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Article #28: Calibration of Trillium Sensors using a Taurus Digitizer

Summary

This article contains the procedure for calculating system sensitivity of a Trillium sensor using a Taurus digitizer. All calibration settings in this example are configured for the Trillium 40. For more information, see your Trillium's User Guide.

Procedure:

- Ensure the Taurus is on, and in Communications mode.
- Connect to the Taurus via a web browser, using its IP Address.
- Ensure that the Taurus is configured correctly for the sensor being calibrated.
- Configure calibration settings as shown in Figure 1 under Advanced Configuration > Calibration, setting the frequency to 1 Hz.

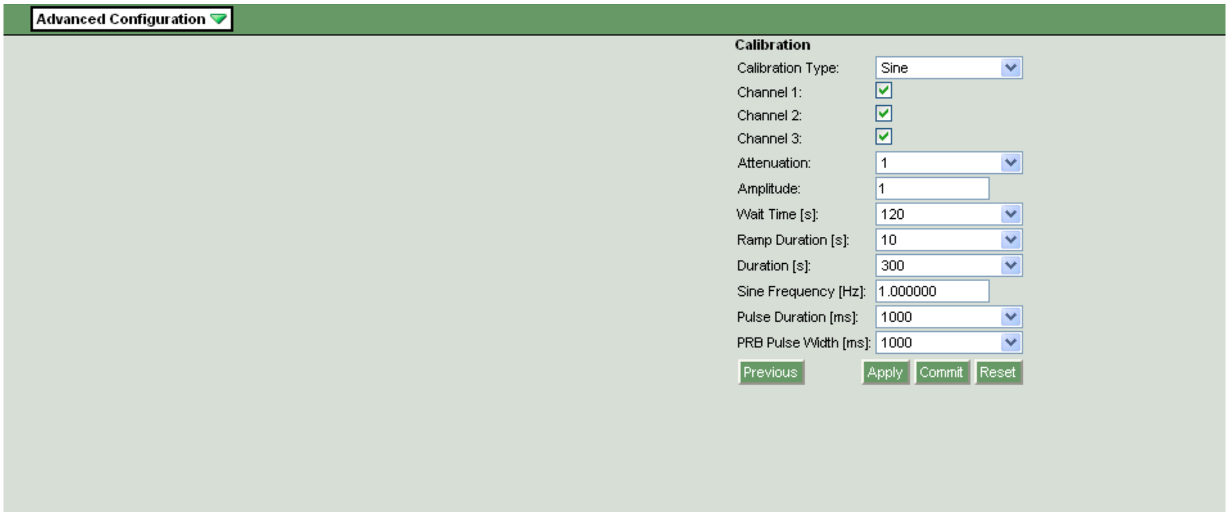

Figure 1: Calibration Signal Configuration

- It is important that the duration of the calibration be long enough so that the system stabilizes – as a rule, the duration should exceed 2 times the value of the time constant. The minimum durations are listed in Table 1.

Model	Minimum Calibration Duration
Trillium 40	80s
Trillium 120	240s
Trillium 240	480s
Trillium Compact	240s

Table 1: Minimum Calibration Duration

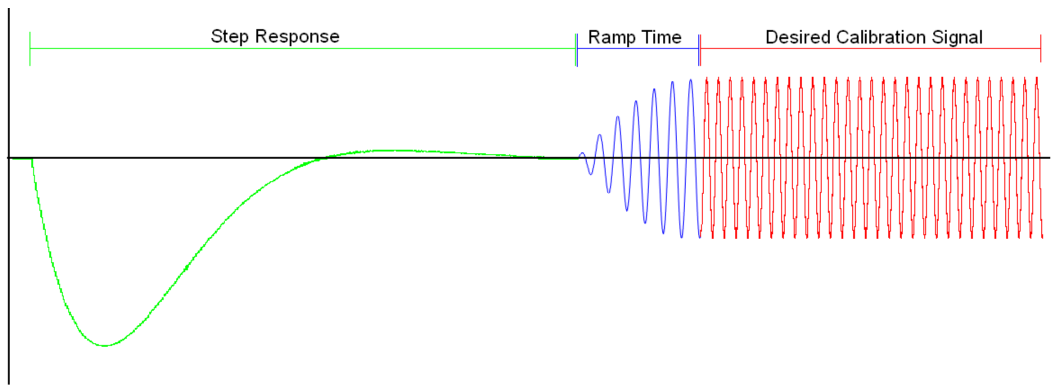

Figure 2: Visual Representation of the response of the system

- Check the digitizer input range, this will be important later. It is recommended to run the digitizer with a 16 Vp-p input range. This is configured in Advanced Configuration > Digitizer > Front End.
- Set the Trillium seismometer to UVW mode. This will enable calibration of individual axes.
- Ensure that the mass positions are within +/- 0.3 V and that the sensor is level. If they are not, initiate mass centering prior to running the calibration.
- To observe the data, set up an NP Data Streamer (Advanced Configuration > Communications > NP Data Streaming) to Apollo Server or directly to Apollo Waveform.
- Start the calibration. Depending on the wait time, this might take a couple minutes.

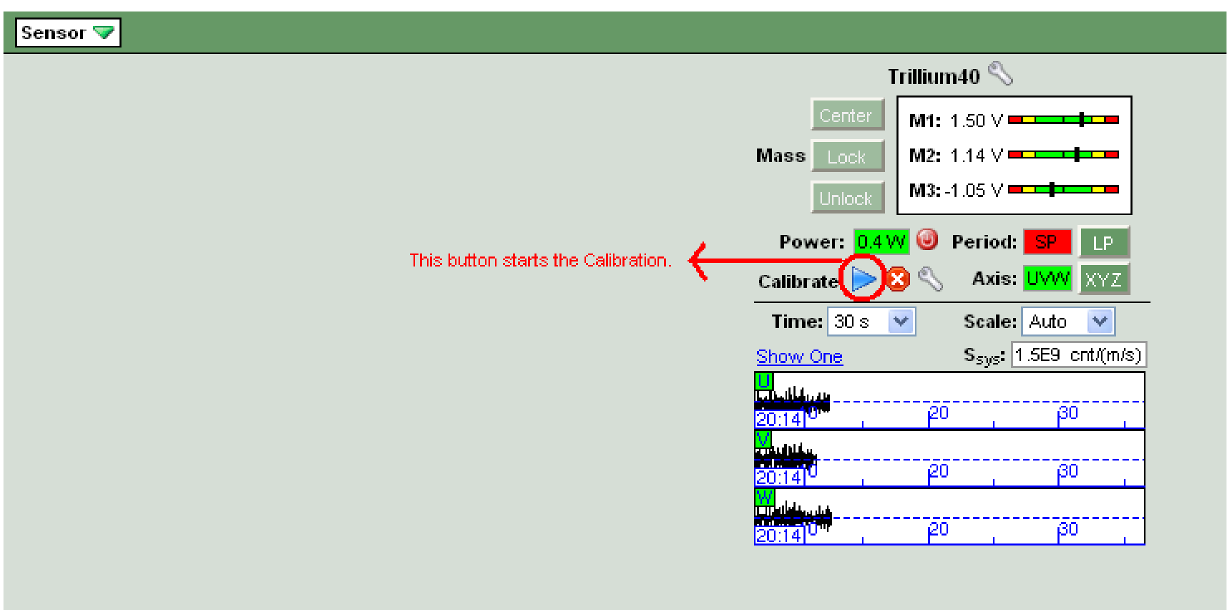

Figure 3: Calibration Initialization

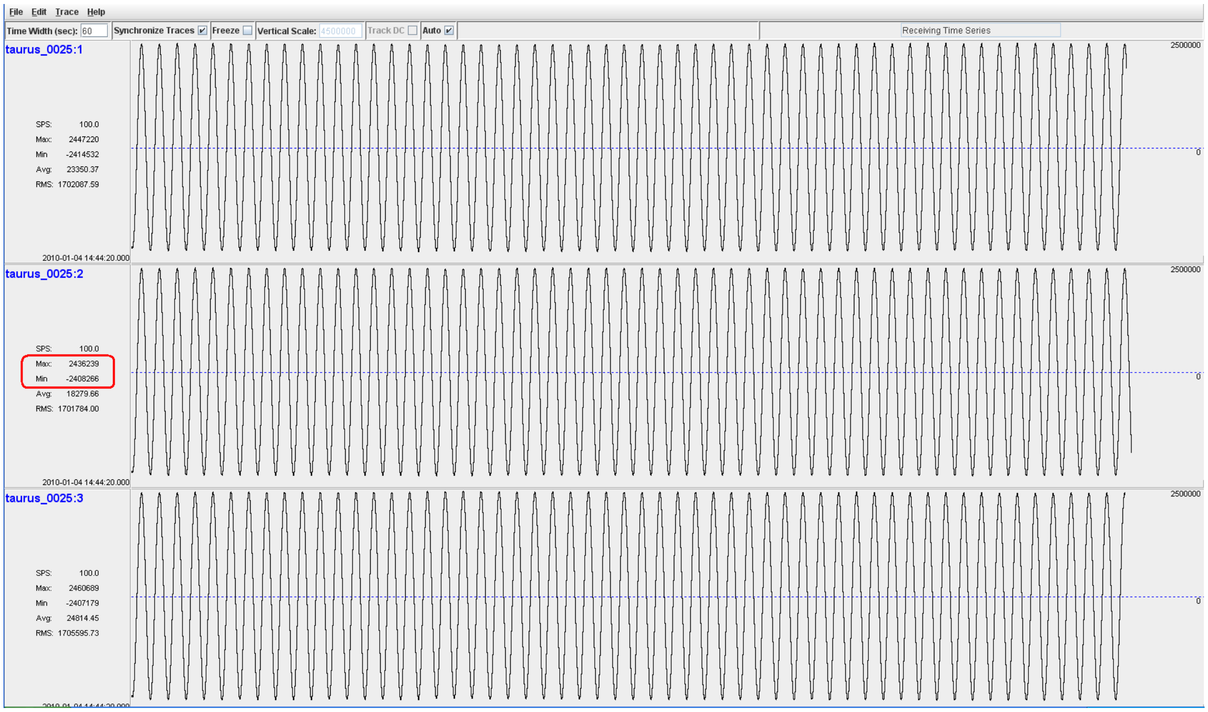

Figure 4: Calibration output in Apollo Waveform

- Apollo Waveform gives a Max and Min value that will be very close to a single cycle's peak to peak value: Max – Min = p-p value. The Amplitude in counts, *AC*, is equal to half that value: (p-p value) / 2. For this output, *AC* is 4844505/2 = 2.42×10^{6}.
- The other important value we need is the Simulated Velocity input, *SV*. It can be calculated as follows:
  - i) Obtain the Calibration Coil constant, *C*, for the sensor. Calibration coil constants for Trillium sensors are:

    Trillium-40: 102.46 V/(m/s^2)
    Trillium-120: 97.75 V/(m/s^2)
    Trillium-240: 95.54 V/(m/s^2)
    Trillium Compact: 2.667 V/(m/s^2)
  - ii) To obtain *SV*, use the following formula:
    $SV = (V/C)\times1/(2\pi f)$ where *V* is the voltage in volts, and *f* is the frequency of the sine wave.
  - iii) For example, with an input frequency of 1 Hz, a Trillium-40 and an input calibration signal of 1 V, the simulated velocity component is:
    $SV = (1/102.46) \times (1/2 \times \pi \times 1) = 1.553\times10^{-3}$
- The observed system gain, *G*, is equal to *AC*/*SV*. Using the above results for AC, with a recorded max and min of $\times10^{6}$. This means:

  $G = (2.42/1.553)\times10^{9} = 1.558\times10^{9}$ Counts/(m/s).
- To calculate the Nominal System Gain, G_N, use the values from Table 1:

Seismometer Gain (V/(m/s))			Digitizer Gain (Counts/µV)	
Trillium-40	1553		40 Vp-p	0.4
Trillium-120	1201		16 Vp-p	1
Trillium-240	1196		8 Vp-p	2
Trillium Compact	749.1		4 Vp-p	4
			2 Vp-p	8

Table 1: Seismometer and Digitizer Sensitivity

- The Nominal System Gain is the product: Seismometer Gain × Digitizer Gain
- Continuing with the example, for a Trillium-40, using a 16 Vp-p digitizer range,
  G_N = 1553 V/(m/s) × 1000000 Counts / V = 1.553×10^9 Counts/(m/s)
- So, in this example, the gain of the system differs from the Nominal by 0.32%.