Optical Scientific Inc.

User's Guide
OWI-650 LP WIVIS

Weather Identifier and Visibility Sensor

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REVISION RECORD

Rev. Date	Description of Changes
09/15/11	New document
09/20//11	Document re-work for ease of editing T.D.B.
08/14/12	Repair document TOC and TOF
06/01/16	Correct typo p. 4-5
07/28/17	Change power spec to 125mA @ 12VDC
11/16/18	Added status codes
05/31/19	Added new cable w/ 10 conductor

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KEY TO NOTES

Hint -Provided as a suggestion or "good idea" to simplify or clarify the instructions in the User's Guide.

NOTE:
Used to call attention to a special feature or procedure which must be followed for correct operation of the equipment

CAUTION:
Used to call attention to a concern where damage to the equipment or injury to personnel may occur unless certain steps are followed

WARNING:
Used to call attention to a concern where serious personal injury or death may occur unless basic safety procedures are followed

WARRANTY

Optical Scientific Inc. (OSi) warrants its products to be free of defects in workmanship and material for a period of 12 months from date of shipment. During the warranty period, OSI will repair or replace defective products at its own expense, subject to the following conditions:

1. The Buyer prepays all shipping, insurance, and associated costs to return the defective item to OSi. OSI pays return shipping and insurance.
2. The product must not have experienced misuse, neglect, accident or have been altered or repaired by the Buyer during the warranty period.
3. This warranty and OSi's obligation are in lieu of all other warranties. Implied warranties shall not apply.
4. OSI is not liable for consequential or incidental damages, labor performed in conjunction with removal and replacement, loss of production, or any other loss incurred because of interruption of service or production of incorrect or incomplete weather information.

GLOSSARY

AGC	Automatic Gain Control
AWG	American Wire Gauge
ASCII	American Standard Code for Information Exchange
ASOS	Automated Surface Observing System
CR	Carriage Return
CW	Continuous Wave
DC	Direct Current
FAA	Federal Aviation Administration
FRU	Field Replaceable Unit
HIPS	Hail & Ice Pellet Sensor
IRED	Infrared light Emitting Diode
LDM	Limited Distance Modem
LED	Light Emitting Diode
LP-WIVIS	Weather Identifier and Visibility Sensor Model OWI-650
IR	Infrared
NEMA	National Electrical Manufacturer's Association
NWS	National Weather Service
PC	Personal Computer
PTC	Positive Temperature Coefficient Thermistor
RX	Receive or Receiver
OSI	Optical Scientific, Inc.
TX	Transmit or Transmitter
VAC	Voltage - Alternating Current
VDC	Voltage - Direct Current
WMO	World Meteorological Organization

ENGLISH/METRIC CONVERSION FACTORS	
1 inch = 25.4 mm	1 mm = 0.039 in
1 mile = 1.609 km	1 kilometer = 0.614 ml
1 pound = 0.454 kg	1 kilogram = 2.2 lbs
F = 9/5 C + 32	C = 5/9 (F - 32)

1 INTRODUCTION

1.1 The OWI-650 Improves Your Ability to Measure Precipitation and Visibility

The OWI-650® optically measures precipitation induced scintillation and extinction coefficient and applies algorithms to automatically determine the precipitation type, precipitation rate, and visibility. The OWI-650 is vastly superior to traditional sensors and delivers the reliability and proven performance you need!

OSi's OWI-650 precipitation sensors provide accurate measurement of precipitation in all weather conditions. Equipped with a dual measurement system, the OWI-650 can use both the precipitation and visibility information for a more robust algorithm to optimize performance. As of 2011, OSI has accumulated more than 100 million hours of field experience with optical precipitation and visibility sensors!

OWI-650 now offers many new features and options including:

- NWS or WMO weather code formats
- English or metric units of measure
- Past data (15 min and 60 min)
- Automated calibration
- Downloadable flash ROM
- 12 VDC power (AC power is optional)
- QwikCollect data acquisition and display software (optional)

A major advantage of the OWI-650 is that the measurements are not affected by buildup of dust, dirt or ice on the lenses.

The weather processing software includes an artificial intelligence and fuzzy logic-based algorithm that makes the baselines self-adaptive. This corrects the scintillation and forward scattering coefficient changes caused by gradual obscuration of the light path. The need for frequent lens cleaning is eliminated, enabling the OWI-650 to operate for long periods of time completely unattended.

Also, the OWI-650 is equipped with flash ROM which can be remotely downloaded if a program change or upgrade is necessary.

1.2 Performance Specifications for OWI-650 LP-WIVIS

PRESENT WEATHER	
Measurement Technique	Scintillation with optical forward scattering
Present Weather Codes	More than 50 NWS & WMO codes
Present Weather Type Identification	Rain, freezing rain, snow, freezing drizzle, mist, mixed, fog, haze, clear
Sensor Data Update Rate	Once per minute
Sensor Reporting Units	Metric Standard (English optional)
Rain Dynamic Range	0.1 to 3000 mm/hr
Rain Accuracy	5% Accumulation
Snow / Rain Accumulation	0.001 to 999.999 mm
Snow / Rain Resolution	0.001 mm
Snow Dynamic Range	0.01 to 300 mm/hr
Snow Accuracy	10% Accumulation
VISIBILITY	
Contrast Threshold	5%
Ambient Light Dynamic Measurement Range	0 to 9,990 candles / m2
AMBIENT LIGHT	
Dynamic Range	0 to 10,000 candles/m²

Electrical Specification	
Power Requirements	
Electronics	12 VDC @ 125 mA
Lens Heaters	12 VDC @ 600 mA
	(Optional Power Supply Box to accept universal 100-240 VAC, 50-60 Hz @ 50 VA
Signal Output	RS-232 ASCII
Transient Protection	All power and RS-232 signal lines fully protected

Environmental Specification	
Temperature	-40° to +50° C (-40° to 122° F)
Humidity	0-100%
Precipitation/Dust	NEMA-4 type protection

Physical Specification	
OWI-650 Power Supply Box	533 mm L x 193 mm W x 102 mm D (21" x 8" x 4") 229 mm W x 267 mm H x 165 mm D (9" x 10.5" x 6.5")
OWI-650 Power Supply Box	2.2 kg (5 lbs) 4.0 kg (9 lbs)
Cable Lengths -OWI-650	3.0 meter (10 ft) *Call OSi if longer cable is needed

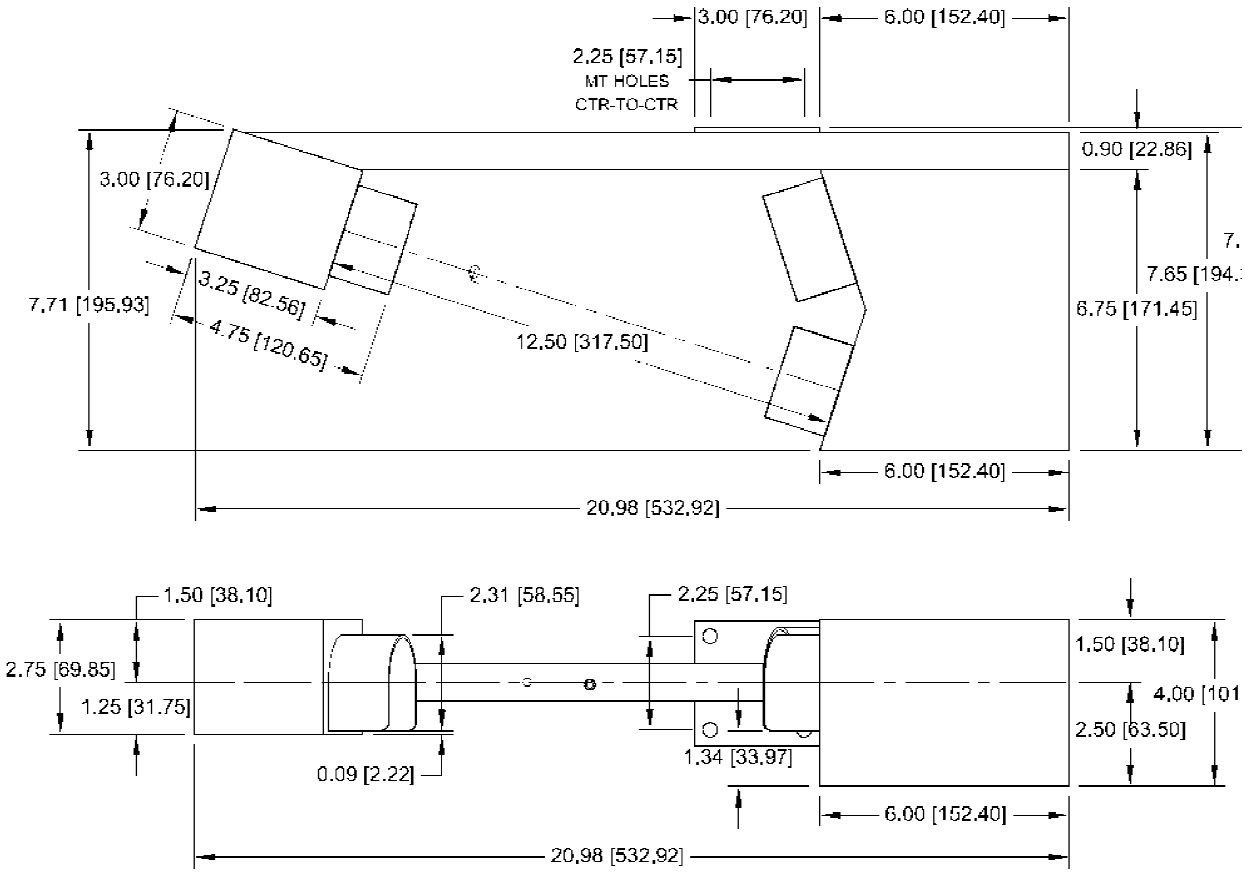

Figure 1-1 OWI-650 Dimensions

1.3 Major Components of the OWI-650

OWI-650 Optical Sensor [P/N 2827-100] sensor uses a compact, triple aperture optical system to measure both precipitation and visibility.

The sensor frame is all aluminum, welded design. The small box (TX) is the transmitter unit and contains an IRED diode and lenses with heaters. As shown in Figure 1-2, the large box (RX) contains 2 independent receiver sections each consisting of a photo diode, lenses with heaters, and pre-amplifier electronics. These two sections operate independently. The first receiver detects present weather (in-beam) and the second detects visibility (off-axis). A small panel is attached to the sensor arm to block stray transmitter light from entering the off-axis receiver. The generated signals are sent to the Digital Signal Processor (DSP) board located behind the receivers. The resulting weather data is communicated via RS-232 to customer's Data Acquisition System (DAS). The sensor is powered by +12 VDC supplied from the DAS.
The lens heaters which prevent dew, frost, and snow from building up on the lenses are self-regulating devices. They are "on" continuously but draw more current when the outside temperature is cold and less when the temperature is warm.

Figure 1-2 OWI-650

All wiring is contained within the sensor frame. The OWI-650 sensor is completely sealed at the factory. Drilling or otherwise breaching the frame seal will possibly damage the sensor, and will void any warranty.
The connecting cable for power and data is found at the bottom of the receiver box along with the temperature probe. The 3 m (10 ft.) long cable, P/N 2827-157, is supplied as part of the sensor to connect the OWI-650 optical sensor to the customer's DAS. A 1/4-20 threaded hard point and screw are provided on the side of the receiver for electrical grounding. A green ground cable, P/N 1203-153-1, is included to connect the sensor to earth ground.

An integral mounting plate, part of the sensor cross arm, is provided to attach the sensor to a user-supplied structure. The U-bolts supplied with the OWI-650 will clamp the sensor frame to either a vertical or horizontal pipe up to 50 mm in diameter.

1.3.1 Power Supply Box P/N 1203-105 (optional)

If DC power is not supplied, a power supply box that converts AC power to 12 VDC is available. The power supply box is a fiberglass NEMA-4 rated box with hinged access door. The box contains the DC power supply, an AC terminal block (TB1), and a DC-Power/RS-232 terminal block (TB3). A block diagram of the power supply box is shown in Figure 1-4.

The power supply box is mounted with OSI-supplied fasteners using the four (4) mounting tabs at the rear of the box.

The bottom of the box has three half-inch conduit holes (0.86 in. dia.) for user connections, and a ground stud. The OWI-650 sensor cable attaches to the terminal block TB2 in the power supply box. A ground stud is provided to connect the green ground cable, P/N 1203-153-1, to the sensor head. A user-supplied ground wire must be also connected to the stud to connect the system to earth ground

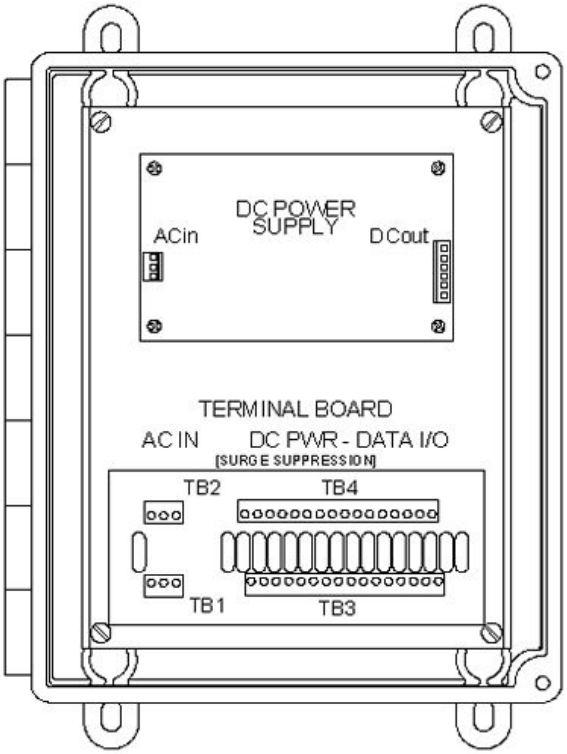

Figure 1-3 Power Supply Box

NOTE:
Terms "ground"," electrical ground", "earth ground" are as defined by the National Electric Code or governing local authority

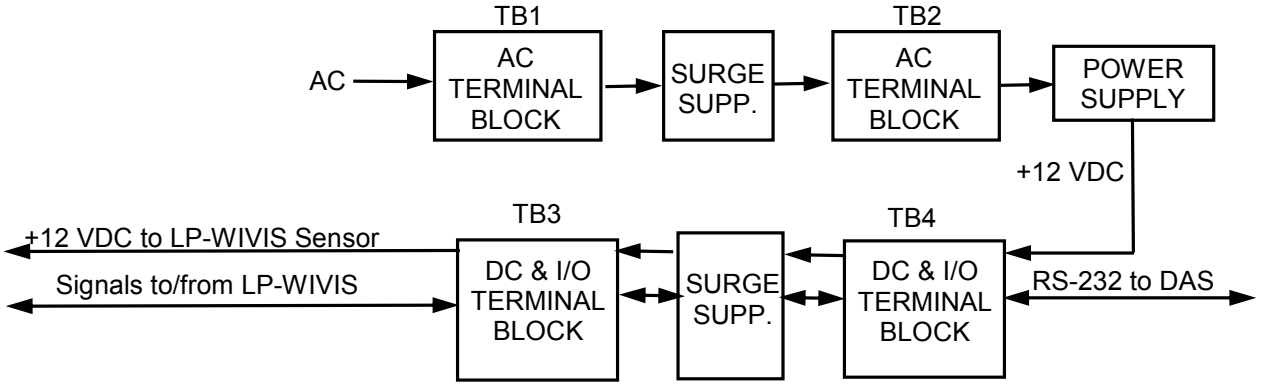

Figure 1-4 Power Supply Box Block Diagram

1.4 Accessories for OWI-650

Several accessories are available from OSI for the OWI-650. Contact the Sales Office for more information.

QwikCollect for Windows® Data Acquisition Software

The software runs on any IBM compatible personal computer with Microsoft Windows version 98 through XP Service Pack3. The software automatically collects the OWI-650 data, stores it on the hard drive, and displays it both graphically and as text in real time.

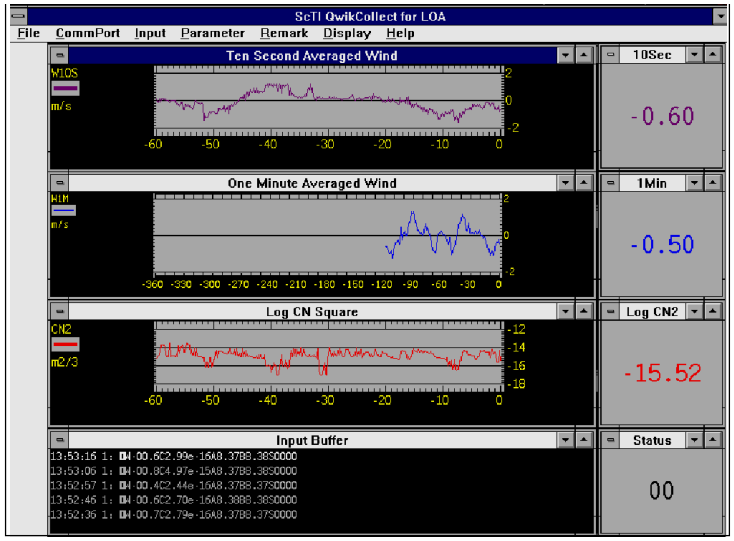

Figure 1-5 QwickCollect Software

Limited Distance Modems (LDM)

A pair of LDMs is available if the distance between the OWI-650 and computer is more than the RS-232 specified distance of 100 feet. One LDM is installed inside the OWI-650 power supply box and the other is connected to the user's computer. The LDMs operate over 2 unconditioned twisted wire pairs up to 14 km (9 mile) if the wire gauge is 19 AWG or larger. Detailed description of the LDM is in Appendix A

2 INSTALLATION OF THE OWI-650 LP-WIVIS

2.1 Siting and Installation Guidelines

The OWI-650 may be installed almost anywhere outdoors but an area free and clear of obstructions and contamination sources will help insure good sensor performance.

OWI-650 makes both precipitation and visibility measurements so the siting criteria should be evaluated carefully for the best measurements. In general, OWI-650 should be located on level or slightly sloping ground where the sensor site will be exposed to the same environment as the area around it. Installation on the top of a hill or in a depression will result in non-representative visibility readings. Ideally, the area around the site should be free of buildings, trees, and other obstructions.

OSI recommends that the siting and installation follow the general guidelines established by the Office of the Federal Coordinator for Meteorology (OFCM). The Federal Standard for Siting Meteorological Sensors at Airports, OFCM document # FSM-S4-1987, makes the following recommendations:

1. Distance from Obstructions - The distance between the sensor and obstructions such as trees or buildings should be at least 2 times the height of the obstruction on all sides. For example, if a 20 meter high tree is located alongside the OWI-650, the OWI-650 should be at least 40 meters away from the tree. This restriction reduces the effects of wind turbulence created by the nearby obstruction and makes the OWI-650 precipitation measurement more representative. No obstructions of any type should be closer than 10 meters from the off-axis lens side of the sensor. This will help prevent stray light scattered from the obstruction from entering the receiver optics.

NOTE:
Do not locate the OWI-650 where tree branches or wires will hang over the sensor!

2. Separation from Turbulence & Contamination Sources - Do not mount the OWI-650 near building exhaust vents, strobe lights, or sources of smoke or steam. Where possible, locate the OWI-650 as far away from runways and roads as possible to reduce optics fouling from wind blown road dirt. An ideal distance is at least 30 meters.

3. Sensor Height, Rigidity, Verticality, and Orientation - The OFCM recommends that the present weather and visibility sensor be mounted at a height of 3 meters (10 feet). This height is not always possible due to constraints imposed by the site. Mounting the OWI-650 sensor lower than 2 m or higher than 5 m is not generally recommended.

- The OWI-650 installation must be rigid so that wind-induced vibration does not cause false alarms. This can be accomplished by mounting the sensor to a thick wall pipe such as "Schedule 40" type or to a rigid boom arm of 1 meter length or less. Mounting the OWI-650 on the top of a building is acceptable if it is located near the center of the building away from the wind turbulence that may occur near the edges.

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

- The OWI-650 is generally oriented with off-axis lens facing away from highway or contamination sources to avoid dirt splash directly into the lenses.

- The OWI-650 should be oriented to avoid direct sunlight shining into the off-axis lens.

 **Hint** - Standing at the LP-WIVIS site, take a picture in each direction (north, east, south, & west) to record the topography and obstructions for future reference.

Siting Guidelines To Remember

- Sensor mounted 2-3 meters high
- Rigid mounting pole
- In-beam lens aperture horizontal to +/- 2 degrees
- Off-axis lens avoids direct sunlight shining into the lens
- At least 10 m "free area" in front of the off-axis lens
- No overhanging trees, wires, or roof lines
- Distance between OWI-650 and closest obstruction at least 2 times obstruction height
- As far from runway, road, and contamination sources as possible. If it can't be done, face the off-axis lens away from road or contamination sources.

2.2 OWI-650 Mechanical Installation

2.2.1 Preparation

Prior to beginning the OWI-650 installation, the sensor and site should be checked, and any preparatory work completed.

The OWI-650 is packed in one (1) heavy walled corrugated carton. Packed in this carton are the sensor, cables, User's Guide, light block kit, sensor U-bolt mounting hardware, and mounting bracket. If power supply box is ordered, there will be the second carton for power supply box and its mounting hardware. When opening the cartons be careful to avoid spilling the contents. Report any shortage or shipping damage to OSI within 3 days.

User-supplied Items Required

- If power supply box is ordered, two (2) ½ inch conduit size weather-tight fittings for the holes in the bottom of the power supply box for power and signal cable entry.
- A copper-clad ground rod and large diameter copper wire are needed to properly ground the OWI-650 per local electrical codes.
- Mounting pole or tower to install sensor, HIPS head (option) and power supply box (option).
- AC and RS-232 cables, terminated with "ring" terminals, are needed for power and signal connections inside the power supply box (option).
- Users are urged to provide surge suppression on power and RS-232 lines to the OWI-650 sensor on the user side of the system.

CAUTION :
Do NOT drill holes in any portion of the LP-WIVIS sensor! Doing so will void the warranty and may allow water to enter the sensor

Prepare the Site

- Carefully choose the site using the guidelines in Section 2.1.
- Following applicable electrical and building codes, install a concrete mounting base, mounting pole or tower, AC power cable, RS-232 signal cable, and ground rod.

Prepare the Sensor

- Attach the 2 ea U-bolts to the OWI-650 mounting plate with the 1/4-20 hex locking nuts with the stainless-steel mounting bracket sandwiched between as shown in Figure 2.-1. To mount the OWI-650 to a vertical pipe, install the U-bolts horizontally as shown. To mount to a horizontal pipe or boom arm, install them vertically using the same holes. Do not tighten the nuts completely until the sensor head is installed on the pole.

Figure 2-1 U-Bolt Installation

- The light block is attached to the sensor arm with steel lanyard cable. Screw the captive 1/4-20 thumb screw to the threaded hole located on the OWI-650 sensor arm as shown. Insure that the light block mounting tab is oriented towards the small TX head.

Prepare the Power Supply Box (optional)n

- If power supply box is ordered, install the waterproof cable glands or conduit fittings in three (3) holes in the bottom of the power supply box for the AC, RS-232, and sensor cables.

- On the mounting pole or tower, prepare cross arm supports or brackets to mount the power supply box using the dimensions as shown in Figure 2.-2.

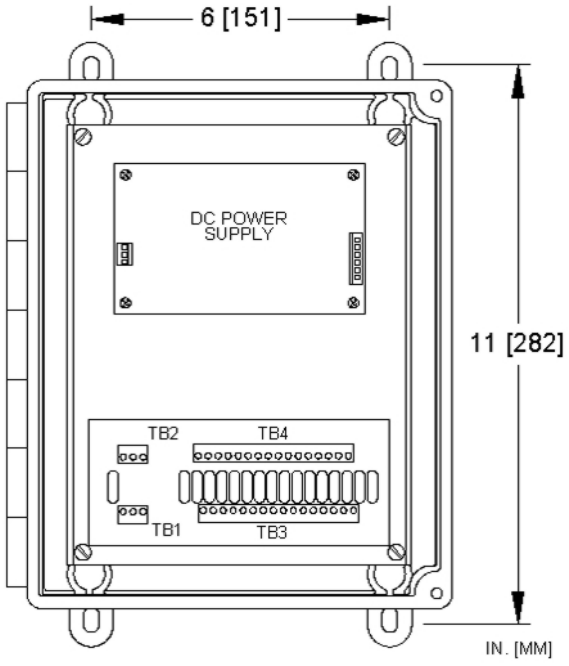

Figure 2-2 Power Supply Box Mounting Holes

2.2.2 Mounting the OWI-650

Because there are so many different ways to install the OWI-650, the installation procedure described in this section should be considered "typical".

Install the Sensor Head and Cable

1. Attach the sensor to the mounting pole using the two (2) U-bolts. Do not tighten the U-bolt nuts completely until the head is oriented.

2. Rotate the sensor head until the off-axis lens is facing away from direct sun-shining and free of objects within 10 meters, as shown in Figure 2-3.

3. Tighten the U-bolt nuts when the orientation is correct. (Do not over tighten such that the mounting plate is bent)

4. Secure the head cables to the pole every 1-meter using tie-wraps or other straps.

5. Following Section 2.2.3, connect the sensor cable to the user's DAS +12 VDC supply and RS-232 port.

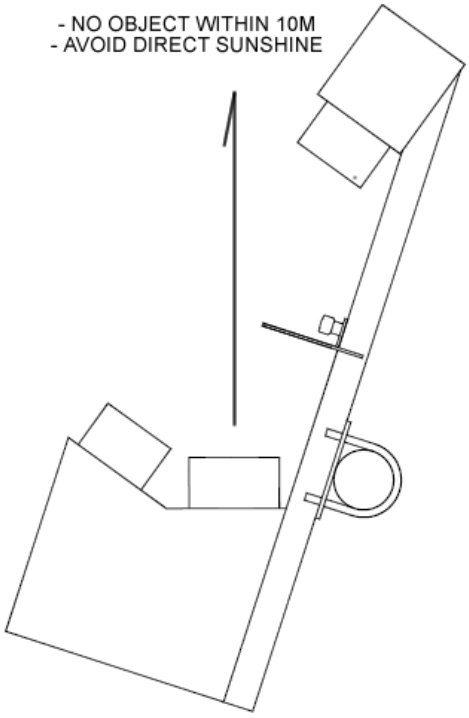

Figure 2-3 Sensor Head Orientation

Install the (optional) Power Supply Box

1. Attach the power supply box to the mounting pole brackets using the hardware supplied with the OWI-650.

2. Following Section 2.2.4, connect the power line, RS-232 line, and sensor cable to the terminal blocks 1 and 2 in the power supply box through three access holes, see figure 2-4.

3. Connect the sensor green wire and the user-supplied ground rod wire to the 1/4-20 stud on the bottom of the box using the hardware supplied with the OWI-650.

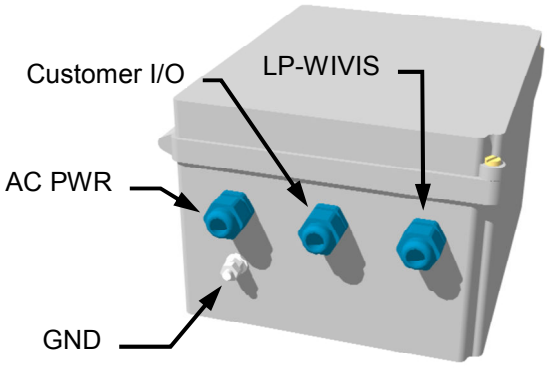

Figure 2-4 Power Supply Box Bottom

4. Secure any loose cable to the mounting pole using tie-wraps or other straps.

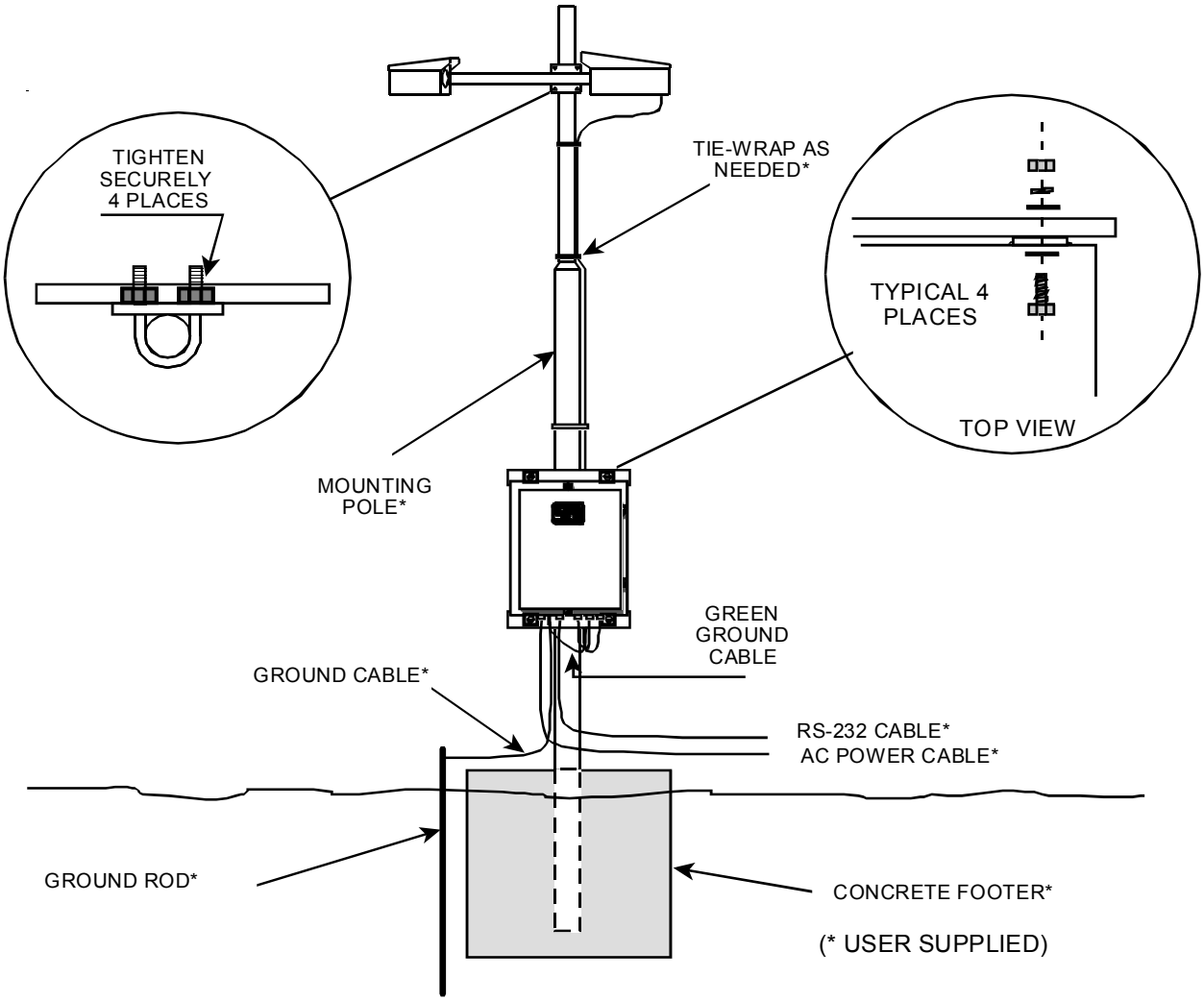

Figure 2-5 OWI-650 Installation (example)

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2.2.3 Connecting the OWI-650 Sensor to the DAS

User connection is made to the user's DAS for the 12 VDC and RS-232 connections

Cable Connection

The standard OWI-650 cable is 3 meters (10 feet) long and ends with five pairs of wires tinned at the end plus a cable shield with an insulating ring

The first pair which is Red/Black pair is for providing 12VDC to OWI-650 electronics. The second pair is White/Black pair for providing 12VDC to OWI-650 heaters. The third Blue/Black pair and the fourth Green/Black pair are used for RS-232 transmit and receive signals to the DAS. The fifth Yellow/Black pair is not used for standard OWI-650 configuration.

1. Feed the free end of the OWI-650 cable through the existing electrical box for user's DAS through ½" cable gland.

2. Ground the cable shield by fastening the insulating ring to a grounded frame inside the electrical box.

3. Connect the Red and White wires of Red/Black, White/Black pairs to 12VDC source using suitable connection method. Connect the black wires of the same pairs to power ground.

4. Connect the sensor RS-232 transmit pair (Blue/Black) to user DAS RS-232 receive positions. Then connect the sensor RS-232 receive pair (Green/Black) to DAS RS-232 transmit positions. If only one RS-232 ground is available, then combine both ground black wires from sensor RS-232 to the DAS RS-232 ground.

5. Ensure that none of the wires are stressed, and then hand tightens the gland seal. The color and the respective function are listed in the table bellow for easy reference.

RS-232 Pair	Color	Function	PCAT DB9 Type Connector Pin #	PC DB25 Type Connector Pin #
Blue/Black	Blue	Sensor TX	2 of DB9	3 of DB25
Blue/Black	Black	TX Return	5 of DB9	7 of DB25
	GND	Earth Ground	Cable Shield (opt.)	Cable Shield (opt.)
Green/Black	Green	Sensor RX	3 of DB9	2 of DB25
Green/Black	Black	RX Return	5 of DB9	7 of DB25

NOTE:
The information provided in the table serves as a general guide for connecting the other end of the RS-232 cable to the user-supplied computer. Refer to the computer users' manual for wiring instructions specific to your computer.

CAUTION:
If the OWI-650 Power Supply Box is ***not*** *used, Users must provide surge protection*

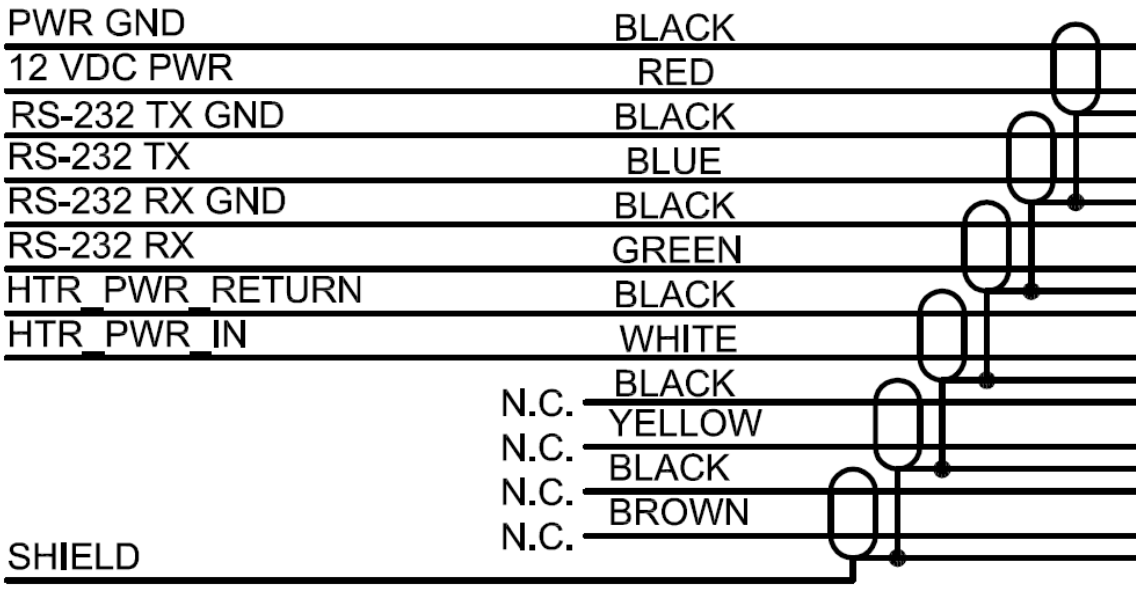


Figure 2-6 OSI-2827-157 OWI Sensor Cable Wiring Connections

Since May 2019, an alternate cable has been supplied which eliminated confusion with multiple black wires as shwn below

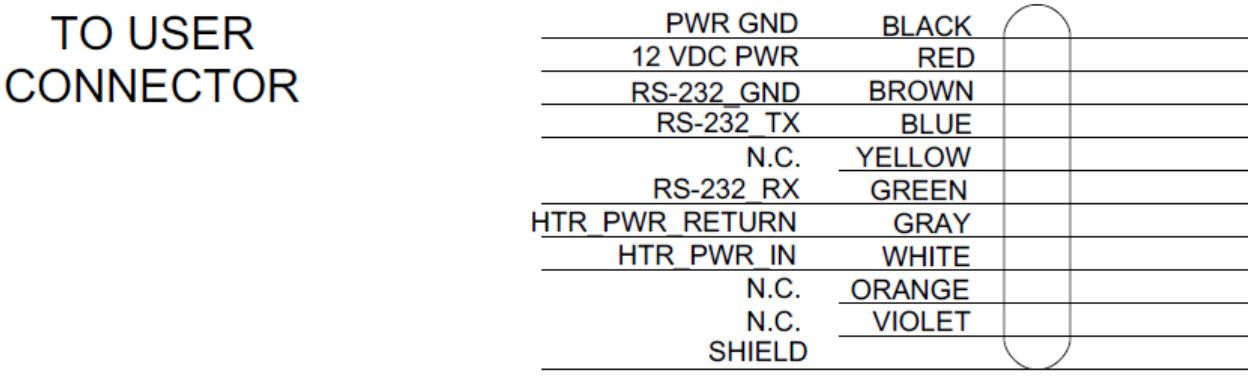


Figure 2-7 OSi2827-157 Rev C Alternate OWI Sensor Cable Wiring Connections

2.2.4 Connecting the OWI-650 Sensor to the (optional) Power Supply Box

User connection is made to the Power Supply Box for AC power and RS-232 connections.

Prepare the power supply box

On the mounting pole or tower, prepare cross arm supports or brackets to mount the power supply box following procedures in Section 2.2.2

Thread cables through waterproof cable glands or conduit fittings in three (3) ½" holes in the bottom of the power supply box for the AC power, RS-232 cable, and OWI-650 sensor cable.

AC Power Line Connection

AC power connections are made to the AC terminal block (TB1) located in the lower left-hand corner of the power supply box. A 3-wire, single phase AC source is required consisting of hot, neutral, and earth ground connections.

WARNING:
Turn off power at the source before making the electrical connections to the Power Supply Box

1. Feed the free end of the user-supplied power cable through the left cable gland or conduit fitting. A 3-wire 16 to 18 AWG cable is recommended.

2. The ends of the wires should be stripped and tinned.

3. Connect the 3 wires in the user-supplied power cable as shown in the table below.

4. During installation, check the power cable wire colors in the first column of the table below for reference.

AC Power Cable Wire Color	AC Power Function	TB 1 Position
Black / Brown	AC Hot	1
White / Blue	AC Neutral	2
Green / Green- Yellow	Earth Ground	3
See Figure 2-7		

Power Supply Box OWI-650 Sensor Cable Connection

OWI-650 sensor cable is composed of 5 pair wires plus cable shield connection. The first pair (red/black) is used for providing 12VDC power to the sensor. The second pair (white/black) is used for providing 12VDC to OWI-650 lens heaters. The third (blue/black) and fourth pair (green/black) is used for sensor RS-232 transmit and receive, respectively. The fifth pair (yellow/black) is reserved for future use.

1. Feed the OWI-650 Sensor cable through right cable gland or conduit fitting.
2. Connect the four pairs of wires
3. Connect the cable shield ground insulating ring to the base plate grounding screw.

OWI-650 Wire Pair	Color	Function	TB3 Position
Red/Black	Black	Sensor Power Ground	1
Red/Black	Red	+12 VDC PWR	2
White/Black	Black	Heater Power Ground	3
White/Black	White	+12 VDC HTR PWR	4
Blue/Black	Black	TX Return	6
Blue/Black	Blue	Sensor TX	5
Green/Black	Black	RX Return	6
Green/Black	Green	Sensor RX	7
Yellow/Black	Black	Not Used	
Yellow/Black	Yellow	Not Used	

For the new revision cable with 10 conductor wires use following table

Color	Function	TB3 Position
Black	Sensor Power Ground	1
Red	+12 VDC PWR	2
GREY	Heater Power Ground	3
White	+12 VDC HTR PWR	4
BROWN	RS232 Return	6
Blue	Sensor TX	5
Yellow	Not Used	
Green	Sensor RX	7
Orange	Not Used	
Violet	Not Used	

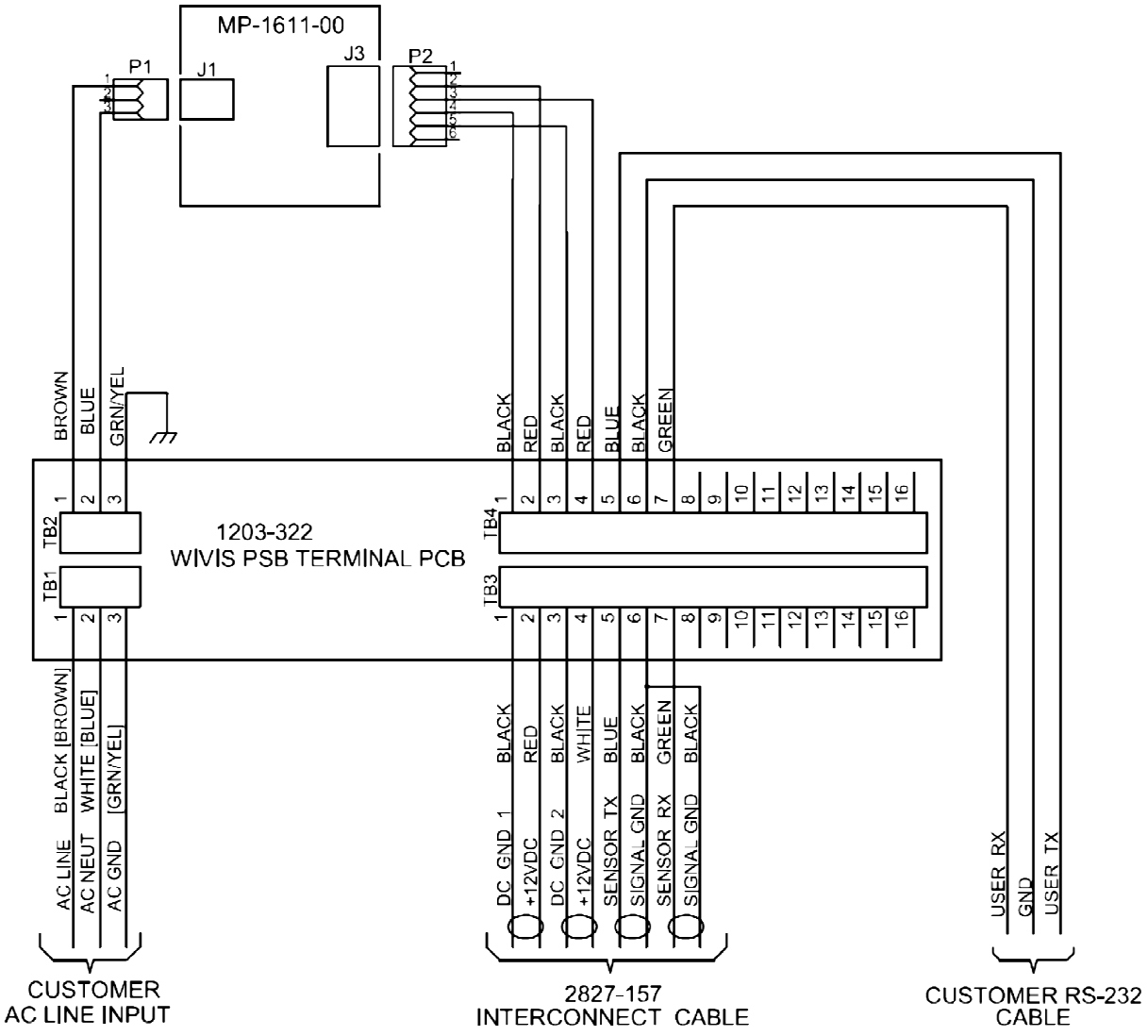


Figure 2-8 Power Supply Box Wiring Connections

3 OWI-650 THEORY OF OPERATION

3.1 Sensor Theory

The OWI-650 sensor is a self-contained unit consisting of electro-optical components, heaters, DSP, and cables.

The OWI-650 measures precipitation by detecting the optical irregularities induced by particles falling through a beam of partially coherent infrared light (in the sample volume). These irregularities are known as scintillation. The twinkling of stars is a familiar example of scintillation. By detecting the intensity of the scintillations which are characteristic of precipitation, the precipitation rate is determined. By analyzing the frequency spectrum of the induced scintillation, the precipitation type (i.e. rain, snow, etc) is determined. Precipitation is measured using the sensor head "in-beam" optics.

The OWI-650 measures visibility by determining the amount of forward scattered light received at the off-axis detector. Light is scattered by precipitation, dust, smoke, fog and other obstructions to visibility in the sample volume. This signal, known as the scatter coefficient, is converted to visibility with an OSI proprietary algorithm. Visibility is measured using the sensor head "off-axis" optics.

A block diagram of the sensor front end is shown in Figure 3-1. The sensor front end consists of:

- TX Portion
  IR Light Emitting Diode
  Heated transmitter optical lens assembly

- RX Portion
  2 heated receiver optical lens assemblies
  2 photo detector and preamplifier assemblies

- Internal Cabling
  3 internal signal cables for connection to DSP board for post processing
  3 internal power cables to supply power to the TX/RX electronics and heaters

The TX portion of the sensor head uses an infrared light emitting diode (IRED) as a light source that is modulated to eliminate interference in the system caused by ambient light. The IRED has a very long lifetime, is relatively low power, invisible to the eye, and presents no radiation hazard to the user. The IRED is housed in the smaller of the sensor head boxes. A lens is used to collimate the IRED's CW modulated light into a slightly diverged beam. The transmit and receive lenses are heated by dual self-regulating positive temperature coefficient (PTC) thermistor disks, to a point above ambient temperature to reduce dew, frost, and snow on the lenses.

The larger sensor rectangular box houses the in-beam receive optics for present weather sensing, the off-axis receive optics for visibility sensing, and associated photo diodes and preamplifier electronics. As shown in Figure 3.1, the in-beam light passes through a horizontal line aperture to increase the precipitation detection sensitivity to particles falling vertically. The full aperture is used on the off-axis optics.

A precision thermistor-type temperature probe is attached to the end of the sensor cross arm. It is used for automatic temperature compensation in the algorithm and to measure ambient air temperatures.

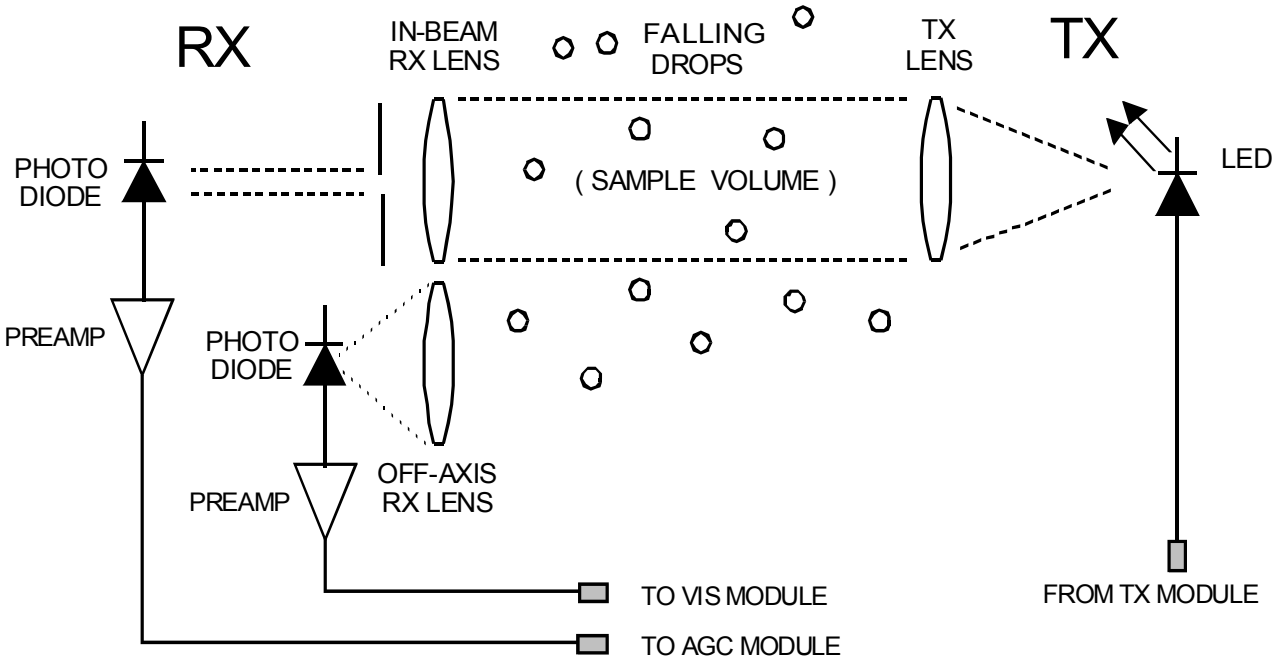


Figure 3-1 Sensor Front End Block Diagram

3.2 DSP Algorithm Modules

The OWI-650 front end signals are processed by a DSP for weather products determinations and communications.

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

High Channel - The high channel detects precipitation-induced frequencies in the range of 1 to 4 kHz which are associated with rain.

Low Channel - The low channel detects precipitation-induced frequencies in the range of 25 to 250 Hz which are associated with snow.

Particle Channel - The particle channel detects the occurrence of falling precipitation.

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

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

Digital Module - Contains the A/D, sample and hold, and digital control logic to sample the outputs of the signal processing cards. It determines the precipitation type, precipitation intensity, and the visibility using OSI algorithms. The digital module also performs real time self-tests to continually detect faults in the OWI-650 and contains the RS-232 communications port.

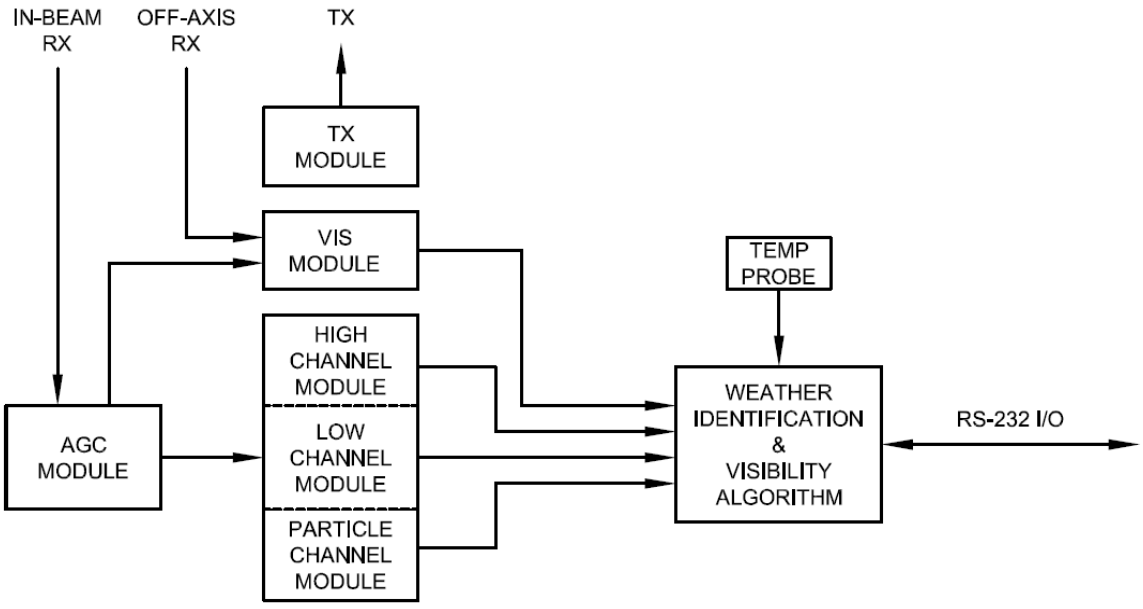


Figure 3-2 DSP and Ancillary Subassemblies Block Diagram

4 OWI-650 OPERATION WITH A COMPUTER

OWI-650 Data Format and Protocol The WIVIS responds to a series of computer commands that the user may select during set-up, operation, and maintenance of the sensor.

- **Physical Level**

The Serial Input/Output (SIO) signal interface consists of a 3-wire RS-232-C connection. If cable length must exceed 100 feet between the WIVIS and computer, contact OSI about using limited distance modems (LDM).

- **Link Level**

Data transfer across the WIVIS / computer interface is implemented via a serial, ASCII encoded, full duplex, 9600 baud, asynchronous transfer link. Data transfer in the computer-to-WIVIS direction is limited to a simple, single character poll. Data transfers in the WIVIS-to-computer direction are simple fixed-format ASCII strings, started with an STX character (hex 02) and terminated with a carriage return (<CR>).

- **Frame Format**

The standard WIVIS output frame format is shown below. Details of the data fields are presented in a later section. Each of the transmitted characters are eight (8) bit (msb -- bit 7 -- always 0), no parity ASCII (decimal codes 0 to 127), with 1 stop bit. The status code and other information, is formatted in this way as printable ASCII characters to aid in system debugging and field maintenance.
The OWI-650 responds to several different types of single character ASCII polls. It is recommended that the "C" Poll be used. The "C" poll provides both data and diagnostic information.

POLL	DESCRIPTION
A	Send routine data - NWS WX codes
B	Send fixed test data string
C	Send routine and diagnostic data - NWS WX codes
D	Send routine & past data - WMO WX codes
E	Send routine and manufacturer diagnostic data
R	Reset microprocessor and accumulation
V	Send Hardware & Software Version
Z	Reset accumulation to zero

NOTE:
The OWI-650 commands are case sensitive and unless otherwise noted, require the use of capital letters, i.e.; "C" rather than "c".

4.1 Data Polls and Responses

4.1.1 "A" Poll Response

The "A" poll is used to obtain routine past weather and visibility data in NWS format.

The type "A" poll (short message format) is used for normal operation when NWS weather codes are desired. This poll should be issued once every 60 seconds, and in response, the OWI-650 will transmit a 26 character string that contains present weather in NWS code format, precipitation rate, visibility information, sensor status, and frame checksum information. Note that the OWI-650 algorithm recalculates the present weather and visibility every 60 seconds. Therefore, it serves no purpose to poll the sensor more than once a minute.

OWI-650 ASCII routine data ("A" poll) string is formatted as shown below:

Format:	[STX]	W	w	w	P	p	p	p	p	S	s	s	s	s	V	v	v	v	v	c	c	B	g	g	g	[CR]
Byte:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26

Byte	Description	Value
1	Start of transmission	[STX]
2	Weather type marker	W
3 - 4	Present weather field	ww
5	Precipitation marker	P
6 - 9	Precipitation rate field	pppp
10	Status field marker	S
11 - 14	Status field	ssss
15	Visibility field marker	V
16 - 19	Visibility field	vvvv
20 - 21	Check sum field	cc
22	Ambient light marker	B
23 - 25	Ambient light field	ggg
26	Carriage Return	[CR]

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

1. The capital letters "W", "P", "S", "V", and "B" serve as place markers for the Weather, Precipitation, Status, Visibility, and Ambient Light data fields to follow. These markers are fixed in position and coding. They are included within the string to simplify manual interpretation of the sensor output.

2. ww is a two (2) byte field indicating present weather. The weather codes contained in this field are described in Section 4.2.1.

3. pppp is a four (4) byte field indicating the precipitation rate. Zero is formatted as four zeros ("0000"). The number is a floating point format, varying from .001 to 9999. The units are inches/hour (millimeter/hour) rain rate, averaged over a one minute period.

4. ssss is a four (4) character field containing ASCII encoded hex value reserved for error and status codes. Each character represents a four bit field of binary information. The four bit field contains status information of the FRUs. The status codes in this field are described in Section 4.2.2.

5. vvvv is a four (4) byte field indicating the visibility reading. The number is a floating format with ranges as shown from 0.001 to 10 miles (16 kilometers) visibility, averaged over a three minute period.

6. cc is a two (2) byte field containing ASCII encoded 8 bit hex value for a modulo 256 checksum of the data between [STX] and [CR]. [STX], [CR], and cc are not included in the checksum calculation. The calculation of the checksum is described in Section 4.1.5.

7. ggg is a three (3) byte ASCII numeric field indicating the corresponding one-minute ambient light received by the off-axis receiver. The unit is 10 candles/m2.

4.1.2 "C" Poll Response

The "C" poll is used to obtain routine data and past weather in NWS format.

The type "C" poll is a long (61 or 68 characters) output format which includes present weather in NWS code format, precipitation rate, visibility, and full raw data, along with status and checksum data. This poll is used for performing normal polls in addition to acquiring raw sensor data for evaluation or diagnostic purposes.

OWI-650 ASCII full raw data string ("C" poll) is formatted as shown on the following page:

```
Format: [STX] W  w  w  P  p  p  p  p  S  s  s  s  s  V  v  v  v  v  c  c  X  n  n  n
          |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
Byte:     1   2  3  4  5  6  7  8  9  10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

Format:  z  z  z  L  n  n  n  b  b  b  K  n  n  n  b  b  b  H  n  n  n  b  b  b
         |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
Byte:   26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49

Format: E  n  n  n  g  g  g  T  t  t  t  A  n  n  n  b  b  b  [CR]
        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
Byte:  50  5 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67  68
```

Byte	Description	Value
1	Start of transmission	[STX]
2	Weather type marker	W
3 - 4	Present weather field	ww
5	Precipitation marker	P
6 - 9	Precipitation rate field	pppp
10	Status field marker	S
11 - 14	Status field	ssss
15	Visibility field marker	V
16 - 19	Visibility field	vvvv
20 - 21	Check sum field	cc
22	Carrier raw data field marker	X
23 - 25	Carrier 1 min. raw data	nnn
26-28	Low/Particle/High lock indicator	zzz
29	Low raw data field marker	L
30 - 32	Low 1 min average raw data	nnn
33 - 35	Low baseline	bbb
36	Particle raw data field marker	K
37 - 39	Particle 1 min average raw data	nnn
40 - 42	Particle baseline	bbb
43	High raw data field marker	H
44 - 46	High 1 min average raw data	nnn
47 - 49	High baseline	bbb
50	Extinction field marker	E
51 - 53	Extinction field	nnn
54 - 56	Ambient light field	ggg
57	Temperature field marker	T
58 - 60	Temperature field	ttt
61	Acoustic raw data field marker	A
62 - 64	Acoustic 1 min average raw data	nnn
65 - 67	Acoustic baseline	bbb
68	Carriage return	[CR]

This section describes the format of the various fixed fields as they are used in the "C" poll responses just previously.

1. The capital letters "W", "P", "S", "V", "X", "L", "K", "H", "E", "T" and "A" above serve as place markers for the Weather, Precipitation, Status, Visibility, Carrier, Low, Particle, High, Extinction, Temperature, and Acoustic data fields to follow.

2. ww is a two (2) byte field indicating present weather. The weather codes contained in this field are described in Section 4.2.1.

3. pppp is a four (4) byte field indicating the precipitation rate. Zero is formatted as four zeros ("0000"). The number is a floating point format, varying from .001 to 9999. The units are inches/hour (millimeter/hour) rain rate, averaged over a one minute period.

4. ssss is a four (4) character field containing decimal value reserved for error and status codes. The status codes in this field are described in Section 4.2.2.

5. vvvv is a four (4) byte field indicating the visibility reading. The number is a floating format with ranges as shown from 0.001 to 10 miles (16 kilometers) visibility, averaged over a three minute period.

6. cc is a two (2) byte field containing ASCII encoded 8 bit hex value for a modulo 256 checksum of the data between [STX] and [CR]. [STX], [CR], and cc are not included in the checksum calculation. The calculation of the checksum is described in Section 4.2.5.

7. nnn is a three (3) byte ASCII numeric field indicating the corresponding one minute averaged raw data. Leading / unused positions are filled with zeros. Valid values are -99 to 999.
8. zzz is a three (3) character ASCII numeric field indicating the lock on (0) or off (1) status of the low, particle counting, and high channels, respectively. (NOTE USE OF NEGATIVE LOGIC CONVENTION HERE)

9. bbb is a three (3) byte ASCII numeric field indicating the respective data channel adaptive baseline values. Leading / unused positions are filled with zeros. Valid values are -99 to 999.

10. ggg is a three (3) byte ASCII numeric field indicating the corresponding one-minute ambient light received by the off-axis receiver. The unit is 10 candles/m².

11. ttt is a three (3) byte ASCII numeric field indicating the temperature indicated by the probe on the bottom of the OWI-650 sensor frame. It is for diagnostic purposes and should not be used as a true meteorological temperature. The valid values are -99 to 999 in units of degrees F (C). Note, a value of -99 indicates a defective or missing temperature probe

4.1.3 "D" Poll Response

The "D" poll is used to obtain routine data and past weather in WMO format.

The type "D" poll (short message format) is used for normal operation when WMO weather codes are desired. This poll should be issued once every 60 seconds, and in response, the OWI-650 will transmit a 39 character string that contains present weather in WMO code format, precipitation rate, sensor status, visibility, frame checksum information, ambient light information, precipitation accumulation, and past weather data codes. Note that the OWI-650 algorithm recalculates the present weather and visibility every 60 seconds. Therefore, it serves no purpose to poll the sensor more than once a minute.

OWI-650 ASCII routine and past data string is formatted as shown below:

```
Format: [STX] W  w  w  P  p  p  p  p  S  s  s  s  s  V  v  v  v  v  c  c  B  g  g  g
          |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
Byte:     1   2  3  4  5  6  7  8  9  10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

Format:  A  a  a  a  a  a  a  a  Z  w' w' w" w"  [CR]
         |  |  |  |  |  |  |  |  |  |  |  |  |    |
Byte:    26 27 28 29 30 31 32 33 34 35 36 37 38   39
```

Byte	Description	Value
1	Start of transmission	[STX]
2	Weather type marker	W
3 - 4	Present weather field	ww
5	Precipitation marker	P
6 - 9	Precipitation rate field	pppp
10	Status field marker	S
11 - 14	Status field	ssss
15	Visibility field marker	V
16 - 19	Visibility field	vvvv
20 - 21	Check sum field	cc
22	Ambient light marker	B
23 - 25	Ambient light field	ggg
26	Accumulation field marker	A
27 - 33	Precipitation accumulation	aaa.aaa
34	Past weather data marker	Z
35 - 36	15 minute weather code	w ' w '
37 - 38	60 minute weather code	w " w "
39	Carriage Return	[CR]

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

1. The capital letters "W", "P", "S", "V", "B", "A", and "Z" above serve as place markers for the Weather, Precipitation, Status, Visibility, Ambient Light, Accumulation, and Past Weather data fields to follow. These markers are fixed in position and coding. They are included within the format to simplify manual interpretation of the sensor output.

2. w w is a two (2) byte field indicating present weather. The weather codes contained in this field are described in Section 4.2.1.

3. pppp is a four (4) byte field indicating the precipitation rate or equivalent water content for snow. Zero is formatted as four zeros ("0000"). The number is a floating point format, varying from .001 to 9999. The units are millimeter/hour rain rate, averaged over a one minute period.

4. ssss is a four (4) character field containing ASCII encoded hex value reserved for error and status codes. Each character represents a four bit field of binary information. The four bit field contains status information of the FRUs. The status codes in this field are described in Section 4.2.2.

5. vvvv is a four (4) byte field indicating the visibility reading. The number is a floating format, varying from .001 to 10 miles (16 kilometers) visibility, averaged over a three minute period.

6. cc is a two (2) byte field containing ASCII encoded 8 bit hex value for a modulo 256 checksum of the data between [STX] and [CR]. [STX], [CR], and cc are not included in the checksum calculation. The calculation of the checksum is described in Section 4.1.5.

7. ggg is a three (3) byte ASCII numeric field indicating the corresponding one-minute ambient light received by the off-axis receiver. The unit is 10 candles/m2..

8. aaa.aaa is a seven (7) byte, fixed decimal, ASCII numeric field indicating the precipitation accumulation. Accumulation will reset to zero when the sensor power is cycled, or when a "R" poll is sent to the OWI-650. The valid values are 000.000 to 999.999 in units of millimeters.

9. w'w' is a two (2) byte field that contains one of the WMO codes from the format table. It represents the highest present weather code that has been reported in the past 15 minutes.

10. w"w" is a two (2) byte field that contains one of the WMO codes from the format table. It represents the highest present weather code that has been reported in the past 60 minutes.

4.1.4 Miscellaneous Polls

There are several polls which are used during installation and maintenance of the OWI-650. It is recommended that the user be familiar with them.

- **RESPONSE TO THE "B" POLL**

The type "B" poll (simulation data) is used for field test and diagnostic purposes. This mode outputs a fixed (never changing) string of 17 characters. OWI-650 ASCII diagnostic data string is formatted as shown below:

```
Format: [STX] W  N  P  P  1  2  3  4  S  5  6  7  8  3  C  [CR]
          |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |
Byte:     1   2  3  4  5  6  7  8  9  10 11 12 13 14 15 16  17
```

Byte	Description	Value
1	Start of transmission	[STX]
2	Weather type marker	W
3 - 4	Present weather (dummy)	NP
5	Precipitation marker	P
6 - 9	Precipitation rate (dummy)	1234
10	Status field marker	S
11 - 14	Status field (dummy)	5678
15 - 16	Check sum field (dummy)	3C
17	Carriage Return	[CR]

- **RESPONSE TO THE "R" POLL**

This command is used to reset the OWI-650 to the start-up mode. It performs a similar function as turning the power off/on. Note that the "R" poll also resets the precipitation accumulation to zero. The primary advantage is that the "R" poll can be sent remotely. Do not use the "R" poll once the OWI-650 is operating in normal mode unless there is a problem with the sensor.

In response to receiving the "R" poll, the OWI-650 will output the following:

[STX] SYSTEM RESTART [CR]
[STX] [CR]

- **RESPONSE TO THE "V" POLL**

This command is used to determine the current version of OWI-650 firmware. It allows the information to be read remotely without having to unplug the DSP board to read the information directly from the Flash memory.

A typical response to the "V" poll is shown as follows:

[STX]VerDSP WIVDS39S 08/29/11 [CR]

Note, the exact firmware version number and date reported by the sensor depend on the firmware residing in the OWI-650.

- **RESPONSE TO THE "Z" POLL**

This command is used to automatically reset the OWI-650 precipitation accumulation to zero. It is available only if the "D" poll is included with the firmware.

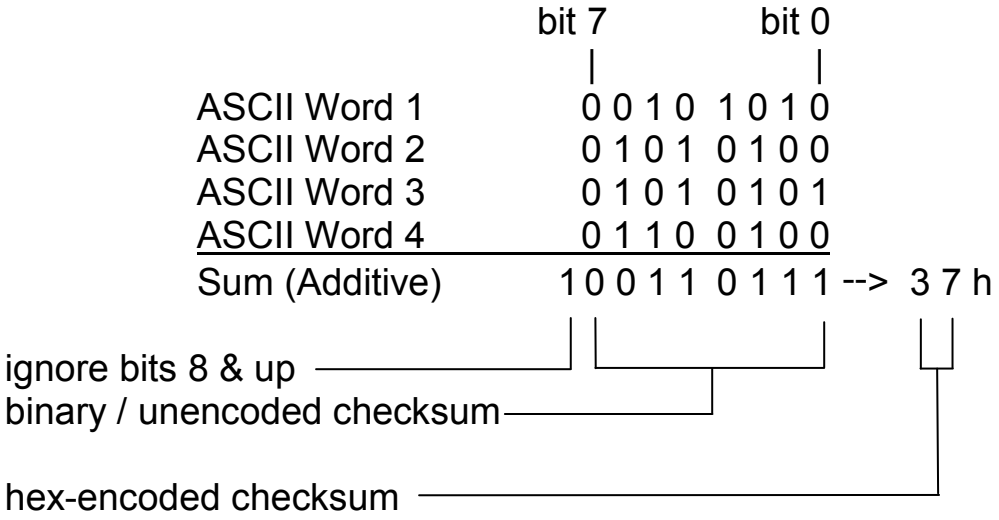
In response to receiving the "Z" poll, the OWI-650 will output the following:

[STX] ACCUMULATION ZERO-OUT [CR]

4.1.5 Checksum Calculation

A two byte check sum is included in most data polls as a way to verify correct transmission of the data string. Its use is optional.

The checksum word is calculated based upon the least significant eight (8) bits of the additive sum (Modulo-256) of all ASCII-encoded (with zero in bit 7) bytes between but not including the STX and the checksum itself of the frame. The Checksum word (upper then lower nibble) shall be ASCII-encoded to produce two (2) ASCII characters which are transmitted across the serial link in the same fashion as the Opcode and Data Field, with the upper nibble sent first. An example is provided below to illustrate the checksum operation:



(Note: A word here is defined as 8 bits.)

The unencoded checksum, segmented into two (2) 4-bit nibbles, would then be ASCII-encoded to produce two (2) 8-bit ASCII characters prior to transmission over the serial link. In this case, an ASCII "3" and an ASCII "7".

4.2 Data Interpretation

4.2.1 Weather Codes

"A", "C" and "E" poll data are in NWS weather code format while the "D" poll data is in WMO format.

- **"A", "C" & "E" Poll - NWS Code Format**

The "A", "C" and "E" Poll responses contain weather codes formatted in NWS type format. The latest one-minute weather code (ww) is found in bytes 3 and 4 immediately following the "W" place marker.

WX Code	NWS WX Code Description	WX Code	NWS WX Code Description
L-	Light Drizzle	I-	Light Ice Pellet*
L_	Moderate Drizzle	I	Moderate Ice Pellet*
L+	Heavy Drizzle	I+	Heavy Ice Pellet*
R-	Light Rain	A-	Light Hail*
R_	Moderate Rain	A	Moderate Hail*
R+	Heavy Rain	A+	Heavy Hail*
P-	Light Precipitation	__	No Precipitation
P_	Moderate Precipitation	--	Start-up code
P+	Heavy Precipitation	ER	Error Condition
S-	Light Snow	CL	Lenses need to be cleaned
S_	Moderate Snow		only reported with no precip)
S+	Heavy Snow		

* Ice pellet and hail codes are only available with the optional HIPS sensor.

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

- **"D" Poll - WMO Code Format**

The "D" poll response contains weather codes formatted in WMO type format. The latest one-minute weather code (ww) is found in bytes 3-4 immediately following the "W" place marker. The past weather codes (w'w' and w"w") are found in bytes 35-36 and 37-38 immediately following the "Z" place marker.

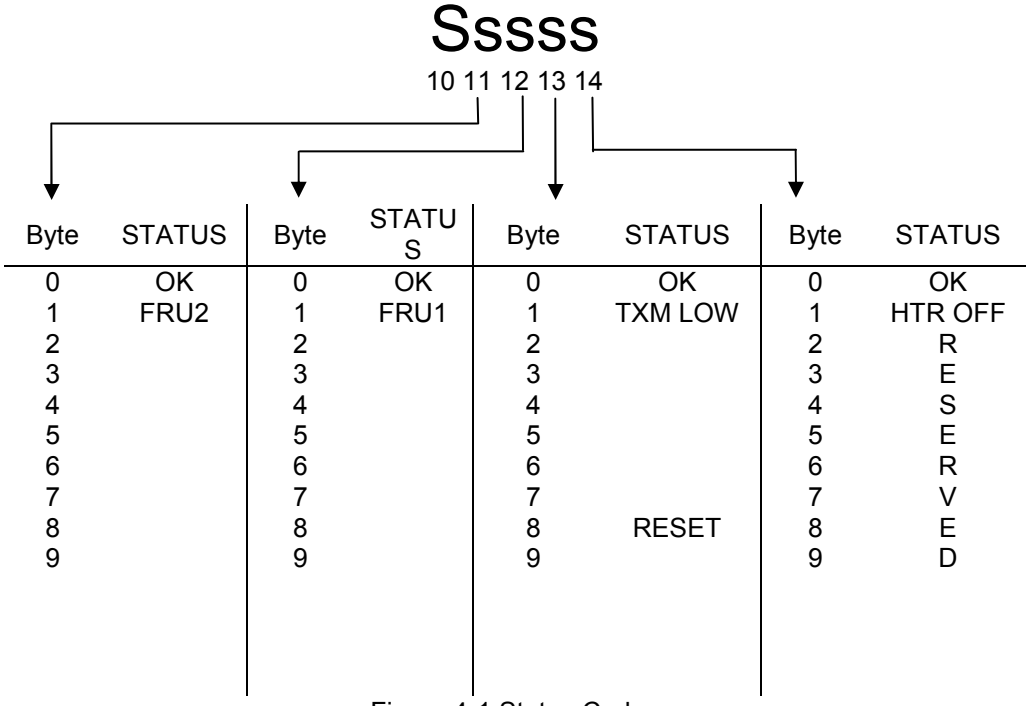
WX Code	WMO WX Code Description	WX Code	WMO WX Code Description
00	No Significant Weather	61	Rain, not freezing, slight
04	Haze	62	Rain, not freezing, moderate
10	Mist	63	Rain, not freezing, heavy
20	Fog detected in last hour	64	Rain, freezing, slight
21	Precip detected in last hour	65	Rain, freezing, moderate
22	Drizzle detected in last hour	66	Rain, freezing, heavy
23	Rain detected in last hour	67	Rain/snow, slight
24	Snow detected in last hour	68	Rain/snow, moderate or heavy
30	Fog	71	Snow, slight
41	Precipitation, slight or moderate	72	Snow, moderate
47	Freezing precip, slight or moderate	73	Snow, heavy
51	Drizzle, not freezing, slight	74	Ice Pellet, slight*
52	Drizzle, not freezing, moderate	75	Ice Pellet, moderate*
53	Drizzle, not freezing, heavy	76	Ice Pellet, heavy*
54	Drizzle, freezing, slight	93	Hail, Light*
55	Drizzle, freezing, moderate	93	Hail, Moderate *
56	Drizzle, freezing, heavy	96	Hail, Heavy*
57	Drizzle and rain, slight	--	Start-up code
58	Drizzle & rain, moderate or heavy	ER	Error Condition
		CL	Lenses need to be cleaned (only reported when no precipitation)

* Ice pellet and hail codes are only available with the optional HIPS sensor.

The "--" code will be output in this and other data fields during the first 60 seconds or so after reset or power-up of the sensor.

4.2.2 Status Codes

Status codes The status codes are a convenient way for the WIVIS to report sensor condition and identify faulty subassemblies. The status field, denoted by s s s s (4 bytes) in the WIVIS data output format, is a 4 byte field of sensor status bytes. The codes can be interpreted as shown below.



Byte	STATUS	Byte	STATUS	Byte	STATUS	Byte	STATUS
0	OK	0	OK	0	OK	0	OK
1	FRU2	1	FRU1	1	TXM LOW	1	HTR OFF
2		2		2		2	R
3		3		3		3	E
4		4		4		4	S
5		5		5		5	E
6		6		6		6	R
7		7		7		7	V
8		8		8	RESET	8	E
9		9		9		9	D

Figure 4-1 Status Codes

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

Example: Status codes read S0180. Interpret this code as follows:
Byte 11 = 0 OK
Byte 12 = 1 FRU 1 probably bad
Byte 13 = 8 Sensor was reset in past 2 minutes
Byte 14 = 0 OK

Solution: Wait for 2 minutes to verify that the reset bit turns off. Status code will now read S0100 indicating that there may be a problem with FRU 1. Replace FRU 1 (Sensor Head) and check status codes. After 2 minutes (when reset bit turns off again) status codes should be S0000.

In normal operation (excluding the first two minutes after reset or power-up), the status bytes will be all low (0000). A non-zero character in any of the four positions indicates the suspected failure of an FRU. The host system should take action to alert maintenance personnel of a possible problem. In addition, data from the OWI should be disregarded and a "missing" report issued. (Note that the OWI does not necessarily

stop outputting data when a status bit flags an error condition.) A summary of the active status bits and the corresponding FRU's and assembly numbers are given below:

FRU #	Item Description	OSI P/N
FRU 1	LP-WIVIS Optical Sensor Assembly	2827-101
FRU 2	Power Supply Box	1203-105

4.2.3 Maintenance Message

Through OWI-650 carrier strength measurement and statistical analysis, the sensor reports optical surface condition. On the current commercial OWI-650, a warning is issued first and then, if ignored and dirt continues to build, the resultant contamination will eventually result in an error being reported.

The waning message is "CL" on the weather code for all the data polling and the error condition is "ER" on the weather code.

5 MAINTENANCE & TROUBLESHOOTING

5.1 Routine Maintenance & Quick Check

The OWI-650 takes only a few minutes every 3-6 months to maintain. In most cases, only a few simple checks are required.

Equipment Required

1. Clean Cotton Cloth or Lens Tissue
2. Common Household Glass Cleaner

- **Check Lens Heaters**

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

- **Clean Lenses**

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

- **Quick Check of Data Fields**

The following checks are general in nature and should be used as a general indication that the sensor is working properly. This test should be performed when there is no precipitation and after the sensor has stabilized for at least 30 minutes. Send the OWI-650 a "C" poll and observe the response. The data fields in Bold shown below are the channels of interest.

W__P0000**S0000**Vvvvvcc**Xnnn**zzz**Lnnn**bbb**Knnn**bbb**Hnnn**bbbEnnnggg**Tttt**

W__ - The present weather field should not contain any data (two blank spaces) if there is no precipitation falling.
S0000-The status fields should all read zero if the OWI-650 has been operating (and not reset using "R" poll) for at least 2 minutes. If the status fields are not all zeros, refer to Section 4.2.2 for an interpretation of the possible problem.
Xnnn - The one-minute carrier strength reading will generally read in the range of 405 to 415.
Lnnn - The one-minute low channel reading will generally read in the range of -30 to 50.
Knnn - The one-minute particle channel reading will generally read in the range of 0 to 150.
Hnnn - The one-minute high channel reading will generally read in the range of 40 to 120.
Tt t t - Temperature should be representative of the ambient temperature +- 5 degrees. The temperature probe is thermally connected to the OWI-650 sensor frame so it generally reads warmer than the ambient temperature due to internal heating of the frame.

Hint - If the "Quick Check" values do not appear to be correct, record at least 10 minutes of the complete "C" poll string and fax or e-mail them to OSI Technical Support (techsupport@opticalscientific.com) for evaluation. Include the weather conditions at the site during the period in question such as air temperature, wind speed, type of precipitation if any, etc.

OWI-650 FIELD REPLACEABLE PARTS LIST

The following list of FRUs (Field Replaceable Units) are available for maintenance and repair of the OWI-650 in the field or depot. The sensor head contains no user replaceable parts and can not be repaired except at the OSI factory.

OWI-650 FIELD REPLACEABLE UNITS		
FRU #		**OSI P/N SUBASSEMBLY DESCRIPTION**
FRU 1	2827-101	LP-WIVIS Optical Sensor Assembly
FRU 2	1203-105	Power Supply Box Assembly (complete)

6 APPENDIX A LIMITED DISTANCE MODEM

The LDM option is available for installations where it is not possible for the customers' computer to be located within 100 feet of the OWI-650 sensor.

Two (2) LDMs are required to make the long distance connection between the OWI-650 and user PC. The LDMs operate transparently as if there were a standard cable connection. Figure A.1-1 illustrates the key components of the LDM.

The LDM at the OWI-650 sensor is linked to the LDM at the customers' computer serial port with an RS-232 cable. This cable is fabricated at the site by the customer to suit their requirements. The OWI-650 operates at 9600 baud and can operate up to the following distances, depending on wire gauge:

19 AWG	14.5 km (9.0 miles)
24 AWG	10.0 km (6.2 miles)
26 AWG	6.9 km (4.3 miles)

The LDM at the OWI-650 sensor is installed in the power supply box. The LDM at the user PC is connected to an available serial port such as COM2 on the back of the PC. The user makes connections to the small terminal strip on the LDM as shown in Figure 6-1.

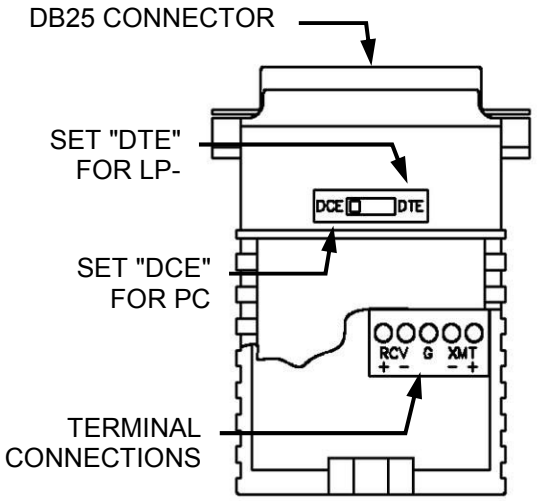


Figure 6-1 LDM Components

Switch Settings

In order for communications to be properly established, both LDM's must be configured properly. The LDM at the sensor is switched to "DTE". The LDM, at the PC serial port is switched to "DCE".

LDM Connections at the OWI-650

Connections at the OWI-650 are made to the terminal block as shown in Figure 6-2.

WARNING:
Turn off power at the source before making the wiring connections to the Power Supply Box

1. Wire the LDM as shown in Figure 6-2 and connect it to the terminal block as shown

2. Feed the free end of an RS-232 cable through the center cable gland in the bottom of the power supply box, and install a DB25 connector as shown. An 18-26 AWG cable is recommended.

3. See that none of the wires are stressed, and hand tighten the gland seal.

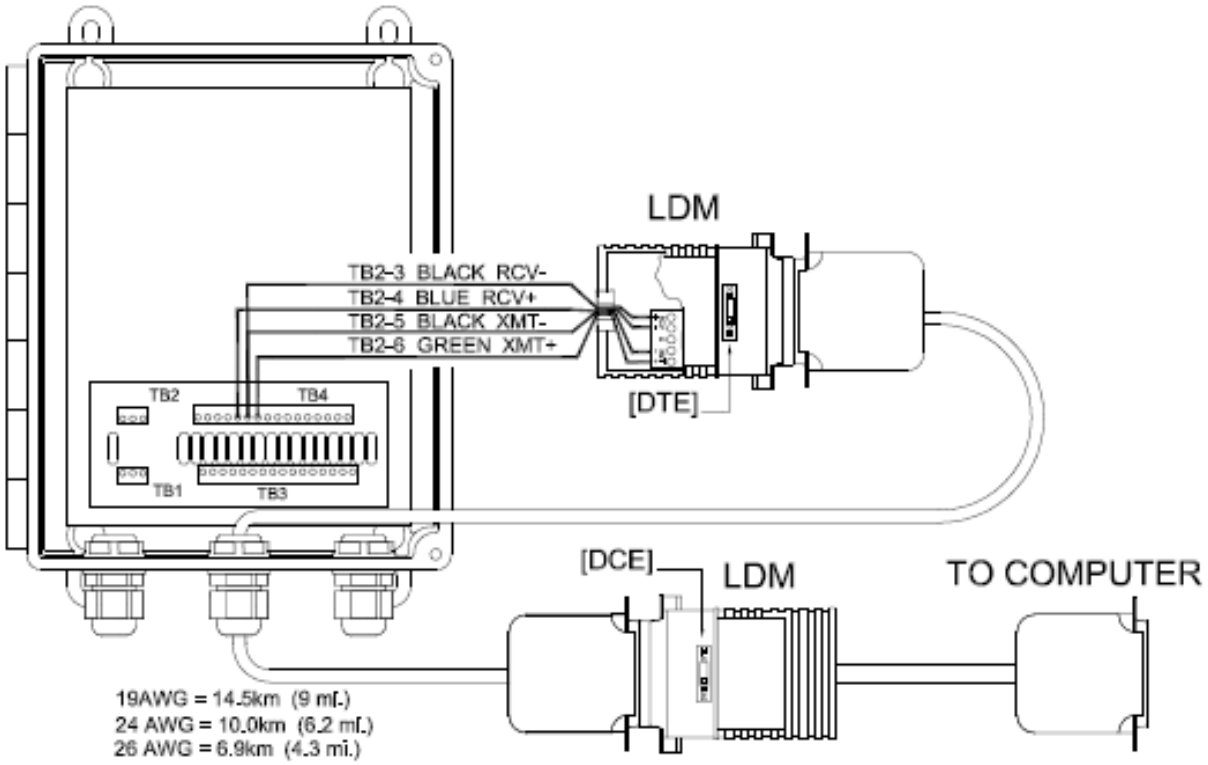


Figure 6-2 LDM Connections

LDM Connections at the PC

1. Attach a DB 25 cable to the LDM.
2. Connect the wires to the LDM as shown in the table below
3. Connect the cable shield wire to the LDM terminal marked "G".
4. Plug the wired LDM into an unused 25-pin serial I/O port on the PC (typically COM2)

LDM Cable Connection Table			
Wire Color	**OWI-650**	**Function**	**User PC**
GREEN	XMT+	Sensor TX	RCV+
BLACK	XMT-	TX Return	RCV-
	n/c	Earth Ground	GND
BLACK	RCV-	Sensor RX	XMT+
BLUE	RCV+	RX Return	XMT-