User's Guide

Thermoelectric Temperature Controller
LDT-5416

ILX Lightwave®
A Newport Company

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Safety and Warranty Information

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Safety Information and the Manual

Throughout this manual, you will see the words “Caution” and “Warning” indicating potentially dangerous or hazardous situations which, if not avoided, could result in death, serious or minor injury, or damage to the product. Specifically:

Caution indicates a potentially hazardous situation which can result in minor or moderate injury or damage to the product or equipment.

Warning indicates a potentially dangerous situation which can result in serious injury or death.

General Safety Considerations

If any of the following conditions exist, or are even suspected, do not use the instrument until safe operation can be verified by trained service personnel:

- Visible damage
- Severe transport stress
- Prolonged storage under adverse conditions
- Failure to perform intended measurements or functions

If necessary, return the instrument to ILX Lightwave, or authorized local ILX Lightwave distributor, for service or repair to ensure that safety features are maintained.

All instruments returned to ILX Lightwave are required to have a Return Authorization Number assigned by an official representative of ILX Lightwave Corporation prior to shipping the instrument. See Returning an Instrument for more information.

Safety Symbols

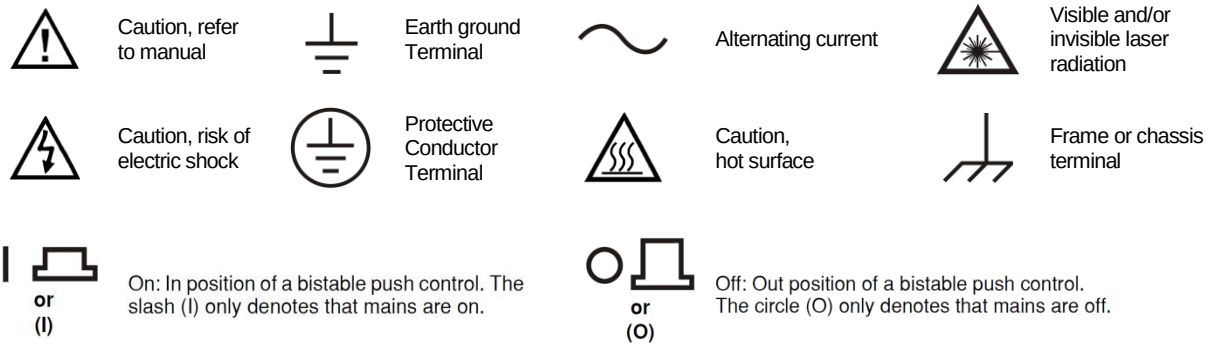
This section describes the safety symbols and classifications.

Technical specifications including electrical ratings and weight are included within the manual. See the Table of Contents to locate the specifications and other product information. The following classifications are standard across all ILX Lightwave products:

- Indoor use only
- Ordinary Protection: This product is NOT protected against the harmful ingress of moisture.
- IEC Class I Equipment (grounded type)
- Mains supply voltage fluctuations are not to exceed ±10% of the nominal supply voltage.
- Pollution Degree II
- Installation (overvoltage) Category II for transient over-voltages
- Maximum Relative Humidity: <85% RH, non-condensing
- Operating temperature range of 10°C to 40°C
- Storage and transportation temperature of –40°C to 70°C
- Maximum altitude: 3000m (9843ft.)
- This equipment is suitable for continuous operation.

Safety Marking Symbols

This section provides a description of the safety marking symbols that appear on the instrument. These symbols provide information about potentially dangerous situations which can result in death, injury, or damage to the instrument and other components.



Warranty

ILX Lightwave Corporation warrants this instrument to be free from defects in material and workmanship for a period of one year from date of shipment. During the warranty period, ILX will repair or replace the unit, at our option, without charge.

Limitations

This warranty does not apply to defects caused by abuse, modifications, or to use of the product for which it was not intended.

This warranty is in lieu of all other warranties, expressed or implied, including any implied warranty of merchantability or fitness for any particular purpose. ILX Lightwave Corporation shall not be liable for any incidental, special, or consequential damages.

If a problem occurs, please contact ILX Lightwave Corporation with the instrument's serial number, and thoroughly describe the nature of the problem.

Returning an Instrument

If an instrument is to be shipped to ILX Lightwave for repair or service, be sure to:

- Obtain a Return Merchandise Authorization number (RMA) from ILX Customer Service prior to shipping the instrument.
- Attach a tag to the instrument identifying the owner and indicating the required service or repair. Include the instrument serial number from the rear panel of the instrument.
- Attach the anti-static protective caps that were shipped with the instrument.
- Place the instrument in the original packing container with at least 3 inches (7.5 cm) of compressible packaging material. Shipping damage is not covered by this warranty.
- Secure the packing box with fiber reinforced strapping tape or metal bands.
- Send the instrument, transportation pre-paid, to ILX Lightwave. Clearly write the return authorization number on the outside of the box and on the shipping paperwork. ILX Lightwave recommends you insure the shipment.
- If the original shipping container is not available, place your instrument in a container with at least 3 inches (7.5 cm) of compressible packaging material on all sides.

Repairs are made and the instrument returned transportation pre-paid. Repairs are warranted for the remainder of the original warranty or for 90 days, whichever is greater.

Claims for Shipping Damage

When you receive the instrument, inspect it immediately for any damage or shortages on the packing list. If the instrument is damaged, file a claim with the carrier. The factory will supply you with a quotation for estimated costs of repair. You must negotiate and settle with the carrier for the amount of damage.

Comments, Suggestions, and Problems

To ensure that you get the most out of your ILX Lightwave product, we ask that you direct any product operation or service related questions or comments to ILX Lightwave Customer Support. You may contact us in whatever way is most convenient:

Phone:	(800) 459-9459 or (406) 586-1244
Fax:	(406) 586-9405
On the web at:	http://www.newport.com/locations/brandcontacts.aspx?brandid=19
Or mail to:	
	ILX Lightwave Corporation
	31950 East Frontage Road
	Bozeman, Montana, U.S.A 59715-8642
	www.newport.com/ilxlightwave

When contacting ILX Lightwave, please have the following information:

- ✓ Model Number
- ✓ Serial Number
- ✓ End-user Name
- ✓ Company
- ✓ Phone
- ✓ Fax
- ✓ Description of what is connected to the ILX Lightwave instrument
- ✓ Description of the problem

If ILX Lightwave determines that a return to the factory is necessary, a Return Merchandise Authorization (RMA) number will be issued. Please mark this number on the outside of the shipping box.

You or your shipping service is responsible for any shipping damage when returning the instrument to ILX Lightwave; ILX recommends you insure the shipment. If the original shipping container is not available, place your instrument in a container with at least 3 inches (7.5 cm) of compressible packaging material on all sides.

We look forward to serving you even better in the future!

Chapter 1:
Introduction and Specifications

This chapter is an introduction to the LDT-5416 Thermoelectric Temperature Controller.

- ✓ Safety Considerations and unpacking information
- ✓ Product Overview
- ✓ Options and accessories
- ✓ Specifications

Safety Considerations

WARNING

If any of the following symptoms exist, or are even suspected, remove the LDT-5416 from service. Do not use the LDT-5416 until trained service personnel can verify safe operation.

- **Visible damage**
- **Severe transport stress**
- **Prolonged storage under adverse conditions**
- **Failure to perform intended measurements or functions**

If necessary, return the LDT-5416 to ILX Lightwave for service and repair to ensure that safety features are maintained.

Initial Inspection

When you receive your LDT-5416 Thermoelectric Temperature Controller, verity that the following items were shipped with the instrument

- Certificate of Calibration
- USB Flash Drive with LDT-5416 Thermoelectric Controller Manual
- Power Cord

Product Overview

The LDT-5416 is a thermoelectric temperature controller capable of stably and accurately controlling thermoelectric mounts in low power applications. This is achieved by modulating the current through a thermoelectric load and continuously monitoring the feedback signal generated from a thermistor temperature sensor. The linear output stage of the LDT-5416 offers the low current noise necessary to achieve the temperature stability required in most low-noise and frequency-stabilized laser applications.

Features of the LDT-5416 include:

- Long term temperature stability of ±0.01°C
- Linearized thermistor mode allows temperature readout accurate to ±1°C with specific 10kΩ thermistors
- Bipolar 16 Watt linear output stage
- PI control loop with adjustable P gain and fixed I gain
- 12 Volt bias for operating external fans
- Buffered analog measurement output

If cleaning is required, use a clean dry cloth. Do not use solvents.

Figure 1.1 – LDT-5416 Front Panel

Figure 1.2 – LDT-5416 Rear Panel

Options and Accessories

Options and accessories available for LDT-5416 Thermoelectric Temperature Controller include the following:

DESCRIPTION	MODEL / PART NUMBER
Temperature Controller Interconnect Cable (terminated with 9-pin DSUB)	CC-505S
Temperature Controller Interconnect Cable (unterminated)	CC-501S
Calibrated 10kΩ Thermistor	TS-510
Uncalibrated 10kΩ Thermistor	TS-520
Uncalibrated 100kΩ Thermistor	TS-525
Unipolar Control Adapter	UCA-350
TO-Can Laser Diode Mount	LDM-4405
Telecommunications Series Laser Diode Mount	LDM-4980
Production Line TO-Can Laser Diode Mount	LDM-4990

Specifications

CONTROL SYSTEM

Temperature Stability (1 hour):[2]	±0.005 °C
Temperature Stability (24 hours):[2]	±0.01 °C
Temperature Coefficient:	<0.0025 °C/ °C
Control Algorithm:	Proportional (Adjustable) Integral (Fixed)

SENSOR

Thermistor:	NTC (2-wire)
Thermistor Sensor Resistance	
10 µA Bias Setting	
Range:	0 to 199.9 kΩ
Resolution (Display):	0.1 kΩ
Accuracy:	±1% of reading ±100Ω
100 µA Bias Setting	
Range:	0 to 19.99 kΩ
Resolution (Display):	0.01 kΩ
Accuracy:	±1% of reading ±10Ω
Linearized Thermistor Mode[3]	
Range:	10 - 40°C (0 to 15 kΩ)
Resolution (Display):	0.1 °C
Accuracy:	±1 °C

TEC OUTPUT

Output Type:	Bidirectional, linear
Isolation:	Floating with respect to earth ground
Output Current	Specified only for ambient temperatures 23±5°C
Range:	-4.00 A to + 4.00 A
Resolution (Display):	0.01 A
Accuracy:	±0.05 A
Current Limit Range:	-4.00 A to +4.00 A
Compliance Voltage:	±4 V
Maximum Output Power:	>16W
Current Noise and Ripple:	<2 mA rms

AUXILIARY OUTPUT

Analog Output Gain Factor:	100 mV/kΩ (100 µA) 10 mV/kΩ (10 µA)
Analog Output Impedance:	2 kΩ (nominal)
External Fan Output Voltage:	12 V (nominal)
External Fan Output Max. Current:	100 mA (maximum)

GENERAL

I/O Connectors:	Female 15-pin, D-sub (TEC I/O) Isolated Female BNC (Analog Output)
Power Requirements:	100-240 VAC; 50/60 Hz; 75W
Size (HxWxD):	14.2 cm x 25.9 cm x 6.6 cm; 5.6" x 10.2" x 2.6"
Weight:	1.35 kg (3.0 lbs.)
Operating Temperature:	10 °C to 40 °C
Storage Temperature:	-40 °C to 70 °C
Humidity:	<85%, relative, non-condensing
Compliance:	CE

NOTES

1. All specifications unless otherwise noted are for a one hour warm up.
2. Temperature stability tested at 25 °C with a 10 kΩ thermistor on the 100 µA setting.
3. To achieve rated accuracy, a 10 kΩ thermistor with at least 1% accuracy and a Beta in the range of 3900 to 4050 must be used. Use of a thermistor outside of this accuracy and Beta will result in inaccurate temperature readings and set points.

ORDERING INFORMATION

LDT-5416	Thermoelectric Temperature Controller
LDM-4405	Low Cost TO-Can Laser Diode Mount
CC-501S	TE Controller / Unterminated Interconnect Cable
CC-505S	TE Controller / Laser Diode Mount Interconnect Cable
TS-510	10kΩ Calibrated Thermistor (±0.2°C)
UCA-350	Unipolar Heater Control Adapter

In keeping with our commitment to continuing improvement, ILX Lightwave reserves the right to change specifications without notice or liability for such changes.

Chapter 2: General Operation

This chapter is an overview of the operation of the LDT-5416 Thermoelectric Temperature Controller.

- ✓ Power requirements
- ✓ Front panel operation
- ✓ General operating procedures

Grounding Requirements

The LDT-5416 Thermoelectric Temperature Controller comes with a three conductor AC power cable. The power cable must be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adaptor with the grounding wire connected to an electrical ground (safety ground). ILX Lightwave recommends connecting the instrument only to properly earth grounded receptacles. The power cord connector and provided power cable meet IEC safety standards.

AC Line Power Requirements

The LDT-5416 Thermoelectric Temperature Controller features a universal input and can be operated at nominal line voltages of 90 - 240 VAC and 50 – 60 Hz.

The Power Up Sequence

WARNING

Prior to power up ensure that the ventilation holes located on the left and right hand side as well as on the top of the instrument have no obstructions that would impede airflow.

With the LDT-5416 connected to an AC power source, pressing **POWER** supplies AC line power to the instrument. After power-up, make sure that the OUTPUT is off (LED unlit) until you have configured the instrument for your application.

Connections

Temperature Control Output: A 15-pin D-Subminiature connector is located on the back panel of the instrument. The connections for each terminal are shown below.

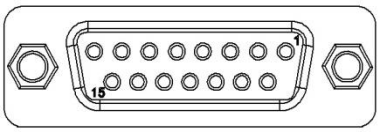
LDT-5416	
	
PIN NUMBER	**CONNECTION**
1	TE Module (+)
2	TE Module (+)
3	TE Module (-)
4	TE Module (-)
5	External Setpoint
6	External Setpoint
7	Sensor (+)
8	Sensor (-)
9	Analog Ground
10	Control Signal
11	N/C
12	N/C
13	N/C
14	Fan (+)
15	Fan (-)

Figure 2.1 – LDT-5416 Output Connector

The TE drive current is available at the 15 pin connector. Pins 1 and 2 and pins 3 and 4 are tied together internally. Pins 1 and 2 source current while cooling and sink current while heating. Pins 3 and 4 sink current while cooling and source current while heating.

An NTC Thermistor is required to sense the load temperature and must be connected between pins 7 and 8.

An external resistor may be used to control the setpoint resistance; this resistor must be connected between pins 5 and 6. The SET RESISTANCE switch must be in the EXT position in order to use the external resistor as a setpoint, otherwise the setpoint is controlled by the front panel knob.

The control signal on pin 10 provides approximately a 1 V/A signal referenced to pin 9, which can be used to drive an isolated booster current supply.

Pins 14 and 15 provide the ability to power an external fan through the 15-pin DSUB connector. This circuit can provide up to 100 mA at a nominal voltage of 12 VDC. This feature includes current limiting and over-power shutdown for the external fan.

THERMISTOR MODE: A three position switch that adjusts the measurement and setpoint current sources and also determines how the values are displayed on the front panel. The **10µA** and **100µA** positions configure the sensor current source for the selected value and displays the value of the setpoint and current sensor in kΩ on the front panel. **°C LINEARIZED FOR 10kΩ** is a special mode that places a 10kΩ resistor in parallel with the thermistor to linearize the temperature response. The front panel is calibrated to display the approximate temperature with an accuracy of ±1.0°C in °C when a 10kΩ thermistor is used as the sensor.

SET RESISTANCE: Allows the operator to bypass the set resistance function of the front panel and externally control to a known resistance. When the switch is in the **EXT** position, the temperature is controlled to match the resistance measured between pins 5 and 6 of the **OUTPUT** connector. This mode is useful if always operating at the same setpoint. When the switch is in the **INT** position, the external resistor is ignored and the front panel knob controls the temperature setpoint.

ANALOG OUTPUT: An isolated BNC connector is located on the rear panel of the LDT-5416 that provides the capability to externally measure the voltage at the thermistor terminals. The nominal gain of this connection is 10mV/kΩ in the 10µA range and 100mV/kΩ in the 100µA range. In the linearized operating mode the voltage present at this connection mirrors the voltage present across the parallel combination of the thermistor and a 10kΩ resistor with 100µA passing through the combination. The nominal output impedance of this connection is 2kΩ.

GAIN: A single turn potentiometer which adjusts the control loop gain. This adjustment affects the slew rate and settling time of the LDT-5416 when reaching the desired setpoint. If the GAIN is set too low (counter-clockwise), the LDT-5416 will take longer to reach the desired setpoint. If the GAIN is set too high (clockwise), the LDT-5416 may oscillate around the desired setpoint. To adjust, use a small blade screwdriver.

Front Panel Operation

This section describes the fundamentals of operation for the LDT-5416 Thermoelectric Temperature Controller. The order of descriptions will follow the normal progression of how the user would typically configure the instrument for use for the first time.

Figure 2.2 – LDT-5416 Front Panel

Power On / Off

The POWER button applies power to the LDT-5416.

I LIMIT Knob

The current LIMIT knob allows the user to set the upper limit of the output current. The user may adjust the output current from zero (LIMIT knob turned fully counterclockwise CCW) to 4 Amps (LIMIT knob turned fully clockwise CW). This LIMIT knob is recessed to prevent accidental readjustment of the output current during operation.

The LIMIT current value is not displayed, but the adjustment is linear. For example, setting the LIMIT knob half-way between 0 and 4 Amps will limit the output current to 2 Amp. A more accurate LIMIT setting may be attained by the following procedure:

1. Connect a short between pins 2 and 3 of DB15 (TE OUTPUT connector on rear panel). Connect a 10 kΩ resistor across pins 7 and 8 of DB15.

2. Set the DISPLAY MODE switch to TE CURRENT. Turn the OUTPUT switch on (LED lit). Adjust the Main Control Knob fully counter-clockwise (CCW).

3. Adjust the LIMIT control until the display reads the desired limit current. Turn the OUTPUT off, remove the short from pins 2 and 3 of DB15, and remove the resistor form pins 7 and 8 of DB15.

During operation the TE output current is unconditionally limited to the value set by the LIMIT adjustment

Setpoint Adjustment Knob

The Setpoint Adjustment knob is located on the upper right side of the LDT-5416 front panel and is used to set the desired operating, or setpoint, resistance or temperature of the load. The setpoint may be set from 0.00kΩ to ~20.00kΩ when the instrument is in the 100µA Sensor Mode (see SENSOR MODE below), from 0.0kΩ to ~200.0kΩ in the 10µA mode and from approximately 10°C to 70°C but will only meet the stated accuracy specification when set between 10°C and 40°C (see LINEARIZED MODE below). Rotating the knob clockwise in 10/100 µA mode will increase the resistance (decrease the temperature) and rotating counterclockwise will decrease the resistance (increase the temperature). When the LDT-5416 is in **°C LINEARIZED FOR 10kΩ** rotating the knob counter clockwise will increase the temperature and when rotating clockwise will decrease the temperature. This is due to the negative temperature coefficient of NTC thermistors where in a decrease in resistance represents an increase in temperature.

Display Mode and 7 Segment LED Display

Using the button located under the DISPLAY MODE will allow the user to cycle between ACTUAL, SET, and TEC CURRENT on the 7 segment LED display. When the ACTUAL LED is illuminated the display reads the measured resistance or temperature (linearized mode) of the thermistor, the SET LED when illuminated displays the set point resistance or temperature (linearized mode), and when the TE CURRENT LED is illuminated the LDT-5416 will display the actual measured TEC current.

Error Indicators

TEC OPEN: Indicates that the thermoelectric voltage exceeds the rated compliance voltage of the instrument. The output must be on to enable monitoring of **TEC OPEN**. Detection of a **TEC OPEN**

state will shut the output off. The indicator will remain illuminated after a fault until the output is enabled or power is cycled. In some instances a **TEC OPEN** fault may occur with high impedance TECs and can be remedied by reducing the current limit as to reduce the maximum voltage generated.

SNS OPEN: Indicates that the thermistor or external setpoint resistance has exceeded 50kΩ when the 100µA or Linearized sensor mode is selected or 500kΩ when the 10µA sensor mode is selected. Like the **TEC OPEN** indicator, the output must be on to enable monitoring of **SNS OPEN.** Detection of a **SNS OPEN** state will shut the output off. The indicator will remain illuminated after a fault until the output is enabled or power is cycled.

I LIMIT: This LED indicates that the current output is limited by the limit setpoint. It is normal for this indicator to illuminate shortly after turning the output on, or when load power changes significantly. If the indicator stays on or occasionally turns on after a long period, the controller cannot maintain temperature due to the power requirements of the load. Changing the temperature setpoint, or increasing the current limit, if it is safe to do so, can fix this problem.

Output Off/On Button

The OUTPUT off/on switch is located in the lower right-hand corner of the front panel. This switch has a toggling action which turns the output current of the LDT-5416 off and on. When the output is active, the LED indicator just above the switch will be lit.

When the OUTPUT is off, it is safe to connect or disconnect sensitive devices from the LDT-5416, even though the power supply is on. The OUTPUT is off when AC power is first applied to the instrument. Additionally, there are three other conditions which will automatically cause the output to reset to the off state:

- Power Drop-outs - AC line power drop-outs lasting more than about 1 second will trigger an internal power monitor and cause the output to switch unconditionally to the off state. This sequence is also initiated when the LDT-5416 is switched off or unplugged.
- SNS OPEN - If the externally connected thermistor or set point resistor is open, the output is switched to the off state and the SNS OPEN LED indicator is illuminated.
- TEC OPEN – If the connected TEC exceeds the rated voltage of the LDT-5416 the output will be disabled and the TEC OPEN LED will be illuminated.

If any of these conditions occur and the OUTPUT turns off; output may be turned on again by first correcting the cause of the fault and then pressing the OUTPUT off/on switch.

General Operating Procedures

The discussion below presents guidelines for operation as well as some common operating procedures.

Warm-Up and Environmental Considerations

To achieve the rated accuracy, allow the LDT-5416 to warm-up for at least one hour before use. Operate the controller within the environmental limits specified in Chapter 1.

General Guidelines for Sensor Selection and Safety Limits

This section presents some guidelines to assist in selecting the optimal settings for your application.

Sensor Options

The LDT-5416 Thermoelectric Temperature Controller can measure resistance of a thermistor and display the output either in resistance or a calculated temperature. When the rear panel switch is set to 100µA or 10µA the LDT-5416 will display resistance. When the rear panel switch is set to °C LINEARIZED FOR 10kΩ the LDT-5416 will display a calculated temperature.

Thermistor Range

Thermistors can span a wide temperature range, but their practical range is limited by their non-linear resistance properties. As the sensed temperature increases, the resistance of the thermistor decreases significantly and the thermistor resistance changes less for an equivalent temperature change, therefore the thermistor becomes less sensitive. Consider the temperature and sensitivity figures in Table 2.2.

Table 2.2 Thermistor Sensitivity Values

Temperature	Sensitivity
-20°C	5600 Ω/°C
25°C	439 Ω/°C
50°C	137 Ω/°C

In the LDT-5416 the practical upper temperature limit is the temperature at which the thermistor becomes insensitive to temperature changes. The lower end of the temperature range is limited by the maximum input voltage of the LDT-5416. Thermistor resistance and voltage are related through Ohms Law (V = I x R). The LDT-5416 supplies current to the thermistor, either 10µA or 100µA, and as the resistance changes, a changing voltage signal is available to the thermistor inputs of the LDT-5416. The LDT-5416 will over-range when the input voltage exceeds about 2.0 Volts. The maximum temperature ranges for a typical 10kΩ thermistor (a 10kΩ thermistor has a resistance of 10kΩ ohms at 25°C) are given in Table 2.3 below.

Table 2.3 Temperature Ranges (10kΩ Thermistor)

Temperature	Sensitivity
10 µA	-37°C to over +60°C
100 µA	+8°C to over +100°C

Selecting and Using Thermistors

The type of thermistor you choose will depend primarily on the operating temperature range. From Figure 2.3 you can also see that 10kΩ thermistors are generally a good choice for most laser diode applications where high stability is required at near room temperatures. Similarly, 5kΩ thermistors are often a good choice for detector cooling applications where you want to operate at temperatures from -30°C to room temperature. Much higher or lower temperature ranges can be controlled through the use of higher or lower resistance thermistors. For more information on thermistor selection, see ILX Lightwave Application Note #2, Selecting and Using Thermistors for Temperature Control.

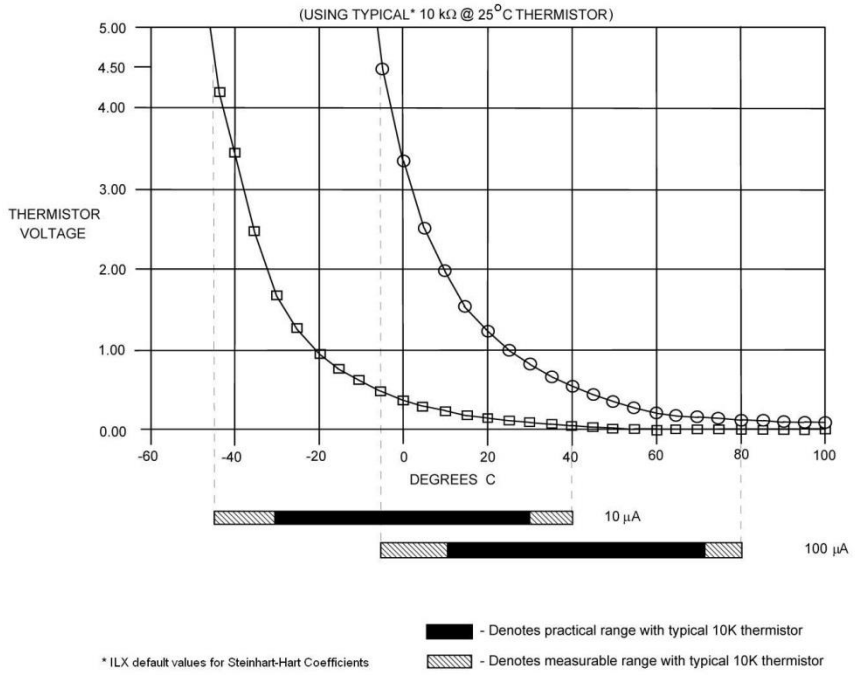


Figure 2.3 Thermistor Temperature Range

Temperature from Resistance

The LDT-5416 Thermoelectric Temperature Controller primarily displays resistance of the thermistor; several methods can be used to convert the resistance to a temperature.

Resistance-Temperature Conversions Charts - Most thermistor manufacturers will supply a resistance - temperature (R-T) chart for their thermistors. These charts provide a direct and simple conversion. Although the temperature accuracy will not be better than the tolerance of the thermistor, this accuracy may be more than adequate for most applications. If temperature accuracy to within 1°C is all that is required, this method is the best.

In many cases the manufacturer will supply a universal conversion table for each particular thermistor material type that they sell. This table is used for all 25°C nominal resistance value thermistors made of that material. In these tables the resistance is not given directly. But rather, a scaling factor is given at each temperature. Resistance is found then by multiplying the nominal resistance value by the scaling factor at a given temperature. The scaling factor is often represented as the ratio R_T/R_{25}.

For example, if the thermistor is rated as a 10kΩ thermistor, then R_{25} = 10,000Ω (the resistance at 25°C). To find the resistance at 10°C, find the ratio factor at 10°C as supplied by the manufacturer. If the ratio was 1.99, then the resistance at 10°C would be 10,000 x 1.99 = 19,900Ω.

Table 2.4 shows some typical values of resistance ratios and temperatures for a thermistor.

Table 2.4 Typical Thermistor R/T Data

Temperature in °C	R_T/R_{25}
10	1.990
11	1.897
12	1.809
13	1.726
14	1.646
15	1.571

Use of the Steinhart-Hart Equation - The Steinhart-Hart equation accurately models the non-linear R-T characteristic curve of a negative temperature coefficient (NTC) thermistor. When the correct constants for a thermistor are known, the Steinhart-Hart equation can be used to convert between resistance and temperature. This method offers the advantage of accurately calculating R-T values at any point on the curve, not just those supplied by the manufacturer.

There are several forms of the Steinhart-Hart equation. The form of the Steinhart-Hart equation which is used by ILX Lightwave is:

$$\frac{1}{T} = C_1 + C_2(Ln\ R) + C_3(Ln\ R)^3$$

Where R is the resistance in ohms; C_1, C_2, and C_3 are the Steinhart-Hart constants for a particular thermistor.

These constants may be derived specifically for each thermistor, or the nominal value for a thermistor may be used (see ILX Lightwave Application Note #4 Thermistor Calibration and the Steinhart-Hart Equation). ILX Lightwave supplies the Steinhart-Hart constants when a TS-510 calibrated thermistor is purchased.

Linearized Thermistor Mode – For users wanting to display a calculated temperature without using one of the methods above the LDT-5416 has a unique mode that when selected will display and control to a calculated temperature. To use this mode the LDT-5416 sensor select switch must be set to **°C LINEARIZED FOR 10kΩ**. This mode can only be used with 10kΩ thermistors with 1% accuracy and a Beta of 3900 to 4050. In this mode, the display will show temperature with an accuracy of ±1.0°C. For users requiring higher accuracy or not using a 10kΩ thermistor one of the other methods above should be used.

WARNING

Use of 10kΩ thermistors with accuracy greater than 1% and a Beta value outside of the range of 3900 to 4050 can result in temperature readings exceeding ±1.0°C of set point. Potential damage to the load may occur due to inaccurate set points.

General Operation

1. Plug the LDT-5416 into an AC power source within the specified range of the instrument.

2. Turn on the LDT-5416 by pressing and releasing the power switch to latch it to the on position. The output will be disabled at power up and the unit display mode will power up in the same mode which existed when the power was last shut off

3. Set the maximum current for the TE module by adjusting the **I LIMIT** control.

4. Set the rear panel **THERMISTOR MODE** switch to an acceptable current for your sensor. If using a 10kΩ thermistor you can use the **°C LINEARIZED FOR 10kΩ** mode to display and control temperature.

5. For front panel setpoint control, ensure the **SET RESISTANCE** switch on the rear panel is set to the **INT** position. Press the **DISPLAY MODE** button until **SET** is illuminated. Adjust the setpoint on the display using the large setpoint knob.

   For fixed external control, ensure the **SET RESISTANCE** switch on the rear panel is set to **EXT** and an external resistor is connected between pin 5 and 6 of the **OUTPUT** connector. The setpoint resistance can be verified on the front panel by pressing the **DISPLAY MODE** button until **SET** is illuminated.

6. Ensure that the TE module and thermistor are connected to the OUTPUT connector and turn the OUTPUT on. The indicator above the ON button will illuminate when the output is on.
7. Press the **DISPLAY MODE** button until **ACTUAL** is illuminated to monitor the sensor resistance/temperature. If the resistance does not settle at the set point, but instead oscillates by more than one significant digit around the setpoint, turn the **GAIN** control adjustment on the rear panel counter-clockwise to decrease the gain. Alternatively if it is taking a long time to get to the setpoint, the **GAIN** control can be adjusted clockwise to increase the gain.
8. TE current can be monitored at any point during operation by pressing the **DISPLAY MODE** button until **TE CURRENT** is illuminated.

Chapter 3: Troubleshooting

This chapter will help you resolve any problems you may experience with your LDT-5416. If you need additional help, please contact ILX Lightwave Customer Service.

ILX Lightwave Corporation provides in-house calibration services for ILX instruments. International customers may contact our service centers for regional calibration support. Most ILX instruments, including the LDT-5416 require yearly calibration to ensure performance to published specifications. ILX factory calibrations employ NIST traceable measurement instrumentation, and our calibration engineers and technicians use automated test equipment to accurately and efficiently capture and record calibration data. An original certificate of calibration is provided with all instrument calibrations, and a detailed report showing any pre-calibration out-of-tolerance conditions is available upon request.

Calibration turn-around times are normally ten business days or less. Please contact ILX Customer Support for additional calibration information.

For further assistance with technical solutions and troubleshooting, visit us online at www.newport.com/ilxlightwave.

Troubleshooting Guide

This section lists some common problems and corrective actions. In the event that the corrective action does not resolve the problem, please contact ILX Lightwave.

For a comprehensive list of frequently asked questions, see the ILX Lightwave website or contact ILX Lightwave Customer Service (see Comments, Suggestions, and Problems on page viii for contact information).

SYMPTOM	CORRECTIVE ACTION
The instrument does not power up	Check the power cord to make sure that it is properly connected and check the wall outlet by connecting to a known operational device.
SNS OPEN indicator stays illuminated and OUTPUT won't turn on.	Check the **SET RESISTOR** switch on the rear panel. If it is in the **EXT** position, there must be an external resistor connected across pins 5 and 6 of **OUTPUT** connector. If the intended use is for front panel setpoint control move the switch to the **INT** position. Check the thermistor connections to be sure they are not open circuit and that the **THERMISTOR MODE** switch is in the correct position for the thermistor used.
The **I LIMIT** indicator goes on and stays on and the LDT-5416 can't control to temperature.	It is normal for the **I LIMIT** indicator to turn on when there is a large difference between the setpoint and the sensed temperature, but if the indicator stays on and the **ACTUAL** value does not become closer to the **SET** value there may be issues with your setup. Check the **I LIMIT** adjustment knob by setting the display mode to **TE CURRENT** and adjust the **I LIMIT** knob until the indicator turns off or the rated current of the TE being used is reached. Turn off the output. If the actual value approaches the setpoint faster than with the output on, it is likely that the TE is wired backward. Reverse the polarity of the leads. Adjust the setpoint to a value closer to the actual reading. If the I LIMIT indication goes away it means that you have exceeded the power capability of the LDT-5416. Either use a new setpoint, or contact an ILX Lightwave technical sales representative to help you with your application.
The **ACTUAL** values oscillate around the **SET** value.	Reduce the rear panel **GAIN** control by adjusting counter clockwise.