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# **Sensor Functional Checks and Calibration Procedures**

for

Aviation Weather Observing Stations  
(AWOS)

*Version 1.0*

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Prepared by

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## Sensor Functional Checks and Calibration Procedures

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## Sensor Functional Checks and Calibration Procedures

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### CONVENTIONS USED.

In this manual, text or field names that appear on a computer display screen are indicated by **bold** type. Text or commands that are entered into a computer via a keyboard are indicated by *italic* type. Keyboard single stroke inputs are indicated by brackets, such as <*enter*> or <↑>.



## Sensor Functional Checks and Calibration Procedures

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### WARNINGS, CAUTIONS AND NOTES.

**WARNING** and **CAUTION** statements are strategically placed throughout this text prior to operating procedures, practices, and/or conditions, which are considered essential to ensure the protection of personnel (**WARNING**) or equipment and property (**CAUTION**). A **WARNING** or **CAUTION** will appear each time the related step is repeated. Prior to starting any task, the **WARNINGS** or **CAUTIONS** included in the text before the task shall be reviewed and understood.

- a. A warning identifies a procedural step that, if not correctly followed, will result in injury, loss of life or destruction of equipment.
- b. A caution identifies a procedural step that, if not correctly followed, may result in damage to equipment.
- c. A note identifies information, operating procedure, etc. requiring special emphasis.

Examples of notes, warnings and cautions are as follows:

#### NOTE

**Be sure to disconnect FDCU battery leads before opening FDCU AC Power switch. This process prevents FDCU battery from supplying power to FDCU circuits when main AC power is removed.**

#### **WARNING**

#### **DO NOT WEAR JEWELRY**

**Remove earrings, watches, and other metallic objects that may cause shock or burn hazards.**

#### **CAUTION**

**Do not short or bridge battery terminals with any object. Do not operate UPS without battery.**



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## Sensor Functional Checks and Calibration Procedures

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## Sensor Functional Checks and Calibration Procedures

### SECTION 1 - SENSOR FUNCTIONAL PERFORMANCE CHECKS

Sensor functional checks require viewing sensor data on a laptop computer. This section describes how to set up a laptop computer and perform certain sensor functional tests.

#### 1.1 Laptop Terminal Emulator Setup

##### Support Equipment Required:

Cable, DB-9F to DB-9M

Computer, Personal, Laptop with terminal emulation software (such as Hyper-Terminal)

a. Connect laptop to FDCU maintenance port inside FDCU using DB-9F to DB-9M cable. With laptop running Windows®, select **Start, Programs, Accessories, Communications, Hyper-Terminal**. The **Connection Description** dialog box appears. (If not, select **Call, Disconnect, Connect** and the **Connection Description** dialog box for a new Connection to appear).

b. Type *FDCU* as the connection name, select any icon, and select **OK**.

c. The **Connect To** dialog box appears. In Connect Using the pull-down list, select **Com 1, Com 2, Com 3** or **Com 4** (as appropriate) and Select **OK**.

d. The **COM Properties** dialog opens. Set port settings to **115200** bits per second, **8** data bits, **No Parity**, **1 Stop** bit, **No Flow Control**, and Select **OK**.

e. Press *<enter>*.

f. At the password prompt, type *awos <enter>*.

g. Type *sum l <enter>*. A summary similar to [Figure 1-1](#) will appear and continually update the data. As an alternative, type *sum h <enter>* and a summary similar to [Figure 1-2](#) will appear. This summary does not update the data, but it supplies labels for each of the data elements.

FDCU	ok:100	2	14.30	27.25C	296 3.6%	3816	5140
ZENM	idle	2:47					
ZENO	ok:100	4	23.7C	40%	1016.9	////	0
GILLW02	ok:100	5	0.4	86.0			00
CL31	ok:100	25	0	0	0	0:000000000000	020
SMS200	ok:100	16	00.27	00.27	00.000	30	000
LINK	ok:5	27	4693	2776			

Figure 1-1 – Sum l Summary Screen



## Sensor Functional Checks and Calibration Procedures

FDCU	Zeno Maintenance Port	BatU	Temp	IRQ CPU	UsedMem	FreeMem	
ZENM		AT RH	BP1	24hrRain	30sRain	ZenoBits	
ZENO		Wspeed	Wdir	CloudB1	CloudB2	RawStat	
GILL		VisInst	VisP1m	VertVis	RainP1m	WMO Code	
CL31		TotalPkts	MsgCnt	ByteCnt	<ignore>		
BIRAL						RawStat	
LINK						RawStat	
CAE-0001	Net 1/1 */*			2:47	06/10/2010	21:22:25	
FDCU	ok:100	2	14.30	27.25C	296 3.6%	3816	5140
ZENM	idle	2:47					
ZENO	ok:100	4	23.7C	40%	1016.9	////	0
GILLW02	ok:100	5	0.4		86.0		00
CL31	ok:100	25	0	0	0	0:000000000000	020
SWS200	ok:100	16	00.27	00.27	00.000	30	000
LINK	ok:5	27	4693	2776			

Figure 1-2 – *Sum h* Summary Screen

### 1.2 Ceilometer

#### Support Equipment Required:

- Cable, DB-9F to DB-9M
- Computer, Personal, Laptop
- Standard Screwdriver

- a. Open ceilometer access cover and electronics housing door (requires supplied key). Verify Main power switch, Ceilometer Heater, and Ceilometer Battery switches are all in the ON position.
- b. Connect laptop to FDCU maintenance port and at the prompt type *chat cl31 <enter>*.
- c. Type *OPEN* to access the CL31 command prompt, which will be “CEILO”.
- d. Type *GET FAILURE STATUS* at the CEILO > prompt (double-echoed characters should appear).
- e. Verify all Alarms, Warnings, and System fields read “OK”, and suspect module field equals “None”
- f. Type *CLOSE* to exit out of the CEILO > command prompt.
- g. Key *<ctrl-a> q <enter>* to exit out of sensor chat. At the prompt, type *sum h<enter>*.
- h. Note values from CloudB1, CloudB2, and VertVis fields from the SSEM summary screen.
- i. Wait 2-4 minutes, type *sum l <enter>*, and the values should change if clouds are being detected.
- j. Turn off the ceilometer battery power switch, wait two minutes and verify the ceilometer battery failure message is present in the summary screen.
- k. Turn on the ceilometer battery power switch, wait two minutes and verify the ceilometer battery failure message is no longer present.
- l. Repeat steps k and l, substituting the Main power switch for the battery power switch.
- m. Key *<ctrl-c>* to return to the SSEM prompt.
- n. Close ceilometer electronics housing door, close ceilometer front access door.



## Sensor Functional Checks and Calibration Procedures

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### 1.3 AT/RH Sensor

#### Support Equipment Required:

Cable, DB-9F to DB-9M  
Computer, Personal,  
Meter, Temperature/Humidity  
Standard Screwdriver

- a. Connect laptop to FDCU maintenance port, and at the prompt, type *sum l <enter>*.
- b. Note **air temperature** field reading on laptop.
- c. Set Temperature/Humidity Meter to read temperature.
- d. Position Temperature/Humidity Meter at mouth of AT/RH Sensor shield assembly such that air drawn into aspirated shield is drawn across Temperature/Humidity Meter
- e. Wait several minutes for Temperature/Humidity Meter to stabilize.
- f. Record Temperature/Humidity Meter and laptop **air temperature** field readings.
- g. Wait 2 minutes and repeat step f noting each reading. For inclement weather, wait 15 minutes.
- h. Wait another 2 minutes and repeat step f noting each reading. For inclement weather wait 15 minutes.
- i. Average the three Temperature/Humidity Meter readings. Separately, average the three laptop **air temperature** field readings.
- j. Compare average Temperature/Humidity Meter reading to the average laptop **air temperature** field reading. Difference should be less than 1.5° C.
- k. Note **relative humidity** field reading on laptop.
- l. Set Temperature/Humidity Meter to read **humidity**.
- m. Record Temperature/Humidity Meter and laptop **relative humidity** field readings.
- n. Wait 2 minutes and repeat step m. For inclement weather wait 15 minutes.
- o. Wait 2 more minutes and repeat step m. For inclement weather wait 15 minutes.
- p. Average the three Temperature/Humidity Meter readings and laptop **relative humidity** field readings.
- q. Compare average Temperature/Humidity Meter reading to average laptop **relative humidity** field reading. Difference should be less than  $\pm 5\%$ .

#### NOTE

**In cold weather, it may take longer for the hand-held meter to stabilize. It might be beneficial to take a large rubber band or tape, and attach the hand-held meter to the sensor.**

### 1.4 Wind Sensor

#### Support Equipment Required:

Cable, DB-9F to DB-9M  
Computer, Personal, Laptop  
Standard Screwdriver



## Sensor Functional Checks and Calibration Procedures

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- a. Connect laptop to FDCU maintenance port, and at the prompt, type *sum l <enter>*.
- b. Ensure that the **RawStat** field reads 00.

### 1.5 **Barometer**

#### **Support Equipment Required:**

Cable, DB-9F to DB-9M  
Computer, Personal, Laptop  
Barometer, Reference  
Standard Screwdriver

- a. Connect laptop to FDCU maintenance port and type *sum l <enter>*.
  - b. Turn Digital Barometer on and wait 5 minutes for Digital Barometer to stabilize.
  - c. Note barometric pressure indicated on Digital Barometer.
- a. Note pressure indicated in barometric pressure field on laptop. The **barometric pressure** reading should be within **0.67 hPa** of Digital Barometer reading.

### 1.6 **Visibility/Present Weather Sensor**

#### **Support Equipment Required:**

Cable, DB-9F to DB-9M  
Computer, Personal, Laptop  
SWS Calibration Kit  
Standard Screwdriver

#### **NOTE**

**Perform the following procedures only when the visibility is greater than 10 kilometers and the sensor has been powered for at least one hour.**

#### 1.6.1 **Calibration Overview**

The Meteorological Optical Range (MOR) calibration of the forward scatter channel and the backscatter channel are checked by the procedure outlined below.

The Calibration Reference Plaque used for the calibration check has been assigned a forward scatter value which is a simulation of a MOR expressed in kilometers. This value is shown on the label on the black plastic connector which attaches the arm to the calibration screen.

The SWS-200 plaque also has a backscatter value which although it also is expressed in kilometers, is an artificial value assigned only for the purpose of checking that the sensitivity of the backscatter channel is within its proper limits.



## Sensor Functional Checks and Calibration Procedures

### 1.6.2 Calibration Check

- a. Clean the lenses.
- b. Attach the calibration reference plaque to the sensor as shown in **Error! Reference source not found.** (power to the sensor need not be removed). Do not stand close to the sensor during calibration as reflections may cause errors in the reported values.

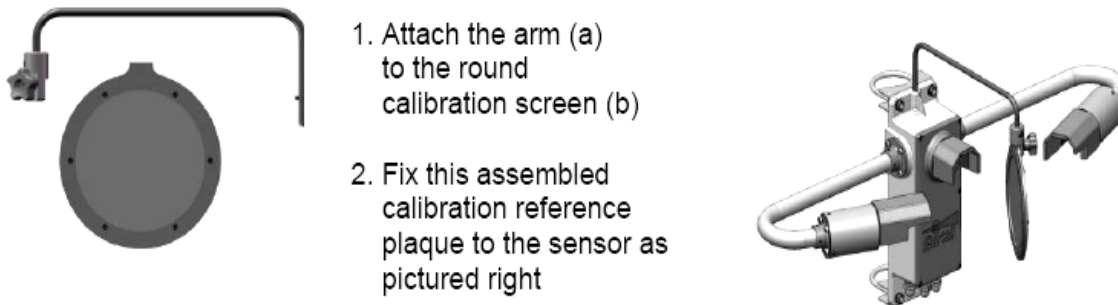


Figure 1-3 – Assembly of Calibration Reference Plaque

#### **MOR Zero Check:**

- c. Insert the gray foam plugs from the calibration kit in the front of each window blocking out all light.
- d. Connect laptop to FDCU maintenance port per laptop terminal emulator procedures and at the prompt, type *chat visi* <enter>.
- e. Type *RST* <enter>. Verify the response **OK**.
- f. If the sensor is operating in the polled mode, type *D?* at 60 seconds intervals. (If the sensor is set to automatically output data then the sensor will output data every 60 seconds.)
- g. Wait for the fifth data message from the sensor. Verify that the forward scatter MOR (located in 4th field) is 20Km.
- h. Type *BB?* <enter>. Verify that the response value is approximately  $000.00 \pm 1$ .
- i. Remove the foam plugs.

#### **MOR gain Check:**

- j. Type *RST* <enter>. Verify the response **OK**.
- k. If the sensor is operating in the polled mode, type *D?* at 60 seconds intervals. (If the sensor is set to automatically output data then the sensor will output data every 60 seconds).
- l. Wait for the fifth data message from the sensor. Verify that the forward scatter MOR (located in 4th field) is within 10% of the calibration reference plaque value (noted on the label attached to the plaque).
- m. Type *BB?* <enter>. If the response value is within  $\pm 20\%$  of the value assigned to the calibration reference plaque, the value is correct. Remove the calibration reference plaque from the sensor. Hit the ESC key to terminate, followed by <ctrl> a (both keys pressed simultaneously), then *q* <enter> to exit chat mode. If the value is not within  $\pm 20\%$ , proceed to the next step.
- n. Type *CO*. Verify the response **OK**.
- o. Type *CE*. The sensor should reply as follows:

CLEAN WINDOWS,



## Sensor Functional Checks and Calibration Procedures

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BLOCK FWD SCAT RCVR OPTICS,  
BLOCK BK SCAT RCVR OPTICS,  
INSTALL REF STD,  
ENTER FWD SCAT VALUE  
FORM: XXX.XX

p. Insert the gray foam plugs from the calibration kit in the front of each window blocking out all light.

q. Enter Forward CAL value of calibration plaque. The sensor should reply as follows:

ENTER BACK SCAT VALUE FORM: XXX.XX

r. Enter Backscatter CAL value of calibration reference plaque.

s. Wait for approximately 2 minutes. The sensor should reply as follows:

REMOVE BOTH RCVR OPTICS BLOCKS, ENTER "OK"

t. Remove foam plugs from all windows and type OK. The sensor should reply as follows:

CAL CONTINUES

u. Wait for approximately 2 minutes. The sensor should reply as follows:

CAL COMPLETE REMOVE REF STD

v. Wait for the third data message to be received at the PC.

w. Note the 'Total MOR' value reported by the sensor.

x. Type **BB?** <enter>. If the Total MOR reported is within 3% of the Forward MOR value of the plaque and the response to the BB? command is within 5% of the Backscatter calibration value of the plaque then the sensor is within its calibration limits. Remove the calibration reference plaque from the sensor. Hit the ESC key to terminate, followed by <ctrl> a (both keys pressed simultaneously), then q <enter> to exit chat mode.

### 1.7 PWD Functional Check/Calibration

#### Support Equipment Required:

Cable, DB-9F to DB-9M

Computer, Personal, Laptop

Calibration kit

a. Clean the lenses and the opaque glass plates.

b. Connect laptop to FDCU maintenance port and at the prompt, type **chat visi** <enter>.

c. Place the blocking plate (with foam) in the receiver hood and wait for 30 seconds.

d. Type **open** \*<enter>.



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### NOTE

After typing the open \* command, a prompt (>) appears. If there is no activity for 90 seconds, the prompt (>) will disappear and the open \* command must be typed again.

- e. Type **ZERO**<enter>. PWD22 should answer as follows: ZERO SIGNAL: OK>
- f. Remove the blocking plate.
- g. Note signal value printed on glass calibrator plates.
- h. Install the calibrator plates to the lens hoods making sure transmitter plate mounts to transmitter lens and receiver plate mounts on receiver lens. Refer to Figure 1-4 below.

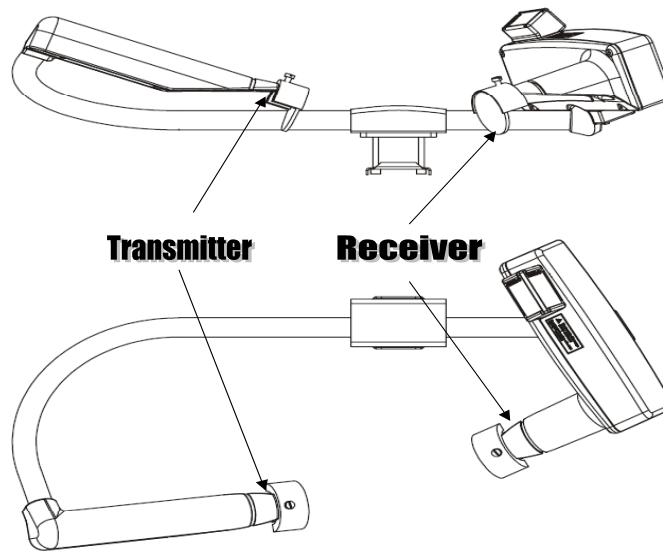


Figure 1-4 - Assembling the Opaque Glass Plates

- i. Move away from the optical path and wait for 30 seconds.
- j. Type **open** \*<enter> .
- k. Type **CHEC**<enter> .
- l. After one minute, read the displayed signal.
- m. If the difference is less than 5 % from the values on the calibrator plates, calibration is correct. Hit the ESC key to terminate, followed by <ctrl> a (both keys pressed simultaneously), then q <enter> to exit chat mode. If the value is not within 5%, proceed to the next step.
- n. Type **open** \*<enter> .
- o. Type **CAL** calibrator signal value (from value on glass plates) <enter>.  
For example: CAL 485  
PWD22 calculates a new scaling factor and stores it in the non-volatile memory (EEPROM).
- p. Type **open** \* <enter>.



## Sensor Functional Checks and Calibration Procedures

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- q. Type **CHEC** *<enter>* to verify that the new scaling factor is in use. The displayed signal value should be equal to the calibrator signal value. If the difference between the new scaling factor and the factory calibrated one is more than 20 %, the **CAL** command will be ignored. Check PWD22 and the calibrator for hardware or mechanical errors. Also consult Vaisala.
- r. Terminate the **CHEC** command by pressing the ESC key.
- s. Type *<ctrl> a* (both keys pressed simultaneously), then *q <enter>* to exit chat mode.

### 1.8 Freezing Rain Sensor

#### Support Equipment Required:

- Cable, DB-9F to DB-9M
- Computer, Personal, Laptop
- Standard Screwdriver

#### Material Required:

- Freeze Spray (if available)

- a. Connect laptop to FDCU maintenance port, and at the prompt, type *sum l <enter>*.
- b. Verify FZRAIN reads “ok”, is updating data, and has a “ZP” in the RawMsg status field.
- c. Return to the SSEM command prompt by keying *<ctrl-c>*.
- d. Enter a sensor chat session by typing *chat fzrain <enter>*.
- e. Type **Z4**, this issues a command to start a self-diagnostics routine. After receiving the Z4 command, the sensor should respond within 30 seconds showing “**ZP E3**” in normal conditions, or “**ZD D7**” in deicing conditions.
- f. Key *<ctrl-a> q <enter>* to exit out of sensor chat and return to the SSEM prompt.
- g. Type *sum l <enter>*.
- h. Note **freezing rain probe** field frequency reading (the sensor has a frequency signal output).

#### NOTE

**Freeze spray can freeze human tissue. User should avoid spraying their skin or eyes. Use appropriate skin and eye protection.**

- i. Spray Freeze Spray on Freezing Rain Sensor probe for 3 to 5 seconds (Tip: to get a greater change in frequency, spray water mist and then Freeze Spray).
- j. **Freezing rain probe** field frequency reading shown on laptop should decrease within 2 minutes. Actual decrease will depend on ambient conditions as sensor takes into consideration ambient temperature and conditions of rain.
- k. If no decrease was noted, repeat step c and spray directly on the probe for a longer period, especially if weather conditions are warm.



## Sensor Functional Checks and Calibration Procedures

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### 1.9 Rain Gauge

#### Support Equipment Required:

Cable, DB-9F to DB-9M  
Computer, Personal, Laptop  
Phillips Screwdriver  
Standard Screwdriver

#### Material Required:

Water

#### NOTE

**Do not perform this procedure while precipitation is occurring.**

- a. Disconnect main communication cable from bottom of FDCU.
- b. Connect laptop to FDCU maintenance port, and type *sum l <enter>*.
- c. Record the value under rain accumulation as a **START** value. Do NOT use the rain accum. (30s) value.

#### NOTE

**The funnel feeds rain into a dual-chambered tipping bucket assembly. Each time a tip occurs, 0.254mm (0.01 in.) of precipitation accumulation is measured. Rain Accumulation is the total amount accumulated during test. The rain accum. (30s) signifies the amount of rain in 30 seconds.**

- d. Loosen three screws securing Rain Gauge cover to Rain Gauge base, and remove cover from base.
- e. Disconnect the in-line heater connector. Set cover aside such that cable is not damaged.
- f. Check bubble level in base for level mounting. If adjustment is required:
  - 1) Loosen one screw securing appropriate mounting foot to base.
  - 2) Raise or lower position of base relative to mounting foot as necessary.
  - 3) Tighten screw to secure mounting foot to base.
  - 4) Repeat for each mounting foot as necessary to produce level mounting.
- g. Tip the bucket once with your finger, wait about 5 seconds and tip it again with your finger.
- h. After approximately one minute, rain accumulation value should increase by 0.508mm (0.254mm per tip) from the START value.
- i. Connect internal heater connector, position the cover on the base and secure using the three screws.
- j. Pour a small amount of water slowly into the funnel to cause the bucket to tip twice. This will ensure that the in-line heater connection is not interfering with the tipping bucket. If you do not hear a tip, remove the funnel and repeat steps i and j.
- k. Connect main communication cable to bottom of FDCU.



## Sensor Functional Checks and Calibration Procedures

### 1.10 Wind Sensor

#### Support Equipment Required:

Cable, DB-9F to DB-9M  
Computer, Personal, Laptop  
Standard Screwdriver  
Field Verifier  
Cloth bag

- a. Connect laptop to FDCU maintenance port, and at the prompt, type *sum l* <enter>.
- b. Slip the field verifier over the three transducers. See Figure 3-3.

**CAUTION**

Do not bend transducer heads to fit the field verifier. Replace sensor if the field verifier does not fit.

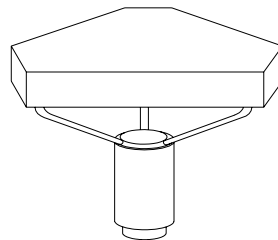


Figure 1-5 - Field Verifier

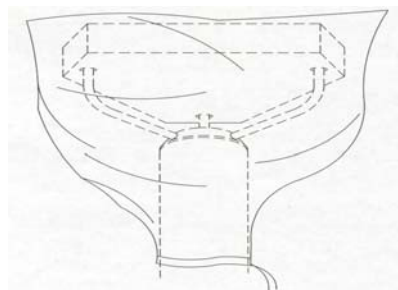


Figure 1-6 - Cloth Bag on Field Verifier

- c. Cover field verifier and wind sensor with cloth bag as shown in Figure 3-4. Pull the string on the cloth bag and tie.
- d. Wait 30 seconds before performing the test to ensure that the wind speed average has stabilized.



## Sensor Functional Checks and Calibration Procedures

- e. With the field verifier in place, check to ensure that the resultant wind speed output is zero.
- f. If the sensor fails, replace it with a known good unit. Otherwise, remove the bag and field verifier.

### 1.11 **Lightning Detector Functional Test**

#### **NOTE**

**This sensor has approximately 90% detection efficiency for single Cloud-Ground discharges (flashes) within 10 miles (16km), and 100% for thunderstorms within 10 miles with 3 or more CG discharges.**

#### **Support Equipment Required**

Cable, DB-9M to DB-9F  
Computer, Personal, Laptop  
Screwdrivers– Phillips and flat head

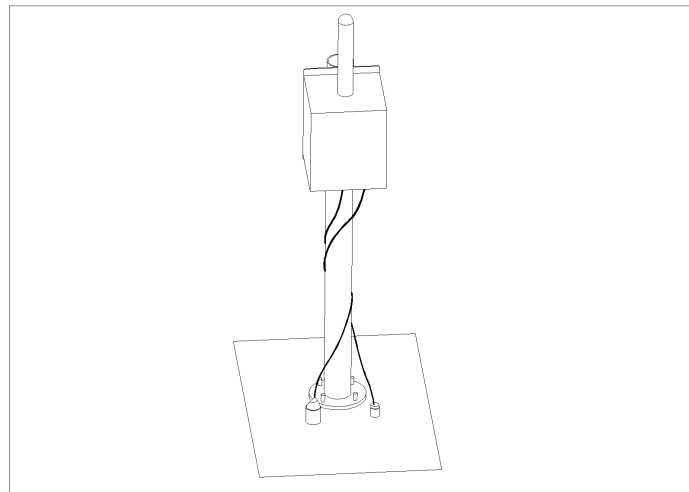


Figure 1-7. Lightning Sensor

#### **NOTE**

- a. Connect laptop to FDCU maintenance port.
- b. **Lightning-self test** field on laptop should read **OK**.
- c. If **lightning-self test** field does not read **OK**, wait 2 minutes.
- d. Type *show sum* <enter>. **Lightning-self test** field on laptop should read **OK**.
- e. Perform a sensor self-check test as follows: At the **ssem-FPRI**> prompt, type *sensor 6 chat* <enter>.



## Sensor Functional Checks and Calibration Procedures

- f. Type *C* <enter>. This command initiates a self-test routine.  
A typical response message: **P 00H 16 C 0 0 0 0 0 0.000**.  
**P** = Pass, **F** = Fail  
**00H to 3FH**: Status byte (see next step)  
**16 C**: Internal temperature (Acceptable limit: -10°C to 70°C)  
Other fields are not used.
- g. If F, or if status byte is not 00H, or if temperature is out of range, troubleshoot.
- h. Type *B* <enter>. This is the 'Send Status Message' command. For a typical message, see Figure 1-8.

```
precipitation rate 0.000 mm/hr      fdcu heater      OFF
freezing rain probe 39980 Hz        zeno             OK
cloud height 1      04560 ft        precipid        OK
cloud depth 1       00560 ft        freezing-rain    OK
cloud height 2      00000 ft        ceilometer      OK
cloud depth 2       00000 ft        lightning       OK
cloud height 3      00000 ft        visibility      OK
cloud depth 3       00000 ft        als            OK
vertical visibility 00000 ft        fdcu           OK
ceilometer range   24610 ft
ssem-FPRI> sensor 6 chat
Type ^D or ~ to terminate chat with serial6 (/dev/ttyS7) at 9600 baud
FLASHES:
NEAR: N 0      NE 0      E 0      SE 0      S 0      SW 0      W 0      NW 0
DIST: N 0      NE 0      E 0      SE 0      S 0      SW 0      W 0      NW 0
OVHD 0      CLOUD 0      TOTAL 0
STROKES:
NEAR: N 0      NE 0      E 0      SE 0      S 0      SW 0      W 0      NW 0
DIST: N 0      NE 0      E 0      SE 0      S 0      SW 0      W 0      NW 0
OVHD 0      CLOUD 0      TOTAL 0
PASS 1      FAIL 0      TLOST 0      SLOST 0
P 00H 23 C 0 0 0 0 0 0.000
P 00H 23 C 0 0 0 0 0 0.000
-
```

Figure 1-8. Lightning Sensor Status Message (B) and Selftest Message (C)

- i. If there has been thunderstorm activity in the last 24 hours, check for a FLASH Total count.  
The Sensor stores lightning history counts for the past 24 hours. Every 15-minutes the count is updated (the 24-hour history is a rolling count). All counts clear when Sensor is powered up or reset. FLASHES consist of STROKES; if there are Cloud-to-Ground flashes, the count of flashes will normally be higher than strokes. OVHD refers to Cloud-to-Ground flashes/strokes. CLOUD refers to Cloud-to-Cloud flashes/strokes.
- j. Check for total of selftest PASS and FAIL. Sensor initiated selftest occur automatically every 30 minutes (selftest results are ignored during thunderstorm activity, because the high level of electrical noise can distort results). If FAIL messages appear, check on a daily basis during thunderstorm season and on a weekly basis during off-season for a rising trend in selftest failures.
- k. TLOST refers to data transmission errors. If TLOST errors appear, check for a trend per step j above. If necessary, check FDCU-sensor cabling.
- l. Exit sensor chat mode by entering <Ctrl> <d>.



## Sensor Functional Checks and Calibration Procedures

- m. Perform visual inspection of the Sensor electronics. Open the door of the sensor cabinet. Inspect the status LEDs on the Processor Board, located on the back of the door. See Figure 1-9 and Table 1-1. If abnormal, troubleshoot.

Table 1-1. The LEDs display in Normal State

LED	Function	Normal State	Abnormal State
RUN	Sensor is running	On	Off
5VOK	Digital 5V supply in spec	On	Off
12VOK	12V supply in spec	On	Off
O5VOK	Optical 5V supply in spec	On	Off
A5VOK	Analog 5V supply in spec	On	Off
ENA	Enable threshold crossings	Off when no lightning in Sensor's range. (Flashing when processing flashes or running selftest).	Always On (indicates constant RF noise)
OPT	Optical threshold crossings		Always On (indicates constant optical noise)
OVER	Overrange signal		On
FLASH	Indicates a valid flash		On
TXD0	Serial port 0 transmit activity		Off. (On when Sensor transmits data to FDCU).



## Sensor Functional Checks and Calibration Procedures

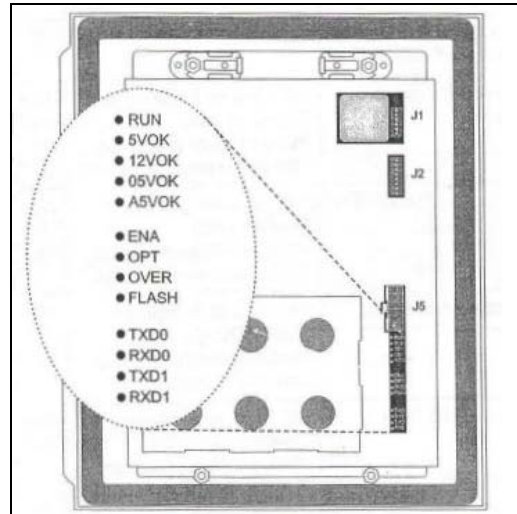


Figure 1-9. Processor Board

- n. Inspect Power/Comm Board indicators to that Figure 1-10 and Table 1-2. Replace sensor if indicators show abnormal state.

Table 1-2. Power/Com Normal/Abnormal States

Indicator	Function	Normal State	Abnormal State
<b>LP2</b>	Sufficient AC power to heater circuit	<b>ON</b>	<b>OFF</b> (Fuses F3 or F4 blown, switch S2 off or sensor has no power)
<b>LP3</b>	Indicates heater is running.	<b>OFF</b> > 50°F (10°C) <b>ON</b> < 32°F (0°C) Either <b>OFF/ON</b> from 32°-50°F (0-10°C)	<b>ON</b> > 50° F (10°C) <b>OFF</b> < 32°F (0°C)
<b>LED1</b>	Power to 12V supply is within spec	<b>ON</b>	<b>OFF</b>
<b>LED4</b>	Power to 5V supply is within spec	<b>ON</b>	<b>OFF</b>
<b>Fuses F1, F2</b>	Sensor power	<b>Closed (short)</b>	<b>Open</b>



## Sensor Functional Checks and Calibration Procedures

<b>Fuses F3, F4</b>	Heater power	<b>Closed (short)</b>	<b>Open</b>
<b>Switch S1</b>	Sensor power	<b>Closed (on)</b>	<b>Open (off)</b>
<b>Switch S2</b>	Heater power	<b>Closed (on)</b>	<b>Open (off)</b>

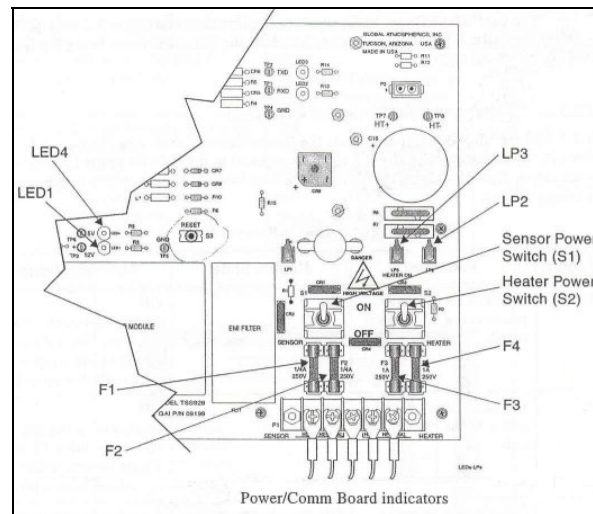


Figure 1-10. Power/Com Board Indicators

- o. Inspect the Power/Comm Board for damage to MOV transient suppressors, (Figure 1-11) CR1 and CR2 may not be installed. Burn marks, cracking and/or external carbon are signs of failure. (MOV damage is cumulative. Eventually, components will fail short, and will open the fuse.) Replace sensor if damaged.



## Sensor Functional Checks and Calibration Procedures

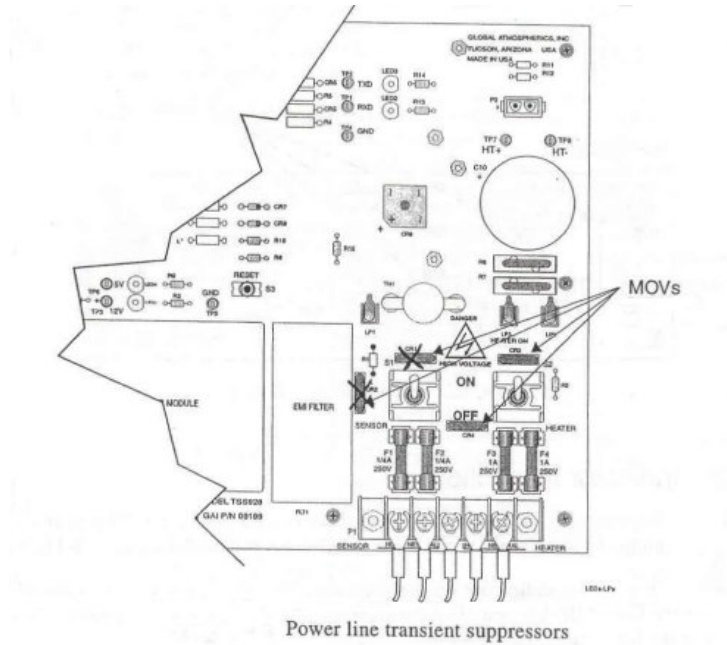


Figure 1-11. Power/Comm Board Transient Suppressor locations

- p. On RS-232 Comm Board, verify that the TranZorb transient suppressors CR1 and CR2 are not cracked, broken or charred. Normal failure mode is a short. Replace sensor if devices damaged (Figure 1-12).

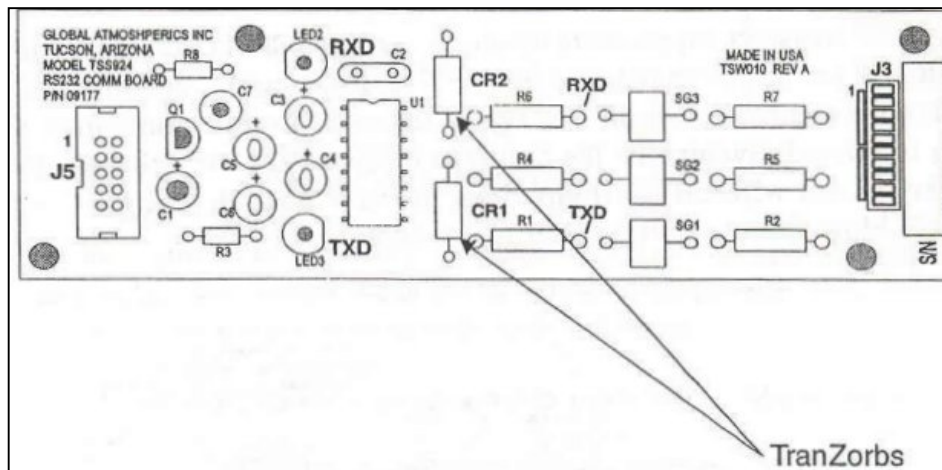


Figure 1-12. RS-232 Comm Board Transient Suppressor locations



## Sensor Functional Checks and Calibration Procedures

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### 1.12 Precipitation ID Sensor Functional Test

NOTE

**This test should be performed in daylight.**

#### Support Equipment Required

- Cable, DB-9M to DB-9F
- Computer, Personal, Laptop
- Screwdrivers – Phillips and flathead

#### Material Required

- Cloth, Cotton, Lint-free
- Glass Cleaner

- a. Connect laptop to FDCU maintenance port.
- b. **Precipid** field on laptop should read **OK**.
- c. Note **precipitation ID** and **precipitation rate** field readings on laptop.
- d. Clean lenses.
- e. Type show sum <enter>.
- f. The Precipitation ID and Precipitation Rate field readings should return to previous values.
- g. Verify calibration. If values are within limits, it is not necessary to calibrate the sensor.
- h. Enter sensor chat mode as follows: At the **ssem-FPRI**> prompt, type *sensor 3 chat* <enter>.
- i. Next type C <enter>. (Note: C command is case sensitive-must be capital C).
- j. The sensor should respond with a data string of calibration and diagnostic data. The data fields in **BOLD** shown below are the values of interest ('nnn' stands for a variable number).
- k.

**W\_P0000**S0000**Vvvvcc**Xnnn**zzz**Lnnn**bbb**Knnn**bbb**Hnnn**bbbEnnnnnnTnnn**

Field	Content	Expected Range of Values	Action if Fail or out of range
W_-		Blank if no precipitation falling	Calibrate sensor if out of range
<b>S0000</b>	Status Field	<b>Status field should contain four zeros</b>	<b>Replace Sensor if anything but S0000</b>
<b>Xnnn</b>	Carrier Strength	405 to 420	Calibrate sensor if out of range
<b>Lnnn</b>	Low Channel	-30 to 50	Calibrate sensor if out of range



## Sensor Functional Checks and Calibration Procedures

<b>Knnn</b>	Particle Channel	1 to 150	Calibrate sensor if out of range
<b>Hnnn</b>	High Channel	40 to 120	Calibrate sensor if out of range

- l. If values are out of limits, perform calibration. If values are within limits, it is not necessary to perform the field calibration.
- m. If no calibration is required, type `<ctrl> <d>` to exit sensor chat mode.

### 1.13 Precipitation ID Calibration

#### NOTE

**The following Precip ID Sensor field calibration is only required on an annual basis, or after a repair/replacement of the Precip ID sensor, or if the sensor is determined to be out of calibration. This procedure requires approximately 30 minutes. If sufficient time is not available, do not begin the procedure. This test should not be performed when precipitation or fog is occurring.**

#### Support Equipment Required

- Cable, DB-9M to DB-9F
- OSI TST-120 Field Cal Kit
- Computer, Personal, Laptop
- Tuning tool
- Screw driver – flat head

#### Material Required

- Cloth, Cotton, Lint-free
- Glass Cleaner

- a. Prior to the calibration, clean the lenses on the transmitter and receiver.
- b. Connect laptop to FDCU maintenance port. Type *sensor 3 chat <enter>*.
- c. Poll the sensor as follows: type `<C>` (note: case sensitive) polling command. In order to see a change on the laptop, you must type the `<C>` each time you require a refreshed data string. The data string will look like the example below. The Xnnn field (where ‘nnn’ is a number) is the Carrier field. It is highlighted, as it is the first field to be examined and possibly adjusted.

W P000S2000Vvvvcc**Xnnn**zzzLnnnbbbKnnnbbbHnnnbbbEnnnbbbTnnn

- d. In the data string, the Carrier raw data field should contain:



## Sensor Functional Checks and Calibration Procedures

Channel	Data Value	Tolerance
Carrier	“X405 to 420”	Anywhere in range

Note: The Carrier raw data field should be in the range of 405-420. If it is within range, proceed to Step v. If it is out of range, go to next step (Carrier Channel Adjustment). Do NOT power down sensor yet.

### NOTE

**In order to reduce temperature changes in the electronic circuitry, it is important to minimize the amount of time that the enclosure door is open. In addition, in the following procedures it is unnecessary and undesirable to try to “tune” the potentiometers to exactly the middle value.**

### NOTE

**If any of the data values are outside the tolerance in the table, adjustment is necessary for that field; otherwise, go to step r. Make minor adjustments (1/8 to 1/4 turns) and evaluate change for desired result.**

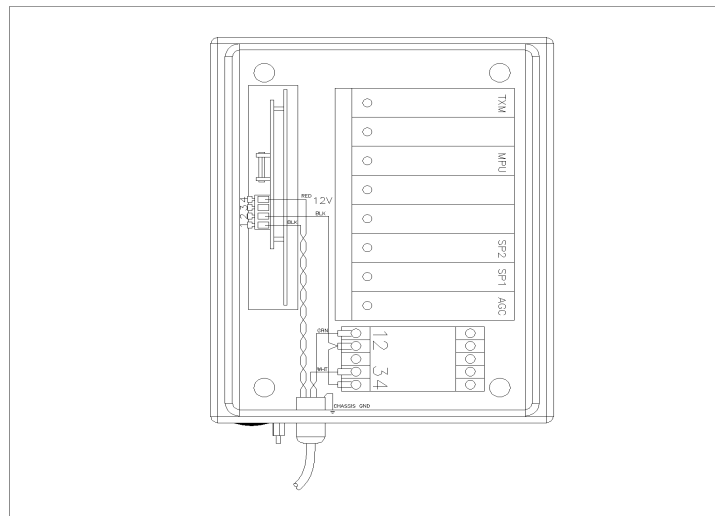


Figure 1-13. Precip ID Electronic Enclosure Circuit Card Location

- e. Open the electronics enclosure door (Figure 1-13).

### NOTE

**If manufacturer warranty sticker is covering potentiometer stating “Calibration void if seal is broken”, contact AFWA CSC. Do not remove sticker until determination is made whether item is under warranty.**



## Sensor Functional Checks and Calibration Procedures

- f. **Carrier Channel Adjustment** (refer to Figure 1-14).
- 1) Open electronic enclosure and locate “C” pot.
  - 2) Adjust: “C” pot as shown to increase or decrease data value.
  - 3) Wait: 2-3 minutes
  - 4) Verify (by entering <C> command) Carrier channel is “X405 to 420” per data fields shown below:

```
W P0000S2000VvvvvccXnnnzzzLnnnbbbKnnnbbbHnnnbbbEnnnbbbTnnn
```

- 5) Readjust: As necessary to reach correct value.

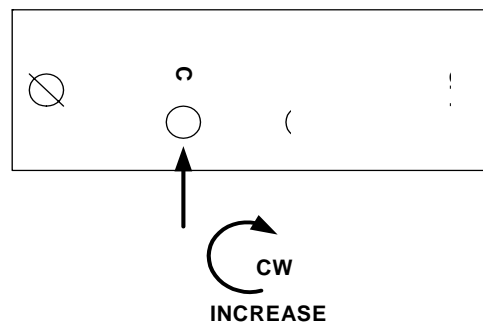


Figure 1-14. Carrier Channel Adjustment

- g. Turn power to the sensor OFF by disconnecting the cable to the FDCU.
- h. Locate the transmitter card labeled TXM in the card cage. Loosen the knurled thumbscrew and remove the TXM card.
- i. Install the Calibration Card from the OSI Field Cal Kit into the empty slot of the TXM card. It may be necessary to loosen or remove the plate on the slot directly below the TMX slot in order to slide in the Calibration Card.
- j. Close the enclosure door, and turn power to the sensor ON by reconnecting the FDCU cable.
- k. Type *sensor 3 chat* <enter>.
- l. Allow at least 5 minutes for the sensor to stabilize before making any reading from the data string.
- m. Poll the sensor as follows: type <C> (note: case sensitive) polling command at an interval of 1 minute to allow stabilization. In order to see a change on the laptop, you must type the <C> each time you require a refreshed data string.



## Sensor Functional Checks and Calibration Procedures

- n. In the data string, the **Low (L)**, **Particle (K)** and **High (H)** raw data field should contain initial data values. The data fields in **bold** shown below are the data values of interest in the procedure:

W P0000S2000VvvvvccXnnnzzz**LnnnbbbKnnnbbbHnnnbbbEnnnbbbTnnn**

- o. Determine if the data values are all in spec (refer to Table 1-3).

Table 1-3. Present Weather Calibration Worksheet

Channel	Data Value	Tolerance	Before Cal	Adjust Spec	After Cal
Low (L)	<b>“L241”</b>	+/- 10		<b>L241 +/- 5</b>	
Particle (K)	<b>“K400”</b>	+/- 20		<b>K400 +/- 10</b>	
High (H)	<b>“H174”</b>	+/- 10		<b>H174 +/- 5</b>	
L-H*	<b>67</b>	+/- 8		<b>67 +/- 8</b>	

\*L-H is calculated as L241-H174=67. If, as an example, L value was L250 and H value was H165, the L and H fields would be within spec, but L250-H165=85 would be out of spec.

- p. **Low Channel Adjustment:** (refer to Figure 1-15).
- 1) Locate “L” pot.
  - 2) Adjust: “L” pot to increase or decrease data value.
  - 3) Wait: 2-3 minutes.
  - 4) Verify: Low channel is **“L241” +/- 5** per data fields shown below:

W P0000S2000VvvvvccXnnnzzz**LnnnbbbKnnnbbbHnnnbbbEnnnbbbTnnn**

- 5) Readjust: As necessary to reach correct value

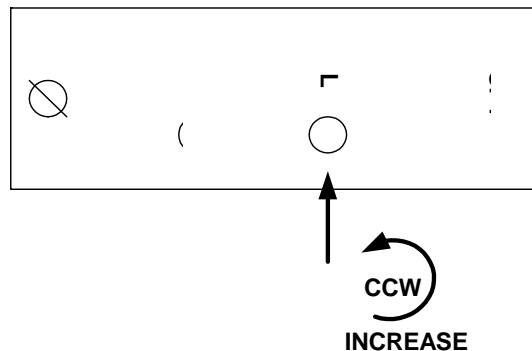


Figure 1-15. Low Channel Adjustment



## Sensor Functional Checks and Calibration Procedures

q. **Particle Channel Adjustment:** (refer to Figure 1-16).

- 1) Locate “P” pot.
- 2) Adjust: “P” pot as shown in Figure 1-16 to increase or decrease data value.
- 3) Wait: 2-3 minutes.
- 4) Verify: Particle channel is “K400” +/- 10 per data fields shown below:

W P000S2000VvvvvccXnnnzzzLnnnbbb <b>Knnnbbb</b> HnnnbbbEnnnbbbTnnn
--

- 5) Readjust: As necessary to reach correct value

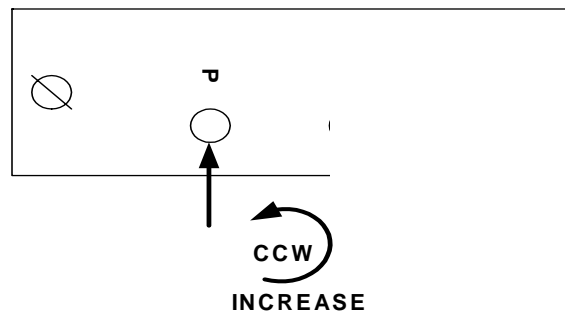


Figure 1-16. Particle Channel Adjustment

r. **High Channel Adjustment:** (refer to Figure 1-17).

- 1) Locate “H” pot.
- 2) Adjust: “H” pot to increase or decrease data value
- 3) Wait: 2-3 minutes
- 4) Verify: High channel is “H174” +/- 5 per data fields shown below:

W P000S2000VvvvvccXnnnzzzLnnnbbbKnnnbbb <b>Hnnnbbb</b> EnnnbbbTnnn
--

- 5) Readjust: As necessary to reach correct value

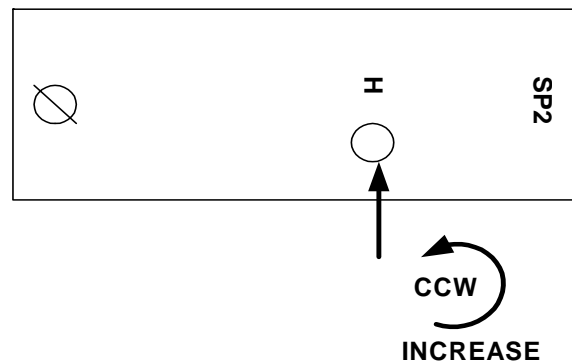


Figure 1-17. High Channel Adjustment



## Sensor Functional Checks and Calibration Procedures

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- s. Turn power to the sensor **OFF** by disconnecting FDCU sensor cable.
- t. Remove the Calibration Card and reinstall the TXM card back into its slot. Tighten the thumb screw to secure the card. Remember to close the electronics enclosure door.
- u. Turn power to the sensor ON by reconnecting the FDCU cable.
- v. Type `<ctrl> <d>` to exit sensor chat mode.
- w. At the prompt, type `show sum <enter>` to see sensor data.
- x. Verify sensor is working correctly by placing an opaque object between the two lenses and looking for a change in the Precipitation ID (NP to RA or +RA) on the terminal screen.

### 1.14 **Visibility Sensor Functional Test and Self-Alignment**

#### **NOTE**

**This test must be performed in daylight, with winds less than 10 kts and visibility greater than 1 mile.**

#### **Support Equipment Required:**

Cable, DB-9M to DB-9F  
Computer, Personal, Laptop  
Test Set, Visibility Sensor  
Measuring Device such as ruler (1 ft.) or tape measure

#### **Material Required:**

Glass cleaner  
Cotton cloth, lint free  
Screwdriver – flat head

#### **WARNING**

**It is recommended that two people perform the test procedure. To prevent falling, ensure Safety Harness, Fixed lanyard, and Vertical Safety Climbing Sleeve are properly attached to climbing pole.**

#### **NOTE**

**Prior to performing any sensor test, the user should notify appropriate Users of action and follow any applicable instructions or procedures in the AWOS application software manual.**

- a. Connect laptop to FDCU maintenance port.



## Sensor Functional Checks and Calibration Procedures

- b. **Visibility** field on laptop should read **OK**. If not troubleshoot.
- c. Access sensor using Safety Harness, Fixed Lanyard and Vertical Safety Climbing Sleeve.
- d. Inspect and clean sensor windows if there is any noticeable fouling from dirt, etc.

### NOTE

**Visibility Sensor field calibration has two steps, ZERO CALIBRATION and SPAN CALIBRATION. The ZERO calibration corrects the sensor for changes in offset (primarily affects high visibility readings). The SPAN calibration corrects the sensor for changes in the slope or gain of the sensor (primarily affects low visibility readings). Either calibration routine may be aborted before completion by typing the <ESC> key.**

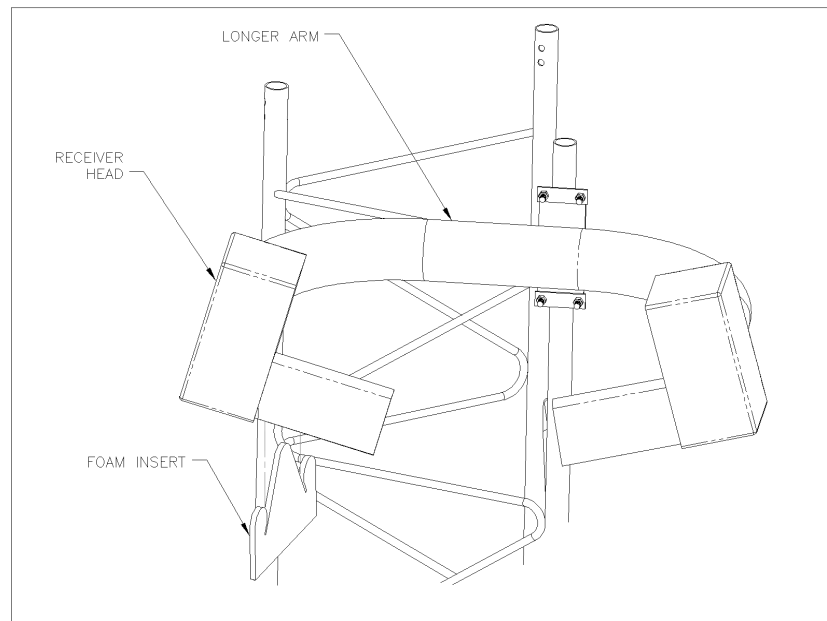


Figure 1-18. Visibility Sensor – Foam Insert Illustration

#### 1.14.1 Procedure for ZERO Calibration:

- a. Insert black foam filter in Test Set into Receiver hood against window. Receiver is on the longer arm (left arm when viewed from front) (see Figure 1-18).
- b. On laptop, type (in lower case) *sensor 8 chat* <enter>. (To exit this command, type <Ctrl> d).
- c. Type <Ctrl> v (Both keys should be pressed simultaneously) (see Figure 1-19).
- d. At **password** prompt, type *foggy* (lower case) <enter>.



## Sensor Functional Checks and Calibration Procedures

---

- e. Screen message appears: **Password accepted, Operator is now Super-User.**

### NOTE

**Disregard any data stream being displayed.**

- e. Type *fz*.
- f. The message: **Are you sure you want to perform Calibration Zero? (y/N)** appears.
- g. Type *y*.
- h. Press any key to initiate self-alignment routine.

The Total routine takes approximately 5 minutes to run: **Settling before Zero Calibration** (3 minutes) and **Performing Zero Calibration** (2 minutes). While each subroutine is running, the left (**Loop**) column shows time remaining in seconds until the current subroutine is finished.

An example of the screen following the *sensor 8 chat* command is shown below. Note the data stream (P,00002, etc.) which is meaningless for this procedure. Also note how *foggy* Password puts the User into the Super User status.



## Sensor Functional Checks and Calibration Procedures

```
FDCU - HyperTerminal
File Edit View Call Transfer Help
[Icons]

ssem-FPRI>
ssem-FPRI>
ssem-FPRI>
ssem-FPRI>
ssem-FPRI>
ssem-FPRI>
ssem-FPRI>
ssem-FPRI>
ssem-FPRI>
ssem-FPRI> sensor 8 chat
Type ^D or ~ to terminate chat with serial8 (/dev/ttyS9) at 9600 baud
P,00443, 0, 4, 6.3582, 6.2989, 0.0593,16288, 53.50287,Km, 0.056060,

Password? -> *****

Password accepted, Operator is now Super User
P,00443, 0, 4, 6.3302, 6.3060, 0.0243,16288, 54.31043,Km, 0.055226,

Are you sure you want to perform Calibration Zero? (y/N) -> Y

The sensor must be "settled" in the Zero state before starting.
Put the Opaque Filter on the Receiver and,

Press a key when ready...
```

Figure 1-19. Sensor 8 Chat Example

### NOTE

**Do not wait more than 15 seconds to respond after completion of self-alignment routine. If too much time elapses, results of self-alignment routine are automatically deleted. If this occurs, press <esc> and repeat procedure beginning at step e.**

- i. When routine is finished, message **OK to save Zero? (y/N)** appears.
- j. Type y. (**Writing settings to the EEPROM** appears).
- k. The message **OK to save TxPwrCal? (y/N)** appears.
- l. Type y. (**Writing settings to the EEPROM** appears). This completes the Zero Calibration.



## Sensor Functional Checks and Calibration Procedures

### 1.14.2 Procedure for SPAN Calibration:

This procedure is written assuming that one Maintenance person is still in the sensor 8 chat mode (see Figure 1-19) and another Maintenance person is properly harnessed on the climbing pole.

- a. Remove foam filter from receiver hood.
- b. Note and record EXCO value printed on scatter plate.
- c. The Scatter Plate should have no smudges, fingerprints, etc.; it can be cleaned as needed with any commercial glass cleaner. Do *not* use harsh solvents containing acetone, trichloroethane, methyl-ethyl-ketone, etc., to clean the Scatter Plate, as they can cause permanent damage.
- d. Carefully hang scatter plate by hooking top bracket over top of sensor cross arm (see Figure 1-20).
- e. Using a measuring device, precisely center scatter plate on cross arm, equidistant (5-5/16 inches or 136 mm) from edge of each hood.

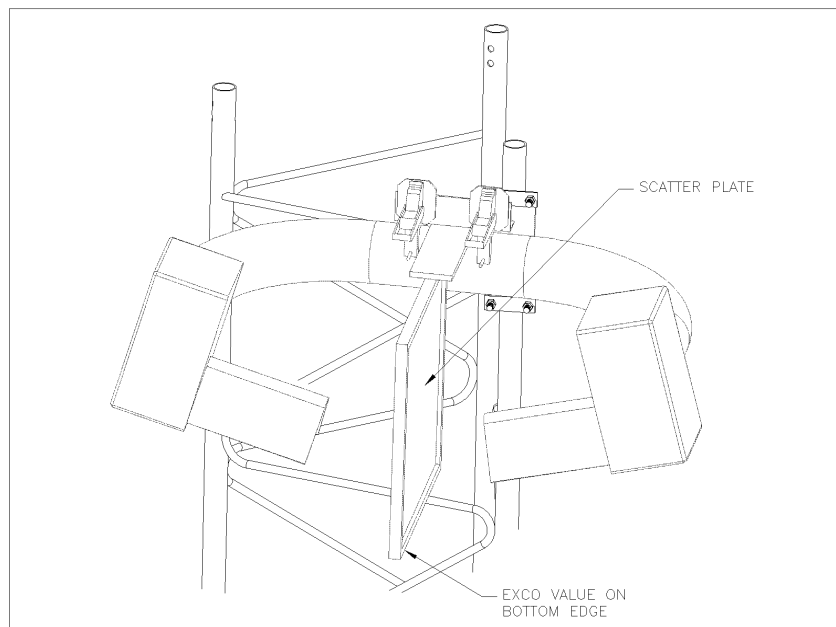


Figure 1-20. Visibility Sensor - Scatter Plate Installed

- f. Type *fs*.
- g. The message **Are you sure you want to perform Span Calibration (y/N)** appears.
- h. Type *y*.



## Sensor Functional Checks and Calibration Procedures

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- i. Verify that the **CAL\_ExtCo** value displayed on laptop is the same as that marked on scatter plate.
- j. If values match, type *y* and go to step q.
- k. If values do not match, perform the following, in order to input the EXCO=xxx value:
  1. Type *fc*.
  2. When the message **Update rate (in seconds) [xx] →** appears, press *<enter>* until you see the following field: **CAL\_ExtCo** value.
  3. At the **CAL\_ExtCo** value, input value marked on scatter plate, and press *<enter>*.
  4. Press *<esc>*.
  5. Type *fc*.
  6. Verify that the new **CAL\_ExtCo** value is correct.
  7. Press *<esc>*.
- l. Type *fs*.
- m. **Are you sure you want to perform Span Calibration (y/N)** appears.
- n. Type *y*.
- o. **Is “Cal\_ExtCo” = xxx.0000 correct? (y/N)** appears (where xxx is previously entered value).
- p. Type *y*.
- q. Press any key to initiate self-alignment routine. The total routine takes 5 minutes. Two messages appear: **Settling before Span Calibration** (3 minutes) and **Performing Span Calibration** (2 minutes).
- r. At completion of routine, **OK to save Fog\_Span? (Y/N)** appears.
- s. Type *y*. The message **Writing settings to the EEPROM...** appears. This completes Span Calibration.
- t. Type *<Ctrl> v <enter>* to end password session.
- u. Type *<Ctrl> d* to exit chat session.
- v. You should now be back at the **ssem – FPRI>** screen. Type *show sum <enter>* to see if the Visibility field reads OK.
- w. Access sensor using Safety Harness, Fixed Lanyard and Vertical Safety Climbing Sleeve.
- x. Remove scatter plate from Visibility Sensor and store properly with Test Set.

### 1.15 **Ambient Light Sensor**

#### **NOTE**

**This test must be performed in daylight. Ambient Light Sensor is part of Visibility/Ambient Light Sensor.**



## Sensor Functional Checks and Calibration Procedures

### Support Equipment Required

- Cable, DB-9M to DB-9F
- Computer, Personal, Laptop
- Screwdriver - flathead
- Protractor/Inclinometer/Angle Locator

### WARNING

**It is recommended that two people perform the test procedure.**

- a. Using protractor/inclinometer/angle locator, ensure Ambient Light Sensor is angled between  $4^{\circ}$  and  $8^{\circ}$  above horizontal (Figure 1-21).
- b. Connect laptop to FDCU maintenance port.
- c. Note **ambient light** field reading on laptop.
- d. Access sensor using Safety Harness, Fixed Lanyard and Vertical Safety Climbing Sleeve.
- e. Cover Ambient Light Sensor with bag, box, or other covering to block light.

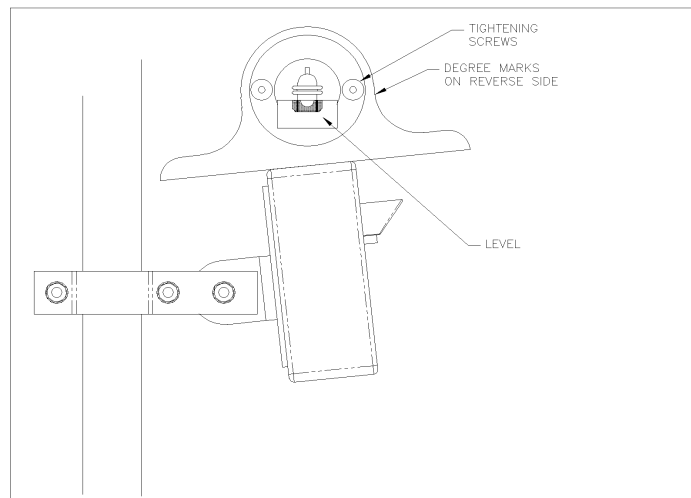


Figure 1-21. Ambient Light Sensor - Protractor/Inclinometer/Angle Locator

- f. Wait approximately 1-2 minutes, then type `show sum <enter>`. Note change in **ambient light** field reading.
- g. If no change, replace Visibility/Ambient Light Sensor.
- h. Access sensor using Safety Harness, Fixed Lanyard and Vertical Safety Climbing Sleeve. Remove covering from Ambient Light Sensor.



## Sensor Functional Checks and Calibration Procedures

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- i. Wait approximately 1-2 minutes, then type *show sum* <enter>. **Ambient light** reading should return to previous value.
- j. If not, replace Visibility/Ambient Light Sensor.

### 1.16 **Freezing Rain Sensor Functional Test**

#### **Support Equipment Required:**

Cable, DB-9M to DB-9F  
Computer, Personal, Laptop  
Screwdriver – flat head  
Gloves (skin protection)  
Goggles (eye protection)

#### **Material Required:**

Freeze Spray

### **WARNING**

**It is recommended that two people perform the test procedure.**

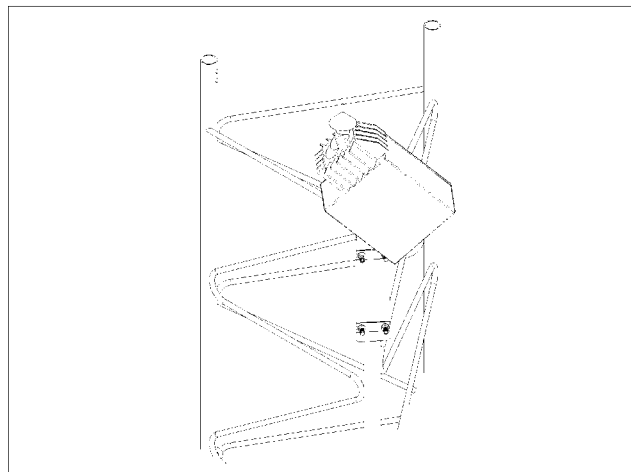


Figure 1-22. Freezing Rain Sensor - Probe Illustration



## Sensor Functional Checks and Calibration Procedures

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- a. Connect laptop to FDCU maintenance port, and at the prompt, type *show sum <enter>*.
- b. **Freezing-rain** field on laptop should read **OK**.
- c. Note **freezing rain probe** frequency reading (the sensor has a frequency signal output).

### NOTE

For reference, the frequency specifications are as follows: Under non-icing conditions, for temperatures range -20°C to 5°C, the base frequency signal is 40,000Hz  $\pm$  25Hz (for temperatures outside this range, for each degree C outside range, add 0.5Hz to  $\pm$  25Hz tolerance). Detection of 0.01 in of ice (the minimum detection threshold) will be indicated by a change in base frequency to below 39970 Hz (at a rate exceeding 10Hz per 15 min.). Continuation of freezing rain or frost beyond 0.01 in. will result in further decreases of frequency.

### WARNING

**FREEZE SPRAY CAN FREEZE TISSUE AND USER SHOULD AVOID SPRAYING THEIR SKIN OR EYES. USE APPROPRIATE SKIN AND EYE PROTECTION.**

- d. Spray Freeze Spray on Freezing Rain Sensor probe for 3 to 5 seconds. (Tip: to get a greater change in frequency, spray water mist and then Freeze Spray).
- e. Wait 2 minutes, then type *show sum <enter>*.
- f. **Freezing rain probe** field frequency reading shown on laptop should decrease. Actual decrease will depend on ambient conditions as sensor takes into consideration ambient temperature and conditions of rain.
- g. If no decrease was noted, repeat step d and spray directly on the probe for a longer period, especially if weather conditions are warm.
- h. Wait 2 minutes, then type *show sum <enter>*.
- i. If no change, troubleshoot. If necessary, replace Freezing Rain Sensor.
- j. Wait 2 –4 minutes, then type *show sum <enter>* to see if frequency goes back near its original value.
- k. If no change, troubleshoot. If necessary, replace Freezing Rain Sensor.



## Sensor Functional Checks and Calibration Procedures

### 1.17 Wind Monitor (Normal Installation) Functional Test

#### Support Equipment Required:

Cable, DB-9M to DB-9F	Disc, Propeller Torque
Computer, Personal, Laptop	Drive, Anemometer
Fixture, Vane Angle	Gauge, Vane Torque
Cable, Test, Wind Monitor	Wrench
Screwdriver – flat head	

#### WARNING

**Prior to performing maintenance on wind monitor, verify current and forecast wind speeds for your installation with the base weather station. Exercise caution when lowering tower to avoid injury or damage to nearby people or equipment. If wind speed is above 25 kts, DO NOT attempt to lower or raise tower. If wind speed is between 15 and 25 kts, use two people to lower or raise tower. If wind speed is less than 15 kts, one person may lower or raise tower.**

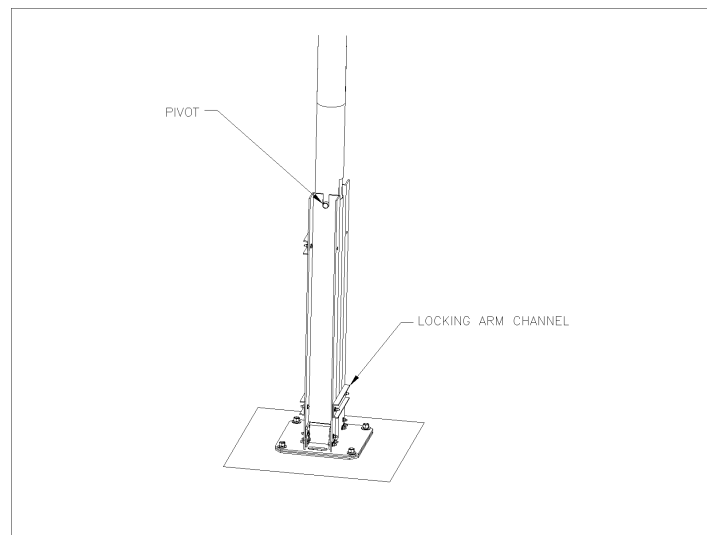


Figure 1-23. 10-Meter Tower Pivot Assembly - Close-up



## Sensor Functional Checks and Calibration Procedures

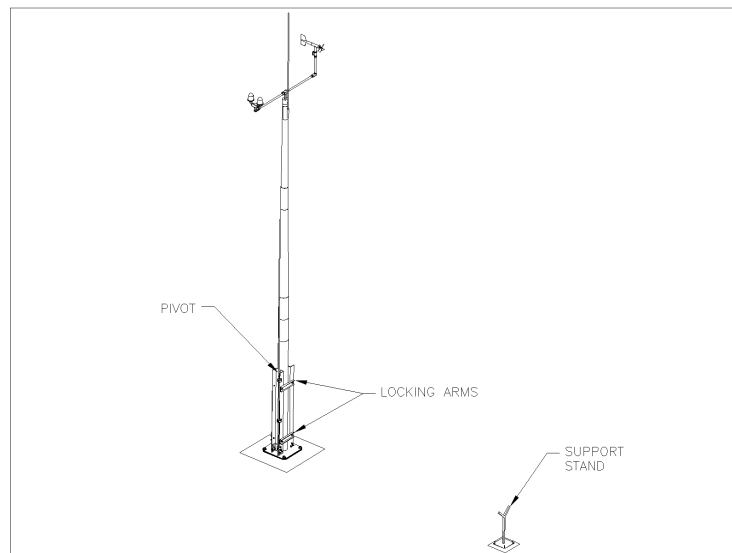


Figure 1-24. 10-Meter Tower and Support Stand

- Remove two bolts (3/4") securing single locking assembly channel to C-channels at tower base (Figure 1-23).
- Carefully lower tower about its pivot point until tower rests on support stand (Figure 1-24).
- Secure tower to support stand with safety chain.
- Inspect conditions of Wind Monitor, mounting hardware, ground connections, and cables.
- Check that Wind Monitor propeller rotates freely, and that Wind Monitor body rotates freely about mounting post (no grit in bearings). If not, replace Wind Monitor.

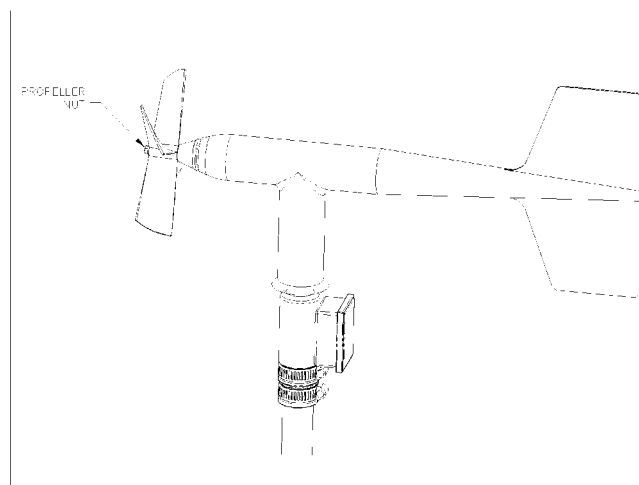


Figure 1-25. Wind Monitor - Propeller Nut



## Sensor Functional Checks and Calibration Procedures

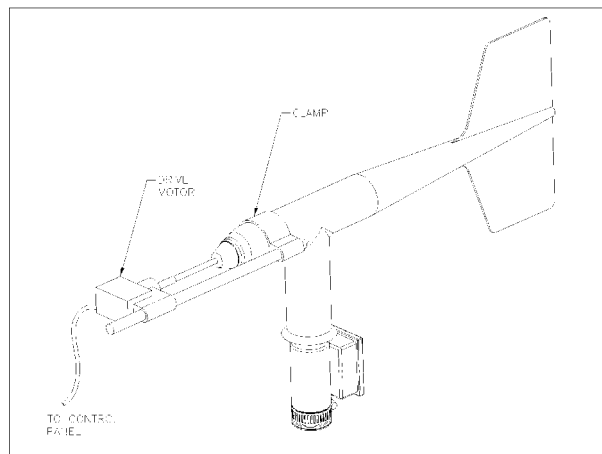


Figure 1-26. Wind Monitor – Wind Speed Test

### 1.17.1 Wind Speed Test (Normal)

The following steps use an Anemometer to check the accuracy of wind speed readings.

- a. Remove propeller nut and propeller from Wind Monitor (See Figure 1-25).
- b. Connect Anemometer Drive to the Wind Monitor drive shaft (see Figure 1-26).
  1. Position Anemometer Drive spar on clamp to Wind Monitor body such that rubber-coupling sleeve on drive motor reaches Wind Monitor propeller shaft. Do not tighten clamp screw yet.
  2. Slip coupling sleeve onto propeller shaft.
  3. Adjust clamp position such that coupling sleeve is as straight as possible, and tighten screw on clamp to fix motor in position.
- c. Connect laptop to FDCU maintenance port.
- d. **Wind speed** field on laptop should read **0.0 kts**.
- e. Set Anemometer Drive controls as follows:
  1. ON/OFF switch to ON.
  2. CW/CCW switch to CW.
  3. RPM such that 200 appears on display.
- f. Wait 20 seconds, then type *show sum* <enter>. **Wind speed** field on laptop should read between **0.0 and 2.3 kts**. If not, troubleshoot.
- g. Set Anemometer Drive RPM controls for 1600.
- h. Wait 20 seconds, then type *show sum* <enter>. **Wind speed** field on laptop should read between **15.0 and 15.5 kts**. If not, troubleshoot.
- i. Set Anemometer Drive RPM controls for 6400.
- j. Wait 20 seconds, then type *show sum* <enter>. **Wind speed** field on laptop should read between **59.7 and 62.2 kts**. If not, troubleshoot.
- k. Set Anemometer Drive ON/OFF control to OFF.



## Sensor Functional Checks and Calibration Procedures

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### 1.17.2 Wind Direction Test (Normal)

#### NOTE

**DO NOT LOOSEN BAND CLAMP (See Figure 1-27) SECURING ORIENTATION RING TO MOUNTING POST (BOTTOM-MOST CLAMP). Moving orientation ring results in losing Wind Monitor alignment to true south, causing all wind direction readings to be invalid. If orientation ring is moved, Wind Monitor must be realigned.**

- a. Leaving Anemometer Drive connected; loosen band clamp (upper clamp) securing Wind Monitor mounting post assembly to mounting post. Slide Wind Monitor (including junction box and mounting post assembly) off mounting post.
- b. Position Wind Monitor on Vane Angle Fixture such that (south) indexing pin on fixture orientation ring is engaged in notch on mounting post assembly (*notch ends up under the junction box*). This ensures continued alignment to true south during the test procedure (see Figure 1-27).
- c. Position tail of Wind Monitor in Vane Angle Fixture alignment arm notch (V-notch).
- d. Secure mounting post assembly to fixture mounting post using band clamp.
- e. Set Anemometer Drive ON/OFF control to ON, and set RPM controls for 1600.
- f. Position Vane Angle Fixture such that indicator points to 30°.

#### NOTE

**Wind vane reading indicates instantaneous vane position. Wind direction reading indicates average vane position over the last 5 seconds.**



## Sensor Functional Checks and Calibration Procedures

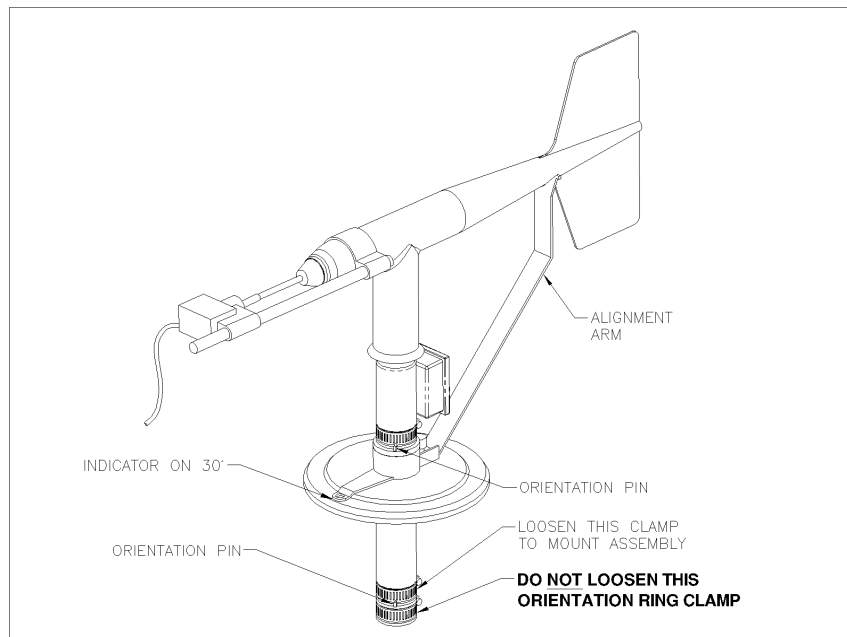


Figure 1-27. Wind Monitor – Wind Direction Test

- g. Wait 20 seconds, then type *show sum* <enter>. **Wind direction** and **wind vane** readings on laptop should be between **25<sup>0</sup>** and **35<sup>0</sup>**. If not, troubleshoot.
- h. Position Vane Angle Fixture such that indicator points to 120<sup>0</sup>.
- i. Wait 20 seconds, then type *show sum* <enter>. **Wind direction** and **wind vane** readings on laptop should be between **115<sup>0</sup>** and **125<sup>0</sup>**. If not, troubleshoot.
- j. Position Vane Angle Fixture such that indicator points to 210<sup>0</sup>.
- k. Wait 20 seconds, then type *show sum* <enter>. **Wind direction** and **wind vane** readings on laptop should be between **205<sup>0</sup>** and **215<sup>0</sup>**. If not, troubleshoot.
- l. Position Vane Angle Fixture such that indicator points to 300<sup>0</sup>.
- m. Wait 20 seconds, then type *show sum* <enter>. **Wind direction** and **wind vane** readings on laptop should be between **295<sup>0</sup>** and **305<sup>0</sup>**. If not, troubleshoot.
- n. Set Anemometer Drive ON/OFF control to OFF. Disconnect Anemometer Drive from Wind Monitor.

### NOTE

**DO NOT LOOSEN BAND CLAMP (See Figure 1-27) SECURING ORIENTATION RING TO MOUNTING POST (BOTTOM-MOST CLAMP). Moving orientation ring results in losing Wind Monitor alignment to true south, causing all wind direction readings to be invalid. If orientation ring is moved, Wind Monitor must be realigned.**



## Sensor Functional Checks and Calibration Procedures

### 1.17.3 Wind Monitor Propeller Torque and Vane Test

- a. Remove Wind Monitor to sheltered area.
- b. Install 1gram weight (silver screw) in second hole (from center) and 0.1 gram weight (black screw) in fifth (outer) hole of Propeller Torque Disc. (This equates to 2.5 g-cm torque.) These weights are included with the test kit.
- c. Position Propeller Torque Disc on Wind Monitor propeller shaft ensuring alignment ridges mesh with depressions in propeller shaft cone, and secure using propeller nut.
- d. Hold shaft vertically as shown in Figure 1-28 and the bottom of shaft should rest on flat surface.
- e. Hold Propeller Torque Disc such that weights are level with and to the right of propeller shaft (3:00 position).
- f. Release Propeller Torque Disc. Disc should rotate smoothly clockwise with weights finishing directly below propeller shaft (5:30 to 6:30 position). Free rotation indicates good bearing/transducer condition. If not, replace Wind Monitor.

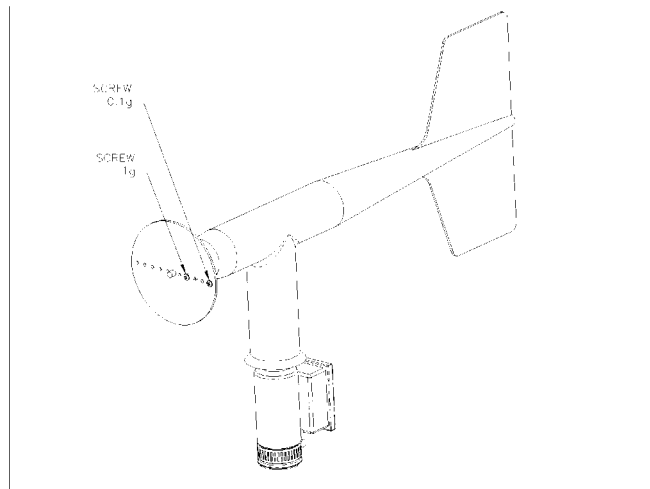


Figure 1-28. Wind Vane - Propeller Torque

- g. Hold Propeller Torque Disc such that weights are level with and to the left of propeller shaft (9:00 position).
- h. Release Propeller Torque Disc. Disc should rotate smoothly counterclockwise with weights finishing directly below propeller shaft (5:30 to 6:30 position). If not, replace Wind Monitor.
- i. Remove Propeller Torque Disc.
- j. Remove tail of Wind Monitor from Van Angle Fixture alignment arm notch (V-notch).



## Sensor Functional Checks and Calibration Procedures

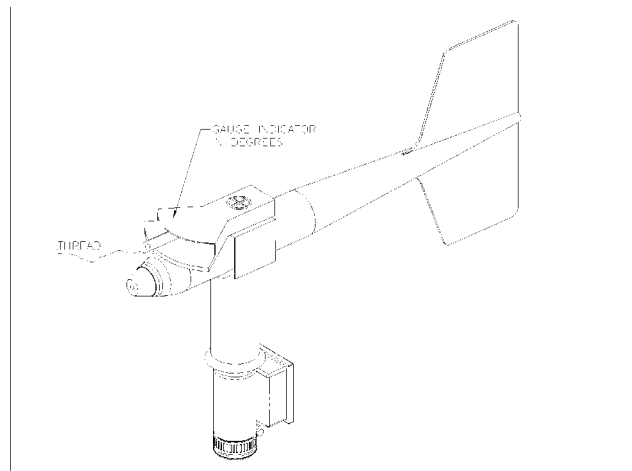


Figure 1-29. Wine Vane – Vane Angle Torque Gauge

### NOTE

**Be sure to observe Vane Torque Gauge indicator from directly above indicator to eliminate parallax errors.**

- k. Snap Vane Torque Gauge onto Wind Monitor body such that gauge is level and crosshairs on gauge are directly above mounting post (See Figure 1-29).
- l. With Wind Monitor motionless, use thread attached to Vane Torque Gauge indicator (observe indicator) to very slowly and gently apply force (pull) until Wind Monitor vane moves. Indicator should read less than 30 at all times. If not, replace Wind Monitor.
- m. With Wind Monitor motionless, use thread attached to Vane Torque Gauge indicator (observe indicator) to very slowly and gently apply force (pull) in opposite direction of previous step until Wind Monitor vane moves. Indicator should read less than 30 at all times. If not, replace Wind Monitor.
- n. Remove Vane Torque Gauge indicator.
- o. Loosen band clamp, and remove Wind Monitor from Vane Angle fixture.
- p. Install Wind Monitor on 10 m tower. Ensure Wind Monitor is aligned using the notch on the orientation ring.
- q. Insert cable wire through watertight cable port and terminal strip.
- r. Reconnect cable wires to junction box.
- s. Tighten strain relief.
- t. Install four screws to secure cover to Wind Monitor Junction box.
- u. Reinstall propeller and tighten nut finger tight.
- v. Reconnect wind monitor cable to FDCU.



## Sensor Functional Checks and Calibration Procedures

- w. Carefully raise tower above its pivot point until tower is vertical in the channel tower base.
- x. Reinstall bolts to secure tower in C-channels.

### 1.18 **Wind Monitor (Extreme Installation) Functional Test**

#### **Support Equipment Required:**

- Cable, DB-9M to DB-9F
- Protractor/Inclinometer/Angle Locator
- Computer, Personal, Laptop
- Drive, Anemometer

#### **WARNING**

**Prior to performing maintenance on wind monitor, verify current and forecast wind speeds for your installation with the base weather station. Exercise caution when lowering tower to avoid injury or damage to nearby people or equipment. If wind speed is above 25 kts, DO NOT attempt to lower or raise tower. If wind speed is between 15 and 25 kts, use two people to lower or raise tower. If wind speed is less than 15 kts, one person may lower or raise tower.**

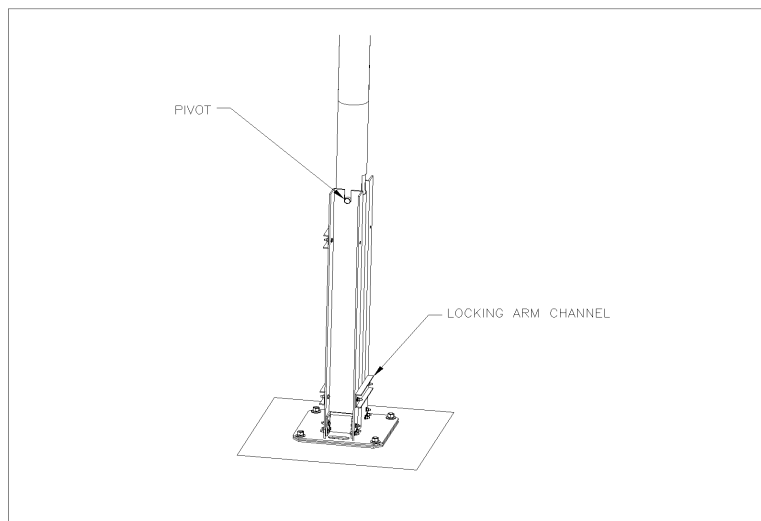


Figure 1-30. 10-Meter Tower Pivot Assembly - Close-up



## Sensor Functional Checks and Calibration Procedures

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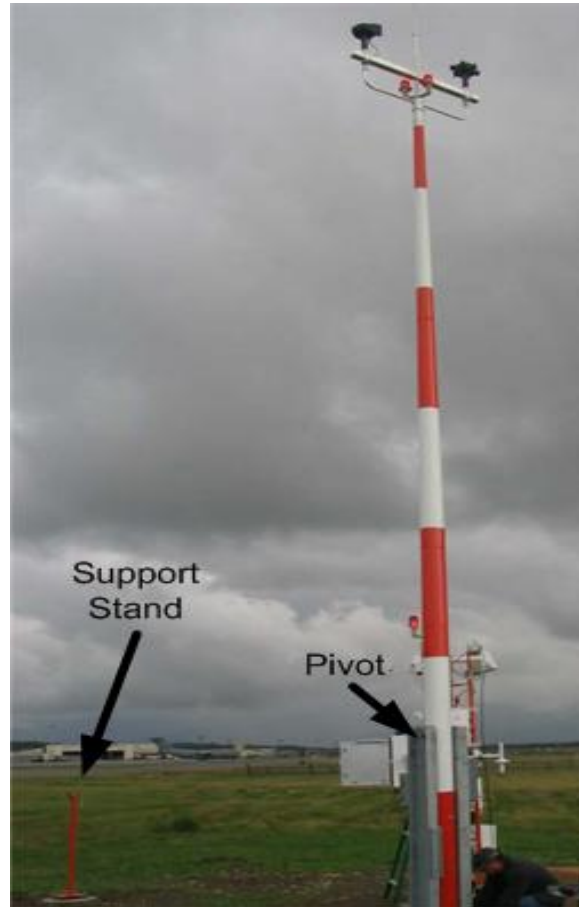


Figure 1-31. 10-Meter Tower and Support Stand

- a. Remove two bolts (3/4") securing single locking assembly channel to C-channels at tower base (Figure 1-30).
- b. Carefully lower tower about its pivot point until tower rests on support stand (Figure 1-31).
- c. Secure tower to support stand with safety chain.
- d. Inspect conditions of Wind Monitor, mounting hardware, ground connections, and cables.
- e. Check that Rotor Anemometer and Direction Vane rotate freely and appear to have no grit in bearings. If it does not rotate freely, replace Wind Monitor (Extreme).



## Sensor Functional Checks and Calibration Procedures

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### 1.18.1 Wind Speed Test (Extreme)

#### NOTE

The following steps require the removal of small parts. Keep these parts in a safe location to ensure they are not lost or damaged.

- a. Remove nut holding rotor anemometer to shaft (See Figure 1-32).

#### NOTE

Ensure rotor anemometer does not fall off mounting post after washer is removed.

- b. Loosen set screw on washer and remove washer (See Figure 1-33).



Figure 1-32. Rotor Anemometer Nut



## Sensor Functional Checks and Calibration Procedures

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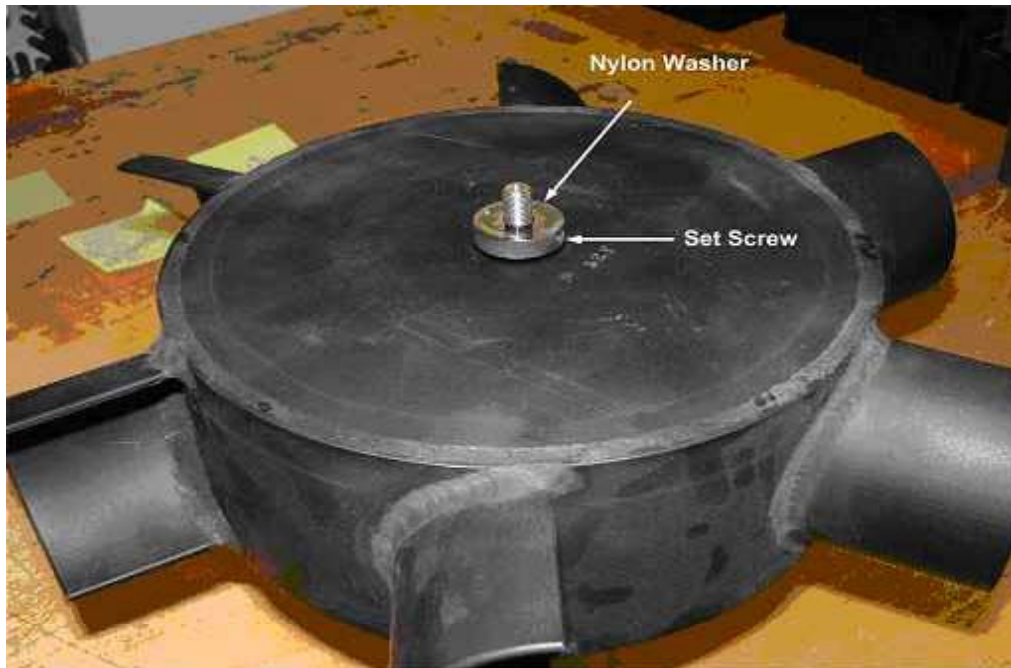


Figure 1-33. Washer with Set Screw

- c. Remove rotor from shaft.
- d. Connect anemometer drive to the rotor anemometer drive shaft using the anemometer drive rubber-coupling sleeve (See Figure 1-34).



## Sensor Functional Checks and Calibration Procedures



Figure 1-34. Rubber-Coupling Sleeve Connected to Rotor Anemometer Drive Shaft.

- e. Connect laptop to FDCU maintenance port.
- f. **Wind speed** field on laptop should read **0.0 kts**.

### NOTE

**Rubber-coupling sleeve must be held in a straight line with rotor anemometer drive shaft.**

- g. Set Anemometer Drive controls as follows:
  - 4. CW/CCW switch to CW.
  - 5. ON/OFF switch to ON.
  - 6. RPM such that 200 appears on display.
- h. Wait 20 seconds, then type *show sum* <enter>. **Wind speed** field on laptop should read between **19.5 and 21.4 kts**. If not, troubleshoot.
- i. Set Anemometer Drive RPM controls for 400.
- j. Wait 20 seconds, then type *show sum* <enter>. **Wind speed** field on laptop should read between **36.8 and 44.9 kts**. If not, troubleshoot.
- k. Set Anemometer Drive RPM controls for 600.
- l. Wait 20 seconds, then type *show sum* <enter>. **Wind speed** field on laptop should read between **55.2 and 67.3 kts**. If not, troubleshoot.
- m. Set Anemometer Drive RPM controls for 800.



## Sensor Functional Checks and Calibration Procedures

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- n. Wait 20 seconds, then type *show sum <enter>*. **Wind speed** field on laptop should read between **73.7 and 89.9 kts**. If not, troubleshoot.
- o. Set Anemometer Drive RPM controls for 1100.
- p. Wait 20 seconds, then type *show sum <enter>*. **Wind speed** field on laptop should read between **101.3 and 123.7 kts**. If not, troubleshoot.
- q. Set Anemometer Drive ON/OFF control to OFF.
- r. Disconnect anemometer drive from rotor anemometer drive shaft.
- s. Place rotor over drive shaft.

### NOTE

**Do not over tighten washer or rotor anemometer nut.**

- t. Place washer over drive shaft and tighten set screw (ensure indexing pin on bottom of washer is positioned in small hole on top of rotor).
- u. Place nut over drive shaft and tighten with wrench.
- v. Carefully raise tower above its pivot point until tower is vertical in the channel tower base.
- w. Reinstall bolts to secure tower in C-channels.
- a. Turn on breaker in power distribution panel.

### 1.18.2 Wind Direction Test (Extreme)

- b. Perform steps a through e of the Taylor Wind Monitor Alignment Procedure to obtain the true prone tower bearing of the 10-m tower.
- c. With wind vane pointing straight down, place the protractor/inclinometer/angle locator against the side of the wind vane (See Figure 1-35). Ensure needle on protractor/inclinometer/angle locator reads exactly 0° (this ensures wind vane is straight down).
- d. Keeping wind vane pointing straight down, check wind vane value from show summary screen of FDCU laptop. Ensure this value matches the true prone tower bearing (if not, repeat alignment procedure).
- e. Keeping protractor/inclinometer/angle locator against wind vane, rotate wind vane at 45° increments and insure wind vane value matches appropriately (see Table 6-4).



## Sensor Functional Checks and Calibration Procedures



Figure 1-35 Wind Direction Test Protractor/Inclinometer/Angle Locator Position

Table 1-4. Wind Direction Readings

	<b>True Prone Tower Bearing</b>	<b>Rotation of Wind Vane from Starting Position</b>	<b>Direction of Wind Vane (True Prone Tower Bearing + Rotation of Wind Vane)</b>	<b>Wind Direction (Degrees)</b>	<b>Tolerance (Degrees)</b>
Reading 1		None			$\pm 5^\circ$
Reading 2		Clockwise $090^\circ$			$\pm 5^\circ$
Reading 3		Clockwise $180^\circ$			$\pm 5^\circ$
Reading 4		Clockwise $270^\circ$			$\pm 5^\circ$

- f. If values do not compare, troubleshoot.



## Sensor Functional Checks and Calibration Procedures

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