LabVIEW™ Virtual Instrument for WTC3293 (WTC3243 Demonstration Board)

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INTRODUCTION

This application note discusses the setup and use of the LabVIEW™ Virtual Instrument (VI) for the WTC3293 (Demonstration Board for the WTC3243 Temperature Controller). The WTC3293 circuitry allows the WTC3243 to act as a component in a temperature control instrument. The LabVIEW™ VI controls the WTC3293 via a multifunction data acquisition (DAQ) card, allowing the WTC3293 and a PC to act as an instrument, i.e. a virtual instrument. Virtual instruments are available for both National Instruments and Keithley multifunction DAQ boards.

The sub-virtual instruments (or subvi's) used by these programs are contained in the WTC Demo.llb library. This free code can be downloaded from http://www.wavelengthelectronics.com.

For DAQ board type:	Virtual Instrument:
National Instruments E-Series DAQ	WTC Demo with Events.vi
Keithley KPCMCIA-16AIAO	WTC Demo KI.vi

These virtual instruments provide a front panel to control and monitor the WTC3293 operation as well as auxiliary panels to configure temperature sensors and setup data logging. Properly configuring the virtual instrument for your sensor converts voltage measurements from the WTC3293 into temperature values in °C and displays this information in graphical form.

The virtual instrument code is modular and can be modified by the end user. For example, the user might choose to use bench top instruments to replace the DAQ board by substituting the DAQ D/A set point voltage (VSET) with a function generator and the DAQ A/D measurements using a digital multi-meter.

SYSTEM REQUIREMENTS

These virtual instruments were created with LabVIEW™ version 6.0.2. Operation of these virtual instruments was verified on a typical desktop PC running Windows2000 and a National Instruments PCI-6052 E-series multifunction DAQ board and on a notebook computer running Windows98 and a Keithley KPCMCIA-16AIAO DAQ card. The virtual instrument code can be modified to operate on any DAQ equipped with two A/D channels with 16-bit resolution and one D/A channel with at least 12-bit resolution. A D/A output channel of at least 12-bit resolution is required for dynamic temperature control via the DAQ. Alternatively, a stable function generator, such as the Agilent 33120A, could be used to provide the set point voltage.

The virtual instrument for the PCI-6052E DAQ board uses National Instruments' DAQ Events, which has been implemented only on Windows platforms as of this writing. DAQ Events reduce the amount of traditional polling required and improve the overall efficiency of operation.

Figure 2 shows how to connect the DAQ board to the WTC3293. The power supply returns should be connected to PGND and the COM connection on the WTC3293 should be reserved for measurements only.

The user must ensure that the voltage limits of the DAQ board are not exceeded. For example, The PCI-6052E board input is limited to no more than 11 V. The VDD supply should not exceed this limit. In this case, a 5V supply is suggested for compatibility with the optional 5V fan. (The optional fans, sold as part of the Thermal Solutions Kit, come in 5V and 12V configurations.) The VS supply powering the TEC may be set to a higher voltage if necessary without risk to the control and measurement electronics.

The user is responsible for obtaining and installing the correct DAQ driver and LabVIEW^{TM} support software packages for his/her installation.

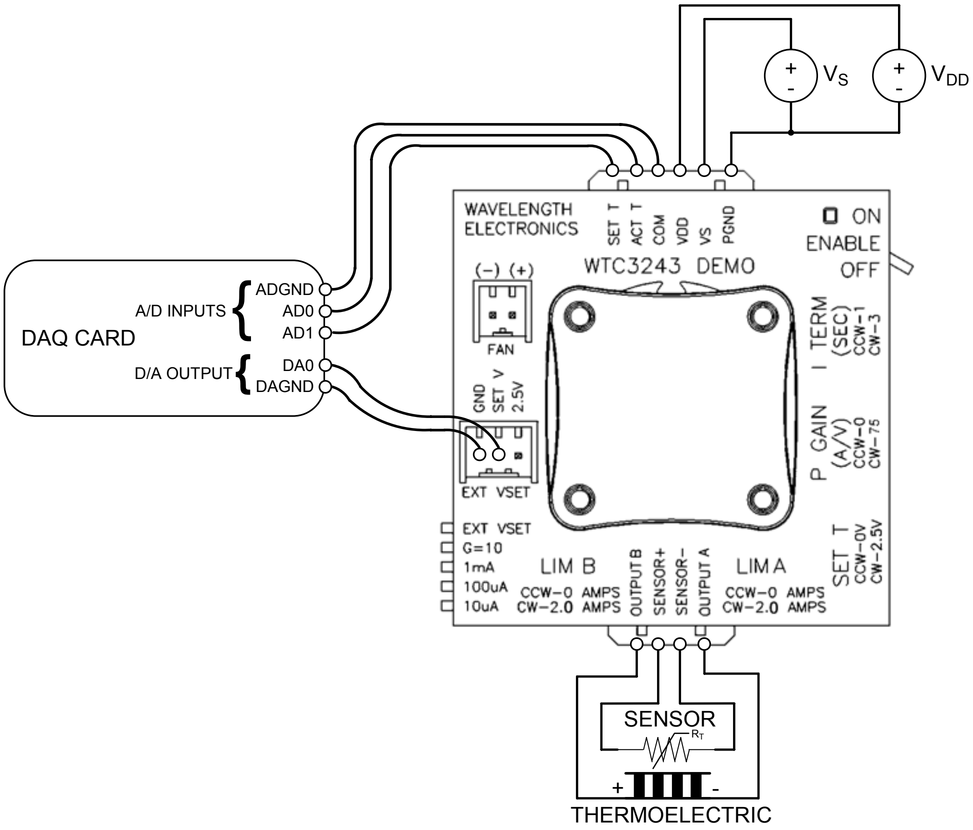


Figure 2. Typical Hardware Configuration.

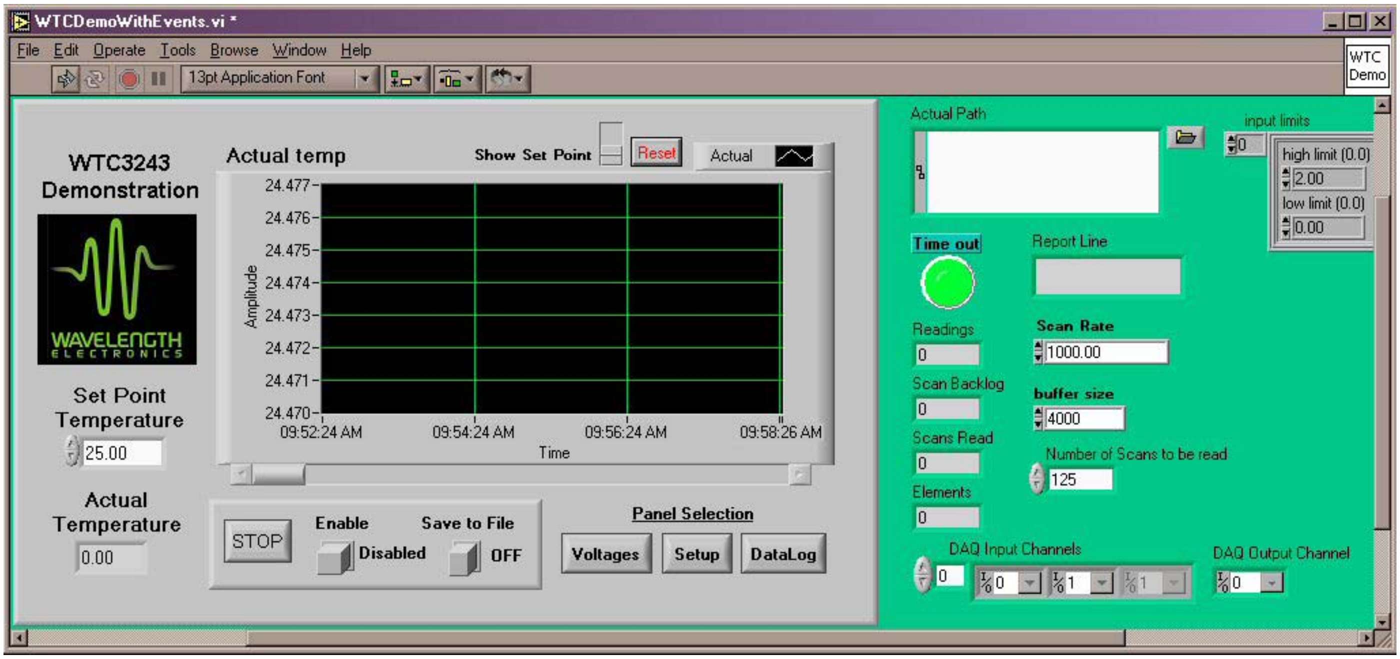
BASIC OPERATION SETUP

Press the **Setup** button after starting the virtual instrument and configure the settings for your temperature sensor. Select default parameters or enter custom settings.

The **DataLog** button brings up a page for entering a starting path for a data log file as well as setting the time between points to be logged. Starting and stopping data logging is done from the Controls (default) front panel.

An easy way to preset the sensor and data logging values is to load the VI without starting it. Place the operation cursor on the edge of the panel and right click. Under **Visible Items**, enable **Tabs** and select the **Settings** tab. Make the necessary changes to the data entry boxes. After entering data in a box, right click on the box and select **Data Operations>>Make current value default**. Select the **DataLog** tab and again enter default data and set as default. It is recommended that the visible Tabs be disabled prior to operation to allow the program dynamic control of the front panel display.

The A/D channels may be configured as single ended or differential. Differential configuration is recommended if the cable from the WTC3293 to the computer exceeds about one meter in length.



Set Point Temperature: 25.00
Actual Temperature: 0.00
Enable: Disabled
Save to File: OFF
input limits: 0
high limit (0.0): 2.00
low limit (0.0): 0.00
Readings: 0
Scan Backlog: 0
Scans Read: 0
Elements: 0
Scan Rate: 1000.00
buffer size: 4000
Number of Scans to be read: 125
DAQ Input Channels: 0 | 0 | 1 | 1
DAQ Output Channel: 0

Figure 1. Screenshot of WTC Demo with Events.vi.

THEORY OF OPERATION

Maximum sensitivity and stability can be obtained by continuous buffered acquisition. This also minimizes any noise induced in the DAQ output channels resulting from starting and stopping the A/D. The main thread of the program reads from the acquisition buffer and computer averages eight times per second. After one second, the eight averages are then averaged for a one second cumulative average reading. One second averaging provides for a very convenient cadence for the temperature vs. time graph. Most thermal loads have a time constant of a second or longer, so the data smoothing does not bias the display.

For faster loads, it is possible to update the graphs up to eight times per second by removing the inner most loop in the diagram for the main program thread. It is also necessary to set the XScale.Multiplier to 0.125 (1/8 sec.) and adjust the time-out criteria and buffer length to match the update period. For updates faster than once per second, the graphs can be updated based on the DAQ clock rate rather than using the CPU time. In this mode the graph's time axis (X) will drift from the CPU time.

The PCI-6052E version of the program uses DAQ Events to reduce CPU overhead in polling for the buffer-full condition. The KPCMCIA-16AIAO version uses standard polling techniques of earlier versions of LabVIEW™.

Optimal data logging is achieved using the PC's local hard drive. The program does support data logging to a network drive, but this raises the possibility of CPU lockup waiting for network access, causing the main thread of the program to miss a second or more of the acquired data. If this time-out condition is detected, the program resets the DAQ and restarts the acquisition. The time axis of the temperature vs. time graph will fall off real time by the amount of time lost in the wait. Data logging however, will recover correct time stamping within one sample. To restore correct time display in the graphs, press the **Reset** button at the top of the Temperature graph.

Changing the process priority for the VI is not recommended. Increasing the priority can result in other processes, such as clock updates, to occur more randomly or not at all, throwing off the time accuracy of the plots and recorded data, potentially resulting in suppressing writing of data to the disk.

The program also monitors the front panel to detect changes in control parameters such as set point temperature. Controls are provided for fine-tuning of the set point voltage versus actual settling sensor voltage.

SENSOR CALIBRATION CORRECTION FACTORS

The program uses the Steinhart-Hart formula for converting between thermistor resistance values and temperature and uses the Callendar-Van Dusen formula for RTDs. It provides for entry of calibration data for custom thermistors and RTDs as well as providing default values for commonly used thermistors and RTDs.

The virtual instrument can also correct the offset between the setpoint voltage (VSET) and the actual sensor voltage after settling to the desired temperature. Since the voltage offset is highly linear, a simple way to determine the correction gain and offset is to let the WTC3243 settle at temperatures around the desired set point. Then plot ActT vs. VSET and obtain the slope of this line as

$$\text{Slope} = \frac{\text{ActT2} - \text{ActT1}}{\text{VSET2} - \text{VSET1}}$$

to obtain:

$$\text{Correction Gain} = \frac{1}{\text{Slope}}.$$

$$\text{Correction Offset} = (\text{Slope} * \text{VSET2}) - \text{Act2}.$$

Alternatively, linear regression techniques may be used to obtain the correction parameters.

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Keywords:

Temperature controller, Thermistor, Thermoelectric, ntc thermistor, tec controllers, temperature controller, temperature controls, temperature sensor, thermistor, thermistors, thermo electric, thermo-electric, thermoelectric, thermoelectric control, thermoelectric controller, thermoelectric controllers, thermoelectric cooler, thermoelectric coolers, thermoelectric cooling, Peltier device, Peltier cooler, heat pump, WTC3243, LabView Driver