Product Manual

Sensor

TS100SS

Aspirated Radiation Shield

Revision: 01/2020

RELIABLE SINCE 1974 MONITORING

CAMPBELL SCIENTIFIC

Limited warranty

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Assistance

Products may not be returned without prior authorization. The following contact information is for US and international customers residing in countries served by Campbell Scientific, Inc. directly. Affiliate companies handle repairs for customers within their territories. Please visit www.campbellsci.com to determine which Campbell Scientific company serves your country.

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

For all returns, the customer must fill out a "Statement of Product Cleanliness and Decontamination" form and comply with the requirements specified in it. The form is available from our website at www.campbellsci.com/repair. A completed form must be either emailed to repair@campbellsci.com or faxed to (435) 227-9106. Campbell Scientific is unable to process any returns until we receive this form. If the form is not received within three days of product receipt or is incomplete, the product will be returned to the customer at the customer's expense. Campbell Scientific reserves the right to refuse service on products that were exposed to contaminants that may cause health or safety concerns for our employees.

Safety

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

Use tripods, towers, and attachments to tripods and towers only for purposes for which they are designed. Do not exceed design limits. Be familiar and comply with all instructions provided in product manuals. Manuals are available at www.campbellsci.com or by telephoning (435) 227-9000 (USA). You are responsible for conformance with governing codes and regulations, including safety regulations, and the integrity and location of structures or land to which towers, tripods, and any attachments are attached. Installation sites should be evaluated and approved by a qualified engineer. If questions or concerns arise regarding installation, use, or maintenance of tripods, towers, attachments, or electrical connections, consult with a licensed and qualified engineer or electrician.

General

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

Utility and Electrical

- **You can be killed** or sustain serious bodily injury if the tripod, tower, or attachments you are installing, constructing, using, or maintaining, or a tool, stake, or anchor, come in **contact with overhead or underground utility lines**.
- Maintain a distance of at least one-and-one-half times structure height, 20 feet, or the distance required by applicable law, **whichever is greater**, between overhead utility lines and the structure (tripod, tower, attachments, or tools).
- Prior to performing site or installation work, inform all utility companies and have all underground utilities marked.
- Comply with all electrical codes. Electrical equipment and related grounding devices should be installed by a licensed and qualified electrician.

Elevated Work and Weather

- Exercise extreme caution when performing elevated work.
- Use appropriate equipment and safety practices.
- During installation and maintenance, keep tower and tripod sites clear of un-trained or non-essential personnel. Take precautions to prevent elevated tools and objects from dropping.
- Do not perform any work in inclement weather, including wind, rain, snow, lightning, etc.

Maintenance

- Periodically (at least yearly) check for wear and damage, including corrosion, stress cracks, frayed cables, loose cable clamps, cable tightness, etc. and take necessary corrective actions.
- Periodically (at least yearly) check electrical ground connections.

WHILE EVERY ATTEMPT IS MADE TO EMBODY THE HIGHEST DEGREE OF SAFETY IN ALL CAMPBELL SCIENTIFIC PRODUCTS, THE CUSTOMER ASSUMES ALL RISK FROM ANY INJURY RESULTING FROM IMPROPER INSTALLATION, USE, OR MAINTENANCE OF TRIPODS, TOWERS, OR ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC.

Table of contents

1. Introduction

The TS100SS, manufactured by Apogee Instruments, Inc., is a fan-aspirated radiation shield that minimizes temperature-measurement errors caused by incident solar radiation. The unique aerodynamic shape and rugged, low-power fan make it the first research-grade fan-aspirated shield that is practical for use on battery- or solar-powered stations. The shield protects the sensor and accommodates various combinations of thermistors, PRTs, and humidity sensors using one of the sensor port adapter plugs.

Typical applications include air temperature and humidity measurements in weather networks, often for weather forecasting, and solar energy sites. Fan-aspirated shields are also important in the precise measurement of air temperature and humidity gradients above the land surface and in climate change monitoring.

2. Precautions

- READ AND UNDERSTAND the Safety (p. iii) section at the front of this manual.
- Care should be taken when opening the shipping package to not damage or cut the cable jacket. If damage to the cable is suspected, consult with Campbell Scientific.
- The TS100SS is a precision instrument. Please handle it with care.

3. Initial inspection

- Upon receipt of the TS100SS, inspect the packaging and contents for damage. File any damage claims with the shipping company.
- Immediately check package contents against the shipping documentation. Contact Campbell Scientific about any discrepancies.
- The TS100SS is shipped with the cable, cable tie tabs, and two cable ties; a port adapter is ordered as an accessory (FIGURE 3-1 (p. 2)).

FIGURE 3-1. Components shipped with the TS100SS

4. QuickStart

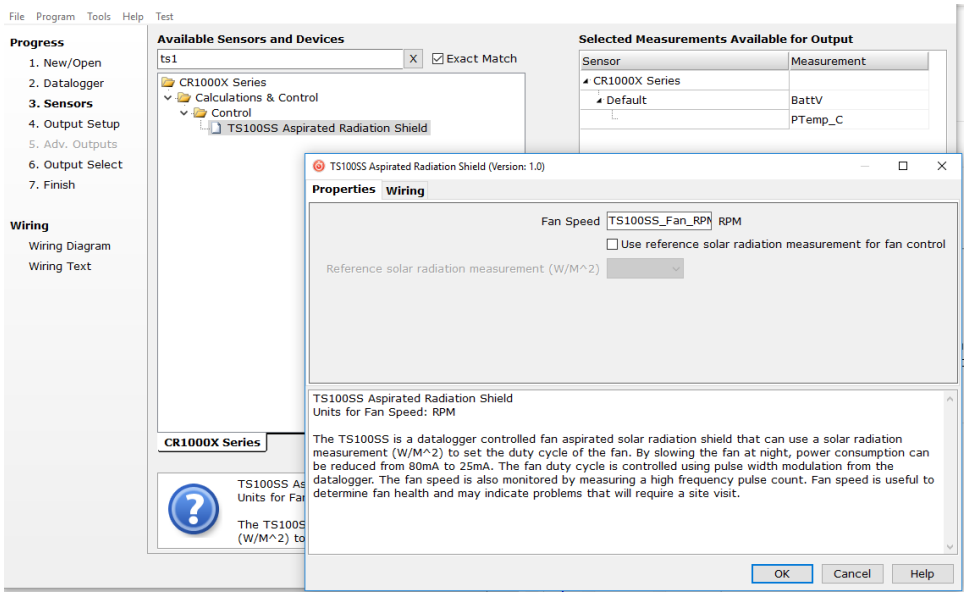
A video that describes data logger programming using Short Cut is available at: www.campbellsci.com/videos/cr1000x-datalogger-getting-started-program-part-3. Short Cut is an easy way to program your data logger to measure the sensor and assign data logger wiring terminals. Short Cut is available as a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

The following procedure also shows using Short Cut to program the TS100SS.

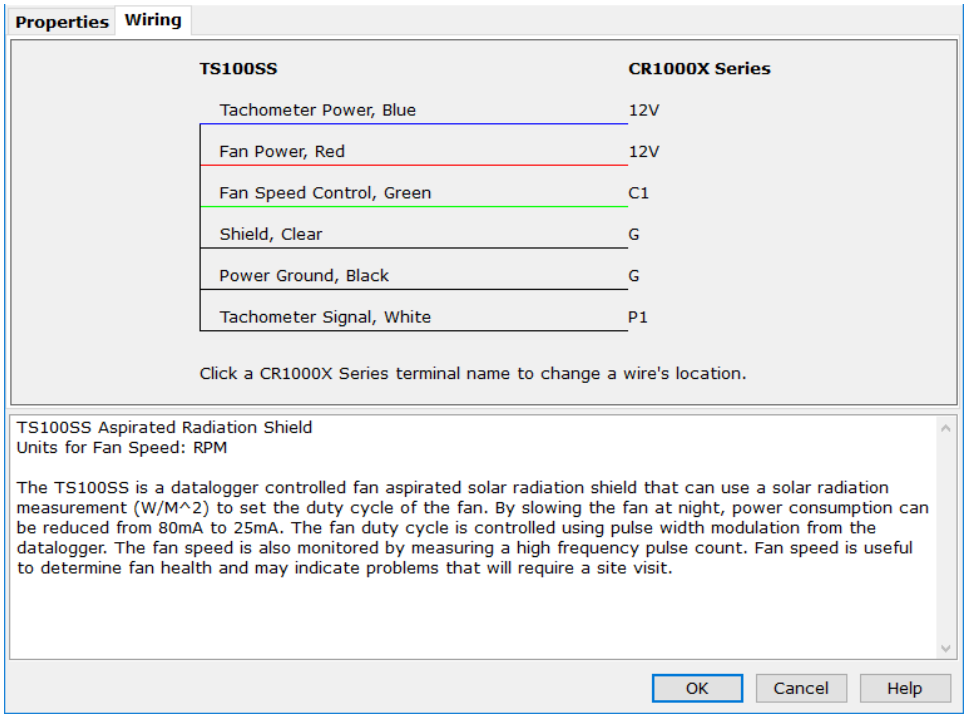
1. Open Short Cut and click **Create New Program**.
2. Double-click the data logger model.

> **NOTE:**
> If using a solar radiation measurement to control the fan, add the solar sensor to Short Cut before adding the TS100SS. The solar radiation output needs to be in W/m^2. Refer to the solar radiation sensor manual for more information.

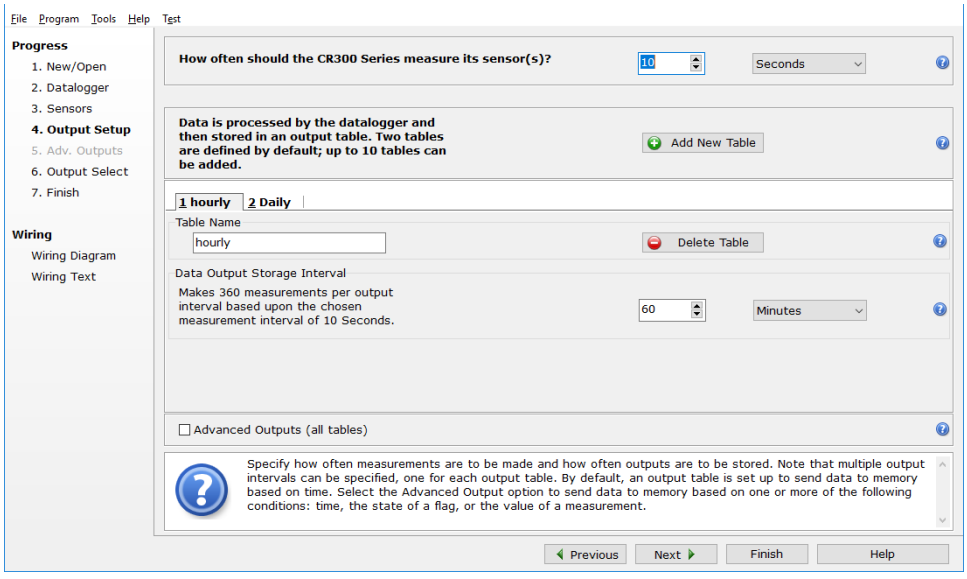
3. In the **Available Sensors and Devices** box, type TS100SS or find the device in the **Calculations & Control** > **Control** folder, and double-click **TS100SS Aspirated Radiation Shield**. If not using a solar radiation measurement, uncheck the **Use reference solar radiation measurement for fan control** box. Otherwise, select the correct variable name for the reference solar radiation measurement.



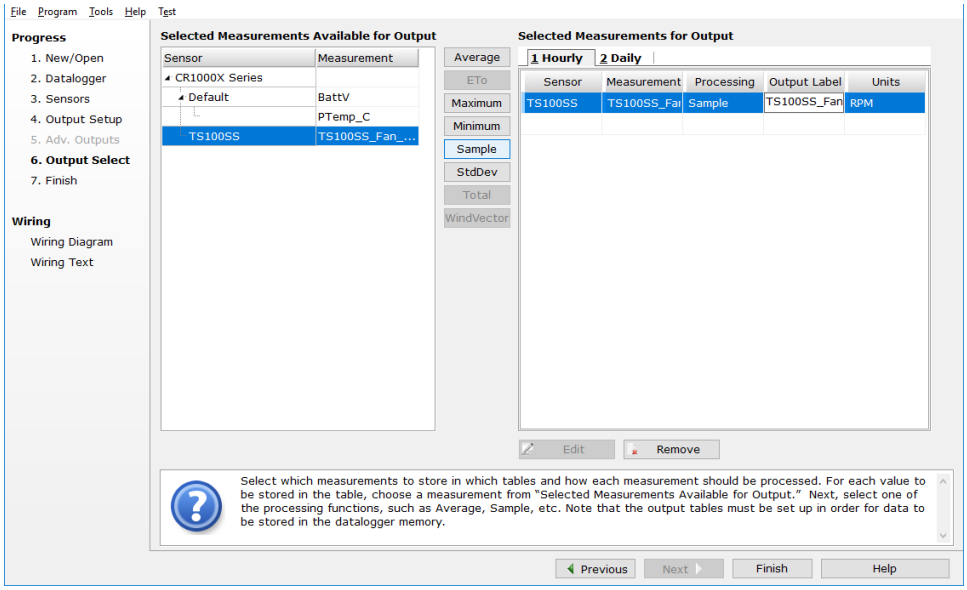
4. Click the **Wiring** tab. Click **OK** after wiring the sensor.



5. Repeat steps three and four for other sensors you want to measure. Click **Next**.
6. In **Output Setup**, type the scan rate, a **Table Name**, and **Data Output Storage Interval**. Click **Next**.



7. Select the output options.



8. Click **Finish** and save the program. Send the program to the data logger if the data logger is connected to the computer.
9. If the sensor is connected to the data logger, check the output of the sensor in the data display in LoggerNet, RTDAQ, PC400, or PC200W to make sure it is making reasonable measurements.

5. Overview

The TS100SS is a fan-aspirated radiation shield that minimizes temperature-measurement errors caused by incident solar radiation. It has a detachable cable and a sensor port that fits several adapters that allow the shield to house different temperature and temperature and relative humidity sensors. Under some environmental conditions (e.g., high wind speed, low solar radiation), accurate measurements can be made without running the fan at full speed. Fan speed and power consumption can be decreased using a pulse width modulation (PWM) signal. The PWM signal should have a frequency of approximately 20 kHz and a duty cycle of 50 to 100%, where a duty cycle of 100% is full power and 50% is low power. Running the fan in a low power mode reduces the current drain from 80 mA to approximately 25 mA. The only way to completely stop the fan is to turn the power off.

The fan also has a tachometer to monitor blade revolutions per minute (RPM). The tachometer outputs a pulse voltage signal. The pulse multiplied by 30 yields fan RPMs. The RPM should be near 4500 in full power mode and 2500 in low power mode. In addition to the tachometer output

wire, there is a pull-up wire (power input). This allows a user-defined maximum output voltage from the tachometer, and facilitates interfacing with multiple measurement devices.

6. Specifications

Difference among individual replicate shields:	< 0.1 °C
Aspiration rate:	6 m s^{-1} at full speed; 3 m s^{-1} at half speed
Fan input voltage requirement:	10.8 to 13.2 VDC
Fan current draw:	80 mA at full-speed; 25 mA at half-speed
IP rating:	IP55
Height:	22.0 cm (8.7 in)
Diameter:	27.0 cm (10.6 in)
Weight:	840 g (1.9 lb)

7. Installation

If you are programming your data logger with Short Cut, skip Wiring (p. 9) and Programming (p. 9). Short Cut does this work for you. See QuickStart (p. 2) for a tutorial.

7.1 Siting

Avoid placing the shield near buildings, paved surfaces, or any other location which may create a micro-environment significantly different than ambient environment. The World Meteorological Organization (WMO) recommends a mounting height of 1.25 to 2 m above ground. Air temperature typically decreases with increasing height above the ground surface. Ensure that the sensor port (the hole in the side of the shield where the air temperature and/or humidity probe mounts) faces the nearest global pole (north for northern hemisphere, south for southern hemisphere) to maximize shading of the cable wires.

7.2 Mounting

The shield mounts on a crossarm or horizontal pipe (1-1/4 inch to 2 inch IPS). The adapter allows one temperature and relative humidity probe (HygroVUE 5 or HMP60).

1. Attach the hat to the pipe with the U-bolt, nuts, and rubber washers (FIGURE 7-1 (p. 7)).

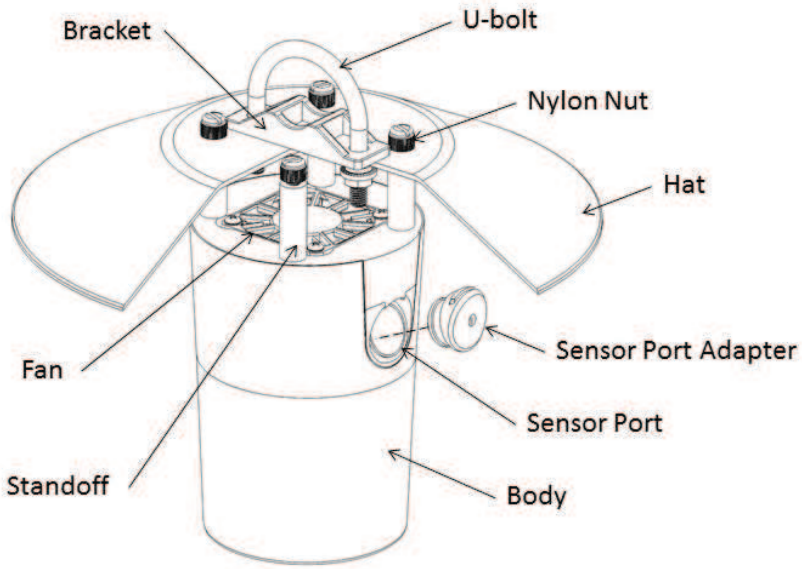


FIGURE 7-1. Components of the TS100SS

2. If not already assembled, insert the shorter threaded end of the nylon standoffs into the shield body (FIGURE 7-2 (p. 8)).

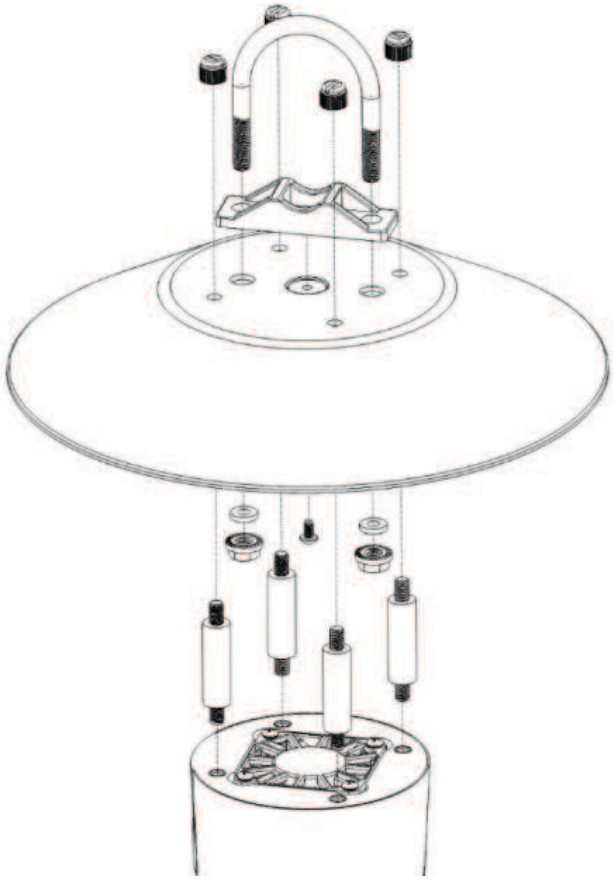


FIGURE 7-2. Exploded view

3. With the sensor port facing the nearest pole, align the standoffs to the four corresponding holes in the hat and secure with nylon nuts.
4. Insert the sensor port adapter into the sensor port.
5. Slowly insert the sensor into the adapter until the sensor tip is centered in the air stream.
6. If the O-ring binds or comes lose, remove the sensor, fix the O-ring positioning, and reinsert the sensor. Applying petroleum jelly and rotating the sensor while inserting it can ensure the O-ring remains properly positioned.
7. Fasten a cable-tie mount on a flat surface on the underside of the hat. The fan cable comes out the top of the shield under the hat. Secure the cable to the cable-tie mount using a cable tie.
8. Route the cable to the data logger, and secure the cable to the mounting structure using cable ties.

7.3 Wiring

Table 7-1 (p. 9) provides wiring for the TS100SS fan-aspirated radiation shield. The tachometer requires the connection to a power supply.

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

Wire color	Wire function	Data logger terminal	Tachometer power supply
Red	12 VDC	12V	N/A
Black	Power ground	G	N/A
Clear	Shield	⏚ (analog ground)	N/A
Green	Fan speed control	C (control terminal), U configured for pulse width modulation[1]	N/A
Blue	Tachometer power	N/A	VDC +
White	Tachometer output	P, C (control terminal), U configured for high-frequency pulse counting[1]	N/A

[1]U and C terminals are automatically configured by the measurement instruction for Campbell Scientific CR6 data logger.

7.4 Programming

Accurate measurements can be made at slower fan speeds under conditions such as during the night, high wind speed, and low solar radiation. Running the fan at a lower speed reduces the current drain. The CRBasic program can reduce the fan speed based on these conditions by using the `PWM()` CRBasic instruction. Syntax for this instruction is the following:

```
PWM (Duty_Cycle, Port, Period, Units )
```

A `Duty_Cycle` of 1 operates the fan at full power and a `Duty_Cycle` of 0.5 operates the fan at low power. The period needs to be 50 with the units as microseconds.

The fan has a tachometer to monitor blade revolutions per minute (RPMs) to ensure it is working properly. The tachometer outputs a pulse voltage signal that is measured by the `PulseCount()` instruction, which has the following syntax:

```
PulseCount( Dest, Reps, PChan, PConfig, POption, Mult, Offset )
```

The `Dest` parameter will store the RPMs. Choose high frequency for the `PConfig` parameter and choose frequency in Hertz for the `POption`. The multiplier should be 50 and the offset 0.

Downloadable example programs are available at: www.campbellsci.com/downloads/ts100ss-example-programs.

8. Maintenance

> 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 (p. ii) page at the beginning of this manual for more information.

Regularly inspect the shield and clean as needed by wiping the surface with a moist rag. Also, check all mounting nuts and tighten if they are loose.

The fan has a tachometer that monitors RPMs (see Programming (p. 9)). If less than 4500 RPMs at full speed, check for blockage. If there isn't a blockage, replace the fan using the following procedure:

1. Disconnect the TS100SS cable from the fan-cable connector (FIGURE 8-1 (p. 10)).

FIGURE 8-1. Top of the TS100SS without hat and standoffs

2. Remove the screws that are holding the fan in the shield body.
3. Lift the old fan from the shield body.

4. Place the new fan (FIGURE 8-2 (p. 11)) in the shield body and orient the fan so the fan pulls air upwards through the shield towards the hat.

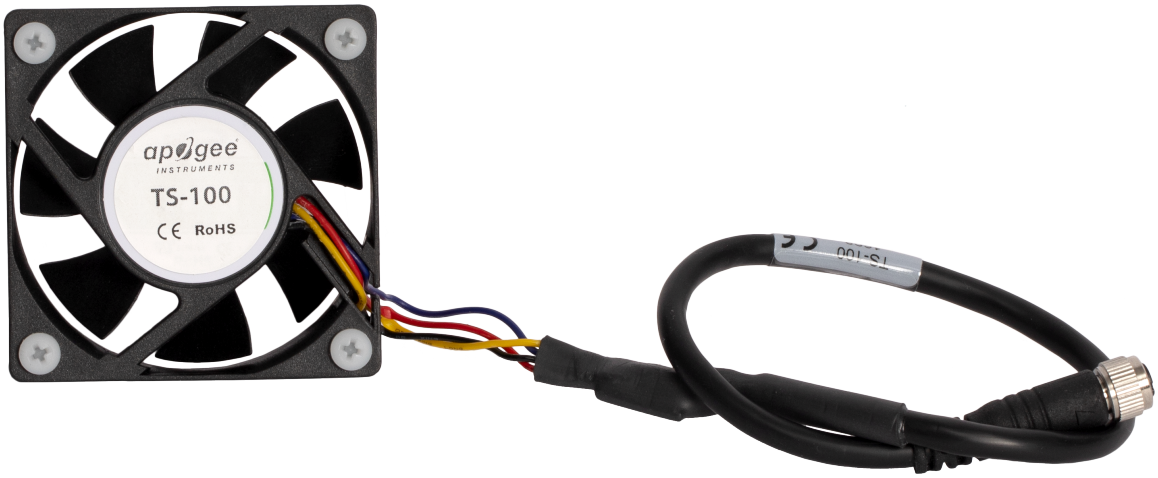


FIGURE 8-2. Replacement fan

5. Replace and tighten the screws.
6. Connect the TS100SS cable to the fan-cable connector.

Appendix A. Importing Short Cut code into CRBasic Editor

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

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

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

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

2. To add the Short Cut wiring information into the new CRBasic program, open the .DEF file located in the C:\campbellsci\SCWin folder, and copy the wiring information, which is at the beginning of the .DEF file.
3. Go into the CRBasic program and paste the wiring information into it.
4. In the CRBasic program, highlight the wiring information, right-click, and select **Comment Block**. This adds an apostrophe (') to the beginning of each of the highlighted lines, which instructs the data logger compiler to ignore those lines when compiling. The **Comment Block** feature is demonstrated at about 5:10 in the CRBasic | Features video.

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