

Operating Instructions

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Warning notice system

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.

 DANGER
indicates that death or severe personal injury will result if proper precautions are not taken.
 WARNING
indicates that death or severe personal injury may result if proper precautions are not taken.
 CAUTION
indicates that minor personal injury can result if proper precautions are not taken.
NOTICE
indicates that property damage can result if proper precautions are not taken.

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 product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Proper use of Siemens products

Note the following:

 WARNING
Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

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Disclaimer of Liability

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

Preface

Purpose of the operating instructions

The information in these operating instructions enables you to operate the ET 200PA SMART Distributed I/O system with the IM 650 interface module, the ET 200PA SMART I/O modules, and the single-width I/O modules of the S7-300 range released for PCS 7 as a DP slave.

Note

The ET 200PA SMART I/O modules function only in connection with an IM 650 interface module. If the ET 200PA SMART modules are plugged behind an ET 200M interface module (e.g., IM 153-2BA02) or behind an S7-300 CPU, the function of the ET 200PA SMART modules is not available. The ET 200PA SMART modules indicate this with a red SF LED flashing at 2 Hz. An ET 200PA SMART module does not affect the ET 200M / S7-300 bus. This means that other modules of the ET 200M / S7 300 station remain operable without restriction.

Basic knowledge required

To understand the operating instructions you require general experience in the field of automation engineering.

Range of validity of these operating instructions

	Module	Article no.	As of product version
Interface module	Interface module IM 650-8PH	6ES7650-8PH00-xAA0	01
I/O modules	Digital input module DI 16 x 24VDC	6ES7650-8DK70-xAA0	01
	Digital input module DI 32 x 24VDC	6ES7650-8DK80-xAA0	01
	Digital output module DO 16 x 24VDC/0.5A	6ES7650-8EK70-xAA0	01
	Digital output module DO 32 x 24VDC/0.5A	6ES7650-8EK80-xAA0	01
	Analog input module AI 8 x 13-bit	6ES7650-8AE60-xAA0	01
	Analog input module AI 8 x 16-bit	6ES7650-8AK60-xAA0	01
	Analog input module AI 16 x 16-bit	6ES7650-8AK70-xAA0	01
	Analog input module AI 8 x 16-bit HART	6ES7650-8AT60-xAA0	01
	Analog input module AI 8 x TC/4xRTD	6ES7650-8AR60-xAA0	01
	Analog output module AO 8 x 12-bit	6ES7650-8BK60-xAA0	01
	Analog output module AO 8 x 16-bit HART	6ES7650-8BT60-xAA0	01

	Module	Article no.	As of product version
Active bus modules (BM)	Bus module (BM) PS/IM	6ES7650 8PA00-xAA0	01
	Bus module (BM) 2x40	6ES7650 8PC00-xAA0	01
	Bus module (BM) IM/IM	6ES7650 8PB00-xAA0	01

x = 1: Module with conformal coating for use under elevated ambient conditions

x = 0: Standard module

Convention: In the following, the designation IM 650 is used in the operating instructions for the 650-8PH interface module.

For new versions of the ET 200PA SMART components, we reserve the right to enclose product information containing current information about the respective module or the operating instructions.

This product information can also be found on the Internet (<http://support.automation.siemens.com>). Search there for "ET 200PA SMART", for example.

Approvals, standards and certificates

See section "Standards and approvals".

Position in the Information Landscape

This manual contains a complete description of the ET 200PA SMART Distributed I/O system.

If you are using I/O modules from the S7-300 series of modules, you can find information on them in the following manuals:

Manual	Contents
Automation System S7-300, Module Data (http://support.automation.siemens.com/WW/view/en/8859629)	• General technical specifications • Power supply modules • Digital modules • Analog modules • Order numbers for S7-300
ET 200M Signal Modules for Process Automation (http://support.automation.siemens.com/WW/view/en/7215812)	• Overview of the use in process automation • Parameter assignment with <i>SIMATIC PDM</i> • Digital input module • Digital output module
ET 200M Distributed I/O Device HART Analog Modules (http://support.automation.siemens.com/WW/view/en/22063748)	• HART analog modules • Expanded input data (HART auxiliary variables)

ET 200PA SMART I/O modules

10.1 Module overview

The following I/O modules are available in the ET 200PA SMART system:

Module	Article no.	Article no. (with conformal coating)
Digital input module DI16xDC24V	6ES7650-8DK70-0AA0	6ES7650-8DK70-1AA0
Digital input module DI32xDC24V	6ES7650-8DK80-0AA0	6ES7650-8DK80-1AA0
Digital output module DO16xDC24V/0.5A	6ES7650-8EK70-0AA0	6ES7650-8EK70-1AA0
Digital output module DO32xDC24V/0.5A	6ES7650-8EK80-0AA0	6ES7650-8EK80-1AA0
Analog input module AI8x13Bit	6ES7650-8AE60-0AA0	6ES7650-8AE60-1AA0
Analog input module AI8x16Bit	6ES7650-8AK60-0AA0	6ES7650-8AK60-1AA0
Analog input module AI16x16Bit	6ES7650-8AK70-0AA0	6ES7650-8AK70-1AA0
Analog input module AI8xTC/4xRTD	6ES7650-8AR60-0AA0	6ES7650-8AR60-1AA0
Analog input module AI 8 x 16-bit HART ¹	6ES7650-8AT60-0AA0	6ES7650-8AT60-1AA0
Analog output module AO8x12Bit	6ES7650-8BK60-0AA0	6ES7650-8BK60-1AA0
Analog output module AO 8 x 16-bit HART ¹	6ES7650-8BT60-0AA0	6ES7650-8BT60-1AA0

¹ Available as of PCS 7 V9.0 SP2 and the corresponding update collection

In addition to the ET 200PA SMART I/O modules specified in this table, the following modules can also be used in an ET 200PA SMART system.

- Numerous S7-300 standard I/O modules and HART analog modules that are also approved for use in an ET 200PA SMART in the list of released modules PCS 7 (as of V8.1).
- Numerous counter modules and point-to-point couplings which are also approved for use in an ET 200PA SMART in the list of released modules PCS 7 (as of V8.1).

If you are using modules from the S7-300 series of modules, you can find information for them in the following manuals:

- Automation System S7-300, Module Data (<http://support.automation.siemens.com/WW/view/en/8859629>)
- ET 200M, Signal Modules for Process Automation (<http://support.automation.siemens.com/WW/view/en/7215812>)
- ET 200M Distributed I/O Device HART Analog Modules (<http://support.automation.siemens.com/WW/view/en/22063748>)

Note

The ET 200PA SMART I/O modules function only in an ET 200PA SMART station conjunction with an IM 650 interface module.

If the ET 200PA SMART modules are located behind an ET 200M interface module or an S7-300 CPU, the function of the ET 200PA SMART modules is not available. The ET 200PA SMART modules indicate this by a red SF LED (group error LED) flashing at 2 Hz.

The ET 200PA SMART modules do not affect the ET 200M / S7-300 bus. This means other modules of the ET 200M / S7-300 station remain operable without restriction.

Redundant use

All ET 200PA SMART modules can be used redundantly with the following exceptions:

- Analog input module AI 8 x 13 Bit cannot be used in a redundant configuration.
- Analog input module AI8xTC/4 x RTD can only be used in a redundant configuration for voltage measurement and thermocouple measurement. Only with redundant encoders for thermocouple measurement, however.
- Analog output module AO 8 x 12 Bit can only be used in a redundant configuration for current output.

In redundant mode, the modules are present in duplicate and are configured and operated redundantly.

Redundant use is only permitted when using two identical modules (same article number).

You can find additional information on the subject of redundancy in the Automation System S7-400H Fault-Tolerant Systems (<http://support.automation.siemens.com/WW/view/en/1186523>) manual

Parameter assignment

You configure the modules via the respective parameter assignment dialogs in HW Config. Once you have defined all parameters, transfer the parameters from the programming device to the CPU. The CPU passes the parameters to the respective modules at a change of operating mode from STOP → RUN.

Parameter reassignment in runtime

Parameter reassignment in runtime is possible for all ET 200PA SMART modules.

Input modules do not change the process input value while they are being re-configured.

Diagnostics and diagnostic messages

I/O modules with diagnostic capability have assignable and non-assignable diagnostic messages.

You only receive assignable diagnostic messages if you have enabled the diagnostics using the module-specific parameter assignment dialog of HW Config.

Non-assignable diagnostic messages are always provided by the module regardless of whether the diagnostics is enabled.

Pending diagnostic information is displayed via the group error display (SF LED).

Diagnostic interrupts are only signaled by the I/O modules if "Diagnostic interrupt" is enabled via the respective parameter assignment dialog.

Group error display (SF LED)

The group error display (SF LED) of the ET 200PA SMART modules indicates the following:

- Operation of the ET 200PA SMART module centrally in an S7-300 system or an ET 200M station. In this case, the SF LED flashes at 2 Hz. The ET200PA SMART module is not ready for operation.
All the remaining modules can be operated without restriction.
- Error state of the respective module in the case of modules with diagnostic capability The SF LED lights up as soon as diagnostic information of a module is detected. It goes out when all causes of the diagnostic information (errors) are eliminated.

Internal module defects are indicated for modules with and without diagnostic capability. The SF-LED lights up when a module defect has been detected.

10.2 Digital input modules

Overview of properties

The table below presents the ET 200PA SMART digital input modules based on their most important properties.

Table 10-1 ET 200PA SMART digital input modules

Properties	Module	
	DI 16 x DC24V	DI 32 x DC24V
	6ES7650-8DK70-xAA0	6ES7650-8DK80-xAA0
Number of inputs	16 Isolated in groups of 16	32 Isolated in groups of 16
Rated input voltage	24 V DC	24 V DC
Suitable for...	2-/3-/4-wire proximity switches (BEROs)	
Configurable diagnostics	Yes	No
Diagnostic interrupt	Yes	No
Adjustable input delays	Yes, for entire module	No

10.2.2 Digital input module DI 16 x DC24V

Article numbers

Standard module: 6ES7 650-8DK70-0AA0

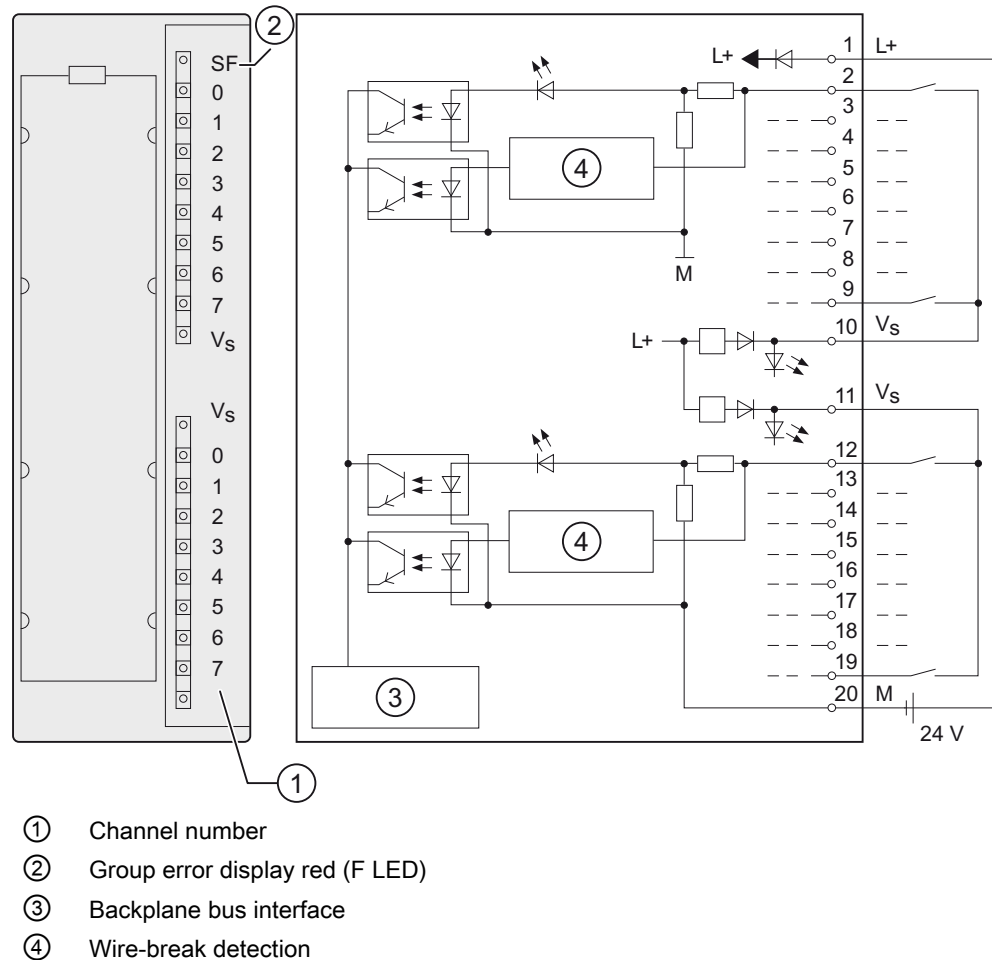
Module with conformal coating: 6ES7 650-8DK70-1AA0

Properties

The DI 16 x DC 24 V is characterized by the following properties:

- 16 inputs, isolated in groups of 16
- Rated input voltage 24 V DC
- Input characteristics according to IEC 61131, Type 2
- Suitable for switches and 2-/3-/4-wire proximity switches (BEROs)
- 2 short-circuit-proof sensor supplies for each group of 8 channels
- "Sensor supply (Vs)" status displays
- External redundant sensor supply infeed is supported
- Group error display (SF)
- Configurable diagnostics
- Configurable diagnostic interrupt
- Configurable input delays
- Configuration in Run (CiR) supported

Wiring and block diagram of the DI 16 x DC 24 V



Wiring diagram for redundant sensor supply

The figure below shows how sensors can be additionally supplied with a redundant voltage source using V_s .

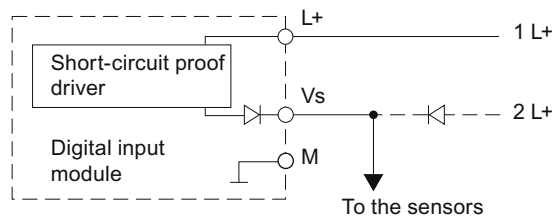


Figure 10-1 Wiring diagram for the redundant supply of sensors of the DI 16 x DC 24 V

Wiring diagram for resistance circuit of the sensors

For wire-break detection, it is necessary to connect sensor contacts with a resistor even in case of "0" signal.

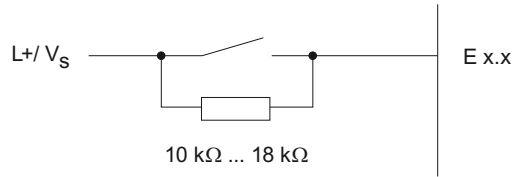
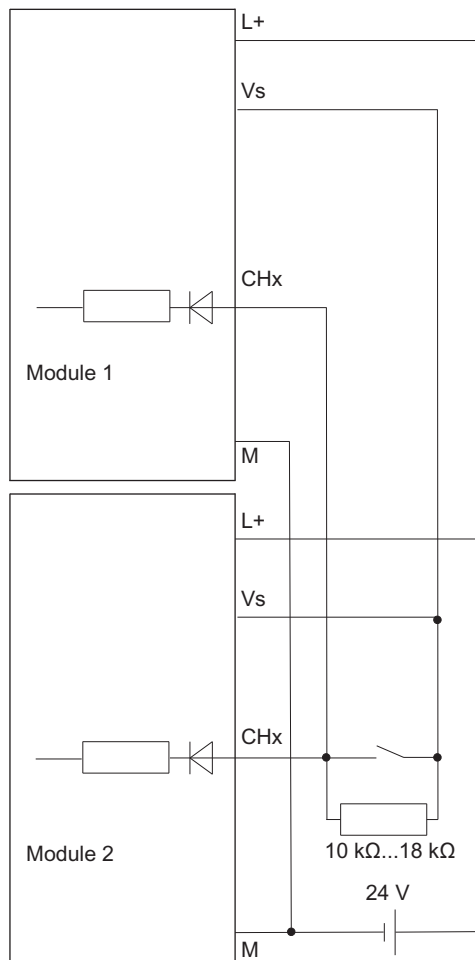


Figure 10-2 Wiring diagram for resistance circuit of the sensors of the DI 16 x DC 24 V

Redundant use

The inputs can be operated redundantly without external connection of diodes.



Technical specifications of the DI 16 x DC 24 V

Technical specifications	
Dimensions and weight	
Dimensions W x H x D (mm)	40 x 125 x 117
Weight	Approx. 200 g
Module-specific data	
Number of inputs	16
Cable length	
• Unshielded	Max. 600 m
• Shielded	Max. 1000 m
Voltages, currents, potentials	
Rated supply voltage of electronics and sensors L+	24 V DC
• Reverse polarity protection	Yes
Number of simultaneously controllable inputs	
• Horizontal mounting position Up to 60 °C	16
• Vertical mounting position Up to 40 °C	16
Electrical isolation	
• Between channels plus sensor circuits (L+) and back-plane bus	Yes
• Between channels – in groups of	16
Isolation, designed for basic isolation	
• Between different circuits	75 V DC / 60 V AC
Isolation tested with	500 V AC or 707 V DC, type test
Current consumption	
• From backplane bus	Max. 130 mA
• From load voltage L+ (without sensor supply V _S)	Max. 90 mA
Power loss of the module	Typ. 4 W
Status, interrupts, diagnostics	
Status display	Green LED per channel
Sensor supply status	Green LED per sensor supply output
Group error display (SF LED)	Yes
Diagnostic interrupts	Configurable
Diagnostic functions	Configurable
Sensor supply outputs	
Number of outputs	2
Output voltage	
• On load	Min. L+ (- 2.5 V)
Output current	
• Rated value	120 mA
• Permitted range	0 to 150 mA

Technical specifications	
Additional (redundant) supply	Permitted
Short-circuit protection	Yes, electronic
Sensor selection data	
Input voltage - Rated value - For "1" signal - For "0" signal	24 V DC From 13 to 30 V From - 30 to + 5 V
Input current When signal "1" is present	Typ. 7 mA
Input characteristics	According to IEC 61131, Type 2
Connection of 2-wire BEROs Permissible quiescent current	Supported Max. 2 mA
Connecting the signal transmitter	Using a 20-pin front connector
Resistance circuit of the sensor for wire-break detection	10 to 18 kilohm
Time/frequency	
Internal preparation time for diagnostics	Max. 40 ms
Input delay - Configurable - Rated value	Yes Typ. 0.1/0.5/3/15/20 ms

10.2.2.1 Parameters of the DI 16 x DC 24 V

Parameter assignment

The parameters are assigned using the parameter assignment dialog of HW Config

Parameters of the DI 16 x DC 24 V

The table below provides an overview of the assignable parameters and their default settings for the DI 16 x DC 24 V.

The default settings apply when you have not assigned parameters in HW Config or you have not changed any parameters.

Table 10-2 Parameters of the DI 16 x DC 24 V

Parameter	Value range	Default setting	Scope
Diagnostic interrupt enable	Yes / No	Yes	Module
Input delay	0.1 ms 0.5 ms 3 ms 15 ms 20 ms	3 ms	Module
Diagnostics			
• No sensor supply	Yes / No	Yes	Channel
• Wire break	Yes / No	Yes	Channel

Assignment of the sensor supplies to channel groups

The 2 sensor supplies of the module are used to supply two channel groups: inputs 0 to 7 and inputs 8 to 15. You also assign the diagnostics for the sensor supply in these channel groups.

Group diagnostics

The diagnostics parameter "Group diagnostics" enables the signaling of channel-specific errors to be switched off, with the exception of parameter assignment errors.

Tolerances of the assignable input delays

Table 10-3 Tolerances of the input delays of the DI 16 x DC 24 V

Assigned input delay	Tolerance
0.1 ms	60 µs to 140 µs
0.5 ms	400 µs to 900 µs
3 ms (default)	2.6 ms to 3.3 ms
15 ms	12 ms to 15 ms
20 ms	17 ms to 23 ms

10.2.2.2 Diagnostics of the DI 16 x DC 24 V

Introduction

Module faults and channel faults are displayed via the group error display (SF LED) and signaled via the diagnostic data records 0/1.

Diagnostic messages and possible corrective measures

The table below provides an overview of the diagnostic messages of the DI 16 x DC 24 V.

Table 10-4 Diagnostic messages of the DI 16 x DC 24 V and possible corrective measures

Diagnostic message	Configurable	Possible cause of error	Corrective measure
No sensor or load voltage	Yes	Overload of sensor supply	Eliminate the overload
		Short-circuit of sensor supply to M	Eliminate the short-circuit
Wire break	Yes	Interruption of the actuator connection	Check the wiring
No external auxiliary voltage	No	Supply voltage L+ of module missing	Feed supply L+
Module-internal supply voltage failed	No	Supply voltage L+ of module missing	Feed supply L+
		Module-internal fuse defective	Replace the module
Module parameters not assigned	No	Startup error	Reassign the module parameters
Incorrect parameters	No	One parameter, or the combination of parameters, is not plausible	Reassign the module parameters
Time monitoring tripped	No	Intermittently high electromagnetic interference	Eliminate the interference and switch the ET 200PA SMART station off and on.
EPROM error	No	Module defective	Replace the module
RAM error	No	Module defective	Replace the module

No sensor or load voltage

When "No sensor supply" diagnostics is activated, failure of the sensor supply is always signaled for all affected channels.

Reaction to failure of the supply voltage

The input value is initially held for the duration of 20 ms to 40 ms before the "0" signal is transferred to the CPU. Supply voltage dips < 20 ms do not change the process value.

Failure of the supply voltage with redundant sensor supply infeed

Note

When an external redundant supply is applied to the sensor supply (Vs) and the L+ supply voltage fails, failure of the sensor supply is not signaled. Instead, a failure of the internal and/or external auxiliary voltage and/or a blown fuse is signaled.

Short-circuit of the sensor supply Vs

The status LED of the sensor supply goes out in the event of a short-circuit of the sensor supply Vs, irrespective of the parameter assignment.

Wire break

In order for a wire break to be detected even in case of "0" signal, a resistance of 10 to 18 kilohms must be wired parallel to the sensor contacts.

10.3 Digital output modules

Overview of properties

The table below presents the ET 200PA SMART digital output modules based on their most important properties.

Table 10-5 Digital output modules

Properties	Module	
	DO16 x 24V/0.5A	DO32 x 24V/0.5A
	6ES7650-8EK70-xAA0	6ES7650-8EK80-xAA0
Number of outputs	16 Isolated in groups of 16	32 Isolated in groups of 8
Output current	0.5 A	0.5 A
Rated load voltage	24 V DC	24 V DC
Suitable for	Solenoid valves, DC contactors and signal lamps	
Configurable diagnostics	Yes	No
Diagnostic interrupt	Yes	No
Substitute value output	Yes (channel-specific)	No

10.3.1 Digital output module DO 32 x DC 24 V/ 0.5 A

Article numbers

Standard module: 6ES7 650-8EK80-0AA0

Module with conformal coating: 6ES7 650-8EK80-1AA0