

Firmware version 2

- IOMod 16DI user manual

IOMod 16DI user manual

1. Introduction

The IOMod 16DI is a compact, standalone digital input controller compatible with **Modbus RTU, IEC 60870-5-101, and IEC 60870-5-103** protocols. It is designed for industrial applications that require digital signaling and robust communication. The IOMod is an ideal solution for process monitoring in remote locations and integrates seamlessly with any SCADA system.

1.1 Features

- 16 digital inputs;
- Pulse counting and ON-time measurement functionality;
- Galvanically isolated inputs for enhanced safety and reliability;
- Configurable using the IOMod utility app for user-friendly setup;
- RS485 communication for robust data exchange;
- LED indicators for input status, data transmission (Rx), and data reception (Tx);
- Compact case with a removable transparent front panel;
- DIN rail mounting for seamless integration into industrial systems.

1.2 Block diagram

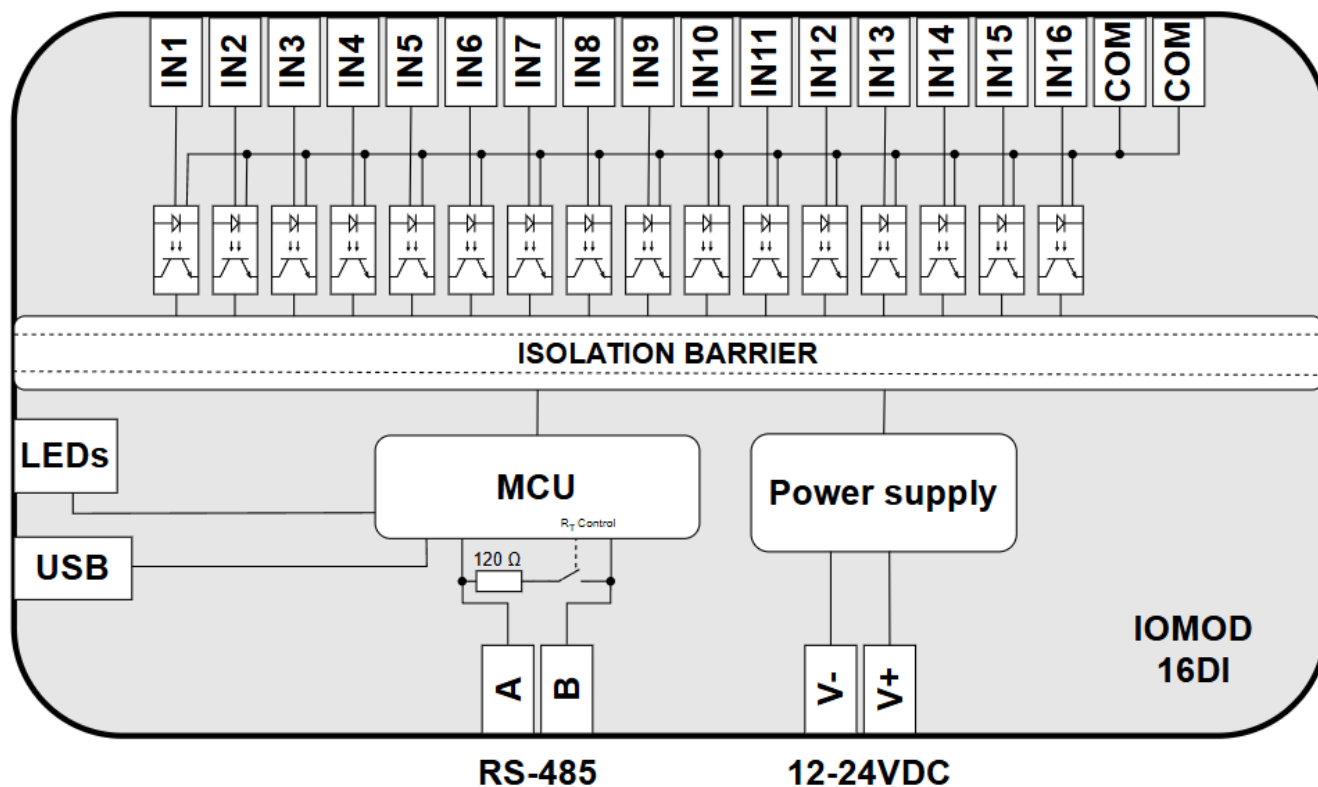


Fig. 1.2 IOMod 16DI internal structure and block diagram

2. Hardware data

2.1 Mechanical drawings

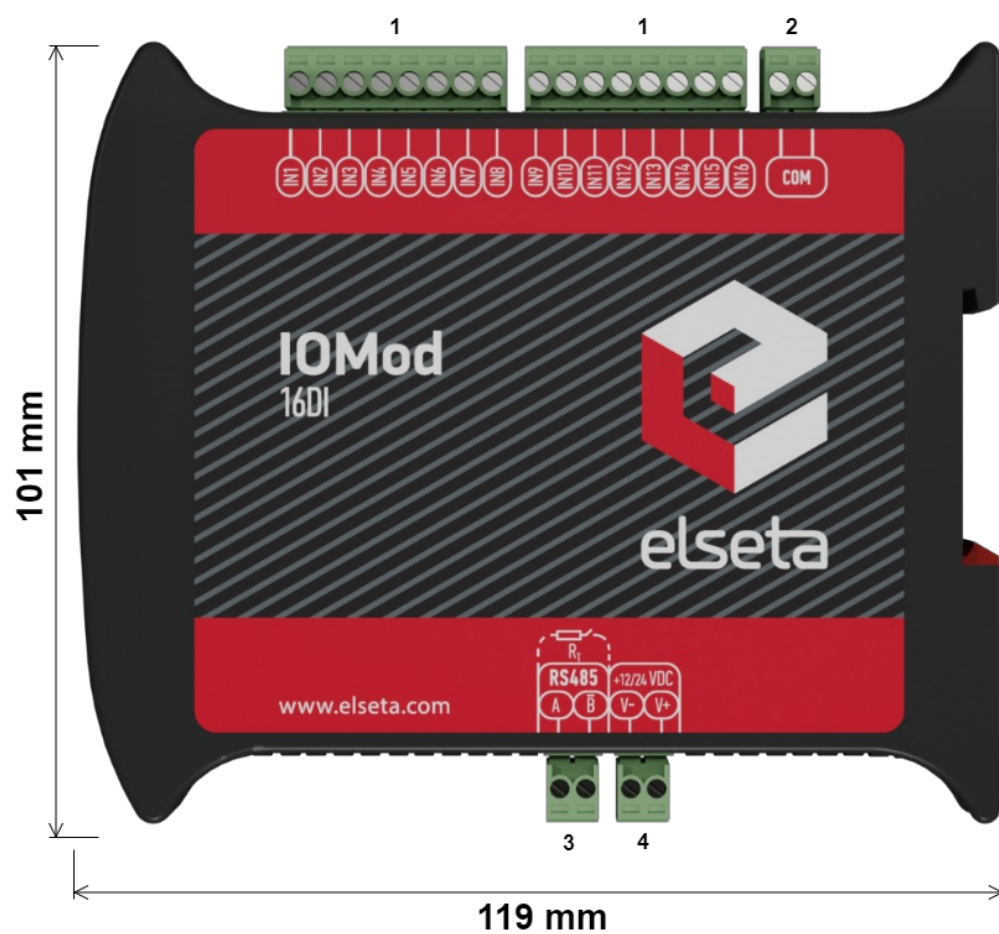


Fig. 2.1.1.1 IOMod 16DI side view with dimensions and terminals description. 1 - Digital inputs; 2 - Common inputs; 3 - RS485 interface; 4 - Power supply input

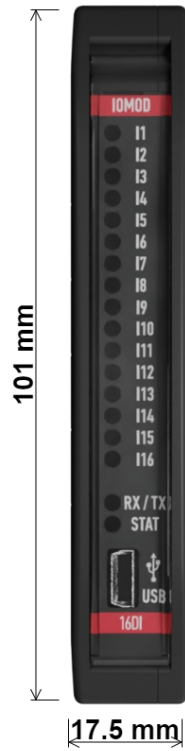


Fig. 2.1.1.2 IOMod 16DI front view with dimensions

2.2 Terminal connections

IOMod 16DI has 22 terminals, which are depicted below:



Fig. 2.2.1 IOMod 16DI terminals diagram

The description of each terminal can be found in the table below:

Table 2.2.1 Terminal Specifications

Terminal number	Terminal name	Description
1	DI1	Digital inputs
2	DI2	
3	DI3	
4	DI4	
5	DI5	
6	DI6	
7	DI7	
8	DI8	
9	DI9	
10	DI10	
11	DI11	

12	DI12	
13	DI13	
14	DI14	
15	DI15	
16	DI16	
17	COM	Common
18	COM	Common
19	A	RS485 input
20	B	RS485 input
21	V-	Power source input
22	V+	Power source input

2.3 Status indication

IOMod 16DI has LEDs (Fig. 2.3.1), which are used to indicate inputs, communication and power statuses.



Fig. 2.3.1 IOMod 16DI LEDs physical location

The description of each IOMod 16DI LED can be found in the table below:

Table 2.3.1 Description of LEDs

Name	LED color	Description
I1- I16	□ (orange)	Indicates input status
RX/TX	□ (green)	Flashing green light indicates active communication via RS485 interface

STAT	(green)	Power source is connected to the power supply input
	(blue)	IOMod 16DI is connected to an external device via USB mini cable

3. Technical information

Table 3.1 Technical specifications

System		
Dimension	101 x 119 x 17.5 mm	
Case	ABS, black	
Working environment	Indoor	
Operating temperature	-40°C ... +85°C	
Recommended operating conditions	5-60°C and 20-80%RH	
Configuration	USB, RS485	
Firmware upgrade	USB, RS485	
Electrical specifications		
Inputs	Nominal input voltage range	4-33VDC (@current 1.3mA - 16mA)
	Isolation	16 X 3kV _(RMS)
Power		
Power Supply	9-33 VDC (full range)	
Current consumption	40 mA @ 12 VDC, 20 mA @ 24 VDC	

4. Mounting and installation

4.1 Connection Diagrams

In this chapter the various options of connecting the device to systems are discussed.

4.1.1 Digital inputs

The typical application of IOMod 16DI inputs is shown in Fig. 4.1.1. When the default configuration for the inputs is applied, the user will observe inputs connected to +12/24V as “high” or in state “1,” and the input status LED will illuminate.

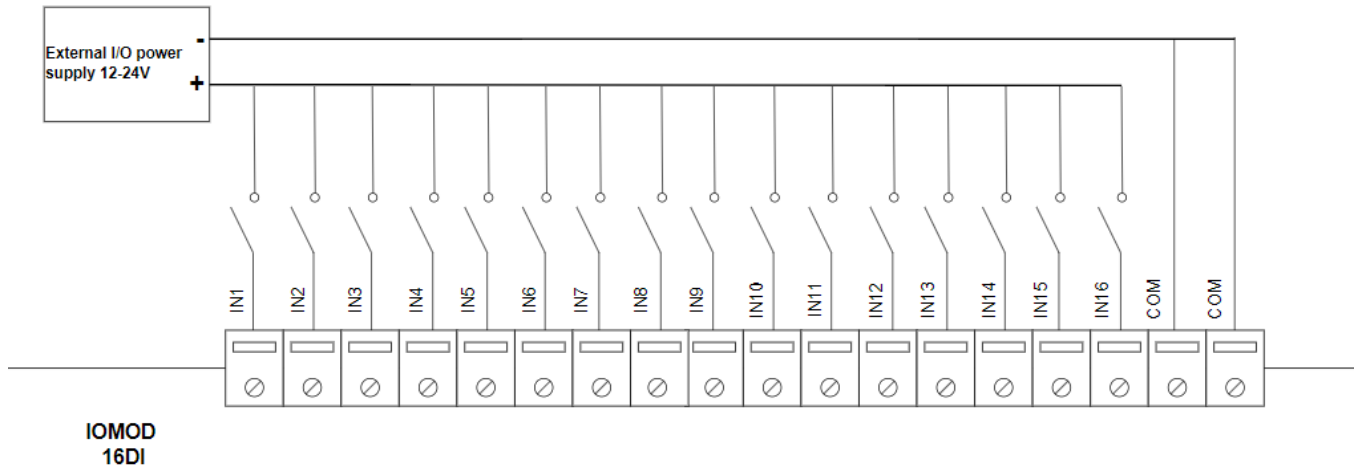


Fig. 4.1.1 Input configuration example

The user can configure the inputs to be driven by a 0V (active low) signal (see Fig. 4.1.2). With this configuration, inputs connected to 0V will be displayed as “high” or in state “1,” and the input status LED will illuminate.

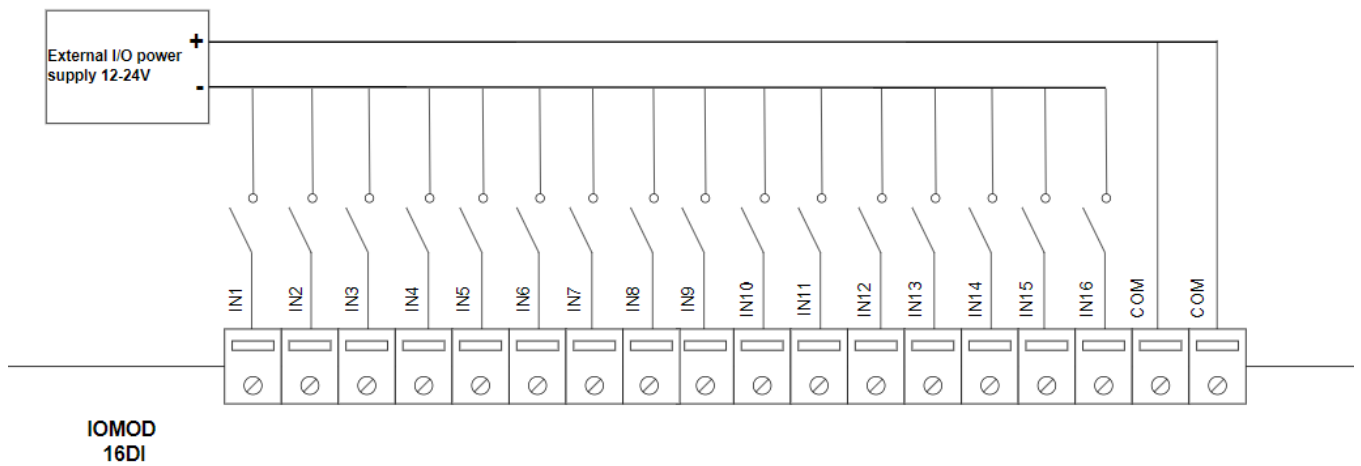


Fig. 4.1.2 Configuration of inverted polarity inputs

4.2 Power supply

IOMod 16DI needs to be powered by a 9-33 V power source. IOMod power supply inputs are located next to RS485 interface inputs (Fig. 4.2.1).

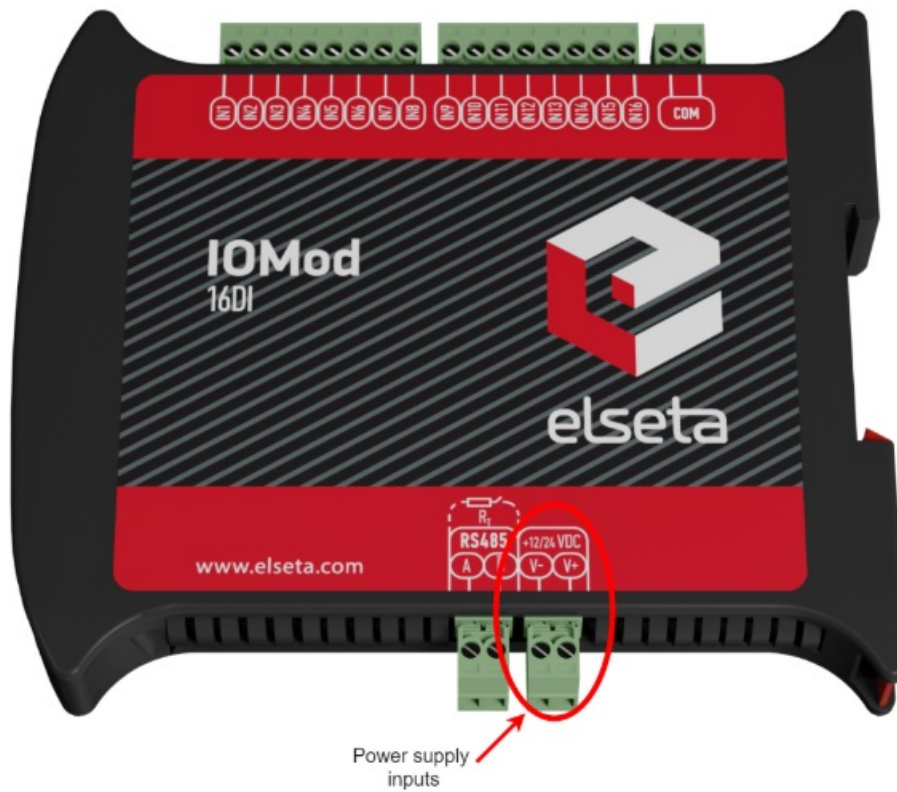


Fig. 4.2.1 Power supply inputs physical location

4.3 USB connection

The IOMod 16DI device features a USB-mini connection port, primarily used to establish a physical connection between the IOMod and a PC. By selecting the USB interface and the correct communication port in the IOMod Utility, the user can connect to the IOMod to control its parameters and monitor data.

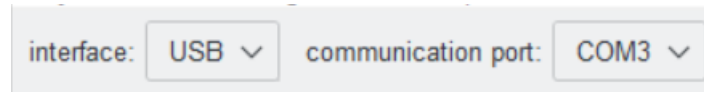


Fig. 4.3.1 IOMod Utility interface and communication port parameters

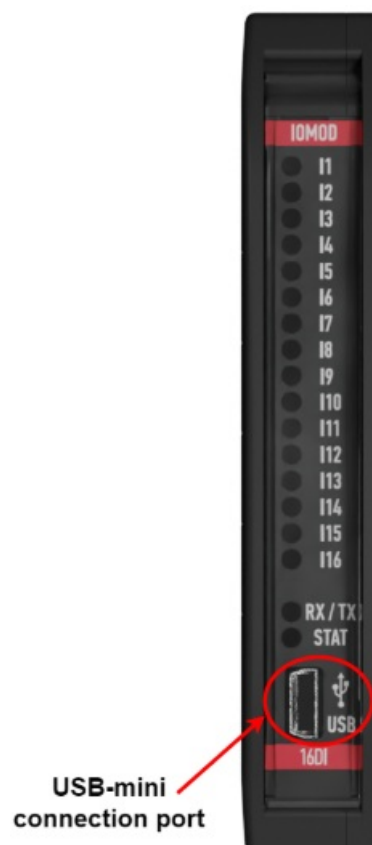



Fig. 4.3.2. IOMod 16DI USB connection port physical location

5. Parametrization

IOMod 16DI default communication settings

Table 5.1 IOMod 16DI default communication protocol settings

Protocol	baudrate	parity	stop bits	wait byte count	slave address	link address size	ASDU size	COT size	IOA size	Input function
Modbus	19200	Even	1	8	1					
IEC 101	19200	Even	1	8	1	1	1	1	2	
IEC 103	19200	Even	1	8	1					253

 *Default IOMod 16DI communication protocol is Modbus

5.1 Device settings for **Modbus** protocol

Communication settings

IOMod 16DI configuration is performed via IOMod Utility (the manual can be accessed[here](#)).



The screenshot shows the 'Communication settings' tab in the IOMod Utility application. The 'Protocol' is set to 'Modbus'. The 'Baudrate' is set to '19200'. The 'Parity' is set to 'E'. The 'Stop bits' are set to '1'. The 'Terminating resistor' is set to 'disabled'. The 'Bit wait time for packet' is set to '8'.

Fig. 5.1.1 Modbus protocol communication settings tab on IOMod utility app

For Modbus protocol users can set: Link address, baudrate, parity, stop bits, terminating resistor and bit wait time. See the table below for parameter ranges and default values (Table 5.1.1).

Table 5.1.1 Communication parameters range and default values

Parameter	Range	Default values
Link address	1-256	1
Baudrate	600, 1200, 2400, 4800, 9600, 19200, 28800, 38400, 57600, 76800, 115200	19200
Parity	None, Odd, Even, Mark, Space	Even
Stop bits	1, 2	1
Terminating resistor	Enable or disable	disabled
Bit wait time for packet	8-256	8

General IOMod settings

More device parameters can be changed with IOMod utility under IOMod settings tab. For Modbus protocol user can set input inversion and input filter.

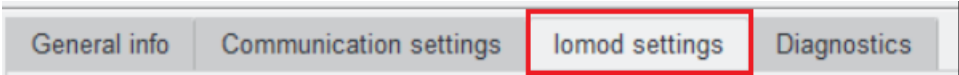


Fig. 5.1.2 IOMod settings tab on utility application

Input Inversion

If the user wants the input status to display as "ON" when the input signal is in a low state, the inputs can be logically inverted via IOMod utility application under the *IOMod settings* tab (Fig. 5.1.3)

When input inversion is enabled, the input state will show 1 (ON) when no signal is connected and will change to 0 (OFF) when the input is activated.

Note: The input indication LEDs are not affected by this inversion and will continue to reflect the actual signal state.

Example:

Input 2 has input inversion enabled in the IOMod Utility application. Both inputs, IN1 and IN2, are physically activated, and the LEDs on the IOMod are lit for both inputs. However, on the SCADA system:

- IN1 will be displayed as "1" (ON).
- IN2 will be displayed as "0" (OFF) due to the input inversion setting.

Input inversion can be enabled via IOMod utility application under the *IOMod settings* tab.

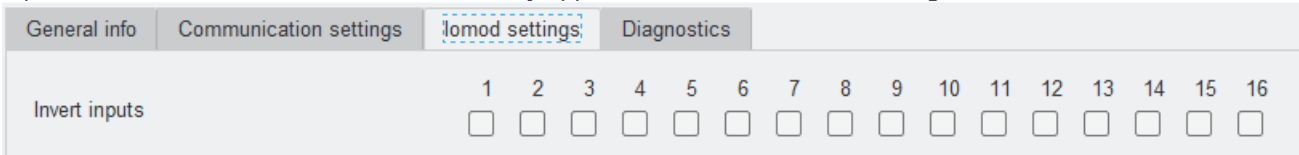


Fig. 5.1.3 Input inversion on IOMod utility app

Input filter

The filter time specifies the duration for which the input must remain stable before a status change is transmitted. The time interval is set in milliseconds. Default interval is 50 ms.

Input filter time can be set in the IOMod utility application under the *IOMod settings* tab (Fig. 5.1.4).

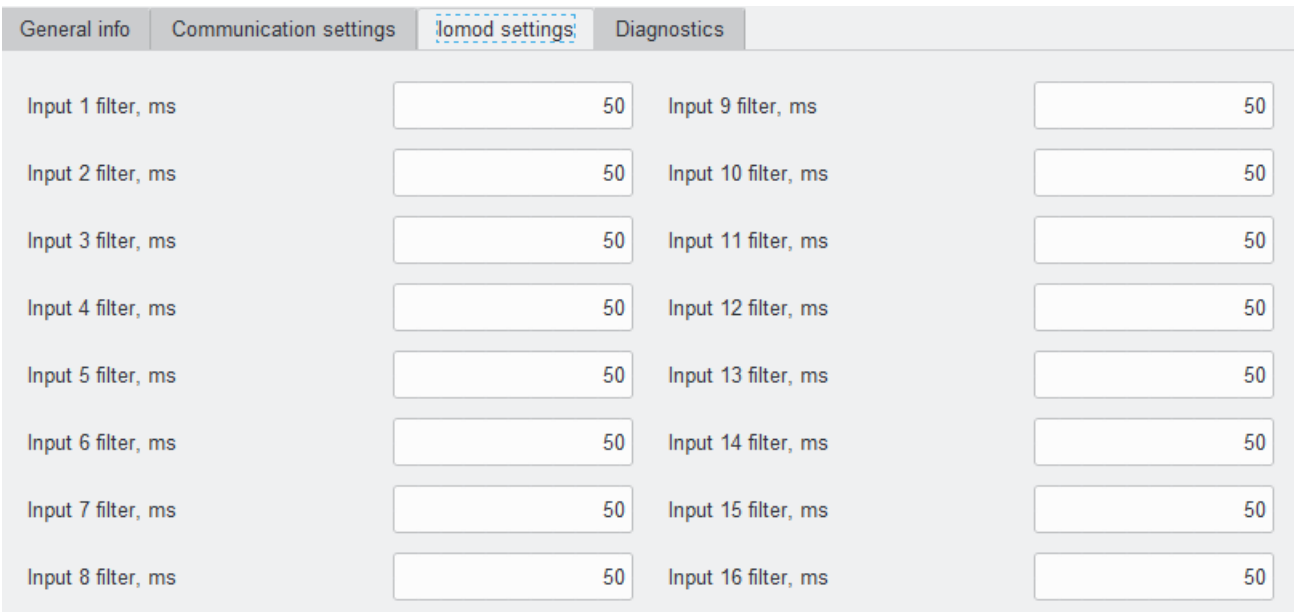


Fig. 5.1.4 Input filter on IOMod utility app

5.2 Device settings for IEC 60870-5-101 protocol

IOMod 16DI configuration is performed via IOMod Utility application (the manual can be accessed[here](#)).

General info
Communication settings
Iomod settings
Diagnostics

Protocol
IEC101

Baudrate
19200

Parity
E

Stop bits
1

Terminating resistor
☐

Bit wait time for packet
8

Time synchronization timeout
300

Link address size
1

ASDU size
1

COT size
1

IOA size
2

Fig. 5.2.1 Communication settings on the IOMod utility application

For IEC 60870-5-101 protocol users can set: Link address, baudrate, parity, stop bits, terminating resistor, bit wait time, time synchronization timeout, link address size, ASDU size, COT size, and IOA size using the IOMod utility application (Fig 5.2.1) See the table below for parameter ranges and default values for IEC 60870-5-101 protocol (Table 5.2.1).

Table 5.2.1 parameters range and default values of IOMod

Parameter	Range	Default values
Link address	1-65535*	1
Baudrate	600, 1200, 2400, 4800, 9600, 19200, 28800, 38400, 57600, 76800, 115200	19200
Parity	None, Odd, Even, Mark, Space	Even
Stop bits	1, 2	1
Terminating resistor	Enable or disable	disabled
Bit wait time for packet	8-256	8
Time synchronization timeout (s)	1-65535	300
Link address size	1, 2	1
ASDU size	1, 2	1
COT size	1, 2	1
IOA size	1, 2, 3	2

i *To use Link address value greater than 256, Link address size must be set to "2".

General IOMod settings

More device parameters can be changed with IOMod utility application under IOMod settings tab. For the IEC 60870-5-101 protocol users can configure the following settings: input grouping, swap grouped inputs, invert inputs, and inputs filters.

Input Grouping

Certain applications require combining two inputs into a single DPI input. This is done by grouping two neighboring pins, where the first pin in the pair must be odd-numbered . When grouped, the second pin in the pair is not used anymore – all requests to this pin will generate an error.

Example:

- **Valid:** IN1 and IN2 (IN2 becomes unused).
- **Invalid:** IN2 and IN3.

Input grouping can be achieved via IOMod utility application under the *IOMod settings* tab (Fig. 5.2.2).

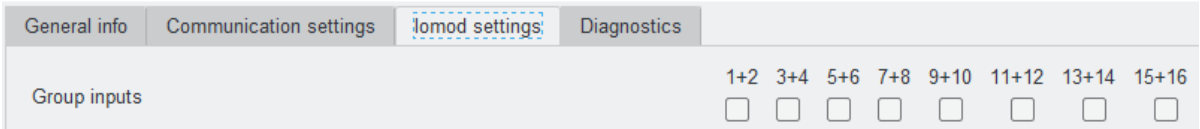


Fig. 5.2.2 Input grouping settings on IOMod utility app

Swap grouped inputs

Grouped inputs are referred to as Double Point Information (DPI) inputs. DPI signals consist of two bits of information, allowing for four possible states, thus providing more detail compared to single-point inputs. For example: The INDETERMINATE state might indicate that part of the equipment is turned off or that a mechanical component responsible for switching is stuck between states. The ERROR state could signify that both contacts are connected, possibly indicating a short circuit in the equipment.

Table 5.2.2 Double-point states

Value	State
00	indeterminate
01	off
10	on
11	error

Practical usage example of Swap Grouped Inputs setting: In a typical configuration, an active IN1 indicates the OFF position, and an active IN2 indicates the ON position. However, if a technician accidentally mismatches the cables during installation, resulting in IN1 indicating ON and IN2 indicating OFF, the Swap Grouped Inputs setting allows the positions of the inputs to be swapped without requiring any physical reconnection of the cables.

Swap grouped inputs can be enabled via IOMod utility application under the *IOMod settings* tab (Fig. 5.2.3).

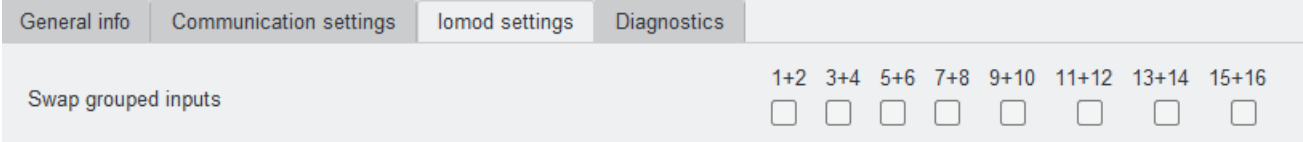


Fig. 5.2.3 Swap grouped inputs setting on IOMod utility application

Input inversion

Enables logical inversion of signal states. If the user wants the input status to display as "ON" when the input signal is in a low state, the inputs can be logically inverted

When input inversion is enabled, the input state will show 1 (ON) when input is deactivated and will change to 0 (OFF) when the input is activated.

Note: The input indication LEDs are not affected by this inversion and will continue to reflect the actual signal state.

Example:

Input 2 has input inversion enabled in the IOMod Utility application. Both inputs, IN1 and IN2, are physically activated, and the LEDs on the IOMod are lit for both inputs. However, on the SCADA system:

- IN1 will be displayed as "1" (ON).
- IN2 will be displayed as "0" (OFF) due to the input inversion setting.

Input inversion can enabled via IOMod utility application under the *IOMod settings* tab (Fig. 5.2.4)

General info	Communication settings	Iomod settings	Diagnostics														
Invert inputs		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Fig. 5.2.4 Input inversion setting on IOMod utility application

Input Filtering

The filter time specifies the duration for which the input must remain stable before a status change is transmitted. The time interval is set in milliseconds. The default interval is 50 ms.

Input filter time can be set in the IOMod utility application under the *IOMod settings* tab (Fig. 5.2.5).

General info	Communication settings	Iomod settings	Diagnostics
Input 1 filter, ms	<input type="text" value="50"/>	Input 9 filter, ms	<input type="text" value="50"/>
Input 2 filter, ms	<input type="text" value="50"/>	Input 10 filter, ms	<input type="text" value="50"/>
Input 3 filter, ms	<input type="text" value="50"/>	Input 11 filter, ms	<input type="text" value="50"/>
Input 4 filter, ms	<input type="text" value="50"/>	Input 12 filter, ms	<input type="text" value="50"/>
Input 5 filter, ms	<input type="text" value="50"/>	Input 13 filter, ms	<input type="text" value="50"/>
Input 6 filter, ms	<input type="text" value="50"/>	Input 14 filter, ms	<input type="text" value="50"/>
Input 7 filter, ms	<input type="text" value="50"/>	Input 15 filter, ms	<input type="text" value="50"/>
Input 8 filter, ms	<input type="text" value="50"/>	Input 16 filter, ms	<input type="text" value="50"/>

Fig. 5.2.5 Input filter time setting on IOMod utility application

5.3 Device settings for **IEC 60870-5-103** protocol

IOMod 16DI configuration is performed via IOMod Utility application (the manual can be accessed[here](#)).

General info	Communication settings	Iomod settings	Diagnostics
Protocol		IEC103	
Baudrate		19200	
Parity		E	
Stop bits		1	
Terminating resistor		<input type="checkbox"/>	
Bit wait time for packet		<input type="text" value="8"/>	
Time synchronization timeout		<input type="text" value="300"/>	
Input function		<input type="text" value="253"/>	
Output command function		<input type="text" value="254"/>	
Output status function		<input type="text" value="254"/>	

Fig. 5.3.1 Communication settings on the IOMod utility application

For IEC 60870-5-103 protocol users can set: Link address, baudrate, parity, stop bits, terminating resistor, bit wait time, time synchronization timeout, and input function using the IOMod utility application (Fig 5.3.1) See the table below for parameters range and default values for IEC 60870-5-103 protocol (Table 5.3.1).

Table 5.3.1 parameters range and default values of IOMod

Parameter	Range	Default values
Link address	1-256	1
Baudrate	600, 1200, 2400, 4800, 9600, 19200, 28800, 38400, 57600, 76800, 115200	19200
Parity	None, Odd, Even, Mark, Space	Even
Stop bits	1, 2	1
Terminating resistor	Enable or disable	disabled
Bit wait time for packet	8-256	8
Time synchronization timeout (s)	1-65535	300
Input function		253

General IOMod settings

More device parameters can be changed with IOMod utility application under IOMod settings tab. For the IEC 60870-5-103 protocol user can set: input grouping, swap grouped inputs, invert inputs and filter inputs.

Input Grouping

Certain applications require combining two inputs into a single DPI input. This is done by grouping two neighboring pins, where the first pin in the pair must be odd-numbered. When grouped, the second pin in the pair is not used anymore – all requests to this pin will generate an error.

Example:

- **Valid:** IN1 and IN2 (IN2 becomes unused).
- **Invalid:** IN2 and IN3.

Input grouping can be achieved via IOMod utility application under the *IOMod settings* tab (Fig. 5.3.2).

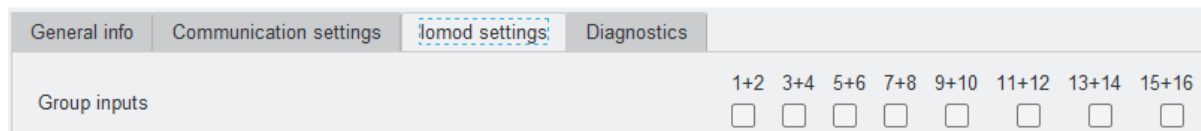


Fig. 5.3.2 Input grouping settings on IOMod utility app

Swap grouped inputs

Grouped inputs are referred to as Double Point Information (DPI). DPI signals consist of two bits of information, allowing for four possible states, thus providing more detail compared to single-point inputs. For example: The INDETERMINATE state might indicate that part of the equipment is turned off or that a mechanical component responsible for switching is stuck between states. The ERROR state could signify that both contacts are connected, possibly indicating a short circuit in the equipment.

Table 5.3.2 Double-point states

Value	State
00	indeterminate
01	off

10	on
11	error

Practical usage example of Swap Grouped Inputs setting: In a typical configuration, an active IN1 indicates the OFF position, and an active IN2 indicates the ON position. However, if a technician accidentally mismatches the cables during installation, resulting in IN1 indicating ON and IN2 indicating OFF, the Swap Grouped Inputs setting allows the positions of the inputs to be swapped without requiring any physical reconnection of the cables.

Swap grouped inputs can be enabled via IOMod utility application under the *IOMod settings* tab (Fig. 5.3.3).

General info	Communication settings	Iomod settings	Diagnostics	
Swap grouped inputs				1+2 3+4 5+6 7+8 9+10 11+12 13+14 15+16
				<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>

Fig. 5.3.3 Swap grouped inputs setting on IOMod utility application

Input inversion

Enables logical inversion of signal states. If the user wants the input status to display as "ON" when the input signal is in a low state, the inputs can be logically inverted

When input inversion is enabled, the input state will show 1 (ON) when no signal is connected and will change to 0 (OFF) when the input is activated.

Note: The input indication LEDs are not affected by this inversion and will continue to reflect the actual signal state.

Example:
Input 2 has input inversion enabled in the IOMod Utility application. Both inputs, IN1 and IN2, are physically activated, and the LEDs on the IOMod are lit for both inputs. However, on the SCADA system:

- IN1 will be displayed as "1" (ON).
- IN2 will be displayed as "0" (OFF) due to the input inversion setting.

Input inversion can be enabled via IOMod utility application under the *IOMod settings* tab (Fig. 5.3.4).

General info	Communication settings	Iomod settings	Diagnostics	
Invert inputs			1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	
			<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	

Fig. 5.3.4 Input inversion setting on IOMod utility application

Input Filtering

The filter time specifies the duration for which the input must remain stable before a status change is transmitted. The time interval is set in milliseconds. The default interval is 50ms.

Input filter time can be set in the IOMod utility application under the *IOMod settings* tab (Fig. 5.3.5).

General info	Communication settings	Iomod settings	Diagnostics
Input 1 filter, ms	<input type="text" value="50"/>	Input 9 filter, ms	<input type="text" value="50"/>
Input 2 filter, ms	<input type="text" value="50"/>	Input 10 filter, ms	<input type="text" value="50"/>
Input 3 filter, ms	<input type="text" value="50"/>	Input 11 filter, ms	<input type="text" value="50"/>
Input 4 filter, ms	<input type="text" value="50"/>	Input 12 filter, ms	<input type="text" value="50"/>
Input 5 filter, ms	<input type="text" value="50"/>	Input 13 filter, ms	<input type="text" value="50"/>
Input 6 filter, ms	<input type="text" value="50"/>	Input 14 filter, ms	<input type="text" value="50"/>
Input 7 filter, ms	<input type="text" value="50"/>	Input 15 filter, ms	<input type="text" value="50"/>
Input 8 filter, ms	<input type="text" value="50"/>	Input 16 filter, ms	<input type="text" value="50"/>

Fig. 5.3.5 Input filter time setting on IOMod utility application

6. Communication protocols

The IOMod 16DI supports three communication protocols: **Modbus RTU, IEC 60870-5-101, and IEC 60870-5-103**. These protocols allow a user, via a master device, to read data from the IOMod. The desired communication protocol can be selected using the IOMod Utility application (Fig. 6.1) The Utility's interface allows users to connect to IOMod via USB port or RS485. More information about this tool and its installation can be found on detailed IOMod Utility manual [here](#).

General info	Communication settings	Iomod settings	Diagnostics
Protocol	<div>IEC101 ▾</div> <div> Modbus ✓ IEC101 IEC103 </div>		
Baudrate			
Parity			

Fig. 6.1 IOMod utility app protocol selection window

6.1 Modbus RTU protocol operational information

Modbus RTU protocol is a simple and widely used messaging structure for serial communication. In the case of Modbus protocol IOMod 16DI will send data only after receiving correct queries from a master device. Supported Modbus function codes: FC1, FC2, FC3, FC6 and FC16.

01 (0x01) Read Coil status

As the name implies, it is designed for reading digital data. In the context of IOMod 16DI FC1 requests allow to read digital input statuses. Please note that the input statuses cannot be overwritten separately but can only be read (R access).

02 (0x02) Read Discrete Inputs

As the name implies, it is designed for reading digital data. In the context of IOMod 16DI FC2 requests allow to read digital input statuses. Please note that the input statuses cannot be overwritten separately but can only be read (R access).

03 (0x03) Read Holding Registers

Allows the user to read counter/timer values dedicated to digital inputs. There are two types of values - Pulse Counter and On Timer. The pulse counter tracks the number of pulses for the respective input. While the On timer calculates the duration for which the respective input remained in its active state.

06 (0x06) Preset Single Register

Sets single register. This command is used to change the values of Pulse counter and ON timer.

16 (0x16) Preset Multiple Registers

Sets multiple registers. This command is used to change the values of Pulse counter and ON timer.

6.1.1 Modbus register mapping table

Table 6.1.1 Modbus registers

Discrete Inputs FC02			
Address (Dec)	Description	Data type	Access
0	Read digital input DI1	BOOLEAN	R
1	Read digital input DI2	BOOLEAN	R
2	Read digital input DI3	BOOLEAN	R
3	Read digital input DI4	BOOLEAN	R
4	Read digital input DI5	BOOLEAN	R
5	Read digital input DI6	BOOLEAN	R
6	Read digital input DI7	BOOLEAN	R
7	Read digital input DI8	BOOLEAN	R
8	Read digital input DI9	BOOLEAN	R
9	Read digital input DI10	BOOLEAN	R
10	Read digital input DI11	BOOLEAN	R
11	Read digital input DI12	BOOLEAN	R
12	Read digital input DI13	BOOLEAN	R
13	Read digital input DI14	BOOLEAN	R
14	Read digital input DI15	BOOLEAN	R
15	Read digital input DI16	BOOLEAN	R

Holding Register FC03			
Address (Dec)	Description	Data type	Access
0	input 1 pulse count	UINT16	RW
1-2	input 1 on time	UINT32	RW
3	input 2 pulse count	UINT16	RW
4-5	input 2 on time	UINT32	RW
6	input 3 pulse count	UINT16	RW
7-8	input 3 on time	UINT32	RW
9	input 4 pulse count	UINT16	RW
10-11	input 4 on time	UINT32	RW
12	input 5 pulse count	UINT16	RW
13-14	input 5 on time	UINT32	RW

15	input 6 pulse count	UINT16	RW
16-17	input 6 on time	UINT32	RW
18	input 7 pulse count	UINT16	RW
19-20	input 7 on time	UINT32	RW
21	input 8 pulse count	UINT16	RW
22-23	input 8 on time	UINT32	RW
24	input 9 pulse count	UINT16	RW
25-26	input 9 on time	UINT32	RW
27	input 10 pulse count	UINT16	RW
28-29	input 10 on time	UINT32	RW
30	input 11 pulse count	UINT16	RW
31-32	input 11 on time	UINT32	RW
33	input 12 pulse count	UINT16	RW
34-35	input 12 on time	UINT32	RW
36	input 13 pulse count	UINT16	RW
37-38	input 13 on time	UINT32	RW
39	input 14 pulse count	UINT16	RW
40-41	input 14 on time	UINT32	RW
42	input 15pulse count	UINT16	RW
43-44	input 15 on time	UINT32	RW
45	input 16 pulse count	UINT16	RW
46-47	input 16 on time	UINT32	RW

6.2 IEC 60870-5-101 protocol operational information

Introduction

IEC 60870-5-101 (IEC101) is a communication protocol designed for telecontrol applications in power systems, facilitating communication between a master station and slave devices. Unlike the Modbus protocol, IEC101 allows to transfer additional information like timestamp and quality attributes.

The IOMod 16DI uses the IEC101 protocol to transmit signals in a standardized format. Each signal is mapped to an Information Object Address (IOA) and assigned Type Identifier (TI). This format conveys binary status changes (e.g., whether a circuit breaker is open or closed) with associated timestamps.

Time synchronization is critical for logging events. To synchronize time, the master sends a Time Sync command C_CS_NA_1 (103) with Cause of Transmission (COT) 6. According to the IEC 60870-5-101 protocol specification, time synchronization can be performed for multiple devices using broadcast messages. A master device sends a broadcast timesync command with a broadcast link address. This ensures consistent time-stamping for event recording and fault detection across the network.

Table 6.2.1 IEC 60870-5-101 protocol registers

IOA	Description	Type
1	input 1 SPI event	30 (M_SP_TB_1)
2	input 2 SPI event	30 (M_SP_TB_1)
3	input 3 SPI event	30 (M_SP_TB_1)
4	input 4 SPI event	30 (M_SP_TB_1)
5	input 5 SPI event	30 (M_SP_TB_1)

6	input 6 SPI event	30 (M_SP_TB_1)
7	input 7 SPI event	30 (M_SP_TB_1)
8	input 8 SPI event	30 (M_SP_TB_1)
9	input 9 SPI event	30 (M_SP_TB_1)
10	input 10 SPI event	30 (M_SP_TB_1)
11	input 11 SPI event	30 (M_SP_TB_1)
12	input 12 SPI event	30 (M_SP_TB_1)
13	input 13 SPI event	30 (M_SP_TB_1)
14	input 14 SPI event	30 (M_SP_TB_1)
15	input 15 SPI event	30 (M_SP_TB_1)
16	input 16 SPI event	30 (M_SP_TB_1)

Table 6.2.2 IEC 60870-5-101 protocol register table for grouped inputs

IOA	Description	Type
1	input 1-2 DPI event	31 (M_DP_TB_1)
3	input 3-4 DPI event	31 (M_DP_TB_1)
5	input 5-6 DPI event	31 (M_DP_TB_1)
7	input 7-8 DPI event	31 (M_DP_TB_1)
9	input 9-10 DPI event	31 (M_DP_TB_1)
11	input 11-12 DPI event	31 (M_DP_TB_1)
13	input 13-14 DPI event	31 (M_DP_TB_1)
15	input 15-16 DPI event	31 (M_DP_TB_1)

 * SPI - single-point information, DPI - double-point information

Table 6.2.3 Double-point states

Value	State
00	intermediate
01	off
10	on

11	error
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6.3 IEC 60870-5-103 protocol operational information

Introduction

IEC 60870-5-103 (IEC103) is a communication protocol specifically designed for protection equipment in power systems, enabling communication between a master station and slave devices such as protection relays and Remote Terminal Units (RTUs). This protocol ensures efficient and reliable data exchange, focusing on events, fault records, and protection settings.

The IOMod 16DI utilizes the IEC103 protocol to transmit data in a standardized format. Signals are mapped to predefined Information Object Addresses (IOA) and Type Identifiers (TI). The protocol is optimized for transferring detailed information, such as event-driven data and device status updates, ensuring precise monitoring and control of power system protection devices.

Time synchronization is critical for logging events. To synchronize time, the master sends a Time Sync command with function 0 and Cause of Transmission (COT) 8. According to the IEC 60870-5-103 protocol specification, time synchronization can be performed for multiple devices using broadcast messages. For broadcast time synchronization, the master device sends a periodic signal with a time stamp to synchronize the system time of slave devices. If synchronization fails, devices default to their local system time until they successfully resynchronize.

Table 6.3.1 IEC 60870-5-103 protocol registers

Type	INF	FUN	Description
1 (M_TTM_TA_3)	1	253	input 1 event
1 (M_TTM_TA_3)	2	253	input 2 event
1 (M_TTM_TA_3)	3	253	input 3 event
1 (M_TTM_TA_3)	4	253	input 4 event
1 (M_TTM_TA_3)	5	253	input 5 event
1 (M_TTM_TA_3)	6	253	input 6 event
1 (M_TTM_TA_3)	7	253	input 7 event
1 (M_TTM_TA_3)	8	253	input 8 event
1 (M_TTM_TA_3)	9	253	input 9 event
1 (M_TTM_TA_3)	10	253	input 10 event
1 (M_TTM_TA_3)	11	253	input 11 event
1 (M_TTM_TA_3)	12	253	input 12 event
1 (M_TTM_TA_3)	13	253	input 13 event
1 (M_TTM_TA_3)	14	253	input 14 event
1 (M_TTM_TA_3)	15	253	input 15 event
1 (M_TTM_TA_3)	16	253	input 16 event

Table 6.3.2 IEC 60870-5-103 protocol register table for grouped inputs

Type	INF	FUN	Description
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1 (M_TTM_TA_3)	1	253	input 1-2 event
1 (M_TTM_TA_3)	3	253	input 3-4 event
1 (M_TTM_TA_3)	5	253	input 5-6 event
1 (M_TTM_TA_3)	7	253	input 7-8 event
1 (M_TTM_TA_3)	9	253	input 9-10 event
1 (M_TTM_TA_3)	11	253	input 11-12 event
1 (M_TTM_TA_3)	13	253	input 13-14 event
1 (M_TTM_TA_3)	15	253	input 15-16 event

Table 6.3.3 Double-point states

Value	State
00	intermediate
01	off
10	on
11	error