

MultiSource™

7154 SERIES

USER'S MANUAL



MULTICHANNEL
TEC CONTROLLER

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Introduction

Thank you for choosing the **7154 TEC MultiSource** multi-channel temperature controller 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 fully operated locally, but is more intended for report control via its computer interfaces.

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

- AutoTune for automatic PID parameter calculation
- 0.004°C temperature stability
- 0.001°C set point resolution
- Up to 60W of independently controllable bi-polar outputs

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:

- **1260B MultiSource Cable, 5A, 2m**
This cable has DB-15 male/female connectors for interfacing to the LaserMount, TECMount or other connectorized fixtures, and supports up to 5A of TEC current and connections for the fan interface.
- **1261B MultiSource Cable, 2m, Pigtailed**
This cable has a female DB-15 connector for plugging into the **MultiSource** and tinned leads for wiring into custom solutions.
- **1600 10kΩ Thermistor**
Accurate to $\pm 0.2^{\circ}\text{C}$.
- **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



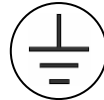
Power Off



Power On



Caution, refer to manual



Earth ground



Caution, risk of electric shock

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 TEC limits are set correctly, particularly the ITE current limit. It is also good to set the temperature limits to ensure the controller does not operate outside of the capabilities of the device. Use the menu from each sub-channel to configure each channel's limits.

You can also use ArroyoControl via an Ethernet connection but must first install the COM Port Redirector software, more on that is available in the *Using the COM Port Redirector* section below.

Next, connect the cables between your laser mount or other fixture and the TEC **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, set the set points to an appropriate temperature and turn the outputs on via ArroyoControl, or pressing and holding the **On/Off** within the channel display on the **MultiSource**.

If you notice the temperature is oscillating around the set point and not stabilizing, you may need to adjust the **Gain** setting in the TEC Settings dialog. You can use the AutoTune feature (via ArroyoControl) to automatically calculate the best PID values, or select from a set of eight factory preset values that typically cover most applications. To use the factory gains, if the temperature is quickly jumping up and down, the **Gain** will typically need to be reduced. If the temperature is slowly moving up and down, try a higher **Gain**. You may need to experiment with several gain settings to find the ideal value, and for even finer control, you can set the **Gain** to *PID* and directly set the PID control values.

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 (I) 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.



7154 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 in:

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.
- 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: an error has occurred, with error message on display
- Blue LED: 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 or off.

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
25	Off	25	25

Master Status Window

Ch	T _{SET} =	25.00	I=	0.00
1	T=	25.00	V=	0.00

Channel Status Window

Settings and Menu

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-TEC-related settings.

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

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

- *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
- *Menu* – 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 *Menu* 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 <i>No</i> . To enable changing the set point while in Remote mode, set this Value to <i>Yes</i> .	No
Err While Rmt	To turn off the display of errors while in remote mode, set this value to <i>No</i> . To display errors while in remote mode, set this value to <i>Yes</i> .	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 zero.	5 minutes

Menu	Description	Factory Default
Audible Beep	This setting controls when the unit produces audible feedback. Set to <i>No</i> to prevent sound, or <i>Yes</i> to enable audible alerts such as error messages.	Yes
AuxOut	Controls the state of the auxiliary digital output.	Off
Network Menu		
Edit Settings	Enable editing and viewing of the network settings. Set to <i>Yes</i> to display settings below	No
IP Mode	Set to <i>Auto</i> (assign dynamic IP address by DHCP/BOOTP/AutoIP) or <i>Static</i> (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

TEC Channel Menu

Menu	Description	Factory Default
Root Menu		
Tset	Temperature set point, only displayed when operating in the T mode.	25.000°C

Menu	Description	Factory Default
Rset	Resistance set point, only displayed when operating in the R mode.	10.000k Ω
Iset	Current set point, only displayed when operating in the ITE mode.	0.00A
Mount	Specify the mount connected to the channel. If using a TEC-controlled Arroyo mount, select the appropriate model. Otherwise, select <i>User Defined</i> .	User Defined
Gain	Gain controls the response of the temperature controller. A higher gain value will cause the controller to respond more quickly to the difference between the set point and the actual temperature, while a lower value will cause it to respond more slowly. Select <i>PID</i> for direct access to the PID parameters. See <i>Gain Control and the PID Loop</i> section below.	10
PID P	The proportional term of the PID loop. Will only be available if Gain is set to <i>PID</i> .	1
PID I	The integral term of the PID loop. Will only be available if Gain is set to <i>PID</i> .	0.01
PID D	The derivative term of the PID loop. Will only be available if Gain is set to <i>PID</i> .	0
I Lim	I Lim sets the current limit of the temperature controller. The limit should be set to a value that is suitable for your Peltier device. See <i>Using the Current Limit</i> below for more details.	3A
V Lim	V Lim sets the voltage limit of the temperature controller. See <i>Using the Voltage Limit</i> below for more details.	Instrument Rating + 2 Volts
T-Lo Lim	Only displayed when operating in T & Ite Modes, T-Lo Lim is the lower temperature limit.	-99°C
T-Hi Lim	Only displayed when operating in T & Ite Modes, T-Hi Lim is the upper temperature limit.	125°C

Menu	Description	Factory Default
R-Lo Lim	Only displayed when operating in R Mode, R-Lo Lim is the lower sensor limit.	0.01k Ω
R-Hi Lim	Only displayed when operating in R Mode, R-Hi Lim is the upper sensor limit.	45k Ω
Mode	This sets the operating mode (<i>T Mode</i> , <i>R Mode</i> , or <i>Ite Mode</i>) of the channel.	T Mode
Sensor Menu		
ThermA	The A term in the Steinhart-Hart equation for use with the thermistor sensor.	1.12924E-03
ThermB	The B term in the Steinhart-Hart equation for use with the thermistor sensor.	2.34108E-04
ThermC	The C term in the Steinhart-Hart equation for use with the thermistor sensor.	0.87755E-07
Tol Time	Tolerance time is the amount of time, in seconds, that the actual temperature must be within the set point temperature +/- the Tol Temp value for the unit to be considered in tolerance.	5 seconds
Tol Temp	Tolerance temperature is a temperature band (in $^{\circ}\text{C}$) around the set point temperature. When the actual temperature is within this band for longer than the Tol Time setting, then the unit is considered to be in tolerance.	0.1 $^{\circ}\text{C}$
Digital I/O Menu		
In Func	Selects the action to perform when TEC digital input is true.	None
In Invert	Inverts the active state of TEC digital input, only displayed when In Func is other than <i>None</i> ..	No
Out Func	Selects what status is used to control digital output / LED.	Off
Out Invert	Inverts the state of digital output, only displayed when Out Func is other than <i>None</i> ..	No

Menu	Description	Factory Default
AuxIn Func	Selects the action to perform when the auxiliary digital input is true.	None
AuxIn Invert	Inverts the active state of auxiliary digital input, only displayed when AuxIn Func is other than <i>None</i> .	No
Intlk Err	Selects if an interlock error is closed (shorted) or open.	If Open
Fan Setup Menu		
Ext Fan	Enables or disables the external fan power supply. See the <i>External Fan Control</i> section below for more information.	Off
Ext Fan Mode	Controls when the fan operates. See the <i>External Fan Control</i> section below for more information.	Auto
Ext Fan Off	When Ext Fan Mode is set to <i>Delay</i> , this setting defines the number of minutes to delay turning off the fan after the TEC output has been turned off. See the <i>External Fan Control</i> section below for more information.	5 minutes
Out Off Menu		
Thi Limit	Turns off the TEC output if the TEC exceeds the temperature high limit	Yes
Tlo Limit	Turns off the TEC output if the TEC exceeds the temperature low limit	Yes
Sensor Open	Turns off the TEC output if the sensor appears to be an open circuit	Yes
Sensor Short	Turns off the TEC output if the sensor appears to be a short circuit	Yes
R Limit	Turns off the TEC output if the TEC exceeds the sensor limit	No
Out of Tol	Turns off the TEC output if the TEC is out of tolerance	No
I Limit	Turns off the TEC output if the TEC hits the current limit	No

Menu	Description	Factory Default
V Limit	Turns off the TEC output if the TEC hits the voltage limit	No
TEC Open	Turns off the TEC output if the TEC module appears to be an open circuit	Yes
Thermal Runaway	Turns off the TEC output if the TEC module appears to be in thermal run-away.	Yes
Advanced Menu		
T Rate	Selects a desired temperature ramp rate in degrees Celsius per minute. Set to 0.0°C/min to disable rate limiting.	0.0°C/min
Tset Step	Adjusts the increment of the temperature set point from 0.001°C to as much as 10°C.	0.001°C
H/C Mode	This selects the heating and/or cooling mode of the channel. See the <i>Resistive Heaters and Heat/Cool Only Modes</i> section for more information.	Heat/Cool
Cable R	The resistance of the cable and connectors, in ohms. This setting allows for accurate voltage measurement at the TEC by removing the voltage loss of the cable.	0.0080Ω
Invert ITE	Reverses the direction of the current. Same as reversing the TE+ and TE- wires.	No
AutoOn Mode	Enables automatic turn-on of the output with optional set point override.	No
AutoOn Delay	Sets the number of seconds after power-up before the output is turned on.	0 seconds
AutoOn Tset	Sets the set point override value if the AutoOn Mode is set to "Yes/T".	25°C

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.

Power and Cable Connections



7154 **MultiSource** Rear Panel

TEC Output Connector

Each TEC **Output** connection is a female DB-15, and has the following pin-out:

DB-15 Pin	Description
1, 2, & 9	TE (+)
3, 4, & 10	TE (-)
5 & 6	Earth Ground
7	Sensor +
8	Sensor -
11	Fan +
12	Fan / Interlock Ground
13	Interlock+ / LED+
14	No connection
15	No connection

TEC Output Connector (DB-15 Female)

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.

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 TEC 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.

Function	DB to DB p/n	DB to Pigtail p/n
TEC	1260B	1261B

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 TEC 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

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

However, it is critical that the TEC and sensor connections be fully floating, not only with respect to earth ground, but also with respect to each other. Having a common connection between sensors can cause erroneous readings. More critically, common connections between the TE+ or TE- pins can lead to short-circuit conditions inside the instrument, which can cause damage to the electronics. It is recommended that there are no common or earth ground connections to any of the signal pins or any of the Output connectors. If you have any questions, please contact the factory.

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

Using the Auxiliary Interface

The Auxiliary Interface of the **MultiSource** has one digital input and one digital output that can be programmed for a variety of functions.

The digital input can be assigned to act as either an additional interlock input, or as a remote output on/off control. The logic of the digital input can be reversed, or inverted, to allow for active low signals. The digital input is shared across all four channels, and these settings can be found in each channel's **Digital I/O Menu » AuxIn Func** and **AuxIn Invert** menu entries.

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 the digital outputs of all channels are low.
- *Any High* – the digital output will turn on when the digital output of any of the channels is high.
- *All High* – the digital output will only turn on when all the digital outputs of all channels are high.

The digital output includes a 100Ω series resistor, limiting current draw to about 20mA. 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.

Using the System Interlock

The **MultiSource** has a dedicated system Interlock input that can be used to disable the TEC outputs. Via each channel's **Digital I/O » Intlk Err** menu entry, the interlock can be used to generate an error and shutdown the output if the interlock input is open (*Is Open*) or shorted (*If Closed*).

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.

Using the TEC Interlock/LED Interface

In addition to the Auxiliary Interface and System Interlock described above, the **MultiSource** also features a combination digital input/digital output/LED driver at on each channel output. The most common use of this interface is to turn on an LED when the output is on, but other functions can be assigned to the LED operation, and it can also be used as a digital input to remotely control the on/off state of the channel, or to act as an additional interlock function.

The **In Func** setting controls how the digital input is to be used:

- *Off* – ignore the digital input
- *Interlock* – prevent operation until circuit is closed
- *Output On* – turn on the output when circuit is closed

The **In Invert** setting reverses the logic when set to yes. For example, if **In Func** was set to *Output On*, the output would turn on when the circuit was opened.

Of special note is the *Output On* function: this action is taken only on a transition from open to closed state of the circuit. This allows the output to be turned off via the front panel or remote commands even when the circuit is closed.

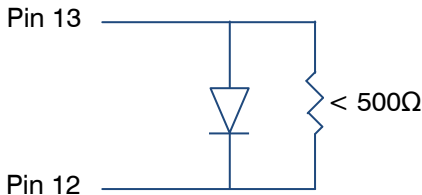
You can also drive an LED using the **Out Func** setting. For example, this could be used to turn on a LED whenever the output is on, but there are several functions to choose from:

- *Off* – turn the output off (this is the default setting)
- *On* – turn the output on
- *Out On* – whenever the channel output is on
- *Stable* – when the channel output has stabilized
- *T Limit* – the temperature exceeds the limits
- *I Limit* – operating at the current limit
- *Remote* – the unit is in remote mode
- *V Limit* – operating at the voltage limit

Like the digital input, a **Out Invert** setting is available to invert the logic of the digital output for active low signals.

Closing the Circuit

A +5V supply is used to bias the LED, and goes through a 100Ω series resistor. To close the circuit, a resistance of less than 500Ω must be placed across the interlock/LED pins. If driving an LED, place the LED in parallel with an external resistor:



Lowering the resistor value will increase the brightness of the LED. A value of 150Ω is a good starting point, with blue LEDs often needing high resistance values.

Unlike the System Interlock and Auxiliary Interface, the TEC Interlock/LED Interface must be kept isolated from other signals. Contact the factory for additional support if full isolation is not possible.

Using the Temperature Controller

The **MultiSource** is a 4-channel temperature controller, 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.

TEC Control Modes

The **MultiSource** offers three TEC control modes: constant temperature mode (T Mode), and constant resistance mode (R Mode), and constant current mode (Ite Mode).

Changing the control mode is done through the TEC menu by changing the **Mode** parameter to **T Mode**, **R Mode**, or **Ite Mode**.

Constant temperature mode uses the sensor constants to calculate the resistance of the thermistor at the desired or actual temperature.

While most users will only need the temperature control mode, the constant resistance mode allows you to bypass the sensor equation and directly select the sensor set point. This can be useful when only the desired sensor value is known, or when the sensor-to-temperature conversion values are not available for your sensor.

Using the TEC Limits

All TEC limits are implemented in software, but due to the relatively slow nature of the TEC, software is normally sufficient.

Both high and low temperature limits are available, and by default will turn the TEC output off unless this has been disabled.

Likewise, the sensor limits define an upper and lower limit for the sensor, but unlike the temperature limits, the sensor limits will **not** turn the output off unless specifically enabled.

See *Out Off Menu* for more information on enabling and disabling limits.

Selecting the Fixture

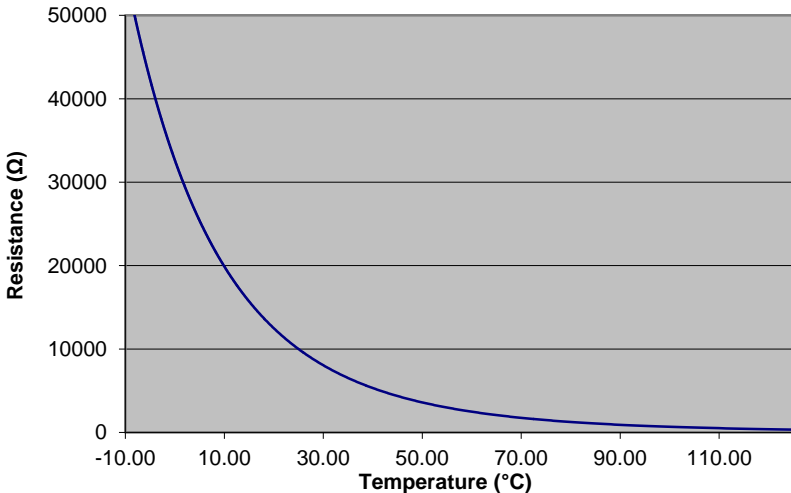
The **MultiSource** has integrated support for many of the mounts offered by Arroyo Instruments, such as the **205 TEC Butterfly LaserMount**. To simplify operation when using these mounts, you can change the **Mount** setting in the menu to the mount type you are using. By selecting a mount, the current limit, temperature limits, default gain, and sensor settings are automatically adjusted to values appropriate to the mount, and menu settings limited to the capabilities of the mount. For example, when the **205** is selected, the current limit is adjusted to the mount's rated limit to prevent damage to the mount's Peltier cooler.

Adjusting the **Mount** setting to *User Defined* removes all software limits, allowing unrestricted operation of the **MultiSource**.

Working With Thermistors

The **MultiSource** is designed to work with negative temperature coefficient (NTC) thermistors, such as the BetaTHERM 10K3A1 thermistor used in the **LaserMounts** and **TECMounts**. 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

As can be seen by the graph, the resistance of the thermistor drops very quickly. In the typical control range (0°C to 40°C), typical 10K thermistors offer good

sensitivity to changes in temperature, and this is the range in which most 10K thermistors are typically used. 10K thermistors can be used at much higher temperatures, but will suffer poorer temperature stability performance because of the lower sensitivity. When evaluating the performance of a thermistor, it is important to understand the resistance sensitivity of the thermistor at your application temperature, which varies greatly by temperature and thermistor types.

The **MultiSource** supports operation using 100µA constant current source, which limits the upper measurement range to 45kΩ. For most 10K thermistors, this translates into a low-operating range of approximately -7°C before a sensor open error is indicated.

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 **MultiSource** defaults to the coefficients for the BetaTHERM 10K3A1 thermistor (A = 1.12924x10⁻³, B = 2.34108x10⁻⁴, C = 0.87755x10⁻⁷). You can change the coefficients under the **Sensor Coeffs** menu.

Gain Control and the PID Loop

The **MultiSource** supports a fully configurable PID loop, allowing full customization of the PID control parameters. To simplify control, eight standard gain settings are also defined, and many applications can achieve acceptable performance with these predefined gain settings, eliminating the need to understand and adjust the PID loop.

The predefined gains are numbered 1 through 300, and set using the **Gain** menu setting. Increasing the gain value will increase the speed of the control loop. For full access to the PID parameters, change the **Gain** setting to *PID*, and the individual P, I, and D values will be available as settings in the menu.

The PID parameters function within a mathematical formula as described below:

$$\text{Output} = P * \varepsilon + I * \sum \varepsilon dt + D * \frac{d\varepsilon}{dt}$$

Where ε is the error in the system, expressed as:

$$\varepsilon = \text{Target} - \text{Actual}$$

The controller can calculate ideal PID values using the AutoTune function, discussed in detail in the next section.

To manually adjust the PID, start by changing the I and D values to zero, and adjust the P value so that it reaches the set point as quickly as possible without overshooting the set point an unacceptable amount. Gradually increase the I value until the set point is achieved without oscillation. In many systems, the D term is not needed and may be left at zero.

For additional information on PID loop tuning, consult online resources such as Wikipedia (http://en.wikipedia.org/wiki/PID_controller) or search for terms such as “Ziegler-Nichols method”, or “PID Loop”.

Using the AutoTune Function

The **MultiSource** is capable of automatically determining PID parameters for most applications. Using a form of the Ziegler-Nichols method, the **MultiSource** will step through a process to determine the thermal response of the mount, which can then be used in a mathematical model to calculate the PID parameters.

The PID parameters generated by AutoTune are not necessarily the *ideal* PID parameters, and small improvements may be possible by further refining the results manually.

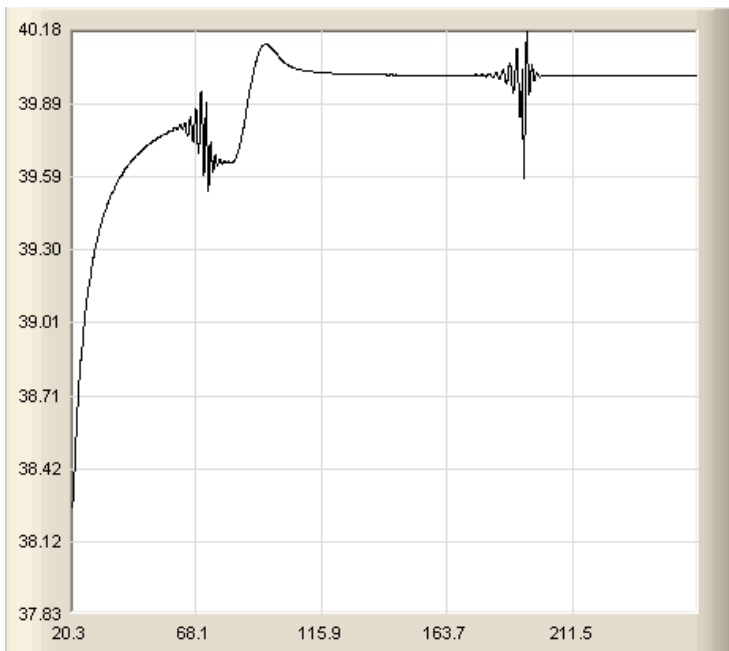
Before starting the AutoTune function, it is best to begin from ambient conditions, either with the TEC off and the mount stabilized at ambient, or the TEC on and the set point around 25°C. While this is not required, it can produce better results. AutoTune only functions in temperature mode. PID parameters must be manually determined for R mode.

Make sure the current and temperature limits are set prior to starting AutoTune. AutoTune will intentionally cause your mount to oscillate, so the temperature limit should be at least 5 to 10 degrees away from the test point to avoid tripping a limit during the process.

The AutoTune function is started by sending the TEC:AUTOTUNE command. The command will immediately put the instrument into AutoTune mode, and the display will indicate progress. The TEC:AUTOTUNE? query can be used to monitor the process of AutoTune. A response of 1 indicates AutoTune is in progress. Once complete, the instrument will respond with a 2 if AutoTune failed or a 3 if AutoTune succeeded. A response of 0 is returned if the instrument has never started an AutoTune process.

Once the AutoTune process starts, the display will indicate the present temperature, which step it is performing, and the word "AutoTune" will flash on the display.

The typical temperature profile of an AutoTune process is shown in the graph below. The first step, which is the calculation of the P and D parameters, completes at around 68 seconds, then the mount is allowed to stabilize with the new P and D parameters,. Then the second step begins, which is the determination of the I term. This completes around 200 seconds into the test, and then the output stabilizes with the calculated set of PID parameters for the remaining portion of the graph.



Once the AutoTune process is complete, the output will remain on and operating with the new PID parameters. The **Gain** setting will be changed to *PID*.

If the AutoTune process fails, the instrument will display an E-436 AutoTune Failed error message and turn the output off. Any of the following can cause the AutoTune to fail:

- Noisy temperature measurements, which make it difficult to accurately measure oscillations
- Any condition that causes the output to turn off (temperature limits, sensor limits, etc.)
- Systems with very low P or I terms

If the Auto-Tune fails due to thermal system limitations, you will need to manually modify the PID parameters as described in the section above or select factory gain setting.

You can turn the output off at any time to cancel the AutoTune process, and the PID parameters will remain unchanged (an E-436 will also be displayed).

More details on the use of the TEC:AUTOTUNE command can be found in the *Computer Interfacing Manual*.

Controlling the Temperature Rate of Change

Some applications require that temperature is changed at a specific rate to prevent damage that might otherwise come from rapid changes in device temperature. Using the **Advanced Menu » T Rate** setting, it is possible to control the temperature ramp rate of the controller, limiting the rate of change to specific degrees Celsius per minute.

Because the temperature rate function relies on the instrument tracking a gradually changing set point, a proper gain setting (or PID values) are important to achieve a smooth and continuous temperature transition.

To disable the temperature rate function, simply set **T Rate** to $0.0^{\circ}\text{C}/\text{min}$.

Using the Current Limit

The current limit in the **MultiSource** is used to limit the amount of current that is delivered to the mount. Because the **MultiSource** has a hardware current-controlled output, the current will not exceed the limit at any time in any mode. Set the limit by adjusting the **I Lim** parameter in the main menu.

Operating at the current limit is common, especially when transitioning from one temperature to another. There is no harm or danger to the **MultiSource** when operating in this condition.

Using the Voltage Limit

The **MultiSource** also supports a software-controlled voltage limit. In most applications, the voltage limit is not needed, and can be left at the maximum setting, as the **MultiSource** is a current output controller, and the voltage simply goes to whatever voltage is required by the TEC. By default, the voltage limit is set to the rating of the instrument plus 2 volts, so it will not engage unless adjusted lower.

It is important to understand that the voltage limit is a software imposed limit, which means that the response time to over-limit conditions can be several hundred milliseconds. During that response time, a significant over-voltage condition can persist. However, with a properly set current limit, the device is still protected from excessive power conditions, and should not pose any danger to TEC devices due to the relatively short duration of the over-voltage condition.

For the voltage limit to engage, the following conditions must be met:

- **V Lim** in the main menu is set to 1V or higher
- **Enable V Lim** is set to Yes in the **Out Off Menu**
- At least 25mA of TEC current

The last point is to ensure there is a sufficient current signal that can be used in calculating the load impedance (and therefore limit the current to correctly limit the voltage).

Operating at the voltage limit is common, especially when transitioning from one temperature to another. There is no harm or danger to the **MultiSource** when operating in this condition.

Changing the Set Point Step Size

In many applications, user will manually adjust the instrument between only a few set points, such as thermal testing in a production environment. In these applications the high resolution of the temperature set point can actually be a hindrance, as precisely adjusting between 25.00°C and 50.00°C, for example, will entail over- and under-shoots as the operator changes from one set point to the other.

Using the **Advanced Menu » Tset Step** setting, you can select a step size of 0.001, 0.005, 0.01, 0.05, 0.1, 0.5, 1, 5, or 10°C. In the above application, a step size of 5°C would allow for rapid and easy adjustment between the two temperatures.

Note that the step will adjust based on the current set point, so, for example, if the set point was 25.31°C and the step size was 5°C, the instrument would adjust to 30.31°C, 35.31°C, etc. you may want to adjust the set point to a good starting point before increasing the step size.

Note that changing the step size will not change the resolution of the displayed value for either the set point or the actual temperature.

Out Off Menu

The entries in the **Out Off Menu** are there to control which conditions of the temperature controller will turn off the output. The following conditions are listed, along with their defaults:

- **Thi Limit** (default *Yes*)
- **Tlo Limit** (default *Yes*)
- **Sensor Open** (default *Yes*)
- **Sensor Short** (default *Yes*)
- **R Limit** (default *No*)
- **Out of Tol** (default *No*)
- **I Limit** (default *No*)
- **V Limit** (default *No*)
- **TEC Open** (default *Yes*)
- **Thermal Runaway** (default *No*)

For each condition, if the menu item is set to *Yes* and the condition is detected, the output will be shut off.

Use the TEC:ENABLE:OUTOFF command to change these settings remotely.

External Fan Control

The **MultiSource** has a built-in 12V DC power supply designed to provide up to 350mA to an external fan, such as those built into the **240 Series** and **TECMounts**. When using the **MultiSource** with mounts that require a fan, no additional external power supply is needed, however, the cable must include the wiring needed for the fan. The **1260B**, **1261B**, **1262**, and **1263** cables include the wiring.

Fan control is setup in the menu using the **Ext Fan**, **Ext Fan Mode**, and **Ext Fan Off** settings.

Ext Fan can be set to *Off* or *On*. When set to *Off*, the fan power is never turned on.

The fan on/off mode can be controlled using the **Ext Fan Mode** setting. There are five modes:

<i>Auto</i>	Fan is turned on whenever the TEC output is on, and turns off when the TEC output is turned off.
<i>On</i>	Fan is always on.
<i>Delay</i>	Similar to the <i>Auto</i> mode, the fan is turned on whenever the TEC output is on, but when the TEC is turned off, the fan will remain running for an additional number of minutes as defined by the Ext Fan Off setting.
<i>Cool</i>	Fan is turned on whenever the TEC output is on and cooling, off otherwise.
<i>Heat</i>	Fan is turned on whenever the TEC output is on and heating, off otherwise.

Resistive Heaters and Heat/Cool Only Modes

The **MultiSource** supports temperature control using resistive heaters instead of Peltier coolers. With resistive heaters, cooling is obviously not possible, and the **MultiSource** must be configured to not attempt to cool the output, or a run-away condition will occur when the cooling current actually causes additional heating.

If your application requires, you can also configure the **MultiSource** to operate in a cool-only mode. This is only possible with Peltier coolers, as resistive heaters will heat regardless of the direction of current.

To change the cooling mode, adjust the **H/C Mode** setting to *Heat/Cool*, *Heat Only*, or *Cool Only*, via Advanced Menu as appropriate.

Compensating for TEC Cable Resistance

Because the high currents the **MultiSource** can drive through the Peltier, the voltage loss through the cable and connectors of the system can significantly affect the TEC voltage measurement. In most cases, accurate voltage measurements are not needed, and the default compensation of the instrument is sufficient. To improve the compensation, the **Cable R** setting in the menu allows you to specify the cable resistance, which is then used to dynamically subtract the voltage drop by simply using the formula $V = I * R$ to calculate the voltage loss, where I is the TEC ITE current, and R is the **Cable R** setting. This value is then removed from the voltage measurement to display an accurate TEC voltage measurement.

The safest method of calculating cable resistance is to short the ITE+ and ITE- connections, making sure whatever you are using to short the terminals is not

itself adding resistance to the circuit. Use short, heavy gauge wires, preferably soldered onto the terminals to minimize any resistance the short might add. Place the short as close to the Peltier as is reasonable. A simple approach is to unplug the cable from the mount and place a shorting plug on the mount end of the cable, which is easily made from a male DB15 connector and a soldering iron to solder the ITE+ and ITE- pins together. Make sure the Peltier is disconnected to protect it from current overloading during the test.

Change the instrument to ITE mode and set the current to 5A. Depending on your setup, you may first need to change the Mount to User Defined and adjust the limit to 5A. Turn on the output and after the voltage has stabilize, make a note of it and turn the output off. Enter the measured voltage into the following equation to calculate **Cable R**:

$$\text{Cable R} = \text{Voltage} / 5$$

Enter the resulting values into the **Cable R** menu entry and return the instrument to its original configuration. Typical values for **Cable R** are 0.008 to 0.040, but depend on your actual configuration.

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:

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

NOTE

For sensors, the calibration is applied to the measurement of the sensor, not the temperature. To adjust the resistance-to-temperature conversion, change the sensor coefficients as needed.

To prevent accidental modification of the calibration settings, the entries are only editable when TEC: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 ITE 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 sensor or TEC measurement (for example, kilo-ohms (kΩ) for thermistors, and ohms (kΩ) for RTDs, Amps for ITE current, etc.).

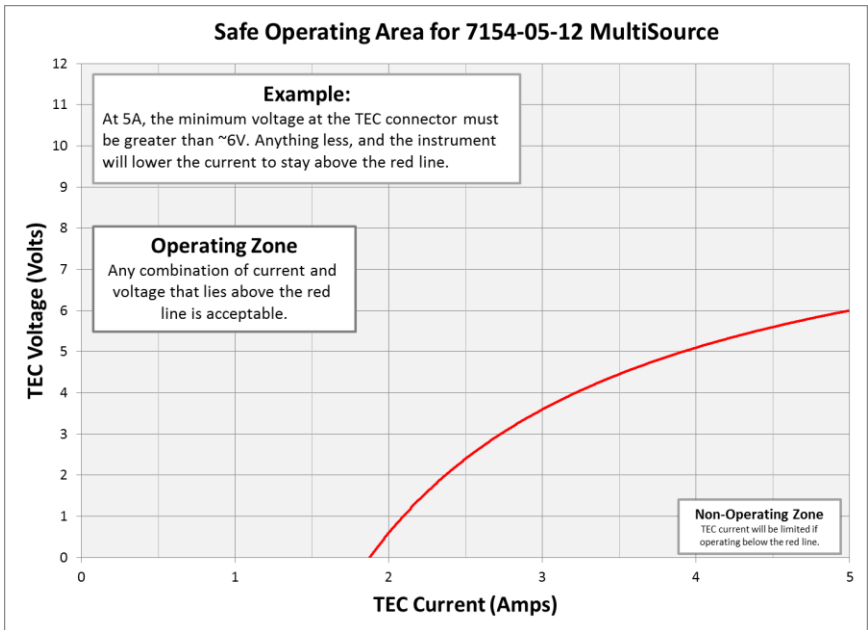
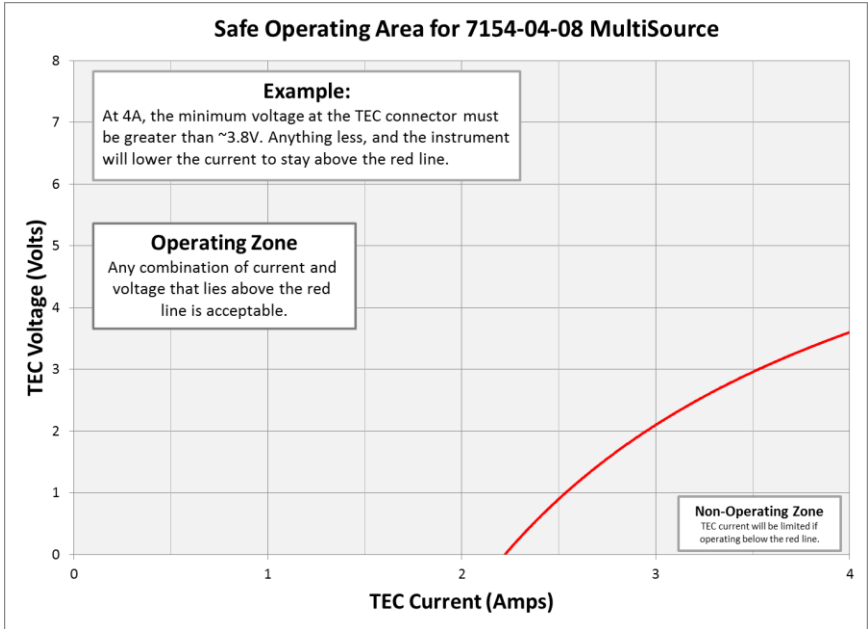
Thermal Considerations

The **MultiSource** is designed to provide high power in a small enclosure, but the **MultiSource** can be thermally overloaded if operated at high currents with a low voltage.

In the event of a thermal overload, the **MultiSource** will automatically protect itself by lowering the TEC current until it is no longer in an overload condition. While this may lower the deliverable power to your TEC, it will prevent any damage to the **MultiSource**.

Each channel is individually monitored, so a thermal overload on one channel will not affect the operation of the other three channels.

You will find the safe operating area for the two standard models below:



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-402	Sensor open, output turned off	A sensor open circuit was detected and the output was turned off.
E-403	Module open, output turned off	A Peltier module open circuit was detected and the output was turned off.
E-404	I limit, output turned off	A current limit was detected and the output was turned off.
E-405	V limit, output turned off	A voltage limit was detected and the output was turned off.
E-406	Thermistor resistance limit, output turned off	The thermistor resistance limit (high or low) was exceeded and the output was turned off.
E-407	Temperature limit, output turned off	The temperature limit (high or low) was exceeded and the output was turned off.
E-409	Sensor changed, output turned off	The sensor type was changed, causing the output to be turned off.
E-410	Temperature was out of tolerance, output turned off	The temperature went out of tolerance and the output was turned off.
E-415	Sensor short, output turned off	A sensor short circuit was detected and the output was turned off.
E-416	Cal failed	An error occurred during calibration that caused the calibration to fail. The unit is no longer in calibration mode.
E-419	TEC not stable	The TEC is considered stable if the temperature has changed less than 0.02°C for more than 20 seconds.
E-433	Not a TEC	The TEC:CHAN command attempted to select a non-TEC channel

E-434	Its limit exceeds cable rating	The cable plugged into the unit is not rated to carry the current as set by the current limit. Use a 1262 cable, 1263 cable, or custom cable with ID pin connected to analog ground, or reduce the current limit below 5A.
E-435	Mode Change	A mode change occurred when the output was on, forcing the output off.
E-436	AutoTune failed	The AutoTune process failed. See the "Using the AutoTune Function" for more information.
E-437	AutoTune in T mode only	The AutoTune process is only available in T (temperature) mode. In R mode, the PID parameters must be determined manually.
E-438	Thermal Trip	The thermal limit of the heat sink was reached, output turned off.
E-439	Thermal Run-Away	Thermal run-away, output off
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-801	Burst Mode, Hold Output	When in Io (Burst) mode, to turn the output on, the Output button must be held down for at least one second. If it is held down for less than one second, this warning message informs the user that the Output button press did not turn the output on.
W-803	User reset to factory defaults	Notification message only: User pressed key sequence on start-up to reset unit to factory defaults.
W-805	User recall turned outputs off	Notification message only: A user configuration was recalled from memory while the outputs were on, resulting in the outputs being turned off.
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-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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European Community Declaration of Conformity

EC Declaration of Conformity



I/We

Arroyo Instruments

of

1201 Prospect Street
San Luis Obispo, CA
USA

declare that

7154 Series MultiSource Temperature Controller

In accordance with the following European Commission Directives:

2014/30/EU - Electromagnetic compatibility (EMC)

2014/35/EU - Low Voltage Directive (LVD)

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: ± 4 kV contact, ± 8 kV air

EN 61000-4-3:2010 Radiated Immunity: ± 3 V/m

EN 61000-4-4:2012 Electrical Fast Transients/Burst: ± 1 kV AC, ± 0.5 kV I/O

EN 61000-4-5:2014 Surges: ± 0.5 kV differential mode, ± 1 kV common mode


EN 61000-4-6:2014 Conducted Immunity: 3V

EN 61000-4-11:2004 Supply Dips and Variations: 100%, 60%, 30%

This Certificate is the Manufacturer's Declaration which states that the **7154 Series MultiSource Temperature Controller** 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
(TITLE OF AUTHORIZED PERSON)

March 23, 2018
(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