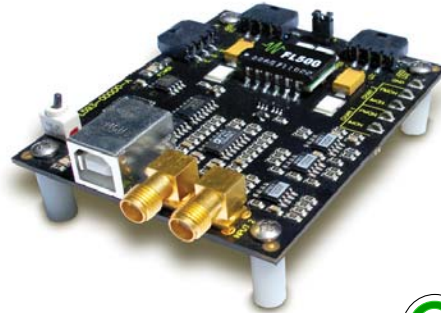# WAVELENGTH
E L E C T R O N I C S

FL593

USB Controlled Dual-Channel Laser Diode Driver

RoHS Compliant

DESCRIPTION:

The FL593 brings Wavelength's low noise FL500 laser diode driver under USB computer control. This full speed USB controller comes with a robust driver, a simple Windows™ control interface, and an easy-to-use development API for rapidly building custom applications.

On-board nonvolatile memory holds operational settings. Download a configuration, then disconnect the FL593 from the PC and it continues operating – standalone. Or use USB hubs to control multiple units from a single computer USB port.

This adaptable module is ideal for remotely controlling multiple laser diodes – such as burn-in racks, L-I characterization systems, etc. Setpoint, current limit, channel tracking and feedback mode settings are all under computer control. Optional analog inputs facilitate up to 500 kHz modulation in Constant Current mode.

FEATURES:

- Low noise laser diode control
- Controls lasers with common photodiode cathode (Type A) configuration or isolated photodiode (Type B) configuration
- Independent Constant Current or Constant Power mode settings
- Drive 2 channels up to 250 mA each or a single channel up to 500 mA
- Wide supply voltage range: +4.5 to 9 V
- Analog signal monitoring points
- Safety Interlock
- Includes input/output & USB cables
- Application software included
- Application programming interface (API) library available
- FL500 is Reflow Oven Compatible

ORDERING INFORMATION:

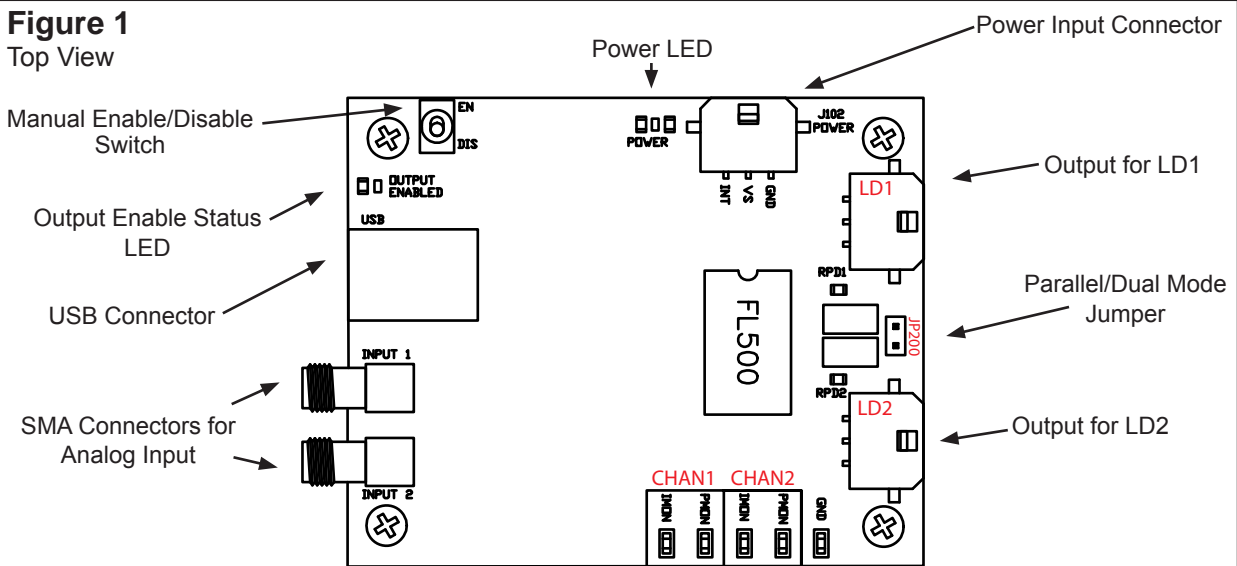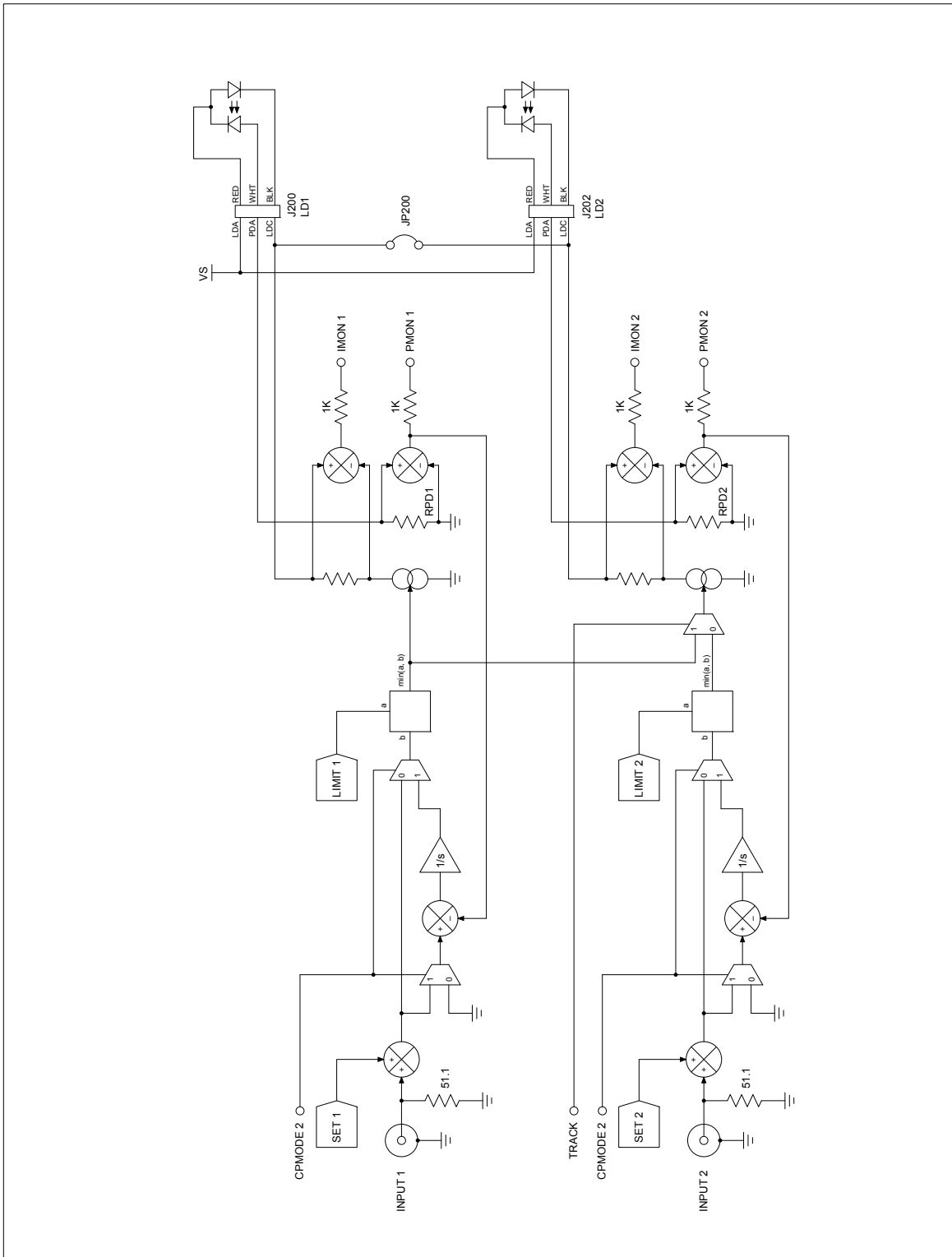| FL593FL	WITH FL500 installed

Figure 1
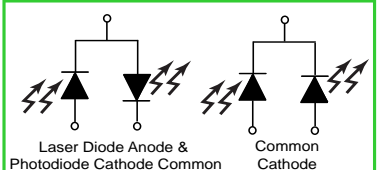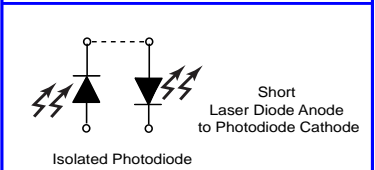Top View

Manual Enable/Disable Switch

Output Enable Status LED

USB Connector

SMA Connectors for Analog Input

Power LED

Power Input Connector

Output for LD1

Parallel/Dual Mode Jumper

Output for LD2

Figure 2 -- FL593 BLOCK DIAGRAM

SETUP INFORMATION

Fill in the following chart of configuration and operation mode options prior to installation. Have this data available before calling Wavelength Electronics Technical Support.

Description	Value in your application	Notes
Laser Diode Configuration	A, B or C	The FL593FL supports type A or B laser diodes. See below for explanation of laser diode types.

Type A Laser Diode	Type B Laser Diode	Type C Laser Diode
Laser Diode Anode & Photodiode Cathode Common Common Cathode	Short Laser Diode Anode to Photodiode Cathode Isolated Photodiode	Laser Diode Cathode & Photodiode Anode Common Common Anode

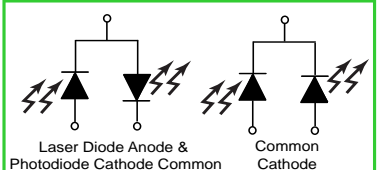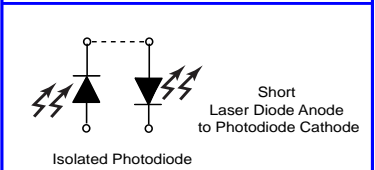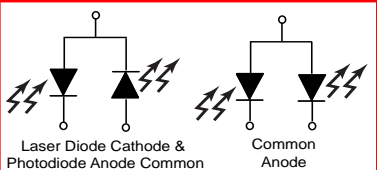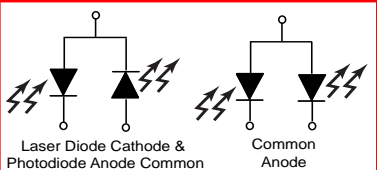|		
Laser Diode Max Current		
Operating LD Current		
Operating PD Current		
Operating Mode	CC or CP	Constant Current (CC): Laser diode current is fixed, power varies. Constant Power (CP): Laser diode current varies. Photodiode current is fixed. Power output is fixed
Power Supply Voltage		Make sure to check the SOA curve in the FL500 datasheet or use the online SOA calculator at: http://www.teamwavelength.com/permanent/fl593/support/soa.html
Channel Count	1 or 2	Will one or two control outputs be required?
Tracking Configuration	Parallel or Independent	Will the control outputs function in unison or independently?

SPECIFICATIONS

Description	Value
Size	3.25 x 2.5 x 1.125 inches (8.25 x 6.375 x 3 mm)
Weight	1.6 ounces
Supply Voltage (V_S)	4.5 – 9 Volts
Quiescent Current (maximum)	80 mA (5 V), 95 mA (9 V)
Modes (software selectable)	Constant Current or Constant Power
Output Current	250 mA per channel or 500 mA paralleled
USB Interface	Full Speed, Self-powered USB 2.0
Operating Temperature	15°C to 45°C [1]
Storage Temperature	-55°C to 125°C
A/D & D/A Resolution	12 bits (61 µA step size)
Analog Input	50 Ω termination
Operating System	Windows 32-bit operating systems: 2000, Vista, XP or Windows 7, US English Edition [2]
Memory	256 MB minimum
.NET Framework	2.0 or higher

NOTES:
(1) Ambient air temperature. Active airflow may be required when the FL500 is dissipating more than ½ Watt.

(2) The software is not compatible with 64-bit operating systems, nor is it compatible with Windows 95/98/ME.

QUICK START

The following is an overview of the steps required to connect the FL593 and install the USB software. Greater detail is contained in the Operating Instructions of this manual. Please review the entire manual before operating the FL593 and the Quick Connect Application -- it contains important tips and safety information to help protect your data and your laser.

1. Connect FL593 Power Cable

Connect the power supply for the FL593 to the device (J102) with the cable provided.

2. Connect the PC USB

Connect the USB cable to the appropriate port on the PC. Connect the USB cable to the FL593.

NOTE: When connecting or disconnecting the FL593 from the host computer, it is better to do so at the device USB port.

3. Insert Wavelength Installation CD

Insert the installation CD provided with the FL593 into the CD drive of the PC.

4. Logon

If required by your system, logon to the PC. Administrator privileges are required to install new hardware or software. The Wavelength Installation will not proceed without proper authorization.

NOTE: Administrator privileges are not required to run the QuickConnect Application once it has been installed.

5. Install WEIUSB Driver

If this is the first time that the FL593 has been connected to the PC, the operating system will notify the user that new hardware has been found and launch a hardware installation utility. If the Wavelength CD is in the CD drive, the WEIUSB driver will automatically be found and installed.

6. Install Quick Connect Application (QCA)

The QCA Installation utility will launch automatically. Select "Product Manual" to download the manual. Select "Install QCA" to begin software installation.

7. Verify Installation

Verify successful installation by closing the QCA Installation utility and selecting the Wavelength Electronics QCA program from the Start Menu Program Group. When the application window opens, select Open Device from the File menu. A selection window should appear with a device displayed for selection.

OPERATING INSTRUCTIONS -- SOFTWARE INSTALLATION

1. Connect the Power Supply

A cable (WCB101) is provided to connect to the power input connector shown in Figure 1. The wires should be connected as follows:

Pin	Label	Color	Description
1	INT	White	Interlock
2	VS	Red	Power Supply
3	GND	Black	Ground

The interlock connection is provided to allow for disabling the laser output in case of opening a safety shield or protective cover. This line must be held at ground potential to allow device operation. If the interlock is floating or held above 0.8 V, the device output will be disabled.

NOTE: Use the lowest power supply voltage necessary to meet the compliance (threshold voltage) needs for the laser. Excess voltage will result in undesirable power dissipation in the FL500 device on the FL593 board. To ensure that the FL500 operates within the Safe Operating Area (SOA) refer to the SOA charts in the FL500 manual or the online SOA calculator at:
http://www.teamwavelength.com/permanent/tools/.

2. Connect to Host Computer Via USB Cable

Standard USB peripheral cables are used to connect the FL593 to the host computer. USB hubs and extension cables may be used as necessary according to USB specifications.

A USB compatible cable is provided with the FL593 device. Connect this cable to the PC port and to the USB connector on the FL593 board.

3. Power on FL593

When power is applied to the FL593, the POWER LED will come on. Factory default settings are for zero current, however, you may choose to disable any possible output by setting the ENABLE switch on the board to DISABLE (DIS).

When the FL593 is first powered up, the PC may alert the user that a new piece of USB hardware has been detected.

Installation of the hardware driver will occur in conjunction with installation of the QuickConnect Application software.

Also on first power-up, the FL593 will execute a default set of configuration instructions that sets all limits and setpoints to zero, disables the output, and puts the system in dual channel, Constant Current mode.

4. Load Software

The Wavelength USB driver and the FL593 QuickConnect software must be downloaded and installed prior to using the FL593 with your computer. Software can be installed from the CD included by request with your order, or from Wavelength's website using the links below.

The Wavelength USB driver is required for use with all Wavelength USB devices.

Administrator privileges are required to install new hardware or software. The Installation CD will prompt for the appropriate logon.

NOTE: Administrator privileges are not required to run the QuickConnect Application once it has been installed.

The latest version of the Wavelength USB driver can be downloaded at:

http://www.teamwavelength.com/permanent/usb/driver.html

The FL593 QuickConnect Application software can be downloaded at:
http://www.teamwavelength.com/permanent/fl593/download/

OPERATING INSTRUCTIONS -- SOFTWARE INSTALLATION (continued)

5. Install QuickConnect™ Application (QCA) Files

The Quick Connect Application Installation utility provides five options: *Driver Installation Instructions, FL593 Product Manual, QuickConnect™ Software Installation, API Reference Documentation,* and *Browse CD.*

Figure 3: Installation Utility

The Product Manual and additional support documentation are also available from the QCA Help menu. These can be accessed at any time by clicking the *FL593 Product Manual* link. A PDF-viewer application is required to open the manual.

Clicking the *Driver Installation Instructions* link will open a document that provides step-by-step guidance for installing the hardware driver. This is in HTML format and will be displayed in the available web browser application.

Clicking the *API Reference Documentation* link will open a hot-linked HTML document that provides advanced programming information, such as variable classes used, communication interface structure, and code samples. A web browser is required to view this document, which is also available from the QCA Help menu.

Clicking the *Browse CD* link will allow you to view the file structure on the CD and manually copy or open selected items.

To install the QuickConnect™ Application itself and begin using the FL593 with USB control, click the *QuickConnect™ Software Installation* link.

You will be allowed to specify a program file location. This is where the executable files, the drivers and the default configurations will be stored. Data and configuration files generated during use of the QCA with the FL593 can be stored in separately designated locations.

NOTE: If the "Just Me" installation option is selected, the Wavelength Program Group will only be available from the Start menu if the installer has logged on.

OPERATING INSTRUCTIONS -- SOFTWARE INSTALLATION (continued)

6. Install WEIUSB Driver

If this is the first time that the FL593 has been connected to the PC, the operating system will notify the user that new hardware has been found and launch the hardware installation utility. If the Wavelength Installation CD is in the CD drive, the WEIUSB driver will automatically be found and installed.

NOTE: The WEIUSB driver is an unsigned driver for Microsoft. Systems that have been configured to block installation of unsigned drivers will not be able to run the QCA or the FL593 over USB. If you are having difficulties, please contact your IT department for installation assistance.

If you use more than one FL593 device, each device will register as new hardware the first time it is recognized by the computer. For this reason it is useful to keep the CD in a known location or download the driver files from the web and store them on the PC. During installation, the utility can be instructed to locate them on the Wavelength website, but it is more efficient if they are already resident on the computer or CD.

NOTE: If you intend to use multiple FL593 units, please contact Wavelength Technical Support for an efficient way of registering the driver once for all of them.

7. Verify Installation

Verify successful installation by closing the QCA Installation utility and selecting the Wavelength Electronics QCA program from the Start Menu Program Group. When the QCA application window opens, select Open Device from the File menu. A selection window will appear with a device displayed for selection.

Select the displayed device and click the *Open Device* button. This will open a device window for the FL593 in the QCA. From this window, it is possible to configure the device for your specific application requirements.

NOTE: When multiple FL593 units are simultaneously connected to the host computer, they will be listed in the order in which they were connected. Review the identifying information in the right-hand pane before opening the device.

If any problems were encountered when opening the FL593 in the QCA, please refer to the Troubleshooting section of this manual, or contact Tech Support by phone at 406-587-4910, or by email at techsupport@teamwavelength.com.

Figure 4: Open Device
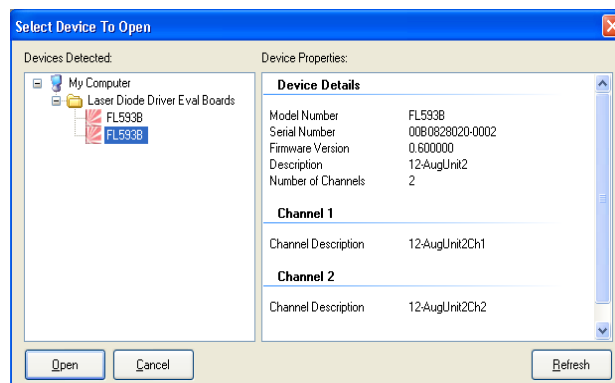
8. Set RPD (Photodiode Feedback Resistor) -- Optional

The factory installs a 1 kΩ photodiode feedback resistor (R_{PD}), giving a transfer function of 1 mA/V of photodiode feedback current (maximum 1 mA PD current). If your application requires a different transfer function or range (see sections 17 and 18, page 16), modify the board with a different resistor, and change the R_{PD} value in the Operating Profile tab before setting any other parameters in the QCA.

Open the FL593 in the QCA. The default tab is the Operating tab. Ensure that the Operating Mode is set to Constant Current (CC).

In CC mode, the R_{PD} value is modifiable. In Constant Power (CP) mode it is read-only.

Ensure that the Tracking Configuration is set to Independent. In parallel mode, the R_{PD} value for Channel 2 cannot be accessed.

Next ensure that the Output Enable check box is not checked, meaning that output has been disabled. The R_{PD} value cannot be modified while output is enabled.

Finally, ensure that both the Limit and Setpoint values are set to the factory default of zero (0).

Now you can set the R_{PD} value to match the resistor chosen for the FL593 board and your application. Type in the number desired and press the <Enter> key, tab out of the field, or use the mouse to select a different data entry field.

Once you have entered the correct R_{PD} value, you will need to save the profile to the device. Click the *Save Profile* button. You will be offered the choice of *Save to File* or *Save to Device*. Choose the *Save to Device* option and click *OK*.

9. Configure for Dual (Independent) or Parallel Operation

The outputs can be operated as independent current sources for up to 250 mA per channel or can be paralleled to sum the current of both channels into the LD connectors. With the outputs paralleled the maximum output current is 500 mA.

The position of jumper JP200 selects whether the channel outputs are summed together. When the jumper is installed, the output current from both channels is combined for use with a single laser diode. Each channel setpoint and limit will still operate independently of each other. The jumper JP200 shorts the LDC pins on each of the output connectors, J200 and J202. (Reference Figure 1, page 1)

To operate both channels in parallel: Set the channel tracking to parallel in the FL593 QCA software. Then install the shunt onto jumper JP200 to combine the outputs of both channels.

To operate both channels independently: Ensure that the jumper JP200 has been removed, isolating each channel's output. Then set the channel tracking to independent in the FL593 QCA software.

OPERATING INSTRUCTIONS -- HARDWARE CONFIGURATION (continued)

10. Connect the Laser Diode(s)

The FL593 supports Type A or Type B lasers (see diagrams page 3). Connection to the laser diode(s) can be made with the cable (WCB102) provided using the following connections.

Pin	Label	Color	Description
1	LDA	Red	Laser Anode
2	PDA	White	Photodiode Anode
3	LDC	Black	Laser Cathode

Cables should have as low an inductive value as possible, and should not exceed approximately one meter in length.

Connections to the laser diode should occur while power is disconnected from the FL593. Failure to remove power prior to connection or disconnection of the load may result in injury to persons or irreparable damage to the laser diode.

Figure 5: Simulated Laser Loads
Constant Current Mode:

Laser Diode Anode

1N4001

1N4001

1 Ω (optional)

Laser Diode Cathode

The 1N4001 general purpose rectifier has a forward voltage of 1.1V per diode and is suitable for simulation of drive currents less than 1 Amp.

Figure 6: Simulated Laser Loads
Constant Power Mode:

PD ANODE

LD ANODE

1N4001

1N4001

0.33 μF or larger

24 Ω

LD CATHODE

2N3906

This circuit provides a fixed photodiode current. The 24 Ω resistor typically produces 30 mA of laser diode current. Vary the resistor size to change the current output.

NOTE: A simulated laser diode load is recommended for initial operation (See Figures 5 & 6). Simulation of the laser allows the user to become familiar with the configuration and operation of the laser driver without risking damage to an expensive laser diode. Always check the Laser Diode Driver, Safe Operating Area analysis tool to avoid excessive power dissipation in the laser driver: http://www.teamwavelength.com/permanent/fl593/support/soa.html**.**
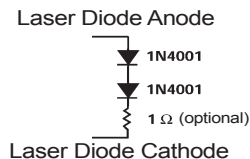
11. Analog Input Modulation Connections

The analog modulation input allows an external voltage source to control the amplitude of the laser driver output. This modulation is summed with any DC bias set with the QCA software to achieve the final setpoint voltage.

In the dual channel (independent) configuration, the transfer function of output current to input voltage in Constant Current mode is 125 mA/V.

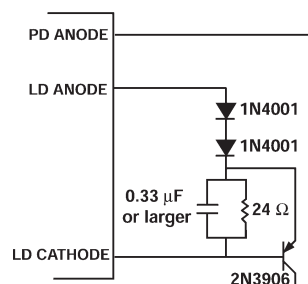For Constant Current parallel operation, the transfer function of output current to input voltage is 250 mA/V.

In Constant Power mode, the transfer function of photodiode feedback current to input voltage is: $(1 / 2R_{PD})$, where R_{PD} is the resistance of the photodiode feedback resistor (in units of Ohms).   This rule applies to both independent and parallel configurations. (Factory default is 500 µA/V.)

The analog input is allowed to be negative by an amount equal to the DC bias set by the digital interface. Since the analog input is added to the DC bias, this allows the external analog signal to shut off the output current.

In parallel configuration, the analog input is only taken from the Channel 1 analog input.

The analog inputs have a 50 Ω input impedance, and do not need to be terminated when not being used.

The total output current, in either parallel or independent configuration, operating in either Constant Current or Constant Power mode, will not exceed the limit current specified via the QCA. When operating in parallel configuration, the limit current is controlled by the limit function for Channel 1.

12. Quick Connect™ Application (QCA)

Figure 7: Device Operation Tab

Device Status Pane -- #1

Area #1, circled in red above, is the Device Status Pane. This information is visible in every tab.

The Device Information section displays information specific to the device, including serial number, firmware version, and assigned name.

The Device Status section displays the current state of the device. Output is displayed in red when disabled and green when enabled. Tracking configuration and calibration mode are also indicated. This section is updated continuously and in real-time.

The Channel Information sections display the limit and setpoint settings, updated whenever they are user-modified. Also displayed are real-time IMON and PMON values, updated as determined by the data sampling cadence.

Feedback Mode & R_{PD} -- #2 & 3

Areas #2 and #3, circled in green, are channel specific and allow the feedback mode, channel name and resistor value to be set for each channel.

Channel Tracking -- #4

Area #4, circled in blue, allows the channel tracking to be set.

The setting used here determines how the firmware processes the control signals, but tracking mode is still dependent on setting or removing the physical jumper.

For Parallel mode operation, only Channel 1 is visible. Inputs (limit and setpoint) to Channel 2 are summed into the Channel 1 data. PMON feedback must go through Channel 1 on the FL593 device, or the PMON reading in the Device Status Pane will be zero. Limit and Setpoint range scales are adjusted in Parallel mode to reflect the increased allowable current of 500 mA.

OPERATING INSTRUCTIONS - QuickConnect OPERATION (continued)

Limit and Setpoint Configuration -- #5

Area #5, circled in purple above, is the Limit and Setpoint Configuration section. The Limit and Setpoint can be configured on a per channel basis.

In Constant Current, Independent mode, both channels will be displayed, the data units will be mA for both Limit and Setpoint, and the range maximum will be 250 mA.

In Constant Current, Parallel mode, only Channel 1 will be displayed, the data units will be mA for both Limit and Setpoint, and the range maximum will be 500 mA.

In Constant Power mode, the data units will be mA for Limit and μA for Setpoint, and the range maximum will depend on the R_{PD} value entered. In Independent mode both channels will be visible. In Parallel mode, only Channel 1 will be displayed.

Limit and Setpoint values can be modified in a variety of ways. Exact values can be entered in the text field below the slider control.

The slider bar can be clicked for major scale tick increase/decrease. The keyboard up/down arrows can be used to change the slider values by minor scale ticks. The slider can be manipulated for continuous change along scale. If the slider is used, the corresponding numerical value will be displayed in the text field below the control.

A value is accepted when focus is moved to a new field. This can be accomplished by pressing the <Enter> key on the keyboard, tabbing out of the field, or mouse-clicking on a new field. Once a value has been accepted, the Device Status Pane will update the Channel Information with the new value.

Output Enable, Profile Load/Save -- #6

Area #6 is circled in yellow above. It sets output enable/disable, and allows unit identification, profile load/save, and closing the device window for a specific unit.

The *Output Enable* checkbox controls the output status of the device. Three states must ALL be enabled in order for output to be enabled: 1) The Interlock must not be triggered (this is indicated in green on the Device Status Pane). 2) The local switch on the the FL593 board must be enabled (also indicated in green on the Device Status Pane). 3) The *Output Enable* checkbox must be checked in the QCA. If all three conditions are met the output will be enabled. This is indicated in the Device Status Pane with Output State shown as Enabled in green.

The *Enable Identification Function* checkbox toggles a visual signal on the FL593 board. When the box is checked, the Output Enable Status LED on the FL593 will strobe. This is an especially useful feature if multiple units are simultaneously being monitored and controlled by the QCA. By toggling the checkbox and activating the LED strobe, it is possible to identify the device whose window is currently displayed in the QCA for modification.

This section also includes three buttons: *Load Profile*, *Save Profile*, and *Close Device*.

The *Close Device* button will close the window for the specific FL593 device, but not the QCA application. If multiple units are being monitored, those windows will remain open.

The *Load Profile* button allows a profile to be loaded to the QCA from a file (file extension .DEVCNF) or from the device itself. Loading a profile from the device sets the operating parameters to those in the Power Up profile.

The *Save Profile* button allows a set of parameters established in the Operating tab to be saved, either to the device (resetting the Power Up profile to the new values) or to a file for later access.

OPERATING INSTRUCTIONS - QuickConnect OPERATION (continued)

13. QCA - Power Up Profile Tab

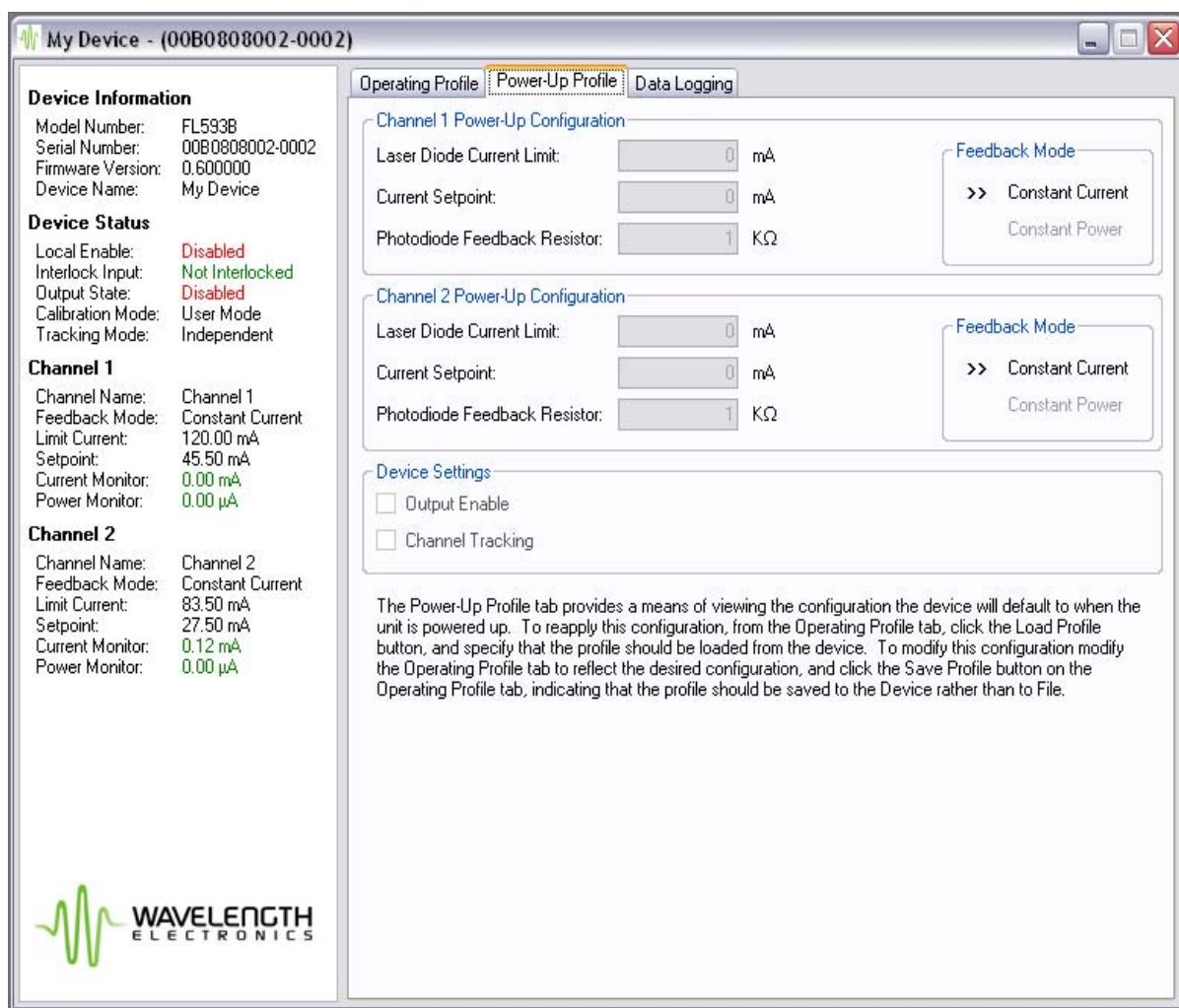The Power Up Profile tab is Read-Only.

Figure 8: Power Up Profile Tab

The Power Up profile is the set of parameters that will be loaded when the FL593 is turned on.

The Operating profile is the set of parameters actively being used, even if the QCA device window has been closed or output has been disabled. As long as the FL593 device has not been turned off, the Operating profile determines which parameters are used.

Therefore, it is often useful to be able to verify what the difference is between the two profiles.

The Power Up Profile tab is designed to allow quick and efficient verification of the Power Up profile values.

To transfer the parameters defined in the Operating tab into the device for power up, click the *Save Profile* button in the Operating tab. Select the *Save to Device* option. To save a profile to the device, output must be disabled.

To restore Power Up parameters into active operation, click the *Load Profile* button in the Operating tab. Select *Load from Device*.

OPERATING INSTRUCTIONS - QuickConnect OPERATION (continued)

14. QCA - Data Logging Tab

The Data Logging Tab allows you to set which parameters to log to file, their order, the sampling rate (cadence), and the log file name.

The default sampling rate is 250 ms, but may be set to anything from 100 ms to 10 seconds (10,000 ms). Data logging must be explicitly enabled any time the QCA device window closes or the FL593 is powered-up.
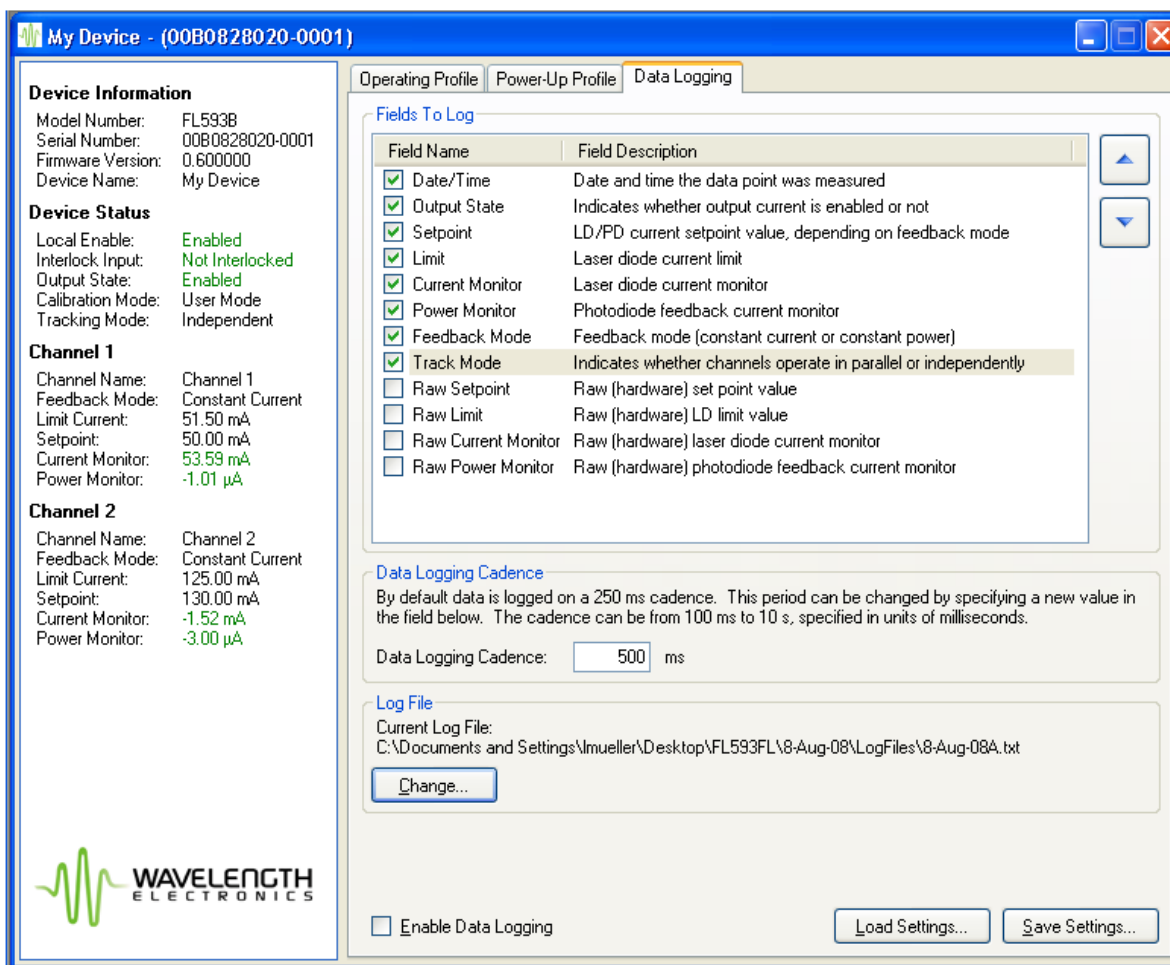

Figure 9: Data Logging Tab

The data logging file name is specific to a user session of the QCA. If a QCA station is used by multiple people, each can define their preferred logging parameters and cadence.

In the case of multiple units monitored simultaneously, it is important to verify the log file name before enabling logging to ensure that each unit's data is routed to the correct file.

Once a data logging parameter set has been defined, it can be saved as a configuration file. To save a parameter set, click the *Save Settings* button. A standard Windows *Save* dialog will appear and you can specify the file location.

To load a saved parameter set, click the *Load Settings* button. A standard Windows *Open* dialog will appear from which you can select the configuration to load (file extension .LOGCNF). Logging must still be explicitly enabled, even if the configuration was saved after logging was enabled.

OPERATING INSTRUCTIONS - QuickConnect OPERATION (continued)

15. QCA - Calibration Tab

The Calibration Tab is only available in Service and Calibration mode.

In Service mode, the values displayed are Read-Only. In Calibration mode, the values can be modified to optimize measurement resolution and device performance over specific operating ranges.
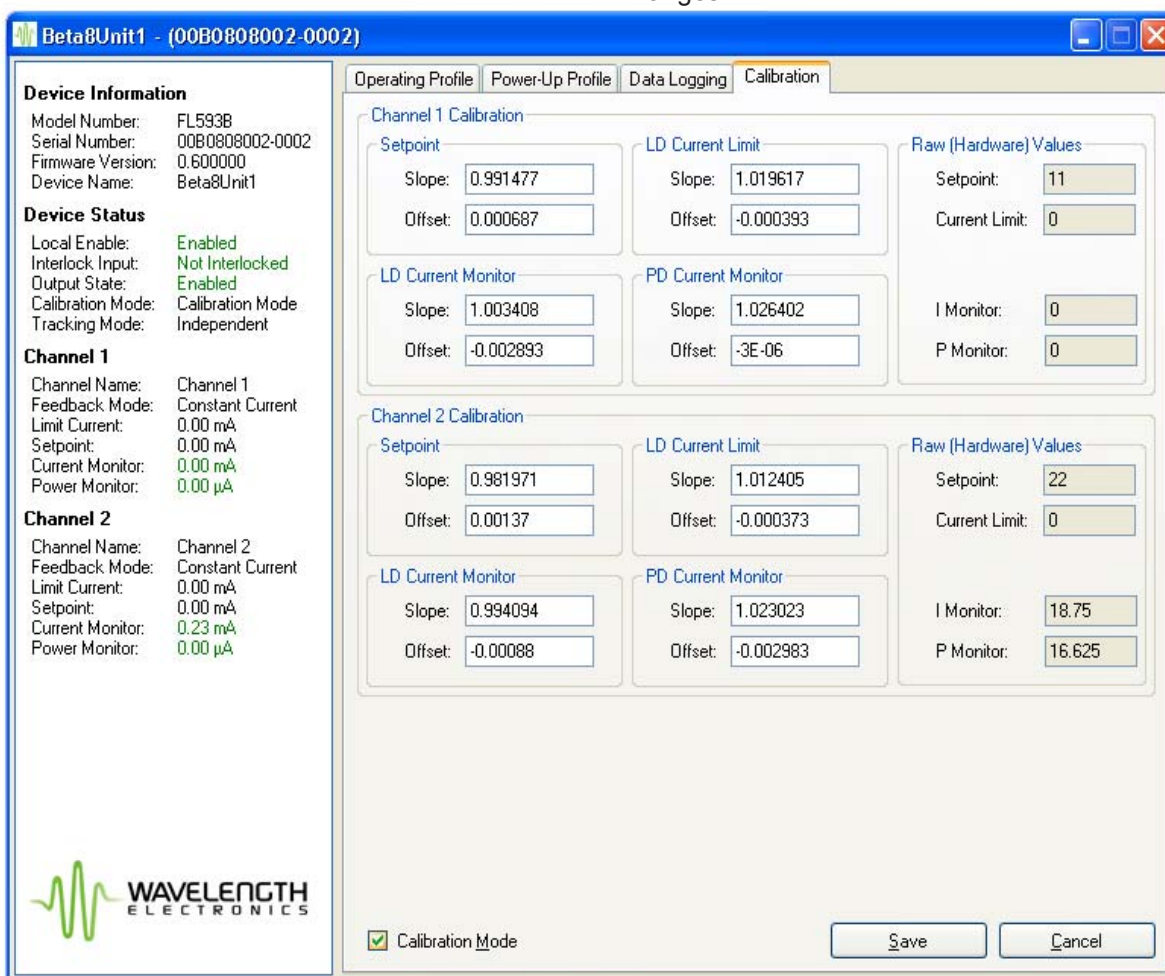

Figure 10: Calibration Tab

To enter Service mode, check the *Enable Service Mode* checkbox at the bottom of the Operating Profile tab. This will cause a Calibration tab to be displayed.

Click on the Calibration tab header to view that pane. The values shown include slope and offset calculation constants, and raw hardware values for Limit, Setpoint, IMON and PMON. Values for each channel are updated in real-time.

To enter Calibration mode, check the *Calibration Mode* checkbox at the bottom of the Calibration tab. This will present a password authorization dialog. Calibration is only available with a password. The password may be obtained by contacting Wavelength Electronics Tech Support. Factory default calibration is designed to support the full current range of the FL593. Recalibration can allow better performance in a limited operating current range.

OPERATING INSTRUCTIONS - QuickConnect OPERATION (continued)

Calibration is perfomed by executing a series of measurement and calculation steps that is partially automated by a spreadsheet. This spreadsheet is supplied with the QCA, as part of the Help menu selection. The spreadsheet is also access controlled with the Calibration password.

Wavelength Electronics will provide the Calibration password and step-by-step instructions for establishing a measurement environment, selecting the required data point values, and recording the results in the spreadsheet.

The spreadsheet calculations are then input into the Calibration tab field values.

QCA Main Menu

In addition to the user interface tabs for displaying and entering data, the QCA has a global menu. The options are *File* and *Help*.

From the *File* menu option, you can open a device, close a device, or exit the QCA.

The *Help* menu allows selection of Product Manual, API Documentation, Tech Support, Calibration, or About.

Selecting *Product Manual* opens a PDF version of the FL593 Product Manual for concurrent display. This manual will not be available if a PDF reader application is not installed on the QCA host computer.

Selecting *API Documentation* opens a window with an interactive set of documents describing aspects of the API and .NET interface. These pages include programming examples, class descriptions, and information necessary for custom application programming. They contain active links to several Microsoft and Wavelength Electronics website pages.

Selecting *Tech Support* will launch the default email editor resident on the host computer. Technical questions received via email will be addressed by Wavelength Technical Support promptly. You may also reference the Troubleshooting section at the back of the manual.

Selecting *Calibration* will display an authorization dialog that requires the Calibration password received from Tech Support. Once the password is correctly entered, the calibration spreadsheet will automatically be launched in a concurrent application.

Selecting *About* will display a window containing descriptive information about the QCA application -- copyright, version, etc. This may be useful when contacting Tech Support to help determine which QCA version is installed.

Additional information that may be required by Tech Support, such as device firmware version and serial number can be found in the Device Information section of the Device Status Pane in the main QCA interface.

OPERATING INSTRUCTIONS - ENABLE & MONITOR FL593

16. Enable Device

The OUTPUT ENABLED LED on the FL593 will not light until all three safety conditions are met:

1. Local (on-board) Enable switch set to ENABLE.

2. Interlock actively shorted to GND potential (<0.8 V).

3. Remote Enable command from the host PC or a preset configuration setting to enable the output on power-up.

The Device Status section of the Device Status Pane shows the state of the ENABLE switch on the FL593 (LEN – Local Enable) as well as the state of the Interlock signal (XEN – External Interlock Enable). Also shown is the overall state whether the output is Enabled. This includes the state of the remote enable command from the host PC.

17. Monitor Laser Diode (LD) Current and Photodiode (PD) Current

The PC host application, QuickConnect, displays the LD current (IMON) and photodiode feedback (PMON) signals from the FL593 for each channel. The FL593 uses 12-bit resolution for these measurements.

The IMON value is displayed in units of mA, while the PMON value is displayed in units of μA. When operating in the independent configuration QuickConnect will display both the IMON and PMON values separately for each channel. When operating in the parallel configuration the values for Channel 2 will not be displayed, rather the total value of measured laser diode current and photodiode feedback current will be displayed in the IMON and PMON fields for Channel 1.

The FL593 includes test points for manual measurement of the IMON and PMON values for each channel, as well as a ground reference test point. These test points are located on the board below the FL500 device, next to the LD2 connection, as depicted in Figure 11. These test points allow the IMON and PMON values to be examined with a Volt meter without the use of the USB interface and Quick Connect.

The voltage range on both the IMON and PMON test points for both channels has a range of 0-2V. To calculate output current for a channel based on the IMON voltage measured at one of the IMON test points, use the following formula:

$$I_{LDn} = \frac{V_{IMONn}}{8\Omega}$$

Where I_{LDn} is the laser diode current for the channel n, and V_{IMONn} is the voltage measured at the respective channel n IMON test point.
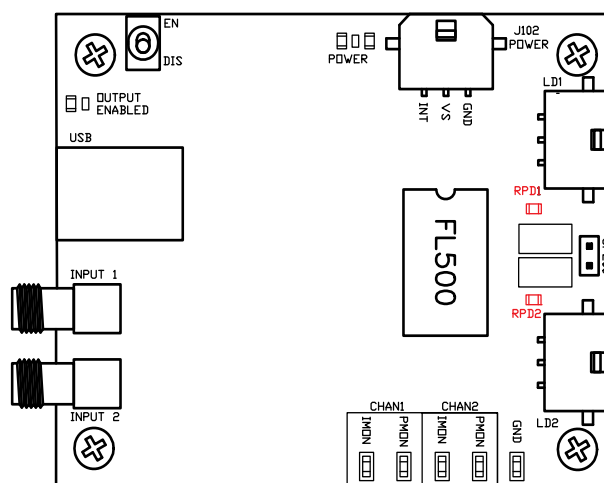
Figure 11: RPD positions

The photodiode feedback current can be calculated for a measured PMON voltage using the following equation:

$$I_{PDn} = \frac{V_{PMONn}}{2R_{PDn}}$$

Where I_{PDn} is the photodiode feedback current for the specified channel n, V_{PMONn} is the voltage measured at the channel n PMON test point, and R_{PDn} is the photodiode feedback resistor value in units of Ohms. The FL593 ships standard with 1kΩ resistors for both R_{PD} current sense resistors. [Resistors are 1206, 1/8 W.]

OPERATING INSTRUCTIONS - ENABLE & MONITOR FL593 (continued)

18. Monitor LD and PD Current
(continued)

Whether operated in independent or parallel configuration the IMON and PMON test points on the FL593 board for each channel will only indicate the laser diode and photodiode current for each respective channel. Software, when operating in the parallel configuration, will report IMON as the summed combination of the measured IMON1 and IMON2, and will report PMON from channel 1. The test points on board will always output signals representing the discrete currents for each channel, and allow user monitoring of the analog measurement of both laser and photodiode currents, independent of any control of the USB interface.

The IMONn amplitude is directly proportional to the laser diode current for channel n. This signal represents measured current flowing through the laser diode and has a range of 0-2V, corresponding to 0-250mA for each channel. This gives a transfer function of 125mA of laser diode current per volt observed at the test point (125 mA/V).

The PMONn amplitude is directly proportional to the photodiode current for channel n. This signal represents measured current flowing through the monitor photodiode and has a range of 0-2V. The actual range of measurement across the photodiode sense resistor, RPDn, is 0-1V, which then has a gain of 2 applied to it, producing the voltage observed at the test point. This means that the corresponding 0-2V test point voltage correlates to a photodiode current of 0 to IPD(MAX) where IPD(MAX) is defined as the maximum photodiode feedback current, computed as 1V / RPD. By default the FL593 has installed a 1KΩ resistor for RPD, providing an IPD(MAX) of 1 mA.

The chart on page 22 provides a comparison of some common resistor values and the maximum associated PD setpoint.

RESOLUTION
The FL593 utilizes 12-bit A/D converters for IMON and PMON, and 12-bit D/A converters for digital control over the set point and limit currents. The following table quantifies how this translates to resolution in control and measurement:

PARAMETER	CC INDEPENDENT	CC PARALLEL	CP INDEPENDENT	CP PARALLEL
SETPOINT	61 μA (I_{LD})	122 μA (I_{LD})	244 nA (I_{PD})	244 nA (I_{PD})
LIMIT	61 μA (I_{LD})	122 μA (I_{LD})	61 μA (I_{LD})	122 μA (I_{LD})
IMON	61 μA	61 μA	61 μA	61 μA
PMON	244 nA	244 nA	244 nA	244 nA

The values for PMON and set point in CP mode reflect an assumption of RPD = 1 KΩ.

NOTE: These resolutions are the theoretical limits given the resolution of the hardware on the FL593. Actual performance may vary slightly within the linearity of the control and measurement hardware. Typical linearity is 3.5 bits. This can be used as a multiplier with these values to determine the worst case resolution.

ADDITIONAL INFORMATION -- CIRCUIT DIAGRAMS
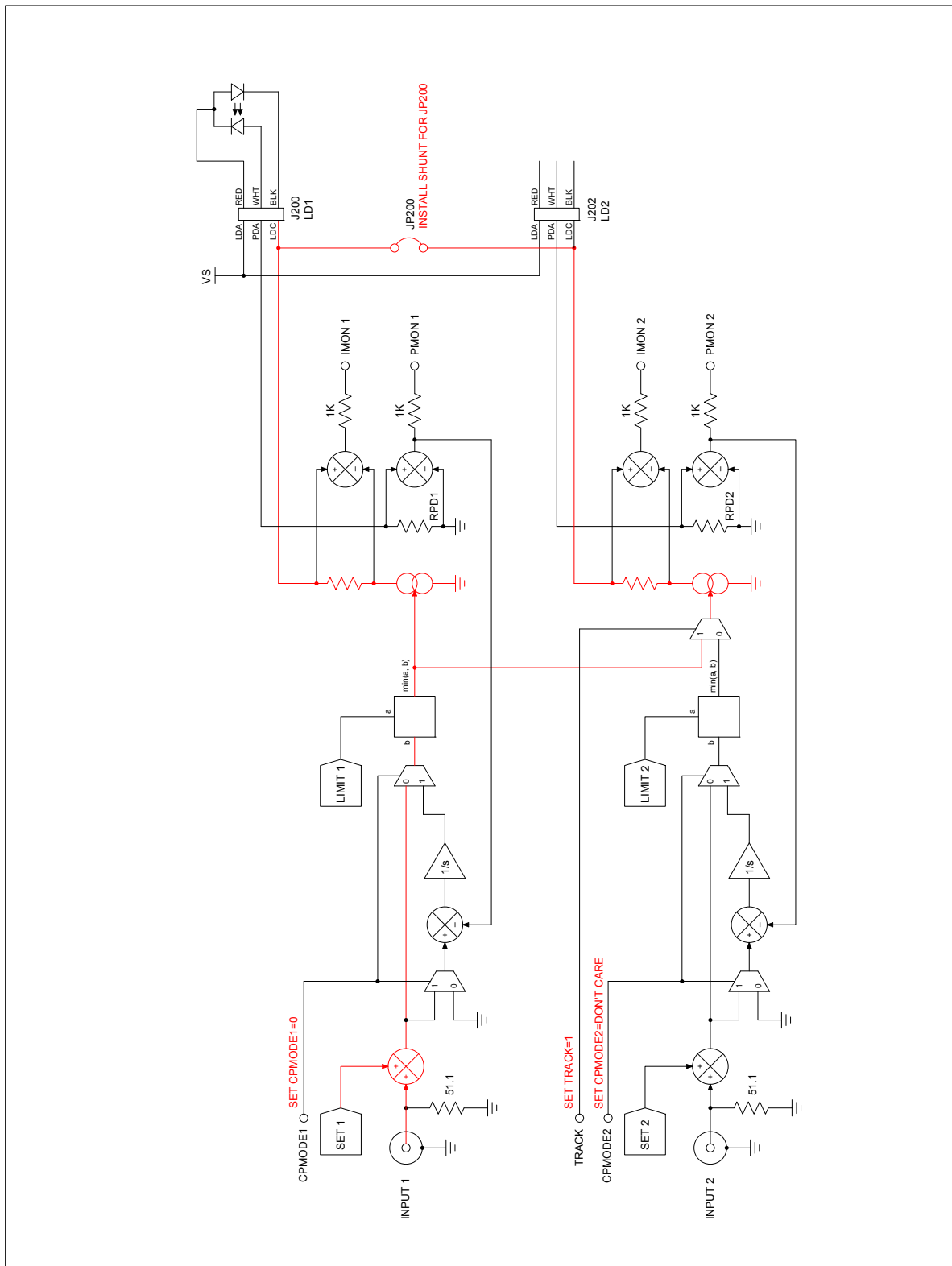
**Figure 12: Independent Mode Operation --
Constant Current or Constant Power**
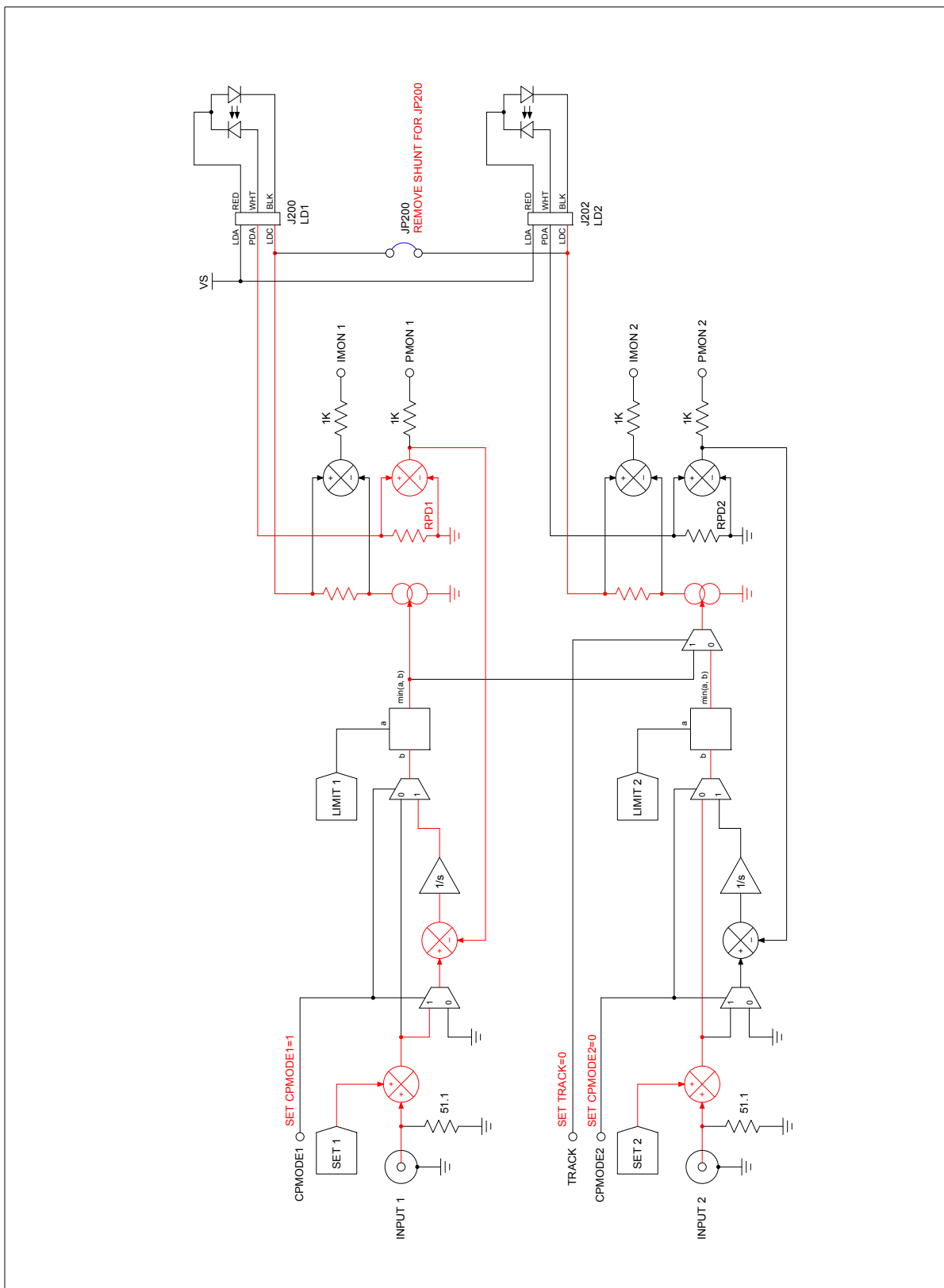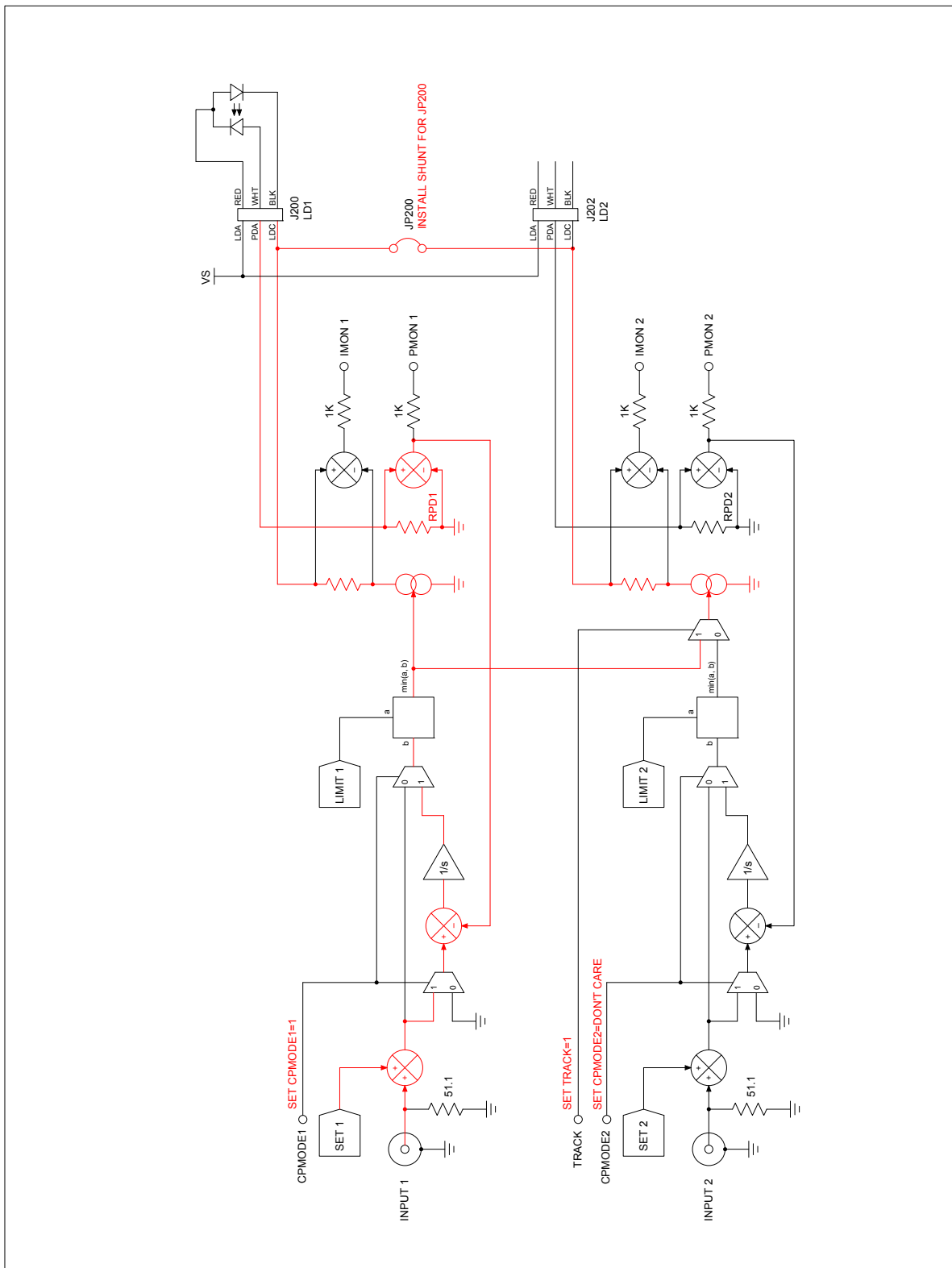
ADDITIONAL INFORMATION -- CIRCUIT DIAGRAMS (continued)

**Figure 13: Parallel Mode Operation --
Constant Current**

ADDITIONAL INFORMATION -- CIRCUIT DIAGRAMS (continued)

Figure 14: Parallel Mode Operation --
Constant Power

ADDITIONAL INFORMATION -- TIPS & TECHNIQUES

ANALOG TEST POINTS

Test points for direct analog monitoring of the IMON and PMON signals for each channel are provided on the FL593 circuit board as indicated in Figure 15. These signals are referenced to the ground (GND) potential. The voltages are

$$V_{IMON} = I_{LD} * (8\Omega)$$
$$V_{PMON} = I_{PD} * 2 * R_{PD}$$

Or

$$I_{LD} = V_{IMON} / (8\Omega)$$
$$I_{PD} = V_{PMON} / (2 * R_{PD})$$

The default value for R_{PD} is 1 kΩ.
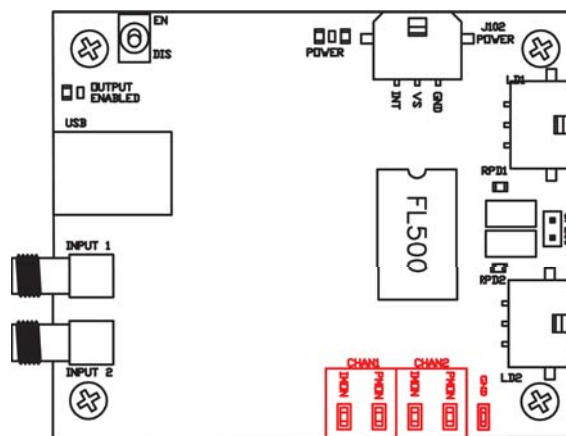
Figure 15: Analog Monitor Points

THERMAL DERATING

The FL593 output capacity derates with temperature according to the thermal efficiency and dissipation of the FL500 dual-channel laser driver component. In still air the power dissipation limit is 500 mW/channel, with a maximum of 1 W for the FL500 device. With a forced air volume of ~4.2 ft^3/min, the maximum power dissipation of the FL500 is 1 W/channel, with a maximum of 2 W for the FL500 device.

When the heat sink temperature of the FL500 reaches a temperature of 45°C the thermal performance begins to derate at a rate of approximately -26.3 mW/°C for still air, and at a rate of approximately -62.5 mW/°C for forced air with the volume mentioned above. The result is a power limiting of the maximum safe output current to zero output current when the temperature of the heat sink reaches 85°C. Figure 16 illustrates the power derating curve in terms of total FL500 device power.

Figure 16: Power Dissipation vs. Temperature

ADDITIONAL INFORMATION -- TIPS & TECHNIQUES

R$_{PD}$ VALUE & PD SETPOINT LIMIT

The chart below shows the relation between R$_{PD}$ value and PD setpoint maximum when operating in Constant Power mode.
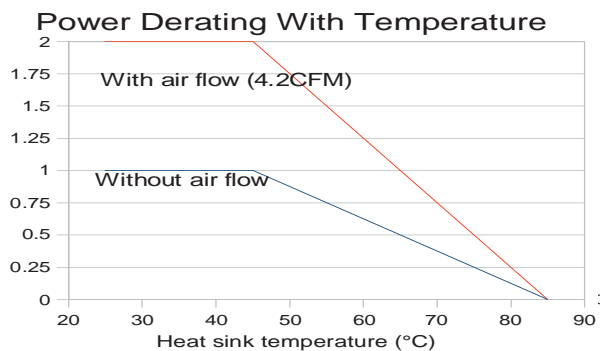
R$_{PD}$ Selection Guide	
R$_{PD}$ (kΩ)	**Maximum PD Current** (µA)
0.1	10,000
0.2	5,000
0.3	3,333
0.4	2,500
0.5	2,000
0.6	1,667
0.7	1,429
0.8	1,250
0.9	1,111
1	1,000
2	500
3	333
4	250
5	200
6	167
7	143
8	125
9	111
10	100
20	50
30	33
40	25
50	20
60	17
70	14
80	13
90	11
100	10

SOFTWARE OPERATION

1. FL593 units already connected to open dialogs will not show up on the selection list.

2. When changing between CC and CP modes, the program will set the laser output current to zero to avoid transient conditions that may damage the laser. The Setpoint scale changes to reflect the new meaning of the Setpoint value, i.e. PD versus LD current.

3. When changing between dual and parallel tracking configurations, the FL593 will be disabled to avoid transients that may damage the laser. During parallel operation, only Channel 1 is visible on the screen, as this controls both channels of the FL500 laser driver.

4. The photodiode monitoring circuitry is active whether or not the device is in constant power (CP) mode. This allows for sweeping the laser diode (LD) current in constant current mode and monitoring the photodiode (PD) feedback for rapid measurement of the PD sensitivity.

5. The Identify function can be helpful to physically identify the specific unit being controlled. It does not affect output status.

ADDITIONAL DOCUMENTATION

Data sheet/manual for the FL500 dual source laser driver is available at
http://www.teamwavelength.com/permanent/fl593/download/.

Software documentation for the Application Programming Interface (API) may be downloaded from
http://www.teamwavelength.com/permanent/usb/docs/api/
or by calling the Wavelength Electronics sales office at 406-587-4910.

ADDITIONAL INFORMATION -- ADVANCED PROGRAMMING

The USB driver and QuickConnect software provided with the FL593 is intended to give users access to all of the basic functionality of the FL593. A complete Application Programming Interface (API) is available for use by customers to develop their own host computer programs to perform unique operations, such as integrating the FL593 for operating or testing lasers or LEDs as part of a complete instrument.

Additionally, the FL593 firmware may be customized to adapt a device for specific operations. Please contact Wavelength Electronics to see what can be done to optimize the device for your unique needs.

The FL593 utilizes the WEIUSB device driver and protocol. If you are just getting started developing applications using the WEIUSB protocol or the APIs provided by Wavelength Electronics, it is strongly recommended that you read the *Concepts* document associated with the WEIUSB device driver and APIs, available in HTML format from Wavelength's website, to learn about the WEIUSB device driver and the object model provided by the associated APIs.

More detailed documentation is also available about the WEIUSB driver and protocol if desired. This document is available in HTML format from Wavelength's website. Note that this reference is not required for implementing applications that utilize WEIUSB devices using any of the APIs provided by Wavelength, but rather provides a more detailed reference of the inner workings of the protocol and device driver, and may be useful to developers building applications and systems using C/C++, or for users who would like to access WEIUSB devices without the use of the provided APIs.

In addition to the standard command set that must be supported by all WEIUSB devices, the following table lists the commands that can be issued to the FL593 to operate the device. The variables displayed below are described in greater detail on the following pages.

SOFTWARE LINKS
Concepts document:
http://www.teamwavelength.com/permanent/usb/docs/api/concepts.html

Detailed protocol and driver documentation:
http://www.teamwavelength.com/permanent/usb/docs/api/weiprot.html.

Mnemonic	Code	Op Types	Description
ALARM	0x10	Read	Read the alarm flags for the unit.
SETPOINT	0x11	Read, Write, Min, Max	Set or read the setpoint. The units of the value specified depends on the MODE of the device.
LIMIT	0x12	Read, Write, Min, Max	Set or read the current limit in units of Amps. This current limit applies regardless of whether operating in CC or CP mode. This limit applies also to the analog modulation applied to the unit.
MODE	0x13	Read, Write	Set or read feedback mode.
TRACK	0x14	Read, Write	Set or read tracking configuration.
IMON	0x15	Read, Min, Max	Read current monitor for the specified channel.
PMON	0x16	Read, Min, Max	Read power monitor for the specified channel.
ENABLE	0x17	Read, Write	Enable or disable the output.
RPD	0x19	Read, Write, Min, Max	Set or read the value of the photodiode feedback resistor for the specified channel in units of kΩ.
CAL_ISCALE	0xE2	Read, Write	Set or read the calibration scaling value for the current monitor measurement circuit for the specified channel.

ADDITIONAL INFORMATION -- ADVANCED PROGRAMMING (continued)

ALARM

The ALARM command allows the host to read the status flags for the device. Each character in the data field of the response packet represents a status flag. The following table describes each flag, with character 0 being the left most character in the data field string:

Flag	Name	Description
0	OUTPUT	Output status. A value of '0' indicates output is off. A value of '1' indicates output is on. This is the resulting product of XEN, LEN and REN (XEN*LEN*REN).
1	XEN	External Enable flag. A value of '0' indicates that the interlock pin (J102 pin 1) is floating or asserted to a logic 1. A value of '1' indicates that the interlock pin is asserted to a logic 0 (disable interlock).
2	LEN	Local enable flag. Indicates whether the enable switch on the FL593 (S100) is set to the enable ('1') or disable position ('0').
3	REN	Remote enable flag. Indicates whether the unit has been enabled remotely by the ENABLE command.
4	MODE1	Indicates feedback mode for channel 1. A value of '0' indicates CC mode, '1' indicates CP mode.
5	MODE2	Indicates feedback mode for channel 2. A value of '0' indicates CC mode, '1' indicates CP mode.
6	PARA	Parallel mode flag; indicates the current state of the TRACK command. A value of '0' indicates channels are operated independently, '1' indicates the channels are operated in parallel.
7	IDENT	State of the IDENTIFY flag. A value of '0' indicates IDENTIFY command is inactive, '1' indicates the function is active.
8	WRITE	Indicates whether a write operation to nonvolatile memory is in progress following a SAVE command. Device will not complete other control operations requested while the WRITE flag is set.
9	CALMODE	Indicates if the device is in calibration mode. Calibration mode is entered by issuing the PASSWD command, and is exited by issuing a REVERT command.

SETPOINT

The SETPOINT command allows the host to control the output amplitude. The units applied to the setpoint value depend on the MODE of the channel specified in the command. If in CC mode, this value is specified in units of Amps of laser diode current. If in CP mode, this value is specified in units of mAs of photodiode feedback current.

LIMIT

Allows the host to control the laser diode current limit for the channel specified in the command. This value is specified in units of Amps of laser diode current. This current limit will apply to both the amplitude established by remote software as well as the amplitude set by the analog modulation inputs. If operating in CP mode and the setpoint attempts to achieve an output amplitude that would cause the laser diode current to exceed this limit, the output amplitude will be limited to the power that can be produced at the specified laser diode limit current.

ADDITIONAL INFORMATION -- ADVANCED PROGRAMMING (continued)

MODE

The MODE command allows the host PC to detect and control the feedback mode of the channels of the FL593. The FL593 will look at the left-most digit of the data field when writing the MODE command. If the left-most digit contains a '0', the specified channel will operate in CC mode. If set to '1', the FL593 channel will operate in CP mode, utilizing the photodiode feedback from the laser diode to regulate optical power of the laser diode.

NOTE: When operating in CC mode, the FL593 will still measure and make available the photodiode feedback current monitor voltage, allowing the host application to monitor optical power while directly controlling laser diode current.

ENABLE

The output enable is controlled by three input factors, the external enable (interlock, or XEN), the local enable switch on the FL593 (LEN), and the remote enable controlled via the host PC (REN). The ENABLE command allows the host PC via USB to control the state of the REN flag. The laser diode output is enabled under the following boolean condition:

$$OUT\_EN = REN * LEN * !XEN$$

If the configuration saved into the FL593 contains a REN value of 1, the FL593 is capable of automatically enabling laser diode output upon power up assuming the conditions for LEN and XEN are satisfied, even if the FL593 is not connected to a PC on power up.

TRACK

The FL593 is capable of operating as two independent 250 mA current sources, or a single 500 mA current source. The TRACK command allows software to control which configuration is being used. The FL593 will look at the left-most digit of the data field when writing the TRACK command to determine the output configuration to use. If this value is set to '0', the FL593 will operate as two independent 250 mA current sources, each with its own current and power monitors, photodiode feedback, output setpoint, modulation input and current limit. If this value is '1', the second channel will be paralleled with the first channel, doubling the output current capacity of the first channel, and causing the FL593 to act as a single channel 500 mA current source (parallel mode).

When operated in parallel mode, the second channel's setpoint is derived from the first channel's inputs, both the remote setpoint and the analog modulation. The limit current for channel 1 governs the output of both current sources. The photodiode for channel 1 is used for controlling the laser diode in CP mode. The current and power monitors for channel 1 are also used to measure the aggregate output current and power.

NOTE: To operate in parallel mode, the output jumper on the FL593, JP200, must be shorted to shunt output current from both output channels through the same output connector. Simply changing the mode in the QCA will generate inaccurate measurements and may result in severe damage to the laser diode.

ADDITIONAL INFORMATION -- ADVANCED PROGRAMMING (continued)

IMON

The FL593 provides a current monitor circuit that measures the actual output current through the laser diode in real time. The current monitor for a channel can be measured by querying the FL593 with the IMON command, setting the Channel field of the command to the channel number of interest. Whether the FL593 is enabled or not, the IMON command will retrieve the current monitor value from the measurement circuit.

NOTE: When the FL593 is not connected to a host PC via USB, the FL593 will stop acquiring IMON measurements until reconnected to a PC to reduce the digital noise on the FL593 board.

PMON

The FL593 contains an integrated photodiode current measurement circuit that is used to control the laser diode's optical power output when operating in CP mode. The power monitor command allows the host PC to measure at any time the photodiode feedback current, whether operating in CP or CC mode. As with the IMON command, the channel of interest can be specified by setting the channel number of the Channel field in the command packet sent to the FL593.

NOTE: As with the current monitor, when the FL593 is not connected to the host PC via USB, the FL593 will discontinue acquiring power monitor data until reconnected to a PC via USB to reduce the digital noise. This does not affect the operation of the FL593 in CP mode; the FL593 will maintain control of the laser diode's output power with respect to the photodiode feedback without the PMON measurements.

PRODUCT-SPECIFIC END CODES

There are no product-specific end code values that will be returned by the FL593. The standard set of end codes are used. For more information on the end codes, see the HTML documentation of the WEIUSB protocol.

RPD

The photodiode sense resistor value must be known by the FL593 to accurately measure the photodiode feedback current and control the laser diode power with accuracy. The RPD command allows the host PC to configure the photodiode resistor value in units of kΩ. If the photodiode sense resistor is changed to accommodate a different photodiode current range, this value must be updated in the FL593 to provide accurate power measurements and obtain accurate power control.

The RPD command can also be used to provide a scaled calibration for fine tuning of the photodiode current measurement.

CAL_ISCALE

CALIBRATION MODE ONLY. The ISCALE command allows a scaling multiplier to be set for each channel independently. This value will be used to scale the current monitor measurements. This enables a simple calibration to be performed to improve the accuracy of laser diode current measurements over a smaller range of the total available output current range. The current monitor measurement assumes linearity in current monitor values. The CAL_ISCALE value allows for adjustment of the slope of the current measurement. The FL593 ships from the factory with a value for CAL_ISCALE of 1. The data field when using the CAL_ISCALE command can be any floating point value by which IMON values will be scaled.

NOTE: The CAL_ISCALE value does not apply to the current limit, as the current limit applies limiting to the setpoint value, and is not based on the IMON measurement for a channel.

Contact Wavelength's technical support staff for further assistance in changing the CAL_ISCALE value for a channel.

ADDITIONAL INFORMATION -- TROUBLESHOOTING

PMON VALUE IS ZERO

There are two likely causes for the PMON value to be displayed as 0 µA. One is related to parallel mode operation, the other to calibration.

Parallel Mode: If the unit has been placed into Parallel mode but the laser diode is connected to the LD2 output connector, the PMON values will not be available to the FL593 for display. Although the IMON values are summed across both channels when JP200 is in place, this is not the case for the PMON values. If it is important to monitor PMON in parallel mode, use LD1 as the laser diode output channel.

Calibration: If a calibration has just been performed and the other values are displayed correctly, it is possible that the channel PMON offset was incorrectly transferred to the calibration tab data field. If the PMON offset is several orders of magnitude too high, it will force a negative FL593 calculation which will be defaulted to zero. There are three very common reasons that this can occur. 1) The IMON offset was transferred instead of the PMON offset. These values are usually identical but off by three orders of magnitude. 2) During data entry several leading zeros were left off the decimal PMON offset value. Adding three leading zeros to the right of the decimal point may be sufficient to correct the problem. 3) When entering the PMON offset values into the B10, C10, and D10 fields of the spreadsheet, the wrong order of magnitude was used (i.e., 0.5 instead of 500).

UNIT SERIAL # IS "Call Wavelength"

The unit serial number is programmed at the factory and will always be alphanumeric on a functioning unit. The FL593 firmware has been hard-coded to present the serial number "Call Wavelength" if communication between EEPROM and RAM is disrupted. This indicates a fatal hardware failure where the device cannot communicate with itself and any data displayed in this situation is suspect.

DATA RESOLUTION IS OUT OF SPECIFICATION

There are two likely causes for a degradation of data resolution during operation.

1) If the FL500 overheats during operation, it will begin to lose resolution. The FL593 has been designed to provide data resolution of 3 mA or better. If this does not appear to be the case, the FL500 may be overheating. Forced air flow across the unit is sufficient to restore the expected resolution.

2) The device is functioning at the upper edge of the allowable current range. If the unit is in parallel mode with a limit of 495 mA and a setpoint of 500 mA, it is likely that the resolution will not be as tight as expected. This can be corrected by recalibrating the unit for optimum performance in the 450-500 mA range instead of the 0-250 mA range.

CALIBRATION MODE *SAVE PROFILE* GENERATES ERROR

It is not possible to change the channel tracking while in calibration mode. It is not possible to enter calibration mode while in parallel operation. Therefore, if the Power Up profile is tracked, and has not been changed prior to entering Calibration mode, it will not be possible to save values to the device and an error will be generated.

To correct this, exit Calibration mode, disable the output, set the operating parameters to independent CC mode and save the profile to device. Re-enter Calibration mode and proceed.

ADDITIONAL INFORMATION -- TROUBLESHOOTING (continued)

SWITCHING TRACKING MODE LOSES SETTINGS

The FL593 has been designed to protect the laser diode from sudden current spikes when switching between Constant Power and Constant Current mode.

If a channel has been in CP mode and is switched to CC mode, the setpoint value will be defaulted to 0.

If the unit has been operating in parallel CP mode, switching to independent mode will maintain the channel 1 settings, but Channel 2 will be defaulted to CC mode with a setpoint of zero.

During CP operation current flows through an integrator. Even after disabling output, current may still be accumulated in this integrator. Defaulting to CC mode allows the current to bleed off rather than sending a sudden spike through the laser diode.
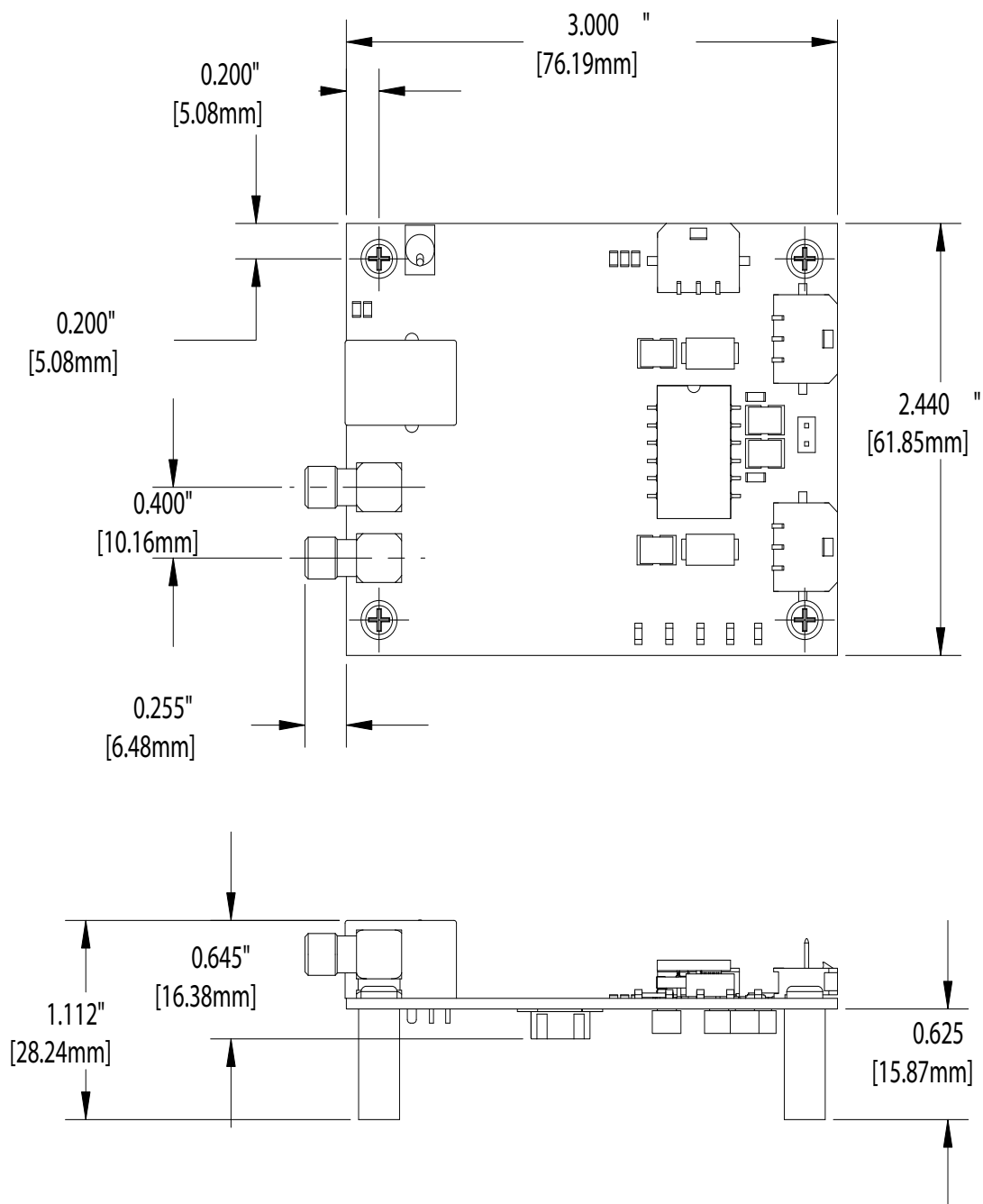
If mode or setpoint has been reset, either re-enter the desired values or load a profile from file to device. If your application requires switching between CC and CP mode or parallel and independent CP mode, it would be useful to create the desired profiles in advance and save them to file so that they can easily be reloaded.

MONITOR IN PARALLEL MODE DOESN'T REFLECT ACTUAL CURRENT

If the monitor signal jumps above setpoint, it is likely that inductance is present in the cable to the laser diode. The current through the laser diode is still stable. Only the monitoring is affected. The cables provided by the factory are specifically designed to minimize inductance. With your cabling, either shorten the length or use twisted pair cables to minimize inductance and eliminate the monitor error.

MECHANICAL SPECIFICATIONS*
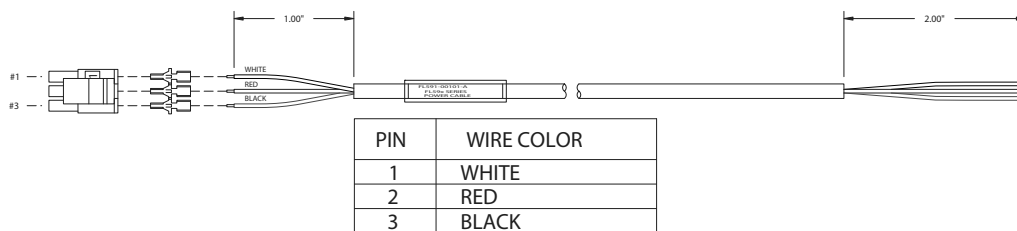
FL500 is reflow oven compatible

3.000   "
[76.19mm]

0.200"
[5.08mm]

0.200"
[5.08mm]

2.440   "
[61.85mm]

0.400"
[10.16mm]

0.255"
[6.48mm]

0.645"
[16.38mm]

1.112"
[28.24mm]

0.625
[15.87mm]

*All Tolerances are +/- 5%

MECHANICAL SPECIFICATIONS* (continued)

FL591-00101-A, FL590 Series Power Cable

PIN	WIRE COLOR
1	WHITE
2	RED
3	BLACK

FL591-00102-A, FL590 Series Output Cable

PIN	WIRE COLOR
1	RED
2	WHITE
3	BLACK

www.teamWavelength.com
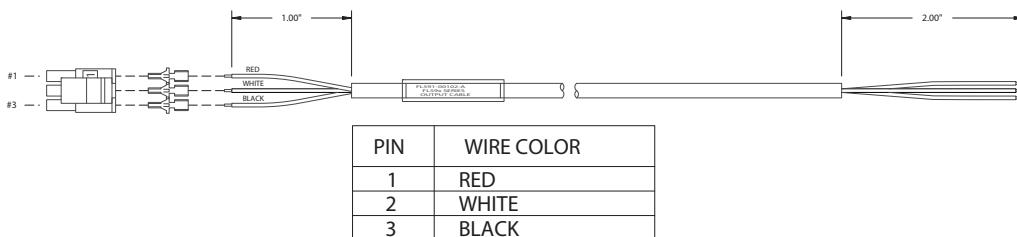
CERTIFICATION AND WARRANTY

CERTIFICATION:

Wavelength Electronics (Wavelength) certifies that this product met it's 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 product 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.

No other warranty is expressed or implied. Wavelength specifically disclaims the implied warranties of merchantilability 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.

REVERSE ENGINEERING PROHIBITED:

Buyer, End-User, or Third-Party Reseller are expressly prohibited from reverse engineering, decompiling, or disassembling this product.

NOTICE:

The information contained in this document is subject to change without notice. Wavelength will not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this material. No part of this document may be translated to another language without the prior written consent of Wavelength.

SAFETY:

There are no user serviceable parts inside this product. Return the product to Wavelength Electronics for service and repair to ensure that safety features are maintained.

LIFE SUPPORT POLICY:

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.

QuickConnect™ is a trademark of Wavelength Electronics, Inc.

REVISION HISTORY		
REVISION	DATE	NOTES
REV. A	29-Nov-07	Initial release
REV. B	30-Sep-08	Updated to reflect released product
REV. C	24-Feb-09	Updated for FL500 Reflow Oven compatibility
REV. D	28-Apr-09	Added connection info
REV. E	31-Aug-09	Updated links to support new website
REV. F	16-Sep-11	Revised operating system compatibility
REV. G	17-Feb-12	Updated cabling mechanical specs

WAVELENGTH ELECTRONICS, INC.
51 Evergreen Drive
Bozeman, Montana, 59715
web: **www.teamWavelength.com**
phone: **(406) 587-4910 Sales/Tech Support**
fax: **(406) 587-4911**
e-mail: **sales@teamWavelength.com**