

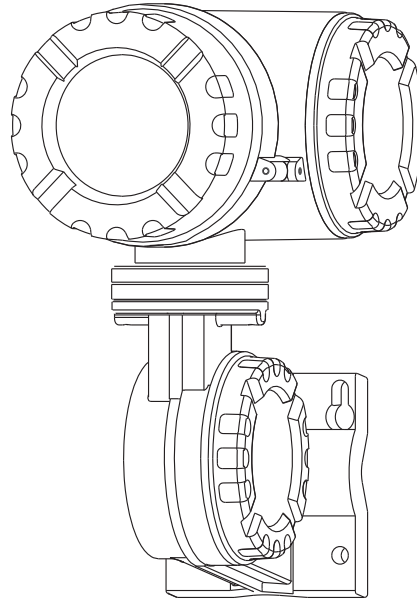
# 4590 Tank Side Monitor

L&J Tankway Communication Protocol



## *Service Manual*

Software Version v01.04



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# 1 Introduction

This protocol guide explains the operation of the L&J Tankway protocol ???per Modicon document PI-MBUS-300 Rev C (1991)?? implemented in the Varec 4590 Tank Side Monitor (TSM).





## 2 Implementation

The implementation of the L&J Tankway protocol for the 4590 TSM 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 4590 TSM communicates with existing L&J Tankway masters.

Check compatibility carefully to ensure that the 4590 TSM is properly configured for the data format expected by the host system or computer. Due to the unique application requirements of the 4590 TSM application, exceptions have been made and noted.

**Note!** There is no guarantee that the interpretation made here will be the same as that followed by the L&J master.

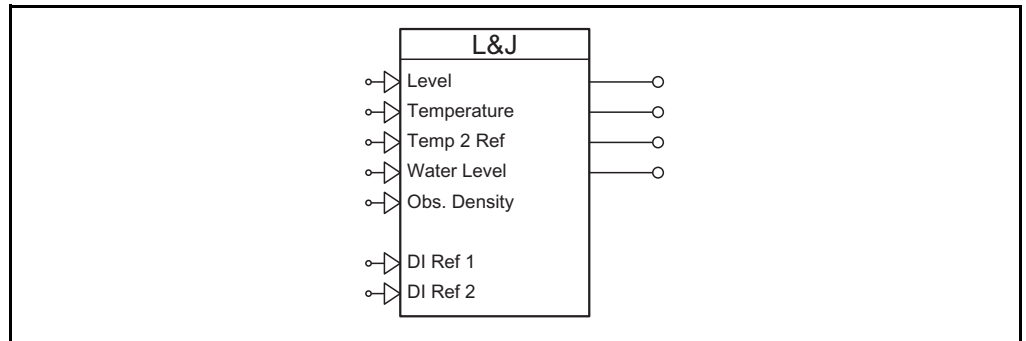


Figure 2-1: Function Block "L&J Output"



### 3 Installation Recommendations

Follow these recommendations for field installation of the 4590 TSM with the L&J Tankway protocol variant:

- Use two twisted pairs of 18 AWG wire (one power and one communication).
- Connect the units in parallel as shown in Figure 3-1 to avoid crosstalk between the signals.
- Connect the gauges in parallel as shown in Figure 3-2.
- The maximum suggested cable length is 10 km.

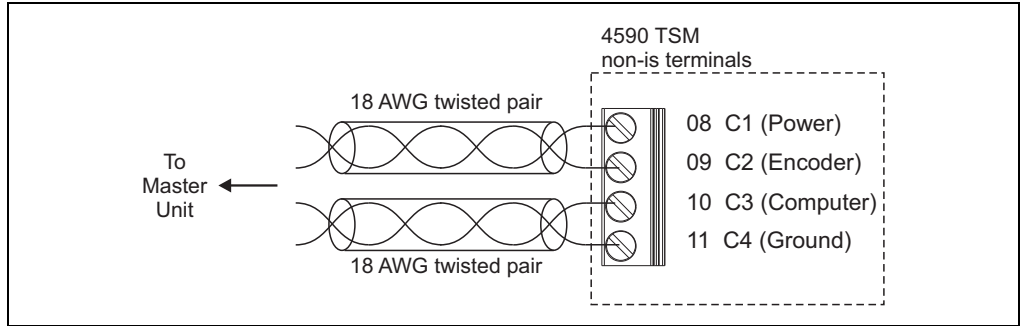


Figure 3-1: Wiring diagram for L&J Protocol

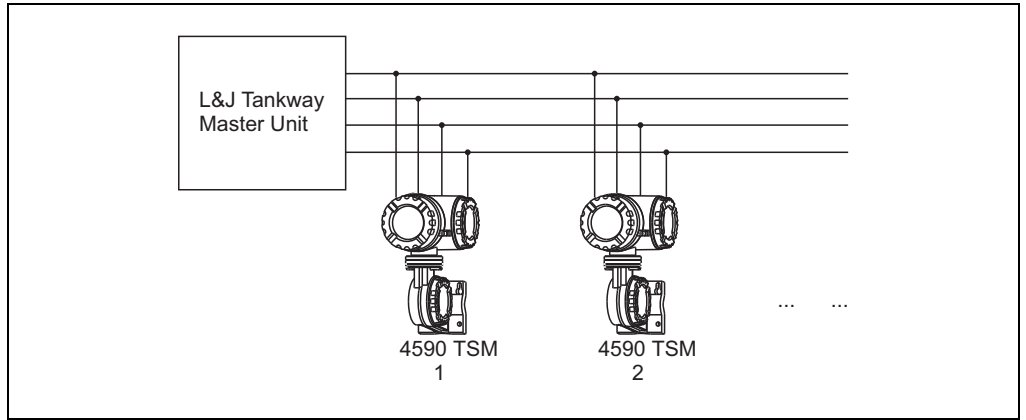


Figure 3-2: Standard topology for L&J Protocol



## 4 Configuration

The L&J Tankway interface on the 4590 TSM must be configured to establish communication. The local display or ToF tool allows the user to set the 4590 TSM L&J interface to match the L&J Tankway master settings.

### 4.1 Configuration Settings

#### 4.1.1 Address

The 4590 TSM addresses provide unique identification for the host. The 4590 TSM 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 4590 TSM 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 on the 4590 TSM supports two variants of the L&J Tankway protocol referred to as the “L&J Standard” and the “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 4590 TSM as shown below:

- **L&J Tankway Standard:** This communication variant provides only level and temperature. The host uses L&J commands 1 and 2 to poll the 4590 TSM for level and temperature. A parameter in the 4590 TSM allows you to specify how the 4590 TSM 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 4590 TSM is able to report four measured values (level, temperature, water level, and density). The L&J host uses command 96 to poll the 4590 TSM for the four values together. The data encoding is fixed when using the L&J Tankway Servo .

Table 4-1 summarizes the L&J Tankway commands supported by the 4590 TSM.

Table 4-1: Tankway Commands Supported by the 4590 TSM

Command	Description
1	Report level (L&J Tankway Standard)
2	Report product temperature (L&J Tankway Standard)
4	Report temperature 2 <sup>1)</sup> (L&J Tankway Standard)
96	Report an extended set of data (level, temperature, water level, and density)

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

Table 4-2 summarizes the L&J Tankway Standard Level Coding Types supported by the 4590 TSM.

*Table 4-2: L&J Tankway Standard Level Encoding Types*

Device Type	Description
CCW Varec	Uses gray code table for the CCW Varec Tank Gauge
CCW S&J	Uses gray code table for the CCW Shand & Jurs Tank Gauge
Ft & 100	Whole number of feet and 100 <sup>ths</sup> of an inch
1/32 inch	Number of 32 <sup>nds</sup> of an inch

## 4.2 Configuration Parameters

For successful communication on an L&J Tankway loop, a number of configuration settings must be made to match the configuration of the bus.

Table 4-3 summarizes the configuration information required by the 4590 TSM.

*Table 4-3: L&J Tankway Interface Configuration*

Configuration Item	Valid Entries	Default
ID	0 -127	1
Device Type	<ul style="list-style-type: none"> <li>• CCW Varec</li> <li>• CCW S&amp;J</li> <li>• ft &amp; 100<sup>ths</sup></li> <li>• 1/32 inch</li> </ul>	CCW Varec
Baud Rate	<ul style="list-style-type: none"> <li>• 300</li> <li>• 600</li> <li>• 1200</li> <li>• 2400</li> </ul>	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 Description of Configuration Parameters

Table 4-4 summarizes the configuration parameters that make up the Basic Setup. The numbers in parentheses indicate the menu position.

Table 4-4: Submenu "Basic Setup"<sup>(921x)</sup>

Field	Description	Default	Protected
ID <sup>(9211)</sup>	This is the identifier value. The 4590 TSM will respond to requests which contain this identifier value.	1	W&M Switch
Baud Rate <sup>(9212)</sup>	Selects which of the possible baud rates communication should work at.	1200	W&M Switch
Type <sup>(9213)</sup> (Parity Type)	Describes the format used to encode the level value sent to the control room.	CCW S&J	W&M Switch
DI REF 1 <sup>(9214)</sup> (Discrete Reference 1)	Indicates which discrete value will be transmitted as L&J Discrete Value 1.	IS DI #1, Value	
DI REF 2 <sup>(9215)</sup> (Discrete Reference 2)	Indicates which discrete value will be transmitted as L&J Discrete Value 2.	IS DI #2, Value	
Temp 2 Ref <sup>(9216)</sup> (Temperature #2 Reference)	Indicates which value will be transmitted as L&J Temperature #2. The default is connected to the Tank Vapor Temperature.	Tank Values, Vapor Temperature	

Table 4-5 summarizes the configuration parameters that make up the "Diagnostics" Submenu.

Table 4-5: Submenu "Diagnostics"<sup>(922x)</sup>

Field	Description	Height of Bar
Output Status <sup>(9221)</sup>	The Communication Status Graph (CSG) provides a simple graphical overview of communication between the gauges and the control room.	<p>The height of the bar represents the activity during the last second as follows.</p> <ul style="list-style-type: none"> <li>Replied to Host (largest bar)</li> <li>Received Request for this 4590 TSM</li> <li>Request for another gauge on this bus</li> <li>Bytes were detected on the bus</li> <li>Bits were detected on the bus (smallest bar)</li> <li>Nothing detected (no bar, gap in graph)</li> </ul>

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





## 5 Measured Values

Depending on the incoming request, the L&J Tankway response sent by the 4590 TSM contains 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 5-1 lists the limits applied to the returned level value depending on the device type.

Table 5-1: *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 & 100 <sup>ths</sup>	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 5-2: *Level Error Handling*

Device Type	Condition		
	Level Invalid/Offline	Level Below 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 & 100 <sup>ths</sup>	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 5-3 lists the limits applied to the returned temperature value. These limits do not depend on the device type as shown below:

Table 5-3: *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 5-4: *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 Chapter 4, Protocol Variants for more information. In this case, the 4590 TSM 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".

Tables 5-5 and 5-6 list the limits and error-handling applied to these parameters.

Table 5-5: "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 <sup>3</sup>	kg/m <sup>3</sup>
Water Level	0.0 to 95.5	1/32 inch	ft

Table 5-6: "Servo" Reply Values Error Handling

Condition	Parameter			
	Level	Temperature	Density	BS&W
Invalid/Offline	Level Valid Bit not set (bit 3.1) <sup>1)</sup>	Temperature Invalid Bit set (bit 3.1) <sup>1)</sup>	Max. Value	BS&W Valid Bit not set (bit 3.0) <sup>1)</sup>
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 5-10, L&J Tankway Servo Reply Message Structure for more information.

## 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 are added and the message is sent. UART configuration for L&J is fixed—one start bit, one stop bit, and even parity.

### 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 as shown in Table 5-7:

Table 5-7: L&J Tankway Request Range

Byte	Description
1	Bit 7 is always 1 Bit 0 to 6 hold the device ID
2	Bit 7 is always 0 Bits 6 and 5 are set (together) to request an extended reply (L&J Tankway Servo) Bits 4 and 3 are always 0 Bit 2 is set, if temperature 2 is requested <sup>1)</sup> (L&J Tankway Standard) Bit 1 is set, if temperature 1 is requested <sup>1)</sup> (L&J Tankway Standard) Bit 0 is set, if level is requested <sup>1)</sup> (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.

### 5.4.2 Reply Message

The reply message from the 4590 TSM depends on the L&J Tankway interface settings of the 4590 TSM. However, it always consists of a single message.

#### Level Request Reply

This reply from the 4590 TSM 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 is encoded as follows:

Table 5-8: L&J Tankway Level Reply Coding

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

### Temperature Request Reply

This reply of the 4590 TSM consists of a message containing the following information:

Table 5-9: L&J Tankway Temperature Reply Coding

Byte	Description
1	All bits hold the temperature data bits 0 – 7 <sup>1)</sup>
2	Bit 7 indicates the status of discrete IO 2 Bit 6 indicates the status of discrete IO 1 Bit 5, if set, indicates that the temperature is +ve Bit 4, if set, indicates that the value is over range (or invalid) Bits 0 – 3 hold the temperature bits 8 – 11 <sup>1)</sup>

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 4590 TSM is a 16-byte message containing four measurement values (level, temperature, water level, and density) and some status flag bits.

The content of the message is described in Table 5-10. Each cell represents a byte of the reply message.

Table 5-10: 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
1	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 byte 1 and byte 2) contain the binary coded value representing a number of 32<sup>hds</sup> of an inch in the level.

**Note!** This encoding does not depend on the "device type" parameter of the 4590 TSM.

**Temperature (Bytes 6+7)**

Byte	Description
1	All bits hold the temperature data bits 0 – 7 <sup>1)</sup>
2	Bit 7 indicates the status of discrete IO 2 Bit 6 indicates the status of discrete IO 1 Bit 5, if set, indicates that the temperature is +ve Bit 4, if set, indicates that the value is over range (or invalid) Bits 0 – 3 hold the temperature bits 8 – 11 <sup>1)</sup>

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 byte 1 and byte 2) contain the binary coded value representing the water level in the tank (number of 32<sup>nds</sup> of an inch).

**Density (Bytes 12+13)**

The full 16 bits (density byte 1 and byte 2) contain the binary coded value representing the density of kg/m<sup>3</sup>.

**CRC (Byte 16)**

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



## NOTES

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