NCS-TT106
Temperature Transmitter

Contents

1. Brief Introduction

NCS-TT106 smart temperature module, using the fieldbus technology, is a new generation of smart fieldbus temperature transmitter and it is an indispensable field device for process control. NCS-TT106 transmitter integrates abundant function blocks and realizes not only general measurement function but also complicated control strategy.

NCS-TT106 uses digital technology, so it can connect with many types of thermocouple and thermo resistive sensors. It has wide range and simple interface between field and control room, which reduces the expense of installation, operation and maintenance.

NCS-TT106 supports HART, FF, and PA protocols. It can be widely used in the petroleum, chemicals, electricity, and metallurgical industries, etc.
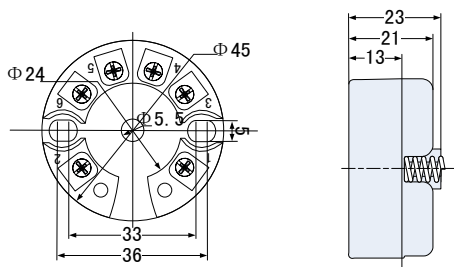
2. Installation

2.1 Dimension

Figure 2.1 Temperature Module Dimension (Unit: mm)

2.2 Installation

Via positioning hole, use two screws to install the temperature module to temperature housing or rail.
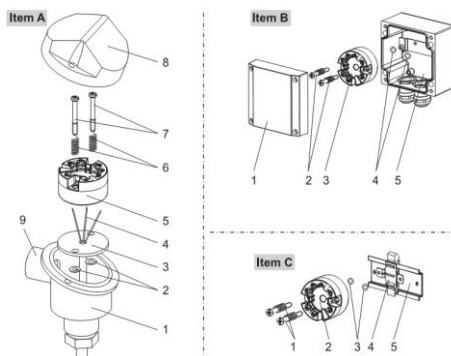
Figure 2.2 Installation

2.3 Wiring

Figure 2.3 Wiring

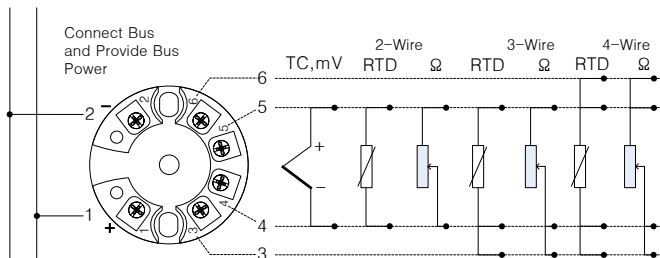Fieldbus temperature module power and bus signal share a pair of cable, and it is called bus cable. It is suggested the user use fieldbus special cable recommended by IEC61158-2.

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The signal cable and bus cable cannot share wires or wire slot with other device power wire, and they shall be away from device with high power.

The shielded wires of bus ends shall be connected to the ground.

3. FF Temperature TRANSMIITER Configuration

3.1 Topology Connection

FF transmitter supports many kinds of connection, as shown in Figure 3.1. There is a transmitter bus connection, and the bus ends are connected with terminal matching resistance, which ensures the signal quality. The maximum length of bus is 1900m and it can be prolonged to 10km with repeaters.
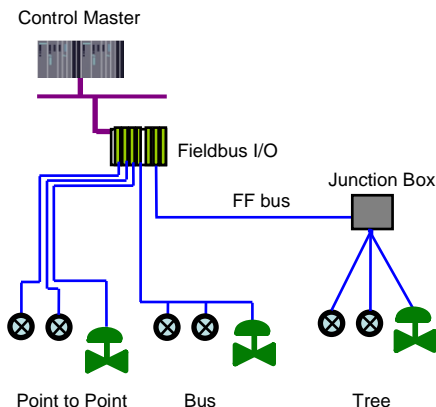
Figure 3.1 FF Network Topology
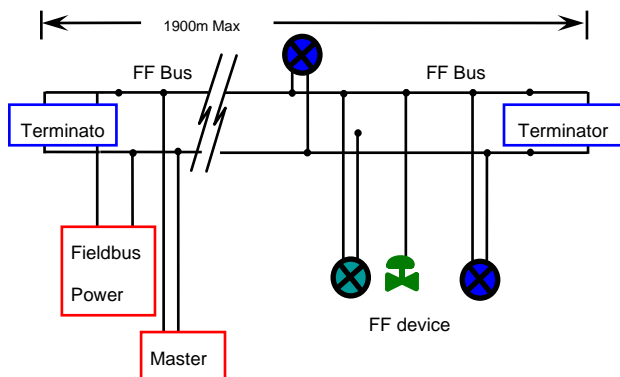
Figure 3.2　FF Bus Connection

3.2 Function Block

FF smart transmitter realizes FF standard function blocks, shown as below. Please refer to related FF protocol documents for detailed info about function block setting.

Function Block	Description
RESOURCE(RB2)	Resource block is used to describe device characters in the field, such as device name, manufacture, serial number. There is no input or output parameter in resource block. Generally there is only one resource block for each device.
TEMP_SENSOR 1(TTB)	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.
AI 1(AI)	Analog input function block is used to achieve transducer block input data and transfer it to other function blocks, and has the function of range conversion, square root, cut mantissa, etc.

3.3 Function Configuration

Smart temperature transmitter supports FF Configuration Software, NCS4000 Configuration Software from Microcyber, NI-FBUS from NI, DeltaV from Rosemont, etc. Now take NI-FBUS from NI as an example to introduction the configuration method of smart temperature transmitter.

● Configuration Environment
(1) PC, Windows 2000 or Windows XP;
(2) NI USB-8486, H1 bus power, H1 terminator;
(3) NI-FBUS Configurator.
● Sensor Type Configuration
Sensor type can be set by modifying transducer block SENSOR_TYPE parameter, such as PT100, CU50, etc.

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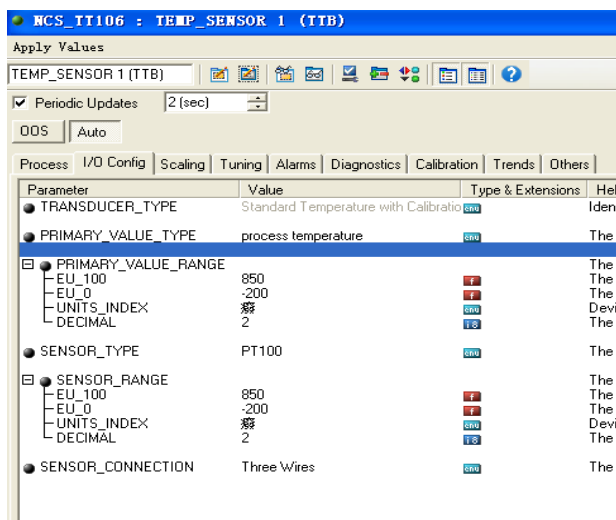
Figure 3.3 Sensor Type Configuration

● **2-wire Zero Point Calibration Configuration**

For 2-wire measurement, 2-wire zero point calibration can be realized by modifying transducer block TWO_WIRES_COMPENSATION parameter. Firstly, give zero point value to channel to make 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 means that 2-wire zero point calibration is successful.

● **Enable Cold End Compensation**

If the sensor is thermocouple, the user can set cold end compensation via parameter RJ_TYPE, when it is set as Internal, it enable inside cold end compensation. At this

time, RJ_TEMP value is the temperature value measured inside, that is SENCONDARY_VALUE. When it is set as External, the user can set EXTERNAL_RJ_VALUE to configure fixed cold end compensation value, the RJ_TEMP at this time is EXTERNAL_RJ_VALUE. When it is set as No reference, the cold end compensation is forbidden.
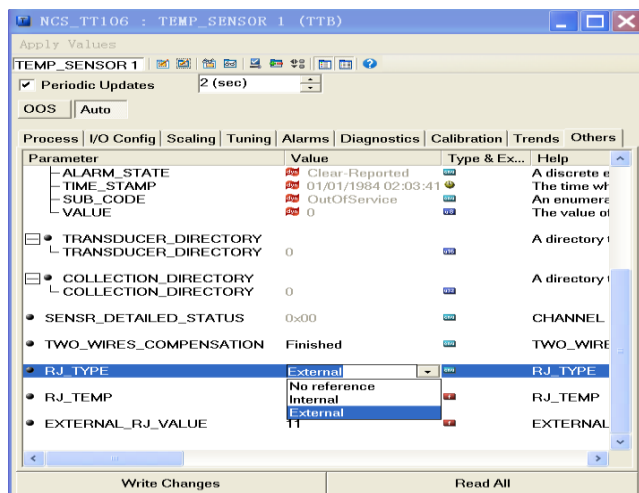

Figure 3.4　RJ_TYPE Configuration

● **2-point Linearization Calibration**

Temperature transmitter has strict calibration in factory. Generally, it is not necessary for user to calibrate. The user can use CAL_POINT_HI, CAL_POINT_LO and CAL_UNIT to realize 2-point linearization calibration. The operation steps shown as following:

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(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 failed if there is a great deviation between write-in calibration data and practical input channel data.**

4. PA Temperature TRANSMIITER Configuration

4.1 Topology Connection

Profibus PA transmitter supports many kinds of connection, as shown in Figure 4.1. There is a transmitter bus connection, and the bus ends are connected with terminal matching resistance, which ensures the signal quality. The maximum length of bus is 1900m and it can be prolonged to 10km with repeaters.
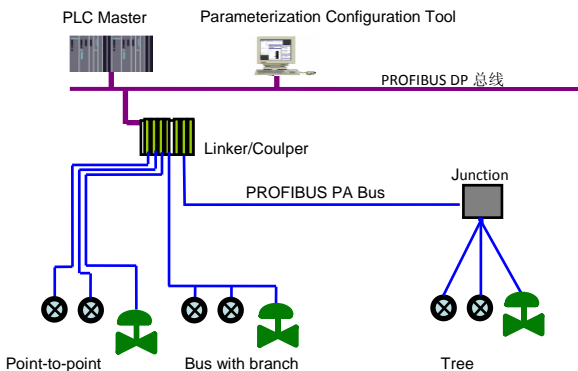
Figure 4.1   PA Network Topology
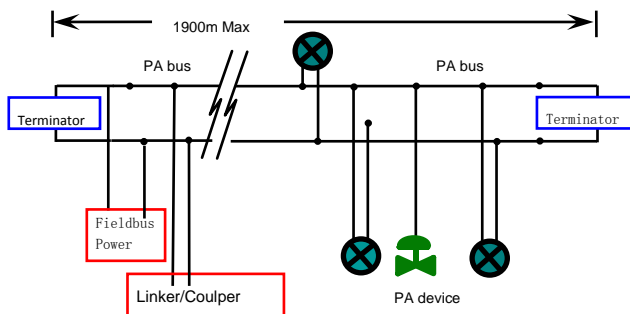
Figure 4.2   FF Bus Connection

4.2 Function Block

PA smart transmitter realizes PA standard function blocks, shown as below. Please refer to related PA protocol documents for detailed info about function block setting.

Function Block	Description
Physical Block	Physical block describes device hardware information, recognizing and diagnosing information, including device tag number, software version, hardware version and installation dates, etc.
Transducer Block	Transducer block separates function blocks from the instrument input and output characteristic, and it mainly realizes the function such as calibration and linearization for input and output data, and then provides the processed

	data to AI via inner channel.
Analog Input Block	AI block gets simulation processing value from the inner channel, and then processes the value, providing proper measurement value to master via bus communication.

4.3 Function Configuration

PA smart transmitter parameter configuration follows Profibus PA Specification Version 3.01. It can realize read and write function for transmitter function block parameters via Simatic PDM, also is able to configure temperature module via Siemens Step7.

● Configuration Environment
(1) PC, Windows 2000 or Windows XP;
(2) Siemens Step7 Configuration Software, Siemens PDM Device Management Software;
(3) DP/PA coupler or linker;
(4) 1 Master such as PLC, 2 Master such as CP5611;
(5) PA Terminator;
(6) Standard temperature source.

● Temperature Transducer Block Parameter Configuration
Transducer block separates function block from sensors, actuators and other I/O devices. It depends on the device supplier to access and control I/O devices. Transducer block is able to get input data and set output data by accessing

I/O devices. Generally, transducer block has the function of linearization, specialization, temperature compensation and data's control and exchange, etc. Transducer block structure is shown as figure 4.3.

Figure 4.3 Transducer Block Structure

The transducer block parameters as following:

Parameter	Function Description
INPUT_FAULT_GEN	Input fault: includes the failure diagnosed objects of all values. 0: Device normal Bit 0: Rj Failure Bit 1: Hardware failure Bit 2-4: Reservation Bit 5: Manufacture designation Bit 6: Communication failure Bit 7: Manufacture designation

INPUT_FAULT_1	Input fault: the failure diagnosed objects related to SV_1 0: Input normal Bit 0: Higher than the upper range Bit 1: lower than the lower range Bit 2: Break Bit 3: Short Circuit Bit 4-7: Reservation
BIAS_1	Deviation value for processing parameters of Channel 1 Units are designated by PRIMARY_VALUE_UNIT.
INPUT_RANGE	0: mV Range 1 => mV 100 128: Ω Range 1 => Ohm 500 129: Ω Range 2 => Ohm 4000
LIN_TYPE	Linearization type
SENSOR_WIRE_CHECK_1	Enable open circuit testing and short circuit testing: 0: open circuit testing enable, short circuit testing enable; 1: open circuit testing enable, short circuit testing forbidden; 2: open circuit testing forbidden, short circuit testing enable; 3: open circuit testing forbidden,

	short circuit testing forbidden.
PRIMARY_VALUE	Temperature module measurement value and status Units are designated by PRIMARY_VALUE_UNIT.
PRIMARY_VALUE_UNIT	Temperature module measurement value engineering unit code
UPPER_SENSOR_LIMIT	Sensor physical upper limit value
LOWER_SENSOR_LIMIT	Sensor physical lower limit value
SECONDARY_VALUE_1 (SV_1)	From Channel 1 and the calibrated value and status calibrated by BIAS_1. Units are designated by PRIMARY_VALUE_UNIT.

Thermocouple additional parameters as following:

Parameter	Function Description
EXTERNAL_RJ_VALUE	Outer reference point temperature, can be input automatically. Units are designated by PRIMARY_VALUE_UNIT. If the unit is not for temperature, it should be set as ℃.

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RJ_TEMP	Reference point temperature. Unit is set by PRIMARY_VALUE_UNIT. If the unit is not for temperature, it should be set as ℃.
RJ_TYPE	Setting reference point type, coding as follows: 0: No reference, no compensation. 1: Inner, temperature at reference point self-tested by the device. 2: Outer, temperature at reference point from outer. Choose 1 when in default.

Thermo resistance additional parameters as following:

Parameter	Function Description
SENSOR_CONNECTION	It can be used to connect sensor with 2-wire or 3-wire. 0: 2-wire 1: 3-wire 2: 4-wire

Parameters defined by manufacture as following:

Parameter	Function Description
SENSOR_VALUE_1	Original data value for sensor 1.
CAL_POINT_HI	Calibration value at the highest point;

	The unit is designated by CAL_UNIT.
CAL_POINT_LO	Calibration value at the lowest point; The unit is designated by CAL_UNIT.
CAL_MIN_SPAN	Allowable minimum step length during the calibration ensures the calibration smoothly, and the distance between highest point and lowest point is not too close. The unit is designated by CAL_UNIT.
CAL_UNIT	Calibration units (℃, Ω, mV)
TWO_WIRES_COMPEN SATION	2-wire zero point compensation
R0 ADJUST	Used to calibrate the sensor connected to temperature module

● PROFIBUS periodic data communication configuration
PROFIBUS DP periodic data communication is to exchange input output data, between 1 master and slave station, in the polling way. The communication method is non-connected. In every cycling period, 1 master sends data exchange request, the slave answers it passively. The periodic data communication is mainly applied in

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configuration between slave and PLC master. With it, master PLC receives slave input data or output the data to slave station.

PA smart temperature module periodic data communication configuration is similar to PROFIBUS DP slave, only a coupler or a linker between PA bus and DP bus is needed to add between PA bus and DP bus.

PA smart temperature module periodic data comes from output parameters of AI function block. There are 5 bytes, including 4 bytes of temperature floating data and 1 byte status byte. As for periodic communication, 2 identifiers are supported by transmitter, they are, short identifier 0x94 and long identifier 0x42, 0x84, 0x08 and 0x05. The user may use Siemens Step7 to configure periodic data communication for PROFIBUS PA.

Following is an example for configuration via Siemens Step7:

Turn on SIMATIC Manager, select PLC master and create a new project, shown as Figure 4.4.
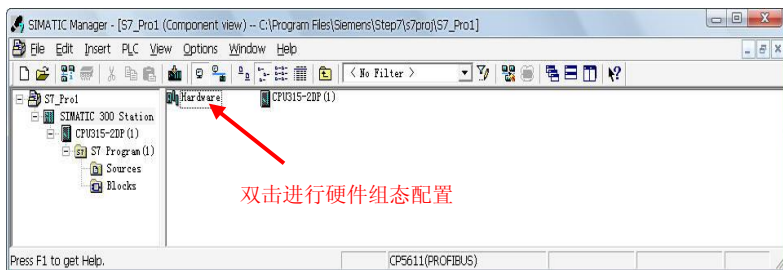

Figure 4.4 Select PLC Master and Create a New Project

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Click Hardware twice to turn on HW Config Software Hardware Configuration. Select Install GSD to install PA temperature module GSD file in Option list, shown as Figure 5.5.
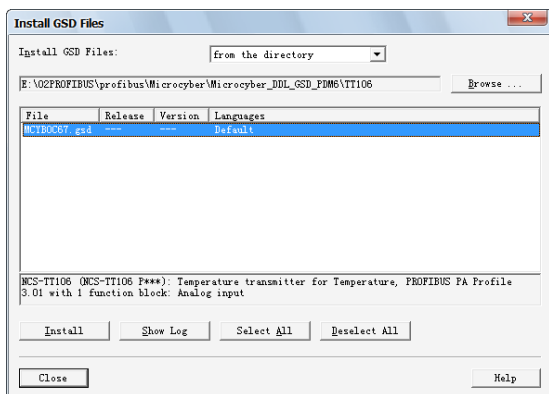

Figure 4.5 Install GSD

After GSD file is installed successfully, the installed PA device will be listed in the PROFIBUS-PA index MicrocyberInc.on the right of HW Config Software. Click it and drag it to the PROFIBUS DP bus, shown as figure 4.6.

Figure 4.6 Drag PA Devcie to PROFIBUS DP Bus

Download the configuration information to PLC master in the PLC list. Then the periodic data communication configuration between PA instrument and master is finished, shown as Figure 4.7.
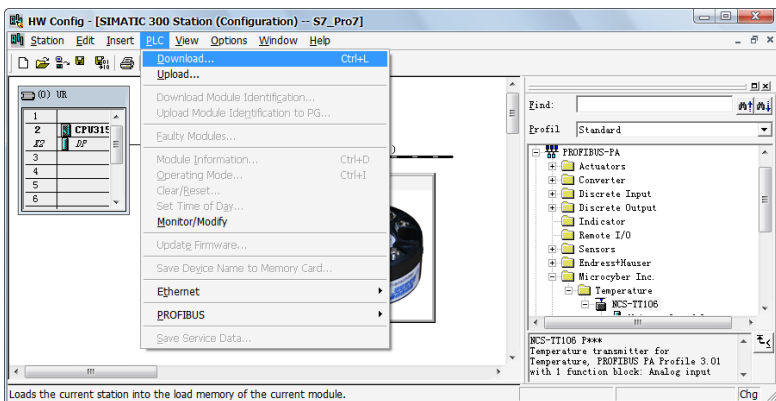

Figure 4.7   Download Configuration Info to PLC

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● PROFIBUS non-periodic data communication configuration

PROFIBUS DP non-periodic data communication is the data communication between 2 master and slave, facing connection. The data communication is non-periodic, without affecting periodic data communication. The non-periodic data is mainly PA function block parameters, together with recognizing and diagnosing information for the device. The non-periodic data communication is mainly applied in management, recognizing, diagnosing, testing, maintaining for PA device.

Siemens device management software SIMATIC PDM can be used to realize the non-periodic data configuration for PA instrument.

There is an example given below to show non-periodic data configuration for PA instrument.

Open the LifeList software attached by SIMATIC PDM, select Start to scan DP bus in Scan list, shown as Figure 4.8.
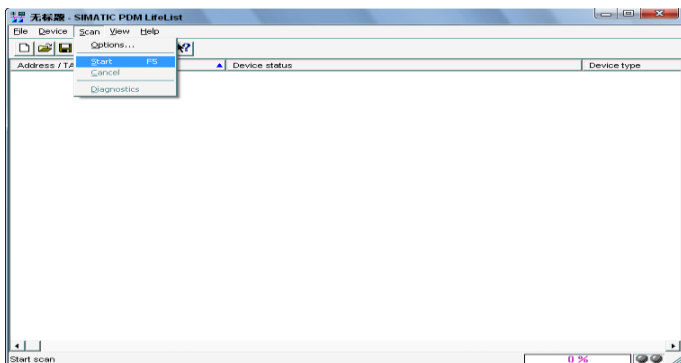
Figure 4.8 Start LifeList

After scanning the bus, slave device in DP bus will be listed, meanwhile the device manufacture ID number and some diagnosing information are displayed, shown as Figure 4.9.
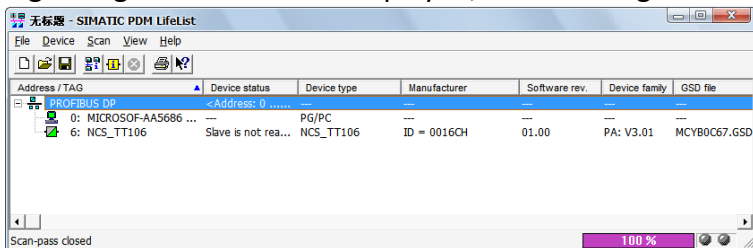

Figure 4.9 Scan DP Bus and List PA Device

Click PA device twice to start SIMATIC PDM software. The user may read, write and diagnose parameter for PA device. Select the Device catalog... when the user is asked to select the PA instrument type, lead the GSD document. Microcyber Inc\NCS-TT106 can be selected for the NCS-TT106 series of PA temperature module, shown as Figure 4.10.
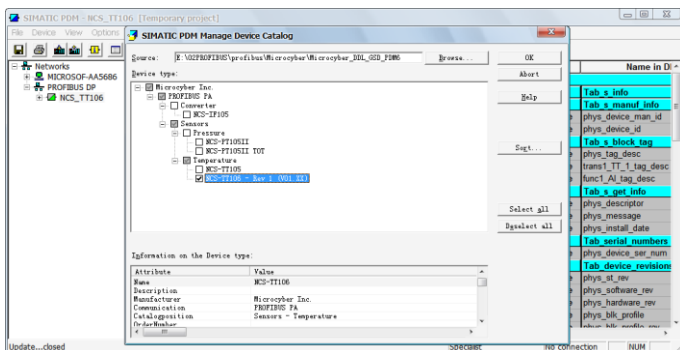
Figure 4.10 Select Device Type

After selecting the device type, click OK, thus non-periodic data communication is configured successfully. Via the function of upload and download function of PDM Software, the parameter read and write can be realized, shown as Figure 4.11.
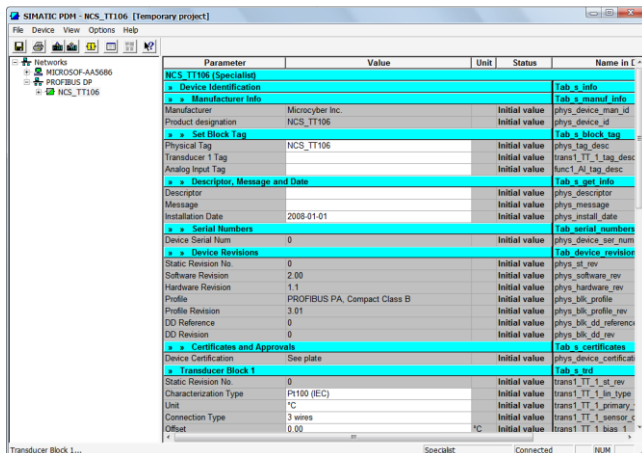

Figure 4.11   Device Management via PDM Software

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● Configuration Function

PA smart temperature module realizes PA standard function blocks. With PDM software, after configuration, choose Device -> Configuration, to do operation for transducer block or AI function block.

● Sensor Type Configuration

Sensor Type can be set by modifying Characterization Type of transducer block and Input Range and Mode Parameters. E.g. PT100, CU50, etc. When Characterization Type Parameter is Linear, Input Range and Mode Parameter is effective.

● 2-wire Zero Point Calibration Configuration

For 2-wire measurement, the user may use TWO_WIRES_COMPENSION parameter to do zero point calibration. First, give zero value to the channel, which will cut the channel off. Next, turn on PDM software, after the configuration, choose Device -> Configuration -> Transducer Block 1. In Advanced Settings, there is 2-wire calibration function. After pressing write button, when Finished is displayed, it means 2-wire zero point calibration is successful.

● Enable Cold-end Temperature Compensation

When thermocouple is used as sensor, Reference Junction Temperature parameter of transducer block is cold-end temperature value. Primary Value is measurement value referenced cold-end temperature value. If $0℃$ is to display

in primary value output, it can be realized by setting Reference Junction parameter. If 1℃ is to display in primary value output, it can be realized by measurement temperature as well as cold-end temperature as Primary Value output. The cold-end temperature compensation is enabled in default.

● 2-point Linearity Calibration

The strict calibration must be done to temperature module in the factory, so it is not necessary for users to calibrate again. The parameters such as Lower Calibration Point, Upper Calibration Point and Calibration Unit are used to carry out 2-point linearity calibration. The operation steps are as following:

(1) Turn on PDF software, after configuration; choose Device -> Calibration -> Lower/Upper, get page of temperature calibration.

(2) Make sure of sensor type, set Characterization Type and Input Range and Mode, and set Calibration Unit according to sensor type. It supports the parameters℃, Ω, and mV. Write the parameter after the setting.

(3) Give standard data to channel to calibrate via standard source. When the input is stable, write calibration data to Upper Calibration Point or Lower Calibration Point according to the operation one is upper calibration or lower calibration. If there is no write error, the calibration is successful. Notes: There should not be a

great deviation between written calibration data and practical input channel data, otherwise the calibration will be in failure.

Notes: When the user uses Device -> Master Reset, it may bring in the instrument CPU reset as well as communication broken, which is normal. Please connect again.

5. Maintenance

Phenomenon	Solution
No Communication	**Temperature Module Connection** Check the bus cable connection Check bus power polarity Check bus cable shield, whether it is single point earthing or not
	Bus Power Bus power should in the range 9 ~ 32V for the temperature module, and bus noise and ripple should fulfill: (1) peak-to-peak value noise 16mV, 7~39kHz; (2) peak-to-peak value noise 2V, 47~63HZ, non-intrinsically safety (3) peak-to-peak value noise 0.2V, 47~63HZ, intrinsically safety (4) peak-to-peak value noise 1.6V, 3.9M~125MHZ.
	Network Connection Check network topology structure Check terminal matcher and wiring Check the length of main trunk and branch

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	Address Conflict When coming to market, the temperature module has a random address, avoiding address conflict. But on a network segment it still possibly appears address conflicts. When conflict occurs, sometimes conflicting device will be temporary address online, you should just reset the device address. Sometimes device will not be temporary address online, you should cut off the electricity of conflicting device, and then power them one by one, modify the address of new powered device as non-conflicting.
	Temperature Module Failure Replace the temperature module with others for testing.
Reading Error	**Temperature Module Connection Failure** Check sensor short circuit, open circuit, and earthing. Check sensor
	Noise Disturb Adjust damping Check the house earthing Check the terminal

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	Check the cable is away from the strong electromagnetic interference
	Software Configuration Check sensor type configuration Check function block parameter configuration
	Temperature Module Failure Replace the temperature module with others for testing.

6. Technical Specification

6.1 Basic Parameter

Input Signal	Resistance: PT100, CU50, CU100, 0~500Ω, 0~4000Ω Thermocouple: B, E, J, N, K, R, S, T Voltage signal: -100mV～100mV
Channel	Signal
RTD Wiring	2-wire, 3-wire, 4-wire
Bus Power	9~32 VDC Current consumption (static): ≤14mA
Bus Signal	Communication ratio 31.25Kbit/s, current mode
Isolation	Between terminal and housing: 500 Vrms (707 VDC)
Working Temperature	-40℃~85℃
Humidity Range	10%~90%RH
Start Time	≤5s
Refresh Time	0.5s

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EMC	GB/T 18268-2000
Protection	IP20

6.2 RTD Parameter

● RTD Parameter at Normal Temperature (25℃)

Signal Type	Suggested Range (℃)	Accuracy
Resistance Signal	0~400 Ω ,0~4000 Ω	0.09 Ω , 0.7 Ω
PT100	-200~850℃	±0.3℃
PT1000	-200~850℃	±0.3℃
CU50	-50~150℃	±0.5℃
CU100	-50~150℃	±0.4℃

● RTD Other Parameter

Wiring	2, 3, 4
Common Mode Rejection	≥70Db (50Hz and 60Hz)
Series Mode Rejection	≥70dB(50Hz and 60Hz)
Temperature Effect	<50ppm/℃

6.3 Thermocouple

Parameter

● Thermocouple Parameter at Normal Temperature (25℃)

Signal Type	Suggested Range (℃)	Accuracy
mV	-100Mv~100mV	0.05%
B	500℃~1810℃	±1.0℃
E	-200℃~1000℃	±0.4℃
J	-190℃~1200℃	±0.4℃
K	-200℃~1372℃	±0.4℃
N	-190℃~1300℃	±0.8℃
R	0℃~1768℃	±1.0℃
S	0℃~1768℃	±1.0℃
T	-200℃~400℃	±0.4℃

● Thermocouple Other Parameter

Compensation Accuracy	-2℃~5℃
Sensor Type	B,E,J,N,K,R,S,T -100mV~100mV Voltage
Common Mode Rejection	≥70Db (50Hz and 60Hz)

Series Mode Rejection	≥70dB(50Hz and 60Hz)
Temperature Effect	<50ppm/℃

6.4 Physical Parameter

Dimension	¢45*23mm
Housing Material	Nylon