Special Documentation
NMR8x, NMS8x, NRF8x
V1 Communication Protocol

Tank Gauging

Endress+Hauser

People for Process Automation

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1   Introduction

This protocol guide explains the operation of the Endress+Hauser V1 protocol implemented in the Tank Gauging devices NRF81, NMS80, NMS81, NMS83, NMR81 and NMR84 (called Nxx8 in the following sections).

The implementation of the V1 protocol provides a standard form of digital communication via a two wire system.

1.1   Physical layer

The V1 communication takes place on a two-wire voltage mode bus. Bits are represented by the pulse width in requests from the control room and voltage level for the response. The V1 protocol encoded a clock pulse from the control room for both requests and replies removing the need for a baud rate setting in the slave devices.

1.2   New V1 protocol

The implementation on the tank gauging devices Nxx8 only supports the new V1 protocol. The new V1 protocol encodes ASCII requests and responses onto the bus allowing the addressing of a large number of possible data values depending on the slave device capabilities.

The protocol also includes two special commands Z0 and Z1. These commands are replied to by the slave with a response encoding all the main tank parameters into one data block. These commands allow faster polling times for the main tank values.

1.3   Documentation

For device specific documentation please refer to the related operating instructions:

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

2 Configuration

The V1 related parameters on the Nxx8 devices must be configured to establish communication. The local display or Fieldcare can be used for configuration. For further information, see device specific operating instructions.

2.1 V1 configuration

The below table provides an overview of available V1 configuration parameters and their meaning:

Configuration item	Valid entries	Remarks
V1 address	**1** to 99	Identifier of the device for the V1 communication.

Level mapping	• **+ve**
	• +ve & -ve
		Parameter to choose if only positive or positive and negative values can be transmitted.
		• **+ve**
		  Only positive values can be transmitted (0.0 to 99 999.9 mm)
		• **+ve & -ve**
		  Positive and negative numbers can be transmitted
		  (–49 999.9 to +50 000.0 mm

Line impedance	0 to **15**	Adjusts the impedance of the communication line. [i] The line impedance affects the voltage difference between a logical 0 and a logical 1 on the message of the device to the bus. The default setting is suitable for most applications.

Compatibility mode	• **Nxx5xx**
	• Nxx8x
		Affects content of the following parameters (only valid for devices: NMS80, NMS81, NMS83)
		• Gauge status
		• Balance flag
		
		Meaning of the options:
		• **Nxx5xx**:
		  • Only statuses which existed in NMS5x are used in the Z0 and Z1 response.
		  • The **Balance flag** parameter will only hold the values 0 (unbalanced) or 1 (balanced).
		• **Nxx8x**:
		  • All available gauge statuses are used in the Z0 and Z1 response.
		  • The **Balance flag** parameter will hold the values 0 to 4.

3 Data mapping and format

3.1 Z0 and Z1 response

The Z0 and Z1 responses provide the main measured values in one reply. Below tables provide an overview which parameter, data range and format is transmitted.

V1 parameter	Data source / explanation	Min	Max	Resolution	Unit	Available in
Level	Tank level	0.0	99 999.9	0.1	mm	Z0, Z1
		−49 999.9	50 000.0			
Temperature	Liquid temperature	−999.9	999.9	0.1	℃	Z0
Gauge status	Gauge status [1]	-	-	-	none	Z0, Z1
Device error	See chapter "Device error mapping"	-	-	-	none	Z0, Z1
External status	Configurable	-	-	-	none	Z0, Z1
Value percent	Configurable	0.0	100.0	0.1	%	Z0
Alarm status	Configurable	-	-	-	none	Z0, Z1
Balance flag	Balance flag [2]	-	-	-	none	Z0, Z1
Gauge command	Echo of request	-	-	-	none	Z0, Z1

[1] Only available for NMS80, NMS81 and NMS83. For all other devices the value is '05' – level measurement balanced

[2] Only available for NMS80, NMS81 and NMS83. For all other devices the value is '01' – level balanced

3.1.1 Device error mapping

The table below shows how device errors are mapped and transmitted in the Z0 and Z1 commands.

Diagnostic code	Short text	Transmitted value
/	No error	00
C970	Overtension	01
C971	Undertension	02
All other Diagnostic codes with diagnostic behavior "Alarm"		03

3.1.2 External status mapping

The external status allows to transfer signals from the digital input of the Nxx8 devices via V1 to the host system. This can be configured by the following parameters found in the device menu:

External status bit	Parameter
1	SP 1 value selector
2	SP 2 value selector
3	SP 3 value selector
4	SP 4 value selector

Before any Digital input can be selected, the Digital IO must be configured as an input. See device specific operating instructions.

3.1.3   Value percent mapping

The ZO response allows to transfer an input signal represented as percentage. This can be used to transfer the 4 to 20 mA current input or the tank level in percent. The measured value can be selected by the **Value percent selector** parameter.

3.1.4   Alarm status mapping

The Nxx8 devices can have up to 4 configurable alarms. These alarms can be transferred via the Z0 and Z1 command. This can be configured by the following parameters found in the device menu:

Alarm status bit	Parameter
1	Alarm 1 input source
2	Alarm 2 input source
3	Alarm 3 input source
4	Alarm 4 input source

Before choosing the Alarms, they have to be enabled and configured. See device specific operating instructions.

3.1.5   Gauge Command

Gauge command is only executed in NMS8x devices.

Gauge command	Code [ASCII]
Level	0
Up	1
Stop	2
Bottom Level	3
Upper I/F Level	6
Lower I/F Level	9
Upper Density	5
Middle Density	7
Lower Density	8
Repeatability	A
Water Dip	B
Release Overtension	4
Tank Profile	C
Interface Profile	D
Manual Profile	E
Level Standby	F
Offset Standby	G

3.1.6   Gauge status mapping

Depending on the Protocol mode parameter, the content of the Gauge status parameter is adjusted. In the NMS5x mode, only values which also existed in the NMS5x Gauge status is

output to the bus. In the NMS8x mode all Gauge status values are available in this parameter.

i Gauge status is only available in NMS8x devices. For all other devices this parameter will return 05 – level measurement balanced.

Gauge status of device	Protocol Mode			
	NMS8xs		NMS5x	
	Code [ASCII]	NMS8x naming	Code [ASCII]	NMS5x naming
Displacer at reference position	1	Displacer at reference position	1	Displacer hoisting up
Displacer hoisting up	2	Displacer hoisting up	1	Displacer hoisting up
Displacer stop	4	Displacer stop	2	Displacer stop
Level measurement balanced	5	Level measurement balanced	5	Level measurement, balanced
Upper interface level balanced	6	Upper interface level balanced	8	Upp. I/F level, balanced
Lower Interface level balanced	7	Lower Interface level balanced	12	Midd. I/F level, balanced
Bottom measurement balanced	8	Bottom measurement balanced	3	Bottom meas. balanced
Upper density done	9	Upper density done	4	Seek Upper Density
Middle density done	10	Middle density done	10	Seek Middle Density
Lower density done	11	Lower density done	11	Seek Density Bottom
Release overtension	12	Release overtension	9	Release over tension
Calibration activated	13	Calibration activated	13	Calibration activated
Seek level	14	Seek level	5	Level measurement, balanced
Follow level	15	Follow level	5	Level measurement, balanced
Seek upper interface level	19	Seek upper interface level	8	Upp. I/F level, balanced
Follow upper interface level	20	Follow upper interface level	8	Upp. I/F level, balanced
Seek lower interface level	21	Seek lower interface level	12	Midd. I/F level, balanced
Follow lower interface level	22	Follow lower interface level	12	Midd. I/F level, balanced
Seek bottom level	23	Seek bottom level	3	Bottom meas. balanced
Stopped at high stop	25	Stopped at high stop	2	Displacer stop
Stopped at low stop	26	Stopped at low stop	2	Displacer stop
Repeatability testing	27	Repeatability testing	27	Repeatability testing
Seek water level	28	Seek water level	28	Water level, balanced
Water dip finished	29	Water dip finished	28	Water level, balanced
Proof test done	32	Maintenance Mode	2	Displacer stop
Dip displacer	32	Maintenance Mode	2	Displacer stop
Verify weight	32	Maintenance Mode	2	Displacer stop
Verify distance	32	Maintenance Mode	2	Displacer stop
Start detector update	32	Maintenance Mode	2	Displacer stop
Detector update running	32	Maintenance Mode	2	Displacer stop

Gauge status of device	Protocol Mode			
	NMS8xs		NMS5x	
	Code [ASCII]	NMS8x naming	Code [ASCII]	NMS5x naming
Verify updated detector software	32	Maintenance Mode	2	Displacer stop
Finish detector update	32	Maintenance Mode	2	Displacer stop
Startup	33	Startup	2	Displacer stop
Check detector software version	33	Startup	2	Displacer stop
Water level error	34	Water level error	28	Water level, balanced
Slow hoist up	35	Slow hoist up	1	Displacer hoisting up
Level found	36	Level found	5	Level measurement, balanced
Bottom done	37	Bottom done	3	Bottom meas. balanced
Profile done	38	Profile done	2	Displacer stop
Above liquid	39	Above liquid	27	Repeatability testing
Overtension released	40	Overtension released	9	Release over tension
Temporary balanced	41	Temporary balanced	5	Level measurement, balanced
Lower density error	42	Lower density error	11	Seek Density Bottom
Middle density error	43	Middle density error	10	Seek Middle Density
Profile error	44	Profile error	4	Seek Upper Density
Upper density error	45	Upper density error	4	Seek Upper Density
Wait for level	46	Wait for level	5	Level measurement, balanced
Seek standby position	47	Seek standby position	5	Level measurement, balanced
Move to target	48	Move to target	4	Seek Upper Density
Measure density	49	Measure density	4	Seek Upper Density
Measure in air	50	Measure in air	4	Seek Upper Density
Bottom error	51	Bottom error	3	Bottom meas. balanced

3.1.7   Balance flag mapping

Depending on Parameter "Protocol mode" the content of parameter Balance flag is adjusted.

Gauge status of device	Protocol Mode			
	NMS8xs		NMS5x	
	Code [ASCII]	NMS8x naming	Code [ASCII]	NMS5x naming
Unbalanced	0	Unbalanced	0	OFF
Level Balanced	1	Level Balanced	1	ON
Upper IF Balanced	2	Upper IF Balanced	1	ON
Lower IF Balanced	3	Lower IF Balanced	1	ON
Bottom Balanced	4	Bottom Balanced	1	ON

3.1.8 Diagnostic information

The diagnostic information of the device is provided on the V1 R-Command. All device diagnostic codes have a number between 0...999 and an additional preceeding letter describing the kind of status. For the codes refer to the Operaing Instructions of the device, chapter "Diagnostics and troubleshooting". The preceeding letter is coded according to below table and added to the diagnostic code:

Status Signal	Value
F	3000
C	2000
S	1000
M	0000

3.2 Mode item table

In addition to the data transferred via the Z0 and Z1 response the following parameters can be accessed at the indicated mode/item locations.

Duplication of several values provides compatibility to older existing V1 slave devices.

Mode	Item	Parameter name	Access	MIN	MAX	Resolution	Unit
00	01	Displacer position	r	0	99 999.9	0.1	mm
00	09	Tank level	r	0	99 999.9	0.1	mm
13	14						
00	02	Tank ullage	r	0	99 999.9	0.1	mm
13	13						
00	03	Upper interface level	r	0	99 999.9	0.1	mm
13	15						
00	04	Lower interface level	r	0	99 999.9	0.1	mm
00	05	Bottom level	r	0	99 999.9	0.1	mm
13	16						
00	06	Measured upper density	r	0	3.0000	0.0001	g/ml
13	11						
00	07	Measured middle density	r	0	3.0000	0.0001	g/ml
13	12						
00	08	Measured lower density	r	0	3.0000	0.0001	g/ml
01	04	Vapor temperature	r	−200.0	+395.5	0.1	℃
01	05	Water level	r	0	99 999.9	0.1	mm
06	01	High stop level	r	0	99 999.9	0.1	mm
24	01	Element temperature 1	r	−200.0	+359.5	0.1	℃
24	02	Element temperature 2	r	−200.0	+359.5	0.1	℃
24	03	Element temperature 3	r	−200.0	+359.5	0.1	℃
24	04	Element temperature 4	r	−200.0	+359.5	0.1	℃
24	05	Element temperature 5	r	−200.0	+359.5	0.1	℃
24	06	Element temperature 6	r	−200.0	+359.5	0.1	℃
24	07	Element temperature 7	r	−200.0	+359.5	0.1	℃

Mode	Item	Parameter name	Access	MIN	MAX	Resolution	Unit
24	08	Element temperature 8	r	−200.0	+359.5	0.1	℃
24	09	Element temperature 9	r	−200.0	+359.5	0.1	℃
24	10	Element temperature 10	r	−200.0	+359.5	0.1	℃
24	11	Element temperature 11	r	−200.0	+359.5	0.1	℃
24	12	Element temperature 12	r	−200.0	+359.5	0.1	℃
24	13	Element temperature 13	r	−200.0	+359.5	0.1	℃
24	14	Element temperature 14	r	−200.0	+359.5	0.1	℃
24	15	Element temperature 15	r	−200.0	+359.5	0.1	℃
24	16	Element temperature 16	r	−200.0	+359.5	0.1	℃
24	17	Element temperature 17	r	−200.0	+359.5	0.1	℃
24	18	Element temperature 18	r	−200.0	+359.5	0.1	℃
24	19	Element temperature 19	r	−200.0	+359.5	0.1	℃
24	20	Element temperature 20	r	−200.0	+359.5	0.1	℃
24	21	Element temperature 21	r	−200.0	+359.5	0.1	℃
24	22	Element temperature 22	r	−200.0	+359.5	0.1	℃
24	23	Element temperature 23	r	−200.0	+359.5	0.1	℃
24	24	Element temperature 24	r	−200.0	+359.5	0.1	℃
24	25	reserved for future	r	0	0	0.1	
48	04	Observed density temperature	r	−200.0	+359.5	0.1	℃
48	05	Observed density	r	0	3.0000	0.0001	g/ml
54	05						
48	06	Liquid temperature	r	−200.0	+359.5	0.1	℃
54	06						
49	01	Profile density 1	r	0	3.0000	0.0001	g/ml
55	01						
49	02	Profile density 2	r	0	3.0000	0.0001	g/ml
55	02						
49	03	Profile density 3	r	0	3.0000	0.0001	g/ml
55	03						
49	04	Profile density 4	r	0	3.0000	0.0001	g/ml
55	04						
49	05	Profile density 5	r	0	3.0000	0.0001	g/ml
55	05						
49	06	Profile density 6	r	0	3.0000	0.0001	g/ml
55	06						
49	07	Profile density 7	r	0	3.0000	0.0001	g/ml
55	07						
49	08	Profile density 8	r	0	3.0000	0.0001	g/ml
55	08						
49	09	Profile density 9	r	0	3.0000	0.0001	g/ml
55	09						
49	10	Profile density 10	r	0	3.0000	0.0001	g/ml
55	10						

Mode	Item	Parameter name	Access	MIN	MAX	Resolution	Unit
50	01	Profile density 11	r	0	3.0000	0.0001	g/ml
56	01						
50	02	Profile density 12	r	0	3.0000	0.0001	g/ml
56	02						
50	03	Profile density 13	r	0	3.0000	0.0001	g/ml
56	03						
50	04	Profile density 14	r	0	3.0000	0.0001	g/ml
56	04						
50	05	Profile density 15	r	0	3.0000	0.0001	g/ml
56	05						
50	06	Profile density 16	r	0	3.0000	0.0001	g/ml
56	06						
50	07	Profile density 17	r	0	3.0000	0.0001	g/ml
50	08	Profile density 18	r	0	3.0000	0.0001	g/ml
50	09	Profile density 19	r	0	3.0000	0.0001	g/ml
50	10	Profile density 20	r	0	3.0000	0.0001	g/ml
50	11	Profile density 21	r	0	3.0000	0.0001	g/ml
50	12	Profile density 22	r	0	3.0000	0.0001	g/ml
50	13	Profile density 23	r	0	3.0000	0.0001	g/ml
50	14	Profile density 24	r	0	3.0000	0.0001	g/ml
50	15	Profile density 25	r	0	3.0000	0.0001	g/ml
50	16	Profile density 26	r	0	3.0000	0.0001	g/ml
50	17	Profile density 27	r	0	3.0000	0.0001	g/ml
50	18	Profile density 28	r	0	3.0000	0.0001	g/ml
50	19	Profile density 29	r	0	3.0000	0.0001	g/ml
50	20	Profile density 30	r	0	3.0000	0.0001	g/ml
50	21	Profile density 31	r	0	3.0000	0.0001	g/ml
50	22	Profile density 32	r	0	3.0000	0.0001	g/ml
50	23	Profile density 33	r	0	3.0000	0.0001	g/ml
50	24	Profile density 34	r	0	3.0000	0.0001	g/ml
50	25	Profile density 35	r	0	3.0000	0.0001	g/ml
50	26	Profile density 36	r	0	3.0000	0.0001	g/ml
50	27	Profile density 37	r	0	3.0000	0.0001	g/ml
50	28	Profile density 38	r	0	3.0000	0.0001	g/ml
50	29	Profile density 39	r	0	3.0000	0.0001	g/ml
50	30	Profile density 40	r	0	3.0000	0.0001	g/ml
50	31	Profile density 41	r	0	3.0000	0.0001	g/ml
50	32	Profile density 42	r	0	3.0000	0.0001	g/ml
50	33	Profile density 43	r	0	3.0000	0.0001	g/ml
50	34	Profile density 44	r	0	3.0000	0.0001	Profile
50	35	Profile density 45	r	0	3.0000	0.0001	g/ml
50	36	Profile density 46	r	0	3.0000	0.0001	g/ml
50	37	Profile density 47	r	0	3.0000	0.0001	g/ml

Mode	Item	Parameter name	Access	MIN	MAX	Resolution	Unit
50	38	Profile density 48	r	0	3.0000	0.0001	g/ml
50	39	Profile density 49	r	0	3.0000	0.0001	g/ml
50	40	Profile density 50	r	0	3.0000	0.0001	g/ml
51	01	Profile density position 1	r	0	99999.9	0.1	mm
57	01						
51	02	Profile density position 2	r	0	99999.9	0.1	mm
57	02						
51	03	Profile density position 3	r	0	99999.9	0.1	mm
57	03						
51	04	Profile density position 4	r	0	99999.9	0.1	mm
57	04						
51	05	Profile density position 5	r	0	99999.9	0.1	mm
57	05						
51	06	Profile density position 6	r	0	99999.9	0.1	mm
57	06						
51	07	Profile density position 7	r	0	99999.9	0.1	mm
57	07						
51	08	Profile density position 8	r	0	99999.9	0.1	mm
57	08						
51	09	Profile density position 9	r	0	99999.9	0.1	mm
57	09						
51	10	Profile density position 10	r	0	99999.9	0.1	mm
57	10						
52	01	Profile density position 11	r	0	99999.9	0.1	mm
58	01						
52	02	Profile density position 12	r	0	99999.9	0.1	mm
58	02						
52	03	Profile density position 13	r	0	99999.9	0.1	mm
58	03						
52	04	Profile density position 14	r	0	99999.9	0.1	mm
58	04						
52	05	Profile density position 15	r	0	99999.9	0.1	mm
58	05						
52	06	Profile density position 16	r	0	99999.9	0.1	mm
58	06						
52	07	Profile density position 17	r	0	99999.9	0.1	mm
52	08	Profile density position 18	r	0	99999.9	0.1	mm
52	09	Profile density position 19	r	0	99999.9	0.1	mm
52	10	Profile density position 20	r	0	99999.9	0.1	mm
52	11	Profile density position 21	r	0	99999.9	0.1	mm
52	12	Profile density position 22	r	0	99999.9	0.1	mm
52	13	Profile density position 23	r	0	99999.9	0.1	mm
52	14	Profile density position 24	r	0	99999.9	0.1	mm

Mode	Item	Parameter name	Access	MIN	MAX	Resolution	Unit
52	15	Profile density position 25	r	0	99999.9	0.1	mm
52	16	Profile density position 26	r	0	99999.9	0.1	mm
52	17	Profile density position 27	r	0	99999.9	0.1	mm
52	18	Profile density position 28	r	0	99999.9	0.1	mm
52	19	Profile density position 29	r	0	99999.9	0.1	mm
52	20	Profile density position 30	r	0	99999.9	0.1	mm
52	21	Profile density position 31	r	0	99999.9	0.1	mm
52	22	Profile density position 32	r	0	99999.9	0.1	mm
52	23	Profile density position 33	r	0	99999.9	0.1	mm
52	24	Profile density position 34	r	0	99999.9	0.1	mm
52	25	Profile density position 35	r	0	99999.9	0.1	mm
52	26	Profile density position 36	r	0	99999.9	0.1	mm
52	27	Profile density position 37	r	0	99999.9	0.1	mm
52	28	Profile density position 38	r	0	99999.9	0.1	mm
52	29	Profile density position 39	r	0	99999.9	0.1	mm
52	30	Profile density position 40	r	0	99999.9	0.1	mm
52	31	Profile density position 41	r	0	99999.9	0.1	mm
52	32	Profile density position 42	r	0	99999.9	0.1	mm
52	33	Profile density position 43	r	0	99999.9	0.1	mm
52	34	Profile density position 44	r	0	99999.9	0.1	mm
52	35	Profile density position 45	r	0	99999.9	0.1	mm
52	36	Profile density position 46	r	0	99999.9	0.1	mm
52	37	Profile density position 47	r	0	99999.9	0.1	mm
52	38	Profile density position 48	r	0	99999.9	0.1	mm
52	39	Profile density position 49	r	0	99999.9	0.1	mm
52	40	Profile density position 50	r	0	99999.9	0.1	mm
60	01	W&M status	r	0			
60	02	P1 (bottom)	r	0	9999.99	0.01	kPa
60	03	P2 (middle)	r	0	9999.99	0.01	kPa
60	04	P3 (top)	r	0	9999.99	0.01	kPa
60	05	Monitoring counter	r	0	2^31	0	int32
60	06	Actual diagnostics	r	0	9999	0	/

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