Model 8364-E
Forward-Scatter Visibility Sensor

☒	**FAA APPROVED** ECP192 — 2011 Sept 23
☐	**NOT FAA APPROVED**

User's Manual

Rev. K

allweatherinc

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Disclaimer
The information and specifications described in this manual are subject to change without notice.

Latest Manual Version
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1. INTRODUCTION

The Model 8364-E Visibility Sensor is an active electro-optical instrument that determines visibility by measuring the optical extinction coefficient of a beam of light as it passes through a known volume of air. Any particles in the air such as fog, rain, or snow will affect the extinction coefficient. This value can then be transmitted to an external computer in its unaltered form or translated into an equivalent visibility in miles or kilometers covering a range of 33 feet to 20 miles.

In AWOS systems, the extinction coefficient value is sent to the Model 1190 Data Collection Platform (DCP), which passes the value along with sensor status information to the Model 2090 Central Data Processor (CDP). The CDP then calculates visibility, variable visibility, and RVR (international systems only) over a visibility range of 33 feet to more than 20 miles.

When used in AWOS systems, the 8364-E sensor does not require the optional Handheld Terminal; all setup, test, and calibration functions are accessible from the AWOS DCP's built-in keypad and display. Other AWOS features include support for a Day/Night sensor and an ambient light sensor (ALS), which is required for RVR applications. For 220 VAC applications, a transformer kit is available to allow the sensor (which normally operates at 110 V, 60 Hz) to operate from a 220 V, 50 Hz AC supply.

The Model 8364-E utilizes a unique two-sensor design that eliminates measurement errors and simplifies calibration. The sensing portion of the sensor (optical emitters and detectors) operates in conjunction with a visibility controller, which performs control functions for the emitters and detectors, performs built-in test and calibration functions, processes data, and calculates the extinction coefficient product. For applications where an analog output is required, an optional Analog Output module is available.

2. INSTALLATION

This instrument is thoroughly tested and fully calibrated at the factory and is ready for installation. A calibration check should be performed, however, upon completion of the installation procedure (see Section 4). Please refer to the return authorization card included in the packing box if damage has occurred. Also, notify All Weather Inc.

The Model 8364-E consists of the visibility sensor (two emitters and two detectors), an optional day/night sensor or ambient light sensor, and a visibility controller.

2.1 SENSOR SITING

Locate the sensor as far as practical from strobe lights and other modulated light sources. Do not locate it in an area that is subject to localized obstructions to vision (e.g., smoke, dust, etc.). At the same time, it should not be so isolated that it cannot detect more widespread obstructions when they affect visibility in the area of concern.

The sensor should be mounted so that the optics are 10' ±2' (3 ± 0.6 m) above ground or 6' (2 m) above the average maximum snow depth, whichever is higher. Keep the area within 6' (2 m) of the sensor free of all vegetation and well drained, and keep any grass or vegetation within 100' (30 m) of the sensor clipped to a height of about 10" (25 cm). These precautions are necessary to reduce interference of insects and carbon-based aerosols (e.g., terpenes) with sensor performance.

In installations where multiple visibility sensors are used, it is important to maintain adequate optical isolation between the sensors. Care must be taken to ensure that the optical emitter of one unit is not within the field of view of any others. It is recommended that no sensor be installed within 50 feet of another and that the orientation of adjacent sensors be parallel.

2.2 AWOS SITING

Site AWOS installations according to siting order 6560.20.

2.3 MAST INSTALLATION

The visibility sensor mounts on a 2.87" (73 mm) O.D. mast. A section of 2.5" (64 mm) I.D. standard galvanized steel pipe can be used as a mast with no drawbacks or special adaptation. Construct a foundation for the mast according to the details in **Figure 2-1**. When embedding the mast in the concrete, make sure the mast is vertical to within ± 2 degrees. Bevel all pad edges.

2.4 CONDUIT AND JUNCTION BOXES

For most installations, conduit should be routed to the sensor to accommodate the power line to the sensor and the signal line from the sensor to the host computer or DCP. For ease of connection, junction boxes can be installed near the base of the mast, and rigid or flex conduit installed between the junctions boxes and visibility controller. Refer to **Figure 2-2** for conduit and junction box installation details.

2.5 VISIBILITY SENSOR INSTALLATION

After installing the mast, follow the instructions below for assembling and installing the sensor:

1. (See **Figure 2-3**). Place the crossmember onto the mast so that the mast slides into the crossmember base. There are labels on either end of the crossmember; one reads “POLE” and the other reads “EQUATOR”. Align the crossmember so that the POLE arrow is pointing toward the nearest pole (North in the Northern Hemisphere, and South in the Southern Hemisphere). This will be the emitter end of the sensor.
2. Tighten the bolts in the base of the crossmember so that it does not rotate.

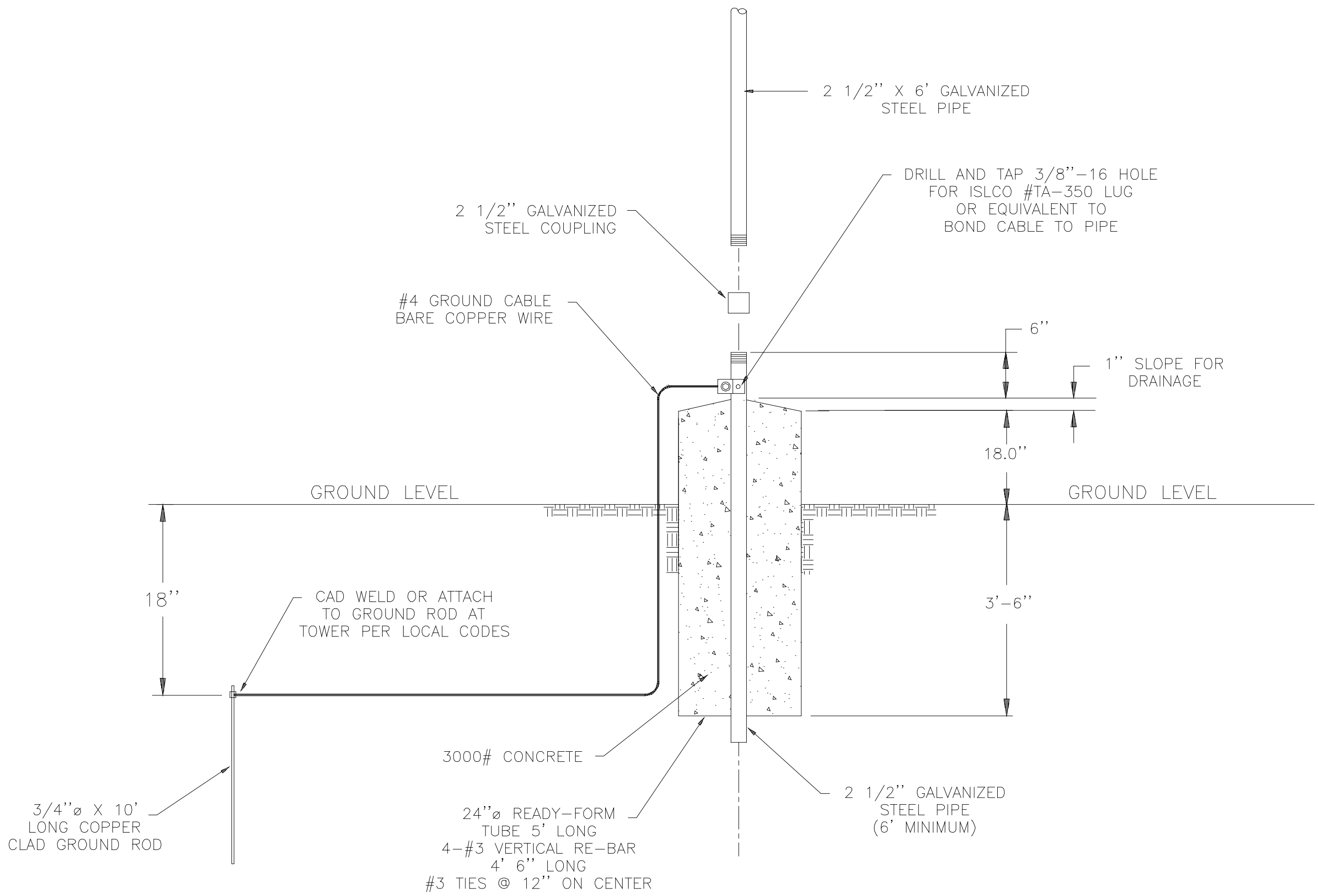


Figure 2-1. Visibility sensor foundation.

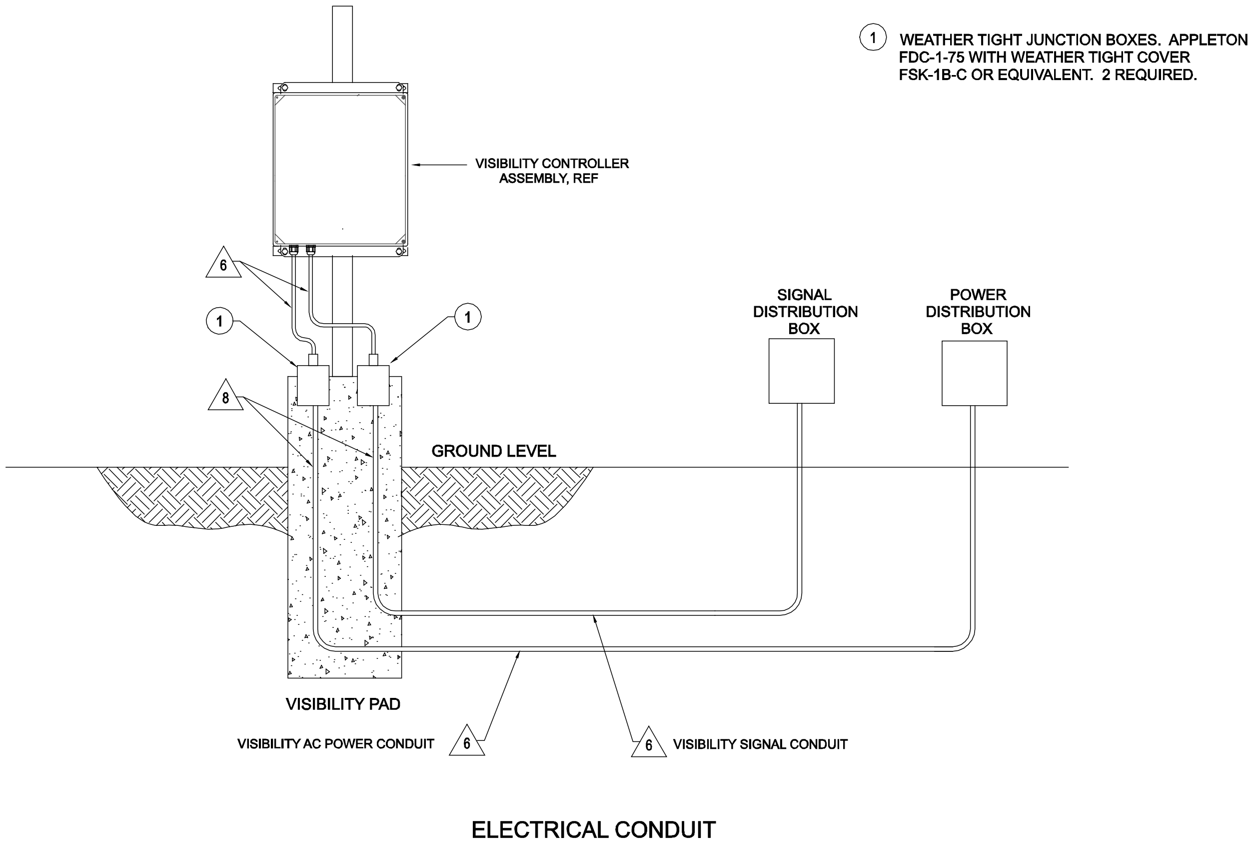


Figure 2-2. Visibility sensor conduit and junction box installation.

3. Each of the two uprights has a label on either arm. The labels on one upright read “EMITTER 0 “ and “EMITTER 1” (emitter upright), and the labels on the other read “DETECTOR 0” and “DETECTOR 1” (detector upright). Bolt the emitter upright to the “POLE” end of the crossmember using the four 1/4" X 2 3/4" bolts, lockwashers, and flat washers supplied in the hardware kit (see **Figure 2-4**). The holes in the ends of the crossmember are threaded, so no nuts are required.
4. The emitter and detector sensor heads are labelled as EMITTER 0, EMITTER 1, DETECTOR 0, and DETECTOR 1; note the label on each. Route the cable from EMITTER 0 through the top of the upright arm labeled “EMITTER 0” and out the bottom (see **Figure 2-5**).
5. Slide the sensor head into the cap at the top of the upright arm as shown in **Figure 2-6**. The sensor head is keyed to ensure proper alignment. Mount it so that the hood is facing toward the upright arm diagonal to it (DETECTOR 1) at the other end of the crossmember.
6. Tighten the two bolts in the cap as shown in **Figure 2-7** so that the head is held securely in place. *Do not loosen the lower set screws that hold the caps to the uprights. These are set at the factory and are critical to proper sensor alignment.*
7. Feed the sensor cable from the bottom of the upright arm along the underside of the upright and then along the underside of the crossmember. Secure with cable ties provided. The free end of the cable will be connected to the visibility controller after the controller is installed.
8. Follow Steps 4-7 for Emitter 1.
9. The detectors are mounted in the same way as the emitters, in the following arrangement: Detector 1 is mounted diagonally to Emitter 0, and Detector 0 diagonally to Emitter 1. Follow Steps 4-7 to install the detectors.

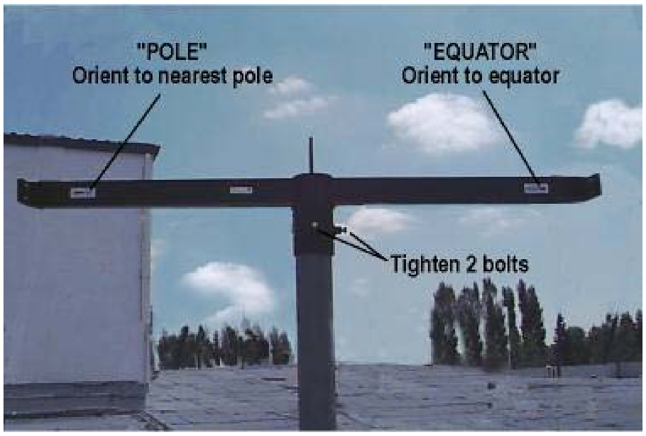


Figure 2-3. The Visibility Sensor crossmember mounts to the sensor mast with two bolts, oriented according to the "POLE" and "EQUATOR" labels.

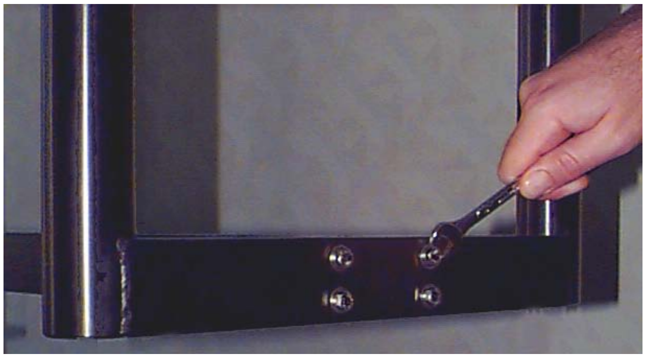


Figure 2-4. Install the emitter and detector uprights onto the crossmember and secure with four bolts.

Figure 2-5. Route the sensor head cable down through the upright arm.

Figure 2-6. Slide the sensor head into the upright arm cap.

Figure 2-7. Tighten the 2 bolts securing the head to the upright arm cap.

2.6 VISIBILITY CONTROLLER

The visibility controller mounts on the mast below the sensor using the M488173 mounting kit.

1. Mount the visibility controller on the mast with the top of the enclosure 5’6" (167 cm) from ground level, or at least 3 feet (1 meter) above maximum snow level using mounting kit M488173 as shown in **Figure 2-8**.
2. Cables are identified with labels at their ends. Route the cables through the four strain reliefs on the bottom of the controller enclosure as shown in **Figure 2-9** by folding the connector back over the cable and bending the cable 90°. This will enable the connector and cable to fit through the strain relief nut and grommet and through the strain relief itself into the enclosure.
3. Connect the sensor cables to the corresponding connectors on the controller board as shown in **Figure 2-10**. Care must be taken to ensure that the cables are properly installed prior to connecting power.

CAUTION

NEVER INSTALL OR REMOVE A CABLE
WITH POWER APPLIED

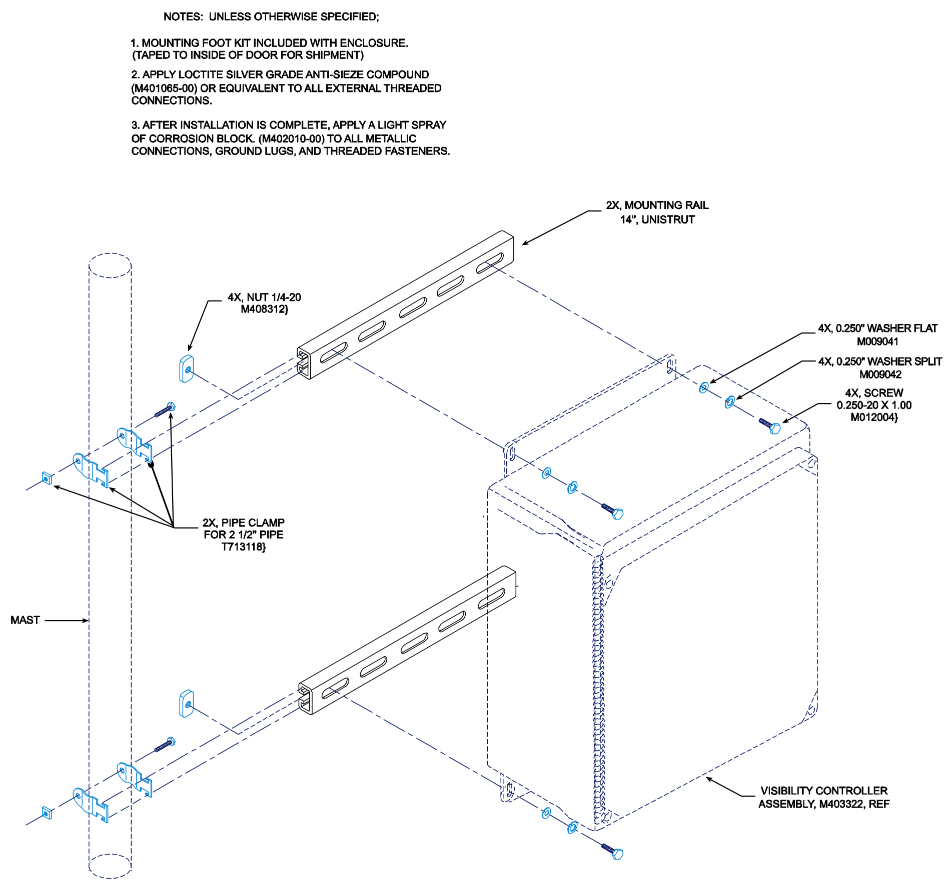


Figure 2-8. The visibility controller mounts to the visibility sensor mast beneath the sensor crossarm using the M488173 mounting kit.

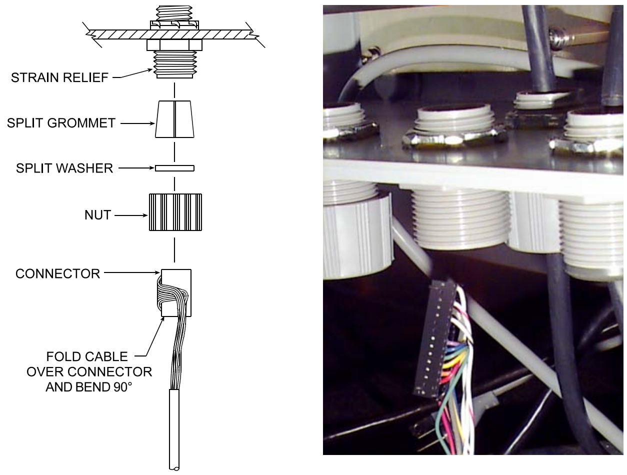


Figure 2-9. Carefully fold the head connectors back over the wires and feed them through the strain reliefs.

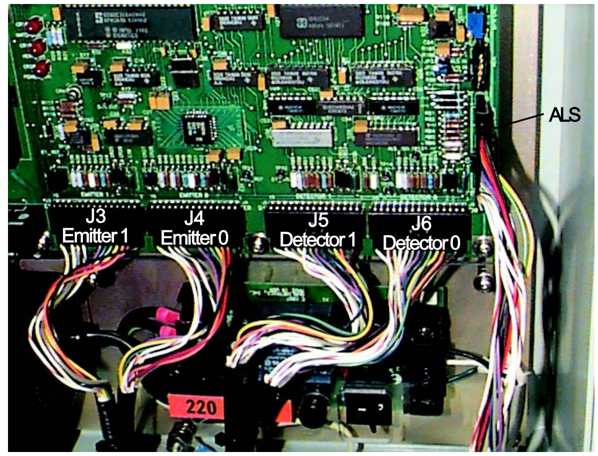


Figure 2-10. Connect the sensor head cables to the connectors on the controller board as shown.

2.6.1 Power Connection

CAUTION

NEVER INSTALL OR REMOVE A CABLE
WITH POWER APPLIED.

THIS SENSOR IS A 110 VAC DEVICE.

CONNECT TO 220 V ONLY IF 220VAC KIT M488174
IS INSTALLED.

The 8364-E is a 110 V AC device. An optional 220 V AC kit (M488174) is available for installations where the supply power is 220 V. Do not connect 220 V without a 220 V kit installed.

To connect power to the 8364-E controller, follow the steps below.

1. Route power for the sensor through conduit or through a 3/8" strain relief installed in one of the two left side cutouts (when viewed from below with the door up, as in **Figure 2-11**) on the underside of the visibility controller.
2. Terminate the AC power cable to TB1 on the controller board as shown in **Figure 2-12**.

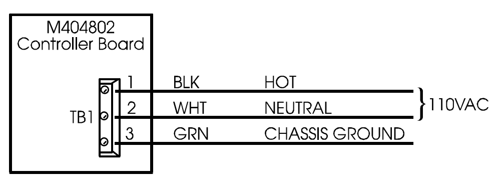


Figure 2-12. Visibility controller AC wiring.

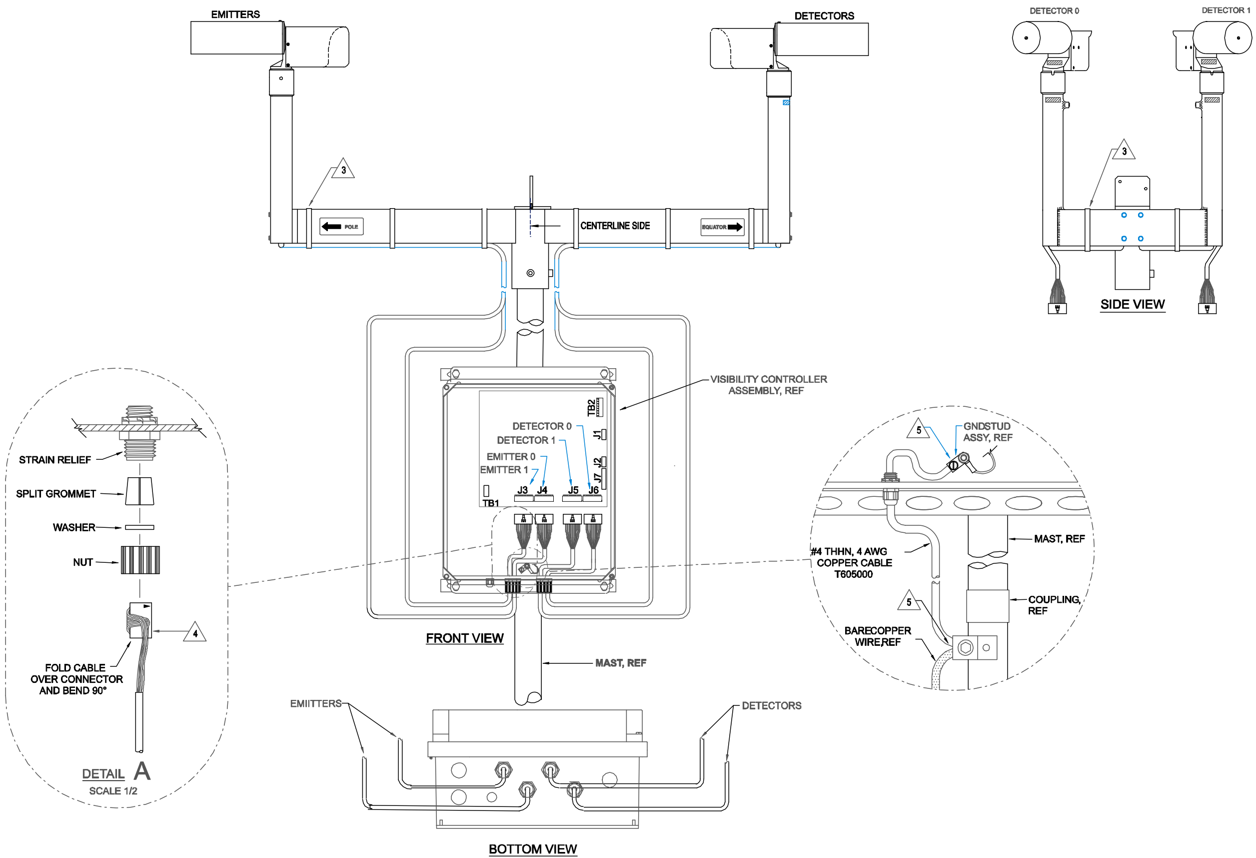


Figure 2-11. The emitters and detectors are located in relation to one another as shown, and the sensor cables secured with cable ties to the underside of the crossmember. Cables enter the controller enclosure through strain reliefs on the enclosure's underside. Ground the sensor as shown in the detail.

(Note: The position of the voltage selection switch on the controller board is irrelevant to sensor operation. It does not control voltage levels on the 8364-E, so can be set to either 110 V or 220 V without effect. To operate from 220 V, however, the optional 220 VAC kit <u>must</u> be used.)

2.6.2 Ground Cable Installation

In order for the sensor's built-in lightning protection to function properly, the visibility controller must be grounded as shown in **Figure 2-13**. To install grounding, follow the steps below.

1. Drill and tap a 1/4 -20 hole in the mast. Install a grounding clamp in the hole.
2. Route a 10' length of ground cable (4 AWG multi-strand insulated wire, available from All Weather Inc. as P/N T605000) through a strain relief into the controller enclosure. (To route the cable through the strain relief, disassemble the strain relief and feed the cable through the nut, washer, split grommet, and strain relief body, then screw the nut onto the strain relief body.)
3. Inside the enclosure, bend the cable 90° and connect it to the ground lug on the bottom center of the controller board.
4. Connect the other end of the ground cable to the ground clamp on the mast.
5. Finally, connect a bare copper ground wire between the ground rod and the ground clamp on the mast.

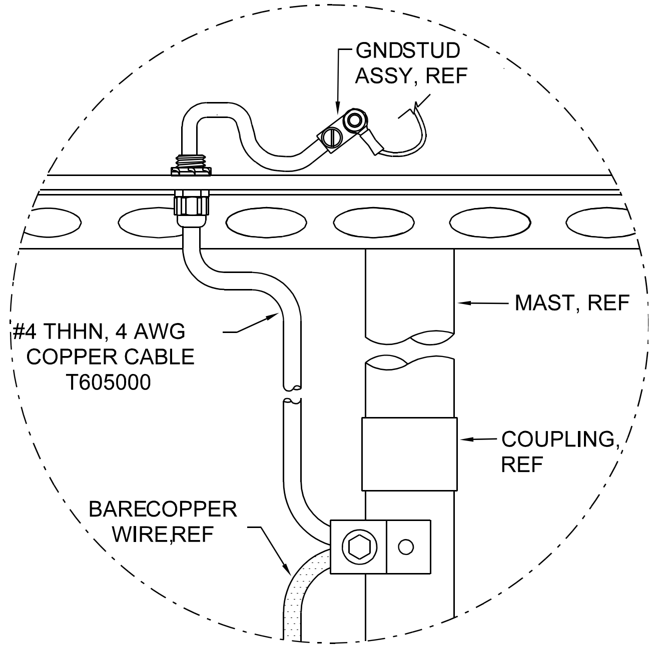


Figure 2-13. Ground cable installation.

2.6.3 220 V AC Kit Installation

(See Figure 2-14) The M488174 220 VAC kit provides a step-down transformer to allow the 8364-E to run from a 220 VAC supply. (*Note: This kit is normally installed at the factory*.)

1. Remove the existing cable installed between TB1 and TB2 on the visibility controller board.
2. The transformer mounts to the visibility controller board, in the lower left corner as shown in Figure 5-9, to the four studs protruding up from the board. Leave the existing nuts installed on the studs. Set the transformer in place over the studs so that it rests on the nuts.

   Secure the transformer with a flat washer, lock washer, and nut at each corner.
3. Trim the three wires extending from the transformer's primary side to approximately 6" and attach spade lugs.
4. Form a service loop in the primary wires (to which you just attached spade lugs) and connect to terminals 1, 2, and 3 of TB2 as shown in Figure 5-9:

   smooth BLACK (line) to pin 1

   ridged BLACK (neutral) to pin 2

   GREEN (ground) to pin 3
5. Cut the wires from the transformer's secondary side to approximately 6", and strip the ends. Connect to pins 1, 2, and 3 of TB1 as shown in Figure 5-9:

   smooth BLACK to pin 1

   ridged BLACK to pin 2

   GREEN (ground) to pin 3
6. Install the "**220 VOLTS**" sticker over the AC power selector switch. The position of this switch does not matter.

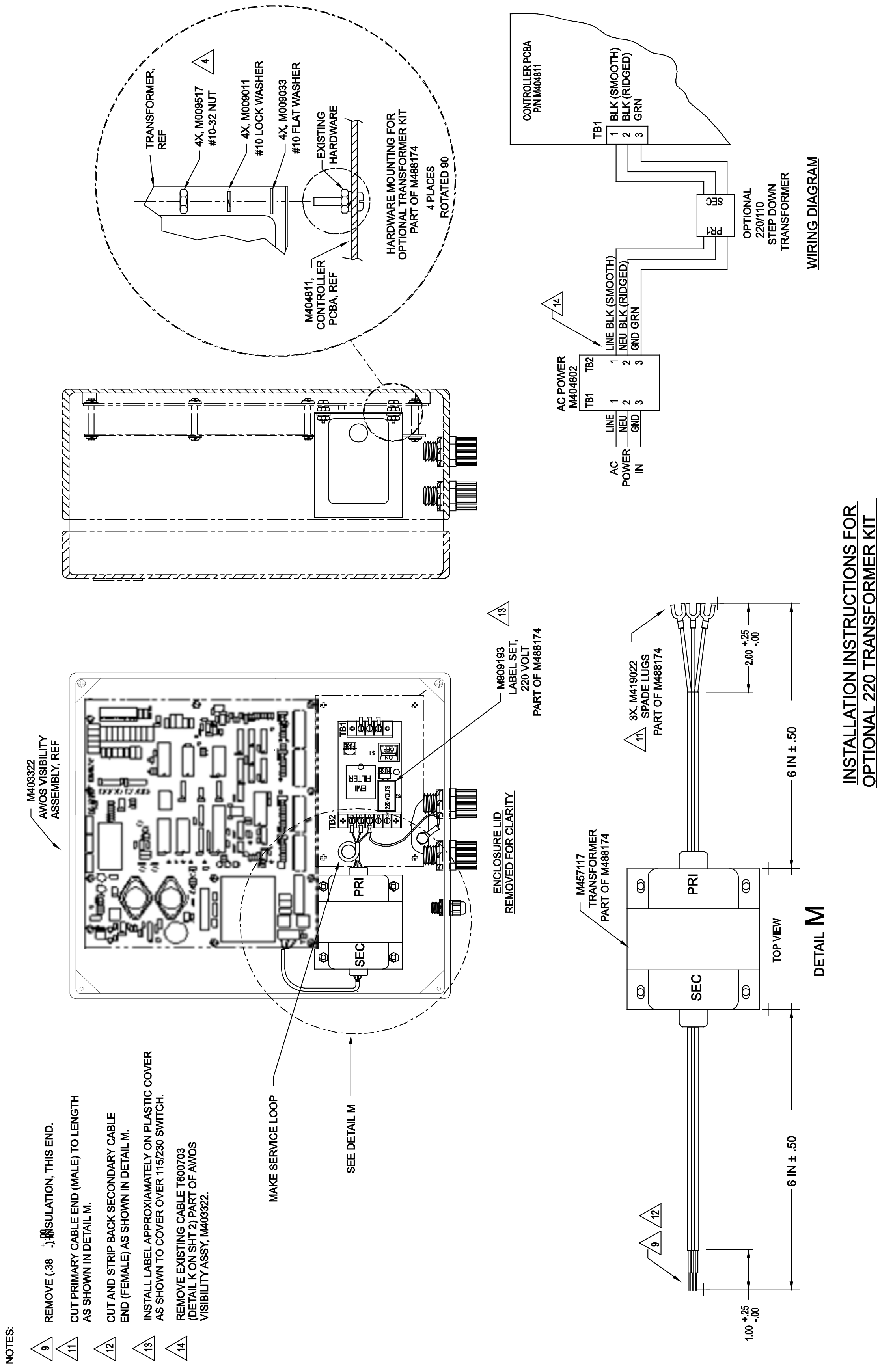


Figure 2-14. 220 V AC kit installation

2.6.4 SIgnal Connections

The RS-485 and RS-232 outputs are available on terminal block TB2 on the controller board The connections are shown in **Table 2-1**.

Table 2-1
TB2 Serial Output Pin Designations

TB2 Pin	Description
1	RS-485 (-)
2	RS-485 (+)
3	RS-232 Tx Data
4	RS-232 RTS
5	RS-232 Rx Data
6	RS-232 CTS
7	RS-232 GND
8	Chassis GND

An explanation of the output data stream in both standard and AWOS formats is provided in **Table 5-1** and **Table 5-2**.

For AWOS systems, route the data cable to the DCP. Refer to the ***Model 1190 DCP User's Manual*** (1190-001) for instructions on connecting the data cable to the DCP.

2.6.5 Powering Up the Sensor

Once the sensor and controller are installed, and power and signal lines have been connected, turn on the power switch inside the visibility controller. The sensor will begin collecting and processing data.

2.7 OPTIONAL KITS

The following sections provide installation instructions for the optional feature kits available with the 8364-E. For detailed descriptions of the kits and their uses, refer to ***Chapter 9—Kits***.

2.7.1 Ambient Light Sensor Kit Installation

(See Figures 2-15, 2-16, and 2-17) The ambient light sensor mounts to the center of the visibility sensor's emitter upright crosspiece using the included ALS mount and existing hardware. The sensor cable routes into the controller enclosure through a strain relief and connects to J7 on the controller board.

1. Remove two existing screws, lock washers, and flat washers from the emitter upright crosspiece as shown in **Figure 2-16**.
2. Install the ALS mount onto the crosspiece using the removed hardware.
3. Feed the ALS cable through the top of the ALS mount, then lower the base of the ALS head into the mount.
4. Secure the ALS head to the mount with two allen screws. **Figure 2-15** shows a fully installed ALS head.
5. Install a strain relief in the top right hole of the enclosure (when seen from below, as in **Figure 2-16**).
6. Remove the nut, washer and grommet from the strain relief.

(Figure 2-15. The ALS head mounts to the center of the emitter upright crosspiece.

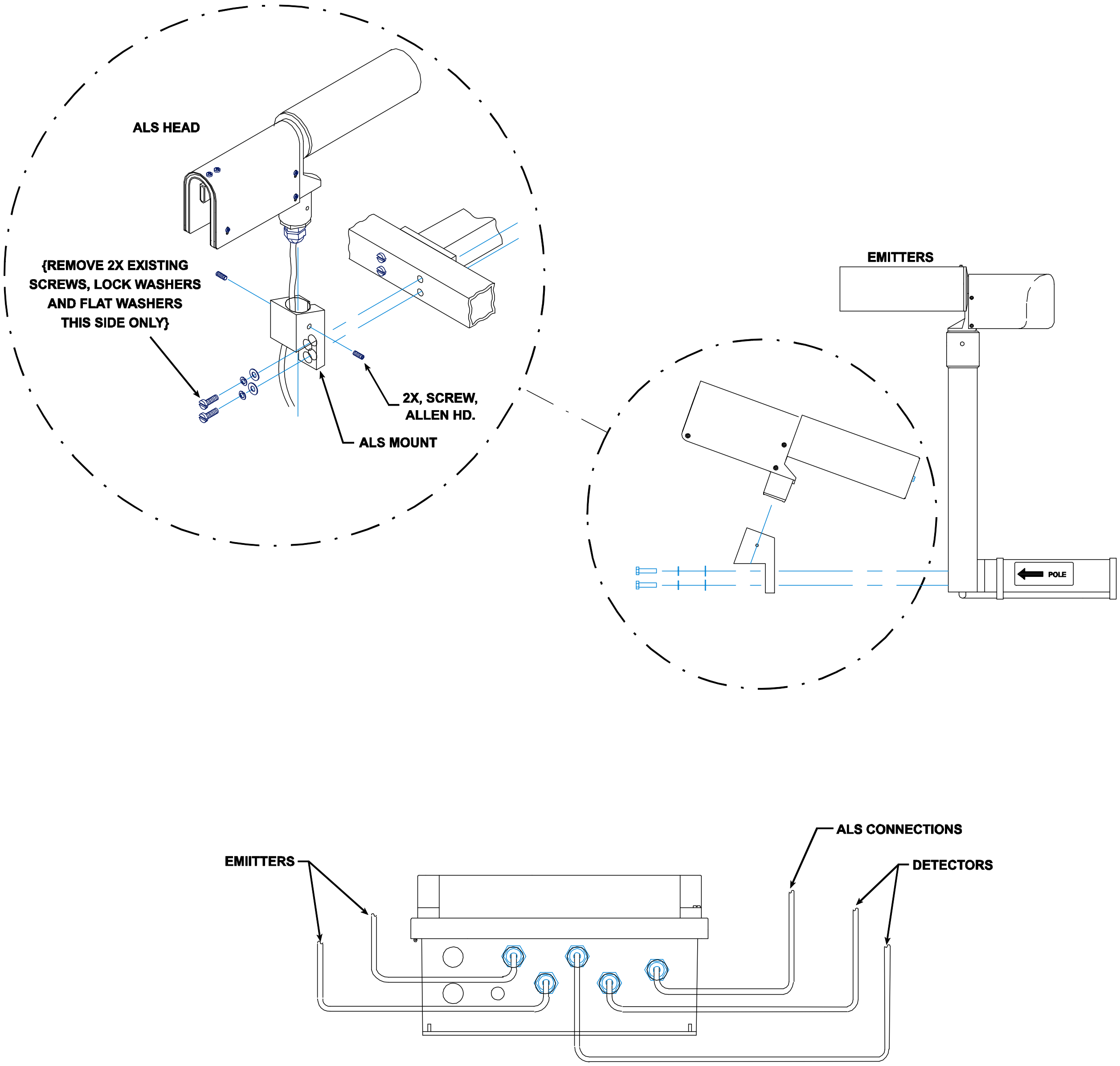


Figure 2-16. ALS sensor installation.

7. Route the cable through the nut, washer, and grommet by folding the cable back over the connector, then bending the cable 90° so that the profile of the cable end and connector is small enough to fit through the nut and strain relief (see **Figure 2-16**).
8. With the cable still folded over the connector, feed the cable through the strain relief and into the enclosure.
9. Plug the connector into J7 on the controller board as shown in **Figure 2-17**.
10. Install jumper JP3; remove jumper JP2.

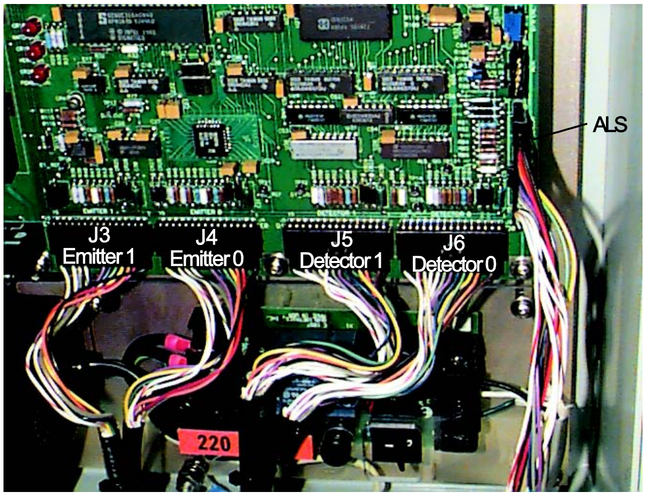


Figure 2-17. After feeding the ALS cable through a strain relief, connect it to J7 on the controller board.

2.7.2Day/Night Sensor Kit Installation

(See Figure 2-18) The day/night sensor installs on the underside of the visibility controller enclosure and connects to J7 on the controller board.

1. Remove the sealing nut from the day/night sensor's threaded neck.
2. To make the cable end and connector profile small enough to fit through the cutout in the bottom of the enclosure, fold the cable back over the connector, then bend the cable 90° as shown in **Figure 2-9**.
3. With the cable still folded over the connector, feed the cable through the far right cutout in the underside of the enclosure (when seen from below with the door topmost) and into the enclosure.
4. Feed the rest of the cable into the enclosure, and insert the sensor into the cutout so that the threaded neck is inside.
5. Inside the enclosure, feed the cable through the sealing nut and thread the nut onto the sensor neck. Tighten the nut snugly so that the sensor is tight against the base of the enclosure.
6. Plug the connector into J7 on the controller board.
7. Install jumper JP2; remove jumper JP3.
8. Align the sensor to North in the Northern Hemisphere and South in the Southern Hemisphere by rotating the visibility controller enclosure as necessary so that the sensor's photoelectric eye faces North or South as required, with an unobstructed field of view.

2.7.3 Battery Backup Kit Installation

(**See Figures 2-19** and **2-20**) The Battery Backup Kit can provide up to 3 hours of operation at temperatures above 0° C. A charging circuit on the controller board maintains a full charge on the battery when AC power is present. The battery attaches to the inside of the visibility controller enclosure door using velcro strips.

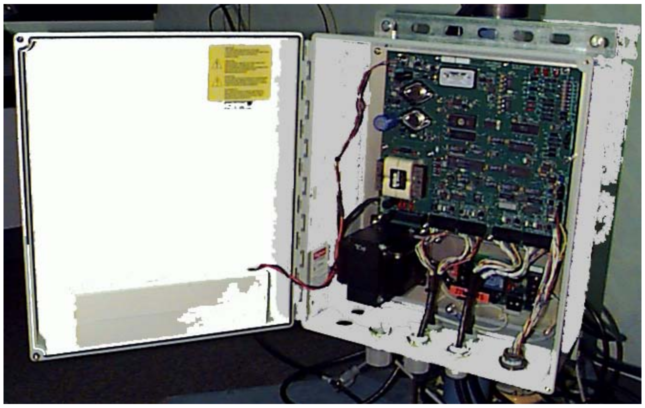


Figure 2-19. Mount the backup battery to the lower edge of the enclosure door using velcro strips.

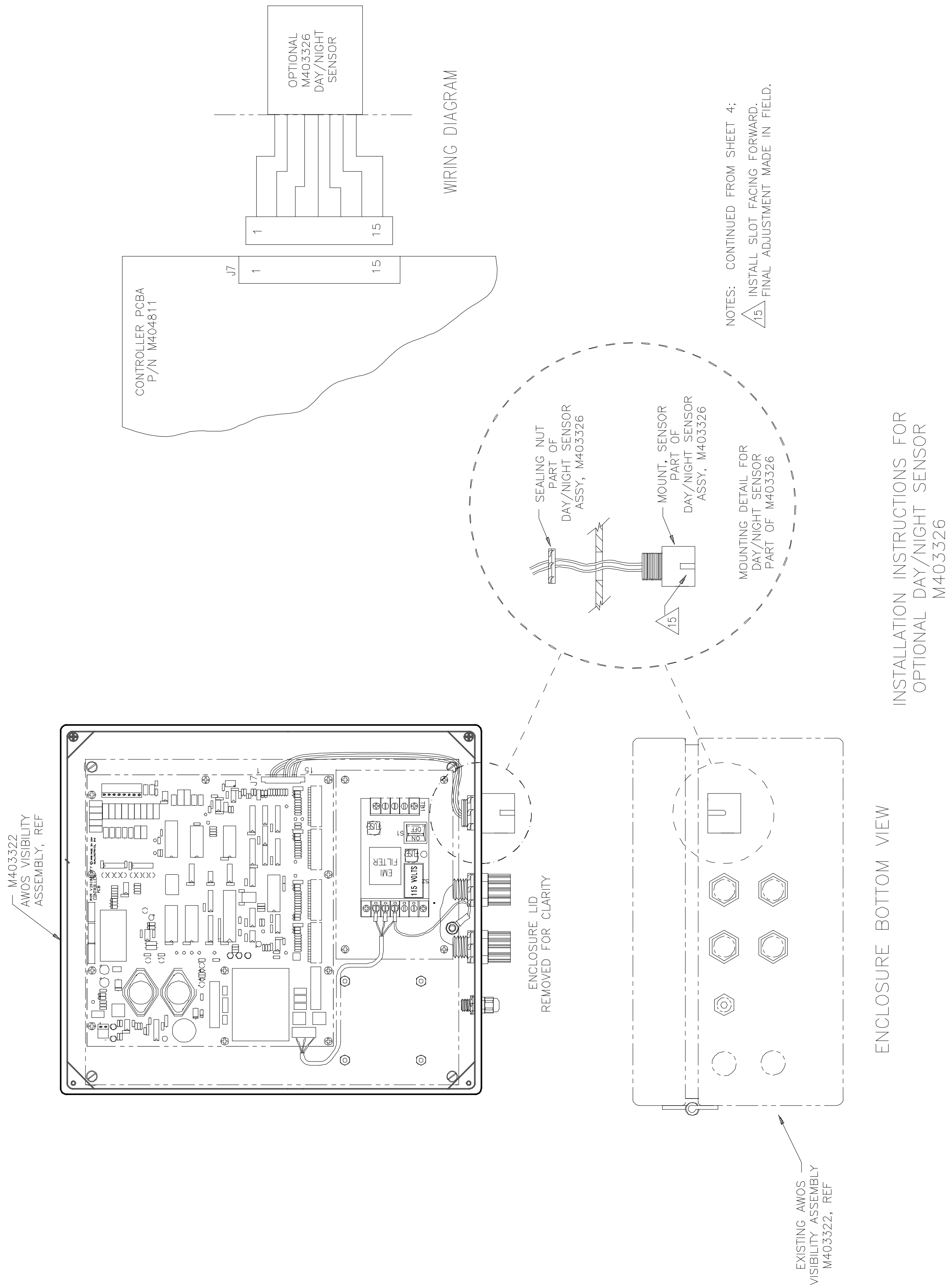


Figure 2-18. Day/Night sensor installation

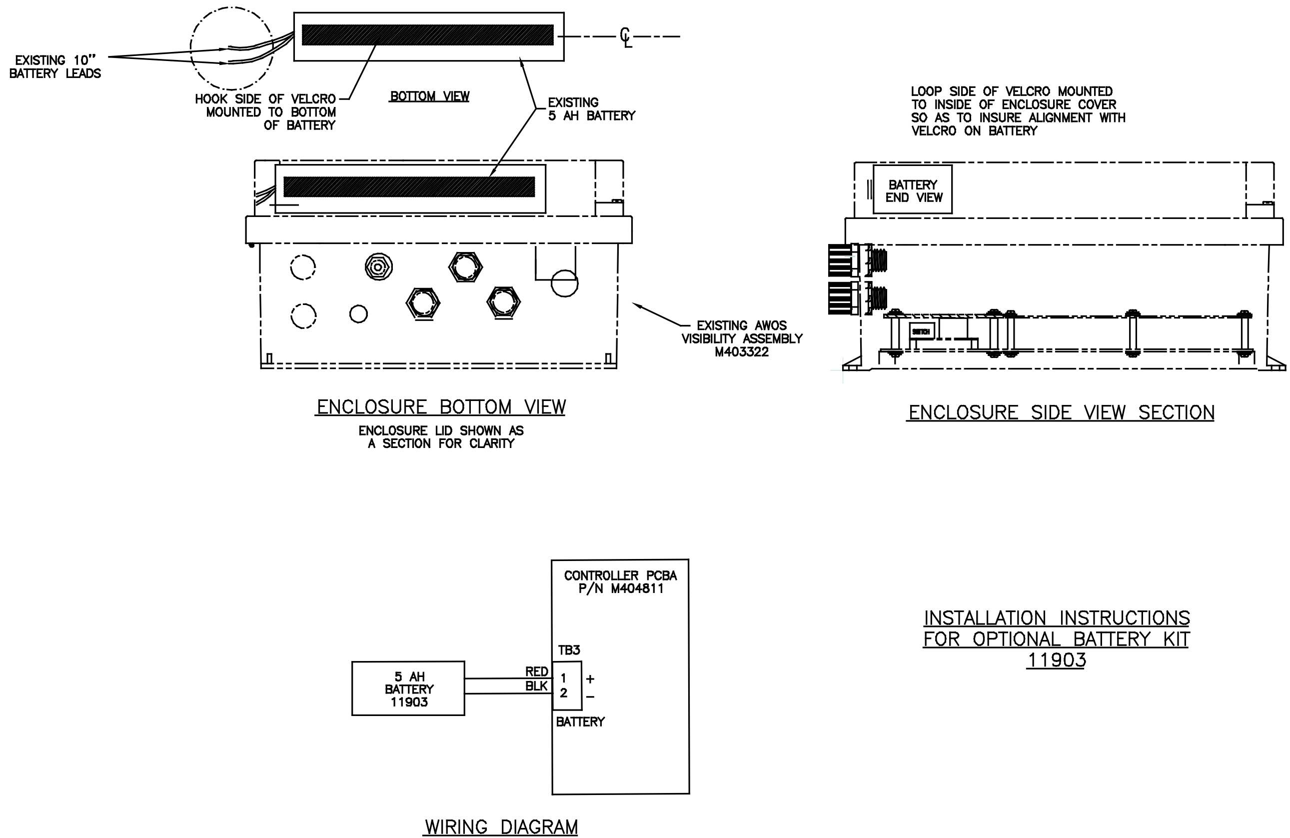


Figure 2-20. Battery kit installation

1. Attach a velcro strip to the bottom of the battery, and a mating strip to the lower lip of the enclosure door, so that when installed the battery will rest on the lower edge of the door (see **Figure 2-19**).
2. Connect the wires from the battery to TB3 on the controller board.

   RED wire to pin 1 (+)

   BLACK wire to pin 2 (-)

Caution:

Be careful not to touch the battery leads together when connecting or handling the battery!

3. Turn the BATTERY switch (S1) on the controller board ON.

In the event of a loss of AC power, the backup battery will automatically become the sensor's power source. If, however, the system is powered up on battery power only, the BATTERY START switch must be depressed to initiate battery power.

The BATTERY START switch is located in the upper left of the controller board just to the left of the large, rectangular component U4. To initiate battery power, depress the BATTERY START button and hold it down for 3-4 seconds.

The backup battery does not power the sensor head heaters, so performance will be somewhat degraded when running from battery power in cold temperatures.

When transporting the controller, always disconnect the battery and remove it from the enclosure door before transporting.

2.7.4 Analog Output Module Installation

Notes:

The Visibility Controller PCB must be modified at the factory prior to installation of the Analog Output Module.

A Day/Night detector cannot be used when an Analog Output Module is installed.

In cases where an analog output is desired in addition to the normal serial data output, an Analog Output Module is available. The module consists of a printed circuit board and cable assembly and attaches readily to the Controller board within the Visibility Controller.

(**See Figure 2-21**) To install the module, remove two screws from the Controller board and set the mounting bracket in place over the two screw holes. Replace the two screws to secure the bracket. Connect one end of the Analog Output Module cable to connector J2 ("AUX") on the Visibility Controller board. The other end of the cable attaches to J12 on the Analog Output Module PCB.

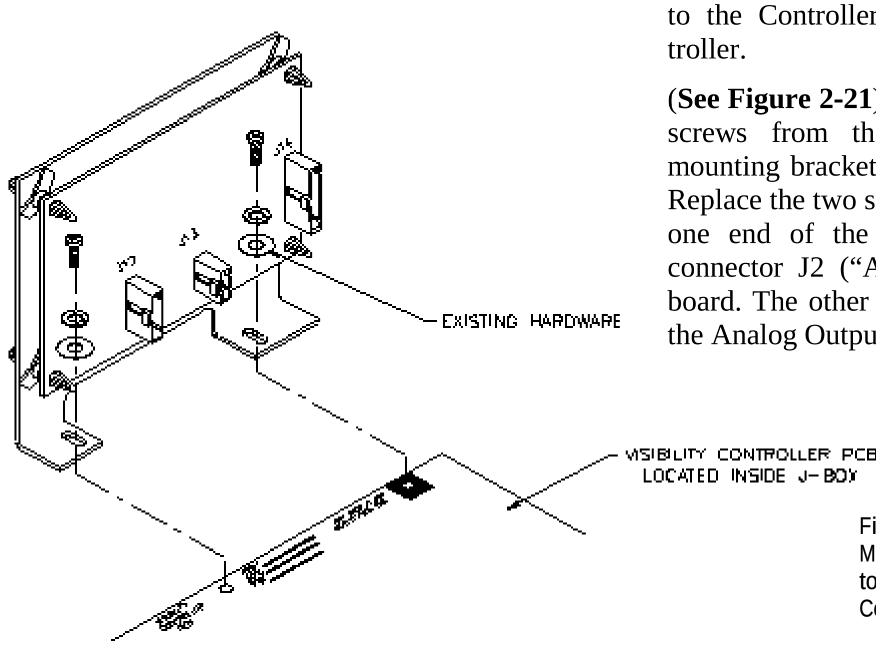


Figure 2-21. The optional Analog Output Module is mounted on a bracket that attaches to the Controller board within the Visibility Controller box.

Once the module is installed, the analog output becomes available at J13 on the Analog Output Module PCB. Attach the analog data output cable's 2-pin connector to J-13, and connect the other end to the external analog device (chart recorder, display, etc.). The output signal is a voltage varying between 0 volts and 1 volt and representing a logarithmic scale of visibility in meters over the measurement range (10 meters to 32 kilometers). A level of 0 volts represents a sensor or controller fault. **Table 2-2** shows the output voltages for several visibility values.

Table 2-2
Analog Output Voltage vs. Visibility

Output Voltage	Visibility in Meters
1 V	30,000 m
0.993 V	15,000 m
0.893 V	10,000 m
0.826 V	5,000 m
0.670 V	1,000 m
0.603 V	500 m
0.447 V	100 m
0.379 V	50 m
0.223 V	10 m

2.7.5 Handheld Terminal Installation

The M488175 Handheld Terminal Kit is used to configure the visibility sensor as explained in the ***Setup*** chapter. Though a VT52 terminal can be used (or any computer running terminal emulation software, such as Procomm), the Handheld Terminal is recommended owing to its ease of use and portability. The M488175 kit includes the Handheld Terminal and a controller cable. When the Handheld Terminal is received, a standard cable is normally in place. This cable must be removed and the cable included in the kit installed before using the Handheld Terminal with the 8364-E. Once the cable is installed, connect the flat connector at the other end of the cable to J1 on the controller board.

3. SETUP

When the visibility sensor is first installed, specific setup parameters must be entered. This is done using the optional M488175 Handheld Terminal kit, or a VT52 terminal (or any computer running terminal emulation software, such as Procomm) connected to the controller board's "HANDHELD TERMINAL" port (J1). In AWOS installations, the 8364-E is preconfigured and no configuration is required. **Table 3-1** shows the standard AWOS configuration settings.

Table 3-1
AWOS Configuration Settings

Function	Setting	Value
Report Type	4	Standard
Output Mode	1	10 seconds
Averaging Interval	0	3 min
Output Type	1	Extinction Coefficient
Units	0	Miles
Computer Baud Rate	1	4800 bps
Sensor Address	00	Address 00

If a VT52 terminal or computer is used in place of the Handheld Terminal, wire the interconnecting cable as shown in **Figure 3-1**. The VT52 should be set to 1200 bps, 8 data bits, 1 stop bit, and no parity.

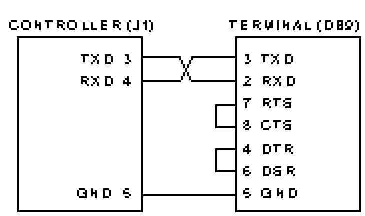


Figure 3-1. When connecting a VT52 terminal to the visibility controller, tie the terminal's RTS and CTS lines together and tie DTR to DSR — this is necessary since handshaking is not implemented in the controller's communication protocol.

The Handheld Terminal connects to connector J1 on the controller board. A separate cable (part of kit M488175) is provided for use with the 8364-E, and this must be installed in place of the standard cable before using the Handheld Terminal.

1. Remove the standard cable from the Handheld Terminal, and replace it with the 8364-E cable included in the kit.
2. Open the controller enclosure door and plug the Handheld Terminal cable into J1 on the controller board.
3. The terminal will power up automatically. After the terminal begins receiving data from the controller, the display will change to the normal visibility output format.

3.1.1 Setup Menu

To enter the Setup Menu, press the "ENT" key on the Handheld Display's keypad or "Return" on a VT52. The following menu will appear:

```
0=EXIT   1=D/T    2=CAL
3=TEST   4=BOOT   5=CFG
```

0=EXIT Pressing **0** will exit you from the Setup Menu.

1=D/T Pressing **1** allows you to set the correct date and time.

2=CAL Pressing **2** will put the system into calibration mode. The calibration procedure is explained in detail in the ***Calibration*** chapter of this manual.

3=TEST Pressing **3** will put the system into test mode.

4=BOOT Pressing **4** allows you to perform either a software or a system reboot.

5=CFG Pressing **5** allows you to enter configuration mode.

If you make an error while making an entry: use the arrow keys to place the cursor beneath the character to be corrected and enter the new value. The new value will overwrite the old one.

3.1.2 Date/Time Setup

Enter **1** at the Setup Menu to change the time or date. The display will read:

```
0=Exit        1=Set Date
2=Set Time
```

To enter the date, press **1**. The display will read:

```
Enter date ddmmyyyy
```

Enter the date in the format shown (for example, 01081998 for August 1, 1998), then press "ENT" (or “Return”). The display will return to the Date/Time menu. To enter the time, press **2** at the Date/Time menu. The display will read:

```
Enter time hhmmss
```

Enter the time in the format shown (for example, 133015 for 1:30:15 pm), then press "ENT" (or “Return”). The display will return to the Date/Time menu. To return to the main menu, press **0** at the Date/Time menu.

3.1.3 Calibration Mode

Pressing **2** at the Setup Menu will put the system into calibration mode. Refer to the ***Calibration*** chapter of this manual for instructions in using this mode to calibrate the 8364-E.

3.1.4 Test Mode

Pressing **3** at the Setup Menu will put the system into test mode. There are five selections in the test menu:

```
0=Exit      1=Stat      2=Diag
3=Mode 0                4=Mode 1
```

These options allow for internal testing of the system in specific operational modes.

Pressing **0** (Exit) returns you to the main setup menu.

Pressing **1** (Stat) will display current values for the three status words:

```
System Status:  0048
0000  0001      #=Cont
```

The meanings of the status words are explained in the ***Theory of Operation*** chapter of this manual, and in **Table 5-4**, **Table 5-5**, and **Table 5-6**. Pressing the # key will return you to the test menu.

Pressing **2** (Diag) will initiate the diagnostics program, a series of tests of various system components (RAM, ROM, etc.). When you choose this option, a diagnostics menu will be displayed:

```
0=Exit   1=RAM    2=ROM
3=Pwr    4=NV RAM
```

To select a test to run, press the number key for that test. As the test is running, a progress message such as the following will be displayed:

```
RAM Test in
progress. . .
```

When the test is completed, a message such as the following will be displayed if the test has been successful:

```
RAM Test PASS
                    #=Cont
```

Hit the # key to return to the diagnostics menu and carry out any other tests. All the tests return a PASS or FAIL message when completed, with the Power Supply test (Pwr) returning pass or fail status for each of the three monitored power supply levels (5V, 15V, and -15V).

If any of the tests returns a FAIL message, the test has uncovered a problem that must be corrected before the sensor is put back into service.

Pressing **3** (Mode 0) places the instrument into Mode 0 with Emitter 0 on and Emitter 1 off. Detector 1 is set to the Lo gain mode for direct transmission, while Detector 0 is set into the Hi gain mode for scattered transmission. Mode 0 is used for initial alignment of the emitter/detector pair. Two values will be displayed. The "d00" value represents the indirect counts received at Detector 0. The "d01" value on the second line of the display represents the direct counts received at Detector 1.

Counts:	d00=927	
d01=25136		#=Cont

This test is used in troubleshooting sensor problems, and is explained in detail in the ***Troubleshooting*** chapter of this manual.

Pressing **4** (Mode 1) places the instrument into Mode 1 with Emitter 1 on and Emitter 0 off. Detector 1 is set to the Lo gain mode for direct transmission, while Detector 0 is set into the Hi gain mode. Two values will be displayed. The "d11" value represents the indirect counts received at Detector 1. The "d10" value on the second line of the display represents the direct counts received at Detector 0.

Counts:	d11=725	
d10=25727		#=Cont

This test is used in troubleshooting sensor problems, and is explained in detail in the ***Troubleshooting*** chapter of this manual.

To return to the main setup menu from the test menu, press **0**.

3.1.5 Boot

Pressing **4** at the Setup Menu (Boot) gives you the option of restarting the 8364-E using either a software reboot or a system reboot.

0=Exit	1=SW Reboot
2=System Reboot	

Pressing **0** will return you to the main setup menu without resetting the sensor.

Pressing **1** will initiate a software reboot, which resets the sensor firmware, but does not affect the sensor hardware.

Pressing **2** will reset the entire system. Power will be reset, and the sensor will restart. If the sensor is running under battery power exclusively, the BATTERY START switch must be depressed to restart battery power.

3.1.6 System Configuration

Sensors are configured at the factory for ideal performance in a particular application. Depending on this configuration, certain of the following screens and prompts may be omitted.

Press **5** at the Setup Menu to initiate system configuration. The first menu will show:

Report Type:	0=AWOS
	1=STD

Select the report type by pressing the appropriate number key.When AWOS output is selected, the configuration is set automatically and the message "End of Configuration—Saving Data" will be displayed. You will then be returned to the setup menu. If standard output is chosen, the display will then prompt you for the output interval.

Output Int:		0=10sec	
(min)	1=1	2=5	3=10

Select an output interval. The display will advance to the averaging interval menu:

Avg Interval:		(min)
0=3	1=5	2=10

Select an averaging interval. The display will advance to the output type menu:

Output	0=Vis
Type :	1=Ext Coef

Select an output type (visibility or extinction coefficient). The display will advance to the units menu:

Units:	0=miles
	1=kilometers

Select a units system for displayed data. The display will advance to the baud rate menu:

```
Baud:    0=300    1=1200
2=2400   3=4800   4=9600
```

The value entered here sets the baud rate for the data output serial port (external computer). Select a baud rate for the port. The display will advance to the sensor address menu:

```
SENSOR ADDR. (0 - 9)
Enter 1 digit
```

If multiple visibility sensors are connected to a central computer, this option lets you specify a unique address for each sensor. When a single sensor is used, the address 0 is normally assigned to it.

To assign a sensor address to the sensor, enter any one-digit value between 0 and 9. This will complete the configuration procedure, and the configuration data will be saved automatically. The display will read:

```
End of Configuration
Saving Data
```

Once the data is saved to nonvolatile RAM, the display will return to the setup menu.

To exit from the setup menu and return to the normal display, press 0 at the setup menu.

4. OPERATION

4.1 SWITCHES

4.1.1 Main Power Switch

The main power switch is located on the AC Interface board, a smaller printed circuit board mounted in the lower right corner of the controller enclosure, beneath the controller board (see **Figure 4-1**). This switch must be in the ON position when operating from AC power.

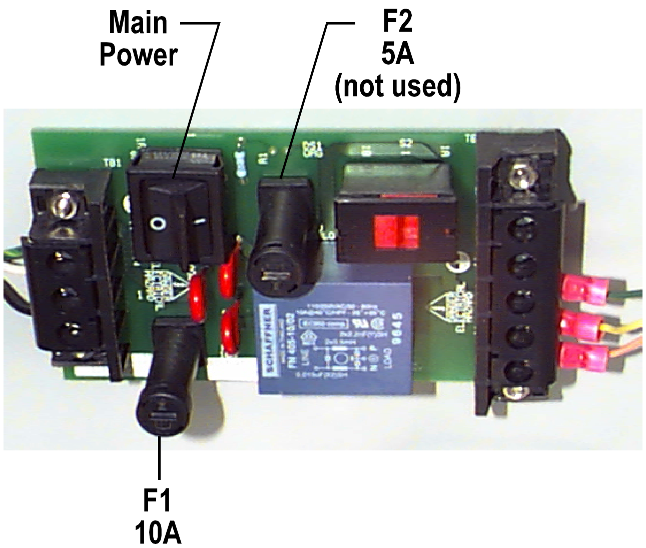


Figure 4-1. The AC Interface board is located in the lower right corner of the controller enclosure, beneath the controller board.

4.1.2 Battery Switch

The Battery ON/OFF switch located in the upper left corner of the controller board (see **Figure 4-2**) allows an installed optional backup battery to power the system and to be charged by AC power. This switch must be ON to charge the battery or power the system from battery power. When AC power is removed, however, and the system is not operating from battery power, this switch should be turned OFF to prevent the battery from being depleted.

4.1.3 Battery Start Switch

If an optional backup battery is installed, it will automatically become the sensor's power source in the event of a loss of AC power. If, however, the system is powered up on battery power only, the BATTERY START switch must be depressed to initiate battery power.

The BATTERY START switch is located in the upper left of the controller board just to the left of the large, rectangular component U4 (see **Figure 4-2**). To initiate battery power, depress the BATTERY START button and hold it down for 3-4 seconds.

4.2 CONTROLLER BOARD LEDS

A series of LEDs located on the controller board provide a visual indication of sensor operation. **Figure 4-2** shows the location of these LEDs.

4.2.1 Watchdog LED

The red "WATCHDOG" LED should blink on and off during normal operation, indicating that processing is proceeding normally. If the LED does not light at all, or if it stays lighted, an error has occurred.

4.2.2 Heat On LED

The red "HEAT_ON" LED lights when the sensor head heaters are running.

4.2.3 Power On LED

The red "POWER_ON" LED lights whenever AC line power is being supplied to the controller board. This LED will be off when running from battery power.

4.2.4 Battery LEDs

Two LEDs in the upper left of the controller board monitor the charge of the optional backup battery. The green "BATT CHARGED" LED indicates, when lighted, that the battery is charged to operating levels. The red "FLOAT CHARGE" LED indicates, when lighted, that the battery is in the final stages of its charging cycle. When the battery is being charged after being largely depleted, both the "FLOAT CHARGE" and "BATT CHARGED" lights will be off until the charging cycle is nearly complete.

4.3 JUMPERS

Two jumpers on the controller board are used to set the sensor to operate with a Day/Night or ALS sensor. When a Day/Night sensor is installed, JP2 should be installed and JP3 removed (see **Figure 4-2** for jumper locations). When an ALS sensor is installed, JP3 should be installed and JP2 removed. When neither sensor is installed, both jumpers should be removed.

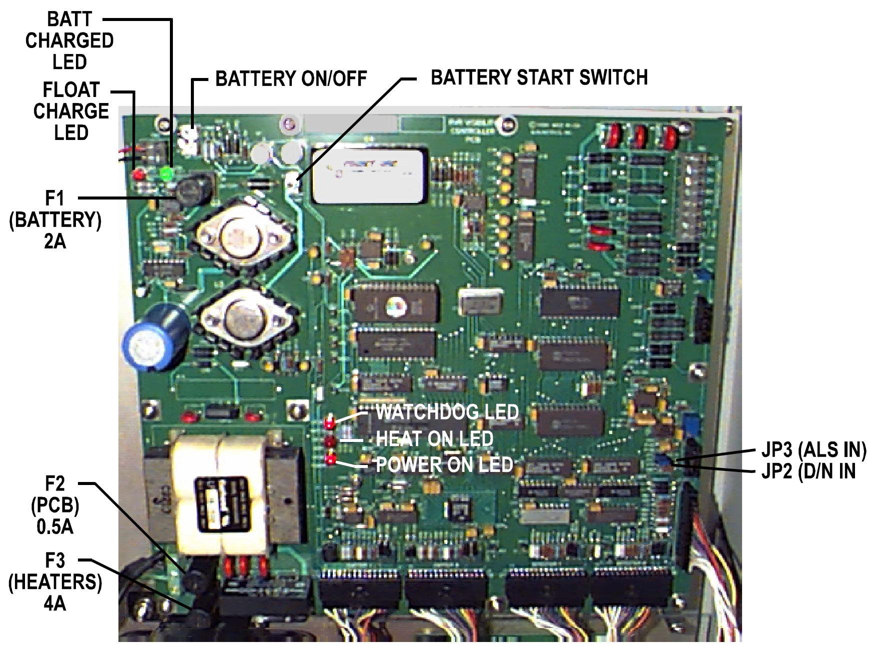


Figure 4-2. Controller board component locations.

4.4 FUSES

Three fuses are located on the controller board, and two on the AC interface board (see **Figures 4-1** and **4-2**). Though installed, fuse F2 on the AC interface board is not used and should never need to be replaced. The remaining fuses should only be replaced by fuses of the same rating, as shown in the list below.

AC Interface Board

F1	10A 250V, 5x20 mm slow blow

Controller Board

F1	2A 250V, 5x20 mm
F2	0.5A 250V, 5x20 mm
F3	4A 250V, 5x20 mm

4.5 HANDHELD TERMINAL

The Handheld Terminal is used primarily for setup, calibration, and testing of the 8364-E. However, when the Handheld Terminal is connected but inactive (no key has been pressed over the span of the last output interval) the display will show the time and date, and will alternately display the ALS value (if connected) and the current visibility value. The rate at which the display switches between ALS and visibility data is determined by the output interval (set through the setup procedure). At each output interval, the display will switch to the other data screen (from ALS to visibility, or from visibility to ALS). For example, if the output interval is set to 30 seconds, the ALS data will be displayed for 30 seconds, then the display will switch to visibility data, which will be shown for the next 30 seconds before the display again switches to ALS data.

5. THEORY OF OPERATION

5.1 GENERAL

The Model 8364-E forward scatter visibility sensor measures atmospheric optical extinction coefficient. An infrared emitting diode illuminates the atmospheric sample volume with amplitude-modulated narrow-band optical radiation centered at 865 nanometer wavelength. Optical energy scattered by interaction with particles in the sample volume is measured at a scatter angle of 35 degrees. This angle is selected because it provides a linear scattered signal amplitude for the particle size distribution of interest (haze, fog, rain, and snow). A solid state silicon photodetector measures optical energy scattered from the sample volume. An optical interference filter allows the photodetector to see only a narrow band of energy centered at the 865 nanometer wavelength of the optical emitter array. Signal conditioning after the photodetector detects only signals which are in phase with, and at the same modulation frequency as, the optical source. This synchronous lock-in detection technique provides an output signal proportional to the scattered optical energy which is unaffected by background light or noise created by optical sources in the field of view of the photodetector.

The precise amount of optical energy entering the sample volume must be known if the measured optical extinction coefficient is to be representative of actual visibility. Effects of temperature changes must be compensated for, as must the degradation of optical transmission caused by contaminants on the emitter windows. The impact of these contaminants on optical transmission can be significant. This is true both for long term contaminants such as blowing dust, dirt, or precipitation, and for transient effects such as condensation during fog events.

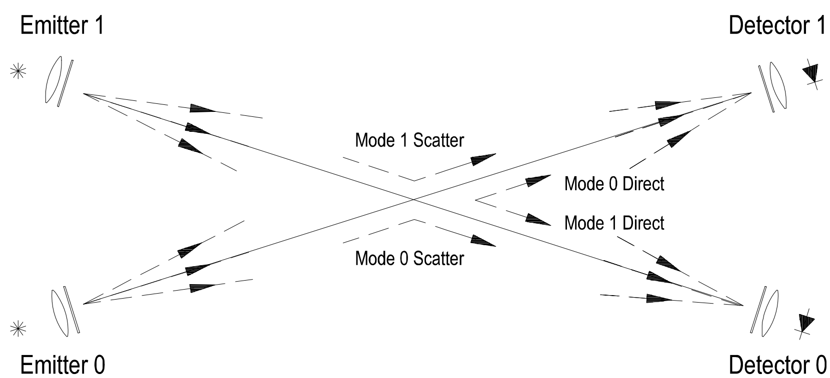


Figure 5-1. The 8364 Visibility Sensor measures both direct and scattered optical energy, eliminating the need for absolute calibration.

A similar source for error occurs at the optical detector. Previous forward scatter visibility sensor designs have been based upon performing precise absolute measurements during variable environmental conditions in hostile environments. The All Weather Inc. approach is different. The Model 8364-E uses a technique for measuring optical extinction coefficient that does not depend upon absolute calibration of the optical emitter and optical detector. Two optical emitters are used along with two optical detectors to measure four parameters. Facing emitter/detector pairs measure the direct optical transmission through the sample volume, while the optical energy scattered by haze, fog, rain, or snow is measured by emitter/detector pairs at a 35° angle to one another. Calculations performed using these measured parameters yield an absolute extinction coefficient value independent of contaminants upon the optical surfaces or the effects of temperature changes on the optical source and measurement electronics.

The visibility controller contains a microprocessor that performs all the necessary calculations. The visibility controller output is provided through the serial communications port. The output product is programmable for either visibility (in miles or kilometers) or extinction coefficient. In addition, the output includes sensor status information (such as current sensor configuration, output mode, and averaging interval), as well as calibration, maintenance, and built-in test status. The visibility controller can be configured for timed output or for operation in an interrogated mode. The averaging interval is programmable for running averages calculated over a period of from 3 minutes to 10 minutes.

User programming is performed in a menu-driven format via a portable Display Terminal (DT) or the AWOS DCP's built-in keypad and display.

Calibration of the sensor is performed by inserting an optical scattering device into the sample volume (see Section 4). This calibration is traceable to Air Force Geophysical Laboratory reference transmissometers.

AWOS installations require a day/night sensor and a rain gauge. These sensors assist the AWOS Central Data Processor (CDP) in implementing the FAA visibility algorithm. AWOS installations that calculate runway visual range (RVR) require an ambient light sensor (in place of a day/night sensor) and a runway light setting interface.

5.2 FUNCTIONAL DESCRIPTION

5.2.1 Visibility Sensor

Two infrared optical emitter assemblies and two optical detector assemblies operate under the control of the visibility controller. Mode selection, data collection, algorithm processing, heater control, self-test, and communications tasks are handled by the visibility controller.

Figure 5-2 shows a diagram of the optical emitter assembly. Power and control logic are provided by the visibility controller. Power is conditioned in the emitter assembly housing for use by the emitter electronics. The control logic programs a constant current source which drives a single infrared emitting diode. The emitter diode is amplitude modulated at 1024 Hz with a 50% duty cycle. This provides synchronization logic for the optical detectors. Heater power is provided by the visibility controller. Temperature information gathered by a solid-state temperature sensor is sent from the emitter assembly housing to the visibility controller.

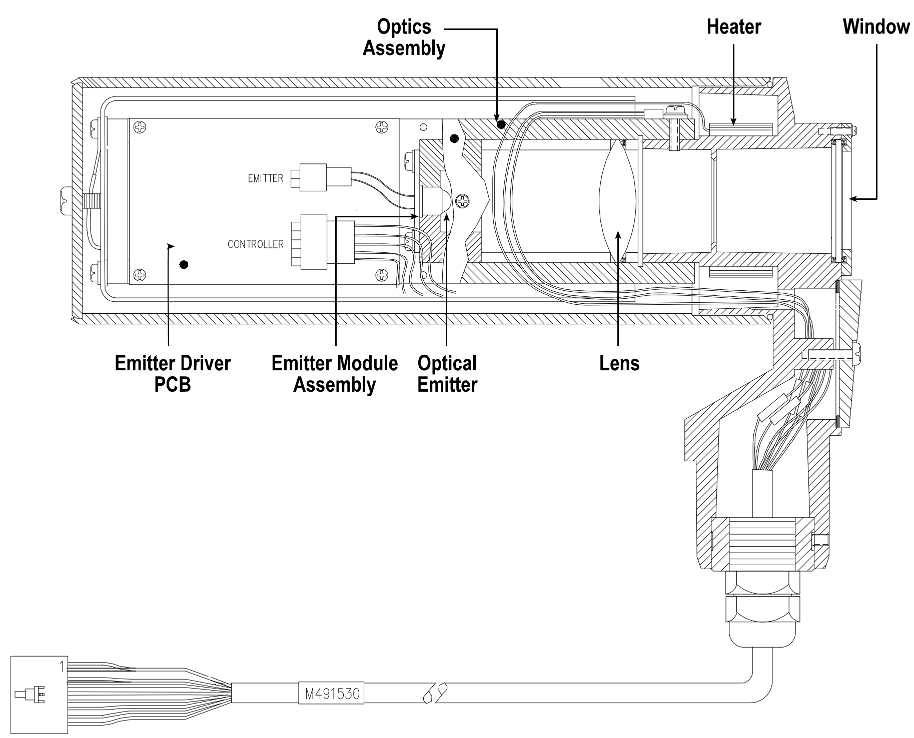


Figure 5-2. The optical emitter assembly consists of an infrared emitting diode, a heater element, and emitter control electronics.

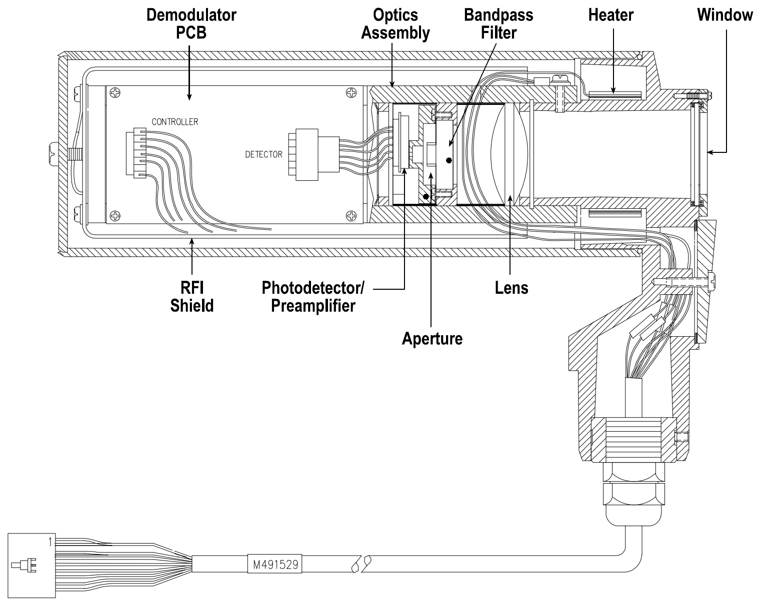


Figure 5-3. The optical detector assembly consists of an optical bandpass filter, aperture, photodetector and preamplifier, heater element, and signal conditioning. electronics.

Figure 5-3 shows a diagram of the optical detector assembly. Power and control logic are provided by the visibility controller. Power is conditioned in the detector assembly housing for use by the detector electronics. Optical radiation from the sample volume enters through a 1-3/8 inch (35 mm) aperture. The field of view has a 1/2 angle of 3 degrees. Optical radiation is focused by a quartz lens through an optical bandpass filter, then through a limiting aperture and onto a .92 square inch (23.4 millimeter square) silicon photodetector.

The optical bandpass filter allows only a narrow wavelength range to pass through to the detector. The wavelength range is centered at the emission wavelength of the optical emitter. The filter, aperture, and silicon photodetector are parts of an integrated filter/aperture/detector/preamplifier package. This hermeticcally sealed package features very high sensitivity, low noise, and excellent linearity over a wide dynamic range. The photodetector/preamplifier output goes to an active electronic bandpass filter having a center frequency tuned to the modulation frequency of the optical emitters. A high gain amplifier locked to the photodetector/preamplifier is used to amplify the scattered signal.

The demodulator circuit is referenced to the emitter modulation frequency, and acts as a full wave rectifier for signals which are in phase with, and at the same frequency as, the modulation reference. The demodulated signal is then filtered. The filtered output is a DC voltage proportional to the component of the incoming optical energy, and this is converted into a digital format by the voltage-to-frequency converter. The resultant frequency is output by the detector assembly for processing by the visibility controller. The frequency format prevents noise in the interconnecting cable between the detector assembly and visibility controller from contaminating analog signals.

The detector assembly optical sensitivity is digitally programmed by the visibility controller. Programmable gains are switched at the photodetector/preamplifier and high gain amplifier. Three gain settings are used to cover the detector dynamic range. One gain setting is used for the direct transmission mode measurement, while the other two cover the scattering mode range requirements.

5.2.2 Visibility Controller

The emitter and detector assemblies are controlled by the visibility controller, which generates the reference frequency for emitter modulation and detector demodulation, sets all emitter and detector modes of operation, measures the detector assembly frequency output, and processes the extinction coefficient algorithm.

The heater controller measures temperature within each emitter and detector enclosure. Solid-state temperature sensors inside each housing provide an analog voltage proportional to enclosure temperature. The temperature controller monitors these signals, turning 50 Watt heater elements on and off with a solid-state switch.

5.2.3 Time Constant

The sensor's time constant is a function of the averaging interval selected. For a step change in extinction coefficient, the sensor output data will cross 1/e of the final value in the times listed below.

Averaging Interval	*Time Constant*
3 Minute	1½ Minutes—(standard for AWOS)
5 Minute	2 Minutes—(optional)
10 Minute	3½ Minutes—(optional)

5.2.4 Background Sensitivity

The visibility sensor is unaffected by normal ambient or background optical radiation. The lock-in detection technique previously described averages to zero any signal not in phase with, and at the same frequency as, the emitter modulation frequency.

5.3 OPERATION

5.3.1 Measurement mode

During normal operation, the visibility sensor will operate in the measurement mode. While in the measurement mode, the sensor alternates between Mode 0 and Mode 1 operation with a period of 15 seconds. Each half cycle, a new pair of detector measurements is acquired (one direct and one scatter). Each new pair of measurements is checked for integrity. The measurement cycle period is 1 minute long, with 30 seconds spent in each mode. At the end of each 30 second measurement cycle, a new pair of measured values is available for update of the extinction coefficient product. Should the data be missing for some reason, the measured value will be indicated as MM.MMM.

5.3.2 Three-Headed Operation

A special mode of operation has been incorporated into the design of the Model 8364-E to allow it to continue operating even after one of the sensor heads has failed. Three-headed operation is initiated automatically when the software determines that one of the sensor heads (emitters or detectors) is not functioning properly. In this mode, special algorithms are used to determine visibility based on the outputs of the three operational heads.

Three-headed mode is intended as an interim measure to provide visibility data until the system can be repaired. The accuracy of a fully functioning system is impossible to maintain when all four heads are not providing data, and the data generated in three-headed mode should be considered an approximation and the sensor should be repaired as soon as possible. In some cases the problem is transitory, and the system will return to full operation on its own. Monitoring the system’s two status words will provide valuable troubleshooting information, including the identity of the head that has failed. Section 3.3.2.1.1 and Tables 3-3 and 3-4 explain the meanings of the status words.

5.3.3 Sensor Output

The Model 8364-E outputs serial data in both RS-232 and RS-485 formats. If analog output is desired, the optional analog output module must be added to the controller board as described in the ***Installation*** section of this manual. With the optional analog output module installed, visibility data is output as an analog signal varying between 0 and 1 volt.

In serial data mode, the output data packet contains supplementary status and operation information in addition to the visibility data. Serial mode also allows the user to customize the system’s operation for the most useful data output, with the settings for a number of parameters accessible to and changeable by the user. The output interval, averaging interval, output type (visibility or extinction coefficient), and units (miles or kilometers) can all be set through the Setup menu (see **Setup** in the ***Installation*** section of this manual).

5.3.4 Output Data Format

Sensor output is available in two formats: Standard format and AWOS format.

Standard Output Data Format

(See **Table 5-1**). In standard format, the visibility output data is embedded within a transmission packet that provides for start synchronization and data transmission quality checks. The first part of the packet is the “preface”, which consists of three SYNC characters. This allows a simple routine to detect the beginning of a packet, even in noisy conditions.

After the three-character preface comes the actual packet, which includes: sensor model, sensor address, date, time, visibility (reported as visibility in miles or kilometers or extinction coeffiecient in 1/miles or 1/kilometers), ALS value (in candela/m^2), and status words 0, 1, and 2 (see **Tables 5-4**, **5-5**, and **5-6**). The final part of the packet provides data on several sensor parameters that can be helpful in trouble-shooting errors. These include: heater status, sensor head temperature data, sensor mode counts, and ALS counts. All the characters in the packet are printable ASCII to allow monitoring by a terminal. Items that consist of one byte of information are encoded in hexadecimal as two ASCII characters. So 76 decimal = 4c hex is encoded as “4C” (capitals are used). Such items will be denoted as an “ASCII byte”. Similarly, 16 bit items are encoded as 4 hex digits, called an “ASCII word”.

The cyclic redundancy code, CRC16, covers all bytes after the three sync characters, 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.

AWOS Output Data Format

(See **Table 5-2**). AWOS output is the data format used in AWOS systems between the 8364-E and the AWOS Model 1190 DCP. The AWOS format data packet consists of the extinction coefficient as calculated by the 8364-E, and status words 0, 1, and 2 (see **Tables 5-4**, **5-5**, and **5-6**).

The AWOS Model 1190 DCP is able to poll the sensor using the following command:

```
VISI00<cr><lf>
```

where 00 is sensor address 0

11 is sensor address 1

and so on, up to 99 for sensor address 9.

The interface is 4800 baud, 8 data bits, 1 stop bit, no parity.

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.

5.3.5 Status Words

Three status words are output by the 8364-E, and can be used for troubleshooting sensor problems. Status word 0 (**Table 5-4**) contains information vital for ensuring data integrity, along with some basic configuration information. Status word 1 (**Table 5-5**) contains status information for the emitter and detector heads and operational modes. Status word 2 (**Table 5-6**) contains ALS and Day/Night sensor status information, along with power supply status.

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.

Table 5-1 Standard Output Data Format			
Segment	Length (bytes)	Description	Example
Preface	3	three sync characters	161616 (h)
Packet header	6	sensor description	8364-E
blank			
Sensor address	2	range from 00-99, inclusive	01
blank			
Date	10	dd-mm-yyyy	15-06-1998
blank			
Time	10	hh:mm:ss	11:35:05
blank			
Visibility	up to 7 characters	visibility (mi. or km) or extinction coefficient (mi. or km)	1.16 (ext. coeff.)
blank			
ALS value	up to 5 digits	ALS data	245
blank			
Status word 0	4	see Table 5-3	0048 (h)
blank			
Status word 1	4	see Table 5-4	0000 (h)
blank			
Status word 2	4	see Table 5-5	0004 (h)
blank			
Heater Status	up to 5 characters	On or Off Status	"H-ON" or "H-OFF"
blank			
Detector 0 Temp	6	Temp in °C	33.45
blank			
Detector 1 Temp	6	Temp in °C	33.45
blank			
Emitter 0 Temp	6	Temp in °C	33.45
blank			
Emitter 1 Temp	6	Temp in °C	33.45
blank			
Mode 0 indirect	6	counts	700
blank			
Mode 0 direct	6	counts	31342
blank			
Mode 1 direct	6	counts	30288
blank			
Mode 1 indirect	6	counts	700
blank			
ALS w/led on	6	counts	500
blank			
ALS w/led off	6	counts	10
blank			
CRC	2	crc, msbyte	ASCII byte "XX"
CRC	2	crc, lsbyte	ASCII byte "XX"
Termination	1-2	cr-lf	

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

Table 5-2
AWOS Output Data Format

Segment	Length (bytes)	Description	Example
Extinction coefficient	3	extinction coefficient from 8364-E	1.16
blank			
Status word 0	4	see **Table 5-3**	0048 (h)
blank			
Status word 1	4	see **Table 5-4**	0000 (h)
blank			
Status word 2	4	see **Table 5-5**	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			
8364-E flag	1	1 if 8364-E; 0 if other model	1
blank			
ending sequence	3	always 0<sp>0<sp>0	0 0 0
CRC	2	crc, msbyte	ASCII byte "XX"
CRC	2	crc, lsbyte	ASCII byte "XX"
Termination	1-2	cr-lf	

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

The following section contains a step-by-step discussion of how to decode an example status word. A worksheet is also provided in **Table 5-7**, 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.

Example

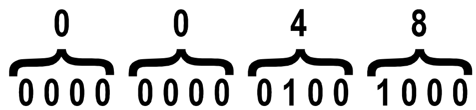
As an example of how to decode a status word, the value 0048 can be used. This is a common value for status word 0, since it represents a common configuration and operating status for an 8364-E functioning normally.

To decode the status word, the first step is converting the four hexadecimal characters to their binary equivalents. **Table 5-3** shows the binary equivalents for all the possible hexadecimal characters.

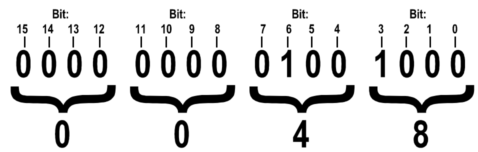
Table 5-3
Hexadecimal and Binary Equivalents

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

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 sixteen bits in total, with each bit having a value of either 0 or 1. Starting with the right-most bit, next number each bit, beginning with Bit 0 as shown below.



The bits can then be compared against **Table 5-4** to determine their meanings.

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 5-4** 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 5-4**, 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 5-4**, 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.

Visibility Sensor Status Word 0			
BIT	FUNCTION	VALUE	MEANING
2-1-0	averaging interval	000 001 010	3 minutes 5 minutes 10 minutes
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)
10	visibility data missing status	0 1	OK data missing—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		

Visibility Sensor Status Word 1			
BIT	FUNCTION		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		

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	15V power supply status	0 1	OK failed
11	-15V power supply status	0 1	OK failed
12-15	unused		

Table 5-7
Status Word Worksheet

Status Word 0

	Bit:				Bit:				Bit:				Bit:			
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Binary:																
Hexadecimal:	________				________				________				________			

Status Word 1

	Bit:				Bit:				Bit:				Bit:			
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Binary:																
Hexadecimal:	________				________				________				________			

Status Word 2

	Bit:				Bit:				Bit:				Bit:			
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Binary:																
Hexadecimal:	________				________				________				________			

6. VISIBILITY AND RVR

The Model 8364-E Visibility Sensor can be used to determine Runway Visual Range (RVR) in aviation applications with the addition of an Ambient Light Sensor (M) and a Runway Lights Setting Interface. This chapter explains the principle and measurement of visibility and RVR in detail, along with the specific methods used with the 8364-E.

6.1 DEFINITIONS

Visibility was first defined for meteorological purposes as a quantity to be estimated by a human observer, and observations made in that way are widely used. However, the estimation of visibility is affected by many subjective and physical factors. The essential meteorological quantity, which is the transparency of the atmosphere, can be measured objectively, and is represented by the meteorological optical range (MOR).

The *meteorological optical range* is the length of path in the atmosphere required to reduce the luminous flux in a collimated beam from an incandescent lamp, at a color temperature of 2700° K, to 5% of its original value, the luminous flux being evaluated by means of the photometric luminosity function of the International Commission on Illumination (ICI).

Meteorological visibility by day is defined as the greatest distance at which a black object of suitable dimensions, located near the ground, can be seen and recognized when observed against a scattering background of fog, sky, etc. It should be emphasized that the criterion for recognizing an object, and not merely for seeing the object without recognizing what it is, should be used.

Meteorological visibility at night is defined as:

(a) The greatest distance at which a black object of suitable dimensions could be seen and recognized, if the general illumination were raised to the normal daylight level; or

(b) The greatest distance at which lights of moderate intensity can be seen and identified.

Airlight is light from the Sun and the sky which is scattered into the eyes of an observer by atmospheric suspensoids (and, to a slight extent, by air molecules) lying in the observer's cone of vision. That is, airlight reaches the eye in the same manner as diffuse sky radiation reaches the Earth's surface. Airlight is the fundamental factor limiting the daytime horizontal visibility for black objects because its contributions, integrated along the cone of vision from eye to object, raise the apparent luminance of a sufficiently remote black object to a level which is indistinguishable from that of the background sky. Contrary to subjective estimate, most of the airlight entering an observer's eye originates in portions of his cone of vision lying rather close to him.

The following four photometric qualities are defined in detail in various standards, such as by the International Electrotechnical Commission (IEC, 1987):

(a) *Luminous flux* (symbol: *F (or Φ)*, unit: lumen) is a quantity derived from radiant flux by evaluating the radiation according to its action upon the ICI standard photometric observer;

(b) *Luminous intensity* (symbol: *I*, unit: candela or lm sr^{-1}) is luminous flux per unit solid angle;

(c) *Luminance* (symbol: *L*, unit: cd m^{-2}) is luminous intensity per unit area;

(d) *Illuminance* (symbol: *E*, unit: lux or lm m^{-2}) is luminous flux per unit area.

The *extinction coefficient* (symbol σ) is the proportion of luminous flux lost by a collimated beam, emitted by an incandescent source at a color temperature of 2700° K, while traveling the length of a unit distance in the atmosphere. The coefficient is a measure of the attenuation due to both absorption and scattering.

The *luminance contrast* (symbol *C*) is the ratio of the difference between the luminance of an object and its background and the luminance of the background.

The *contrast threshold* (symbol ε) is the minimum value of the luminance contrast that the human eye can detect, i.e. the value which allows an object to be distinguished from its background. The contrast threshold varies with the individual.

The *illuminance threshold (E_t) is* the smallest illuminance, at the eye, for the detection of point sources of light against a background of specified luminance. The value of *Et*, therefore, varies according to lighting conditions.

The *transmission factor* (symbol *T*) is defined, for a collimated beam from an incandescent source at a color temperature of 2700° K, as the fraction of luminous flux which remains in the beam after traversing an optical path of a given length in the atmosphere. The transmission factor is also called the transmission coefficient. The terms transmittance or transmissive power of the atmosphere are also used when the path is defined, i.e. of a specific length (e.g. in the case of a transmissometer). In this case, *T* is often multiplied by 100 and expressed in percent.

6.2 UNITS AND SCALES

The meteorological visibility or MOR is expressed in meters or kilometers. The measurement range varies according to application. While for synoptic meteorological requirements, the scale of MOR readings extends from below 100 m to more than 70 km, the measurement range may be more restricted for other applications. This is the case for civil aviation where the upper limit may be 10 km. This range may be further reduced when applied to the measurement of runway visual range representing landing and takeoff conditions in reduced visibility. Runway visual range is required only between 50 and 1500 meters. For other applications, such as road or sea traffic, different limits may be applied according to both the requirements and the locations where the measurements are made.

The errors of visibility measurements increase in proportion to the visibility, and measurement scales take account of this. This fact is reflected in the code used for synoptic reports by the use of three linear segments with decreasing resolution, i.e. 100 to 5 000 m in steps of 100 m, 6 to 30 km in steps of 1 km, and 35 to 70 km in steps of 5 km. This scale allows visibility to be reported with a better resolution than the accuracy of the measurement except when visibility is less than about 900 meters.

6.2.1 Meteorological Requirements

The concept of visibility is used extensively in meteorology in two distinct ways. Firstly, it is one of the elements identifying air-mass characteristics, especially for the needs of synoptic meteorology and climatology. Here, visibility must be representative of the optical state of the atmosphere. Secondly, it is an operational variable which corresponds to specific criteria or special applications. For this purpose, it is expressed directly in terms of the distance at which specific markers or lights can be seen. One of the most important special applications is found in meteorological services to aviation.

The measure of visibility used in meteorology should be free from the influence of extra-meteorological conditions, but it must be simply related to intuitive concepts of visibility and to the distance at which common objects can be seen under normal conditions. MOR has been defined to meet these requirements, being convenient for instrumental methods by day and night, and having well-understood relations with other measures of visibility. MOR has been formally adopted by WMO as the measure of visibility for both general and aeronautical uses (WMO, 1990a). It is also recognized by the International Electrotechnical Commission (IEC, 1987) for application in atmospheric optics and visual signaling.

MOR is related to the intuitive concept of visibility through the contrast threshold. In 1924, Koschmieder, followed by Helmholtz, proposed a value of 0.02 for ε. Other values have been proposed by other authors. They vary from 0.0077 to 0.06, or even 0.2. The smaller value yields a larger estimate of the visibility for given atmospheric conditions. For aeronautical requirements, it is accepted that E is higher than 0.02, and it is taken as 0.05 since, for a pilot, the contrast of an object (runway markings) with respect to the surrounding terrain is much lower than that of an object against the horizon. It is assumed that when an observer can just see and recognize a black object against the horizon, the apparent contrast of the object is 0.05. This leads to the choice of 0.05 as the transmission factor adopted in the definition of MOR.

6.2.2 Methods of Measurement

Visibility is a complex psychophysical phenomenon, governed mainly by the atmospheric extinction coefficient associated with solid and liquid particles held in suspension in the atmosphere. The extinction is caused primarily by scattering rather than by absorption of the light. Its estimation is subject to variations in individual perception and interpretative ability as well as the light source characteristics and the transmission factor. Thus, any visual estimate of visibility is subjective.

When visibility is estimated by a human observer it depends not only on the photometric and dimensional characteristics of the object which is, or should be, perceived, but also on the observer's contrast threshold. At night, it depends on the intensity of the light sources, the background illuminance and, if estimated by an observer, on the adaptation of the observer's eyes to darkness and the observer's illuminance threshold. The estimation of visibility at night is particularly problematic. The first definition of visibility at night provided at the beginning of this chapter is given in terms of equivalent daytime visibility in order to ensure that no artificial changes occur in estimating the visibility at dawn and at twilight. The second definition has practical applications especially for aeronautical requirements, but it is not the same as the first and usually gives different results. Both are evidently imprecise.

Instrumental methods measure the extinction coefficient from which the MOR may be calculated. The visibility may then be calculated from knowledge of the contrast and illuminance thresholds, or by assigning agreed values to them. However, fixed instruments are used on the assumption that the extinct-tion coefficient is independent of distance. Some instruments measure attenuation directly and others measure scattering of light to derive the extinction coefficient. The brief analysis of the physics of visibility in this chapter may be useful for understanding the relations between the various measures of the extinction coefficient, and for considering the instruments used to measure it.

6.3 BASIC EQUATIONS

The basic equation for visibility measurements is the Bouguer-Lambert law:

$$F = F_0 e^{-\sigma x} \qquad (1)$$

where F is the luminous flux received after a length of path x in the atmosphere and *Fo is* the flux for x = O. Differentiating, we obtain:

$$\sigma = \frac{-dF}{F} \cdot \frac{1}{dx} \qquad (2)$$

Note that this law is valid only for monochromatic light, but may be applied to a spectral flux to a good approximation. The transmission factor is:

$$T = \frac{F}{F_0} \qquad (3)$$

Mathematical relationships between MOR and the various variables representing the optical state of the atmosphere may be deduced from the Bouguer-Lambert law. From equations 1 and 3 we may write:

$$T = \frac{F}{F_0} = e^{-\sigma x} \qquad (4)$$

If this law is applied to the MOR definition T = 0.05, then x = P and the following may be written:

$$T = 0.05 = e^{-\sigma P} \qquad (5)$$

Hence, the mathematical relation of MOR to the extinction coefficient is:

$$P = \left(\frac{1}{\sigma}\right) \cdot \ln\left(\frac{1}{0.05}\right) \approx \frac{3}{\sigma} \qquad (6)$$

where ln is the log to base e, or the natural logarithm. When combining equation 4, after being deduced from the Bouguer-Lambert law, and equation 6, the following equation is obtained.

$$P = x \cdot \frac{\ln(0.05)}{\ln(T)} \qquad (7)$$

This equation is used as a basis for measuring MOR with transmissometers.

6.3.1 Meteorological Visibility in Daylight

The contrast of luminance is:

$$C = \frac{L_b - L_h}{L_h} \quad (8)$$

where L_h is the luminance of the horizon, and L_b is the luminance of the object.

The luminance of the horizon arises from the airlight scattered from the atmosphere along the observer's line of sight. It should be noted that if the object is darker than the horizon, then C is negative, and that if the object is black (L_b = 0), then C = -1.

In 1924, Koschmieder established a relationship, which later became known as Koschmieder's law, between the apparent contrast (C_x) of an object, seen against the horizon sky by a distant observer, and its inherent contrast (C_o), i.e. the contrast that the object would have against the horizon when seen from very short range. Koschmieder's relationship can be written as:

$$C_x = C_0 e^{-\sigma x} \quad (9)$$

This relationship is valid provided the scatter coefficient is independent of the azimuth angle and there is uniform illumination along the whole path between the observer, the object, and the horizon. If a black object is viewed against the horizon ($C_o = -1$) and the apparent contrast is -0.05, then equation 9 reduces to:

$$0.05 = e^{-\sigma x} \quad (10)$$

Comparing this result with equation 5 shows that when the magnitude of the apparent contrast of a black object seen against the horizon is 0.05, then that object is at MOR (P).

6.3.2Meteorological Visibility at Night

The distance at which a light (a night visibility marker) can be seen at night is not simply related to MOR. It depends not only on MOR and the intensity of the light, but also on the illuminance at the observer's eye from all other light sources.

In 1876, Allard proposed the law of attenuation of light from a point source of known intensity (I) as a function of distance (x) and extinction coefficient (σ). The illuminance *(E)* of a point light source is given by:

$$E = I \cdot r^{-2} \cdot e^{-\sigma x} \quad (11)$$

When the light is just visible, *E* = *Et* and the following may be written:

$$\sigma = \left(\frac{1}{r}\right) \cdot \ln\left(\frac{I}{E_t \cdot x^2}\right) \quad (12)$$

Noting that P = (l/a) • ln (1/0.05) in equation 9.6, we may write:

$$P = r \cdot \frac{\ln\left(\frac{1}{0.05}\right)}{\ln\left(\frac{I}{E_t \cdot x^2}\right)} \quad (13)$$

6.4 RUNWAY VISUAL RANGE (RVR)

Runway Visual Range (RVR) is used in aviation applications, and is defined as the range over which the pilot of an aircraft on the center line of a runway can see the runway surface markings or the lights delineating the runway or identifying its center line.

The main purpose of RVR is to provide pilots, air traffic services units, and other aeronautical users with information on runway visibility conditions during periods of low visibility, whether due to fog—the most frequent cause of low visibility in many places—or to other causes such as rain, snow, or sand storms. In particular, RVR is required to allow an assessment to be made as to whether conditions are above or below the specified operating minima.

Assessment of RVR is by calculation, based on Koschmieder's law in the case of objects or markings—that is, during daytime—and Allard's law in the case of lights—that is, at night—taking into account the prevailing atmospheric conditions.

As explained earlier, an observer (in this case a pilot in the cockpit) can see and identify objects such as markers, small trees, etc. if the contrast ratio with the sky or fog background is 0.05. The maximum visual range of such objects can be calculated for this contrast ratio if atmospheric transmittance (*t*) or extinction coefficient (σ) are known. The 8364-E determines extinction coefficient, and uses this value to determine the maximum visual range. This calculated range is usually referred to as the MOR, as explained earlier. However, when the MOR by day exceeds the RVR based on lights, it is usually quoted as the RVR.

RVR based on lights takes into account three factors.

1. The intensity of the runway edge and runway center line lights (*I*)
2. The optical clarity of the atmosphere, expressed in terms of atmospheric transmittance (*t*) or extinction coefficient (σ)
3. The visual threshold of illumination (E_t) of the eye that is required for a point source or small light to be visible. This is related to the measured luminance of the background against which the light is viewed

These three factors are evaluated using the 8364-E (which calculates the extinction coefficient—optical clarity of the atmosphere), the M488171 ambient light sensor (which measures the background luminance—used to determine the visual threshold of illumination), and the Runway Lights Setting Interface (which communicates the intensity of the runway lights to the RVR software).

6.4.18364-E RVR Calculation

When using the 8364-E to determine RVR, All Weather Inc.'s RVR software is used in conjunction with the 8364-E, a Model M488171 Ambient Light Sensor, and a Runway Lights Setting Interface. To perform the runway visual range calculations, the software uses the raw data of background luminance, runway light intensity, and extinction coefficient to calculate both Allard's and Koschmieder's laws. It then determines which routine gives the greatest runway visual range and returns that number.

The variables used in determining RVR are defined as follows:

K the RVR value calculated from Koschmieder's equations

R the RVR value calculated from Allard's equations

σ the extinction coefficient for Koschmieder's law in daytime

bgl background luminance in candelas/sq. meter

I light intensity in candle power

E_T illumination threshold

Calculate the runway light intensity in candle power from light setting interface from the chart describing intensity of the runway lights.

Calculate Koschmieder's law for daylight visibility using the following formula:

$$K = \frac{\ln \cdot 0.05}{\sigma}$$

Calculate Allard's value from the following equations:

$$E_T = 10^{-5.7+.64\log(bgl)}$$

$$E_T = \frac{Ie^{-\sigma R}}{R^2}$$

Choose the larger value, i.e., maximum (R, K). This is the RVR.

6.4.2 Reporting Range

The increments between reported RVR values vary according to the existing RVR. In general, the lower the RVR, the smaller the increments used to report RVR. As RVR increases, less precision is required, and the increments become larger. The minimum value reported is 50 meters, and the maximum is 2000 meters. The following table shows the range and increments used with this system:

RVR Range	Increment
<50m	Display shows "<50m"
50-500m	50m
500-1000m	100m
1000-2000m	200m
>2000m	Display shows ">2000m"

7. ALIGNMENT

7.1 8364-E VISIBILITY SENSOR SYSTEM ALIGNMENT

The 8364 is tested and aligned at the factory prior to shipment. After the testing is completed, the support structure is disassembled and the sensor heads are removed and packed separately. The customer reassembles the support structure and installs the heads in the upright end caps. Under normal circumstances, alignment is not needed. If the upright end caps come loose, however, alignment will need to be performed. To avoid this, be sure to never loosen the end cap set screws located at the base of each end cap. Loosen only the large head mounting bolts when removing or installing a head.

Alignment is a complex procedure. If a local facility is not available capable of performing this procedure, the sensor should be returned to All Weather Inc. for realignment.

Alignment should be done inside, away from the weather, in a dry, open room. Do not try to align the system in a small area, as the reflections off of walls and the like will distort the results and will yield unsatisfactory alignment.

Note that **alignment is not the same as calibration**. Alignment essentially configures the system so that calibration will be possible and accurate. A poorly aligned system will lose its accuracy, and the calibration may be suspect, even though the system is put through calibration successfully. Hence, it is important that a new calibration sequence be performed after every alignment. Any calibration performed prior to an alignment is null and void.

The following items are required:

- oscilloscope
- Phillips head screwdriver
- slotted screwdriver
- potentiometer tuner screwdriver (small slotted screwdriver)
- two pieces of foam rubber or similar material used to block the emitter emissions
- standard calibration paddle
- digital multimeter with frequency counter

7.1.1 Field Alignment Check

The mechanical and electrical alignment of the sensor heads can be performed in the field using a DMM with a frequency counter according to the procedure below.

1. Measure the Detector 0 frequency output at TP14 on the main controller board. The measured frequency should be between 10–16.7 kHz in mode 1 (Emitter 1 on). ***Note: the sensor switches between mode 0 and mode 1 every 7.5 seconds. To avoid this, set the controller to mode 1 using a handheld terminal.***
2. Measure the Detector 1 frequency output at TP12 on the main controller board. The measured frequency should be between 10–16.7 kHz in mode 0 (Emitter 0 on). ***Note: the sensor switches between mode 0 and mode 1 every 7.5 seconds. To avoid this, set the controller to mode 0 using a handheld terminal.***

If the results of the above two tests are within the specified range, the heads are in mechanical and electrical alignment.

Note that the direct counts as reported in the standard output data format are equal to twice the measured frequency. For example: if the frequency measured at TP14 during the Mode 1 test is 12.2 kHz, the direct count for Detector 0 will be 24400. In general, if the direct counts of Detector 0 and Detector 1 are between 20000 and 33400, the heads are in alignment.

If the tests show the heads to be out of alignment, adjust the sensor by loosening the heads and rotating them for maximum signal at TP14 (for Detector 0/Emitter 1 pair) and TP12 (for Detector 1/Emitter 0 pair).

7.1.2 Sensor Head Mechanical Alignment

1. Remove outer covers (white canisters) and RFI shields (anodized canisters) from sensor head modules.
2. Place sensor in mode 0 using the Display Terminal or AWOS DCP.
3. Place scope probe at TP8 of Demodulator 1. A display approximate to that shown in **Figure 7-1** should appear on the screen.
4. Loosen Detector 1 head assembly and rotate to obtain maximum frequency (minimum separation time for the pattern seen at TP8). Don’t worry about the magnitudes of the signals at this point; just try to reduce the time spacing as much as possible. Retighten, and make sure that the signal strength does not diminish when tightening. This may require a deft touch.
5. Loosen Emitter 0 head assembly and rotate to obtain maximum frequency (minimum pulse separation time). Retighten, and make sure that the signal strength does not diminish when tightening.

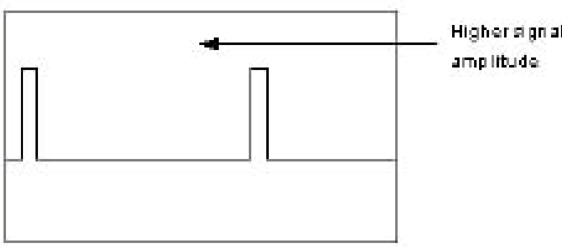


Figure 7-1. Signal at TP8 of Demodulator 1.

6. Place sensor in mode 1.
7. Place scope probe at TP8 of Demodulator 0.
8. Loosen Detector 0 head assembly and rotate to obtain maximum frequency (minimum pulse separation time). Retighten, and make sure that the signal strength does not diminish when tightening.
9. Loosen Emitter 1 head assembly and rotate to obtain maximum frequency (minimum pulse separation time). Retighten, and make sure that the signal strength does not diminish when tightening.

7.1.3 Bandpass Filter Adjustment

1. Keep the sensor in mode 1 (switch into mode 1 if not already there).
2. Attach the calibration paddle to its normal position.
3. Place scope probe at TP1 on Demodulator 1.
4. Adjust potentiometer R25 on Demodulator 1 for a rectified sine wave. **Figure 7-2** shows the appropriate pattern.

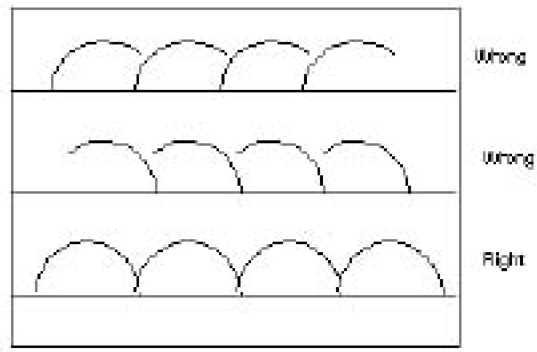


Figure 7-2. Rectified sine wave at TP1 of Demodulator 1 after adjusting R25.

5. Place sensor in mode 0.
6. Place scope probe at TP1 on Demodulator 0.
7. Adjust potentiometer R25 on Demodulator 0 for a rectified sine wave, as done above for the other side.
8. Remove the calibration paddle.

7.1.4 Emitter Output Adjustment

1. Place sensor in mode 0.
2. Place scope probe at TP7 on Demodulator 1.
3. Adjust potentiometer R2 on emitter 0 to obtain a 3.0 V p-p (±0.1 V) sine wave.
4. Place sensor in mode 1.
5. Place scope probe at TP7 on Demodulator 0.
6. Adjust potentiometer R2 on emitter 1 to obtain a 3.0 V p-p (±0.1 V) sine wave.

7.1.5 Offset and Gain Adjustments

1. Place sensor in mode 0.
2. Place scope probe at TP8 on Detector 1 Demodulator board.
3. Completely block the signal into Detector 1 using dense foam rubber or the like.
4. Adjust potentiometer R34 on Demodulator 1 for a 6.0 ±0.2 ms period.
5. Unblock Detector 1 (remove the foam rubber).
6. Adjust potentiometer R37 on Demodulator 1 for a 66 ±1 µs period.

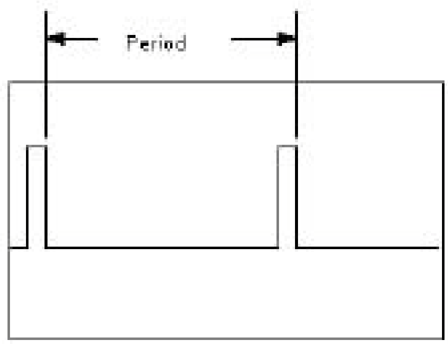


Figure 7-3. Period of signal at TP8 of Demodulators 0 and 1.

7. Place sensor in mode 1.
8. Place scope probe at TP8 on Detector 0 Demodulator board.
9. Completely block the signal into Detector 0 using dense foam rubber or the like.
10. Adjust potentiometer R34 on Demodulator 0 for a 6.0 ± 0.2 ms period.
11. Unblock Emitter 1.
12. Adjust potentiometer R37 on Demodulator 0 for a 66 ± 1 µs period.

7.1.6 System Balance

1. Mount the standard calibration paddle in its normal position.
2. Place the sensor in mode 1.
3. Place scope probe at TP8 on Demodulator 1.
4. Record the pulse separation time on the data sheet.
5. Place the sensor in mode 0.
6. Place scope probe at TP8 on Demodulator 0.
7. Record the period on the data sheet.
8. System balance should be within 25%. Multiply the higher number (longer period) by 0.75. This is the minimum period for the smaller number. If the smaller number is greater than or equal to the calculated value, the system balance passes. If it is smaller, then the heads will have to be adjusted.
9. If the heads have to be adjusted for balance, adjust the emitter and detector for the shorter period away from the other two heads. If Mode 0 had the shorter period, this is Emitter 0 and Detector 1, otherwise it is Emitter 1 and Detector 0.
10. To calculate the point that the head should be adjusted, use the following formula:

$$Period\_set = Period\_low + \frac{Period\_high - Period\_low}{2}$$

11. Rotate the indicated Emitter and Detector equally away from the other two heads until the approximate *Period_set* is reached. The opposite heads will then have to be aligned as explained in *Sensor Head Mechanical Alignment*. Both Emitter heads will have to be readjusted as explained in *Emitter Output Adjustment*. Repeat the system balance test.
12. Replace all of the sensor head covers.

7.2 SENSOR CALIBRATION

The sensor must be put through a calibration procedure after every alignment—follow the directions in the following chapter. It is important that the sensor not be calibrated in a tightly enclosed area, but rather after it has been mounted at its permanent site.

8. CALIBRATION

The visibility sensor can be calibrated either indoors or outdoors using the M104744 calibration paddle (see **Figure 8-1**). When calibrating outdoors, there must be at least 7 miles visibility and winds should be calm. The calibration paddle is traceable to Air Force Geophysics Laboratory reference transmissometers. Equivalent extinction coefficient values are printed on each paddle.

Calibration mode is entered by input from the portable Handheld Terminal, a computer running terminal emulation software (such as Procomm), or the AWOS DCP's keypad/display.

1. Enter the main menu by pressing the "ENT" key, then press "2" to select calibration. With AWOS systems, press the maintenance switch, then press the # key on the DCP keypad repeatedly until the 8364-E calibration screen appears.
2. Enter the calibration coefficient shown on the calibration paddle's label.
3. A routine will be executed by the visibility controller to ensure proper operation prior to calibration measurements. You will be prompted to perform routine maintenance, such as removal of obstructions in the optical paths and cleaning of the sensor windows, during this routine. While you are performing the requested maintenance, the sensor will operate alternately in both modes to keep the optical emitters at thermal equilibrium. When you press a key to continue, as prompted, the controller may take up to one minute to respond. The sensor will then begin its calibration measurements.
4. The initial measurement takes five minutes. When the five minute interval is complete, you will be prompted to insert the calibration paddle.
5. Insert the calibration paddle (see **Figure 6-1**), then rotate the entire crossmember and upright assembly 180°. Hit the # key to continue.
6. After a second five minute measurement interval, you will be prompted to remove the calibration paddle and block the emitters ("COVER EMS").
7. Remove the calibration paddle at this point and rotate the crossmember and upright assembly back to its original position. Insert a piece of black foam over each emitter opening so that no emitted radiation will reach the detectors. Press the # key to continue.
8. Following a further set of measurements, a new set of calibration coefficients are generated for the sensor. The new coefficients are stored in a protected EEPROM. This calibration method requires no fine adjustment of analog circuitry, nor opening of the emitter or detector heads.
9. Upon completion of the measurement cycle, the display will show the old and new calibration values. Under normal conditions, the variance between the new and old values should be less than 2%. You will be given the option to accept or reject the new values.

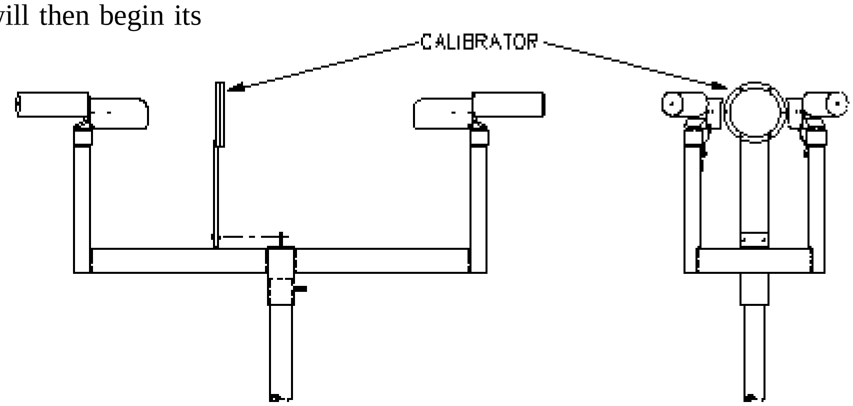


Figure 8-1. The calibration program will prompt you to insert the calibrator for the second set of calibration measurements.

10. Press the appropriate key to accept or reject the new value. With AWOS systems, press the # key to accept the new value, or press the * key to reject it.
11. Record the old and new calibration values in an ongoing log for future reference.
12. Once the calibration value has been accepted, the visibility controller will return to normal measurement mode using the newly calculated calibration values.

8.1 ALS CALIBRATION

When purchased and shipped with an 8364-E, the optional ambient light sensor (ALS) is factory calibrated and should not need to be recalibrated under normal conditions. The ALS is also equipped with a built-in self-calibration feature that automatically adjusts the sensor to compensate for many factors that can affect performance. If the ALS is replaced in the field or added to an existing 8364-E, however, it will need to be calibrated. The ALS can only be calibrated after installation onto the 8364-E.

Caution: ALS calibration is a precise procedure and requires specialized tools. If performed without proper equipment, initiating ALS calibration can lead to improper calibration and invalidate all ALS readings. If calibration is required, it is recmmended that it be performed by All Weather Inc.

8.1.1 Required Equipment

- Handheld Terminal, VT52 terminal or terminal emulation software, or AWOS DCP
- photometer (United Detector Technology Model 161 Optometer or equivalent) set to measure candela/m^2
- indicator unit (United Detector Technology Model 61 or equivalent)
- photometric filter (United Detector Technology Model 111 or equivalent)
- 15° lumilens (United Detector Technology Model 1153 or equivalent)
- variable, high-intensity lamp
- black, opaque bag

8.1.2 Calibration Procedure

The ALS sensor is calibrated indoors. The calibration program will prompt you to perform certain actions (covering the ALS head, for instance) during the procedure. Follow the directions on the screen.

1. Set up the high-intensity lamp so that its light is reflected from a wall or other surface toward the ALS lens.
2. Orient the photometer so that it is viewing the same area as the ALS sensor.
3. Adjust the lamp until the photometer indicator reads somewhere between 3,000-5,000 candela/m^2
4. Enter calibration mode by calling up the setup menu, then pressing **2** for "Cal". At the calibration menu, press **2** for "ALS Cal". (With AWOS systems, before calibrating the sensor you must press the maintenance switch and set the station ID DIP switch to an address other than 0.)
5. When prompted to enter the ambient light, enter the value displayed on the photometer indicator, then press "Ent".
6. You will be prompted to clean the ALS window. Clean the window, then press "#" to continue.
7. The calibration program will then put the ALS sensor through a series of 18 averaging cycles. The display will count these cycles as they pass.
8. You will then be prompted to cover the ALS sensor. Cover the sensor head with a black, opaque bag. Cover the photometer as well to verify that the reading drops to 0. Press "#" to continue.
9. A second set of 18 averaging cycles will be initiated. At the end of this, you will be prompted to remove the ALS sensor cover. Remove the black bag.
10. You will be presented with the results of the calibration, beginning with the old and new slopes. Press "#" to continue. The final screen will show the percentage of change from the sensor's previous calibration setting. Press "#" to accept this value, or press "*" to reject it and perform the calibration a second time.

11. After accepting the new calibration setting, the sensor will write the new value to NVRAM (during which time the message "Wait..." will be displayed), then you will see the message "Ambient light calibration completed" and the display will return to the calibration menu.
12. Press **0** at the calibration menu to return to the setup menu, then press 0 again to return to the normal display. After several output intervals have elapsed, the displayed ALS value should be within 10% of the value displayed on the photometer indicator.

8.2 DAY/NIGHT SENSOR CALIBRATION

The optional Day/Night sensor is calibrated before shipment, and should not need to be recalibrated. The sensor is ruggedly constructed and has proven to be very stable over long periods of service in the field. If the sensor should need to be recalibrated, it should be returned along with the entire visibility controller to All Weather Inc. for servicing.

9. MAINTENANCE

9.1 NON-AWOS PREVENTIVE MAINTENANCE

The visibility sensor is designed for installation, calibration, and maintenance by one person. For sensors in non-AWOS installations, All Weather Inc. recommends routine sensor maintenance every 120 days, including cleaning and calibration checks.

(Note: Windows may need to be cleaned more frequently, depending on environmental conditions.)

1. Use a soft cloth and a solution of mild detergent in water or a commercial grade window cleaner to clean the emitter and detector windows.
2. As a final rinse, clean the windows with a soft cloth and water only to eliminate any soap streaks.
3. Remove any spider webs or other debris which may block the optical paths.
4. Calibrate the visibility sensor as described in **Chapter 5**, *Calibration*.

9.2 AWOS PERIODIC MAINTENANCE

Periodic maintenance of AWOS sensors is divided into three categories: monthly maintenance, triannual maintenance, and annual maintenance. The listed maintenance routines are performed according to that schedule.

9.2.1 Tools and Equipment Required

- Calibration paddle
- Lens cleaning solution
- Soft cloth

9.2.2 Monthly Maintenance

Clean the visibility sensor windows using a soft cloth and lens cleaning solution.

9.2.3 Triannual Maintenance

Clean the visibility sensor windows using a soft cloth and lens cleaning solution. Calibrate the visibility sensor as described in **Chapter 5**, *Calibration*.

9.2.4 Annual Maintenance

Clean the visibility sensor windows using a soft cloth and lens cleaning solution. Calibrate the visibility sensor as described in **Chapter 6**, *Calibration*. If a Day/Night sensor is installed, check its operation as follows.

1. During daytime, set the DCP’s LCD display to show Day/Night status.
2. Verify that the display shows the sensor is reading properly (daytime).
3. Cover the lens with a black bag. Within 3-5 minutes the output should switch to the on (night) state.
4. Uncover the lens, and verify that the output switches back to the off (day) state.

9.3 FUSES

Three fuses are located on the controller board, and two on the AC interface board (see **Figures 4-1** and **4-2**). Though installed, fuse F2 on the AC interface board is not used and should never need to be replaced. The remaining fuses should only be replaced by fuses of the same rating, as shown in the list below.

AC Interface Board

F1	10A 250V, 5x20 mm slow blow

Controller Board

F1	2A 250V, 5x20 mm
F2	0.5A 250V, 5x20 mm
F3	4A 250V, 5x20 mm

10. TROUBLESHOOTING

10.1 TROUBLESHOOTING FLOWCHART

A troubleshooting flowchart (**Figure 10-3**) is included at the end of this chapter to assist in tracing sensor and controller problems. Use this chart to locate the problem and to determine the necessary tests for isolating the cause and correcting it. The following section, ***Fault Isolation***, describes in detail the troubleshooting tests prescribed in the chart. (*Note: For best results, perform the tests under high visibility conditions*.)

10.2 FAULT ISOLATION

A fault in the visibility sensor will be manifested in one of three ways:

- The sensor does not complete the visibility cycle
- An erroneous value is reported
- A sensor fault is indicated

Accurate tracing of the indicated problem to its source is necessary for efficient repair of the sensor. To do this, a series of measurements are made under varying conditions and the results recorded on a diagnostic worksheet (**Figure 10-1**). The data accumulated from these measurements allows the sensor element at fault to be determined.

10.2.1 Test Measurements

The various tests made in isolating a problem are initiated through the Handheld Terminal, a VT52 terminal or computer running terminal emulation software (such as Procomm), or the AWOS DCP's keypad/display. To set the system up for testing:

1. On non-AWOS systems, connect the Handheld Terminal to the labelled connector on the visibility controller, or connect a computer or VT52 terminal as explained in ***Setup***. On AWOS systems, press the maintenance switch at the DCP.
2. Press # to call up the main menu.
3. Press “4” to call up the Test menu.

There are two test modes available from the Test menu: Mode 0 and Mode 1. A series of measurements will be taken in each mode under five different sets of circumstances:

- **Normal setup, calibration paddle in**
- **Normal setup, calibration paddle out**
- **Two emitter cables swapped, two detector cables swapped, calibration paddle in**
- **Two emitter cables swapped, two detector cables swapped, calibration paddle out**
- **Sensor head assembly rotated 180°**

VISIBILITY SENSOR DIAGNOSTIC WORKSHEET						
Mode	Value	Normal		Cables Swapped		Rotate D
		Paddle Out	Paddle In	Paddle Out	Paddle In	
Mode 0						
Mode 0						
Mode 1						
Mode 1						

Figure 10-1. Diagnostic Worksheet

10.2.2 Mode 0 Test

The first measurement mode used for testing is Mode 0. To enter this mode:

1. Press “1” at the Test menu to begin the Mode 0 test. The display will show:

   ```
   MODE 0 Test in
   progress. . .
   ```

   In this mode, the emitters and detectors are functioning as follows:

   - Emitter 0 ON
   - Emitter 1 OFF
   - Detector 0 HIGH GAIN mode measuring scattered energy
   - Detector 1 LOW GAIN mode measuring direct energy

2. After the first 15-second measuring cycle, the measured values will be shown on the display. The first set of measurements is always suspect, so use the values displayed following the second 15-second measuring cycle for diagnostics. The values should resemble those shown below:

   ```
   Counts:        d00=927
   d01=25136               #=Cont
   ```

3. Record the values on the worksheet.
4. Press the # key. The ALS counts will be shown. Ignore this screen for now. This value is used for advanced troubleshooting of the ALS sensor, and requires specialized equipment. Press the # again at the ALS counts screen to return to the test menu.
5. Insert the calibrator and take a second set of measurements. Again, use the values generated from the second measuring cycle.
6. Disconnect power from the sensor.
7. Disconnect the two emitter cables from their connectors on the visibility controller.
8. Connect **Emitter 0** to the **Emitter 1** connector on the visibility controller, and connect **Emitter 1** to **Emitter 2**’s connector on the visibility controller.
9. Disconnect the two detector cables from their connectors on the visibility controller.
10. Connect **Detector 0** to the **Detector 1** connector on the visibility controller, and connect **Detector 1** to **Detector 2**’s connector on the visibility controller.
11. Reconnect power to the sensor.
12. Enter test Mode 0 and record the values obtained from the second measuring cycle on the worksheet.
13. Insert the calibrator and take a second set of measurements. Again, use the values generated from the second measuring cycle.
14. Remove power from the sensor and return the sensor cables to their normal positions. Reconnect power to the sensor.
15. Loosen the bolt holding the sensor crossmember to the mast and rotate the sensor head assembly 180°.
16. Enter test Mode 0 and record the values obtained from the second measuring cycle on the work-sheet.

10.2.3 Mode 1 Test

The next measurement mode used for testing is Mode 1. To enter this mode:

1. Press “2” at the Test menu to begin the Mode 1 test. The display will show:

   ```
   MODE 1 Test in
   progress. . .
   ```

   In this mode, the emitters and detectors are functioning as follows:

   - Emitter 0 OFF
   - Emitter 1 ON
   - Detector 0 LOW GAIN mode measuring direct energy
   - Detector 1 HIGH GAIN mode measuring scattered energy

2. After the first 15-second measuring cycle, the measured values will be shown on the display. The first set of measurements is always suspect, so use the values displayed following the second 15-second measuring cycle for diagnostics. The values should resemble those shown below:

   ```
   Counts:        d11=725
   d10=25727             #=Cont
   ```

3. Record the values on the worksheet.
4. Press the # key. The ALS counts will be shown. Ignore this screen for now. This value is used for advanced troubleshooting of the ALS sensor, and requires specialized equipment. Press the # again at the ALS counts screen to return to the test menu.
5. Insert the calibrator and take a second set of measurements. Again, use the values generated from the second measuring cycle.
6. Disconnect power from the sensor.
7. Disconnect the two emitter cables from their connectors on the visibility controller.
8. Connect **Emitter 0** to the **Emitter 1** connector on the visibility controller, and connect **Emitter 1** to **Emitter 2**’s connector on the visibility controller.

VISIBILITY SENSOR DIAGNOSTIC WORKSHEET						
Mode	Value	Normal		Cables Swapped		Rotate D
		Paddle Out	Paddle In	Paddle Out	Paddle In	
Mode 0	D00	650	18000	625	20000	650
Mode 0	D01	25000	675	27000	600	25000
Mode 1	D10	27000	600	25000	675	27000
Mode 1	D11	625	20000	650	18000	625

Figure 10-2. Sample Diagnostic Worksheet

9. Disconnect the two detector cables from their connectors on the visibility controller.
10. Connect **Detector 0** to the **Detector 1** connector on the visibility controller, and connect **Detector 1** to **Detector 2**'s connector on the visibility controller.
11. Reconnect power to the sensor.
12. Enter test Mode 1 and record the values obtained from the second measuring cycle on the worksheet.
13. Insert the calibrator and take a second set of measurements. Again, wait for the second measuring cycle to record the values.
14. Remove power from the sensor and return the sensor cables to their normal positions. Reconnect power to the sensor.
15. Loosen the bolt holding the sensor crossmember to the mast and rotate the sensor head assembly 180°.
16. Enter test Mode 1 and record the values obtained from the second measuring cycle on the worksheet.

10.2.4 Data Evaluation

The values shown on the display during testing represent counts of the detector output frequency, and will vary with the strength of the received optical signal. A sample worksheet with typical values is shown in **Figure 10-2**.

The sample values in **Figure 10-2** are idealized values meant to demonstrate the relationships between them when the sensor is operating normally. The actual values may vary fairly widely from these, but their relationships will be unaltered when the sensor is functioning properly. Deviation from the relative values is the main indicator of a problem's source. Under normal conditions, the relationships are as follows:

- With the calibrator out, direct values should be high (20,000 to 33,000), and scatter values should be low (500 to 15,000). The exact values will depend on weather conditions at the time of measurement. In low visibility conditions, scatter values may go very high; inserting the calibrator, however, will still cause them to go higher.
- The calibrator paddle scatters the majority of the emitted energy and greatly reduces the amount of direct energy passing through (simulating very low visibility). With the calibrator in, therefore, the reported values should be the inverse of those described above: direct values will be low, and scatter values will be high.

Swapping the sensor cables causes the sensor to operate as a mirror image of normal, and allows you to determine whether a fault is located in the visibility controller or one of the heads. The direct emitter-detector signal is the surest indicator of a fault, since a weak or erratic signal may not be as apparent in the scatter values.

If, after swapping the sensor cables, suspicious values appear in the same place (the sensor gives the same reading for the swapped emitter-detector pair as for the original pair) the problem is likely in the controller. If the suspicious values appear on the same emitter-detector pair in their new location, the problem is likely in one of those heads.

To further isolate a sensor head fault, swap the two emitter cables only (connect the **Emitter 0** cable to the **Emitter 1** connector, and **Emitter 1** to the **Emitter 0** connector). If the suspicious value now appears on the same detector, the detector is at fault. If the suspicious value appears on the other detector, the emitter is at fault.

10.3 ALS TROUBLESHOOTING

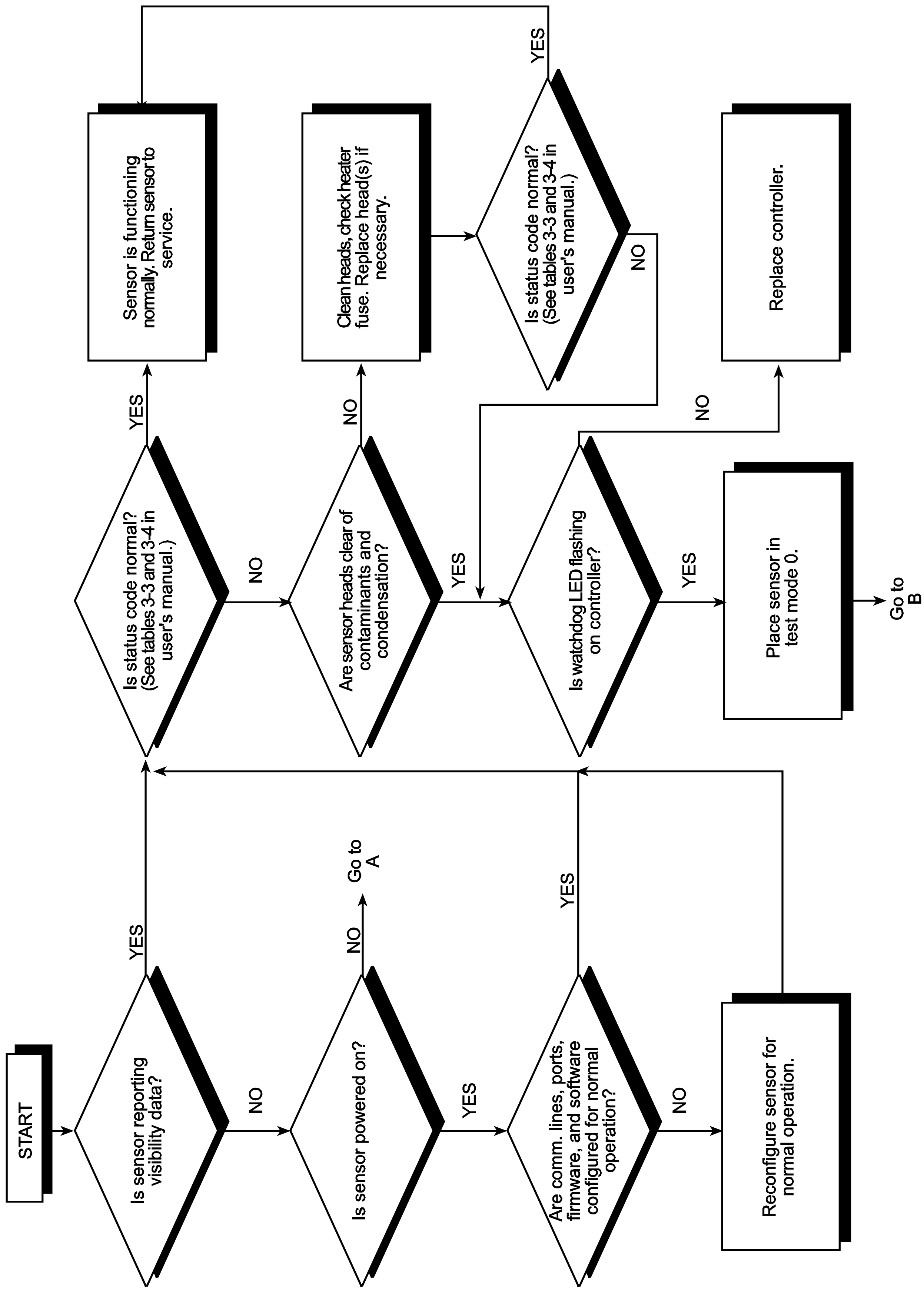
If an ALS is installed, its operation can be checked by verifying that the ambient light reading drops to near 0 candela in darkness, then returns to normal values in daylight.

1. During daytime, observe the ALS reading on the Handheld Terminal, VT52, or computer running terminal emulation software (connected as described in the ***Setup*** chapter). The ALS reading will follow the visibility data on the main display after one output interval has elapsed. (Note: When the sensor is first powered up, a short time is required—about 10 minutes— for the sensor to acquire sufficient data for an average.)
2. Note the ALS reading.
3. Cover the ALS head with a black bag as completely as possible. Observe the ALS reading to see that it drops to near 0 candela.
4. Uncover the head and verify that the ALS output returns to near its original value.
5. If the ALS value does not drop to near 0 candela when covered, or does not return to near its original value when uncovered, contact All Weather Inc. Customer Service.

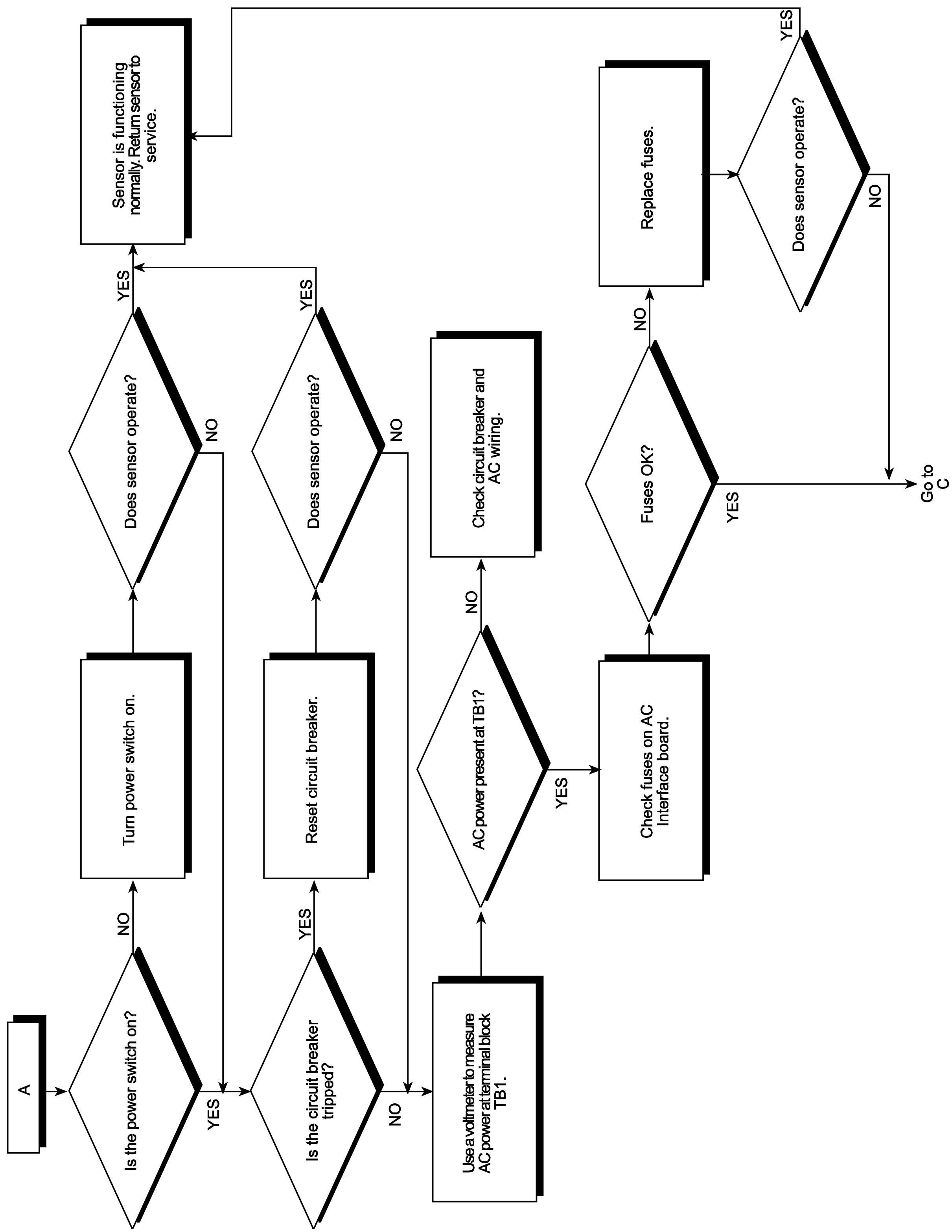
10.4 DAY/NIGHT SENSOR TROUBLESHOOTING

If a Day/Night sensor is installed, check its operation as follows.

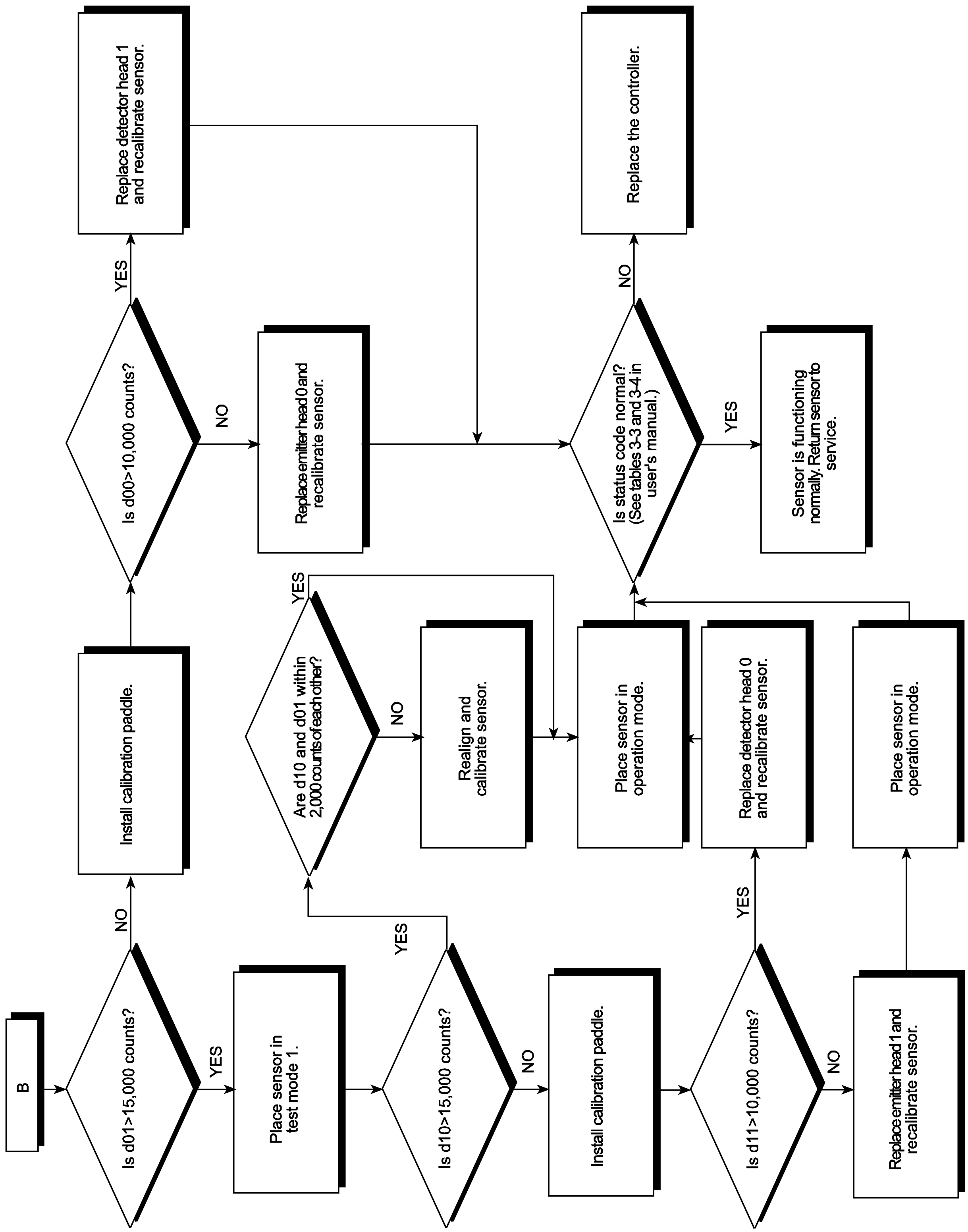
1. During daytime, set the DCP's LCD display to show Day/Night status.
2. Verify that the display shows the sensor is reading properly (daytime).
3. Cover the lens with a black bag. Within 3-5 minutes the output should switch to the on (night) state.
4. Uncover the lens, and verify that the output switches back to the off (day) state.
5. If the sensor does not behave as expected, contact All Weather Inc. Customer Service. If the sensor is to be returned for service, the visibility controller (enclosure and board) must be returned as well.



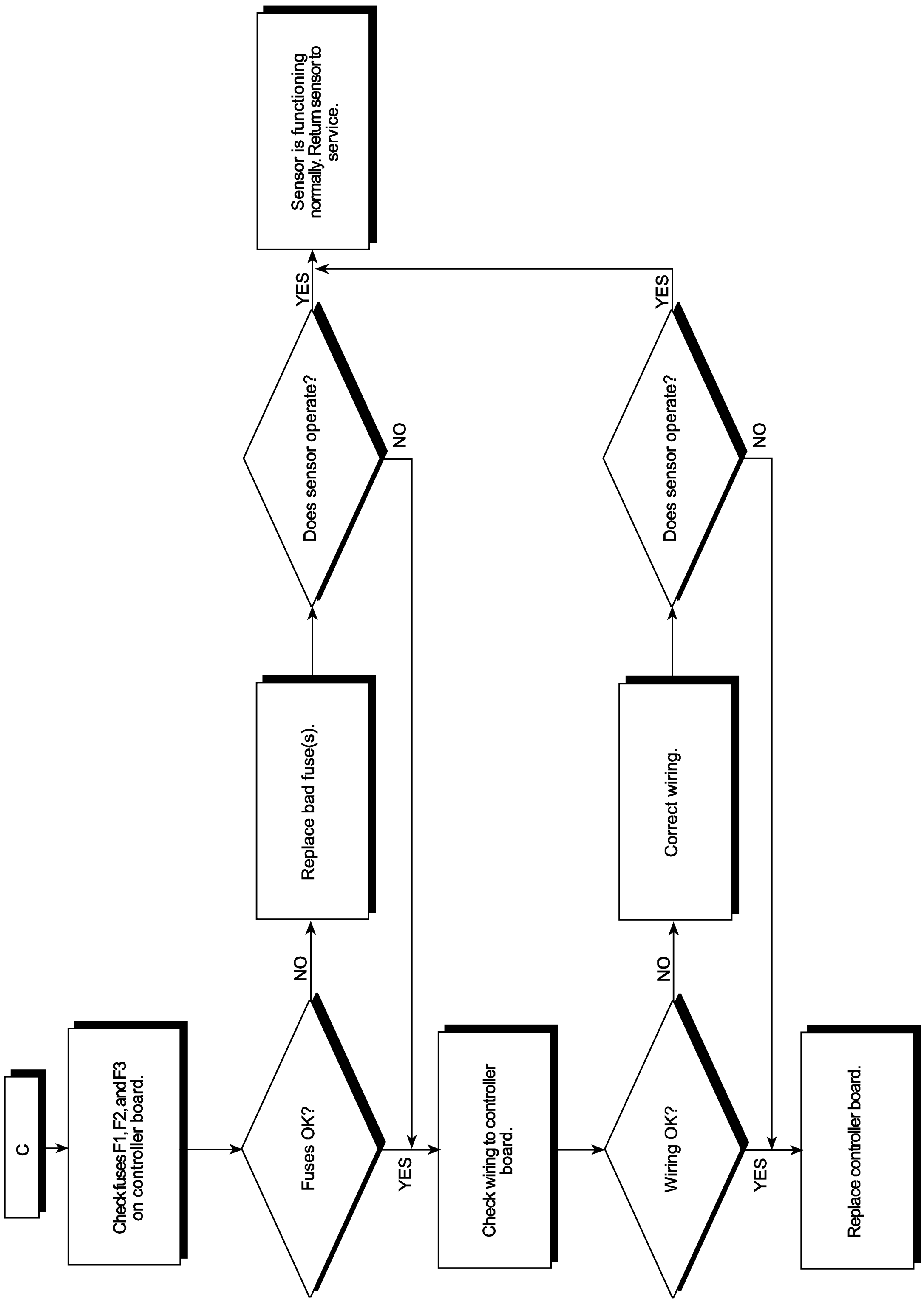
(Figure 10-3) Troubleshooting flowchart.



(Figure 10-3) Troubleshooting flowchart—cont.



(Figure 10-3) Troubleshooting flowchart—cont.



(Figure 10-3) Troubleshooting flowchart—cont.

11. KITS

11.1 VISIBILITY CONTROLLER MOUNTING KIT

The Visibility Controller Mounting Kit (M488173) is used to mount the visibility controller to the visibility sensor pole. For instructions in using this kit, refer to the ***Installation*** chapter of this manual.

11.2 AMBIENT LIGHT SENSOR (ALS) KIT

An optional Ambient Light Sensor Kit (M488171) is available for the 8364-E for use in calculating Runway Visual Range (RVR). The ambient light sensor provides luminance of a six degree field of view of the north horizon sky at an elevation of 20° to the horizon. The ambient light sensor generates an output frequency signal that is proportional to the actual ambient light level over the range of 0-40,000 Candelas per square meter. Accuracy of the sensor is 10% of reading or 0.5 Candelas per square meter, whichever is greater.

Signal processing is provided by the 8364-E. A single interface cable between the ALS and the 8364-E provides AC heater power, DC power, signal lines, and control lines. This cable plugs into connector J7 on the visibility controller board (M404811).

11.2.1 Calibration

Calibration of the ambient light sensor is performed at the factory prior to shipment. This calibration is referred to as an absolute calibration. To maintain a level of accuracy comparable to this initial absolute calibration (compensate for operation between cleaning of the optical surfaces), a relative calibration is performed automatically and continuously by the sensor itself. The ambient light sensor has proven to be very stable over long periods of service in the field. Because the absolute calibration process requires specialized equipment and procedures, it is recommended that the sensor be returned to All Weather Inc. if recalibration is required.

11.2.2 Specifications

Operating Temperature Range	-40° to +60° C
Storage Temperature Range	-55° to +65° C
Measuring Range	0 to 40,000 candela per sq meter
Accuracy	±10% of reading or 0.5 candela; whichever is greater
Field of View	6 degrees
Mounted Angle Above Horizon	20 degrees

11.3 DAY/NIGHT SENSOR KIT

A Day/Night Sensor Kit (M403326) is available for the 8364-E for adjusting visibility readings for daytime and nighttime conditions. The sensor mounts to the visibility controller enclosure, and is used primarily in AWOS installations, where separate algorithms are used for calculating daytime and nighttime visibility. The Day/Night sensor senses ambient light and reports the existing day or night state. Daytime is reported when the ambient light intensity is above 2.7 footcandles. Nighttime activation occurs when the ambient light intensity falls below 0.7 footcandles.

The Day/Night sensor senses ambient light using a photodiode detector, which converts light energy into an electrical current. This current is then converted into a negative voltage representing the light energy in footcandles. (For example, -2.0 VDC represents 2 footcandles of ambient light.) This voltage is present at TP16 on the visibility controller board.

A comparator circuit is used to provide a switched output from the sensor corresponding to the sensed daytime or nighttime condition. Daytime is represented by an output of 0VDC, and nighttime by an output of 5 VDC. A certain amount of hysteresis is designed into the comparator circuit to prevent false day/night indications near the sensor's switch-over point. A 10W heater is built into the sensor to prevent condensation or ice buildup on the photodetector lens.

11.3.1 Specifications

Sensing Element	photodiode
Night Activation	<0.7 ±0.15 footcandles
Day activation	>2.7 ±0.2 footcandles
Temperature Range	-40° to 60° C
Output Level—day	0 VDC
Output Level—night	5.0 VDC
Size	1.5"H × 1.5"W × 1.5"D

11.4 BATTERY BACKUP KIT

A 5 AH Battery Backup Kit (Model 11903) is available for powering the visibility sensor during power outages. The battery connects to the 8364-E Visibility Sensor via TB3 on the Controller board, and can provide up to 3 hours of operation at temperatures above 0°C. The Controller board M404811 has a charging circuit that maintains a full charge on the battery when AC power is present.

Switch S1 ("BATTERY ON/OFF") controls the battery voltage to the Controller board. This switch must be in the ON position in order for the battery to be charged during AC operation and to provide power to the visibility sensor during a loss of AC power.

In the event of a loss of AC power, the backup battery will automatically become the sensor's power source. If, however, the system is powered up on battery power only, the BATTERY START switch must be depressed to initiate battery power.

The BATTERY START switch is located in the upper left of the controller board just to the left of the large, rectangular component U4. To initiate battery power, depress the BATTERY START button and hold it down for 3-4 seconds.

The backup battery does not power the sensor head heaters, so performance will be somewhat degraded when running from battery power in cold temperatures.

Note: During operation, the “POWER ON” LED should remain illuminated, and the “WATCHDOG” LED should blink at the rate of once per second.

11.5 220 V KIT

The 8364-E can operate at 220 VAC with the optional M488174 220V Kit installed. This option is pre-installed at the factory and consists of a step-down transformer to convert the incoming 220 VAC to 115 VAC for use by the visibility sensor. The visibility sensor is properly labeled at the factory to indicate an operating voltage of 220 VAC. The transformer is installed inside the visibility controller enclosure.

11.6 ANALOG OUTPUT KIT

In cases where an analog output is desired in addition to the normal serial output, an Analog Output Kit (M488107) is available. The module consists of a printed circuit board and cable assembly and attaches readily to the Controller board within the Visibility Controller (see **Section 2.4** for installation instructions). This output is a voltage varying between 0 volts and 1 volt that is output each time visibility is calculated (every 30 seconds). A logarithmic scale is used to represent visibility, allowing the entire measurement range of 10 meters to 30 kilometers to be covered by the 0-1 volt output range. The output value represents a point on that scale corresponding to the measured visibility in meters. **Table 11-1** shows the output voltages for several visibility values, and **Table 11-2** shows the equation used to derive visibility values from output voltage. A level of 0 volts represents a sensor or controller fault; a more precise idea of the nature of the fault can be had by checking the status word contained in the serial output message.

Table 11-1
Analog Output Voltage vs. Visibility

Output Voltage	Visibility in Meters
1 V	30,000 m
0.993 V	15,000 m
0.893 V	10,000 m
0.826 V	5,000 m
0.670 V	1,000 m
0.603 V	500 m
0.447 V	100 m
0.379 V	50 m
0.223 V	10 m

Table 11-2
$Vis = 10^{(V \times 4.7712)}$
where:
Vis = visibility in meters
V = output voltage

11.6.1 Handheld Terminal Kit

The M488175 Handheld Terminal Kit is used to configure and calibrate the visibility sensor as explained in the ***Setup***, and ***Calibration*** chapters. Though a VT52 terminal or a computer running terminal emulation software can be used, the Handheld Terminal is recommended owing to its ease of use and portability. (Note: In AWOS systems, the DCP is used to configure and calibrate the sensor, and no Handheld Terminal is required.) The M488175 kit includes the Handheld Terminal and a controller cable. When the Handheld Terminal is received, a standard cable is normally in place. This cable must be removed and the cable included in the kit installed before using the Handheld Terminal with the 8364-E. Instructions for using the Handheld Terminal are provided in the relevant sections of this manual (***Installation, Setup***, ***Alignment***, ***Calibration***, and ***Troubleshooting***).

12. WARRANTY

Unless specified otherwise, All Weather Inc. (the Company) warrants its products to be free from defects in material and workmanship under normal use and service for one year from date of shipment, subject to the following conditions:

a. The obligation of the Company under this warranty is limited to repairing or replacing items or parts which have been returned to the Company and which upon examination are disclosed, to the Company’s satisfaction, to have been defective in material or workmanship at time of manufacture.

b. The claimant shall pay the cost of shipping any part or instrument to the Company. If the Company determines the part to be defective in material or workmanship, the Company shall prepay the cost of shipping the repaired instrument to the claimant. Under no circumstances will the Company reimburse claimant for cost incurred in removing and/or reinstalling replacement parts.

c. This warranty shall not apply to any Company products which have been subjected to misuse, negligence, or accident.

d. This warranty and the Company’s obligation thereunder is in lieu of all other warranties, express or implied, including warranties of merchantability and fitness for a particular purpose, consequential damages, and all other obligations or liabilities.

No other person or organization is authorized to give any other warranty or to assume any additional obligation on the Company’s behalf, unless made in writing and signed by an authorized officer of the Company.

13. SPECIFICATIONS

Parameter	Specification
Measurement Range	33 ft to 20 miles (10 m to 32 km)
Accuracy	15% RMSE
Measurement Type	MOR or Extinction Coefficient
Averaging Intervals	3, 5, or 10 min
Measurement Units	miles or km
Operating Principle	Dual Technology — direct attenuation and forward-scatter
Light Source	Infrared LED
Optical Bandpass Filter	865 nm ± 35 nm
Detector	Silicon Photodiode
Principal Scatter Detection Angle	35 degrees
Serial Output	RS-485 or RS-232
Output Interval	Programmable: Interrogate, 10 s, 1 min, or 10 min
Output Format	ASCII characters
Baud Rate	Programmable: 300, 1200, 2400, 4800, or 9600 bps
Serial Port Parameter Setting	8-N-1 (8 data bits, no parity, 1 stop bit)
Analog Output Option	
Output Voltage	0–1 V
Output Impedance	100 Ω
Handheld Terminal Port	
Baud Rate	1200 bps
Serial Port Parameter Setting	8-N-1 (8 data bits, no parity, 1 stop bit)
Power Requirements	
Supply Voltage	115 V AC, 60 Hz 240 V AC, 50–60 Hz with M488174 220 V Kit
Max. Current Consumption (ALS installed, heaters on)	1.773 A

Parameter		Specification
Environmental		
Operating Temperature		-40 to +136ºF (-40 to +55ºC)
Storage Temperature		-67 to +136ºF (-55 to +55ºC)
Relative Humidity		5–100%, noncondensing
Wind		up to 120 knots (220 km/h)
Hail Resistance		up to 0.5" (1.3 cm) dia.
Ice Buildup		up to 0.5"/h (1.3 cm/h)
Elevation		-100 to 10,000 ft ASL (-30 to 3030 m ASL)
Mechanical		
Controller Assembly Enclosure		NEMA 4X
Mounting	Sensor Assembly	2.5" (6.35 cm) dia. mast
	Controller Assembly	Unistrut mounted
Dimensions	Sensor Assembly	61" L × 19" W × 21" H (155 cm × 48 cm × 53 cm)
	Controller Assembly	14" W × 16" H × 6" D (30 cm × 36 cm × 15 cm)
Weight		74 lbs (33 kg)
Shipping Weight		135 lbs (61 kg)

14. OPTIONS AND PARTS LIST

Table 13-1 shows the lowest replaceable units (LRUs) for the Model 8364-E Forward Scatter Visibility Sensor, as well as available options and their part numbers.

Table 13-1
Model 8364-E Forward Scatter Visibility Sensor
Options and Parts List

Part Number	Description
M105061-00	Emitter Head
M105060-00	Detector Head
M403322	Visibility Controller
M404811	Visibility Controller board
M442046	2A 250V, 5x20mm fuse (F1—controller board)
M442057	0.5A 250V, 5x20mm fuse (F2—controller board)
M442048	4A 250V, 5x20mm fuse (F3—controller board)
M404802	AC Interface board
M442071	10A 250V, 5x20mm slow blow fuse (F1—AC interface board)
M442070	5A 250V, 5x20mm slow blow fuse (F2—AC interface board) NOT USED
M469058	Firmware
M104744	Calibration Paddle
Options	
M488171	Ambient Light Sensor kit
M403326	Day/Night Sensor kit
Model 11903	Battery backup kit
M488174	220V AC kit
M488107	Analog output kit
M488175	Handheld Terminal kit

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