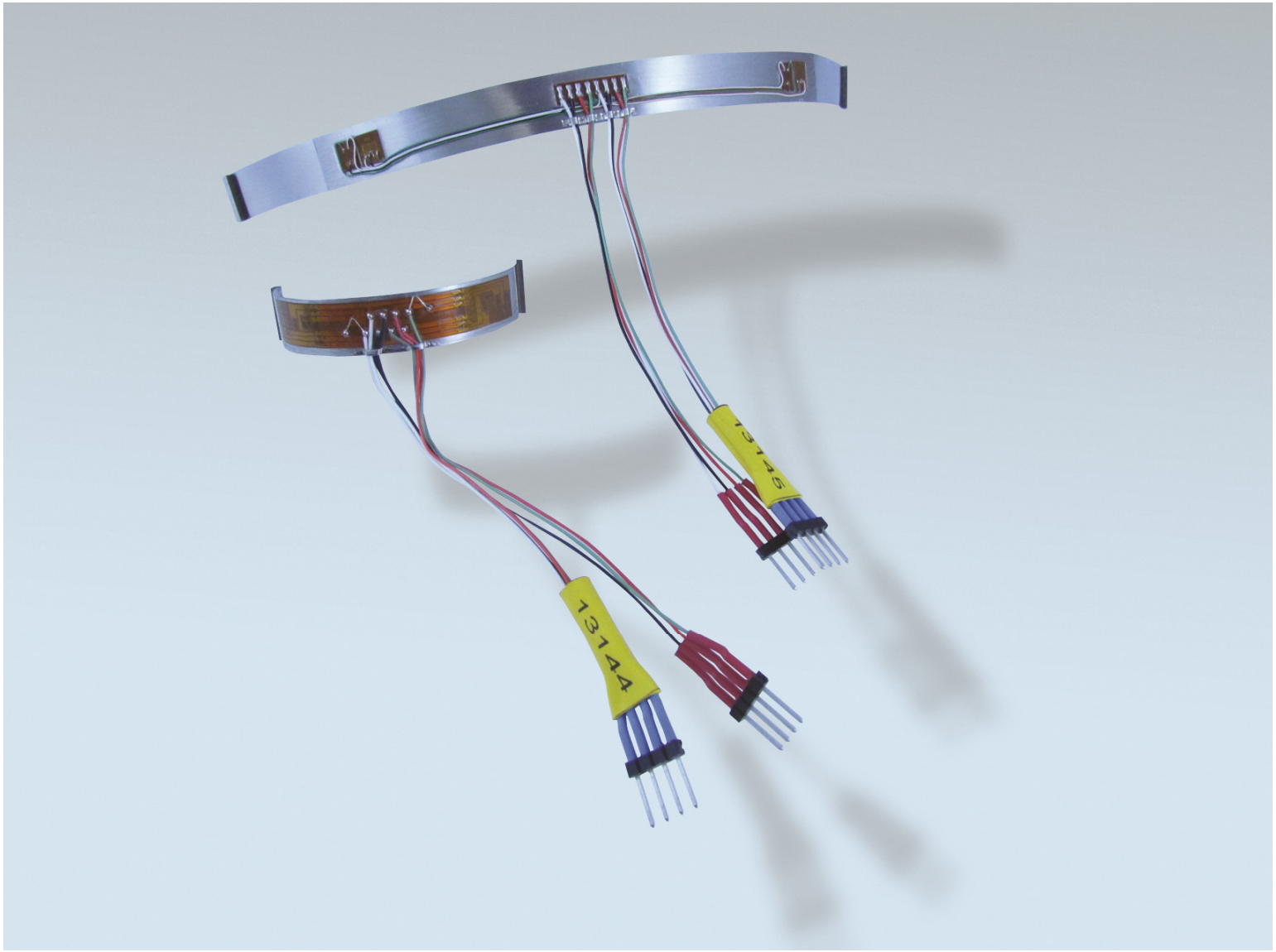
QSS Installation & Calibration

Presented by:
Joe Gomes
Field Service Manager

TELEDYNE LECROY TEST SERVICES
Everywhereyoulook™

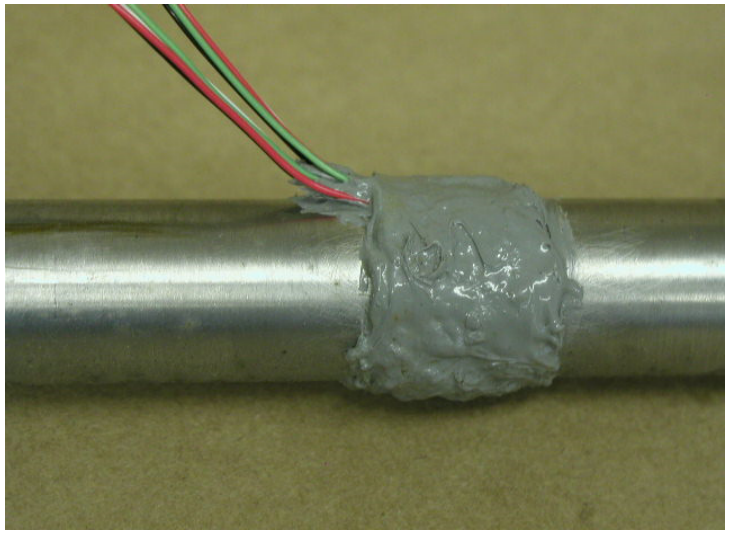
QSS Installation and Calibration



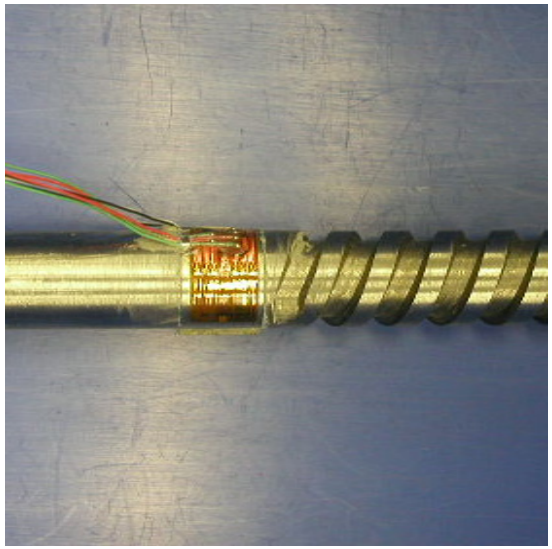
QSS Installation and Calibration

Determining a QSS Location

- The Valve will need to be stroked to determine a QSS location.
- Then we need to know if the QSS will be mounted inside or outside the transition zone.



Outside the transition Zone



Inside the transition Zone

QSS Installation and Calibration

Calculating a QSS sensitivity

- To calculate a sensitivity for the QSS it MUST be mounted outside the transition zone.
- Outside the transition Zone means that the QSS is mounted away from any keyways, threads or steps in the valve stem.
- The QSS needs to be mounted at least twice the depth of the transition away from the transition to be considered outside.
    - Example: If the root of the threads are 1/8”deep then the QSS needs to be mounted at least ¼” away from the treads.

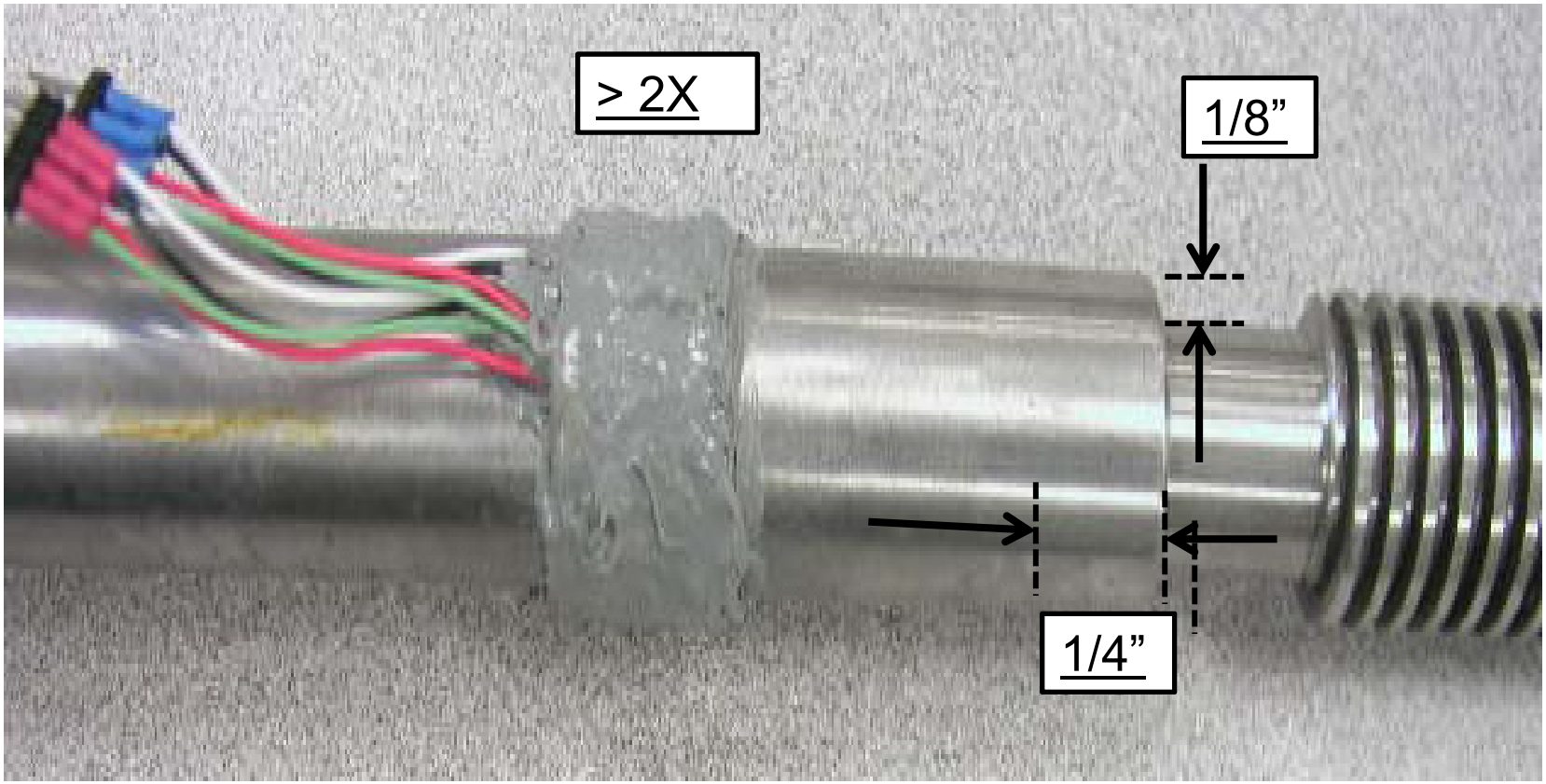
QSS Installation and Calibration

Two methods for determining a sensitivity for installations within the transition zone

- In situ calibration using a calibrated load cell and calibration rig. Appling a know load and recording the QSS output. Quiklook will display an xy plot with a calibrated output in engineering units per mV/V. This can be performed in both thrust and torque.
- Teledyne will perform a mock up test in the office and determine the sensitivity. This means that an exact replica of the stem would have to be machined using the same material as the valve stem. Then a QSS will be installed and tested in our material testing machines or torque stand. The replica will be calibrated and the sensitivity can be applied to the actual valve. Note that QSS MUST be mounts exactly as it is mounted on the replica or mockup stem.

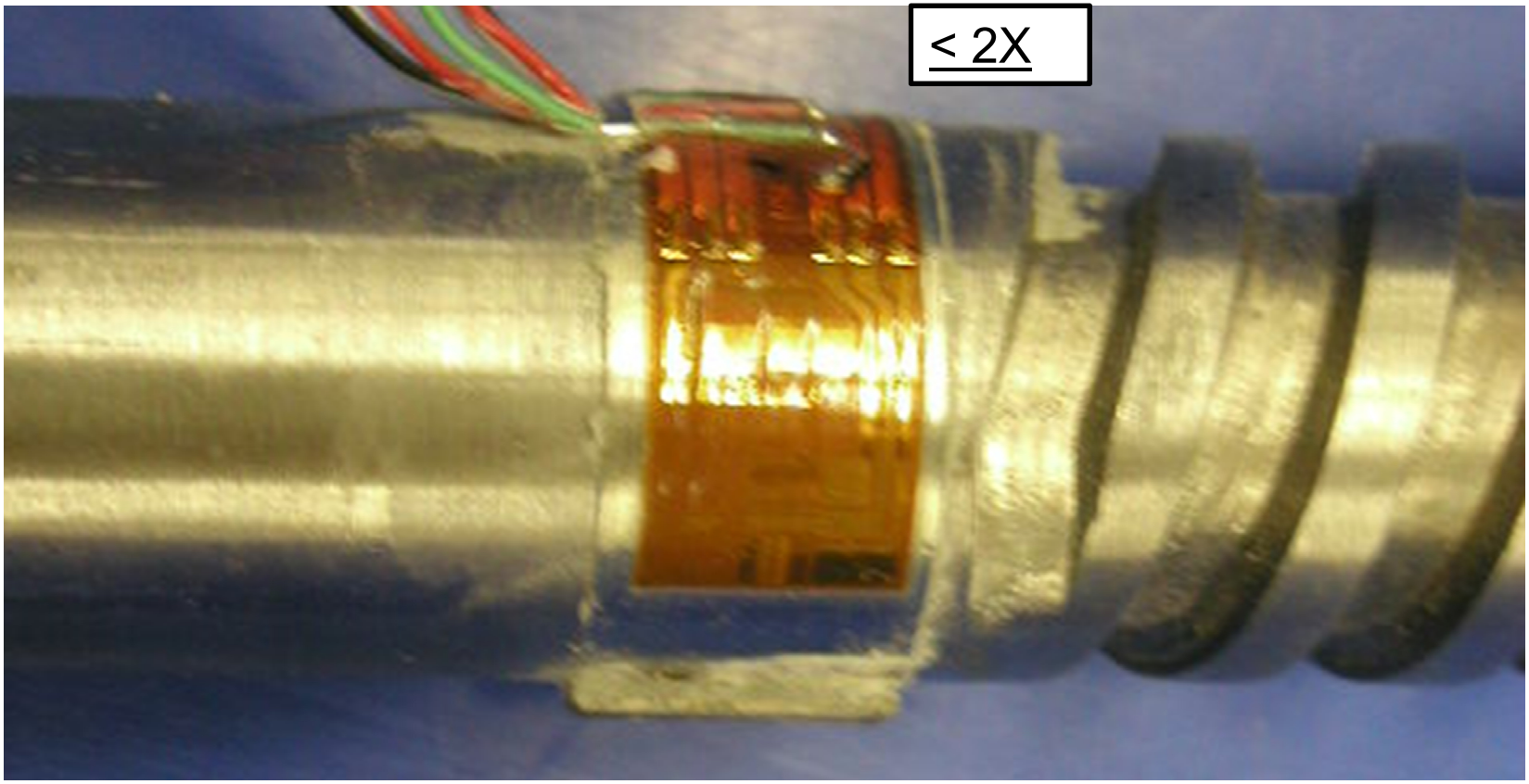
QSS Installation and Calibration

Outside the transition zone



QSS Installation and Calibration

Inside the transition zone



QSS Installation and Calibration

Calculating a QSS sensitivity mounted outside the transition zone.

$$\text{QSS Torque Sensitivity} = 16.363 \times \frac{D^3E}{(GF)(1+\mu)} \quad \frac{\text{ft-lb}}{\text{mV / V}}$$

$$\text{QSS Thrust Sensitivity} = 1570.8 \times \frac{D^2E}{(GF)(1+\mu)} \quad \frac{\text{lb}}{\text{mV / V}}$$

D = Stem Diameter at Gage Location = .875 inches

E = Young's Modulus for Stem Material / 10^6 = 29.1 lb/in^2

μ = Poisson's Ratio for Stem Material = 0.291

GF = Gage Factor for Strain Gage:

Thrust GF = 2.08 Torque GF = 2.08

Vexc = Excitation Voltage = (volts DC)

QSS SENSITIVITIES for QUIKLOOK

$$\text{QSS Torque Sensitivity} = 16.363 \times \frac{(\ .875\ )^3\ (\ 29.1\ )}{(\ 2.08\ )\ (\ 1+\ 0.291\ )} = \boxed{118.793} \quad \frac{\text{ft-lb}}{\text{mV / V}}$$

$$\text{QSS Thrust Sensitivity} = 1570.8 \times \frac{(\ .875\ )^2\ (\ 29.1\ )}{(\ 2.08\ )\ (\ 1+\ 0.291\ )} = \boxed{13{,}032.880} \quad \frac{\text{lb}}{\text{mV / V}}$$

QSS Installation and Calibration

Calculated sensitivity vs Calilbrated accuracy

- Calculated Sensitivity is 8.1% of reading and 8.2% of reading when used with Quiklook.
- Calibrated QSS is 3% of reading in the direction it was calibrated.
  - Example, most calibrations performed in the plants are done in compression only (closed). The compression numbers can be used in the open direction as well but you would us a slightly higher accuracy which is around 4.25%.
  - The thrust calibration could be used to calculate a better torque number as well. By backing out the thrust numbers we can assume a more accurate properties of the stem material and get a 5% of reading on the torque.

QSS Installation and Calibration

Calibration Rig (Thrust).

CERTIFICATE OF CALIBRATION

Client: _____

Project No: _____ Purchase Order No: _____

Type: QSS Serial No: _____ Model: _____ Capacity: _____

CALIBRATION STANDARD

Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due
QLFS 2015.208 07/27/2015 17:35:20	160600	17007	07/01/15	07/01/16

Data Pt.	Load Cell (Lbs)	Thrust (mV/V)	Best Fit (Lbs)	Deviation (Lbs)
1	-4.35	-0.0005	-4.65	-0.30
24	0.65	0.0000	1.61	0.97
47	-107.61	-0.0080	-106.04	1.57
70	-114.36	-0.0084	-111.89	2.47
93	-1159.85	-0.0862	-1162.95	-3.10
116	-1938.29	-0.1437	-1938.87	-0.58
139	-2551.93	-0.1891	-2552.08	-0.15
162	-3163.29	-0.2342	-3162.22	1.07
185	-3568.43	-0.2641	-3566.26	2.17
208	-3829.13	-0.2834	-3826.67	2.46
231	-3832.12	-0.2836	-3829.73	2.39
254	-3802.38	-0.2815	-3801.36	1.02
277	-3787.44	-0.2805	-3786.92	0.52
300	-3303.72	-0.2450	-3308.09	-4.37
323	-2371.79	-0.1761	-2376.66	-4.87
346	-1553.03	-0.1154	-1557.43	-4.40
369	-842.48	-0.0627	-845.43	-2.95
392	-377.20	-0.0280	-376.81	0.39
415	-128.74	-0.0095	-126.01	2.73
438	3.27	0.0003	6.14	2.86
443 *	3.62	0.0003	6.10	2.48
456	3.34	0.0002	4.93	1.59

Sensitivity for Compression = 13508.8399 (Lbs) / (mV/V)
Y-Intercept for Compression = 1.79
Coefficient of Determination (Rsquare) = 1.0000

CERTIFIED BY: Technician: _____ Date: 8/9/2016

Engineer: _____ Date: 8/9/2016

TELEDYNE TEST SERVICES
A Teledyne Technologies Company

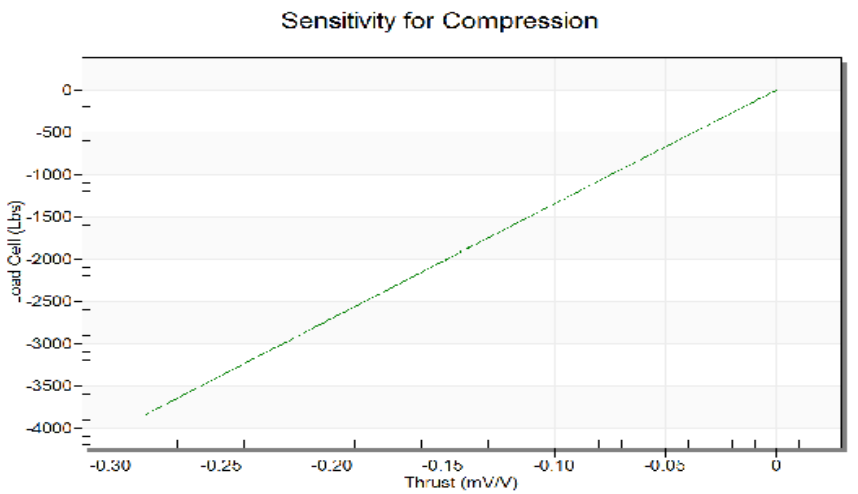
513 Mill Street Marion, Massachusetts 02738-1549 Telephone: 508-748-0103 Fax: 508-748-2029

CERTIFICATE OF CALIBRATION

Client: _____

Project No: _____ Purchase Order No: _____

Type: QSS Serial No: _____ Model: _____ Capacity: _____



Reference:

Sensitivity for Compression = 13508.8399 (Lbs) / (mV/V)

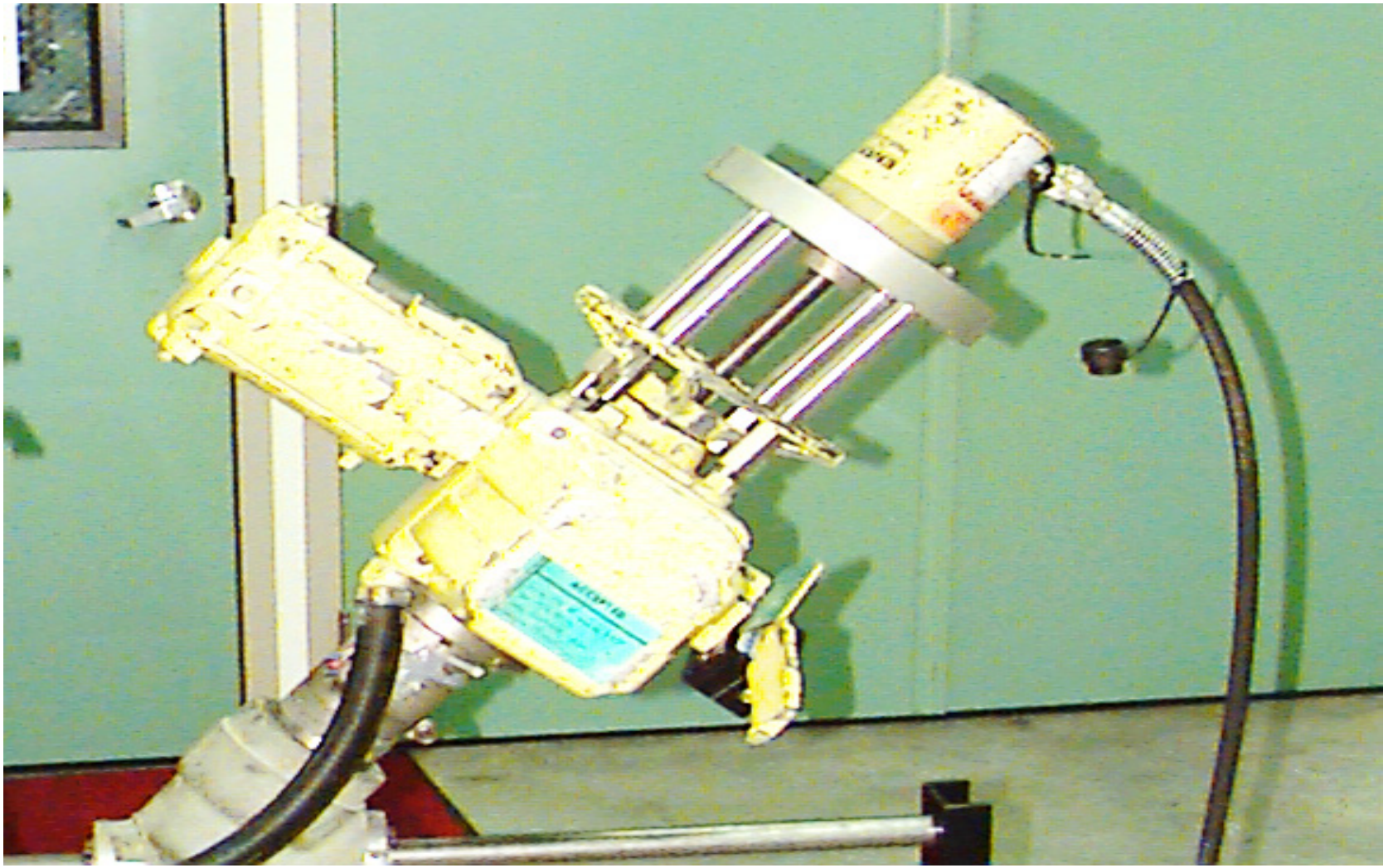
Y-Intercept for Compression = 1.79

Coefficient of Determination (Rsquare) = 1.0000

F:\Calibration\162223512.cdb MRNT SSCSL02.jgomes 8/10/2016 2:41:31 PM

QSS Installation and Calibration

Calibration results.



QSS Installation and Calibration

QSS Installation problems

- People tend to get in a hurry and dont follow the procedure as written.
  - Short cuts are taken in the cleaning process.
  - The conditioning and neutralizing of the stem needs to be done correctly.
  - Not enough Glue is applied or it is starting to cure before installing the QSS clip.
  - Not Appling the protective coating.
  - Not probing the QSS prior to use.

QSS Installation and Calibration

QSS Installation problem fixes

- Cleaning: Clean, Clean, Clean
  - Sand and clean with M-Prep Conditioner. This step should be repeated until the stem is CLEAN. Wipe the excess off before it dries.
  - Clean with M-Prep Neutralizer and wipe the excess off before it dries. Try to neutralize a larger area than what was conditioned.

- Not enough glue
  - It is better to wipe off the excess glue after the QSS is mounted than to not have enough.

QSS Installation and Calibration

QSS Installation problem fixes

- QSS Probe Check after installation
  - Most procedures recommend probing the individual strain gages on a QSS while monitoring the output to verify adequate bonding. The numbers should change slightly, but then return within 0.010 mV/V from the original reading.
  - While probing the gage the output should not change more than 0.040 mV/V even though it returns within 0.010 mV/V.
  - The next video will show how to do this.

QSS Installation and Calibration (BAD QSS MOUNT)

QSS Installation and Calibration (GOOD QSS MOUNT)

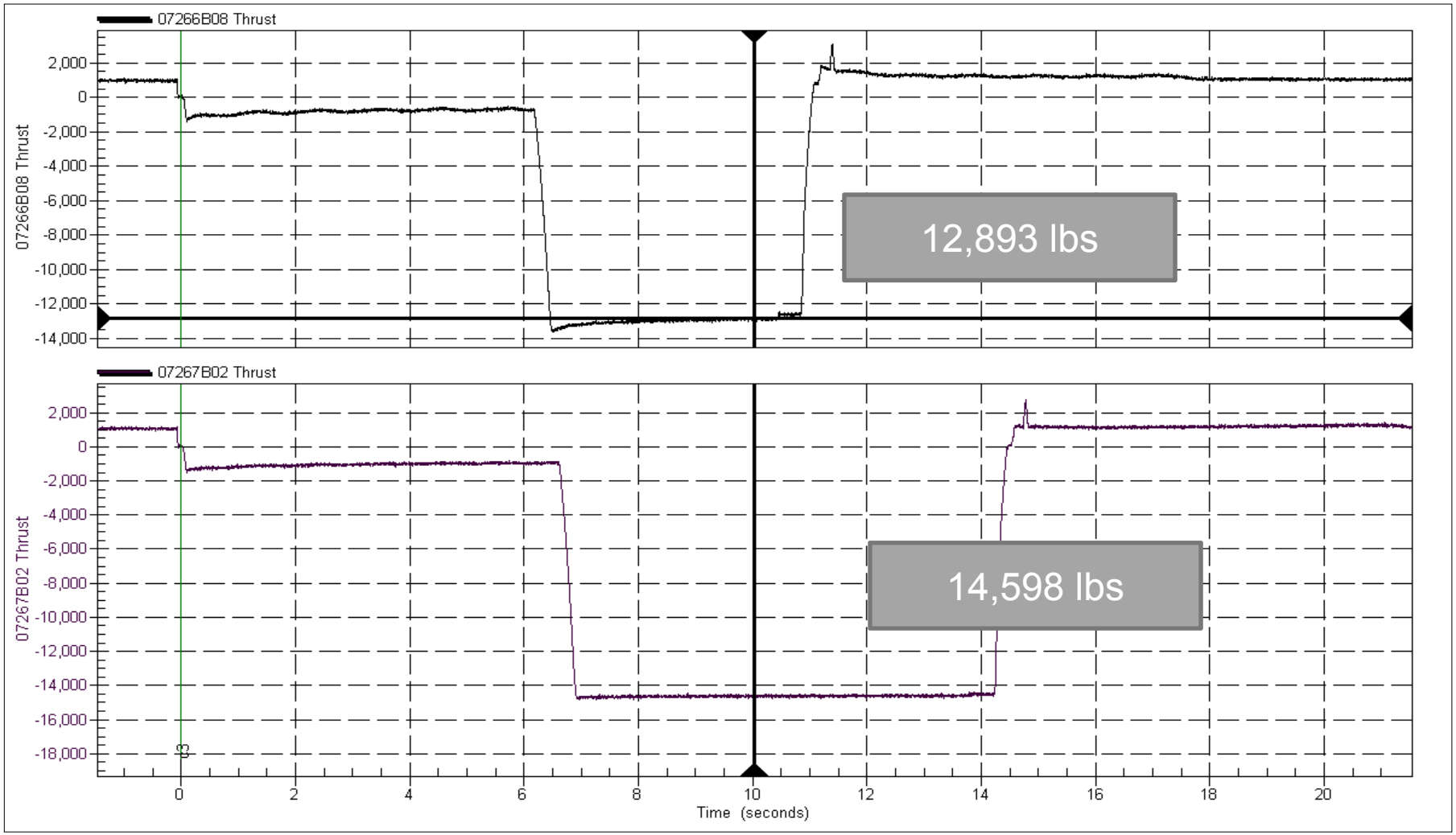
QSS Installation and Calibration

BAD vs GOOD QSS Installation

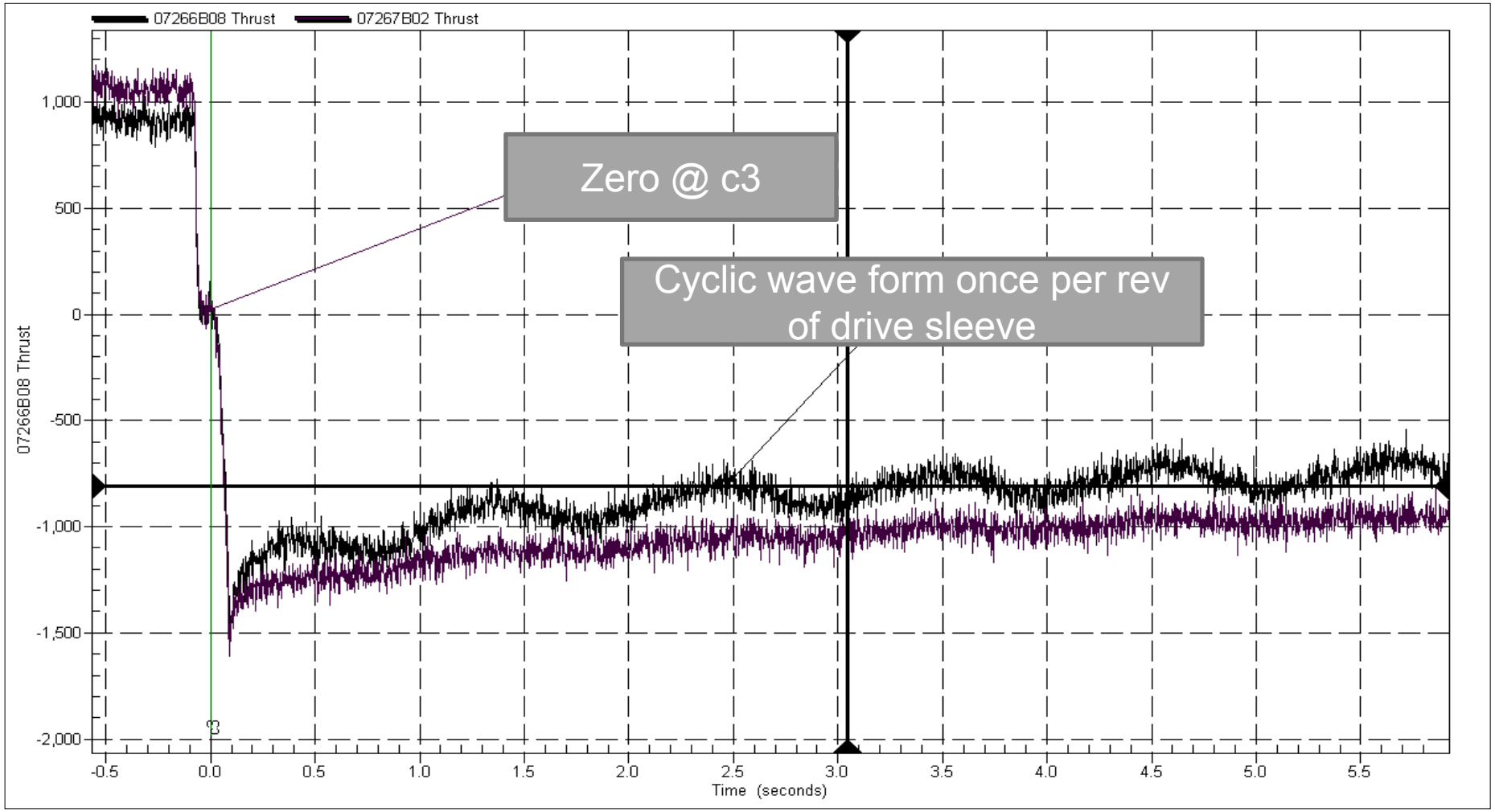
The following slides show thrust traces from the same valve. Nothing has changed on the valve between the traces except for remounting the QSS.

QSS Installation and Calibration

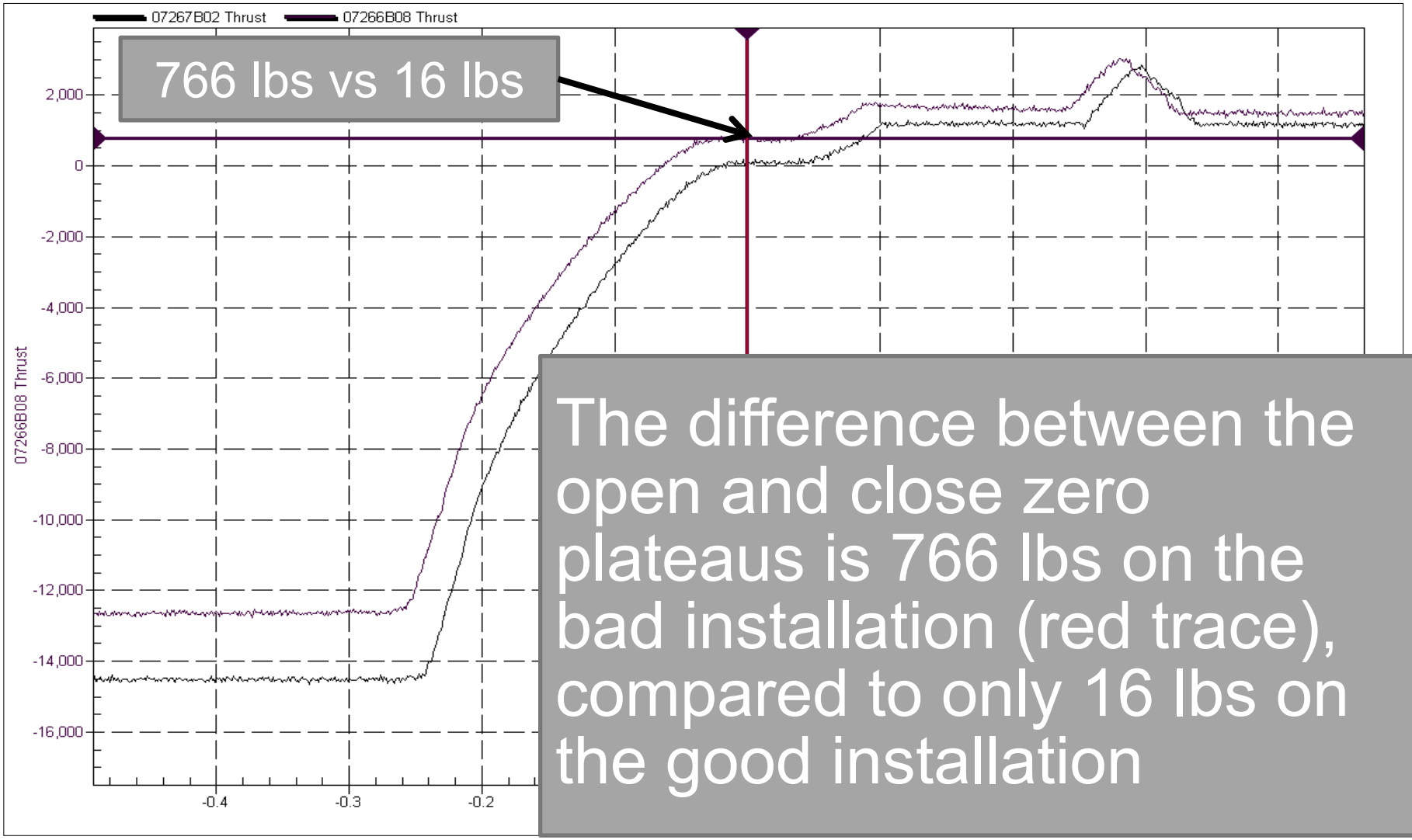
Thrust Overlay @ Marker c3



QSS Installation and Calibration

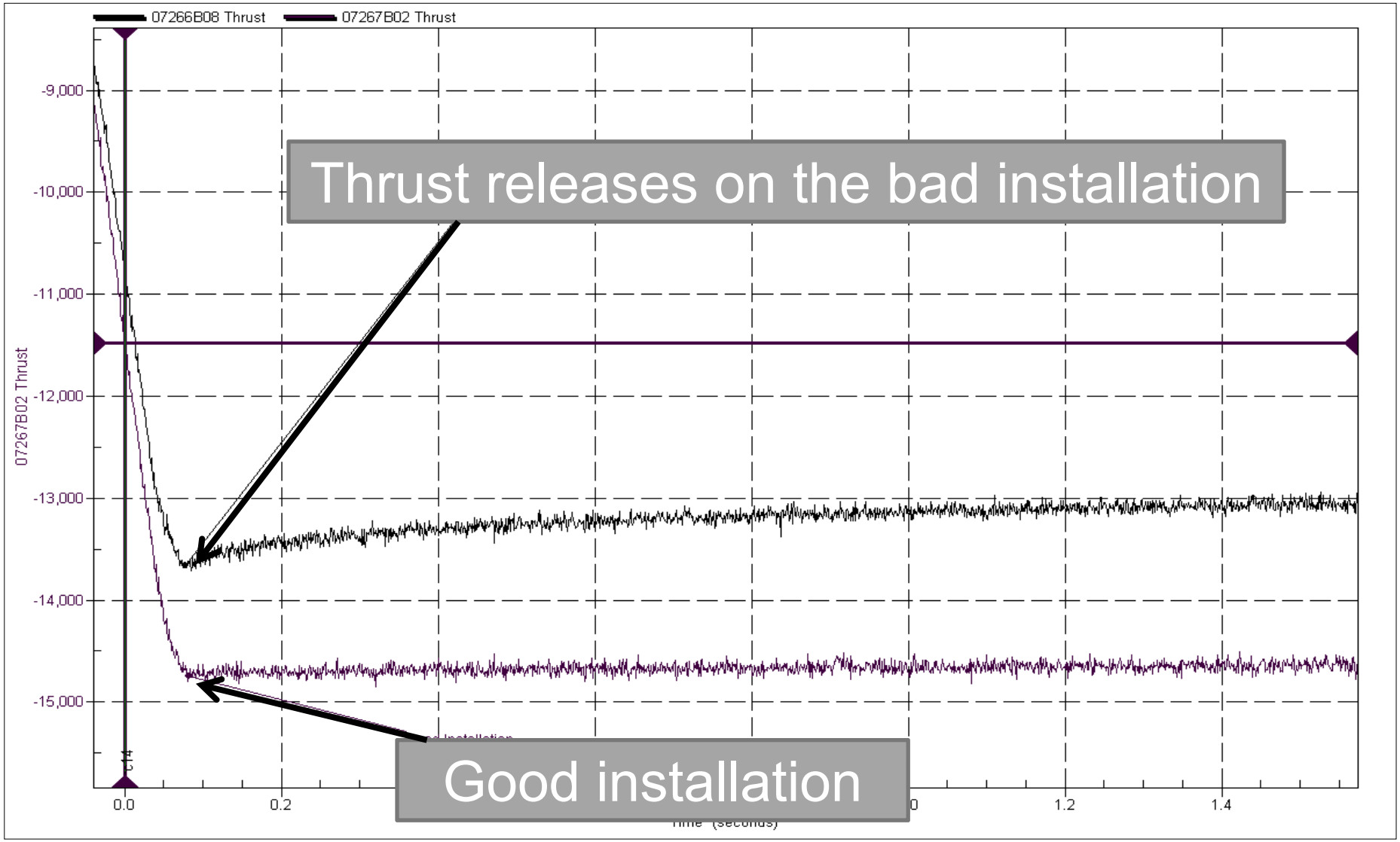


QSS Installation and Calibration



The difference between the open and close zero plateaus is 766 lbs on the bad installation (red trace), compared to only 16 lbs on the good installation

QSS Installation and Calibration



QSS Installation and Calibration

Moister proofing the installation

All of the epoxy that are used for a QSS are hydroscopic. So the epoxy will absorb the moister in the are and can destroy the bond over time. Some installation are temporary and therefor the protective coating are not applied. When the testing is complete the QSS is not removed and outages later the QSS could be used. The probe test will tell if you still have a good bond, but it only take a few more minutes to install the protective coating.

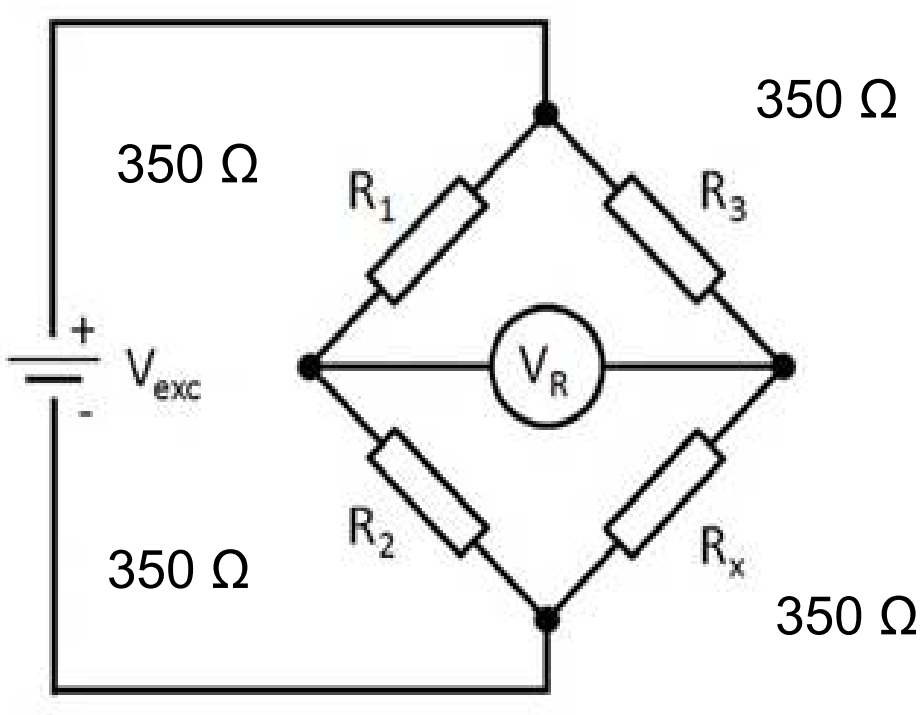
QSS Installation and Calibration

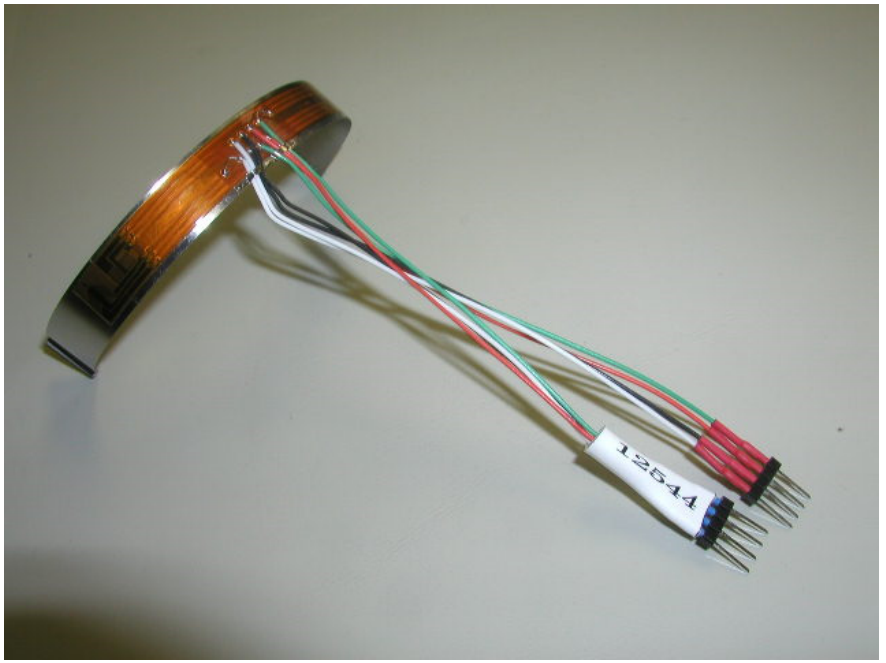
Why is all of this important

- The strain gages used in the Wheatstone bridge is very accurate and also delicate
  - The individual strain gages in a QSS read how much the stem moves in 1 millionth of and inch of movement per inch (μ”/”). The strain gage resistance change when under stress.
  - Each QSS has a gage factor. This is output of the QSS in ohms.
    i.e a GF of 2.08 means that each individual strain gage in the Wheatstone bridge will change 2.08 μΩ/Ω per μ”/” when under strain
  - Strain, stem material properties and diameter are used to calculate the sensitivity in lbs/mV/V for the Quiklook system.

QSS Installation and Calibration

This is a balanced strain gage bridge. An excitation voltage applied (Vexc) and all of the resistors are equal so the output (Vr) is 0.

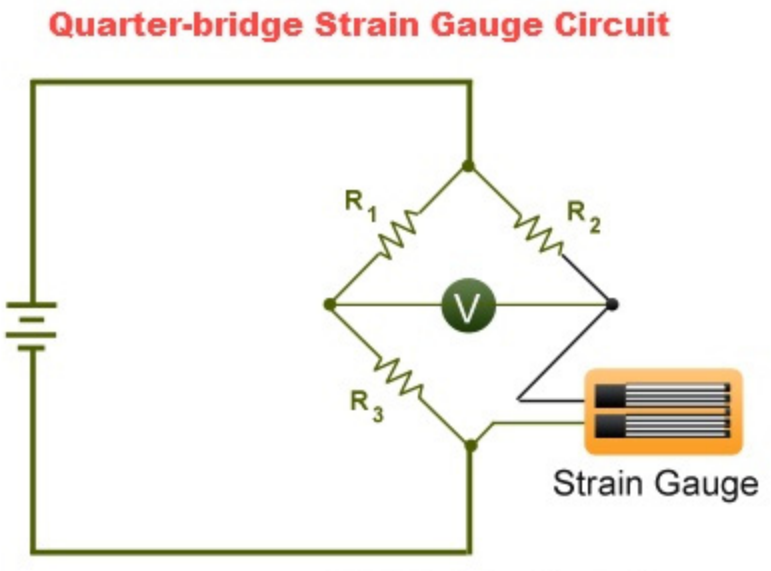


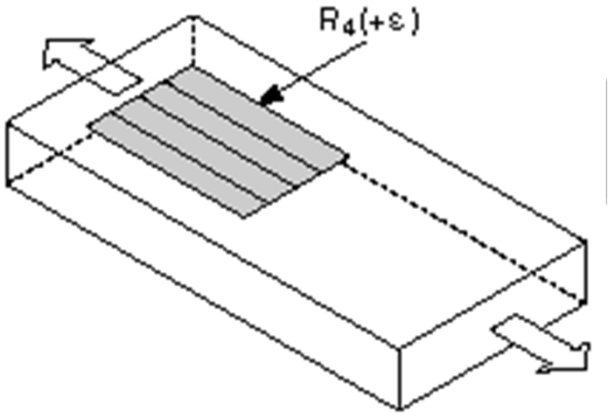


QSS Installation and Calibration

If we were to apply a load in the axial direction that stretch the stem by 0.000001” the strain gage would change in resistance 0.00000208 Ω/Ω.

- 0.00000208 * 350 Ω strain gage = 0.00091 Ω total
- The output voltages changes because the strain gage bridge is no longer balanced



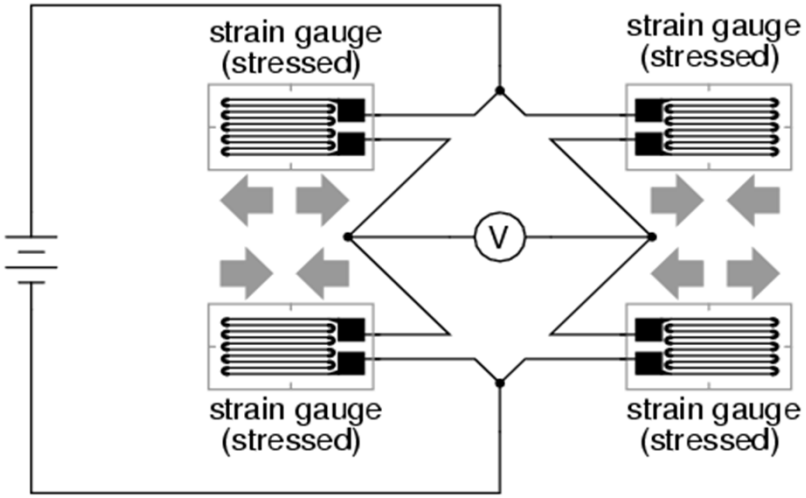


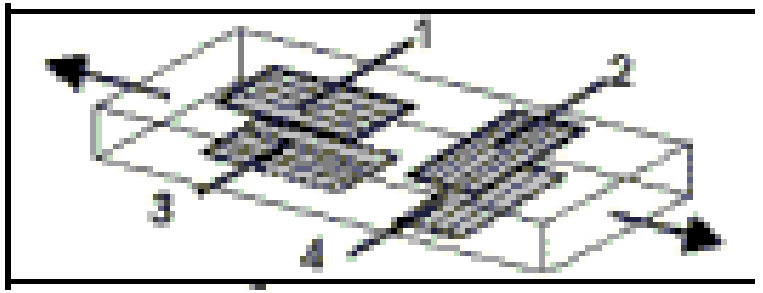
QSS Installation and Calibration

Full Wheatstone bridge

- 4 gages, 1 and 3 are axial, 2 and 4 are Poisson gages
- 1 and 3 both change in resistance as the previous slide.
- 2 and 4 are reading the Poisson ratio. Which means that the stem will change in diameter by approximately .3 of the axial change. I.E. the stem if stretch will get smaller in diameter.
- When loaded in the axial direction and the way the gages are configured the output voltage should be go positive or negative depending on compression of tension.

Full-bridge strain gauge circuit



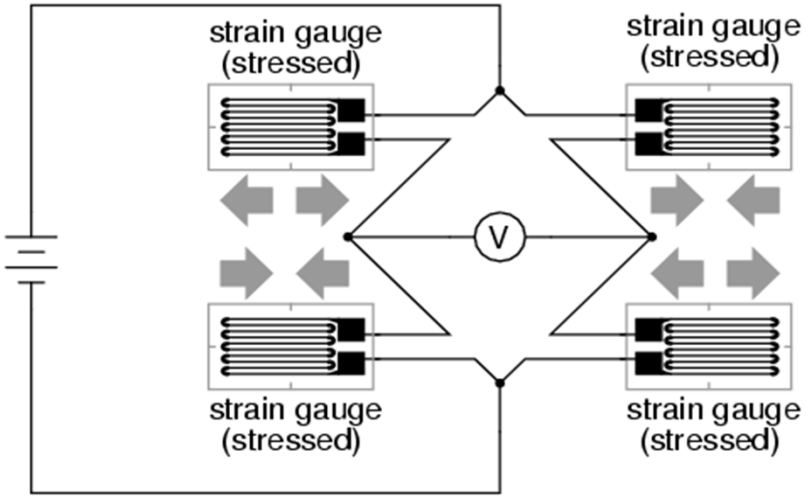


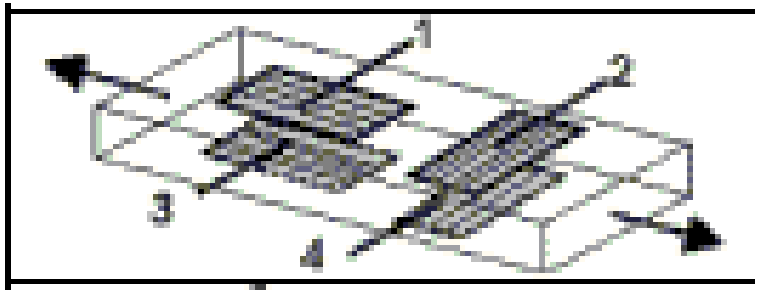
QSS Installation and Calibration

Advantages of Full Wheatstone bridge

- The bridge output is amplified by 2.6 (2 axial and 2 Poisson gages)
- Effects of temperature
- Other effects are such as bending are canceled out. If this picture below was to be bent, gages 1 and 3 would now go in the opposite direction and would cancel each other out rather than ad up. This is why the QSS are sized to the stem. This puts the strain gages 180 degrees apart from each other.

Full-bridge strain gauge circuit





Any Questions?

THANK YOU

TELEDYNE LECROY TEST SERVICES
Everywhereyoulook™