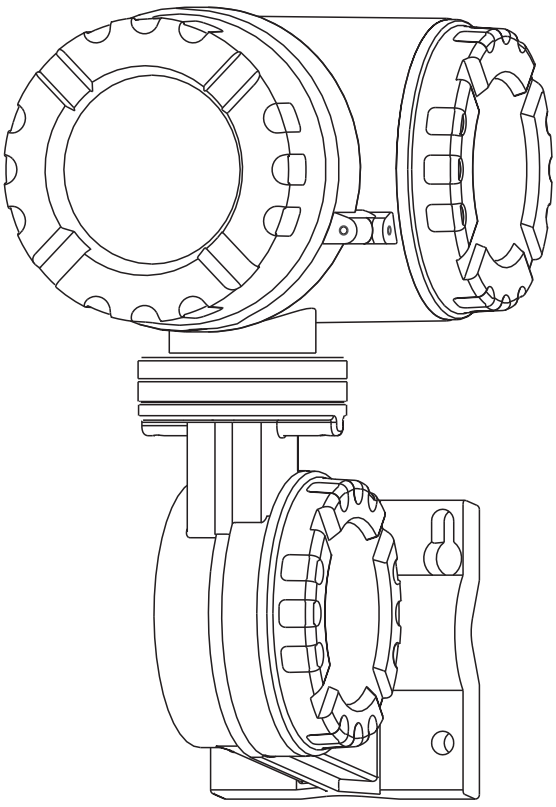
Level Pressure Flow Temperature Liquid Analysis Registration Systems Components Services Solutions

GPE communication protocol

# Tank Side Monitor NRF590

## Inventory Control



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Endress+Hauser

People for Process Automation

# Table of contents

# 1 Introduction

This protocol guide explains the operation of the GPE protocol implemented in the Endress+Hauser Tank Side Monitor NRF590.

# 2 Implementation

The implementation of the GPE protocol for the Tank Side Monitor provides a standard form of digital communication via a current loop. An effort has been made to parallel current implementations to the greatest extent possible, so that the Tank Side Monitor communicates with existing GPE 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.

Note!
This is no guarantee, however, that the interpretation made here will be the same as that followed by the GPE master.

The GPE protocol supports three modes of communication and within each mode four commands

## 2.1 GPE Modes (Device Types)

| Device Type (23111) | Description |
|---|---|
| Short Reply | New GPE Protocol, used by devices which incorporporate a microcontroller |
| Long Reply | Old GPE Protocol, used by older hardware controlled systems |
| 1mm Reply | Expanded protocol for higher measurement resolution |

## 2.2 GPE Functions

| Function | Description |
|---|---|
| LT | Used to obtain Level and Temperature |
| LTA | Used to obtain Level, Temperature and 4 ... 20mA VAlue |
| LTC | Used to close a discrete contact and obtain Level and Temperature |
| LTO | Used to open a discrete contact and obtain Level and Temperature |

# 3 Configuration

The GPE port on the Tank Side Monitor must be configured to establish communications. The local Tank Side Monitor display or ToF Tool allow the user to set up the GPE parameters needed for a correct communication with a GPE master unit.

## 3.1 Address

Tank Side Monitor addresses provide unique identification for the host. The Tank Side Monitor address is configurable through the local display or ToF tool. This address may range from 0 to 99 and must be unique for each GPE device on a loop. A Tank Side Monitor unit will ONLY answer to a request that contains the same Address or Communication ID that the unit is set to.

## 3.2 Configuration settings

In order for successful communication on a GPE loop a number of configuration settings must be made to match the configuration of the loop.

### 3.2.1 Summary of Configuration Parameters

A summary of the configuration information required by the Tank Side Monitor is shown in the following table.

| Configuration parameter | Valid Entries | Default |
|---|---|---|
| ID | 0 ... 99 | 1 |
| Baudrate | 250 ... 350 baud | 300 |
| Type | ■ Short Reply<br>■ Long Reply<br>■ 1mm Reply | Short Reply |
| Loop Mode | ■ Not Checked<br>■ Checked | Not Checked |
| Loop Number | 0 ... 4 | 0 |
| Long Reply Type | ■ Type 1<br>■ Type 2<br>■ Type 3 | Type 1 |
| 4-20mA Ref | List of TSM parameters | IS AI Input Value |
| Contact Ref | DIO#x or Alarms | IS DI#1 Input Value |
| Conv Fact Adj | 0.5 ... 1.5 | 1.0 |

### 3.2.2 Description of Configuration Parameters

**Loop Number (23107)**

The loop parameter forms a second part of the identification of a message, if enabled (see Loop Mode parameter) it will be compared with the value in the received message. The message will only be processed if they match.

**ID (9211)**

This is a unique number for this device on the GPE loop, only when the Tank Side Monitor receives a request message with this number is a response generated.

**Baudrate (9212)**

Specifies the communication speed used on the GPE loop.

### Type (9213)

Specifies the format of the response generated by the Tank Side Monitor.

### Loop Mode (9214)

Indicates if the loop value within the request message should be evaluated or not. If not then the Tank Side Monitor will respond to all messages with it's ID number no matter which loop number is in the request.

### Long Reply Type (9224)

The value determines how the "Level 0.1" value is encoded into the long reply "Fine Level 0.1" and "Coarse Level 0.1" digits. See "Long Reply Additional Information".

### 4-20mA Ref (9221)

This parameter is used to connect a calculated or measured value within the Tank Side Monitor to this part of the response message. There are specific limitations on the range of values which can be transmitted.

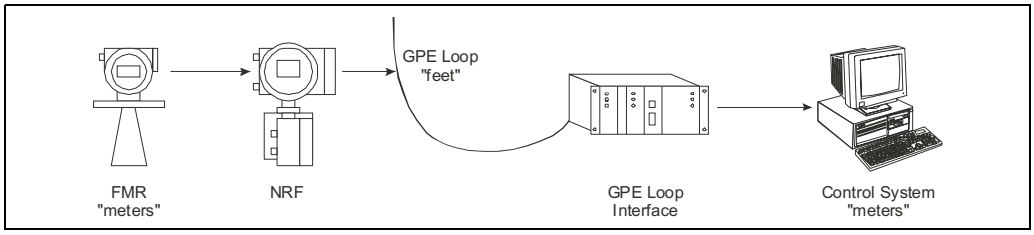
### Contact Ref (9222)

This parameter selects the discrete output which will be controlled by the LTC & LTO command. The status of this output is also returned as part of the Tank Side Monitors response message.

### Conversion Factor Adjust (9223)

This parameter allows the level value transmitted on the GPE bus to be adjusted to compensates for inaccuracies in control room equipment during unit conversion, for example.

*Example*




In this example, the NRF will have to be set to "feet" as the GPE loop is working in "feet". The NRF will convert the level from the FMR using the correct conversion factor (1ft = 0.3048m), however the GPE Loop Interface to the Control System may use an inaccurate conversion (e.g. 1ft = 0.3m). To compensate for this inaccuracy, the "Conversion Factor Adjustment" (CFA) value can be set as follows:

CFA = accurate conversion factor / inaccurate conversion factor
= 0.3048/0.3
= 1.016

The NRF will then multiply its value in by this adjustment value before sending on the GPE bus (Note, only the value sent on the bus is affected, the displayed value and value used for internal calculations will not be changed by this paramater). The control room will then after conversion have the correct value.

| | **CFA = 1.000** | **CFA = 1.016** | **Remarks** |
|---|---|---|---|
| FMR Value | 2.540 m | 2.540 m | |
| NRF Displayed Value | 8.333 ft | 8.333 ft | 1 ft = 0.3048 m |
| Value Sent to GPE Loop | 8.333 | 8.466 | = value * CFA |
| Control System Value | 2.500 m | 2.540 m | 1 ft = 0.3 m |

# 4 Measured values

## 4.1 Measured Value Ranges

The GPE response will contain between 2 and 3 measurement values, level, temperature and 4-20mA value (LTA function only). Depending on the setting of the GPE parameters these values are subject to the following limits.

| Measurement Value[1] | Reply Type | | | Description of Value |
|---|---|---|---|---|
| | Short | Long | 1mm | |
| Level | 0.000[2] ... +199.995 | 0.000 ... +199.999 | 0.0000 ... +199.9999 | Value of Tank Corrected Level in current Tank Level Units |
| Temperature | -799 ... +799 | -799 ... +799 | -799.9 ... +799.9 | Tank Temp in current Tank Temp Units |
| 4-20mA | -19.99 ... +19.99 | -19.99 ... +19.99 | -1999.99 ... +1999.99 | Value of linked parameter in its current units[3] |

1) Resolution of all values is +/- one significant figure of the specific units, except level in type "short"

2) The smallest unit of level increment is 0.005 of the specific units.

3) If the units are ft-in-16 or ft-in-8 the value of Level is in decimal ft.

## 4.2 Measured Value Error Handling

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

1. If a value (level, temperature or 4-20mA) is below the minimum value then the minimum value is returned.
2. If a value (level, temperature or 4-20mA) is above the maximum value then the maximum value is returned.
3. If a value (level, temperature or 4-20mA) is undefined, invalid or offline the maximum is returned.

# 5 GPE Message Formats

## 5.1 Physical Layer

The GPE 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 baudrate and communication settings. Each group of bits together with their start, stop and parity represents an ASCII character forming the elements of the messages. Within each character bits 0 to 3 are under to encode decimal values, while the remaining 3 or 4 bits are used to provide additional information.

## 5.2 Request Message

The request is a sequence of three characters sent from the control room, these characters encode the loop number and the device whose data is requested as well as which GPE function is to be executed.

| Byte | Bits 0-3 | Bits 4-6 or7 | Description |
|---|---|---|---|
| 1st | 0 to 4 | 0x20 | Loop Number |
| 2nd | 0 to 9 | 0x40 ... 0x70 | Address 1 |
| 3rd | 0 to 9 | 0x40 ... 0x70 | Address 10 |

The value of the upper bits in the 2nd and 3rd byte describes the GPE function to be executed:

| Bits 4-6 or7 | Function | Description |
|---|---|---|
| 0x40 | LTA | Return Level, Temperature and 4-20mA Value |
| 0x50 | LT | Return Level and Temperature |
| 0x60 | LTC | Close the discrete output and return level and temperature |
| 0x70 | LTO | Open the discrete output and return level and temperature |

## 5.3 Reply Message

The reply from the Tank Side Monitor depends on the function requested by the control room and the Device Type configuration parameter of the Tank Side Monitor.

### 5.3.1 Reply to Functions LT, LTC and LTO

The reply from the Tank Side Monitor is the same for all three functions LT, LTC & LTO, the upper bits of the characters are all 0x30. However the replies do differ depending on the Device Type selected.

| Reply Byte | Reply Type | | |
|---|---|---|---|
| | Short | Long | 1mm |
| 1st | Address 1 | Address 1 | Address 1 |
| 2nd | Address 10 | Address 10 | Address 10 |
| 3rd | Level 0.01 | Fine Level 0.001 | Level 0.0001 |
| 4th | Level 0.1 | Fine Level 0.01 | Level 0.001 |
| 5th | Level 1 | Fine Level 0.1 | Level 0.01 |
| 6th | Level 10 | Coarse Level 0.1 | Level 0.1 |

| Reply Byte | Reply Type | | |
|---|---|---|---|
| | Short | Long | 1mm |
| 7th | Level 100[1] | Coarse Level 1 | Level 1 |
| 8th | Temp 1 | Coarse Level 10 | Level 10 |
| 9th | Temp 10 | Coarse Level 100[2] | Level 100 |
| 10th | Temp 100[3] | Temp 1 | Temp 0.1 |
| 11th | | Temp 10 | Temp 1 |
| 12th | | Temp 100[3] | Temp 10 |
| 13th | | | Temp 100[3] |

1) This level value can only be 0 or 1. Bit 2 if set indicates an additional 0.005 should be added to the value. Bit 3 if set indicates the discrete output is closed.

2) This level value can only be 0 or 1. Bit 3 if set indicates the discrete output is closed.

3) This temperature value can only be between 0 and 7. Bit 3 if set indicates the value is a –ve temperature.

### 5.3.2 Reply to Functions LTA

The reply from the Tank Side Monitor for the function LTA differs not only by the contents but also by the value of the upper bits of the characters which are all 0x20. However the replies do differ depending on the Device Type selected.

| Reply Byte | Reply Type | | |
|---|---|---|---|
| | Short | Long | 1mm |
| 1st | Address 1 | Address 1 | Address 1 |
| 2nd | Address 10 | Address 10 | Address 10 |
| 3rd | Level 0.01 | Fine Level 0.001 | Level 0.0001 |
| 4th | Level 0.1 | Fine Level 0.01 | Level 0.001 |
| 5th | Level 1 | Fine Level 0.1 | Level 0.01 |
| 6th | Level 10 | Coarse Level 0.1 | Level 0.1 |
| 7th | Level 100[1] | Coarse Level 1 | Level 1 |
| 8th | Temp 1 | Coarse Level 10 | Level 10 |
| 9th | Temp 10 | Coarse Level 100[2] | Level 100 |
| 10th | Temp 100[3] | Temp 1 | Temp 0.1 |
| 11th | 4-20mA 0.01 | Temp 10 | Temp 1 |
| 12th | 4-20mA 0.1 | Temp 100[3] | Temp 10 |
| 13th | 4-20mA 1 | 4-20mA 0.01 | Temp 100[3] |
| 14th | 4-20mA 10[4] | 4-20mA 0.1 | 4-20mA 0.01 |
| 15th | | 4-20mA 1 | 4-20mA 0.1 |
| 16th | | 4-20mA 10[4] | 4-20mA 1 |
| 17th | | | 4-20mA 10 |
| 18th | | | 4-20mA 100 |
| 19th | | | 4-20mA 1000[4] |

1) This level value can only be 0 or 1. Bit 2 if set indicates an additional 0.005 should be added to the value. Bit 3 if set indicates the discrete output is closed.

2) This level value can only be 0 or 1. Bit 3 if set indicates the discrete output is closed.

3) This temperature value can only be between 0 and 7. Bit 3 if set indicates the value is a –ve temperature.

4) This 4-20mA value can only be 0 or 1. Bit 1 if set indicates the value is a –ve one.

### 5.3.3 Long Reply Additional Information

In the long reply the level is sent as two components, this was used due to the mechanical nature of the old devices which employed this protocol. When the Tank Side Monitor is used in this mode, these values are as follows:

| | **Long Reply Type** | | |
|---|---|---|---|
| | **0** | **1** | **2** |
| Fine Level 0.001 | Level 0.001 | | |
| Fine Level 0.01 | Level 0.01 | | |
| Fine Level 0.1 | 0 | Level 0.1 | Level 0.1 |
| Coarse Level 0.1 | Level 0.1 | 0 | Level 0.1 |
| Coarse Level 1 | Level 1 | | |
| Coarse Level 10 | Level 10 | | |
| Coarse Level 100 | Level 100 | | |

The Long Reply Type parameter allows you to adjust the layout so when the two values (Fine & Coarse) are combined in the control system a accurate level can be obtained.

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