SIEMENS

SIMATIC

SM331; AI 8 x 12 Bit

Getting Started
Part 3: Thermo Couples

Safety-related Guidelines

This manual contains notices intended to ensure personal safety, as well as to protect the products and connected equipment against damage. These notices are highlighted by the symbols shown below and graded according to severity by the following texts:

⚠ **Danger**
indicates that death, severe personal injury or substantial property damage will result if proper precautions are not taken.

⚠ **Warning**
indicates that death, severe personal injury, or substantial property damage can result if proper precautions are not taken.

⚠ **Caution**
indicates that minor personal injury or property damage can result if proper precautions are not taken.

Note
contains important information about the product, its operation or a part of the document to which special attention is drawn.

Qualified personnel

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Correct Usage

Please observe the following:

⚠ **Warning**
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The product will function correctly and safely only if it is transported, stored, set up, and installed as intended, and operated and maintained with care.

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Table of Contents:

1   Preface

Purpose of the Getting Started

The Getting Started gives you a complete overview of the commissioning of the analog module SM331 (6ES7331-7KF02-0AB0). It assists you in the installation and parameterization of the hardware of the thermo couples and the configuration with SIMATIC Manager.

The target audience of the Getting Started is a beginner with only basic experience in configuration, commissioning and servicing of automation systems.

What to expect

Step by step the procedures from mounting the module to storing analog values in the STEP 7 user program are explained using an example. You will be guided through the following sections

- Problem analysis

- Mechanical setup of the sample station

- Electrical connection of the sample station

- Configuration with SIMATIC Manager

- Creating a small user program with STEP 7, which stores the read analog values in a data block

- Triggering and interpreting a diagnostic and hardware interrupt

2 Prerequisites

2.1 Required basic knowledge

No special knowledge in the area of automation technique is required to understand this description. As the configuration of the analog module is based on the software STEP 7, knowledge of STEP 7 would be advantageous.

Further information on STEP7 can be found in the electronic manuals delivered with STEP 7.

Knowledge of PC or similar devices (e.g. programming devices) using the operating system Windows 95/98/2000/NT or XP is assumed.

2.2 Required Hardware and Software

The scope of delivery of the analog module consists of two parts:

- Module SM331

- Front connector which enables it to comfortably connect the power supply and the data connections.

Table 2-1 Components of the analog module

Quantity	Article	Order number
1	SM 331, OPTICALLY ISOLATED 8 AE, ALARM DIAGNOSTICS	6ES7331-7KF02-0AB0
1	20-PIN FRONT CONNECTOR WITH SPRING CONTACTS <u>Alternatively:</u> 20-pin FRONT CONNECTOR WITH SCREW CONTACTS	6ES7392-1BJ00-0AA0 6ES7392-1AJ00-0AA0
1	SIMATIC S7 SHIELD CONNECTING ELEMENT	6ES7390-5AA00-0AA0
2	SIMATIC 7, , TERMINAL ELEMENT F. 1 CABLE W. TO 13MM IN DIA.	6ES7390-5CA00-0AA0

The following general SIMATIC components are also required for the example.

Table 2-2 SIMATIC Components of the sample station

Quantity	Article	Order number
1	POWER SUPPLY. PS 307 AC 120/230V, DC 24V, 5A (incl. power supply bridge circuit)	6ES7307-1EA00-0AA0
1	CPU 315-2DP	6ES7315-2AG10-0AB0
1	MICRO MEMORY CARD, NFLASH, 128KBYTE	6ES7953-8LG00-0AA0
1	SIMATIC S7-300, RAIL L=530MM	6ES7390-1AF30-0AA0
1	Programming device (PG) with MPI-interface and MPI-cable PC with corresponding interface card	Depending on the configuration

Installed Software STEP 7:

Table 2-3   Software STEP 7

Quantity	Article	Order number
1	STEP 7 Software version 5.2 or later is installed on the programming device.	6ES7810-4CC06-0YX0

The following thermo couples can be used for the acquisition of analog signals:

Table 2-4   Thermo couples of the sample station

Quantity	Article	Order number
2	Thermo couple type J	Depending on the manufacturer
2	Thermo couple type K	Depending on the manufacturer
1	Siemens Compensation box (Type J – DC 24V)	M72166-B4200

Note

This „Getting Started" describes only the application of the thermo couples. If you want to use other transducers, then you have to wire and parameterize the SM331 differently.

Separate „Getting Starteds" are available for 4-20mA current transducers, voltage transducers and the resistance thermometer PT100 standard which can be connected to the SM331.

Furthermore, the following tools and materials are necessary:

Table 2-5   General tools and materials

Quantity	Article	Order number
multiple	M6-bolts and nuts (Length depending on the mounting place)	standard
1	Screwdriver with blade width 3,5 mm	standard
1	Screwdriver with blade width 4,5 mm	standard
1	Wire cutting pliers and tools for stripping	standard
1	Tools for mounting cable end sleeves	standard
X m	Wire for grounding the rail with 10 mm^2 diameter, Ring terminal with 6,5 mm hole. Length according to local conditions	standard
X m	Flexible wire with 1mm^2 diameter with fitting wire end sleeves, form A in 3 different colours – blue, red and green.	standard
X m	3-wire power cord (AC 230/120V) with protective earth contact socket, length according to local conditions.	standard

Quantity	Article	Order number
1	Calibration device (Measuring instrument for commissioning that can measure and supply current)	Depending on the manufacturer

3   Task

The Getting Started leads you successfully through a sample application in which you will install the following thermo couples:

A) Two thermo couples with type J and type K, which are directly installed on the analog module SM331 (Using the internal reference junction).

B) Two equal thermo couples type J each, which are connected through an intermediate terminal (compensation point with external compensation box)

You will activate failure diagnostics and hardware interrupts. You have analog input module SM331, AI8x12 Bit (order number 6ES7 331-7KF02-0AB0) available.

The module can process up to 8 analog inputs and trigger hardware and diagnostic interrupts. For each module different measurement types can be set (e.g. current or voltage measurement; PT 100; thermo couple).

The following mounting options are described in the sample task:

• The thermo couples are installed close enough to the analog module and therefore the cables can be connected directly to the module

• The connection location of the thermo couples is further away from the analog module.
In this case the compensation wire is replaced by a copper wire through a terminal. A compensation box has to be installed in the close vicinity of the terminal.
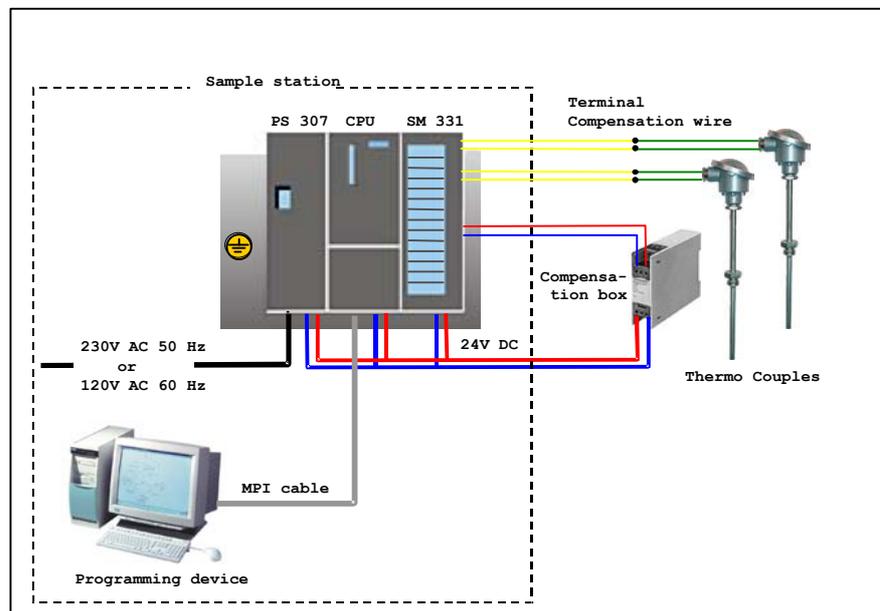
Figure 3-1   Components of the sample station

You will be guided through these steps

- Mechanical setup of the sample station (see chapter 4)
    - General mounting instructions for S7-300 modules
    - Configuration of the SM331 for the two selected measurement transducer types
- Electrical connection of the sample station (see chapter 5)
    - Wiring of the power supply and the CPU
    - Wiring of the analog module
    - Standard pin layout of the voltage transducer and resistance thermometer
- Configuration with SIMATIC Manager (see chapter 6)
    - Using the project wizard
    - Completing the automatically generated hardware configuration
    - Integration of a supplied user source code
- User program testing (see chapter 7)
    - Interpretation of the read values
    - Conversion of the measured values into readable analog values
- Utilizing the diagnostic capabilities of the SM331 module (see chapter 8)
    - Triggering a diagnostic interrupt
    - Analyzing the diagnostics data
- Application of hardware interrupts (see chapter 9)
    - Parameterization of hardware interrupts
    - Configuration and analysis of hardware interrupts

4 Mechanical setup of the sample station

The setup of the sample station is divided into two steps. First, the setup of the power supply and the CPU is explained. After becoming acquainted with the analog module SM331 the mounting of it is described.

4.1 Mounting of the sample station

Before you can use the analog input module SM331, you need a basic setup of general SIMATIC S7-300 components.

The order of the mounting takes place from left to right:

- Power supply PS307

- CPU 315-2DP

- Analog module SM331

Table 4-1   Mounting of the sample station (without SM331)

Step	Graphics	Description
1		Bolt together the rail to the ground (screw size: M6) so that at least 40 mm space remains above and below the rail. If the base is a grounded sheet metal or a grounded mounting plate, ensure that the rail and the base are connected together with low resistance. Connect the rail with a protective ground wire. An M6 bolt is available on the rail for this purpose.
2		Mounting the power supply: • Hang the power supply to the top end of the rail
3		• and tighten it at the bottom to the rail.

Step	Graphics	Description
4		Connect the bus connector (delivered with the SM331) to the **left** connector at the back of the CPU.
5		Mounting the CPU: • Hang the CPU to the top end of the rail • Push it all the way left to the power supply • Push it down • and tighten the bottom screw to the rail

4.2 Mounting the analog module

The measuring range modules should be plugged in accordingly before the mounting of SM331 (see chapter 4.2.3).

In this section you will learn

- Which components you need
- What the properties of the analog input module are
- What a measuring range module is and how it is setup
- How you mount the already setup module

4.2.1 Components of the SM331

A functional analog module consists of the following components:

- Module SM331 (in our example 6ES7331-7KF02-0AB0)
- 20-pin front connector. There are two types of front connectors:
  - With spring contacts (Order number 6ES7392-1BJ00-0AA0)
  - With screw contacts (Order number 6ES7392-1AJ00-0AA0)
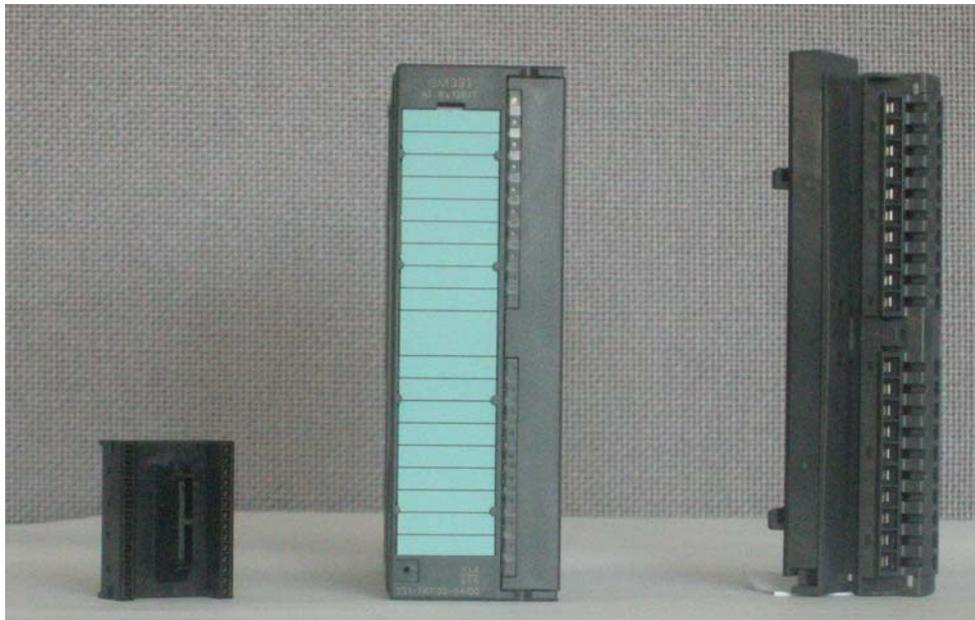
Figure 4-1   Components of the SM331

Table 4-2   The scope of delivery of SM331

Components
Analog module SM331
Labelling strips
Bus connector
2 cable ties (not in the picture) to tie the external wiring

4.2.2 Properties of the analog module

The module is a universal analog module applicable to the most common applications.

The desired measuring mode should be adjusted directly on the module with the measuring range module (see chapter 4.2.3).

- 8 inputs in 4 channel groups (each group with two inputs of same type)
- Measurement resolution adjustable for each channel group
- User defined selection of measuring mode for each channel group:
  - Voltage
  - Current
  - Resistance
  - Temperature
- Configurable diagnostic interrupt
- Two channels with limit value interrupt (only channel 0 and channel 2 are configurable)
- Electrically isolated against backpane bus
- Electrically isolated against load voltage (exception: At least one module is set to position D)

Alternatively applicable SM331; AI 8 x TC (only for thermo couples)

If you install thermo couples solely, you can also use the analog module SM331; AI 8 x TC with the order number 6ES7331-7PF10-0AB0. Notes on connecting this device can be found in the reference manual „Automation system S7-300 technical data".

4.2.3 Measuring range modules

The module SM331 has four measuring range modules (one measuring range module per channel group). Each measuring range module can be set to 4 different positions (A, B, C or D). With the position you determine which transducer you connect to the respective channel group.
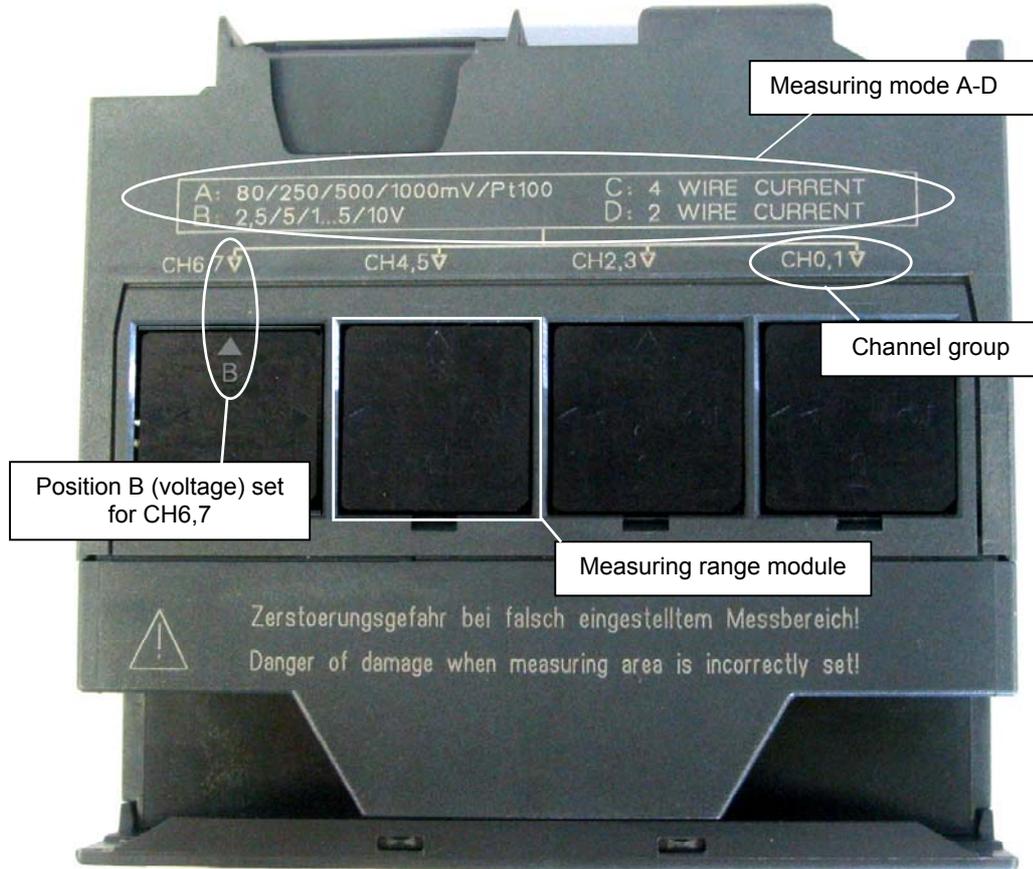
Figure 4-2   4 measuring range modules with default setting B (Voltage)

Table 4-3   Possible positions of the measuring range module

Position	Measurement type
A	Thermo couple / Resistance measurement
B	Voltage (default setting)
C	Current (4 wire transducer)
D	Current (2 wire transducer)

In our sample task we use the channel groups CH0, 1 and CH2, 3 in the measurement mode „Thermo couple". Verify that the measuring range modules are set to Position A. If needed adjust to the desired position (see. Table 4-4).

Table 4-4   Positioning of the measuring range module
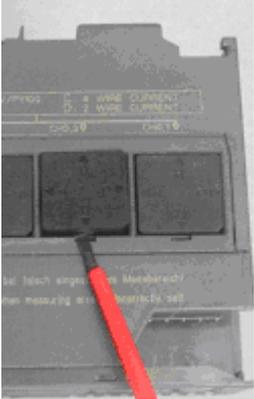
Step	Graphics	Description
1		With a screwdriver, pull out the two measuring range modules
2		Turn the measuring range module to the desired position
3		Plug the measuring range modules back into the module In our example, the module must have the following positions: CH0,1: A CH2,3: A CH4,5: B CH6,7: B
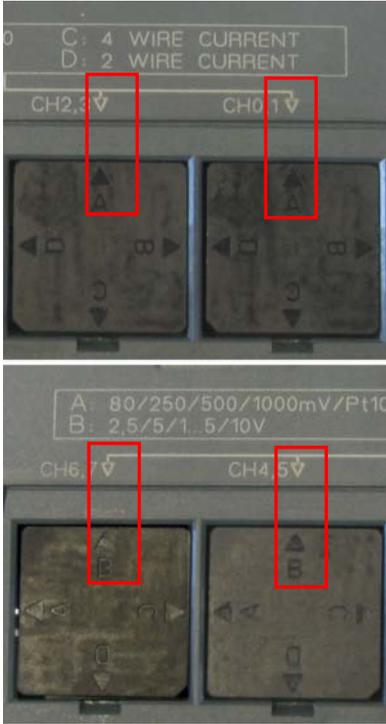
4.2.4 Mounting the SM331 module

After you have prepared the analog module accordingly, mount it to the rail as well.

Table 4-5   Mounting the SM331 module

Step	Graphics	Description
1		Mounting the SM331: • Insert the SM331 to the top part of the rail • Push it all the way left to the CPU • Push down • and tighten the screw at the bottom to the rail
2		Mounting the front connector: • Press the upper release button of the front connector block • Insert the front connector into the module until it snaps in
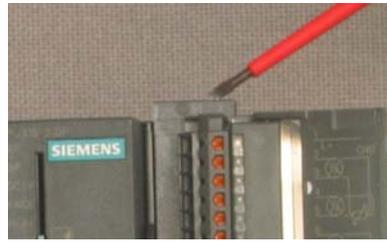
Mechanically the sample station is now completely mounted.

5 Electrical connection of the sample station

This chapter describes how the various parts of the sample station from the power supply to the analog module are electrically wired.

⚠	**Warning** You might get an electrical shock if the power supply PS307 is turned on or the power cord is connected to the line. Wire the S7-300 only in the power-off state.

5.1 Wiring the power supply and the CPU

Figure 5-1   Wiring the power supply and the CPU

The sample station requires a power supply. The wiring is done as follows:

Table 5-1   Wiring of the power supply and the CPU

Step	Graphics	Description
1		Open the front flap of the power supply and the CPU
2		Unscrew the pull relief bracket of the power supply
3		Remove the insulation from the power cord, attach the cable end sleeves (for multi-wire cords) and connect it to the power supply
4		Tighten the pull relief bracket
5		Insert the power supply bridge circuit between the power supply and the CPU and tighten it. Do **not** modify the grounding switch as the SM331 is already set up electrically isolated. Information about the CPU's grounding switch: • Pressed: Electrically connected (Default setting) • Pulled: Electrically isolated
6		Confirm that the setting of the voltage selector is set to your local line voltage. The power supply's default setting is AC 230 V. In order to change this setting, do the following: Remove the protective cap with a screwdriver, adjust the switch according to your line voltage and put the protective cap back on.
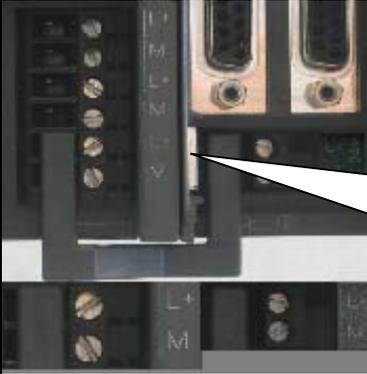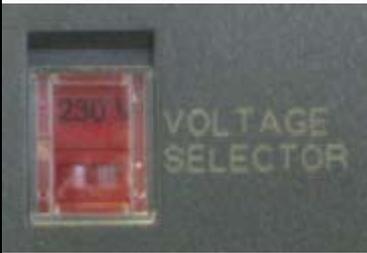
5.2 Connection variations of the analog module

For the connection of thermo couples the wiring of the analog module SM331 differs only through the selection of:

- ▪ Usage of the internal reference junction
- ▪ Usage of an external reference junction

In the following chapters you will be led through the two types of connection variations with internal and external reference junction.

5.2.1 Shielded wires for analog signals

You should use shielded and twisted pair wires for analog signals. That minimizes interference. The shield of the analog wires should be grounded at both ends.

If there are any voltage differences between the ends of the wires, a compensation current might flow, which can interfere with the analog signals. In this case you should either ground the shield only at one end or install an appropriate compensation wire.

Table 5-2   Usage of the internal and external reference junction

Properties	Usage of an internal reference junction	Usage of an external reference junction
Wiring with thermo couples of same type	A maximum of 8 thermo couples is possible	A maximum of 8 thermo couples is possible
Wiring with a combination of different thermo couple types	For each channel group 2 thermo couples of the same type can be installed. Meaning: A total of 8 thermo couples with maximum 4 different types can be installed.	A combination of different thermo couples is **not** possible. All channels of the module refer to the same reference junction. Therefore a maximum of 8 thermo couples of same type can be installed.
Usable connection wires	• Direct connection of the thermo couples • Connection through compensation wires	Long copper wires are possible. Connection of the thermo couples directly at the reference junction.

5.2.2 Connection diagram of thermo couples with internal reference junction

The following figure shows the analog module SM331 with thermo couples connected via a compensation wire and internal reference junction.
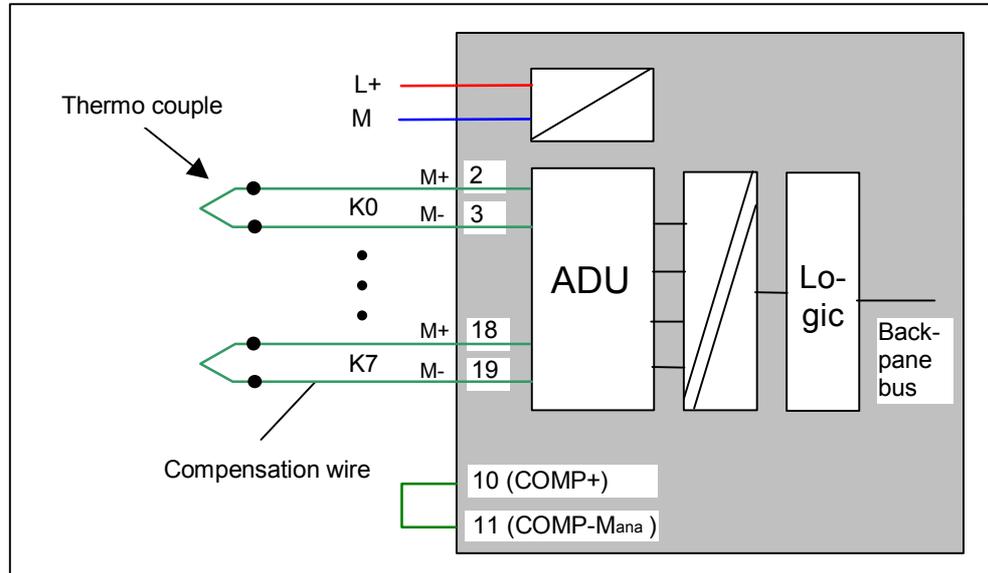
Figure 5-2   Connection diagram: Usage of internal reference junction

The compensation wire always has to be the same material (alloy) as the thermo couple itself.

On a channel group, only thermo couples with the same type can be installed.

5.2.3 Connection diagram of an analog module with internal reference junction

The wiring of the analog module consists of the following tasks:

- Installation of power supply (red wire)
- Installation of the compensation wires for the thermo couples
- Short circuiting the reference junction
- Grounding and short circuiting unused channels (blue wires)

Details of the wiring are explained in the next chapter.
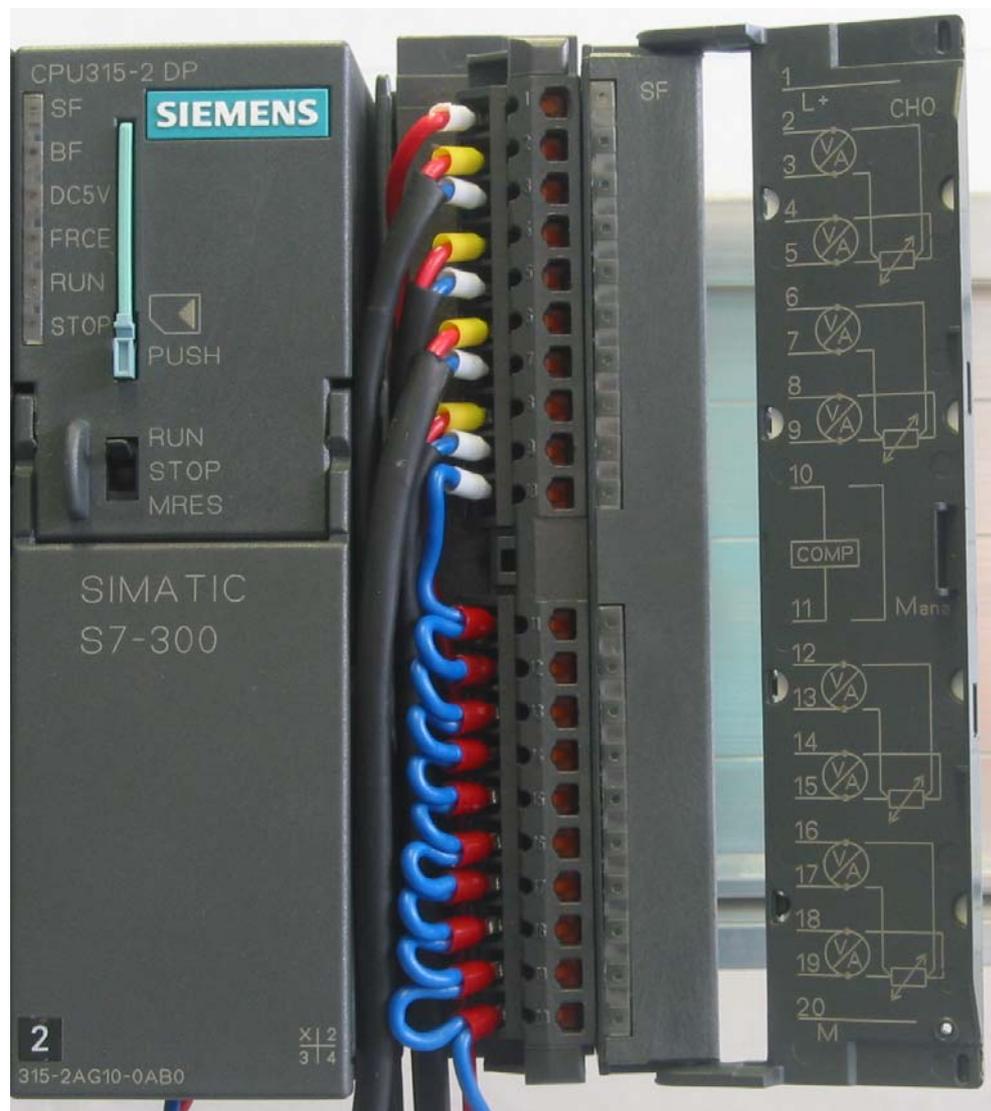
Figure 5-3   SM331 Front connector wiring

5.2.4 Wiring of the analog module with internal reference junction

Connect the thermo couples directly or via compensation wires to the inputs of the module. The following table describes the wiring step by step:

Table 5-3   SM331 Front connector wiring

	Graphics	Wiring	Comments
1		Open the front flap of SM331	The terminals are pictured on the front flap
2		Remove 6 mm of the insulation of the wire ends that you want to plug into the front connector and put the appropriate wire end sleeves.	
3		Connect the front connector as follows Terminal 1: L+	Power supply of the module
4		Terminal 2: M+ First thermo couple type J Terminal 3: M- First thermo couple type J Terminal 4: M+ Second thermo couple type J Terminal 5: M- Second thermo couple type J Terminal 6: M+ First thermo couple type K Terminal 7: M- First thermo couple type K Terminal 8: M+ Second thermo couple type K Terminal 9: M- Second thermo couple type K	Standard wiring for thermo couples with internal reference junctions. If you swap M+ and M-, you will get the wrong measurement values which will not correspond to the real temperature!
5		Terminal 10: (Comp+) and Terminal 11: (Comp-)	Thermo couples that are connected directly or via compensation wires do not need an external reference junction. The external reference junction is short circuited via the bridge.
6		Short circuit terminal 11: (M_{ana}) and terminal 12 till 19 and connect with terminal 20: M	The unused channel groups should be short circuited with M_{ana} (Comp-) and M to reach optimum interference resistance. **Note:** Terminal 11 M_{ana} is called Comp- when used with an external cold junction.
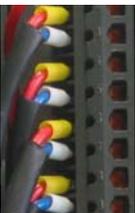
5.2.5 Connection diagram of thermo couples with external reference junction

The diagram illustrates the analog module SM331 with connection

- of thermo couples over a connection point for compensation wire

- of an external reference junction
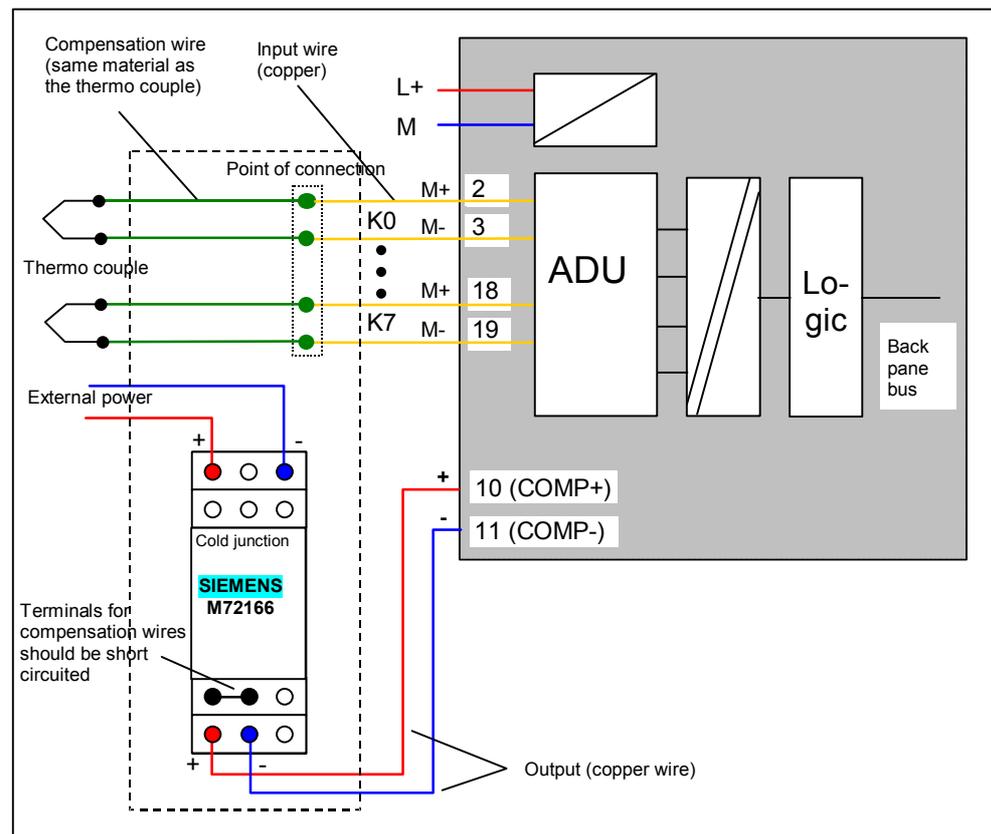
Figure 5-4   Wiring: Thermo couple with external reference junction

With external compensation the temperature of the reference junction of the thermo couples are acquired via the compensation box.

The compensation box contains a bridge circuit, which is calibrated for a certain temperature (calibration temperature).

The connection of the compensation wires should stand in the direct vicinity of the compensation box. Only then can you guarantee that the surrounding temperature of the connection point of the thermo couple and the compensation box is the same.

5.2.6 Connection diagram of the analog module with external reference junction

The wiring of the analog module consists of the following tasks:

- Connection of the power supply (red cable)

- Connection of the compensation wires from thermo couples

- Connection of the reference junction

- Grounding and short circuiting of unused channels (blue cables)

You will find details of the wiring in chapter 5.2.7
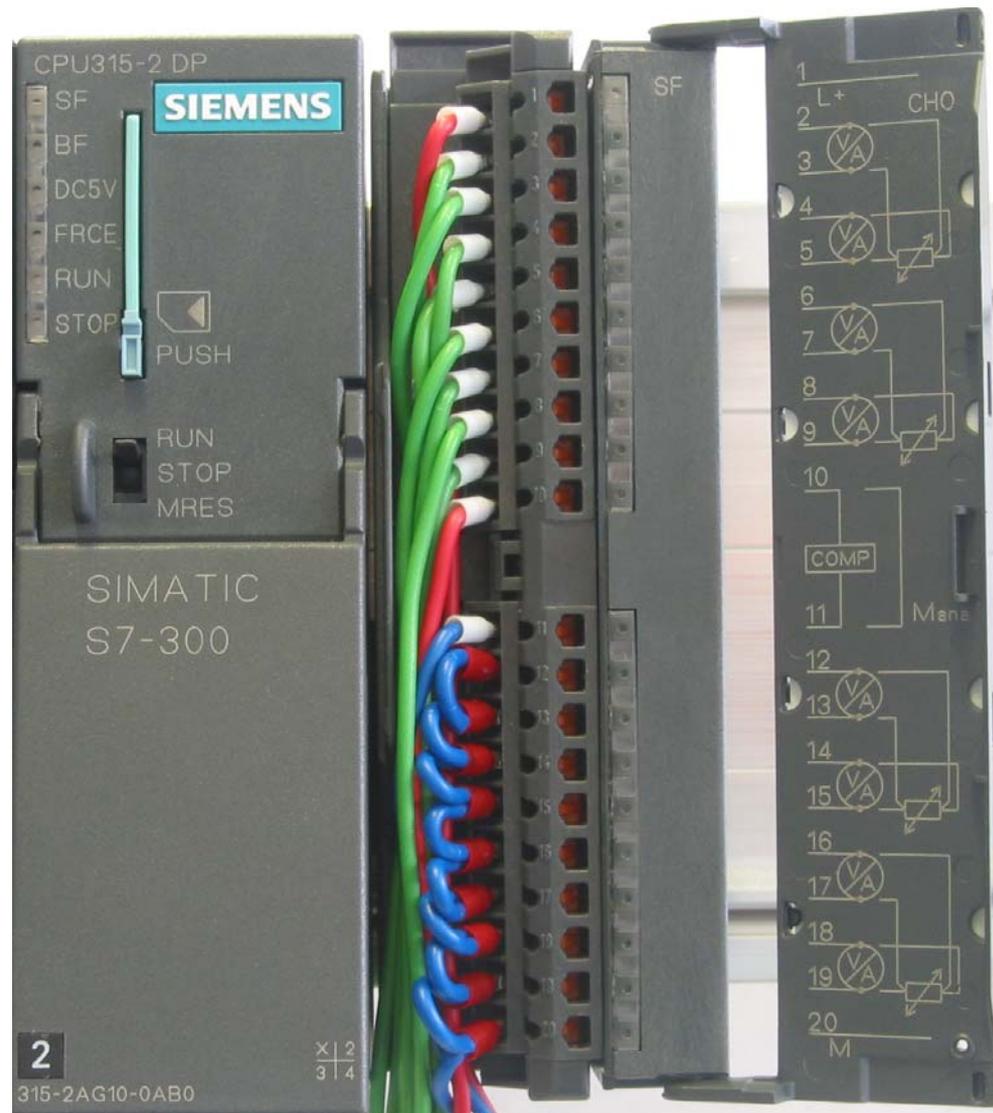
Figure 5-5   SM331 Front connector wiring

5.2.7 Wiring of the analog module with external reference junction

Install the thermo coupled over a compensation point. From this terminal on, copper wires are used all the way to the module SM331. The detailed tasks for wiring are explained below step by step:

Table 5-4   SM331 Front connector wiring

	Graphics	Wiring	Comment
1		Open the front flap of the SM331	The terminals are pictured on the front flap
2		Remove 6 mm of the insulation of the wire ends that you want to plug into the front connector and put the appropriate wire end sleeves.	
3		Wire the front connector as follows: Terminal 1: L+	L+ from the power supply of the module
4		Terminal 2: M+ First thermo couple type J Terminal 3: M- First thermo couple type J Terminal 4: M+ Second thermo couple type J Terminal 5: M- Second thermo couple type J Terminal 6: M+ Third thermo couple type J Terminal 7: M- Third thermo couple type J Terminal 8: M+ Fourth thermo couple type J Terminal 9: M- Fourth thermo couple type J	Standard wiring of thermo couples with external reference junction If you swap M+ and M- wiring, you will get the wrong measurement values, which will not correspond to the real temperature!
5		Connect terminal 10: (Comp+) and Terminal 11: (Comp-) with cold junction	The wiring of the compensation box is described in chapter 5.2.8
6		Short circuit terminal 12 to 19 and connect with terminal 20 Terminal 20: M	The unused channel groups should be short circuited with M to reach optimum interference resistance. M from the power supply of the module
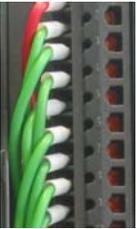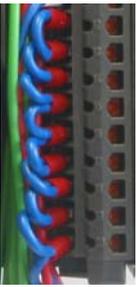
5.2.8 Wiring of the external reference junction

In our example we use a Siemens compensation box for thermo couple type J (MLFB M72166-B4200) with 24 V DC as external power. The compensation box should be mounted in the direct vicinity of the connection point.

Figure 5-6   Point of connection
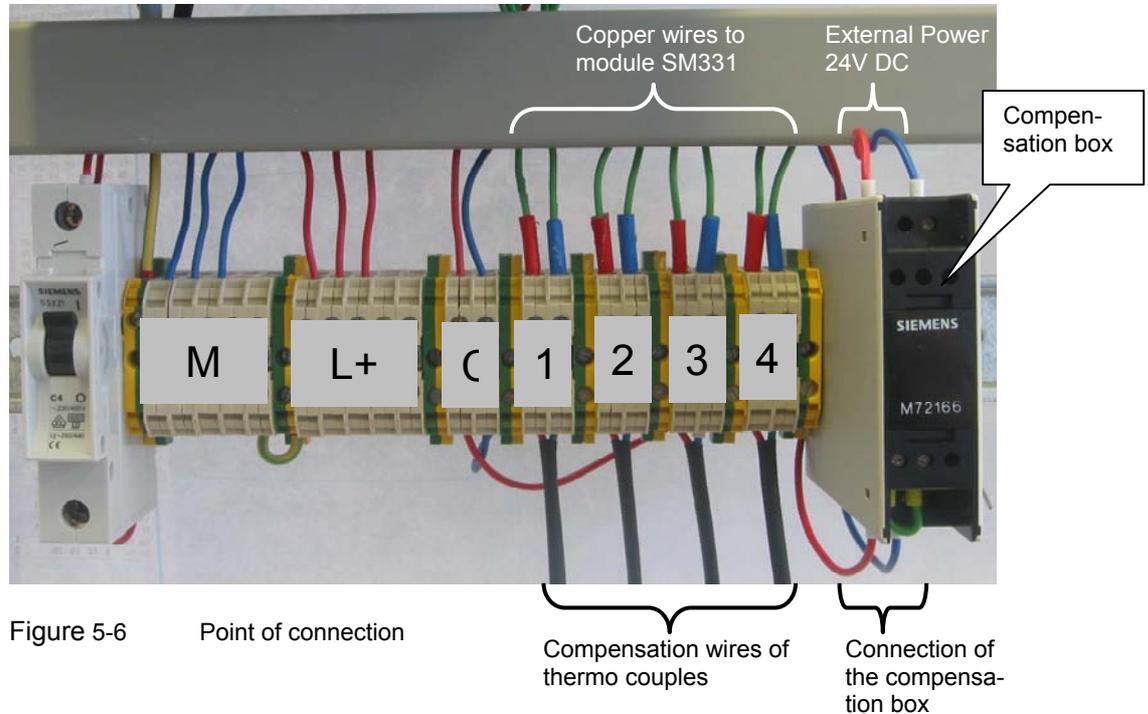
Table 5-5   Wiring of the compensation box

Graphics	Wiring	Comments
	Wire the compensation box as follows: Terminal 1: M External power 24V DC Terminal 3: L+ External power 24V DC	
	Short circuit terminal 11 and 12 (green cable) Connect terminal 8 with terminal 11 (Comp-) of the SM331 Connect terminal 9 with terminal 10 (Comp+) of the SM331	The reference temperature of 0° C that is required by SM331 is set by short circuiting terminals 11 and 12

5.2.9 Switch on now

If you want to test the wiring, you may now switch the power supply on.

Do not forget to set the CPU to STOP (see red circle)

Figure 5-7   Successful wiring, CPU in STOP mode

If a red LED is lit, then there is an error in the wiring. Verify your wiring.

6 Configuration with SIMATIC Manager

In this chapter you will be guided through the following tasks:

- Creating a new STEP7 project
- Parameterization of the hardware configuration

6.1 Create a new STEP7 Project

For configuring the new CPU 315-2 DP use STEP7 V5.2 or later version.

Start SIMATIC Manager by clicking the symbol „SIMATIC Manager" on your windows desktop and create a new project with the STEP7 wizard „New Project".
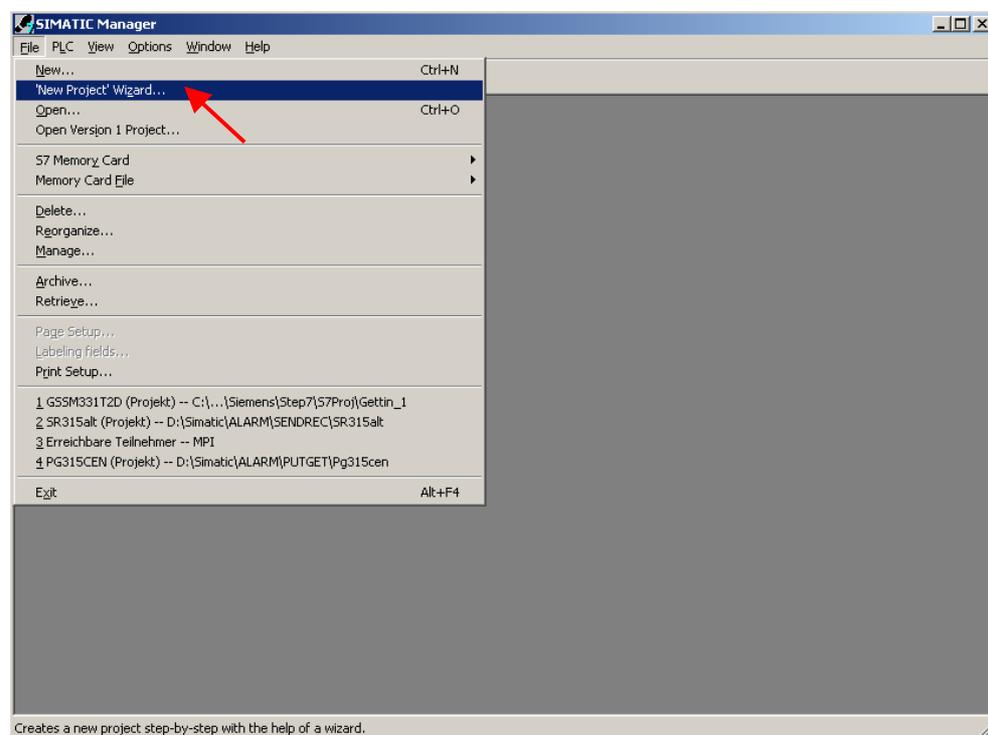
Figure 6-1   Execute STEP7 wizard „New Project"

An introduction window pops up. The wizard will guide you through the creation of a new project.
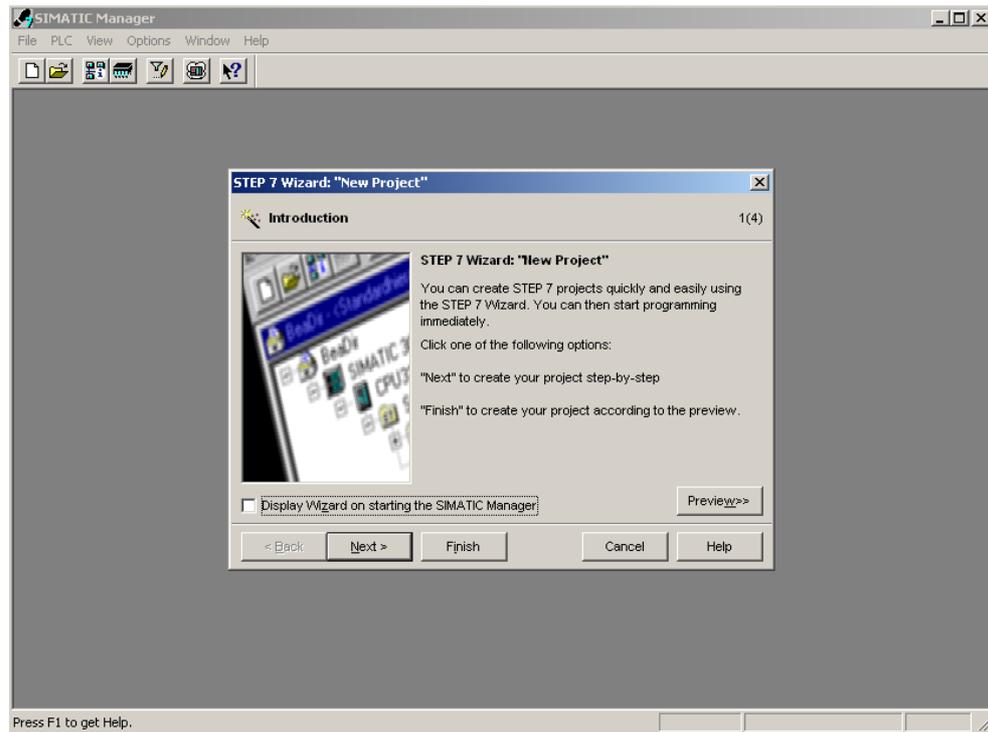
Figure 6-2   STEP7 wizard „New Project", Introduction

During the creation the following inputs are necessary:

- Selection of the CPU type

- Definition of the basic user program

- Selection of organization blocks

- Project name

Click „Next"

6.1.1 CPU Selection

Choose the CPU 315-2DP for the sample project. (You can also use our example for a different CPU). Then choose your CPU.
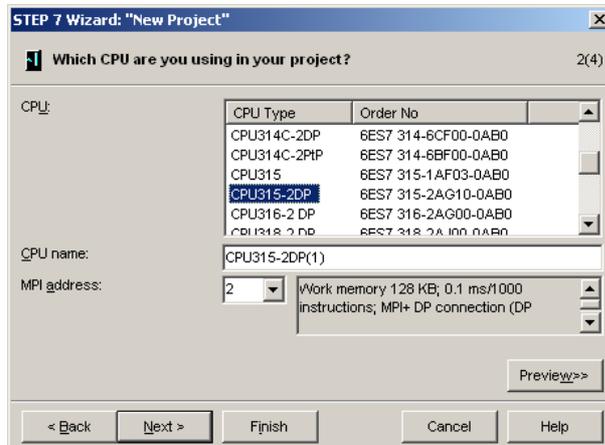
Figure 6-3   STEP 7 wizard „New Project", CPU selection

Click „Next"

6.1.2 Definition of the basic user program

Choose the SIMATIC language STL and select the following organization blocks (OBs):

- OB1   Program Cycle Organization Block
- OB40   Hardware interrupt
- OB82   Diagnostic interrupt

OB1 is required in every project and is called cyclically.
OB40 is called when a hardware interrupt occurs.
OB82 is called when a diagnostic interrupt occurs.
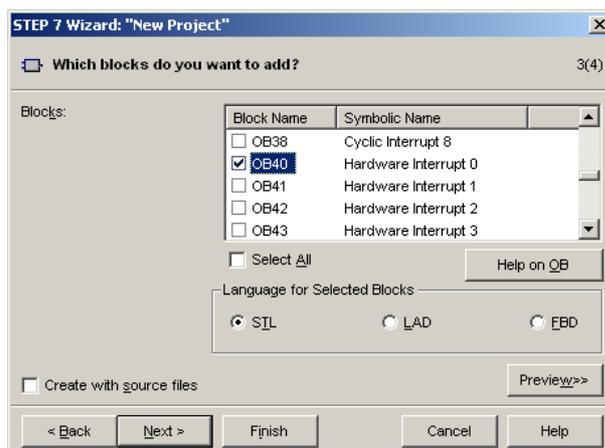
Figure 6-4   STEP 7 wizard „New Project": Insert organization blocks

Click „Next"

6.1.3   Specify the project name

Select the edit field "Project name" and overwrite the name in it with "Getting Started S7 SM331".
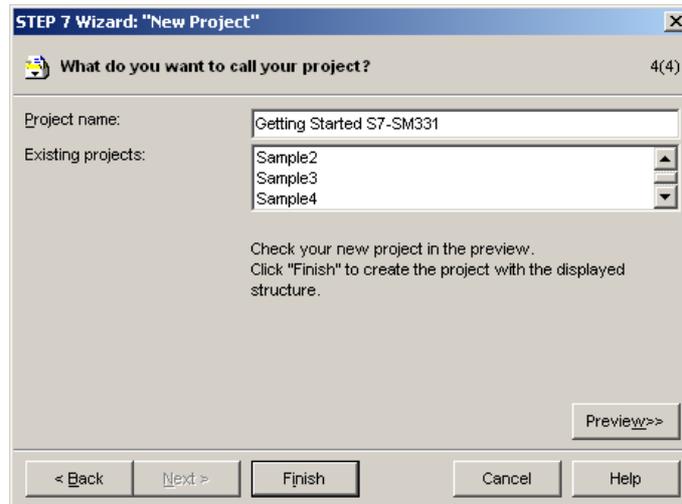
Figure 6-5   STEP 7 wizard „New Project": Specify project name

Click „Finish". The basic STEP 7 project is created automatically.

6.1.4   Resulting S7 project is created

The wizard has created the project "Getting Started S7 SM331". In the right pane you can find the inserted organization blocks.
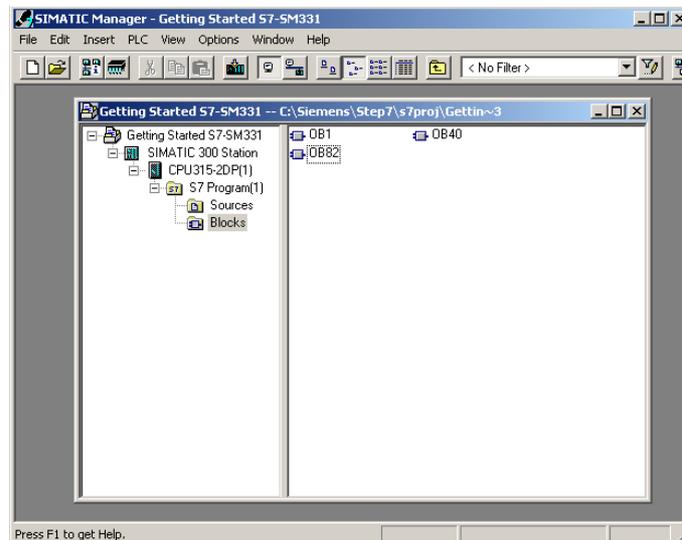
Figure 6-6   STEP 7 wizard „New Project": Result

6.2 Hardware configuration

The STEP 7 wizard has created a basic S7 project. You also need a complete hardware configuration in order to create the system data for the CPU.

6.2.1 Create the hardware configuration

You can create the hardware configuration of the sample station with the help of SIMATIC Managers.

In order to do this, select the folder „SIMATIC 300 Station" on the left hand pane. Start the hardware configuration by double clicking the icon "Hardware" on the right hand pane.
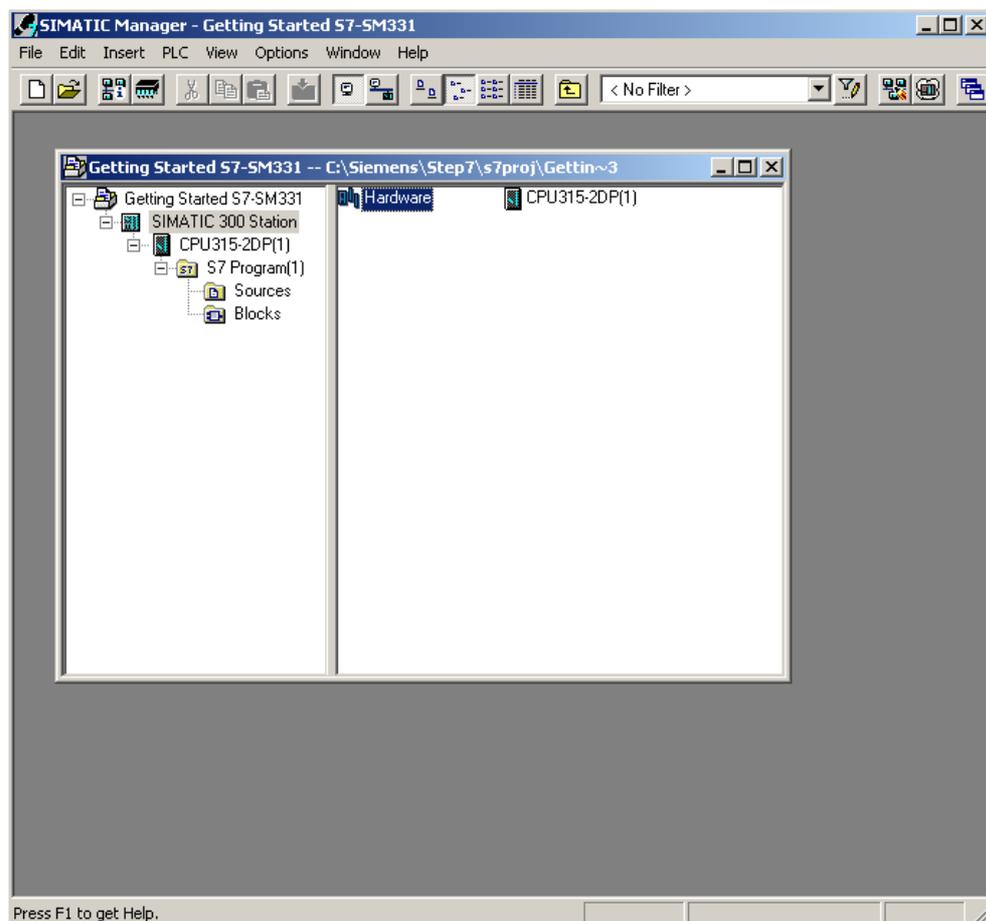
Figure 6-7   Starting the hardware configuration

6.2.2 Insert SIMATIC components

First select a power supply from the hardware catalogue.

If the hardware catalogue is not visible, open it with the shortcut key Ctrl+K or by clicking the catalogue symbol (blue arrow).

In the hardware catalogue you can browse through the SIMATIC 300 folder to the PS-300 folder.

Select the PS307 5A from the right window and drag it into slot 1 (see red arrow) in the configuration table.

Figure 6-8   Hardware configuration: Basic configuration

Result: PS 307 5A appears in the configuration of your rack.

Insert analog module

There are many SM331 analog modules. For this project we use an SM331, AI8x12 Bit with the order number 6ES7 331-7KF02-0AB0.

The order number is displayed at the bottom of the Hardware catalog (see blue arrow)

Click on SM331 AI8x12Bit in the right window and drag it to the first available field on slot 4 (see red arrow) of your rack.

Now you have inserted all the modules into the hardware configuration. In the next Step you parameterize the modules.
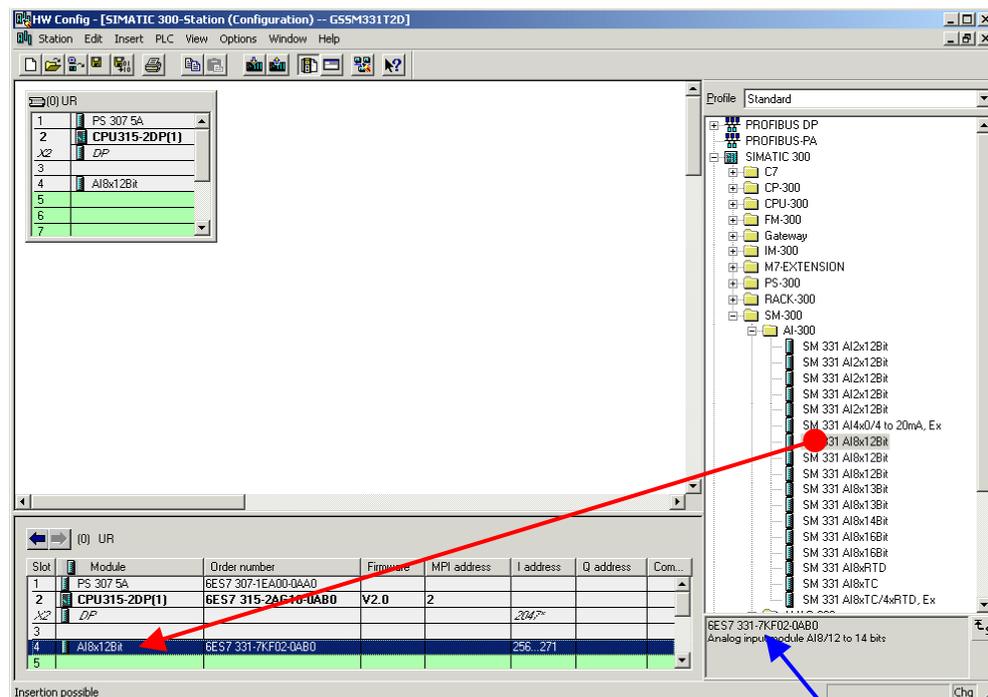
Figure 6-9   Hardware configuration: Insert SM331

Order number of the module

SIMATIC Manager inserts the analog module with its standard settings. You can now modify the parameters to change the sensor types, diagnostics and interrupt capabilities.

6.2.3   Parameterization of the analog module of the sample station

You can now modify the parameters to change the sensor types, diagnostics and interrupt capabilities.

To open the parameterization, double click the analog module in the hardware configuration. The „Properties" window of the SM331 will open.

Overview of the functionalities with internal compensation

The table shows you, which parameters have to be set for internal compensation.

Table 6-1   SM331 Functionalities of the sample station with internal Compensation

Functionalities	Description	Comments
Process reactions	Diagnosis – active Hardware interrupt when limit value exceeded – active	
Sensor 1	Thermo couple type J	Channel group (Input) 0 - 1
Sensor 2	Thermo couple type J	Channel group (Input) 0 - 1
Sensor 3	Thermo couple type K	Channel group (Input) 2 - 3
Sensor 4	Thermo couple type K	Channel group (Input) 2 - 3

Parameterization of SM331 with internal compensation

If you want to parameterize SM331 for internal compensation, please set the module as follows:
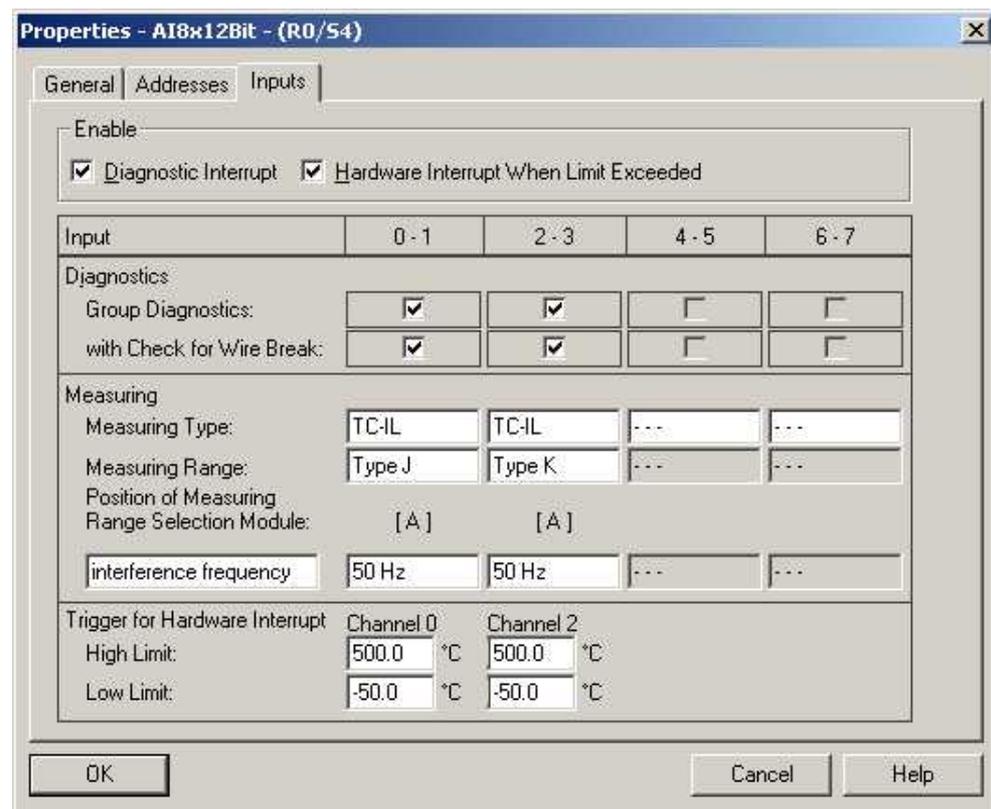
Figure 6-10   SM331: Parameterisation of thermo couples with internal reference junctions

Overview of the functionalities with external compensation

The table shows you, which parameters have to be set for external compensation.

Table 6-2   SM331 Functionalities of the sample station with external compensation

Functionalities	Description	Comments
Process reactions	Diagnosis – active Hardware interrupt when limit value exceeded – active	
Sensor 1	Thermo couple type J	Channel group (Input) 0 - 1
Sensor 2	Thermo couple type J	Channel group (Input) 0 - 1
Sensor 3	Thermo couple type J	Channel group (Input) 2 - 3
Sensor 4	Thermo couple type J	Channel group (Input) 2 - 3

Parameter window with external compensation

If you want to use an external compensation box, please set the module as follows:
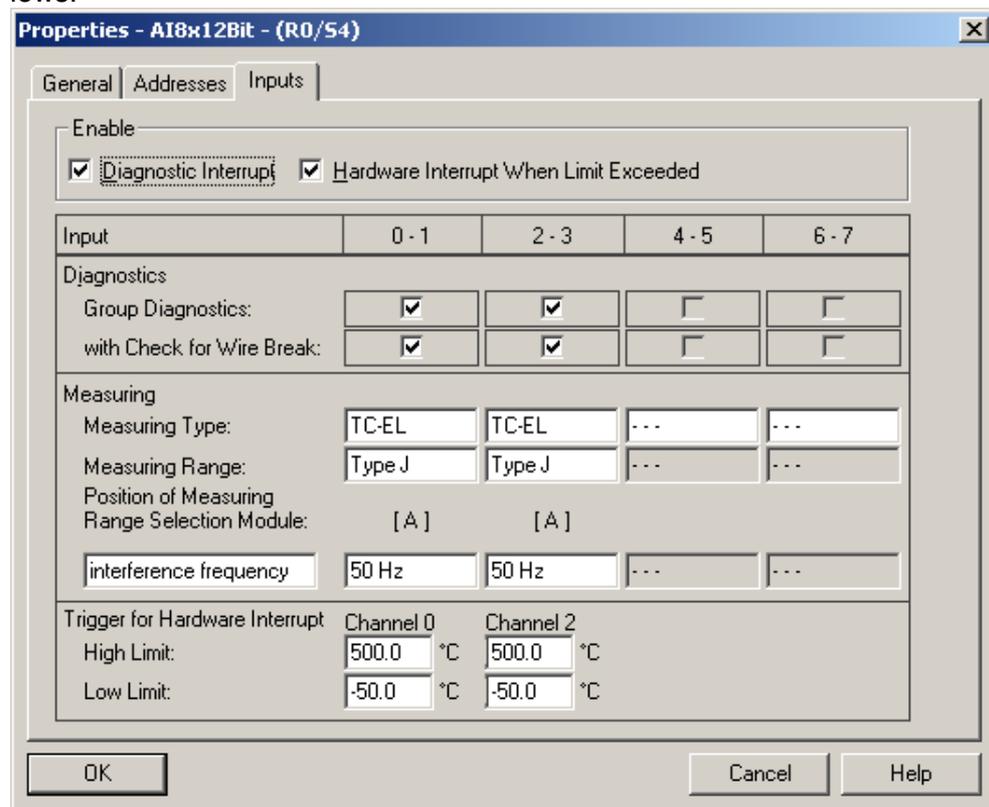
Figure 6-11   SM331: Parameterization for thermo couples with external reference junctions

6.2.4   Explanation of the settings of SM331

Diagnostic interrupt

When the diagnostic interrupt is activated, the diagnostic OB82 is called if the grounding or the power supply is lacking.

Hardware interrupt when limit exceeded

If the parameter „Hardware interrupt when limit exceeded" is activated, hardware interrupt OB40 is called when the set limit values are exceeded or under ran. Only channels (inputs) 0 and 2 are capable of triggering hardware interrupts. All other inputs cannot trigger hardware interrupts.

The limit values can be set in the same window under „Trigger for Hardware Interrupt".

Group Diagnostics

If Group Diagnostics is selected, channel specific diagnostic interrupts are activated (see chap. 8.3). When a diagnostic event occurs, OB82 is called.

Wire break detection

When wire break detection is activated, wire breaks will be diagnosed. OB82 is called.

Measuring type

TC-IL: Thermo couple with internal reference junction.

TC-EL: Thermo couple with external reference junction

Measuring range

Specification of the thermo couple type.

Position of the measuring range modules

The required position of the measuring range modules are shown (chapter 4.2.3).

Interference frequency (Interference frequency suppression)

The interface frequency is set to your local power line frequency.

Completion of the hardware configuration

Close the parameter window.

Compile and save the project via Station → Save and Compile (Ctrl+S)

With this the hardware configuration of the project is completed.

6.2.5   Power up test

For testing, do a power up test and download the system data.

Power up

Table 6-3   Power up
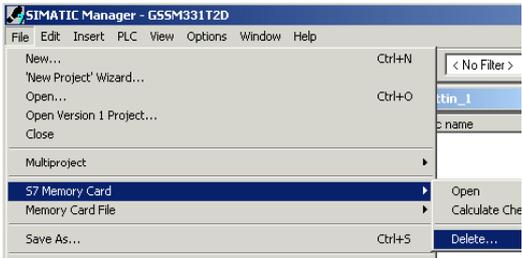
#	Graphics	Description
1		Erase your Micro Memory Card with a Power PG or a PC with external programming device: In SIMATIC Manager click "File → S7 Memory Card → Delete …" The Micro Memory Card is deleted.
2		Turn off the CPU's power supply. Insert the MMC into the CPU Turn on the power supply.
3		If the CPU is in RUN mode, set it to STOP mode.
4		Turn on the power supply again. If the STOP LED blinks, the CPU requests for a reset. Acknowledge this by turning the switch mode to MRES for a quick second.
5		Connect the CPU to the PG with an MPI cable. To do this, connect the MPI cable with the CPU's MPI port. Connect the other end to the PG interface of your programming device.
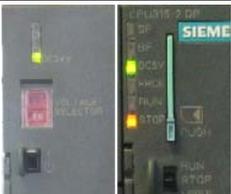
Download hardware configuration

Download the hardware configuration into the CPU with HW Config.

Click the symbol „Load to module" (shown in the red circle).
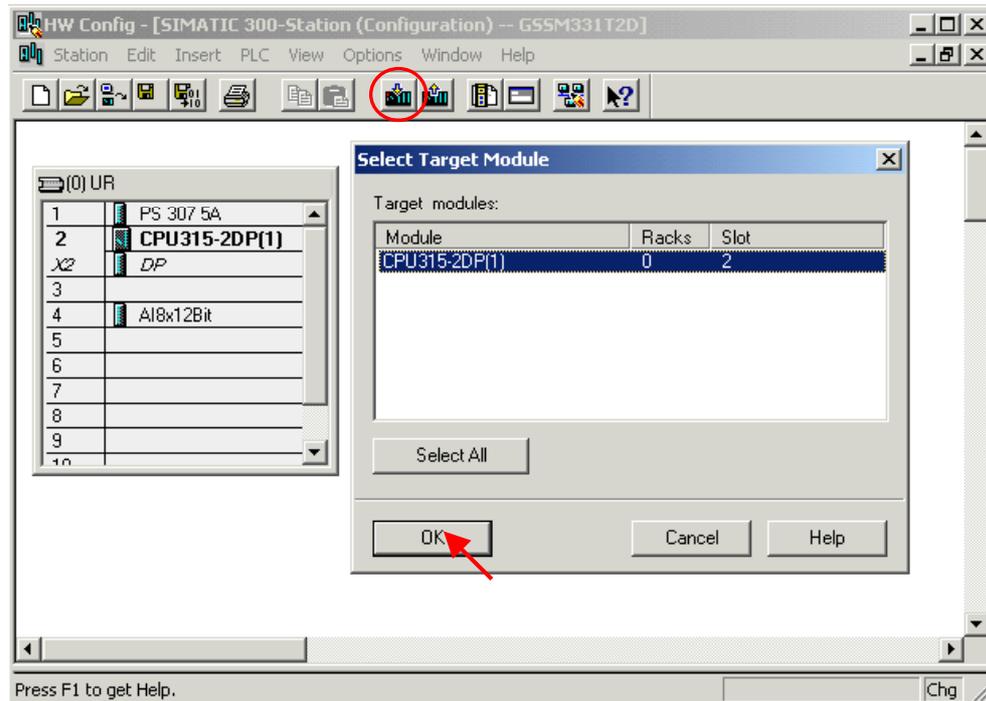
Figure 6-12   CPU Hardware configuration download (1)

When the dialog window „Select target module" pops up, click "OK". (red arrow).
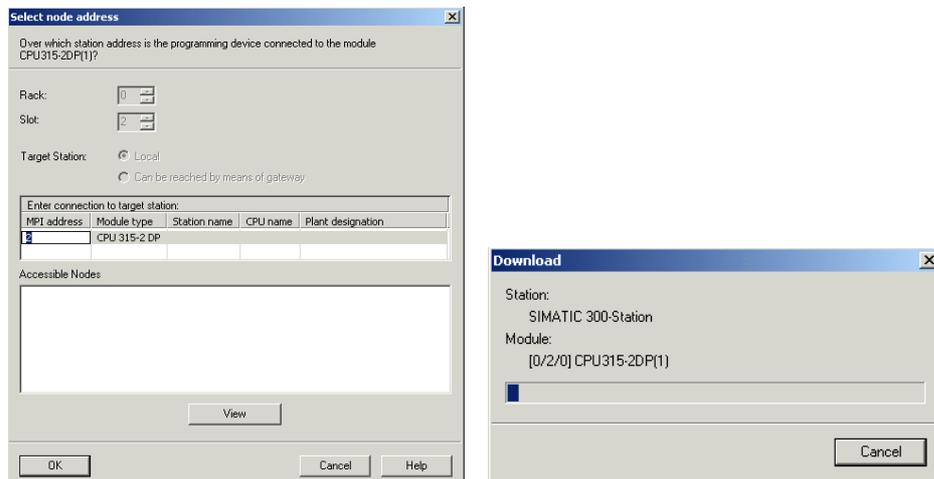
Figure 6-13   CPU Hardware configuration download (2)

The dialog window „Select target address" comes up. Click on "OK". The system data are now transferred into the CPU.

Starting the CPU

Set the CPU to RUN mode.

If the hardware configuration is done correctly, two green LEDs (RUN and DC5V) should be lit at the CPU

Figure 6-14   CPU in the error free state

If the RUN_LED light is not lit, then there is an error.

In order to locate the error, read the diagnostic buffer with a PG. Possible reason for errors:

- The wiring is done wrong
- The coding device is plugged in wrong
- You have entered the parameters of SM331 wrong.

6.3 STEP 7 user program

6.3.1 Function of the user program

The sample user program:

- Stores the sensor values in a data block
- Saves the status information of the hardware interrupts in a memory word.

The status information is acknowledged by means of a bit. Furthermore, the channel values (values of the input words) are stored in another data block.

In the user program the following tasks have to be performed:

1. Cyclical storage of the analog input values in a data block (DB1)

2. Cyclical conversion of the analog input values in floating point values (FC1) and storage in a data block (DB2)

3. Acknowledgement of the hardware interrupt status when the acknowledge marker (M200.0) is TRUE.

4. Store the status in a memory word (MW100) when a hardware interrupt occurs.

Table 6-4   Structure of the user program

Execution mode	Responsible organisation block	Programming task	Used blocks or markers
Cyclic execution	OB1	Store analog input values	DB1
		Convert and store the sensor signals	FC1, DB2
		Acknowledge hardware interrupt	M200.0
Execution triggered by hardware interrupt	OB40	Save status	MW100
Execution triggered by diagnostic interrupt	OB82	Has to be implemented because a module with diagnostic capabilities are used	---

Diagnostic interrupt OB82

In the STEP 7 program, OB82 is used for modules with diagnostic capabilities.

If the module detects a failure (coming and going event), the module requests the CPU for diagnostics. As a reaction to this the operating system calls OB82.

In our example we use OB82 only for preventing the CPU from changing to STOP mode. In OB82 you can program the reaction on diagnostic alarms.

6.3.2   Create user program

You have two ways to create a user program:

o If you know how to program STEP 7 STL, then you can create and program the necessary blocks and the function blocks in the Blocks folder of STEP 7.

o You can insert the user program from an STL source into the project. In this "Getting started" we describe this way.

Creating a user program in STEP 7 requires three steps:

1. Download the source file directly from the web page
2. Import source file
3. Compile source file

1. Download the source file

You can download the source file directly from the web page from which you loaded this "Getting Started". Click on „Info", and the download window will be opened.

- Note the name of the source file
- Save the source on your hard drive.

2. Import source file

You can import the source file into SIMATIC Manager as follows:

- Right click the folder „Sources"
- Select „Insert new Object" → External Source...
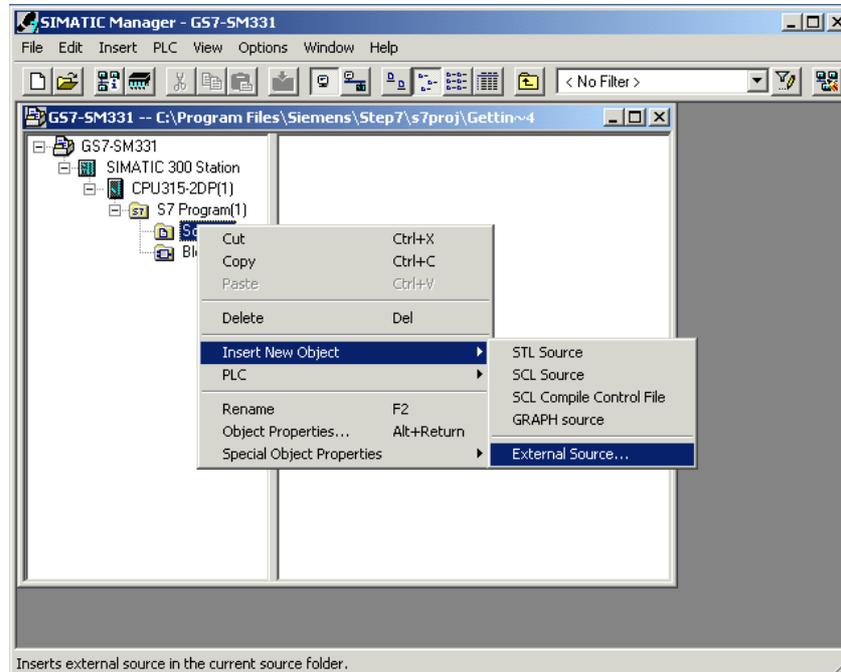
Figure 6-15   Import external source

In the dialog window „Insert external source" browse for the source file that you have already downloaded and saved on your hard drive.

Select the source file GSSM331T1DE.AWL.
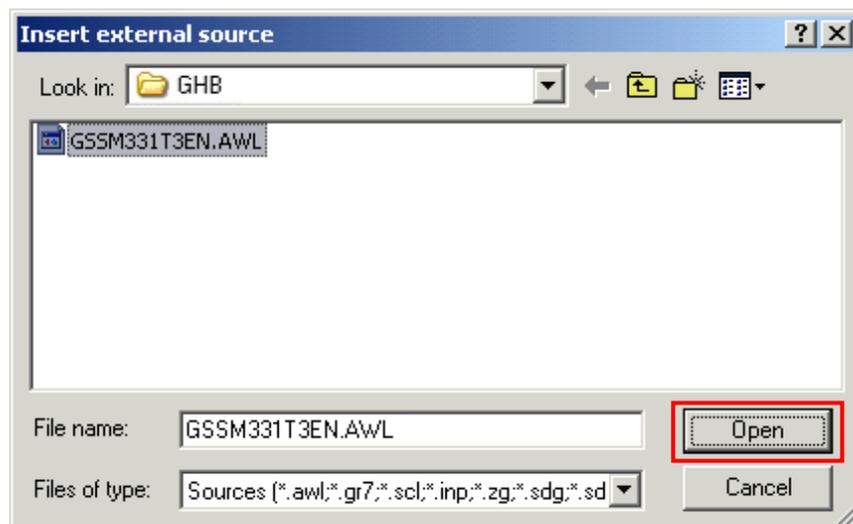
Figure 6-16   Import external source

Click „Open"

SIMATIC Manager has opened the source file. On the right pane you can see the source file inserted.
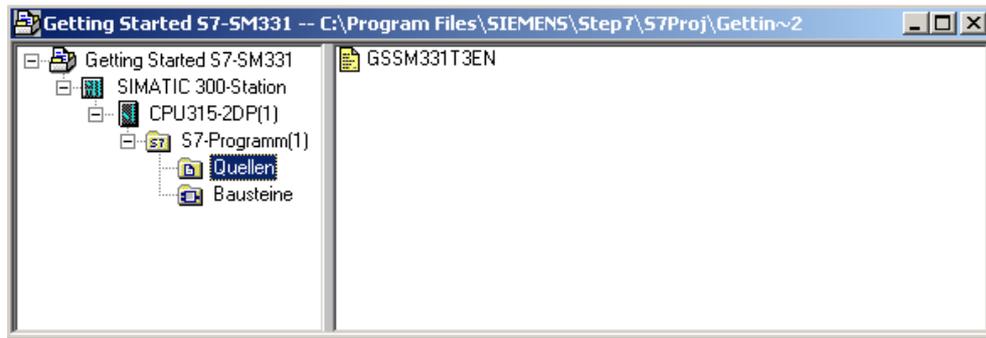
Figure 6-17   Storing the source file

3. Compile source code

In order to create an executable STEP 7 program, the STL source has to be compiled.

Double click the source file in the Sources folder (see red arrow). The source code editor is called.

In the window of the source code editor you can view the source code (code from Chapter 10).
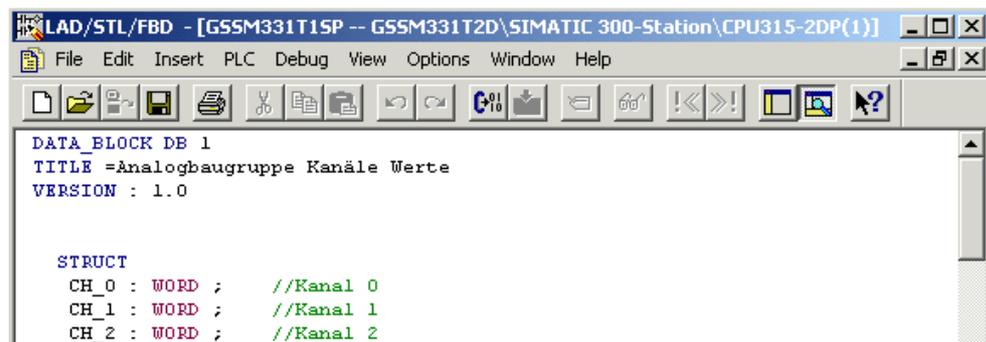
Figure 6-18 Source code editor

After the source code is loaded, start the compilation.

Press the shortcut key Ctrl+B or select File → Compile. The compilation starts immediately.
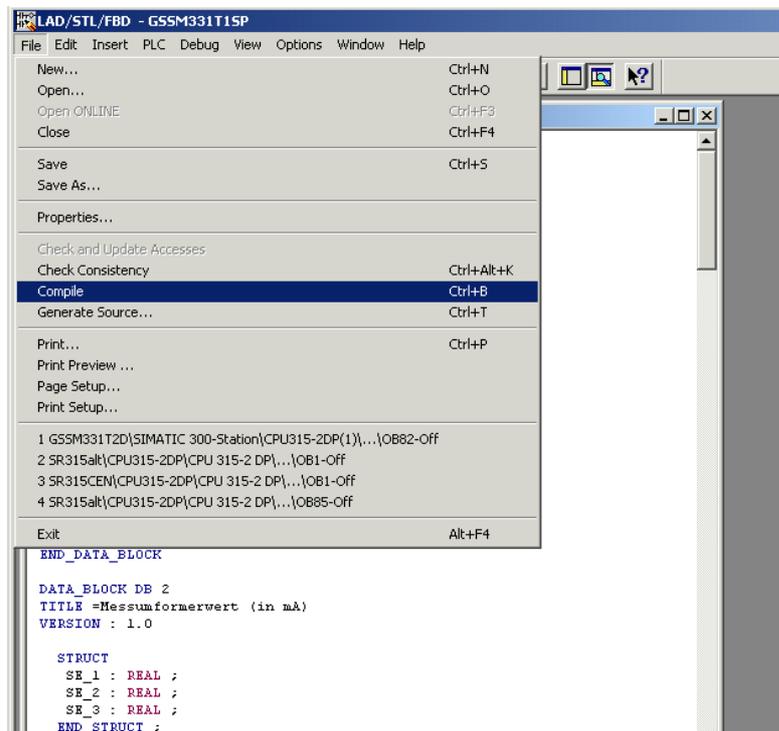
Figure 6-19 Compilation of the STL source

In case of warning or error messages, check the source code.
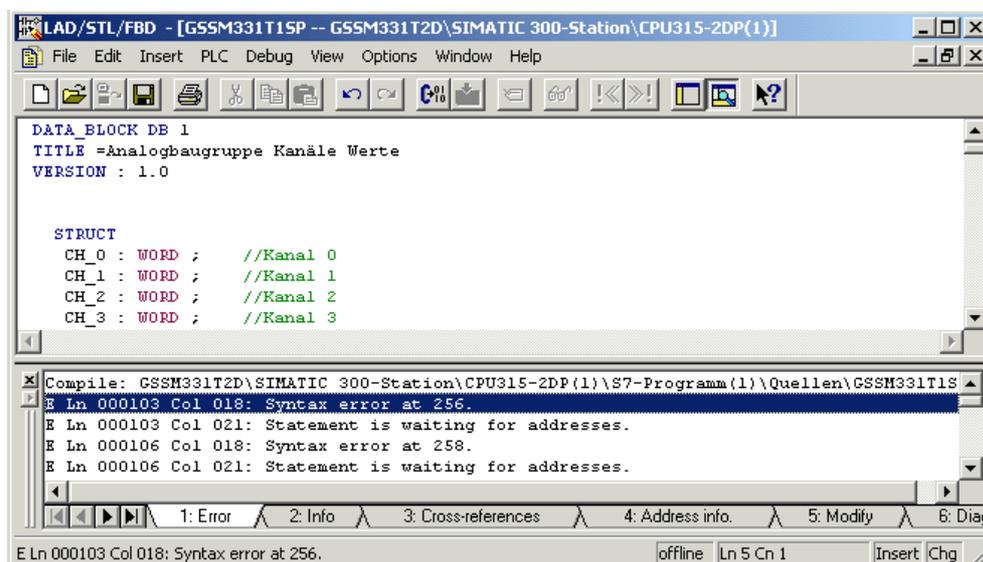
Figure 6-20 Source code editor, messages after compilation

Close the source code editor.

After compiling the STL source without errors the following blocks should be in the Blocks folder:

OB1, OB40, OB82, FC1, DB1 und DB2
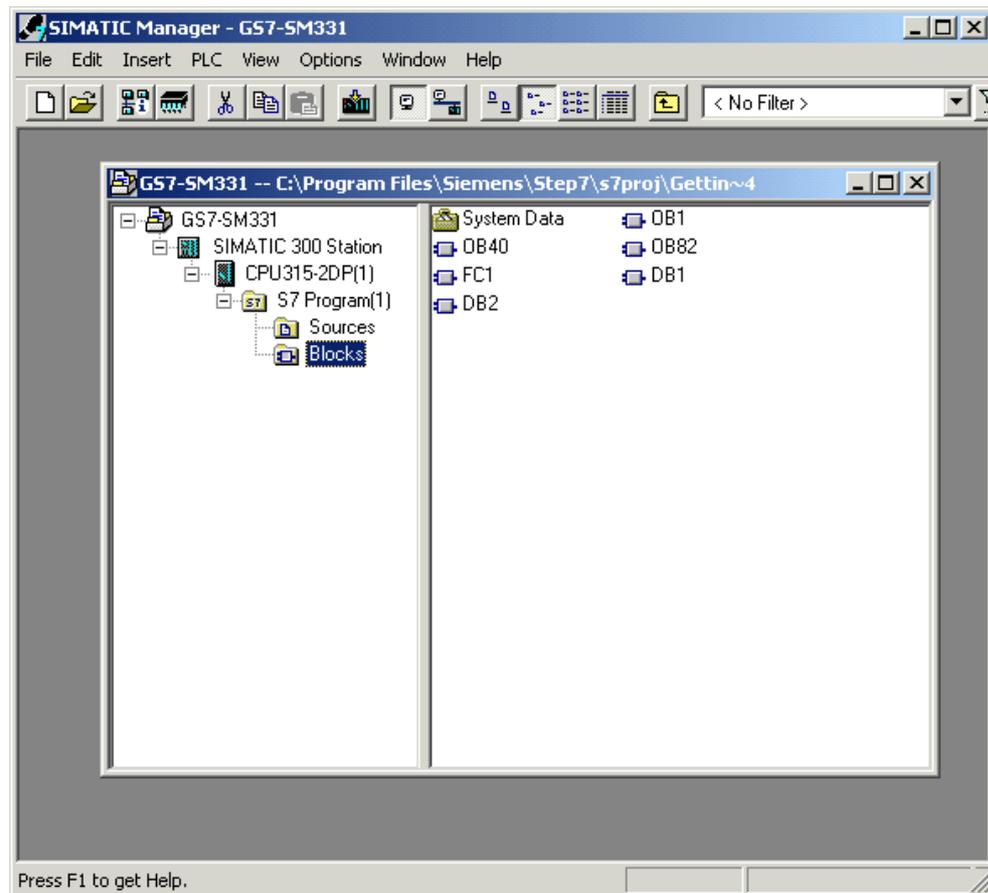
Figure 6-21   Generated blocks

7 Test the user program

7.1 Download system data and user program

Hardware and software are ready now. The next step is to download the
system data and the user program into the automation system. To do this,
execute the following steps:

Table 7-1   Download user program and system data

Step	Description
1	With SIMATIC Manager download the user program and the system data (containing the hardware configuration) into the CPU.
2	Follow the instructions on the screen. If all sensors are properly connected, the CPU and the SM331 will not show any red error lights. The error free state of the CPU is displayed by the green „RUN" light.
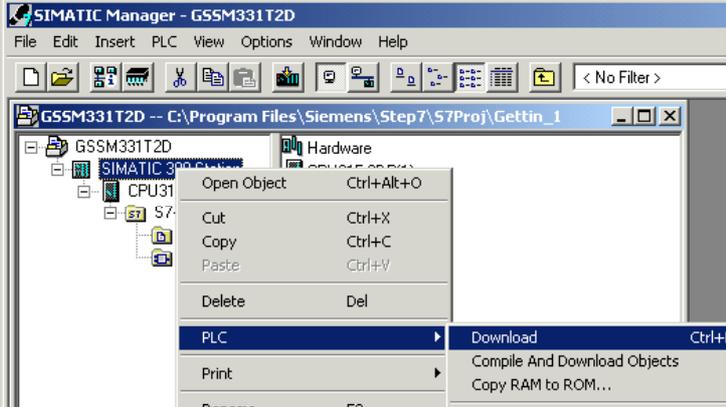
Smart Label

The labelling strips for the modules were created with Siemens S7-SmartLabel. (Order no.: 2XV9 450-1SL01-0YX0)

The original size of the labelling strips are displayed in Figure 7-1

```
PEW 256

PEW 258

PEW 260

PEW 262

LA: PEW 256
       S7-
   SmartLabel

PEW 264

PEW 266

PEW 268

PEW 270

```

Figure 7-1   S7-SmartLabel labelling strip of the example

7.2 Visualization of the sensor signals

In order to visualize the sensor signals, insert a variable table as follows into the project. To do this, select from the context menu of the Blocks folder:

Insert new object → Variable Table
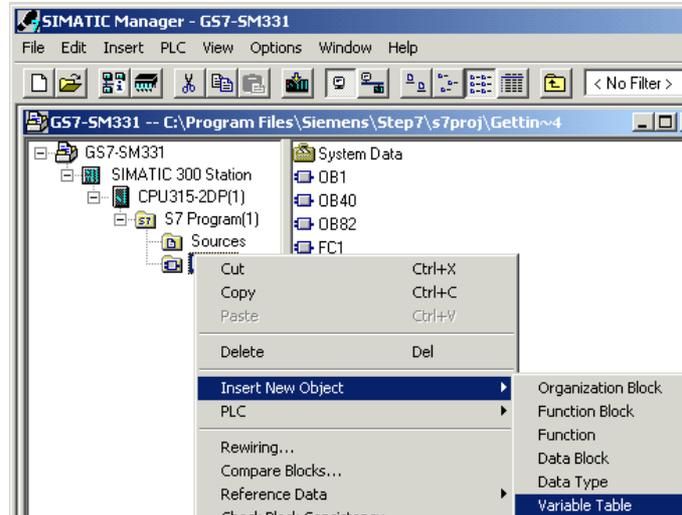
Figure 7-2   Insert variable table

Fill in the new variable table as follows:

Figure 7-3   Variable table Control_Display

Monitoring of variables

In order to monitor variables, open the online view of the controller by clicking the eyeglasses symbol. Now you can monitor the values in the data blocks and the markers.
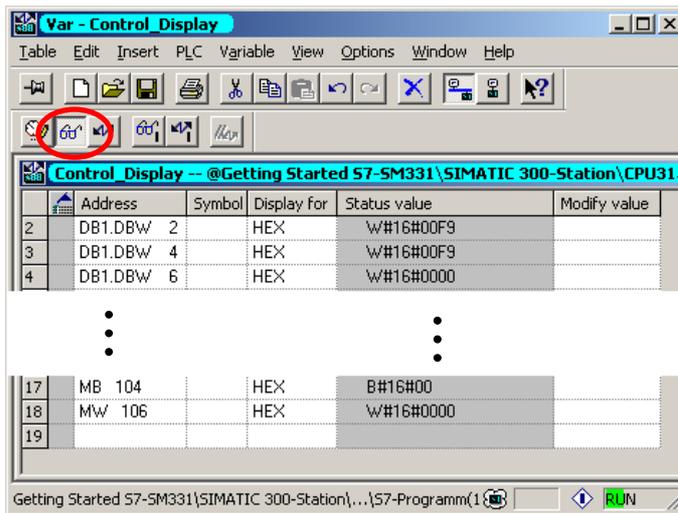
Figure 7-4   Online view of the variable table

Modification of variables

For modifying the Process Control Acknowledgement, enter the desired value (TRUE or FALSE) into the column „Modify Value". The value depends on whether you want to activate or deactivate the acknowledgement. Click the symbol with the two arrows.
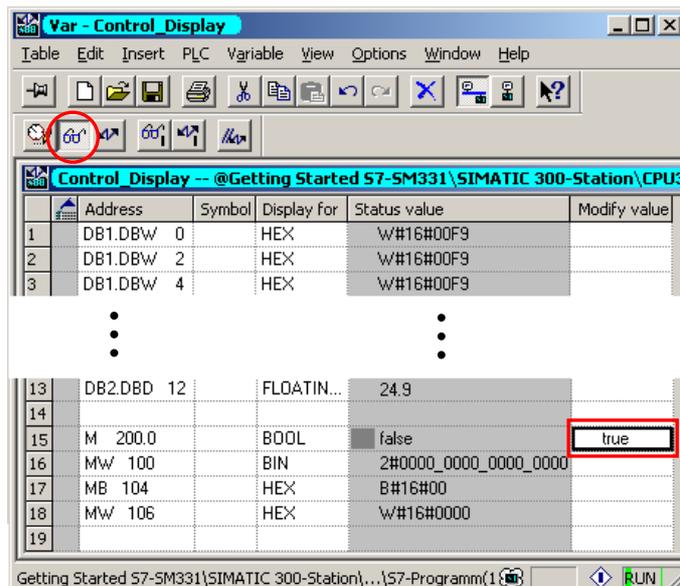
Figure 7-5   Modification of variables

Specifics for monitoring the variables

While monitoring the values you might have noticed that the channel values are different from the analog values. The reason for this is that the analog module only supports the binary format "Word" (16 bits). Therefore the values of the analog module have to be converted.

7.3 Analog value display of the thermo couple

Analog input modules convert the analog process signal into a digital format (16 bit word).

If you want to display the analog process values, then the digital values of the module should be converted to decimal values.

In our sample program the process values are shown in the readable format °C. The conversion of the digital values into decimal values is realized in the programmed function FC1.

In the following tables you will find information on the temperature range and the digital values (display in hexadecimal) of the thermo couples that are created by the module.

- Type E
- Type J
- Type K
- Type L

Analog value display for thermo couple type E

Table 7-2   Analog value display for thermo couple type E

Analog value display		Temperature	Scope	Comments
32767	7FFF	> 1200,0°C	Overflow	From hex value 16#2E01 on, the sensor value is above the configured measurement value range and is no more valid.
12000	2E00	1200,0 °C	Over steering range	This range corresponds to a tolerance band before the overflow range is reached. Within this range the resolution is not optimal.
...	...	...		
10001	2711	1000,1 °C		
10000	2710	1000,0°C	Nominal range	The nominal range is the normal range for acquiring measurement values. This range guarantees optimal resolution.
…	…	…		
…	…	…		
-2700	F574	-270,0°C		
< -2700	<F574	< -270,0°C	Underflow	If the wiring is wrong (e.g. swapped wires or open circuited inputs) or a sensor error occurs in a negative range (e.g. wrong thermo couple type) the analog module will report an underflow for values lower than 16#F0C4 and the output will be 16#8000.

Analog value display for thermo couple type J

Table 7-3   Analog value display for thermo couple type J

Decimal	Hexadec imal	Temperature	Scope	Comments
32767	7FFF	> 1450,0°C	Overflow	From hex values from 16#38A5 on, the sensor value is above the configured measurement value range and is no more valid.
14500	38A4	1450,0 °C	Over steering range	This range corresponds to a tolerance band before the overflow range is reached. Within this range the resolution is not optimal.
...	...	...		
12010	2EEA	1201,0 °C		
12000	2EE0	1200,0°C	Nominal range	The nominal range is the normal range for recording measurement values. This range guarantees optimal resolution.
…	…	…		
…	…	…		
-2100	F7CC	-210,0°C		
< -210	<F7CC	< -210,0°C	Underflow	If the wiring is wrong (e.g. swapped wires or open circuited inputs) or a sensor error occurs in a negative range (e.g. wrong thermo couple type) the analog module will report an underflow for values lower than 16#F31C and the output will be 16#8000.

Analog value display for thermo couple type K

Table 7-4   Analog value display for thermo couple type K

Decimal	Hexadec imal	Temperature	Scope	Comments
32767	7FFF	> 1622,0°C	Overflow	From hex value 16#3F5D on, the sensor value is above the configured measurement value range and is no more valid.
16220	3F5C	1450,0 °C	Over steering range	This range corresponds to a tolerance band before the overflow range is reached. Within this range the resolution is not optimal.
...	...	...		
13730	35A2	1373,0 °C		
13720	3598	1372,0 °C	Nominal range	The nominal range is the normal range for recording measurement values. This range guarantees optimal resolution.
…	…	…		
…	…	…		
-2700	F574	-270,0 °C		
< -2700	<F574	< -270,0 °C	Underflow	If the wiring is wrong (e.g. swapped wires or open circuited inputs) or a sensor error occurs in a negative range (e.g. wrong thermo couple type) the analog module will report an underflow for values lower than 16#F0C4 and the output will be 16#8000.

Analog value display for thermo couple type L

Table 7-5   Analog value display for thermo couple type L

Decimal	Hexadecimal	Temperature	Scope	Comments
32767	7FFF	> 1150,0°C	Overflow	From hex value 16#2CED on, the sensor value is above the configured measurement value range and is no more valid.
11500	2CEC	1150,0 °C	Over steering range	This range corresponds to a tolerance band before the overflow range is reached. Within this range the resolution is not optimal.
...	...	...		
9010	2332	901,0 °C		
9000	2328	900,0 °C	Nominal range	The nominal range is the normal range for recording measurement values. This range guarantees optimal resolution.
…	…	…		
…	…	…		
-2000	F830	-200,0 °C		
< -2000	<F830	< -200,0 °C	Underflow	If the wiring is wrong (e.g. swapped wires or open circuited inputs) or a sensor error occurs in a negative range (e.g. wrong thermo couple type) the analog module will report an underflow for values lower than 16#F380 and the output will be 16#8000.

8　Diagnostic interrupt

Diagnostic interrupts enable the user program to react on hardware failures.

Modules must have diagnostic capabilities in order to generate diagnostic interrupts.

In OB82 you program the reaction on diagnostic interrupts.

8.1　Read diagnostic data from a PG

The analog input module SM331 AI8x12 has diagnostic capabilities.

Diagnostic interrupts that occur are signalled by the red „SF" LED on the SM331 and on the CPU.

Table 8-1　Creating hardware failure
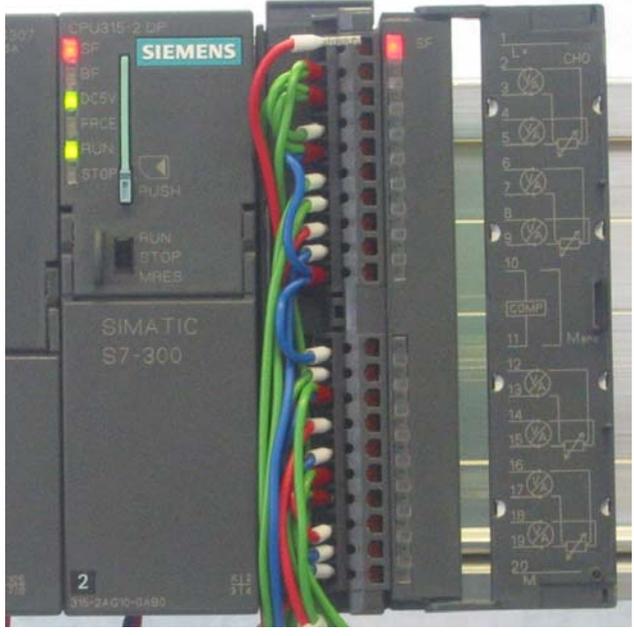
Graphics	Description
	Release the power supply wire from terminal 1 Result: A diagnostic interrupt is triggered.

The cause of the failure can be determined online by requesting the module information.

In order to view the module status "Online", do the following:

- Select the SM331 in the hardware configuration
- Click the menu item PLC -→ Module Information... in order to perform a hardware diagnosis.
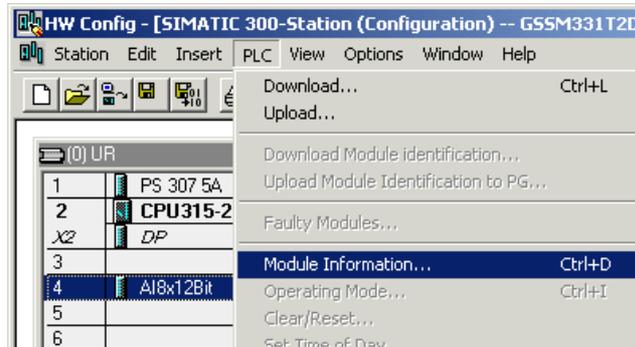
Figure 8-1   Module information

8.2   General hardware interrupt

On the Diagnostic Interrupt tab you will find information for the reported failure..

The interrupts are not channel dependent and apply to the entire module.
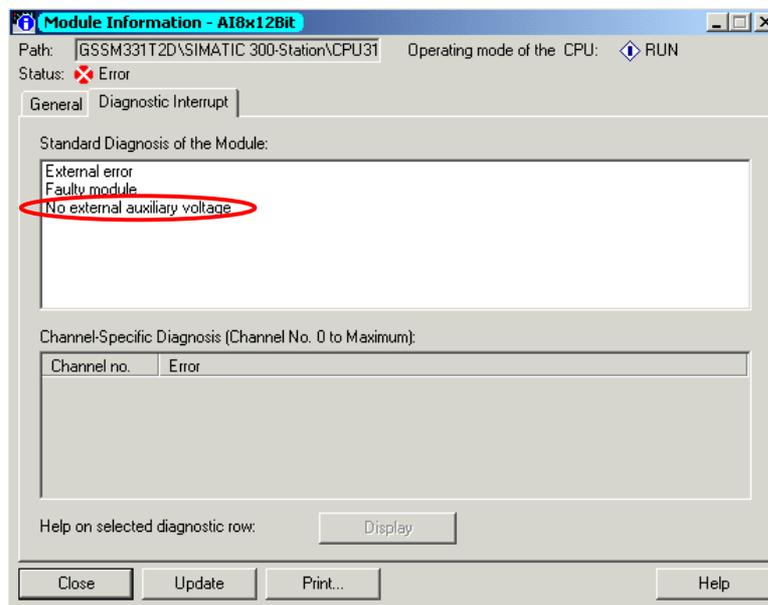
Figure 8-2   Diagnostics for SM331

8.3 Channel dependant diagnostic interrupts

There are five channel dependent diagnostic interrupts:

- Configuration or parameterization errors
- Common mode errors
- Wire break
- Underflow
- Overflow

Note

Here we only show you the channel specific diagnosis for the measuring type of thermo couple. Other measuring modes are similar but not described here.

8.3.1 Configuration / parameterization errors

The position of the measuring range modules does not match the measuring mode set in the hardware configuration.

8.3.2 Common mode errors

The voltage difference U_{cm} between the inputs (M-) and the reference voltage potential of the measuring circuit (M_{ana}) is too high.

In our example this failure cannot occur, because M_{ana} at the voltage transducer is connected to M-.

8.3.3 Wire break

For all thermo couple types you can detect a wire break in the diagnostics.
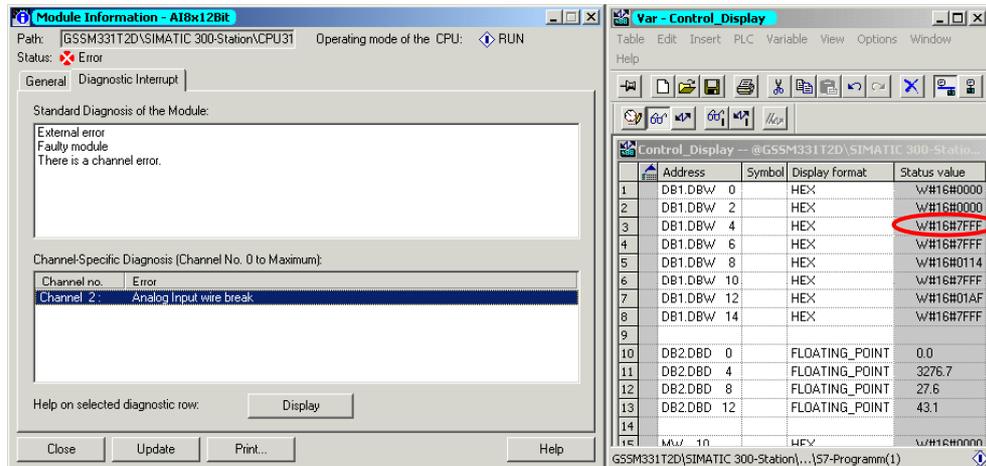
Figure 8-3   Left: Diagnostic display with wire break / Right: Variable table

The display for the analog values shows an overflow (HEX 7FFF).

8.3.4 Underflow

The thermo couples can trigger the diagnostic message „Analog input measuring range / low limit exceeded". If you install the wrong thermo couple type you can also create an underflow.

In our sample we have simulated a thermo couple type E with a thermo couple simulator (till –270 °C). At –210.1 °C we get an underflow of the measuring range.
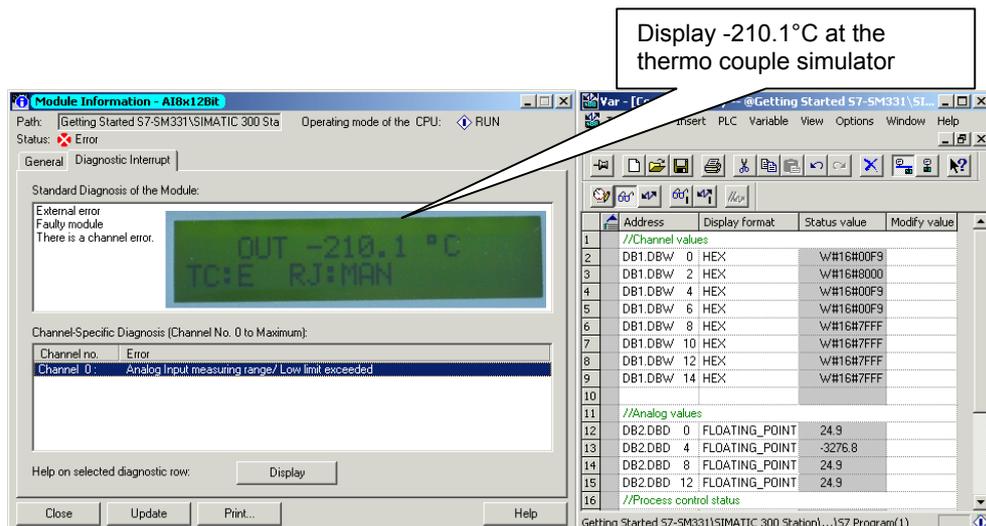
Figure 8-4   Left: Diagnostic display with underflow / Right: Variable table

8.3.5   Overflow

The thermo couples can trigger the diagnostic message „Analog input measuring range / High limit exceeded".

In our sample we have simulated a thermo couple type B with a thermo couple simulator (till +1700 °C). At 1450.1 °C we get an overflow of the measuring range.
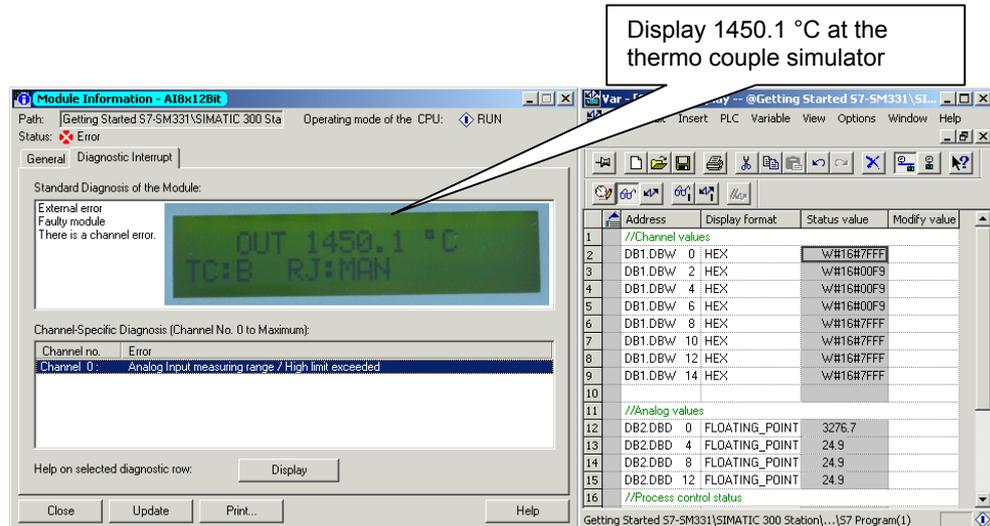
Figure 8-5   Left: Diagnostic display with overflow / Right: Variable table

9   Hardware interrupt

A special feature of the SM331 AI8x12bit is its capability to trigger hardware interrupts. Two channels (0 and 2) can be configured that way.

The limit values of the hardware interrupts should be specified for the thermo couples in °C (not in °F or K).

Properties of the hardware interrupt trigger

In order to trigger a hardware interrupt, the limit values have to be within the nominal range of the measuring mode.

Example:
You use a thermo couple type J with a nominal value of
-210.0°C and 1450.0°C. When you enter the lower limit value of -250 °C the setting is accepted by the system but the hardware interrupt is not triggered because the diagnostic interrupt (underflow of the nominal value) is always triggered first.

In our example, Channel 0 (thermo couple type J) is configured with the following limit values:

- Lower limit value: -50 °C

- Upper limit value: +500 °C

If these values exceed or fall below the nominal range, hardware interrupt OB40 will be triggered.

Hardware interrupt OB40

In General hardware interrupts call an interrupt organization block of the CPU. In our example OB40 is called.

In the STEP7 program, OB40 is used for hardware interrupts. Depending on the CPU more hardware interrupts can be configured.

If a hardware interrupt occurs, OB40 is called. In the user program of OB40 you can program the reaction of the automation system on hardware interrupts.

In the sample user program, OB40 reads the cause of the hardware interrupt. This can be found in the temporary variable structure OB40_POINT_ADDR (Local bytes 8 to 11).
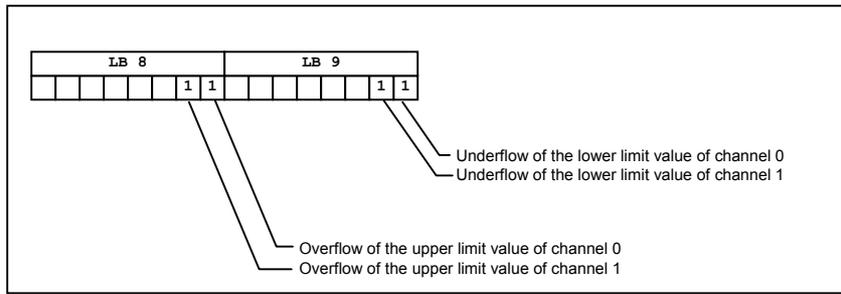
Figure 9-1   Start-up information of OB40: Which event has triggered the
              hardware interrupt for which limit value

In the example OB40 only transfers LB8 and LB9 into a memory word
(MW100). The memory word is displayed in the existing variable table.

You can acknowledge the memory word in OB1 by setting marker bit
M200.0 or by setting it to TRUE in the variable table.

Simulation of a hardware interrupt

When you heat a thermo couple type J with a lighter, in the variable table in
MW100 you will get the binary value 0000 0001 0000 0000. That means
the OB40 was called and channel 0 had an overflow of the upper limit value
>500°C.
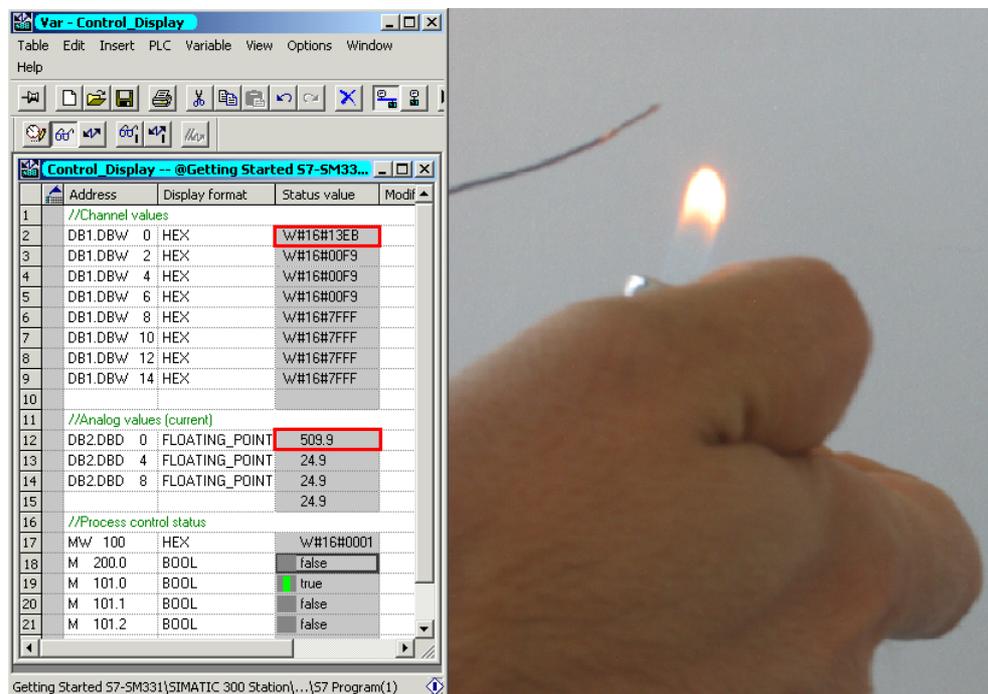
Figure 9-2   Hardware interrupt: Channel 0 upper limit value overflow

10 Source code of the User Program

In this chapter you can get a quick overview of the functions of the user program of the sample station. A flowchart shows the general program structure and in the STL source code you will find the complete program in detail.

For your own application you can download the STL source code directly from the HTML website from which you have downloaded this Getting Started (see chapter 6.3.2).

Flowchart

The red text corresponds to the source code in the user program.
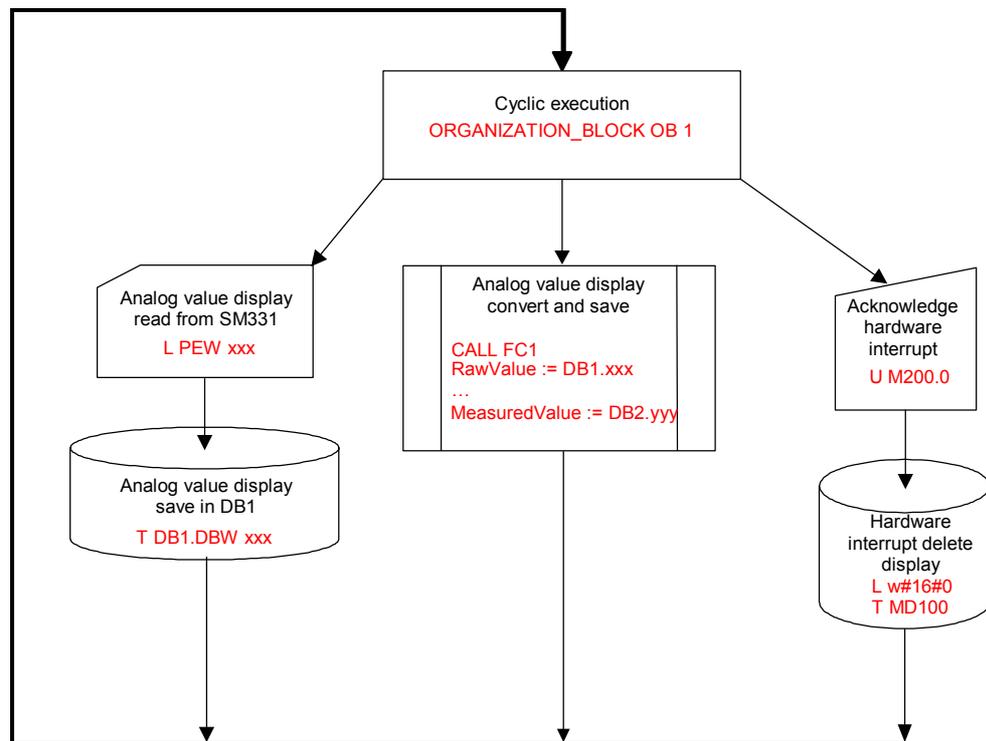
Figure 10-1   OB1 Flowchart

Variable description

Table 10-1   Variable description

Variable	Description
DB1.DBW 0	Channel 0 Analog value display
DB1.DBW 2	Channel 1 Analog value display
DB1.DBW 4	Channel 2 Analog value display
DB1.DBW 6	Channel 3 Analog value display
DB1.DBW 8	Channel 4 Analog value display
DB1.DBW 10	Channel 5 Analog value display
DB1.DBW 12	Channel 6 Analog value display
DB1.DBW 14	Channel 7 Analog value display
DB2.DBD 0	Thermo couple (°C)
DB2.DBD 4	Thermo couple (°C)
DB2.DBD 8	Thermo couple (°C)
DB2.DBD 12	Thermo couple (°C)
M200.0	Hardware interrupt acknowledge
MW 100	Hardware interrupt status

STL source code

```
DATA_BLOCK DB 1
TITLE =
VERSION : 0.1


  STRUCT
   CH_0 : INT ; //Channel 0
   CH_1 : INT ; //Channel 1
   CH_2 : INT ; //Channel 2
   CH_3 : INT ; //Channel 3
   CH_4 : INT ; //Channel 4
   CH_5 : INT ; //Channel 5
   CH_6 : INT ; //Channel 6
   CH_7 : INT ; //Channel 7
  END_STRUCT ;
BEGIN
   CH_0 := 0;
   CH_1 := 0;
   CH_2 := 0;
   CH_3 := 0;
   CH_4 := 0;
   CH_5 := 0;
   CH_6 := 0;
   CH_7 := 0;
END_DATA_BLOCK

DATA_BLOCK DB 2
TITLE =
VERSION : 0.1


  STRUCT
   SE_1 : REAL ;    // Temperature
   SE_2 : REAL ;    // Temperature
   SE_3 : REAL ;    // Not used
```

```
    SE_4 : REAL ;      // Not used
  END_STRUCT ;
BEGIN
    SE_1 := 0.000000e+000;
    SE_2 := 0.000000e+000;
    SE_3 := 0.000000e+000;
    SE_4 := 0.000000e+000;
END_DATA_BLOCK

FUNCTION FC 1 : VOID
TITLE =
VERSION : 0.1


VAR_INPUT
  RawValue : INT ;
  Factor : REAL ;
  Offset : REAL ;
  OverFlow : INT ;
  OverRange : INT ;
  UnderRange : INT ;
  UnderFlow : INT ;
END_VAR
VAR_OUTPUT
  MeasuredValue : REAL ;
  Status : WORD ;
END_VAR
VAR_TEMP
  TInt : INT ;
  TDoubleInt : DINT ;
  TFactor : REAL ;
  TOffset : REAL ;
  TFactor1 : DINT ;
  TFactor2 : REAL ;
END_VAR
BEGIN
NETWORK
TITLE = Conversion

      L     #RawValue;
      ITD   ;
      DTR   ;
      L     #Factor;
      *R    ;
      L     #Offset;
      +R    ;
      T     #MeasuredValue;

NETWORK
TITLE = Analog value display monitoring

      L     W#16#0;
      T     #Status;


      L     #RawValue;
      L     #OverFlow;
      >=I   ;
      SPB   m_of;

      L     #RawValue;
      L     #OverRange;
      >=I   ;
      SPB   m_or;

      L     #RawValue;
      L     #UnderFlow;
      <=I   ;
      SPB   m_uf;

      L     #RawValue;
      L     #UnderRange;
```

```
        <=I    ;
        SPB    m_ur;

        SPA    end;

m_of:   L      W#16#800;
        T      #Status;
        SPA    end;

m_or:   L      W#16#400;
        T      #Status;
        SPA    end;

m_uf:   L      W#16#200;
        T      #Status;
        SPA    end;

m_ur:   L      W#16#100;
        T      #Status;
        SPA    end;

end:    NOP    0;

END_FUNCTION


ORGANIZATION_BLOCK OB 1
TITLE = "Main Program Sweep (Cycle)"
VERSION : 0.1


VAR_TEMP
  OB1_EV_CLASS : BYTE ; //Bits 0-3 = 1 (Coming event), Bits 4-7 = 1 (Event class 1)
  OB1_SCAN_1 : BYTE ;    //1 (Cold restart scan 1 of OB 1), 3 (Scan 2-n of OB 1)
  OB1_PRIORITY : BYTE ; //Priority of OB Execution
  OB1_OB_NUMBR : BYTE ; //1 (Organization block 1, OB1)
  OB1_RESERVED_1 : BYTE ;    //Reserved for system
  OB1_RESERVED_2 : BYTE ;    //Reserved for system
  OB1_PREV_CYCLE : INT ;     //Cycle time of previous OB1 scan (milliseconds)
  OB1_MIN_CYCLE : INT ; //Minimum cycle time of OB1 (milliseconds)
  OB1_MAX_CYCLE : INT ; //Maximum cycle time of OB1 (milliseconds)
  OB1_DATE_TIME : DATE_AND_TIME ;    //Date and time OB1 started
END_VAR
BEGIN
NETWORK
TITLE = Transfer channel values to data block DB1
// Channel 0 -> Data block
        L      PEW  256;
        T      DB1.DBW    0;

// Channel 1 -> Data block
        L      PEW  258;
        T      DB1.DBW    2;

// Channel 2 -> Data block
        L      PEW  260;
        T      DB1.DBW    4;

// Channel 3 -> Data block
        L      PEW  262;
        T      DB1.DBW    6;

// Channel 4 -> Data block
        L      PEW  264;
        T      DB1.DBW    8;

// Channel 5 -> Data block
        L      PEW  266;
        T      DB1.DBW   10;

// Channel 6 -> Data block
```

```
        L      PEW   268;
        T      DB1.DBW   12;

// Channel 7 -> Data block
        L      PEW   270;
        T      DB1.DBW   14;


NETWORK
TITLE = Conversion of analog value display -> measurement value
// Channel 1 : Thermo couple type J
        CALL FC      1 (
            RawValue                  := DB1.DBW      0,
            Factor                    := 1.000000e-001,
            Offset                    := 0.000000e+000,
            OverFlow                  := 14501,
            OverRange                 := 12010,
            UnderRange                := -2101,
            UnderFlow                 := -2101,
            MeasuredValue             := DB2.DBD      0,
            Status                    := MW     10);

// Channel 2 : Thermo couple type J

        CALL FC      1 (
            RawValue                  := DB1.DBW      2,
            Factor                    := 1.000000e-001,
            Offset                    := 0.000000e+000,
            OverFlow                  := 14501,
            OverRange                 := 12010,
            UnderRange                := -2101,
            UnderFlow                 := -2101,
            MeasuredValue             := DB2.DBD      4,
            Status                    := MW     20);

// Channel 3 : Thermo couple type K

        CALL FC      1 (
            RawValue                  := DB1.DBW      4,
            Factor                    := 1.000000e-001,
            Offset                    := 0.000000e+000,
            OverFlow                  := 16221,
            OverRange                 := 13730,
            UnderRange                := -2701,
            UnderFlow                 := -2701,
            MeasuredValue             := DB2.DBD      8,
            Status                    := MW     30);

// Channel 4 : Thermo couple type K

        CALL FC      1 (
            RawValue                  := DB1.DBW      6,
            Factor                    := 1.000000e-001,
            Offset                    := 0.000000e+000,
            OverFlow                  := 16221,
            OverRange                 := 13730,
            UnderRange                := -2701,
            UnderFlow                 := -2701,
            MeasuredValue             := DB2.DBD     12,
            Status                    := MW     40);


NETWORK
TITLE = Acknowledge hardware interrupt

        U      M    200.0;
        FP     M    200.1;
        SPBN   m001;
        L      0;
        T      MD    100;
        T      MW    104;
        T      MW    106;
```

```
      R    M    200.0;
m001: NOP   0;


END_ORGANIZATION_BLOCK

ORGANIZATION_BLOCK OB 40
TITLE = "Hardware Interrupt"
VERSION : 0.1


VAR_TEMP
  OB40_EV_CLASS : BYTE ;//Bits 0-3 = 1 (Coming event), Bits 4-7 = 1 (Event class 1)
  OB40_STRT_INF : BYTE ;    //16#41 (OB 40 has started)
  OB40_PRIORITY : BYTE ;    //Priority of OB Execution
  OB40_OB_NUMBR : BYTE ;    //40 (Organization block 40, OB40)
  OB40_RESERVED_1 : BYTE ;  //Reserved for system
  OB40_IO_FLAG : BYTE ; //16#54 (input module), 16#55 (output module)
  OB40_MDL_ADDR : WORD ;    //Base address of module initiating interrupt
  OB40_POINT_ADDR : DWORD ; //Interrupt status of the module
  OB40_DATE_TIME : DATE_AND_TIME ;  //Date and time OB40 started
END_VAR
BEGIN
NETWORK
TITLE =

      L     #OB40_IO_FLAG; // OB40_IO_FLAG        : 16#54 = input module
      T     MB   104; //                         : 16#55 = output module

      L     #OB40_MDL_ADDR; // OB40_MDL_ADDR      : Start address of the module
      T     MW   106; //                          which has triggered this

      L     #OB40_POINT_ADDR; // OB40_POINT_ADDR : LB8 = Exceeding high limit value
      T     MD   100;

      NOP   0; // OB40_POINT_ADDR : LB9 = Underflow of low limit value
      NOP   0;


END_ORGANIZATION_BLOCK

ORGANIZATION_BLOCK OB 82
TITLE = "I/O Point Fault"
VERSION : 0.1


VAR_TEMP
  OB82_EV_CLASS : BYTE ;    //16#39, Event class 3, Entering event state, Internal
fault event
  OB82_FLT_ID : BYTE ;  //16#XX, Fault identifcation code
  OB82_PRIORITY : BYTE ;    //Priority of OB Execution
  OB82_OB_NUMBR : BYTE ;    //82 (Organization block 82, OB82)
  OB82_RESERVED_1 : BYTE ;  //Reserved for system
  OB82_IO_FLAG : BYTE ; //Input (01010100), Output (01010101)
  OB82_MDL_ADDR : WORD ;    //Base address of module with fault
  OB82_MDL_DEFECT : BOOL ;  //Module defective
  OB82_INT_FAULT : BOOL ;   //Internal fault
  OB82_EXT_FAULT : BOOL ;   //External fault
  OB82_PNT_INFO : BOOL ;    //Point information
  OB82_EXT_VOLTAGE : BOOL ; //External voltage low
  OB82_FLD_CONNCTR : BOOL ; //Field wiring connector missing
  OB82_NO_CONFIG : BOOL ;   //Module has no configuration data
  OB82_CONFIG_ERR : BOOL ;  //Module has configuration error
  OB82_MDL_TYPE : BYTE ;    //Type of module
  OB82_SUB_MDL_ERR : BOOL ; //Sub-Module is missing or has error
  OB82_COMM_FAULT : BOOL ;  //Communication fault
  OB82_MDL_STOP : BOOL ;    //Module is stopped
  OB82_WTCH_DOG_FLT : BOOL ;    //Watch dog timer stopped module
  OB82_INT_PS_FLT : BOOL ;  //Internal power supply fault
  OB82_PRIM_BATT_FLT : BOOL ;   //Primary battery is in fault
  OB82_BCKUP_BATT_FLT : BOOL ;  //Backup battery is in fault
  OB82_RESERVED_2 : BOOL ;  //Reserved for system
```

```
  OB82_RACK_FLT : BOOL ;     //Rack fault, only for bus interface module
  OB82_PROC_FLT : BOOL ;     //Processor fault
  OB82_EPROM_FLT : BOOL ;    //EPROM fault
  OB82_RAM_FLT : BOOL ; //RAM fault
  OB82_ADU_FLT : BOOL ; //ADU fault
  OB82_FUSE_FLT : BOOL ;     //Fuse fault
  OB82_HW_INTR_FLT : BOOL ;   //Hardware interupt input in fault
  OB82_RESERVED_3 : BOOL ;   //Reserved for system
  OB82_DATE_TIME : DATE_AND_TIME ;  //Date and time OB82 started
END_VAR
BEGIN
END_ORGANIZATION_BLOCK
```