MANUFACTURER DOCUMENT PACKAGE

Manufacturer's Manual

Reference package for procurement and maintenance review

HIMA

HIMatrix F1 DI 1601 SILworX

SAFETY DIGITAL INPUT MODULE

Used with the applicable HIMatrix F1 DI 16 01 configuration.

REFERENCE PACKAGE

OFFICIAL DOCUMENT

Selected official manufacturer pages follow this cover.

Source: HIMA F1 DI 16 01 Manual HI 800 153 E Rev. 1.01; safety, connection and product data sections.

1.3 Formatting Conventions

To ensure improved readability and comprehensibility, the following fonts are used in this document:

Bold:	To highlight important parts Names of buttons, menu functions and tabs that can be clicked and used in the programming tool.
Italics:	For parameters and system variables
`Courier`	Literal user inputs
RUN	Operating state are designated by capitals
Chapter 1.2.3	Cross references are hyperlinks even though they are not particularly marked. When the cursor hovers over a hyperlink, it changes its shape. Click the hyperlink to jump to the corresponding position.

Safety notes and operating tips are particularly marked.

1.3.1 Safety Notes

The safety notes are represented as described below.
These notes must absolutely be observed to reduce the risk to a minimum. The content is structured as follows:

- Signal word: danger, warning, caution, notice
- Type and source of danger
- Consequences arising from the danger
- Danger prevention

⚠ SIGNAL WORD



Type and source of danger!
Consequences arising from the danger
Danger prevention

The signal words have the following meanings:

- Danger indicates hazardous situation which, if not avoided, will result in death or serious injury.
- Warning indicates hazardous situation which, if not avoided, could result in death or serious injury.
- Warning indicates hazardous situation which, if not avoided, could result in minor or modest injury.
- Notice indicates a hazardous situation which, if not avoided, could result in property damage.

NOTE



Type and source of damage!
Damage prevention

1.3.2 Operating Tips

Additional information is structured as presented in the following example:

i The text corresponding to the additional information is located here.

Useful tips and tricks appear as follows:

TIP The tip text is located here.

2 Safety

The following safety information, notes and instructions must be strictly observed. The product may only be used if all guidelines and safety instructions are adhered to.

This product is operated with SELV or PELV. No imminent danger results from the product itself. The use in Ex-Zone is permitted if additional measures are taken.

2.1 Intended Use

HIMatrix components are designed for assembling safety-related controller systems.

When using the components in the HIMatrix system, comply with the following general requirements

2.1.1 Environmental Requirements

Requirement type	Range of values [1]
Protection class	Protection class III in accordance with IEC/EN 61131-2
Ambient temperature	0...+60 °C
Storage temperature	-40...+85 °C
Pollution	Pollution degree II in accordance with IEC/EN 61131-2
Altitude	< 2000 m
Housing	Standard: IP20
Supply voltage	24 VDC
[1] The values specified in the technical data apply and are decisive for devices with extended environmental requirements.	

Table 3: Environmental Requirements

Exposing the HIMax system to environmental conditions other than those specified in this manual can cause the HIMatrix system to malfunction.

2.1.2 ESD Protective Measures

Only personnel with knowledge of ESD protective measures may modify or extend the system or replace devices.

NOTE



Device damage due to electrostatic discharge!

- **When performing the work, make sure that the workspace is free of static, and wear an ESD wrist strap.**
- **If not used, ensure that the device is protected from electrostatic discharge, e.g., by storing it in its packaging.**

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

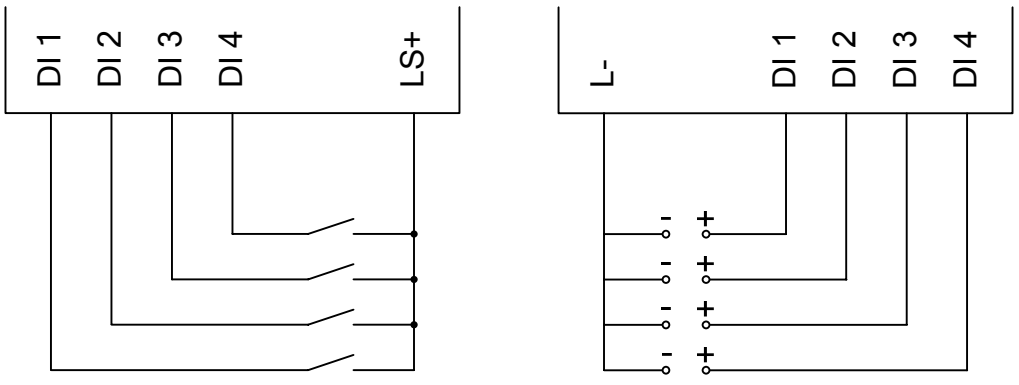
The remote I/O is equipped with safety-related inputs. The input values on the inputs are safely transmitted to the connected controller via safe**ethernet**.

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.

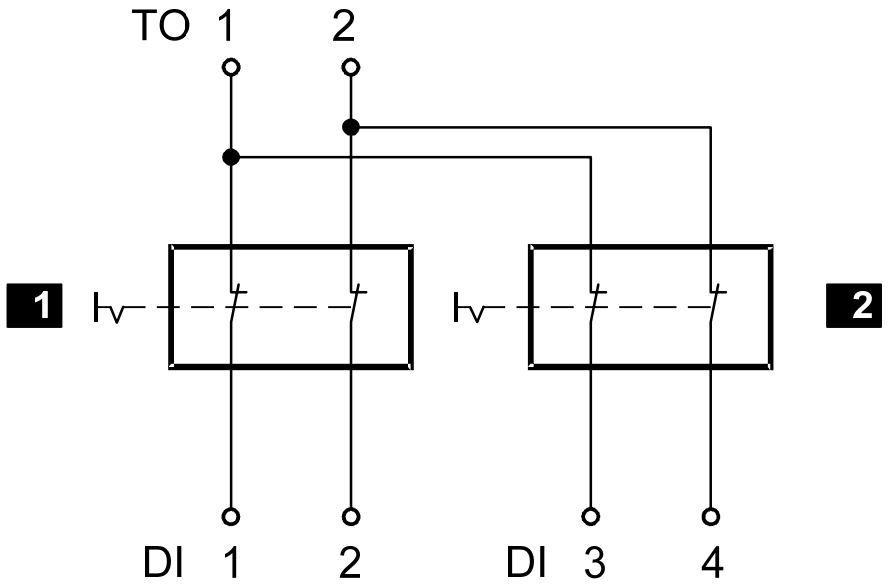
In addition to the channel signal value, the user program must also consider the corresponding error code.

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.

3.4.2 Communication

The remote I/O communicates with the associated controller via safe**ethernet**.

3.4.2.1 Connections for Ethernet Communication

Property	Description
Port	2 x RJ-45
Transfer standard	10/100/Base-T, half and full duplex
Auto negotiation	Yes
Auto crossover	Yes
Connection socket	RJ-45
IP address	Freely configurable[1)]
Subnet mask	Freely configurable[1)]
Supported protocols	▪ Safety-related: safe**ethernet** ▪ Non-safety-related: programming and debugging tool (PADT), SNTP
[1)] The general rules for assigning IP address and subnet masks must be adhered to.	

Table 9: Ethernet Interfaces Properties

The two RJ-45 connectors with integrated LEDs are located on the bottom left-hand side of the enclosure. For more information on the communication LEDs, refer to Chapter 3.4.1.3.

The connection parameters are read based on the MAC address (media access control address) defined during manufacturing.

The MAC address for the remote I/O is specified on a label located above the two RJ-45 connectors (1 and 2).

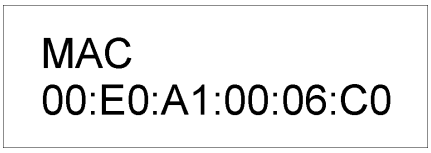


Figure 6: Sample MAC Address Label

The remote I/O is equipped with an integrated switch for safety-related Ethernet communication (safe**ethernet**). For further information on the integrated switch and safe**ethernet**, refer to Chapter *Communication* of the System Manual for Compact Systems HI 800 141 E.

3.4.2.2 Network Ports Used for Ethernet Communication

UDP ports	Usage
8000	Programming and operation with the programming tools
8001	Configuration of the remote I/O using the PES (ELOP II Factory)
8004	Configuration of the remote I/O using the PES (SILworX)
6010	safe**ethernet**
123	SNTP (time synchronization between PES and remote I/O, PES and external devices)

Table 10: Network Ports in Use

3.4.3 Pulsed Outputs

The 4 digital pulsed outputs can be used for Line Control to detect short-circuits and open-circuits on digital inputs, e.g., on an EMERGENCY STOP button complying with Cat. 4 in accordance with EN 954-1.

i Pulsed outputs must not be used as safety-related outputs (e.g., for activating safety-related actuators)!

3.4.4 Reset Key

The remote I/O is equipped with a reset key. The key is only required if the user name or password for administrator access is not known. If only the IP address set for the remote I/O does not match the PADT (PC), the connection can be established with a `Route add` entry on the PC.

The key can be accessed through a small round hole located approximately 5 cm from the upper left-hand side of the enclosure. The key is engaged using a suitable pin made of insulating material to avoid short-circuits within the remote I/O.

The reset is only effective if the remote I/O is rebooted (switched off and on) while the key is simultaneously engaged for at least 20 seconds. Engaging the key during operation has no effect.

Properties and behavior of the remote I/IO after a reboot with engaged reset key:

- Connection parameters (IP address and system ID) are set to the default values.
- All accounts are deactivated except for the *administrator* default account with empty password.

After a new reboot without the reset key engaged, the connection parameters (IP address and system ID) and accounts become effective.

- Those configured by the user.
- Those valid prior to rebooting with the reset key engaged, if no changes were performed.

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 Start-Up

To start up the remote I/O, it must be mounted, connected and configured in the programming tool.

4.1 Installation and Mounting

The remote I/O is mounted on a 35 mm DIN rail such as described in the HIMatrix System Manual for Compact Systems.

4.1.1 Connection of the Digital Inputs

Use the following terminals to connect the digital inputs:

Terminal	Designation	Function (inputs DI)
1	LS+	Sensor supply of the inputs 1...4
2	1	Digital input 1
3	2	Digital input 2
4	3	Digital input 3
5	4	Digital input 4
6	L-	Ground
Terminal	Designation	Function (inputs DI)
7	LS+	Sensor supply of the inputs 5...8
8	5	Digital input 5
9	6	Digital input 6
10	7	Digital input 7
11	8	Digital input 8
12	L-	Ground
Terminal	Designation	Function (inputs DI)
13	LS+	Sensor supply of the inputs 9...12
14	9	Digital input 9
15	10	Digital input 10
16	11	Digital input 11
17	12	Digital input 12
18	L-	Ground
Terminal	Designation	Function (inputs DI)
19	LS+	Sensor supply of the inputs 13...16
20	13	Digital input 13
21	14	Digital input 14
22	15	Digital input 15
23	16	Digital input 16
24	L-	Ground

Table 16: Terminal Assignment for the Digital Inputs

4.1.1.1 Surges on Digital Inputs

Due to the short cycle time of the HIMatrix systems, a surge pulse as described in EN 61000-4-5 can be read in to the digital inputs as a short-term high level.

The following measures ensure proper operation in environments where surges may occur:

1. Install shielded input wires
2. Activate noise blanking: a signal must be present for at least two cycles before it is evaluated.

i Activating noise blanking increases the response time of the HIMatrix system!

i The measures specified above are not necessary if the plant design precludes surges from occurring within the system.

In particular, the design must include protective measures with respect to overvoltage, lightning, earth grounding and plant wiring in accordance with the relevant standards and the instructions specified in the System Manual (HI 800 141 E or HI 800 191 E).

4.1.2 Connection of Digital Pulsed Outputs

Use the following terminals to connect the 4 digital pulsed outputs:

Terminal	Designation	Function (pulsed outputs TO)
25	L-	Ground
26	1	Pulsed output 1
27	2	Pulsed output 2
28	3	Pulsed output 3
29	4	Pulsed output 4
30	L-	Ground

Table 17: Terminal Assignment for the Digital Pulsed Outputs

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:

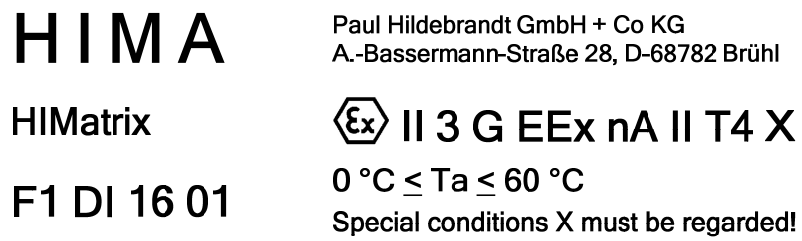


Figure 7: Label for Ex Conditions

4.2 Configuration

The remote I/O can be configured using a programming tool, SILworX or ELOP II Factory. Which programming tool should be used depends on the revision status of the operating system (firmware):

- ELOP II Factory is required for operating system versions prior to 7.
- SILworX is required for operating system version 7 and beyond.

i ELOP II Factory is required to load a new operating system (version 7 and beyond) into a remote I/O with a CPU operating system version prior to 7. SILworX is then required once the loading procedure is completed.

4.3 Configuration with SILworX

In the Hardware Editor, the remote I/Os are represented like a base plate equipped with the following modules:

- Processor module (CPU)
- Input module (DI 16) with Line Control

Double-click the module to open the Detail View with the corresponding tabs. The tabs are used to assign the global variables configured in the user program to the system parameter of the corresponding module.

4.3.1 Parameters and Error Codes for the Inputs and Output

The following tables specify the system parameters that can be read and set for the inputs and outputs, including the corresponding error codes.

In the user program, the error codes can be read using the variables assigned within the logic.

The error codes can also be displayed in SILworX.

4.3.2 Digital Inputs F1 DI 16 01

The following tables present the statuses and parameters for the input module (DI 16) in the same order as given in the Hardware Editor.

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