# Advanced Weather Station

Installation
Manual

# Introduction

The advanced weather station is a compact and economical solution for photovoltaic installations. It measures ambient air temperature, PV panel temperature, wind speed and direction, global irradiance, and is capable of measuring plane-of-array irradiance. The weather station is SunSpec compliant and uses a half-duplex serial port for Modbus communication to a host.

### Unpacking the System

When unpacking the system the following components should be located.

| | |
|---|---|
| A1300 – | Unit Sensor Assembly<br>Global Irradiance Sensor<br>Ambient Temp. Sensor<br>Anemometer |
| A2010 | Plane-of-Array Sensor |
| A2101 | PV Cell Temp. Sensor |
| A1020 | Mounting Mast |
| | Instruction Manual |

If the system was ordered with any accessories or optional sensors, they should be located while unpacking the system.

<u>Optional accessories and sensors:</u>

| | |
|---|---|
| A2101 | PV Cell Temp. Sensor |
| A3000 - | Mono-Mount |

If any of the components are missing, contact DECK Monitoring immediately.

# Installing the Weather Station

It is suggested that the system be operated at ground level to make sure that all components are working properly prior to installation.

If any of the components are damaged or malfunctioning upon receipt, contact DECK Monitoring immediately.

### Site Requirements and Considerations

Ambient air temperature, global irradiance, and wind speed and direction can be affected by obstructions and local topography. Each site is different and presents challenges in its own unique way. Any object, in excess of 10° above the horizontal plane, must not block the global irradiance sensor. The weather station sensor assembly, which contains the ambient air temperature and wind speed and direction sensor, should be no closer than 10 times any obstruction's height and should be placed away from any dark, heat-absorbing surface.

When roof-mounting the sensor assembly, the unit should be mounted toward an edge of the roof preferably on the prevailing wind side of the building and should be at least 2-1/2 feet above the roofline. Avoid locating the station near any heat sources such as chimneys or vents.

## Installation

#### Weather Station

Mount the support mast securely to a support structure. This may be done by using the Mono-Mount, which is sold as an accessory to the Advanced Weather Station. The mast may also be attached to a support structure using U-Bolts. Do not tighten the support structure to the weather station unit as directional orientation will be required.

Rotate the assembled unit until the electronics enclosure faces TRUE SOUTH or TRUE NORTH if you are in the northern or southern hemisphere, respectively. Secure the support mast to the assembly. Rotation is prevented by lining up the two holes in each mast. At this point the entire unit should be secured to the support structure.

It is crucial that the device be oriented as precisely as possible. The wind direction measurement is directly related to this positioning.

#### Irradiance Sensors

The weather station uses two pyranometers to measure global and plane-of-array irradiance. The global pyranometer is directly attached to the sensor assembly, and does not have to be adjusted in any way. The plane-of-array pyranometer is supplied with 25ft of cable and a solar panel mounting bracket. The plane-of-array pyranometer is user installed.

Both pyranometers are shipped with a protective cap on their lens. During installation, the cap should be removed exposing the opaque white lens.

Global Irradiance

The pyranometer is attached to the sensor assembly and is oriented to measure global irradiance. To accurately measure this quantity the sensor must be level, orientated either TRUE SOUTH or TRUE NORTH if you are in the northern or southern hemisphere, respectively, and objects above 10° above the horizontal plane must not block the sensor.

Plane-of-Array Irradiance

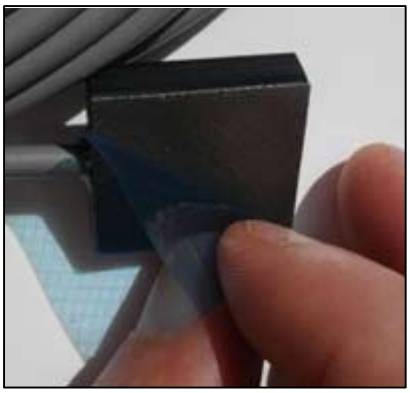
The plane-of array pyranometer is mounted on the side of the solar array. The sensor should be at the same zenith and azimuth angle as the panels in the solar array in order to correctly measure the plane-of-array irradiance.

**PV Temperature Sensors**

This sensor is designed to attach directly to any solar panel. When placed on the center back side of the panel, it accurately measures the temperature of the panel.

Prior to installation of the PV temperature sensor onto the PV panel, the installation area of the panel back should be thoroughly cleaned. This cleaning will ensure a good bond between sensor and panel and allow for accurate panel temperature readings.

After cleaning, peel off the protective adhesive tape on the temperature sensor and stick it onto the back of the panel. Firmly press the sensor into place. Refer to the picture below. The cable should be secured within 8 inches of the temperature-sensing element.



Run the cable back to the weather station and connect to the PV temperature sensor terminals.

If the cable length is insufficient for the installation, additional cable can be added to the existing cable. If this is done, an accuracy derating factor must be added to the overall temperature accuracy of this sensor. For every 100ft of cable added, an accuracy derating factor of -0.125°C must be taken into account.

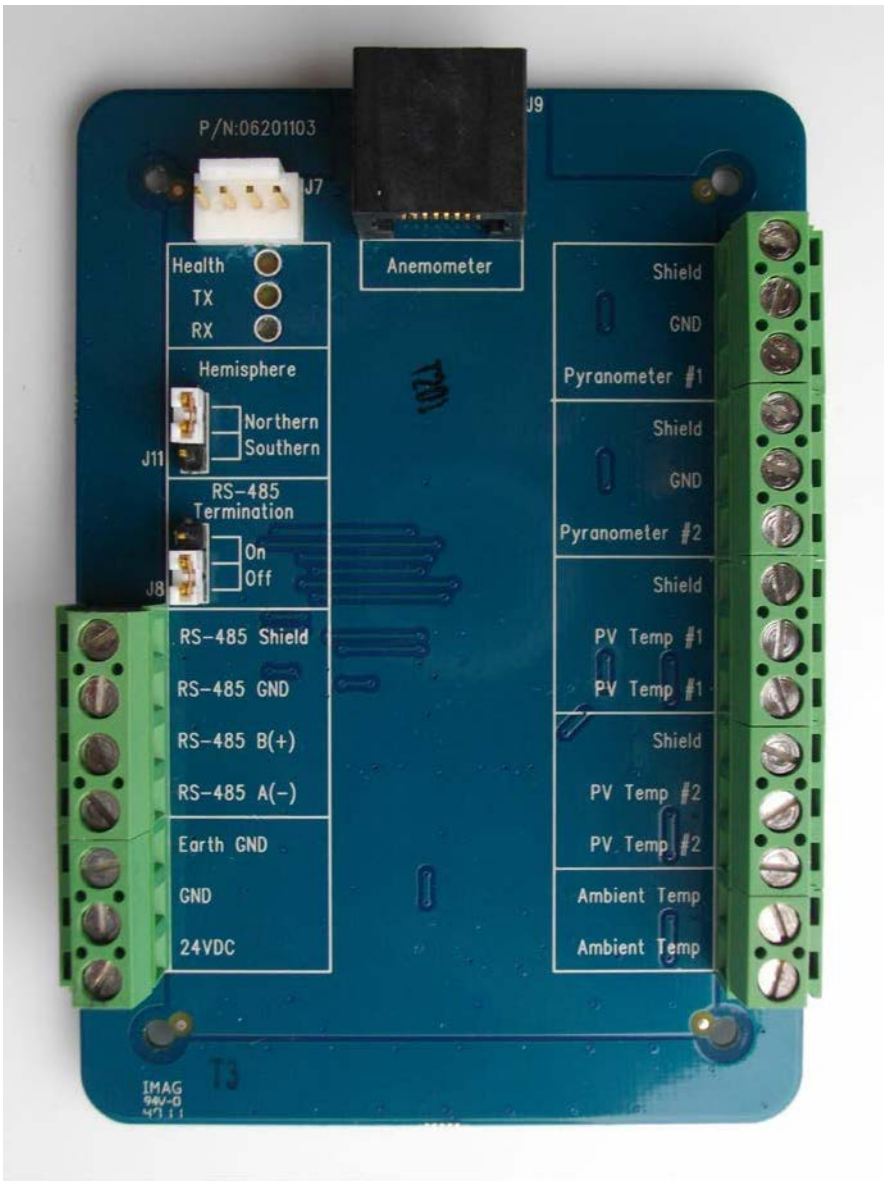
**Anemometer**

The anemometer is directly attached to the top of the sensor assembly. For correct wind direction operation the weather station must be oriented correctly.

By default the weather station is configured for operation in the Northern hemisphere. This only requires that the irradiance sensor faces due South. If the weather station is going to be used in the Southern hemisphere it must be mounted with the irradiance sensor facing North. In addition, the hemisphere jumper inside the weather station must be changed from Northern to Southern as shown in the image within the wiring section.

## Wiring

To enter the enclosure with a cable, the front cover must first be removed. Remove the four Philips head screws from the back of the enclosure. Once the lid is removed, the circuit board is exposed. The inside of the enclosure will appear as below.



**Connecting Plane-of-Array and Global Irradiance Sensors**

The irradiance sensors are polarity sensitive and the signal wires must go to the appropriate corresponding screw terminal. If either of the Irradiance sensors are not used they should be terminated with a 0-ohm shunt between the positive and negative signal.

Due to the modbus register map, the Plane-of-Array and Global Irradiance sensors are not interchangeable. The global irradiance sensor connects to “Pyranometer #1” and the plane-of-array irradiance sensor connects to “Pyranometer #2.” Each is labeled on the printed circuit board.

Global Irradiance Sensor Terminals

| | |
|---|---|
| Pyranometer #1: | Positive Signal |
| Ground: | Negative Signal |
| Shield: | Cable Shield and Drain |

Plane-of-Array Sensor Terminals

| | |
|---|---|
| Pyranometer #2: | Positive Signal |
| Ground: | Negative Signal |
| Shield: | Cable Shield and Drain |

**Connecting External PV Temperature Sensor**

The PV sensors are not polarity sensitive. Therefore, each signal wire is interchangeable. The sensor comes with a 25ft length of cable. If a temperature sensor is not used, it should be terminated with a 0-ohm shunt between the positive and negative signal.

PV Temperature Terminals

| | |
|---|---|
| PV Temp #2: | Signal |
| PV Temp #2: | Signal |
| PV Temp #2 Shield: | Cable Shield and Drain |

**Connecting RS-485**

Wiring connections are made using the 4-pin screw terminal inside of the weather station electronics enclosure. Cable is not supplied with the unit. The RS-485/422 lines can be terminated with a 120 ohm resistor. This can be anabled by moving the termination jumper, located inside the unit, to the “ON” position. This requires removing the enclosure cover. To do this, remove the 4 screws on the bottom side of the unit.

RS-485/422 Terminals

| | |
|---|---|
| A (-) : | Negative RS-485 |
| B (+) : | Positive RS-485 |
| Gnd: | Signal Ground |
| Shield: | Cable Shield and Drain |

RS-485 is rated to 4,000 feet (1,200 m) at 90 kbps. The RS-485 port on the weather station is surge protected but not isolated.

**Connecting the Power Supply**

The power supply is nominally rated for 24VDC but can accept a voltage in the range of 10 to 30VDC. The inputs are reverse polarity, surge, overvoltage and over current protected. The power supply is not isolated.

Power Supply Terminals

| | |
|---|---|
| Earth Gnd: | Earth Ground, intended for connection to an RF Protected Ground |
| Gnd: | Negative Supply Voltage |
| 24VDC: | Positive Supply Voltage |

When replacing the cover, make sure that all installed cables are pinched by the black foam on the bottom of the enclosure. This will enable a weather resistant seal.

## SunSpec and Modbus

The Advanced Weather Station follows the SunSpec standard. Refer to the official SunSpec specifications for application information. The full register map is listed below. The weather station has the following default communication settings:

Serial/ General
Baud Rate: 9600
Parity: None
Stop Bits: 1

RS-232
Flow control: None

RS-485
Interface Mode: 2-Wire Half Duplex

Modbus
Device ID: 60

### Register Map

| Start | End | # | Name | Type | Units | Scale Factor | Contents | Description |
|---|---|---|---|---|---|---|---|---|
| 0001 | 0002 | 2 | C_SunSpec_ID | uint32 | N/A | N/A | "SunS" | Well-known value. Uniquely identifies this as a SunSpec Modbus Map |
| 0003 | 0003 | 1 | C_SunSpec_DID | uint16 | N/A | N/A | 0x0001 | Well-known value. Uniquely identifies this as a SunSpec Common Model block |
| 0004 | 0004 | 1 | C_SunSpec_Length | uint16 | registers | N/A | 65 | Length of common model block |
| 0005 | 0020 | 16 | C-Manufacturer | String(32) | N/A | N/A | "Rainwise_Inc" | Well-known value |
| 0021 | 0036 | 16 | C-Model | String(32) | N/A | N/A | "PVmet-200" | Manuf specific value |
| 0037 | 0044 | 8 | C-Options | String(16) | N/A | N/A | "0" | Manuf specific value |
| 0045 | 0052 | 8 | C-Version | String(16) | N/A | N/A | "1" | Manuf specific value |
| 0053 | 0068 | 16 | C_Serial Number | String(32) | N/A | N/A | "Serial" | Manuf specific value |
| 0069 | 0069 | 1 | C_DeviceAddress | unint16 | N/A | N/A | 60 | Modbus Id |
| 0070 | 0070 | 1 | C_SunSpec_DID | int16 | N/A | N/A | 307 | Start of next Device |
| 0071 | 0071 | 1 | C_SunSpec_Length | int16 | N/A | N/A | 11 | Device Model Block Size |
| 0072 | 0072 | 1 | E_BaseMet_Air Temperature | int16 | °C | -1 | Measured | Ambient Air Temperature |
| 0073 | 0073 | 1 | E_BaseMet_Relative Humidity | int16 | % | 0 | N/A | Relative Humidity |
| 0074 | 0074 | 1 | E_BaseMet_Barometric_Pressure | int16 | Hpa | 0 | N/A | Barometric Pressure |
| 0075 | 0075 | 1 | E_BaseMet_Wind_Speed | int16 | m/s | 0 | Measured | Wind Speed |
| 0076 | 0076 | 1 | E_BaseMet_Wind_Direction | int16 | Degrees | 0 | Measured | Wind Direction |
| 0077 | 0077 | 1 | E_BaseMet_Rain | int16 | Inches | 0 | N/A | Rainfall |
| 0078 | 0078 | 1 | E_BaseMet_Snow | int16 | Inches | 0 | N/A | Snowfall since last poll |
| 0079 | 0079 | 1 | E_BaseMet_PPT_Type | int16 | Inches | N/A | N/A | Precipitation Type (WMO 4680 SYNOP code reference) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 0080 | 0080 | 1 | E_BaseMet_Electric _Field | int16 | V/m | 0 | N/A | Electric Field |
| 0081 | 0081 | 1 | E_BaseMet_Surface _Wetness | int16 | kOhms | 0 | N/A | Surface Wetness |
| 0082 | 0082 | 1 | E_BaseMet_Soil _Moisture | int16 | % | 0 | N/A | Soil Moisture |
| 0083 | 0083 | 1 | C_SunSpec_DID | int16 | N/A | 0 | 302 | Well-known value. Uniquely identifies this as a SunSpec Irradiance Model |
| 0084 | 0084 | 1 | C_Sunspec_Length | int16 | N/A | 0 | 5 | Variable length model block =(5*n), where n=number of sensors blocks |
| 0085 | 0085 | 1 | E_Irradiance_Global _Horizontal_1 | uint16 | W/m² | 0 | Measured | Global Horizontal Irradiance |
| 0086 | 0086 | 1 | E_Irradiance _Plane-of-Array_1 | uint16 | W/m² | 0 | Measured | Plane-of-Array Irradiance |
| 0087 | 0087 | 1 | E_Irradiance_Diffuse_1 | uint16 | W/m² | 0 | N/A | Diffuse Irradiance |
| 0088 | 0088 | 1 | E_Irradiance_Direct_1 | uint16 | W/m² | 0 | N/A | Direct Irradiance |
| 0089 | 0089 | 1 | E_Irradiance_Other_1 | uint16 | W/m² | 0 | N/A | Some other type Irradiance |
| 0090 | 0090 | 1 | C_SunSpec_DID | int16 | N/A | 0 | 303 | Well-known value. Uniquely identifies this as a SunSpec Back of Module Temperature Model |
| 0091 | 0091 | 1 | C_Sunspec_Length | int16 | N/A | 0 | 2 | Variable length model block =(5*n), where n=number of sensors blocks |
| 0092 | 0092 | 1 | E_BOM_Temp_1 | int16 | ℃ | -1 | Measured | Back of module temperature |
| 0093 | 0093 | 1 | E_BOM_Temp_2 | int16 | ℃ | -1 | Measured | Back of module temperature |
| 0094 | 0094 | 1 | EndOfSunspecBlock | uint16 | N/A | N/A | 0xFFFF | End of SunSpec Block |
| 0095 | 0095 | 1 | C_Sunspec_Length | uint16 | N/A | 0 | 0 | Terminate length, zero |
| 0200 | 0200 | 1 | Modbus Id - Write Register | int16 | N/A | N/A | 60 | Modbus device address, write register |

## Changing the Modbus Device Address

### Materials Required

- Computer with USB port
- USB to RS485 cable
- TTY program (PuTTY)

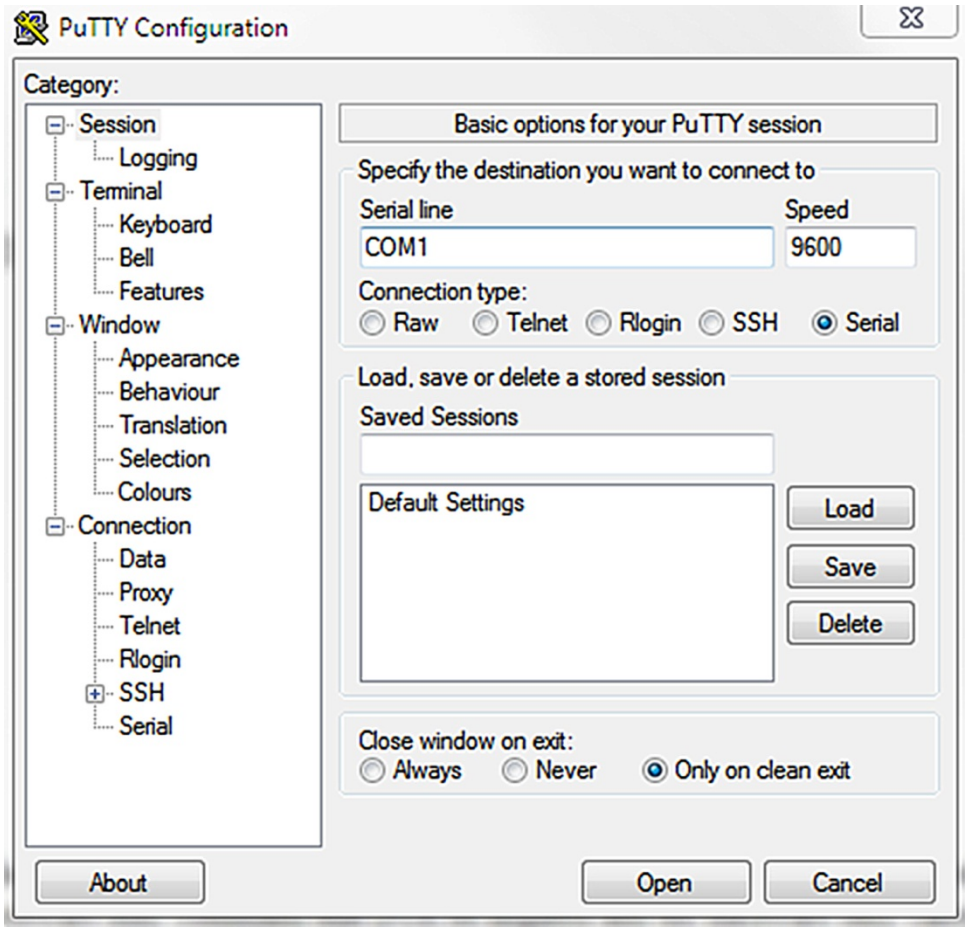
### Preparation

1. Attach USB to RS485 converter from a PC to the 485 terminal of the device, observing polarity.
2. Attach 24VDC power to meteorological station.
3. Determine Virtual COM Port (VCP) assignment in the host operating system

**Execution**

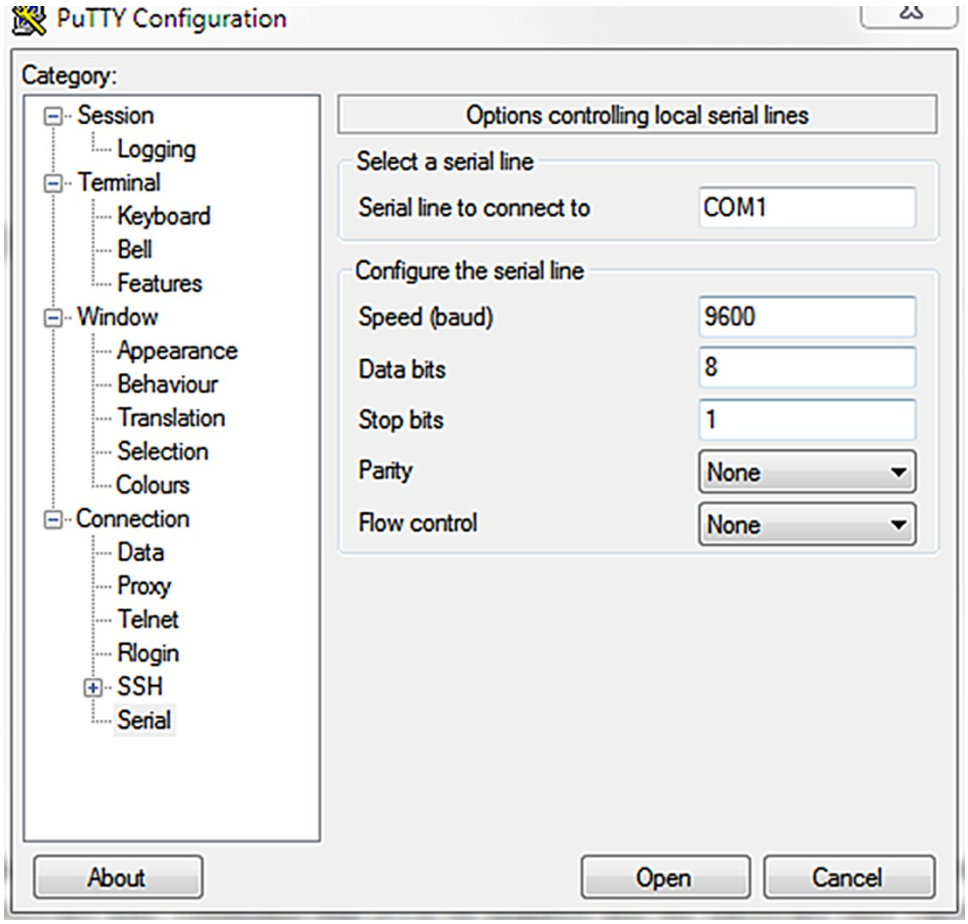
1. Open PuTTY  and start a new session

   Set connection type for this session to Serial



Set the following conditions for serial communication

- Baud rate: 9600 bps
- Data bits: 8
- Stop bits: 1
- Parity: none
- Flow control: none




2. Data Terminal Ready (DTR) on handshake must be asserted
3. In the terminal enter 3 consecutive plus signs, one second apart (+++)
4. "+++Command Mode+++" string will appear
   Note: The unit will exit command mode 1 minute after initiation if no action is taken
5. Determine the current Modbus address by entering into the terminal MBID=?
6. To assign a new address to the unit enter into the terminal MBID=X followed by return key, where X = a whole number value between 1 and 254
7. Verify the current Modbus address by entering into the terminal MBID=?

8. Wait one minute and disconnect 24VDC
9. Disconnect USB to RS485

**Note:**
Alternative methods for connecting to the RS485 include RS232 to RS485 and other serial communication adapters. Please see the manufacturer's recommendations regarding these methods.

Similarly, alternative TTY applications may be used, so long as these communication conditions are met.

## Command Mode

By default, the weather station will boot in Modbus mode and will not respond to the commands listed here. To enter the command mode, issue three '+' characters one second apart. The weather station will return a message indicating that it is in command mode. After one minute of inactivity it will exit command mode and return to the default Modbus mode.

Commands must be terminated with a <CR> character. Responses begin and end with a <CR><LF>.

If the command syntax or parameters are incorrect, the device will respond with ERROR. If the command is accepted, the device will respond with OK.

Commands may not be chained together. Commands are not case sensitive.

**Get Column Headers:** HEADER

Description: Returns a series of comma-delimited text descriptions. These descriptions are used to identify the type and order of the returned data in both NOW and DOWNLOAD commands.

Values: None

Syntax: HEADER

Sample Response:

HDR,"AIR TEMP","PV TEMP1","PV TEMP2","SOLAR","SOLAR2","WSPD" ,"WDIR","CHIP_TEMP",!076

Key:

HDR : Identifier, HDR= Header, MSG= Message, REC= Data Record, MAX= Maximums and MIN= Minimums.

| | |
|---|---|
| AIR TEMP | : Current ambient air temperature. |
| PV TEMP1 | : First current Back-of-Module temperature. |
| PV TEMP2 | : Second current Back-of-Module temperature. |
| SOLAR | : Current global horizontal irradiance. |
| SOLAR2 | : Plane-of-Array irradiance. |
| WSPD | : Wind speed. |
| WDIR | : Wind direction. |
| CHIP_TEMP | : CPU temperature. |
| !XXXX | : CRC-16 Checksum. *See Calculating the Checksum.* |

*NOTE: The parameter count may increase in future models.*

**Get Current Data:** NOW

Description: Returns the current values in a comma-delimited format. The order of the data values correspond to the output of the HEADER command. NO DATA is returned if the unit has not received a transmission from the weather station.

Values: None
Syntax: NOW

Sample Response:

22.5,-40.0,-40.0,0, 0,180,29.3,!168

**Auto Output:** AUTO

Description: Automatically outputs current data every second. This is equivalent to issuing the NOW command every second. This mode will exit upon reception of any character. If no data is received from the weather station, the units will not output.

Values: None
Syntax: AUTO

Sample Response:

OK

**Software Reboot:** REBOOT

Description: Forces a soft reboot of the interface. Upon boot up, the version information is output.

Values: None
Syntax: REBOOT

Sample Response:

None

**Version Information:** VERSION

Description: Returns firmware version information.

Values: None
Syntax: VERSION

Sample Response:

Rainwise Inc PVmet-200 Version: 1.1 Build 001 Jun 17

**Modbus Device Address:** MBID

Description: The Modbus device address can be viewed or changed using this command. The default is address is 60

Values: ?,1 - 255

Syntax (Read): MBID=?
Syntax (Write): MBID=60

Sample Read Response:
60

Sample Write Response:
OK

**Serial Number:** SERIAL

Description: The serial number of the device can be viewed or changed using this command. The serial number string is returned in the SunSpec Common block.

Values: ?, character string (31 character limit)

Syntax (Read): SERIAL=?
Syntax (Write): SERIAL=ABC123

Sample Read Response:
ABC123

Sample Write Response:
OK

**Command Mode:** EXIT

Description: Exits from the command mode. Modbus is not functional in command mode.

Values: None

Syntax: EXIT

Sample Response:

Existing Command Mode...

**Calculating the Checksum:**

The weather station uses a 16 CRC checksum. The CRC uses the same polynomial as the one used in Xmodem transfers (XMODEM-CRC).
The Polynomial is as follows:

$x^{16} + x^{12} + x^{5} + 1$

The CRC calculation starts at the first ASCII character of the response. Leading carriage return line feeds are not included. All characters are included in the calculation until but not including the exclamation character. The checksum is represented as a hexadecimal number.

The following C example code can be used to calculate the checksum:

```
/* Global Variables */
unsigned short int acc;

/* ***************************************************************************
/* Initialize Accumulator
/* ***************************************************************************/
void
crc16Init(void)
{
 acc= 0;
}

/* ***************************************************************************
/* Add byte
/* ***************************************************************************/
void
crc16Add( unsigned short int _data )
{
   unsigned char n;

   for (n=8; n ;n--)
   {
    if ((acc & 0x8000)>0)
    {
     acc<<= 1;
     _data<<= 1;
     if ((_data & 256)!=0)
       acc+
        +;
     acc^= 0x1021;
    }
   else
    {
       acc<<= 1;
       _data<<= 1;
       if ((_data & 256)!=0)
    }   acc++;
   }
}
```

```
/* ************************************************************************
/* Return CRC accumulator
/* ************************************************************************/
unsigned short int crc16Acc(void)
{
 unsigned short int tmp= acc, retval;

 crc16Add(0);
 crc16Add(0);      // add two zeros
 to get a valid crc retval= acc;
 acc= tmp;  //restore acc

 return retval;
}
```