

LaserPak™

485 SERIES

USER'S MANUAL



**LASER DIODE
DRIVER**

Table of Contents

Introduction	3
Safety Terms and Symbols	5
Quick Start	7
Installation	8
Control Modes.....	11
Settings	12
Cable Wiring for Modulation	14
Using the Cable R Setting.....	14
Remote Mode Operation.....	16
Installing the USB Drivers	16
Interface Connectors.....	17
Connecting to the LaserPak.....	20
Working With Thermistors.....	21
Using the Analog Interface.....	23
Grounding Considerations.....	26
Photodiode Input Considerations	27
Using Limits.....	28
Thermal Considerations	28
Changing the AC Line Voltage Setting	29
Specifications	32
Error Messages	33
Mechanical Drawings	34
Maintenance and Service.....	36
EC Declaration of Conformity	38
UK Declaration of Conformity	39

Introduction

Thank you for choosing the **LaserPak** from Arroyo Instruments. Your **LaserPak** is a combination of leading edge technology combined with years of experience in the field of current control, and based on the proven designs found in the **4200** and **4300 Series LaserSources**.

The **LaserPak** was design for system integration applications, or simply where a user interface, like that found on the **4300 Series LaserSource**, is not required or desired. With a range of power options, both RS232 and USB computer interfaces, analog interface, and small footprint, the **LaserPak** will fit into almost any current control application.

LaserPak's analog interface provides a way of both controlling and monitoring the instrument, with analog set point, current and photodiode current monitoring, stable indicator, and on/off control and status. This allows for control in applications that do not have a computer interface.

In addition to constant current and constant photodiode current modes, the **LaserPak** also operates in constant voltage control mode, allowing you to use it in precision voltage applications, such as EML devices, or for doing V-I measurement graphs.

The **LaserPak** offers all the features you would expect from a modern precision laser diode driver, including:

- 10ppm current stability over one hour
- Broad range of currents
- Comprehensive laser protection circuitry, including hardware voltage and current limits.
- External analog modulation
- Power control mode, both in photodiode current (AMC) or computed photodiode power (APC) modes.
- Voltage control mode

What's in the Box

Along with the **LaserPak** itself, a CD with electronic copies of this manual, the **Computer Interfacing Manual**, and USB drivers are included. For USA customers, a power cord is included. For non-USA customers, an IEC-60320-C13 rated AC power cord must be provided.

Accessories

Arroyo Instruments also sells several accessories designed to work with the **LaserPak**. These include:

- **LaserSource Cable, 2m (p/n 1220B)**
This cable has DB-9 male/female connectors for interfacing to the LaserMount or other connectorized fixtures.
- **LaserSource Cable, 2m, Pigtailed (p/n 1221B)**
This cable has a female DB-9 connector for plugging into the **LaserSource** and tinned leads for wiring into custom solutions.
- **Pak Series Rack Mount Kit, 3 or 5 units (p/n 1402-RM)**
For installing your **TECPak** or **LaserPak** into a standard 19" rack. The kit accepts either 3 units for a 2U installation, or 5 units for a 3U installation.
- **RS-232 NULL Cable, 3m (p/n 1200-NULL)**
- **USB Cable, 3m (p/n 1201)**

Safety Terms and Symbols

The following safety-related terms are used in this manual:

- **Warnings** (noted by the WARNING heading) explain dangers that could result in physical injury or death;
- **Cautions** (noted by the CAUTION heading) explain conditions that could result in damage to the instrument, other equipment, or your device.
- **Notes** (noted by the NOTES heading) are **not** safety-related, and are intended simply to point out important information.

If, at any time, any of the following conditions exist, or are suspected of existing, discontinue use of the unit until it can be inspected by qualified service personnel:

- Visible damage to the unit, including damage or stress caused during product shipment;
- Storage of the unit outside the standard storage temperature or humidity rating, or prolonged storage under harsh conditions;
- Failure to operate properly.

If needed, contact your distributor or Arroyo Instruments for service or repair to ensure the safety of the product is maintained.

Symbols



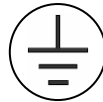
Power Off



Power On



Caution, refer to manual



Earth ground



Caution, risk of electric shock

General Warnings

WARNING

Potentially lethal voltages exist within this instrument. This instrument is intended for use by qualified personnel who understand the shock and laser hazards and are familiar with safety procedures required to avoid injury. Read this manual completely before attempting to use this product.

WARNING

To avoid electrical shock, ensure a 3-prong power cord is used, and is plugged into a earth-grounded receptacle. Failure to do so can result in severe injury or death.

CAUTION

There are no user-serviceable parts inside. All service and repair work shall be done by Arroyo Instruments or personnel authorized by Arroyo Instruments. Modifications done by non-authorized personnel will void the warranty. Please see the Service section later in this manual for instructions on how to obtain service for this instrument.

Quick Start

The latest generation of the **LaserPak** requires the requires proper AC voltage selection before plugging into the AC mains.

After unpacking the unit, ensure that the voltage selection is set to the correct voltage. This is critical, as incorrect voltages can damage the unit. The **LaserPak** is factory configured to the destination county's AC line voltage prior to shipment, and should not need to be changed. See *Verifying the Voltage Selection* in the **Installation** section below on how to identify the voltage settings of the instrument.

Once the voltage selection has been completed, plug the AC cord into the unit and into the wall outlet. Turn on the power switch located on the IPC, and the unit will power up. The AC Power LED should light, and the On / Error LED should remain dark.

Control of the **LaserPak** can be done two ways: use the RS232 or USB computer interfaces and control the instrument from the PC, or use the analog interface. This quick start guide uses the computer interface. More information on the analog interface can be found later in the manual.

To control the **LaserPak** from the PC, use the **Arroyo Control** software located on the CD that came with the instrument (it can also be downloaded from our web site). The software is located in the **Software** folder on the CD. Simply launch the installer and follow the on-screen prompts.

Once the software is installed, plug the instrument into your RS-232 or USB interface. For USB users, the instrument may also ask for drivers, which can either be automatically downloaded from the Windows Update site or manually installed from the CD.

Launch **Arroyo Control**, and in the **LaserSource** panel (if one is not visible, click Add Panel in the lower right of the window, and click Add a Laser Panel), select the communications port to which your **LaserPak** is connected. For USB users, this will usually be the highest numbered port in the list. Click Connect, and **Arroyo Control** will begin controlling the **LaserPak**. Once connected, you will be able to adjust settings, limits, and turn the output on or off.

Next, connect the cable between your LaserMount or other fixture and the **Output** connector of the **LaserPak**. We recommend using our cables as they have been designed to work well with the **LaserPak**. If using your own cables, ensure they have been properly wired according to the pin-out of the **LaserPak** and your fixture.

Prior to turning the output on, click the **Settings...** button and adjust the current and voltage limits as appropriate for your device. You will typically want the limits to be 10% or more above the operation limits of your device. When setting the voltage limit, take into account the voltage loss in the cable, which can amount to several tenths of a volt at higher currents.

When first turning on the system, start with a set point of 0mA and turn the output on. Initially increase in small steps (a few milliamps) to ensure the wiring is correct. Once the system appears to be running correctly, you can adjust the set point to the desired operating value.

It's that simple. For more detailed operating and installation instructions, read on.

Installation

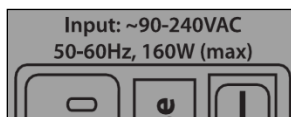
Installation of the **LaserPak** is very straightforward, as the quick start section above illustrated. This section will provide additional details and considerations for installing your **LaserPak**.

After unpacking the unit, make sure all packing materials have been removed and nothing obscures the ventilation ports on the front and back of the unit.

Verifying the Voltage Selection

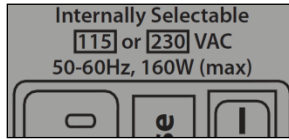
Before powering on the unit, ensure that the voltage selection is set correctly. Improper voltage selection can easily damage the unit.

On first generation **LaserPaks**, the AC input was a universal 90-240VAC, and no voltage selection is required for these units. To determine if your **LaserPak** is of the universal AC input type, review the label on the top of the unit. If it indicates "**Input: ~90-240VAC**", as shown in the illustration below, then your unit is universal input and you may skip this section and move on to *Powering Up the Unit*.



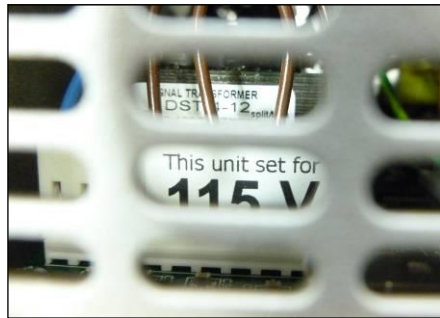
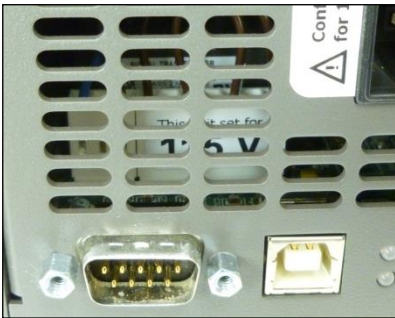
***Portion of label showing input voltage range
(for universal AC input LaserPaks)***

For second generation **LaserPaks**, as part of a design upgrade to improve noise performance, the unit must be configured for the proper line voltage. On these **LaserPaks**, the label will indicate "**Internally Selectable 115 or 230 VAC**", as shown in the illustration below:



**Portion of label showing input voltage range
(for selectable 115VAC or 230VAC input LaserPaks)**

There will also be a white sticker next to the IPC indicating the factory configured voltage range, or look into the vent holes to see the rating marked on the jumper inside the unit:



Voltage selection is done at the factory to match the AC mains standard for the country to which the product is being shipped. If your unit is not a universal input, or the AC mains are not correct for your application, please see the section entitled **Changing the AC Line Voltage Setting** towards the end of this manual for information on how to verify or change the AC line voltage.

CAUTION

Do not exceed 250VAC on the line input.

It is critical to select the proper voltage selection prior to applying power to the unit. If the actual voltage exceeds the voltage selection by +/-10%, damage to the unit may occur.

Powering Up the Unit

Connect the AC power cord to the unit. Turn the power switch, located on the AC power input power connector, into the on (I) position. The unit will go

through a quick power-up self-test, and return to the last known operating state. The AC Power LED will light up, and the On / Error LED should remain dark until the output is turned on (if **Automatic Output On** has been enabled in **Arroyo User Limits**, the On LED may light without user intervention).

Ventilation

The **LaserPak** has vent holes on the front and rear of the unit. You must not block these vent holes, or overheating may occur, causing damage to the unit.

CAUTION

Do not operate the unit above +40°C ambient, and ensure the instrument is properly ventilated, or the unit may overheat and possible damage to the instrument may occur.

Rack Mounting

A rack mount kit (**p/n 1402-RM**) for standard 19" racks is available for the **LaserPak**, and supports the rack mount of up to five units in either a 2U or 3U high opening, depending on the orientation of the **LaserPak**. Because the units only ventilate from the front and rear, no air gapping is required above or below the units, and they can be rack mounted immediately above other equipment (no rack spacers required).

Warm-up and Environmental Considerations

In order to achieve the highest level of accuracy, the **LaserPak** should be powered on for at least one hour prior to taking measurements. In addition, ensure that the unit is not operating outside the ambient temperature range or humidity conditions.

Control Modes

The **LaserPak** offers five laser control modes: **Io (ACC)**, **Io HiBW (ACC)**, **Im (AMC)**, **Po (APC)**, and **Vf (AVC)**.

Changing the control mode is done through the Arroyo Control by changing the **Mode** setting.

Io and **Io HiBW** modes (referred to collectively as ACC, or automatic current control modes) are used to drive a specific current through the laser diode. When in this mode, the set point will be in milliamperes, and the **LaserPak** will drive the desired current through the laser diode as long as the voltage at the chosen set point does not exceed the voltage limit. In **Io** mode, you will be limited to less than a 10 Hz bandwidth. To modulate above that rate, use the **Io HiBW**, which is a high bandwidth current mode supporting modulation.

Im mode (also referred to as AMC, or automatic monitor photodiode control, mode) is used to control the laser diode using the monitor diode feedback. You select the target monitor diode current, and the **LaserPak** will drive exactly enough forward current through the laser diode to generate the selected monitor diode current. Only low frequency modulation (10Hz or less) is possible in **Im** mode due to the feedback latencies of the photodiode itself.

Po mode (also referred to as APC, or automatic power control, mode) is simply **Im** mode with a mathematical constant applied to the set point, providing a convenient way of operating in milliwatts. Using the **PD Resp** factor (in $\mu\text{A}/\text{mW}$), a **Po** set point is internally converted to an equivalent **Im** set point by the driver, which is then used to control the photodiode feedback. For example, if the **PD Resp** factor was 10, then a set point of 1mW would be the same as a set point of 10 μA .

Vf mode (also referred to as AVC, or automatic voltage control, mode) is used to control the voltage driven through the device. Unlike ACC mode, AVC mode allows the current to drive to whatever current is necessary to achieve the voltage set point, so long as it does not exceed the current limit. As with **Im** mode, only low frequency modulation (10Hz or less) is possible in **Vf** mode.

Modulation

The instrument supports external analog modulation using the modulation pins on the analog interface connector. Modulation rates vary by model, so see your model's specification for the maximum modulation rates. Only **Io HiBW** mode supports high speed modulation. All other modes of operation have a modulation bandwidth of 10Hz or less.

Settings

All parameters of the **LaserPak** can be viewed and changed using **ArroyoControl**, or via the appropriate computer command.

Menu	Description	Factory Default	Computer Command
Basic Settings			
Mode	As described in the <i>Control Modes</i> section above, the unit offers five control modes: Io (ACC), Io HiBW (ACC), Im (AMC), Po (APC), and Vf (AVC). Change this setting to select a new mode.	Io (ACC)	LAS:MODE
Io limit	This setting controls the maximum amount of forward current that can be delivered to the laser diode. This limit is implemented in hardware for immediate response. For more information about limits, see <i>Hardware and Software Limits</i> below.	Maximum	LAS:LIM:LDI
Im limit	This setting controls the maximum amount of monitor photodiode current the unit will allow. This limit is implemented in software. For more information about limits, see <i>Hardware and Software Limits</i> below.	Maximum	LAS:LIM:MDI
Po limit	This setting controls the maximum amount of monitor photodiode power the unit will allow. This limit is implemented in software. For more information about limits, see <i>Hardware and Software Limits</i> below.	Maximum	LAS:LIM:MDP
Vf limit	This setting controls the maximum amount of forward voltage that can be delivered to the laser diode. This limit is implemented in hardware for immediate response. For more information about limits, see <i>Hardware and Software Limits</i> below.	Maximum	LAS:LIM:LDV

Menu	Description	Factory Default	Computer Command
Cable R	The cable resistance, in ohms. This setting can be used to compensate for voltage losses in the cable due to cable and connector resistances. Cable R is ignored in Vf (AVC) Mode. For more information about this feature, see <i>Using the Cable R Setting</i> below.	0.0000 Ω	LAS:CABLER
PD Resp	This factor is used by the unit to convert from monitor photodiode current into optical power. The value is in terms of microamps per milliwatt ($\mu\text{A}/\text{mW}$), such that power = photodiode current divided by the factor.	0.00 $\mu\text{A}/\text{mW}$	LAS:CALPD
Tol Time	Tolerance time is the amount of time, in seconds, that the measured value (current, voltage, etc.) must be within the set point +/- the tolerance for the unit to be considered in tolerance. In Io modes, the tolerance is defined by Tol Io . For Im/Po modes, the tolerance is fixed at 50 μA . For Vf mode, the tolerance is fixed at 50mV.	5 seconds	LAS:TOL
Tol Io	Tolerance current is a band (in mA) around the set point. When the actual current is within this band for longer than the Tol Time setting, then the unit is considered to be in tolerance.	10.0mA	LAS:TOL
On Delay	The delay, from the time the output is turned on with the LAS:OUTPUT command or the analog interface to when the output is actually energized.	3000ms	ONDELAY

Cable Wiring for Modulation

When modulating at higher frequencies (>1 kHz), it is critical that high quality, shielded twisted pair cabling be used, and wire size suitable for the applied current (or the equivalent if using a multi-conductor cable). See the chart below for suggested sizes. Failure to do so may result in current oscillations that may damage your laser. When operating in these modes, always use shielded cable and never use individual wires to connect the instrument to your laser. If in doubt, use a current probe attached to an oscilloscope to monitor actual performance.

Arroyo Instruments offers the 1222/1223 series cables specifically for this application. For questions, contact the factory or your local representative for additional help.

Current (A)	Recommend Wire Gauge
Below 1A	22 AWG
1A to 5A	20 AWG
5A or greater	18 AWG

Using the Cable R Setting

The **Cable R** setting allows you to calculate the voltage at the laser by subtracting the voltage loss through the cable and connectors. This is done by measuring or calculating the cable resistance and entering the value, in ohms, into the **Settings** dialog within **Arroyo Control**. The instrument will then use the $V = I * R$ formula to calculate the voltage loss in the cable and subtract that from the actual measured voltage, displaying the result as V_f on the display.

Common values for **Cable R** range from 0.0300Ω to 0.0900Ω , but can be significantly higher if you have long runs, many connector interfaces, or small gauge wire.

While it is possible to use a DMM to measure the resistance of the cable, because resistance is so small, you will not typically get proper readings. A better approach is to use the instrument to drive current through the system and then measure the voltage loss to determine resistance. There are two ways to best calculate the voltage loss:

Measure the Voltage at the Laser

If you have an accurate DMM and can measure the voltage across the laser (or accurately know the voltage of the laser at a specific current) and voltage across the pins at the **Output** connector, then the difference between the measured voltages is the voltage loss in the cable. Use this formula to calculate resistance:

$$Cable R = \frac{V_{Output} - V_{laser}}{I_{AMPS}}$$

Note that the current is expressed in *amps*, not *milliamps*, so divide the set point by 1000 before using it in this equation.

Short the Connection at the End of the Cable

A second method, which can be done with just the **LaserPak**, is to short the cable at the end of the cable (nearest the laser diode), drive current through the cable and measure the voltage. The resistance is found using a simpler version of the formula above:

$$Cable R = \frac{V_{Output}}{I_{AMPS}}$$

Note that the current is expressed in *amps*, not *milliamps*. The easiest way is to drive 1A of current. When I_{AMPS} equals 1A (1000mA), the measured voltage is also the resistance of the cable.

To short the cable, disconnect the laser and short the anode and cathode together as close to the end of the cable as possible. Ideally, the short should be done by soldering the anode and cathode wires together to minimize the resistance in the short itself.

How the Calculation Is Used

The **LaserPak** continuously takes the measured current, multiplies it by the resistance (**Cable R**), subtracts the result from the actual voltage at the output connector, and displays this value on screen as **Vf**. However, there are some limitations to how the cable loss calculation is used:

1. The value for **Vf Limit** is always the voltage at the connector. This means that the **Vf Limit** must take into account all the voltage required, including the cable loss (i.e., the voltage displayed if the **Cable R** value were zero).
2. **Cable R** is ignored in Vf mode. This means that the set point and measured voltage are always the voltages at the connector, and **Cable R** is not used.

Remote Mode Operation

Remote mode operation is when the **LaserPak** is being controlled by a computer over the USB or RS232 interfaces. Details on how to communicate with the **LaserPak** can be found in the ***Computer Interfacing Manual*** which is included on the CD that accompanied this product.

Installing the USB Drivers

Using the **LaserPak** via USB is just as simple as using the serial port. In fact, once you have installed the USB drivers, the instrument will appear as a virtual serial port that you can use just like a normal serial port.

To install the drivers, simply plug in the instrument to your computer. When the **Add New Hardware** wizard appears, insert the CD you received with the **LaserPak** and follow the on-screen instructions.

Once the drivers are installed, the **LaserPak** will be available as a standard COM (serial) port. In the event you have multiple Arroyo Instruments products plugged in simultaneously, you will need to experiment to see which instrument was assigned to which port. For example, you could send a *IDN? query and see which instrument goes into remote mode.

Interface Connectors

In addition to the input power connector described above, there are four connectors on the **LaserPak**: the output connector, the analog interface connector, the USB connector, and RS232 connector.



LaserPak Front Panel



LaserPak Rear Panel

Laser Output Connector

The **Output** connector is a female DB-9, and has the following pin-out:

DB-9 Pin	Description
1	Interlock+
2	Interlock –
3	Earth Ground
4 & 5	Laser Cathode
6	Photodiode (PD) Cathode
7	Photodiode (PD) Anode
8 & 9	Laser Anode
Shell	Earth Ground

Output Connector (DB-9 Female)

Arroyo Instruments has followed industry conventions for laser DB-9 connections, and is compatible with pin-outs from other vendors.

Analog Interface Connector

The Analog Interface connection is a male DB-15, and has the following pin-out:

DB-15 Pin	Description
1	On/Off Control Input
2	On/Off Status Output
3	Stable Output
4	Analog Current Monitor
5	Modulation+
6	Modulation-
7	+3.3V Auxiliary Supply
8	Ground
9	Auxiliary Analog Input
10	Thermistor
11	Analog Photodiode Monitor
13-15	No Connection

Analog Interface Connector (DB-15 Female)

The +3.3V auxiliary supply is provided for external low-power electronics. Current draw on this supply should not exceed 100mA. The Ground pin provides the ground reference for the logic inputs and analog outputs as well as the auxiliary power supply. The modulation input has a separate analog ground reference (Modulation-), which can be common to Ground if your setup requires it. The analog interface is described in detail in the *Using the Analog Interface* section below.

USB Connector

The USB connector is a standard Type B female connector, and can be plugged into any USB 1.1 or USB 2.0 port. For more information on using the USB interface, see the ***Computer Interfacing Manual*** which is included on the CD that accompanied this product.

RS232 Connector

The RS232 connection is male DB-9 connector wired in a NULL modem configuration.

Pin	Description
2	Receive
3	Transmit
5	Ground
1,4,6	Commoned together
7,8	Commoned together
9	No connection
Shell	Earth ground

RS232 Connector (DB-9 Male)

For more information on using the RS232 interface, see the **Computer Interfacing Manual** which is included on the CD that accompanied this product.

Connecting to the LaserPak

A laser diode is very sensitive to electro-static discharge (ESD), over-voltage, and over-current conditions. When connecting a laser to the **LaserPak**, make sure proper ESD procedures are taken. In addition, it is critical that the proper current limit and voltage limit be set for the laser diode. Exceeding the laser diode's rated current or voltage can damage or destroy the laser diode, and the **LaserPak's** hardware protection features can only protect the laser diode if these limits are properly set.

NOTE

While connecting to only one of the DB-9's cathode (pins 4 and 5) and anode (pins 8 and 9) connections is required, you should connect cathode to both pins 4 and 5, and anode to both pins 8 and 9 to provide the best connection through the DB-9 connector.

CAUTION

The interlock connections must be kept isolated from all other connections and from earth ground. Failure to do so may damage the instrument.

The Laser anode and cathode outputs are electrically isolated from earth ground, as are the photodiode inputs. However, **the ground of the analog interface cannot be connected to either the laser anode or cathode**. When connecting multiple LaserPaks using a common anode or cathode connection (such as a multi-stage laser), typically only one point of connection can be made between LaserPaks. Please contact the factory to verify your wiring plan.

NOTE

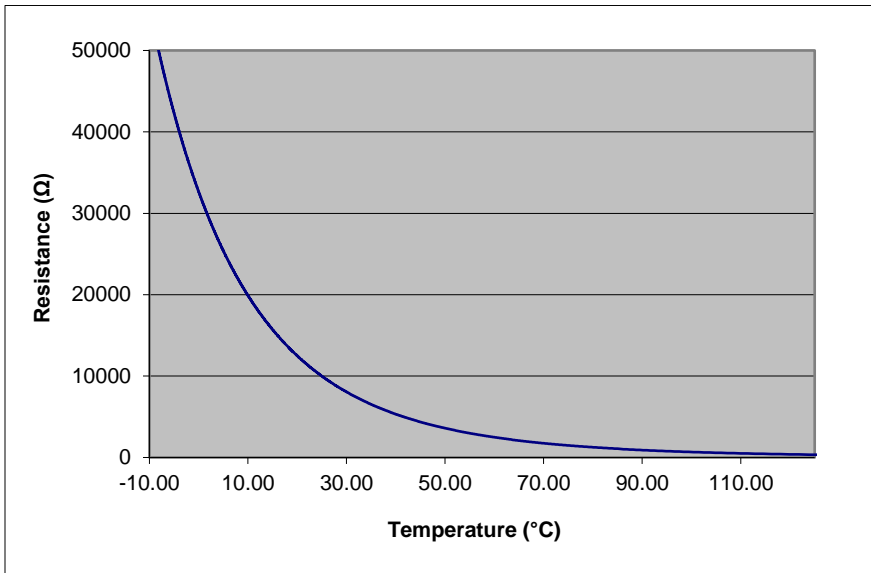
Connections to the **LaserPak** and the laser diode fixture must be secure. Tighten any screws on the DB-9 connectors, and make sure all connections are in good condition. Poor or intermittent connections can damage or destroy the laser diode.

See the manual for your laser (and fixture) for additional safety and operational information.

Working With Thermistors

The **LaserPak** is designed to work with 10k Ω negative temperature coefficient (NTC) thermistors, such as the BetaTHERM 10K3A1 thermistor used in the **LaserMounts**. A thermistor works by translating temperature into resistance, with resistance decreasing as temperature increases (hence the 'negative coefficient').

Here is a typical response curve of a thermistor:



Typical Resistance vs. Temperature Graph

The **LaserPak** uses a ratio-metric measurement, with a well known 10k Ω fixed resistor and a precision voltage reference to determine the thermistor resistor. Because of this, the circuit is most sensitive and accurate at 20°C, but is usable with reasonable accuracy from a range of -10°C to 75°C.

When connecting a thermistor to the **LaserPak**, one side of the thermistor should be connected to the Thermistor input on the analog interface (pin 10), while the other side should be connected to the Ground input (pin 8).

Temperature or resistance measurements can be read over the computer interface using the LASER:T? or LASER:R? commands, respectively.

The Steinhart-Hart Equation

As can be seen from the temperature versus resistance graph above, resistance varies inversely with temperature in a non-linear fashion. This relationship can be accurately modeled by polynomial equations, and one such being the Steinhart-Hart equation:

$$\frac{1}{T} = A + B * \ln(R) + C * \ln(R)^3$$

The coefficients A, B, and C can usually be obtained from the thermistor manufacturer. The **LaserPak** defaults to the coefficients for the BetaTHERM 10K3A1 thermistor ($A = 1.12924 \times 10^{-3}$, $B = 2.34108 \times 10^{-4}$, $C = 0.87755 \times 10^{-7}$). You can change the coefficients using the LAS: CONST command, or through the **Settings** dialog within **Arroyo Control**. .

Using the Analog Interface

The Analog Interface is a feature not found on our bench top laser drivers, as it is designed to be used in applications where a user interface, or even a PC, is not available.

The Analog Interface has two sections: the logic level control/status pins, and the analog control/monitor pins, plus an auxiliary power supply. The +3.3V auxiliary supply is provided for external low-power electronics, and current draw on this supply should not exceed 100mA. The Ground pin provides the ground reference for the logic level inputs and outputs, and analog outputs. The modulation input has a separate ground (Modulation-).

The logic level inputs operate off a low or high voltage input. A logic zero (below 1V) is considered to be off or false, while a logic one (above 2.5V, but do not exceed 5V) is considered to be on or true. For logic level outputs, a false will be 0V, while a true will be 3.3V.

CAUTION

Do not exceed 5V DC on any logic input pin or 3V DC on any analog input pin, or damage to the instrument may occur.

There are three logic level pins:

On/Off Control Input

This input controls the on/off state of the instrument. When this input transitions from off to on, the output is turned on and begins controlling to the set point. Similarly, when it transitions from on to off, the output is turned off.

It is possible to use the analog interface with the computer interface, as the **LaserPak** is looking for a **change** in the logic input to turn the output on or off, as appropriate (considered an *edge* triggered input, rather than a *level* triggered input). It is possible for the computer interface to turn the output on or off as well, ignoring the steady state of the logic input. However, as soon as the logic input changes state, then the **LaserPak's** output will also be changed to reflect the new state.

For example, if the logic input goes from false to true (turn the output on), then the output will be turned on. Later, if a LAS:OUT OFF is received from the computer (turn the output off), then the output will be

turned off, *even though the logic input is still high*. Likewise, if the computer sends a LAS:OUT ON, the output will be turned on, regardless of the logic input's state. Later, if the logic input goes from true to false, then the output will be turned off.

In this way, on/off operation can be supported simultaneously through the analog interface and the PC interface without conflict.

On/Off Status Output

This logic level output reflects the present output state of the instrument. When it is on, this output will be high.

Stable Status Output

The output is considered stable when the actual drive value has remained within the tolerance band around the set point for a specific amount of time (as defined by the tolerance settings). Once the output is considered stable, then this logic level output will be set to high. If the set point is changed, or a disturbance causes the actual output to fall outside the tolerance setting, then this logic level output will be set to false, and the process starts over. The output will also be false whenever the output is off.

In addition, there are several analog signals:

Analog Modulation Input

The analog modulation input allows the user to change the set point using a voltage signal. The voltage input range is from 0V to 10V, where 0V equals a set point of zero, and 10V equals a set point of the full scale range.

For example, on a 5A driver, 10V input would attempt to drive 5A, which is the full scale of the instrument. In this case, the transfer function would be 500mA/V.

The modulation input is **added** to the set point of the instrument. For example, if you were operating in Io Mode, and the set point was 500mA on a 5A driver, and you applied a voltage of 4V (which is equal to 2A), then the output drive current would be 2.5A.

CAUTION

The allowable voltage input range on the analog input is 0 to 10V. Be sure not to exceed 10V on the input, or damage to the instrument may occur.

Analog Current Monitor Output

The actual current being driven by the instrument is provided as an output voltage, where 2.5V equals full scale of the output.

Analog Photodiode Current Monitor Output

The actual photodiode current measured by the instrument is provided as an output voltage, where 2.5V equals FS of the output.

Thermistor Input

Thermistor operation is described in the *Working With Thermistors* section above. The thermistor should be connected to the Thermistor and Ground pins.

Auxiliary Analog Input

This input accepts from 0V to 2.5V input, and it's measurement can be read using the LAS:AUX? query.

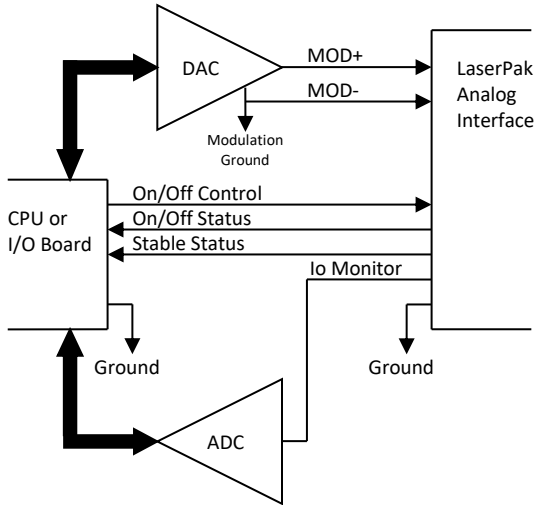
Connecting to the Analog Interface

Connecting to the Analog Interface is very straightforward. Because the inputs and outputs are buffered, you do not need any external filters or buffers, unless your application requires it. The logic level interfaces are all high impedance, as is the modulation input. The analog current and photodiode current monitors output are driven through a 499 Ω resistor to protect against output shorting.

CAUTION

Do not connect the analog interface ground pin to either the laser anode or laser cathode connections, as it may damage your laser or the instrument.

A typical application might look like this:



Grounding Considerations

The **LaserPak** employs a different isolation strategy than the **LaserSource** instruments, which use optical isolation. The **LaserPak** instead uses high impedance differential measurements with an earth ground bypass capacitor to minimize ground loop potentials. However, improperly wired setups can still cause ground loops, so care should still be employed, and any ground loops identified and broken. From any point in the system, make sure that there is only a single path to earth ground.

Photodiode Input Considerations

Great care was taken in the design of the photodiode input stage to support all wiring configurations of the laser and photodiode (common anode, common cathode, etc.) without requiring the laser diode to be wired differently depending on the laser/photodiode wiring scheme.

The **LaserPak** comes configured for -3V photodiode bias, which is typically sufficient for any application, although no bias and -5V bias are also available. The -5V bias **cannot** be used if either side of the laser is connected to the photodiode cathode. The “no bias” setting is not typically used, as the current of the photodiode will slightly forward bias the photodiode, which is more than offset by -3V or -5V bias, and is the primary reason for the reverse bias.

To change the bias setting, the cover must be removed and a jumper changed on the circuit board. Make sure the power cord is unplugged from the unit, and also remove the output cable if it is connected. Both jack screws on the output connector need to be removed, as do all 6 black flat head screws on either side of the enclosure. Slide the top off the OUTPUT connector and rotate up. The fan is mounted to the portion of the enclosure you are lifting off, so take care that the power connector to the fan is not stressed.

To change the bias setting, locate J11 on the circuit board. It is on the fan end of the board, right next to the large white power connector. On the board you will see three settings: “NO”, “3V”, and “5V”. Move the jumper to the setting you desire.

When replacing the cover, if the fan was unplugged, make sure to plug it back in (the fan connector is J3, also marked “FAN” on the circuit board). Take care not to pinch the fan wires as the top is put back into place. Screw the six flat head screws back in, and gently screw in the jack screws (do NOT over-tighten the jack screws or you run the risk of snapping them off in the connector).

Using Limits

The **LaserPak** provides several limit features for protection of the laser diode. These include current, voltage, photodiode current, and photodiode power limits.

Both the current and voltage limits are implemented in hardware, providing for fast response to changes in laser diode operation. When a voltage limit is detected, the output is immediately shutdown. Because of the sensitivity of the voltage limit, operating near the limit (within one to two hundred millivolts) is not recommended. In general, you should set the voltage limit to 0.1V to 0.2V higher than any anticipated operating point. The voltage limit is tested against *the voltage at the connector*. Any **Cable R** value is ignored, as **Cable R** is a software only calculation, and the voltage limit is implemented in hardware. See *Using the Cable R Setting*, above, for more information on the **Cable R** setting.

Unlike the voltage limit, the current limit simply prevents the **LaserPak** from delivering more current than the limit is set to. When the current limit engages, the output will remain on.

The photodiode current and photodiode power limits are implemented in software and may take up to one second to trigger when these conditions occur, and therefore should not be relied on to provide fast protection of the laser diode.

Thermal Considerations

The **LaserPak** is designed to provide high power in a small enclosure. A key component is an adjustable power supply that is dynamically tuned to meet the needs of your load. However, when operating at high currents and very low voltages, it is possible that more heat than the **LaserPak** can manage will be generated inside the instrument. In that condition, the instrument will automatically shut itself off and generate an E-537 error message.

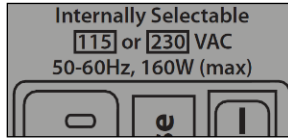
A possible fix to this condition is lowering the **Vf Limit** to just above the highest voltage needed for the maximum set point you will be using. This gives the unit a "hint" as to the required voltage, and may be enough to eliminate the thermal trip error.

If your instrument still continues to thermally trip, you will need to add series resistance with the laser to remove some of the power from inside the unit. Typically, a 20W 1Ω load resistor in series with the laser is sufficient, but higher resistances and or power handling may be needed, depending on the voltage and current configuration of your **LaserPak**.

Please feel free to consult the factory for more information and support.

Changing the AC Line Voltage Setting

This section only applies to 2nd generation **LaserPaks** which must be configured to match the AC mains voltage to which they will be connected. On these **LaserPaks**, the label will indicate “**Internally Selectable 115 or 230 VAC**”, as shown in the illustration below:



***Portion of label showing input voltage range
(for selectable 115VAC or 230VAC input LaserPaks)***

To change the voltage selection, you will need the appropriate AC jumper harness, as pictured below. The harness is not normally supplied with the unit, and must be requested from Arroyo Instruments.

Once you have the required AC jumper, remove the power cord from the unit. Using a 5/16" hex driver or wrench, remove the two jack screws from the DB-15F OUTPUT connector, as shown with the two red arrows below:



Next, using a #1 Philips screwdriver, remove the three black screws from each side of the instrument (six total), as shown below:



Gently slide the cover forward, over the OUTPUT connector, until the top is clear of the bottom, far enough that the AC selector harness is visible, as shown below:



If the top is fan is removed too far, the fan may become unplugged. If this happens, simply reconnect it to the J2 connector on the PCB, and take care that the fan wires are not pinched when sliding the cover back on.

Remove the existing AC selector harness from the PCB and install the new one. The two available harnesses are shown below:



Slide the top cover back onto the bottom, ensuring that the fan wire is not being pinched. Install the six black Phillips flat head screws. Install the two jack screws into the OUTPUT connector. Tighten only lightly, or you risk the change of snapping off the head of the jack screw.

Finally, to avoid confusion, remove the external sticker indicating the old AC voltage. You can still verify the AC voltage as the AC selection harness is clearly visible through the vent holes.

Avoid confusion!
Remove this label



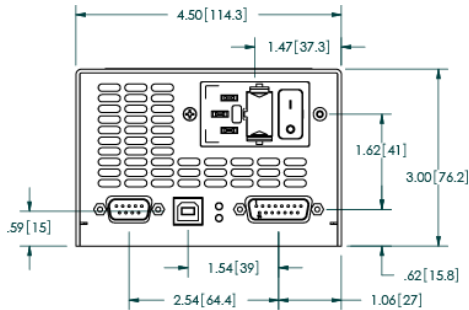
Specifications

Description	Specifications		
CW Mode Specifications	485-02-15	485-04-08	485-08-05
SETPOINT			
LASER CURRENT			
Range (mA)	0 – 2000	0 – 4000	0 – 8000
Resolution (mA)	0.1	0.1	0.5
Accuracy (±[% set+mA])	0.05% + 0.4	0.05% + 0.8	0.05% + 1.6
Stability (ppm, time)	< 10, 1 hour		
Temperature Coeff (ppm/°C)	50		
Noise/Ripple (µA rms)	< 60	< 100	< 200
Transients (µA)	< 300	< 400	< 600
Compliance Voltage (V)	15	8	5
PHOTODIODE CURRENT			
Range (µA)	5 – 10,000		
Resolution (µA)	1		
Accuracy (±[% set+µA])	0.05% + 1		
Stability (ppm, time)	< 200, 24 hours		
Temperature Coeff (ppm/°C)	< 200		
PD Bias (V)	Jumper selectable: No bias, -3V (default), -5V		
LASER VOLTAGE			
Range (V)	0 – 15	0 – 8	0 – 5
Resolution (V)	0.001		
Accuracy (±[% set+V])	0.05% + 0.005		
Stability (ppm, time)	< 50, 1 hour		
Temperature Coeff (ppm/°C)	< 100		
EXTERNAL MODULATION			
Input Range	0 – 10V, 10kΩ		
Modulation Bandwidth	65kHz	50kHz	40kHz
MEASUREMENT			
LASER CURRENT			
Resolution (mA)	0.1	0.1	0.5
Accuracy (±[% reading+ mA])	0.05% + 0.4	0.05% + 0.8	0.05% + 1.6
LASER VOLTAGE			
Resolution (V)	0.001		
Accuracy (±[% reading+ V])	0.05% + 0.004		
PHOTODIODE CURRENT			
Resolution (µA)	1		
Accuracy (±[% reading+ µA])	0.05% + 2		
LIMITS			
LASER CURRENT			
Resolution (mA)	1		
Accuracy (±[% reading+ mA])	20	40	80
LASER VOLTAGE			
Resolution (V)	0.1		
Accuracy (±% FS)	2.5%		
GENERAL			
Laser Connector	DB-9, female		
Photodiode/Interlock Connector	On LDD connector		
Computer Interface	USB 2.0 Full Speed (Type B), RS-232 (DB-9, male)		
Power	115VAC / 230VAC (internally selectable), 50/60 Hz		
Size (H x W x D) [inches (mm)]	3.0 (77) x 4.5 (115) x 8.5 (216)		
Operating Temperature	+10°C to +40°C		
Storage Temperature	-20°C to +60°C		

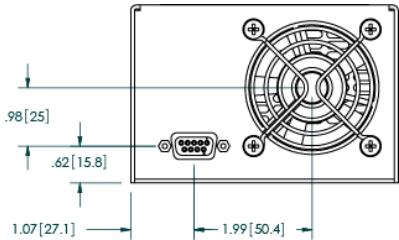
Error Messages

Error Code	Description	Cause
E-100	General Error	The error code is non-specific, and is generally used when no other error code is suitable.
E-102	Message too long	The message is too long to process (USB/Serial only).
E-123	Path not found	The message used an invalid path command (USB/Serial only).
E-124	Data mismatch	The message contained data that did not match the expected format (USB/Serial only).
E-201	Data out of range	The message attempted to set a value that was outside the allowable range (USB/Serial only).
E-202	Invalid data type	When trying to parse the message, the data was in an invalid format (USB/Serial only).
E-204	Suffix not valid	An invalid number base suffix (radix) was encountered when parsing a number (USB/Serial only).
E-501	Interlock shutdown output	The interlock input (pins 1 and 2 of the output connector) were not shorted when the output was on.
E-504	Laser current limit disabled output.	The laser output was turned off because a current limit was detected and the corresponding bit in the OUTOFF register was set.
E-505	Laser voltage limit disabled output	The laser voltage exceeded the voltage limit and the output was turned off.
E-506	Laser photodiode current limit disabled output	The laser output was turned off because a photodiode current limit was detected and the corresponding bit in the OUTOFF register was set.
E-507	Laser photodiode power limit disabled output	The laser output was turned off because a photodiode power limit was detected and the corresponding bit in the OUTOFF register was set.
E-509	Laser short circuit disabled output	The laser output was turned off because a short condition was detected and the corresponding bit in the OUTOFF register was set.
E-510	Laser out of tolerance disabled output	The laser output was turned off because an out-of-tolerance condition was detected and the corresponding bit in the OUTOFF register was set.
E-511	Laser control error disabled output	A hardware control error was detected which forced a shutdown of the laser output.
E-512	Power failure	A power failure was detected.
E-514	Laser mode change disabled output	A change in the operating mode of the LaserPak while the output was on shutdown the output.
E-516	Incorrect configuration for calibration to start	The LaserPak was not configured properly, including the mode and output on state, to be able to start the desired calibration process.
E-517	Calibration must have the output on to start	The laser output must be on for the calibration process to start.
E-534	Po mode selected with PD Response set to zero	Attempted to select Po mode and PD Response was zero, or LaserPak was in Po mode and PD Response was set to zero.
E-535	Calibration cancelled	The active calibration process was cancelled.
E-537	Thermal trip	Excessive power dissipated inside unit. Lower voltage limit or add series resistance. See "Thermal Considerations" for more details.
E-998	Command not supported	A command was recognized but not supported by the LaserPak.
E-999	Non-specific error	A non-specific error was encountered.

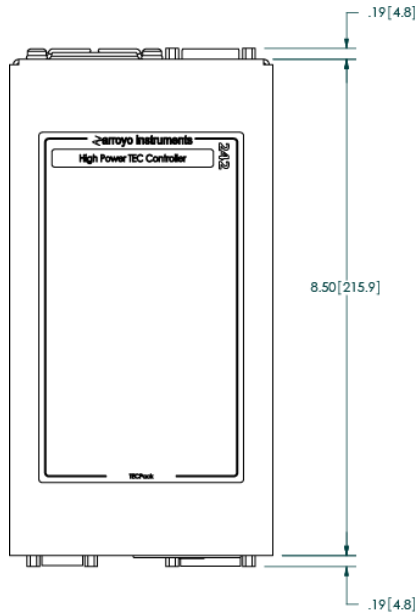
Mechanical Drawings



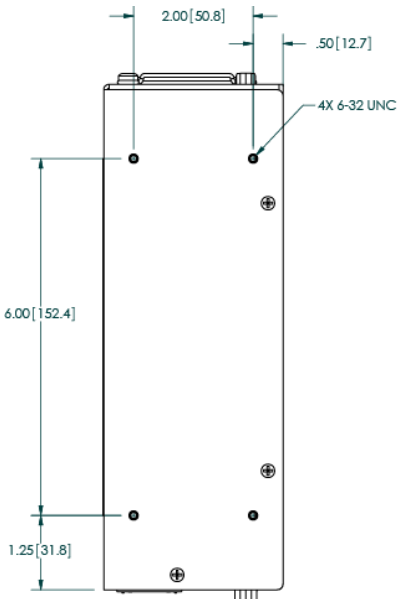
Front View



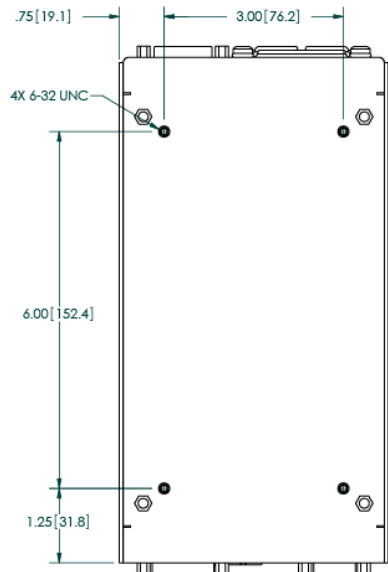
Rear View



Top View



Left Side View



Bottom View

Maintenance and Service

Maintenance

The **LaserPak** requires no regular maintenance other than product calibration. To clean the instrument, use cotton cloth that is only damp (not wet) with a light solution of soap and water.

Fuses

Under normal operation, you should never need to replace a fuse. However, if either fuse does blow, use only T 250V, 2A, IEC 60127-2 5x20mm metric fuses with a current rating as specified on the unit as replacements.

If, after replacing the fuse, it continues to blow, immediately discontinue use of the instrument and contact service for support.

Service

Service and repair for the **LaserPak** can be obtained by contacting the distributor from where you purchased the instrument, or directly from Arroyo Instruments. A complete list of distributors is available on the Arroyo Instruments web site.

You can contact Arroyo Instruments through one of these methods:

By mail:	Arroyo Instruments 1201 Prospect Street San Luis Obispo, CA 93401 USA
By phone:	+1 (805) 543-1302
By fax:	+1 (805) 543-1303
By email:	support@arroyoinstruments.com
On the web:	http://www.arroyoinstruments.com

In all cases, Arroyo Instruments requires a return materials authorization (RMA) number. You must contact Arroyo Instruments and obtain an RMA number prior to returning your instrument, or the shipment may be rejected and sent back to you.

Warranty

Arroyo Instruments warrants that this product will be free from defects in material and workmanship and will comply with Arroyo Instruments' published specifications at the time of sale for a period of one year from date of shipment. If found to be defective during the warranty period, the product will either be repaired or replaced at Arroyo Instruments' option.

To exercise this warranty, write or call your local Arroyo Instruments representative, or contact the factory directly at the address given above. You will be given prompt assistance and return instructions. Send the product, freight prepaid, to the indicated service facility. Repairs will be made and the instrument returned freight prepaid. Repaired products are warranted for the balance of the original warranty period or 90 days, whichever first occurs.

Limitation of Warranty

The above warranties do not apply to products which have been repaired or modified without Arroyo Instruments' written approval, or products subjected to unusual physical, thermal or electrical stress, improper installation, misuse, abuse, accident or negligence in use, storage, transportation or handling. This warranty also does not apply to fuses, batteries, or damage from battery leakage.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE. ARROYO INSTRUMENTS SHALL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, OR CONSEQUENTIAL DAMAGES RESULTING FROM THE PURCHASE OR USE OF ITS PRODUCTS.

EC Declaration of Conformity

EC Declaration of Conformity



I/We

Arroyo Instruments

of

1201 Prospect Street
San Luis Obispo, CA
USA

declare that

485 Series LaserPak Laser Diode Driver

In accordance with the following directives

EMC Directive: 89/336/EEC
Low Voltage Directive: 73/23/EEC
RoHS Directive: 2015/863/EU

has been designed and manufactured to the following specifications:

EMC Directive Test Standards

EN 61326 Electrical Equipment for Measurement, Control and Laboratory Use EMC Requirements. This encompasses 10 individual Tests


Low Voltage Directive Test Standards

EN 61010 Electrical Equipment for Measurement, Control and Laboratory Use Safety Requirements.

This Certificate is the Manufacturer's Declaration which states that the **485 Series LaserPak Laser Diode Driver** is Compliant to the above noted EU Directives and are therefore, eligible to bear the CE MARK.

I hereby declare that the equipment named above has been designed to comply with the relevant sections of the above referenced specifications. The unit complies with all essential requirements of the Directives.

Paul. Corr
(NAME OF AUTHORIZED PERSON)


(SIGNATURE OF AUTHORIZED PERSON)

President
(TITLE OF AUTHORIZED PERSON)

1 February 2010
(DATE OF ISSUE)

UK Declaration of Conformity

EC Declaration of Conformity



I/We

Arroyo Instruments

of

1201 Prospect Street
San Luis Obispo, CA 93401
USA

declare that

485 Series LaserPak Laser Diode Driver

In accordance with the following U.K. Legislation Regulations:

Electrical Equipment (Safety) Regulations 2016
Electromagnetic Compatibility (EMC) Regulations 2016
The Restriction of the Use of Certain Hazardous Substances in
Electrical and Electronic Equipment Regulations 2012

has been designed and manufactured to the following specifications:

EMC Directive Test Standards

EN 61326 Electrical Equipment for Measurement, Control and Laboratory Use EMC Requirements. This encompasses 10 individual Tests


Low Voltage Directive Test Standards

EN 61010 Electrical Equipment for Measurement, Control and Laboratory Use Safety Requirements.

This Certificate is the Manufacturer's Declaration which states that the **485 Series LaserPak Laser Diode Driver** is Compliant to the above noted U.K. Legislation and are therefore, eligible to bear the UKCA MARK.

I hereby declare that the equipment named above has been designed to comply with the relevant sections of the above referenced specifications. The unit complies with all essential requirements of the U.K. Legislation Regulations.

Paul Corr
(NAME OF AUTHORIZED PERSON)


(SIGNATURE OF AUTHORIZED PERSON)

President
(TITLE OF AUTHORIZED PERSON)

September 27, 2022
(DATE OF ISSUE)



1201 Prospect Street, San Luis Obispo, CA 93401

Tel: (805) 543-1302 Fax: (805) 543-1303

sales@arroyoinstruments.com

www.arroyoinstruments.com