Modbus Quick Start Guide
Professional FW Version 6

Modbus is a widely used serial communication protocol across a variety of industries, including environmental sensing. Being an open standard protocol, it can be used by any manufacturer as it is not proprietary. If you require longer communication distances, higher data rates, or need to interface with a wider range of devices, Modbus is the preferred choice.

The HydraProbe utilizes Modbus RTU over RS485 protocol. The acronym RTU stands for "remote terminal unit," which means the HydraProbe can be connected to a supervisory computer or a data logger. The physical connection is established using the RS485 electrical interface, which ensures secure and accurate data transfer. Protocol specifics can be found at https://modbus.org.

Technical Specifications:

Power	Requirements	9 to 16 VDC (12VDC Ideal)
	Consumption	2.5 mA idle / 25 mA active for 2s Active
Wiring	Red	+ Power Input
	Black	Ground
	White	Modbus A
	Green	Modbus B
Communication	Baud Rate	1200-115200 (9600 default)
	Data Bits	8
	Parity	None
	Stop Bits	1

How To Use:

Using Modbus involves setting up a master-slave communication system between devices. The master device (logger) sends requests to the slave device (HydraProbe) to read or write data, and the slave devices respond with the requested data. The basic steps to use Modbus are below:

1. Set up the physical connection: Connect the devices using the appropriate physical interface. For HydraProbe this will be RS485.

2. Set up the Modbus communication parameters: Configure the baud rate, parity, data bits, and stop bits to match the settings of both the master and slave devices.

3. Assign Modbus addresses: Assign a unique Modbus address to each slave device on the network.

4. Follow the instructions for the logger you want to use or develop your own Modbus application: There are different libraries and software tools available to simplify the development of Modbus applications, depending on the programming language or platform used. If you plan to use Python, reach out to Stevens for an example script.

5. Test: Test the communication between the devices and make any necessary adjustments to the application or settings.

Readings:

Addressing
Each Modbus sensor must have its own unique address. The default address is "1".

Request Readings
To read data from the HydraProbe use function code 03, "read holding registers". Data is stored as 32-bit floating point with big endian word order. Parameters are stored over 2 Modbus registers so you must read a minimum of two registers at a time to get a full 32-bit value.

Take a Reading and Return Value
Takes a reading then returns the value. Can take up to 2 seconds.

Modbus Register Address	Description
110	Soil Moisture (wfv)
112	Soil Temperature (C)
114	Soil Temperature (F)
116	Bulk EC (Temperature Corrected) (S/m)
118	Bulk EC (S/m)
120	Pore Water EC (S/m)
122	Real Dielectric Permittivity
124	Imaginary Dielectric Permittivity
126	Imaginary Dielectric Permittivity (Temperature Corrected)
128	Dielectric Loss Tangent
130	Diode Temperature (C)

Return Stored Reading
Returns data from last measurement reading. Requires a reading request first. To write data to the HydraProbe use function code 16, "write holding registers".

Modbus Register Address	Description
1002	Reading Request
10	Soil Moisture (wfv)
12	Soil Temperature (C)
14	Soil Temperature (F)
16	Bulk EC (Temperature Corrected) (S/m)
18	Bulk EC (S/m)
20	Pore Water EC (S/m)
22	Real Dielectric Permittivity
24	Imaginary Dielectric Permittivity
26	Imaginary Dielectric Permittivity (Temperature Corrected)
28	Dielectric Loss Tangent
30	Diode Temperature (C)

Return Last Reading and Take New Reading

Returns reading from last measurement then takes a new reading. The sensor will be unresponsive for up to 1 second while taking the measurement.

Modbus Register Address	Description
210	Soil Moisture (wfv)
212	Soil Temperature (C)
214	Soil Temperature (F)
216	Bulk EC (Temperature Corrected) (S/m)
218	Bulk EC (S/m)
220	Pore Water EC (S/m)
222	Real Dielectric Permittivity
224	Imaginary Dielectric Permittivity
226	Imaginary Dielectric Permittivity (Temperature Corrected)
228	Dielectric Loss Tangent
230	Diode Temperature (C)

Configuration:

Information

To read data from the HydraProbe use function code 03, "read holding registers.

Description	Modbus Register Address	Number of Registers	Type	Writeable
Serial number	1020	8	Ascii	N
Firmware version	1070	3	Ascii	N
Model number	1016	2	Ascii	N

Pore Water Offset

To read data from the HydraProbe use function code 03, "read holding registers.

To write data to the HydraProbe use function code 16, "write holding registers".

Description	Modbus Register Address	Number of Registers	Type	Writeable
Read/Write Pore Water Offset	1112	2	32-bit float big endian	Y
Reset Pore Water Offset to default 3.4	1115	1	n/a	Y

Baud Rate

The default baud rate is 9600. To change the rate, write the corresponding value of the desired baud rate from the table below.

To read data from the HydraProbe use function code 03, "read holding registers.
To write data to the HydraProbe use function code 16, "write holding registers".

Description	Modbus Register Address	Number of Registers	Type	Writeable
Read/Write Pore Water Offset	1001	1	byte	Y

Baud Rate	Value to read/write
1200	0
2400	1
4800	2
9600	3
14400	4
19200	5
28800	6
31250	7
38400	8
56000	9
57600	10
76800	11
115200	12

Calibration

The following extended command will change the coefficients in one of two general formulas that translate the real dielectric permittivity to soil moisture. In many cases, the HydraProbe will not need to be recalibrated. The default General calibration has been heavily reviewed and will provide reasonable accuracy for most applications. If you need to change the calibration or if a custom calibration is required, we recommend referring to the HydraProbe user manual for more information.

To read data from the HydraProbe use function code 03, "read holding registers.
To write data to the HydraProbe use function code 16, "write holding registers".

Description	Modbus Register Address	Number of Registers	Type	Writeable
Calibration soil type G – General O – Organic R – Rockwool C – Custom 1 K – Custom 2	1009	2	Ascii	Y
Coefficient A	1100	2	32-bit float big endian	Y
Coefficient B	1102	2	32-bit float big endian	Y
Coefficient C	1104	2	32-bit float big endian	Y
Coefficient D	1106	2	32-bit float big endian	Y
Coefficient E	1108	2	32-bit float big endian	Y
Coefficient F	1110	2	32-bit float big endian	Y
Reset all coefficients to default	1114	1	n/a	Y

Accuracy and Ranges

Parameter	
Soil moisture for inorganic mineral soils	Accuracy*: +/- 0.01 WFV for most soils (m^3, m^{-3}) +/- <0.03 for fine textured soil (typical) Range: From Complete Dry to Full Saturation (0% to 100% of saturation)
Bulk EC	Accuracy: +/- 2.0% or 0.02 S/m Whichever is greater Range: 0 to 1.5 S/m
Temperature	Accuracy: +/- 0.3 °C Range: -40 to 75 °C
Inter-Sensor Variability	+/- 0.012 WFV (typical)
Pore Water EC	Hilhorst Equation, depends on soil conditions

*Accuracy of soil moisture depends on the soil and is highly variable.

Model Numbers

Version Part # Suffix	
02	Professional, w/25 ft. cable
04	Professional, w/50 ft. cable
06	Professional, w/100 ft. cable