



Level



Pressure



Flow



Temperature



Liquid
Analysis



Registration



Systems
Components



Services

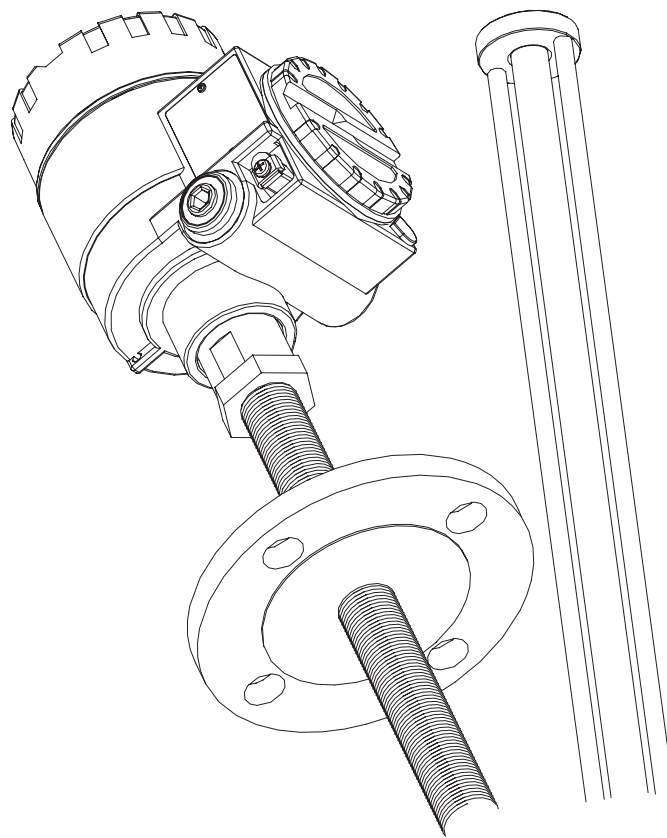


Solutions

Operating Instructions and Description of Instrument Function

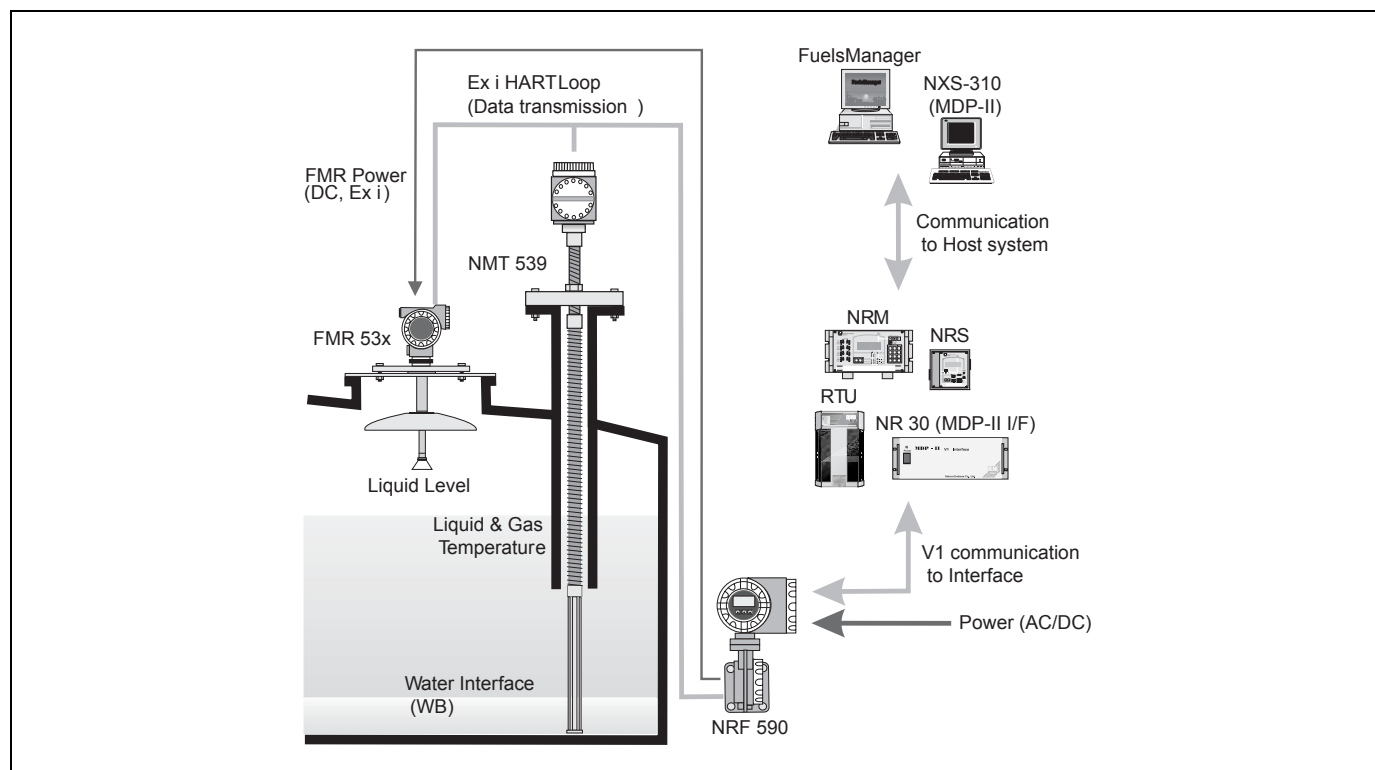
Prothermo NMT539

Temperature



Operating Instructions and Description of Instrument Functions

Basic device layout of the Prothermo NMT539



Step 1. Prothermo installation on tank top

- The actual installation may require an installer to work in a hazardous area. Safety must be taken into account in order to avoid any harmful conditions.
- The installation method depends on the type of Prothermo. Refer to BA025N/08/en "Installation Instructions."

Step 2. Wiring to the host instruments (Tank Side Monitor NRF590 or Proservo NMS5/7)

- Wiring material and conditions must be in accordance with intrinsically safe standards.
- One end (normally on the host instrument side) of the shield twisted pair of cables must be grounded at the terminal connection.
- Refer to BA025N/08/en "Installation Instructions."

Step 3. Prothermo NMT539 initial setup

- Both NMT539's own device setting and local HART setting to the host instrument must be performed.

Step 4. Data flow from the Prothermo NMT539 to the host instruments

- Individual element temperature data: Individual row element temperature can be accessed regardless of liquid level information on the NMT539's data matrix.
- Average temperature data: The host instrument sends liquid level data on the HART line to the Prothermo. The Prothermo calculates both Gas / Liquid phase average temperature based on this given liquid level.
- Water Bottom (WB) data: WB data and information are continuously scanned and transmitted by host instruments as long as the local HART connection is active.

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1 Safety instructions

1.1 Designated use

The Prothermo NMT539 is a multi-spot Pt100 average thermometer combined with a HART signal converter to meet the demand of temperature measurement for both custody transfer and inventory control applications. One unique feature is the implementation of capacitance water / oil interface measurement functionality (Water Bottom) for radar tank gauging applications together with the Endress+Hauser Micropilot S-series radars and the Tank Side Monitor NRF590. Mounted on the tank top, the NMT539 provides both temperature and water interface information on the two wire, intrinsically safe (i.s.) powered local HART loop. The designated host controller can be either the Endress+Hauser Tank Side Monitor NRF590 or Proservo NMS5/7.

1.2 Installation, commissioning and operation

- Mounting, electrical installation, start-up and maintenance of the instrument may only be carried out by trained personnel authorized by the operator of the facility.
- Personnel must absolutely and without fail read and understand this Operating Manual before carrying out its instructions.
- The instrument may only be operated by personnel who are authorized and trained by the operator of the facility. All instructions in this manual are to be observed without fail.
- The installer must make sure that the measuring system is correctly wired according to the wiring diagrams. The measuring system is to be grounded. Detailed Installation instructions are described in BA1025N/08/en.
- Please observe all provisions valid for your country and pertaining to the opening and repairing of electrical devices.

1.3 Operational safety

Hazardous areas

Measuring systems for use in hazardous environments are accompanied by separate "Ex documentation", which is an integral part of this Operating Manual. Strict compliance with the installation instructions and ratings as stated in this supplementary documentation is mandatory.

- Ensure that all personnel are suitably qualified.
- Observe the specifications in the certificate as well as national and local regulations.

FCC approval

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Caution!



Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

1.4 Return

The following procedures must be carried out before the NMT539 is sent to Endress+Hauser for repair:

- Always enclose a duly completed "Declaration of Contamination" form. Only then can Endress+Hauser transport, examine and repair a returned device.
- Enclose special handling instructions if necessary, for example, safety data sheet as per EN 91/155/EEC.
- Remove all residue which may be present. Pay special attention to the gasket grooves and crevices where fluid may be present. This is especially important if the fluid is dangerous to health, e.g. corrosive, poisonous, carcinogenic, radioactive, etc.

Note!



A copy of the "**Declaration of Contamination**" is included at the end of this operating manual.

Caution!



- No instrument should be sent back for repair without all dangerous material being completely removed first, e.g. in scratches or diffused through plastic.
- Incomplete cleaning of the instrument may result in waste disposal or cause harm to personnel (burns, etc.). Any costs arising from this will be charged to the operator of the instrument.

1.5 Disposal

In case of disposal, please separate the different components according to their material consistency.

1.6 Software history

| Software version | Changes to Software | Associated documentation |
|------------------|--|---|
| V 01.01.00 | Original software. – | BA025N (Installation Instructions) BA026N (Operating Instructions and Description of Instrument Functions) |
| V 01.45.00 | Access Code 164 sets default to UK element spacing, Cu90, and multi-element. | BA025N/08/en/04.06 (Installation Instructions) BA026N/08/en/04.06 (Operating Instructions and Description of Instrument Functions) |




1.7 Contact addresses of Endress+Hauser

The addresses of Endress+Hauser are given on the back cover of this operating manual. If you have any questions, please do not hesitate to contact your E+H representative.



1.8 Notes on safety conventions and symbols

In order to highlight safety-relevant or alternative operating procedures in the manual, the following conventions have been used, each indicated by a corresponding symbol in the margin.






Safety conventions

| Symbol | Meaning |
|---|---|
|  | Warning! A warning highlights actions or procedures which, if not performed correctly, will lead to personal injury, a safety hazard or destruction of the instrument |
|  | Caution! Caution highlights actions or procedures which, if not performed correctly, may lead to personal injury or incorrect functioning of the instrument |
|  | Note! A note highlights actions or procedures which, if not performed correctly, may indirectly affect operation or may lead to an instrument response which is not planned |

Explosion protection

| | |
|---|---|
|  | Device certified for use in explosion hazardous area If the device has this symbol embossed on its name plate, it can be installed in an explosion hazardous area |
|  | Explosion hazardous areas Symbol used in drawings to indicate explosion hazardous areas. – Devices located in and wiring entering areas with the designation “explosion hazardous areas” must conform with the stated type of protection |
|  | Safe area (non-explosion hazardous area) Symbol used in drawings to indicate, if necessary, non-explosion hazardous areas. – Devices located in safe areas still require a certificate if their outputs run into explosion hazardous areas |

Electrical symbols

| | |
|---|---|
|  | Direct voltage A terminal to which or from which a direct current or voltage may be applied or supplied |
|  | Alternating voltage A terminal to which or from which an alternating (sine-wave) current or voltage may be applied or supplied |
|  | Grounded terminal A grounded terminal, which as far as the operator is concerned, is already grounded by means of an earth grounding system |
|  | Protective grounding (earth) terminal A terminal which must be connected to earth ground prior to making any other connection to the equipment |
|  | Equipotential connection (earth bonding) A connection made to the plant grounding system which may be of type e.g. neutral star or equipotential line according to national or company practice |

Ordering structure NMT539

8

Endress+Hauser

2.2 Scope of delivery



Caution!

It is essential to follow the instructions concerning the unpacking, transport and storage of measuring instruments given in the chapter, Incoming acceptance, transport and storage.

The scope of delivery consists of:

- Assembled instrument
- Accessories

Accompanying documentation:

- Installation manual
- Operation and Description of Instrument Functions
- Approval documentation: if this is not included in the operating manual.

2.3 Certificates and approvals

CE mark, declaration of conformity

The instrument is designed to meet state-of-the-art safety requirements, has been tested and left the factory in a condition in which it is safe to operate. The instrument complies with the applicable standards and regulations in accordance with EN 61010 "Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures." The instrument described in this manual thus complies with the statutory requirements of the EG directives. Endress+Hauser confirms the successful testing of the instrument by affixing to it the CE mark.

2.4 Registered trademarks

HART[®]

Registered trademark of HART Communication Foundation, Austin, USA

ToF[®]

Registered trademark of the company Endress+Hauser GmbH+Co. KG, Maulburg, Germany

2.5 Incoming acceptance, transport, storage

2.5.1 Incoming acceptance

Check the packing and contents for any signs of damage.

Check the shipment, make sure nothing is missing and that the scope of supply matches your order.

2.5.2 Transport

Caution!



Follow the safety instructions and transport conditions for instruments of more than 18 kg.

2.5.3 Storage

Pack the measuring instrument so that it is protected against impacts from storage and transport.

The original packing material provides the optimum protection for this.

The permissible storage temperature is -40 °C...+85 °C (-40 °F...+185 °F).

3 Initial set up

3.1 Local HART connection

3.1.1 As an Endress+Hauser tank gauging instrument

The NMT539 has been developed and designated primarily to work with the Endress+Hauser tank gauging host instruments Tank Side Monitor NRF590 or Proservo NMS5/7. Both temperature and / or water bottom information are transmitted on a two wire i.s HART loop to the host instrument. Since both the NRF590 and NMS5/7 have a pre-configured menu for NMT series functionality as default, simple wiring to the NMT539 will complete the initial setup for the NMT539.

Note!



Please refer to the Installation manual BA025N/08/en for the NMT539 physical installation procedure prior to start up.

3.1.2 As a standalone generic HART instrument

The NMT539 is a HART foundation registered intrinsically safe loop powered device. The NMT539 provides four basic types of data as standard and parameter information via HART protocol, command 3. Configuration to host communication can be performed by a HC (Hand Communicator) or the Endress+Hauser ToF field service tool to set a specific HART address.

Note!



The availability of each of the four parameter can vary depending on the selected NMT539 measurement function on the product code.

Temperature measurement

20: Measurement function

0: Converter only

1: Temperature + converter

These four basic data are available as standard.

1. Average liquid temperature
2. Average gas phase temperature
3. Level (entered liquid level at "VH02 measured distance")
4. Device status

Water Bottom (WB) measurement

20: Measurement function

2: Water bottom + converter

These four basic data are available as standard.

1. Water bottom level
2. WB probe capacitance
3. WB probe frequency
4. Device status

Temperature + water bottom + converter

20: Measurement function

3: Temperature + water bottom + converter

These four basic data are available as standard.

1. Average liquid temperature
2. Water bottom level
3. Average gas phase temperature
4. Device status

3.2 Device set up: Tank Side Monitor NRF590

Connect the loop powered HART communication cable from the NRF590 (intrinsically safe side compartment) to the NMT539 according to BA025 "Installation Instructions."

Since the Tank Side Monitor NRF590 has been designed to recognize the NMT539 as a specific Endress+Hauser HART instrument, set up is easy.

3.2.1 HART scanner

After the physical cabling between the NMT539 and the NRF590 is complete, scan all connected loop powered HART devices by activating "HART SCAN" on the Tank Side Monitor.

Caution!



Not all Tank Side Monitor NRF590 have fully accessible compatibility to recognize the NMT539. Consult with your Endress+Hauser representative to cross check the software and hardware version of the NRF590.

3.2.2 The NMT539 specific parameter set up on the NRF590

Note!



Configuration of NMT539 parameters on the display of the NRF590 is dependent on the installed software and hardware version of the NRF590. Please refer to the operating manual of the Tank Side Monitor NRF590 to determine accessible parameters.

All required initial setup and configuration can be performed by the ToF field service tool. Detailed information will be described in the following operation related chapters.

3.3 Device set up: Proservo NMS5/7

The Proservo NMS5/7 is also specifically designed to recognize the NMT539. Connect local HART cabling between the NMT539 and the NMS5/7 on terminals 24 and 25.

Caution!



Depending on the required certification of the connected NMS5/7, the terminal arrangement of 24 and 25 may have legal consequences. Confirm the order code of the NMS5/7 to clarify the intrinsically safe designation on terminals 24 and 25.

3.3.1 Preparation of Proservo NMS5/7

The Proservo NMS5/7 must be pre-configured to accept the NMT539 connection via the multi drop HART loop.

GVH362: NMT connection

"Average Temp." must be selected in order to configure the NMT539.

Caution!



To change this parameter, an access code is required. Please refer to the BA006 NMS5/7 operation manual for further information.

3.3.2 NMT539 configuration on Proservo NMS5/7

Most required NMT539 parameters can be configured on G4 "Temperature" matrix as it is on the display of the NMS5/7.

Caution!



Water Bottom (WB) sensor information is not available on the Proservo before ROM version 4.24. Please consult with your Endress+Hauser representative to update the installed Proservo function.

Typical NMT539 parameters (equivalent to the NMT 535 and 538) are displayed on the matrix of the Proservo NMS5/7

G0 Static matrix

GVH010: Liquid Temp

Calculated average liquid temperature value, determined by the NMT539

GVH013: Gas Temperature

Calculated average gas phase temperature value, determined by the NMT539

G4 Dynamic Matrix: Temperature

GVH440: Liquid Temp

The same value indicated on GVH010 Liquid Temp

GVH441: Gas Temperature

The same value indicated on GVH013 Gas Temperature

GVH442: Measured Level

Liquid level value established in the Proservo NMS5/7. The NMT539 must have liquid level data in order to calculate both liquid and gas phase average temperature.

GVH447: Reference Zero

Indication of the converted 100 Ohm reference resistor deviation value compares to the actual inserted element value in the temperature probe. The reading value of reference resistor and its deviation are continuously monitored during operation to prevent from performing an incorrect calculation. Indicated tolerance should be within $\pm 0.15^{\circ}\text{C}$ ($\pm 0.27^{\circ}\text{F}$) depending on element characteristics, e.g. Pt100 elements have 100 Ohm resistance at 0°C (32°F); therefore, the reading value should be within $0^{\circ}\text{C} \pm 0.15^{\circ}\text{C}$ ($32^{\circ}\text{F} \pm 0.27^{\circ}\text{F}$) or less.

GVH449: Reference 150

Indication of the converted 200 Ohm reference resistor deviation value compares to the actual inserted element value in the temperature probe. The reading value of reference resistor and its deviation are continuously monitored during operation to prevent from performing an incorrect calculation. Indicated tolerance should be within $\pm 0.15^{\circ}\text{C}$ ($\pm 0.27^{\circ}\text{F}$) depending on element characteristics.

GVH450~459; Temp No.1~10

The temperature reading value from each inserted element in the probe. The reading element temperature above 11~16 must be selected at the GVH470 "Select Point", then the read value at the GVH473 "Element Temp."

GVH460~49; Element Position No.1~10

Each element position in the probe. Indicating element position above 11~16 must be selected at the GVH470 "Select Point", then the read position at GVH474 "Element Position"

GVH470: Select Point

A matrix to select the desired element data on GVH471 "Zero Adjust", GVH473 "Element Temp" and GVH474 "Element Position."

GVH480: Diagnostic

Display of error code message. Please refer to the error code chart in a later chapter of this manual.

GVH482: Total No. Element

Enter the number of installed temperature elements in the average temperature probe.

GVH485: Type of Interval

Select type of element interval.

Even: Element spacing will be equally spaced by providing the distance at GVH487 "Element Interval", and the lowest element position can be set at GVH486 "Bottom Point."

Not Even: Element spacing will be unequally distributed. As a result, each element position must be manually entered.

Note!

This parameter setting is only used to change the theoretical element position within NMT539's software for average calculation purposes. It does not effect the physical location of the temperature element position.

GVH486:Bottom Point

The lowest inserted element position in the average temperature probe.

Note!

This parameter setting is only used to change the theoretical element position within NMT539's software for average calculation purposes. It does not effect the physical location of the temperature element position.

GVH487:Element Interval

Enter the desired element interval when "Even" in GVH485 "Type of Interval" is selected.

Note!

This parameter setting is only used to change the theoretical element position within NMT539's software for average calculation purposes. It does not effect the physical location of the temperature element position.

4 Operation and Description of Instrument Function

NMT539 has segmented HART device code depending on measurement function. Following 4 HART device codes are normally pre-set at the Sakura factory by jumper setting.

Caution!



Do not attempt to change jumper setting by disassembling NMT539's internal module. It may cause major malfunction due to distorted precise factory calibration.

4.0.1 HART Device designation

HART device code "183":

Designated device code when NMT539 is connected to older version Proservo NMS5/7 (software version 4.24 or older). NMT539 will be recognized just like a previous NMT series NMT 535 / 538. As a result only temperature related function will be activated within the system. No WB sensor equipped version NMT539 is available with code 183.

HART device code "184":

Device code for temperature measurement function only. Similar to code 183, but this 184 is specifically designed for NMT539 converter only version and converter + temperature version. No WB sensor is available with code 184.

HART device code "185":

Device code 185 has very segmented function due to its purpose. No temperature measurement function is available. Designation to be a single minded water I/F measurement sensor.

HART device code "186":

Device code for fully equipped NMT539. Both temperature and Water Bottom measurement function is available.

4.0.2 Device Data

Tag Number: read and write

Default: HART

A customer specific device identification and control number (or name). Tank name, site number, or any other ID can be entered.

Assembly Number: read and write

Default: 0

Manufacture control number based on production process.

4.1 Temperature measurement

These 2 HART device codes "183 and 184" are designated to perform only temperature measurement function. Available parameter and function are follows. Description of these parameters are the information based on ToF tool menu.



Note!

HART device code will be only visible when default header position or VH99 "Device Type Code" on ToF tool menu is available.

Designated temperature measurement function device is available on following product order code.

20:Measuring Function

0:Converter Only

1:Converter + temperature

4:Converter + temperature (W&M certification)

4.1.1 Primary values: VH00 ~ VH09

VH00 Liquid Temp

Item type:read only

Range:-200°C ~ 240°C



Note!

Display of measured liquid phase average temperature. Liquid level input must be provided by Micropilot radar level gauge (via Tank Side Monitor) or Proservo NMS5/7 series servo level gauge in order to calculate true liquid average temperature.

VH01 Gas Temp

Item type:read only

Range:-200°C ~ 240°C

Display of measured gas (vapor) phase average temperature.



Note!

Display of measured gas (vapor) phase average temperature. Liquid level input must be provided by Micropilot radar level gauge (via Tank Side Monitor) or Proservo NMS5/7 series servo level gauge in order to calculate true gas average temperature.

VH02 Measured Distance

Item type:read and write

Range:0mm ~ 99999mm

Display of provided liquid level by connected level gauge. Manual level input, directly entering desired level value, is also available for the device test purpose.

VH07 Temperature 0

Item type:read only

Display of converted 100 Ohm reference resistor deviation value compares to actual inserted element value in temperature probe. The reading value of reference resistor and its deviation are continuously monitored during operation to prevent from performing an incorrect calculation.

Caution!



Indicated tolerance should be within $\pm 0.15^{\circ}\text{C}$ ($\pm 0.27^{\circ}\text{F}$) depending on element characteristics, e.g. Pt100 element has 100 Ohm resistance at 0°C (32°F); therefore, the reading value should be within $0^{\circ}\text{C} \pm 0.15^{\circ}\text{C}$ ($32^{\circ}\text{F} \pm 0.27^{\circ}\text{F}$) or less.

VH09 Temperature 17

Item type:read only

Display of the converted 200 Ohm reference resistor deviation value compares to the actual inserted element value in the temperature probe. The reading value of reference resistor and its deviation are continuously monitored during operation to prevent from performing an incorrect calculation. Indicated tolerance should be within $\pm 0.15^{\circ}\text{C}$ ($\pm 0.27^{\circ}\text{F}$) depending on element characteristics.

4.1.2 Element Temperature 1: VH10 ~ VH19

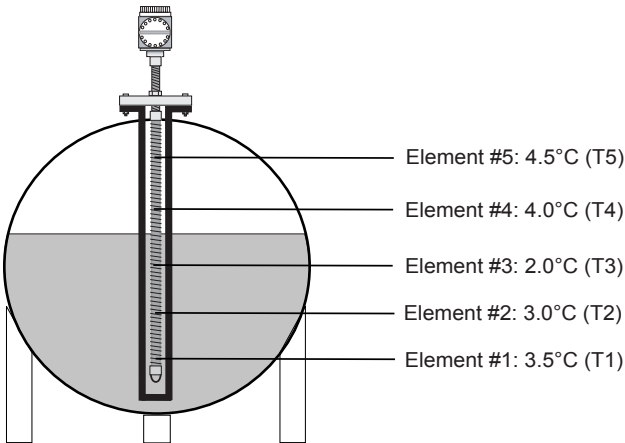
VH10 ~ 19 Temperature 1 ~ 10
Item type:read only
Range:-200°C ~ 240°C
Display of individual measured element temperature.

4.1.3 Element Temperature 2: VH20 ~ VH29

VH20 ~ 25 Temperature 11 ~ 16
Item type:read only
Range:-200°C ~ 240°C
Display of individual element temperature.

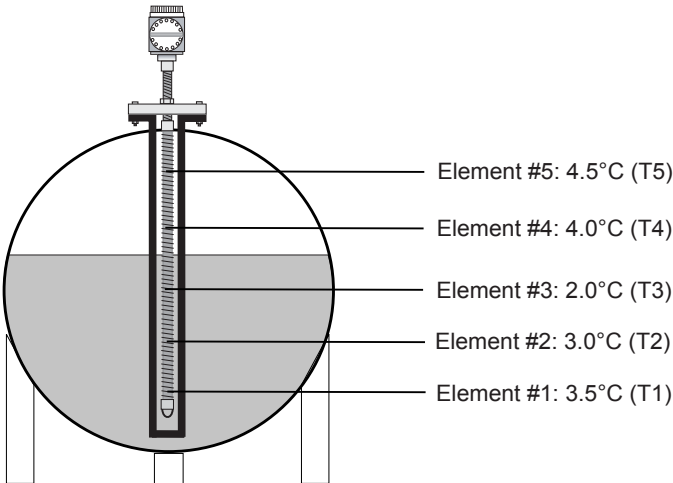
VH26 Selec. Ave Method
Item type:select
Selection:Standard, Advanced
Selection of average calculation method.

Standard: A Conventional calculation method. Regardless of tank shape, average temperature calculation will be performed based on following example (example: liquid temperature).



Formula:(T1 + T2 + T3) / # of element in liquid phase
= Average temperature (3.5°C + 3.0°C + 2.0°C) / 3 = 2.83°C

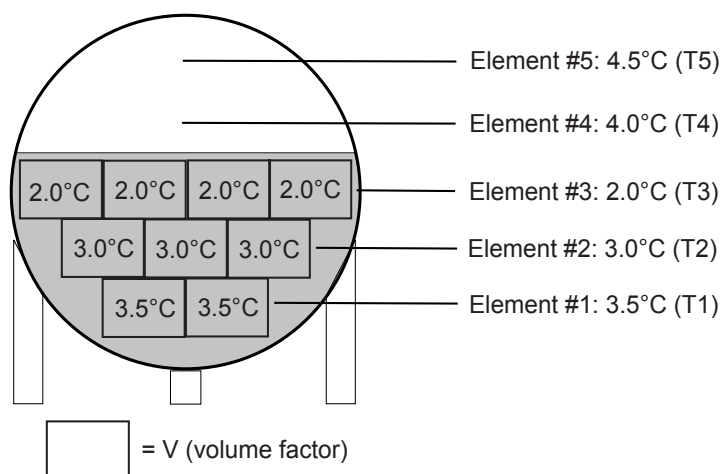
Advanced: Average temperature calculation with additional factor to compensate unequal volume distribution (example: liquid temperature).



Formula: (T1*V1 + T2*V2 + T3*V3) / (V1 + V2 + V3) = Average temperature

Note!

V = # of additional volume factor and related parameters are determined at VH53, 54 and 55.



$$(3.5^{\circ}\text{C} \times 2 + 3.0^{\circ}\text{C} \times 3 + 2.0^{\circ}\text{C} \times 4) / (2 + 3 + 4) = 2.67^{\circ}\text{C}$$

VH27 Multi Spot Type

Item type:select

Selection:Spot, Multi

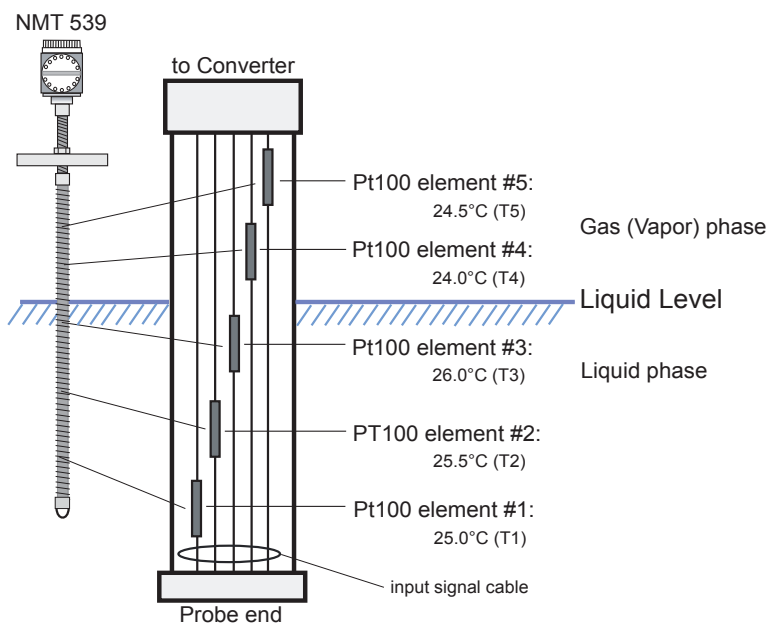
Selection of element physical layout in the probe, mainly NMT539 Converter Only version requires this function when it has connected to foreign average temperature probe.

Caution!

On the contrary, NMT539 Converter + Temperature version always has "Spot" element layout. Selecting parameter to "Multi" will cause faulty calculation.

Spot:

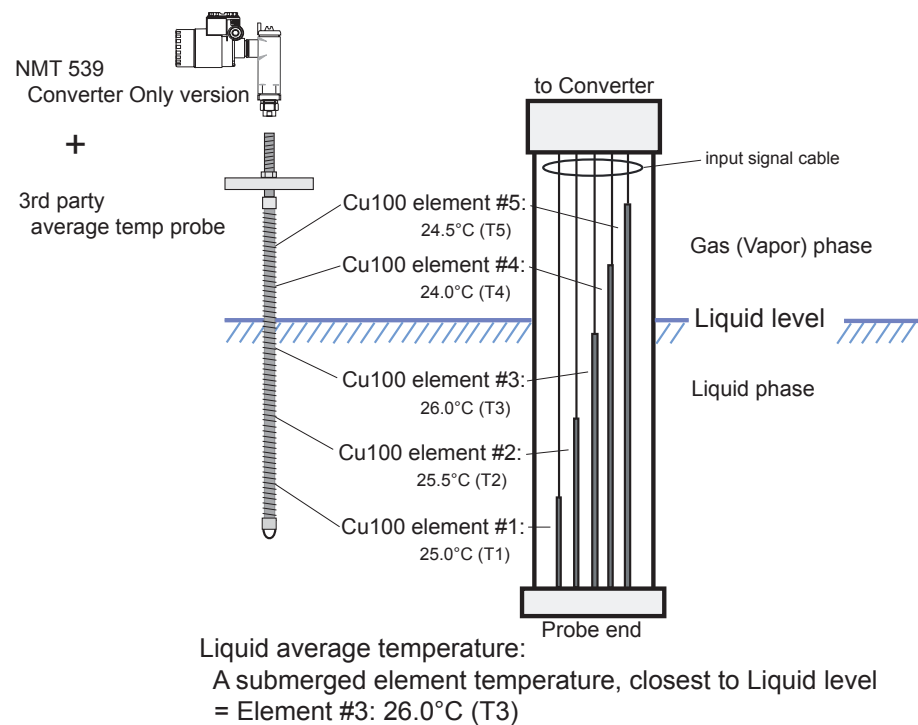
Same number of element (resistance and material) locates in each input cable in the probe. Average calculation is performed based on sum of submerged element temperature value / total number of element submerged.



$$\text{Liquid average temperature} = (T1 + T2 + T3) / 3 = 25.5^{\circ}\text{C}$$

Multi:

Different length or number of element inserted in each input cable. Average temperature is considered as the closest submerged element to the liquid level.

**VH28 Lower Limit**

Item type:read and write

Default value:-20.5°C

RANGE:-999.9°C ~ 999.9°C

Low limit temperature alarm parameter when measurement detects below design and approved temperature.

VH29 Upper Limit

Item type:read and write

Default value:245°C

Range:-999.9°C ~ 999.9°C

Hi limit temperature alarm parameter when measurement detects above design and approved temperature.

4.1.4 Element Position 1: VH30 ~ VH39

VH30 ~VH39 Position 1 ~ 10

Item type:read and write

Range:0mm ~ 99999mm

Individual element position from tank bottom. Calculation is automatically performed when element spacing "Even" is selected at VH85. All of element position must be manually entered when "Not Even" element spacing is selected at VH85.

4.1.5 Element Position 2: VH40 ~ VH49

VH40 ~VH45 Position 11 ~ 16

Item type:read and write

Range:0mm ~ 99999mm

Individual element position from tank bottom. Calculation is automatically performed when element spacing "Even" is selected at VH85. All of element position must be manually entered when "Not Even" element spacing is selected at VH85.

VH46 Hysterese Width

Item type:read and write

Default:10mm

Range:0mm ~ 99999mm

Element switching point hysteresis. Entered hysteresis as a offset value is added on the liquid level when the liquid level is raising, subtracted when lowering to prevent from hunching by unstable liquid surface condition.

VH47 Clear Memory

Item type:select

Default:None (0)

Selection:None, Clear

Reset matrix parameter to default setting.

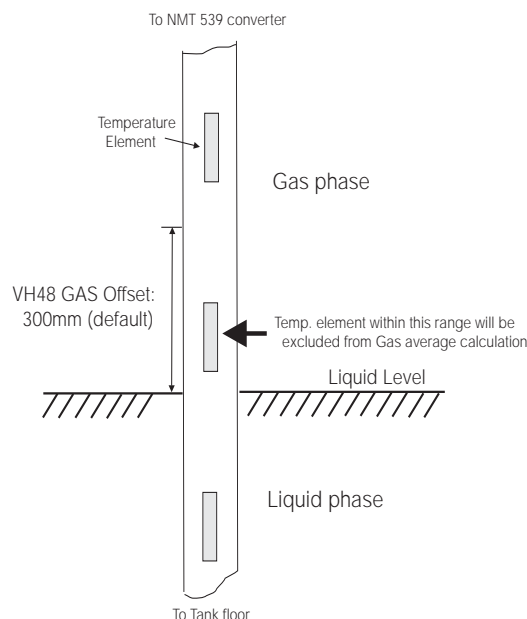
VH48 Gas Offset

Item type:read and write

Default:300mm

Range:0mm ~ 99999mm

A function to exclude specific element(s) from gas (vapor) phase average temperature calculation when element(s) stay within entered value from given liquid level.



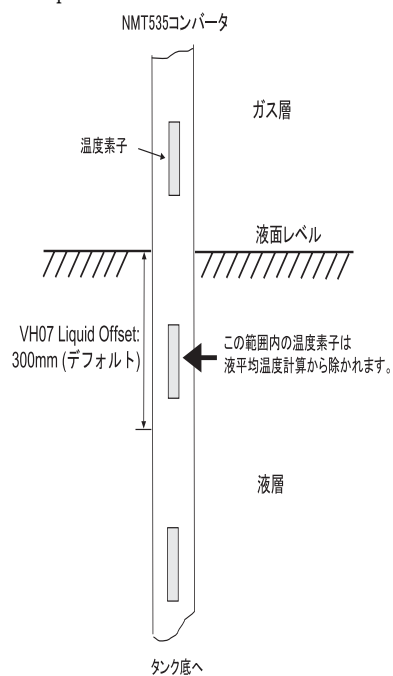
VH49 Liquid Offset

Item type:read and write

Default:300mm

Range:0mm ~ 99999mm

A function to exclude element (s) from liquid phase average temperature calculation when element (s) stays within entered value from given liquid level.



4.1.6 WB primary and Advanced temp: VH50 ~ VH59

VH53 Element Point

Item type:select

Default:0

Selection:0 ~ 15 (element #1 = 0, element #16 = 15)

Select element number for "Advanced" average calculation at VH26. Selected element position will be displayed on VH54 "Element Position" and enable to change additional volume factor at VH55 "Element Volume."

VH54 Element Position

Item type:read only

Range:0m ~ 99999mm

A display of selected element position on VH53.

VH55 Element Volume

Item type:read and write

Range:1 ~ 99999.9

Setting additional factor on selected element at VH53. Extra volume can be added on specific element for advanced average temperature calculation. (Details, please refer to the description of VH26 "Select Average Method" on page 18)

4.1.7 WB Adjustment and Operation Power: VH60 ~ VH69

VH67 Common Voltage

Item type:read only

Range:0 ~ 255 (0 ~ 3V)

A display of temperature element line (both signal and common) running voltage. Detected voltage across common line (shall be between 0 ~ 3V) is converted to range of 0 ~ 255 count when it is displayed.

VH68 Output Current

Item type:read and write

Default:16000 at 6mA

Range:0 ~ 65535

Adjustment of NMT539 current consumption. In order to prevent current over shoot within multidrop HART loop, this function limits the NMT539 power consumption based on set parameter. Normally, NMT539 with temperature measurement function is operated within 6mA of current consumption. Use a tester to check the current flow in the loop. Reducing the value makes NMT539 to consume smaller current.

VH69 Ref Voltage

Item type:read and write

Default:200

Range:0 ~ 255

A parameter to draw power supply failure alarm. NMT539 operates at minimum 16VDC of supply voltage via multi drop HART loop under normal operating condition. NMT539 will transmits error message when supply voltage drops below 16VDC with default value setting 200.

4.1.8 Temperature Adjustment: VH70 ~ VH79

VH70 Element Select

Item type:select

Range:0 ~ 19

Selection of "need adjustment" temperature element (0 = #1 element, 15 = #16 element, 19 = reference 100 Ohm resistor). Detailed value and parameter of the element selected in this matrix can be shown in,

VH71 "Zero Adjust"

VH73 "Temperature X"

VH74 "Position X"

VH75 "Resistance X"

VH76 "Resistance Adj"

VH71 Zero Adjust

Item type:read and write

Default:0

Range:-1000.0 ~ 1000.0

Zero adjustment of individual element that is selected at VH70. The reading value can be adjusted when the measured temperature indicates minor offset value compare to precision reference thermometer.



Note!

Selected element #2 indicates 25.4°C, then reference thermometer indicates 25.2°C, then set "-0.2" in this matrix. #2 element now has constant artificial -0.2°C offset based on raw measurement.

VH72 Adjust Span

Item type:read and write

Default:1

Range:0.8 ~ 1.2

The span adjustment that applies to all of installed temperature element. A linearized factor of given parameter is multiplied to raw element measurement for final calculation.



Note!

All of displayed individual temperature value are calculated based on following formula.

VH73: "Temperature X" = raw element temperature x span (VH72) + zero offset (VH71)

VH73 Temperature X

Item type:read only

Specified element temperature selected at VH70. Shown value is also indicated at individual element temperature at VH10 ~ VH25. The value is calculated based on formula indicated on above VH72.

VH74 Position X

Item type:read and write

Range:0mm ~ 99999mm

A position of specified element at VH70. Each element positions are also determined when "Not Even" element spacing is selected at VH85.

VH75 Resistance X

Item type:read only

A display of specified element resistance selected at VH70.

VH76 Resistance Adj.

Item type:read and write

Default: 0

Range:-1000.0 ~ 1000.0

Adjustment of specified element resistance at VH70. Minor resistance adjustment can be applied on the reading value.

**Note!**

Selected element #5 indicates 100.3 Ohm, then reference precision resistor indicates 100.0 Ohm at the same environmental condition, then set "-0.3" in this matrix. #5 element now has constant artificial -0.3°C offset resistance based on raw measurement.

VH77 Element Type

Item type:select

Selection:Pt100, Cu90, Cu100, PtCu100, JPt100

A selection of element conversion formula when foreign average temperature probe is connected to NMT539 Converter Only version.

**Caution!**

NMT539 Converter + Temperature version always consists "Pt100" element with "Spot" element layout. Do not attempt to change these parameters.

**Element conversion
Formula:**

Pt100 (formula above 0°C): $R = -0.580195 \times 10^{-4} \times T^2 + 0.390802 \times T + 100$

Pt100 (formula below 0°C): $R = -4.2735 \times 10^{-10} \times T^4 + 4.273 \times 10^{-8} \times T^3 - 0.58019 \times 10^{-4} \times T^2 + 3.90802 \times T + 100$

Cu90: $R = 0.3809 \times T + 90.4778$

Cu100: $R = 0.38826 \times T + 90.2935$

PtCu100: $R = 3.3367 \times 10^{-7} \times T^3 - 2.25225 \times 10^{-5} \times T^2 + 0.38416 \times T + 100.17$

JPt100:

VH78 Average Number

Item type:read and write

Default:1

Range;1 ~ 10

Number of sampling for average calculation prior to determine final display value. Increasing number of sampling will prevent from faulty display.

**Caution!**

Additional sampling # will cause slower reaction time on value switch over. Maximum 1 sampling sequence will take approximately 2 sec. {total 21 elements (16 temp elements and 5 integrated reference resistors)}

NH79 Protect Code

Item type:read and write

Default:0

Range:0 ~ 999

Access code 530 to enable select and write command available.

4.1.9 Device setting 1: VH80 ~ VH89

VH80:Present Error

Item type:read only

Display of error message presence. Following code will be indicated.

Error code

0:No error presence
 1:Common line open
 2: undetermined
 3:#1 element open
 4:#1 element short
 5:#2 element open
 6:#2 element short
 7:#3 element open
 8:#3 element short
 9:#4 element open
 10:#4 element short
 11:#5 element open
 12:#5 element short
 13:#6 element open
 14:#6 element short
 15:#7 element open
 16:#7 element short
 17:#8 element open
 18:#8 element short
 19:#9 element open
 20:#9 element short
 21:#10 element open
 22:#10 element short
 23:#0 element over range
 24:Memory defect (ROM)
 25:#11 element open
 26:#11 element short
 27:#12 element open
 28:#12 element short
 29:Element exposed (liquid level below #1 element position)
 30:undetermined
 31:undetermined
 32:Low power supply
 33:#13 element open
 34:#13 element short
 35:#14 element open
 36:#14 element short
 37:#15 element open
 38:#15 element short
 39:#16 element open
 40:#16 element short
 41:Memory defect (RAM)
 42:Memory defect (EEROM)
 43:WB line open
 44:WB line short

VH81 Temperature Unit

Item type:select

Default:°C

Selection:C, F, K

Selection of temperature display unit. Based on universal HART setting, °C(HART code: 32), °F(HART code: 33) and °K(HART code: 35) is available.

Note!



Selection of temperature display unit only applies to reply data from NMT539. Data transmission from host gauge (NRF590 or NMS5/7) to NMT539 must be performed by °C unit only (terminology of HART command 133)

VH82 Element Number

Item type:read and write

Default:10 (NMT539 Converter Only version)

Range:1 ~ 16

Entering # of available temperature element. This function mainly used with NMT539 Converter Only version.

**Caution!**

Do not change the default parameter on NMT539 Converter + Temperature version. # of element on this version is pre-determined by customer's choice. It may cause faulty calculation or unnecessary error display.

VH83 No. of Preambles

Item type:read and write

Default:5

Range:2 ~ 20

Setting # of preamble for HART communication.

VH84 Distance Unit

Item type:select

Default:mm

Selection:ft., m, inch, mm

Selection of level display unit. It applies to both liquid level display on VH02 "Liquid Level" and VH50 "Water Bottom Level." Level units are coded based on universal HART setting, ft. (HART code: 44), m (HART code: 45), inch (HART code: 47), mm (HART code: 49).

VH85 Kind of Interval

Item type:select

Default:Even Interval (NMT539 Converter Only version)

Selection:Even Interval, Not Even

Selection of element interval depending on spacing layout. This function is normally used for NMT539 Converter Only version.

**Caution!**

Do not change its parameter on NMT539 Converter + Temperature version unless repairing. Kind of Interval and individual element positions are physically determined at factory.

VH86 Bottom Point

Item type:read and write

Default:500mm

Range:0mm ~ 99999mm

Position of #1 element that is also called "Bottom Point." #1 element position becomes critically important when "Even Interval" is selected at VH85 because remaining element positions rely on this location of Bottom Point.

VH87 Element Interval

Item type:read and write

Default:1000mm (NMT539 Converter Only version)

Range:0mm ~ 99999mm

Designated to Even Interval spacing.

**Caution!**

Changing element interval, setting element position, these are only applied to reconfigure switching points for average temperature calculation. The physical element position will never be changed!!

VH88 Short Error

Item type:read and write

Default:-49.5

Range:-49.5 ~ 359.5

A type of error message when any of element has short circuit. Method of display can be configured at VH92 "Error Display Select."

VH89 Open Error

Item type:read write

Default:359.9

Range:-49.5 ~ 359.5

A type of error message when any of element has open circuit. Method of display can be configured at VH92 "Error Display Select."

4.1.10 Device setting 2: VH90 ~ VH99

VH90 Device ID Number

Item type:read and write

Default:0

Range:0 ~ 16777214

In order to distinguish own device ID when NMT539 is connected in multi drop HART loop.



Caution!

Changing device ID may lead to communication error because of mismatched pre-registered device ID and HART address.

VH91 Previous Error

Item type:read only

Display of error history. Coded error message will be the same contents as VH80.

VH92 Error Dis. Sel.

Item type:select

Default:0_OFF

Selection:0_OFF, 1_ON

Type of VH88 "Short Error Value" and VH89 "Open Error Value" display selection.

0_OFF:These 2 error messages will not be transmitted to the connected host gauge. This function automatically exclude defected element in average temperature calculation.

1_ON:Error message will be transmitted to the host gauge. As a result, VH88 and 89's numeric error code will be displayed on host gauge default screen and may transmit to upper receiver as well.

VH93 Custody Mode

Item type:select

Default:0_OFF

Selection:0_OFF, 1_ON

A software switch to prohibit over write for Weight and Measure application when 1_ON is selected.



Note!

Hardware over ride protection is located on main CPU board. Set jumper terminal JP1 7-8 will enables no parameter re-configuration available.

VH94 Polling Address

Item type:read and write

Default:2

Range:1 ~ 15

Polling address for HART communication

VH95 Manufacture ID

Item type:read only

Default:17

A manufacture ID within E+H instrumentation.

VH96 Software Version

Item type:read only

A display of installed software version.

VH97 Hardware Version

Item type:read only

A display of recognized hardware version.

VH98 Below Bottom

Item type:select

Default:0_OFF

Selection:0_OFF, 1_ON

A type of error display when liquid level drops below #1 element (Bottom Point). Error code "29" is displayed on VH80 and VH91 when 0_ON is selected.

VH99 Device Type Code

Item type:read only

Device type will be displayed.

- 184:Temperature measurement function only
- 185:WB function only
- 186:Temperature + WB function

4.2 Water Bottom measurement

A HART device codes "185" is designated to perform only water bottom (water interface) measurement function. Available parameter and function are follows. Description of these parameters are the information based on ToF tool menu.

Note!



HART device code will be only visible when default header position or VH99 "Device Type Code" on ToF tool menu is available.

Designated temperature measurement function device based on order structure.
20:Measuring Function
2:Converter + WB

4.2.1 Element Position: VH40 ~ VH49

VH47 Clear Memory

Item type:select
Default:None (0)
Selection:None, Clear
Reset matrix parameter to default setting.

4.2.2 WB primary and Advanced temp: VH50 ~ VH59

VH50 Water Level

Item type:read only
A display of measured water I/F level "Water Bottom."

Note!



Measurement value is calculated based on following formula.

$$\text{VH50} = (\text{VH52}) / (\text{VH63}) \times (\text{VH59}) + (\text{VH58})$$

VH52: measured WB probe frequency
VH63: frequency change / mm
VH59: linear factor of WB probe
VH58: offset value

VH51 Capacitance

Item type:read only
Range:1000mm probe: 10 ~ 1000pF
2000mm probe: 10 ~ 2200pF
3000mm probe: 10 ~ 3000pF
A display of calculated WB probe capacitance based on frequency.

VH52 WB Frequency

Item type:read only
Range:1200Hz ~ 4500Hz
A display of WB probe measured frequency.

VH57 Sel. Water Span

Item type:select
Selection:1000mm, 2000mm, 3000mm
A selection of WB probe length.

Note!



A custom length (TSP) probe shorter than standard 1000mm also can be compatible with selecting 1000mm.

VH58 Offset Water

Item type:read and write

Default:0

Range:-200 ~ +2000

Enable to apply WB level offset on measured value.

Note!

Example, measured WB value is 530mm. Then, hand dip measurement indicates 535mm. Enter -5.000 in VH58 enables reducing entire measurement value -5mm of offset constantly.

VH59 Water Span

Item type:read and write

Default:11

Range:0.1 ~ 99.9

A linearity of WB probe capacitance adjustment. The linear incline can be adjusted in order to compensate minor WB probe characteristic.

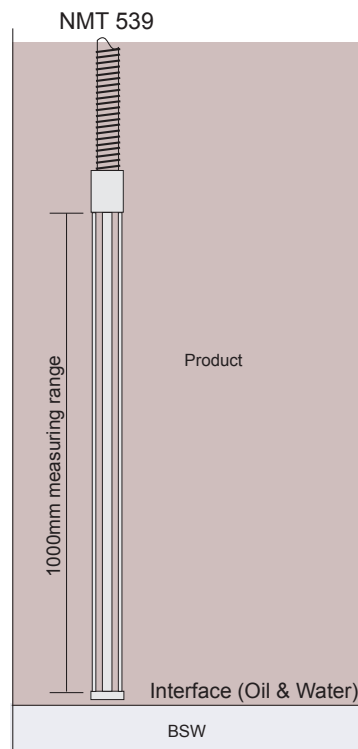
4.2.3 WB Adjustment and Operation Power: VH60 ~ VH69**VH60 Empty Frequency**

Item type:read and write

Default:1200Hz

Range:0Hz ~ 9999Hz

Enter measured frequency (VH52 value) when WB probe is submerged in oil layer (no water touched on NMT539 WB probe).

**Note!**

Default setting (0mm water level = 1200Hz) is established as a factory reference condition. Mark Interface (Oil and Water) level with manual hand dip or any other measuring method performed at "Empty Frequency" when re-calibration is required with actual condition.

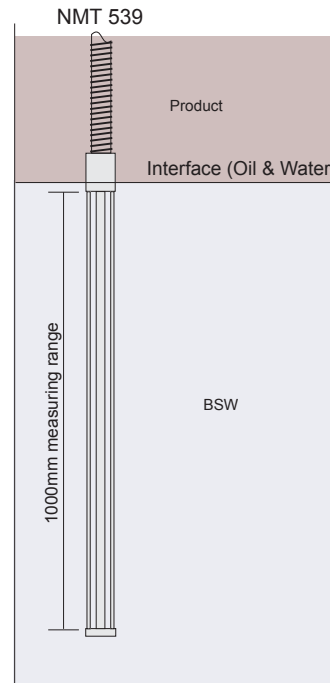
VH61 Full Frequency

Item type:read and write

Default:4500Hz

Range:0 ~ 9999Hz

Enter measured frequency (VH52 value) when WB probe is detecting water I/F least 300mm.

**Note!**

Default setting (1000mm water level = 4500Hz) is established as a factory reference condition. Mark Interface (Oil and Water) level with manual hand dip or any other measuring method performed at "Full Frequency" when re-calibration is required with actual condition.

VH62 Probe Length

Item type:read and write

Default:1000mm or 2000mm

Range:1mm ~ 9999m

Enter the WB probe calibration distance (length). An actual measurement range is determined by the physical probe length. However, available probe length in operating tank might be different from default value for re-calibration at the site.

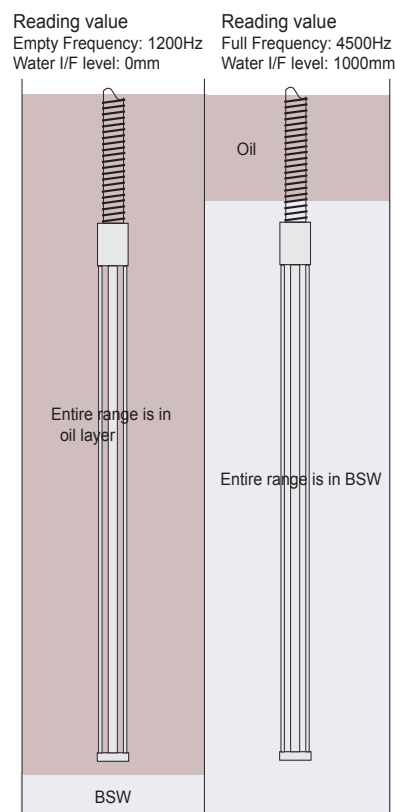
**Note!**

Default setting has 1000mm or 2000mm probe length because of the factory calibration method utilizes absolutely no water (0mm water I/F) condition at VH60 "Empty Frequency", and completely submerged (above 1000mm or 2000mm water I/F) condition at VH61 "Full Frequency" to define probe linearity (VH 63 "Water Factor").

Formula: $(VH61 - VH60) / VH62 = VH63$

Example at factory default:

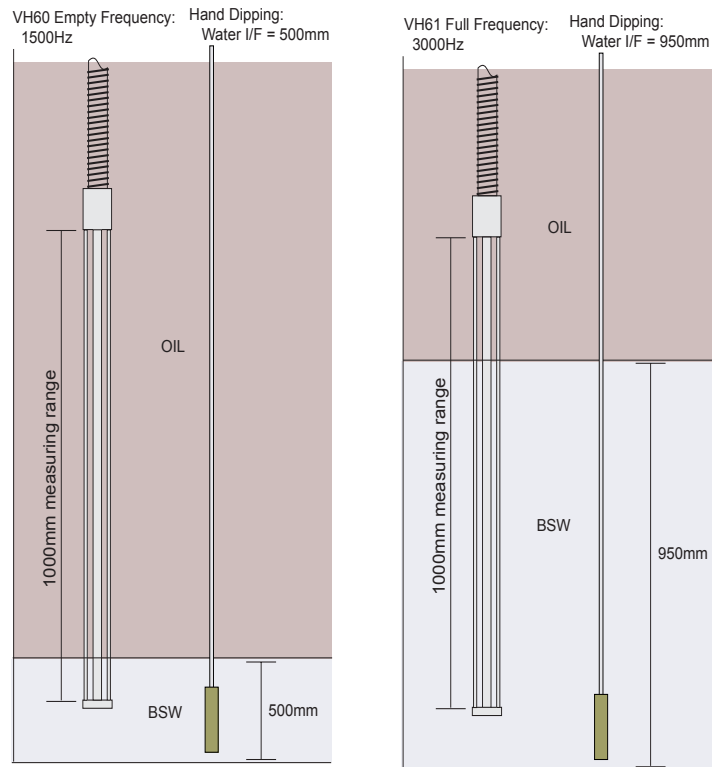
- VH60 = 1200Hz (Water I/F = 0mm)
- VH61 = 4500Hz (Water I/F = 1000mm)
- VH62 = 1000mm
- VH63 = 3.3Hz



$$(4500\text{Hz} - 1200\text{Hz}) / 1000\text{mm} = 3.3\text{Hz} / 1\text{mm}$$

Re-calibration at actual site in operating tank

Performing re-calibration in operating tank will take several process in order to determine actual water I/F by employing auxiliary instrument. After performing manual water I/F dipping at 2 different BSW level, WB probe calibration distance (VH62 Probe Length) can be calculated as follow.



$$950\text{mm} - 500\text{mm} = 450\text{mm}$$

Re-calibrated WB probe linearity in operating tank
 $(3000\text{Hz} - 1500\text{Hz}) / 450 = 3.33\text{Hz} / 1\text{mm}$

- VH60 Empty Frequency: 1500Hz
- VH61 Full Frequency: 3000Hz
- VH62 Probe Length: 450mm
- VH63 Water Factor: 3.33Hz

**Caution!**

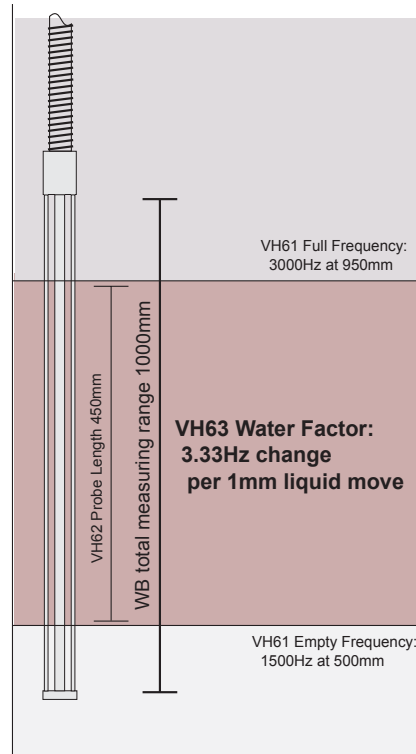
WB probe linearity may differ from default condition to actual in-tank condition. Liquid characteristics (both oil and water), in-tank temperature and other surrounding environment can greatly effect on the probe linearity.

VH63 Water Factor

Item type:read only

A display of WB probe linearity per 1mm liquid movement in Hz (frequency) unit. The calculation is performed based on following formula.

$(\text{VH61 "Full Frequency"} - \text{VH60 "Empty Frequency"}) / \text{VH62 "Probe Length"} = \text{VH63 "Water Factor"}.$

**Note!**

Once, Water Factor is determined by given parameters, actual water I/F measurement is calculated from detected frequency to distance conversion.

VH68 Output Current

Item type:read and write

Default:16000 at 6mA

Range:0 ~ 65535

Adjustment of NMT539 current consumption. In order to prevent current over shoot within multidrop HART loop, this function limits the NMT539 power consumption based on set parameter. Normally, NMT539 with temperature measurement function is operated within 6mA of current consumption. Use a tester to check the current flow in the loop. Reducing the value makes NMT539 to consume smaller current.

VH69 Ref Voltage

Item type:read and write

Default:200

Range:0 ~ 255

A parameter to draw power supply failure alarm. NMT539 operates at minimum 16VDC of supply voltage via multi drop HART loop under normal operating condition. NMT539 will transmits error message when supply voltage drops below 16VDC with default value setting 200.

4.2.4 Temperature Adjustment: VH70 ~ VH79

NH79 Protect Code

Item type:read and write

Default:0

Range:0 ~ 999

Access code 530 to enable select and write command available.

4.2.5 Device setting 1: VH80 ~ VH89

VH80:Present Error

Item type:read only

Display of error message presence. Following code will be indicated.

Error code

0:No error presence

1:Common line open

2: undetermined

3:#1 element open

4:#1 element short

5:#2 element open

6:#2 element short

7:#3 element open

8:#3 element short

9:#4 element open

10:#4 element short

11:#5 element open

12:#5 element short

13:#6 element open

14:#6 element short

15:#7 element open

16:#7 element short

17:#8 element open

18:#8 element short

19:#9 element open

20:#9 element short

21:#10 element open

22:#10 element short

23:#0 element over range

24:Memory defect (ROM)

25:#11 element open

26:#11 element short

27:#12 element open

28:#12 element short

29:Element exposed (liquid level below #1 element position)

30:undetermined

31:undetermined

32:Low power supply

33:#13 element open

34:#13 element short

35:#14 element open

36:#14 element short

37:#15 element open

38:#15 element short

39:#16 element open

40:#16 element short

41:Memory defect (RAM)

42:Memory defect (EEROM)

43:WB line open

44:WB line short

VH83 No. of Preambles

Item type:read and write

Default:5

Range:2 ~ 20

Setting # of preamble for HART communication.

VH84 Distance Unit

Item type:select

Default:mm

Selection:ft., m, inch, mm

Selection of level display unit. It applies to both liquid level display on VH02 "Liquid Level" and VH50 "Water Bottom Level." Level units are coded based on universal HART setting, ft. (HART code: 44), m (HART code: 45), inch (HART code: 47), mm (HART code: 49).

4.2.6 Device setting 2: VH90 ~ VH99

VH90 Device ID Number

Item type:read and write

Default:0

Range:0 ~ 16777214

In order to distinguish own device ID when NMT539 is connected in multi drop HART loop.

Caution!



Changing device ID may lead to communication error because of mismatched pre-registered device ID and HART address.

VH91 Previous Error

Item type:read only

Display of error history. Coded error message will be the same contents as VH80.

VH93 Custody Mode

Item type:select

Default:0_OFF

Selection:0_OFF, 1_ON

A software switch to prohibit over write for Weight and Measure application when 1_ON is selected.

Note!



Hardware over ride protection is located on main CPU board. Set jumper terminal JP1 7-8 will enables no parameter re-configuration available.

VH94 Polling Address

Item type:read and write

Default:2

Range:1 ~ 15

Polling address for HART communication

VH95 Manufacture ID

Item type:read only

Default:17

A manufacture ID within E+H instrumentation.

VH96 Software Version

Item type:read only

A display of installed software version.

VH97 Hardware Version

Item type:read only

A display of recognized hardware version.

VH99 Device Type Code

Item type:read only

Device type will be displayed.

- 184:Temperature measurement function only
- 185:WB function only
- 186:Temperature + WB function

4.3 Temperature + Water Bottom measurement

HART device codes "186" is designated to perform both temperature and Water Bottom function as a fully integrated NMT539. Available parameter and function are follows. Description of these parameters are the information based on ToF tool menu.



Note!

HART device code will be only visible when default header position or VH99 "Device Type Code" on ToF tool menu is available.

Designated temperature and Water Bottom measurement function device is based on following order structure.

20:Measuring Function

3:Converter + temperature + WB

5:Converter + temperature + WB (W&M certification)

4.3.1 Primary values: VH00 ~ VH09

VH00 Liquid Temp

Item type:read only

Range:-200°C ~ 240°C



Note!

Display of measured liquid phase average temperature. Liquid level input must be provided by Micropilot radar level gauge (via Tank Side Monitor) or Proservo NMS5/7 series servo level gauge in order to calculate true liquid average temperature.

VH01 Gas Temp

Item type:read only

Range:-200°C ~ 240°C

Display of measured gas (vapor) phase average temperature.



Note!

Display of measured gas (vapor) phase average temperature. Liquid level input must be provided by Micropilot radar level gauge (via Tank Side Monitor) or Proservo NMS5/7 series servo level gauge in order to calculate true gas average temperature.

VH02 Measured Distance

Item type:read and write

Range:0mm ~ 99999mm

Display of provided liquid level by connected level gauge. Manual level input, directly entering desired level value, is also available for the device test purpose.

VH07 Temperature 0

Item type:read only

Display of converted 100 Ohm reference resistor deviation value compares to the actual inserted element value in the temperature probe. The Reading value of reference resistor and its deviation are continuously monitored during operation to prevent from performing incorrect calculation.



Caution!

Indicated tolerance should be within $\pm 0.15^{\circ}\text{C}$ ($\pm 0.27^{\circ}\text{F}$) depending on element characteristics, e.g. Pt100 elements have 100 Ohm resistance at 0°C (32°F); therefore, the reading value should be within $0^{\circ}\text{C} \pm 0.15^{\circ}\text{C}$ ($32^{\circ}\text{F} \pm 0.27^{\circ}\text{F}$) or less.

VH09 Temperature 17

Item type:read only

Display of the converted 200 Ohm reference resistor deviation value compares to the actual inserted element value in the temperature probe. The reading value of reference resistor and its deviation are continuously monitored during operation to prevent from performing an incorrect calculation. Indicated tolerance should be within $\pm 0.15^{\circ}\text{C}$ ($\pm 0.27^{\circ}\text{F}$) depending on element characteristics. Element Temperature 1: VH10 ~ VH19

VH10 ~ 19 Temperature 1 ~ 10

Item type:read only

Range: -200°C ~ 240°C

Display of individual measured element temperature.

4.3.2 Element Temperature 2: VH20 ~ VH29**VH20 ~ 25 Temperature 11 ~ 16**

Item type:read only

Range: -200°C ~ 240°C

Display of individual element temperature.

VH26 Selec. Ave Method

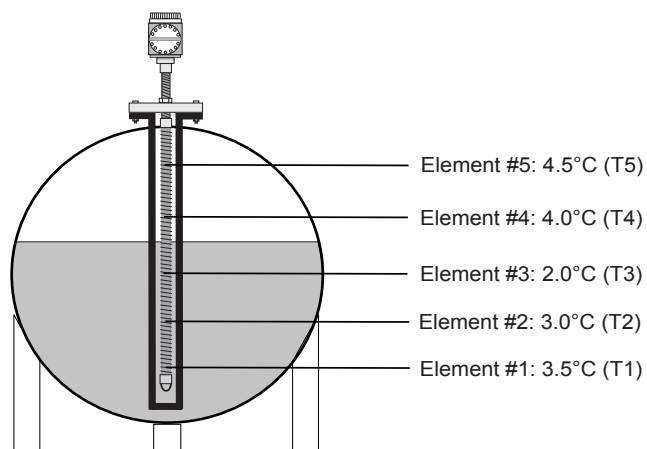
Item type:select

Selection:Standard, Advanced

Selection of average calculation method.

Standard:

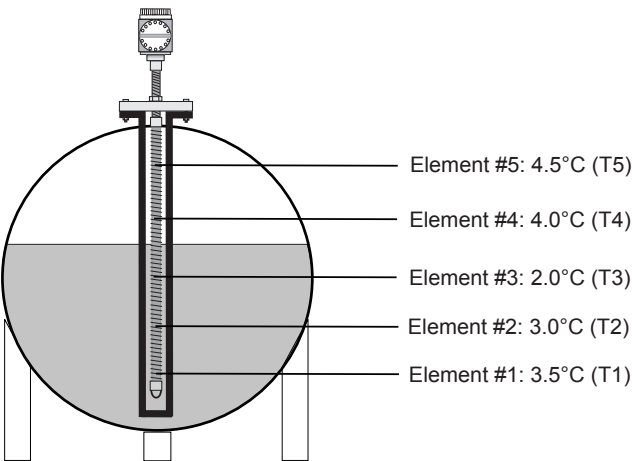
A Conventional calculation method. Regardless of tank shape, average temperature calculation will be performed based on following example (liquid phase).



Formula: $(T1 + T2 + T3) / \# \text{ of element in liquid phase}$
 = Average temperature $(3.5^{\circ}\text{C} + 3.0^{\circ}\text{C} + 2.0^{\circ}\text{C}) / 3 = 2.83^{\circ}\text{C}$

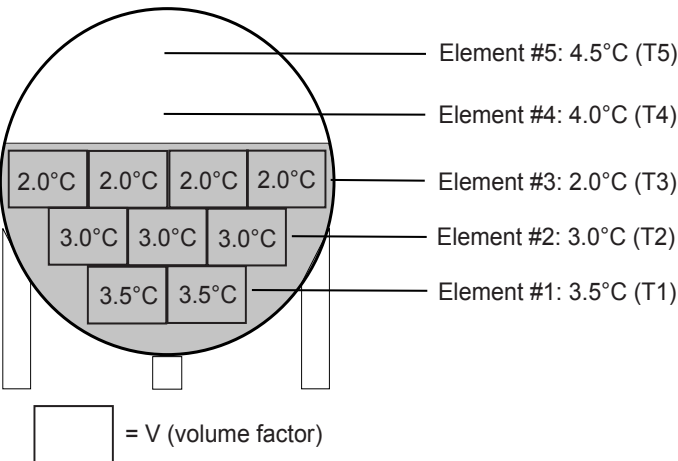
Advanced:

Average temperature calculation with additional factor to compensate unequal volume distribution (liquid phase).



Formula: $(T1 \cdot V1 + T2 \cdot V2 + T3 \cdot V3) / (V1 + V2 + V3) = \text{Average temperature}$

Note!
V = # of additional volume factor that is determined at VH53, 53 and 55



$(3.5^{\circ}\text{C} \times 2 + 3.0^{\circ}\text{C} \times 3 + 2.0^{\circ}\text{C} \times 4) / (2 + 3 + 4) = 2.67^{\circ}\text{C}$

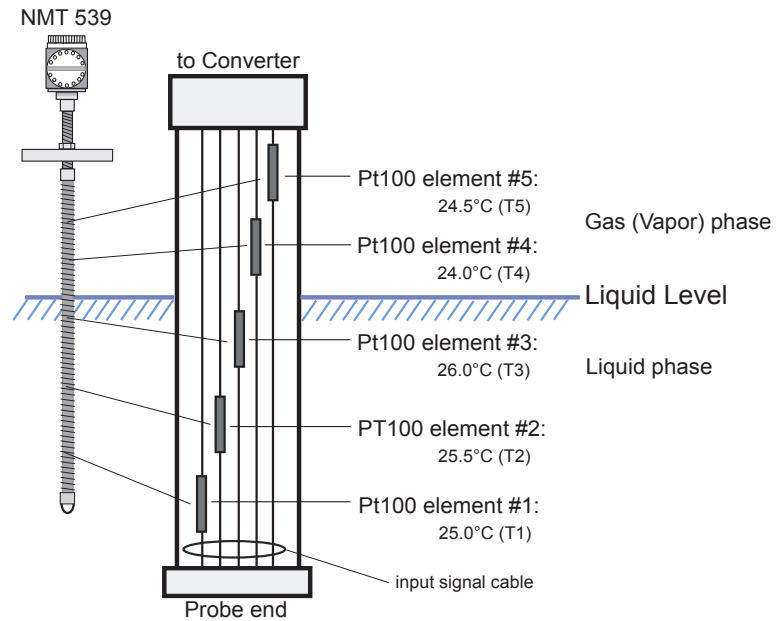
VH27 Multi Spot Type

Item type:select
Selection:Spot, Multi
Selection of element physical layout in the probe, mainly NMT539 Converter Only version requires this function when it has connected to foreign average temperature probe.

Caution!
On the contrary, NMT539 Converter + Temperature version always has "Spot" element layout. Selecting parameter to "Multi" will cause faulty calculation.

Spot:

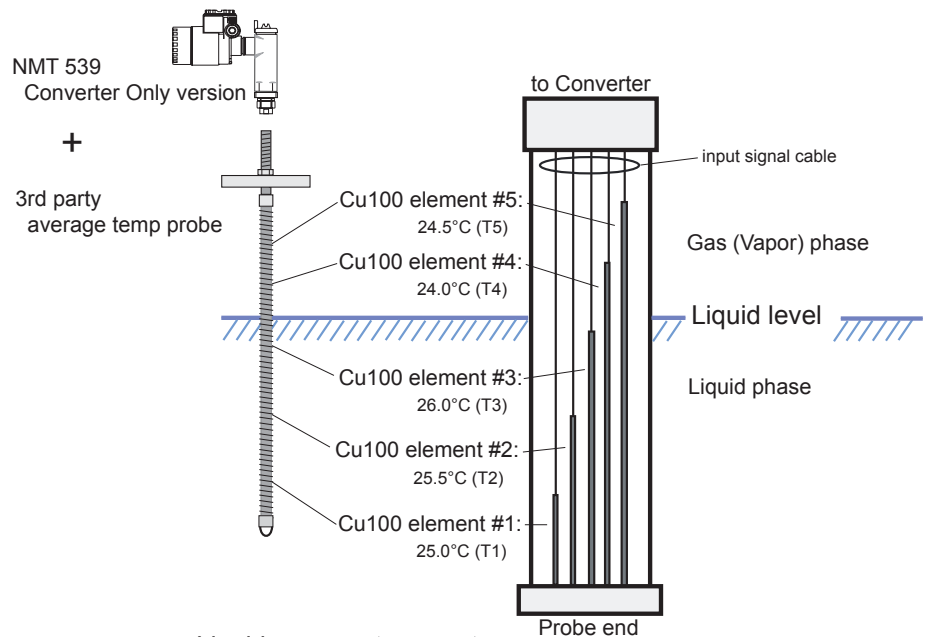
Same number of element (resistance and material) locates in each input cable in the probe. Average calculation is performed based on (sum of submerged element temperature value) / number of element submerged.



$$\text{Liquid average temperature} = (T1 + T2 + T3) / 3 = 25.5^\circ\text{C}$$

Multi:

Different length or number of element inserted in each input cable. Average temperature is considered as the closest submerged element to the liquid level.



Liquid average temperature:
A submerged element temperature, closest to Liquid level
= Element #3: 26.0°C (T3)

VH28 Lower Limit

Item type: read and write

Default value: -20.5°C

RANGE: -999.9°C ~ 999.9°C

Low limit temperature alarm parameter when measurement detects below design and approved temperature.

VH29 Upper Limit

Item type:read and write

Default value:245°C

Range:-999.9°C ~ 999.9°C

Hi limit temperature alarm parameter when measurement detects above design and approved temperature.

4.3.3 Element Position 1: VH30 ~ VH39

VH30 ~VH39 Position 1 ~ 10

Item type:read and write

Range:0mm ~ 99999mm

Individual element position from tank bottom. Calculation is automatically performed when element spacing "Even" is selected at VH85. All of element position must be manually entered when "Not Even" element spacing is selected at VH85.

4.3.4 Element Position 2: VH40 ~ VH49

VH40 ~VH45 Position 11 ~ 16

Item type:read and write

Range:0mm ~ 99999mm

Individual element position from tank bottom. Calculation is automatically performed when element spacing "Even" is selected at VH85. All of element position must be manually entered when "Not Even" element spacing is selected at VH85.

VH46 Hysterese Width

Item type:read and write

Default:10mm

Range:0mm ~ 99999mm

Element switching point hysteresis. Entered hysteresis as a offset value is added on the liquid level when the liquid level is raising, subtracted when lowering to prevent from hunching by unstable liquid surface condition.

VH47 Clear Memory

Item type:select

Default:None (0)

Selection:None, Clear

Reset matrix parameter to default setting.

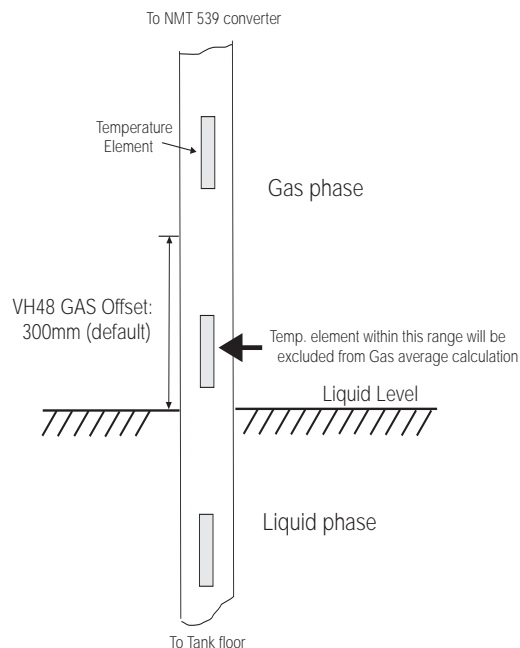
VH48 Gas Offset

Item type:read and write

Default:300mm

Range:0mm ~ 99999mm

A function to exclude specific element(s) from gas (vapor) phase average temperature calculation when element(s) stay within entered value from given liquid level.



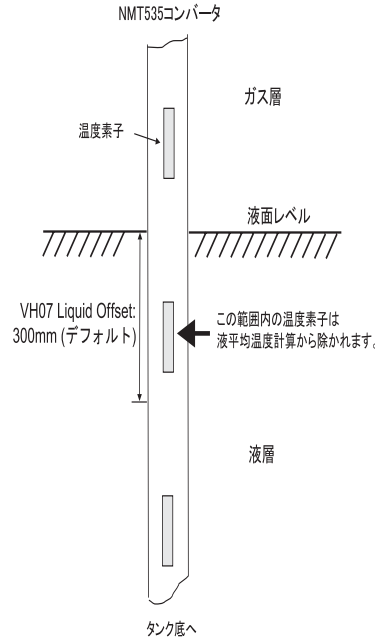
VH49 Liquid Offset

Item type:read and write

Default:300mm

Range:0mm ~ 99999mm

A function to exclude element (s) from liquid phase average temperature calculation when element (s) stays within entered value from given liquid level.

**4.3.5 WB primary and Advanced temp: VH50 ~ VH59****VH50 Water Level**

Item type:read only

A display of measured water I/F level "Water Bottom."

Note!

Measurement value is calculated based on following formula.

$$\text{VH50} = (\text{VH52}) / (\text{VH63}) \times (\text{VH59}) + (\text{VH58})$$

VH52: measured WB probe frequency

VH63: frequency change / mm

VH59: linear factor of WB probe

VH58: offset value

VH51 Capacitance

Item type:read only

Range:1000mm probe: 10 ~ 1000pF

2000mm probe: 10 ~ 2200pF

3000mm probe: 10 ~ 3000pF

A display of calculated WB probe capacitance based on frequency.

VH52 WB Frequency

Item type:read only

Range:1200Hz ~ 4500Hz

A display of WB probe measured frequency.

VH53 Element Point

Item type:select

Default:0

Selection:0 ~ 15 (element #1 = 0, element #16 = 15)

Select element number for "Advanced" average calculation at VH26. Selected element position will be displayed on VH54 "Element Position" and enable to change additional volume factor at VH55 "Element Volume."

VH54 Element Position

Item type:read only

Range:0m ~ 99999mm

A display of selected element position on VH53.

VH55 Element Volume

Item type:read and write

Range:1 ~ 99999.9

Setting additional factor on selected element at VH53. Extra volume can be added on specific element for advanced average temperature calculation. (Details, please refer to the description of VH26 "Select Average Method" on page 18)

VH57 Sel. Water Span

Item type:select

Selection:1000mm, 2000mm, 3000mm

A selection of WB probe length.

Note!

A custom length (TSP) probe shorter than standard 1000mm also can be compatible with selecting 1000mm.

VH58 Offset Water

Item type:read and write

Default:0

Range:-200 ~ +2000

Enable to apply WB level offset on measured value.

Note!

Example, measured WB value is 530mm. Then, hand dip measurement indicates 535mm. Enter - 5.000 in VH58 enables reducing entire measurement value -5mm of offset constantly.

VH59 Water Span

Item type:read and write

Default:11

Range:0.1 ~ 99.9

A linearity of WB probe capacitance adjustment. The linear incline can be adjusted in order to compensate minor WB probe characteristic.

4.3.6 WB Adjustment and Operation Power: VH60 ~ VH69

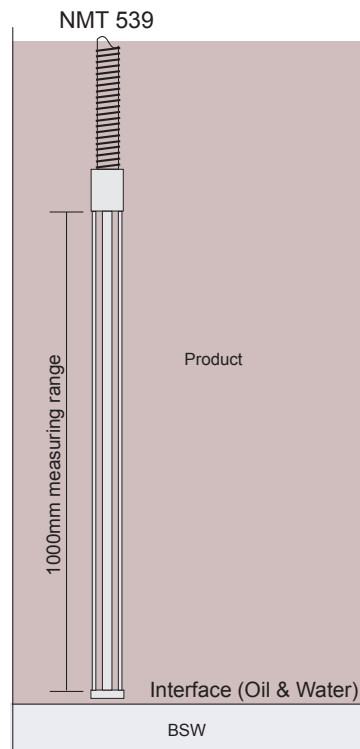
VH60 Empty Frequency

Item type:read and write

Default:1200Hz

Range:0Hz ~ 9999Hz

Enter measured frequency (VH52 value) when WB probe is submerged in oil layer (no water touched on NMT539 WB probe).



Note!



Default setting (0mm water level = 1200Hz) is established as a factory reference condition. Mark Interface (Oil and Water) level with manual hand dip or any other measuring method performed at "Empty Frequency" when re-calibration is required with actual condition.

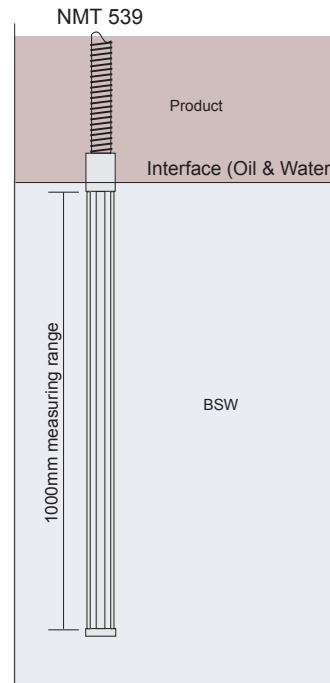
VH61 Full Frequency

Item type:read and write

Default:4500Hz

Range:0 ~ 9999Hz

Enter measured frequency (VH52 value) when WB probe is detecting water I/F least 300mm.

**Note!**

Default setting (1000mm water level = 4500Hz) is established as a factory reference condition. Mark Interface (Oil and Water) level with manual hand dip or any other measuring method performed at "Full Frequency" when re-calibration is required with actual condition.

VH62 Probe Length

Item type: read and write

Default: 1000mm or 2000mm

Range: 1mm ~ 9999m

Enter the WB probe calibration distance (length). An actual measurement range is determined by the physical probe length. However, available probe length in operating tank might be different from default value for re-calibration at the site.

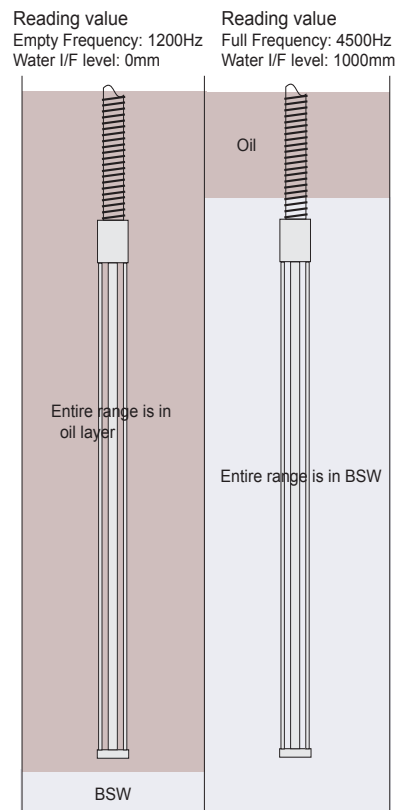
**Note!**

Default setting has 1000mm or 2000mm probe length because of the factory calibration method utilizes absolutely no water (0mm water I/F) condition at VH60 "Empty Frequency", and completely submerged (above 1000mm or 2000mm water I/F) condition at VH61 "Full Frequency" to define probe linearity (VH 63 "Water Factor").

Formula: $(VH61 - VH60) / VH62 = VH63$

Example at factory default:

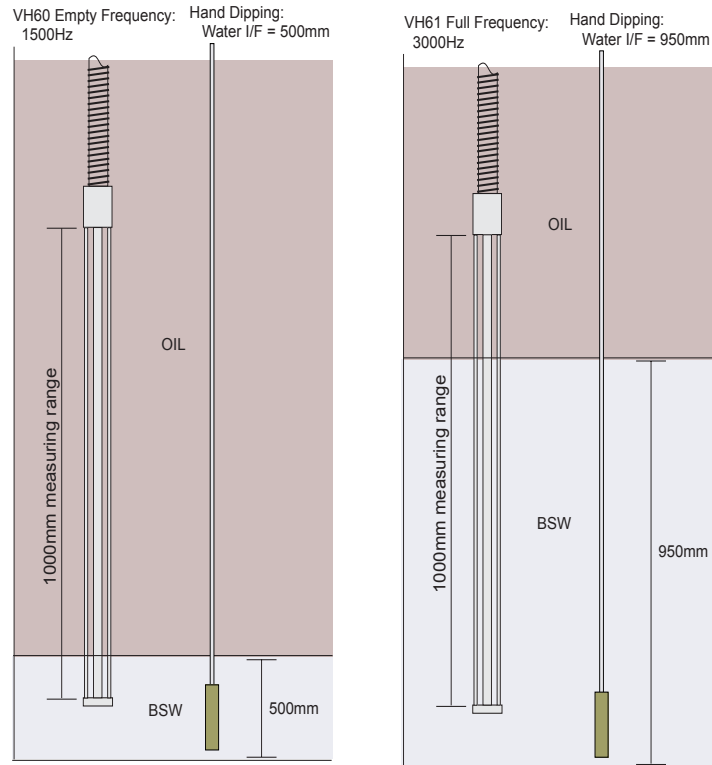
- VH60 = 1200Hz (Water I/F = 0mm)
- VH61 = 4500Hz (Water I/F = 1000mm)
- VH62 = 1000mm
- VH63 = 3.3Hz



$$(4500\text{Hz} - 1200\text{Hz}) / 1000\text{mm} = 3.3\text{Hz} / 1\text{mm}$$

Re-calibration at actual site in operating tank

Performing re-calibration in operating tank will take several process in order to determine actual water I/F by employing auxiliary instrument. After performing manual water I/F dipping at 2 different BSW level, WB probe calibration distance (VH62 Probe Length) can be calculated as follow.



$$950\text{mm} - 500\text{mm} = 450\text{mm}$$

Re-calibrated WB probe linearity in operating tank
 $(3000\text{Hz} - 1500\text{Hz}) / 450 = 3.33\text{Hz} / 1\text{mm}$

- VH60 Empty Frequency: 1500Hz
- VH61 Full Frequency: 3000Hz
- VH62 Probe Length: 450mm
- VH63 Water Factor: 3.33Hz

Caution!

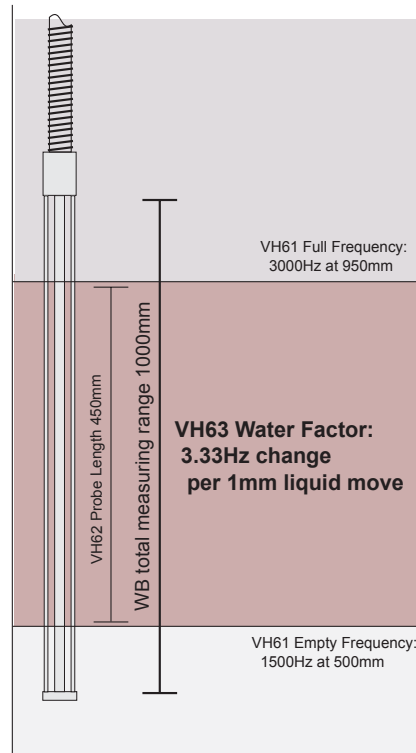
WB probe linearity may differ from default condition to actual in-tank condition. Liquid characteristics (both oil and water), in-tank temperature and other surrounding environment can greatly effect on the probe linearity.

VH63 Water Factor

Item type:read only

A display of WB probe linearity per 1mm liquid movement in Hz (frequency) unit. The calculation is performed based on following formula.

$(\text{VH61 "Full Frequency"} - \text{VH60 "Empty Frequency"}) / \text{VH62 "Probe Length"} = \text{VH63 "Water Factor"}.$

**Note!**

Once, Water Factor is determined by given parameters, actual water I/F measurement is calculated from detected frequency to distance conversion.

VH67 Common Voltage

Item type:read only

Range:0 ~ 255 (0 ~ 3V)

A display of temperature element line (both signal and common) running voltage. Detected voltage across common line (shall be between 0 ~ 3V) is converted to range of 0 ~ 255 count when it is displayed.

VH68 Output Current

Item type:read and write

Default:16000 at 6mA

Range:0 ~ 65535

Adjustment of NMT539 current consumption. In order to prevent current over shoot within multidrop HART loop, this function limits the NMT539 power consumption based on set parameter. Normally, NMT539 with temperature measurement function is operated within 6mA of current consumption. Use a tester to check the current flow in the loop. Reducing the value makes NMT539 to consume smaller current.

VH69 Ref Voltage

Item type:read and write

Default:200

Range:0 ~ 255

A parameter to draw power supply failure alarm. NMT539 operates at minimum 16VDC of supply voltage via multi drop HART loop under normal operating condition. NMT539 will transmits error message when supply voltage drops below 16VDC with default value setting 200.

4.3.7 Temperature Adjustment: VH70 ~ VH79

VH70 Element Select

Item type:select

Range:0 ~ 19

Selection of "need adjustment" temperature element (0 = #1 element, 15 = #16 element, 19 = reference 100 Ohm resistor). Detailed value and parameter of the element selected in this matrix can be shown in,

VH71 "Zero Adjust"

VH73 "Temperature X"

VH74 "Position X"

VH75 "Resistance X"

VH76 "Resistance Adj"

VH71 Zero Adjust

Item type:read and write

Default:0

Range:-1000.0 ~ 1000.0

Zero adjustment of individual element that is selected at VH70. The reading value can be adjusted when the measured temperature indicates minor offset value compare to precision reference thermometer.

Note!



Selected element #2 indicates 25.4°C, then reference thermometer indicates 25.2°C, then set "-0.2" in this matrix. #2 element now has constant artificial -0.2°C offset based on raw measurement.

VH72 Adjust Span

Item type:read and write

Default:1

Range:0.8 ~ 1.2

The span adjustment that applies to all of installed temperature element. A linearized factor of given parameter is multiplied to raw element measurement for final calculation.

Note!



All of displayed individual temperature value are calculated based on following formula.

VH73: "Temperature X" = raw element temperature x span (VH72) + zero offset (VH71)

VH73 Temperature X

Item type:read only

Specified element temperature selected at VH70. Shown value is also indicated at individual element temperature at VH10 ~ VH25. The value is calculated based on formula indicated on above VH72.

VH74 Position X

Item type:read and write

Range:0mm ~ 99999mm

A position of specified element at VH70. Each element positions are also determined when "Not Even" element spacing is selected at VH85.

VH75 Resistance X

Item type:read only

A display of specified element resistance selected at VH70.

VH76 Resistance Adj.

Item type:read and write

Default: 0

Range:-1000.0 ~ 1000.0

Adjustment of specified element resistance at VH70. Minor resistance adjustment can be applied on the reading value.

Note!



Selected element #5 indicates 100.3 Ohm, then reference precision resistor indicates 100.0 Ohm at the same environmental condition, then set "-0.3" in this matrix. #5 element now has constant artificial -0.3°C offset resistance based on raw measurement.

VH77 Element Type

Item type:select

Selection:Pt100, Cu90, Cu100, PtCu100, JPt100

A selection of element conversion formula when foreign average temperature probe is connected to NMT539 Converter Only version

Caution!



NMT539 Converter + Temperature version always consists "Pt100" element with "Spot" element layout. Do not attempt to change these parameters.

Element conversion Formula:

Pt100 (formula above 0°C): $R = -0.580195 \times 10^{-4} \times T^2 + 0.390802 \times T + 100$

Pt100 (formula below 0°C): $R = -4.2735 \times 10^{-10} \times T^4 + 4.273 \times 10^{-8} \times T^3 - 0.58019 \times 10^{-4} \times T^2 + 3.90802 \times T + 100$

Cu90: $R = 0.3809 \times T + 90.4778$

Cu100: $R = 0.38826 \times T + 90.2935$

PtCu100: $R = 3.3367 \times 10^{-7} \times T^3 - 2.25225 \times 10^{-5} \times T^2 + 0.38416 \times T + 100.17$

JPt100:

VH78 Average Number

Item type:read and write

Default:1

Range;1 ~ 10

Number of sampling for average calculation prior to determine final display value. Increasing number of sampling will prevent from faulty display.

Caution!



Additional sampling # will cause slower reaction time on value switch over. Maximum 1 sampling sequence will take approximately 2 sec. {total 21 elements (16 temp elements and 5 integrated reference resistors)}

NH79 Protect Code

Item type:read and write

Default:0

Range:0 ~ 999

Access code 530 to enable select and write command available.

4.3.8 Device setting 1: VH80 ~ VH89

VH80:Present Error

Item type:read only

Display of error message presence. Following code will be indicated.

Error code

0:No error presence
 1:Common line open
 2: undetermined
 3:#1 element open
 4:#1 element short
 5:#2 element open
 6:#2 element short
 7:#3 element open
 8:#3 element short
 9:#4 element open
 10:#4 element short
 11:#5 element open
 12:#5 element short
 13:#6 element open
 14:#6 element short
 15:#7 element open
 16:#7 element short
 17:#8 element open
 18:#8 element short
 19:#9 element open
 20:#9 element short
 21:#10 element open
 22:#10 element short
 23:#0 element over range
 24:Memory defect (ROM)
 25:#11 element open
 26:#11 element short
 27:#12 element open
 28:#12 element short
 29:Element exposed (liquid level below #1 element position)
 30:undetermined
 31:undetermined
 32:Low power supply
 33:#13 element open
 34:#13 element short
 35:#14 element open
 36:#14 element short
 37:#15 element open
 38:#15 element short
 39:#16 element open
 40:#16 element short
 41:Memory defect (RAM)
 42:Memory defect (EEROM)
 43:WB line open
 44:WB line short

VH81 Temperature Unit

Item type:select

Default:°C

Selection:C, F, K

Selection of temperature display unit. Based on universal HART setting, °C(HART code: 32), °F(HART code: 33) and °K(HART code: 35) is available.

Note!



Selection of temperature display unit only applies to reply data from NMT539. Data transmission from host gauge (NRF590 or NMS5/7) to NMT539 must be performed by °C unit only (terminology of HART command 133)

VH82 Element Number

Item type:read and write

Default:10 (NMT539 Converter Only version)

Range:1 ~ 16

Entering # of available temperature element. This function mainly used with NMT539 Converter Only version.

Caution!

Do not change the default parameter on NMT539 Converter + Temperature version. # of element on this version is pre-determined by customer's choice. It may cause faulty calculation or unnecessary error display.

VH83 No. of Preambles

Item type:read and write

Default:5

Range:2 ~ 20

Setting # of preamble for HART communication.

VH84 Distance Unit

Item type:select

Default:mm

Selection:ft., m, inch, mm

Selection of level display unit. It applies to both liquid level display on VH02 "Liquid Level" and VH50 "Water Bottom Level." Level units are coded based on universal HART setting, ft. (HART code: 44), m (HART code: 45), inch (HART code: 47), mm (HART code: 49).

VH85 Kind of Interval

Item type:select

Default:Even Interval (NMT539 Converter Only version)

Selection:Even Interval, Not Even

Selection of element interval depending on spacing layout. This function is normally used for NMT539 Converter Only version.

Caution!

Do not change its parameter on NMT539 Converter + Temperature version unless repairing. Kind of Interval and individual element positions are physically determined at factory.

VH86 Bottom Point

Item type:read and write

Default:500mm

Range:0mm ~ 99999mm

Position of #1 element that is also called "Bottom Point." #1 element position becomes critically important when "Even Interval" is selected at VH85 because remaining element positions rely on this location of Bottom Point.

VH87 Element Interval

Item type:read and write

Default:1000mm (NMT539 Converter Only version)

Range:0mm ~ 99999mm

Designated to Even Interval spacing.

Caution!

Changing element interval, setting element position, these are only applied to reconfigure switching points for average temperature calculation. The physical element position will never be changed!!

VH88 Short Error

Item type:read and write

Default:-49.5

Range:-49.5 ~ 359.5

A type of error message when any of element has short circuit. Method of display can be configured at VH92 "Error Display Select."

VH89 Open Error

Item type:read write

Default:359.9

Range:-49.5 ~ 359.5

A type of error message when any of element has open circuit. Method of display can be configured at VH92 "Error Display Select."

4.3.9 Device setting 2: VH90 ~ VH99

VH90 Device ID Number

Item type:read and write

Default:0

Range:0 ~ 16777214

In order to distinguish own device ID when NMT539 is connected in multi drop HART loop.

Caution!



Changing device ID may lead to communication error because of mismatched pre-registered device ID and HART address.

VH91 Previous Error

Item type:read only

Display of error history. Coded error message will be the same contents as VH80.

VH92 Error Dis. Sel.

Item type:select

Default:0_OFF

Selection:0_OFF, 1_ON

Type of VH88 "Short Error Value" and VH89 "Open Error Value" display selection.

0_OFF:These 2 error messages will not be transmitted to the connected host gauge. This function automatically exclude defected element in average temperature calculation.

1_ON:Error message will be transmitted to the host gauge. As a result, VH88 and 89's numeric error code will be displayed on host gauge default screen and may transmit to upper receiver as well.

VH93 Custody Mode

Item type:select

Default:0_OFF

Selection:0_OFF, 1_ON

A software switch to prohibit over write for Weight and Measure application when 1_ON is selected.

Note!



Hardware over ride protection is located on main CPU board. Set jumper terminal JP1 7-8 will enables no parameter re-configuration available.

VH94 Polling Address

Item type:read and write

Default:2

Range:1 ~ 15

Polling address for HART communication

VH95 Manufacture ID

Item type:read only

Default:17

A manufacture ID within E+H instrumentation.

VH96 Software Version

Item type:read only

A display of installed software version.

VH97 Hardware Version

Item type:read only

A display of recognized hardware version.

VH98 Below Bottom

Item type:select

Default:0_OFF

Selection:0_OFF, 1_ON

A type of error display when liquid level drops below #1 element (Bottom Point). Error code "29" is displayed on VH80 and VH91 when 0_ON is selected.

VH99 Device Type Code

Item type:read only

Device type will be displayed.

- 184:Temperature measurement function only
- 185:WB function only
- 186:Temperature + WB function

5 Maintenance

5.1 Maintenance

The NMT539 Prothermo Average temperature + WB instrument requires no special maintenance.

Exterior cleaning

When cleaning the NMT539, always use cleaning agents that do not attack the surface of the housing and the seals.

Repairs

The Endress+Hauser repair concept assumes that the measuring devices have a modular design and that customers are able to undertake repairs themselves. Spare parts are contained in suitable kits. They contain the related replacement instructions. All the spare parts kits which you can order from Endress+Hauser for repairs to the NMT539 Prothermo are listed with their order numbers on later pages. Please contact Endress+Hauser Service for further information on service and spare parts.

Repairs to Ex-approved devices

When carrying out repairs to Ex-approved devices, please note the following:

- Repairs to Ex-approved devices may only be carried out by trained personnel or by Endress+Hauser Service.
- Comply with the prevailing standards, national Ex-area regulations, safety instructions (XA) and certificates.
- Only use original spare parts from Endress+Hauser.
- When ordering a spare part, please note the device designation on the nameplate. Only replace parts with identical parts.
- Carry out repairs according to the instructions. On completion of repairs, carry out the specified routine test on the device.
- Only Endress+Hauser Service may convert a certified device into a different certified variant.
- Document all repair work and conversions.

Replacement

After a complete Prothermo electronic module has been replaced, the parameters must be manually re-entered to the replaced new module in order to maintain the proper operation. Measurement can continue without having to carry out a new setup.

After an probe or electronic has been replaced, a new calibration should be carried out. This is described in the Service Manual SM00xN/08/en. 05.04.

6 Trouble-shooting

6.1 System error messages

| Code | Description | Possible cause | Remedy |
|------|-----------------------|---|---|
| 1 | Common line open | Ground (common) line has open circuit. All of temperature element signal will be disabled or defected. | check connector attachment on the module; then check continuity on common (black) cable to #1 cable (red) |
| 3~39 | Element open | Temperature element signal cable (#1 ~ 16) has open circuit. | check connector attachment on the module; then check continuity on pointed signal cable (#1 ~ 16) |
| 4~40 | Element short | Temperature element signal cable (#1 ~ 16) has short circuit. | disengage connector from the module; then check continuity on pointed signal cable (#1 ~ 16) |
| 23 | #0 element over range | When reference #0 element has more than $\pm 1.1^{\circ}\text{C}$ deviation from 0°C . | check power supply voltage on NMT539 HART terminal H+ and H- |
| 24 | Memory defect (ROM) | When a defect was discovered during whole memory parameter check. Cyclic data comparison between previous check sum to current one. | replace main CPU board |
| 29 | Element exposed | Liquid level dropped below #1 element position. | no liquid temperature measurement is available. |
| 32 | Low power supply | Supply voltage on multi drop HART loop to NMT539 is withdrawn below 16VDC from designated host instrument. | check power supply on the host instrument and consumption of connected loop powered HART device |
| 41 | Memory defect (RAM) | A defect during Write and Read sequence was imcompleted. | replace main CPU board |
| 42 | Memory defect (EEROM) | A defect during Write command was imcompleted. | check the write command itself that is acceptable to NMT539; if command is OK, replace main CPU board |
| 43 | WB line open | WB capacitance signal loop has open circuit. | check connectoe attachment on CF board at module in converter housing |
| 44 | WB line short | WB capacitance signal loop has short circuit | disengage connector and check continuity of WB signal between housing to signal cable |

Tab. 1 System error messages



Note!

These error code will be mainly displayed on ToF tool display when the tool is properly connected. Method and description of error display on host instrument, please refer to documentation of Tank Side monitor NRF590 or Proservo NMS5/7.

7 Technical data

7.1 Technical data at a glance

| Application | |
|----------------------------|---|
| Application | <p>The Prothermo NMT539 performs precise liquid and gas phase average temperature measurement of custody transfer bulk storage tank application. Along with capacitance water to oil interface measurement probe, complete temperature and WB (BSW) level measurement in crude oil and other bi-layer liquid tank application are accomplished.</p> <ul style="list-style-type: none"> ■ Standard 2" flange installation ■ Overall 30m (40m pending) temperature measurement range ■ Up to 1m or 2m of BSW measurement range (3m optional) |
| Function and system design | |
| Measuring principle | <p>Temperature measurement NMT539 consists of platinum characterized temperature element "Pt100" up to 16 elements in SUS316 protection tube. Pt100 has an unique characteristic of linear resistance change across surrounding ambient temperature change. Module in NMT539 converter head recives this resistance signal change as input variable and converts to temperature data. Then, all of converted and calculated data are transmitted on loop powered HART signal to designated host instrument</p> <p>WB (water interface) measurement: An attached capacitance level measurement probe detects presence of water. The level of water is converted into given frequency variable (default setting) and its data is transmitted via HART converter to connected host instrument.</p> |
| Equipment architecture | see Installation Manual BA025N/08/en |
| Input | |
| Measured variable | <p>Temperature measurement Temperature conversion range: -200 ~ +240°C Standard temp probe: -40 ~ +100°C Wide range temp probe: -55 ~ +235°C Fridge range temp probe: -200 ~ +71°C... pending WB measurement Standard probe range: 1m or 2m Optional range: 3m</p> |
| Measuring range | see Technical Information TI042N/08/en |
| Output | |
| Output signal | <ul style="list-style-type: none"> ■ HART protocol (multi drop HART loop connection) |
| Signal on alarm | <p>Error information can be accessed via the following interfaces and transmitted digital protocol (refer to the operation manials on following instruments)</p> <ul style="list-style-type: none"> ■ Tank Side monitor NRF590 ■ Proservo NMSS/7 |
| Auxiliary energy | |
| Load HART | Minimum load for HART communication: 250 W |
| Cable entry | see Technical Information TI042N/08/en |
| Supply voltage | 16 ~ 30VDC (on multi drop HART loop) |
| Current consumption | <p>Less than 6mA with temperature maesurement Less than 12mA with WB (and temperature) measurement</p> |

| Performance characteristics | |
|-----------------------------------|--|
| Reference operating conditions | <ul style="list-style-type: none"> temperature = +25 °C (77 °F) ±5 °C (9 °F) pressure = 1013 mbar abs. (14.7 psia) ±20 mbar (0.3 psi) relative humidity (air) = 65 % ± 20% |
| Maximum measured error | <p>Typical statements for reference conditions, include linearity, repeatability, and hysteresis:</p> <ul style="list-style-type: none"> Linearity: <ul style="list-style-type: none"> Temperature: ±0.15°C (0.27°F) + number of element deviation (based on IEC class A standard) WB: 4mm (±2mm) for 1m probe installed |
| Operating conditions | |
| Operating conditions | |
| Installation instructions | see Installation Manual BA025N/08/en |
| Environment | |
| Storage temperature | -40 °C ... +85 °C |
| Climate class | DIN EN 60068-2-38 (test Z/AD) |
| Degree of protection | <ul style="list-style-type: none"> housing: IP 65, (Converter only, open housing: IP20) probe: IP 68 |
| Electromagnetic compatibility | <p>When installing the probes in metal and concrete tanks and when using a coax probe:</p> <ul style="list-style-type: none"> Interference Emission to EN 61326, Electrical Equipment Class B Interference Immunity to EN 61326, Annex A (Industrial) |
| Process conditions | |
| Process temperature range | see Technical Information TI042N/08/en |
| Process temperature limits | see Technical Information TI 042N/08/en |
| Process pressure limits | see Technical Information TI042N/08/en |
| Mechanical construction | |
| Design, dimensions | see Technical Information TI042N/08/en |
| Weight | see Technical Information TI042N/08/en |
| Material | see Technical Information TI042N/08/en |
| Process connection | see Technical Information TI042N/08/en |
| Certificates and approvals | |
| CE approval | The measuring system meets the legal requirements of the EC-guidelines. Endress+Hauser confirms the instrument passing the required tests by attaching the CE-mark. |
| External standards and guidelines | <p>EN 60529 Protection class of housing (IP-code)</p> <p>EN 61010 Safety regulations for electrical devices for measurement, control, regulation and laboratory use.</p> <p>EN 61326 Emissions (equipment class B), compatibility (appendix A – industrial area)</p> |
| Ex approval | see »Ordering structure NMT539« on page 8 |

| Ordering Information | |
|-----------------------------|--|
| | The E+H service organisation can provide detailed ordering information and information on the order codes on request. |
| Accessories | |
| | see Technical Information TI042N/08/en |
| Supplementary Documentation | |
| Supplementary Documentation | <ul style="list-style-type: none"> ■ System Information NMT539 (SI 025N/08/en) ■ Technical Information (TI 042N/08/en) ■ Installation Manual (BA 025N08/en) |

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