Product Manual

SR50A-Series
Sonic Ranging Sensors
Limited warranty

“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.) 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.”
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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

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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.

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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 hard hat 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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1. Introduction

The SR50A-series sonic ranging sensors provide a non-contact method for determining snow or water depth. They determine depth by emitting an ultrasonic pulse and then measuring the elapsed time between the emission and return of the pulse. An air temperature measurement is required to correct for variations of the speed of sound in air.

Table 1-1 (p. 1) shows the differences between the models. Overview (p. 7) discusses these differences in more details. Throughout this document SR50A will refer to all of the models unless specified otherwise.

<table>
<thead>
<tr>
<th>Model</th>
<th>Anodized aluminum body</th>
<th>Integrated heater</th>
<th>Air temperature sensor included(^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR50A</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SR50AH</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>SR50AT</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>SR50ATH</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

\(^1\) The air temperature sensor included with the SR50AT and SR50ATH is integrated in their cable (FIGURE 1-1 (p. 2)). This temperature sensor must be housed in a multiplate radiation shield.
FIGURE 1-1. SR50AT mounted to a crossarm with the temperature sensor housed in a RAD06 radiation shield

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 (p. iii) section at the front of this manual.
- Never open the sensor while it is connected to power or any other device.
- Always disconnect the sensor using the connector or disconnect the cable wires from their termination points.
- Never operate the sensor with the shield wire disconnected. The shield wire plays an important role in noise emissions and susceptibility as well as transient protection.
- Follow local regulations (see Compliance in Specifications (p. 8)).
3. Initial inspection

Upon receipt of the sensor, inspect the packaging for any signs of shipping damage and, if found, report the damage to the carrier in accordance with policy. The contents of the package should also be inspected and a claim filed if any shipping related damage is discovered.

4. QuickStart

A video that describes data logger programming using Short Cut is available at: www.campbellsci.com/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.com. It is included in installations of LoggerNet, PC200W, PC400, or RTDAQ.

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

**NOTE:**
Skip steps 3 and 4 if using an SR50AT or SR50ATH. Steps 3 and 4 use the 107 thermistor to provide the air temperature measurement required for the SR50A or SR50AH.
3. In the **Available Sensors and Devices** box, start typing 107 or find the 107 in the **Sensors | Temperature** folder. Double click the **107 Temperature Probe**. Use the default of degree Celsius.

4. Click on the **Wiring** tab to see how the sensor is to be wired to the data logger. Click **OK** after wiring the sensor.
5. In the **Available Sensors and Devices** box, start typing SR50A. You can also find the sensor in the **Sensors > Miscellaneous Sensors > SR50/SR50A Sonic Ranging Sensor** folder. Double-click the sensor model. Data defaults to meters, which can be changed by clicking the **Unit of measure box** and selecting cm, ft, or in. Type the **Distance to base**, which is the distance from the wire mesh face to the ground. **SDI-12 Address** defaults to 0. Type the correct **SDI-12 Address** if it has been changed from the factory-set default value. If using an SR50A or SR50AH, click on the **Air temperature (Deg C) reference** box and select the reference temperature variable (T107_C).
6. Click on the **Wiring** tab to see how the sensor is to be wired to the data logger. Click **OK** after wiring the sensor.

![Wiring Diagram](image)

7. Repeat steps five and six for other sensors. Click **Next**.

8. In **Output Setup**, type the scan rate, meaningful table names, and **Data Output Storage Interval**. Click **Next**. Because of the delays using SDI-12, Campbell Scientific recommends measurement scans of 10 seconds or more.

![Output Setup](image)
9. Select the output options.

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

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

5. Overview

The SR50A-series sensors measure the distance from the sensor to a target. They determine the distance to a target by sending out ultrasonic pulses (50 kHz) and listening for the returning echoes that are reflected from the target. The time from transmissions to return of the echo is the basis for obtaining the distance measurement.

Since the speed of sound in air varies with temperature, an independent temperature measurement is required to compensate the distance reading. A simple calculation is applied to initial readings for this purpose. The SR50AT and SR50ATH include a temperature sensor to provide this measurement. The SR50A and SR50AH require an external temperature sensor, such as the 107, to provide the measurement.

The SR50A-series sensors are capable of picking up small targets or targets that are highly absorptive to sound, such as low-density snow. They use a unique echo-processing algorithm to
help ensure measurement reliability. If desired, these sensors can also output a data value indicative of measurement quality.

The SR50A-series sensors meet the stringent requirements of snow depth measurement that make them well suited for a variety of other applications. They have a rugged aluminum chassis that withstands many environments, but is not suitable for marine (salty) environments. The SR50AH and SR50ATH include integrated heaters that prevent ice from coating the transducer, but the heaters increase the power consumption of the sensor; see SR50AH heater operation (p. 107) for more information.

SDI-12, RS-232, and RS-485 output options are available for measuring the SR50A. The SR50A is factory configured as an SDI-12 sensor (address 0) because Campbell Scientific data loggers typically use the SDI-12 format. To use the RS-232 or RS-485 format, three jumpers inside the SR50A need to be moved (Disassembly/assembly procedures (p. 23) and Jumper settings (p. 82)). Refer to RS-232 and RS-485 operation (p. 93) for more information.

6. Specifications

Features:
- Wide operating temperature range
- Compatible with Campbell Scientific CRBasic data loggers: CR200(X) series, CR300 series, CR6 series, CR800 series, CR1000, CR1000X series, CR3000, and CR5000

Power requirements: 9 to 18 Vdc

Quiescent power consumption (no heater)
- SDI-12 mode: < 1.0 mA
- RS-232/RS-485 modes: < 1.25 mA (≤ 9600 bps), < 2.0 mA (> 9600 bps)

Active power consumption (no heater): 250 mA typical

Measurement time: Less than 1.0 s typical for RS-232 or RS-485 measurements
1.2 s typical for SDI-12 measurements

Selectable outputs: SDI-12 (version 1.3)
RS-232 (1200 to 38400 bps)
RS-485 (1200 to 38400 bps)
Measurement range: 0.5 to 10 m (1.6 to 32.8 ft)

Accuracy: ±1 cm (±0.4 in) or 0.4% of distance to target, whichever is greater.

Accuracy specification excludes errors in the temperature compensation. An external temperature compensation is required.

Resolution: 0.25 mm (0.01 in)

Required beam angle clearance: 30°

Operating temperature range: –45 to 50 °C

Maximum cable length: SDI-12 60 m (197 ft)  
RS-232 (9600 bps or less) 30 m (98 ft)  
RS-485 300 m (984 ft); power supply must not drop below 11.0 V or a heavier gage wire is required

Cable type: 4 conductor, 2-twisted pair, 22 awg  
Santoprene jacket

Chassis types: Aluminum or 316L stainless steel

Sensor length: 10.1 cm (4 in)

Sensor diameter: 7.6 cm (3 in)

Sensor weight (no cable)  
Aluminum chassis: 0.4 kg (0.88 lb)  
Stainless-steel chassis: 0.795 kg (1.75 lb)

Cable weight (15 ft): 0.25 kg (0.55 lb)

IP rating  
Electrical housing: IP67  
Transducer: IP64
Compliance: This device complies with Part 15 of the USA Federal Communications Commission (FCC) Rules. Operation in the USA is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

Compliance documents: View at www.campbellsci.com/sr50a
www.campbellsci.com/sr50at-l
www.campbellsci.com/sr50ah-l
www.campbellsci.com/sr50ath-l

6.1 Integrated temperature sensor

Accuracy: ±0.2 °C (0 to 50 °C);
±0.75 °C (–45 to 0 °C)

7. Installation

If you are programming your data logger with Short Cut, skip SDI-12 wiring (p. 14) and Programming (p. 15). Short Cut does this work for you. See QuickStart (p. 3) for a Short Cut tutorial.

If not using SDI-12, refer to RS-232 and RS-485 operation (p. 93) for wiring and programming information.

7.1 Beam angle

When mounting the SR50A, the beam angle needs to be considered. Mount the SR50A perpendicular to the intended target surface. The SR50A has a beam angle of approximately 30 degrees. This means that objects outside this 30-degree beam will not be detected nor interfere with the intended target. Any unwanted target must be outside the 30-degree beam angle.

Determine the required clearance for the beam angle using the following formula and FIGURE 7-1 (p. 11).

Clearance Radius formula:

\[ \text{CONE}_{\text{radius}} = 0.268(\text{CONE}_{\text{height}}) \]
Where,

\[ \text{CONE}_{\text{height}} = \text{the distance to base (Reference Point (p. 11))} \]

\[ \text{CONE}_{\text{radius}} = \text{clearance radius in the same measurement units as the CONE}_{\text{height}} \]

![Figure 7-1. Beam angle clearance](image)

7.2 Mounting height

Mount the SR50A so that the face of the transducer is at least 50 cm (19.7 in) away from the target. However, mounting the sensor too far from the target can increase the absolute error increases. For example, if your sensor is measuring snow depth in an area that will likely not exceed 1.25 m (4.1 ft), then a good height to mount the sensor will be 1.75 to 2.0 m (5.74 to 6.56 ft). Mounting the sensor at a 4 m (13.1 ft) height can result in larger snow depth errors.

7.2.1 Reference Point

The front grill on the ultrasonic transducer is used for the reference for the distance values. Because of the difficulty of measuring from the grill, most users measure the distance from the target to the outer edge of the plastic transducer housing (FIGURE 7-2 (p. 12)) and then add 8 mm (0.3 in) to the measured distance.
7.3 Mounting

To achieve an unobstructed view for the beam, the SR50A is typically mounted to a tripod mast, tower leg, or user-supplied pole using the CM206 6-ft crossarm or a pipe with a 1-inch to 1.75-inch outer diameter. The SR50A Mounting Kit attaches directly to the crossarm or pipe. FIGURE 7-3 (p. 13) shows the SR50A mounted to a crossarm using the mounting kit. A U-bolt mounts the bracket to the crossarm and two screws fasten the SR50A to the bracket.

The SR50A Mounting Stem (FIGURE 7-4 (p. 13)) attaches to the crossarm using the 1-inch-by-1-inch Nu-Rail fitting (FIGURE 7-5 (p. 14)), CM220 right-angle mount, CM230 adjustable-angle mount, or CM230XL extended adjustable-angle mount. Use the CM230 or CM230XL if the ground surface is at an angle.
FIGURE 7-3. Two views of the crossarm installation using the SR50A mounting kit

FIGURE 7-4. SR50A mounting stem
7.4 SDI-12 wiring

**CAUTION:**
Power down your system before wiring the SR50A. Never operate the sensor with the shield wire disconnected. The shield wire plays an important role in noise emissions and susceptibility as well as transient protection.

**Table 7-1: Wire color, function, and data logger connection**

<table>
<thead>
<tr>
<th>Wire color</th>
<th>Wire function</th>
<th>Data logger connection terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>Power ground</td>
<td>G</td>
</tr>
<tr>
<td>Red</td>
<td>Power</td>
<td>12V</td>
</tr>
<tr>
<td>Green</td>
<td>SDI-12 signal</td>
<td>C(^1), SDI-12, or U configured for SDI-12(^1)</td>
</tr>
<tr>
<td>White</td>
<td>Ground</td>
<td>G</td>
</tr>
<tr>
<td>Clear</td>
<td>Shield</td>
<td>G</td>
</tr>
</tbody>
</table>

\(^1\) C and U terminals are automatically configured by the measurement instruction.

To use more than one sensor per data logger, either connect the different sensors to different terminals on the data logger or change the SDI-12 addresses of the sensors and wire them to the
same terminal. Changing the SDI-12 addresses reduces the number of terminals used on the data logger and allows sensors to be connected in a daisy-chain that can minimize cable runs in some applications.

For the CR6 and CR1000X data loggers, triggering conflicts may occur when a companion terminal is used for a triggering instruction such as \texttt{TimerInput()}, \texttt{PulseCount()}, or \texttt{WaitDigTrig()}. For example, if the SR50A is connected to C3 on a CR1000X, C4 cannot be used in the \texttt{TimerInput()}, \texttt{PulseCount()}, or \texttt{WaitDigTrig()} instructions.

Regardless of the data logger, if enough terminals are available, avoid using the companion terminal for another device.

### 7.5 Programming

Short Cut is the best source for up-to-date data logger programming code. 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 \textit{QuickStart} (p. 3). If you wish to import Short Cut code into CRBasic Editor to create or add to a customized program, follow the procedure in \textit{Importing Short Cut code into CRBasic Editor} (p. 28). Programming basics for CRBasic data loggers are provided in the following section. Complete program examples for select CRBasic data loggers can be found in \textit{Example programs} (p. 30).

#### 7.5.1 SDI-12 programming

The \texttt{SDI12Recorder()} instruction is used to measure an SR50A configured for SDI-12 measurements. This instruction sends a request to the sensor to make a measurement and then retrieves the measurement from the sensor. See \textit{SDI-12 measurements} (p. 19) for more information.

For most data loggers, the \texttt{SDI12Recorder()} instruction has the following syntax:

\begin{verbatim}
SDI12Recorder(Destination, SDIPort, SDIAddress, "SDICommand", Multiplier, Offset, FillNAN, WaitonTimeout)
\end{verbatim}

For the \texttt{SDIAddress}, alphabetical characters need to be enclosed in quotes (for example, “A”). Also enclose the \texttt{SDICommand} in quotes as shown. The \texttt{Destination} parameter must be an
array. The required number of values in the array depends on the command (see Table 8-2 (p. 19)).

FillNAN and WaitonTimeout are optional parameters (refer to CRBasic Help for more information).

7.5.2 RS-232 programming

The RS-232 instructions are shown in Table 7-2 (p. 16). Example programs are provided in RS-232 programs (p. 42).

<table>
<thead>
<tr>
<th>Instruction</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>SerialOpen()</td>
<td>Set up a data logger terminal for serial communications.</td>
</tr>
<tr>
<td>SerialFlush()</td>
<td>Clears the buffer.</td>
</tr>
<tr>
<td>Scan()</td>
<td>Establish a scan rate.</td>
</tr>
<tr>
<td>SerialOut()</td>
<td>Send command to the sensor.</td>
</tr>
<tr>
<td>SerialIn()</td>
<td>Set up the COM terminal to receive the incoming serial data. Please note that in the beginning of the CRBasic program, the variable used in the SerialIn() instruction needs to be declared as an ASCII string format.</td>
</tr>
<tr>
<td>SplitStr()</td>
<td>Split out digital count value from the input string.</td>
</tr>
</tbody>
</table>

7.5.3 RS-485 programming

The RS-485 output can be directly read by a CR6-series and CR1000X-series. Other Campbell Scientific data loggers can use an MD485 multidrop interface to read the RS-485 output. Refer to the MD485 manual for information about using the MD485.

Programming for RS-485 output uses the same instructions as the RS-232 output (Table 7-2 (p. 16)). Example programs are provided in RS-485 programs (p. 50).

8. Operation

The SR50A performs multiple echo processing regardless of output formats. It bases every measurement on several readings and applies an algorithm to improve measurement reliability.
The distance to target readings that are obtained from the sensor are referenced from the metal mesh on the face of the transducer. The SR50A projects an ultrasonic beam that can pick up objects in its field of view that is 30° or less. The closest object to the sensor will be detected if it is within this field of view. Unwanted objects must be outside the field of view. If a target is in motion, the SR50A may reject a reading if the target distance changes at a rate of 4 centimeters per second or more.

The SR50A completes a measurement and outputs the data typically in 1 second. In RS-232 and RS-485 serial modes, the data is completed within one second for baud rates of 9600 bps and above. The total time for an SDI-12 measurement can be between 1 to 2 seconds due to the long communication times associated with the 1200 bps data rate.

If the SR50A rejects a reading or does not detect a target, zero will be output for distance to target or –999 for depth values.

### 8.1 Quality numbers

Measurement quality numbers are available with the output data; these numbers indicate the measurement certainty (Table 8-1 (p. 17)). Quality numbers have no units of measure and typically vary from 152 to 600. Numbers that are between 152 and 210 indicate good quality measurements. Zero indicates that the reading was not obtained. Numbers greater than 300 indicate a degree of uncertainty in the measurement. Causes of high numbers include:

- sensor is not perpendicular to the target surface
- target is small and reflects little sound
- target surface is rough or uneven
- target surface is a poor reflector of sound (extremely low-density snow)

<table>
<thead>
<tr>
<th>Quality number range</th>
<th>Quality range description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Not able to read distance</td>
</tr>
<tr>
<td>152 to 210</td>
<td>Good measurement quality numbers</td>
</tr>
<tr>
<td>210 to 300</td>
<td>Reduced echo signal strength</td>
</tr>
<tr>
<td>300 to 600</td>
<td>High measurement uncertainty</td>
</tr>
</tbody>
</table>

Although not necessary, quality numbers provide useful information such as surface density in snow monitoring applications. Please note that quality number values may increase during snowfall events consisting of low-density snow.
8.2 Temperature compensation

The SR50A and SR50AH do not include a temperature sensor to compensate for the speed-of-sound variations in air temperature (Table 1-1 (p. 1)). For these sensors, temperature corrections for the speed of sound must be applied to the readings by using measurements from a reliable and accurate temperature probe, such as the 107. The temperature probe needs to be housed in a radiation shield. Temperature compensation is applied to the sensor output using the following formula:

\[
DISTANCE = \text{READING}_{SR50A} \sqrt{\frac{T\text{ KELVIN}}{273.15}}
\]

**CAUTION:**
The SR50A and SR50AH calculate distance readings using the speed of sound at 0 °C (331.4 m/s). If the temperature compensation formula is not applied, the distance values will not be accurate for temperatures other than 0 °C.

The SR50AT and SR50ATH include a temperature sensor to compensate the speed of sound for variations in air temperature. The temperature sensor is incorporated into the cable as shown in **FIGURE 8-1** (p. 18).

![FIGURE 8-1. SR50AT-CBL](image)
For the RS-232 and RS-485 modes, temperature correction using the integrated temperature probe measurement is applied to the readings by default. For the SDI-12 output mode, the data logger must include a measurement command that outputs temperature. Otherwise, the temperature correction will not be applied. SDI-12 M2, M3, M4, M7, and M8 commands automatically apply the temperature compensation to the readings. (See SDI-12 measurements (p. 19) for the complete list of SDI-12 commands.)

SDI-12 M9 command obtains a temperature measurement without a distance reading, which allows the SR50AT or SR50ATH to function as an SDI-12 temperature sensor.

For the RS-232 and RS-485 modes, the integrated temperature output setting can be turned off if you do not want to use the integrated-temperature probe for the temperature correction. SDI-12 M, M1, M5, and M6 commands do not use the integrated temperature probe measurements to compensate for the speed of sound.

A radiation shield is required for the temperature probe integrated into the sensor cable. Without a radiation shield, heating of the probe from the sun radiation can cause large errors in the temperature reading, which causes erroneous distance measurements.

### 8.3 SDI-12 measurements

The SDI-12 protocol supports the SDI-12 commands listed in Table 8-2 (p. 19).

**NOTE:**
The SR50A needs to be powered for 1.5 s before it can receive an SDI-12 command.

The different commands are entered as options in the SDI-12 recorder instruction. The user has the option to output the distance to target in either meters or feet, or to include the measurement quality numbers.

If the SR50A is unable to detect a proper echo for a measurement, the sensor will return a zero value for the distance to target value.

<table>
<thead>
<tr>
<th>SDI-12 command</th>
<th>Command function/description</th>
<th>Values returned</th>
</tr>
</thead>
<tbody>
<tr>
<td>aM!</td>
<td>Distance-Meters</td>
<td>D</td>
</tr>
<tr>
<td>aM1!</td>
<td>Distance-Meters, Quality Number</td>
<td>D, Q</td>
</tr>
<tr>
<td>aM2!</td>
<td>Distance-Meters, Temperature °C</td>
<td>D, T</td>
</tr>
<tr>
<td>aM3!</td>
<td>Distance-Meters, Quality Number, Temperature °C</td>
<td>D, Q, T</td>
</tr>
<tr>
<td>SDI-12 command</td>
<td>Command function/description</td>
<td>Values returned</td>
</tr>
<tr>
<td>----------------</td>
<td>-----------------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>aM4 !</td>
<td>Snow Depth Meters, Quality Number, Temperature</td>
<td>SD, Q, T</td>
</tr>
<tr>
<td>aM5 !</td>
<td>Distance-Inches</td>
<td>D</td>
</tr>
<tr>
<td>aM6 !</td>
<td>Distance-Inches, Quality Number</td>
<td>D, Q</td>
</tr>
<tr>
<td>aM7 !</td>
<td>Distance-Inches, Quality Number, Temperature °C</td>
<td>D, Q, T</td>
</tr>
<tr>
<td>aM8 !</td>
<td>Snow Depth Inches, Quality Number, Temperature</td>
<td>SD, Q, T</td>
</tr>
<tr>
<td>aM9 !</td>
<td>Temperature °C</td>
<td>T</td>
</tr>
<tr>
<td>aMC !</td>
<td>Measurement Commands with Checksum</td>
<td>Output is the same as aM, aM1-aM9 Checksum is added</td>
</tr>
<tr>
<td>aMCn !</td>
<td></td>
<td></td>
</tr>
<tr>
<td>aC !</td>
<td>Concurrent Measurement Command Distance-Meters</td>
<td>D</td>
</tr>
<tr>
<td>aCn !</td>
<td>Concurrent Measurements Same as M1-M8</td>
<td>Output is the same as M1-M8</td>
</tr>
<tr>
<td>aCC ! aCCn !</td>
<td>Concurrent Measurement Commands with Checksum See aM and aM1-aM8</td>
<td>Output is the same as aM, aM1-aM8 Checksum is added</td>
</tr>
<tr>
<td>aD0 !</td>
<td>Send Data</td>
<td>Dependent upon command sent</td>
</tr>
<tr>
<td>aV !</td>
<td>Verification Command</td>
<td>S1, S2, V, WD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S1 = Operating System Signature</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S2 = BootRom Signature</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V = Supply Voltage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WD = Watch Dog Errors</td>
</tr>
<tr>
<td>aI !</td>
<td>Send Identification</td>
<td>013CAMPBELLSSR50A 2.0SN</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SN = Serial number (5 digits)</td>
</tr>
<tr>
<td>? !</td>
<td>Address Query</td>
<td>a</td>
</tr>
<tr>
<td>aAb !</td>
<td>Change Address Command</td>
<td>b is the new address</td>
</tr>
</tbody>
</table>
### Table 8-2: SDI-12 commands

<table>
<thead>
<tr>
<th>SDI-12 command</th>
<th>Command function/description</th>
<th>Values returned</th>
</tr>
</thead>
<tbody>
<tr>
<td>aXM;D.DDD!</td>
<td>Extended command</td>
<td>a Address is returned</td>
</tr>
<tr>
<td></td>
<td>Set the distance to ground parameter in the SR50AT. The distance must be in meters with no more than three decimal places.</td>
<td></td>
</tr>
<tr>
<td>aXI;DDD.DD!</td>
<td>Extended command</td>
<td>a Address is returned</td>
</tr>
<tr>
<td></td>
<td>Set the distance to ground parameter in the SR50AT. The distance must be in inches with no more than two decimal places.</td>
<td></td>
</tr>
<tr>
<td>aXT;CC.CC!</td>
<td>Extended command</td>
<td>a Address is returned</td>
</tr>
<tr>
<td></td>
<td>Provide the SR50AT with a temperature value to perform onboard temperature compensation. The temperature must be in degrees Celsius with a maximum of seven characters including sign and decimal.</td>
<td></td>
</tr>
<tr>
<td>aR0!</td>
<td>Returns the distance to ground setting in the SR50AT. The units returned are in meters.</td>
<td>DG</td>
</tr>
<tr>
<td>aR1!</td>
<td>Returns the distance to ground setting in the SR50AT. The units returned are in inches.</td>
<td>DG</td>
</tr>
<tr>
<td>aR2!</td>
<td>Returns the temperature sent to the SR50AT for internal temperature compensation. This value remains the same unless power is cycled or a new temperature values is sent.</td>
<td>T</td>
</tr>
</tbody>
</table>

Where a = address of SDI-12 device.
Where n = numbers 1 to 9

When using the M! command, the data logger waits for the time specified by the sensor, sends the D! command, pauses its operation, and waits until either it receives the data from the sensor or the sensor timeout expires. If the data logger receives no response, it will send the command a total of three times, with three retries for each attempt, or until a response is received. Because of the delays this command requires, it is only recommended in measurement scans of 10 seconds or more.

The C! command follows the same pattern as the M! command with the exception that it does not require the data logger to pause its operation until the values are ready. Rather, the data logger picks up the data with the D! command on the next pass through the program. Another measurement request is then sent so that data is ready on the next scan.
The R! command switches the sensor to automatically make measurements and send data every 11 seconds, ±2 seconds, based on the internal clock of the sensor. If measurements are requested at 2 seconds or faster, the sensor will increase its measurement rate to approximately every 5 seconds. This instruction usually takes less than 300 milliseconds to execute. The automatic measurement mode can only be canceled by powering down the sensor to reset it.

The SR50A also supports the MC!, CC!, and RC! commands, which are the same as the previous instructions, but where the C at the end of the instruction forces a validation for the data received from the sensor using a checksum. If the checksum is invalid, the data logger will re-request the data up to three times. The checksum validation increases the measurement time by about 40 milliseconds if there are no errors. Retries will increase the measurement time in proportion to the number of retries.

See SDI-12 sensor support (p. 83) for details of the SDI-12 protocol.

### 8.4 Measuring multiple SDI-12 sensors

Multiple SDI-12 sensors can be connected to a single data logger terminal if they have unique SDI-12 addresses. However, it is easiest to use a different terminal for each SDI-12 sensor instead of changing the address.

The SR50A can have an SDI-12 address of 0 to 9. Some SDI-12 devices can have an SDI-12 address of 0 to 9, A to Z, or a to z. See Change address command (aAb!) (p. 85) to change the SDI-12 address from its default address of 0.

### 9. Maintenance and troubleshooting

The electrostatic transducer requires equal pressure on both sides. Vent holes in the transducer housing are used to equalize pressure. Desiccant placed inside the transducer housing helps prevent condensing humidity. Regularly inspect the desiccant and, if required, replace it. Desiccant capable of absorbing moisture is blue. Once the desiccant becomes saturated, the color changes from blue to pink. In humid environments, replace the desiccant more frequently. Inspection or replacement of the desiccant requires the SR50A to be disassembled (Disassembly/assembly procedures (p. 23)).
Replace the transducer assembly every three years if it is not in a humid environment. Replace the transducer housing assembly every year in humid environments.

- SR50A or SR50AT housing and maintenance kit
- SR50AH or SR50ATH housing and maintenance kit

9.1 Disassembly/assembly procedures

FIGURE 9-1 (p. 23) through FIGURE 9-6 (p. 26) show the procedure for disassembling the SR50A. Disassembly is required to inspect or replace the desiccant, and to change the transducer and the option jumpers.

**CAUTION:**
Before proceeding with any maintenance, always retrieve the data first. Campbell Scientific also recommends saving the data logger program.

**CAUTION:**
Always disconnect the SR50A from the data logger or the connector before disassembling.

FIGURE 9-1. Disconnect Cable from Sensor
FIGURE 9-2. Remove six screws from the transducer housing

FIGURE 9-3. Remove transducer housing and disconnect wires
FIGURE 9-4. Location of desiccant in transducer housing assembly

FIGURE 9-5. Remove and replace desiccant
Carefully reassemble in reverse order.

### 9.2 Data interpretation

Although not common, the SR50A can output invalid reading indicators if unable to obtain a measurement. For distance to target values, a 0.0 reading is usually output. For snow depth outputs, the error indicator value is -999. An invalid temperature reading is also indicated by a -999 reading. For snow depth applications, these can be easily filtered out when analyzing the data.

Consideration should be taken in a control type application to deal with invalid readings. For example, if the sensor is used to initiate a water level alarm, multiple readings should be used to ensure that a single invalid reading does not trigger the alarm condition.
9.3 Data filtering

Two scenarios can produce values with higher than expected errors. One scenario occurs with low density snow, which causes weak echoes to be returned to the sensor. The other scenario occurs when the signal is weak, which is indicated by more echo quality numbers returned to the sensor. Under these circumstances, an SR50A can under, or over, estimate snow depth. If the signal is too weak, the sensor will output a value of 0 for the distance to target. When the echoes are weak, the sensor automatically increases sensitivity, which makes the sensor prone to erroneous readings from flying debris, drifting snow, or obstruction near the beam angle.

The reason not to average values is that high error values can skew the average. The best technique to eliminate errors and filter out high error readings is to take the median value. This technique also helps to automatically filter out zero readings.

Table 9-1 (p. 27) shows a station that reads the SR50A every 5 seconds for 1 minute and takes the median value from the readings. All the programming examples in this manual use this method for data filtering.

<table>
<thead>
<tr>
<th>If 11 consecutive values are as follows for snow depth</th>
<th>After being sorted from low to high</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.33</td>
<td>-1.1</td>
</tr>
<tr>
<td>0.34</td>
<td>0.10</td>
</tr>
<tr>
<td>0.35</td>
<td>0.28</td>
</tr>
<tr>
<td>-1.1 (erroneous reading)</td>
<td>0.32</td>
</tr>
<tr>
<td>2.0 (erroneous reading)</td>
<td>0.33</td>
</tr>
<tr>
<td>0.37</td>
<td>0.33</td>
</tr>
<tr>
<td>0.28</td>
<td>0.34</td>
</tr>
<tr>
<td>0.36</td>
<td>0.35</td>
</tr>
<tr>
<td>0.10 (high error value)</td>
<td>0.36</td>
</tr>
<tr>
<td>0.33</td>
<td>0.37</td>
</tr>
<tr>
<td>0.32</td>
<td>2.0</td>
</tr>
</tbody>
</table>

The best course of action would be to ignore the five lowest values and take the sixth value (0.33).
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)
- .CR2 (CR200(X)-series datalogger code)
- .CR300 (CR300-series datalogger code)
- .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 . 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 program it created.

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 programs

Example programs are provided for the different sensors and different outputs. The example programs use a 107 to provide the temperature measurement needed for temperature compensation when the sensor doesn’t have an integrated temperature probe.

B.1 SDI-12 programs

Table B-1 (p. 30) provides wiring for these programs.

<table>
<thead>
<tr>
<th>Wire color</th>
<th>Sensor wire description</th>
<th>CR1000X terminal</th>
<th>CR6 terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>107 air temperature sensor wiring(^1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>Voltage-excitation input</td>
<td>VX1</td>
<td>U2</td>
</tr>
<tr>
<td>Red</td>
<td>Analog-voltage output</td>
<td>SE1</td>
<td>U1</td>
</tr>
<tr>
<td>Purple</td>
<td>Bridge resistor</td>
<td>⬇</td>
<td>⬇</td>
</tr>
<tr>
<td>Shield</td>
<td>EMF shield</td>
<td>⬇</td>
<td>⬇</td>
</tr>
<tr>
<td></td>
<td>SR50A configured for SDI-12 wiring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td>Power source</td>
<td>12V</td>
<td>12V</td>
</tr>
<tr>
<td>Green</td>
<td>SDI-12 I/O</td>
<td>C1</td>
<td>C1</td>
</tr>
<tr>
<td>White</td>
<td>Not used</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>Black</td>
<td>Ground</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>Shield</td>
<td>Shield/earth ground</td>
<td>G</td>
<td>G</td>
</tr>
</tbody>
</table>

\(^1\) The 107 probe is not used for the SR50AT programs.

CRBasic Example 1: CR1000X SDI-12 program that measures the SR50A and 107

'CR1000X
'This program contains a number of features not found in Short Cut.
'
'The initial distance value from the SR50A head to the ground is
'measured by setting the flag SR50A_MID to TRUE. Set this flag after
'installing the SR50A in the field. Setting this flag will initiate
'a measurement cycle and the resulting value stored as the initial
'distance. The initial distance is used to calculate snow depth.
The PreserveVariables instruction is used to store the initial
'distance in non-volatile memory. If power is lost at the site the
'initial distance value will be restored.'

'A control flag is used to initiate the SR50A measurement cycle. This
'allows for manual control in the field to check distances without
'waiting for the correct time interval to occur. It is also used by
'the data logger to initiate an automated measurement cycle.

'Every measurement cycle is composed of 11 individual measurements
'that are spatially sorted to eliminate any low or high values.
'One measurement is made with each scan. This program has a 10
'second scan rate so it will take 100 seconds to do all 11 scans or
'1 minute and 40 seconds.

'Declare Variables and Units
Public BattV : Units BattV = Volts 'CR1000X battery voltage
Public PnlTmp_C : Units PnlTmp_C = 'C 'CR1000X panel temperature
Public AirTempC : Units AirTempC = 'C 'Air temperature
Public SR50A_Raw(1) = DT : Units DT = meters 'Distance from the SR50A.
Public SR50A_Raw(2) = RawQ : Units RawQ = unitless 'Quality number.

'Array to hold 11 SR50A measurements composed of a distance and
'quality number.
Public SR50A(11,2)

'Sorted array of 11 SR50A measurements composed of a distance and
'quality number. Measurements are sorted by the distance value from
'smallest to largest.
Public Result_SR50A(11,2)

Public TCDT : Units TCDT = meters 'Temperature corrected distance
Public Q : Units Q = unitless 'Quality number
Public Initial_Dist : Units Initial_Dist = meters 'Distance to ground.
Public Snow_Depth : Units Snow_Depth = meters 'Snow depth.

'Controls SR50A measurement. This flag can be manually controlled to
'run tests in the field or is automatically set 2 minutes before the
'hourly data storage interval. This is done so 11 measurements can
'be made and sorted before the values are stored.
Public SR50A_Ctrl As Boolean
'Set this flag to measure and store the initial distance from the SR50A to the ground.
Public SR50A_MID As Boolean

Dim n 'used as a counter

'Define Data Tables
DataTable(Daily,True,-1)
    DataInterval(0,1440,Min,10)
    Minimum(1,BattV,FP2,False,False)
    Maximum (1,BattV,FP2,False,False)
    Minimum(1,PnlTmp_C,FP2,False,False)
    Maximum (1,PnlTmp_C,FP2,False,False)
EndTable

DataTable (Hour,True,-1 )
    DataInterval (0,60,Min,10)
    Sample (1,AirTempC,FP2)
    Sample (1,TCDT,IEEE4)
    Sample (1,Q,FP2)
EndTable

PreserveVariables

'Main Program
BeginProg
    'Main Scan
    n = 1
    Scan(10,Sec,1,0)
        'Battery Voltage measurement 'BattV'
        Battery(BattV)

        'Wiring Panel Temperature measurement 'PnlTmp_C'
        PanelTemp(PnlTmp_C,60)

        '107 Temperature Probe measurement 'AirTempC'
        Therm107(AirTempC,1,1,Vx1,0,60,1,0)

        'Automated snow depth measurement. Must occur two minutes before actual storage time to get 11 measurements completed.
        If TimeIsBetween (58,60,60,Min) Then
            SR50ACtrl = True
        EndIf

        'Set this flag to true to get the initial distance from the SR50A to the ground.
CRBasic Example 1: CR1000X SDI-12 program that measures the SR50A and 107

If SR50A_MID Then SR50ACtrl = True

'Logic to make 11 snow depth measurements, sort them, and store
'the corrected values.
If SR50ACtrl Then
  'SR50A Sonic Ranging Sensor (SDI-12 Output) measurements
  'DT' & 'Q'
  SDI12Recorder(SR50A_Raw(),C1,"0","M1!",1,0)
  'Calculate the temperature corrected distance.
  SR50A(n,1) = SR50A_Raw(1)^SQR((AirTempC+273.15)/273.15)
  SR50A(n,2) = SR50A_Raw(2)
  n += 1
If n > 11 Then
  n = 1
  SR50ACtrl = False
  SortSpa (Result_SR50A(1,1),11,SR50A(1,1),2)
  TCDT = Result_SR50A(6,1)
  Q = Result_SR50A(6,2)
  If SR50A_MID Then
    Initial_Dist = TCDT
    SR50A_MID = False
  EndIf
  Snow_Depth = Initial_Dist - TCDT
EndIf
EndIf

'Call Data Tables and Store Data
CallTable Daily
CallTable Hour
NextScan
EndProg

CRBasic Example 2: CR6 SDI-12 program to measure the SR50A and 107

'C6
'This program contains a number of features not found in Short Cut.
'The initial distance value from the SR50A head to the ground is
'measured by setting the flag SR50A_MID to TRUE. Set this flag after
'installing the SR50A in the field. Setting this flag will initiate
'a measurement cycle and the resulting value stored as the initial
distance. The initial distance is used to calculate snow depth.
The PreserveVariables instruction is used to store the initial
'distance in non-volatile memory. If power is lost at the site the
'initial distance value will be restored.'
CRBasic Example 2: CR6 SDI-12 program to measure the SR50A and 107

'A control flag is used to initiate the SR50A measurement cycle. This
'allows for manual control in the field to check distances without
'waiting for the correct time interval to occur. It is also used by
'the data logger to initiate an automated measurement cycle.

'Every measurement cycle is composed of 11 individual measurements
'that are spatially sorted to eliminate any low or high values.
'One measurement is made with each scan. This program has a 10
'second scan rate so it will take 100 seconds to do all 11 scans or
'1 minute and 40 seconds.

'Declare Variables and Units
Public BattV : Units BattV = Volts 'CR6 battery voltage
Public PnlTmp_C : Units PnlTmp_C = 'C 'CR6 panel temperature
Public AirTempC : Units AirTempC = 'C 'Air temperature

'Array to hold 11 SR50A measurements composed of a distance and
'quality number. 
Public SR50A(11,2)

Public SR50A_Raw(2)
Alias SR50A_Raw(1) = DT : Units DT = meters 'Distance from the SR50A.
Alias SR50A_Raw(2) = RawQ : Units RawQ = unitless 'Quality number.

'Sorted array of 11 SR50A measurements composed of a distance and
'quality number. Measurements are sorted by the distance value from
'smallest to largest. 
Public Result_SR50A(11,2)

Public TCDT : Units TCDT = meters 'Temperature corrected distance
Public Q : Units Q = unitless 'Quality number

Public Initial_Dist : Units Initial_Dist = meters 'Distance to ground. 
Public Snow_Depth : Units Snow_Depth = meters 'Snow depth.

'Controls SR50A measurement. This flag can be manually controlled to
'run tests in the field or is automatically set 2 minutes before the
'hourly data storage interval. This is done so 11 measurements can
'be made and sorted before the values are stored. 
Public SR50A_Ctrl As Boolean

'Set this flag to measure and store the initial distance from the
'SR50A to the ground.
Public SR50A_MID As Boolean

Dim n 'used as a counter
'Define Data Tables
DataTable(Daily,True,-1)
  DataInterval(0,1440,Min,10)
  Minimum(1,BattV,FP2,False,False)
  Maximum(1,BattV,FP2,False,False)
  Minimum(1,PnlTmp_C,FP2,False,False)
  Maximum(1,PnlTmp_C,FP2,False,False)
EndTable

DataTable (Hour,True,-1)
  DataInterval (0,60,Min,10)
  Sample(1,AirTempC,FP2)
  Sample(1,TCDT,IEEE4)
  Sample(1,Q,FP2)
EndTable

PreserveVariables

'Main Program
BeginProg
  'Main Scan
  n = 1
  Scan(10,Sec,1,0)
  'Battery Voltage measurement 'BattV'
  Battery(BattV)

  'Wiring Panel Temperature measurement 'PnlTmp_C'
  PanelTemp(PnlTmp_C,60)

  '107 Temperature Probe measurement 'AirTempC'
  Therm107(AirTempC,1,U1,U2,0,60,1,0)

  'Automated snow depth measurement. Must occur two minutes before
  'actual storage time to get 11 measurements completed.
  If TimeIntoInterval (13,15,Min) Then
    SR50ACtrl = True
  EndIf

  'Set this flag to true to get the initial distance from the SR50A
  'to the ground.
  If SR50A_MID Then SR50ACtrl = True

  'Logic to make 11 snow depth measurements, sort them, and store
  'the corrected values.
  If SR50ACtrl Then
    'SR50A Sonic Ranging Sensor (SDI-12 Output) measurements
CRBasic Example 2: CR6 SDI-12 program to measure the SR50A and 107

'DT' & 'Q'
SDI12Recorder(SR50A_Raw(),C1,"0","M1!",1,0)

'Calculate the temperature corrected distance.
SR50A(n,1) = SR50A_Raw(1)*SQR((AirTempC+273.15)/273.15)
SR50A(n,2) = SR50A_Raw(2)
n += 1
If n > 11 Then
    n = 1
    SR50ACtrl = False
    SortSpa (Result_SR50A(1,1),11,SR50A(1,1),2)
    TCDT = Result_SR50A(6,1)
    Q = Result_SR50A(6,2)
    If SR50A_MID Then
        Initial_Dist = TCDT
        SR50A_MID = False
    EndIf
    Snow_Depth = Initial_Dist - TCDT
EndIf
EndIf

'Call Data Tables and Store Data
CallTable Daily
CallTable Hour
NextScan
EndProg

CRBasic Example 3: CR1000X SDI-12 program that measures the SR50AT

'CR1000X
'This program contains a number of features not found in Short Cut.
'
'The initial distance value from the SR50AT head to the ground is
'measured by setting the flag SR50AT_MID to TRUE. Set this flag after
'installing the SR50AT in the field. Setting this flag will initiate
'a measurement cycle and the resulting value stored as the initial
'distance. The initial distance is used to calculate snow depth.
'The PreserveVariables instruction is used to store the initial
'distance in non-volatile memory. If power is lost at the site, the
'initial distance value will be restored.

'A control flag is used to initiate the SR50AT measurement cycle. This
'allows for manual control in the field to check distances without
'waiting for the correct time interval to occur. It is also used by
'the data logger to initiate an automated measurement cycle.
'Every measurement cycle is composed of 11 individual measurements that are spatially sorted to eliminate any low or high values. One measurement is made with each scan. This program has a 10-second scan rate so it will take 100 seconds to do all 11 scans or 1 minute and 40 seconds.

'Declare Variables and Units
Public BattV : Units BattV = Volts 'battery voltage
Public PnlTmp_C : Units PnlTmp_C = ºC 'panel temperature

'Single measured values.
Public SR50AT_M(3)
Alias SR50AT_M(1) = MDT : Units MDT = meters 'Distance from the SR50AT.
Alias SR50AT_M(2) = MQ : Units MQ = unitless 'Quality number.
Alias SR50AT_M(3) = MAir : Units MAir = ºC 'Air temperature.

'Array to hold 11 SR50AT measurements composed of a distance and quality number, and air temperature.
Public SR50AT(11,3)

'Sorted array of 11 SR50AT measurements composed of a distance and quality number, and temperature. Measurements are sorted by the distance value from smallest to largest.
Public Result_SR50AT(11,3)

Public TCDT : Units TCDT = meters 'Temperature corrected distance
Public Q : Units Q = unitless 'Quality number
Public AirTempC : Units AirTempC = ºC 'Air temperature

Public Initial_Dist : Units Initial_Dist = meters 'Distance to ground.
Public Snow_Depth : Units Snow_Depth = meters 'Snow depth.

'Controls SR50AT measurement. This flag can be manually controlled to run tests in the field or is automatically set 2 minutes before the hourly data storage interval. This is done so 11 measurements can be made and sorted before the values are stored.
Public SR50ATCtrl As Boolean

'Set this flag to measure and store the initial distance from the SR50AT to the ground.
Public SR50AT_MID As Boolean

Dim n 'used as a counter

'Define Data Tables
DataTable(Daily,True,-1)
    DataInterval(0,1440,Min,10)
Minimum(1,BattV,FP2,False,False)
Minimum(1,PnlTmp_C,FP2,False,False)
Maximum (1,BattV,FP2,False,False)
Maximum (1,PnlTmp_C,FP2,False,False)
EndTable

DataTable (Hour,True,-1)
  DataInterval (0,60,Min,10)
  Sample (1,AirTempC,FP2)
  Sample (1,TCDT,IEEE4)
  Sample (1,Q,FP2)
EndTable

PreserveVariables

'Main Program
BeginProg
  'Main Scan
  n = 1
  Scan(10,Sec,1,0)
  'Battery Voltage measurement 'BattV'
  Battery(BattV)
  
  'Wiring Panel Temperature measurement 'PnlTmp_C'
  PanelTemp(PnlTmp_C,60)
  
  'Automated snow depth measurement. Must occur two minutes before 
  'actual storage time to get 11 measurements completed.
  If TimeIntoInterval (58,60,Min) Then
    SR50ATCtrl = True
  EndIf
  
  'Set this flag to true to get the initial distance from the SR50AT 
  'to the ground.
  If SR50AT_MID Then SR50ATCtrl = True
  
  'Logic to make 11 snow depth measurements, sort them, and store 
  'the corrected values.
  If SR50ATCtrl Then
    'SR50AT Sonic Ranging Sensor (SDI-12 Output) measurements
    'MDT, MQ, & MAir
    SDI12Recorder(SR50AT_M(),C1,"0","M3!",1,0)
    'Load the array to be sorted.
    SR50AT(n,1) = SR50AT_M(1)
    SR50AT(n,2) = SR50AT_M(2)
    SR50AT(n,3) = SR50AT_M(3)
    n += 1
CRBasic Example 3: CR1000X SDI-12 program that measures the SR50AT

```
If n > 11 Then
    n = 1
    SR50ATCtrl = False
SortSpa (Result_SR50AT(1,1),11,SR50AT(1,1),2)
TCDT = Result_SR50AT(6,1)
Q = Result_SR50AT(6,2)
AirTempC = Result_SR50AT(6,3)
If SR50AT_MID Then
    Initial_Dist = TCDT
    SR50AT_MID = False
EndIf
Snow_Depth = Initial_Dist - TCDT
EndIf
EndIf

'Call Data Tables and Store Data
CallTable Daily
CallTable Hour
NextScan
EndProg
```

CRBasic Example 4: CR6 SDI-12 program that measures the SR50AT

```
'CR6
'Program: SR50AT_SDI12_FILTER.CR6
'This program contains a number of features not found in Short Cut.

'The initial distance value from the SR50AT head to the ground is
'measured by setting the flag SR50AT_MID to TRUE. Set this flag after
'installing the SR50AT in the field. Setting this flag will initiate
'a measurement cycle and the resulting value stored as the initial
distance. The initial distance is used to calculate snow depth.
'The PreserveVariables instruction is used to store the initial
distance in non-volatile memory. If power is lost at the site, the
'initial distance value will be restored.

'A control flag is used to initiate the SR50AT measurement cycle. This
'allows for manual control in the field to check distances without
'waiting for the correct time interval to occur. It is also used by
'the data logger to initiate an automated measurement cycle.

'Every measurement cycle is composed of 11 individual measurements
'that are spatially sorted to eliminate any low or high values.
'One measurement is made with each scan. This program has a 10
'second scan rate so it will take 100 seconds to do all 11 scans or
```
'1 minute and 40 seconds.'

'Declare Variables and Units
Public BattV : Units BattV = Volts 'battery voltage
Public PnlTmp_C : Units PnlTmp_C = 'C 'panel temperature

'Single measured values.
Public SR50AT_M(3)
Alias SR50AT_M(1) = MDT : Units MDT = meters 'Distance from the SR50AT.
Alias SR50AT_M(2) = MQ : Units MQ = unitless 'Quality number.
Alias SR50AT_M(3) = MAir : Units MAir = 'C 'Quality number.

'Array to hold 11 SR50AT measurements composed of a distance and
'quality number, and air temperature.
Public SR50AT(11,3)

'Sorted array of 11 SR50AT measurements composed of a distance and
'quality number, and temperature. Measurements are sorted by the
'distance value from smallest to largest.
Public Result_SR50AT(11,3)

Public TCDT : Units TCDT = meters 'Temperature corrected distance
Public Q : Units Q = unitless 'Quality number
Public AirTempC : Units AirTempC = 'C 'Air temperature

Public Initial_Dist : Units Initial_Dist = meters 'Distance to ground.
Public Snow_Depth : Units Snow_Depth = meters 'Snow depth.

'Controls SR50AT measurement. This flag can be manually controlled to
'run tests in the field or is automatically set 2 minutes before the
'hourly data storage interval. This is done so 11 measurements can
'be made and sorted before the values are stored.
Public SR50ATCtrl As Boolean

'Set this flag to measure and store the initial distance from the
'SR50AT to the ground.
Public SR50AT_MID As Boolean

Dim n 'used as a counter

'Define Data Tables
DataTable(Daily,True,-1)
  DataInterval(0,1440,Min,10)
  Minimum(1,BattV,FP2,False,False)
  Maximum (1,BattV,FP2,False,False)
  Minimum(1,PnlTmp_C,FP2,False,False)
  Maximum (1,PnlTmp_C,FP2,False,False)
CRBasic Example 4: CR6 SDI-12 program that measures the SR50AT

EndTable

DataTable (Hour, True, -1)
    DataInterval (0, 60, Min, 10)
    Sample (1, AirTempC, FP2)
    Sample (1, TCDT, IEEE4)
    Sample (1, Q, FP2)
EndTable

PreserveVariables

'Main Program
BeginProg
    'Main Scan
    n = 1
    Scan (10, Sec, 1, 0)
    'Battery Voltage measurement 'BattV'
    Battery(BattV)
    
    'Wiring Panel Temperature measurement 'PnlTmp_C'
    PanelTemp(PnlTmp_C, 60)
    
    'Automated snow depth measurement. Must occur two minutes before
    'actual storage time to get 11 measurements completed.
    If TimeIntoInterval (58, 60, Min) Then
        SR50ATCtrl = True
    EndIf
    
    'Set this flag to true to get the initial distance from the SR50AT
    'to the ground.
    If SR50AT_MID Then SR50ATCtrl = True
    
    'Logic to make 11 snow depth measurements, sort them, and store
    'the corrected values.
    If SR50ATCtrl Then
        'SR50AT Sonic Ranging Sensor (SDI-12 Output) measurements
        'MDT, MQ, & MAir
        SDI12Recorder(SR50AT_M(), Cl, "0", "M3!", 1, 0)
        'Load the array to be sorted.
        SR50AT(n, 1) = SR50AT_M(1)
        SR50AT(n, 2) = SR50AT_M(2)
        SR50AT(n, 3) = SR50AT_M(3)
        n += 1
        If n > 11 Then
            n = 1
            SR50ATCtrl = False
            SortSpa (Result_SR50AT(1, 1), 11, SR50AT(1, 1), 2)
**CRBasic Example 4: CR6 SDI-12 program that measures the SR50AT**

\[
\begin{align*}
\text{TCDT} &= \text{Result}_\text{SR50AT}(6,1) \\
\text{Q} &= \text{Result}_\text{SR50AT}(6,2) \\
\text{AirTempC} &= \text{Result}_\text{SR50AT}(6,3) \\
\text{If} & \quad \text{SR50AT}_\text{MID} \quad \text{Then} \\
& \quad \text{Initial}_\text{Dist} = \text{TCDT} \\
& \quad \text{SR50AT}_\text{MID} = \text{False} \\
\text{EndIf} \\
& \quad \text{Snow}_\text{Depth} = \text{Initial}_\text{Dist} - \text{TCDT} \\
\text{EndIf} \\
\end{align*}
\]

*Call Data Tables and Store Data*
- **CallTable** Daily
- **CallTable** Hour
- **NextScan**
- **EndProg**

## B.2 RS-232 programs

Detailed information using RS-232 and RS-485 is provided in *RS-232 and RS-485 operation* (p. 93). **Table B-2** (p. 42) provides wiring for the RS-232 examples.

### Table B-2: Wiring for CR1000X RS-232 example programs

<table>
<thead>
<tr>
<th>Wire color</th>
<th>Sensor wire description</th>
<th>CR1000X terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>107 air temperature sensor wiring</strong>¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>Voltage-excitation input</td>
<td>VX1</td>
</tr>
<tr>
<td>Red</td>
<td>Analog-voltage output</td>
<td>SE1</td>
</tr>
<tr>
<td>Purple</td>
<td>Bridge resistor</td>
<td>‡</td>
</tr>
<tr>
<td>Shield</td>
<td>EMF shield</td>
<td>‡</td>
</tr>
<tr>
<td><strong>SR50A configured for RS-232 wiring</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td>Power source</td>
<td>12V</td>
</tr>
<tr>
<td>White</td>
<td>SR50A RX</td>
<td>C1</td>
</tr>
<tr>
<td>Green</td>
<td>SR50A Tx</td>
<td>C2</td>
</tr>
<tr>
<td>Black</td>
<td>Ground</td>
<td>G</td>
</tr>
<tr>
<td>Shield</td>
<td>Shield/earth ground</td>
<td>‡</td>
</tr>
</tbody>
</table>

¹ The 107 probe is not used for the SR50AT programs.
'CR1000X Series Datalogger
'This program contains a number of features not found in Short Cut.
',
'The initial distance value from the SR50A head to the ground is
'measured by setting the flag SR50A_MID to TRUE. Set this flag after
'installing the SR50A in the field. Setting this flag will initiate
'a measurement cycle and the resulting value stored as the initial
'distance. The initial distance is used to calculate snow depth.
'The PreserveVariables instruction is used to store the initial
'distance in non-volatile memory. If power is lost at the site the
'initial distance value will be restored.'

'A control flag is used to initiate the SR50A measurement cycle. This
'allows for manual control in the field to check distances without
'waiting for the correct time interval to occur. It is also used by
'the data logger to initiate an automated measurement cycle.
'
'Every measurement cycle is composed of 11 individual measurements
'that are spatially sorted to eliminate any low or high values.
'One measurement is made with each scan. This program has a 10
'second scan rate so it will take 100 seconds to do all 11 scans or
'1 minute and 40 seconds.

'Declare Constants
'Default serial address of SR50A is 33. Polling command consists of
'a lower case 'p' followed by the address and a carriage return.
Const POLL_A = "p33" & CHR(13)

'Declare Variables and Units
Public BattV : Units BattV = Volts 'CR1000X battery voltage
Public PnlTmp_C : Units PnlTmp_C = 'C 'CR1000X panel temperature
Public AirTempC : Units AirTempC = 'C 'Air temperature

'Controls SR50A measurement. This flag can be manually controlled to
'run tests in the field or is automatically set 2 minutes before the
'hourly data storage interval. This is done so 11 measurements can
'be made and sorted before the values are stored.
Public SR50ACtrl As Boolean

'Set this flag to measure and store the initial distance from the
'SR50A to the ground.
Public SR50A_MID As Boolean

'Declare SR50AData as a dimensioned string of maximum 50 chrs
Public SR50AData As String * 50
'Values returned from the SR50A.
Public ParseVals(5) As Float
Alias ParseVals(1)=SerialAddress : Units SerialAddress = addr
Alias ParseVals(2)=Raw_Distance : Units Raw_Distance = meters
Alias ParseVals(3)=SignalQuality : Units SignalQuality = value
Alias ParseVals(4)=Diagnostics : Units Diagnostics = value
Alias ParseVals(5)=Checksum : Units Checksum = value

'Array to hold 11 SR50A measurements composed of a distance and '
'quality number.
Public SR50A(11,2)

'Sorted array of 11 SR50A measurements composed of a distance and '
'quality number. Measurements are sorted by the distance value from '
'smallest to largest.
Public Result_SR50A(11,2)

Public TCDT : Units TCDT = meters 'Temperature corrected distance
Public Q : Units Q = unitless 'Quality number
Public Initial_Dist : Units Initial_Dist = meters 'Distance to ground.
Public Snow_Depth : Units Snow_Depth = meters 'Snow depth.

Dim n 'used as a counter

'SR50A diagnostic counters. Values are incremented if an error occurs.
Public ROM_Cntr : Units ROM_Cntr = value
Public SR50A_WtchDg_Cntr : Units SR50A_WtchDg_Cntr = value
Dim scratch

'Define Data Tables
DataTable(Daily,True,-1)
   DataInterval(0,1440,Min,10)
   Minimum(1,BattV,FP2,False,False)
   Maximum (1,BattV,FP2,False,False)
   Minimum(1,PnlTmp_C,FP2,False,False)
   Maximum (1,PnlTmp_C,FP2,False,False)
   Sample (1,ROM_Cntr,FP2)
   Sample (1,SR50A_WtchDg_Cntr,FP2)
EndTable

DataTable (Hour,True,-1 )
   DataInterval (0,60,Min,10)
   Sample (1,AirTempC,FP2)
   Sample (1,TCDT,IEEE4)
   Sample (1,Q,FP2)
EndTable
CRBasic Example 5: CR1000X RS-232 program for measuring the SR50A

PreserveVariables

'Subroutine to sum up errors from the SR50A across the day.
Sub Diag
    scratch = INT(Diagnostics/1000)
    Select Case scratch
    Case 0
        SR50A_WtchDg_Cntr += 1
        ROM_Cntr += 1
    Case 1
        SR50A_WtchDg_Cntr += 1
    Case 10
        ROM_Cntr += 1
    EndSelect
EndSub

'Main Program
BeginProg

'Open and configure C1 and C2 for RS232 communication.
'9600 BAUD is the default:
SerialOpen (ComC1,9600,0,0,200)
n = 1
Scan (10,Sec,3,0)
    Battery (BattV)
    PanelTemp (PnlTmp_C,60)
    'Make an air temperature measurement.
    Therm107 (AirTempC,1,1,Vx1,0,60,1.0,0)

'Automated snow depth measurement. Must occur two minutes before
'actual storage time to get 11 measurements completed.
If TimeIsBetween (58,60,60,Min) Then
    SR50ACtrl = True
EndIf

'Set this flag to true to get the initial distance from the SR50A
'to the ground.
If SR50A_MID Then SR50ACtrl = True

If SR50ACtrl Then
    'Transmit serial command "p33<CR>"
    SerialOut (ComC1,POLL_A,"",0,0)
    'Flush the serial buffer
    SerialFlush (ComC1)
    'Recieve serial string from SR50A
    SerialIn (SR50AData,ComC1,200,CHR(13),50)
    'Pars string into separate values.
    SplitStr (ParseVals(),SR50AData,"",5,0)
CRBasic Example 5: CR1000X RS-232 program for measuring the SR50A

'Calculate the temperature corrected distance.
SR50A(n,1) = ParseVals(2)*SQR((AirTempC+273.15)/273.15)
SR50A(n,2) = ParseVals(3)
n += 1
If n > 11 Then
   n = 1
   SR50ACtrl = False
   SortSpa (Result_SR50A(1,1),11,SR50A(1,1),2)
   TCDT = Result_SR50A(6,1)
   Q = Result_SR50A(6,2)
   If SR50A_MID Then
      Inital_Dist = TCDT
      SR50A_MID = False
   EndIf
   Snow_Depth = Inital_Dist - TCDT
EndIf
'Add up any errors across the day.
Call Diag
EndIf

'Call data tables.
CallTable Hour
CallTable Daily
'Clear diagnostic counters after Daily_Status table is stored.
If Daily.Output(1,1) Then
   ROM_Cntr = 0
   SR50A_WtchDg_Cntr = 0
EndIf
NextScan
EndProg

CRBasic Example 6: CR1000X RS-232 program that measures the SR50AT

'CR1000X Series Datalogger
'This program contains a number of features not found in Short Cut.
'
'The initial distance value from the SR50AT head to the ground is
'measured by setting the flag SR50AT_MID to TRUE. Set this flag after
'installing the SR50AT in the field. Setting this flag will initiate
'a measurement cycle and the resulting value stored as the initial
'distance. The initial distance is used to calculate snow depth.
The PreserveVariables instruction is used to store the initial
'distance in non-volatile memory. If power is lost at the site, the
'initial distance value will be restored.
CRBasic Example 6: CR1000X RS-232 program that measures the SR50AT

'A control flag is used to initiate the SR50AT measurement cycle. This 'allows for manual control in the field to check distances without 'waiting for the correct time interval to occur. It is also used by 'the data logger to initiate an automated measurement cycle.

'Every measurement cycle is composed of 11 individual measurements 'that are spatially sorted to eliminate any low or high values. 'One measurement is made with each scan. This program has a 10 'second scan rate so it will take 100 seconds to do all 11 scans or '1 minute and 40 seconds.

'Declare Constants 'Default serial address of SR50AT is 33. Polling command consists of 'a lower case 'p' followed by the address and a carriage return. 
Const POLL_A = "p33" & CHR(13)

'Declare Variables and Units 
Public BattV : Units BattV = Volts 'battery voltage 
Public PnlTmp_C : Units PnlTmp_C = ºC 'panel temperature 

'Controls SR50AT measurement. This flag can be manually controlled to 'run tests in the field or is automatically set 2 minutes before the 'hourly data storage interval. This is done so 11 measurements can 'be made and sorted before the values are stored. 
Public SR50ATCtrl As Boolean 

'Set this flag to measure and store the initial distance from the 'SR50AT to the ground. 
Public SR50AT_MID As Boolean 

'Declare SR50ATData as a dimensioned string of maximum 50 characters 
Public SR50ATData As String * 50 

'Values returned from the SR50AT. 
Public ParseValsT(6) As Float 
Alias ParseValsT(1)=SerialAddressT : Units SerialAddressT = addr 
Alias ParseValsT(2)=Dist_To_SurfaceT : Units Dist_To_SurfaceT = meters 
Alias ParseValsT(3)=SignalQualityT : Units SignalQualityT = value 
Alias ParseValsT(4)=SR50AT_Temp : Units SR50AT_Temp = ºC 
Alias ParseValsT(5)=DiagnosticsT : Units DiagnosticsT = value 
Alias ParseValsT(6)=ChcksumT : Units ChcksumT = value 

'SR50AT diagnostic counters. Values are incremented if an error occurs. 
Public ROM_Cntr : Units ROM_Cntr = value 
Public SR50AT_WtchDg_Cntr : Units SR50AT_WtchDg_Cntr = value 
Dim scratch
CRBasic Example 6: CR1000X RS-232 program that measures the SR50AT

'Array to hold 11 SR50AT measurements composed of a distance and 'quality number, and air temperature.
Public SR50AT(11,3)

'Sorted array of 11 SR50AT measurements composed of a distance and 'quality number, and temperature. Measurements are sorted by the 'distance value from smallest to largest.
Public Result_SR50AT(11,3)

Public TCDT : Units TCDT = meters 'Temperature corrected distance
Public Q : Units Q = unitless 'Quality number
Public AirTempC : Units AirTempC = °C 'Air temperature

Public Initial_Dist : Units Initial_Dist = meters 'Distance to ground.
Public Snow_Depth : Units Snow_Depth = meters 'Snow depth.

Dim n 'used as a counter

'Define Data Tables
DataTable(Daily,True,-1)
   DataInterval(0,1440,Min,10)
   Minimum(1,BattV,FP2,False,False)
   Maximum (1,BattV,FP2,False,False)
   Minimum (1,PnlTmp_C,FP2,False,False)
   Maximum (1,PnlTmp_C,FP2,False,False)
EndTable

DataTable (Hour,True,-1 )
   DataInterval (0,60,Min,10)
   Sample (1,AirTempC,FP2)
   Sample (1,TCDT,IEEE4)
   Sample (1,Q,FP2)
EndTable

'Subroutine to sum up errors from the SR50AT across the day.
Sub Diag
   scratch = INT(DiagnosticsT/1000)
   Select Case scratch
   Case 0
      SR50AT_WtchDg_Cntr += 1
      ROM_Cntr -= 1
   Case 1
      SR50AT_WtchDg_Cntr += 1
   Case 10
      ROM_Cntr += 1
   EndSelect
EndSub
CRBasic Example 6: CR1000X RS-232 program that measures the SR50AT

PreserveVariables

'Main Program
BeginProg
  'Main Scan
  n = 1
  'Open and configure C1 and C2 for RS232 communication. '9600 BAUD is the default:
  SerialOpen (ComC1,9600,0,0,200)

  Scan(10,Sec,1,0)
  'Battery Voltage measurement 'BattV'
  Battery(BattV)

  'Wiring Panel Temperature measurement 'PnlTmp_C'
  PanelTemp(PnlTmp_C,60)

  'Automated snow depth measurement. Must occur two minutes before actual storage time to get 11 measurements completed.
  If TimeIntoInterval (58,60,Min) Then
    SR50ATCtrl = True
  EndIf

  'Set this flag to true to get the initial distance from the SR50AT to the ground.
  If SR50AT_MID Then SR50ATCtrl = True

  'Logic to make 11 snow depth measurements, sort them, and store the corrected values.
  If SR50ATCtrl Then
    'Transmit serial command "p33<CR>"
    SerialOut (ComC1,POLL_A,"",0,0)
    'Flush the serial buffer
    SerialFlush (ComC1)
    'Receive serial string from SR50AT
    SerialIn (SR50ATData,ComC1,200,CHR(13),50)
    'Parse string into separate values.
    SplitStr (ParseValsT(),SR50ATData,"",5,0)
    'Calculate the temperature corrected distance.
    SR50AT(n,1) = ParseValsT(2)
    SR50AT(n,2) = ParseValsT(3)
    SR50AT(n,3) = ParseValsT(4)
    n += 1
    If n > 11 Then
      n = 1
      SR50ATCtrl = False
**CRBasic Example 6: CR1000X RS-232 program that measures the SR50AT**

```
SortSpa (Result_SR50AT(1,1),11,SR50AT(1,1),2)
TCDT = Result_SR50AT(6,1)
Q = Result_SR50AT(6,2)
AirTempC = Result_SR50AT(6,3)
If SR50AT_MID Then
    Initial_Dist = TCDT
    SR50AT_MID = False
EndIf
Snow_Depth = Initial_Dist - TCDT
'Add up any errors across the day.
    Call Diag
EndIf
EndIf

'Call Data Tables and Store Data
CallTable Hour
CallTable Daily
'Clear diagnostic counters after Daily_Status table is stored.
If Daily.Output(1,1) Then
    ROM_Cntr = 0
    SR50AT_WtchDg_Cntr = 0
EndIf
NextScan
EndProg
```

---

### B.3 RS-485 programs

Detailed information using RS-232 and RS-485 is provided in [RS-232 and RS-485 operation](p. 93).

#### B.3.1 Directly measuring the sensor

The CR6 and CR1000X can read RS-485 output, without an interface such as the MD485. Although this example program is for the CR6, the CR1000X is programmed similarly. Table B-3 (p. 50) provides the wiring for the programs.

**Table B-3: Wiring for CR6 RS-485 program**

<table>
<thead>
<tr>
<th>Wire color</th>
<th>Sensor wire description</th>
<th>CR6 terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>Voltage-excitation input</td>
<td>U2</td>
</tr>
<tr>
<td>Red</td>
<td>Analog-voltage output</td>
<td>U1</td>
</tr>
</tbody>
</table>

---

1. **107 air temperature sensor wiring**
### Table B-3: Wiring for CR6 RS-485 program

<table>
<thead>
<tr>
<th>Wire color</th>
<th>Sensor wire description</th>
<th>CR6 terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purple</td>
<td>Bridge resistor</td>
<td></td>
</tr>
<tr>
<td>Shield</td>
<td>EMF shield</td>
<td></td>
</tr>
</tbody>
</table>

#### SR50A configured for RS-232 Wiring

<table>
<thead>
<tr>
<th>Wire color</th>
<th>Sensor wire description</th>
<th>CR6 terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Power source</td>
<td>12V</td>
</tr>
<tr>
<td>Green</td>
<td>A</td>
<td>C1</td>
</tr>
<tr>
<td>White</td>
<td>B</td>
<td>C2</td>
</tr>
<tr>
<td>Black</td>
<td>Ground</td>
<td>G</td>
</tr>
<tr>
<td>Shield</td>
<td>Shield/earth ground</td>
<td></td>
</tr>
</tbody>
</table>

1 The 107 probe is not used for the SR50AT programs.

### CRBasic Example 7: CR6 program for measuring the RS-485 output of an SR50A

```
'CR6 Series Datalogger
'This program contains a number of features not found in Short Cut.
'
'The initial distance value from the SR50A head to the ground is
'measured by setting the flag SR50A_MID to TRUE. Set this flag after
'installing the SR50A in the field. Setting this flag will initiate
'a measurement cycle and the resulting value stored as the initial
'distance. The initial distance is used to calculate snow depth.
'The PreserveVariables instruction is used to store the initial
'distance in non-volatile memory. If power is lost at the site the
'initial distance value will be restored.'
'
'A control flag is used to initiate the SR50A measurement cycle. This
'allows for manual control in the field to check distances without
'waiting for the correct time interval to occur. It is also used by
'the data logger to initiate an automated measurement cycle.
'
'Every measurement cycle is composed of 11 individual measurements
'that are spatially sorted to eliminate any low or high values.
'One measurement is made with each scan. This program has a 10
'second scan rate so it will take 100 seconds to do all 11 scans or
'1 minute and 40 seconds.
'
'Declare Constants
'Default serial address of SR50A is 33. Polling command consists of
'a lower case 'p' followed by the address and a carriage return.
```
CRBasic Example 7: CR6 program for measuring the RS-485 output of an SR50A

Const POLL_A = "p33" & CHR(13)

'Declare Variables and Units
Public BattV : Units BattV = Volts 'CR6 battery voltage
Public PnlTmp_C : Units PnlTmp_C = 'C 'CR6 panel temperature
Public AirTempC : Units AirTempC = 'C 'Air temperature

'Controls SR50A measurement. This flag can be manually controlled to
'run tests in the field or is automatically set 2 minutes before the
'hourly data storage interval. This is done so 11 measurements can
'be made and sorted before the values are stored.
Public SR50ACtrl As Boolean

'Set this flag to measure and store the initial distance from the
'SR50A to the ground.
Public SR50A_MID As Boolean

'Declare SR50AData as a dimensioned string of maximum 50 chrs
Public SR50AData As String * 50

'Values returned from the SR50A.
Public ParseVals(5) As Float
Alias ParseVals(1)=SerialAddress : Units SerialAddress = addr
Alias ParseVals(2)=Raw_Distance : Units Raw_Distance = meters
Alias ParseVals(3)=SignalQuality : Units SignalQuality = value
Alias ParseVals(4)=Diagnostics : Units Diagnostics = value
Alias ParseVals(5)=Chcksum : Units Chcksum = value

'Array to hold 11 SR50A measurements composed of a distance and
'quality number.
Public SR50A(11,2)

'Sorted array of 11 SR50A measurements composed of a distance and
'quality number. Measurements are sorted by the distance value from
'smallest to largest.
Public Result_SR50A(11,2)

Public TCDT : Units TCDT = meters 'Temperature corrected distance
Public Q : Units Q = unitless 'Quality number
Public Initial_Dist : Units Initial_Dist = meters 'Distance to ground.
Public Snow_Depth : Units Snow_Depth = meters 'Snow depth.

Dim n 'used as a counter

'SR50A diagnostic counters. Values are incremented if an error occurs.
Public ROM_Cntr : Units ROM_Cntr = value
Public SR50A_WtchDg_Cntr : Units SR50A_WtchDg_Cntr = value
Dim scratch

'Define Data Tables
DataTable(Daily,True,-1)
    DataInterval (0,1440,Min,10)
    Minimum (1,BattV,FP2,False,False)
    Maximum (1,BattV,FP2,False,False)
    Minimum (1,PnlTmp_C,FP2,False,False)
    Maximum (1,PnlTmp_C,FP2,False,False)
    Sample (1,ROM_Cntr,FP2)
    Sample (1,SR50A_WtchDg_Cntr,FP2)
EndTable

DataTable (Hour,True,-1)
    DataInterval (0,60,Min,10)
    Sample (1,AirTempC,FP2)
    Sample (1,TCDT,IEEE4)
    Sample (1,Q,FP2)
EndTable

PreserveVariables

'Subroutine to sum up errors from the SR50A across the day.
Sub Diag
    scratch = INT(Diagnostics/1000)
    Select Case scratch
    Case 0
        SR50A_WtchDg_Cntr += 1
        ROM_Cntr += 1
    Case 1
        SR50A_WtchDg_Cntr += 1
    Case 10
        ROM_Cntr += 1
    EndSelect
EndSub

'Main Program
BeginProg
    'Open and configure C1 and C2 for RS485 communication.
    '9600 BAUD is the default set at half-duplex:
    SerialOpen (ComC1,9600,0,0,200,4)
    n = 1

    Scan (10,Sec,0,0)
        Battery (BattV)
        PanelTemp (PnlTmp_C,60)
        'Make an air temperature measurement.
Therm107 (AirTempC,1,U1,U2,0,60,1.0,0)

'Automated snow depth measurement. Must occur two minutes before 'actual storage time to get 11 measurements completed.
If TimeIntoInterval (58,60,Min) Then
  SR50ACtrl = True
EndIf

'Set this flag to true to get the initial distance from the SR50A 'to the ground.
If SR50A_MID Then SR50ACtrl = True

If SR50ACtrl Then
  'Transmit serial command "p33<CR>"
  SerialOut (ComC1,POLL_A,",",0,0)
  'Flush the serial buffer
  SerialFlush (ComC1)
  'Recieve serial string from SR50A
  SerialIn (SR50AData,ComC1,200,CHR(13),50)
  'Pars string into separate values.
  SplitStr (ParseVals(),SR50AData,",",5,0)
  'Calculate the temperature corrected distance.
  SR50A(n,1) = ParseVals(2) * SQR((AirTempC+273.15)/273.15)
  SR50A(n,2) = ParseVals(3)
  n += 1
If n > 11 Then
  n = 1
  SR50ACtrl = False
  SortSpa (Result_SR50A(1,1),11,SR50A(1,1),2)
  TCDT = Result_SR50A(6,1)
  Q = Result_SR50A(6,2)
  If SR50A_MID Then
    Initial_Dist = TCDT
    SR50A_MID = False
  EndIf
  Snow_Depth = Initial_Dist - TCDT
EndIf

'Add up any errors across the day.
Call Diag
EndIf

'Call data tables.
CallTable Hour
CallTable Daily
'Clear diagnostic counters after Daily_Status table is stored.
If Daily.Output(1,1) Then
  ROM_Cntr = 0
CRBasic Example 7: CR6 program for measuring the RS-485 output of an SR50A

```
SR50A_WtchDg_Cntr = 0
EndIf
NextScan
EndProg
```

CRBasic Example 8: CR6 RS-485 program that measures the SR50AT

```
'CR6
'Program: SR50AT_RS485.CR6
'This program contains a number of features not found in Short Cut.
',
'The initial distance value from the SR50AT head to the ground is
'measured by setting the flag SR50AT_MID to TRUE. Set this flag after
'installing the SR50AT in the field. Setting this flag will initiate
'a measurement cycle and the resulting value stored as the initial
distance. The initial distance is used to calculate snow depth.
The PreserveVariables instruction is used to store the initial
distance in non-volatile memory. If power is lost at the site, the
'initial distance value will be restored.
',
'A control flag is used to initiate the SR50AT measurement cycle. This
'allows for manual control in the field to check distances without
'waiting for the correct time interval to occur. It is also used by
'the data logger to initiate an automated measurement cycle.
',
'Every measurement cycle is composed of 11 individual measurements
'that are spatially sorted to eliminate any low or high values.
'One measurement is made with each scan. This program has a 10
'second scan rate so it will take 100 seconds to do all 11 scans or
'1 minute and 40 seconds.
',
'Declare Constants
'Default serial address of SR50AT is 33. Polling command consists of
'a lower case 'p' followed by the address and a carriage return.
Const POLL_A = "p33" & CHR(13)
',
'Declare Variables and Units
Public BattV : Units BattV = Volts 'battery voltage
Public PnlTmp_C : Units PnlTmp_C = ºC 'panel temperature
',
'Controls SR50AT measurement. This flag can be manually controlled to
'run tests in the field or is automatically set 2 minutes before the
'hourly data storage interval. This is done so 11 measurements can
'be made and sorted before the values are stored.
Public SR50ATCtrl As Boolean
```
'Set this flag to measure and store the initial distance from the
'SR50AT to the ground.
Public SR50AT_MID As Boolean

'Declare SR50ATData as a dimensioned string of maximum 50 characters
Public SR50ATData As String * 50

'Values returned from the SR50AT.
Public ParseValsT(6) As Float
Alias ParseValsT(1)=SerialAddressT : Units SerialAddressT = addr
Alias ParseValsT(2)=Dist_To_SurfaceT : Units Dist_To_SurfaceT = meters
Alias ParseValsT(3)=SignalQualityT : Units SignalQualityT = value
Alias ParseValsT(4)=SR50AT_Temp : Units SR50AT_Temp = ºC
Alias ParseValsT(5)=DiagnosticsT : Units DiagnosticsT = value
Alias ParseValsT(6)=ChcksumT : Units ChcksumT = value

'SR50AT diagnostic counters. Values are incremented if an error occurs.
Public ROM_Cntr : Units ROM_Cntr = value
Public SR50AT_WtchDg_Cntr : Units SR50AT_WtchDg_Cntr = value
Dim scratch

'Array to hold 11 SR50AT measurements composed of a distance and
'quality number, and air temperature.
Public SR50AT(11,3)

'Sorted array of 11 SR50AT measurements composed of a distance and
'quality number, and temperature. Measurements are sorted by the
'distance value from smallest to largest.
Public Result_SR50AT(11,3)

Public TCDT : Units TCDT = meters 'Temperature corrected distance
Public Q : Units Q = unitless 'Quality number
Public AirTempC : Units AirTempC = ºC 'Air temperature

Public Initial_Dist : Units Initial_Dist = meters 'Distance to ground.
Public Snow_Depth : Units Snow_Depth = meters 'Snow depth.

Dim n 'used as a counter

'Define Data Tables
DataTable(Daily,True,-1)
   DataInterval(0,1440,Min,10)
   Minimum(1,BattV,FP2,False,False)
   Maximum (1,BattV,FP2,False,False)
   Minimum(1,PnlTmp_C,FP2,False,False)
   Maximum (1,PnlTmp_C,FP2,False,False)
CRBasic Example 8: CR6 RS-485 program that measures the SR50AT

EndTable

DataTable (Hour,True,-1 )
   DataInterval (0,60,Min,10)
   Sample (1,AirTempC,FP2)
   Sample (1,TCDT,IEEE4)
   Sample (1,Q,FP2)
EndTable

'Subroutine to sum up errors from the SR50AT across the day.
Sub Diag
   scratch = INT(DiagnosticsT/1000)
   Select Case scratch
   Case 0
      SR50AT_WtchDg_Cntr += 1
      ROM_Cntr += 1
   Case 1
      SR50AT_WtchDg_Cntr += 1
   Case 10
      ROM_Cntr += 1
   EndSelect
EndSub

PreserveVariables

'Main Program
BeginProg
   'Main Scan
   n = 1
   'Open and configure C1 and C2 for RS232 communication.
   '9600 BAUD is the default:
   SerialOpen (ComC1,9600,0,0,200,4)

   Scan(10,Sec,1,0)
      'Battery Voltage measurement 'BattV'
      Battery(BattV)

      'Wiring Panel Temperature measurement 'PnlTmp_C'
      PanelTemp(PnlTmp_C,60)

      'Automated snow depth measurement. Must occur two minutes before
      'actual storage time to get 11 measurements completed.
      If TimeIntoInterval (58,60,Min) Then
         SR50ATCtrl = True
      EndIf

   'Set this flag to true to get the initial distance from the SR50AT

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CRBasic Example 8: CR6 RS-485 program that measures the SR50AT

' to the ground.
If SR50AT_MID Then SR50ATCtrl = True

' Logic to make 11 snow depth measurements, sort them, and store ' the corrected values.
If SR50ATCtrl Then

'Transmit serial command "p33<CR>"
SerialOut (ComC1,POLL_A,"",0,0)

' Flush the serial buffer
SerialFlush (ComC1)

'Receive serial string from SR50AT
SerialIn (SR50ATData,ComC1,200,CHR(13),50)

' Parse string into separate values.
SplitStr (ParseValsT(),SR50ATData,"",5,0)

' Calculate the temperature corrected distance.
SR50AT(n,1) = ParseValsT(2)
SR50AT(n,2) = ParseValsT(3)
SR50AT(n,3) = ParseValsT(4)
n += 1
If n > 11 Then
    n = 1
    SR50ATCtrl = False
    SortSpa (Result_SR50AT(1,1),11,SR50AT(1,1),2)
    TCDT = Result_SR50AT(6,1)
    Q = Result_SR50AT(6,2)
    AirTempC = Result_SR50AT(6,3)
    If SR50AT_MID Then
        Initial_Dist = TCDT
        SR50AT_MID = False
    EndIf
    Snow_Depth = Initial_Dist - TCDT
    ' Add up any errors across the day.
    Call Diag
EndIf
EndIf

' Call Data Tables and Store Data
CallTable Hour
CallTable Daily

' Clear diagnostic counters after Daily_Status table is stored.
If Daily.Output(1,1) Then
    ROM_Cntr = 0
    SR50AT_WtchDg_Cntr = 0
EndIf
NextScan
EndProg
B.3.2 Using an MD485 and SC110 connector

Our CR800, CR850, CR1000, and CR3000 dataloggers require an MD485 to convert the SR50A RS-485 signals to RS-232. This CR1000 program uses the MD485 to measure the SR50A RS-485 signal. An SC110 9-pin male connector cable is also used to free up the RS-232 terminal on the data logger.

MD485 is powered using a Field Power Cable.

<table>
<thead>
<tr>
<th>Field power cable markings</th>
<th>CR1000 datalogger or directly to 12 Vdc power supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wire Marked (+)</td>
<td>12V</td>
</tr>
<tr>
<td>Wire Marked (–)</td>
<td>G</td>
</tr>
</tbody>
</table>

**Table B-4: 14291 field power cable connections**

<table>
<thead>
<tr>
<th>Wire color</th>
<th>Sensor wire description</th>
<th>CR1000 terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>Voltage-excitation input</td>
<td>VX1</td>
</tr>
<tr>
<td>Red</td>
<td>Analog-voltage output</td>
<td>SE1</td>
</tr>
<tr>
<td>Purple</td>
<td>Bridge resistor</td>
<td></td>
</tr>
<tr>
<td>Shield</td>
<td>EMF shield</td>
<td></td>
</tr>
</tbody>
</table>

107 air temperature sensor wiring

<table>
<thead>
<tr>
<th>Wire color</th>
<th>Sensor wire description</th>
<th>CR1000 terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown</td>
<td>RX</td>
<td>C1</td>
</tr>
<tr>
<td>White</td>
<td>TX</td>
<td>C2</td>
</tr>
<tr>
<td>Yellow</td>
<td>Ground</td>
<td>G</td>
</tr>
<tr>
<td>Shield</td>
<td>Shield/earth ground</td>
<td></td>
</tr>
</tbody>
</table>

**Table B-5: 107 and SC110 wiring for CR1000 RS-232 example program**

SC110 9-pin Male Connector Wiring
(9-pin connector plugged into MD485 RS-232 terminal)

**CAUTION:**
Tape and wire tie the unused SC110 wires so they don’t short against any metal.
Table B-6: SR50A (configured for MD485) wiring to MD485 (9-pin connector plugged into MD485 RS-232 terminal)

<table>
<thead>
<tr>
<th>Wire color</th>
<th>Wire description</th>
<th>MD45 terminal (except where indicated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Power source</td>
<td>CR1000 12V</td>
</tr>
<tr>
<td>Green</td>
<td>A</td>
<td>Any ‘A’ terminal</td>
</tr>
<tr>
<td>White</td>
<td>B</td>
<td>Any ‘B’ terminal</td>
</tr>
<tr>
<td>Black</td>
<td>Ground</td>
<td>↓</td>
</tr>
<tr>
<td>Shield</td>
<td>Shield/earth ground</td>
<td>CR1000 G</td>
</tr>
</tbody>
</table>

CRBasic Example 9: CR1000 program measuring a 107 and SR50A using an MD485/SC110

'CR1000 Series Datalogger
'Program: SR50A_RS485_Terminal_C1-C2.CR1

'This program contains a number of features not found in Short Cut.
'The initial distance value from the SR50A head to the ground is
'measured by setting the flag SR50A_MID to TRUE. Set this flag after
'installing the SR50A in the field. Setting this flag will initiate
'a measurement cycle and the resulting value stored as the initial
'distance. The initial distance is used to calculate snow depth.
'The PreserveVariables instruction is used to store the initial
'distance in non-volatile memory. If power is lost at the site the
'initial distance value will be restored.

'A control flag is used to initiate the SR50A measurement cycle. This
'allows for manual control in the field to check distances without
'waiting for the correct time interval to occur. It is also used by
'the data logger to initiate an automated measurement cycle.

'Every measurement cycle is composed of 11 individual measurements
'that are spatially sorted to eliminate any low or high values.
'One measurement is made with each scan. This program has a 10
'second scan rate so it will take 100 seconds to do all 11 scans.

'Declare Constants
'Default serial address of SR50A is 33. Polling command consists of
'a lower case 'p' followed by the address and a carriage return.
Const POLL_A = "p33" & CHR(13)

'Declare Variables and Units
Public BattV : Units BattV = Volts 'CR1000 battery voltage
Public PnlTmp_C : Units PnlTmp_C = 'C 'CR1000 panel temperature
Public AirTempC : Units AirTempC = 'C 'Air temperature

'Controls SR50A measurement. This flag can be manually controlled to
'run tests in the field or is automatically set 2 minutes before the
'hourly data storage interval. This is done so 11 measurements can
'be made and sorted before the values are stored.
Public SR50ACtrl As Boolean

'Set this flag to measure and store the initial distance from the
'SR50A to the ground.
Public SR50A_MID As Boolean

'Declare SR50AData as a dimensioned string of maximum 50 chrs
Public SR50AData As String * 50

'Values returned from the SR50A.
Public ParseVals(5) As Float
Alias ParseVals(1)=SerialAddress : Units SerialAddress = addr
Alias ParseVals(2)=Raw_Distance : Units Raw_Distance = meters
Alias ParseVals(3)=SignalQuality : Units SignalQuality = value
Alias ParseVals(4)=Diagnostics : Units Diagnostics = value
Alias ParseVals(5)=Checksum : Units Checksum = value

'Array to hold 11 SR50A measurements composed of a distance and
'quality number.
Public SR50A(11,2)

'Sorted array of 11 SR50A measurements composed of a distance and
'quality number. Measurements are sorted by the distance value from
'smallest to largest.
Public Result_SR50A(11,2)
Public TCDT : Units TCDT = meters 'Temperature corrected distance
Public Q : Units Q = unitless 'Quality number
Public Initial_Dist : Units Initial_Dist = meters 'Distance to ground.
Public Snow_Depth : Units Snow_Depth = meters 'Snow depth.

Dim n 'used as a counter

'SR50A diagnostic counters. Values are incremented if an error occurs.
Public ROM_Cntr : Units ROM_Cntr = value
Public SR50A_WtchDg_Cntr : Units SR50A_WtchDg_Cntr = value
Dim scratch

'Define Data Tables
DataTable(Daily,True,-1)
CRBasic Example 9: CR1000 program measuring a 107 and SR50A using an MD485/SC110

```
DataInterval(0,1440,Min,10)
Minimum(1,BattV,FP2,False,False)
Maximum (1,BattV,FP2,False,False)
Minimum(1,PnlTmp_C,FP2,False,False)
Maximum (1,PnlTmp_C,FP2,False,False)
Sample (1,ROM_Cntr,FP2)
Sample (1,SR50A_WtchDg_Cntr,FP2)
EndTable

DataTable (Hour,True,-1)
DataInterval(0,60,Min,10)
Sample(1,AirTempC,FP2)
Sample(1,TCDT,IEEE4)
Sample(1,Q,FP2)
EndTable

PreserveVariables

'Subroutine to sum up errors from the SR50A across the day.
Sub Diag
scratch = INT(Diagnostics/1000)
Select Case scratch
Case 0
SR50A_WtchDg_Cntr += 1
ROM_Cntr += 1
Case 1
SR50A_WtchDg_Cntr += 1
Case 10
ROM_Cntr += 1
EndSelect
EndSub

'Main Program
BeginProg
'Open and configure RS232 terminal for RS232 communication.
'9600 BAUD is the default:
SerialOpen (Com1,9600,0,0,200)
n = 1
Scan (10,Sec,3,0)
Battery (BattV)
PanelTemp (PnlTmp_C, _60Hz)
'Make an air temperature measurement.
Therm107 (AirTempC,1,1,Vx1,0, _60Hz,1,0,0)

Automated snow depth measurement. Must occur two minutes before
actual storage time to get 11 measurements completed.
If TimeIntoInterval (58,60,Min) Then
```
SR50ACtrl = True
EndIf

'Set this flag to true to get the initial distance from the SR50A 'to the ground.
If SR50A_MID Then SR50ACtrl = True

If SR50ACtrl Then
  'Transmit serial command "p33<CR>"
  SerialOut (Com1,POLL_A,"",0,0)
  'Flush the serial buffer
  SerialFlush (Com1)
  'Receive serial string from SR50A
  SerialIn (SR50AData,Com1,200,CHR(13),50)
  'Parse string into separate values.
  SplitStr (ParseVals(),SR50AData,"",5,0)
  'Calculate the temperature corrected distance.
  SR50A(n,1) = ParseVals(2)*SQR((AirTempC+273.15)/273.15)
  SR50A(n,2) = ParseVals(3)
  n += 1
  If n > 11 Then
    n = 1
    SR50ACtrl = False
    SortSpa (Result_SR50A(1,1),11,SR50A(1,1),2)
    TCDT = Result_SR50A(6,1)
    Q = Result_SR50A(6,2)
    If SR50A_MID Then
      Inital_Dist = TCDT
      SR50A_MID = False
      EndIf
    Snow_Depth = Inital_Dist - TCDT
    EndIf
    'Add up any errors across the day.
    Call Diag
  EndIf
  'Call data tables.
  CallTable Hour
  CallTable Daily
  'Clear diagnostic counters after Daily_Status table is stored.
  If Daily.Output(1,1) Then
    ROM_Cntr = 0
    SR50A_WtchDg_Cntr = 0
  EndIf
NextScan
EndProg
'CR1000 Series Datalogger
'Program: SR50AT_RS485_MD485_PORT_C1-C2.CR1
'This program contains a number of features not found in Short Cut.

'The initial distance value from the SR50AT head to the ground is
'measured by setting the flag SR50AT_MID to TRUE. Set this flag after
'installing the SR50AT in the field. Setting this flag will initiate
'a measurement cycle and the resulting value stored as the initial
'distance. The initial distance is used to calculate snow depth.
'The PreserveVariables instruction is used to store the initial
'distance in non-volatile memory. If power is lost at the site, the
'initial distance value will be restored.

'A control flag is used to initiate the SR50AT measurement cycle. This
'allows for manual control in the field to check distances without
'waiting for the correct time interval to occur. It is also used by
'the data logger to initiate an automated measurement cycle.

'Every measurement cycle is composed of 11 individual measurements
'that are spatially sorted to eliminate any low or high values.
'One measurement is made with each scan. This program has a 10
'second scan rate so it will take 100 seconds to do all 11 scans or
'1 minute and 40 seconds.

'Declare Constants
'Default serial address of SR50AT is 33. Polling command consists of
'a lower case 'p' followed by the address and a carriage return.
Const POLL_A = "p33" & CHR(13)

'Declare Variables and Units
Public BattV : Units BattV = Volts 'CR1000 battery voltage
Public PnlTmp_C : Units PnlTmp_C = 'C 'CR1000 panel temperature

'Controls SR50AT measurement. This flag can be manually controlled to
'run tests in the field or is automatically set 2 minutes before the
'hourly data storage interval. This is done so 11 measurements can
'be made and sorted before the values are stored.
Public SR50ATCtrl As Boolean

'Set this flag to measure and store the initial distance from the
'SR50AT to the ground.
Public SR50AT_MID As Boolean

'Declare SR50ATData as a dimensioned string of maximum 50 characters
Public SR50ATData As String * 50

'Values returned from the SR50AT.
Public ParseValsT(6) As Float
Alias ParseValsT(1)=SerialAddressT : Units SerialAddressT = addr
Alias ParseValsT(2)=Dist_To_SurfaceT : Units Dist_To_SurfaceT = meters
Alias ParseValsT(3)=SignalQualityT : Units SignalQualityT = value
Alias ParseValsT(4)=SR50AT.Temp : Units SR50AT.Temp = °C
Alias ParseValsT(5)=DiagnosticsT : Units DiagnosticsT = value
Alias ParseValsT(6)=ChcksumT : Units ChcksumT = value

'SR50AT diagnostic counters. Values are incremented if an error occurs.
Public ROM_Cntr : Units ROM_Cntr = value
Public SR50AT_WtchDg_Cntr : Units SR50AT_WtchDg_Cntr = value
Dim scratch

'Array to hold 11 SR50AT measurements composed of a distance and
'quality number, and air temperature.
Public SR50AT(11,3)

'Sorted array of 11 SR50AT measurements composed of a distance and
'quality number, and temperature. Measurements are sorted by the
'distance value from smallest to largest.
Public Result_SJROAT(11,3)

Public TCDT : Units TCDT = meters 'Temperature corrected distance
Public Q : Units Q = unitless 'Quality number
Public AirTempC : Units AirTempC = °C 'Air temperature

Public Initial_Dist : Units Initial_Dist = meters 'Distance to ground.
Public Snow_Depth : Units Snow_Depth = meters 'Snow depth.

Dim n 'used as a counter

'Define Data Tables
DataTable(Daily,True,-1)
   DataInterval(0,1440,Min,10)
   Minimum(1,BattV,FP2,False,False)
   Maximum (1,BattV,FP2,False,False)
   Minimum(1,PnlTmp_C,FP2,False,False)
   Maximum (1,PnlTmp_C,FP2,False,False)
EndTable

DataTable (Hour,True,-1 )
   DataInterval (0,60,Min,10)
   Sample (1,AirTempC,FP2)
   Sample (1,TCDT,IEEE4)
   Sample (1,Q,FP2)
EndTable
'Subroutine to sum up errors from the SR50AT across the day.
Sub Diag
    scratch = INT(DiagnosticsT/1000)
    Select Case scratch
    Case 0
        SR50AT_WtchDg_cntr += 1
        ROM_cntr += 1
    Case 1
        SR50AT_WtchDg_cntr += 1
    Case 10
        ROM_cntr += 1
    EndSelect
EndSub

PreserveVariables

'Main Program
BeginProg
'Main Scan
    n = 1
    'Open and configure C1 and C2 for RS232 communication.
    '9600 BAUD is the default:
    SerialOpen (Com1,9600,0,0,200)

    Scan(10,Sec,1,0)
        'Battery Voltage measurement 'BattV'
        Battery(BattV)

        'Wiring Panel Temperature measurement 'PnlTmp_C'
        PanelTemp(PnlTmp_C,60Hz)

        'Automated snow depth measurement. Must occur two minutes before
        actual storage time to get 11 measurements completed.
        If TimeIntoInterval (58,60,Min) Then
            SR50ATCtrl = True
        EndIf

        'Set this flag to true to get the initial distance from the SR50AT
        'to the ground.
        If SR50AT_MID Then SR50ATCtrl = True

        'Logic to make 11 snow depth measurements, sort them, and store
        'the corrected values.
        If SR50ATCtrl Then
            'Transmit serial command "p33<CR>"
            SerialOut (Com1,POLL_A,"",0,0)
            'Flush the serial buffer
CRBasic Example 10: CR1000 programming measuring the SR50AT using an MD485/SC110

```
SerialFlush (Com1)
'Send string to receive serial string from SR50AT
SerialIn (SR50ATData, Com1, 200, CHR(13), 50)
'Parse string into separate values.
SplitStr (ParseValsT(), SR50ATData, "", 5, 0)
'Calculate the temperature corrected distance.
SR50AT(n, 1) = ParseValsT(2)
SR50AT(n, 2) = ParseValsT(3)
SR50AT(n, 3) = ParseValsT(4)
n += 1
If n > 11 Then
  n = 1
  SR50ATCtrl = False
  SortSpa (Result_SR50AT(1, 1), 11, SR50AT(1, 1), 2)
  TCDT = Result_SR50AT(6, 1)
  Q = Result_SR50AT(6, 2)
  AirTempC = Result_SR50AT(6, 3)
  If SR50AT_MID Then
    Initial_Dist = TCDT
    SR50AT_MID = False
  EndIf
  Snow_Depth = Initial_Dist - TCDT
'Add up any errors across the day.
Call Diag
EndIf
EndIf

'Call Data Tables and Store Data
CallTable Hour
CallTable Daily
'Clear diagnostic counters after Daily_Status table is stored.
If Daily.Output(1, 1) Then
  ROM_Cntr = 0
  SR50AT_WtchDg_Cntr = 0
EndIf
NextScan
EndProg
```

B.4 Heater programs

The following programs are written for a SR50AH and SR50ATH configured for SDI-12. Detailed information about the heater is provided in SR50AH heater operation (p. 107).
### Table B-7: Wiring for CR1000X and CR6 heater example programs

<table>
<thead>
<tr>
<th>Wire color</th>
<th>Sensor wire description</th>
<th>CR1000X terminal</th>
<th>CR6 terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>107 air temperature sensor wiring</strong>&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>Voltage-excitation input</td>
<td>VX1</td>
<td>U2</td>
</tr>
<tr>
<td>Red</td>
<td>Analog-voltage output</td>
<td>SE1</td>
<td>U1</td>
</tr>
<tr>
<td>Purple</td>
<td>Bridge resistor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shield</td>
<td>EMF shield</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SR50A configured for SDI-12 wiring</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td>Power source</td>
<td>12V</td>
<td>12V</td>
</tr>
<tr>
<td>Green</td>
<td>SDI-12 I/O</td>
<td>C1</td>
<td>C1</td>
</tr>
<tr>
<td>White</td>
<td>Not used</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>Black</td>
<td>Ground</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>Shield</td>
<td>Shield/earth ground</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td><strong>SR50AH heater power cable</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>Power source</td>
<td>SW12-1</td>
<td>SW12-1</td>
</tr>
<tr>
<td>White</td>
<td>Power ground</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>Shield</td>
<td>Shield/earth ground</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>1</sup> The 107 probe is not used for the SR50AT programs.

---

### CRBasic Example 11: CR1000X program example measuring the 107/SR50AH and controlling heater

```
'CR1000X
'This program contains a number of features not found in Short Cut.
',
'The initial distance value from the SR50A head to the ground is measured by setting the flag SR50A_MID to TRUE. Set this flag after installing the SR50A in the field. Setting this flag will initiate a measurement cycle and the resulting value stored as the initial distance. The initial distance is used to calculate snow depth. The PreserveVariables instruction is used to store the initial distance in non-volatile memory. If power is lost at the site the initial distance value will be restored.'
```
CRBasic Example 11: CR1000X program example measuring the 107/SR50AH and controlling heater

'A control flag is used to initiate the SR50A measurement cycle. This allows for manual control in the field to check distances without waiting for the correct time interval to occur. It is also used by the data logger to initiate an automated measurement cycle.

'Every measurement cycle is composed of 11 individual measurements that are spatially sorted to eliminate any low or high values. 'One measurement is made with each scan. This program has a 10 second scan rate so it will take 100 seconds to do all 11 scans or 1 minute and 40 seconds.

'Declare Variables and Units
Public BattV : Units BattV = Volts 'CR1000 battery voltage
Public PnlTmp_C : Units PnlTmp_C = ºC 'CR1000 panel temperature
Public AirTempC : Units AirTempC = ºC 'Air temperature
Public HtrCntrl As Boolean

Public SR50A_Raw(2)
Alias SR50A_Raw(1) = DT : Units DT = meters 'Distance from the SR50A.
Alias SR50A_Raw(2) = RawQ : Units RawQ = unitless 'Quality number.

'Array to hold 11 SR50A measurements composed of a distance and quality number.
Public SR50A(11,2)

'Sorted array of 11 SR50A measurements composed of a distance and quality number. Measurements are sorted by the distance value from smallest to largest.
Public Result_SR50A(11,2)

Public TCDT : Units TCDT = meters 'Temperature corrected distance
Public Q : Units Q = unitless 'Quality number

Public Inital_Dist : Units Inital_Dist = meters 'Distance to ground.
Public Snow_Depth : Units Snow_Depth = meters 'Snow depth.

'Controls SR50A measurement. This flag can be manually controlled to run tests in the field or is automatically set 2 minutes before the hourly data storage interval. This is done so 11 measurements can be made and sorted before the values are stored.
Public SR50ACtrl As Boolean

'Set this flag to measure and store the initial distance from the SR50A to the ground.
Public SR50A_MID As Boolean
Dim n 'used as a counter

'Define Data Tables
DataTable (Daily,True,-1)
   DataInterval (0,1440,Min,10)
   Minimum (1,BattV,FP2,False,False)
   Maximum (1,BattV,FP2,False,False)
   Minimum (1,PnlTmp_C,FP2,False,False)
   Maximum (1,PnlTmp_C,FP2,False,False)
EndTable

DataTable (Hour,True,-1)
   DataInterval (0,60,Min,10)
   Sample (1,AirTempC,FP2)
   Sample (1,TCDT,IEEE4)
   Sample (1,Q,FP2)
EndTable

PreserveVariables

'Main Program
BeginProg
   'Main Scan
   n = 1
   Scan (10,Sec,1,0)
      'Battery Voltage measurement 'BattV'
      Battery (BattV)
      
      'Wiring Panel Temperature measurement 'PnlTmp_C'
      PanelTemp (PnlTmp_C,60)
      
      '107 Temperature Probe measurement 'AirTempC'
      Therm107 (AirTempC,1,1,Vx1,0,60,1,0)
      
      'Automated snow depth measurement. Must occur two minutes before actual storage time to get 11 measurements completed.
      If TimeIsBetween (58,60,60,Min) Then
         SR50ACtrl1 = True
      EndIf
      
      'Set this flag to true to get the initial distance from the SR50A to the ground.
      If SR50A_MID Then SR50ACtrl1 = True
      
      'Logic to make 11 snow depth measurements, sort them, and store the corrected values.
CRBasic Example 11: CR1000X program example measuring the 107/SR50AH and controlling heater

If SR50ACtrl Then
  'SR50A Sonic Ranging Sensor (SDI-12 Output) measurements
  'DT' & 'Q'
  SDI12Recorder(SR50A_Raw(),C1,"0","M1!",1,0)
  'Calculate the temperature corrected distance.
  SR50A(n,1) = SR50A_Raw(1)*SQR((AirTempC+273.15)/273.15)
  SR50A(n,2) = SR50A_Raw(2)
  n += 1
  If n > 11 Then
    n = 1
    SR50ACtrl = False
    SortSpa(Result_SR50A(1,1),11,SR50A(1,1),2)
    TCDT = Result_SR50A(6,1)
    Q = Result_SR50A(6,2)
    If SR50A_MID Then
      Initial_Dist = TCDT
      SR50A_MID = False
    EndIf
    Snow_Depth = Initial_Dist - TCDT
  EndIf
EndIf

'SR50A Heater Control
If BattV >= 11.7 Then
  If AirTempC <= 2 Then HtrCtrl = True
  If AirTempC > 3 Then HtrCtrl = False
Else
  HtrCtrl = False
EndIf
SW12(SW12_1,HtrCtrl,1)
'Call Data Tables and Store Data
CallTable Daily
CallTable Hour
NextScan
EndProg

CRBasic Example 12: CR6 heater program example

'CR6
'This program contains a number of features not found in Short Cut.
',
'The initial distance value from the SR50A head to the ground is measured by setting the flag SR50A_MID to TRUE. Set this flag after installing the SR50A in the field. Setting this flag will initiate a measurement cycle and the resulting value stored as the initial
'distance. The initial distance is used to calculate snow depth. 'The PreserveVariables instruction is used to store the initial 'distance in non-volatile memory. If power is lost at the site the 'initial distance value will be restored.'

'A control flag is used to initiate the SR50A measurement cycle. This 'allows for manual control in the field to check distances without 'waiting for the correct time interval to occur. It is also used by 'the data logger to initiate an automated measurement cycle.

'Every measurement cycle is composed of 11 individual measurements 'that are spatially sorted to eliminate any low or high values. 'One measurement is made with each scan. This program has a 10 'second scan rate so it will take 100 seconds to do all 11 scans or '1 minute and 40 seconds.

'Declare Variables and Units
Public BattV : Units BattV = Volts 'CR6 battery voltage
Public PnlTmp_C : Units PnlTmp_C = 'C 'CR6 panel temperature
Public AirTempC : Units AirTempC = 'C 'Air temperature
Public HtrCtrl As Boolean

'Array to hold 11 SR50A measurements composed of a distance and 'quality number.
Public SR50A(11,2)

Public SR50A_Raw(2)
Alias SR50A_Raw(1) = DT : Units DT = meters 'Distance from the SR50A.
Alias SR50A_Raw(2) = RawQ : Units RawQ = unitless 'Quality number.

'Sorted array of 11 SR50A measurements composed of a distance and 'quality number. Measurements are sorted by the distance value from 'smallest to largest.
Public Result_SR50A(11,2)

Public TCDT : Units TCDT = meters 'Temperature corrected distance
Public Q : Units Q = unitless 'Quality number

Public Inital_Dist : Units Inital_Dist = meters 'Distance to ground.
Public Snow_Depth : Units Snow_Depth = meters 'Snow depth.

'Controls SR50A measurement. This flag can be manually controlled to 'run tests in the field or is automatically set 2 minutes before the 'hourly data storage interval. This is done so 11 measurements can 'be made and sorted before the values are stored.
Public SR50ACtrl As Boolean
'Set this flag to measure and store the initial distance from the
'SR50A to the ground.
Public SR50A_MID As Boolean

Dim n  'used as a counter

'Define Data Tables
DataTable(Daily,True,-1)
    DataInterval(0,1440,Min,10)
    Minimum(1,BattV,FP2,False,False)
    Maximum (1,BattV,FP2,False,False)
    Minimum(1,PnlTmp_C,FP2,False,False)
    Maximum (1,PnlTmp_C,FP2,False,False)
EndTable

DataTable (Hour,True,-1 )
    DataInterval (0,60,Min,10)
    Sample (1,AirTempC,FP2)
    Sample (1,TCDT,IEEE4)
    Sample (1,Q,FP2)
EndTable

PreserveVariables

'Main Program
BeginProg
    'Main Scan
    n = 1
    Scan(10,Sec,1,0)
        'Battery Voltage measurement 'BattV'
        Battery(BattV)

        'Wiring Panel Temperature measurement 'PnlTmp_C'
        PanelTemp(PnlTmp_C,60)

        '107 Temperature Probe measurement 'AirTempC'
        Therm107(AirTempC,1,U1,U2,0,60,1,0)

        'Automated snow depth measurement. Must occur two minutes before
        'actual storage time to get 11 measurements completed.
        If TimeIsBetween (13,15,15,Min) Then
            SR50ACtrl = True
        EndIf

        'Set this flag to true to get the initial distance from the SR50A
        'to the ground.
        If SR50A_MID Then SR50ACtrl = True
CRBasic Example 12: CR6 heater program example

'Logic to make 11 snow depth measurements, sort them, and store 'the corrected values.
If SR50ACtrl Then
  'SR50A Sonic Ranging Sensor (SDI-12 Output) measurements
  'DT' & 'Q'
  SDI12Recorder(SR50A_Raw(),C1,"0","0",1,0)
  'Calculate the temperature corrected distance.
  SR50A(n,1) = SR50A_Raw(1)*SQR((AirTempC+273.15)/273.15)
  SR50A(n,2) = SR50A_Raw(2)
  n += 1
If n > 11 Then
  n = 1
  SR50ACtrl = False
  SortSpa(Result_SR50A(1,1),11,SR50A(1,1),2)
  TCDT = Result_SR50A(6,1)
  Q = Result_SR50A(6,2)
  If SR50A_MID Then
    Initial_Dist = TCDT
    SR50A_MID = False
  EndIf
  Snow_Depth = Initial_Dist - TCDT
EndIf

'SR50A Heater Control
If BattV >= 11.7 Then
  If AirTempC <= 2 Then HtrCntrl = True
  If AirTempC > 3 Then HtrCntrl = False
Else
  HtrCntrl = False
EndIf
SW12(1,HtrCntrl,1)
'Call Data Tables and Store Data
CallTable Daily
CallTable Hour
NextScan
EndProg

CRBasic Example 13: CR1000X program measuring the SR50ATH and controlling the heater

'CR1000X
'This program contains a number of features not found in Short Cut.
'
'The initial distance value from the SR50AT head to the ground is
'measured by setting the flag SR50AT_MID to TRUE. Set this flag after
'installing the SR50AT in the field. Setting this flag will initiate  
a measurement cycle and the resulting value stored as the initial  
'distance. The initial distance is used to calculate snow depth.  
The PreserveVariables instruction is used to store the initial  
distance in non-volatile memory. If power is lost at the site, the  
'initial distance value will be restored.

'A control flag is used to initiate the SR50AT measurement cycle. This  
'allows for manual control in the field to check distances without  
'waiting for the correct time interval to occur. It is also used by  
'the data logger to initiate an automated measurement cycle.

'Every measurement cycle is composed of 11 individual measurements  
'that are spatially sorted to eliminate any low or high values.  
'One measurement is made with each scan. This program has a 10  
'second scan rate so it will take 100 seconds to do all 11 scans or  
'1 minute and 40 seconds.

'The heater is controlled using the HtrCntrl flag. Program uses the  
'data logger SW12 line to power the heater. Battery voltage must be  
'greater than 11.7vdc and the air temperature must be less than, or  
'equal to, 2°C to power the heater.

PipelineMode

'Declare Variables and Units
Public BattV : Units BattV = Volts 'battery voltage
Public PnlTmp_C : Units PnlTmp_C = °C 'panel temperature
Public HtrCntrl As Boolean

'Single measured values.
Public SR50AT_M(3)
Alias SR50AT_M(1) = MDT : Units MDT = meters 'Distance from the SR50AT.
Alias SR50AT_M(2) = MQ : Units MQ = unitless 'Quality number.
Alias SR50AT_M(3) = MAir : Units MAir = °C 'Air temperature.

'Array to hold 11 SR50AT measurements composed of a distance and  
'quality number, and air temperature.
Public SR50AT(11,3)

'Sorted array of 11 SR50AT measurements composed of a distance and  
'quality number, and temperature. Measurements are sorted by the  
'distance value from smallest to largest.
Public Result_SR50AT(11,3)

Public TCDT : Units TCDT = meters 'Temperature corrected distance
Public Q : Units Q = unitless 'Quality number
Public AirTempC : Units AirTempC = 'C  'Air temperature
Public Initial_Dist : Units Initial_Dist = meters  'Distance to ground.
Public Snow_Depth : Units Snow_Depth = meters  'Snow depth.

'Controls SR50AT measurement. This flag can be manually controlled to
'run tests in the field or is automatically set 2 minutes before the
'hourly data storage interval. This is done so 11 measurements can
'be made and sorted before the values are stored.
Public SR50ATCtrl As Boolean

'Set this flag to measure and store the initial distance from the
'SR50AT to the ground.
Public SR50AT_MID As Boolean

Dim n  'used as a counter

'Define Data Tables
DataTable(Daily,True,-1)
   DataInterval(0,1440,Min,10)
   Minimum(1,BattV,FP2,False,False)
   Maximum(1,BattV,FP2,False,False)
   Minimum(1,PnlTmp_C,FP2,False,False)
   Maximum(1,PnlTmp_C,FP2,False,False)
EndTable

DataTable (Hour,True,-1 )
   DataInterval(0,60,Min,10)
   Sample(1,AirTempC,FP2)
   Sample(1,TCDT,IEEE4)
   Sample(1,Q,FP2)
EndTable

PreserveVariables

'Main Program
BeginProg
   'Main Scan
   n = 1
   Scan(10,Sec,1,0)
      'Battery Voltage measurement 'BattV
      Battery(BattV)

      'Wiring Panel Temperature measurement 'PnlTmp_C
      PnlTemp(PnlTmp_C,60)

      'Automated snow depth measurement. Must occur two minutes before
'Actual storage time to get 11 measurements completed.
If TimeIntoInterval (58, 60, Min) Then
   SR50ATCtrl = True
EndIf

'Set this flag to true to get the initial distance from the SR50AT to the ground.
If SR50AT_MID Then SR50ATCtrl = True

'Logic to make 11 snow depth measurements, sort them, and store the corrected values.
If SR50ATCtrl Then
   'SR50AT Sonic Ranging Sensor (SDI-12 Output) measurements
   'MDT, MQ, & MAir
   SDI12Recorder(SR50AT_M(), C1, "0", "M3!", 1, 0)
   'Load the array to be sorted.
   SR50AT(1,1) = SR50AT_M(1)
   SR50AT(1,2) = SR50AT_M(2)
   SR50AT(1,3) = SR50AT_M(3)
   n += 1
   If n > 11 Then
      n = 1
      SR50ATCtrl = False
      SortSpa (Result_SR50AT(1,1), 11, SR50AT(1,1), 2)
      TCDT = Result_SR50AT(6, 1)
      Q = Result_SR50AT(6, 2)
      AirTempC = Result_SR50AT(6, 3)
      If SR50AT_MID Then
         Initial_Dist = TCDT
         SR50AT_MID = False
      EndIf
      Snow_Depth = Initial_Dist - TCDT
   EndIf
EndIf

'SR50ATH heater control. Voltage must be above 11.7 VDC and the air temperature less than 2°C to turn on the heater.
If BattV >= 11.7 Then
   If AirTempC <= 2 Then HtrCtrl = True
   If AirTempC > 3 Then HtrCtrl = False
Else
   HtrCtrl = False
EndIf
SW12(SW12_1, HtrCtrl)

'Call Data Tables and Store Data
CallTable Daily
CRBasic Example 13: CR1000X program measuring the SR50ATH and controlling the heater

```
CallTable Hour
NextScan
EndProg
```

CRBasic Example 14: CR6 program measuring the SR50ATH and controlling the heater

```
'CR6
'Program: SR50ATH_SDI12_FILTER.CR6
'This program contains a number of features not found in Short Cut.

'The initial distance value from the SR50AT head to the ground is
'measured by setting the flag SR50AT_MID to TRUE. Set this flag after
'installing the SR50AT in the field. Setting this flag will initiate
'a measurement cycle and the resulting value stored as the initial
'distance. The initial distance is used to calculate snow depth.
'The PreserveVariables instruction is used to store the initial
'distance in non-volatile memory. If power is lost at the site, the
'initial distance value will be restored.'

'A control flag is used to initiate the SR50AT measurement cycle. This
'allows for manual control in the field to check distances without
'waiting for the correct time interval to occur. It is also used by
'the data logger to initiate an automated measurement cycle.

'Every measurement cycle is composed of 11 individual measurements
'that are spatially sorted to eliminate any low or high values.
'One measurement is made with each scan. This program has a 10
'second scan rate so it will take 100 seconds to do all 11 scans or
'1 minute and 40 seconds.

'The heater is controlled using the HtrCntrl flag. Program uses the
'data logger SW12 line to power the heater. Battery voltage must be
'greater than 11.7vdc and the air temperature must be less than, or
'equal to, 2°C to power the heater.

PipeLineMode

'Declare Variables and Units
Public BattV : Units BattV = Volts 'battery voltage
Public PnlTmp_C : Units PnlTmp_C = °C 'panel temperature
Public HtrCntrl As Boolean

'Single measured values.
Public SR50AT_M(3)
Alias SR50AT_M(1) = MDT : Units MDT = meters 'Distance from the SR50AT.
CRBasic Example 14: CR6 program measuring the SR50ATH and controlling the heater

Alias SR50AT_M(2) = MQ : Units MQ = unitless 'Quality number.
Alias SR50AT_M(3) = MAir : Units MAir = °C 'Quality number.

'Array to hold 11 SR50AT measurements composed of a distance and
'quality number, and air temperature.
Public SR50AT(11,3)

'Sorted array of 11 SR50AT measurements composed of a distance and
'quality number, and temperature. Measurements are sorted by the
'distance value from smallest to largest.
Public Result_SR50AT(11,3)

Public TCDT : Units TCDT = meters 'Temperature corrected distance
Public Q : Units Q = unitless 'Quality number
Public AirTempC : Units AirTempC = °C 'Air temperature

Public Initial_Dist : Units Initial_Dist = meters 'Distance to ground.
Public Snow_Depth : Units Snow_Depth = meters 'Snow depth.

'Controls SR50AT measurement. This flag can be manually controlled to
'run tests in the field or is automatically set 2 minutes before the
'hourly data storage interval. This is done so 11 measurements can
'be made and sorted before the values are stored.
Public SR50ATCtrl As Boolean

'Set this flag to measure and store the initial distance from the
'SR50AT to the ground.
Public SR50AT_MID As Boolean

Dim n 'used as a counter

'Define Data Tables
DataTable (Daily,True,-1)
    DataInterval(0,1440,Min,10)
    Minimum(1,BattV,FP2,False,False)
    Maximum (1,BattV,FP2,False,False)
    Minimum(1,PnlTmp_C,FP2,False,False)
    Maximum (1,PnlTmp_C,FP2,False,False)
EndTable

DataTable (Hour,True,-1)
    DataInterval(0,60,Min,10)
    Sample (1,AirTempC,FP2)
    Sample (1,TCDT,IEEE4)
    Sample (1,Q,FP2)
EndTable
PreserveVariables

'Main Program
BeginProg
'Main Scan
n = 1
Scan(10,Sec,1,0)
'Battery Voltage measurement 'BattV'
Battery(BattV)

'Wiring Panel Temperature measurement 'PnlTmp_C'
PanelTemp(PnlTmp_C,60)

'Automated snow depth measurement. Must occur two minutes before
'actual storage time to get 11 measurements completed.
If TimeIntoInterval (58,60,Min) Then
SR50ATCtrl = True
EndIf

'Set this flag to true to get the initial distance from the SR50AT
'to the ground.
If SR50AT_MID Then SR50ATCtrl = True

'Logic to make 11 snow depth measurements, sort them, and store
'the corrected values.
If SR50ATCtrl Then
'SR50AT Sonic Ranging Sensor (SDI-12 Output) measurements
'MDT, MQ, & MAir
SDI12Recorder(SR50AT_M(),C1,"0","M3!",1,0)
'Load the array to be sorted.
SR50AT(n,1) = SR50AT_M(1)
SR50AT(n,2) = SR50AT_M(2)
SR50AT(n,3) = SR50AT_M(3)
n += 1
If n > 11 Then
n = 1
SR50ATCtrl = False
SortSpa(Result_SR50AT(1,1),11,SR50AT(1,1),2)
TCDT = Result_SR50AT(6,1)
Q = Result_SR50AT(6,2)
AirTempC = Result_SR50AT(6,3)
If SR50AT_MID Then
Initial_Dist = TCDT
SR50AT_MID = False
EndIf
Snow_Depth = Initial_Dist - TCDT
EndIf
CRBasic Example 14: CR6 program measuring the SR50ATH and controlling the heater

EndIf

'SR50ATH heater control. Voltage must be above 11.7 vdc and the 'air temperature less than 2°C to turn on the heater.
If BattV >= 11.7 Then
  If AirTempC <= 2 Then HtrCntrl = True
  If AirTempC > 3 Then HtrCntrl = False
Else
  HtrCntrl = False
EndIf
SW12(1,HtrCntrl)

'Call Data Tables and Store Data
CallTable Daily
CallTable Hour
NextScan
EndProg
Appendix C. Jumper settings

FIGURE C-1 (p. 82) shows the jumper locations of the SR50A.

The SR50A can be configured with either SDI-12, RS-232 or RS-485 communications. Shunt jumpers can be located on any of the three sets of communication selection headers. Only place the three jumpers on one group at a time. Never install more than three jumpers and never mix the jumpers among the SDI-12, RS-232 or RS-485 locations.

The other jumper located on the SR50A places the sensor in either the normal operation mode or in the program update mode. The program mode is only used for updating the internal operating system of the sensor. During operation, have the jumper in the **RUN** position.

Refer to **Operating system update** (p. 1) for details about SR50A operating system updates.
Appendix D. SDI-12 sensor support

SDI-12, Serial Data Interface at 1200 baud, is a protocol developed to simplify sensor and data logger compatibility. Only three wires are necessary — serial data, ground, and 12 V. With unique addresses, multiple SDI-12 sensors can connect to a single SDI-12 terminal on a Campbell Scientific data logger.

This appendix discusses the structure of SDI-12 commands and the process of querying SDI-12 sensors. For more detailed information, refer to version 1.4 of the SDI-12 protocol, available at www.sdi-12.org.

For additional information, refer to the SDI-12 Sensors | Transparent Mode and SDI-12 Sensors | Watch or Sniffer Mode videos.

D.1 SDI-12 command basics

SDI-12 commands have three components:

- **Sensor address (a)** – a single character and the first character of the command. Use the default address of zero (0) unless multiple sensors are connected to the same port.
- **Command body** – an upper case letter (the “command”), optionally followed by one or more alphanumeric qualifiers.
- **Command termination (!)** – an exclamation mark.

An active sensor responds to each command. Responses have several standard forms and always terminate with <CR><LF> (carriage return and line feed). Standard SDI-12 commands are listed in Table D-1 (p. 83).

<table>
<thead>
<tr>
<th>Name</th>
<th>Command</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acknowledge Active</td>
<td>a!</td>
<td>a&lt;CR&gt;&lt;LF&gt;</td>
</tr>
<tr>
<td>Send Identification</td>
<td>aI!</td>
<td>allccccccccmmmmmmwvxx...xx&lt;CR&gt;&lt;LF&gt;</td>
</tr>
<tr>
<td>Start Verification</td>
<td>aV!</td>
<td>atttn&lt;CR&gt;&lt;LF&gt;</td>
</tr>
</tbody>
</table>
Table D-1: Campbell Scientific sensor SDI-12 command and response set

<table>
<thead>
<tr>
<th>Name</th>
<th>Command</th>
<th>Response¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address Query</td>
<td>?!</td>
<td>a&lt;CR&gt;&lt;LF&gt;</td>
</tr>
<tr>
<td>Change Address</td>
<td>aAb!</td>
<td>b&lt;CR&gt;&lt;LF&gt;</td>
</tr>
<tr>
<td>Start Measurement</td>
<td>aM!</td>
<td>attn&lt;CR&gt;&lt;LF&gt;</td>
</tr>
<tr>
<td></td>
<td>aM1!...aM9!</td>
<td></td>
</tr>
<tr>
<td>Start Measurement and Request CRC</td>
<td>aMC!</td>
<td>attn&lt;CR&gt;&lt;LF&gt;</td>
</tr>
<tr>
<td></td>
<td>aMC1!...aMC9!</td>
<td></td>
</tr>
<tr>
<td>Start Concurrent Measurement</td>
<td>aC!</td>
<td>attn&lt;CR&gt;&lt;LF&gt;</td>
</tr>
<tr>
<td></td>
<td>aC1!...aC9!</td>
<td></td>
</tr>
<tr>
<td>Start Concurrent Measurement and Request CRC</td>
<td>aCC!</td>
<td>attn&lt;CR&gt;&lt;LF&gt;</td>
</tr>
<tr>
<td></td>
<td>aCC1!...aCC9!</td>
<td></td>
</tr>
<tr>
<td>Send Data</td>
<td>aD0!...aD9!</td>
<td>a&lt;values&gt;&lt;CR&gt;&lt;LF&gt; or a&lt;values&gt;&lt;CRC&gt;&lt;CR&gt;&lt;LF&gt;</td>
</tr>
<tr>
<td>Continuous Measurement</td>
<td>aR0!...aR9!</td>
<td>a&lt;values&gt;&lt;CR&gt;&lt;LF&gt;</td>
</tr>
<tr>
<td>Continuous Measurement and Request CRC</td>
<td>aRC0!...aRC9!</td>
<td>a&lt;values&gt;&lt;CRC&gt;&lt;CR&gt;&lt;LF&gt;</td>
</tr>
<tr>
<td>Extended Commands</td>
<td>aXNNN!</td>
<td>a&lt;values&gt;&lt;CR&gt;&lt;LF&gt;</td>
</tr>
</tbody>
</table>

¹ Information on each of these commands is given in the following sections.

D.1.1 Acknowledge active command (a!)
The Acknowledge Active command (a!) is used to test a sensor on the SDI-12 bus. An active sensor responds with its address.

D.1.2 Send identification command (al!)
Sensor identifiers are requested by issuing command al!. The reply is defined by the sensor manufacturer but usually includes the sensor address, SDI-12 version, manufacturer’s name, and sensor model information. Serial number or other sensor specific information may also be included.

<table>
<thead>
<tr>
<th>al!</th>
<th>allccccccccmmmmmmmvvvxxxxxx&lt;CR&gt;&lt;LF&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Sensor SDI-12 address</td>
</tr>
<tr>
<td>ll</td>
<td>SDI-12 version number (indicates compatibility)</td>
</tr>
</tbody>
</table>
D.1.3 Start verification command (aV!)

The response to a Start Verification command can include hardware diagnostics, but like the aI! command, the response is not standardized.

Command: aV!

Response: atttn<CR><LF>

\( a = \) sensor address
\( ttt = \) time, in seconds, until verification information is available
\( n = \) the number of values to be returned when one or more subsequent D! commands are issued

D.1.4 Address query command (?!)

Command ?! requests the address of the connected sensor. The sensor replies to the query with the address, \( a \). This command should only be used with one sensor on the SDI-12 bus at a time.

D.1.5 Change address command (aAb!)

Multiple SDI-12 sensors can connect to a single SDI-12 terminal on a data logger. Each device on a single terminal must have a unique address.

A sensor address is changed with command aAb!, where \( a \) is the current address and \( b \) is the new address. For example, to change an address from 0 to 2, the command is 0A2!. The sensor responds with the new address \( b \), which in this case is 2.

**NOTE:**
Only one sensor should be connected to a particular terminal at a time when changing addresses.
D.1.6 Start measurement commands (aM!)

A measurement is initiated with the M! command. The response to each command has the form atttn<CR><LF>, where

- \( a \) = sensor address
- \( ttt \) = time, in seconds, until measurement data is available. When the data is ready, the sensor notifies the data logger, and the data logger begins issuing D commands.
- \( n \) = the number of values returned when one or more subsequent D commands are issued. For the aM! command, \( n \) is an integer from 0 to 9.

When the aM! is issued, the data logger pauses its operation and waits until either it receives the data from the sensor or the time, \( ttt \), expires. Depending on the scan interval of the data logger program and the response time of the sensor, this may cause skipped scans to occur. In this case make sure your scan interval is longer than the longest measurement time (\( ttt \)).

Table D-2: Example aM! sequence

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0M!</td>
<td>The data logger makes a request to sensor 0 to start a measurement.</td>
</tr>
<tr>
<td>00352&lt;CR&gt;&lt;LF&gt;</td>
<td>Sensor 0 immediately indicates that it will return two values within the next 35 seconds.</td>
</tr>
<tr>
<td>0&lt;CR&gt;&lt;LF&gt;</td>
<td>Within 35 seconds, sensor 0 indicates that it has completed the measurement by sending a service request to the data logger.</td>
</tr>
<tr>
<td>0D0!</td>
<td>The data logger immediately issues the first D command to collect data from the sensor.</td>
</tr>
<tr>
<td>0+.859+3.54&lt;CR&gt;&lt;LF&gt;</td>
<td>The sensor immediately responds with the sensor address and the two values.</td>
</tr>
</tbody>
</table>

D.1.7 Start concurrent measurement commands (aC!)

A concurrent measurement (aC!) command follows the same pattern as the aM! command with the exception that it does not require the data logger to pause its operation, and other SDI-12 sensors may take measurements at the same time. The sensor will not issue a service request to notify the data logger that the measurement is complete. The data logger will issue the aD0! command during the next scan after the measurement time reported by the sensor has expired. To use this command, the scan interval should be 10 seconds or less. The response to each command has the form atttn<CR><LF>, where

- \( a \) = the sensor address
- \( ttt \) = time, in seconds, until the measurement data is available
$nn$ = the number of values to be returned when one or more subsequent D commands are issued.

See the following example. A data logger has three sensors wired into terminal C1. The sensors are addresses X, Y, and Z. The data logger will issue the following commands and receive the following responses:

<table>
<thead>
<tr>
<th>Table D-3: Example aC! sequence</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>XC!</td>
<td>The data logger makes a request to sensor X to start a concurrent measurement.</td>
</tr>
<tr>
<td>X03005&lt;CR&gt;&lt;LF&gt;</td>
<td>Sensor X immediately indicates that it will have 5 (05) values ready for collection within the next 30 (030) seconds.</td>
</tr>
<tr>
<td>YC!</td>
<td>The data logger makes a request to sensor Y to start a concurrent measurement.</td>
</tr>
<tr>
<td>Y04006&lt;CR&gt;&lt;LF&gt;</td>
<td>Sensor Y immediately indicates that it will have 6 (06) values ready for collection within the next 40 (040) seconds.</td>
</tr>
<tr>
<td>ZC!</td>
<td>The data logger makes a request to sensor Z to start a concurrent measurement.</td>
</tr>
<tr>
<td>Z02010&lt;CR&gt;&lt;LF&gt;</td>
<td>Sensor Z immediately indicates that it will have 10 values ready for collection within the next 20 (020) seconds.</td>
</tr>
<tr>
<td>ZD0!</td>
<td>After 20 seconds have passed, the data logger starts the process of collecting the data by issuing the first D command to sensor Z.</td>
</tr>
<tr>
<td>Z+1+2+3+4+5+6+7+8+9+10&lt;CR&gt;&lt;LF&gt;</td>
<td>Sensor Z immediately responds with the sensor address and the 10 values.</td>
</tr>
<tr>
<td>XD0!</td>
<td>10 seconds later, after a total of 30 seconds have passed, the data logger starts the process of data from sensor X by issuing the first D command.</td>
</tr>
<tr>
<td>X+1+2+3+4+5&lt;CR&gt;&lt;LF&gt;</td>
<td>The sensor immediately responds with the sensor address and the 5 values.</td>
</tr>
</tbody>
</table>
Table D-3: Example aC! sequence

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>YD0!</td>
<td>Ten seconds later, after a total of 40 seconds have passed, the data logger starts the process of data from sensor Y by issuing the first D command.</td>
</tr>
<tr>
<td>Y+1+2+3+4+5+6&lt;CR&gt;&lt;LF&gt;</td>
<td>The sensor immediately responds with the sensor address and the 6 values.</td>
</tr>
</tbody>
</table>

D.1.8 Start measurement commands with cyclic redundancy check (aMC! and aCC!)

Error checking is done by using measurement commands with cyclic redundancy checks (aMC! or aCC!). This is most commonly implemented when long cable lengths or electronic noise may impact measurement transmission to the data logger. When these commands are used, the data returned in response to D or R commands must have a cyclic redundancy check (CRC) code appended to it. The CRC code is a 16-bit value encoded within 3 characters appended before the <CR> <LF>. This code is not returned in the data table but checked by the data logger as it comes. The code returned is based on the SDI-12 protocol. See the SDI-12 communication specification for version 1.3 available at www.sdi-12.org to learn more about how the CRC code is developed.

D.1.9 Stopping a measurement command

A measurement command (M!) is stopped if it detects a break signal. A break signal is sent by the data logger before most commands.

A concurrent measurement command (C!) is aborted when another valid command is sent to the sensor before the measurement time has elapsed.

D.1.10 Send data command (aD0! ... aD9!)

The Send Data command requests data from the sensor. It is issued automatically with every type of measurement command (aM!, aMC!, aC!, aCC!). When the measurement command is aM! or aMC!, the data logger issues the aD0! command once a service request has been received from the sensor. When the data logger is issuing concurrent commands (aC! or aCC!), the Send Data command is issued after the required time has elapsed (no service request will be sent by the sensor). In transparent mode (SDI-12 transparent mode (p. 89)), the user asserts this command to obtain data.

Depending on the type of data returned and the number of values a sensor returns, the data logger may need to issue aD0! up to aD9! to retrieve all data. A sensor may return up to 35 characters of data in response to a D command that follows an M! or MC! command. A sensor
may return up to 75 characters of data in response to a D command that follows a C! or CC! command.

Command: aD0! (aD1! ... aD9!)
Response: a<values><CR><LF> or a<values><CRC><CR><LF>

where:

a = the sensor address
<values> = values returned with a polarity sign (+ or –)
<CR><LF> = terminates the response
<CRC> = 16-bit CRC code appended if data was requested with aMC! or aCC!.

D.1.11 Continuous measurement command (aR0! ... aR9!)

Sensors that are able to continuously monitor the phenomena to be measured can be read directly with the R commands (R0! ... R9!). The response to the R commands mirrors the Send Data command (aD0!). A maximum of 75 characters can be returned in the <values> part of the response to the R command.

D.1.12 Extended commands

Many sensors support extended SDI-12 commands. An extended command is specific to a make of sensor and tells the sensor to perform a specific task. They have the following structure. Responses vary from unit to unit. See the sensor manual for specifics.

Command: aXNNNN!

The command will start with the sensor address (a), followed by an X, then a set of optional letters, and terminate with an exclamation point.

Response: a<optional values><CR><LF>

The response will start with the sensor address and end with a carriage return/line feed.

D.2 SDI-12 transparent mode

System operators can manually interrogate and enter settings in probes using transparent mode. Transparent mode is useful in troubleshooting SDI-12 systems because it allows direct communication with probes. Data logger security may need to be unlocked before activating the transparent mode.

Transparent mode is entered while the PC is communicating with the data logger through a terminal emulator program. It is accessed through Campbell Scientific data logger support.
software or other terminal emulator programs. Data logger keyboards and displays cannot be used.

The terminal emulator is accessed by navigating to the Datalogger list in PC200W, the Tools list in PC400, or the Datalogger list in the Connect screen of LoggerNet.

Watch the video: SDI-12 Sensors | Transparent Mode.

The following examples show how to enter transparent mode and change the SDI-12 address of an SDI-12 sensor. The steps shown in Changing an SDI-12 address (p. 90) are used with most Campbell Scientific data loggers. Changing an SDI-12 address — CR200(X) Series (p. 91) lists the steps used for CR200(X)-series dataloggers.

D.2.1 Changing an SDI-12 address

The example below was done with a CR1000, but the steps are only slightly different for CR1000X-series, CR300-series, CR6-series, CR800-series, and CR3000 dataloggers. For CR200(X)-series dataloggers, see Changing an SDI-12 address — CR200(X) Series (p. 91).

1. Connect an SDI-12 sensor to the CR1000.
2. In LoggerNet Connect, under Datalogger, click Terminal Emulator. The terminal emulator window opens.
3. Under Select Device, located in the lower left side of the window, select the CR1000 station.
4. Click Open Terminal.
5. Select All Caps Mode.
6. Press Enter until the data logger responds with the CR1000> prompt.
7. Type SDI12 and press Enter.
8. At the Select SDI12 Port prompt, type the number corresponding to the control port where the sensor is connected and press Enter. The response Entering SDI12 Terminal indicates that the sensor is ready to accept SDI-12 commands.
9. To query the sensor for its current SDI-12 address, type ?! and press Enter. The sensor responds with its SDI-12 address. If no characters are typed within 60 seconds, the mode is exited. In that case, simply type SDI12 again, press Enter, and type the correct control port number when prompted.
10. To change the SDI-12 address, type aAb!, where a is the current address from the above step and b is the new address (see FIGURE D-1 (p. 91). Press Enter. The sensor changes its address and responds with the new address.
11. To exit SDI-12 transparent mode, click Close Terminal.
D.2.2 Changing an SDI-12 address — CR200(X) Series

1. Connect a single SDI-12 sensor to the CR200(X).
2. In LoggerNet Connect, under Datalogger, click Terminal Emulator. The terminal emulator window opens.
3. Under Select Device, located in the lower left side of the window, select the CR200Series station.
4. Click Open Terminal.
5. Select All Caps Mode.
6. Press Enter until the data logger responds with the CR2XX> prompt.
7. Type SDI12 and press Enter.
8. The response SDI12> indicates that the sensor is ready to accept SDI-12 commands.
9. To query the sensor for its current SDI-12 address, type ?I and press Enter. The sensor responds with its SDI-12 address. If no characters are typed within 60 seconds, the mode is exited. In that case, simply type SDI12 again and press Enter.
10. To change the SDI-12 address, type aAb!, where a is the current address from the above step and b is the new address (see FIGURE D-2 (p. 92). Press Enter. The sensor changes its address and responds with the new address.
11. To exit SDI-12 transparent mode, click Close Terminal.
FIGURE D-2. CR200(X) example of using the SDI-12 transparent mode to change the SDI-12 address from 0 to 1

D.3 References

Appendix E. RS-232 and RS-485 operation

The SR50A sensor comes from the factory with the internal jumpers set to SDI-12 mode. To use the SR50A in the RS-232 or RS-485 mode of operation, the jumpers need to be set as outlined in Jumper settings (p. 82). Complete RS-232 or RS-485 CRBasic programs can be found in Example programs (p. 30).

E.1 RS-232 wiring

FIGURE E-1 (p. 94) and Table E-1 (p. 94) show wiring for the SR50A in RS-232 mode. The ground used with the RS-232 connector (pin 5) must use the same ground as the SR50A. For the following example, the power for the SR50A is coming from the data logger. A jumper wire is used from pin 5 of the RS-232 connector to the data logger ground.
Interface with Hood and Hardware Kit, DB9 Female to Terminal Block

![Diagram of DB9 Female to Terminal Block](image)

<table>
<thead>
<tr>
<th>Pin</th>
<th>Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DCD</td>
</tr>
<tr>
<td>2</td>
<td>RXD</td>
</tr>
<tr>
<td>3</td>
<td>TXD</td>
</tr>
<tr>
<td>4</td>
<td>DTR</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
</tr>
<tr>
<td>6</td>
<td>DSR</td>
</tr>
<tr>
<td>7</td>
<td>RTS</td>
</tr>
<tr>
<td>8</td>
<td>CTS</td>
</tr>
<tr>
<td>9</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Pins used for RS-232 communication in **bold** lettering.

*FIGURE E-1. RS-232 DB9 Connector Description*

---

**Table E-1: SR50A RS-232 interface wiring**

<table>
<thead>
<tr>
<th>SR50A wire color</th>
<th>Function</th>
<th>Wiring location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>+12 Vdc power</td>
<td>Power source (data logger: <strong>12V</strong>)</td>
</tr>
<tr>
<td>Black</td>
<td>Power ground</td>
<td>System ground and/or RS-232 receiver ground (data logger: <strong>G</strong>)</td>
</tr>
<tr>
<td>Green</td>
<td>RS-232 (SR50A output)</td>
<td>Pin 2 [RXD] (9-pin RS-232 interface connector)</td>
</tr>
</tbody>
</table>
Table E-1: SR50A RS-232 interface wiring

<table>
<thead>
<tr>
<th>SR50A wire color</th>
<th>Function</th>
<th>Wiring location</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>RS-232 (SR50A input)</td>
<td>Pin 3 [TXD] (9-pin RS-232 interface connector)</td>
</tr>
<tr>
<td>Clear</td>
<td>Shield</td>
<td>G (data logger)</td>
</tr>
<tr>
<td>Jumper wire</td>
<td></td>
<td>Pin 5 [G] (9-pin RS-232 interface connector)</td>
</tr>
</tbody>
</table>

Table E-2: SR50A data logger COM terminal wiring

<table>
<thead>
<tr>
<th>SR50A wire color</th>
<th>Function</th>
<th>CR1000X</th>
<th>CR6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>+12 Vdc power</td>
<td>12V</td>
<td>12V</td>
</tr>
<tr>
<td>Black</td>
<td>Power ground</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>Green</td>
<td>RS-232 (SR50A output)</td>
<td>RX (C6 or C8)</td>
<td>RX (C2)</td>
</tr>
<tr>
<td>White</td>
<td>RS-232 (SR50A input)</td>
<td>TX (C5 or C7)</td>
<td>TX (C1)</td>
</tr>
<tr>
<td>Clear</td>
<td>Shield</td>
<td>G</td>
<td>G</td>
</tr>
</tbody>
</table>

E.2 RS-485 operation

The RS-485 on the SR50A supports half-duplex communications, which means the SR50A can receive and transmit data, but not simultaneously. Normally a master-slave relationship is used in most systems to avoid collisions between transmissions. For this reason, the Auto Measure Output is not recommended for RS-485 communications. It is much better to have a master initiate the communications by using the Measure On Poll or the Auto Measure Polled Output modes.

The CR6 and CR1000X data loggers can read the SR50A output without an interface such as the MD485. For other Campbell Scientific data loggers, the MD485 interface is required to connect one or more SR50A sensors. The RS-485 mode is useful for sensors that require cable lengths that exceed the limits of either RS-232 or SDI-12 communications.

E.3 RS-485 wiring using an MD485

Table E-3 (p. 96) and FIGURE E-2 (p. 96) show the wiring for the SR50A in RS-485 mode.
### Table E-3: Connections for RS-485 mode

<table>
<thead>
<tr>
<th>Color</th>
<th>Function</th>
<th>Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>Power ground</td>
<td>System ground and/or RS-232 receiver ground (pin 5 of a computer (DTE) DB-9 connector)</td>
</tr>
<tr>
<td>Red</td>
<td>Power</td>
<td>Power source +12V</td>
</tr>
<tr>
<td>Green</td>
<td>RS-485 A</td>
<td>MD485 RS-485 A terminal</td>
</tr>
<tr>
<td>White</td>
<td>RS-485 B</td>
<td>MD485 RS-485 B terminal</td>
</tr>
<tr>
<td>Clear</td>
<td>Shield</td>
<td>Shield/earth ground</td>
</tr>
</tbody>
</table>

**FIGURE E-2. SR50A to MD485 Wiring**
E.4 RS-485 wiring to a CR6 or CR1000X datalogger

The SR50A connects to C terminals that are compatible with half-duplex RS 485 communications.

<table>
<thead>
<tr>
<th>Color</th>
<th>Function</th>
<th>Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>Power ground</td>
<td>G</td>
</tr>
<tr>
<td>Red</td>
<td>Power</td>
<td>12V</td>
</tr>
<tr>
<td>Green</td>
<td>RS-485 A</td>
<td>C1</td>
</tr>
<tr>
<td>White</td>
<td>RS-485 B</td>
<td>C2</td>
</tr>
<tr>
<td>Clear</td>
<td>Shield</td>
<td>G</td>
</tr>
</tbody>
</table>

E.5 RS-232 and RS-485 settings

Once the jumpers are set for RS-232 operation, Device Configuration Utility is used to change factory defaults or existing settings. Use a terminal program that allows local echo. The following settings apply to Device Configuration Utility or any program used for communications.

- **Baud rate:** Current SR50A setting (see NOTE)
- **Data bits:** 8
- **Parity:** None
- **Stop bits:** 1
- **Flow control:** None
- **Local echo:** On

**NOTE:**
The factory default baud rate is 9600 bps. Once the baud rate is changed, the new baud rate must be used for further communications to the SR50A. Ensure to keep track of the baud rate setting on the SR50A. If the baud rate setting is unknown, try using the default value of 9600 bps. If that does not work, start the baud rate at 1200 bps and go through all the baud rate settings until the correct one is found.

Select the following when using Device Configuration Utility (FIGURE E-3 (p. 98)).
- **Device Type:** Unknown
- Choose the correct **COM port**.
- By default, the **baud rate** in the SR50A and Device Configuration Utility is set to 9600. Only change the baud rate if you know it has been changed in the SR50A.
- Click **Connect** in the lower left hand corner.
- Uncheck the **All Caps** box.
- Check **Echo Input**.

![Initial terminal window in Device Configuration Utility](image)

**FIGURE E-3. Initial terminal window in Device Configuration Utility**

To enter **Setup** mode, type **setup** in the terminal window and press the **Enter** key. The word **setup** and all options in the setup menu are not case sensitive.

The SR50A should respond with the setup menu shown in **FIGURE E-4** (p. 99).
Table E-5 (p. 99) summarizes the settings that can be changed using the SR50A RS-232 or RS-485 operating modes. Recommended changes are shown in parenthesis.

**Table E-5: RS-232 and RS-485 settings**

<table>
<thead>
<tr>
<th>Setting description</th>
<th>Options</th>
<th>Default value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baud rate</td>
<td>1200, 4800, 9600, 19200, 38400</td>
<td>9600 bps</td>
</tr>
<tr>
<td>Address RS-232/RS-485</td>
<td>Any two alphanumeric characters</td>
<td>33</td>
</tr>
<tr>
<td>Serial operational mode</td>
<td>Measure on poll, Auto-measure, Auto-output, Auto-measure polled output</td>
<td>Auto measure auto output (Change this to measure on poll.)</td>
</tr>
<tr>
<td>Setting description</td>
<td>Options</td>
<td>Default value</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>--------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Distance to target or depth output</td>
<td>Distance to target depth</td>
<td>Distance to target</td>
</tr>
<tr>
<td>Distance to ground</td>
<td>Decimal value in meters</td>
<td>0.0</td>
</tr>
<tr>
<td>Measurement interval units</td>
<td>Seconds</td>
<td>Seconds</td>
</tr>
<tr>
<td>Measurement interval value</td>
<td>Integer 1-255</td>
<td>60</td>
</tr>
<tr>
<td>Output unit</td>
<td>Meters</td>
<td>Meters</td>
</tr>
<tr>
<td>Quality output</td>
<td>On</td>
<td>Off</td>
</tr>
<tr>
<td></td>
<td>Off (Change this to ON.)</td>
<td></td>
</tr>
<tr>
<td>Temperature output</td>
<td>On</td>
<td>Off</td>
</tr>
<tr>
<td></td>
<td>Off</td>
<td>Output valid only for the SR50AT</td>
</tr>
<tr>
<td>Diagnostics output</td>
<td>On</td>
<td>Off</td>
</tr>
<tr>
<td></td>
<td>Off (Change this to ON.)</td>
<td></td>
</tr>
</tbody>
</table>

### E.5.1 Baud rate setting

The factory default baud rate setting of 9600 bps is suitable for most applications. Lower baud rates (1200 or 4800 bps) may improve communication reliability or allow for longer cable lengths. Higher baud rates (19200 or 38400 bps) may be used where faster communications are required.

The quiescent current draw for the SR50A in serial mode is normally 1.25 mA for baud rates of 9600 or less. The current draw increases to 1.5 and 2.25 mA for the baud rates of 19200 or 38400 bps, respectively.

It is possible to download an operating system update to the SR50A via the RS-232 or RS-485 communication interface. Higher baud rates may be desirable to speed up this process.

It may take up to 30 minutes using a speed of 1200 bps, 7 minutes using 9600 bps, or 3 minutes using 38400 bps.
E.5.2 Address

The factory default address is 33. For RS-232 applications, use the factory default address. For RS-485 operation, multiple sensors can be polled individually if different addresses are assigned.

E.5.3 Operational mode setting

Three different operational mode settings are available on the SR50A. Overall system design and desired performance determine which mode to select. The following sections describe each of the three different modes as well as the advantages and disadvantages of each mode.

E.5.3.1 Measure in poll mode

In this mode, the SR50A remains idle until a measurement command is sent (p33<CR>) where 33 is the default serial address. After receiving the measurement command, the SR50A immediately begins a measurement and transmits the resulting data packet when the measurement is complete. Typically, the SR50A transmits the data packet within 1 second of receiving the command packet.

- The SR50A only performs a measurement when requested.
- The data output will lag the measurement command by 1 second.
- This configuration is conducive to a multidrop RS-485 system where individual sensors do not transmit data until they are addressed.

E.5.3.2 Auto measure auto output mode

In this mode, the SR50A automatically exits its low power mode, initiates a measurement, and outputs the data. The frequency that the SR50A performs these functions is set by adjusting the Measurement Interval Units and the Measurement Interval Value parameters.

- No command is required from an external device to obtain a measurement.
- The data recorder or equipment simply needs to read the incoming serial data from the SR50A.

E.5.3.3 Auto measure polled output mode

In this mode, the SR50A automatically exits its low power mode and initiates a measurement. The output data string is not sent until a poll command is received. When a poll command is received by the SR50A, the output data typically commences 100 ms after the poll command is sent.

The frequency that the SR50A performs the measurement is set by adjusting the Measurement Interval Units and the Measurement Interval Value parameters.
• The main advantage of this operating mode is that the receiving device will only have to wait 100 ms for the data instead of 1 second.
• This configuration is also more conducive to a multidrop RS-485 system where individual sensors do not transmit until they are addressed.

E.5.4 Distance to target or depth

The SR50A can output either distance to target values or calculate snow depth values. To obtain a valid snow depth value the parameter distance to ground must be included. The SR50AT will compensate the readings for temperature. Do not use this option on the SR50A sensor unless the SR50A is sent valid temperature reading via the Temperature Input command.

E.5.5 Distance to ground

A valid distance to ground must be entered when the SR50A is configured to output snow depth values. The value must be in meters regardless of the output units that are selected. If the exact value cannot be obtained, it is better to slightly overestimate the value rather than underestimating it. If a Distance to Ground value is too small, the SR50A will output an error value as the snow surface should not be below the ground surface.

E.5.6 Measurement interval units

This setting is only applicable if either the Auto Measure Polled Output or the Auto Measure Auto Output modes are used. The options for the Measurement Interval Units are:

• Seconds
• Minutes
• Hours

Once a unit type is selected, the number of units for the interval is set by changing the Measurement Interval Value parameter. A 60 s interval can be set by setting the units to seconds and the Measurement Interval Value to 60. Alternately, the Measurement Interval Unit could be set to minutes and the Value could be set to 1. The Value setting can only range from 1 to 255.

E.5.7 Measurement interval value

This setting is only applicable if either the Auto Measure Polled Output or the Auto Measure Auto Output modes are used. The Measurement Interval Value can
range from 1 to 255. The units used for the value is set by the *Measurement Interval Units*.

**E.5.8 Quality output**

The SR50A quality numbers can be optionally included in the data output string. The *Quality Output* setting can be set to **ON** or **OFF**.

**E.5.9 Diagnostics output**

The SR50A diagnostics numbers can be optionally included in the data output string. The *Diagnostics Output* setting can be set to **ON** or **OFF**.

**E.6 Serial commands**

The setup command places the SR50A in the serial setup mode. This command should only be sent to customize the sensor settings. Upper and lower case letters are accepted and a carriage return character must also terminate the string.

```
\texttt{\textasciitilde setup<CR>}
```

The poll command is used to obtain the output values. The poll command consists of the upper or lower case letter “p” followed by the SR50A address (default 33). The command must also terminate with a carriage return character.

```
\texttt{\textasciitilde pAA<CR>} \quad \text{where AA is a two-character address and set from the factory to 33}
\texttt{\textasciitilde p33<CR>} \quad \text{Poll command with factory address of 33}
```

The information command is used to query information from the sensor that is not associated with the output of the sensor. For detailed information on the output refer to *Data interpretation* (p. 26).

The information command consists of the upper or lower case letter “i” followed by the SR50A address (default 33). The command must also terminate with a carriage return character.

```
\texttt{\textasciitilde iAA<CR>} \quad \text{where AA is a two-character address and set from the factory to 33}
\texttt{\textasciitilde i33<CR>} \quad \text{information command with factory address of 33}
```

The temperature input command is used to send the SR50A version of the sensor a temperature value that is to be used for temperature compensation. The value sent must be in degrees Celsius and should not exceed eight characters.

The command consists of the upper or lower case letter “t” followed by the SR50A address (default 33) a semicolon and the temperature value. The command must also terminate with a carriage return character (Type for Hyperterminal).
“tAA;-5.5<CR>” – where AA is a two-character address and set from the factory to 33 and –5.5 is the temperature in degrees C
“t33;tt.ttt<CR>” – Temperature command with factory address of 33 and a temperature value in Celsius.

E.7 RS-232/RS-485 data output format

The measurement output string for the SR50A is as follows:

<STX>aa;D.DDD;QQQ;TT.TT;VVVV;CC<CR><LF><ETX>

<STX> is the hex character &h02 (2 in decimal)

aa
These two characters are the serial address of the sensor. The default is 33. Note this is two ASCII characters of &h33 in hexadecimal or 51 in decimal.

D.DDD
This is the distance to target reading. The units depend on the Output Units setting. The number of digits and decimal places also depend on the output unit that is selected. The decimal digits are as follows:

Meters: D.DDD, 0.000 for no valid reading
DD.DDD possible for values past 9.999 m

Centimeters: DDD.DD
DDDD.DD possible for values past 999.99 cm
000.00 output for no valid reading

Millimeters: DDDD
-999 output for no valid reading
9999 Maximum value

Feet: DD.DDD
00.000 output for no valid reading

Inches: DDD.DD
000.00 output for no valid reading

QQQ
This data value is the optional quality value output. The quality value is always a three-digit integer and varies from 152 to 600, where 600 is the poorest quality.

TT.TT
This setting must be set to Off. The SR50A will output a –999.00 if the Temperature Output option is set to ON.
VVVVV
This is the diagnostic output value. Each digit represents a pass or a fail on a diagnostic test.

XVVVV
If X is a 1, then the ROM Memory has passed the signature test.

VXVVV
If X is a 1, then no watchdog errors have occurred.

VVXXX
The three digits XXX are for factory use and should always read 111.

CC
This is a two-character checksum of the data packet. The checksum is the two's complement of the data packet sum including control characters.

    The Least significant byte is used resulting in a two-character checksum.

<STX> = &h02 (Hexadecimal)
<CR> = &h0D (Hexadecimal)
<LF> = &h0A (Hexadecimal)
<ETX> = &h03 (Hexadecimal)

The following is a sample packet with proper checksum:

<STX>33;1838;194;11011;2C<CR><LF><ETX>

SUM =
02+33+33+3B+31+38+33+38+3B+31+39+34+3B+31+31+30+31+31
+3B+0D+0A+03
=0x3D4
Use Last byte only (D4) and calculate two’s complement = 100 – D4 = 2C

<CR>
Carriage return character. 0x0d in hexadecimal or 13 in decimal

<LF>
Line feed character. 0x0a in hexadecimal or 10 in decimal

<ETX>
End of transmission character. 0x03 in hexadecimal or 3 in decimal

The information message output string for the SR50A is as follows:

<STX>aa;SSSSS;H.H;F.F;BBBBB;WWWWW<CR><LF><ETX>

<STX> is the hex character 0x02 (2 in decimal)
These two characters are the serial address of the sensor. The default is 33. Note this is two ASCII characters of 0x33 in hexadecimal or 51 in decimal.

SSSSS  
This is the serial number of the sensor.

H.H  
This is the hardware version of the sensor.

F.F  
This is the operating system version of the sensor.

BBBBB  
This is the checksum of the boot code.

WWWWW  
This is the checksum of the operating system.

CC  
This is a two-character checksum of the data packet. The checksum is the two’s complement of the data packet sum including control characters.

The least significant byte is used resulting in a two-character checksum.

- `<STX> = &h02 (hexadecimal)`
- `<CR> = &h0D (hexadecimal)`
- `<LF> = &h0A (hexadecimal)`
- `<ETX> = &h03 (hexadecimal)`

The following is a sample packet with proper checksum:

```
<STX> 33;1838;194;11011;2C<CR><LF><ETX>
```

```
SUM =
02+33+33+3B+31+38+33+3B+31+39+34+3B+31+31+30+31
+3B+0D+0A+03
=0x3D4
```

Use Last byte only (D4) and calculate two’s complement = 100 – D4 = 2C

- `<CR>`  
  Carriage return character. &h0D in hexadecimal or 13 in decimal

- `<LF>`  
  Line feed character. &h0A in hexadecimal or 10 in decimal

- `<ETX>`  
  End of transmission character. &h03 in hexadecimal or 3 in decimal
Appendix F. SR50AH heater operation

The heater option on the SR50AH is intended for installations where rime ice is problematic. The heater will help to prevent the ice from forming on the transducer, which can impair proper operation of the sensor.

The heater option is easily identifiable as the transducer housing contains a cable port for the heater supply cable.

Always use the heater option wired to switched 12 Vdc source. For battery-operated solar-powered sites, Campbell Scientific recommends that the heater power be turned off when icing conditions are not occurring to reduce power requirements. The heater power must be turned off when operating at temperatures of 25 °C or more.

CRBasic programs that control the heater are provided in Heater programs (p. 67).

F.1 Heater specifications

**Heater resistance:** 75 Ω

**Nominal operating voltage:** 12 V (ac or dc); use a properly conditioned, low-noise power source. A noisy power source will affect operation of the sensor.

**Maximum rated wattage:** 3 W

**Maximum rated voltage:** 15 V (ac or dc)

**Maximum heater operating temperature:** 25 °C; continued use of the heater when temperatures exceed 25 °C may cause permanent damage to the sensor. For proper control of the heating element, see the example program in Heater programs (p. 67).

F.1.1 Heating cable requirements

**Type:** 2 conductor (twisted pair), shielded

**Diameter:** 4 to 6 mm (0.16 to 0.24 in)

**Recommended gage:** 22 AWG for lengths < 30 m (100 ft)
F.2 Heater maintenance

Most of the maintenance is the same as the maintenance for the standard SR50A Maintenance and troubleshooting (p. 22). However, the transducer and desiccant replacement is slightly different for the SR50AH. When ordering replacement transducers, ensure that the replacement transducer maintenance kit is specifically for the heated model.

The procedure to disassemble the SR50AH for desiccant replacement or transducer replacement is as follows:
1. Remove the six Phillips screws on the outermost hole pattern.

**NOTE:**
The screws used on the SR50A have changed from the slotted type to Phillips.

2. Separate the housing from the sensor body and disconnect the connector from the transducer to the main sensor body.
3. To replace the desiccant, remove the desiccant holder plate with the Phillips 4-40 screw. Cutting the tie strap will allow the old packets to be removed for replacement. During reassembly, ensure that the desiccant does not come in contact with the metal backing of the transducer. If only the desiccant is being inspected or replaced, steps 4 and 5 are not required. Steps 4 to 6 are required to replace the transducer only.

4. Your transducer kit comes with a replacement for the O-ring that seats between the main sensor body and the plastic transducer housing. Ensure that the new O-ring is used when reassembled.
5. Remove the three screws from the innermost hole pattern as shown.

6. Replace the transducer assembly and the second O-ring that seats under the transducer assembly.

7. Reassemble the sensor in the reverse order. Please observe the orientation of the parts, wiring, and desiccant.

FIGURE F-2. Complete transducer assembly with power connection