Model 6497
Present Weather and Visibility Sensor

User's Manual

Rev. C

All Weather Inc. • 1165 National Drive • Sacramento, CA 95834 • USA • 800.824.5873 • www.allweatherinc.com

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Latest Manual Version
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All Weather, Inc.
1165 National Drive
Sacramento, CA 95834
Tel.: (916) 928-1000
Fax: (916) 928-1165

Contact Customer Service

- **Phone** support is available from 8:00am - 4:30pm PT, Monday through Friday. Call 916-928-1000 and ask for "Service."
- **Online** support is available by filling out a request at www.allweatherinc.com/support/online-support/
- **E-mail** your support request to support@allweatherinc.com

Revision History

Revision	Date	Summary of Changes
A	2012 Jun 30	Initial release.
B	2015 Apr 25	Use Model 2715 Universal Power and Communication Module with new enclosure
C	2017 Feb 28	Added Table 2 so that Tables 1 and 2 present wiring options involving twisted pair and non twisted pair wire from sensor head

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1. OVERVIEW

The Model 6497 Present Weather and Visibility Sensor is the most advanced sensor of its kind ever made. The fully automated instrument provides accurate visibility, present weather, and precipitation measurement capabilities in a single sensor. This next-generation intelligent sensor uses all digital signal processing for no-drift high-accuracy results.

The Model 6497 Present Weather and Visibility Sensor measures visibility and detects and quantifies rain, snow, drizzle, freezing and mixed precipitation conditions. The sensor is designed for year-round continuous operation in all climate types ranging from extreme arctic to deserts and tropical rain forests. Visibility readings are used to calculate Runway Visual Range (RVR) values.

A major advantage of the Model 6497 Present Weather and Visibility Sensor is that the measurements are not affected by the buildup of dust, dirt or ice on the lenses. The weather processing software includes an artificial intelligence and fuzzy logic-based algorithm that makes the baselines self-adaptive. This corrects the scintillation and forward scattering coefficient changes caused by the gradual obscuration of the light path. The need for frequent lens cleaning is eliminated, enabling the Model 6497 Present Weather and Visibility Sensor to operate for long periods of time completely unattended.

1.1 FEATURES

- Combines present weather identification, precipitation measurement, and visibility into a single rugged package
- Outstanding performance yet low cost
- No field calibration required
- Used advanced scintillation technology
- Intelligent algorithms based on over 100 million hours of sensor field data
- Rugged design — field proven from tropical to arctic environments
- Easy installation and integration
- Long-term reliability — designed for unattended operation year-round
- Unaffected by dust or buildup on lenses
- Reports over 50 NWS/WMO codes
- Virtually no maintenance required
- Built-in self-diagnostics and testing

The Model 2715 Universal Power and Communication Module provides power to the Present Weather and Visibility Sensor and provides a serial interface.

1.2 MODELS

One 6497 model is available.

Model	Description
6497	115 V/230 V AC

1.3 ACCESSORIES

The following accessories and replacement parts are available for the Model 6497 Present Weather and Visibility Sensor.

Part Number	Description
2715	Universal Power and Communication Module
M406306-00	256MB microSD Card
M442089-00	10 A 250 V, 5x20 mm slow blow fuse
M438130-00	Backup Battery

2. SYSTEM DESCRIPTION

2.1 MAJOR COMPONENTS

2.1.1 Sensor Head

The sensor head uses a uses a compact, triple-aperture optical system to measure both precipitation and visibility.

The sensor head frame is an all-aluminum, welded design. The small box (TX) is the transmitter unit and contains an infrared diode and lens with dual heaters. The large box (RX) contains two independent receiver sections, each consisting of a photo diode, a lens with dual heaters, and preamplifier electronics. These two sections operate independently. The first receiver detects present weather (in-beam) and the second receiver detects visibility (off-axis). A small panel is attached to the sensor arm to block stray transmitter light from entering the off-axis receiver. The generated signals are sent to a Digital Signal Processor board located behind the receivers.

The dual lens heaters prevent dew, frost, and snow from building up on the lenses, and are self-regulating devices. They are "on" continuously, drawing more current when the outside temperature is cold and less current when the temperature is warm. All wiring between the transmit and the receive heads is within the welded head frame. The sensor head is completely sealed from water intrusion at the factory. Exercise care should to avoid drilling or otherwise puncturing the frame.

The connecting cable for power and data is found at the bottom of the receiver box along with the temperature probe. The 7.6 m (25 ft) cable is supplied as part of the sensor to connect the Model 6497 Present Weather and Visibility Sensor to the electronics inside the electronics enclosure. A ¼-20 threaded hard point and screw are provided on the side of the receiver for electrical grounding. A green ground cable is included to connect the sensor to earth ground. *The terms "ground," "electrical ground," and "earth ground" are defined by the National Electric Code or governing local authority.*

A mounting plate, an integral part of the sensor head cross arm, is provided to install the head to a user-supplied mast. Two sets of holes in the mounting plate allow the U-bolts supplied with the head to clamp the head to either a vertical or horizontal pipe up to 50 mm in diameter.

Note:

The sensor head frame contains no user serviceable parts - opening the head will void the warranty!

2.1.2 Electronics Enclosure

The electronics enclosure contains the processing electronics, power supplies, and surge protection circuits.

The electronics enclosure is a fiberglass NEMA-4X type box with a hinged access door, and contains the Model 2715 Universal Power and Communication Module. Figure 1 shows the location inside the enclosure.

The Model 2715 Universal Power and Communication Module is field-replaceable.

The electronics enclosure is mounted with the supplied fastener hardware using the four mounting holes on the enclosure. If a 6497 is purchased by itself, no mounting hardware is provided.

Note:

Exercise care to avoid drilling or otherwise puncturing the electronics enclosure.

2.1.3 Universal Power and Communication Module

Two fuses are located on the Universal Power and Communication Module (see Figure 1). Replace the fuses only with fuses of the same rating, as shown below.

- 10 A 250 V, 5×20 mm slow blow

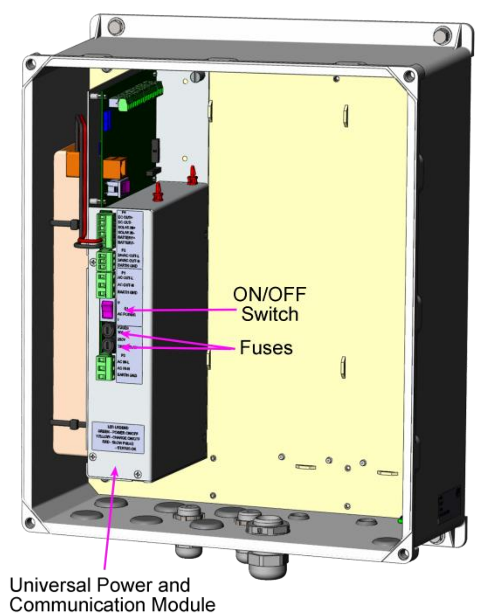


Figure 1. Present Weather and Visibility Sensor Fuses

3. THEORY OF OPERATION

3.1 SENSOR HEAD

The sensor head is a self-contained unit consisting of electro-optical components, heaters, a digital signal processor, and integral cabling to connect with the electronics enclosure.

The sensor measures precipitation by detecting the optical irregularities induced by particles falling through a beam of partially coherent infrared light (in the sample volume). These irregularities are known as scintillation. The twinkling of stars is a familiar example of scintillation. The precipitation rate is determined by detecting the intensity of the scintillations that are characteristic of precipitation. The precipitation type (rain, snow, etc.) is determined by analyzing the frequency spectrum of the induced scintillation. Precipitation is measured using the sensor head "in-beam" optics.

The sensor measures visibility by determining the amount of forward-scattered light received at the off-axis detector. Light is scattered by precipitation, dust, smoke, fog, and other obstructions to visibility in the sample volume. This signal, known as the scatter coefficient, is converted to visibility using a proprietary algorithm. Visibility is measured using the sensor head "off-axis" optics.

A precision thermistor-type temperature probe is attached to the bottom of the receiver box. It is used for automatic temperature compensation in the algorithm. The temperature measured by the probe is not meant for meteorological reporting purposes.

These components make up the sensor head.

- Transmitter
  - Infrared LED
  - Heated transmitter optical lens assembly

- Receiver
  - Heated receiver optical lens assembly
  - Photo detector and preamplifier assembly

- Integral Cables
  - One external cable for connection to electronics enclosure
  - Ground lug for electrical grounding

The transmitter portion of the sensor head uses an infrared LED as a light source that is modulated to eliminate interference in the system caused by background light. The LED has a very long life time, has a relatively low power draw, is invisible to the eye, and presents no radiation hazard to the user.

The LED is housed in the smaller of the sensor head boxes. A lens is used to collimate the LED's carrier-wave modulated light into a slightly diverged beam. The transmit and receive lenses are heated by dual self-regulating positive temperature coefficient thermistors to a temperature just above the ambient temperature to reduce dew, frost, and snow on the lenses.

The larger sensor rectangular box houses the in-beam receive optics for present weather sensing, the off-axis receive optics for visibility sensing, and associated photo diodes and preamplifier electronics. As shown in Figure 2, the in-beam light passes through a horizontal line aperture to increase the precipitation detection sensitivity to particles falling vertically. The full aperture is used on the off-axis optics.

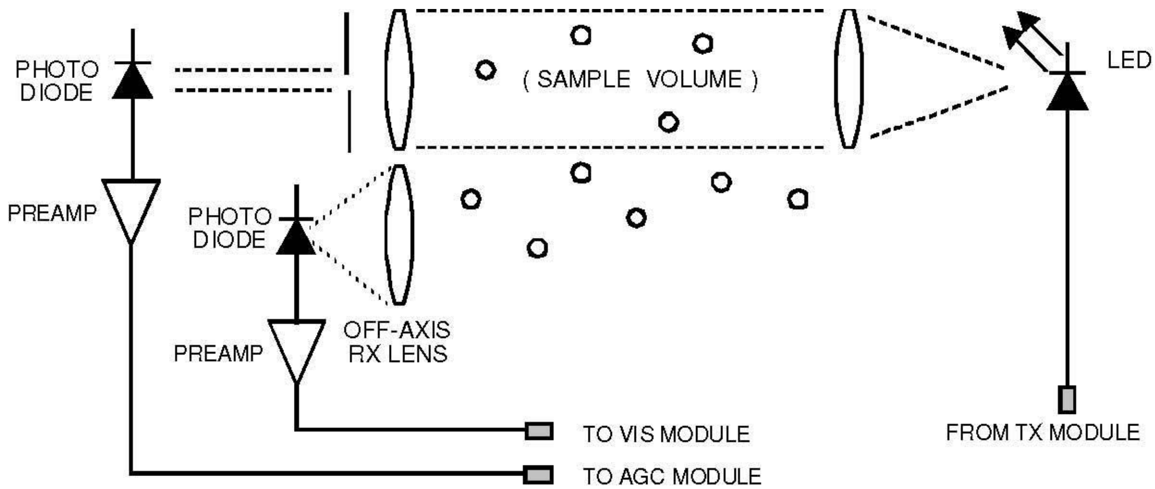


Figure 2. Sensor Operation Block Diagram

Signals from the sensor head are carried in a cable to the electronics enclosure.

3.2 DIGITAL SIGNAL PROCESSING (DSP) ALGORITHM

The electronics supporting the 6497 are integrated inside the sensor head. This section describes the modules that make up the functionality for the DSP algorithm.

The Present Weather Sensor digital signal processor processes the front-end signals.

3.2.1 DSP Algorithm Modules

AGC Module

Automatically adjusts the signal level received from the sensor front end and demodulates the precipitation-induced modulation signal from the carrier frequency.

SP1 Channel

Contains two elements, the carrier (X) channel and the low (L) channel. The carrier channel is used to diagnose the carrier signal strength. The low channel detects precipitation-induced frequencies in the range of 25 to 250 Hz that are associated with snow.

SP2 Channel

Contains two elements, the particle counting (K) channel and the high (H) channel. The particle channel detects the occurrence of falling precipitation. The high channel detects precipitation-induced frequencies in the range of 1 to 4 kHz that are associated with rain.

VIS Module

Contains the amplification, filtering, and synchronous detection to extract the forward-scattered signal related to the visibility.

TX Module

Contains the voltage-controlled oscillator and amplifier to drive the LED in the sensor head.

Digital Module

Contains the A/D, sample and hold, and digital control logic to sample the outputs of the signal processing cards. It determines the precipitation type and intensity using algorithms. The digital module also performs real time self-tests to continually detect faults in the sensor and contains the serial communications port.

Flash ROM Module

Contains an onboard programmable flash ROM and control circuit. A new program can be remotely downloaded without any hardware change.

4. INSTALLATION

4.1 SITING AND INSTALLATION GUIDELINES

The Model 6497 Present Weather and Visibility Sensor may be installed almost anywhere outdoors. An area free and clear of obstructions and contamination sources will help insure good sensor performance.

In general, the sensor should be located on level or slightly sloping ground where the sensor site will be exposed to the same environment as the area around it. Ideally, the area around the site should be free of buildings, trees, and other obstructions.

All Weather, Inc. recommends that the siting and installation follow the general guidelines established by the Office of the Federal Coordinator for Meteorology (OFCM). The *Federal Standard for Siting Meteorological Sensors at Airports*, OFCM document # FSM-S4-1994, makes the following recommendations.

1. Distance from Obstructions — The distance between the sensor and obstructions such as trees or buildings should be at least 2 times the height of the obstruction on all sides. For example, if a tree 20 m high is located alongside the sensor, the sensor should be at least 40 m away from the tree. This restriction reduces the effects of wind turbulence created by the nearby obstruction and makes the precipitation measurement more representative. Do not locate the sensor where tree branches or wires will hang over the sensor!

2. Separation from Turbulence and Contamination Sources — Do not mount the sensor near building exhaust vents, strobe lights, or sources of smoke or steam. Where possible, locate the unit as far away from runways and roads as possible to reduce optics fouling from wind-blown road dirt. An ideal minimum distance is at least 30 m.

3. Sensor Height, Rigidity, Verticality, and Orientation — The OFCM recommends that the Present Weather Sensor be mounted at a height of 10 ft (3 m). This height is not always possible because of constraints imposed by the site. Mounting the sensor head lower than 2 m or higher than 5 m is not generally recommended.

   For AWOS installations, All Weather, Inc. recommends that the sensor head be mounted on a pipe. If the pipe mast is more than 5 cm (2") in diameter, a mast coupling with a diameter of 5 cm (2") or less should be placed on top of the pipe.

   The 6497 may also be installed on the sensor tower at a height of 10 ft above the tower base. Install the controller box on the tower close to the AWOS Data Collection Processor box. When installing on the Model 8518-A Foldover Tower, mount the Present Weather Sensor to the hinged side of the tower.

   The installation must be rigid so that wind-induced vibration does not cause false alarms. This can be accomplished by mounting the sensor to a thick wall pipe such as "Schedule 40" type or to a rigid boom arm 1 m in length or shorter. The Present Weather Sensor may be mounted on the top of a building is acceptable if it located near the center of the building away from the wind turbulence that may occur near the edges.

The sensor head must be mounted vertical within ±2 degrees so that the line aperture on the in-beam lens is horizontal.

4. The sensor head is generally oriented with the transmitter head on the north side (in the Northern hemisphere) so that the receiver optics face north. Align the sensor head so that the receive lens faces north. If the orientation can be altered to either side of north to obtain a "view" with fewer or more distant obstructions, it is generally acceptable to alter the orientation up to ±30 degrees from north.

5. General Recommendations

   - The sensor must be mounted vertical within ± 2 degrees so that the line aperture on the in-beam lens is horizontal.
   - The sensor is generally oriented with off-axis lens facing away from highway or contamination sources to avoid dirt splash directly into the lenses.
   - The sensor should be oriented to avoid direct sunlight shining into the off-axis lens.

Additional siting and installation guidelines are provided in FAA Order 6560.20B, *Siting Criteria for Automated Weather Observation Systems (AWOS)*.

SUGGESTION: Take a picture at the installation site in each direction (north, east, south, and west) to record the topography and obstructions for future reference.

4.2 MECHANICAL INSTALLATION

4.2.1 Preparation

The sensor and site should be readied prior to beginning the installation.

SITING GUIDELINES

- ✓ Sensor head mounted 2–5 m above ground
- ✓ Rigid mounting pole
- ✓ In-beam lens aperture horizontal to ±2 degrees
- ✓ No overhanging trees, wires, or roof lines
- ✓ Distance between sensor and closest obstruction at least 2 times obstruction height
- ✓ As far from road, runway, and contamination sources as possible

The Model 6497 Present Weather and Visibility Sensor is packed in two heavy-walled corrugated cartons. One carton contains the electronics enclosure and the larger, narrow carton contains the sensor head and cables. Also packed in this carton are the sensor head U-bolt mounting hardware, and electronics enclosure mounting hardware. When opening the cartons, be careful to avoid spilling the contents.

CAUTION!

Exercise care when removing the sensor head from its packing carton. The temperature probe at the bottom of the sensor head extends out a short distance and can break easily.

Report any shortages or shipping damage to All Weather Inc. within 3 days.

CAUTION!

Do NOT drill holes in any portion of the sensor head or electronics enclosure! Doing so will void the warranty and may allow water to enter the enclosure!

Site Preparation

1. Choose the site using the guidelines in Section 4.2.1.
2. Following applicable electrical and building codes, install a concrete mounting base, mast or tower, AC power cable, RS-485 signal cable, and ground rod.

4.2.2 Mount the Sensor Head

The sensor must be securely installed and correctly oriented to work properly.

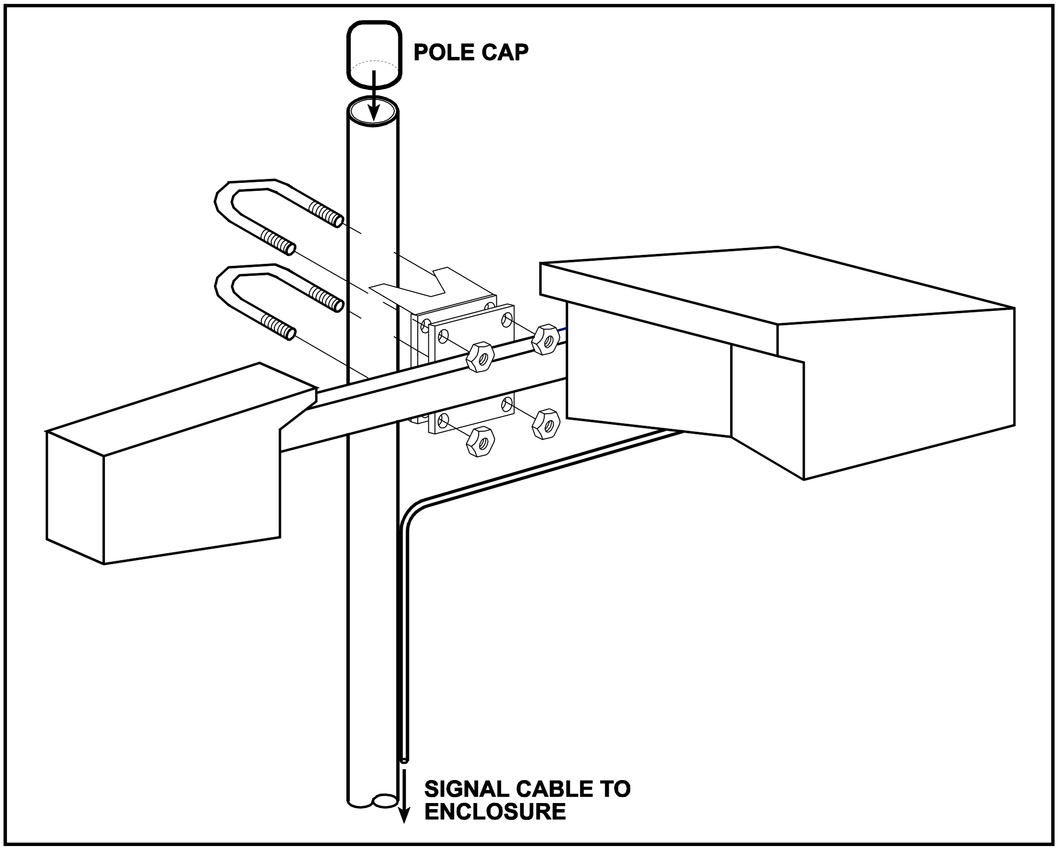


Figure 3. Mounting Present Weather Sensor Head

1. Attach the sensor head using the two U-bolts to connect the mounting plate on the sensor head and the mounting bracket with the ¼-20 hex locking nuts as shown in Figure 3. To mount the head to a vertical mast or tower section, install the U-bolts and mounting bracket horizontally. To mount to a horizontal tower section or boom arm, install them vertically using the same holes.

   Note that the metallurgy of the stainless U-bolts will cause the nuts to seize to the U-bolts and twist them off. Lubricate the threads with anti-seize compound before assembling.

   Do not tighten the nuts completely until the sensor head is installed on the mast or tower and is oriented on the north-south axis as shown in Figure 4.

2. Rotate the sensor head until the receive lens is facing north.

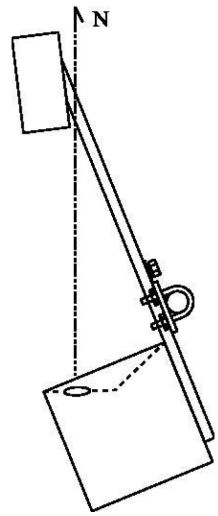


Figure 4. Sensor Head Orientation

When mounting the sensor head on a tower, choose the tower leg that gives the larger head an unobstructed view to the North without rotating the head assembly into the tower. The head assembly should be completely outside the tower as much as possible.

3. Tighten the U-bolt nuts when the orientation is correct. (Do not overtighten such that the mounting plate is bent).
4. Route the cables along the mast or tower to the electronics enclosure and secure them to the mast or tower every meter using tie-wraps or other straps.
5. Connect the ground cable to a ground rod.

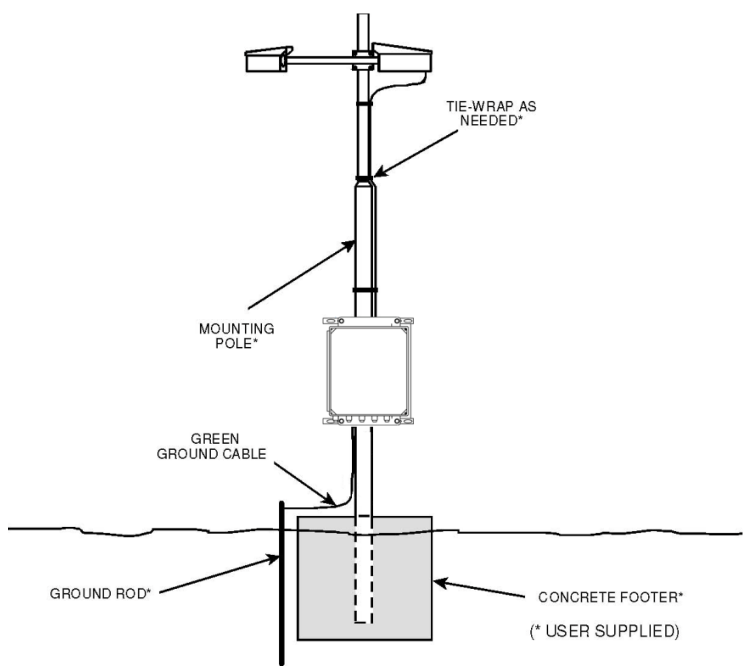


Figure 5. Installation of Ground Cable

4.2.3 Install the Electronics Enclosure

The Electronics Enclosure mounts on the mast below the sensor using the mounting hardware included with the enclosure.

In installations where a non-frangible tower is used, mount the Electronics Enclosure on the mast with the top of the enclosure 5'6" (167 cm) from ground level, or at least 3 ft (1 m) above maximum snow level. In installations where a frangible tower is used, mount the Electronics Enclosure on the mast with the top of the enclosure 3'6" (107 cm) from ground level. Attach the Electronics Enclosure to the mast using mounting hardware as shown in Figure 6.

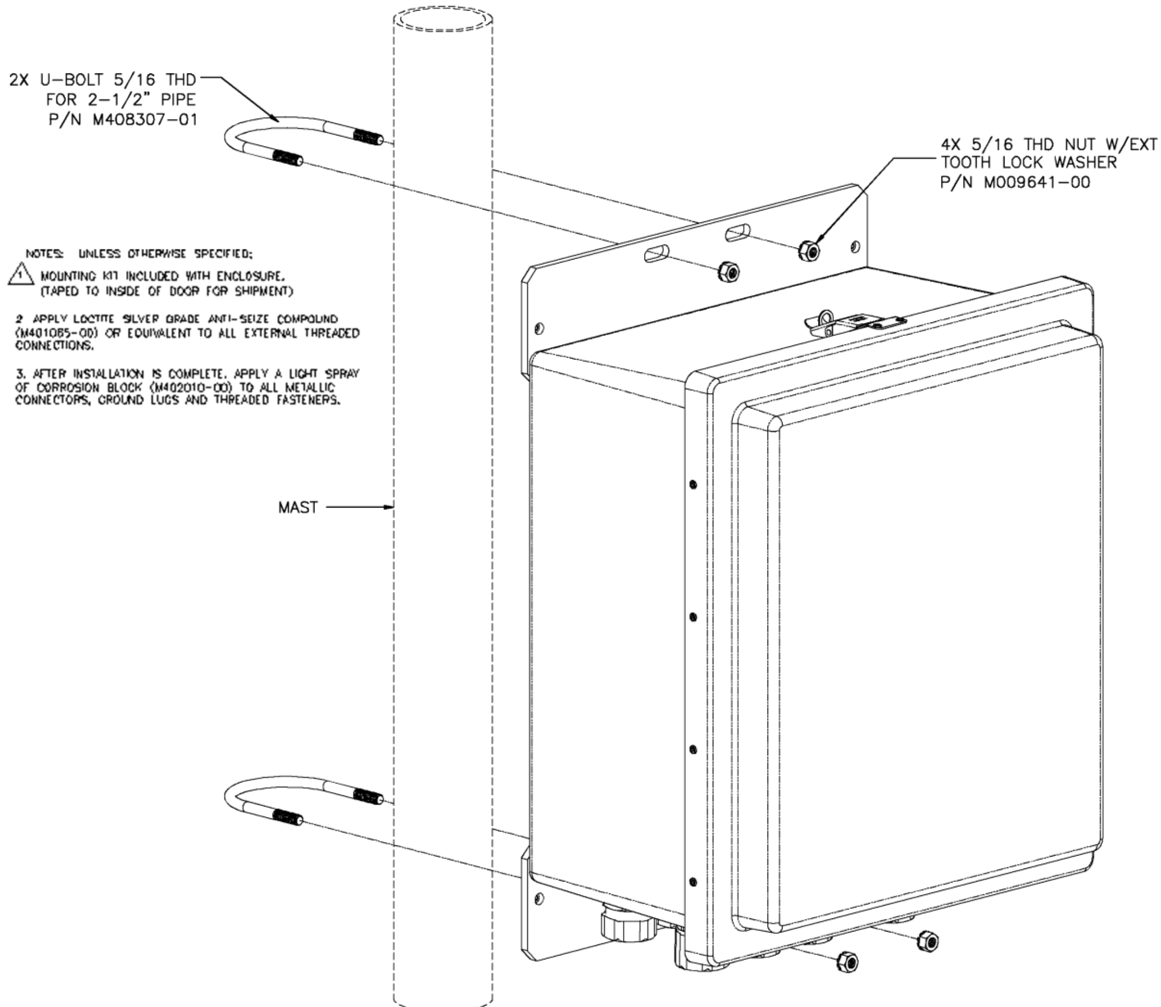


Figure 6. Mounting Enclosure on Mast

These additional steps will help keep the mounting secure and corrosion-resistant.

- Apply anti-seize compound to all external threaded connections.
- Once the installation of the enclosure has been completed, apply a light spray of corrosion block to all metallic connectors and threaded fasteners.

4.3 ELECTRICAL CONNECTIONS

Figure 7 shows the external connections at the bottom of the enclosure.

- AC power conduit.
- Signal cable from sensor head.
- Serial cable to DCP or Central Data Processor (CDP).

A user supplied ground wire should also be connected to the ground lug to ground the Model 6497 Present Weather and Visibility Sensor to earth potential per local electrical codes.

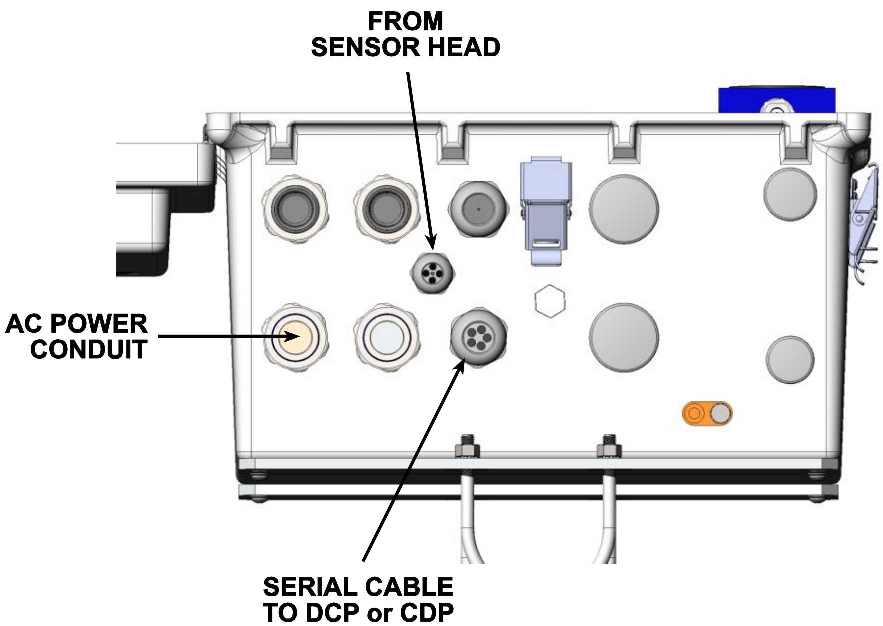


Figure 7. External Connections at Enclosure Bottom

Before proceeding, verify that the power switch on the Universal Power and Communication Module is turned "OFF."

Route the cable from the sensor head to the bottom of the electronics enclosure. Secure the cable to the mast using tie-wraps or other straps.

1. Route the cable from the sensor head into the electronics enclosure as shown in Figure 7.
2. Connect the sensor head wires using a friction lock connector to Serial Output 2 on the Universal Power and Communication Module inside the enclosure shown in Figure 8 according to the wiring diagram in Section 4.3.1.

Figure 8 shows the inside of the electronics enclosure.

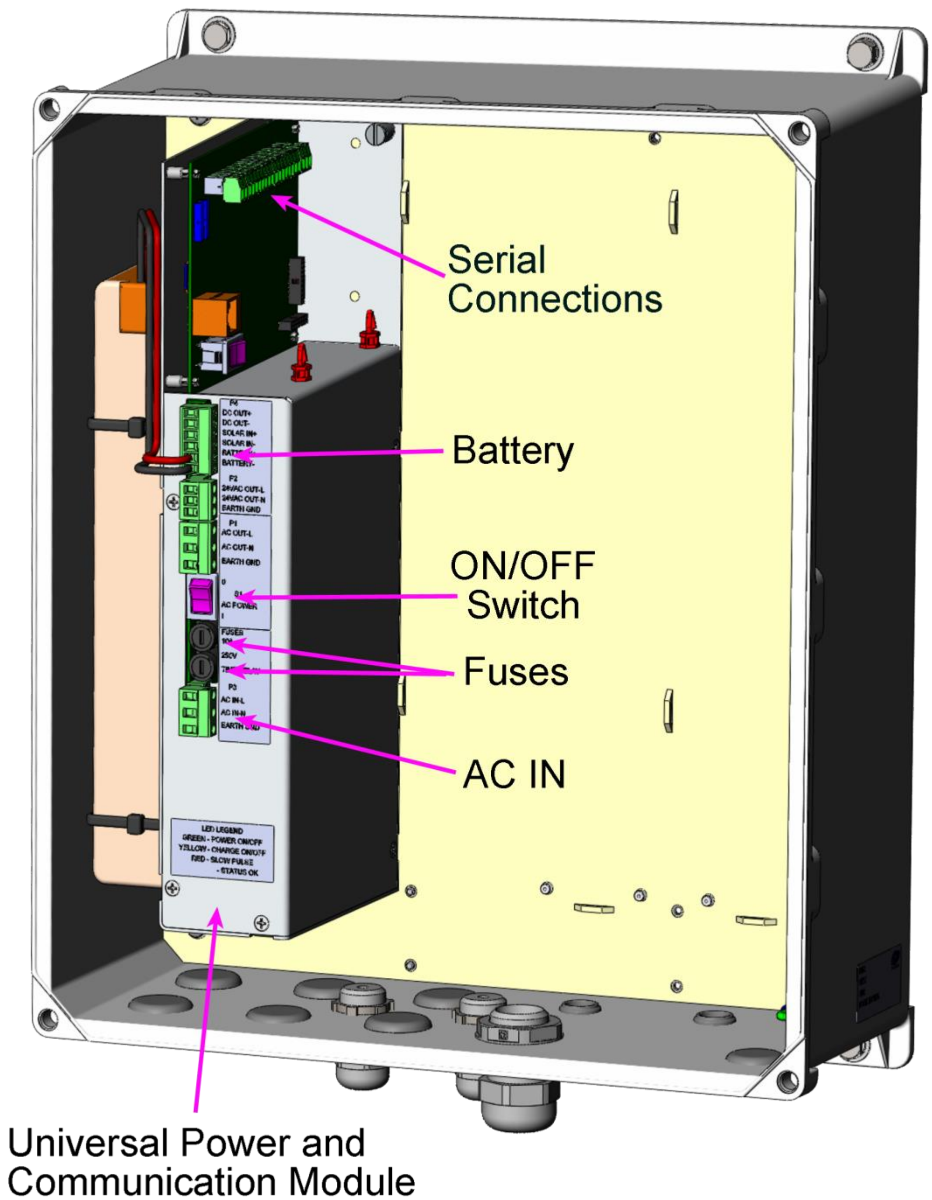


Figure 8. Present Weather and Visibility Sensor Enclosure (inside view)

4.3.1 Summary of Signal and Power Wiring Connections

Table 1 and Table 2 provide the serial connections for the default half-duplex RS-485 serial communication option for the two different styles of wire coming from the sensor head. The Model 2715 Universal Power and Communication Module may also be configured to provide RS-232 or full-duplex RS-485 signals at Serial Output 1. The ***Model 2715 Universal Power and Communication Module User’s Manual*** describes these wiring options and explains how to install the required firmware to support these options.

1. If the shielded serial cable is not already connected to Serial Output 1 on the Universal Power and Communication Module, wire the friction lock connector as shown in Table 1 and Table 2.
2. Feed the free end of the shielded serial cable through the serial cable gland shown in Figure 7.
3. Strip and tin the ends of the wires.
4. Route the cable and connect it to the computer or computer interface.
5. Ensure that none of the wires are stressed, then hand-tighten the gland seals on all the enclosures.

Table 1. Model 6497 Present Weather and Visibility Sensor Signal and Power Wiring (no twisted-pair wiring)

Serial Output 2 Pin	Function	Color
1	HTR + 12 V + 12 V DC	YELLOW RED
2	GND	GREY BLACK
4	RS-232 Rx	GREEN
5	GND	BROWN
8	Cable Shield	SHLD
7	RS-232 Tx	WHITE
Serial Output 1 Pin	**Function**	**Color**
3	RS485 (D–)	Any colors may be used as long as they match the signals on each end of the connection.
4	RS485 (D+)	
5	GROUND	
DC Power Pin	**Function**	**Color**
5	Battery +	RED
6	Battery –	BLACK
AC Pin	**Function**	**Color**
1	HOT	BLACK
2	NEUTRAL	WHITE
3	GROUND	GREEN

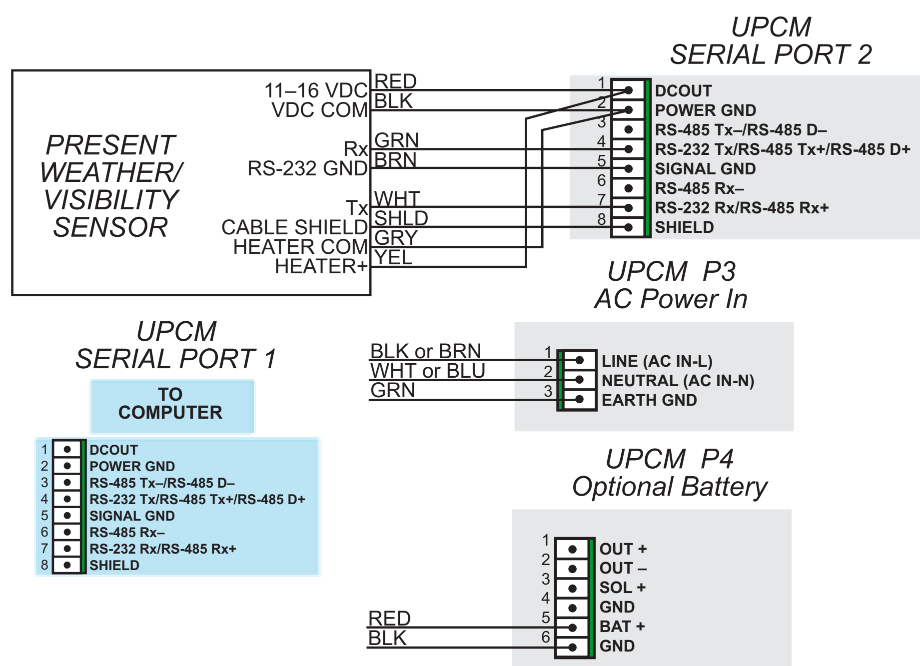
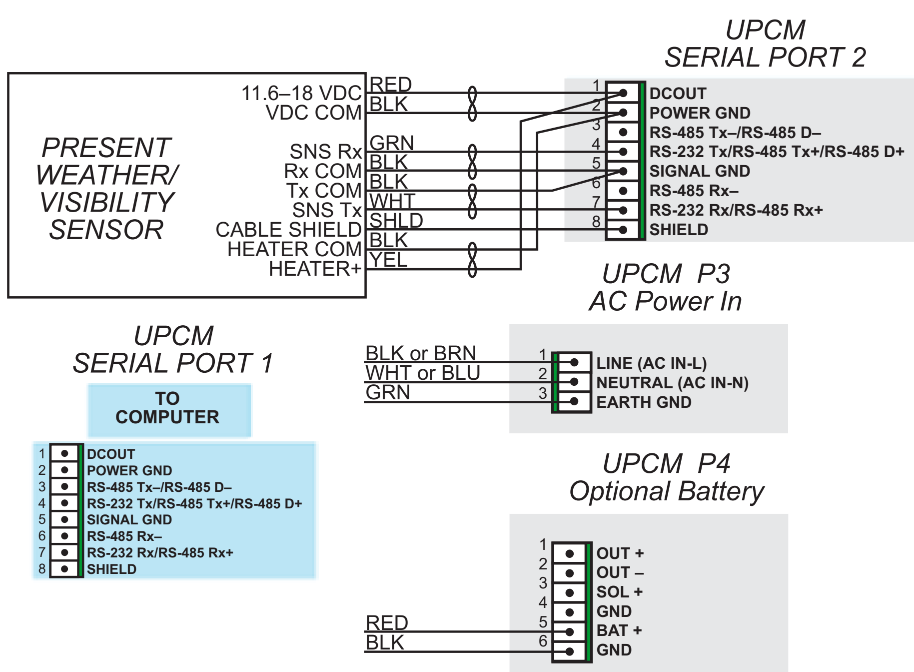


Table 2. Model 6497 Present Weather and Visibility Sensor Signal and Power Wiring (twisted-pair wiring)

Serial Output 2 Pin	Function	Color
1	HTR + 12 V + 12 V DC	YELLOW RED
2	GND	BLACK
4	SNS Rx	GREEN
5	Tx/Rx RTRN	BLACK
7	SNS Tx	WHITE
8	Cable Shield	SHLD
Serial Output 1 Pin	**Function**	**Color**
3	RS485 (D–)	Any colors may be used as long as they match the signals on each end of the connection.
4	RS485 (D+)	
5	GROUND	
DC Power Pin	**Function**	**Color**
5	Battery +	RED
6	Battery –	BLACK
AC Pin	**Function**	**Color**
1	HOT	BLACK
2	NEUTRAL	WHITE
3	GROUND	GREEN



4.3.2 Connecting the Sensor to the AC Power Line

Connections are made to the Universal Power and Communication Module inside the electronics enclosure

AC power connections are made to the Universal Power and Communication Module located inside the electronics enclosure. A 3-wire, single-phase AC source is required consisting of hot, neutral, and earth ground connections.

WARNING

Turn off electrical power at the source before making the electrical connections to the sensor!

1. Install a conduit fitting at the location shown in Figure 7. Feed the power cable through the conduit fitting. A 3-wire 16 to 18 AWG cable is recommended.
2. Connect a friction lock plug connector to the ends of the wires so that hot, neutral, and ground will be connected shown in Table 1 and Table 2.

5. OPERATION WITH AN AWOS

When the Model 6497 Present Weather and Visibility Sensor is connected directly to a CDP or other data processing system, UPCM poll commands can be used. These are described in the ***Model 2715 Universal Power and Communication Module User’s Manual***.

The details in the rest of this chapter are for when the sensor is connected to a DCP.

5.1 SENSOR INTERFACE

5.1.1 Physical

The serial signal consists of a three-wire RS-485 connection.

Data transfer across the interface is implemented via a serial, ASCII encoded, half duplex, 4800 bps, asynchronous transfer link. Data transfer in the DCP-to-sensor direction is limited to a 7-character poll. Data transfers in the sensor-to-DCP direction are fixed-format ASCII strings, starting with an equals sign (=) and terminated with a carriage return (<CR>).

5.1.2 Protocol

In order to keep the interface design effective and simple, the protocol does not support unsolicited messages to the DCP. In other words, the only time the sensor is allowed to transmit a message to the DCP via this link is in direct response to a poll transmission from the DCP, which requires the return of the standard data reply string.

Note that the sensor is sampling data continually (every 5 seconds) and processing the precipitation algorithm (once a minute typical). In most cases, the DCP’s response time to a poll will begin within 100 ms after receiving the poll. Requesting data from the sensor more than once per minute will result in identical data transmittals being sent within the one-minute period.

5.2 PRESENT WEATHER DATA

5.2.1 Poll Command

PRWX*aa* <CR>, where *aa* is the physical address of the sensor (typically 00).

5.2.2 Frame Format

The standard output frame format is shown below. Details of the data fields are presented in a later section. Each of the transmitted characters are eight (8) bit (msb - bit 7 - always 0), no parity ASCII (decimal codes 0 to 127), with 1 stop bit. The status code and other information, is formatted in this way as printable ASCII characters to aid in system debugging and field maintenance.

The output message from the interface computer in response to the poll consists of the following string of characters.

Position	Contents	Description
1	<blank><blank><equals sign>	start of message string
4	WxxPppppSssss	W plus weather code (see Section 5.2.4) P plus rain rate in 0.001 inches per hour S plus four-digit status code (see Section 5.2.5)
17	<blank>	
18	XnnnLnnnKnnnHnnnTnnn	engineering data (see Section 5.2.3)
38	<blank>	
39	sensor crc error counter <blank> sensor input msg counter	engineering data (see Section 5.2.3)
	<blank> 4-character CRC<cr><lf>	crc from position 4 up to but not including the crc itself

5.2.3 Data Format

The raw weather information from the sensor head is encoded in the reply message as follows. Section 5.2.4 provides the processed data that are provided to the DCP by the sensor.

Byte	Description	Value
1	Start of transmission	=
2	Weather type marker	W
3-4	Present weather field	ww
5	Precipitation rate marker	P
6-9	Precipitation rate field	pppp
10	Status field marker	S
11-14	Status field	ssss
15	Blank	0x20
16	Carrier raw data field marker	X
17-19	Carrier 1 min average raw data	nnn
20	Low raw data field marker	L
21-23	Low 1 min average raw data	nnn
24	Particle raw data field marker	K
25-27	Particle 1 min average raw data	nnn
28	High raw data field marker	H
29-31	High 1 min average raw data	nnn
32	Temperature field marker	T
33-35	Temperature field	ttt
36	Blank	0x20

This section describes the format of the various fixed fields as they are used in the poll response above.

1. The capital letters "W", "P", "S", "X", "L", "K", "H", and "T" above serve as place markers for the Weather, Precipitation, Status, Carrier, Low, Particle, High, and Temperature data fields to follow. These markers are fixed in position and coding. They are included within the format to simplify manual interpretation of the sensor output.
2. ww is a two-byte field indicating present weather. The weather codes contained in this field are described in Section 5.2.4.
3. pppp is a four-byte field indicating the precipitation rate. Zero is formatted as four zeros ("0000"). The number is a floating point format, varying from 0.001 to 9999. The units are inches/hour (millimeters/hour) rain rate, averaged over a one minute period.
4. ssss is a four-character field containing ASCII encoded hex value reserved for error and status codes. Each character represents a four bit field of binary information. The four-bit field contains status information of the field-replaceable units (FRUs). The status codes in this field are described in Section 5.2.5.
5. nnn is a three-byte ASCII numeric field indicating the corresponding one-minute averaged raw data in tens of millivolts. Leading/unused positions are filled with zeros. Valid values are -99 to 999. Overflows and underflows are represented as 999 and -99, respectively.

6. ttt is a three-byte ASCII numeric field indicating the temperature indicated by the probe on the bottom of the enclosure. It is for diagnostic purposes and should not be used as a true meteorological temperature. The valid values are -99 to 999 in units of degrees Fahrenheit. Note that a value of -99 indicates a defective or missing temperature probe.

5.2.4 Present Weather Codes

The poll response contains weather codes formatted in NWS type format. The latest one-minute weather code (ww) is found in bytes 3 and 4 immediately following the "W" place marker.

WX Code	NWS WX Code Description	WX Code	NWS WX Code Description
L-	Light Drizzle	___	No Precipitation
L_	Moderate Drizzle	--	Start-up code
L+	Heavy Drizzle	ER	Error Condition
R-	Light Rain	CL	Lenses need to be cleaned (only reported when no precip.)
R_	Moderate Rain		
R+	Heavy Rain		
P-	Light Precipitation		
P_	Moderate Precipitation		
P+	Heavy Precipitation		
S-	Light Snow		
S_	Moderate Snow		
S+	Heavy Snow		
ZL	Freezing Drizzle		
ZR	Freezing Rain		

The "_" (underline) character above represents an ASCII underline character. The "--" code will be output in this and other data fields during the first 60 seconds or so after reset or power-up of the sensor.

Note: AWOS installations with a Present Weather and Visibility Sensor will also report fog, freezing fog, haze, and mist. This information does not originate with the 6497 sensor, but is derived from inputs from other sensors.

5.2.5 Status Codes

The status codes are a convenient way for the sensor to report sensor condition and identify faulty subassemblies.

The status field, denoted by s s s s (four bytes) in the data output format, is a four-byte field of sensor status bytes. The codes can be interpreted as shown in the table below.

	S	s	s	s	s
BYTE	**10**	**11**	**12**	**13**	**14**

BIT	STATUS	BIT	STATUS	BIT	STATUS	BIT	STATUS
0	**OK**	**0**	**OK**	**0**	**OK**	**0**	**OK**
1	**FRU 2**	**1**	**FRU 1**	**1**		**1**	
2		**2**		**2**		**2**	**R**
3		**3**		**3**		**3**	**E**
4		**4**		**4**		**4**	**S**
5		**5**		**5**		**5**	**E**
6		**6**		**6**		**6**	**R**
7		**7**		**7**		**7**	**V**
8		**8**		**8**	**RESET**	**8**	**E**
9		**9**		**9**		**9**	**D**

A status code of 0 in bytes 11, 12, 13 or 14 indicates "no problem," while a number or letter other than 0 indicates one or more FRUs may be defective. For instance, if byte 11 read "1", then FRU 2 should be checked.

Example

Status codes read S0180. Interpret this code as follows.

Byte 11 = 0 OK
Byte 12 = 1 FRU 1 probably bad
Byte 13 = 8 Sensor was reset in past 5 minutes
Byte 14 = 0 OK

Solution

Wait for 5 minutes to verify that the reset bit turns off. The status code will now read S0100, indicating that there may be a problem with FRU 1. Replace FRU 1 (Sensor Head) and recheck the status code. After 5 minutes (when reset bit turns off again) status codes should be S0000.

In normal operation (excluding the first five minutes after reset or power-up), the status bytes will be all low (0000). A non-zero character in any of the four positions indicates the suspected failure of an FRU. The host system should take action to alert maintenance personnel of a possible problem. In addition, data from the OWI should be disregarded and a "missing" report issued. (Note that the sensor does not necessarily stop outputting data when a status bit flags an error condition.) The table below summarizes the active status bits and the corresponding FRUs and assembly numbers.

FRU #	Item Description	All Weather Inc. P/N
FRU 1	Sensor Head Assembly	M482227-00
FRU 2	Electronics Power Supply	2715

The FRUs are available for maintenance and repair of the sensor in the field or depot. The sensor head contains no user replaceable parts and can not be repaired except at the factory.

5.2.6 Check Sum Calculation

The CRC is calculated using a standard crc-16 formula. The algorithm is as follows.

```
/* CRC routine used with AWOS remote sensors

USE:  crc = crc16(buffer, length, initial_value)

      where:  crc is the returned value,
              buffer is the data buffer to compute a crc
              length is the number of bytes in buffer to process
              initial_value is the results of previous crc calculations
                 that will allow the buffer crc to be computed in
                 stages if necessary. If this is not necessary,
                 then set initial_value to 0.

*/


unsigned int crc16(char *string, unsigned int length, unsigned int ival)

    /* buffer address to compute a crc */
    /* number of characters to process */
    /* initial value of crc            */
 {

      static unsigned int crc;

      /*   CRC values for crc16 routine                              */

      static unsigned int crc_vals[] =
      {
            0x0000,0xc0c1,0xc181,0x0140,0xc301,0x03c0,0x0280,0xc241,
            0xc601,0x06c0,0x0780,0xc741,0x0500,0xc5c1,0xc481,0x0440,
            0xcc01,0x0cc0,0x0d80,0xcd41,0x0f00,0xcfc1,0xce81,0x0e40,
            0x0a00,0xcac1,0xcb81,0x0b40,0xc901,0x09c0,0x0880,0xc841,
            0xd801,0x18c0,0x1980,0xd941,0x1b00,0xdbc1,0xda81,0x1a40,
            0x1e00,0xdec1,0xdf81,0x1f40,0xdd01,0x1dc0,0x1c80,0xdc41,
            0x1400,0xd4c1,0xd581,0x1540,0xd701,0x17c0,0x1680,0xd641,
            0xd201,0x12c0,0x1380,0xd341,0x1100,0xd1c1,0xd081,0x1040,
            0xf001,0x30c0,0x3180,0xf141,0x3300,0xf3c1,0xf281,0x3240,
            0x3600,0xf6c1,0xf781,0x3740,0xf501,0x35c0,0x3480,0xf441,
            0x3c00,0xfcc1,0xfd81,0x3d40,0xff01,0x3fc0,0x3e80,0xfe41,
            0xfa01,0x3ac0,0x3b80,0xfb41,0x3900,0xf9c1,0xf881,0x3840,
            0x2800,0xe8c1,0xe981,0x2940,0xeb01,0x2bc0,0x2a80,0xea41,
            0xee01,0x2ec0,0x2f80,0xef41,0x2d00,0xedc1,0xec81,0x2c40,
            0xe401,0x24c0,0x2580,0xe541,0x2700,0xe7c1,0xe681,0x2640,
            0x2200,0xe2c1,0xe381,0x2340,0xe101,0x21c0,0x2080,0xe041,
            0xa001,0x60c0,0x6180,0xa141,0x6300,0xa3c1,0xa281,0x6240,
            0x6600,0xa6c1,0xa781,0x6740,0xa501,0x65c0,0x6480,0xa441,
            0x6c00,0xacc1,0xad81,0x6d40,0xaf01,0x6fc0,0x6e80,0xae41,
            0xaa01,0x6ac0,0x6b80,0xab41,0x6900,0xa9c1,0xa881,0x6840,
            0x7800,0xb8c1,0xb981,0x7940,0xbb01,0x7bc0,0x7a80,0xba41,
            0xbe01,0x7ec0,0x7f80,0xbf41,0x7d00,0xbdc1,0xbc81,0x7c40,
            0xb401,0x74c0,0x7580,0xb541,0x7700,0xb7c1,0xb681,0x7640,
            0x7200,0xb2c1,0xb381,0x7340,0xb101,0x71c0,0x7080,0xb041,
```

```
            0x5000,0x90c1,0x9181,0x5140,0x9301,0x53c0,0x5280,0x9241,
            0x9601,0x56c0,0x5780,0x9741,0x5500,0x95c1,0x9481,0x5440,
            0x9c01,0x5cc0,0x5d80,0x9d41,0x5f00,0x9fc1,0x9e81,0x5e40,
            0x5a00,0x9ac1,0x9b81,0x5b40,0x9901,0x59c0,0x5880,0x9841,
            0x8801,0x48c0,0x4980,0x8941,0x4b00,0x8bc1,0x8a81,0x4a40,
            0x4e00,0x8ec1,0x8f81,0x4f40,0x8d01,0x4dc0,0x4c80,0x8c41,
            0x4400,0x84c1,0x8581,0x4540,0x8701,0x47c0,0x4680,0x8641,
            0x8201,0x42c0,0x4380,0x8341,0x4100,0x81c1,0x8081,0x4040};

crc = ival;
while(length--)
   crc = crc_vals[(*string++ ^ crc) & 0xff] ^ ((crc >> 8) & 0xff);
return crc;
}

/* end crc16 routine */
```

5.3 VISIBILITY DATA

5.3.1 Poll Command

VISI*aa* <CR><LF>, where *aa* is the physical address of the sensor (typically 00).

5.3.2 AWOS Output Data Format

Table 3 shows the data output format used between the 6497 and the DCP in AWOS systems. The AWOS format data packet consists of the extinction coefficient as calculated by the 6497, and Status Words 0, 1, and 2 (see Tables 3, 4, and 5).

The cyclic redundancy code, CRC16, covers all bytes up to but not including the 4 bytes of CRC. Following the packet, but external to it, are a carriage return and a line feed to allow the use of printers or terminals in monitoring the data.

Table 3. AWOS Output Data Format

AWOS Output Data Format			
Segment	**Length (bytes)**	**Description**	**Example**
Extinction coefficient	3	extinction coefficient from 6497	1.16
blank			
Status Word 0	4	see Table 5	0048 (h)
blank			
Status Word 1	4	see Table 6	0000 (h)
blank			
Status Word 2	4	see Table 7	0004 (h)
blank			
ALS value	up to 5 digits	ALS data	245
blank			
Packet counter	1	increments with each packet; range is from 0–7, inclusive	3
blank			
8365 flag	1	1 if 8365; 0 if other model	1
blank			
ending sequence	3	always 0<sp>0<sp>0	0 0 0
CRC	2	CRC, MSB	"ASCII byte ""XX"""
CRC	2	CRC, LSB	"ASCII byte ""XX"""
Termination	1-2	cr-lf	

* ""(XX)"" signifies that the number shown is a hexadecimal number"

5.3.3 Status Words

Three status words are output by the 6497, and can be used for troubleshooting sensor problems. Status Word 0 (Table 4) contains information vital for ensuring data integrity, along with some basic configuration information. Status Word 1 (Table 5) contains status information for the emitter and detector heads and operational modes. Status Word 2 (Table 6) contains ambient light information, along with power supply status.

5.3.3.1 Decoding Status Words

The status words are expressed as hexadecimal numbers derived from the binary values for each of the individual status bits in the word. Hexadecimal numbers are used because a single hexadecimal character can represent four binary digits (bits). The hexadecimal system includes the numbers 0-9 and the characters A-F, with A-F being used to represent the numbers 10-15 with a single character.

Each hexadecimal character in a status word represents the sum of four binary digits (bits). Binary and hexadecimal numbering proceeds from the right to the left, so the rightmost character represents the binary sum of bits 0-3; the second character from the right represents the sum of bits 4-7; the next character to the left represents the sum of bits 8-11; and the leftmost character represents the sum of bits 12-15.

The following section contains a step-by-step discussion of how to decode an example status word. A worksheet is provided in Figure 9, which provides spaces to write in actual status words, with each bit already numbered. This table will simplify status word decoding, and can be copied to provide additional worksheets.

Table 4. Status Word 0

Visibility Sensor Status Word 0			
BIT	**FUNCTION**	**VALUE**	**MEANING**
2-1-0	averaging interval	000 001 010 011	3 minutes 5 minutes 10 minutes 1 minute
5-4-3	output interval	001 010 011 100	10 seconds 1 minute 5 minutes 10 minutes
6	output type	0 1	visibility extinction coefficient
7	units	0 1	miles kilometers
8	configuration error indicator	0 1	OK error
9	visibility data incomplete status	0 1	data complete data incomplete (from at least 1 head)

Table 4. Status Word 0

Visibility Sensor Status Word 0			
BIT	**FUNCTION**	**VALUE**	**MEANING**
10	visibility data missing status	0 1	OK data from more than 1 head is missing
11	visibility dirty window status	0 1	OK window dirty
12	three-headed operation indicator	0 1	Four-headed operation (normal) Three-headed operation
13-15	unused		

Table 5. Status Word 1

Visibility Sensor Status Word 1			
BIT	**FUNCTION**	**VALUE**	**MEANING**
0	mode 0, direct	0 1	OK failed
1	mode 0, indirect	0 1	OK failed
2	mode 1, direct	0 1	OK failed
3	mode 1, indirect	0 1	OK failed
4	emitter 0 status	0 1	OK failed
5	emitter 1 status	0 1	OK failed
6	detector 0 status	0 1	OK failed
7	detector 1 status	0 1	OK failed
8	cross-check	0 1	OK failed
9	emitter 0 heater status	0 1	OK failed
10	emitter 1 heater status	0 1	OK failed
11	detector 0 heater status	0 1	OK failed
12	detector 1 heater status	0 1	OK failed
13	ALS or D/N heater status (note: this bit is ignored when neither an ALS nor Day/Night sensor is present)	0 1	OK failed
14-15	reserved		

Table 6. Status Word 2

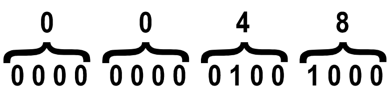
Visibility Sensor Status Word 2			
BIT	**FUNCTION**	**VALUE**	**MEANING**
0	ALS installed status	0 1	ALS present ALS not installed
1	ALS dirty window status	0 1	OK window dirty
2	D/N sensor installed status	0 1	D/N present D/N not installed
3	Day/Night indicator (note: this bit is only valid if a D/N sensor is present)	0 1	night day
4-7	unused		
8	power source indicator	0 1	on AC power on battery power
9	5V power supply status	0 1	OK failed
10	15 V power supply status	0 1	OK failed
11	-15 V power supply status	0 1	OK failed
12-15	unused		

Example

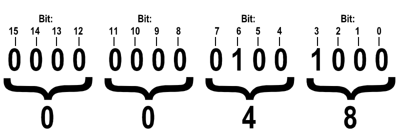
As an example of how to decode a status word, let's use the value 0048. This is a common value for Status Word 0, since it represents a common configuration and operating status for an 6497 functioning normally.

To decode the status word, the first step is to convert the four hexadecimal characters to their binary equivalents. Table 7 shows the binary equivalents for all the possible hexadecimal characters.

Locate the binary equivalent for each hexadecimal character in the table, and write them down. For the example (0048), this would give:



There should be 16 bits in total, with each bit having a value of either 0 or 1. Start with the rightmost bit, assign the next number to each bit, beginning with Bit 0 as shown below.



The bits can then be compared against Table 4 to determine their meanings.

Table 7

Hexadecimal and Binary Equivalents	
Hexadecimal Value	**Binary Value**
0	0 0 0 0
1	0 0 0 1
2	0 0 1 0
3	0 0 1 1
4	0 1 0 0
5	0 1 0 1
6	0 1 1 0
7	0 1 1 1
8	1 0 0 0
9	1 0 0 1
A	1 0 1 0
B	1 0 1 1
C	1 1 0 0
D	1 1 0 1
E	1 1 1 0
F	1 1 1 1

In most cases, each individual bit represents a certain condition based on its value of 0 or 1. The first six bits in Status Word 0 are the only exception to this. These bits are used in combination to convey configuration information (averaging interval and output interval), and so must be looked at as a group rather than as individual bits. To simplify this, Table 4 shows the bit patterns for these two groups of three bits corresponding to a specific averaging or output interval.

Using the same example, the pattern of the first three bits in the status word (again reading right to left) is 0 0 0. Looking at Table 4, this bit pattern for bits 0-2 means that the averaging interval is set to 3 minutes. Looking at the next three bits (bits 3-5), we see the pattern is 0 0 1. Again referring to Table 4, this bit pattern represents an output interval of 10 seconds.

The remaining bits in the status word can then be evaluated individually, by locating a specific bit on the table and reading the meaning of its current value (0 or 1). Status Words 2 and 3 can be translated in the same way, with each bit being matched to its specific operational meaning. By translating all three status words into their individual components, a great deal of information concerning the sensor's operation can be extracted.

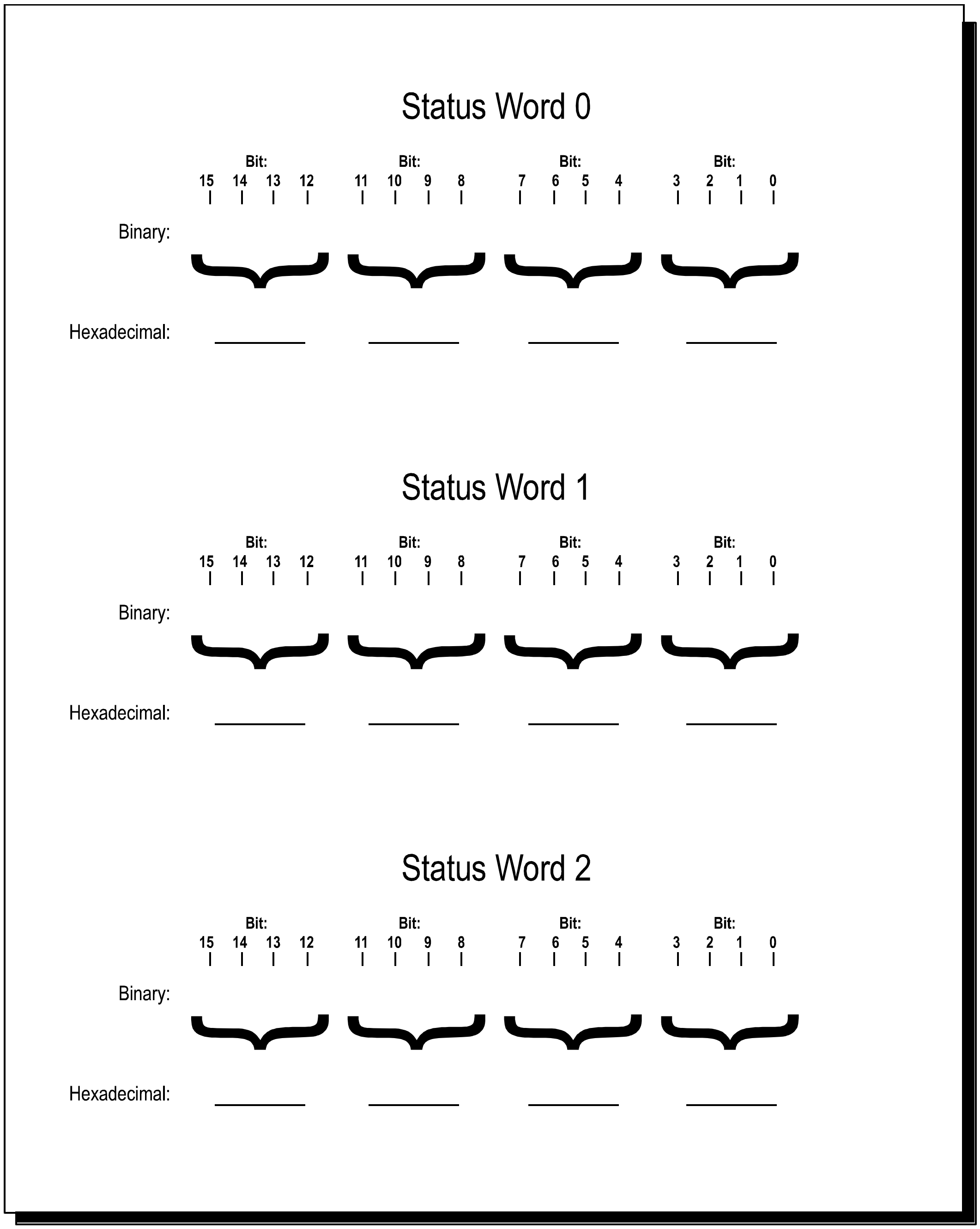


Figure 9. Status Word Worksheet

6. MAINTENANCE AND TROUBLESHOOTING

Equipment Required

- Clean Cotton Cloth or Lens Tissue
- Common Household Glass Cleaner

6.1 MONTHLY MAINTENANCE

1. Check Lens Heaters

   With a clean finger, touch the lenses in front of the disc-shaped heaters, which are bonded to the upper and lower inside surface of lenses. The lens surfaces should be slightly warmer to the touch than the ambient temperature.

2. Clean Lenses

Cleaning the lenses should be done with lint-free cloth and cleaning solution. Clean the lenses by first spraying the lens cleaner on the lens and then wipe gently to prevent scratching the glass optics. In actual practice, moderate dust buildup and scratches on the lenses will not have any discernible effect on the instrument.

6.2 TRIANNUAL MAINTENANCE

Check the status display on the MetObserver diagnostic screen for the Present Weather and Visibility Sensor.

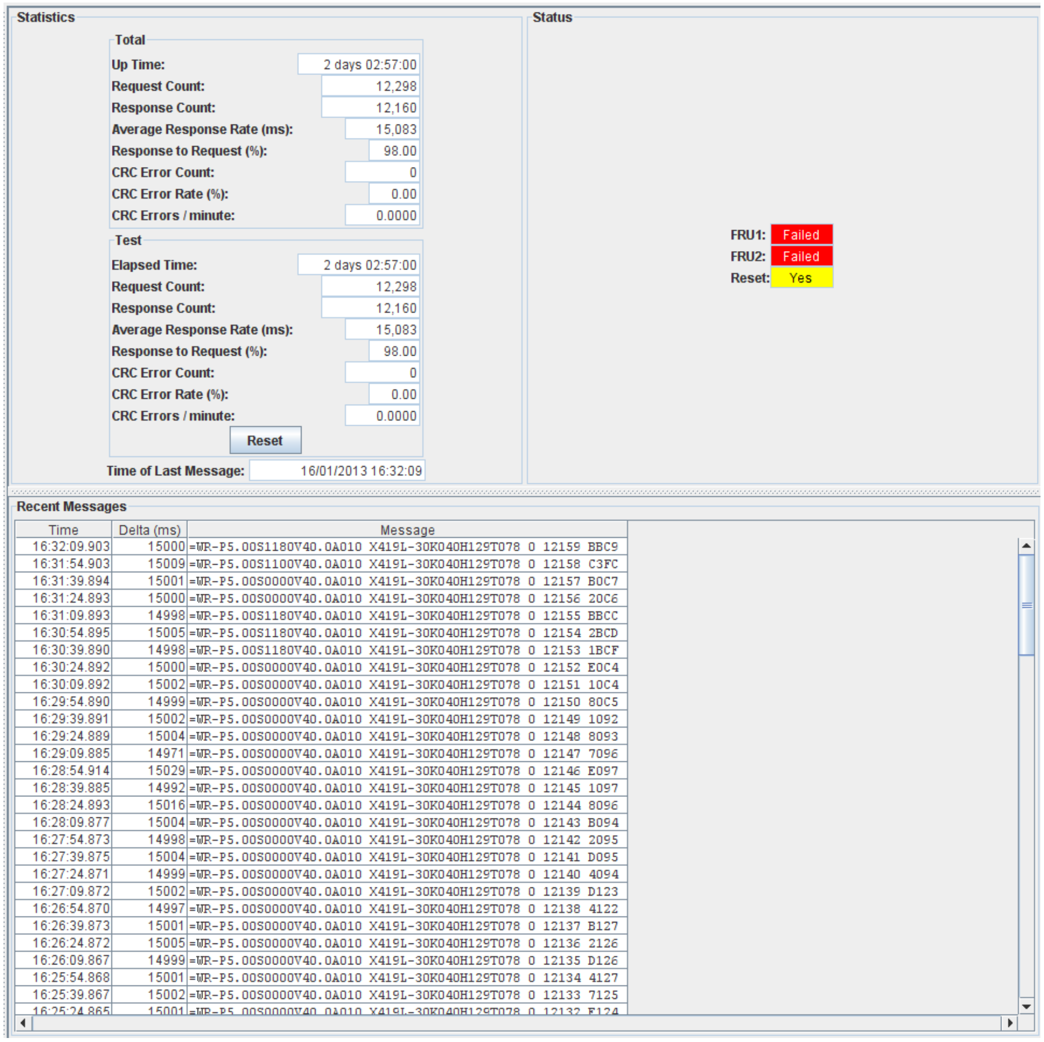


Figure 10. MetObserver Present Weather and Visibility Sensor Diagnostics Screen

The Status pane displays whether FRU1 or FRU2 failed, and whether the sensor has reset.

The Message line in the Recent Message line provides the recent poll responses either for the present weather or the visibility.

```
=WR-P5.00S1180v40.0A010 X419L-30K040H129T078 0 12159 BBC9
```

1. Quick Check on Data Fields

   The following checks are general in nature and should be used as a general indication that the sensor is working properly. This test should be performed when there is no precipitation and after the sensor has stabilized for at least 30 minutes.

W__	The present weather field should not contain any data (two blank spaces) if there is no precipitation falling.
S0000	The status fields should all read zero if the 6497 has been operating (and not reset by a power interruption) for at least 5 minutes. If the status fields are not all zeros, as in the sample line, refer to the *Status Codes* section in Section 5.2.5 for an interpretation of the possible problem.
Xnnn	The one-minute carrier strength reading will generally read in the range of 405 to 415.
Lnnn	The one-minute low channel reading will generally ready in the range of -30 to 50.
Knnn	The one-minute particle channel reading will generally read in the range of 0 to 150.
Hnnn	The one-minute high channel reading will generally read in the range of 40 to 120.
Tttt	Temperature should be representative of the ambient temperature, ±5 degrees. The temperature probe is connected thermally to the electronics enclosure, so it generally reads warmer than the ambient temperature because of internal heating of the enclosure.

If access to MetObserver is not available, check the strength of the carrier signal by displaying the present weather status display on the DCP's LCD display screen. Press the * or # keys until the screen is displayed. The data fields in bold shown below are the channels of interest.

```
W__ P0000S0000VvvvvccXnnnzzzLnnnbbbKnnnbbbHnnnbbbEnnngggTttt
```

1. Quick Check on Data Fields

   The following checks are general in nature and should be used as a general indication that the sensor is working properly. This test should be performed when there is no precipitation and after the sensor has stabilized for at least 30 minutes. Display the present weather data screen on the DCP's LCD display screen using the * and # keys.

```
Present
Weather Data
W__POOOOS0000
```

W___ The present weather field should not contain any data (two underscores) if there is no precipitation falling.

S0000 The status fields should all read zero if the 6490-I has been operating (and not reset by a power interruption) for at least 5 minutes. If the status fields are not all zeros, refer to Section 5.2.5 for an interpretation of the possible problem.

> Hint — If the "Quick Check" values do not appear to be correct, record at least 10 minutes of the complete status string and fax them to the All Weather Inc. Customer Service department (916-928-1165) for evaluation. Include the weather conditions at the site during the period in question (air temperature, wind speed, type of precipitation if any, etc.)

6.3 OPTIONAL MANUAL VISIBILITY CALIBRATION

This section describes a procedure to calibrate the visibility output from the Model 6497 Present Weather and Visibility Sensor. You will need the following accessories to perform this calibration.

- Laptop computer.
- Adapter cable consisting of a USB plug (connects to USB serial port on laptop computer), a USB to serial adapter, and an 8-position terminal block plug (AWI part number M417231-00).

6.3.1 Connections

1. Turn the power off (see Figure 8 for the location of the ON/OFF switch on the Universal Power and Communication Module).
2. Disconnect the friction-lock connector to disconnect the serial cable to the AWOS computer from *Serial Output 1*.
3. Use the adapter cable to connect the laptop to *Serial Output 1* on the Universal Power and Communication Module.

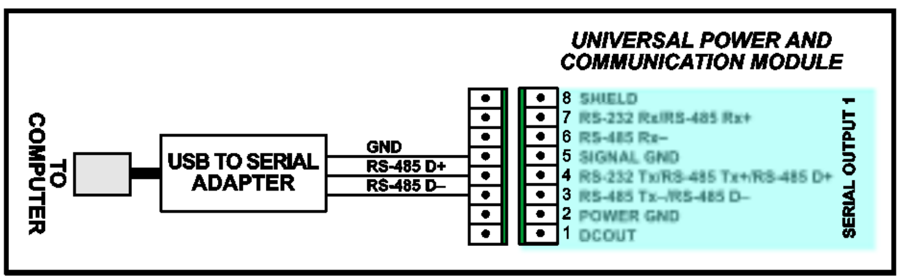


Figure 11. Connecting Present Weather and Visibility Sensor to Laptop

4. Turn the power on (see Figure 8 for the location of the ON/OFF switch on the Universal Power and Communication Module).

6.3.2 Calibration Steps

1. Start a serial emulator on the laptop using TeraTerm or a similar program.
2. Enter a "PWVS" poll command.

   C<CR>

3. The response shown below is displayed.

```
W P0000S0000VvvvvccXnnnzzzLnnnbbbKnnnbbbHnnnbbbEnnngggTttt…
```

4. Look at the background light data in the "ggg" field. If the "ggg" field is less than or equal to 800, then proceed to Step 5; otherwise, adjust the sensor head orientation as described in Step 5.

5. If the background light is greater than 800, loosen the U-bolts on the sensor head and rotate the head away from glare sources such as trees, power poles, etc. Once realigned, repeat Steps 2, 3, and 3.

NOTE:
Do not continue this calibration if the background light cannot be reduced to less than 800.

6. Adjust the full-scale visibility by entering the known visibility into the sensor memory. The best conditions to calibrate the full-scale visibility are on clear days with high visibility. Do not make this adjustment if precipitation is falling.

7. Enter a "W" poll command. "SETPWVS X.XXX"

W<CR>

8. If the weather condition is not suitable for visibility calibration, the sensor will cancel this procedure and send out the following response.

```
COMMAND CANCELED DUE TO UNSUITABLE CONDITION
```

Otherwise the sensor will output the following response.

```
VISIBILITY (KMs) = or VISIBILITY (MIs) =
```

9. Enter the known visibility in the correct units of measure followed by a carrier return. For example, if the visibility is determined to be 5.5 km, enter the visibility as follows.

5.5<CR>

6.3.3 Return Connections to Original Setup

1. Turn the power off (see Figure 8 for the location of the ON/OFF switch on the Universal Power and Communication Module).
2. Disconnect the used to connect the laptop computer to *Serial Output 1*.
3. Reconnect the friction-lock connector to connect the serial cable from the AWOS computer to *Serial Output 1*.
4. Turn the power on (see Figure 8 for the location of the ON/OFF switch on the Universal Power and Communication Module).

7. SPECIFICATIONS

Parameter	Specification
Present Weather Codes Reported	>50 NWS and WMO codes
Rain Dynamic Range	0.1–3000 mm/h
Rain Accumulation	0.1–999,999 mm
Rain Accumulation Resolution	0.001 mm
Rain Accumulation Accuracy	5%
Snow Dynamic Range	0.01–300 mm/h water equivalent
Snow Accumulation	0.001–999,999 mm water equivalent
Snow Accumulation Resolution	0.001 mm
Snow Accumulation Accuracy	10%
Visibility Dynamic Range	0.001–50 km
Visibility Accuracy	±10% up to 5 km ±15% up to 50 km
Visibility Time Constant	3 min (harmonic)
Visibility Contrast Threshold	5%
Ambient Light Dynamic Range	0–107,000 lm/m^2
Serial Data	
Data Update Rate	When polled
Serial Output	RS-485 (half duplex), may be configured for RS-232 or RS-485 (full duplex)
Output Format	ASCII characters
Baud Rate	4800 bps
Serial Port Parameter Setting	8-N-1 (8 data bits, no parity, 1 stop bit)
Power Requirements	
Supply Voltage	115/230 V AC, 50/60 Hz, 50 V•A
Transient Protection	AC power and serial signal lines fully protected
Environmental	
Operating Temperature	-50 to +50ºC (-58 to +122ºF)
Storage Temperature	-50 to +60ºC (-58 to +140ºF)
Relative Humidity	0–100%, noncondensing

Parameter		Specification
Mechanical		
Electronics Enclosure		NEMA 4X fiberglass
Mounting	Sensor Assembly	1.5" (3.8 cm) dia. mast coupling
	Electronics Enclosure	U-bolts
Dimensions	Sensor Assembly	11.5 cm H × 26.7 cm W × 89.1 cm D (4.5" H × 10.6" W × 35.1"D)
	Electronics Enclosure	40.6 cm W × 45.6 cm H × 26.2 cm D (16.00" W × 17.87" H × 10.31" D)
Weight	Sensor Assembly	4.5 kg (10 lb)
	Electronics Enclosure	10.kg (22 lb)
Shipping Weight (2 boxes)		16 kg (35 lb)

8. ADDITIONAL REFERENCES

Refer to the ***Model 2715 Universal Power and Communication Module User’s Manual*** for additional information about the Model 2715 Universal Power and Communication Module, its serial wiring options, and how to install the required firmware to support these options.

9. WARRANTY

Any defect in design, materials, or workmanship which may occur during proper and normal use during a period of 1 year from date of installation or a maximum of 2 years from shipment will be corrected by repair or replacement by All Weather Inc.

All Weather Inc.
1165 National Drive
Sacramento, CA 95818
Fax: 916.928.1165
Phone: 916.928.1000
Toll Free: 800.824.5873

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