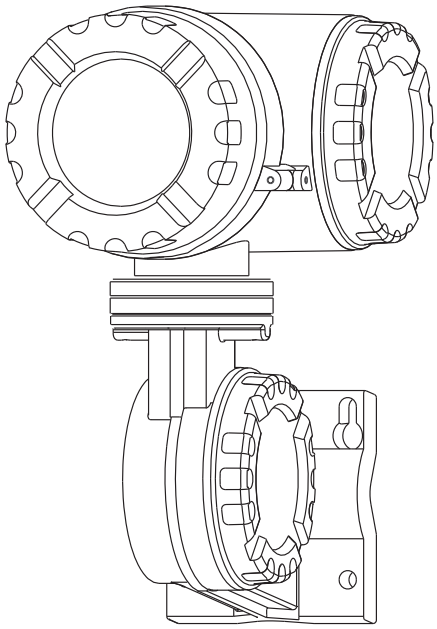
4590 Tank Side Monitor

Description of Instrument Functions



Service Manual

Automation Solutions for oil & gas, defense and aviation applications

Varec®

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Contents

1 Introduction

This guide describes the instrument functions and how to enter parameters for the Varec 4590 Tank Side Monitor (TSM).

This introduction describes two methods for locating a function description in this manual. Also, Section 1.4 on page 3 provides a list of the 4590 TSM parameters and the symbol for each parameter.

1.1 Using the Table of Contents to Locate a Function Description

All the functions are listed in the table of contents sorted by function group (e.g. basic setup, safety settings, etc.). You can access a more detailed description of a function by using a page reference / link.

The table of contents is on page v.

1.2 Using the Index of the Function Menu to Locate a Function Description

To simply navigation within the function menu, each function has a position which is shown in the display. You can access each function via a page reference/link in the function menu index (see page 95) which lists all the function names alphabetically.

1.3 Product Naming Conventions

The names for Varec products that appear in the 4590 TSM graphical display may differ from those used by Varec. These alternate names are used in this manual when necessary.

The following table matches Varec product names to the names used for them in the 4590 TSM display. This list may not be complete.

Displayed Term	Varec Product	
	Name	Abbreviation
FMR / Micropilot	7200 Series Radar Tank Gauges	None
	7500 Series Radar Tank Gauges	
FMR 23X / Micropilot M	7200 Series Radar Tank Gauges	None
FMR 53x / Micropilot S	7500 Series Radar Tank Gauges	None
NMT 532	4532 Average Temperature Converter	453x ATC
NMT 539	4539 Average Temperature/Water Bottom Sensor and Converter	4539 ATC
NMT 539+WB	4539 Average Temperature/Water Bottom Sensor and Converter	4539 ATC
NRF / NRF 590	4590 Tank Side Monitor	4590 TSM
NMT/ NMT 53x / Prothermo	4532 Average Temperature Converter 4535 Average Temperature Converter 4538 Average Temperature/Water Bottom Converter 4539 Average Temperature/Water Bottom Sensor and Converter	453x ATC
NMS / NMS 5/ 7	6005 Servo Tank Gauge	6005 STG

Table 1-1: Varec Terms Compared to Terms Used in Interface

1.4 4590 TSM Parameters

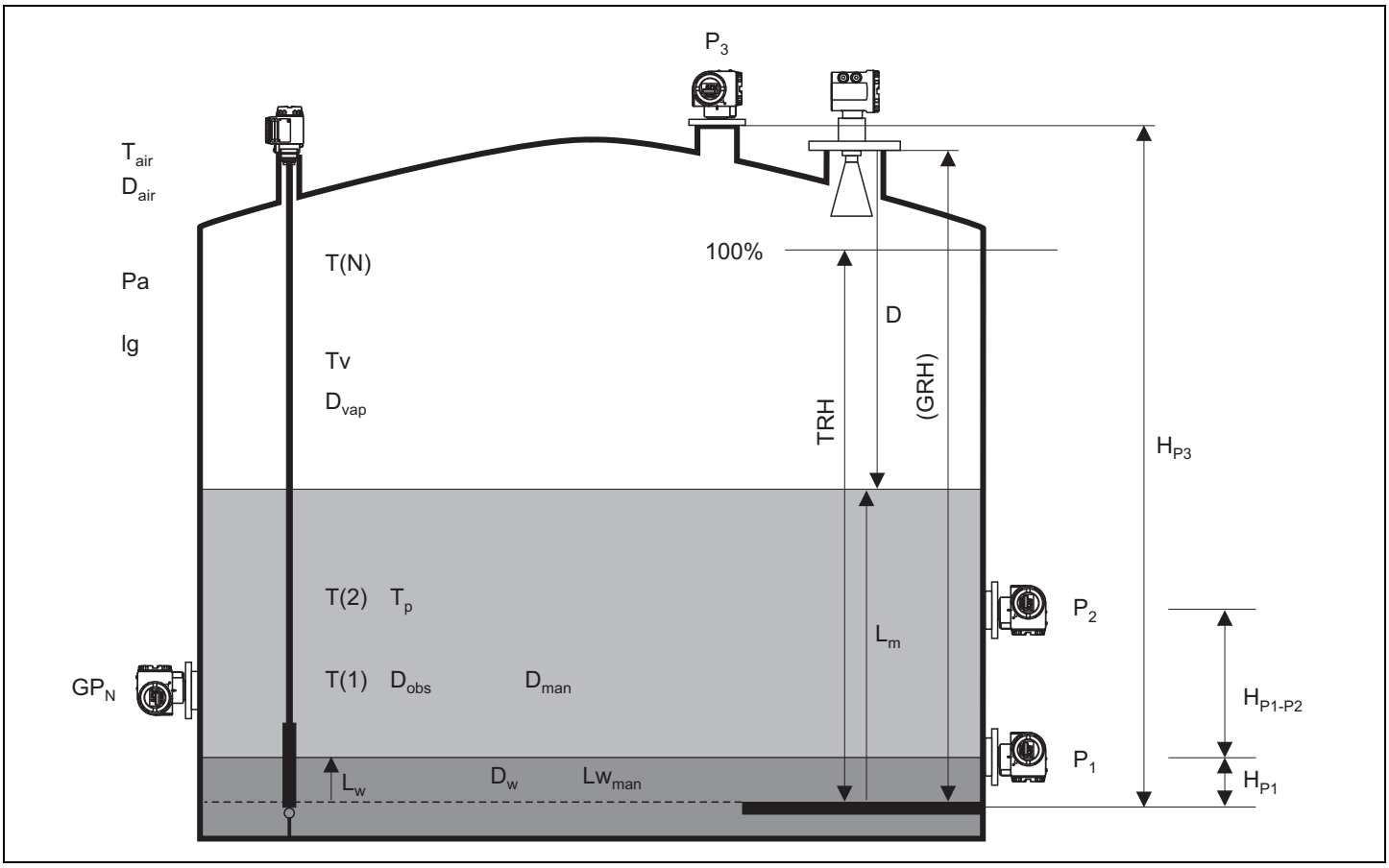


Figure 1-1: 4590 TSM Parameters Diagram

Value (* used in Tank Parameters)	Mathematical Symbol
Product Level*	L_p
Measured Level*	L_m
Level Correction*	L_c
Percentage Level $_{\%}$*	$L_{\%}$
Product Temperature*	T_p
Vapour Temperature*	T_v
Air Temperature*	T_a
Observed Density*	D_{obs}
Vapour Density*	D_{vap}
Air Density*	D_{air}
Manual Density*	D_{man}
Water Level (BSW, FWL)*	L_w
P_1 (Bottom) Pressure*	P_1

Table 1-2: 4590 TSM Parameters

Value (* used in Tank Parameters)	Mathematical Symbol
P_2 (Middle) Pressure*	P_2
P_3 (Top) Pressure*	P_3
Ambient Pressure*	P_a
Pressure Offset P_1*	Po1
Pressure Offset P_2*	Po2
Pressure Offset P_3*	Po3
P_1 Position*	H_{P1} or Z
P_1-P_2 Distance*	$H_{P1\text{-}P2}$
P_1-P_3 Distance*	$H_{P1\text{-}P3}$
P_3 Position*	H_{P3}
Temperature Element (N)*	T(N)
General Purpose Value (N)*	GP_N
Tank Reference Height*	TRH
Local Gravity*	lg
Gauge Reference Height	GRH
Water Density	D_w
Manual Water Level	L_{wman}
Manual Vapour Temperature	T_{vman}
Manual Pressure P_1	P_{1man}
Manual Pressure P_2	P_{2man}
Manual Pressure P_3	P_{3man}
HT Minimum Pressure	HT_{minpr}
HT Minimum Level	$HT_{minlevel}$
HT Hysteresis	HT_{hys}
HT Safety Distance	HT_{Safety}
Correction of the thermal Tank Shell expansion	CTSh Corr
Hydrostatic Tank Deformation	HyTD Corr
HTMS Minimum Level	$HTMS_{minlevel}$

Table 1-2: 4590 TSM Parameters

2 Operation

2.1 Display and Operating Elements

The 4590 TSM is operated via the display module and the three optical keys. The keys can be operated through the cover glass. Therefore, the 4590 TSM does not need to be opened for operation. The backlight of the display is activated during operation for user defined time (always off, 10 sec, 30 sec, 1 min, always on).

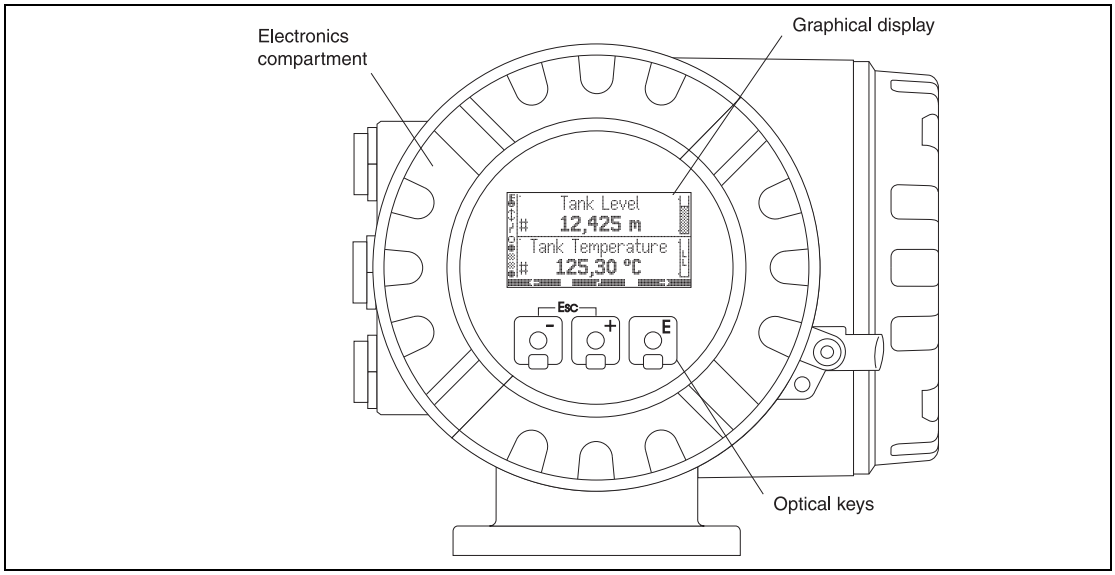


Figure 2-1: Display and Operating Elements Diagram

2.1.1 Product naming

Varec products may be referred to with non-Varec product names in the 4590 TSM display. Refer to section 1.3 on page 2 for a list of product names.

2.1.2 Format of decimal numbers

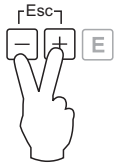
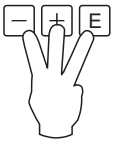
The number of decimal places displayed can be selected from three resolution presets (high, normal, low)

Value	resolution preset		
	low	normal	high
level units			
mm	xxxxx	xxxxx	xxxxx.x
cm	xxxx.x	xxxx.x	xxxx.x
m	xx.xxx	xx.xxx	xx.xxxx
in	xxxx.x	xxxx.x	xxxx.xx
ft	xxx.xxx	xxx.xxx	xxx.xxxx
ft-in-8	xx'xx"x/8	xx'xx"x/8	xx'xx"x/8
ft-in-16	xx'xx"xx/16	xx'xx"xx/16	xx'xx"xx/16
16ths	xxxxx	xxxxx	xxxxx.x
temperature units			
°C	xxx	xxx.x	xxx.xx
°F	xxx	xxx.x	xxx.xx
pressure units			
Pa	xxxxxxx	xxxxxxx	xxxxxxx
kPa	xxxx.x	xxxx.xx	xxxx.xxx
MPa	x.xxxx	x.xxxxx	x.xxxxxx
mbar	xxxxx	xxxxx	xxxxx.x
bar	xx.xxx	xx.xxx	xx.xxxx
psi	xxx	xxx.x	xxx.xx
inH_20	xxxxx	xxxxx.x	xxxxx.x
density units			
kg/m^3	xxxx.x	xxxx.xx	xxxx.xx
g/ml	x.xxxx	x.xxxx	x.xxxxx
lb/ft^3	xx.xx	xx.xxx	xx.xxxx
°API	xxx.xx	xxx.xx	xxx.xxx
current units			
mA	xx.xxx	xx.xxx	xx.xxxx

Table 2-1: Format of Decimal Numbers

2.2 Key Assignment

2.2.1 General key combinations

Key combination	Meaning
	Escape Escape from the current editing opration. If the currently edited value has not been stored , then the parameter will retain its original value.
	Display contrast Opens the menu for the setting of the display contrast.
	
	In the operating menu: Quick Exit Return to the measured value display In the measured value display: Software-locking Sets "Access Code" = 0 (device locked) Sets "Service English" = off (display language as selected by the user)

2.2.2 Softkeys

Except for the aforementioned key combinations, the keys operate as softkeys, i.e. their meaning varies depending on the current position within the operating menu. The meaning is indicated by softkey symbols in the bottom line of the display.

Example

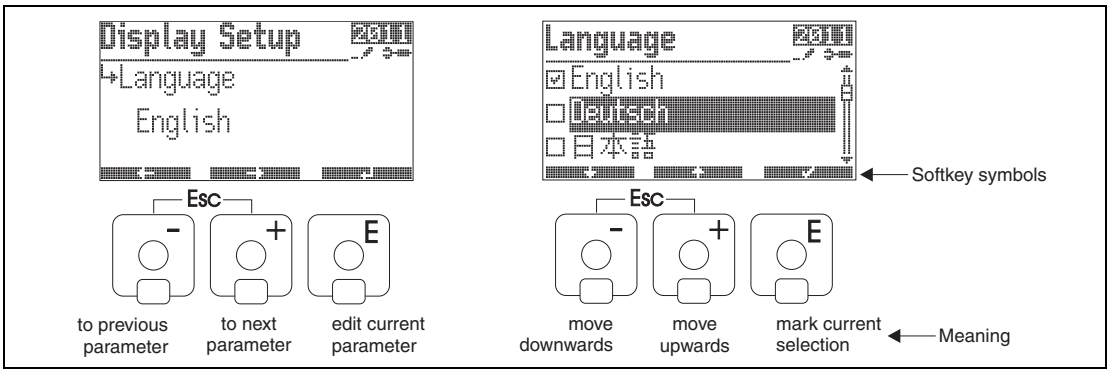


Figure 2-2: Example

2.2.2.1 List of the softkey symbols

Softkey symbol	Meaning
	Move to the previous parameter in the list.
	Move to the next parameter in the list.
	Return to the group selection.
	Enter the current parameter for editing.
	Move the selection in a list up to the previous one.
	Move the selection in a list down to the next one.
	Select the currently highlighted option. “Yes” for yes/no questions.
	Unselect the current option. “No” for yes/no questions.
	Increment a numerical or alphanumerical value by one.
	Decrement a numerical or alphanumerical value by one.
	Display device status.

Table 2-2: List of the Softkey Symbols

2.3 Measured Value Display

The appearance and meaning of the measured value display depends on the configuration of the 4590 TSM. The following picture gives a typical example. The table summarizes all display symbols.

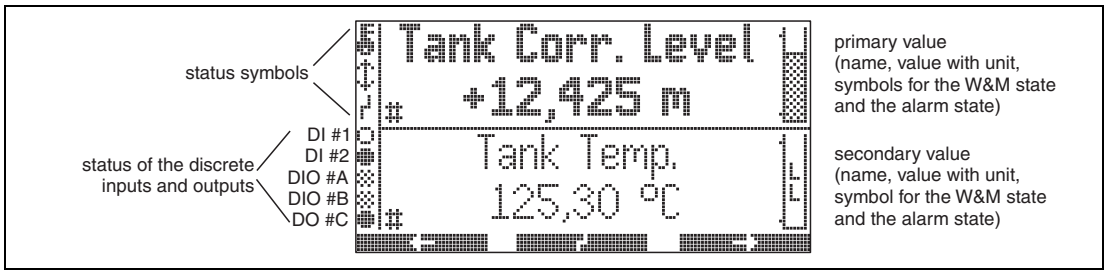


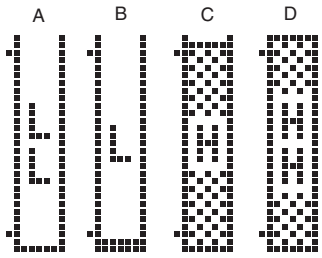
Figure 2-3: Measured Value Display

The primary measurement value is constantly displayed in user configured units and format; the secondary value can display up to four alternately measurement values, in a scroll rate choosen by the user.

Symbol	Meaning
Status of the 4590 TSM	
	**W&M locking** is displayed, if the W&M parameters of the 4590 TSM have been locked by the hardware locking switch.
	**Communication** is displayed if the 4509 TSM is currently communicating on the Fieldbus.
	**Error** is displayed if the 4590 TSM detects an error.
Status of the displayed measuring values	
	**W&M status** is displayed, if the suitability for custody transfer measurement of the measured value can currently not be ensured (e.g. if the W&M locking of the respective sensor is not ensured).
Status of the discrete inputs and outputs	
	**Active** is displayed if the respective discrete input or output currently is in the “active” state.
	**Inactive** is displayed, if the respective discrete input or output currently is in the “inactive” state.
	**“Value unknown” or “Not fitted”** is displayed if “discrete” has been disabled in the operating menu before the first value has been read if the optional module is not installed.
Access code	
	**User** is displayed, if the “user” access code (“100”) has been entered.
	**Service** is displayed, if the “service” access code has been entered.
	**Diagnostic** is displayed, if the “diagnostic” access code has been entered.
Parameter type	
	**Read only** indicates a measured or calculated value
	**Editable** indicates a configuration parameter

Symbol	Meaning
	**W&M locked** indicates the current parameter is locked by the W&M switch
	Cyclic update (flashing left of the parameter name) indicates that the parameter is cyclically updated
	**DD** These parameters are linked to an external Hart device. There is no internal copy of these parameters and their value is not automatically scanned by the system. When one of these parameters is selected on the display it is immediately read from the connected device and displayed, changes are written directly back to the device (which may reject these changes, depending on device configuration e.g. access code or local W&M lock activated).

Table 2-3: Summarized Display Symbols

Symbol	Meaning
Alarm state	
	**Alarm inactive** is displayed, if the measured value displayed in the same section of the display is within the allowed range (i.e. between the L and H limits). The bar within this symbol represents the current value scaled between the L and H limit. If no alarm has been defined for the measured value, this symbol is not displayed.
	**Alarm active (flashing symbols)** A: measured value is below the LL limit B: measured value is between the LL and L limits C: measured value is between the H and HH limits D: measured value is above the HH limit If no alarm has been defined for the measured value, these symbols are not displayed.

2.4 Operating Menu

2.4.1 Entering the menu

The navigation in the operating menu always starts from the main screen (measured value display). From there, the following three menus can be entered by the keys:

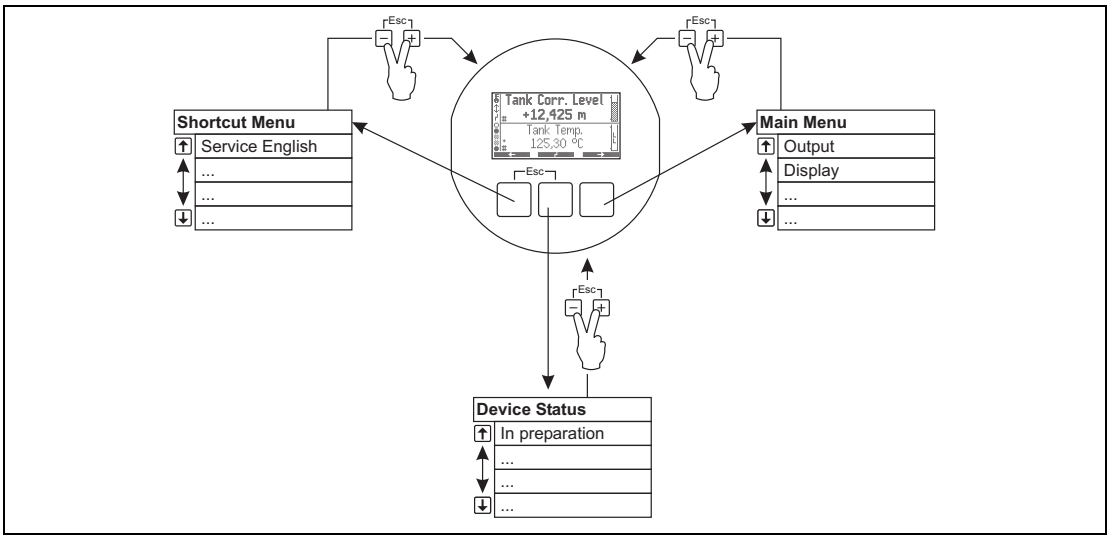


Figure 2-4: Entering the Menu Diagram

2.4.1.1 Shortcut menu

The shortcut menu allows the display language to be changed to “English”, if any other language has been choosen by the customer. By activating the option “Service English”, all parameters are displayed in the English language. Using the “Quick exit” (section 2.2.1, "General key combinations" on page 7) twice, the system is reset to the language and the Software lock is activated.

2.4.1.2 Main menu

The main menu contains all readable and editable parameters of the 4590 TSM. The parameters are distributed among statical and dynamical submenus. Dynamical submenus adapt themselves to the current installation environment of the 4590 TSM. The main menu should be used if one wants to read or edit parameters which are not accessible via the shortcut menu.

2.4.1.3 Device status

The “Device Status” comprises the most important parameters describing the current state of the 4590 TSM (error indication, alarm states etc.). Functions only if a status is active (indicated by the error symbol on the display).

2.4.2 Navigation within the menu

2.4.2.1 Selecting a submenu

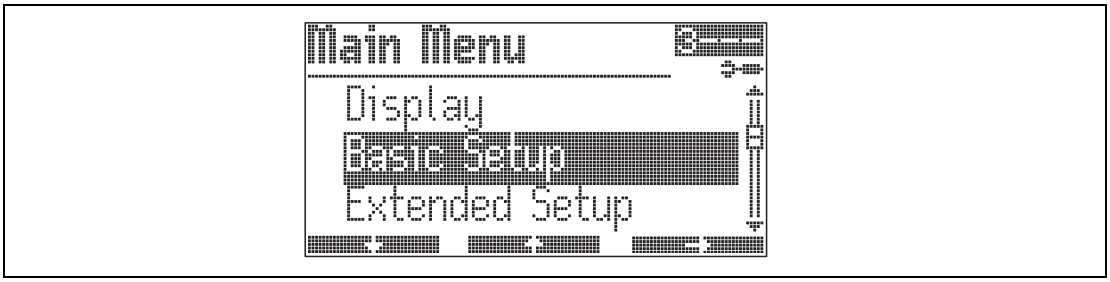


Figure 2-5: Selecting a Submenu Diagram

1. Select the submenu by [▒▒▒] and [▒▒▒] .
2. Go to the first function of the submenu by [▒▒▒] .

2.4.2.2 Selecting a parameter within the submenu

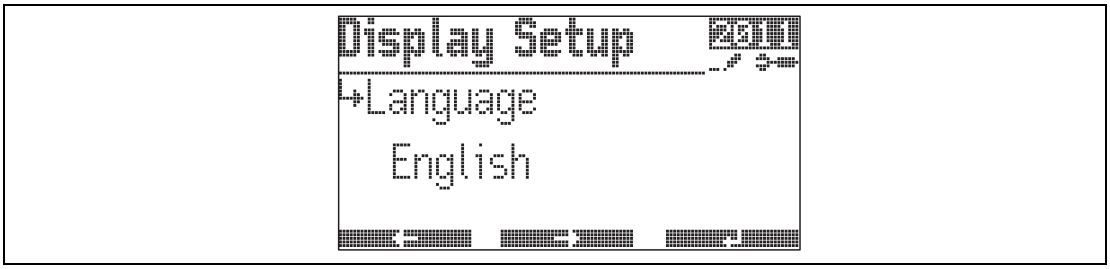


Figure 2-6: Selecting a Parameter Within the Submenu Diagram

1. Go to the previous parameter by [▒▒▒] .
2. Go to the next parameter by [▒▒▒] .
3. Open the current parameter for editing by [▒▒▒] .

2.4.3 Editing parameters

2.4.3.1 Parameters with selection list

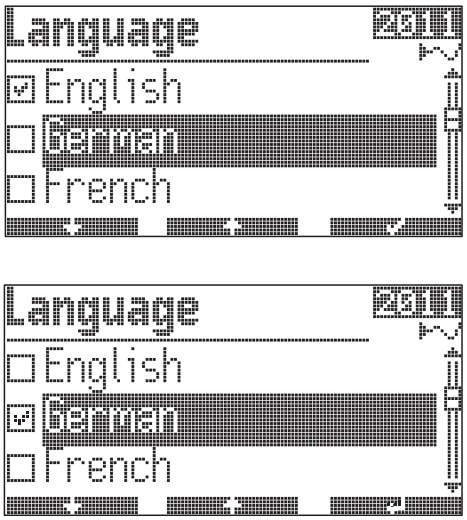


Figure 2-7: Parameters With Selection List Diagram

1. Select the parameter value by [▒▒:▒▒] and [▒▒:▒▒].
2. Mark the selected value by [▒▒✓▒▒].
3. Confirm the marked value by [▒▒↵▒▒].

2.4.3.2 Reference parameters

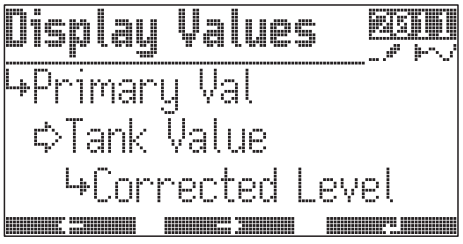


Figure 2-8: Reference Parameters Diagram

Reference parameters describe where a numerical or logical value (here: Primary Value) is obtained from. The selection consists of two steps:

1. Select the function group, from which the value is to be obtained (here: Tank Value).
2. Select the value within this group (here: Corrected Level).

There is a separate selection list for each of these steps.

2.4.3.3 Alphanumeric parameters

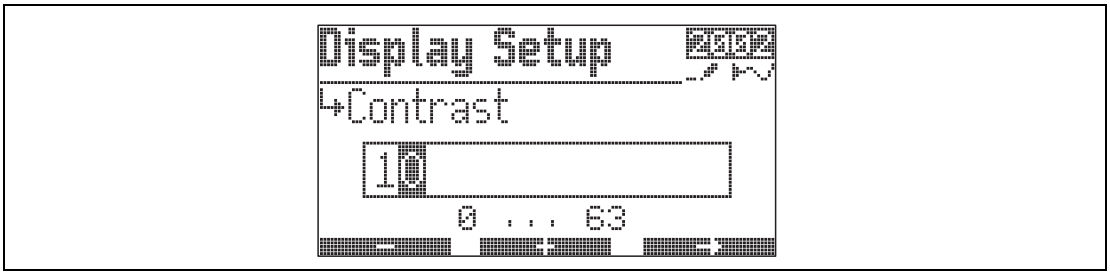


Figure 2-9: Alphanumeric Parameters Diagram

1. Set the activated digit by [redacted] and [redacted] .
2. Go to the next digit by [redacted] .
3. If ↵ appears at the active digit, the currently displayed value can be accepted by [redacted].
4. If ← appears at the active digit, return to the previous digit by [redacted].

2.4.4 Quitting the menu

Return to the measured value display by pressing all keys simultaneously.

2.5 Locking/Unlocking Parameters

2.5.1 Software locking

If the instrument is in the measured value display, it can be locked by pressing all keys simultaneously.

In doing so, “Access Code” is set to “0” (i.e. parameters can no longer be changed) and “Service English” is set to “off” (i.e. the display is returned in the language selected by the customer).

2.5.2 Software unlocking

If you try to edit a parameter, the device goes to the “Access Code” function. Enter “100”. Parameters can be changed again.

2.5.3 W&M hardware locking switch

A hardware locking switch for W&M sealing is located behind the display module. All W&M parameters can be set to definite values and locked by this switch. In this state, the 4590 TSM can be used for W&M applications.

In order to operate the hardware locking switch, proceed as follows:

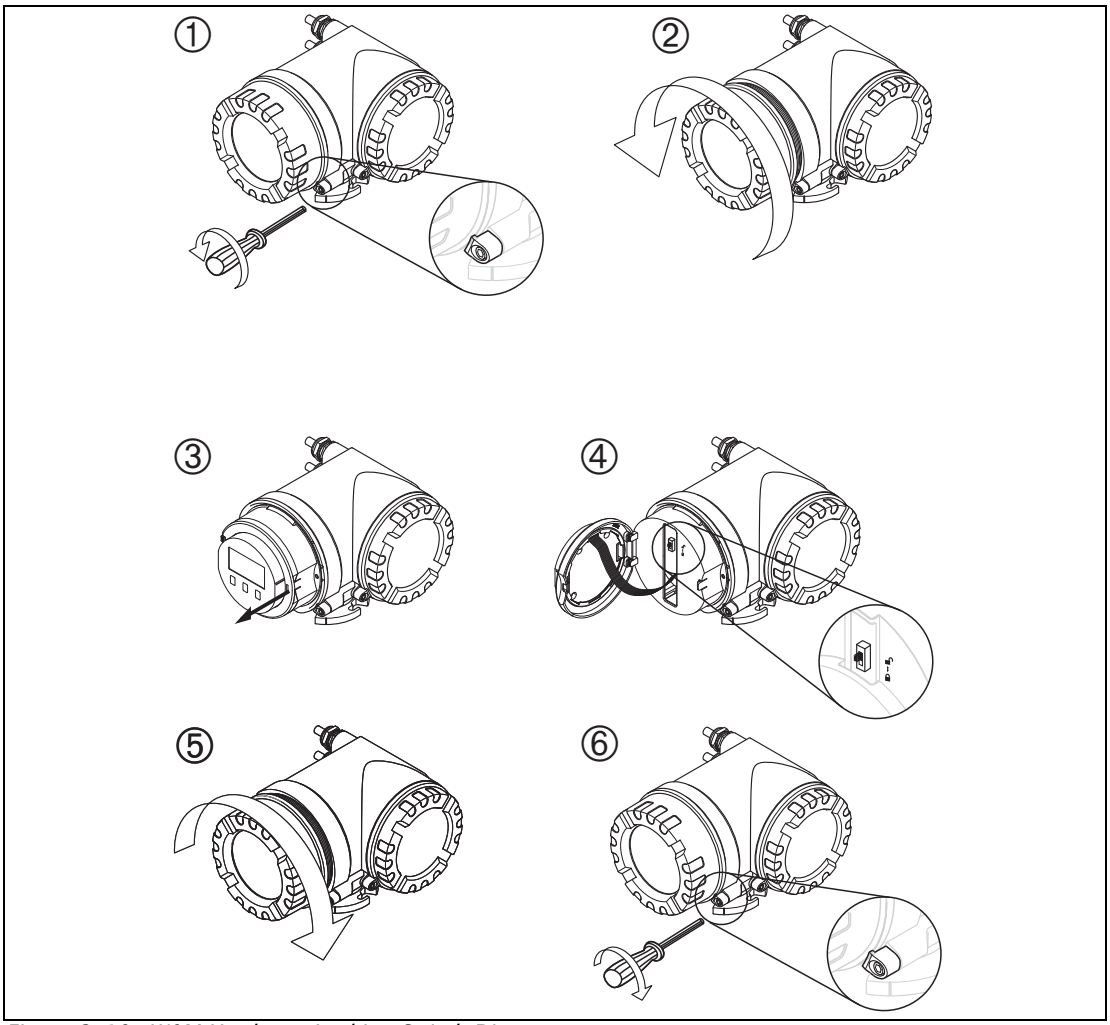


Figure 2-10: W&M Hardware Locking Switch Diagram

Warning! Danger of electrical shock! Before opening the housing, completely switch off the power supply.

1. Using a 3 mm (7/64") Allen wrench, loosen the safety pin for the display lid.
2. Unscrew the display lid.

   Note If the display lid is difficult to unscrew, unplug one of the cables from the cable gland to allow air to enter the housing. Then, attempt once again to unscrew the display lid.

3. Turn the display module sideways.
4. Place the locking shift into the desired position:
5. :W&M parameters are **free**.
6. :W&M parameters are **locked**.
7. Replace the display lid on the 4590 TSM housing.

   Note Make sure to clean threads on lid to remove any dust or particles. Check that O-ring is in place and reapply anti-seize-grease.

8. Adjust the safety pin so it is set over the display lid and tighten. The safety pin can now be secured by a sealing thread and a sealing ring.

2.5.4 Sealing of the 4590 TSM

When the tests according to the applicable regulatory standards have been completed, it is required to secure the housing cover with a sealing wire and a sealing ring.

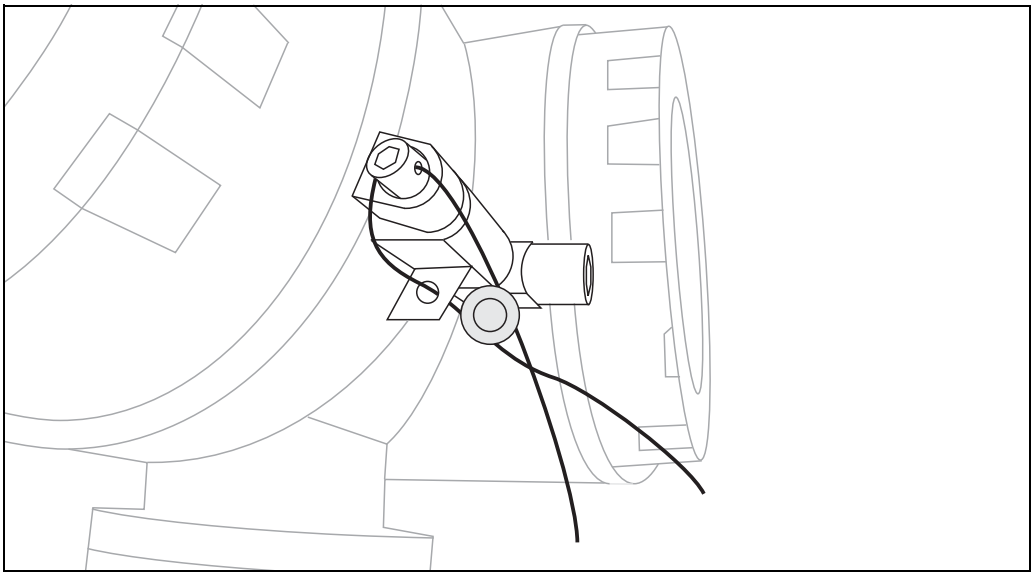


Figure 2-11: Sealing of the 4590 TSM Diagram

3 Tank Calculations and Operation Modes

3.1 Introduction

Depending on the tank instrumentation, the 4590 TSM not only displays and communicates measured values to the Host System, but is also able to perform tank calculations. For tanks equipped with a level and a temperature gauge, the 4590 TSM can be used to correct tank deformations due to thermal expansion (CTSh) and hydrostatic tank movement (HyTD). This functionality was released with SW 02.02.

For tanks equipped with 2 or 3 pressure sensors and temperature sensors, the (observed) product level and the product density can be calculated. This functionality was released with SW 02.02.

For tanks equipped with level, temperature and at least one pressure sensor, the observed product density can be calculated. This functionality was released with SW 02.02.

Product flow can be calculated. This functionality was released with SW 02.02.

3.2 HTG - Measurement Principles

3.2.1 Overview

Hydrostatic Tank Gauging (HTG) is a method to calculate the level and the density of the product inside a tank using pressure measurements only. The pressure is measured at different heights of the tank using one, two or three pressure sensors. With these data either the density or the level of the product (or both) can be calculated. Fig 1 shows a simple conic roof tank and the position of the various pressure sensors (P_1 to P_3).

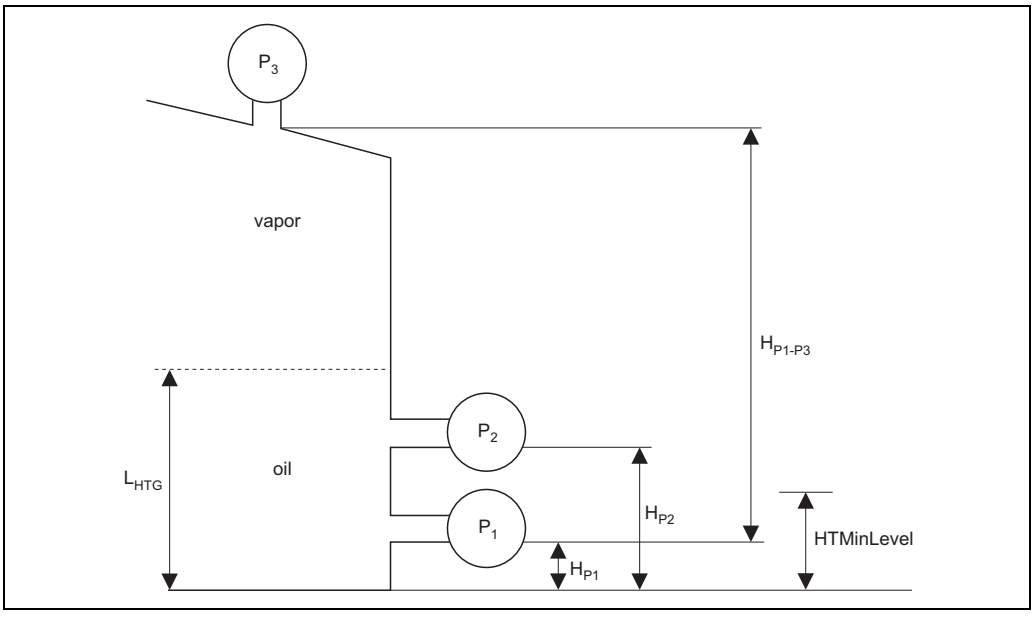


Figure 3-1: HTG overview Diagram

3.2.2 HTG modes and equations

HTG Modes

Two parameters can be calculated with HTG: the level of product in the tank and the density of this product.

To calculate the density both pressure sensors P_1 and P_2 must be present. The density is needed to calculate the level. If the density cannot be calculated (either because the pressure sensor P_2 is not present or because the level of the liquid is too low) then the manual value will be used. The value given by an extra pressure sensor (P_3) located on the top of the tank can be used to make level calculations more accurate.

Four calculations mode are available in the 4590 TSM (selected through the parameter HTGLevel):

- Mode 1 uses a single pressure sensor (P_1). In this mode only the level can be calculated and the density has to be entered manually (parameter ManualDensity).
- Mode 2 uses pressure sensors P_1 and P_3. As in mode 1 only the level can be calculated, the values given by pressure sensor P_3 are used to compensate for the vapour pressure
- Mode 3 uses pressure sensors P_1 and P_2. Both density and level are calculated in this mode.
- Mode 4 uses all three pressure sensors to calculate level and density.

HTG Equations

Mode 1: P1 (Bottom)

$$D_{obs} = D_{man} \qquad L_{HTG} = \frac{P_1}{D_{obs} * lg} + H_{P1}$$

Figure 3-2: Mode 1 – P1 (Bottom) Diagram

Mode 2 ([1]): P1 (Bottom) + P3 (Top)

$$D_{obs} = D_{man} \qquad L_{HTG} = \frac{\frac{P_1 - P_3}{lg} + H_{P1-P3} * D_{air} - H_{P1-P3} * D_{vap}}{D_{obs} - D_{vap}} + H_{P1}$$

Figure 3-3: Mode 2 – P1 (Bottom) + P3 (Top) Diagram

Mode 3: P1 (Bottom) + P2 (Middle)

$$D_{obs} = \frac{P_1 - P_2}{H_{P1-P2} * lg} + D_{air}$$

$$L_{HTG} = \frac{P_1}{D_{obs} * lg} + H_{P1}$$

Figure 3-4: Mode 3 – P1 (Bottom) + P2 (Middle) Diagram

Mode 4: P1 (Bottom) + P2 (Middle) + P3 (Top)

$$D_{obs} = \frac{P_1 - P_2}{H_{P1-P2} * lg} + D_{air}$$

$$L_{HTG} = \frac{\frac{P_1 - P_3}{lg} + H_{P1-P3} * D_{air} - H_{P1-P3} * D_{vap}}{D_{obs} - D_{vap}} + H_{P1}$$

Figure 3-5: Mode 4 - P1 (Bottom) + P2 (Middle) + P3 (Top) Diagram

Level and density are calculated according to following equations:

P_1: pressure measured by pressure sensor P_1 [Pa]
P_2: pressure measured by pressure sensor P_2 [Pa]
P_3: pressure measured by pressure sensor P_3 [Pa]
lg: local gravity (= 9,807 m/s^2)
H_{P1}: distance between P_1 and the tank zero [m]
H_{P1-P2}: distance between P_1 and P_2 [m]
H_{P1-P3}: distance between P_1 and P_3 [m]

D_{man}: manual density (kg / m^3)
D_{obs}: observed product density (kg / m^3)
D_{air}: density of the air outside the tank (kg / m^3)
D_{vap} : density of the vapor in tank (kg / m^3)
L_{HTG} : calculated product level [m]

3.2.3 Parameter range

Calculated/held density and level

To calculate level or density by HTG with the required accuracies, P_1 respectively P_2 have to be covered by a certain product level. If the product level falls below the position of the pressure sensor P_1, calculating the level becomes impossible. Density calculations can only be performed as long as the product level remains above the position of the pressure sensor P_2.

Additionally, if the product level gets too low and gets close to either P_1 or P_2, the uncertainty of the pressure measurement increases. To avoid these uncertainties in the HTG calculations, the calculation will stop before the level reaches the position of the pressure sensor.

Two parameters of the TSM are defined for this purpose:

HTMinLevel defines the position below which no level calculation will be made. If the calculation leads to HTGLevel<HTMinLevel then the value HTMinLevel will be displayed instead of the calculated value.

HTSafetyDistance indicates the minimum amount of product which must be present above the pressure sensor P1 (resp. P2) for the level (resp. density) calculation to take place. If the level gets below H2+HTSafetyDistance then the displayed density will be frozen and stored. The stored value will be displayed as long as the level stays under the limit.

> **Note** The 4590 TSM software always uses the larger of the two values HTMinLevel and H_{P1}+HTSafetyDistance as the switchover point for the level calculation. This was done to avoid unpredictable behavior if the user sets the parameter HTMinLevel so that HTMin-Level<H_{P1}+HTSafety (cf. Figure 3-7 on page 22)

Figure 3-6 to Figure 3-8 demonstrate how the calculations are done depending on the calculated HTGLevel and on the value of the parameter HTMinLevel.

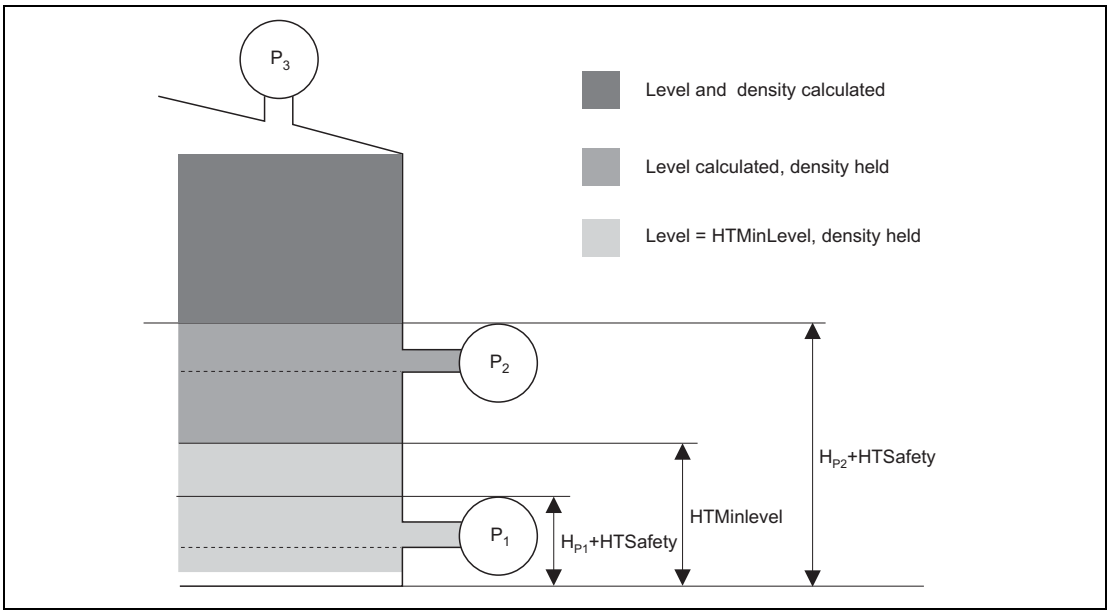


Figure 3-6: Calculation mode (H1<HTMinLevel<H2)

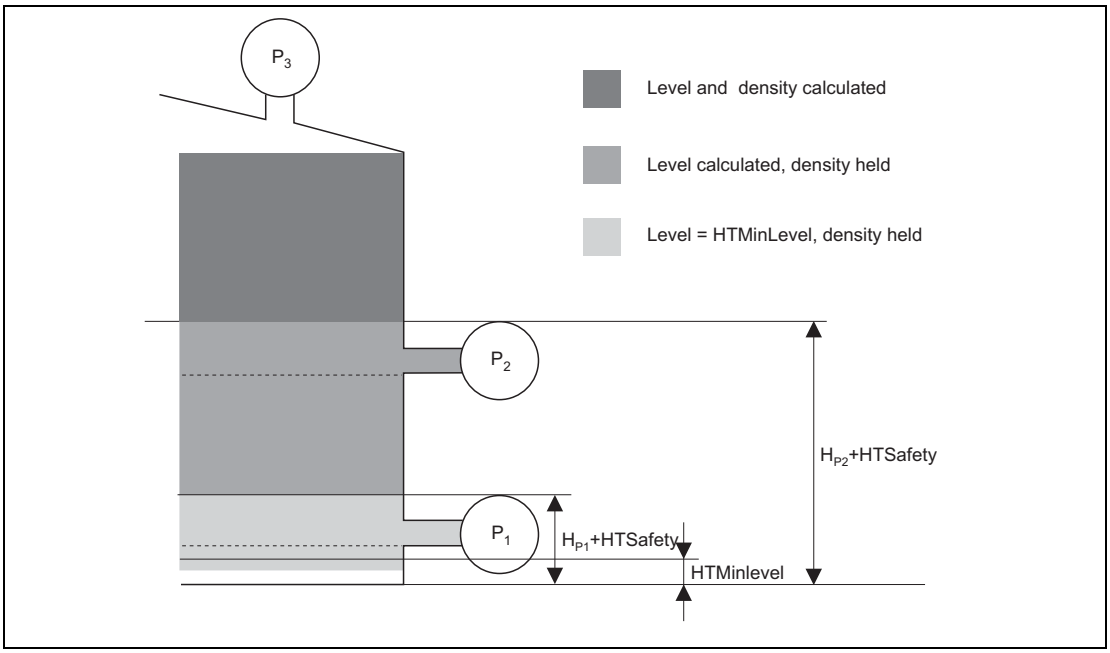


Figure 3-7: Calculation modes (HTMinLevel<H_{P1})

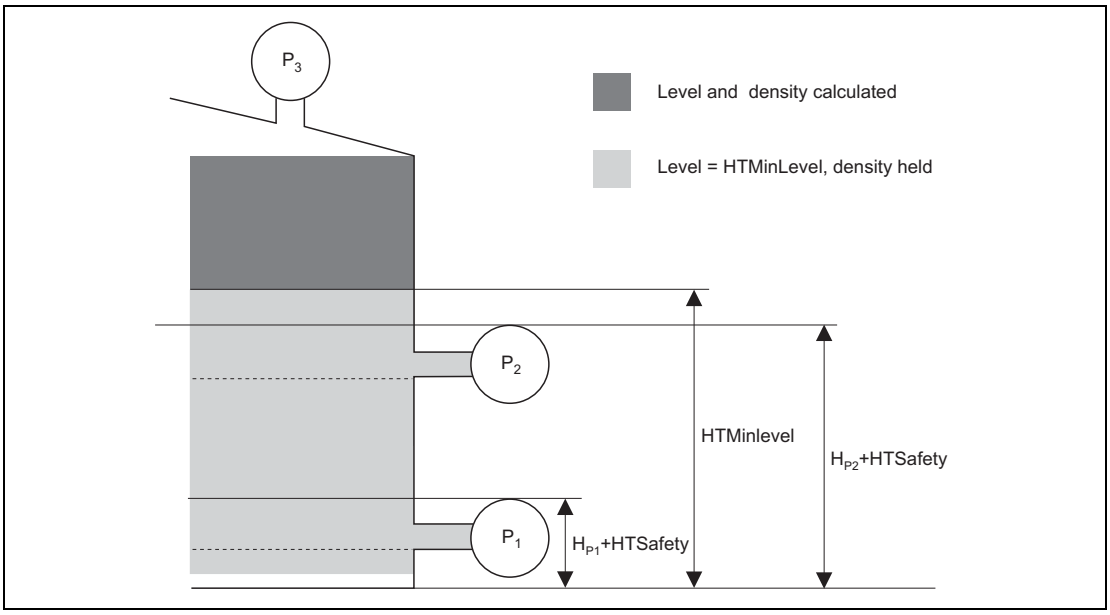


Figure 3-8: Calculation modes (HTMinLevel>H_{P2})

Note If the parameter HTGMode is set to mode 1 (P_1 only) or mode 2 (P_1 and P_3) then the density is not calculated and the ManualDensity parameter is used instead.

Hysteresis

The level of the product in a tank is not constant but slightly varies, due for example to filling disturbances. If the level oscillates around one of the changeover level (HTMinLevel for example), the algorithm will constantly switch between calculating the value and holding the previous result.To avoid this effect a positional hysteresis is defined around each changeover point.

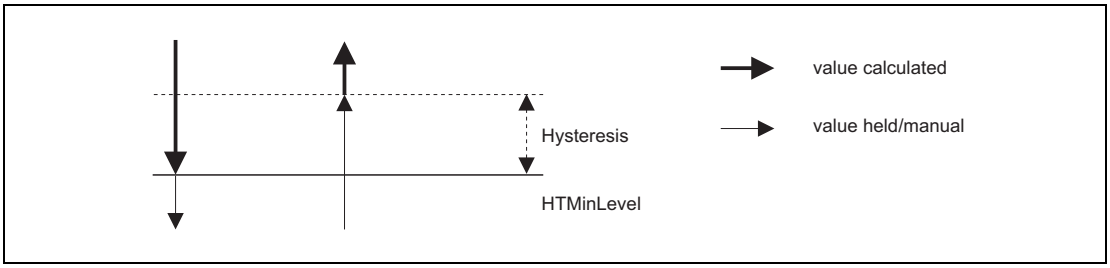


Figure 3-9: Hysteresis principle

Minimum pressure

If the level of the product approaches the position of the pressure sensor P_1 or P_2, the pressure measured by the sensor becomes very small and the measurement might be too inaccurate for the typically required accuracy in Tank Gauging applications. A minimum pressure HTMinPressure is defined to solve this problem. If the pressure measured by the sensor P_1 is smaller than HTMinPressure the software stops calculating the density and either holds the last calculated value (for the density) or returns the HTMinLevel (for HTGLevel).

3.2.4 Error handling

The program handles the errors/failures of the devices as follow:

- **P_1, P_2 or P_3 failure**: if one of the pressure transmitters fails or goes offline this will immediately be reported to the density.
- **Database reading error**: if an error occurs during the reading any of the value used for HTG calculations then both Observed Density and HTGLevel are set to an invalid value.
- **Pressure below HTMinPressure**: if pressure P_1 or the difference P_1–P_3 (in HTGMode 2 and 4) get under the minimum allowed pressure HTMinPressure then the program stops calculating the level, HTMinLevel is returned instead.
  If pressure P_2 (in HTGMode 3 or 4) gets under the minimum value the program stops calculating the density, saves the last density value and the Observed Density will be replaced by this stored value as long as P_2 remains under the minimum value.

3.3 HTMS - Measurement Principles

3.3.1 Overview

The Hybrid Tank Measurement System (HTMS) is a method to calculate the density of a product in a tank based on both a (top mounted) level and at least one (bottom mounted) pressure measurement. An additional pressure sensor can be installed at the top of the tank to provide information about the vapour pressure and to make the density calculation more accurate. The calculation method implemented in the 4590 TSM also takes into account a possible level of water at the bottom of the tank to make density calculations as accurate as possible.

Figure 1 represents a simple conic roof tank. This tank is filled with a product and water. On the top of the tank a level gauge is installed to measure the product level in the tank (e.g. a radar or servo), a pressure sensor P_1 installed at the bottom of the tank measures the pressure of the liquid. An optional pressure sensor P_3 on top of the tank measures the vapour pressure in the upper part of the tank.

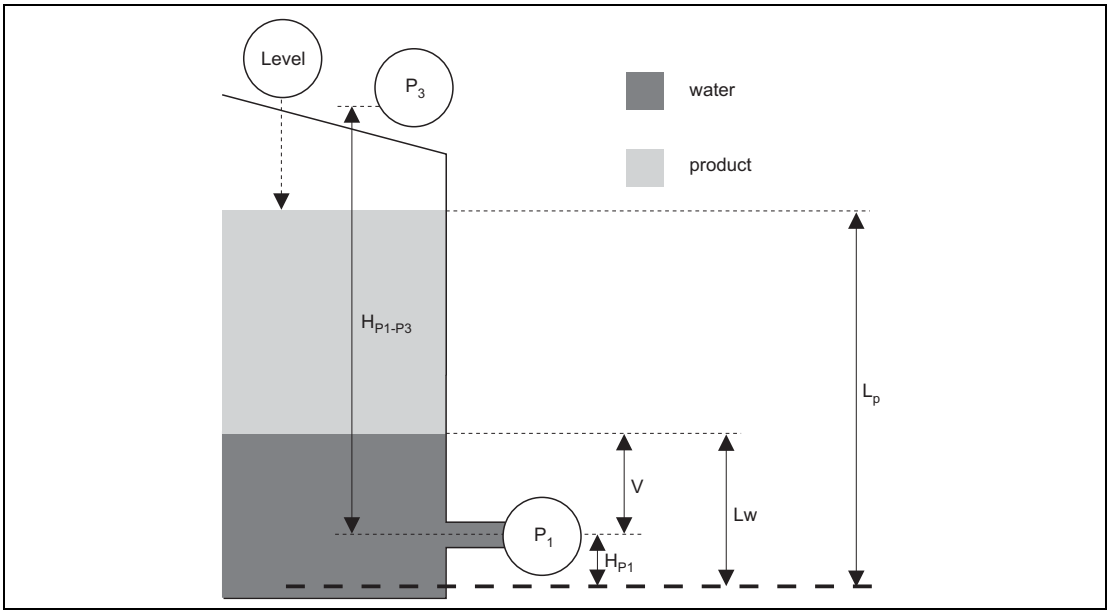


Figure 3-10: Principle of HTMS Calculations

3.3.2 HTMS Equations

Two calculation modes are available for HTMS calculations. Mode 1 only uses a single pressure sensor P_1 at the bottom of the tank, mode 2 uses a second pressure sensor (P_3) on the top of the tank which allows the compensation of the vapour pressure in the tank.

In **mode 1** the density is calculated using the following formula:

$$D_{obs} = \frac{P_1}{lg^* (L_P - v - H_{P1})} - \frac{v^* D_w}{L_P - v - H_{p1}}$$

In **mode 2** the formula is:

$$D_{obs} = \frac{P_1 - P_3}{lg^* (L_P - v - H_{P1})} - \frac{v^* D_w + (H_{P1} - (L_P - H_{P1-P3}))^* D_{vap} - H_{P1-P3} * D_{air}}{L_P - v - H_{P1}}$$

with:

Level and density are calculated according to following equations:

P_1: pressure measured by pressure sensor P_1 [Pa]
P_3: pressure measured by pressure sensor P_3 [Pa]
lg: local gravity (= 9,807 m/s^2)

L_P: product level (m)
H_{P1}: distance between P_1 and the tank zero [m]

$v = L_w - H_{P1}$: water above P_1 (m)
H_{P1-P3}: distance between P_1 and P_3 [m]
D_{obs}: observed product density (kg / m^3)
D_{air}: density of the air outside the tank (kg / m^3)
D_{vap} : density of the vapor in tank (kg / m^3)
L_{HTG} : calculated product level (m)

> **Note** The above formulas are valid for v>=0 (water level above pressure sensor P_1) if the water level is under the position of the pressure sensor P_1 then the density is calculated with v=0.

3.3.3 Limits of validity and hysteresis

Level below pressure sensor

If the level falls below the position of the pressure sensor P_1, the density value will be calculated as follows:

- If a previous, valid calculated value is available then this value will be kept as long as no new calculation is possible.
- If no value was previously calculated then the manual value (entered by the user) will be used.

Minimum level (HTMinLevel)

In the two above equations the calculated density becomes infinite if $L_P - v - H_{P1} = 0$. If the level gets near to this limit the uncertainty in the calculation increases and the calculation results are

no longer reliable. To avoid this situation a minimum level of product in the tank HTMinLevel is defined.

If the value of “LP-v” falls below this limit the calculations will stop and the density will behave as described in the previous paragraph.

Hysteresis

The level of the product in a tank is not constant but slightly varies, due for example to the ripples created by the wind. If the level oscillates around the minimum level (HTMinLevel) the algorithm will constantly switch between calculating the density and holding the previous value.

To avoid this effect a positional hysteresis is defined around the minimum level.

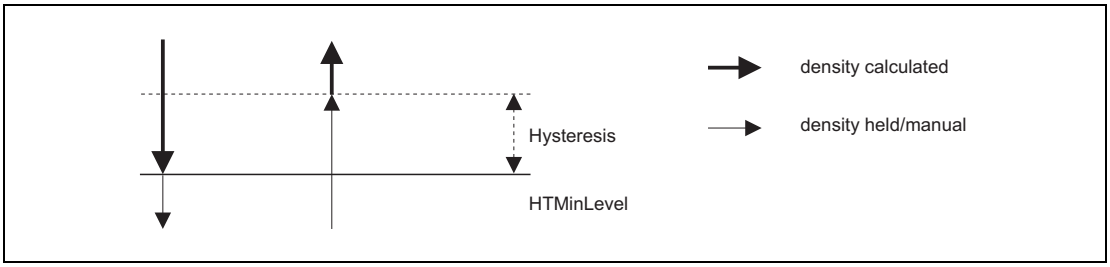


Figure 3-11: Hysteresis principle

Minimum pressure

If the level of the product approaches the position of the pressure sensor P_1, the pressure measured by the sensor becomes very small and the measurement might be too inaccurate for the required Tank Gauging accuracies.

A minimum pressure HTMinPressure is defined to solve this problem. If the pressure measured by the sensor P_1 is smaller than HTMinPressure then the program stops calculating the density and behaves as describe in section 3.2.3, "Parameter range" on page 21.

3.3.4 Error handling

The program handles the error/failures of the devices as follow:

- **Level, P_1 or P_3 failure**: if one of the measuring devices (pressure or level transmitter) fails or goes offline this will immediately be reported to the density.
- **Negative Density**: if the calculations results in a negative value for the density (because of a pressure P_3 being greater as P_1 for example) then an error value will be returned instead.
- **Pressure P1<HTMinPressure or P_1-P_3<HTMinPressure**: if the pressure P_1 or the difference (P_1-P_3) fall under the minimum allowed pressure HTMinPressure then the program will immediately go into either the “manual” or “held” state no matter the level
- **Error while reading database value**: If an error occurs while reading a value in the database, an invalid value will be returned for the density

3.4 Function “Hydrostatic Tank Deformation" (HyTD)

3.4.1 Overview

Hydrostatic Tank deformation can be used to compensate vertical movement of the Gauge Reference Height (GRH) due to bulging of the tank (shell) caused by the hydrostatic pressure exerted by the liquid stored in the tank. The compensation is based on linear approximation obtained from manual hand dips at several levels divided over the full range of the tank.

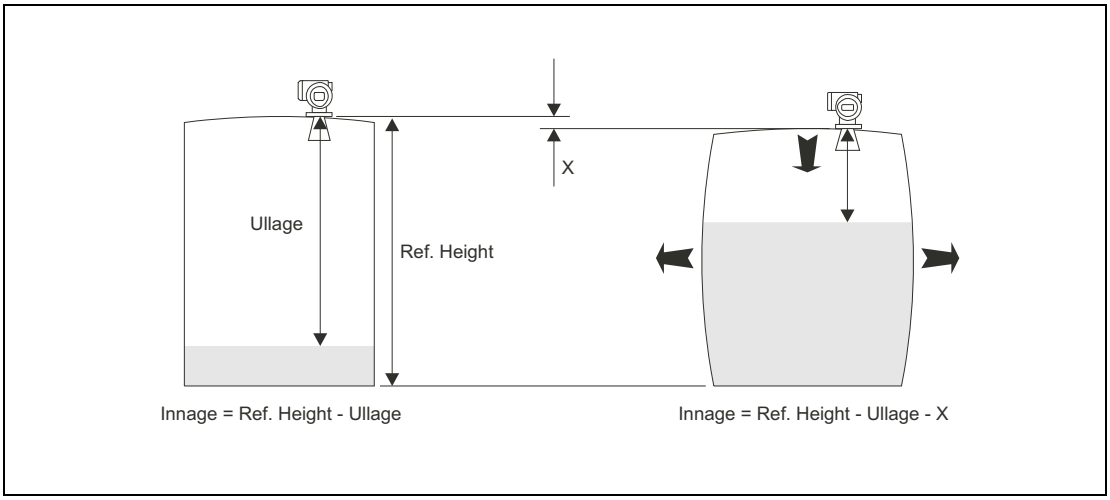


Figure 3-12: Hydrostatic Tank Deformation Diagram

The real amount of deformation varies non-linearly with the level due to the construction of the tank. However, as the correction values are typically small compared to the measured level, a simple straight line method can be used with good results.

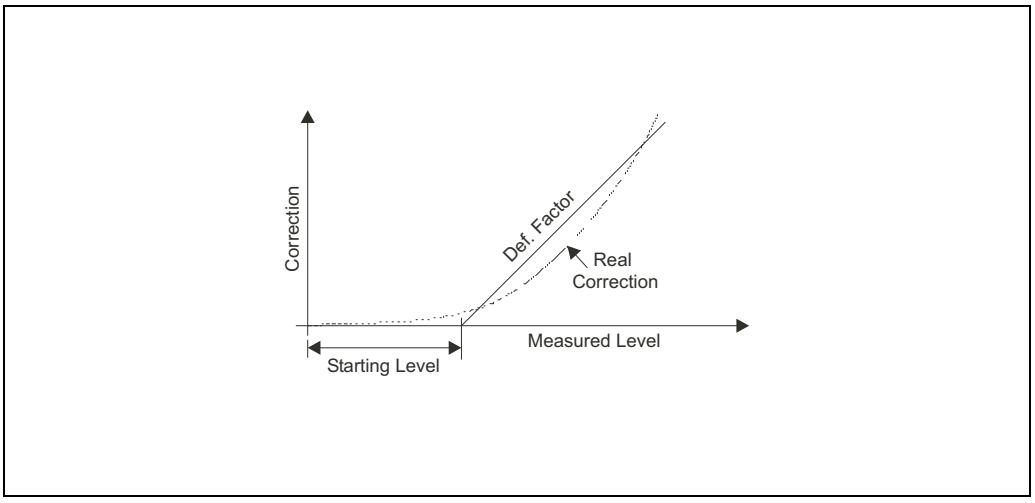


Figure 3-13: Linear Deformation Diagram

3.4.2 HyTD Equation and parameter description

The HyTD correction is calculated using the following equation:

$$C_{HyTD} = -(L_P - L_{START}) * D_{fact} \quad \text{if } L_P > L_{START}$$

Following parameters must be configured for HyTD to be activated:

- L_{START}: starting level above which the linear HyTD correction is applied
- D_{fact}: deformation factor, value in percent (enter 1 for a 1% deformation factor)

Note As the use of this correction will influence the Innage level reading, it is recommended to review the manual hand dip and level verification procedures prior to enabling this correction method.

3.4.3 Implementation:

The HyTD correction is parametrized and calculated according to the following diagram:

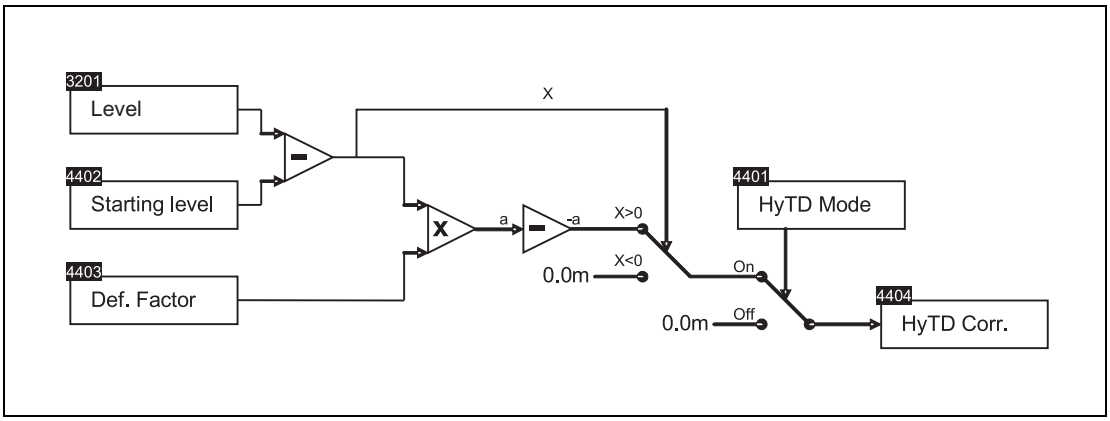


Figure 3-14: HyTD Calculation diagram

3.5 Function “Correction of the Thermal Tank Shell Expansion" (CTSh)

3.5.1 Overview

The CTSh correction compensates for effects on the Gauge Reference Height (GRH) due to temperature effects on the tank shell or stilling well. The temperature effects are separated into two parts, respectively affecting the 'dry' and 'wetted' part of the tank shell or stilling well. The calculation is based on thermal expansion coefficients of steel and 'insulation' factors for both the 'dry' and 'wet' shell. The assessed temperatures are based on manual or automatic measured values and the temperature of the shell when the tank was calibrated (for details refer to API MPMS Chapter 12.1).

Note This correction is advised for any tank gauge operating at conditions deviating considerably (>10 °C or > 20 °F) from the conditions during calibration and extreme high tanks. For refrigerated, cryogenic and heated applications this correction is strictly recommended. As the use of this correction will influence the Innage level reading, it is recommended to review the manual hand dip and level verification procedures prior to enabling this correction method. For ease of use, the correction method can be activated and parametrized based on a simple selection of the appropriate tank type. Type 3 should be selected for the typical non-isolated floating roof tank (without fixed roof). Type 5 is to be used for isolated tanks.

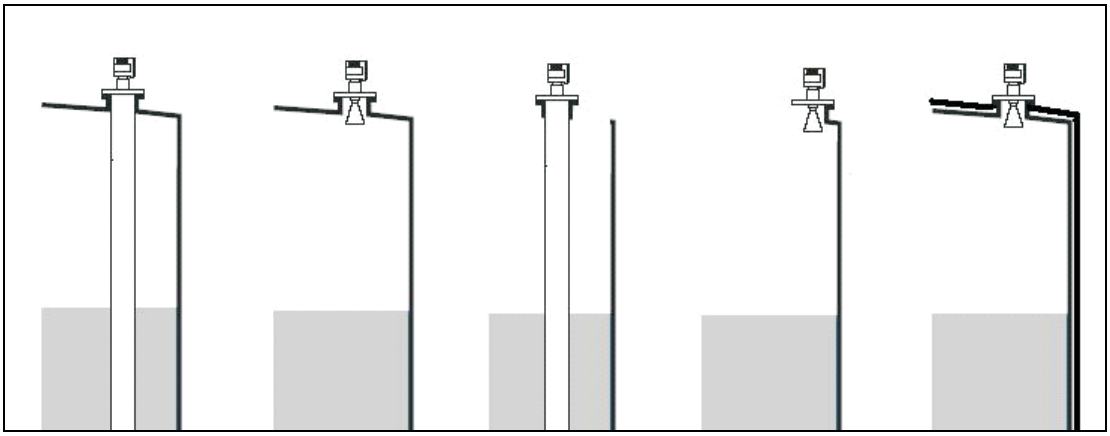


Figure 3-15: Different types of Tank

Tank Type[a)]	Stilling Well	Fixed roof tank	T_W[b)]	T_D[c)]
1	Yes	Yes	T_P	T_V[d)]
2	No	Yes	$\frac{7}{8}T_P + \frac{1}{8}T_A$	$\frac{1}{2}T_V + \frac{1}{2}T_A$
3	Yes	No	T_P	T_A[e)]
4	No	No	$\frac{7}{8}T_P + \frac{1}{8}T_A$	T_A
5	Yes	Yes	T_P[f)]	T_V

a. Figure 3-15 on page 29

b. T_W: Temperature of the wet part of the tank (below product level)

c. T_D: Temperature of the dry part of the tank (above product level)

d. T_V: In tank vapor temperature

e. T_A: Ambient air temperature

f. T_P: Product temperature

Table 3-1: "Wet" and "Dry" Temperature depending of the different tank types

3.5.2 CTSh Equation

The HyTD correction is calculated using the following equation:

$$C_{CTSh} = (TRH - L_P) * EXP * (T_D - T_{CAL}) + L_P * EXP * (T_W - T_{CAL})$$

- C_{CTSh}: Correction due to thermal expansion (m)
  TRH: Tank reference height (m)
- L_P: Product level (m)
- EXP: linear expansion coefficient (m/°C), typical value: 10x10-6 m/°C (18x10-6 m/°F), to be entered in ppm: e.g. "10" for 10x10-6m/°C
- T_{CAL}: calibration temperature (°C)
- T_D: temperature of the "dry" part of the tank (see below) (°C)
- T_W: temperature of the "wet" part of the tank (see below) (°C)

Two parameters appear in the above equation (T_D and T_W) which cannot be directly configured through the 4590 TSM menus. To determine these parameters the type of tank must be determined thanks to the parameters Tank Covered (4302) and Stilling Well (4303).

Figure 3-15 on page 29 shows the four different types of tank, and Table 3-1 gives the value of the two parameters T_D and T_W for each type of tank.

3.5.3 Implementation:

Within the 4590 TSM CTSh correction is calculated according to the following diagram:

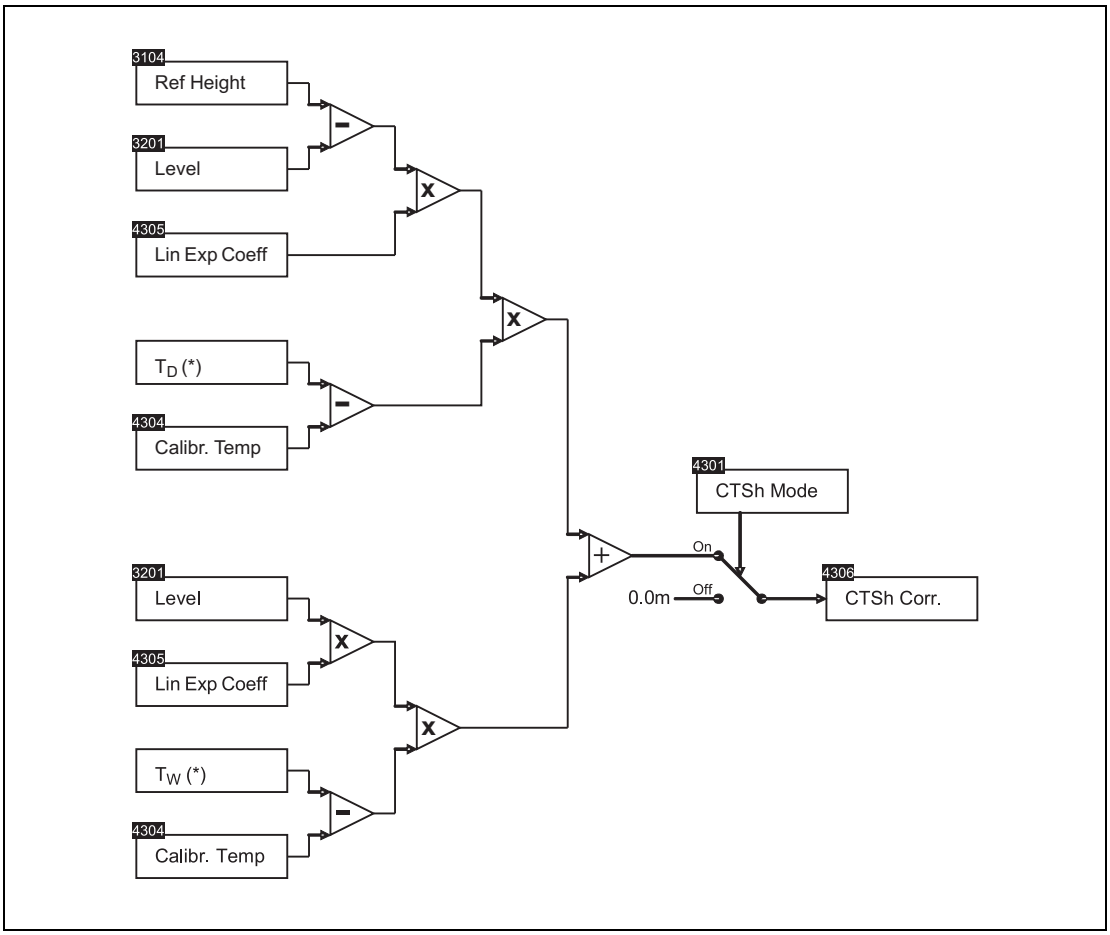


Figure 3-16: CTSh Calculation Diagram

4 Function Menu

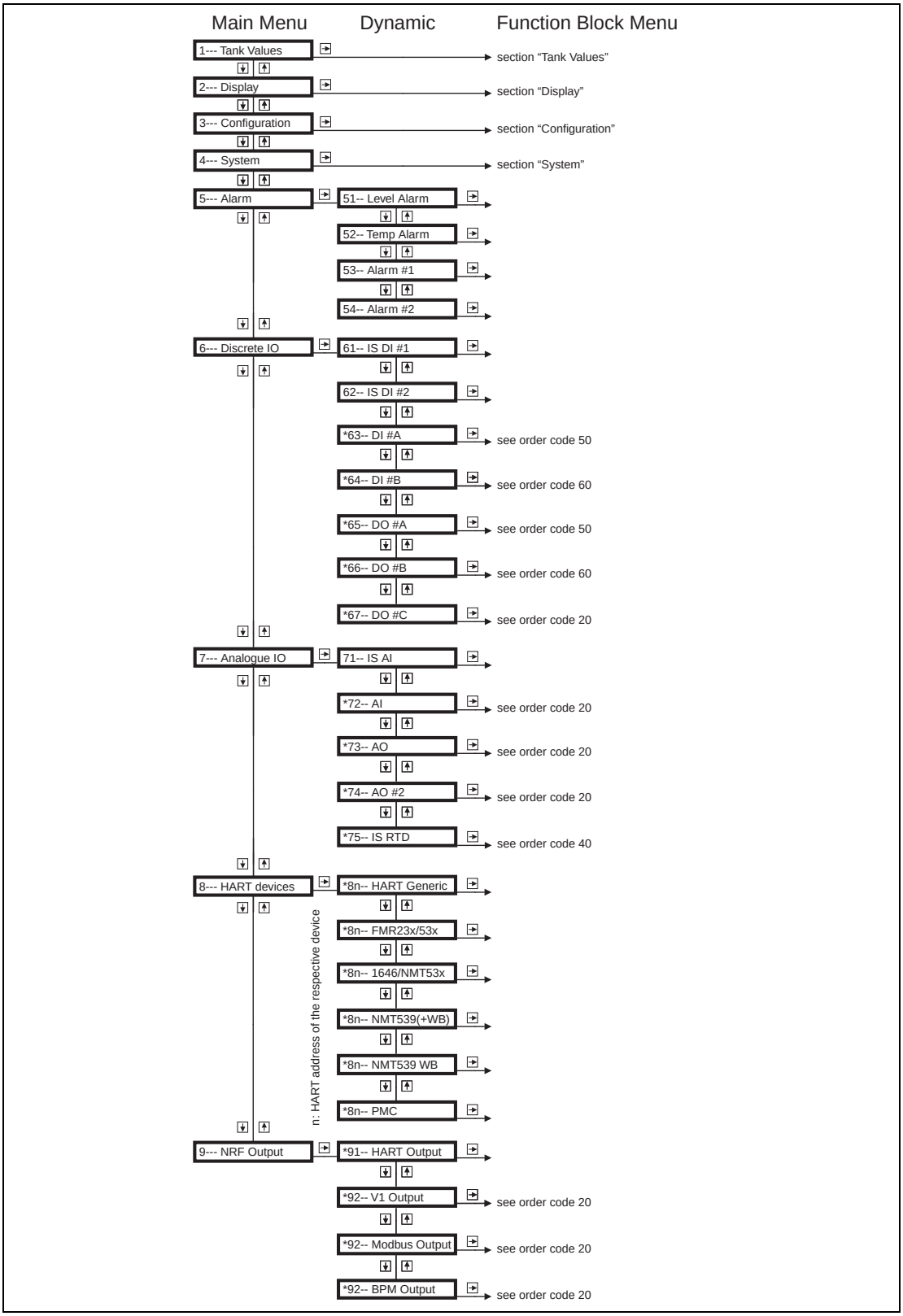


Figure 4-1: Function Menu Diagram

4.1 Menu “Tank Values”

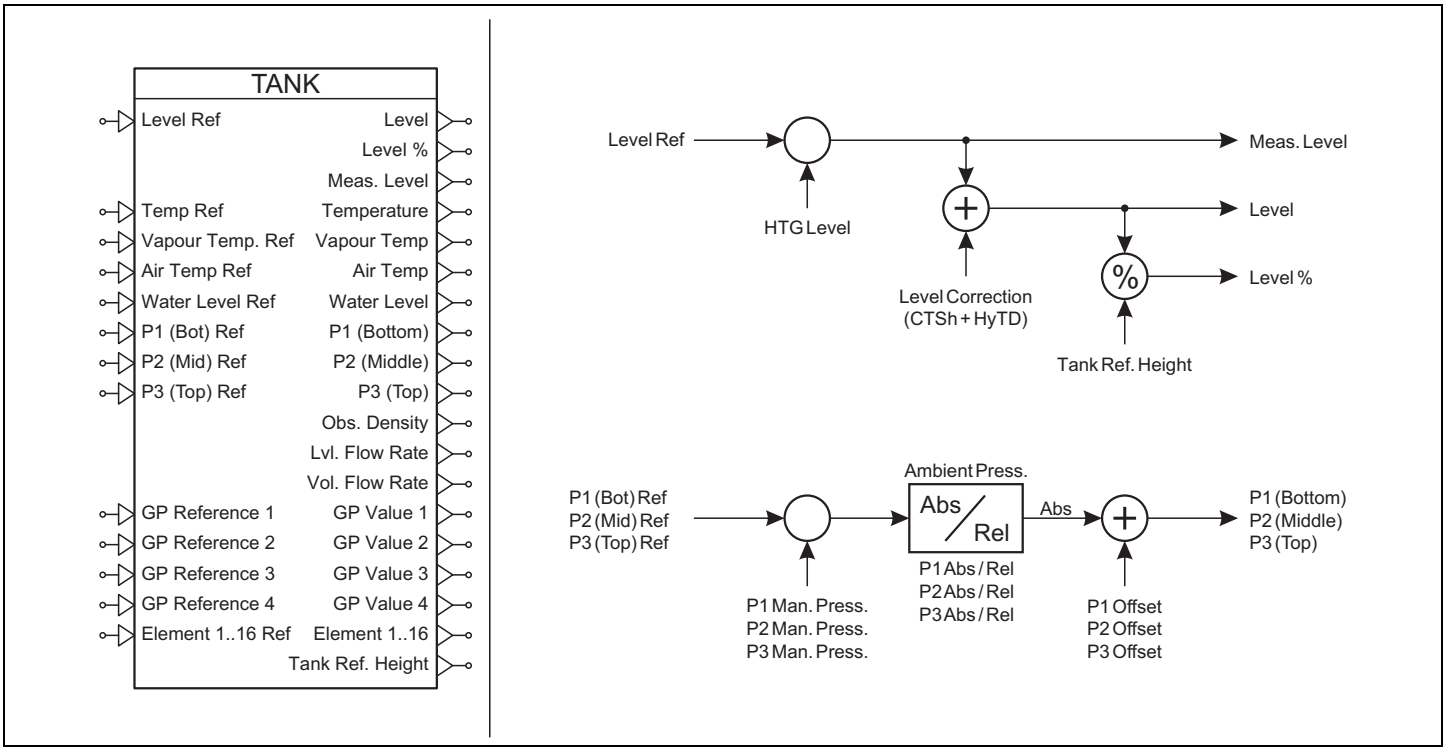


Figure 4-2: Menu “Tank Values” Diagram

The tank values menu allows to view all the measured and calculated tank values:

- Basic Values (level, temperature...)
- Calculated Values (density, HTG level...)
- Extended Values (vapor temperature, water level...)

4.1.1 Submenu “Primary Values” (110X)

Level(1101) Indicates the current measured or calculated level after corrections have been applied. (Read Only)

Temperature(1102) Product Temperature: Indicates the current product temperature. (Read Only)

Obs. Density(1103) Observed Density: Indicates the calculated observed product density (if calculation is activated). (Read Only)

Water Level(1104) Indicates the current water level (can be a manual value). (Read Only)

4.1.2 Submenu “Pressure Values” (120X)

P1 (Bottom) (1201) Pressure P1: Indicates the current P1 (bottom) pressure (can be a manual value). (Read Only)

P2 (Middle) (1202) Pressure P2: Indicates the current P2 (middle) pressure (can be a manual value). (Read Only)

P3 (Top) (1203) Pressure P3: Indicates the current P3 (top) pressure (can be a manual value). (Read Only)

4.1.3 Submenu “Misc. Values” (130X)

Meas. Level (1301) Measured Level: Indicates the current measured level received from the connected level gauge (Read Only)

Level Correction (1302) Current total level correction, this value when applied to level results in corrected level. It contains the sum of all active level correction functions. (Read Only)

Level % (1303) Level as Percentage: Indicates a percentage version of the current corrected level with reference to the reference height value. (Read Only)

Vapour Temp (1304) Vapor Temperature: Indicates the current measured vapor temperature (can be a manual value). (Read Only)

Air Temp (1305) Air Temperature: Indicates the current measured air temperature (can be a manual value). (Read Only)

4.1.4 Submenu “GP Values” (140X)

The “General Purpose” (GP) values allow additional measurements to be passed into the 4590 TSM and through the Tank function block (Tank point); each value can be connected to a measuring source and has a programmable parameter name.

- GP Value 1 (1401)
- GP Value 2 (1402)
- GP Value 3 (1403)
- GP Value 4 (1404)

A full description of the operation of the GP values can be found in the section 4.3, "Menu “Configuration”" on page 38.

4.2 Menu “Display”

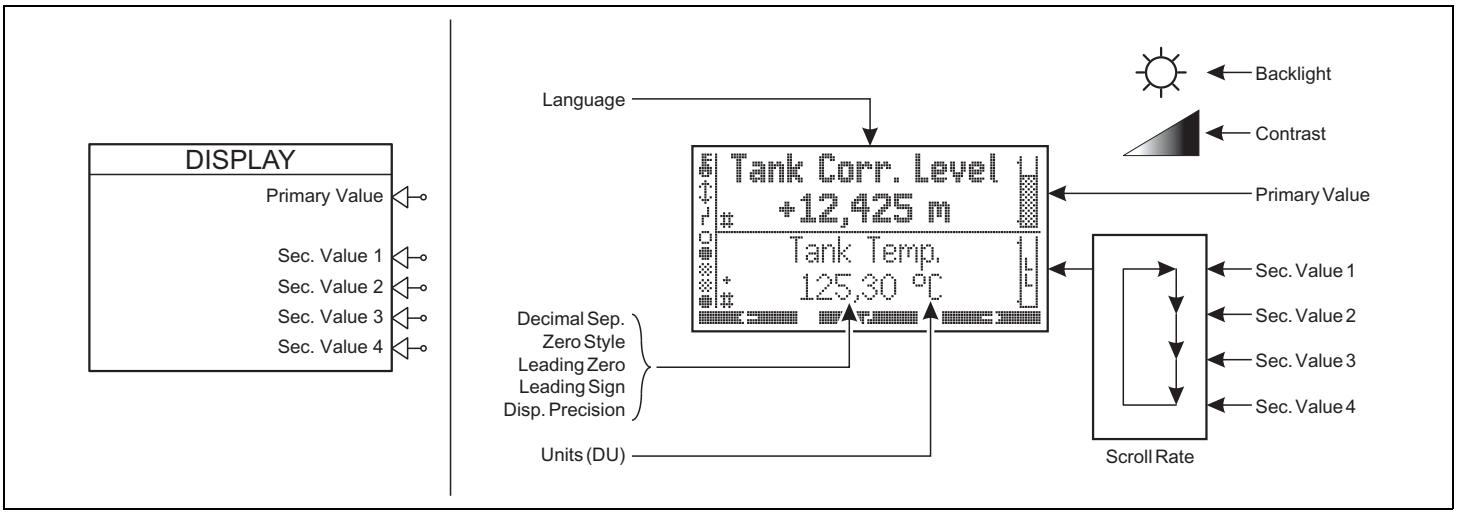


Figure 4-3: Display Menu Diagram

The display menu controls both the function of and the values displayed on the screen of the 4590 TSM. This menu also contains the “Display Units” (DU) for tank values. In the upper part of the display, the primary, user-defined measurement value is displayed. In the lower part, up to 4 values can be displayed consecutively with a scroll rate defined by the user.

The DU values also effect how values are sent to the control room on certain protocols (see individual protocol documents for details).

4.2.1 Submenu “Display Setup” (201X)

These parameters control the general appearance and operation of the display.

Language(2011) Selects the menu language

Contrast(2012) Display Contrast: Controls the contrast of the LCD display. Note: The contrast can also be changed at any time by pressing either (- & E) or (+ & E) keys together to decrease or increase respectively the contrast setting. (Default: 10)

Backlight(2013) Backlight Setting: Indicates if the backlight should always be off, on or under automatic control whenever a key is pressed stay lit for the specified period. (Default: 10 sec)

Scroll Rate(2014) Secondary Value Scroll Rate: The scroll rate indicates the time each secondary value is displayed on the bottom line of the main screen before cycling to the next value. (Default: 4 sec)

Menu Lock(2015) When activated the menu lock function prevents accidental operation of the 4590 TSM menu (either by human or environmental sources). Once active any navigation away from the Main Screen requires the operator to follow a defined (and indicated on the display) sequence of button presses, designed to make accidental operation impossible. (Default: Disabled) (Protected by W&M Switch)

Timeout(2016) Menu Timeout: This timeout returns the display to the main screen from anywhere in the menu if no keys are pressed in the specified period. (Default: 30 min)

Display Test(2018) When activated causes the LCD display to display a fixed sequence of images to indicate that all parts of the display are operating properly

4.2.2 Submenu "Display Values" (202X)

These parameters control which values are displayed on the top and bottom lines of the display.

Primary Value (2021) Primary Value Reference: Indicates which value should be displayed on the top line of the main screen. (Default: Tank Values, Level) (Protected by W&M Switch)

Sec. Value 1 (2022) Secondary Value #1 Reference: Indicates the first of the values which will be cyclically displayed on the bottom line of the main screen. (Default: Tank Values, Product Temperature) (Protected by W&M Switch)

Sec. Value 2 (2023) Secondary Value #2 Reference: Indicates the second of the values which will be cyclically displayed on the bottom line of the main screen. (Default: Undefined) (Protected by W&M Switch)

Sec. Value 3 (2024) Secondary Value #3 Reference: Indicates the third of the values which will be cyclically displayed on the bottom line of the main screen. (Default: Undefined) (Protected by W&M Switch)

Sec. Value 4 (2025) Secondary Value #4 Reference: Indicates the fourth of the values which will be cyclically displayed on the bottom line of the main screen. (Default: Undefined) (Protected by W&M Switch)

4.2.3 Submenu "Display Units" (203X)

Units Preset (2031) Preset Units and Display Format: This setting allows all the display related parameters (units, style of zero, decimal separator, precision...) to be set to one of a number of preset values. Alternatively custom configuration can be selected so each parameter can be set manually. (Default: m, bar,°C) (Protected by W&M Switch)

Level DU (2032) Level Device Units: Indicates which units will be used for level values by the 4590 TSM display. (Default: m) (Protected by W&M Switch)

Temp. DU (2033) Temperature Device Units: Indicates which units will be used for temperature values by the 4590 TSM display. (Default: °C) (Protected by W&M Switch)

Press. DU (2034) Pressure Device Units: Indicates which units will be used for pressure values by the 4590 TSM display. (Default: bar) (Protected by W&M Switch)

Density DU (2035) Density Device Units: Indicates which units will be used for density values by the 4590 TSM display. (Default: kg/m^3) (Protected by W&M Switch)

Flow DU (2036) Rate of Change of Level Device Units: Indicates which units will be used for level flow values by the 4590 TSM display. (Default: m/h) (Protected by W&M Switch)

Volume DU (2037) Volume Device Units: Indicates which units will be used for volume values by the 4590 TSM display. (Default: m^3) (Protected by W&M Switch)

Vol. Flow DU (2038) Volumetic Flow Device Units: Indicates which units will be used as device units for volumetric flow values by the 4590 TSM display. (Default: m^3/h) (Protected by W&M Switch)

4.2.4 Submenu “Extended Setup” (204X)

Decimal Sep. *(2041)* Decimal Separator: Indicates if a decimal point ('.') or a comma (',') should be used to indicate the decimal in numbers displayed. (Default: Period '.') (Protected by W&M Switch)

Zero Style *(2042)* Zero Digit Style: Indicates if the digit zero should be displayed with or without a diagonal line through it. (Default: “0”) (Protected by W&M Switch)

Leading Zero *(2043)* Leading Zeros: Specifies if a leading zeros are displayed in front of the numerical value. (Default: No) (Protected by W&M Switch)

Leading Sign *(2044)* Specifies if the sign of a value (both +ve and -ve) is displayed or if the sign is displayed for -ve numbers only. (Default: -ve) (Protected by W&M Switch)

Disp. Precision *(2045)* Display Precision: All the types of numerical measurements that can be displayed have a format specifying how many digits are to the left and to the right of the decimal separator, this setting allows to choose between three precision settings of the display. (Default: Normal) (Protected by W&M Switch)

Service English *(2047)* Allows a device setup for a language other than English to change to English, e.g. while a service engineer is using the 4590 TSM. It does not change the customers' language setting, which will take back over when the device is either reset or service english is turned off. Normally this parameter is accessed from the shortcut menu. (Default: Off)

4.3 Menu “Configuration”

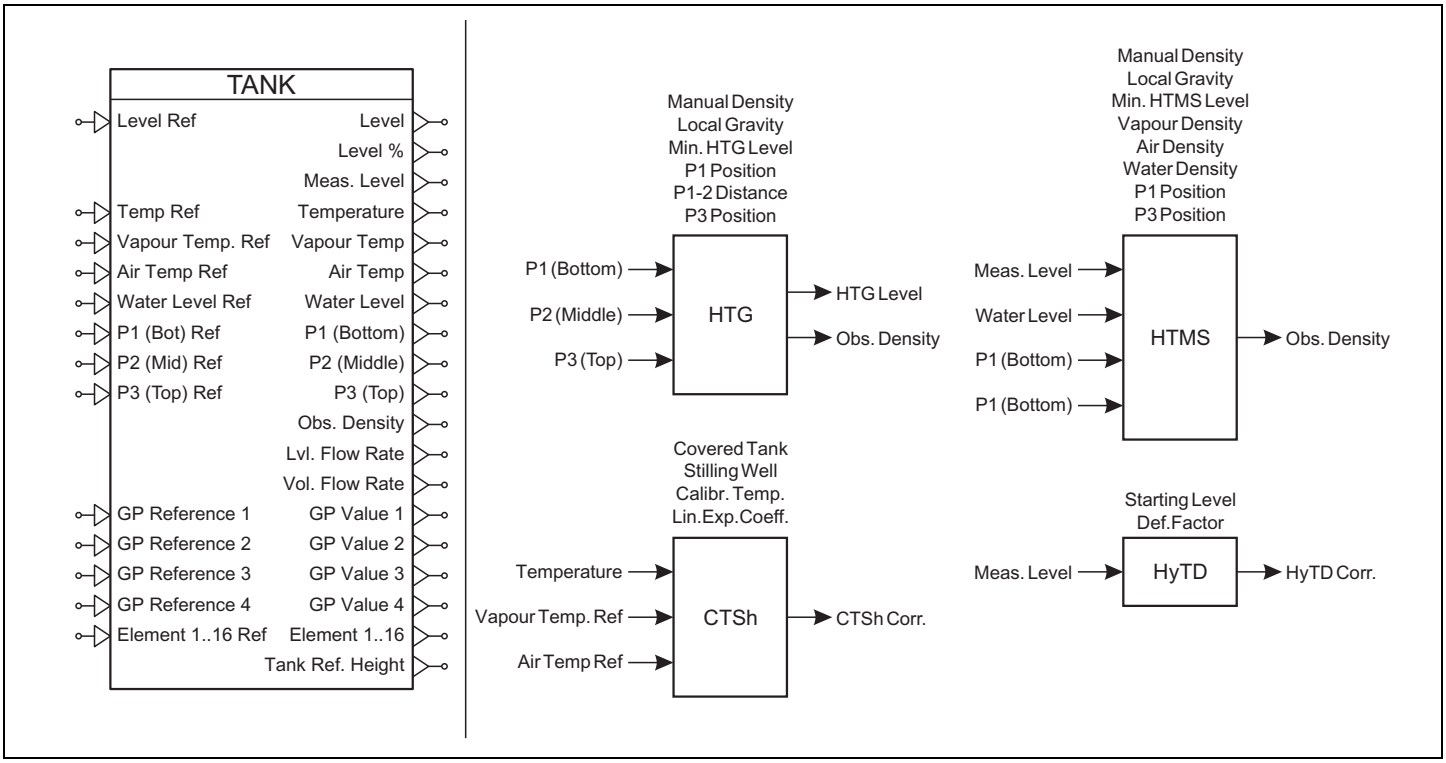


Figure 4-4: Menu “Configuration” Diagram

The Configuration menu provides access to all the 4590 TSM tank settings and calculations.

4.3.1 Submenu "Basic Config." (320X)

Level Ref(3201) Level Reference: Defines the source of the measured level. (Default: Undefined) (Protected by W&M Switch)

Temp Ref(3202) Product Temperature Reference: Defines the source of the measured product temperature. (Default: Undefined) (Protected by W&M Switch)

Tank Ref. Height(3203) Reference Height: Indicates the reference height of the tank, used for corrected level percentage and volume flow calculations. (Default: 20.000 m)

Dip Freeze(3204) (All Modes) Used to activate and de-activate the dip freeze mode, during which the level value is frozen. Normally this parameter can be set through the shortcut menu for quick activation (only when device is commissioned). (Protected by W&M Switch)

Dip Freeze IP(3205) Dip Freeze Switch: This setting allows one of the discrete inputs to activate the dip freeze mode when the input is active. (Default: Undefined) (Protected by W&M Switch)

4.3.2 Submenu "Extended Config." (330X)

Water Level Ref(3301) Water Level Reference: Defines the source of the measured water level or if a manual level is to be used. (Default: Manual)

Man. Water Level(3302) Manual Water Level: Indicates the current manual water level (if used). (Default: 0.000 m)

Vapour Temp. Ref(3303) Vapor Temperature Reference: Defines the source of the measured product vapor temperature of if a manual value is to be used. (Default: Manual)

Man. Vap. Temp(3304) Manual Vapor Temperature: Indicates the current manual vapor temperature (if used). (Default: 25.0 °C)

Air Temp Ref(3305) Air Temperature Reference: Defines the source of the measured air temperature or if a manual value is to be used. (Default: Manual)

Man.Air Temp(3306) Manual Air Temperature: Indicates the current manual air temperature (if used). (Default: 25.0 °C)

Ambient Press.(3307) Ambient Pressure: Indicates the current manual ambient pressure (if used). (Default: 1.00 bar)

4.3.3 Submenu "Pressure Setup" (34XX)

4.3.3.1 Submenu "P1 (Bottom)" (341X)

P1 (Bot) Ref(3411) Pressure Reference P1: Defines the source of the measured pressure P1 (bottom) or if a manual value is to be used. (Default: Manual)

P1 Man. Press.(3412) Manual Pressure P1: Indicates the current manual P1 (bottom) pressure (if used). (Default: 0.00 bar)

P1 Position(3413) Position P1: Indicates the manually entered position of the pressure sensor P1 (bottom) vertically on the tank (with respect to level zero, i.e. the datum plate). (Default: 5.000 m)

P1 Offset(3414) Pressure Offset P1: Indicates a manually entered offset to be applied to the measured value from P1 (bottom) pressure. (Default: 0.00 bar [relative])

P1 Abs / Rel(3415) Pressure Type P1: Indicates if the pressure value P1 (bottom) is absolute or relative. (Default: Gauge)

Note Make sure the connected pressure transmitter operates in the “pressure” mode, NOT in other modes such as “level”!

4.3.3.2 Submenu “P2 (Middle)” (342X)

P2 (Mid) Ref (3421) Pressure Reference P2: Defines the source of the measured pressure P2 (middle) or if a manual value is to be used. (Default: Manual)

P2 Man. Press. (3422) Manual Pressure P2: Indicates the current manual P2 (middle) pressure (if used). (Default: 0.00 bar)

P1-2 Distance (3423) Distance P1 to P2: Indicates the manually entered distance of the pressure sensor P1 (bottom) to the pressure sensor P2 (middle) vertically on the tank (Default: 2.000 m)

P2 Offset (3424) Pressure Offset P2: Indicates a manually entered offset to be applied to the measured value from P2 (middle) pressure. (Default: 0.00 bar [relative])

P2 Abs / Rel (3425) Pressure Type P2: Indicates if the pressure value P2 (middle) is absolute or relative. (Default: Gauge)

4.3.3.3 Submenu “P3 (Top)” (343X)

P3 (Top) Ref (3431) Pressure Reference P3: Defines the source of the measured pressure P3 (top) or if a manual value is to be used. (Default: Manual)

P3 Man. Press. (3432) Manual Pressure P3: Indicates the current manual P3 (top) pressure (if used). (Default: 0.00 bar)

P3 Position (3433) Position P3: Indicates the manually entered position of the pressure sensor P3 (top) vertically on the tank (with respect to level, i.e. the datum plate). (Default: 20.000 m)

P3 Offset (3434) Pressure Offset P3: Indicates a manually entered offset to be applied to the measured value from P3 (top) pressure. (Default: 0.00 bar [relative])

P3 Abs / Rel (3435) Pressure Type P3: Indicates if the pressure value P3 (top) is absolute or relative. (Default: Gauge)

4.3.4 Submenu “GP Values” (35XX)

This submenu contains the configuration of the four “General Purpose” (GP) values, each GP value can be linked to a measured value and provided with a user programmable tag name. This Tag name is then used in the Tank Values menu and on the display.

Note The GP values are displayed in their original measured units at all times.

Note GP values can only be sent to the control room on certain field protocols (refer to the specific protocols document for details)

4.3.4.1 Submenu “GP Value 1..4" (35nX)

Tag 1..4 (35n1) General Purpose Value #1..4 Tag: The tag name for the general purpose value N (GP_N) which when active will be shown on the local display along with the measured value. (Default: “GP Value N”)

Reference 1..4 (35n2) General Purpose Value #1..4 Reference: Indicates the source of the value to be used for general purpose value N (GP_N). (Default: undefined)

GP Value 1..4 (35n3) General Purpose Value #1..4: This parameter shows the current value of this GP value.

4.3.5 Submenu "Calculations" (36XX)

4.3.5.1 Submenu "HTG" (361X)

Hydrostatic Tank Gauging: This calculation allows the 4590 TSM to calculate the product level by using one or more pressure sensors. It can also calculate the product density if both P1 and P2 are supplied.

The following parameters in this group are duplicated from other parts of the menu:

- P1 Position (3615) (see 3413 in Pressure submenu for definition)
- P1-2 Distance (3616) (see 3423 in Pressure submenu for definition)
- P3 Position (3617) (see 3433 in Pressure submenu for definition)
- Obs. Density (3619) (see 1103 in Tank menu for definition)

Note If HTMS is enabled when entering the HTG menu, it will be asked to disable HTMS before the HTG modes are enabled.

Manual Density *(3308)* The manually entered density value (Default: 800.00 kg/m^3)

Local Gravity *(3613)* The manually entered local gravity value (Default: 9.8070 m/s^2)

Min. HTG Level *(3614)* HTG or HTMS Minimum Level: The minimum level which must be present in the tank for HTG & HTMS calculation to operate. If this values is less than P1 position + HT Safety Distance then the latter will be used instead. (Default: 7.000 m)

HTG Level *(3618)* The current calculated HTG level in the tank (only valid when HTG mode is activated). (Read Only)

4.3.5.2 Submenu "HTMS" (362X)

Hybrid Tank Measurement System: This calculations based on the values from a level measuring device and a pressure sensor to calculate the product density.

The following parameters in this group are duplicated from other parts of the menu:

- P3 Man. Press. (3628) (see 3413 in Pressure submenu for definition)
- Tag 3 (3629) (see 3433 in Pressure submenu for definition)
- Obs. Density (362A) (see 1103 in Tank menu for definition)

Note If HTG is enabled when entering the HTMS menu, it will be asked to disable HTMS before the HTMS mode is enabled.

Manual Density *(3622)* The manually entered density value (Default: 800.00 kg/m^3)

Local Gravity *(3623)* The manually entered local gravity value (Default: 9.8070 m/s^2)

Min. HTMS Level *(3624)* The minimum level which must be present in the tank for HTG & HTMS calculation to operate. If this values is less than P1 position + HT Safety Distance then the latter will be used instead. (Default: 7.000 m)

Vapour Density *(3625)* The manually entered vapor density in the tank. (Default: 1.20 kg/m^3)

Air Density *(3626)* The manually entered air density in/around the tank. (Default: 1.20 kg/m^3)

Water Density *(3627)* Manual value for the density of water in the tank (Default: 1000.00 kg/m^3)

4.3.5.3 Submenu “CTSh” (363X)

Thermal Tank Shell Correction: This calculation provides level compensation due to the change in the gauge reference height caused by the thermal expansion/contraction of the tank wall caused by the temperature difference between the product and vapour inside and the outside air temperature. The reference temperature for the CTSh correction is the “temperature of the dry tank” which is defined by the temperature measured at the time when the tank reference height is measured.

> **Note** This mode should not be used in conjunction with HTG as the level is not measured relative to the gauge reference height.

Covered Tank *(3632)* Tank Covered: Used for CTSh calculations, this indicates if the tank is covered and therefore contains a vapor space above either the level or an internal floating roof. (Default: Covered)

Stilling Well *(3633)* Used for CTSh calculations, this indicates if the level measuring device is mounted on top of a stilling well. (Default: No)

Calibr. Temp. *(3634)* Calibration Temp: Indicates the temperature at which the tank was calibrated, i.e. when the tank reference height was measured. (Default: 25.0 °C)

Lin.Exp.Coeff. *(3635)* Linear Expansion Coefficient: The manually entered linear expansion coefficient for the material of the tank wall (value is the expansion ration per degree kelvin). (Default: “Invalid”)

CTSh Corr. *(3636)* CTSh Correction: The current calculated CTSh level correction (only valid when CTSh mode is activated). (Read Only)

4.3.5.4 Submenu “HyTD” (364X)

Hydrostatic Tank Deformation: This calculation provides level compensation due to the change in gauge reference height caused by the product in the tank deforming the tank wall.

> **Note** This mode should not be used in conjunction with HTG as the level is not measured relative to the gauge reference height.

Starting Level *(3642)* HyTD Start Level: The starting level after which the linear HyTD correction will be applied. (Default: 0.500 m)

Def.Factor *(3643)* Deformation Factor: The deformation factor used for the HyTD linear correction. (Default: 0.2%)

HyTD Corr. *(3644)* HyTD Correction: The current calculated HyTD level correction (only valid when HyTD mode is activated). (Read Only)

4.4 Menu "System"

The system menu contains parameters which control the whole system, such as access code, product serial number, software version. The menu also contains the master reset operations for the 4590 TSM.

4.4.1 Submenu "Device Status" (410X)

Current Status (4101) This parameter shows the current active status code with the Highest priority. If more than one status code is currently active you can scroll up and down the list by pressing enter (this list is always in priority order, with the highest being at the top)

Status History (4102) This parameters allows you to view the historical list of current and former status codes, to scroll up and down through the list select enter (the list is in the order the status codes became active, the system run time when the event occurred is shown below the status code)

4.4.2 Submenu "System Param." (420X)

Access Code (4201) The access code controls the way the user operates 4590 TSM.

- Code 100 Allows the user to change configuration parameters and access reset menus

Note The access code automatically times out after 30 minutes of inactivity

Software Ver. (4202) Shows the current software label programmed into the device

W&M State (4203) This parameter shows the state of the "Weight & Measure" switch. When active the checksum value for the device configuration is also displayed.

The weight & measure status is evaluated by the 4590 TSM on two stages:

- On a first stage, the measurement device value coming into the 4590 TSM is evaluated
- On a second stage, the TANK function block is evaluated

The Weight & Measure status of a **measurement device** is o.k. if:

- the custody transfer switch (or the Software setting) of the measurement device is closed
- no alarm status is received from the measurement device
- for the 7500 series Radar Tank Gauges: the custody transfer status is "active positive"
- for a connected RTD transmitter: the sensors custody transfer switch is locked, the sensor position is defined and situated between the defined min and max alarm values

If any of these conditions are not met, then the instruments measured values will be shown with the "#" symbol in the HART device menu.

The Weight & Measure status on the TANK function level is o.k. if:

- the W&M switch of the 4590 TSM is closed
- the referenced measured value has a good Weight & Measure status
- additionally for the level measurement: **no** tank calculations (CTSh, HyTD, HTMS, HTG) are activated

If any of these conditions are not met, then the "#" symbol is displayed along with the displayed tank function group value in the display.

Serial No (4204) The device serial number is displayed and should match the number on the device name plate (this value can be changed by a service engineer)

Order Code (4205) The device order code is displayed and should match the order code on the device name plate (this value can be changed by a service engineer)

Total Run Time (4206) Displays the total run time of the 4590 TSM (in days, hour, minutes & seconds)

ToF Upload (4207) Used to select what type of information is included in the ToF upload. Normally only the parameters are uploaded, however this option allows for a large number of additional pieces of information concerning the 4590 TSM (software, hardware revisions, electronic serial numbers etc.)

4.4.3 Submenu "System Reset" (4R0X)

The system reset provides operations which effect the whole 4590 TSM:

- Restart (no parameters are changed)
- Restore CS (all parameters changed to last saved "Customer Setting" values)
- Restore FS (all parameters changed to Factory default Settings)

Note This menu is only visible when a valid access code has been entered.

Note Each option when selected is followed by a confirmation screen before the requested action will take place.

4.5 Menu "Alarms" (5XXX)

Within the alarm menu, there are four alarm function blocks:

- Level Alarm (51XX)
- Temp Alarm (52XX)
- Alarm #1 (53XX)
- Alarm #2 (54XX)

4.5.1 Function Block "Alarm"

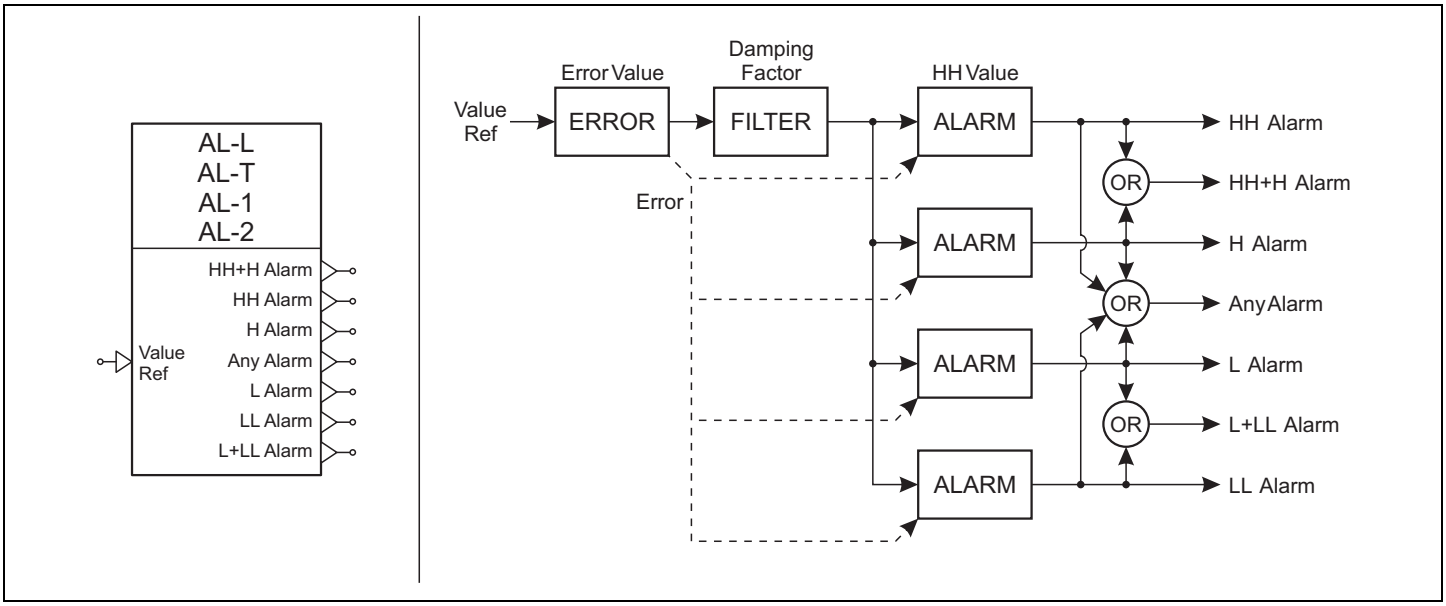


Figure 4-5: Function Block "Alarm" Diagram

All alarms in the 4590 TSM have the same set of parameters and function, upon entering the function, the three operating modes (as well as additional setup) are presented:

- Disabled (5n1X)
- Enabled (5n2X)
- Latching (5n3X)

After enabling the alarm, additional setup parameters may be configured.

4.5.1.1 Submenu "Setup" (5n2X & 5n3X)

Value Ref *(5n21/5n31)* Indicates where the value which will be evaluated for alarm conditions comes from.

- Level Alarm (Default: Tank Values, Level)
- Temp Alarm (Default: Tank Values, Product Temperature)
- Alarm #1 & #2 (Default: Undefined)

LL Value *(5n22/5n32)* Low-Low Alarm Value: This value indicate the point at which the Low-Low alarm should be activated. When the incoming value falls below this point the alarm is activated

and de-activated when the value is above this point (subject to the hysteresis value). (Default: “Unknown”) (Protected by W&M Switch)

L Value *(5n23/5n33)* Low Alarm Value: This value indicate the point at which the Low alarm should be activated. When the incoming value falls below this point the alarm is activated and de-activated when the value is above this point (subject to the hysteresis value). (Default: “Unknown”) (Protected by W&M Switch)

H Value *(5n24/5n34)* High Alarm Value: This value indicate the point at which the High alarm should be activated. When the incoming value rises above this point the alarm is activated and de-activated when the value is below this point (subject to the hysteresis value). (Default: “Unknown”) (Protected by W&M Switch)

HH Value *(5n25/5n35)* High-High Alarm Value: This value indicate the point at which the High-High alarm should be activated. When the incoming value rises above this point the alarm is activated and de-activated when the value is below this point (subject to the hysteresis value). (Default: “Unknown”) (Protected by W&M Switch)

Error Value *(5n26/5n36)* If the value into the alarm function is invalid or has an error the alarm output will go to this fixed value. (Default: All Alarms) (Protected by W&M Switch)

Value *(5n27/5n37)* This is the current input value after filtering. (Read Only)

4.5.1.2 Submenu “Extended Setup” (5n9X & 5nRX)

Damping Factor *(5n41)* The damping factor adjusts the rate values are placed into the filter, therefore changing the response speed of the output to input changes. (Default: 5 sec) (Protected by W&M Switch)

Hysteresis *(5n42)* The hysteresis value is used in conjunction with the alarm values to prevent oscillation of the alarm state when the incoming value is close to an alarm point. For a High or High-High alarm, the value must fall this far below the alarm point before the alarm is de-activated. For a Low or Low-Low alarm, the value must rise this far above the alarm point before the alarm is de-activated. (Default: 0.001 m [relative]) (Protected by W&M Switch)

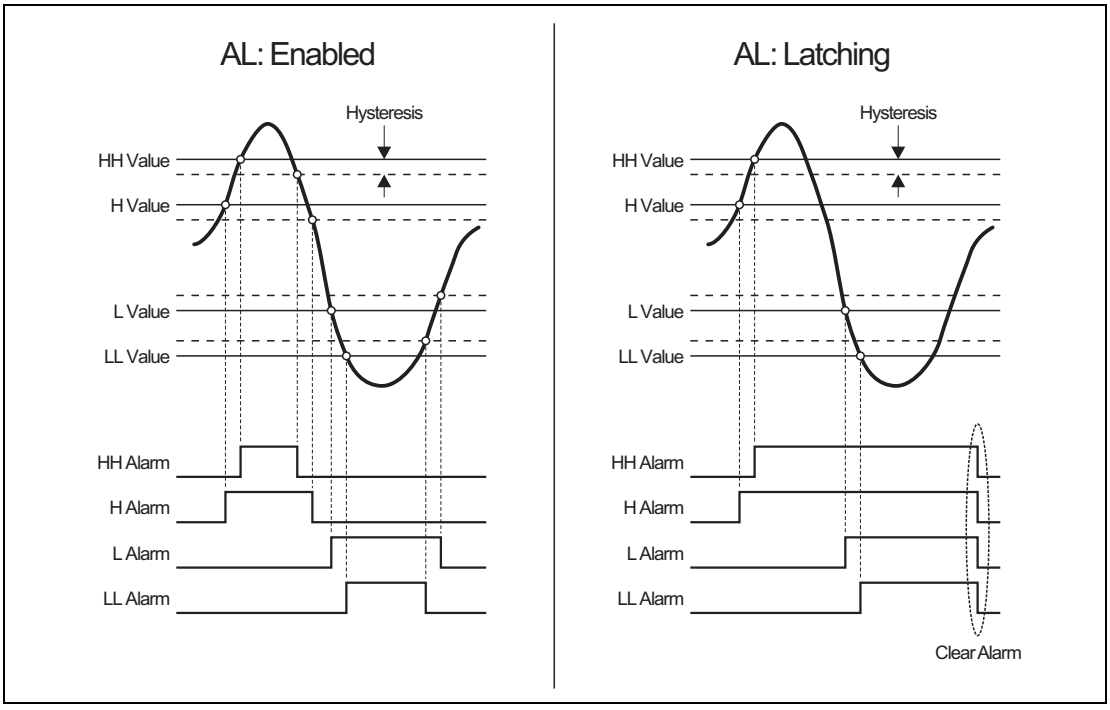


Figure 4-6: AL: Enabled and AL: Latching Diagram

Accept & Clear Current Alarm/s (5n39) Only for Latching operation mode; this final confirmation screen allows to clear the latched alarm state.

4.6 Menu "Discrete I/O" (6XXX)

Within the discrete input / output menu, there are a number of function blocks depending on the configuration of the 4590 TSM:

- IS DI #1 (61XX)
- IS DI #2 (62XX)
- DI #A (63XX) (if input module A fitted)
- DI #B (64XX) (if input module B fitted)
- DO #A (65XX) (if output module A fitted)
- DO #B (66XX) (if output module B fitted)
- DO #C (66XX) (only available with V1)

4.6.1 Function Block "Discrete Input"

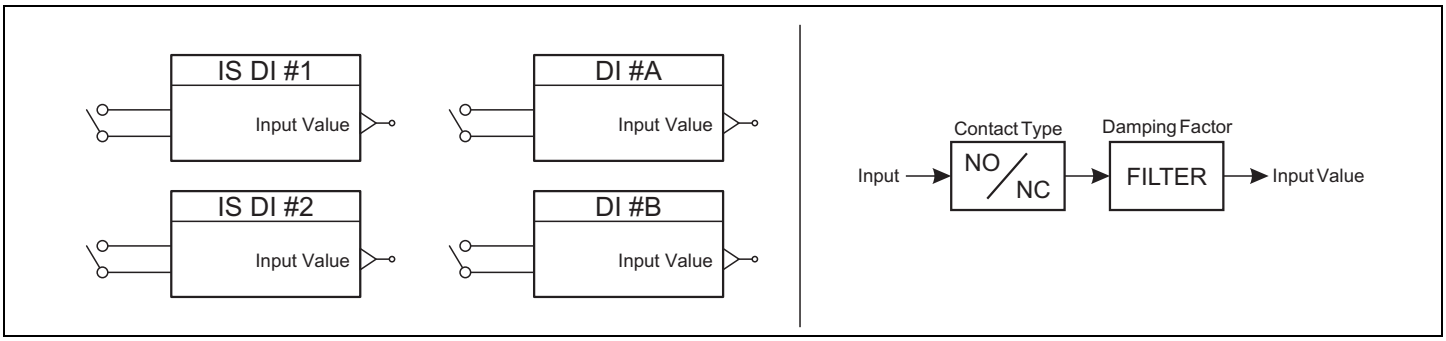


Figure 4-7: Function Block "Discrete Input" Diagram

All discrete inputs on the 4590 TSM have the same set of parameters and function:

4.6.1.1 Submenu "Values" (6n1X)

Input Value (6n11) Value: The measured and filtered value of the input signal. (Read Only)

Input Value (6n12) Measured and calibrated input voltage, which is then used to derive the physical switch state. (Read Only)

4.6.1.2 Submenu "Setup" (6n2X)

Contact Type (6n21) Specifies the type of contact connected to the input; normally open or normally closed. (Default: Normally Open)

Damping Factor (6n22) The damping factor adjusts the rate values are placed into the filter, therefore changing the response speed of the output to input changes. (Default: 5 sec)

4.6.2 Function Block “Discrete Output”

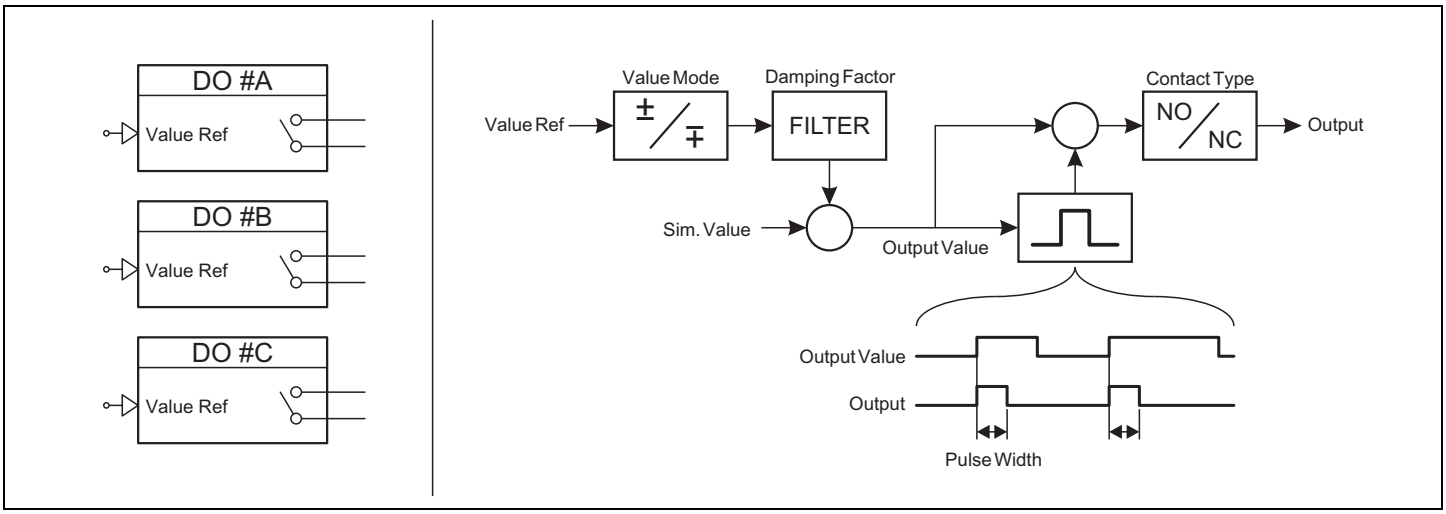


Figure 4-8: Function Block “Discrete Output” Diagram

All discrete outputs on the 4590 TSM have the same set of parameters and function, upon entering the function, the four operating modes (as well as additional setup) are presented:

- Disabled (6n1X)
- Output (6n2X)
- Pulse Out (6n3X) (not available for DO #C)
- Simulate (6n4X)

After enabling the output, additional setup parameters may be configured.

4.6.2.1 Submenu “Setup” (6n2X,6n3X & 6n4X)

Value Ref *(6n21/6n31)* Value Reference: Indicates which discrete value will be used as an input to the DO function and therefore be used to generate the output. (Default: Undefined) (Protected by W&M Switch)

Value Mode *(6n22/6n32)* Allows the user to specify if the input should be used in the normal polarity or if it should be inverted before use. (Default: Normal) (Protected by W&M Switch)

Pulse Width *(6n23/6n33)* Indicates the width of the output pulse to be generated when the input changes from inactive to active, when pulse mode is turned off the output will always following the state of the input. (not available on DO C) (only used when Pulse Mode is selected) (Default: No Pulse) (Protected by W&M Switch)

Contact Type *(6n24/6n34/6n44)* Specifies the type of contact connected to the input; normally open or normally closed. (Default: Normally Open) (Protected by W&M Switch)

Output Value *(6n25/6n35/6n45)* Value: Indicates the output values which is the incoming value after filtering. (Read Only)

Sim. Value *(6n25/6n35/6n45)* Simulation Value: This parameter can be used in conjunction with the mode setting to provide a manual value output from the DO function block. (Default: Inactive) (Protected by W&M Switch)

4.6.2.2 Submenu "Extended Setup" (6n5X)

Damping Factor (6n51) The damping factor adjusts the rate values are placed into the filter, therefore changing the response speed of the output to input changes. (Default: 5 sec) (Protected by W&M Switch)

4.7 Menu "Analogue I/O" (7XXX)

Within the analogue input / output menu, there are a number of function blocks depending on the configuration of the 4590 TSM:

- IS AI (71XX)
- AI (72XX) (depending on the protocol)
- AO (73XX) (depending on the protocol)
- AO #2 (74XX) (depending on the protocol)
- IS RTD (75XX) (if option is selected)

4.7.1 Function Block "Analogue Input"

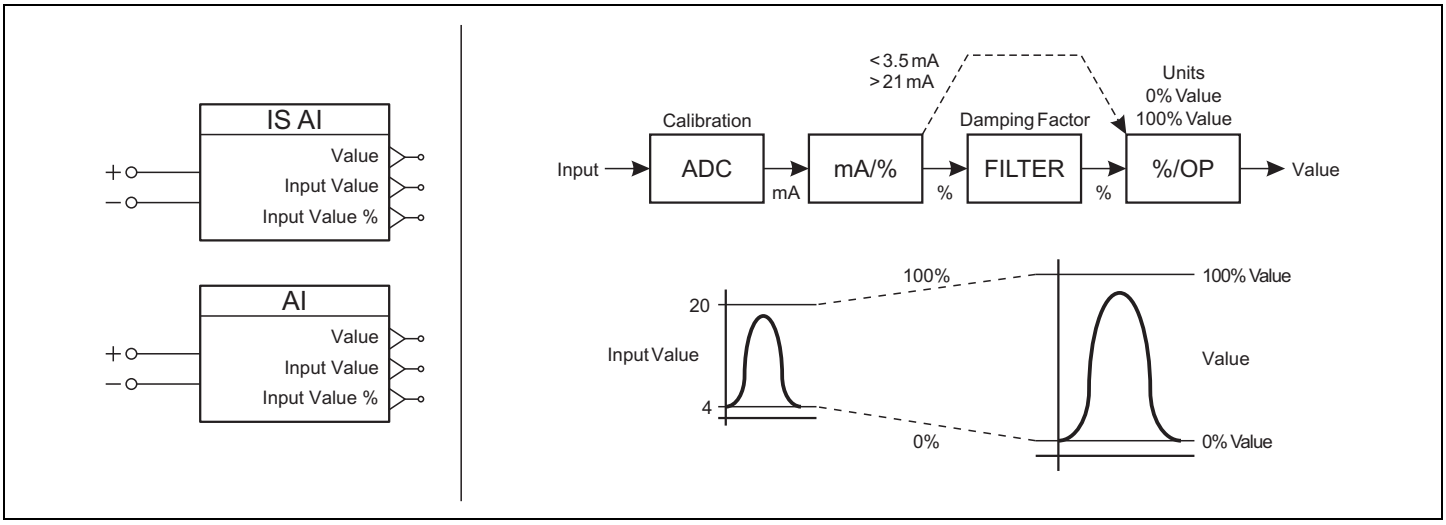


Figure 4-9: Function Block "Analogue Input" Diagram

All analogue inputs in the 4590 TSM have the same set of parameters and function, upon entering the function, the two operating modes (as well as additional setup) are presented:

- Disabled (7n1X)
- Enabled (7n2X)

After enabling the input, additional setup parameters may be configured.

4.7.1.1 Submenu "Setup" (7n2X)

Units (7n21) Specifies which type of units the scaled analogue input value will be converted to (Level, Temperature, Pressure, etc.). The actual unit will be the one set in the display group for the whole 4590 TSM. (Default: Percent) (Protected by W&M Switch)

0% Value (7n22) The point indicates what output value a 4mA (0%) input value should generate. This is then used with the 100% value to produce a linear scaling between input and output values. (Default: “Unknown”) (Protected by W&M Switch)

100% Value (7n23) The point indicates what output value a 20mA (100%) input value should generate. This is then used with the 0% value to produce a linear scaling between input and output values. (Default: “Unknown”) (Protected by W&M Switch)

Value (7n24) The output value calculated from the input value using the 0% and 100% points, expressed in the units selected. (Read Only)

Input Value (7n25) Value in mA: The current input value in mA. (Read Only)

Input Value % (7n26) Value in Percentage: The current input value in a percentage of the 4mA to 20mA range after filtering. (Read Only)

4.7.1.2 Submenu "Calibration" (7n3X)

This menu shows the current calibration state of the analogue input and also allows the operator to change the calibration between factory and user (uncalibrated cannot be selected by the operator). If user calibration is selected the operator can then perform a user calibration following the procedure below:

- Select the user calibration mode and move to the next menu item.
- You will be asked to connect an accurate current source set to 4mA to the analogue input terminals.
- The next menu screen will display the status as the system performs a measurement cycle.
- Next you will be asked to change the setting of the current source to 20mA.
- Again a measurement cycle will be performed.
- Once all the measurements were correctly made the system will save the new calibration.
- Finally you will be able to view the user calibrated input value to verify the operation.

Note To obtain the highest accuracy during a user calibration, it is recommended to use a certified calibrated current source and perform an additional calibration to familiarize your self with the procedure before performing the final calibration.

4.7.1.3 Submenu “Extended Setup” (7n4X)

Damping Factor (7n41) The damping factor adjusts the rate which values are placed into the filter, therefore changing the response speed of the output to input changes. (Default: 5 sec) (Protected by W&M Switch)

4.7.2 Function Block "Analogue Output"

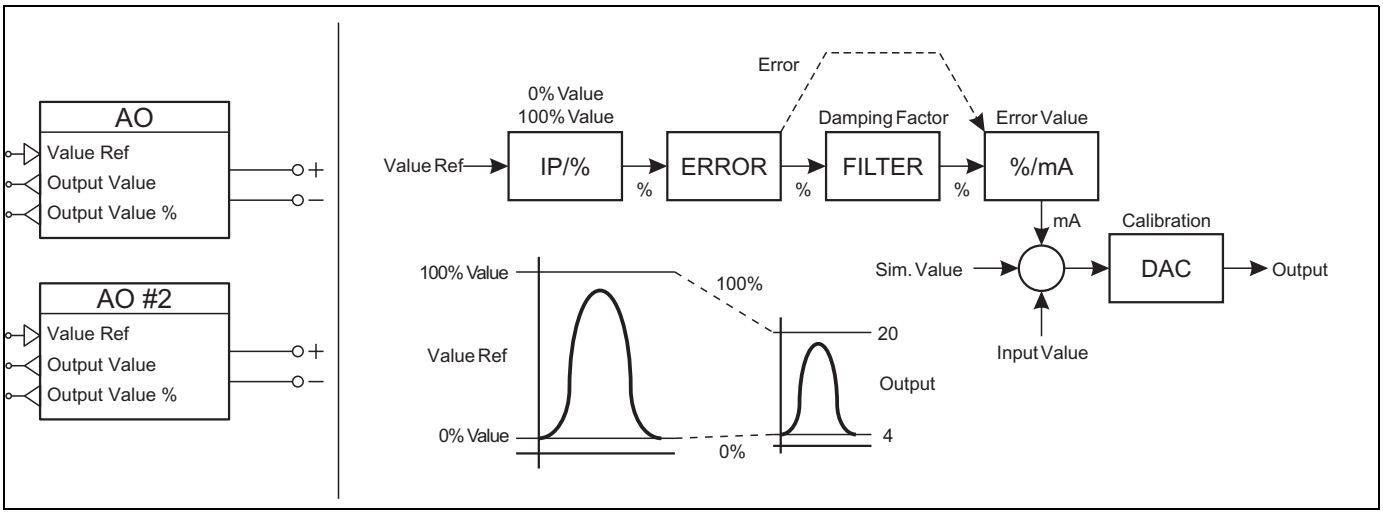


Figure 4-10: Function Block "Analogue Output" Diagram

All analogue outputs in the 4590 TSM have the same set of parameters and function, upon entering the function, a number of operating modes (as well as additional setup) are presented:

- Disabled (7n1X)
- Enabled (7n2X)
- Simulate (7n3X)
- HART Slave (7n4X) (special function AO only)
- HART Master (7n5X) (special function AO only)
- FMR Power Output (7n4X) (special function AO #2 only)

After enabling the alarm, additional setup parameters may be configured.

4.7.2.1 Submenu "Setup" (7n2X)

Value Ref *(7n21/7n42)* Value Reference: Indicates the input value which will be converted to a 4mA to 20mA output signal. (Default: Undefined) (Protected by W&M Switch)

0% Value *(7n22/7n43)* The point indicates what input value should generate an output of 4mA (0%). This is then used with the 100% value to produce a linear scaling between input and output values. (Default: "Unknown") (Protected by W&M Switch)

100% Value *(7n23/7n44)* The point indicates what input value should generate an output of 20mA (100%). This is then used with the 0% value to produce a linear scaling between input and output values. (Default: "Unknown") (Protected by W&M Switch)

Error Value *(7n24/7n45)* This specifies the value (in mA) which will be output when the input value either has a fault or is outside of the 0% to 100% range. (Default: 22.000 mA) (Protected by W&M Switch)

Value *(7n25/7n46)* This value contains the input value after filtering. (Read Only)

Output Value *(7n26/7n47)* Value in mA: The current output value in mA. (Read Only)

Output Value % *(7n27/7n48)* Value in Percentage: The current output value in a percentage of the 4mA to 20mA range. (Read Only)

4.7.2.2 Submenu “Simulate” (7n3X)

Sim. Value (7n31) Simulation Value: This parameter can be used in conjunction with the simulation mode setting to provide a manual value (in mA) as output from the AO. (Default: 4.000 mA) (Protected by W&M Switch)

4.7.2.3 Submenu “HART Slave” (7n4X)

AO only: Depending on the Communication address the output current is either:

- Active 4..20mA (address = 0)
- Fixed current output (address > 0)

When active, the configuration parameters are the same as above.

Ex d Address (7n41) Communication Polling Address: Ex d HART Slave polling address (Note: if set to 0 then the 4..20mA output current will be active, otherwise a fixed current will be used) (Default: 15) (Protected by W&M Switch)

Value Ref (7n21/7n42) Value Reference: Indicates the input value which will be converted to a 4mA to 20mA output signal. (Default: Undefined) (Protected by W&M Switch)

0% Value (7n22/7n43) The point indicates what input value should generate an output of 4mA (0%). This is then used with the 100% value to produce a linear scaling between input and output values. (Default: “Unknown”) (Protected by W&M Switch)

100% Value (7n23/7n44) The point indicates what input value should generate an output of 20mA (100%). This is then used with the 0% value to produce a linear scaling between input and output values. (Default: “Unknown”) (Protected by W&M Switch)

Error Value (7n24/7n45) This specifies the value (in mA) which will be output when the input value either has a fault or is outside of the 0% to 100% range. (Default: 22.000 mA) (Protected by W&M Switch)

Value (7n25/7n46) This value contains the input value after filtering. (Read Only)

Output Value (7n26/7n47) Value in mA: The current output value in mA. (Read Only)

Output Value % (7n27/7n48) Value in Percentage: The current output value in a percentage of the 4mA to 20mA range. (Read Only)

Fixed Current (7n49) Value: Fixed output current when in HART Slave mode with polling address > 0. (Default: 4.000 mA) (Protected by W&M Switch)

4.7.2.4 Submenu “FMR Power Output” (7n4-)

AO #2 only: In this mode the AO #2 is set to its maximum possible current output to provide power for a 4-wire 7500 series radar gauge.

4.7.2.5 Submenu “HART Master” (7n5X)

AO only: AO functions as a HART bus for measuring devices to be connected to the 4590 TSM. The output current on the bus is configurable.

> **Note** The polling address of HART devices on the Ex d bus must **not** be the same as those on the Ex i HART bus.

Fixed Current (7n51) Error Value: Fixed output current when in HART Master mode (Default: 26.000 mA) (Protected by W&M Switch)

4.7.2.6 Submenu "Calibration" (7n6X)

This menu shows the current calibration state of the analogue output and also allows the operator to change the calibration between factory and user (uncalibrated cannot be selected by the operator). If user calibration is selected the operator can then perform a user calibration following the procedure below:

- Select the user calibration mode and move to the next menu item.
- Firstly the system will output a fixed current of approximately 4mA.
- The operator must then accurately measure this current on the analogue output terminals.
- The measured value must then be entered into the 4590 TSM.
- Next the system will output a fixed current of approximately 20mA.
- Again the operator must make an accurate measurement of the output current.
- And enter this measured value into the 4590 TSM
- Once all the measurements were correctly entered the system will save the new calibration.
- Finally you will be able to simulate the calibrated output current value to verify the operation.

Note To obtain the highest accuracy during a user calibration, it is recommended to use a certified calibrated current measurement device and perform an additional calibration to familiarize your self with the procedure before attempting the final calibration.

4.7.2.7 Submenu "Extended Setup" (7n7X)

Damping Factor *(7n71)* The damping factor adjusts the rate which values are placed into the filter, therefore changing the response speed of the output to input changes. (Default: 5 sec) (Protected by W&M Switch)

4.7.3 Function Block "I.S. RTD"

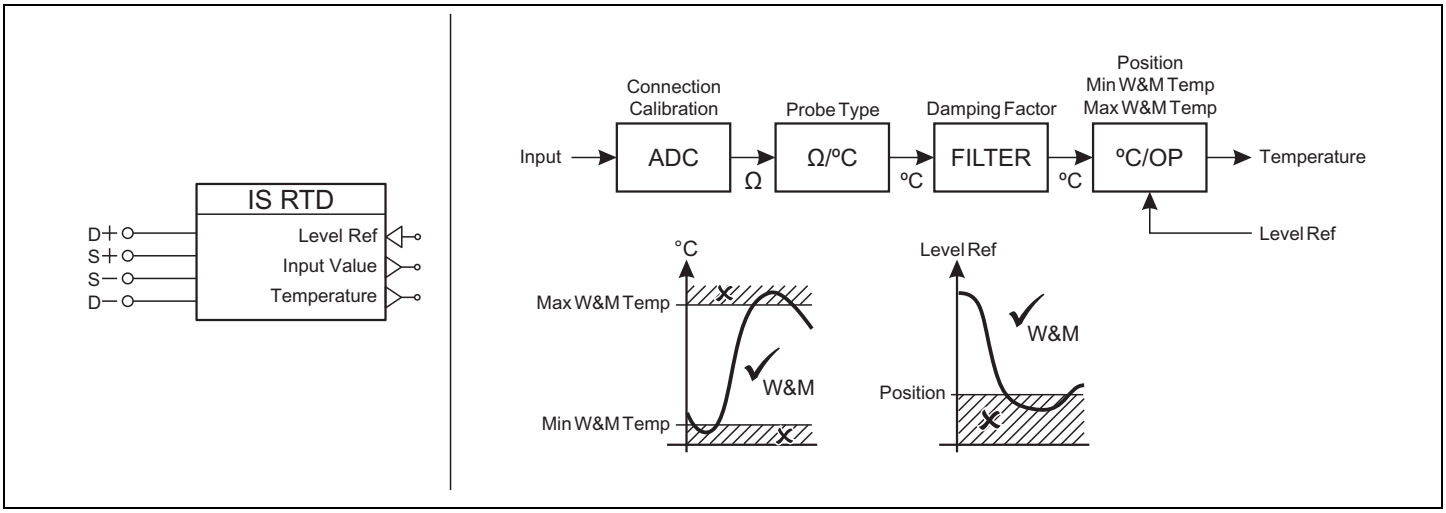


Figure 4-11: Function block "I.S. RTD" Diagram

Upon entering the function the two operating modes (as well as additional setup) are presented:

- Disabled (751X)
- Enabled (752X)

After enabling the function, additional setup parameters may be configured.

4.7.3.1 Submenu "Values" (752X)

Temperature (7521) Temperature Value: Indicates the temperature which is calculated from the input resistance depending on the specified probe type (in current Temp DU). (Read Only)

Input Value (7522) Value in Ohms: Indicates the measured resistance of the probe after it has been filtered (always in ohms). (Read Only)

4.7.3.2 Submenu "Setup" (753X)

Probe Type (7531) Used to select the type of RTD probe connected, and therefore the selection of probe measuring range and conversion function from resistance to temperature. (Default: Pt100 (385)) (Protected by W&M Switch)

Connection (7532) Connection Method: This selects the method of connection used to connect the RTD probe. Three wire allows for partial compensation for the cable resistance while four wire provides full compensation. (Default: 4 Wire) (Protected by W&M Switch)

Position (7533) Probe Position: This value should be set to the height of the RTD probe in the tank, it is used in conjunction with the measured level to indicate the temperature is invalid when no longer covered by the product. (Default: 0.000 m) (Protected by W&M Switch)

Min W&M Temp (7534) Minimum W&M Temperature: This value should be set to the minimum approved temperature for the connected probe; if the temperature falls below this value then the W&M status will be invalidated. (Default: -200.0 °C) (Protected by W&M Switch)

Max W&M Temp (7535) Maximum W&M Temperature: This value should be set to the maximum approved temperature for the connected probe; if the temperature rises above this value then the W&M status will be invalidated. (Default: 200.0 °C) (Protected by W&M Switch)

4.7.3.3 Submenu "Calibration" (754X)

This menu shows the current calibration state of the RTD input, it also allows the operator to change the calibration between factory and user (uncalibrated cannot be selected by the operator). If user calibration is selected the operator can then perform a user calibration following the procedure below:

- Select the user calibration mode and move to the next menu item.
- You will be asked to connect a Pt100 (type 385) simulator set to -200 °C (18.520 ohms) to the RTD input terminals using the 4-wire connection method.
- The next menu screen will display the status as the system performs a measurement cycle.
- Next you will be asked to change the simulator to a setting of +200 °C (175.856 ohms).
- Again a measurement cycle will be performed.
- Next you will be asked to change the simulator to the final setting of +600 °C (313.708 ohms).
- The final measurement cycle will be performed.
- Once all the measurements were correctly made the system will save the new calibration.
- Finally you will be able to view the user calibrated input value to verify the operation.

Note To obtain the highest accuracy during a user calibration, it is recommended to use a certified calibrated Pt100 (type 385) simulator (connected as a 4-wire device) and perform an additional calibration to familiarize your self with the procedure before performing the final calibration.

4.7.3.4 Submenu “Extended Setup” (755X)

Damping Factor (7551) The damping factor adjusts the rate values are placed into the filter, therefore changing the response speed of the output to input changes. (Default: 5 sec) (Protected by W&M Switch)

Pos. Hysteresis (7552) Position Hysteresis: The position hysteresis is used when evaluating the position of the probe and the current fluid level, this value is used to prevent oscillating in the status when the level is close to the position value. (Default: 0.100 m [relative]) (Protected by W&M Switch)

4.8 Menu “HART Devices” (8XXX)

When HART devices have been detected, each device will be given an entry in this menu. Each device is shown with it's polling address shown in “[N]” (n=0..15) brackets after the device name and as the second navigation no (8NXX) (n=0..F).

If the device type is known, a specific menu is provided for configuration, unknown devices are given a generic device menu:

- Generic[n]
- FMR23x[n] (7200 series/Micropilot M Radar Tank Gauge)
- FMR53x[n] (7500 series/Micropilot S Radar Tank Gauge)
- FMR54x[n] (Micropilot S 26GHz)
- 1646[n] (Whessoe/Varec Prothermo)
- NMT53x[n] (453x ATC/Prothermo)
- NMT532[n] (4532 ATC/Prothermo)
- NMT539[n] (4539 ATC/Prothermo)
- NMT539+WB[n] (4539 Average Temperature Transmitter/Prothermo with Water Bottom Probe)
- NMT539 WB[n] (4539 Average Temperature Transmitter/Prothermo Water Bottom Probe only)
- PMD23x[n] (Cerabar M)
- PMC[n] (Cerabar S)
- PMD[n] (Deltabar S)
- PMD7x[n] (Cerabar S Evolution)
- NMS[n] (6005 Servo Tank Gauge/Proservo)
- Model (Deltabar S Evolution)

4.8.1 Function Block "Generic[n]"

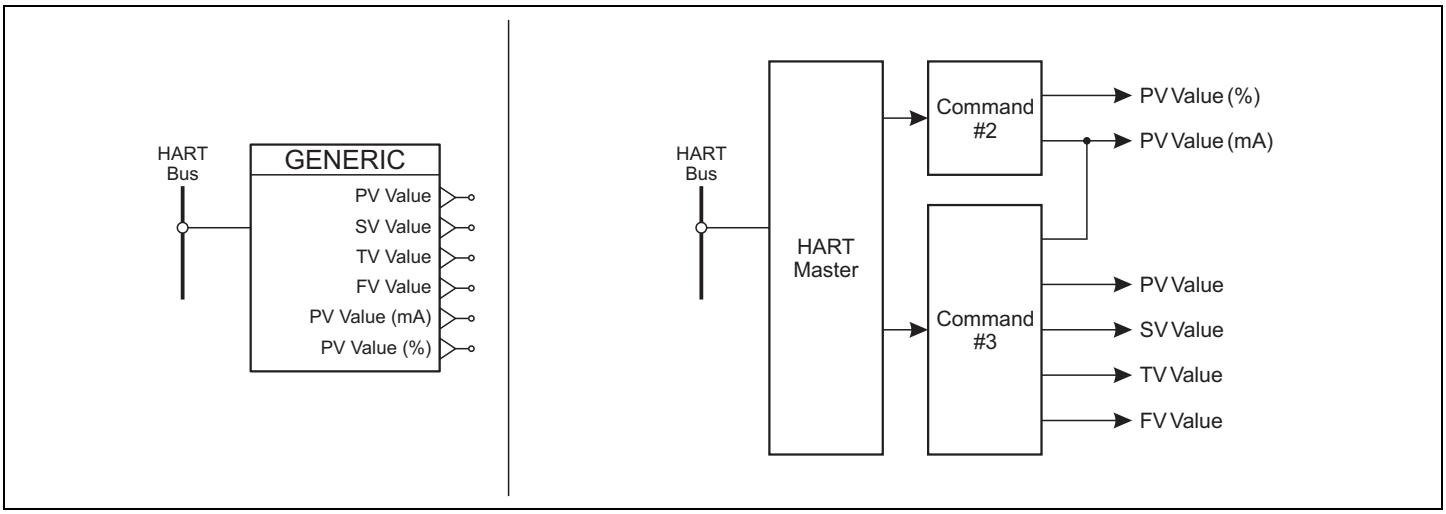


Figure 4-12: Function Block "Generic[n]"

Any HART device which does not have a specific menu in the 4590 TSM is shown with this generic menu.

4.8.1.1 Submenu "Hart[n]" (8n1X)

Comm. Addr *(8n11)* Communication Address: The short HART address used to detect this device. (Protected by W&M Switch)

Device Tag *(8n12)* The tag name programmed into the device. (Default: "")

Device Id *(8n13)* The long HART ID number read from the HART device, containing manufacturer, device type and id number. (Read Only) (DD Parameter)

No Preambles *(8n14)* Number of Preambles: The minimum number of pre-ambles the HART device is requesting for communication. (Read Only) (DD Parameter)

Device Info. *(8n15)* Device Information: The device information (sensor and primary value settings) read from the HART device. (Read Only) (DD Parameter)

Description *(8n16)* Device Description: The device description text read from the HART device. (Read Only) (DD Parameter)

Date *(8n17)* Device Date: The device date read from the HART device. (Read Only) (DD Parameter)

4.8.1.2 Submenu “Values” (8n2X)

PV Value (8n21) Primary Variable: Primary measurement variable value from the HART device. (Read Only)

SV Value (8n22) Secondary Variable: Secondary measurement variable value from the HART device. (Read Only)

TV Value (8n23) Tertiary Variable: Tertiary measurement variable value from the HART device. (Read Only)

FV Value (8n24) Fourth Variable: Fourth measurement variable value from the HART device. (Read Only)

PV Value (mA) (8n25) Primary Variable Current: Primary measurement variable current (in mA) value from the HART device. (Read Only)

PV Value (%) (8n26) Primary Variable Percent of Range: Primary measurement variable value as a percentage of range read from the HART device. (Read Only)

4.8.1.3 Submenu “Information” (8n3X)

Final Ass. No (8n31) Final Assembly Number: Final Assembly Number read from the HART device. (DD Parameter)

Message (8n32) Message string read from the HART device. (DD Parameter)

4.8.1.4 Submenu “Sensor” (8n4X)

Serial No (8n41) Sensor Serial Number: Primary variable sensor serial number read as part of the primary variable sensor information from the HART device. (Read Only) (DD Parameter)

Upper Limit (8n42) Upper Sensor Limit: Primary variable upper sensor limit read as part of the primary variable sensor information from the HART device. (Read Only) (DD Parameter)

Lower Limit (8n43) Lower Sensor Limit: Primary variable lower sensor limit read as part of the primary variable sensor information from the HART device. (Read Only) (DD Parameter)

Min. Span (8n44) Minimum Sensor Span: Primary variable minimum span read as part of the primary variable sensor information from the HART device. (Read Only) (DD Parameter)

4.8.1.5 Submenu “Output” (8n5X)

Alarm Select (8n51) Alarm Selection Code: Primary variable alarm selection code read as part of the primary variable output information from the HART device. (Read Only) (DD Parameter)

Transfer Code (8n52) Transfer Function Code: Primary variable transfer function code read as part of the primary variable output information from the HART device. (Read Only) (DD Parameter)

Upper Range (8n53) Primary Variable Upper Output Range: Primary variable upper output range read as part of the primary variable output information from the HART device. (Read Only) (DD Parameter)

Lower Range (8n54) Primary Variable Lower Output Range: Primary variable lower output range read as part of the primary variable output information from the HART device. (Read Only) (DD Parameter)

Damp. Value (8n55) Primary Variable Output Damping: Primary variable output damping read as part of the primary variable output information from the HART device. (Read Only) (DD Parameter)

Write Prot. (8n56) Write Protect Code: Write protect code read as part of the primary variable output information from the HART device. (Read Only) (DD Parameter)

PVT Dist Code *(8n57)* Private Label Distributor Code: Private label distributor code read as part of the primary variable output information from the HART device. (Read Only) (DD Parameter)

4.8.2 Function Block "FMR[n]"

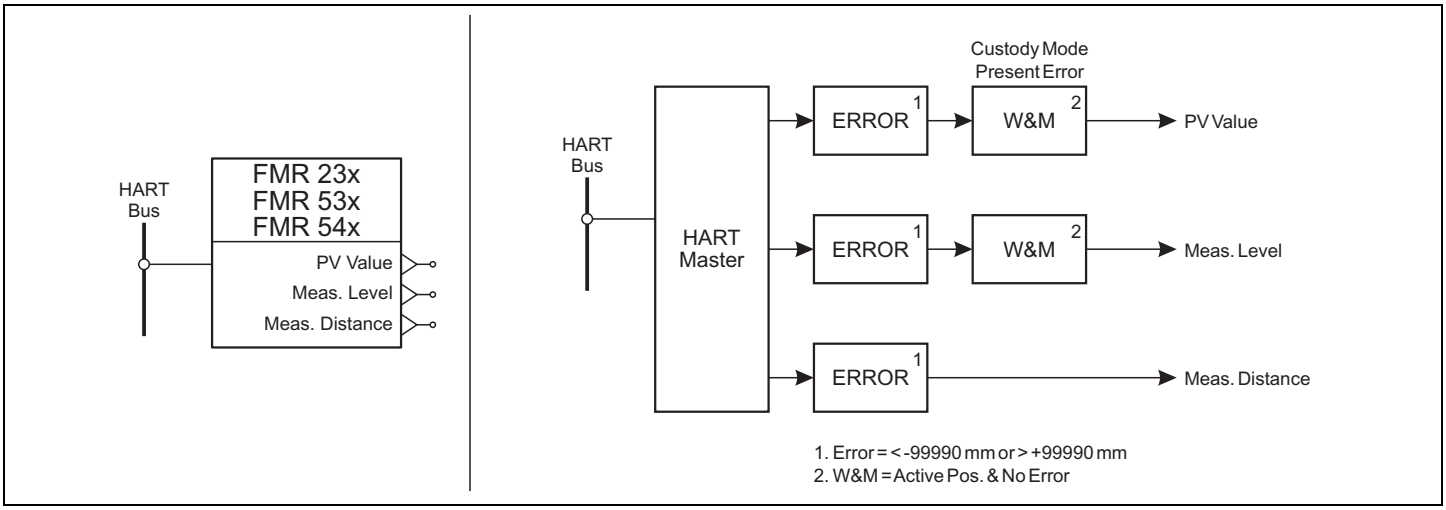


Figure 4-13: Function Block "FMR[n]" Diagram

The FMR menu is used for the following types of Varec radar gauges:

- FMR23x[n] (for FMR23x and FMR24x)
- FMR53x[n] (for FMR53x)
- FMR54x[n] (for FMR54x)

Note The following section gives a brief description of the parameters from the device. For a complete description of the parameters and there function see the HART devices documentation.

4.8.2.1 Submenu "Hart[n]" (8n1X)

Comm. Addr *(8n11)* Communication Address: The short HART address used to detect this device. (Protected by W&M Switch)

Device Tag *(8n12)* The tag name programmed into the device. (Default: "")

Device Id *(8n13)* The long HART ID number read from the HART device, containing manufacturer, device type and id number. (Read Only) (DD Parameter)

No Preambles *(8n14)* Number of Preambles: The minimum number of pre-ambles the HART device is requesting for communication. (Read Only) (DD Parameter)

Device Info. *(8n15)* Device Information: The device information (sensor and primary value settings) read from the HART device. (Read Only) (DD Parameter)

Description *(8n16)* Device Description: The device description text read from the HART device. (Read Only) (DD Parameter)

Date *(8n17)* Device Date: The device date read from the HART device. (Read Only) (DD Parameter)

4.8.2.2 Submenu “Values” (8n2X)

PV Value (8n21) Measured Value: This is the main measured value of device. (Read Only)

Meas. Level (8n22) Measured Level: Output the measured level. (Read Only)

Meas. Distance (8n23) Measured Distance: output the measured distance. (Read Only)

4.8.2.3 Submenu “Basic Setup” (8n3X)

Tank Shape (8n31) This is a selectable parameter in which the user can choose the tank shape. (DD Parameter)

Medium Cond. (8n32) Dielectric Constant: This is a selectable parameter in which the user can choose the dielectric constant of the product. (DD Parameter)

Process Cond. (8n33) Process Condition: This is a selectable parameter in which the process conditions are described. The FMR53x will work with “mm accuracy” if the options “standard” or “calm surface” are choose. (DD Parameter)

Empty Calibr (8n34) Empty Calibration: Distance from sensor flange to minimum level of the tank.The value is displayed in distance unit (m/ft/inch/mm).The Empty calibration is used to calculate the level value. (DD Parameter)

Full Calibr (8n35) Full Calibration: Span minimum to maximum level (DD Parameter)

Pipe Diameter (8n36) Tube Diameter: Inner diameter of bypass or stilling well used for calculating the velocity of the microwaves. (only valid when Tank Shape is set to Bypass or Stilling Well) (DD Parameter)

History Reset (8n37) After first configuration of the FMR53x, the history reset clears the “Index correction table” to start a new learning period. (7500 series Radar Tank Gauges only) (DD Parameter)

4.8.2.4 Submenu “Safety” (8n4X)

Out. on Alarm (8n41) Current Output On Alarm: Selects the reaction of the output on alarm; MAX (22mA), MIN (3.6mA), x mA or HOLD (DD Parameter)

Output Value (8n42) Output On Alarm Value: Output value in mA in case of error. This Value is used if x mA is select in Out.on Alarm parameter. (DD Parameter)

Outp.Echo Lost (8n43) Reaction to Lost Echo: Selects the reaction of the device if the echo is lost; Alarm, Hold or ramp in %/min (DD Parameter)

Ramp Value (8n44) Ramp In %/min: Ascent of ramp for driving measured value in case of lost echo. This Value is used if Reaction to Lost Echo is set to Ramp in %/min. (DD Parameter)

Delay Time (8n45) Delay Time On Lost Echo: Delay in seconds between detection of a lost echo and the reaction of the device. (DD Parameter)

Safety Dist. (8n46) Level within Safety Distance: Distance from blocking distance, in which no sure measurement is possible. If level goes in this area, a message is generated by device. (DD Parameter)

In Safety Dist. (8n47) In Safety Distance: Select reaction of device if level is in safety distance; Alarm, Continue to Measure or Alarm with Acknowledgment. (DD Parameter)

Ackn. Alarm (8n48) Acknowledge Alarm: Reset the safety distance error if level was in safety distance; When selected clears the self holding alarm. (DD Parameter)

Overspill Prot. (8n49) Operation Mode: Selects if the device is operating with active overspill protection (when enabled, some parameters are changed in edit limits, values and locking state) (DD Parameter)

4.8.2.5 Submenu “Extended Cal.” (8n5X)

Check Dist. (8n52) Check Distance: Before effecting a noise suppression (map) the available mapping distance to the product level should be checked. (DD Parameter)

Range of Map (8n53) Suppression Distance: Distance until mapping is record (DD Parameter)

Start Mapping (8n54) Start Mapping Record: Indicates when the mapping of the tank reflections has started. (DD Parameter)

Echo Quality (8n55) Echo Quality in dB: Display the value of echo quality in dB (Echo quality = echo amplitude - FAC) (Read Only) (DD Parameter)

Offset (8n56) Offset Of Measured Level: Offset can be used to correct the measured level (Corrected level = measured level + offset) (DD Parameter)

Output Damping (8n57) Time constant for the output damping of signal in seconds. (DD Parameter)

Blocking Dist. (8n58) Blocking Distance: Distance from flange in which no measuring is possible. (DD Parameter)

Pres.Map Dist (8n59) Present Map Range: Displays the current active noise suppression (map) (Read Only) (DD Parameter)

Cust.Tank Map (8n5A) Custom Tank Map: Selects the user defined tank map (DD Parameter)

4.8.2.6 Submenu “Diagnostics” (8n6X)

Present Error (8n61) Actual Error: Communication: the diagnostic code with the highest priority on display: list with all active diagnostic codes sorted for priority (Read Only) (DD Parameter)

Previous Error (8n62) Last Error: Communication: the diagnostic code which goes away at last on display: list with all diagnostic codes which were before active. (Read Only) (DD Parameter)

Clear Last Err. (8n63) Clear Last Error: Use this parameter to clear the last device error history (DD Parameter)

Unlock Param. (8n64) Operation Code: This code determines how the operator interacts with the device, and which parameter they are allowed to modify. (DD Parameter)

Meas. Level (8n22) Measured Level: Output the measured level. (Read Only)

Meas. Distance (8n23) Measured Distance: output the measured distance. (Read Only)

Applic. Par. (8n67) Application Parameter: Status of the application parameters may have been changed by settings of user in service matrix. (DD Parameter)

Custody Mode (8n68) Output the state of custody (Read Only) (DD Parameter)

4.8.2.7 Submenu “Extra Param” (8n7X)

Distance Units (8n71) Distance Unit: select distance unit.Changes the unit of some parameters... (DD Parameter)

Customer Units (8n72) Customer Unit: change units of other parameters described in dependent parameters. (Read Only) (DD Parameter)

Software Ver (8n73) Build Number: Software Build number. (Read Only) (DD Parameter)

Extended Status (8n74) : Provides additional status information about the device (Read Only) (DD Parameter)

Dip Table State *(8n75)* Displays the current state of the dip table. (7500 series Radar Tank Gauges only) (Read Only) (DD Parameter)

4.8.3 Function Block "NMT"

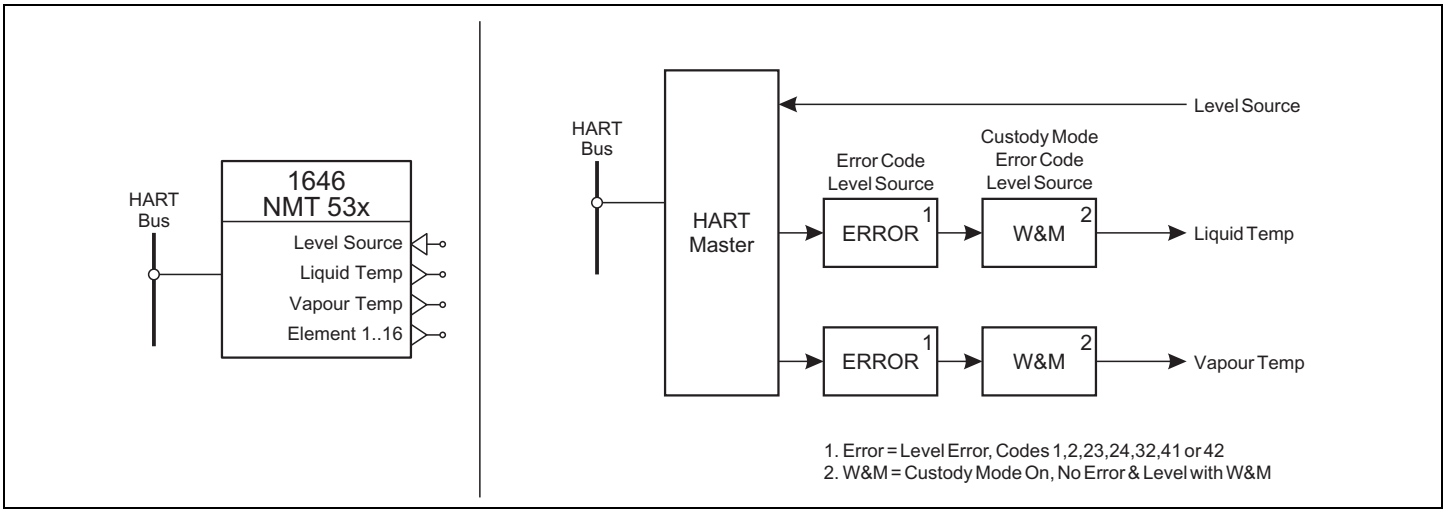


Figure 4-14: Function Block "NMT"

The NMT menu is used for the following types of Varec gauges:

- 1646[n] (for Varec 1646)
- NMT53x[n] (for NMT53x inc NMT538)

The following section gives a brief description of the parameters from the device. For a complete description of the parameters and there function see the HART devices documentation.

4.8.3.1 Submenu "Hart[n]" (8n1X)

Comm. Addr *(8n11)* Communication Address: The short HART address used to detect this device. (Protected by W&M Switch)

Comm. Addr *(8n12)* Device Tag: The tag name programmed into the device, may be used for naming the device in the menus if Use Tag Names is selected in the display group. (Default: "")

Device Id *(8n13)* The long HART ID number read from the HART device, containing manufacturer, device type and id number. (Read Only) (DD Parameter)

No Preambles *(8n14)* Number of Preambles: The minimum number of pre-ambles the HART device is requesting for communication. (Read Only) (DD Parameter)

Device Info. *(8n15)* Device Information: The device information (sensor and primary value settings) read from the HART device. (Read Only) (DD Parameter)

Description *(8n16)* Device Description: The device description text read from the HART device. (Read Only) (DD Parameter)

Date *(8n17)* Device Date: The device date read from the HART device. (Read Only) (DD Parameter)

4.8.3.2 Submenu “Values” (8n2X)

Liquid Temp (8n21) Average Liquid Temperature: The mean value of element temperatures in the liquid, the error value +358 °C is displayed if the calculation cannot be made. (Read Only)

Vapour Temp (8n22) Average Gas Temperature: The mean value of element temperatures above the liquid, the error value +358 °C is displayed if the calculation cannot be made. (Read Only)

Liquid Level (8n24) This is the liquid level which was used for the average temperature calculations, it is automatically updated by the 4590 TSM to be the actual measured level. (Read Only)

Level To NMT (8n27) This parameter holds the current level value to be sent to the NMT, if the level reference is set to manual then this parameter is copied from the manual level parameter, otherwise it holds the value obtained from the specified source. (Read Only)

4.8.3.3 Submenu “Basic Setup” (8n3X)

Access Code (8n31) Access code to allow the parameters in the NMT to be changed. Code 530 unlocks the NMT while any other code locks it. (Protected by W&M Switch) (DD Parameter)

Bottom Point (8n32) The bottom point specifies the level of the lowest temperature element inside the tank, this is then used as the reference to determine which elements are covered at a specific liquid level. (DD Parameter)

Liquid Offset (8n33) An element is only used for the average liquid temperature calculation when it is this distance below the liquid level. (DD Parameter)

Vapour Offset (8n34) Gas Offset: An element is only used for the average gas temperature calculation when it is this distance above the liquid level. (DD Parameter)

Level Source (8n37) Level Reference: Indicates where the level being sent to the NMT should come from within the 4590 TSM, or if a manually entered level should be used. (Default: Tank Values, Level) (Protected by W&M Switch)

Manual Level (8n38) This parameter holds the manually entered level to be sent to the NMT if the level reference is set to Manual. (Default: 0.000 m) (Protected by W&M Switch)

4.8.3.4 Submenu “Extended Setup” (8n4X)

Adjust Span (8n44) Element Span Adjust: The element span value is multiplied to the measured temperature of all elements prior to the elements zero offset being applied. (DD Parameter)

Average No (8n45) Average Number: (DD Parameter)

4.8.3.5 Submenu “Element Setup” (8n5X)

No Elements (8n51) Number of Elements: Specifies the number of measuring elements connected to the NMT (DD Parameter)

Element Type (8n52) Kind Of Element: Selects which type of resistive temperature element is connected to the NMT electronics, and therefore which conversion should be used to obtain temperature from the measured resistance. (Read Only) (DD Parameter)

Interval Type (8n53) Element Interval Type: Indicates if the measuring elements connected to the NMT are spaced at regular or irregular intervals: Regular: means the element spacing value will be used between each element Irregular: allows the position of each element to be individually set. (Not available on NMT532) (DD Parameter)

Interval Size (8n54) Element Interval: When element interval type is set to regular, this value specifies the distance between each element. (DD Parameter)

Short Temp *(8n55)* Short Circuit Error Value: When a short-circuit fault is detected on an element, this error value will be returned instead of the normal measured temperature. (DD Parameter)

Open Temp *(8n56)* Open Circuit Error Value: When an open-circuit fault is detected on an element, this error value will be returned instead of the normal measured temperature. (DD Parameter)

Element 0 *(8n57)* Element Zero Temperature: Temperature conversion value of internal precision 100Ω resistor. (Read Only) (DD Parameter)

Element 17 *(8n58)* Element #17 Temperature: Temperature conversion value of internal precision 200Ω resistor. (Read Only) (DD Parameter)

4.8.3.6 Submenu "Element Values" (8n6X)

This menu contains a submenu for each temperature element in the NMT.

Note This menu is disabled when "Custody Mode" is enabled on the NMT

4.8.3.7 Submenu "Element 1..16" (8n61)

Element 1..16 *(8n63)* Element 1..16 Temperature: Displays the temperature at the specified element.

Position 1..16 *(8n64)* Allows the specification of the position of the selected element when element spacing is set to irregular. (DD Parameter)

4.8.3.8 Submenu "Device Status" (8n8X)

4.8.4 Function Block "NMT532 / NMT539"

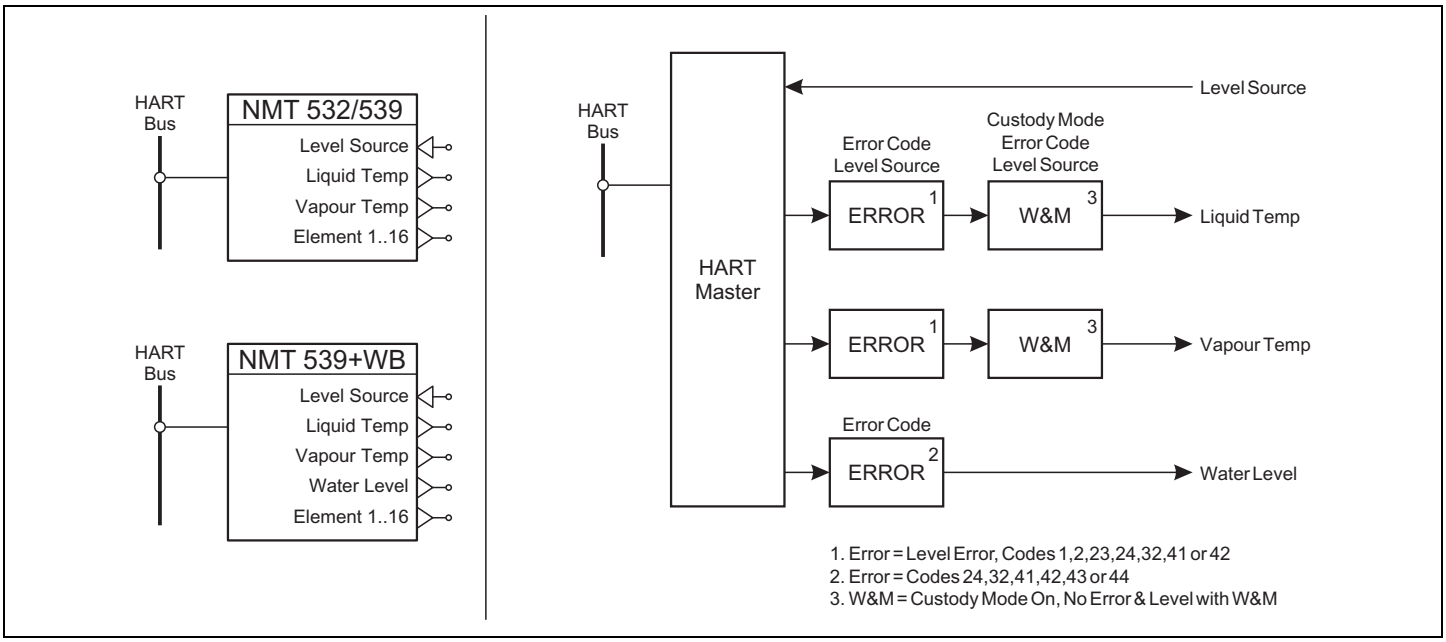


Figure 4-15: Function Block "NMT532 / NMT539" Diagram

The NMT menu is used for the following types of Varec gauges:

- NMT532[n] (for NMT532)

- NMT539[n] (for NMT539)
- NMT539+WB[n] (for NMT539 with Water Bottom Probe)

The following section gives a brief description of the parameters from the device. For a complete description of the parameters and there function see the HART devices documentation.

4.8.4.1 Submenu "Hart[n]" (8n1X)

Comm. Addr (8n11) Communication Address: The short HART address used to detect this device. (Protected by W&M Switch)

Comm. Addr (8n12) Device Tag: The tag name programmed into the device, may be used for naming the device in the menus if Use Tag Names is selected in the display group. (Default: "")

Device Id (8n13) The long HART ID number read from the HART device, containing manufacturer, device type and id number. (Read Only) (DD Parameter)

No Preambles (8n14) Number of Preambles: The minimum number of pre-ambles the HART device is requesting for communication. (Read Only) (DD Parameter)

Device Info. (8n15) Device Information: The device information (sensor and primary value settings) read from the HART device. (Read Only) (DD Parameter)

Description (8n16) Device Description: The device description text read from the HART device. (Read Only) (DD Parameter)

Date (8n17) Device Date: The device date read from the HART device. (Read Only) (DD Parameter)

4.8.4.2 Submenu "Values" (8n2X)

Liquid Temp (8n21) Average Liquid Temperature: The mean value of element temperatures in the liquid, the error value +358 °C is displayed if the calculation cannot be made. (Read Only)

Vapour Temp (8n22) Average Gas Temperature: The mean value of element temperatures above the liquid, the error value +358 °C is displayed if the calculation cannot be made. (Read Only)

Water Level (8n23) Measured water level, calculated from the measured probe frequency, the probe coefficient, the span and offset by the water offset level. (Read Only)

Liquid Level (8n24) This is the liquid level which was used for the average temperature calculations, it is automatically updated by the 4590 TSM to be the actual measured level. (Read Only)

WB Cap. (8n25) Water Probe Capacitance: Static electricity capacitance value, calculated from the probe frequency value. (Read Only) (DD Parameter)

WB Freq. (8n26) Water Probe Frequency: Output frequency of the static electricity capacity form the probe. (Read Only) (DD Parameter)

Level To NMT (8n27) This parameter holds the current level value to be sent to the NMT, if the level reference is set to manual then this parameter is copied from the manual level parameter, otherwise it holds the value obtained from the specified source. (Read Only)

4.8.4.3 Submenu "Basic Setup" (8n3X)

Access Code (8n31) Access code to allow the parameters in the NMT to be changed. Code 530 unlocks the NMT while any other code locks it. (Protected by W&M Switch) (DD Parameter)

Bottom Point (8n32) The bottom point specifies the level of the lowest temperature element inside the tank, this is then used as the reference to determine which elements are covered at a specific liquid level. (DD Parameter)

Liquid Offset (8n33) An element is only used for the average liquid temperature calculation when it is this distance below the liquid level. (DD Parameter)

Vapour Offset (8n34) Gas Offset: An element is only used for the average gas temperature calculation when it is this distance above the liquid level. (DD Parameter)

Level Source (8n37) Level Reference: Indicates where the level being sent to the NMT should come from within the 4590 TSM, or if a manually entered level should be used. (Default: Tank Values, Level) (Protected by W&M Switch)

Manual Level (8n38) This parameter holds the manually entered level to be sent to the NMT if the level reference is set to Manual. (Default: 0.000 m) (Protected by W&M Switch)

4.8.4.4 Submenu "Extended Setup" (8n4X)

Hysteresis (8n41) Element Change Hysteresis: This hysteresis is used in conjunction with the element position to prevent oscillation in the number of active elements the average temperature is calculated from when the level is close to an element position. (DD Parameter)

Avg. Method (8n42) Averaging Method: Selection of the method used for averaging. Standard: The total value of each element is divided by the number of elements. (Σ T1-n / n) Advanced: The total value of each element temperature multiplied by its weighting value divided by the total of the weighting values used. (Σ (T1-n x W1-n) / Σ W1-n) (DD Parameter)

Multi/Spot (8n43) Element Constitution: The type of element constitution: Spot: Single element constitution. Multi: Multiple-element constitution. (NMT539 only) (DD Parameter)

Adjust Span (8n44) Element Span Adjust: The element span value is multiplied to the measured temperature of all elements prior to the elements zero offset being applied. (DD Parameter)

Average No (8n45) Average Number: (DD Parameter)

4.8.4.5 Submenu "Element Setup" (8n5X)

No Elements (8n51) Number of Elements: Specifies the number of measuring elements connected to the NMT (DD Parameter)

Element Type (8n52) Kind Of Element: Selects which type of resistive temperature element is connected to the NMT electronics, and therefore which conversion should be used to obtain temperature from the measured resistance. (DD Parameter)

Interval Type (8n53) Element Interval Type: Indicates if the measuring elements connected to the NMT are spaced at regular or irregular intervals: Regular: means the element spacing value will be used between each element Irregular: allows the position of each element to be individually set. (Not available on NMT532) (DD Parameter)

Interval Size (8n54) Element Interval: When element interval type is set to regular, this value specifies the distance between each element. (DD Parameter)

Short Temp (8n55) Short Circuit Error Value: When a short-circuit fault is detected on an element, this error value will be returned instead of the normal measured temperature. (DD Parameter)

Open Temp (8n56) Open Circuit Error Value: When an open-circuit fault is detected on an element, this error value will be returned instead of the normal measured temperature. (DD Parameter)

Element 0 (8n57) Element Zero Temperature: Temperature conversion value of internal precision100Ω resistor. (Read Only) (DD Parameter)

Element 17 (8n58) Element #17 Temperature: Temperature conversion value of internal precision 200Ω resistor. (Read Only) (DD Parameter)

4.8.4.6 Submenu “Element Values” (8n6X)

This menu contains a submenu for each temperature element in the NMT.

Note This menu is disabled when “Custody Mode” is enabled on the NMT

4.8.4.7 Submenu “Element 1..16" (8n61)

Element 1..16 (8n63) Element 1..16 Temperature: Displays the temperature at the specified element.

Position 1..16 (8n64) Allows the specification of the position of the selected element when element spacing is set to irregular. (DD Parameter)

Weighting 1..16 (8n65) This is a capacity weighting value which for the selected element, it is used in the advanced average calculation method. (DD Parameter)

Resistance 1..16 (8n66) Indicates the measured resistance of the selected element. (Read Only) (DD Parameter)

4.8.4.8 Submenu “Element 19 (100Ω)” (8n61)

This special calibration parameter has a menu like the other elements, but without a “Position” or “Weighting” value.

4.8.4.9 Submenu “WB Probe” (8n7X)

Water Offset (8n71) Water Level Offset: This value is used during the calculation of the water level as a final added offset. (DD Parameter)

Span Selection (8n72) Water Level Probe Select: Length selection of static electricity capacity water probe. (DD Parameter)

Water Span (8n73) The water span value is used as part of the calculation to determine the water level from the probe frequency. (DD Parameter)

Water Factor (8n74) Probe Coefficient: This coefficient expresses the change in frequency of the water probe for every millimeter of water. (Read Only) (DD Parameter)

Empty Freq. (8n75) Frequency in Oil: Frequency of the water level probe when fully immersed in oil. (DD Parameter)

Full Freq. (8n76) Frequency in Water: Frequency of the water level probe when fully immersed in water. (DD Parameter)

4.8.4.10 Submenu “Device Status” (8n8X)

Error Code (8n81) Diagnostic Code: When the NMT electronics detect an error this parameter shows the error code detected. (Read Only) (DD Parameter)

Last Error (8n82) Last Diagnostic Code: This shows the previous error detected. (Read Only) (DD Parameter)

Device Code (8n83) Device Id: This value can be used to identify the NMT as per a customer specifiable number. (DD Parameter)

Error Output (8n84) Output At Error: Determines the behavior of the NMT when an element shows a fault: On: either short or open circuit error value is returned. Off: the element is excluded from average calculation, and a normal average value is returned. (DD Parameter)

Custody Mode (8n85) When set, the parameters in the NMT are locked and protected compliant to W&M requirements, the measured values are then acceptable as W&M value so long as the diagnostic code is normal. (Protected by W&M Switch) (DD Parameter)

Software Id(8n86) Software Version: Indicates the software version number inside the NMT. Example: 14 = version 1.4 (Read Only) (DD Parameter)

Hardware Id(8n87) Hardware Version: Indicates the hadware version number of the NMT. Example: 10 = version 1.0 (Read Only) (DD Parameter)

4.8.4.11 Submenu "Values" (8n2X)

Water Level(8n21) Measured water level, calculated from the measured probe frequency, the probe coefficient, the span and offset by the water offset level. (Read Only)

WB Cap.(8n22) Water Probe Capacitance: Static electricity capacitance value, calculated from the probe frequency value. (Read Only) (DD Parameter)

WB Freq.(8n23) Water Probe Frequency: Output frequency of the static electricity capacity form the probe. (Read Only) (DD Parameter)

4.8.4.12 Submenu "Basic Setup" (8n3X)

Access Code(8n31) Access code to allow the parameters in the NMT to be changed. Code 530 unlocks the NMT while any other code locks it. (Protected by W&M Switch) (DD Parameter)

Hysteresis(8n33) Element Change Hysteresis: This hysteresis is used in conjunction with the element position to prevent oscillation in the number of active elements the average temperature is calculated from when the level is close to an element position. (DD Parameter)

4.8.4.13 Submenu "WB Probe" (8n4X)

Water Offset(8n41) Water Level Offset: This value is used during the calculation of the water level as a final added offset. (DD Parameter)

Span Selection(8n42) Water Level Probe Select: Length selection of static electricity capacity water probe. (DD Parameter)

Water Span(8n43) The water span value is used as part of the calculation to determine the water level from the probe frequency. (DD Parameter)

Water Factor(8n44) Probe Coefficient: This coefficient expresses the change in frequency of the water probe for every millimeter of water. (Read Only) (DD Parameter)

Empty Freq.(8n45) Frequency in Oil: Frequency of the water level probe when fully immersed in oil. (DD Parameter)

Full Freq.(8n46) Frequency in Water: Frequency of the water level probe when fully immersed in water. (DD Parameter)

4.8.4.14 Submenu "Device Status" (8n5X)

Error Code(8n51) Diagnostic Code: When the NMT electronics detect an error this parameter shows the error code detected. (Read Only) (DD Parameter)

Last Error(8n52) Last Diagnostic Code: This shows the previous error detected. (Read Only) (DD Parameter)

Device Code(8n53) Device Id: This value can be used to identify the NMT as per a customer specifiable number. (DD Parameter)

Custody Mode(8n55) When set, the parameters in the NMT are locked and protected compliant to W&M requirements, the measured values are then acceptable as W&M value so long as the diagnostic code is normal. (Protected by W&M Switch) (DD Parameter)

Software Id(8n56) Software Version: Indicates the software version number inside the NMT. Example: 14 = version 1.4 (Read Only) (DD Parameter)

Hardware Id *(8n57)* Hardware Version: Indicates the hardware version number of the NMT. Example: 10 = version 1.0 (Read Only) (DD Parameter)

4.8.5 Function Block “NMT539 WB”

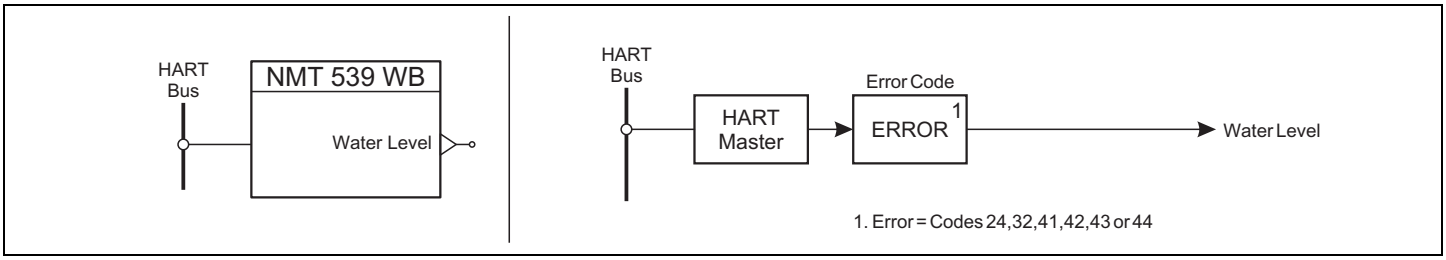


Figure 4-16: Function Block “NMT539 WB”

The NMT menu is used for the following types of Varec gauges:

- NMT539 WB[n] (for NMT539 Water Bottom Probe “No Temperature”)

The following section gives a brief description of the parameters from the device. For a complete description of the parameters and there function see the HART devices documentation.

4.8.5.1 Submenu “Hart[n]” (8n1X)

Comm. Addr *(8n11)* Communication Address: The short HART address used to detect this device. (Protected by W&M Switch)

Comm. Addr *(8n12)* Device Tag: The tag name programmed into the device, may be used for naming the device in the menus if Use Tag Names is selected in the display group. (Default: “”)

Device Id *(8n13)* The long HART ID number read from the HART device, containing manufacturer, device type and id number. (Read Only) (DD Parameter)

No Preambles *(8n14)* Number of Preambles: The minimum number of pre-ambles the HART device is requesting for communication. (Read Only) (DD Parameter)

Device Info. *(8n15)* Device Information: The device information (sensor and primary value settings) read from the HART device. (Read Only) (DD Parameter)

Description *(8n16)* Device Description: The device description text read from the HART device. (Read Only) (DD Parameter)

Date *(8n17)* Device Date: The device date read from the HART device. (Read Only) (DD Parameter)

4.8.6 Function Block “PMC/PMD”

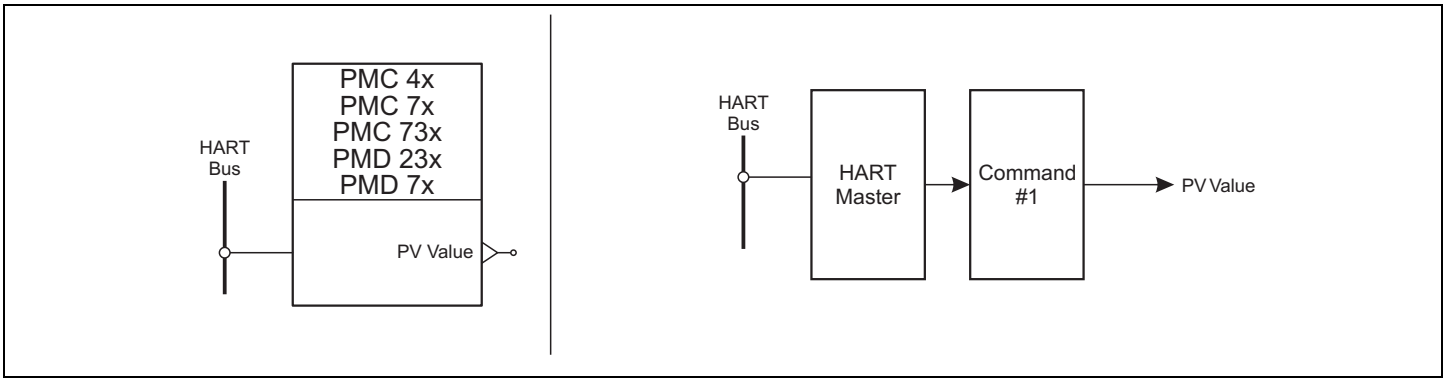


Figure 4-17: Function Block “PMC/PMD” Diagram

The PMC/PMD menu is used for the following types of pressure gauges:

- PMC4x[n] (for PMC/PMP 4x)
- PMC73x[n] (for PMC/PMP 73x/63x)
- PMD23x[n] (for PMD/FMD 23x/63x)
- PMC7x[n] (for PMC/PMP 7x)
- PMD7x[n] (for PMD/FMD 7x)

Note Make sure the connected pressure transmitter operates in the “pressure” mode, NOT in other modes such as “level”!

Note The following section gives a brief description of the parameters from the device. For a complete description of the parameters and there function see the HART devices documentation.

4.8.6.1 Submenu “Hart[n]” (8n1X)

Comm. Addr (8n11) Communication Address: The short HART address used to detect this device. (Protected by W&M Switch)

Device Tag (8n12) The tag name programmed into the device. (Default: “”)

Device Id (8n13) DD The long HART ID number read from the HART device, containing manufacturer, device type and id number. (Read Only) (DD Parameter)

No Preambles (8n14) DD Number of Preambles: The minimum number of pre-ambles the HART device is requesting for communication. (Read Only) (DD Parameter)

Device Info. (8n15) DD Device Information: The device information (sensor and primary value settings) read from the HART device. (Read Only) (DD Parameter)

Description (8n16) DD Device Description: The device description text read from the HART device. (Read Only) (DD Parameter)

Date (8n17) DD Device Date: The device date read from the HART device. (Read Only) (DD Parameter)

4.8.6.2 Submenu “Values” (8n2X)

PV Value (8n21) Measured Value: This parameter indicates the current value measured and corresponds to the on-site display of the device. (Read Only)

4.8.6.3 Submenu “Setup” (8n3X)

Op. Mode (8n31) Operation Mode: Selects the operation mode of the pressure sensor, the 4590 TSM can only select “pressure” mode of operation. (not available for PMC4x) (Protected by W&M Switch) (DD Parameter)

Pressures Unit (8n32) Pressure Unit: Selects a pressure unit. When a new pressure unit is selected, all pressure-related parameters are converted and indicated together with the new pressure unit. (DD Parameter)

Output Damping (8n33) Damping (integration time) affects the speed at which the output signal and the value indicated respond to a change in pressure. (DD Parameter)

Low Sens. Lim. (8n34) Low Sensor Limit: Indicates the lower sensor limit. (Read Only) (DD Parameter)

Hi Sens. Lim. (8n35) High Sensor Limit: Indicates the upper sensor limit. (Read Only) (DD Parameter)

Sensor Press. (8n36) Sensor Pressure: Indicates the current pressure applied to the sensor. (Read Only) (DD Parameter)

Zero Corr. (8n37) Zero Correction: Pressure Sensor Bias (DD Parameter)

4.8.6.4 Submenu “Diagnostic” (8n4X)

Diag. Code (8n41) Diagnostic Code: If the pressure transmitter detects an error or a warning, it generates an error code. This parameter displays the current error code. (Read Only) (DD Parameter)

Last Diag. Code (8n42) Last Diagnostic Code: Indicates the last error code. (Read Only) (DD Parameter)

Security Lock (8n43) Security Locking: Security locking of the parameters in the pressure device. (DD Parameter)

Software No (8n44) Software Number: Indicates the device and software number. (Read Only) (DD Parameter)

Sensor S/N (8n45) Sensor Serial Number: Indicates the serial number of the sensor. (not available for PMC4x) (Read Only) (DD Parameter)

4.8.7 Function Block “NMS”

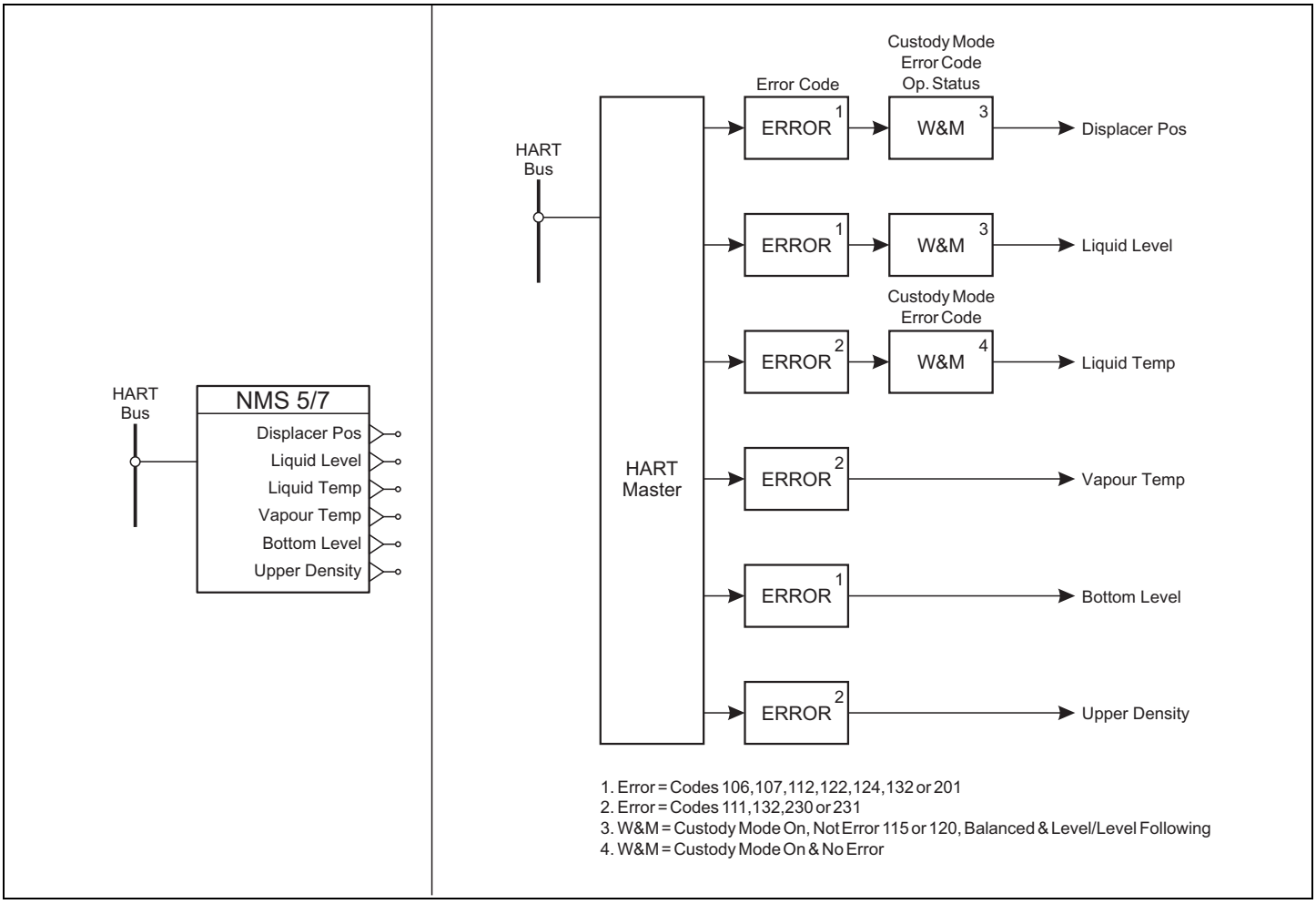


Figure 4-18: Function Block “NMS” Diagram

The NMS menu is used for the following types of Varec gauges:

- NMS[n] (for NMS5 Proservo)
- NMS[n] (for NMS7 Proservo)

Note The following section gives a brief description of the parameters from the device. For a complete description of the parameters and there function see the devices documentation.

4.8.7.1 *Submenu “Hart[n]” (8n1X)*

Comm. Addr *(8n11)* The short HART address used to detect this device. (Protected by W&M Switch)

Device Tag *(8n12)* The tag name programmed into the device. (Default: "")

Device Id *(8n13)* The long HART ID number read from the HART device, containing manufacturer, device type and id number. (Read Only) (DD Parameter)

No Preambles (8n14) The minimum number of pre-ambles the HART device is requesting for communication. (Read Only) (DD Parameter)

Device Info. (8n15) The device information (sensor and primary value settings) read from the HART device. (Read Only) (DD Parameter)

Description (8n16) The device description text read from the HART device. (Read Only) (DD Parameter)

Date (8n17) Device date: The device date read from the HART device. (Read Only) (DD Parameter)

4.8.7.2 Submenu "Values" (8n2X)

Displacer Pos (8n21) Displacer Position: Current measured position of the displacer (GVH=000) (Read Only)

Liquid Temp (8n22) Liquid Temperature: Temperature of the product in the tank from a connected NMT (GVH=010) (Read Only)

Upper Density (8n23) Last measured upper density value (GVH=005) (Read Only)

Bottom Level (8n24) Last measured bottom level (GVH=004) (Read Only)

Vapour Temp (8n25) Vapour Temperature: Temperature of the vapour in the tank from a connected NMT (GVH=013) (Read Only)

Liquid Level (8n26) Last measured liquid level when the NMS had a balanced status (GVH=008) (Read Only)

4.8.7.3 Submenu "Basic Setup" (8n3X)

Access Code (8n31) Access code to Unlock NMS parameters (Read Only) (DD Parameter)

Op. Status (8n32) Operation Mode: Current operating status of the servo (Read Only)

Op. Command (8n33) Operating Command: Servo operating command, used to instruct the servo to perform certain actions (Read Only) (DD Parameter)

Balancing 0 Indicates the balance status of the NMS measurement system (Read Only)

Custody Mode (8n35) Custody Transfer: When enabled indicates custody transfer mode is enabled on the gauge (Read Only)

4.8.7.4 Submenu "No Initialize" (8n4X)

New NMS Status (8n36) Enables or Disables the generation of the new NMS extended status values (Read Only) (DD Parameter)

Error Code (8n41) Device Status code indicates and faults or problems that the NMS (or connected NMT) may be experiencing (Read Only)

Software Ver. (8n42) Software Version: Software version Id (Read Only) (DD Parameter)

4.9 Menu "NRF Output" (9XXX)

The NRF output menu covers both the HART bus/busses and the field protocol which depends on the configuration of the 4590 TSM:

- HART Output (91XX)
- Modbus Output (92XX) (if protocol is selected)

- V1 Output (92XX) (if protocol is selected)
- BPM Output (92XX) (if protocol is selected)
- WM550 Output (92XX) (if protocol is selected)
- L&J Output (92XX) (if protocol is selected)
- Mark/Space Out. (92XX) (if protocol is selected)
- GPE Output (92XX) (if protocol is selected)

4.9.1 Function Block "HART Output"

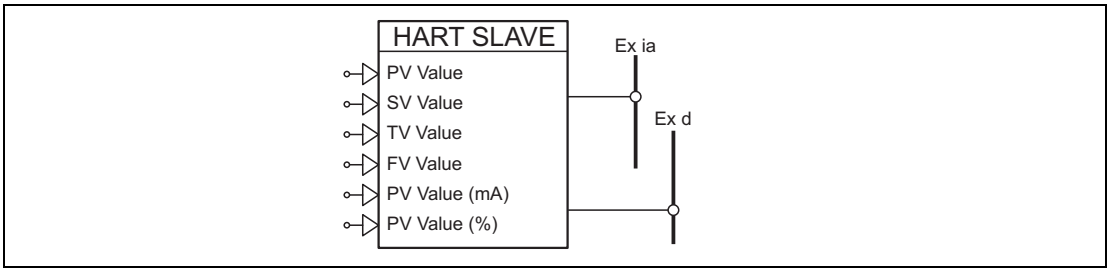


Figure 4-19: Function Block "HART Output" Diagram

This function menu controls the HART scanner and the values available when the 4590 TSM is addressed as a slave device.

4.9.1.1 Submenu "Slave Values" (911X)

PV Value (9111) PV Reference: Indicates which parameter will be returned as the primary value (PV). (Default: Tank Values, Level) (Protected by W&M Switch)

SV Value (9112) SV Reference: Indicates which parameter will be returned as the secondary value (SV). (Default: Tank Values, Product Temperature) (Protected by W&M Switch)

TV Value (9113) TF Reference: Indicates which parameter will be returned as the tertiary value (TV). (Default: Tank Values, Water Level) (Protected by W&M Switch)

FV Value (9114) FV Reference: Indicates which parameter will be returned as the 4th value (FV). (Default: Tank Values, Observed Density) (Protected by W&M Switch)

PV Value (mA) (9115) PV Current Reference: Indicates which parameter will be returned as the primary value (PV) current. (Default: IS AI, Value in mA)

PV Value (%) (9116) PV Percentage Reference: Indicates which parameter will be returned as the primary value (PV) percentage. (Default: Tank Values, Level as Percentage)

4.9.1.2 Submenu "Slave Setup" (912X)

Ex i Address (9121) Communication Address: Ex i HART Bus polling address which the 4590 TSM uses for communication to other HART masters on the HART bus (When the Analogue Output is configured as HART Master, this address is common to both Ex I and Ex d busses) (Default: 15) (Protected by W&M Switch)

Ex d Address (7n41) Communication Polling Address: Ex d HART Slave polling address (Note: if set to 0 then the 4..20mA output current will be active, otherwise a fixed current will be used) (Default: 15) (Protected by W&M Switch)

Tag (9123) The tag name is a short name which can be read from the 4590 TSM over the HART bus to provide customer specific identification. (Default: "4590 TSM")

No Preambles *(9124)* Number of Preambles: This parameter indicates the normal minimum number of pre-ambles used for HART communication, it can be overridden by a specific device if it requests a larger minimum number. (Default: 5)

Device Id *(9125)* Displays this devices unique long HART address containing three values:

- Manufacturer Code (Fixed Value: 17 for Endress+Hauser)
- Device Type (Fixed Value: 20 for 4590 TSM)
- Device unique HART serial number (different for each device)

4.9.1.3 Submenu "Master Setup" (913X)

No Retries *(9131)* Number of Retries: If the 4590 TSM fails to communicate with a connected device, this is the number of attempts it will make before proceeding to the next item to be scanned. (Default: 3)

Hart Bus Reset *(9133)* Force a HART reset on the specified Hart Bus; this is done by removing the power from the devices and then re-initiating the power again.

4.9.2 Function Block "Modbus Output"

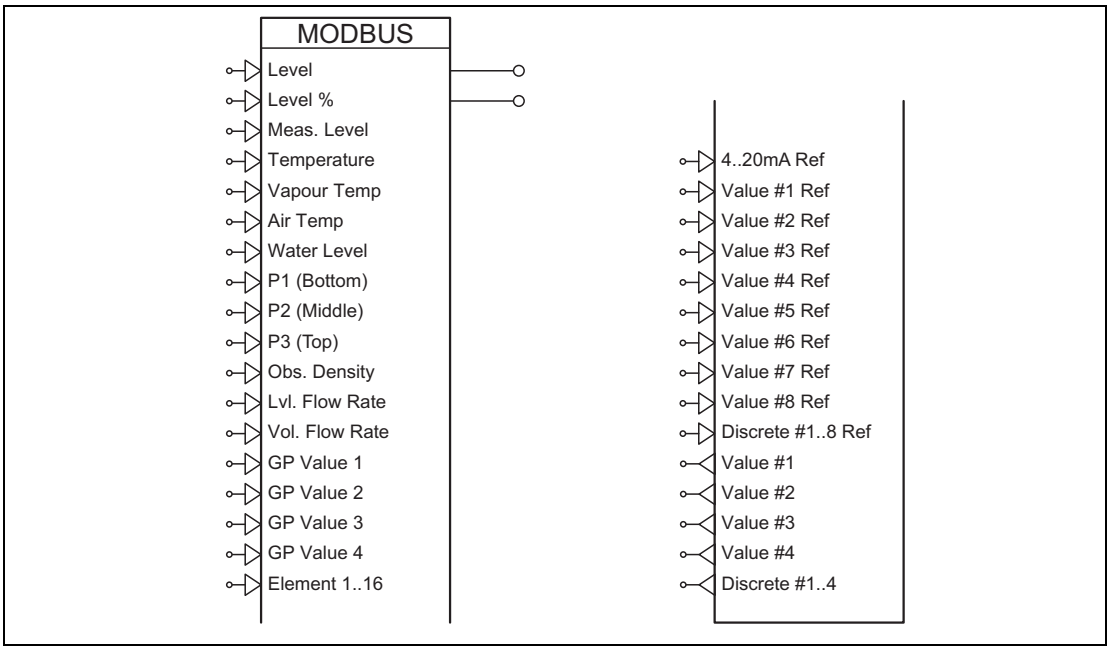


Figure 4-20: Function Block "Modbus Output" Diagram

This function menu controls the field protocol interface, linking the 4590 TSM to the control room.

4.9.2.1 Submenu "Basic Setup" (921X)

Id *(9211)* This is the identifier value. The 4590 TSM will respond to requests which contain this identifier value. (Default: 1) (Protected by W&M Switch)

Baud Rate *(9212)* Selects which of the possible baud rates communication should work at. (Default: 9600) (Protected by W&M Switch)

Type (9213) Parity Type: Describes which parity type will be used for the communication, the default value “1 stop bit” is compatible with the default RTU setting. (Default: 1 Stop Bit) (Protected by W&M Switch)

FP Mode (9214) Floating Point Mode: This specifies the order of the four floating point value bytes during the communication. (Default: Normal) (Protected by W&M Switch)

4..20mA Ref (9215) 4..20mA Value Reference: Specifies the source of the 4..20mA value to be returned by the 4590 TSM (Default: IS AI, Value in mA)

4.9.2.2 Submenu “Extended Setup” (922X)

Word Type (9221) Indicates if the integer value has the range 0 to +65535 or -32768 to +32767. (Default: Unsigned) (Protected by W&M Switch)

Invalid Data (9222) Indicates which data value will be returned for invalid data. (Default: 00) (Protected by W&M Switch)

NRF Ver 1 Map (9223) NRF Version 1 Mapping Mode: Selects the type of value available at the TSM V1 compatible modbus addresses. (Default: Float Vals.)

Bus Terminate (9224) Bus Termination: Selects if the bus termination resistor is applied. This should only be enabled on the last device in a loop (e.g. furthest from the control room) (Default: Off)

CRC Mode (9225) CRC seed value selection used for all communication CRC calculations. (Default: 0xFFFF)

4.9.2.3 Submenu “Modbus Values” (923X)

The 4590 TSM modbus interface provides four floating point values and four discrete (integer) registers which can be written to by the Host system. These values can then be linked to 4590 TSM functions (e.g. providing the Air Temperature value or controlling a discrete output).

Value #1..4 (9231..9234) The parameters show the four floating point values written by the Host system.

Discrete #1..4 (9235..9238) These parameters show the four discrete (integer) values written by the Host system, these values are converted into 4590 TSM discrete state values:

- Unknown (integer value 0)
- Inactive (integer value 1)
- Active (integer value 2)
- Invalid (integer value >= 3)

4.9.2.4 Submenu “UserReg.Mapping” (924X)

As well as the fixed value accessible through the Modbus interface, the 4590 TSM provides an additional eight floating point and eight discrete user selectable values.

Value #1..8 Ref (9241..9248) Value #1..8 Reference: These parameters can be linked to any suitable value within the 4590 TSM for transmission over the Modbus interface.

Discrete #1..8 Ref (9251..9258) Discrete #1..8 Reference: These parameters can be linked to any suitable discrete value within the 4590 TSM for transmission over the Modbus interface.

4.9.2.5 Submenu “Integer Scaling” (926X)

The Modbus implementation as well as offering floating point values can scale these values into single register integer values. To implement this scaling each value type has a 0% and 100% value which can be set through this menu:

- Level Values 0% (9261) 100% (9262)
- Temp. Values 0% (9263) 100% (9264)
- Press. Values 0% (9265) 100% (9266)
- Density Values 0% (9267) 100% (9268)
- Flow Values 0% (9269) 100% (926A)
- Vol. Flow Val. 0% (926B) 100% (926C)
- GP1 Values 0% (926D) 100% (926E)
- GP2 Values 0% (926F) 100% (926G)
- GP3 Values 0% (926H) 100% (926I)
- GP4 Values 0% (926J) 100% (926K)
- User MapValues 0% (926L) 100% (926M)

The 0% value always corresponds to the integer value Zero. If signed integers are selected, then the resulting value will be scaled from −100% to +100%.

Note All user mapped values use the same scaling factors.

4.9.2.6 Submenu “Diagnostics” (927X)

Output Status (9271) The Communication Status Graph (CSG) provides a simple graphical overview of communication between the gauges and the control room. The height of the bar represents the activity during the last second:

- Replied to the Host (largest bar)
- Received Request for this 4590 TSM
- Request for another gauge on this bus
- Bytes were detected on the bus
- Bits were detected on the bus (smallest bar)
- Nothing detected (no bar, gap in graph)

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

4.9.3 Function Block "V1 Output"

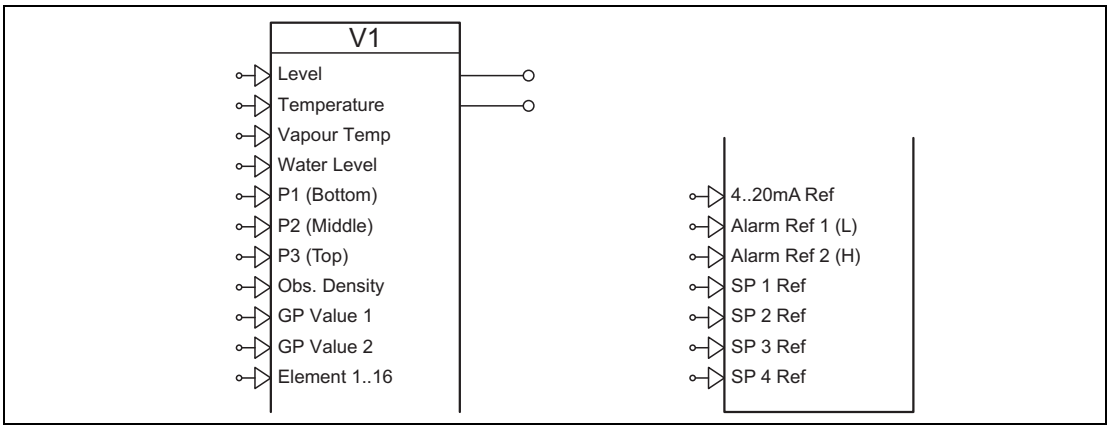


Figure 4-21: Function Block "V1 Output" Diagram

This function menu controls the field protocol interface linking the 4590 TSM to the control room.

4.9.3.1 Submenu "Basic Setup" (921X)

Type *(9211)* Protocol Type: Defines the protocol type (for details check short instructions...). (Default: V1) (Protected by W&M Switch)

Id *(9212)* Identifier value for the V1 communication. The 4590 TSM will respond to requests which contain this identifier value. (Default: 1) (Protected by W&M Switch)

Line Impedance *(9213)* Adjusts the line impedance which effects the voltage difference between a logical 0 and a logic 1 on the reply, normally the default is suitable for most installations. (Default: 15)

Level Mapping *(9214)* Indicates how a -ve level value is represented in the reply. (Default: +ve only) (Protected by W&M Switch)

Service Relay *(9215)* Activates the service relay and disconnect V1 system from the bus. (Default: Off) (Protected by W&M Switch)

4.9.3.2 Submenu “Extended Setup” (922X)

SP 1 Ref(9221) SP 1 Reference: Indicates which discrete value will be transmitted as V1 SP 1 status flag. (Default: IS DI #1, Value)

SP 2 Ref(9222) SP 2 Reference: Indicates which discrete value will be transmitted as V1 SP 2 status flag. (Default: IS DI #2, Value)

SP 3 Ref(9223) SP 3 Reference: Indicates which discrete value will be transmitted as V1 SP 3 status flag. (Default: Undefined)

SP 4 Ref(9224) SP 4 Reference: Indicates which discrete value will be transmitted as V1 SP 4 status flag. (Default: Undefined)

4..20mA Ref(9225) 4..20mA Reference: Indicates which discrete value will be transmitted as the Analogue value. (Default: IS AI, Value in mA)

Alarm Ref 1 (L)(9226) Alarm Reference 1 (High): Indicates which discrete value will be transmitted as V1 Alarm 1 (low) status. The default value is connected to the Level alarm L or LL value. (Default: Level Alarm, Alarm H or HH Active)

Alarm Ref 2 (H)(9227) Alarm Reference 2 (Low): Indicates which discrete value will be transmitted as V1 Alarm 2 (high) status. The default value is connected to the Level alarm H or HH value. (Default: Level Alarm, Alarm L or LL Active)

4.9.3.3 Submenu “Diagnostics” (923X)

Output Status(9231) The Communication Status Graph (CSG) provides a simple graphical overview of communication between the gauges and the control room. The height of the bar represents the activity during the last second:

- Replied to Host (largest bar)
- Received Request for this 4590 TSM
- Request for another gauge on bus
- Bytes were detected on this bus
- Bits were detected on the bus (smallest bar)
- Nothing detected (no bar, gap in graph)

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

4.9.4 Function Block “BPM Output”

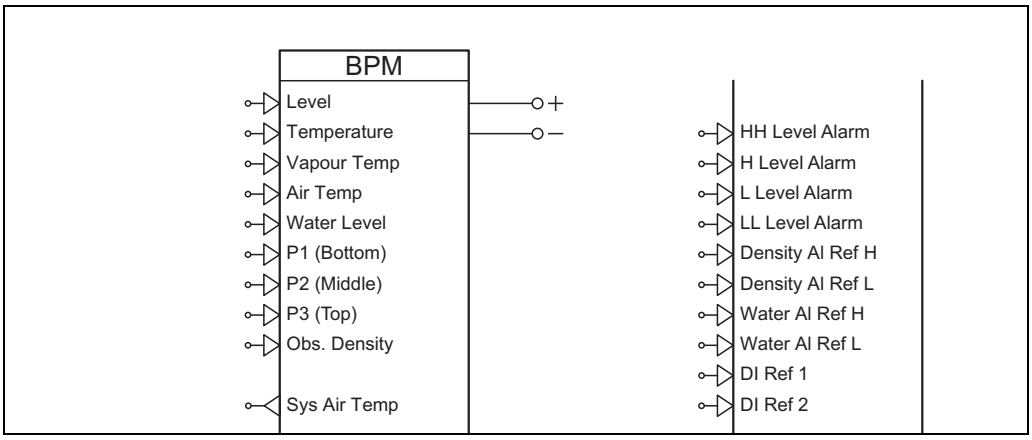


Figure 4-22: Function Block “BPM Output” Diagram

4.9.4.1 Submenu “Basic Setup” (921X)

Id Length (9211)

Specifies if 2-digit or 3-digit long identifier values are used. (Default: 2 Digits) (Protected by W&M Switch)

Id (9212)

Identifier value. The 4590 TSM will respond to requests which contain this identifier value. (2-digit value) (Default: 0) (Protected by W&M Switch)

Id (9212)

This is the identifier value. The 4590 TSM will respond to requests which contain this identifier value. (3-digit value) (Default: 0)

Baud Rate (9213)

Selects at which of the two possible baud rates the communication will work at. (Default: 1200) (Protected by W&M Switch)

TOI (9214)

Type Of Instrument: The “Type Of Instrument” (TOI) is used for differentiating between various device specific protocol variations. By changing this value the system can be matched the capabilities of the host system. (Default: Accept All) (Protected by W&M Switch)

Device No [dn] (9215)

Device Number: The device number can be used by the host system for additional identification. (Default: 590) (Protected by W&M Switch)

Dev. Type [dt] (9216)

Device Type: The device type identifies the type of equipment the 4590 TSM is emulating. The default value 'A' refers to the 854 ATX gauge. (Default: 'A') (Protected by W&M Switch)

4.9.4.2 Submenu “Extended Setup” (922X)

DI Ref 1 (9221)

External #1 Reference: Indicates which discrete value will be transmitted as Enraf External value number 1. (Default: IS DI #1, Value)

DI Ref 2 (9222)

External #2 Reference: Indicates which discrete value will be transmitted as Enraf External value number 2. (Default: IS DI #2, Value)

Sys Air Temp (9227)

System Air Temperature: System supplied Air Temperature. (Read Only)

No Pre.Detect (9239)

Number of Detected Pre-ambles: Indicates the number of pre-ambles we were able to measure in the previous request we received. (Read Only)

4.9.4.3 Submenu “Diagnostics” (923X)

Output Status (9231) The Communication Status Graph (CSG) provides a simple graphical overview of communication between the gauges and the control room. The height of the bar represents the activity during the last second:

- Replied to Host (largest bar)
- Received Request for this 4590 TSM
- Request for another gauge on this bus
- Bytes were detected on the bus
- Bits were detected on the bus (smallest bar)
- Nothing detected (no bar, gap in graph)

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

4.9.5 Function Block “WM550 Output”

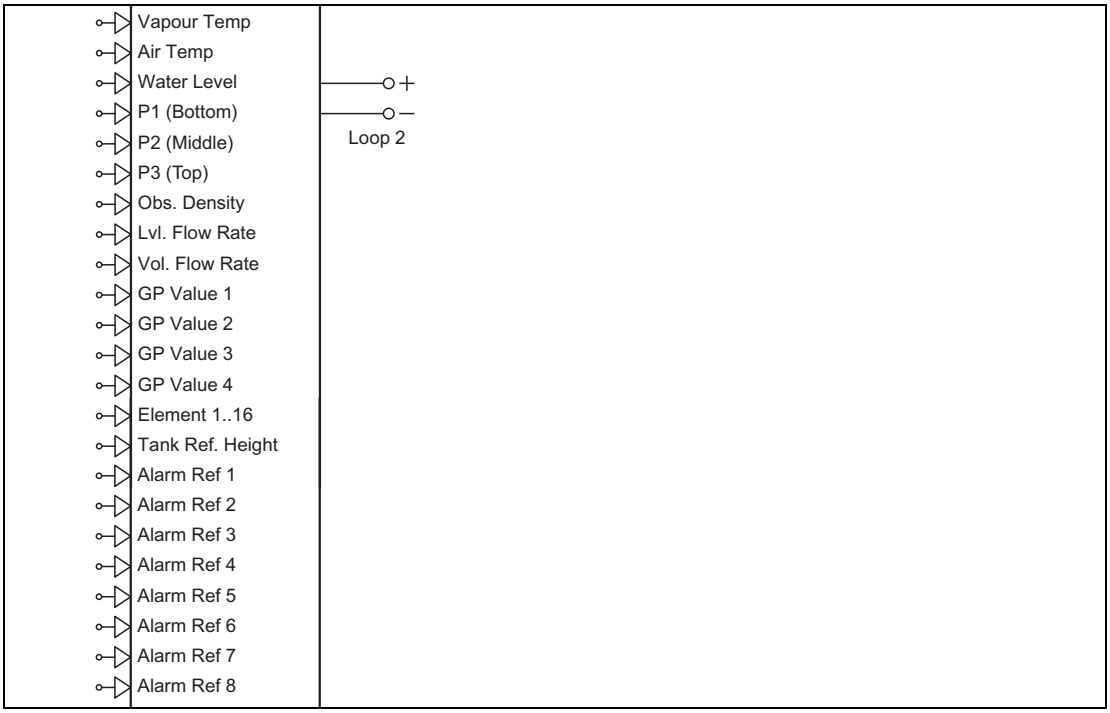


Figure 4-23: Function Block “WM550 Output” Diagram

This function menu controls the field protocol interface, linking the 4590 TSM to the control room.

4.9.5.1 Submenu “Basic Setup” (921X)

Id *(9211)* This is the identifier value. The 4590 TSM will respond to requests which contain this identifier value. (Default: 1) (Protected by W&M Switch)

Baud Rate *(9212)* Selects which of the possible baud rates communication should work at. (Default: 2400) (Protected by W&M Switch)

Software Id *(9213)* Software Identification Value: Describes which parity type will be used for the communication (Default: 2000) (Protected by W&M Switch)

4.9.5.2 Submenu “Extended Setup” (922X)

Alarm Ref 1 *(9221)* Alarm No 1 Reference: Indicates which discrete value will be transmitted as Alarm Bit 1 (Default: Level Alarm, Alarm HH Active)

Alarm Ref 2 *(9222)* Alarm No 2 Reference: Indicates which discrete value will be transmitted as Alarm Bit 2 (Default: Level Alarm, Alarm H Active)

Alarm Ref 3 *(9223)* Alarm No 3 Reference: Indicates which discrete value will be transmitted as Alarm Bit 3 (Default: Level Alarm, Alarm L Active)

Alarm Ref 4 *(9224)* Alarm No 4 Reference: Indicates which discrete value will be transmitted as Alarm Bit 4 (Default: Level Alarm, Alarm LL Active)

Alarm Ref 5 *(9225)* Alarm No 5 Reference: Indicates which discrete value will be transmitted as Alarm Bit 5 (Default: Undefined)

Alarm Ref 6 (9226) Alarm No 6 Reference: Indicates which discrete value will be transmitted as Alarm Bit 6 (Default: Undefined)

Alarm Ref 7 (9227) Alarm No 7 Reference: Indicates which discrete value will be transmitted as Alarm Bit 7 (Default: Undefined)

Alarm Ref 8 (9228) Alarm No 8 Reference: Indicates which discrete value will be transmitted as Alarm Bit 8 (Default: Undefined)

4.9.5.3 Submenu "Loop 2" (923X)

Loop 2 (9231) Loop 2 Operation Mode: Specifies if both loops use the same baud rate or not. (Default: As Loop 1) (Protected by W&M Switch)

Baud Rate (2) (9232) Baud Rate (Loop 2): Selects which of the possible baud rates the second loop will communication with if loop mode is set to different, otherwise both loops will use the normal baud rate. (Default: 2400) (Protected by W&M Switch)

4.9.5.4 Submenu "Diagnostics" (924X)

Output Status (9241) The Communication Status Graph (CSG) provides a simple graphical overview of communication between the gauges and the control room. The height of the bar represents the activity during the last second:

- Replied to Host (largest bar)
- Received Request for this 4590 TSM
- Request for another gauge on the same bus
- Bytes were detected on the bus
- Bits were detected on the bus (smallest bar)
- Nothing detected (no bar, gap in graph)

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

4.9.5.5 Submenu "Diagnostics 2" (925X)

Output Status (9251)

The Communication Status Graph (CSG) provides a simple graphical overview of communication between the gauges and the control room. The height of the bar represents the activity during the last second:

- Replied to Host (largest bar)
- Received Request for this 4590 TSM
- Request for another gauge on the same bus
- Bytes were detected on the bus
- Bits were detected on the bus (smallest bar)
- Nothing detected (no bar, gap in graph)

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

4.9.6 Function Block “L&J Output”

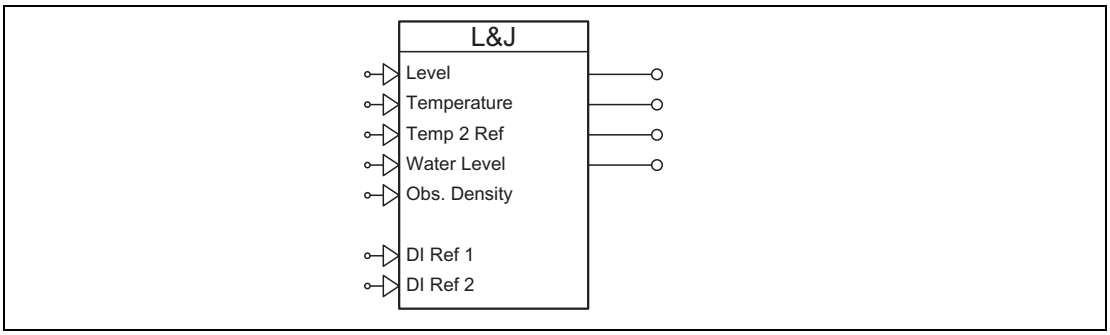


Figure 4-24: Function Block “L&J Output” Diagram

This function menu controls the field protocol interface linking the 4590 TSM to the control room.

4.9.6.1 Submenu “Basic Setup” (921X)

Id *(9211)* This is the identifier value. The 4590 TSM will respond to requests which contain this identifier value. (Default: 1) (Protected by W&M Switch)

Baud Rate *(9212)* Selects which of the possible baud rates communication should work at. (Default: 1200) (Protected by W&M Switch)

Type *(9213)* Parity Type: Describes the format used to encode the level value sent to the control room. (Default: CCW S&J) (Protected by W&M Switch)

DI Ref 1 *(9214)* Discrete Reference 1: Indicates which discrete value will be transmitted as LJ Discrete Value 1. (Default: IS DI #1, Value)

DI Ref 2 *(9215)* Discrete Reference 2: Indicates which discrete value will be transmitted as LJ Discrete Value 2. (Default: IS DI #2, Value)

Temp 2 Ref *(9216)* Temperature #2 Reference: Indicates which value will be transmitted as LJ Temperature #2. The default value is connected to the Tank Vapour Temperature. (Default: Tank Values, Vapor Temperature)

4.9.6.2 Submenu “Diagnostics” (922X)

Output Status *(9221)* The Communication Status Graph (CSG) provides a simple graphical overview of communication between the gauges and the control room. The height of the bar represents the activity during the last second:

- Replied to Host (largest bar)
- Received Request for this 4590 TSM
- Request for another other gauge on this bus
- Bytes were detected on the bus
- Bits were detected on the bus (smallest bar)
- Nothing detected (no bar, gap in graph)

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

4.9.7 Function Block “Mark/Space Out.”

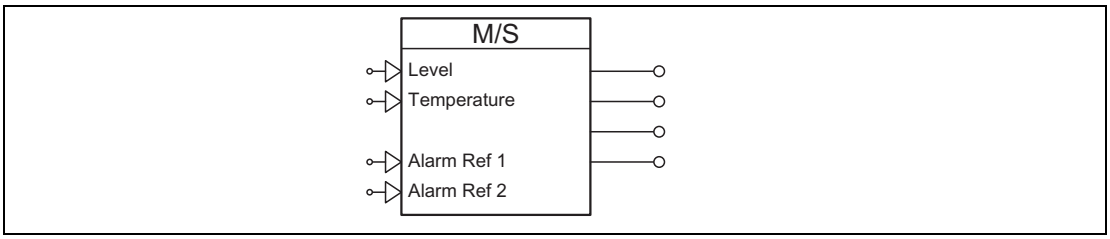


Figure 4-25: Function Block “Mark/Space Out.” Diagram

This function menu controls the field protocol interface linking the 4590 TSM to the control room.

4.9.7.1 Submenu “Basic Setup” (921X)

Id *(9211)* This is the identifier value. The 4590 TSM will respond to requests which contain this identifier value. (Default: 1) (Protected by W&M Switch)

Baud Rate *(9212)* Selects which of the possible baud rates communication should work at. (Default: High) (Protected by W&M Switch)

Type *(9213)* Device Type: Indicates which Mark/Space device the 4590 TSM will emulate. (Default: 1900) (Protected by W&M Switch)

Data Mode *(9214)* Indicates which type of data format will be used in the reply. (Default: 20 m) (Protected by W&M Switch)

Temperature *(9215)* Temperature Mode: Indicates if a temperature will be returned or not. (Default: With Temp) (Protected by W&M Switch)

Temp. Offset *(9216)* Temperature Offset: Indicates if the temperature value returned should have the offset applied to it. (Default: Enabled) (Protected by W&M Switch)

4.9.7.2 Submenu “Extended Setup” (922X)

Alarm Ref 1 *(9221)* Alarm Bit 1 Reference: Reference to the parameter to be returned as the alarm bit 1. (Default: IS DI #1, Value)

Alarm Ref 2 *(9222)* Alarm Bit 2 Reference: Reference to the parameter to be returned as the alarm bit 2. (Default: IS DI #2, Value)

4.9.7.3 Submenu “Diagnostics” (923X)

Output Status *(9231)* The Communication Status Graph (CSG) provides a simple graphical overview of communication between the gauges and the control room. The height of the bar represents the activity during the last second:

- Replied to Host (largest bar)
- Received Request for this 4590 TSM
- Request for another gauge on bus
- Bytes were detected on the bus
- Bits were detected on the bus (smallest bar)
- Nothing detected (no bar, gap in graph)

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

4.9.8 Function Block “GPE Output”

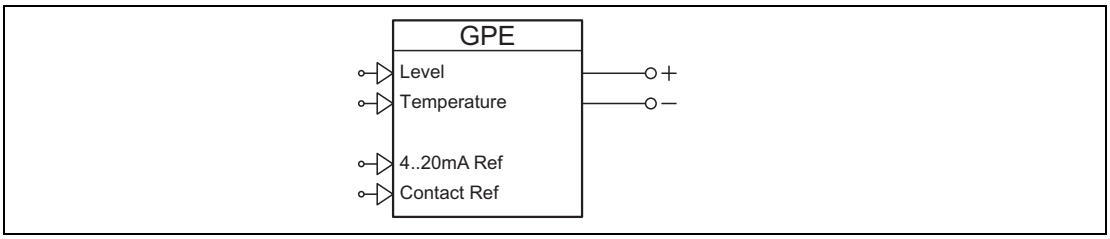


Figure 4-26: Function Block “GPE Output” Diagram

This function menu controls the field protocol interface linking the 4590 TSM to the control room.

4.9.8.1 Submenu “Basic Setup” (921X)

Id *(9211)* This is the identifier value. The 4590 TSM will respond to requests which contain this identifier value. (Default: 1) (Protected by W&M Switch)

Baud Rate *(9212)* Selects which of the possible baud rates communication should work at. (Default: 300) (Protected by W&M Switch)

Type *(9213)* Parity Type: Indicates the type of reply which will be sent by the 4590 TSM. (Default: 1mm Reply) (Protected by W&M Switch)

Loop Mode *(9214)* Indicates if the loop number in the request should be checked or ignored; if it is checked, then only when it matches the 4590 TSM loop number will a reply be sent. (Default: Not Checked) (Protected by W&M Switch)

Loop Number *(9215)* The loop number the 4590 TSM will respond to if checking is enabled. (Default: 0) (Protected by W&M Switch)

4.9.8.2 Submenu “Extended Setup” (922X)

4..20mA Ref *(9221)* Analogue Reference: Reference to the parameter to be returned as the analogue 4..20mA value in the reply. (Default: IS AI, Value in mA)

Contact Ref *(9222)* Contact Reference: Reference to the parameter to be returned as the contact status in the reply. (Default: IS DI #1, Value)

Conv.Adj.Fact. *(9223)* Conversion Adjustment Factor: This value is multiplied with the level before transmission, while normally the default value is fine, changing this value can be useful to compensate for inaccurate unit conversion in host systems. (Default: 1.00 unitless) (Protected by W&M Switch)

L.Reply Type *(9224)* Long Reply Type: Indicates which type of long reply will be sent when Type is set to Long Reply. (Default: Type 1) (Protected by W&M Switch)

4.9.8.3 Submenu “Diagnostics” (923X)

Output Status *(9231)* The Communication Status Graph (CSG) provides a simple graphical overview of communication between the gauges and the control room. The height of the bar represents the activity during the last second:

- Replied to Host (largest bar)
- Received Request for this 4590 TSM
- Request for another gauge on this bus
- Bytes were detected on the bus

- Bits were detected on the bus (smallest bar)
- Nothing detected (no bar, gap in graph)

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

5 Troubleshooting

If you have followed the instructions in this operating manual, the 4590 TSM should work correctly. If this is not the case, 4590 TSM has facilities for analyzing and correcting errors. You can find a structured approach for locating errors on see Section 5.1, "Troubleshooting Instructions" on page 88.

5.1 Troubleshooting Instructions

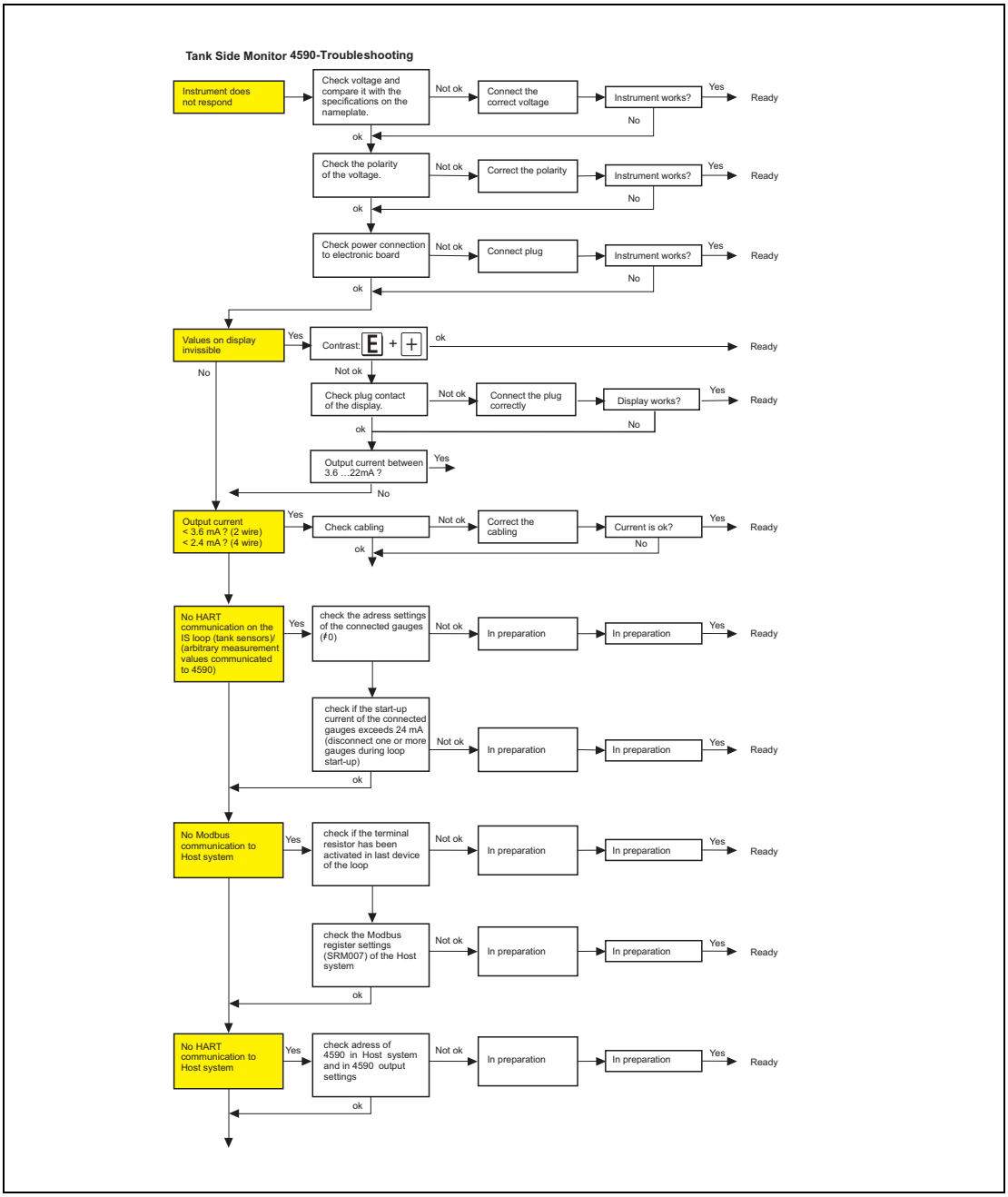


Figure 5-1: Troubleshooting Instructions Diagram

5.2 System Error Messages

Code	Display text	Description	Action
F101	Open Circuit	The input signal to the analogue input circuit is no longer detected, probably due to a broken or disconnected cable	Check installation and cabling.
F102	Overloaded Input	The input signal to the analogue input circuit is > 28 mA	Check installation and cabling.
F103	Device Offline	Indicates the connected HART device is no longer responding to communication	Check device. Check cabling.
M104	Check Device	The connected HART device is indicating through its diagnostic value that a problem exists (not available for Generic HART devices).	Check device diagnostic code and rectify device problem (see the documentation for the specific HART device for details).
S105	IS HART Overload	Indicates the Ex i HART Bus voltage is below 14 V, therefore HART device operation may be abnormal.	Caused due to overloading the HART Bus, check no device has address 0 (active 4...20 mA output) and/or reduce the number of connected devices (see Technical specifications for limits).
F106	IS HART Short	Indicates a short circuit has been detected (voltage below 2 V) on the Ex i HART Bus.	Check installation and cabling.
F107	IS FMR Short	Indicates a short circuit has been detected (voltage below 2 V) on the Ex i Power Circuit for the FMR53x Radar device.	Check installation and cabling.
F108	IS Ext Short	Indicates a short circuit has been detected (voltage below 2 V) on the Ex i External Power output used for IS AI, IS DI#1 and IS DI#2.	Check installation and cabling.
C281	Initialization	Hardware Initialization (e.g. after Power On)	None, for historical information only
F301	Flash Contents[1)]	System initialization error indicating the data stored on the board's Flash Memory chip is corrupt.	Device requires re-flashing or returning to supplier for repair.
F302	No Order Code	System initialization error indicating the factory order code has not been found.	System must be returned to supplier.
F303	App Failure	System initialization error indicating the Application Microcontroller is indicating a failure during initialization	If spare parts have been fitted, make sure both boards are from the same set (do not mix old/new boards) If device has been re-flashed, try again. Otherwise the system must be returned to the supplier.

Table 5-1: System Error Messages

Code	Display text	Description	Action
F304	Com Failure	System initialization error indicating the Communication Microcontroller is indicating a failure during initialization.	If device has been re-flashed, try again. Otherwise the system must be returned to the supplier.
F305	App Error	System initialization error indicating the Application Microcontroller is not communicating with the Main Microcontroller in the system.	If spare parts have been fitted, make sure both boards are from the same set (do not mix old/new boards). If device has been re-flashed, try again. Otherwise the system must be returned to the supplier.
F306	Comm Error	System initialization error indicating the Communication Microcontroller is not communicating with the Main Microcontroller in the system.	If device has been re-flashed, try again. Otherwise the system must be returned to the supplier.
F307	DD Failure	System initialization error indicating what a problem occurred when loading one of the device DDs from the Flash Memory.	If device has been re-flashed, try again. Otherwise the system must be returned to the supplier.
C312	Initialization	Hardware initialization (e.g. after Internal System Reset)	None, for historical information only.
C401	Factory RESET	Indicates the system (or the group) has been reset back to factory settings by the user.	None, for historical information only.
C402	Initialization	Configuration Initialization (e.g. after Soft Reset from Menu)	None, for historical information only.
S432	Calibration	The user and/or factory calibration of this function has failed, and circuit is currently operating without any calibration.	Re-calibrate using User calibration or Return to supplier for repair.
S434	Scaling	The 0% and/or 100% scaling values for the function are invalid, as a result the function cannot operate properly.	Check configuration.
C482	Simulated Output	The output function is currently operating in simulation mode, therefore the output value no longer relates to the process values.	Exit simulation mode.
C483	Simulated Input	The input function is currently operating in simulation mode, therefore the input value no longer relates to the connected process value.	Exit simulation mode.
F501	Value Ref	The value reference used as the input value for this function is no longer valid, therefore the output value is no longer related to the process.	Check configuration.

Table 5-1: System Error Messages

Code	Display text	Description	Action
F502	Device 0 found	Indicates that this device has polling address 0. By definition of the HART standard that also means the device has an active 4...20 mA output signal, as this load can vary such a device can overload the HART bus and is therefore not allowed by the 4590 TSM system.	Change the device HART address or remove device from system.
F503	Level Ref	The level Reference value is no longer valid (e.g. the value it was linked to is no longer available in the system).	Check configuration.
F504	Water Level Ref	The Water Level Reference value is no longer valid (e.g. the value it was linked to is no longer available in the system).	Check configuration.
F505	Temp. Ref	The Temperature Reference value is no longer valid (e.g. the value it was linked to is no longer available in the system).	Check configuration.
F506	Vapor Temp. Ref	The Vapor Temperature Reference value is no longer valid (e.g. the value it was linked to is no longer available in the system).	Check configuration.
F507	Air Temp. Ref	The Air Temperature Reference value is no longer valid (e.g. the value it was linked to is no longer available in the system).	Check configuration.
F508	P1 Ref	The P1 (Bottom) Pressure Reference value is no longer valid (e.g. the value it was linked to is no longer available in the system).	Check configuration.
F509	P2 Ref	The P2 (Middle) Pressure Reference value is no longer valid (e.g. the value it was linked to is no longer available in the system).	Check configuration.
F510	P3 Ref	The P3 (Top) Pressure Reference value is no longer valid (e.g. the value it was linked to is no longer available in the system).	Check configuration.
C511	CS Restored	The user performed a Customer Settings restore operation on the whole system or on this group.	None, for historical information only.
C512	Device Removed	The indicated HART device was removed from the system by the user.	None, for historical information only.

Table 5-1: System Error Messages

Code	Display text	Description	Action
C513	Restart	The software restart operation was selected by the user.	None, for historical information only.
F514	CS Saved	Indicates the user has saved the current configuration of the system as the “Customer Settings”.	None, for historical information only.
C515	User Access	The user access code 100 was entered.	None, for historical information only.
C516	Service Access	The service engineer access code was entered.	None, for historical information only.
C517	Diag. Access	The Varec diagnostic access code was entered.	None, for historical information only.
C518	Unknown Access	An invalid access code was entered.	None, for historical information only.
C519	Access Locked	Indicates the access code was locked, either by changing it to 0 manually or by using the three button method.	None, for historical information only.
C520	Access Timeout	Indicates the access code was removed by the system as the menu had not been used for the timeout period.	None, for historical information only.
S901	Level Held	The tank level value is being held at an old value and no longer being updated (e.g. during Dip Freeze).	This may be normal operation (e.g. during Dip Freeze), otherwise check configuration.
S902	Temp. Held	The tank temperature value is being held at an old value and no longer being updated.	This may be normal operation, otherwise check configuration.
S903	Vap. Temp. Held	The tank vapor temperature value is being held at an old value and no longer being updated.	This may be normal operation, otherwise check configuration.
S904	Air Temp. Held	The tank air temperature value is being held at an old value and no longer being updated.	This may be normal operation, otherwise check configuration.
S905	Water Level Held	The Tank water level value is being held at an old value and no longer being updated.	This may be normal operation, otherwise check configuration.
S906	P1 Held	The tank P1 (bottom) pressure value is being held at an old value and no longer being updated.	This may be normal operation, otherwise check configuration.
S907	P2 Held	The tank P2 (middle) pressure value is being held at an old value and no longer being updated.	This may be normal operation, otherwise check configuration.
S908	P3 Held	The tank P3 (top) pressure value is being held at an old value and no longer being updated.	This may be normal operation, otherwise check configuration.

Table 5-1: System Error Messages

Code	Display text	Description	Action
S909	Obs. Density Held	The tank observed density value is being held at an old value and no longer being updated (e.g. during HTG mode when level is below pressure sensors).	This may be normal operation (e.g. when in HTG mode and the level is below the pressure sensors), otherwise check configuration.
S910	Flow Held	The tank flow rate value is being held at an old value and no longer being updated.	This may be normal operation, otherwise check configuration.
F911	Level Fault	The tank level value has failed.	Check configuration, manual values, reference.
F912	Temp. Fault	The tank temperature value has failed.	Check configuration, manual values, reference.
F913	Vap. Temp. Fault	The tank vapor temperature value has failed.	Check configuration, manual values, reference.
F914	Air Temp. Fault	The tank air temperature value has failed.	Check configuration, manual values, reference.
F915	Water Level Fault	The tank water level value has failed.	Check configuration, manual values, reference.
F916	P1 Fault	The tank P1 (bottom) pressure value has failed.	Check configuration, manual values, reference.
F917	P2 Fault	The tank P2 (middle) pressure value has failed.	Check configuration, manual values, reference.
F918	P3 Fault	The tank P3 (top) pressure value has failed.	Check configuration, manual values, reference.
F919	Obs. Density Fault	The tank observed density value has failed.	Check configuration, manual values, reference.
F920	Flow Fault	The tank flow rate value has failed.	Check configuration, manual values, reference.

Table 5-1: System Error Messages

1. not stored in the status history

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