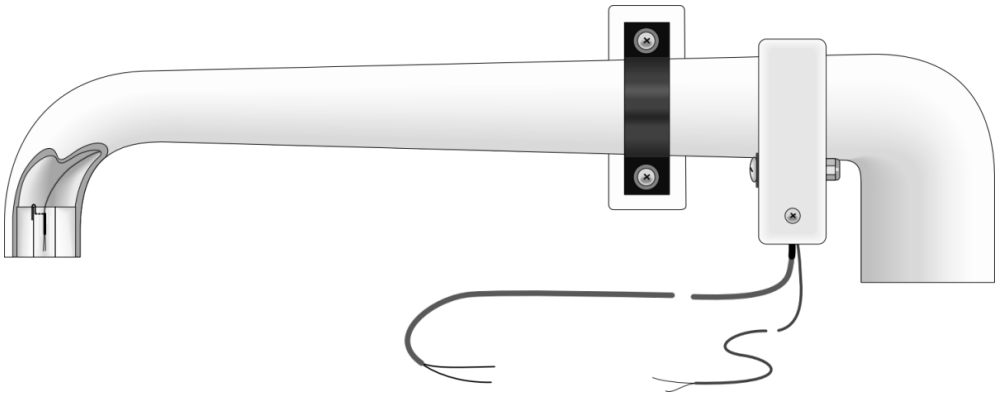
Product Manual

Sensor

ASPTC

Aspirated Shield with Fine Wire Thermocouple



Revision: 7/19

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- Batteries
- Any product which has been subjected to misuse, neglect, acts of God or damage in transit.

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PLEASE READ FIRST

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:

Area: 1 in^2 (square inch) = 645 mm^2

Length: 1 in. (inch) = 25.4 mm
1 ft (foot) = 304.8 mm
1 yard = 0.914 m
1 mile = 1.609 km

Mass: 1 oz. (ounce) = 28.35 g
1 lb (pound weight) = 0.454 kg

Pressure: 1 psi (lb/in^2) = 68.95 mb

Volume: 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

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 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.

Table of Contents

PDF viewers: These page numbers refer to the printed version of this document. Use the PDF reader bookmarks tab for links to specific sections.

ASPTC Aspirated Shield with Fine Wire Thermocouple

1. Introduction

The ASPTC consists of a type-E fine-wire thermocouple mounted in a fan-aspirated radiation shield to provide highly accurate air temperature measurements. You can use one ASPTC to measure absolute air temperature, or you can use two ASPTCs to make delta temperature measurements.

NOTE This manual provides information only for CRBasic data loggers. For retired Edlog data logger support, see an older manual at *www.campbellsci.com/old-manuals*.

2. Precautions

- READ AND UNDERSTAND the *Safety* section at the front of this manual.
- Care should be taken when opening the shipping package to not damage or cut the cable jacket. If damage to the cable is suspected, contact Campbell Scientific.

3. Initial Inspection

Upon receipt of the sensor, inspect the packaging and contents for damage. File damage claims with the shipping company.

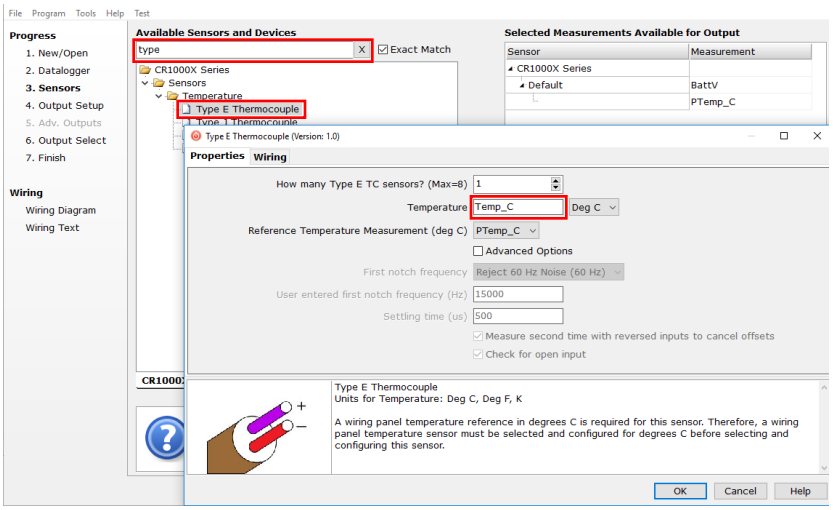
4. QuickStart

A video that describes data logger programming using *Short Cut* is available at: *www.campbellsci.eu/videos/cr1000x-datalogger-getting-started-program-part-3*. *Short Cut* is an easy way to program your data logger to measure the sensor and assign data logger wiring terminals. *Short Cut* is available as a download on *www.campbellsci.eu*. It is included in installations of *LoggerNet*, *PC200W*, *PC400*, or *RTDAQ*.

The following procedure shows using *Short Cut* to program the type-E thermocouple of the ASPTC. A reference temperature measurement is required. For this tutorial, the data logger panel temperature measurement is used as the reference temperature measurement.

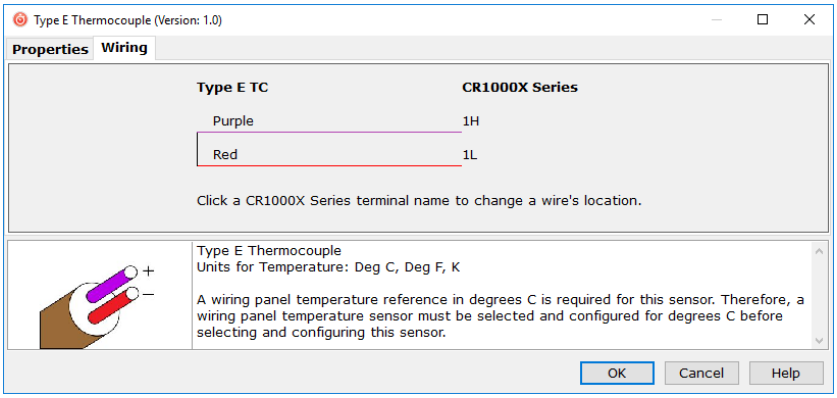
1. Open *Short Cut* and click **Create New Program**.
2. Double-click the data logger model.

3. In the **Available Sensors and Devices** box, type Type E Thermocouple or locate the sensor in the **Sensors** > **Temperature** folder. Double-click **Type E Thermocouple**. The temperature defaults to degrees C. This can be changed by clicking the **Temperature** box and selecting one of the other options.



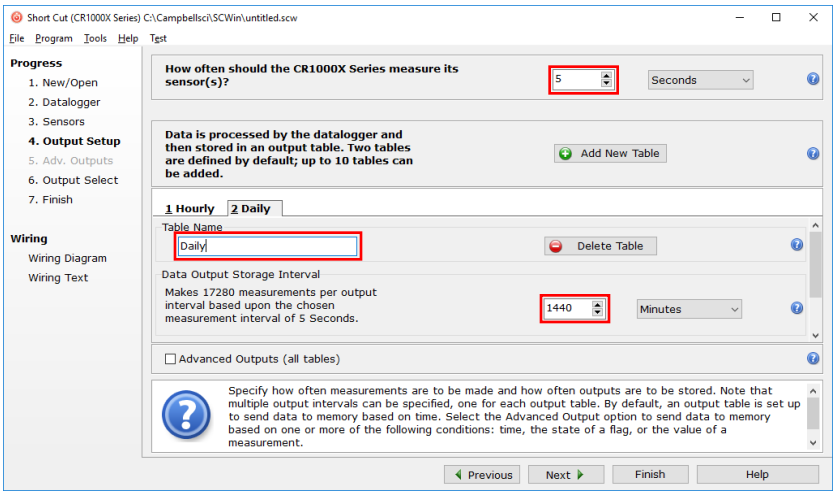
4. Click the **Wiring** tab to see how the sensor is to be wired to the data logger. Click **OK** after wiring the sensor.

NOTE The *Short Cut* wiring diagram is only for the signal cable and does not show the shield wire, which connects to a ground terminal on the data logger. The power cable connects to an external power supply (Section 7.3, *Wiring* (p. 5)).



5. Repeat steps three and four for other sensors you want to measure. Click **Next**.

6. In **Output Setup**, type the scan rate, meaningful **Table Names**, and **Data Output Storage Interval**.



7. Select the measurement and its associated output option.

8. Click **Finish** and save the program. Send the program to the data logger if the data logger is connected to the computer.

9. If the sensor is connected to the data logger, check the output of the sensor in data display *in LoggerNet, PC400, RTDAQ*, or *PC200W* to make sure it is making reasonable measurements.

5. Overview

The ASPTC radiation shield is an elongated tube constructed from white UV-stabilized polyethylene that provides low thermal conductivity and heat retention. A fan draws air across the measurement junction, which reduces solar loading on the thermocouple. The radiation shield also protects the thermocouple, increasing the thermocouple durability.

The ASPTC fine-wire thermocouple consists of a chromel wire and a constantan wire joined at a measurement junction. A voltage potential is generated when the measurement end of the thermocouple is at a different temperature than the reference end of the thermocouple. The magnitude of the voltage potential is related to the temperature difference. Therefore, temperature can be determined by measuring the differences in potential created at the junction of the two wires.

A reference temperature measurement (typically measured at the data logger wiring panel) is required.

6. Specifications

Weight:	0.9 kg (1.9 lb)
Shield	
Material:	UV stabilized polyethylene
Dimension	
Length:	53.3 cm (21 in)
Height:	14.7 cm (5.8 in)
Large Outer Diameter:	5.8 cm (2.3 in)
Small Outer Diameter:	4.6 cm (1.8 in)
Fan	
Air Velocity at Thermocouple:	5.5 m/s @ 12 VDC
Life Expectancy:	65,000 hr @ 30 °C
Current Drain:	260 mA @ 12 VDC
Operating Voltage:	9 to 13 Vdc
Operating Temperature:	–10 to 70 °C
Reverse Polarity Protected	
Thermocouple	
Type:	Chromel-Constantan (type E)
Diameter:	0.0762 mm (0.003 in)
Typical Output:	60 µV/°C

7. Installation

If you are programming your data logger with *Short Cut*, skip Section 7.3, *Wiring* (p. 5), and Section 7.4, *Programming* (p. 6). *Short Cut* does this work for you. See Section 4, *QuickStart* (p. 1), for a *Short Cut* tutorial.

7.1 Power Considerations

The ASPTC should be powered by using an external 12 VDC deep cycle, battery recharged with an SP20R solar panel or by using the PS200 or PS150 recharged with an AC charger. A solar panel used with the PS200 or PS150 does not have enough reserve power for overcast days.

7.2 Mounting

The ASPTC is mounted on a user supplied crossarm with a square cross section of 4 cm x 4 cm (1.5 in x 1.5 in).

The ASPTC also can be mounted on the retired Bowen Ratio arms (FIGURE 7-1) or retired UT018 crossarm (FIGURE 7-2). When using the Bowen Ratio arms to mount the ASPTC, mount it to the side of the arm such that the ASPTC intake is at the same height as the water vapour intake.

FIGURE 7-1. ASPTCs Mounted to Bowen Ratio Arms

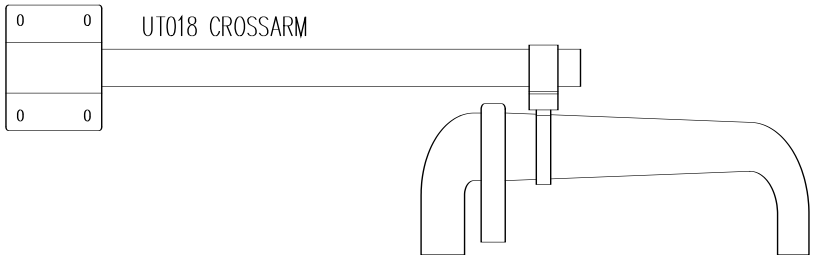


FIGURE 7-2. ASPTC Mounted to the UT018

7.3 Wiring

The ASPTC has a signal cable and a power cable. The signal cable connects to the data logger and the power cable connects to an external power supply. For absolute temperature measurements, differential terminals are recommended to reduce noise. For delta T measurements, the lower ASPTC typically uses single-ended terminals and the upper ASPTC uses differential terminals. TABLE 7-1 shows the wiring for the ASPTC.

TABLE 7-1. Wire Colour, Function, and Connections to the Data Logger

Wire Colour	Function	Data Logger Terminals		External Battery Terminals
		Differential	Single-Ended	
Signal Cable				
Purple	Analogue signal	**U** configured for differential high[1], **DIFF H** (differential high, analogue-voltage input)	**U** configured for single-ended[1], **SE** (single-ended, analogue-voltage input)	NA
Red	Signal reference	**U** configured for differential low[1], **DIFF L** (differential low, analogue-voltage input)	⏚ (analogue ground)	NA
Clear	Shield	⏚ (analogue ground)	⏚ (analogue ground)	NA
Power Cable				
Red	Power	NA	NA	**12V +**
Black	Power ground	NA	NA	**G –**

[1] **U** terminals are automatically configured by the measurement instruction.

7.4 Programming

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

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

A *Short Cut* tutorial is available in Section 4, *QuickStart* *(p. 1)*. If you wish to import *Short Cut* code into *CRBasic Editor* to create or add to a customized 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 sections. Complete program examples for select CRBasic data loggers can be found in Appendix B, *Example Programs* *(p. B-1)*.

7.4.1 Absolute Temperature

Use the **TCDiff()** CRBasic instruction to measure a single ASPTC. The **TCDiff()** instruction has the following form:

```
TCDiff( Dest, Reps, Range, DiffChan, TCType, TRef, RevDiff,
SettlingTime, integration or fN1, Mult, Offset )
```

Choose TypeE for the TCType. A reference temperature measurement (TRef) is required, which can be provided by the data logger panel temperature measurement. Use the **PanelTemp()** instruction to measure the data logger panel temperature.

7.4.2 Delta Temperature

Delta temperature is measured using two ASPTCs. Use the **TCSE()** CRBasic instruction to measure the lower ASPTC. Choose TypeE for the TCType and use the data logger panel temperature measurement for the reference temperature. Use the **TCDiff()** CRBasic instruction to measure the upper ASPTC. Choose TypeE for the TCType and use the lower ASPTC measurement as the reference temperature. If the accuracy of the absolute temperature at both the lower and upper ASPTC is a concern, measure both ASPTCs with the **TCDiff()** CRBasic instruction.

Delta temperature is calculated by subtracting the upper ASPTC measurement from the lower ASPTC measurement.

8. Maintenance

Keep the intake and thermocouple free from debris. Debris can be blown away with a can of compressed air. Tweezers may also be used to pick the debris from the thermocouple. Be careful not to damage the junction.

Appendix A. Importing Short Cut Code into CRBasic Editor

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

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

1. Create the *Short Cut* program following the procedure in Section 4, *QuickStart (p. 1)*. After saving the *Short Cut* program, click the **Advanced** tab then the **CRBasic Editor** button. A program file with a generic name will open in CRBasic. Provide a meaningful name and save the CRBasic program. This program can now be edited for additional refinement.

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

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

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

4. In the CRBasic program, highlight the wiring information, right-click, and select **Comment Block**. This adds an apostrophe (') to the beginning of each of the highlighted lines, which instructs the data logger compiler to ignore those lines when compiling. The **Comment Block** feature is demonstrated at about 5:10 in the *CRBasic | Features* video.

Appendix B. Example Programs

This appendix includes two example CR1000X programs. TABLE B-1 provides the wiring for first example, which measures absolute temperature using one ASPTC. TABLE B-2 provides wiring for the second example program, which uses an upper and a lower ASPTC to measure temperature gradient. The lower ASPTC is measured using single-ended channels and the upper ASPTC is measured using differential channels. The data logger panel temperature is used as the reference temperature for the lower ASPTC measurement. The temperature of the lower ASPTC is used as the reference for the differential thermocouple measurement.

TABLE B-1. Wiring for Absolute Temperature Program Example

Wire Colour	Function	CR1000X Terminals	External Battery Terminals
Signal Cable			
Purple	Analogue signal	**1H**	NA
Red	Signal reference	**1L**	NA
Clear	Shield	⏚ (analogue ground)	NA
Power Cable			
Red	Power	NA	**12V +**
Black	Power ground	NA	**G –**

CRBasic Example B-1. CR1000X Program Measuring Absolute Temperature Using the ASPTC

```
'CR1000X Series Data Logger

Public PTemp_C
Public Temp_C

Units PTemp_C = Deg C
Units Temp_C = Deg C

'Define Data Table
DataTable (Hourly,1,-1)
  DataInterval (0,60,Min,10)
  Average (1,Temp_C, FP2, False)
EndTable

'Main Program
BeginProg
  Scan (1,Sec,0,0)
    PanelTemp (PTemp_C,60)
    TCDiff (Temp_C,1,mV200C,1,TypeE,PTemp_C,TRUE,0,60,1,0)

'Call Data Table and store data
    CallTable (Hourly)
  NextScan
EndProg
```

TABLE B-2. Wiring for Temperature Gradient Example Program				
Wire Colour	**Function**	**CR1000X Terminals**		**External Battery Terminals**
		Upper ASPTC	**Lower ASPTC**	
Signal Cable				
Purple	Analogue signal	**3H**	**SE6**	NA
Red	Signal reference	**3L**	⏚ (analogue ground)	NA
Clear	Shield	⏚ (analogue ground)	⏚ (analogue ground)	NA
Power Cable				
Red	Power	NA	NA	**12V +**
Black	Power ground	NA	NA	**G –**

CRBasic Example B-2. CR1000X Program Measuring Temperature Gradient Using Two ASPTCs

```
'CR1000X Series Data Logger

Public ref_tmpr
Public asp_lwr
Public asp_upr
Public del_asp

Units ref_tmpr = Deg C
Units asp_lwr = Deg C
Units asp_upr = Deg C
Units del_asp= Deg C

'Define Data Table
DataTable (Hourly,1,-1)
  DataInterval (0,60,Min,10)
  Average (1,asp_lwr, FP2, False)
  Average (1,asp_upr, FP2, False)
  Average (1,del_asp, FP2, False)
EndTable

'Main Program
BeginProg
  Scan (1,Sec,0,0)
    PanelTemp (ref_tmpr,60)

'Measure lower and upper ASPTCs

    TCSe (asp_lwr,1,mV200C,6,TypeE,ref_tmpr,TRUE,0,60,1,0)
    TCDiff (asp_upr,1,mV200C,3,TypeE,asp_lwr,TRUE,0,60,1,0)

'Calculate delta temperature
    del_asp = asp_lwr - asp_upr

'Call Data Table and store data
    CallTable (Hourly)
  NextScan
EndProg
```

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