

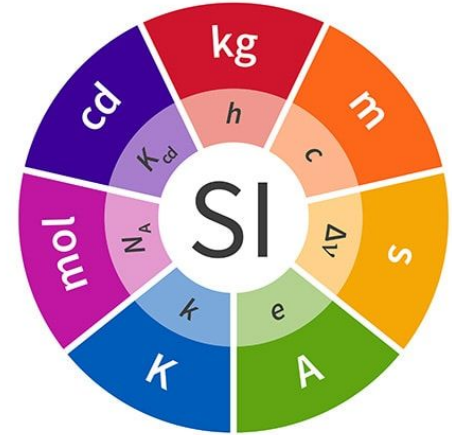
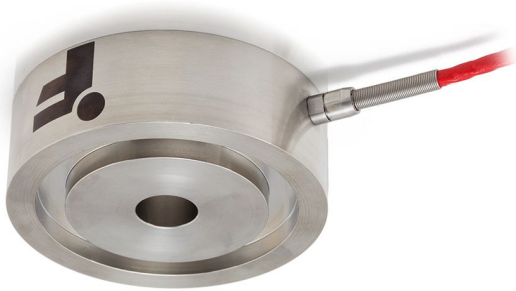


**Don't call the Nobel Committee just yet:
We forgot to calibrate the instruments
before the experiment...**

CartoonCollections.com

Calibration
John R. Leeman
GEARS 2022

Calibration ensures we translate the measured parameter into the correct real-world approximation of reality



“In short, if measurement results matter, calibration matters.”

Calibrations are not forever and should be updated frequently



- New sensor
- Repair or modification of apparatus
- Moving apparatus
- After a shock/temperature/load anomaly
- Elapsed time (calibration schedule)
- Elapsed on time (100 hour inspections)
- Before/after critical measurements
- Questionable output
- Output not matching sister instruments
- Requirements (legal or standards)

In the lab we often utilize a transfer standard to calibrate our "field" instruments or instruments with a traceable calibration



TRANS·TEK
INCORPORATED

CALIBRATION RECORD

10 Industrial Drive, P.O.Box 338, Ellington, CT 06029 Tel. (860) 872-8351 Fax (860) 872-4211

MODEL NUMBER: 0245-00000

SERIAL # D-217081

Sensitivity : 0.3559 VDC / inch(es) / Volt Input

Tolerance:

Max: 0.38

Maximum Non-linearity: 0.2804% F.S.

Min: 0.31

< 0.5% F.S.

Calculation Method: Best Fit Line Thru Zero

Calculated Line: Y = 8.5935 X + 0.0000

Working Range: ±2 inches

Tested at: 24.0110817 VDC Input and > 1 Megaohm Output Load

If the core is not permanently attached to the extension rod, then the transducer was calibrated with the core's marked end towards the transducer's lead end.

CALIBRATION DATA:

| POSITION inch(es) ===== | OUTPUT VDC | | ERROR % F.S. ===== |
|-------------------------------|------------|---------------|--------------------------|
| | Data | Zero Adjusted | |
| -2.0000 | -17.1425 | -17.1399 | -0.1378 |
| -1.6000 | -13.7898 | -13.7872 | 0.1096 |
| -1.2000 | -10.4108 | -10.4082 | 0.2803 |
| -0.8000 | -6.9661 | -6.9635 | 0.2590 |
| -0.4000 | -3.4911 | -3.4885 | 0.1492 |
| 0.0000 | -0.0026 | 0.0000 | 0.0000 |
| 0.4000 | 3.4880 | 3.4906 | 0.1554 |
| 0.8000 | 6.9342 | 6.9368 | 0.1810 |
| 1.2000 | 10.3569 | 10.3595 | 0.1380 |
| 1.6000 | 13.7302 | 13.7328 | -0.0493 |
| 2.0000 | 17.0885 | 17.0911 | -0.2804 |

Calibrated by: _____ Date: 04/15/2021

Per S022-0020 Revision: 2

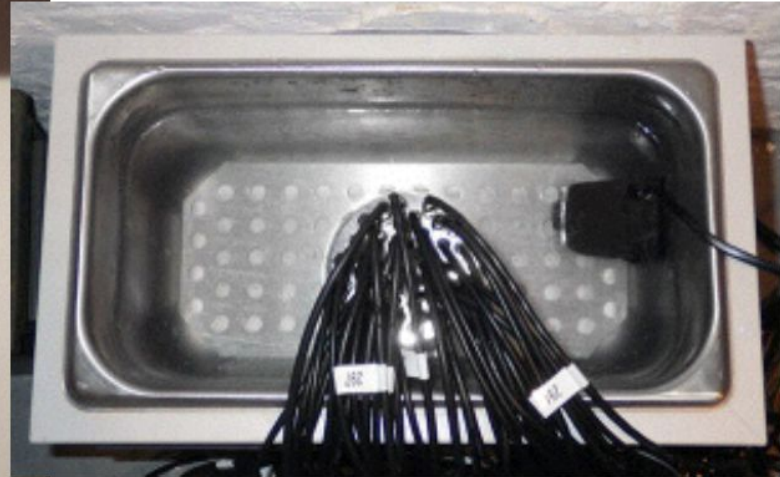
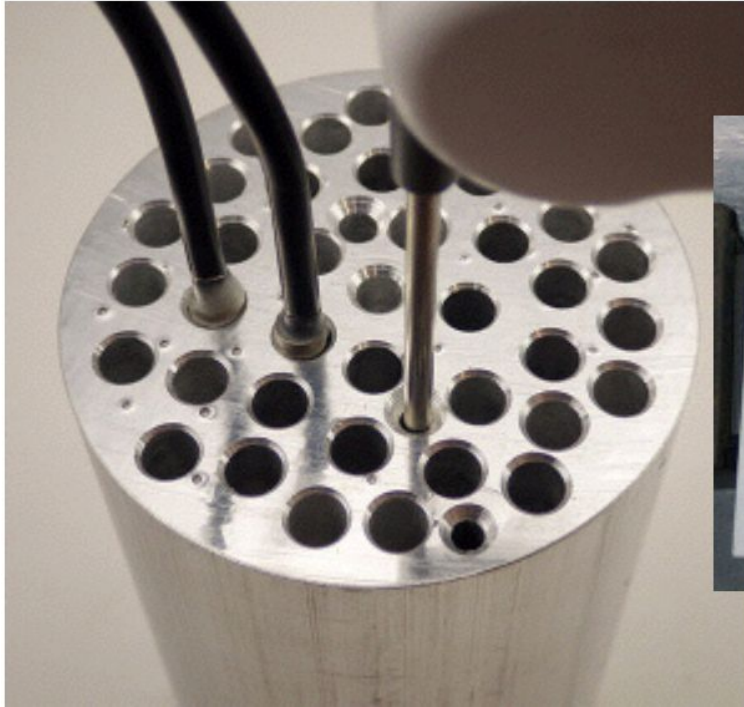
NOTE: Please refer to attached bulletin for additional information

CALIBRATION NOTE:

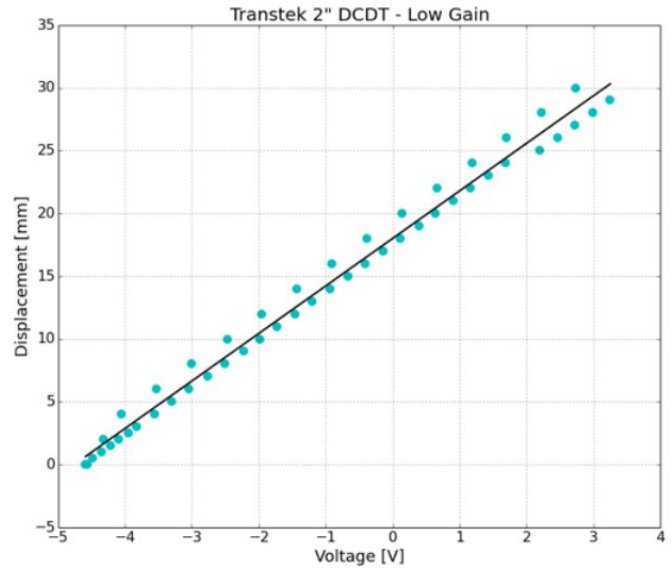
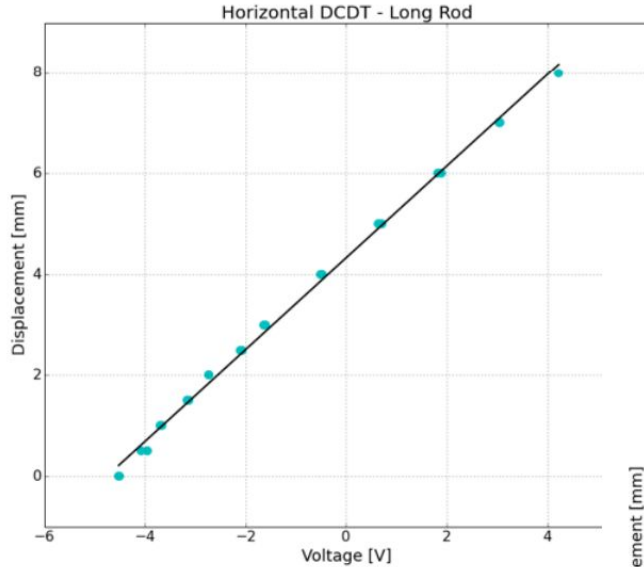
BATCH CODE #2104151100603

Ref. #:1

We take the transducer to known conditions (controlling everything else as best we can) and record the output

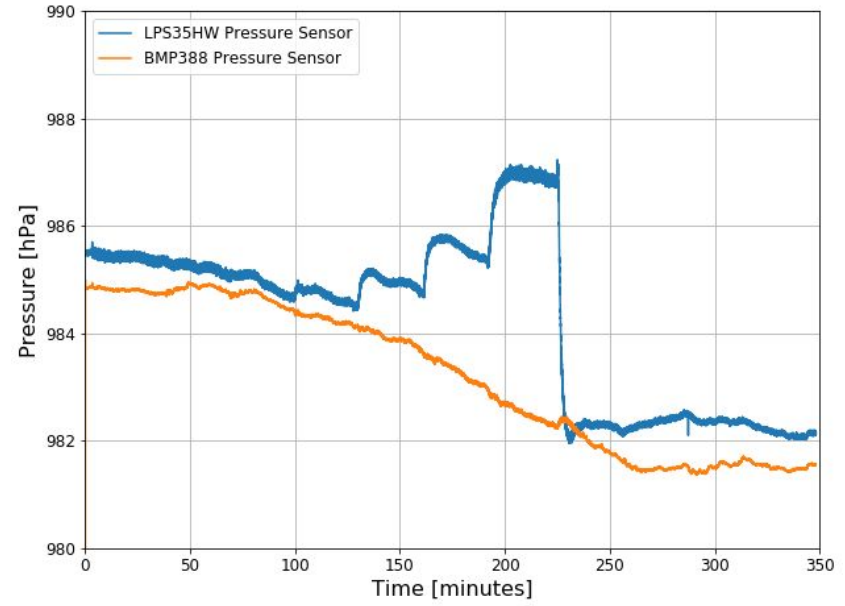
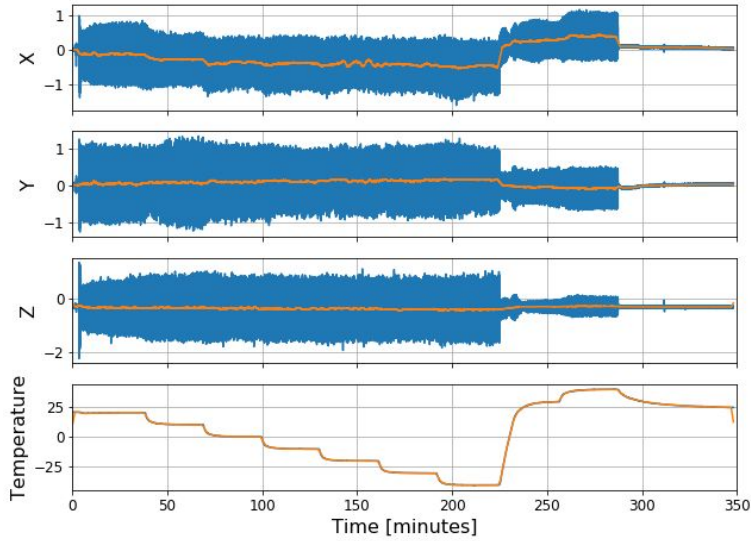


We can then fit a transfer function and accept or reject the result



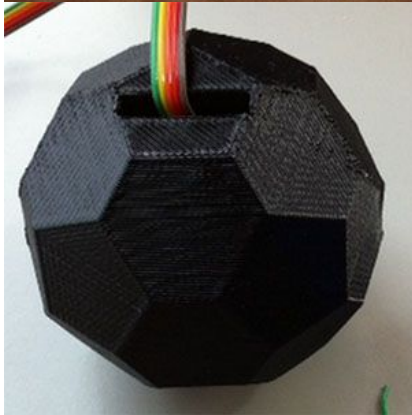
The biggest thing to remember is cross-sensitivity issues!

BNO055 Accelerometer

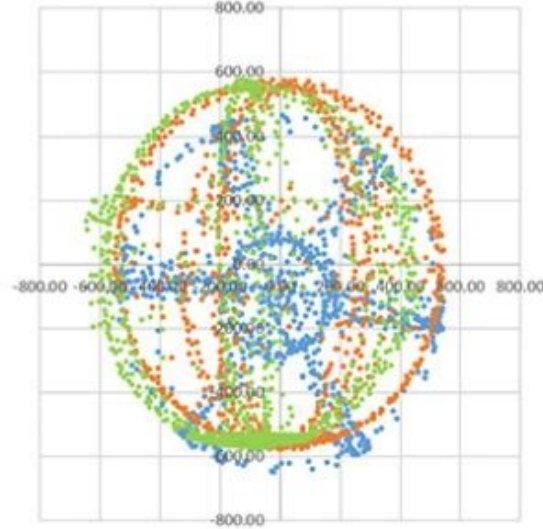


“Everything is a temperature sensor, some things sense other stuff too” - Elecia White

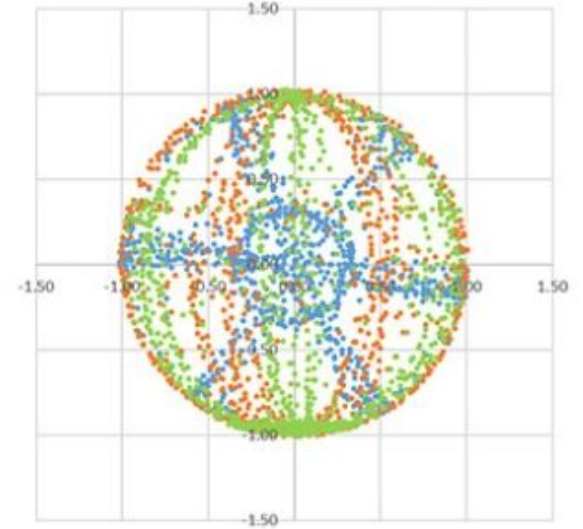
You can also calibrate things to more natural sources



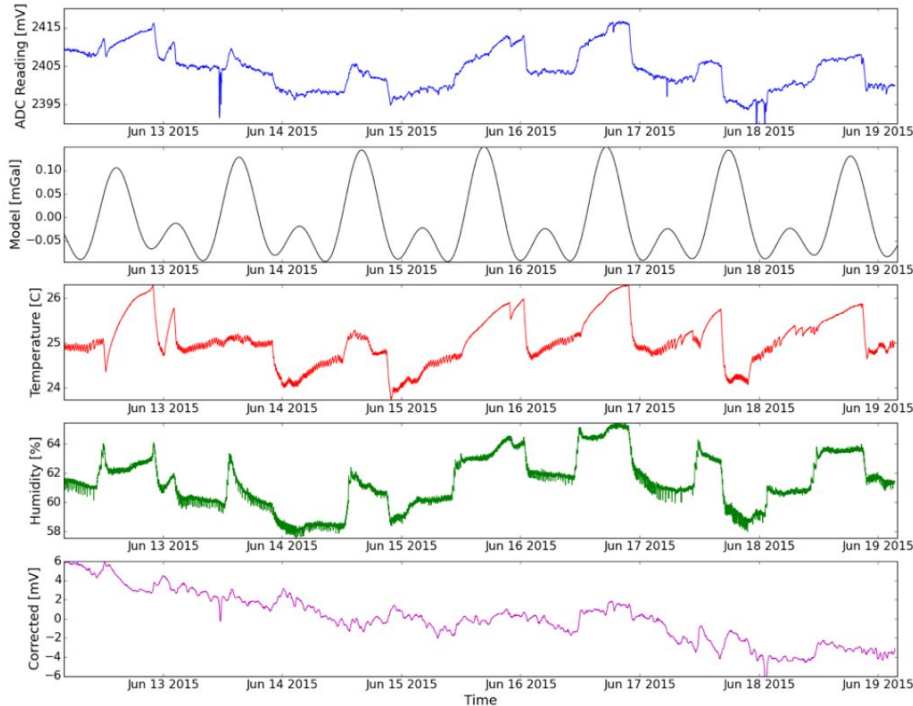
LM303 Mag Raw (In Housing)
X/Y (blue), X/Z (orange) Y/Z (green)



LM303 Mag FreeIMU Calib (In Housing)
X/Y (blue), X/Z (orange), Y/Z (green)



Lots of variables to think about/control



- Temperature
- Humidity
- Pressure
- Orientation
- Time of day
- Traffic/Noise Sources
- Tides
- And on and on

Our recommendations for general equipment

- ASTM if available (just have a procedure recorded)
- Semiannual for first 3 years, annual afterwards
- Before any critical experiment (time vs time cost)
- Against NIST traceable standard (which needs calibrated) or by a lab

Keep a calibration history log in great detail

| 44 mm Solid "V" | | 44mm Solid "H" | | 62mm "V" | | 62mm "H" | |
|-----------------|------------|---------------------|------------|-----------------|-----------|---------------------|-----------|
| 10.94 mV/kN | 12/10/2009 | HG 111.366 mV/kN | 3/27/2009 | 17.82 mV/kN | 3/27/2009 | HG 173.877 mV/kN | 3/27/2009 |
| 11.33 mV/kN | 1/5/2010 | LG 11.58 mV/kN | 3/27/2009 | 18.52 mV/kN | 1/5/2010 | LG 18.08 mV/kN | 3/27/2009 |
| 11.15 mV/kN | 12/5/2010 | HG 110.212 mV/kN | 12/10/2009 | 18.10 mV/kN | 1/10/2011 | HG 207.152 mV/kN | 1/5/2010 |
| 10.869606 mV/kN | 2/5/2014 | LG 11.46 mV/kN | 12/10/2009 | 18.462238 mV/kN | 2/5/2014 | LG 21.54 mV/kN | 1/5/2010 |
| 10.829 mV/kN | 8/29/2014 | HG 114.473 mV/kN | 1/7/2011 | 18.523 mV/kN | 8/29/2014 | HG 196.333 mV/kN | 1/7/2011 |
| 10.786349 mV/kN | 2/10/2015 | LG 11.90 mV/kN | 1/7/2011 | 18.363185 mV/kN | 2/10/2015 | LG 20.415 mV/kN | 1/7/2011 |
| | | HG 108.604244 | 2/5/2014 | | | HG 200.497461 mV/kN | 2/5/2014 |
| | | LG 11.588748 | 2/5/2014 | | | LG 20.939407 mV/kN | 2/5/2014 |
| | | HG 108.71 mV/kN | 5/11/2014 | | | HG 208.905 mV/kN | 8/29/2014 |
| | | LG 11.315 mV/kN | 5/11/2014 | | | LG 21.789 mV/kN | 8/29/2014 |
| | | HG 106.08 mV/kN | 8/1/2014 | | | HG 211.236884 mV/kN | 2/10/2015 |
| | | LG 11.473 mV/kN | 8/1/2014 | | | LG 21.393971 mV/kN | 2/10/2015 |
| | | HG 111.453 mV/kN | 8/29/2014 | | | CELL REBUILT | |
| | | LG 11.658 mV/kN | 8/29/2014 | | | HG 184.014209 mV/kN | 3/6/2015 |
| | | HG 119.423363 mV/kN | 2/10/2015 | | | LG 18.721994 mV/kN | 3/6/2015 |
| | | LG 11.742750 mV/kN | 2/10/2015 | | | | |