User's Guide
Models 18C, 14C and 12C
Cryogenic Temperature Monitor

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Certification

Cryogenic Control Systems, Inc. (Cryo-con) certifies that this product met its published specifications at the time of shipment. Cryo-con further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology (NIST).

Warranty

This product is warranted against defects in materials and workmanship for a period of one year from date of shipment. During this period Cryo-con will, at its option, either repair or replace products which prove to be defective.

For products returned to Cryo-con for warranty service, the Buyer shall prepay shipping charges and Cryo-con shall pay shipping charges to return the product to the Buyer.

However, the Buyer shall pay all shipping charges, duties, and taxes for products returned to Cryo-con from another country.

Warranty Service

For warranty service or repair, this product must be returned to a service facility designated by Cryo-con.

Limitation of Warranty

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by the Buyer, Buyer supplied products or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

The design and implementation of any circuit on this product is the sole responsibility of the Buyer. Cryo-con does not warrant the Buyer's circuitry or malfunctions of this product that result from the Buyer's circuitry.

In addition Cryo-con does not warrant any damage that occurs as a result of the Buyer's circuit or any defects that result from Buyer-supplied products.

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Safety

The monitor does not contain any user serviceable parts. Do not open the enclosure. Do not install substitute parts or perform any unauthorized modification to the product. For service or repair, return the product to Cryo-con or an authorized service center.

Table of Contents

Index of Tables

Index of Figures

Introduction

Input Options: The Model 18C has eight input channels, the 14C has four and the 12C has two. All inputs are identical and independent with each capable of supporting the same wide range of sensor types. Other than the input channel count, there are no differences in the C-series monitor line.

Easy to use: The monitor's front panel consists of a large, bright TFT-LCD display a 4-key keypad, an audio alarm and three status LEDs. Several display formats may be selected. Up to eight temperature readings may be displayed simultaneously or two channels with input names and temperature shown in a large easy to read font. Additional screens include temperature readings along with relay and alarm status information.

A single key press takes the screen to a menu tree where most features and functions of the instrument can be configured.

The status of built-in alarms and relays is indicated by LEDs located below the display.

Input Flexibility: Silicon Diode sensors are supported over their full temperature range by using 10uA constant-current DC excitation.

Positive Temperature Coefficient (PTC) resistor sensors including Platinum and Rhodium-Iron RTDs use constant-current, AC excitation.

Auto-ranged, constant-voltage AC excitation is used to provide robust support for cryogenic Negative Temperature Coefficient (NTC) sensors including Ruthenium-oxide, Carbon-Glass, Cernox™, Carbon-Ceramic, Germanium and several others.

Input Power : The monitors are shipped with a 12VDC@1A external power supply but may be powered by any source providing 7.5 to 48 Volts AC or DC.

The IEEE 802.3af Power-over-Ethernet (PoE) specification is also supported, allowing the monitor to be powered by it's local area network connection. Since PoE provides both instrument power and data over a single cable, remote data acquisition and high channel count systems can be simplified. PoE requires the use of a powered hub or power injector. Ethernet cables up to 300 meters may then be used.

Data logging: Data Logging is performed by continuously recording temperature and status to an internal circular memory buffer. Data is time stamped so that the actual time of an event can be determined. Non-volatile memory is used so that data will survive a power failure. The monitors will log up to 800 samples. Each sample includes readings for all input channels.

Alarms and Relays: Two 10.0A dry-contact relay outputs are available that can be asserted based on temperature setpoints from user selected input channels. These relays are large enough to switch most cryogenic valves.

The visual, remote and audible alarms are supported. Each may be programmed to assert or clear based on temperature setpoints.

Alarms may be latched. These are asserted on an alarm condition and will remain asserted until cleared by the user.

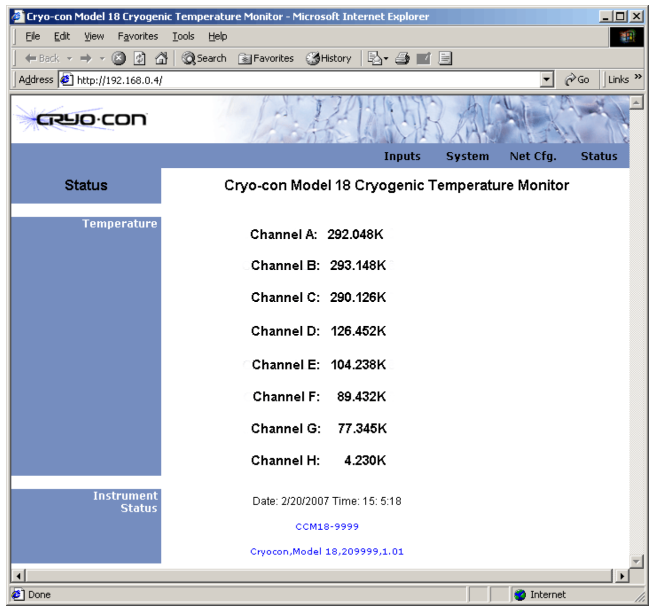
Remote Control: Standard Remote Interfaces include Ethernet and RS-232.

An **IEEE-488.2** GPIB interface is optional and may be field installed at any time. The option consists of an external module that is automatically configured by the monitor. A USB 2.0 serial port emulator option is also available.

The monitor connects directly to any **Ethernet Local-Area-Network** (LAN). TCP and UDP data port servers bring fast Ethernet connectivity to data acquisition software including LabView™.

The **TCP** and **UDP** data port servers bring fast Ethernet connectivity to data acquisition software including LabView™.

Using the **SMTP** protocol, the monitor will send e-mail based on selected alarm conditions.



Using the Ethernet **HTTP** protocol, the monitor's **embedded web server** allows the instrument to be viewed and configured from any web browser.

Remote interfaces implement an IEEE-488.2 SCPI compliant remote command language that is easy to learn and easy to read. This language is identical across all Cryo-con products to ensure that your investment in system software is always protected.

LabView™ drivers are available for all remote interfaces.

Firmware Updates: Full instrument firmware updates may be installed by using the Ethernet connection. Updates are free of charge and generally include enhancements and new features.

Ethernet API: An Applications Program Interface (API) package is supplied that facilitates communication with the instrument using the TCP/IP and UDP protocols. It is supplied as a Microsoft Windows™ DLL that is easily linked with C, C++ or Basic programs.

Preparing the Monitor for Use

Model Identification

The model number is identified on the front and rear panel of the instrument as well as in various instrument displays.

Part Number	Description
Model 18C	Eight-channel monitor. Includes 12VDC external power supply.
Model 14C	Four-channel monitor. Includes 12VDC external power supply.
Model 12C	Two-channel monitor. Includes 12VDC external power supply.
4001-003	Single Power-over-Ethernet Power injector.
4001-002	IEEE-488.2 (GPIB) Option. Field installable.
4001-001	USB 2.0 Option. Serial Port Emulation. Field installable.
04-0281	Relay connector. 4-pin detachable terminal block.

Table 1: Model Identification

Supplied Items

Verify that you have received the following items with your monitor. If anything is missing, contact Cryogenic Control Systems, Inc. directly.

- ❑ Cryogenic Temperature Monitor.
- ❑ User's Manual (PN 3118-029).
- ❑ Cryo-con software CD, Version 12 or above (PN 4134-029).
- ❑ Four, two or one dual-input connector/cable assemblies (PN 4034-038).
- ❑ External Power Supply. 12VDC @ 1.0A. Universal Voltage Input. (PN 05-0006).
- ❑ Certificate of Calibration.

Apply Power to the Monitor

The external power supply provided with the monitor accepts 100 – 240VAC @ 50 – 60Hz and outputs 12VDC @ 1.0A. This may be plugged directly into the monitor's power jack on the rear panel. Alternatively, any supply from 7.5 to 48V, AC or DC with a capacity of greater than 10VA may be used.

The monitor also Power-Over-Ethernet so that power and communications can both be provided by the Ethernet input. An IEEE-802.3AT Power-Over-Ethernet hub or injector is required. Simply plug the cable from this device into the Ethernet input of the monitor. In this case, the power jack should not used.

IMPORTANT: The monitor requires that an Earth Ground reference connection is made at the rear panel. Failure to provide this connection will result in erratic measurements and can even damage input circuits.

ⓘ **NOTE:** The monitor has a power key on the front panel. To turn power ON or OFF, press and hold the power (■) key for two seconds.

> ⓘ **Note:** The monitor uses a smart power on/off scheme. When the power button on the front panel is pressed to turn the unit off, the instrument's setup is copied to flash memory and restored on the next power up. If the front panel button is not used to toggle power to the instrument, the user should configure it and cycle power from the front panel button one time. This will ensure that the proper setup is restored when AC power is applied.

While the Power Up display is shown, the monitor is performing a self-test procedure that verifies the proper function of internal data and program memories, remote interfaces and input channels. If an error is detected during this process, the monitor will freeze operation with an error message display.

```
   Cryo-con Model 18C
SN:201234     Rev:1.11A
IP: 192.168.1.4
IP Adrs Mode: Static
Port:5000   Connected
   00:50:C2:6F:42:38
NVRAM: Valid
 Self Test Passed
```

Caution: Do not remove the instrument’s covers or attempt to repair it. There are no user serviceable parts, jumpers or switches inside the unit. Further, there are no software ROM chips,batteries or battery-backed memories. All firmware installation and instrument calibration functions are performed externally via the remote interfaces.

After about ten seconds, the self-test will complete and the monitor will begin normal operation.

Factory Default Setup

A monitor with factory default settings will have an operational display like the one shown here. The dash (**-**) or dot (**.**) characters indicate that there is no sensor connected.

Note that, in some cases, there will be an erratic temperature display when no sensor is connected. This is not an error condition. The high input impedance of the monitor’s input preamplifier causes erratic voltage values when unconnected.

```
A: 263.000 K --
B: 271.322 K Hi
C: 279.643 K --
D: 287.964 K --
E: 296.285 K --
F: 304.606 K Lo
G: 312.928 K --
H: 321.249 K Lo
```

Input Channel factory defaults are:
- Sensor Units: Kelvin.
- Sensor Type: Pt100 385 (DIN standard 100Ω Platinum RTD)
- Alarm Enables: Off
- To change these, press the **Enter (■)** key then refer to the Input Channel Setup Menu section.

Instrument setup factory defaults are:
- Display Filter Time Constant: 4.0 Seconds.
- Display Resolution: 3 digits.
- Data Logging: Off
- To change these, press the **Enter (■)** key and then select the System Setup Menu.

Network settings are:
- IP Address: 192.168.1.4.
- Subnet Address: 255.255.255.0

> ⓘ **NOTE**: Factory defaults may be restored at any time by use of the following sequence: 1) Turn power to the monitor OFF by pressing the **Enter(■)** key for about two seconds. 2) Press and hold the **Right (▶)** key while turning power back ON. The monitor will display the message "Set Factory Defaults?". Then, press the **DEC (▼)** key to restore defaults or the **INC (▲)** key to continue without resetting.

Technical Assistance

Trouble shooting guides and user's manuals are available on our web page at http://www.cryocon.com. Technical assistance may be also be obtained by contacting Cryo-con as follows:

Cryogenic Control Systems, Inc.
PO Box 7012
Rancho Santa Fe, CA 92067

e-mail: cctechsupport@cryocon.com

For updates to LabVIEW™ drivers, Cryo-con utility software and product documentation, go to our web site at http://www.cryocon.com and select the Download area.

Returning Equipment

If an instrument must be returned to Cryo-con for repair or recalibration, a Return Material Authorization (RMA) number must first be obtained from the factory. This may be done by Telephone, FAX or e-mail.

When requesting an RMA, please provide the following information:

1. Instrument model and serial number.
2. User contact information.
3. Return shipping address.
4. If the return is for service, please provide a description of the malfunction.

If possible, the original packing material should be retained for reshipment. If not available, consult factory for packing assistance.

Cryo-con's shipping address is:

Cryogenic Control Systems, Inc.
17279 La Brisa
Rancho Santa Fe, CA 92067

Options and Accessories

Instrument Accessories

Cryo-con Part #	Description
05-0006	AC Power Cord
4034-038	Dual Sensor Cable, 2 x 8 foot
4034-033	Shielded Sensor Connector Kit (DB9)
3012-020	Panel Mount hardware kit. See Appendix C
3012-021	Bench top instrument stand. See Appendix C
3012-022	Tilt-stand and carry handle. Appendix C
4001-003	Single Power-over-Ethernet Power injector.
4001-002	IEEE-488.2 (GPIB) Option. Field installable.
4001-001	USB 2.0 Option. Serial Port Emulation. Field installable.
3038-029	Additional User's Manual/CD

Table 2: monitor Instrument Accessories

Cryogenic Accessories

Cryo-con Part #	Description
S900	S900 series Silicon Diode Temperature Sensors. Temperature range: 1.4 to 375K.
CP-100	CP-100 series Ceramic Wound RTD, 100Ω
GP-100	GP-100 series Glass Wound RTD, 100Ω
XP-100	XP-100 series Thin Film Platinum RTD, 100Ω
XP-1K	XP-1K series Thin Film Platinum RTD, 1,000Ω

Table 3: Cryogenic Accessories

A Quick Start Guide to the User Interface.

Figure 1: Model 18C Front Panel

Home Status Displays

The instrument powers up with the home status display. This is a status-only display and the contents are user selectable.

The factory default display is shown here. It shows all eight channels plus alarm indicators. Here, the alarm indicators are hidden until an alarm is asserted. The monitor has nine different Home Status displays that can be viewed and selected by pressing the **Right (▶)** key.

```
A: 263.000 K --
B: 271.322 K Hi
C: 279.643 K --
D: 287.964 K --
E: 296.285 K --
F: 304.606 K Lo
G: 312.928 K --
H: 321.249 K Lo
```

Several displays show temperature information in a large, easy to read font. Also shown is the input channel name. This name is a convenience that allows easy association of the input channel with it's actual connection. Channel names may be entered by use of the embedded web site or via any of the remote interfaces.

```
A: Sample Holder
  123.456K

B: Rad. Shield
  234.567K
```

Navigating the Menu Tree

Setup and configuration functions are performed by working with the monitor's menu tree. To access this tree from the Home Status display, press the **Enter (■)** key.

Navigation through all menus is performed by pressing the **INC (▲)** or **DEC (▼)** keys. A cursor will scroll up or down to show additional lines. Moving up the tree is done by pressing the **Right (▶)** key. Note that the Home Status display is at the top of the tree.

The left most character on each line of a menu is the cursor. These cursors are used as follows:

■ Indicates a selectable line. Pressing the **Enter (■)** key will select the function described on the menu line.

+ Indicates that the line is an enumeration field. Pressing the **Enter (■)** key will cause the cursor to flash. Then, pressing the **INC(▲)** or **DEC (▼)** keys will sequence through the allowed choices for the line. To make a selection, press the **Enter (■)** key again. To abort the selection process without making any change, press either the **INC(▲)** or **DEC (▼)** key.

# Indicates that the selection is a numeric entry field. To change the value displayed, press the **Enter (■)** key and the cursor will flash. Then, press he **INC ▲** key to increment the number or the **DEC ▼** key to decrement the number. When the desired value is shown, press the **Enter (■)** key. Or, to abort entry without making any changes, press either the **INC(▲)** or **DEC (▼)** key.

> Note that it is much easier to enter numbers from the embedded web page or from a remote interface.

Key	Description
■ **Enter**	1) From Home screen, go to the top level setup menu. 2) Within a setup menu, Enter data or select a field (cursor display will indicate function). 3) Press and hold this key for two seconds to toggle AC power.
▲ **INC**	1) Scroll Display UP. 2) When in a field selection mode, abort entry and return to scroll mode. 3) In a numeric field, increment.
▼ **DEC**	1) Scroll Display DOWN. 2) When in a field selection mode, abort entry and return to scroll mode. 3) In a numeric field, decrement.
▶ **Right**	1) Move up the menu tree one level eventually returning to the Home Status display. 2) In selection mode, scroll to next selection.

Table 4: Function Key Descriptions.

Example Menu

Shown here is an example input channel setup menu with all of the cursor characters displayed.

```
+ChA:Sample Holder
   123.456 K
 A:20 Pt100 385
 A:BiasVoltage:N/A
 A:Bridge:Auto
 A: Hi Alarm:100.00
 A:Hi Alarm Ena:No
 A:Lo Alarm: 10.000
```

Pressing the **INC (▲)** or **DEC (▼)** keys will move the cursor. Additional lines will be displayed after the last line shown.

The first line is the channel indicator and channel name. pressing the **Enter (■)** key will cause the cursor to flash, then, each time an **INC (▲)** or **DEC (▼)** key is pressed, the next sequential input channel will be shown. Finally, pressing the **Enter (■)** key again will select the displayed channel menu.

The second line is an enumeration. It shows the temperature reading in real-time and allows the selection of temperature units. Pressing the **Enter (■)** key will cause the cursor to flash. Then, pressing the **Right (▶)** key will sequence through the allowed choices of K, C, F or S. To make a selection, press the **Enter (■)** key again.

The sixth line is a numeric entry. To change the value displayed, press the **Enter (■)** key and the cursor will flash. Then, press he **INC (▲)** key to increment the number or the **DEC (▼)** key to decrement the number. When the desired value is shown, press the **Enter (■)** key.

LED indicators

There are three LED indicators below the display. They indicate the following:

Alarm (Red) – An enabled alarm condition is asserted.

Relay 1 (Green) and Relay 2 (Green) - Relay asserted.

Input Channel Displays

Temperature Units may be K, C or F. When Sensor Units (S) is selected, the raw input readings are displayed. These will be in Volts or Ohms depending on the specific sensor.

K	Kelvin
C	Celsius
F	Fahrenheit
Ω	Ohms
V	Volts

Table 5: Temperature Units

If the sensor type is set to None, the Input Channel has been disabled and a blank line is shown.

A sensor fault condition is identified by a temperature display of seven dash (-) characters. This indicates an open, disconnected or shorted sensor.

If a temperature reading is within the measurement range of the instrument but is not within the specified Sensor Calibration Curve, a display of seven dot (.) characters is shown.

	Blank: The sensor type is set to None.
- - - - - - -	Sensor fault, The sensor is open, disconnected or shorted.
. . . .	Measurement is within the range of the instrument but is not within the sensor's calibration curve.

Table 6: Input Channel Error Displays

Power ON / OFF

Pressing the **Power (■)** key will toggle the instrument's AC power on and off. This key must be pressed and held for two seconds before power will toggle.

ⓘ **Note:** The monitor uses a smart power on/off scheme. When the power button on the front panel is pressed to turn the unit off, the instrument's setup is copied to flash memory and restored on the next power up.

Specifications, Features and Functions

Specification Summary

User Interface

Display Type: 21 x 8 character or 128x64 graphics TFT LCD.
Number of Inputs Displayed: Up to Eight.
Keypad: Sealed Silicon Rubber.
Temperature Display: Six significant digits, autoranged.
Display Update Rate: 0.5 Seconds.
Display Units: K, C, F or native sensor units.
Display Resolution: User selectable to seven significant digits.

Input Power

Input voltage is 7.5 to 48V, AC or DC, 10VA.

1. External transformer (Provided). Input 100 – 240VAC @ 50 – 60Hz.
2. IEEE-802.3at Power-Over-Ethernet (requires powered hub or injector).

Input Channels

Input channels are identical and each may be independently configured for any of the supported sensor types.

Sensor Connection: 4-wire differential. DB-9 receptacles connect two channels. Connections are described in the "Sensor Connections" section.

Isolation: Sensor circuits are not electrically isolated from other internal circuits. However, there is a 'single point' internal connection to Earth (or Shield) ground in order to minimize noise coupling.

Input Protection: ±30 Volts maximum.

Supported Sensor Types: Include:

Type	Excitation	Temperature Range
Cernox™	Constant-Voltage AC	1.0K to 420K
Ruthenium-Oxide	Constant-Voltage AC	1.0K to 420K
Germanium	Constant-Voltage AC	1.0K to 420K
Carbon Glass	Constant-Voltage AC	1.0K to 420K
Silicon Diode	10µA DC	1.4 to 500K
Rhodium-Iron	Constant-Current, 1mA AC	1.4 to 800K
Platinum RTD	Constant-Current, 1mA AC	14 to 1200K

Sensor Selection: Front Panel or remote interface. There are no internal jumpers or switches.

Sample Rate: 15Hz per channel in all measurement modes.

Digital Resolution: 24 bits.

Measurement Filter: 0.5, 1, 2, 4, 8, 16, 32 and 64 Seconds.

Calibration Curves: Built-in curves for industry standard sensors plus eight user curves with up to 200 entries each. Interpolation is performed using a Cubic Spline.

Sensor Performance: Ambient Temperature is 25°C ± 5°C for specified accuracy.

Diode Sensors

Configuration: Constant-Current, 10µA ± 0.05% DC excitation. Note: Current source error has negligible effect on measurement accuracy.
Input voltage range: 0 to 2.5VDC.
Accuracy: ±(80µV + 0.005% * reading)
Resolution: 2.3µV
Drift: <25ppm/°C

PTC Resistor Sensors

Configuration: Constant-Current AC resistance.
Drift: 25ppm/ºC
Excitation Frequency: 1.625Hz bipolar square wave.

Range	Max/Min Resistance	Excitation Current	Resolution	Accuracy
PTC100 1mA	400Ω 0.01Ω	1.0mA	0.1mΩ	± (0.004 + 0.01%)Ω
PTC1K 100µA	4.0KΩ 0.1Ω	100µA	1.0mΩ	± (0.05 + 0.02%)Ω

Table 6: Accuracy and Resolution for PTC Resistors

NTC Resistor Sensors, Constant-Voltage AC measurement

Type: Constant-Voltage AC resistance bridge an excitation of 10mV RMS.
Excitation Current: 1.25mA to 100nA, continuously variable.
Excitation Frequency: 1.67Hz bipolar square wave.
Accuracy (% reading + % range): Reading >4Ω and < 30KΩ : ±(0.05% + 0.05%).
Drift: >10Ω, 30ppm/ºC. <10Ω, 35ppm/ºC
Resistance Reading Range: 0 to 100KΩ

Data Logging

Data logging of input channel data is performed into an internal, 2GB byte circular buffer and is time-stamped with a real-time clock. Buffer memory is non-volatile and will retain valid data indefinitely without AC power. The monitor will log about 35 days of data where each entry contains eight temperature readings.

Status Outputs

Visual Alarms*: Independent visual alarms can be configured for each input. They are displayed on the front panel as text characters and an LED indicator.*

Status reported via Remote Interface*: Input channel alarms.*

Relay Outputs

Number: 2
Type: Dry-contact.
Contact ratings: 10A@125 VAC, 5A@250VAC or 5A@30VDC.
Function: Asserted or cleared based on temperature setpoint data.
Deadband: User defined.

Remote Interfaces

Ethernet: *Industry standard 10/100-BaseT. Electrically isolated*

RS-232: Serial port is an RS-232 null modem. Rates are 9600, 19,200, 38,400 and 57,200 Baud.

IEEE-488 (GPIB): External option. Full IEEE-488.2 compliant.

Language: Remote interface language is IEEE-488.2 SCPI compliant. Further, it is identical within the entire Cryo-con instrument line.

Compatibility: National Instruments LabView™ drivers available for all interfaces.

Ethernet API available for C++ and Basic.

Input Channel Characteristics

There are eight independent, multi-purpose input channels; each of which can separately be configured for use with any supported sensor.

The sensor type is selected by the user and this establishes the input configuration. Values of excitation current, voltage gain etc. will be determined by the microprocessor and used to automatically configure the channel. There are no jumpers or optional cards required to configure the various sensors.

Input Configurations

A complete list of the input configurations supported by the monitor is shown below:

Sensor Type	Max. Voltage/ Resistance	Bias Type	Excitation Current
Diode	1.75V	CI	10μA DC
ACR	8Ω to 1.0MΩ	CV	1.0mA to 0.1μA AC
PTC100	0.5 - 400Ω	CI	1.0mA DC
PTC1K	5 - 4.0KΩ	CI	100uA DC
NTC10UA	240KΩ	CI	10uA DC
None	0	None	0

Table 7: Input Configurations

Bias types are:

CI – Constant Current through the sensor.
CV – Constant Voltage-drop across the sensor.

ⓘ **Note:** A complete listing of factory installed sensors and their characteristics can be found in Appendix A.

Measurement Accuracy

Diode Sensors

The formulas for computing measurement accuracy while using diode sensors are:

$$MAV = 60 \cdot 10^{-6} + 5 \cdot 10^{-5} \cdot SenRdg$$

$$MAT = \frac{MAV}{SenSen}$$

Where:

MAV is the electronic Measurement Accuracy in Volts
MAT is the Measurement Accuracy in Kelvin
SenRdg is the sensor reading in Volts at the desired temperature.
SenSen is the sensor sensitivity in Volts / Kelvin at the desired temperature.

For example, if we want to calculate measurement accuracy using a Cryo-con S900 sensor at 10K, we would look up the sensor reading and sensitivity in the S900 data table in Appendix E. At 10K, we see that SenRdg is 1.36317 Volts and SenSen is 0.002604 Volts/Kelvin . Therefore,

$$MAV = 60 \cdot 10^{-6} + 5 \cdot 10^{-5} \cdot 1.36317$$

and

$$MAT = \frac{MAV}{0.002604}$$

The result is that MAV = 128μV and MAT = 49mK.

PTC and NTC Resistor Sensors

The formulas for PTC and NTC resistor sensors are stated above. As an example, here is a computation for a PTC resistor with the PTC100 input configuration:

Where:

$$MAR = 0.002 + 1.0 \cdot 10^{-4} \cdot SenVal$$

$$MAT = \frac{MAR}{SenRdg}$$

MAR is the electronic Measurement Accuracy in Ohms
MAT is the Measurement Accuracy in Kelvin
SenRdg is the sensor reading in Ohms at the desired temperature.
SenSen is the sensor sensitivity in Ohms / Kelvin at the desired temperature.

To calculate measurement accuracy using a 100Ω Platinum RTD in the PTC100 range with the sensor at 77.35K, we would look up the sensor reading and sensitivity in Appendix E. and see that SenRdg is 20.38Ω and SenSen is 0.423 Ω/Kelvin. Therefore, we compute MAR = 0.004038Ω and MAT = 9.5mK.

Input Channel Statistics

Input temperature statistics are continuously maintained on each input channel. This data may be viewed in real time on the Input Channel menu, or accessed via any of the remote I/O ports. Statistics include:

Minimum Temperature.
Maximum Temperature.
Temperature Variance.
Slope and Offset of the best-fit straight line to temperature history.
Accumulation Time

The temperature history may be cleared using a reset command provided.

Electrical Isolation and Input Protection

The input channel measurement circuitry is not isolated from other internal circuits. The common mode voltage between an input sensor connection and the instrument's ground should not exceed ±40V.

Sensor inputs and outputs are provided with protection circuits. The differential voltage between sensor inputs should not exceed ±15V.

Mechanical, Form Factors and Environmental

Enclosure is an Aluminum Extrusion with Aluminum front and rear panels.

The monitor is bench mountable. Panel mounting can be done by using an optional panel mount kit.

Dimensions are: 5.75"W x 2.875"H x 8.75"D. Weight is 3Lbs.

Environmental and Safety Concerns.

Safety

The monitor protects the operator and surrounding area from electric shock or burn, mechanical hazards, excessive temperature, and spread of fire from the instrument.

- Keep Away From Live Circuits: Operating personnel must not remove instrument covers. There are no internal user serviceable parts or adjustments. Refer instrument service to qualified maintenance personnel. Do not replace components with power cable connected. To avoid injuries, always disconnect power and discharge circuits before touching them.
- Cleaning: Do not submerge instrument. Clean exterior only with a damp cloth and mild detergent only.

Environmental Conditions

Environmental conditions outside of the conditions below may pose a hazard to the operator and surrounding area:

- Indoor use only.
- Altitude to 2000 meters.
- Temperature for safe operation: 5 °C to 40 °C.
- Maximum relative humidity: 80% for temperature up to 31 °C decreasing linearly to 50% at 40 °C.
- Power supply voltage fluctuations not to exceed ±10% of the nominal voltage.
- Over voltage category II.
- Pollution degree 2.
- Ventilation: The instrument has ventilation holes in its side covers. Do not block these holes when the instrument is operating.
- Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment is a definite safety hazard.

Basic Operating Procedures

Configuring an Input

Before connecting a new sensor to the monitor, the instrument must be configured to support it. Many temperature sensors are pre-installed in the monitor. In this case, configuration is as easy as selecting it. Otherwise, for custom or calibrated sensors, a configuration and calibration curve must be installed first. Installation can be done by using the supplied Utility Software. For information, refer to the section "Downloading a Sensor Calibration Curve".

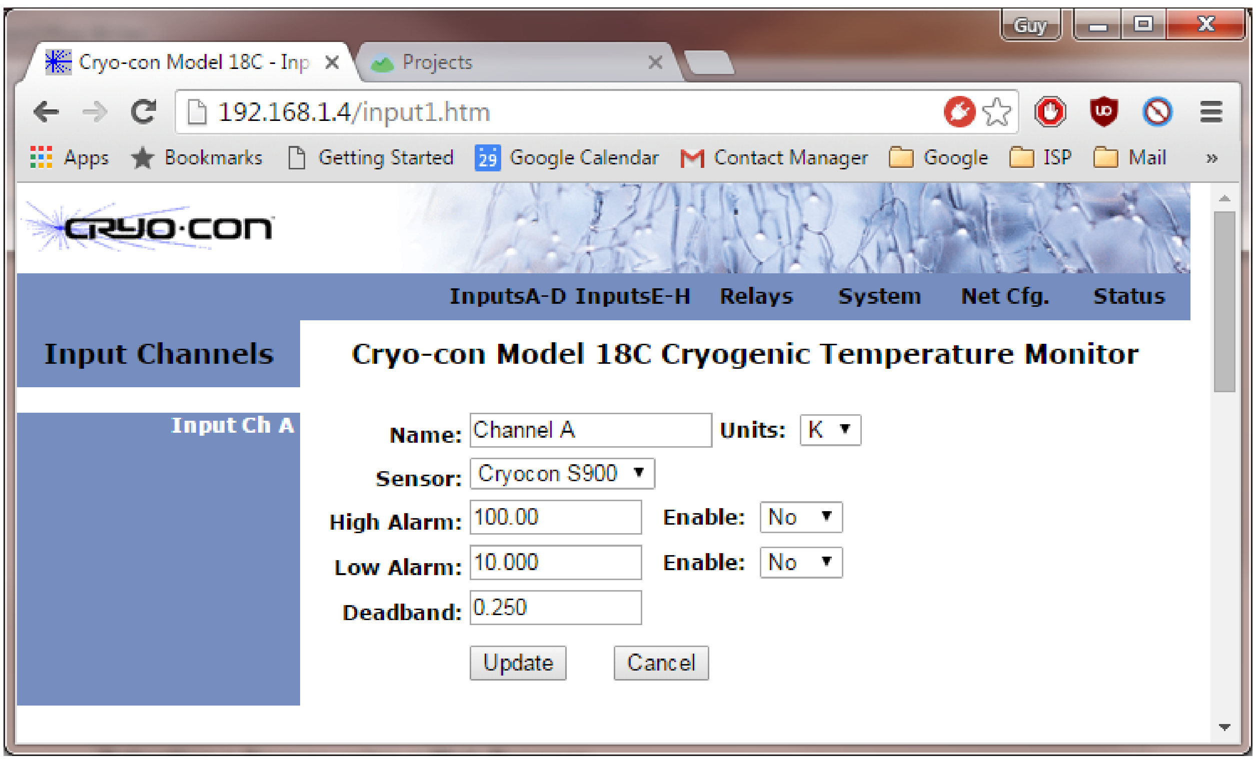
Note: A complete list of sensors installed at the factory is shown in Appendix A.

Selecting a Sensor using a Web Browser

Open the instrument's web page and navigate to the Inputs page. A sample is shown below.

Configure the sensor by filling out the form:

- The sensor name is a user convenience. Use a name that helps to associate the input channel with it's function.
- Select the displayed units of temperature from the drop-down box.
- Select the basic sensor from the drop down box.
- Optionally set an alarm.
- Click Update to transmit this configuration to the instrument.



Selecting a Sensor from the Front Panel.

To configure an input from the front panel, proceed as follows:

1. Navigate to the Input Channel Setup menu for the desired channel. The second line of this menu will show the current temperature in real-time. This field also lets you select the desired display units.
2. Use the **Up** ▲ or **Down** ▼ keys to go to the **Sen:** field then press **Enter** ■ to scroll through a list of available sensors. When the desired sensor is seen, press the **Enter** ■ again to make the selection.

From this point, you can continue to add an alarm or view the statistics of the selected input. The full input channel configuration menu is shown here for reference.

```
+ChA:Channel A
  77.123K
 A:Sen:Pt100 385
 A:Bridge: Auto
 A:High Alarm:200.000
 A:High Enable:    No
 A:Low Alarm: 200.000
 A:Low Alarm Ena:Yes
 A:Deadband:0.250
 A:Latched Enable:No
 A:Max:     123.00K
 A:Min:      23.00K
 A:Accum: 1.0000 Min
 A:S2: 0.0123
 A:M:-0.030K/Min
 A:b: 0.500K
 A:Reset Statistics
```

ⓘ **Note:** Select **None** to disable the input channel.

Downloading a Sensor Calibration Curve

The monitor accommodates up to eight user-defined sensor calibration curves that can be used for custom or calibrated sensors. Since these curves have up to 200 entries, they are usually maintained on a computer as a text file and downloaded to the controller by using the Cryo-con Utility Software.

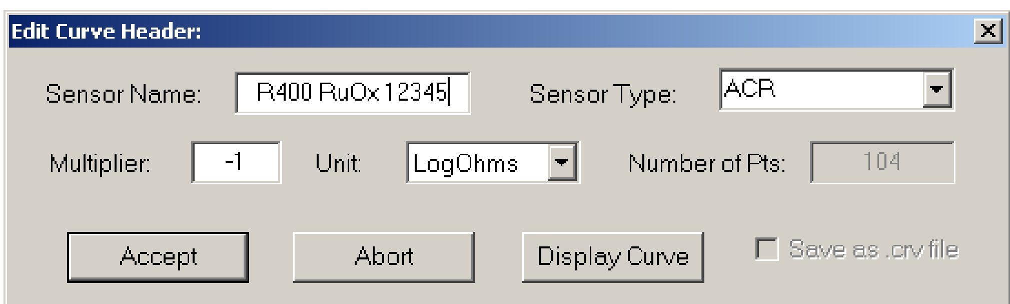
Cryo-con sensor calibration curves have a file extension of .crv. They may be opened and edited with any text editor. The format of the file is detailed in Appendix A.

The process for downloading a sensor calibration curve using the Cryo-con utility software is detailed in the section titled Downloading or Uploading a Sensor Calibration Curve. This section discusses how to set up a curve specifically for download to the monitor.

The Cryo-con utility software will read and attempt to parse the following file types:

Sensor Curve File Types	
Cryo-con .crv	Directly supported.
Lakeshore .340	Supported. Reads curve data. Header information must be entered by using the header dialog box.
SI .txt	Columns are reversed from other formats. Must be manually converted to a .crv file before use.
Other .txt	Must be converted to a .crv file before use.

In order to download a file, run the utility software and select 'Sensor Curve Download'. The user will be prompted to select a file. Once the software has read the file, the header information dialog box will appear.



The Sensor Name can be any string, up to 15 characters, that helps identify the sensor. The Sensor Type, Multiplier and Unit fields affect how the instrument is configured, so they must be correctly set or unexpected results will be obtained.

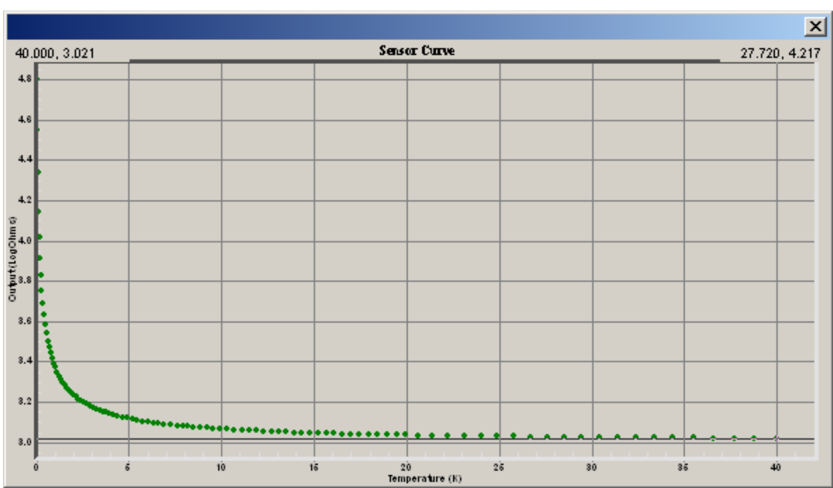
Sensor	Type	Multiplier	Units	Example
Cernox™	ACR	-1.0	LogOhms	CX1030E1.crv
Ruthenium-Oxide	ACR	-1.0	LogOhms	LSRX102.crv
Thermistors	ACR	-1.0	LogOhms	LSRX102.crv
Rhodium-Iron 27Ω	PTC100	1.0	Ohms	rhfe27.crv
Germanium	ACR	-1.0	LogOhms	LSRX102.crv
Carbon Glass	ACR	-1.0	LogOhms	LSRX102.crv
Silicon diode	Diode	-1.0	Volts	s900diode.crv
Carbon Ceramic	ACR	-1.0	LogOhms	LSRX102.crv
Platinum 100Ω	PTC100	1.0	Ohms	PT100385.crv
Platinum 1KΩ	PTC1K	1.0	Ohms	PT1K385.crv
GaAlAs diode	Diode	-1.0	Volts	s900diode.crv

Table 8: Recommended Sensor Configuration Data

Note that NTC resistor data is generally in units of LogOhms. However, it can also be in units of Ohms. Be sure to check the curve data for reasonableness.

> ⓘ **Note:** One simple way to generate a sensor calibration curve is to open a similar sensor file with a text editor and paste in your own data. The example files in the above table are for that purpose. They are located in the monitor sub-directory of the Cryo-con utility software package.

At this point, it is a good idea to view a graph of the curve data.



The above graph is for a Ruthenium-Oxide sensor with units of LogOhms. It shows the typical highly non-linear curve for that type sensor. If the curve data was in units of Ohms, it would be so extremely non-linear that significant errors might result.

Proceed with downloading the curve to the instrument.

Using Relays

The Model 18C monitors have two relays that can be used to control external processes. Able to switch up to 10 Amperes, they can even be used with large solenoid valves or motors.

Relays can be configured for several modes of operation. **Auto** is the basic way of setting the monitor to assert a relay based on a high or low temperature setpoint. **AutoC** mode is the logical inverse of **Auto** mode in that it asserts the relay when a temperature measurement is within a high and low limit rather than outside of it. The **On** and **Off** modes simply assert or clear a relay under remote control.

Relay Modes	
Auto	Relay is controlled by enabled high and low setpoints.
AutoC	Logical complement of Auto mode. Used for fail-safe configurations.
ManualOn	Relay is in manual mode and is asserted.
ManualOff	Relay is in manual mode and is clear.

Table 9: Relay Modes

Relay status indicators are used to show the status of a relay. These indicators are the same when viewed on the front panel, the embedded web page or from a remote command. Additionally, there are two LEDs on the front panel that illuminate whenever their relay is asserted.

Relay Status Indicators	
--- or **OFF**	Relay is not asserted
HI	Asserted by a high temperature condition.
LO	Asserted by a low temperature condition.
ON	Asserted.

Table 10: Relay Status Indicators

Relay Configuration

Relay configuration can be done from the front panel, the embedded web server or by using remote commands.

From the front panel, the Relay Setup Menu is used for configuration. This menu is accessed from the Home menu by pressing the **Enter** key and then selecting Relay 1 or 2. Here, the relay Source input may be selected as any of the input channels and the Mode field controls relay operation. The Deadband field sets the amount of hysteresis applied to the temperature measurement before a relay is toggled.

```
+Relay1 Setup Menu
 1:Source:ChA
 1:Src Temp:273.123
 1:Rly Status: --
 1:Mode: Auto
 1:Deadband: 0.25
 1:High: 200.00
 1:High Enable: No
 1:Low: 100.00
 1:Low Enable: No
```

As an example, if the deadband is set to 0.25K, a high temperature relay condition will not assert until the input channel's temperature exceeds the setpoint by 0.25K and will not clear until the temperature drops back to 0.25K below the setpoint.

Relay Auto Mode

Auto mode is used to implement simple high and low setpoint operation. Setting a relay to assert on a high temperature condition requires setting Auto mode, setting a high setpoint then enabling the high setpoint. Similarly for a low setpoint, the low setpoint must be enabled and set.

Example: To assert a relay when a temperature measurement exceeds 330K or drops below 250K, set the **Mode** field to Auto, the **High** field to 330, the **High Enable** to Yes, the **Low** field to 250 and the **Low Enable** to Yes.

Assuming a deadband of 0.25K, the relay will assert high at 330.25K and clear at 329.75K. It will also assert low at 249.75K and clear again at 250.25K.

Relay AutoC Mode

The AutoC is the logical complement of Auto mode. This will assert a relay when the input temperature is within a window.

The primary use of AutoC mode is to implement a fail-safe function. Here, the relay will only be asserted when an input temperature reading is both valid and within the high and low setpoints. Presumably, the process being monitored would only continue to function when the relay is asserted.

To set a fail-safe function, the user must a) Set the Mode to AutoC, b) Set both the high enable and low enable to Yes and c) Set a window by entering a high and low setpoint.

Example: To set a fail-safe function that asserts a relay when the input temperature is valid and within the range of 250K to 310K, do the following:

- Set the relay **Mode** to AutoC.
- Set both the **high** and **low enables** to Yes.
- Set the **High Setpoint** to 310K and the **Low Setpoint** to 250K.

Relay ON and OFF Modes

The On and Off modes manually assert or clear a relay. They are primarily used with remote control. For example, the remote command that turns relay #1 ON is:

```
RELAY 1:MODE ManualON
```

Data Logging

The monitor has an internal data logging capability that uses non-volatile memory. Logging of input channel temperature data is performed to a circular buffer that contains up to 1,000 samples. Each sample contains all eight temperature readings plus a time stamp from a real time clock.

The data logging buffer may be read by using the Cryo-con Utility software package. This will save the logging buffer as a text file (.CSV) that can be opened by spreadsheet and text editor programs.

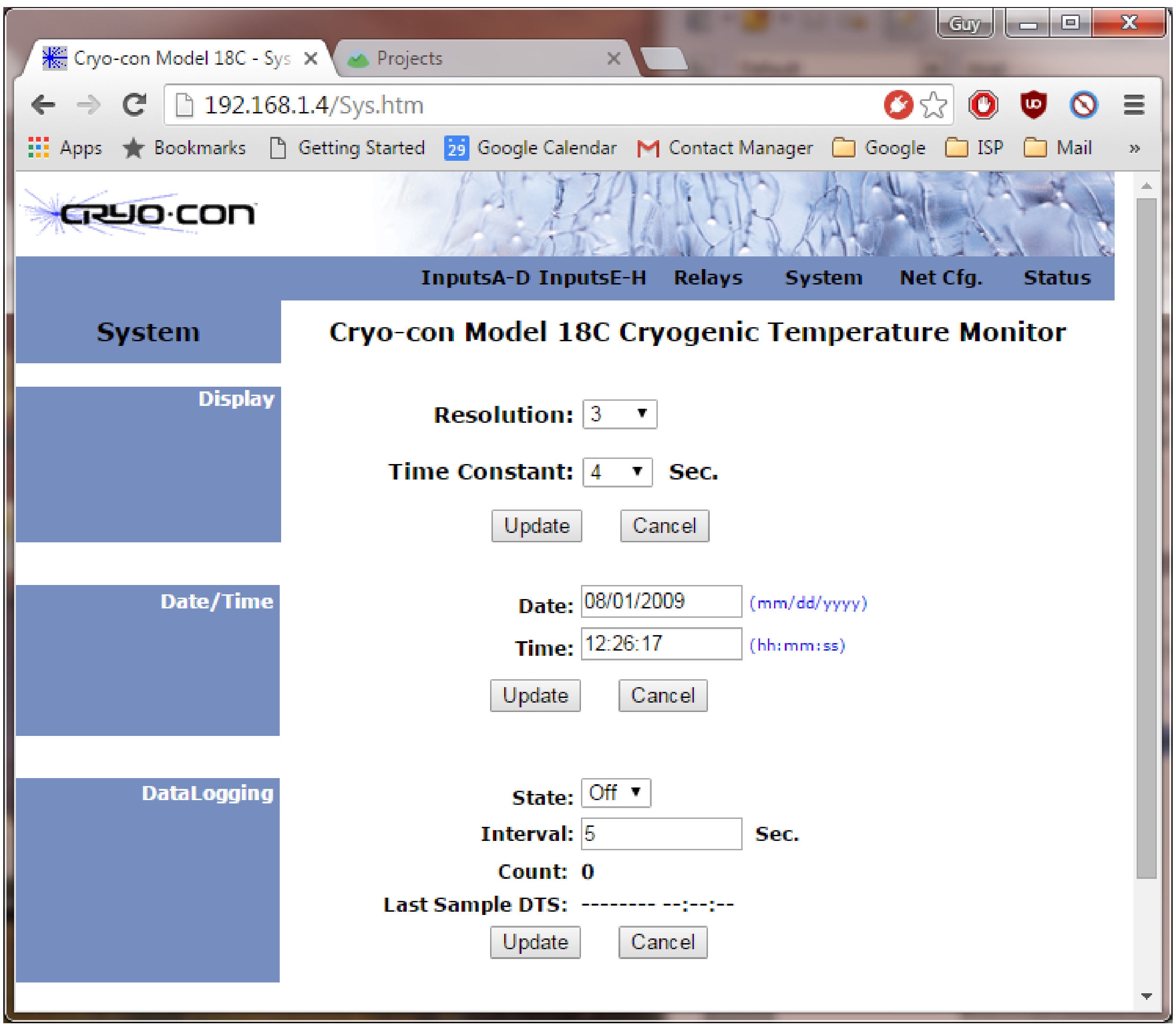
Data Logging Setup

The best way to setup data logging is by using the embedded web server. However, it can also be performed from the front panel.

Data logging can be configured and enabled from the embedded web server's System page. The Logging Enable field turns logging on and off and the Interval field sets the logging sample rate. The Current Count field shows how many samples have been accumulated.

From the front panel, data logging may be configured by going to the System Setup menu and scrolling down to the Data Log Enable and Interval fields.

Once enabled, data logging will continue until stopped. When the input buffer is full, new samples will over-write the oldest samples.



Reading the Data Log Buffer

Reading, or uploading, the monitor data logging buffer is best done using the Cryo-con Utility Software.

Launch the software and connect to the instrument. Next, click on the Data Logging menu field and then click on Upload. This will launch a series of dialog boxes that will take you through the data logging process.

> ⓘ **Note:** The Cryo-con Utility software can perform data logging by continuously reading samples from a connected instrument. This is a different function than uploading the internal log buffer from the instrument. The internal data logging function does not require a connection to a computer.

Using Temperature Alarms

The Model 18C monitors provide programmable temperature alarms on each input channel. High and low temperature alarms may be entered and enabled.

Alarm conditions are indicated on the front panel by the Alarm LED and various display fields. They are also reported via the remote interfaces.

When the audible alarm is enabled, a buzzer will sound whenever an alarm is asserted.

Latched alarms are also supported. These must be manually cleared as they remain asserted even after the condition that caused them has been cleared.

Alarm Status Indicators	
---	No alarm.
HI	Asserted by a high temperature condition.
LO	Asserted by a low temperature condition.
	A latched alarm is indicated by appending the letter L to the status indicator.

Table 11: Alarm Status Indicators

ⓘ **Note:** To clear a latched alarm, press any of the keys on the front panel.

Alarm Configuration

Alarm configuration can be done from the front panel, the embedded web server or by using remote commands. From the front panel, the Input Channel Setup Menu is used. This is accessed from the Home menu by pressing the **Enter** key and then selecting an input channel for the alarm.

```
+ChA:Channel A
  77.123K
 A:Sen:Pt100 385
 A:Bridge: Auto
 A:High Alarm:200.000
 A:High Enable:    No
 A:Low Alarm: 200.000
 A:Low Alarm Ena:Yes
 A:Deadband:0.250
 A:Latched Enable:No
 A:Audio Enable:  No
```

Basic configuration is done by entering a setpoint and then enabling the desired alarm. The Deadband field sets the amount of hysteresis applied to the temperature measurement before an alarm is toggled.

As an example, if the deadband is set to 0.25K, a high temperature alarm will not assert until the input channel's temperature exceeds the setpoint by 0.25K and will not clear until the temperature drops back to 0.25K below the setpoint.

From this menu, latched and audio alarms can also be set.

Setting an Ambient Temperature Alarm

The sensor type 'Internal' reads an internal temperature sensor located near the instrument's primary voltage reference. This measurement should read slightly above ambient temperature and is useful to track variations in ambient temperature for correlation with external events. It can also be used to set alarms for when the ambient temperature is outside the range where your measurements are at specified accuracy.

To configure an ambient temperature alarm, set the sensor type to Internal and then proceed as with any other alarm.

Shielding and Grounding Issues

Grounding

Power supplied to the instrument by an external supply or via Power-Over-Ethernet does not provide an earth ground reference. In order to minimize noise coupling into the instrument and customer's equipment, connection to an earth ground reference should be established by some other means. Common methods include:

1. Connecting the sensor cable shield to the instrument's chassis on one end and to the cryostat ground on the other.
2. Connection of a ground wire from the instrument's rear panel to a ground reference.

IMPORTANT: The monitor requires that an Earth Ground reference connection is made at the rear panel. Failure to provide this connection will result in erratic measurements and can even damage input circuits.

The sensor cables provided connect their shields to the monitor's chassis; Therefore, the required Earth Ground can be made by connecting the shield wire at the opposite end to a ground reference point. This is usually done by connecting it to the back-shell of the cryostat connector.

The Single-Point-Ground

The Model 18C supports a single-point grounding scheme to prevent ground loops and low frequency power-line noise pickup.

A single-point-ground scheme starts with the establishment of a good quality ground point somewhere in your system. All components of the system, including the cryostat and connected instruments, should have a direct low impedance connection to this point.

In many systems, the ground point can be the third-wire-ground connection of the AC power outlet. If your facility does not provide a good quality ground in it's AC power distribution scheme, it is strongly recommended that one be fabricated. Noise pickup and ground loop problems are usually traced to how this connection is made.

In order for the instrument’s grounding and shielding scheme is working effectively:

1. All sensors and heaters must be electrically floating with respect to ground.
2. The instrument side of all sensor cable shields must be connected to their connector’s metal back-shell. Heater cables should have their shields connected to the chassis ground lug.
3. At least one cable must have it's shield connected to the connector's back-shell on the cryostat end. This will complete a Faraday Cage RFI shield around the system.
4. A good quality earth-ground point must be established. All instruments and the cryostat should have a direct connection to this point.

ⓘ **Note:** There is some possibility that a ground-loop will be formed when a cable shield is connected at both the cryostat and instrument end. If this happens, it is recommended that the ground-loop first be fixed and then the connection be made. Ground-loops are usually fixed by properly implementing a single-point-ground scheme.

ⓘ **Note:** The Ethernet LAN interface is electrically isolated and cannot introduce ground loops.

Instrument Calibration

Calibration of the monitor requires the use of various voltage and resistance standards in order to generate calibration factors for the many measurement ranges available.

Calibration is ‘Closed-Case’. There are no internal mechanical adjustments required. The monitor cannot be calibrated from the front panel.

Calibration data is stored in the instrument’s non-volatile memory and is accessed only via the remote interfaces. Calibration of a measurement range is the simple process of generating an offset and gain value. However, since there are several input ranges available on each sensor input, the process can be time consuming.

Caution: Any calibration procedure will require the adjustment of internal data that can significantly affect the accuracy of the instrument. Failure to completely follow the instructions in this chapter may result in degraded instrument performance.
The Cryo-con utility software used in this procedure will first read all calibration data out of the instrument before any modifications. It is good practice to record these values for future reference and backup.

Cryo-con Calibration Services

When the instrument is due for calibration, contact Cryo-con for low-cost recalibration. The monitor is supported on our automated calibration systems which allow Cryo-con to provide this service at competitive prices.

Calibration Interval

The monitor should be calibrated on a regular interval determined by the measurement accuracy requirements of your application.

A 90-day interval is recommended for the most demanding applications, while a 1-year or 2-year interval may be adequate for less demanding applications. Cryo-con does not recommend extending calibration intervals beyond 2 years.

Whatever calibration interval you select, Cryo-con recommends that complete re-adjustment should always be performed at the calibration interval. This will increase your confidence that the instrument will remain within specification for the next calibration interval. This criterion for re-adjustment provides the best measure of the instrument’s long-term stability. Performance data measured using this method can easily be used to extend future calibration intervals.

Calibration Procedure

Please contact Cryo-con for a complete calibration procedure.

Remote Operation

Remote Interface Configuration

The monitor has two remote interfaces: The 10/100-BaseT Ethernet LAN and the RS-232. There are also two external options: IEEE-488.2 (GPIB) and USB. Connection to all of these interfaces is made on the rear panel of the instrument. For specifics about the connectors and cables required, refer to the section on Rear Panel Connections.

Supported Protocols

HTTP: The monitor's HTTP server is used to implement the instrument's embedded web server. Up to five connections are supported simultaneously and connections are automatically closed after five minutes of inactivity.

SMTP: The Simple Mail Transport Protocol is used to send E-mail from the monitor to a selected address. E-mail is used to report instrument status and is triggered by various user selected events. If sending e-mail over the Internet is desired, the local area network connected to the monitor will have to have an active mail server.

TIMEP: The Time Protocol allows a client to obtain the date and time from a host TIMEP server. If a time server is available on the Local Area Network, the monitor will periodically query it to update it's internal real-time clock.

TCP: The Transmission Control Protoco provides reliable, flow-controlled, end-to-end, communication between two connected devices. TCP operates even if packets are delayed, duplicated, lost, delivered out of order, or delivered with corrupted or truncated data.

UDP: The User Datagram Protocol implemented on the monitor is similar to TCP but is connectionless. Since a connection does not need to be negotiated or maintained, UDP has a much lower overhead than TCP.

In the monitor, a TCP port is available for communication using an ASCII command language. This is how the instrument interfaces some data acquisition software packages, including LabView™. Where the user is implementing custom software, UDP is recommended because of it's lower overhead.

Ethernet Configuration

Each device on an Ethernet Local Area Network must have a unique IP Address. Further, the address assigned to the monitor must be within the range of the computers you want it to communicate with. This range is determined by the Subnet Mask.

The monitor factory default settings are as follows:

> IP address: 192.168.1.4
> Subnet Mask: 255.255.255.0
> Gateway: 192.168.0.1
> TCP Data Socket: 5000, UDP Data Socket: 5001

UDP Configuration

UDP is a simple connection-less protocol that can be used to communicate with Cryo-con instruments. The user binds a UDP socket and communicates with the instrument in a fashion similar to RS-232 style communications.

TCP Data Socket Configuration

TCP is a connection orientated protocol that is more complex and has higher overhead than UDP. The user must bind a TCP socket and negotiate a connection before communicating with an instrument.

Web site configuration

The instrument's embedded web site may be opened in any web browser by typing **http://192.168.1.4** into the address bar, and the monitor's Home Page should appear.

IEEE-488 (GPIB) Option Configuration

The only configuration parameter for the optional GPIB interface is to set the address. This is done by using the System Functions Menu described above. Once the external GPIB interface is connected to the controller's LAN port, configuration is performed by the instrument.

Note that each device on the GPIB interface must have a unique address. Set the instrument's address to any value between 1 and 31. The factory default is 12.

The GPIB interface does not use a termination character, or EOS. Rather, it uses the EOI hardware handshake method to signal the end of a line. Therefore, the host must be configured to talk to the instrument using EOI and no EOS.

Primary Address:	1-31
Secondary Address:	None
Timeout	2S
Terminate Read on EOS	NO
Set EOI with EOS on Writes	YES
EOS byte	N/A

Table 12: GPIB Host Setup Parameters

RS-232 Configuration

The user can select RS-232 Baud Rates between 300 and 38,400. The factory default is 9600.

The Baud Rate is changeable from the instrument's front panel by using the System Functions Menu.

Other RS-232 communications parameters are fixed in the instrument. They are set as follows:

Parity: None, Bits: 8, Stop Bits: 1, Mode: Half Duplex

The RS-232 interface uses a "New Line", or Line Feed character as a line termination. In the C programming language, this character is \n or hexadecimal 0xA. All strings sent to the instrument must be terminated by this character.

The controller will always return the \r\n character sequence at the end of each line.

SCPI Programming Guide

General Overview

This brief is intended to assist the user interested in SCPI programming of any Cryo-con instrument. The SCPI interface language is common to all Cryo-con products.

Since the language supports both simple and advanced functions, it may initially seem complex. However, the use of English language keywords and a tree-structured architecture make it easy to read and learn.

Language Architecture

The programming language used by all Cryo-con instruments is described as follows:

- The industry standard SCPI language defined by the IEEE-488.2 standard is used. Therefore, anyone with experience in test and measurement will find it familiar.
- All Cryo-con instruments use the same language and future instruments will continue in the same fashion. Therefore, your investment in system software will not be lost when a product is revised or obsoleted.
- Keywords used in commands are common English words, not cryptic acronyms. This makes command lines easy to read and understand, even for someone that is not familiar with the instrument.
- The SCPI is a 'tree structured' language where commands are divided into groups and associated commands into sub-groups. This architecture simplifies composing commands and improves readability.

Purpose

If your intent is to remotely program a Cryo-con instrument with fairly simple sequences, you can skip to the section titled "Commonly Used Commands". This is a simple cheat-sheet format list of the commands that are most frequently used.

If you are an advanced user with a familiarity of the SCPI programming language, the section titled "SCPI Command Descriptions" is a complete reference to all commands.

If you are not familiar with the SCPI language but need to perform advanced programming tasks, the SCPI is introduced in the next section.

For all users, the section titled "Debugging Tips" is often helpful and the "SCPI Command Tree" is a single page listing that shows the syntax of each command.

An Introduction to the SCPI Language

SCPI is an acronym for **S**tandard **C**ommands for **P**rogrammable **I**nstruments. Commonly called 'skippy', it is an ASCII-based instrument command language defined by the IEEE-488.2 specification and is commonly used by test and measurement instruments.

SCPI commands are based on a hierarchical structure, also known as a tree system. In this system, associated commands are grouped together under a common node or root, thus forming subsystems. A portion the command tree for a Cryo-con instrument is shown here:

```
INPut                    SYSTem
    TEMPerature              BEEP
    UNITs                    ADRS
    VARIance                 LOCKout
    SLOPe
    ALARm
    NAMe

LOOP                     CONFig
    SETPT                    SAVE
    RANGe                    RESTore
    RATe
```

In the above, INPut and LOOP are root keywords whereas UNITs and RATe are second-level keywords. A *colon* (:) separates a command keyword from lower-level keyword.

Command Format

The format used to show commands is shown here:

```
INPut {A |B |C |D}:ALARm:HIGH <value>;
     NAMe "name";
```

The command language is case-insensitive, but commands are shown here as a mixture of upper and lower case letters. The upper-case letters indicate the abbreviated spelling for the command. For shorter program lines, send the abbreviated form. For better program readability, send the long form.

For example, in the above statement, INP and INPUT are all acceptable.

Braces ({ }) enclose the parameter choices for a given command string. The braces are not sent as part of the command string.

A *vertical bar* (|) separates multiple parameter choices for a given command string.

Triangle brackets (< >) indicate that you must specify a numeric value for the enclosed parameter.

Double-quote (") marks must enclose string parameters.

Commands are terminated using a semicolon (;) character. The semicolon at the end of the line is assumed and is optional.

The {}, |, <> and " characters are for the illustration of the command syntax and not part of the command syntax.

Command Separators

A *colon* (:) is used to separate a command keyword from a lower-level keyword. You must insert a *blank space* to separate a parameter from a command keyword.

Compound Commands

A semicolon (;) is used as a separator character that separates commands within the same subsystem. For example, sending the following command string:

```
INPut A:UNITs K;TEMPer?;
```

has the same effect as sending the following two commands:

```
INPut A:UNITs K;
INPut A:TEMPer?;
```

If multiple commands address different subsystems, the combination of a semicolon (;) and a colon (:) are used. The semi-colon terminates the previous command and the colon indicates that the next command is in a different subsystem. For example:

```
INPut A:TEMPer?;:LOOP 1:SETPt 123.45;
```

has the effect of sending the following two commands:

```
INPut A:TEMPer?;
LOOP 1:SETPt 123.45;
```

Queries
You can query the current value of most parameters by adding a question mark (?) to the command. For example, the following command set the setpoint on control loop 1 to 123.45:

```
LOOP 1:SETPt 123.45;
```

You can change it into a query that reads the setpoint by using the following:

```
LOOP 1:SETPt?;
```

The instrument's response will be a numeric string such as: 123.45.

Compound queries are commonly used to save programming steps. For example, the query:

```
LOOP 1:SETPt?;PGAin?;IGAin?;DGAin?;
```

reports the loop 1 setpoint, P-gain, I-gain and D-gain. An example response is:

```
123.45;20.0;60;12.5;
```

Note that the response is also separated by semicolons.

The representation of the decimal symbol for floating point numbers must be a period, '.', instead of comma, ',' as is customary used in some European countries.

Command Terminators
Commands must be terminated by an ASCII line-feed(\n) character.

SCPI Common Commands
The IEEE-488.2 SCPI standard defines a set of common commands that perform basic functions like reset, self-test and status reporting. Note that they are called common commands because they must be common to all SCPI compliant instruments, not because they are commonly used.

Common commands always begin with an asterisk (*), are four to five characters in length and may include one or more parameters. Examples are:

```
*IDN?
*CLS
*OPC?
```

SCPI Parameter Types
The SCPI language defines several different data formats to be used in program messages and response messages.

Numeric Parameters: Commands that require numeric parameters will accept all commonly used decimal representations of numbers including optional signs, decimal points and scientific notation.

Enumeration Parameters: These are used to set values that have a limited number of choices. Query responses will always return an enumeration parameter in upper-case letters. Some examples of commands with enumeration parameters are:

```
INPut {A | B | C | D}:UNITs {K | C | F | S}
LOOP {1 | 2}:TYPe  {OFF | MAN | PID | TABLE | RAMPP}
```

String Parameters: String parameters can be up to 15 characters in length and can contain any ASCII characters excluding the double-quote ("). String parameters must be enclosed in double-quotes ("). For example:

```
CONFig 4:NAMe "Cold Plate"
```

Commonly Used Commands.

A complete summary of SCPI commands is given in the User's Manual chapter titled "SCPI Command Summary". The manual also has complete descriptions of all SCPI commands. This section is intended to show a few of the more commonly used commands.

ⓘ **NOTE:** SCPI commands are not case sensitive.

Function	Command	Comment
Instrument Identification		
Read the instrument identification string	***idn?**	Returns the instrument identification string in IEEE-488.2 format. For example:"Cryocon,Model 18C,204683,2.41" identifies the manufacturer followed by the model name, serial number and firmware revision code.
Input Channel Commands Parameter for the input is A, B, C or D corresponding to inputs A, B, C or D.		
Read the temperature on input channel B	**input? b**	Temperature is returned in the current display units. Format is a numeric string. For example: 123.4567
Set the temperature units on input channel A to Kelvin.	**input a:units k**	Choices are K- Kelvin, C- Celsius, F- Fahrenheit and S- native sensor units (Volts or Ohms).
Read the temperature units on channel B	**input b:units?**	Return is: K, C, F or S.

Table 13: Commonly Used SCPI Commands

Debugging Tips

1. To view the last command that the instrument received and the last response it generated, press the System key and then select the Network Configuration Menu. The last two lines of this menu show > and < characters. These two lines show the last command received by the instrument and the last response generated.
2. Some commands require the instrument to write to non-volatile flash type memory, which can be time consuming. In order to avoid overrunning the instrument use compound commands that return a value, thus indicating that command processing is complete. For example:
   INPUT A:UNITS K;UNITS?
   will respond with the input units only after the command has completed. Another example:
   LOOP 1:SETPOINT 1234.5;:*OPC?
   Here, the operation complete command :*OPC? will return a '1' when command processing is complete.
3. It is often easiest to test commands by using the Cryo-con utility software. Run the program, connect to the instrument and use the Interact mode to send commands and view the response. Alternatively, any communications program like Windows Hyperterminal can be used to interact with the instrument via the LAN or serial ports.
4. Keywords in all SCPI commands may be shortened. The short form of a keyword is the first four characters of the word, except if the fourth is a vowel. If so, the truncated form is the first three characters of the word. Some examples are: inp for input, syst for system alar for alarm etc.

SCPI Command Tree

SYSTEM commands

SYSTem:ADRes <address>
SYSTem:AMBient?
SYSTem:BAUD {9600 | 19200 | 38400 | 57200}
SYSTem:BEEP <seconds>
SYSTem:DATe "mm/dd/yyyy"
SYSTem:DISTc {0.5 | 1 | 2 | 4 | 8 | 16 | 32 | 64}
SYSTem:DRES {FULL | 1 | 2 | 3}
SYSTem:FWREV?
SYSTem:HOMe
SYSTem:HWRev?
SYSTem:RESeed
SYSTem:NAME "name"
SYSTem:NVSave
SYSTem:RESeed
SYSTem:TIMe "hh:mm:ss"

Input Commands

INPut? {A | ... | H}   or   INPut {A | ... | H}:TEMPerature?
INPut {A | ... | H}:UNITs {K | C | F | S}
INPut {A | ... | H}:NAMe “Input Channel Name”
INPut {A | ... | H}:SENPr?
INPut {A | ... | H}::BRANge {Auto | 1.0mA | 100uA | 10uA}
INPut {A | ... | H}::SENSor <ix>
INPut {A | ... | H}:ALARm?
INPut { A | ... | H }:ALARm:HIGHest <setpt>
INPut { A | ... | H }:ALARm:LOWest <setpt>
INPut { A | ... | H }:ALARm:HIENa { YES | NO }
INPut { A | ... | H }:ALARm:LOENa { YES | NO }
INPut { A | ... | H }:ALARm:Clear
INPut { A | ... | H }:ALARm:LTEna { YES | NO }
INPut { A | ... | H }:ALARm:AUDio { YES | NO }
INPut { A | ... | H }:MINimum?
INPut { A | ... | H }:MAXimum?
INPut { A | ... | H }:VARiance?
INPut { A | ... | H }:SLOpe?
INPut { A | ... | H }:OFFSet?
INPut { A | ... | H }:TIMe?
INPut { A | ... | H }:RESet
INPut { A | ... | H }:TCOFfset
INPut { A | ... | H }:TCGAin

Sensor Calibration Curve Commands

CALcur
SENSor <index>:NAMe name string"
SENSor <index>:NENTry?
SENSor <index>:UNITs {VOLTS | OHMS | LOGOHM}
SENSor <index>:
    TYPe { DIODE | ACR | PTC100 | PTC1K | NTC10UA }
SENSor <index>:MULTiply <multiplier>

Data Logging Commands

DLOG:RUN {OFF | ON}
DLOG:TIMe <Seconds>
DLOG:COUNt?
DLOG:READ?
DLOG:RESET
DLOG:CLEAR

Relay Commands

RELay? {1 | 2}
RELay {1 | 2} :SOURce {A | B | C | D}
RELay {1 | 2} :MODe {auto | autocomp | control | on | off}
RELay {1 | 2} :HIGHest <setpt>
RELay {1 | 2} :LOWEST <setpt>
RELay {1 | 2} :DEADband <deadband>
RELay {1 | 2} :HIENa { YES | NO }
RELay {1 | 2} :LOENa { YES | NO }
RELay {1 | 2} :TEMP?

Network Commands

NETWork:IPADdress
NETWork:MACaddress
NETWork:NAME "name"
NETWork:DHCP {ON | OFF}

Mail Commands

MAIL {A | ... | H} :ADDR “IPA”
MAIL {A | ... | H}:FROM ”from e-mail address”
MAIL {A | ... | H}:DEST “to e-mail address”
MAIL {A | ... | H}:PORT <port number>
MAIL {A | ... | H}:STATE {ON | OFF}

IEEE Common Commands

*CLS
*ESE
*ESR
*OPC
*IDN?
*RST
*SRE
*STB

SCPI Command Descriptions

IEEE Common Commands

*OPC

The *OPC command will cause the instrument to set the operation complete bit in the Standard Event (SEV) status register when all pending device operations have finished.
The *OPC Query places an ASCII ‘1’ in the output queue when all pending device operations have completed.

*IDN?

The *IDN? Query will cause the instrument to identify itself. The Model 18C will return the following string:

Cryocon, Model 18C,<serial number>,<firmware revision>

Where: <serial number> is the unit's serial number and <firmware revision> is the revision level of the unit's firmware

System Commands.

System commands are a group of commands associated with the overall status and configuration of the instrument rather than a specific internal subsystem.

SYSTem:ADRes <address>

Sets and queries the address that the IEEE-488.2 (GPIB) remote interface will use. The address is a numeric value between 1 and 31 with a factory default of 12. The addresses assigned to instruments must be unique on each GPIB bus structure. This command has no effect on other interfaces.

SYSTem:AMBient?

Queries the internal reference junction temperature. Value reported as a decimal number in units of Celius.

SYSTem:BAUD {9600 | 19200 | 38400 | 57200}

Sets or queries the RS 232 Baud rate.

SYSTem:BEEP <seconds>

Asserts the audible alarm for a specified number of seconds. Command only, no query.

SYSTem:DATe "mm/dd/yyyy"

Sets or queries the instrument's date. Date is in string format and is surrounded by double-quotes. Format is mm/dd/yyyy for month / day / year.

SYSTem:DISTc {0.5 | 1 | 2 | 4 | 8 | 16 | 32 | 64}

Set or query the display filter time constant. The display filter is time-constant filter that is applied to all reported or displayed temperature data. Available time constants are 0.5, 1, 2, 4, 8, 16, 32 or 64 Seconds.

SYSTem:DRES {FULL | 1 | 2 | 3}

Sets or queries the instrument's display resolution. Choices are:

- FULL: Display temperature with the maximum possible resolution.
- 1, 2 or 3: Display will display the specified number of digits to the right of the decimal point.

NOTE: This command only sets the number of digits displayed on the front panel display. It does NOT affect the internal accuracy of the instrument or the format of measurements reported on the remote interfaces.

The main use for this command is to eliminate the flicker in low order digits when the instrument is used in a noisy environment.

SYSTem:FWREV?

Queries the instrument’s firmware revision level.

SYSTem:HOMe
Causes the front panel display to go to the Operate Screen.

SYSTem:HWRev?
Queries the instrument's hardware revision level.

SYSTEM:NAME "name"
The controller contains a unit name string that may be set or queried using this command. This can be used to assign a descriptive name to the instrument.

SYSTem:NVSave
Save NV RAM to Flash. This saves the entire instrument configuration to flash memory so that it will be restored on the next power-up.

SYSTem:RESeed
Re-seeds the input channel's averaging filter, allowing the reading to settle significantly faster.

> ⓘ **Note:** The RESEED command is useful in systems where a computer is waiting for a reading to settle. Issuing the RESEED command will reduce the required settling time of the reading.

SYSTem:TIMe "hh:mm:ss"
Sets or queries the instrument's time. Time is in string format and is surrounded by double-quotes. Format is hh:mm:ss for hour:mm:ss. Twenty-four hour format is used.

Input Commands

The INPUT group of commands are associated with the configuration and status of the four input channels.

Parameter references to the input channels may be:

- Numeric ranging in value from zero to seven.
- Channel ID tags including CHA or CHB.
- Alphabetic including A or B.

INPut? {A|…|H} or
INPut {A|…|H}:TEMPerature?
The INPUT query reports the current temperature reading on any of the input channels. Temperature is filtered by the display time constant filter and reported in display units. Query only.

INPut {A|…|H}:UNITs {K | C | F | S}
Sets or queries the display units of temperature used by the specified input channel. Units may be K for Kelvin, C for Celsius, F for Fahrenheit or S for primitive sensor units. In the case of sensor units, the instrument will determine if the actual units are Volts or Ohms based on the actual sensor type.

INPut {A|…| H}:NAMe "Name String"
Sets or queries the name string for the selected input channel. The name string can be up to 15 ASCII characters. The string is used to name the input channel in order to clarify it's use.

INPut {A|…| H}:BRANge {Auto | 1.0mA | 100uA | 10uA}
Sets or queries the resistance bridge excitation range. This is a range-hold function. Normally, this is set to auto so that the instrument will autorange excitation. For special applications, the resistance bridge may be set to a specific excitation range.

INPut {A|…| H}:SENPr?
The INPUT:SENPR query reports the reading on a selected input channel. For diode sensors, the reading is in Volts while resistor sensors are reported in Ohms. The reading is not filtered by the display time-constant filter. However, the synchronous input filter has been applied. Query only.

INPut {A|…| H}:SENSor <ix>
Sets or queries the sensor index number. <ix>, is taken from Appendix A.

INPut {A|…|H}:ALARm?

Queries the alarm status of the specified input channel. Status is a two character string where:

--	indicates that no alarms are asserted
SF	indicates a Sensor Fault condition.
HI	indicates a high temperature alarm
LO	indicates a low temperature alarm.

There is a 0.25K hysteresis in the assertion of a high or low temperature alarm condition.

The user selectable display time constant filter is applied to input channel temperature data before alarm conditions are tested.

INPut {A|…|H}:ALARm:HIGHest <setpt>

Sets or queries the temperature setting of the high temperature alarm for the specified input channel. When this temperature is exceeded, an enabled high temperature alarm condition will be asserted.

INPut {A|…|H}:ALARm:LOWEst <setpt>

Sets or queries the temperature setting of the low temperature alarm for the specified input channel. When the input channel temperature is below this, an enabled low temperature alarm condition will be asserted.

<setpt> is the alarm setpoint temperature.

INPut {A|…|H}:ALARm:HIENa {YES | NO}

Sets or queries the high temperature alarm enable for the specified input channel. An alarm must be enabled before it can be asserted.

INPut {A|…|H}:ALARm:LOENa {YES | NO }

Sets or queries the low temperature alarm enable for the specified input channel. An alarm must be enabled before it can be asserted.

INPut {A|…|H}:ALARm:LTENa {YES | NO }

Sets or queries the latched alarm enable mode. When an alarm is latched, it can be cleared by using the CLEar command.

INPut {A|…|H}:ALARm:CLEar

Clears any latched alarm on the selected input channel.

INPut {A|…|H}:ALARm:AUDio {YES | NO }

Sets or queries the audio alarm enable. When enabled, an audio alarm will sound whenever an alarm condition is asserted.

INPut {A|…|H}:MINimum?

Queries the minimum temperature that has occurred on an input channel since the statitics were reset.

INPut {A|…|H}:MAXimum?

Queries the maximum temperature that has occurred on an input channel since the statitics were reset.

INPut {A|…|H}:VARiance?

Queries the temperature variance that has occurred on an input channel since the statitics were reset. Variance is calculated as the Standard Deviation squared.

INPut {A|…|H}:SLOpe?

Queries the input channel statistics. SLOPE is the slope of the best fit straight line passing through all temperature samples that have been collected since the statitics were reset. SLOPE is in units of the input channel display per Minute.

INPut {A|…|H}:OFFSet?

Queries the input channel statistics. OFFSET is the offset of the best fit straight line passing through all temperature samples that have been collected since the statitics were reset. OFFSET is in units of the input channel display.

INPut {A|…|H}:TIMe?

Queries the time duration over which input channel statistics have been accumulated. Query only.

INPut {A|…|H}:RESet

Resets the accumulation of input channel statistical data. Command only affects the selected input channel.

INPut {A|…|H}:TCOFfset <offset>

Sets or queries the offset value for thermocouple inputs. <offset> is the decimal value of offset and is in units of Kelvin. Refer to the section on Using Thermocouple Sensors for more information.

INPut {A|…|H}:TCGAin <gain>

Sets or queries the gain value for thermocouple inputs. <gain> is the decimal value of the gain applied to thermocouple readings and is in units of volts per volts. Refer to the section on Using Thermocouple Sensors for more information.

Relay Commands

RELay? {1 | 2}

Relay Status Query. The two auxiliary relays available in the monitor are addressed as 0 and 1. The RELAYS command can be used to query the status of each relay where:

--	Relay is in Auto mode and is clear.
Hi	Relay is asserted by a high temperature condition.
Lo	Relay is asserted by a low temperature condition.
ON	Relay is in manual mode and is asserted.
OFF	Relay is in manual mode and is clear.

RELay {1|2} :SOURce {A|…|H}

Relay Input Source. Sets or queries the source input channel for a specified relay.

RELay {1|2} :HIGHest <setpt>

Relay High setpoint. Sets or queries the temperature setting of the high temperature setpoint for the specified relay. Parameter <setpt> is floating-point numeric and is in units of the controlling input channel.

RELay {1|2} :MODe {AUTO | AUTOC | MANUALON | MANUALOFF}

Set or query the relay mode. Modes are:

Auto	Relay is controlled by enabled high and low setpoints.
AutoC	Operation is inverse of Auto mode. Used for fail-safe operation.
ON	Relay is in manual mode and is asserted.
OFF	Relay is in manual mode and is clear.

RELay {1|2} :LOWest <setpt>

Relay Low setpoint. Sets or queries the temperature setting of the low temperature setpoint for a specified relay. Parameter <setpt> is floating-point numeric and is in units of the controlling input channel.

RELay {1|2} :HIENa {YES | NO }

Relay High Enable. Sets or queries the high temperature enable for the specified relay.

RELay {1|2} :LOENa {YES | NO }

Relay Low Enable. Sets or queries the low temperature enable for the specified relay.

RELay {1|2} :DEAdband <dead-band>

Sets or queries the dead-band parameter. This controls the amount of hysteresis that is applied before a relay is asserted or cleared. Parameter <dead-band> is floating-point numeric and is in units of the controlling input channel.

Sensor Calibration Curve Commands

The CALCUR commands are used to transfer sensor calibration curves between the instrument and the host controller.

Curves are referenced by an index number. In the monitor, there are eight user curves numbered 1 through 8.

The CALCUR data block consists of many lines of ASCII text. The format is the same as the file format for user calibration curves, which is detailed in the section User Calibration Curve File Format.

`CALCUR <index>`

Sets or queries sensor calibration curve data.

Uses a fragmented message protocol to sens many lines of ASCII text to the instrument.

Note: It is much easier to use Cryo-con's Utility Software to send and receive sensor calibration curves.

Sensor commands

Sensor commands are used to set and query information about the sensors installed in the controller. Both factory and user installed sensors can be queried, but only user sensors may be edited.

> ⓘ **NOTE:** Factory installed sensors are indexed from 0 to 61. User installed sensors have index values from 61 to 68 corresponding to user curves 1 through 8. For additional information, refer to Appendix A.

`SENSor <index>:name "Name String"`

Sets and queries the name string of the user-installed sensor at index <index>. The name string can be up to 15 ASCII characters.

`SENSor <index>:NENTry?`

Queries the number of entries in the user-installed sensor at index <index>. Response is a decimal integer ranging from zero to 200.

`SENSor <index>:UNITs` {VOLT| LOGOHM | OHMS}

Sets or queries the units of a user installed calibration curve at <index>. For information on the curve units, refer to the User Calibration Curve File Format section.

`SENSor <index>:`
`TYPe` {DIODE | ACR | PTC100 | PTC1K | NTC10UA}

Sets or queries the type of sensor at <index>. For more information on sensor types, please refer to the Input Configurations section. Index is 0 through 7.

`SENSor <index>:MULTiply <multiplier>`

Sets or queries the multiplier field of a user installed calibration curve at <index>. For information on the multiplier, refer to the User Calibration Curve File Format section.

Network Commands

The following commands are used to configure the monitor's Ethernet interface.

NETWork:IPADdress "IPA"

Sets or queries the monitor's IP address. The address is expressed as an ASCII string, so the input parameter must be enclosed in quotes. For example, the default IP address parameter is 192.168.1.4".

NETWork:PORT <port number>

Sets or queries the monitor's TCP port number. Default is 5000.

NETWork:MACADdress?

Queries the instrument's MAC address. The address is returned as an ASCII string. Cryo-con MAC addresses range from 00:50:C2:6F:40:00 to 00:50:C2:6F:4f:ff. They cannot be changed by the user.

NETWork:NAME "name"

The controller contains a unit name string that may be set or queried using this command. This can be used to assign a descriptive name to the instrument. This command is the same as the SYSTem:NAME command.

NETWork:DHCP {ON | OFF}

Set or query DHCP enable. Changes do not take effect until the next power cycle.

Mail Commands

MAIL {A | ... | H}:ADDR "IPA"

Set or query the e-mail server IP address. Parameter format is an ASCII string and must be enclosed in quotation marks. For example: "192.168.0.1".

MAIL {A | ... | H}:FROM "from e-mail address"

Set or query the 'from' e-mail address. Parameter is an ASCII String. For example: "model18@mynetwork.com".

MAIL {A | ... | H}:DEST "to e-mail address"

Set or query the 'from' e-mail address. Parameter is an ASCII String. For example: "model18@mynetwork.com".

MAIL {A | ... | H}:PORT <port number>

Set or query the e-mail port. Parameter is integer and default is 25.

MAIL {A | ... | H}:STATE {ON | OFF}

Set or query the input channel e-mail send enables. If a channel is enabled, e-mail will be sent when an alarm condition is asserted on the selected input channel.

Data Logging Commands

DLOG:STATe {ON|OFF}

Turns the data logging function ON or OFF. Equivalent to Start / STOP.

DLOG:INTerval <Seconds>

Sets the data logging time interval in seconds.

DLOG:COUNt?

Queries the number of entries in the log buffer.

DLOG?
DLOG:READ?

Reads the entire contents of the log buffer. Each record is sent on a single line. Format is:

<#>, MM/DD/YYYY, HR,MN,SC, ChA, CHB, ChC,ChD

where:

<#> is the record number.
MM/DD/YYYY is the date in Month, Day, Year format.
HR,MN,SC is the time in Hour, Minute, Second format.

Lines end with a <CR><LF> sequence. End of transmission is indicated by a line that only contains a semi-colon.

DLOG:RESEt

Sets the logging record number to zero.

DLOG:CLEAr

Clears the data logging buffer.

Code snippet in C++

The following code opens a Cryo-con instrument at address 192.168.1.4 on the Local Area Network. It is written in Microsoft Visual C++ and uses the eZNET LAN library provided on the Cryo-con utility CD.

```
// -----  Example Ethernet LAN program using C++  -----
// TCPIP declarations
#include "TCPIPdrv.h"

  TCPIPdrv LAN; //Define global LAN object
  char IPA[ ] = "192.168.1.4"; //Instrument's IP address on the LAN
  char tempstr[257]; //temporary character string

  //Open the instrument.
  If(!LAN.open(IPA)){
     //can't connect...
     LAN.close();
     throw ("Can't talk to instrument");
  };
  //read the IDN string
  LAN.IO("*IDN?",tempstr,256);
  printf("IDN is %s\n",tempstr); //Print IDN

  //read the MAC address
  LAN.IO("net:mac?",tempstr,256);
  printf("MAC is: %s\n",tempstr);

  //Start temperature control
  LAN.IO("control");

  //Stop temperature control
  LAN.IO("stop");

  //Read channel B input
  LAN.IO("input? B",tempstr,256);
  printf("Channel B temperature is: %s\n",tempstr);

  //send compound command to input channel A and wait for it to finish.
  LAN.IO("INPUT A:UNIT S;SENSOR 33;:*OPC?",tempstr,256);

  //close the instrument
  LAN.close();
```

EU Declaration of Conformity

According to ISO/IEC Guide 22 and EN 45014

Product Category:	Process Control Equipment
Product Type:	Temperature Measuring System
Model Numbers:	Model 18C, Model 14C and Model 12C
Manufacturer's Name:	Cryogenic Control Systems, Inc.
Manufacturer's Address:	

P. O. Box 7012
Rancho Santa Fe, CA 92067
Tel: (858) 756- 3900, Fax: 858. 759. 3515

The before mentioned products comply with the following EU directives:

89/336/EEC, "Council Directive of 3 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility"

73/23/EEC, "Council Directive of 19 February 1973 on the harmonization of the laws of Member States relating to electrical equipment designed for use within certain voltage limits".

The compliance of the above mentioned product with the Directives and with the following essential requirements is hereby confirmed:

Emissions	Immunity	Safety
EN 55011,1998	EN 50082-1, 1997	EN 61010, 1994 A2: May 96

The technical files and other documentation are on file with Mr. Guy Covert, President and CEO.

As the manufacturer we declare under our sole responsibility that the above mentioned products comply with the above named directives.

Guy D. Covert
President, Cryogenic Control Systems, Inc.
July 15, 2011

Appendix A: Installed Sensor Curves

Factory Installed Curves

The following is a list of factory-installed sensors and the corresponding sensor index.

Sensor #	Name	Description
0	None	No Sensor. Used to turn the selected input channel off.
1	Cryo-con S900	Cryo-con S700 series Silicon diode. Range: 1.4 to 500K. 10µA constant current excitation.
2	LS DT-670	Lakeshore DT-670 series Silicon diode, Curve 11. Range: 1.4 to 500K. 10µA constant current excitation.
3	LS DT-470	Lakeshore DT-470 series Silicon diode, Curve 10. Range: 1.4 to 500K. 10µA constant current excitation.
4	CD-12A	Cryo Industries CD-12A Silicon diode. Range: 1.4 to 500K. 10µA constant current excitation.
5	SI 410 Diode	Scientific Instruments, Inc. 410 diode Curve. Range: 1.5 to 450K. 10µA excitation.
20	Pt100 385	DIN43760 standard 100Ω Platinum RTD. Range: 23 to 873K, 1mA excitation.
21	Pt1K 385	1000Ω at 0°C Platinum RTD using DIN43760 standard calibration curve. Range: 23 to 1023K, 100µA excitation.
22	Pt10K 385	10KΩ at 0°C Platinum RTD. Temperature coefficient 0.00385, Range: 23 to 873K, 10µA excitation.
23	RhFe 27, 1mA	Rhodium-Iron. 27Ω at 0°C. 1mA DC excitation. 1.5 to 873K
31	SI RO-105	Scientific Instruments Inc. RO-105 Ruthenium Oxide sensor. Temperature range is: 2 to 273K. Use with the NTC10uA input configuration only.
32	SI RO-600	Scientific Instruments Inc. RO-600 Ruthenium-Oxide sensor with constant-voltage AC excitation. Temperature range is: <1.0 to 40K. bias.
33	Cryo-con R500	Cryocon R500 Ruthenium-Oxide sensor with constant-voltage AC excitation. Temperature range is: <1.0 to 40K.
34	Cryo-con R400	Cryocon R400 Ruthenium-Oxide sensor. Temperature range is: 2 to 273K. Use with the NTC10uA input configuration only.
45	TC Type K	Thermocouple, Type K. Range: 3.2 to 1643K
46	TC Type E	Thermocouple, Type E. Range: 3.2 to 1273K
47	TC Type T	Thermocouple, Type T. Range: 3.2 to 673K
48	TC AuFe .07%	Chromel-AuFe 7% thermocouple. Range: 3 to 610K
0	None	No Sensor. Used to turn the selected input channel off.

The SENSor commands are used to query and edit sensors installed in the controller. For example, the command:

INPUT B SENSor 34 would set input B to use the R400 sensor.
INPUT A: SENSor 1 would set input A to use the S900 diode.
INPUT A: SENSor 0 would turn input A off by setting the sensor to 'none'.
SENSor 1:NAME? Returns the name string at index 1.

Factory installed sensors may not be edited by using these commands.

User Installed Sensor Curves

The user may install up to eight custom sensors. This table shows the sensor index and default name of the user curves:

User Curve	Sensor #	Default Name
0	61	User Sensor 1
1	62	User Sensor 2
2	63	User Sensor 3
3	64	User Sensor 4
4	65	User Sensor 5
5	66	User Sensor 6
6	67	User Sensor 7
7	68	User Sensor 8

Using the above table, the SENSor commands can be used to address the user curves. For example:

INPUT B SENSor 62 assigns input B to user sensor #2.
SENSor 64:NAME? Returns the name string of user sensor 4
SENSor 63:TYPE ACR sets the type of user sensor #3 to ACR.

ⓘ **NOTE:** Factory installed sensors are indexed from 0 to 60. User installed sensors have index values from 61 to 68 corresponding to user curves 1 through 8.

Sensor Curves on CD

The following sensors are available on the CD supplied:

File	Description
Cryocon S700	Cryo-con S700 series Silicon diode. Range: 1.4 to 500K. 10μA constant current excitation.
CryocalD3.crv	Cryocal D3 Silicon diode. Range: 1.5 to 300K
SI410.crv	Scientific Instruments, Inc. SI-410 Silicon diode. Range: 1.5 to 450K
Curve10.crv	Lakeshore Curve 10 Silicon diode curve for DT-470 series diodes. Range: 1.4 to 495K.
Curve11.crv	Lakeshore Curve 10 Silicon diode curve for DT-670 series diodes. Range: 1.4 to 500K.
PT100385.crv	Cryocon CP-100, DIN43760 or IEC751 standard Platinum RTD, 100Ω at 0°C. Range: 23 to 1020K
PT1K385.crv	DIN43760 or IEC751 standard Platinum RTD, 1000Ω at 0°C. Range: 23 to 1020K
PT1003902.crv	Platinum RTD, 100Ω at 0°C Temperature coefficient 0.003902 Ω/C. Range: 73K to 833K.
PT1K375.crv	Platinum RTD, 1000Ω at 0°C Temperature coefficient 0.00375 Ω/C. Range: 73K to 833K.
aufe07cr.crv	Chromel-AuFe 7% thermocouple. Range: 3 to 610K
TCTypeE.crv	Thermocouple, Type E. Range: 3.2 to 1273K
TCTypeK.crv	Thermocouple, Type K. Range: 3.2 to 1643K
TCTypeT.crv	Thermocouple, Type T. Range: 3.2 to 673K
CX1030E1.crv	Cernox™ CX1030 example curve. Range: 4 to 325K

User Calibration Curve File Format

Sensor calibration curves may be sent to any Cryo-con instrument using a properly formatted text file. This file has the extension .crv. It consists of a header block, lines of curve data and is terminated by a single semicolon (;) character.

The header consists of four lines as follows:

Sensor Name:	Sensor name string
Sensor Type:	Enumeration
Multiplier:	Signed numeric
Units:	Units of calibration curve: {OHMS | VOLTS | LOGOHM}

The Sensor Name string can be up to 15 characters and is used to identify the individual sensor curve. When downloaded to a Cryo-con instrument, this name appears in the sensor selection menu of the embedded web server and will appear on all sensor selection fields on the front panel.

The Sensor Type Enumeration identifies the required input configuration of the input channel. For the monitor, selections are: DIODE, PTC100, PTC1K, NTC10uA and ACR. These configurations are described in the section titled Supported Sensor Configurations.

The Multiplier field is a signed, decimal number that identifies the sensor's temperature coefficient and curve multiplier. Generally, for Negative-Temperature-Coefficient (NTC) sensors, the value of the multiplier is -1.0 and for a Positive-Temperature-Coefficient (PTC) sensor, the value is 1.0.

As an advanced function, the multiplier field can be used as a multiplier for the entire calibration curve. For example, a 10KΩ Platinum RTD can use a calibration curve for a 100Ω Platinum RTD by using a multiplier of 100.0.

The fourth line of the header is the sensor units field. This may be Volts, Ohms or Logohm. Generally, diode type sensor curves will be in units of Volts and most resistance sensors will be in units of Ohms. However, many resistance sensors used at low temperature have highly nonlinear curves. In this case, the use of Logohm units give a more linear curve and provide better interpolation accuracy. Logohm is the base-10 logarithm of Ohms.

Examples of sensor calibration curves that are in units of Ohms include Platinum RTDs and Rhodium-Iron RTDs. Examples of sensors that best use Logohm include Cernox™, Ruthenium-Oxide and Carbon-Ceramic.

After the header block, there are two to 200 lines of sensor calibration data points. Each point of a curve contains a sensor reading and the corresponding temperature. Sensor readings are in units specified by the units line in the curve header. Temperature is always in Kelvin.

The format of an entry is:

<sensor reading> <Temperature>

Where <sensor reading> is a floating-point sensor reading and <Temperature> is a floating-point temperature in Kelvin. Numbers are separated by one or more white spaces.

Floating point numbers may be entered with many significant digits. They will be converted to 32 bit floating point which supports about six significant digits.

The last entry of a table is indicated by a semicolon (;) character with no characters on the line.

> ⓘ **NOTE:** All curves must have a minimum of two entries and a maximum of 200 entries.

Entries may be sent to the instrument in any order. The instrument will sort the curve in ascending order of sensor reading before it is copied to Flash RAM. Entries containing invalid numeric fields are deleted before the curve is stored.

The following is an example of a calibration curve:

```
Good Diode
Diode
–1.0
volts
0.34295   300.1205
0.32042   273.1512
0.35832   315.0000
1.20000   3.150231
1.05150   8.162345\
0.53234   460.1436
;
```

In summary,

1. The first line is a name string that can be up to 15 characters. Longer strings are truncated by the instrument.

   The second line identifies the instrument's input configuration and must be one of the allowed selections.

2. The third line is the multiplier field and is 1.0 for PTC sensors and -1.0 for NTC sensors or diodes.
3. The fourth line of the header is the sensor units and must be Volts, Ohms or Logohm.
4. Curve entries must be the sensor reading followed by the temperature in units of Kelvin. Values are separated by one or more white space or tab characters.
5. The last line in the file has a single semicolon (;) character.
6. It is recommended that the curve back is read after downloading to ensure that the instrument parsed the file correctly. This is easily done by using the Cryo-con utility software's curve upload function under Operations>Sensor Curve>upload.

Appendix B: Updating Instrument Firmware

Updates require the use of the Cryo-con Firmware Update Utility software and a hex file containing the updated firmware. These are available on the Internet.

> ⓘ **Note:** Updating firmware in any instrument is not entirely without risk. Please only perform the procedure when some down time is available.
> The update will abort on the detection of a hardware malfunction. Also, the update may change instrument features that you are currently using in a different way. Factory defaults settings are restored that will erase any existing user calibration curves or PID tables.

Updating unit firmware

Before starting, be sure to have the **FWutility.exe** file and a hex file that contains the desired firmware update.

> ⓘ **Note:** The flash loader software does NOT check the hex file for compatibility with the target instrument. Please be sure that you are using the correct file.

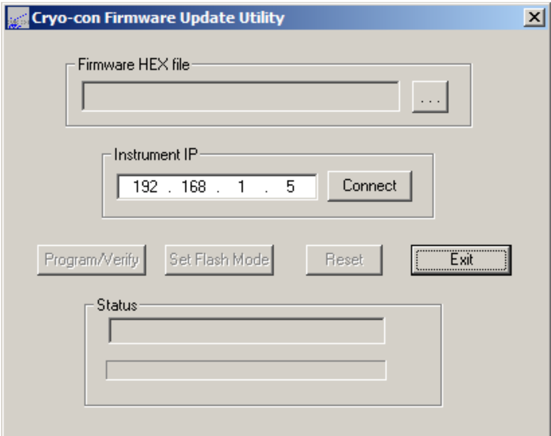
Forcing a firmware download

A firmware download does not generally need to be forced since the Firmware Utility will automatically set the download state. However, if the unit is non-functional, a firmware download may be forced as follows:

1. Press and holding the **DEC (▼)** key during power up.
2. When the "Operator Abort" message appears, press the **DEC (▼)** key to continue normally or press the **INC (▲)** key to abort to the firmware downloader.

Loading Firmware

Start the firmware update by running the Cryo-con Firmware Utility. This launches a dialog box as shown here.



The instrument's default IP will appear in the dialog box. This can be changed if necessary.

Click the **Connect** button. The status box should update to indicate a connection, but the instrument display will not change.

Next, the firmware update file needs to be selected. Click on the browse button (**. . .**) to launch a file selection dialog.

Select the firmware hex file and click **Open**. The Firmware HEX file field will be updated with the file name. Also, the **Set Flash Mode** button will become active.

Caution: Once you click the **Set Flash Mode** button, the instrument will enter the firmware update mode and will not function normally again until the entire firmware update process is complete without error. Be sure you have the correct hex file before proceeding.

Click the **Set Flash Mode** button to set the instrument into the flash programming mode. The instrument will reset and start in the flash load mode. This is indicated by the display shown.

```
Boot-loader 1.05
Hold DEC key to abort
```

Since the instrument was reset, click **Connect** again to re-establish contact. This activates the **Program/Verify** button. The instrument will now display “Connected...”

Click the **Program/Verify** button to start the firmware download.

The last few lines of the instrument's display will indicate the status. First, the flash memories are erased and then individual records are programmed and verified.

There are about 4500 records in a typical file and the programming process takes about ten minutes.

When programming is complete, the unit will automatically reset and begin running the updated firmware. Factory defaults are also restored.

It is possible to power the instrument OFF during the programming process. This will require a re-start of the entire process after powering ON again. Once the download progress starts, the instrument powers-up in the boot loader mode and will not run the normal instrument firmware until the entire download process is completed without error.

If an error occurs, an error message will display on the instrument's front panel for 20 seconds and then an alert box will show on the PC. If the error persists after several programming attempts, there is a hardware problem and you will need to contact Cryo-con.

Appendix C: Troubleshooting Guide

Error Displays

Display	Condition
- - - - - - - K Or an erratic display of temperature.	Input channel voltage measurement is out of range. Ensure that the sensor is connected and properly wired. Ensure that the polarity of the sensor connections is correct. Refer to the Sensor Connections section. Many sensors can be checked with a standard Ohmmeter. For resistor sensors, ensure that the resistance is correct by measuring across both the Sense and Excitation contacts. For a diode sensor, measure the forward and reverse resistance to ensure a diode-type function.
. . . . K	Input channel is within range, but measurement is outside the limits of the selected sensor's calibration curve. Check sensor connections as described above. Ensure that the proper sensor has been selected. Refer to the Input Channel Setup Menus section. Change the sensor units to Volts or Ohms and ensure that the resulting measurement is within the selected calibration curve.

Temperature Measurement Errors

Symptom	**Condition**
Noise on temperature measurements.	Possible causes: 1. Excessive noise pickup, especially AC power line noise. Check your wiring and shielding. Sensors must be floating, so check that there is no continuity between the sensor connection and ground. Review the System Shielding and Grounding Issues section. Check for shielding problems by temporarily removing the input connector's backshell. If the noise changes significantly, current is being carried by the shields and is being coupled into the controller. 2. Use a longer display filter time constant to reduce displayed noise.

Remote I/O problems

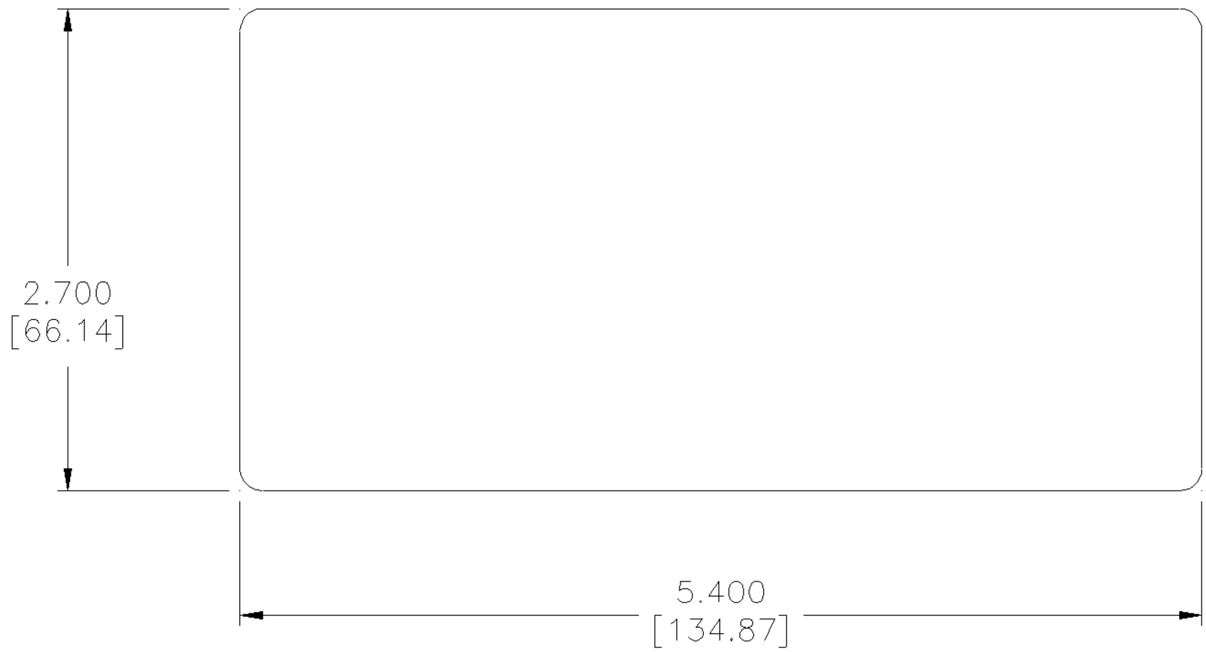
<table>
<tr><th>Symptom</th><th>Condition</th></tr>
<tr><td>Can't talk to RS-232 interface.</td><td>Possible causes:
1. Ensure that the baud rate of the controller matches that of the host computer. To check the controller's baud rate, press the System key and scroll down to the RIO-RS232 field.
2. Ensure that the host computer settings are 8-bits, No parity, one stop bit.
3. The RS-232 port does not have an effective hardware handshake method. Therefore, terminator characters must be used on all strings sent to the controller. Review the RS-232 Configuration section.
4. Ensure that you are using a Null-Modem type cable.
Debugging tip: Cryo-con utility software can be used to talk to the controller over the RS-232 port using the terminal mode. All command and response strings are displayed. This is a good way to establish a connection.</td></tr>
<tr><td>Intermittent lockup on RS-232 interface.</td><td>Possible causes:
1. Long cables. Try using a lower baud rate. In some cases, inserting a 50mS delay between commands will help.
2. Noise pickup. Try using shielded cables with the shield connected to a metal backshell at both ends.
3. Don't send reset (RST) commands to the controller before reading.</td></tr>
<tr><td>Can't talk to the LAN interface.</td><td>Possible causes:
1. A Category 5 crossover patch cable is being used where a Category 5 patch cable should be used, or visa-versa.
2. The TCP settings between the monitor and the PC are incompatible. Review the network configuration section.
3. PC Client software not configured to use TCP Data Socket 5000.
Debugging tip: Cryo-con utility software can be used to talk to the monitor over the LAN Data Socket port using the terminal mode. All command and response strings are displayed. Since the software provides the proper interface setup, it is a good way to establish initial connection.</td></tr>
</table>

Appendix D: Enclosure Options

Panel Mounting

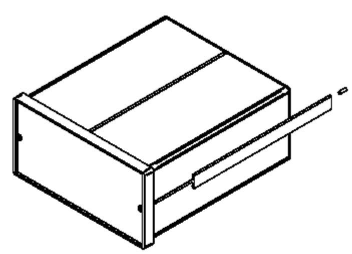
Panel Cutout

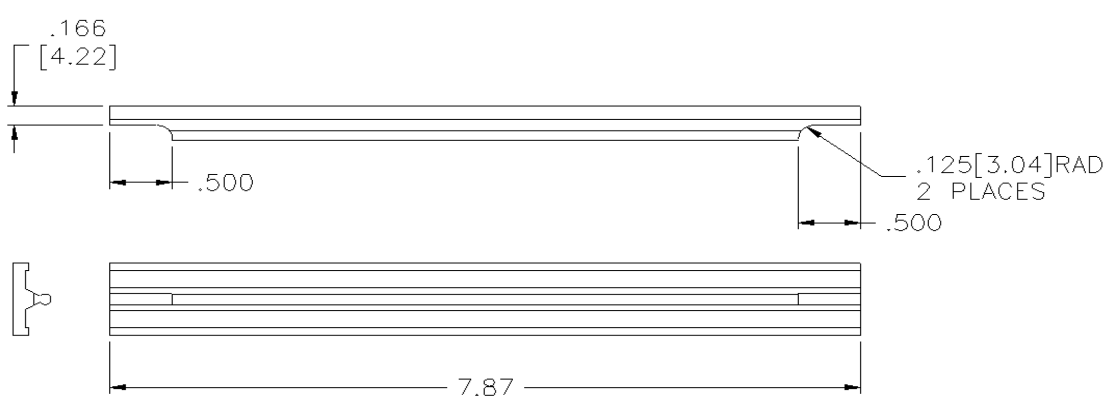
Shown here is a cut-out drawing for panel mounting of the monitor.



Panel Mount Kit

The monitor mounts to panel by sliding the enclosure through a panel cut-out hole and then installing the panel mount kit, Cryo-con part number 4012-020. Drawings and assembly of the panel mount kit are shown here.





Instrument Stand

The Instrument Stand accessory, Cryo-con part number 4012-021, is used to mount the monitor on a bench top. It tilts the instrument up by 15° for an improved viewing angle.

Appendix E: Sensor Data

Cryo-con S900 Silicon Diode

The Cryo-con S900 Silicon diode sensor with a 10µA excitation current.

Volts	Temp(K)	Volts	Temp(K)	Volts	Temp(K)
0.09077	500.00	0.86921	160.00	1.06858	52.00
0.09281	499.00	0.87959	155.00	1.07023	51.00
0.11153	490.00	0.88988	150.00	1.07188	50.00
0.13320	480.00	0.90008	145.00	1.07353	49.00
0.15565	470.00	0.91021	140.00	1.07517	48.00
0.17873	460.00	0.92022	135.00	1.07681	47.00
0.20231	450.00	0.93008	130.00	1.07844	46.00
0.22623	440.00	0.93976	125.00	1.08008	45.00
0.25016	430.00	0.94927	120.00	1.08171	44.00
0.27403	420.00	0.95867	115.00	1.08334	43.00
0.29785	410.00	0.96794	110.00	1.08497	42.00
0.32161	400.00	0.97710	105.00	1.08659	41.00
0.34532	390.00	0.98615	100.00	1.08821	40.00
0.34768	389.00	0.99510	95.00	1.08983	39.00
0.36898	380.00	1.00393	90.00	1.09145	38.00
0.39261	370.00	1.00569	89.00	1.09306	37.00
0.41620	360.00	1.00744	88.00	1.09468	36.00
0.43976	350.00	1.00918	87.00	1.09629	35.00
0.46330	340.00	1.01093	86.00	1.09791	34.00
0.48681	330.00	1.01267	85.00	1.09952	33.00
0.51024	320.00	1.01439	84.00	1.10124	32.00
0.52192	315.00	1.01612	83.00	1.10295	31.00
0.53356	310.00	1.01785	82.00	1.10465	30.00
0.54516	305.00	1.01957	81.00	1.10643	29.00
0.55674	300.00	1.02127	80.00	1.10828	28.00
0.56828	295.00	1.02299	79.00	1.10996	27.00
0.57980	290.00	1.02471	78.00	1.11217	26.00
0.59131	285.00	1.02642	77.00	1.11480	25.00
0.60279	280.00	1.02814	76.00	1.11828	24.00
0.61427	275.00	1.02985	75.00	1.12425	23.00
0.62573	270.00	1.03156	74.00	1.13841	22.00
0.63716	265.00	1.03327	73.00	1.16246	21.00
0.64855	260.00	1.03498	72.00	1.18193	20.00
0.65992	255.00	1.03669	71.00	1.19816	19.00
0.67124	250.00	1.03839	70.00	1.21325	18.00
0.68253	245.00	1.04010	69.00	1.22816	17.00
0.69379	240.00	1.04179	68.00	1.24342	16.00
0.70503	235.00	1.04349	67.00	1.25932	15.00
0.71624	230.00	1.04518	66.00	1.27621	14.00
0.72743	225.00	1.04687	65.00	1.29401	13.00
0.73861	220.00	1.04856	64.00	1.31277	12.00
0.74978	215.00	1.05024	63.00	1.33317	11.00
0.76094	210.00	1.05192	62.00	1.35568	10.00
0.77205	205.00	1.05360	61.00	1.37998	9.00
0.78311	200.00	1.05528	60.00	1.40827	8.00
0.79412	195.00	1.05696	59.00	1.44098	7.00
0.80508	190.00	1.05863	58.00	1.47740	6.00
0.81599	185.00	1.06029	57.00	1.51590	5.00
0.82680	180.00	1.06196	56.00	1.55483	4.00
0.83754	175.00	1.06362	55.00	1.59108	3.00
0.84818	170.00	1.06528	54.00	1.62255	2.00
0.85874	165.00	1.06693	53.00	1.64342	1.00

SI RO-600 Ruthenium-Oxide Sensor

10mV AC excitation.

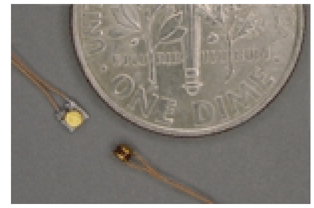
Temp(K)	Ohms	Ohms/K
300.00	1000	-0.08
200.00	1008	-0.13
100.00	1025	-0.33
80.00	1032	-0.49
60.00	1042	-0.84
40.00	1058	-1.50
20.00	1101	-4.08
15.00	1127	-7.20
10.00	1178	-15.40
9.00	1195	-18.80
8.00	1216	-23.60
7.00	1243	-30.50
6.00	1277	-40.90
5.00	1325	-57.80
4.50	1356	-70.50
4.30	1371	-76.90
4.20	1378	-80.40
4.00	1395	-88.20
3.90	1404	-92.60
3.80	1413	-97.30
3.70	1423	-102.30
3.60	1433	-107.70
3.50	1444	-113.70
3.40	1455	-120.10
3.30	1467	-127.20
3.20	1480	-134.80
3.10	1493	-143.20
3.00	1508	-152.40
2.90	1523	-162.70
2.80	1539	-173.90
2.70	1556	-186.40
2.60	1575	-200.40
2.50	1595	-216.10
2.40	1617	-233.80
2.30	1640	-253.80
2.20	1666	-276.70
2.10	1693	-302.80
2.00	1723	-343.50
1.90	1758	-355.00
1.80	1793	-396.10
1.70	1833	-444.90
1.60	1877	-503.20
1.50	1928	-573.80
1.40	1985	-660.60
1.30	2051	-768.80
1.20	2128	-906.00
1.10	2219	-1083.90
1.00	2327	-1203.00
0.99	2339	-1226.00

Temp(K)	Ohms	Ohms/K
0.98	2351	-1251.00
0.97	2364	-1277.00
0.96	2377	-1303.00
0.95	2390	-1331.00
0.94	2403	-1359.00
0.93	2417	-1388.00
0.92	2430	-1417.00
0.91	2445	-1449.00
0.90	2459	-1481.00
0.89	2474	-1514.00
0.88	2489	-1548.00
0.87	2505	-1583.00
0.86	2520	-1621.00
0.85	2537	-1658.00
0.84	2553	-1697.00
0.83	2570	-1738.00
0.82	2588	-1781.00
0.81	2605	-1824.00
0.80	2624	-1869.00
0.79	2642	-1917.00
0.78	2661	-1966.00
0.77	2681	-2016.00
0.76	2701	-2070.00
0.75	2722	-2124.00
0.74	2743	-2182.00
0.73	2765	-2242.00
0.72	2787	-2304.00
0.71	2810	-2368.00
0.70	2834	-2436.00
0.69	2858	-2507.00
0.68	2884	-2580.00
0.67	2909	-2658.00
0.66	2936	-2738.00
0.65	2963	-2822.00
0.64	2992	-2911.00
0.63	3021	-3003.00
0.62	3051	-3100.00
0.61	3082	-3202.00
0.60	3114	-3309.00
0.59	3147	-3422.00
0.58	3181	-3540.00
0.57	3216	-3665.00
0.56	3253	-3796.00
0.55	3291	-3935.00
0.54	3330	-4082.00
0.53	3371	-4237.00
0.52	3414	-4401.00
0.51	3458	-4576.00
0.50	3503	-4760.00

Temp(K)	Ohms	Ohms/K
0.49	3551	-4956.00
0.48	3600	-5164.00
0.47	3652	-5388.00
0.46	3706	-5624.00
0.45	3762	-5877.00
0.44	3821	-6149.00
0.43	3883	-6439.00
0.42	3947	-6751.00
0.41	4014	-7086.00
0.40	4085	-7447.00
0.39	4160	-7837.00
0.38	4238	-8259.00
0.37	4321	-8715.00
0.36	4408	-9212.00
0.35	4500	-9753.00
0.34	4598	-10343.00
0.33	4701	-10989.00
0.32	4811	-11699.00
0.31	4928	-12481.00
0.30	5053	-13345.00
0.29	5186	-14303.00
0.28	5329	-15369.00
0.27	5483	-16562.00
0.26	5648	-17901.00
0.25	5827	-19412.00
0.24	6022	-21126.00
0.23	6233	-23081.00
0.22	6464	-25325.00
0.21	6717	-27920.00
0.20	6996	-30943.00
0.19	7305	-34493.00
0.18	7650	-38706.00
0.17	8037	-43758.00
0.16	8475	-49892.00
0.15	8974	-57444.00
0.14	9548	-66902.00
0.13	10217	-78978.00
0.12	11007	-94764.00
0.11	11955	-116005.00
0.10	13115	-145658.00
0.09	14571	-189096.00
0.08	16462	-257192.00
0.07	19034	-375766.00
0.06	22792	-628083.00
0.05	29073	

Sensor Packages

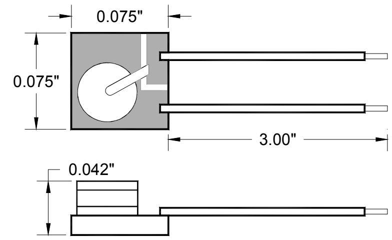
The SM and CP Sensor Packages



The S900-SM is mounted in a rugged surface-mounted package. This compact package features a low thermal mass and is easy to install.

Package material is gold plated OHFC copper on an Alumina substrate. Solder limits the temperature range to 400K.

Leads are 3 inches, material is 37 AWG copper with Polyimide insulation. Positive connection is Red and negative is Black.



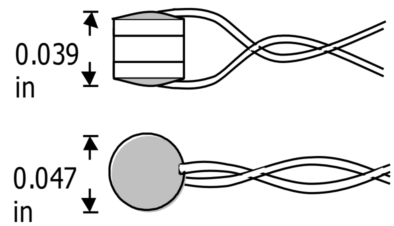
Sensor is easily installed by attaching the substrate directly to the desired surface using cryogenic varnish. Leads should be thermally anchored.

The CP is an ultra-compact 'CP'. It features low thermal mass and operation to 500K.

Package material is gold plated OHFC copper.

Leads are 3 inches. Material is 37 AWG copper with Polyimide insulation. Positive connection is Red and negative is Black.

This package is extremely small and has a low thermal mass.



The BB Sensor Package

The BB package is an industry standard 0.310" bobbin package that fe the internal sensing element. This ensures a rapid thermal response ar between the sensing element and the sensor package. Mechanical inte performance even in severe applications.

With the bobbin package, the lead wires are thermally anchored to the for accurate sensor readings.

Bobbin Package Specifications	
Bobbin Material	Gold plated Oxygen free hard Copper.
Marking	Individual serial number.
Sensor Bonding	Stycast® epoxy.
Mass	1.1g excluding leads.
Leads	36 inches, 36AWG Phosphor-Bronze. Four-lead color coded cryogenic ribbon cable. Insulation is heavy Formvar® .
Mounting	4-40 machine screw.
Temperature	400K Maximum.

Table 14: BB Package Specifications

Cable Color Codes	
V+	Clear
V-	Green
I+	Black
I-	Red

Table 15: Cable Color Code

Connections to the BB package are made using a color-coded four-wire, 36 AWG cryogenic ribbon cable.

Wires may be separated by dipping in Isopropyl Alcohol and then wiping clean.

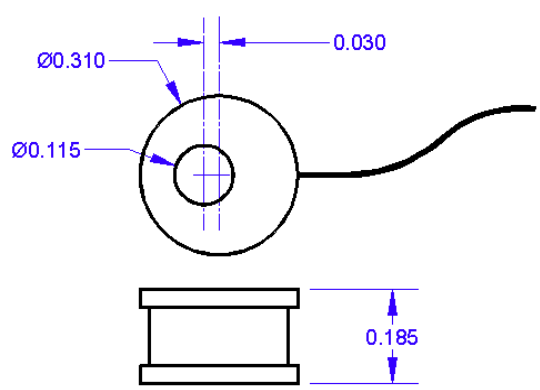
Insulation is Formvarf and is difficult to strip. Techniques include use of a mechanical stripper, scrapping with a razor blade and passing the wire quickly over a low flame.

The BB package is easily mounted with a #4-40 brass screw. A brass screw is recommended because thermal stress will be reduced at cryogenic temperature.

The mounting surface should be clean. A rinse with Isopropyl Alcohol is recommended.

First, apply a small amount of Apiezonf N grease to the threads of the screw and on the mounting surface of the sensor package.

Next, place the bobbin on the mounting surface, insert screw through bobbin and lightly tighten.



Appendix G: Sensor Data Tables

Silicon Diode

Silicon diode sensors offer good sensitivity over a wide temperature range and are reasonably interchangeable.

Use in magnetic fields is not recommended.

Silicon diode sensors use a constant-current DC excitation of 10μA.

Cryo-con S900 Silicon Diode
Name: Cryocon S900 Configuration: Diode

T(K)	Volts	mV/K
1.4	1.63864	-36.56
4.2	1.53960	-33.91
10	1.35568	-26.04
20	1.18193	-11.34
30	1.10465	-3.12
50	1.07188	-1.46
77.35	1.02511	-1.69
100	0.98615	-1.85
150	0.88988	-2.03
200	0.78311	-2.17
250	0.67124	-2.28
300	0.55674	-2.36
355	0.42759	-2.33
400	0.32161	-2.38
450	0.20231	-2.37
500	0.09077	-2.12

Scientific Instruments SI-430 and SI-440
Name: SI 430 Diode Configuration: Diode
Name: SI 440 Diode Configuration: Diode

T(K)	Volts	mV/K
1.4	1.63864	-36.56
4.2	1.53960	-33.91
10	1.36317	-26.04
20	1.17370	-11.34
30	1.10343	-3.12
50	1.07399	-1.46
77.35	1.02511	-1.69
100	0.98740	-1.85
150	0.89011	-2.03
200	0.78272	-2.17
250	0.67085	-2.28
300	0.55665	-2.36
355	0.42759	-2.33
400	0.32161	-2.38
450	0.20231	-2.37
500	0.09077	-2.12

Scientific Instruments SI-410
Name: SI 410 Diode Configuration: Diode

T(K)	Volts	mV/K
1.4	1.71488	-10.54
4.2	1.64660	-32.13
10	1.39562	-35.28
20	1.17592	-20.43
30	1.10136	-1.75
50	1.06957	-1.59
77.35	1.14905	-1.72
100	0.98322	-1.82
150	0.88603	-2.00
200	0.78059	-2.14
250	0.67023	-2.23
300	0.55672	-2.28
350	0.44105	-2.32
400	0.32319	-2.36
450	0.20429	-2.38

Lakeshore DT-670 Silicon Diode
Name: LS DT-670 Configuration: Diode

T(K)	Volts	mV/K
1.4	1.64429	-12.49
4.2	1.57848	-31.59
10	1.38373	-26.84
20	1.19775	-15.63
30	1.10624	-1.96
50	1.07310	-1.61
77.35	1.02759	-1.73
100	0.98697	-1.85
150	0.88911	-2.05
200	0.78372	-2.16
250	0.67346	-2.24
300	0.55964	-2.30
350	0.44337	-2.34
400	0.32584	-2.36
450	0.20676	-2.39
500	0.09068	-2.12

Lakeshore DT-470 Silicon Diode Name: LS DT-470 Configuration: Diode		
T(K)	**Volts**	**mV/K**
1.4	1.6981	-13.1
4.2	1.6260	-33.6
10	1.4201	-28.7
20	1.2144	-17.6
30	1.1070	-2.34
50	1.0705	-1.75
77.35	1.0203	-1.92
100	0.9755	-2.04
150	0.8687	-2.19
200	0.7555	-2.31
250	0.6384	-2.37
300	0.5189	-2.4
350	0.3978	-2.44
400	0.2746	-2.49
450	0.1499	-2.46
475	0.0906	-2.22

Platinum RTD

Platinum RTD sensors feature high stability, low magnetic field dependence and excellent interchangeability. They conform to the DIN43760 standard curve.

The monitor uses 1.0mA Constant-Current AC excitation.

Platinum RTD, DIN43760 and IEC751 Name: Pt100 385 Configuration: PTC100 Name: Pt1K 385 Configuration: PTC1K		
T(K)	**Ohms**	**Ω/K**
20	2.2913	0.085
30	3.6596	0.191
50	9.3865	0.360
77.35	20.380	0.423
100	29.989	0.423
150	50.788	0.409
200	71.011	0.400
250	90.845	0.393
300	110.354	0.387
400	148.640	0.383
500	185.668	0.378
600	221.535	0.372
700	256.243	0.366
800	289.789	0.360
900	324.302	0.318
1123	390.47	0.293

Rhodium-Iron

Rhodium-Iron sensors feature high stability, low magnetic field dependence and reasonable interchangeability.

The monitor supports them with 1.0mA Constant-Current AC excitation.

Rhodium-Iron 27Ω Name: RhFe 27 1mA Configuration: PTC100		
T(K)	**Ohms**	**Ω/K**
1.4	1.5204	0.178
4.2	1.9577	0.135
10	2.5634	0.081
20	3.1632	0.046
30	3.5786	0.040
50	4.5902	0.064
77.4	6.8341	0.096
100	9.1375	0.106
150	14.463	0.105
200	19.641	0.102
250	24.686	0.101
300	29.697	0.101
350	34.731	0.101
400	39.824	0.103

Cernox™

Cernox™ temperature sensors do not follow a standard calibration curve. Data shown here is for typical sensors.

The monitor supports Cernox™ using a 10mV Constant-Voltage AC excitation. This extends low temperature operation to about 2.0K.

Lakeshore Cernox™ CX-1010 Name: User Supplied Config: ACR		
T(K)	**Ohms**	**Ω/K**
0.1	21389	-558110
0.2	4401.6	-38756
0.3	2322.4	-10788
0.4	1604.7	-4765.9
0.5	1248.2	-2665.2
1	662.43	-514.88
1.4	518.97	-251.77
2	413.26	-124.05
3	328.95	-58.036
4.2	277.32	-32.209
6	234.44	-17.816
10	187.11	-8.063
20	138.79	-3.057
30	115.38	-1.819
40	100.32	-1.252
50	89.551	-0.929
77.35	70.837	-0.510
100	61.180	-0.358
150	47.782	-0.202
200	39.666	-0.130
250	34.236	-0.090
300	30.392	-0.065

Lakeshore Cernox™ CX-1030 Name: User Supplied Config: ACR		
T(K)	**Ohms**	**Ω/K**
0.3	31312	-357490
0.4	13507	-89651
0.5	7855.7	-34613
1	2355.1	-3265.2
1.4	1540.1	-1264.9
2	1058.4	-509.26
3	740.78	-199.11
4.2	574.20	-97.344
6	451.41	-48.174
10	331.67	-19.042
20	225.19	-6.258
30	179.12	-3.453
40	151.29	-2.249
50	132.34	-1.601
77.35	101.16	-0.820
100	85.940	-0.552
150	65.864	-0.295
200	54.228	-0.184
250	46.664	-0.124
300	41.420	-0.088
350	37.621	-0.065
400	34.779	-0.050
420	33.839	-0.045

Lakeshore Cernox™ CX-1050 Name: User Supplied Config: ACR		
T(K)	**Ohms**	**Ω/K**
1.4	26566	-48449
2	11844	-11916
3	5733.4	-3042.4
4.2	3507.2	-1120.8
6	2252.9	-432.14
10	1313.5	-128.58
20	692.81	-30.871
30	482.88	-14.373
40	373.11	-8.392
50	305.19	-5.507
77.35	205.67	-2.412
100	162.81	-1.488
150	112.05	-0.693
200	85.800	-0.397
250	69.931	-0.253
300	59.467	-0.173
350	52.142	-0.124
400	46.782	-0.093
420	45.030	-0.089

Lakeshore Cernox™ CX-1070 Name: User Supplied Config: ACR		
T(K)	**Ohms**	**Ω/K**
4.2	5979.4	-2225.3
6	3577.5	-794.30
10	1927.2	-214.11
20	938.93	-46.553
30	629.90	-20.613
40	474.89	-11.663
50	381.42	-7.490
77.35	248.66	-3.150
100	193.29	-1.899
150	129.60	-0.854
200	97.626	-0.477
250	78.723	-0.299
300	66.441	-0.201
350	57.955	-0.143
400	51.815	-0.106
420	49.819	-0.094

Lakeshore Cernox™ CX-1080 Name: User Supplied Config: ACR		
T(K)	**Ohms**	**Ω/K**
20	6157.5	-480.08
30	3319.7	-165.61
40	2167.6	-79.551
50	1565.3	-45.401
77.35	836.52	-15.398
100	581.14	-8.213
150	328.75	-3.057
200	220.93	-1.506
250	163.73	-0.863
300	129.39	-0.545
350	106.98	-0.368
400	91.463	-0.261
420	86.550	-0.231

Ruthenium-Oxide

Scientific Instruments RO-600 Name: SI RO-600 Config: ACR		
T(K)	**Ohms**	**Ω/K**
0.05	29072	-628083
0.1	13114	-145658
0.2	6996	-30943
0.3	5053	-13345
0.5	3503	-4760
1	2327	-1203
1.4	1985	-660.6
2	1723	-343.5
3	1508	-152.4
4.2	1378	-80.4
6	1277	-40.9
10	1178	-15.4
20	1101	-4.08
30	1053	-4.0
40	1009	-3.5

Scientific Instruments RO-105 Name: SI RO-105 Config: NTC10uA		
T(K)	**Ohms**	**Ω/K**
2	239556	-17787
3	221769	-13961
4	207807	-11343
6	187171	-7647
10	163317	-3907
20	138709	-1400
30	128199	-745
40	122128	-474
100	108595	-108
200	102432	-34
273	100604	-0.05

Appendix H: Rear Panel Connections

Rear Panel

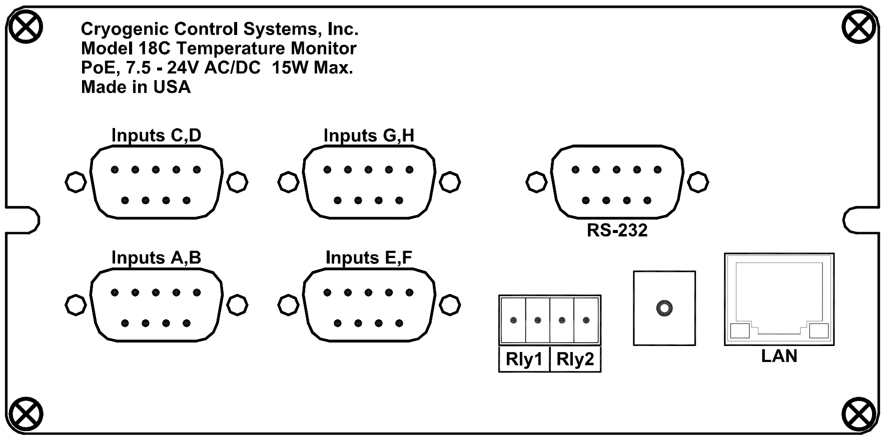


Figure 2: Model 18C Rear Panel

Power input

The external power supply provided with the monitor accepts 100 – 240VAC @ 50 – 60Hz and outputs 12VDC @ 1.0A. This may be plugged directly into the monitor's power jack. Alternatively, any supply from 7.5 to 48V DC or up to 24V AC with a capacity of greater than 10VA may be used. The jack is 2.1mm with positive voltage on the center and negative on the sleeve.

Power-Over-Ethernet is also supported. An IEEE-802.3af Power-Over-Ethernet hub or injector is required. Plug the cable from this device into the Ethernet input of the monitor. In this case, the power jack should not used.

IMPORTANT: The monitor requires that an Earth Ground reference connection is made at the rear panel. Failure to provide this connection will result in erratic measurements and can even damage input circuits.

The sensor cables provided connect their shields to the monitor's chassis; Therefore, the required Earth Ground can be made by connecting the shield wire at the opposite end to a ground reference point. This is usually done by connecting it to the back-shell of the cryostat connector.

Sensor Connections

All sensor connections are made at the rear panel of the monitor using the two DB-9 receptacles provided. There are two channels on each connector. Sensors should be connected to the monitor using the four-wire method. Signal connection is as follows:

Input Channel	Color Code	Signal	DB9 Pin
ChA	White	Current(+)	8
ChA	Green	Current(-)	9
ChA	Red	Sense(+)	4
ChA	Black	Sense(-)	5
ChB	White	Current(+)	6
ChB	Green	Current(-)	7
ChB	Red	Sense(+)	1
ChB	Black	Sense(-)	2

Table 16: Dual Sensor Cable Color Codes

The cable used is Belden 8723. This is a dual twisted pair cable with individual shields and a drain wire. The shields and drain wire are connected to the DB9 connector's metal back-shell in order to complete the shielding connection.

Relay Connections

Relay connections are made on the rear panel using the 3.5mm, 4-pin detachable terminal block provided.

Terminal block contacts are rated at 10.0A. Relay contact ratings are 10A@125 VAC, 5A@250VAC or 5A@30VDC.

Pin	Function
1	Relay #1 N.O.
2	Relay #1 Common.
3	Relay #2 N.O.
4	Relay #2 Common.

Table 17: Relay Connections

Ethernet (LAN) Connection

The Ethernet connection on the Model 18C is a standard RJ-45 connector with two status LEDs. The left most LED indicates that a valid connection has been made to a hub or computer and the right most LED indicates activity on the LAN.

The instrument may be powered by an IEEE-802.3af Power-Over-Ethernet compatible powered hub or power injector. When connected to the RJ-45 input, the instrument will negotiate power requirements with the hub and then power itself from the Ethernet cable. Since power and data are taken from a single cable, wiring can be simplified.

Power-Over-Ethernet supplies are NOT earth ground referenced. Some other connection between the instrument's chassis and earth ground should be fabricated in order to minimize noise coupling. Please refer to the section on grounding and shielding.

IEEE-488.2 Connections

The optional IEEE-488.2 (GPIB) connection is installed by connecting the dongle to the Ethernet port using a LAN cable. The interface will be configured by the instrument and will appear to your system as a standard IEEE-488.2 device.

RS-232 Connections

The monitor uses a DB-9 dual female null-modem cable for RS-232 serial communication. Baud rates are 9600, 19,200, 38,400, 57,200 and 115200. Other communications parameters are fixed in the instrument as follows:

Parity – None, Bits – 8, Stop Bits – 1.

Pin	Function	Pin	Function
1	NC	6	NC
2	RXD, Receive data	7	NC
3	TXD, Transmit data	8	NC
4	NC	9	NC
5	Ground		

Table 18: RS-232 DB-9 Connector Pinout

INDEX