Flexão por Ponte Completa (Tipo I)



- Quatro strain-gages ativos: todos montados na direção das tensões normais de flexão;
- Altamente sensível à tensão de flexão;
- Não mede tensão normal axial;
- Compensa a temperatura;
- Compensa a resistência do condutor;
- Sensibilidade a $1000 \mu\epsilon$ é $\sim 2,0 \text{ mVout/VEX}$.

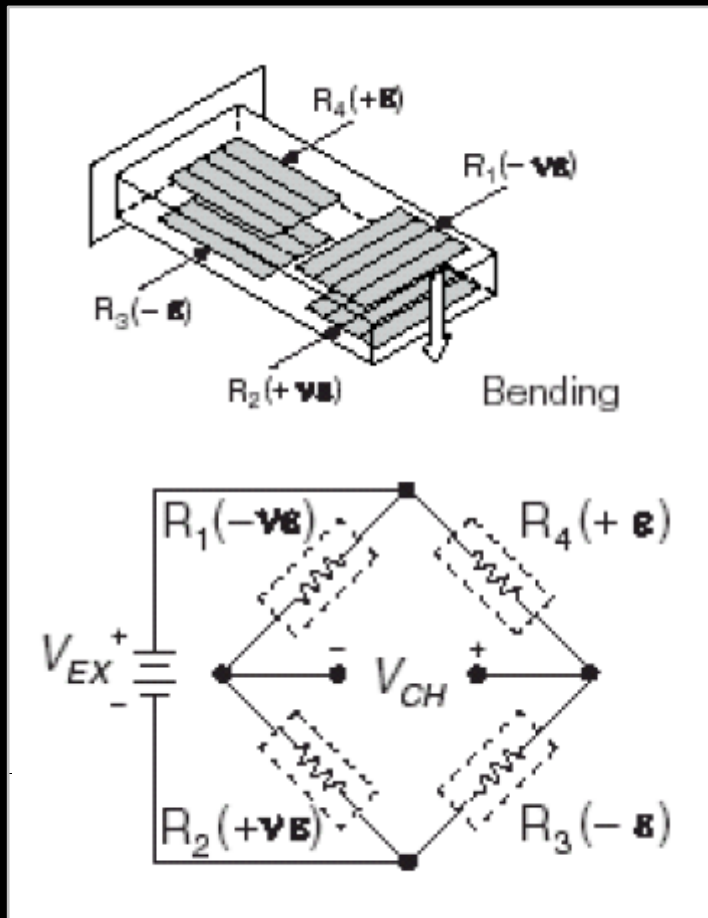
$$\Rightarrow \epsilon = \frac{V_r}{G} \quad [\mu\epsilon]$$



Extensometria

Ponte completa – Procedimento

Medindo deformações da Flexão por Ponte Completa (Tipo II)



- Quatro strain-gauge ativos.
- Não mede a tensão axial.
- Compensa a temperatura.
- Compensa a deformação transversal devida ao efeito de Poisson.
- Compensa a resistência do condutor.
- Sensibilidade a $1000 \mu\epsilon$ é $\sim 1,3 \text{ mVout/VEX}$.

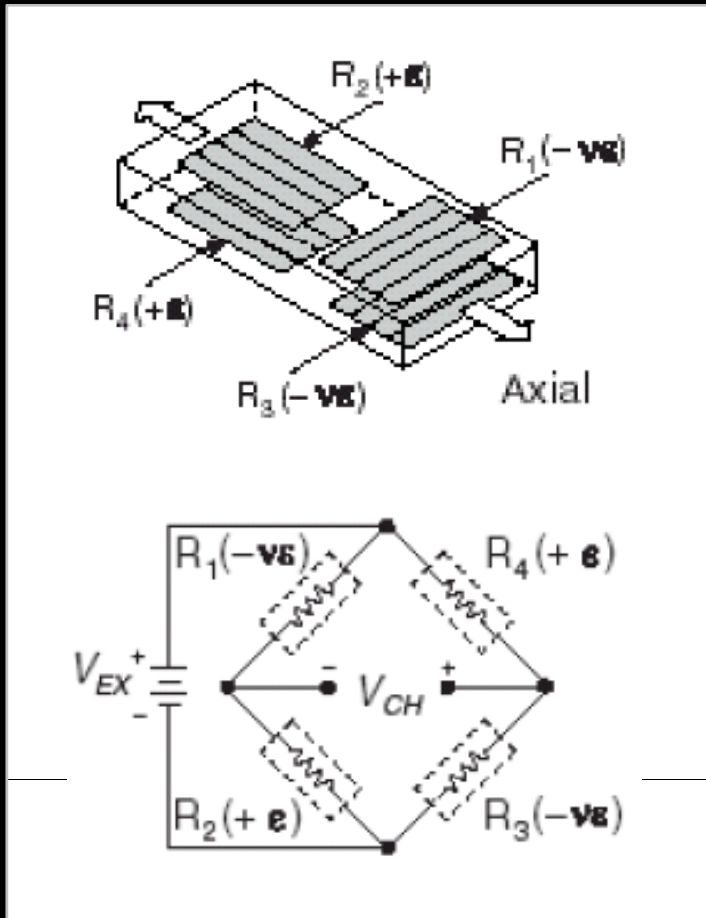
$$\Rightarrow \epsilon = \frac{2V_r}{G(1+\nu)} \quad [\mu\epsilon]$$



Extensometria

Ponte completa – Procedimento

Medindo deformações axiais por Ponte Completa (Tipo III)



- Quatro strain-gauge ativos.
- Não mede a tensão normal devida à flexão.
- Compensa a temperatura.
- Compensa a deformação transversal devida ao efeito de Poisson.
- Compensa a resistência do condutor.
- Sensibilidade a $1000 \mu\epsilon$ é $\sim 1,3 \text{ mVout/VEX}$.

$$\Rightarrow \epsilon = \frac{2V_r}{G(1+\nu)} \quad [\mu\epsilon]$$



Extensometria

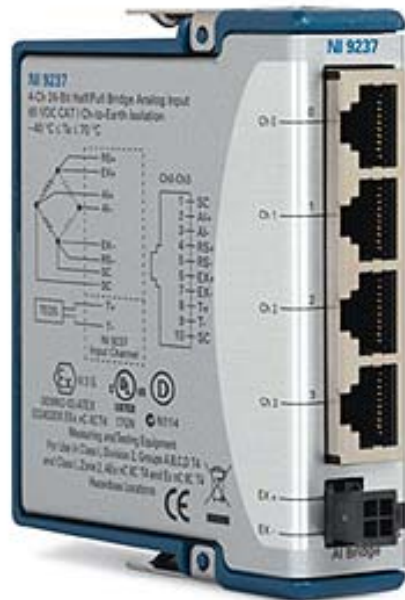
Equipamento National Instruments

Acessórios:

Placa NI-9237

4-Ch 24Bit Half/Full Bridge Analog Input

- *cabo RJ-50/RJ-50*
- *caixa 9949 (1/2 ponte ou ponte completa)*
- *caixa 9944 (1/4 de ponte)*

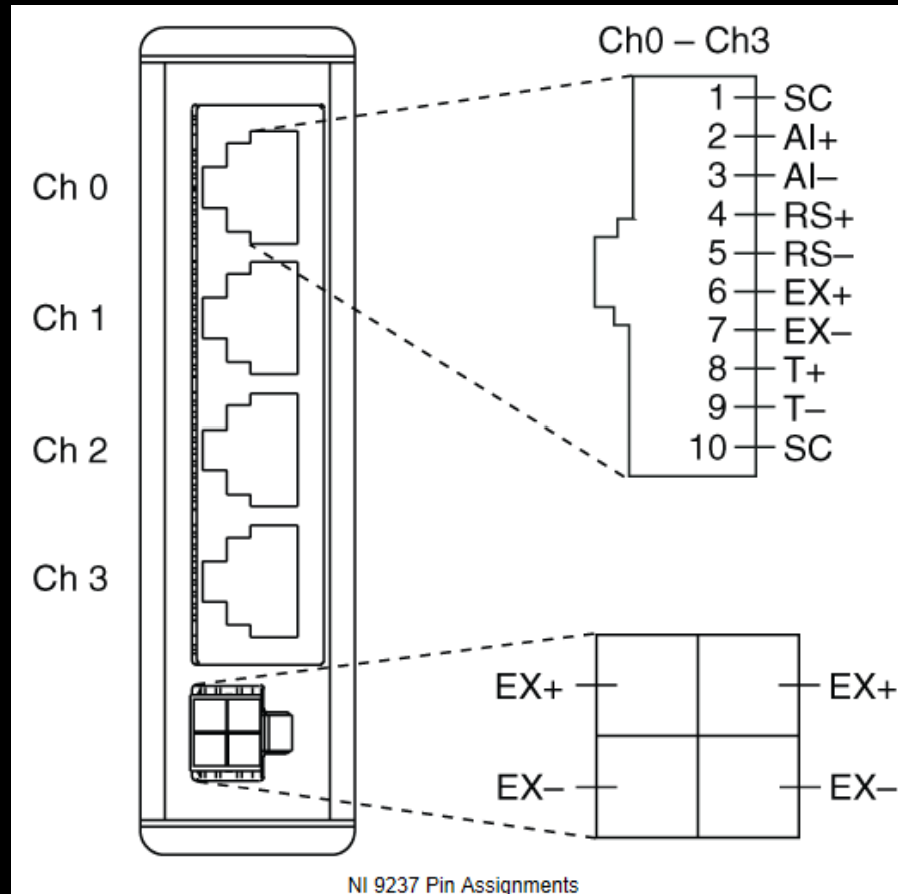




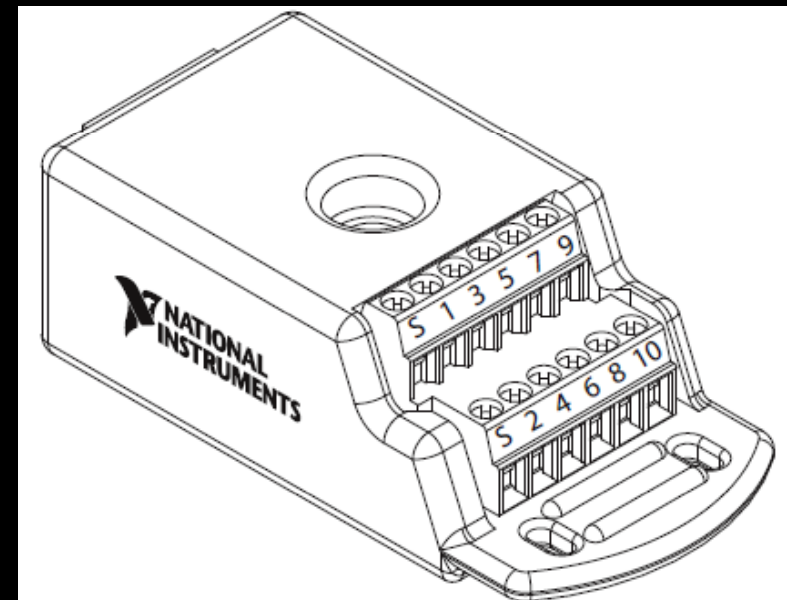
Extensometria

1/2 Ponte – Procedimento

Terminais do conector RJ-50 da placa NI-9237



Caixa de completamento de ponte NI 9949

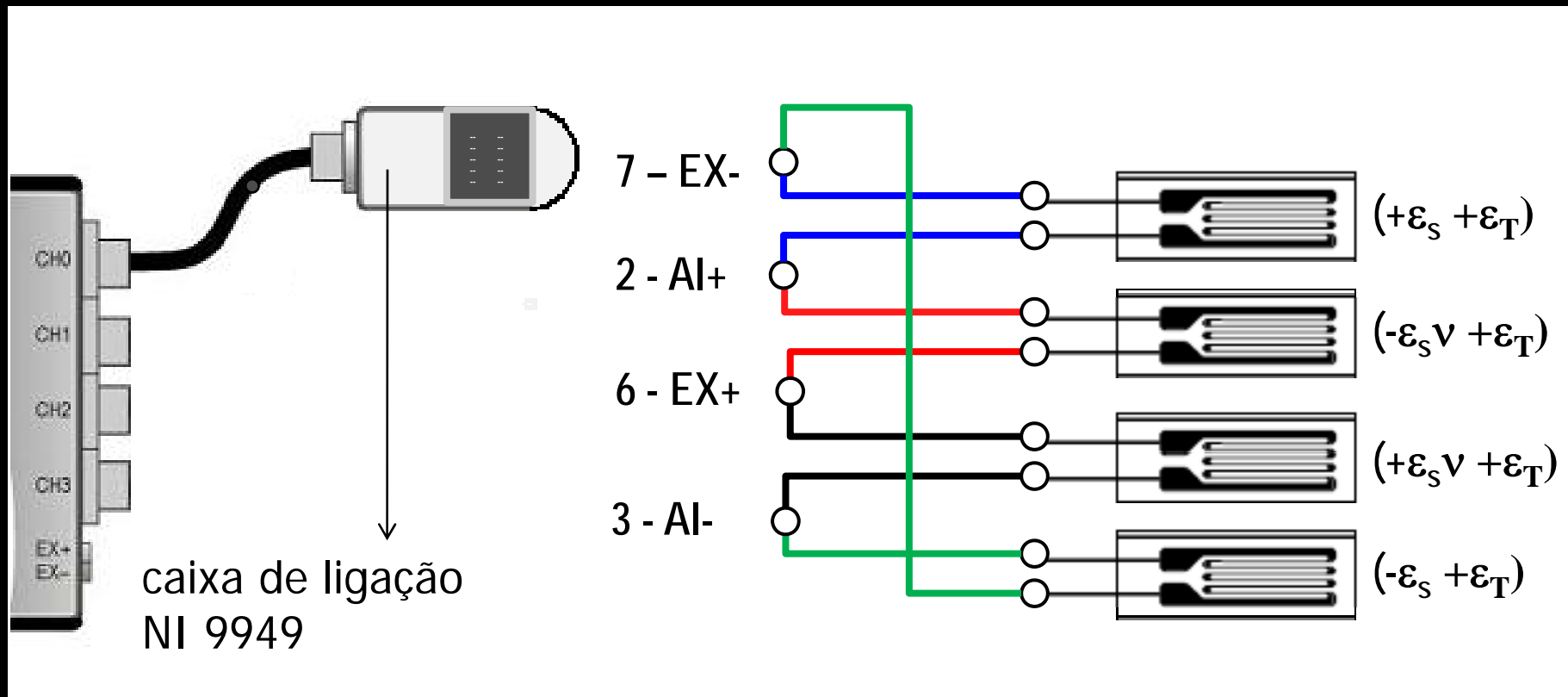




Extensometria

Ponte completa – Procedimento

Ligação dos fios na caixa de conexão de ponte NI 9949 para flexão com ponte completa (tipo II):





Signal Express:

Ver a pasta:

Connection Diagram

Step Setup | Data View | Recording Options | Project Documentation | **Connection Diagram**

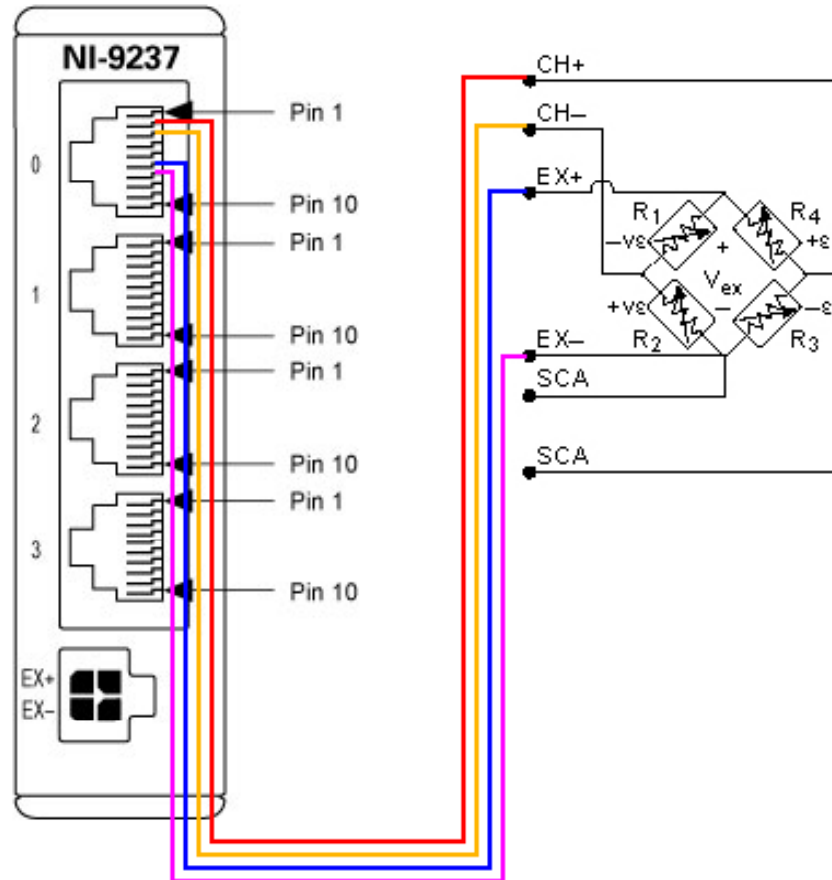
Channels in Task

Dev1_ai0

Connections List

Point 1	Point 2
Strain Gage Full Bridge 2/C1	NI-9237/CH0/2
Strain Gage Full Bridge 2/C1	NI-9237/CH0/3
Strain Gage Full Bridge 2/E>	NI-9237/CH0/6
Strain Gage Full Bridge 2/E>	NI-9237/CH0/7

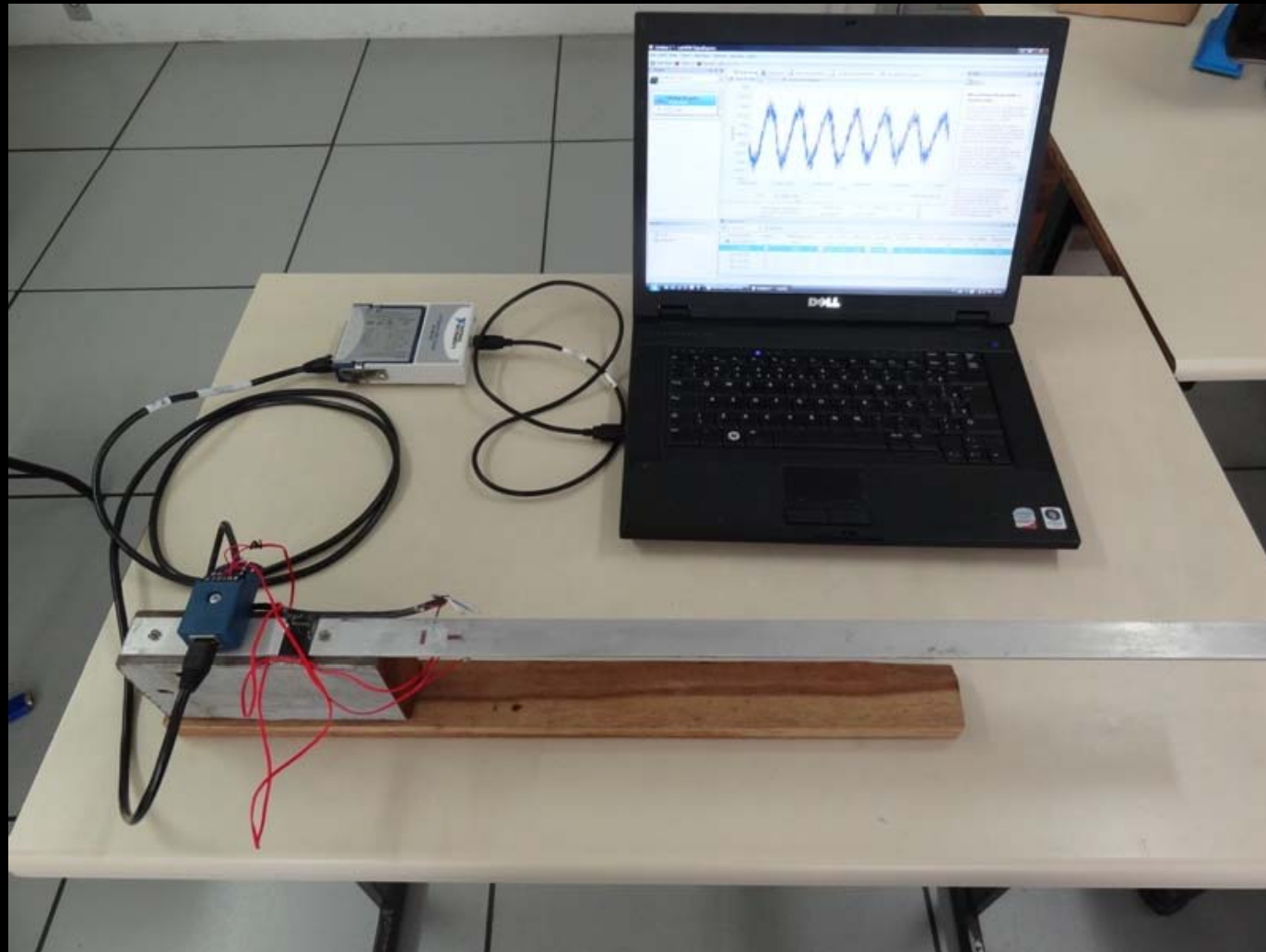
Save to HTML...





Extensometria

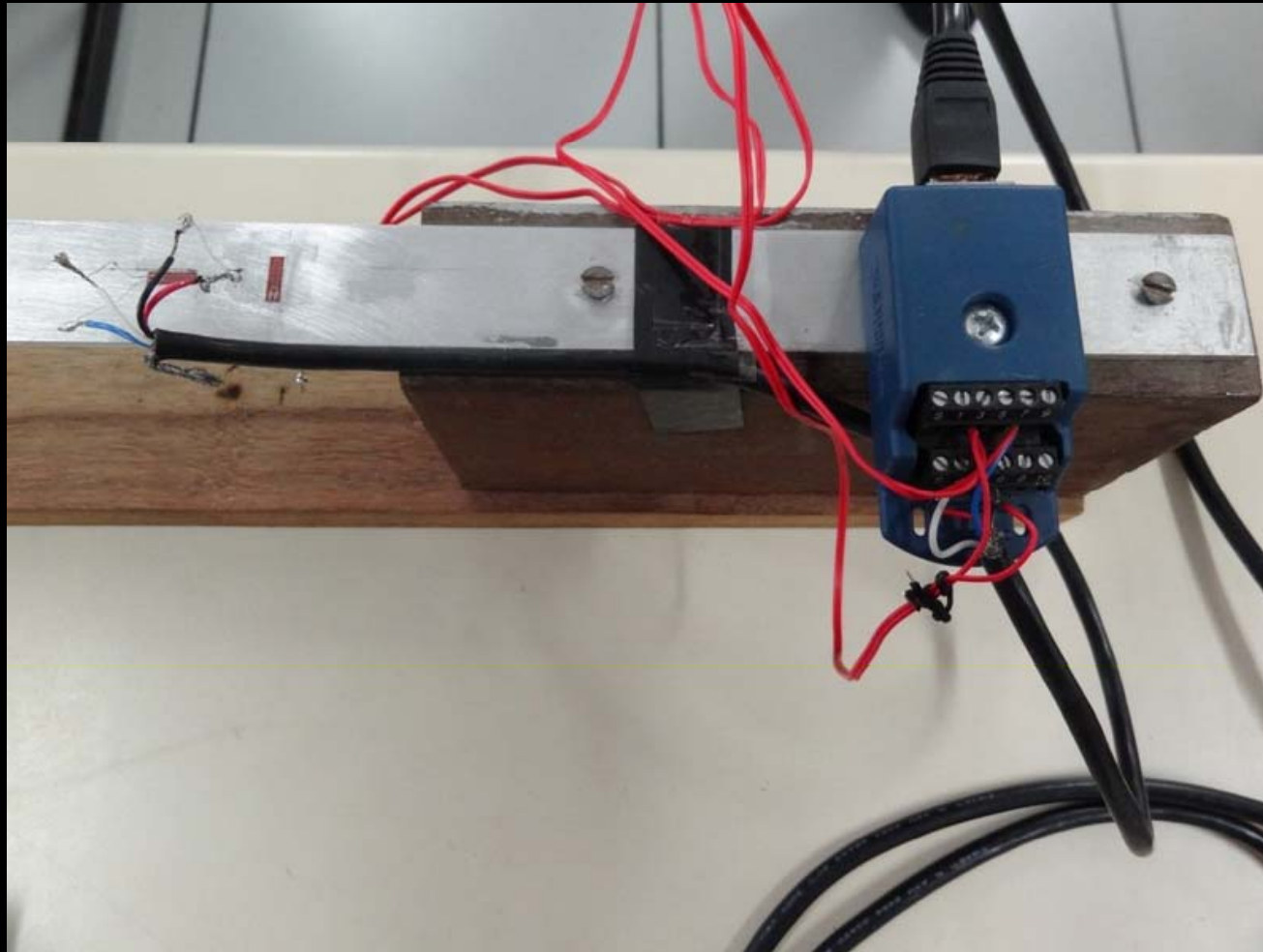
Teste conduzido em aula





Extensometria

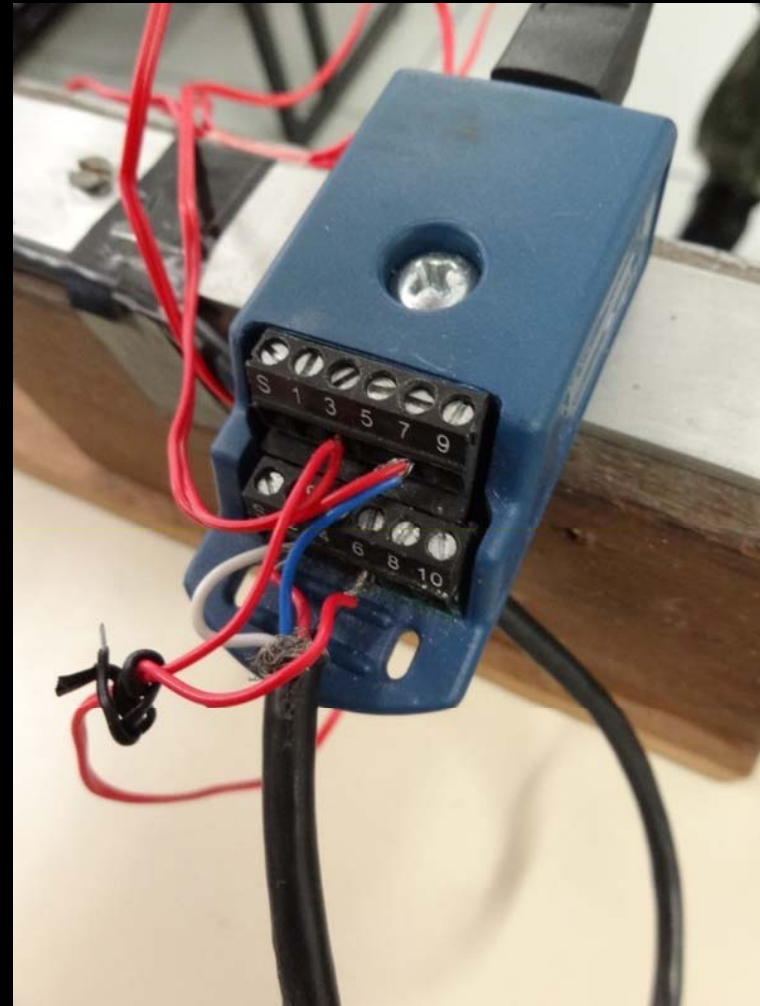
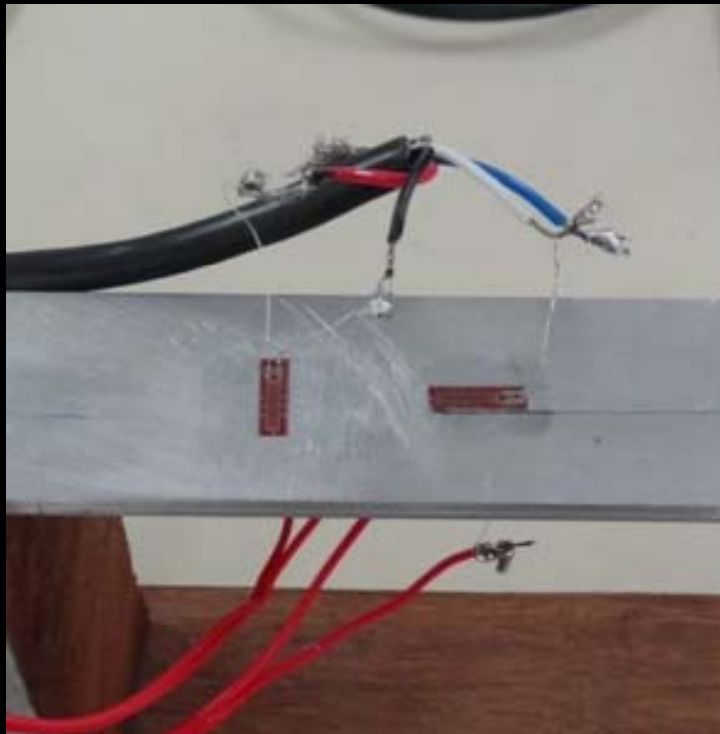
Teste conduzido em aula





Extensometria

Teste conduzido em aula



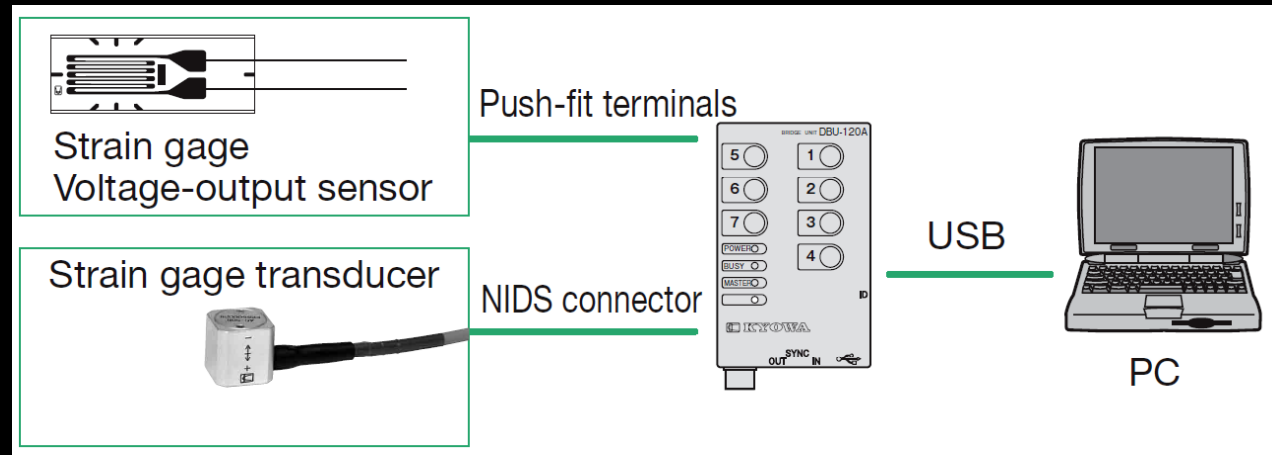


Extensometria

Equipamento Kyowa

Dispositivo DBU-120A

1-Ch 16Bit Quarter/Half/Full Bridge Analog Input



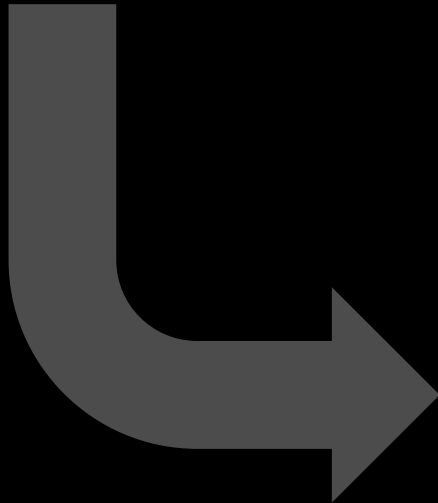


Extensometria

DBU-120A - Kyowa

Ponte completa:

Ligação dos condutores nos terminais 1 a 4



SOURCE EXCITER INPUT RANGE

The screenshot shows the software interface for the DBU-120A extensometer. It is divided into four main sections: SOURCE, EXCITER, INPUT, and RANGE. The SOURCE section has three options: a strain gauge, a cylindrical component, and an AC source. The EXCITER section shows a bridge exciter circuit with a dropdown menu set to 2V. The INPUT section shows a diamond-shaped bridge circuit with four resistors, with a dropdown menu set to 120ohm. The RANGE section shows an amplifier icon with a dropdown menu set to 1K μ m/m. Below these sections is the CONNECTION section, which shows a diagram of four strain gauges connected to terminals 1, 2, 3, and 4. At the bottom right, there is a 'Copy Source DB' dropdown menu set to 0 and a 'Copy' button.

Bridge Exciter: 2V

Bridge resistance: 120ohm

Bridge Completion: Full Bridge

Range: 1K μ m/m

CONNECTION

Copy Source DB: 0

Copy