Product Manual

TEMP 120

20-Channel Thermocouple Module

GRANITE SERIES
TEMP 120
20-Channel Thermocouple

RELIABLE SINCE 1974 MONITORING

CAMPBELL SCIENTIFIC®

Table of contents

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, is 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** ⌁ 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.
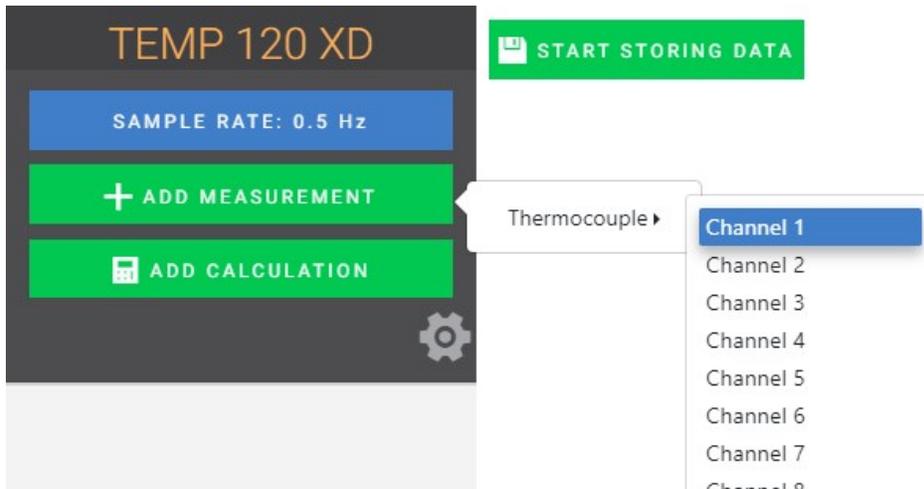
10. Complete the rest of the form and **Apply** to save the configuration.

11. Check the resulting measurements in the numeric and graphic displays.
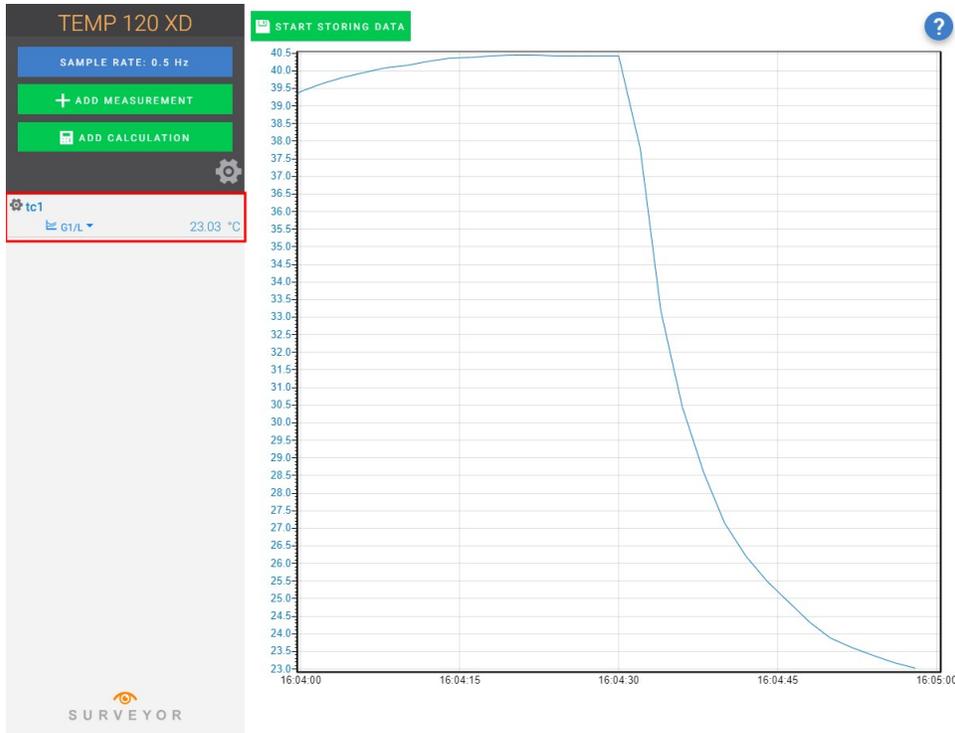
12. Click **Start Storing Data** START STORING DATA. While data is being stored the options to stop and pause data storage become available.

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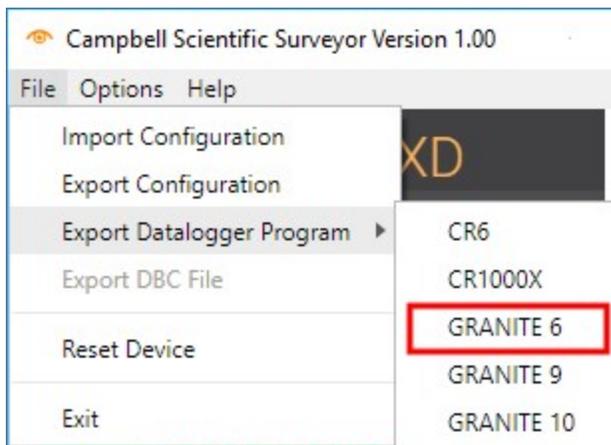
3. By default, the CRBasic program will be saved in C:\Users*username*\Documents\SURVEYOR.

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.
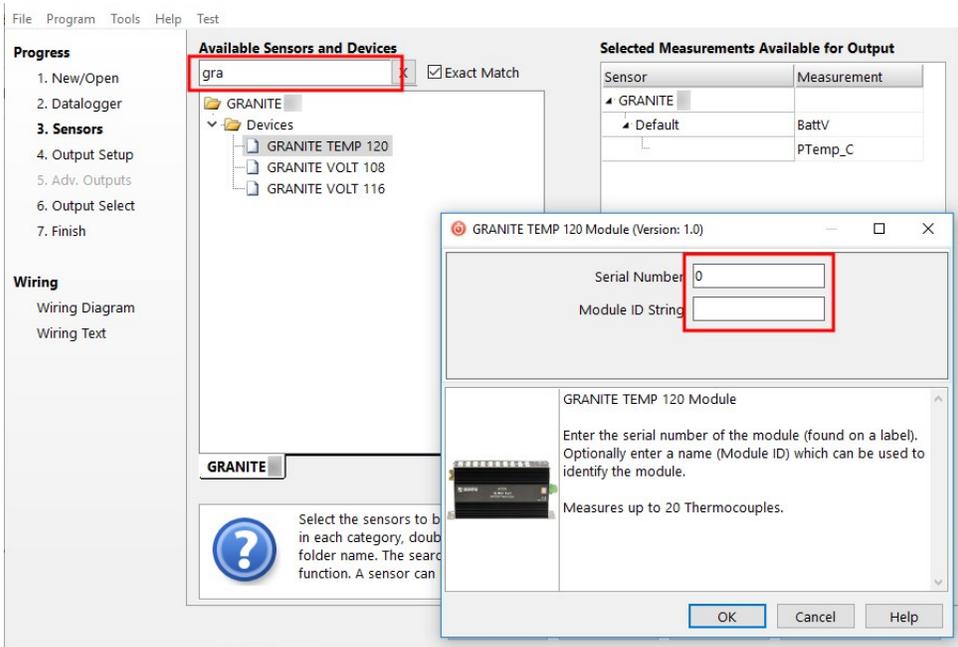
4. In the **Available Sensors and Devices** box, type Type T. You can also locate the thermocouple in the **Sensors** > **Temperature** folder. Double click **Type T Thermocouple**. Type the number of type T thermocouples connected to the TEMP 120. The temperature defaults to degree C. This can be changed by clicking the **Temperature** units box and selecting one of the other options.
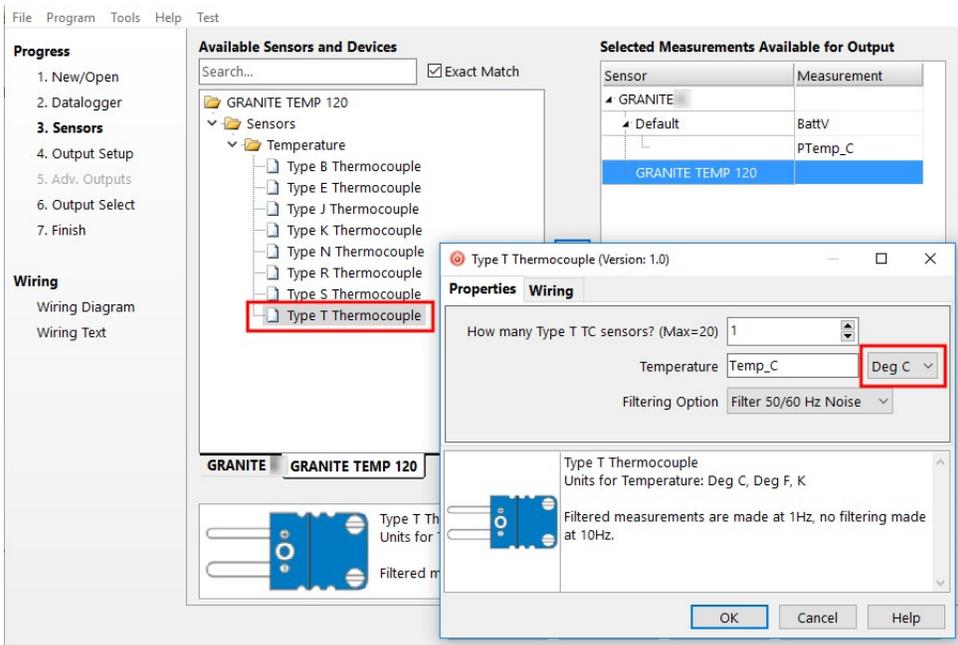
5. Click on the **Wiring** tab to see how the sensor is to be wired to the TEMP 120. Click **OK** after wiring the thermocouple.
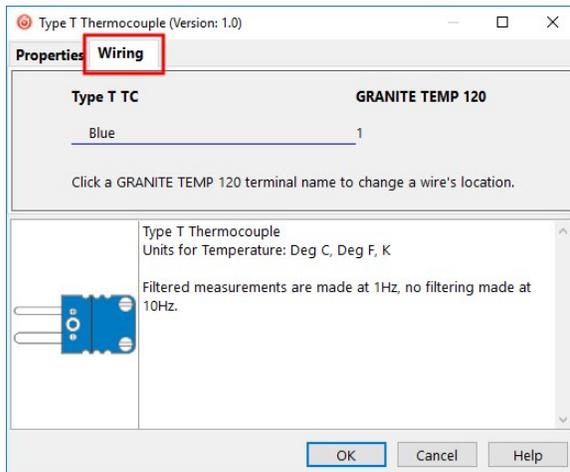
6. Repeat steps four and five for other sensors you want to measure. Click **Next**.

7. In **Output Setup**, type the scan rate, a meaningful table name, and the **Data Output Storage Interval**.
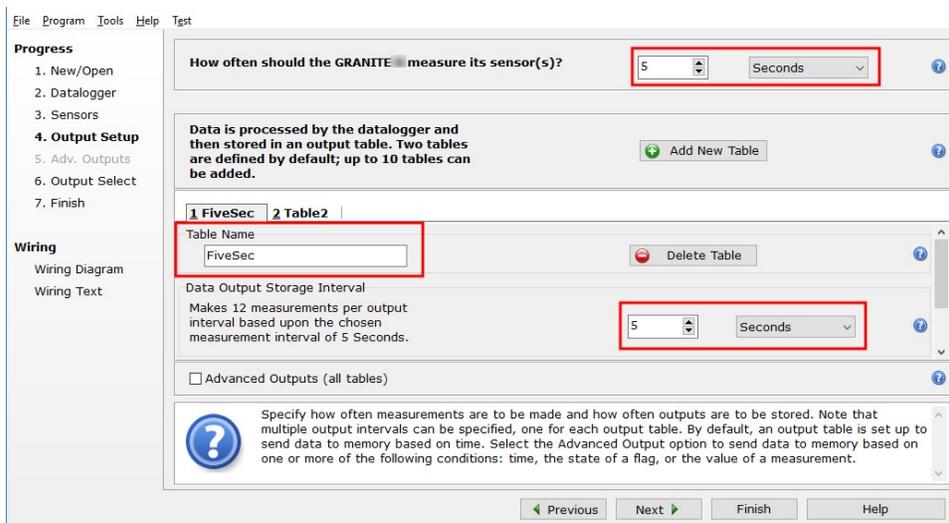
8. Select the measurement and its associated output option.
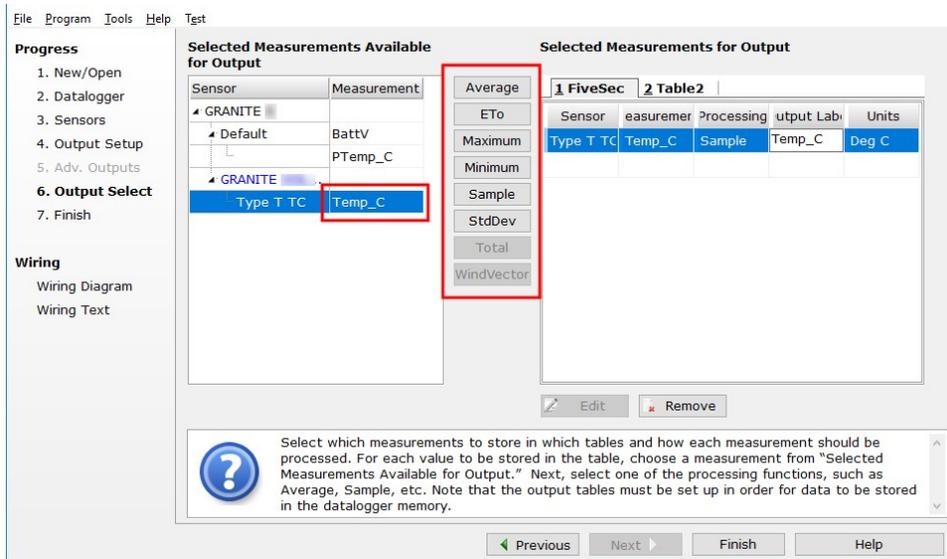
9. Click **Finish** and save the program. Send the program just created to the data logger if it is connected to the computer.

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.
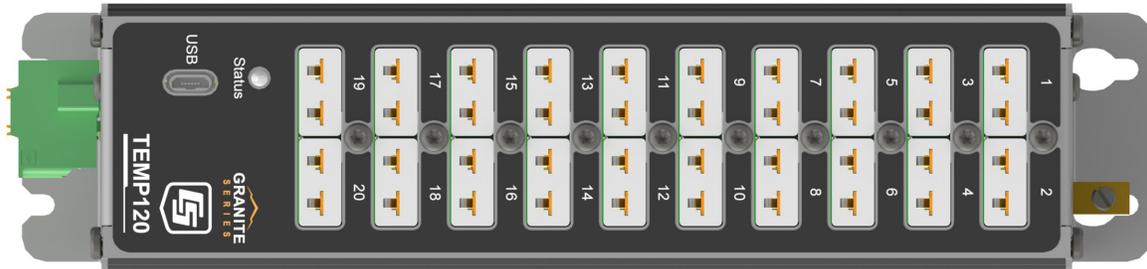
FIGURE 7-1. TEMP 120 Wiring panel

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. 25).

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. 25).

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
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

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 the *Device Configuration Utility*, select **GRANITE** > **TEMP 120**. Click the **Install the USB** driver link 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. 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 Connect Instructions text provided on the right.
4. 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.
5. Apply 9.6 to 32 VDC to the power terminals on the device.
6. Click the browse button next to **Communication Port**.

7. 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 s ÷ .05 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()`.

```
'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).
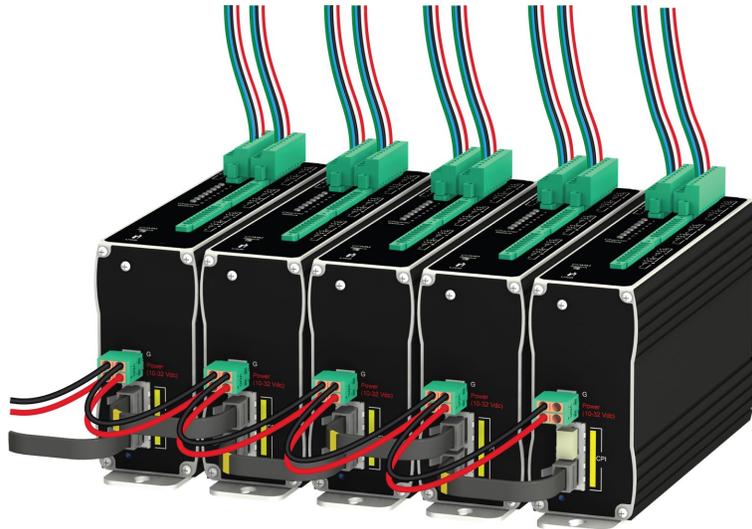
FIGURE 9-1. Multiple GRANITE Measurement Modules connected in a daisy-chain topology

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. 18).

> **NOTE:**
> Do not use a CPI terminator with this configuration.
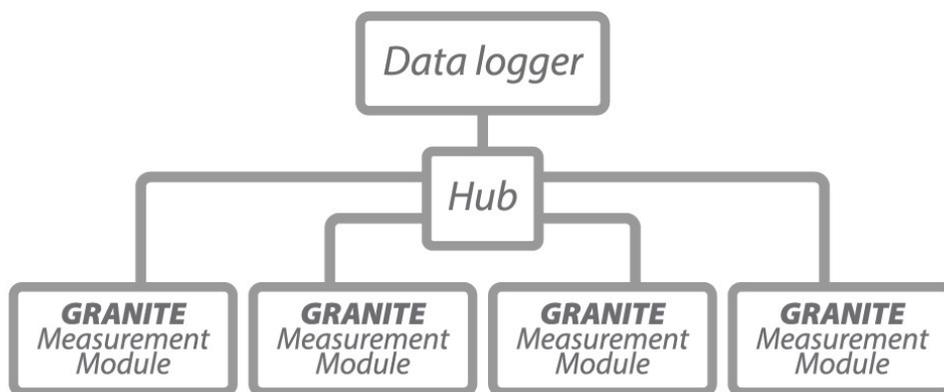
FIGURE 9-2. Multiple GRANITE Measurement Modules connected in a star topology

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). 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			
	Maximum total cable length (ft)		
Bit Rate[1] (kbps)	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.

11. Maintenance and calibration

- Protect the TEMP 120 from humidity and moisture.
- Send to Campbell Scientific for factory calibration 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. 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 that 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. The **ModuleInfo()** array shows the following information:

CDM Type, Serial Number, Device Name, CPI Address, Activity

The last entry in the **ModuleInfo()** index shows the activity of the module. Possible entries and their meanings are shown in the following table.

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 the *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. After saving the *Short Cut* program, click the **Advanced** tab then the **CRBasic Editor** button. A program file with a generic name will open in CRBasic. 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 it created.

2. To add the *Short Cut* wiring information into the new CRBasic program, open the .DEF file located in the C:\campbellsci\SCWin folder, and copy the wiring information, which is at the beginning of the .DEF file.

3. Go into the CRBasic program and paste the wiring information into it.

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
```

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- **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**.
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- Only use power sources approved for use in the country of installation to power Campbell Scientific devices.

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- Periodically (at least yearly) check electrical ground connections.

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Email:	sales@campbellsci.co.uk
Website:	www.campbellsci.co.uk

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