ATI Mini40 DAQ F/T sensor information and tips

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Abstract

This document is meant to be a summary of all the relevant information I have found while working with the ATI Mini40 DAQ F/T sensor. It contain all the information and instructions to operate such sensor in various environments such as LabView, Python and MATLAB using the Keysight 34970A Data Acquisition Unit.

1 What kind of sensor is the ATI Mini40 DAQ F/T?

The transducer is a compact, durable, monolithic structure that converts force and torque into analog strain gage signals. The force applied to the transducer flexes three symmetrically placed beams using Hooke's law (from page 16 of the manual 9620-05-DAQ):

- s = E·e
- s = Stress applied to the beam (s is proportional to force)
- E = Elasticity modulus of the beam
- e = Strain applied to the beam

Semiconductor strain gages are attached to the beams and act as strain-sensitive resistors. The resistance of the strain gage changes as a function of the applied strain as follows:

- ΔR = Sa·Ro·e
- ΔR = Change in resistance of strain gage
- Sa = Gage factor of strain gage
- Ro = Resistance of strain gage unstrained
- e = Strain applied to strain gage

1.1 Load calculation

From page 18 of the manual:

Additionally to this, gain correction factor is only required when a customer amplifier is being used. Refer to page 20 of the manual for more information.

2 Wiring and connecting to a DAQ

There are two different wiring alternatives for the DAQ version of this sensor:

- Differential connections to DAQ (Figure **??**)
- Single-ended connections to DAQ(Figure **??**)

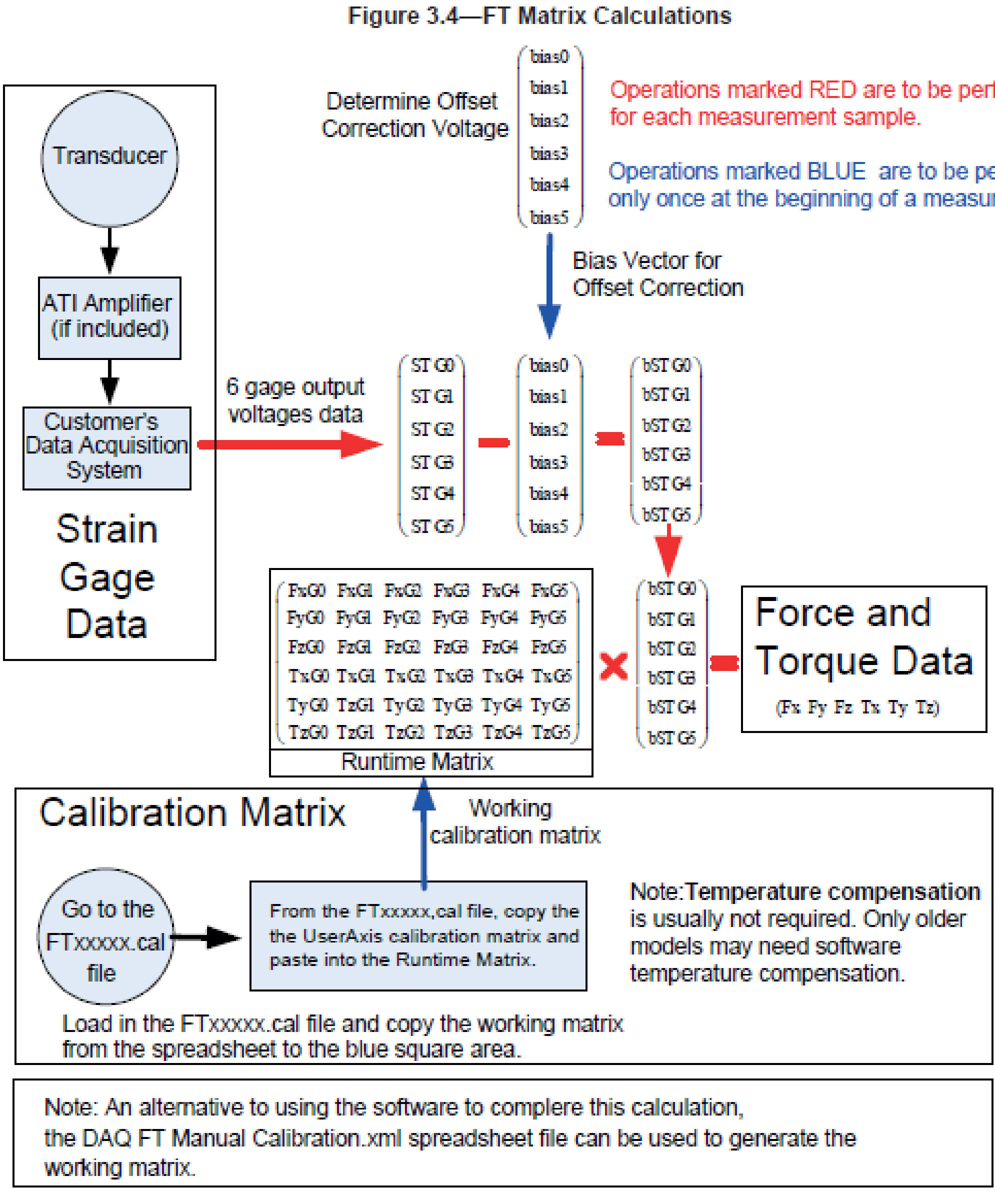

Figure 1: Load calculation process

A connection from the DAQ F/T's AGnd/AIGnd line to the data acquisition system's analog input ground or analog ground is required in most cases. This line allows the return of the small amount of current used by the data acquisition system. Noise can result if this current isn't returned via the AGnd/AIGnd path. For best noise performance, the cabling from the PS/IFPS connector should be shielded and each strain gage's signals in a twisted pair. The shielding should be connected to the PS/IFPS connector shell and to the shell of the data acquisition system's connector. If the data acquisition system has no connector or its connector shell is electrically floating, then the shield at the PS/IPFS connector should be connected to the AGnd/AIGnd signal.

2.1 Sampling

For best performance in all applications (page 37 from 9620-05-DAQ), the transducer electronics have bandwidth of 5kHz to 10kHz (depending on gain settings). This allows collection of all transducer frequency content. Note: that to satisfy the Nyquist Theorem, the data needs to be coupled at a rate

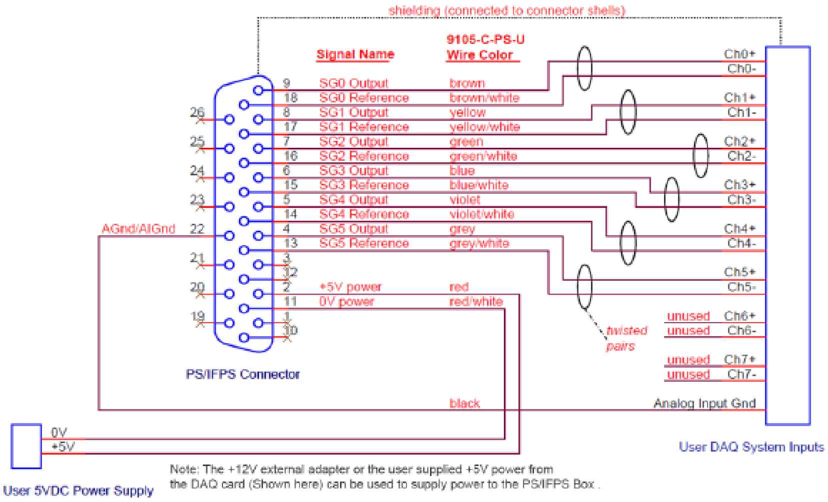

Figure 2: Differential wiring connections to data acquisition system (page 35 from 9620-05-DAQ)

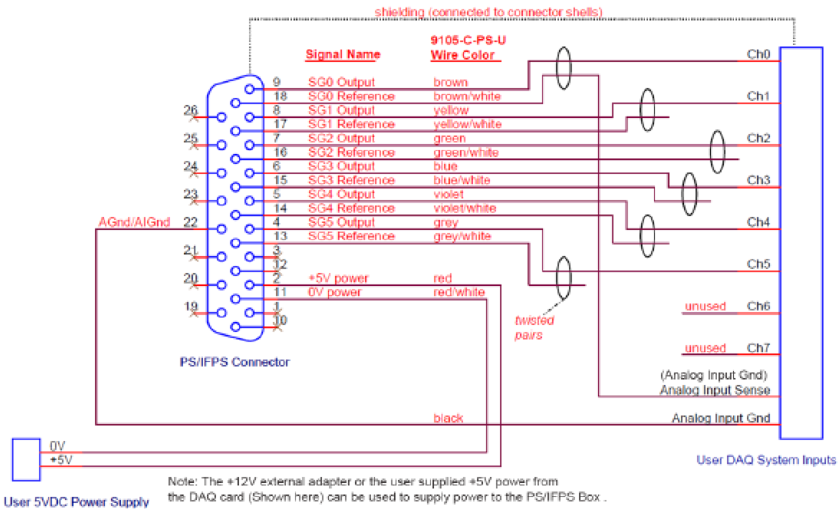

Figure 3: Single-ended wiring connections to data acquisition system (page 36 from 9620-05-DAQ)

greater than twice the highest frequency present, even if data at that frequency is not preferred

2.2 Range

As specified in the ATI site, the range of the sensor for the calibration US-20-40 is the following defined as the average of the worst and best case scenarios:

Table 1: Range values in imperial and metric systems

Fx, Fy	Fz	Tx,Ty	Tz
20 lbf	60 lbf	40 lbf-in	40 lbf-in
88.9644 N	266.893 N	4.51939 N-m	4.51939 N-m

2.3 Resolution

As specified in the ATI site, the resolution of the sensor for the calibration US-20-40 is the following defined as the average of the worst and best case scenarios:

Table 2: Resolution values in imperial and metric systems

Fx, Fy	Fz	Tx,Ty	Tz
1/200 lbf	1/100 lbf	1/200 lbf-in	1/200 lbf-in
0.022241108 N	0.0444822 N	0.000564924 N-m	0.000564924 N-m

3 Keysight 34970A connection to PC

The connection is made via a GPIB-USB-HS cable. The GPIB-USB-HS is an IEEE 488 controller device for computers with USB slots. The GPIB-USB-HS achieves maximum IEEE 488.2 performance. The exact model can be found in Amazon. The differences with the original true version of this device are not the sxope of this document.

4 LabView

LabView offers two main ways of interacting with the Keysight 34970A DAQ:

- General purpose Virtual Instrument Software Architecture (VISA) blocks.NI-VISA is an API that provides a programming interface to control Ethernet/LXI, GPIB, serial, USB, PXI, and VXI instruments in NI application development environments like LabVIEW, LabWindows/CVI, and Measurement Studio. The API is installed through the NI-VISA driver [1].
- Agilent Technologies / Keysight Technologies 34970A drivers. These block are based on the VISA blocks but offer a more user-friendly approach to configuring the instrument as well as reading data from it.

The example provided in this repository uses generic VISA blocks. In Figure 4, the block diagram of the VI can be seen:

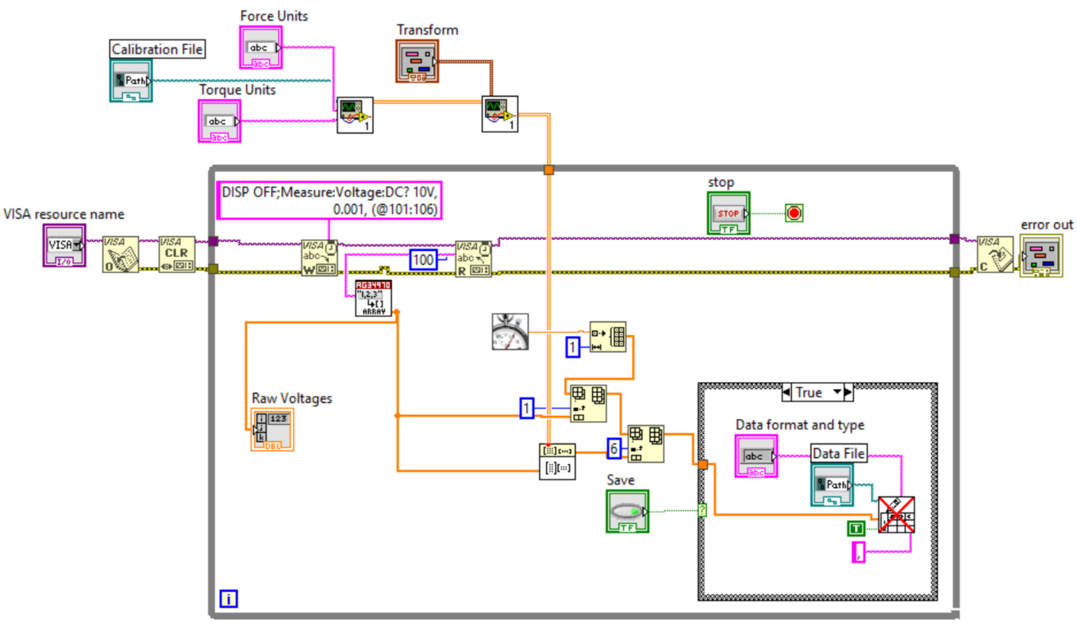

Figure 4: LabView block diagram

Inside the while loop, the write and read blocks are interacting with the instrument. Every iteration, the *write* block sends the following commands to the DAQ:

- DISP OFF: This command turns off the display of the external instrument. This speeds up the sampling process.

- MEASure:VOLTage:DC? 10V, 0.001, (@101:106): The first part of the command 'MEASure:VOLTage:DC?' is requesting the measurement of the voltage. The question mark indicates a query command. The two numbers following such query are the *range* and the *resolution*, respectively. There are alternative values for these parameters. See more in pages 211 to 217 from the manual.

5 Python

References

[1] "Ni-visa overview - ni." [Online]. Available: https://www.ni.com/en/support/documentation/supplemental/06/ni-visa-overview.html

[2] "Agilent technologies / keysight technologies 34970a data acquisition unit - instrument driver - national instruments." [Online]. Available: http://sine.ni.com/apps/utf8/niid_web_display.model_page?p_model_id=5547