Interpreting Register Values in the Sure Cross® Wireless System

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Technical Note

Interpreting Register Values in the Banner Wireless System

The units conversion table defines the type and range of values for each type of I/O.

The wireless devices have many different units of measure for inputs including: milliamp (mA), voltage (V), temperature (°C or °F), humidity (RH), or a raw 16-bit or 32-bit value. Outputs can be either current (4 to 20 mA, 0 to 20 mA) or voltage (0 to 10 V dc). All values stored in Modbus registers are unsigned numbers, except for temperature readings. The temperature readings are stored as signed numbers (two's complement).

The following table defines the range of values and descriptions for input units.

Input Type	I/O Range		Holding Register **Representation**		Data Conversion	**Description**
	Min.	Max.	Min.	Max.		
Discrete	0	1	0	1	-	-
0 to 20 mA	0.0 mA	20.0 mA	0	65535	(20 mA ÷ 65535) × Reg Value = mA	Linear mapping of unsigned register value to current
4 to 20 mA	4.0 mA	20.0 mA	0	65535	((16 mA ÷ 65535) × Reg Value) + 4 = mA	Linear mapping of unsigned register value to current
0 to 10 V dc	0.0 V dc	10.0 V dc	0	65535	(10 V ÷ 65535) × Reg Value = V	Linear mapping of unsigned register value to voltage
Temp C/F (high resolution)	–1638.3	+1638.4	0	65535	(Converted Reg Value) ÷ 20 = Temp	Signed Values
Counter	0	65535	0	65535	-	-
16-bit T30UF	0 mm	65535 mm	0	65535	None; stored as millimeter value	Unsigned
Humidity	0% RH	100% RH	0	10000	(Reg Value) ÷ 100 = Relative Humidity (RH)	Unsigned

Temperature Measurements:

- In high resolution mode, the temperature = (Modbus register value) ÷ 20. For high resolution temperature input, 0 in the register is interpreted as 0° and 65535 in the register (0xFFFF) is interpreted as –1 ÷ 20 = –0.05°.
- In low resolution mode, the temperature is (Modbus register value) ÷ 2. For low resolution temperature input, 0 in the register is interpreted as 0° and 65535 in the register (0xFFFF) is interpreted as –1 ÷ 2 = –0.5°. The I/O range values are –16383 through 16384.

When using a 4 to 20 mA sensor with a 0 to 20 mA input, the sensor uses the 4 to 20 mA section of the total range. Using a 4 to 20 mA with a 0 to 20 mA input allows you to determine when you have an error condition with the sensor. A normal input reading between 4 and 20 mA indicates a functioning sensor whereas a value below 4 mA indicates an error condition, such as a broken wire or loose connection. Some Sure Cross devices allow you to configure the analog inputs and outputs to use either 0 to 20 mA or 4 to 20 mA.

Signed Numbers

Temperature values are stored in Modbus registers as two's complement signed numbers. Using two's complement allows negative numbers to be stored in Modbus registers.

Although not technically a sign bit, the most significant bit (MSB) indicates a negative number when the value is set to one (1). When the most significant bit is zero (0), the value is greater than or equal to zero.

Modbus register values of 32768 through 65535 (decimal) represent negative temperatures. These numbers in binary form are: 1000 0000 0000 0000 through 1111 1111 1111 1111.

To convert to a negative temperature value from a Modbus register value, first convert the value from the two's complement number. To convert from a two's complement number in binary form, invert all the bits (0 changes to 1, 1 changes to a 0), then add 1. Convert this binary value to a decimal value and divide by either 20 (high resolution mode) or 2 (low resolution mode) to calculate the negative temperature.

Register Value		Converted Decimal	Calculated Temperature (Converted Decimal ÷ 20)
Two's Complement Value	Decimal Value		
0000 0000 0000 0101	5	5	0.25

Register Value		Converted Decimal	Calculated Temperature (Converted Decimal ÷ 20)
Two's Complement Value	Decimal Value		
0000 0000 0000 0100	4	4	0.20
0000 0000 0000 0011	3	3	0.15
0000 0000 0000 0010	2	2	0.10
0000 0000 0000 0001	1	1	0.05
0000 0000 0000 0000	0	0	0
1111 1111 1111 1111	65535	-1	-0.05
1111 1111 1111 1110	65534	-2	-0.10
1111 1111 1111 1101	65533	-3	-0.15
1111 1111 1111 1100	65532	-4	-.20
1111 1111 1111 1011	65531	-5	-0.25
1111 1100 0001 1000	64536	-1000	-50