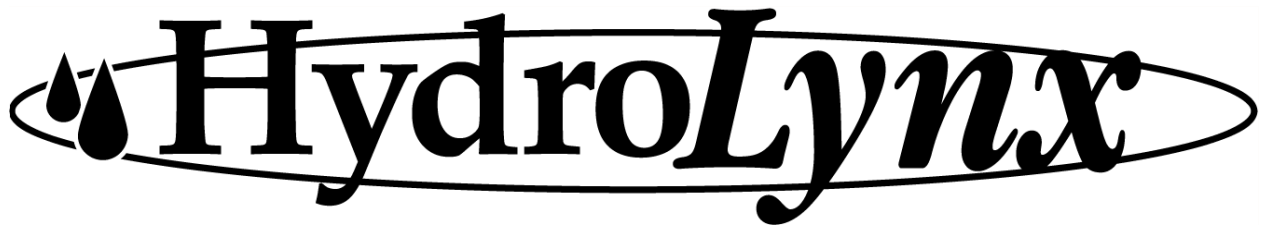


# HydroLynx Systems, Inc.

Model 4015  
Pyranometer

Instruction Manual



Document No: A102813  
Document Revision Date: December, 2004

## Receiving and Unpacking

Carefully unpack all components and compare to the packing list. Notify HydroLynx Systems immediately concerning any discrepancy. Inspect equipment to detect any damage that may have occurred during shipment. In the event of damage, any claim for loss must be filed immediately with the carrier by the consignee. If the equipment was shipped via Parcel Post or UPS, contact HydroLynx Systems for instructions.

## Returns

If equipment is to be returned to the factory for any reason, call HydroLynx between 8:00 a.m. and 4:00 p.m. Pacific Time to request a Return Authorization Number (RA#). Include with the returned equipment a description of the problem and the name, address, and daytime phone number of the sender. Carefully pack the equipment to prevent damage during the return shipment. Call HydroLynx for packing instructions in the case of delicate or sensitive items. If packing facilities are not available, take the equipment to the nearest Post Office, UPS, or other freight service and obtain assistance with packaging. Please write the RA# on the outside of the box.

## Warranty

HydroLynx Systems warrants that its products are free from defects in material and workmanship under normal use and service for a period of one year from the date of shipment from the factory. HydroLynx Systems' obligations under this warranty are limited to, at HydroLynx's option: (i) replacing; or (ii) repairing; any product determined to be defective. In no case shall HydroLynx Systems' liability exceed product's original purchase price. This warranty does not apply to any equipment that has been repaired or altered, except by HydroLynx Systems, or that has been subjected to misuse, negligence, or accident. It is expressly agreed that this warranty will be in lieu of all warranties of fitness and in lieu of the warranty of merchantability.

## Address

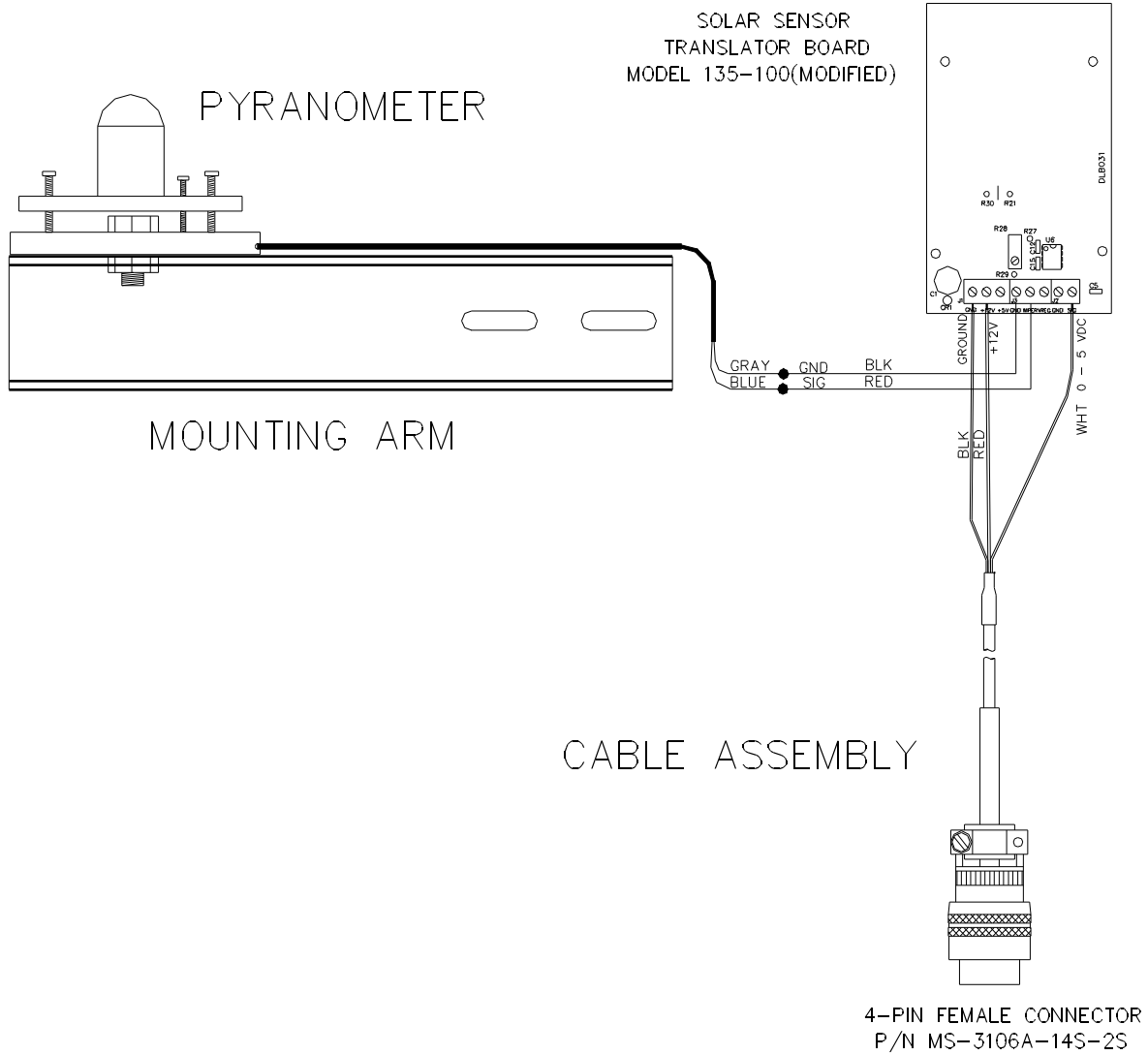
**HydroLynx Systems, Inc.  
950 Riverside Pkwy., Suite 10  
West Sacramento, CA 95605  
Phone: (916) 374-1800  
Fax: (916) 374-1877  
E-mail: [hydro@hydrolynx.com](mailto:hydro@hydrolynx.com)**

Copyright © 2004 by HydroLynx Systems, Inc.

# TABLE OF CONTENTS

SECTION NO.	PAGE NO.
Equipment Configuration and Parts Identification .....	4
1.0 INTRODUCTION .....	5
1.1 General Description .....	5
1.2 Specifications .....	6
2.0 INSTALLATION .....	7
2.1 Pyranometer .....	7
2.2 Translator .....	7
3.0 OPERATION .....	9
3.1 Pyranometer .....	9
3.2 Translator .....	9
4.0 CALIBRATION .....	10
4.1 Pyranometer .....	10
4.2 Translator .....	10
5.0 MAINTENANCE .....	11
5.1 Pyranometer .....	11
5.2 Translator .....	11
6.0 DRAWINGS .....	12

### Equipment Configuration and Parts Identification



Sensor: Model 4015 Pyranometer

## 1.0 INTRODUCTION

### 1.1 General Description

The Model 4015 Pyranometer is a solar radiation sensor with a translator circuit board. The pyranometer is designed to measure global solar radiation producing a linear output voltage in response to the amount of radiation energy. The translator board amplifies the millivolt output signal of the pyranometer into a 0-5 Vdc signal compatible with the Model 5096 ALERT Data Transmitter. The translator board is typically housed inside a NEMA-4 enclosure. A 9' length of cable connects the pyranometer output signal into the translator board. A 10' length of cable with a circular connector is used to connect the translator board output signal into the 5096 Transmitter.

Designed around a silicon sensing element, the Model 4015 Pyranometer is capable of making continuous measurements of direct and scattered sky radiation. The pyranometer has been designed to present a small profile, to be lightweight, and to install easily.

Silicon responds to sun and sky radiation through the light spectrum of 0.35 to 1.15 microns. The silicon photovoltaic wafer produces a voltage equal to about 105 millivolts per 1400 watts per square meter of surface area. Whenever the sensor output is integrated over a daily period, the accuracy of the value will be within  $\pm 3\%$ . Typically, the instantaneous sensor output accuracy is  $\pm 5\%$ . Temperature compensation is provided for a range of +40 to +140 °F. Each instrument is provided with a certificate of calibration showing the output voltage sensitivity. Cosine effects and air mass effects on the output are made during the calibration procedure. Calibration of the pyranometer is accomplished by performing a comparison test using a laboratory standard pyranometer. During the calibration test both pyranometers are exposed to sky radiation. The translator circuit board amplifies the 0 to 105 millivolt output signal into a 0 to 5 volt dc signal that is compatible with the input voltage requirements of the 5096 Transmitter.

The construction of the pyranometer features a lightweight, aluminum base plate and thermal mass, and a Pyrex glass dome. Three threaded bolts provide the ability to level the instrument whenever it is mounted onto a flat surface or is used with a leveling plate. For most installations, the pyranometer is mounted onto a mast or boom that includes a leveling plate. A nine foot long, two conductor, shielded cable is physically attached to the silicon wafer through the pyranometer body. The cable is used to connect the output signal to the monitoring equipment.

The translator circuit board is normally installed inside a NEMA 4 enclosure constructed of fiberglass and plastic. The board is mounted onto an aluminum plate inside the enclosure. Terminal blocks are used to make connections with the input and output signal wires and the power wires. For some applications the translator board may be installed into an enclosure with one or more circuit boards to conserve space. The enclosure is usually mounted inside the ALERT system standpipe.

## 1.2 Specifications

### Pyranometer

Spectral response:	0.35 to 1.15 microns
Calibration:	Comparison to Eppley PSP with natural radiation
Absolute error:	±5% maximum, typical ±3%
Sensitivity:	Typically 0.075 mV/W/m <sup>2</sup>
Output:	105 mV per 1400 W/m <sup>2</sup>
Response time:	< 1 millisecond
Detector:	Silicon photovoltaic cell
Temperature compensation:	+40 to +140°F(+4 to +60°C)
Impedance:	1 ohm
Windshield:	Pyrex glass dome
Leveling:	Circular level and three threaded feet
Size:	5" dia x 2" high (127 x 51 mm)
Weight/Shipping:	1 lb/1.5 lbs (0.5kg/0.7kg)
Power requirements:	None

### Translator

Input range:	0 to 105 mVdc, typical
Output range:	0 to 5 Vdc
Scaling:	0 to 1400 W/m <sup>2</sup>
Overall accuracy:	0.5%
Operating temperature:	-22 to +140°F (-30 to +60°C)
Storage temperature:	-40 to 212°F (-40 to 100°C)
Relative humidity:	0 to 100%, non-condensing
Connectors:	Compression screw terminal blocks
Power:	+12 Vdc
Current consumption:	20 mA, typical
Circuit board size:	3.5" x 2.5" (89 x 64 mm)
Circuit board weight:	4 oz (0.1 kg)
Enclosure size:	5-3/8" x 7-1/4" x 4-3/4" (137 x 184 x 121 mm)
Enclosure weight:	2 lbs (0.92 kg)

## 2.0 INSTALLATION

Carefully unpack the pyranometer and the translator enclosure. For equipment shipped as a complete set with the sensor installed onto the leveling plate, inspect the wiring to ensure none of the wires have been damaged. Also, inspect the glass dome to ensure that it is intact and has no cracks. Remove any packing materials that may have become lodged between the plates.

### 2.1 Pyranometer

Select an installation site exhibiting a terrain typical of the area under study. In the northern hemisphere, the pyranometer should be located to the south of any objects that might cast shadows. The site should not be subjected to the sun's reflections from nearby objects. Also, the pyranometer is typically mounted at a height of 5 feet (1.5m) above the surface level for data correlation with weather service data.

Install the pyranometer onto a flat surface. If possible, position the spirit level toward North for northern hemisphere sites, and toward South for southern hemisphere sites. Carefully level the pyranometer by centering the bubble in the spirit level. Adjust the leveling screws individually to "zero" in on the level setting. Upon completing the leveling of the pyranometer, secure the pyranometer to the mounting surface by placing a fourth bolt through the unthreaded hole in the base of the pyranometer. The leveling plate furnished by HydroLynx has a hole that aligns with the securing bolt hole of the pyranometer. The leveling bolts should only make contact with the mounting surface and should not be threaded into the mounting surface. Apply only light pressure to the securing bolt to avoid upsetting the level of the pyranometer. By using a double set of nuts and lock washers, the securing bolt should be slightly loose but unable to work free due to vibration.

When the HydroLynx mounting arm and leveling plate assembly are to be used for mounting the pyranometer, install the mounting arm first, taking care to level the arm as closely as possible. Securely mount the arm so that it will not work loose over time.

Route the output signal cable along the mounting arm. Secure the cable to the arm using black, ultraviolet resistant, cable ties. Prevent the cable from being loose to avoid damage during high winds. Additional cable may be added as required. Due to the type of sensing device and the voltage level of the output signal, cable lengths should be less than 200 feet.

### 2.2 Translator

The translator enclosure can be installed in a variety of ways, depending upon the site and the available structures. The enclosure is designed for mounting onto a flat surface such as a wall or a panel. Flanges extend from the ends of the back edge of the enclosure. The flanges have bolt holes, two per flange. For systems furnished by HydroLynx, all necessary mounting hardware for the enclosure will be furnished. In the case of the ALERT standpipe, a metal bracket is attached to the back of the enclosure that will enable the enclosure to be hung onto the box mounting plate inside the standpipe. The end of the

bracket slides over the side of the plate allowing easy installation and removal of the enclosure.

When the enclosure has been installed, route the output signal cable in the most convenient manner and connect the cable to the monitoring equipment. In an ALERT system, the pyranometer output signal cable must be routed through the antenna mast and into the standpipe through the cable port. The cable is then inserted into the enclosure through the cable port strain relief and attached to the circuit board terminals. The translator output signal cable is routed down through the standpipe and the 4-pin circular connector is attached to the matching connector on the 5096 Transmitter.

Wiring connections for the terminal blocks of the translator are shown in the tables below. Also shown are the wiring connections for the 4-pin connector. Wire colors shown are standard HydroLynx colors. Wire colors may vary for cables supplied by others.

### **INPUT SIGNAL CONNECTIONS**

[J1-1] POWER GROUND BLACK  
[J1-2] POWER +12VDC RED

[J3-1] PYR GROUND GRAY  
[J3-2] PYR SIGNAL BLUE

### **OUTPUT SIGNAL CONNECTIONS**

[J2-1] OUT GROUND BLACK  
[J2-2] OUT SIGNAL WHITE

### **OUTPUT SIGNAL CONNECTOR PIN WIRING**

[A] OUT SIGNAL WHITE  
[B] NOT USED  
[C] POWER +12 VDC RED  
[D] POWER GROUND BLACK

## 3.0 OPERATION

### 3.1 Pyranometer

Sky radiation is a mixture of direct radiation from the sun as well as scattered radiation due to clouds and particles in the atmosphere. By placing the pyranometer horizontal and facing toward the sky, the silicon wafer is able to receive energy from the sky radiation. The physical properties of the silicon converts the solar radiation energy into electrical energy. By controlling the fabrication of the silicon, the electrical output from the silicon can be linearized and made to be proportional to the sky radiation. For this pyranometer design, the output signal is approximately 0.075 millivolts per watt per square meter of surface area. Since the instrument is a light sensitive device as opposed to a heat sensitive device, the output response is instantaneous. The output signal sensitivity will vary slightly from one pyranometer to another due to minor variations in the silicon that are uncontrollable. To compensate for these variations, a calibration sensitivity for each pyranometer is generated.

The silicon wafer is mounted on an aluminum platform, connected thermally to the aluminum base plate, and covered by a polished Pyrex glass hemisphere. A bubble spirit level is mounted onto one side of the base plate to assist in the installation and leveling of the pyranometer. The volume of air inside the glass hemisphere is sealed and is kept dry by an enclosed desiccant.

The output signal of the pyranometer is a millivolt signal with a range of zero to about 105 millivolts maximum, equal to zero to  $1400 \text{ Wm}^{-2}$ . For most sites, the maximum value of solar radiation that can be detected is around  $1000 \text{ Wm}^{-2}$  due to atmospheric pollution. The output signal may be connected directly into monitoring equipment. In some cases, the signal may need to be amplified for proper use with the monitoring equipment.

### 3.2 Translator

The translator used with the pyranometer is a +12 Vdc powered, single stage, operational amplifier circuit. The gain of the circuit has been set to amplify the input signal received from the pyranometer into a 0 to 5 Vdc signal for use with the 5096 Transmitter. The 0-5 Vdc signal is calibrated so that it is proportional to a measured range of 0 to  $1400 \text{ Wm}^{-2}$ . The amplifier circuit is matched to the pyranometer sensitivity by setting potentiometer R28 in the feedback loop of IC U6:A.

## 4.0 CALIBRATION

### 4.1 Pyranometer

Each Silicon Cell Pyranometer is calibrated against a certified solar radiation standard, such as the Eppley Laboratories Precision Spectral Pyranometer. The calibration is performed under clear skies and full sun conditions at solar noon. Comparison readings are taken of the two instruments in order to produce an output response curve for the Silicon Cell Pyranometer. The standard instrument is certified annually and is stored indoors when not in use. The output voltages should be measured using a precision 4-1/2 digit voltmeter.

Pyranometers can experience a change in the output signal calibration due to the constant exposure to the sun's radiation. The calibration should be checked annually to insure accuracy of the data. For non-critical applications, the calibration should be checked at least every two years. Calibration checking may be performed by sending the pyranometer to HydroLynx, or by the customer, using a second pyranometer that has been stored indoors and is used only for this task.

### 4.2 Translator

The translator circuit board is calibrated in the test lab using a precision millivolt source and a 4-1/2 digit voltmeter. The sensor is disconnected from the board during the calibration. With the input terminals shorted, the output is measured to verify a reading of 0.000 volts dc ( $\pm 0.030$  Vdc). Attaching the precision millivolt source to the input terminals, the millivolt source is set for a value equal to the maximum voltage output expected from the pyranometer. The maximum output voltage is calculated from the sensitivity value given on the calibration certificate. The voltage is typically about 105 millivolts for  $1400 \text{ Wm}^{-2}$ . With the input voltage set for 0.105 Vdc, potentiometer R28 is adjusted until the output signal is 5.000 Vdc.

Verification of the pyranometer operation with the translator board can be achieved using either direct sun light or an incandescent light source. Look for an output voltage change at the translator as the light source is turned on and off.

## 5.0 MAINTENANCE

### 5.1 Pyranometer

Regularly scheduled maintenance of the Model 4015 is required due to the nature of the measurement and to the design of the instrument. Because the radiation must pass through the glass hemisphere, the glass must be kept free of insects, accumulated dust, dirt, bird droppings, and water droplets, all of which can partially or totally block the light. For critical use, the glass may require a daily cleaning, before sunrise. For non-critical use, at least a weekly cleaning is required to avoid errors in the data or total loss of data.

Clean the glass with a soft clean cotton cloth and water. Do not use any solvents or cleansers with abrasive additives. Carefully dry the glass and remove any streaks or smudges. The glass may be polished by using clean tissue paper.

Inspect the installation regularly to help avoid loose or missing hardware and to insure that the level of the pyranometer is maintained.

For instruments that have been calibrated since December 1, 1993, provision has been made to accommodate the changing of the desiccant located beneath the sensing element. The desiccant should be changed whenever moisture appears on the inside of the glass dome. Inspect the desiccant regularly and change it immediately if it appears to be pink in color. For best results, change the desiccant on a regular basis at least annually.

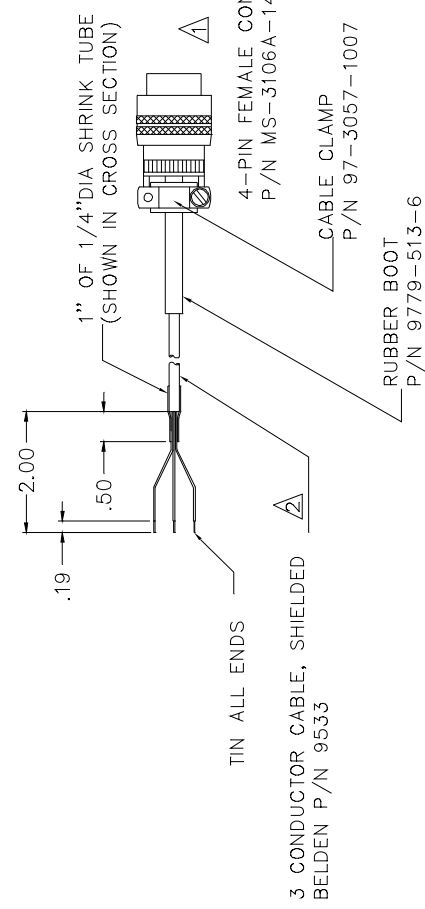
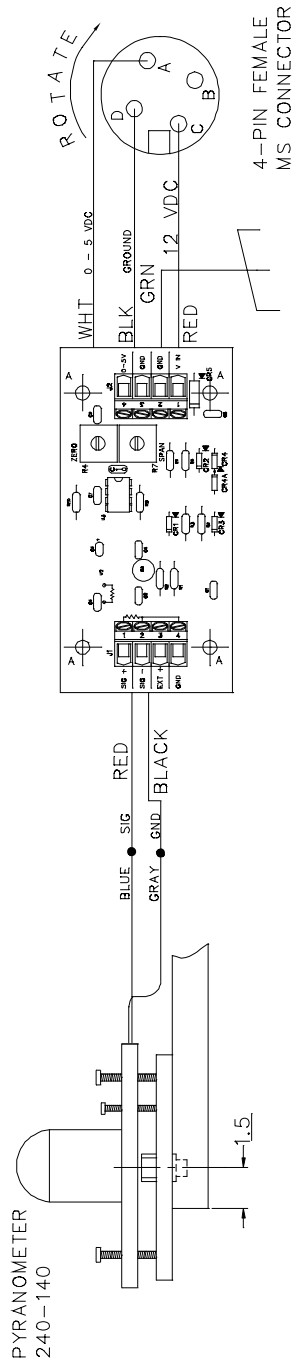
To change the desiccant, remove the sensor from its mounting support and turn it upside down. Carefully cut off the name tag using a razor blade or a sharp knife. Remove the plug that is in the large hole beneath the name tag. Dig out the sealant and unscrew the plug using a hex wrench. Turn the sensor back over and gently shake it to remove the desiccant. Turn the sensor over again and refill the sensor body with fresh desiccant. Replace the plug. Notice that the plug does not tighten fully. Turn the plug until it is about 1/16" below the plate surface. Reseal the plug completely using 100% Silicone sealer. Replace the name tag using the same sealant. Remember that the desiccant should have a deep blue color when it is moisture free.

### 5.2 Translator

The translator requires no routine maintenance. Occasional checking of the circuit operation should be made to ensure accuracy of the data and to determine that the equipment is operating correctly. The circuit should be tested using the precision millivolt source and digital voltmeter. The enclosure and mounting hardware should be inspected regularly to avoid loose or missing hardware and to detect breaks in the cables and enclosure surfaces. Replace any missing or damaged parts as soon as possible to avoid major problems later.

## 6.0 DRAWINGS

AC108018 Wiring Diagram - Chassis  
AC105045 Installation  
AC100953 Calibration Curve - W/m<sup>2</sup> vs Vdc  
A100903 4015 Calibration Data Sheet

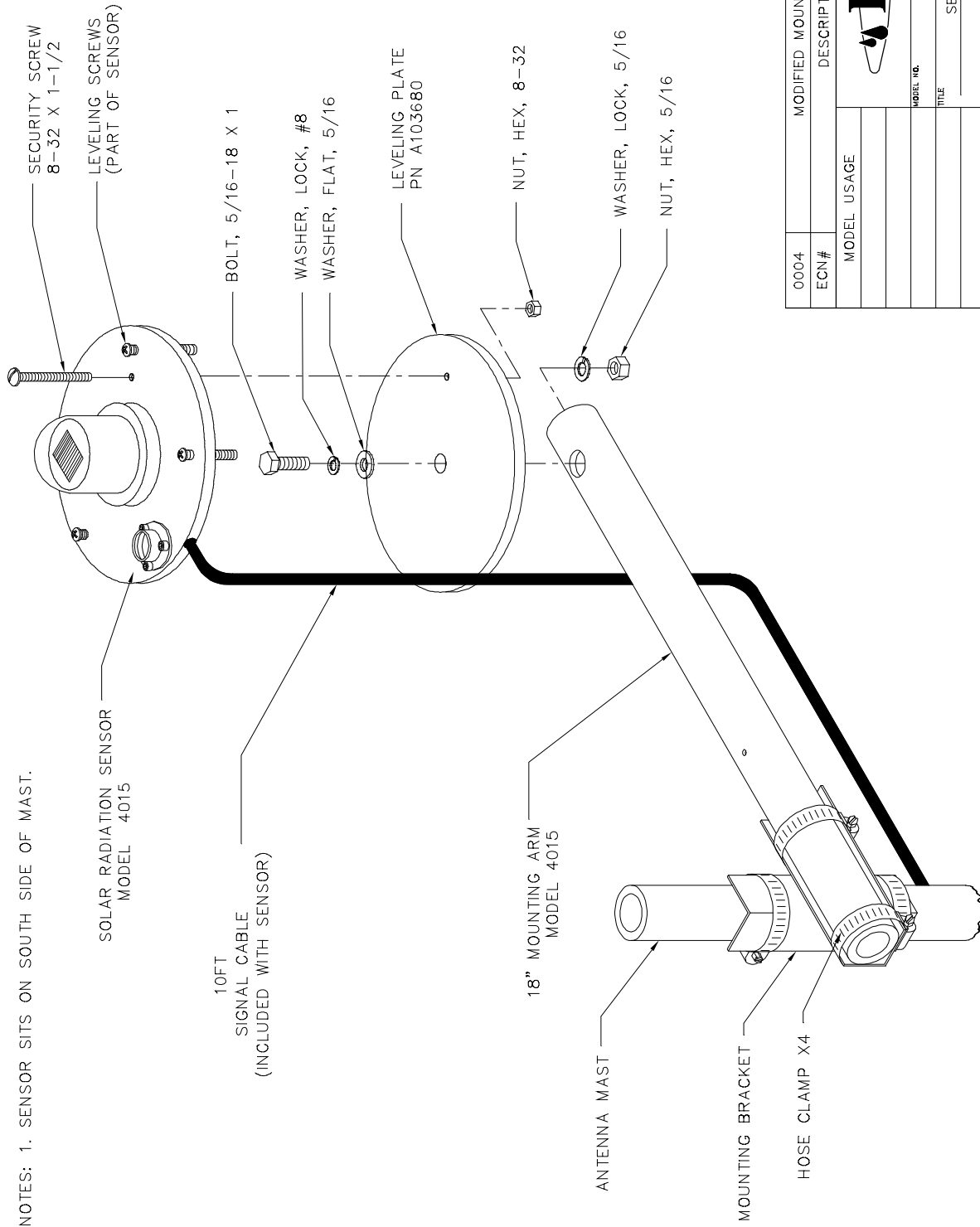


CABLE ASSEMBLY

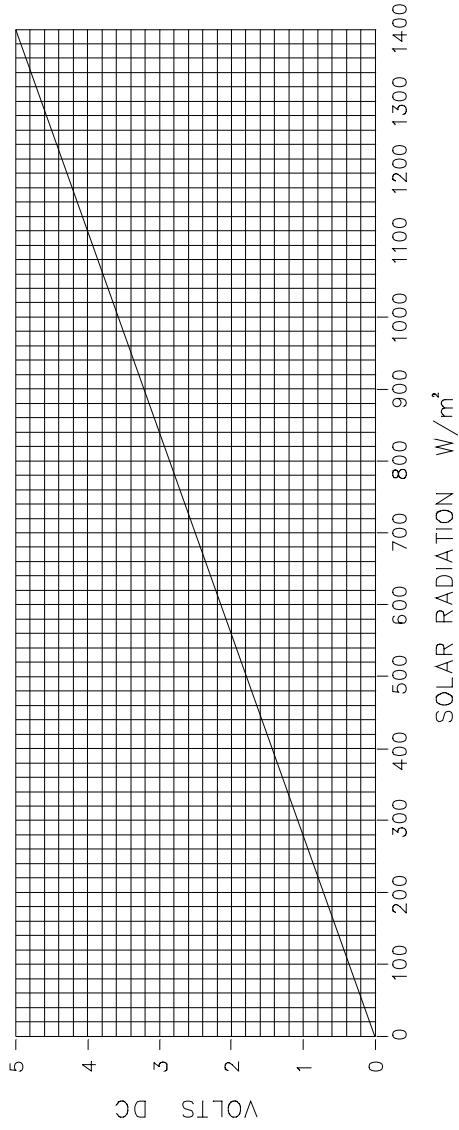
- 1. USE 5/16" OF 1/8" DIA SHRINK TUBING (X3) OVER SOLDERED PINS ON CONNECTOR.
- 2. CABLE LENGTHS ARE: FOR 4015 25FT OR AS SPEC'D FOR 5081 16FT OR AS SPEC'D REQ'D: 1 PER UNIT
- 3. PYRANOMETER SAME AS NOVALYNX MODEL 240-140 (4015) OR 240-120 (4016).
- 4. SENSOR CABLE MAY BE EXTENDED USING BLACK AND RED CABLE AS SHOWN.

N/A	REDRAWN ON NEW BORDER	12/16/99
ECN#	DESCRIPTION	DATE
MODEL USAGE	<b>HydroLynx</b>	
MODEL NO.	4015 / 4016	
TITLE	CHASSIS	
DRAWN BY	DATE	DWG TYPE
L. STANCIL	02/06/02	WIRING DIAGRAM
CHECKED BY	DATE	SIZE
	B	DWG NO.
		AC108018
		REV

NOTES: 1. SENSOR SITS ON SOUTH SIDE OF MAST.



0004	MODIFIED MOUNTING ARM	4/4/00
ECN #	DESCRIPTION	DATE
MODEL USAGE		
MODEL NO. 4015		
TITLE SENSOR w/ MOUNTING ARM		
DATE 4/4/00		
DRAWN BY B MICHAUD		
CHECKED BY		
DATE 4/4/00	DATE	DATE
SIZE B	REV A	REV
ASSEMBLY/ INSTALL		REV
AC105045		REV



N/A		REDRAWN ON NEW BORDER	07/21/00
ECN #		DESCRIPTION	DATE
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES TOLERANCES		MODEL USAGE	
FRACTIONS = $\epsilon$		<b>HydroLynx</b>	
.XX = $\epsilon$		MODEL NO.	4015 / 4016
.XXX = $\epsilon$		TITLE	VOLTAGE VERSUS WATTS/ $m^2$
MAT'L		DWG TYPE	CURVE
FINISH		DRAWN BY	T. JOHNSTON
TREATMENT		CHECKED BY	
		DATE	07/21/00
		DATE	
		SIZE	A
		DWG NO.	AC100953
		REV	A



MODEL 4015 CALIBRATION DATA SHEET

Document# 100903

SN \_\_\_\_\_

TECH \_\_\_\_\_

DATE \_\_\_\_\_

1. Solar Radiation Translator Calibration:

Low Cal Point	mV Input	OUTPUT	
		Calculated	Actual +/-0.5%
0.0 W/m <sup>2</sup>	_____	0.000 V	_____ V
Hi Cal			
1400 W/m <sup>2</sup>	_____	5.000 V	_____ V
Mid Cal			
700 W/m <sup>2</sup>	_____	2.500 V	_____ V

2. Pyranometer Calibration Coefficient

2.0077 ÷ \_\_\_\_\_ = \_\_\_\_\_ mV

1 W/m<sup>2</sup> = \_\_\_\_\_ mV

NOTES: \_\_\_\_\_

\_\_\_\_\_

-----

3. Solar Radiation Formulas:

Cal/cm<sup>2</sup> min x 697.3 = Watts/meter<sup>2</sup>

Cal/cm<sup>2</sup> min x 1.000 = Langleys/minute

Cal/cm<sup>2</sup> min x 69.73 = milliWatts/centimeter<sup>2</sup>