



TEMP 120

20-Channel Thermocouple Module



Please read first

About this manual

Please note that this manual was produced by Campbell Scientific Inc. primarily for the North American market. Some spellings, weights and measures may reflect this. In addition, while most of the information in the manual is correct for all countries, certain information is specific to the North American market and so may not be applicable to European users. Differences include the U.S. standard external power supply details where some information (for example the AC transformer input voltage) will not be applicable for British/European use. Please note, however, *that when a power supply adapter is ordered from Campbell Scientific it will be suitable for use in your country.*

Reference to some radio transmitters, digital cell phones and aerials (antennas) may also not be applicable according to your locality. Some brackets, shields and enclosure options, including wiring, are not sold as standard items in the European market; in some cases alternatives are offered.

Recycling information for countries subject to WEEE regulations 2012/19/EU



At the end of this product's life it should not be put in commercial or domestic refuse but sent for recycling. Any batteries contained within the product or used during the products life should be removed from the product and also be sent to an appropriate recycling facility, per [The Waste Electrical and Electronic Equipment \(WEEE\) Regulations 2012/19/EU](#). Campbell Scientific can advise on the recycling of the equipment and in some cases arrange collection and the correct disposal of it, although charges may apply for some items or territories. For further support, please contact Campbell Scientific, or your local agent.

Table of contents

1. Introduction	1
2. Precautions	1
3. Initial inspection	1
4. Measurement quickstart using SURVEYOR	2
5. Programming quickstart using SURVEYOR	4
6. Programming quickstart using Short Cut	5
7. Overview	8
7.1 Wiring panel overview	9
7.1.1 Communications ports	10
7.1.2 LED indicators	10
7.1.2.1 COMM status	10
7.1.2.2 CPI port	10
8. Specifications	10
8.1 Thermocouple measurement specifications	10
8.2 Module	12
8.2.1 Communications	12
8.2.2 System	12
8.2.3 Power requirements	12
8.2.4 Compliance	12
8.2.5 Physical attributes	12
9. Installation	13
9.1 Install driver for computer connection	13
9.2 Operating systems	13
9.3 Configuring TEMP 120	14
9.3.1 Configuring with SURVEYOR	14
9.3.2 Configuring with the CPIAddModule() instruction	14
9.3.3 Configuring with Device Configuration Utility	15
9.3.4 Configuring with CPIStatus table	15
9.4 Data logger programming	16

9.4.1 Scan buffers	16
9.4.2 GRANITE Measurement Module instructions	16
9.5 Data logger connection	17
9.6 Connecting multiple GRANITE Measurement Modules	17
9.6.1 Daisy-chain topology	18
9.6.2 Star topology	18
9.7 Power connection	19
9.7.1 Power-up sequence	19
9.8 Earth ground connection	19
9.9 Mounting in an enclosure	20
10. Operation	21
10.1 SURVEYOR control	21
10.2 Data logger control	21
10.3 Measurements	21
10.4 CPI network bit rate	22
10.5 Multiple devices	23
11. Maintenance and calibration	23
12. Troubleshooting	24
12.1 CPIStatus table	24
12.2 Status LED	25
12.3 CPI port LEDs	26
12.4 Replacing a GRANITE Measurement Module	26
Appendix A. Importing Short Cut code into CRBasic Editor	27
Appendix B. Example programs	28
B.1 Configuring GRANITE Measurement Module with CPIAddModule()	28
B.2 Measuring thermocouples	29
B.3 Measuring TEMP 120 and VOLT 108 at different speeds	30
B.4 Synchronized TEMP 120 and VOLT 108 measurements	31

1. Introduction


The TEMP 120 is a 20-channel thermocouple measurement module. For sensor connections it offers universal type miniature thermocouple jacks. An individual reference junction temperature sensor is located at the base of every connection. Since the device is purpose built, it uses a simplified data logger measurement instruction and computes the compensated temperature onboard rather than relying on a data logger to make the calculation.

2. Precautions



- READ AND UNDERSTAND the [Safety](#) section at the back of this manual.
- WARNING:
 - Protect from over-voltage
 - Protect from water
 - Protect from ESD (electrostatic discharge)
- IMPORTANT: Maintain a level of calibration appropriate to the application. Campbell Scientific recommends factory recalibration of Extended Duty (XD) TEMP 120 units every three years.

3. Initial inspection




- Inspect the packaging and contents for damage immediately. File damage claims with the shipping company.
- Check packaging materials for all products. Check model numbers, part numbers, product descriptions, and cable lengths against shipping documents. Model or part numbers are found on each product. Cable numbers are normally found at the end of the cable that connects to the measurement device. Check that expected cable lengths were received. Contact Campbell Scientific immediately if you find any discrepancies.
- Check the operating system version in the TEMP 120, and the data logger. Update as needed. See [Operating systems](#) (p. 13).

- For more information on accessing the calibration certificate watch a video at www.campbellsci.com/videos/calibration-certs .

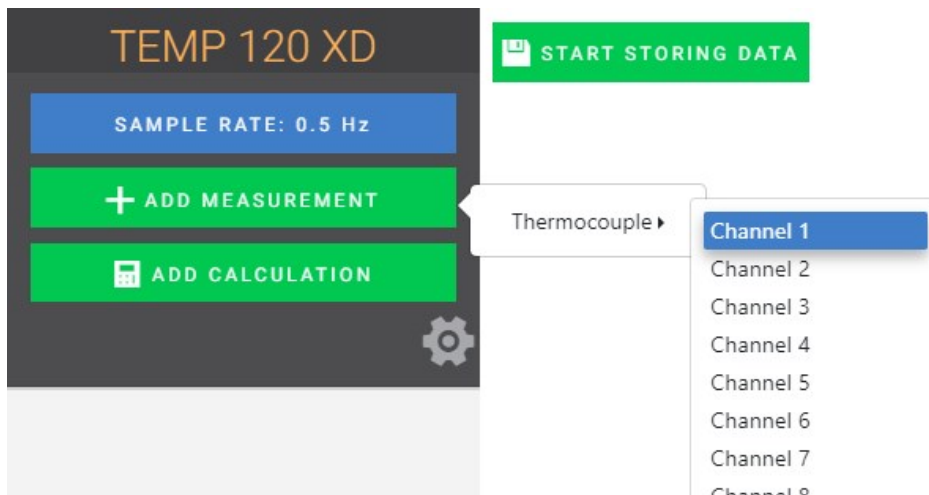
4. Measurement quickstart using *SURVEYOR*

Campbell Scientific *SURVEYOR* software is an easy way to quickly see measurement results and store data from the TEMP 120. The module configuration can be saved on the computer or exported as a CRBasic data logger program. *SURVEYOR* is available as a download from www.campbellsci.com/cs-surveyor . A video tutorial is available at www.campbellsci.com/videos/surveyor .

This section will guide you through reading a differential Type-T thermocouple on a TEMP 120. With minor changes, these steps can apply to other compatible measurements.

1. Open *SURVEYOR* .
2. Connect a USB cable between your computer and the TEMP 120 **USB** port.
3. Apply 9.6 to 32 VDC external power using the green **Power** connector on the side of the TEMP 120.
4. Select **Connect Now** .
5. Select the communications port, it will be labeled similar to **TEMP 120 (COM3)**.
6. Make selections for **Speed or Noise Rejection** and **CAN enabled**. See the *SURVEYOR* help  for more information on all settings.
7. Click **APPLY**.
8. Select a **SAMPLE RATE**. For this exercise, select **1/2 Hz**.

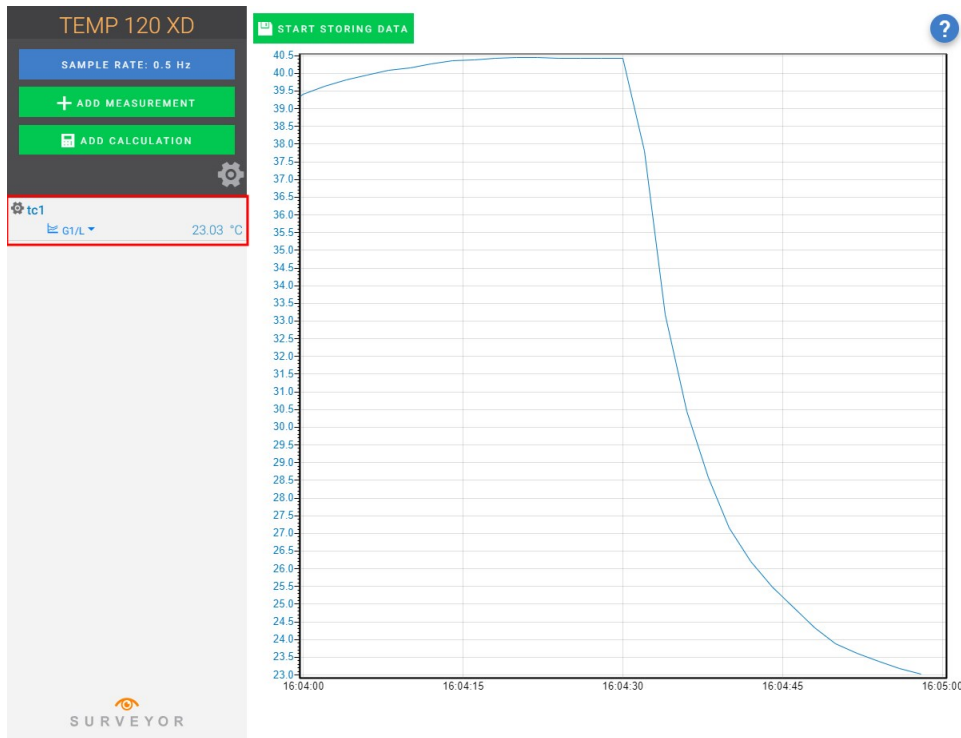
9. **ADD MEASUREMENT(s)**. For this exercise, add a Type-T differential thermocouple on **Channel 1**. Insert the sensor into Terminal 1 on the TEMP 120.



10. Complete the rest of the form and **APPLY** to save the configuration.

The 'Thermocouple1 Properties' dialog box is shown. It has a title bar with a close button. The 'Variable Name' field contains 'tc1'. The 'Thermocouple Type' dropdown is set to 'TypeT Copper Constantan'. The 'Units' dropdown is set to '°C'. The 'Number of Sensors' field contains '1'.

11. Check the resulting measurements in the numeric and graphic displays.



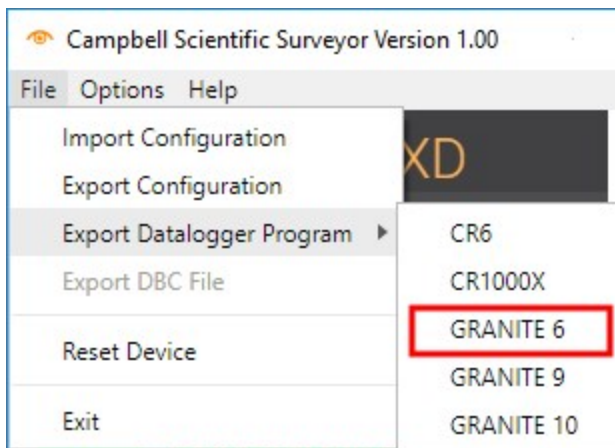
12. Click **START STORING DATA** . While data is being stored, the options to stop and pause data storage become available.

5. Programming quickstart using *SURVEYOR*

Campbell Scientific *SURVEYOR* is an easy way to generate a simple *CRBasic* program for your TEMP 120 Campbell Scientific data acquisition system.


1. Configure the TEMP 120 for measurements, see [Measurement quickstart using SURVEYOR](#) (p. 2).

2. Select **File > Export Datalogger Program** then select the data logger you will be connecting the TEMP 120 to. For this example, we'll select GRANITE 6.



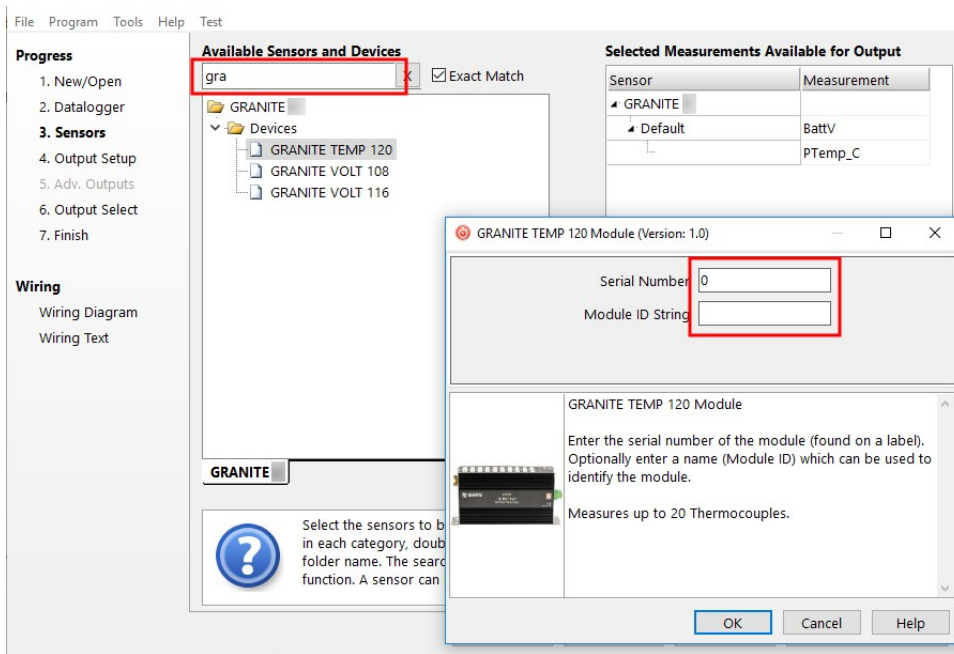
3. By default, the *CRBasic* program will be saved in C:\Users\username\Documents\SURVEYOR.

6. Programming quickstart using *Short Cut*

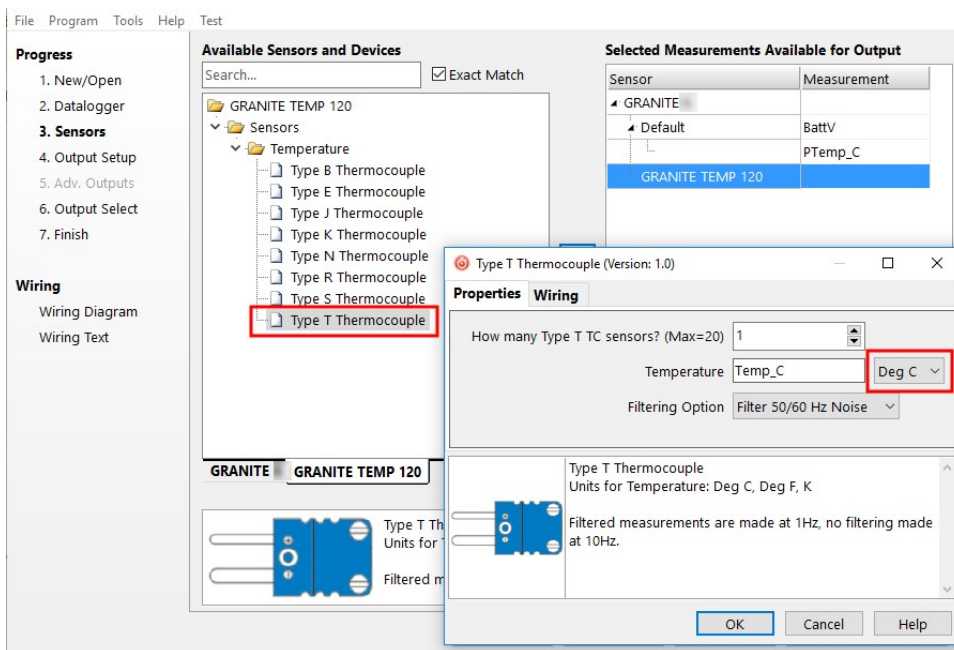
Short Cut is another easy way to program a Campbell Scientific data acquisition system to measure a sensor and assign wiring terminals. *Short Cut* is available as a download from www.campbellsci.com/shortcut . It is also included in installations of *LoggerNet*, *RTDAQ*, and *PC400*.

The following procedure shows using *Short Cut* to program the data logger to measure a type-T thermocouple on a TEMP 120.

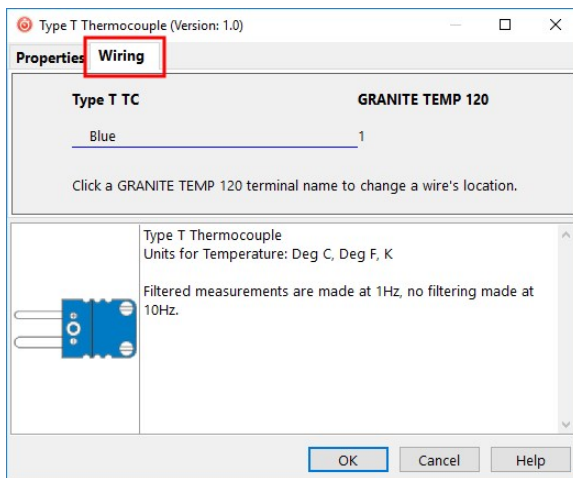
1. Open *Short Cut* and click **Create New Program**.
2. Double-click your data logger.
3. In the **Available Sensors and Devices** box, start typing GRANITE. You can also locate it in the **Devices** folder. Double click the GRANITE Measurement Module you are working with. Type the serial number located on the TEMP 120 label. Optionally, type a name in the **Module ID String** if you want the module to have an ID. This is useful when multiple TEMP 120 modules are connected to the data logger.



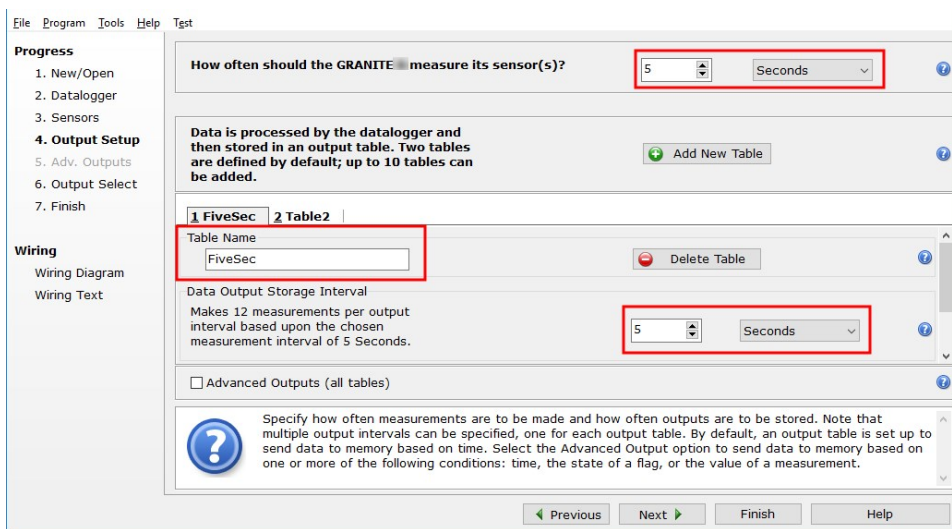
4. In the **Available Sensors and Devices** box, type Type T. You can also locate the thermocouple in the **Sensors > Temperature** folder. Double click **Type T Thermocouple**. Type the number of type T thermocouples connected to the TEMP 120. The temperature defaults to degree C. This can be changed by clicking the **Temperature** units box and selecting one of the other options.



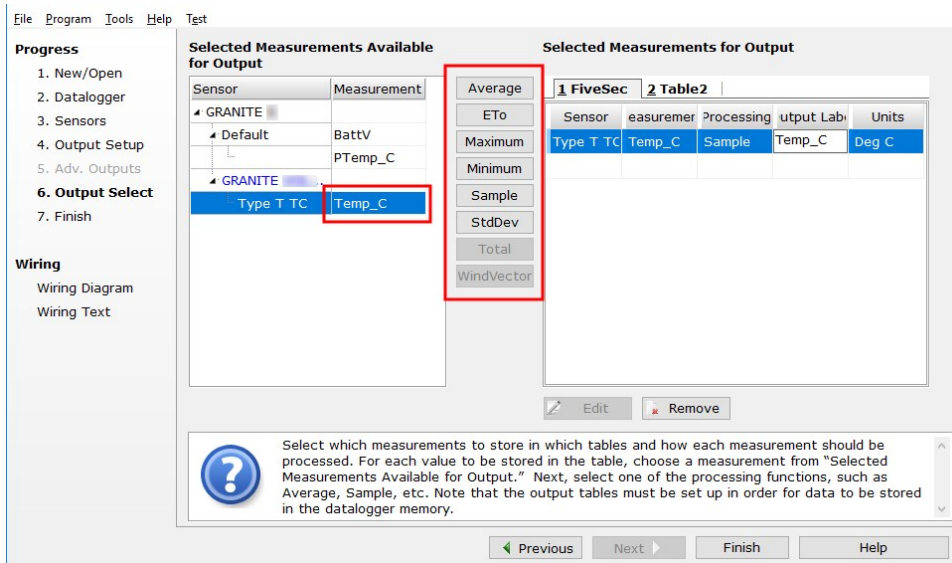
- Click on the **Wiring** tab to see how the sensor is to be wired to the TEMP 120. Click **OK** after wiring the thermocouple.



- Repeat steps four and five for other sensors you want to measure. Click **Next**.
- In **Output Setup**, type the scan rate, a meaningful table name, and the **Data Output Storage Interval**.



8. Select the measurement and its associated output option.



9. Click **Finish** and save the program. Send the program just created to the data logger if it is connected to the computer.
10. If the thermocouple is connected to the TEMP 120, check the output of the thermocouple in the data display of *LoggerNet*, *RTDAQ*, or *PC400* to make sure it is making reasonable measurements.

7. Overview

The TEMP 120 expands the number of thermocouple measurement terminals and increases the measurement speed potential in a data logger system. GRANITE Measurement Modules operate through a data logger program and communicate using the CAN peripheral interface (CPI). A single data logger can operate multiple GRANITE Measurement Modules.

The TEMP 120 is compatible with the following data loggers:

- GRANITE 10
- GRANITE 9
- GRANITE 6
- CR6
- CR1000X

7.1 Wiring panel overview

The thermocouple jacks are keyed, requiring plugs to be inserted with the wider (-) blade to the left.

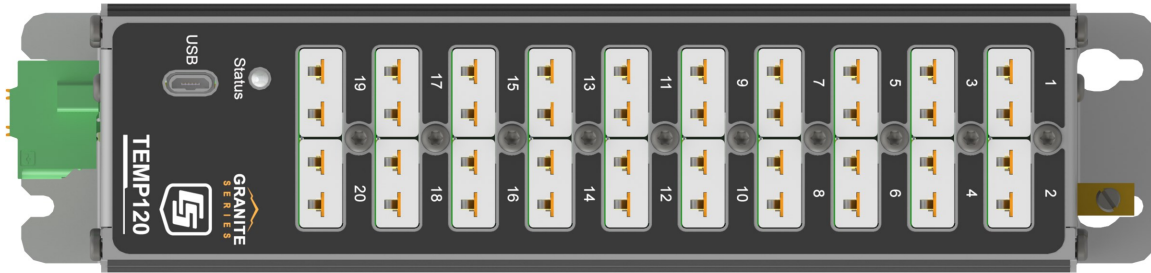


Figure 7-1. TEMP 120 Wiring panel

The removable **Power** connector is the connection point for external power supply components. The power supply must be in the range of 9.6 to 32 VDC.

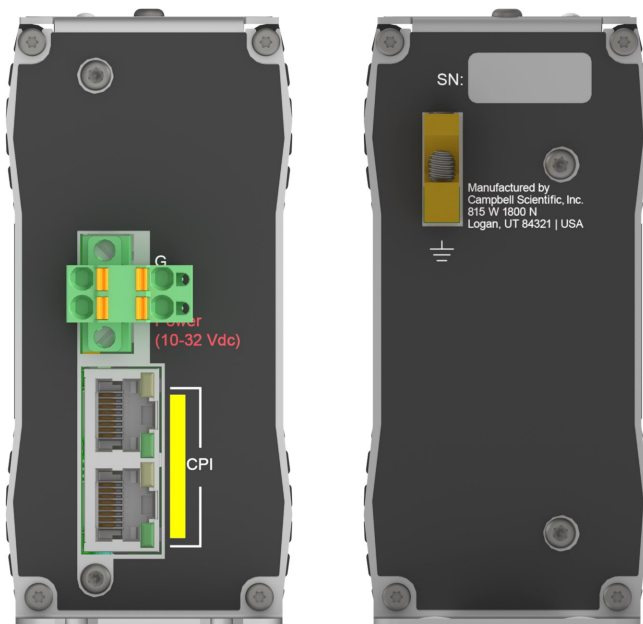


Figure 7-2. Power and CPI ports view (left) and ground lug view (right)

Earth Ground Lug (⚡) – connection point for a heavy-gage earth-ground wire. A good earth connection is necessary to secure the ground potential of the TEMP 120 and shunt transients away from electronics. 14 AWG wire, minimum, is recommended.

7.1.1 Communications ports

One micro-B **USB** port, labeled **USB**, is for communicating with a computer through *SURVEYOR* or *Device Configuration Utility* software.

CPI is a proprietary protocol that supports GRANITE Measurement Modules. Two RJ45 ports labeled **CPI** enable communications with a Campbell Scientific data logger and other GRANITE Measurement Modules.

7.1.2 LED indicators

7.1.2.1 COMM status

When the TEMP 120 has successfully been configured by a data logger, the **COMM Status** LED will flash green. For scan rates 500 ms or slower, it will flash at the scan rate. For faster scan rates, the LED will flash green every few scans. See [Table 12-2](#) (p. 26).

7.1.2.2 CPI port

When the TEMP 120 has successfully been configured by a data logger, the green LED on the **CPI** port will flash. For scan rates 500 ms or slower, it will flash at the scan rate. For faster scan rates, the green LED will flash every few scans. A flashing orange LED indicates bus activity. A solid orange LED indicates a bus error. See [Table 12-3](#) (p. 26).

8. Specifications

All Standard Duty (SD) TEMP 120 units meet electrical specifications in a temperature range of -40 to 70 °C, non-condensing environment. Extended Duty (XD) units are tested over an extended temperature range of -55 to 85 °C. Recommended calibration interval of XD units is every three years.

8.1 Thermocouple measurement specifications

Thermocouple measurements use a 24-bit Analog-to-Digital (A-to-D) converter. One channel at a time is measured in numeric succession.

Terminals: 20 channels - Universal (copper/copper), miniature socket connectors

Supported types: B, E, J, K, N, R, S, T

Internal cold junction accuracy

SD (–40 to 70 °C): ± 0.05 °C typical (20 to 40 °C)
 ± 0.28 °C maximum (–40 to 70 °C)

XD (–55 to 85 °C): ± 0.36 °C maximum

Total measurement accuracy (static temperature environment)

SD (–40 to 70 °C): ± 0.4 °C typical (20 to 40 °C)
 ± 0.8 °C maximum (–40 to 70 °C)

XD (–55 to 85 °C): ± 1.0 °C maximum

Total measurement accuracy (rapid temperature environment ramps)

(8 °C per minute ambient gradient)

SD (–40 to 70 °C): ± 3 °C maximum

XD (–55 to 85 °C): ± 3 °C maximum

Resolution: 0.015 °C

Measurement Performance Verification and Calibration:

SD (–40 to 70 °C): Performance is based on engineering design and verified in a laboratory environment. Does not include a Certificate of Calibration.

XD (–55 to 85 °C): Performance is based on engineering design and verified over the full temperature range of the product and includes a Certificate of Calibration and Instrument Data Report.

Speed. All 20 channels at rates

up to: 10 Hz when filtering is disabled

1 Hz when filtering is enabled

Input limits: 0.25 to 3.0 VDC (Built-in ± 1.65 VDC bias voltage)

Maximum input voltage: ± 10 VDC

DC common-mode rejection: ≥ 115 dB

Normal-mode rejection: > 80 dB at 50 and 60 Hz

8.2 Module

8.2.1 Communications

CPI:	RJ45 interface to Campbell Scientific data loggers, sensors, and GRANITE Measurement Modules.
USB:	USB micro-B device only, 2.0 full-speed 12 Mbps, for computer connection.


8.2.2 System

Processor:	Renesas RX63N (32-bit with hardware FPU, running at 96 MHz)
Memory:	2 MB SRAM
A/D Convertor:	24-bit sigma-delta

8.2.3 Power requirements

Voltage:	9.6 to 32 VDC
Typical Current Drain	
Sleep:	5 mA
Active:	30 mA

8.2.4 Compliance

View EU Declarations of Conformity at www.campbellsci.com/temp120 .

8.2.5 Physical attributes

Dimensions:	20.3 x 12.7 x 5.1 cm (8.0 x 5.0 x 2.0 in); additional clearance required for cables and wires
Weight:	0.9 kg (1.95 lb)
Operating temperature	
Standard duty (SD):	−40 to 70 °C
Extended duty (XD):	−55 to 85 °C

9. Installation

Preconfigure and test stations in an indoor location before doing the field installation.

After installing a field station, wait long enough to confirm that good measurements are being made, that data is collected by the data logger, and that data from the data logger can be copied to a computer.

9.1 Install driver for computer connection	13
9.2 Operating systems	13
9.3 Configuring TEMP 120	14
9.4 Data logger programming	16
9.5 Data logger connection	17
9.6 Connecting multiple GRANITE Measurement Modules	17
9.7 Power connection	19
9.8 Earth ground connection	19
9.9 Mounting in an enclosure	20

9.1 Install driver for computer connection


SURVEYOR automatically installs the required drivers. See: [Measurement quickstart using SURVEYOR](#) (p. 2). When **SURVEYOR** is not used, the device driver must be installed before connecting to the TEMP 120 via USB for the first time.

To install the device driver using *Device Configuration Utility*, select **Granite > TEMP 120**. Click **Install USB Driver** and follow the prompts.

TIP:

Driver installation is optional for computers running Windows 10 and later.

9.2 Operating systems

Campbell Scientific posts operating system (OS) updates at www.campbellsci.com/downloads  when they become available. Before deploying instruments, check OS versions and update as needed to the most recent version. Use the *Device Configuration Utility* and follow the procedures on the **Send OS** tab.

NOTE:

For best performance, use the most recent OS for each device.

9.3 Configuring TEMP 120

The TEMP 120 arrives ready to be connected to a system with a default CPI address of 1. Device configuration is only required when multiple GRANITE Measurement Modules are connected to a single data logger. Each module must have a unique CPI address. Set a unique device name for further distinction between GRANITE Measurement Modules.

Configure the TEMP 120 using one of four methods: through *SURVEYOR*, the `CPIAddModule()` program instruction, *Device Configuration Utility* software, or the `CPIStatus` table.

9.3.1 Configuring with *SURVEYOR*

Modules are automatically configured when connected to *SURVEYOR*. *SURVEYOR* sets the module CPI address to 1 and uses the device type and serial number to generate and assign a device name such as 'TEMP120-1234'.

For more information see [Measurement quickstart using SURVEYOR](#) (p. 2).

9.3.2 Configuring with the `CPIAddModule()` instruction

To configure a TEMP 120 within a program, use the `CPIAddModule()` instruction. A separate instruction is used for each device. The `CPIAddModule()` instruction overrides settings entered by other means, such as *Device Configuration Utility* or the `CPIStatus` table.

```
CPIAddModule(CDMType, CDMSerialNo, CDMDeviceName, CPIAddress)
```

The data logger creates an internal list of CPI modules from each `CPIAddModule()` instruction. Modules added to the CPI bus will be checked against this list and reconfigured accordingly. See a programming example: [Configuring GRANITE Measurement Module with CPIAddModule\(\)](#) (p. 28).

NOTE:

The `CPIAddModule()` instruction overrides changes made through *SURVEYOR*, *Device Configuration Utility* or the `CPIStatus` table.

9.3.3 Configuring with *Device Configuration Utility*

Install the device driver before connecting the TEMP 120 to a computer. This is optional for Windows 10, or later, operating systems.

1. Open *Device Configuration Utility*.
2. Under **Device Type**, select **Granite > TEMP 120**.
3. Carefully review the Connecting with USB Instructions text provided on the right.
4. Apply 9.6 to 32 VDC to the power terminals on the device.
5. With the USB device driver installation complete, connect the supplied USB cable between the USB port on your computer and the **USB** port on the TEMP 120.
6. Select **Direct** under **Connection Type**
7. Under **Communication Port**, select the port labeled **TEMP 120**.
8. Click **OK**.
9. Click **Connect** then **OK** to avoid conflicts.
10. Set the **Device Name** (optional) and the **CPI Address**.
 - a. **Device Name** is a user-editable field to set a unique name to the TEMP 120. The default name is **TEMP 120**.
 - b. **CPI Address** specifies the address of the TEMP 120. Each GRANITE Measurement Module connected to the same data logger must have a unique address. By default, the TEMP 120 uses a CPI address of 1. Allowable addresses are 1 through 120.
11. Click **APPLY** to save your changes.

9.3.4 Configuring with CPIStatus table

When a GRANITE Measurement Module is used in a program, the data logger adds a **CPIStatus** table to display current CPI information. View the **CPIStatus** table in the *LoggerNet* Connect screen, or *Device Configuration Utility Data Monitor* tab. Information about each module included in the data logger program or connected to the CPI bus appears in the **CPIStatus** table within the **ModuleInfo()** array. Information is shown in the following order:

GRANITE Measurement Module Type, Serial Number, Device Name, CPI Address, Activity,
CDM OS Version

Within the **ModuleInfo()** array index string, the Device Name and CPI Address fields can be edited. This provides a way to rename and readdress a TEMP 120 through Campbell Scientific software without editing the CRBasic program or connecting directly to the **USB** port.

See [CPIStatus table](#) (p. 24) for additional information.

9.4 Data logger programming

Short Cut is the best source for up-to-date data logger programming code. Programming code is needed when:

- Creating a program for a new data logger installation
- Adding sensors to an existing data logger program

If your data acquisition requirements are simple, you can likely create and maintain a data logger program exclusively with **Short Cut**. If your data acquisition needs are more complex, the files that **Short Cut** creates are a great source for programming code to start a new program or add to an existing custom program.

NOTE:

Short Cut cannot edit programs after they are imported and edited in **CRBasic Editor**.


See [Programming quickstart using Short Cut](#) (p. 5) for a **Short Cut** tutorial. If you wish to import **Short Cut** code into **CRBasic Editor** to create or add to a customized program, follow the procedure in [Importing Short Cut code into CRBasic Editor](#) (p. 27). Complete program examples can be found in: [Example programs](#) (p. 28).

9.4.1 Scan buffers

When TEMP 120 instructions are included in a program, Campbell Scientific recommends setting the **BufferOption** of the [Scan\(\)](#) instruction to a value greater than or equal to two seconds' worth of scans. For example, if the scan rate is 50 ms (.05 s), set the **BufferOption** to **40** ($2\text{ s} \div .05\text{ s} = 40$). At a minimum, the **BufferOption** should be set to **3**.

The data logger processes the data from the TEMP 120 in batches according to frame syncs received from the TEMP 120. Upon receiving a batch of data, the data logger puts it into a processing queue. Processing the data may take more time than is available in a single scan. The **BufferOption** allows the data logger to balance its task load by processing the data from the TEMP 120 during subsequent scans while maintaining correct data time stamps. If a **BufferOption** is not set, the data logger will attempt to process all of the data during the scan it is received, which can result in skipped scans. Scan buffers are only used when the data logger is running in pipeline mode.

9.4.2 GRANITE Measurement Module instructions

For the most current information on data logger instructions, refer to the [CRBasic Editor Help](#) .

The first two parameters for each CDM instruction are the **CDMType** and **CPI_Addr**. **CDMType** refers to the GRANITE Measurement Model used; use **TEMP120**. **CPI_Addr** is the address of the TEMP 120. Connect sensors to the terminals specified within the corresponding measurement instructions. The following program example shows the use of **CDM_TCComp()**.

CRBasic Example 1: Measuring one thermocouple

```
'Program Example: Measuring a type-T thermocouple  
Public tc1  
  
BeginProg  
  CPIAddModule(TEMP120, 16, "TEMP120-16", 1)  
  Scan(2000000, usec, 500, 0)  
  'Measure Type T thermocouple on TEMP 120, CPI address 1  
  CDM_TCComp(TEMP120, 1, tc1, 1, 1, TypeT, 1, 0)  
  NextScan  
EndProg
```

9.5 Data logger connection

TEMP 120 devices communicate with a data logger through a **CPI** port. Each TEMP 120 ships with a 6-inch RJ45 cable for this connection, though any CAT5e, or better, RJ45 cable can be used. To allow daisy-chaining, two **CPI** ports are available on the TEMP 120. Either **CPI** port on the TEMP 120 connects directly to the **CPI** port on a GRANITE 10, GRANITE 9, GRANITE 6, CR6, or CR1000X data logger.

9.6 Connecting multiple GRANITE Measurement Modules

The CPI bus, which handles the communications between the data logger and GRANITE Measurement Modules, can accept addresses **1 to 120**. Multiple GRANITE Measurement Modules may be connected to a single data logger using a daisy-chain or star topology. In both network configurations, as total cable length increases, the maximum possible bit rate decreases. Therefore, in networks with long cable lengths, it may be necessary to use the **CPISpeed()** instruction to decrease the CPI network bit rate from its default 250 kbps. Limitations on cable length and bit rate are discussed further in **CPI network bit rate** (p. 22) and listed in **Table 10-1** (p. 23).

9.6.1 Daisy-chain topology

In a daisy-chain topology, GRANITE Measurement Modules are connected one after another, as shown in [Figure 9-1](#) (p. 18).

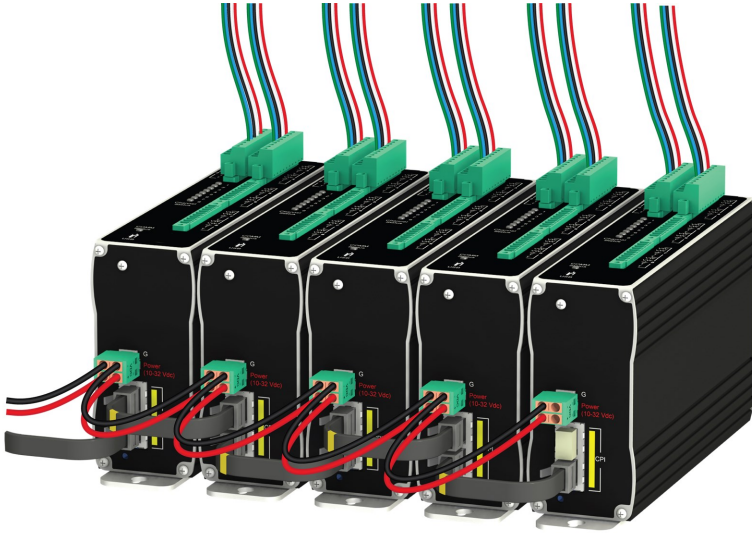


Figure 9-1. Multiple GRANITE Measurement Modules connected in a daisy-chain topology

For best performance, a CPI terminator (supplied in a CPI Network Kit) is installed in the open CPI port at the end of a daisy-chain network. For more information see: <https://s.campbellsci.com/documents/us/technical-papers/cpi-bus.pdf>.

9.6.2 Star topology

A star topology uses a passive RJ45 hub, such as the HUB-CPI, to connect multiple GRANITE Measurement Modules. An illustration of this is shown in [Figure 9-2](#) (p. 19).

NOTE:

Do not use a CPI terminator with this configuration.

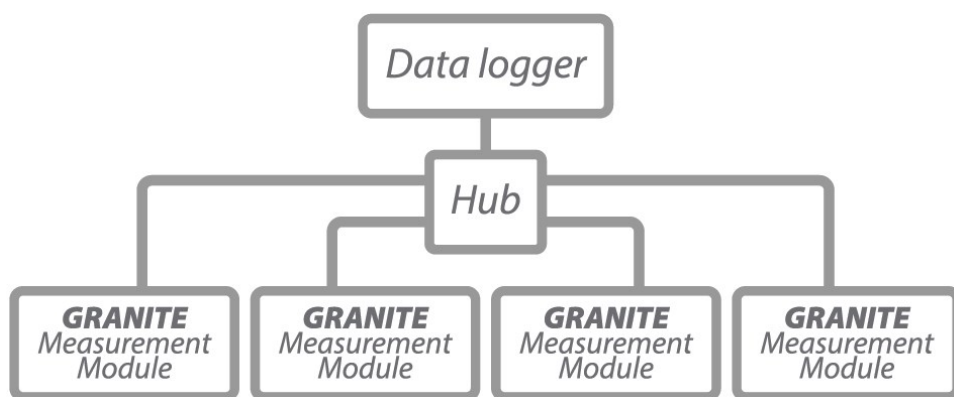


Figure 9-2. Multiple GRANITE Measurement Modules connected in a star topology

9.7 Power connection

Connect the power supply to the removable **Power** connector on the side of the TEMP 120. Power supplies providing voltages from 9.6 to 32 VDC may be used.

- While the input power requirements of Campbell Scientific instruments vary, there is one constant – they all run on 12 VDC. To keep things simple, we only discuss the use of 12 VDC power supplies in this manual.
- Do not connect energized wires to an instrument. All connections discussed assume de-energized wires. Switch off power supplies before making connections.
- Double check the polarity of connections before switching on power supplies.

9.7.1 Power-up sequence

Best practice is to start all instruments in a station simultaneously from a single power supply. If this is not possible, first turn on TEMP 120s, then the data logger. This procedure will reduce the time required to synchronize the CPI bus.

See [Status LED](#) (p. 25) for more information.

9.8 Earth ground connection

Earth grounding provides protection from static discharge, transients, and power surges. A ground lug is provided on the TEMP 120 for connection to earth ground, see [Wiring panel overview](#) (p. 9). At a minimum, 14 AWG ground wire is recommended. The earth side of the connection should be to a grounding rod or other grounded device.

9.9 Mounting in an enclosure

Campbell Scientific data loggers and GRANITE Measurement Module brackets have mounting holes through which small screws are inserted into nylon anchors in an enclosure backplate.



Figure 9-3. Enclosure backplate mounting

If mounting to a DIN rail, use the GRANITE-series DIN-Rail Kit as shown in the following images.

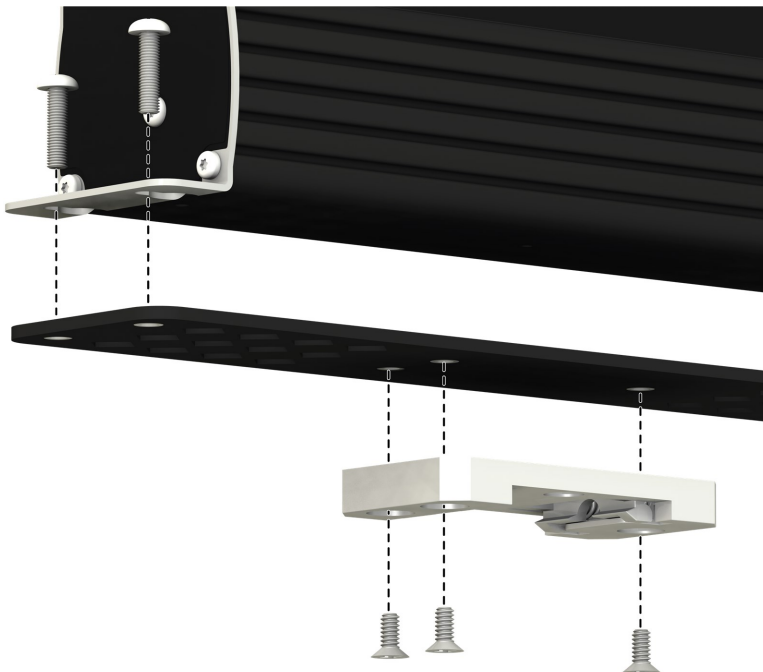


Figure 9-4. GRANITE DIN-Rail Mounting Kit



Figure 9-5. DIN rail mounting

10. Operation

The TEMP 120 makes thermocouple measurements either under the direction of *SURVEYOR* or the data logger.

10.1 *SURVEYOR* control

SURVEYOR sets up the TEMP 120 to start making measurements, display data, and store that data to a computer. For more information, see [Measurement quickstart using SURVEYOR](#) (p. 2).

10.2 Data logger control

Upon compiling the program, the data logger sends information to each TEMP 120 about every relevant sequence, scan, and measurement. The data logger uses a data sync to initiate measurements on the TEMP 120. Because measurements can be made in multiple scans, slow sequences, sub-scans, and subroutines, the data logger firsts sends a message to the modules indicating which measurements are to be made upon the next data sync.

When the TEMP 120 receives a sync signal, it begins making measurements. The measurement order on the TEMP 120 follows the sequence of the instructions addressed to it within the current active scan of the data logger program. After the measurements are completed, it sends the data to the data logger for processing.

10.3 Measurements

The TEMP 120 is a purpose-built device made to measure thermocouples. Beyond specifying input channels and thermocouple types, you only need to specify two operational parameters: temperature units (Celsius, Fahrenheit, or Kelvin) and filtering.

Measurements can be made with filtering enabled or disabled. When enabled, the input signal is filtered to remove 50 and 60 Hz components. Filtering requires additional measurement time and limits the minimum measurement period to 1 second (maximum measurement rate of 1 Hz). Disabling the filter allows a minimum period of 100 milliseconds (maximum rate of 10 Hz).

NOTE:

The maximum measurement rate is unaffected by the number of thermocouples measured. If filtering is enabled, any number of channels on the device (up to 20) can be measured as fast as 1 Hz. If filtering is disabled, any number of channels (up to 20) can be measured at up to 10 Hz.

CRBasic [Subscan\(\)](#) and [SlowSequence\(\)](#) programming provide two different options for measuring groups of sensors at different rates. See [Example programs](#) (p. 28).

10.4 CPI network bit rate

A CPI network is capable of operating at 1000, 500, 250, 125, or 50 kbps, depending on your network configuration (see [Connecting multiple GRANITE Measurement Modules](#) [p. 17]). This is the rate that data are transferred from the GRANITE Measurement Module to the data logger. When multiple GRANITE Measurement Modules are making measurements faster than 1 Hz, it is important to ensure that the CPI network bit rate is higher than the rate that data is generated by the GRANITE Measurement Modules within the network.


To calculate how many kilobits per second (kbps) will be generated, use the following **equation** for each GRANITE Measurement Module in your network:

Kilobits per second = (number of measurements) × (measurement frequency) × (0.064 kilobits per measurement)

The network topology and cable length affect the maximum allowable CPI network bit rate. Refer to [Table 10-1](#) (p. 23) for the maximum cable length allowed for the topology and bit rate your network requires. The bit rate of the network defaults to 250 kbps and can be changed by using the [CPISpeed\(\)](#) instruction in the data logger program.

Table 10-1: Network topology, bit rate, and cable length			
Bit Rate ¹ (kbps)	Maximum total cable length (ft)		
	Daisy-chain topology		Star topology
	Full termination	Half termination	No termination
1000	50	1	not viable
500	200	200	100
250	500	400	400
125	1200	1000	1000
50	2800	2400	2400
¹ Default Bit Rate is 250 kbps. Change with CPISpeed() instruction.			

10.5 Multiple devices

Multiple GRANITE Measurement Modules may be connected to a single data logger using a daisy-chain or star topology (see [Connecting multiple GRANITE Measurement Modules](#) [p. 17]). In both network configurations, as total cable length increases, the maximum possible bit rate decreases. Limitations on cable length and baud rate are examined in the document [Designing Physical Network Layouts for the CPI Bus](#) .

When including two or more TEMP 120 devices in the program, the processing mode of the data logger affects the measurement timing of each TEMP 120. In sequential mode, the TEMP 120 devices make measurements one after the other, following the order of their instructions within the program. Conversely, in pipeline mode, the devices start their measurements simultaneously. Pipeline mode is recommended.

Maintenance and calibration

- Protect the TEMP 120 from humidity and moisture.
- Send to Campbell Scientific for a performance verification and/or recalibration (-XD option only for recalibration) every three years.

If sending the TEMP 120 to Campbell Scientific for calibration or repair, consult first with a Campbell Scientific representative. If the TEMP 120 is malfunctioning, be prepared to perform some troubleshooting procedures with Campbell Scientific. Many problems can be resolved with

a conversation. If calibration or repair is needed, the procedure shown in [Assistance](#) should be followed when sending the product.

12. Troubleshooting

1. Check the voltage of the power source at the **Power** connector. It should be between 9.6 and 32 VDC.
2. Check wires and cables for the following:
 - Loose connection points
 - Faulty connectors
 - Cut wires
 - Damaged insulation, which allows water to migrate into the cable. Water, whether or not it comes in contact with wire, can cause system failure. Water may increase the dielectric constant of the cable sufficiently to impede sensor signals, or it may migrate into the sensor, which will damage sensor electronics.
3. Check the **CRBasic** program. Verify that enough data logger memory has been allocated for real-time data buffering. Typically, a [Scan\(\)](#) BufferOption of 300 to 500 should suffice. Create a simplified version of the program, or break it up into multiple smaller units to test individually. For example, if a sensor signal-to-data conversion is faulty, create a program that only measures that sensor and stores the data, absent from all other inputs and data. Write these mini-programs before going to the field, if possible.
4. Verify that each TEMP 120 in the network has a unique CPI address.
5. Check the data logger and TEMP 120 operating system and update them as needed.
6. Check that the scan rate is long enough for the measurement time. The data logger compiler often catches scan rates that are too fast.
7. Ensure the CPI network bit rate is fast enough for the data generated and that it can accommodate the cable lengths in use. (See [CPI network bit rate](#) [p. 22].)

12.1 CPIStatus table

Information in the **CPIStatus** table, located in the data logger, helps in troubleshooting.

Record No	21
Time Stamp	9/9/2020 1:15:56 PM
BusLoad	0.192
ModuleReportCount	2
ActiveModules	2
BuffErr	0
RxErrMax	0
TxErrMax	0
FrameErr	0
ModuleInfo(1)	CDM-VW300,1050,4,4,Unused,CDM-VW300.06
ModuleInfo(2)	VWIRE305,2005,VWIRE305,3,Unused,VWIRE305.06
ModuleInfo(3)	VOLT108,1605,CDM A108,1,Active
ModuleInfo(4)	VOLT116,1701,A116,2,Active
ModuleInfo(5)	TEMP120,5,MyThermometer,5,Unused,TEMP120.Beta.01.00.2020.09.08.1457

Figure 12-1. CPIStatus table

The **ModuleInfo()** array shows the following information:

Module Type, Serial Number, Device Name, CPI Address, Activity, Operating System Version

The activity entry in the **ModuleInfo()** index shows the current state of the module. Possible activity entries and their meanings are shown in the following table. The device serial number is displayed after the activity entry.

Table 12-1: CPIStatus activity	
Response	Meaning
Active	The module is connected to the CPI bus and is making measurements according to the data logger program.
Offline	The module was present after startup but is no longer responding.
Unused	The module is or was connected and powered but is not included in the data logger program.
Wait Config	The module has not yet responded to a data logger's attempts to configure it.
Config Fail	The module could not be configured. A configuration error message is appended to this response.

12.2 Status LED

The Status LED indicates the current operation of the TEMP 120, as shown in the following table.

Table 12-2: COMM Status LED Activity		
Green	Flashing	Module has been configured by data logger and is receiving sync signals
Orange	Flashing	Device has not been configured by data logger
Red	Single-Flash	Device has been configured but is not receiving sync signals
	Double-Flash	Device has encountered a scan timeout
	Solid	Error

12.3 CPI port LEDs

Green and Orange LEDs on the CPI bus indicate the current operation of the CPI bus as shown in the following table.

Table 12-3: CPI port LED activity		
Green	Flashing	Frame sync
Orange	Flash	CPI activity
	Solid	CPI bus fault

12.4 Replacing a GRANITE Measurement Module

An existing TEMP 120 can be replaced with a new module using the same CPI address without requiring a change to the program.

Appendix A. Importing *Short Cut* code into *CRBasic Editor*


Short Cut creates a .DEF file that contains wiring information and a program file that can be imported into *CRBasic Editor*. By default, these files reside in the C:\campbellsci\SCWin folder.

Import *Short Cut* program file and wiring information into *CRBasic Editor*.

1. Create the *Short Cut* program, then save it. Click the **Advanced** tab then the **CRBasic Editor** button. Your program file will open in CRBasic with a generic name. Provide a meaningful name and save the CRBasic program. This program can now be edited for additional refinement.

NOTE:

Once the file is edited with *CRBasic Editor*, *Short Cut* can no longer be used to edit the program.

2. To add the *Short Cut* wiring information into the new CRBasic program, open the .DEF file located in the C:\campbellsci\SCWin folder. Copy the wiring information found at the beginning of the .DEF file.
3. Go into the CRBasic program and paste the wiring information at the beginning of the program.
4. In the CRBasic program, highlight the wiring information, right-click, and select **Comment Block**. This adds an apostrophe (') to the beginning of each of the highlighted lines, which instructs the data logger compiler to ignore those lines when compiling. The **Comment Block** feature is demonstrated at about 5:10 in the [CRBasic | Features](#) video .

Appendix B. Example programs

These programs were written for a GRANITE 6 data logger, except where noted. With slight modifications, they can be used with other Campbell Scientific data loggers.

NOTE:

For the GRANITE 10 and GRANITE 9 data loggers, the `CPIBusAddress` parameter must include the CPI bus when using bus B. Bus A is the default. For example, `CPI_BusB + 2` specifies CPI bus B and CPI address 2.

B.1 Configuring GRANITE Measurement Module with `CPIAddModule()`

The following program sets CPI addresses and device names on TEMP 120s with serial numbers 1234, 1235, and 1236 and makes 15 Type-T thermocouple measurements on each module.

CRBasic Example 2: Using `CPIAddModule()`

```
'GRANITE 6 Datalogger
'This program sets CPI addresses and device names of three TEMP 120s and
'measures 15 input channels on each device.
'Declare Variables and Units
Public TC_Set1(15) : Units TC_Set1 = DegC
Public TC_Set2(15) : Units TC_Set2 = DegC
Public TC_Set3(15) : Units TC_Set3 = DegC
'Main Program
BeginProg
  'Set CPI Addresses
  CPIAddModule(TEMP120, 1234, "A", 4)
  CPIAddModule(TEMP120, 1235, "12345", 5)
  CPIAddModule(TEMP120, 1236, "TEMP 120 in Pump House", 6)
  'Main Scan
  Scan(5, SEC, 3, 0)
    '15 TCs on each TEMP 120 w/ CPI addresses 4, 5, and 6
    CDM_TCComp(TEMP120, 4, TC_Set1(), 15, 1, TypeT, TRUE, 0)
    CDM_TCComp(TEMP120, 5, TC_Set2(), 15, 1, TypeT, TRUE, 0)
    CDM_TCComp(TEMP120, 6, TC_Set3(), 15, 1, TypeT, TRUE, 0)
  NextScan
EndProg
```


B.2 Measuring thermocouples

The following program measures 20 thermocouples on a TEMP 120. This example uses `CDM_TCComp()` to measure both the reference thermistor and thermocouples.

CRBasic Example 3: Measuring thermocouples

```
'GRANITE 6 Datalogger
'This program sets CPI Address and Device Name on a TEMP 120 with serial
'number 1234 and uses the TEMP 120 to measure 20 Type-T thermocouples.
'Declare Variables and Units
Public TC(20) : Units TC = DegC
'Define Data Tables
DataTable(Hourly, TRUE, -1)
    DataInterval(0, 60, MIN, 10)
    Average(20, TC(), FP2, FALSE)
EndTable
'Main Program
BeginProg
    'Set CPI Address
    CPIAddModule(TEMP120, 1234, "A", 4)
    Scan(5, SEC, 3, 0)
    'Measure 20 Type-T thermocouples on TEMP 120 with CPI address 4
    CDM_TCComp(TEMP120, 4, TC(), 20, 1, TypeT, 1, 0)
    'Call Data Tables and Store Data
    CallTable(Hourly)
    NextScan
EndProg
```

B.3 Measuring TEMP 120 and VOLT 108 at different speeds

The following program measures a full-bridge sensor on a VOLT 108 at 100 Hz in the main sequence, and 20 type-T thermocouples on a TEMP 120 module in a 5-second slow sequence.

CRBasic Example 4: Measuring TEMP 120 and VOLT 108

```
'GRANITE 6 Datalogger
'This program uses a VOLT 108 module to measure a full-bridge sensor
'at 100 Hz in the main sequence, and a TEMP 120 module to measure 20
'type-T thermocouples in a 5-second slow sequence.
'Declare Variables and Units
Public strain_raw : Units strain_raw = mVpV
Public TC(20) : Units TC = DegC
'Define Data Tables
DataTable(OneSec, TRUE, -1)
  DataInterval(0, 1, SEC, 10)
  Maximum(1, strain_raw, FP2, FALSE, TRUE)
EndTable
DataTable(Hourly, TRUE, -1)
  DataInterval(0, 60, MIN, 10)
  Average(20, TC(), FP2, FALSE)
EndTable
'Main Program
BeginProg
  'MainSequence
  Scan(10, MSEC, 20, 0)
    'Measure full-bridge sensor on VOLT 108 at CPI address 1
    CDM_BrFull(VOLT108, 1, strain_raw, 1, mV200, 1, X1, 1, 5000, _
    TRUE, TRUE, 1000, 1000, 1.0, 0.0)
    'Call 1-second data table to process and store data
    CallTable(OneSec)
  NextScan
EndSequence
  SlowSequence
  Scan(5, SEC, 1, 0)
    'Measure 20 Type-T thermocouples on TEMP 120 with CPI address 2
    CDM_TCComp(TEMP120, 2, TC(), 20, 1, TYPET, 1, 0)
    'Call hourly data table to process and store data
    CallTable(Hourly)
  NextScan
EndSequence
EndProg
```

B.4 Synchronized TEMP 120 and VOLT 108 measurements

The following program measures a full-bridge sensor on a VOLT 108 at 100 Hz, and 20 type-T thermocouples on a TEMP 120 module at 1 Hz. The measurements are synchronized by putting the faster measurements in a [SubScan](#).

CRBasic Example 5: Synchronized TEMP 120 and VOLT 108 measurements

```
'GRANITE 6 Datalogger
'This program uses a TEMP 120 module to measure 20 type-T thermocouples at
'1 Hz and a VOLT 108 module to measure a full-bridge sensor at 100 Hz. A
'SubScan instruction is used to synchronize the full-bridge
'measurements with the thermocouple measurements.
'Declare Variables and Units
Public TC(20)      : Units TC          = DegC
Public strain_raw : Units strain_raw = mVpV
'Define Data Tables
DataTable(OneSec, TRUE, -1)
  DataInterval(0, 1, SEC, 10)
  Average(20, TC(), FP2, FALSE)
  Maximum(1, strain_raw, FP2, FALSE, TRUE)
EndTable
'Main Program
BeginProg
  Scan(1, SEC, 3, 0)
    'Measure 20 Type-T thermocouples on TEMP 120 with CPI address 1
    CDM_TCComp(TEMP120, 1, TC(), 20, 1, TYPET, 1, 0)
    SubScan(10, MSEC, 100)
      'Measure full-bridge sensor on VOLT 108 with CPI address 2
      CDM_BrFull(VOLT108, 2, strain_raw, 1, mV200, 1, X1, 1, _
        5000, TRUE, TRUE, 1000, 1000, 1.0, 0.0)
    NextSubScan
    'Call data table to process and store data
    CallTable(OneSec)
  NextScan
EndProg
```


Limited warranty

Covered equipment is warranted/guaranteed against defects in materials and workmanship under normal use and service for the period listed on your sales invoice or the product order information web page. The covered period begins on the date of shipment unless otherwise specified. For a repair to be covered under warranty, the following criteria must be met:

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2. The defect cannot be the result of misuse.
3. The defect must have occurred within a specified period of time; and
4. The determination must be made by a qualified technician at a Campbell Scientific Service Center/ repair facility.

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1. Equipment which has been modified or altered in any way without the written permission of Campbell Scientific.
2. Batteries; and
3. Any equipment which has been subjected to misuse, neglect, acts of God or damage in transit.


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Assistance

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When returning equipment, a RMA number must be clearly marked on the outside of the package. Please state the faults as clearly as possible. Quotations for repairs can be given on request.

It is the policy of Campbell Scientific to protect the health of its employees and provide a safe working environment. In support of this policy, when equipment is returned to Campbell Scientific, Logan, UT, USA, it is mandatory that a “[Declaration of Hazardous Material and Decontamination](#)” form be received before the return can be processed. If the form is not received within 5 working days of product receipt or is incomplete, the product will be returned to the customer at the customer’s expense. For details on decontamination standards specific to your country, please reach out to your [regional Campbell Scientific](#) office.

NOTE:

All goods that cross trade boundaries may be subject to some form of fee (customs clearance, duties or import tax). Also, some regional offices require a purchase order upfront if a product is out of the warranty period. Please contact your [regional Campbell Scientific](#) office for details.

Safety

DANGER — MANY HAZARDS ARE ASSOCIATED WITH INSTALLING, USING, MAINTAINING, AND WORKING ON OR AROUND TRIPODS, TOWERS, AND ANY ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC. FAILURE TO PROPERLY AND COMPLETELY ASSEMBLE, INSTALL, OPERATE, USE, AND MAINTAIN TRIPODS, TOWERS, AND ATTACHMENTS, AND FAILURE TO HEED WARNINGS, INCREASES THE RISK OF DEATH, ACCIDENT, SERIOUS INJURY, PROPERTY DAMAGE, AND PRODUCT FAILURE. TAKE ALL REASONABLE PRECAUTIONS TO AVOID THESE HAZARDS. CHECK WITH YOUR ORGANIZATION'S SAFETY COORDINATOR (OR POLICY) FOR PROCEDURES AND REQUIRED PROTECTIVE EQUIPMENT PRIOR TO PERFORMING ANY WORK.

Use tripods, towers, and attachments to tripods and towers only for purposes for which they are designed. Do not exceed design limits. Be familiar and comply with all instructions provided in product manuals. Manuals are available at www.campbellsci.com You are responsible for conformance with governing codes and regulations, including safety regulations, and the integrity and location of structures or land to which towers, tripods, and any attachments are attached. Installation sites should be evaluated and approved by a qualified engineer. If questions or concerns arise regarding installation, use, or maintenance of tripods, towers, attachments, or electrical connections, consult with a licensed and qualified engineer or electrician.

General

- Protect from over-voltage.
- Protect electrical equipment from water.
- Protect from electrostatic discharge (ESD).
- Protect from lightning.
- Prior to performing site or installation work, obtain required approvals and permits. Comply with all governing structure-height regulations, such as those of the FAA in the USA.
- Use only qualified personnel for installation, use, and maintenance of tripods and towers, and any attachments to tripods and towers. The use of licensed and qualified contractors is highly recommended.
- Read all applicable instructions carefully and understand procedures thoroughly before beginning work.
- Wear a hardhat and eye protection, and take other appropriate safety precautions while working on or around tripods and towers.
- Do not climb tripods or towers at any time, and prohibit climbing by other persons. Take reasonable precautions to secure tripod and tower sites from trespassers.
- Use only manufacturer recommended parts, materials, and tools.

Utility and Electrical

- You can be killed or sustain serious bodily injury if the tripod, tower, or attachments you are installing, constructing, using, or maintaining, or a tool, stake, or anchor, come in contact with overhead or underground utility lines.
- Maintain a distance of at least one-and-one-half times structure height, 6 meters (20 feet), or the distance required by applicable law, whichever is greater, between overhead utility lines and the structure (tripod, tower, attachments, or tools).
- Prior to performing site or installation work, inform all utility companies and have all underground utilities marked.
- Comply with all electrical codes. Electrical equipment and related grounding devices should be installed by a licensed and qualified electrician.
- Only use power sources approved for use in the country of installation to power Campbell Scientific devices.

Elevated Work and Weather

- Exercise extreme caution when performing elevated work.
- Use appropriate equipment and safety practices.
- During installation and maintenance, keep tower and tripod sites clear of un-trained or non-essential personnel. Take precautions to prevent elevated tools and objects from dropping.
- Do not perform any work in inclement weather, including wind, rain, snow, lightning, etc.

Internal Battery

- Be aware of fire, explosion, and severe-burn hazards.
- Misuse or improper installation of the internal lithium battery can cause severe injury.

- Do not recharge, disassemble, heat above 100 °C (212 °F), solder directly to the cell, incinerate, or expose contents to water. Dispose of spent batteries properly.

Use and disposal of batteries

- Where batteries need to be transported to the installation site, ensure they are packed to prevent the battery terminals shorting which could cause a fire or explosion. Especially in the case of lithium batteries, ensure they are packed and transported in a way that complies with local shipping regulations and the safety requirements of the carriers involved.
- When installing the batteries follow the installation instructions very carefully. This is to avoid risk of damage to the equipment caused by installing the wrong type of battery or reverse connections.
- When disposing of used batteries, it is still important to avoid the risk of shorting. Do not dispose of the batteries in a fire as there is risk of explosion and leakage of harmful chemicals into the environment. Batteries should be disposed of at registered recycling facilities.

Avoiding unnecessary exposure to radio transmitter radiation

- Where the equipment includes a radio transmitter, precautions should be taken to avoid unnecessary exposure to radiation from the antenna. The degree of caution required varies with the power of the transmitter, but as a rule it is best to avoid getting closer to the antenna than 20 cm (8 inches) when the antenna is active. In particular keep your head away from the antenna. For higher power radios (in excess of 1 W ERP) turn the radio off when servicing the system, unless the antenna is installed away from the station, e.g. it is mounted above the system on an arm or pole.

Maintenance

- Periodically (at least yearly) check for wear and damage, including corrosion, stress cracks, frayed cables, loose cable clamps, cable tightness, etc. and take necessary corrective actions.
- Periodically (at least yearly) check electrical ground connections.

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