MICROCYBER

NCS-TT105

Smart temperature transmitter

User manual

Warning

1. It is forbidden to disassemble the temperature module by user.

2. Please check if the supply voltage of temperature transmitter meets the power supply voltage requirements in the manual.

Version： V3.0

Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions. Any suggestions for improvement are welcome.

Microcyber Corporation 2022

The technical data may change at any time.

Company Introduction

Microcyber Corporation established as a high-tech enterprise by the Shenyang Institute of Automation Chinese Academy of Sciences, mainly engages in advanced industrial control systems, equipments, instruments and chips for industrial process automation control solutions in the research, development, production and application. Microcyber undertakes a number of national scientific and technical key task and "863" project, and has Liaoning Province networked control systems engineering research center.

Microcyber successfully developed the first domestically certified fieldbus protocol master stack, the first nationally certified fieldbus instrument, and the first domestic safety instrument certified by German TüV, and co-hosted with other units It has formulated the first domestic industrial Ethernet protocol standard EPA and the first industrial wireless communication protocol standard WIA-PA, which have become IEC international standards.

The products and technologies of Microcyber have won two second prizes of National Science and Technology Progress Award, one National Science and Technology Invention Award, one first prize of Science and Technology Progress of Chinese Academy of Sciences, and one first prize of Liaoning Province Science and Technology Progress. The products are exported to Europe and the United States, etc. In developed countries, top companies in the industry such as Emerson in the United States, Rotork in the United Kingdom, and Bifold in the United Kingdom have adopted Microcyber 's key technologies or key components in their products, and have successfully completed more than 200 large-scale automation engineering projects.

Microcyber passed the Authentication of ISO 9001 Quality System, and has an outstanding innovative R&D team, plentiful practical experiences of design of the Automatic engineering, a leading product series, a huge market network, a strict quality management system and an excellent enterprise culture. All these further a solid foundation of entrepreneurship and sustainable development for Microcyber.

Carrying the ideals of employees, creating customer value and promoting enterprise development.

Content

~ III ~

1 OVERVIEW

NCS-TT105 smart temperature transmitter adopts fieldbus technology, is a new generation of fieldbus smart temperature transmitter, and is an indispensable field device in process control. The device integrates rich functional modules, which can realize both general detection functions and complex control strategies.

NCS-TT105 adopts digital technology, which can be applied to a variety of thermal resistance and thermocouple sensors, with a wide range, simple interface between the field and the control room, and can greatly reduce the cost of installation, operation and maintenance.

NCS-TT105 smart temperature transmitter supports HART, FF, PA protocol and can be widely used in petroleum, chemical, power plant, metallurgy and other industries.

● The dimensions of the smart temperature transmitter are shown in the Figure 1.1 below:
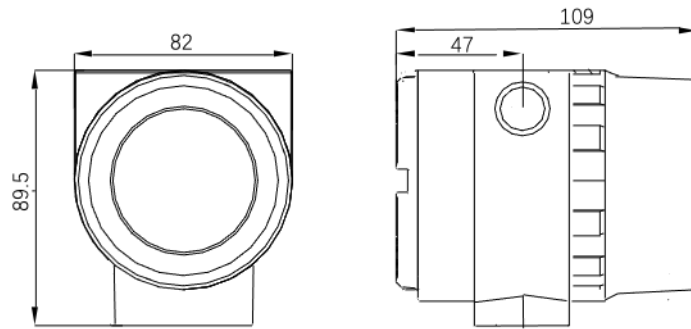
Figure 1.1 Dimensions of temperature transmitter (unit: mm)

2 INSTALLATION

2.1 Transmitter Installation

For the installation of smart temperature transmitter, there are three types of mounting brackets available: tube-mounted flat bracket, tube-mounted curved bracket, and disk-mounted curved bracket. Correspondingly, there are three installation methods, namely flat bracket tube installation, curved bracket plate installation, and curved bracket tube installation. The installation methods are described below:

A typical installation of **flat bracket tube installation** is shown in Figure 2.1,fix the transmitter on the tube-mounted flat bracket, and then fix the tube-mounted flat bracket to the vertical tube of about Φ50mm through U-bolts.。

Figure 2.2 shows the typical installation method of the **curved bracket plate installation**. Fix the transmitter on the panel mounting bracket, and then fix the panel mounting bracket on the dial with M10 bolts (provided by the user).

Figure 2.3 ＆ Figure 2.4 show the typical installation method of the **curved bracket tube installation**. Fix the transmitter on the tube mount bracket, and then fix the tube mount bracket to the horizontal pipe of about Φ50mm through U-bolts.
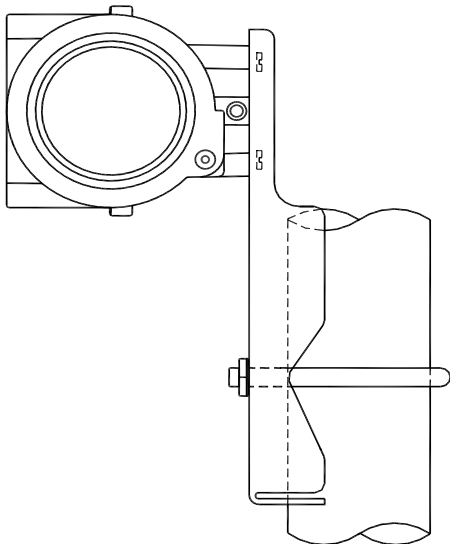
Figure 2.1 Flat bracket tube installation
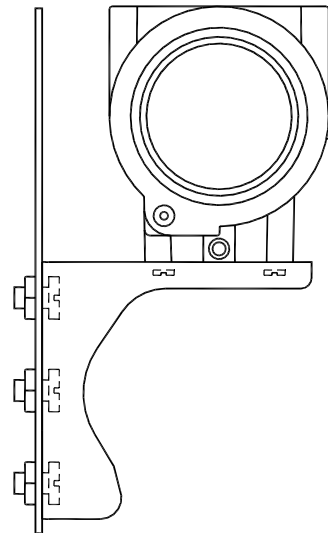
Figure 2.2 Curved bracket plate installation
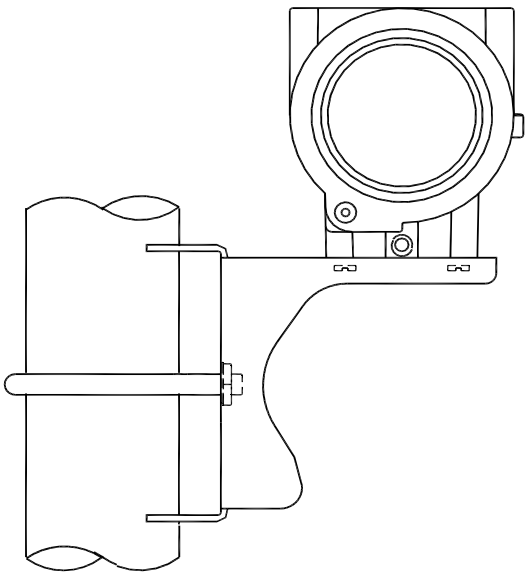
Figure 2.4 curved bracket tube installation 1
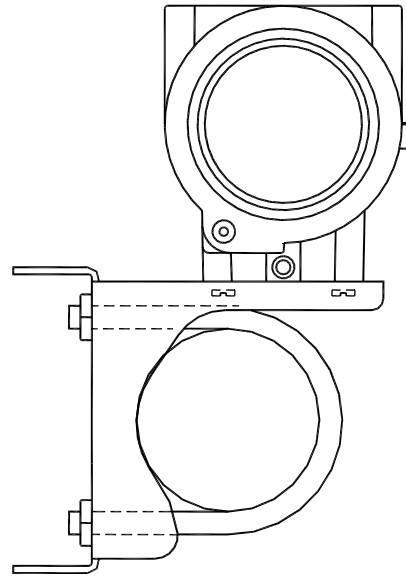
Figure 2.3 curved bracket tube installation 2

2.2 Hardware Interface

The overall hardware interface diagram of the temperature transmitter is shown in Figure 2.5:
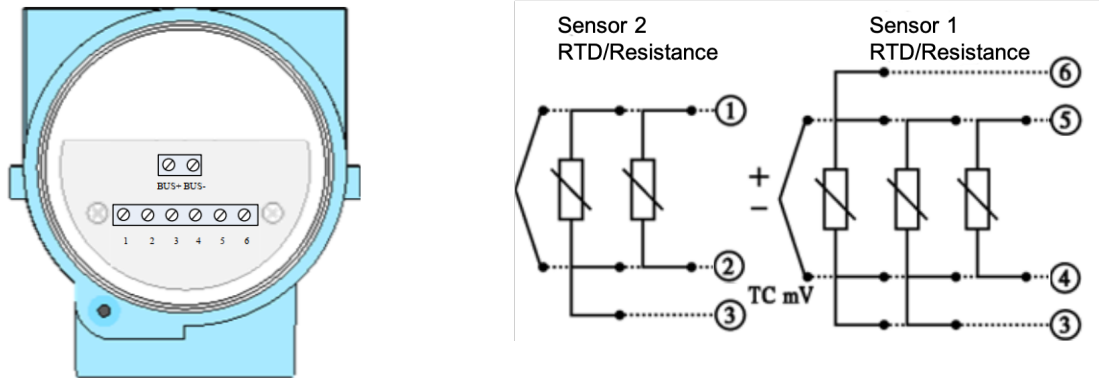
Figure 2.5 Hardware Interface Description

Sensor Input 1								
		RTD 2-wire	RTD 3-wire	RTD 4-wire	Resistance 2-wire	Resistance 3-wire	Resistance 4-wire	Thermocouple	mV
Sensor Input 2	RTD 2-wire	☑	☑	☑	X	X	X	☑	X
	RTD 3-wire	☑	☑	☑	X	X	X	☑	X
	Resistance 2-wire	X	X	X	☑	☑	☑	X	X
	Resistance 3-wire	X	X	X	☑	☑	☑	X	X
	Thermocouple	☑	☑	☑	X	X	X	☑	X
	mV	X	X	X	X	X	X	X	☑

Figure 2.6 Sensor Wiring Instructions

For two-channel measurements, both channel units must have the same settings (e.g. both temperature units).

● Failure Alarm Setting

The HART temperature transmitter has a self-diagnostic function. When faults are detected, such as sensor open circuit, sensor short circuit or AD error, the transmitter will automatically output alarm current. The mode of alarm current depends on the setting of fault alarm current dial switch on communication card. When the "AL" dial switch is on the side of OFF, the alarm current is higher than 21.75 mA. When the AL dial switch is on

the ON side, the alarm current is <3.7mA.

- Configuration protection settings

HART temperature transmitter provides dial switch settings for device configuration protection or not. When the configuration protection status is set, the dial switch is transferred to the ON side and the socket card does not allow any operation to change the configuration of the device. Conversely, a dial switch on the OFF side allows configuration changes to be made to the device.

2.3 Bus Power Interface

The power supply of the temperature transmitter in the fieldbus shares a pair of cables with the bus signal, called the bus cable.

Bus cables should not share pipes or open slots with power lines of high-power equipment and should be kept away from high-power equipment. The shield wires at both ends of the bus should be grounded.

3 FF SMART TEMPERATURE TRANSMITTER CONFIGURATION

3.1 Topological connection

FF transmitter supports many kinds of connection, as shown in Figure 3.1. There is a transmitter bus connection; the bus ends are connect terminal matching resistance, which ensures the signal quality, as shown in Figure 3.2.The maximum length of bus is 1900 meters and it can be prolonged to 10 kilometers with repeaters.
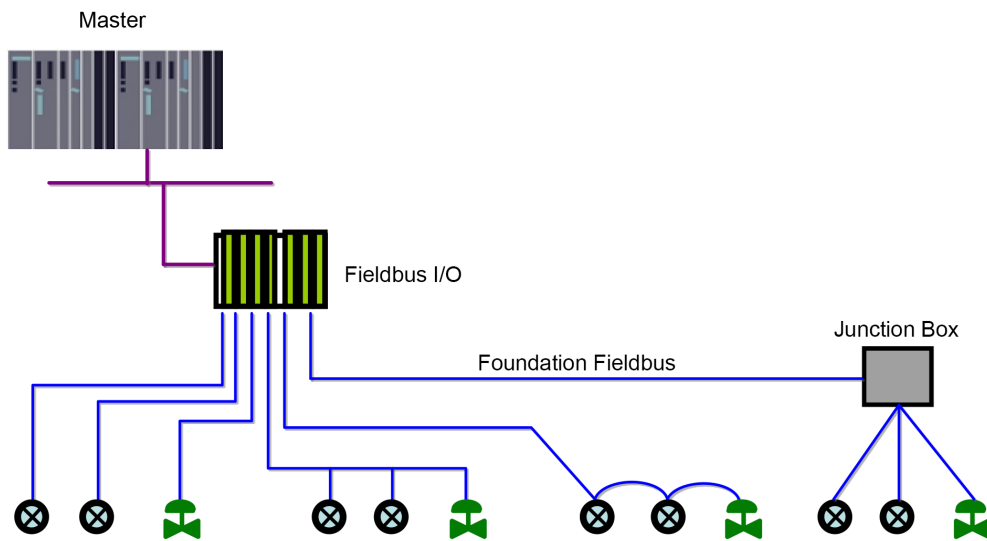

Figure 3.1 FF network topology
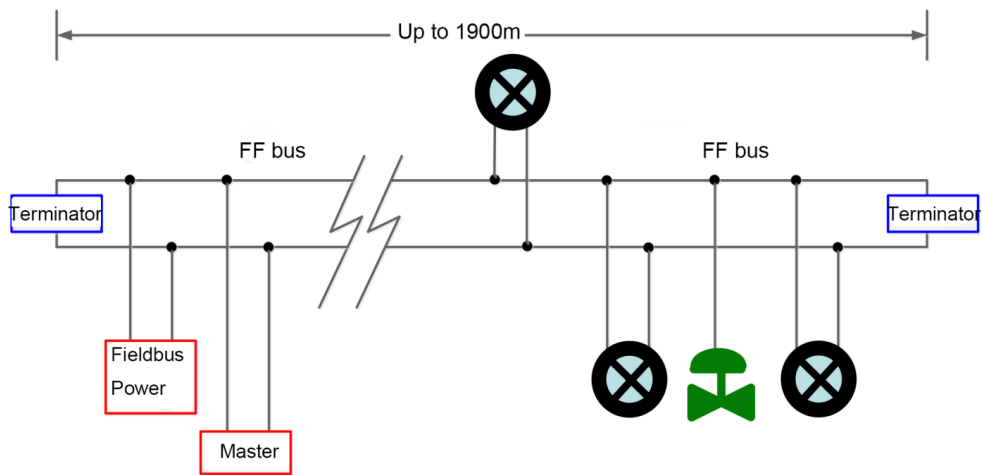
Figure 3.2 FF bus connection

3.2 Function Block

FF smart transmitters carries out the FF standard function blocks, shown as the table below. Please refer to related FF protocol document for detailed info about configuration methods of function blocks.

Function Block	Description
RES	Resource block is used to describe the device identity in the field, such as device name, manufacture, serial number. There is no input or output parameter in the resource block. Generally, there is only one resource block for each device.
TEMP_SENSORX	Transducer block is used to read sensor hardware data, or write the data in the field to related hardware. Transducer block includes the info such as range, sensor type, linearization, I/O data, etc.
DSP	DSP block is used to configure display info in LCD.
PID	PID function block has the function of PID control and setting point adjustment, process value(PV) filtering and alarm, output tracking, etc.
AI	Analog input function block is used to achieve transducer block input data and transfer to other function blocks, has the function of range conversion, square root, cut mantissa, etc.
IS	This block has four analog inputs that may be selected by an input parameter or according to a criterion as first good, maximum, minimum, middle and average.
SC	This block has capability for two signal characteristics based on the same curve. The second input has an option for swapping "x" to "y", and inverse function may be used in signal characteristic of read-back variables.
AR	This module is designed to allow easy use of popular measurement math functions.
OS	The output splitter block provides the ability to drive two control outputs from a single input. Each output is a linear function of some portion of the input.

3.3 Function configuration

The smart temperature transmitter supports general FF configuration software such as FF configuration software and NCS4000 configuration software of Microcyber, NI-FBUS Configurator of NI Company, and DeltaV of Rosemont Company for configuration and debugging. The following mainly takes the FF configuration software of Microcyber as an example to introduce the configuration method of the smart temperature transmitter.

3.3.1 Configuration tool

1)   PC, the operating system is Windows XP, Windows7 or Windows10;

2)   NI USB-8486,H1 bus power supply, H1 terminal matcher;

3)   NI-FBUS Configurator；

3.3.2 Sensor type configuration

Sensor type can be set by modifying SENSOR_TYPE parameter of transducer block, such as PT100, CU50.
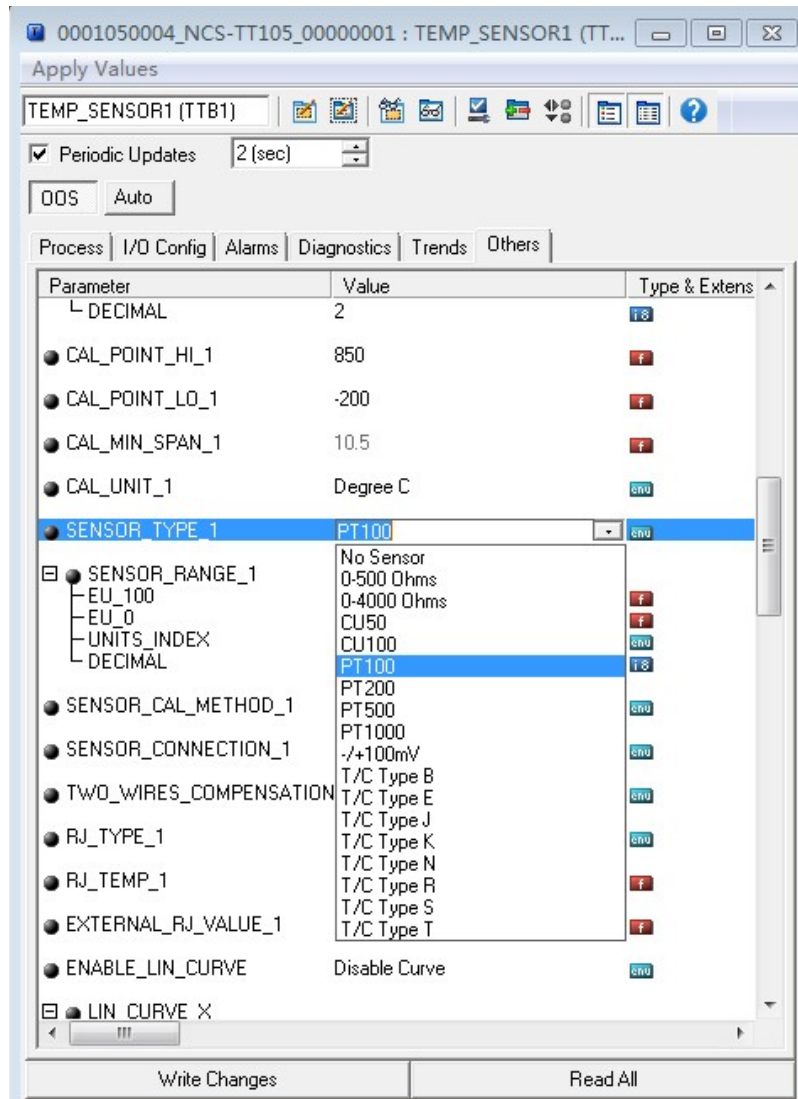
Figure 3.3 Sensor type configuration

3.3.3 Two-wire zero point calibration configuration

For two-wire measurement, the two-wire zero point calibration can be set by modifying TWO_WIRES_COMPENSATION parameter of transducer block. Firstly, give zero point value to channel making a short circuit. Then set the TWO_WIRES_COMPENSATION parameter as "Start" to write in. If it is successful, read the parameter. If the parameter value is "Finished", it indicates that two-wire zero point calibration is successful.

3.3.4 Enable cold junction compensation

When using a thermocouple as a sensor, the parameter SENCONDARY_VALUE of the transformer block represents the temperature value of the cold junction. The sensor enables the cold junction compensation function by default. Users can also set the cold junction compensation through the parameter RJ_TYPE. If it is set to Internal, the cold junction compensation is enabled. In this case, the value of PRIMARY_VALUE is the temperature value after cold junction compensation. If it is set to no reference, the cold junction compensation is disabled. At this time, the value of PRIMARY_VALUE is the temperature value without cold junction compensation.

3.3.5 Two-point linearization calibration

Temperature transmitter has strict calibration in factory. Generally, it is not necessary for user to calibrate. User can use CAL_POINT_HI, CAL_POINT_LO and CAL_UNIT to carry out two-point linearization calibration. Operation steps shown as following:

1) Make sure and set SESOR_TYPE, and set CAL_UNIT according to sensor type. Now it supports Celsius, Ohms and MV.

2) Set transducer block MODE parameter as "OOS", and then set the SENSOR_CAL_METHOD as "User Trim Standard Calibration".

3) Give standard data to channel to calibrate via standard source, when the input is stable, write calibration data to CAL_POINT_HI or CAL_POINT_LO according to upper limit calibration or lower limit calibration. It is successful if there is no write error. **Notes: The calibration will be fail if there is a great deviation between write-in calibration data and practical input channel data.**

3.3.6 Multi-point linearization calibration

User can carry out the second calibration for transmitters via calibration parameters CAL_CURVE_X and CAL_CURVE_Y of transducer blocks:

1) The smart temperature transmitter provides 16 calibration point inputs, that is, the parameter CAL_POINT_Y array of the transformation block. The user can sequentially write the output values to be calibrated into the array and select a good unit. For example, when performing three-point interpolation calibration, the user can select 10, 20, and 30 as the calibration points, and write these three values in the CAL_POINT_Y array in turn, as shown in Figure 3.4.
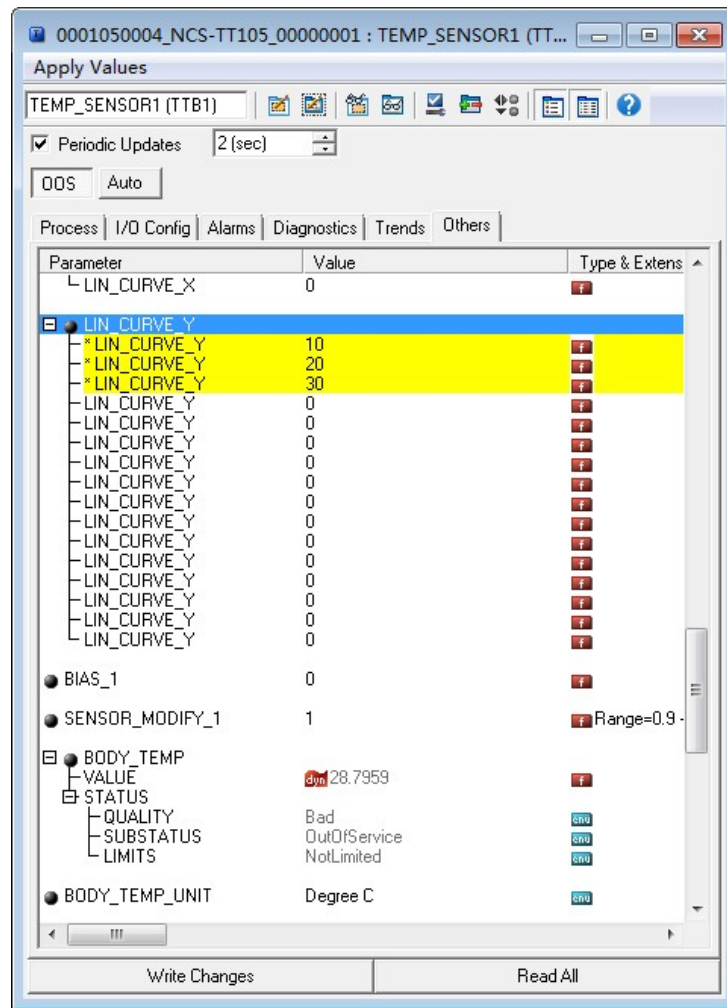
Figure 3.4 CAL_POINT_Y configuration

2) Input standard signal via standard source, open the related transducer block, read the PRIMARY_VALUE value and write it to the CAL_POINT_X array. For example, if the read value is 10.2, 20.5, 30.4, are written to the CAL_POINT_X array, shown as Figure 3.5. The calibration is finished.

Figure 3.5 CAL_POINT_X configuration

3) Set SENSOR_CAL_METHOD as "User Trim special Calibration" and set ENABLE_LIN_CURVE as "Enable Curve", which makes the smart transmitter work according to calibrated characteristic curve.

3.3.7 User Default Configuration

The user can save and restore the custom default configuration parameters through the user default configuration USERPARM_SAVE_RST of the transform block. The specific parameter configuration is as follows:

1) Save as user default:Set the current configuration parameters as user default configuration parameters.

2) Reset user default:Restore the configuration parameters to user-defined configuration parameters.

3.3.8 LCD Configuration

By default, the smart temperature transmitter display shows four groups of display information, as shown in

Figure 3.6 .If the user needs to display other function block parameter information, it can be configured as follows (X stands for 1, 2, 3, 4, there are four groups of parameters in total, and each group can be configured differently. The smart temperature transmitter can display four groups of different parameter information cyclically). If the parameter configuration is incorrect, the display of the smart temperature transmitter will only show CONFIG_ERR.

1) DISP_VALUE_X:This parameter is the display parameter. After the data source is selected, the data and status are automatically loaded.

2) DISP_VALUE_UNIT_X:This parameter is the display parameter data unit. After the data source is selected, the data units are automatically loaded.

3) DISP_SOURCE__X:This parameter is the display parameter data source. Can be selected by the user. For example, to display PV2, select Primary Value 2.

4) DISP_VALUE_FORMAT_:This parameter is the display parameter format, which can be selected by the user.
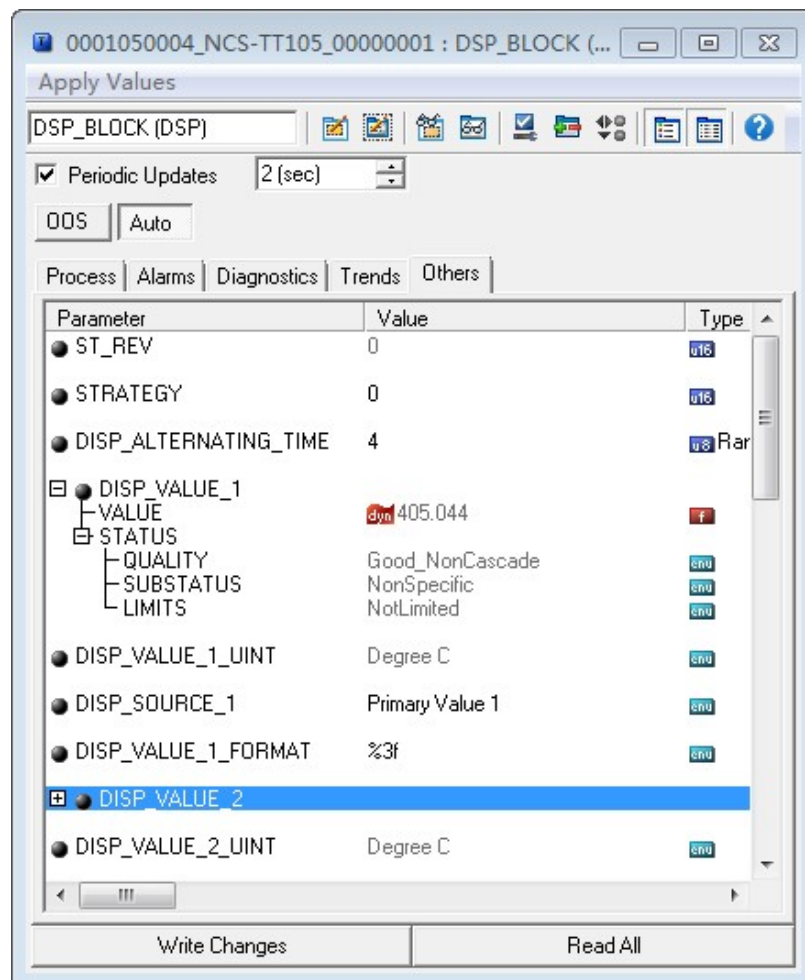
Figure 3.6 Parameter configuration for display block

4 PA SMART TEMPERATURE TRANSMITTER CONFIGURATION

4.1 Topological Connection

A PROFIBUS PA network topology can have a variety of different structures, as shown in Figure 4.1Figure 4.2 shows the bus connection of the PA instrument. Both ends of the bus need to be connected to terminating resistors to ensure the quality of the bus signal. The bus has a maximum length of 1,900 m and can be extended to 10 km using a repeater.

Figure 4.1 PROFIBUS PA network topology

Figure 4.2 PROFIBUS PA bus connection

4.2 Functional Block

The PA-type smart transmitter implements the PA standard function block, as shown in the table below. For the function block configuration method, please refer to the PROFIBUS PA regulation.

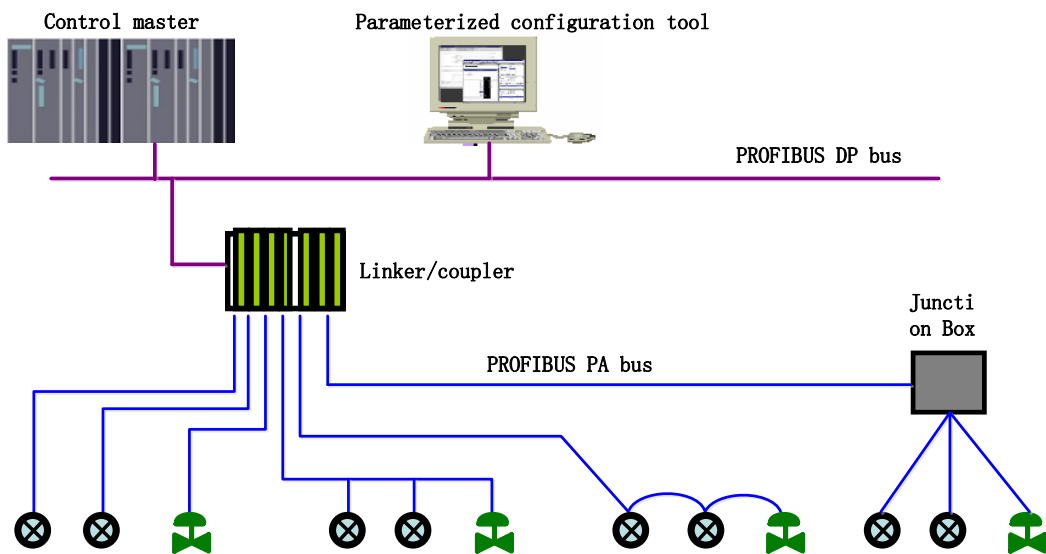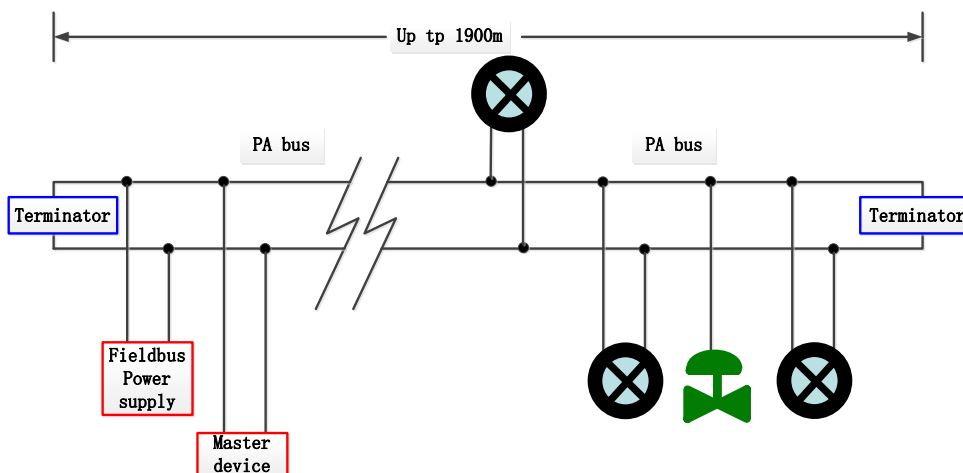| Function block name	Functional block description
Physical Block	The Physical Function Block (PB). Specific hardware information and identification and diagnosis information are described, including the device bit number, software version, hardware version, installation date, etc
Transducer Block1	Convert Block (TB). Separating the functional block from the input and output characteristics of the instrument, it mainly completes the calibration and linearization of the input and output data, and provides the processed data to the AI functional block through the internal channel
Transducer Block2	Transducer Block (TB). Separating the functional block from the input and output characteristics of the instrument, it mainly completes the calibration and linearization of the input and output data, and provides the processed data to the AI functional block through the internal channel
Analog Input Block1	Analog Quantity Input function block (AI). The simulated process values are obtained from the conversion block through the internal channels, which are processed, and the appropriate measurements are provided to the main station equipment through the bus communication
Analog Input Block2	Analog Quantity Input function block (AI). The simulated process values are obtained from the conversion block through the internal channels, which are processed, and the appropriate measurements are provided to the main station equipment through the bus communication
Analog Input Block3	Analog Quantity Input function block (AI). The simulated process values are obtained from the conversion block through the internal channels, which are processed, and the appropriate measurements are provided to the main station equipment through the bus communication
Analog Input Block4	Analog Quantity Input function block (AI). The simulated process values are obtained from the conversion block through the internal channels, which are processed, and the appropriate measurements are provided to the main station equipment through the bus communication

4.3 Functional Configuration

The parameter configuration of PA smart transmitter follows PROFIUBS PA regulation version 3.02. You can read and write the function block parameters of the transmitter using Siemens device management software Simatic PDM, or configure the transmitter using Siemens Step7 configuration software.

4.3.1 Functional Configuration

1)   PC machine, the operating system is Windows 2000 or Windows XP;

2) Siemens Step7 Configuration Software, Siemens PDM Equipment Management software;

3) DP / PA coupler or linker;

4) Class 1 main station such as PLC, class 2 main station such as CP5611 card;

5) PA terminal Mater;

6) Standard temperature source.

4.3.2 Temperature Transducer Block Parameter Configuration

The transducer block separates the function block from physically proprietary I / O devices, such as sensors and actuators, which relies on the implementation of the device vendor to access or control the I / O devices. Through access to the I / O device, the transducer block can acquire the input data or set the output data. Generally, the conversion blocks have the functions of linearization, characterization, temperature compensation, control, and exchange of data.The structure of the transducer block is shown in Figure 4.3.

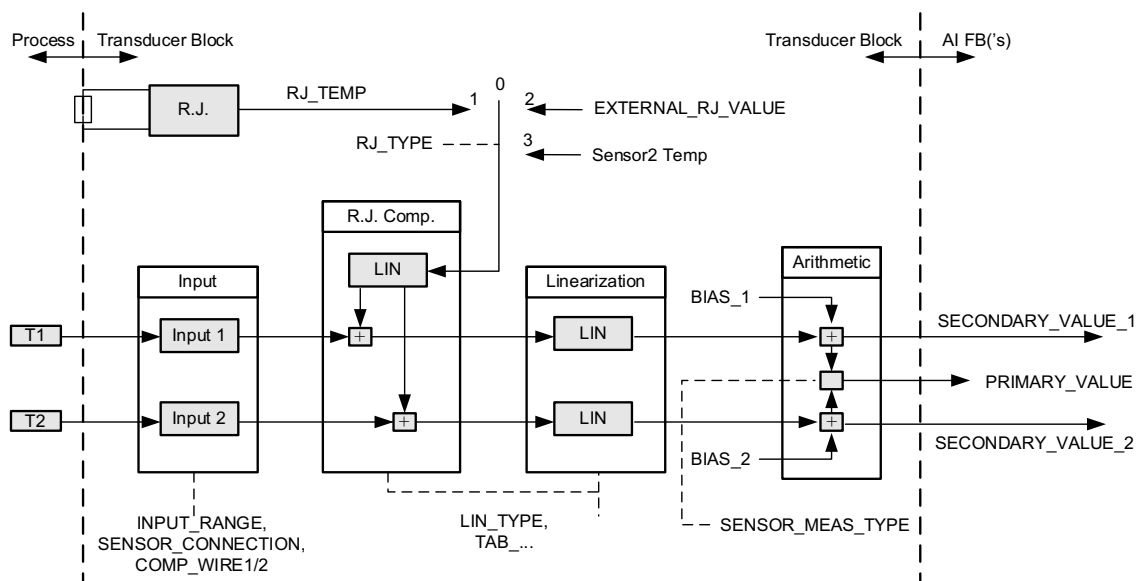Figure 4.3 transducer block structure

The parameters of the conversion blocks are shown in the following table:

Parameter	Functional description
INPUT_FAULT_GEN	Enter a fault: An error diagnostic object with all values. 0: Equipment is normal Bit 0: Rj error Bit 1: A hardware error Bits 2-4: reserved

Parameter	Functional description
	Position 5: vendor designation Bit 6: a communication error Position 7: vendor designation
INPUT_FAULT_1	Enter fault: SV_1 related error diagnostic object. 0: Input is normal Bit 0: reserved Bit 1: above the upper limit range Position 2: open circuit Bits 3-5: reserved Bit 6: a communication error
INPUT_FAULT_2	Enter fault: SV_2 related error diagnostic object. See bit: INPUT_FAULT_1
BIAS_1	Channel 1 Process variable deviation values. The unit is specified by PRIMARY_VALUE_UNIT.
BIAS_2	Channel 2 Process variable deviation values. The unit is specified by PRIMARY_VALUE_UNIT.
INPUT_RANGE	0: mV range 1 => mV 100 128: Range 1 => Ohm 500 129: Range 2 => Ohm 4000
LIN_TYPE	Linear type.
SENSOR_MEAS_TYPE	Sensor mathematical function type. The encoding is as follows: 0: PV = SV_1 1: PV = SV_2 128: PV = SV_1-SV_2 difference 129: PV = SV_2-SV_1 difference 192: PV = ½ * (SV_1 + SV_2) average 193: PV = ½ * (SV_1 + SV_2) redundant value 220: PV= SV_1 hot spare value
SENSOR_WIRE_CHECK_1	Enables open circuit detection or short circuit detection. The encoding is as follows: 0: Open circuit detection, short circuit detection are enabled; 1: Open circuit detection enabling and short circuit detection is prohibited; 2: Open circuit detection is prohibited and short circuit detection is enabled 3: Open circuit detection and short circuit detection are prohibited.

Parameter	Functional description
SENSOR_WIRE_CHECK_2	Enables open circuit detection or short circuit detection. The encoding is as follows: 0: Open circuit detection, short circuit detection are enabled; 1: Open circuit detection enabling and short circuit detection is prohibited; 2: Open circuit detection is prohibited and short circuit detection is enabled 3: Open circuit detection and short circuit detection are prohibited.
PRIMARY_VALUE	Transmitter measurements and status. The unit is specified by PRIMARY_VALUE_UNIT.
PRIMARY_VALUE_UNIT	Transmitter measurement value engineering unit code.
UPPER_SENSOR_LIMIT	Sensor physical upper limit value.
LOWER_SENSOR_LIMIT	Sensor physical lower limits.
SECONDARY_VALUE_1 (SV_1)	Process values and states derived from channel 1 and corrected by BIAS_1. The unit is specified by PRIMARY_VALUE_UNIT.
SECONDARY_VALUE_2 (SV_2)	Process values and states derived from channel 2 and corrected by BIAS_2. The unit is specified by PRIMARY_VALUE_UNIT.

The thermocouple additional parameters are shown in the following table:

Parameter	Functional description
EXTERNAL_RJ_VALUE	Fixed values from an external reference point. The unit is specified by PRIMARY_VALUE_UNIT. If the unit of PRIMARY_VALUE_UNIT is not a temperature unit (for example: mV), the unit is set to ℃.
RJ_TEMP	Fixed values from an external reference point. The unit is specified by PRIMARY_VALUE_UNIT. If the unit of PRIMARY_VALUE_UNIT is not a temperature unit (for example: mV), the unit is set to ℃.
RJ_TYPE	Set the reference point type. The encoding is as follows: 0: No reference, no use of compensation; 1: Internal reference point temperature of the equipment; 2: External, the reference point temperature from the outside; 3: Temperature measured in S ensor 2 channel 2 (Sensor 1 support only); Default selection of 1.

Additional thermoelectric resistance parameters are shown in the following table：

Parameter	Functional description
COMP_WIRE1	Linear compensation of 2 or 3 for thermal resistance 1. Units are fixed to Ω.
COMP_WIRE2	Linear compensation for thermostor 2. Units are fixed to Ω.
SENSOR_CONNECTION	Sensor 1, Sensor 2 can choose 2,3,4 (only Sensor 1 support) to connect to the sensor. 0: Second line system; 1: third line system; 2: four line system.

The manufacturer custom parameters are shown in the following table:

Parameter	Functional description
SENSOR_VALUE_1	Sensor 1 raw data value.
SENSOR_VALUE_2	Sensor 2 raw data value.
CAL_POINT_HI	Maximum point calibration value. The unit is specified by CAL_UNIT.
CAL_POINT_LO	Minpoint calibration value. The unit is specified by CAL_UNIT.
CAL_MIN_SPAN	Minimum step length allowed during the calibration. This minimum step size ensures a smooth calibration process, so that the highest minimum point of the calibration is not too close, and the unit is specified by CAL_UNIT.
CAL_UNIT	Calibration unit. Currently it only supports Celsius, and ohms and millivolt.
TWO_WIRES_COMPENSATION	Two-line system of zero-point compensation.
CUSTOM_TC_NAME	To store the name of the user-custom TC type.
CUSTOM_TC_POLY_COUNT	Number of user-custom TC type polynomials: 1~5
CUSTOM_TC_MIN_IN	User-custom TC type minimum input value (x).
CUSTOM_TC_MIN_OUT	User-custom TC type minimum output value (y).
CUSTOM_TC_MAX_OUT	User-custom TC type maximum output value (y).
CUSTOM_TC_POLY1	The first set of user-custom TC type polynomial coefficients consists of 6 data: Upper limit of the first paragraph, x^0coefficient a, x^1coefficient b, x^2coefficient c, x^3coefficient d, x^4coefficient e.
CUSTOM_TC_POLY2	The second group of user-custom TC type polynomial coefficients consists of 6 data: The second paragraph upper limit, x^0coefficient a, x^1coefficient b, x^2coefficient c,

	x^3coefficient d, x^4coefficient e.
CUSTOM_TC_POLY3	The third group of user-custom TC type polynomial coefficient consists of 6 data: The third paragraph, the upper limit, x^0coefficient a, x^1coefficient b, x^2coefficient c, x^3coefficient d, x^4coefficient e.
CUSTOM_TC_POLY4	The fourth group of user-custom TC type polynomial coefficient consists of 6 data: Upper limit of paragraph 4, x^0coefficient a, x^1coefficient b, x^2coefficient c, x^3coefficient d, x^4coefficient e.
CUSTOM_TC_POLY5	The fifth group of user custom TC type polynomial coefficient consists of 6 data: Upper limit of paragraph 5, x^0coefficient a, x^1coefficient b, x^2coefficient c, x^3coefficient d, x^4coefficient e.
CUSTOM_TC_RJ_POLY	User custom TC type cold end temperature polynomial coefficient, a total of 4 data composition: x^0coefficient a, x^1coefficient b, x^2coefficient c, x^3coefficient d.

CUSTOM_RTD_NAME	To res the name of the user custom RTD type.
CUSTUM_RTD_POLY_COUNT	Number of user-custom RTD type polynomials: 1~5
CUSTOM_RTD_MIN_IN	User-custom RTD type minimum input value (x).
CUSTOM_RTD_MIN_OUT	User-custom RTD type minimum output value (y).
CUSTOM_RTD_MAX_OUT	User-custom RTD type maximum output value (y).
CUSTOM_RTD_POLY1	The first set of user-custom RTD type polynomial coefficients consists of 6 data: Upper limit of the first paragraph, x^0coefficient a,x^1coefficient b,x^2coefficient c,x^3coefficient d,x^4coefficient e.
CUSTOM_RTD_POLY2	The second group of user-custom RTD type polynomial coefficients consists of 6 data: The second paragraph upper limit, x^0coefficient a, x^1coefficient b, x^2coefficient c, x^3coefficient d, x^4coefficient e.
CUSTOM_RTD_POLY3	The third group of user-custom RTD type polynomial coefficient consists of 6 data: The third paragraph, the upper limit, x^0coefficient a, x^1coefficient b ,x^2coefficient c, x^3coefficient d, x^4coefficient e.
CUSTOM_RTD_POLY4	The fourth group of user-custom RTD type polynomial coefficient consists of 6 data: Upper limit of paragraph 4, x^0coefficient a, x^1coefficient b, x^2coefficient c, x^3coefficient d, x^4coefficient e.
CUSTOM_RTD_POLY5	The fifth group of user custom RTD type polynomial coefficient consists of 6 data: Upper limit of paragraph 5, x^0coefficient a, x^1coefficient b, x^2coefficient c,

	x³coefficient d, x⁴coefficient e.
TAB_ENTRY	Calibration table current selection index.
TAB_X_Y_VALUE	Value of the current selection item of the calibration table (x, y)
TAB_MIN_NUMBER	Minimum points of the calibration table.
TAB_MAX_NUMBER	Maximum points of the calibration table.
TAB_OP_CODE	Calibrate the form operating method.
TAB_STATUS	Calibrate the table operating status.
TAB_ACTUAL_NUMBER	Actual number of points of the calibration table.

4.3.3 PROFIBUS The Loop Data Communication Configuration

The circular data communication of PROFIBUS DP refers to the class 1 master station and slave station to exchange input and output data in the primary and secondary polling mode, and the communication mode is unconnected. In each cycle, the class 1 master station actively sends the data exchange request, while the slave station passively responds to the request of the main station. The cyclic data communication is mainly applied to the configuration of the slave station and the PLC master station equipment. Through the cyclic data communication, the master station PLC obtains the input data of the slave station or exports the output data to the slave station in real time.

The circular data communication configuration of PA smart transmitter is basically the same as that of PROFIBUS DP slave station, but the use of coupler or linker between PA bus and DP bus is needed.

The PA smart transmitter cycle data comes from the output parameters of 4 AI functional blocks in the device, and each A I transmits 5 bytes, including 4 bytes of floating-point data and 1 byte of status data. For recurrent communication, the transmitter supports two identifiers, namely, the short identifier 0x94 and the long identifier 0x42,0x84,0x08,0x05. Cyclic data communication configuration of PROFIBUS PA can be performed using Siemens Step7.

Examples of PA transmitters using Siemens Step7 are given below.

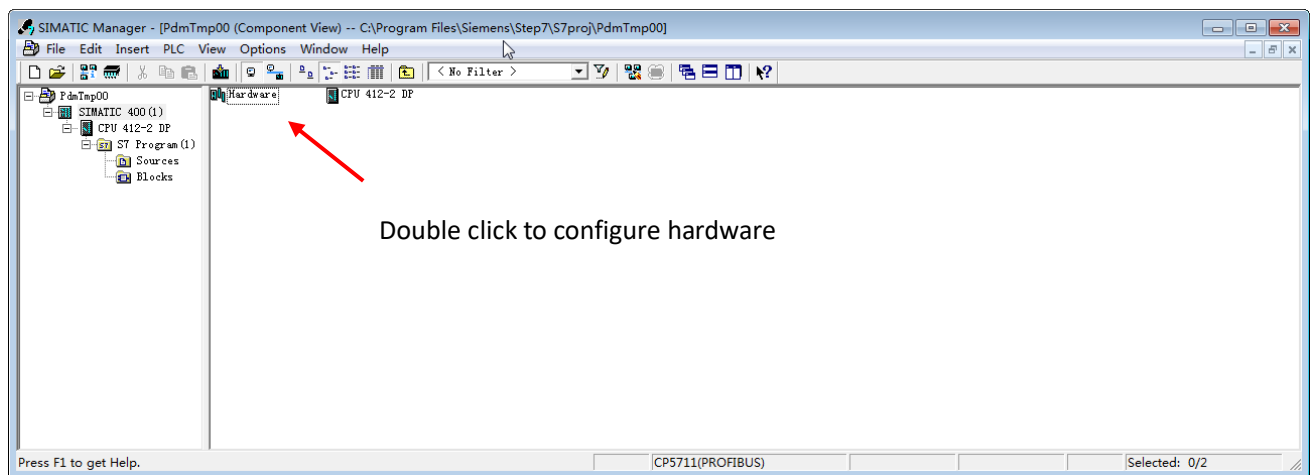Open SIMATIC Manager, select PLC master and create a new project, see Figure 4.4.

Figure 4.4 Select the PLC master station and build a new project

Double-click Hardware to punch in the HW Config software and hardware configuration. Select the GSD file for the Install GSD Install PA transmitter in the Option menu, see Figure 4.5.
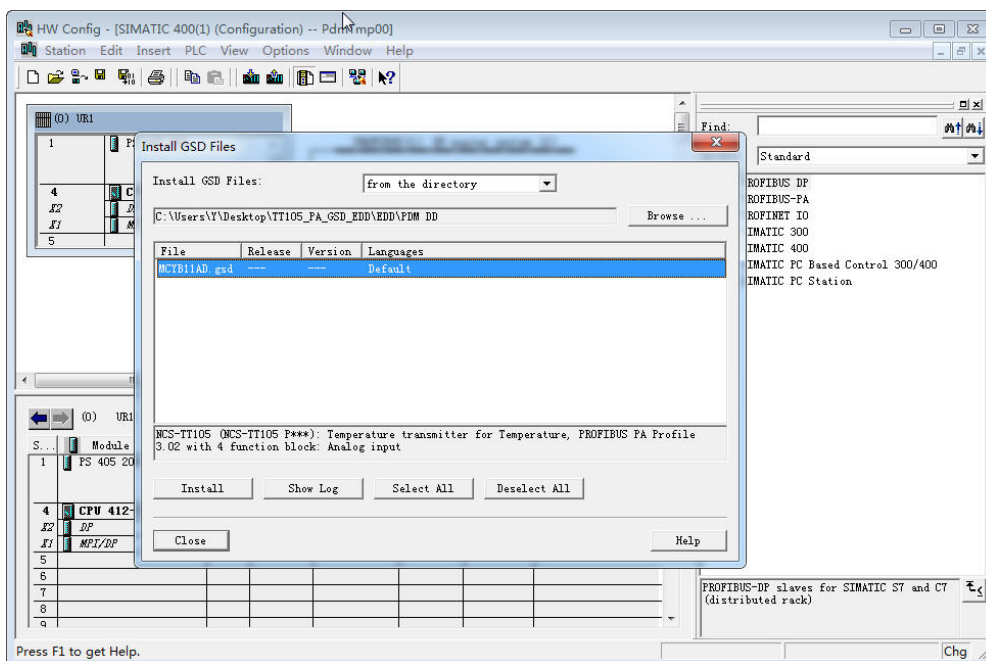

Figure 4.5 Installing the GSD files

After the GSD file is successfully installed, the PA devices just installed are listed in the PROFIBUS-PA category in the device list on the right side of the HW Config software. Select it with the mouse and drag and drop it on the PROFIBS DP bus, see Figure 4.6.
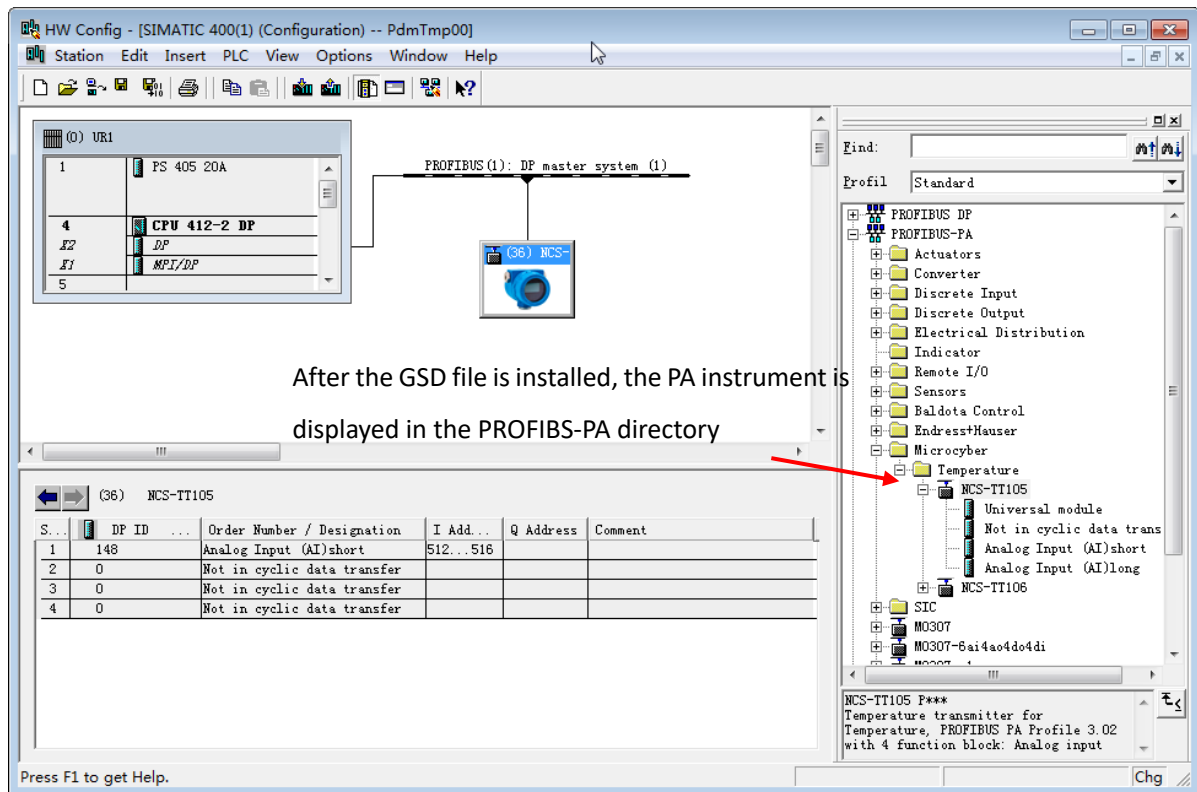
Figure 4.6 Drag the PA devices to the PROFIBUS DP bus

In the PLC menu, select Download to download the configuration information to the PLC master station. This completes the cyclic data communication configuration of the PA instrument and the master station, as shown in Figure 4.7.
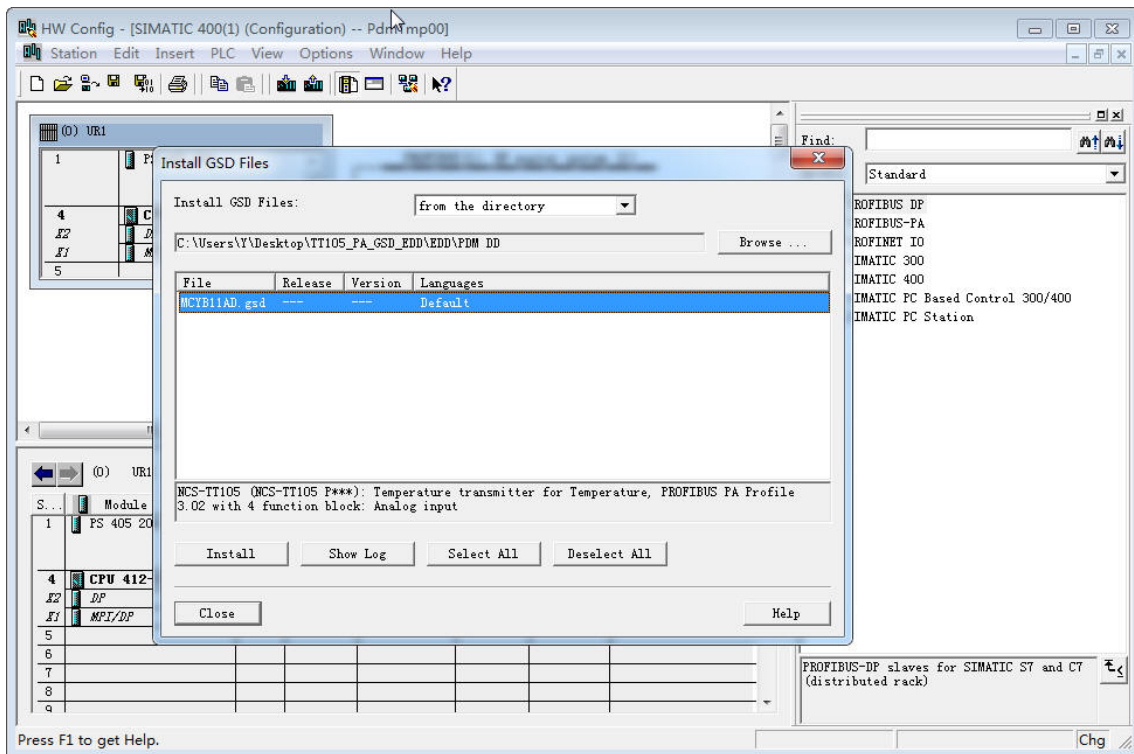
Figure 4.7 Download the configuration information to the PLC

4.3.4 PROFIBUS Non-loop Data Communication Configuration

Non-cyclic data communication of PROFIBUS DP refers to the connection-oriented data communication between class 2 master stations and slave stations.The data communication is performed in a non-cyclic period of the bus without affecting the cyclic data communication. Non-cyclic data is mainly the parameters of PA functional block and the identification and diagnosis information of equipment. Non-cyclic data communication is mainly used in the management, diagnosis, identification, adjustment and maintenance of PA equipment.

Noncyclic data communication configuration can be performed for PA instruments through Siemens equipment management software SIMATIC PDM.

Example of noncyclic communication configuration of PA smart transmitters using SIMATIC PDM are given below.

Open the Device catalog... Software, to import the GSD files.For MS0207 to select the imported Microcyber \ MS020 Figure 4.8.
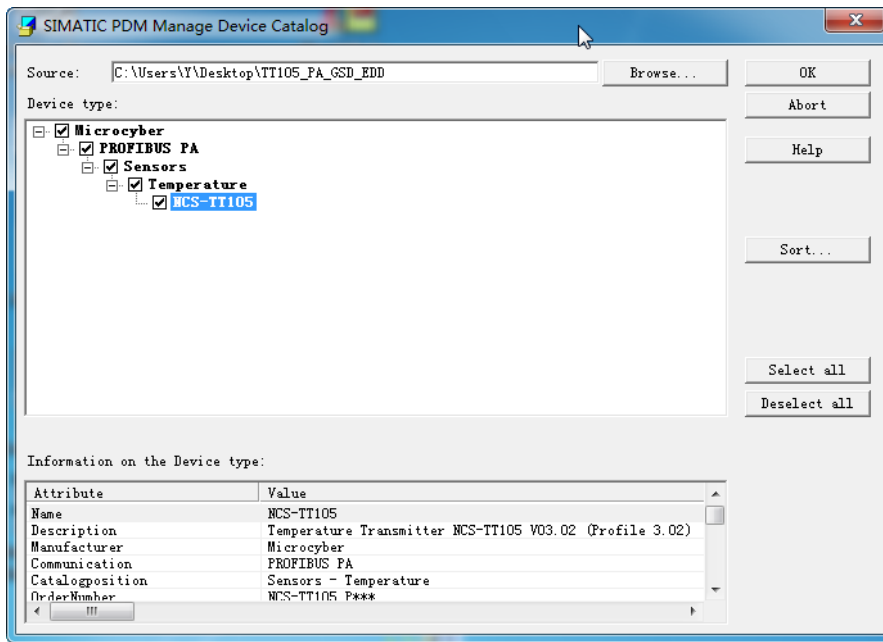
Figure 4.8 Selecting a Device Type

Open the LifeList software included with SIMATIC PDM, and select the Start Scan DP bus under the Scan menu, see Figure 4.9.
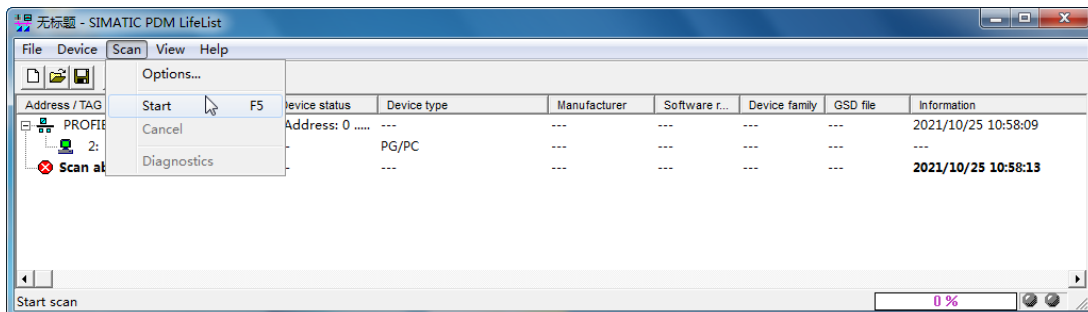

Figure 4.9 Starting the LifeList

After scanning the bus, the slave station equipment on the DP bus will be listed, while showing the manufacturer ID number of the device and some diagnostic information,show in Figure 4.10.
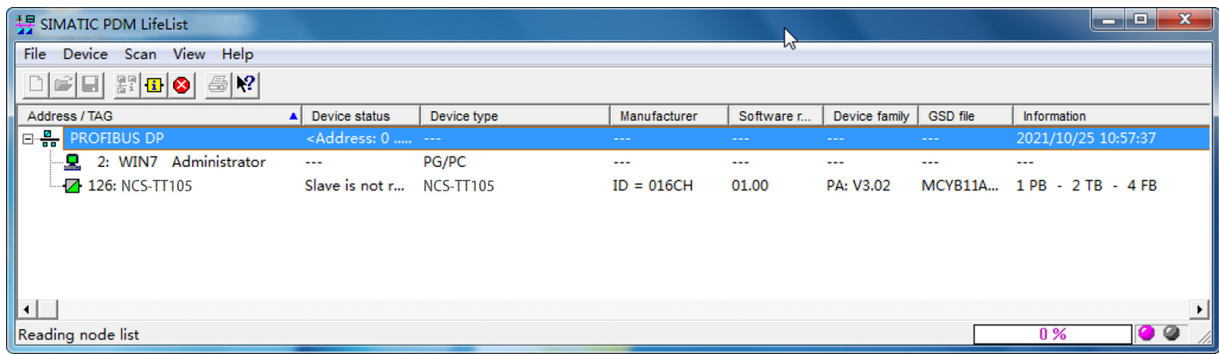
Figure 4.10 The Scan DP bus lists the PA devices

Double-clicking on the PA device starts the SIMATIC PDM software. Through this software, parameter reading and diagnosis of the PA device can be performed. The parameter reading and writing of the PA instrument can be completed through the upload and download function of the PDM software, see Figure 4.11.
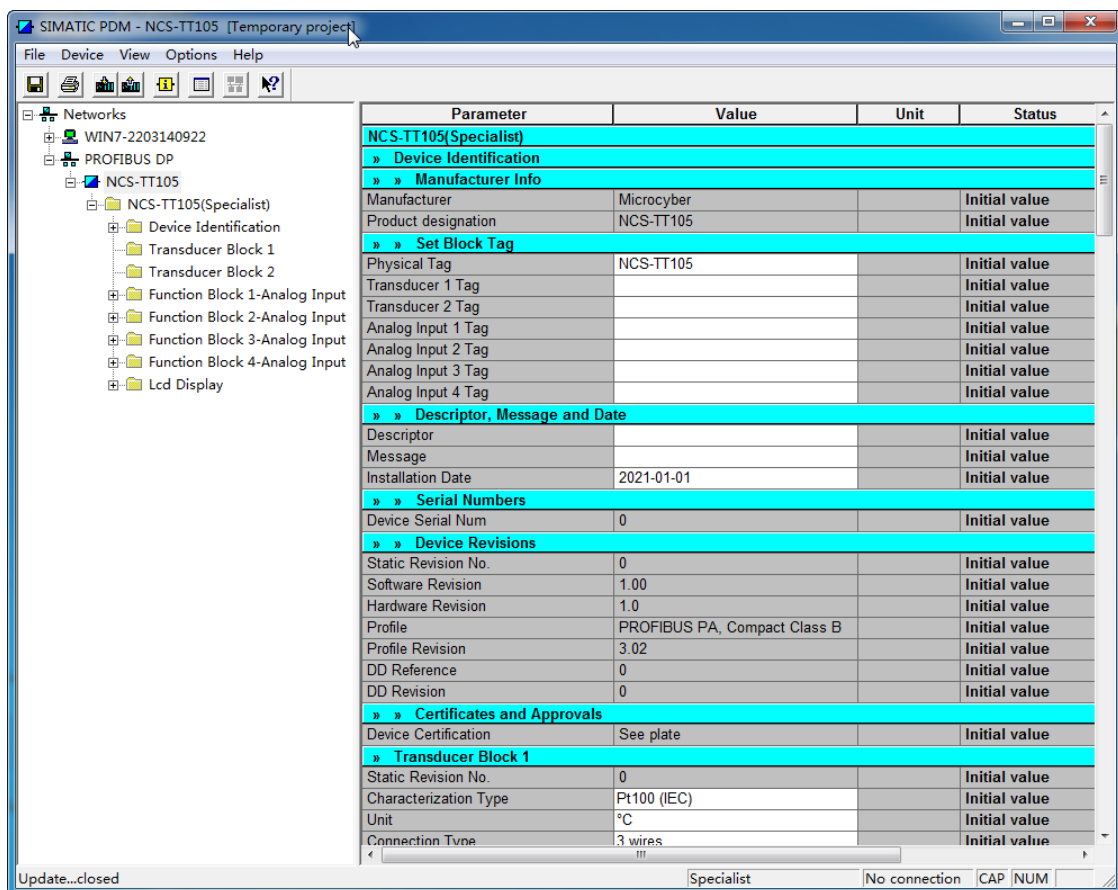

Figure 4.11 Device management using the PDM software

4.3.5 Online Configuration Function

The PA-type smart transmitter realizes the functional block of the PA standard, and the online state function

realizes the function of composing the functional block parameters separately. With PDM software, select Device-> Configuration to write the function block parameters.

4.3.6 Sensor Type Configuration

By modifying the Characterization Type and Input Range and Mode parameters of the conversion block, you can set the type of sensors, such as PT100, CU50, etc. The Input Range and Mode parameter is valid when the Characterization Type parameter is Linear.

4.3.7 Two-line System Zero-point Calibration Configuration

In the two-line measurement, the two-line zero-point calibration can be performed. First, give the channel zero value, namely the cable end connected to the sensor. Then open the PDM software, configure, select the Device-> Configuration-> Transducer Block 1 item, and set the two-line calibration function in the Set 2-Wire Compensation box in the Advanced Settings.

Press the Write button, when the Finished dialog box appears, indicates that the two-line zero point calibration is successful;

Press the Reset button, when the Finished dialog box appears, indicates the two-line zero calibration zero success.

4.3.8 Enable the Cold-end Temperature Compensation

When using the thermocouple as a sensor, the conversion block Reference Junction Temperature parameter represents the cold end temperature value, and the Primary Value represents the temperature value of the measurement end phase for the cold end. If the Primary Value output measurement relative to 0 degrees (i. e., the cold end temperature is 0 degrees) is required, it can be achieved by setting the Reference Junction parameter.

When the Reference Junction parameter is set to Internal measured reference junction, the cold end temperature is the internal collected value of the temperature transmitter;

When the Reference Junction parameter is set to External Fixed Value, the cold end temperature is Ext Reference Junction Temperature;

When the Reference Junction parameter is set to S ensor 2, the cold end temperature is Sensor 2.**Note: When selecting this option, channel 2 should be configured as thermoresistance or thermocouple.**

The default, the cold-end temperature compensation Reference Junction parameter is set to Internal measured

reference junction.

4.3.9 Custom TC Sensor Type

When Characterization Type selects Custom defined TC, multiple groups of custom linear polynomials appear. A custom polynomial type of TC is completed by filling in the appropriate polynomial coefficient and range. For instance:

CUSTOM_TC_NAME	Custom TC Example
CUSTOM_TC_POLY_COUNT	5
CUSTOM_TC_MIN_IN	-6500.0
CUSTOM_TC_MIN_OUT	-100.0
CUSTOM_TC_MAX_OUT	1200.0

Custom TC sensor polynomial coefficients for examples:

CUSTOM_TC_POLY_X	max.input limit in µV for POLY_X	4th degree coefficient for POLY_X	3th degree coefficient for POLY_X	2th degree coefficient for POLY_X	1st degree coefficient for POLY_X	0degree coefficient for POLY_X
CUSTOM_TC_POLY_1	-3200.0	-3.84E-13	-5.65E-9	-3.36E-5	-6.10E-2	-8.44E1
CUSTOM_TC_POLY_2	3500.0	-8.13E-15	7.29E-11	-4.18E-7	2.53E-2	-1.08E-2
CUSTOM_TC_POLY_3	10000.0	-1.35E-15	1.50E-11	1.41E-7	2.26E-2	4.18
CUSTOM_TC_POLY_4	30000.0	3.49E-18	2.19E-12	-1.53E-7	2.68E-2	-9.26
CUSTOM_TC_POLY_5	70000.0	6.27E-17	-8.76E-12	5.34E-7	8.69E-3	1.65E2

	3th degree coefficient	2th degree coefficient	1st degree coefficient	0 degree coefficient
CUSTOM_TC_RJ_POLY	-1.11E-4	2.65E-2	3.94E1	3.94E-1

For example, if the input voltage of the temperature transmitter TC end is 5000 V and the cold end temperature is 25°C, and the voltage value corresponding to the cold end temperature can be calculated according to the formula:

~ 27 ~

U_{RJ}= 3.94 * 10^{-1}+ 3.94 * 10^1* 25 + 2.65 * 10^{-2}* 25^2- 1.11 * 10^{-4}* 25^3= 1000 μV

After adding this voltage to the input end of the TC (5000 + 1000), the corresponding temperature value is calculated according to the calculation formula:

4.18 + 2.26 * 10-2 * 6000 + 1.41 * 10-7 * 60002 + 1.50 * 10-11 * 60003 - 1.35 * 10-15 * 60004 = 146.3 °C

4.3.10 Custom RTD Sensor Type

When Characterization Type selects Custom defined RTD, multiple groups of custom linear polynomials appear. A custom polynomial type of TC is completed by filling in the appropriate polynomial coefficient and range. Please refer to the way of custom TC to set.

4.3.11 Multi-point-linearized Calibration

Considering the sensor accuracy and error problems, our temperature transmitter also provides a multi-point linearized calibration function. Provide 2-16 calibration points for arbitrary selection.

When User Calibration Table-> Calibration is selected, a dialog box popup and the user can add data for multiple calibration points as required. The dialog box provides three functions: reading, writing and reset tables. When writing a table, the first input needs to write several calibration points, through this way to select the number of calibration points.
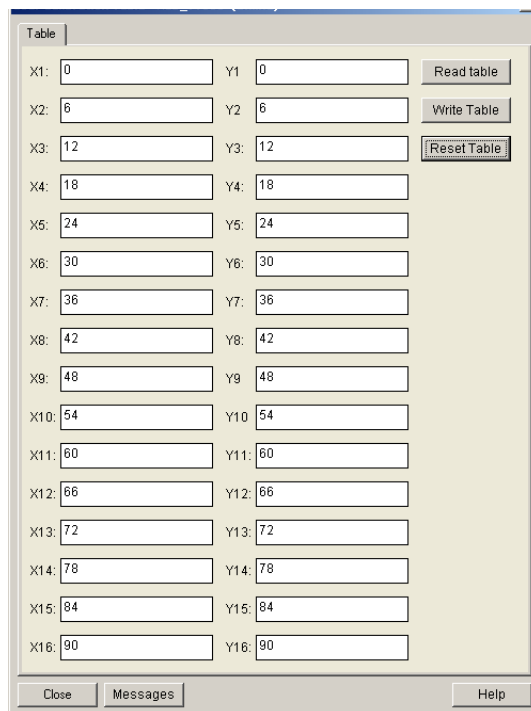

Figure 4.12 Multi-point-calibration of users

4.3.12 Two-point Linearized Calibration

The temperature transmitter has been strictly corrected before leaving the factory, and the correction generally does not require the user. Users use parameters such as Lower Calibration Point, Upper Calibration Point, and Calibration Unit to achieve a two-point linearized calibration.

The temperature transmitter has been strictly corrected before leaving the factory, and the correction generally does not require the user. Users use parameters such as Lower Calibration Point, Upper Calibration Point, and Calibration Unit to achieve a two-point linearized calibration.

The operation steps are as follows:

1) Open the PDM software, after the configuration completes, select the Device-> Calibration-> Lower / Upper item, and call out the temperature calibration page.

2) Determine the sensor type and set the Characterization Type and Input Range and Mode parameters. If the calibration unit Calibration Unit parameter is set according to the sensor type, only degrees Celsius, ohm and millivolt are supported. After the setup completes, write to the parameter.

3) The channel standard data needs to be calibrated through the standard source. After the input is stable, the calibration data is written to the Upper Calibration Point or Lower Calibration Point parameter according to the upper or lower limit calibration of the operation. Without prompt writing error, the calibration is successful. **Note: the written calibration data and the actual input channel data should not be greatly biased, otherwise the calibration will fail.**

Note: When Device-> Master Reset is used, the instrument CPU will be reset, causing a temporary communication interruption, which is a normal phenomenon and can be reconnected.

5 HART TEMPERATURE TRANSMITTER CONFIGURATION

5.1 Topological connection

The connection mode of the temperature transmitter includes (4~20) mA compatible mode and networking mode.
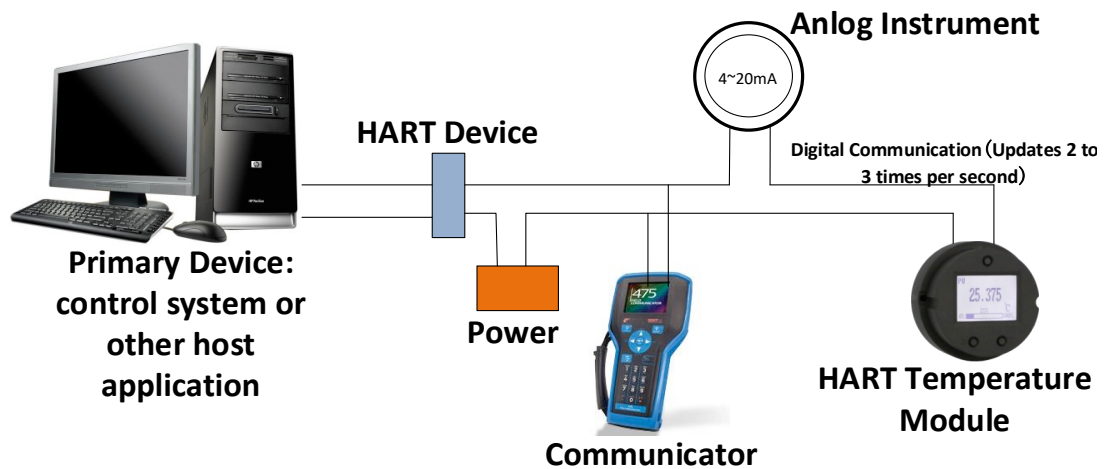
5.1.1 4~20mA compatible mode

Figure 5.1 (4~20) mA compatibility mode

Feature:

1) Access to the previous level control system through the HART interface equipment;

2) Sharing of analog and digital communication methods;

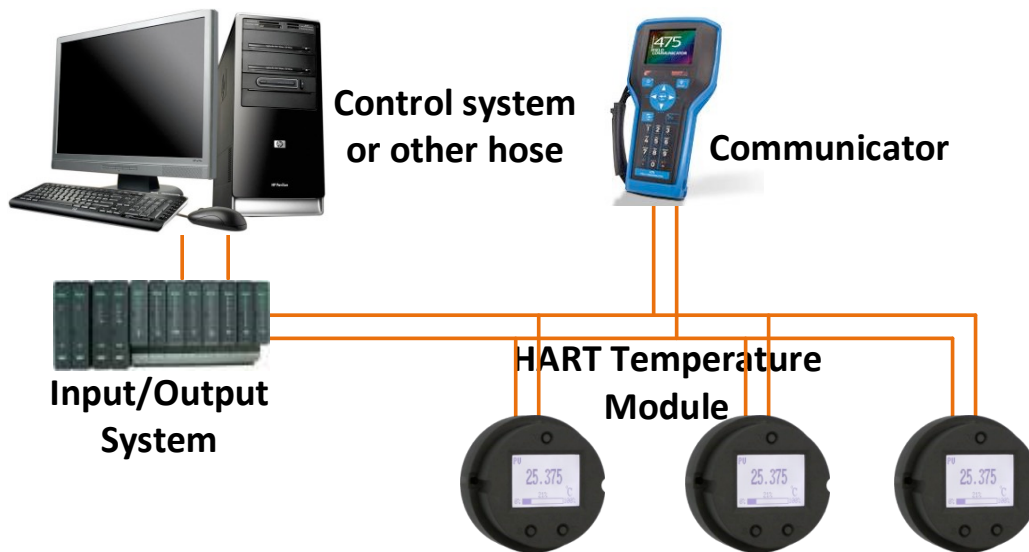3) The HART slave equipment short address is 0.

5.1.2 Networking mode

Figure 5.2 HART networking mode

Feature:

1) Access to the upper-level control system through the AI module;

2) Using only the digital function of the HART system, the current on the line is fixed to 4 mA;

3) HART7.0 supports up to 64 (polling address 0~63) device networking.

5.2 Function Configuration

The temperature transmitter supports the HartMPT configuration software developed by Microcyber, the SDC625 and other general HART configuration software of HART Foundation to conduct configuration debugging. The following mainly takes the HartMPT configuration software as an example to introduce the configuration method of the temperature transmitter. It mainly includes the following functions:

1) Basic information configuration: configure the basic information of online equipment, including tag, address, date, assembly number and other information;

2) Configuration information configuration: configure the configuration information of the online equipment, including the main variable range, damping and other information;

3) Sensor information configuration: configure the sensor information of the online device, including type, wiring and other information;

4) Current calibration: can calibrate (4~20) mA current of the online device, and can also set the fixed current output;

5) Variable monitoring: you can regularly refresh all the dynamic variables of the selected online device and display the trend curve of the current device primary variable;

5.2.1 Configuration setting

1) PC with serial port, the OS is Windows 2000 \ Windows XP \ Windows 7;

2) HART Modem and serial port wire;

3) Matching resistance (230~550) Ω;

5.2.2 Basic information configuration

Basic information of the transmitter can be read or modified through the Basic Information tab. Modifiable information includes device short address, message, description, station number, date, assembly number; modifiable information includes alarm selection, write protection, manufacturer ID, manufacturer, device type, device ID, long address, and version information, as shown in Figure 5.3.

Figure 5.3 Basic Information

The information can be downloaded to the device by pressing the Apply button.

1) The range of address selection is 0~15;

2) Messages can enter up to 32 characters;

3) Description can enter up to 16 characters;

4) The maximum length of the label is 8 specified characters;

5) The Date range is from 1,900 to 2,155;

6) The maximum length of the assembly number is 6 specified characters.

5.2.3 Configuration of configuration information

The configuration information of the transmitter can be read or modified through the configuration information tab, including the output variable of the display device (main variable, cold end temperature value, current value, percentage), the setting of the main variable information (damping value, unit, range upper limit, range lower limit), etc., as shown in Figure 5.4

Figure 5.4 Configuration information

➢ Damp: range, 0 to 32 seconds.

➢ Unit: The change of the PV unit directly affects the variables associated with the unit, such as the upper and lower limit of the range, the upper and lower limit of the sensor, etc. When modifying the unit, the upper and lower limit of the main variable range cannot be modified at the same time, and should be modified separately.

➢ Units can be set to: °C, °F, °R, K, mV, Ohm.

➢ Upper range limit: PV value corresponding to 20mA output current.

➢ Lower range limit: corresponding to the PV value of 4mA output current.

The information can be downloaded to the device by pressing the Apply button.

➢ Set the upper Range Limit button with the current value: set the current PV value of the device to the upper limit of the main variable range, and the lower range is unchanged.

➢ Set the Range Lower Limit button with the current value: Set the current PV value of the device to the lower limit of the primary variable range, which may also change the upper limit.

➢ Set the primary variable zero point " button with the current value: in the zero temperature condition, take the current PV value of the device as the main variable zero point.

5.2.4 Sensor configuration

The Sensor Information tab allows you to view the currently configured sensor information (upper, lower, minimum span) and the type, line system, etc. of each sensor configuration separately. As shown in Figure 5.5.
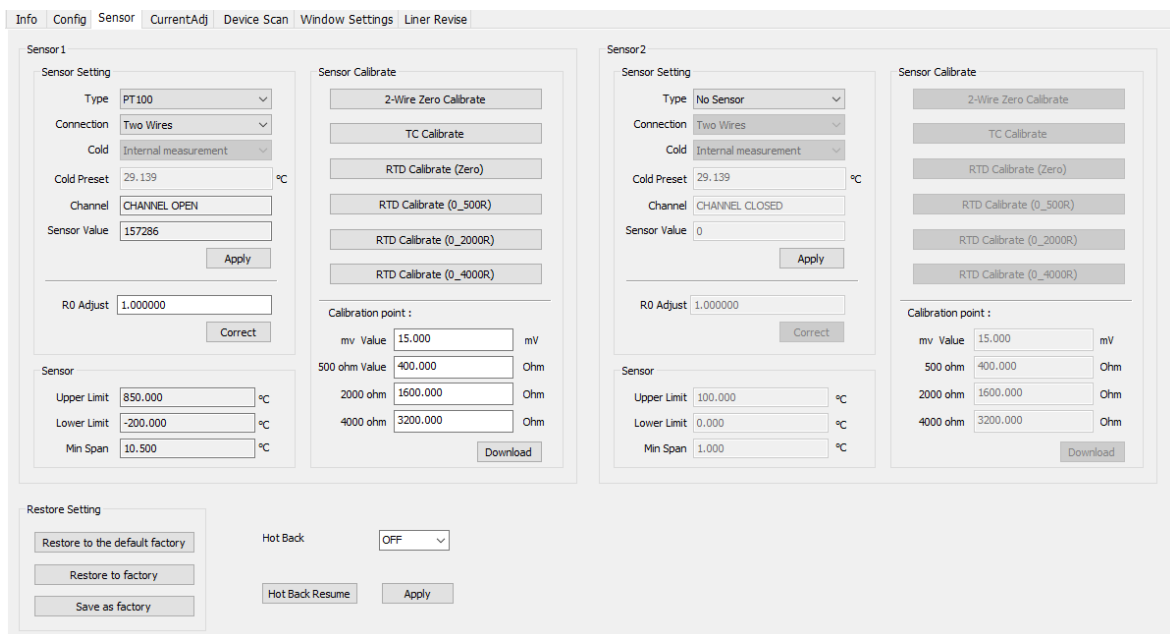

Figure 5.5 Sensor Configuration

Sensor type: Set the supported sensor model, see the following table:

Sensor type	description
0_500R	Resistance, (0 ~ 500) Ω
0_4000R	Resistance, (0 ~ 4,000) Ω
CU50	Cu50
CU100	Cu100
PT100	PT100
PT200	PT200

PT500	PT500
PT1000	PT1000
100mV	MV voltage signal, range: (-100 ~ 100) mV
B_TC	B thermocouple
E_TC	E thermocouple
J_TC	J thermocouple
K_TC	K thermocouple
N_TC	N thermocouple
R_TC	R thermocouple
S_TC	S thermocouple
T_TC	T thermocouple

➢ Sensor types include resistors (0_500 Ω, 0_4000 Ω), thermal resistors (Cu 50, Cu 100, Pt100, and Pt1000), -100~ + 100mV, and thermocouples (B, E, J, K, N, R, S, and T).

➢ Wire can be set as 2,3,4 wires (resistance, thermal resistance signal), the thermocouple is 2 wires. Only 2,3 wires for sensor 2.

➢ Cold-end compensation is only valid for the thermocouples. It can be set as cold end prohibition, internal measurement, fixed value and sensor 2 measurement. The cold end is prohibited, the transmitter will not compensate the cold end; internal measurement: the cold end of the temperature is provided by the internal temperature chip; the fixed value of the temperature is the external set temperature; the sensor 2 measurement: the temperature of the temperature of the sensor 2, the sensor 2 should be connected to Pt 100.

➢ Channel status shows the sensor channel status (open circuit, short circuit, etc.).

➢ Sensor channel values display the original value of the sensor channel.

➢ The R0 correction factor corrects the error of the sensor itself (range 0.9 to 1.1).

➢ When the temperature transmitter is connected to the RTD in 2-wire , in order to avoid the error of the resistance on the cable, it can be short connected at the sensor end, and then click the 'two-wire zero-point calibration' button to eliminate the error of the resistance on the cable.

➢ The TC calibration performs the factory calibration of the thermocouple and the millivolt signals.

> ➢ RTD calibration factory thermal resistance and resistance signals.

> ➢ The standard value: the value when you calibrate the transmitter.

> ➢ Restore factory default values: Click this button and all data returns to the default factory status.

> ➢ Save as a factory Value: Click this button to save the current configuration as a factory value. When you click the "Restore Factory Setting" button again, it will revert to this saved configuration.

> ➢ Factory reset: Click this button to restore the data to the factory status. If the user has saved the factory value, it returns to the user-saved configuration; otherwise, it returns to the default factory state.

5.2.5 Current calibration

Current calibration steps are as follows:

1) To connect the circuit, it is necessary to string into five and a half precision ammeter in the equipment output circuit;

2) Set the polling address of the device to 0, see Basic information configuration, and you can skip this step if the polling address is already 0;

3) Enter the current calibration tab;

4) Select the "Current value" as 4mA. After the ammeter is stable, enter the reading of the ammeter in the "Adjust value" text box, and click the "Apply" button;

5) Select the "Current value" as 20 mA. After the ammeter is stable, enter the reading of the ammeter in the "Adjust value" text box, and click the "Apply" button;

6) Select Current Value as blank to calculate the current output by the device at the PV value.

Note: When the current output value of the device is high alarm current, 4mA can not be calibrated; when the current output value of the device is low alarm current, 20mA cannot be calibrated;

Configure the current fixed output:

Users can configure the fixed current output in the current calibration tab. After clicking "Manual Send", input the current value that the device will fixed output in the next text box, and click "Enter / Exit Fixed Current Mode" to enter or exit the fixed current output mode. The title of the button takes turns showing "Enter Fixed Current Mode" and "Exit Fixed Current Mode" to prompt the user to operate.

When the temperature transmitter is running continuously, the value of the main variable continuously compares with the upper and lower limits. When the value of the main variable exceeds the upper and lower

limits of the range, the temperature transmitter outputs a fixed current, indicating that the main variable exceeds the range. When the main variable is high and the upper limit, the temperature transmitter output is fixed 20.8mA; when below the lower limit, the temperature transmitter output is fixed 3.8mA.

Figure 5.6 Current calibration

Note: The calibration current and fixed current output function can only be performed when the polling address of the device is 0, and the other polling addresses are in full digital communication mode, which will prompt the error message "command execution failure".

5.2.6 Variable monitoring

Through the variable monitoring tab, you can refresh all the dynamic variables of the selected device and display the trend curve of the main variable of the current device at regular times. The current refreshed variables are: PV value, current value, percentage, and cold end temperature.
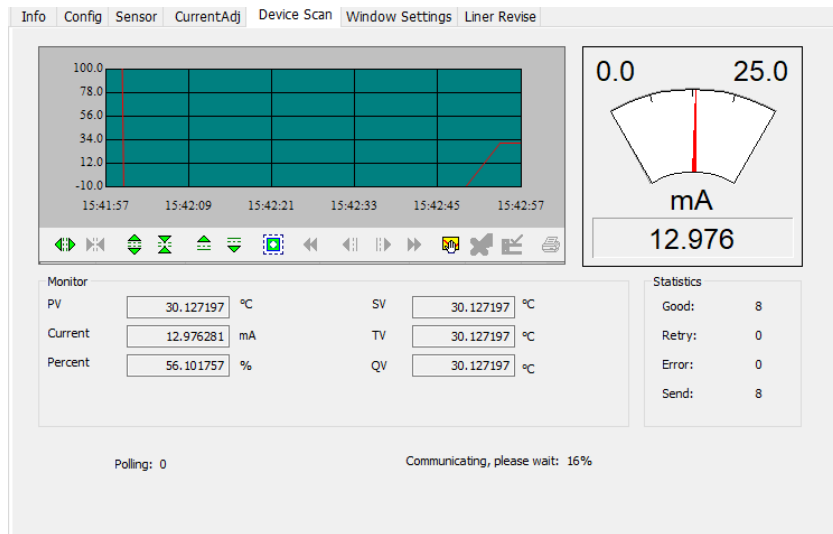
Figure 5.7 Variable monitoring

5.2.7 Linear revision

Multipoint calibration of the sensor is possible through the linear revision function. The correction mode can choose "analog" and "digital" two modes. The number of corrected points can be freely selected between 2 and 16 points. When a second multi-point calibration is required, click the "Recovery Default" button to make the next calibration.
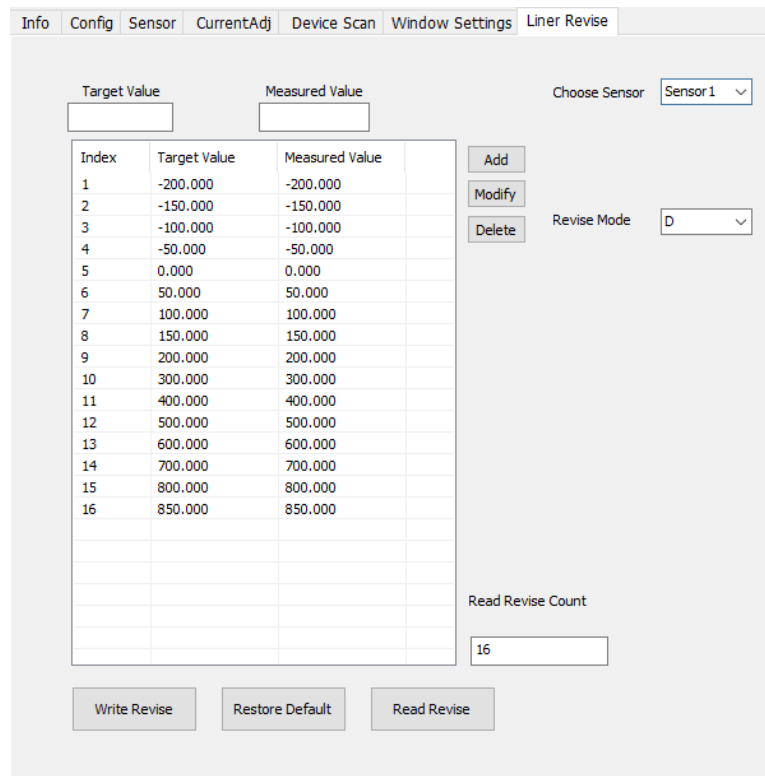

Figure 5.8 Linear revision

6 SITE ADJUSTMENT

6.1 LCD and key description

The temperature transmitter is equipped with dot matrix LCD and local button adjustment function, so that users can fully adjust the temperature transmitter (temperature transmitter + sensor + housing) locally.

There are 3 keys, [M], [S], [Z] keys, and [M] keys are the mode keys, mainly responsible for "Function selection", "Cursor Move", and "OK".The [S] and [Z] keys are the input adjustment keys, mainly responsible for the "front and back menu turn" and the "value of the addition and subtraction".
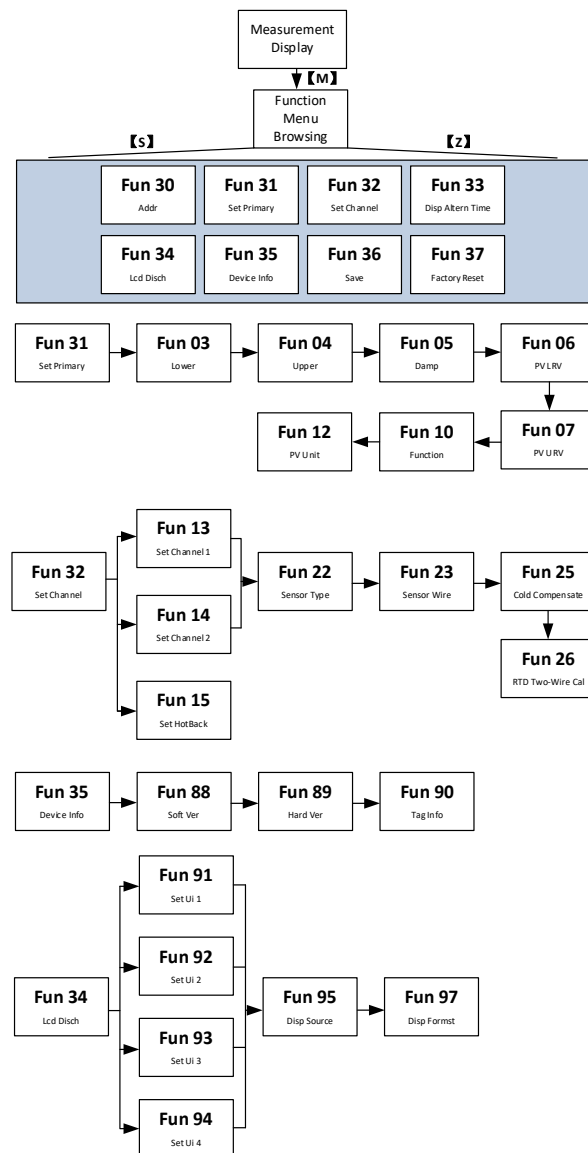
Note: ① F F / PA protocol does not have the Fun 31 and Fun 15 menus.

② PA protocol adds the Fun 12 menu after the Fun 26.

③ FF protocol adds the Fun 6, Fun 7, and Fun 12 menu after Fun 26, and the Fun 6, Fun 7 and Fun 12, and Fun 22 cannot be changed at the same time.

7 MAINTENANCE

Phenomenon	Solution
No Communication	Temperature transmitter connection Check the bus cable connection Check power polarity Check the bus cable shield for single point grounding
	network connections Check the network topology correctness
	Address conflict The default short address is set by the temperature transmitter to 0. But address conflicts are still possible on one network. When a conflict occurs, please reset the address of the device. Sometimes it will be completely offline, you can cut off the conflict device first, and then power on one by one, and modify the address of the new power device to the non-conflict address. Power up in order, change the address, until all online.
	Temperature transmitter fault Replace it and test by other temperature transmitters
Read error or Output alarm current	Temperature transmitter connection problem Check the sensor for short circuit, open circuit, ground, etc Check the sensor for fault
	Noise Distrub Regulate damping Check the terminals for moisture Check whether the cable laying is far away from the strong interference sources
	Software Settings Check that the sensor type is configured correctly

8 TECHNICAL SPECIFICATIONS

8.1 Basic Parameter

Input Signal	Pt100、Pt1000、PT 200、PT500、CU50、CU100、0～500Ω、0~4000 Ω; B E J K N R S T thermocouple, -100mV~100mV	
RTD mode of connection	2,3,4 wires connection	
Power	FF/PA	(9～32)VDC
	HART	(11.5～45)VDC
Bus protocol	(4～20)mA+HART, FF, PA	
Channels	2 channels	
Insulation	1000VAC	
Display	LCD LCD display or no display (optional)	
Temperature Range	Operating temperature of the transmitter body: (-40~85) ℃ (no display) (-20~70) ℃ (with display)	
Humidity Range	(5～95)%RH	
Storage Temperature	-40 ～ 85℃	
Start Time	5-Second Time (HART) 8-Second (FF, PA)	
Refresh Time	The 0.8 ~ 1.3s depends on the type and wiring mode of the sensor	
Damping Adjustment	Time constant of 0 to 32 seconds	
Cold-end Temperature	±0.5℃	
Alerting signal (only HART)	The alarm output can be set at 3.5 … 23 mA Upper / lower limit current 20.8mA / 3.7mA	
Current accuracy (only HART)	0.03%	
Voltage Influence	±0.005%/V	
Ex Level	Ex ia IIC T4 Ga (developed according to this standard, not certification)	

8.2 Technical indicators of thermal power resistance

- RTD Accuracy (25℃)

Sensor type	Working range (℃)	Accuracy (25℃)	Heating drift (per ° C)
Resistance	0~500Ω	±0.04Ω	±0.001Ω
	0~4000Ω	±0.35Ω	±0.015Ω
PT100	-200 ~ 850℃	±0.15℃	±0.003℃
PT 200	-200 ~ 850℃	±0.15℃	±0.005℃
PT 500	-200 ~ 850℃	±0.15℃	±0.005℃
PT1000	-200 ~ 850℃	±0.15℃	±0.005℃
CU50	-50 ~ 150℃	±0.15℃	±0.005℃
CU100	-50~ 150℃	±0.10℃	±0.003℃

- Other technical indicators of RTD

Wiring	2,3,4 wire
Common mode rejection	70 dB (50 Hz and 60 Hz)
Differential mode inhibition ratio	70 dB (50 Hz and 60 Hz)

8.3 Thermo Couple technical indicators

- Thermal couple accuracy (25℃)

Signal type	Sensor range range (℃)	accuracy (25℃)	Heating drift (per ° C)
millivolt	-100mV ~ +100mV	±0.025mV	±0.001 mV
B	500 ℃~ 1810℃	±0.77℃	±0.050℃
E	-200 ℃~ 1000℃	±0.20℃	±0.025℃
J	-190 ℃~ 1200℃	±0.35℃	±0.01℃
K	-200℃ ~ 1372℃	±0.40℃	±0.025℃

N	-190℃ ~ 1300℃	±0.50℃	±0.015℃
R	0℃ ~ 1768℃	±0.75℃	±0.023℃
S	0 ℃~ 1768℃	±0.70℃	±0.023℃
T	-200℃ ~ 400℃	±0.35℃	±0.015℃

- Other technical indicators of the thermocouple

Sensor type	B, E, J, N, K, R, S, T; (-100~100) mV voltage
Common mode rejection	70 dB (50 Hz and 60 Hz)
Differential mode inhibition ratio	70 dB (50 Hz and 60 Hz)

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