

# SIEMENS

## SIMATIC

## FM 455 S

### Getting Started

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## Safety Guidelines

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.



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### Danger

indicates that death or severe personal injury **will** result if proper precautions are not taken.

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### Warning

indicates that death or severe personal injury **may** result if proper precautions are not taken.

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### Caution

with a safety alert symbol, indicates that minor personal injury can result if proper precautions are not taken.

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### Caution

without a safety alert symbol, indicates that property damage can result if proper precautions are not taken.

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### Notice

indicates that an unintended result or situation can occur if the corresponding information is not taken into account.

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If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

## Qualified Personnel

The device/system may only be set up and used in conjunction with this documentation. Commissioning and operation of a device/system may only be performed by **qualified personnel**. Within the context of the safety notes in this documentation qualified persons are defined as persons who are authorized to commission, ground and label devices, systems and circuits in accordance with established safety practices and standards.

## Prescribed Usage

Note the following:



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### Warning

This device may only be used for the applications described in the catalog or the technical description and only in connection with devices or components from other manufacturers which have been approved or recommended by Siemens. Correct, reliable operation of the product requires proper transport, storage, positioning and assembly as well as careful operation and maintenance.

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

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# Introduction

## **Purpose of this documentation**

Based on a practical example, this manual leads you through the various steps in commissioning a fully functional application, and thus introduces the basic functions of FM 455 S hardware and software, and corresponding test features. The references to the manual should give you an initial overview of the information it contains.

Wiring and tuning of the controller will take approx. one to two hours, depending on your experience.



# Requirements

## Requirements

Hardware and software requirements:

- An S7-400 station, consisting of a power supply module and a CPU.
- STEP 7 ( $\geq$ V4.02) is properly installed on your PG.
- You have configured a project for the S7-400 station.
- The PG is connected to the CPU.
- You have an FM 455 S module and its configuration package, including all necessary accessories, such as front connectors, encoders (sensors), switches, final control elements (actuators), and wiring material.





## Learning units

### 3.1 Installing the configuration package

#### Procedure

The configuration package contains a configuration tool for FM 455 S, all function blocks (FCs) you need to integrate your FM in the CPU user program, and includes various example programs.

To install the software, place the CD into your drive, and then run SETUP.EXE from this CD.

Follow the setup instructions (see the *FM 455 Controller Module*, manual, chapter "Assigning parameters to FM 455".)

### 3.2 FM 455 S, installing and wiring

#### Procedure

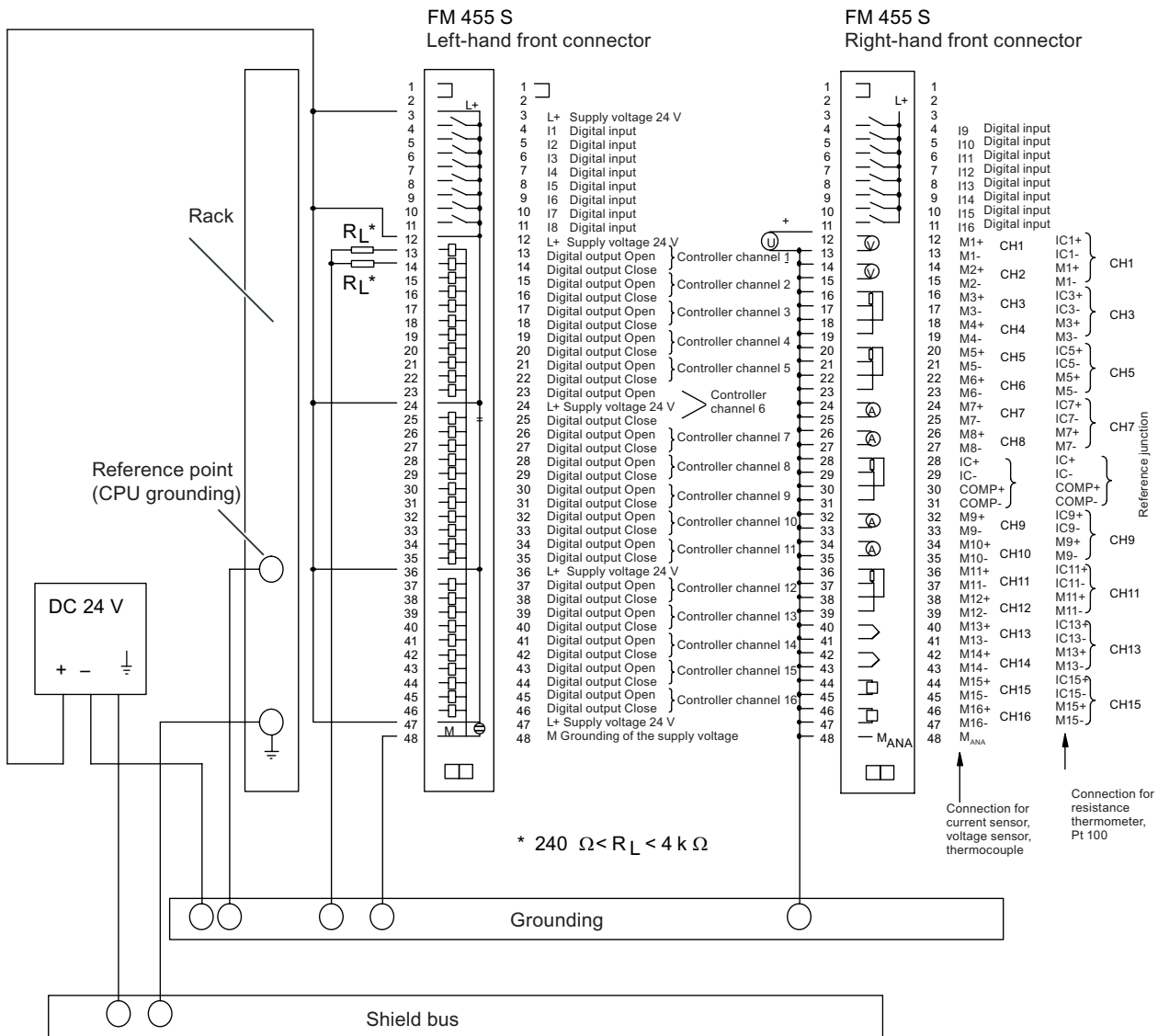
Before you install FM 455 S, set the coding key module for channels 1 and 2 to position B (see the *FM 455 Controller Module* manual, chapter "Setting the measurement type and the measuring ranges of the analog input channels".)

Place the FM 455 S into its rack slot, then swivel it down, and screw-tighten it (refer to the *FM 455 Controller Module*, chapter "Installing and removing the FM 455".)

The wiring diagram below shows you the front connector wiring of a controller channel with voltage input. The wiring of other sensors and actuators is described in the "Wiring the FM 455" and "Connecting measuring sensors and loads/actuators" chapters of the *Controller Module FM 455* manual.

Always short-circuit any unused analog inputs and the comparator by wiring these to M<sub>ANA</sub> and M, regardless whether or not you configured those inputs on the user interface.

You do not necessarily have to wire the digital inputs to operate a controller. The wiring of digital inputs is also described in the "Wiring the FM 455" and "Connecting measuring sensors and loads/actuators" chapters of the *Controller Module FM 455* manual. The possible usage of the digital inputs is described in the "Digital inputs" chapter of this manual.



Insert the wired front connectors into the FM 455 S. Make sure they engage with an audible click.

## 3.3 Preparations for programming

### Procedure

1. Open your project in SIMATIC Manager (see the *Controller Module FM 455* manual, chapter "Assigning parameters to FM 455".)
2. Open the "HW Config" configuration table in your project.
3. Select the FM 455 S with order no. 6ES7 455-1VS00-0AE0 from the hardware catalog, then drag-and-drop it to the required slot (in our example: slot 5.)
4. Open the "Properties - FM 455 S PID Control" dialog box by double-clicking this FM 455 S.
5. Note down the module address defined in the addresses tab (in this example: 512 = 200H.) You need this address in the next step to integrate the FM 455 S in your user program.
6. Check out the "basic parameters":
  - Generate interrupt: none
  - Select interrupt: none



This setting prevents the FM from outputting a diagnostics interrupt to the CPU after a transducer error has been detected (see the *Controller Module FM 455* manual, chapter "Faults and diagnostics".)

Click **Parameters...** to open the programming interface. The next sections will only deal with parameters required for the sample project. We are not going to show and describe all programming interfaces.

## 3.4 Programming the analog input parameters

### Procedure

In the first step, select a sensor type to enable the module to process an analog input and the corresponding controller.

1. Click  of analog input 1.
  - Click Sensor type. Set the parameter "voltage 0 ... 10 V" as sensor type, then save and confirm your settings by clicking OK.  
This also closes the dialog box.
  - Click Normalize , then define the required physical range of values for the setpoint and actual value.  
Define a "high" limit which corresponds with 10 V at the input.  
Define a "low" limit which corresponds with 0 V at the input. Save your settings by clicking OK.
2. Close the "Analog input 1" dialog box by clicking Close.

For further information, refer to the Online Help.

## 3.5 Programming the error signal parameter

### Procedure

Do not change the default controller type "Fixed setpoint or cascade controller" and "Step controller without position feedback."

1. Click Error signal.
  - To see which sources are selected for the setpoint and actual value, click Setpoint und Actual value A. Do not change the default "Setpoint: by function block", and "Actual value A: conditioned analog input 1," and close both windows by clicking Cancel.
  - Open the Switch Safety Setpoint window. There, you can define the module's reaction to CPU failure, and its startup characteristics.
  - On the Limit window, define the high and low limits of the setpoint. Save this setting by clicking **OK**.
2. Close the Error signal window.

For further information, refer to the Online Help.

## 3.6 Programming the controller parameters

### Procedure

Click Control algorithm to view all optional settings.

The selection returns a fuzzy temperature control and a PID control option. PID action control is set by default. Do not change this setting, and then close the "Controller 1" dialog box. The tuning of relevant control parameters is described further down.

For further information, refer to the Online Help.

## 3.7 Programming the controller output parameters

### Procedure

1. Click Controller output.

- There, you can define the signals or operating states triggering a transition at the controller output - for example, to a safety manipulated value, tracking input or external manipulated value.

It is not required to edit those parameters.

- Open the Switch Safety Setpoint window.

There, you can define the module's reaction to transducer errors, and its startup characteristics. For the step controller without position feedback, you can close the control valve completely if you configure a safety manipulated value of 0% (see the *Controller Module FM 455* manual.)

- Open the Pulse shaper dialog box by clicking the relevant button.

There, you enter the motor runtime of the control valve, and define the required minimum pulse / pause duration. To prevent the control valve from being permanently driven up to the mechanical stop, you can here define the source of the stop signals which are preferably wired to a digital input of FM 455 S.

The digital outputs "Open" and "Close" are set to zero when the relevant limit stop signal is active.

2. Close the "Controller Output" dialog box.

The binary outputs of FM 455 S are permanently assigned to the controller channels. Controller 1 uses outputs 1 and 2, controller 2 the outputs 3 and 4, and so forth.

For further information, refer to the Online Help.

## 3.8 Saving parameter data and transferring those to FM 455

### Procedure

You have successfully completed programming.

1. Save your settings by selecting **File > Save**, and then close the programming interface with **File > Exit**.
2. Close the "Properties - FM455 S PID Control" dialog box by clicking **OK**.
3. Save your configuration data to the project by selecting **Station > Save**.
4. When the CPU is in STOP, select **PLC > Download** to module to download the configuration data.

The data are now downloaded directly to the CPU, and transferred to FM 455 S. Provided you backup configuration data on the CPU, the CPU always transfers those data to FM 455 S at each STOP to RUN transition.

**Test:** Cycle the power supply to the CPU and FM 455 S off and on. Provided you have properly programmed and wired the module, the red INTF and EXTf LEDs light up briefly, and then go dark after the module has successfully completed its self-test. The yellow backup LED is lit when the CPU is in STOP, and is switched off again when the CPU goes into RUN.

## 3.9 Integrating FM 455 S in the user program

### Procedure

1. In SIMATIC Manager, select **File > Open... > Libraries** to open the FM\_PID library.
2. Copy FB 31 FM\_PID from the FM 355, 455 PID Control / blocks container of the FM\_PID library to the "Blocks" container of your project.  
At FB 31 PID\_FM, you can
  - edit operating parameters such as setpoints, or toggle from manual to auto mode
  - read process values from the FM, such as the actual value, the manipulated variable, or the current operating states
  - edit controller parameters based on the process state.
3. Add a watchdog interrupt OB to your project such as OB 35. Open OB 35, call FB 31 PID\_FM in OB 35, and then assign this FB call an instance DB, for example:  
CALL "PID\_FM", DB 50
4. Set the module address you noted down earlier on at parameter MOD\_ADDR (see "Programming FM 455 S".)
5. At the CHANNEL parameter, set the channel number of the controller whose parameters you want to read/write with this call.
6. You can define the setpoint at parameter SP\_RE.  
You can toggle manual / auto mode, and set default values at the LMN\_REON and LMN\_RE parameters. When using the step controller, you can completely close the control valve by setting the manual value LMN\_RE 0%, and close it completely if you set a manual value LMN\_RE 100%. (see the *Controller Module FM 455* manual.)
7. Select **File > Save** to save OB 35.
8. Open the symbol editor to assign a symbolic name to the new instance DB, for example, DB\_cont1.

For further information, refer to the *FM 455 Controller Module* manual.

## 3.10 Editing controller parameters of the user program

### Procedure

To let you modify specific parameters while the system is in RUN, FB PID\_FM first has to read the FM 455 parameters at startup, as you do not only transfer the deltas, but rather all parameters to the FM. Corresponding declaration at the COM\_RST parameter of FB 31 PID\_FM in OB 100:

**SET**

**= "DB\_cont1".COM\_RST**

FB 31 PID\_FM will now read the FM 455 controller parameters at the first call of OB 35, and then saves these to its instance DB. You can now edit specific values such as the controller GAIN. Set parameter LOAD\_PAR = TRUE in OB 35 to transfer the parameter data from the instance DB to FM 455 S. Successful completion of this action is indicated by the reset of COM\_RST or LOAD\_PAR (see the *Controller Module FM 455* manual, "The function block PID\_FM and "Assignment of the DBs".)

## 3.11 Download finished example program "SIMATIC 400 Station1 (S)"

### Procedure

We recommend you use the example "SIMATIC 400 Station1 (S)" of the FM\_PIDEx project for the next tests. As a result you can try out the FM 455 S on a simulated control section without using real processes (refer to the *FM 455 Controller Module* manual, chapter "Application example for the FM 455 S").

1. In HW Config, replace your FM 455 S with the FM 455 S of the example.
2. In the HW Config, check the cyclic interrupt clock cycle of the OB 35. 100 ms must be set as the execution time.
3. Save, compile and download this configuration.
4. Copy all blocks, except system data and the SFCs 58 and 59, from the blocks container of the sample project to the blocks container of the user program.
5. Check the module address setting at the MOD\_ADDR parameter of DB 31. It must tally with the FM 455 S address that is entered in the HW Config.
6. Download those blocks to the CPU.

## 3.12 Testing the controller test using the loop monitor and curve recorder functions

### Procedure

You open the loop display in the parameterization interface by opening online **Test > Loop display** in the FM 455 S of the example program. The loop monitor lets you manually enter setpoints and manipulated values to test the controller.

To open the curve recorder, call instance DB 31 of the example program by selecting **Test > Curve Recorder** in the FM 455 S programming interface. You can use the curve recorder to record the trend of a setpoint step, for example.

For further information on the loop monitor and curve recorder, refer to the Online Help (click **Help** in the relevant view.)

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### Note

You toggle from PG setpoint mode to PG manipulated value mode when operating the step controller by setting the SP\_OP\_ON, SP\_OP, LMNSOPON, LMNUP\_OP and LMNDN\_OP variables at FB 31 PID\_FM. Those variables are reserved for this specific function and should not be implemented in the user program.

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## 3.13 PID controller tuning

### Procedure

Start tuning the step controller by measuring the motor actuating time.

1. Open online in the parameterization interface with **Test > Motor actuating time** of the instance DB 31 of the example program.
  - If you do not use actuator limit signals of the stepping motor or if your process does not support a drive in and out of the control valve, then you must configure the actuating time and then click on **OK**.
  - When using the actuator limit signals of the stepping motor, and you have interconnected these with FM 455 S, select the "Actuator signals of the stepping motor" and use these for measuring the actuating time.

Follow the instructions in the "Measuring motor actuating time" window, and set PG mode for the actuating signal.

2. To initiate the measurement, click "**Start**" in the "Measuring motor actuating time" window, and then confirm the "Measuring motor actuating time" message box with OK.

The system will now measure the opening and closing times of the control valve.

3. When the result is output, click **OK** in the "Measuring motor actuating time" and "Close loop monitor" windows.

The "Measuring motor actuating time" window opens where you can edit the minimum pulse / pause periods. Select **PLC > Download** to transfer the values to the instance DB of FB 31 PID\_FM, and from there to FM 455 S.

4. Select **Test > Controller** optimization on the programming interface to open instance DB 31 of the sample program.
5. Follow the instructions of the "Controller Optimization" message box.
6. At the "Setpoint" entry, toggle to PG mode and then click "**Send**".
7. Confirm and apply the defaults of the "Controller optimization: preparing for data recording" with OK.

The message box requests you to set the setpoint to the operating point. Click "**Send**" to set an operating setpoint of 0%, for example. You can then, after the actual values has settled, confirm your entries by clicking **OK** on the "Controller optimization" message box.

8. Enter a setpoint of 30% in the loop monitor, and then click **Send**.

Data logging is now active. You now have to wait until the program detects that the process value has reached a steady state. This detection period may seem rather long. However, often noise generated by the measured value is frequently superimposed on the process value. The data logging period was slightly extended in order to safely eliminate any negative effects of this noise on the controller settings.

9. When the "reverse excitation" message is output in the "Controller optimization" message box, click **Close** to close the loop monitor, and close the message box with OK.

The following window shows the conveyed process and controller parameters and offers you a PI controller.

10. Click "**Load PI**". Click **Yes** on the next "Write parameters for controller optimization" dialog box.

The controller parameters you determined are now saved to the offline data storage, and to the instance DB of FB 31 PID\_FM. You can now transfer those data to FM 455 S by setting the LOAD\_PAR parameter at this instance DB.

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**Note**

Do not forget to download the modified parameters from the offline data storage to system data of the CPU. You can only perform this operation in the HW Config configuration table. If you forget to do so, the FM 455 S controller parameters will be overwritten with the old data at the next CPU transition from STOP to RUN.

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## Further Information

### 4.1 Tuning temperature controllers

#### Information

For further information, refer to the *Controller Module FM 455* manual, chapter "Parameter optimization at a temperature controller" and to the Online Help.

### 4.2 Diagnostics

#### Error diagnostics

Errors may occur due to faulty parameters, incorrect wiring, or transducer failure. FM 455 S indicates such errors at the group error LED.

For information on the analysis of such errors, refer to the *FM 455 Controller Module* manual, chapter "Faults and diagnostics."

### 4.3 Examples

#### Project FM\_PIDEx

The FM\_PIDEx project contains an additional set of examples for your orientation. You can also adapt those examples to suit your application.

