*1 General*

The weather monitoring system comprises of the following apparatus to monitor and display the information to the user.

a) Set of sensors.
b) Two sets of Sensor Data aggregator modules
c) Weather monitoring HMI Unit.

*1.1 Sensors*

The following Sensors are included in the package to monitor various weather parameters

### 1.1.1 Wind Direction and Wind Speed Sensor



Wind speed and wind direction is a composite Sensor Module. Rugged components stand up to hurricane-force winds, yet are sensitive to a light breeze. Includes sealed bearings for long life, the range and accuracy specifications have been verified in wind-tunnel tests. In areas where icing of the anemometer is a problem, drip rings deflect water from the joint between moving parts.

## General Specification

| | |
|---|---|
| Operating Temperature | -40° to +149°F (-40° to +65°C) |
| Wind Speed Sensor type | Solid state magnetic sensor |
| Wind Direction Sensor type | Wind vane and potentiometer |
| Cable Type | 4-conductor, 26 AWG |
| Dimensions (length x width x height) | 15.0" x 1.5" x 18.0" (381 mm x 38 mm x 457 mm) |
| Weight | 1 lbs. 4 oz. (1.332 kg) |
| Wind Direction Display Resolution | 1 |
| Wind Direction Range | 0 ~ 360 º |

| Wind Direction Accuracy | ±3° |
|---|---|
| Wind Speed Resolution | 1 kph |
| Wind Speed Range | 1 to 322 km/h |
| Wind Speed Accuracy | ± 3 km/h  or ±5%, whichever is greater |
| Wind Vane and Control Head material | UV-resistant ABS |
| Wind Cups material | Polycarbonate |
| Anemometer Arm material | Black-anodized aluminum |

## Wiring Details

| Black | Wind speed contact closure to ground |
|---|---|
| Red | Ground |
| Green | Wind direction pot wiper (20KΩ potentiometer) |
| Yellow | Pot supply voltage |
| Wind Speed Translation Formula | 1600 rev/hr = 1 mph |

$V = P(2.25/T)$ (V = speed in mph, P = no. of pulses per sample period

T = sample period in seconds)

| Wind Direction Translation | Variable resistance 0 - 20KΩ; 10KΩ = south, 180° |
|---|---|

### 1.1.2  Ambient Temperature and Humidity Sensor

The Ambient Temperature and humidity is housed in the most effective passive shelter. The shield protects the temperature sensor from solar radiation and other sources of radiated and reflected heat. The Multi-plate construction of the shield allows maximum airflow for accurate readings.

## General Specification

| | |
|---|---|
| Measuring Range | 0 to 100% RH , -40 to 65 °C |
| Accuracy @ 23°C | $\pm$ 3% RH , $\pm$ 0.3 ° C |

## Wiring Details

| | |
|---|---|
| Blue / White | $I^2C$ Communication |
| Green | Ground |
| Yellow | Supply voltage |

### 1.1.3   Rainfall Sensor

The Rain Collector is designed to meet the guidelines of the World Meteorological Organization. Rain enters the collector cone, passes through a debris-filtering screen, and collects in one chamber of the tipping bucket. The bucket tips when it has collected an amount of water equal to the increment in which the collector measures 0.2 mm. As the bucket tips, it causes a switch closure and brings the second tipping bucket chamber into position. The rain water drains out through the screened drains in the base of the collector.

The collector is designed for years of accurate, trouble-free service. The body and base of the collector are constructed of tough, UV resistant plastic; the tipping bucket pivots on bearings that minimize friction and wear. Stainless steel adjustment screws under each chamber of the tipping bucket allow you to fine-tune the calibration of the Rain Collector.

 Rain Collector is wind tunnel tested to be stable in winds up to 140 MPH

New features of the improvised version are as below

- The Base for rainfall sensor is provided with U-bolt or screw mounting to allow fixing to any suitable stub pole or post.
- Provisions are made for pins to be inserted around the top of the funnel to deter bird-perching.
- Pronounced grooves in the outer surface of the cone for easier removal for cleaning and maintenance
- Larger and much improved debris screen (lower Centre) which gently clicks home within the funnel
- The combination of all of these new features provides a gauge that can be easily mounted to a convenient pole or post; one that should be much less prone to blocking by extraneous

debris; and one that can deliver accurate and cost-effective rainfall measurement (with fine calibration, if required).

## General Specification

| | |
|---|---|
| Sensor Type | Tipping bucket with magnetic reed switch |
| Output | Contact closure for 0.2mm |
| Housing Material | UV-stabilized ABS plastic |

**Dimensions**

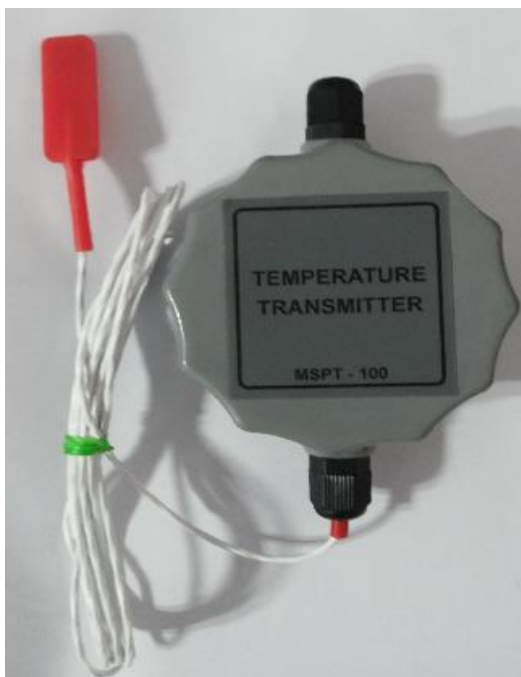| | |
|---|---|
| Rain Collector | 8.75" diameter x 9.5" high (16.5 cm diameter x 24 cm high) |
| Collection Area | 33.2 in2 (214 cm2) |
| Weight | 2 lbs. 3 oz. (1 kg) |

**Wiring Details**

| | |
|---|---|
| Red / Black (Shorted) | Switching contact |
| Green / Yellow  (Shorted) | Switching contact |

**1.1.4    Pyranometer 1 Sensor**
**1.1.5    Pyranometer 2 Sensor**

**1.1.6    Module Temperature 1 and 2 Sensors**

The surface temperature monitoring sensor is a 3-wire Platinum 100 sensor which is to be mounted below the solar panel for measuring the surface temperature. The Temperature sensor is further connected to temperature transmitter which provides 4 ~ 20 mA signal corresponding to 0 to 100 °C

## General Specification of Temperature Sensor

| | |
|---|---|
| Element Type | 3-wire Platinum 100 ohm |
| Operating temperature range | -40 to +150 °C |
| Accuracy | DIN EN 60751 class A |
| Material | Teflon / silicon rubber |
| Dimensions | 40 x 14 x 7 mm |
| Resistance @ 0°C | 100 Ohm |
| Cable Length | 2mts |

## General Specification of Temperature transmitter

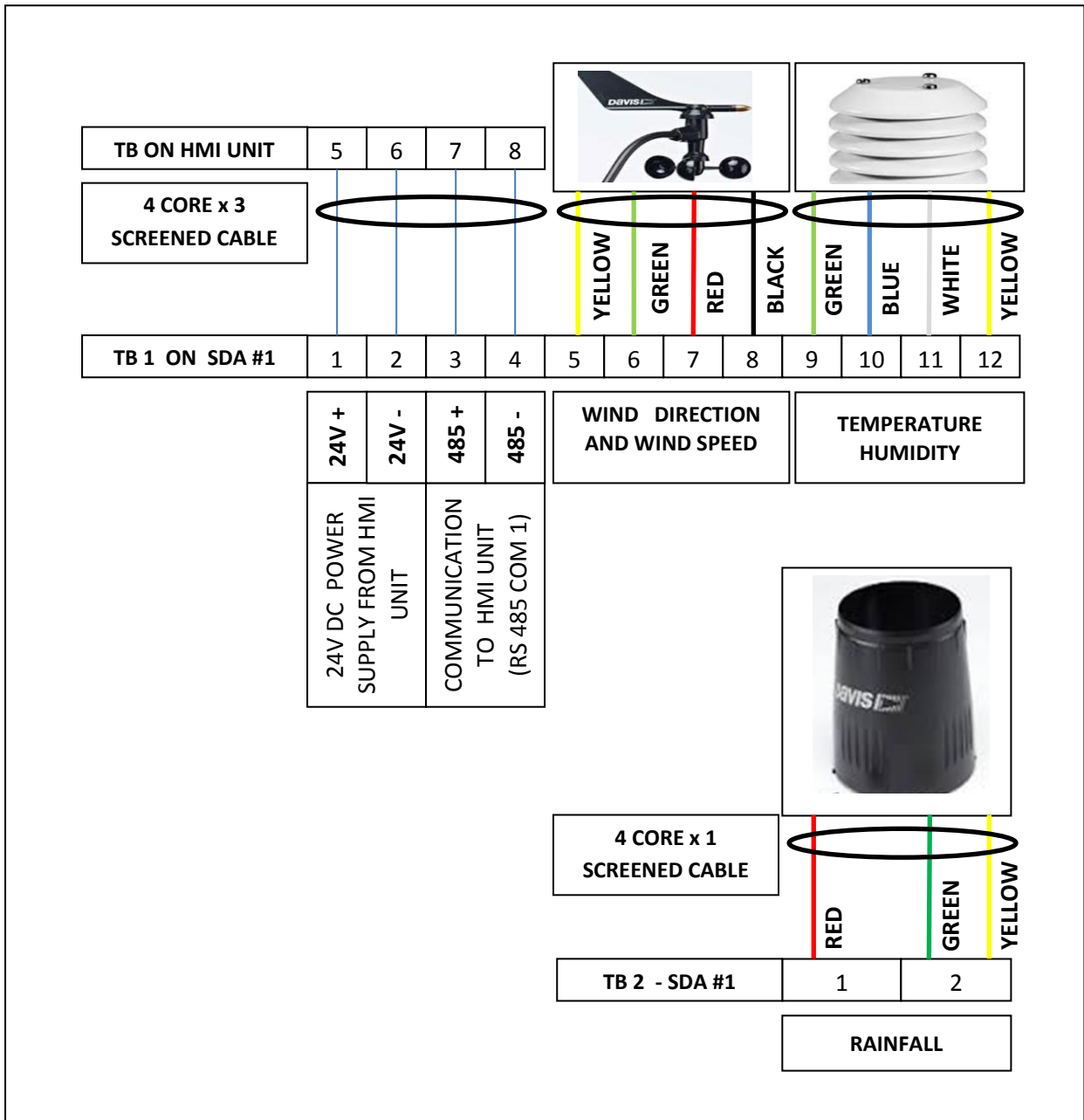| | |
|---|---|
| Measuring Range | 0 to 100 °C |
| Accuracy | ± 0.5 ° C |
| Output | 4-20mA |
| Supply Voltage | 12 to 26 VDC |
| Housing | Poly carbonate watertight enclosure |
| Enclosure Protection Class | IP-65 |
| Weight | Approx 150gms |

### 1.2 Sensor Data Aggregator

There are two Sensor data Aggregators modules, SDA #1 and SDA #2 respectively, SDA #1 and SDA #2 will be the gateway for connecting sensor data to the HMI on a Modbus RS 485 Communication network.
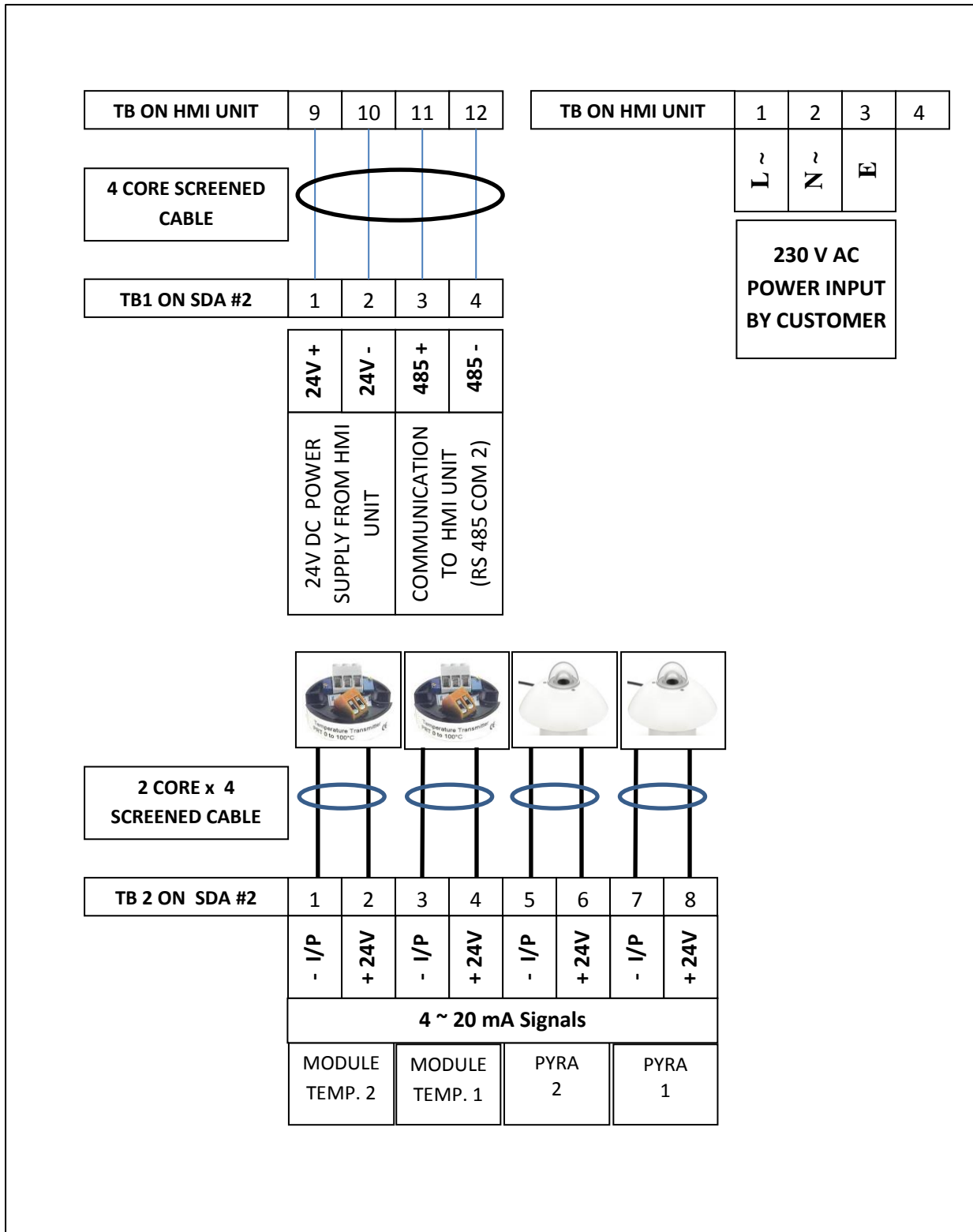
### 1.2.1. Sensor Data Aggregator 1 (SDA #1)

Following Sensors will be connected to microcontroller board of SDA # 1. SDA #1 will aggregate the sensor data and transmit the Information to the HMI module on RS485 Com 1 communication port.

➤ Wind Direction Sensor
➤ Wind Speed Sensor
➤ Ambient Temperature Sensor
➤ Ambient Humidity Sensor
➤ Rainfall

## WIRING DIAGRAM OF SDA #1

| TB ON HMI UNIT | 5 | 6 | 7 | 8 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 CORE x 3 SCREENED CABLE | | | | | | | | | | | | |
| | | | | | YELLOW | GREEN | RED | BLACK | GREEN | BLUE | WHITE | YELLOW |
| TB 1 ON SDA #1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |

| 24V + | 24V - | 485 + | 485 - | WIND DIRECTION AND WIND SPEED | TEMPERATURE HUMIDITY |
|---|---|---|---|---|---|
| 24V DC POWER SUPPLY FROM HMI UNIT | | COMMUNICATION TO HMI UNIT (RS 485 COM 1) | | | |

| 4 CORE x 1 SCREENED CABLE | | |
|---|---|---|
| | RED | GREEN | YELLOW |

| TB 2 - SDA #1 | 1 | 2 |
|---|---|---|

**RAINFALL**

### 1.2.2. Sensor Data Aggregator 2 (SDA #2)

Following Sensors will be connected to microcontroller board of SDA # 2. SDA #2 will aggregate the sensor data and transmit the Information to the HMI module on RS485 Com 1 communication port.

➢ Pyranometer 1
➢ Pyranometer 2
➢ Module Temperature 1

**Logics Power**

➢ Module Temperature 2

## WIRING DIAGRAM OF SDA #2

| TB ON HMI UNIT | 9 | 10 | 11 | 12 |
|---|---|---|---|---|

| 4 CORE SCREENED CABLE |
|---|

| TB ON HMI UNIT | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| | L ~ | N ~ | E | |

**230 V AC POWER INPUT BY CUSTOMER**

| TB1 ON SDA #2 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| | 24V + | 24V - | 485 + | 485 - |
| | 24V DC POWER SUPPLY FROM HMI UNIT | | COMMUNICATION TO HMI UNIT (RS 485 COM 2) | |

| 2 CORE x 4 SCREENED CABLE |
|---|

| TB 2 ON SDA #2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| | - I/P | + 24V | - I/P | + 24V | - I/P | + 24V | - I/P | + 24V |
| | **4 ~ 20 mA Signals** | | | | | | | |
| | MODULE TEMP. 2 | | MODULE TEMP. 1 | | PYRA 2 | | PYRA 1 | |

*1.3 HMI UNIT*

HMI unit is wall mounting unit which consists of a 4.3" Touch Screen Display and a 24 V DC power supply unit for powering up Touch Screen, SDA #1, SDA #2 and Field Sensors.

The Touch screen Display module is a programmable device which has two RS 485 Serial Communication ports, USB port and an RJ 45 Ethernet communication port. As already explained the RS 485 serial communication ports are used to communicate with the SDA #1 ( Com 1) and SDA # 2 ( Com 2) for acquiring data from the field sensor network. The data acquisitions from the sensors are on a real time basis.

The acquired data is processed by the CPU of the touch screen display and the data are displayed on the touch screen which has been custom programmed for the Weather monitoring station application. The details of the screen configured for user interface is explained in subsequent sections. The Touch screen is configured to sleep automatically after 5 minutes touching the screen will wake and display the current screen.

The acquired data are also logged and information is stored in the internal memory of the CPU for further retrieval and analysis. The logged data can be downloaded to the USB memory stick which has been included as part of the supply package.

*1.4 Weather Station TOUCH SCREEN DISPLAY UNIT*

Various user friendly screens are developed for monitoring Weather station sensor data, data logging and configuring the system itself. The screens are self-explanatory however the subsequent sections will provide the brief insight on the screens developed for ready reference.

### 1.4.1   Main Screen        :        For displaying all the sensor data

This Screen displays the entire sensor data, the raw data from the sensors are process and suitable conversions are applied in the program and the values are displayed as per the engineering units mentioned above. No further conversion factor or scaling is required. Current date and Time are also displayed for reference.

The screen has few navigation buttons to further navigate to the corresponding screens. The descriptions of the Navigation tabs are as below.

> - *"Trends"*      : Navigates to the Trends Main Screen.
> - *"Datalog"*      : Navigates to the Data Logger Screen.
> - *"***" (left)*      *: Navigates to the calibration Screen.*
>
>      *This screen is password protected any changes here to be made by Authorized personal only)*
>
> - *"***" (Right)*   *: Navigates to the System Configuration Screen.*
>
>      *This screen is password protected any changes here to be made by Authorized personal only)*

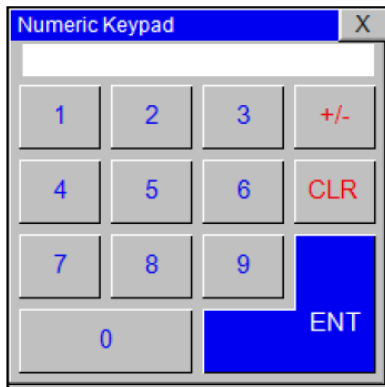**1.4.2   Calibration  Screen        :        For Calibration of sensor raw data**



This screen can be reached by pressing **"***"** on the **left** of the main screen. This screen is password protected and is displayed only on successfully entry of password in the pop up window.
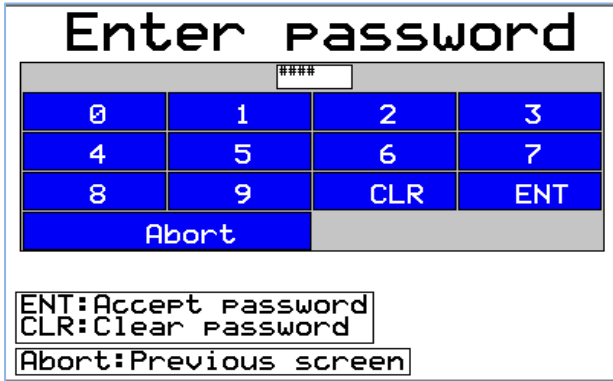
*POP UP screen Enter Password*

*Key in the Password and Press ENT.*

This calibration screen enables the calibration of each raw data to fine tune the inaccuracies if any on the sensor data. For each signal OFFSET and GAIN parameters can be adjusted. The formula applied for calibration is *"Calibrated data = Raw data x GAIN ± OFFSET".* Both the OFFSET and GAIN are float parameters. A Numeric Key pad is displayed on pressing the corresponding Numeric data box for each signal.



*POP UP Numeric Key Pad*

*Key in the Desired valves and Press ENT.*

OFFSET can be set in the range of -9.9 to +9.9 and GAIN can be set form 0 to 2.0. **Note that these calibration parameters are to be modified by Authorized personnel only**. The corrections applied here will affect displayed data, data logging and data transmitted on Modbus TCP/IP network. Pressing the **"Main"** Navigation Tab takes back the display to the Main Screen.
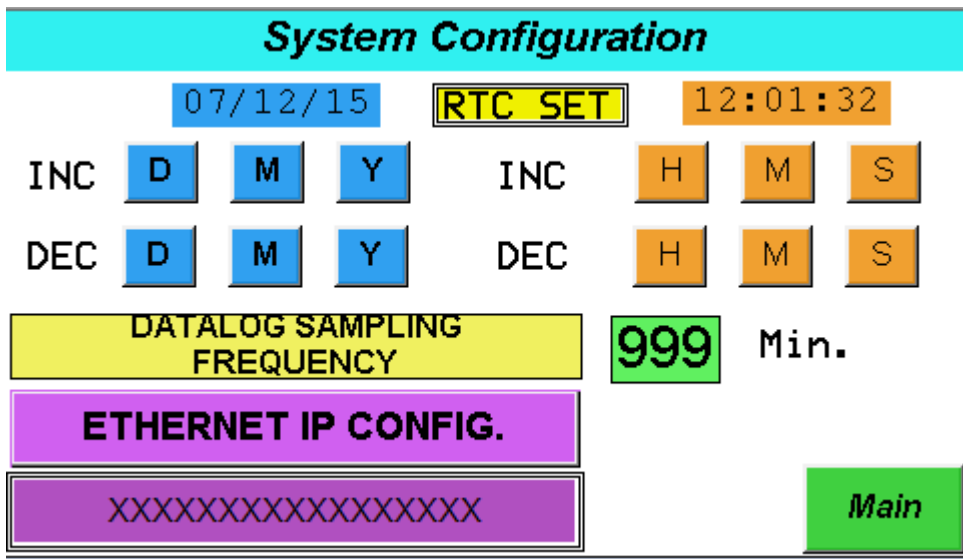
### 1.4.3 System Configuration Screen : For Configuring System

This screen can be reached by pressing **"***"** on the **Right** of the main screen. This screen is password protected and is displayed only on successful password entry in the pop up numeric keypad. **Note that these calibration parameters are to be modified by Authorized personnel only**.

**Logics Power**
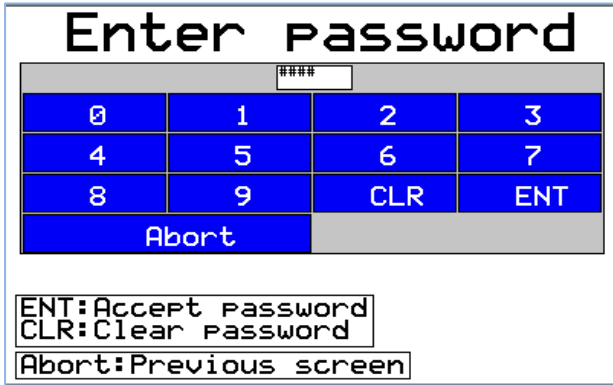


*POP UP screen Enter Password*

*Key in the Password and Press ENT.*



## Setting Up RTC

This System Configuration screen can be used to set up the real time clock (RTC) if it needs to be adjusted. Current RTC date and time are displayed for reference, the time/date can be adjusted by pressing the corresponding increment and decrement buttons above.

## Setting Ethernet Parameters

The screen is also used to set the Modbus TCP/IP communication parameters. The Default parameters are as mentioned in **section 1.3.1**. If it needs to be changed press "**ETHERNET IP CONFIG**" button. This will enable a POP UP screen as below to facilitate changing of the default communication parameters.
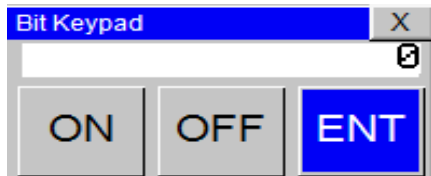
After changing press Confirm and Exit with password

*POP UP System Setup Menu*

*Key in the desired valve and press Confirm to set.*

➢ **USB HOST Function**

USB host function is used to download new program or to upgrade the software of the display unit. When the need arises we will supply the ZIP file of the updated program, the contents of the ZIP folder needs to the copied to the **EMPTY FORMATED (FAT32)** USB disk and The USB stick needs to be plugged in to the USB port of the Display unit before the operations can begin. On pressing the **"USB HOST FUNCTION"** button a POP UP bit keypad as below is displayed, Press "ON" and Press "ENT" to activate USB host function.



*POP UP Bit Keypad*

*Press ON and Then ENT to activate USB host Function.*
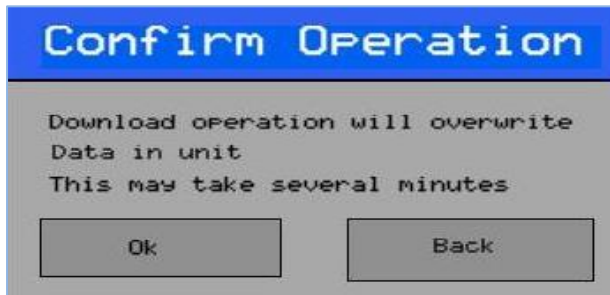
Select the desired options and Press **"DOWNLOAD"**

![Logics Power logo]

Confirm Operation POP UP menu is displayed as below, Confirm by pressing "OK"



Once the Download is complete following message is displayed and subsequently Display unit reboots again for the new program to take effect.

**1.4.5 Data Log Screen               :          For Configuring and downloading data**
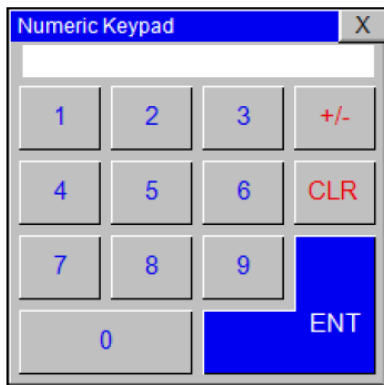
Data Logging automatically begins as long as the unit is powered ON, The Unit can be configured for a logging interval of **1 to 120 Minutes**. The data log memory is capable of holding approximately one month data in its memory. The Data logging is on **FIFO** basis when the internal memory is fully consumed data logged first will be automatically deleted to accommodate current data to be stored. It is recommended to download the data which is logged from the internal memory to the USB stick **at least one in a month** and further copy the information from the USB stick to other sources for offline use and future analysis. **Please also note** that the initialization of data download to the USB stick will erase any previous data log file before the new data log file is copied to it, so please ensure that the any previous data log file in the USB stick are copied to other sources for future use.

  ➢ *Data Log Download to USB*

This screen can be reached by pressing **"Datalog"** button on the main screen. Before downloading data log file to the USB stick start and end time limits need to be set.

By pressing the each **"Numeric data field"** a POP UP numeric Keypad is displayed as below.



*POP UP Numeric Key Pad*

*Key in the desired valves and*
*Press ENT.*

After setting the desired start and end date / time limits press **"Download to USB"** Button. Please note longer durations need longer time for downloading **so be patient!!.** If the duration is too long check for the "Download Status Reg." data field and ensure that there are no errors as per the description below. The"Download Status Reg." data field displays the various numbers after pressing the **Download to USB"** Button. These numbers correspond to either S**tatus** or **Errors** as described below

.

| Error Description | Error Code |
|---|---|
| Logger group is not correct. | 3 |
| File output device code is not correct. | 5 |
| Start/End Date/Time not correct. | 6 |
| File name error (See Note2 Below) | 7 |
| Stick not detected | 51 |
| Get Descriptor Error | 52 |
| Set Address Error | 53 |
| Get Configuration Error | 54 |
| Set Configuration Error | 55 |
| Enumeration Failed | 56 |
| Host MS Inquiry Error | 57 |
| Host request sense Error | 58 |
| Host read capacity Error | 59 |
| Host test unit ready Error | 60 |
| host_ms_read_10 Error | 61 |
| host_ms_write_10 Error | 62 |

| Status Description | Status Code |
|---|---|
| Task / Instruction inputs are read correctly | 255 |
| Enumeration Complete | 81 |
| Host MS task Complete | 82 |
| Reserved | 83 |
| Reserved | 84 |
| Folder Created | 85 |
| Folder Found | 86 |
| File Search Complete | 87 |
| File deleted if previous file have same name , created again and begin logged data uploading | 88 |
| If file is not found, new file is created and begins logged data uploading | 89 |
| Logged data uploaded successfully | 90 |

If there are no errors the data log file is downloaded to the USB stick and "DONE" message is displayed on the screen. Subsequently the USB stick can be safely removed and the Data log file can be copied to other sources. The Data log flie downloaded to the USB stick is in ***.csv** format which can be imported or opened by an excel application. The snapshot of the imported data log file is as below.

| | A | B | C | D | E | F | G | H | I | J | K | L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | DATE | TIME | Wind Dir. | Wind Spe | Amb. Tem | Humidity | Rainfall (n | Pyra1 (w/Sqm) | Pyra2 (w/Sqm) | Mod. ` | Mod. Temp2 (DegC) | |
| 2 | | | | | | | | | | | | |
| 3 | 21-08-15 | 20:29:45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 4 | 21-08-15 | 20:29:55 | 191 | 0 | 27.8 | 70 | 540.6 | 782 | 790 | 48.6 | 48.2 | |
| 5 | 21-08-15 | 20:30:05 | 191 | 0 | 27.8 | 69.8 | 540.6 | 781 | 789 | 48.6 | 48.2 | |
| 6 | 21-08-15 | 20:30:15 | 191 | 0 | 27.8 | 69.8 | 540.6 | 781 | 789 | 48.5 | 48.2 | |
| 7 | 21-08-15 | 20:30:25 | 191 | 0 | 27.9 | 69.7 | 540.6 | 781 | 789 | 48.5 | 48.2 | |
| 8 | 21-08-15 | 20:30:35 | 191 | 0 | 27.9 | 69.7 | 540.6 | 782 | 789 | 48.7 | 48.2 | |
| 9 | 21-08-15 | 20:30:45 | 191 | 0 | 27.9 | 69.6 | 540.6 | 781 | 789 | 48.7 | 48.2 | |
| 10 | 21-08-15 | 20:30:55 | 191 | 0 | 27.9 | 69.6 | 540.6 | 781 | 789 | 48.6 | 48.2 | |
| 11 | 21-08-15 | 20:31:05 | 191 | 0 | 27.9 | 69.6 | 540.6 | 781 | 789 | 48.5 | 48.2 | |
| 12 | 21-08-15 | 20:31:15 | 191 | 0 | 27.9 | 69.5 | 540.6 | 782 | 789 | 48.5 | 48.2 | |
| 13 | 21-08-15 | 20:31:25 | 191 | 0 | 27.9 | 69.5 | 540.6 | 782 | 789 | 48.5 | 48.2 | |
| 14 | 21-08-15 | 20:31:35 | 191 | 0 | 27.9 | 69.4 | 540.6 | 782 | 789 | 48.7 | 48.2 | |
| 15 | 21-08-15 | 20:31:45 | 191 | 0 | 27.9 | 69.3 | 540.6 | 782 | 789 | 48.6 | 48.2 | |
| 16 | 21-08-15 | 20:31:55 | 191 | 0 | 27.9 | 69.2 | 540.6 | 781 | 789 | 48.6 | 48.2 | |
| 17 | 21-08-15 | 20:32:05 | 191 | 0 | 27.9 | 69.1 | 540.6 | 782 | 789 | 48.5 | 48.2 | |
| 18 | 21-08-15 | 20:32:15 | 191 | 0 | 27.9 | 69 | 540.6 | 781 | 789 | 48.5 | 48.3 | |
| 19 | 21-08-15 | 20:32:25 | 191 | 0 | 27.9 | 69 | 540.6 | 782 | 790 | 48.7 | 48.2 | |
| 20 | 21-08-15 | 20:32:35 | 191 | 0 | 27.9 | 68.9 | 540.6 | 781 | 789 | 48.6 | 48.2 | |
| 21 | 21-08-15 | 20:32:45 | 191 | 0 | 27.9 | 68.9 | 540.6 | 782 | 789 | 48.6 | 48.2 | |
| 22 | 21-08-15 | 20:32:55 | 191 | 0 | 27.9 | 68.9 | 540.6 | 782 | 789 | 48.5 | 48.2 | |
| 23 | 21-08-15 | 20:33:05 | 191 | 0 | 27.9 | 68.8 | 540.6 | 782 | 789 | 48.5 | 48.2 | |

*1.5. Weather Station Modbus TCP/IP Details*

The acquired data are also transmitted over Modbus TCP/IP protocol on the RJ 45 Ethernet communication port on a real time basis. The details of the Modbus TCP/IP Communication are as below.

Communication Details

> ➢ Protocol           :      Modbus TCP/IP
> ➢ Node Address     :      1
> ➢ Port              :      502
> ➢ Default I/P Address   :      192.168.0.254
> ➢ Default Subnet Mask   :      255.255.255.0
> ➢ Default Gateway    :      0.0.0.0
> ➢ Download Port     :      5000

**Holding Register Details**

| Parameter | Holding Register | Raw value Example | Actual Value Example |
|---|---|---|---|
| Wind Direction  Deg | 450001 | 180 | 180 |
| Wind Speed  Km/hr | 450002 | 30 | 30 |
| Temperature  °C | 450003 | 350 | 35.0 |
| Humidity  % | 450004 | 700 | 70.0 |
| Daily Rain mm | 450005 | 200 | 20.0 |
| Pyranometer 1 w/m2 | 450006 | 900 | 900 |
| Pyranometer 2 w/m2 | 450007 | 900 | 900 |
| Module Temperature 1 °C | 450008 | 550 | 55.0 |
| Module Temperature 2 °C | 450009 | 550 | 55.0 |

*Note : Pyranometer Scaling  4 -20 mA  corresponds to 0 -1600 w/m2*