MultiSource™
7144 SERIES
USER'S MANUAL

**MULTICHANNEL
LASER DRIVER**

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Introduction

Thank you for choosing the **7144 Laser MultiSource** multi-channel laser driver from Arroyo Instruments. With a 2x20 character VFD display, both Ethernet and USB computer interfaces, and built-in rack mounting, the **MultiSource** works equally well in small- and large-scale deployments.

The user interface of the **MultiSource** provides status for each channel in the system, along with on/off control. The unit can be operated locally but is more intended for remote control via its computer interfaces.

The **MultiSource** offers all the features you would expect from a modern precision controller, including:

- Comprehensive laser protection circuitry, including hardware voltage and current limits, and fast transient shutdown.
- Power mode control, both in photodiode current (AMC) or computed photodiode power (APC) modes.
- Simultaneous reading of current set point, voltage measurement, and photodiode current or power measurement.
- External analog modulation

What's in the Box

Along with the **MultiSource** 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 **MultiSource**. These include:

- **1220B LaserSource Cable, 4A, 2m**
  This cable has DB-9 male/female connectors for interfacing to the LaserMount or other connectorized fixtures and shielded twisted pair conductors for improved modulation performance. A pigtailed version of this cable, with tinned ends for soldering into custom solutions, is available as p/n **1221B**.
- **1201 USB Cable, 3m**

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

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General Warnings

WARNING

Potentially lethal voltages exist within this instrument. This instrument is intended for use by qualified personnel who understand the shock 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 an 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

After unpacking the unit, and all packing material has been removed, place the controller into a rack or onto bench top. Plug the AC cord into the unit and into the wall outlet. Turn on the power switch located on the front panel, and the unit will power up, displaying the model information, serial number, and firmware version number.

The most important consideration is to ensure the Laser limits are set correctly, particularly the laser current limit. It is also good to set the voltage limits to enhance the protection of the device.

You can use the menu from each sub-channel to configure each channel's limits, or use **ArroyoControl** or your own program to make changes settings via the computer interface.

To use **ArroyoControl** over the Ethernet interface, you must first install the COM Port Redirector software, as **ArroyoControl** cannot make direct network connections. More information is available in the *Using the COM Port Redirector* section below.

Next, connect the cables between your laser mount or other fixture and the Laser **OUTPUT** connectors of the **MultiSource**. We recommend using our cables as they have been designed to work well with the **MultiSource**. If using your own cables, ensure they have been properly wired according to the pin-out of the **MultiSource** and your fixture.

Finally, change the set points to an appropriate setting and turn the outputs on by pressing and holding the **On**/**Off** within the channel display on the **MultiSource**.

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Installation

Installation of the **MultiSource** is very straightforward, some of which was detailed in the section above. This section will provide additional details and considerations for installing your **MultiSource**.

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

CAUTION
Do not exceed 250VAC on the line input.

It is critical to maintain the proper voltage input into the unit. If the actual voltage exceeds 250VAC, damage to the unit may occur.

Powering Up the Unit

Connect the AC power cord to the unit. You must properly ground the unit by plugging the supplied power cord into a three-prong grounded outlet, or using a three-to-two prong adapter and connecting the ground tab to earth ground.

Turn the power switch, located on the front panel, into the on (|) position. The unit will display the model, serial number, and firmware version, go through a quick power-up self-test, and return to the last known operating state.

Ventilation

The **MultiSource** has vent holes on the sides, and front and back 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 unit may occur.

Rack Mounting

The **MultiSource** features integrated rack mount ears, and is design to work with standard 19" rack systems. Because the unit partially draws air from the side, and therefore inside the rack housing, be sure that the internal rack ambient temperature (which will typically be several degrees higher than room ambient) does not exceed the unit's operating temperature.

Warm-up and Environmental Considerations

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

Operation

The Front Panel

The front panel operation of the **MultiSource** is very simple. Due to the complex nature of the instrument, most operations are intended to be done remotely using either ArroyoControl, or a software program you develop. However, full monitoring and control is available front the front panel.

7144 MultiSource Main Screen

There are only two buttons on the front panel: **Up [Menu]**, and **Down [On/Off]**.

When quickly pressed and released (a short press), the buttons function as up and down buttons, scrolling between each of the individual channel status screens and the main summary screen.

If a button is pressed and held for over a second (a long press), the secondary action occurs, and its action depends on what screen the user is it:

Master Status Window (all four channels displayed):

- On/Off: Turns all channels off. Individual channels can only be turned back on in the individual Channel Status Windows.

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- Menu: enters the system menu.

Channel Status Window:

- On/Off: Turns an individual channel on or off
- Menu: enters the individual channel menu.

If in remote mode, the first long press of the Menu button exits remote mode. A second long press is needed to enter the menu.

There are four LEDs: green, yellow, red, and blue:

- Green LED: lit when AC power is applied
- Yellow LED: lit once remote communication has been established
- Red LED: lit once an error has occurred, with error message on display
- Blue LED: lit when in the Master Status Window, indicates one or more channels is on; when in an individual Channel Status Window, indicates if that specific channel is on.
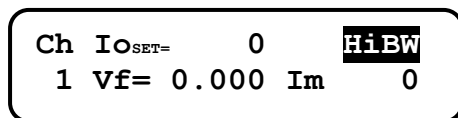
Display Windows

The display will typically show the *Master Status Window*, which is a summary of all channels on the system. It can also display the *Channel Status Window,* which is a more detailed status of a single channel.

Example displays are shown below:

```
Ch 1|Ch 2|Ch 3|Ch 4
 On | Off| On | On
```
Master Status Window

```
Ch IoSET=     0     HiBW
 1 Vf= 0.000 Im      0
```
Channel Status Window

Measurements

One of the advantages of the **MultiSource** is its ability to display both the set point and two measurements simultaneously. The table below shows which values will appear on the display depending on the mode selected:

Mode	Setpoint	Displayed Measurements
Io	Current (mA)	PD current or power and voltage
Im	PD current (μA)	Current and voltage
Po	PD power (mW)	Current and voltage
Vf	Voltage (V)	Current and PD current or power

The instrument will show photodiode current or photodiode power, depending on the value of **PD Resp**. Photodiode current is shown whenever **PD Resp** is zero, while photodiode power will be shown whenever **PD Resp** is non-zero. See the *Control Modes* section below for more information on the various modes.

Status Messages

The instrument will display status messages in the upper-right corner of the display indicating several different conditions that may be of interest to the user. If multiple conditions exist simultaneously, then the instrument will cycle through each condition, displaying each status message for approximately one second.

Possible condition messages are:

`Lock`	The interlock is open and the unit cannot be turned on.
`LoBW`	The unit is in low bandwidth mode.
`HiBW`	The unit is in high bandwidth mode.
`ILim`	The unit is in current limit.
`MLim`	The unit is in photodiode current limit.
`PLim`	The unit is in photodiode power limit.
`Script`	The unit is executing a script or *WAI command.

Settings and Menus

Most parameters of the **MultiSource** can be viewed and changed within the menu, but some settings can only be adjusted remotely. There are two distinct menus: the **system menu**, which is only reachable when viewing the *Master Status Window*, and the individual **channel menus**, which are available from the *Channel Status Window* of each channel.

The system menu includes system-level settings such as Ethernet configuration, display, and other non-Laser-related settings.

The channel menu includes all of the channel specific settings, such as set points, limits, and other Laser-specific settings.

Once you have entered a menu, there are four distinct actions:

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- *Up* – short press (less than 1 second) of the **Up [Menu]** button
- *Down* – short press (less than 1 second) of the **Down [On**/**Off]** button
- *Exit* – long press (more than 1 second) of the **Up [Menu]** button
- *Edit* – long press (more than 1 second) of the **Down [On**/**Off]** button

To scroll through the menu, use the *Up* and *Down* actions.

To edit an item, use the *Edit* action to make changes to the item. An asterisk will be displayed in the right-most column indicating you are editing the setting. Use the *Up* and *Down* actions to change to different values. Once setting has been adjusted to the desired value, use the *Edit* action to save the setting.

To enter a sub-menu, select the sub-menu and use the *Edit* action. You will then be positioned at the top of the new sub-menu settings.

To exit the menu, use the *Exit* action. If you are in the middle of editing a setting, this will also save the then current value of the setting before exiting.

Below is a complete list of available settings:

System Menu

Menu	Description	Factory Default
Root Menu		
Set While Rmt	To disable changing the set point while in Remote Mode, set this value to *No*. To enable changing the set point while in Remote mode, set this Value to *Yes*.	Yes
Err While Rmt	To turn off the display of errors while in remote mode, set this value to *No*. To display errors while in remote mode, set this value to *Yes*.	Yes
Brightness	The vacuum florescent display can be set to one of eight brightness levels.	100%
AutoDim Display	Automatically dims the display to the lowest setting, can be disabled by setting to No.	Yes
Audible Beep	This setting controls when the unit produces audible feedback. Set to *No* to prevent sound, or *Yes* to enable audible alerts such an error messages.	Yes
AuxOut	Controls the state of the auxiliary digital output.	Off

Menu	Description	Factory Default
Network Menu		
Edit Settings	Enable editing and viewing of the network settings. Set to *Yes* to display settings below	No
IP Mode	Set to *Auto* (assign dynamic IP address by DHCP/BOOTP/AutoIP) or *Static* (assign static IP address manually).	Auto
DHCP	Enable DHCP IP assignment.	Yes
BOOTP	Enable BOOTP IP assignment.	Yes
AutoIP	Enable Auto-IP assignment.	Yes
IP A/B/C/D	IP address.	Assigned via DHCP
Subnet Mask	Subnet mask	Assigned via DHCP
Gateway A/B/C/D	Gateway IP address. Not required, can be left 0.0.0.0.	Assigned via DHCP
Clr Web PW	Clears the Web Password used to authenticate Web connections.	No
Clr Serial PW	Clears the Serial Password used to authenticate Telnet/VCP connections.	No

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Laser Channel Menu

Menu	Description	Factory Default
Root Menu		
Io set	Current setpoint in Io (ACC) mode	0mA
Im set	Photodiode current setpoint in Im (AMC) mode	0uA
Po set	Photodiode power setpoint in Po (APC) mode	0mW
Vf set	Voltage setpoint in Vf (AVC) mode	0.000V
Mode	As described in the *Laser Control Modes* section below, 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)
Io Res	Resolution of the Io set point and measurement. Available options are dependent on the range of the instrument.	Depends on model
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 *Using Limits* below.	Maximum
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 *Using Limits* below.	Maximum
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 *Using Limits* below.	Maximum
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 *Using Limits* below.	Maximum
Vf Sense	Selects the remote voltage sense lines for diode voltage measurement. Pins 4 & 5 of the **Monitor** / **Interlock** connector must be wiring to the diode. See *Using Remote Voltage Sense* below for more details.	Local

Menu	Description	Factory Default
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 *Using the Cable R Setting* below. Not available when using remote voltage sense.	0.0000 Ω
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 (µA/mW), such that power = photodiode current divided by the factor.	0.00µA/mW
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 50uA. For Vf mode, the tolerance is fixed at 50mV.	5 seconds
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
On Delay	The delay, from the time the **Output** button is pressed to when the output is actually energized.	3000ms
Advanced Menu		
Off if I Lim	Enables output shutdown on current limit. Adjusts the OUTOFF register.	No
Off if Im Lim	Enables output shutdown on photodiode current limit. Adjusts the OUTOFF register.	No
Off if Po Lim	Enables output shutdown on photodiode power limit. Adjusts the OUTOFF register.	No
Off if Out of Tolerance	Enables output shutdown on out of tolerance. Adjusts the OUTOFF register.	No
Ramp Time	Controls the ramp rate for turn on/turn off and changes in set point.	80ms

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Remote Mode Operation

"Remote mode" operation is when the **MultiSource** is being controlled by a computer over the USB or Ethernet interfaces. When in remote mode, the **MultiSource** behaves differently, preventing you from affecting the operation of the instrument, such as changing the set point. You cannot enter the menu without taking the unit out of remote mode. While in remote mode, the **Remote** LED will light.

Details on how to communicate with the **MultiSource** can be found in the *Computer Interfacing Manual* which is included on the CD that accompanied this product.

Using the USB Interface

Using the **MultiSource** via USB is just as simple as using a serial port. In fact, once you have installed the USB drivers, the instrument will appear as a virtual serial port that behaves similarly to a standard RS-232C-type serial port.

To install the drivers, simply plug in the instrument to your computer. Most Windows installations will automatically install the drivers needed to communicate with the instrument. In the event drivers are needed, insert the CD you received with the **MultiSource** and follow the on-screen instructions.

Once the drivers are installed, to determine the COM port number, go to **Control Panel** and select **System**. Once the **System Properties** dialog appears, choose the **Hardware** tab then click on the **Device Manager** button. When the **Device Manager** appears, click on the plus sign to the left of **Ports**. The port identified as a **USB Serial Port** is the **MultiSource**. 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.

Using the Network Interface

The Ethernet interface on the **MultiSource** can be used in one of two ways: a Telnet connection to port 10001 or using the COM Port Redirector software to create a virtual COM port (VCP).

The Telnet connection requires no additional software, but the program making the connection must be able to communicate over network connections.

A simpler approach is to use the COM Port Redirector (CPR) software, which will create a virtual COM port much like the USB connection. No specialized networking support is required, and the same program that can communicate over the USB VCP can also be used with the network VCP.

To install the CPR software, either download from the Arroyo Instruments web site, or you can find it on the CD you received with the **MultiSource**. Follow the on-screen prompts to install the software.

Once installed, start the software. You will also find instructions along with the installation program on how to identify and install the virtual COM port. Follow those instructions to add a new COM port and connect it to the IP address of the **MultiSource**.

In most cases the CPR software will detect the **MultiSource** when you click Search for Devices, but if you need to manually determine the IP Address information, you can do so by reviewing the IP settings in the Network menu of the **MultiSource**. If you have multiple **MultiSource** controllers on your network, the model number and serial number are included in the unit description to help identify the specific unit.

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Power and Cable Connections

Laser Output Connector

Each Laser **Channel** connection is a female DB9, and has the following pin-out:

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

LASER Output Connector (DB-9 Female)

Modulation Input Connector

For units equipped with the optional external analog modulation capability, there are two modulation input connectors, one for channels 1 and 2, and a second for channels 3 and 4. Each is a 4-pin Phoenix socket with the following pin-out:

| Pin	Description
1	Channel 2 or 4 Modulation +
2	Channel 2 or 4 Modulation −
3	Channel 1 or 3 Modulation +
4	Channel 1 or 3 Modulation −

Modulation Connector (4-Pin Phoenix)
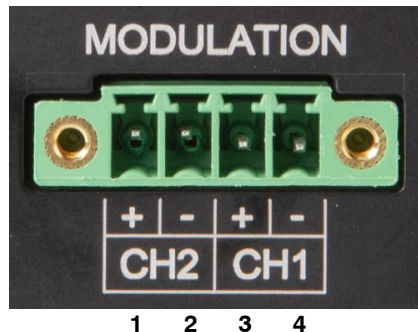
See *Analog Modulation* below for additional information.

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.

Ethernet Connector

The Ethernet connection is a standard RJ-45 connector, and compatible with 100Base-T networks.
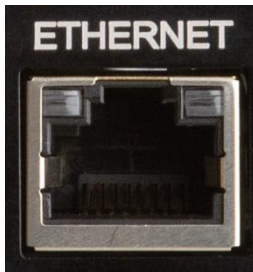
For more information on using the Ethernet interfaces, see the *Computer Interfacing Manual* which is included on the CD that accompanied this product.

Auxiliary Connector

The Auxiliary connector is a 4-pin Phoenix socket with the following pin-out:

Pin	Description
1	Aux +5V
2	Aux Input
3	Aux Output
4	Aux/Interlock Ground

Auxiliary Connector (4-Pin Phoenix)

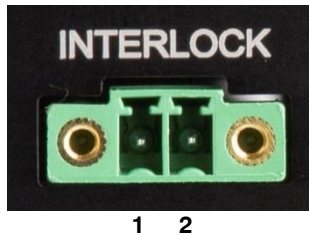
1   2   3   4

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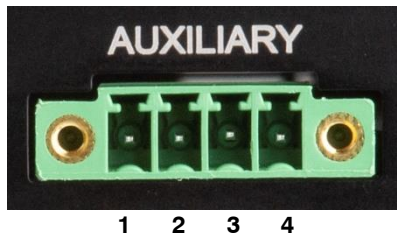
See *Using the Auxiliary Interface* below for additional information.

Interlock Connector

The Interlock connector is a 2-pin Phoenix socket with the following pin-out:

Pin	Description
1	Interlock
2	Interlock Ground

Interlock Connector (2-Pin Phoenix)

See *Using the Interlock* below for additional information.

Choosing a Cable

A cable is required for the Laser outputs. Arroyo Instruments carries cables specifically designed for these applications, both with a DB connector on the device end or with a bare wire pigtail for terminating the connection into a custom mount or device.

Current Rating	DB to DB p/n	DB to Pigtail p/n
Up to 20 Amps	1230	1231
Up to 40 Amps	1232	1233

NOTE

Connections to the **MultiSource** and the fixture must be secure. Tighten any screws on the DB connectors, and make sure all connections are in good condition.

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

Wiring and Grounding Considerations

In order to minimize grounding issues, all signal and ground connections on the **MultiSource** are isolated from earth ground. The Laser Output connector does include an Earth Ground pin, but this is to provide a grounding path to a remotely attached fixture, and does not interact with any of the other signal pins.

CAUTION

Laser and sensor connections must be isolated from all other signals and from earth ground or damage to the instrument many occur.

A key feature of the **MultiSource** is the optical isolation of the photodiode input from the laser output. By isolating the photodiode, earth grounding of the photodiode anode or cathode cannot cause a ground loop through the instrument. Likewise, the laser anode and cathode connections are also isolated from earth ground.

However, if you use the earth ground pin of the **Output** connector (pin A2), it is possible to create a ground loop if the instrument's earth ground is connected to a fixture or optical table that is also earth grounded. Make sure that from your laser diode package there is only a single path to earth ground.

The Ethernet, USB, Chassis Interlock, and Auxiliary Digital I/O pins can be connected to earth ground without affecting the operation of the instrument.

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Using the Auxiliary Interface

The Auxiliary Interface (4-pin Phoenix connector) of the **MultiSource** has one digital input and one digital output that can be programmed for a variety of functions. It also supports a +5V auxiliary interface that can be used to power external circuitry or relays.

The digital input can be monitored through user software and used to trigger whatever actions the user program defines. Via the System Menu **AuxOut** menu entry, the auxiliary output can be directly set to be *Off* (0V) or *On* (5V), or assigned as a summary function to control its output state. The available functions are:

- *All Low* – the digital output will only turn on when all channels are off.
- *Any High* – the digital output will turn on when any channel is on.
- *All High* – the digital output will only turn on when all channels are on.

The digital output includes a 200Ω series resistor, limiting current draw to about 25mA. If the output is to be used as a signaling LED, an additional current limiting resistor may be required.

The auxiliary digital I/O shares a common ground with the Interlock Interface. If left unconnected, the digital input will be pulled up into an 'On' or 'Open' state via an internal pull-up resistor.

Likewise, the +5V power supply is also isolated and can provide up to 200mA of isolated 5V power.

Using the System Interlock

The **MultiSource** has a dedicated system Interlock input that can be used to disable all Laser outputs.

The Interlock input is an electrically isolated input allowing for safe integration into both mechanical-type switch closures as well as electronic switches. It has a pull-up resistor, so if left disconnected, the interlock status will be "on" or open.

The system interlock is a software-monitored interlock, which means there could be up to 100ms latency between the interlock opening and the lasers shutting down.

The Interlock shares a common ground with the auxiliary digital I/O.

Using the Laser Interlock/LED Interface

In addition to the Auxiliary Interface and System Interlock described above, the **MultiSource** also features a combination interlock/LED driver on the output connector of each channel.

When the laser is off, the input can be monitor for switch closure, and the LED can be turned on or set into a flashing mode (the LED will light only if the circuit is complete, meaning any external switch must be closed).

When the laser is on, the LED is always on, and the input acts as a hardware interlock, and will immediately shutdown the laser is the circuit is broken.

Closing the Circuit

A +5V supply is used to bias the LED and goes through a 200Ω series resistor. To close the circuit, there must be 4.5V or less across pins 13 and 12. A short circuit can be used, but an LED can optionally be connected.

Depending on the type of LED, no resistor, series resistor, or parallel resistor can be used. Red, green, and yellow LEDs may require no resistor. Blue LEDs are too efficient to be wired with a series resistor and must use the parallel resistor option.

When using a series resistor, the higher the resistor value, the dimmer the LED. Do not use too high of a resistance value or it may always register as an open circuit.
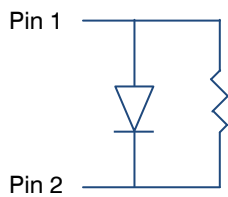
When using a parallel resistor, the lower the resistor value, the dimmer the LED. Red, green, and yellow LEDs will typically use higher resistances (1kΩ or more), while blue LEDs will use smaller resistor values (typically around 100Ω).
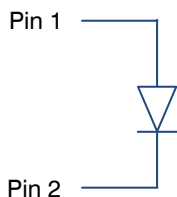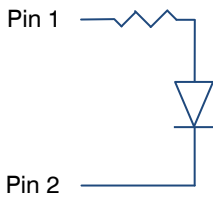
Pin 1	Pin 1	Pin 1
Pin 2	Pin 2	Pin 2
No Resistor	*Series Resistor*	*Parallel Resistor*

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Using the Laser Driver

The **MultiSource** is a 4-channel laser driver, but each channel is fully independent, with channel-specific set points, limits, and operating modes. The operations described below can be carried out independently on any or all of the channels.

Laser Control Modes

The **MultiSource** offers the following control modes: **Io (ACC), Io HiBW (ACC), Im (AMC)**, **Po (APC)**, and **Vf (AVC)**. Each channel is fully independent and can operate in any mode.

Changing the control mode is done through the menu by changing the Mode parameter in the Laser menu to one of these values.

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 milliamps, and the **MultiSource** 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. For units with the optional analog modulation input capability, **Io HiBW** mode is available for modulation at bandwidths above 10 Hz bandwidth.

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 **MultiSource** will drive exactly enough forward current through the laser diode to generate the selected monitor diode current.

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 µA/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 10µA.

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.

Modulation (Optional)

Certain models support external analog modulation using the **Modulation** input for each channel. 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.

Using the Laser Limits

Both the laser 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 at least to 0.1V to 0.2V higher than any anticipated operating point, and 0.5V higher is typically used. The voltage limit is tested against *the voltage at the connector*, unless in remote voltage sense mode. Any **Laser Cable R** value is ignored, as **Laser 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 **Laser Cable R** setting.

Unlike the voltage limit, the current limit simply prevents the **MultiSource** from delivering more current than the limit is set to. When the current limit engages, the output will remain on (unless Off if I Lim enabled in the Advanced Menu or LAS:ENAB:OUTOFF register).

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.

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Analog Modulation (Optional Feature)

If your unit includes the optional analog modulation input capability, this allows for external control of the current set point using a 0 to 10V analog signal. 10V equals the maximum operating range, which is dependent on the model. For example, applying 10V to a **7144-0.5-08** will drive an output current of 500 mA, meaning a "transfer function" of 50 mA per Volt.

In addition, the set point **adds** to the modulation input, so using the same example, if you were to apply 5V and the set point was 10mA, then the resulting drive current would be 260mA (5V = 250mA plus the 10mA set point).

You must also consider that the modulation input is not a precision input, so for accurate current control, you should calibrate the modulation input using a one point or two-point calibration and apply the calibration to your voltage input. You can read actual current using the LAS:I? query.

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). Failure to do so may result in current oscillations or excessive overshoots 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.

Compensating for Voltage Loss

All cables and connectors have a small, but measurable, resistance. When driving current through them, this resistance causes a voltage loss in the cable, and if not compensated for, will result in errors in laser or LED voltage measurement. In many cases, this is not a problem, as highly accurate voltage measurement is not required, and the error can be ignored. However, if accurate voltage measurements are required, the **MultiSource** offers two methods to compensate for this loss: the **Cable R** setting and four-wire sense. **Cable R** compensation is software only, so it requires no special wiring to implement. Four-wire sense, on the other hand, does require additional wiring, but is the most accurate method. Details on both are found below.

Using Remote Voltage Sense

The **MultiSource** supports remote (4-wire type) voltage measurement of the laser diode, providing a higher accuracy voltage measurement by directly measuring voltage at the diode itself. While the **Cable R** setting described below can provide some of the same benefits of remote voltage sense, remote voltage sense is a superior method, and they differ in a few key ways:

1. No need to calculate cable resistance
2. Voltage measurement is accurate even if the cable resistance changes
3. The hardware safety circuits use the remote voltage, providing for a greater degree of protection (**Vf Limit** works on the remote voltage at the laser rather than the local voltage at the connector)
4. Works in voltage control mode

The diagram below shows conceptually how to wire the laser to the **MultiSource**, using a 4-wire connection:
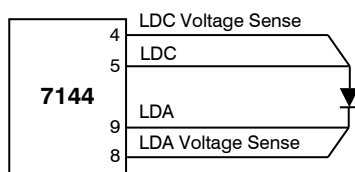
However, remote voltage sense does have a few drawbacks:

1. If the remote sense wires are disconnected, it disables the hardware voltage limit as well as the measurement of laser voltage.
2. Requires two additional wires to be run to the device.

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Using remote voltage sense is very simple. First connect pin 4 of the **Laser Output** to the laser cathode, and pin 8 to the laser anode, then in the menu, set **Vf Sense** to *Remote*. Indicated voltage will now be the remote diode voltage.

When using remote voltage sense, any **Cable R** setting is ignored.

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 menu. 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 Vf on the display.

Common values for **Cable R** range from 0.0300 Ω to 0.0900 Ω 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 (most DMMs are not designed to properly measure small resistances). 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 **Laser 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 does not require a DMM and can be done with just the **MultiSource**, is to short the anode and cathode wires at the end of the cable (nearest the laser diode), drive current through the cable and note the indicated voltage on the **MultiSource**. The resistance is found using a simpler version of the formula above:

$$Cable\ R = \frac{Vf}{I_{AMPS}}$$

Note that the current is expressed in *amps*, not *milliamps*.

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 **MultiSource** 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* (except when using remote voltage sense, see above). 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.

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User Calibration

The **MultiSource** supports the ability to apply a user calibration to all measurement and control functions of the instrument. This allows for field calibration of the instrument as needed to meet the requirements of the user's application.

> **NOTE**
>
> Changing the user calibration parameters directly modifies the performance of the instrument. User calibrations should only be performed by individuals experienced in instrument calibration.

> **NOTE**
>
> Ensure that the standards used to calibrate the instrument exceed the instrument's specifications. A test uncertainty ratio of 4:1 or better is recommended, unless otherwise required by your application.

User calibration can only be performed by sending appropriate commands to the instrument over the computer interface (either USB or Ethernet). The commands are more fully documented in the *Computer Interfacing Manual*, but the essential commands are:

LAS:USERCAL:EDIT   Enabled modification of user calibration settings
LAS:USERCAL:PUT   Changes user calibration settings
LAS:USERCAL:GET   Retrieves user calibration settings
LAS:USERCAL:RESET   Resets all user calibration settings to factory defaults

To prevent accidental modification of the calibration settings, the entries are only editable when LAS:USERCAL:EDIT 1 command is sent remotely. By default, **M** and **B** values are 1.000 and 0.00, respectively, but can be adjusted to change the sensor measurement. The calibrated measurement is computed as follows:

$$\text{User calibrated reading} = \mathbf{M} * \text{reading} + \mathbf{B}$$

For set point, such as Io set and analog output, the set point is calculated as follows:

$$\text{User calibrated setpoint} = \mathbf{M} * \text{set point} + \mathbf{B}$$

B is always in the units of the measurement being calibrated (for example, milliamps for Io, volts for Vf, ohms for sensor resistance, etc.).

Specifications

All specifications stated after 1 hour warm-up.

Description	Laser Specifications			
	7144-0.5-08	**7144-01-08**	**7144-02-04**	**7144-04-04**
LASER				
SETPOINT				
LASER CURRENT				
Range (mA)	500	1000	2000	4000
Max Resolution (mA)	0.02	0.05	0.1	0.2
Accuracy (±[% set+mA])	0.025% + 0.12	0.025% + 0.3	0.05% + 0.4	0.05% + 0.8
Stability (ppm, time)	< 10, 1 hour			
Temperature Coeff (ppm/°C)	50			
Noise/Ripple (µA rms)[1]	< 4	< 8	< 20	< 25
Transients (µA)	< 150	< 250	< 350	< 500
Compliance Voltage (V)	8	8	4	4
PHOTODIODE CURRENT				
Range (µA)	2 – 5,000			
Resolution (µA)	0.1			
Accuracy (±[% set+µA])	0.05% + 1			
Stability (ppm, time)	< 200, 24 hours			
Temperature Coeff (ppm/°C)	< 200			
PD Bias (V)	-3V, fixed			
LASER VOLTAGE				
Range (V)	0 – 8	0 – 8	0 – 4	0 – 4
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 (V)	0 – 10			
Modulation Bandwidth (kHz)	100	85	75	65
MEASUREMENT				
LASER CURRENT				
Resolution (mA)	0.02	0.05	0.1	0.2
Accuracy (±[% set+mA])	0.025% + 0.12	0.025% + 0.3	0.05% + 0.4	0.05% + 0.8
LASER VOLTAGE				
Resolution (V)	0.001			
Accuracy (±[% read+V])	0.05% + 0.005			
PHOTODIODE CURRENT				
Resolution (µA)	0.1			
Accuracy (±[% read+µA])	0.05% + 1			
LIMITS				
LASER CURRENT				
Resolution (mA)	1			
Accuracy (±% FS)	1%			
LASER VOLTAGE				
Resolution (V)	0.1			
Accuracy (±% FS)	2.5%			
GENERAL				

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[1] *Noise measured across non-inductive resistor in low bandwidth mode*

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Description	Laser Specifications
Display Type	2x20 VFD
Laser Connector	DB9 x 4, female
Computer Interface	USB 2.0 Full Speed and Ethernet
Power (50/60 Hz)	90 – 240 V, 50 / 60 Hz
Size (H x W x D) [inches (mm)]	1.75 (45) x 19 (483) x 14.76 (375)
Operating Temperature	+10℃ to +40℃
Storage Temperature	-20℃ to +60℃

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-126	Too few or too many elements	An incorrect number of parameters was passed to a command.
E-127	Change not Allowed	An attempt was made to change a parameter that cannot be changed, or is currently read-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-220	Script Save Failed	At attempt to save a script failed. This can be caused if the script number is out of range, or the script memory is corrupted.
E-221	Cannot embed script	A script was executed that contained a reference to another script.
E-222	Cannot execute script	At attempt to execute a script failed. This can be caused if the script number is out of range, no script exists for the selected index, or the script memory is corrupted.
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-508	TEC off disabled output	The laser output was turned off because the TEC was off 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	A hardware control error was detected which forced a

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	disabled output	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 MultiSource while the output was on shutdown the output.
E-516	Incorrect configuration for calibration to start	The MultiSource 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 MultiSource 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.
I-703	Laser usercal reset	The laser user calibration data was reset to factory defaults.
W-800	Remote voltage sense is low	When in remote voltage sense mode, the MultiSource detected a significant difference between the remote voltage and the voltage at the connector, which may indicate a problem with the remote voltage sense connection.
W-803	User reset to factory defaults	Notification message only: User pressed key sequence on start-up to reset unit to factory defaults.
E-980	Module Offline	Communications was attempted to off-line module.
E-981 thru E-984	Slave module X communication failure	A communication failure to the referenced slave module was detected. Slave module taken offline.
E-989	Network Interface Error	Failure to communicate with network interface.
E-990 thru E-997	Hardware-related errors	A hardware related error occurred. Attempt a power cycle to resolve. If error continues to occur, contact factory.
E-998	Command not supported	A command was recognized but not supported by the MultiSource.
E-999	Non-specific error	A non-specific error was encountered.

Maintenance and Service

Maintenance

The **MultiSource** 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 Time Delay/Slow Blow T 250V, 10A, IEC 60127-2 5x20mm metric fuses 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 **MultiSource** 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.

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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

C E

I/We

Arroyo Instruments

of

1201 Prospect Street
San Luis Obispo, CA
USA

declare that

7144 Series MultiSource Laser Diode Driver

In accordance with the following European Commission Directives:

2014/30/EU - Electromagnetic compatibility (EMC)
2014/35/EU - Low Voltage Directive (LVD)
2015/863/EU - RoHS Directive

has been designed and manufactured to the following specifications:

Under 2014/30/EU

In accordance with EN 61326-1:2013, Emission
CISPR 11 Class A, Group 1 radiated and conducted emissions

In accordance with EN 61326-1:2013, Immunity
EN 61000-4-2:2009 Electrostatic Discharge: ±4kV contact, ±8kV air
EN 61000-4-3:2010 Radiated Immunity: ±3V/m
EN 61000-4-4:2012 Electrical Fast Transients/Burst: ±1kV AC, ±0.5kV I/O
EN 61000-4-5:2014 Surges: ±0.5kV differential mode, ±1kV common mode
EN 61000-4-6:2014 Conducted Immunity: 3V
EN 61000-4-11:2004 Supply Dips and Variations: 100%, 60%, 30%

Under 2014/35/EU

In accordance with EN 61010-1:2010

This Certificate is the Manufacturer's Declaration which states that the **7144 Series MultiSource Laser Diode Driver** is Compliant to the above noted EU Directives and 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   March 23, 2018
(TITLE OF AUTHORIZED PERSON)   (DATE OF ISSUE)

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UK Declaration of Conformity

UK Declaration of Conformity

UK
CA

I/We

Arroyo Instruments

of

1201 Prospect Street
San Luis Obispo, CA
USA

declare that

7144 Series MultiSource Laser Diode Driver

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

Electrical Equipment (Safety) Regulations 2016
Electromagnetic Compatibility (EMC) Regulations 2016

has been designed and manufactured to the following specifications:

Under Electromagnetic Compatibility (EMC) Regulations 2016

In accordance with EN 61326-1:2013, Emission
CISPR 11 Class A, Group 1 radiated and conducted emissions

In accordance with EN 61326-1:2013, Immunity
EN 61000-4-2:2009 Electrostatic Discharge: ±4kV contact, ±8kV air
EN 61000-4-3:2010 Radiated Immunity: ±3V/m
EN 61000-4-4:2012 Electrical Fast Transients/Burst: ±1kV AC, ±0.5kV I/O
EN 61000-4-5:2014 Surges: ±0.5kV differential mode, ±1kV common mode
EN 61000-4-6:2014 Conducted Immunity: 3V
EN 61000-4-11:2004 Supply Dips and Variations: 100%, 60%, 30%

Under Electrical Equipment (Safety) Regulations 2016

In accordance with EN 61010-1:2010

This Certificate is the Manufacturer's Declaration which states that the **7144 Series MultiSource Laser Diode Driver** is Compliant to the above noted U.K. Legislation and 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)

NOTES:

NOTES:

arroyo instruments

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