Special Documentation
NMR8x, NMS8x, NRF8x

Tank Gauging
WM550 Protocol

Endress+Hauser

People for Process Automation

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1   Introduction

This protocol guide explains the operation of the WM550 protocol implemented in the Tank gauging devices NRF81, NMS80, NMS81, NMS83, NMR81 and NMR84 (called Nxx8 in the following sections). The implementation of the WM550 protocol provides a standard form of digital communication via a two wire loop system. The Nxx8x implementation of the WM550 protocol supports a variety of tasks. For a detailed description refer to → 🖹 9

For details on the configuration and operation of the devices, refer to the Operating Instructions as specified in the following table.

Device	Operating Instructions
Micropilot NMR81	BA01450G
Micropilot NMR84	BA01453G
Proservo NMS80	BA01456G
Proservo NMS81	BA01459G
Proservo NMS83	BA01462G
Tankside Monitor NRF81	BA01465G

2 Installation recommendation

Please ensure to follow the following recommendations for field installation of the Nxx8x devices with the WM550 protocol variant:
- Cable with twisted and non-shielded pairs
- Cable with at least 0.5 mm^2 section
- Maximum total cable resistance: 250 Ω
- Cable with low capacitance
- The maximum number of field devices for the WM550 protocol is 15 (excl. master unit)
- Maximum length of 7 000 m (22 967 ft)

The use of a cable with a large cross section is advised for long cable length. Depending on cable specification, topology and length, it might be necessary to reduce baud rate.

The maximum number of devices depends on the maximum output voltage of the master and the voltage drop of slaves. The voltage drop of Nxx8x devices is aproximately 4.0 V.

When using NXA820 as a master with exclusively Nxx8x devices, it is recommended to restrict the maximum number of slave devices to 12 when using long cable length.

3   WM550 Configuration

The WM550 related parameters on the Nxx8 devices must be configured to establish communication. The local display or Fieldcare can be used for configuration. Please refer to the appropriate BA for further information

3.1   Single WM550/Dual WM550

The Nxx8x devices can be ordered either with a single WM550 IO module (Option 040 =C1) or with two independent WM550 modules (Option 060 = E1, E2, E3). If using two WM550 modules, each module can be configured independent of the other. The device will show configuration parameters for each module. Care must be taken to use the same configuration for both modules.

3.2   WM550 configuration

Bold type marks the default settings.

Configuration item	Valid entries	Remarks
WM550 address	0 to 63 (**1**)	This address must be unique for each WM550 device on a loop. Each Nxx8x IO module responds when a query has been sent to its unique address by the host.
Baudrate	• 600 • 1200 • **2400** • 4800	Defines the Baud rate of the communication.
Software ID	• 0 to 9999 • **2000**	Defines the Software ID which is replied to the Host system by Task 32. Refer to the Host System documentation for further information.
Compatibility mode	• **Nxx8x** • Nxx5xx	Affects the number of element temperature values which are transferred by Task 13: • Nxx8x: Task 13 replies with 24 element values • Nxx5xx: Task 13 replies with 16 element values. Old receivers might not be capable of receiving more than 16 elements.
Discrete [n] selector [n] = 1...4	• **None** • Balance flag • Alarm [n] any • Alarm [n] HighHigh • Alarm [n] High or HighHigh • Alarm [n] High • Alarm [n] Low • Alarm [n] Low or LowLow • Alarm [n] LowLow • Digital [x1-2] • Digital [x3-4]	Determines the input source which is transferred as Alarm bit [n] value in the corresponding WM550 tasks. Balance flag is only available for NMS8x devices. The Alarm [n]/Digital input needs to be configured prior to WM550 Discrete [n] selector. Otherwise it will not show up in the value list.

4   Measured values

4.1   Measured value ranges

Measured value	Minimum value	Maximum value	Granularity	Unit
Tank level	0	65 000	1	mm
Liquid temperature	−400.0	400.0	0.1	C
Tank level %	0.00	100.00	0.01	%
P3 (top)	0.0	25.0	0.1	bar
Observed density, Upper density	0.0	9 999.9	0.1	Kg/m³
Tank reference height	0	65 000	1	mm
Water level	0	9 999	1	mm
Element temperature	−400.0	400.0	0.1	C
Displacer position	0	65 000	1	mm

The min/max limits and granularity are not valid for task 51. Task 51 transfers values as floats or integer.

4.2   Measured value error handling

The following error handling rules are applied to all values returned in the WM550 message.

1. If a value (level, temperature or any other) is below the minimum value, then the minimum value is returned.

2. If a value (level, temperature or any other) is above the maximum value then the maximum value is returned.

3. If a value (level, temperature or any other) invalid, simulated or unknown the appropriate WM550 invalid bit or code is returned for that value along with the appropriate diagnostic code. See table below:

Name	Conditions for Error	Diagnostic value
Data not ready	Measured value is unknown	0x01
Simulation	Distance simulation active	0x02
Stowed	Gauge status = Displacer at reference position or Stopped at high stop (Only available for Device NMS)	0x03
Invalid data	Measured value is invalid	0x04

For Task 51 the error handling is advanced. Each float value contains 3 status bits to transfer additional information.

Value status bits			Conditions for Error	Output value
WM	S1	S0		
1	0	0	Set when device is W&M locked and value is valid	Measured value
0	0	1	Set in case the measured value hast a warning	Measured value
0	1	0	Set if measured value is unknown	Measured value

Value status bits			Conditions for Error	Output value
WM	S1	S0		
0	1	1	Set when Distance Simulation active	> = 100 000 000.0
			Set when measured value is invalid	
			Set when requested index is not available	

If distance simulation is switched on (for SIL Proof-testing), the tank level value is set to max on WM550 output due to W&M requirements.

5 WM550 message formats

5.1 Physical layer

The WM550 communication takes place on a 20mA current loop. Bits are represented by current flowing or not in the loop. These bits are generated and interpreted by a standard serial communication controller (UART) running at the selected baud rate and communication settings. Each group of 7 or 8 bits together with their start, stop and parity if required represents an ASCII character forming the elements of the messages.

5.2 Protocol layer

The request messages on the bus (called Tasks) instruct the device what data or action is required, the device will then reply with the appropriate response.

5.2.1 Overview of supported tasks

The following table shows an overview of the different tasks and subtasks supported by the Nxx8x devices.

Task	Sub Task	Task Name	Executed Gauge Command (NMS8x only)
0	1	Error return	/
1		Status report	/
2		Alarms and Level	Level
3		Alarms and Level	Up
4		Alarms, Level and Temperature	Level
5		Alarms, Level and Temperature	Up
6		Percentage level	Up
9		Alarms, Level and Temperature	/
10		Alarms, Level and Temperature	Level
11		Alarms, Level and Temperature	Level
12		Programmed tank height	/
13		Average Thermometer data	/
17	3	Water level	/
	9	Upper density	/
	10	Bottom density	/
	11	Observed density	/
27		Alarms, level, temperature & percentage level	Level
28		Alarms, level, temperature & percentage level	Up
30		Alarms, level, temperature, percentage level, pressure	Level
31		Alarms, level, temperature, percentage level, pressure	Up
32		Software identification and date	/
36		Alarms, level, temperature, % level, Head	Level [1]
37		Alarms, level, temperature, % level, Head	Up
38		Intelligent sensing head command	Task specific

Task	Sub Task	Task Name	Executed Gauge Command (NMS8x only)
51		Extended measured value index table	/
99		Device identification	/

1)   Only if Active Gauge command is Up

5.2.2   Task 0 - Error return

Task 0 is the response when an unidentifiable request is received.

Value	Type	Value returned
Error number	byte	0x01: Illegal task

5.2.3   Task 1 - Status report

Task 1 is the used to request field device status information.

Value	Type	Value returned
Serving	Bit	0: for device type NRF or NMR 1: for device type NMS
Stowed	Bit	0: for NRF and NMR 1: if displacer is at reference position or high stop
CIF lock	Bit	0: reset by Task 10, 11 1: Up (Stow) command received by Task 9 from this interface
NMT	Bit	1: Hart device NMT is connected

5.2.4   Task 2, 3 - Alarm and Level

Value	Type	Value returned
Alarm 1	Bit	Content of Discrete 1 selector
Alarm 2	Bit	Content of Discrete 2 selector
Alarm 3	Bit	Content of Discrete 3 selector
Alarm 4	Bit	Content of Discrete 4 selector
Servo Check	Bit	0: NMR or NRF 1: if Device is NMS and Balance flag is unbalanced
Tank level	Number	Tank level value in mm

5.2.5   Task 4, 5, 9, 10, 11 - Alarm, Level and Temperature

This task is used to request alarms, level and temperature data.
- Task 4: Gauge command set to: Level
- Task 5: Gauge command set to: Up
- Task 9: Gauge command set to: Up [1]
- Task 10:Gauge command set to: Level, CIF_lock bit cleared
- Task 11: Gauge command set to: Level, CIF_lock bit cleared

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1)   , CIF_lock bit: If this bit is set, the communication interface (CIF) will not accept any Gauge command until cleared by Task 10 or 11.

Value	Type	Value returned
Alarm 1	Bit	Content of Discrete 1 selector
Alarm 2	Bit	Content of Discrete 2 selector
Alarm 3	Bit	Content of Discrete 3 selector
Alarm 4	Bit	Content of Discrete 4 selector
Servo Check	Bit	0: NMR or NRF 1: if Device is NMS and Balance flag is unbalanced
Tank level	Number	Tank level value in mm
Temperature	Number	Liquid temperature in ℃

5.2.6   Task 6 - Percentage level

This task is used to request level data as a percentage of the preset tank height.

Value	Type	Value returned
Tank level %	Number	Tank level in % calculated from Tank level and Tank reference height

5.2.7   Task 12 - Programmed tank height

This task is used to request the preset tank height from the field unit.

Value	Type	Value returned
Alarm 1	Bit	Content of Discrete 1 selector
Alarm 2	Bit	Content of Discrete 2 selector
Alarm 3	Bit	Content of Discrete 3 selector
Alarm 4	Bit	Content of Discrete 4 selector
Servo Check	Bit	0: NMR or NRF 1: if Device is NMS and Balance flag is unbalanced
Tank reference height	Number	Tank reference height in mm

5.2.8   Task 13 - Average Thermometer data

This task is used to request the data for all elements of the averaging thermometer.

Value	Type	Value returned
Element number	Number	Depending on setting of parameter "Compatibility mode" - Nxx5xx: 15 temperature elements ■ Old receivers might not be capable of receiving more than 15 elements. ■ Nxx8x: 24 temperature elements
Element temperature	Number	Element temperature values from connected multipoint thermometer #1..#15 or #1..#24 in 0.1℃

5.2.9   Task 17 - Density and BSW data

This task is used to request BSW value (Water level), Density value (upper density), Datum position value (Bottom level) or average density value (Observed density).

Subtask 3: Water level

Value	Type	Value returned
Water level	Number	Water level in mm

Subtask 9: Upper density

Value	Type	Value returned
Upper density (Density value)	Number	Upper density value in 0.1 kg/m³ ℹ NMS8x sets this value to 9999.9kg/m³ if the density measurement failed due to a process error. (E.g. no liquid in tank)

Subtask 10: Bottom level

Value	Type	Value returned
Bottom level (Datum position)	Number	Bottom level in mm Only available for NMS8x.

Subtask 11: Observed density

Value	Type	Value returned
Observed density (average density value)	Number	Observed density value in 0.1 kg/m³
Observed density temperature	Number	Observed density temperature value in 0.1 ℃

5.2.10   Task 27, 28 - Alarms, level, temperature & percentage level

This task is used to request alarms, level, temperature and percentage level:
- Task 27: Gauge command set to: **Level** option
- Task 28: Gauge command set to: **Up** option

Value	Type	Value returned
Alarm 1	Bit	Content of Discrete 1 selector
Alarm 2	Bit	Content of Discrete 2 selector
Alarm 3	Bit	Content of Discrete 3 selector
Alarm 4	Bit	Content of Discrete 4 selector
Servo Check	Bit	0: NMR or NRF 1: if Device is NMS and Balance flag is unbalanced
Tank level	Number	Tank level in mm
Liquid temperature	Number	Liquid temperature value in 0.1 ℃
Tank level %	Number	Tank level in 0.01 %

5.2.11   Task 30, 31 - Alarms, level, temperature, percentage level, pressure

This task is used to request alarms, level, temperature and percentage level:
- Task 30: Gauge command set to: Level
- Task 31: Gauge command set to: Up

Value	Type	Value returned
Alarm 1	Bit	Content of Discrete 1 selector
Alarm 2	Bit	Content of Discrete 2 selector
Alarm 3	Bit	Content of Discrete 3 selector
Alarm 4	Bit	Content of Discrete 4 selector

Value	Type	Value returned
Servo Check	Bit	0: NMR or NRF 1: if Device is NMS and Balance flag is unbalanced
Tank level	Number	Tank level in mm
Liquid temperature	Number	Liquid temperature value in 0.1 ℃
Tank level %	Number	Tank level in 0.01 %
P3	Number	P3 pressure value in 0.1 bar

5.2.12   Task 32 - Software identification and Date

This task is used to request software identification from parameter Software ID.

Value	Type	Value returned
Software ID	Number	Content of parameter software ID ℹ️ Some WM550 receivers use this value to determine which data will be requested from the gauge. See receiver specific documentation.
Software date	Number	????

5.2.13   Task 36, 37 - Alarms, level, temperature, % level, Head

This task is used to request level, temperature, percentage level and displacer position:
- Task 36: Gauge command set to: Level (only if Active gauge command is Up)
- Task 37: Gauge command set to: Up

Value	Type	Value returned
Alarm 1	Bit	Content of Discrete 1 selector
Alarm 2	Bit	Content of Discrete 2 selector
Alarm 3	Bit	Content of Discrete 3 selector
Alarm 4	Bit	Content of Discrete 4 selector
Servo Check	Bit	0: NMR or NRF 1: if Device is NMS and Balance flag is unbalanced
Tank level	Number	Tank level in mm
Liquid temperature	Number	Liquid temperature value in 0.1 ℃
Tank level %	Number	Tank level in 0.01 %
P3	Number	P3 pressure value in 0.1 bar
Displacer position	Number	Displacer position value in mm Only available for NMS8x
Seek level	Bit	Set if Gauge status is Seek level, Level found, Wait for level, Seek standby position Only available for NMS8x
Profile	Bit	Set during density profile execution (Tank profile, Interface profile or Manual profile) Only available for NMS8x
Dip	Bit	Set during Upper density command execution Only available for NMS8x
Seek water level	Bit	Set while Gauge status is "Seek upper interface" Only available for NMS8x
Follow water level	Bit	Set while Gauge status is Follow upper interface level or Upper interface level balanced Only available for NMS8x

Value	Type	Value returned
Seek bottom level	Bit	Set during Bottom level command execution Only available for NMS8x
Follow level	Bit	Set while device measures level Only available for NMS8x

5.2.14 Task 38 - Intelligent sensing head command

This task is used to carry out gauge commands on a Proservo Same data is returned as in Task 36. By the request message, the following Gauge commands can be executed:
- Stop
- Tank profile
- Manual profile
- Upper density
- Upper I/F level
- Water dip
- Bottom level

Depending on the WM550 receiver the possible commands might be limited. See specific documentation.

5.2.15 Task 51 - Extended measured value index table

This task was firstly introduced by Tankside monitor NRF590 and allows to request a maximum of 8 values per request. The values are coded as integer or float and therefore do not obey the limitations of the value encoding in the original tasks.

Index	Name	Unit	Type
0	Not available	/	/
1	Diagnostic code	/	unit32
2	Tank level	mm	IEEE754 float
3	Tank level %	%	IEEE754 float
4	Water level	mm	IEEE754 float
5	Liquid temperature	℃	IEEE754 float
6	Air temperature	℃	IEEE754 float
7	Vapor temperature	℃	IEEE754 float
8	P1 (bottom)	bar	IEEE754 float
9	P2 (middle)	bar	IEEE754 float
10	P3 (top)	bar	IEEE754 float
11	Observed density	kg/m³	IEEE754 float
12	Element temperature 1	℃	IEEE754 float
...			
35	Element temperature 24	℃	IEEE754 float
36	Tank reference height	mm	IEEE754 float
37	Observed density temperature	℃	IEEE754 float
38	CLG corrected level	mm	IEEE754 float
...			
64	Gauge status	/	uint32
65	Balance flag	/	uint32

Index	Name	Unit	Type
66	Displacer position	mm	IEEE754 float
67	Measured upper density	kg/m³	IEEE754 float
68	Measured middle density	kg/m³	IEEE754 float
69	Measured lower density	kg/m³	IEEE754 float
70	GP value 1	*	IEEE754 float
71	GP value 2	*	IEEE754 float
72	GP value 3	*	IEEE754 float
73	GP value 4	*	IEEE754 float
74	Monitoring counter	/	uint32

Please note, the encoding of parameters Diagnostic code, Gauge command and Balance flag is done same as for Modbus communication. See SD02066G/00/EN.

5.2.16 Task 99 - device identification

This task is newly introduced to identify the connected device on the bus:

Value	Type	Value returned
Manufacturer ID	Number	Manufacturer ID as defined for HART communication: 0x0011
Device ID	Number	Device ID as defined for HART communication: • NMS8x: 0x002D • NMR8x: 0x002E • NRF81: 0x002F
Device revision	Number	Device revision as defined for HART communication: Derived from Software version: e.g. 01.04.zz → Device revision = 4

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