3 Product Description

The safety-related **F1 DI 16 01** remote I/O is a compact system in a metal enclosure with 16 digital inputs and 4 pulsed outputs.

The remote I/O is available in two model variants for SILworX and two model variants for ELOP II Factory. All variants are described in this manual.

The remote I/O serves to extend the I/O level of HIMax and HIMatrix controllers, and is connected to them via safe**ethernet**. The remote I/O itself is not able to run a user program.

The HIMatrix remote I/Os are not multi-master capable.

The remote I/O is suitable for mounting in Ex-zone 2, see Chapter 4.1.3.

The device has been certified by the TÜV for safety-related applications up to SIL 3 (IEC 61508, IEC 61511 and IEC 62061), Cat. 4 (EN 954-1) and PL e (EN ISO 13849-1). Further safety standards, application standards and test standards are specified in the certificate available on the HIMA website.

3.1 Safety Function

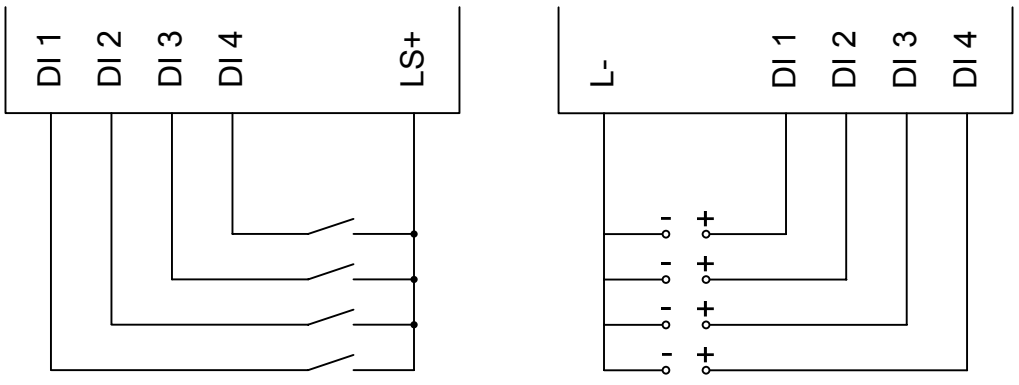
The remote I/O is equipped with safety-related inputs. The input values on the inputs are safely transmitted to the connected controller via safe**ethernet**.

3.1.1 Safety-Related Digital Inputs

The remote I/O is equipped with 16 digital inputs. The state (HIGH, LOW) of each input is signaled by an individual LED.

Mechanical contacts without own power supply or signal power source can be connected to the inputs. Potential-free mechanical contacts without own power supply are fed via an internal short-circuit-proof 24 V power source (LS+). Each 24 V power source supplies a group of 4 mechanical contacts. Figure 1 shows how the connection is performed.

With signal voltage sources, the corresponding ground must be connected to the input (L-), see Figure 1.



Connection of potential-free mechanical contacts

Connection of signal power sources

Figure 1: Connections to Safety-Related Digital Inputs

For the external wiring and the connection of sensors, apply the de-energized-to-trip principle. Thus, if a fault occurs, the input signals adopt a de-energized, safe state (low level).

An external wire is not monitored, however, an open-circuit is considered as safe low level.

3.1.1.1 Reaction in the Event of a Fault

If the device detects a fault on a digital input, the user program processes a low level in accordance with the de-energized to trip principle.

The device activates the *FAULT* LED.

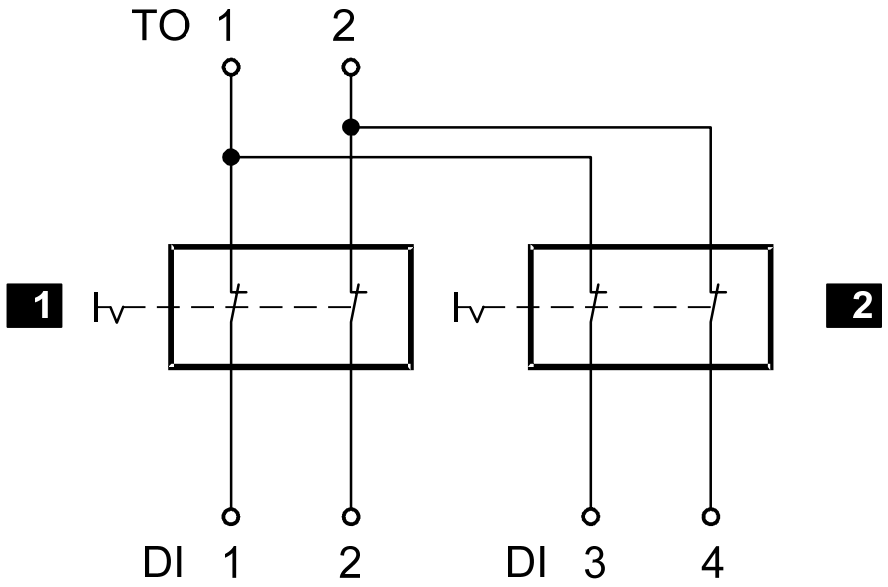
In addition to the channel signal value, the user program must also consider the corresponding error code.

The error code allows the user to configure additional fault reactions in the user program.

3.1.2 Line Control

Line control is a monitoring function for detecting short-circuits or open-circuits and can be configured for the remote I/O, e.g., on EMERGENCY STOP inputs complying with Cat. 4 in accordance with EN 954-1.

To this end, connect the pulsed outputs TO 1...TO 2 of the system to the digital inputs (DI) of the same system as follows:



1 EMERGENCY STOP 1
2 EMERGENCY STOP 2

EMERGENCY STOP devices in accordance with EN 60947-5-1 and EN 60947-5-5

Figure 2: Line Control

The remote I/O pulses the pulsed outputs (TO) to detect the line short-circuits and open-circuits to the digital inputs (DI). To do so, configure the *Value [BOOL]* -> system variable in SILworX and the *DO[0x].Value* system signal in ELOP II Factory. The variables for the pulsed outputs must begin with channel 1 and reside in direct sequence, one after the other.

If the following faults occur, the *FAULT* LED located on the front plate of the controller blinks, the inputs are set to low level and an (evaluable) error code is created:

- Cross-circuit between two parallel lines,
- Improper connections of two lines (e.g., TO 2 to DI 3),
- Earth fault of a line (with earthed ground only),
- Open-circuit or open contacts, i.e., including when one of the two EMERGENCY STOP switches mentioned above has been engaged, the *FAULT* LED blinks and the error code is created.

For more information on how to configure line control in the user program, refer to the HIMatrix Engineering Manual HI 800 101 E.

3.2 Equipment, Scope of Delivery

The available variants and their part numbers are listed below:

Designation	Description	Part no.
F1 DI 16 01	Remote I/O with 16 digital inputs, operating temperature 0...+60 °C, for ELOP II Factory programming tool.	98 2200405
F1 DI 16 011 (-20 °C)	Remote I/O with 16 digital inputs, operating temperature -20...+60 °C, for ELOP II Factory programming tool.	98 2200456
F1 DI 16 01 SILworX	Remote I/O with 16 digital inputs, operating temperature 0...+60 °C, for SILworX programming tool.	98 2200479
F1 DI 16 011 SILworX (-20 °C)	Remote I/O with 16 digital inputs, operating temperature -20...+60 °C, for SILworX programming tool.	98 2200488

Table 4: Part Numbers

3.2.1 IP Address and System ID (SRS)

A transparent label is delivered with the device to allow one to note the IP address and the system ID (SRS for system rack slot) after a change.

IP___.___.___.___SRS____.__.__

Default value for IP address:	192.168.0.99
Default value for SRS:	60000.200.0 (SILworX)
	60000.0.0 (ELOP II Factory)

The label must not be affixed such that the air vents on the enclosure are covered.

Refer to the First Steps manual of the programming tool for more information on how to modify the IP address and the system ID.

3.4.1 LED Indicators

The light-emitting diodes (LEDs) indicate the operating state of the remote I/O. The LEDs are classified as follows:

- Operating voltage LED
- System LEDs
- Communication LEDs
- I/O LEDs

3.4.1.1 Operating Voltage LED

LED	Color	Status	Description
24 VDC	Green	On	24 VDC operating voltage present
		Off	No operating voltage

Table 5: Operating Voltage LED

3.4.1.2 System LEDs

While the system is being booted, all LEDs are lit simultaneously.

LED	Color	Status	Description
RUN	Green	On	Device in RUN, normal operation A loaded user program is being executed (not with remote I/Os).
		Blinking	Device in STOP A new operating system is being loaded.
		Off	The device is not in the RUN state.
ERROR	Red	On	The device is in the ERROR STOP state. Internal fault detected by self-tests e.g., hardware fault, software error or cycle time overrun. The processor system can only be restarted with a command from the PADT (reboot).
		Blinking	If ERROR blinks and all others LEDs are lit simultaneously, the boot loader has detected an operating system fault in the flash memory and waits for a new operating system to be loaded.
		Off	No faults detected.
PROG	Yellow	On	A new configuration is being loaded into the device.
		Blinking	The device switches from INIT to STOP A new operating system is being loaded into the flash ROM.
		Off	No configuration or operating system is being loaded.
FORCE	Yellow	On	The device is in RUN, forcing was activated.
		Blinking	The device is in STOP, forcing has been prepared and is activated when the device is started.
		Off	Forcing is not activated. The FORCE LED of a remote I/O is not functioning. The FORCE LED of the associated controller serves to signal the forcing of a remote I/O.
FAULT	Yellow	On	The loaded configuration is defective. The new operating system is corrupted (after OS download).
		Blinking	Fault while loading a new operating system One or multiple I/O faults occurred.
		Off	None of the described faults occurred.
OSL	Yellow	Blinking	Operating system emergency loader active.
		Off	Operating system emergency loader inactive.
BL	Yellow	Blinking	OS and OLS binary defective or INIT_FAIL hardware fault.
		Off	Boot loader inactive

Table 6: System LEDs

3.4.1.3 Communication LEDs

All RJ-45 connectors are provided with a green and a yellow LED. The LEDs signal the following states:

LED	Status	Description
Green	On	Full duplex operation
	Blinking	Collision
	Off	Half duplex operation, no collision
Yellow	On	Connection available
	Blinking	Interface activity
	Off	No connection available

Table 7: Ethernet Indicators

3.4.1.4 I/O LEDs

LED	Color	Status	Description
DI 1...16	Yellow	On	The related channel is active (energized).
		Off	The related channel is inactive (de-energized).
TO 1...4	Yellow	On	Pulsed output activated.
		Off	Pulsed output deactivated.

Table 8: I/O LEDs

3.5 Product Data

General	
Response time	≥ 20 ms
Ethernet interfaces	2 x RJ-45, 10/100BaseT (with 100 Mbit/s) with integrated switch
Operating voltage	24 VDC, -15 %...+20 %, w_{ss} ≤ 15 %, from a power supply unit with safe insulation in accordance with IEC 61131-2.
Current input	max. 0.8 A
Fuse (external)	10 A time-lag
Operating temperature	0 °C...+60 °C
Storage temperature	-40 °C...+85 °C
Type of protection	IP20
Max. dimensions (without plug)	Width: 152 mm (with enclosure screws) Height: 114 mm (with fixing bolt) Depth: 66 mm (with earthing screw)
Weight	0.7 kg

Table 11: Product Data

Digital inputs	
Number of inputs	16 (non-galvanically isolated)
High level: voltage current input	15...30 VDC ≥ 2 mA at 15 V
Low level: voltage current input	max. 5 VDC max. 1.5 mA (1 mA at 5 V)
Switching point	typ. 7.5 V
Switching time	250 µs
Supply	4 x 19.2 V / 40 mA (at 24 V), short-circuit-proof

Table 12: Specifications for Digital Inputs

Pulsed outputs	
Number of outputs	4 (non-galvanically isolated)
Output voltage	≥ L+ minus 4 V
Output current	approx. 60 mA
Minimum load	none
Behavior with overload	4 x ≥ 19.2 V, short-circuit current 60 mA at 24 V

Table 13: Specifications for the Pulsed Outputs

3.5.1 Product Data F1 DI 16 011 (-20 °C)

The F1 16 011 (-20 °C) model variant is intended for use at the extended temperature range of -20…+60 °C. The electronic components are coated with a protective lacquer.

HIMatrix F1 DI 16 011	
Operating temperature	-20 °C...+60 °C
Weight	approx. 0.7 kg

Table 14: Product Data of F1 16 011 (-20 °C)

4.1.3 Mounting the F1 DI 16 01 in Zone 2

(EC Directive 94/9/EC, ATEX)

The remote I/O is suitable for mounting in zone 2. Refer to the corresponding declaration of conformity available on the HIMA website.

When mounting the device, observe the special conditions specified in the following section.

Special Conditions X

1. Mount the remote I/O in an enclosure that meets the EN 60079-15 requirements and achieves a type of protection of at least IP54, in accordance with EN 60529. Provide the device with the following label:

   Work is only permitted in the de-energized state

   Exception:
   If a potentially explosive atmosphere has been precluded, work can be also performed when the device is under voltage.
2. The enclosure in use must be able to safely dissipate the generated heat. Depending on the output load and supply voltage, the HIMatrix F1 DI 16 01 has a power dissipation ranging between 7 W and 17 W.
3. Protect the HIMatrix F1 DI 16 01 with a 10 A time-lag fuse.
   The F1 DI 16 01 must be supplied with 24 VDC from a power supply unit with safe isolation. Use power supply units of type PELV or SELV only.
4. Applicable standards:

VDE 0170/0171 Part 16,	DIN EN 60079-15: 2004-5
VDE 0165 Part 1,	DIN EN 60079-14: 1998-08

Pay particular attention to the following sections

DIN EN 60079-15:	
Chapter 5	Design
Chapter 6	Terminals and cabling
Chapter 7	Air and creeping distances
Chapter 14	Connectors
DIN EN 60079-14:	
Chapter 5.2.3	Equipment for use in zone 2
Chapter 9.3	Cabling for zones 1 and 2
Chapter 12.2	Equipment for zones 1 and 2

The remote I/O is additionally equipped with the represented label:

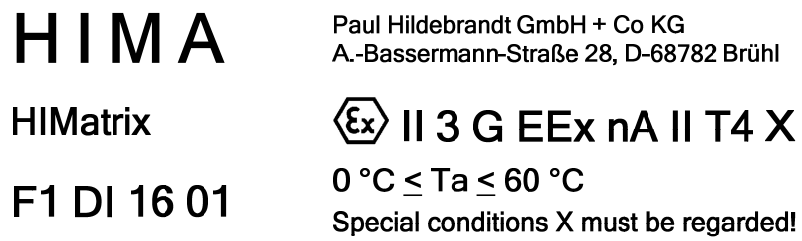


Figure 7: Label for Ex Conditions

4.3.2.1 **Module** Tab

The **Module** tab contains the following system parameters.

<table>
<tr><th>System parameter</th><th>Data type</th><th>R/W</th><th>Description</th></tr>
<tr><td>DI No. of Pulse Channel</td><td>USINT</td><td>W</td><td>Number of pulsed outputs (supply outputs)
<table><tr><th>Coding</th><th>Description</th></tr><tr><td>0</td><td>No pulsed output planned for LS/LB[1)] detection</td></tr><tr><td>1</td><td>Pulsed output 1 planned for LS/LB[1)] detection</td></tr><tr><td>2</td><td>Pulsed outputs 1 and 2 planned for LS/LB[1)] detection</td></tr><tr><td>4</td><td>Pulsed outputs 1...4 planned for LS/LB[1)] detection</td></tr></table>Pulsed outputs must not be used as safety-related outputs!</td></tr>
<tr><td>DI Pulse Slot</td><td>UDINT</td><td>W</td><td>Slot of the line control module.
(LS/LB[1)] detection), set the value to 3</td></tr>
<tr><td>DI Pulse Delay (10E-6 s)</td><td>UINT</td><td>W</td><td>Waiting time for line control (detection of short-circuits or cross-circuits)</td></tr>
<tr><td>DI.Error Code</td><td>WORD</td><td>R</td><td>Error codes for all digital inputs
<table><tr><th>Coding</th><th>Description</th></tr><tr><td>0x0001</td><td>Fault within the digital inputs</td></tr><tr><td>0x0002</td><td>FTT test of test pattern faulty</td></tr></table></td></tr>
<tr><td>DO.Error Code</td><td>WORD</td><td>R</td><td>Error code of the TO unit as a whole
<table><tr><th>Coding</th><th>Description</th></tr><tr><td>0x0001</td><td>Error of the TO unit as a whole:</td></tr></table></td></tr>
<tr><td>Module Error Code</td><td>WORD</td><td>R</td><td>Module error code
<table><tr><th>Coding</th><th>Description</th></tr><tr><td>0x0000</td><td>I/O processing, if required with errors see other error codes</td></tr><tr><td>0x0001</td><td>No I/O processing (remote I/O not in RUN)</td></tr><tr><td>0x0002</td><td>No I/O processing during the booting test</td></tr><tr><td>0x0004</td><td>Manufacturer interface operating</td></tr><tr><td>0x0010</td><td>No I/O processing: incorrect configuration</td></tr><tr><td>0x0020</td><td>No I/O processing: fault rate exceeded</td></tr><tr><td>0x0040/ 0x0080</td><td>No I/O processing: configured module not plugged in</td></tr></table></td></tr>
<tr><td>Module SRS</td><td>[UDINT]</td><td>R</td><td>Slot number (System Rack Slot)</td></tr>
<tr><td>Module Type</td><td>[UINT]</td><td>R</td><td>Type of module, target value: 0x00A5 [165_{dec}]</td></tr>
<tr><td colspan="4">1) LS/LB (short-circuit/open-circuit)</td></tr>
</table>

Table 18: SILworX - System Parameters for Digital Inputs, **Module** Tab

4.3.2.2 **DI 16: DO-Channels** Tab

The **DI 16: DO-Channels** tab contains the following system parameters.

System parameter	Data type	R/W	Description
Channel no.	---	R	Channel number, defined by default
-> Error Code [BYTE]	BYTE	R	Error code of the individual digital pulsed output channels: Coding: 0x01 — Description: Fault in the digital output module
Value [BOOL] ->	BOOL	W	Output value for DO channels: 1 = output energized 0 = output de-energized **Pulsed outputs must not be used as safety-related outputs!**

Table 19: SILworX - System Parameters for Pulsed Outputs, **DI 16: DO-Channels** tab

4.3.2.3 **DI 16: DI-Channels** Tab

The **DI 16: Channels** tab contains the following system parameters.

System parameter	Data type	R/W	Description
Channel no.	---	R	Channel number, defined by default
-> Error Code [BYTE]	BYTE	R	Error codes for the digital input channels 0x01: Fault in the digital input module 0x10: Short-circuit of the channel 0x80: Intermittence between pulsed output TO and digital input DI, e.g., ▪ Open-circuit ▪ Open switch ▪ L+ low voltage
-> Value [BOOL]	BOOL	R	Iput values for the digital input channels 0 = input de-energized 1 = input energized
Pulse Channel [USINT] ->	USINT	W	Source channel for pulsed supply 0: Input channel 1: Pulse of the 1st TO channel 2: Pulse of the 2nd TO channel 3: Pulse of the 3rd TO channel 4: Pulse of the 4th TO channel

Table 20: SILworX - System Parameters for Digital Inputs, **DI 16: DI-Channels** tab