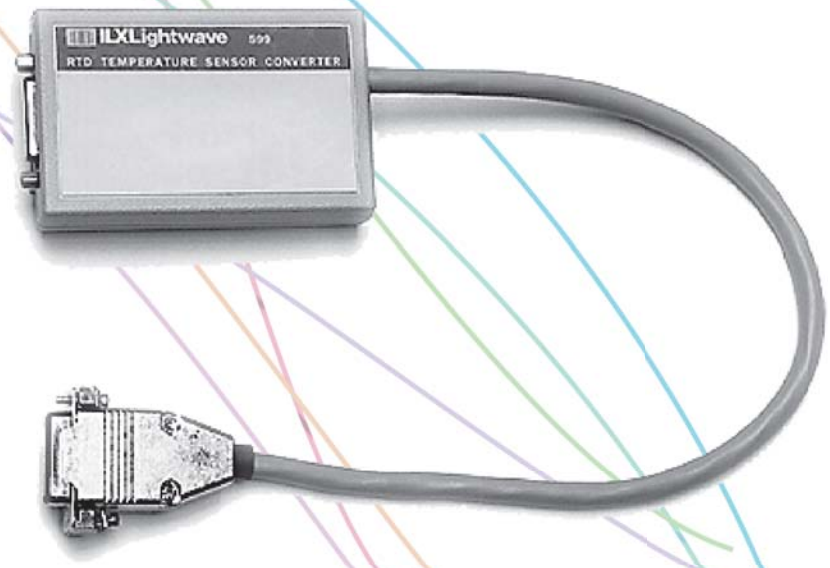
User's Guide

Temperature Sensor Converter
TSC-599



ILX Lightwave®
A Newport Corporation Brand

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SAFETY AND WARRANTY INFORMATION

The Safety and Warranty Information section provides details about cautionary symbols used in the manual, safety markings used on the instrument, and information about the Warranty including Customer Service contact information.

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.

Visible and/or invisible laser radiation. Avoid direct exposure to the beam.

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 (see the contact information on page vii).

All instruments returned to ILX Lightwave are required to have a Return Authorization Number assigned by an official representative of ILX Lightwave Corporation. See Returning an Instrument on page v 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.
- 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 overvoltages
- Maximum Relative Humidity: <80% RH, non-condensing
- Operating temperature range of 0 °C to 40 °C
- Storage and transportation temperature of –40 °C to 70 °C
- Maximum altitude: 3000 m (9843 ft.)
- 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.

 Caution, refer to manual	 Earth ground Terminal	 Alternating current	 Visible and/or invisible laser radiation
 Caution, risk of electric shock	 Protective Conductor Terminal	 Caution, hot surface	 Frame or chassis Terminal
 **or** **(I)** On: In position of a bistable push control. The slash (I) only denotes that mains are on.		 **or** **(O)** Off: Out position of a bistable push control. The circle (O) only denotes that mains are off.	

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 fuses, lamps, 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:

1. Obtain a Return Authorization number (RA) from ILX Customer Service.
2. 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.
3. Attach the anti-static protective caps that were shipped with the instrument and place the instrument in a protective anti-static bag.
4. 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.**
5. Secure the packing box with fiber reinforced strapping tape or metal bands.
6. 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: . . . . . ilx.custhelp.com

Or mail to:

ILX Lightwave Corporation
P. O. Box 6310
Bozeman, Montana, U.S.A 59771
www.ilxlightwave.com

When you contact us, 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, you are issued a Return Authorization (RA) number. Please mark this number on the outside of the shipping box.

You or your shipping service are 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 manual contains information for using the 599 RTD Temperature Sensor Converter, as well as procedures for optimizing the calibration of your temperature sensor. By following these procedures, the user will be able to achieve the most accurate results.

Product Overview

The 599 RTD Temperature Sensor Converter is a device which allows an RTD, or resistance temperature detector, to be used as a temperature sensor with the ILX Lightwave LDT-5910B, LDT-5525 Temperature Controllers, ILX Lightwave Laser Diode Controllers (LDC-3700 Series), and the LPA-9000 Series Laser Parameter Analyzers. The 599 is designed to be used with 100 ohm, 500 ohm and 1Kohm two-lead RTDs.

Specifications

Connectors[1]	15-pin D-subminiature
Sensor Type[2]	2-wire RTD (1K, 500 and 100 ohm)
Sensor Current (mA)	2.0 mA
Temperature Readout Range	-20 ^{o}C to +100 ^{o}C
RTD Set Point Accuracy[3,4]	$\pm$ 0.2 ^{o}C
Short Term Stability (10 minutes)[3]	< $\pm$ 0.01 ^{o}C
Long Term Stability (24 hours)[3]	< $\pm$ 0.02 ^{o}C
Error Due to a Temperature Change of Enclosure	0.04% / ^{o}C
Typical Temperature Readout Error Due to RTD Non-Linearity (-20 ^{o}C to + 100 ^{o}C)	0.75 ^{o}C
Size	0.9” x 2.4” x 3.8”
Weight	6.75 ounces (191 grams)
Operating Temperature	0 ^{o}C to 40 ^{o}C
Storage Temperature	-40 ^{o}C to +70 ^{o}C
Humidity	< 95% relative humity, non-condensing

1. Input connector pin configuration is compatible with the ILX Lightwave LDT-5910B, LDT-5525 Temperature Controllers, ILX Lightwave Laser Diode Controllers (LDC-3700 Series) and the LPA-9000 Series Laser Parameter Analyzers.
2. Sensor resistance setting is internally switch selectable.
3. Specification of ILX Lightwave LDT-5910B Temperature Controller used with the 599 RTD Temperature Sensor Converter and a 100 ohm platinum RTD temperature sensor.
4. Typical specification; set-point accuracy depends upon user-defined calibration constants, ambient temperature fluctuations, the particular temperature sensor used and other factors.

CHAPTER 2

OPERATION

Installation

Prior to installing the 599, the RTD sensor type must be selected. Open the 599 enclosure by removing the two #2 Phillips-head screws. Position the large slide switch into either the 100 ohm, 500 ohm or 1Kohm position depending on the RTD sensor type used. (Switch positions are labeled on the printed circuit board.) Reassemble the 599 enclosure.

Note: Opening the 599 enclosure will NOT void the ILX Lightwave Warranty. However, the user should not adjust any internal trimpots, as the 599 has been factory calibrated.

To install the 599 Temperature Sensor Converter, first position the sensor select switch of your ILX Lightwave Temperature Controller to the “AD590” position. Then plug the 15-pin male D-subminiature connector on the 599 into the 15-pin female D-subminiature connector on the rear panel of the temperature controller. The 15-pin female D-sub connector on the 599 will now function the same as the 15-pin D-sub connector on the back of the temperature controller (with the exception that an RTD temperature sensor, instead of an AD590 sensor, should be connected to pins seven and eight). Refer to the appropriate ILX Lightwave Temperature Controller Manual for temperature control operation.

Possible Sources of Error

The following sections outline several factors which may reduce the accuracy of the 599 RTD Temperature Sensor Converter. ILX suggests that the user follow the outlined suggestions to minimize the influence of these factors.

RTD Non-Linearity

By a first approximation, the change in resistance of an RTD with respect to temperature is given by:

$$R = R_0 (1 + \alpha T)$$

where R_o is the resistance of the RTD at 0 ^oC, T is the temperature in Celsius and α is a constant. However, this approximation is not completely accurate, as an RTD is typically about 0.5% non-linear in the range between 0 and 100 ^oC. The 599 RTD Temperature Sensor Converter gives a linear response for a change in sensor resistance, R. The formula for the temperature displayed on the temperature controller (in ^oC) is given by:

$$T^{display} = C1 + C2 * (K * R - 273.15)$$

where C1 and C2 are the calibration constants set on the temperature controller, and K is an internally-set constant. To reduce the error due to non-linearity of the RTD, the calibration constants C1 and C2 should be set using the two-point calibration method. The two points should be as close together as possible (while still spanning the region of interest). Refer to a later section for a description of the two-point calibration.

RTD Self-Heating

The error due to self-heating of the RTD will vary, depending on the size and shape of the RTD and the thermal environment. To minimize this error, the calibration constants on the temperature sensor should be set with the RTD in the same type of thermal environment in which is will be used.

Ambient Temperature Change

The change in ambient temperature surrounding the enclosure will effect the temperature reading slightly. To minimize this error, the temperature controller and the 599 should be warmed-up properly prior to calibration (approximately 1 hour is sufficient) and the room temperature should be fairly stable.

Wire Resistance

The wire used to connect the RTD to the 599 Temperature Converter will add some small error. However, this error may be offset by properly adjusting the calibration constant C1.

Thermocouple Effects

This effect is usually quite small and can be minimized by property selecting the type of wire used to connect the RTD leads to the 599 Temperature Converter. In addition, these effects may be offset by properly adjusting the calibration constant C1.

Setting the Calibration Constants

For a first approximation, the calibration constants C1 and C2 may be set by using the following equations. This will usually give an accuracy within 1 ^{o}C.

C1 = 0

C2 = 1 / 273.15 * α

Here α is a constant dependent upon the particular RTD. Two common values of α are 0.00385 and 0.00392.

If more accuracy is desired, the two-point calibration method may be used. The accuracy of this procedure depends upon the accuracy of the known temperatures, externally measured. It is used to determine the zero offset and the gain offset (slope) of the RTD device.

The two-point calibration procedure is outlined below:

1. Connect the RTD to the 599 Temperature Converter unit. Connect the 599 Temperature Converter to the Temperature Controller and allow the Temperature Controller to warm up for at least 1 hour.

2. Select the C1 parameter of the Temperature Controller and enter a value for C1. Read and record the value of C1. Next, select the C2 parameter and enter a value for C2. Read and record the value of C2. (The user may with to use the formulas for C1 and C2 as a first approximation.)

3. Set up the Temperature Controller for constant temperature operation. Place the sensor at an accurately known and stable temperature T_{a1}. Allow the temperature controller to stabilize and read the displayed temperature, T_{d1}. Record these values.

4. Repeat step 3 for another known temperature, T_{a2}, and the corresponding displayed temperature, T_{d2}.

   Note: The two temperature, T_{a1} and T_{a2}, should be at the bounds of the intended operating range. For best results, make the range between the two temperatures as small as possible, while still covering the temperature range of interest.

5. Calculate the new values of C1 ($C1_{new}$) and C2 ($C2_{new}$) using the following equations:

   First, determine the intermediate values of V and U, where:

   $V = (T_{a1} - T_{a2}) / (T_{d1} - T_{d2})$, and

   $U = T_{a1} - (T_{d1} * V)$

   C1new and C2new can then be determined with the following:

   $C1_{new} = U + (V * C1)$

   $C2_{new} = V * C2$

6. Replace C1 with C1new by selecting the C1 parameter of the Temperature Controller and entering the new value, C1new. Similarly, replace C2 with C2new. It is not necessary to repeat the calibration procedure at this point.