



# AM25T

## Solid-State Thermocouple Multiplexer





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# PLEASE READ FIRST

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## About this manual

Please note that this manual was originally produced by Campbell Scientific Inc. primarily for the North American market. Some spellings, weights and measures may reflect this origin.

Some useful conversion factors:

<b>Area:</b> 1 in <sup>2</sup> (square inch) = 645 mm <sup>2</sup>	<b>Mass:</b> 1 oz. (ounce) = 28.35 g 1 lb (pound weight) = 0.454 kg
<b>Length:</b> 1 in. (inch) = 25.4 mm 1 ft (foot) = 304.8 mm 1 yard = 0.914 m 1 mile = 1.609 km	<b>Pressure:</b> 1 psi (lb/in <sup>2</sup> ) = 68.95 mb
	<b>Volume:</b> 1 UK pint = 568.3 ml 1 UK gallon = 4.546 litres 1 US gallon = 3.785 litres

In addition, while most of the information in the manual is correct for all countries, certain information is specific to the North American market and so may not be applicable to European users.

Differences include the U.S standard external power supply details where some information (for example the AC transformer input voltage) will not be applicable for British/European use. *Please note, however, that when a power supply adapter is ordered it will be suitable for use in your country.*

Reference to some radio transmitters, digital cell phones and aerials may also not be applicable according to your locality.

Some brackets, shields and enclosure options, including wiring, are not sold as standard items in the European market; in some cases alternatives are offered. Details of the alternatives will be covered in separate manuals.

Part numbers prefixed with a “#” symbol are special order parts for use with non-EU variants or for special installations. Please quote the full part number with the # when ordering.

## Recycling information



At the end of this product's life it should not be put in commercial or domestic refuse but sent for recycling. Any batteries contained within the product or used during the products life should be removed from the product and also be sent to an appropriate recycling facility.

Campbell Scientific Ltd can advise on the recycling of the equipment and in some cases arrange collection and the correct disposal of it, although charges may apply for some items or territories.

For further advice or support, please contact Campbell Scientific Ltd, or your local agent.



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# 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.eu](http://www.campbellsci.eu) or by telephoning +44(0) 1509 828 888 (UK). 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, or 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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# AM25T Solid-State Thermocouple Multiplexer

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## 1. Introduction

The AM25T (FIGURE 1-1) multiplexer increases the number of channels for measuring thermocouples or voltage sensors with Campbell Scientific data loggers. The AM25T is positioned between the sensors and the data logger. The data logger controls the AM25T solid-state relays, sequentially connecting each sensor to the data logger.

The AM25T is not suitable for resistive bridge measurements (high impedance of the solid-state relays) or multiplexing power (25 mA maximum switching current).

A maximum of 25 thermocouples (differential voltage measurement) can be multiplexed by an AM25T. Single-ended voltage measurements are not recommended.

The AM25T must be used in a noncondensing environment. An enclosure is required for field use. In applications where one or two multiplexers are deployed in the field, the ENC12/14 can be used. The ENC16/18 can be used to house several multiplexers at the same site.



FIGURE 1-1. AM25T Solid-State Thermocouple Multiplexer

## 2. Precautions

- The AM25T is not designed to multiplex power. Its intended function is to switch low-level analogue signals. Switched currents in excess of 25 mA will degrade the relay contacts involved, rendering that channel unsuitable for further low-level analogue measurement. Customers who need to switch power are directed to Campbell Scientific's SDM-CD16AC, A6REL-12, or A21REL-12 relays.
- After wiring an AM25T, 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 data logger, wiring panel, sensor, or multiplexer (not covered under warranty).

## 3. Initial Inspection

- The AM25T ships with:
  - AM25T Cover
  - Mounting Grommet (qty: 4)
  - Mounting Screw (qty: 4)
- Upon receipt of the AM25T, 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. Overview

The AM25T is connected to the data logger with eight insulated wires and a large ground wire. These wires are used to power and control the multiplexer, and connect the common analogue inputs to the data logger.

### 4.1 Measurement Terminals

There are 25 differential channels on the AM25T. These channels are labelled **1H** and **1L** through **25H** and **25L**. The channels are sequentially connected and reversed to the common channels **HI** and **LO**.

### 4.2 Excitation Terminal (VX)

This terminal is used to excite the reference temperature (PRT) on the AM25T. The excitation line is protected from transients with a transorb. (Earlier versions of the AM25T, prior to serial number 1839, used a Zener diode for protection. The diode limited the negative excitation voltage to -400 mV.)

### 4.3 Power (12V)

The AM25T requires a 9.6 to 16 Vdc (12 Vdc nominal) power supply.

In low current drain applications, it is convenient to power the AM25T from the data logger battery. For power intensive operations, use a high amp hour 12 Vdc battery.

See Campbell Scientific's application note on power supplies (<https://s.campbellsci.com/documents/eu/technical-papers/pow-sup.pdf>) for information on calculating the power requirements for a system.

### 4.4 Power Ground (G), Ground Terminals ( $\perp$ )

Each differential input channel has a ground terminal located next to it. The ground terminals ( $\perp$ ) are common with the power ground (G) and the ground lug on the base. Connect the sensor shields to the ground terminals ( $\perp$ ). Always tie the data logger and multiplexer to a common earth ground via the ground lug.

### 4.5 Analogue Ground ( $\perp$ )

The analogue ground terminal is the ground reference for the AM25T reference temperature measurement. It is the  $\perp$  terminal located between the **VX** and **HI** terminals. Analogue ground is not common with the other ground terminals labelled **G**. **The analogue ground terminal must be connected to the data logger ground as shown in TABLE 7-1.**

### 4.6 Reset (RES)

A control terminal is used to operate the **RES** channel. The AM25T is reset and activated by applying and holding 5 Vdc to the **RES** channel. Once the AM25T is activated, the AM25T reference temperature can be immediately measured. The AM25T enters its quiescent state when the **RES** channel is set to 0 Vdc.

### 4.7 Clock (CLK)

Pulsing the **CLK** channel sequentially advances the relays. A control terminal is used to operate the **CLK** channel.

The first **CLK** pulse advances the relays to the reference temperature excitation channel. The second **CLK** pulse advances the relays and connects **HI** and **LO** to **1H** and **1L** on the multiplexer.

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#### NOTE

Two clock pulses are required to advance to the next adjacent sensor input channel on the AM25T.

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The fourth **CLK** pulse advances the relays and connects **HI** and **LO** to **2H** and **2L**. The sixth **CLK** pulse advance the relays and connects **HI** and **LO** to **3H** and **3L**. This sequence is continued for the remaining input channels.

## 5. Terminal Strips

The AM25T is housed in an anodized aluminum case with a cover that helps reduce temperature gradients across the terminal strips (FIGURE 5-1).

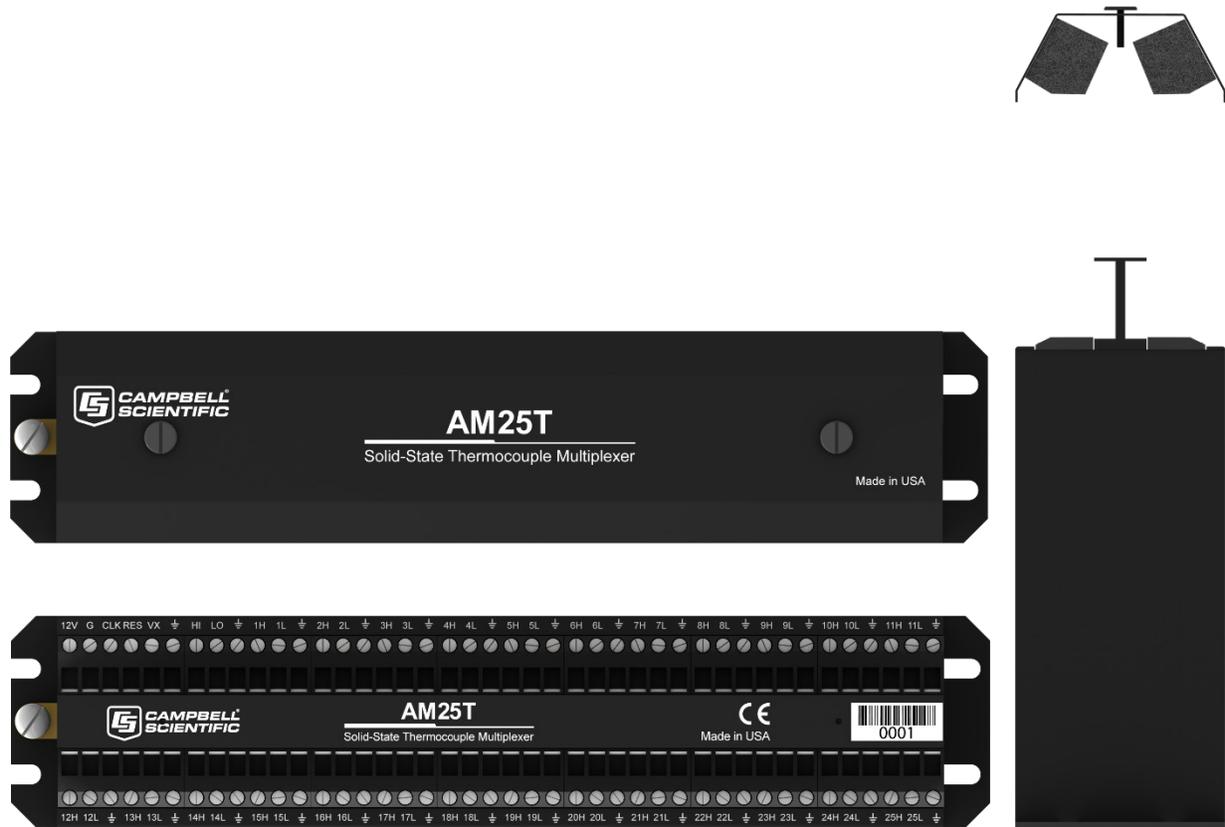


FIGURE 5-1. AM25T Solid-State Thermocouple Multiplexer with Cover (Screw Terminal Strips)

The terminal strips that run the length of the AM25T are for sensor connections. All inputs are protected by spark gaps. All terminals accept stripped and tinned wires up to AWG wire gauge 16. A strain-relief flange is located between the input terminals.

Starting with serial number 10147, the AM25T uses spring-loaded terminals for attaching wires (FIGURE 5-2). To attach a wire, use a small flat-head screwdriver to push the white spring release next to the terminal the wire is being attached to. Insert the wire into the terminal, then remove the screwdriver.



FIGURE 5-2. AM25T with Spring-Loaded Terminals

As shown in FIGURE 5-1, AM25T multiplexers prior to serial number 10147 will have screw terminals for each wire. To attach a wire, loosen the screw to widen the terminal gap, insert the wire, then tighten the screw.

## 6. Specifications

<b>Power:</b>	Unregulated 9.6 to 16 Vdc; 12 Vdc nominal
<b>Current Drain</b>	
<b>Quiescent:</b>	0.5 mA
<b>Active:</b>	1.0 mA (typical)
<b>Enable</b>	
<b>Inactive:</b>	< 0.9 V
<b>Active:</b>	3.5 to 5.0 V (7 V max.)
<b>Clock</b>	
The relays are advanced on the falling edge of the clock pulse (transition from >3.5 V to <1.5 V; 7 V max.). The minimum clock pulse width is limited by the data logger.	
<b>Minimum ON Time:</b>	50 microseconds
<b>Minimum OFF Time:</b>	60 microseconds
<b>Operating Temperature</b>	
<b>Standard:</b>	-40 to 85 °C
<b>PRT Accuracy:</b>	±0.4 °C

<b>Operating Humidity Noncondensing:</b>	0 to 95%
<b>Dimensions</b>	
<b>Length:</b>	23.6 cm (9.3 in)
<b>Width:</b>	5.10 cm (2.0 in)
<b>Depth:</b>	13.2 cm (5.2 in)
<b>Weight:</b>	0.91 kg (2.0 lb) 3.6 kg (8.0 lb); shipping
<b>Expandability (Nominal)*:</b>	1 AM25T per CR300 or CR310 (requires OS version 6 or later) 2 AM25Ts per CR800 or CR850 3 AM25Ts per CR6 4 AM25Ts per CR1000, CR1000X, CR3000 7 AM25Ts per CR5000 CR9000X variable, depending on how many CR9051E modules are installed
<b>Maximum Data Cable Length:</b>	Multiplexers can be located up to 305 m (1000 ft) from the data logger. When lightning protection is required, do not exceed 152 m (500 ft) in data cable length. The spark gaps will not fire if the heavy ground wire is longer than 152 m (500 ft).
<b>Typical relay Resistance:</b>	500 $\Omega$
<b>Maximum Switching Current:</b>	25 mA; switching currents greater than 25 mA damages the relays and renders them unusable.
<b>Compliance:</b>	View the EU Declaration of Conformity at <a href="http://www.campbellsci.eu/am25t">www.campbellsci.eu/am25t</a>

\*Assumes sequential activation of multiplexers and that each data logger channel is uniquely dedicated. If your application requires additional multiplexing capability, please consult Campbell Scientific for application assistance.

## 7. Installation

### 7.1 Installing the AM25T

The AM25T may be operated in a non-condensing environment, such as a laboratory, without being housed in an enclosure. For field use, the AM25T must be protected against dust and liquid. Campbell Scientific offers weather-resistant enclosures for this purpose.

Fasten the AM25T to the enclosure backplate. Securely fasten the wires to the strain relief flange running between the AM25T terminal strips and install the cover to reduce temperature gradients during thermocouple measurements.

## 7.2 Data Logger to AM25T Wiring

When powering the AM25T from the same battery as the data logger, connect the data logger to the AM25T as shown in TABLE 7-1. Two CABLE4CBL-L cables typically carry control, power, and measurement signals between the AM25T and the data logger.

### WARNING

**Do not reverse the polarity of the +12 volt and ground wires. Damage to the multiplexer, sensors, and data logger will occur.**

A separate battery can be used to power the AM25T. A separate battery might be used when the AM25T is installed some distance from the data logger. Ground must be connected between the data logger and the AM25T (FIGURE 7-1).

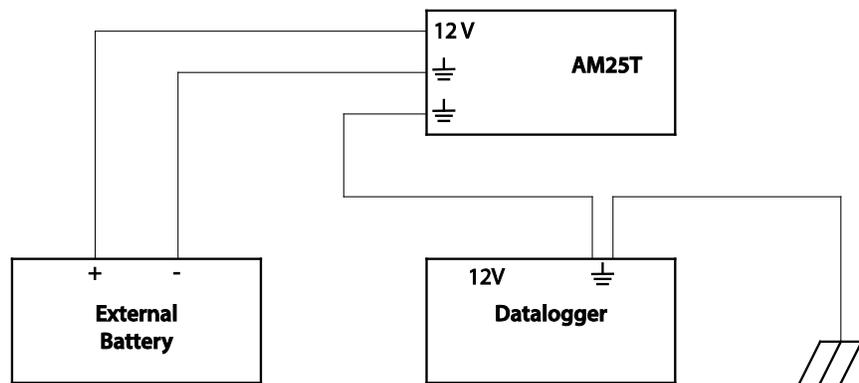


FIGURE 7-1. External Battery Connections

When cables in excess of 152 m (500 feet) are used to connect the data logger to the AM25T, it may be necessary to compensate for the drop in PRT excitation voltage.

### CAUTION

All AM25T inputs are spark gap protected. To ensure that the spark gaps fire, the large ground wire between the AM25T and the data logger must not be greater than 152 m (500 ft). In applications where lightning protection is not required, limit the data cable length between the AM25T and the data logger to 305 m (1000 ft).

**TABLE 7-1. AM25T to Data Logger Wiring**

Function	AM25T	Data Logger
12 Vdc Power	<b>12V</b>	<b>12V</b>
Power Ground	<b>G</b>	<b>G</b>
Analogue Ground <sup>1</sup>	$\perp$	$\perp$
Clock	<b>CLK</b>	<b>U</b> or Control Terminal
Reset	<b>RES</b>	<b>U</b> or Control Terminal
PRT Excitation	<b>VX</b>	<b>VX, U</b> , or Control Terminal
Common High	<b>HI</b>	<b>Diff H, U</b> , or Control Terminal
Common Low	<b>LO</b>	<b>Diff L, U</b> , or Control Terminal

<sup>1</sup>Analogue Ground is the  $\perp$  terminal located between the **VX** and **HI** terminals on the AM25T.

### 7.3 Sensor to AM25T Wiring

This section and the examples describe differential voltage measurements of thermocouples. It is possible to make single-ended measurements with the AM25T; however, they are more likely to have problems.

Shield wires are connected to the analogue ground ( $\perp$ ) terminal next to the measurement channel and left unattached at the sensor.

#### 7.3.1 Thermocouple Measurement

An internal reference PRT is located in the AM25T. This reference temperature does not require an additional data logger input to measure the reference.

Thermal gradients between the AM25T sensor input terminals and the PRT cause errors in thermocouple readings. For example, a one-degree gradient between input terminals and the PRT will result in a one-degree measurement error. The thermal bar in the AM25T, which includes the strain relief, and the AM25T cover are designed to reduce gradients. The PRT is attached to the thermal bar.

Heat conduction along the thermocouple wire, into the terminal strips, can be reduced by coiling excess wire inside the enclosure.

For a differential voltage measurement of a thermocouple, wire the high side of the thermocouple to the high side of a differential input channel on the AM25T and the low side of the thermocouple to the low side of the channel.

Thermocouples that follow the U.S. industry standards use red insulation on the low side of the thermocouple. Wire one thermocouple per differential input channel (FIGURE 7-2).

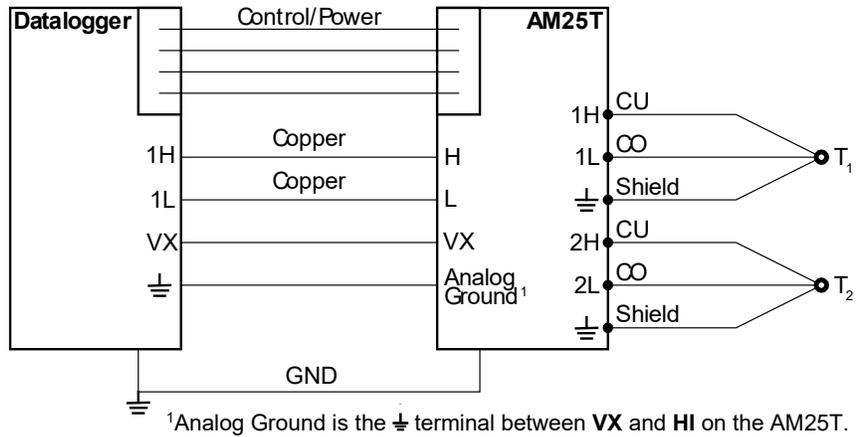


FIGURE 7-2. Differential Measurement of Type T Thermocouple

### 7.3.2 Differential Analogue Measurements

Connect one differential sensor to a differential AM25T input channel. Connect the sensor shields to the analogue ground ( $\perp$ ) terminals next to the input channel. Up to 25 differential sensors may be measured by one differential channel on the data logger (FIGURE 7-3).

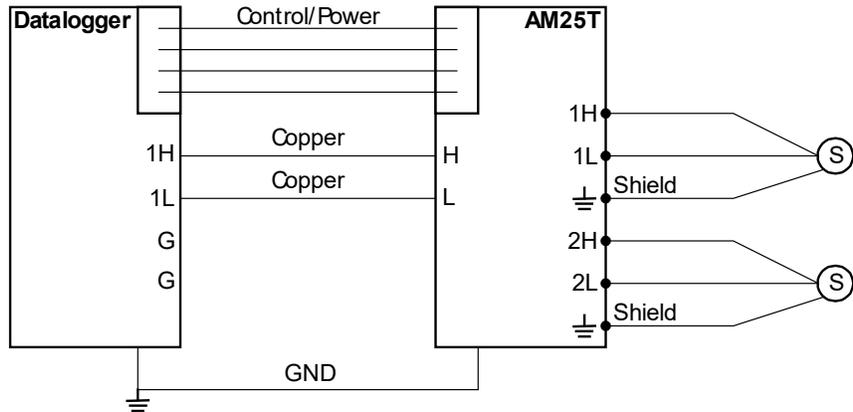


FIGURE 7-3. Differential Voltage Measurement

### 7.3.3 Mixed Sensor Types

Different sensors may be mixed on the AM25T. Additional loops and measurement instructions will be required.

## 8. Operation

### 8.1 General Measurement Considerations

Wires have additional capacitance that increases the time required for a signal to settle its true value. To reduce settling time, Campbell Scientific

recommends use of Teflon®, polyethylene, or polypropylene insulation around individual conductors. Do not use PVC as conductor insulation. PVC may be used as a cable jacket.

With long wire lengths, a delay within the measurement instruction will allow the capacitance of the lead wires to discharge before the measurement is made. Consult the measurement section of the data logger user instruction and information for more information.

## 8.2 Data Logger Programming

*Short Cut* can build many program configurations for various supported sensors, providing a quick way to generate a program and wiring diagram (FIGURE 8-1). *Short Cut* can be downloaded free of charge ([www.campbellsci.eu](http://www.campbellsci.eu)).

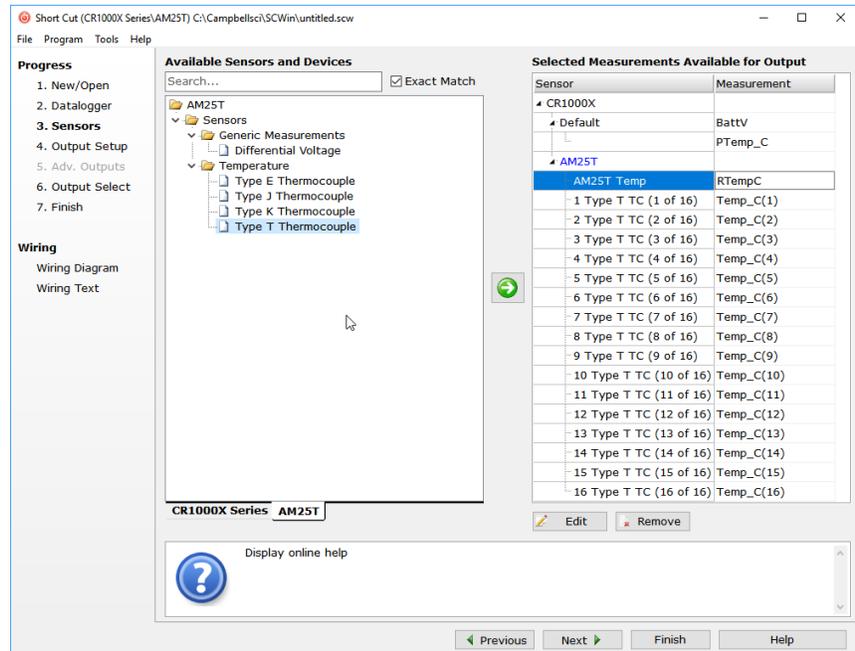


FIGURE 8-1. *Short Cut*

*Short Cut* is the best source for up-to-date data logger program code. Program code is needed when:

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

If the data acquisition requirements are simple, a data logger program can be created and maintained exclusively with *Short Cut*. If the data acquisition needs are more complex, the files that *Short Cut* creates are a great source for program 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*.

If there is a need to import *Short Cut* code into the *CRBasic Editor* to create or add to a custom program, follow the procedure in Appendix A, *Importing Short Cut Code Into CRBasic Editor* (p. A-1). Programming basics for *CRBasic* data loggers are provided in the following section. A complete program example for a select data logger can be found in Appendix B, Example Program (p. B-1).

### 8.2.1 CRBasic Programming

In *CRBasic*, the **AM25T()** instruction is used to control the AM25T multiplexer with the data logger. The instruction measures the PRT incorporated in the AM25T and uses it as a reference temperature for thermocouple measurements. The **AM25T()** instruction and parameters are as follows:

**AM25T** (Dest, Repts, Range, AM25TChan, DiffChan, TCTYPE, TRef, ClkPort, ResPort, ExChan, RevDiff, SettlingTime, Integ/ $f_{NL}$ , Mult, Offset)

For information on this instruction, refer to the *CRBasic Help*.

## 9. Maintenance

Maintain a level of calibration appropriate to the application. Campbell Scientific recommends factory recalibration of the AM25T every five years. Consider the following factors when setting a calibration schedule:

- the importance of the measurements
- how long the multiplexer will be used
- the operating environment
- how the multiplexer will be handled



# Appendix A. Importing Short Cut Code Into CRBasic Editor

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This tutorial shows:

- Importing a *Short Cut* program into a program editor for additional refinement
- Importing 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)
- .CR9 (CR9000(X) datalogger code)

Import *Short Cut* code and wiring diagram into *CRBasic Editor*:

1. Create the *Short Cut* program following the procedure in Section 4, *Overview* (p. 2). Finish the program. On the **Advanced** tab, click the **CRBasic Editor** button. The program opens in CRBasic with the name **noname.CR\_**. Provide a name and save the program.

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## NOTE

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

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2. The program can now be edited, saved, and sent to the data logger.
3. Import wiring information to the program by opening the associated .DEF file. By default, it is saved 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 data logger 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 Program

In this example, 25 type T thermocouples are connected to the AM25T. One **AM25T()** instruction will measure the AM25T PRT and the thermocouples. This program is written for the CR6 datalogger. Other CRBasic data loggers are programmed similarly. TABLE B-1 shows the wiring used with the example.

Function	AM25T	Data Logger
+12 Vdc Power	12V	12V
Power Ground	G	G
Analogue Ground <sup>1</sup>	⏏	⏏
Clock	CLK	U1
Reset	RES	U2
PRT Excitation	VX	U3
Common High	HI	U5
Common Low	LO	U6

<sup>1</sup>Analogue Ground is the ⏏ terminal located between the VX and HI terminals on the AM25T.

## CRBasic Example B-1. CR6 Program Using One Instruction to Measure Both the Reference Temperature and Thermocouples

```
'CR6 Series
'Declare Variables and Units
Public BattV
Public PTemp_C
Public RTempC
Public Temp_C(25)

Units BattV=Volts
Units PTemp_C=Deg C
Units RTempC=Deg C
Units Temp_C=Deg C

'Define Data Tables
DataTable(Dat15sec,True,-1)
  DataInterval(0,15,Sec,10)
  Sample(1,RTempC,FP2)
  Sample(25,Temp_C(1),FP2)
EndTable

DataTable(Dat5Min,True,-1)
  DataInterval(0,5,Min,10)
  Minimum(1,BattV,FP2,False,False)
  Average(1,RTempC,FP2,False)
  Average(25,Temp_C(1),FP2,False)
EndTable
```

```
'Main Program
BeginProg
'Main Scan
Scan(5,Sec,0,0)
'Default CR6 Datalogger Battery Voltage measurement 'BattV'
Battery(BattV)
'Default CR6 Datalogger Wiring Panel Temperature measurement 'PTemp_C'
PanelTemp(PTemp_C,60)
'Type T (copper-constantan) Thermocouple measurements 'Temp_C()' on the AM25T Multiplexer
AM25T(Temp_C),25,mv200C,1,U5,TypeT,RTempC,U1,U2,U3,True,0,60,1,0)
'Call Data Tables and Store Data
CallTable Dat15sec
CallTable Dat5Min
NextScan
EndProg
```



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