INSTRUCTION MANUAL

RAWS-H Remote Automated Weather Station

Revision: 12/13

Warranty

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For all returns, the customer must fill out a "Statement of Product Cleanliness and Decontamination" form and comply with the requirements specified in it. The form is available from our web site at *www.campbellsci.com/repair*. A completed form must be either emailed to *repair@campbellsci.com* or faxed to (435) 227-9106. Campbell Scientific is unable to process any returns until we receive this form. If the form is not received within three days of product receipt or is incomplete, the product will be returned to the customer at the customer's expense. Campbell Scientific reserves the right to refuse service on products that were exposed to contaminants that may cause health or safety concerns for our employees.

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RAWS-H Remote Automated Weather Station

1. Introduction

The RAWS-H allows customers who own a Handar Data Collection Platform to upgrade to a Campbell Scientific Remote Automated Weather Station, while using the sensors and tower that they already own. The RAWS-H contains an aluminum 14- by 18-in. environmental enclosure, a CR1000M Module, a 12 Vdc sealed rechargeable battery, a CH100 regulator, a Handar sensor connector panel, a wiring panel, and a CR1000KD Keyboard Display.

Handar sensors that measure wind speed and direction, air temperature and relative humidity, precipitation, and solar radiation can be attached to the Handar sensor connector panel. The RAWS-H provides a wiring panel for attaching additional sensors that measure barometric pressure, fuel moisture or temperature, snow depth, or stream flow.

FIGURE 1-1. Color coded, keyed connector panel

NOTE Keep this manual and the CR1000KD Keyboard Display with the RAWS. Review the station siting and orientation section before field deployment. If a problem is encountered, review the troubleshooting sections in this manual and Appendix A, *Equipment Wiring and Connector Panel Jumper Location*.

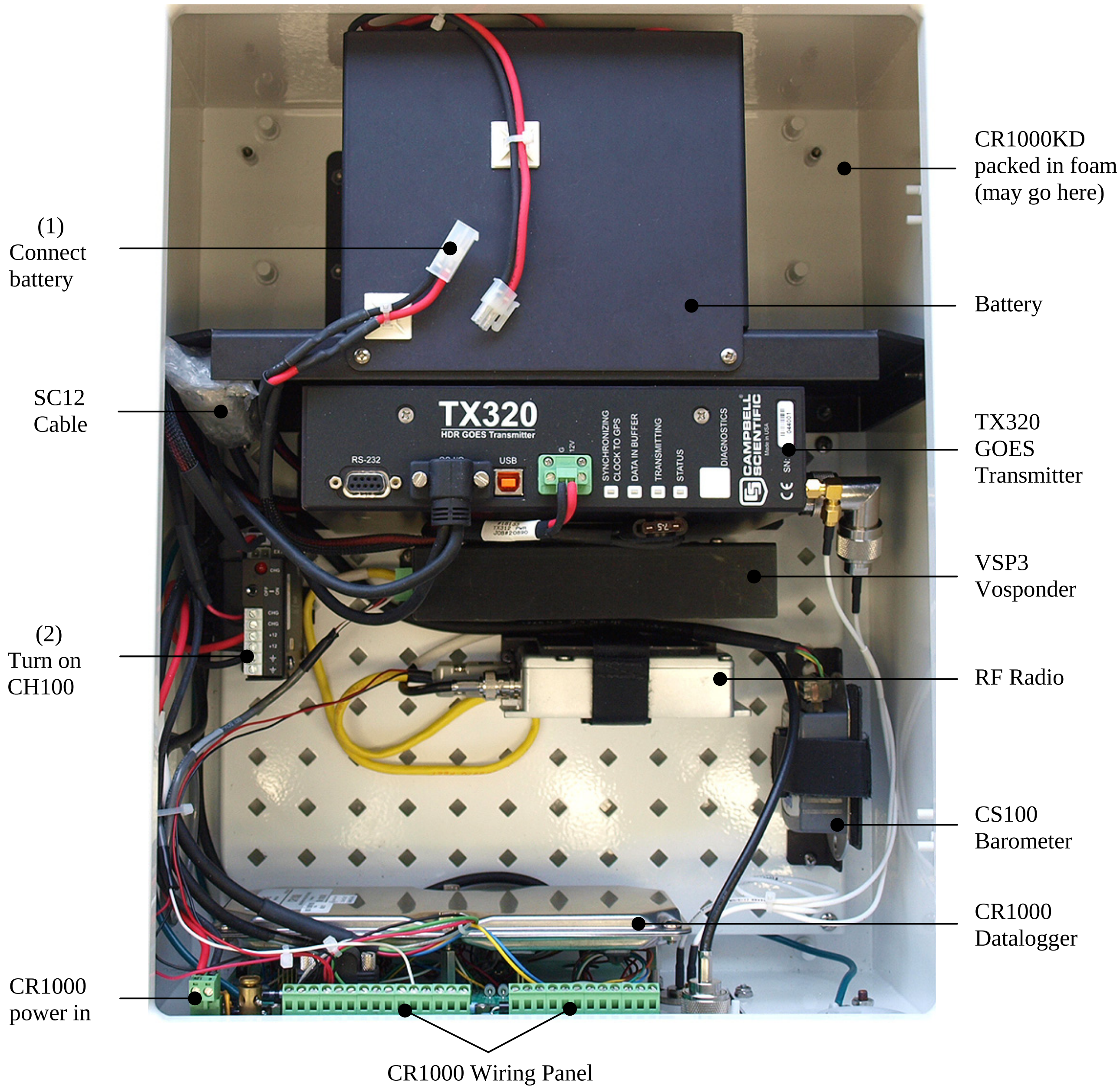

FIGURE 1-2. Inside environmental enclosure (optional equipment shown)

NOTE Customized Handar sensor programming can be developed for a nominal fee. Program development will require datalogger support software (LoggerNet or PC400) purchased from Campbell Scientific.

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2. Getting Started

Set up and test your station before field deployment.

NOTE Keep this manual and the CR1000KD Keyboard Display with the RAWS.

Review the station siting and orientation section before field deployment. If a problem is encountered, review the equipment wiring and troubleshooting sections in this manual.

After siting and leveling the RAWS, open the enclosure and (1) connect the battery cable and (2) verify the CH100 switch is in the 'on' position.

NOTE When this equipment is not in use (for example, transport or storage), disconnect battery cable to the CH100.

3. Station Siting and Orientation

3.1 General Description

Selecting an appropriate site for the RAWS is critical in order to obtain accurate meteorological data. In general, the site should be representative of the general area of interest and away from the influence of obstructions such as buildings and trees.

WARNING **If any part of the weather station comes in contact with power lines, you could be killed. Contact local utilities for the location of buried utility lines before digging or driving ground rods.**

See Section 8, *References*, for a list of references that discuss siting recommendations.

3.2 Air Temperature and Relative Humidity

A temperature and relative humidity (RH) sensor should be located over an open level area at least 9 m in diameter (EPA). The surface should be covered by short grass, or where grass does not grow, the natural earth surface. The sensor must be housed inside a radiation shield and adequately ventilated.

Situations to avoid include:

- large industrial heat sources
- rooftops
- steep slopes
- sheltered hollow
- high vegetation
- shaded areas
- swamps

- areas where snow drifts occur
- low places holding standing water after rains

3.3 Precipitation

A rain gage should be located over an open level area covered by short grass, or where grass does not grow, the natural earth surface. Level the rain gage.

3.4 Solar Radiation

A solar radiation sensor should be located to avoid shadows on the sensor at any time. Orient the solar radiation sensor where the solar radiation sensor faces the equator minimizing the chance of shading from other weather station structures. Reflective surfaces and sources of artificial radiation should be avoided. Level the solar radiation sensor.

3.5 Wind Speed and Direction

A wind sensor should be located over open level terrain and at a distance of at least ten times (EPA) the height of any nearby building, tree, or other obstruction.

3.6 Barometric Pressure

The CS100 barometric pressure sensor can be mounted to the back plate inside the RAWS environmental enclosure.

3.7 Fuel Moisture and Fuel Temperature

The fuel moisture and fuel temperature sensor should be left outside at the field site continually exposed to the same conditions as forest fuels. The fuel moisture and fuel temperature dowel rods absorb and desorb moisture from its surroundings. Install the probes horizontally on the mounting stake and face the sensors towards the equator above a representative forest floor duff layer. Place the sensor away from foot traffic areas.

4. Sensor Wiring

4.1 Air Temperature and Relative Humidity

The temperature/RH sensor attaches to the connector labeled TEMP/RH; this connector is color coded orange. This sensor is internally wired from the RAWS connector panel to the CR1000 datalogger.

TABLE 4-1. TEMP/RH Connector (color coded orange)

Connector Pin	Description	CR1000 Terminal
A	Temperature H	1L
B	Sensor Excitation	VX1
C	Sensor Signal L/⏚	⏚
D	Power Ground	G
E	RH Signal	1H
F	Switched 12 V	SW_12V

4.2 Rain Gage

The rain gage attaches to the connector labeled PRECIP; this connector is color coded blue. This sensor is internally wired from the RAWS connector panel to the CR1000 datalogger.

TABLE 4-2. PRECIP Connector (color coded blue)

Connector Pin	Description	Datalogger Connection
A	Tipping Bucket	C6
B	5 V	5V
C	Ground	G

4.3 Solar Radiation

The solar radiation sensor attaches to the connector labeled SOLAR RAD SDI-12; this connector is color coded green. The pyranometer sensor is internally wired from the RAWS connector panel to the CR1000 datalogger.

TABLE 4-3. SOLAR RAD SDI-12 Connector (color coded green)

Connector Pin	Description	CR1000 Terminal
A	Solar Sensor +	3H
B	Solar Sensor -	3L shorted to ⏚
C	Solar Sensor Ground	⏚
D	SDI-12 Ground	G (used for a second SDI-12 sensor)
E	SDI-12 Signal	C5 (used for a second SDI-12 sensor)
F	SDI-12 12 V	12V (used for a second SDI-12 sensor)

4.4 Wind Speed and Direction

The wind set attaches to the connector labeled WS/WD; this connector is color coded red. The wind set is internally wired from the RAWS connector panel to the CR1000 datalogger.

TABLE 4-4. WS/WD Connector (color coded red)

Connector Pin	Description	CR1000 Terminal
A	Sensor Ground	⏚
B	Wind Direction Excitation	VX2
C	Wind Direction Signal	2H
D	Power Ground	G
E	+12 V power	12V
F	Wind Speed Signal	P1

4.4.1 SDI-12 Sensor

An SDI-12 sensor can be attached to the connector labeled SDI-12; this connector is color coded yellow. The SDI-12 sensor is internally wired from the RAWS connector panel to the CR1000 datalogger.

TABLE 4-5. SDI-12 Connector (color coded yellow)

Connector Pin	Description	Datalogger Connection
A	SDI-12 Signal	C7
B	12 V	12V
C	Power Ground	G

4.5 Fuel Moisture and Fuel Temperature

The Campbell Scientific CS506 and CS205 sensors are combined into one connector (pn CS516-LQ). This sensor is internally wired from the RAWS connector panel to the CR1000 datalogger. This sensor attaches to the connector labeled FM/FT, which is color coded brown.

TABLE 4-6. FM/FT Connector (color coded brown)

Connector Pin	Description	CR1000 Terminal
A	CS205 Temperature Signal	4L
B	Sensor Ground	⏚
C	CS205 Temperature Excitation	VX1
D	CS506 FM Enable	C8
E	CS506 FM Signal	4H
F	CS506 FM 12 V	12V

4.6 Barometric Pressure

The barometric pressure sensor (pn CS100-QD) is mounted inside the RAWS environmental enclosure and the sensor wires are attached to the CR1000 printed circuit board wiring panel.

TABLE 4-7. CS100-QD Wiring

CS100 Wire Color	CR1000 Terminal
Blue	5L
Yellow	⏚
Red	12V
Clear	G
Black	G
Green	C4

CAUTION The CS100 is sensitive to static when the back plate is removed. To avoid damage, take adequate anti-static measures when handling this sensor.

5. Equipment Wiring and Troubleshooting

5.1 Solar Panels

5.1.1 General Description

The RAWS solar panel is a photovoltaic power source used for charging lead acid batteries. The SP20-Handar 20 watt solar panel is used for system configurations that have higher-than-average power requirements. It is also recommended for use at higher elevations and latitudes. The solar panel should be mounted facing the equator.

The SP10-Handar 10 watt solar panel is recommended for a RAWS where NO communication equipment is used. The SP20-Handar 20 watt solar panel is recommended for a RAWS where communication equipment is used (for example, GOES, voice, cell phone, or radio).

NOTE If the user supplies a solar panel for the RAWS, use an unregulated solar panel. The solar panel size depends on the station power requirements, specifically the communication equipment selected for the station.

The SP10-Handar solar panel outputs 0.59 Amps, 8.9 Watts typical peak power.

The SP20-Handar solar panel outputs 1.17 Amps, 18 Watts typical peak power.

5.1.2 Wiring

The RAWS solar panel attaches to the connector panel labeled “BATT CHARGER/SOLAR PANEL”. Inside the RAWS environmental enclosure the “BATT CHARGER/SOLAR PANEL” connector pin A and pin B are wired to the CH100’s “CHG” and “CHG” ports. Polarity does not matter; either lead can be connected to either terminal. The CH100 has two functions: blocking any current flow from the battery to the solar panel, and limiting the source current to the battery.

5.1.3 Troubleshooting

If a problem is suspected, it may be checked by measuring the voltage output from the solar panel. Check the voltage with a voltmeter connected between the two leads going to the CH100’s “CHG” “CHG” terminals located inside the environmental enclosure (15 to 28 Vdc). There must be solar radiation incident on the panel and there must be a load connected to the solar panel. The load can be the datalogger, other equipment, or a 75 ohm resistor capable of dissipating solar panel power between the two leads. No voltage output implies a bad solar panel, regulator, or cable. The magnitude of the voltage output depends on the incident solar radiation. Check the sensor cable. Disconnect the connector and look for damaged pins.

5.2 Charger/Regulator

5.2.1 General Description

The 12 volt charger/regulator (pn CH100) is a charging regulator for 12 V rechargeable batteries. The CH100 is connected to an external charging source such as an unregulated solar panel (pn SP20-Handar or SP10-Handar) or a wall charger (pn 29796). The CH100 has two functions: blocking any current flow from the battery to the solar panel, and limiting the source current to the battery.

FIGURE 5-1. 12 volt charger/regulator

5.2.2 Wiring

The leads from the RAWS connector panel "BATT CHARGER/SOLAR PANEL" connector COLOR CODED PURPLE are wired to the CH100 "CHG" terminals. Polarity does not matter; either lead can be connected to either terminal. The charge indicating diode should be "ON" when voltage to the charging circuitry (CHG Terminals) is present.

An internal and/or external battery can be connected to the CH100 by means of INT (Internal) or EXT (External) connectors. The battery red lead connects to the positive battery terminal and the black lead connects to the negative terminal.

NOTE Connect 12 V power to the datalogger and/or peripherals using the "+12 and Ground" terminals. The ON-OFF switch applies power to these 12 V terminals.

WARNING **Reversal of battery polarity will damage the CH100 or battery.**

CAUTION A battery must be attached for the CH100 to function correctly as a power supply.

CAUTION It is possible to leave two batteries connected. The battery connections are diode isolated; however, if one of the batteries fails, it could draw all the charging current and the other battery will be discharged.

5.2.3 Troubleshooting

If a problem is suspected, the CH100 may be checked by measuring:

- input voltage between the two CHG terminals. From a solar panel, the voltage should be 15 to 28 Vdc. From the standard wall charger (pn 29796), the voltage should be 24 Vdc.
- charging output voltage (BATT INT or EXT terminal) with battery disconnected about 13.5 to 14 Vdc
- power out (+12 terminals) about 11 to 14 Vdc

No voltage output implies a bad solar panel, regulator, or battery.

NOTE Power out (+12 terminals) is controlled by the CH100's ON-OFF switch position.

5.3 Battery

5.3.1 General Description

The RAWS battery is a rechargeable 12 volt battery. The battery requires a regulated charging source provided by the CH100 connected to an unregulated solar panel or a wall charger.

WARNING **RAWS rechargeable batteries are designed to be float charged. Permanent damage occurs and battery life is shortened if the battery is allowed to discharge below 10.5 volts.**

5.3.2 Wiring

The RAWS rechargeable battery should be connected to the CH100's INT (Internal) connector. The battery red lead connects to the positive battery terminal and the black lead connects to the negative terminal. If desired, an external battery can be connected to the CH100's EXT (External) connector.

WARNING **Reversal of battery polarity will damage the CH100 or battery.**

CAUTION It is possible to leave two batteries connected. The battery connections are diode isolated; however, if one of the batteries fails, it could draw all the charging current and the other battery will be discharged.

5.3.3 Troubleshooting

If a problem is suspected, measure the +12 V and Ground terminal on the CR1000 printed circuit board wiring panel. Acceptable readings are +11 to +14 Vdc. Use PC200W software to collect the 1-HR data table from the CR1000 datalogger and review the historical record of battery voltage.

5.4 GOES Transmitter

5.4.1 General Description

The High Data Rate GOES transmitter (pn TX320) shown in FIGURE 5-2 supports one-way communication, via satellite, from a Campbell Scientific datalogger to a ground receiving station. Satellite telemetry offers a convenient communication alternative for field stations where phone systems or RF systems are impractical or rendered unreliable after a tragedy to the local infrastructure. Data transmission rates of 100, 300, and 1200 bps are supported. Because clock accuracy is critical for GOES satellite telemetry, the TX320 includes a robust, TCXO-based real-time clock and a GPS receiver.

The TX320 has two siting requirements for proper operation. The GOES antenna must have a clear view of the spacecraft. The GOES antenna is directional and should be aimed at the spacecraft; both elevation and azimuth are unique to the location of the planet and must be set. A poorly aimed antenna will cause a drop in signal strength or possibly prevent successful transmission.

For more information on the TX320 and antenna siting, go to our website at *www.campbellsci.com*, enter the “TX320” in the “Search” box, and go to the equipment manual. The TX320 manual is also provided on the ResourceDVD which ships with the RAWS-H.

NOTE The spacecraft specific DCP-Setup parameters for the GOES transmitter must be entered in the CR1000 program.

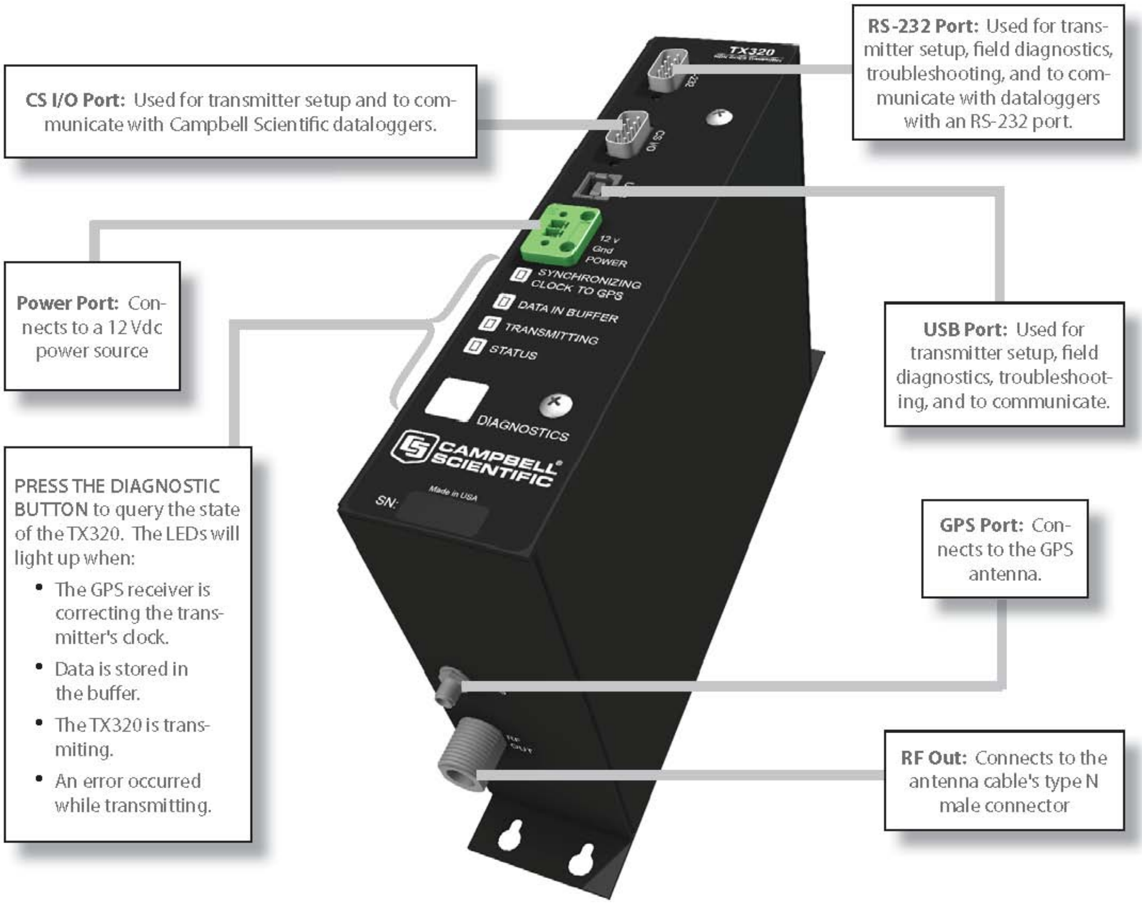

FIGURE 5-2. GOES transmitter

5.4.2 Wiring

The TX320 is mounted inside the RAWS environmental enclosure and the transmitter connections are described below.

TABLE 5-1. GOES Transmitter Connections

TX320 Connector	Connects To
CS I/O	CR1000 CS I/O port via SC12 cable (shipped with the RAWS-H)
GPS	GPS antenna cable
RF Out	GOES antenna cable
Green Power Port	Battery Cable Junction Connector

5.4.3 Troubleshooting

If a problem is suspected, the TX320 may be checked by measuring the +12 V and Ground terminal on the CR1000 PC-board wiring panel. Acceptable readings are +11 to +14 Vdc. Check the SC12 cable connection between the CR1000 wiring panel and the TX320. Press the TX320 diagnostic button to query the state of the transmitter.

5.5 CR1000 Keyboard/Display

5.5.1 General Description

The CR1000 Keyboard/Display (pn CR1000KD) shown in FIGURE 5-3 is used to check datalogger status, to display or plot sensor readings and stored values, to enter numeric data, or to change port/flag state. The CR1000KD is powered from the CR1000 printed circuit board “CS I/O” connector via a standard 9-pin serial cable (pn 10873) that ships with the RAWS.

Power Up Screen
Press any key for Power up Screen
Press ^ to turn on/off backlight
Press <> to adjust contrast

RAWS-H Setup Screen
Press up/down arrow to select menu item
Press Enter to see menu choices
Press up/down arrow to highlight menu choice
Press Enter to select menu choice
Press Esc to move up a menu
Press Enter to move down a menu

FIGURE 5-3. CR1000 keyboard/display

5.5.2 Wiring

The CR1000KD connects to the CR1000's CS I/O connector using the 10873 cable that ships with the RAWS-H.

5.5.3 Troubleshooting

If a problem is suspected, the CR1000KD may be checked by connecting the CR1000KD to the CR1000 PC board 9-Pin "CS I/O" connector using the 9-pin serial cable (pn 10873). The CR1000KD display should be visible. Check the CH100's ON/OFF switch. If the display is not visible, check the CR1000 wiring panel for 12 volt power. If the CR1000 is unresponsive to CR1000KD key strokes, there might be a problem with the CR1000 datalogger.

5.6 CR1000 Datalogger

5.6.1 General Description

The CR1000 shown in FIGURE 5-4 provides sensor measurement, timekeeping, data reduction, data/program storage, and control functions. The CR1000 includes 2 Mbytes of memory for data and program storage. A lithium battery backs up the RAM and real-time clock. The CR1000 also suspends execution when primary power drops below 9.6 V, reducing the possibility of inaccurate measurements.

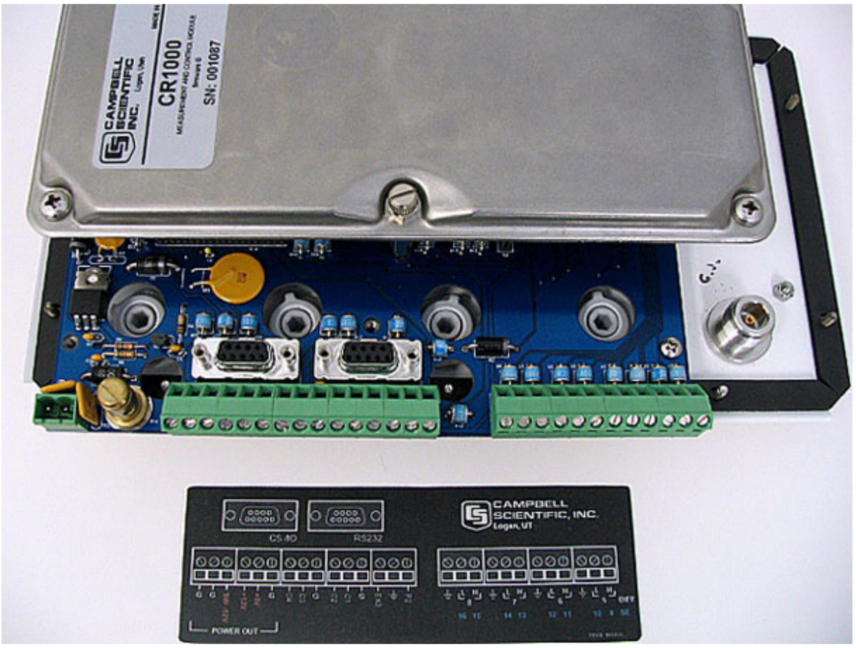

FIGURE 5-4. CR1000 and printed circuit wiring panel

5.6.2 Wiring

The CR1000 is mounted inside the RAWS environmental enclosure and fastened to the CR1000 printed circuit board wiring panel; connect 12 V power to the CR1000 printed circuit board wiring panel green power connector. The CH100's ON-OFF switch applies power to the 12 V terminals.

5.6.3 Troubleshooting

If a problem is suspected, the CR1000 may be checked by connecting the CR1000KD to the CR1000 printed circuit board 9-Pin "CSI/O" connector using the 9-pin serial cable (pn 10873). The CR1000KD display should be visible. If the display is not visible, check the CR1000 printed circuit board for 12 volt power. If the CR1000 is unresponsive to CR1000KD key strokes, there might be a problem with the CR1000 datalogger.

6. Desiccant

A humidity indicator card and desiccant packs are provided with the weather station. Place the humidity indicator card and 2 ea. desiccant packs inside the enclosure. Desiccant packets inside the enclosure should be replaced with fresh packets when the upper dot on the indicator begins to turn pink. The indicator tab does not need to be replaced unless the colored circles overrun. A humidity indicator card (pn 28878) and desiccant pack (pn 4905) may be ordered through Campbell Scientific. Desiccant packs inside of the datalogger do not require replacement under normal conditions.

7. Sensor and Equipment Maintenance

Proper maintenance of weather station components is essential to obtain accurate data. Equipment must be in good operating condition, which requires a program of regular inspection and maintenance. Routine and simple maintenance can be accomplished by the person in charge of the weather station. More difficult maintenance, such as sensor calibration, sensor performance testing (for example, bearing torque), and sensor component replacement, generally requires sending the instrument to Campbell Scientific. A station log should be maintained for each weather station that includes equipment model and serial numbers and maintenance that was performed.

NOTE Consult the equipment manual for routine maintenance procedures.

NOTE Contact Campbell Scientific, Inc., phone (435) 227-9000, for a RMA number before returning sensor or equipment for service.

8. References

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9. RAWS Orientation

9.1 Determining True North and Sensor Orientation

Orientation of the wind direction sensor is done after the datalogger has been programmed and the location of True North has been determined. True North is usually found by reading a magnetic compass and applying the site-specific correction for magnetic declination; where the magnetic declination is the number of degrees between True North and Magnetic North. Magnetic declination for a specific site can be obtained from a USGS map, local airport, or through the web calculator offered by the USGS (Section 9.2, *USGS Web Calculator*). A general map showing magnetic declination for the contiguous United States is shown in FIGURE 9-1.

Declination angles are always subtracted from the compass reading to find True North. A declination angle east of True North is reported as positive a value and is subtracted from 360 (0) degrees to find True North as shown FIGURE 9-2. A declination angle west of True North is reported as a negative value and is also subtracted from 0 (360) degrees to find True North as shown in FIGURE 9-3. Note that when a negative number is subtracted from a positive number, the resulting arithmetic operation is addition.

For example, the declination for Longmont, CO is 10.1°, thus True North is 360° ─ 10.1°, or 349.9° as read on a compass. Likewise, the declination for Mc Henry, IL is ─2.6°, and True North is 0° ─ (─2.6°), or 2.6° as read on a compass.

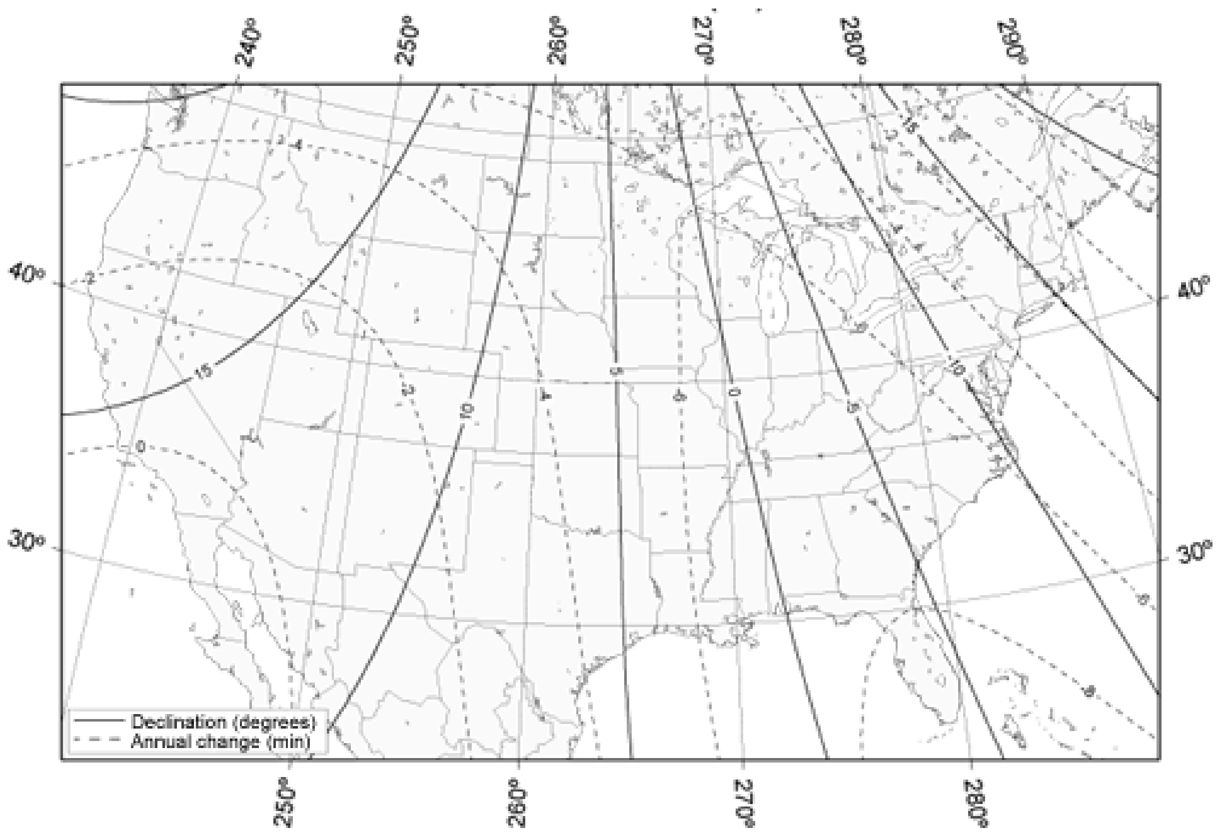


FIGURE 9-1. Magnetic declination for the contiguous United States

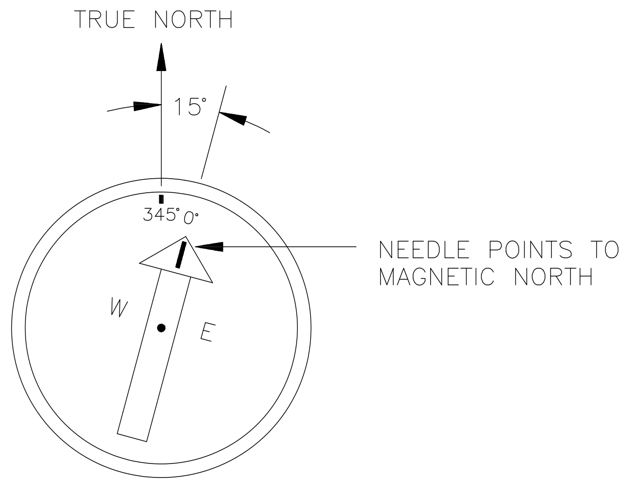


FIGURE 9-2. A declination angle east of True North (positive) is subtracted from 360 (0) degrees to find True North

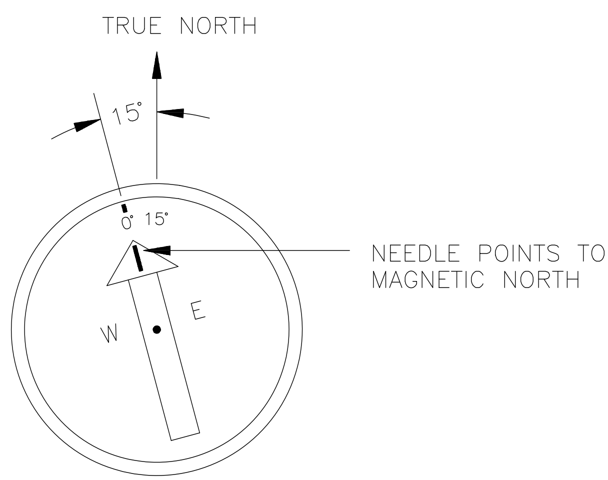


FIGURE 9-3. A declination angle west of True North (negative) is subtracted from 0 (360) degrees to find True North

9.2 USGS Web Calculator

The USGS provides an easy way of determining the declination of a specific site. Since magnetic declination fluctuates with time, it should be adjusted each time the wind sensor orientation is adjusted. The calculator can be accessed at: *www.ngdc.noaa.gov/geomagmodels/Declination.jsp*. FIGURE 9-4 shows an example for Logan, UT.

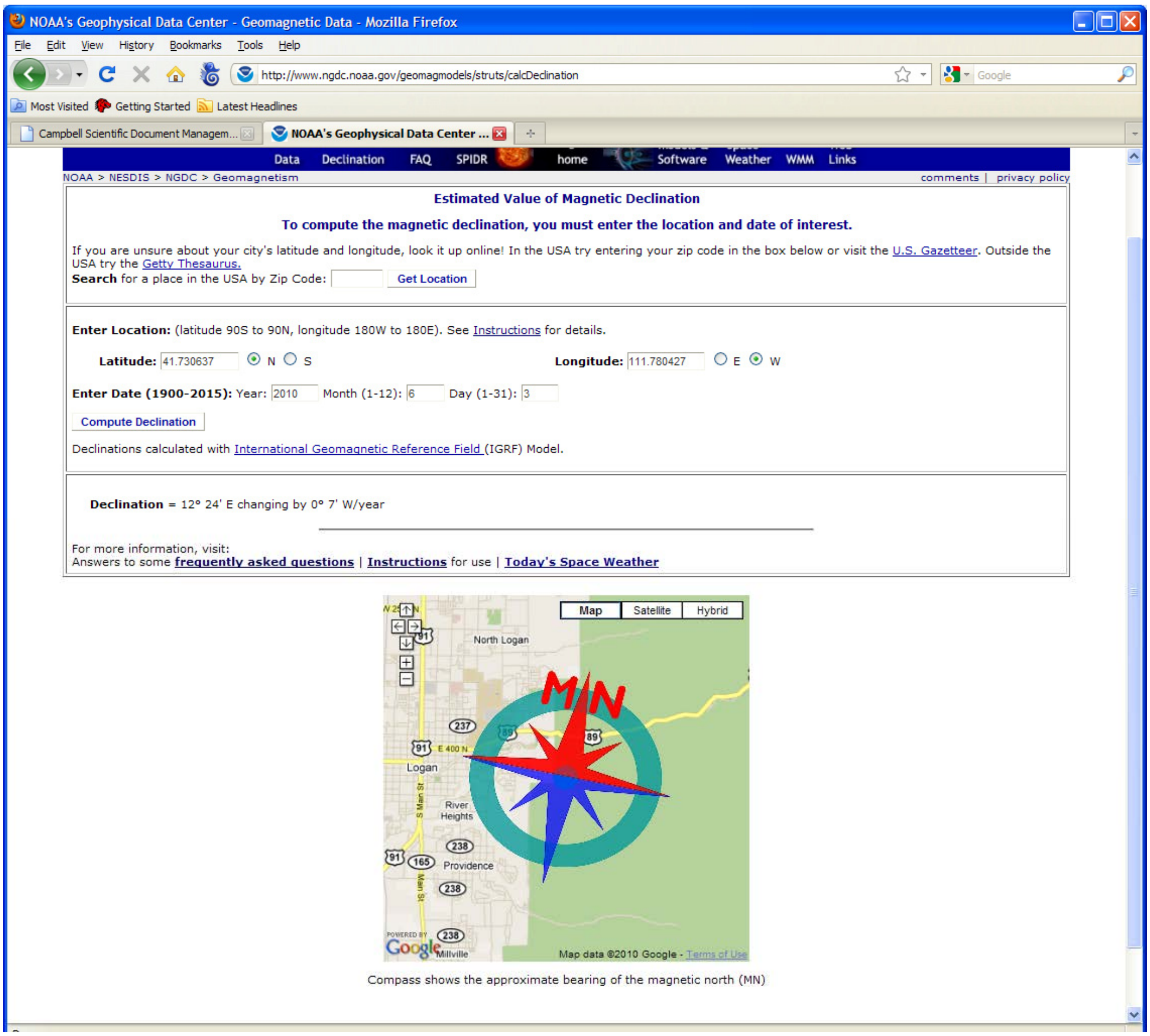


FIGURE 9-4. USGS web calculator

In the example above the declination for Logan, UT is 12º 24′ or 12.4º. As shown in FIGURE 9-4, the declination for Utah is east (positive), so True North for this site is 360 – 12.4 = 347.6 degrees. The annual change is 7 minutes west per year or —7 minutes/year.

Appendix A. Equipment Wiring and Connector Panel Jumper Location

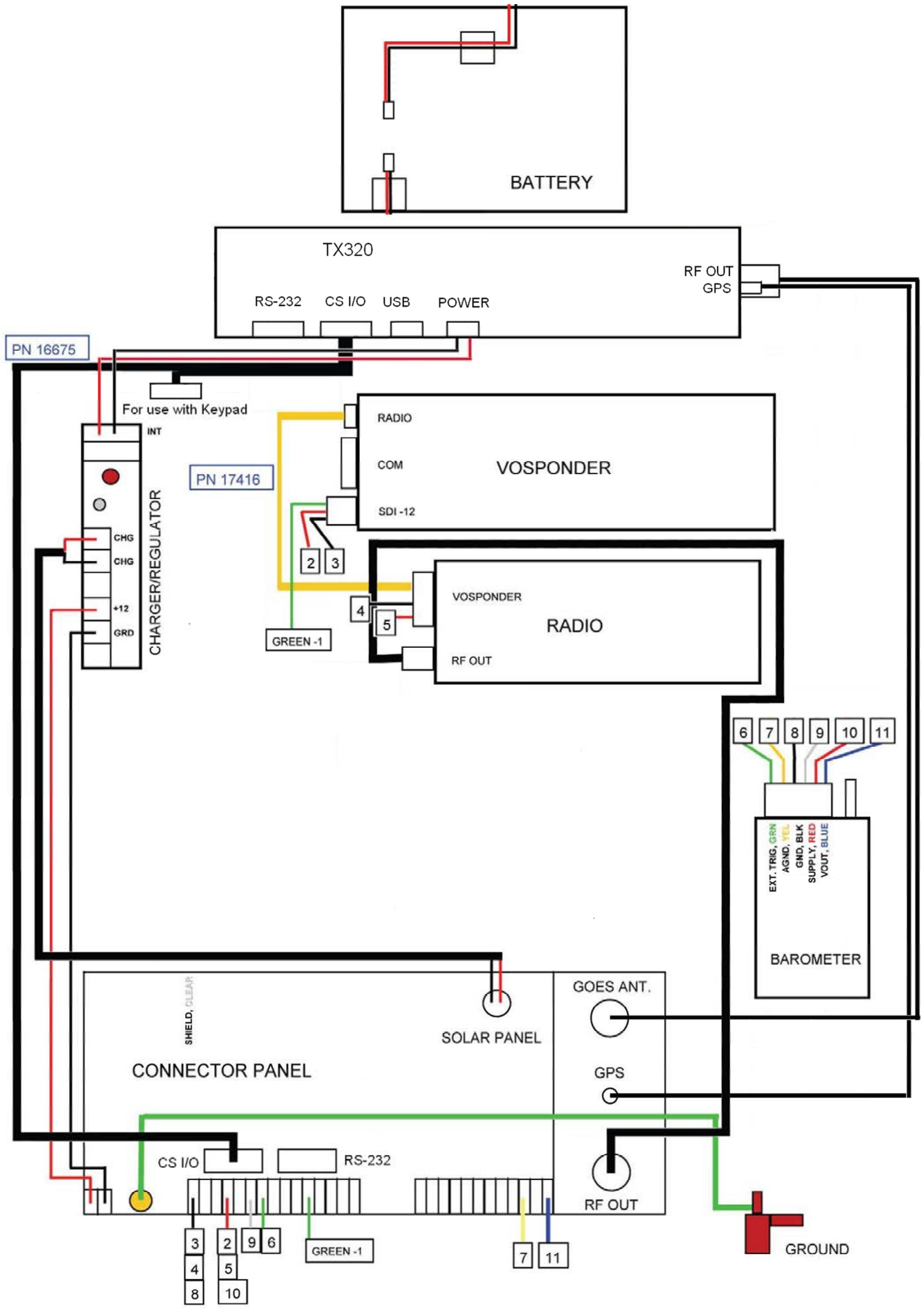


FIGURE A-1. RAWS-H equipment wiring

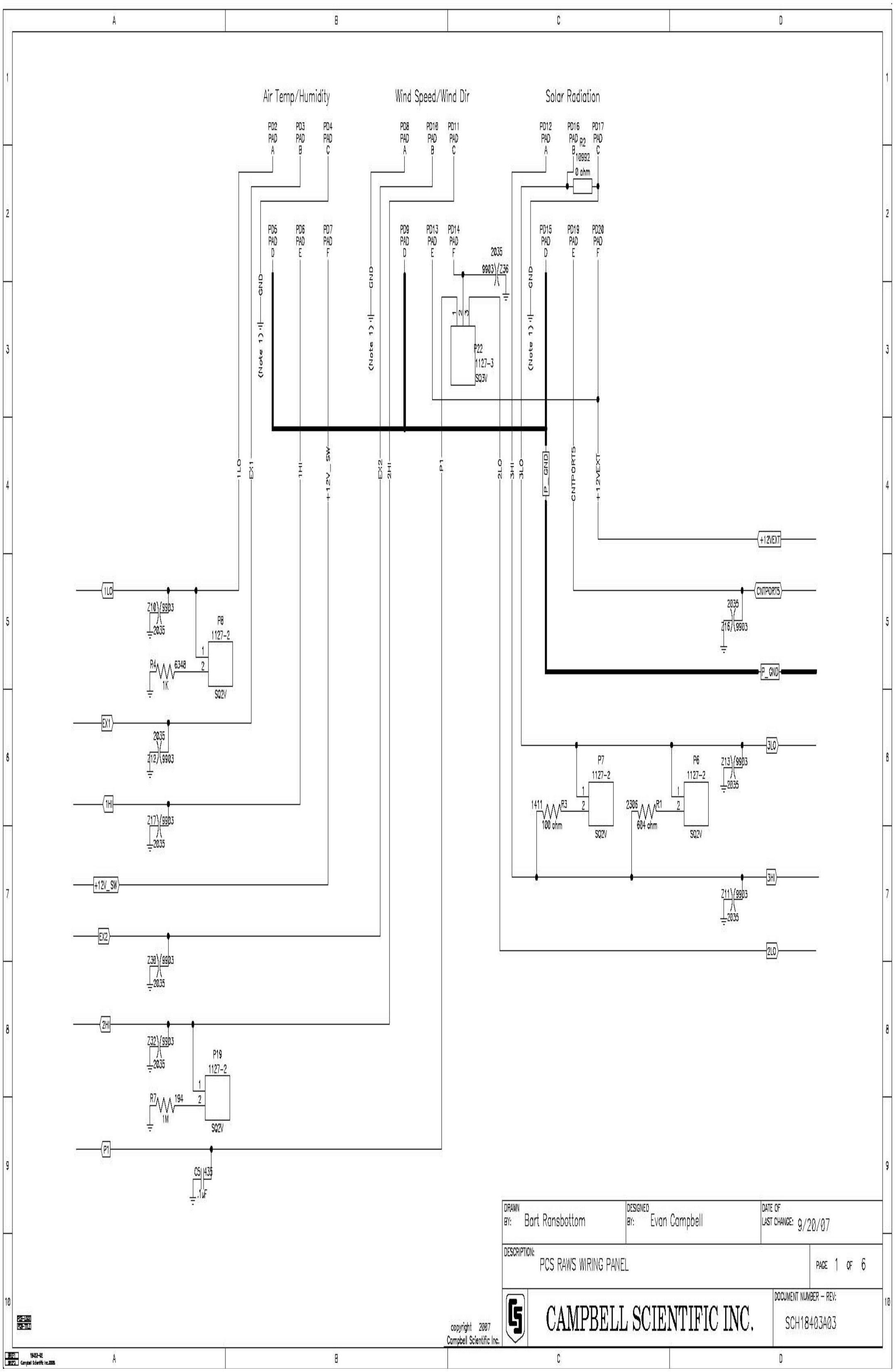


FIGURE A-2. RAWS-H connector panel schematic 1 of 2

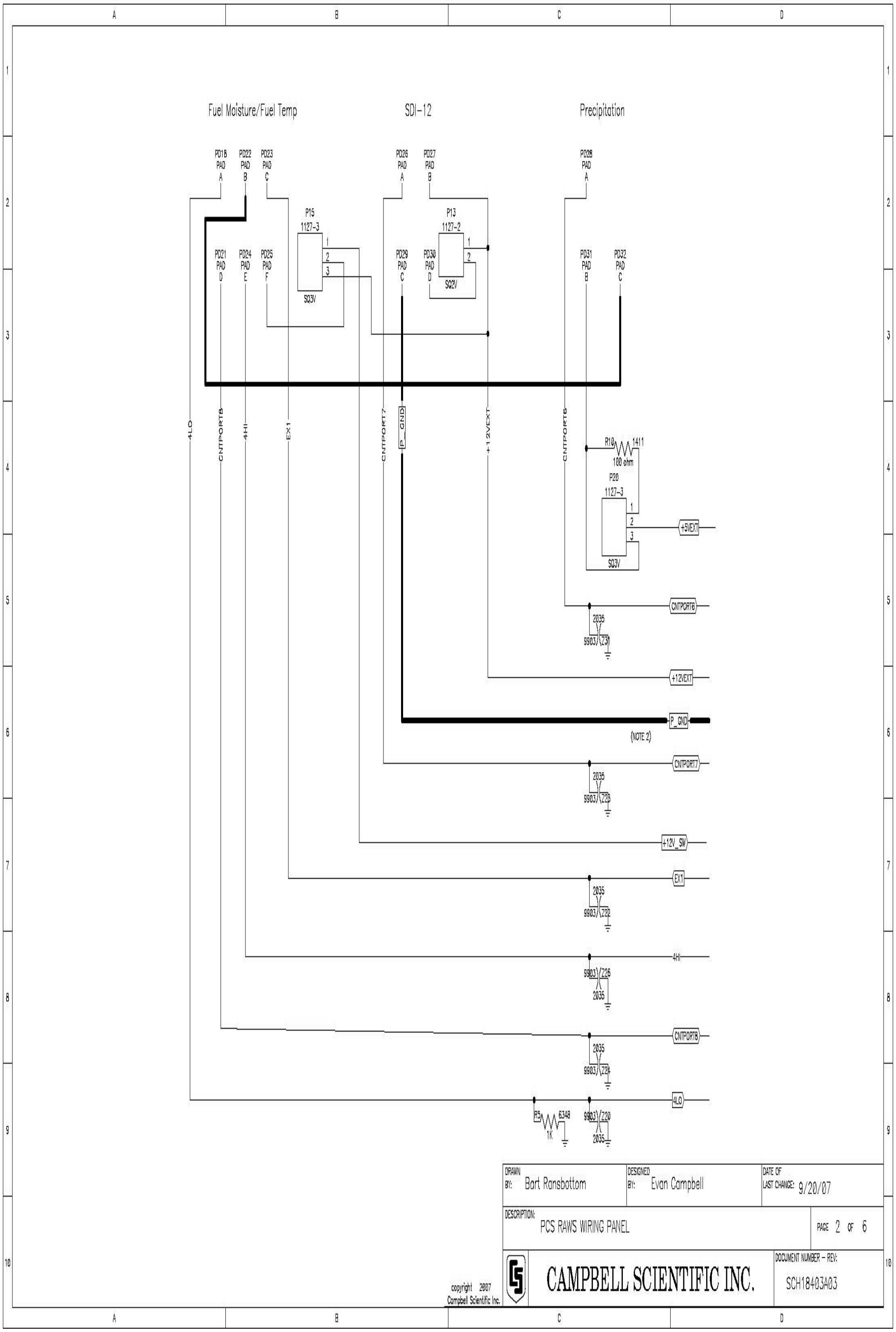
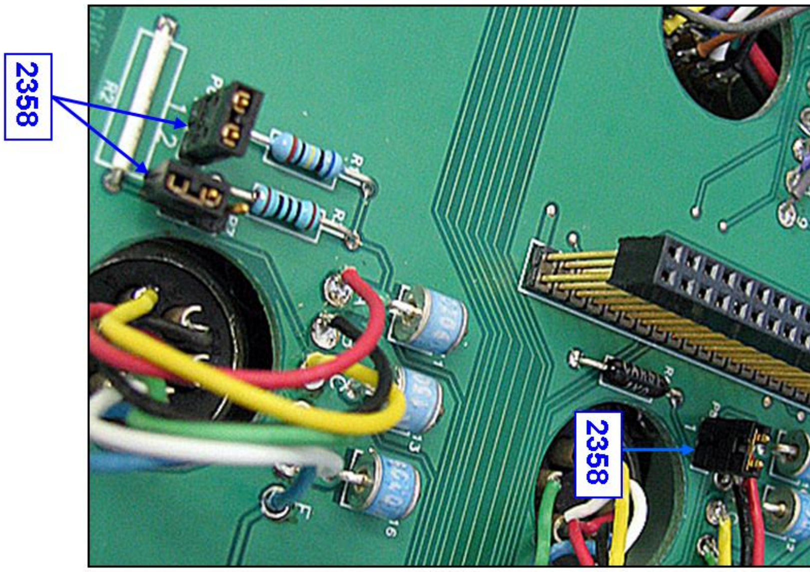
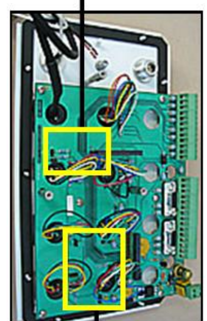


FIGURE A-3. RAWS-H connector panel schematic 2 of 2

Default Jumper Locations

Page A-2			Page A-3		
P22	Jumper	1 to 2	P15	Jumper	1 to 2
	Open	2 to 3		Open	2 to 3
P8	Jumper	1 to 2	P13	Open	1 to 2
P19	Open	1 to 2	P20	Jumper	1 to 2
P7	Open	1 to 2		Open	2 to 3
P6	Jumper	1 to 2			





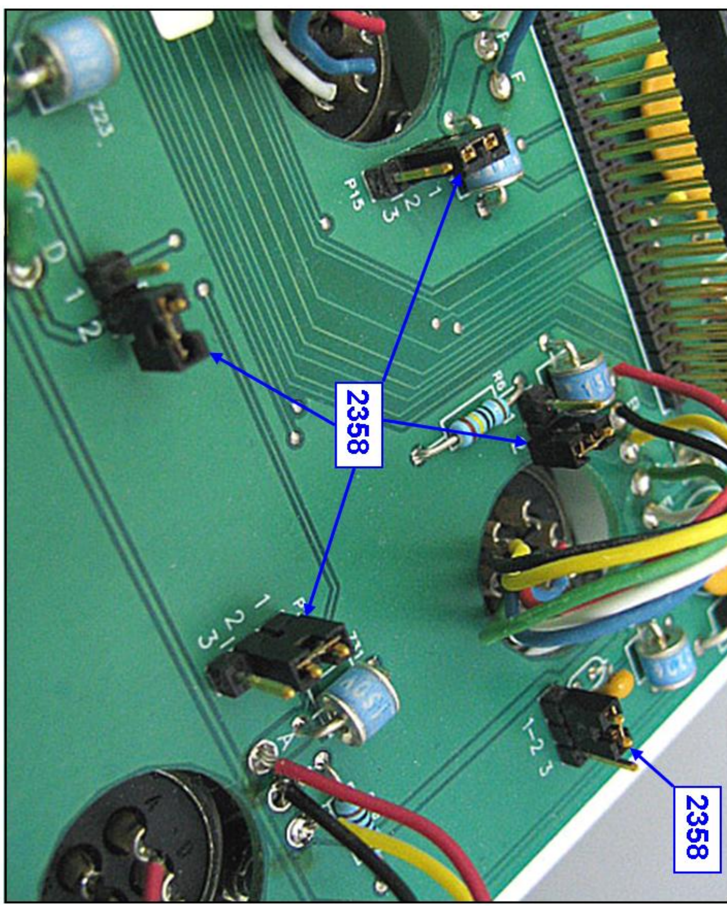


FIGURE A-4. RAWS-H connector panel jumper location

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