METEOROLOGICAL INSTRUMENTS

INSTRUCTIONS

Sentry™ Visibility Sensor

MODEL 73000

Serial Output Version

(Ref SVS1)

CE

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P/N: 73000S-90
REV: E021720

This equipment is in conformity with the following directives, standards, or other normative documents:

EMC Directive 2014/30/EU

EN 61326-1:2010

ROHS Directive 2011/65/EU

MODEL 73000
Sentry™ Serial Output Sensor

VISIBILITY SENSOR SPECIFICATION SUMMARY

Performance
- Visibility Range: 30m - 16km (10 m - 10 km Optional)
- Extinction Range: 100 - 0.1863 km^{-1} (300 - 0.30 km^{-1} optional)
- Accuracy: +/- 10 %
- Time Constant: User selectable from 10 sec to several minutes
- Resolution: 1 m in meter scale, 10 m in kilometer scale
- Scatter Angle: 42° nominal
- Source: 850 nm LED

Power
- 10-36 VDC, 8 VA nominal (20 VA w/Hood Heaters)

Physical
- Weight: 8 kg (18 lb) nominal
- Dimensions: 889 mm W x 292 mm H x 305 mm D (35 in x 11.5 in x 12 in)
- Mounting: Nominal 40 mm pipe 48.3 mm OD max (1-1/2 inch IPS pipe, 1.9 inch OD max) Optional 25 mm pipe, 33 mm OD max (1 inch IPS pipe, 1.3 OD max)

Environmental
- Temperature: -40º to 60º C
- Humidity: 0-100%
- Protection: IP66 (NEMA-4X)

Outputs (Available options are shown)
- RS-232 serial ASCII data — Option S
- RS-422 serial ASCII data — Option T
- RS-485 serial ASCII data — Option U
- Control Relay * — Option C
- Diagnostic Relay * — Option D
- 1 Control, 1 Diagnostic Relay * — Option F

(* Note: Relays are rated for 100VDC, 0.25A MAX)

NOTE:

For proper operation, the Sentry optics MUST be kept clean.

See Section 5.3 for cleaning instructions!

1.0 INTRODUCTION

Visibility is the term commonly used to express how far a person can see. But the question is actually quite complicated due to the complex psychological and physical nature of the measurement. As reported by the World Meteorological Organization (WMO), “any visual estimate of visibility is subjective.” Visibility, better known as meteorological optical range (MOR), is the greatest distance that a large dark object can be seen and recognized against a light sky background.

Questions often arise as to the size and color of the object or target. The object must be large (subtend an angle of >0.5 degrees). Depending on the distance from the observer, a white church steeple that is 4 feet wide and 1000 feet away is an unacceptable target since it only subtends an angle of 0.2 degrees and is the wrong color. A light pole that is only 1 foot in diameter is an even worse choice as a target! Some of the other factors that affect a humans ability to measure visibility are the ambient light level, the persons corrected vision, and the training of that person to be a qualified weather observer. Even with these factors equal between two qualified observers, they will not agree in their assessment of the visibility.

Our ability to “see” a long distance is altered by what are known as obstructions to vision. These obstructions fall into two classes, hydrometeors that are wet and lithometeors that are dry. Examples of hydrometeors include rain, snow, fog, mist, drizzle, and spray. Examples of lithometeors include salt, pollen, smoke, exhaust fumes, and dust.

As light propagates through the atmosphere it is attenuated by absorption and scattering from these “obstructions to vision”. The Beer-Lambert-Boguers law gives the relationship between light attenuation and scattering and absorption. The fraction of light lost to scattering and absorption per unit distance in a participating medium is known as the extinction coefficient, σ. The standard unit of measure of extinction coefficient is km^{-1}.

Conversion from extinction coefficient to visibility involves different algorithms, one for daytime and one for night. Daytime visibility is related to the viewing of dark objects against a light sky as previously mentioned. For measurement of visibility in the daytime, Koschmieder’s Law is used: $V = 3/\sigma$, where V is the visibility and σ is the extinction coefficient. Nighttime visibility is related to the distance at which a point source of light of known intensity can be seen. For measurement of visibility at night, Allard’s Law is used: $V = e^{-\sigma * V}/0.00336$, where V is the visibility and σ is the extinction coefficient.

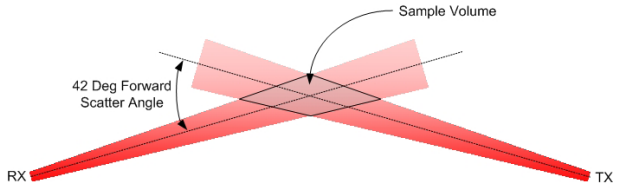
Most users will use only the Koschmieder’s ($V = 3/\sigma$) formula. The aviation community typically uses a photometer to measure the day/night condition and applies both formulas depending on the ambient background light.

Fortunately, sensors have been developed that can measure visibility. They employ one of two methods to measure atmospheric visibility, either transmissivity or scattering. Sensors that measure the transmissivity of the atmosphere (transmissometers) are research tools that are often used as standards against which other sensors are compared. They are not practical for most automated measurement systems due to their high cost to purchase, install, and maintain.

1.1 How the Sentry™ Works

The Sentry™ uses the principle of forward scattering. The optical system is designed such that the infrared light projected from the transmitter (TX) intersects the field of view of the receiver (RX) with a forward angle of 42º. The area of intersection is known as the sample volume. The 42º forward angle ensures performance over a wide range of particle sizes in the sample volume including smoke, dust, haze, fog, rain and snow.

When the air is clear, very little light is scattered since there are few particles in the sample volume resulting in a small signal received by the sensor. As the number of particles in the sample volume increases, the amount of light detected by the receiver also increases. In other words, the received signal strength is inversely proportional to the visibility.



Forward Scatter Geometry

1.2 Specifications of the Sentry™

The integrated, one-piece housing design of the Sentry™ keeps all cabling internal to the sensor for the ultimate protection against the elements. The sensor housing is made from anodized aluminum and the enclosures are rugged, UV-resistant fiberglass and environmentally rated to IP66.

The sensor uses ”look down” geometry to reduce optical window contamination and the windows have continuous duty anti-dew heaters, and optional thermostatically controlled external hood heaters are available for protection in cold & wet weather conditions. All power and signal lines to the Sentry™ are protected with surge and EMI filtering to help guarantee uninterrupted service for the life of the sensor.

1.2.1 Description of Options & Accessories

The model number of the Sentry™ is key to understanding what options are installed in each unit. The model number is found on the sensor label, (example shown below), which is located on the outside of the Main Electronics Enclosure.

The model number is composed of 2 parts. The 5 numeric characters indicate the model (example: 73000) followed by options characters which identify the specific option/s on the unit.

- “D” = 12VDC mains voltage
- “S” = serial output option

1.2.2 Serial Output & Relay Options

The 2nd option character group describes the analog output options on the Sentry™. The 3rd suffix designates an output relay, as described in the table below.

2nd Suffix	3rd Suffix	This output provides….
S		RS-232 serial ASCII data string
T		RS-422 serial ASCII data string
U		RS-485 Multi-drop, serial ASCII data string
	C	Control Relay - Control Relay Output provides user adjustable visibility threshold to activate a relay. This option allows simple control of warning lights, foghorns, and other indication devices. The SPDT relays provide normally open (NO) and normally closed (NC) contacts and are rated at 100 VDC, 0.25A.
	D	Diagnostic Relay - Diagnostic Relay Output provides remote indication of sensor status. The relay is continuously activated and will deactivate if a complete power failure occurs or when any of 4 diagnostic tests fail. It checks +5 VDC, +12 VDC, -12 VDC, and transmitter sync for proper operation. The SPDT relays provide normally open (NO) and normally closed (NC) contacts and are rated at 100 VDC, 0.25A.
	F	1 Control Relay, 1 Diagnostic Relay

1.2.3 Hood Heaters

Model 73004 features silicone resistance heaters installed under each black metal hood that covers the transmitter and receiver heads. The heaters prevent blowing snow from clogging the sensor’s optical path, they are thermostatically controlled to automatically turn on at ~3º C and off at ~8º C. Each hood heater consumes 6 W of power from the 12 VDC input power.

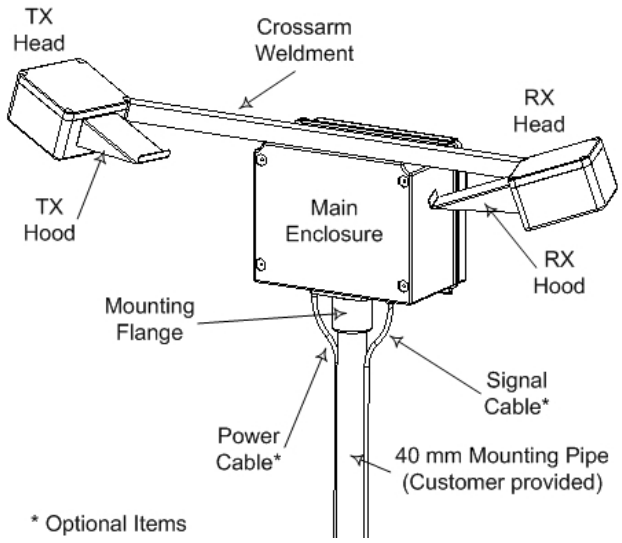
1.2.4 Accessories

Accessories are available for the Sentry™ as described below.

Part Number	Accessory Name	Description
73062	Calibration Fixture	***Required*** for installation and maintenance of the sensor. Provides a traceable calibration of the sensor by scattering a known amount of light from the transmitter to the receiver. One Calibration Fixture can be used on several Sentry™ Visibility Sensors. (See Section 4.0)
73038	Hood Extension Set	The units slip over the existing sensor hoods to provide additional protection from heavily contaminated air found at some sites. Includes a set of 2 hood extensions that are easily installed and removable for sensor calibration with a screwdriver.
74050	Mounting Bracket	Used to mount the Sentry Visibility Sensor with standard 1-1/2" mounting flange. It is designed to provide a durable, vibration-free installation of the Sentry and can be installed against a flat wall, traffic & light poles, or typical ROHN-type tower leg. (See Section 2.2)
74058	Serial RS-232 Test Cable	Recommended serial cable to connect from RJ11 jack on Microprocessor PCB to DB9 connector on user Laptop PC. Used for sensor set-up and calibration using the local port. Four (4) meter (13 feet) long.
74057	Serial RS-232 Output Cable	Optional twisted shielded pair cable, 22 AWG PVC jacket where "xx" is the length in meters. Max 30 m (100 ft). Complete with DB9 Connector on one end.
74055	DC Power Cable	Optional 2-conductor twisted shielded, 16 AWG, PVC jacket. Max 15 m (50 ft) recommended.

1.3 Sensor Description

The Sentry™ is a compact sensor consisting of three (3) major components mounted to a cross arm.

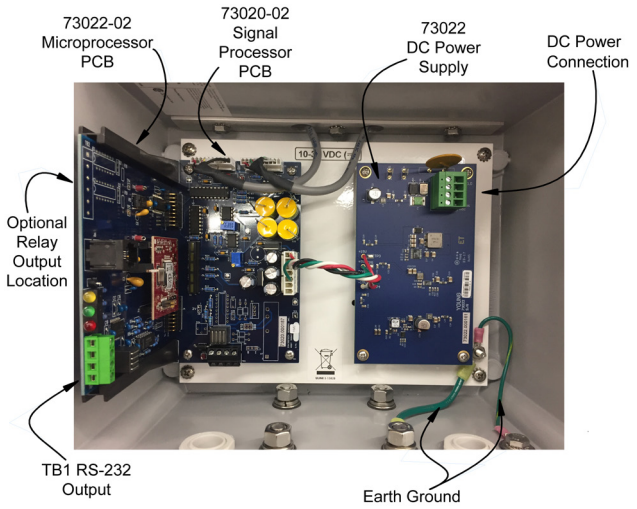


A description of the major components is provided below:

Component	Description and Function
TX Head	Externally, the TX Head consists of a weatherproof enclosure to house the electrical and optical assemblies and a hood to protect the optics from direct sunlight and precipitation. If the hood heater is ordered, the hood will have a silicone heater adhered to the underside to help prevent snow from blocking the optics. Inside the TX enclosure are a Transmitter PCB, high power LED, optical lens with heater, and mounting brackets. There are no user serviceable parts in the TX Head. ***WARNING: Opening the TX Head will void the warranty of the sensor.***
RX Head	Externally, the RX Head consists of a weatherproof enclosure to house the electrical and optical assemblies and a hood to protect the optics from direct sunlight and precipitation. If the hood heater is ordered, the hood will have a silicone heater adhered to the underside to help prevent snow from blocking the optics. Inside the RX enclosure are a Receiver PCB, PIN photodiode, optical lens with heater, and mounting brackets. There are no user serviceable parts in the RX Head. ***WARNING: Opening the RX Head will void the warranty of the sensor.***
Main Electronics Enclosure	Externally, the Main Enclosure consists of a weatherproof enclosure with hinged door for easy access. A mounting flange is attached to the bottom of the Enclosure for attachment to a support pole of 40 mm dia (1-½" Schedule 40) pipe. A mounting plate is attached to the backside of the Enclosure for use in calibrating the sensor (See section 4.0). The internal components are discussed in the next section.

Main Enclosure Part Numbers

Main Enclosure Components	Description and Function
DC Power Supply 73022	The DC/DC Converter Module provides +5, +15, and –15 VDC power to the sensor electronics. Also provides DC surge protection, EMI filtering, and short circuit protection via resettable fuses. The user makes DC power connections directly to this PCB using the built-in terminal board, TB1. The user connects a regulated DC voltage between 10-36 VDC capable of supplying 1A.
Signal Processor PCB 73020-02	This PCB provides signal and DC power distribution to all sensor components. The received signal from the RX PCB is demodulated using the synchronization pulses from the TX PCB. After demodulation, the signal is filtered through a low pass filter, amplified, and scaled to the appropriate level. The Signal processor also contains test points and an array of LEDs (D1) that indicate sensor status. In normal operation, the lower 3 of the LEDs are on continuously, one is off, and the upper most LED is blinking approximately once every 2 seconds. Additional information on the diagnostics and test points is contained in Section 5, Maintenance.
Microprocessor PCB 74022-02 Control relay 74022C Diag. relay 74022D Control & Diag. Relay 74022F	This PCB plugs into the Signal Processor PCB as a daughter board allowing it to receive power supply voltages and signals through edge connectors. The PCB contains a multi-channel A/D converter, microprocessor module, RS-232 drivers, and ancillary components. The Microprocessor PCB also contains an RJ11 connector for local RS-232 connections, LED indicators for board status, and test points. Circuitry for control & diagnostic relays, Day/ Night Photometer, and D/A converter for analog output are optionally available.
Converter Module RS-422 / RS-485 74022-04	If ordered, the sensor is supplied with a 485LDRC9 Din Rail mounted data converter. The 485LDRC9 optical isolated unit provides 2KV isolation, additional input power filtering and transient voltage suppressors on data lines. The converter automatically takes the Sentry RS-232 data output and formats it to RS-422 data for point to point transmission, or RS-485 data for long distance multi-point transmission. (Up to 4,000 feet data transmission for either method)

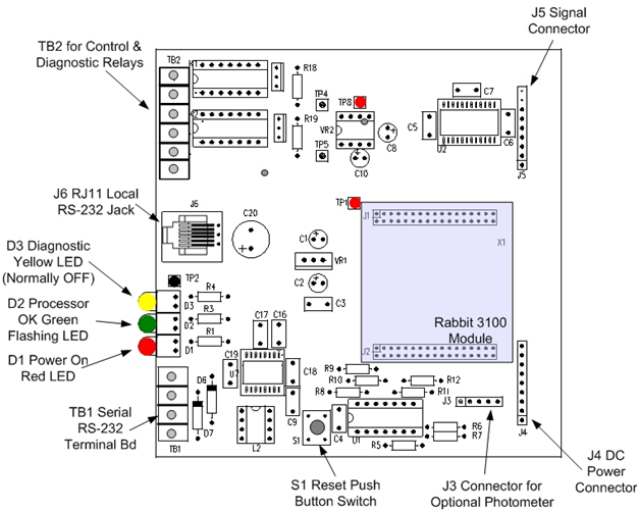


Main Enclosure Components

1.4 Microprocessor Description

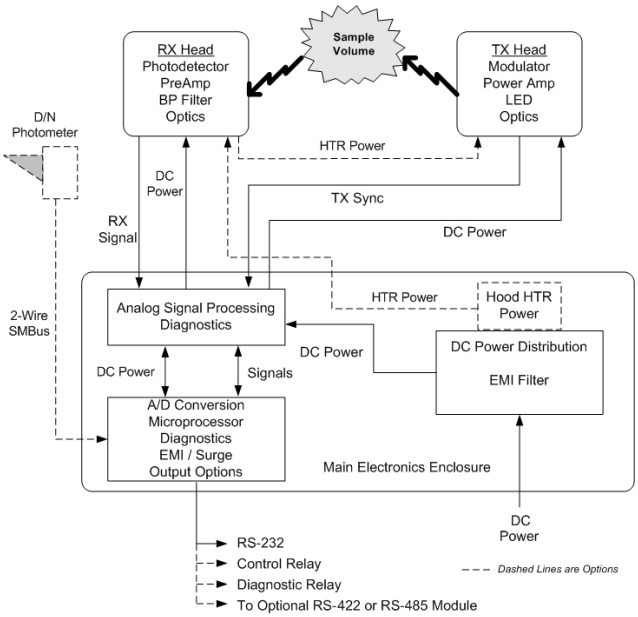
The Microprocessor PCB is a custom designed board that uses the RabbitCore microprocessor core as the embedded processor. Powered by the new Rabbit 3000™ microprocessor, the compact RCM3100 boasts powerful features including 2 serial ports, 256K of Flash and 128K of SRAM, and operates at 29.4 MHz and 3.3 V (with 5 V-tolerant I/O). Built-in low-EMI features, including a clock spectrum spreader, help eliminate emissions-related problems. The Rabbit 3000 processor's compact, C-friendly instruction set and high clock speeds produce fast results for math, logic, and I/O.

The Rabbit Module operates as a daughter board to the main Microprocessor PCB with all signal, data, and power connections made through J1 and J2. The main Microprocessor contains all of the ancillary components including multi-channel A/D Converter, 2-channel RS-232 line Driver/Receiver, local & remote reset circuitry, and diagnostic circuits. The optional Photometer operates over a 2-wire SMBus and connects to J3. Optional circuitry is available for control & diagnostic relays.



1.5 Signal Flow

Sentry™ is an electro-optic instrument based on the proven forward scatter measurement technique. The signal flow diagram below illustrates the sensor functionality.



The TX Head consists of both electrical and optical subassemblies. The TX PCB contains a frequency source, modulator, power amplifier, phase shifter, temperature compensator, and high power LED. The IR light from an LED is beam formed by an optical lens and projected into the sample volume where it encounters airborne particulate matter. A synchronization pulse is sent from the TX PCB to the Signal Processor PCB to synchronize the demodulation of the received signal. The power and signal cable from the TX Head terminates at J3 on the Signal Processor PCB in the Main Electronics Enclosure.

Light is scattered from the particulate matter in the sample volume in a forward direction and detected by the RX Head. A lens focuses the received IR light onto a sensitive photo detector. The RX PCB provides amplification and bandpass filtering of the received signal before being sent to the Signal Processor PCB. The power and signal cable from the RX Head terminates at J2 on the Signal Processor PCB in the Main Electronics Enclosure.

A Microprocessor PCB converts the sensor output voltage to a digital signal that is then processed and converted to a serial ASCII data string over an RS-232 interface. This PCB also runs the calibration routine that simplifies sensor calibration by storing all calibration constants in memory thereby eliminating the adjustment of potentiometers in the field. The MPU also provides optional outputs for control & diagnostic relays and linear analog output.

The optional D/N Photometer receives power and data interface with the Microprocessor through a connector, installed on the bottom of the Main Electronics Enclosure.

2.0 INSTALLATION

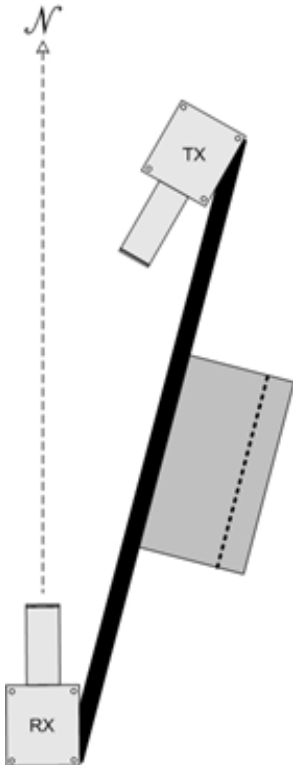
2.1 Site Preparation

Site selection and preparation are critical for the successful performance of the Sentry™ Visibility Sensor. If you do not choose a good location for the sensor or fail to install it correctly, it will not measure data that is representative of the visibility in the area. We will be glad to help you with your installation. *Call or email any questions & send pictures of proposed locations to discuss your particular application!*

2.1.1 Siting Guidelines

General guidelines for all users:

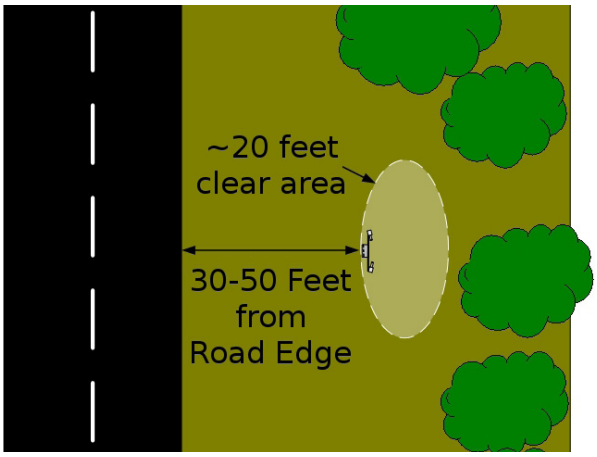
- Use sturdy pole or pedestal to reduce vibration.
- Locate the sensor in an area that is representative of the area to be monitored.
- Do not locate the sensor near strobe lights and other modulated light sources.
- Do not locate the sensor in an area that is subject to localized sources of smoke, fog, or mist (air handling exhausts, smoke stacks, etc) unless you are trying to measure the reduction in visibility from these sources.
- The area within 5-6 meters (16-20 feet) of the sensor should be free of all vegetation over 25 cm (10 inch) tall and well drained.
- Avoid any vertical objects such as hills, walls, or plants within this area.
- If in path of the TX beam, light may be reflected back into the receiver giving false readings.
- If in path of RX beam, stray sunlight may be reflected back into the receiver giving false readings
- Mount the sensor so the optics are at least 2.5-3 meters (8-10 feet) above ground or 2.5 meters (8 feet) above the average maximum snow depth, whichever is higher.
- In general, orient the sensor receiver optics so they face within 30° of North in the Northern hemisphere or South in the Southern hemisphere to eliminate direct sunlight contamination. In the southern Hemisphere, rotate the sensor 180°. Note the orientation is not critical; it may be adjusted to fit the needs of the installation.



Sensor Orientation

For installations in road weather information systems (RWIS), special conditions may apply:

- Do not locate the sensor on the top of a hill or bottom of a basin unless you wish to measure the visibility in that limited area as may be required for road weather applications.
- Do not locate the sensor too near a roadway to avoid the wet, dirty plumes from passing vehicles that may contaminate the sensor optics.
- If the installation must be near the edge of the road it may be best to orient the sensor parallel to the road with the Main Electronics Enclosure facing the roadway as shown in illustration.
- The Federal Highway Administration (FHWA) has established standards for RWIS systems siting. Contact FHWA and request Publication No. FHWA-HOP-05-206 or visit http://ops.fhwa.dot.gov/publications/ess05/index.htm.
- The World Meteorological Organization (WMO) has published Report No. 61 - Road Meteorological Observations that also recommends sensor siting. Contact the WMO and request TD 842 (IOM 61) or http://www.wmo.int/pages/prog/www/IMOP/publications-IOM-series.html.



Installations in rail or road tunnels, the Tunnel Guidelines document may be requested by sending an E-Mail to: met.sales@youngusa.com It contains information on visibility sensor siting recommendations within the tunnel, specifics about installing the Sentry™, and guidance information about how several agencies around the world are using the data from tunnel mounted visibility sensors.

Installations on offshore platforms, the EEx Sentry Siting document may be requested by sending an E-Mail to: met.sales@youngusa.com. It contains specific information for siting & installing the Sentry™ on offshore platforms to ensure proper operation in that critical environment.

For installations at airports the user is encouraged to contact one of the regulating agencies to ensure compliance with aviation requirements:

- U.S.A. – Office of the Federal Coordinator for Meteorology at 301.427.2002 (Silver Spring, Maryland) for a copy of "Federal Standard for Siting Meteorological Sensors at Airports, OFCM, FCM-S4-1994" and other related documents. or visit http://www.ofcm.gov/siting/text/a-cover.htm.
- International – International Civil Aviation Organization at 514.954.8022 (Montreal, Quebec Canada) for a copy of "Manual of Aeronautical Meteorological Practice" and other related documents. Or visit http://www.icao.int/icao/en/sales.htm.

2.1.2 Site Preperation

The selected site must be prepared in accordance with local construction codes and therefore the information provided in this section is for guidance. The Sentry™ is typically installed in one of two ways; attached to an existing structure such has a meteorological tower or as a stand-alone installation. In either case, provisions must be made for physically supporting the structure, earth grounding, power, and signal wiring.

- Earth Grounding – The Sentry™ must be grounded to an approved earth terminal for electrical safety and for the built-in lightning protection circuitry to work properly. Additional information on earth grounding is found in Section 2.4.2.
- Power – The Sentry™ requires a source of 12 VDC at 1 A current. Consideration should be made to add power and signal junction boxes near the sensor during the construction phase.
- Signal Wiring – The rule of thumb is that the shorter the signal wire, the better. R.M. Young Company recommends that signal wires be <15 m (<50 ft) and 22 AWG (0.326 mm2) or larger wire gauge. Exceptions to this rule are made for the optional 4-20 ma current loop output option and the control relay option where the cable may be much longer.
- Support Structure - If the sensor is to be installed as a stand-alone instrument, prepare a concrete footer as shown in Figure 2.1.2-1. It is recommended that depth of the concrete footer is below the frost line to avoid heaving. When preparing for the concrete footer also plan for earth grounding, power wiring, and signal wiring

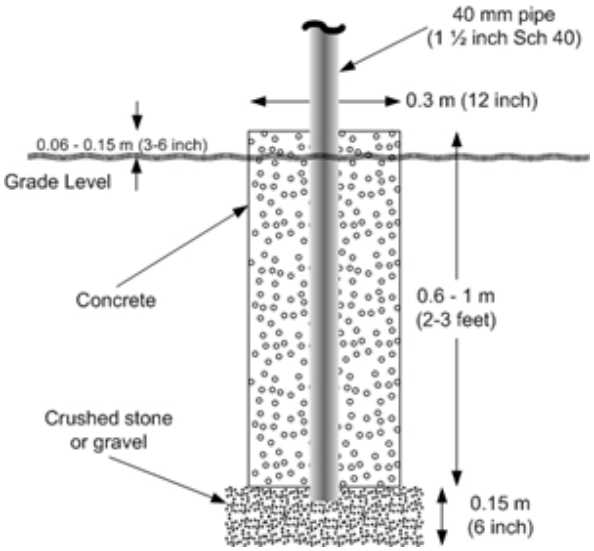


Figure 2.1.2-1 Site Preparation – Concrete Footer

- The Sentry™ may also be installed on an existing structure such as a traffic pole or triangular tower using the optional 74050 Mounting Bracket. A customer provided boom arm structure may also be assembled from 1 ½ inch schedule 40 pipe & fittings as shown in Figure 2.1.2-2. The boom arm structure should be attached to the side of the triangulate tower with U-bolts or similar hardware. When selecting which side of the tower to use, make certain that the sensor sample volume is facing away from the tower and not over the boom arm while still aligning the receiver optics facing in a northerly direction or parallel with the roadway.

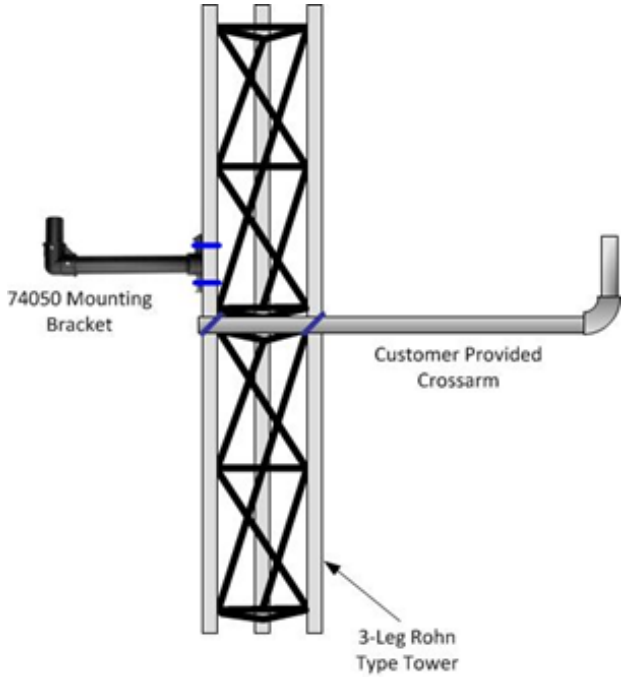
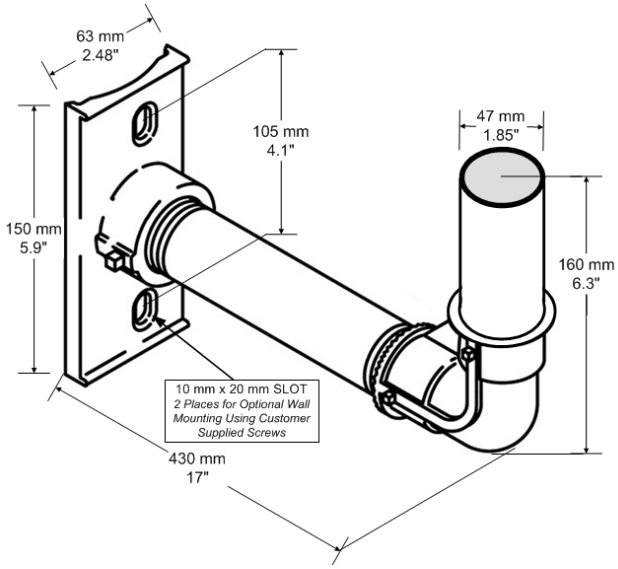


Figure 2.1.2-2 Site Preparation – Mounting Brackets



74050 Optional Mounting Bracket

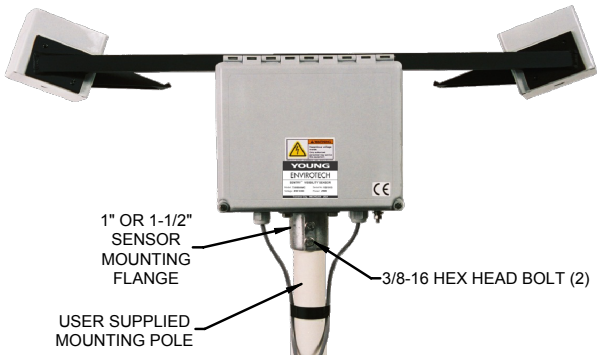
2.2 Mechanical Installation

Once the site preparation is complete, physically installing the Sentry™ is simple. Follow these steps to complete the mechanical installation as shown below.

When unpacking the sensor, carefully remove the packing material and lift the sensor out of the shipping carton. If the sensor must be laid down, lay it flat with the front door of the Main Electronics Enclosure down to avoid any damage to the sensor heads or hoods.

Equipment required for installation:

- 9/16” wrench, 9/16” nut driver, or adjustable wrench



Mechanical Installation

1. Remove the sensor from the shipping carton and inspect for obvious damage.
2. Lift the sensor over the mounting pole and carefully lower it to engage the flange.
3. Rotate the sensor per the instructions in Secttion 2.1.1.
4. Tighten the two (2) 3/8-16 hex head bolts in the flange to secure the sensor to the pole.
5. Go to Section 2.3 to connect the signal wiring.

2.3 Signal Wiring

The signal wiring depends on the output options that are supplied with the sensor. Refer to the model number label on the outside of the Main Electronics Enclosure. The suffixes after the five numerical digits indicate the installed options as follows:

Suffix	Output	See section
S	RS-232	2.3.1 / 2.3.2
T	RS-422	2.3.3
U	RS-485	2.3.4
C	Control Relay	2.3.5
D	Diagnostic Relay	2.3.5
F	1 Control, 1 Diagnostic Relay	2.3.5

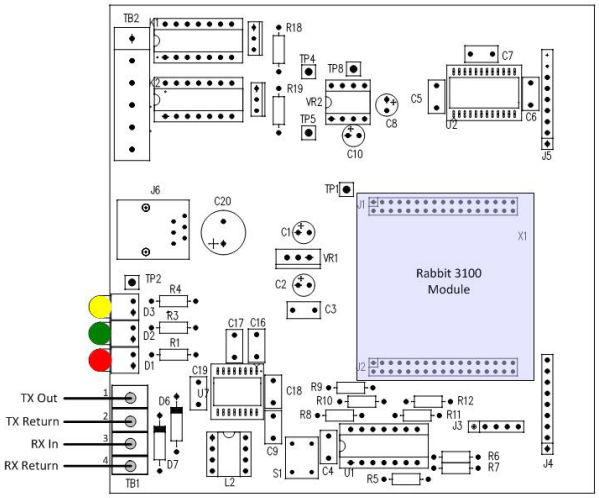
There will be a piece of foam to hold the Microprocessor PCB secure during shipment – discard it.

2.3.1 Primary RS-232 Serial Connection

1. Loosen the cord grip on the lower left bottom of the Main Electronics Enclosure.
2. Feed a 2 twisted, shielded pair cable into the enclosure through the cord grip. 22 AWG (0.326 mm2) or larger wire is recommended. The maximum cable run should be <15 m (50 ft).
3. Strip ~6 mm (1/4") of insulation from each of the four conductors and connect them to the Microprocessor PCB TB1 as shown in Table 2.3.1-1and Figure 2.3.2-1 below. Wire a DB9 or DB25 connector to the other end of the cable for connection to the user computer equipment.

TB1 Terminal	Function	Typical DB9 Pin #	Typical DB25 Pin #
1	Transmit Out (TX+)	2	3
2	Transmit Return (TX-)	5	7
3	Receive In (RX+)	3	2
4	Receive Return (RX-)	5	7

4. Tighten the cord grip to secure the signal cable.
5. Connect the other end of the cable to the user's data acquisition equipment per the manufacturers instructions. Connect the cable shield to either signal ground or earth ground at the data acquisition system as required.
6. Go to Section 2.4 for electrical power wiring instructions.



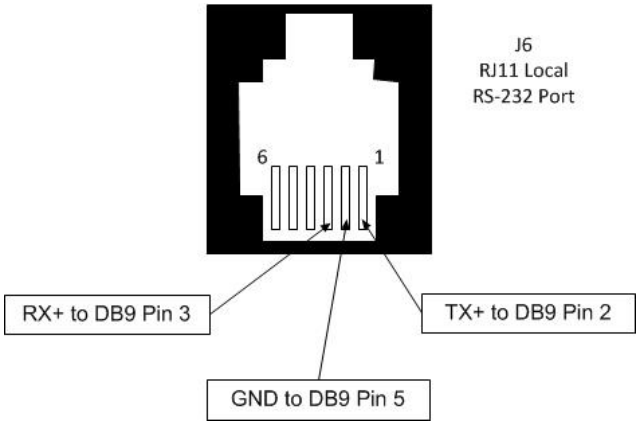
2.3.2 Local RS-232 Serial Connection

The optional 74058 Serial Test Cable is recommended for short term testing, set-up, and calibration of the Sentry™ sensor. It allows the user to connect their laptop PC to the RJ11 connector (J6) on the Microprocessor PCB. The user may also make a cable by following the wiring information:

--- Note ---

The local serial port does not have EMI or surge protection so it should not be used for permanent serial connections. Use TB1 for permanent connections!

RJ11 Terminal	Function	Typical DB9 Pin #	Typical DB25 Pin #
1	Transmit Out (TX+)	2	3
2 / 4	Transmit Return (TX-)	5	7
3	Receive In (RX+)	3	2

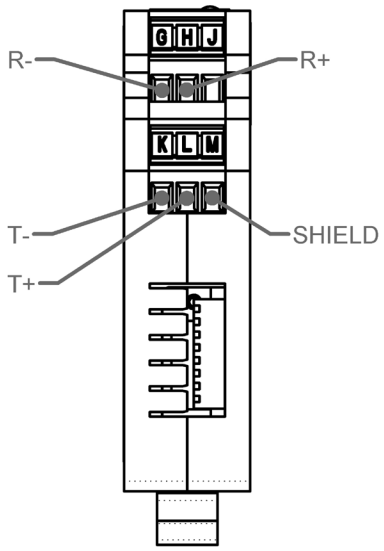


J6 RJ11 Wiring (Front View)

2.3.3 RS-422 Serial Output Connection

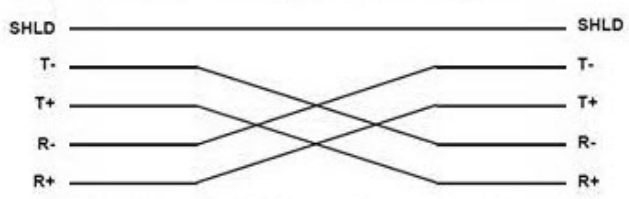
1. Loosen the cord grip on the lower left bottom of the Main Electronics Enclosure.
2. Feed a 2 twisted, shielded pair cable into the enclosure through the cord grip. 22 AWG (0.326 mm2) or larger wire is recommended. The cable run can be as long as ~1200 m (4000 ft.)
3. Strip ~6 mm (1/4") of insulation from each of the conductors and connect them to the terminals of the RS-422 Module using the information shown below.

485LDRC9 Converter Terminal	From User RS-422 Device	Wire Color (Record here)
G	R- Signal	
H	R+ Signal	
J	n/c	
K	T- Signal	
L	T+ Signal	
M	Shield	



RS-422 Connections
View of Bottom of Converter

Full-Duplex Wiring Method

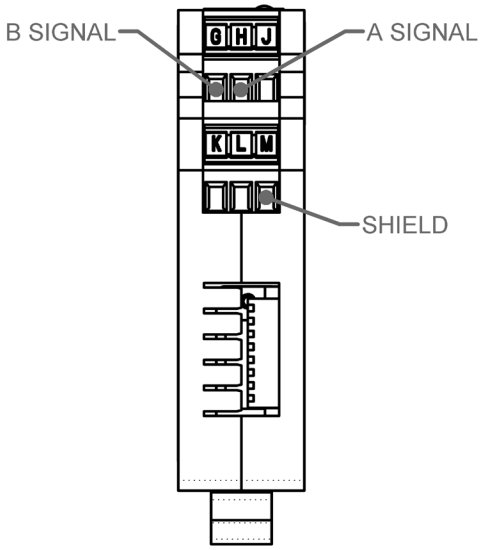


Note that the RS-422 transmit & receive wiring are

2.3.4 RS-485 Serial Output Connection

1. Loosen the cord grip on the lower left bottom of the Main Electronics Enclosure.
2. Feed a 2 twisted, shielded pair cable into the enclosure through the cord grip. 22 AWG (0.326 mm2) or larger wire is recommended. The cable run can be as long as ~1200 m (4000 ft.)
3. Strip ~6 mm (1/4") of insulation from each of the conductors and connect them to the terminals of the RS-485 Module using the information shown below.

485LDRC9 Converter Terminal	RS-485 Function	Wire Color (Record here)
G	B Signal	
H	A Signal	
J	n/c	
K	n/c	
L	n/c	
M	Shield	



RS-485 Connections
View of Bottom of Converter

--- Note ---

The Converter is configured as non-terminated at the factory.

2.3.5 Control & Diagnostic Relay Output Connection

The Sentry™ Control & Diagnostic relay option is part of an auxiliary PCB that plugs into the Signal Processor PCB in the Main Electronics Enclosure. User connections are made to TB2 of the respective relay board.

1. Loosen the cord grip on the lower left bottom of the Main Electronics Enclosure.
2. Feed a twisted, shielded pair cable into the enclosure through the cord grip. 22 AWG (0.362 mm^2) or larger wire is recommended. The cable run should be as short as possible (<15m).
3. Strip ~6 mm (1/4") of insulation from each of the conductors and connect them to TB2 using the information provided below for each specific board.
4. Tighten the cord grip to secure the signal cable.
5. Connect the other end of the cable to the users data acquisition equipment per the manufacturers instructions. To reduce noise on the cable, connect the cable shield to either signal ground or earth ground at the data acquisition system.
6. Go to Section 2.4 for electrical power wiring instructions.

74022C Control Microprocessor PCB

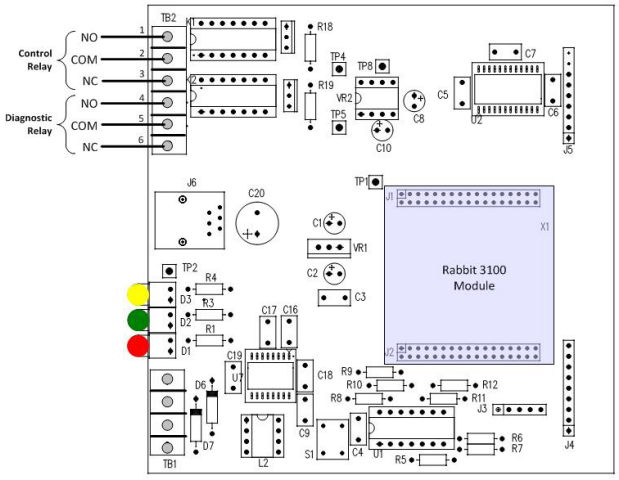
Control relay option (Sensor 73000D-x-C), connect them to TB2 as shown below.

TB2 Terminal	Function
1	Normally Open (NO)
2	Common
3	Normally Closed (NC)

74022D Diagnostic Microprocessor PCB

Diagnostic relay option (Sensor 73000D-x-D), connect them to TB2 as shown below.

TB2 Terminal	Function
4	Normally Open (NO)
5	Common
6	Normally Closed (NC)



Control & Diagnostic Relay Output Signal Connections

2.4 Electrical Power Installation

Read the information in Section 2 of this User's Guide completely before proceeding. Remember that local electrical codes supersede the recommendations provided herein. If you have a question, call R.M. Young Company at 231-946-3980.

Proper voltage for the Sentry™ is 10-36 VDC.

For protection from lightning and other electrical surges, the sensor should be grounded to a rod driven into the ground adjacent to the sensor per Section 2.4.2.

Equipment required:

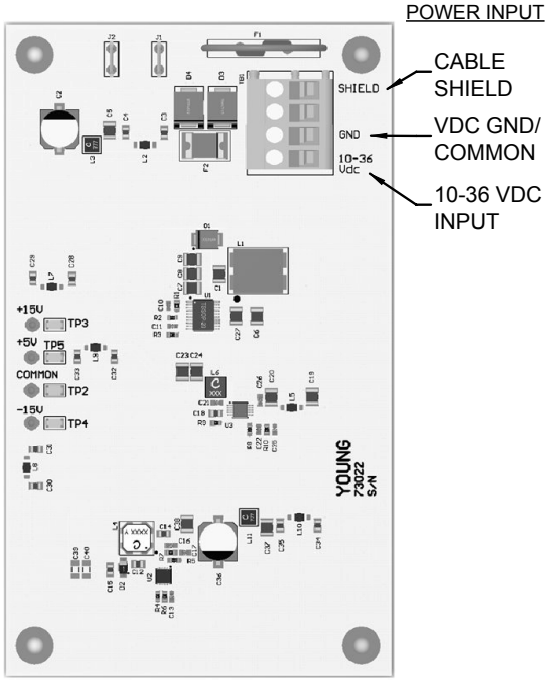
- ¼ inch straight blade screwdriver
- Small screwdriver
- Wire cutters
- Wire strippers
- Adjustable wrench
- 7/16 inch wrench, nut driver, or adjustable wrench

2.4.1 DC Power Connection

1. A regulated DC power supply with a rating of 1 Amp minimum is recommended to power the Sentry™.
2. Loosen the cord grip on the lower right bottom of the Main Electronics Enclosure.
3. Feed a 2 - conductor power cable into the enclosure through the cord grip. 18 AWG (0.823 mm^2) or larger wire is recommended.
4. Strip ~6 mm (1/4") of insulation from each of the conductors and connect them to TB1 of the 73022 DC Power PCB Assy as described in this table.

TB1	DC Power Version	User Wire Color
1	+10-36 VDC	
2	VDC Common	
3	(No Connection)	
4	Shield	

5. Tighten the cord grip to secure the power cord.
6. Go to Section 2.4.2 for earth grounding the Sentry™.

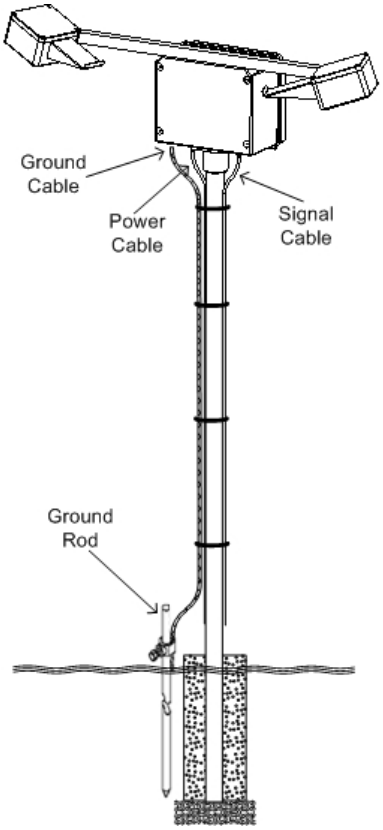


DC Power Wiring

2.4.2 Earth Grounding Connections

Earth grounding is required to ensure that the surge protection devices in the sensor work properly. In addition, it also provides a safety ground that may be required by local electrical codes. A ¼-20 threaded stud is provided on the bottom of the Sentry™ Main Electronics Enclosure for this purpose.

1. Drive an 8-10 foot long copper clad ground rod into the earth, adjacent to the sensor support structure.
2. Obtain a large gauge copper wire (#4 AWG (21 mm^2) typical) and connect it to the ¼-20 ground stud on the bottom of the Sentry™ enclosure to the ground rod using the shortest length of wire necessary. Do not over tighten the ¼-20 nut.



Earth Grounding

3.0 Setup and Operation

The Sentry™ comes standard with a 4-wire RS-232 serial interface. It is always available to the user via the RJ11 Telco Jack on the MPU PCB, even if the sensor is supplied with an RS-422 or RS-485 interface. The user should establish communications from the Sentry™ to a laptop or other computer using HyperTerminal or similar terminal emulator program. A 74058 Serial Cable is available.

Initially, the serial port on the user's computer should be configured as follows:

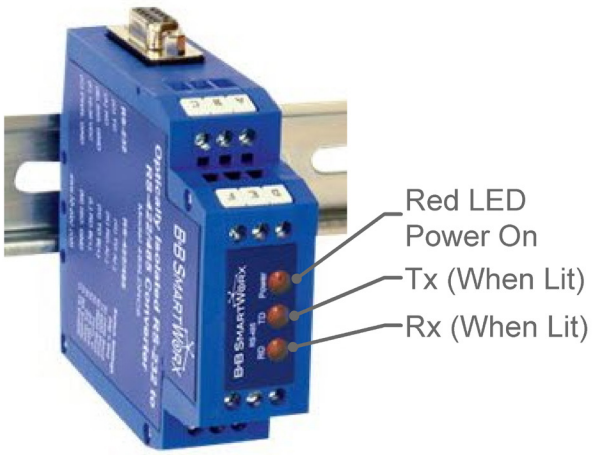
- 19,200 bps
- 1 start bit
- 8 data bits
- no parity
- 1 stop bit
- no flow control

Once communications are established, the user can change baud rate and other operating parameters using the VS command described in Section 3.3.6.

For sensor checkout & calibration, the RS-232 connection should be made at the secondary port RJ11 telco jack on the Microprocessor PCB. The RJ11 connector is meant as a local port for the convenience of the user and does not contain EMI or surge protection. The RJ11 secondary (local) port is always configured for 19200 baud. DO NOT use the RJ11 jack for connecting the Sentry™ to the user computer for normal operation.

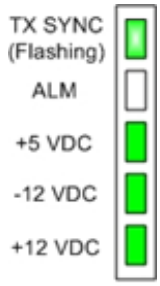
If the Sentry™ was ordered with RS-422 or RS-485, an additional module will be installed on a Din Rail between the Signal Processor PCB and DC Power Supply. It is factory wired to the primary RS-232 port of the Microprocessor PCB for signal and to the DC Power Supply PCB for power. It is configured at the factory for proper RS-422 or RS-485 output.

Upon power-up, the following indicators should be present.

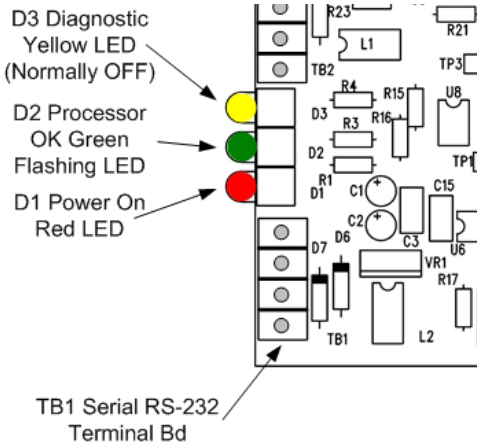


- Red Power LED on. The Tx & Rx LED's only illuminate briefly when data is communicated over the interface.

- Observe the LED array on the 73020-02 Signal Processor PCB. It should be illuminated as shown.



- Observe 3 LEDs on top edge of Microprocessor PCB. The red LED should be ON indicating 3.3 VDC power, the green LED should be flashing indicating microprocessor functionality, and the yellow LED should be OFF indicating that there are no diagnostic faults.



3.1 Poll Commands – RS-232 & RS-422

The Sentry™ responds to a variety of commands, followed by a <CR>.

Poll	Description
V1	Provides extinction coefficient (EXCO)
V2	Provides visibility in user selected units of measure
V3	Provides EXCO, visibility, photometer reading
VC	Runs calibration routine
VR	Resets microprocessor
VS	Runs set-up routine
VER	Displays software revision & date
SHOW CALPARAMS	Displays the current calibration parameters

Note that the poll commands are case insensitive so either “v1” or “V1” may be used. The sensor responds with a comma-delimited ASCII data string that may be easily parsed with either a spreadsheet program or other user provided software package.

3.2 Poll Commands – RS-485

For RS-485 multi-point operation, the sensor poll command must be prefixed with an address assigned to the sensor. The default address of the Sentry™ is “140”. The user can change the address as shown in Section 3.3.6.9. The Sentry™ responds to a limited number of commands when in the RS-485 configuration, followed by a <CR>.

Poll	Description
14xV1	Provides extinction coefficient (EXCO)
14xV2	Provides visibility in user selected units of measure
14xV3	Provides EXCO, visibility, photometer reading

Note that the poll commands are case insensitive so either “14v1” or “14V1” may be used. The sensor responds with a comma-delimited ASCII data string that may be easily parsed with either a spreadsheet program or other user provided software package. When using the RS-485 interface, only these 3 commands function over the primary port. To access the other commands as shown in the table of Section 3.1, use the local port using the RJ11 Telco Jack.

3.3 Poll Response Details

3.3.1 V1 Poll

Sensor Response:

51.65,D,P0000,00 (RS-232 & RS-422)
140,51.65,D,P0000,00 (RS-485)

where:

- 140 is the sensor address (RS-485 only)
- 51.65 is the extinction coefficient in units of /km
- D is the day/night status if the photometer is installed (default is D if no photometer)
- P0000 is the pass/fail status
- 00 is the status of the optional relay control:
  - 00 - both relays are not energized
  - 01 - only diagnostic relay is energized
  - 10 - only control relay is energized
  - 11 - both relays are energized

3.3.2 V2 Poll

Sensor Response:

0.058,D,P0000,00 00 (RS-232 & RS-422)
140,0.058,D,P0000,00 (RS-485)

where:

- 140 is the sensor address (RS-485 only)
- 0.058 is the visibility in units of km (user selectable)
- D is the day/night status if the photometer is installed (default is D if no photometer)
- P0000 is the pass/fail status
- 00 is the status of the optional relay control lines:
  - 00 - both relays are not energized
  - 01 - only diagnostic relay is energized
  - 10 - only control relay is energized
  - 11 - both relays are energized

3.3.3 V3 Poll

Sensor Response:

51.65,0.058,24.442,D,P0000,00 (RS-232 & RS-422)
140,51.65,0.058,24.442,D,P0000,00 (RS-485)

where:

- 140 is the sensor address (only for RS-485 configuration)
- 51.65 is the extinction coefficient in units of /km
- 0.058 is the visibility in units of km (user selectable)
- 24.442 is the photometer light reading in units of LUX
- D is the day/night status if the photometer is installed (default is D if no photometer))
- P0000 is the pass/fail status
- .00 is the status of the optional relay control lines:
  - 00 - both relays are not energized
  - 01 - only diagnostic relay is energized
  - 10 - only control relay is energized
  - 11 - both relays are energized

3.3.4 VC Command

Sensor Response:
Ready to Calibrate?

Y - continue
R - reset parameters to default and reboot system
N - return to normal operation
Enter Choice (N):Y

Note – Additional information on the automatic calibration routine is included in Section 4.1.

3.3.5 VR Command

Sensor Response:

Reset System ?
0)NO
1)YES
Enter Choice: 1
EnviroTech Inc. Sentry Visibility Sensor
13/07/2011 ver 2.93 build 5
(Note –your software version and revision date may be different!)

Note - To cancel the reset, press “0” rather than “1”.

3.3.6 VS Command

Sensor Response:

Current Sensor Config:

1) Continuous Data is ENABLED with 10 secs update
2) Averaging Time = None
3) Visibility Unit = Km
4) Photo Meter is DISABLED
5) Control Relay Low Threshold = 1.00 Km
6) Control Relay High Threshold = 2.00 Km
7) Control Relay Persistent Time = 0 Minute(s)
8) Primary Port Baud Rate = 19200
9) Primary Port RS485 Address = 0
Note – Item 9 is only displayed if the sensor is configured for RS-485

To Change Sensor Config:

0) No Change
1) Disable Continuous Data Output
2) Set Averaging Time
3) Set Visibility Unit
4) Enable Photo Meter
5) Set Control Relay Low Threshold
6) Set Control Relay High Threshold
7) Set Control Relay Persistent Time
8) Set Primary Port Baud Rate
9) Set Primary Port RS485 Address
Enter Choice:
Note – Item 9 is only displayed if the sensor is configured for RS-485

3.3.6.1 Continuous Data Output

This is a toggle command that is changed ON or OFF by entering a “1”. When the Continuous data is ENABLED as in this example, entering a “1” results in the following:

Enter Choice: 1
Send Continuous Data is DISABLED

If the continuous data is DISABLED and you want to ENABLE it, enter a “1”. Then select 10 second, 30 second or 1 minute output rates as shown below. Entering a “2” results in the following:

Enter Choice: 1
Set Continuous Data Time

0) 10 seconds
1) 30 seconds
2) 1 minute

Enter Choice: 2

Send Continuous Data is ENABLED with 1 minute update

Do not use the continuous data output mode when the sensor is configured with RS-485!

3.3.6.2 Averaging Time

Any one of five averaging periods may be chosen with this command. When a “2” is entered to change the averaging, the following is output. Entering a “3” will then set the averaging to 2-minutes as shown.

Enter Choice: 2

Set Averaging Time Constant

1) 30 seconds
2) 1 minute
3) 2 minutes
4) 5 minutes

Enter Choice: 3

New averaging time constant = 2 minute
Note – Most applications should use 1 or 2 minute averaging.

3.3.6.3 Visibility Unit

Any one of five visibility units of measure may be chosen with this command. When a “3” is entered to change the units of measure, the following is output. Entering a “0” will set the units of measure to meters as shown.

Enter Choice: 3
Set Visibility Unit

0) Meters
1) Kilometers
2) Nautical Miles
3) Statue Miles
4) Feet

Enter Choice: 0

New Visibility Unit = Meters

3.3.6.4 Photo Meter

This is a toggle command that is changed ON or OFF by entering a “1”. When the Photo Meter is DISABLED as in this example, entering a “4” results in the following:

Enter Choice: 4
Photo Meter is ENABLED

3.3.6.5 Set Control Relay Low Threshold

If the Sentry is supplied with the control relay option, the threshold at which the relay activates when the visibility decreases may be set with this command. The default visibility is 1 km. When a “5” is entered to change the low threshold, the following is output.

Enter choice: 5
Current Ctrl Relay Energize Low Threshold is 1.00 Km
Set New Low Threshold [Km] = .5
New Ctrl Relay Energize Low Threshold is 0.50 Km

Note that if the sensor is configured using the VS command to read in units of measure other than Km, the control relay thresholds will be displayed in those same units.

3.3.6.6 Set Control Relay High Threshold

If the Sentry is supplied with the control relay option, the threshold at which the relay deactivates when the visibility increases may be set with this command. The default visibility is 2 km. The deactivate point (high threshold) should always be higher than the activate point (low threshold) to prevent the relay from turning on/off when the visibility is fluctuating around the threshold.

When a “6” is entered to change the high threshold, the following is output.

```
Enter Choice: 6
Current Ctrl Relay DeEnergize High Threshold is 2.00 Km
Set New High Threshold [Km] = 2.5
New Ctrl Relay DeEnergize High Threshold is 2.50 Km
```

3.3.6.7 Set Control Relay Persistent Time

If the Sentry is supplied with the control relay option, the time delay (persistence) before the relay is activated and deactivated may be set with this command. The default persistence is 0 minutes. The persistence may be set from 0 to 60 minutes and this controls both the delay to turn on the relay and the delay to turn off the relay. Users who control fog horns, warning lights or similar devices will find this option useful to prevent inadvertent control relay activations from a single minute of low visibility that might be caused by a swarm of insects, blowing leaves, etc.

When a “7” is entered to change the persistence, the following is output:

```
Enter Choice: 7
Current Ctrl Relay Persistent Time is 0 minute(s)
Set Ctrl Relay Persistence Time [0-60 minutes] = 3
New Ctrl Relay persistent time 3 minutes(s)
```

3.3.6.8 Primary Port Baud Rate

Any one of several baud rates may be chosen with this command. When a “8” is entered to change the baud rate, the following is output. Entering a “4” will set baud rate to 19,200 baud as shown.

```
Enter Choice: 8
Current Primary Port baud rate is 9600
Set New Primary Port baud rate
    0) No Change
    1) 2400
    2) 4800
    3) 9600
    4) 19200
Enter Choice: 4
Primary Port baud rate 19200
```

Note – Only the primary port baud rate is changed with the set-up routine. The local RS-232 port accessible from the RJ11 J6 connector on the Microprocessor always operates at 19200 baud.

3.3.6.9 Set Primary Port RS485 Address

If the Sentry is supplied with the RS-485 interface option the default address is 0. The user can select an address code of 141 – 149.

When a “9” is entered to change the address, the following is output.

```
Enter Choice: 9
Current Primary Port RS485 address is 0
Enter New Primary Port RS485 Address from 1 - 9
Enter Choice:
```

3.4 VER Command

When the “VER” command is sent, the sensor responds with the following information about the software:

```
EnviroTech Inc. Sentry Visibility Sensor
13/07/11 ver 2.93 build 5
```

Note – The information shown above is typical – your software version and revision date may be different!

3.5 SHOW CALPARAMS Command

When the “SHOW CALPARAMS” command is sent, the sensor responds with the following information about the calibration parameters:

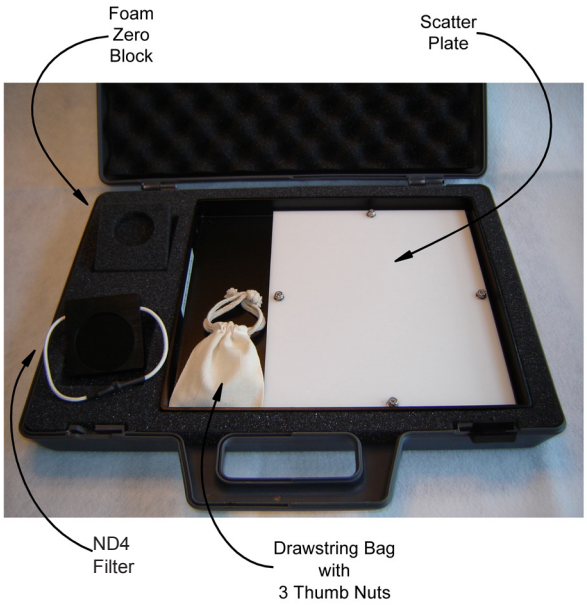
```
SHOW CALPARAMS
Calibration Parameters
    Zero Offset Voltage 0.004124
    Entered EXCO 24.900000
    Measured EXCO is 24.8726417
```

Note – the values shown are typical and depend on the calibration of the sensor. Typically, the following values are typical:

- Zero offset voltage should be ~5 mVDC.
- Entered & measured EXCO in the range of 20-40 but this depends on the calibration fixture used during calibration.

4.0 Calibration

The Sentry™ is initially calibrated at the factory using a standard Calibration Fixture. It is recommended that the calibration be checked during the field installation and every 6 months afterward. The calibration procedure should be performed when the visibility is >1/2 mile, with no precipitation.



73062 Calibration Fixture

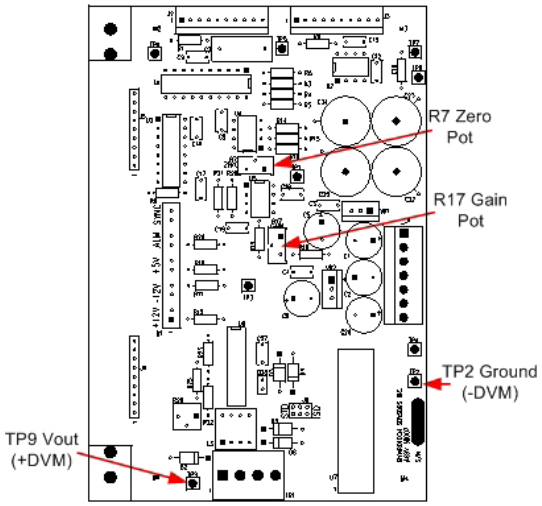
The 73062 Calibration Fixture, is used to check the sensor calibration. The Calibration Fixture consists of portable Attaché Case with:

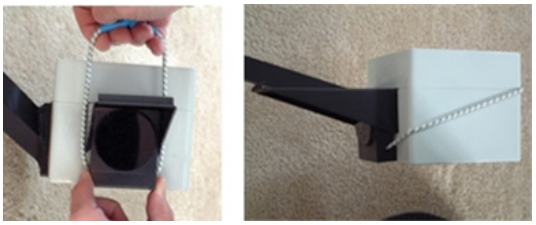
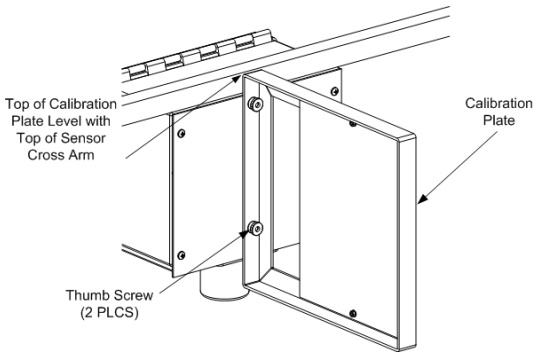
1. Foam Light Block for checking the sensor zero
2. Neutral Density (ND4) Filter for checking the sensor span
3. Scatter Plate used in conjunction with the ND Filter for checking the sensor span
4. Thumb nuts for attaching the Scatter Plate to the mounting studs on the back of the Main Electronics Enclosure. Three (3) thumb nuts are provided, 2 for use to hold the Scatter Plate and 1 as a spare. Any ¼-20 hex nut can also be used but the thumb nuts are easier to use and require no tools. The Calibration Fixture is assigned a factory traceable extinction coefficient (EXCO) that is recorded on the ND4 Filter and the Scatter Plate.

Equipment Needed:

- 73062 Calibration Fixture
- Clean cloth
- Window cleaning solution
- Common hand tools
- PC with Terminal emulator software
- 74058 Serial Test Cable
- Digital Volt Meter

4.1 Procedure for Calibrating the Serial Output Sentry™ sensor

Step	Procedure
1	Inspect the Scatter Plate and ND4 Filter to ensure they are clean, free of scratches, and mechanically sound. Verify that the extinction coefficient (EXCO) on the scatter plate and ND4 filter match exactly. If you are uncertain about the integrity of the Calibration Fixture, contact R.M. Young Company for information about returning it for service.
2	Clean the sensor windows with common window cleaner and remove any insect nests, spider webs or other debris under the hoods to ensure that the optical path is clear. If 73038 Hood Extensions are installed, loosen the retaining screw and remove them before cleaning the lenses. Leave then off until the calibration is complete.
3	If the sensor was off, turn the sensor power ON and wait 30 minutes.
4	Connect a digital voltmeter (DVM) with 4-½ digit resolution to the inputs of the customer data acquisition (DA) system. Connecting at the DA system will more accurately reflect what the DA system is measuring. A 1 mV offset can cause a large difference at the 10-mile full-scale output of the Sentry™. If unable to connect to the data acquisition system inputs, connect to TP9 (+) and TP2 (-) of the Signal Processing PCB as shown.  Calibration Test Points and Adjustment Points
5	Install the Foam Light Block securely over the receiver optics by pushing it up under the hood and against the optics to completely block any incoming light. The Light Block is concave so that it completely covers the protruding glass lens. It is very important that the plug completely block out all incoming light. Even very small amounts of stray light may cause the offset to be affected. *--- NOTE ---* *Never install the Scatter Plate during the zero check because the scattered signal is so intense that some of the light may reach the receiver. Be aware that scattered reflections within an enclosed room such as a laboratory may also affect the zero. If in doubt about the zero, cover the transmitter and receiver heads with a cloth to block any stray light.*
6	Wait 5 minutes for the signal to stabilize.
7	Read the DVM and adjust R7 (Zero Pot) of the Signal Processing PCB to 4.0mv ± .05mv

Step	Procedure
8	Remove the Foam Light Block and set aside for use in step 20.
9	Install the ND Filter securely over the receiver optics by pushing it up under the hood and against the optics to completely block any incoming light. Stretch the elastic cord around the back of the RX Enclosure to hold the filter in place as shown.  Installation of ND4 Filter
10	Install the Scatter Plate on the threaded studs on the back of the Main Electronics Enclosure using the thumbnuts supplied in the 73062 Calibration Fixture. Note the Scatter Plate orientation. The Plate installs with the ¼" circular mounting hole on the top stud and the ¼" slot on the bottom stud. When installed correctly, the top of the plate will be flush with the top of the sensor cross arm.  Installing the Scatter Plate
11	Wait 5 minutes for the signal to stabilize.
12	Record the EXCO written on the Calibration Fixture: EXCO = _____/km
13	Compute the equivalent sensor calibration voltage from the EXCO above as follows: <u>Standard Visibility Range of 30m – 16 km</u> • SCV = EXCO / 20 = _____ VDC <u>Optional Visibility Range of 10m – 10 km</u> • Sensor Cal Voltage = EXCO / 60 = _____ VDC *Note: SCV = Sensor Cal Voltage. Also, to insure correct calibration calculations, verify the Visibility Range marked on the inside of the Main Electronics Enclosure and use appropriate formula..*
14	Read the DVM and adjust R17 (Span Pot) of the Signal Processing PCB to the calculated cal voltage recorded in Step 13, ±1 mV
15	Remove the ND4 filter and scatter plate and set aside for use in Step 22.
16	Connect a Laptop PC to the RJ11 local port (J6) of the Microprocessor PCB using the supplied 74058 Serial Test Cable. Open HyperTerminal or other terminal emulation program configured for 19.2K baud, N,8,1. Set the Flow Control to None.

Step	Procedure
17	At the PC, send the V3 <CR> poll and observe the returned data string to verify that communications have been established.
18	The Sentry calibration is performed using the VC <CR> command that runs the automatic routine. It is a step-by-step procedure that prompts for the user to take certain steps such as installing the foam light block and entering needed information. --- NOTE --- Before proceeding with the calibration, review Steps 5, 9 & 10 and associated illustrations for specifics on how to install the calibration fixture parts.
19	Send VC <CR> to start the calibration routine. Observe the following text on the PC…
20	Ready to Calibrate? Y – continue R - reset parameters to default and reboot system N - return to normal operation Enter Choice (N):Y Cover RX Optics with zero block foam, then press<CR>
21	Note - Press Y to start calibration and observe the following…
22	Performing zero adjust calibration (5 minutes)... please wait Old ZERO was 0.0050300, new ZERO is 0.004124 Y - Accept and continue N - Abort calibration Enter Choice (N):Y Remove zero block foam and install scatter plate & ND4 Filter, then press <CR>
23	*Note - The new ZERO is normally in the range of 0.003 to 0.007 VDC*
24	Enter scatter plate EXCO and press <CR> (Note - Enter the EXCO printed on your calibration fixt!) 24.9 Performing SPAN calibration (5 minutes)... please wait Old measured SPAN was 24.91000, new measured SPAN is 24.8726417 Y - Accept and continue N - Abort calibration Enter Choice (N):Y
25	Note – The new measured SPAN should equal the entered EXCO +/- 2%
26	Remove scatter plate & ND4 Filter, store in carrying case along with foam block. Press <CR> to reboot. The calibration completed.
27	Disconnect the serial test cable from the Microprocessor PCB.
28	Close and secure the door of the Main Electronics Enclosure.
29	If used, reinstall the 73038 Hood Extensions.

5.0 Maintenance

5.1 R.M. Young Company Product Warranty:

Warranty

R.M. Young Company (Seller) warrants this Sentry Visibility Sensor to be free of defects in material and workmanship under normal conditions for a period of twenty-four (24) months from date of shipment subject to the following:

- Warranty does not apply to products that have been subject to mishandling, misapplication, modification, abuse, neglect, accident of nature, or shipping damage.
- The Seller is not liable for incidental or consequential damage caused by its products including but not limited to: damages for loss of use, income, profit, or good will; losses sustained as a result of death or injury to any persons; and/or damages to property other than the product. In no case shall the Seller's liability exceed the price paid for the product.
- This warranty is expressly in lieu of any other expressed or implied warranty of merchantability or fitness for a particular purpose, and of any obligations or liabilities on the part of the Seller or its employees or agents.

5.2 Correcting Defects Under the Warranty

Contact R.M. Young Company to discuss the reason for returning a product and to obtain the return material authorization (RMA) number. Items to be returned to R.M. Young Company for any reason must be accompanied by a return material authorization number. Mark the outside of all shipping cartons and correspondence with the RMA number.

Buyer shall return the product to R.M. Young Company , prepaid transportation. Upon receipt, R.M. Young Company will evaluate the product to determine the cause of the reported problem and the applicability of the warranty. Products deemed to be covered by the warranty will be repaired by R.M. Young Company at no charge to the Buyer and returned to the Buyer, prepaid surface transportation. R.M. Young Company will prepare an estimate for products not under warranty and submit the quotation to the Buyer for approval.

5.3 Preventative Maintenance

Regular field Maintenance is recommended to keep the Sentry™ in good working order. In most operating environments, quarterly (120 day) Maintenance is recommended. Calibration, as described in Section 4 is performed every six (6) months. Each user should select the Maintenance frequency that meets their needs. In some road weather applications where the sensor is exposed to wet, dirty spray from passing vehicles, it may be necessary to clean the optics more frequently.

If 73038 Hood Extensions are installed, loosen the retaining screw and remove them before cleaning the lenses.

Typical Preventative Maintenance Schedule

	Installation	3 month	3 month	3 month	3 month
Clean Lenses		YES	YES	YES	YES
Calibrate	YES		YES		YES

Remember that the sensor output data will be incorrect during the maintenance activities. Either turn the sensor power off or note the date and time of the maintenance for later reference.

Equipment Needed:

- Soft cloth
- Window cleaning solution
- Common hand tools

Procedure:

1. Using a straight blade screwdriver, loosen the two (2) screws that secure the door on the Main Electronics Enclosure.
2. On the Signal Processor PCB, observe that the first three (3) green LEDs are lit on D1. Observe that the last LED is blinking at approximately 1 Hz (once per second). Refer to section 5.4.1-1.
3. On the Microprocessor PCB, observe that the red LED is lit, the green LED is blinking, and the yellow LED is off. Refer to section 5.4.3-1.
4. Use caution when following the steps below. If it is below ~ 5º C (40º F), the external hood heaters may be HOT. Turn sensor power off before proceeding.
5. Using the soft cloth, clean the area under the TX and TX hoods. Look before you reach under the hoods for wasp or beehives!
6. Clean away any old spider webs that are on the sensor cross arm, heads and enclosure.
7. Spray the TX and RX lenses liberally with the window cleaner and wipe thoroughly with a soft, clean cloth. A cotton swab can be used to clean around the edges of the lens.
8. If your sensor is equipped with a photometer, clean the glass window under the hood with a cotton swab and glass cleaner.
9. If the power was turned off, turn it back ON and observe the indicator lights per step 3.
10. Close the Main Electronics Enclosure door and tighten the two (2) screws to secure the door.

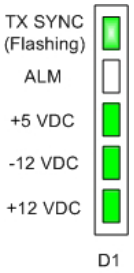
--- A Note About Spiders ---

Spiders can be a problem at certain times of the year. They may leave webs that cross the sensor's optical path causing inaccurate readings. There appears to be no product available on the market today that will eliminate spider infestations.

5.4 Corrective Maintenance

5.4.1 Initial Checks

1. Open the Main Electronics Enclosure by loosening the 2 captive screws on the cover.
2. Observe LED array on the Signal Processor PCB. It should be illuminated as shown. The ALM LED should be OFF.



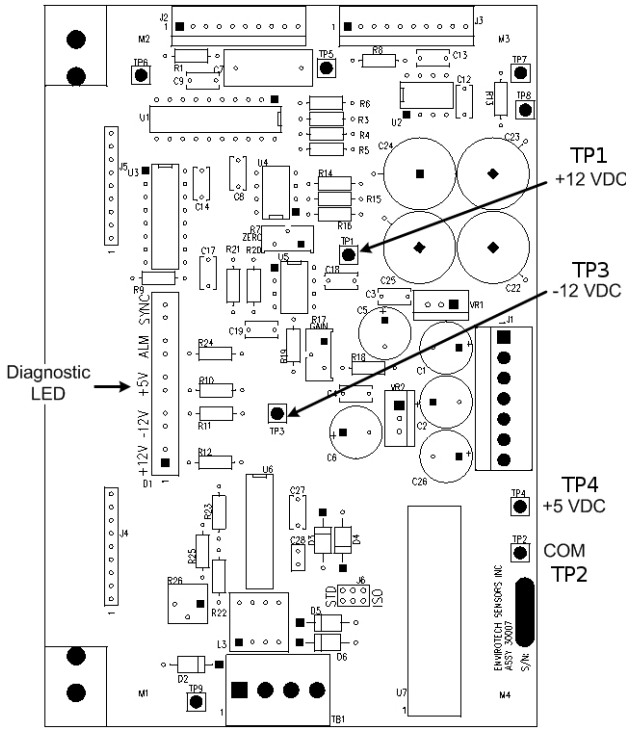
LED Display

5.4.2 Signal Processor Test Points

Equipment required:

- 3-1/2 Digit Digital Volt Meter
- Oscilloscope

1. Observe LED array on the Signal Processor PCB. It should be illuminated as shown in Section 3.
2. Measure the power supply voltages at TP1, TP3, & TP4 of the Signal Processor PCB as shown and verify that they are within tolerance as listed in the table below. Use TP2 as the ground reference.
3. If the power supply voltages are incorrect, go to Section 5.4.4 to test the DC power supply.
4. If LED 5 is not blinking ~30 times per minute (1/2 Hz) measure the SYNC pulse at TP6 using an oscilloscope. If the SYNC is out of tolerance, replace the sensor per the general installation instructions in Section 2.



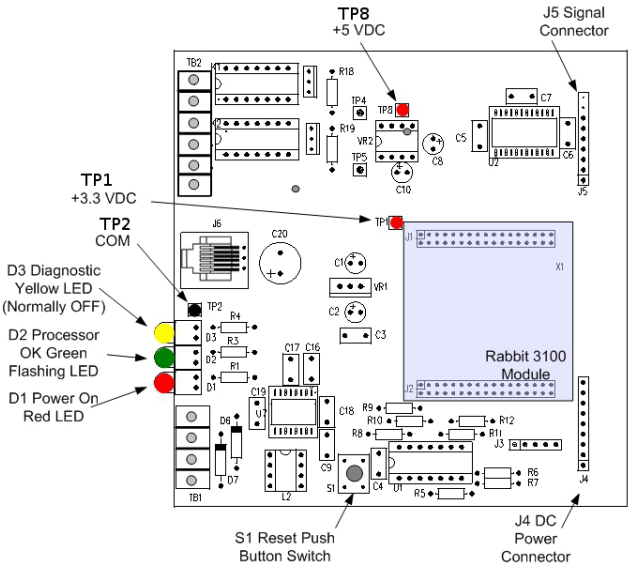
LED	Status	Indication	Test Point	Tolerance
1	ON	+12 VDC	TP 1	12.0 +/- 0.5 VDC
2	ON	-12 VDC	TP 3	-12.0 +/- 0.5 VDC
3	ON	+5 VDC	TP 4	5.0 +/- 0.25 VDC
4	OFF			
5	BLINKING	SYNC	TP 6	5 Vp-p @ 2200 +/- 100 Hz

5.4.3 Microprocessor Test Points

Equipment required:

- 3-1/2 Digit Digital Volt Meter

1. Observe LED array on the Microprocessor PCB. It should be illuminated as shown below.
2. If the red LED is on but the green LED is off (or on steady), press the Microprocessor reset button, S1. If it starts to flash on/off, the software reset resolved the problem.
3. If the yellow LED is on, one or more self-tests has failed. Go to Section 5.4.5 to decode the error message.
4. Measure the power supply voltages at TP1 & TP8 of the Microprocessor PCB and verify that they are within tolerance as listed in table below. Use TP2 (COM) as the ground reference.
5. If any of the voltages are out of tolerance, replace the Microprocessor PCB per the remove and replace instructions in Section 5.4.7.



Test Point	Indication	Tolerance of Indication
TP 1	+3.3 VDC Power Supply	+/- 0.2 VDC
TP 8	+5 VDC Reference	+/- 0.02 VDC

5.4.4 Power Supply Test Points

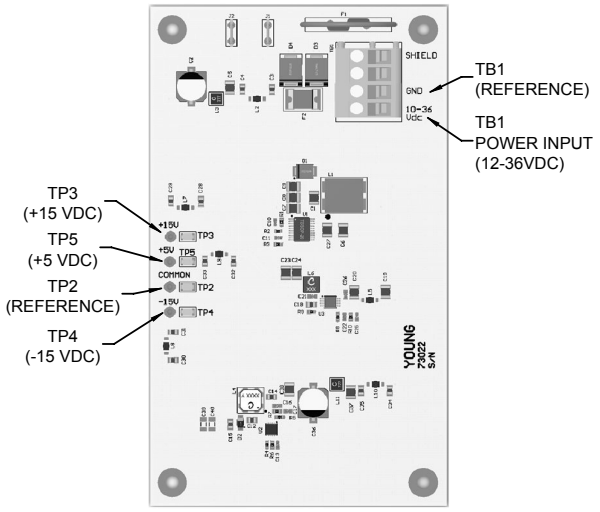
Equipment required:

- 3-1/2 Digit Digital Volt Meter
- Oscilloscope

If TP1, TP2, or TP3 are out of tolerance, measure the voltages from the DC Power Supply PCB as shown below.

--- Note ---
When measuring the 10-36VDC input,
use the GND terminal of TB1 as the reference.
When measuring TP3, TP4, and TP5 output voltages,
use TP2 as the reference.

Test Point	Tolerance
TB1 power input	10 VDC Minimum / 36 VDC Maximum
TP3	+15.0 +/-0.5 VDC
TP4	-15.0 +/-0.5 VDC
TP5	+5.0 +/-0.25 VDC



DC Power Supply Test Points

1. If the TP1 voltage is zero, check D1 (surge protection), D2 (reverse protection diode), and F1 (resettable fuse) on the DC Power Supply PCB. Replace as needed or return the DC Power Supply for factory repair.
2. If the TP1 voltage is < 10 VDC or >36 VDC check for proper DC power from the customer equipment.
3. If TP3, TP4, or TP5 voltages are out of tolerance, replace the DC Power Supply PCB per the remove & replace instructions in Section 5.4.7.

5.4.5 Self Test Error Codes

To read the error codes, connect a Laptop PC to the RJ11 local port (J6) of the Microprocessor PCB using a 74058 Serial Test Cable (Sold seperately). Open HyperTerminal or other terminal emulation program configured for 19.2K baud, N,8,1. Type “V3” <CR> to request the long data string.

The ASCII coded RS-232 data string contains a comma-delimited field that includes sensor diagnostics. Exact placement of this group of characters depends on what data poll is being used. However, the diagnostic group always starts with the letter P for pass or F for fail, followed by 4 characters. For instance, a diagnostic code group of “P0000” indicates that the sensor is currently passing all sensor diagnostics. If the diagnostic code group is “F0024”, this indicates that the +5 VDC power supply and transmit sync pulse are defective. The table below provides a complete list of error codes the sensor can utilize.

Alarm Code for 5th character (first character = F for failure):

Alarm Code	+12V Power Supply Error	+5V Power Supply Error	-15V Power Supply Error	+15V Power Supply Error
F***1				*
F***2			*	
F***3			*	*
F***4		*		
F***5		*		*
F***6		*	*	
F***7		*	*	*
F***8	*			
F***9	*			*
F***A	*		*	
F***B	*		*	*
F***C	*	*		
F***D	*	*		*
F***E	*	*	*	
F***F	*	*	*	*

Alarm Code for 4th character (first character = F for failure):

Alarm Code	Temperature Channel Error	Photo Sensor Error	Transmit Sync Pulse Error	-12V Power Supply Error
F**1*				*
F**2*			*	
F**3*			*	*
F**4*		*		
F**5*		*		*
F**6*		*	*	
F**7*		*	*	*
F**8*	*			
F**9*	*			*
F**A*	*		*	
F**B*	*		*	*
F**C*	*	*		
F**D*	*	*		*
F**E*	*	*	*	
F**F*	*	*	*	*

Alarm Code for 3rd character (first character = F for failure):

Alarm Code	Not Used	Not Used	Visibility Data Error	Visibility Channel Error
F*1**				*
F*2**			*	
F*3**			*	*

Alarm Code for 2nd character (NOT USED):

5.4.6 Troubleshooting Scenarios

These scenarios assume that the power supply and test point checks described above have been completed.

Case 1 - Visibility too high (sensor analog output too low) for long periods when it is obvious that the ambient visibility is low (i.e. foggy).

- Check for lens blockage due to snow or wet blowing leaves – clear as needed.
- Check for lens heater operation by feeling the lens with your finger. The lens should be warmer than the TX/RX head area around the heated lens – replace sensor if lens heater not operational or condensation continues to be a problem.
- Check for physical damage to the sensor heads or cross arm. Misalignment of these parts will result in TX and RX beams not intersecting correctly – replace sensor.
- Observe that the TX LED is operating by looking at the the beam under the hood through the optics. This test is best performed in low light. It should glow red in color.
- Problem could be internal to the sensor – replace sensor per the general installation instructions in Section 2.

Case 2 - Visibility too low (sensor analog output too high) for long periods when it is obvious that ambient visibility is high (i.e. clear).

- Check for spider webs or insect nests under the hoods or anywhere within the sensor sample volume – clean as needed.
- Check for other sources of interference that would cause light scattering such as physical damage to hoods or other parts of the head – remove interference or replace sensor as needed.
- Problem could be internal to the sensor – replace sensor per the general installation instructions in Section 2.

5.4.7 Remove & Replace Instructions

Only certain parts of the Sentry™ may be replaced in the field. The TX and RX Heads are not field repairable and should not be opened. The Signal Processor PCB in the Main Electronics Enclosure is not field replaceable. Contact R.M. Young Company if you have a question about what is repairable or replaceable in the field.

Instructions to remove and replace Sentry's components are listed below.

Equipment required:

- Flat blade screwdrivers
- #2 Phillips screwdriver
- 3/8" nut driver
- Adjustable wrench
- Needle nosed pliers
- Wire cutters

DC Power Supply - Turn power OFF before proceeding with the removal and replacement instructions provided in this Section!

- Removal – Using a small flat blade screwdriver, loosen the 2 DC input power wires from TB1 of the DC Power Supply PCB. Unplug the white 7-pin connector from J1 on the right side of the Signal Processor PCB. Using a small flat blade screwdriver, unscrew the 4 corner screws that hold the DC Power Supply PCB to the base plate. Carefully lift the PCB out of the enclosure.
- Replacement – Place the new DC Power Supply PCB over the base plate standoffs and replace the 4 screws and washers to secure it. Plug the white 7-pin connector into J1 of the Signal Processor PCB. Rewire the DC power input wires to TB1 per Section 2.4.1.
- Calibrate the sensor per Section 4 before returning the Sentry™ to service.

Microprocessor / RS-232 Output Option PCB - Turn power OFF before proceeding with the removal and replacement instructions provided in this Section!

- Removal – Using a small flat blade screwdriver, loosen the RS-232 signal wires from TB1 of the Microprocessor / RS-232 Output Option PCB. If used, unplug the photometer cable from J3 of the Microprocessor PCB. Carefully slide the PCB out of the card guides of the Signal Processor PCB.
- Replacement – Place the new Microprocessor/ RS-232 Output Option PCB into the card guides of the Signal Processor PCB and carefully seat the mating connectors. Rewire the user signal wires to TB1 and TB2 per Section 2.3.
- Calibrate the sensor per Section 4 before returning the Sentry™ to service.

5.5 Field Replaceable Units (FRU's)

Only certain parts of the Sentry™ may be replaced in the field. The TX and RX Heads are not field repairable and should not be opened. The Signal Processor PCB in the Main Electronics Enclosure is not field replaceable without factory training. Table 5.5-1 provides a list of the field replaceable units. Contact R.M. Young Company for information about what FRUs are applicable to your Sentry™.

FRU Description	FRU P/N
DC Power Supply Assy	73022
Signal Processor PCB *Note1*	73020-02
Microprocessor / RS-232 PCB Assy *Note1*	74022-02
Microprocessor / RS-232 w/Control Relay	74022C
Microprocessor / RS-232 w/Diagnostic Relay	74022D
Microprocessor / RS-232 w/Control & Diagnostic Relay	74022F
RS-422 Converter Module *Note2* RS-485 Converter Module *Note2*	74022-04

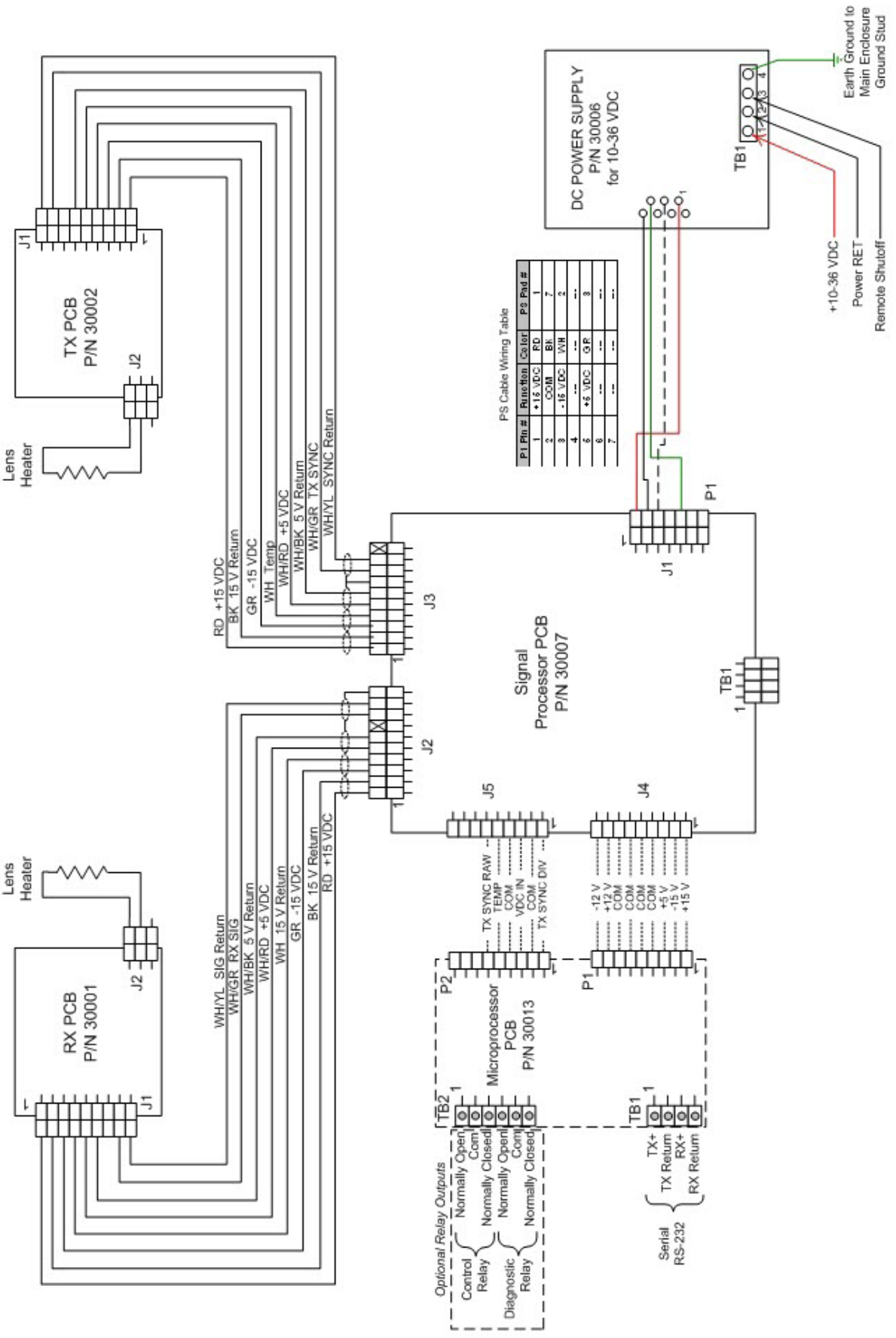
Note1: You must order the exact replacement – see your PCB for complete part number.

Note2: When ordering 74022-04 FRU, please include your Sensor Model number in correspondance to receive properly configured unit.

APPENDIX

CABLE & WIRING DIAGRAM

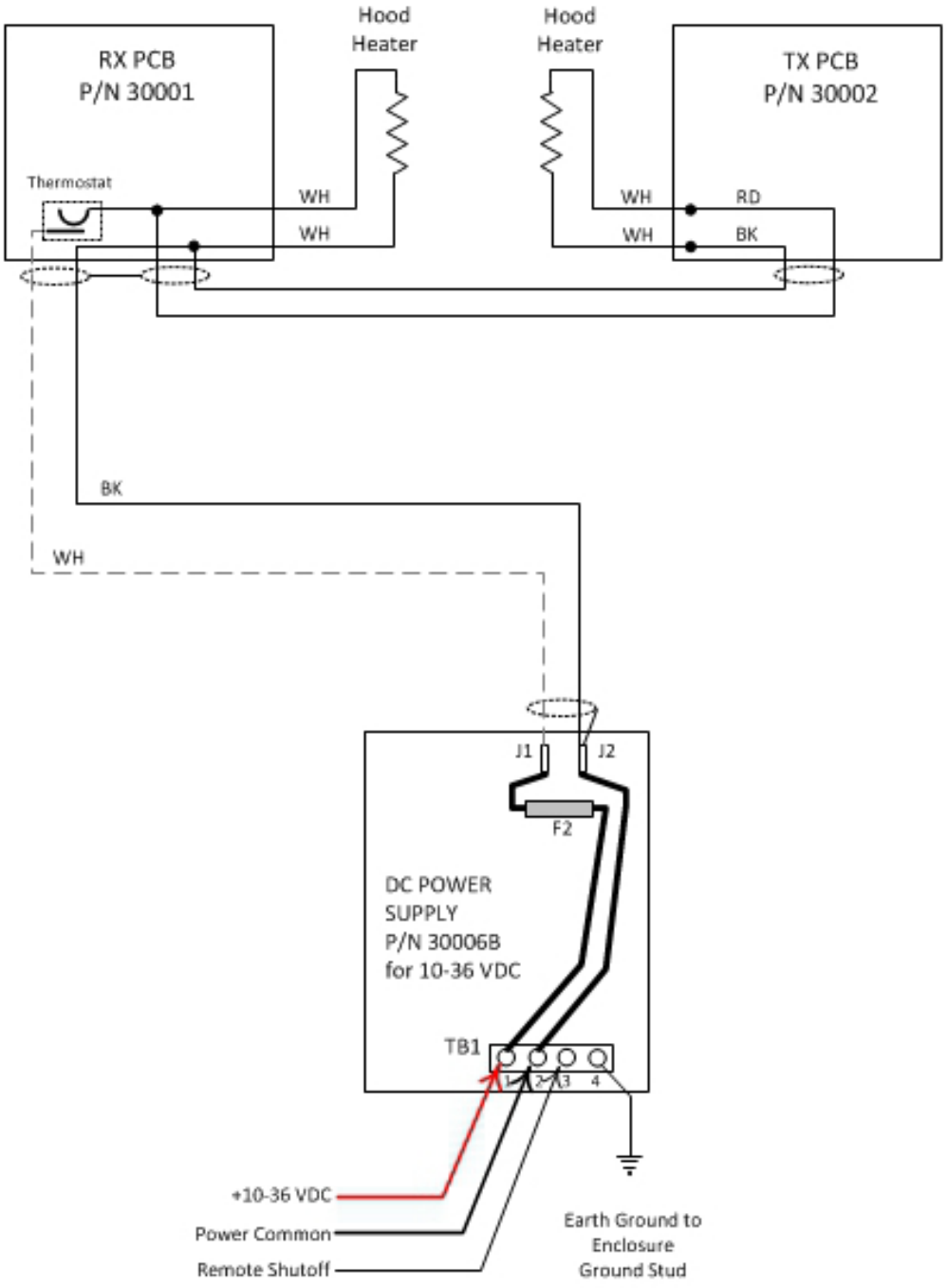
DC Power Schematic



73000S-90(E)

CABLE & WIRING DIAGRAM

Optional Hood Heaters



73000S-90(E)

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