STRAIN GAGES FOR HOSTILE ENVIRONMENTS

By: Vince Wnuk, HPI - Ayer, MA 01432

Presented at the – IMAC XXVI Exhibition

Orlando, FL

February, 2008

HPI

HISTORY

Late 1950's….First field application strain gages manufactured

Mid 1960's….First high temperature field applications manufactured

1976….Coast Guard commissions to develop under-sea sensors

1976….First strain gages built and tested in Gloucester Harbor

1977….4 models manufactured for underwater and civil applications

1980….Over 100 models offered for marine, civil, and industrial applications

1989….Special sensors manufactured for covert applications

1990….Amplified versions offered for direct data acquisition applications

2000….Over 200 models offered for marine, civil, and industrial applications

2008….

HPI

APPLICATIONS

RAILROAD….Rails, Cars, Wheels

SHIPBOARD….Above Decks, Below Decks, Shaft and Motors

MARINE….Docks, Locks, Dams, and Buoys

BRIDGES….Decks, Structure, Health Monitoring

CIVIL….Any Outdoor Structure Including Wood and Concrete

HPI

TYPES OF STRAIN GAGES

RESISTIVE…… $\Delta R / \Delta \varepsilon$

Foil Strain Gages – Room Temperature
Wire Strain Gages – High Temperature

CAPACITIVE…… $\Delta C / \Delta \varepsilon$

High Temperature Applications
Very Long Term Applications

VIBRATING WIRE …….. $\Delta F / \Delta \varepsilon$

FIBER OPTIC…….... **Fabry-Poirot**
Bragg Grating

HPI

THINGS TO CONSIDER WHEN CHOOSING A STRAIN GAGE

- Minimum and maximum exposure and operating temperature
- Material of specimen; Properties of specimen
- Humidity/Steam/Water Submersion
- Oil and other chemical exposure elements
- Pressure of environment
- Turbulence of environment
- Maximum/minimum strain limits (resolution vs range)
- Length of test time required
- Static or dynamic test (especially high temperature)

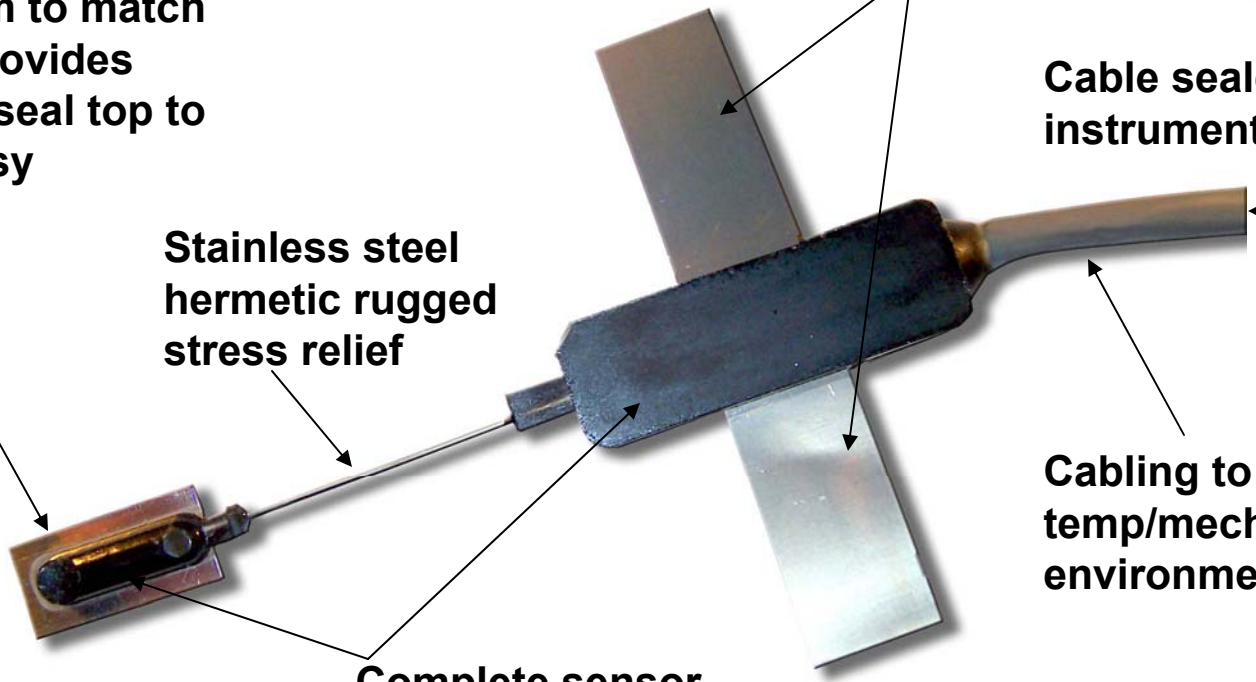
HPI

Large mechanical cable anchor

Metallic shim to match specimen provides water proof seal top to bottom – easy installation

Cable sealed at instrumentation end

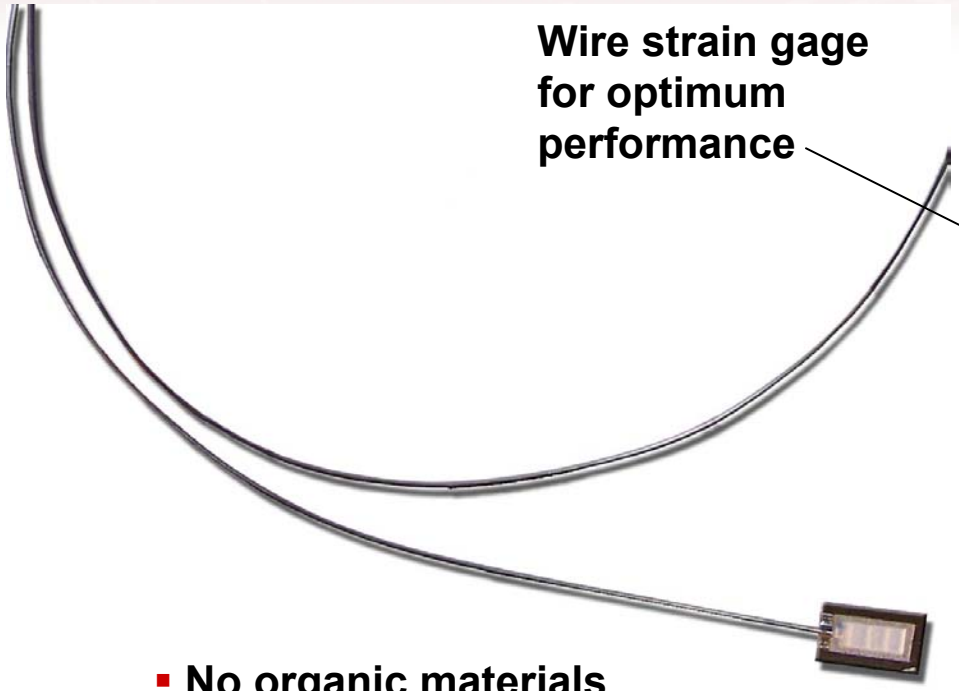
Stainless steel hermetic rugged stress relief



Cabling to match temp/mech/press environment

Complete sensor and cable sealant to 500 PSI

HPI



Wire strain gage for optimum performance

Aerospace quality shim for use in high temperatures

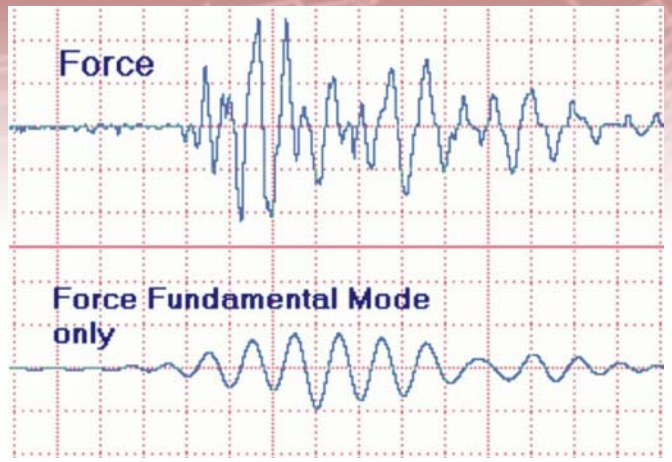
Ceramic installation

Cable rated to 900°C

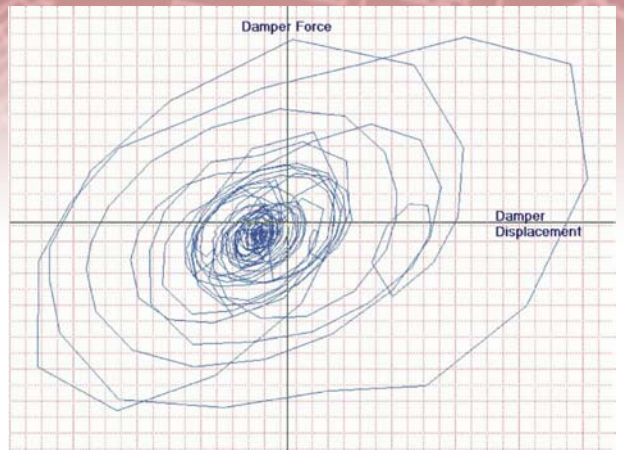
- No organic materials
- Useable to 400°C, 550°C, 900°C
- Nuclear approved

HPI

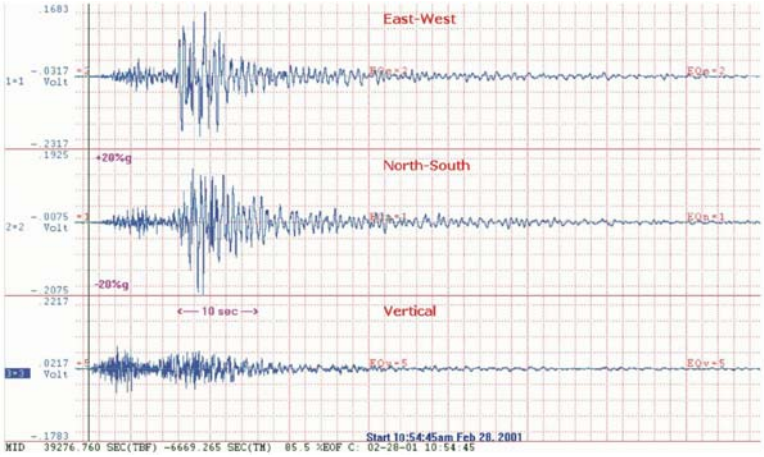
HPI



Seismic event measurements during earthquake at Safeco Field, Seattle, WA February 28, 2001



Force vs. displacement measurements during earthquake at Safeco Field, Seattle, WA - February 28, 2001

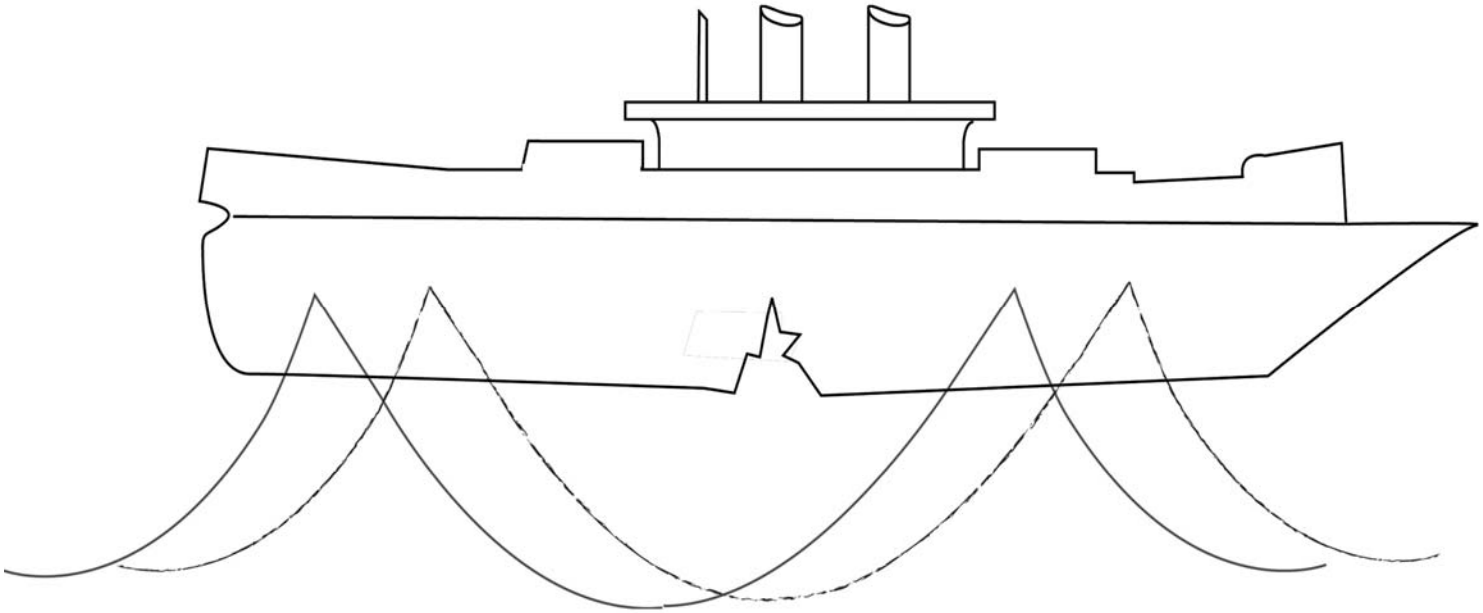


Ground movement measurements during earthquake at Safeco Field, Seattle, WA February 28, 2001

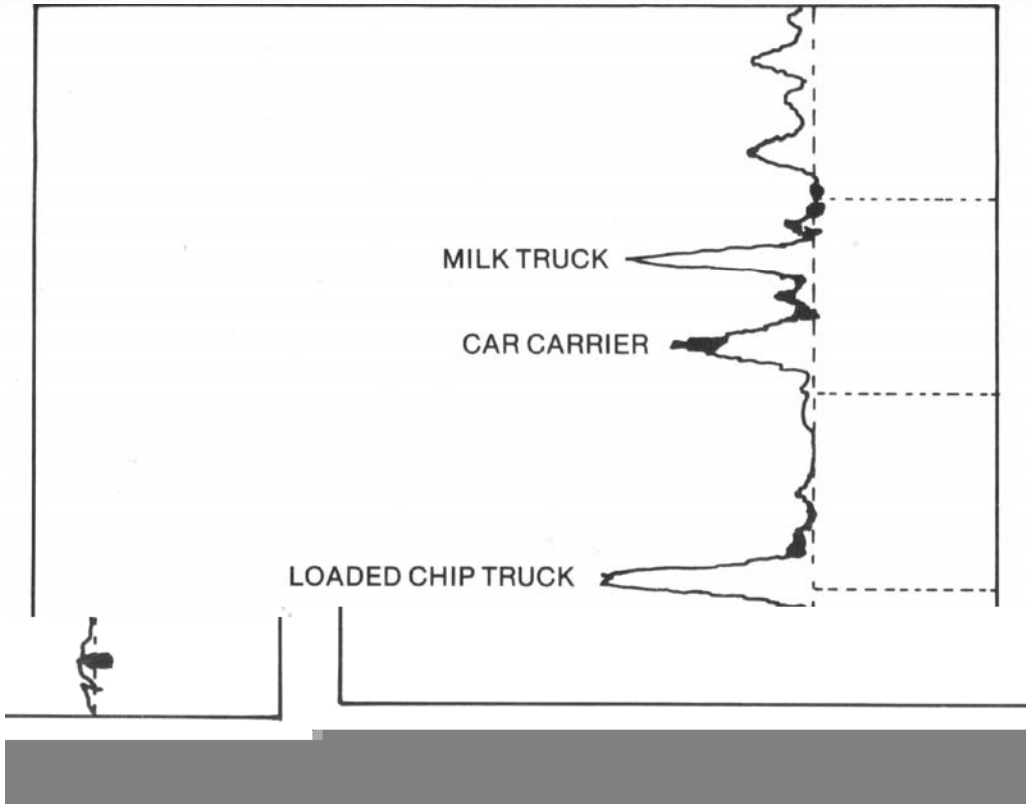
HPI

HPI

HPI

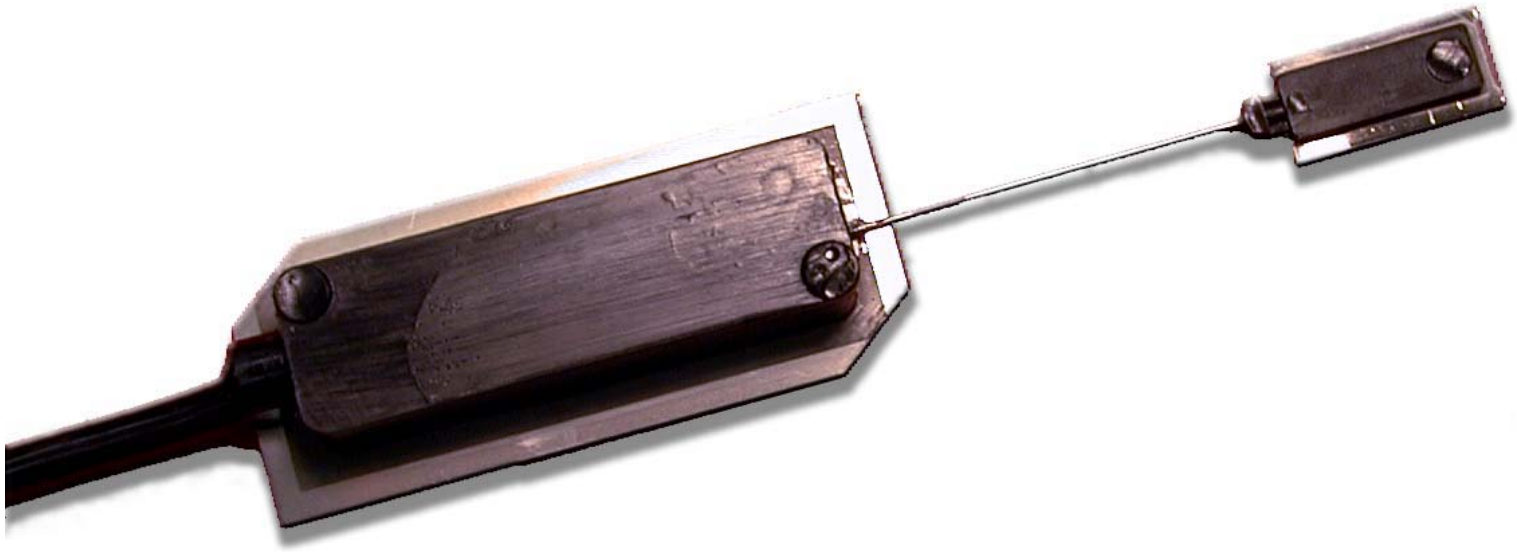


HPI

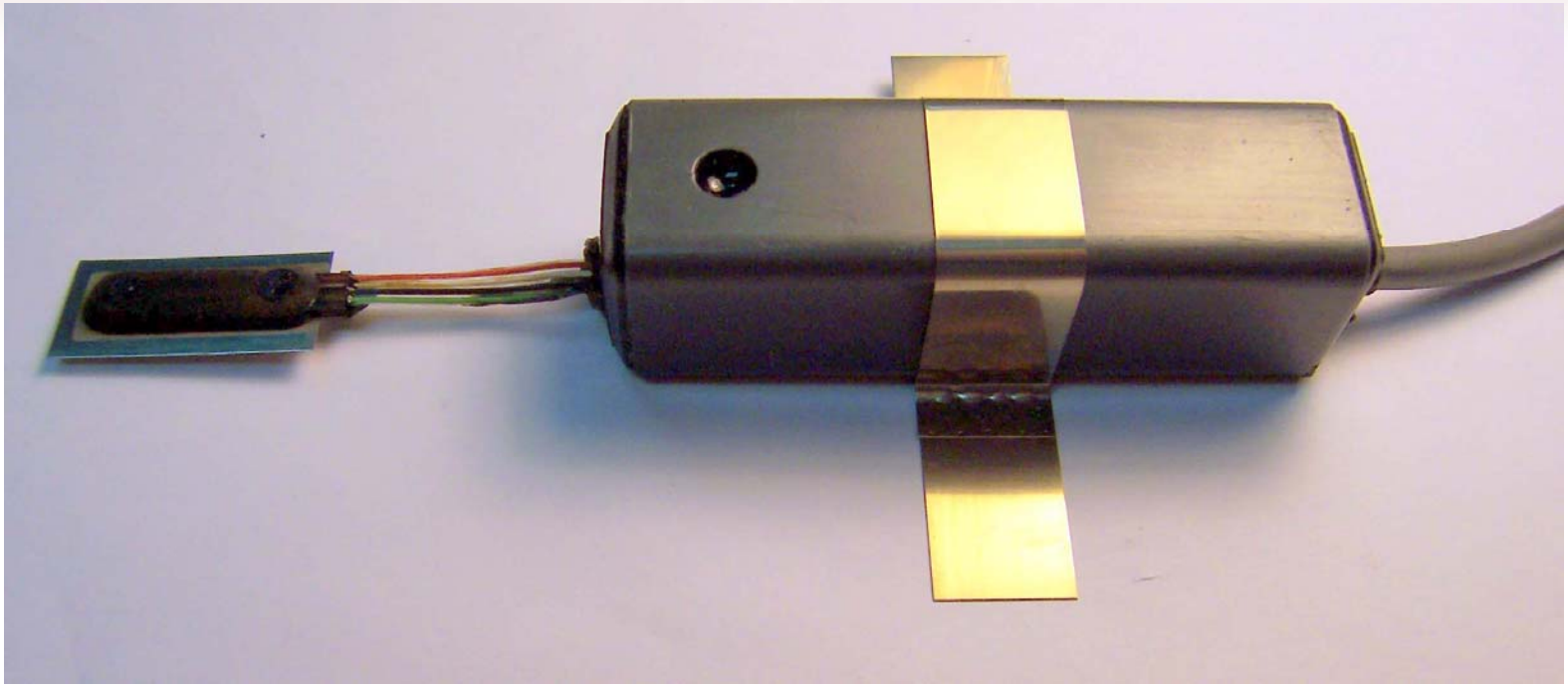


HPI

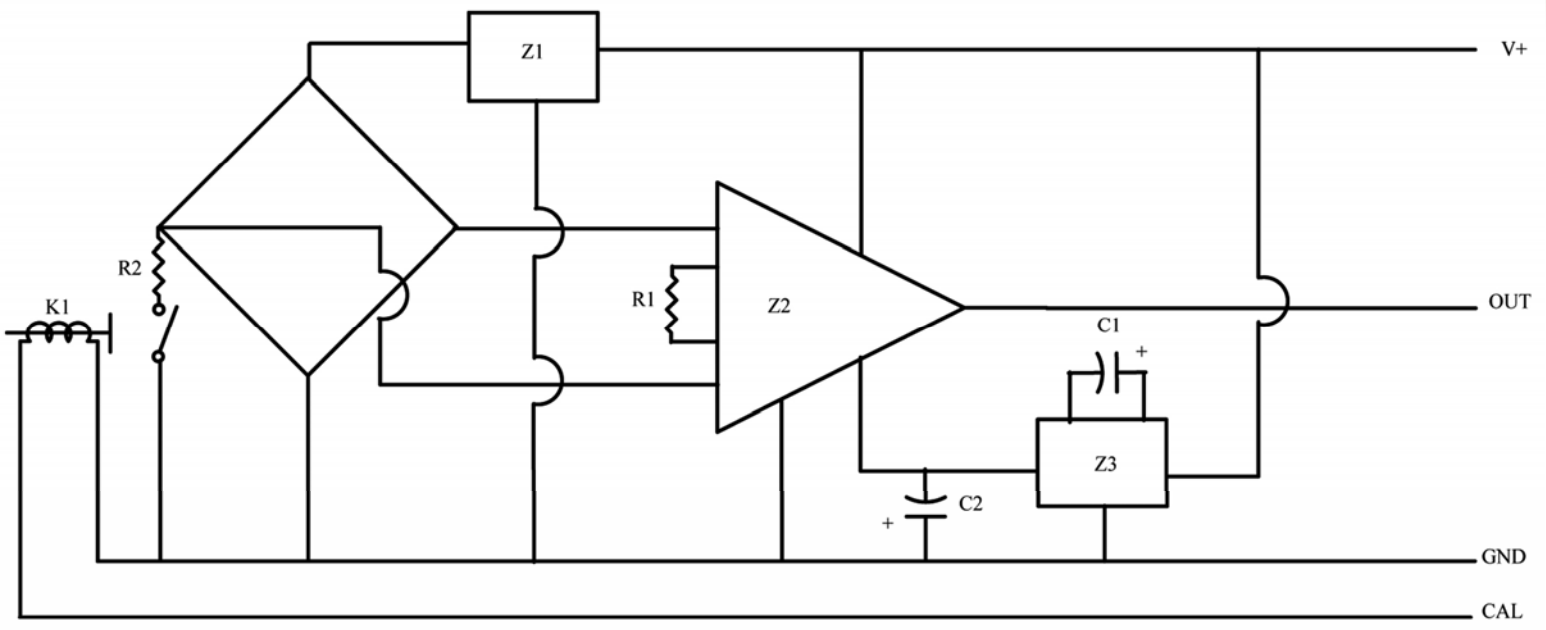
HPI



HPI



HPI



INPUT POWER: +15 Volts DC
EXCITATION: 5 Volts, Factory Set
GAIN: 1,000 Factory Set
CAL RESISTOR: 349.65K, Across 350 OHM Bridge, Typical
OUTPUT: 4.92 Volts/1000 $\mu\varepsilon$

HPI

CONCLUSIONS

- Strain gages are useable in many extreme environments
- Strain gages are fail safe sensors
- Strain gages are the most economical way to take field data

HPI