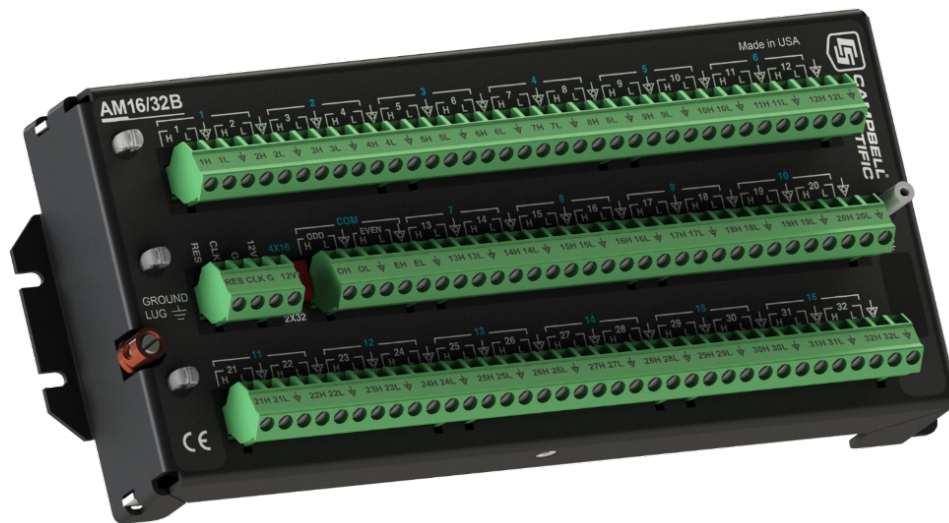




# AM16/32B

## Relay Multiplexer



# **Limited Warranty**

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“Products manufactured by CSI are warranted by CSI to be free from defects in materials and workmanship under normal use and service for twelve months from the date of shipment unless otherwise specified in the corresponding product manual. (Product manuals are available for review online at [www.campbellsci.com](http://www.campbellsci.com).) Products not manufactured by CSI, but that are resold by CSI, are warranted only to the limits extended by the original manufacturer. Batteries, fine-wire thermocouples, desiccant, and other consumables have no warranty. CSI’s obligation under this warranty is limited to repairing or replacing (at CSI’s option) defective Products, which shall be the sole and exclusive remedy under this warranty. The Customer assumes all costs of removing, reinstalling, and shipping defective Products to CSI. CSI will return such Products by surface carrier prepaid within the continental United States of America. To all other locations, CSI will return such Products best way CIP (port of entry) per Incoterms ® 2010. This warranty shall not apply to any Products which have been subjected to modification, misuse, neglect, improper service, accidents of nature, or shipping damage. This warranty is in lieu of all other warranties, expressed or implied. The warranty for installation services performed by CSI such as programming to customer specifications, electrical connections to Products manufactured by CSI, and Product specific training, is part of CSI’s product warranty. **CSI EXPRESSLY DISCLAIMS AND EXCLUDES ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. CSI hereby disclaims, to the fullest extent allowed by applicable law, any and all warranties and conditions with respect to the Products, whether express, implied or statutory, other than those expressly provided herein.”**

# Assistance

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Products may not be returned without prior authorization. The following contact information is for US and international customers residing in countries served by Campbell Scientific, Inc. directly. Affiliate companies handle repairs for customers within their territories. Please visit [www.campbellsci.com](http://www.campbellsci.com) to determine which Campbell Scientific company serves your country.

To obtain a Returned Materials Authorization (RMA) number, contact CAMPBELL SCIENTIFIC, INC., phone (435) 227-9000. Please write the issued RMA number clearly on the outside of the shipping container. Campbell Scientific's shipping address is:

**CAMPBELL SCIENTIFIC, INC.**

RMA# \_\_\_\_\_  
815 West 1800 North  
Logan, Utah 84321-1784

For all returns, the customer must fill out a "Statement of Product Cleanliness and Decontamination" form and comply with the requirements specified in it. The form is available from our website at [www.campbellsci.com/repair](http://www.campbellsci.com/repair). A completed form must be either emailed to [repair@campbellsci.com](mailto:repair@campbellsci.com) or faxed to (435) 227-9106. Campbell Scientific is unable to process any returns until we receive this form. If the form is not received within three days of product receipt or is incomplete, the product will be returned to the customer at the customer's expense. Campbell Scientific reserves the right to refuse service on products that were exposed to contaminants that may cause health or safety concerns for our employees.

# Safety

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**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](http://www.campbellsci.com) or by telephoning (435) 227-9000 (USA). 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

- 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, 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.

## 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.

## 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.

WHILE EVERY ATTEMPT IS MADE TO EMBODY THE HIGHEST DEGREE OF SAFETY IN ALL CAMPBELL SCIENTIFIC PRODUCTS, THE CUSTOMER ASSUMES ALL RISK FROM ANY INJURY RESULTING FROM IMPROPER INSTALLATION, USE, OR MAINTENANCE OF TRIPODS, TOWERS, OR ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC.

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# AM16/32B Relay Multiplexer

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## 1. Introduction

The primary function of the AM16/32B multiplexer is to increase the number of sensors that can be measured by CR300-series, CR6-series, CR800-series, CR1000, CR1000X-series, CR3000, and CR5000 dataloggers. The AM16/32B is positioned between the sensors and the datalogger. Mechanical relays in the AM16/32B connect each of the sensor channels in turn to a common output destined for the datalogger. The user program advances the multiplexer through the sensor channels, making measurements and storing data.

A slide switch located on the AM16/32B top panel selects one of two modes of operation. In 2x32 mode, the multiplexer adds 32 terminal pairs. In 4x16 mode, it adds 16 terminal groups with four terminals each. The datalogger program is written according to the selected mode and the sensors to be measured.

The maximum number of sensors multiplexed by an AM16/32B depends primarily on the type(s) of sensors to be measured.

---

### NOTE

This manual provides information for CRBasic dataloggers and AM16/32Bs with serial numbers greater than 5056.

For Edlog datalogger support or for specifications for AM16/32Bs with serial numbers less than 5056, see an older version of this manual at [www.campbellsci.com/old-manuals](http://www.campbellsci.com/old-manuals).

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## 1.1 Typical Applications

The AM16/32B is intended for use in applications where more terminals are needed than the datalogger has available. Most commonly, the AM16/32B is used to multiplex analog sensor signals, although it can also be used to multiplex switched excitations, continuous analog outputs, or even certain pulse counting measurements (those that require only intermittent sampling). It is also possible to multiplex sensors of different, but compatible, types (see Section 8.1.4, *Mixed Sensor Types* (p. 17)).

## 1.2 Compatibility

The AM16/32B is compatible with Campbell Scientific's CR300-series, CR6-series, CR800-series, CR1000, CR1000X-series, CR3000, and CR5000 dataloggers.

The AM16/32B is compatible with a wide variety of commercially available sensors. As long as relay contact current maximums are not exceeded (see Section 2, *Precautions* (p. 2)), and no more than four lines are switched at a time, system compatibility for a specific sensor is determined by sensor-datalogger compatibility.

**NOTE**

The AM16/32B is also compatible with the CDM-A108 and CDM-A116 24-bit analog input modules by using the **CRBasic CDM\_MuxSelect()** instruction. Refer to the *CRBasic Help* for information on using the AM16/32B with these modules. The CDM-A100 Series manual includes a sample program for the CDM-A108 and the AM16/32B.

---

## 2. Precautions

The AM16/32B is not designed to multiplex power. Its intended function is to switch low-level analog signals. Switched currents in excess of 30 mA will degrade the relay contacts involved, rendering that channel unsuitable for further low-level analog measurement. Customers who need to switch power are directed to Campbell Scientific's SDM-CD16AC, A6REL-12, or A21REL-12 relays.

Changing the setting of the mode switch from 4x16 to 2x32 connects **COM ODD H** to **COM EVEN H** and also **COM ODD L** to **COM EVEN L**. After wiring the AM16/32B, exercise due care to avoid inadvertently putting excess voltage on a line or short-circuiting a power supply, which might damage connected devices such as datalogger, wiring panel, sensor, or multiplexer, and which would not be covered under warranty.

## 3. Initial Inspection

- The AM16/32B ships with:
  - 4 grommets
  - 4 screws
- Upon receipt of the AM16/32B, inspect the packaging and contents for damage. File damage claims with the shipping company.
- Immediately check package contents. Thoroughly check all packaging material for product that may be concealed. Check model number, part numbers, and product descriptions against the shipping documents. Model or part numbers are found on each product. On cables, the number is often found at the end of the cable that connects to the measurement device. Ensure that the expected lengths of cables were received. Contact Campbell Scientific immediately if there are any discrepancies.

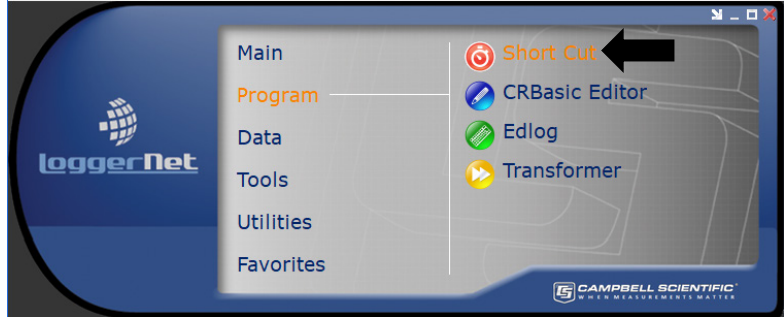
## 4. QuickStart

*Short Cut* is an easy way to program your datalogger to make measurements through an AM16/32B multiplexer. *Short Cut* is included in installations of *LoggerNet*, *PC400*, *PC200W*, and *RTDAQ*. It is also available as a download on [www.campbellsci.com](http://www.campbellsci.com).

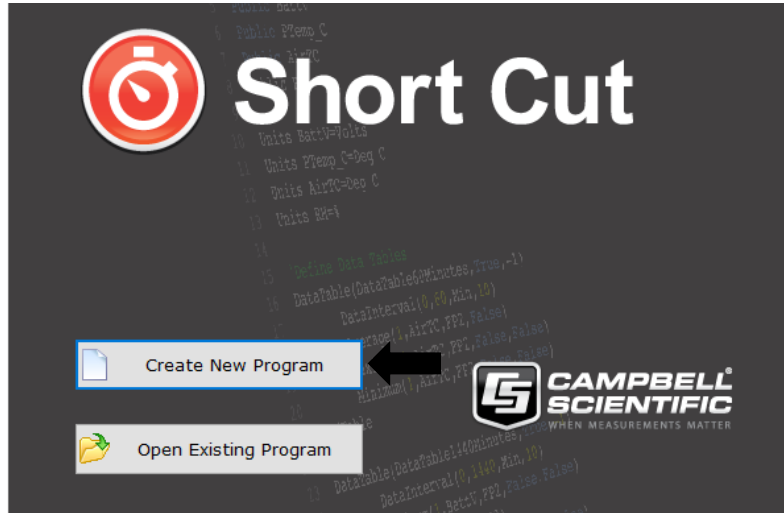
This section will guide you through programming a datalogger to measure 6 Campbell Scientific 107 temperature sensors as an example for creating a program using a multiplexer. With minor changes, these steps can apply to other measurements and dataloggers.



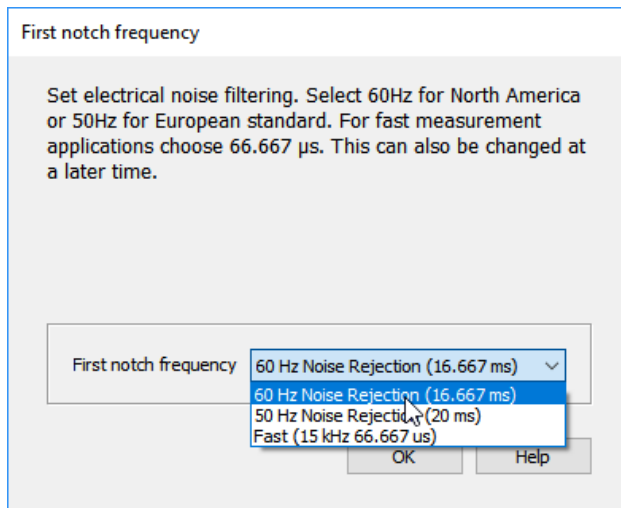
Open *Short Cut*. From the *LoggerNet* toolbar, click **Program | Short Cut**. In *PC200W* and *PC400*, click on the *Short Cut* icon.



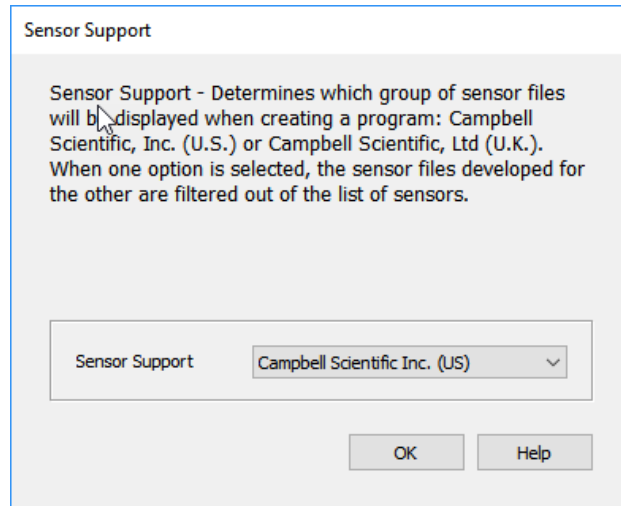
Select **Create New Program**.



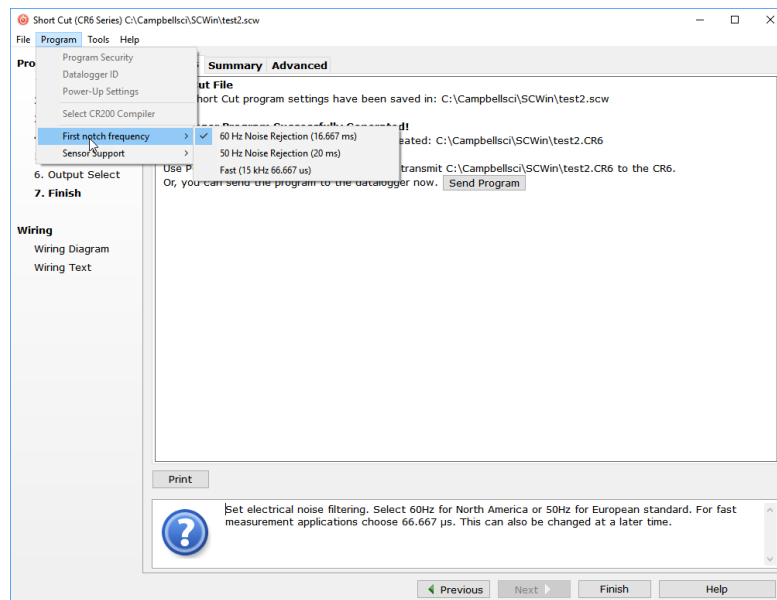
**NOTE:** The first time *Short Cut* is run, a prompt will appear asking for a choice of first notch frequency. Select **60 Hz Noise Rejection** for the United States and areas using 60 Hz ac voltage. Select **50 Hz Noise Rejection** for most of Europe and areas that operate at 50 Hz.



A second prompt lists sensor support options. **Campbell Scientific, Inc. (US)** is probably the best fit if you are outside Europe.



To change the first notch frequency or sensor support option for future programs, use the **Program** menu.



Select your datalogger model in the **Datalogger Model** drop-down list. This tutorial uses the CR6-series datalogger.



The **Progress Bar** is used to track the progress of the program being created. It is also used to jump directly to any step in the programming process.

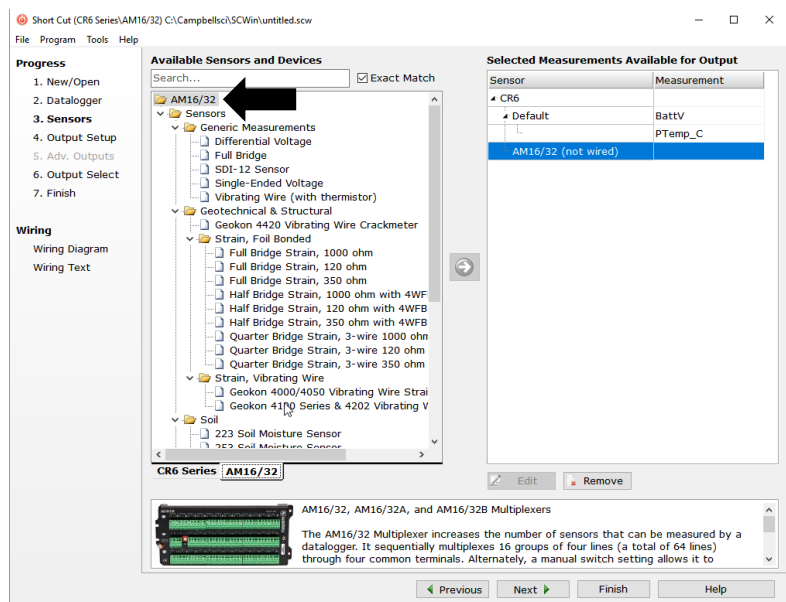
**Progress**

1. New/Open
2. Datalogger
- 3. Sensors**
4. Output Setup
5. Adv. Outputs
6. Output Select
7. Finish

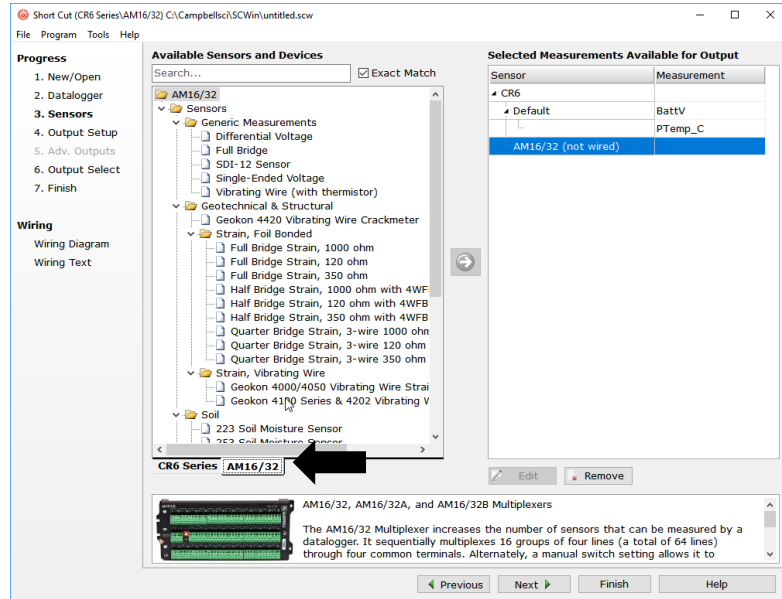
**Wiring**

- Wiring Diagram
- Wiring Text

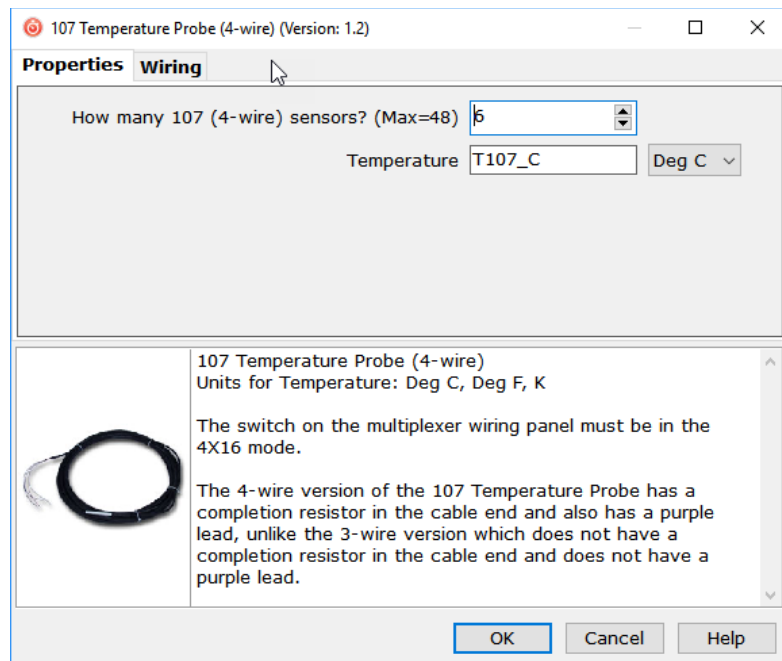
The next window displays **Available Sensors and Devices**. Expand a folder by clicking on the ► symbol. Expand the **Devices** folder, then double-click on the **AM16/32** to add it to the **Selected** panel.



When the AM16/32 multiplexer is added as a device, a new **AM16/32** tab will appear at the bottom of the **Available Sensors and Devices** pane. With the **AM16/32** tab selected, select the **Sensors | Temperature** subfolder. Double-click on **107 Temperature Probe (4-wire)**.

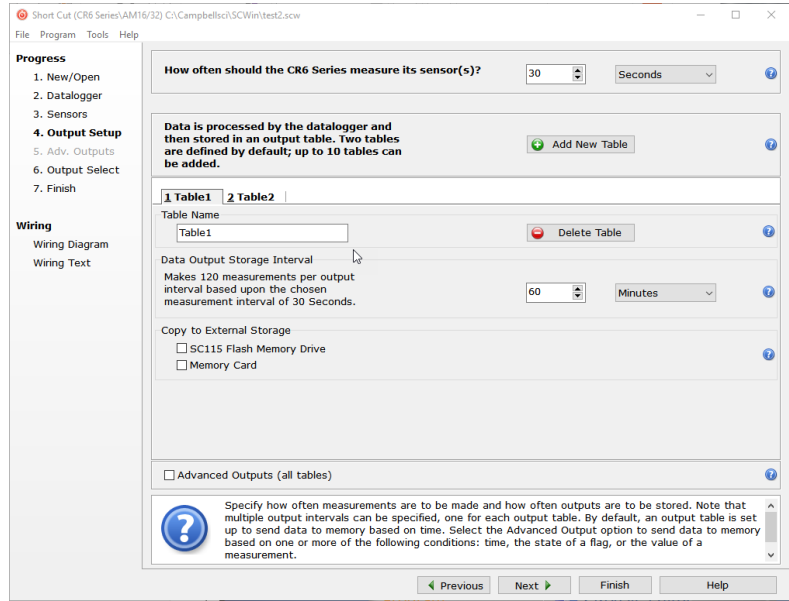


In the resulting window, enter the number of 107 temperature probes to measure on this AM16/32B multiplexer. For this tutorial, enter **6** as the number of 107 (4-wire) sensors to add. Click **OK** in the dialog window to accept the default name of **T107\_C** and the default units of **Deg C**.

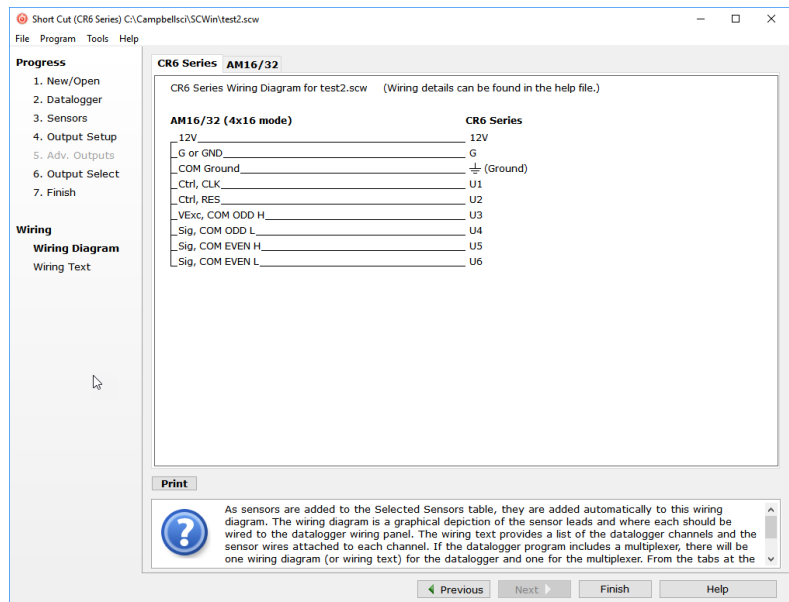


In the **Scan Interval** box, enter how frequently the datalogger should make measurements. When measuring with an AM16/32B multiplexer, we recommend an interval of 30 seconds or longer. Enter **30** and select **Seconds**.

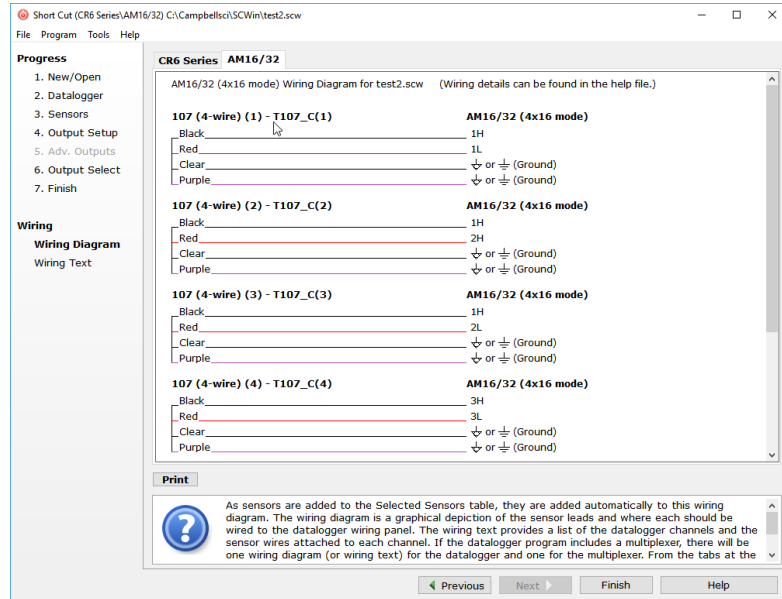
Click **Next**.



After adding the measurements, click **Wiring Diagram** to see how the sensors are to be wired to the AM16/32B and how the AM16/32B is to be wired to the datalogger. The datalogger tab (**CR6 Series** in this example) shows the connection between the AM16/32B and the datalogger, and the **AM16/32** tab shows the sensor connection to the AM16/32B.



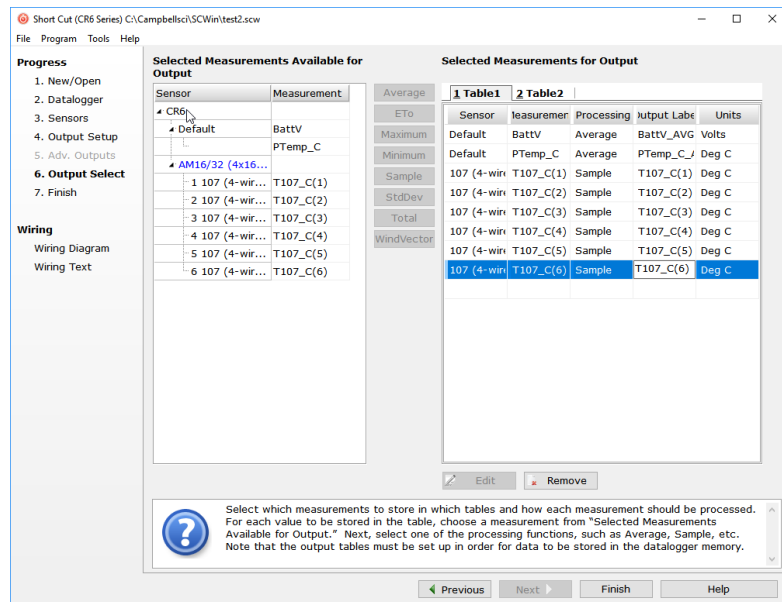
With power disconnected, wire the sensors and devices as shown in the wiring diagrams. Insert the wires, taking care to tighten the terminals on the conductors themselves, not the insulation.



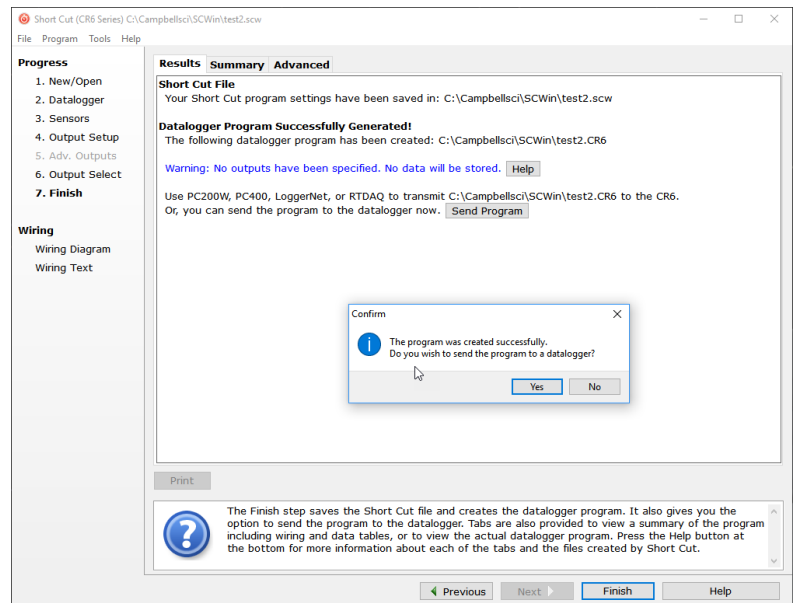
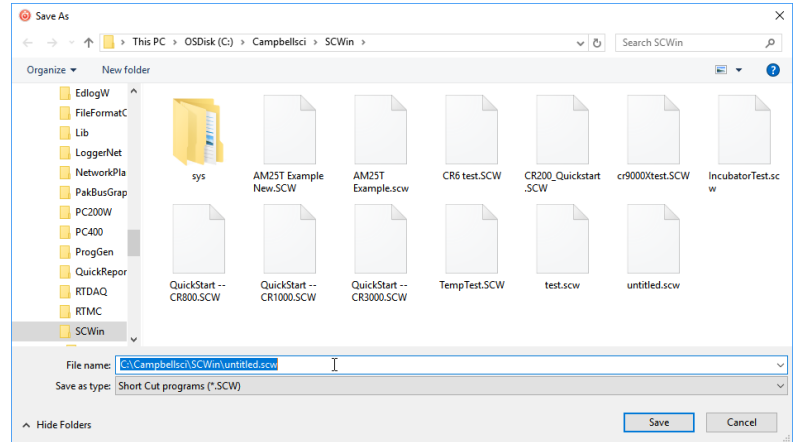
Click on **Sensors** in the **Progress** list to return to the sensor-selection screen.

Select any other sensors you have in the **Sensors** section. Add sensors to the datalogger by selecting the datalogger tab (**CR6** in this example). Add sensors to the multiplexer by selecting the **AM16/32** tab.

Finish the remaining *Short Cut* steps to complete the program. The remaining steps are outlined in *Short Cut Help*, which is accessed by clicking on **Help | Short Cut Help | Contents | Programming Steps**.



If *LoggerNet*, *PC200W*, *PC400*, or *RTDAQ* is running on your computer and the computer-to-datalogger connection is active, you can click **Finish** in *Short Cut*, and you will be prompted to send the program just created to the datalogger.



After powering on and sending the program to the datalogger, check the output of sensors in the datalogger support software data display to make sure they are making reasonable measurements.

## 5. Overview

Under datalogger control, the AM16/32B sequentially connects terminal pairs or groups to datalogger terminals. This effectively expands the number of terminals available on a datalogger.

FIGURE 5-1 shows the wiring panel of the AM16/32B multiplexer. The group of four terminals located near the mode switch are dedicated to the connection of datalogger power and control lines. **COM ODD** and **EVEN** terminals on the other side of the mode switch carry multiplexed signals destined for datalogger terminals. The remaining terminals on the AM16/32B are for sensor and sensor-shield connection. All of the inputs of the AM16/32B are protected against surges with transient suppression. Datalogger-to-AM16/32B cabling requires a minimum of six and as many as nine individually insulated wires with shields.

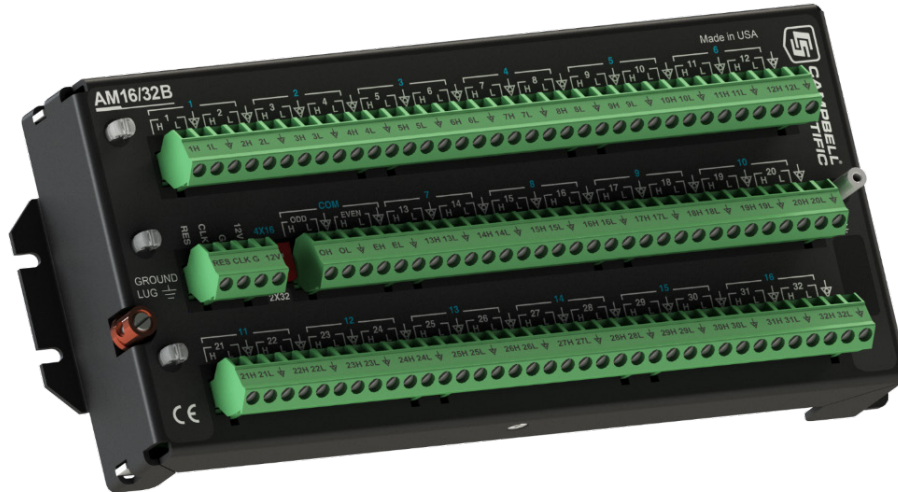


FIGURE 5-1. AM16/32B Relay Multiplexer

## 6. AM16/32B Specifications

<b>Power<sup>1, 2</sup>:</b>	Unregulated 9.6 to 16 Vdc
<b>Current Drain</b>	
<b>Quiescent:</b>	< 210 $\mu$ A
<b>Active:</b>	6 mA typical in 2x32 mode 11 mA typical in 4x16 mode
<b>Reset<sup>1</sup>:</b>	A continuous signal between 3.3 Vdc and 8 Vdc holds the AM16/32B in an active state (where a clock pulse can trigger a channel advance). A signal voltage < 0.9 Vdc deactivates the AM16/32B (clock pulse will not trigger a channel advance; AM16/32B is also reset).
<b>Clock<sup>1</sup>:</b>	On the transition from <1.5 V to >3.3 V, a channel advance is actuated on the leading edge of the clock signal; clock pulse should be a minimum of 1 ms wide; maximum voltage is 8 Vdc.
<b>Operational Temperature</b>	
<b>Standard:</b>	-25 to 50 $^{\circ}$ C
<b>Extended:</b>	-55 to 85 $^{\circ}$ C
<b>Operational Humidity:</b>	0 to 95%, non-condensing
<b>Dimensions</b>	
<b>Length:</b>	23.9 cm (9.4 in)
<b>Width:</b>	10.2 cm (4.0 in)
<b>Depth:</b>	4.6 cm (1.8 in)
<b>Weight:</b>	680 g (1.5 lb) (approx.)



<b>Mounting Tab Hole Spacing:</b>	1 x 3 x 9 in. Up to 1/8 in or 3 mm diameter screws.
<b>Expandability<sup>3</sup> (nominal):</b>	1 AM16/32B per CR300 4 AM16/32Bs per CR6 2 AM16/32Bs per CR800/CR850 4 AM16/32Bs per CR1000 4 AM16/32Bs per CR1000X 4 AM16/32Bs per CR3000 4 AM16/32Bs per CR5000
<b>Maximum Cable Length:</b>	Depends on sensor and scan rate. In general, longer lead lengths necessitate longer measurement delays. Refer to datalogger and sensor manuals for details.
<b>Maximum Switching Current<sup>4</sup>:</b>	500 mA
<b>Contact Specifications</b>	
<b>Initial Contact Resistance:</b>	<0.1 $\Omega$ max.
<b>Initial Contact Bounce:</b>	<1 ms
<b>Contact Material:</b>	Silver Palladium
<b>Wiper to N.O. Contact Capacitance:</b>	0.5 pF
<b>Typical Low-current (&lt;30 mA) Life:</b>	5 x 10 <sup>7</sup> operations
<b>Maximum Contact Voltage Rating:</b>	70 V
<b>Relay Switching</b>	
<b>Thermal emf:</b>	0.3 $\mu$ V typical; 0.5 $\mu$ V maximum
<b>Operate Time:</b>	<10 ms over temperature and supply ranges
	Break-before-make guaranteed by design. Relays disengage from previous selected channel before engaging next channel.
<b>ESD</b>	
<b>Air Discharge:</b>	complies with IEC61000-4-2, test level 4 ( $\pm$ 15 kV)
<b>Contact Discharge:</b>	complies with IEC61000-4-2, test level 4 ( $\pm$ 8 kV)
<b>Surge:</b>	Complies with IEC61000-4-5, test level 3 ( $\pm$ 2 kV, 2 ohms coupling impedance)
<b>Compliance:</b>	View EU Declaration of Conformity at <a href="http://www.campbellsci.com/am16-32b">www.campbellsci.com/am16-32b</a>

<sup>1</sup> Reset and clock protected by 8 V varistors; +12 V input is protected by +16 V TransZorb®.

<sup>2</sup> For power specifications on serial numbers less than 5056, refer to an older version of this manual at [www.campbellsci.com/old-manuals](http://www.campbellsci.com/old-manuals).

<sup>3</sup> Assumes sequential activation of multiplexers and that each datalogger channel is uniquely dedicated. If the application requires additional multiplexing capability, please consult Campbell Scientific for application assistance.

<sup>4</sup> Switching currents greater than 30 mA (occasional 50 mA current is acceptable) will degrade the contact surfaces of the mechanical relays and increase their resistance. This will adversely affect the suitability of these relays to multiplex low voltage signals. Although a relay used in this manner no longer qualifies for low voltage measurement, it continues to be useful for switching currents in excess of 30 mA.

## 7. Installation

If you are programming your datalogger with *Short Cut*, skip Section 7.1, *Wiring to Datalogger*. *Short Cut* creates a wiring diagram for you. See Section 4, *QuickStart* (p. 2), for a *Short Cut* tutorial.

### 7.1 Wiring to Datalogger

Removable terminal strips allow wiring to remain intact while the multiplexer is used elsewhere. The green terminal strips are easily removed; no tools are required. Replacement terminal strips may be purchased from Campbell Scientific.

#### 7.1.1 Control Terminals

TABLE 7-1 depicts control connections to Campbell Scientific dataloggers.

TABLE 7-1. Control Terminal Function and Datalogger Connection <sup>1</sup>		
Control Terminal	Function	Datalogger Connection Terminal
12V	Power	12V
G	Power ground	G (power ground)
CLK	Clock	C (control port), U (universal) terminal configured for control
RES	Reset	C, U terminal configured for control

<sup>1</sup>Connect the cable shield to **G** on the AM16/32B and to **G** on the CR6 series, CR800 series, CR1000, or CR3000. Connect to  $\perp$  on the CR5000.

#### 7.1.2 COM Terminals

The four terminals dedicated to multiplexer-datalogger connection are located under the blue **COM** label next to the mode switch. The terminals are labeled: **ODD H/L** and **EVEN H/L**. In 4x16 mode, the AM16/32B maintains the four **COM** terminals electrically isolated from one another. In 2x32 mode, the AM16/32B maintains an internal connection between **ODD H** and **EVEN H** and between **ODD L** and **EVEN L**. How the **COM** terminals connect to datalogger terminals determines the function of the measurement terminals. For proper function, these terminals must be wired according to the measurement instructions in the CRBasic program. See Section 8, *Operation* (p. 14), for details and Appendix B, *Example Measurements and Programs* (p. B-1), for examples.

Common  $\nabla$  terminals are provided next to the **COM ODD** and **COM EVEN** terminals. They connect internally to the other thirty-two  $\nabla$  terminals on the AM16/32B and are connected at all times (not switched). Their function is to provide a path to ground for sensor cable shields. A **COM**  $\nabla$  terminal should be wired to datalogger ground ( $\perp$ ) as shown in FIGURE 7-1.

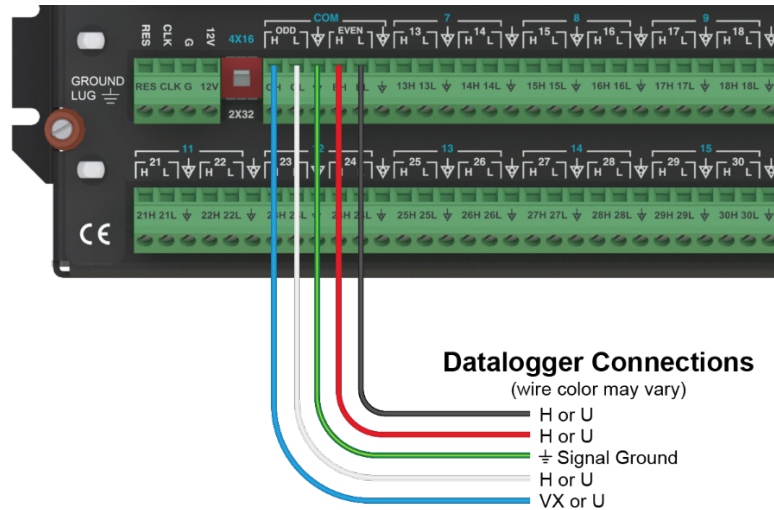


FIGURE 7-1. Example of AM16/32B-to-datalogger signal connection (4x16 mode)

### 7.1.3 Measurement Terminals

Wire sensors and transducers according to the **COM** terminal connections and the measurement instructions in the CRBasic program. See Section 8, *Operation* (p. 14) for details and Appendix B, *Example Measurements and Programs* (p. B-1), for examples.

## 7.2 Grounding

The AM16/32B has a ground lug that should be connected to earth ground via an 8 AWG wire. This connection should be as short as possible. The ground lug provides a path to dissipate surges that might propagate on a sensor shield line. An 8 V, bi-polar TransZorb® connects shield ground to the ground lug.

The AM16/32B **GND** terminal is connected to datalogger power ground. The AM16/32B **GND** terminal is also connected to the cable shield and, via that, to datalogger power ground (see TABLE 7-1). If a separate power supply is used, the AM16/32B ground should also connect to the power supply ground. An AM16/32B **COM**  $\nabla$  terminal should connect to a datalogger signal ground ( $\perp$ ) via the cable that connects the **COM** terminals (see FIGURE 7-1). The datalogger must connect to earth ground by one of the methods described in the installation and maintenance section of the datalogger manual.

## 7.3 Power Supply

The AM16/32B requires a continuous power supply for operation. The positive side of the power supply is connected to **12V**, and the negative side is connected to **G**. Connect the **G** wire first for safety.

The average power required to operate an AM16/32B depends on the percentage of time it is active per time period. At a minimum, the power supply must be able to sustain the system between site visits anticipating the worst environmental extremes. Refer to the application note *Power Supplies* and the video *Power Budgeting*, both available at [www.campbellsci.com](http://www.campbellsci.com), for more help in selecting a power supply.

## 7.4 Installation in Enclosure

The AM16/32B must be protected from moisture. Moisture in the electronics will seriously damage the AM16/32B. In most cases, protection from water is easily accomplished by placing the AM16/32B in a weathertight enclosure with desiccant and elevating the enclosure above the ground. Desiccant in enclosures should be changed periodically.

Mount the AM16/32B to an enclosure backplate by inserting the included screws through the mounting holes in the AM16/32B and into the included grommets.

# 8. Operation

The reset (**RES**) line is used to switch on the AM16/32B by applying 3.3 to 8 Vdc. When this line drops lower than 0.9 Vdc, the multiplexer enters a quiescent, low current-drain state. In the quiescent state, the common (**COM**) terminals are electrically disconnected from all of the sensor input channels. **RES** should always connect to a datalogger terminal configured for control. The **PortSet()** instruction controls the reset line.

After **RES** has been set high, a pulse on **CLK** advances the channels. The voltage level must fall below 1.5 Vdc and then rise above 3.3 Vdc to clock the multiplexer. In a typical operation, this is accomplished with either the **PulsePort()** or **PortSet()** instruction. Another method of operation uses the **MuxSelect()** instruction to advance to a channel specified in the instruction.

When **RES** first goes high, the **COM** terminals (**ODD H**, **ODD L** and **EVEN H**, **EVEN L**) are disconnected from all measurement terminals. When the first **CLK** pulse arrives, the **COM** terminals are switched to connect with the first set of measurement terminals according to the mode switch, either 4x16 or 2x32. When a second **CLK** pulse arrives, the common lines are switched to connect to the second set of measurement terminals. The multiplexer advances a channel on the rising edge of the **CLK** pulse.

---

**NOTE**

The **CLK** pulse should be at least 1 ms long. A delay (typically 10 ms or more) is inserted between the beginning of the **CLK** pulse and the measurement instruction to ensure sufficient settling time to relay contacts.

---

The terminals for sensor attachment are divided into 16 groups (panel switch set to **4x16**) or into 32 groups (panel switch set to **2x32**). The groups consist of four or two Simultaneously Enabled Terminals (SETs). With the panel switch set to **4X16**, the blue channel numbers apply. The SETs are numbered starting at **1 (1H, 1L, 2H, 2L)** and continuing until SET **16 (31H, 31L, 32H, 32L)**.

In 4x16 mode, the odd-numbered terminals (example: **5H, 5L**) are relay-switched to the **COM ODD** terminals while the even terminals (**6H, 6L**) are switched to the **COM EVEN** terminals. When activated by the **RES** line, as the AM16/32B receives clock pulses from the datalogger, each SET of four in turn is switched into contact with the four **COM** terminals. For example, when the first clock pulse is received from the datalogger, SET **1**, consisting of **1H, 1L, 2H, and 2L**, is connected to **COM ODD H, ODD L, EVEN H, and EVEN L** terminals respectively. When the second clock pulse is received, the first SET is switched out (SET **1** sensor inputs become open circuits), and SET **2 (3H, 3L, 4H, 4L)** are connected to the four **COM** terminals. A given SET will typically be connected to the common terminals for 10 ms.

With the panel switch set to **2X32**, the white channel numbers apply. The SETs are labeled beginning with **1H, 1L** and ending with **32H, 32L**. In 2x32 mode when the AM16/32B selects a given channel, the **H** terminal is relay-connected to both **COM H** terminals, and the **L** sensor terminal is connected to both **COM L** terminals.

## 8.1 Programming

### 8.1.1 Short Cut Programs

In most cases, *Short Cut* is the best way to create or begin datalogger programs for the AM16/32B multiplexer. See Section 4, *QuickStart* (p. 2), for a *Short Cut* tutorial. The details that follow pertain to CRBasic programs generated by *Short Cut*. For measurement and program examples, see Appendix B, *Example Measurements and Programs* (p. B-1).

---

#### NOTE

To accommodate the AM16/32 and AM16/32A, *Short Cut* adds a delay of 150 ms after disabling the multiplexer. This delay is not required for the AM16/32B and may be deleted to increase the speed of the program.

---

When programming with *Short Cut*, three instructions operate the multiplexer: 1) the **PortSet()** instruction enables or disables the multiplexer, 2) the **SubScan()/NextSubScan** instruction begins/ends the measurement loop, and 3) the **PulsePort()** instruction clocks through the measurement channels. The CRBasic program must also specifically increment an index variable and use that variable to determine where each measurement is stored. The generalized programming sequence follows:

---

#### NOTE

The CR5000 does not support the **PulsePort()** instruction. Refer to CRBasic Example B-8, *CR5000 Program Example* (p. B-12), for this datalogger.

---

```

'Turn AM16/32B Multiplexer on
PortSet(2,1)
Delay(0,150,mSec)
'Reset counter
LCount=1
'Begin measurement loop
SubScan(0,uSec,5) 'measures 5 sets
'Switch to next AM16/32B Multiplexer channel
PulsePort(1,10000)
'Make measurements
'Increment counter according to measurement mode
LCount=LCount+1
NextSubScan
'Turn AM16/32 Multiplexer off
PortSet(2,0)

```

The **SubScan()** instruction is used to create a measurement loop for the multiplexer. The third parameter in the **SubScan()** instruction, **Count**, is the number of sets on the multiplexer that will be used. For example, if the instruction is **SubScan(0,μSec,7)** and the multiplexer is in 2x32 mode, the first seven terminal pairs (numbers in white) on the multiplexer will be used. When in 4x16 mode, this instruction will use the first seven groups of four (numbers in blue) on the multiplexer.

It may be desirable to use the repetition parameter, **Reps**, of the measurement instructions between **SubScan()** and **NextSubScan**. The repetitions parameter is the number of sensors per instruction that will be measured. See the examples below:

#### Example 1

```

'Example 1
LCount = 1
SubScan (0,uSec,7)
  PulsePort (C1,10000)
  VoltDiff (Dest(LCount),1,mV5000,1,True ,0,60,1.0,0)
  LCount = LCount + 1
NextSubScan

```

In this example, one measurement is made per **VoltDiff()** instruction because the instruction has a repetition parameter of **1** (the second parameter in the **VoltDiff()** instruction). With the multiplexer in 2x32 mode, differential voltage measurements will be made on the first seven 2x32 terminal pairs because the **Count** parameter of the **SubScan()** instruction is 7.

#### Example 2

```

'Example 2
LCount = 1
SubScan (0,uSec,7)
  PulsePort (C1,10000)
  VoltDiff (Dest(LCount),2,mV5000,1,True ,0,60,1.0,0)
  LCount = LCount + 2
NextSubScan

```

With the multiplexer in 4x16 mode, differential voltage measurements will be made on the first seven 4x16 terminal groups because the **Count** parameter of the **SubScan()** instruction is 7. Two differential sensors are measured per terminal group because the **VoltDiff()** instruction has a repetition parameter of **2**. Thus, a total of 14 differential voltage measurements will be made (2 measurement per subscan • 7 subscans = 14).

### 8.1.2 Using CRBasic MuxSelect() Instruction

The CRBasic **MuxSelect()** instruction is used to enable the multiplexer and select a specific channel to begin measurements. This can simplify your datalogger program by making one set of measurements at a time. Use the **PulsePort()** instruction to advance the multiplexer and the **PortSet()** instruction to disable it. The generalized programming sequence follows:

```
'Turn AM16/32B Multiplexer on, C1-CLK, C2-RES
'Advance to first measurement channel in SET 1
MuxSelect (C1, C2 ,20,1,1)
'Make SET 1 measurements
'<insert measurement instruction(s)>
'Advance to first measurement channel in SET 2
PulsePort (C1 ,10000) 'move to Set 2
'Make SET 2 measurements
'<insert measurement instruction(s)>
'Advance to first measurement channel in SET 3
PulsePort (C1 ,10000) 'move to Set 3
'Make SET 3 measurements
'<insert measurement instruction(s)>
'Turn AM16/32 Multiplexer off
PortSet(C2,0)
```

For measurement and program examples, see Appendix B, *Example Measurements and Programs (p. B-1)*.

### 8.1.3 General Programming Considerations

Excitation voltage, integration time, and delay time associated with measuring the signal, and the speed at which the channels are advanced, can be varied within the datalogger program. In general, longer delay times are necessary when sensors and datalogger are separated by longer lead lengths. Consult the datalogger or sensor manual for additional information on these topics.

### 8.1.4 Mixed Sensor Types

In applications where sensor types are mixed, experienced programmers can create multiple configurations, though it is preferred to use multiple multiplexers for these situations. When programming for mixed sensors on a single AM16/32B, it is especially important to verify that each measurement is reasonable. Consult Campbell Scientific for application assistance when it is necessary to multiplex markedly different sensor types in an application.

## 8.2 General Measurement Considerations

### 8.2.1 Long Cable Lengths

Longer sensor-to-AM16/32B cables result in greater induced and capacitively coupled voltages (cross talk) between cable wires. It may also be necessary to program a delay within the measurement instruction to allow time for lead-wire capacitances to discharge after advancing a channel, before the measurement is made. This can be done by increasing the *Delay* parameter in the **PulsePort()** instruction or by adding a **Delay()** instruction after the **PulsePort()** instruction. A delay of 20 ms or more is recommended.

### 8.2.2 Completion Resistors

In some applications, it is advantageous to place completion resistors at the AM16/32B terminal strips. Certain sensors specific to the use of multiplexers

are available from Campbell Scientific. Examples include soil moisture probes and thermistor probes.

### **8.2.3 Contact Degradation**

Once excitation in excess of 30 mA has been multiplexed, that channel's relay contacts have been rendered unsuitable for further low voltage measurement. To prevent undue degradation, it is advisable to reserve certain channels for sensor excitation and employ other channels for sensor signals.

Refer to Section [2](#), *Precautions (p. 2)*, for more information on contact degradation.



# Appendix A. Importing Short Cut Code Into CRBasic Editor

---

This tutorial shows:

- How to import a *Short Cut* program into a program editor for additional refinement
- How to import a wiring diagram from *Short Cut* into the comments of a custom program

*Short Cut* creates files, which can be imported into *CRBasic Editor*. Assuming defaults were used when *Short Cut* was installed, these files reside in the C:\campbellsci\SCWin folder:

- .DEF (wiring and memory usage information)
- .CR6 (CR6-series datalogger code)
- .CR8 (CR800-series datalogger code)
- .CR1 (CR1000 datalogger code)
- .CR1X (CR1000X-series datalogger code)
- .CR3 (CR3000 datalogger code)
- .CR5 (CR5000 datalogger code)

Use the following procedure to import *Short Cut* code and wiring diagram into *CRBasic Editor*.

1. Create the *Short Cut* program following the procedure in Section 4, *QuickStart* (p. 2). Finish the program. On the **Advanced** tab, click the **CRBasic Editor** button. The program opens in CRBasic with the name **noname.CR\_**. Now save the program with your desired name in any folder.

---

## NOTE

Once the file is edited with *CRBasic Editor*, *Short Cut* can no longer be used to edit the datalogger program. Change the name of the program file or move it, or *Short Cut* may overwrite it next time it is used.

---

2. The program can now be edited, saved, and sent to the datalogger.
3. Import wiring information to the program by opening the associated .DEF file. By default, it will be in the c:\campbellsci\SCWin folder. Copy and paste the section beginning with heading “–Wiring for CRXXX–” into the CRBasic program, usually at the head of the file. After pasting, edit the information such that an apostrophe (') begins each line. This character instructs the datalogger compiler to ignore the line when compiling. You can highlight several lines of CRBasic code then right-click and select **Comment Block**. (This feature is demonstrated at about 5:10 in the [CRBasic | Features](#) video.)

# Appendix B. Example Measurements and Programs

---

This section covers sensor-to-AM16/32B connections and AM16/32B-to-datalogger connections. Most programs were created in *Short Cut*. The following are examples only and should not be construed as the only way to make a particular measurement. See the measurement section of the datalogger manual for more information on basic bridge measurements. Most of the following examples do not depict datalogger-to-AM16/32B control connections (Section 7.1.1, *Control Terminals (p. 12)*), but their presence is implied and required.

## B.1 Single-Ended Voltage Measurement

FIGURE B-1 shows a typical connection for single-ended voltage measurements. Using this method, a datalogger can make up to 48 single-ended voltage measurements through a multiplexer. See CRBasic Example B-1, CRBasic Example B-2, and TABLE B-1 for a related program and wiring diagram, or use *Short Cut* to create your own.

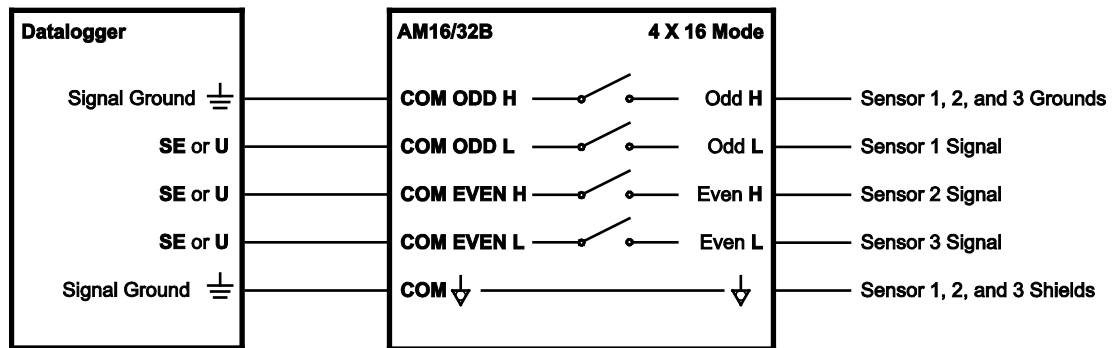


FIGURE B-1. Typical single-ended voltage measurement connection

**TABLE B-1. Wiring for Single-Ended Voltage Measurements CRBasic Example**

CR1000X	CR300	AM16/32B in 4X16 Mode		Sensors
		Control and COM Terminals	Measurement Terminals	
⏏ (Signal Ground)	⏏ (Signal Ground)	COM ODD H	Odd-numbered H terminal	Sensor 1, 2, and 3 grounds
1H	1H	COM ODD L	Odd-numbered L terminal	Sensor 1 signal
1L	1L	COM EVEN H	Even-numbered H terminal	Sensor 2 signal
2H	2H	COM EVEN L	Even-numbered L terminal	Sensor 3 signal
⏏	⏏	COM ⏏	⏏	Sensor 1, 2, and 3 shields
12V	SW12V	12V		
G	G	G		
C1	C1	CLK		
C2	C2	RES		

CRBasic Example B-1 is a CR300-series program. With minor adjustments, this program can be used with the CR1000X series, CR6 series, CR800 series, CR1000, or CR3000. The AM16/32B must be in 4x16 mode.

**CRBasic Example B-1. Single Ended Voltage Measurements Using MuxSelect()**

```
'Multiplexer in 4X16 Mode
'Declare Variables and Units
Public SEVolt(9)
Units SEVolt=mV
'Define Data Tables
DataTable (Hourly,True,-1)
  DataInterval(0,60,Min,10)
  Sample(9,SEVolt(),FP2)
EndTable
DataTable(Daily,True,-1)
  DataInterval(0,1440,Min,10)
  Average(9,SEVolt(),FP2,False)
EndTable
'Main Program'
BeginProg
  SW12 (1 ) 'provide power to AM16/32B

'Main Scan
Scan(30,Sec,1,0)
'>>>>> Set 1
'Turn AM16/32B Multiplexer On, start measurements on mux channel 1
MuxSelect (C1,C2 ,20,1,1)
'3 repetitions, writing to SEVolt(1), SEVolt(2) and SEVolt(3)
'3 repetitions, measuring 1H, 1L, 2H on mux
VoltSe(SEVolt(1),3,mv2500,1,True,0,60,1,0)
'>>>>> Set 2
PulsePort (C1 ,10000) 'to move to Set 2
'start measurements on mux channel 3
'3 repetitions, writing to SEVolt(4), SEVolt(5) and SEVolt(6)
'3 repetitions, measuring 3H, 3L, 4H on mux
VoltSe(SEVolt(4),3,mv2500,1,True,0,60,1,0)
'>>>>> Set 3
PulsePort (C1 ,10000) 'to move to Set 3
```

```

'3 repetitions, writing to SEVOLT(7), SEVOLT(8) and SEVOLT(9)
'3 repetitions, measuring 5H, 5L, 6H on mux
VOLTSE(SEVOLT(7),3,mv2500,1,True,0,60,1,0)
'Turn AM16/32B Multiplexer Off
PortSet(C2,0)
'Call Data Tables and Store Data
CallTable Hourly
CallTable Daily
NextScan
EndProg

```

The following example is a CR1000X program. With minor adjustments, this program can be used with the CR6 series, CR800 series, CR1000, or CR3000. The AM16/32B must be in 4x16 mode.

### CRBasic Example B-2. Single-Ended Voltage Measurements

```

'Declare Variables and Units
Public BattV
Public Ptemp_C
Public LCount
Public SEVOLT(48)

Units BattV=Volts
Units Ptemp_C=Deg C
Units SEVOLT=mV

'Define Data Tables
DataTable (Hourly,True,-1)
  DataInterval(0,60,Min,10)
  Sample(48,SEVOLT(),FP2)
EndTable

DataTable(Daily,True,-1)
  DataInterval(0,1440,Min,10)
  Average (48,SEVOLT(),FP2,False)
  Minimum(1,BattV,FP2,False,False)
EndTable

'Main Program'
BeginProg
'Main Scan
Scan(30,Sec,1,0)
'Default CR1000X Datalogger Battery Voltage measurement 'BattV'
Battery(BattV)
'Default CR1000X Datalogger Wiring Panel Temperature measurement 'Ptemp_C'
PanelTemp(Ptemp_C,_60Hz)
'Turn AM16/32B Multiplexer On
PortSet(C2,1)
Delay(0,150,mSec)
LCount=1
SubScan(0,uSec,16)
'Switch to next AM16/32B Multiplexer channel
PulsePort(C1,10000)
'Generic Single Ended Voltage measurements 'SEVOLT() on AM16/32B Multiplexer
VOLTSE(SEVOLT(LCount),3,mv5000,1,True,0,_60Hz,1,0)
LCount=LCount+3
NextSubScan
'Turn AM16/32B Multiplexer Off
PortSet(C2,0)
'Call Data Tables and Store Data
CallTable Hourly
CallTable Daily
NextScan
EndProg

```

## B.2 Differential Voltage Measurement

FIGURE B-2 shows a typical connection for differential voltage measurements. Using this method, a datalogger can make up to 32 differential voltage measurements through a multiplexer. See CRBasic Example B-3, CRBasic Example B-4, and TABLE B-2 for related programs and wiring diagram, or use *Short Cut* to create your own.

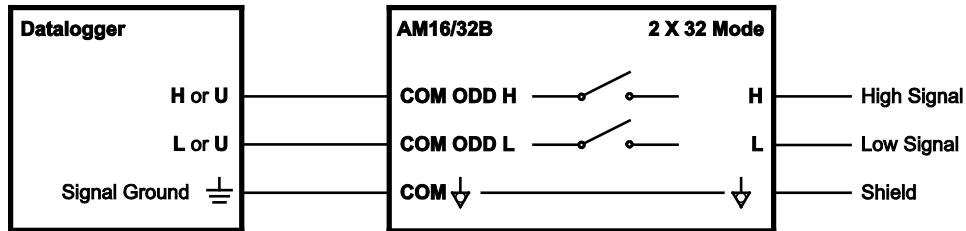


FIGURE B-2. Typical differential voltage measurement connection

Notice that these programs use arrays for multipliers and offsets. This allows you to adjust multipliers and offsets for each sensor individually. For example, in this program the third multiplier, *8*, and the third offset, *9*, would be applied to the third measurement, *DiffV(3)*.

TABLE B-2. Wiring for Differential Voltage Measurements CRBasic Example

CR1000X	CR300	AM16/32B in 2X32 Mode		Sensors
		Control and COM Terminals	Measurement Terminals	
1H	1H	COM ODD H	H	High signal
1L	1L	COM ODD L	L	Low signal
⏏ (Signal Ground)	⏏ (Signal Ground)	COM ⏏	⏏	Shield
12V	SW12V	12V		
G	G	G		
C1	C1	CLK		
C2	C2	RES		

CRBasic Example B-3 is a CR300-series program. With minor adjustments, this program can be used with the CR1000X series, CR6 series, CR800 series, CR1000, or CR3000. The AM16/32B must be in 2x32 mode.

**CRBasic Example B-3. Differential Voltage Measurements Using MuxSelect()**

```

'Multiplexer in 2X32 mode
'Declare Variables and Units
Public DiffV(3)
Public Mult(3)={9,1,8}
Public Offs(3)={5,4,9}
Units DiffV=mV
'Define Data Tables
DataTable (Hourly,True,-1)
  DataInterval(0,60,Min,10)
  Sample(3,DiffV(),FP2)
EndTable
DataTable(Daily,True,-1)
  DataInterval(0,1440,Min,10)
  Average (3,DiffV(),FP2,False)
EndTable
'Main Program'
BeginProg
  SW12 (1 ) 'provide power to AM16/32B

  'Main Scan
  Scan(30,Sec,1,0)
  '>>>>> Set 1
  'Turn AM16/32B Multiplexer On, start measurements on mux channel 1
  MuxSelect (C1,C2 ,20,1,1)
  '1 repetition, writing to DiffV(1)
  '1 repetition, measuring 1 H/L on mux
  VoltDiff(DiffV(1),1,mv34,1,True,0,_60Hz, Mult(1),Offs(1))
  '>>>>> Set 2
  PulsePort (C1 ,10000) 'move to Set 2
  '1 repetition, writing to DiffV(2)
  '1 repetitions, measuring 2 H/L on mux
  VoltDiff(DiffV(2),1,mv34,1,True,0,_60Hz, Mult(2),Offs(2))
  '>>>>> Set 3
  PulsePort (C1 ,10000) 'move to Set 3
  '1 repetition, writing to DiffV(3)
  '1 repetitions, measuring 3 H/L on mux
  VoltDiff(DiffV(3),1,mv34,1,True,0,_60Hz, Mult(3),Offs(3))
  'Turn AM16/32B Multiplexer Off
  PortSet (C2,0)
  'Call Data Tables and Store Data
  CallTable Hourly
  CallTable Daily
  NextScan
EndProg

```

The following example is a CR1000X program. With minor adjustments, this program can be used with the CR6 series, CR800 series, CR1000, or CR3000. The AM16/32B must be in 2x32 mode.

**CRBasic Example B-4. Differential Voltage Measurements**

```

'Declare Variables and Units
Public BattV
Public Ptemp_C
Public LCount
Public DiffV(32)
Public Mult(32)={9,1,8,8,8,1,5,2,8,5,3,6,2,6,5,5,2,9,1,7,8,8,2,3,9,2,8,1,7,2,7,4}
Public Offs(32)={5,4,9,8,4,1,1,1,7,4,8,2,6,9,7,5,9,2,3,5,2,1,9,3,8,4,3,6,5,9,3,3}

Units BattV=Volts
Units Ptemp_C=Deg C
Units DiffV=mV

'Define Data Tables

```

```

DataTable(Hourly,True,-1)
  DataInterval(0,60,Min,10)
  Sample(32,DiffV(),FP2)
EndTable

'Main Program
BeginProg
'Main Scan
Scan(30,Sec,1,0)
  'Default CR1000X Datalogger Battery Voltage measurement 'BattV'
  Battery(BattV)
  'Default CR1000X Datalogger Wiring Panel Temperature measurement 'PTemp_C'
  PanelTemp(PTemp_C,_60Hz)
  'Turn AM16/32B Multiplexer On
  PortSet(C2,1)
  Delay(0,150,mSec)
  LCount=1
  SubScan(0,uSec,32)
    'Switch to nextx AM16/32B Multiplexer channel
    PulsePort(C1,10000)
    'Generic Differential Voltage measurements 'DiffV()' on AM16/32B Multiplexer
    VoltDiff(DiffV(LCount),1,mV5000,1,True,0,_60Hz, Mult(LCount),Offs(LCount))
    LCount=LCount+1
  NextSubScan
  'Turn AM16/32B Multiplexer Off
  PortSet(C2,0)
  'Call Data Tables and Store Data
  CallTable Hourly
NextScan
EndProg

```

## B.3 Half-Bridge Measurement

FIGURE B-3 shows a typical connection for half-bridge measurements, such as 107 temperature sensors. Using this method, a datalogger can make up to 48 half-bridge measurements through a multiplexer. See CRBasic Example B-5 and TABLE B-3 for a related program and wiring diagram, or use *Short Cut* to create your own.

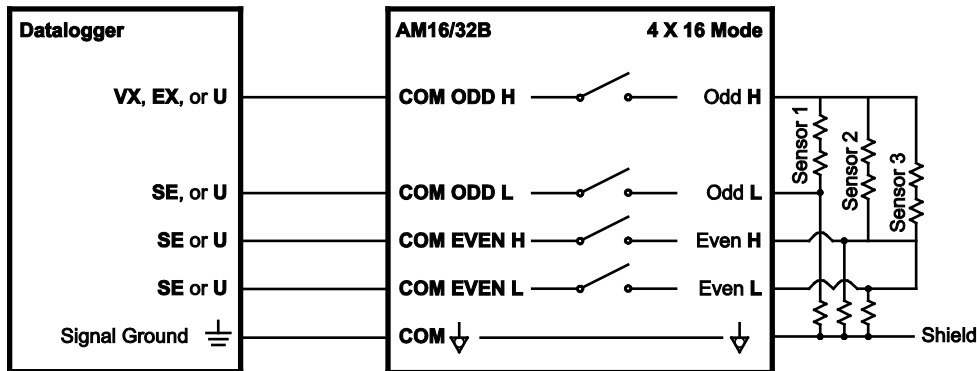


FIGURE B-3. Typical half-bridge measurement connection

The following example is a CR6-series program. With minor adjustments, this program can be used with the CR300 series, CR800 series, CR1000, or CR3000. This program measures 48 Campbell Scientific 107 temperature sensors through an AM16/32B. The AM16/32B must be in 4x16 mode.

TABLE B-3. Wiring for Campbell Scientific 107 Temperature Sensors CRBasic Example			
CR6	AM16/32B in 4X16 Mode		Sensors
	Control and COM Terminals	Measurement Terminals	
U3	COM ODD H	Odd-numbered H terminal	Sensor 1, 2, and 3 excitation (black wire)
U4	COM ODD L	Odd-numbered L terminal	Sensor 1 signal (red wire)
U5	COM EVEN H	Even-numbered H terminal	Sensor 2 signal (red wire)
U6	COM EVEN L	Even-numbered L terminal	Sensor 3 signal (red wire)
⏏ (Signal Ground)	COM ⏏	⏏	Sensor 1, 2, and 3 grounds and shields (purple and clear wires)
12V	12V		
G	G		
U1	CLK		
U2	RES		

CRBasic Example B-5. Campbell Scientific 107 Temperature Sensors

```

'Declare Variables and Units
Dim LCount
Public BattV
Public PTemp_C
Public T107_C(48)

Units BattV=Volts
Units PTemp_C=Deg C
Units T107_C=Deg C

'Define Data Tables
DataTable(Hourly,True,-1)
  DataInterval(0,60,Min,10)
  Sample(48,T107_C(),FP2)
EndTable

DataTable(Daily,True,-1)
  DataInterval(0,1440,Min,10)
  Minimum(1,BattV,FP2,False,False)
EndTable

'Main Program
BeginProg
  'Main Scan
  Scan(30,Sec,1,0)
  'Default CR6 DataLogger Battery Voltage measurement 'BattV'
  Battery(BattV)
  'Default CR6 DataLogger Wiring Panel Temperature measurement 'PTemp_C'
  PanelTemp(PTemp_C,60)
  'Turn AM16/32 Multiplexer On
  PortSet(U2,1)
  Delay(0,150,mSec)
  LCount=1
  SubScan(0,uSec,16)
  'Switch to next AM16/32 Multiplexer channel

```



```

PulsePort(U1,10000)
'107 Temperature Probe (4-wire) measurements 'T107_CC' on AM16/32
Therm107(T107_C(LCount),3,U4,U3,0,60,1,0)
LCount=LCount+3
NextSubScan
'Turn AM16/32 Multiplexer Off
PortSet(U2,0)
'Call Data Tables and Store Data
CallTable Hourly
CallTable Daily
NextScan
EndProg
    
```

## B.4 Full-Bridge Measurement

Up to sixteen full-bridge measurements may be multiplexed through the AM16/32B. A problem with making full-bridge measurements with this configuration is that the resistance of the lead wire and multiplexer relays can cause a voltage drop, reducing the excitation at the bridge. The following section describes a configuration that compensates for this by measuring the excitation at the bridge. See CRBasic Example B-6 and TABLE B-4 for a related program and wiring diagram, or use *Short Cut* to create your own.

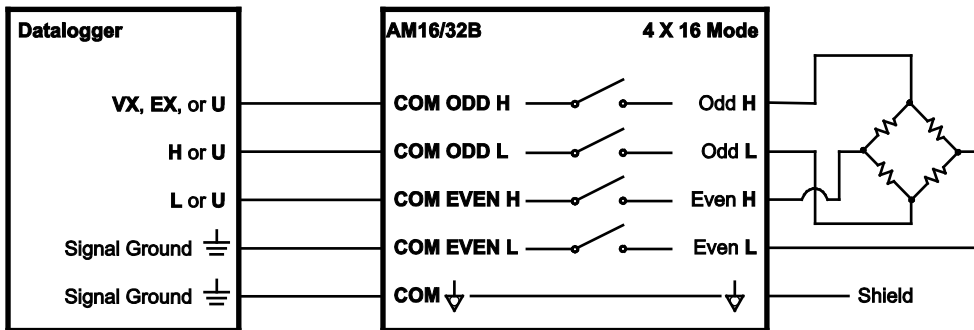


FIGURE B-4. Full-bridge measurement

The following example is a CR1000X program. With minor adjustments, this program can be used with the CR300 series, CR6 series, CR800 series, CR1000, or CR3000. This program measures 16 load cell sensors through an AM16/32B. The AM16/32B must be in 4x16 mode.

TABLE B-4. Wiring for Load Cells CRBasic Example

CR1000X	AM16/32B in 4X16 Mode		Sensors
	Control and COM Terminals	Measurement Terminals	
VX1	COM ODD H	Odd-numbered H	Excitation
⊥ (Signal Ground)	COM ODD L	Odd-numbered L	Ground
1H	COM EVEN H	Even-numbered H	High
1L	COM EVEN L	Even-numbered L	Low
⊥	COM ⚡	⚡	Shield
12V	12V		
G	G		
C1	CLK		
C2	RES		

CRBasic Example B-6. Load Cells

```

'Declare Variables and Units
Public BattV
Public FCloaded
Public Ptemp_C
Public CReps
Public ZMode
Public CIndex
Public CAvg
Public LCount
Public LoadCell(16)
Public COff(16)
Public Mult(16)={1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1}
Public Offs(16)={0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0}

Units BattV=Volts
Units Ptemp_C=Deg C
Units LoadCell=mV/V

'Define Data Tables
DataTable(TenSecond,True,-1)
  DataInterval (0,10,Sec,10)
  Sample(16,LoadCell(),FP2)
  Sample(1,BattV,FP2)
  Sample(1,Ptemp_C,FP2)
EndTable

'Calibration History Table
DataTable(CalHist,NewFieldCal,10)
  SampleFieldCal
EndTable

'Main Program
BeginProg
  'Initialize calibration variables for Generic Full Bridge
  'measurements 'LoadCell()' on the AM16/32B Multiplexer
  CIndex=1 : CAvg=1 : CReps=16
  For LCount = 1 To 16
    COff(LCount)=Offs(LCount)
  Next

```

```

'Load the most recent calibration values from the CalHist table
FCLoaded=LoadFieldCal(True)
'Main Scan
Scan(10,Sec,1,0)
'Default CR1000X Datalogger Battery Voltage measurement 'BattV'
Battery(BattV)
'Default CR1000X Datalogger Wiring Panel Temperature measurement 'PTemp_C'
PanelTemp(PTemp_C,_60Hz)
'Turn AM16/32B Multiplexer On
PortSet(C2,1)
Delay(0,150,mSec)
LCount=1
SubScan(0,uSec,16)
'Switch to next AM16/32B Multiplexer channel
PulsePort(C1,10000)
'Generic Full Bridge measurements 'LoadCell()' on the AM16/32B Multiplexer
BrFull(LoadCell(LCount),1,mV200,1,Vx1,1,2500,1,1,0,60,Mult(LCount),Coff(LCount))
LCount=LCount+1
NextSubScan
'Zeroing calibration for Generic Full Bridge
'measurements 'LoadCell()' on the AM16/32B Multiplexer
FieldCal(0,LoadCell(),CReps,0,COff(),ZMode,0,CIndex,CAvg)
'Turn AM16/32B Multiplexer Off
PortSet(C2,0)
'Call Data Tables and Store Data
CallTable TenSecond
CallTable CalHist
NextScan
EndProg
    
```

The following example is a CR1000 program. With minor adjustments, this program can be used with the CR300 series, CR6 series, CR800 series, or CR3000. This program measures 48 Campbell Scientific CS616 water content reflectometers through an AM16/32B. The AM16/32B must be in 4x16 mode. See CRBasic Example B-7 and TABLE B-5 for a related program and wiring diagram, or use *Short Cut* to create your own.

**TABLE B-5. Wiring for CS616 Sensor CRBasic Example**

CR1000	AM16/32B in 4X16 Mode		Sensors <sup>1</sup>
	Control and COM Terminals	Measurement Terminals	
C2	COM ODD H	Odd-numbered H	Sensor 1, 2, and 3 Orange
1H	COM ODD L	Odd-numbered L	Sensor 1 Green
1L	COM EVEN H	Even-numbered H	Sensor 2 Green
2H	COM EVEN L	Even-numbered L	Sensor 3 Green
⊥ (Signal Ground)	COM ⚡	⚡	Black
12V	12V		
G	G		
C1	CLK		
C3	RES		

<sup>1</sup>The red wire for each CS616 connects to the 12V terminal of the datalogger. The clear wire for each CS616 connects to the G terminal of the datalogger. User-supplied terminal blocks may be required.

**CRBasic Example B-7. CS616 Sensors**

```

'Declare Variables and Units
Dim LCount
Public BattV
Public PTemp_C
Public VW(48)
Public PA_uS(48)

Units BattV=Volts
Units PTemp_C=Deg C
Units PA_uS=uSec

'Define Data Tables
DataTable(Hourly,True,-1)
  DataInterval(0,60,Min,10)
  Sample (48,VW()),FP2)
  Sample (48,PA_uS()),FP2)
EndTable

'Main Program
BeginProg
  'Main Scan
  Scan(60,Sec,1,0)
    'Default CR1000X Datalogger Battery Voltage measurement 'BattV'
    Battery(BattV)
    'Default CR1000X Datalogger Wiring Panel Temperature measurement 'PTemp_C'
    PanelTemp(PTemp_C,_60Hz)
    If TimeIntoInterval(0,60,Min) Then
      'Turn AM16/32B Multiplexer On
      PortSet(C3,1)
      Delay(0,150,mSec)
      LCount=1
      SubScan(0,uSec,16)
        'Switch to next AM16/32B Multiplexer channel
        PulsePort(C1,10000)
        'CS616 Water Content Reflectometer measurements 'VW()' and 'PA_uS()' on AM16/32B
        CS616(PA_uS(LCount),3,1,C1,3,1,0)
        LCount=LCount+3
      NextSubScan
      For LCount=1 To 48
        VW(LCount)=-0.0663+(-0.0063*PA_uS(LCount))+(0.0007*PA_uS(LCount)^2)
      Next
      'Turn AM16/32B Off
      PortSet(C3,0)
    EndIf
    'Call Data Tables and Store Data
    CallTable Hourly
  NextScan
EndProg

```

## B.5 CR5000 Program Example

This CR5000 program uses the AM16/32B in 4x16 mode to measure 16 100  $\Omega$  Platinum Resistance Thermometers (PRTs). See TABLE B-6 for wiring.

TABLE B-6. Wiring for CR5000 Program Example

CR5000	AM16/32B in 4X16 Mode		PRT (4 Wires)
	Control and COM Terminals	Measurement Terminals	
IX1	COM ODD H	Odd-numbered H terminal	Excitation
IXR	COM ODD L	Odd-numbered L terminal	Excitation return
7H	COM EVEN H	Even-numbered H terminal	Sense wire excitation side
7L	COM EVEN L	Even-numbered L terminal	Sense wire return side
⏏ (Signal Ground)	COM ⏏		
12V	12V		
G	G		
C2	CLK		
C1	RES		

### CRBasic Example B-8. CR5000 Program Example

```
'CR5000 Example Program to measure 16 100-ohm Platinum Resistance Thermometers
'connected to an AM16/32B multiplexer used in the 4x16 configuration. The program also
'measures 6 copper constantan thermocouples.
'The Thermocouples are connected to differential channels 1-6.

'Declare Variables:
Public TRef, TCTemp(6), PRTResist(16), PRTTemp(16)
Dim LCount 'Counter for setting Array element to correct value for multiplexer measurement

'Declare Output Table for 15 minute averages:
DataTable (Avg15Min,1,-1)
  DataInterval (0,15,Min,10)
  Average (1,TRef,IEEE4,0)
  Average (6,TCTemp(),IEEE4,0)
  Average (16,PRTTemp(),IEEE4,0)
EndTable

BeginProg
  Scan (60,Sec,3,0)
  PanelTemp (TRef,250)
  TCDiff (TCTemp(),6,mV20C ,1,TypeT,TRef,True ,0,250,1.0,0)
  Portset (1 ,1) 'Set C1 high to Enable Multiplexer
  LCount=0
  SubScan(0,sec,16)
  'Pulse C2 (Set High, Delay, Set Low) to clock multiplexer
  Portset (2,1 )
  Delay (0,10,mSec)
  Portset (2,0)
  LCount=LCount+1
  'The Resistance measurement measures the PRT resistance:
  Resistance (PRTResist(LCount),1,mV50,7,LCountx1,1,500,True ,True ,0,250,0.01,0)
  'With a multiplier of 0.01 (1/100) the value returned is R/Ro (Resist/Resist @ 0 deg)
```

```
'the required input for the PRT temperature calculation instruction.  
NextSubScan  
Portset (1 ,0)           'Set C1 Low to disable Multiplexer  
'Calculate the Temperature from R/Ro:  
PRT (PRTTemp(1),16,PTRResist(1),1.0,0)  
CallTable Avg15Min      'Call the DataTable  
NextScan  
EndProg
```

# Appendix C. Thermocouple Measurement

---

If the AM16/32B will be used in thermocouple measurements, the practices outlined below should be followed to make the best possible measurement. The datalogger manuals contain thorough discussions of thermocouple measurement and error analysis. These topics will not be covered here.

---

**NOTE** The AM16/32B is not recommended for making highly accurate thermocouple measurements. Instead, Campbell Scientific recommends the AM25T, which uses an onboard PRT as a reference junction.

---

## C.1 Measurement Considerations

### C.1.1 Reference Junction

As shown in FIGURE C-1 and FIGURE C-2, two reference junction configurations are possible: 1) reference located at the datalogger or 2) reference at the AM16/32B.

### C.1.2 Datalogger Reference

If the reference junction is at the datalogger, matching thermocouple wire should be run between the **COM** terminals of the multiplexer and the differential input channel on the datalogger (observe TC wire polarity).

The CR300, CR6, CR1000, CR800, CR850, CR3000, and CR5000 have built-in temperature references.

---

**NOTE** The measurement from the CR6 and CR300 **PanelTemp()** instruction does not accurately reflect the temperature of the wiring panel, since it measures the temperature of the main processing board. Therefore, if the processor or charge (CHG) input are active, the PanelTemp measurement will be warmer than ambient. This should be taken into consideration if this measurement is used as a reference temperature for thermocouples.

---

When the reference junction is located at the datalogger, the signal wires between the datalogger and the AM16/32B must be of the same wire type as the thermocouple (FIGURE C-1). The “polarity” of the thermocouple wires must be maintained on each side of the multiplexer (for example, if constantan wire is input to an **L** terminal, then a constantan wire should run between the multiplexer **COM ODD L** terminal and the datalogger measurement terminal). FIGURE C-1 and FIGURE C-2 depict type T thermocouple applications, but other thermocouple types (for example, E, J, and K) may also be measured and linearized by the dataloggers.

It is not recommended to make measurements of any other sensor type through the AM16/32B if thermocouples are measured with respect to the datalogger reference (the signal wires between the datalogger and AM16/32B are made of thermocouple wire). Two problems would arise due to the properties of thermocouple wire.

First, an extraneous thermocouple voltage would be added to the non-thermocouple signal at the junction of dissimilar metals (for example, the multiplexer **COM** terminals). The magnitude of this signal would vary with the temperature difference between the datalogger and the AM16/32B.

Second, some thermocouple wires have a greater resistance than copper, which adds resistance to the non-thermocouple sensor circuit. For example, constantan is approximately 26 times more resistive than copper.

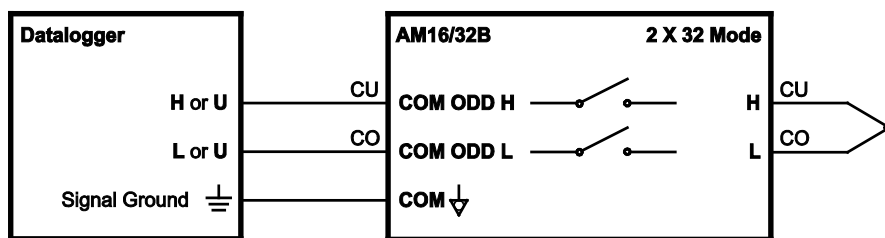


FIGURE C-1. Differential thermocouple measurement with reference junction at the datalogger

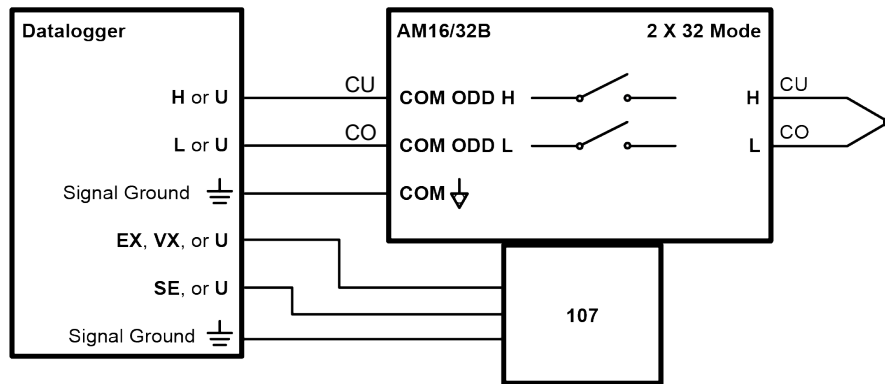


FIGURE C-2. Differential thermocouple measurement with reference junction at the AM16/32B (using 107-L thermistor)

### C.1.3 AM16/32B Reference

An external reference, usually a thermistor, can be located at the AM16/32B, as shown in FIGURE C-2. This approach requires an additional single-ended datalogger input to measure the reference. Position the reference next to the **COM** terminals and, when practical, measure the thermocouples on SETs that are in close proximity to the **COM** terminals in order to minimize thermal gradients.



### C.1.4 Thermal Gradients

Thermal gradients between the AM16/32B measurement terminals and COM terminals can cause errors in thermocouple readings. For example, with type T thermocouples, a one-degree gradient between the input terminals and the COM terminals will result in an approximate one-degree measurement error. Installing the aluminum cover plate (FIGURE C-3) helps to minimize gradients. For best results, the AM16/32B should be shielded and insulated from all radiant- and conducted-thermal sources. When an enclosure is used, gradients resulting from heat conducted along the thermocouple wire can be minimized by coiling some wire inside the enclosure. This technique allows heat to largely dissipate before it reaches the terminals. If the AM16/32B is housed in a field enclosure, the enclosure should be shielded from solar radiation.



FIGURE C-3. AM16/32B aluminum cover plate

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