Manual Supplement
00809-0600-2410, Rev AA
2017

Rosemount™ 2410 Tank Hub

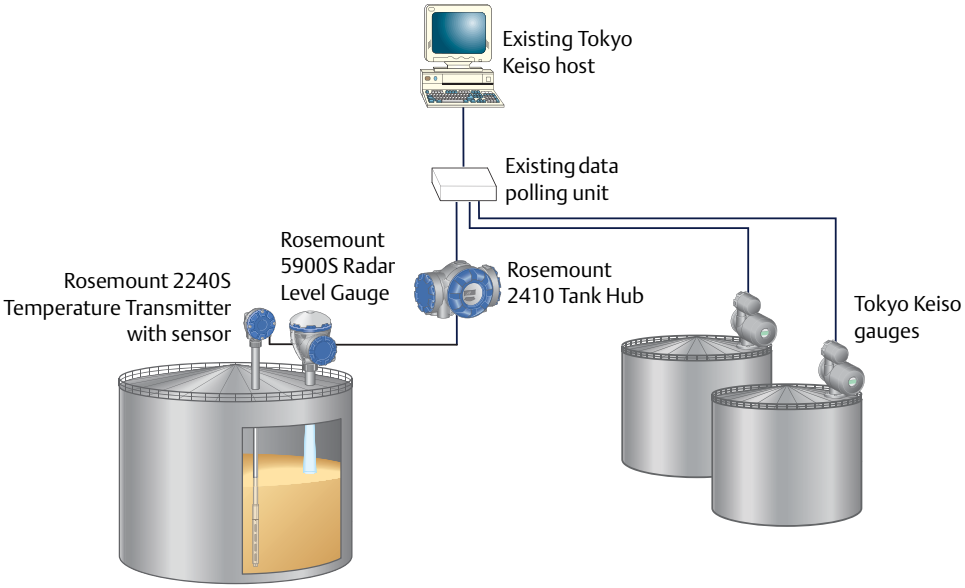
Tokyo Keiso emulation instruction

1.0 Introduction

The purpose of this document is to provide guidelines on how to change from other manufacturer's devices to Rosemount equipment by exchanging gauges. When a gauge is replaced with a Rosemount gauge, it is necessary to configure the Rosemount 2410 Tank Hub for emulation.

The Rosemount field devices, for example Rosemount 5900 Radar Level Gauge and Rosemount 2240S Temperature Transmitter, are connected to the tank hub using the intrinsically safe Tankbus as usual. Emulation is done in the tank hub only. Each tank hub can emulate up to 10 tanks (10 separate gauges)[(1)].

Figure 1. Rosemount Devices Replacing Old Gauges in an Existing Tokyo Keiso System



1. *Tank hub version "Multiple tanks" can emulate up to 10 tanks (10 gauges), tank hub version "Single tank" can emulate up to 2 tanks (2 gauges).*

1.1 Emulation capabilities

Emulation enables the ability to replace old devices in another vendor's existing tank gauging system, with Rosemount devices. The Rosemount device will act just like the replaced gauge, using the other vendor's protocol to communicate.

By using the other vendor's field and control room communication protocol together with modern Rosemount tank gauging devices, the legacy system is modernized step-by-step. The legacy system can be upgraded while tanks are in operation and existing wiring can be re-used.

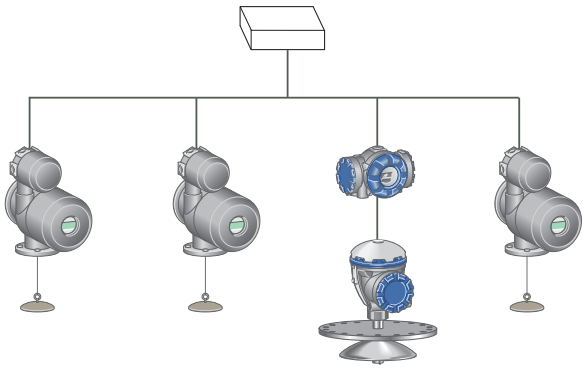
The tank hub can emulate replaced devices, acting as a slave.

Tank hub acting as slave

When an old gauge from another vendor is replaced with a tank hub connected to a Rosemount field device, the tank hub will act as a slave answering requests and sending data upwards towards the host.

A stepwise "bottom-up" upgrade is done by replacing legacy gauges to begin with, and changing the complete control system at a later occasion.

Figure 2. Tank Hub Slave Emulation



1.2 Tokyo Keiso system characteristics

The tank hub can emulate up to 10 tank positions[1], each supporting:

- Level or Ullage value
- Interface Level or Ullage
- Average Liquid temperature
- Spot temperature for 15 sensors

Observed density is also supported for up to three tank positions.

Electrical interface and protocol

Table 1. Tokyo Keiso Protocol Options

Protocol	Electrical interface
Tokyo Keiso	Tokyo Keiso Non-IS 2-wire half duplex communication bus

Protocol request commands

The Tokyo Keiso protocol is based on a request/reply schedule. The request is transmitted on the Tokyo Keiso bus and contains the address of the gauge together with a specific command. The request is always six bytes. The number of bytes in the response depends on the request command.[2]

There are two kinds of request commands:

- Measurement value and status requests
- Operational servo commands

The tank hub replies are designed to correspond to the replies usually sent from a servo gauge. From the perspective of the Tokyo Keiso host, communication will work just as before the servo gauge was replaced by a tank hub.

Table 2. Measurement Value and Status Requests

Command	ASCII code	Tank hub replies
O	0x4F	Level (or Ullage), Average temperature, Contact status, Float status, Alarm status and Error status (E1 for invalid Level and E2 for invalid Average Temperature).
X	0x58	Temperature sensor 1-5: Not connected status, Over range status, Dummy character.
Y	0x59	Temperature sensor 6-10: Not connected status, Over range status, Dummy character.
Z	0x5A	Temperature sensor 11-15: Not connected status, Over range status, Dummy character.
P	0x50	Not supported by the tank hub.
g	0x67	Observed density and status (valid or invalid).

1. *Tank hub version "Multiple tanks" can emulate up to 10 tanks (10 gauges), tank hub version "Single tank" can emulate up to 2 tanks (2 gauges).*
2. *For additional information about the Tokyo Keiso protocol, contact your local Emerson Automation Solutions/Rosemount Tank Gauging representative.*

Table 3. Servo Commands

Command	ASCII code	Servo command description	Tank hub implementation
M	0x4D	Control for measured liquid surface	After this command, the level value in request command O is the product level.
N	0x4E	Control for measured interface	After this command, the level value in request command O is the free water level.
n	0x6E	Control for measured bottom	After this command, the level value in request command O is the bottom (0 m).
S	0x53	Control for stop	Not supported by Rosemount 2410 Tank Hub. Unsuccessful response status will be sent.
U	0x55	Control for hoist	Not supported by Rosemount 2410 Tank Hub. Unsuccessful response status will be sent.
L	0x4C	Control for down	Not supported by Rosemount 2410 Tank Hub. Unsuccessful response status will be sent.
G	0x47	Control for measure density	Successful response status will be sent.

1.3 Rosemount 2410 Tank Hub communication

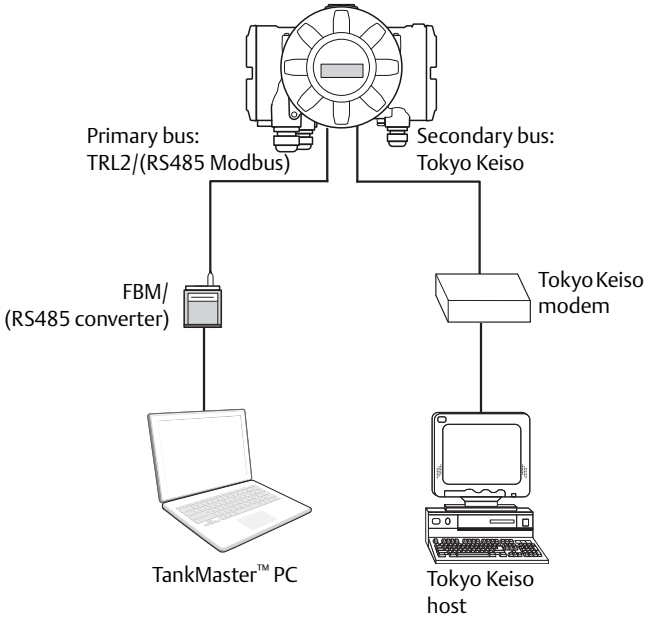
The tank hub has slots for two independent communication boards, primary and secondary field bus, for TRL2 Modbus®, RS485 Modbus, emulation or wireless communication.

The Tokyo Keiso interface can only be connected to the Rosemount 2410 secondary field bus.

Configuration is performed as usual by connecting a FBM to the primary bus. The primary bus can be used for regular TRL2 or RS485 Modbus communication.

Figure 3. Tokyo Keiso Emulation with Digital Current Loop on Secondary Field Bus

Tank hub with configuration on primary field bus and Tokyo Keiso emulation on secondary field bus



2.0 Electrical installation

2.1 Rosemount 2410 Tank Hub connections(1)

Figure 4. Terminal Block in the Explosion-Proof/Flameproof Compartment

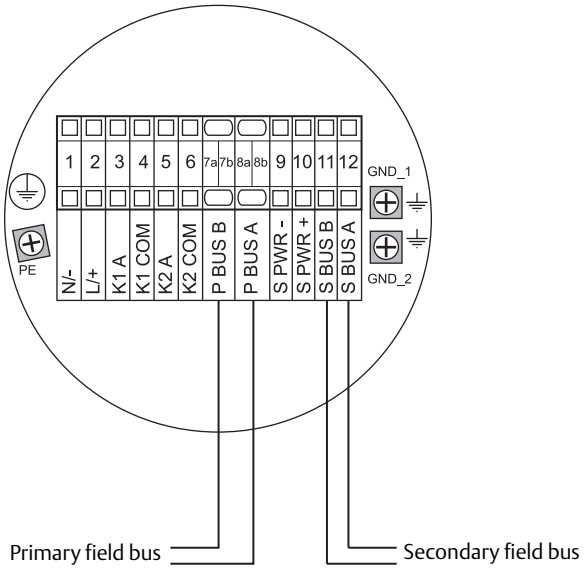


Table 4. Terminal Assignment for Non-Intrinsically Safe Side

Terminal	Designation	Function
1	N/-	Power, Neutral / DC -
2	L/+	Power, Line / DC +
3	K1 A	Relay 1 output (optional). Hardware configurable NO/NC.
4	K1 com	Relay 1 common
5	K2 A	Relay 2 output (optional). Hardware configurable NO/NC.
6	K2 com	Relay 2 common
7a/7b	P Bus B	Primary communication bus B
8a/8b	P Bus A	Primary communication bus A
9	S Pwr -	Secondary bus power - (N/A for Tokyo Keiso)
10	S Pwr +	Secondary bus power + (N/A for Tokyo Keiso)
11	S Bus B	Secondary communication bus - (Tokyo Keiso Y-wire)
12	S Bus A	Secondary communication bus + (Tokyo Keiso Y-wire)
PE	PE	Power supply protective ground
GND_1	GND_1	Housing chassis/shield Primary bus
GND_2	GND_2	Housing chassis/shield Secondary bus

1. *Consult the Tokyo Keiso Electrical Installation Drawing (D7000003-779) for further information.*

3.0 Configuration

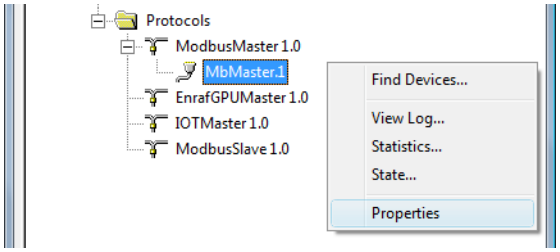
The Rosemount 2410 Tank Hub is configured by using the TankMaster WinSetup configuration program[1]. WinSetup is a user-friendly software package that includes basic configuration options as well as advanced configuration and service functions.

Configuration of the Rosemount 2410 Tokyo Keiso emulation function can be performed with the WinSetup program using the FBM or a RS485 converter, depending on the tank hub configuration.

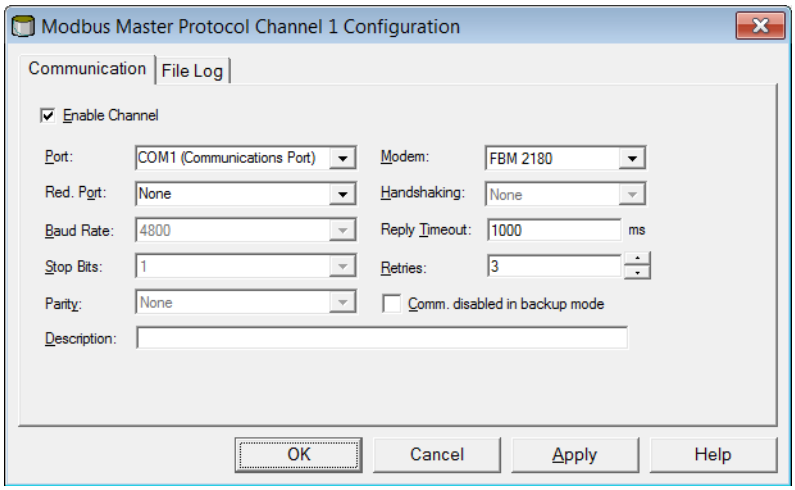
3.1 Set up Modbus communication protocol

This section describes how to configure the Modbus Master protocol channel for communication. To specify PC communication port and the standard communication parameters, do the following:

1. Open the **Protocols** folder in the *Workspace* window.
2. Select the **Modbus Master** icon.



3. Right click the proper **MBMaster** icon and select **Properties** to configure the protocol channel.
4. Select the **Communication** tab.



1. *See the Rosemount Tank Gauging System Configuration Manual for more information on how to use the TankMaster WinSetup software to configure the Rosemount 2410 Tank Hub.*

5. Set the communication parameters:

	FBM	RS485 converter
Port	The COM port the FBM is connected to	The COM port the converter is connected to
Baud rate	4800	9600
Stop bits	1	1
Parity	None	None
Modem	FBM 2180	RS-485
Handshaking	None	RTS/CTS
Reply timeout	1000 ms	1000 ms
Retries	3	3
Description	Text describing the configured channel	Text describing the configured channel

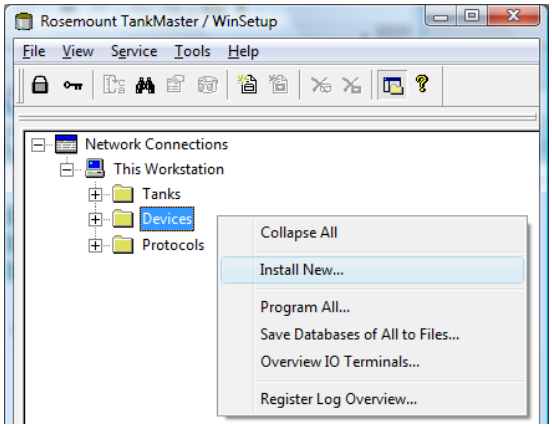
6. Select the **Enable Channel** check box to activate the protocol channel.
7. Select **OK** to store the current configuration and close the configuration window.

3.2 Install Rosemount 2410 Tank Hub in WinSetup

The TankMaster WinSetup wizard is the recommended tool for installing the tank hub. The installation wizard covers basic configuration of the tank hub.

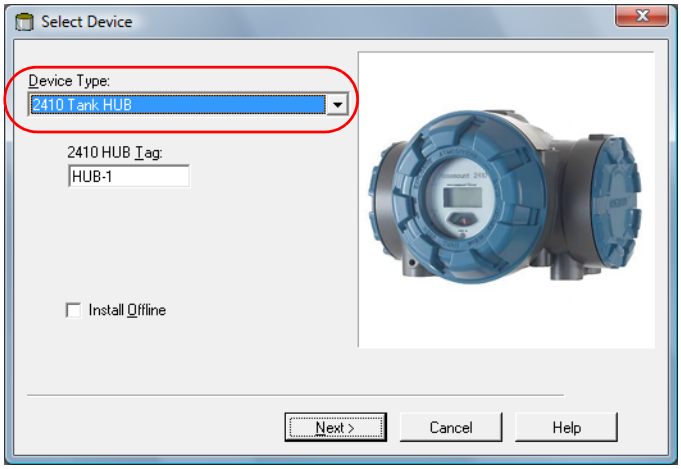
Perform the following steps to start the installation wizard in TankMaster WinSetup:

1. In the *Workspace* window select the **Device** folder.



2. Right click and select **Install New**, or from the *Service* menu select the **Devices/Install New** option. The *Select Device* window appears.

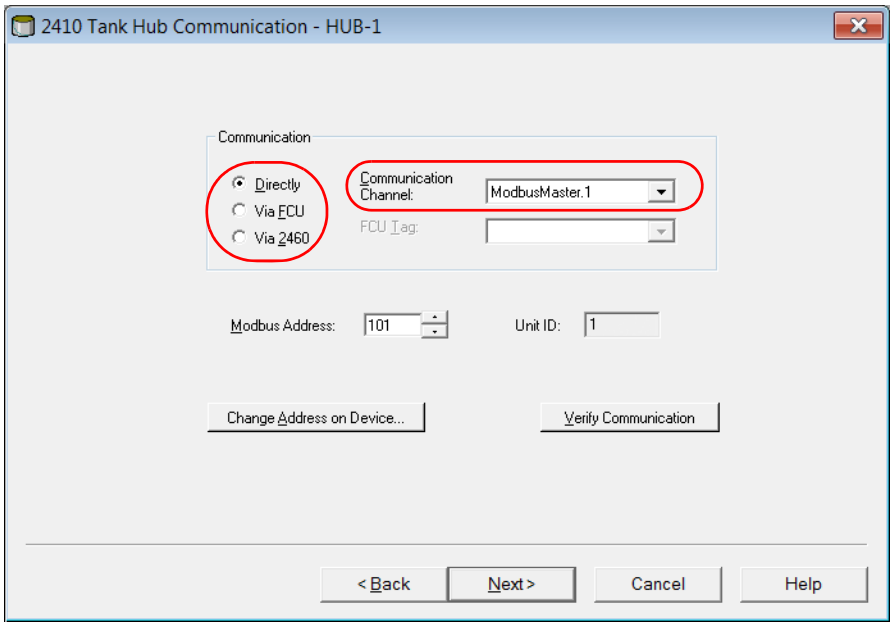
3. From the *Device Type* drop-down list, select the **2410 Tank Hub** option.



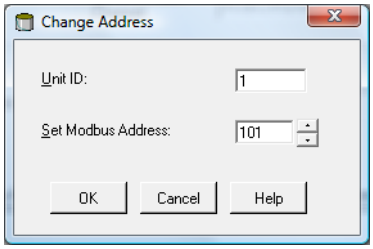
4. Type a name on the *2410 HUB Tag* field.
   The 2410 Hub Tag will be used as an identifier for the tank hub in various windows and dialogs.

5. Select **Next**. The *2410 Tank Hub Communication* window appears.

6. Make sure TankMaster communicates directly with the tank hub and that the proper communication channel is chosen.



7. Default Modbus Address is 247 for the tank hub. It is recommended to change it to an address 101-199. Do the following:
   a. In the *2410 Tank Hub Communication* window select **Change Address on Device...** to open the *Change Address* window.



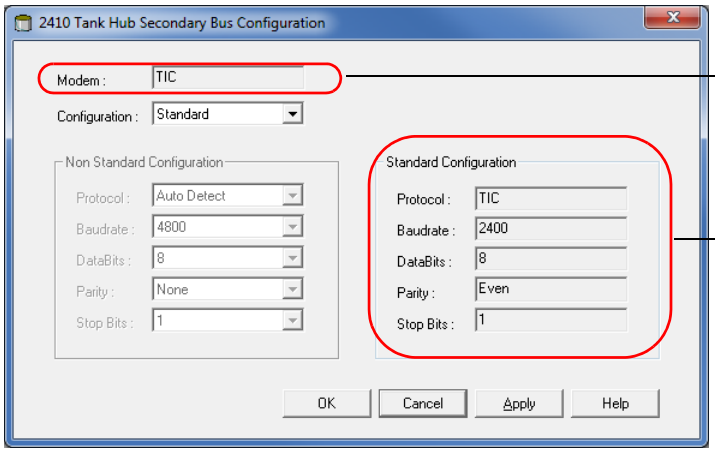
   b. Enter the **Unit ID** and select the new Modbus Address.
   When changing the device address, the Unit ID is used as a unique identifier of the device. The Unit ID can be found on a label mounted on the device.
   c. Select **OK** to confirm the address settings and close the *Change Address* window.
   d. In the *2410 Tank Hub Communication* window select **Verify Communication** to check that communication is established between the TankMaster work station and the tank hub. The **Unit ID** will appear when TankMaster finds the tank hub.
8. In the *2410 Tank Hub Communication* window select **Next** to continue the installation procedure of the tank hub.
9. Continue configuration as usual for a tank hub installation.

3.3 Verify Tokyo Keiso communication parameters

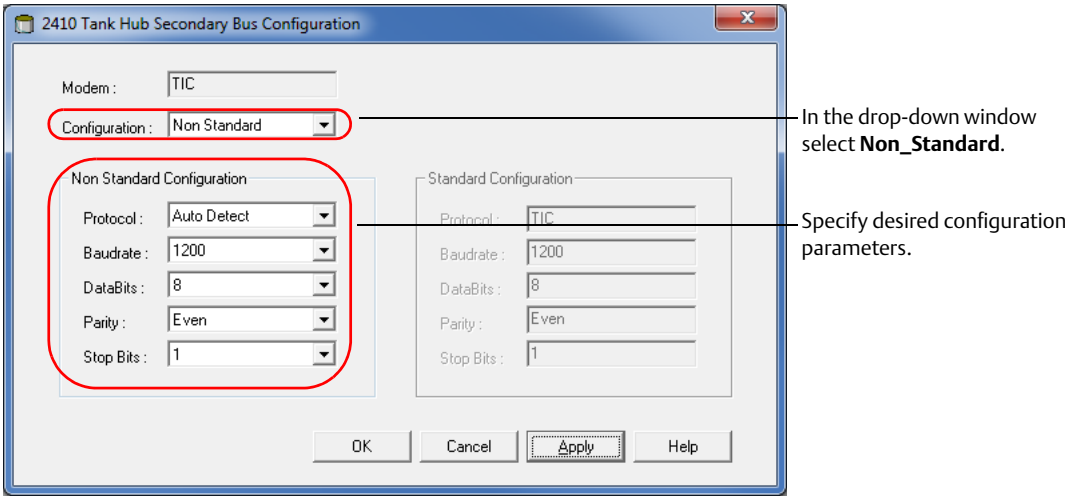
When a Tokyo Keiso modem has been detected by the tank hub, the communication parameters for the interface are automatically configured to the most commonly used parameters:

Start bits	1
Data bits	8
Parity	Odd, Even, None (default Even)
Stop bits	1
Baud rate	300-9600 baud (default 2400)
RxToTx Time	Default 30 ms

1. In the *Workspace* window, right click the Rosemount 2410 icon and select **Properties**. Select the **Configuration** tab, and continue by selecting the **Secondary Bus** button.
2. Check that the modem is detected and that the correct communication parameters are configured.



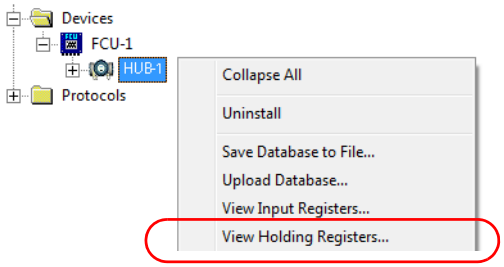
   a. If configuration parameters need to be changed, set Configuration to Non_Standard and change the configuration in the Non Standard Configuration frame.



3.4 Configure specific variables for Tokyo Keiso emulation

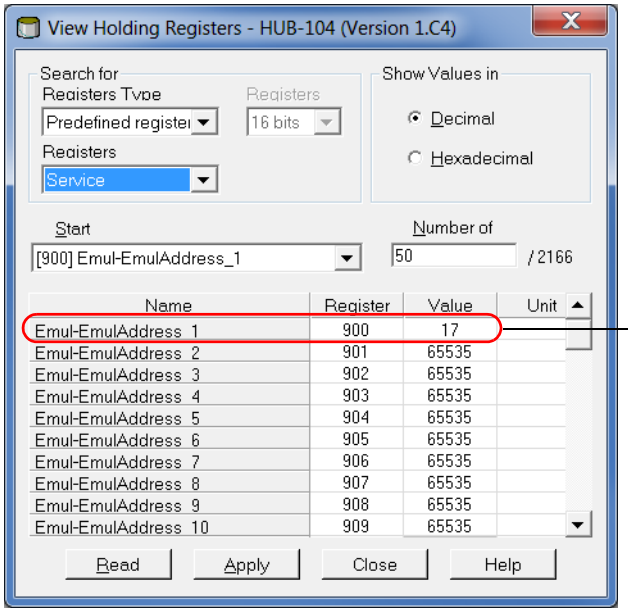
The tank hub holding registers are used to configure the Tokyo Keiso emulation variables.

1. In the *TankMaster WinSetup* workspace window, right click the tank hub device icon.
2. To view the holding registers, select the **View Holding Registers** option.



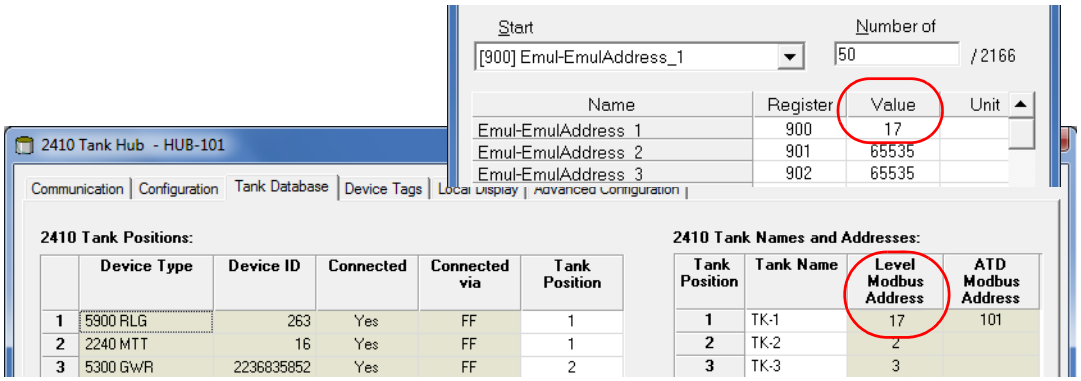
3. When replacing a Tokyo Keiso gauge with a Rosemount device, the Rosemount device must have the same Tokyo Keiso address as the gauge being replaced.

   Enter the required emulation address in holding registers 900-909, valid Tokyo Keiso addresses are 0-255[1].



1. *Emulation address is by default set to "65535" for tank positions that are not in use.*

Tip!
In the Tank Database tab, set the Modbus address to the same as the chosen Tokyo Keiso address for each device.



3.5 Optional Tokyo Keiso emulation configuration

1. Consider optional emulation configuration, see section "Optional Tokyo Keiso emulation configuration" on page 15.

3.6 Configure field devices

When the tank hub configuration is completed, the Rosemount field devices, for example Rosemount 5900 Radar Level Gauge and Rosemount 2240S Multi-input Temperature Transmitter, must be configured as well. The field devices are configured as usual, for further information see the Rosemount Tank Gauging System Configuration Manual.

1. Configure the field devices by using the *Properties* window of each device.
2. Verify that level and temperature values are valid.

3.7 Start Tokyo Keiso emulation

1. If not already connected, connect the tank hub to the Tokyo Keiso host.
2. The tank hub will now automatically switch to Tokyo Keiso mode and act like a Tokyo Keiso gauge.

4.0 Troubleshooting

Communication status

Table 5. Troubleshooting Chart

Problem	Cause
No communication with the tank hub using TRL2 bus or RS485.	1. Incorrect Modbus address. 2. Incorrect communication parameter settings. Check LCD Display during startup, for used settings.
No communication with the tank hub using the Tokyo Keiso bus, and no Tokyo Keiso bytes are received (input register 1256).	1. Tank hub software is older than 1.E2. 2. Tokyo Keiso bus is not connected correctly. 3. Tokyo Keiso bus baud rate is not the same as configured in the tank hub. 4. Tokyo Keiso bus parity is not the same as configured in the tank hub.
No communication with the tank hub using the Tokyo Keiso bus, but the tank hub is receiving Tokyo Keiso requests (input register 1256).	1. Host Tokyo Keiso address is not the same as configured in the tank hub. 2. The tank hub is responding to fast. Change the RxToTx time, see Table 14 on page 20.
Tokyo Keiso level value is received by the host but is incorrect.	1. Tank hub invalid level. 2. Tokyo Keiso adress is not in correct tank hub position. 3. Tank positions 3-10 are used for a tank hub version “Single tank”.
Tokyo Keiso temperature value is received by the host but is incorrect.	1. Tank hub Invalid temperature. 2. Tokyo Keiso adress is not in correct tank hub position. 3. Tank positions 3-10 are used for a tank hub version “Single tank”.

Message status

Verify that communication is working properly, by checking the input registers as described in Table 6. See Table 7 for troubleshooting actions.

Table 6. Messages Input Registers

Register number	Input register	Description
1256	RecMessages	Total queries received.
1258	MessagesToMe	Number of received queries addressed to me.
1260	SentMessages	Number of sent messages.

Table 7. Messages Troubleshooting Chart

Symptom	Action
Input register RecMessages does not enumerate	Check that: ■ cables are properly connected. ■ the tank hub is in Tokyo Keiso mode. ■ the tank hub is configured for Tokyo Keiso emulation.
Input register MessagesToMe does not enumerate	Check that the Tokyo Keiso address is correct.
Input register SentMessages does not enumerate	Check that the host is sending proper requests.

5.0 Optional configuration and settings

5.1 Optional Tokyo Keiso emulation configuration

Engineering units

The tank hub automatically converts all measurement values to the correct engineering unit. No additional configuration is needed.

Gauge type

There are no gauge type settings for Tokyo Keiso emulation.

Invalid level measurements

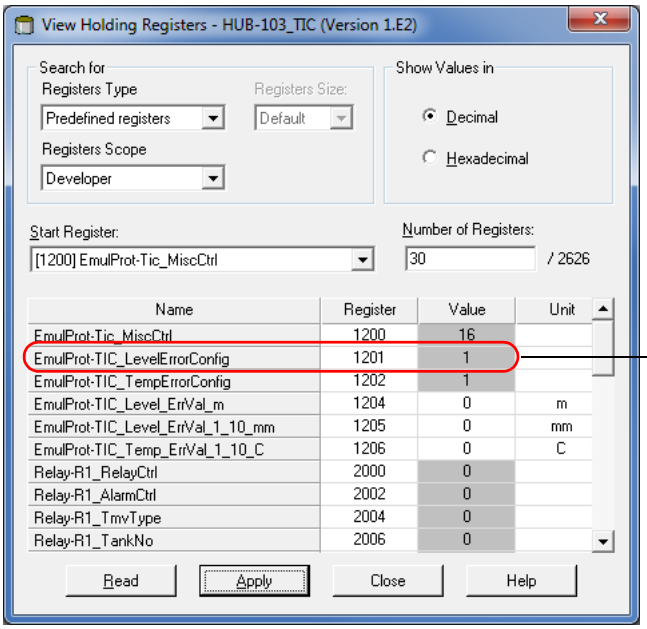
The tank hub reply on the Tokyo Keiso host request command “O” for level can be customized if the level value is invalid.

Use holding register TIC_LevelErrorConfig (1201) to customize your reply configuration. See Table 8 on page 15 and Figure 5 on page 16. This configuration is applicable on all tank positions.

Table 8. Holding Register TIC_LevelErrorConfig 1201

Value	Value definition	Description
0	Default	The tank hub will reply with the default level value 99999.9 mm. It is recommended to keep the configuration as Default.
1	Last_Valid	The tank hub will reply with the last good level value.
2	Invalid_Value	The tank hub will reply with the level value that is present in the tank hub even if the level is considered to be invalid.
3	User_Defined	The tank hub will reply will level value configured in holding registers 1204 and 1205 (see Table 9).

Figure 5. TIC_LevelErrorConfig Example



Example:
Holding register TIC_LevelErrorConfig (1201) is set to value *1*. The tank hub will reply with the last good level value.

Table 9. User Defined Invalid Level Value

Input register	Register number	Default value	Description
Emul_Level_ErrVal_m	1204	0	Meter part of the user defined invalid level value.
Emul_Level_ErrVal_1_10_mm	1205	0	1/10 mm part of the user defined invalid level value.

Invalid temperature measurements

The tank hub reply on the Tokyo Keiso host request commands “O, X, Y and Z” for temperature can be customized if the temperature value is invalid.

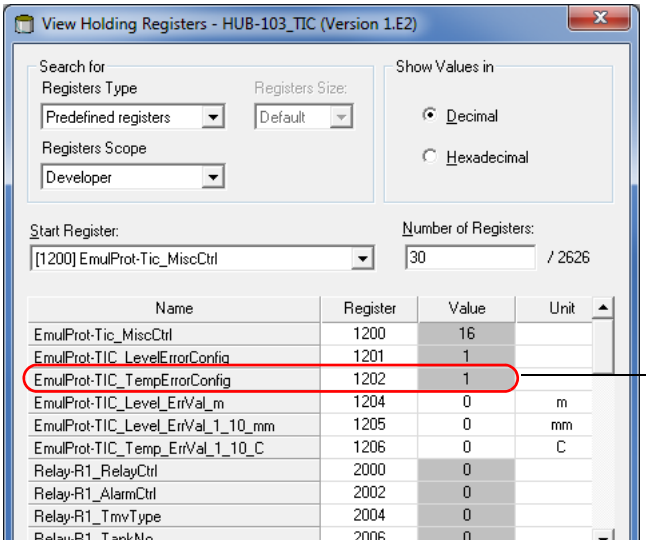
Use holding register TIC_TempErrorConfig (1202) to customize your reply configuration. See Table 10 on page 17 and Figure 6 on page 17. This configuration is applicable on all tank positions.

Table 10. Holding Register TIC_TempErrorConfig (1202)

Value	Definition	Description
0	Default	The tank hub will reply with default temperature value 999.9 °C. It is recommended to keep the configuration as Default.
1	Last Valid	The tank hub will reply with the last good temperature value.
2	Invalid Value	The tank hub will reply with the temperature value that is present in the tank hub even if the temperature is considered to be invalid.(1)
3	User Defined Error Set	The tank hub will reply with the temperature value configured in holding register 1206 (see Table 11). The average temperature status Error (E2) will be set.
4	User Defined No Error Set	The tank hub will reply will temperature value configured in holding register 1206 (see Table 11). The average temperature status Error (E2) will not be set.
5	No Temp installed	All temperature values will be 0xF0 00 (no temperature sensor installed) and Error status will be Normal (0).

1. *Note that the tank hub will use -300.0 °C to indicate invalid temperature (configurable in holding register 6096).*

Figure 6. TIC_TempErrorConfig Example



Example:
Holding register TIC_TempErrorConfig (1202) is set to value *1*. The tank hub will reply with the latest good temperature value.

Table 11. User Defined Invalid Temperature Value

Input register	Register number	Default value	Description
Emul_Temp_ErrVal_1_10_C	1206	0	User defined invalid temperature value in 1/10 °C.

MiscControl

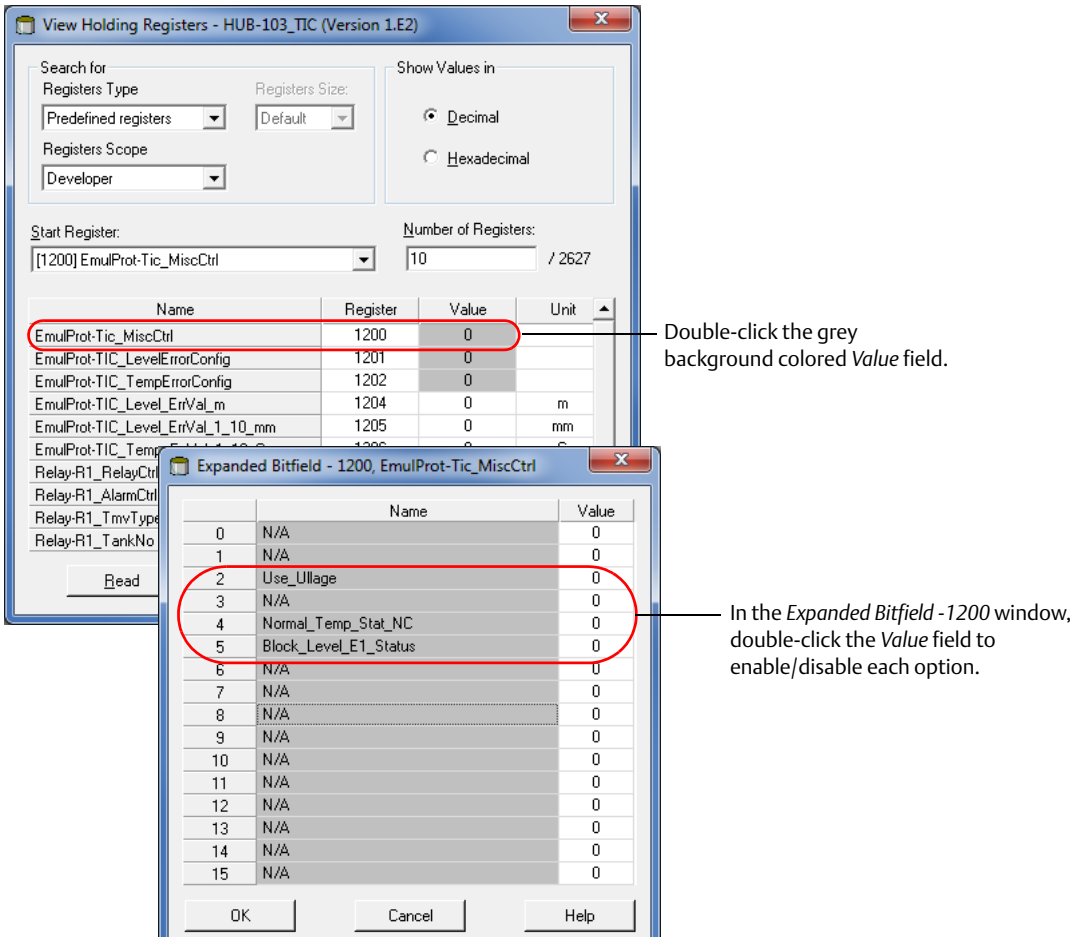
Use holding register 1200 (Tic_MiscControl) to set some optional configuration bits, see Table 12.

Table 12. Holding Register TIC_MiscControl 1200

Bit	Name	Default value	Description
2	Use_Ullage	0x0	By setting bit 2, the tank hub will reply with ullage instead of level.
4	Normal Temp_Status_ NC	0x0	By setting bit 4, the tank hub will reply with 0xF0 00 (No temperature sensor installed) and Error status Normal (0) for all not connected temperature sensors.(1)(2) The number of connected temperature sensors are controlled by holding registers, described in section "Number of connected temperature sensors" on page 19.
5	Block_Level_E1_Status	0x0	By setting bit 5, the tank hub will not indicate invalid level in the reply for Measurement value command O. (Status byte E1).

1. *The holding register TIC_TempErrorConfig (1202) should be set to Default, Invalid value or User Defined.*
2. *The average temperature will be set to 0xF0 00 if no temperature sensors are connected.*

Figure 7. TIC_MiscCtrl



Number of connected temperature sensors

The holding registers described in Table 13 are used to state the number of temperature sensor connected for each tank position.(1)

The values set in these holding registers are only used when the MiscCtrl register bit 4 is enabled (see page 18). All not connected sensors will then have normal error status and value 0xF0 00.

Table 13. Number of Connected Temperature Sensors

Name	Register number	Default value
NoOfsensors_1	2500	16
NoOfsensors_2	2576	16
NoOfsensors_3	2652	16
NoOfsensors_4	2728	16
NoOfsensors_5	2804	16
NoOfsensors_6	2880	16
NoOfsensors_7	2956	16
NoOfsensors_8	3032	16
NoOfsensors_9	3108	16
NoOfsensors_10	3184	16

1. *The holding registers in Table 13 are set when the temperature sensors are configured for average temperature calculation in TankMaster WinSetup. For further information see the ATD Average Temperature Calculation in Rosemount Tank Gauging System Configuration Manual.*

5.2 Advanced communication settings

In some cases, response time or other communication parameters used by the Tokyo Keiso host system or field devices may differ from the standard values. In these situations, the communication parameters can be changed in the tank hub modem settings, by writing to the holding registers described in Table 14.

Table 14. Advanced Communication Settings

Holding register	Register number	Default value	Description
ResponseTimeout	757	0	Maximum time in ms from the request to the reply has to be transmitted by the tank hub. If set to 0, the default response time for the used protocol will be used.
GapTimeout	758	0	Maximum time in ms between characters in a request. If set to 0, an appropriate gap timeout will be calculated from the used baud rate.
RxToTxTime	759	0	Minimum time in ms from the request to the response. If set to 0, the default response time for the used protocol will be used.
TxToRxTime	760	0	Minimum time in ms from the response to the request. If set to 0, the default response time for the used protocol will be used.
ActiveBeforeTx	761	0	Active wait period (RTS) in ms before start of transmission. If set to 0, the default response time for the used protocol will be used.
ActiveAfterTx	762	0	Active wait period (RTS) in ms after start of transmission. If set to 0, the default response time for the used protocol will be used.

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