INSTRUCTION MANUAL

253 and 257

Soil Matric Potential Sensors

Revision: 5/17

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14532 131 Avenue NW
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Precautions

DANGER — MANY HAZARDS ARE ASSOCIATED WITH INSTALLING, USING, MAINTAINING, AND WORKING ON OR AROUND **TRIPODS, TOWERS, AND ANY ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC**. FAILURE TO PROPERLY AND COMPLETELY ASSEMBLE, INSTALL, OPERATE, USE, AND MAINTAIN TRIPODS, TOWERS, AND ATTACHMENTS, AND FAILURE TO HEED WARNINGS, INCREASES THE RISK OF DEATH, ACCIDENT, SERIOUS INJURY, PROPERTY DAMAGE, AND PRODUCT FAILURE. TAKE ALL REASONABLE PRECAUTIONS TO AVOID THESE HAZARDS. CHECK WITH YOUR ORGANIZATION'S SAFETY COORDINATOR (OR POLICY) FOR PROCEDURES AND REQUIRED PROTECTIVE EQUIPMENT PRIOR TO PERFORMING ANY WORK.

Use tripods, towers, and attachments to tripods and towers only for purposes for which they are designed. Do not exceed design limits. Be familiar and comply with all instructions provided in product manuals. Manuals are available at www.campbellsci.ca or by telephoning (780) 454-2505 (Canada). You are responsible for conformance with governing codes and regulations, including safety regulations, and the integrity and location of structures or land to which towers, tripods, and any attachments are attached. Installation sites should be evaluated and approved by a qualified personnel (e.g. engineer). If questions or concerns arise regarding installation, use, or maintenance of tripods, towers, attachments, or electrical connections, consult with a licensed and qualified engineer or electrician.

General

- Prior to performing site or installation work, obtain required approvals and permits.
- Use only qualified personnel for installation, use, and maintenance of tripods and towers, and any attachments to tripods and towers. The use of licensed and qualified contractors is highly recommended.
- Read all applicable instructions carefully and understand procedures thoroughly before beginning work.
- Wear a **hardhat** and **eye protection**, and take **other appropriate safety precautions** while working on or around tripods and towers.
- **Do not climb** tripods or towers at any time, and prohibit climbing by other persons. Take reasonable precautions to secure tripod and tower sites from trespassers.
- Use only manufacturer recommended parts, materials, and tools.

Utility and Electrical

- **You can be killed** or sustain serious bodily injury if the tripod, tower, or attachments you are installing, constructing, using, or maintaining, or a tool, stake, or anchor, come in **contact with overhead or underground utility lines**.
- Maintain a distance of at least one-and-one-half times structure height, 6 meters (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 CLIENT 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.

PLEASE READ FIRST

About this manual

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

Some useful conversion factors:

Area:	1 in^2 (square inch) = 645 mm^2
Length:	1 in. (inch) = 25.4 mm
	1 ft (foot) = 304.8 mm
	1 yard = 0.914 m
	1 mile = 1.609 km
Mass:	1 oz. (ounce) = 28.35 g
	1 lb (pound weight) = 0.454 kg
Pressure:	1 psi (lb/in2) = 68.95 mb
Volume:	1 US gallon = 3.785 litres

In addition, part ordering numbers may vary. For example, the CABLE5CBL is a CSI part number and known as a FIN5COND at Campbell Scientific Canada (CSC). CSC Technical Support will be pleased to assist with any questions.

About sensor wiring

Please note that certain sensor configurations may require a user supplied jumper wire. It is recommended to review the sensor configuration requirements for your application and supply the jumper wire is necessary.

Table of Contents

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

Appendices

Figures

Tables

CRBasic Examples

253 and 257 Soil Matric Potential Sensors

1. Introduction

The 253 and 257 soil matric potential sensors are solid-state, electrical-resistance sensing devices with a granular matrix that estimate soil water potential between 0 and –2 bars (typically wetter or irrigated soils).

The 253 needs to be connected to an AM16/32-series multiplexer, and is intended for applications where a larger number of sensors will be monitored. The 257 connects directly to our dataloggers.

NOTE This manual provides information only for CRBasic dataloggers. It is also compatible with our retired Edlog dataloggers. For Edlog datalogger support, see an older manual at *www.campbellsci.com/old-manuals*.

2. Precautions

- READ AND UNDERSTAND the *Safety* section at the front of this manual.
- The black outer jacket of the cable is Santoprene® rubber. This jacket will support combustion in air. It is rated as slow burning when tested according to U.L. 94 H.B. and will pass FMVSS302. Local fire codes may preclude its use inside buildings.
- Avoid installing in depressions where water will puddle after a rain storm.
- Don't place the 253 or 257 in high spots or near changes in slope unless wanting to measure the variability created by such differences.
- When removing the sensor prior to harvest of annual crops, do so just after the last irrigation when the soil is moist.
- When removing a sensor, do not pull the sensor out by its wires.
- Careful removal prevents sensor and membrane damage.

3. Initial Inspection

- Upon receipt of a 253 or 257, inspect the packaging and contents for damage. File damage claims with the shipping company.
- The model number and cable length are printed on a label at the connection end of the cable. Check this information against the shipping documents to ensure the correct product and cable length are received.

4. QuickStart

Short Cut is an easy way to program your datalogger to measure the 253 or 257 and assign datalogger wiring terminals. *Short Cut* is available as a download on *www.campbellsci.com* and the *ResourceDVD*. It is included in installations of *LoggerNet*, *PC200W*, *PC400*, or *RTDAQ*.

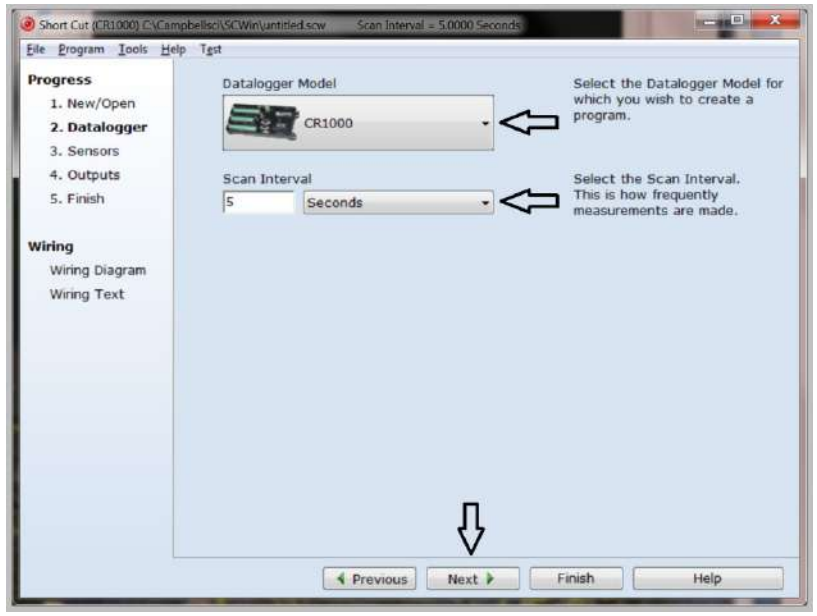
The following sections show using *Short Cut* to program the 253 and 257.

NOTE *Short Cut* requires the use of a soil temperature sensor before the 253 or 257 sensor is added. This is needed because there is a temperature correction factor in the equations that convert sensor resistance. In these Quickstart examples, a 107-L temperature probe is used to measure soil temperature.

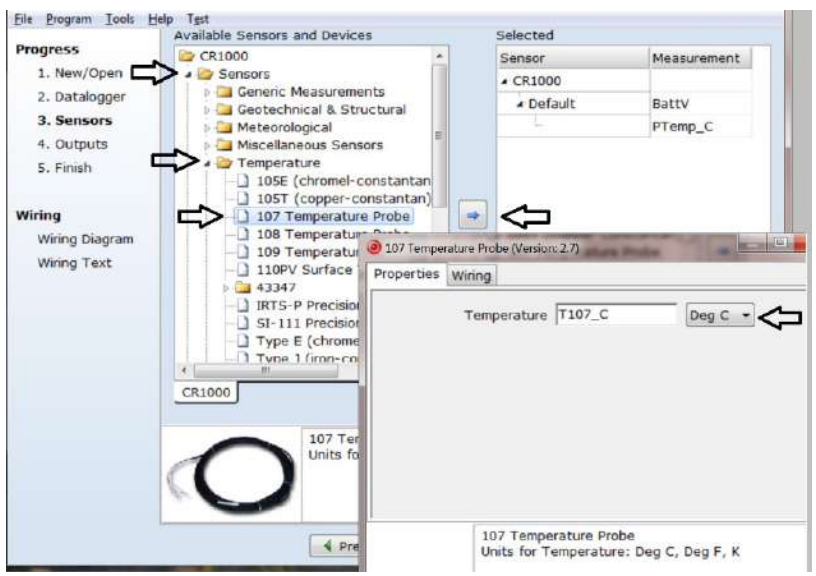
4.1.1 257 SCWin Programming

1. Open *Short Cut*. Click **New Program**.

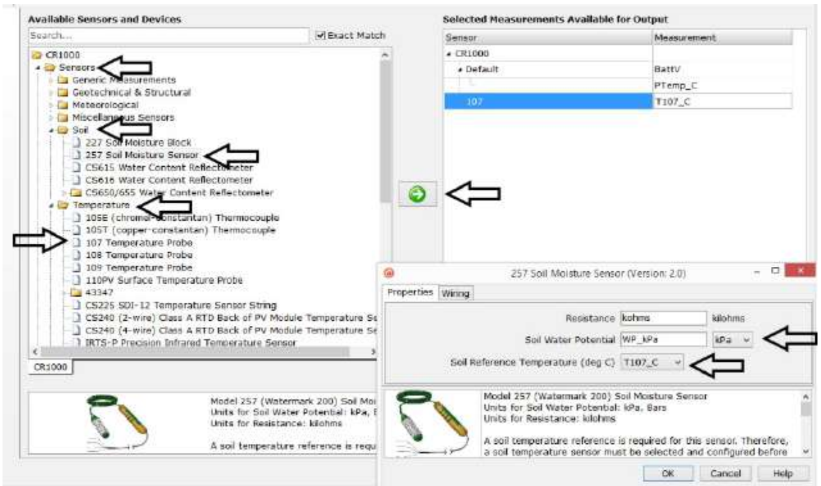
2. Select **Datalogger Model** and **Scan Interval** (default of **5** seconds is **OK** for most applications). Click **Next**.



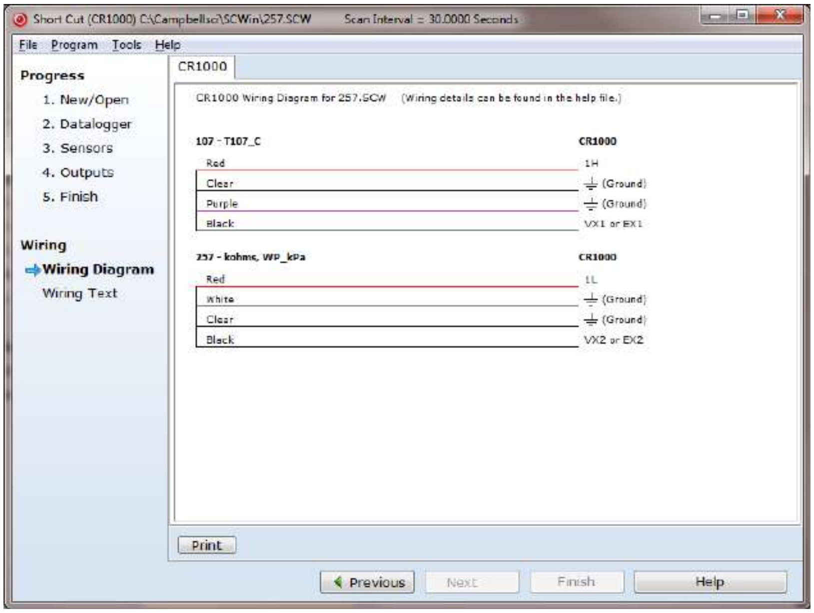
3. Under the **Available Sensors and Devices** list, select the **Sensors** folder, then select the **Temperature** sub-folder. Select **107 Temperature Probe**. Click  to move the selection to the **Selected** device window. Use the default units of degree Celsius. Click **OK**.



4. Under the **Available Sensors and Devices** list, select the **Sensors | Meteorological | Soil Moisture | 257 Soil Moisture Sensor**. Click [button] to move the selection to the **Selected** device window. Select the resistance units, soil water potential units, and soil reference temperature.



5. After selecting the sensor, click **Wiring Diagram** to see how the sensor is to be wired to the datalogger. The wiring diagram can be printed now or after more sensors are added.



6. Select any other sensors you have, then finish the remaining *Short Cut* steps to complete the program. The remaining steps are outlined in *Short Cut Help*, which is accessed by clicking on **Help | Contents | Programming Steps**.

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

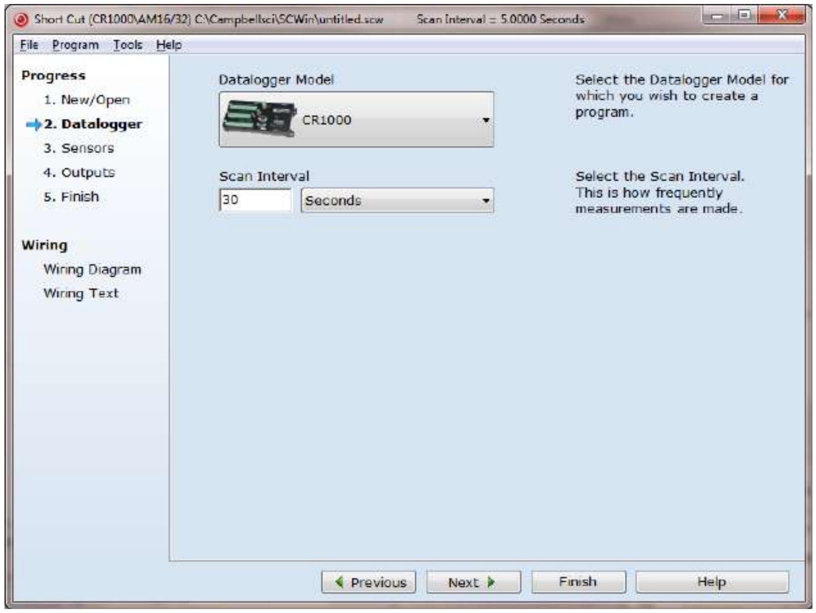
8. If the sensors are connected to the datalogger, as shown in the wiring diagram in step 5, check the output of the sensors in the datalogger support software data display to make sure it is making reasonable measurements.

4.1.2 253 SCWin Programming

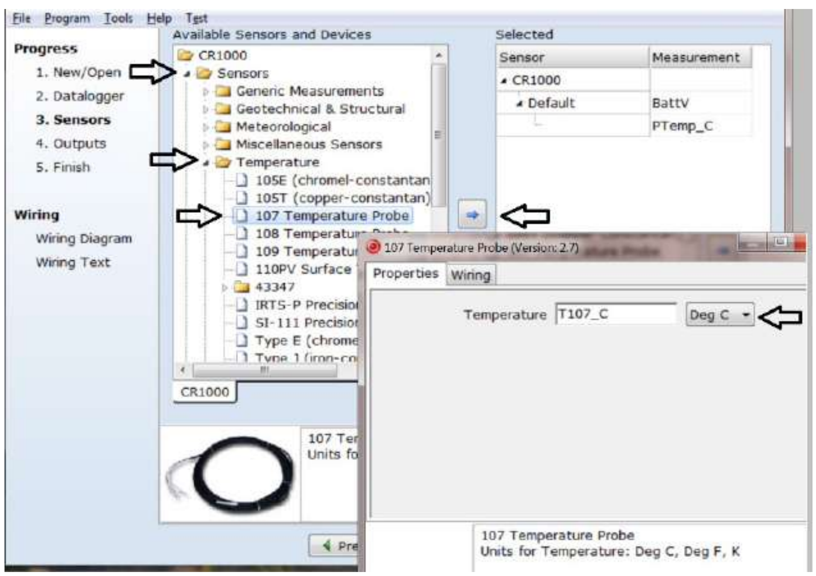
1. Open *Short Cut*. Click **New Program**.

2. Select the datalogger and enter the scan interval, and select **Next**.

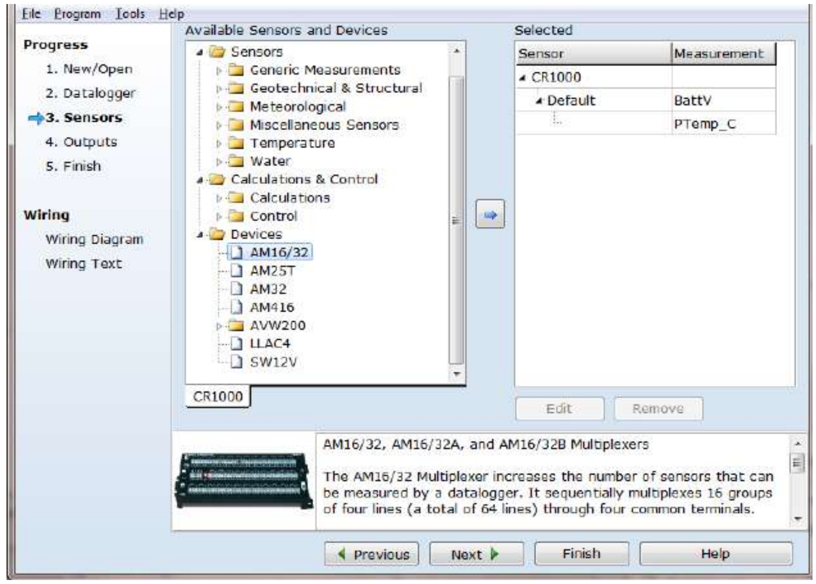
NOTE A scan rate of 30 seconds or longer is recommended when using a multiplexer.



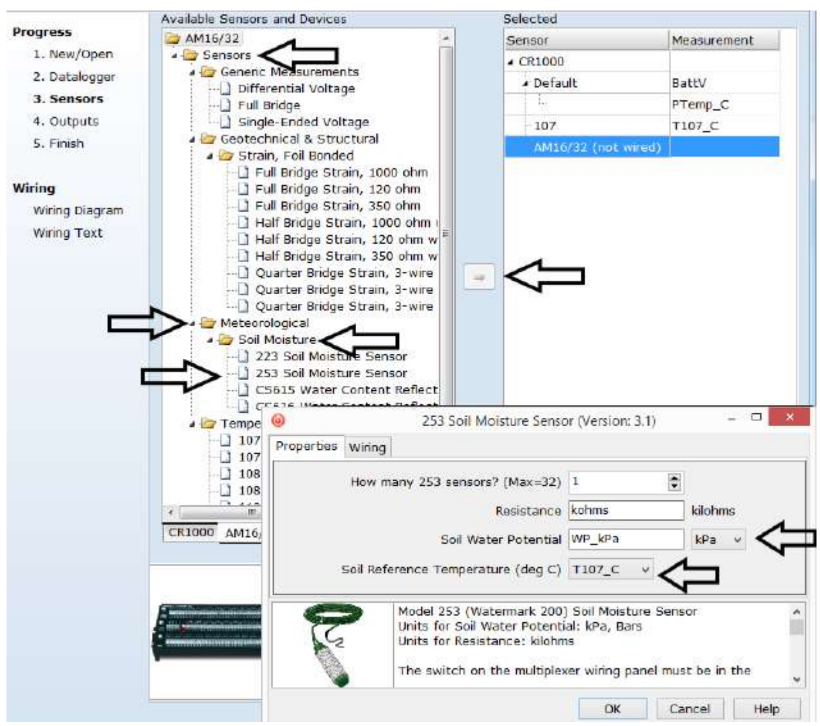
3. Under the **Available Sensors and Devices** list, select the **Sensors** folder, then select the **Temperature** sub-folder. Select **107 Temperature Probe**. Click to move the selection to the **Selected** device window. Use the default units of degree Celsius. Click **OK**.



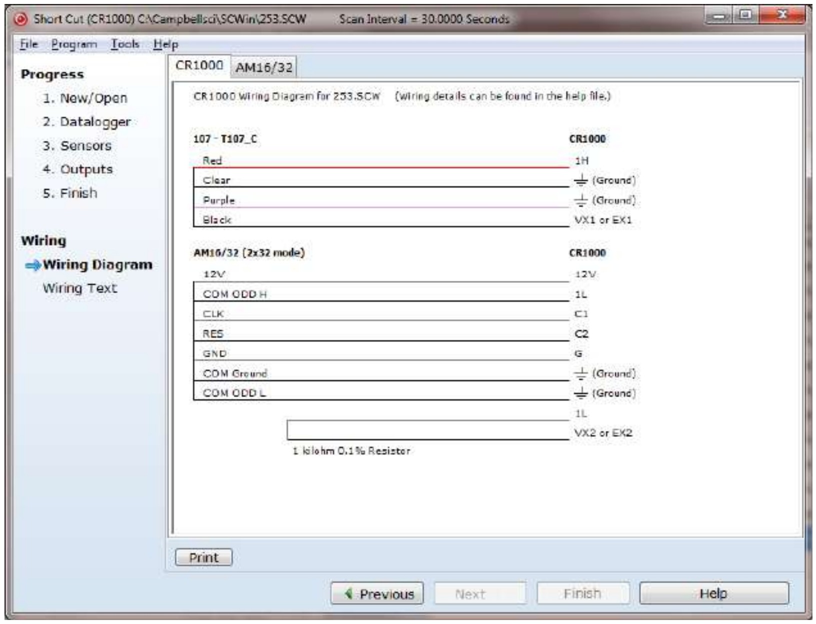
4. Under the **Available Sensors and Devices** list, select **Devices** folder, then select **AM16/32**. Click [→] to move the selection to the **Selected** device window.



5. Under the **Sensors** list, select the **Meteorological | Soil Moisture | 253 Soil Moisture Sensor**. Click [→] to move the selection to the **Selected** device window. Select the number of sensors, resistance units, soil water potential units, and soil reference temperature.



6. After selecting the sensor, click **Wiring Diagram** to see how the sensor is to be wired to the datalogger. The wiring diagram can be printed now or after more sensors are added.



7. Select any other sensors you have, then finish the remaining *Short Cut* steps to complete the program. The remaining steps are outlined in *Short Cut Help*, which is accessed by clicking on **Help | Contents | Programming Steps**.

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

9. If the sensors are connected to the datalogger, as shown in the wiring diagram in step 6, check the output of the sensors in the datalogger support software data display to make sure it is making reasonable measurements.

5. Overview

The 253 and 257 soil matric potential sensors provide a convenient method of estimating water potential of wetter soils in the range of 0 to –200 kPa. The 253 is the Watermark 200 Soil Matric Potential Block modified for use with Campbell Scientific multiplexers and the 257 is the Watermark 200 Soil Matric Potential Block modified for use with Campbell Scientific dataloggers.

The –L option on the Model 257-L and 253-L indicates that the cable length is user specified. This manual refers to the sensors as the 257 and 253. The typical cable length for the 257 is 25 ft. The following two cable termination options are offered for the 257:

- Pigtails that connect directly to a Campbell Scientific datalogger (cable termination option –PT).
- Connector that attaches to a prewired enclosure (cable termination option –PW).

For 253 applications, most of the cable length used is between the datalogger and the multiplexer, which reduces overall cable costs and allows each cable attached to the 253 to be shorter. The cable length of each 253 only needs to cover the distance from the multiplexer to the point of measurement. Typical cable length for the 253 is 25 to 50 ft.

The difference between the 253 and the 257 is that there is a capacitor circuit and completion resistor installed in the 257 cable (FIGURE 5-1) to allow for direct connection to a datalogger, while the 253 does not have any added circuitry. For applications requiring many sensors on an analog multiplexer, the 253 is used and one or more completion resistors are connected to the datalogger wiring panel. A capacitor circuit is not required for the 253 on a multiplexer because the electrical connection between the sensor and the datalogger is interrupted when the multiplexer is deactivated. Any potential difference between the datalogger earth ground and the electrodes in the sensor is thus eliminated.

The 253 and 257 consist of two concentric electrodes embedded in a reference granular matrix material. The granular matrix material is surrounded by a synthetic membrane for protection against deterioration. An internal gypsum tablet buffers against the salinity levels found in irrigated soils.

If cultivation practices allow, the sensor can be left in the soil all year, eliminating the need to remove the sensor during the winter months.

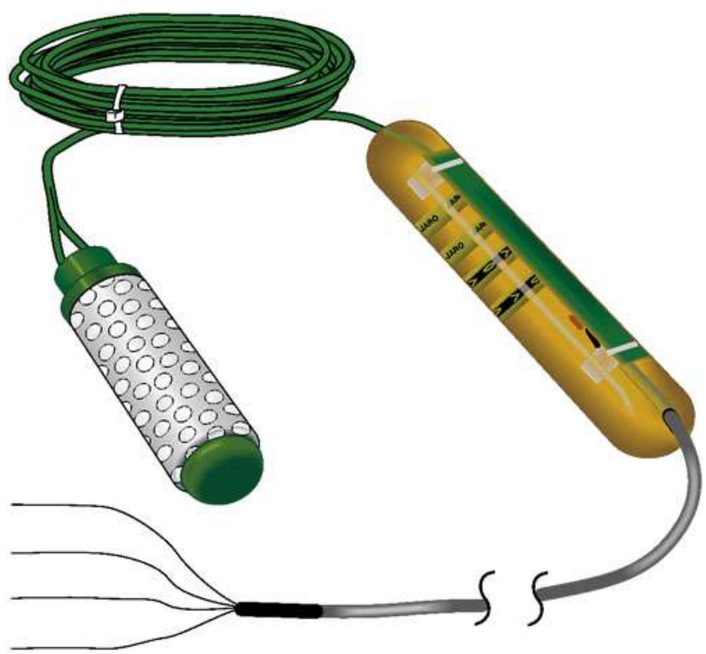


FIGURE 5-1. 257 Soil Matric Potential Sensor with capacitor circuit and completion resistor installed in cable. Model 253 is the same, except that it does not have completion circuitry in the cable.

6. Specifications

Features:

- Survives freeze-thaw cycles
- Rugged, long-lasting sensor
- Buffers salts in soil
- No maintenance required
- The 257 contains blocking capacitors in its cable that minimizes galvanic degradation and measurement errors due to ground loops
- For the 253, the multiplexer connection prevents electrolysis from prematurely destroying the probe
- Compatible with Campbell Scientific CRBasic Dataloggers: CR6, CR800-series, CR1000, CR3000, and CR5000

Range:	0 to –200 kPa
Dimensions:	8.26 cm (3.25 in)
Diameter:	1.91 cm (0.75 in)
Weight:	363 g (0.8 lb)

7. Operation

If you are programming your datalogger with *Short Cut*, skip Section 7.2, *Wiring* *(p. 11)*, and Section 7.3, *Programming* *(p. 14)*. *Short Cut* does this work for you. See Section 4, *QuickStart* *(p. 2)*, for a *Short Cut* tutorial.

7.1 Installation/Removal

NOTE Placement of the sensor is important. To acquire representative measurements, avoid high spots, slope changes, or depressions where water puddles. Typically, the sensor should be located in the root system of the crop.

1. Soak sensors in water for one hour then allow them to dry, ideally for 1 to 2 days.

2. Repeat Step 1 twice if time permits.

3. Make the sensor access holes to the required depth. Often, a 22 mm (7/8 in) diameter rod can be used to make the hole. However, if the soil is very coarse or gravelly, an oversized hole (25 to 32 mm) may be required to prevent abrasion damage to the sensor membrane. The ideal method of making an oversized access hole is to have a stepped tool that makes an oversized hole for the upper portion and an exact size hole for the lower portion.

4. If the hole is oversized (25 to 32 mm), mix a slurry of soil and water to a creamy consistency and place it into the sensor access hole.

5. Insert the sensors in the sensor access hole. A length of 1/2 inch class 315 PVC pipe fits snugly over the sensor collar and can be used to push in the sensor. The PVC can be left in place with the wires threaded through the pipe and the open end taped shut (duct tape is adequate). This practice also simplifies the removal of the sensors. When using PVC piping, solvent weld the PVC pipe to the sensor collar. Use PVC/ABS cement on the stainless steel sensors with the green top. Use clear PVC cement only on the PVC sensors with the gray top.

6. Force the soil or slurry to envelope the sensors. This will ensure uniform soil contact.

NOTE Snug fit in the soil is extremely important. Lack of a snug fit is the premier problem with sensor effectiveness.

7. Carefully, back fill the hole, and tamp down to prevent air pockets which could allow water to channel down to the sensor.

8. When removing sensors prior to harvest in annual crops, do so just after the last irrigation when the soil is moist.

CAUTION Do not pull the sensor out by the wires. Careful removal prevents sensor and membrane damage.

9. When sensors are removed for winter storage, clean, dry, and place them in a plastic bag.

7.2 Wiring

7.2.1 257 Wiring

The 257's cable includes a capacitor circuit that stops galvanic action due to the differences in potential between the datalogger earth ground and the electrodes in the block. This allows it to connect directly to a datalogger (TABLE 7-1 and FIGURE 7-1).

TABLE 7-1. 257 Wiring

Wire Color	Wire Function	Datalogger Connection Terminal
Black	Voltage-excitation input	**U** configured for voltage excitation[1], **EX**, **VX (**voltage excitation)
Red	Analog-voltage output	**U** configured for single-ended analog input[1], **SE** (single-ended, analog-voltage input)
White	Negative signal	**AG** or ⏚ (analog ground)
Clear	Shield	**AG** or ⏚ (analog ground)

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

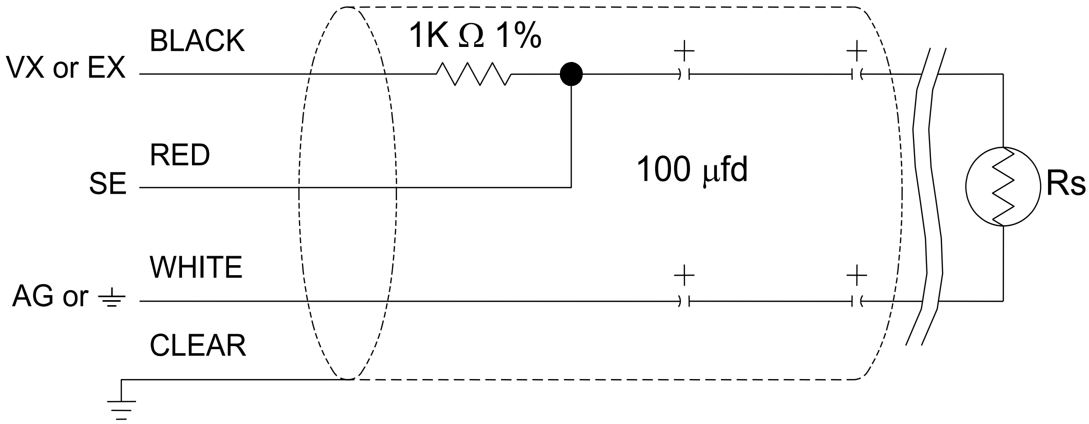


FIGURE 7-1. 257 schematic

7.2.2 253 Wiring

The 253 typically connects to an AM16/32-series multiplexer (TABLE 7-2), but it also is compatible with the long retired AM32 and AM416 multiplexers.

TABLE 7-2. 257-to AM16/32-series Multiplexer Wiring

Wire Color	Wire Function	Multiplexer Connection Terminal
White	Voltage-excitation input	**H**
Black	Analog-voltage output	**L**
Clear	Shield	⏚ or ⏚ (ground)

The multiplexer connects to the datalogger (refer to the multiplexer manual or *www.campbellsci.com/am16-32b-ordering* for information on the cables available for connecting the multiplexer to the datalogger). A 1000 ohm resistor at the datalogger wiring panel is used to complete the half bridge circuitry.

TABLE 7-3 and FIGURE 7-2 show the datalogger-to-multiplexer connections for the 2 x 32 mode. Appendix B.2, *253 Program Example* (p. B-3), shows wiring for the 4 x 16 mode.

TABLE 7-3. Datalogger to AM16/32-series Multiplexer Wiring (2 x 32 Mode)

Datalogger Connection Terminal	Multiplexer Connection Terminal
12V	12V
G	G
C (control port)	RES
C (control port)	CLK
U configured for voltage excitation[1], **EX**, **VX** (voltage excitation)	
U configured for single-ended analog input[1], **SE** (single-ended, analog-voltage input)	COM ODD H
AG or ⏚ (analog ground)	COM ODD L
AG or ⏚ (analog ground)	COM ▽ or ⏚ (ground)
[1]**U** channels are automatically configured by the measurement instruction.	

1000 Ω resistor

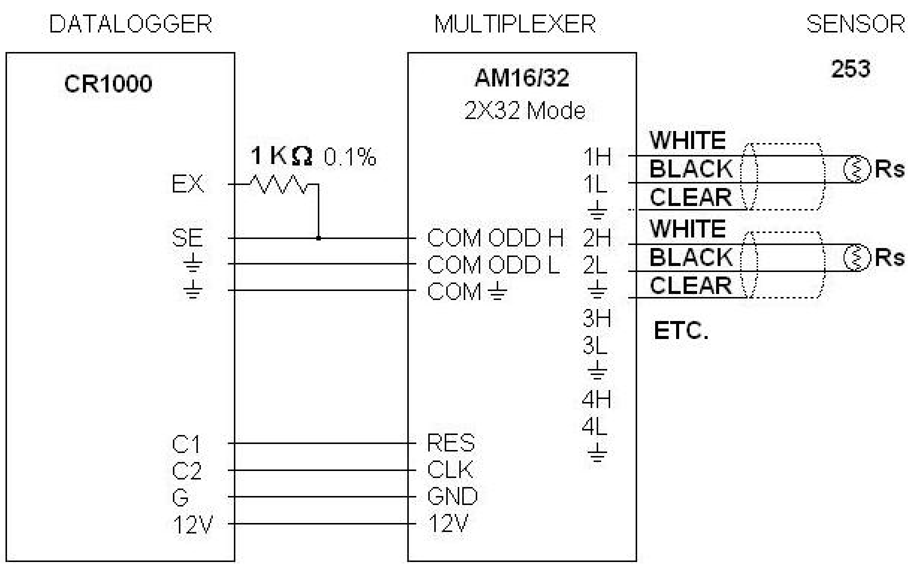


FIGURE 7-2. 253 wiring example

7.3 Programming

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

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

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

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

A *Short Cut* tutorial is available in Section 4, *QuickStart (p. 2)*. If you wish to import *Short Cut* code into *CRBasic Editor* to create or add to a customized program, follow the procedure in Appendix A, *Importing Short Cut Code Into CRBasic Editor (p. A-1)*.

Programming basics for CRBasic dataloggers are in the following sections. Complete program examples for select CRBasic dataloggers can be found in Appendix B, *Example Programs (p. B-1)*. Programming basics and programming examples for Edlog dataloggers are provided at *www.campbellsci.com/old-manuals*.

7.3.1 BRHalf Instruction

CRBasic dataloggers use the **BRHalf()** instruction with the *RevEx* argument set to *True* to excite and measure the 253 and 257. The result of the **BRHalf()** instruction is the ratio of the measured voltage divided by the excitation voltage. The result needs to be converted to resistance and then converted to soil water potential.

TABLE 7-4 shows the excitation and voltage ranges used with the CRBasic dataloggers.

TABLE 7-4. Excitation and Voltage Ranges for CRBasic Dataloggers

Datalogger	mV excitation	Full Scale Range
CR800 Series	250	± 250 mV
CR6	200	± 200 mV
CR1000	250	± 250 mV
CR3000	200	± 200 mV
CR5000	200	± 200 mV

7.3.2 Calculations

The CRBasic program should include the following to calculate resistance, adjust the resistance for soil temperature, and calculate soil water potential:

```
kohms=kohms/(1-kohms)
kohms=(100+(1.8*T107_C+32)-69.8)/100*kohms
If kohms<=1 Then
  WP_kPa=-(20*kohms-11)
Else
  WP_kPa=-(-0.00279*kohms^3+0.19109*kohms^2+3.71485*kohms+6.73956)
EndIf
```

where,

kohms = the variable storing the **BRHalf()** result

T107_C = the variable storing the temperature sensor measurement (degree Celsius)

WP_kPa = water potential

7.3.2.1 Soil Water Matric Potential in Other Units

To report measurement results in other units, multiply the soil water potential by the appropriate conversion constant from TABLE 7-5.

TABLE 7-5. Conversion of Matric Potential to Other Units

Desired Unit	Multiply Result By
kPa	1.0
MPa	0.001
Bar	0.01

7.4 Interpreting Results

As a general guide, 253 and 257 measurements indicate soil matric potential as follows:

0 to –10 kPa =	Saturated soil
–10 to –20 kPa =	Soil is adequately wet (except coarse sands, which are beginning to lose water).
–20 to –60 kPa =	Usual range for irrigation (except heavy clay).
–60 to –100 kPa =	Usual range for irrigation for heavy clay soils.
–100 to –200 kPa =	Soil is becoming dangerously dry for maximum production.

8. Troubleshooting

NOTE All factory repairs and recalibrations require a returned material authorization (RMA) and completion of the "Declaration of Hazardous Material and Decontamination" form. Refer to the *Assistance* page at the beginning of this manual for more information.

To test the sensor, submerge it in water. Measurements should be from –3 to +3 kPa. Let the sensor dry for 30 to 48 hours. You should see the reading increase from 0 to 15,000+ kPa. If the reading does not increase to 15,000 kPA, replace the sensor. If the reading increases as expected, put the sensor back in the water. The reading should run right back down to zero in 1 to 2 minutes.

If the sensor passes these tests but it is still not functioning properly, consider the following:

1. Sensor may not have a snug fit in the soil. This usually happens when an oversized access hole has been used and the backfilling of the area around the sensor is not complete.

2. Sensor is not in an active portion of the root system, or the irrigation is not reaching the sensor area. This can happen if the sensor is sitting on top of a rock or below a hard pan which may impede water movement. Re-installing the sensor usually solves this problem.

3. When the soil dries out to the point where you are seeing readings higher than 80 kPa, the contact between soil and sensor can be lost because the soil may start to shrink away from the sensor. An irrigation which only results in a partial rewetting of the soil will not fully rewet the sensor, which can result in continued high readings from the 257. Full rewetting of the soil and sensor usually restores soil to sensor contact. This is most often seen in the heavier soils and during peak crop water demand when irrigation may not be fully adequate. The plotting of readings on a chart is most useful in getting a good picture of this sort of behavior.

9. Reference

Thompson, S.J. and C.F. Armstrong, Calibration of the Watermark Model 200 Soil matric potential Sensor, Applied Engineering in Agriculture, Vol. 3, No. 2, pp. 186-189, 1987.

Parts of this manual were contributed by Irrometer Company, Inc., manufacturer of the Watermark 200.

Appendix A. Importing Short Cut Code Into CRBasic Editor

This tutorial shows:

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

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

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

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

1. Create the *Short Cut* program following the procedure in Section 4, *QuickStart* *(p. 2)*. Finish the program and exit *Short Cut*. Make note of the file name used when saving the *Short Cut* program.

2. Open *CRBasic Editor*.

3. Click **File | Open**. Assuming the default paths were used when *Short Cut* was installed, navigate to C:\CampbellSci\SCWin folder. The file of interest has the .CR6, .CR8, .CR1, .CR3, or .CR5 extension. Select the file and click **Open**.

4. Immediately save the file in a folder different from C:\Campbellsci\SCWin, or save the file with a different file name.

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

5. The program can now be edited, saved, and sent to the datalogger.

6. Import wiring information to the program by opening the associated .DEF file. Copy and paste the section beginning with heading "-Wiring for CRXXX–" into the CRBasic program, usually at the head of the file. After pasting, edit the information such that an apostrophe (**'**) begins each line. This character instructs the datalogger compiler to ignore the line when compiling.

Appendix B. Example Programs

These examples show programs written for the CR1000 and the CR6 dataloggers. With minor changes to excitation and voltage ranges, the code in the CR1000 examples will work with the CR800-series, CR3000, and CR5000 dataloggers (see TABLE 7-4).

B.1 257 Program Examples

The following examples demonstrate the programming used to measure the resistance (kΩ) of one 257 sensor with the datalogger. A 107 temperature probe is measured first for temperature correction of the 257 reading. Voltage range codes for other CRBasic dataloggers are shown in TABLE 7-4. Sensor wiring for this example is shown in TABLE B-1.

TABLE B-1. 107/257 Wiring for Example Program

Sensor	Wire	Function	CR1000	CR6
107	Black	Excitation	VX1	U1
	Red	Positive Signal	SE1 (1H)	U2
	Purple	Negative Signal	⏚	⏚
	Clear	Shield	⏚	⏚
257	Black	Excitation	VX2	U4
	Red	Positive Signal	SE2 (1L)	U3
	White	Negative Signal	⏚	⏚
	Clear	Shield	⏚	⏚

CRBasic Example B-1. CR6 Program Measuring a 107 and 257

```
'CR6 Series

'Declare Variables and Units
Public T107_C
Public kohms
Public WP_kPa

Units T107_C=Deg C
Units kohms=kilohms
Units WP_kPa=kPa

'Define Data Tables
DataTable(Table1,True,-1)
  DataInterval(0,60,Min,10)
  Average(1,T107_C,FP2,False)
  Sample(1,WP_kPa,FP2)
EndTable

'Main Program
BeginProg
  'Main Scan
  Scan(5,Sec,1,0)
```

```
    '107 Temperature Probe measurement 'T107_C'
    Therm107(T107_C,1,U2,U1,0,60,1,0)
    '257 Soil Moisture Sensor measurements 'kohms' and 'WP_kPa'
    BrHalf(kohms,1,mV200,U3,U4,1,200,True,0,15000,1,0)
    kohms=kohms/(1-kohms)
    kohms=(100+(1.8*T107_C+32)-69.8)/100*kohms
    If kohms<=1 Then
      WP_kPa=-(20*kohms-11)
    Else
      WP_kPa=-(-0.00279*kohms^3+0.19109*kohms^2+3.71485*kohms+6.73956)
    EndIf
    'Call Data Tables and Store Data
    CallTable Table1
  NextScan
EndProg
```

CRBasic Example B-2. CR1000 Program Measuring a 107 and 257

```
'CR1000

'Declare Variables and Units
Dim Scratc
Public T107_C
Public kohms
Public WP_kPa

Units T107_C=Deg C
Units kohms=kilohms
Units WP_kPa=kPa

'Define Data Tables
DataTable(Table1,True,-1)
  DataInterval(0,60,Min,10)
  Average(1,T107_C,FP2,False)
  Sample(1,WP_kPa,FP2)
EndTable

'Main Program
BeginProg
  'Main Scan
  Scan(5,Sec,1,0)
    '107 Temperature Probe measurement 'T107_C'
    Therm107(T107_C,1,1,1,0,_60Hz,1,0)
    '257 Soil Moisture Sensor measurements 'kohms' and 'WP_kPa'
    BrHalf(kohms,1,mV250,2,Vx2,1,250,True,0,250,1,0)
    kohms=kohms/(1-kohms)
    kohms=(100+(1.8*T107_C+32)-69.8)/100*kohms
    If kohms<=1 Then
      WP_kPa=-(20*kohms-11)
    Else
      WP_kPa=-(-0.00279*kohms^3+0.19109*kohms^2+3.71485*kohms+6.73956)
    EndIf
    'Call Data Tables and Store Data
    CallTable Table1
  NextScan
EndProg
```

B.2 253 Program Example

The following example demonstrates the programming used to measure five 107 temperature probes and five 253 sensors on an AM16/32-series multiplexer (4x16 mode) with the CR1000 datalogger. In this example, a 107 temperature probe is buried at the same depth as a corresponding 253 sensor. Voltage range codes for other CRBasic dataloggers are shown in TABLE 7-4. Sensor wiring is shown in TABLE B-2.

TABLE B-2. Wiring for 253 Example

CR1000	AM16/32	Sensor	Wire	Function
12V	12V			
G	GND			
C1	RES			
C2	CLK			
VX1	COM ODD H			
SE1 (1H)	COM ODD L			
Ground	COM GROUND			
SE2 (1L)	COM EVEN H			
Ground	COM EVEN L			
1000 ohm resistor from SE2 to VX2				
	1H	107	Black	Excitation
	1L		Red	Positive Signal
	GROUND		Purple	Negative Signal
	GROUND		Clear	Shield
	2H	253	White	Positive Signal
	2L		Black	Negative Signal
	GROUND		Clear	Shield
	Continue wiring sensors to multiplexer with 107 probes attaching to odd numbered channels and 253 sensors to even numbered channels. AM16/32 in 4x16 mode.			

CRBasic Example B-3. CR1000 Program Measuring Five 107s and Five 253s

```
'CR1000
Public T107_C(5), WP_kPa(5), kOhms(5)
Dim i

Units T107_C()=Deg C
Units kOhms()=kOhms
Units WP_kPa()=kPa

DataTable(Hourly,true,-1)
  DataInterval(0,60,Min,10)
  Average(5, T107_C, FP2, 0)
  Sample(5, WP_kPa, FP2)
  Sample(5, kOhms, FP2)
EndTable

BeginProg
  Scan(60,Sec, 3, 0)
    PortSet(1,1) 'Turn AM16/32 Multiplexer On
    Delay(0,150,mSec)
    i = 1
  SubScan (0,uSec,5)
      PulsePort(2,10000)
      'Soil temperature measurement
      Therm107(T107_C(i),1,1,VX1,0,250,1,0)
      '253 Soil Moisture Sensor measurements
      BrHalf(kOhms(i),1,mV250,2,VX2,1,250,true,0,250,1,0)
      'Convert resistance ratios to kOhms
      kOhms(i) = kOhms(i)/(1-kOhms(i))
      kOhms(i)=(100+(1.8*T107_C(i)+32)-69.8)/100*kOhms(i)
      i = i+1
    NextSubScan
    PortSet(1,0) 'Turn AM16/32 Multiplexer Off
    'Convert kOhms to water potential
    For i = 1 To 5
      If kOhms(i)<=1 Then
      WP_kPa(i)=-(20*kOhms(i)-11)
      Else
      WP_kPa(i)=-(-0.00279*kOhms(i)^3+0.19109*kOhms(i)^2+3.71485*kOhms(i)+6.73956)
      EndIf
    Next i
    CallTable Hourly 'Call Data Table and Store Data
  NextScan
EndProg
```

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