Technical Information
Prothermo NMT539
Intrinsically Safe Multi-signal Converter with Precision Average Temperature and Water Bottom Sensor for Inventory Control and Custody Transfer Applications

Application
Prothermo NMT539 is based on API (American Petroleum Institute) Manual of Petroleum Measurement Standard, Chapter 7, and enables high accuracy temperature measurement. At the same time, it is an intelligent average temperature sensor for tank gauging with an optional WB capacitance sensor at the bottom of the temperature probe.

For average temperature measurement, it consists of precision multi-spot Pt100 elements.

NMT539 is a highly capable solution that provides both constant average temperature data and water interface data via local HART communication.

For accurate inventory measurement, it is best suited connected to Endress+Hauser's Proservo, Tank Side Monitor, or Micropilot radar.

Features and Benefits
- 2-wire local HART communication is employed and complete digital design without data transmission error is used.
- Intrinsically safe device allowing for the safest electrical configuration possible
- Available in three different versions based on customer requirements:
  - Converter Only
  - Converter and Temperature probe
  - Converter, temperature and water bottom (WB) probe
- Converter is compatible with Pt100, Cu90, and PtCu100.
- Variety of process connections and cable entries available to meet worldwide classifications.
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# Important Document Information

## Notes on Safety Conventions and Symbols

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<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="A0011189-EN" alt="DANGER" /></td>
<td><strong>DANGER!</strong> This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.</td>
</tr>
<tr>
<td><img src="A0011190-EN" alt="WARNING" /></td>
<td><strong>WARNING!</strong> This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.</td>
</tr>
<tr>
<td><img src="A0011191-EN" alt="CAUTION" /></td>
<td><strong>CAUTION!</strong> This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.</td>
</tr>
<tr>
<td><img src="A0011192-EN" alt="NOTICE" /></td>
<td><strong>NOTICE!</strong> This symbol contains information on procedures and other facts which do not result in personal injury.</td>
</tr>
</tbody>
</table>

## Symbols for Certain Types of Information

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="A0011182" alt="Allowed" /></td>
<td><strong>Allowed</strong> Indicates procedures, processes or actions that are allowed.</td>
</tr>
<tr>
<td><img src="A0011183" alt="Recommendation" /></td>
<td><strong>Recommendation</strong> Indicates procedures, processes or actions that are recommended.</td>
</tr>
<tr>
<td><img src="A0011184" alt="Forbidden" /></td>
<td><strong>Forbidden</strong> Indicates procedures, processes or actions that are forbidden.</td>
</tr>
<tr>
<td><img src="A0011193" alt="Tip" /></td>
<td><strong>Tip</strong> Indicates additional information.</td>
</tr>
</tbody>
</table>
Function and System Design

System Design

NMT539 is available in three different versions:
- Converter Only
- Converter + Average Temperature Probe
- Converter + Average Temp Probe + Water Bottom Probe

The converter only version can be retrofitted without modifications onto existing third party average temperature probes, such as Whesseo Varec 9909 and 1700 and Weed Beacon MW type probes. The average temperature probe + converter inherits all the functionality of the former NMT 535/536/537 series. The average temperature + WB + converter is the ultimate multi-function sensor, transmitting temperature and water interface level data along only one pair of local HART signal cables to the host NM55, Servo gauge TG55, Digital Transmitter TMD1or Tank Side Monitor NRF560.

NMT539 + WB Operation Principle (Converter + Temp + WB probe version)

Figure 1: NRF560 System Configuration

NOTICE

Each type of NMT539 including converter only or converter + average temperature are simplified versions for combination of converter + average temperature probe + WB (Water Bottom) Probe.
Endress+Hauser offers a wide range of solutions to integrate field data into the process management requirement. The diagrams above describe some individual solutions according to various Ex concepts. For additional application requirements, contact local Endress+Hauser representatives.
NMT539 Ex ia and NMS5 Ex d [ia] Combination

NMT539 Converter + Temp. Probe Version

NMT539 is the successor of the former NMT 535 Ex i version. For proper migration, NMT539 has inherited all the functionality and specifications of NMT 535 including process connections, cable entries and wiring method.

Since NMS5 already provides water interface measurement, NMT539 converter + average temperature may be the best version when used in combination with NMS5. When the converter + WB + average temperature version is used in combination with NMS5, the product in the tank will be thoroughly managed with level, continuous average temperature, and water interface measurement.

Most configuration and parameter settings for NMT539 can be performed via NMS5 programming matrix.

NMT539 receives liquid level data from NMS5, then calculates liquid and gas phase average temperature. Calculated data and basic information including raw data for each temperature element and device status are transmitted to NMS5.

- Since NMS5 is a multi-functional device (measurement and data transmission), NRF560 acts as a tank side remote data indicator and tank gauge operation terminal for NMS5.
- All gathered data in the field interface unit is sent to inventory management software, such as Endress+Hauser's Tankvision, Fuelsmanager, Tank computer or directly sent to the customer's specific DCS or PLC.

Figure 3: System Diagram (ATEX, FM, CSA, Ex i) with NMS5

NOTICE
The connection of NMT539 shown above is only available to connect with NMS Ex d [ia].
NMT539 Converter + Temp. + WB version

NMT539 Converter + Temp. + WB is utilized effectively in combination with radar level gauging. Water interface, temperature and level measurement, with data collection and calculations via the NRF560, allow for optimal inventory control. Basic functionality of NMT539 is displayed and configured on NRF590. Detailed NMT539 functionality and data access can be performed by FieldCare.

NMT539 receives radar level data from the NRF560 and then calculates liquid and gas phase average temperature. Calculated and standard data including temperature element raw data and device status are transmitted to NRF590.

NMT539

All gathered data in the field interface unit is sent to inventory management software, such as Endress+Hauser's Tankvision, Fuelsmanager, tank computer or directly sent to the customer's specific DCS or PLC.
NMT539 Ex d [ia] and TMD1 Combination

Average temperature data is transmitted to transmitter TMD1 via local HART communication.

**CAUTION**

If NMT539 WB probe and NRF560 are used together, confirm that the supply voltage to TMD1 is stable at 100 VAC or more.

NMT539 Ex d [ia] and TGM5 or NMS5 Combination

**CAUTION**

If NMT539 WB probe and NRF560 are used together, confirm that the supply voltage to TGM5 is stable at 100VAC or more.
NMT539 high temperature specification (application more than 100°C) is Ex i output. When using NMT539 with NMS5/NMS7, Barrier Box NAB560 is required.

![System Diagram with NMS5/NMS7 and NMT539](image)

**Installation to Fixed Roof Tank**

![Fixed Roof Tank, Unit of Measurement: mm (in)](image)
Installation to Floating Roof Tank 1

[Diagram of Floating Roof Tank 1]

Figure 9: Floating Roof Tank 1, Unit of Measurement: mm (in)

Installation to Floating Roof Tank 2

[Diagram of Floating Roof Tank 2]

Figure 10: Floating Roof Tank 2, Unit of Measurement: mm (in)
Installation to Floating Roof Tank 3

Figure 11: Floating Roof Tank 3, Unit of Measurement: mm (in)
**Application for Pressurized Tank**

Pressurized tank is required to install a thermo well to protect the probe from the pressure.

- When the pressure inside the tank exceeds 1 bar (100KPa, 14.5psi), a thermo well which does not have any holes or slits must be installed.
- NMT539 is installed in the thermo well from the top of the tank nozzle.
- Cover the bottom of the thermo well and weld it to protect the probe from the pressure.

![Figure 12: Stilling Well for Pressurized Tank](image)

**WARNING**

- When the pressure inside the tank exceeds 1 bar (100KPa, 14.5psi), a thermo well which does not have any holes or slits must be installed.
- NMT539 is installed in the thermo well from the top of the tank nozzle.
- Cover the bottom of the thermo well and weld it to protect the probe from the pressure.

![Figure 13: Welding Part of Stilling Well](image)
## Input and Output

### Measured Variables

**Temperature Measuring Range:**
- Temperature conversion: -200 to +235 °C (-328 to +455 °F), (-170 to +235°C TIIS)
- Standard: -40 to +100°C (-20 to +100°C TIIS)
- Wide range: -55 to +235°C (-20 to +235°C TIIS)
- Cryogenic: -170 to +60°C
- Probe length: Max. 99.9999m (333.33ft) (ATEX, IECEx), Max. 40.000m (131.2ft) (TIIS, FM, CSA, NEPSI)

**Water Interface Level (Water Bottom) Range**
- Standard: 1m or 2m (3.3 to 6.6 ft)

### Compatible Element (Converter Only Version)

- Pt100
- Cu90
- Cu100
- PtCu100
- JPt100

TIIS is only available for Pt100 and JPt100.

**NOTICE**

NMT539 Converter + Temp. version has only Pt100 elements installed. The element types above can be utilized in third party temperature probes, such as the Endress+Hauser 9909, 1700 or Weed Beacon MWR. Other manufacturer multi-resistant and multi-spot average temperature probes may be compatible.

### Number of Elements

- 2 to 16 points

### Communication

- NMS5/NMS7
- NRF560
- TMD1
- TGM5

**Local HART**

2 wire, Endress + Hauser local HART protocol to host commanding gauge.

Local HART is used for communication in NMT539, NRF560, NMS5/NMS7, and NRF590.

### Alarm Signal

Error information via the following interface and transmission digital protocol. Refer to Operating Instructions for details of each device.

- NMS5: BA00401G, NMS7: BA1001N
- NRF590: BA256F (BA00256F), BA257F (BA00257F)

### Output Signal

- Local HART protocol

### Connection

- NMS5/NMS7
- NRF590
- TMD1
- TGM5
## Auxiliary Energy

<table>
<thead>
<tr>
<th>Load HART</th>
<th>Minimum loading for local HART circuit: 250Ω</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overvoltage Protection</strong></td>
<td>NMT539 has internal surge arrester which complies with EN / IEC 61000-4-5 (Line to Line 1.0kV). Connect the metallic housing of the NMT539 to the tank wall or screen directly with an electrically conductive lead to ensure reliable potential matching.</td>
</tr>
<tr>
<td><strong>Supply Voltage</strong></td>
<td>DC16 to 30V: Ex ia</td>
</tr>
<tr>
<td></td>
<td>DC20 to 24V: TIIS Ex d [ia] connectable only TGM5, TMD, NMS: Ex d</td>
</tr>
<tr>
<td><strong>Power Consumption</strong></td>
<td>Ex ia: 6mA (Temperature measurement)</td>
</tr>
<tr>
<td></td>
<td>12mA (WB measurement)</td>
</tr>
<tr>
<td></td>
<td>TIIS Ex d [ia]: 8mA (Temperature measurement)</td>
</tr>
<tr>
<td></td>
<td>14mA (WB measurement)</td>
</tr>
</tbody>
</table>
Performance Characteristics

Temperature Accuracy

±0.1°C or better (under the reference condition) *1

Reference condition*1:
Accuracy of RTD - Temperature conversion. Accuracy measurement shall be conditioned with precisely calibrated dial resistor or IEC60751/DIN EN 60751 class A Pt100 ohm temperature element.

WB Accuracy

±2mm or less (under the reference condition)*2

Reference condition*2:
Measurement condition is based on 80% span of 1m probe in water / air interface at a temperature of 25°C.

The Factory default is adjusted based on DC (εr)=2.1

Reference Operating Conditions

- Temperature = +25°C(77°F) ±5 (9°F)
- Pressure = 1013mbar abs. ± 20mbar abs. (1013hPa abs. ± 20hPa abs., 14.7 psi abs ± 0.3 psi abs.)
- Relative humidity (air) = 65% ± 20% (linearity)

Maximum Measured Error

Typical statements for reference conditions, include linearity, repeatability, and hysteresis:
- Linearity:
  - Temperature: ±0.15°C (0.27°F) + value of element deviation (based on IEC 60751/ DIN EN 60751)
    Standard version class A: ± (0.15 + 0.002 x ltl)
    PTB version class B: ± (0.3 + 0.005 x ltl)/10
  - WB: ± 2mm *2

New Module

NMT539 employs a completely new electronic module compared to the previous NMT 535.

<table>
<thead>
<tr>
<th></th>
<th>NMT539</th>
<th>NMT 535</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU Performance</td>
<td>16 bit</td>
<td>8 bit</td>
</tr>
<tr>
<td>Clock Speed</td>
<td>2.7648 MHz</td>
<td>0.9216 MHz</td>
</tr>
<tr>
<td>Memory Capacity (RAM)</td>
<td>20K bytes</td>
<td>176 bytes</td>
</tr>
<tr>
<td>EEPROM</td>
<td>2K bytes</td>
<td>256 bytes</td>
</tr>
<tr>
<td>Flash Memory</td>
<td>256K bytes</td>
<td>16K bytes</td>
</tr>
<tr>
<td>Total # of Print Boards</td>
<td>4 (5 with Capacitance board)</td>
<td>5</td>
</tr>
<tr>
<td>Current Consumption (Converter + Temp. Probe)</td>
<td>6mA: 16VDC Ex ia</td>
<td>8mA: 16VDC Ex d [ia]</td>
</tr>
<tr>
<td></td>
<td>12mA: Ex ia</td>
<td>14mA: Ex d [ia]</td>
</tr>
</tbody>
</table>

All-in-one Program

The powerful processor enables multi-function calculations under a single program. This means that there is no need for a variety of spare parts.

RTD Temperature Calculation

The main CPU board now has all the required data processing functionality, including RTD - local HART conversion. With the NMT 538, various programs were required depending on temperature element characteristics, such as Pt100, Cu90, Cu100 and PtCu100. The new NMT539 has all the programs in one powerful processor.

Capacitance - Local HART Signal Conversion

A separate C/F (Capacitance - Frequency) module can be connected directly to the CPU board when NMT539 is equipped with WB sensor.
# Operating Condition: Environment and Process

| **Ambient Temperature Range** | -40 to +85°C (-40 to +185°F)  
|                             | -20 to +60°C (-4 to +140°F) for TIIS  |
| **Storage Temperature**     | -40 to +85°C (-40 to +185°F)  |
| **Climate Class**           | DIN EN 60068-2-38 (test Z/AD)  |
| **Degree of Protection**    | - Housing: IP65, (Converter only, open housing: IP20)  
|                             | - Probe: IP68  |
| **Electromagnetic Compatibility** | - Interference Emission to EN 61326, Electrical Equipment Class B  
|                             | - Interference Immunity to EN 61326, Annex A (Industrial)  |
| **Process Temperature Range** | Temperature probe: -170 to +235°C (-274 to +455°F)  
|                             | WB probe: 0 to +100°C (+32 to +212°F)  |
| **Process Pressure Limits**  | 1 bar (100kPa, 14.5psi)  |
| **Data Transmission**       | 2.5mm coaxial cable & common ground  |

**WARNING**

If the tank inside is over this process pressure, it is required to install stilling well to protect the probe from the pressure.
Operating Condition: Installation

Cable Grand

Wiring of the NMT539 must meet explosion proof or intrinsically safe requirements. The following cable entries are available:

- Thread G 1/2"
- Thread NPT 1/2"
- Thread M20

Only G1/2 is selectable for TIIS Ex d [ia] and for TIIS Ex d [ia], 2 cable glands SXC-16B are attached.

**WARNING**
Ensure to use the cable glands attached to NMT539. Cable gland is not provided for other NMT539 specifications excluding TIIS Ex d [ia]. Size and condition of the communication cable must meet the requirements of intrinsically safe local HART communication.

Process Connection

**Converter Only Version**

NMT539's local HART converter can fit onto third party average temperature probes with the following mechanical connection size and type:

- G 3/4" (equivalent to NPS 3/4") universal coupling: Housing type 1
- M20 threaded: housing type 2, specific design to fit to Varec 1700 terminal housing

**CAUTION**

- Use sealing tape to secure the connection between converter and temperature probe.
- Refer to the NMT539 instruction manual for the detailed installation procedure.

**Converter + Temp., Converter + Temp. + WB Version**

All versions have the same installation method to fit with the tank nozzle. The following flange sizes are available:

- 10K 50A RF, SUS316, flange JIS B2220
- NPS 2" Cl.150 RF, SUS316 flange ASME B16.5
- DN50 PN10 B1, SUS316, flange EN1092-1 (DIN2527 B)
- 50A 150lbs RF, SUS316, flange JPI 7S-15

Height Adjustment for NMT539

When installing NMT539, height adjustment can be performed within approximately ±180 mm (7") from the original height.

**NOTICE**

The height adjuster is not included in "Converter Only" version.

**WARNING**

Tighten the lock nut with sealing tape to secure NMT539 flange at the end of installation. A loose lock nut may lead to improper tank sealing or unexpected leakage into the tank.

WB Blocking Distance

The Water Bottom sensor can be set as low as zero clearance from the tank floor by using height adjuster. Due to mechanical design of WB sensor, bottom plate has approximately 10mm thickness. This will become a blocking distance (ineffective measuring range).

**WARNING**

Calculate vertical movement of NMT539 installation height prior to setting the WB sensor bottom clearance. Typical tank shell deformation causes vertical movement at a minimum 20 ~ 30mm (1”). Excessive weight load of entire NMT539 on WB sensor by contacting tank floor may cause critical damage that disables accurate & stable WB level measurement.
Recommended Installation Height

Figure 14: Recommended Installation, Unit of Measurement: mm (in)

NOTICE

- The required bottom clearances of both the temperature probe and WB sensor vary depending on the anchoring method. Consider the required bottom clearance when ordering NMT539. See the recommended bottom clearance shown above and/or consult Endress+Hauser representatives for further information.

- When ordering NMT539 with special element position and bottom clearance, refer to "Ordering Information," section 80, Element Spacing. Select 4, Equally spaced, defined by length.

- The standard location of the lowest temperature element should be set at 500 mm (20") from the bottom of the tank regardless of probe type.
Recommended Stilling Well Installation

Datum plate should be mounted on the bottom of the tank below the slotted stilling well (see ⑤) or located 300mm (12 inches) or more below the slotted stilling well (see ②). When anchor weight is not used in the stilling well method, the water should fill the tank up to the bottom from the end of the stilling well, enough to allow liquid to enter/exit the pipe and water probe is installed into the place which is lower than the bottom of the stilling well to get the tip of the water probe.

When using stilling well, it is available from 2 inches (50A) (JIS, ANSI) pipe. When using anchor weight, use 4 inches (100A)(JIS, ANSI) pipe or more.

⚠️ WARNING

Avoid turbulence in the water so that WB (Water Bottom) sensor will not be damaged.

![Recommended stilling well installation diagram](image)

Installation Equipment

The bottom anchor hook on WB sensor is not available when "A: no installation material" is selected. The Converter + Temp. probe version includes the bottom anchor hook as standard, although, "A: no installation material" is selected.

Contents of Anchoring Hardware: Based on Choice of "100: Mounting Attachment"

<table>
<thead>
<tr>
<th>A:</th>
<th>B:</th>
<th>C:</th>
<th>D:</th>
<th>E:</th>
<th>F:</th>
<th>G:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not selected</td>
<td>Anchor weight</td>
<td>Anchor weight</td>
<td>Tension wire +</td>
<td>Tension wire +</td>
<td>Bottom hook,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(High profile, D120)</td>
<td>(Low profile, hexagon H41)</td>
<td>wire hook +</td>
<td>wire hook +</td>
<td>Low profile</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NPT1 top anchor</td>
<td>R1 top anchor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0:</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Converter only</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1:</td>
<td>bottom hook</td>
<td>bottom hook</td>
<td>bottom hook base plate</td>
<td>bottom hook base plate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temp. + Converter</td>
<td>anchor weight</td>
<td>anchor weight</td>
<td>wire hook</td>
<td>wire hook</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>sling wire</td>
<td>sling wire</td>
<td>NPT1 top anchor</td>
<td>R1 top anchor</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>tension wire</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3:</td>
<td>none</td>
<td>same as above</td>
<td>same as above</td>
<td>same as above</td>
<td>same as above</td>
<td>bottom hook</td>
</tr>
<tr>
<td>Temp. + WB + Converter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Mounting Attachment -1
(Converter + Temperature Probe)

A: "Not Selected", B: "High Profile Anchor, D120", D: "Tension Wire + Wire Hook + NPT1 Top Anchor" or F: "Tension Wire + Wire Hook + R1 Top Anchor"

![Diagram of attachment options](image)

Figure 16: Attachment 1, Unit of Measurement: mm (in)

"High profile anchor weight" is the anchor method designed for converter + temperature probe. Both temperature probe and WB sensor with "High profile anchor weight" and "Tension wire anchor" methods have a recommended clearance below the bottom of the anchor hook of approximately 400 mm (16’). This clearance can be easily changed by turning the height adjuster at the top of the tank.

NOTICE

When ordering NMT539, refer to "Ordering Information," section 80 (Temperature Element Spacing).
Mounting Attachment-2
(Converter + Temperature Probe + Water Bottom Probe)

A: "Not Selected", B: "High Profile Anchor, D120", C: "Low Profile Anchor, Hexagon H41"
D: "Tension Wire + Wire Hook + NPT1 Top Anchor", F: "Tension Wire + Wire Hook + R1 Top Anchor" or
G: Bottom Hook, Low Profile

"Low profile anchor weight" is provided to anchor WB probe and to measure accurately water bottom range. When installing NMT539 into the small tank nozzle [max. 2 inches (50A)] of operating tank, it is available as mounting attachment for converter + temperature probe version. Both the temperature probe and WB sensor with "Low profile anchor weight" at 100. Mounting attachment option (refer to Ordering Information) should have 200 mm (8") of bottom clearance from the edge of probes.

The lowest possible WB measuring point can be approximately 10 mm from the tank floor with "No installation material" selected (refer to Ordering Information). If necessary, use the height adjuster to set at the desired installation height. No bottom anchor hook is available with the WB sensor and 100: Mounting attachment "A: No installation material". A bottom hook is attached on WB sensor but a low profile anchor is not included to the option "G: Bottom hook, low profile"
#1 Element Position of NMT539

Figure 18: #1 Element Position, Unit of Measurement: mm (in)

Anchor Weight Method

Figure 19: Anchor Weight Method, Unit of Measurement: mm (in)
Operating Condition: Wiring

TIIS Ex d [ia] Wiring

When NMT539 TIIS... Ex d [ia] available only in Japan, Class A grounding directly from NMT539 is required.

⚠️ CAUTION

The grounding cable for safety barrier should be connected independent of any other devices or purpose, according to “Class A grounding” standards.
Use a conductive grounding wire with cross-sectional dimensions 2~2.6mm².
In an instrumentation room, a field device with Class A ground may be connected in common with the communication cable shield.

Class A Ground General Description

<table>
<thead>
<tr>
<th>Ground Resistance Value</th>
<th>10Ω or less</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grounding Cable</td>
<td></td>
</tr>
<tr>
<td>Tensile strength: 1.04kN metallic wire or more</td>
<td></td>
</tr>
<tr>
<td>Cable core cross section diameter: 2~2.6mm copper wire or more</td>
<td></td>
</tr>
<tr>
<td>Cable finished external diameter: more than φ8mm</td>
<td></td>
</tr>
</tbody>
</table>

Grounding Cable Construction (TIIS Ex d [ia])

Figure 20: Grounding Cable
Connecting Diagram (THS Ex d [ia])

CAUTION
Install wiring in a manner to prevent current or voltage from causing electro magnetic interference on the i.s. circuit.

Hazardous Area
Non-hazardous Area

Measuring Device in A Tank

Ex ia Compartment

CN2-1
Ex ia Circuit
CN2-4

Measuring Temp. Tube
Water Bottom Sensor

Class A grounding

Hazardous Area
Non-hazardous Area

Measuring Device in A Tank

Ex ia Compartment

CN2-1
Ex ia Circuit
CN2-4

Measuring Temp. Tube
Water Bottom Sensor

Class A grounding

*Measuring Part

*Measuring parts: In case of average temperature measuring, there is no water bottom probe.

CAUTION
when grounding the barrier, connect with tank or use the shielded wire for remote cable
When using the shielded wire for remote cable, refer to “Electrical connection”.

Figure 21: Connecting Diagram
Operating Condition: Terminal Connection

**Ex ia NMT539 Terminal**  
NMT539 (Ex ia) allows an intrinsically safe local HART connection. Refer to the i.s. regulation for establishing wiring and field device layout.

![NMT539 Terminal (Ex ia)](image1)

**ATEX, IECEx FM, CSA, NEPSI Ex d [ia] NMS5 Terminal**  
Since NMT539 is an intrinsically safe instrument, the terminal connection to the Ex i side on local HART connection is allowed on NMS5 terminal housing.

![NMT5 Terminal (ATEX, FM, CSA, Ex d [ia])] (image2)

**CAUTION**  
Do not connect NMT539 local HART communication on terminals 4 and 5 on NMS5. These terminals are designed to connect Ex d local HART communication.
**TIIS Ex d [ia] NMT539 Terminal**

NMT539 Ex d [ia] allows a local HART connection available in Japan. Refer to the i.s. regulation for establishing wiring and field device layout.

Local HART multi drop connection varies depending on the approval type.

![Figure 24: NMT539 Terminal (TIIS Ex d [ia])](image)

**Ex d NMS5 Connection**

Connect NMT539 Ex d [ia] to NMS5 Ex d terminals.

![Figure 25: NMS5 Terminal (Ex d)](image)
When TGM5 (except Sakura code (collector common), BCD (emitter common), BCD (collector common) is equipped with local HART communication, it is possible to connect Ex d [ia] equipment, however terminal number depends on the specification. See terminal figure for TGM5.

In case of TMD1-xBxxxxxxxxx (with local HART input), it is possible to connect Ex d [ia] equipment, however terminal number depends on the specification. See terminal figure for TMD1.

Terminal Connection of NRF590

NRF590 has three sets of i.s. local HART terminals.

**CAUTION**

Do not connect signal local HART lines from NMT539 to terminals 30 and 31. These terminals are designed to supply drive power for Micropilot S (FMR53x and FMR540).
Mechanical Construction

**Type 1: Converter Only Version**

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Unit of Measurement: mm (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>319 (12.56)</td>
<td></td>
</tr>
<tr>
<td>189 (7.44)</td>
<td></td>
</tr>
<tr>
<td>48 (1.89)</td>
<td></td>
</tr>
</tbody>
</table>

Figure 28: Type 1 Dimensions, Unit of Measurement: mm (in)

**Type 1: Measuring Function**

The Converter only version is the direct replacement of the previous NMT 538 series. Connection and compatibility are provided to third party temperature probes with various element types. Unlike the NMT 538, the powerful processor of the NMT539 calculates and converts the following element types without altering the program (EPROM installed software):

- Pt100
- Cu100
- Cu90
- PtCu100

The type 1 converter also enables connection to a dual function average temperature and capacitance WB probe, such as Weed Beacon MWR. Wiring, however, requires the isolation of the RTD temperature signal from the capacitance WB signal on coaxial cable. The wiring of the temperature signal is exactly the same as Endress+Hauser’s 1700, 9909 and other RTD probes. The coaxial (WB) cable must be routed from the existing auxiliary capacitance to local HART (or 4 to 20 mA) converter via NMT539’s terminal compartment.

NOTICE

- NMT539 is only compatible with MRTs (Multi-Resistance Thermometers) and/or MSTs (Multi-Spot Thermometers). It is not designed to work with "Thermocouple" type thermometers.
- The physical connection between probe to NMT539 is completed by Zinc plated carbon steel G 3/4” (NPS 3/4”) universal threaded coupling. In case a different thread size is required, Endress+Hauser can provide the simplest and most efficient solution by adapting a variety of coupling sizes and materials based on existing temperature probe specifications.
- The power supply and data transmission lines are both fed to the host gauge, NMS5 or NRF560, by one pair of local HART loop connections. In addition to the user-friendly display, NMT539 can also be configured and operated via FieldCare. Type 2: Converter Only Version for Varec 1700, M20 threaded connection.
**Type 2: Converter Only Version**

Type 2: Measuring Function

Type 2 has the same function as Type 1, however type 2 is designed in a way so that special M20 threaded connection allows NMT539 converter to fit directly onto the current terminal housing of 1700.

The wiring of RTD signals from the probe to NMT539 must be done in the terminal box of 1700. Type 2 converter has a primary housing which contains NMT539 electronics. Therefore no secondary housing is needed.

⚠️ **CAUTION**

Secure the threaded connection with sealing tape and tighten the lock nut at the time of actual installation. A loose connection of NMT539 & Varec 1700 terminal housing may cause serious electrical damage depending on environmental conditions.

**Converter + Average Temperature Probe Version**

**NOTICE**

The position of the welded flange can not be adjusted.
Measuring Function

W&M approved high accuracy temperature device is well suited for both custody transfer and inventory control applications. Based on the product temperature range and specific application, NMT539 has several different temperature ranges to meet application requirements:

Temperature and Approvals

<table>
<thead>
<tr>
<th>Temperature Range</th>
<th>Application</th>
<th>010: Approval</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 -40 to +100 °C</td>
<td>Most standard temperature range for inventory control applications.</td>
<td>- ✓ - - ✓✓✓✓✓</td>
</tr>
<tr>
<td>2 -55 to +235 °C</td>
<td>Capability of high and/or low temperature product applications like sulfur &amp; asphalt and moderate liquid/gas application.</td>
<td>- ✓ - - ✓✓✓✓✓</td>
</tr>
<tr>
<td>3 -170 to +60 °C</td>
<td>Cryogenic, e.g. LNG, ethylene.</td>
<td>✓ ✓ - - ✓✓✓✓✓</td>
</tr>
<tr>
<td>4 -20 to +120 °C</td>
<td>PTB (Germany): W&amp;M certified applications.</td>
<td>- ✓ - - ✓✓✓✓✓</td>
</tr>
<tr>
<td>5 -20 to +100 °C</td>
<td>Most standard temperature range for inventory control applications.</td>
<td>✓ - - ✓ - - - -</td>
</tr>
<tr>
<td>6 -20 to +235 °C</td>
<td>Capability of high and/or low temperature product applications like sulfur &amp; asphalt and moderate liquid/gas application.</td>
<td>- ✓ - - ✓ - - -</td>
</tr>
</tbody>
</table>

NMT539 converter and average temperature probe consists of up to 16 IEC60751/DIN EN 60751 class A Pt100 elements in the protection tube. The very sensitive sensor elements change resistance values depending on the surrounding temperature. Therefore, applied voltage through this sensor deviates based on resistance change at the element.

As a specific design to meet intrinsically safe standards, NMT539 converter and temperature version is built with a very efficient power management concept.

In order to achieve the highest degree of measurement accuracy and mechanical & electrical durability, NMT539 employs a powerful processor, large storage capacity, and simple module structure.

To achieve the user-friendly concept, the newly adopted height adjuster allows the adjustment of the installation height up to approximately 360mm (14") at the process connection (flange) depending on the tank shape and condition.

W&M Function

NMT539 converter and temperature probe is custody transfer approved. Once NMT539 is configured to "W&M mode", all the changeable parameters are frozen by software and mechanical protect switch.
Converter + Average Temperature Probe + WB Probe Version

The position of the welded flange cannot be adjusted.

Measuring Function

NMT539 is available in the ultimate all-in-one 'Converter + Temp. + WB' version. Both temperature and WB data are fully accessible on one pair of local HART communication lines. Parameters can be configured via NMS5/NMS7, NRF560, and FieldCare.

The integrated WB sensor (capacitance water interface measurement) is set at the bottom of the average temperature probe. The standard WB measurement ranges are 1m (3.3 ft) and 2m (6.6 ft). The tube structured WB sensor is made of SUS304 pipe and exterior is protected by an additional 1mm thick PFA tube. Pt 100 elements are set inside of this tube structure, meaning that temperature measurement is not disturbed due to WB functionality.

⚠️ CAUTION

- Due to the characteristic of capacitance measurement, precise initial calibration must be performed in order to achieve the maximum measurement accuracy. The condition of tank contents (both oil & water), liquid temperature and individual probe characteristic can greatly effect the measurement performance. Specific accuracy & repeatability measurement must be taken within the same environment in order to perform data comparison.

- If water in the tank freezes, it is not possible to measure the water interface. Protect the water in the tank from freezing.
**WB Probe Design**

![WB Probe Design Diagram](image)

Figure 32: WB Probe Design, Unit of Measurement: mm (in)

**Welding Flange Type**

![Welding Flange Diagram](image)

Figure 33: Welding Flange, Unit of Measurement: mm (in)

Because flange is completely welded, the waterproof is improved. However the position of the flange cannot be adjusted after welding. The waterproof is only for TIIS.
Protective Cover for TIIS Exd [ia]

Figure 34: Protective Cover, Unit of Measurement: mm (in)

The cover is only for TIIS Exd [ia] specification.

**Weight**

- Approx. 13kg
- Condition:
- 16 elements
- Temp. probe: 10m
- WB probe: 1m
- NPS 2” Cl.150 RF, 316 flange ASME B16.5

**Material**

- Elements: Class A Pt100, IEC60751/DIN EN 60751/JIS C1604
- Housing: Aluminum die cast
- Temp. probe: SUS316, SUS316L (refer to drawing on 26 page)
- WB sensor: SUS316 (center rod SUS 304 & PFA protected)
## Human Interface

### Operation Using FieldCare

NMT539 can also be operated via FieldCare Package. These programs support commissioning, securing of data, signal analysis and documentation of the instruments.

FieldCare Packages support the following functions:
- Online configuration of transmitters
- Loading and saving of instrument data (Upload/Download)
- Confirmation of measuring points
Certificates and Approvals

CE Mark
By attaching the CE mark, Endress+Hauser confirms that the instruments pass the required tests.

Ex Approvals

<table>
<thead>
<tr>
<th>Ex Approval</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATEX</td>
<td>II 1/2 G Ex ia IIB T2 to T6 Ga/Gb (converter with temperature and/or WB) II 2G Ex ia IIB T2 to T6 Gb (converter only)</td>
</tr>
<tr>
<td>IECEx</td>
<td>Ex ia IIB T2 to T6 Ga/Gb (converter with temperature and/or WB) Ex ia IIB T2 to T6 Ga/Gb (converter only)</td>
</tr>
<tr>
<td>FM</td>
<td>IS Class I, Div. 1, Gp. C, D, T6, T4, T3, T2 Class I, Zone 0, AEEx ia IIB, T6, T4, T3, T2</td>
</tr>
<tr>
<td>CSA</td>
<td>Ex ia Class I, Div. I, Gp. C, D, T6 to T2 Ex ia IIB T6 to T2</td>
</tr>
<tr>
<td>TIIS</td>
<td>Ex ia IIB T4 Ex ia IIB T2 Ex d [ia] IIB T4</td>
</tr>
<tr>
<td>NEPSI</td>
<td>Ex ia IIB T2 to T6 (converter with temperature and/or WB) Ex ia IIB T2 to T6 (converter only)</td>
</tr>
</tbody>
</table>

PTB W&M Approval
PTB 14.70 08.01 (Germany)

External Standards and Guidelines

IEC 61326 Appendix: A, Immunity according to table A-1

EN 60529
Protection class of housing (IP-code)

EN 61326
Emissions (equipment class B), compatibility (appendix A - industrial area) EN61000-4-2 Immunity to electrostatic discharge
## Order Information

### 010 Approval:
- 0 Weather proof, IP65 NEMA4X
- 7 FM IS Cl.I Div.1 Gr.C-D
- 8 CSA IS Cl.I Div.1 Gr.C-D
- B ATEX Ex (ia) IIB T2-T6
- C TIIS Ex ia IIB T2
- A TIIS Ex ia IIB T4
- E TIIS Ex d (ia) IIB T4
- F IEC Ex ia IIB T2-T6 Ga
- G NEPSI Ex ia IIB T2-T6
- 9 Special version, TSP-no. to be spec.

### 020 Application:
- 0 Converter
- 1 Temperature, Converter
- 3 Temperature, Water Bottom, Converter
- 4 Temperature, Converter (PTB type approval)
- 5 Temperature, Converter, Water Bottom (PTB type approval)
- 9 Special version, TSP-no. to be spec.

### 030 Temperature Measuring Range:
- 0 Not selected
- 5 -20 ...+100 °C
- 7 -40 ...+100 °C
- 6 -20 ...+235 °C
- 2 -55 ...+235 °C
- 3 -170 ...+60 °C
- 4 -20 ...+120 °C (PTB type approval only)
- 9 Special version, TSP-no. to be spec.

### 040 Water Bottom Measuring Range:
- 0 Not selected
- 1 1m/3.3 ft.
- 2 2m/6.6 ft.
- 9 Special version, TSP-no. to be spec.

### 050 Cable Entry:
- A Thread G1/2
- B Thread NPT1/2
- D Thread M20
- Y Special version, TSP-no. to be spec.

### 060 Process Connection:
- 0 10K 50A RF, 316, flange JIS B2220
- 1 NPS 2" Cl.150 RF, 316 flange ASME B16.5
- 2 DN50 PN10 B1, 316, flange EN1092-1 (DIN2527 B)
- 3 50A 150lbs RF, 316, flange JPI 75-15
- 4 Universal coupling, G3/4, (Converter only)
- 5 Thread M20 (converter only)
- 9 Special version, TSP-no. to be spec.
### Temperature Element:

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2 x Pt100</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>3 x Pt100</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>4 x Pt100</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>5 x Pt100</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>6 x Pt100</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>7 x Pt100</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>8 x Pt100</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>9 x Pt100</td>
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</tr>
<tr>
<td>J</td>
<td>10 x Pt100</td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>11 x Pt100</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>12 x Pt100</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>13 x Pt100</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>14 x Pt100</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>15 x Pt100</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>16 x Pt100</td>
<td></td>
</tr>
<tr>
<td>Q</td>
<td>Not selected</td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td>Special version, TSP-no. to be spec.</td>
<td></td>
</tr>
</tbody>
</table>

### Temperature Element Spacing:

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>UK standard (converter only)</td>
</tr>
<tr>
<td>3</td>
<td>1m / 39°</td>
</tr>
<tr>
<td>2</td>
<td>1.5m / 59°</td>
</tr>
<tr>
<td>1</td>
<td>2m / 79°</td>
</tr>
<tr>
<td>5</td>
<td>3m / 118°</td>
</tr>
<tr>
<td>4</td>
<td>Requested spacing, defined by length</td>
</tr>
<tr>
<td>6</td>
<td>Not selected</td>
</tr>
<tr>
<td>9</td>
<td>Special version, TSP-no. to be spec.</td>
</tr>
</tbody>
</table>

### Probe Length:

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>...mm</td>
</tr>
<tr>
<td>C</td>
<td>...Gas-tight feed through</td>
</tr>
<tr>
<td>B</td>
<td>Not selected</td>
</tr>
<tr>
<td>Y</td>
<td>Special version, TSP-no. to be spec.</td>
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### Mounting Attachment:

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Not selected</td>
</tr>
<tr>
<td>B</td>
<td>Anchor weight, high profile (D120)</td>
</tr>
<tr>
<td>C</td>
<td>Anchor weight, low profile (hexagon H41)</td>
</tr>
<tr>
<td>D</td>
<td>Tension wire, wire hook, NPT1 top anchor</td>
</tr>
<tr>
<td>F</td>
<td>Tension wire, wire hook, R1 top anchor</td>
</tr>
<tr>
<td>G</td>
<td>Bottom hook, low profile</td>
</tr>
<tr>
<td>Y</td>
<td>Special version, TSP-no. to be spec.</td>
</tr>
</tbody>
</table>

---

**NOTICE**

090 Probe Length:
- A: .....mm (TIIS: 1000 ≤ L ≤ 30000), (ATEX & IECEx: 1000 ≤ L ≤ 99999), (FM & CSA & NEPSI: 1000 ≤ L ≤ 40000)
- B: .....Gas-tight feed through (TIIS: 1000 ≤ L ≤ 40000, flange welding type)
- Y: .....mm (TIIS: 30000 < L ≤ 40000)

---

Endress+Hauser
**Accessories**

**Anchor Weight (High Profile, D120)**

*Mounting Attachment Option: B*

This high profile anchor type is designed for converter + temperature probe versions.

**CAUTION**

Installation of the anchor weight will cause the lowest temperature measurement position to be raised approximately 400mm (16") from the tank floor.

For installing the high profile anchor from a tank top nozzle, confirm that the nozzle opening is 6 inches (150A) or more.

![Anchor Weight for High Profile](image)

Different dimensions, weight and material for the anchor weight are also available.

---

**Anchor Weight (Low Profile, Hexagon H41)**

*Mounting Attachment Option: C*

The low profile anchor weight is mainly designed to fix WB sensor, securing it straight up without shortening WB measuring range. It is also suitable for an existing tank installation with a small nozzle opening for converter and temperature version.

![Anchor Weight for Low Profile](image)

---

**Material:**
- Weight: JIS SS400 (Mild Carbon Steel)
- Eyebolt: JIS SS400 (Mild Carbon Steel)
- Weight: Approx. 16kg

**Dimensions:**
- 120 (4.72)
- 180 (7.09)
- 222 (8.74)

**Material:**
- Weight: JIS SS400 (Mild Carbon Steel)
- Eyebolt: JIS SS400 (Mild Carbon Steel)
- Weight: Approx. 12kg

**Dimensions:**
- 42 (1.65)
- 1040 (40.94)
- 48 (1.89)
**Wire Hook, Top Anchor**

**Mounting Attachment Option: D, F**

- **Material:** JIS SS400 (Mild Carbon Steel)
- **Weight:** Approx. 1.5kg

![Wire Hook Diagram]

Figure 37: Wire Hook, Unit of Measurement: mm (in)

Actual tension can be performed between wire hook and top anchor with using a tension wire (SUS316, stranded, 3mm diameter).

- **Material:** ADC (Aluminium)
- **Exterior:** JIS SS400 (Mild Carbon Steel)
- **Internal Parts:** SUS316, Carbon Steel
- **Weight:** Approx. 1.2kg

![Top Anchor Diagram]

Figure 38: Top Anchor Dimension, Unit of Measurement: mm (in)

**NOTICE**

The standard process connection of the top anchor is R1 or NPT1 threaded connection. However other sizes and materials can be used for the process connection and the flange.
## Documentation

### Technical Information

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>T00462G</td>
<td>Proservo NMS5</td>
</tr>
<tr>
<td>T00461G</td>
<td>Promonitor NRF560</td>
</tr>
<tr>
<td>T00463G</td>
<td>Servo Gauge TGM5</td>
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<tr>
<td></td>
<td>Digital Transmitter TMD1</td>
</tr>
</tbody>
</table>

### Operating Instructions

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BA01025G</td>
<td>Prothermo NMT539 (Installation Instructions)</td>
</tr>
<tr>
<td>BA01026G</td>
<td>Prothermo NMT539 (Operating Instructions and Description of Instrument Function)</td>
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### Certificates

<table>
<thead>
<tr>
<th>NMT539</th>
<th>TIIS</th>
<th>ATEX</th>
<th>IEC</th>
<th>NEPSI</th>
<th>FM</th>
<th>CSA</th>
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<tbody>
<tr>
<td>Temp. Converter</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Temp. and/or WB Sensor (Exi)</td>
<td>Ex63-820XJ</td>
<td>XA00585G-A</td>
<td>XA00583G-A</td>
<td>XA01259G</td>
<td>Ex61-851-1</td>
<td>Ex61-712-2</td>
</tr>
<tr>
<td>Average Temp. (High Temp.)</td>
<td>Ex95-823XJ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Temp. (Low Temp.)</td>
<td>Ex1060-953XJ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Temp. and/or WB Sensor (Ex d [ia])</td>
<td>Ex1061-986XJ</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Appendix

## Stainless Steel Conversion Table

The stainless steel material used in products of Endress + Hauser Yamanashi normally have expressions according to Japanese industrial standards, such as JIS (Japanese Industrial Standard). Each country or region may have different expressions.

The following conversion table contains the expression of equivalent stainless steel material based on chemical composition and mechanical properties.

<table>
<thead>
<tr>
<th>Country</th>
<th>Standard</th>
<th>Expressions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>JIS</td>
<td>SUS304</td>
</tr>
<tr>
<td>Germany</td>
<td>DIN 17006</td>
<td>X5 CrNi 18-10</td>
</tr>
<tr>
<td></td>
<td>W.N. 17007</td>
<td>1.4301 / 1.4303</td>
</tr>
<tr>
<td>France</td>
<td>AFNOR</td>
<td>Z 6 CN 18-10</td>
</tr>
<tr>
<td>Italy</td>
<td>UNI</td>
<td>X5 CrNi 1810</td>
</tr>
<tr>
<td>U.K.</td>
<td>BSI</td>
<td>304S15 / 304S16</td>
</tr>
<tr>
<td>U.S.A.</td>
<td>AISI</td>
<td>304</td>
</tr>
<tr>
<td>E.U.</td>
<td>EURONORM</td>
<td>X6 CrNi 1810</td>
</tr>
<tr>
<td>Spain</td>
<td>UNE</td>
<td>X6 CrNi 19-10</td>
</tr>
<tr>
<td>Russia</td>
<td>GOST</td>
<td>08KH18N10</td>
</tr>
<tr>
<td></td>
<td>ISO</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>ASME</td>
<td>S30400</td>
</tr>
</tbody>
</table>

**NOTICE**

Standards may be not necessarily correspond exactly to JIS, because they are defined by mechanical and chemical criteria.