Engineering of a SIMATIC ET 200AL with IO-link

SIMATIC ET 200AL, IO-Link, SIRIUS ACT

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1 Introduction

1.1 Overview

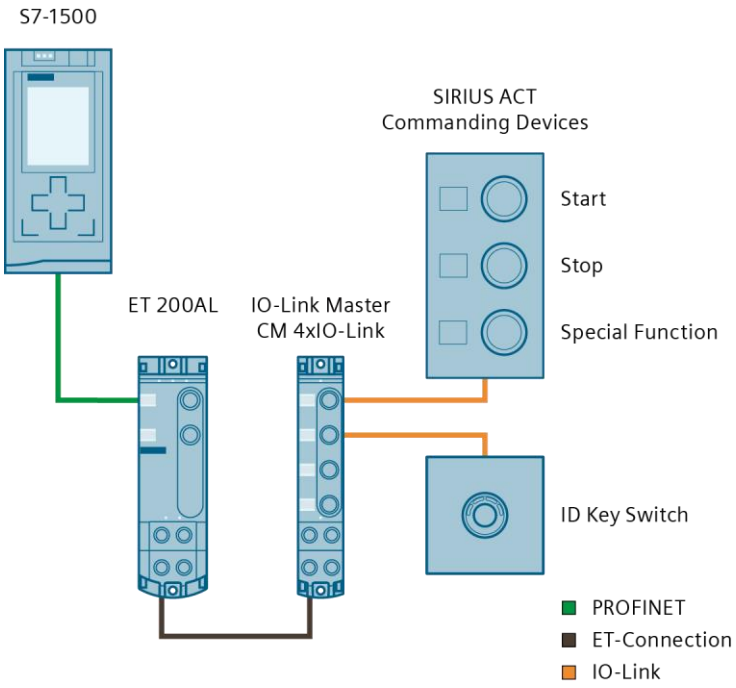
The SIMATIC ET 200AL has a high IP65/67 degree of protection, a particularly compact design, a small space requirement and low weight. It has been specially designed for distributed control electronics in confined spaces and applications involving motion.

SIMATIC ET 200AL modules can easily be installed in any position. They are mounted directly in a machine or assembly line on site, where they use M8 or M12 connections to connect sensors and actuators.

In combination with IO-Link, even wiring can be reduced.

The IO-Link at a field level makes for much easier integration of all components and provides maximum transparency and efficiency with regard to the final meters of the process – thus ensuring seamless communication.

Figure 1-1: Overview



This sample application contains the following descriptions:

- Configuring an ET 200AL and a CM 4xIO-Link in the TIA Portal
- Configuring the IO-Link master (CM 4xIO-Link) and IO-Link devices in the PCT (Port Configuration Tool)
- Incorporating the signals of the IO-Link control devices in the user program
- Logging IDs of the inserted ID key with a timestamp

1.2 Mode of operation

Setup

A SIMATIC S7-1500 control is used as an IO controller. The ET 200AL interface module and the CM 4xIO link are installed in the field and connected to the IO controller via PROFINET.

To operate the machine on-site, the SIRIUS ACT control devices are used, which are connected via IO-Link to the ET 200AL. These so-called IO-Link electronics modules are fitted into the housings of the control devices, which convert the signals of the control devices to IO-Link.

The electronic module in the upper housing (see Figure 1-1) has 8 inputs/outputs that are freely programmable via the PCT (Port Configuration Tool). The default setting of 6 inputs and 2 outputs is suitable for this application example.

A permission control for the operation of the machine is realized with the SIRIUS ACT ID key switch. The ID key switch must be installed in its own housing because the electronics module takes up more space than there is available in conventional housing.

The control devices are connected with the IO-Link master using two assembled M8 lines, which significantly reduces the wiring effort.

Application

To operate the machine, the user inserts his ID key into the key switch. The SIRIUS ACT ID key is divided into five permission levels that are color coded:

- Green: Level 1
- Yellow: Levels 1 to 2
- Red: Levels 1 to 3
- Blue: Levels 1 to 4
- White: The permission level is set individually via the PCT

Figure 1-2: SIRIUS ACT ID Key Switch

To start the machine, an ID key must be inserted. The machine may be stopped at any time, even without an ID key.

Depending on the permission level of the inserted ID key, the user can control different operating modes of the machine.

In addition to the permission level, each ID key has a unique identification number. This identification number is read out when the ID key is placed in the user program and is saved in a data block along with a timestamp.

In the event that the machine malfunctions, an analysis can therefore be undertaken to see who has recently been operating the machine.

1.3 Components used

This application example was created with these hardware and software components:

Table 1-1: Hardware and software components used

Component	Number	Article number	Note
Power supply	1	6EP1332-4BA00	PM 70 W
SIMATIC S7-1500	1	6ES7516-3AN01-0AB0	CPU 1516-3 PN/DP FW 2.1
SIMATIC Memory Card	1	6ES7954-8LF01-0AA0	SMC 24MB
ET 200AL Interface Module	1	6ES7157-1AB00-0AB0	
CM 4 x IO-Link	1	6ES7147-5JD00-0BA0	
SIRIUS ACT ID Key Switch	1	3SU1030-4WS10-0AA0	
SIRIUS ACT ID Key	1	3SU1900-0FU60-0AA0	White, individually coded, programmable several times
IO-Link electronic module for ID key switch	1	3SU1400-1GD10-1AA0	
Housing for ID key switch	1	3SU1801-1AA00-1AA1	Plastic version
Empty enclosure	1	3SU1803-0AA00-0AB1	Plastic version
IO-Link Electronic Module	1	3SU1400-2HL10-6AA0	8 inputs/outputs, freely programmable
Illuminated pushbutton, white	1	3SU1031-0AB60-0AA0	Start button
Pushbutton, black	1	3SU1030-0AB10-0AA0	Stop pushbutton
Illuminated pushbutton, yellow	1	3SU1031-0AB30-0AA0	Special functions
Holders without module	4	3SU1500-0AA10-0AA0	ID key switch, start and stop buttons, special function
Contact module for base mounting, 1S	2	3SU1400-2AA10-1BA0	Start button, special function
Contact module for base mounting, 1Ö	1	3SU1400-2AA10-1CA0	Stop pushbutton
LED module for base mounting, white	1	3SU1401-2BB60-1AA0	Start button, 24 V DC
LED module for base mounting, yellow	1	3SU1401-2BB30-1AA0	Special function, 24 V DC
M12 socket, 4-pin	2	3SU1950-0HA10-0AA0	
M8 power cable	1	6ES7194-2LH20-1AC0	Pre-assembled at one end
M8 power cable	1	6ES7194-2LH03-1AA0	Pre-assembled at both ends
Bus cable for PROFINET M12	1	3RK1902-2HB30	Pre-assembled at one end
Bus cable for M8 ET connection	1	6ES7194-2LH03-0AA0	Pre-assembled at both ends
SIMATIC RF IO-Link plug-in cable	2	6GT2891-4MH50	Pre-assembled, 5 m

This application example consists of the following components:

Table 1-2: Components of the application example

Component	File name	Note
Documentation	109750451_ET200AL_IO-Link_DOC_V10_de.pdf	This document
TIA Portal Project:	109750451_ET200AL_IO-Link_PROJ_V10_de.zip	TIA Portal V14 SP1

2 Engineering

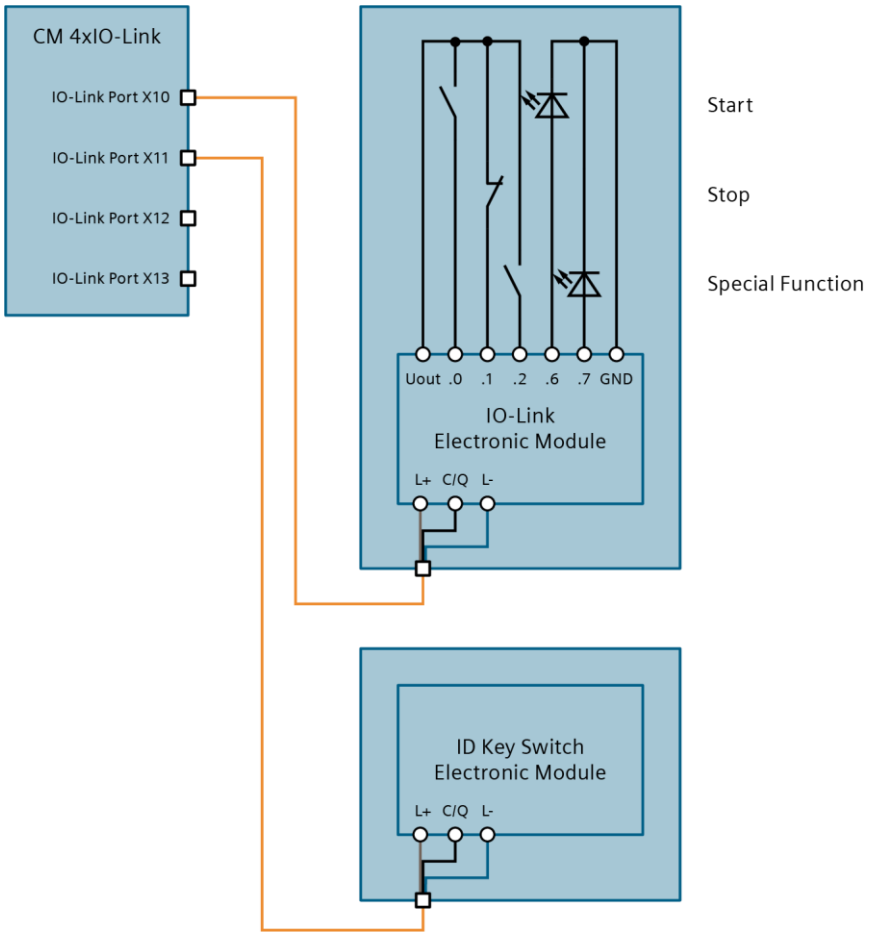
2.1 Hardware setup

The hardware setup is illustrated in Figure 1-1. This chapter describes the installation and wiring of the control devices.

Install control device with start and stop button and mode selector switch

1. Screw the housing with 3 control points.
2. Punch a hole in the housing base and screw the M12 connector into it.
3. Push the push button into the opening in the cover and fix it in place with the holders.
4. Snap a normally closed contact module onto housing slot C1.
5. Snap a white LED module onto housing slot C3.
6. Snap a break contact module onto housing slot B1.
7. Snap a normally closed contact module onto housing slot A1.
8. Snap the yellow LED module onto housing slot A3.
9. Snap the IO-Link electronic module between slots.
10. Connect the contact and LED modules as shown in Figure 2-1 to the IO-Link electronic module.
11. Connect the M12 bushing to the IO-Link electronic module.
12. Place the cover on the base and screw the housing together.
13. Connect the control device with a pre-assembled 4-pin M12 cable to port X10 of the CM 4xIO-Link.

Figure 2-1: Wiring control devices



Install control device with ID key switch

1. Screw the housing with a control point.
2. Punch a hole in the housing base and screw the M12 connector into it.
3. Push the ID key switch into the opening in the cover and fix it in place with the holders.
4. Snap the electronic module to the holder.
5. Connect the M12 bushing to the electronic module.
6. Place the cover on the base and screw the housing together.
7. Connect the control device with a pre-assembled 4-pin M12 cable to port X11 of the CM 4xIO-Link.

2.2 Configuration

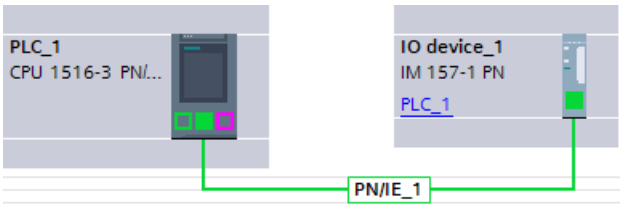
With this application example, you will receive a complete TIA portal project. To download the provided project, go straight to chapter 2.2.3.

The next chapters contain all the steps to adjust the project (without program).

2.2.1 Configuring the CPU and ET 200AL

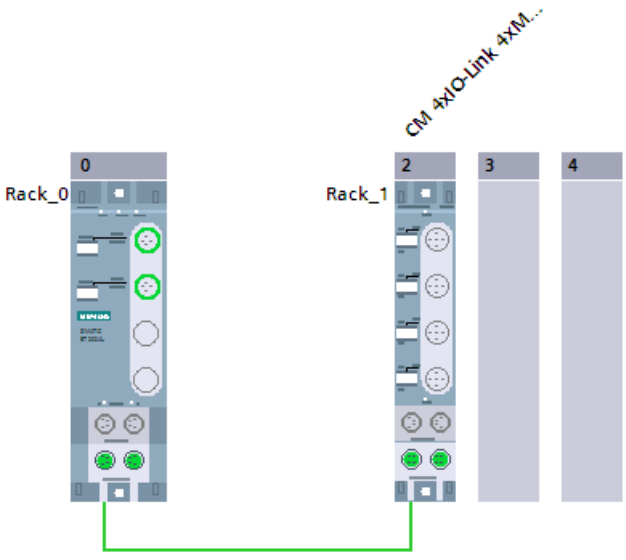
1. Open the TIA Portal V14 and create a new project.
2. Switch to the project view if necessary.
3. Open "Devices & Networks".
4. Move a CPU from the hardware catalog into the workspace.
5. Move ET 200AL interface module from the "decentralized periphery hardware catalog > ET 200AL > interface modules > PROFINET > IM 157-1" (“Distributed I/O > ET 200AL > interface modules> PROFINET> IM 157-1 PN") in the normal working range.
6. Connect the PROFINET interface of both devices.

Figure 2-2



7. Double-click on the interface module to switch the device view.
8. Move the CM 4xIO-Link 4xM12 from the hardware catalog under “Communication modules > IO-Link master” in slot 2.
   The interface module and CM are automatically connected.

Figure 2-3



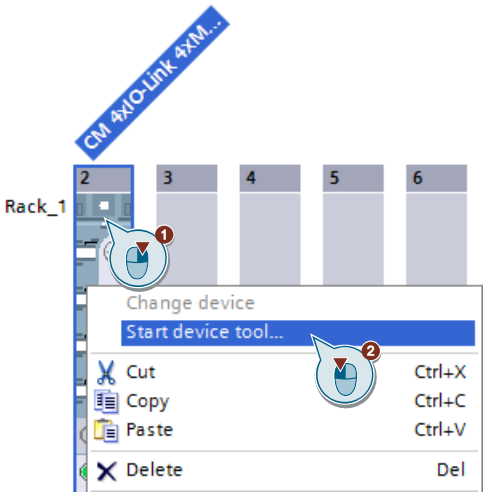
2.2.2 Configuring the CM 4xIO-Link

For the following steps, you need to have installed PCT. You can download the PCT from the Industry Online Support:

https://support.industry.siemens.com/cs/ww/en/view/32469496

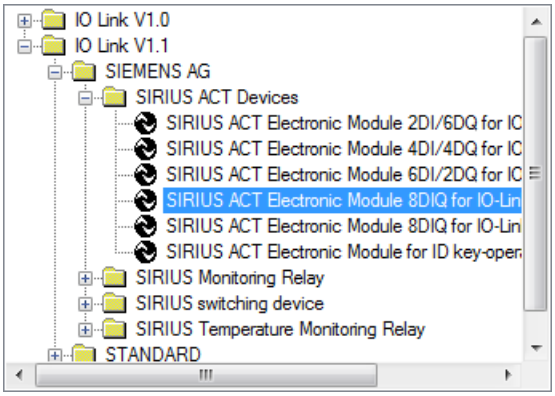
1. Right-click in the device view of the ET 200AL on the CM 4xIO-Link and select "Start device tool...".

   Figure 2-4



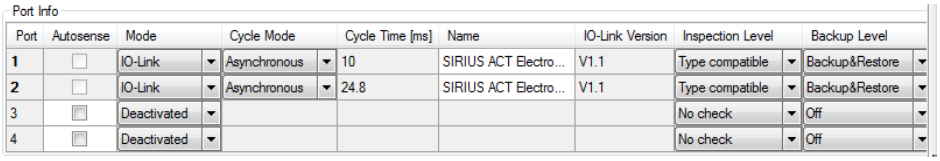
2. Confirm the dialog with “Start”.
3. If necessary, select the interface with which the PC is connected to the control and confirm with “OK”.
4. Select "SIRIUS ACT electronics module 8DIQ” from the catalog under "IO Link v1.1 > SIEMENS AG > SIRIUS ACT devices" and move it to port 1 in the normal working range.

   Figure 2-5



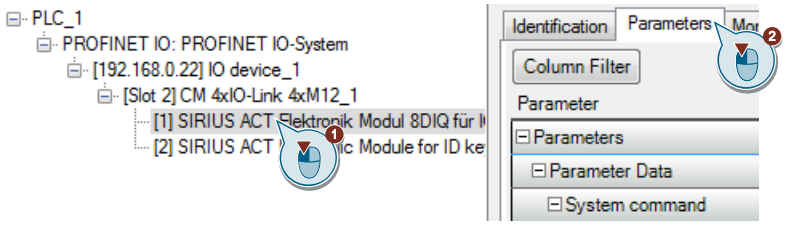
5. Select "SIRIUS ACT electronics module for ID key switches" from the catalog under "IO Link v1.1 > SIEMENS AG > SIRIUS ACT devices" and move it to port 2 in the normal working range.

Figure 2-6



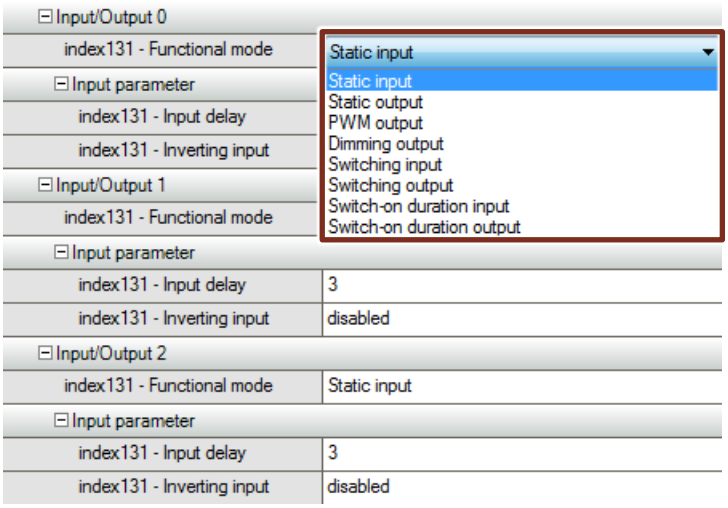
6. Select "SIRIUS ACT electronics module 8DIQ" from the Navigation and open the “Parameters” tab.

Figure 2-7



7. If necessary, adapt the settings of the inputs/outputs. The default setting of 6 inputs and 2 outputs is suitable for this application example.

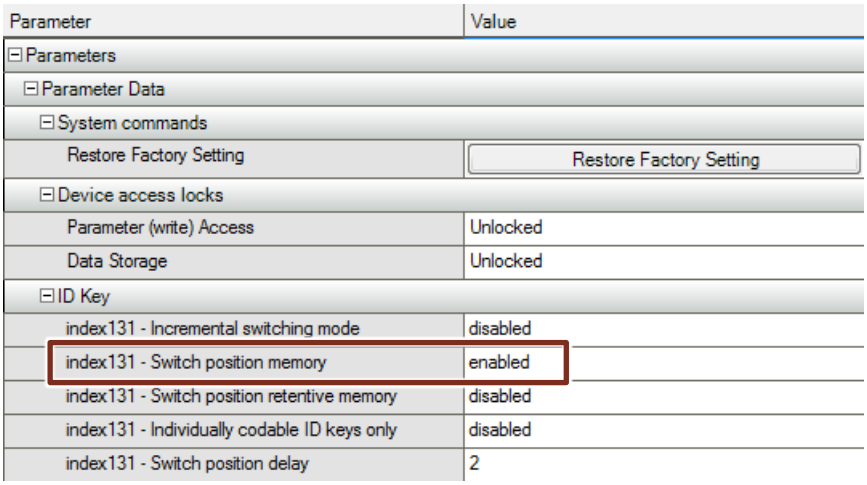
Figure 2-8



8. Select "SIRIUS ACT electronics module for ID key switches" from the Navigation and open the “Parameters” tab.

9. In order for the ID key switch to retain the selected switch position even when the ID key is removed, enable the “Switch position memory” setting.

Figure 2-9



10. Close PCT and confirm the dialog to save the changes in the project.

2.2.3 Downloading the project and the devices

For the following steps, the hardware must be set up and accessible over the network from the engineering system.

Preparation

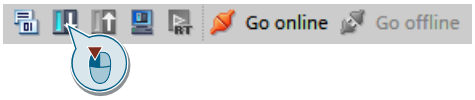
Proceed as follows to download the prepared project:

1. Download the project "109750451_ET200AL_IO-Link_PROJ_V10_de.zip" and unpack the file:
   https://support.industry.siemens.com/cs/ww/en/view/109750451
2. Open the TIA Portal V14 and open the unpacked project.
3. Switch to the project view if necessary.

Downloading the CPU and ET 200AL

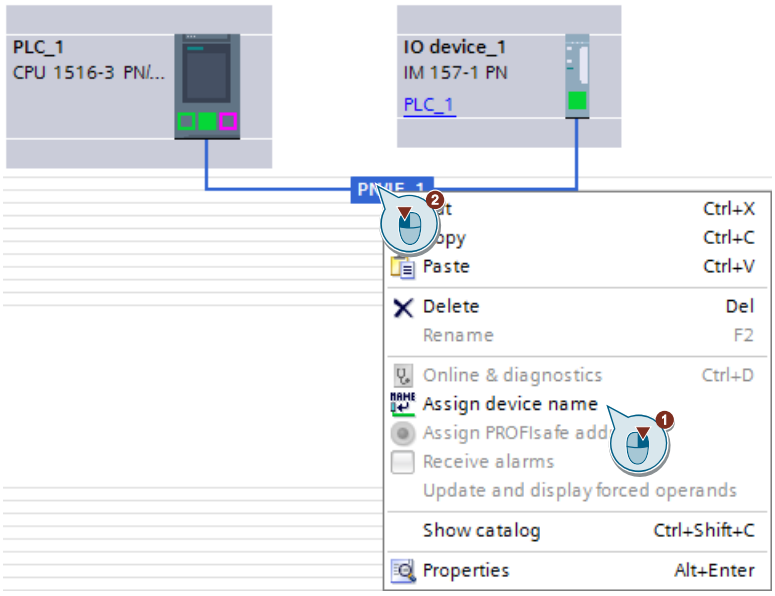
1. Select the CPU from the project navigation and click on “Download to device”.

   Figure 2-10



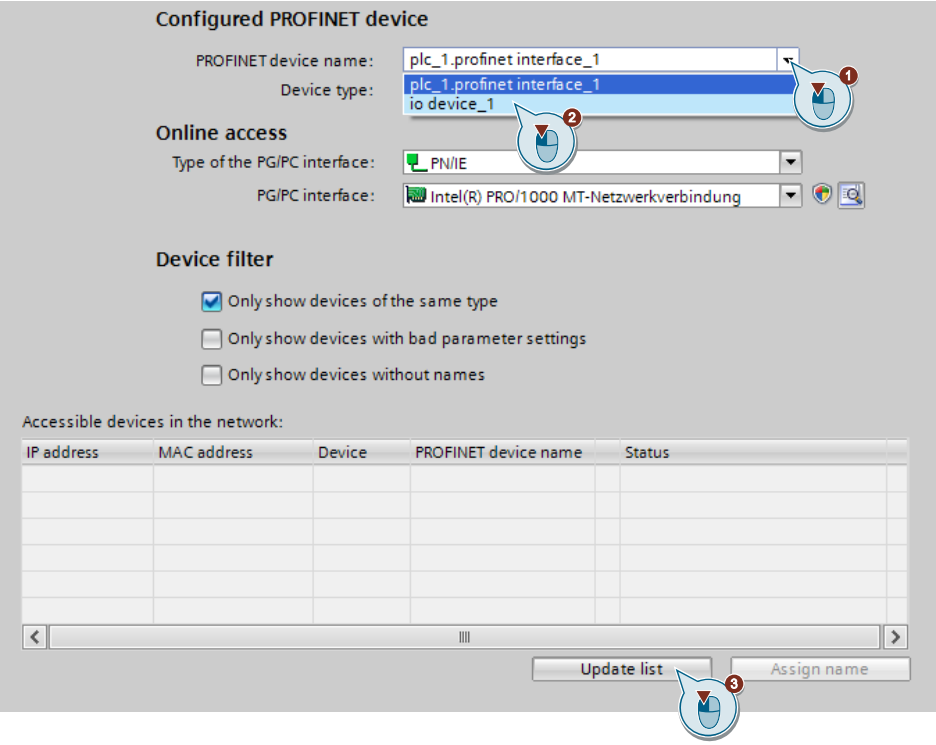
2. Open "Devices & Networks".
3. Right click on the PROFINET strand and select “Assign device name”.

   Figure 2-11



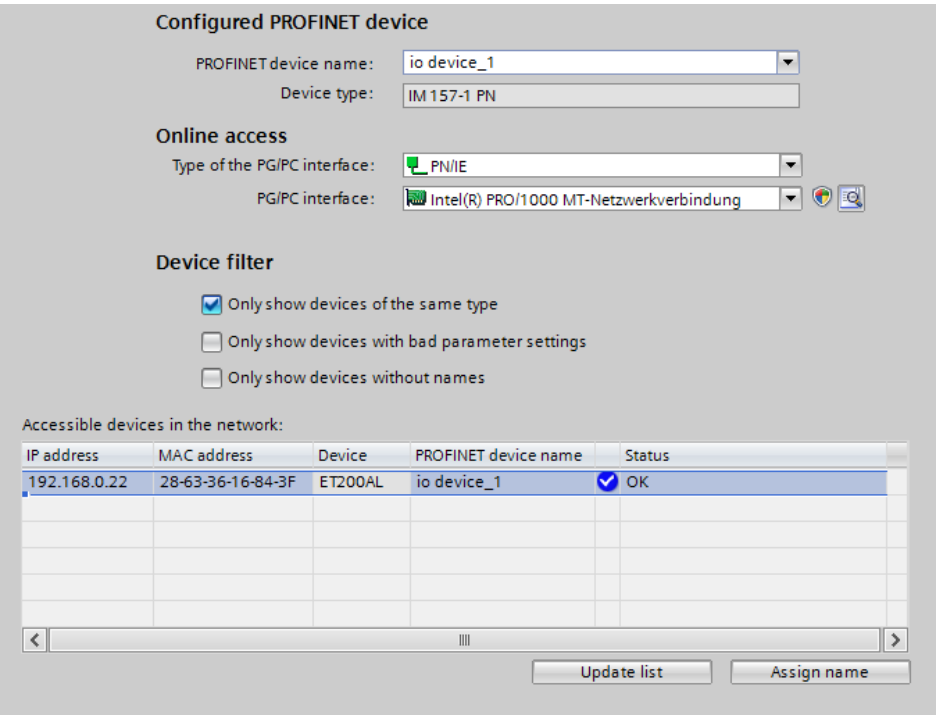
4. Select the IO device from the drop-down list and click on “Update list”.

Figure 2-12



5. Select ET 200AL from the list and click on “Assign name”.

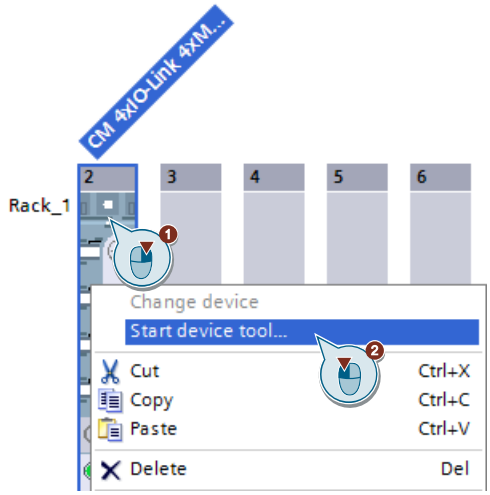
Figure 2-13



Downloading the IO-Link master and devices

1. Open the device view of ET 200AL.
2. Right-click on the CM 4xIO-Link and select “Start device tool...”.

   Figure 2-14



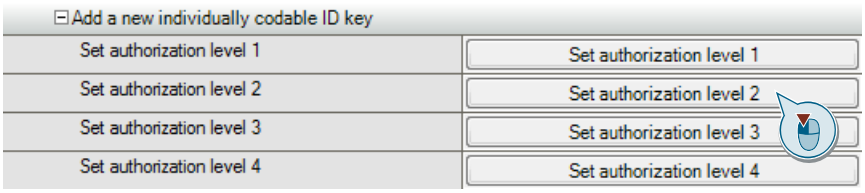
3. Confirm the dialog with “Start”.
4. If necessary, select the interface with which the PC is connected to the control and confirm with “OK”.
5. Choose "CM 4xIO-Link" from the navigation and download the configuration to the IO-Link master and the IO-Link devices.

   Figure 2-15

2.2.4 Assigning a white ID key a permission level

1. In the PCT, select "SIRIUS ACT electronics module for ID key switches" from the Navigation and open the “Parameters” tab.
2. Insert a white ID key into the ID key switch.
3. Click the pushbutton for the desired permission level.

   Figure 2-16



4. Repeat steps 2 and 3 for each ID key.

5. To see the stored ID key and assigned permission levels, select the stored area from the drop-down list and go online.

Figure 2-17

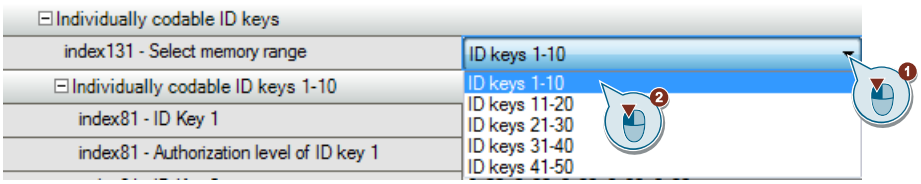


Figure 2-18

Figure 2-19

Individually codable ID keys	
index131 - Select memory range	ID keys 1-10
Individually codable ID keys 1-10	
index81 - ID Key 1	0x1B, 0xAF, 0xBB, 0x17, 0x04
index81 - Authorization level ...	2
index81 - ID Key 2	0x00, 0x00, 0x00, 0x00, 0x00
index81 - Authorization level ...	0
index81 - ID Key 3	0x00, 0x00, 0x00, 0x00, 0x00
index81 - Authorization level ...	0
index81 - ID Key 4	0x00, 0x00, 0x00, 0x00, 0x00
index81 - Authorization level ...	0
index81 - ID Key 5	0x00, 0x00, 0x00, 0x00, 0x00
index81 - Authorization level ...	0
index81 - ID Key 6	0x00, 0x00, 0x00, 0x00, 0x00
index81 - Authorization level ...	0

2.3 Operation

Selecting the operating mode

Depending on the permission level of the inserted ID key, you can address the network with one of four modes of operation (in this example, only positions 1 and 2 are to be used). Proceed as follows:

1. Insert the respective ID key into the ID key switch.
2. Turn the switch to the right until the desired setting flashes green. If the LED is illuminated continuously, the level is selected.
3. Remove the ID key. The selected position of the switch remains set.

Note You can only change the mode of operation with an ID key, the permission level of which matches the currently selected mode of operation.

Starting and stopping the machine

You can only start the machine with an ID key, the permission level of which matches the currently selected mode of operation. You can stop the machine at any time without an ID key. Proceed as follows:

1. Insert an ID key in the ID key switch, the permission level of which corresponds to the currently selected mode of operation.
2. To start the machine, use the start button.
3. Remove the ID key.
4. To stop the machine, use the stop button.

3 Additional information

3.1 IO-Link basics

Definition

IO-Link is an innovative and point-to-point communication interface specified in IEC 61131-9 for the sensor/actuator domain.

IO-Link comprises the following system components:

- IO-Link master
- IO-Link device, e.g.
  - Sensors/actuators
  - RFID reader
  - I/O modules
  - Valves
- Unshielded 3-conductor standard cable
- Use of an engineering tool for the configuration and parameterization of IO-Links.

Connection technology IP65/67

For the connection technology in IP65/67, M12 connectors, among others, have been defined; sensors should have a 4-pin connector and actuators should have a 5-pin connector. IO-Link master has, as the basics, a 5-pin M12 socket.

The connector assignment is specified as follows in accordance with IEC 60974-5-2:

- Pin 1: 24 V
- Pin 3: 0 V
- Pin 4: Switching and communication line (C/Q)

Via these 3 pins, in addition to the IO-Link communication, there is also an energy supply for devices with a maximum 200 mA.

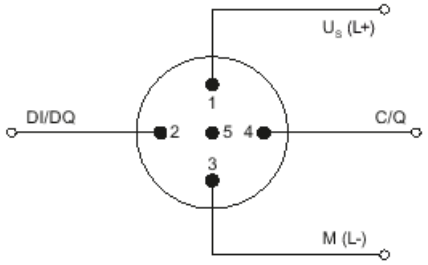
Port types IP65/67

The specification for IO-Link master shows there are two types of ports:

- Port Class A (type A)

  With this type, the functions of pins 2 and 5 are not given. The manufacturer defines these functions. Generally, pin 2 is used with an additional digital channel.

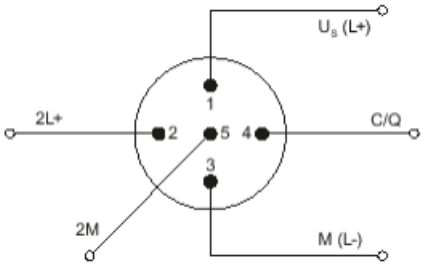
Figure 3-1



- Port Class B (type B)

  This type offers an additional supply voltage and is suitable for the connection of devices that have an increased power requirement (e.g. valve clusters). Thereby, an additional (electrically isolated) supply voltage is provided via pins 2 and 5. A 5-wire standard cable is required to use this additional supply voltage.

  Figure 3-2



Connecting cable

The connection of the devices with the master is realized through a maximum length of 20 m of unshielded 3-wire standard cables. Standard cables can be used for the wiring of sensors. Shielding or compliance with specific guidelines for the laying of cables is not necessary.

IODD Device Description

For each device, an electronic device description is available in the form of the IODD file (IO device description). The IODD holds a wealth of information for system integration:

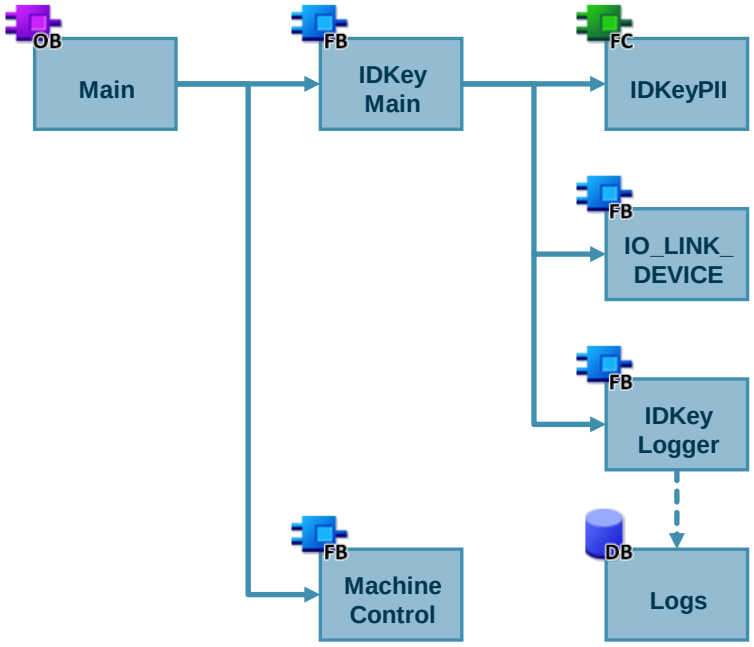
- Communications properties
- Device parameters with value range and default value
- Identification, process and diagnostics data
- Device data
- Text Description
- Image of the device
- Logo of the manufacturer

You can find IODD files in the IODDfinder of the IO-Link Consortium:

http://ioddfinder.io-link.com

3.2 Specific functionality

Figure 3-3: Program structure



3.2.1 Reading the IO-Link electronic module

The address range of the IO-Link electronic module is structured as follows:

Table 3-1: Process image input

BYTE	Bits	Meaning
x + 0	0	1: Ready
	1	1: Group error
	2 – 7	Reserved
x + 1	0 – 7	DI.0 – DI.7

Table 3-2: Process image output

BYTE	Bits	Meaning
x + 0	0 – 7	DQ.0 – DQ.7

3.2.2 Reading the IO-Link electronic module for ID key switch

Process image input

The process image of the input contains the most important status information in the electronic module for the ID key switch.

Table 3-3: Process image input

BYTE	Bits	Meaning
x + 0	0	1: Ready
	1	1: Group error
	2 – 7	Reserved
x + 1	0	1: ID key detected
	1 – 3	Permission level
	4 – 6	Switch position

The process image of the inputs is written in the "IDKeyPII" function with slice access on a PLC data type.

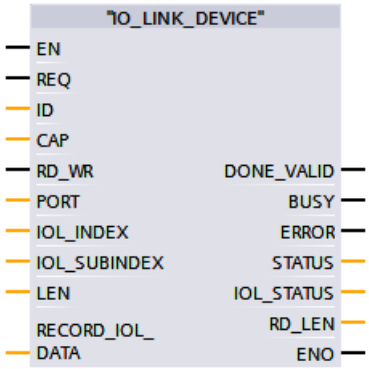
ID output

In addition to the process image of the inputs, the ID key switch provides additional information as data records that can be output acyclically.

To read the data sets, use FB "IDKeyMain" from FB 'IO_LINK_DEVICE", which you can download separately from Industry Online Support:

https://support.industry.siemens.com/cs/ww/en/view/82981502

Figure 3-4: FB "IO_LINK_DEVICE"



Data set 94 contains the ID of the inserted ID key. The record is requested from the electronics module with a positive edge at the “REQ” input. The trigger used is the “ID key detected” signal from the process image of the inputs.

The FB issues the data set to the “RECORD_IOL_DATA” parameter in the form of a byte array. The ID is stored in bytes 16 to 20, and is converted into a string from FB "IDKeyMain".

3.2.3 Logging the IDs

After the FB "IO_LINK_DEVICE" has successfully output the ID, it will be logged with a timestamp. The IDs are stored in a ring buffer. When the ring buffer is full, the oldest entry is overwritten.

The ring buffer is implemented in the FB "IDKeyLogger".

20 IDs are stored in the provided TIA Portal project. If you require a larger ring buffer, adjust the size of the array in DB "Logs".

Figure 3-5: DB "Logs"

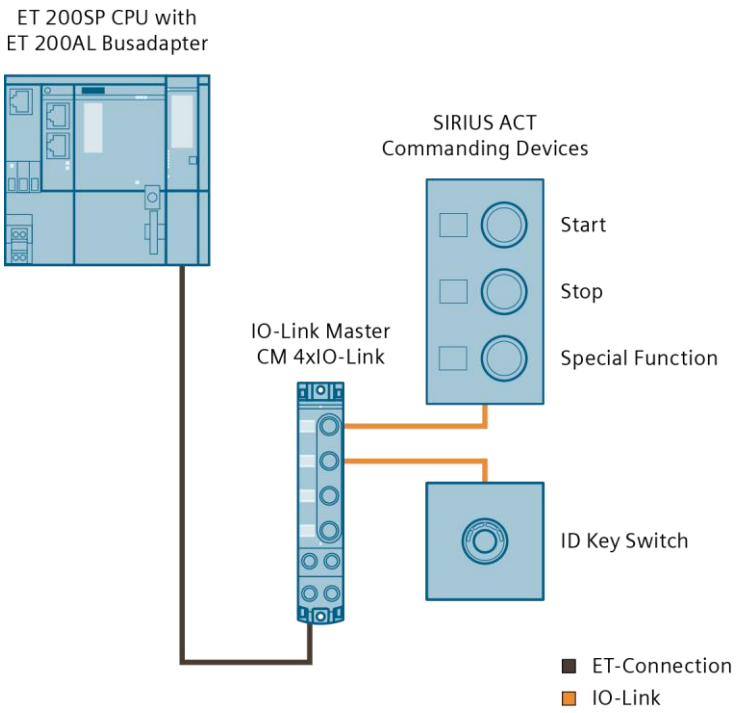
Logs

	Name	Data type	Start value	Monitor value
1	Static			
2	logs	Array[0..19] of "typ...		
3	logs[0]	"typeLog"		
4	dateTime	DTL	DTL#1970-01-01-0	DTL#2017-10-10-14:07:20.0...
5	id	String	''	'62 81 F3 18 04'
6	logs[1]	"typeLog"		
7	dateTime	DTL	DTL#1970-01-01-0	DTL#2017-10-10-13:21:06.0...
8	id	String	''	'1B AF BB 17 04'
9	logs[2]	"typeLog"		
10	dateTime	DTL	DTL#1970-01-01-0	DTL#2017-10-10-13:17:06.0...
11	id	String	''	'1B AF BB 17 04'
12	logs[3]	"typeLog"		
13	dateTime	DTL	DTL#1970-01-01-0	DTL#2017-10-10-11:47:06.0...
14	id	String	''	'62 81 F3 18 04'
15	logs[4]	"typeLog"		
16	logs[5]	"typeLog"		
17	logs[6]	"typeLog"		
18	logs[7]	"typeLog"		

3.3 Alternative solutions

A possible alternative is to use an ET 200SP CPU with ET 200AL bus adapter, to which you can directly connect the IO-Link master CM 4xIO-Link.

Figure 3-6: Alternative solution using ET 200SP CPU



Note Take note that the distance between the bus adapter and the IO-Link master must not exceed a maximum 15 m since this corresponds to the maximal possible bus line length for the ET-connection.

4 Appendix

4.1 Service and Support

Industry Online Support

Do you have any questions or need assistance?

Siemens Industry Online Support offers round the clock access to our entire service and support know-how and portfolio.

The Industry Online Support is the central address for information about our products, solutions and services.

Product information, manuals, downloads, FAQs, application examples and videos – all information is accessible with just a few mouse clicks:
https://support.industry.siemens.com

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Industry Online Support app

You will receive optimum support wherever you are with the "Siemens Industry Online Support" app. The app is available for Apple iOS, Android and Windows Phone:
https://support.industry.siemens.com/cs/ww/en/sc/2067

4.2 Links and literature

Table 4-1: Links and literature

No.	Topic
\1\	Siemens Industry Online Support https://support.industry.siemens.com
\2\	Link to the entry page of the application example https://support.industry.siemens.com/cs/ww/en/view/109750451
\3\	System Manual - SIRIUS ACT 3SU1 Pushbuttons and Signaling Devices https://support.industry.siemens.com/cs/ww/en/view/107542462
\4\	Acyclic Read and Write with the IO-Link Library https://support.industry.siemens.com/cs/ww/en/view/82981502
\5\	PCT (Port Configuration Tool) https://support.industry.siemens.com/cs/ww/en/view/32469496
\6\	IODDfinder http://ioddfinder.io-link.com

4.3 Change documentation

Table 4-2: Change documentation

Version	Date	Modifications
V1.0	12/2017	First version