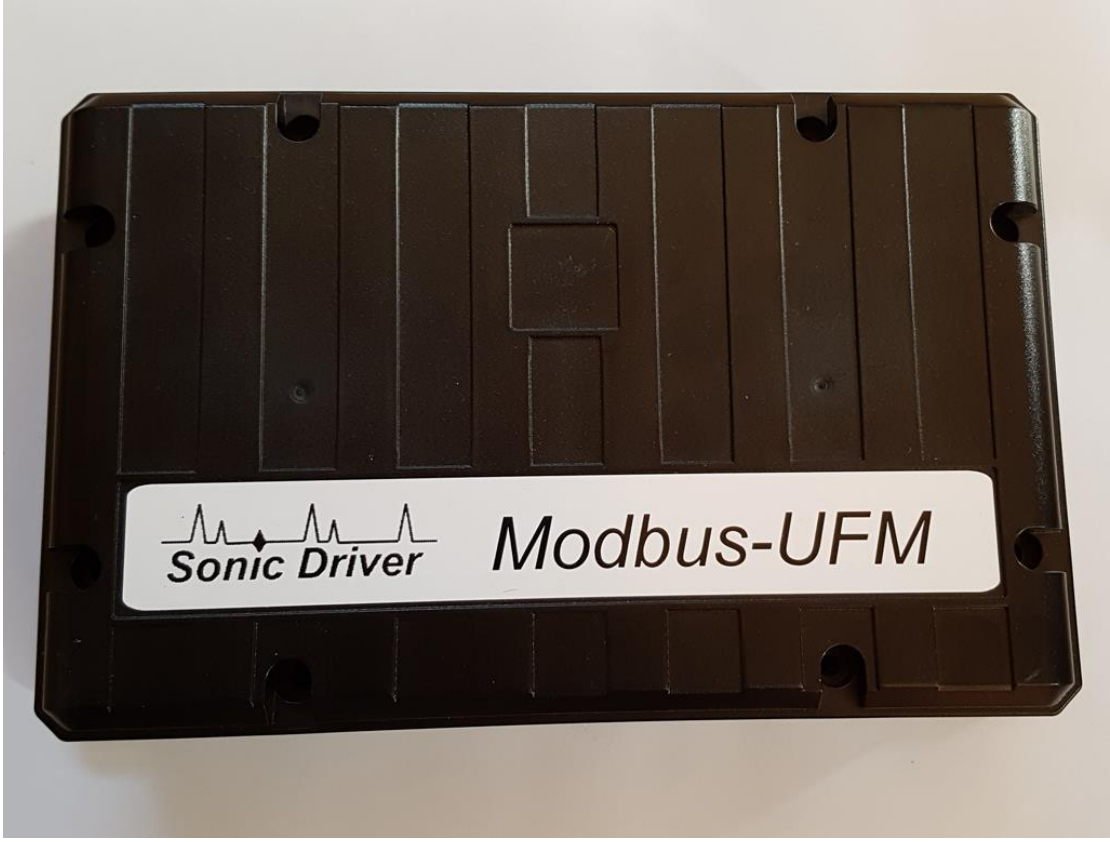
Made in Britain

MODBUS WALL-UFM, Modbus RTU Slave Meter

Operating Instructions

Version 2.0



13th March 2023

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1.0 Introduction

Modbus RTU Slave functionality is implemented on the Sonic Driver™ clamp-on MODBUS WALL ultrasonic flowmeter (MODBUS WALL-UFM).

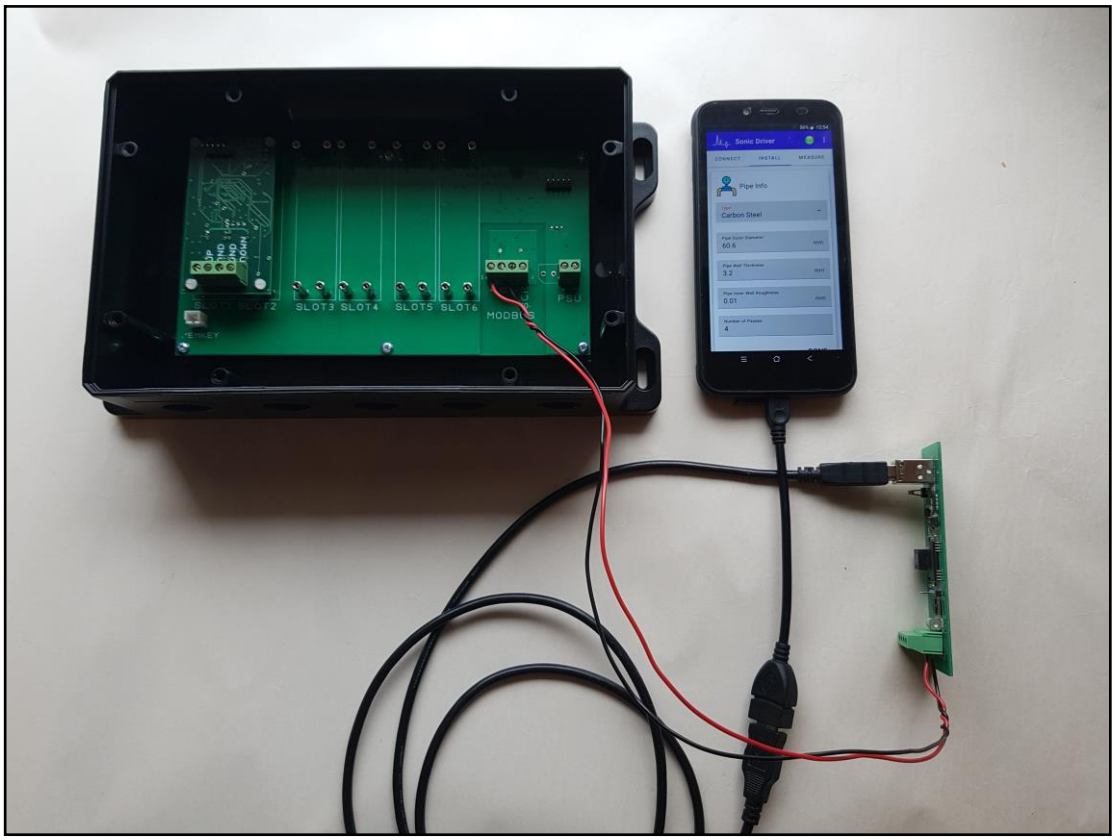
Meter settings are fully configurable on the UFM using a Windows based program running on a PC or laptop or an Android app running on a mobile phone. In addition a full range of flow measurements and diagnostics can be read from the meter.

Once installed and commissioned the computer or mobile can be disconnected and the meter wired back to a control room PCL or similar.

1.1 Mode

The Modbus RTU protocol is implemented over RS485 hardware.

Mobile connection uses a USB-OTG cable and Modbus interface. PC connection uses a USB A/B cable and a Modbus interface, see figure(1).



Figure(1) Mobile and PC connections

Physical connection to the 2-wire bus is via the screw terminals on the UFM board. The terminals are labelled 'A' and 'B'.

Note that some equipment manufacturers label their terminals in other ways, e.g. ‘+’ and ‘-‘ so the exact order that the wires are connected may be reversed.

There is also a screw terminal for connection of cable screen. This may be connected at either the Master or the Slave UFM if necessary.

1.2 Baud rate

The RS485 baud rate is **19200**.

1.3 Parity

The RS485 parity is **Even**.

1.4 Stop Bits

The RS485 stop bits is **1**.

1.5 Modbus Address

The Modbus-UFM Slave address is programmable from 1 to 255.

The default Slave address is set to **1**.

1.6 Data bits

RS485 serial data is fixed at **8 bits**.

1.7 Register format

In the UFM each Modbus register is a 16-bit word, consisting of two 8-bit bytes.

Register data in Modbus messages are packed as 2 bytes per register. The binary contents are right justified in each byte. For each register the first byte contains the high order bits and the second byte contains the low order bits.

A floating-point number is stored as 32 bits using 4 bytes and therefore occupies 2 Modbus registers.

1.8 Representation of floating-point values

The UFM stores floating point values in IEEE 754 single precision format.

The bus Master accesses a floating-point value from any one of 4 different register tables. Each register table represents a different byte order.

Table start	Byte order	Common Description
0x0000	1,0,3,2	Floating-point Little-Endian with byte swap **(Default)**
0x1000	0,1,2,3	Floating-point Little-Endian Format
0x2000	3,2,1,0	Floating-point Big-Endian Format
0x3000	2,3,0,1	Floating point Big-Endian with byte swap

By reading the first 2 registers of each table the user can determine which format matches their system when a fixed test value of **1234.0** is received.

2.0 Modbus Commands

The UFM implements Modbus commands 03, 04, 06 and 16.

2.1 Read Holding Registers 03

This function code is used to read from 2 to 110 contiguous holding registers from the UFM. Registers are addressed starting at zero. Therefore holding registers numbered 1-110 are addressed as 0-109.

The Modbus Master specifies a start address and register count.

2.2 Read Input Registers 04

This function code is used to read from 2 to 110 contiguous input registers from the flowmeter. Registers are addressed starting at zero. Therefore input registers numbered 1-110 are addressed as 0-109.

The Modbus Master specifies a start address and register count.

2.3 Write Single Register 06

This function code is used to write a single register. This function code is used to program integer values in the UFM.

The Master specifies an address and 16-bit data value for write.

The value is an unsigned 16-bit value. Valid values are defined for each register address, see appendix 3

Writing a value of 0x00 to register 60011 will clear the unit's internal error log.

2.4 Write Single Register 16

This function code is used to write multiple registers. This function code is used to program 32-bit floating-point values in the UFM.

The Master specifies an address and 32-bit data value for write.

The value is a pair of unsigned 16-bit values. Valid values are defined for each register address, see appendix 3.

3.0 Broadcast address

The UFM supports broadcast address **0**.

In broadcast address mode the Modbus master can send a command to all slaves.

No response is sent by the slaves.

4.0 Communications Software

There are several communications programs available for download online.

The UFM has been tested using Modbus Poll (for Windows platform) and Modbus Monitor (for Android and Windows platforms).

Appendix 1: Communication Command Structure

Read holding registers		
	Slave ID	(1 byte)
	Function	(1 byte=03H)
	Start Address	(2 bytes)
	No. of Registers R	(2 bytes)
	CRC code	(2 bytes)
Reply		
	Slave ID	(1 byte)
	Function	(1 byte)
N = 2R	Byte Count N	(1 byte)
	Hex Data	(N bytes)
	CRC code	(2 bytes)
Read input registers		
	Slave ID	(1 byte)
	Function	(1 byte=04H)
	Start Address	(2 bytes)
	No. of Registers R	(2 bytes)
	CRC code	(2 bytes)
Reply		
	Slave ID	(1 byte)
	Function	(1 byte)
N = 2R	Byte Count N	(1 byte)
	Hex Data	(N bytes)
	CRC code	(2 bytes)
Write single register	Slave ID	(1 byte)
	Function	(1 byte=06H)
	Start Address	(2 bytes)
	Hex Data	(2 bytes)
	CRC code	(2 bytes)
Write multiple registers	Slave ID	(1 byte)
	Function	(1 byte=10H)
	Start Address	(2 bytes)
	No. of Registers R	(2 bytes)
N = 2R	Hex Data	(N bytes)
	CRC Code	(2 bytes)

Appendix 2: Command 03 and 04 UFM Register Map

Modbus Address	Measurement/Variable	Bytes	Format
40001	Fixed test pattern 1234.0	4	IEEE
40002			
40003	Flow Velocity (m/s)	4	IEEE
40004			
40005	Flow Rate Volumetric (l/min)	4	IEEE
40006			
40007	Flow Rate Mass (kg/min)	4	IEEE
40008			
40009	Flow Rate Heat (KJ/s)	4	IEEE
40010			
40011	Amplifier gain (dB)	4	IEEE
40012			
40013	Signal Amplitude (dB)	4	IEEE
40014			
40015	Signal Noise (dB)	4	IEEE
40016			
40017	SNR (dB)	4	IEEE
40018			
40019	Delta Time Difference (ns)	4	IEEE
40020			
40021	Upstream Transit Time (us)	4	IEEE
40022			
40023	Downstream Transit Time (us)	4	IEEE
40024			
40025	Arrival Bin	4	IEEE
40026			
40027	Signal Quality 1 (us)	4	IEEE
40028			
40029	Signal Quality 2 (ADU)	4	IEEE
40030			
40031	Meter Error Code	4	IEEE
40032			
40033	Transducer Type (List)	4	IEEE
40034			
40035	Transducer Wedge Angle (deg)	4	IEEE
40036			
40037	Transducer SOS at 20 deg C (m/s)	4	IEEE
40038			
40039	Transducer SOS at 60 deg C (m/s)	4	IEEE
40040			
40041	Transducer Crystal Offset (m)	4	IEEE
40042			
40043	Transducer Spacing Offset (m)	4	IEEE
40044			

40045	Transducer Frequency Code (List)	4	IEEE
40046			
40047	Transducer Delta Time Offset(ns)	4	IEEE
40048			
40049	Transducer K Factor	4	IEEE
40050			
40051	Pipe Type (List)	4	IEEE
40052			
40053	Pipe SOS (m/s)	4	IEEE
40054			
40055	Pipe Outer Diameter (m)	4	IEEE
40056			
40057	Pipe Wall Thickness (m)	4	IEEE
40058			
40059	Pipe Inner Wall Roughness (m)	4	IEEE
40060			
40061	Fluid Type (List)	4	IEEE
40062			
40063	Fluid Temperature (deg C)	4	IEEE
40064			
40065	Fluid SOS (m/s)	4	IEEE
40066			
40067	Fluid Density (kg/m3)	4	IEEE
40068			
40069	Fluid Kinematic (cSt)	4	IEEE
40070			
40071	Fluid SHC (J/(kg.K))	4	IEEE
40072			
40073	Flow Minimum Cut-off (m/s)	4	IEEE
40074			
40075	Flow Damping (s)	4	IEEE
40076			
40077	Modbus Address	4	IEEE
40078			
40079	Corrected SOS (m/s)	4	IEEE
40080			
40081	Window Delay (us)	4	IEEE
40082			
40083	Zero Tracking (On/Off)	4	IEEE
40084			
40085	Zero Calibration (On/Off)	4	IEEE
40086			
40087	Dynamic Temperature (On/Off)	4	IEEE
40088			
40089	Inlet Temperature (deg C)	4	IEEE
40090			
40091	Outlet Temperature (deg C)	4	IEEE

40092			
40093	Flow Profile K Factor	4	IEEE
40094			
40095	Reynolds Number	4	IEEE
40096			
40097	Number of Passes	4	IEEE
40098			
40099	Tup Method	4	IEEE
40100			
40101	Transducer Spacing (m)	4	IEEE
40102			
40103	ATA/ETA (%)	4	IEEE
40104			
40105	Iout Minimum Value (l/min)	4	IEEE
40106			
40107	Iout Maximum Value (l/min)	4	IEEE
40108			
40109	Relay Alarm Value (l/min)	4	IEEE
40110			

Text Strings, company name (26 chars), model code (26 chars), serial number (8 chars), HW/SW version (6 chars)

Modbus Address	Text Strings, 2 chars	Bytes	Format
40300	So	2	Word
40301	ni	2	Word
40302	c< >	2	Word
40303	Dr	2	Word
40304	Iv	2	Word
40305	er	2	Word
40306	< >< >	2	Word
40307	< >< >	2	Word
40308	< >< >	2	Word
40309	< >< >	2	Word
40310	< >< >	2	Word
40311	< >< >	2	Word
40312	< >< >	2	Word
40313	MO	2	Word
40314	DB	2	Word
40315	US	2	Word
40316	< >W	2	Word
40317	AL	2	Word
40318	L-	2	Word
40319	UF	2	Word
40320	M< >	2	Word
40321	ST	2	Word
40322	D< >	2	Word

40323	< >< >	2	Word
40324	< >< >	2	Word
40325	< >< >	2	Word
40326	10	2	Word
40327	00	2	Word
40328	00	2	Word
40329	00	2	Word
40330	20	2	Word
40331	02	2	Word
40332	00	2	Word

Serial number in the example is 1000000, HW and SW versions are 2.00 and 2.00.

Signal Data Trace Values, as pairs of 8-bit values.

Modbus Address	Signal Data Trace Value Pairs	Bytes	Format
40401	8-bit data point 0, 8-bit data point 1	2	WORD
40402	8-bit data point 2, 8-bit data point 3	2	WORD
40403	8-bit data point 4, 8-bit data point 5	2	WORD
40404	8-bit data point 6, 8-bit data point 7	2	WORD
40405	8-bit data point 8, 8-bit data point 9	2	WORD
40406	8-bit data point 10, 8-bit data point 11	2	WORD
..	…,…	..	…
..	…,…	..	…
40649	8-bit data point 496, 8-bit data point 497	2	WORD
40650	8-bit data point 498, 8-bit data point 499	2	WORD

Appendix 3: Command 06 and 16 Definitions

	Write Single	Write Multiple	16/32 bit Write	Value	Default	Minimum	Maximum	SI Unit	
Value	CMD 06	CMD 16							
Transducer Type	0		16	1	1	0	3	List	DN40/DM10/DM20/DS10
Transducer Wedge Angle		0	32	40.000	40.000	1.000	90.000	deg	
Transducer SOS at 20degC		2	32	2522.000	2522.000	500.000	7000.000	m/s	
Transducer SOS at 60degC		4	32	2522.000	2522.000	500.000	7000.000	m/s	
Transducer Crystal Offset		6	32	0.012	0.012	0.001	0.100	m	
Transducer Spacing Offset		8	32	0.030	0.030	0.001	0.100	m	
Transducer Transmit Code	1		16	1	1	0	2		4/1/2 MHz
Transducer Delta Transit Time Offset		10	32	0	0	-2.00E-08	2.00E-08	s	
Transducer K Factor		12	32	1.000	1.000	0.001	1000.000		
Pipe Type	2		16	0	0	0	6	List	Carbon Steel/Stainless Steel/Copper/PVC/Cast Iron/Ductile Iron/HDPE
Pipe SOS		14	32	3230.0	3230.0	500.0	7000.0	m/s	
Pipe Outer Diameter		16	32	0.0606	0.0606	0.01	6.50	m	
Pipe Wall Thickness		18	32	0.0032	0.0032	0.0005	0.1	m	
Pipe Inner Wall Roughness		20	32	0.00001	0.00001	0.000001	0.002	m	
Fluid Type	3		16	0	0	0	3	List	Water/Petrol/Diesel/Glycol-Water
Fluid Temperature		22	32	18.000	18.000	0.000	150.000	deg C	
Fluid SOS		24	32	1475.000	1475.000	50.000	3000.000	m/s	
Fluid Density		26	32	998.520	998.520	50.000	3000.000	kg/m2	
Fluid Kinematic		28	32	1.080	1.080	0.001	40000.000	cSt	
Fluid Specific Heat Capacity		30	32	4184.000	4184.000	10.000	10000.000	J/(g.K)	

Minimum Flow Cut Off		32	32	0.025	0.025	0.000	1.000	m/s	
Flow damping	4		16	10	10	0	255	s	
Modbus Address	5		16	1	1	1	255		
Transducer Wedge Corrected SOS		34	32	2522.000	2522.000	500.000	7000.000	m/s	
Sampling Window delay	6		16	169	169	11	65535	us	
Zero Tracking On/Off	7		16	1	1	0	1	On/Off	
Zero calibration On/Off	8		16	0	0	0	1	On/Off	
Dynamic Temperature On/Off	9		16	0	0	0	1	On/Off	
Number of Passes	10		16	4	4	1	16		
Tup Method	12		16	3	3	0	4	List	Method 0, 1, 2, 3, 4
Iout Minimum Value		36	32	0	0	-1000000.0	1000000.0	l/min	
Iout Maximum Value		38	32	160.0	160.0	-1000000.0	1000000.0	l/min	
Relay Alarm Value		40	32	40.0	40.0	-1000000.0	1000000.0	l/min	

Sonic Driver