ARTISAN®
TECHNOLOGY GROUP

Your **definitive** source for quality pre-owned equipment.

**Artisan Technology Group**
(217) 352-9330 | sales@artisantg.com | artisantg.com

**Full-service, independent repair center**
with experienced engineers and technicians on staff.

**We buy your excess, underutilized, and idle equipment**
along with credit for buybacks and trade-ins.

**Custom engineering**
so your equipment works exactly as you specify.

- Critical and expedited services
- In stock / Ready-to-ship
- Leasing / Rentals / Demos
- ITAR-certified secure asset solutions

**Expert team | Trust guarantee | 100% satisfaction**

All trademarks, brand names, and brands appearing herein are the property of their respective owners.

Find the *National Instruments FP-RTD-124* at our website: *Click HERE*

*FieldPoint Operating Instructions*

# FP-RTD-124 AND cFP-RTD-124

## Eight-Channel Four-Wire RTD and Resistance Input Modules

These operating instructions describe how to install and use the National Instruments FP-RTD-124 and cFP-RTD-124 three-wire RTD and resistance input modules (referred to inclusively as the [c]FP-RTD-124). For details on configuring and accessing the [c]FP-RTD-124 over a network, refer to the user manual for the FieldPoint network module you are using.

## Features

The [c]FP-RTD-124 is a FieldPoint RTD and resistance input module with the following features:

- Inputs for 100 Ω platinum RTDs (resistance temperature detectors)
- Built-in linearization for six TCR (temperature coefficient of resistance, or alpha) values of RTDs
- Direct resistance measurements with a 400 Ω range
- Four-wire measurement for high accuracy
- 16-bit resolution
- Filtering against 50 and 60 Hz noise
- 2,300 $V_{rms}$ transient overvoltage protection
- –40 to 70 °C operation
- Hot plug-and-play

FieldPoint™, National Instruments™, NI™, and ni.com™ are trademarks of National Instruments Corporation. Product and company names mentioned herein are trademarks or trade names of their respective companies. For patents covering National Instruments products, refer to the appropriate location: **Help»Patents** in your software, the `patents.txt` file on your CD, or `ni.com/patents`.

*323349A-01 October 2002*

*© 2002 National Instruments Corp. All rights reserved.*

NATIONAL INSTRUMENTS™

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## Installing the FP-RTD-124

The FP-RTD-124 mounts on a FieldPoint terminal base (FP-TB-*x*). Hot plug-and-play enables you to install the FP-RTD-124 onto a powered terminal base without disturbing the operation of other modules or terminal bases. The FP-RTD-124 receives operating power from the terminal base.

To install the FP-RTD-124, refer to Figure 1 and complete the following steps:

1. Slide the terminal base key to either position X, used for any module, or position 1, used for the FP-RTD-124 module.
2. Align the FP-RTD-124 alignment slots with the guide rails on the terminal base.
3. Press firmly to seat the FP-RTD-124 on the terminal base. When the module is firmly seated, the terminal base latch locks it into place.

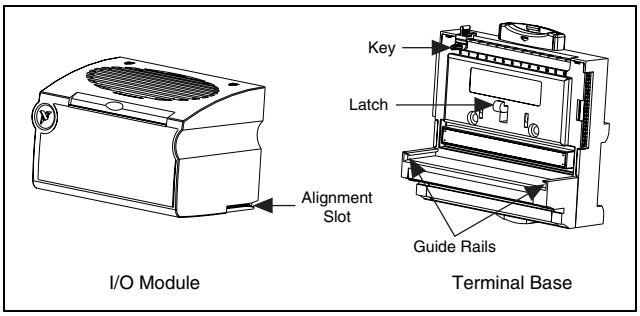



**Figure 1.** Installing the FP-RTD-124

## Installing the cFP-RTD-124

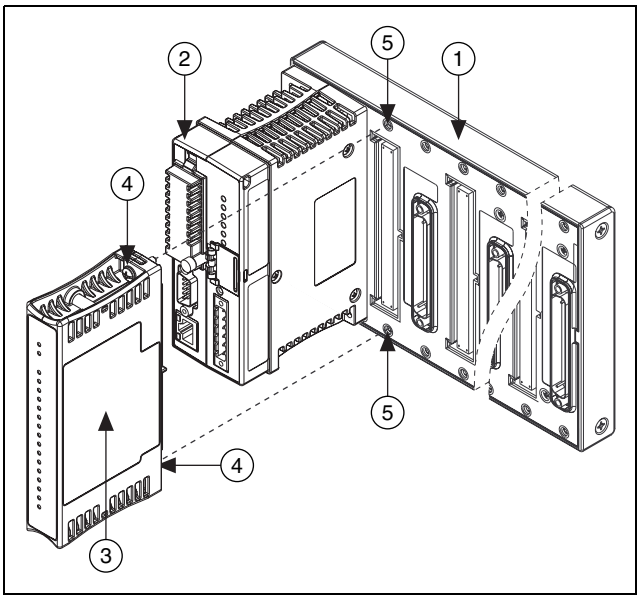
The cFP-RTD-124 mounts on a Compact FieldPoint backplane (cFP-BP-*x*). Hot plug-and-play enables you to install the cFP-RTD-124 onto a powered backplane without disturbing the operation of other modules or connector blocks. The cFP-RTD-124 receives operating power from the backplane.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

To install the cFP-RTD-124, refer to Figure 2 and complete the following steps:

1. Align the captive screws on the cFP-RTD-124 with the holes on the backplane. The alignment keys on the cFP-RTD-124 prevent backward insertion.
2. Press firmly to seat the cFP-RTD-124 on the backplane.
3. Using a number 2 Phillips screwdriver with a shank of at least 64 mm (2.5 in.) length, tighten the captive screws to 1.1 N · m (10 lb · in.) of torque. The nylon coating on the screws prevents them from loosening.




| | | | | | |
|---|---|---|---|---|---|
| 1 | cFP Backplane | 3 | cFP I/O Module | 5 | Screw Holes |
| 2 | cFP Controller Module | 4 | Captive Screws | | |

**Figure 2.** Installing the cFP-RTD-124



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## Wiring the [c]FP-RTD-124

The FP-TB-*x* terminal bases have connections for each of the eight input channels on the FP-RTD-124. The cFP-CB-*x* connector blocks provide the same connections for the cFP-RTD-124.

Table 1 lists the terminal assignments for the signals associated with each channel.

**Table 1.** Terminal Assignments

| Channel | Terminal Numbers | | | |
|---|---|---|---|---|
| | SENSE+ | SENSE– | EXCITE+ | COM |
| 0 | 1 | 2 | 17 | 18 |
| 1 | 3 | 4 | 19 | 20 |
| 2 | 5 | 6 | 21 | 22 |
| 3 | 7 | 8 | 23 | 24 |
| 4 | 9 | 10 | 25 | 26 |
| 5 | 11 | 12 | 27 | 28 |
| 6 | 13 | 14 | 29 | 30 |
| 7 | 15 | 16 | 31 | 32 |

If you are using shielded wiring, you can reduce input signal noise by connecting one end of the shield to the COM terminal. Do not connect the shield to any of the wires at the signal end.

## Taking RTD Measurements with the [c]FP-RTD-124

The [c]FP-RTD-124 has eight input channels. All eight channels share a common ground that is isolated from other modules in the FieldPoint system. Each channel pulses a 2 mA excitation current out of the EXCITE+ terminal. The excitation current returns through the COM terminal. The SENSE+ and SENSE– terminals measure resistance and compensate for lead resistance errors. Each channel is filtered, then sampled by a 16-bit analog-to-digital converter.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figure 3 shows the input circuitry on one channel.

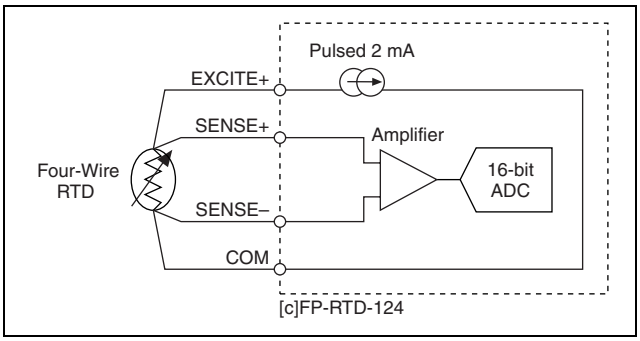



**Figure 3.** FP-RTD-124 Input Circuit

## Taking Measurements from Four-Wire RTDs

Four-wire RTDs generally have two wires of one color and two of another color (usually red and white). Connect the wires of one color to the positive terminals (EXCITE+ and SENSE+). Connect the wires of the other color to the negative terminals (COM and SENSE–).

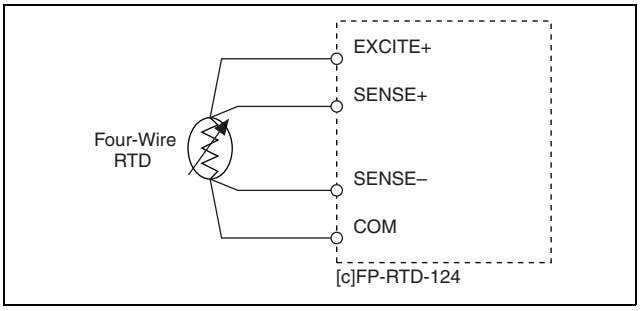



**Figure 4.** Four-Wire RTD Connections on One Channel

## Taking Measurements from Three-Wire RTDs

NI recommends the [c]FP-RTD-122 for three-wire RTD measurements because it includes special sensing circuitry to compensate for up to 95% of the lead resistance of the third wire. Most three-wire RTDs have two wires of one color (usually red, sometimes black) and one wire of another color (usually white, sometimes red). Connect the two wires of the same color to the



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

negative terminals (COM and SENSE–). Connect the third wire to the positive terminal (SENSE+). Use a short jumper wire to connect the EXCITE+ terminal to the SENSE+ terminal.

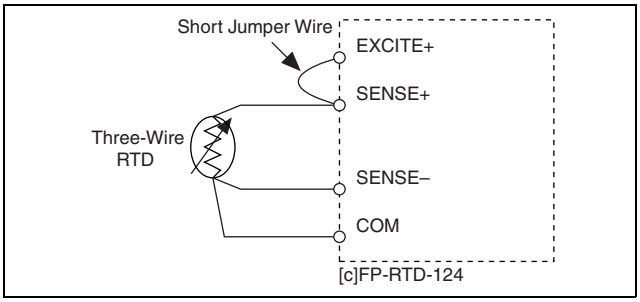



**Figure 5.** Three-Wire RTD Connections on One Channel

## Taking Measurements from Two-Wire RTDs

Connect one wire of a two-wire RTD to the SENSE+ terminal and the other wire to the SENSE– terminal. Use a short jumper wire to connect the SENSE+ terminal to the EXCITE+ terminal. Use another short jumper wire to connect the SENSE– terminal to the COM terminal.

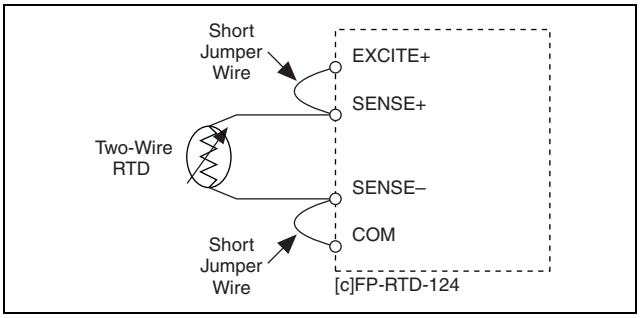



**Figure 6.** Two-Wire RTD Connections on One Channel



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## Measuring Resistance

You can use the [c]FP-RTD-124 to measure resistance in ohms. In this way, you can take measurements from RTDs of types that the [c]FP-RTD-124 does not directly support (such as 120 Ω nickel RTDs) and from resistive devices other than RTDs. You can measure resistances up to 400 Ω. Resistance values greater than 400 Ω, including open circuits, result in an `Out of range` error for the affected channels. The [c]FP-RTD-124 ignores any configuration of RTD type for channels with resistance selected.

## Converting Resistance Measurements to Temperature Measurements

The [c]FP-RTD-124 has built-in linearization algorithms for platinum RTDs of either 100 or 1,000 Ω nominal resistance, and for 6 TCR (or alpha, α) values. The TCR is the average temperature coefficient of resistance of an RTD from 0 to 100 °C. This document specifies TCR in units of mΩ/Ω/°C.

The [c]FP-RTD-124 linearizes resistance values and returns readings in units of temperature. The available ranges are 73 to 1,123 K, –200 to 850 °C, and –328 to 1,562 °F. You can configure each channel independently, so you can connect different types of RTDs to each channel.

**Note** You must configure each channel of the [c]FP-RTD-124 for the type of RTD connected to it. The module does not automatically recognize RTD types.

### RTD Types

RTD types are specified by material composition, nominal resistance at 0 °C, and TCR. The [c]FP-RTD-124 can directly measure the temperature of platinum RTDs of 100 Ω nominal resistance. These RTDs are commonly referred to as PT100 RTDs.

Different types of platinum RTDs have different TCRs. The [c]FP-RTD-124 supports the following TCRs: 3.750, 3.851, 3.911, 3.916, 3.920, and 3.928 mΩ/Ω/°C. The most common TCR for RTDs is 3.851 mΩ/Ω/°C. It is defined in international standards such as IEC-751, DIN 43760, BS 1904, and ASTM E1137. The TCR of 3.928 mΩ/Ω/°C is used in the reference function for platinum thermometers in the International Temperature Scale of 1990 (ITS-90) for high-accuracy metrology applications.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Unfortunately, not all TCR values are as well defined by standards organizations, and the behavior of RTDs with the same TCR value may vary from vendor to vendor. The variations are usually small, and the built-in linearization algorithms of the [c]FP-RTD-124 are appropriate for nearly all applications.

The [c]FP-RTD-124 uses a linearization curve known as the Callendar-Van Dusen equation to measure the temperature of RTDs. The equation is as follows:

Temperatures below 0 °C:

$$R_T = R_0[1 + \mathrm{A} \times T + \mathrm{B} \times T^2 + \mathrm{C} \times T^3 \times (T - 100\ ^\circ\mathrm{C})]$$

Temperatures above 0 °C:

$$R_T = R_0[1 + \mathrm{A} \times T + \mathrm{B} \times T^2]$$

$T$ = temperature in °C

$R_T$ = RTD resistance at temperature $T$

$R_0$ = RTD nominal resistance at 0 °C

A, B, and C are coefficients given in Table 2.

Table 2 lists the coefficients used in this equation for each of the TCR values that the [c]FP-RTD-124 supports. If you have a nonstandard RTD that does not match one of these linearization curves, measure the resistance with the [c]FP-RTD-124 and convert the resistance to temperature in the manner suggested by the RTD vendor.

**Table 2.** Callendar-Van Dusen Coefficients Used by the [c]FP-RTD-124

| TCR mΩ/Ω/°C | A $(°C)^{-1}$ | B $(°C)^{-2}$ | C $(°C)^{-4}$ |
|---|---|---|---|
| 3.750 | $3.81 \times 10^{-3}$ | $-6.02 \times 10^{-7}$ | $-6.0 \times 10^{-12}$ |
| 3.851 | $3.9083 \times 10^{-3}$ | $-5.775 \times 10^{-7}$ | $-4.183 \times 10^{-12}$ |
| 3.911 | $3.9692 \times 10^{-3}$ | $-5.8495 \times 10^{-7}$ | $-4.233 \times 10^{-12}$ |
| 3.916 | $3.9739 \times 10^{-3}$ | $-5.870 \times 10^{-7}$ | $-4.4 \times 10^{-12}$ |
| 3.920 | $3.9787 \times 10^{-3}$ | $-5.8686 \times 10^{-7}$ | $-4.167 \times 10^{-12}$ |
| 3.928 | $3.9888 \times 10^{-3}$ | $-5.915 \times 10^{-7}$ | $-3.85 \times 10^{-12}$ |



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## Effects of Lead Resistance

The [c]FP-RTD-124 measures resistance by driving a current through a circuit and sensing the resulting voltage. Any resistance in the lead wires that connect to the RTD can add errors to your readings if the measured voltage includes the drop across these wires.

For example, consider a two-wire RTD element connected as previously shown in Figure 2. The resistance of the lead wires is indistinguishable from the resistance of the RTD element. In a typical application using 10 m of 22 AWG copper wire, each of the two leads adds approximately 0.5 Ω of error to the measurement. The 0.5 Ω of error corresponds to a temperature error of about 2.6 °C. Using the three-wire RTD connection in Figure 2 causes the inclusion of only one of the leads in the sensed measurement. The resultant error caused by lead resistances is half that of the error in the two-wire example.

The most accurate way to measure temperature from RTDs is the four-wire method shown in Figures 2 and 3. With this method, one pair, the EXCITE and COM leads, carries the current through the RTD. The other pair, the SENSE leads, measures the voltage developed by the RTD element independent of the lead resistance.

## Status Indicators

The [c]FP-RTD-124 has two green status LEDs, **POWER** and **READY**. After you insert the [c]FP-RTD-124 into a terminal base or backplane and apply power to the connected network module, the green **POWER** indicator lights and the [c]FP-RTD-124 informs the network module of its presence. When the network module recognizes the [c]FP-RTD-124, it sends initial configuration information to the [c]FP-RTD-124. After receiving this initial information, the green **READY** indicator lights and the [c]FP-RTD-124 is in normal operating mode.

## Isolation and Safety Guidelines

**Caution** Read the following information before attempting to connect the [c]FP-RTD-124 to any circuits that may contain hazardous voltages.

This section describes the isolation of the [c]FP-RTD-124 and its compliance with international safety standards. The field wiring



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

connections are isolated from the backplane and the inter-module communication bus. The isolation is provided by the module, which has optical and galvanic isolation barriers designed and tested to protect against transient fault voltages of up to 2,300 $V_{rms}$.

Follow these guidelines to ensure a safe total system:

- The [c]FP-RTD-124 has a safety isolation barrier between the I/O channels and the inter-module communication bus. There is no isolation between channels unless otherwise noted. If any of the channels on a module are wired at a hazardous potential, make sure that all other devices or circuits connected to that module are properly insulated from human contact.
- Do *not* share the external supply voltages (the V and C terminals) with other devices (including other FieldPoint devices), unless those devices are isolated from human contact.
- For Compact FieldPoint, you *must* connect the protective earth (PE) ground terminal on the cFP-BP-*x* backplane to the system safety ground. The backplane PE ground terminal has the following symbol stamped beside it: ⏚. Connect the backplane PE ground terminal to the system safety ground using 14 AWG (1.6 mm) wire with a ring lug. Use the 5/16 in. panhead screw shipped with the backplane to secure the ring lug to the backplane PE ground terminal.
- As with any hazardous voltage wiring, make sure that all wiring and connections meet applicable electrical codes and commonsense practices. Mount terminal bases and backplanes in an area, position, or cabinet that prevents accidental or unauthorized access to wiring that carries hazardous voltages.
- Operate the [c]FP-RTD-124 only at or below Pollution Degree 2. Pollution Degree 2 means that only nonconductive pollution occurs in most cases. Occasionally, however, a temporary conductivity caused by condensation must be expected.
- Refer to the FieldPoint product label for regulatory certification under hazardous location standards. If the FieldPoint product is not certified for operation in hazardous locations, do not operate it in an explosive atmosphere or where there may be flammable gases or fumes.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

# Specifications

These specifications are typical for the range –40 to 70 °C unless otherwise noted.

## Input Characteristics

Number of channels ..... 8

ADC resolution ..... 16 bits

Type of ADC ..... Delta-sigma

Input signal ranges (software-selectable by channel)

Temperature ..... 73 to 1123 K
–200 to 850 °C
–328 to 1562 °F

Resistance ..... 0 to 400 Ω

Temperature accuracy

| | Error | | | |
|---|---|---|---|---|
| | 15 to 35 °C | | –40 to 70 °C | |
| Measured Value | Typical | Maximum | Typical | Maximum |
| –200 to 150 °C | 0.15 | 0.25 | 0.30 | 0.60 |
| 150 to 850 °C | 0.25 | 0.50 | 0.80 | 1.50 |

Resolution ..... 0.016 °C

Resistance accuracy

Offset error ..... 0.03 Ω typical, 0.1 Ω max

Gain error ..... 0.06% typical, 0.1% max

Resolution ..... 0.0061 Ω

Excitation current ..... 135 ms pulses of 2 mA every second

Input noise ..... ±1 bit peak-to-peak

Signal input bandwidth ..... 3 Hz

Update rate ..... Each channel is updated once a second



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## Physical Characteristics

Indicators ..... Green **POWER** and **READY** indicators

Weight

FP-RTD-124 ..... 140 g (4.8 oz)

cFP-RTD-124 ..... 110 g (3.7 oz)

## Power Requirements

Power from network module ..... 350 mW

## Isolation Voltage

Channel-to-channel isolation ..... No isolation between channels

Transient overvoltage..... 2,300 $V_{rms}$

## Environmental

FieldPoint modules are intended for indoor use only. For outdoor use, FieldPoint modules must be mounted inside a sealed enclosure.

Operating temperature ..... –40 to 70 °C

Storage temperature ..... –55 to 100 °C

Humidity ..... 10 to 90% RH, noncondensing

Maximum altitude..... 2,000 m

Pollution Degree ..... 2

## Shock and Vibration

Operating shock (IEC 68-2-27)

cFP-RTD-124..... 50 g, 3 ms half sine, 3 shocks; 30 g, 11 ms half sine, 3 shocks

Operating vibration, random (IEC 60068-2-34)

FP-RTD-124 ..... 10–500 Hz, 2.2 $g_{rms}$

cFP-RTD-124 ..... 10–500 Hz, 5 $g_{rms}$

Operating vibration, sinusoidal (IEC 60068-2-6)

[c]FP-RTD-124..... 10–500 Hz, 5 g



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## Safety

The [c]FP-RTD-124 is designed to meet the requirements of the following standards for safety and electrical equipment for measurement, control, and laboratory use.

- EN 61010-1, IEC 61010-1
- UL 3121-1
- CAN/CSA C22.2 No. 1010.1

For certifications under regulatory standards, including hazardous location standards, refer to the product label or to `ni.com`.

## Electromagnetic Compatibility

CE, C-Tick, and FCC Part 15 (Class A) Compliant

Electromagnetic emissions ..... EN 55011 Class A at 10 m
FCC Part 15A above 1 GHz

Electromagnetic immunity..... Evaluated to EN 61326:
1997/A1: 1998, Table 1

**Note** For full EMC compliance, you must operate this device with shielded cabling. Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, click **Declaration of Conformity** at `ni.com/hardref.nsf/`. Refer to the *Read Me First* document that accompanies the product for regulatory statements regarding FCC compliance.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

### Mechanical Dimensions

Figure 7 shows the mechanical dimensions of the FP-RTD-124 installed on a terminal base. Dimensions are given in millimeters [inches]. If you are using the cFP-RTD-124, refer to the Compact FieldPoint controller user manual for the dimensions and cabling clearance requirements of the Compact FieldPoint system.

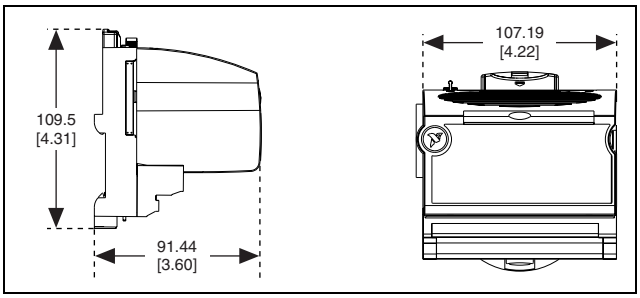



**Figure 7.** FP-RTD-124 Mechanical Dimensions

## Where to Go for Support

For more information about setting up your FieldPoint modular I/O system, refer to these National Instruments documents:

- FieldPoint network module user manual
- Other FieldPoint I/O module operating instructions
- FieldPoint terminal base operating instructions

If you no longer have the print versions of these documents, you can find them online at `ni.com`.

If you have searched the technical support resources on our Web site and still cannot find the answers you need, contact your local office or National Instruments corporate. For telephone support in the United States, dial 512 795 8248. For telephone support outside the United States, contact your local branch office:

Australia 03 9879 5166, Austria 0662 45 79 90 0,
Belgium 02 757 00 20, Brazil 55 11 3262 3599,
Canada (Calgary) 403 274 9391,
Canada (Montreal) 514 288 5722,
Canada (Ottawa) 613 233 5949, Canada (Québec) 514 694 8521,
Canada (Toronto) 905 785 0085, China 86 21 6555 7838,
Czech Republic 02 2423 5774, Denmark 45 76 26 00,



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Finland 09 725 725 11, France 01 48 14 24 24,
Germany 089 741 31 30, Greece 01 42 96 427,
Hong Kong 2645 3186, India 91 80 4190000,
Israel 03 6393737, Italy 02 413091, Japan 03 5472 2970,
Korea 02 3451 3400, Malaysia 603 9596711,
Mexico 001 800 010 0793, Netherlands 0348 433466,
New Zealand 09 914 0488, Norway 32 27 73 00,
Poland 22 3390 150, Portugal 210 311 210, Russia 095 238 7139,
Singapore 65 6 226 5886, Slovenia 3 425 4200,
South Africa 11 805 8197, Spain 91 640 0085,
Sweden 08 587 895 00, Switzerland 056 200 51 51,
Taiwan 02 2528 7227, United Kingdom 01635 523545



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

**Artisan Technology Group** is an independent supplier of quality pre-owned equipment

## Gold-standard solutions

Extend the life of your critical industrial, commercial, and military systems with our superior service and support.

## We buy equipment

Planning to upgrade your current equipment? Have surplus equipment taking up shelf space? We'll give it a new home.

## Learn more!

Visit us at **artisantg.com** for more info on price quotes, drivers, technical specifications, manuals, and documentation.

Artisan Scientific Corporation dba Artisan Technology Group is not an affiliate, representative, or authorized distributor for any manufacturer listed herein.

We're here to make your life easier. How can we help you today?

(217) 352-9330 | sales@artisantg.com | artisantg.com

ARTISAN® TECHNOLOGY GROUP