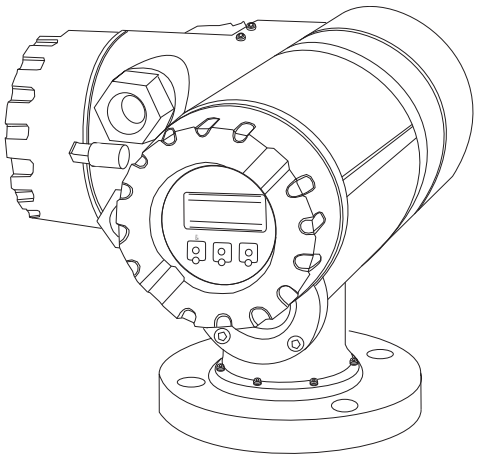
6000 Servo Tank Gauge

Service Manual for Modbus Communication Protocol



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Contents

1 Introduction

This manual explains the operation of the MODBUS protocol per Modicon for document PI-MBUS-300 REV C (1991) implemented in the 6000 Servo Tank Gauge (STG). MODBUS protocol defines the format of data and the techniques used to control the flow of data. In MODBUS, the flow of data between two devices used a master/slave type arrangement. The 6000 STG acts as a MODBUS slave and runs on the EIA (RS)-485 version of the MODBUS communication board.

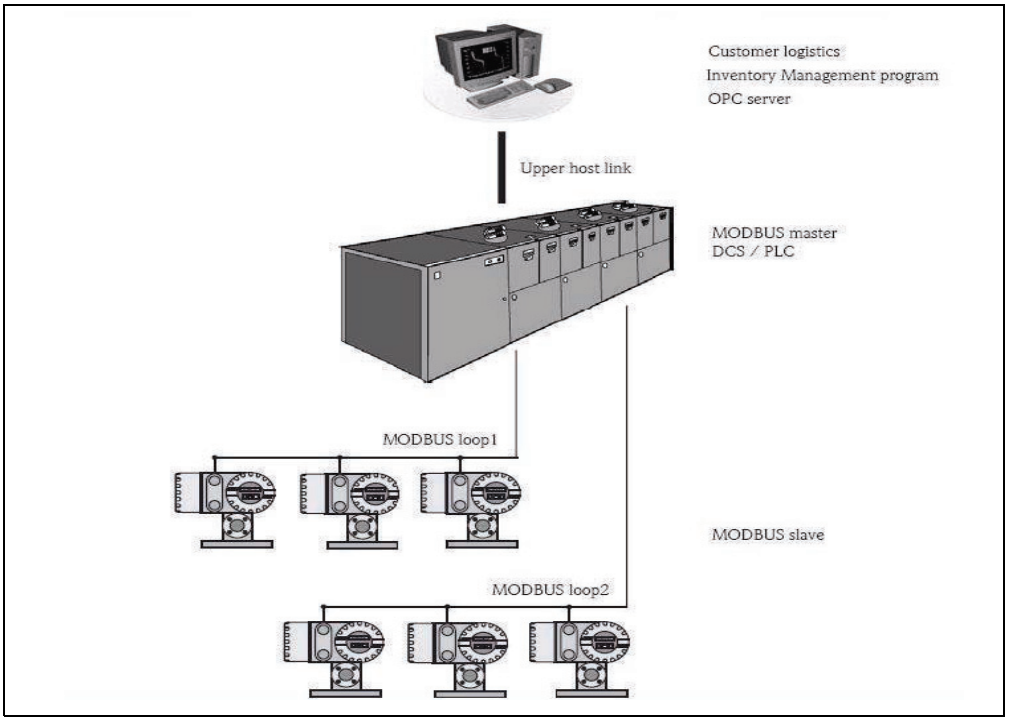


Figure 1-1: Typical device layout for MODBUS communication with 6000 Servo Tank Gauge

2 Implementation

The implementation of the MODBUS protocol for the 6000 STG provides a standard form of digital communication. Every effort has been made to parallel current implementations so that the 6000 STG communicates with existing MODBUS masters.

Check compatibility carefully to ensure that the 6000 STG is properly configured for the data format expected by the host computer. Due to the unique application requirements of the 6000 STG, exceptions have been made and noted.

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

The 6000 STG implementation of the MODBUS protocol provides for the passing of measured and calculated variables, configuration information and diagnostics in data registers. Data is sent in these registers as floating-point values, word values, numeric codes related to configuration lists, status summary words (packed bits) or individual status flags (single bits).

One master and up to 31 6000 STG's may be multi-dropped on a single EIA (RS) 485 communication bus. The MODBUS functions implemented in the 6000 STG are listed in the following table

Function Code	Function	Information Type	MODBUS Nomenclature
03	Read	Word, code, status word, floating point	Read output registers
04	Read	Word, code, status word, floating point	Read input registers
06	Write	Word, Code, status word	Preset single register
16	Write	Word, Code, status word, floating point	Force multiple registers

Table 2-1: MODBUS functions

3 Configuration

The MODBUS port on the 6000 STG must be configured to establish communications. The local display allows the user to set the 6000 STG MODBUS port to match the MODBUS master.

6000 STG addresses provide unique identification for the host. The 6000 STG address is configurable through the local display. The address may range from 1 to 247 and must be unique for each MODBUS device on a loop. Each 6000 STG only responds when a query has been sent to its unique address by the host.

The MODBUS protocol supports two modes of transmission. Remote Terminal Unit (RTU) or ASCII (American Standard Code for Information Interchange). The choice between these two modes is dependent on the preference of the host. RTU is often the preferred protocol because of its improved error detection capabilities and higher throughput. ASCII mode uses ASCII printable characters to pass information compared to the RTU transmission code.

Note! The 6000 STG only supports the RTU mode of MODBUS communications.

3.1 Exception

Because the 6000 STG does not distinguish between inputs and outputs, function codes 01 and 02 as they apply to bits, and function codes 03 and 04 as they apply to numerical values refer to the same data registers.

3.2 Parameters

The EIA (RS) 485 port must be configured for a transmission speed (baud rate). Allowable values are 1200, 2400, 4800, 9600 and 19200 bits per second. This item must be configured using the local display. A summary of the configuration information required by the 6000 STG in order to implement MODBUS is provided in the following table.

Configuration Item	Valid Entries	MODBUS Configurable	Local Display Configurable
MODBUS address	1...247	No	Yes
Baud rate	600 1200 2400 4800 9600 19200	No	Yes
Parity	Odd Even None	No	Yes
Word type	Unsigned Signed	No	No

Table 3-2: MODBUS configuration information

4 Function and Data Formats

The MODBUS data in the 6000 STG is arranged in word registers, floating point registers and status bit registers. The assignment for these registers are found in Section 7 "MODBUS register assignment". The 6000 STG also supports a two 16-bit register floating point data format. Function codes 03 and 04 are used to read these floating point register pairs while function code 16 is used to write the floating point register pairs.

A complete description of all MODBUS commands can be found in the Modicon MODBUS Protocol Reference Guide, document number PI-MBUS-300.

4.1 Word Registers

Word registers holding 16-bits of data (sometimes referred to as Integers) are the most commonly used type of MODBUS data and are supported by most MODBUS hosts. In the 6000 STG implementation, the MODBUS word registers are used to transfer one of the following four formats:

- Word data (unsigned) – a scaled number from 0 to 65535.
- Integer Data (signed) – a scaled number from -32768 to +32767.
- Coded Data – Multiple choice configuration data chosen from a coded list.
- Packed Bit Data – Registers form of 16 packed single bits.

The word and coded data registers contain all of the information needed to configure and read process data. Any word register may be read with function code 03 or function code 04. These same registers may be written one at a time with function code 06 or multiple registers can be written with function code 16.

4.2 Word Data

The word data (unsigned) is a whole number between 0 and 65535 stored as a 16-bit binary number.

4.3 Integer Data

Integer data (signed) is a scaled number from -32768 to +32767.

4.4 Coded Data

Coded data corresponds to a look-up table value. Data written to these registers must be a valid table entry or the value is rejected. For example within the 6000 STG the units of a value are represented by the HART standard value look-up (see Section 7 "MODBUS register assignments"). Therefore, if the Units value read from a HART device was 45 (002D Hex), the units would be Meters.

4.5 Packed Bits

Packed bits represent 16 individual statuses packed into one register. The status bits have been packed this way for systems that prefer handling only register information. The bits within the packed register are grouped by data function type.

4.6 Floating-Point Registers

Although not part of the MODBUS protocol specification, floating point numbers have been implemented using the IEEE 754 standard 32 bit representation [see IEEE Computer Society (1985) "IEEE Standard for Binary Floating-Point Arithmetic, IEEE Std. 754-1985" for complete technical information on this format]. Floating point numbers increase accuracy and reduce the complexity required in scaling word values and provide a means to transmit numbers used by the 6000 STG Tank Gauge that are not easily scaled.

5 Exception Responses

The exception responses returned by the 6000 STG are listed below.

Exception	Response	Reason
01	Illegal function	Attempt to use functions that are not supported
02	Illegal data address	Data address (bit or register) is not defined
03	Illegal data value	Data value being written is out of range
10 (0x0A)	Value read only	Data address being written is read only

Table 5-3: MODBUS exception responses

In addition, messages that are received with a parity error, checksum error or message format error will be ignored.

6 Hardware Implementation

The 6000 STG uses a 2-Wire EIA (RS) 485 hardware interface to communicate with the MODBUS master. EIA (RS) 485 is a high speed differential communications network which allows up to 32 devices to operate on one network. The 6000 STG and MODBUS master share a twisted pair wire to communicate.

The communication distance EIA (RS) 485 can reliably travel depends on baud rate (communication speed), wire quality, environmental electrical noise, wiring configuration and the number of multi-dropped 6000 STG's. The recommended wire for an EIA (RS) 485 system is 18-gauge or larger, shielded, twisted pairs. The shield should be grounded at the MODBUS master (control system or computer) end.

6.1 Termination

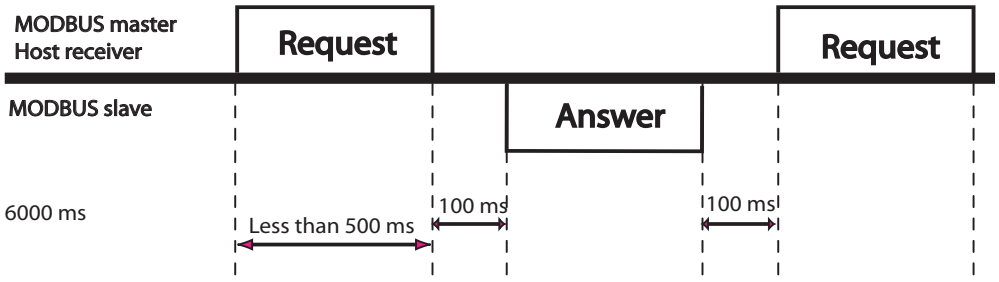
Termination resistors should be placed at each end of the communication bus to minimize reflections on the line. If multiple 6000 STG's are connected using MODBUS communication, then an adjustment must be made on the MODBUS communication board.

6.2 RS-485 MODBUS Interface

There are various methods of interfacing a RS-485 MODBUS loop to the control system. The method used will depend on the system and software being installed. However, if a PC RS-485 interface is required, it is recommended that this be an internal industrial specification interface card (e.g. ISA, PCI, PCMCIA) providing galvanic isolation and lightening protection and not an external RS-232 to RS-485 converter.

6.3 MODBUS Transmission Sequence

The 6000 STG Servo Host receiver MODBUS communication shall have an ideal sequence in order to perform smooth data transmission and avoid unnecessary data loss.



Note! 100 millisecond time between "Request" from the MODBUS host to "Answer" by the Servo Tank Gauge will ensure safe data acquisition especially when the transmission distance is relatively long (max. loop distance limited to 1200m).

7 Modbus Register Assignment

7.1 MODBUS Registers for Primary Information

MODBUS Register *1	Code	Data Item	Data Range	Unit (default)	Note	Data Format	GVH *2	Remarks
1	03/04	Displacer Position	0 ~ 65535.0	mm		Float	000	*3
2								
3	03/04	Liquid Level	0~65535.0	mm		Float	008	*3
4								
5	03/04	Liquid Temperature	-200.0 ~ 360.0	℃	10^{-1}	Integer	010	*4
6	03/04	Average Gas Temperature	-200.0 ~ 360.0	℃	10^{-1}	Integer	013	*4
7	03/04	HART Device 1 Data				Float	011	
8								
9	03/04	Hart Device 2 Data				Float	012	
10								
11	03/04	Water Bottom Level	0~65535.0	mm		Float	014	*3
12								
13	03/04	Upper Density	0~3.2767	g/ml	10^{-4}	Word	005	
14	03/04	Middle Density	0~3.2767	g/ml	10^{-4}	Word	006	
15	03/04	Lower Density	0~3.2767	g/ml	10^{-4}	Word	007	
16	03/04	Upper Interface Level	0~65535.0	mm		Float	002	*3
17								
18	03/04	Middle Interface Level	0~65535.0	mm		Float	003	*3
19								
20	03/04	Tank Bottom Level	0~65535.0	mm		Float	004	*3
21								
22	03/04	Gauge Status	0~31			Word	021	*5
23	03/04	Balance Signal	0~1			Word	022	
24	03/04	Device Error	0~999			Word	036	*6
25	03/04	Level Alarm	0~3			Word	034	
26		Spare						
27	06/16	Gauge Operation	0~10		Preset	Word	025	*7
28	06/16	Density Operation Select	0~3		Preset	Word	840	*8
29		Spare						

Table 7-4: MODBUS registers for primary information

Remarks:

1. Depending on the MODBUS function code selected, the following offset values must be added.
   - function code 03: 40000
   - function code 04: 30000

2. GVH represents the location of the data or parameters that are stored in the 6000 STG Servo matrix (See the matrix chart in the 6000 STG-Installation & Operations manual for the name and definition of specific matrix positions).
   - G: represents the matrix group
   - V: vertical row of selected matrix group
   - H: horizontal row within the selected vertical row in the matrix group

3. Units related to “Length” are available from mm, cm, m, ft and in. The selection of units must be configured at GVH 760 “LEV. UNIT (HOST)” in the servo.

4. Units related to “Temperature” are available in °C or °F. The selection of units must be configured at GVH 761 “TEMP. UNIT (HOST)” in the servo.

Note! Units related to “density” for the MODBUS communication are only available in g/ml. The desired density unit display, however, can be expressed on the display unit of servo by configuring the desired parameter on GVH 767 “DEN.UNIT”.

5. Refer to the Gauge Status code in section 8.1.

6. Refer to the Device Error Status code in section 8.2.

7. Refer to the Gauge Operation code in section 8.3.

8. Selection of density operation command.
   - 0: Spot Upper Density
   - 1: Tank Profile
   - 2: I/F Profile
   - 3: Manual I/F Profile

Note! The actual measured data and parameters in MODBUS register 13 and 62~100 depend on the type of density operation entered.

7.2 MODBUS Registers for Specific Temperature Data

Individual element position and measured value are available when the servo is connected to the N453X Average Temperature Sensor and Converter (ATC).

MODBUS Register *1	Code	Data Item	Data Range	Unit (default)	Note	Data Format	GVH *2	Remarks
30	03/04	NMT Element Temp. 1	-200.0~360.0	℃	10^{-1}	Integer	450	*4
31	03/04	NMT Element Temp. 2	-200.0~360.0	℃	10^{-1}	Integer	451	*4
32	03/04	NMT Element Temp. 3	-200.0~360.0	℃	10^{-1}	Integer	452	*4
33	03/04	NMT Element Temp. 4	-200.0~360.0	℃	10^{-1}	Integer	453	*4
34	03/04	NMT Element Temp.5	-200.0~360.0	℃	10^{-1}	Integer	454	*4
35	03/04	NMT Element Temp. 6	-200.0~360.0	℃	10^{-1}	Integer	455	*4
36	03/04	NMT Element Temp. 7	-200.0~360.0	℃	10^{-1}	Integer	456	*4
37	03/04	NMT Element Temp. 8	-200.0~360.0	℃	10^{-1}	Integer	457	*4
38	03/04	NMT Element Temp. 9	-200.0~360.0	℃	10^{-1}	Integer	458	*4
39	03/04	NMT Element Temp. 10	-200.0~360.0	℃	10^{-1}	Integer	459	*4
40	03/04	NMT Element Temp. 11	-200.0~360.0	℃	10^{-1}	Integer	473	*4*9
41	03/04	NMT Element Temp. 12	-200.0~360.0	℃	10^{-1}	Integer	473	*4*9
42	03/04	NMT Element Temp. 13	-200.0~360.0	℃	10^{-1}	Integer	473	*4*9
43	03/04	NMT Element Temp. 14	-200.0~360.0	℃	10^{-1}	Integer	473	*4*9
44	03/04	NMT Element Temp. 15	-200.0~360.0	℃	10^{-1}	Integer	473	*4*9
45	03/04	NMT Element Temp. 16	-200.0~360.0	℃	10^{-1}	Integer	473	*4*9
46	03/04	NMT Element Position 1	0~65535	mm		Word	460	*3
47	03/04	NMT Element Position 2	0~65535	mm		Word	461	*3
48	03/04	NMT Element Position 3	0~65535	mm		Word	462	*3
49	03/04	NMT Element Position 4	0~65535	mm		Word	463	*3

MODBUS Register *1	Code	Data Item	Data Range	Unit (default)	Note	Data Format	GVH *2	Remarks
50	03/04	NMT Element Position 5	0~65535	mm		Word	464	*3
51	03/04	NMT Element Position 6	0~65535	mm		Word	465	*3
52	03/04	NMT Element Position 7	0~65535	mm		Word	466	*3
53	03/04	NMT Element Position 8	0~65535	mm		Word	467	*3
54	03/04	NMT Element Position 9	0~65535	mm		Word	468	*3
55	03/04	NMT Element Position 10	0~65535	mm		Word	469	*3
56	03/04	NMT Element Position 11	0~65535	mm		Word	477	*3*9
57	03/04	NMT Element Position 12	0~65535	mm		Word	477	*3*9
58	03/04	NMT Element Position 13	0~65535	mm		Word	477	*3*9
59	03/04	NMT Element Position 14	0~65535	mm		Word	477	*3*9
60	03/04	NMT Element Position 15	0~65535	mm		Word	477	*3*9
61	03/04	NMT Element Position 16	0~65535	mm		Word	477	*3*9

Table 7-5: MODBUS registers for specific temperature data

Remarks:

9. The NMT Element 11~16 temperature and position must be configured on the matrix position GVH 470 “SELECT POINT” when these values need to be visualized on the servo’s display.

7.3 MODBUS Registers for Specific Density Data

The measured value of the “Density Profile” operation can be transmitted on the MODBUS communication.

Note! The optional measuring function code within the Servo’s order structure must be selected in order to perform the density profile.

MODBUS Register *1	Code	Data Item	Data Range	Unit (default)	Note	Data Format	GVH *2	Remarks
62	03/04	Density Profile Operation Status	0~9			Word	850/950	*8*10
63	03/04	Level Condition	0~9			Word	851/951	*11
64	03/04	Operation Time (Day)	00~31	DD		Word		
65	03/04	Operation Time (Time)	0000~2459	HH MM		Word	852	
66	03/04	I/F Level	0~65535	mm		Word	953	
67	03/04	Average Profile Density	0~3.2767	g/ml	10^{-4}	Word	854/954	
68	03/04	Average Temp.	-200.0~360	℃	10^{-1}	Integer	855/955	
69	03/04	Profile Density 01	0~3.2767	g/ml	10^{-4}	Word	860/960	
70	03/04	Profile Density 02	0~3.2767	g/ml	10^{-4}	Word	861/961	
71	03/04	Profile Density 03	0~3.2767	g/ml	10^{-4}	Word	862/962	
72	03/04	Profile Density 04	0~3.2767	g/ml	10^{-4}	Word	863/963	
73	03/04	Profile Density 05	0~3.2767	g/ml	10^{-4}	Word	864/964	
74	03/04	Profile Density 06	0~3.2767	g/ml	10^{-4}	Word	865/965	
75	03/04	Profile Density 07	0~3.2767	g/ml	10^{-4}	Word	866/966	
76	03/04	Profile Density 08	0~3.2767	g/ml	10^{-4}	Word	867/967	
77	03/04	Profile Density 09	0~3.2767	g/ml	10^{-4}	Word	868/968	
78	03/04	Profile Density 10	0~3.2767	g/ml	10^{-4}	Word	869/969	
79	03/04	Profile Density 11	0~3.2767	g/ml	10^{-4}	Word	870/970	
80	03/04	Profile Density 12	0~3.2767	g/ml	10^{-4}	Word	871/971	
81	03/04	Profile Density 13	0~3.2767	g/ml	10^{-4}	Word	872/972	

MODBUS Register *1	Code	Data Item	Data Range	Unit (default)	Note	Data Format	GVH *2	Remarks
82	03/04	Profile Density 14	0~3.2767	g/ml	10^{-4}	Word	873/973	
83	03/04	Profile Density 15	0~3.2767	g/ml	10^{-4}	Word	874/974	
84	03/04	Profile Density 16	0~3.2767	g/ml	10^{-4}	Word	875/975	
85	03/04	Profile Position 01	0~65535	mm		Word	880/980	
86	03/04	Profile Position 02	0~65535	mm		Word	881/981	
87	03/04	Profile Position 03	0~65535	mm		Word	882/982	
88	03/04	Profile Position 04	0~65535	mm		Word	883/983	
89	03/04	Profile Position 05	0~65535	mm		Word	884/984	
90	03/04	Profile Position 06	0~65535	mm		Word	885/985	
91	03/04	Profile Position 07	0~65535	mm		Word	886/986	
92	03/04	Profile Position 08	0~65535	mm		Word	887/987	
93	03/04	Profile Position 09	0~65535	mm		Word	888/988	
94	03/04	Profile Position 10	0~65535	mm		Word	889/989	
95	03/04	Profile Position 11	0~65535	mm		Word	890/990	
96	03/04	Profile Position 12	0~65535	mm		Word	891/991	
97	03/04	Profile Position 13	0~65535	mm		Word	892/992	
98	03/04	Profile Position 14	0~65535	mm		Word	893/993	
99	03/04	Profile Position 15	0~65535	mm		Word	894/994	
100	03/04	Profile Position 16	0~65535	mm		Word	895/995	

Table 7-6: MODBUS registers for specific density data

Remarks

10. Refer to the Density Profile Operation Status code in section 8.4.
11. Refer to the Density Profile Level Condition code in section 8.5.

7.4 Compatible MODBUS Registers for the 4590 Tank Side Monitor (TSM)

The following MODBUS registers contain exactly the same values and parameters as were described in 7.1~7.4. These are, in addition, available in specific MODBUS register addresses that are used in the 4590 TSM.

MODBUS Register *1	Code	Data Item	Data Range	Unit (default)	Note	Data Format	GVH *2	Remarks
3001	03/04	Liquid Level	0~65535.0	mm		Float	008	*3
3002								
3003	03/04	Displacer Position	0~65535.0	mm		Float	000	*3
3004								
3005	03/04	Liquid Temperature	-200.0~360.0	°C	10^{-1}	Float	010	*4
3006								
3007	03/04	HART Device 1 Data				Float	011	
3008								
3009	03/04	HART Device 2 Data				Float	012	
3010								
3011	03/04	Spare	0000					
3012	03/04	Spare	0000					
3013	03/04	Upper Density	0~3.2767	g/ml	10^{-4}	Float	005	
3014								
3015	03/04	Water Bottom Level	0~6553.0	mm		Float	014	*3
3016								
3017	03/04	Average Gas Temperature	-200.0~360.0	°C	10^{-1}	Float	013	*4
3018								

Table 7-7: Compatible MODBUS registers for the 4590 Tank Side Monitor (TSM)

Note!

7.4 MODBUS registers only contains primary value and parameters which can be shared by both the servo and 4590 TSM. In contrast, each instrument has several device designated functions which are not implemented in the other (e.g. Destiny Profile Operation: Servo only, Calculated volume: 4590 TSM only).

8 Servo Tank Gauge Specific Codes

Since the servo is an intelligent gauge that performs both measurement and data transmission at the same time, device specific gauge status, error and operation codes have been implemented to monitor the operational condition.

8.1 Gauge Status Code

Code	Description	Remarks
0	No definition	
1	Displacer at reference position	
2	Displacer hoisting up	
3	Displacer going down	
4	Displacer stop	
5	Level measurement, balanced	
6	Up. I/F level, balanced	*1
7	Mid. I/F level, balanced	*1
8	Bottom measurement, balanced	*1
9	Upper Density, finished	*1
10	Middle Density, finished	*1
11	Bottom Density, finished	*1
12	Release over tension	
13	Calibration activated	
14	Seek level	
15	Follow level	
16	Seek Upper Density	*1
17	Seek Middle Density	*1
18	Seek Density Bottom	*1
19	Seek Upper I/F level	*1
20	Follow up. I/F level	*1
21	Seek Mid. I/F level	*1
22	Follow Mid. I/F level	*1
23	Seek Bottom Level	
24	Not initialized	
25	Stopped at High Stop	
26	Stopped at Low Stop	
27	Repeatability testing	
28	Seeking water level	*1
29	Water level, balanced	*1

Code	Description	Remarks
30	Follow water level	*1
31	Over/Under tension	

Table 8-8: Gauge status code

Remarks

1. Status available when the 6000 STG is implemented with Interface and Density measurement functionality.

8.2 Device Error Code

Error Code	Description	Definition	Remarks
0	No error	No error present	
101	OVER TENSION	Measured displacer weight exceeds the Over Tension set point at GVH 162	
102	UNDER TENSION	Measured displacer weight reduced below the Under Tension set point at GVH 163	
106	Z PHASE NO INPUT (2ND)	Unable to recognize Z phase pulse (1 complete rotation of encoder) to CPU after retry	
107	ADC/SENSOR ERROR	Signal from A/D converter out of the range	
111	LOCAL ERROR NMT	Recognized device error at the N453X ATC (Average Temperature)	*2
112	Z PHASE NO INPUT (1st)	Unable to recognize Z phase pulse (1 complete rotation of encoder) to CPU	
113	LOCAL ERROR NRF	Recognized device error at the N4560 Servo Monitor	*3
114	SIFA ERROR	Local HART master IC failure on the 6000 STG servo	
115	WIRE CALIB, ERROR	Excess auto wire calibration range (e.g. build up on the wire)	
120	DISPLACER CALIB. ERROR	Excess auto weight calibration range (e.g. deposit and build up on the displacer)	
121	LCD CHECK	Recognized error of the display panel 3 keys control input to the CPU	
122	A PHASE NO INPUT	Unable to recognize A phase pulse (20 pulse/1 rotation of encoder) to the CPU	
124	POWER FAILURE	Supply voltage drop below allowable value	
201	MEMORY ERROR	Memory defect in W&M parameters	
232	LOCAL ERROR DEVICE 1	Recognized device error at connected HART Device 1	*3
233	LOCAL ERROR DEVICE 2	Recognized device error at connected HART Device 2	
240	DEVICE ERROR NRF	Local HART communication error to the N4560 Servo Monitor	
250	DEVICE ERROR NMT	Local HART communication error to the N453X ATC	
130	DEVICE ERROR: DEVICE 1	Local HART communication error to HART device 1	*3
131	DEVICE ERROR: DEVICE 2	Local HART communication error to HART device 2	*3
132	ROM ERROR	Failure in the EEPROM data	
133	ECONOUCE CONTACT ON	Status input activated via connected switch (e.g. Leak detector, level alarm switch)	

Table 8-9: Device error code

Remarks

2. Error code available only when the N453X ATC or 3 wire RTD SPOT temperature bulb is connected.
3. Error code available only when the N4560 Servo Monitor or HART device 1/2 is connected.

8.3 Gauge Operation Code

Code	Description	Remarks
0	LEVEL	
1	UP	
2	STOP	
3	BOTTOM LEVEL	
4	UPPER I/F LEVEL	*1
5	MIDDLE I/F LEVEL	*1
6	UPPER DENSITY	*1*4
7	MIDDLE DENSITY	*1
8	BOTTOM DENSITY	*1
9	REPEATABILITY	
10	WATER DIP	*1

Table 8-10: Gauge operation code

Remarks

4. The Upper Density operation command can initiate several density measurement functions depending on the selection made at the MODBUS register 28 or GVH 840 “OPE.SELECT.” Refer to the installation and operation manual about the definition of the various density measurements.

8.4 Density Profile Operation Status

The newly implemented "Density Profile" function requires certain conditions to be established prior to the operation. Also, this feature ensures proper operation throughout its sequence.

Code	Description	Definition	Remarks
0	ACCEPTING	Accepting density profile command.	*5
1	STANDBY	Command accepted, waiting for other parameters to be prepared for the measurement.	*6
2	IN OPERATION	In Tank Profile (density profile throughout the tank) operation.	
3	OPR.END	Density profile measurement operation finished normally.	
4	UN_BALANCE_ERR	Error condition report, displacer could not balance during STANDBY/measuring position.	*7
5	OPR. ERR.STOP	Error condition report based on incomplete operation, displacer shall return to level.	
6	I/F OPERATION	In Interface Profile (density profile within upper layer) operation.	
7	I/F ERR. STOP	Error condition report caused by incomplete I/F Profile measurement.	
8	I/F MANU. OPE	In Manual Interface Profile (density profile within upper layer with manually entered interface level) operation.	*8
9	END/LEVEL SHORT	Error condition report caused by too low a level.	*9

Table 8-11: Density profile operation status

Remarks

5. All three density profile operations (Tank Profile, I/F Profile and Manual I/F Profile) always start from the liquid level measurement. The density profile operation command will not be accepted unless the displacer of the Servo Tank Gauge is at the liquid level.

6. Density profile measurement requires the following condition to be satisfied.

   Liquid level movement: The operation requires a stable liquid level. The parameter can be configured at the following matrix.

   -GVH844 "BAL.LEVEL": Default 2.0mm. Range 1.0~99.9mm

   The liquid level is continuously monitored every 5 minutes. The condition is met when the liquid movement stays within this set parameter.

7. The displacer must balance in order to perform stable density measurement. Each balancing position has a waiver (waiting period) before cancelling the operation.

   -GVH847 "OPE.Wait Time": Default 1min. Range 0~99 min.

   If the condition in GVH847 "BAL. LEVEL" is not satisfied, the time set in this matrix will be a waiver before the entire operation is cancelled.

   -GVH845 "UP Wait Time": Default 1 min., Range 0~99 min.

-GVH846 “LIQ Wait Time”: Default 1 min., Range 0~99 min.

8. Interface level value has to be manually entered in GVH842 “I/F Man.Level” before the operation command is issued.
9. The operation will be ignored if the level is too close to tank floor. Default setting is 300mm.

8.5 Density Profile Level Condition

Designated displacer balance status for the density profile measurement.

Code	Description	Definition	Remarks
0	Off level measurement	Displacer is not positioned at the liquid level.	
1	Stable	Displacer balanced at liquid level.	
2	Unstable	Displacer unbalanced (seeking) at liquid level.	
3	Ignore Condition	Density Profile operation without confirming the level condition or displacer location.	*10

Table 8-12: Density profile level condition

Remarks

10. Maintenance purpose only!

9 MODBUS Example Telegram

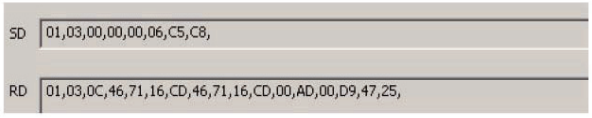
9.1 2 Registered Data Request from Address 0000 (Function Code 03)

- Gauge position data 4671179A (15429.9mm)

9.2 1 Registered Data Request from Address 0004 (Function Code 04)

- Temperature data 00AD (17.3°C)

9.3 6 Registered Data Request from Address 0000 (Function Code 03)

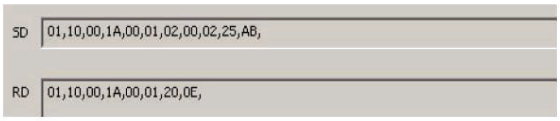


- Gauge position data 467116CD (15429.7mm)
- Level data 467116CD (15429.7mm)
- Temperature data 00AD (17.3°C)
- Gas Temperature data 00D9 (21.7°C)

9.4 0X0001 Writing in Address 001 (Function Code 06)

- Gauge operation command: UP

9.5 0x0002 Writing in Address 001A (Function Code 16)



- Gauge operation command: STOP

10 Configuration for MODBUS

The 6000 STG provides configuration parameters to meet the MODBUS communication system compatibility.

10.1 Communication Speed (RS485 Baud Rate)

The communication speed and parity can be configured based on the MODBUS communication environment.

Matrix position: GVH295 "MODBUS Config"

0:1200bps/ EVEN parity

1: 1200bps/ ODD parity

2: 1200bps/ NONE parity

3: 2400bps/ EVEN parity

4: 2400bps/ ODD parity

5: 2400bps/ NONE parity

6: 4800bps/ EVEN parity

7: 4800bps/ ODD parity

8: 4800bps/ NONE parity

9: 9600bps/ EVEN parity

10: 9600bps/ ODD parity

11: 9600bps/ NONE parity

12: 19200bps/ EVEN parity

13: 19200bps/ ODD parity

14: 19200bps/ NONE parity

10.2 Slave Address Setting

The slave address for each connected Servo Tank Gauge on the MODBUS communication loop can be configured.

Matrix position: GVH285 "ADDRESS"

- Default: 1
- Range: 1~247

NOTES

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