Hydronix Microwave Moisture Sensor Modbus Protocol Register Mapping

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The product described in this documentation is subject to continuous development and improvement. All information of a technical nature and particulars of the product and its use including the information and particulars contained in this documentation are given by Hydronix in good faith.

Hydronix welcomes comments and suggestions relating to the product and this documentation

ACKNOWLEDGEMENTS

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Revision history

Revision No	Date	Description of Change
1.0.0	March 2021	First Release
1.1.0	July 2021	Added Filter Include Registers

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Table of Figures

This guide details the Modbus RTU protocol supported by Hydronix Microwave Moisture sensors. Only sensor utilising firmware HS0102 v1.11.00 or above are configured for Modbus RTU communication. The information detailed in this guide provides an overview of the default Modbus settings and register maps.

For detailed instructions on the operation of the sensor, see the Sensor Configuration and Calibration Guide HD0679. For electrical installation advice, see the Electrical Installation Guide HD0678.

For further information on the Modbus protocol the specification is available from www.modbus.org

1 Default Settings

All Hydronix Modbus enabled sensors are supplied with the following default settings (Table 1). The Modbus setting can only be adjusted using Hydro-Com software, available for download from www.hydronix.com

See the Hydro-Com user guide HD0682 for details on how to configure the Modbus settings.

Parameter	Default Value
Slave Address	1
Baud Rate	19200
Parity	None
Stop Bits	1
Data Bits	8

Table 1: Default Settings

2 Supported Modbus registers

The following Modbus Functions are supported by the sensor (Table 2).

Modbus Function Code	Register Address Start Value	Data Type and Operation
02	10001	Read Input Bit
03	40001	Read One or More Holding registers
04	30001	Read One or More Input Registers
05	1	Write Single Output Bit
06	40001	Write Single Holding Register
16	40001	Write One or More Holding Registers

Table 2: Supported Modbus Functions

2.1 Function Code 02 (0x02) Read Discrete Input

Function Code 02 enables the reading of 1-2000 continuous discrete inputs.

To read the current state of a discrete input, or multiple inputs, the master must send a Read Discrete Inputs request message. The read discrete input message specifies the starting location of the register to read and the number of registers required. The Discrete input registers are numbered starting at 0, therefore, inputs 1-100 are addressed as 0-99.

The results of the input status request are packed as one bit per input of the data field in the reply, with a 1 = ON and 0 = OFF. The LSB in the reply data represents the first input status with each subsequent bit representing the input status in the request. If more than 8 input values are returned additional bytes are returned with any remaining bits set to 0. The byte count field in the reply indicates the number of bytes in the data field of the reply.

In the following example (Table 3) the master requests to read 3 input registers starting at register 0 (10001).

The reply message contains 1 byte. The data value is 0x04 (00000100), therefore, input number 3 is active, all other inputs are off.

Request		Reply	
Field Name	**Hex**	**Field Name**	**Hex**
Slave Address	02	Slave address	02
Function Code	02	Function Code	02
Starting Address Hi	00	Byte Count	01
Starting Address Lo	00	Input Status	04
Number of Inputs Hi	00	Checksum	A0
Number of Inputs Lo	03	Checksum	0F
Check Sum	0x38		
Check Sum	0x38		

Table 3: Function Code 02 Example

2.2 Function Code 03 (0x03) Read One or More Holding Registers

Function Code 03 enables the reading of one or more adjoining holding registers. The request message stipulates the starting address and number of registers required to be read. The holding registers are numbered starting at 0, therefore, inputs 1-100 are addressed as 0-99.

The reply message contains the data packed into two bytes per register

In the following example (Table 4) the master requests to read 3 Holding registers starting at register 51 (40052). The reply message contains 6 bytes. Register 51 value: is 0x00 0x00 (Decimal 0), Register 52: value is 0x01 0xF4 (Decimal 500) and Register 53 value is: 0x00 0x05 (Decimal 5).

Request		Reply	
Field Name	**Hex**	**Field Name**	**Hex**
Slave Address	03	Slave address	03
Function Code	03	Function Code	03
Starting Address Hi	00	Byte Count	06
Starting Address Lo	33	Register Value Hi (51)	00
Number of Inputs Hi	00	Register Value Lo (51)	00
Number of Inputs Lo	03	Register Value Hi (52)	01
Checksum	F4	Register Value Lo (52)	F4
Checksum	26	Register Value Hi (53)	00
		Register Value Lo (53)	05
		Checksum	B8
		Checksum	18

Table 4: Function Code 03 Example

2.3 Function Code 04 (0x04) Read One or More Input Registers

Function Code 04 enables the reading of one or more adjoining input registers. The request message stipulates the starting address and number of registers required to be read. The input registers are numbered starting at 0, therefore, inputs 1-100 are addressed as 0-99.

The reply message contains the data packed into two bytes per register

In the following example (Table 5) the master requests to read 2 input registers starting at register 0 (30001).

The reply message contains 4 bytes. Register 0 value: is 0xFF 0xF6 (-10) and Register 1 value is: 0x00 0x10 (16).

Request		Reply	
Field Name	**Hex**	**Field Name**	**Hex**
Slave Address	02	Slave address	02
Function Code	04	Function Code	04
Starting Address Hi	00	Byte Count	04
Starting Address Lo	00	Register Value Hi (0)	FF
Number of Inputs Hi	00	Register Value Lo (0)	F6
Number of Inputs Lo	02	Register Value Hi (1)	00
Checksum	71	Register Value Lo (1)	10
Checksum	F8	Checksum	19
		Checksum	6E

Table 5: Function Code 04 example

2.4 Function Code 05 (0x05) Write Single Output Bit

Function Code 05 enables the writing of one Output Bit. The Output Bits are numbered starting at 0, therefore, Bits 1-100 and addressed as 0-99. The output is configured ON/OFF, a value of 0xFF 0x00 will set the output to ON a value of 0x00 0x00 will set the output to OFF.

The reply message will echo the request if successful.

In the following example (Table 6) the master requests to set the output bit at register location 3 (Modbus 4) to ON.

The reply message indicated the request is successful by sending an echo of the request.

Request		Reply	
Field Name	**Hex**	**Field Name**	**Hex**
Slave Address	04	Slave address	04
Function Code	05	Function Code	05
Address Hi	00	Address Hi	00
Address Lo	03	Address Lo	03
Output Value Hi	FF	Output Value Hi	FF
Output Value Lo	00	Output Value Lo	00
Checksum	7C	Checksum	7C
Checksum	6F	Checksum	6F

Table 6: Function Code 05 Example

2.5 Function Code 06 (0x06) Write Single Holding Register

Function Code 06 enables the writing of one Holding Register. The Holding registers are numbered starting at 0, therefore, registers 1-100 are addressed as 0-99.

The reply message will echo the request if successful.

In the following example (Table 7) the request is to write 0x07 0xD0 to register 2 (40003)

The reply message indicated the request is successful by sending an echo of the request.

Request		Reply	
Field Name	**Hex**	**Field Name**	**Hex**
Slave Address	03	Slave address	03
Function Code	06	Function Code	06
Address Hi	00	Address Hi	00
Address Lo	02	Address Lo	02
Output Value Hi	07	Output Value Hi	07
Output Value Lo	D0	Output Value Lo	D0
Checksum	2A	Checksum	2A
Checksum	44	Checksum	44

Table 7: Function Code 06 Example

2.6 Function Code 16 (0x10) Write Multiple Holding Register

Function Code 16 enables the writing of up to 123 adjoining Holding Registers. The Holding Registers are numbered starting at 0, therefore, registers 1-100 are addressed as 0-99.

The reply message will contain the function code, starting register address and the number of registers written if successful.

In the following example (Table 8), a request is made to send values 0x13 0x88, 0x19 0x64, 0x10 0x68 to 3 registers starting at address 6 (40007).

The reply message indicates that the request has been successful by indicating the quantity of registers written.

Request		Reply	
Field Name	**Hex**	**Field Name**	**Hex**
Slave Address	04	Slave address	04
Function Code	10	Function Code	10
Address Hi	00	Address Hi	00
Address Lo	06	Address Lo	06
Number of Registers Hi	00	Number of Registers Hi	00
Number of Registers Lo	03	Number of Registers Lo	03
Byte Count	06	Checksum	60
Register Value Hi	13	Checksum	5C
Register Value Lo	88		
Register Value Hi	19		
Register Value Lo	64		
Register Value Hi	10		
Register Value Lo	68		
Checksum	A2		
Checksum	8B		

Table 8: Function Code 16 Example

3 Error Messages (Exception Codes)

If the Modbus slave device receives a request that is invalid from the master, it will respond with an Exception code. The sensor will reply with an exception code if a non-supported Function code is used or an Illegal register address is requested.

The Exception response is identified by the return of the Function code with the high order bit set to 1. The exception code is also sent to identify the type of error.

Note: The sensor does not range check any values a register is set to. If a value outside the specified range is set this can result in the sensor failing to operate correctly. See the Modbus Register list page 21

The following exception codes are supported (Table 9).

Exception Code	Name	Description
01	Illegal Function	The function code in the message is not supported by the slave. Hydronix sensors only support Function codes: 2, 3, 4, 5, 6 and 16
02	Illegal Address	The register address referenced in the message, or the quantity of registers, is not valid for the specified function code.

Table 9: Exception Codes

In following example (Table 10) a request to read 3 Input registers starting at address 699 (30700) is sent. Access to address 699, 700 and 701 are not permitted. A 02 Exception code is generated with the Function code high order bit set to 1.

Request		Reply	
Field Name	**Hex**	**Field Name**	**Hex**
Slave Address	03	Slave Address	03
Function Code	04	Function Code	84
Register address Hi	02	Exception Code	02
Register Address Lo	BB	Checksum	63
Number of Registers Hi	00	Checksum	01
Number of Registers Lo	03		
Checksum	C0		
Checksum	74		

Table 10: Exception Example

4 Invalid Data Read/Write (Sensor specific)

4.1 Read

If a read request of data from a register not valid for a specific sensor type is performed, for example Raw Unscaled Mode V (Register 30002) from a Hydro-Probe sensor, a value of -99 (after the appropriate scaling) will be returned.

4.2 Write

If an attempt to write to an unsupported Holding register for a specific sensor, for example Hydro-Probe Calibration Coefficient B Mode V (Register 40009), the input value will be ignored by the sensor. No error message is sent.

5 Data Types

5.1 16-bit Integer

The standard output type of the sensor. Each register represents a 16-bit integer. If unsigned the range will be 0 to 65535, if signed the values will be in the range of -32767 to 32767.

Scaling

All 16-bit Integer values represent a floating-point number, unless stated in the register table, and will require scaling to match the decimal place precision.

Example: A returned Value of 100 with 2 decimal place precision represents a value of 1.00

5.2 32-bit Signed Integer

Certain outputs values from the sensor can be higher than the maximum a 16-bit integer can accommodate and therefore will require a 32-bit integer. To accommodate the extended range the sensor will combine two 16-bit integer outputs to create a 32-bit integer. These values can be either signed or Unsigned.

Calculation of the Higher order register

$Register_{high}$ = 32-bit Value/65536

$Register_{low}$ = 32-bit Value Modulus x 65536

Output Value = $Register_{high}$ x 65536 + $Register_{low}$

Example 32-bit Unsigned

A value of 98765432 is output as an Unsigned 32-bit integer.

98765432 = 0x05E30A78

$Register_{high}$ = 0x05E3 = 1507

$Register_{low}$ = 0x0A78 = 2680

Value = 1507 x 65536 + 2680 = 98765432

Example 32-bit Signed

A value of -98765432 is output as a Signed 32-bit integer.

-98765432 = 0xFA1CF588

$Register_{high}$ = 0xFA1C (Signed) = -1508

$Register_{low}$ = 0xF588 (Unsigned) = 62856

Value = -1508 x 65536 + 62856 = -98765432

Scaling

All 32-bit Integra values represent a floating-point number, unless stated in the register table, and will require scaling to match the decimal place precision.

Example: A returned Value of 100 with 2 decimal place precision represents a value of 1.00

5.3 Boolean

When several Boolean registers are requested, the sensor will pack the results into a single message. Each bit in the message represents one Modbus register with the LSB representing the first register in the request.

Example: A value of 0000 0101 indicates the first and third registers in the request are active.

Note: Any unused bits in the message (towards the MSB) are filled as 0.

5.4 Ascii

For Ascii formatted messages the message string is spread across several Modbus registers. Only one character is returned per register. Therefore, the higher order Byte in these messages is set as 0x00.

Example: The word HYDRONIX would be represented by the following Hex values

0x00 0x48, 0x00 0x59, 0x00 0x44, 0x00 0x52, 0x00 0x4F, 0x00 0x4E, 0x00 0x49, 0x00 0x58.

Note: All unused registers will be return as 0 (0x00 0x00)

The following table details the default Modbus data registers that are supported by Hydronix Microwave moisture sensors. Only sensors utilising software HS0102 v1.11.0 or above are Modbus enabled.

1 Modbus Registers

Name	Modbus Address	Number of Registers	Data Format	Access	Description	Valid Data Range
Commit Configuration to Flash memory	2	1		Write	If changes to the sensor configuration are to be maintained through power outages, then they must first be committed to the Flash EPROM. However, the Flash EPROM has only a finite life (low 1000's) for configuration changes and each time the 'commit to flash' action is performed one of these 'lives' is used. Hence it would be normal to perform all required configuration changes first and then issue a single command to commit the changes to Flash.	0xFF
Stop Averaging	3	1		Write	If the digital input has not been configured for Average/Hold use, then it is possible to control batch averaging using this register to stop the batch Average	0xFF
Start Averaging	4	1		Write	If the digital input has not been configured for Average/Hold use, then it is possible to control batch averaging using this register to start the batch Average.	0xFF
Auto Calibrate (AutoCal)	5	1		Write	Starts the AutoCal process	0xFF
Backup Configuration to Flash	6	1		Write	Writes the backup copy of the configuration in Flash. Should be used sparingly to reduce risk of corruption	0xFF
Restore Configuration from backup	7	1		Write	Restores the Backed-up configuration to RAM and but does not commit to the main copy in Flash.	0xFF

Name	Modbus Address	Number of Registers	Data Format	Access	Description	Valid Data Range
Disable Signal Filtering	8	1		Write	Disables the filtering of the raw signal and holds the previous filtered value. Will not work if the digital input (40026) has been set to “Filter Include”. The default state for the filtering is “Enabled”	0xFF
Enable Signal Filtering	9	1		Write	Enables the filtering of the raw signal. Will not work if the digital input (40026) has been set to “Filter Include”. The default state for the filtering is “Enabled”	0xFF
Digital Input State	10001	1		Read	State of first Digital Input	
Digital IO State	10002	1		Read	Digital IO State (Digital Input 2)	
Averaging Status	10003	1	0: Reading is held 1: Averaging in progress	Read	Averaging Status	
Filter Include Status	10004	1	0: Filter Value is Held 1: Filtering is Enabled	Read	Status of the Filter Include.	
Raw Unscaled Mode F	30001	1	Represents a Floating-Point Number 2 Decimal Place precision	Read	The Raw Unfiltered reading from the sensor scaled from 0 (air) to 100 (water) Calculated in Mode F	
Raw Unscaled Mode V	30002	1	Represents a Floating-Point Number 2 Decimal Place precision	Read	The Raw Unfiltered reading from the sensor scaled from 0 (air) to 100 (water) Calculated in Mode V. **Not applicable for Hydro-Probe or Hydro-Trac sensors.**	
Raw Unscaled Mode E	30003	1	Represents a Floating-Point Number 2 Decimal Place precision	Read	The Raw Unfiltered reading from the sensor scaled from 0 (air) to 100 (water) Calculated in Mode E. **Not applicable for Hydro-Probe or Hydro-Trac sensors.**	
Filtered Unscaled Mode F	30004	1	Represents a Floating-Point Number 2 Decimal Place	Read	The Filtered reading from the sensor scaled from 0 (air) to 100 (water). In synchronised measurement mode, this will	

Name	Modbus Address	Number of Registers	Data Format	Access	Description	Valid Data Range
			precision		be the synchronised average reading. Mode F	
Filtered Unscaled Mode V	30005	1	Represents a Floating-Point Number 2 Decimal Place precision	Read	The Filtered reading from the sensor scaled from 0 (air) to 100 (water). In synchronised measurement mode, this will be the synchronised average reading. Mode V. **Not applicable for Hydro-Probe or Hydro-Trac sensors.**	
Filtered Unscaled Mode E	30006	1	Represents a Floating-Point Number 2 Decimal Place precision	Read	The Filtered reading from the sensor scaled from 0 (air) to 100 (water). In synchronised measurement mode, this will be the synchronised average reading. Mode E. **Not applicable for Hydro-Probe or Hydro-Trac sensors.**	
Average Unscaled Mode F	30007	1	Represents a Floating-Point Number 2 Decimal Place precision	Read	The average value of the material passing in front of the sensor between start/stop transitions of the average/hold input, or when triggered using the Remote averaging function. Scaled 0 (air) to 100 (water). Calculated in Mode F	
Average Unscaled Mode V	30008	1	Represents a Floating-Point Number 2 Decimal Place precision	Read	The average value of the material passing in front of the sensor between start/stop transitions of the average/hold input, or when triggered using the Remote averaging function. Scaled 0 (air) to 100 (water). Calculated in Mode V. **Not applicable for Hydro-Probe or Hydro-Trac sensors.**	
Average Unscaled Mode E	30009	1	Represents a Floating-Point Number 2 Decimal Place precision	Read	The average value of the material passing in front of the sensor between start/stop transitions of the average/hold input, or when triggered using the Remote averaging function. Scaled 0 (air) to 100 (water). Calculated in Mode E. **Not applicable for Hydro-Probe or Hydro-Trac sensors.**	
Raw Moisture Mode F	30010	1	Represents a Floating-Point Number 2 Decimal Place precision	Read	The Raw (Unfiltered) moisture reading of the material, calculated in Mode F. **Not applicable for Hydro-Trac sensors.**	

Name	Modbus Address	Number of Registers	Data Format	Access	Description	Valid Data Range
Raw Moisture Mode V	30011	1	Represents a Floating-Point Number 2 Decimal Place precision	Read	The Raw (Unfiltered) moisture reading of the material, calculated in Mode V. **Not applicable for Hydro-Probe or Hydro-Trac sensors.**	
Raw Moisture Mode E	30012	1	Represents a Floating-Point Number 2 Decimal Place precision	Read	The Raw (Unfiltered) moisture reading of the material, calculated in Mode E. **Not applicable for Hydro-Probe or Hydro-Trac sensors.**	
Filtered Moisture Mode F	30013	1	Represents a Floating-Point Number 2 Decimal Place precision	Read	The filtered moisture reading of the material using the configured settings calculated in Mode F. In synchronised measurement mode, this will return the synchronised average reading. **Not applicable for Hydro-Trac sensors.**	
Filtered Moisture Mode V	30014	1	Represents a Floating-Point Number 2 Decimal Place precision	Read	The filtered moisture reading of the material using the configured settings calculated in Mode V. In synchronised measurement mode, this will return the synchronised average reading. **Not applicable for Hydro-Probe or Hydro-Trac sensors.**	
Filtered Moisture Mode E	30015	1	Represents a Floating-Point Number 2 Decimal Place precision	Read	The filtered moisture reading of the material using the configured settings calculated in Mode E. In synchronised measurement mode, this will return the synchronised average reading. **Not applicable for Hydro-Probe or Hydro-Trac sensors.**	
Average Moisture, Mode F	30016	1	Represents a Floating-Point Number 2 Decimal Place precision	Read	The Average Moisture value of the material passing in front of the sensor between start/stop transitions of the average/hold input, or when triggered using the Remote Averaging function. Calculated in Mode F. **Not applicable for Hydro-Trac sensors.**	
Average Moisture, Mode V	30017	1	Represents a Floating-Point Number 2 Decimal Place precision	Read	The Average Moisture value of the material passing in front of the sensor between start/stop transitions of the average/hold input, or when triggered using the Remote	

Name	Modbus Address	Number of Registers	Data Format	Access	Description	Valid Data Range
					Averaging function. Calculated in Mode V. **Not applicable for Hydro-Probe or Hydro-Trac sensors.**	
Average Moisture, Mode E	30018	1	Represents a Floating-Point Number 2 Decimal Place precision	Read	The Average Moisture value of the material passing in front of the sensor between start/stop transitions of the average/hold input, or when triggered using the Remote Averaging function. Calculated in Mode E. **Not applicable for Hydro-Probe or Hydro-Trac sensors.**	
Electronics Temperature	30019	1	Represents a Floating-Point number with 2 decimal place precision	Read	Internal Electronics temperature of the sensor, in ºC	
Resonator Temperature	30020	1	Represents a Floating-Point number with 2 decimal place precision	Read	Temperature of the resonator within the sensor, in ºC	
Material Temperature	30021	1	Represents a Floating-Point number with 2 decimal place precision	Read	Temperature of the measured material, in ºC	
Brix value	30022	1	Represents a Floating-Point number with 2 decimal place precision	Read	The calculated Brix value of the material. **Hydro-Trac and Hydro-Probe SE Sensors only**	
Data Max Temp	30023	1	Represents a Floating-Point number with 1 decimal place precision	Read	Maximum Electronics Temperature recorded by the sensor.	
Data Min Temp	30024	1	Represents a Floating-Point number with 1 decimal place precision	Read	Minimum Electronics Temperature recorded by the sensor.	

Name	Modbus Address	Number of Registers	Data Format	Access	Description	Valid Data Range
Data Max Res Temp	30025	1	Represents a Floating-Point number with 1 decimal place precision	Read	Maximum Resonator Temperature recorded by the sensor.	
Data Min Res Temp	30026	1	Represents a Floating-Point number with 1 decimal place precision	Read	Minimum Resonator Temperature recorded by the sensor.	
AutoTrack Value	30027	1	Represents a Floating-Point number with 3 decimal place precision	Read	The average of the Unscaled value calculated over the configured AutoTrack Time.	
AutoTrack Deviation	30028	1	Represents a Floating-Point number with 2 decimal place precision	Read	The rms deviation of the Unscaled from the AutoTrack Value over the AutoTrack Time period. Provides an indication of homogeneity.	
Reserved	30029	1		Read	Reserved	
Reserved	30030	1		Read	Reserved	
Reserved	30031	1		Read	Reserved	
Reserved	30032	1		Read	Reserved	
Reserved	30033	1		Read	Reserved	

Name	Modbus Address	Number of Registers	Data Format	Access	Description	Valid Data Range
Reserved	30034	1		Read	Reserved	
Config Air Frequency	30035	1	Represents floating-point number in MHz with 1 decimal place precision.	Read/Write	Frequency measurement in air at 20C. Calibrated in Production and should not normally be changed.	
Config Water Frequency	30036	1	Represents floating-point number in MHz with 1 decimal place precision	Read/Write	Frequency measurement in water at 20C. Calibrated in Production and should not normally be changed.	
Config Air Amplitude	30037	1	Represents a floating-point number with 1 decimal place precision	Read/Write	Amplitude measurement in air at 20C. Calibrated in Production and should not normally be changed. **Not applicable for Hydro-Probe or Hydro-Trac sensors.**	
Config Water Amplitude	30038	1	Represents a floating-point number with 1 decimal place precision	Read/Write	Amplitude measurement in water at 20C. Calibrated in Production and should not normally be changed. **Not applicable for Hydro-Probe or Hydro-Trac sensors.**	
Electronics Frequency Temperature Coefficient	30039	2	(32 Bit) Represents floating point number with 4 decimal place precision	Read/Write	Temperature compensation for the frequency measurement, Electronics portion of the sensor, in MHz / ºC	
Resonator Frequency Temperature Coefficient	30041	2	(32 Bit) Represents floating point number with 4 decimal place precision	Read/Write	Temperature compensation for the frequency measurement, Resonator portion of the sensor, in MHz / ºC	

Name	Modbus Address	Number of Registers	Data Format	Access	Description	Valid Data Range
Material Frequency Temperature Coefficient	30043	2	(32 Bit) Represents floating point number with 4 decimal place precision	Read/Write	Temperature compensation for the frequency measurement, Material portion of the sensor, in MHz / ºC	
Electronics Temperature Amplitude compensation coefficient	30045	2	(32 Bit) Represents a floating-point number with 4 decimal place precision	Read/Write	Temperature compensation for the Amplitude measurement, Electronics portion of the sensor, in MHz / ºC. Set in Production and should not normally be changed. **Not applicable for Hydro-Probe or Hydro-Trac sensors.**	
Resonator Temperature Amplitude compensation coefficient	30047	2	(32 Bit) Represents a floating-point number with 4 decimal place precision	Read/Write	Temperature compensation for the Amplitude measurement, Resonator portion of the sensor, in MHz / ºC. Set in Production and should not normally be changed. **Not applicable for Hydro-Probe or Hydro-Trac sensors.**	
Material Temperature Amplitude compensation coefficient	30049	2	(32 Bit) Represents a floating-point number with 4 decimal place precision	Read/Write	Temperature compensation for the Amplitude measurement, Material portion of the sensor, in MHz / ºC. Set in Production and should not normally be changed. **Not applicable for Hydro-Probe or Hydro-Trac sensors.**	
Flash Writes	30051	1	Integer	Read	Number of recorded write operations to the Data Flash	
Hardware corrupt count	30052	1	Integer	Read	The number of times the Data Flash was found to be corrupted and corrected	
Hardware reset count	30053	1	Integer	Read	The number of times the sensor has been reset (started up)	
Auto Calibrate state	30054	1	Defined integer values: 0: Can AutoCal 1: AutoCal successful 2: AutoCal Failed 3: Busy 9: Can't AutoCal	Read		

Name	Modbus Address	Number of Registers	Data Format	Access	Description	Valid Data Range
Sensor status	30055	2	Defined Binary Flag Values (representing bit location): 0: Invalid (Live) 1: Invalid (Latched) 2: Unreliable (Live) 3: Unreliable (Latched) 4: Offscale (Live) 5: Offscale (Latched) 6: Too Hot (Live) 7: Too Hot (Latched) 8: Too Cold (Live) 9: Too Cold (Latched) 10: Stable (Live) 11: Stable (Latched) 12: Material Too Hot (Live) 13: Material Too Hot (Latched) 14: Material Too Cold (Live) 15: Material Too Cold (Latched) [Start of LO Register] 16: Cal Out of Range (Live) 17: Cal Out of Range (Latched) 18: Unscaled Out of Range (Live) 19: Unscaled Out of Range (Latched) 20: Supply 5V Error (Live) 21: Supply 5V Error (Latched) 22: RF Ref Error (Live) 23: RF Ref Error (Latched) 24: Digital IO Mode	Read	27 bits provide the status information of the sensor. A ‘1’ indicates that the described condition is true. A ‘1’ in a latched position implies that the state has existed at some point since the status was last read but may no longer be present. Register 30039 contains the first 16 flag values (0-15), register 30040 represents the final 11 flags with all remaining bits set to 0. Both registers start at the LSB See Appendix A for the description of each sensor flag value.	

Name	Modbus Address	Number of Registers	Data Format	Access	Description	Valid Data Range
			25: Digital Input Status Flag 26: Digital IO Status Fla			
Config Sensor Type	30057	1	Defined hexadecimal Integer values: 0x000: NOT SET / UNDEFINED 0x010: ORBITER 0x020: HYDROTRAC 0x028: HYDROPROBE SE 0x040: HYDROMIX 0x048: HYDROMIX XT 0x04A: HYDROMIX XT-FS 0x04C: HYDROMIX XT-EX 0x04E: HYDROMIX XT-EX-FS 0x080: Reserved 0x100: HYDROPROBE 0x108: HYDROPROBE XT 0x201: HYDROPROBE HT 0x202: HYDROMIX HT 0x204: HYDROMIX HT-FS 0x206: HYDROMIX HT-EX 0x208: HYDROMIX HT EX-FS 0x400: ETRACEMIX	Read	This register identifies the configured product type which influences the behaviour of the sensor and allows a host system to identify available functionality.	
Config Orbiter Arm Type	30058	1	Defined hexadecimal Integer values: 0x00: NOT SET / ORBA1 / ORBA2 0x10: ORBA1c (all lengths) 0x20: ORBA2c 560mm 0x21: ORBA2c 700mm	Read	The type and length of the Arm fitted. This is read back from the Arm. **Hydro-Probe Orbiter Sensors only**.	

Name	Modbus Address	Number of Registers	Data Format	Access	Description	Valid Data Range
			0x22: ORBA2c 1200mm 0x23: ORBA2c 1420mm			
Hardware Sensor ID	30301	8	One Ascii character per register	Read	Represents the Hardware ID as a string. E.g. "1A452F8C"	
Software Part Number	30309	6	One Ascii character per register	Read	Represents the software part number as a string. E.g. "HS0102"	
Software Version	30315	8	One Ascii character per register	Read	Represents the software version as a string. E.g. "v1.11.00"	
Calibration Coefficient A, Mode F	40001	2	(32 bit) Represents a Floating-Point number with 5 decimal place precision	Read/Write	Calibration coefficient A in $y = Ax^2 + Bx + C – ssd$ **Not applicable for Hydro-Trac sensors.** **All existing calibration data stored in the sensor (Name and Calibration points for all modes) is deleted when this coefficient value is updated. Both registers must be updated.**	
Calibration Coefficient A, Mode V	40003	2	(32 bit) Represents a Floating-Point number with 5 decimal place precision.	Read/Write	Calibration coefficient A in $y = Ax^2 + Bx + C – ssd$ **Not applicable for Hydro-Probe or Hydro-Trac sensors.** **All existing calibration data stored in the sensor (Name and Calibration points for all modes) is deleted when this coefficient value is updated. Both registers must be updated.**	
Calibration Coefficient A, Mode E	40005	2	(32 bit) Represents a Floating-Point number with 5 decimal place precision.	Read/Write	Calibration coefficient A in $y = Ax^2 + Bx + C – ssd$ **Not applicable for Hydro-Probe or Hydro-Trac sensors.** **All existing calibration data stored in the sensor (Name and Calibration points for all modes) is deleted when**	

Name	Modbus Address	Number of Registers	Data Format	Access	Description	Valid Data Range
					this coefficient value is updated. Both registers must be updated.	
Calibration Coefficient B, Mode F	40007	2	(32 bit) Represents a Floating-Point number with 5 decimal place precision.	Read/Write	Calibration coefficient B in $y = Ax^2 + Bx + C – ssd$ **Not applicable for Hydro-Trac sensors. All existing calibration data stored in the sensor (Name and Calibration points for all modes) is deleted when this coefficient value is updated. Both registers must be updated.**	
Calibration Coefficient B, Mode V	40009	2	(32 bit) Represents a Floating-Point number with 5 decimal place precision.	Read/Write	Calibration coefficient B in $y = Ax^2 + Bx + C – ssd$ **Not applicable for Hydro-Probe or Hydro-Trac sensors. All existing calibration data stored in the sensor (Name and Calibration points for all modes) is deleted when this coefficient value is updated. Both registers must be updated.**	
Calibration Coefficient B, Mode E	40011	2	(32 bit) Represents a Floating-Point number with 5 decimal place precision.	Read/Write	Calibration coefficient B in $y = Ax^2 + Bx + C – ssd$ **Not applicable for Hydro-Probe or Hydro-Trac sensors. All existing calibration data stored in the sensor (Name and Calibration points for all modes) is deleted when this coefficient value is updated. Both registers must be updated.**	
Calibration Coefficient C, Mode F	40013	2	(32 bit) Represents a Floating-Point number with 5 decimal place precision.	Read/Write	Calibration coefficient C in $y = Ax^2 + Bx + C – ssd$ **Not applicable for Hydro-Trac sensors. All existing calibration data stored in the sensor (Name and Calibration points for all modes) is deleted when this coefficient value is updated. Both registers must be updated.**	

Name	Modbus Address	Number of Registers	Data Format	Access	Description	Valid Data Range
Calibration Coefficient C, Mode V	40015	2	(32 bit) Represents a Floating-Point number with 5 decimal place precision.	Read/Write	Calibration coefficient C in $y = Ax^2 + Bx + C – ssd$ **Not applicable for Hydro-Probe or Hydro-Trac sensors. All existing calibration data stored in the sensor (Name and Calibration points for all modes) is deleted when this coefficient value is updated. Both registers must be updated.**	
Calibration Coefficient C, Mode E	40017	2	(32 bit) Represents a Floating-Point number with 5 decimal place precision.	Read/Write	Calibration coefficient C in $y = Ax^2 + Bx + C – ssd$ **Not applicable for Hydro-Probe or Hydro-Trac sensors. All existing calibration data stored in the sensor (Name and Calibration points for all modes) is deleted when this coefficient value is updated. Both registers must be updated.**	
Calibration SSD	40019	2	(32 bit) Represents a Floating-Point number with 5 decimal place precision.	Read/Write	Saturated Surface Dry (ssd) value in $y = Ax^2 + Bx + C – ssd$ **Not applicable for Hydro-Trac sensors. All existing calibration data stored in the sensor (Name and Calibration points for all modes) is deleted when this coefficient value is updated. Both registers must be updated.**	
Config Output Type	40021	1	Defined Integer values: 0: 4-20mA 1: 0-20mA	Read/Write	Analogue output type. Same type is set for all analogue outputs.	
Config Output 1 Variable	40022	1	Lower byte represents defined Integer values: 0x00: Raw Moisture 0x01: Filtered Moisture 0x02: Average Moisture 0x03: Raw Unscaled	Read/Write	Defines which measured variable is output on the first analogue output. For Moisture outputs, range is scaled using Config Output Low Moisture (Register 40024) and Config Output High Moisture (Register 40025).	

Name	Modbus Address	Number of Registers	Data Format	Access	Description	Valid Data Range
			0x04: Filtered Unscaled 0x05: Average Unscaled 0x06: Remote Value 0x07: Brix 0x08: Not Used 0x09: Material Temp 0x0A: Not Used 0x0B: not Used 0x0C: AutoTrack Value 0x0D: AutoTrack Deviation Option 0x07 is only available on Hydro-Trac products Upper byte represents the Measurement Mode used: 0x00: Mode F 0x02: Mode V 0x03: Mode E		For AutoTrack Deviation, range is scaled 0 – 5. For all other outputs, range is scaled 0 – 100. For example: 0x0301 will output Filtered Moisture in Mode E. **Upper byte not applicable for Hydro-Probe or Hydro-Trac sensors, set value as 0x00.**	
Config Output 2 Variable	40023	1	Lower byte represents defined Integer values: 0x00: Raw Moisture 0x01: Filtered Moisture 0x02: Average Moisture 0x03: Raw Unscaled 0x04: Filtered Unscaled 0x05: Average Unscaled 0x06: Remote Value 0x07: Brix 0x08: Not Used 0x09: Material Temp 0x0A: Not Used 0x0B: not Used	Read/Write	Defines which measured variable is output on the second analogue output. For Moisture outputs, range is scaled using Config Output Low Moisture (Register 40024) and Config Output High Moisture (Register 40025). For AutoTrack Deviation, range is scaled 0 – 5. For all other outputs, range is scaled 0 – 100. For example: 0x0301 will output Filtered Moisture in Mode E.	

Name	Modbus Address	Number of Registers	Data Format	Access	Description	Valid Data Range
			0x0C: AutoTrack Value 0x0D: AutoTrack Deviation Option 0x07 is only available on Hydro-Trac products Upper byte represents the Measurement Mode used: 0x00: Mode F 0x02: Mode V 0x03: Mode E		**Upper byte not applicable for Hydro-Probe or Hydro-Trac sensors, set value as 0x00**	
Config Output Low Moisture	40024	1	Represents Floating point number with 1 decimal place precision: 0.0 to 100.0	Read/Write	Moisture value corresponding to minimum current output of either 4mA or 0mA, depending on setting of Register 40021	0.0 to 100.0
Config Output High Moisture	40025	1	Represents Floating point number with 1 decimal place precision: 0.0 to 100.0	Read/Write	Moisture value corresponding to maximum current output of 20mA.	0.0 to 100.0
Config Input Function	40026	1	Defined Integer Values: 0: Unused 1: Average / Hold 2: Moisture / Temperature 3: Synchronised Reading Trigger 4: Not used 5: Filter Include	Read/Write	Digital 1 Function **Mode 1**, signal will be averaged while input is active, and held whilst it is inactive. **Mode 2**, current loop 1 will output Material Temperature if the input is active, otherwise it will output the parameter configured by Register 40022. **Mode 3**, a new synchronised measurement cycle is started when the input goes active. Timing of transition to inactive is unimportant. **Mode 5**, when active the filtering of the raw signal will be enabled, when inactive the filtering will be held. When this function is selected, the Filter Include Status will be set to 0 until the input is active.	

Name	Modbus Address	Number of Registers	Data Format	Access	Description	Valid Data Range
Config IO2 function	40027	1	Defined integer values: 0: Unused 1: Moisture / Temperature 2: Bin Empty 3: Moisture out of range 4: Sensor ok 5: not used 6: Material Temperature Alarm 7: AutoTrack Stable 8: Calibration out of Range 9: Average/Hold	Read/Write	Second digital I/O line function **Mode 1**, current loop 1 will output Material Temperature if the input is active, otherwise it will output the parameter configured by Register 40023 **Mode 2**, the output will be active if the Moisture reading is below the Average Include Low limit (40036) or the Unscaled is below the Unscaled Include Low limit (40038). Alarm Mode (40055) determines which mode F, V, E is used for this check. **Mode 3**, the output will be active if the Moisture reading is above or below the Average include limits (40036 & 40037) or the Unscaled reading is above or below the Unscaled Include limits (40038 & 40039). Alarm Mode (40055) determines which mode F, V, E is used for this check. **Mode 4**, the output will be active if : • The frequency reading is between the defined air and water calibration points +/- 3%; • The amplitude reading is between the defined air and water calibration points +/- 3%; • The temperature of the internal electronics is below it's safe operating limit; • The temperature of the RF resonator is above its minimum safe operating limit; • The internal supply voltage is in range; This output is normally active, so a broken wire or faulty output circuit will indicate a failure. **Mode 6**, the output will be active if the material Temperature is outside the configured limits **Mode 7**, the output will be active if the AutoTrack Deviation is below the AutoTrack Deviation threshold (40035). **Mode 8**, the output will be active if the Unscaled reading for any mode is more than three points above or below the	

Name	Modbus Address	Number of Registers	Data Format	Access	Description	Valid Data Range
					range of Unscaled values used in the calibration. Indicates that another calibration point could / should be made. **Mode 9**, signal will be averaged while input is active, and held whilst it is inactive.	
Config Average / Hold Delay	40028	1	Defined Integer values: 0: 0.0s 1: 0.5s 2: 1.0s 3: 1.5s 4: 2.0s 5: 5.0s 6: 10.0s 7: 20.0s	Read/Write	Defines the delay between an Average Start signal on the Digital input and the Averaging process starting. This allows for flowing material to reach the sensor after a silo gate is opened, for example, to ensure an accurate average is calculated.	
Config Filtering Time	40029	1	Defined Integer values: 0: 0.0s 1: 1.0s 2: 2.5s 3: 5.0s 4: 7.5s 5: 10.0s Or any other integer value less than 100, which is taken to be a time in seconds	Read/Write	Defines the intensity of the time-based smoothing filter.	
Config Positive Slew Rate Filter	40030	1	Defined Integer values: 0: unused 1: Light 2: Medium 3: Heavy or custom value from 4 to 50	Read/Write	Defines the intensity of the slew rate limiting filter for positive going signals. For custom values, 4 gives a very heavy filter and 50 gives a very light filter.	

Name	Modbus Address	Number of Registers	Data Format	Access	Description	Valid Data Range
Config Negative Slew Rate Filter	40031	1	Defined Integer values: 0: unused 1: Light 2: Medium 3: Heavy or custom value from 4 to 51	Read/Write	Defines the intensity of the slew rate limiting filter for negative going signals. For custom values, 4 gives a very heavy filter and 50 gives a very light filter.	
Config DSP Type	40032	1	Defined Integer values: 0: unused 1: Very Light 2: Light 3: Medium 4: Heavy 5: Very Heavy	Read/Write	Sets the intensity of the DSP filter applied to the signal.	
Config Filter Include Low	40033	1	Represents a floating-point number with 1 decimal place precision	Read/Write	A threshold below which Raw Unscaled values will not be used in calculation of the Filtered Unscaled and therefore Filtered Moisture. If Raw Unscaled is below the threshold, the previous value of Filtered Unscaled will be retained until Raw Unscaled exceeds the threshold again	
Config AutoTrack time	40034	1	Integer value in seconds, 0 - 100	Read/Write	AutoTrack detection window. Moving Average period over which the AutoTrack Value and Deviation is calculated	0 to 100
Config AutoTrack Deviation Threshold	40035	1	Represents a floating-point number with 3 decimal place precision	Read/Write	Threshold with which the AutoTrack deviation is compared to determine the signal stability and used to set the relevant Sensor Status flags. Alarm Mode (40055) determines which Mode F, V, E, is used for this check.	
Config Average Include Low	40036	1	Represents a floating-point number with 1 decimal place precision	Read/Write	Lower limit of Moisture values to include when calculating Average Moisture. Can be used to exclude air pockets in the material, for example	

Name	Modbus Address	Number of Registers	Data Format	Access	Description	Valid Data Range
Config Average Include High	40037	1	Represents a floating-point number with 1 decimal place precision	Read/Write	Upper limit of Moisture values to include when calculating Average Moisture	
Config Unscaled Include Low	40038	1	Represents a floating-point number with 1 decimal place precision	Read/Write	Lower limit of Unscaled values to include when calculating Average Moisture. Can be used to exclude air pockets in the material, for example	
Config Unscaled Include High	40039	1	Represents a floating-point number with 1 decimal place precision	Read/Write	Upper limit of Unscaled values to include when calculating Average Moisture.	
Config Averaging Mode	40040	1	Defined integer values: 0: Average is calculated from Raw values 1: Average is calculated from Filtered values.	Read/Write	Setting 0 would be used for best results in 'batch' type applications. Setting 1 would be used for 'continuous flow' type applications	
Config Calibration Type	40041	1	Defined integer values: 0: Undefined 1: Linear 2: Quadratic 3: Exponential	Read/Write	Linear or Polynomial type calibration is used for all materials except Brix type measurements when Exponential is used. **Only valid types for the current product type can be set.**	
Config Calibration Rules	40042	1	Defined integer values: 0: None Used 1: Sand 0 - 2mm 2: Sand 0 - 4mm 3: Gravel 4 - 8mm 4: Stone 8 - 16mm 5: Stone 16 - 22mm	Read/Write	Records which set of rules were used by a Host system to calculate the calibration coefficients. **Only applicable for Hydro-Probe sensors.**	
Config Brix Calibration Coefficient A	40043	2	(32 bit) Represents a floating-point number with 5 decimal place precision	Read/Write	The A value used to calculate a Brix value. **Hydro-Trac and Hydro-Probe SE sensors only.**	

Name	Modbus Address	Number of Registers	Data Format	Access	Description	Valid Data Range
					All existing calibration data stored in the sensor (Name and Calibration points for all modes) is deleted when this coefficient value is updated. Both registers must be updated.	
Config Brix Calibration Coefficient B	40045	2	(32 bit) Represents a floating-point number with 5 decimal place precision	Read/Write	The B value used to calculate a Brix value. **Hydro-Trac and Hydro-Probe SE sensors only.** **All existing calibration data stored in the sensor (Name and Calibration points for all modes) is deleted when this coefficient value is updated. Both registers must be updated.**	
Config Brix Calibration Coefficient C	40047	2	(32 bit) Represents a floating-point number with 5 decimal place precision	Read/Write	The C value used to calculate a Brix value. **Hydro-Trac and Hydro-Probe SE sensors only.** **All existing calibration data stored in the sensor (Name and Calibration points for all modes) is deleted when this coefficient value is updated. Both registers must be updated.**	
Config Brix Calibration Coefficient D	40049	2	(32 bit) Represents a floating-point number with 5 decimal place precision	Read/Write	The D value used to calculate a Brix value. **Hydro-Trac and Hydro-Probe SE sensors only.** **All existing calibration data stored in the sensor (Name and Calibration points for all modes) is deleted when this coefficient value is updated. Both registers must be updated.**	
Config Alarm Mode	40051	1	Defined integer values: 0: Mode F 2: Mode V 3: Mode E 5: Legacy	Read/Write	Determines which Measurement Mode is used for checks of the alarm outputs: Bin Empty, Moisture Out of Range, AutoTrack Stable and Calibration out of Range.. **Not applicable for Hydro-Probe or Hydro-Trac sensors.**	
Remote Value	40052	1	Represents a floating-point number between 0 and 100 with 1 decimal place precision	Read/Write	Value in % to output on Analogue if Config Output Variable is set to Remote Value. May be used by control system to signal additional data via an analogue loop.	

Name	Modbus Address	Number of Registers	Data Format	Access	Description	Valid Data Range
Config Electronics Temperature Offset	40053	1	Represents a floating-point number with 1 decimal place precision	Read/Write	Offset correction for Electronics Temperature sensor	
Config Resonator Temperature Offset	40054	1	Represents a floating-point number with 1 decimal place precision	Read/Write	Offset correction for Resonator Temperature sensor	
Config Material Temperature Offset	40055	1	Represents a floating-point number with 1 decimal place precision	Read/Write	Offset correction for Material Temperature sensor	
Config Material Temp Alarm Low	40056	1	Represents a floating-point number with 1 decimal place precision	Read/Write	If Material Temperature is below this value, relevant bit of the Status Word is set, and Digital Output is set (if configured)	
Config Material Temp Alarm High	40057	1	Represents a floating-point number with 1 decimal place precision	Read/Write	If Material Temperature is above this value, relevant bit of the Status Word is set, and Digital Output is set (if configured)	
Config Comms Reply Delay	40058	1	Defined Integer values: 0: 0ms - 10ms 1: 10ms - 20ms 2: 20ms - 30ms 3: 30ms - 40ms (default) 4; 40ms - 50ms 5: 50ms - 60ms 6: 60ms - 70ms 7: 70ms - 80ms	Read/Write	Specifies the minimum delay between receiving a message and sending the reply. This parameter is volatile, i.e. it is not saved to Flash to prevent a sensor getting locked into a fast mode which the host doesn't support. Each host application can then set this depending on its hardware configuration, or a measurement of the comms reliability. Due to the asynchronous nature of the communications, each setting covers a range of times and is a minimum delay time – actual reply may take longer.	
Sensor Name	40301	39	One Ascii character per register. Higher Byte is always 0x00.	Read/Write	A string representing the Sensor Name. Any unused characters (registers) after the end of the string should be set to 0x0000.	

Appendix A Sensor Status Flag

The ‘Sensor status flag returns a series of 27 0 and 1 in the form ‘001001100111000’ which should be interpreted from right to left according to the table below. In each case, the latched version indicates that the condition occurred at some time in the recent past since the status was last requested and might therefore have had some effect on an average value (latches reset upon reading).

Bit #	Description	
0	Data Invalid: either Unscaled or Moisture is outside of the defined Average Include limits. (Applies to F Mode measurement only)	Current
1		Latched
2	Unreliable. Behaviour not currently defined.	Current
3		Latched
4	Off-scale. The analogue output has been driven beyond its configured upper or lower limits.	Current
5		Latched
6	Sensor Too Hot - the temperature of the internal electronics is greater than 85ºC. This may damage the sensor.	Current
7		Latched
8	Sensor Too Cold - the temperature of the measurement system (resonator) is below 1ºC	Current
9		Latched
10	AutoTrack Status – indicates whether the AutoTrack deviation is within the configured Maximum deviation.	Current
11		Latched
12	Material Temperature Hot Alarm – exceeds configured limit	Current
13		Latched
14	Material Temperature Cold Alarm – below configured limit	Current
15		Latched
16	Calibration Out of Range – indicates that the current Unscaled reading is beyond the range covered by the points in the Material Calibration. Taking of an extra point is advisable. This function is performed on the measurement mode selected using the configured Alarm Mode (Modbus 40051).	Current
17		Latched
18	Frequency or Amplitude Out of Range – Either the Frequency or Amplitude reading is outside of the Air and Water range configured	Current
19		Latched
20	The internal supply voltage is out of tolerance	Current
21		Latched
22	RF recalibration error	Current

Bit #	Description	
23		Latched
24	I/O line 2 direction: 1 = output	Current
25	Digital input 1. The state of I/O line 1 (input)	Current
26	Digital input 2. The state of I/O line 2 (input or output)	Current

1 Document Cross Reference

This section lists all of the other documents that are referred to in this User Guide. You may find it beneficial to have a copy available when reading to this guide.

Document Number	Title
HD0679	Hydronix Moisture Sensor Configuration and Calibration Guide
HD0678	Hydronix Moisture Sensor Electrical Installation Guide
HD0682	Hydro-Com User Guide

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