Pirani Gauge Digital Readout

Software Design Document

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1. Introduction

a. Purpose

This hardware to software interface will take the analog voltage output of a Pirani Gauge measuring vacuum within a LINAC beamline and output a virtual readout in the LINAC control room.

b. Scope

This software reads the voltages of a Pirani Gauge and outputs a digital reading into a master system, which will eventually consider all measurements necessary for running the LINAC in one interface. This is part of an ongoing effort at CENPA to convert all mechanical readouts to digital for ease of troubleshooting LINAC issues.

c. Definitions and Acronyms

LINAC: linear particle accelerator ARA: Acoustic Resonator Analyzer LV: LabView 2011 32-bit CENPA: center for experimental nuclear physics and astrophysics

2. System Overview

As the LINAC at CENPA is ~70 years old, failures while attempting to run beam for experiments are quite common. A fairly common one is vacuum failure, which is obviously problematic when you try to run a beam of particles and they hit a group of unknown particles on their way to the target. It can be very obnoxious to troubleshoot the many things that can go wrong with the LINAC as most of the readouts are mechanical and placed all over the lab. By creating a Labview program to monitor the beam vacuum and deliver a warning (Boolean true) the life of beam operator will become much easier when more inevitable LINAC issues come into fruition.

3. System Architecture

Pirani gauge should be wired to the DAQ assistant as follows.

Pirani Gauge ports 🡪 NI 6009 ports (as connected by wires)

17 🡪 2

18 🡪 1

16 🡪 5

15 🡪 6

a. Architectural Design

The voltage across ports 17 & 18 of the pirani readout correspond to the pressure the pirani gauge is reading. There is data given by the pirani gauge manufacturers regarding the pressure value corresponding to the analog readout along 512 even spacing’s of the analog voltage, which we agreed with the leader of the effort to convert the LINAC readouts from mechanical to digital would probably be the most accurate source to reference for determining value of the voltage with the voltage given by the pirani gauge. The reference data is thus read by a spreadsheet read vi which give us a vector of pressure values we can reference using the voltage measurement. The vector is then passed into a while loop where the bulk of the program lies. Within the while loop a DAQ assistant continuously measures the voltage across ports 17 and 18 of the pirani gauge. Since the maximum voltage is 10 and minimum is 0, and there are 512 indexes in the reference data vector, we divide the voltage readout by 10 / 512 and round to the nearest integer of that value, creating an index value. By passing the reference vector and index value into a mathscript window, the proper pressure value is pulled out of the reference vector and outputted from the mathscript window, where it is fed into 3 indicators and 2 comparators.

The indicators are a logarithmically spaced meter, simple value readout, and a waveform graph with a logarithmically spaced y-axis. The readout is helpful for being able to see a precise value of what the pressure is, whereas the graph and meter are more helpful for visualizing how pressure is changing with time. The comparators are used to determine whether the pressure reading is at an acceptable level or not, so if the pressure is above a certain one comparator is true, which lights a display on the front panel, and if below a different comparator is true, lighting an alternate front panel readout. The acceptable pressure, or trigger value, can either be passed in from another VI or determined with a control in the front panel.

The DAQ simultaneously measures a resistance across ports 5 & 6 of the DAQ, 15 & 16 of the pirani gauge. This corresponds to a circuit, which monitors the filament the pirani gauge uses to measure the pressure. If there is a fault in the filament, the resistance spikes, and is otherwise very low. Thus this value is constantly being fed into a greater than 100 comparator, which will light a front panel display if true.

b. Design Rationale

The VI accepts a trigger value and outputs a Boolean corresponding to whether the pressure is below that trigger value, another Boolean indicating if the filament is broken, and the pressure value. The pirani gauge and vacuum are used to deal with relatively high pressures as far as the beamline of the LINAC is concerned, and is used in tandem with other vacuums to achieve the desired magnitude of pressure. It is best for the VI to accept a trigger value and output whether the value is met so that when all the vacuums and gauges have similar VIs, one could activate a vacuum with a program, and tell the program to wait until the trigger value is met before activating the next vacuum to bring the beamline to a lower magnitude of pressure. It is also important to output the wellbeing of the filament of the pirani gauge, so that it is easy to determine the cause of the problem if an error were to occur.

4. Human Interface Design

1. Overview of User Interface

The front panel display shows a logarithmically spaced meter, pressure vs. time graph in which the pressure values are logarithmically spaced, numeric pressure indicator, a control for the trigger value, an LED that lights up if the filament measuring pressure is broken, and a 2 LEDs indicating pressure compared with trigger value, one lighting red if pressure is above that value, and another lighting green if below. The meter makes it simple to see where the pressure is compared with the range of the gauge readings. The graph makes it easy for users to see how the pressure has changed with time. The trigger LED’s make it obvious whether pressure is good or not, and the filament fault LED obviously shows whether the pressure is acceptable or not. The numeric display is good for making it easy to determine the precise value of the pressure with a quick glance.