Product Manual

Measurement & Control Peripheral

AM25T

Solid-State Thermocouple Multiplexer

Revision: 8/18

RELIABLE SINCE 1974 MONITORING

CAMPBELL SCIENTIFIC

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General

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- 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.

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- 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.

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AM25T Solid-State Thermocouple Multiplexer

1. Introduction

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

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 analog signals. Switched currents in excess of 25 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.

- 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 datalogger, 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 datalogger with eight insulated wires and a large ground wire. These wires are used to power and control the multiplexer, and connect the common analog inputs to the datalogger.

4.1 Measurement Terminals

There are 25 differential channels on the AM25T. These channels are labeled **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 datalogger's 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/us/technical-papers/pow-sup.pdf*) for information on calculating the power requirements for a system.

4.4 Power Ground (G), Ground Terminals (⏚)

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

4.5 Analog Ground (⏚)

The analog ground terminal is the ground reference for the AM25T reference temperature measurement. It is the ⏚ terminal located between the **VX** and **HI** terminals. Analog ground is not common with the other ground terminals labeled **G**. **The analog ground terminal must be connected to the datalogger 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.

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

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. Overview

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

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 1.5 mm (0.059 inches) in diameter. A strain-relief flange is located between the input terminals.

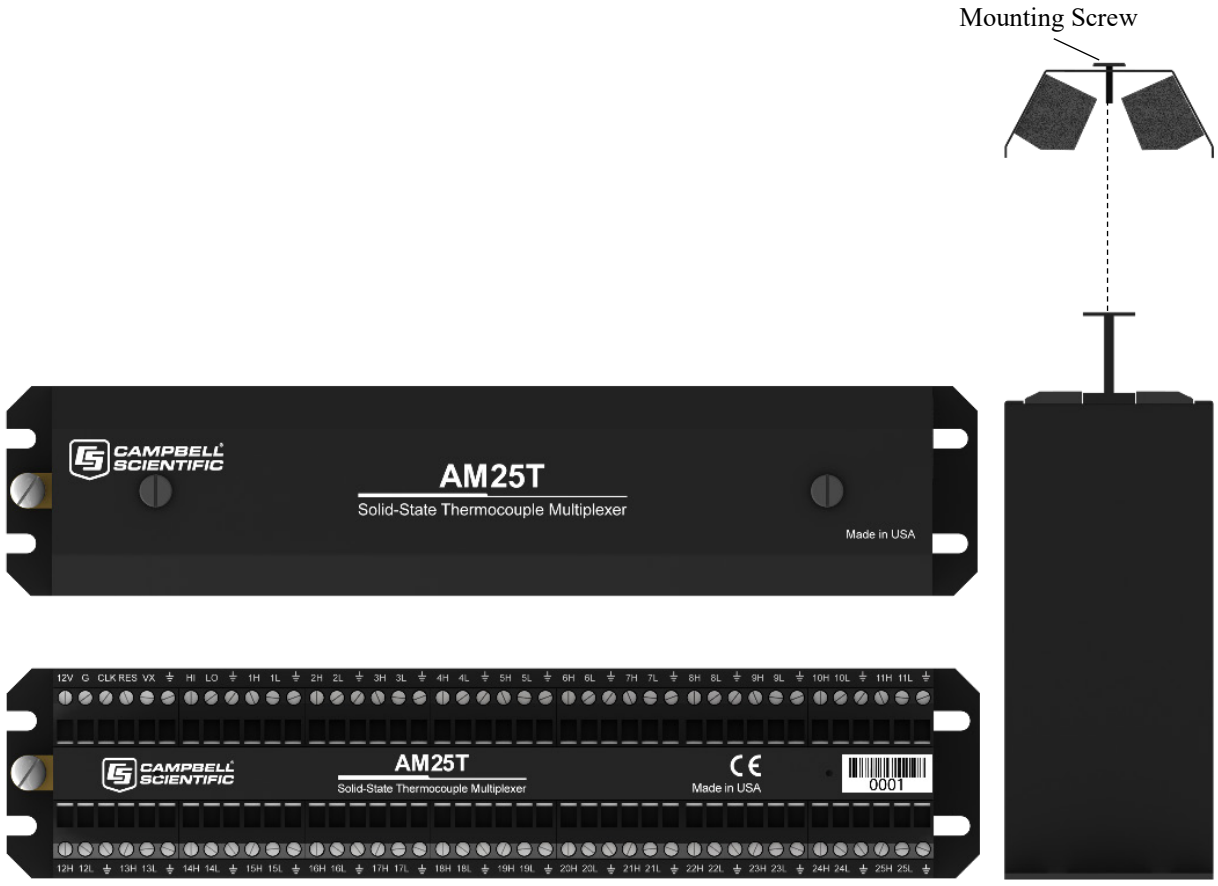

FIGURE 5-1. AM25T Solid-State Thermocouple Multiplexer with Cover

6. Specifications

Power:	Unregulated 9.6 to 16 Vdc; 12 Vdc nominal
Current Drain	
Quiescent:	0.5 mA
Active:	1.0 mA (typical)
Enable	
Inactive:	< 0.9 V
Active:	3.5 to 5.0 V (7 V max.)

Clock

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 datalogger.

Minimum ON Time: 50 microseconds
Minimum OFF Time: 60 microseconds

Operating Temperature
Standard: –40 to 85 °C

PRT Accuracy: ±0.4 °C

Operating Humidity
Noncondensing: 0 to 95%

Dimensions
Length: 23.6 cm (9.3 in)
Width: 5.10 cm (2.0 in)
Depth: 13.2 cm (5.2 in)

Weight: 0.91 kg (2.0 lb)
3.6 kg (8.0 lb); shipping

Expandability (Nominal)*: 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

Maximum Data Cable Length: Multiplexers can be located up to 305 m (1000 ft) from the datalogger. 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).

Typical relay Resistance: 500 Ω

Maximum Switching Current: 25 mA; switching currents greater than 25 mA damages the relays and renders them unusable.

Compliance: View the EU Declaration of Conformity at *www.campbellsci.com/am25t*

*Assumes sequential activation of multiplexers and that each datalogger 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 Datalogger to AM25T Wiring

When powering the AM25T from the same battery as the datalogger, connect the datalogger 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 datalogger.

WARNING

Do not reverse the polarity of the +12 volt and ground wires. Damage to the multiplexer, sensors, and datalogger 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 datalogger. Ground must be connected between the datalogger and the AM25T (FIGURE 7-1).

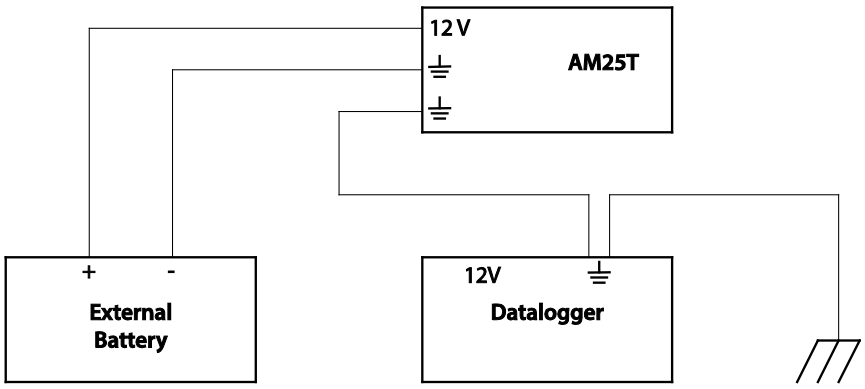

FIGURE 7-1. External Battery Connections

When cables in excess of 152 m (500 feet) are used to connect the datalogger 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 datalogger 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 datalogger to 305 m (1000 ft).

TABLE 7-1. AM25T to Datalogger Wiring

Function	AM25T	Datalogger
12 Vdc Power	**12V**	**12V**
Power Ground	**G**	**G**
Analog Ground[1]	⏚	⏚
Clock	**CLK**	**U** or Control Terminal
Reset	**RES**	**U** or Control Terminal
PRT Excitation	**VX**	**VX**, **U**, or Control Terminal
Common High	**HI**	**Diff H**, **U**, or Control Terminal
Common Low	**LO**	**Diff L**, **U**, or Control Terminal

[1]Analog Ground is the ⏚ 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 analog ground (⏚) 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 datalogger 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).

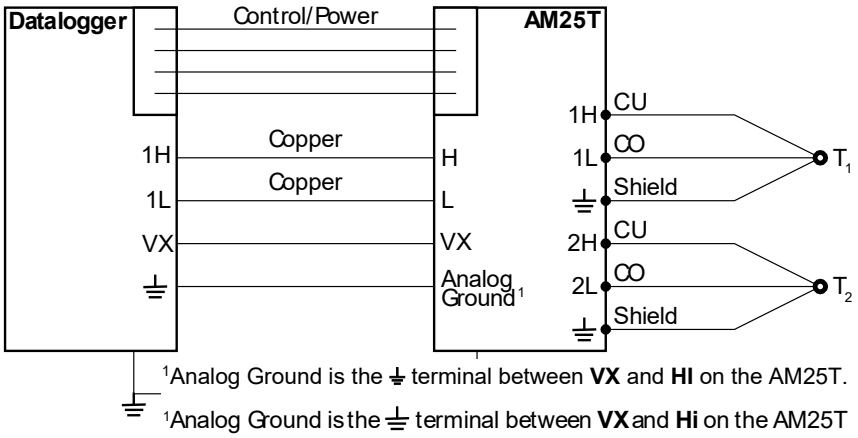

FIGURE 7-2. Differential Measurement of Type T Thermocouple

7.3.2 Differential Analog Measurements

Connect one differential sensor to a differential AM25T input channel. Connect the sensor shields to the analog ground (⏚) terminals next to the input channel. Up to 25 differential sensors may be measured by one differential channel on the datalogger (FIGURE 7-3).

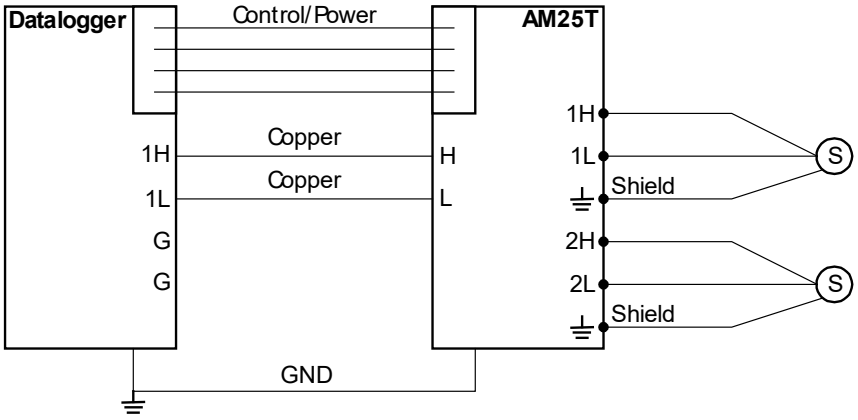

FIGURE 7-3. Differential Voltage Measurement

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 datalogger user instruction and information for more information.

8.2 Datalogger 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.com*).

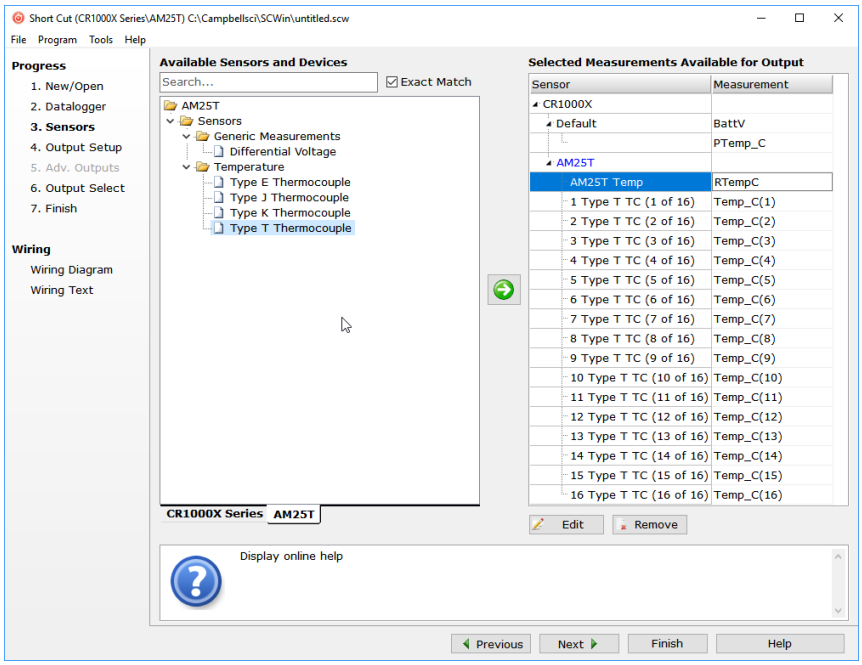

FIGURE 8-1. Short Cut

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

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

If the data acquisition requirements are simple, a datalogger 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 dataloggers are provided in the following section. A complete program example for a select datalogger 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 datalogger. 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, Reps, Range, AM25TChan, DiffChan, TCType, TRef,
ClkPort, ResPort, ExChan, RevDiff, SettlingTime, Integ/fN1, 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

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.

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

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 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 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 Program

In this example, 25 type T thermocouples are connected to the AM25T. One **AM25T()** instruction will measure the AM25T's PRT and the thermocouples. This program is written for the CR6 datalogger. Other CRBasic dataloggers are programmed similarly. TABLE B-1 shows the wiring used with the example.

TABLE B-1. Wiring for CR6 Example

Function	AM25T	Datalogger
+12 Vdc Power	**12V**	**12V**
Power Ground	**G**	**G**
Analog Ground[1]	⏚	⏚
Clock	**CLK**	**U1**
Reset	**RES**	**U2**
PRT Excitation	**VX**	**U3**
Common High	**HI**	**U5**
Common Low	**LO**	**U6**

[1]Analog 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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