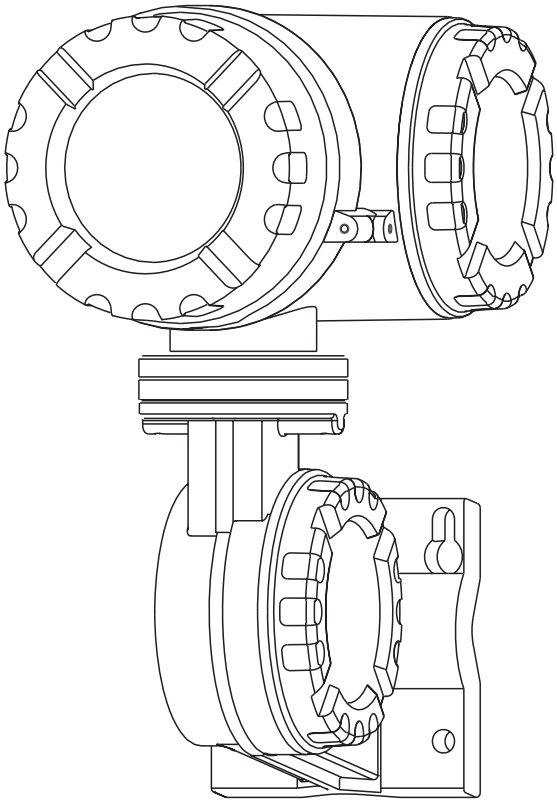
Level Pressure Flow Temperature Liquid Analysis Registration Systems Components Services Solutions

L&J Tankway communication protocol

Tank Side Monitor NRF590

Inventory Control



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V02.03

Endress+Hauser
People for Process Automation

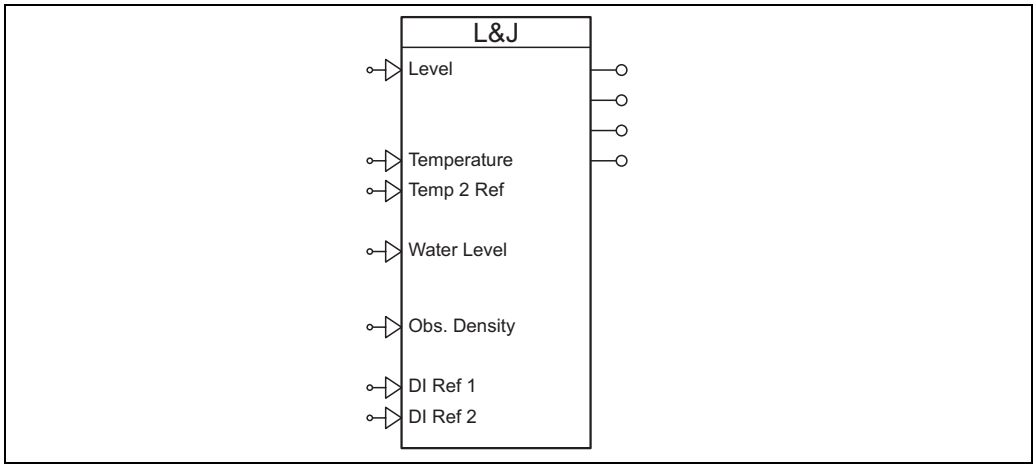
Table of contents

1 Introduction

This protocol guide explains the operation of the L&J Tankway protocol implemented in the Endress+Hauser Tank Side Monitor NRF 590.

2 Implementation

The implementation of the L&J Tankway protocol for the Tank Side Monitor provides a standard form of digital communication via a voltage mode bus. An effort has been made to parallel current implementations to the greatest extent possible, so that the Tank Side Monitor communicates with existing L&J Tankway masters.
Check compatibility carefully to ensure that the Tank Side Monitor is properly configured for the data format expected by the host system or computer. Exceptions made because of the unique requirements of the Tank Side Monitor application have been noted. This is no guarantee however that the interpretation made here will be the same as that followed by the L&J master.



3 Installation Recommendation

Please insure to follow the following recommendations for field installation of the NRF590:

- Use two twisted pairs fo 18 AWG wire
- Connect the two cables as shown on the figure below to avoid crosstalk betweens the signals.
- Connect the gauges in parallel as shown on figure 2 below.
- The maximum suggested cable length is 10 km.

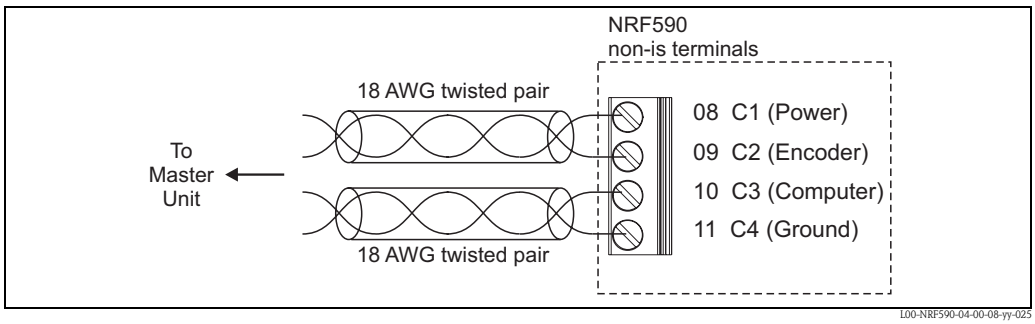


Fig. 1: Wiring diagram for L&J Tankway Protocol

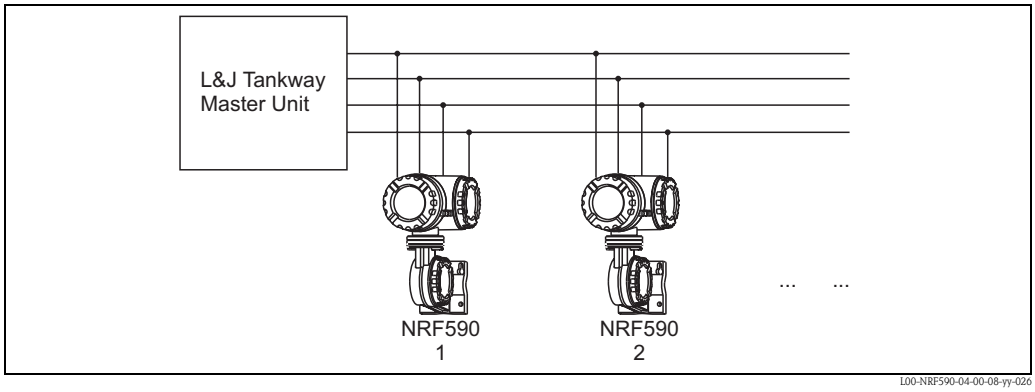


Fig. 2: Standard topology for L&J Tankway Protocol

4 Configuration

The L&J interface on the Tank Side Monitor must be configured to establish communication. The local display or the ToF tool allows the user to set the Tank Side Monitor L&J interface to match the L&J Tankway master settings.

4.1 Configuration Settings

4.1.1 Address

Tank Side Monitor addresses provide unique identification for the host. The Tank Side Monitor address is configured through the local display or ToF tool. This address may range from 0 to 127 and must be unique for each L&J Tankway device on a loop. Each Tank Side Monitor only responds when a query has been sent to its unique address by the host.

4.1.2 Protocol Variants

The L&J Tankway interface of the Tank Side Monitor supports two variants of the L&J Tankway protocol refered to as “L&J Tankway Standard” and “L&J Tankway Servo”. The choice of the communication variant (Standard or Servo) is done in the L&J host system and defines which commands the host uses to poll the Tank Side Monitor:

- **L&J Tankway Standard**: This communication variant provides only Level and Temperature. The host uses L&J commands 1 and 2 to poll the Tank Side Monitor for level and temperature. A parameter in the Tank Side Monitor allows to specify how the Tank Side Monitor encodes the level value when reporting level (response to command 1). Table 2 describes the possible encoding formats.
- **L&J Tankway Servo**: using this protocol the Tank Side Monitor is able to report four measured values (level, temperature, water level and density). The L&J host uses command 96 to poll the Tank Side Monitor for the four values together. The data encoding when using L&J Tankway Servo is fixed.

Table 1 summarizes the L&J Tankway commands supported by the Tank Side Monitor.

Table 1: Tankway commands supported by the Tank Side Monitor

Command	Description
1	Report level (L&J Tankway Standard)
2	Report product temperature (L&J Tankway Standard)
4	Report temperature 2[1)] (L&J Tankway Standard)
96	Report an extended set of data (level, temperature, water level, density)

1) The source of the temperature to be returned can be configured through the parameter Temp2ref (9216)

Table 2: L&J Tankway standard level encoding types

Device Type	Description
CCW Varec	Uses gray code table for CW VAREC Tank Gauge
CCW S&J	Uses gray code table for CCW Shand & Jurs Tank Gauge
Ft & 100ths	Whole number of Feet and 100^{ths} of an inch
1/32 inch	Number of 32^{nds} of an inch

4.2 Configuration Parameters

In order for successful communication on a L&J Tankway loop a number of configuration settings must be made to match the configuration of the bus. A summary of the configuration information required by teh Tank Side Monitor is shown in Table 3.

Table 3: L&J Tankway interface configuration

Configuration Item	Valid Entries	Default
ID	0 to 127	1
Device Type	■ CCW Varec ■ CCW S&J ■ ft & 100ths ■ 1/32 inch	CCW Varec
BAud Rate	■ 300 ■ 600 ■ 1200 ■ 2400	1200
Temp 2 Ref	Any Temperature Ref	Vap Temp Ref
Discrete Ref 1	Any discrete or alarm value	IS DI 1
Discrete Ref 2	Any discrete or alarm value	IS DI 2

4.2.1 Submenu "Basic Setup" (921X)

Id (9211)

This is the identifier value. The Tank Side Monitor will respond to requests which contain this identifier value. (Default: 1) (Protected by W&M Switch)

Baud Rate (9212)

Selects which of the possible baud rates communication should work at. (Default: 1200) (Protected by W&M Switch)

Type (9213)

Parity Type: Describes the format used to encode the level value sent to the control room. (Default: CCW S&J) (Protected by W&M Switch)

DI Ref 1 (9214)

Discrete Reference 1: Indicates which discrete value will be transmitted as LJ Discrete Value 1. (Default: IS DI #1, Value)

DI Ref 2 (9215)

Discrete Reference 2: Indicates which discrete value will be transmitted as LJ Discrete Value 2. (Default: IS DI #2, Value)

Temp 2 Ref (9216)

Temperature #2 Reference: Indicates which value will be transmitted as LJ Temperature #2. The default value is connected to the Tank Vapour Temperature. (Default: Tank Values, Vapor Temperature)

4.2.2 Submenu "Diagnostics" (922X)

Output Status (9221)

The Communication Status Graph (CSG) provides a simple graphical overview of communication between the gauges and the control room. The height of the bar represents the activity during the last second:

- Replied to Host (largest bar)
- Received Request for this NRF590
- Request for another other gauge on this bus
- Bytes were detected on the bus
- Bits were detected on the bus (smallest bar)
- Nothing detected (no bar, gap in graph)

Under normal operating conditions only the top three should be seen (with or without gaps).

5 Measured Values

Depending on the incoming request the L&J Tankway response sent by the Tank Side Monitor will contain one or more measurement values. Depending on the reply and on the L&J parameters these values are subject to the following limits.

5.1 Level Request (L&J Tankways Standard)

Table 4 shows the limits applied to the returned level value depending on the device type.

Table 4: Level Range

Measured Value	Device Type	Value Range	Granularity	Units
Level	CCW Varec	0.0 to 95.5	1/16 inch	ft
	CCW S&J	0.0 to 95.5	1/16 inch	ft
	Ft & 100ths	0.0 to 95.5	1/8 inch	ft
	1/32 inch	0.0 to 95.5	1/32 inch	ft

The following error handling rules are applied to the level value returned in the L&J Tankway message.

Table 5: Level Error Handling

Device Type	Condition		
	Level Invalid/Offline	Level bleow min value	Level above max value
CCW Varec	Maximum value	Minimum value	Maximum value
CCW S&J	Invalid Gray code	Minimum value	Maximum value
Ft & 100ths	Invalid Gray code	Minimum value	Maximum value
1/32 inch	Maximum value	Minimum value	Maximum value

5.2 Temperature Request (L&J Tankway Standard)

Table 6 shows the limits applied to the returned temperature value. These limits do not depend on the device type.

Table 6: Temperature Range

Measured Value	Device Type	Value Range	Granularity	Units
Temperature	All	-819.0 to +819.0	0.2 °F	°F

Error and over range are treated as follows:

Table 7: Temperature Error Handling

Condition	Responses for all device types
Temperature Invalid/Offline	Temperature Invalid bit set
Temperature below min. value	Minimum value
Temperature above max. value	Maximum value

5.3 L&J Tankway Servo Request

If the host is configured for the "L&J Tankway Servo" protocol variant, data are requested using the command 96 (see page 6). In this case the Tank Side Monitor reply uses a specific response. This response contains four measurement values (level, temperature, water level and density). Their encodings do not depend on the parameter "device type".
Table 8 and Table 9 show the limits and error handling applied to these parameters.

Table 8: "Servo" Reply Value Range

Measured Value	Value Range	Granularity	Units
Level	0.0 to 95.5	1/32 inch	ft
Temperature	-819.0 to +819.0	0.2 °F	°F
Density	0.0 to 65535	1 kg/m^3	kg/m^3
Water Level	0.0 to 95.5	1/32 inch	ft

Table 9: "Servo" Reply Values Error Handling

Condition	Parameter			
	Level	Temperature	Density	BS&W
Invalid/Offline	Level Valid bit not set (bit 3.1)[1)]	Temperature Invalid bit set (bit 3.1)[1]	Max Value	BS&W Valie bit not set (bit 3.0)[1]
Below Min. Value	Min. Value	Min. Value	Min. Value	Min. Value
Above Max. Value	Max. Value	Max. Value	Max. Value	Max. Value

1) bit x.y designates the bit number x of the byte number y in the response (see Table 13).

5.4 L&J Tankway Message Format

The L&J Tankway communication takes place on a pair of cables normally at 30 VDC (one for transmission and one for reception). Bits are represented by digital voltage levels on these cables. These bits are then assembled into bytes. Parity bit, stop bit and start bit[1)] are added and the message is sent.

5.4.1 Request Message

The request is a message block, sent from the control room; these bits encode the device whose data is requested as well as the command to be performed.

Table 10: L&J Tankway Request Range

Byte	Description
1st	Bit 7 is always 1. Bit 0 to 6 hold the device ID.
2nd	Bit 7 is always 0. Bit 6 and 5 are set (together) to request an extended reply (L&J Tankway Servo) Bit 4 and 3 are always 0 Bit 2 is set if temperature 2 is requested[1)] (L&J Tankway Standard) Bit 1 is set if temperature 1 is requested[1] (L&J Tankway Standard) Bit 0 is set if level is requested[1] (L&J Tankway Standard)

1) only one of these bits can be set at a time and not if bits 5 and 6 are set.

1) UART configuration for L&J is fixed: one start bit, one stop bit, even parity.

5.4.2 Reply Message

The reply message from the Tank Side Monitor depends on the L&J Tankway interface settings of the Tank Side Monitor. However it always consists of a single message.

Level Request Reply

This reply from the Tank Side Monitor consists of a message where all 16 bits of the data are used to encode the level value. Depending on the Device Type setting the level will be encoded as follows:

Table 11: L&J Tankway Level Reply Coding

Device Type	Description
CCW Varec	1st byte: gray code value of the number of ½ foot in the level 2nd byte: gray code value of the number of 1/16 inch in the level
CCW S&J	1st byte: gray code value of the number of ½ foot in the level 2nd byte: gray code value of the number of 1/16 inch in the level
Ft & 100ths	1st byte: binary coded value of the number of whole feet in the level 2nd byte: binary coded value of the number of 1/8 inch in the level
1/32 inch	The full 16 bytes of the reply contain the binary encoded value representing a number of 32nds of inch in the level.

Temperature Request Reply

This reply of the Tank Side Monitor consists of a message containing the following information:

Table 12: L&J Tankway Temperature Reply Coding

Byte	Description
1st	All bits hold the temperature data bits 0 … 7[1)]
2nd	Bit 7 indicates the status of discrete IO 2 Bit 6 indicates the status of discrete IO 1 Bit 5 if set indicates the temperature is +ve Bit 4 if set indicates the value is over range (or invalid) Bits 0 … 3 hold the temperature bits 8 … 11[1]

1) The temperature is stored as a binary number representing the number of 0.2°F in the value.

L&J Tankway Servo Reply

This reply of the Tank Side Monitor is a 16 bytes message containing four measurements values (level, temperature, water level and density) and some status flag bits.
The content of the message is describe on Table 13(each cell representing a byte of the reply message).

Table 13: L&J Tankway Servo Reply Message Structure

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
–	–	flag bits	level byte 1	level byte 2	temp byte 1	temp byte 2	BS&W byte 1

Byte 9	Byte 10	Byte 11	Byte 12	Byte 13	Byte 14	Byte 15	Byte 16
BS&W byte 2	–	–	dens byte 1	dens byte 2	–	–	CRC

Flag bits (Byte 3)

Byte	Description
1st	Bit 7..2 are always 0 Bit 1 if set indicates the Level value (bytes 4+5 of the reply) is valid Bit 0 if set indicates the BS&W value (bytes 6+7 of the reply) is valid

Level (Bytes 4+5)

The full 16 bits (level byte1 and byte2) contain the binary coded value representing a number of 32nds of an inch in the level.

Note!
This encoding does not depend on the "device type" parameter of the Tank Side Monitor.

Temperature (Bytes 6+7)

Byte	Description
1st	All bits hold the temperature data bits 0 … 7[1)]
2nd	Bit 7 indicates the status of discrete IO 2 Bit 6 indicates the status of discrete IO 1 Bit 5 if set indicates the temperature is +ve Bit 4 if set indicates the value is over range (or invalid) Bits 0 … 3 hold the temperature bits 8 … 11[1]

1) The temperature is stored as a binary number representing the number of 0.2°F in the value.

BS&W (Bytes 8+9)

The full 16 bits (BS&W byte1 and byte2) contain the binary coded value representing the water level in the tank (number of 32nds of an inch).

Density (Bytes 12+13)

The full 16 bits (density byte1 and byte2) contain the binary coded value representing the density in kg/m^3.

CRC (Byte 16)

The CRC byte is calculated by adding all the bytes of the reply

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