

**DATA FORMAT SPECIFICATION
FOR RAIN GAUGE
AND SOIL MOISTURE SENSOR**

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1 Physical Connections and Interfaces

'Rain gauge with v3 sensor boards' means a set of sensors which includes a v3.1 Metsense board, a v3.1 Lightsense board, a Chemsense board, and a Rain Gauge. In this section, we will only deal with physical connection between Rain Gauge and Metsense board.

Physical connections between a Metsense board and a rain gauge are shown in the Figure 1. A rain gauge is connected to Metsense board directly through wires. The connection between the rain gauge and Metsense board is detected through an analog read signal through pin 2 of 3V3AD. When zero voltage, ground, is connected to Pin 2 of 3V3AD, sensor board notices that a rain gauge is connected. Therefore, the ground line from rain gauge need to be connected to both pin 1, which is ground, and 2 of 3V3AD simultaneously. The rain gauge deliver data through pin 2 of JP2, digital up/down signal.



Figure 1: Connections between a Metsense board and a rain gauge

Detail wiring to the rain gauge and board is shown in Figure 2 - 4. Wire from the rain gauge as shown in Figure 2 is going out through a hole of the body of the rain gauge as shown in Figure 3, and connected to the board as shown in Figure 1. Before the two lines from the rain gauge are connected to the Metsense board, the ground line need to be distinguished. You can use a multimeter to find one. Set a multimeter to measure voltage, connect each of the line to probes of the multimeter and move a tick inside of the rain gauge. Then you can tell which one is ground.

Pin detail of the Metsense board is shown in Figure 4. Deep blue square marked in Figure 4 is a ground pin, and light blue square is a connection pin. The connection pin and ground line of rain gauge need to be connected to the ground pin. Data pin marked as a red square need to be connected to data line of rain gauge.



Figure 2: Connections inside of the rain gauge

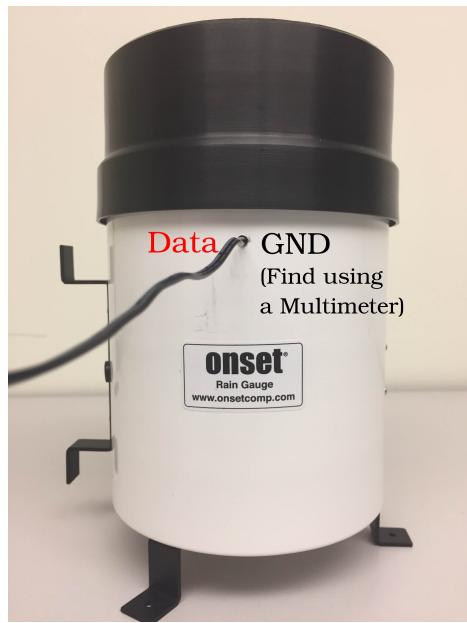


Figure 3: Connections outside of the rain gauge

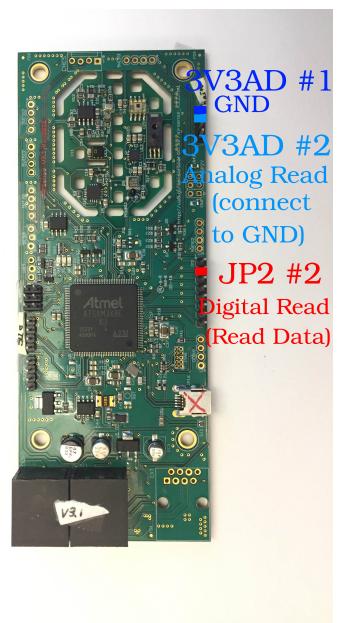


Figure 4: Connections to the Metsense board

2 Data Transmission

The data from the sensor boards is sent as a formatted unit of data – a transmission packet. A transmission packet is composed of several data sub-packets, each of which carries information pertaining to the parameter listed in the sub-packet. The data sub-packet, especially for additional sensors, rain gauge and soil moisture sensor, are described here.

2.1 Data Sub-packets

The data segment of the transmission packet is further broken down into many sub-packets. The sub-packet starts with a source identifier. One bit validity field and seven bits “length of the sub-packet” field are packed together as the next byte. The length field counts the number of bytes following it which make up the sub-packet. The table below shows the organization of a rain gauge sub-packet.

If the field is set to 1, it indicates a valid measurement/reading, and if the validity bit is set to 0 if the sensor represented in the sub-packet is dead, disabled, unconnected, unresponsive or if data could not be collected from the sensor in the time window. If the validity is 0, the particular invalid sub-packet is not packed into a transmission packet.

2.1.1 Rain Gauge

As shown in Table 1, sensor identifier of rain gauge is 0xFC, which is 252 in decimal, and if the data are valid, second byte will be 0x84, which means the sub-packet is valid and length of the sub-packet is 4 Bytes.

Source ID (1 Byte)	1-bit Validity [0: invalid, 1: valid] 7-bit Data Length (1 Byte)	Data (2 Bytes)
0xFC	0x84 (valid)	count of pendant event

Table 1: Sub-packet for rain gauge

2.1.2 Soil Moisture Sensor

As shown in Table 2, sensor identifier of soil sensor is 0xFB, which is 251 in decimal, and if the data are valid, second byte will be 0x84, which means the sub-packet is valid and length of the sub-packet is 6 Bytes.

Source ID (1 Byte)	1-bit Validity 7-bit Data Length [0: invalid, 1: valid] (1 Byte)	Data (6 Bytes)
0xFB	0x86 (valid)	Dielectric permittivity in Format 6 (2 Bytes)
		Electric Conductivity in Format 6 (2 Bytes)
		Temperature in Format 6 (2 Bytes)

Table 2: Sub-packet for rain gauge

2.2 Data Formats

The data sent in each sub-packet is encoded in one or more formats. Currently we define eight formats for various types of data including integers, bytes, and floating point numbers. Rain gauge data encoded as format 1, which is integers in range 0 to 65535, as shown in Table 3. Therefore the data of the rain gauge is an integer, and it means the count of pendant event inside the rain gauge. One event of the pendant means 0.01 in. (0.254 mm) of precipitation. Soil sensor data is encoded as format 6, which is integers in range -127.99 to 127.99 , as shown in Table 3. Therefore the data of the soil sensor are float point dielectric, conductivity, and temperature.

Format	Number of Bytes Used	Value Represented	Value Range
1	2	unsigned int_16 input	$0 - 65535$
6	2	float input	$[-127.99, 127.99]$

Table 3: Data format for rain gauge

3 Sensor Data Units

The outputs of sensors need to be processed to meaningful values. The Table 4 shows the unit for the sensor values. ‘Raw Units’ in the table means the unit for the packtized data, which you can get directly from the coresense boards, and ‘Processed Units’ means the unit which can be used after data conversion.

3.1 Rain Gauge

The conversion method for the rain gauge is provided as comments in the table.

Sensor	Sensor ID	Raw Units	Processed Units	Comments
Rain Gauge	0xFC	integer	in. or mm	One pendant event = 0.01 in. = 0.254 mm precipitation = output × 0.01 (or 0.254)

Table 4: Sub-packet data for sensors

3.2 Soil Moisture Sensor

And data from the Metsense board of this soil sensor does not need a conversion method since the data from the board are the processed values.

Sensor	Sensor ID	Raw Units	Processed Units	Comments
Soil sensor	0xFC	No unit, dS/m, °C	No unit, dS/m, °C	

Table 5: Sub-packet for rain gauge