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Ultrasonic Flowmeters

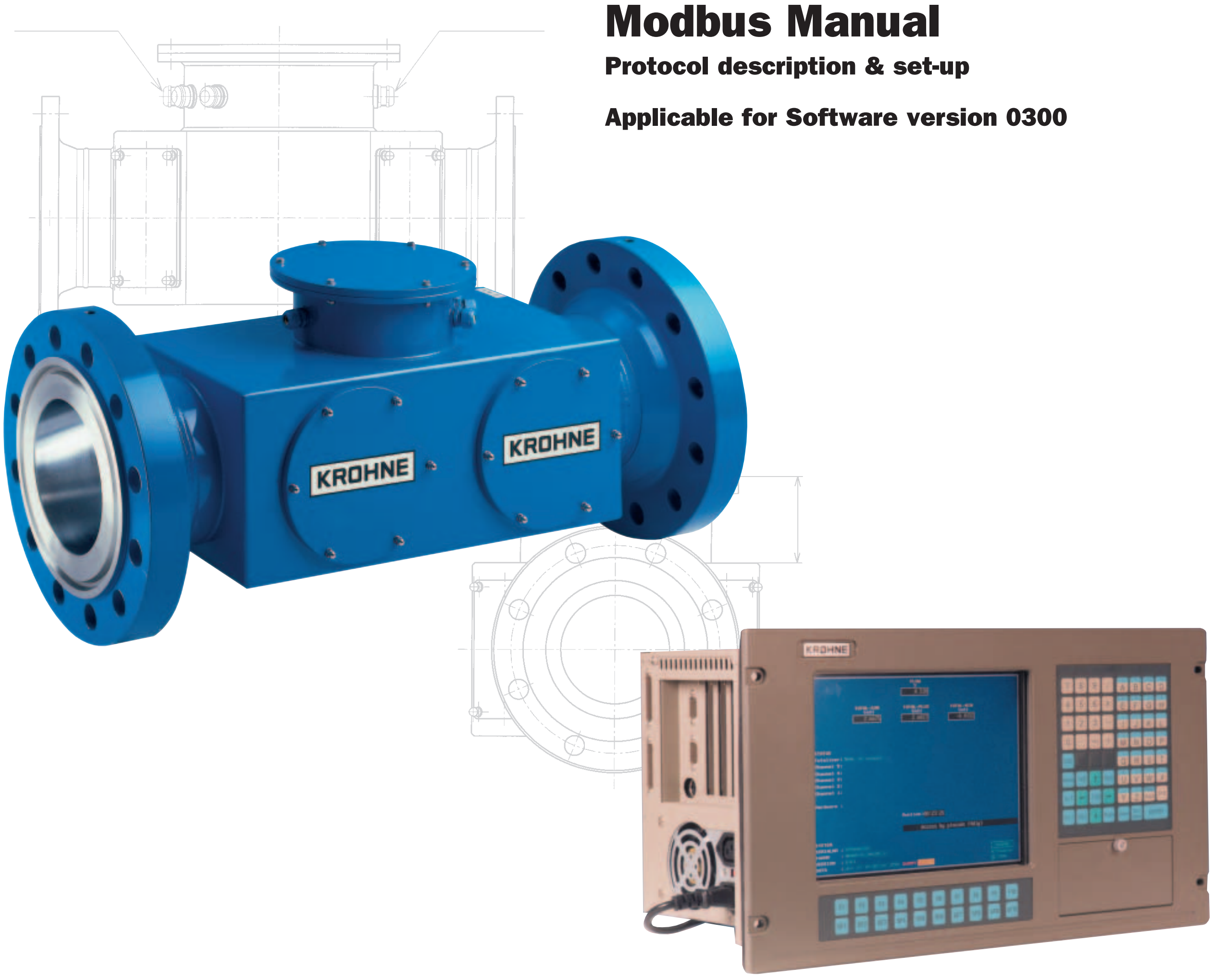
ALTOSONIC V

Reference Guide

Modbus Manual

Protocol description & set-up

Applicable for Software version 0300



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(ALTOSONIC V version 3.00.00 and higher)

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1 INTRODUCTION

This manual describes how to use the Modbus protocol with the ALTOSONIC V flow meter system.

From this point in the manual the following abbreviations are used for the ALTOSONIC-V system:
UFS-V: Ultrasonic Flow Sensor (primary flow meter body)
UFC-V: Ultrasonic Flow Converter (5 converters)
UFP-V: Ultrasonic Flow Processor

Introduction to Modbus

For communication with host systems the flow controller emulates a Modbus compatible controller.

The Modbus protocol defines a message structure that controllers will recognise and use, regardless of the type of network over which they communicate. It describes:

- the process a controller uses to request access to other devices,
- how it will respond to requests from the other devices, and
- how errors will be detected and reported.

Controllers communicate using a master-slave principle. Only the master can initiate transactions (requests), and only the addressed device responds. In case of a broadcast request none of the slaves will respond.

The Modbus request consist of:

- an address,
- a function code defining the requested action,
- data (if necessary for the requested function), and
- error check for testing the integrity of the message.

The slave's response contains:

- the slave address,
- data conform the request type, and
- error check.

If the data integrity test fails, no response is sent back.
If a request cannot be processed an exception message is returned.

2 SERIAL TRANSMISSION FORMAT

The two transmission modes used are called:
1. ASCII, and
2. RTU.

The user has to select the desired mode along with the serial communication parameters (baud rate, parity-type).

Note that all these parameters must be the same for all controllers in the network.

2.1 ASCII-mode

- Each byte of the message is sent as two ASCII characters.
  This means only the ASCII characters 0-9, A-F are transmitted.
- Serial communication parameters:
  1 start byte, 7 data bits, even/odd/no parity, 1 stop bit if parity is used and two stop bits if no parity is used.
- Error check field:
  Longitudinal Redundancy Check (LRC).

The advantage of ASCII mode is that it allows for a time interval up to 1 second between characters without causing a timeout.
A disadvantage of ASCII mode is the larger message length.

2.2 RTU-mode

- Each byte of the message is sent as 8 bits.
- Serial communication parameters:
  1 start byte, 8 data bits, even/odd/no parity, 1 stop bit if parity is used, and two stop bits if no parity is used.
- Error check field:
  Cyclic Redundancy Check (CRC).

3 MODBUS MESSAGE FRAMING

ASCII-mode
In ASCII-mode a message starts with a colon character (:) and ends with a carriage return–linefeed. Intervals up to one second can elapse between characters within the message. If the interval is longer, a timeout error occurs and the message is rejected.

RTU mode
In RTU-mode a message starts with a silent interval of at least 3.5 character times. The entire message frame must be transmitted as a continuous stream. If a silent interval of more than 3.5 character times occurs before completion of the frame, the receiving device flushes the incoming message and assumes that the next byte will be the address field for the new message.

➢ See 9.1 Appendix A for the applied timeout values.

Example of a typical message frame:

	START	ADDRESS	FUNCTION	DATA	DATA CHECK	END
ASCII Mode	':'	2 characters	2 characters	N*2 characters	LRC 2 characters	CR-LF
RTU Mode	3.5 characters silent interval	8 bits	8 bits	N*8 bits	CRC 16 bits	3.5 character silent interval

3.1 The Address Field

The address field of a message frame contains:

- 2 characters (ASCII-mode) or
- 8 bits (RTU-mode).

Valid slave addresses are 1 to 247.
Address 0 is used for a broadcast to address all slaves.

3.2 The Function Field

The function field of a message frame contains:

- 2 characters (ASCII-mode) or
- 8 bits (RTU-mode).

Valid codes lie in a range of 1 to 127.

The function code tells the slave which kind of action to perform.
The supported functions are listed in chapter 5.
A slave response always contains the function code of the request. If a function is not applicable, the slave sends an exception response. An exception is indicated by a returned function code with bit 8 (most significant byte) set.

3.3 The Data Field

The data field contains 8 bit values in the range of 0 to FF hexadecimal.
In ASCII mode this byte is made of 2 ASCII characters.

The data field of messages contains information which both master and slave use to perform an action. This includes the register address, quantity of registers, and the necessary data.

3.4 The Error Checking Field

The error checking field contents depend on the transmission mode.
Two kinds of error methods are used.

Error check with ASCII-mode
When the ASCII mode is used, the error-checking field contains two ASCII characters.
The error check characters are the result of a Longitudinal Redundancy Check calculation. This is performed on the message contents with exception of the beginning colon, the carriage return and line feed characters.
The LRC characters are appended to the message as the last field preceding the
CR-LF characters.
- See 9.2 Appendix B for more information about the Longitudinal Redundancy Check.

Error check with RTU-mode
When RTU mode is used, the error-checking field contains a 16-bit value implemented as two bytes.
The error check value is the result of a Cyclic Redundancy Check calculation performed on the message contents.
The CRC field is appended to the message as the last field.
- See 9.3 Appendix C for more information about the Cyclic Redundancy Check.

3.5 Other Error Checking Methods

Standard Modbus uses two kinds of error checking methods:
1. Character based check
   an additional parity bit for each character (even or odd parity).
2. Message based check
   an additional error check calculated over the entire message.

Both character check and message check are generated in the transmitting device and applied to the message before transmission.
The slave checks each character and the entire message frame during receipt.

The master has a predetermined timeout interval before aborting the transaction. This interval is set long enough for any slave to respond normally.
The timeout interval is set by the parameter ***7.2 REQUEST_TO_RESPONSE_TIMEOUT***.

ASCII mode
In ASCII mode the maximum time between 2 characters is one second. If a longer interval occurs, the message will be rejected and the search for a starting character (colon) is resumed.

RTU mode
In RTU mode the entire message frame must be transmitted as a continuous stream. If a silent interval of more than 3.5 character times occurs before completion of the frame, the receiving device flushes the incoming message and assumes that the next byte will be the address field for the new message.

4 PHYSICAL COMMUNICATION LAYER

The Modbus protocol is a half-duplex protocol. The physical layer can be half or full duplex.
The Modbus driver supports both half (RS485) and full (RS232/RS422) duplex communication layers.

In case of RS485, the parameter ***3.8 MODBUS_UART_HALF_DUPLEX*** must be turned on. The transmitter is activated when the UFP-V transmits data.
The RS485 receiver may **not be disabled** e.g. the transmitted data must also be received by the UFP-V for correct functioning!

4.1 When using RS232 to RS485 converters

- Always use isolated converters!
- Use the types that enable the transmitter by means of the **Request To Send signal**.
- Use the parameter ***3.4 MODBUS_UART_RTS_MODE*** to define whether a *high* or a *low* level enables the transmitter.
- Check if the terminator resistor corresponds with the characteristic line impedance.
- Use pull-up and pull down resistors for fail safe operation.
- If possible, use the Serial Communication port that uses Interrupt Request 3.

4.2 When using serial I/O cards with RS485 drivers

- Use the types that enable the transmitter by means of the **Request To Send signal.**
- Use the parameter ***3.4 MODBUS_UART_RTS_MODE*** to define whether a *high* or a *low* level enables the transmitter.
- Check if the terminator resistor corresponds with the characteristic line impedance.
- Use pull-up and pull down resistors for fail safe operation.
- Set the IO-address and Interrupt number to the correct values.
- When possible, use Interrupt Request 3.

5 SUPPORTED FUNCTIONS

All data addresses in Modbus messages are referenced to zero.
For example:

- Coil 1 is addressed as Coil 0000.
- Holding register 40001 is addressed as 0000. Note that the function code specifies the operation of a 'holding register', therefore the 4xxxx reference is implicit.

When functions which do not support broadcast requests, are accessed with a broadcast address, the request will be rejected.

5.1 Function 01: READ COIL STATUS

Description
Function 1 reads the ON/OFF status of discrete inputs or discrete variables in the slave (0 x references called coils).
Broadcast is not supported.

Query
The query specifies the starting coil and the quantity of coils to read.
The maximum number of coils requested each request is limited to 2000.

Example
Here is an example of a request to read coils 20-56 from slave device 17:

Header	Slave Address	Function	Starting address		Number of points		Error check	Trailer
			Hi	Low	Hi	Low		
--	11(h)	01(h)	00(h)	13(h)	00(h)	25(h)	--	--

Response

Header	Slave address	Function	Byte count	Data					Error check	Trailer
				Coil 27-20	Coil 35-28	Coil 43-36	Coil 51-44	Coil 56-52		
--	11(h)	01(h)	05(h)	CD(h)	6B(h)	B2(h)	0E(h)	1B(h)	--	--

The coil status in the response message is packed as one coil per bit of the data field. Status is indicated as 1= ON, 0= OFF.
The LSB of the first data byte contains the coil addressed in the query. The other coils follow toward the high order end of this byte and from 'low order to high order' in subsequent bytes.

If the returned coil quantity is not a multiple of eight, the remaining bits in the final data byte will be padded with zeros (toward the high order end of the byte). The Byte Count field specifies the quantity of complete bytes of data.

The status of coils 27-20 is shown as the byte value CD hex, or binary 1100 1101.
Coil 27 is the MSB of this byte, and coil 20 is the LSB. Left to right, the status of coils 27 through 20 is ON-ON-OFF-OFF-ON-ON-OFF-ON.

By convention, bits within a byte are shown with the MSB to the left, and the LSB to the right. Thus the coils in the first byte are '27 through 20', from left to right, The next byte has coils '35 through 28', left to right. As the bits are transmitted serially, they flow from LSB to MSB: 20…27, 28...35, and so on.

In the last data byte, the status of coils 56-52 is shown as the byte value 1B hex, or binary 0001 1011. Coil 56 is in the fourth bit position from the left, and coil 52 is the LSB of this byte. The status of coils 56 through 52 is ON-ON-OFF-ON-ON.

Note how the three remaining bits (toward the high order end) are zero-filled.

If the request is not applicable an exception response will be sent.
- See chapter 5.10 for exception responses.

5.2 Function 02: READ INPUT STATUS

In the UFP-V Modbus protocol, function 1 and 2 perform the same processing and are interchangeable.

5.3 Function 03: READ MULTIPLE HOLDING REGISTERS

Description
Function 3 reads the binary contents of holding registers (4X references) in the slave.
Broadcast is not supported.
The maximum number of registers at each request is limited to 125 registers, 125 integers, or 62 long integers or 62 floats or 31 doubles.

Query
The query message specifies the starting register and the quantity of registers to be read. Registers are addressed starting at zero. Registers 1-16 are addressed as 0-15.

Example
Here is an example of a request to read registers 40108-40110 from slave device 17:

Header	Slave Address	Function	Starting address		Number of points		Error check	Trailer
			Hi	Low	Hi	Low		
--	11(h)	03(h)	00(h)	6B(h)	00(h)	03(h)	--	--

Response

Header	Slave address	Funct.	Byte count	Data						Error check	Trailer
				Reg. 40108 Hi	Reg. 40108 Low	Reg. 40109 Hi	Reg. 40109 Low	Reg. 40110 Hi	Reg. 40110 Low		
--	11(h)	03(h)	06(h)	02(h)	2B(h)	00(h)	00(h)	00(h)	64(h)	--	--

The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register the first byte contains the high order byte, the second the low order bits.

The contents of register 40108 are shown as the two byte values of 02 2B hex (555 decimal).
The contents of register 40109 are 00 00 hex and of register 40110 00 64 hex (100 decimal).

If the request is not applicable an exception response will be sent.
- See chapter 5.10 for exception responses.

5.4 Function 04: READ INPUT REGISTERS

In the UFP-V Modbus protocol, function 3 and 4 perform the same processing and are interchangeable.

5.5 Function 05: WRITE SINGLE COIL

Description
Function 5 forces a single coil to either ON or OFF (0x reference).
When the address is a broadcast, all slaves will process the request.

Query
The query message specifies the coil reference to be forced. Coils are addressed starting at zero (coil 1 is addressed as zero).

The requested ON/OFF status is specified by a constant in the query data field. A value of *FF 00* hex requests the coil to be ON. A value of 00 00 requests it to be OFF. All other values are illegal and do not affect the coil and generate an exception.

Example
Here is an example of a request to force coil 173 ON in slave device 17.

Header	Slave Address	Function	Coil Address		Data		Error Check	Trailer
			Hi	Low	Hi	Low		
--	11(h)	05(h)	00(h)	AC(h)	FF(h)	00(h)	--	--

The normal response is an echo of the query, returned after the coils state has been forced.

Header	Slave Address	Function	Coil Address		Data		Error Check	Trailer
			Hi	Low	Hi	Low		
--	11(h)	05(h)	00(h)	AC(h)	FF(h)	00(h)	--	--

If the request is not applicable an exception response will be sent.
- ➢ See chapter 5.10 for exception responses.

5.6 Function 06: WRITE SINGLE HOLDING REGISTER

Description
Function 6 pre-sets a value into a single holding register (4x reference).
When the address is a broadcast, all slaves will process the request.

Query
The query specifies the register reference to be preset. Registers are starting at address zero.
The requested value (preset) is specified in the query data field, which is a 16-bit value.

Example
Here is an example of a request to preset register 40002 to *00 03* in slave 17.

Header	Slave Address	Function	Register Address		Data		Error Check	Trailer
			Hi	Low	Hi	Low		
--	11(h)	06(h)	00(h)	01(h)	00(h)	03(h)	--	--

Response is an echo of the query, returned after the register contents have been pre-set.

Header	Slave Address	Function	Register Address		Data		Error Check	Trailer
			Hi	Low	Hi	Low		
--	11(h)	06(h)	00(h)	01(h)	00(h)	03(h)	--	--

If the request is not applicable an exception response will be sent.
➢ See chapter 5.10 for exception responses.

5.7 Function 8: DIAGNOSTICS

Description
Function 8 provides a test for checking the communication system between the master and the slave.

Query
The function uses a two-byte sub-function field in the query to define the test to be performed.

Header	Slave address	Function	Sub-function	Data Hi+Lo	Error check	Trailer
--	11(h)	08(h)	00 00(h)	A1B8 (h)	--	--

Only sub-function 0 is supported, which response is to loop back the query data.
Function 8 is only supported in slave mode.

5.8 Function 15: WRITE MULTIPLE COILS

Description
Function 15 forces each coil (0x reference) in a sequence of coils to either ON or OFF.
When the address is a broadcast, all slaves will process the request.

Query
The query message specifies the coil reference to be forced. Coils are addressed starting at zero (coil 1 is addressed as 0).

Example
Here is an example of a request to force a series of coils starting at coil 20 in slave 17. The query data contents are two bytes *CD 01* hex, the binary bits correspond to the coils in the following way:

Bit	1	1	0	0	1	1	0	1	0	0	0	0	0	0	0	1
Coil	27	26	25	24	23	22	21	20	x	x	x	x	x	x	29	28

X means don't care and are made zero.

The first byte transmitted (*CD*) addressed coils 27…20, where by the least significant bit addresses the lowest coil (*20*) in this set.

The next byte transmitted (*01*) addresses coils 29 and 28, with the least significant bit addressing the lowest coil (*28*) in this set. Unused bits in the last data byte should be left zero.

Request:

Header	Slave Address	Function	Coil address		Quantity Of points		Byte counts	Force data		Error check	Trailer
			Hi	Low	Hi	Low		Hi	Low		
--	11(h)	0F(h)	00(h)	13(h)	00(h)	0A(h)	02(h)	CD(h)	01(h)	--	--

Response
The normal response returns the slave address, function code, starting address, and quantity of coils forced.

Header	Slave Address	Function	Coil Address		Quantity Of points		Error check	Trailer
			Hi	Low	Hi	Low		
--	11(h)	0F(h)	00(h)	13(h)	00(h)	0A(h)	--	--

If the request is not applicable an exception response will be sent.
➢ See chapter 5.10 for exception responses.

5.9 Function 16: WRITE MULTIPLE HOLDING REGISTERS

Description
Function 16 pre-sets values into a sequence of holding registers (4x reference).
When the address is a broadcast, the function pre-sets the same register references in all attached slaves.

Query
The query message specifies the register references to be pre-set. Registers are addressed starting at zero (register 1 is addressed as 0).

Example
Here is an example of a request to pre-set two registers starting at 40002 to *00 0A* end *01 02* hex, in slave device 17.

Header	Slave Address	Funct.	Starting address		Quantity Registers		Byte counts	Data				Error check	Trailer
			Hi	Low	Hi	Low		Hi	Low	Hi	Low		
--	11(h)	10(h)	00(h)	01(h)	00(h)	02(h)	04(h)	00(h)	0A(h)	01(h)	02(h)	--	--

Response
The normal response returns the slave address, the function code, starting address, and quantity of registers pre-set.

Header	Slave Address	Function	Starting Address		Quantity Of points		Error check	Trailer
			Hi	Low	Hi	Low		
--	11(h)	10(h)	00(h)	01(h)	00(h)	02(h)	--	--

If the request is not applicable an exception response will be sent.
➢ See chapter 5.10 for exception responses.

5.10 Exception Responses

Except for broadcast messages, a master device expects a normal response, when it sends a query to a slave device.

One of the four possible events can occur from the master's query:

1. If the slave device receives the query without a communication error and can handle the query normally, it returns a normal response.
2. If the slave does not receive the query due to a communication error, no response is returned. The master program will eventually process a timeout condition for the query.
3. If the slave receives the query, but detects a communication error (parity, CRC, LRC), no response is returned. The master program will eventually process a timeout condition for the query.
4. If the slave receives the query without a communication error, but cannot handle it, the slave will return an exception response informing the master of the nature of the error.

The exception response message has two fields that differentiate it from a normal response:
1 the function code field; and
2 the data field.

Ad 1 Function Code Field
In a normal response the slave echoes the function code of the original query in the function code field of the response. All function codes have a most significant bit of 0.
In an exception response the slave sets the most significant bit of the function code to 1.
The master recognises the exception response by means of this bit and can examine the data field for the exception code.

Ad 2 Data field
In an exception response the slave returns an exception code in the data field.
This defines the slave condition that caused the exception.

The exception response message:

Header	Slave address	Function	Exception code	Error check	Trailer

Exception codes

Code	Name	Meaning
01	Illegal function	The function code in the query is not an allowable action for the slave.
02	Illegal data address	The data address received in the query is not an allowable address for the slave.

6 HANDLING OF LARGE DATA TYPES

The standard Modbus specification does not explain how data types larger than 16 bits should be handled. The standard Modbus functions to modify holding registers are used for handling larger data types.

Function 03 (read multiple holding registers), function 06 (write single holding register), and function 16 (write multiple holding registers) are used to read or modify these data types.

In the UFP-V each register-area contains a data type.

In order to maintain compatibility with older systems, a parameter ***5.2 MODBUS_MODICON_COMPAT*** controls how the registers are counted.
In modicon compatible mode the data is counted as 16 bit registers.
In not-modicon compatible mode the data is counted on the data type, so a float is one register!

Notice that function 6 in not-modicon compatible mode will also write one type of the accompanying data type!

<u>The supported data types are:</u>

- Integer (16 bit)
- Long integer (32 bit)
- Float (32 bit)
- Double (64 bit)

The register ranges for each data type:

Function	**Address (default)**	**Data type**	**Number of registers to request for each data type**	
			Modicon compatible	**Not Modicon compatible**
1,2,5,15	1000..2999	Boolean	1	1
3,4,6,16	3000..3999	Integer	1	1
	5000..5999	Long integer	2	1
	6000..6999	Double	4	1
	7000..7999	Float	2	1

Notice that in *modicon compatible mode* each data type larger than 16 bits should be addressed as 16 bit registers. For instance the first float is located on address 7000/7001 the next float is located on address 7002/7003.

A double would be accessed by four 16-bit registers, so the first double 6000/6001/6002/6003 and the next double 6004/6005/6006/6007.

The data in the chapter 8.4 Modbus Mapping Assignments is printed as it should be accessed in *not-modicon compatible* mode.

6.1 Floating Point Representation

The exponent is biased by 127.
The mantissa is 24 bits with the most significant bit 1 (not stored), 23 bit stored.

Biased exponent	Mantissa 3 (high)	Mantissa 2	Mantissa 1 (low)
SEEE EEEE	E MMM MMMM	MMMM MMMM	MMMM MMMM

6.2 Double Representation

The exponent is biased by 1023.
The mantissa is 53 bits with the most significant bit 1 (not stored), 52 bits stored.

Biased exponent	Exp+Mantissa	Mantissa 6	Mantissa 5
SEEE EEEE	EEEE MMMM	MMMM MMMM	MMMM MMMM

Mantissa 4	Mantissa 3	Mantissa 2	Mantissa 1
MMMM MMMM	MMMM MMMM	MMMM MMMM	MMMM MMMM

6.3 Transmit Sequence

Integers are transmitted and stored with the most significant part first.
<u>Example</u>
Integer value 1790 decimal (6FE hexadecimal) is transmitted as:

First transmitted byte in data field	Second transmitted byte in data field
06	FE

Long integers could be transmitted in two possible ways:
<u>Example</u>
Long integer value 305419896 (12345678 hexadecimal)
The transmit order in both modes:

Normal mode	(1) 12_h	(2) 34_h	(3) 56_h	(4) 78_h
Reversed mode	(3) 56_h	(4) 78_h	(1) 12_h	(2) 34_h

Floats could be transmitted in two ways:

<u>Example:</u>

The float number 4.125977 will give the IEEE representation.

S	EXPONENT	MANTISSA
0	1000 0001	(1) 000 0100 0000 1000 0000 0000

- A biased exponent of 129 (81 hexadecimal) is exponent 2.
- A positive sign
- Mantissa = 4 + 1/8 + 1/1024. Note that the first bit is not stored!

The transmit order in both modes:

IEEE	(1) 40_h	(2) 84_h	(3) 08_h	(4) 00_h
Normal mode	(1) 40_h	(2) 84_h	(3) 08_h	(4) 00_h
Reversed mode	(3) 08_h	(4) 00_h	(1) 40_h	(2) 84_h

Doubles could be transmitted in two ways:
<u>Example</u>
The double number 4.125000001862645 will give the IEEE representation.

S	EXPONENT	MANTISSA
0	100 0000 0001	(1)0000 1000 0000 0000 0000 0000 0000 0010 0000 0000 0000 0000 0000

- A biased exponent of 1025 (401 hexadecimal) is exp. 2
- A positive sign
- Mantissa = 4 + 1/8 + 1/536870912. Note that the first bit is not stored!

The transmit order in both modes:

IEEE	(1) 40_h	(2) 10_h	(3) 80_h	(4) 00_h	(5) 00_h	(6) 20_h	(7) 00_h	(8) 00_h
Normal mode	(1) 40_h	(2) 10_h	(3) 80_h	(4) 00_h	(5) 00_h	(6) 20_h	(7) 00_h	(8) 00_h
Reversed mode	(3) 80_h	(4) 00_h	(1) 40_h	(2) 10_h	(7) 00_h	(8) 00_h	(5) 00_h	(6) 20_h

6.4 Maximum requested points

The maximum points in a single request depend on the type of data.

Data type	Modicon compatible mode (count on 16 bit registers)	Not Modicon compatible mode (count on type)
Boolean	2000	2000
Integer	125	125
Long integer	124	62
Float	124	62
Double	124	31

How to set up a redundant system
<u>Two or more UFP-V systems</u>
If one or more UFP-V systems are used with one host system, the host system must support Modbus master mode. The UFP-V will then operate in Modbus slave mode.

<u>Two or more host systems</u>
As a result of operational safety, some applications require more than 1 host-system communicating with one UFP-V.

If the UFP-V is used in slave mode, only one host-master may be connected.

One solution is to use the UFP-V as a Modbus master. Now the data is sent to the first addressed host (first poll block), the second poll block sends the data to the next host.
The data could be different, because the measured data is updated.

Another solution is to send the data to the hosts by means of a broadcast. Now all host systems receive the same data.

7 SET-UP OF THE UFP-V MODBUS DRIVER

7.1 Driver Contents

The driver contains:

- Standard Modbus protocol according to Modicon.
- Simulation of Modbus Master and Slave mode.
- ASCII-mode and RTU mode.
- Half and full duplex communication layers supported.
- Transmitter ON/OFF level select for half-duplex mode.
- Seven or eight data bits, Even/Odd/No parity, 1 or 2 stop bits
- Extended data type support.
- Function 1, 2, 3, 4, 5, 6, 8,15,16 including exception generation.

7.2 Hardware set-up

To set up the Modbus communication first the **hardware** should be set-up.

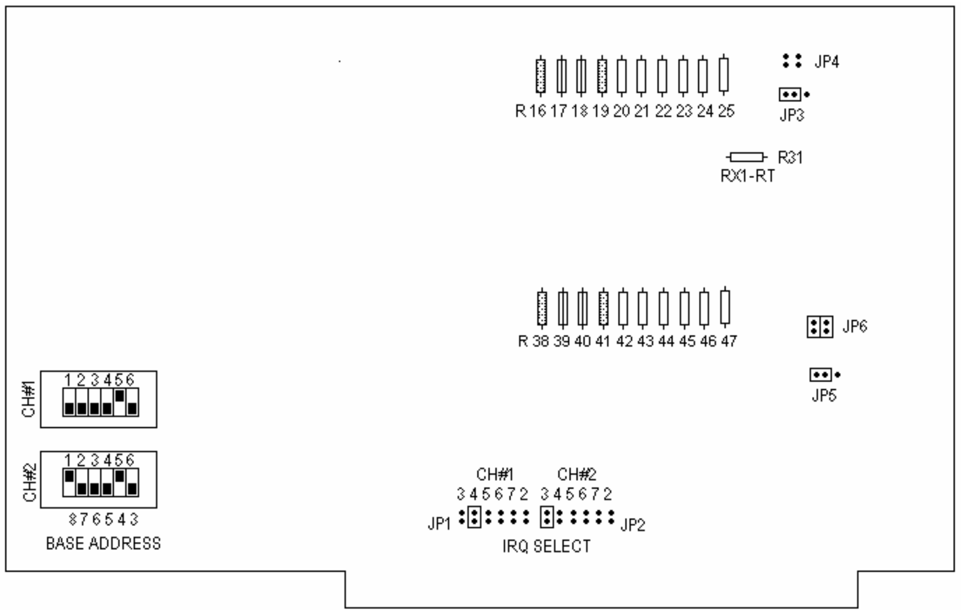
The UFP is equipped with a RS485/RS422 Communication Card which provide 2 serial communication channels, the first channel CH1 is used for the communication with the UFC-V, please do not change anything here. The second channel CH2 is free for communication with host systems .

There are two generations of RS485 cards:

- AX4285A formerly installed
- PCL745s currently installed

7.2.1 RS485/422 card: AX4285A

The first generation of RS 485 cards used



DIP SWITCH CH1***	: COM 3 Baseaddress ch#1: 3E8
DIP SWITCH CH2***	: COM 4 Baseaddress ch#2: 2E8
JP1***	: COM3 Interrupt IRQ4
JP2***	: COM4 Interrupt IRQ3
JP3***	: COM3 RS 485 mode
JP4***	: COM3 Serial resistors enabled, No jumpers installed
JP5	: COM4 RS 485 mode as default
JP6	: COM4 Serial resistors not enabled, jumpers installed

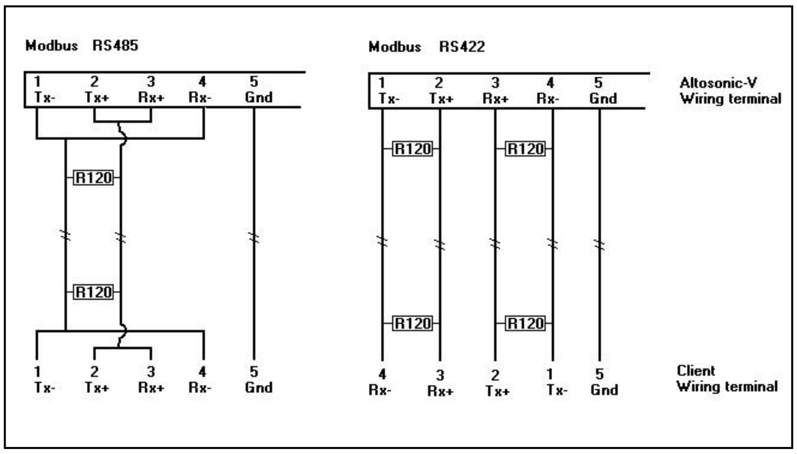
***(=Krohne Altometer setting)

NOTE:

RS485 mode and RS422 mode for COM4 (Modbus) differs in set-up by:

- Jumper JP5 RS485 or RS422
- The external wiring for RS422 and RS485

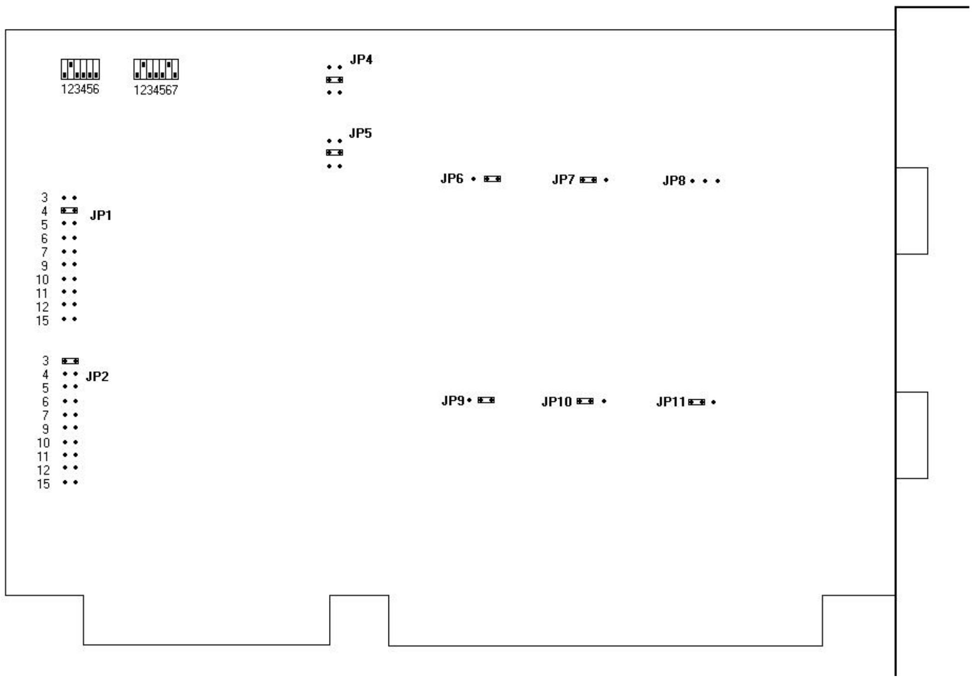
External wiring AX5285A for Modbus:


Modbus RS485
Modbus RS422
1 Tx- 2 Tx+ 3 Rx+ 4 Rx- 5 Gnd
Altosonic-V Wiring terminal
R120
4 Rx- 3 Rx+ 2 Tx+ 1 Tx- 5 Gnd
Client Wiring terminal

The resistors of 120 Ohm must be placed at the ALTOSONIC-V wiring terminal

7.2.2 RS485/422 card: PCL-745 S

The current generation RS485/422 card



Dip switch ch1***	: COM 3 Address 3E8 (Krohne Altometer setting)
Dip switch ch2***	: COM4 Address 2E8
JP1***	: Interrupt COM3 IRQ4
JP2***	: Interrupt COM4 IRQ3
JP4***	: Transmit driver enable COM3 always RTS
JP5	: Transmit driver enable COM4 default RTS
JP6***	: Receive COM3 (422 is always on)
JP7***	: Terminator jumper COM3 120
JP8***	: Terminator jumper COM3 always not installed
JP9***	: Receive COM4 (422 is always on)
JP10***	: Terminator jumper COM4 120
JP11	: Terminator jumper COM4 (120 for RS422 mode, not installed for RS485 mode)

***(=Krohne Altometer setting)

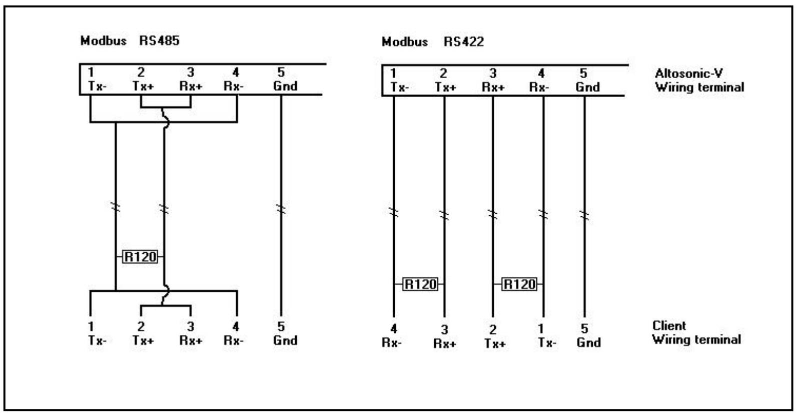
NOTE:

JP6 and JP9 are always 422 because the receiver is for both RS485 mode and RS422 mode expected to be enabled for the UFP-Program.

RS485 mode and RS422 mode for COM4 (Modbus) therefore only differs in set up by:

- Jumper JP11 not installed (RS485) or installed on 120 (RS422)
- The external wiring for RS422 and RS485

External wiring PCL745 for Modbus:



7.3 Software set-up

Now set-up the software, all the settings for the Modbus driver is done in the file [coms0300.dat].
See also chapter 9.4 Appendix D: Coms0300.dat file

7.3.1 First set the parameters for the communication line

- ***3.1 MODBUS_UART_BASEADRESS*** for channel 1 is COM4 this is baseaddress **0x2E8**
- ***3.2 MODBUS_UART_INTERRUPT*** is for COM4 set to interrupt **3**.
- Depends on your application : ***3.3 MODBUS_UART_BAUDRATE*** **1200,2400,4800,9600,19200**
- ***3.4 MODBUS_UART_RTS_MODE*** to **0**.
- Depends on your application : ***3.5 MODBUS_UART_N_DATABITS*** to **7 or 8**
- Depends on your application : ***3.6 MODBUS_UART_N_STOPBITS*** to **1 or 2**
- Depends on your application : ***3.7 MODBUS_UART_PARITY*** **to none, even or odd**.
- Depends on your application : ***3.3 MODBUS_UART_BAUDRATE*** **1200,2400,4800,9600,19200**
- Depends on your application :
  If you use **RS485** set ***3.8 MODBUS_UART_HALF_DUPLEX*** to **HALF_DUPLEX**(=1)
  If you use **RS422** set ***3.8 MODBUS_UART_HALF_DUPLEX*** to **FULL_DUPLEX**(=0)

7.3.2 Now select the parameters for the used protocol

- Select the frame type **RTU** or **ASCII** with ***3.9 MODBUS_TRANSFER_MODE***.
- Set the UFP-V as **MASTER** or **SLAVE** device with ***5.1 MODBUS_DEVICE_TYPE***.
- Select if variables, which are larger than 16 bits are still counted as the number of 16 bit
- Set the data points requesting type by parameter ***5.2 MODBUS_MODICON_COMPAT***:
  By type is **not modicon compitable (=0)**
  By 16 bit registers is **modicon compitable (=1)**
-

7.3.3 The UFP-V as SLAVE device

The slave mode is activated when the parameter ***5.1 MODBUS_DEVICE_TYPE***=1.

- If the UFP-V acts like a **Modbus Slave device**, set the SlaveID with ***5.3 MODBUS_SLAVE_ID***.
- The ***5.4 FLAG_HOLD_TIME*** is a hold time on the status flags (Booleans only).
  The ***5.4 FLAG_HOLD_TIME*** freezes the flags after the flag has changed from state.
  Set this time a bit larger than the maximum communication-request interval.
- The next fields define to which Modbus addresses the data of the UFP-V is mapped to, these settings are default settings and should not be changed, only if necessary.
  The fields are ***6 DATAFIELD*** **1 to N**, for every DATAFIELD an access mode could be set.
  The ***6 ACCES MODE*** defines how the data is send and interpreted when the UFP-V is in **slave-mode**.
- See the manual of the accompanying byte-order of transmission/reception with the 2 modes.

For Slave-use the driver should be working now.

7.3.4 The UFP-V as Master

The master mode is activated when the parameter ***5.1 MODBUS_DEVICE_TYPE***=2.
For **master mode** the UFP-V must know what it should send to the connected slave device, therefore the master works with **poll blocks.** Each poll block defines how a transaction should take place i.e. which slave is addressed, which registers are read or write and how to do it.

The maximum number of poll blocks to define is 20. The number of poll blocks to use is set with the parameter ***7.1 NUMBER_OF_POLLBLOCKS_TO_USE***.
During start-up of the UFP-V, a poll block validation check will be done. Only the number of poll blocks defined in ***7.1 NUMBER_OF_POLLBLOCKS_TO_USE*** will be checked.
The maximum response time after a poll block request is set by the parameter
7.2 R***EQUEST_TO_RESPONSE_TIMEOUT.***
If no response is received from the slave within this time, a poll block timeout error is generated.

So for every pollblock (=data movement) set :

- The ***7.3a SLAVEID*** : the address of the slave device , notice that 0 is a broadcast to all slaves, not all the functions are allowed with broadcast messages.
- The ***7.3b MASTER REGISTER***, this is the location of the data in the UFP-V.
- The ***7.3c SLAVE REGISTER***, this is the location of the data in the slave device.
- The ***7.3d N_POINTS***, this is always the number data points of the specific datatype to transfer, like 1 Boolean, 1 int, 1 float. The real number of 16 bit registers in the Modbus message is **calculated**.
  For instance, in modicon compatible mode the number of registers in the **message** is always 2 times the number of floats.
  In not-modicon compatible mode the number of registers in the **message** is always the same as number of floats. So **number of points** in the pollblock definition always count the **datatypes**.
- The ***7.3e FUNCTION*** selects which Modbus function is used for the data transfer (see a complete list in the manual).
- The ***7.3f DATATYPE*** is for internal validation only but should be filled in correctly.
- The ***7.3g DATANOTATION*** defines in which byte-order the data is send, float, longs, doubles may be send with different notations (like big and little indian).
- The ***7.3h DELAY*** is the time to wait after the last pollblock has been send before sending the next pollblock. When all the pollblocks are defined, select with
  7.1 NUMBER_OF_POLLBLOCKS_TO_USE, which pollblocks to use. 1=first one only, 2 is number one and two …and so on.

7.4 What can go wrong?

When using RS485, check:

- Are the connections between terminal 1 and 4 made?
- Are the connections between terminal 2 and 3 made?
- Is the terminate resistor placed between 1+4 and 2+3 (only if UFP-V is the end of the line).
- Is the jumper set to 485 and not 422? (else the transmitter will continuously be activated and destroy received messages)
- Is the polarity correct? Are the lines by accident swapped?
- Is the software set to Half Duplex (***3.8 MODBUS_UART_HALF_DUPLEX***=1)

When using RS422, check:

- Are both terminator resistors placed at the end of the cable on the TX+, TX- and RX+, RX- lines?
- Is the jumper on the RS485 card set to 422?
- Is the software set to Full duplex ((***3.8 MODBUS_UART_HALF_DUPLEX***=0)?

Other checks:

- Are the following items correct:
  baud rate (***3.3 MODBUS_UART_BAUDRATE***)
  N stop bits (***3.6 MODBUS_UART_N_STOPBITS***)
  parity (***3.7 MODBUS_UART_PARITY***)
- Are both systems in the same mode **RTU/ASCII** (ASV system = **3.9 MODBUS_TRANSFER_MODE)**?
- Is the Slave ID (***5.3 MODBUS_SLAVE_ID***) correct?
- Notice that RTU requires precise timing specifications, some of the RS485 -> RS232/422 converters perform data buffering and may give problems.
  If this is the problem try the ASCII mode (***3.9 MODBUS_TRANSFER_MODE***).
- Notice that the Slave device will not give any response when it is addressed with a broadcast (SlaveID=0).

Extra information:
The UFP-V has extra windows, which provide information about the Modbus communication:
These windows are accessed from the Main Window by function key F10
See also ALTOSONIC-V Operating Manual (chapter RUNTIME WINDOWS)

7.5 How Status Flags are Updated

If the status flags must be self-resetting

Each machine cycle (35 ms) all the error and warning flags are updated with the last machine status.
An active flag will be pending for at least (***5.4 FLAG_HOLD_TIME*** * 35) ms.
An Active Flag may be reset earlier (by writing a zero) than the pending time (***5.4 FLAG_HOLD_TIME*** * 35 ms), but the next update will be after the pending time.

If the flags must be acknowledged
To activate this mode, the parameter ***5.4 FLAG_HOLD_TIME*** must be set to 0. Each machine cycle (35 ms) all warning and error flags are updated with the last machine status.
The flags can be reset by:

- writing a 0 to these flags or
- writing a 1 to the accompanying acknowledge flag (each status flag has an accompanying acknowledge flag) or
- writing a 1 to the acknowledge_all flag
  (for host computers with limited free programmable Boolean space).

Example of reading a status flag from an UFP-V in slave mode

The status flag is read by the master.

1. **If the status flag is active**,
   the master uses this state to perform its actions and sends an acknowledgement to the UFP-V by setting the accompanying ACK_flag to 1.
   Now the UFP-V updates the status flag with the actual status.
   Note that in this mode the status flag remains active until the acknowledge is given.
2. **If the status flag is not active**,
   the master removes the acknowledge by resetting the ACK_flag.

Example of reading status flag 0 from an UFP-V in master mode

1. The first poll block sends the status flag to the master
2. **If the status flag is active**, the master uses this status to perform his actions and sends an acknowledgement to UFP-V by means of setting the accompanying ACK_flag to 1.
3. The next poll block reads this ACK_FLAG and updates it in the UFP-V,
   now the UFP-V updates the status flag with the actual status.
3. **If the flag is not active**, the master removes the acknowledgement by resetting the ACK_flag.

As long as the ACK_flag is active the status flag is updated every 35 milliseconds.

If the communication speed is known, choose the ***5.4 FLAG_HOLD_TIME*** large enough to give the host the possibility to detect the state of the flags.

To set-up a more secure system use the acknowledge method. A disadvantage is the increase in communication time.

5.4 FLAG_HOLD_TIME is located in the coms0300.dat file.
See also chapter 9.4 Appendix D: Coms0300.dat file

7.6 How data is written to the float field

Field 6 (addresses are default mapped to address 7500) is the read/write field for floats.
Current applications for writing to the UFP-V system are:

1. **API settings** for the parameters used in the UFP-Program for calculating Standard/Mass flow and totals. The addresses used are 7501…7514 for floats and 2068…2069, 2201.. 2214 for Booleans

2. **External flow meter settings** for the parameters used in the UFP-Program for proving an external flow meter such as a turbine meter.
   Connection is established through a pulse input and temperature and pressure at external conditions.
   The addresses used are 7521…7523 for floats and 2070, 2071, 2221… 2223 for Booleans

3. **System time deviation**
   The UFP-Program has a system time that can be altered by input of deviation [s] on current system time.
   In file COMS0300.dat section 5.6 this must be configured to enable the writing.
   For current system time see Integers 3033…3038
   The addresses used for writing are 7577 for floats and 2230 for Booleans.

4. **Densito meter calibration data**
   The UFP-Program can measure the density with a densito meter.
   There are 4 data sets, 2 for Solartron and 2 for Sarasota.
   See Floats 7531…7566 and Booleans 2231…2241 for writing the data.

5. **Override values on secondary inputs**
   In the UFP-Program it is possible to manually override the secondary input values when the specific parameter is used in the calculation and the Alarm output is enabled in the Initialisation file CLNT0300.dat
   See Floats 7578…7588 and Booleans 2072…2081 and 2243…2255.

6. **UFP Batch control (internal batch)**
   The UFP-Program is capable of batching. A serial printer connected to the UFP prints tickets.
   This batch control is done by a single float 7530 that handles specific float values as control commands.
   On success the float value returns 1 on not permitted returns 0.
   For status on batch control etc. see Integers 3020…3023 and Long 5008.
   Internal UFP-Program batch is done by batch1 values see Float 7077…7127.

7. **Secondary inputs through Modbus communication**
   Instead of using AD or frequency input it is possible to measure a secondary input through Modbus.
   Note that this must be configured in the CLNT0300.dat file section 9.
   The time out value on new input can be configured in file COMS0300.dat section 5.5.
   If the new value is not written before this timeout value elapses the specific input generates an alarm.
   After every new input value, the time out counter is reset.
   See Floats 7567…7576.

Applications 1…5 can only be accessed for writing when first a Boolean is set that enables writing for 30 seconds. This is described in the next paragraph 7.6.1

7.6.1 How to write in the float field to the specific application

Applications 1…5 can only be accessed for writing when first a Boolean is set that enables writing for 30 seconds.
How to handle:

- To enable writing to a float field as described in application 1...5, an enable Boolean referring to the application must be written to the xxxxx *enable writing data* Boolean.
  For example for application 1 this is Boolean 2201.
- After writing this Boolean there will be 30 seconds of time to write float data to the application field. The time remaining to write to the application field can be read from float xxxxx*Time to update a parameter*
  For example for application 1 this is Float 7501
- If data is changed this can be read in the Boolean field as mentioned per application. These Booleans must be reset by the host
  For example for application 1 this is Booleans 2202…2214
- There is also an overall data changed Boolean per specific application. This Boolean automatic resets after saving the data.
  For example for application 1 this is Boolean 2068.
- When data is changed it can be secured by saving it in the UFP-V system. This is done by writing an enable Boolean per application field.
  For example application 1 is Boolean 2069.

  This action will automatically reset (0) the Booleans:
  Xxxxx Data changed in float write field. For example application 1 is Boolean 2068.
  xxxxx Save changed data in float write field. For example application 1 is Boolean 2069
  xxxxx Enable writing data. For example application 1 is Boolean 2201

8 MODBUS MAPPING ASSIGNMENTS

The available data is grouped in four levels:
1. Primary data
2. Data for analysis
3. Data for error analysis
4. Control data

The data are grouped by data type.

8.1 Field 0 (Read only Boolean field)

This data is read only and can be accessed with Modbus function 1 and 2 in Modbus slave mode and with functions 5 and 15 in Modbus master mode.

Without further notice 0=non and 1=active

Starting addresses are mapped to address 1000 (default).

1	Basic flow measurement warning	(Level **1**)
2	Basic flow measurement error	(Level **1**)
3	System runtime warning	(Level **1**)
4	System runtime error	(Level **1**)
5	System set-up warning	(Level **1**)
6	System set-up error	(Level **1**)
7	Totaliser process: sum totaliser rollover occurred	(Level **1**)
8	Totaliser process: totaliser reset occurred	(Level **1**)
9	Flow direction	(Level **1**) 0=forward 1=reverse
10	Algo. Basic flow on output	(Level **2**)
11	Reserved	
12	Algo. Reyn. Correction on output.	(Level **2**)
13	Swirl correction on output	(Level **2**)
14	Temperature correction on output	(Level **2**)
15	Standard volume on output	(Level **2**)
16	API group out of range	(Level **2**)
17	Correction parameters hold. Due to flow deviation	(Level **2**)
18	Reserved	
19	Alarm on reading: temperature process	(Level **2**)
20	Alarm on reading: pressure process	(Level **2**)
21	Alarm on reading: densito meter density	(Level **2**)
22	Alarm on reading: temperature body	(Level **2**)
23	Totaliser standard: sum totaliser rollover occurred	(Level **2**)
24	Totaliser standard: totaliser reset occurred	(Level **2**)
25	Totaliser process: forward totaliser rollover occurred	(Level **2**)
26	Totaliser process: reverse totaliser rollover occurred	(Level **2**)
27	Totaliser standard: forward totaliser rollover occurred	(Level **2**)
28	Totaliser standard: reverse totaliser rollover occurred	(Level **2**)
29	Totaliser mass: sum totaliser rollover occurred	(Level **2**)
30	Totaliser mass: totaliser reset occurred	(Level **2**)
31	Totaliser mass: forward totaliser rollover occurred	(Level **2**)
32	Totaliser mass: reverse totaliser rollover occurred	(Level **2**)
33	Over range data path 1	(Level **3**)
34	Over range data path 2	(Level **3**)
35	Over range data path 3	(Level **3**)
36	Over range data path 4	(Level **3**)
37	Over range data path 5	(Level **3**)
38	Path failure path 1	(Level **3**)
39	Path failure path 2	(Level **3**)

40	Path failure path 3	(Level **3**)
41	Path failure path 4	(Level **3**)
42	Path failure path 5	(Level **3**)
43	Deviation in sound velocity path 1	(Level **3**)
44	Deviation in sound velocity path 2	(Level **3**)
45	Deviation in sound velocity path 3	(Level **3**)
46	Deviation in sound velocity path 4	(Level **3**)
47	Deviation in sound velocity path 5	(Level **3**)
48	Communication failure path 1	(Level **3**)
49	Communication failure path 2	(Level **3**)
50	Communication failure path 3	(Level **3**)
51	Communication failure path 4	(Level **3**)
52	Communication failure path 5	(Level **3**)
53	Real profile sampling on hold. Due to channel failures or flow deviation	(Level **2**)
54	Alarm on reading: external viscosity	(Level **2**)
55	Alarm on reading: temperature densito meter	(Level **2**)
56	Alarm on reading: pressure densito meter	(Level **2**)
57	Alarm on reading: temperature proving (external flow meter)	(Level **2**)
58	Alarm on reading: pressure proving (external flow meter)	(Level **2**)
59	Densito meter switch alarm	(Level **2**)
60	Real profile out of range during correction of channel(s)	(Level **2**)
61	Alarm on reading: standard density input	(Level **2**)
62	Alarm on service value: temperature body	(Level **2**)
63	Alarm on service value: temperature process	(Level **2**)
64	Alarm on service value: temperature proving (external flow meter)	(Level **2**)
65	Alarm on service value: temperature densito meter	(Level **2**)
66	Alarm on service value: pressure process	(Level **2**)
67	Alarm on service value: pressure proving (external flow meter)	(Level **2**)
68	Alarm on service value: pressure densito meter	(Level **2**)
69	Alarm on service value: densito meter density	(Level **2**)
70	Alarm on service value: standard density	(Level **2**)
71	Alarm on service value: viscosity external	(Level **2**)
72	Override enable possible for temperature body	(Level **1**)
73	Override enable possible for temperature process	(Level **1**)
74	Override enable possible for temperature proving (external flow meter)	(Level **1**)
75	Override enable possible for temperature densito meter	(Level **1**)
76	Override enable possible for pressure process	(Level **1**)
77	Override enable possible for pressure proving (external flow meter)	(Level **1**)
78	Override enable possible for pressure densito meter	(Level **1**)
79	Override enable possible for density densito meter	(Level **1**)
80	Override enable possible for density standard	(Level **1**)
81	Override enable possible for viscosity external	(Level **1**)
82	Override default (automatic) temperature body	(Level **2**) if enabled in CLNT0300.dat
83	Override default (automatic) temperature process	(Level **2**) if enabled in CLNT0300.dat
84	Override default (automatic) temperature proving (external flow meter)	(Level **2**) if enabled in CLNT0300.dat
85	Override default (automatic) temperature densito meter	(Level **2**) if enabled in CLNT0300.dat
86	Override default (automatic) pressure process	(Level **2**) if enabled in CLNT0300.dat
87	Override default (automatic) pressure proving (external flow meter)	(Level **2**) if enabled in CLNT0300.dat
88	Override default (automatic) pressure densito meter	(Level **2**) if enabled in CLNT0300.dat
89	Override default (automatic) density densito meter	(Level **2**) if enabled in CLNT0300.dat
90	Override default (automatic) density standard	(Level **2**) if enabled in CLNT0300.dat
91	Override default (automatic) viscosity external	(Level **2**) if enabled in CLNT0300.dat
92	Batch valid. The last batch completed (no save after program stop)	(Level **1**) 0=not valid, 1=valid
93…128	Reserved	

8.2 Field 1 (Read/Write Boolean Field)

These data can be accessed with Modbus function 1, 2, 5 and 15. Starting addresses are mapped to address 2000 (default).
Without further notice 0=non and 1=active

1…64	Acknowledge_flags_field_0	(Level **1**)
65.	General_acknowledge_flags_field_0	(Level **1**)
66.	Reset all errors	(Level **4**) automatic reset
67.	Reset all totalisers and all errors	(Level **4**) automatic reset
68.	API: data changed in float write field (API 202...214)	(Level **1**) automatic reset
69.	API: save changed data in float write field (API 202...214)	(Level **4**) automatic reset
70.	EXT: data changed in float write field (EXT 222...223)	(Level **1**) automatic reset
71.	EXT: save changed data in float write field (EXT 222...223)	(Level **4**) automatic reset
72.	EXT: restart proving of external flow meter	(Level **4**) automatic reset
73.	Batch 1 reset averages For Continuous Pipe Line Measurement by host , not for the UFP internal CPL batch mode	(Level **4**) automatic reset
74	Batch 2 reset averages For Continuous Pipe Line Measurement by host	(Level **4**) automatic reset
75	Modbus output for all totalisers and batch 1+2 values on hold for 30 sec. (Internally all totalisers continue)	(Level **4**) automatic reset or write 0 to release
76…200	Reserved	
201.	API enable writing data	(Level **4**) reset after 30 sec
202.	API change in: correction type	(Level **1**) manual reset
203.	API change in: density standard type	(Level **1**) manual reset
204.	API change in: fluid type	(Level **1**) manual reset
205.	API change in: stand. density crude (fluid type 0)	(Level **1**) manual reset
206.	API change in: stand. density gasoline (fluid type 1)	(Level **1**) manual reset
207.	API change in: stand. density trans.area(fluid type 2)	(Level **1**) manual reset
208.	API change in: stand. density jet group (fluid type 3)	(Level **1**) manual reset
209.	API change in: stand. density fuel oil (fluid type 4)	(Level **1**) manual reset
210.	API change in: stand. density free fill (fluid type 5)	(Level **1**) manual reset
211.	API change in: free fill K0	(Level **1**) manual reset
212.	API change in: free fill K1	(Level **1**) manual reset
213.	API change in: free fill K2	(Level **1**) manual reset
214.	API change in: temperature standard	(Level **1**) manual reset
215...220	Reserved	
221.	EXT enable writing data	(Level **4**) automatic reset 30 s
222.	EXT change in: K-factor external flow meter	(Level **1**) manual reset
223.	EXT change in: parameters changeable under flowing condition or under low flow cut-off	(Level **1**) manual reset
224…229	Reserved	
230	SYSTEM TIME deviation enable writing (see float 7577)	(Level **4**) if enabled in set-up
231.	SOLARTRON1 enable writing data	(Level **4**) automatic reset 30 s
232.	SOLARTRON1 change in: calibration data	(Level **1**) automatic reset
233.	SOLARTRON1 save and enable written data	(Level **1**) automatic reset
234.	SOLARTRON2 enable writing data	(Level **4**) automatic reset 30 s
235.	SOLARTRON2 change in: calibration data	(Level **1**) automatic reset
236.	SOLARTRON2 save and enable written data	(Level **1**) automatic reset
237.	SARASOTA1 enable writing data	(Level **4**) automatic reset 30 s
238.	SARASOTA1 change in: calibration data	(Level **1**) automatic reset
239.	SARASOTA1 save and enable written data	(Level **1**) automatic reset
240.	SARASOTA2 enable writing data	(Level **4**) automatic reset 30 s
241.	SARASOTA2 change in: calibration data	(Level **1**) automatic reset
242.	SARASOTA2 save and enable written data	(Level **1**) automatic reset
243.	OVERRIDE enable writing data	(Level **4**) automatic reset 30 s
244.	OVERRIDE change in: override data	(Level **1**) automatic reset
245.	OVERRIDE save and enable written data	(Level **1**) automatic reset
246.	OVERRIDE enable to set value Temperature Body	(Level **4**) if enable to override
247.	OVERRIDE enable to set value Temperature Process	(Level **4**) if enable to override
248.	OVERRIDE enable to set value Temperature Proving (external flow	(Level **4**) if enable to override

	meter)	
249.	OVERRIDE enable to set value temperature densito meter	(Level **4**) if enable to override
250.	OVERRIDE enable to set value pressure process	(Level **4**) if enable to override
251.	OVERRIDE enable to set value pressure proving (external flow meter)	(Level **4**) if enable to override
252.	OVERRIDE enable to set value pressure densito meter to override	(Level **4**) if enable to override
253.	OVERRIDE enable to set value density densito meter to override	(Level **4**) if enable to override
254.	OVERRIDE enable to set value density standard to override	(Level **4**) if enable to override
255.	OVERRIDE enable to set value viscosity dynamic to override	(Level **4**) if enable to override
256…320	Reserved	

Reset totalisers will automatically reset the rollover bits of all totalisers, alarms and process time.

8.3 Field 2 (Read only Integer Field)

This data is read only and can be accessed with Modbus function 3 and 4 in Modbus slave mode and with functions 6 and 16 in Modbus master mode.
Starting addresses are mapped to address 3000 (default).

1	Flow process	(Level **1**) scaled –32768…32767 ⇔ -125%… +125%
2	Sound velocity average	(Level **1**) scaled –32768…32767 ⇔ -3276.8…3276.7 m/s
3	Temperature process	(Level **1**) scaled –32768…32767 ⇔ -327.68…327.67 °C
4	Pressure process	(Level **1**) scaled –32768…32767 ⇔ -327.68…327.67 Bar
5	Density process	(Level **1**) scaled 0...32767 ⇔ 0…1638.35 kg/m3
6	Temperature body	(Level **1**) scaled –32768…32767 ⇔ -327.68...327.67 °C
7	Flow standard	(Level **1**) scaled –32768…32767 ⇔ -125% …+125%
8	Flow mass	(Level **1**) scaled –32768…32767 ⇔ -125% …+125%
9	Flow of channel 1	(Level **2**) scaled –32768…32767 ⇔ -125% …+125%
10	Flow of channel 2	(Level **2**) scaled –32768…32767 ⇔ -125% …+125%
11	Flow of channel 3	(Level **2**) scaled –32768…32767 ⇔ -125% …+125%
12	Flow of channel 4	(Level **2**) scaled –32768…32767 ⇔ -125% …+125%
13	Flow of channel 5	(Level **2**) scaled –32768…32767 ⇔ -125% …+125%
14	Sound velocity of channel 1	(Level **2**) scaled 0…32767 ⇔ 0…3276.7 m/s
15	Sound velocity of channel 2	(Level **2**) scaled 0…32767 ⇔ 0…3276.7 m/s
16	Sound velocity of channel 3	(Level **2**) scaled 0…32767 ⇔ 0…3276.7 m/s
17	Sound velocity of channel 4	(Level **2**) scaled 0…32767 ⇔ 0…3276.7 m/s
18	Sound velocity of channel 5	(Level **2**) scaled 0…32767 ⇔ 0…3276.7 m/s
19	Density meter choice	(Level **2**) 0=AD /Modbus input 1=Solartron1 2=Solartron2 3=Sarasota 1 4=Sarasota2 5=Freq-span
20	UFP batch1 ticket number	(Level **1**) 0…32767
21	UFP batch1 status	(Level **1**) 0=non 1=setup 2=running 3=end-batch 5=end-printing 6=end-printfail 7=confirm 10=reset
22	UFP batch1 printer status	(Level **1**) 0=Ready to print 1=Fail in printing 2=Busy (During print task) 2=Check for printer connection (when no print task) 3=No printer connection
23	UFP batch1 print task	(Level **1**) 0 =No print task 1…2 =Attempt to print first character of header 3 =Time out value countdown for actual printing 4…98=Printing headers

		99 =Successful printing batch ticket 100 =Ready to confirm print task 101 =Ready to reset on batch status RESET
24	Reserved	
25	System set-up warning/error number	(Level **3**)
26	System runtime warning/error number	(Level **3**)
27	System messages 01…16	(Level **3**)
28	System messages 17…32	(Level **3**)
29	System messages 33…48	(Level **3**)
30	System messages 49…64	(Level **3**)
31	Number of current warnings	(Level **3**)
32	Number of current alarms	(Level **3**)
33	SYSTEM TIME: seconds	(Level **1**) 0…59
34	SYSTEM TIME: minutes	(Level **1**) 0…59
35	SYSTEM TIME: Hours	(Level **1**) 0…23
36	SYSTEM TIME: Day	(Level **1**) 1…31
37	SYSTEM TIME: Month	(Level **1**) 1…12
38	SYSTEM TIME: Year	(Level **1**) 2001…
39…40	Reserved	

8.4 Field 3 (Read only Long Integer Field)

This data is read only and can be accessed with Modbus function 3 and 4 in Modbus slave mode and with functions 6 and 16 in Modbus master mode.

Starting addresses are mapped to address 5000 (default).

1	Resetable totaliser: process sum	(Level **1**) Value in Liters
2	Flow: process	(Level **1**) scaled -32768 ... +32767 ⇔ -125% …+125%
3	Sound velocity average	(Level **1**) scaled 0…32767 ⇔ 0…3276.7 m/s
4	Resetable totaliser: standard sum	(Level **1**) Value in Liters
5	Flow: standard	(Level **1**) scaled -32768 … +32767 ⇔ -125%… +125%
6	Resetable totaliser: mass sum	(Level **1**) Value in Kilograms
7	Flow: mass	(Level **1**) scaled -32768 … +32767 ⇔ -125%… +125%
8	UFP batch1 ticket count	(Level **1**) 0….2147483647
9	Resetable totaliser: process forward	(Level **1**) Value in liters
10	Resetable totaliser: process reverse	(Level **1**) Value in liters
11	Resetable totaliser: standard forward	(Level **1**) Value in liters
12	Resetable totaliser: standard reverse	(Level **1**) Value in liters
13	Resetable totaliser: mass forward	(Level **1**) Value in kilograms
14	Resetable totaliser: mass reverse	(Level **1**) Value in kilograms
15	UFP serial number	(Level **1**)
16	Software version	(Level **1**)
17	System set-up warning/error number	(Level **3**)
18	System runtime warning/error number	(Level **3**)
19	System messages 01...32	(Level **3**)
20	System messages 33…64	(Level **3**)
21	Resetable totaliser: external flow meter process	(Level **1**) in Liters
22	Resetable totaliser: external flow meter standard	(Level **1**) in Liters
23	Resetable totaliser: external flow meter mass	(Level **1**) in kg
24	Process time (resets on totaliser reset)	(Level **2**) Value in seconds, used as watch dog for host
25	Non resetable totaliser: process sum	(Level **1**) Value in 0.1m3
26	Non resetable totaliser: process forward	(Level **1**) Value in 0.1m3
27	Non resetable totaliser: process reverse	(Level **1**) Value in 0.1m3
28	Non resetable totaliser: standard sum	(Level **1**) Value in 0.1m3
29	Non resetable totaliser: standard forward	(Level **1**) Value in 0.1m3
30	Non resetable totaliser: standard reverse	(Level **1**) Value in 0.1m3
31	Non resetable totaliser: mass sum	(Level **1**) Value in 0.1ton
32	Non resetable totaliser: mass forward	(Level **1**) Value in 0.1ton
33	Non resetable totaliser: mass reverse	(Level **1**) Value in 0.1ton

8.5 Field 4 (Read only Float Field)

This data is read only and can be accessed with Modbus function 3 and 4 in Modbus slave mode and with functions 6 and 16 in Modbus master mode.

Starting addresses are mapped to address 7000 (default).

1	Flow process	(Level **1**) in m^3/hr
2	Sound velocity average	(Level **1**) in m/s
3	Temperature process	(Level **1**) in °C
4	Pressure process	(Level **1**) in bar
5	Density process	(Level **1**) in kg/m^3
6	Temperature body	(Level **1**) in °C
7	Flow standard	(Level **1**) in m^3/hr
8	Flow mass	(Level **1**) in ton/hr
9	Flow of channel 1	(Level **2**) 0 to 1000
10	Flow of channel 2	(Level **2**) 0 to 1000
11	Flow of channel 3	(Level **2**) 0 to 1000
12	Flow of channel 4	(Level **2**) 0 to 1000
13	Flow of channel 5	(Level **2**) 0 to 1000
14	Sound velocity of path 1	(Level **2**) in m/s
15	Sound velocity of path 2	(Level **2**) in m/s
16	Sound velocity of path 3	(Level **2**) in m/s
17	Sound velocity of path 4	(Level **2**) in m/s
18	Sound velocity of path 5	(Level **2**) in m/s
19	Remaining hold time on correction. Due to flow deviation	(Level **2**) in s
20	Reynolds number	(Level **2**)
21	Swirl number	(Level **2**)
22	Viscosity Internal	(Level **2**) 10^{-6} m^2/s
23	A	(Level **3**)
24	B	(Level **3**)
25	A_offset	(Level **3**)
26	B_offset	(Level **3**)
27	Kr	(Level **3**)
28	Ks	(Level **3**)
29	Reserved	
30	Reserved	
31	Kb	(Level **2**)
32	Density standard	(Level **1**) in kg/m^3
33	AGC converter path 1	(Level **2**) in mA
34	AGC converter path 2	(Level **2**) in mA
35	AGC converter path 3	(Level **2**) in mA
36	AGC converter path 4	(Level **2**) in mA
37	AGC converter path 5	(Level **2**) in mA
38	Remaining hold time on real-profile sampling. Due to flow deviation or channel failures	(Level **2**) in s
39	Averaged flow path 1 from standard deviation calculation	(Level **2**) 0 to 1000
40	Averaged flow path 2 from standard deviation calculation	(Level **2**) 0 to 1000
41	Averaged flow path 3 from standard deviation calculation	(Level **2**) 0 to 1000
42	Averaged flow path 4 from standard deviation calculation	(Level **2**) 0 to 1000
43	Averaged flow path 5 from standard deviation calculation	(Level **2**) 0 to 1000
44	Viscosity external	(Level **1**) in cSt
45	Temperature densito meter	(Level **1**) in °C
46	Pressure densito meter	(Level **1**) in bar
47	Temperature proving (external flow meter)	(Level **1**) in °C
48	Pressure proving (external flow meter)	(Level **1**) in bar
49	Standard deviation of path 1	(Level **2**) in %
50	Standard deviation of path 2	(Level **2**) in %
51	Standard deviation of path 3	(Level **2**) in %
52	Standard deviation of path 4	(Level **2**) in %
53	Standard deviation of path 5	(Level **2**) in %

54	Standard deviation of Flow	(Level **2**) in %
55	Max deviation on tau2::tau2/10 for correction path 1	(Level **3**) in %
56	Max deviation on tau2::tau2/10 for correction path 2	(Level **3**) in %
57	Max deviation on tau2::tau2/10 for correction path 3	(Level **3**) in %
58	Max deviation on tau2::tau2/10 for correction path 4	(Level **3**) in %
59	Max deviation on tau2::tau2/10 for correction path 5	(Level **3**) in %
60	Max deviation on tau2::tau2/10 for correction flow	(Level **3**) in %
61	Max deviation on treal::treal/10 for profile measure path 1	(Level **3**) in %
62	Max deviation on treal::treal/10 for profile measure path 2	(Level **3**) in %
63	Max deviation on treal::treal/10 for profile measure path 3	(Level **3**) in %
64	Max deviation on treal::treal/10 for profile measure path 4	(Level **3**) in %
65	Max deviation on treal::treal/10 for profile measure path 5	(Level **3**) in %
66	Max deviation on treal::treal/10 for profile measure	(Level **3**) in %
67	Density densito meter	(Level **1**) in kg/m3
68	Maximum flow rate 100%	(Level **1**) in m3/h
69	Ctl (15°C to process)	(Level **1**)
70	Cpl (0 Bar to process)	(Level **1**)
71	Ctl (15°C to standard)	(Level **1**)
72	Cpl (0 Bar to standard, always 1)	(Level **1**)
73	Ctl (15°C to densito meter)	(Level **1**)
74	Cpl (0 Bar to densito meter)	(Level **1**)
75	Ctl (15°C to proving external flow meter)	(Level **1**)
76	Cpl (0 Bar to proving external flow meter)	(Level **1**)
77	Batch 1 average temperature body	(Level **1**) in °C
78	Batch 1 average temperature process	(Level **1**) in °C
79	Batch 1 average temperature proving (external flow meter)	(Level **1**) in °C
80	Batch 1 average temperature densito meter	(Level **1**) in °C
81	Batch 1 average pressure process	(Level **1**) in bar
82	Batch 1 average pressure proving (external flow meter)	(Level **1**) in bar
83	Batch 1 average pressure densito meter	(Level **1**) in bar
84	Batch 1 average density densito meter	(Level **1**) in kg/m3
85	Batch 1 average density standard	(Level **1**) in kg/m3
86	Batch 1 average Viscosity external	(Level **1**) in cSt
87	Batch 1 average Ctl (15°C to process)	(Level **1**)
88	Batch 1 average Cpl (0 Bar to process)	(Level **1**)
89	Batch 1 average Ctl (15°C to standard)	(Level **1**)
90	Batch 1 average Cpl (0 Bar to standard, always 1)	(Level **1**)
91	Batch 1 average Ctl (15°C to densito meter)	(Level **1**)
92	Batch 1 average Cpl (0 Bar to densito meter)	(Level **1**)
93	Batch 1 average Ctl (15°C to proving external flow meter)	(Level **1**)
94	Batch 1 average Cpl (0 Bar to proving external flow meter)	(Level **1**)
95	Batch 1 average temperature standard	(Level **1**) in °C
96	Batch 1 average density process	(Level **1**) in kg/m3
97	Batch 1 average flow actual	(Level **1**) in m3/h
98	Batch 1 average density proving external flow meter	(Level **1**) in kg/m3
99	Batch 1 average flow proving external flow meter	(Level **1**) in m3/h
100	Batch 1 average Installed K factor proving (external flow meter)	(Level **1**) in pulse/liter
101	Batch 1 found New K factor proving (external flow meter)	(Level **1**) in pulse/liter
102	Batch 1 difference installed vs new found Kfactor (external flow meter)	(Level **1**) %
103	Batch 1 alarm: general Flow 1-4 channels down	Level **2**) in [s]
104	Batch 1 alarm: general Flow all channels down	(Level **2**) in [s]
105	Batch 1 alarm: calculation API group mismatch	(Level **2**) in [s]
106	Batch 1 alarm: system runtime alarm occurred	(Level **2**) in [s]
107	Batch 1 alarm: real time profile out of range when used	(Level **2**) in [s]
108	Batch 1 alarm: measurement out of range temperature body	(Level **2**) in [s]
109	Batch 1 alarm: measurement out of range temperature process	(Level **2**) in [s]
110	Batch 1 alarm: measurement out of range temperature proving (external)	(Level **2**) in [s]
111	Batch 1 alarm: measurement out of range temperature densito meter	(Level **2**) in [s]
112	Batch 1 alarm: measurement out of range pressure process	(Level **2**) in [s]
113	Batch 1 alarm: measurement out of range pressure proving (external)	(Level **2**) in [s]
114	Batch 1 alarm: measurement out of range pressure densito meter	(Level **2**) in [s]
115	Batch 1 alarm: measurement out of range density densito meter	(Level **2**) in [s]
116	Batch 1 alarm: measurement out of range density standard	(Level **2**) in [s]
117	Batch 1 alarm: measurement out of range viscosity external	(Level **2**) in [s]

118	Batch 1 alarm: override applied temperature body	(Level **2**) in [s]
119	Batch 1 alarm: override applied temperature process	(Level **2**) in [s]
120	Batch 1 alarm: override applied temperature proving (external flow meter)	(Level **2**) in [s]
121	Batch 1 alarm: override applied temperature densito meter	(Level **2**) in [s]
122	Batch 1 alarm: override applied pressure process	(Level **2**) in [s]
123	Batch 1 alarm: override applied pressure proving (external flow meter)	(Level **2**) in [s]
124	Batch 1 alarm: override applied pressure densito meter	(Level **2**) in [s]
125	Batch 1 alarm: override applied density densito meter	(Level **2**) in [s]
126	Batch 1 alarm: override applied density standard	(Level **2**) in [s]
127	Batch 1 alarm: override applied viscosity external	(Level **2**) in [s]
128	Batch 2 average temperature body	(Level **1**) in °C
129	Batch 2 average temperature process	(Level **1**) in °C
130	Batch 2 average temperature proving (external flow meter)	(Level **1**) in °C
131.	Batch 2 average temperature densito meter	(Level **1**) in °C
132.	Batch 2 average pressure process	(Level **1**) in bar
133.	Batch 2 average pressure proving (external flow meter)	(Level **1**) in bar
134.	Batch 2 average pressure densito meter	(Level **1**) in bar
135.	Batch 2 average density densito meter	(Level **1**) in kg/m3
136	Batch 2 average density standard	(Level **1**) in kg/m3
137	Batch 2 average Viscosity external	(Level **1**) in cSt
138	Batch 2 average Ctl (15°C to process)	(Level **1**)
139	Batch 2 average Cpl (0 Bar to process)	(Level **1**)
140	Batch 2 average Ctl (15°C to standard)	(Level **1**)
141	Batch 2 average Cpl (0 Bar to standard, always 1)	(Level **1**)
142	Batch 2 average Ctl (15°C to densito meter)	(Level **1**)
143	Batch 2 average Cpl (0 Bar to densito meter)	(Level **1**)
144	Batch 2 average Ctl (15°C to proving external flow meter)	(Level **1**)
145	Batch 2 average Cpl (0 Bar to proving external flow meter)	(Level **1**)
146	Batch 2 average temperature standard	(Level **1**) in °C
147	Batch 2 average density process	(Level **1**) in kg/m3
148	Batch 2 average flow actual	(Level **1**) in m3/h
149	Batch 2 average density proving external flow meter	(Level **1**) in kg/m3
150	Batch 2 average flow proving external flow meter	(Level **1**) in m3/h
151	Batch 2 average Installed K factor proving (external flow meter)	(Level **1**) in pulse/liter
152	Batch 2 found New K factor proving (external flow meter)	(Level **1**) in pulse/liter
153	Batch 2 difference installed vs new found Kfactor (external flow meter)	(Level **1**) %
154	Batch 2 alarm: general Flow 1-4 channels down	Level **2**) in [s]
155	Batch 2 alarm: general Flow all channels down	(Level **2**) in [s]
156.	Batch 2 alarm: calculation API group mismatch	(Level **2**) in [s]
157	Batch 2 alarm: system runtime alarm occurred	(Level **2**) in [s]
158	Batch 2 alarm: real time profile out of range when used	(Level **2**) in [s]
159	Batch 2 alarm: measurement out of range temperature body	(Level **2**) in [s]
160	Batch 2 alarm: measurement out of range temperature process	(Level **2**) in [s]
161	Batch 2 alarm: measurement out of range temperature proving (external)	(Level **2**) in [s]
162	Batch 2 alarm: measurement out of range temperature densito meter	(Level **2**) in [s]
163	Batch 2 alarm: measurement out of range pressure process	(Level **2**) in [s]
164	Batch 2 alarm: measurement out of range pressure proving (external)	(Level **2**) in [s]
165	Batch 2 alarm: measurement out of range pressure densito meter	(Level **2**) in [s]
166	Batch 2 alarm: measurement out of range density densito meter	(Level **2**) in [s]
167	Batch 2 alarm: measurement out of range density standard	(Level **2**) in [s]
168	Batch 2 alarm: measurement out of range viscosity external	(Level **2**) in [s]
169	Batch 2 alarm: override applied temperature body	(Level **2**) in [s]
170	Batch 2 alarm: override applied temperature process	(Level **2**) in [s]
171	Batch 2 alarm: override applied temperature proving (external flow meter)	(Level **2**) in [s]
172	Batch 2 alarm: override applied temperature densito meter	(Level **2**) in [s]
173	Batch 2 alarm: override applied pressure process	(Level **2**) in [s]
174	Batch 2 alarm: override applied pressure proving (external flow meter)	(Level **2**) in [s]
175	Batch 2 alarm: override applied pressure densito meter	(Level **2**) in [s]
176	Batch 2 alarm: override applied density densito meter	(Level **2**) in [s]
177	Batch 2 alarm: override applied density standard	(Level **2**) in [s]
178	Batch 2 alarm: override applied viscosity external	(Level **2**) in [s]
179	Service value: temperature body	(Level **2**) in °C
180	Service value: temperature process	(Level **2**) in °C
181	Service value: temperature proving (external flow meter)	(Level **2**) in °C

182	Service value: temperature densito meter	(Level **2**) in °C
183	Service value: pressure process	(Level **2**) in Bar
184	Service value: pressure proving (external flow meter)	(Level **2**) in Bar
185	Service value: pressure densito meter	(Level **2**) in Bar
186	Service value: density densito meter	(Level **2**) in kg/m3
187	Service value: density standard	(Level **2**) in kg/m3
188	Service value: viscosity external	(Level **2**) in cSt
189	Flow profile in channel 1 (indication)	(Level **1**) in m/s
190	Flow profile in channel 2 (indication)	(Level **1**) in m/s
191	Flow profile in channel 3 (indication)	(Level **1**) in m/s
192	Flow profile in channel 4 (indication)	(Level **1**) in m/s
193	Flow profile in channel 5 (indication)	(Level **1**) in m/s
194..213	Krohne use only	
214…220	Reserved	

8.6 Field 5 (Read only Double Field)

This data is read only and can be accessed with Modbus function 3 and 4 in Modbus slave mode and with functions 6 and 16 in Modbus master mode.

Starting addresses are mapped to address 6000 (default).

1	Resetable totaliser: process sum	(Level **1**) in Liters
2	Flow process	(Level **1**) in m^3/hr
3	Sound velocity average	(Level **1**) in m/s
4	Resetable totaliser: standard sum	(Level **1**) in Liters
5	Flow standard	(Level **1**) in m3/hr
6	Resetable totaliser: mass sum	(Level **1**) in kg
7	Flow mass	(Level **1**) in Ton/hr
8	Reserved	(Level **1**)
9	Resetable totaliser: process forward	(Level **1**) in Liters
10	Resetable totaliser: process reverse	(Level **1**) in Liters
11	Resetable totaliser: standard forward	(Level **1**) in Liters
12	Resetable totaliser: standard reverse	(Level **1**) in Liters
13	Resetable totaliser: mass forward	(Level **1**) in kg
14	Resetable totaliser: mass reverse	(Level **1**) in kg
15	Resetable totaliser: external flow meter process	(Level **1**) in Liters
16	Resetable totaliser: external flow meter standard	(Level **1**) in Liters
17	Resetable totaliser: external flow meter mass	(Level **1**) in kg
18	Non resetable totaliser: process sum	(Level **1**) Value in m3
19	Non resetable totaliser: process forward	(Level **1**) Value in m3
20	Non resetable totaliser: process reverse	(Level **1**) Value in m3
21	Non resetable totaliser: standard sum	(Level **1**) Value in m3
22	Non resetable totaliser: standard forward	(Level **1**) Value in m3
23	Non resetable totaliser: standard reverse	(Level **1**) Value in m3
24	Non resetable totaliser: mass sum	(Level **1**) Value in ton
25	Non resetable totaliser: mass forward	(Level **1**) Value in ton
26	Non resetable totaliser: mass reverse	(Level **1**) Value in ton
27…33	Reserved	

8.7 Field 6 (Read/Write Float Field)

In slave mode write to field by function 16, read from field by function 3.
In Master mode write to field by function 3, read from field by function 16
Starting addresses are mapped to address 7500 (default).

NOTE that for explanation on how to handle writing to these parameters:
see chapters
7.6 How data is written to the float field
8.8 Explanation of Data Available to Modbus

1	API: time to update a parameter (read only)	(Level **1**) in sec, max 30 sec
2	API: correction type	(Level **4**) 0,1,2
3	API: density standard type	(Level **4**) 0,1,2
4	API: fluid type	(Level **4**) 0,1,2,3,4,5
5	API: stand. Density crude (fluid type 0)	(Level **4**) 610.5..1075.0 kg/m3
6	API: stand. Density gasoline (fluid type 1)	(Level **4**) 653.0.. 770.0 kg/m3
7	API: stand. Density trans.area(fluid type 2)	(Level **4**) 770.5.. 787.5 kg/m3
8	API: stand. Density jet group (fluid type 3)	(Level **4**) 788.0.. 838.5 kg/m3
9	API: stand. Density fuel oil (fluid type 4)	(Level **4**) 839.0..1075.0 kg/m3
10	API: stand. Density free fill (fluid type 5)	(Level **4**) 500.0..2000.0 kg/m3
11	API: free fill K0	(Level **4**) –10^{e}9 .. 10^{e}9
12	API: free fill K1	(Level **4**) –10^{e}9 .. 10^{e}9
13	API: free fill K2	(Level **4**) –10^{e}9 .. 10^{e}9
14	API: temperature standard	(Level **4**) 0-30°C
15...20	Reserved	
21	EXT: time to update a parameter (read only)	(Level **1**) in sec, max 30 sec
22	EXT: external K factor	(Level 4) in pulse/liter
23	EXT/API: parameters changeable under flowing condition or beneath low-flow cut-off	(Level 4) 0=always 1=only < low flow cut-off
24...29	Reserved	
30	UFP batch control: Normal: Setup=9 (if UFP batch1 status batch=0 is no batch) Cancel=5 (if UFP batch1 status batch=1 is set-up) Start batch=119 (if UFP batch1 status batch=1 is set-up) End batch=229 (if UFP batch1 status batch=1 is running) reset printing=1009 (if UFP batch1 status batch=5…10 is printing) Confirm ticket=779 (if UFP batch1 status batch=10 is confirm) Continuous pipe line measurement, ticket on demand: End with no reset values=559 (if UFP batch1 status batch is not printing) End with reset values=229 (if UFP batch1 status batch is not printing) Reset printing=1009 (if UFP batch1 status batch 5…10 is printing) 559 and 229 have automatic freeze of batch values (on Modbus) for a maximum of 30 seconds (see also Boolean 2075)	(Level **4**) On command value input: Return 0 if not accepted Return 1 if accepted Reset to -99999 after 5 seconds
31	Solartron1: time to update a parameter (read only)	(Level **1**) in sec, max 30 sec
32	Solartron1: K0	(Level **4**) calib. Parameter
33	Solartron1: K1	(Level **4**) calib. Parameter
34	Solartron1: K2	(Level **4**) calib. Parameter
35	Solartron1: K18	(Level **4**) calib. Parameter
36	Solartron1: K19	(Level **4**) calib. Parameter
37	Solartron1: K20A	(Level **4**) calib. Parameter
38	Solartron1: K20B	(Level **4**) calib. Parameter
39	Solartron1: K21A	(Level **4**) calib. Parameter
40	Solartron1: K21B	(Level **4**) calib. Parameter
41	Solartron2: Time to update a parameter (read only)	(Level **1**) in sec, max 30 sec
42	Solartron2: K0	(Level **4**) calib. Parameter
43	Solartron2: K1	(Level **4**) calib. Parameter
44	Solartron2: K2	(Level **4**) calib. Parameter
45	Solartron2: K18	(Level **4**) calib. Parameter

46	Solartron2: K19	(Level **4**) calib. Parameter
47	Solartron2: K20A	(Level **4**) calib. Parameter
48	Solartron2: K20B	(Level **4**) calib. Parameter
49	Solartron2: K21A	(Level **4**) calib. Parameter
50	Solartron2: K21B	(Level **4**) calib. Parameter
51	Sarasota1: Time to update a parameter (read only)	(Level **1**) in sec, max 30 sec
52	Sarasota1: K	(Level **4**) calib. Parameter
53	Sarasota1: T0	(Level **4**) calib. Parameter
54	Sarasota1: D0	(Level **4**) calib. Parameter
55	Sarasota1: Nt	(Level **4**) calib. Parameter
56	Sarasota1: Np	(Level **4**) calib. Parameter
57	Sarasota1: Tcal	(Level **4**) calib. Parameter
58	Sarasota1: Pcal	(Level **4**) calib. Parameter
59	Sarasota2: Time to update a parameter (read only)	(Level **1**) in sec, max 30 sec
60	Sarasota2: K	(Level **4**) calib. Parameter
61	Sarasota2: T0	(Level **4**) calib. Parameter
62	Sarasota2: D0	(Level **4**) calib. Parameter
63	Sarasota2: Nt	(Level **4**) calib. Parameter
64	Sarasota2: Np	(Level **4**) calib. Parameter
65	Sarasota2: Tcal	(Level **4**) calib. Parameter
66	Sarasota2: Pcal	(Level **4**) calib. Parameter
67	Input in UFP (if enabled in UFP): temperature body	(Level **4**) in °C
68	Input in UFP (if enabled in UFP): temperature process	(Level **4**) in °C
69	Input in UFP (if enabled in UFP): temperature proving, external flow meter	(Level **4**) in °C
70	Input in UFP (if enabled in UFP): temperature densito meter	(Level **4**) in °C
71	Input in UFP (if enabled in UFP): pressure process	(Level **4**) in Bar
72	Input in UFP (if enabled in UFP): pressure proving, external flow meter	(Level **4**) in Bar
73	Input in UFP (if enabled in UFP): pressure densito meter	(Level **4**) in Bar
74	Input in UFP (if enabled in UFP): density densito meter	(Level **4**) in kg/m3
75	Input in UFP (if enabled in UFP): density standard	(Level **4**) in kg/m3
76	Input in UFP (if enabled in UFP): viscosity dynamic	(Level **4**) in cSt
77	System time UFP adjust in seconds See Boolean 2230 to enable write	(Level 4) in sec, -7200…7200 seconds
78	OVERRIDE : time to update a parameter (read only)	(Level **1**) in sec, max 30 sec
79	OVERRIDE if set is enabled: temperature body	(Level **4**) in °C
80	OVERRIDE if set is enabled: temperature process to override	(Level **4**) in °C
81	OVERRIDE if set is enabled: temperature proving to override	(Level **4**) in °C
82	OVERRIDE if set is enabled: temperature densito meter to override	(Level **4**) in °C
83	OVERRIDE if set is enabled: pressure process to override	(Level **4**) in Bar
84	OVERRIDE if set is enabled: pressure proving to override	(Level **4**) in Bar
85	OVERRIDE if set is enabled: pressure densito meter to override	(Level **4**) in Bar
86	OVERRIDE if set is enabled: density densito meter to override	(Level **4**) in kg/m3
87	OVERRIDE if set is enabled: density standard to override	(Level **4**) in kg/m3
88	OVERRIDE if set is enabled: viscosity external to override	(Level **4**) in cSt
89	Batch reference number for internal batch ticket Possible to enter during the batch (in case of a program stop number is set to 0. After batch stop, the number is reset to 0.	(Level **4**)
90	Krohne use only	
91..105	Reserved	

8.8 Explanation of Data Available to Modbus

Basic Flow measurement WARNING
This warning occurs if 1…4 paths fail, but the system works within specifications.
Possible sources of the warning are over range, path failure, deviation in sound velocity or communication failure.

Basic Flow measurement ERROR
This error occurs if all paths fail.
Possible sources of the error are over range, path failure, deviation in sound velocity, communication failure

System Runtime WARNING
This warning is caused by system failures or failures from the Modbus driver. See system messages
These failures will not influence the flow measurement.
The last warning number is saved into the integer and long integer field *System Runtime warning/error number…*

System Runtime ERROR
This error is caused by system failures. See system messages
These failures might influence the flow measurement.
The last error number is saved into the integer and long integer field *System Runtime warning/error number*.

System Set-up WARNING
This error is caused by insufficient statistical data during set-up. Default data is used until enough statistical information is recorded (under normal conditions).
In this case the warning is self-resolving.
Another possibility is an improper initialisation of the Modbus driver (Modbus will not be accessible). In this case, the warning remains active.
The integer and long integer *System Set-up warning/error number* contains the error number.
- See the ALTOSONIC-V Operating Manual

System Set-up ERROR
This error is caused by an improper initialisation. The Modbus driver may be initialised successfully.
The integer and long integer *System Set-up warning/error number* contains the error number.
- See the ALTOSONIC-V Operating Manual

Resetable totaliser Rollover occurred
Status for if the totaliser exceeds the value of 1^E9 liter, the totaliser is decreased with 1^E9 and the totaliser Rollover occurred Boolean is set.

Resetable totaliser Reset occurred
Status for if the totaliser has been reset (by Modbus, manually, or relay contact).

Flow direction
Status for the current flow direction: 0=forward direction, and 1=reverse direction.

Algo. Basic flow on output
Status for calculation with the basic algorithm.

Algo. Reyn. Correction on output
Status for calculation with the basic algorithm, including Reynolds correction algorithm.

Swirl correction on output
Status for calculation with the basic algorithm, including Swirl correction algorithm.

Temperature correction on output
Status for correction for tube expansion caused by temperature deviation.

Standard volume on output
Status for the corrected/calculated standard conditions of 15 °C and 1 Bar.

Correction parameters HOLD. Due to flow deviation
In case of large flow deviation the correction parameters are 'frozen' until enough statistical information is available to perform a reliable correction.

Overrange data sensor 1…5
This Boolean exists for each ultrasonic channel.
If the flow converter measuring the flow is out of range (±125%) this Boolean is set.

Path failure sensor 1…5
This Boolean exists for each ultrasonic channel.
If the flow converter detects an ultrasonic path failure, this Boolean is set.
Path failure is mostly due to gas, but might be caused by an obstructive solid particle.

Deviation in sound velocity sensor 1…5
This Boolean exists for each ultrasonic channel.
The measurement program calculates the mean sound velocity out of the three most nearby values and checks all channels on their deviation to this mean value.
If the deviation is too large this Boolean is set.

Communication failure sensor 1…5
This Boolean exists for each ultrasonic channel.
The data transfer with the flow converter is tested with a data validation check, if this test is negative this Boolean is set.

Real profile sampling on hold
Warning that Real Profile Sampling is on hold due to channel failure (1..5), extreme flow deviations or low flow.

External Viscosity meter, Temperature external densito meter, Pressure external densito meter, Temperature external flow meter, Pressure external flow meter out of range
Warning that the specific reading is out of limits (set for low and high alarm).

Acknowledge_flags_field_0
- See chapter 7.5 for more information on this Boolean.

General_acknowledge_flags_field_0
- See chapter 7.5 to for more information on this Boolean.

Reset All errors
This Boolean can be set to reset/update all errors, occurred under runtime condition.
This Boolean is self-resetting.

Reset Totalisers and All Errors
This Boolean can be set to reset all the totalisers **AND** to reset/update all errors **AND** process time, occurred under runtime condition. (Action is performed if Boolean is set to 1).
This Boolean is self-resetting.

Flow actual /Flow standard / Flow mass
Value for the flow available as scaled integer, scaled long integer, float and double.
The floating-point numbers represent the flow in m^3/hr or kg/m3, the scaled integers are scaled to the full-scale value (-32768 … +32767 ⇔ -125%… +125%).

Sound velocity
Value for the sound velocity, available as scaled integer, scaled long integer, float and double.

The floating-point numbers represent the sound velocity in m/s, the scaled integers are scaled to 32767 (scaled 0...32767 ⇔ 0...3276.7 m/s).

Flow of path 1…5
Available as scaled integer and float, these values represent internal UFP-V units.

Sound velocity of path 1...5
Available as scaled integer and float.
The floating-point numbers represent the sound velocity in m/s, the scaled integers are scaled to 32767 (scaled 0…32767 ⇔ 0...3276.7 m/s).

System Set-up warning/error number
This value contains the number of the last occurred system set-up warning or system set-up error.

System Runtime warning/error number
This value contains the number of the last occurred system runtime warning or system runtime error.

System messages 1…64
Each system message corresponds to a bit in this integer value.
If a system message occurs, the accompanying bit is set, the bit remains set until the *Reset_All_Errors* Boolean is set.
The messages are numbered from the least significant bit to the most significant bit.
Integer values contains the occurred-status of 16 messages,
Long integers contain the occurred-status of 32 messages,

Process/standard/mass Totaliser
Sum of forward and reverse for the process/standard/mass totalisers, available as long integer and double. All data types represents the totaliser in Liters (volumes) or (mass) kg, the totalisers have a rollover at 1^E9.
Is resetable.

Forward process/standard/mass Totaliser
Values for the forward totalisers, available as long integer and double. All data types represents the forward totalisers in Liters(volumes) or (mass) kg, the totalisers have a rollover at 1^E9.
Is resetable.

Reverse process/standard/mass Totaliser
Values for the reverse totalisers, available as long integer and double. All data types represents the forward totalisers in Liters(volumes) or kg(mass), the totalisers have a rollover at 1^E9.
Is resetable.

Remaining HOLD time on real-profile sampling
In case of large flow deviation or low flow, the real-profile sampling is on hold until the flow has stabilised. Until then no new real-profile is sampled

API: Time to update a parameter (read only)
Time remaining to update a float in the API application field. Starts at 20 seconds remaining time after the Boolean *2201 API enable writing data* and counting down to 0 seconds. When at 0 seconds the Boolean 2201 will reset (0) and it is not possible to write to the application field.

API: Correction type
The type of correction to calculate the standard volume and/or mass.
0: Disable, no standard volume or mass will be calculated.
1: Standard volume/mass by API 2540
2: Mass measurement by process density (measured by densito meter)

API: Density standard type
When the correction type is 1 (Standard volume/mass by API2540):
The type of density standard (at temperature and pressure standard)
0: Fill in manually
1: Calculated from process density ((measured by densito meter)
2: On AD/Modbus input

API: Fluid type
When the correction type is 1 (Standard volume/mass by API2540):
The type of fluid:
0: Crude
1: Gasoline
2: Trans.area
3: Jet group
4: Fuel oil
5: Free fill

API: Stand. Density crude/gasoline/trans.area/jetgroup/fuel oil/free fill
When the correction type is 1 (Standard volume/mass by API2540):
Limits for 15°C standard

Crude	: 610.5..1075.0 kg/m3
Gasoline	: 653.0.. 770.0 kg/m3
Trans.area	: 770.5.. 787.5 kg/m3
Jet group	: 788.0.. 838.5 kg/m3
Fuel oil	: 839.0..1075.0 kg/m3
free fill	: 500.0..2000.0 kg/m3

When a value is outside the limits the UFP-V system will not accept the value

API: Free Fill K0/1/2
When the correction type is 1 (Standard volume/mass by API2540) and Fluid type is 5 (free fill):
K0…K2 are factors used in the API calculation.
Limits are $-10^{e}9$ .. $10^{e}9$

API: Temperature standard
When the correction type is 1 (Standard volume/mass by API2540):
The standard temperature is the temperature at standard conditions.
Limits are 0..30°C

Batch averages 1 on temperatures, pressures, densities, and correction factors
On reset Totalisers (or Boolean set to 1 only) new batch averages are made for a maximum of 1500 days, after 1500 days the averages are no longer calculated.

Batch averages 2 on temperatures, pressures, densities, and correction factors
Boolean set to 1 only new batch averages are made for a maximum of 1500 days, after 1500 days the averages are no longer calculated.

8.9 The System Messages

The system messages contains the system runtime warnings and alarms. They are stored as bits into the integer data. Each system message is packed as one message per bit of the integer. The message is active if the accompanying bit is one. The messages are numbered from the least significant bit to the most significant bit.

The status of the system is divided into:

- System Runtime Warnings. These are caused by system failures. These failures will not influence the flow measurement.
- System Runtime Alarms. These are caused by system failures. These failures might influence the flow measurement.
  Identified System Runtime Errors are numbered 1 to 60 are:

Identified System Runtime Errors are numbered 1 to 60, A = alarm, W = warning:

Error no.	In function	Problem	Consequence
A : 1	Get RS485 data from converters	Overrun, missed data	Missed data, message
A : 2	Self test	Error in self-test	Non-reliable memory
A : 3	Batch start / stop	Error during saving files of start or stop	File lost but ticket is made
A : 4	Profile correction (REAL)	Error in state_correction	Attempt divide to by zero
W: 5	Read Backup all files	Error in reading backup file	Possible loss of backup file
W: 6	Switching disk	Error in finding a drive	Message
W: 7	System time	A notice that the system time was adjusted manually or by Modbus.	No consequence for totalisers or process time, only on ticket time
W: 8	End of a calibration	Error write in calibration report	File lost, message
A: 9	Batch status backup	Status file corrupt	Possible loss of batch status
W: 10	Override values files	Error in opening/closing override value file	Override values not stored but still in use
A: 11	Batch totaliser backup	Totaliser backup-file corrupt	File lost , message
A: 12	Batch average backup	Average backup-file corrupt	File lost, message
A: 13	Batch ticket create	Error in creating batch ticket file	Ticket itself is made for printing but lost during saving
W: 14	Opening file (for update)	Error in opening REAL file	File lost, message
W: 15	Closing file (for update)	Error in closing REAL file	File lost, message
W: 16	API settings	Error in file, defaults are loaded and saved	Old settings lost
W: 17	Batch 2	A alarm on batch 2 file (Batch 2 is only used through Modbus with a Scada system)	File lost, message
W: 18	Check free disk-space	Error dos_getdiskfree() call	Time-out function 30 s
W: 19	Check free disk-space	Low on disk-space	Time-out function 30 s
W: 20	Ad card overrun	The requested AD card is not noticed	Solve the problem
W: 21	Opening file (for update)	Error opening API table file	File lost, message
W: 22	Value check	1 or more API values defaulted	Check the installed parameters
W: 23	Opening file (for update)	Error opening external flow meter file	File lost, message
W: 24	Value check	Default external flow meter K-factor	Check the installed K-factor
W: 25	Counter input	Unable to read Counter value	Read on next entry
A : 26	Calibration MP103 card	MPCA File corrupt	Install backup
A : 27	Calibration AD card	File corrupt	Install backup
A : 28	Calibration data Densito Cells	File corrupt	Automatic install of default values Set the correct values on-line
A : 29	Batch ticket currently saved	A Requested batch ticket not available for printing	A ticket by that name was not saved or had a previous save error
A : 30	Batch ticket	CRC error in a Batch ticket	A ticket was not saved correctly or was changed manually
W: 31	Read batch ticket previously saved	A Requested batch ticket not available for printing	A ticket by that name was not saved or had a previous save error
W : 32	Batch ticket close file	Error in closing a ticket file	Ticket file not closed , probably because it could not be opened

See for the communication runtime errors also the **ALTOSONIC V Modbus Manual.**

Err no.	In function	Problem	Consequence
W: 33	Modbus master	Poll block not send due to transmit error	
W: 34	Modbus master	Poll block response time-out occurred	
W: 35	Modbus master	Invalid Slave ID in response	
W: 36	Modbus master	Invalid function in response	
W: 37	Modbus master	Response not correct	
W: 38	Modbus master	Error handling function 1,2	
W: 39	Modbus master	Error handling function 3,4	
W: 40	Modbus master	Error handling function 5	
W: 41	Modbus master	Error handling function 6	
W: 42	Modbus master	Error handling function 15	
W: 43	Modbus master	Error handling function 16	
W: 44	Modbus master	Exception received	
W: 45	Modbus master	Error unpacking Boolean data	
W: 46	Modbus master	Error unpacking integer data	
W: 47	Modbus master	Error unpacking long integer data	
W: 48	Modbus master	Error unpacking float data	
W: 49	Modbus master	Error unpacking double data	
W: 50	Modbus master/slave	Error incorrect message length	
W: 51	Modbus master/slave	Invalid CRC or LRC received	
W: 52	Modbus master/slave	Error receive buffer saturated	
W: 53	Modbus master/slave	UART error (parity, framing, overrun)	
W: 54	Modbus master/slave	Transmit buffer not empty for new transmission	
W: 55	Modbus slave	Unsupported function requested	
W: 56	Modbus slave	Unsupported register(s) requested	
W: 57	Modbus slave	Requested data Level and function mismatch	
W: 58	Modbus slave	Too many data point (registers) requested	
W: 59	Modbus slave	Error unpacking received data	
W: 60	Modbus slave	Broadcast not allowed	

9 Appendices

9.1 Appendix A: Time out values

The character length lies between 9 and 12 bits

The UFP-V determines the time between two bytes to recognise a communication failure or the end of a message. UFP-V discriminates between a timeout between 2 bytes and a timeout after the last byte, which occurs at the end of a message.

The time between two bytes is measured with a resolution of ±100 us.
To detect the timeout state (end of message) a timer is incremented every millisecond. A received byte will reset the timer. Every millisecond the timer value will be checked for a timeout value, when it will exceed a defined value it will mark the last received byte as *end of message*.

Notice that the serial communication is a asynchrony process with respect to the used timer interrupt, therefore a 'jitter' of 1 ms must be taken into account.

Modbus defined timeout values for every baud rate with N number of bytes:

Baud rate	9 bit		10 bit		11 bit		12 bit	
Timeout chars	3.5	4.0	3.5	4.0	3.5	4.0	3.5	4.0
1200	26.25 ms	30 ms	29.17 ms	33.34 ms	32.08 ms	36.67 ms	35.00 ms	40 ms
2400	13.16 ms	15 ms	14.58 ms	6.67 ms	16.04 ms	18.33 ms	17.50 ms	20 ms
4800	6.56 ms	7.5 ms	7.29 ms	8.33 ms	8.02 ms	9.17 ms	8.75 ms	10 ms
9600	3.28 ms	3.75 ms	3.65 ms	4.16 ms	4.01 ms	4.58 ms	4.38 ms	5 ms
19200	1.64 ms	1.88 ms	1.82 ms	2.08 ms	2.01 ms	2.29 ms	2.19 ms	2.5 ms

The maximum time to detect a timeout (end of message) used in UFP-V:

Baud rate	9	10	11	12
1200	28…29 ms	31…32 ms	33…34 ms	36…37 ms
2400	14…15 ms	15…16 ms	16…17 ms	18…19 ms
4800	6…7 ms	7…8 ms	8…9 ms	9…10 ms
9600	3…4 ms	3…4 ms	4…5 ms	4…5 ms
19200	2…3 ms	2…3 ms	2…3 ms	2…3 ms

The maximum time between 2 characters in a message (GAP) used in UFP-V:

Baud rate	9	10	11	12
1200	28.2 ms	31.3 ms	34.4 ms	37.5 ms
2400	14.1 ms	15.6 ms	17.2 ms	8.8 ms
4800	7.0 ms	7.8 ms	8.6 ms	9.4 ms
9600	3.5 ms	3.9 ms	4.3 ms	4.7 ms
19200	1.8 ms	1.95 ms	2.2 ms	2.4 ms

9.2 Appendix B: LRC Generation

(As taken from the website: www.modicon.com/techpubs/crc7.html)

The Longitudinal Redundancy Check (LRC) field is one byte, containing an eight-bit binary value. The LRC value is calculated by the transmitting device, which appends the LRC to the message. The receiving device recalculates an LRC during receipt of the message, and compares the calculated value to the actual value it received in the LRC field. If the two values are not equal, an error results.
The LRC is calculated by adding together successive eight-bit bytes in the message, discarding any carries, then two's complementing the result. The LRC is an eight-bit field, therefore each new addition of a character that would result in a value higher than 255 decimal simply rolls over the field's value through zero. Because there is no ninth bit, the carry is discarded automatically.

Generating an LRC

Step 1 :
Add all bytes in the message, excluding the starting colon and ending CRLF. Add them into an eight-bit field, so that carries will be discarded.
Step 2
Subtract the final field value from FF hex (all 1's), to produce the ones-complement.
Step 3
Add 1 to produce the two's-complement.

Placing the LRC into the Message

When the the eight-bit LRC (two ASCII characters) is transmitted in the message, the high order character will be transmitted first, followed by the low order character-e.g., if the LRC value is 61 hex (0110 0001):

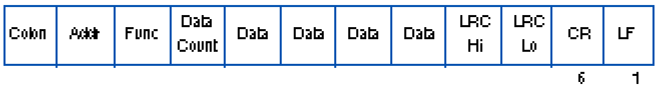


Figure 8 LRC Character Sequence

Example

An example of a C language function performing LRC generation is shown below.
The function takes two arguments:

unsigned char *auchMsg ;	A pointer to the message buffer containing binary data to be used for generating the LRC
unsigned short usDataLen ;	The quantity of bytes in the message buffer. The function returns the LRC as a type unsigned char.

LRC Generation Function

```
static unsigned char LRC(auchMsg, usDataLen)
unsigned char *auchMsg ;                      /* message to calculate  */
unsigned short usDataLen ;                    /* LRC upon quantity of  */
                                              /* bytes in message      */
{
        unsigned char uchLRC = 0 ;            /* LRC char initialized  */
        while (usDataLen--)                   /* pass through message  */
                uchLRC += *auchMsg++ ;        /* buffer add buffer byte*/
                                              /* without carry         */
        return ((unsigned char)(-((char_uchLRC))) ;
                                              /* return twos complemen */
}
```

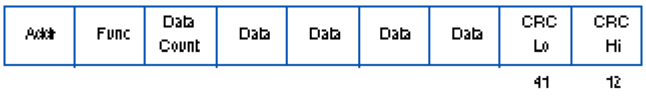
9.3 Appendix C: CRC generation

(As taken from the website: www.modicon.com/techpubs/crc7.html)
The Cyclical Redundancy Check (CRC) field is two bytes, containing a 16-bit binary value. The CRC value is calculated by the transmitting device, which appends the CRC to the message. The receiving device recalculates a CRC during receipt of the message, and compares the calculated value to the actual value it received in the CRC field. If the two values are not equal, an error results.
The CRC is started by first preloading a 16-bit register to all 1's. Then a process begins of applying successive eight-bit bytes of the message to the current contents of the register. Only the eight bits of data

in each character are used for generating the CRC. Start and stop bits, and the parity bit, do not apply to the CRC.
During generation of the CRC, each eight-bit character is exclusive ORed with the register contents. The result is shifted in the direction of the least significant bit (LSB), with a zero filled into the most significant bit (MSB) position. The LSB is extracted and examined. If the LSB was a 1, the register is then exclusive ORed with a preset, fixed value. If the LSB was a 0, no exclusive OR takes place.
This process is repeated until eight shifts have been performed. After the last (eighth) shift, the next eight-bit character is exclusive ORed with the register's current value, and the process repeats for eight more shifts as described above. The final contents of the register, after all the characters of the message have been applied, is the CRC value.

Generating a CRC
Step 1
Load a 16-bit register with FFFF hex (all 1's). Call this the CRC register.
Step 2
Exclusive OR the first eight-bit byte of the message with the low order byte of the 16-bit CRC register, putting the result in the CRC register.
Step 3
Shift the CRC register one bit to the right (toward the LSB), zerofilling the MSB. Extract and examine the LSB.
Step 4
If the LSB is 0, repeat Step 3 (another shift). If the LSB is 1, Exclusive OR the CRC register with the polynomial value A001 hex (1010 0000 0000 0001).
Step 5
Repeat Steps 3 and 4 until eight shifts have been performed. When this is done, a complete eight-bit byte will have been processed.
Step 6
Repeat Steps 2 ... 5 for the next eight-bit byte of the message. Continue doing this until all bytes have been processed.
Result
The final contents of the CRC register is the CRC value.
Step 7
When the CRC is placed into the message, its upper and lower bytes must be swapped as described below.

Placing the CRC into the Message
When the 16-bit CRC (two eight-bit bytes) is transmitted in the message, the low order byte will be transmitted first, followed by the high order byte-e.g., if the CRC value is 1241 hex (0001 0010 0100 0001):



Addr	Func	Data Count	Data	Data	Data	Data	CRC Lo	CRC Hi
							41	12

Figure 9 CRC Byte Sequence

Example
An example of a C language function performing CRC generation is shown on the following pages. All of the possible CRC values are preloaded into two arrays, which are simply indexed as the function increments through the message buffer. One array contains all of the 256 possible CRC values for the high byte of the 16-bit CRC field, and the other array contains all of the values for the low byte.
Indexing the CRC in this way provides faster execution than would be achieved by calculating a new CRC value with each new character from the message buffer.

☞
Note: This function performs the swapping of the high/low CRC bytes internally. The bytes are already swapped in the CRC value that is returned from the function. Therefore the CRC value returned from the function can be directly placed into the message for transmission.
The function takes two arguments:

unsigned char *puchMsg ;	A pointer to the message buffer containing binary data to be used for generating the CRC
unsigned short usDataLen ;	The quantity of bytes in the message buffer.

The function returns the CRC as a type unsigned short.

CRC Generation Function

```
unsigned short CRC16(puchMsg, usDataLen)
unsigned char *puchMsg ;                        /* message to calculate CRC upon */
unsigned short usDataLen ;                      /* quantity of bytes in message  */
{
unsigned char uchCRCHi = 0xFF ;                 /* high CRC byte initialized */
unsigned char uchCRCLo = 0xFF ;                 /* low CRC byte initialized  */
unsigned uIndex ;                               /* will index into CRC lookup table */

        while (usDataLen--)                     /* pass through message buffer */
                {
                uIndex = uchCRCHi ^ *puchMsg++ ;   /* calculate the CRC   */
                uchCRCHi = uchCRCLo ^ auchCRCHi[uIndex] ;
                uchCRCLo = auchCRCLo[uIndex] ;
                }
        return (uchCRCHi << 8 | uchCRCLo) ;
}
```

High Order Byte Table

```
/* Table of CRC values for high-order byte */
static unsigned char auchCRCHi[] = {
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0,
0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1,
0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1,
0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0,
0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40,
0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1,
0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0,
0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40,
0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0,
0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40,
0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1,
0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0,
0x80, 0x41, 0x00, 0xC1, 0x81, 0x40
} ;
```

Low Order Byte Table

```
/* Table of CRC values for low-order byte */
static char auchCRCLo[] = {
0x00, 0xC0, 0xC1, 0x01, 0xC3, 0x03, 0x02, 0xC2, 0xC6, 0x06,
0x07, 0xC7, 0x05, 0xC5, 0xC4, 0x04, 0xCC, 0x0C, 0x0D, 0xCD,
0x0F, 0xCF, 0xCE, 0x0E, 0x0A, 0xCA, 0xCB, 0x0B, 0xC9, 0x09,
0x08, 0xC8, 0xD8, 0x18, 0x19, 0xD9, 0x1B, 0xDB, 0xDA, 0x1A,
0x1E, 0xDE, 0xDF, 0x1F, 0xDD, 0x1D, 0x1C, 0xDC, 0x14, 0xD4,
0xD5, 0x15, 0xD7, 0x17, 0x16, 0xD6, 0xD2, 0x12, 0x13, 0xD3,
0x11, 0xD1, 0xD0, 0x10, 0xF0, 0x30, 0x31, 0xF1, 0x33, 0xF3,
0xF2, 0x32, 0x36, 0xF6, 0xF7, 0x37, 0xF5, 0x35, 0x34, 0xF4,
0x3C, 0xFC, 0xFD, 0x3D, 0xFF, 0x3F, 0x3E, 0xFE, 0xFA, 0x3A,
0x3B, 0xFB, 0x39, 0xF9, 0xF8, 0x38, 0x28, 0xE8, 0xE9, 0x29,
0xEB, 0x2B, 0x2A, 0xEA, 0xEE, 0x2E, 0x2F, 0xEF, 0x2D, 0xED,
0xEC, 0x2C, 0xE4, 0x24, 0x25, 0xE5, 0x27, 0xE7, 0xE6, 0x26,
0x22, 0xE2, 0xE3, 0x23, 0xE1, 0x21, 0x20, 0xE0, 0xA0, 0x60,
0x61, 0xA1, 0x63, 0xA3, 0xA2, 0x62, 0x66, 0xA6, 0xA7, 0x67,
0xA5, 0x65, 0x64, 0xA4, 0x6C, 0xAC, 0xAD, 0x6D, 0xAF, 0x6F,
0x6E, 0xAE, 0xAA, 0x6A, 0x6B, 0xAB, 0x69, 0xA9, 0xA8, 0x68,
0x78, 0xB8, 0xB9, 0x79, 0xBB, 0x7B, 0x7A, 0xBA, 0xBE, 0x7E,
0x7F, 0xBF, 0x7D, 0xBD, 0xBC, 0x7C, 0xB4, 0x74, 0x75, 0xB5,
0x77, 0xB7, 0xB6, 0x76, 0x72, 0xB2, 0xB3, 0x73, 0xB1, 0x71,
0x70, 0xB0, 0x50, 0x90, 0x91, 0x51, 0x93, 0x53, 0x52, 0x92,
0x96, 0x56, 0x57, 0x97, 0x55, 0x95, 0x94, 0x54, 0x9C, 0x5C,
0x5D, 0x9D, 0x5F, 0x9F, 0x9E, 0x5E, 0x5A, 0x9A, 0x9B, 0x5B,
0x99, 0x59, 0x58, 0x98, 0x88, 0x48, 0x49, 0x89, 0x4B, 0x8B,
0x8A, 0x4A, 0x4E, 0x8E, 0x8F, 0x4F, 0x8D, 0x4D, 0x4C, 0x8C,
0x44, 0x84, 0x85, 0x45, 0x87, 0x47, 0x46, 0x86, 0x82, 0x42,
0x43, 0x83, 0x41, 0x81, 0x80, 0x40
} ;
```

9.4 Appendix D: Coms0300.dat

File example as used by ALTOSONIC-V system

```
------------------------------------------------------------------------------------------------------------------------
1<1 UFC500 COMMUNICATION SETUP>
1.1 UFC_UART_BASEADDRESS        =#3E8     // COM1=0x3F8, COM2=0x2F8
                                          // COM3=0x3E8, COM4=0x2E8
1.2 UFC_UART_INTERRUPT          =#4       // 3 OR 4, (IRQ3=COM2/4)  (IRQ4=COM1/3)
1.3 UFC_UART_BAUDRATE           =#28800   // DO NOT CHANGE !
1.4 UFC_UART_RTS_MODE           =#0       // ENABLE TRANSMITTER WITH LOGICAL 0 OR 1
------------------------------------------------------------------------------------------------------------------------
2<PRINTER COMMUNICATION SETUP>
2.1 PRINTER_COMPORT             =#1       //1,2,3,4
2.2 PRINTER_WORD_LENGTH         =#8       //7 or 8
2.3 PRINTER_PARITY              =#2       //0=disabled,1=odd,2=even
2.4 PRINTER_STOP_BITS           =#1       //1 or 2
2.5 PRINTER_BAUDRATE            =#9600    //38400, 19200, 9600, 4800, 2400, 1800
                                          //1200, 600, 300, 200, 150, 134.5, 110, 75
2.6 PRINTER_DTR_POLARITY        =#1       //0=pos,1=neg
2.7 PRINTER_RTS_POLARITY        =#1       //0=pos,1=neg
2.8 PRINTER_TIMEOUT             =#5000    //Timeout[ms] on acknowledges etc.
2.9 PRINTER_TIMEOUT_MANAGE      =#10      //Timeout[ s] for print management switch
------------------------------------------------------------------------------------------------------------------------
3<MODBUS COMMUNICATION SETUP>
3.1 MODBUS_UART_BASEADDRESS =#2E8         // COM1=0x3F8, COM2=0x2F8
                                          // COM3=0x3E8, COM4=0x2E8
3.2 MODBUS_UART_INTERRUPT       =#3       // 3,4 :  (IRQ3=COM2/4)  (IRQ4=COM1/3)
3.3 MODBUS_UART_BAUDRATE        =#9600    // 1200,2400,4800,9600,19200
3.3 MODBUS_UART_RTS_MODE        =#0       // 0,1 : ENABLE TRANSMITTER LOGICAL 0 OR 1
3.4 MODBUS_UART_N_DATABITS      =#8       // 7,8 : NUMBER OF DATABITS
3.5 MODBUS_UART_N_STOPBITS      =#1       // 1,2 : NUMBER OF STOPBITS
3.6 MODBUS_UART_PARITY          =#0       // 0..2: PARITY 0=NONE,1=ODD,2=EVEN
3.7 MODBUS_UART_HALF_DUPLEX     =#0       // 0,1 : 0=FULL_DUPLEX,1=HALF DUPLEX
3.8 MODBUS_TRANSFER_MODE        =#1       // 0,1 : 0=ASCII 1=RTU
------------------------------------------------------------------------------------------------------------------------
4<SYSTEM CHECK>
4.1 DISPLAY_SYSTEM_INTERRUPTS =#1         // 0,1 : 0=NO 1=YES
4.2 LOG_RECEIVED_DATA           =#0       // 0..10240 : 0=NO to 10240 KB
------------------------------------------------------------------------------------------------------------------------
5<MODBUS TYPE DEFINITION >
5.1 MODBUS_DEVICE_TYPE          =#1       // 1,2 : 1=SLAVE 2=MASTER
5.2 MODBUS_MODICON_COMPAT.      =#1       // 0,1 : 0=NOT MODICON COMPATIBLE
                                          //       1=MODICON COMPATIBLE
5.3 MODBUS_SLAVE_ID             =#1       // 0.. 247
5.4 FLAG_HOLD_TIME              =#90      // N * 35 ms flag hold time.
5.5 TIME_OUT_ON_READIN          =#10      // TIMEOUT in N seconds for New value input
5.6 TIME_CORRECTION_MODBUS      =#1       // Update system time through modbus
                                          // 0=disable, 1= enable
------------------------------------------------------------------------------------------------------------------------
6<MODBUS SLAVE ADDRES DEFINITION>
STARTREGISTERS:
6.1 DATAFIELD  1                =#1000    //R Boolean
        ACCES MODE 1            =#0       //0,1: 0=NORMAL 1=REVERSED DATATYPE
6.2 DATAFIELD  2                =#2000    //RW Boolean
        ACCES MODE 2            =#0       //0,1: 0=NORMAL 1=REVERSED DATATYPE
6.3 DATAFIELD  3                =#3000    //R integer
        ACCES MODE 3            =#0       //0,1: 0=NORMAL 1=REVERSED DATATYPE
6.4 DATAFIELD  4                =#5000    //R long integer
        ACCES MODE 4            =#0       //0,1: 0=NORMAL 1=REVERSED DATATYPE
6.5 DATAFIELD  5                =#7000    //R float
        ACCES MODE 5            =#0       //0,1: 0=NORMAL 1=REVERSED DATATYPE
6.6 DATAFIELD  6                =#6000    //R double
        ACCES MODE 6            =#0       //0,1: 0=NORMAL 1=REVERSED DATATYPE
6.7 DATAFIELD  7                =#7500    //RW float
        ACCES MODE 7            =#0       //0,1: 0=NORMAL 1=REVERSED DATATYPE
```

```
------------------------------------------------------------------------------------------------------------------------------------------
7<MODBUS MASTER POLLBLOCK DEFINITION>
7.1 NUMBER_OF_POLLBLOCKS_TO_USE       =#1       //1..20 NUMBER OF POLLBLOCKS TO TRANSMIT
7.2 REQUEST_TO_RESPONSE_TIMOUT        =#10      //35 ms units

   POLLBLOCK:
    SLAVEID              - MODBUS SLAVE ADDRESS, 0..247
    MASTERREGISTER       - ADDRESS OF DATA IN ALTOSONIC_V, 0..10000
    SLAVEREGISTER        - ADDRESS OF DATA IN SLAVE, 0..10000
    N_POINTS             - NUMB OF DATA ITEMS TO TRANSFER(NOT REGISTERS BUT DATATYPES)0..255
    FUNCTION             - FUNCTION TO USE FOR DATA TRANSFER,1..16
    DATATYPE             - DATATYPE FOR CODING,DECODING AND VERIFICATION
                           1=boolean
                           2=integer
                           3=longinteger
                           4=float
                           5=double
    DATANOTATION         - NORMAL(0) OR REVERSED NOTATION(1) OF THE DATATYPE
    DELAY                - DELAY TO TRANSMIT NEXT POLLBLOCK 1..30000

7.3
NR      SLAVEID  MASTERREG.  SLAVEREG.  N_POINTS  FUNC   DATATYPE  DATANOT.  DELAY
1       #1       #2000       #7501      #2000        #1    #1        #0        #5
2       #1       #3010       #3501      #10          #3    #2        #0        #5
3       #1       #7010       #7501      #10          #3    #4        #0        #5
4       #1       #5010       #5501      #10          #3    #3        #0        #5
5       #1       #7018       #7501      #2           #3    #4        #0        #5
6       #0       #0          #0         #1           #1    #1        #0        #1
7       #0       #0          #0         #1           #1    #1        #0        #1
8       #0       #0          #0         #1           #1    #1        #0        #1
9       #0       #0          #0         #1           #1    #1        #0        #1
10      #0       #0          #0         #1           #1    #1        #0        #1
11      #0       #0          #0         #1           #1    #1        #0        #1
12      #0       #0          #0         #1           #1    #1        #0        #1
13      #0       #0          #0         #1           #1    #1        #0        #1
14      #0       #0          #0         #1           #1    #1        #0        #1
15      #0       #0          #0         #1           #1    #1        #0        #1
16      #0       #0          #0         #1           #1    #1        #0        #1
17      #0       #0          #0         #1           #1    #1        #0        #1
18      #0       #0          #0         #1           #1    #1        #0        #1
19      #0       #0          #0         #1           #1    #1        #0        #1
20      #0       #0          #0         #1           #1    #1        #0        #1
------------------------------------------------------------------------------------------------------------------------------------------
```

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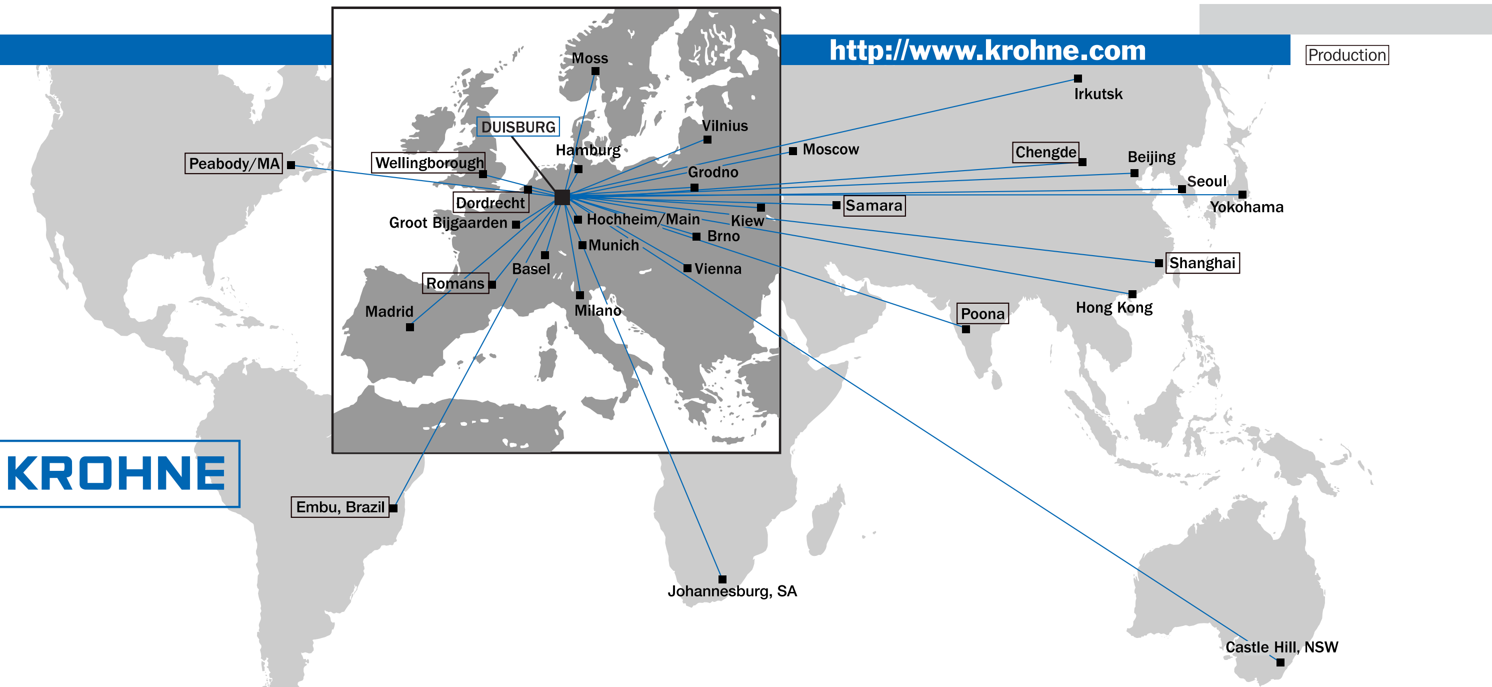

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