VIRTUAL INSTRUMENT

Remote Control of LAB Series Instruments

QCL LAB, TC LAB, LDTC LAB

REMOTE INSTRUMENT CONTROL

Wavelength's Virtual Instruments offer higher level remote control based on the Command Set for these TMC class instruments. See the LAB Series Instrument Command Set document for lower level control.

These free applications are executable files that use the National Instruments Run Time Engine.

One of each type of instrument can be operated at a time.

If you would like different default values or functionality, or the full VI, contact Technical Support. Custom Virtual Instruments can easily be coded.

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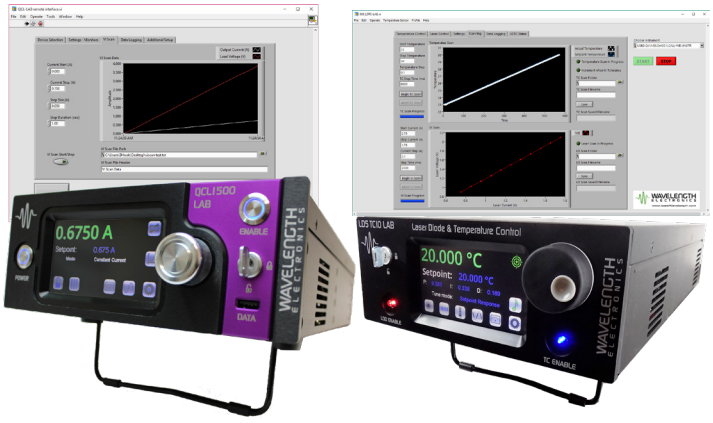

COMPUTER SPECIFICATIONS

COMPUTER SYSTEM REQUIREMENTS	
Windows Operating System Compatibility	Windows 10/8.1/8/7 SP1 (32- and 64-bit) Windows Server 2012 R2 (64-bit) Windows Server 2008 R2 SP1 (64-bit)
Processor	Pentium III/Celeron 866 MHz (or equivalent) or later (32-bit) Pentium 4 G1 (or equivalent) or later (64-bit)
RAM	256 MB minimum
Screen Resolution	1024 x 768 pixels
Disk Space	5 GB available hard disk space (32-bit) 20 GB DirectX 9 graphics device with WDDM 1.0 or higher driver (64-bit)
Installation Prerequisites	NI LabVIEW® -OR- NI Runtime Engine for 2015, SP1 - 32 bit (2017, 64 bit for LDTC LAB) NI-VISA Device Drivers

406-587-4910

www.teamWavelength.com

Applies to Revision 1

WAVELENGTH ELECTRONICS

OPERATING INSTRUCTIONS - QC LAB

The QCL LAB firmware version must be 1.5 or greater to operate with this VI.

INSTALL THE NATIONAL INSTRUMENTS RUNTIME ENGINE 2015

Prior to installing Wavelength's Virtual Instrument application, the National Instrument (NI) Runtime Engine 2015 must be installed on the remote computer.

When installing the Virtual Instrument .EXE file, if the Runtime Engine is not already installed on the computer, a message with a link to the NI website download page opens. Follow the download instructions on the page. The Runtime Engine can take several minutes to install and requires restarting the computer.

INSTALL QCL LAB VIRTUAL INSTRUMENT APPLICATION

1. On the Wavelength QCL Software Downloads page, click the LabVIEW Interface for QCL LAB Series Instrument and download it to the computer.
2. Save the file to the computer, and open it.
3. Follow the prompts to install the application.

CONNECT THE QCL LAB TO THE REMOTE COMPUTER

1. Connect a USB or Ethernet cable from the instrument to the remote computer and turn on the rear panel power switch. See the *QCL LAB datasheet* for other connections.

   NOTE: If using an Ethernet connection, configure the network settings with NI-MAX or similar.
2. On the computer, open the Virtual Instrument application.
3. On the **Device Selection** tab, in the *QCL Instrument ID* field, choose the instrument to communicate with. The instrument is identified by the Serial Number, as shown in **Figure 1**.

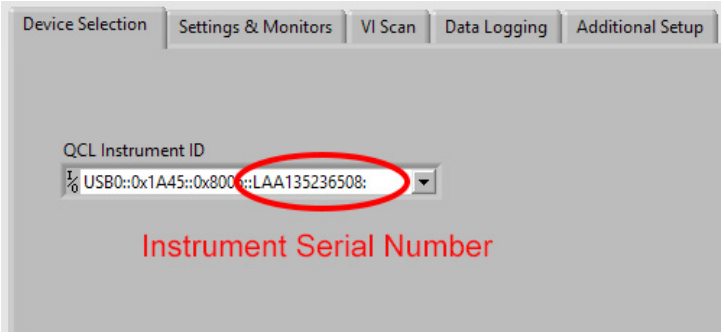

Figure 1. Device Selection Tab

4. On the Virtual Instrument toolbar, click the **Run** icon to communicate with the instrument once you have entered the operating values on the **Settings & Monitors** tab and want to apply the settings. If this icon is visible, the VI is not running and any changes made on screen will not be implemented.

ADDITIONAL CONTROLS

Running: Indicates that the instrument and application are communicating and commands to implement settings are continuously sent.

Run Continuously: This control is not used.

Running Continuously: This control is not used.

Abort Execution: This stops the application immediately, interrupting any commands that are currently in process. It is NOT recommended to use this method of stopping the application. Instead, use the STOP button.

Stop: Use the Stop button to gracefully end remote control of the instrument. Any commands in process are completed prior to ending remote control. The QCL LAB instrument will continue to run in LOCAL MODE.

SETTINGS & MONITORS TAB

The **Settings & Monitors** tab is used as the main control for remote operation.

Power: The *Power* button functions the same as the front panel power switch on the instrument.

Enable: The *Enable* button enables current to the load and functions the same as the Enable button on the front panel of the QCL LAB instrument.

SETTINGS

Setpoint (A): In the *Setpoint* control, type the desired setpoint, in Amps, that will be driven to the load. The range is 0 Amps to the maximum output current allowed by the QCL LAB instrument selected.

Current Limit (A): In the *Current Limit* control, type the maximum value, in Amps, that the QCL LAB instrument should not exceed to the laser. The range must be between 8% and 120% of the maximum current allowed by the QCL LAB instrument selected.

Max Supply Voltage (V): In the *Max Supply Voltage* control, type the maximum voltage, in Volts, from the internal supply. The range must be between 18 V and 28 V. The available voltage to the load is about 8 V below the value specified.

Cable Resistance (Ω): In the *Cable Resistance* control, type the resistance of the cable, in Ohms, between the QCL LAB instrument and the load. The QCL voltage displayed will be:

$$V_{DISPLAYED} = V_{ACTUAL} - (R_{CABLE} * I_{OUTPUT})$$

This calibration parameter gives a better representation of the voltage at the actual load. The range is 0 to 4 Ohms.

Turn On Delay (msec): In the *Turn On Delay* control, type the time, in milliseconds, to delay sending current to the load after the *Enable* button or control is pressed. The range is an integer between 1 and 25500 milliseconds. Factory default is 2 seconds to match CDRH safety requirements.

MONITORS

Actual QCL Current (A): Monitor output current, in Amps, to the load.

Actual QCL Voltage (V): Monitor output voltage, in Volts, to the load.

Interlock Status: The green indicator illuminates when all interlocks are set to enable the output current. The front panel key switch must be turned to ON (unlocked), and active and passive interlock inputs on the rear panel must be configured to allow output. When this indicator is grayed and the Enable button is pushed, an interlock error will be triggered by the QCL LAB instrument.

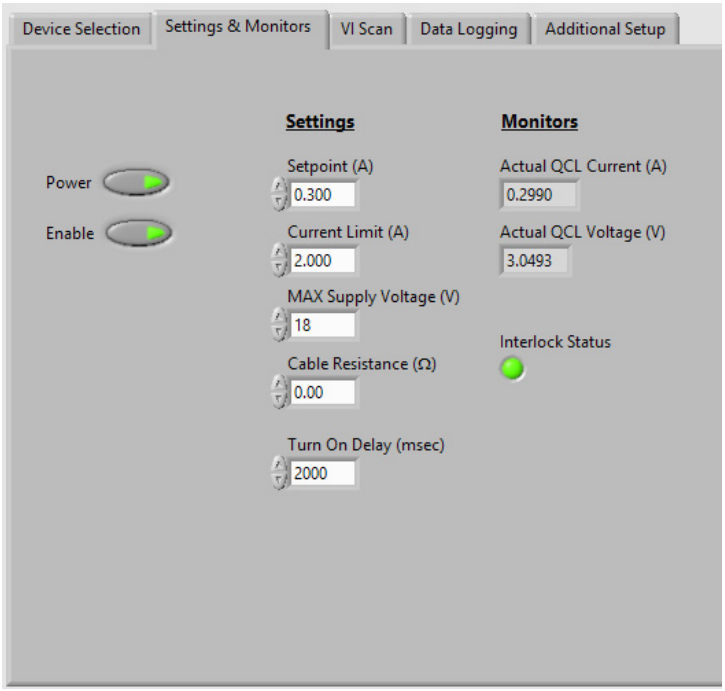

Figure 2. Settings & Monitors Tab

VI SCAN TAB

Perform a VI characterization scan of the QCL load. Input scan settings, file name and location to store the scan data, and start or stop the scan.

Current Start (A): In the *Current Start* control, type the current, in Amps, at which to start the VI scan. The scan records current versus voltage data for the load. The range is 0 Amps to the maximum output current allowed by the QCL LAB instrument selected.

Current Stop (A): In the *Current Stop* control, type the current, in Amps, at which to stop the VI scan. The range is 0 Amps to the maximum output current allowed by the QCL LAB instrument selected. The scan will not increase current beyond the Current Limit set on the Settings & Monitors tab.

Step Size (A): In the *Step Size* control, type the magnitude, in Amps, for each step in the VI scan. The step size and duration determines the length of the scan. The minimum step size must be non-zero. A negative value will result in a scan with decreasing current.

Step Duration (sec): In the *Step Duration* control, type the time delay, in seconds, between each step in the VI scan. The step size and duration determines the length of the scan. The range is 1 to 10 seconds. A duration of greater than 2 seconds is recommended for best stability.

VI Scan Data Graph: Plot of output current versus load voltage.

VI Scan File Path: Type the file path to the location where the scan data is to be stored. Click the folder icon to browse for a location. A file name must be provided before a scan can be run.

VI Scan File Header: In the *VI Scan File Header* control, type the heading that appears at the top of a new scan data file. If you are appending data to an existing file, the header name will not be changed in the file regardless of whether this control field has changed.

VI Scan Start/Stop: Click this button to start or stop a scan. A file path must be specified before running a scan. When the button is lit, the scan is running. The button turns gray when the scan is complete. To stop a scan in progress, click the button.

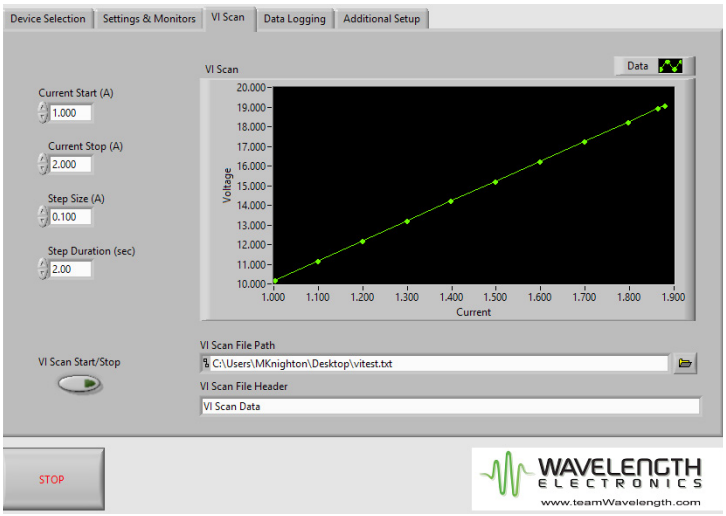

Figure 3. VI Scan Tab - Results with Resistive Test Load

DATA LOGGING TAB

The chart display starts when the Virtual Instrument application starts. It displays the last 17 minutes of data.

Interval (sec): In the *Interval* control, type the desired interval, in seconds, for data to be recorded. The range is 1 to 10 seconds.

Log Data button: Click this button to start or stop logging output current and current limit data to a file. A file path must be specified before data can be logged. When the button is lit, the data is being recorded. To stop logging data, click the button again.

Output Data Graph: Plot of output current and current limit. This data is live and only logged to the file specified in the file path selected below when the Log Data button is pressed.

Output Current (A): The output current is shown in white.

Current Limit (V): The current limit is shown in red.

Logged Data File Path: Type a file path to the location where the data is to be stored. Click the folder icon to browse for a location. A file location must be specified before data can be logged.

Logged Data File Header: In the *Logged Data File Header* control, type the heading that appears at the top of a new data file. If appending data, the file header is not rewritten.

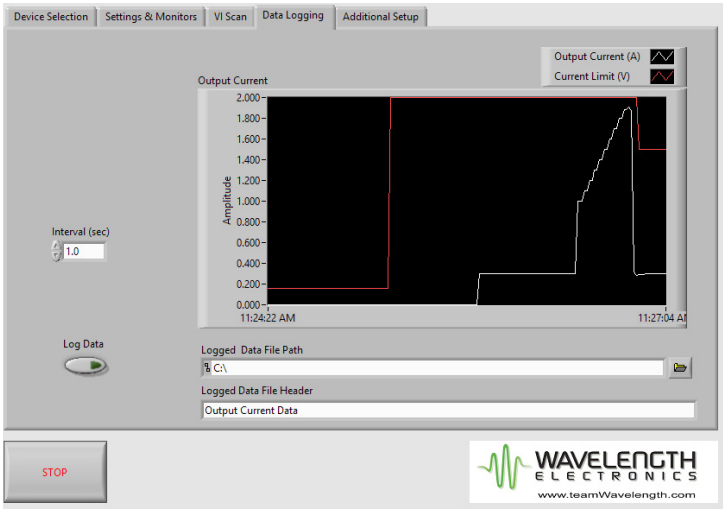

Figure 4. Data Logging Tab

ADDITIONAL SETUP TAB

Get Errors: Click the *Get Errors* button to retrieve all error codes stored on the QCL LAB instrument. These are displayed in the *Error Text* field. See the QCL LAB datasheet for more information on error messages. Once the errors have been retrieved, the button turns gray and the errors are automatically cleared from the instrument error queue.

Existing Profile Name: Click in the field to list all of the existing profile names stored on the QCL LAB instrument. The name selected in this control is affected by the *Save New Profile Name* control.

Save New Profile Name: Two lines can be saved as a profile name in the instrument. Enter the name you want and then press the *Save New Profile Name* control to save a new name (line 1 & line 2) to the profile listed under the existing name. A maximum of 15 characters is allowed in each line.

New Name Line 1: A maximum of 15 characters is allowed.

New Name Line 2: A maximum of 15 characters is allowed.

Figure 5. Additional Setup Tab

OPERATING INSTRUCTIONS - TC LAB

INSTALL THE NATIONAL INSTRUMENTS RUNTIME ENGINE 2015

Prior to installing Wavelength's Virtual Instrument application, the National Instrument (NI) Runtime Engine 2015 must be installed on the remote computer.

When installing the Virtual Instrument .EXE file, if the Runtime Engine is not already installed on the computer, a message with a link to the NI website download page opens. Follow the download instructions on the page. The Runtime Engine can take several minutes to install and requires restarting the computer.

INSTALL TC LAB VIRTUAL INSTRUMENT APPLICATION

1. On the Wavelength TC Software Downloads page, click the LabVIEW Interface for the TC LAB Series and download it to the computer.
2. Save the file to the computer, and open it.
3. Follow the prompts to install the application.

CONNECT THE TC LAB TO THE REMOTE COMPUTER

1. Connect a USB or Ethernet cable from the instrument to the remote computer and turn on the rear panel power switch. See the *TC LAB datasheet* for other connections.

   NOTE: If using an Ethernet connection, configure the network settings with NI-MAX or similar.
2. On the computer, open the Virtual Instrument application.
3. On the **Device Selection** tab, in the *TC Device ID* field, choose the instrument to communicate with. The instrument is identified by the Serial Number, as shown in **Figure 6**.

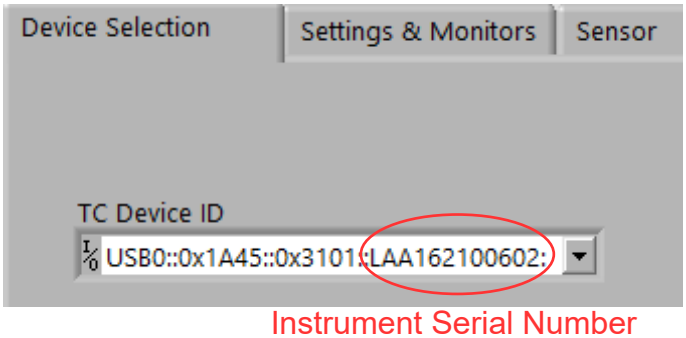

Figure 6. Device Selection Tab

4. On the Virtual Instrument toolbar, click the **Run** icon to communicate with the instrument once you have entered the operating values on the **Settings & Monitors** tab and want to apply the settings. If this icon is visible, the VI is not running, and any changes made on screen will not be implemented.

ADDITIONAL CONTROLS

Running: Indicates that the instrument and application are communicating and commands to implement settings are continuously sent.

Run Continuously: This control is not used.

Running Continuously: This control is not used.

Abort Execution: This stops the application immediately, interrupting any commands that are currently in process. It is NOT recommended to use this method of stopping the application. Instead, use the STOP button.

Stop: Use the Stop button to gracefully end remote control of the instrument. Any commands in process are completed prior to ending remote control. The TC LAB instrument will continue to run in LOCAL MODE.

SETTINGS & MONITORS TAB

The **Settings & Monitors** tab is used as the main control for remote operation.

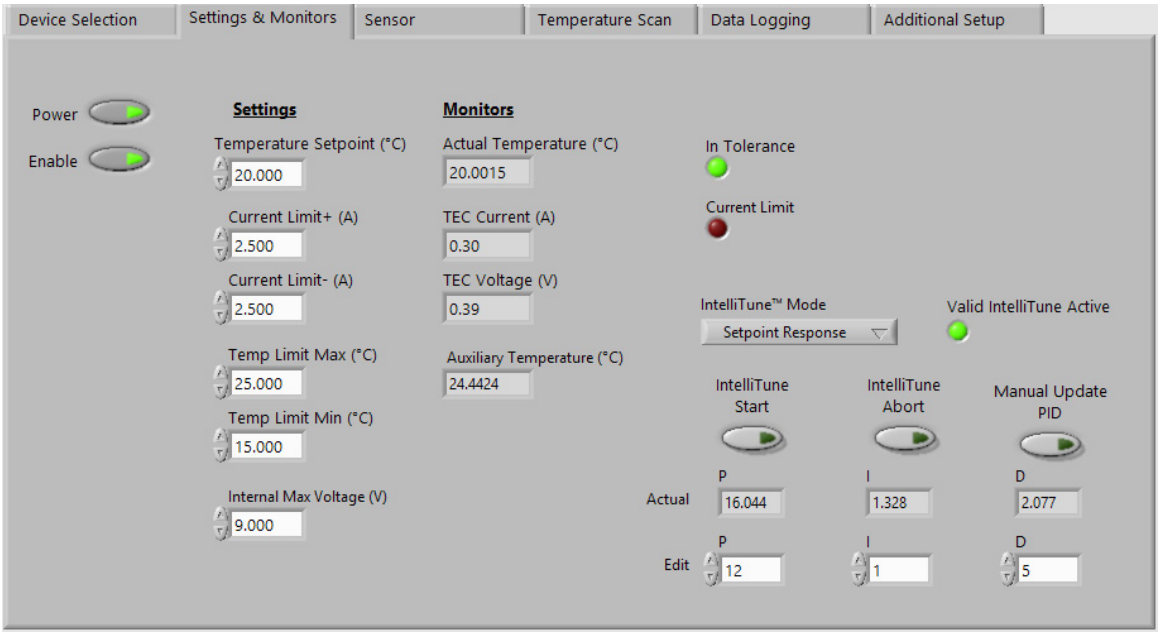

Figure 7. Settings & Monitors Tab

Power: The *Power* button functions the same as the front panel power switch on the instrument.

Enable: The *Enable* button enables current to the load and functions the same as the Enable button on the front panel of the TC LAB instrument.

SETTINGS

Temperature Setpoint (°C): In the *Temperature Setpoint* control, type the desired setpoint, in degrees Celsius. The instrument will attempt to control the load to the temperature entered when output current is enabled. The range is determined by the *Temp Limit Min* and *Temp Limit Max* controls below.

Current Limit + (A): In the *Current Limit+* control, type the maximum value, in Amps, that the TC LAB instrument should not exceed to the load in the positive direction. The range is between 0 and the maximum current allowed by the TC LAB instrument selected.

Current Limit - (A): In the *Current Limit-* control, type the maximum current, in Amps, that the TC LAB instrument should not exceed to the load in the negative direction. The range is between 0 and the maximum current allowed by the TC LAB instrument selected. Although this is the negative current limit, it should be entered as a positive number.

Temp Limit Max (°C): In the *Temp Limit Max* control, type the maximum temperature limit value, in degrees Celsius. This sets the upper limit both for the setpoint and for triggering the laser diode shutdown output. The range is between -99 and +250°C, and may not be less than the value for the temperature setpoint.

Temp Limit Min (°C): In the *Temp Limit Min* control, type the minimum temperature limit value, in degrees Celsius. This sets the lower limit both for the temperature setpoint and for triggering the laser diode shutdown output. The range is between -99 and +250°C, and may not be greater than the value for the temperature setpoint.

Internal Max Voltage (V): In the *Internal Max Voltage* control, type the voltage limit, in Volts, that is available to the load. The range is between 9 and 18V.

MONITORS

Actual Temperature (°C): Monitor the Actual Temperature in degrees Celsius. The sensor calibration is determined on the **Sensor** tab.

TEC Current (A): Monitor the output current through the load in Amps.

TEC Voltage (V): Monitor the voltage across the load in Volts.

Auxiliary Temperature (°C): Monitor the temperature of the auxiliary sensor in degrees Celsius.

LED INDICATORS

In Tolerance: LED becomes lit when the relationship between actual and setpoint temperatures is within the *Tolerance Parameters*. *Tolerance Parameters* are configured on the **Additional Setup** tab.

Current Limit: This LED becomes lit when the TC LAB instrument is operating in either the positive or negative current limit set in Current Limit.

INTELLITUNE® SETTINGS

IntelliTune Mode: Choose *IntelliTune Mode*. The TC LAB instrument will characterize the best PID parameters for your load based on this setting once the *IntelliTune Start* button is pressed if not in Manual Tune mode.

- *Manual Tune* - IntelliTune will not run.
- *Setpoint Response* - Drives the load to temperature fastest.
- *Disturbance Rejection* - Minimizes overshoot.

See the IntelliTune Application Note for more information.

Valid IntelliTune Active: This LED becomes lit when valid IntelliTune data is stored for the currently selected sensor.

IntelliTune Start: Start an IntelliTune cycle based on the selection on the *IntelliTune Mode* control. The button will remain lit until the scan is complete. Clicking the button again after starting IntelliTune will not stop the cycle. The *IntelliTune Abort* button must be used to stop a cycle in progress. If IntelliTune does not complete properly, call customer support for assistance.

IntelliTune Abort: Stop an IntelliTune cycle in progress.

Manual Update PID: Pushing this button will update the PID coefficients to those configured in the controls below.

Actual PID: Monitors the actual proportional, integrator, and derivative terms. These terms will automatically update if IntelliTune mode is changed between Setpoint Response and Disturbance Rejection modes if a valid IntelliTune scan is active.

Edit PID: These controls set the proportional, integrator, and derivative terms for Manual Tuning. P, I, and D will be set to the present control parameters when the *Manual Update PID* button is pressed.

SENSOR TAB

The **Sensor** tab is where the active sensor is chosen, custom sensors are created, or bias currents are adjusted.

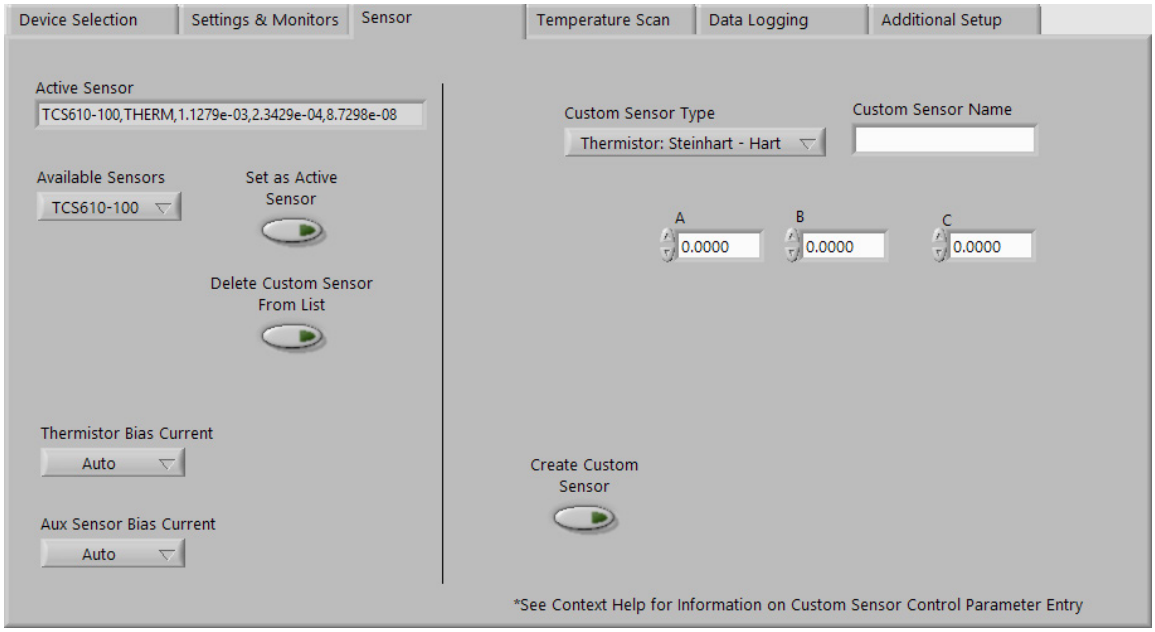

Figure 8. Sensor Tab

Active Sensor: Shows the sensor that is currently selected for use with the TC LAB instrument. The sensor name that is displayed also contains sensor specifications, which vary depending on the type:

- *Thermistor:* Displays the Steinhart-Hart coefficients.
- *RTD:* Displays either the D, I, A Curve Fit, or the slope and offset values.
- *Optical, Voltage IC, Current IC:* Displays the slope and offset values.

For example, if a RTD sensor is the active sensor, and "D, 100" is returned, the instrument is using a DIN Curve Fit for a 100Ω RTD.

Available Sensors: Lists all of the sensor profiles stored in memory for the TC LAB instrument. The sensor name selected in this dropdown menu can be set to the active sensor.

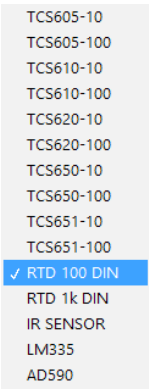

Figure 9. Factory-configured sensor list.

Set as Active Sensor: Set the sensor profile selected with the *Available Sensors* dropdown menu to be the active sensor configuration for the TC LAB instrument.

Delete Custom Sensor From List: Delete a user-created sensor profile selected with the *Available Sensors* control. Attempting to delete a factory configured sensor will result in an error message on the TC LAB instrument.

Thermistor Bias Current: If the TC LAB instrument is configured to use a thermistor type sensor, this control will configure the bias current. Choose *Auto* to allow the TC LAB auto-range function to choose an appropriate bias current or select a suitable range that will produce a voltage across your sensor of 1 to 10 Volts.

Aux Sensor Bias Current: This control will configure the bias current for the auxiliary sensor. Choose *Auto* to allow the TC LAB auto-range function to choose an appropriate bias current or select a suitable range that will produce a voltage across your sensor of 1 to 10 Volts.

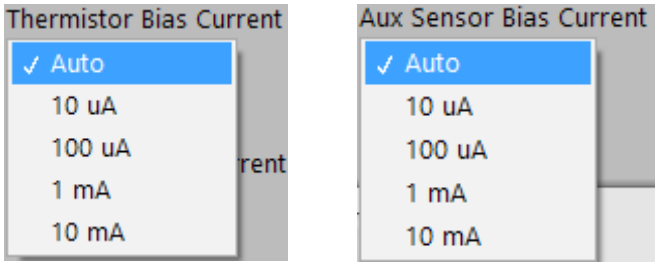

Figure 10. Thermistor and Auxiliary Sensor Bias Current options.

Custom Sensor Type: Choose a sensor type for custom sensor configuration. A sensor name and parameters below must also be configured before the *Create Custom Sensor* button is pushed.

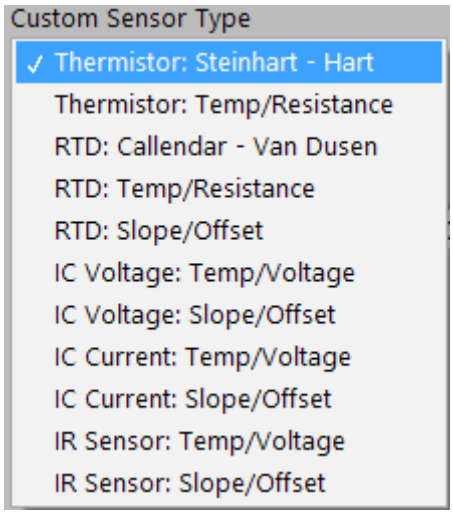

Figure 11. Available Custom Sensor Type options.

Custom Sensor Name: Enter a name for the custom sensor profile. Characters entered should be English letters or numbers. There is a fifteen character maximum limit. If a sensor name is input that exceeds fifteen characters, the name will be truncated after the fifteenth character.

Calibration Coefficients: Depending on the choice of sensor, different calibration options will appear.

- Thermistor (Steinhart-Hart)
  - A, B, C need to be populated by the A, B, C Steinhart-Hart coefficients, respectively.
- Temperature/Resistance *or* Temperature/Voltage
  - For Temperature/Resistance sensors: T1 (R1), T2 (R2), T3 (R3) need to be populated by the temperatures (resistances) for the first, second, and third temperature/resistance pairs, respectively.
  - For Temperature/Voltage sensors: T1 (V1), T2 (V2), T3 (V3) need to be populated by the temperatures (voltages) for the first, second, and third temperature/voltage pairs, respectively.
- RTD (Callendar - Van Dusen)
  - R_0 needs to be populated by the resistance at 0°C.
- Slope/Offset
  - m and b need to be populated by the slope and offset at 0°C, respectively, for a linear approximation of the sensor. Units for the slope are: °C/Ω for RTD, °C/V all others. Units for the offset are: Ω for RTD, V all others. Note that in both cases, the current is across 10kΩ for current based sensors.

Create Custom Sensor: When the *Create Custom Sensor* button is pressed, *Sensor Type*, *Sensor Name*, and configuration parameters are sent to the TC LAB instrument. To use the created sensor, choose its name from the *Available Sensors* list and then press the *Set as Active Sensor* button.

TEMPERATURE SCAN TAB

The **Temperature Scan** tab allows plotting and saving of temperature (actual and set) as a function of time, over a range of temperatures defined in the controls of this tab.

Note that while the functionality of the Temperature Scan in the VI is the same as that on the front panel of the instrument, the commands to carry this scan out are different. For the remote temperature scan, the temperature iterations are done within the VI, and as such, no data will be logged to a flash drive, if inserted. The data will be saved to the appropriate file directory, as specified below.

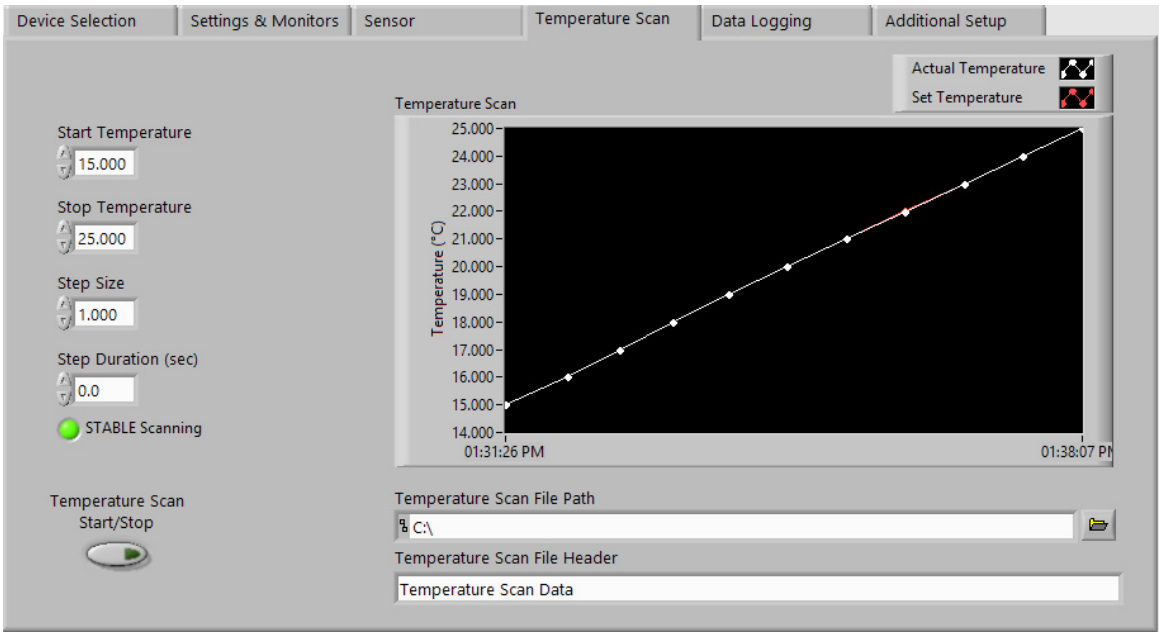

Figure 12. Temperature Scan Tab

Start Temperature: In the *Start Temperature* control, type the temperature, in degrees Celsius, at which to start the temperature scan. The range is determined by the minimum and maximum temperature limits configured on the **Settings & Monitors** tab.

Stop Temperature: In the *Stop Temperature* control, type the temperature, in degrees Celsius, at which to stop the temperature scan. The range is determined by the minimum and maximum temperature limits configured on the **Settings & Monitors** tab.

Step Size: In the *Step Size* control, enter the magnitude of each step in the temperature scan in degrees Celsius. The step size and step duration will determine the length of the scan. The minimum step size must be non-zero. A negative value will result in a scan with decreasing temperature.

Step Duration: In the *Step Duration* control, enter the time delay between steps in seconds. If a value of 0 is entered, the *STABLE Scanning* indicator will be lit and the temperature will be allowed to stabilize at the setpoint before the setpoint is incremented and the data is logged. Stabilization is based on the tolerance parameters on the Additional Setup tab. If *STABLE Scanning* is not used, the range is 1 to 50 seconds.

STABLE Scanning: If the *Step Duration* control is set to 0, the LED will be lit, indicating STABLE Scanning. If it is set to a non-zero value, this LED will remain unlit.

Temperature Scan Start/Stop: Click this button to start or stop a scan. A file path must be specified before running a scan. When the button is lit, the scan is running. The button becomes unlit when the scan is complete. To stop a scan in progress, click the button again. The scan records actual and setpoint temperature over time.

Temperature Scan File Path: Type the file path to the location where the data is to be stored. Click the folder icon to browse for a location. A file name must be provided before a scan can be run.

Temperature Scan File Header: In the *Temperature Scan File Header* control, type the heading that appears at the top of a new scan data file. If you are appending data to an existing file, the header name will not be changed in the file regardless of whether this control field has been changed.

Temperature Scan Graph: Plot of actual temperature, temperature setpoint vs. time. This data is logged to the file specified in the file path selected below when the *Temperature Scan Start/Stop* button is pressed.

DATA LOGGING TAB

The chart display starts when the Virtual Instrument application starts. It displays the last 17 minutes of data.

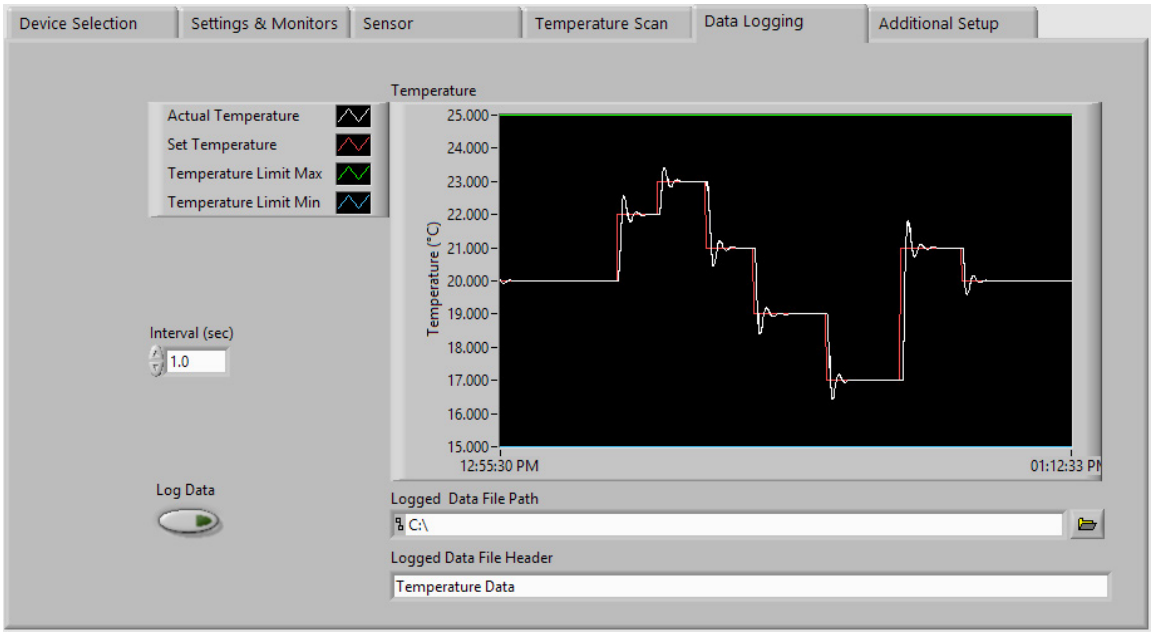

Figure 13. Data Logging Tab

Interval (sec): In the *Interval* control, type the desired interval, in seconds, for data to be recorded. The range is 1 to 10 seconds.

Log Data button: Click this button to start or stop logging actual and setpoint temperature data to a file. A file path must be specified before data can be logged. When the button is lit, the data is being recorded. To stop logging data, click the button again.

Temperature Graph: Plot of temperature limits, setpoint, and actual temperature in °C. This data is live and only logged to the file specified in the file path selected below when the *Log Data* button is pressed.

Actual Temperature (°C): The actual temperature is shown in white.

Set Temperature (°C): The setpoint temperature is shown in red.

Temperature Limit Max (°C): The set maximum temperature is shown in green.

Temperature Limit Min (°C): The set minimum temperature is shown in blue.

Logged Data File Path: Type a file path to the location where the data is to be stored. Click the folder icon to browse for a location. A file location must be specified before data can be logged.

Logged Data File Header: In the *Logged Data File Header* control, type the heading that appears at the top of a new data file. If appending data, the file header is not rewritten.

ADDITIONAL SETUP TAB

The **Additional Setup** tab is where profile names can be edited, added, and saved. Additionally, cable resistance, tolerance parameters, remote enable, and laser shutdown signal polarity are set on the **Additional Setup** tab.

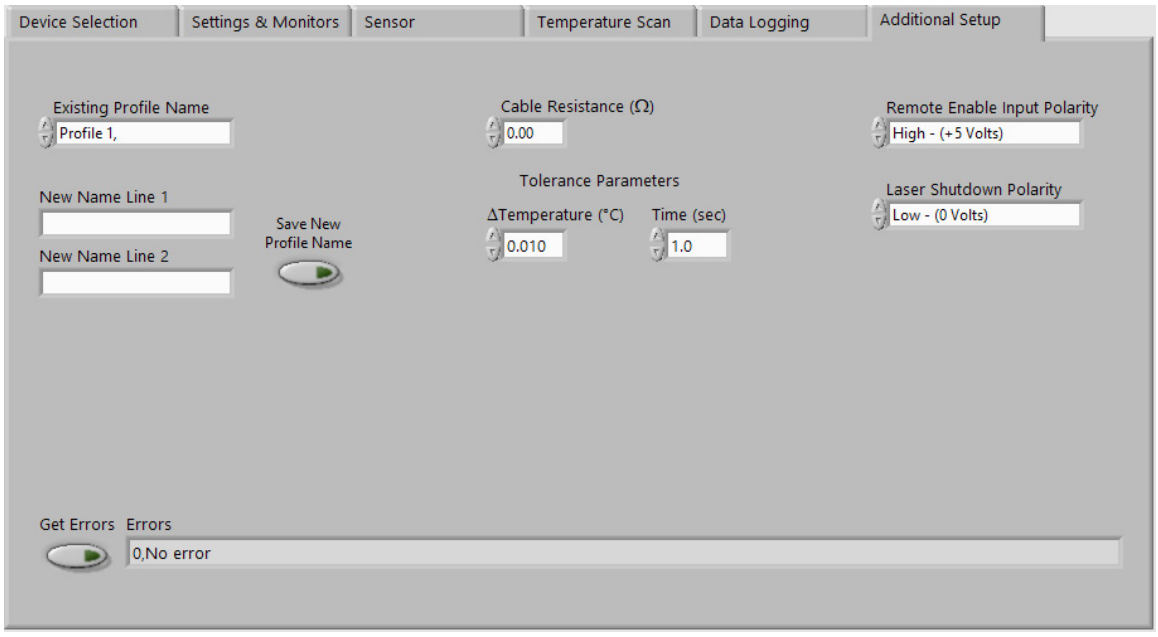

Figure 14. Additional Setup Tab

Existing Profile Name: Click in the field to list all of the existing profile names stored on the TC LAB instrument. The name selected in this control is affected by the *Save New Profile Name* control.

New Name Line 1: A maximum of 15 characters is allowed.

New Name Line 2: A maximum of 15 characters is allowed.

Save New Profile Name: Two lines can be saved as a profile name in the instrument. Enter the name you want and then press the *Save New Profile Name* control to save a new name (line 1 & line 2) to the profile listed under the existing name. A maximum of 15 characters is allowed in each line. Note that only the Profile Name text is saved to the unit. Operating parameters can only be saved by using the Save function on the front panel.

Get Errors: Click the *Get Errors* button to retrieve all error codes stored on the TC LAB instrument. These are displayed in the *Errors* text field. See the TC LAB datasheet for more information on error messages. Once the errors have been retrieved, the button turns gray and the errors are automatically cleared from the instrument error queue. Errors cannot be retrieved while an IntelliTune scan is in progress.

Cable Resistance (Ω): In the *Cable Resistance* control, type the resistance of the cable, in Ohms, between the TC LAB instrument and the load. The resistance is multiplied by output current and subtracted from the load voltage. This calibration parameter gives a better representation of the voltage at the actual load. The range is 0 to 4 Ohms.

Tolerance Parameters: Sets parameters that will enable the TC LAB instrument to define when the temperature is within an acceptable temperature range to be considered "at temperature."

- Δ Temperature (°C): In the *Δ Temperature* control, enter the maximum difference between setpoint and actual temperature for the system to be considered "in tolerance." Minimum tolerance that can be set is 0.01 °C.
- Time (sec): In the *Time* control, enter the amount of time that the temperature differential must be within range before the temperature is considered stable.

If the sensor temperature is within both the temperature and time parameters, the unit will show a target icon on the front panel, the *In Tolerance* LED on the **Settings & Monitors** tab will become lit, and the rear panel 'At Temperature Status' pin will be set.

Remote Enable Input Polarity: In the *Remote Enable Input Polarity* control, select the polarity for the remote enable input on the Status/Enable D-sub on the rear panel to allow output current. The input must be at the level selected before the front panel 'Enable' can be activated. Options are: High (+5V), and Low (0V). Factory default polarity is ENABLE HIGH.

Laser Shutdown Polarity: In the *Laser Shutdown Polarity* control, select the active level for the laser diode shutdown output. The signal will go to the level indicated when the Actual Temperature exceeds the temperature limits. Options are: High (+5V) and Low (0V). The temperature limits are configured on the **Settings & Monitors** tab. Factory default polarity is ACTIVE HI.

OPERATING INSTRUCTIONS - LDTC LAB

INSTALL THE NATIONAL INSTRUMENTS RUNTIME ENGINE 2017

Prior to installing Wavelength's Virtual Instrument application, the National Instruments (NI) Runtime Engine 2017 must be installed on the remote computer.

When installing the Virtual Instrument .EXE file, if the Runtime Engine is not already installed on the computer, a message with a link to the NI website download page opens. The Runtime Engine can take several minutes to install and requires restarting the computer.

INSTALL LDTC LAB VIRTUAL INSTRUMENT APPLICATION

1. On the Software Downloads page, click the LabVIEW Interface for LDTC LAB Series Instrument and download it to the computer.
2. Save the file to the computer, and open it.
3. Follow the prompts to install the application.

CONNECT THE LDTC LAB TO THE REMOTE COMPUTER

Connect a USB cable from the instrument to the remote computer, turn on the rear panel switch and open the Virtual Instrument application.

Choose the instrument to control using the *Choose Instrument* dropdown menu on the right hand side. The list is filtered, and will only show LDTC LAB instruments connected to the computer.

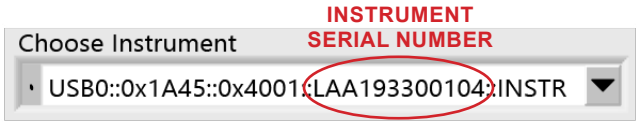

Figure 15. Choose the LDTC LAB to control.

The other functionality of the executable is disabled until a proper connection is made with an instrument.

Start: Use this button to initialize the program after selecting the instrument.

Once a connection is made, the program will initialize all the parameters to match the local values on the instrument.

ADDITIONAL CONTROLS

Stop: Use this button to gracefully stop the execution of the program.

Run: This button will only be available if the program has been stopped previously. Use it to re-start the execution of the program. This is located in the upper left corner of the window.

Running: This icon will only appear when the program is currently running after pressing the **Start** button. This will replace the **Run** button in the upper left corner.

USING THE GUI

The graphical user interface (GUI) for the LDTC LAB allows the user to set and monitor the status of the instrument remotely. **Figure 16** gives an example of the GUI.

Numerical monitor-only values have a gray background, and are uneditable fields (for example, see Actual Temperature). Boolean monitors are dark for FALSE and lit for TRUE (see In Tolerance) and are also uneditable.

Button controls set a boolean value, and also indicate the current value of their state (for example, see TC ENABLE).

Controls have a white background, and are editable either through typing the desired value directly in the field, or by choosing the desired setting from a dropdown box (see Temperature Setpoint and Temperature Units). When a value is set using a control, the instrument is immediately queried, and the field is updated with the current status of the instrument. In this way, the GUI maintains synchronization with the instrument.

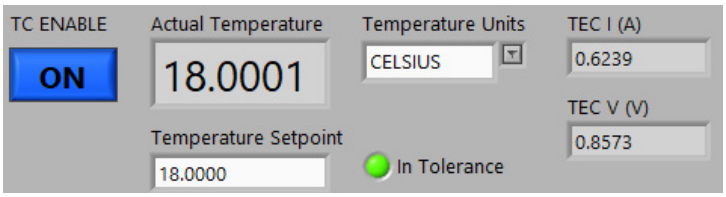

Figure 16. Various controls and monitors on the GUI.
TC ENABLE: TC current is enabled.
Actual Temperature: Read only field - the temperature of the currently used sensor. Actual Temperature shown is 18.0001ºC.
Temperature Units: Dropdown box - choice is to display temperature in degrees Celsius.
TEC I (A) & TEC V (V): Read only fields - TEC current and voltage. The TEC Current shown is 0.6239 A, and the TEC Voltage shown is 0.8573 V.
Temperature Setpoint: Editable field - 18.0000ºC has been chosen for the setpoint.
In Tolerance: Indicator is lit, so Actual Temperature is within tolerance settings of setpoint.

TEMPERATURE CONTROL TAB

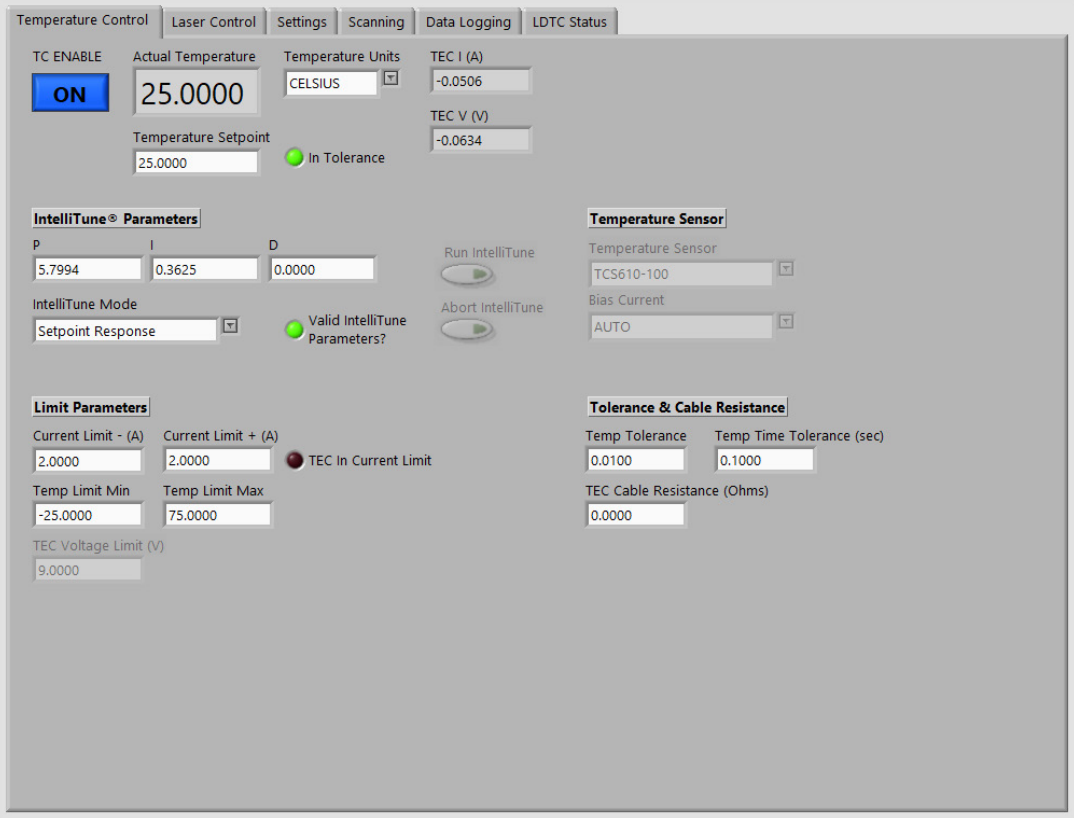

Figure 17. Temperature Control Tab

TC ENABLE: Press this boolean control to enable or disable output current to the TEC.

Figure 18. Output current disabled (left) and enabled (right).

Actual Temperature: This indicator displays the actual temperature measured by the sensor. It is displayed in the units chosen in the *Temperature Units* dropdown menu.

Temperature Units: Choose the units for the temperature parameter display. Choose either Celsius, Kelvin, Fahrenheit, or Raw units.

TEC I (A): This indicator shows the current across the thermoelectric in Amps.

TEC V (V): This indicator shows the voltage across the thermoelectric in Volts.

Temperature Setpoint: Set the desired temperature of the system. Set in the units displayed in the *Temperature Units* dropdown menu. Instrument limits are -99 to 250°C. This input is also bounded by *Temp Limit Min* and *Temp Limit Max*.

In Tolerance: This boolean indicator is lit when the temperature is "in tolerance" as described by the *Temp Tolerance* and *Temp Time Tolerance* fields.

INTELLITUNE® PARAMETERS

P: Sets the proportional gain term value. Range is 0.1-1000.

I: Sets the integral term value. Range is 0-200.

D: Sets the derivative term value. Range is 0-100.

Run IntelliTune: Press this boolean control to begin an IntelliTune scan. The instrument will beep twice to indicate a finished, successful scan. It lights while IntelliTune is running.

IntelliTune Mode: Set the IntelliTune Mode to either Setpoint Response, Disturbance Rejection, or Manual Tuning using this dropdown menu.

Valid IntelliTune Parameters?: This indicator is lit if there is active IntelliTune data stored on the instrument for the current configuration.

Abort IntelliTune: Use this control to cancel an IntelliTune scan in progress. This control is disabled unless IntelliTune is currently characterizing.

Refer to the LDTC LAB USER GUIDE for guidance in using IntelliTune.

TEMPERATURE SENSOR

Temperature Sensor: Use this dropdown menu to select the sensor for temperature control. It is populated with all the available factory- and user-defined sensors.

Bias Current: Use this dropdown menu to select the bias current for the temperature sensor. Options are Automatic, 10 µA, 100 µA, 1 mA, 10 mA.

LIMIT PARAMETERS

Current Limit - (A): Enter the negative current limit for the thermoelectric here as a positive number in Amps. Maximum value is model-dependent.

Current Limit + (A): Enter the positive current limit for the thermoelectric here as a positive number in Amps. Maximum value is model-dependent.

TEC In Current Limit: This indicator will light if the unit is operating in a current limit condition. This usually happens when first driving toward a distant setpoint.

Temp Limit Min: Enter the low temperature limit here in units chosen by the *Temperature Units* dropdown. Available range is -99 to 250°C. This value must be less than *Temperature Setpoint* and *Temp Limit Max*.

Temp Limit Max: Enter the high temperature limit here in units chosen by the *Temperature Units* dropdown. Available range is -99 to 250°C. This value must be greater than *Temperature Setpoint* and *Temp Limit Min*.

TEC Voltage Limit (V): Enter the maximum voltage to the TEC here. This parameter is updated by IntelliTune. Range is 9 to 18 V.

TOLERANCE & CABLE RESISTANCE

Temp Tolerance: Defines the temperature window for the in-tolerance criteria. Range is 0.01 to 10°C.

Temp Time Tolerance (sec): Defines the time window for the in-tolerance criteria. Range is 0.1 to 50 seconds. If the actual temperature stays within *Setpoint Temperature* ± *Temp Tolerance* range for the length of time tolerance, the system is stable and considered "In-Tolerance."

TEC Cable Resistance (Ohms): Set the value of the cable resistance to the thermoelectric in ohms. Range is 0 to 10 Ω.

LASER CONTROL TAB

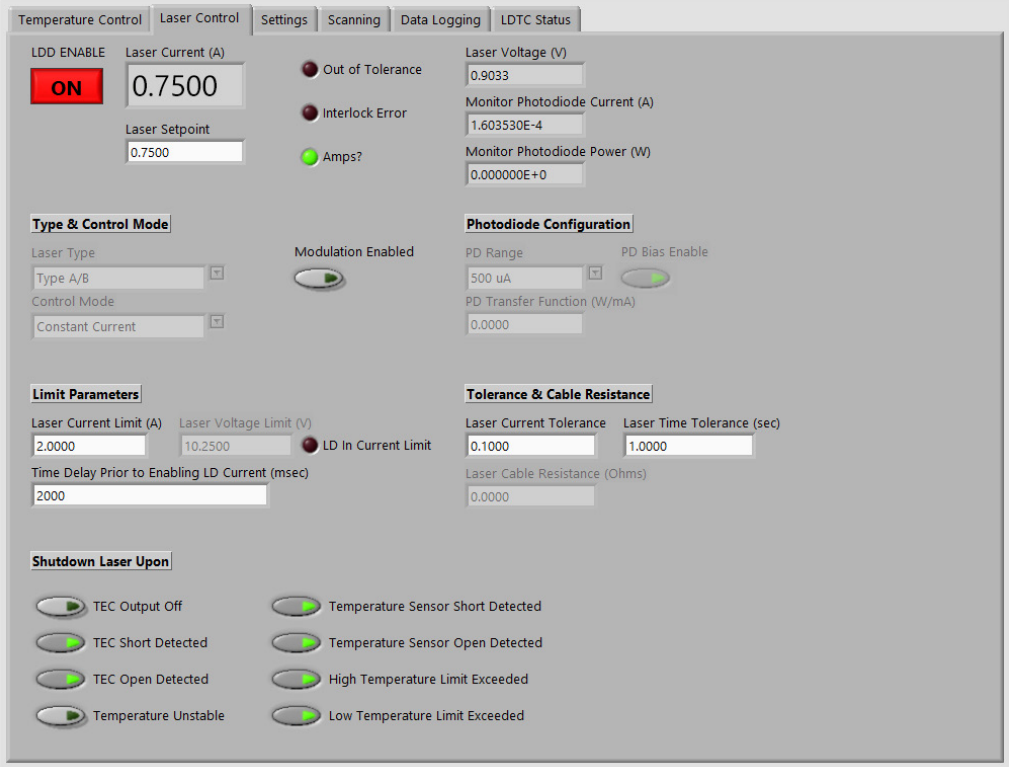

Figure 19. Laser Control Tab

LDD ENABLE: Press this boolean control to enable or disable laser current.

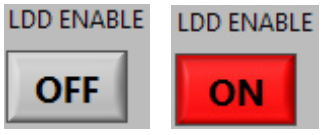

Figure 20. Output current disabled (left) and enabled (right).

Laser Current (A or **mA):** This indicator shows the current through the laser diode.

Laser Setpoint: This control sets the output current to the laser. The interpretation of this value depends on the *Control Mode*. In Constant Current, this sets the laser diode current setpoint. In Constant Power, this sets either the **Photodiode Current (A)** setpoint (zero *PD Transfer Function*) or the **Photodiode Power (W)** setpoint (nonzero *PD Transfer Function*).

Out of Tolerance: This indicator lights if the current output is outside the tolerance window defined by *Laser Current Tolerance* and *Laser Time Tolerance*.

Interlock Error: This indicator lights if any of the required interlocks are not satisfied.

Amps?: This indicator lights if the units are in Amps [defined by the command **LASer:AMPS?** returning 1 (true).] If the indicator is not lit, the units are in mA. This will affect Laser Setpoint, Laser Current, Laser Current Limit, Laser Current Tolerance, Start Current, Stop Current, Current Step, and units of Laser Current in the Scanning and Data Logging Tabs.

Laser Voltage (V): This indicator displays the voltage measured across the laser in Volts.

Monitor Photodiode Current (A): This indicator displays the current, in Amps, measured through the photodiode.

Monitor Photodiode Power (W): This indicator displays the power calculated (*Monitor Photodiode Current* × *PD Transfer Function*) in Watts.

TYPE & CONTROL MODE

Laser Type: Choose the laser type connected to the instrument (Type A/B or Type C).

Control Mode: Choose the control mode, either Constant Current or Constant Power.

Modulation Enabled: This boolean control dictates whether modulation input is used. If enabled, the modulation signal sums with the laser current setpoint. Because of the limited sampling speed of the VI, the actual value of the modulation will not be completely displayed in Laser Current if the modulation varies with time.

PHOTODIODE CONFIGURATION

PD Range: Select the operating range for the photodiode. The three options are 500 µA, 5 mA, 10 mA. Choose the range that optimizes the dynamic range of the photodiode.

PD Transfer Function (W/mA): Set the transfer function that scales the photodiode current to power. Units are W/mA and the range is 0 to 0.1.

PD Bias Enable: This boolean control sets whether the photodiode bias voltage is on (TRUE) or off (FALSE).

LIMIT PARAMETERS

Laser Current Limit (A or **mA):** Set the current limit for the laser. Limit is model-dependent.

Laser Voltage Limit (V): Set the voltage limit for the laser in Volts.

LD In Current Limit: This indicator is lit if the laser driver is operating in a current limit condition.

Time Delay Prior to Enabling LD Current (msec): Sets the delay time in milliseconds between when the output on command is sent and when output is enabled. Range is 0 to 30000 ms.

TOLERANCE & CABLE RESISTANCE

Laser Current Tolerance: Defines the current window for the output to be considered in tolerance. Range is 1 mA to instrument maximum.

Laser Time Tolerance (sec): Defines the time window for the output to be considered in tolerance. Range is 0.1 to 50 seconds.

Laser Cable Resistance (Ohms): Set the resistance for the cable connection to the laser in Ohms. Range is 0 to 4 Ω.

SHUTDOWN LASER UPON

Set any of these controls to TRUE to trigger laser current shutdown if the described condition exists. Any combination of TRUE controls is acceptable.

SETTINGS TAB

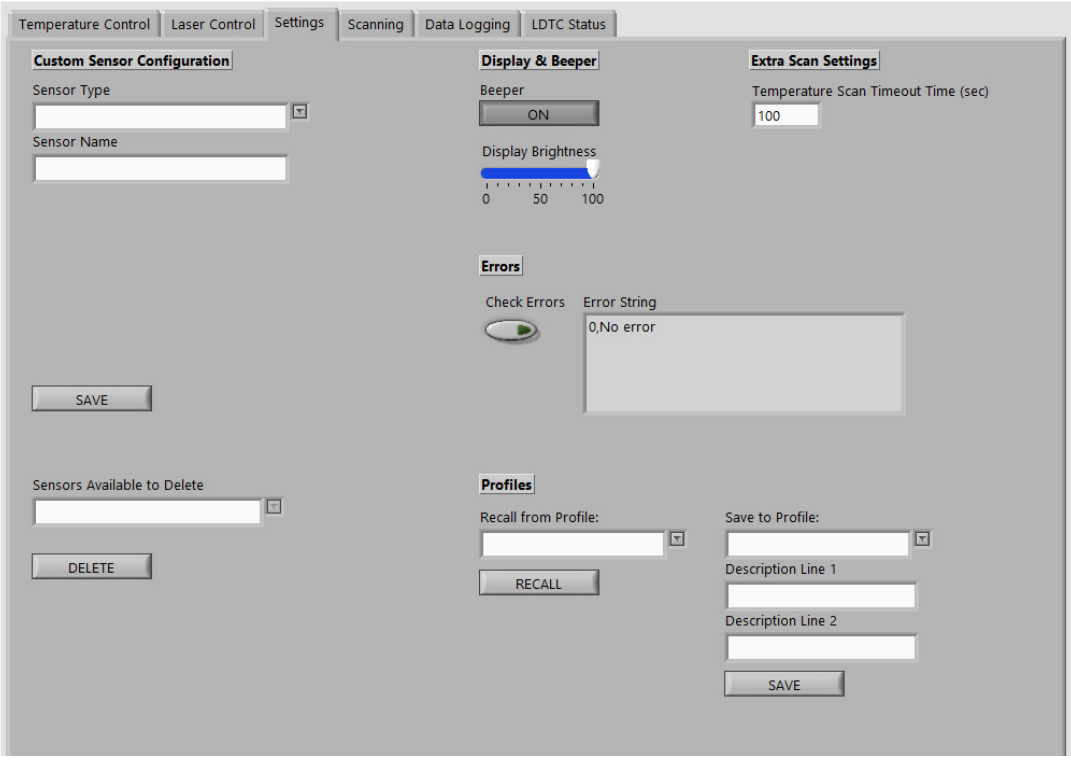

Figure 21. Settings Tab

CUSTOM SENSOR CONFIGURATION

Sensor Type: Use this dropdown menu to select the type of sensor to create. Options are: Thermistor (Therm), RTD, Current IC (ICI), or Voltage IC (ICV). There are multiple calibration methods, these are sensor type-dependent. There are multiple options for parameters depending on the sensor you select:

SO: Slope / Offset

TV: Temperature / Voltage

DAI: Callendar - Van Dusen Curve Fit

SH: Steinhart - Hart

TR: Temperature / Resistance

See **Calibration** for more information.

Sensor Name: Use this field to name the sensor that will be created. There is a 16 character limit (additional characters will be truncated). This is the description that will appear on the front panel of the instrument, and will populate the *Sensor* dropdown menu on the **Temperature Control** tab.

Calibration: Depending on the sensor chosen in the *Sensor Type* dropdown, different calibration fields will populate the screen. There will be either Temperature/Resistance pairs, Temperature/Voltage pairs, Steinhart-Hart coefficients, Callendar-Van Dusen parameters, or Slope/Offset parameters that can be used to characterize the sensor.

Save Configured Sensor: Press the **SAVE** button when the calibration parameters, the *Sensor Name*, and the *Sensor Type* have been properly filled out. Pressing **SAVE** will commit the input parameters to the instrument's local memory. Factory sensors cannot be overwritten.

Sensors Available to Delete: This list is populated by user-created sensors. Factory-defined sensors will not appear on this list because they cannot be deleted. To delete a sensor, choose it from this list, then press **DELETE** below.

Delete: Use this button to delete a sensor selected from the *Sensors Available to Delete* dropdown menu.

DISPLAY & BEEPER

Beeper: This boolean control defines whether the beeper on the instrument is enabled ("ON") or muted ("MUTE").

Display Brightness: This slider defines the front panel brightness in terms of a percentage of maximum brightness.

EXTRA SCAN SETTINGS

Temperature Scan Timeout Time (s): Use this field to change the Scan Timeout Time in seconds. When the temperature scan step time is set to "0" or "Increment when in Tolerance", the scan will timeout and stop if tolerance has not been reached in the designated time limit.

ERRORS

Check Errors: Use this button to query the *Error String* of the instrument. When lit, the query is in process. You can also clear errors displayed on the instrument front panel by checking errors.

Error String: This indicator displays the contents of the error queue when **Check Errors** is pressed. Format is "Error Number, Error Description."

PROFILES

Recall from Profile: Choose which profile to populate the instrument settings. Once the desired profile has been selected, press **RECALL** to load the profile. The application will write the values to the instrument, pause, and re-initialize to ensure synchronization.

Save to Profile: Choose to which profile the current instrument configuration will be saved. Once the desired profile has been selected, press **SAVE** to commit the current configuration to the instrument's memory. There are 10 user profiles that can be configured.

Description Lines: Two lines are visible on the instrument front panel for Save and Recall operations. *Line 1* and *Line 2* commit string descriptors to the profile. Each has a 16 character limit (truncated beyond 16 characters).

SCANNING TAB

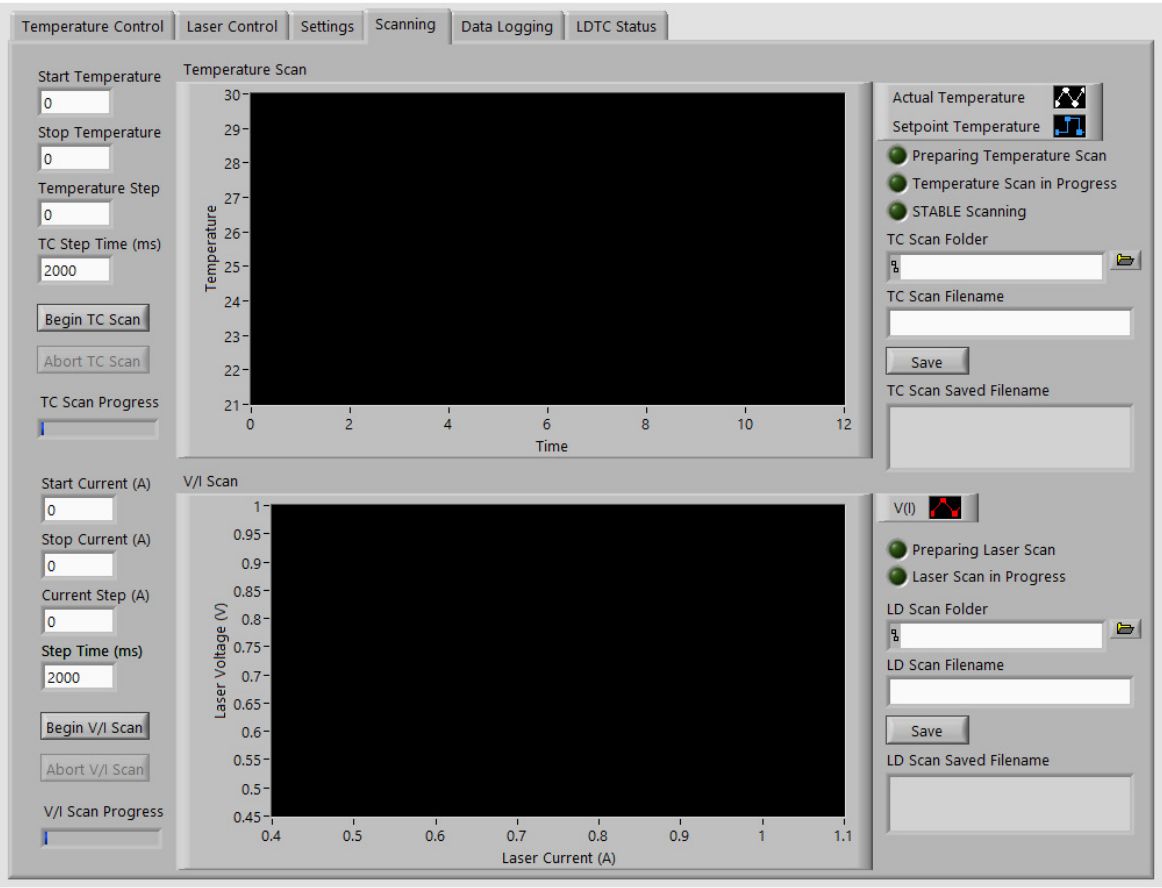

Figure 22. Scanning Tab

TEMPERATURE SCAN

Start Temperature: Input the temperature for the scan to begin. Units are the currently selected temperature units.

Stop Temperature: Input the temperature for the scan to end. Units are the currently selected temperature units.

Temperature Step: Input the size of an individual step in the currently selected temperature units.

TC Step Time (ms): Input the time between steps in milliseconds. If "0" is input, the scan will take place in *Stable Scanning* mode (this indicator will be lit). In this mode, the next step in the scan will not take place until the temperature is "in tolerance." The range is 2000 to 10000 milliseconds (with the option of 0).

Begin TC Scan: Press **Begin TC Scan** once the scan parameters are input and the scan is ready to begin.

Abort TC Scan: Press **Abort TC Scan** to abort a scan in progress.

TC Scan Progress: This indicator shows the progress of the current scan.

Preparing Temperature Scan: This indicator is lit when the **Begin TC Scan** button has been pressed, but the scan has not yet started. Some scans will take slightly longer to begin based on the system settings.

Temperature Scan in Progress: This indicator is lit if a temperature scan is currently taking place.

STABLE Scanning: This indicator is lit if the scan is taking place in Stable scanning mode.

TC Scan Folder: Select a folder where temperature scan data should be saved.

TC Scan Filename: Name the file to be saved. The filename input here will have the suffix "_YYYYMMDD_HHMM" appended to it.

Save TC Scan Data: Press **SAVE** to save the collected data to the file path dictated by *TC Scan Folder* and the filename provided in *TC Scan Filename*.

TC Scan Saved Filename: This field will show the name of the Saved TC Scan Data.

Temperature Scan Plot: This plot shows the collected data. Data points are Actual Temperature (white circular points) and Setpoint Temperature (blue square points).

V/I SCAN

V/I Scan should only be operated in Constant Current (CC) Mode.

Start Current (A or mA): Input the laser current value for the scan to begin.

Stop Current (A or mA): Input the laser current value for the scan to end.

Current Step (A or mA): Input the value the current should increment each step.

Step Time (ms): Input the amount of time the scan should wait between steps, in milliseconds. The range is 2000 to 10000.

Begin V/I Scan: Press the **Begin V/I Scan** button when the scan is configured and is ready to begin.

Abort V/I Scan: Press the **Abort V/I Scan** button to end a scan.

V/I Scan Progress: This indicator shows the progress of the scan currently running.

Preparing Laser Scan: This indicator is lit when the **Begin V/I Scan** button has been pressed but the instrument is waiting for Laser Current to reach stability at the start current. The scan will abort if the current does not come in to tolerance within 30 seconds.

Laser Scan in Progress: This indicator is lit if the laser current is being scanned.

LD Scan Folder: Select a folder to save the laser scan data in.

LD Scan Filename: Name the file to be saved. The filename input here will have the suffix "_YYYYMMDD_HHMM" appended to it.

Save LD Scan Data: Press **SAVE** to save the collected data to the file path dictated by *LD Scan Folder* and the filename provided in *LD Scan Filename*.

LD Scan Saved Filename: This field will show the name of the Saved LD Scan Data.

V/I Scan Plot: This plot shows the collected data. Data points are Laser Voltage (in Volts) as a function of Laser Current (in A or mA). Plot is shown as a red line with square data points.

DATA LOGGING TAB

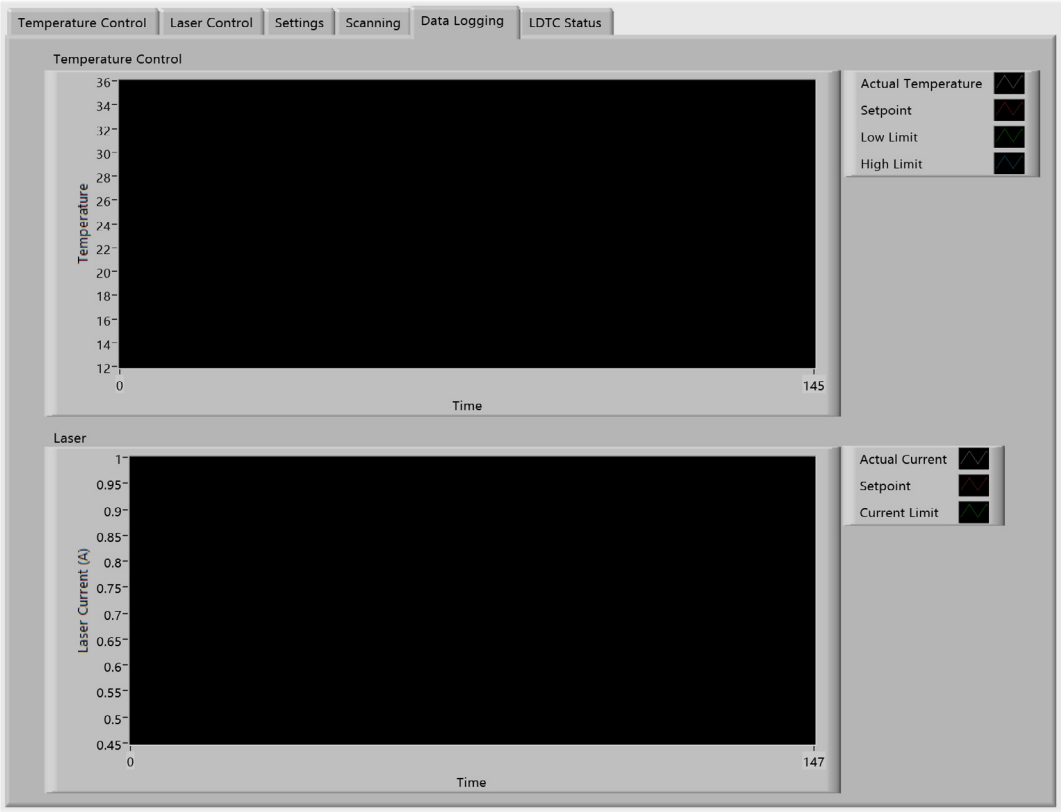

Figure 23. Data Logging Tab

TEMPERATURE CONTROL

This plot shows various temperature control parameters as a function of time. There are four parameters that populate the plot:

- Actual Temperature (white)
- Setpoint Temperature (red)
- Low Temperature Limit (green)
- High Temperature Limit (blue)

Temperature is plotted in the units currently active on the instrument.

LASER

This plot shows various laser control parameters as a function of time. There are three parameters that populate the plot:

- Actual Laser Current (white)
- Setpoint Laser Current (red)
- Current Limit (green)

The laser current is plotted in units currently active on the instrument (mA or A).

LDTC STATUS TAB

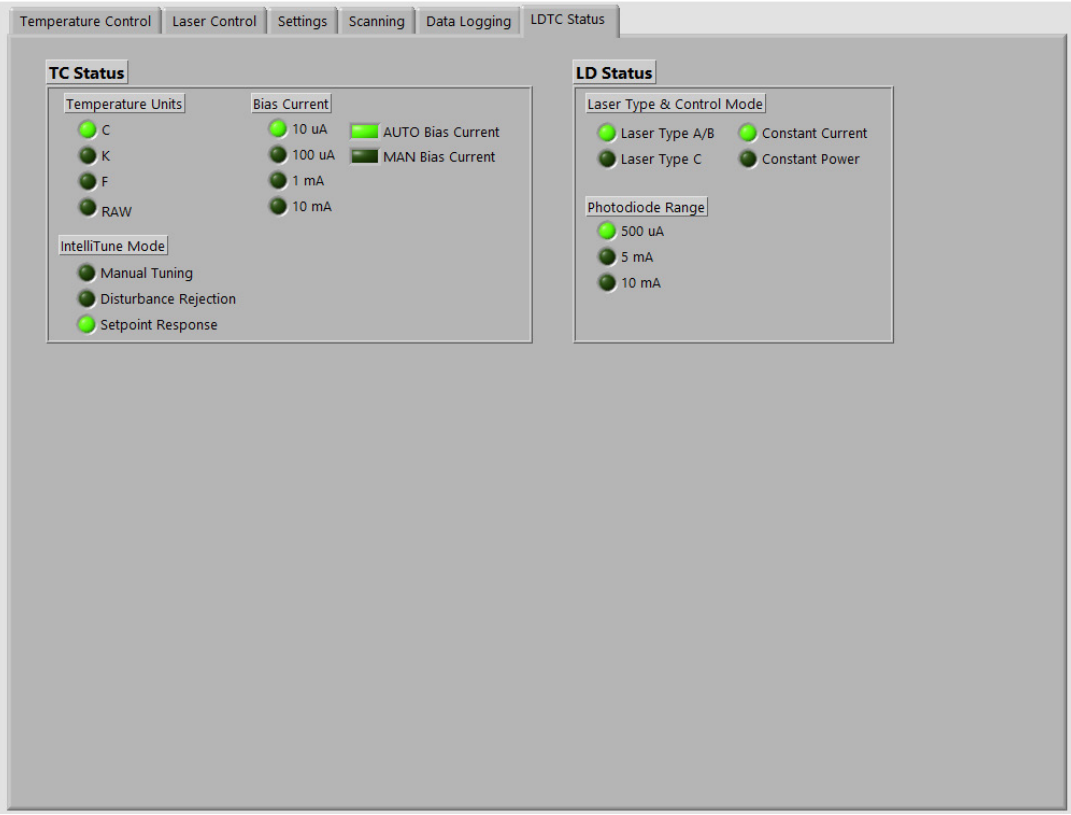

Figure 24. LDTC Status Tab

TC STATUS

Temperature Units: The indicator corresponding to the currently active temperature units will be lit.

Bias Current: There will be two indicators lit in this cluster, one indicates if bias current is auto ranging (AUTO) or manually fixed to a value (MAN). The bias current being applied to the sensor is also lit (10 µA, 100 µA, 1 mA, or 10 mA), indicating the bias current value.

IntelliTune Mode: One of the mode indicators will be lit, indicating the current IntelliTune mode setting.

LD STATUS

Laser Type & Control Mode: There will be two indicators lit in this cluster, one of either Laser Type A/B or Laser Type C, and one of either Constant Current (CC) or Constant Power (CP), indicating the laser type and operation mode currently active.

Photodiode Range: One of the indicators corresponding to the active photodiode range will be lit.

ADDITIONAL TECHNICAL INFORMATION

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LabVIEW is a registered trademark of National Instruments.

TROUBLESHOOTING

PROBLEM	POTENTIAL CAUSE	SOLUTION
My instrument does not appear in the Choose Instrument / Device ID menu.	The instrument is not connected to the computer properly or the power is not on.	• Check the power cables to make sure they are attached properly and securely, and the rear power switch is turned on. • Check USB cable or Ethernet cable and network settings.
The changes I have made on the VI are not appearing on my instrument.	The VI is not communicating with the instrument.	Make sure that the "Run" or "START" button on the VI is pressed to have remote changes implemented.
I'm getting a LabVIEW timeout error, device ID error, or an incompatible instrument error.	Communication with the instrument has not been established or has been lost.	Restart the application and re-select the proper instrument in the Choose Instrument / Device ID menu.
I try to run the Runtime Environment file and "*This application can't run on your PC*" shows up	The NI file downloaded is corrupt.	Download the file again.
I don't know what version of the file I'm running		On the executable file, right click then choose *Properties*. The version number is on the *Details* tab .
Context Help is not displaying.	Context Help is disabled.	Under the Help menu of the NI Runtime Engine, choose *Show Context Help*. Or press Ctrl+H.
I try to change the temperature in the TC LAB VI, but the VI resets the value to a different temperature.	A Temperature Scan is in progress.	Either wait for the temperature scan to finish, or abort the temperature scan to enable immediate temperature setpoint adjustment.
When I click "Get Errors" in the TC LAB VI, the button lights up, but no errors appear.	Either an IntelliTune scan or a Temperature Scan is in progress.	If the VI is currently running an IntelliTune or a Temperature scan, the VI waits for the scan to complete prior to checking for errors. If you wish to see the errors immediately, abort the scan that is running.
I can't press the **START** button or the **STOP** button. They are "grayed out."	The VI has stopped/disconnected from the instrument.	Press the **Run** button (upper left hand corner) and then the **START** button. You may need to select your instrument beforehand. If the application has stopped ungracefully, restart the VI.
I downloaded the Runtime Engine and installed it, but the error saying I need it is still showing.	Installed 32 bit instead of 64 bit (or the reverse).	NI Runtime Engine is specific to the computer on which you are installing. In Control Panel - System determine if you have 32 or 64 bit system. Install the corresponding NI Runtime Engine.
During temperature scan, after each step, it seems to miss a datapoint.	When setpoint changes, P, I, & D coefficients are recalculated. There is a brief time where Actual Temperature is not available. Accurate date is still recorded.	Try STABLE scanning.

WARRANTY & CERTIFICATION

CERTIFICATION

Wavelength Electronics, Inc. (Wavelength) certifies that this product met its published specifications at the time of shipment. Wavelength further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology, to the extent allowed by that organization's calibration facilities, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Wavelength software is warranted against defects in materials and workmanship for a period of 90 days from date of shipment. During the warranty period, Wavelength will, at its option, either repair or replace products which prove to be defective.

WARRANTY SERVICE

For warranty service or repair, this product must be returned to the factory. An RMA is required for products returned to Wavelength for warranty service. The Buyer shall prepay shipping charges to Wavelength and Wavelength shall pay shipping charges to return the product to the Buyer upon determination of defective materials or workmanship. However, the Buyer shall pay all shipping charges, duties, and taxes for products returned to Wavelength from another country.

LIMITATIONS OF WARRANTY

The warranty shall not apply to defects resulting from improper use or misuse of the product or operation outside published specifications. Warranty for the QCL instrument is invalid if the instrument cover has been removed for any reason. No other warranty is expressed or implied. Wavelength specifically disclaims the implied warranties of merchantability and fitness for a particular purpose.

EXCLUSIVE REMEDIES

The remedies provided herein are the Buyer's sole and exclusive remedies. Wavelength shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory.

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LIFE SUPPORT POLICY

This important safety information applies to all Wavelength electrical and electronic products and accessories:

As a general policy, Wavelength Electronics, Inc. does not recommend the use of any of its products in life support applications where the failure or malfunction of the Wavelength product can be reasonably expected to cause failure of the life support device or to significantly affect its safety or effectiveness. Wavelength will not knowingly sell its products for use in such applications unless it receives written assurances satisfactory to Wavelength that the risks of injury or damage have been minimized, the customer assumes all such risks, and there is no product liability for Wavelength. Examples of devices considered to be life support devices are:

> neonatal oxygen analyzers, nerve stimulators (for any use), auto-transfusion devices, blood pumps, defibrillators, arrhythmia detectors and alarms, pacemakers, hemodialysis systems, peritoneal dialysis systems, ventilators of all types, and infusion pumps as well as other devices designated as "critical" by the FDA. The above are representative examples only and are not intended to be conclusive or exclusive of any other life support device.

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REVISION	DATE	NOTES
A	January 2017	Initial Release
B	May 2017	Introduced TC LAB VI
C	October 2019	Introduced LDTC LAB VI