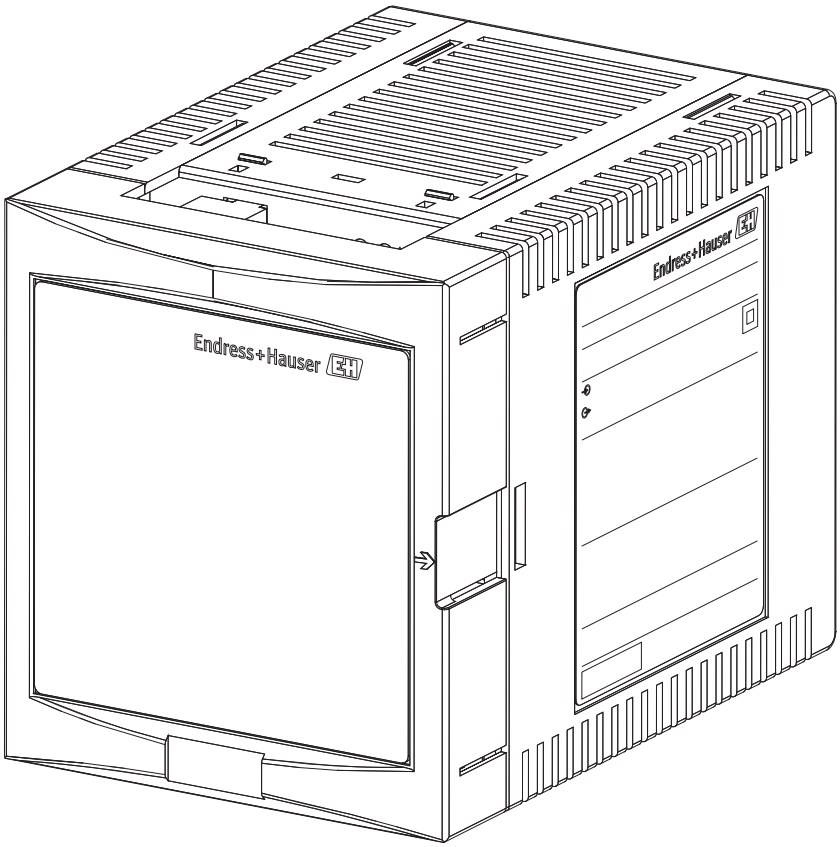
BA01334G/00/EN/01.14
71260207

Valid as of software version:
1.1.0

Modbus Map Protocol
Tankvision Gauge Link NXA20
Enraf BPM / Emerson TRL/2 to RS485 Modbus



Endress+Hauser
People for Process Automation

Table of Contents

1 Document information

1.1 Target audience for this manual

This manual should support during the installation of the NXA20 units. It deals with the mechenical, electrical and signal line installation. The first commisioning steps are described as well.
Beside basic PC operating knowledge no special training is needed to perform the Tank Gauging System operations. Nevertheless it is recommended receiving a training on the system by Endress+Hauser.

1.2 Version history

Document version	Valid for SW version	Changes to the previous version
BA01334G/00/EN/01.14	1.1.0	Initial version

1.3 Document function

1.3.1 Used symbols

Safety symbols

Symbol	Meaning
 A0011189-EN	**DANGER!** This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.
 A0011190-EN	**WARNING!** This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.
 A0011191-EN	**CAUTION!** This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.
 A0011192-EN	**NOTICE!** This symbol contains information on procedures and other facts which do not result in personal injury.

Electrical symbols

Symbol	Meaning
 A0011197	**Direct current** A terminal to which DC voltage is applied or through which direct current flows.
A0011198	**Alternating current** A terminal to which alternating voltage is applied or through which alternating current flows.
 A0011200	**Ground connection** A grounded terminal which, as far as the operator is concerned, is grounded via a grounding system.
 A0011199	**Protective ground connection** A terminal which must be connected to ground prior to establishing any other connections.

Symbols for certain types of information

Symbol	Meaning
 A0011193	**Tip** Indicates additional information.
 A0011195	**Reference to page** Refers to the corresponding page number.
1. , 2. , 3. ...	Series of steps
 A0018373	Result of a sequence of actions

Symbols in graphics

Symbol	Meaning
1, 2, 3 ...	Item numbers
1. , 2. , 3. ...	Series of steps
A, **B**, **C** ...	Views
 A0011187	**Hazardous area** Indicates a hazardous area.
 A0011188	**Indicates a non-hazardous location** Safe area (non-hazardous area)

1.4 Documentation

1.4.1 Operating instructions

Document number	Instrument	Type of Document
BA01334G/00	Tankvision NXA20 Gauge Link	Installation, Operation and Maintenance Manual

2 Basic safety instructions

2.1 Requirements for the personnel

The personnel for installation, commissioning, diagnostics and maintenance must fulfill the following requirements:

- Trained, qualified specialists: must have a relevant qualification for this specific function and task
- Are authorized by the plant owner/operator
- Are familiar with federal/national regulations
- Before beginning work, the specialist staff must have read and understood the instructions in the Operating Instructions and supplementary documentation as well as in the certificates
  (depending on the application)
- Following instructions and basic conditions

The operating personnel must fulfill the following requirements:

- Being instructed and authorized according to the requirements of the task by the facility's owner operator
- Following the instructions in these Operating Instructions

2.2 IT security

We only provide a warranty if the device is installed and used as described in the Operating Instructions. The device is equipped with security mechanisms to protect it against any inadvertent changes to the device settings.

IT security measures in line with operators' security standards and designed to provide additional protection for the device and device data transfer must be implemented by the operators themselves.

2.3 Designated use

2.3.1 Application

The Tankvision Gauge Link is a tank gauging protocol converter to allow integration of third party gauging equipment into the Tankvision system. The Tankvision Gauge Link is available with a range of different field bus interface options. Most field bus interfaces will support connection of a number of gauges in a “multi-drop” or bus configuration. The number of gauges which may be configured in the Tankvision Gauge Link is limited to 32, which should be adequate for most typical tank gauging field busses, however electrical and / or protocol limitations may reduce this number. The functionality which obtains will be determined by that offered by the connected gauge(s) and the interface / protocol.
Connection to the host system is via EIA/TIA-485 (formerly RS-485) Modbus. This is primarily intended for “one-to-one” connection with the Tankvision Tank Scanner or similar device.
The Tankvision Gauge Link must only be used in “safe” areas where there is no hazard from the presence of potentially explosive or flammable atmospheres.
The Tankvision Gauge Link has not been assessed in respect of functional safety. Accordingly it is not intended to be used as a safety critical component or part of a safety critical system or in the implementation of any safety function.

2.4 Workplace safety

For work on and with the device:

- Wear the required personal protective equipment according to federal/national regulations.
- Switch off the supply voltage before connecting the device.

2.5 Operational safety

Risk of injury!

- Operate the device in proper technical condition and fail-safe condition only.
- The operator is responsible for interference-free operation of the device.

Conversions to the device
Unauthorized modifications to the device are not permitted and can lead to unforeseeable dangers

- If, despite this, modifications are required, consult with Endress+Hauser.

Repair
To ensure continued operational safety and reliability,

- Carry out repairs on the device only if they are expressly permitted.
- Observe federal/national regulations pertaining to repair of an electrical device.
- Use original spare parts and accessories from Endress+Hauser only.

2.6 Product safety

The device is designed to meet state-of-the-art safety requirements, has been tested and left thefactory in a condition in which it is safe to operate. The device complies with the applicable standards and regulations as listed in the EC declaration of conformity and thus complies with the statutory requirements of the EG directives. Endress+Hauser confirms the successful testing of the device by affixing to it the CE mark.

3 Identification

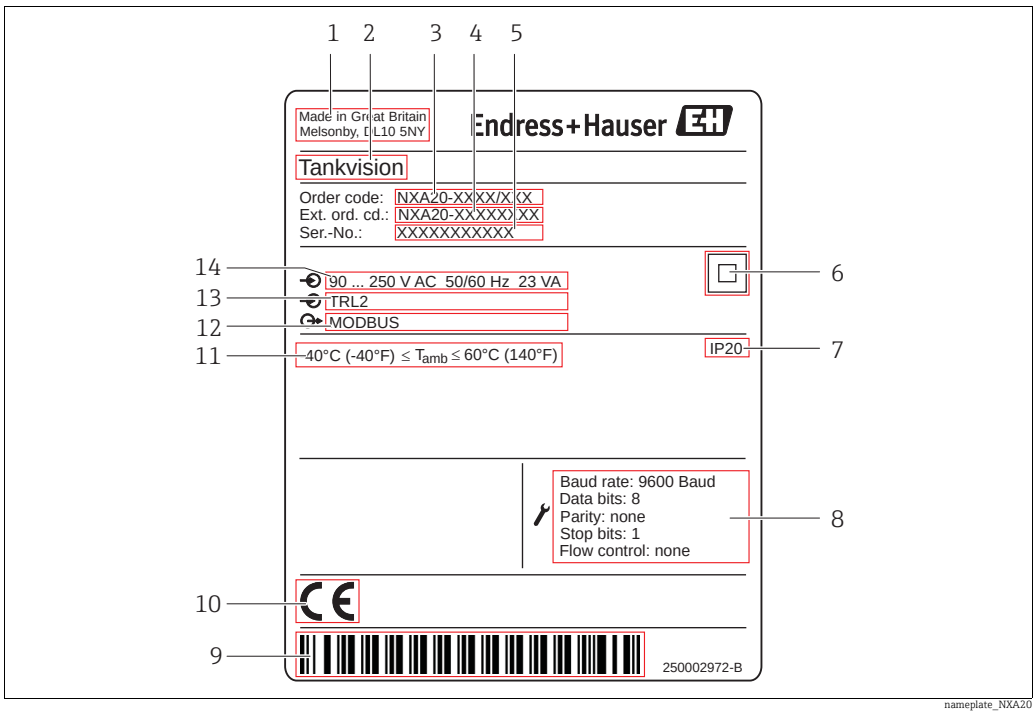
3.1 Product identification

The following options are available for identification of the measuring device:

- Nameplate specifications
- Order code with breakdown of the device features on the delivery note
- Enter serial numbers from nameplates in W@M Device Viewer (www.endress.com/deviceviewer): All information about the measuring device is displayed.

For an overview of the technical documentation provided, enter the serial number from the nameplates in the W@M Device Viewer (www.endress.com/deviceviewer)

3.2 Nameplate



1 *Address of manufacturer*
2 *Device name*
3 *Order code*
4 *Extended order code (Ext. ord. cd.)*
5 *Serial number (Ser. no.)*
6 *Data Matrix Code*
7 *Degree of protection*
8 *Technical data of the Serial Service port*
9 *Barcode*
10 *CE mark*
11 *Admissible ambient temperature*
12 *Type of fieldbus communication (output)*
13 *Type of fieldbus communication (input)*
14 *Supply voltage*

3.3 Order code and device version

To find out the version of your device, enter the order code indicated on the nameplate in the search screen at the following address: www.products.endress.com/order-ident

3.4 Registered trademarks

Microsoft®, Windows® and Internet Explorer®
Registered trademarks of the Microsoft Corporation

Modbus®
Registered trademark of the Modbus-IDA, Hopkinton, MA, USA

Java®
Registered trademark of Sun Microsystems, Inc.

Mozilla® Firefox®
Registered trademark of the Mozilla Foundation

Enraf, Honeywell, Rosemount, Emerson, Saab, L&J, VAREC, GPE are registered trademarks and trademarks of these organizations and companies.
All other marks are property of their respective owners.

4 Introduction

This specification details the Modbus Protocol to be used by a host system or Modbus Master device to interface with the TVGL (Tankvision Gauge Link) so as to retrieve data from the attached gauges.
Requests made outside the modbus map register range as detailed below will cause the TVGL to return an exception. Similarly any requests for functions which are not detailed below will cause the TVGL to reply will an exception.
Parameters and data can only be configured and returned if the attached gauge will support that feature otherwise the TVGL will return an error code for the associated parameter.
When references are made to data offset. Data offset represents 1 less than the Modicon register.
There are 2 versions of the Tank Vision Gauge Link. A version which supports the Enraf GPU protocol and a version which supports the SAAB Rosemount TRL/2 protocol.

4.1 Reference documentation

The Modbus interface shall be in accordance with the Modicon Modbus Protocol Reference Guide, PI-MBUS-300, Rev.J.

4.2 Communication Parameters

- Baud Rate: 1200 to 19200 Baud
- Start Bits: 1
- Stop Bits: 1
- Data Bits: 8
- Parity: NONE

4.3 Modbus Type

The Modbus protocol will be RTU mode.

4.4 Timeout and retries

The TVGL is a Modbus Slave device, as such it is the responsibility of the Modbus Master to provide for communication timeouts and retries in the event of missing, incomplete or corrupted responses.
It is recommended that the Master device provides a timeout timer of more than one second and even longer for slow baud rates between the issuing of a request to the TVGL and determination of a bad response.
In the event of a bad response, the Master should retransmit its request to the TVGL. The Master should not deem that communication with the TVGL has failed unless the Master still fails to receive a valid response after a predetermined number of retries.

5 Modbus Task – Function: 4 (read 16 bit registers)

5.1 Modbus Address

There will be multiple addresses up to 32.
For Enraf Emulation addresses which can be used can either be 1 – 100. Where the RTU address will be the Enraf Gauge Address, except for RTU address 100 which will represent Enraf Gauge address 00.
For Emersion TRL/2 Emulation the RTU address will be the Gauge address.
The RTU address corresponds to the Enraf or Emerson level address, found in holding registers, data offset 0 – 31 (40001 – 40032).
Each map can have up to 1000 registers, Each map will be identical for each RTU address.
Different units can be read determined by how the Enraf or Emersion gauge is configured.

5.2 Primary information

Data Offset	Data	Units	Units	Units	Data type
	CURRENT DATA				
0	DISPLACER POSITION	M	Decimal FT	Decimal Inches	Float
1					
2	LIQUID LEVEL	M	Decimal FT	Decimal Inches	Float
3	–	–	–	–	–
4	LIQUID TEMPERATURE	Deg C x 10	Deg F x 10	–	Signed integer
5	AVERAGE GAS TEMPERATURE	Deg C x 10	Deg F x 10	–	Signed integer
6	BASE PRESSURE P1	Pa / 100	PSI x 100	–	Signed integer
7	LIQUID PRESSURE P2	Pa / 100	PSI x 100	–	Signed integer
8	VAPOUR PRESSURE P3	Pa / 100	PSI x 100	–	Signed integer
9	OBSERVED TEMPERATURE	Deg C x 10	Deg F x 10	–	Signed integer
10	WATER LEVEL	M	Decimal FT	Decimal Inches	Float
11	–	–	–	–	–
12	AVERAGE PROFILE DENSITY	Kg/m^3 x 10	API x 100	Lbs/ft^3 x 100	Signed integer
13	PRODUCT LEVEL STATUS	–	–	–	Bitmap
14	PRODUCT TEMP STATUS	–	–	–	Bitmap
15	WATER LEVEL STATUS	–	–	–	Bitmap
16	VAPOUR TEMP STATUS	–	–	–	Bitmap
17	BASE PRESSURE P1 STATUS	–	–	–	Bitmap
18	LIQUID PRESSURE P2 STATUS	–	–	–	Bitmap
19	VAPOUR PRESSURE P3 STATUS	–	–	–	Bitmap
20	DENSITY STATUS	–	–	–	Bitmap
21	GAUGE STATUS CODE	–	–	–	Signed integer
22	SENSOR POSITION STATUS	–	–	–	Bitmap
23	SPARE	–	–	–	–
24	SPARE	–	–	–	–
25	SPARE	–	–	–	–

Data Offset	Data	Units	Units	Units	Data type
26	GAUGE OPERATION *1	–	–	–	Signed integer
27	SPARE	–	–	–	–
28	SPARE	–	–	–	–
29	SPARE	–	–	–	–

*1 … To issue a Gauge Command use function code 6.

5.3 Temperature data

Data Offset	Data	Units	Units	Data type
	MULTI-ELEMENTS			
29	TEMPERATURE ELEMENT 1	Deg C x 10	Deg F x 10	Signed integer
30	TEMPERATURE ELEMENT 2	Deg C x 10	Deg F x 10	Signed integer
31	TEMPERATURE ELEMENT 3	Deg C x 10	Deg F x 10	Signed integer
32	TEMPERATURE ELEMENT 4	Deg C x 10	Deg F x 10	Signed integer
33	TEMPERATURE ELEMENT 5	Deg C x 10	Deg F x 10	Signed integer
34	TEMPERATURE ELEMENT 6	Deg C x 10	Deg F x 10	Signed integer
35	TEMPERATURE ELEMENT 7	Deg C x 10	Deg F x 10	Signed integer
36	TEMPERATURE ELEMENT 8	Deg C x 10	Deg F x 10	Signed integer
37	TEMPERATURE ELEMENT 9	Deg C x 10	Deg F x 10	Signed integer
38	TEMPERATURE ELEMENT 10	Deg C x 10	Deg F x 10	Signed integer
39	TEMPERATURE ELEMENT 11	Deg C x 10	Deg F x 10	Signed integer
40	TEMPERATURE ELEMENT 12	Deg C x 10	Deg F x 10	Signed integer
41	TEMPERATURE ELEMENT 13	Deg C x 10	Deg F x 10	Signed integer
42	TEMPERATURE ELEMENT 14	Deg C x 10	Deg F x 10	Signed integer
43	TEMPERATURE ELEMENT 15	Deg C x 10	Deg F x 10	Signed integer
44	TEMPERATURE ELEMENT 16	Deg C x 10	Deg F x 10	Signed integer
45	TEMPERATURE ELEMENT 17	Deg C x 10	Deg F x 10	Signed integer
46	TEMPERATURE ELEMENT 18	Deg C x 10	Deg F x 10	Signed integer
47	TEMPERATURE ELEMENT 19	Deg C x 10	Deg F x 10	Signed integer
48	TEMPERATURE ELEMENT 20	Deg C x 10	Deg F x 10	Signed integer
49	TEMPERATURE ELEMENT 21	Deg C x 10	Deg F x 10	Signed integer
50	TEMPERATURE ELEMENT 22	Deg C x 10	Deg F x 10	Signed integer
51	TEMPERATURE ELEMENT 23	Deg C x 10	Deg F x 10	Signed integer
52	TEMPERATURE ELEMENT 24	Deg C x 10	Deg F x 10	Signed integer
53	TEMPERATURE ELEMENT 25	Deg C x 10	Deg F x 10	Signed integer
54	TEMPERATURE ELEMENT 26	Deg C x 10	Deg F x 10	Signed integer
55	TEMPERATURE ELEMENT 27	Deg C x 10	Deg F x 10	Signed integer
56	TEMPERATURE ELEMENT 28	Deg C x 10	Deg F x 10	Signed integer
57	TEMPERATURE ELEMENT 29	Deg C x 10	Deg F x 10	Signed integer
58	TEMPERATURE ELEMENT 30	Deg C x 10	Deg F x 10	Signed integer
59	TEMPERATURE ELEMENT 31	Deg C x 10	Deg F x 10	Signed integer

Data Offset	Data	Units	Units	Data type
60	TEMPERATURE ELEMENT 32	Deg C x 10	Deg F x 10	Signed integer

5.4 Density data

Data Offset	Data	Units	Units	Units	Data type
	Density				
66	Average Profile Density	Kg/M^3 x 10	API x 100	LBs/Ft^3 x 100	Signed integer
67	Observed Temperature	Deg C x 10	Deg F x 10	–	Signed integer
68	Density at position 1 (R0)	Kg/M^3 x 10	API x 100	LBs/Ft^3 x 100	Signed integer
69	Density at position 2 (R1)	Kg/M^3 x 10	API x 100	LBs/Ft^3 x 100	Signed integer
70	Density at position 3 (R2)	Kg/M^3 x 10	API x 100	LBs/Ft^3 x 100	Signed integer
71	Density at position 4 (R3)	Kg/M^3 x 10	API x 100	LBs/Ft^3 x 100	Signed integer
72	Density at position 5 (R4)	Kg/M^3 x 10	API x 100	LBs/Ft^3 x 100	Signed integer
73	Density at position 6 (R5)	Kg/M^3 x 10	API x 100	LBs/Ft^3 x 100	Signed integer
74	Density at position 7 (R6)	Kg/M^3 x 10	API x 100	LBs/Ft^3 x 100	Signed integer
75	Density at position 8 (R7)	Kg/M^3 x 10	API x 100	LBs/Ft^3 x 100	Signed integer
76	Density at position 9 (R8)	Kg/M^3 x 10	API x 100	LBs/Ft^3 x 100	Signed integer
77	Density at position 10 (R9)	Kg/M^3 x 10	API x 100	LBs/Ft^3 x 100	Signed integer
78	Position 1 (D0)	mm	1/16th	–	Signed integer
79	Position 2 (D1)	mm	1/16th	–	Signed integer
80	Position 3 (D2)	mm	1/16th	–	Signed integer
81	Position 4 (D3)	mm	1/16th	–	Signed integer
82	Position 5 (D4)	mm	1/16th	–	Signed integer
83	Position 6 (D5)	mm	1/16th	–	Signed integer
84	Position 7 (D6)	mm	1/16th	–	Signed integer
85	Position 8 (D7)	mm	1/16th	–	Signed integer
86	Position 9 (D8)	mm	1/16th	–	Signed integer
87	Position 10 (D9)	mm	1/16th	–	Signed integer
88	Density position 1 Status	–	–	–	Bitmap
89	Density position 2 Status	–	–	–	Bitmap
90	Density position 3 Status	–	–	–	Bitmap
91	Density position 4 Status	–	–	–	Bitmap
92	Density position 5 Status	–	–	–	Bitmap
93	Density position 6 Status	–	–	–	Bitmap
94	Density position 7 Status	–	–	–	Bitmap
95	Density position 8 Status	–	–	–	Bitmap
96	Density position 9 Status	–	–	–	Bitmap
97	Density position 10 Status	–	–	–	Bitmap
98	Density status at position 1	–	–	–	Bitmap
99	Density status at position 2	–	–	–	Bitmap
100	Density status at position 3	–	–	–	Bitmap
101	Density status at position 4	–	–	–	Bitmap

Data Offset	Data	Units	Units	Units	Data type
102	Density status at position 5	–	–	–	Bitmap
103	Density status at position 6	–	–	–	Bitmap
104	Density status at position 7	–	–	–	Bitmap
105	Density status at position 8	–	–	–	Bitmap
106	Density status at position 9	–	–	–	Bitmap
107	Density status at position 10	–	–	–	Bitmap

These values will only be available once density command has been issued and completed successfully. These values will be retained until the next density command. The values will be lost if the TVGL is powered down.

5.5 Temperature data status

Data Offset	Data	Units	Units	Data type
	MULTI-ELEMENTS			
110	TEMP ELEMENT 1 STATUS	–	–	Bitmap
111	TEMP ELEMENT 2 STATUS	–	–	Bitmap
112	TEMP ELEMENT 3 STATUS	–	–	Bitmap
113	TEMP ELEMENT 4 STATUS	–	–	Bitmap
114	TEMP ELEMENT 5 STATUS	–	–	Bitmap
115	TEMP ELEMENT 6 STATUS	–	–	Bitmap
116	TEMP ELEMENT 7 STATUS	–	–	Bitmap
117	TEMP ELEMENT 8 STATUS	–	–	Bitmap
118	TEMP ELEMENT 9 STATUS	–	–	Bitmap
119	TEMP ELEMENT 10 STATUS	–	–	Bitmap
120	TEMP ELEMENT 11 STATUS	–	–	Bitmap
121	TEMP ELEMENT 12 STATUS	–	–	Bitmap
122	TEMP ELEMENT 13 STATUS	–	–	Bitmap
123	TEMP ELEMENT 14 STATUS	–	–	Bitmap
124	TEMP ELEMENT 15 STATUS	–	–	Bitmap
125	TEMP ELEMENT 16 STATUS	–	–	Bitmap
126	TEMP ELEMENT 17 STATUS	–	–	Bitmap
127	TEMP ELEMENT 18 STATUS	–	–	Bitmap
128	TEMP ELEMENT 19 STATUS	–	–	Bitmap
129	TEMP ELEMENT 20 STATUS	–	–	Bitmap
130	TEMP ELEMENT 21 STATUS	–	–	Bitmap
131	TEMP ELEMENT 22 STATUS	–	–	Bitmap
132	TEMP ELEMENT 23 STATUS	–	–	Bitmap
133	TEMP ELEMENT 24 STATUS	–	–	Bitmap
134	TEMP ELEMENT 25 STATUS	–	–	Bitmap
135	TEMP ELEMENT 26 STATUS	–	–	Bitmap
136	TEMP ELEMENT 27 STATUS	–	–	Bitmap

Data Offset	Data	Units	Units	Data type
137	TEMP ELEMENT 28 STATUS	–	–	Bitmap
138	TEMP ELEMENT 29 STATUS	–	–	Bitmap
139	TEMP ELEMENT 30 STATUS	–	–	Bitmap
140	TEMP ELEMENT 31 STATUS	–	–	Bitmap
141	TEMP ELEMENT 32 STATUS	–	–	Bitmap

5.6 Floating point format and signed integer level format

Data Offset	Data	Units	Units	Units	Data type
	CURRENT DATA				
400	DISPLACER POSITION	mm	1/16th	–	Signed integer
401	LIQUID LEVEL	mm	1/16th	–	Signed integer
402 - 403	AV TEMPERATURE	Deg C	Deg F	–	Float
404	WATER LEVEL	mm	1/16th	–	Signed integer
406 – 407	VAPOUR TEMP	Deg C	Deg F	–	Float
408 – 409	BASE PRESSURE P1	Pa	KPa	PSI	Float
410 – 411	LIQUID PRESSURE P2	Pa	KPa	PSI	Float
412 – 413	VAPOUR PRESSURE P3	Pa	KPa	PSI	Float
414 – 415	AVERAGE PROFILE DENSITY	Kg/M^3	Deg API	Lb/ft^3	Float
416 – 417	OBSERVED TEMPERATURE	Deg C	Deg F	–	Float
418 – 419	SPARE	–	–	–	–
420 – 421	SPARE	–	–	–	–
422 – 423	SPARE	–	–	–	–
424	SPARE	–	–	–	–
425	SPARE	–	–	–	–
426 – 427	SPARE	–	–	–	–
428	SPARE	–	–	–	–
429	PRODUCT LEVEL STATUS	–	–	–	Bitmap
430	PRODUCT TEMP STATUS	–	–	–	Bitmap
431	WATER LEVEL STATUS	–	–	–	Bitmap
432	VAPOUR TEMP STATUS	–	–	–	Bitmap
433	BASE PRESSURE P1 STATUS	–	–	–	Bitmap
434	LIQUID PRESSURE P2 STATUS	–	–	–	Bitmap
435	VAPOUR PRESSURE P3 STATUS	–	–	–	Bitmap
436	DENSITY STATUS	–	–	–	Bitmap
437	SPARE	–	–	–	–
438	SPARE	–	–	–	–
439	SENSOR POSITION STATUS	–	–	–	Bitmap

5.7 Temperature data

Data Offset	Data	Units	Units	Data type
	MULTI-ELEMENTS			
500	TEMPERATURE ELEMENT 1	Deg C	Deg F	Float
502	TEMPERATURE ELEMENT 2	Deg C	Deg F	Float
504	TEMPERATURE ELEMENT 3	Deg C	Deg F	Float
506	TEMPERATURE ELEMENT 4	Deg C	Deg F	Float
508	TEMPERATURE ELEMENT 5	Deg C	Deg F	Float
510	TEMPERATURE ELEMENT 6	Deg C	Deg F	Float
512	TEMPERATURE ELEMENT 7	Deg C	Deg F	Float
514	TEMPERATURE ELEMENT 8	Deg C	Deg F	Float
516	TEMPERATURE ELEMENT 9	Deg C	Deg F	Float
518	TEMPERATURE ELEMENT 10	Deg C	Deg F	Float
520	TEMPERATURE ELEMENT 11	Deg C	Deg F	Float
522	TEMPERATURE ELEMENT 12	Deg C	Deg F	Float
524	TEMPERATURE ELEMENT 13	Deg C	Deg F	Float
526	TEMPERATURE ELEMENT 14	Deg C	Deg F	Float
528	TEMPERATURE ELEMENT 15	Deg C	Deg F	Float
530	TEMPERATURE ELEMENT 16	Deg C	Deg F	Float
532	TEMPERATURE ELEMENT 17	Deg C	Deg F	Float
534	TEMPERATURE ELEMENT 18	Deg C	Deg F	Float
536	TEMPERATURE ELEMENT 19	Deg C	Deg F	Float
538	TEMPERATURE ELEMENT 20	Deg C	Deg F	Float
540	TEMPERATURE ELEMENT 21	Deg C	Deg F	Float
542	TEMPERATURE ELEMENT 22	Deg C	Deg F	Float
544	TEMPERATURE ELEMENT 23	Deg C	Deg F	Float
546	TEMPERATURE ELEMENT 24	Deg C	Deg F	Float
548	TEMPERATURE ELEMENT 25	Deg C	Deg F	Float
550	TEMPERATURE ELEMENT 26	Deg C	Deg F	Float
552	TEMPERATURE ELEMENT 27	Deg C	Deg F	Float
554	TEMPERATURE ELEMENT 28	Deg C	Deg F	Float
556	TEMPERATURE ELEMENT 29	Deg C	Deg F	Float
558	TEMPERATURE ELEMENT 30	Deg C	Deg F	Float
560	TEMPERATURE ELEMENT 31	Deg C	Deg F	Float
562	TEMPERATURE ELEMENT 32	Deg C	Deg F	Float

5.8 Temperature data status

Data Offset	Data	Units	Units	Data type
	MULTI-ELEMENTS			
564	TEMP ELEMENT 1 STATUS	–	–	Bitmap
565	TEMP ELEMENT 2 STATUS	–	–	Bitmap

Data Offset	Data	Units	Units	Data type
566	TEMP ELEMENT 3 STATUS	–	–	Bitmap
567	TEMP ELEMENT 4 STATUS	–	–	Bitmap
568	TEMP ELEMENT 5 STATUS	–	–	Bitmap
569	TEMP ELEMENT 6 STATUS	–	–	Bitmap
570	TEMP ELEMENT 7 STATUS	–	–	Bitmap
571	TEMP ELEMENT 8 STATUS	–	–	Bitmap
572	TEMP ELEMENT 9 STATUS	–	–	Bitmap
573	TEMP ELEMENT 10 STATUS	–	–	Bitmap
574	TEMP ELEMENT 11 STATUS	–	–	Bitmap
575	TEMP ELEMENT 12 STATUS	–	–	Bitmap
576	TEMP ELEMENT 13 STATUS	–	–	Bitmap
577	TEMP ELEMENT 14 STATUS	–	–	Bitmap
578	TEMP ELEMENT 15 STATUS	–	–	Bitmap
579	TEMP ELEMENT 16 STATUS	–	–	Bitmap
580	TEMP ELEMENT 17 STATUS	–	–	Bitmap
581	TEMP ELEMENT 18 STATUS	–	–	Bitmap
582	TEMP ELEMENT 19 STATUS	–	–	Bitmap
583	TEMP ELEMENT 20 STATUS	–	–	Bitmap
584	TEMP ELEMENT 21 STATUS	–	–	Bitmap
585	TEMP ELEMENT 22 STATUS	–	–	Bitmap
586	TEMP ELEMENT 23 STATUS	–	–	Bitmap
587	TEMP ELEMENT 24 STATUS	–	–	Bitmap
588	TEMP ELEMENT 25 STATUS	–	–	Bitmap
589	TEMP ELEMENT 26 STATUS	–	–	Bitmap
590	TEMP ELEMENT 27 STATUS	–	–	Bitmap
591	TEMP ELEMENT 28 STATUS	–	–	Bitmap
592	TEMP ELEMENT 29 STATUS	–	–	Bitmap
593	TEMP ELEMENT 30 STATUS	–	–	Bitmap
594	TEMP ELEMENT 31 STATUS	–	–	Bitmap
595	TEMP ELEMENT 32 STATUS	–	–	Bitmap

5.9 Density data

Data Offset	Data	Units	Units	Units	Data type
	Density				
600-601	Density at position 1 (R0)	Kg/M^3	Deg API	LBs/Ft^3	Float
602-603	Density at position 2 (R1)	Kg/M^3	Deg API	LBs/Ft^3	Float
604-605	Density at position 3 (R2)	Kg/M^3	Deg API	LBs/Ft^3	Float
606-607	Density at position 4 (R3)	Kg/M^3	Deg API	LBs/Ft^3	Float
608-609	Density at position 5 (R4)	Kg/M^3	Deg API	LBs/Ft^3	Float
610-611	Density at position 6 (R5)	Kg/M^3	Deg API	LBs/Ft^3	Float
612-613	Density at position 7 (R6)	Kg/M^3	Deg API	LBs/Ft^3	Float

Data Offset	Data	Units	Units	Units	Data type
614-615	Density at position 8 (R7)	Kg/M^3	Deg API	LBs/Ft^3	Float
616-617	Density at position 9 (R8)	Kg/M^3	Deg API	LBs/Ft^3	Float
618-629	Density at position 10 (R9)	Kg/M^3	Deg API	LBs/Ft^3	Float
620-621	Position 1 (D0)	M	Decimal FT	Decimal Inches	Float
622-623	Position 2 (D1)	M	Decimal FT	Decimal Inches	Float
624-625	Position 3 (D2)	M	Decimal FT	Decimal Inches	Float
626-627	Position 4 (D3)	M	Decimal FT	Decimal Inches	Float
628-629	Position 5 (D4)	M	Decimal FT	Decimal Inches	Float
630-631	Position 6 (D5)	M	Decimal FT	Decimal Inches	Float
632-633	Position 7 (D6)	M	Decimal FT	Decimal Inches	Float
634-635	Position 8 (D7)	M	Decimal FT	Decimal Inches	Float
636-637	Position 9 (D8)	M	Decimal FT	Decimal Inches	Float
638-639	Position 10 (D9)	M	Decimal FT	Decimal Inches	Float
640	Density position 1 Status	–	–	–	Bitmap
641	Density position 2 Status	–	–	–	Bitmap
642	Density position 3 Status	–	–	–	Bitmap
643	Density position 4 Status	–	–	–	Bitmap
644	Density position 5 Status	–	–	–	Bitmap
645	Density position 6 Status	–	–	–	Bitmap
646	Density position 7 Status	–	–	–	Bitmap
647	Density position 8 Status	–	–	–	Bitmap
648	Density position 9 Status	–	–	–	Bitmap
649	Density position 10 Status	–	–	–	Bitmap
650	Density status at position 1	–	–	–	Bitmap
651	Density status at position 2	–	–	–	Bitmap
652	Density status at position 3	–	–	–	Bitmap
653	Density status at position 4	–	–	–	Bitmap
654	Density status at position 5	–	–	–	Bitmap
655	Density status at position 6	–	–	–	Bitmap
656	Density status at position 7	–	–	–	Bitmap
657	Density status at position 8	–	–	–	Bitmap
658	Density status at position 9	–	–	–	Bitmap
659	Density status at position 10	–	–	–	Bitmap

These values will only be available once density command has been issued and completed successfully. These values will be retained until the next density command. The values will be lost if the TVGL is powered down.

5.10 Diagnostic data

This data will be returned using RTU address 247 only.

Data Offset	Data	Units	Units	Data type
190	VERSION No OPERATIONAL	–	–	Signed Integer
191	VERSION No FUNCTIONAL	–	–	Signed Integer
192	VERSION No TRIVIAL	–	–	Signed Integer
193	PRODUCT ID	–	–	Signed Integer
194	CHECKSUM MSB	–	–	HEX
195	CHECKSUM LSB	–	–	HEX
196	HEARBEAT MSB	–	–	Signed Integer
197	HEARTBEAT LSB	–	–	Signed Integer

Registers 190, 191 and 192 hold the version number of the Tank Vision Gauge Link, this number is also printed when using terminal emulation program at the engineers port (for example Hyper-terminal). Command INFO will print the version number when using hyper-terminal.
Register 193 hold the project number of the Tank Vision Gauge Link. This number is always 264.
Registers 194 and 195 hold the checksum. The hexadecimal number in these 2 registers will be the same number printed in hyper-terminal or similar emulation programs when the command INFO is requested. This helps to confirm the correct version of firmware is installed in the Tank Vision Gauge Link.
Registers 196 and 197 hold a heartbeat number. This number increment's once a second, once the number has reached its limit it will roll back to zero and start incrementing again. On power up the heartbeat number will always start at zero.

6 Enraf Devices

6.1 Modbus Task

Function: 3 (read holding registers)

6.2 Modbus Address

One map has a block of registers. Data offset 0 – 1131 (40001 – 41132). The registers which can be modified are in the range of 32 registers. Data offset 0 – 31 (40001 – 40032) with an offset by a factor of 100 (see holding register map below). The data can be viewed using an address used for function 4, or default address 247.
The Enraf addresses will be displayed in the order in which they were entered using function 6 or 16. The level addresses must be entered starting at data offset 0 (40001) and every additional register must be entered immediately after the previous address.
The Enraf gauge address entered must be between 0 – 99, any address entered out of this range will default to 255 (0xff) and will not be used.
For data offset 1100 – 1131 (41101 – 41132), Ascii characters R (82), S (83) or N (78) must be entered, any other value and the TVGL will not recognize it.

82 = R = RADAR
83 = S = SERVO
78 = N = NRF590/811/none Enraf gauge

When N is configured for a gauge type, status registers ZQS or ZQR will not be polled for and the status will be read from the "B" record.
When R is configured for a gauge type, then water dip, density scan and servo commands cannot be used. Commands can only be used if the gauge type is configured as an "S".
Holding registers 600 – 631 are reserved and not used.
All holding registers above 31 to the next 100 in the block are un-used.

6.3 Level addresses

Data Offset	Data	Initial value	Data type
0	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
1	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
2	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
3	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
4	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
5	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
6	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
7	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
8	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
9	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
10	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
11	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
12	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
13	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
14	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
15	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer

Data Offset	Data	Initial value	Data type
16	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
17	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
18	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
19	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
20	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
21	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
22	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
23	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
24	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
25	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
26	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
27	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
28	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
29	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
30	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer
31	ENRAF LEVEL ADDRESS	255 (0xFF)	Signed integer

6.4 Average temperature addresses

Data Offset	Data	Initial value	Data type
100	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
101	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
102	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
103	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
104	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
105	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
106	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
107	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
108	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
109	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
110	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
111	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
112	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
113	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
114	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
115	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
116	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
117	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
118	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
119	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
120	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
121	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
122	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer

Data Offset	Data	Initial value	Data type
123	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
124	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
125	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
126	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
127	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
128	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
129	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
130	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer
131	ENRAF AVERAGE TEMP ADDRESS	255 (0xFF)	Signed integer

6.5 Temperature element addresses

Data Offset	Data	Initial value	Data type
200	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
201	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
202	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
203	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
204	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
205	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
206	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
207	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
208	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
209	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
210	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
211	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
212	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
213	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
214	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
215	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
216	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
217	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
218	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
219	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
220	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
221	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
222	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
223	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
224	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
225	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
226	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
227	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
228	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
229	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer

Data Offset	Data	Initial value	Data type
230	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer
231	ENRAF TEMP ELEMENTS ADDRESS	255 (0xFF)	Signed integer

6.6 Live Water addresses

Data Offset	Data	Initial value	Data type
300	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
301	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
302	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
303	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
304	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
305	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
306	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
307	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
308	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
309	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
310	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
311	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
312	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
313	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
314	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
315	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
316	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
317	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
318	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
319	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
320	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
321	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
322	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
323	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
324	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
325	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
326	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
327	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
328	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
329	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
330	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer
331	ENRAF LIVE WATER ADDRESS	255 (0xFF)	Signed integer

6.7 Water dip addresses

Data Offset	Data	Initial value	Data type
400	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer

Data Offset	Data	Initial value	Data type
401	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
402	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
403	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
404	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
405	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
406	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
407	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
408	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
409	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
410	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
411	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
412	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
413	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
414	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
415	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
416	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
417	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
418	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
419	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
420	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
421	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
422	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
423	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
424	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
425	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
426	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
427	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
428	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
429	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
430	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer
431	ENRAF WATER DIP ADDRESS	255 (0xFF)	Signed integer

6.8 Density addresses

Data Offset	Data	Initial value	Data type
500	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
501	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
502	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
503	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
504	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
505	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
506	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
507	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer

Data Offset	Data	Initial value	Data type
508	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
509	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
510	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
511	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
512	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
513	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
514	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
515	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
516	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
517	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
518	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
519	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
520	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
521	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
522	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
523	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
524	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
525	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
526	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
527	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
528	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
529	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
530	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer
531	ENRAF DENSITY ADDRESS	255 (0xFF)	Signed integer

6.9 Reserved addresses

Data Offset	Data	Initial value	Data type
600	RESERVED	255 (0xFF)	Signed integer
601	RESERVED	255 (0xFF)	Signed integer
602	RESERVED	255 (0xFF)	Signed integer
603	RESERVED	255 (0xFF)	Signed integer
604	RESERVED	255 (0xFF)	Signed integer
605	RESERVED	255 (0xFF)	Signed integer
606	RESERVED	255 (0xFF)	Signed integer
607	RESERVED	255 (0xFF)	Signed integer
608	RESERVED	255 (0xFF)	Signed integer
609	RESERVED	255 (0xFF)	Signed integer
610	RESERVED	255 (0xFF)	Signed integer
611	RESERVED	255 (0xFF)	Signed integer
612	RESERVED	255 (0xFF)	Signed integer
613	RESERVED	255 (0xFF)	Signed integer
614	RESERVED	255 (0xFF)	Signed integer

Data Offset	Data	Initial value	Data type
615	RESERVED	255 (0xFF)	Signed integer
616	RESERVED	255 (0xFF)	Signed integer
617	RESERVED	255 (0xFF)	Signed integer
618	RESERVED	255 (0xFF)	Signed integer
619	RESERVED	255 (0xFF)	Signed integer
620	RESERVED	255 (0xFF)	Signed integer
621	RESERVED	255 (0xFF)	Signed integer
622	RESERVED	255 (0xFF)	Signed integer
623	RESERVED	255 (0xFF)	Signed integer
624	RESERVED	255 (0xFF)	Signed integer
625	RESERVED	255 (0xFF)	Signed integer
626	RESERVED	255 (0xFF)	Signed integer
627	RESERVED	255 (0xFF)	Signed integer
628	RESERVED	255 (0xFF)	Signed integer
629	RESERVED	255 (0xFF)	Signed integer
630	RESERVED	255 (0xFF)	Signed integer
631	RESERVED	255 (0xFF)	Signed integer

6.10 Vapour temperature addresses

Data Offset	Data	Initial value	Data type
700	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
701	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
702	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
703	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
704	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
705	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
706	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
707	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
708	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
709	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
710	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
711	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
712	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
713	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
714	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
715	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
716	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
717	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
718	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
719	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
720	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
721	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer

Data Offset	Data	Initial value	Data type
722	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
723	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
724	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
725	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
726	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
727	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
728	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
729	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
730	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer
731	ENRAF VAPOUR TEMP ADDRESS	255 (0xFF)	Signed integer

6.11 Base pressure P1 addresses

Data Offset	Data	Initial value	Data type
800	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
801	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
802	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
803	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
804	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
805	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
806	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
807	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
808	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
809	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
810	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
811	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
812	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
813	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
814	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
815	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
816	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
817	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
818	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
819	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
820	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
821	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
822	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
823	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
824	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
825	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
826	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
827	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
828	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer

Data Offset	Data	Initial value	Data type
829	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
830	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer
831	ENRAF BASE PRESSURE P1 ADDRESS	255 (0xFF)	Signed integer

6.12 Liquid pressure P2 addresses

Data Offset	Data	Initial value	Data type
900	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
901	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
902	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
903	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
904	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
905	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
906	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
907	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
908	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
909	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
910	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
911	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
912	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
913	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
914	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
915	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
916	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
917	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
918	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
919	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
920	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
921	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
922	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
923	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
924	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
925	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
926	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
927	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
928	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
929	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
930	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer
931	ENRAF LIQUID PRESSURE P2 ADDRESS	255 (0xFF)	Signed integer

6.13 Vapour pressure P3 addresses

Data Offset	Data	Initial value	Data type
1000	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1001	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1002	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1003	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1004	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1005	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1006	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1007	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1008	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1009	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1010	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1011	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1012	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1013	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1014	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1015	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1016	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1017	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1018	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1019	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1020	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1021	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1022	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1023	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1024	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1025	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1026	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1027	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1028	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1029	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1030	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer
1031	ENRAF VAPOUR PRESSURE P3 ADDRESS	255 (0xFF)	Signed integer

6.14 Type of Enraf gauge

Data Offset	Data	Initial value	Data type
1100	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1101	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1102	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1103	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1104	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer

Data Offset	Data	Initial value	Data type
1105	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1106	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1107	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1108	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1109	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1110	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1111	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1112	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1113	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1114	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1115	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1116	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1117	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1118	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1119	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1120	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1121	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1122	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1123	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1124	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1125	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1126	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1127	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1128	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1129	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1130	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer
1131	ENRAF GAUGE TYPE	255 (0xFF)	Signed integer

7 Emerson Devices

The below map is used when configuring the TVGL to connect to Emerson devices.

7.1 Modbus Task

Function: 3 (read holding registers)

7.2 Modbus Address

One map has a block of registers. Data offset 0 – 1131 (40001 – 41132). The registers which can be modified are in the range of 32 registers. Data offset 0 – 31 (40001 – 40032) with an offset by a factor of 100 (see holding register map below). The data can be viewed using an address used for function 4, or default address 247.
The Emerson addresses will be displayed in the order in which they were entered using function 6 or 16. The level addresses must be entered starting at data offset 0 (40001) and every additional register must be entered immediately after the previous address.
The Emerson gauge address entered must be between 1 – 247, any address entered out of this range will default to 255 (0xff).
Register block, data offset 0 – 31 (40001 – 40032) will be the address of the device to poll for all data apart from all the temperature measuring devices.
Register block, data offset 100 – 131 (40101 – 401032) will be the address of the device to poll for all temperature devices only. This address can be the same as the 0 -31 offset block if DAU is not used.
All the other register blocks detailed below will be the actual register to map the data from for the appropriate parameter. All these registers will be mapped from the RTU address listed in registers, offset 0 – 31.

The below registers need to be entered if the associated parameter is required.

Analogue input current 1: 06
Analogue input current 2: 07
Analogue input current 3: 08
Analogue input 1: 30
Analogue input 2: 32
HART Input 3: 36
HART Input 2: 38
HART Input 1: 40

Holding registers 200 – 231, 400 – 431, 500 – 531, 600 – 631 and 1100 – 1131 are not used.
All holding registers above 31 to the next 100 in the block are un-used.

7.3 All parameter gauge address except temperature devices

Data Offset	Data	Initial value	Data type
0	GAUGE ADDRESS	255 (0xFF)	Signed integer
1	GAUGE ADDRESS	255 (0xFF)	Signed integer
2	GAUGE ADDRESS	255 (0xFF)	Signed integer
3	GAUGE ADDRESS	255 (0xFF)	Signed integer
4	GAUGE ADDRESS	255 (0xFF)	Signed integer
5	GAUGE ADDRESS	255 (0xFF)	Signed integer

Data Offset	Data	Initial value	Data type
6	GAUGE ADDRESS	255 (0xFF)	Signed integer
7	GAUGE ADDRESS	255 (0xFF)	Signed integer
8	GAUGE ADDRESS	255 (0xFF)	Signed integer
9	GAUGE ADDRESS	255 (0xFF)	Signed integer
10	GAUGE ADDRESS	255 (0xFF)	Signed integer
11	GAUGE ADDRESS	255 (0xFF)	Signed integer
12	GAUGE ADDRESS	255 (0xFF)	Signed integer
13	GAUGE ADDRESS	255 (0xFF)	Signed integer
14	GAUGE ADDRESS	255 (0xFF)	Signed integer
15	GAUGE ADDRESS	255 (0xFF)	Signed integer
16	GAUGE ADDRESS	255 (0xFF)	Signed integer
17	GAUGE ADDRESS	255 (0xFF)	Signed integer
18	GAUGE ADDRESS	255 (0xFF)	Signed integer
19	GAUGE ADDRESS	255 (0xFF)	Signed integer
20	GAUGE ADDRESS	255 (0xFF)	Signed integer
21	GAUGE ADDRESS	255 (0xFF)	Signed integer
22	GAUGE ADDRESS	255 (0xFF)	Signed integer
23	GAUGE ADDRESS	255 (0xFF)	Signed integer
24	GAUGE ADDRESS	255 (0xFF)	Signed integer
25	GAUGE ADDRESS	255 (0xFF)	Signed integer
26	GAUGE ADDRESS	255 (0xFF)	Signed integer
27	GAUGE ADDRESS	255 (0xFF)	Signed integer
28	GAUGE ADDRESS	255 (0xFF)	Signed integer
29	GAUGE ADDRESS	255 (0xFF)	Signed integer
30	GAUGE ADDRESS	255 (0xFF)	Signed integer
31	GAUGE ADDRESS	255 (0xFF)	Signed integer

7.4 Temperature device addresses

Data Offset	Data	Initial value	Data type
100	DAU ADDRESS	255 (0xFF)	Signed integer
101	DAU ADDRESS	255 (0xFF)	Signed integer
102	DAU ADDRESS	255 (0xFF)	Signed integer
103	DAU ADDRESS	255 (0xFF)	Signed integer
104	DAU ADDRESS	255 (0xFF)	Signed integer
105	DAU ADDRESS	255 (0xFF)	Signed integer
106	DAU ADDRESS	255 (0xFF)	Signed integer
107	DAU ADDRESS	255 (0xFF)	Signed integer
108	DAU ADDRESS	255 (0xFF)	Signed integer
109	DAU ADDRESS	255 (0xFF)	Signed integer
110	DAU ADDRESS	255 (0xFF)	Signed integer
111	DAU ADDRESS	255 (0xFF)	Signed integer
112	DAU ADDRESS	255 (0xFF)	Signed integer

Data Offset	Data	Initial value	Data type
113	DAU ADDRESS	255 (0xFF)	Signed integer
114	DAU ADDRESS	255 (0xFF)	Signed integer
115	DAU ADDRESS	255 (0xFF)	Signed integer
116	DAU ADDRESS	255 (0xFF)	Signed integer
117	DAU ADDRESS	255 (0xFF)	Signed integer
118	DAU ADDRESS	255 (0xFF)	Signed integer
119	DAU ADDRESS	255 (0xFF)	Signed integer
120	DAU ADDRESS	255 (0xFF)	Signed integer
121	DAU ADDRESS	255 (0xFF)	Signed integer
122	DAU ADDRESS	255 (0xFF)	Signed integer
123	DAU ADDRESS	255 (0xFF)	Signed integer
124	DAU ADDRESS	255 (0xFF)	Signed integer
125	DAU ADDRESS	255 (0xFF)	Signed integer
126	DAU ADDRESS	255 (0xFF)	Signed integer
127	DAU ADDRESS	255 (0xFF)	Signed integer
128	DAU ADDRESS	255 (0xFF)	Signed integer
129	DAU ADDRESS	255 (0xFF)	Signed integer
130	DAU ADDRESS	255 (0xFF)	Signed integer
131	DAU ADDRESS	255 (0xFF)	Signed integer

7.5 Live Water registers

Data Offset	Data	Initial value	Data type
300	LIVE WATER REGISTER	255 (0xFF)	Signed integer
301	LIVE WATER REGISTER	255 (0xFF)	Signed integer
302	LIVE WATER REGISTER	255 (0xFF)	Signed integer
303	LIVE WATER REGISTER	255 (0xFF)	Signed integer
304	LIVE WATER REGISTER	255 (0xFF)	Signed integer
305	LIVE WATER REGISTER	255 (0xFF)	Signed integer
306	LIVE WATER REGISTER	255 (0xFF)	Signed integer
307	LIVE WATER REGISTER	255 (0xFF)	Signed integer
308	LIVE WATER REGISTER	255 (0xFF)	Signed integer
309	LIVE WATER REGISTER	255 (0xFF)	Signed integer
310	LIVE WATER REGISTER	255 (0xFF)	Signed integer
311	LIVE WATER REGISTER	255 (0xFF)	Signed integer
312	LIVE WATER REGISTER	255 (0xFF)	Signed integer
313	LIVE WATER REGISTER	255 (0xFF)	Signed integer
314	LIVE WATER REGISTER	255 (0xFF)	Signed integer
315	LIVE WATER REGISTER	255 (0xFF)	Signed integer
316	LIVE WATER REGISTER	255 (0xFF)	Signed integer
317	LIVE WATER REGISTER	255 (0xFF)	Signed integer
318	LIVE WATER REGISTER	255 (0xFF)	Signed integer
319	LIVE WATER REGISTER	255 (0xFF)	Signed integer

Data Offset	Data	Initial value	Data type
320	LIVE WATER REGISTER	255 (0xFF)	Signed integer
321	LIVE WATER REGISTER	255 (0xFF)	Signed integer
322	LIVE WATER REGISTER	255 (0xFF)	Signed integer
323	LIVE WATER REGISTER	255 (0xFF)	Signed integer
324	LIVE WATER REGISTER	255 (0xFF)	Signed integer
325	LIVE WATER REGISTER	255 (0xFF)	Signed integer
326	LIVE WATER REGISTER	255 (0xFF)	Signed integer
327	LIVE WATER REGISTER	255 (0xFF)	Signed integer
328	LIVE WATER REGISTER	255 (0xFF)	Signed integer
329	LIVE WATER REGISTER	255 (0xFF)	Signed integer
330	LIVE WATER REGISTER	255 (0xFF)	Signed integer
331	LIVE WATER REGISTER	255 (0xFF)	Signed integer

7.6 Vapour temperature registers

Data Offset	Data	Initial value	Data type
700	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
701	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
702	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
703	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
704	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
705	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
706	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
707	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
708	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
709	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
710	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
711	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
712	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
713	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
714	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
715	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
716	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
717	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
718	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
719	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
720	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
721	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
722	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
723	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
724	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
725	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
726	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer

Data Offset	Data	Initial value	Data type
727	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
728	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
729	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
730	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer
731	VAPOUR TEMP REGISTER	255 (0xFF)	Signed integer

7.7 Base pressure P1 registers

Data Offset	Data	Initial value	Data type
800	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
801	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
802	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
803	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
804	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
805	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
806	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
807	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
808	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
809	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
810	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
811	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
812	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
813	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
814	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
815	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
816	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
817	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
818	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
819	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
820	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
821	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
822	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
823	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
824	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
825	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
826	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
827	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
828	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
829	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
830	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer
831	BASE PRESSURE P1 REGISTER	255 (0xFF)	Signed integer

7.8 Liquid pressure P2 registers

Data Offset	Data	Initial value	Data type
900	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
901	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
902	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
903	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
904	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
905	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
906	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
907	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
908	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
909	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
910	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
911	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
912	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
913	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
914	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
915	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
916	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
917	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
918	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
919	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
920	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
921	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
922	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
923	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
924	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
925	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
926	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
927	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
928	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
929	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
930	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer
931	LIQUID PRESSURE P2 REGISTER	255 (0xFF)	Signed integer

7.9 Vapour pressure P3 registers

Data Offset	Data	Initial value	Data type
1000	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1001	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1002	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1003	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1004	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer

Data Offset	Data	Initial value	Data type
1005	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1006	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1007	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1008	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1009	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1010	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1011	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1012	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1013	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1014	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1015	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1016	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1017	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1018	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1019	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1020	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1021	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1022	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1023	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1024	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1025	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1026	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1027	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1028	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1029	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1030	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer
1031	VAPOUR PRESSURE P3 REGISTER	255 (0xFF)	Signed integer

8 Modbus Task – Function: 1 (read coil status)

8.1 Modbus Address

One map has 48 coils. The address used will be the same as any of the addresses used for function 4.
When a request for read coil status is made, function 1, the TVGL will return a value of zero (0) for every coil within the 48 coil range.
The purpose of this is depending on the system polling the TVGL, the host made need to poll for function 1 if force single coils (function 5) is going to be used.

9 Modbus Task – Function: 5 (Force single coil)

9.1 Modbus Address

The address used will be any of the addresses used in function 4.
This function is used to Stow, unstow, servo check or water dip.
The TVGL will only respond to one of four of the commands, other wise it will reply with an exception. The corresponding Enraf gauge will respond to the appropriate command.

10 Modbus Task – Function: 15 (Force multiple coil)

10.1 Modbus Address

The address used will be any of the addresses used in function 4.
This function is used to Stow, unstow, servo check or water dip.
The TVGL will only respond to one of four of the commands, other wise it will reply with an exception. The coil address must be within the range as shown below. The corresponding Enraf gauge will respond to the appropriate command.

The coil addresses correspond to the gauge command below.

Coil Address offset	Command
11 (00012)	Unstow, Unlock
12 (00013)	Servo Check, Test Gauge
13 (00014)	Stow, Lock Test
14 (00015)	Water dip

11 Modbus Task – Function: 6 (Preset single register)

11.1 Modbus Address

The modbus address used can be any of the addresses used in function 4 or a default address of 247.
This function is used to configure gauge addresses for all the parameters mentioned in function 3, read holding registers.
This function is also used as a Gauge operation command.
When configuring the Enraf gauge addresses the Enraf address entered must be between 0 and 99, Emerson addresses must be between 1 – 246. Any other value transmitted to the TVGL will cause the TVGL to default the address to 255. The level addresses must be entered starting at data offset 0 (40001) and every additional register must be entered immediately after the previous address.
The gauge addresses entered can be viewed using function 3.
Any modbus register out of the register range, the TVGL will reply with an exception except for data offset 26 (40027).
When using Function code 6 for gauge operation commands, the data offset 26 (40027) is used for the commands. Write the below value to the command register will cause the appropriate command. The command issued to an address must have a gauge which can support the command.

11.2 Gauge operation code. Data offset 26 (40027)

Value	Description
0	Level / Unstow
1	Up / Stow
2	Stop / Freeze
6	Density Scan
9	Repeatability / servo check
10	Water dip

12 Modbus Task – Function: 16 (Preset multiple register)

12.1 Modbus Address

The modbus address used can be any of the addresses used in function 4 or a default address of 247.
This function is used to configure gauge addresses for all the parameters mentioned in function 3, read holding registers.
The Enraf address must be between 0 and 99, Emerson addresses must be between 1 – 246.
Any other value transmitted to the TVGL will cause the TVGL to default the address to 255.
The level addresses must be entered starting at data offset 0 (40001) and every additional register must be entered immediately after the previous address. (see instruction manual for detailed information).
The gauge addresses entered can be viewed using function 3.
Any modbus register out of the register range, the TVGL will reply with an exception.

13 Modbus Task – Function: 8 (sub function 0) (Diagnostics)

13.1 Modbus Address

The TVGL will echo back the request from this function code when RTU address 247 is used. The data field length must be 2 bytes long.

14 Status

Details of the status input registers. Uninitialized data for status and all registers are set to "0xffff", (all bits are set).

14.1 Product Level Status

Bit	Description
0	General Product Level Fail
1	Reserved
2	Motor top limit switch
3	Unstow / unlock
4	Stowed / Locktest
5	Reserved
6	Reserved
7	Reserved
8	Reserved
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	Reserved
15	Reserved

14.2 Product Temperature Status

Bit	Description
0	General Product Temperature Fail
1	Reserved
2	Reserved
3	Reserved
4	Reserved
5	Reserved
6	Reserved
7	Reserved
8	Reserved
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	Reserved
15	Reserved

14.3 Water Level Status

Bit	Description
0	General Water Level Fail
1	Searching for water
2	Returning to product level
3	Water level found
4	Reserved
5	Reserved
6	Reserved
7	Reserved
8	Reserved
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	Reserved
15	Reserved

14.4 Vapour Temperature Status

Bit	Description
0	General Vapour Temperature Fail
1	Reserved
2	Reserved
3	Reserved
4	Reserved
5	Reserved
6	Reserved
7	Reserved
8	Reserved
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	Reserved
15	Reserved

14.5 Base Pressure P1 Status

Bit	Description
0	General Base Pressure P1 Fail

Bit	Description
1	Reserved
2	Reserved
3	Reserved
4	Reserved
5	Reserved
6	Reserved
7	Reserved
8	Reserved
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	Reserved
15	Reserved

14.6 Liquid Pressure P2 Status

Bit	Description
0	General Vapour Pressure P2 Fail
1	Reserved
2	Reserved
3	Reserved
4	Reserved
5	Reserved
6	Reserved
7	Reserved
8	Reserved
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	Reserved
15	Reserved

14.7 Vapour Pressure P3 Status

Bit	Description
0	General Vapour Pressure P3 Fail
1	Reserved
2	Reserved
3	Reserved

Bit	Description
4	Reserved
5	Reserved
6	Reserved
7	Reserved
8	Reserved
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	Reserved
15	Reserved

14.8 Density Status

Bit	Description
0	General Density Status Fail
1	Reserved
2	Reserved
3	Reserved
4	Reserved
5	Reserved
6	Reserved
7	Reserved
8	Reserved
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	Reserved
15	Reserved

14.9 Sensor Position Status

Bit	Description
0	Low Low Alarm
1	Low Alarm
2	High Alarm
3	High High Alarm
4	Reserved
5	Reserved
6	Reserved

Bit	Description
7	Reserved
8	Reserved
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	Reserved
15	Reserved

14.10 Temperature Element

Bit	Description
0	Fail in temp. reading (general Element temp. fail)
1	Fail in average product temperature reading
2	Fail in average vapour temperature reading
3	Level exceeds lowest temperature element
4	Level exceeds highest temperature element
5	Temp. element fail (one or more elements defect)
6	1
7	0
8	Last valid level used
9	Manual level used
10	Level timeout
11	Device not calibrated (MTT only)
12	Exceeding specified differential temperature (MTT only)
13	Out of specified temperature range
14	1
15	0

14.11 Density Position Status

Bit	Description
0	General failure / default settings
1	No value Y4 level
2	Level / distance exceeds MH value
3	Level / distance exceeds ML value
4	0
5	0
6	1
7	0
8	Distance exceeds level y4, DB too small
9	Density distance stops below DZ or EZ

Bit	Description
10	No valid DK and / or DN levels
11	0
12	0
13	0
14	1
15	0

14.12 Density Status

Bit	Description
0	General fail / default settings
1	Measurement not complete
2	0 = TP. 1 = IP
3	No measuring point or measuring point out of range
4	Conversion overflow
5	Conversion underflow
6	1
7	0
8	Reserved
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	Reserved
15	Reserved

14.13 Gauge Status

Value	Description
2	Displacer at reference position (Stowed)
3	Displacer hoisting up (Stowing)
4	Displacer stopped
5	Level Measurement, balanced.
9	Density Profile complete
14	Seek level, unstowing
16	Density profile active
25	Stop at high stop
26	Stop at low stop
27	Repeatability, servo check
28	Seeking water level
30	Follow water level
255	Error

If an error occurs (255), use the status registers to determine which parameter has failed. If the appropriate status register is not zero, then that parameter has failed.

Index

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