

# LVDT Calibration

Enzo Tapia

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## 1 Abstract

This document is a summary of what is necessary to calibrate the LVDTs of the VIS in general. In the first part we detailed the LVDT Driver Board and then we continue with a general procedure of calibration.

## 2 LVDT Board



Figure 1: LVDT Board

There are three settings in the LVDT Board:

[1] Ref Trimmer: This board gets the excitation signal from the LVDT Main Board and distributes it via circuit to the 4 channels. By turning the "Ref Trimmers" we are able to increase or decrease the amplitude of the signal sent to each primary coils of the LVDTs. Adjusting this parameter will have an effect

at the Output of the LVDT Main Board. Using a probe we can view the signals in the points P0-P3 (P0 for channel 0, P1 for Channel 1, etc). See figure 1.

[2] Phase Trimmer: The demodulation process is done by multiplying the return signal (secondary Coil signal) with the reference signal (signal used for the primary coil). If both signals are in phase, the result is of the form  $\sin^2\theta$ . See figure 2. Then using a LPF, the signal can be smoothed and we can get a voltage linearly proportional to the position of the core.

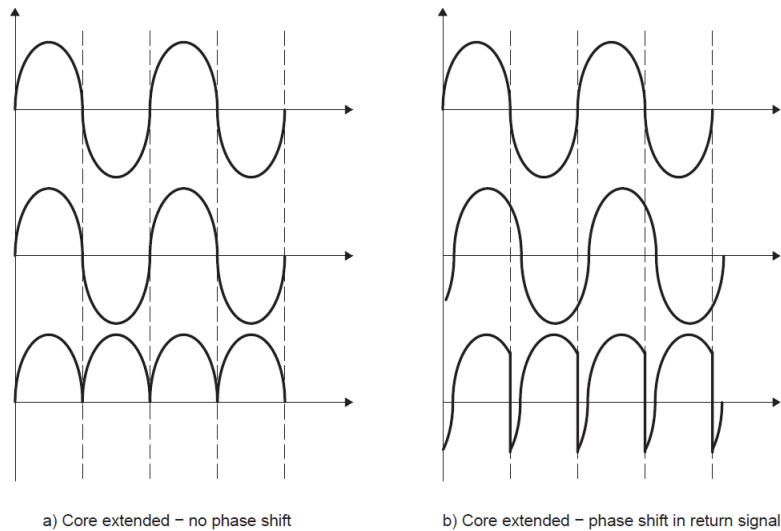


Figure 2: Demodulation of the return signal (Secondary coil)

If the signals are not in phase, the multiplication process yields sum and difference terms which in combination give under shoots in the rectified signal. See figure 2. So by turning the "Phase trimmers" we can shift the phase of the demodulation signal. And this trimmers are reachable from the front side of the rack. See figure 1.

[3] Gain Trimmer: By adjusting the "Gain Trimmers" we can change the magnitude of the demodulated output signal. This means we can tune the voltage range to get a maximum dynamic range. Or in another words, we can set the V/mm of an LVDT being such that the full range of the ADC is used in the desired range or in the constrained range. It is possible to measure the value of the gain resistor by using a multimeter between the pin6 fo the IC INA103 and the soldering point ate the "Gain Trimmers", which is at the side of the IC AD630ARZ (the side of the trimmer with 1 and not 2 soldering points). See figure 1.

### 3 LVDT Calibration Procedure

1. To calibrate and operate the LVDTs, we need to connect them to the LVDT Driver board, and set a signal in the Signal Generator for the excitation of the primary coil. In the figure 3. We can see the connections used for the SR2 as an example.

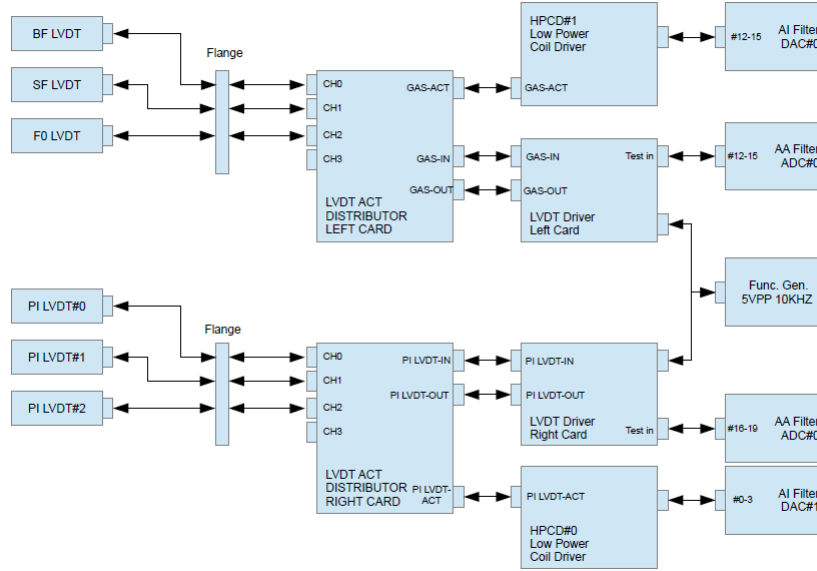


Figure 3: SR2 LVDT Connections

2. Then we need to set an excitation signal for the primary coil at the signal generator. Typically some  $V_{pp}$  at 10 kHz. We use 5 Vpp and 10 kHz for the SR2.

3. When everything is connected, we need to move the core of the LVDTs to the end in one direction. That means by pushing or pulling the suspensions rods in the case of GAS filters or applying some yaw movement in the Preisolator in the case of the horizontal LVDTs.

4. With the core at the extreme final position we need to adjust the phase trimmer in order to get the return signal and the reference signal in phase. In principle we should compare this two signals with an Oscilloscope but it is more simple to look at the value of the demodulated signal in the digital model (MEDM screens) and adjust the trimmer until we get the maximum value. This is indeed setting the reference signal and the return signal (secondary coil signal) in phase. See figure 2.

5. With the core in the same final position and now that we have the signals in phase, we can adjust the gain of the demodulated signal with the Gain Trimmers. So in this step we can set the V/mm of the LVDT for the desired range. It is recommendable but not totally necessary to use the whole digital range for the calibration, that means get a value close to  $\pm 32000$  [cnt] which is the maximum limit of the digital system.

6. Finally, we need to move the core gradually back to the center position and then to the another end of the LVDT range. And we need to register the data at different points in order to check the linearity of the device. As an example, we can see in the figure 4 the calibration done for the BF GAS of the SR2 suspension.

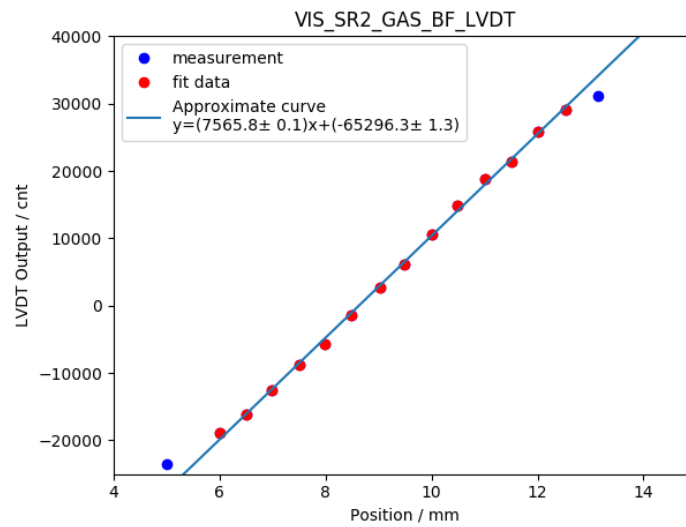


Figure 4: Calibration of SR2 BF GAS