



## **PVmet™ 500 Series**

### **User's Guide**

10/11/2018

**Rev. 1.2**

Copyright © 2018 by RainWise, Inc.

All rights reserved. No part of this work may be reproduced in any form except by written permission of the publisher. All rights of translation are reserved.

PVmet™ is a trademark of RainWise, Inc. | [www.rainwise.com](http://www.rainwise.com)

<b>INTRODUCTION</b>	<b>4</b>
<b>INSTALLING THE WEATHER STATION</b>	<b>4</b>
SITING REQUIREMENTS AND CONSIDERATIONS	4
<i>Relative humidity and Temperature SENSOR</i>	5
<i>Anemometer</i>	6
<i>Solar Irradiance SENSORS</i>	6
<i>Back of module temperature sensors</i>	7
MOUNTING	8
<b>ELECTRICAL</b>	<b>9</b>
POWER	10
RS-485	10
WIND	11
<i>Mini Aervane</i>	12
<i>Ultrasonic</i>	13
PRECIPITATION	14
RELATIVE HUMIDITY AND TEMPERATURE	14
BACK OF MODULE TEMPERATURE SENSOR	14
SOLAR IRRADIANCE	16
<b>OPERATION</b>	<b>17</b>
SUNSPEC REGISTER MAP	17
<i>Supported SunSpec models</i>	17
<i>PVmet-500Holding registers</i>	19
<i>Scaling</i>	19
<i>Rainfall Operation</i>	19
<i>Unsupported fields</i>	20
DEVICE SETTINGS	20
<i>Modbus Address (Register 200)</i>	20

<i>Irradiance Sensitivity Settings (Registers 202,203,204)</i>	20
<i>Baud Rate (Register 205)</i>	21
<i>Wind Sensor Selection (Register 206)</i>	21
<i>Rainfall Accumulator (Register 215)</i>	22
<b>GENERAL SPECIFICATIONS</b>	<b>23</b>
SENSORS	23
<i>Operating Environment</i>	23
<i>Ambient Air Temperature Sensor</i>	23
<i>Relative Humidity</i>	23
<i>Barometric Pressure</i>	23
ELECTRICAL	24
<i>Power</i>	24
<i>RS-485</i>	24
<i>Solar Irradiance input</i>	24
MATERIAL SPECIFICATIONS	24
<i>Sensor Assembly</i>	24
<i>Enclosure</i>	25
<b>APPENDIX</b>	<b>26</b>
FULL PVMET-500SUNSPEC MAP	26
FULL DEVICE SETTINGS REGISTER MAP	27
BOTTOM MAST DIMENSIONS	28
<b>SUPPORT</b>	<b>29</b>
<b>WARRANTY</b>	<b>29</b>

## INTRODUCTION

Thank you for purchasing the PVmet-500 weather station. The PVmet-500 is a precision, modular, and compact weather station that uses Modbus communication over RS-485 that is SunSpec compliant. The PVmet-500 was primarily designed for use in the photovoltaic market for monitoring the following parameters:

- Solar irradiance ( $\times 3$ )
- Back of module temperature ( $\times 3$ )
- Wind speed
- Wind direction
- Barometric pressure
- Relative Humidity
- Ambient temperature
- Precipitation

The PVmet 500's easy installation and simple operation make it a preferred choice for the solar irradiance market.

## INSTALLING THE WEATHER STATION



*The weather station is typically mounted out of normal reach, so the system should be operated at ground level to make sure that all components are working properly prior to installation. Operation of the unit is covered in Section RS-485.*

The PVmet-500 was designed to be easily installed in many ways. The base unit consists of a NEMA rated enclosure mounted to a PVC mast with a hygrometer mounted to the top as shown in Figure 1.



Figure 1: PVmet-500 Base unit

## SITING REQUIREMENTS AND CONSIDERATIONS

Weather station sensors can be affected by obstructions and local topography. Each site is different and presents challenges in its own unique way. The PVmet-500 installation requires careful consideration and planning to determine the best location without introducing measurement errors.

---

## RELATIVE HUMIDITY AND TEMPERATURE SENSOR

The relative humidity and ambient air temperature (RHT) are measured with a digital integrated circuit. The RHT sensor is protected within white sloped plastic solar reflecting shields.



Figure 2: RHT sensor solar shield housing

The RHT sensor is susceptible to radiated heat, so it must be located away from heat producing equipment and must be kept away from surfaces that can radiate heat after being exposed to sunlight for extended periods of time. The recommended distance to a large surface (i.e. the ground, cement mounting pad or rooftop) is 1.25m to 2m as shown in Figure 3.

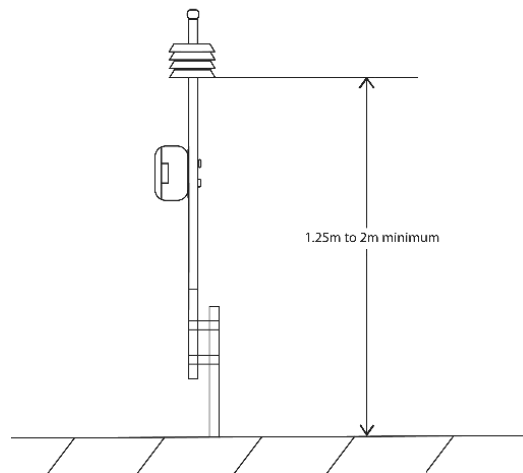


Figure 3: Recommended height for proper ambient temperature readings

If the surface below the RHT sensor is black or a dark color such as asphalt or black roofing material raising the sensor higher is recommended. Adequate air flow improves sensor performance so mounting in free space away from walls is also recommended.

---

## ANEMOMETER

An anemometer can be attached to the top of the PVmet-500Series in place of the supplied top cap as seen in Figure 4.



Figure 4: PVmet-500Series with a Miniaervane and ultrasonic anemometers

Installation instructions are included with each anemometer. The anemometer is typically located 10m above the ground. Buildings, trees, and other obstructions can cause turbulent air which may impact the accuracy of the wind speed/direction measurements. To reduce added inaccuracies the anemometer must be located greater than 10x the height away from any obstructions as shown in Figure 5.

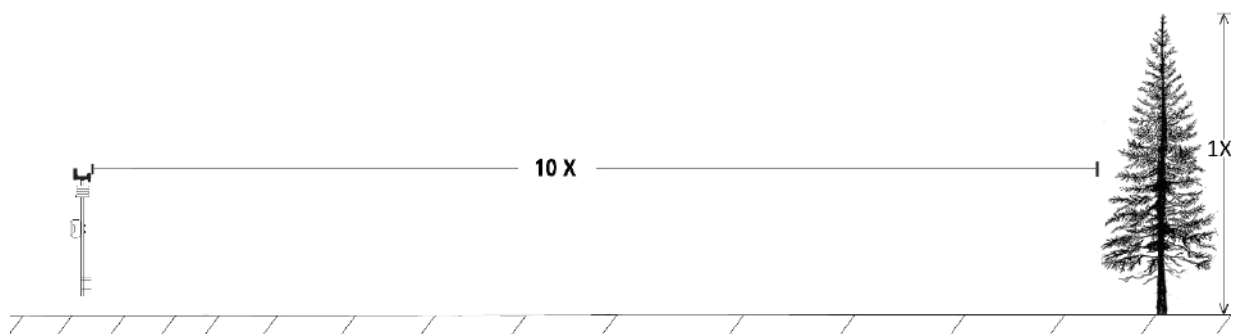


Figure 5: Minimum distance to obstructions

Even at 10x the distance of the height, turbulent air can cause inaccurate measurements, so it is recommended to use the 10x rule as an absolute minimum.

---

## SOLAR IRRADIANCE SENSORS

Solar irradiance sensors are sensitive pieces of electronics that require careful installation. The PVmet-500 supports up to three solar irradiance sensors. Typical installations will have a global and plane of array (P.O.A.) with some having a third sensor mounted to measure diffuse or ground reflected irradiance.

The global irradiance sensor must be positioned with as much exposure to the sky as possible. Errors from reflected light off buildings or from shading will cause significant errors. Most sensors include a small bubble level to aid in installation but if not equipped a torpedo level can be used to level the sensor in both axis.

P.O.A. sensors can be mounted to the solar array or separately. If the solar panels are mounted on a tracking system, then the P.O.A. sensor must also be mounted on the tracking system. If the solar panels are not on a tracking system, then the angle of the panels can be measured and the P.O.A. sensor set to the same angle but will have to be readjusted if the panels alignment is changed seasonally.

For diffuse or ground reflected sensors follow the instructions that come with the sensor.



*Each solar irradiance sensor will come with directions for proper mounting and they should be followed carefully.*

---

#### BACK OF MODULE TEMPERATURE SENSORS

The back of module temperature sensors (B.O.M) are 2-wire, resistive NTC devices. Sensors should be mounted near the center of the panel to more accurately represent the overall average panel temperature. The sensors are provided with thermally conductive adhesive tape. Epoxy cement can be used if desired, but this will make removal/replacement difficult.

## MOUNTING MAST

The bottom mast is mounted first using bolts or U-bolts which can be provided separately. Typical installation is using U-bolts to attach the bottom mast to horizontal sections of Unistrut® close to the inverter monitoring equipment as shown in Figure 6.

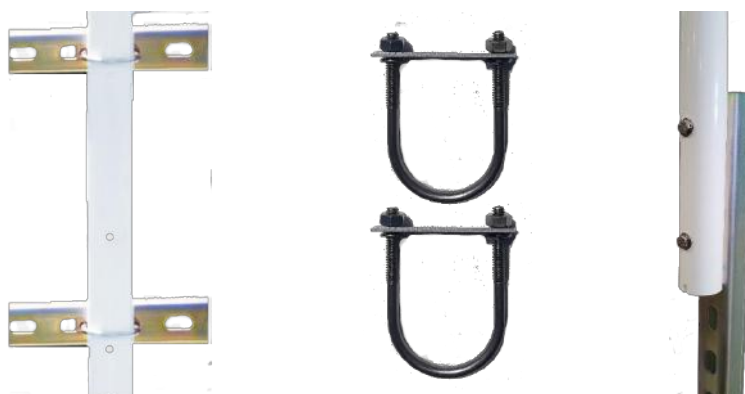


Figure 6: Possible mounting solutions

Care must be taken to not overtighten the U-bolts or bolts which could damage the PVC mast. The dimensions for the bottom mast are shown in Figure 17.

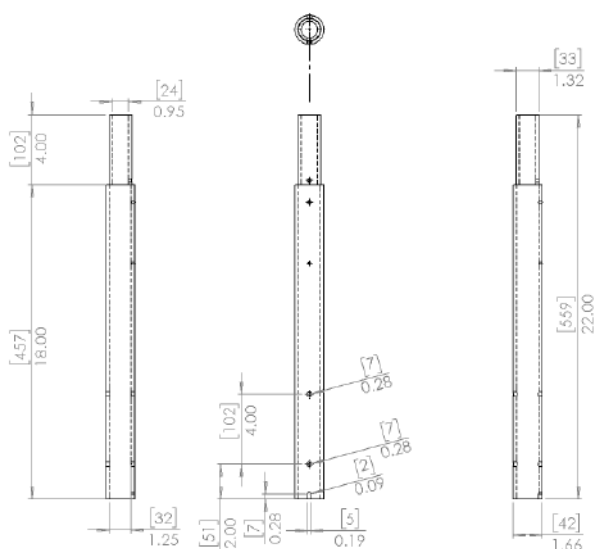


Figure 7: Mast dimensions in inches [millimeters]

The bottom mast should be mounted as vertical as possible in both X and Y axis. Verified with a level. Having the mast located close to vertical is important for proper operation of the wind anemometer if so equipped.

The bottom mast has a #2 Phillips screw near the top that the top unit slides over. Facing the screw out towards where the station is easiest to access will make accessing the panel easier in the future. The topmast can rotate independently of the middle mast so the anemometer can be properly aligned to the North, indicated by a small N near the bottom of the anemometer on the topmast or by



the small N located on the ultrasonic anemometer. Both the screw for the topmast and the screw for the entire top unit must be tightened to finalize the installation.

## ELECTRICAL



*Electrical connections should be verified before applying power to the unit to prevent the possibility of causing permanent damage.*

The PVmet-500i is designed to be electrically robust if properly installed following the instructions in this manual. The enclosure has a built-in latch on the right side of the unit. To open, push in on the latch and pull the cover open. This latch securely keeps the enclosure closed, if additional security is needed there is an eye for a tag or padlock.

Cable quick entry/retention slots are located on the bottom side of the enclosure for easy installation of additional sensor cables as shown in Figure 88.



Figure 8: Cable entry retaining slots

The rubber seals minimize dust and water intrusion. Care should be taken when placing new cables in the slots so that the cables do not create large openings.

## POWER REQUIREMENTS

The power circuit is electrically isolated providing excellent protection from ground loop faults. The PVmet-500 requires a 10-30VDC, 1.5W power supply. Large wattage supplies can be used.

Reverse input and overcurrent protection are provided on board. Figure 99 shows proper termination of the power connections with a single point ground.



*The supply is fully isolated. The 0V and Earth ground inputs are not connected internally. Earth ground must be connected to the PVmet-500.*

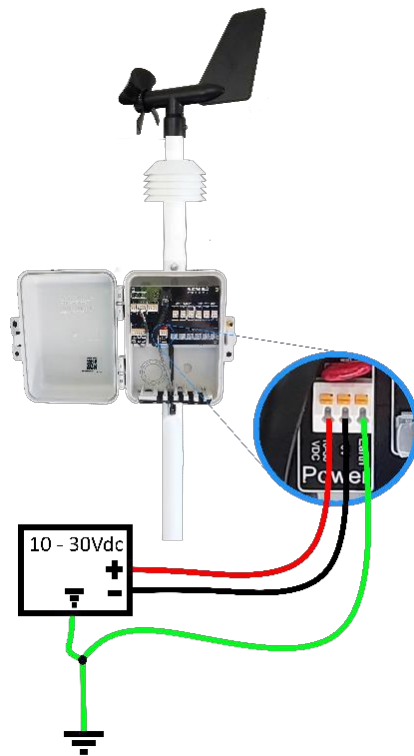


Figure 9: Power connections with a single point ground



*If the incoming power wiring is shielded, the shield connection should be connected at the power supply end only. The earth connection is critical for protection and noise mitigation. The earth connection should be connected to the common bonding point within the cabinet the power supply is in.*

## RS-485 COMMUNICATIONS

The PVmet-500 uses RS-485 communication because of its reliable nature and its widespread adoption by industry. The RS-485 communication circuit is electrically isolated from the rest of the PVmet-500 main board to prevent damage from ground mismatches. The RS-485 circuit is also hardened against ESD, EMI, DC overvoltage, and AC power line cross using gas discharge tubes and high voltage current limiting devices. RS-485 requires three connections for reliable communication shown in Figure 10.



Figure 10: RS-485 Connections

Additional connections are provided as jumpers for connecting more RS-485 devices. The two A and B terminal pairs are internally connected.

The A(-) and B(+) connections are differential providing excellent noise immunity and the third connection is the common input which gives a reference for the other lines. A shield should also be used to shunt away the noise and because the RS-485 circuit is completely isolated the shield can be used for the common connection as well. A typical installation is shown in Figure 11.

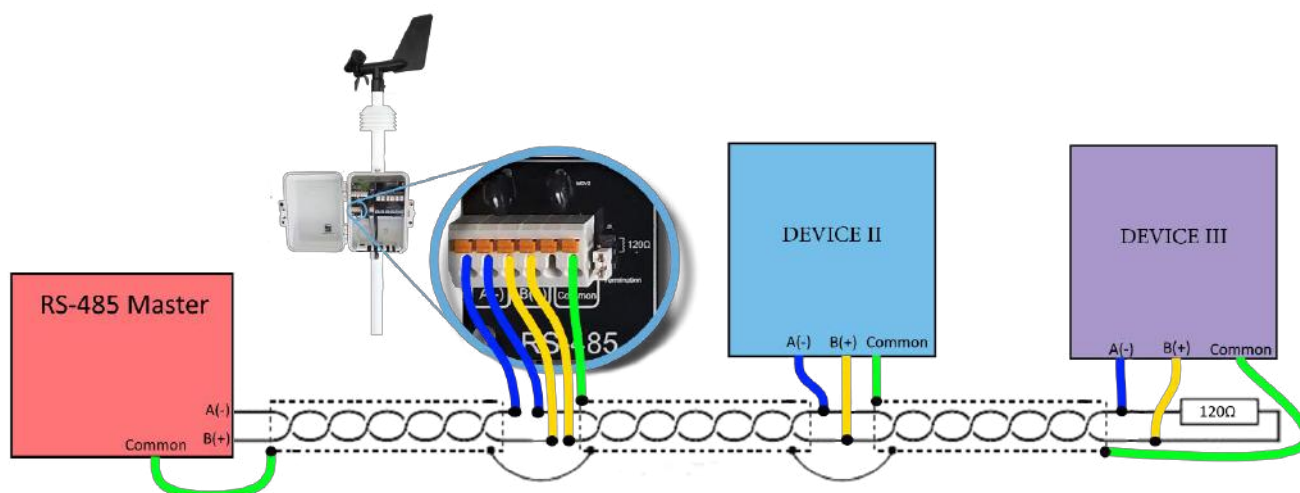


Figure 11: Typical installation where the shield and ground are used together

The wiring for the A(-) and B(+) should be twisted pair 50Ω impedance cable for better signal quality. A 120Ω termination resistor is provided on the board and is enabled by placing the provided jumper across the resistor symbol. The termination resistor may not be required if the RS-485 run is less than 10 meters and there are only two devices within the network. The termination resistor should only be used on the last device in the series of devices. Typically, the termination should be applied at both ends of the cable. An additional termination resistor may be required at the master. For most installations start with no termination. If communication issues are observed then apply the termination to reducing ringing.

## WIND SENSOR CONNECTIONS

Two different styles of the wind anemometer sensor are supported, the Mini Aervane (typical) and an optional ultrasonic anemometer. See Wind Sensor Selection (Register 206) for selecting which type is used.

---

## MINIAERVANE

The typical PVmet-500 installation will come with the Miniaervane anemometer which provides the wind speed from 0 to 67m/s as well as the wind vector in 16 cardinal directions. The Miniaervane uses RJ45 connectors on the main board and on the bottom of the sensor as shown in Figure 12.

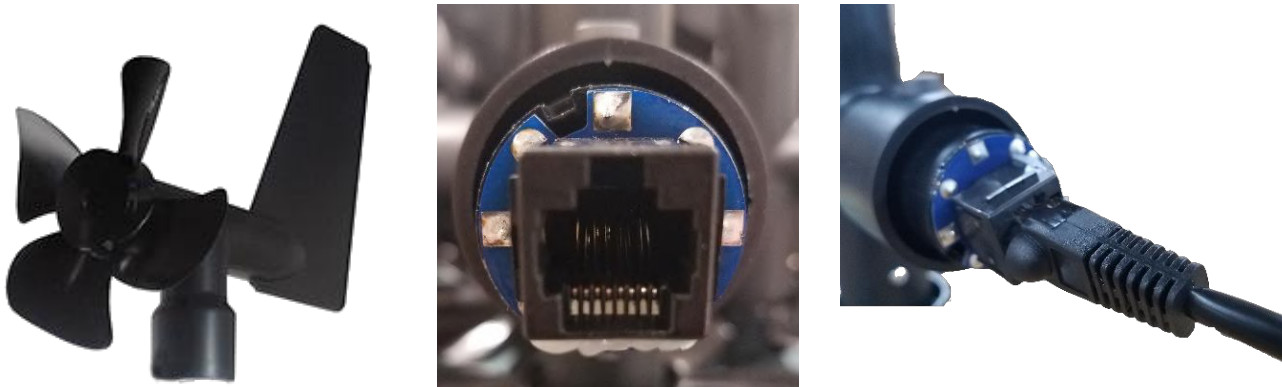


Figure 12: Miniaervane connections

To install the Miniaervane remove the cap screw and remove the cap. Also, remove and discard the red cable support plug in the top of the mast. Connect the RJ-45 connector to the sensor and slide the Miniaervane onto the mast making sure the slot on the base is aligned with the screw as shown in

Figure 13.



Figure 13: Miniaervane slot



Figure 14: Miniaervane properly installed

The screw is then tightened down without over tightening and the Miniaervane is installed as shown in Figure 14.

---

## ULTRASONIC

Provision is provided for connecting an ultrasonic anemometer, showing in Figure 15, instead of the Miniaervane. The ultrasonic sensor provides both wind speed and direction without any moving parts. The ultrasonic sensor uses the same power as the power in and is isolated from the rest of the motherboard. The ultrasonic sensor used must be verified capable of using the customer supplied power in the range from 10 to 30VDC.



Figure 15: Ultrasonic sensor

To install the ultrasonic anemometer, remove the cap screw and remove the cap. Also remove the cable support plug in the top of the mast. To wire in the ultrasonic the RJ45 cable can be used to pull the wires for the ultrasonic through the mast section. It may be easier to cut the RJ45 connector off the end of the cable then tape the ultrasonic wires to it to pull it through. If the cable is having difficulty getting through the mast the two bolts holding the PVmet-500 enclosure on the mast can be temporarily removed and then reinstalled after the cable is pulled through.

The ultrasonic communicates with the PVmet-500 using a serial RS-232 cable. Connect the sensors transmit (TX) to the PVmet-500's receive (RX) terminal. The sensor RX is connected to the PVmet-500's TX terminal. The ultrasonic sensor provided by RainWise is part number 500-0913 and is shown below in Figure 16.



Figure 16: RainWise ultrasonic part number 500-0913


## RAINFALL / PRECIPITATION SENSOR

There are two terminals on the main board for an optional rain gauge. The PVmet-500 is compatible with any 0.2mm tipping bucket rain gauge that uses a normally open switch contact. The inputs are not polarity sensitive.

## RELATIVE HUMIDITY AND TEMPERATURE SENSOR

The relative humidity/temperature sensor is pre-installed at the factory. The sensor is precisely placed within the tube putting the sensor in-line with holes to allow adequate air flow. If the sensor requires replacement, separate the top mast from the middle mast while feeding a little cable up through the hole under the enclosure.

The temperature sensor is mounted on a long thin PCB board that has ears for locating it in the proper position within the temperature shield stack. Because the sensor is exposed to moisture and dust the cable is terminated on the board and completely sealed so the cable and sensor are changed as a unit. It can be difficult to get the new cable feed through the mast then up through the hole below the enclosure so attaching a tagline to the old sensor before removing it will make installation of the new sensor easier.

RHT Terminal	Wire Color	
+	Red	
DA	Green	
CL	White	
-	Black	

## BACK OF MODULE TEMPERATURE SENSOR

The PVmet-500 is designed to support up to three back of module (BOM) temperature sensors as shown in Figure 17.



Figure 17: BOM sensors

The only BOM sensors supported are provided by RainWise and they are 10K PTC thermistors in an aluminum housing. No other temperature sensors are supported at this time. The sensors are purely resistive, so the electrical connections are reversible. The cable for the BOM sensor is shielded for noise reduction and to protect from ESD/EMI. The shield is not connected at the sensor end it is only to be connected at one point, directly at the main board using the 360° shield connector which is internally connected to the earth ground connection. Notice how the shield wire is wrapped around the sheath of the cable in Figure 17.



Figure 17: Typical BOM wire end and wire end with wrapped shield

The 360° shield spring clamp provides a solid shield connection and a good path for dissipating noise and transients. To attach the cable simply press the cable with wrapped shield into the spring clamp as shown in Figure 18.



Figure 18: BOM cable inserted into 360° shield connection

Properly connecting the shield is important for sensor accuracy and system protection. If the BOM sensor is located too far from the PVmet-500 for the included length of cable an extension cable can be used if the shield is connected and not connected to ground except at the PVmet-500 360° shield connector. Changing the length of the cable will cause an error in the temperature reading. To counter the added error of a longer cable a temperature derating factor of  $-0.041\text{ }^{\circ}\text{C}$  per meter of extended cable. Table 1 shows some common examples of temperature correction.

Table 1: Example BOM temp corrections due to longer cables.

Extended Cable (m)	Temp (C°)	Temp reported by station (C°)	Correction to Add (C°)
10	25	25.041	$-0.0041 \times 10 = -0.041$
50	25	25.205	$-0.0041 \times 50 = -0.205$
100	25	25.41	$-0.0041 \times 100 = -0.41$
100	40	40.41	$-0.0041 \times 100 = -0.41$

## SOLAR IRRADIANCE

Solar irradiance is the primary measurements for the PVmet 500. There are 3 solar irradiance inputs. The maximum voltage output allowed for solar irradiance sensors is 1.5V. The inputs are well protected against EMI/ESD but due to the low voltage signals from solar irradiance sensors, they are highly sensitive. Care must be taken to route cabling away from electrically noisy equipment such as power inverters and motors. The solar irradiance sensor must have a shielded wire. The shielded wire must not be connected at the sensor end, it is to be terminated at the PVmet-500360° shield connection only as depicted in 20.



Figure 20: Solar irradiance sensor shield connection

Due to the high input impedance of the solar irradiance inputs additional cable length should not cause a significant error, but keeping cable runs as short as possible will help minimize error from noise.



## OPERATION

The PVmet-500 is designed to work with an RS-485 SunSpec compliant host. The PVmet-500 communicates with a host logger, DCS or SCADA via Modbus RTU interface. The system requirements are listed in

Table 2.

Table 2: Default Modbus RS-485 Communication settings

<b>Baud Rate:</b>	9600 or 19200bps
<b>Parity:</b>	None
<b>Stop Bits:</b>	1
<b>Data bits:</b>	8
<b>Slave Address:</b>	60
<b>Interface mode:</b>	2-wire half duplex
<b>Max Modbus Poll Rate:</b>	100ms

## SUNSPEC REGISTER MAP

The PVmet-500 was designed to follow SunSpec models outlined by the SunSpec Alliance. Other registers other than SunSpec specified ones are provided for extra features if desired.

---

### SUPPORTED SUNSPEC MODELS

The PVmet-500 is SunSpec compliant and supports several environmental and irradiance models 302, 303 and 307.

The 302 model is for solar irradiance. The PVmet-500 provides data for global horizontal irradiance, plane-of-array irradiance and other irradiance, all other data should be ignored. The 302 model has the following data characteristics shown in Table 3.

Table 3: SunSpec model 302, Solar Irradiance

Address Offset	Block Offset	Size	Name	Label	Value	Type	Units	SF	R/W	Description
0		1	ID	Irradiance Model	302	uint16			R	Include to support various irradiance measurements
1		1	L		5	uint16			R	Model Length
2	0	1	GHI	GHI		uint16	W/m2		R	Global Horizontal Irradiance
3	1	1	POAI	POAI		uint16	W/m2		R	Plane-of-Array Irradiance
4	2	1	DFI	DFI		uint16	W/m2		R	Diffuse Irradiance
5	3	1	DNI	DNI		uint16	W/m2		R	Direct Normal Irradiance
6	4	1	OTI	OTI		uint16	W/m2		R	Other Irradiance

The 303 model in the SunSpec standard is for the back of module (BOM) temperature sensors and has the following characteristics shown in Table 4.

Table 4: SunSpec model 303, back of module temperature

Field Type	Address Offset	Block Offset	Size	Name	Label	Value	Type	Units	SF	R/W	Description
Header	0		1	ID	BOM Temperature Model	303	uint16			R	Include supporting a variable number of BOM temperature measurements
Header	1		1	L		2	uint16			R	Model Length
Repeating Block	2	0	1	TmpBOM	Temp		int16	C	-1	R	Back of module temperature measurement

Model 307 in the SunSpec standard is for the base meteorological. The PVmet-500 can produce data for:

- Ambient Temperature
- Relative Humidity
- Barometric Pressure
- Wind Speed
- Wind Direction
- Rainfall

The rest of the data for model 307 can be ignored. Table 5 shows the SunSpec model 307 data characteristics.

Table 5: SunSpec model 307, base meteorological

Field Type	Address Offset	Block Offset	Size	Name	Label	Value	Type	Unit	SF	R/W	Description	Notes
Header	0		1	ID	Base Met	307	uint16			R	Base Meteorological Model	This model supersedes model 301
Header	1		1	L		11	uint16			R	Model Length	
Fixed Block	2	0	1	TmpAmb	Ambient Temperature		int16	C	-1	R		
Fixed Block	3	1	1	RH	Relative Humidity		int16	Pct		R		
Fixed Block	4	2	1	Pres	Barometric Pressure		int16	HPa		R		
Fixed Block	5	3	1	WndSpd	Wind Speed		int16	m/s		R		
Fixed Block	6	4	1	WndDir	Wind Direction		int16	deg		R		
Fixed Block	7	5	1	Rain	Rainfall		int16	mm		R		
Fixed Block	8	6	1	Snw	Snow Depth		int16	mm		R		
Fixed Block	9	7	1	PPT	Precipitation Type		int16			R	Precipitation Type (WMO 4680 SYNOP code reference)	
Fixed Block	10	8	1	ElecFld	Electric Field		int16	Vm		R		
Fixed Block	11	9	1	SurWet	Surface Wetness		int16	kΩ		R		
Fixed Block	12	10	1	SoilWet	Soil Wetness		int16	Pct		R		

## PVMET-500HOLDING REGISTERS

A complete table of all the SunSpec holding registers is shown in the appendix.

The PVmet 500's first register C SunSpec ID is located at 40,001. This document assumes base 1 addressing is being used. If the host system uses base 0 addressing, decrement the starting register values shown by 1.

All registers in the SunSpec Register map are read-only. Use the Modbus 03 command to access the data. Do not attempt to read beyond the specified map, the PVmet-500 may not respond.

## SCALING

Holding registers only support integer values (no decimal points). To improve resolution many of the measured values are scaled up by a factor of 10 or 100. The Modbus master must convert the data point to a floating-point variable and multiply by the "scale factor" indicated in the table below. For example, a temperature of 25.3°C will be reported as 253. Multiplying by the scale factor of 0.1 results in a final value of 25.3.

## RAINFALL OPERATION

The SunSpec specification for rainfall mandates that the rainfall register 40 077 will reset after each Modbus poll. To effectively use this parameter, the host system must implement a separate running rainfall counter variable in the host system. The contents of the rainfall register must then be added to this variable on EVERY read. As this may be difficult to implement on many systems a second register has been provided outside the SunSpec register map. The separately provided value is a running counter in mm.

---

## UNSUPPORTED FIELDS

The register map reserves register for all combinations of sensors supported by the RainWise stations. Not all will be available on any one system. Sensors/fields that are not supported can contain the hexadecimal value of 8000. Some fields require the purchase of additional sensors. The values reported by fields that don't have valid sensors installed should be ignored.

## DEVICE SETTINGS

All settings and user selectable options are configured using a set of Modbus registers. These registers are located outside of the standard SunSpec register block. They do not affect a SunSpec compliant logger's ability to correctly identify and read the PVmet 500. A terminal emulator program is required to change device settings for use with any other protocol.

---

### MODBUS ADDRESS (REGISTER 200)

The PVmet-500 comes with a default Modbus address of 60. The address can be changed by writing to register 200 shown in Table 6.

Table 6: Device setting Modbus Id

	#	Name	Type	Units	Scale Factor	Contents	R/W	Description
200	1	Modbus Id	int16	-	-	60	R/W	Modbus device address

Once the address is written the PVmet-500 will store the new address in permanent flash memory. The new address will take effect immediately. The valid address range is 1 to 255.



It is only recommended to change this address if a conflict is anticipated. If the address has been modified and is unknown it can be discovered by reading only holding register number 200 at Modbus address 250. Be sure to only read a single register. The PVmet-500 will not respond to register read requests other than 200. You cannot write to this register with address 250. Set your master to read the address reported and then write the desired address to register 200.

---

### IRRADIANCE SENSITIVITY SETTINGS (REGISTERS 202,203,204)

Irradiance sensors have a range of sensitivity calibrations. This can vary from sensor to sensor. In most cases, especially with thermopile sensors, each sensor will be supplied with a sensitivity constant. This is typically expressed as microVolts per Watt meter squared ( $\mu\text{V}/\text{Wm}^{-2}$ ). The PVmet-500 defaults all three sensor inputs to 5.00  $\mu\text{V}/\text{Wm}^{-2}$ . Taking the scale factor into account the constant is expressed as 500. The sensitivity registers are shown in in

Table 7: Device setting registers for solar irradiance sensitivity

	#	Name	Type	Units	Scale Factor	Contents	R/W	Description
201	1	Irradiance_Global_Sensitivity	uint16	$\mu\text{V}/\text{Wm}^{-2}$	0.01	500	R/W	Sensitivity setting of solar irradiance sensor
202	1	Irradiance_Plane_of_Array_Sensitivity	uint16	$\mu\text{V}/\text{Wm}^{-2}$	0.01	500	R/W	Sensitivity setting of solar irradiance sensor
203	1	Irradiance_Other_Sensitivity	uint16	$\mu\text{V}/\text{Wm}^{-2}$	0.01	500	R/W	Sensitivity setting of solar irradiance sensor

To input the correct value for the sensitivity, divide the sensitivity displayed on the solar irradiance sensor by the scale factor as shown below.

$$\frac{(\text{sensor sensitivity}) \mu V / W m^{-2}}{\text{scale factor}} = \text{register value}$$

$$\text{Example: } \frac{5.00 \mu V / W m^{-2}}{0.01} = 500$$

Some sensors have sensitivities specified in  $W m^{-2} / mV$  which must be converted to  $\mu V / W m^{-2}$  by inverting the sensitivity as shown below.

$$(\text{sensor sensitivity}) \mu V / W m^{-2} \rightarrow \frac{mV}{((\text{sensor sensitivity}) W m^{-2})}$$

Then convert the mV to  $\mu V$  by multiplying by 1000.

$$\frac{mV}{(\text{sensor sensitivity}) W m^{-2}} = \frac{1000 \mu V}{(\text{sensor sensitivity}) W m^{-2}} = \frac{1000}{(\text{sensor sensitivity})} \mu V / W m^{-2}$$

$$\text{Example: } 20.00 W m^{-2} / mV \rightarrow \frac{mV}{20.00 W m^{-2}} = \frac{1000 \mu V}{20.00 W m^{-2}} = 50 \mu V / W m^{-2}$$

The value put into the register for a sensor with  $20.00 W m^{-2} / mV$  would be  $50 \mu V / W m^{-2} / 0.01 = 5000$ .

---

## BAUD RATE (REGISTER 205)

The PVmet-500 can operate at two different baud rates, 9600 and 19200. Register characteristics are shown in Table 1.

Table 8: Device settings baud rate register

	#	Name	Type	Units	Scale Factor	Contents	R/W	Description
205	1	Baud Rate	uint16	-	-	9600	R/W	Baud Rate, 9600 or 19200

The default baud rate is 9600. The baud rate can be optionally increased to 19,200 baud. Write either 9600 or 19200 to this register. The baud rate change takes effect after a reboot or power cycle.

---

## WIND SENSOR SELECTION (REGISTER 206)

The PVmet-500 supports either the RainWise Miniaervane or ultrasonic wind sensor. The default selection for register 206 is a 0 which is the RainWise Miniaervane. Writing a 1 to register 206 will enable ultrasonic wind sensor support.

Table 9: Device settings wind sensor selection register

	#	Name	Type	Units	Scale Factor	Contents	R/W	Description
206	1	Wind Sensor	uint16	-	-	0	R/W	Wind Sensor Selector, 0 = prop, 1 = ultrasonic

Table 1 lists the requirements for using an ultrasonic sensor.

Table 10: Ultrasonic sensor requirements

<b>Power:</b>	10 -30VDC
<b>Interface:</b>	RS-232
<b>Protocol:</b>	NMEA0183
<b>Baud Rate:</b>	4800
<b>Data Bits:</b>	8
<b>Parity:</b>	None
<b>Stop Bits:</b>	1

---

#### RAINFALL ACCUMULATOR (REGISTER 215)

Due to the restrictions of how rainfall is processed in SunSpec the PVmet-500 maintains a secondary rainfall accumulation counter.

	#	Name	Type	Units	Scale Factor	Contents	R/W	Description
215	1	Rainfall Accumulation	uint16	mm	0.01	0	R/W	Accumulation in mm

This register continually accrues rainfall and does not reset on reading as does the Sunspec register for rainfall. Rainfall is reported in 10ths of a millimeter. The register will accumulate up to a maximum accumulation of 6553.5 mm (reported as 65535). The register will roll over back to zero on the 6553.6 mm of rain. The register will also return to zero if power is interrupted. This register can be written to at any time. It is recommended that the host system clears the register once a day once the daily total has been recorded.

## GENERAL SPECIFICATIONS

All specifications are to be assumed at 25°C unless otherwise specified.

## SENSORS

---

### OPERATING ENVIRONMENT

Temperature:	-40°C to 60°C (-40 to 140°F)
Humidity:	0-100% Condensing

---

### AMBIENT AIR TEMPERATURE SENSOR

Range:	-40°C to 70°C (-40 to 158°F)
Accuracy:	+/- 0.4°C (0.5°F)
Thermal Time Constant:	30 sec.
Resolution:	0.1°C

---

### RELATIVE HUMIDITY

Range:	0 to 100%
Accuracy:	+/-5%
Resolution:	1%

---

### BAROMETRIC PRESSURE

Range:	552 to 1084 hPa (mbar)
Accuracy:	+/- 1.7 hPa (mbar)
Resolution:	1 hPa (mbar)

## ELECTRICAL

### POWER

Voltage:	10-30VDC
Current:	150mA Peak, 50mA nominal

### RS-485

Operating Voltage:	-7 to +12VDC
Output voltage low:	0.4VDC
Output voltage high:	4.6VDC
Input voltage high:	3.5VDC
Input voltage low:	0.8VDC
Input Hysteresis:	0.22VDC
Input pullup/pulldown current:	$\pm 10\mu\text{A}$

### SOLAR IRRADIANCE INPUT

Voltage Input:	$\pm 1.5\text{V Max}$
Input current:	$\pm 0.2\text{nA}$
Common mode voltage:	1.65VDC
Differential input only	

## MATERIAL SPECIFICATIONS

The PVmet-500 is made with 100% RoHS compliant materials.

### SENSOR ASSEMBLY

Mast:	Polyvinyl Chloride
Heat Shields:	Acrylonitrile Butadiene Styrene



---

## ENCLOSURE

Body:	Polypropylene with UV inhibitor
Hardware:	18-8 Stainless Steel
	Powder Coated 5052 Aluminum
Wire Ingress:	Foam Rubber

## APPENDIX

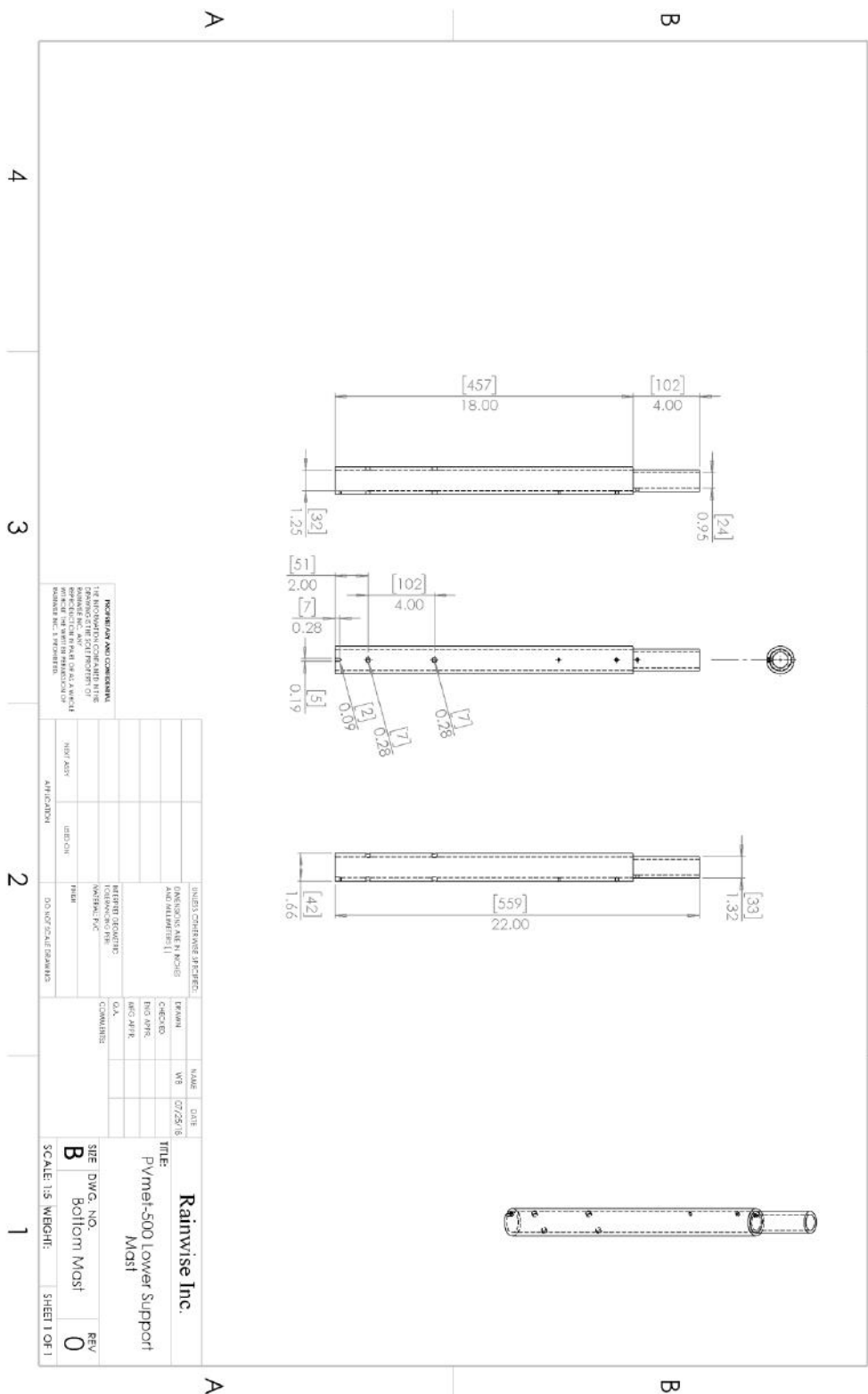
### FULL PVMET-500SUNSPEC MAP

Start	#	Name	Type	Units	S F	Contents	Description
40001	2	C_SunSpec_ID	uint32	-	-	"SunS"	Well-known value. Uniquely identifies this as a SunSpec Modbus Map
40003	1	C_SunSpec_DID	uint16	-	-	0x0001	Well-known value. Uniquely identifies this as a SunSpec Common Model block
40004	1	C_SunSpec_Length	uint16	-	-	65	Length of common model block
40005	16	C-Manufacturer	String(32)	-	-	"Rainwise_Inc"	Well-known value
40021	16	C-Model	String(32)	-	-	"PVMet 500"	Manuf specific value
40037	8	C-Options	String(16)	-	-	"0"	Manuf specific value
40045	8	C-Version	String(16)	-	-	"1"	Manuf specific value
40053	16	C_Serial Number	String(32)	-	-	"Serial"	Manuf specific value
40069	1	C_DeviceAddress	uint16	-	-	60	Modbus Id
40070	1	C_SunSpec_DID	int16	-	-	307	Start of next Device
40071	1	C_SunSpec_Length	int16	-	-	11	Device Model Block Size
40072	1	E_BaseMet_Air Temperature	int16	°C	0.1	Measured	Ambient Air Temperature
40073	1	E_BaseMet_Relative Humidity	int16	%	1	Measured	Relative Humidity
40074	1	E_BaseMet_Barometric_Pressure	int16	Hpa	1	Measured	Barometric Pressure
40075	1	E_BaseMet_Wind_Speed	int16	m/s	1	Measured	Wind Speed
40076	1	E_BaseMet_Wind_Direction	int16	Degree	1	Measured	Wind Direction
40077	1	E_BaseMet_Rain	int16	mm	1	Measured	Rainfall
40078	1	E_BaseMet_Snow	int16	mm	1	-	Snowfall since last poll
40079	1	E_BaseMet_PPT_Type	int16	mm	1	-	Precipitation Type (WMO 4680 SYNOP code)
40080	1	E_BaseMet_Electric_Field	int16	V/m	1	-	Electric Field
40081	1	E_BaseMet_Surface_Wetness	int16	kΩ	1	-	Surface Wetness
40082	1	E_BaseMet_Soil_Moisture	int16	%	1	-	Soil Moisture
40083	1	C_SunSpec_DID	int16	-	-	302	Well-known value. Uniquely identifies this as a SunSpec Irradiance Model
40084	1	C_Sunspec_Length	int16	-	-	5	Variable length model block =(5*n), where n=number of sensors blocks
40085	1	E_Irradiance_Global_Horizontal_1	uint16	W/m²	1	Measured	Global Horizontal Irradiance
40086	1	E_Irradiance_Plane-of-Array_1	uint16	W/m²	1	Measured	Plane-of-Array Irradiance
40087	1	E_Irradiance_Diffuse_1	uint16	W/m²	1	-	Diffuse Irradiance
40088	1	E_Irradiance_Direct_1	uint16	W/m²	1	-	Direct Irradiance
40089	1	E_Irradiance_Other_1	uint16	W/m²	1	Measured	Some other type Irradiance
40090	1	C_SunSpec_DID	int16	-	-	303	Well-known value. Uniquely identifies this as a SunSpec Back of Module Temperature Model
40091	1	C_Sunspec_Length	int16	-	-	3	Variable length model block =(5*n), where n=number of sensors blocks
40092	1	E_BOM_Temp_1	int16	°C	0.1	Measured	Back of module temperature
40093	1	E_BOM_Temp_2	int16	°C	0.1	Measured	Back of module temperature
40094	1	E_BOM_Temp_3	int16	°C	0.1	Measured	Back of module temperature
40095	1	EndOfSunspecBlock	uint16	-	-	0xFFFF	End of SunSpec Block
40096	1	C_Sunspec_Length	uint16	-	-	0	Terminate length, zero

## FULL DEVICE SETTINGS REGISTER MAP

	#	Name	Type	Units	Scale Factor	Contents	R/W	Description	
	200	1	Modbus Id	int16	-	-	60	R/W	Modbus device address
	201	1	Irradiance_Global_Sensitivity	uint16	μV/Wm <sup>-2</sup>	0.01	500	R/W	Sensitivity setting of solar irradiance sensor
	202	1	Irradiance_Plane_of_Array_Sensitivity	uint16	μV/Wm <sup>-2</sup>	0.01	500	R/W	Sensitivity setting of solar irradiance sensor
	203	1	Irradiance_Other_Sensitivity	uint16	μV/Wm <sup>-2</sup>	0.01	500	R/W	Sensitivity setting of solar irradiance sensor
	204	1	Reserved	int16	-	-	-	-	
	205	1	Baud Rate	uint16	-	-	9600	R/W	Baud Rate, 9600 or 19200
	206	1	Wind Sensor	uint16	-	-	0	R/W	Wind Sensor Selector, 0 = Miniaervane, 1 = ultrasonic
	215	1	Rainfall Accumulation	uint16	mm	0.01	0	R	Accumulation in mm

## BOTTOM MAST DIMENSIONS



## SUPPORT

For support please contact RainWise Inc. at 1-800-762-5723.

## WARRANTY

RainWise, Inc. warrants this product against defects in materials and workmanship for a period of two (2) years from the date of purchase and agrees to repair or replace any defective product without charge.

This warranty does not cover damage resulting from accident, misuse or abuse, lack of reasonable care, the fixing of any attachment not provided with the product, or damage due to a lightning strike or power surge. RainWise will not reimburse for take-down or reinstallation charges. RainWise will not pay for any warranty service performed by a non-authorized repair service. No responsibility is assumed for any special, incidental or consequential damages. No other warranty, written or oral is authorized by RainWise, Inc.

NOTE: This warranty gives you specific legal rights, and you may have other rights which vary from state to state. Some states do not allow the exclusion of 'incidental or consequential damages,' and so the above exclusions and limitations may not apply to you.

To return a unit under warranty: call 1-800-762-5723 within the continental US or (207) 288-5169. Within 90 days after the date of purchase, RainWise will issue a UPS call tag for pick-up of the equipment at your address. RainWise will also pay for return UPS charges. If expedited shipping is requested, the express cost must be paid by the customer. After 90 days from the date of purchase, the customer is responsible for all shipping charges.

**IMPORTANT:** Make sure equipment is properly packed - preferably in the original box. Damage incurred in shipping is not covered by this warranty.