

IOMOD88 User Manual Modbus v1.4

Introduction

IOMOD 8DI8DO is a compact size stand-alone Modbus (RTU) or IEC 60870-5-103 digital input and digital output controller. IOMOD is used for industrial applications, where digital signaling is used and robust communication is needed. IOMOD is ideal solution for applications such as data acquisition, observation, control, process monitoring, testing and measurement at remote places. It is controlled over Modbus or IEC 60870-5-103 protocol, and can be used with any SCADA system.

Features

- 8 digital inputs with configurable active signal polarity, or input inversion; Pulse count and ON time count
- 8 digital open collector outputs for relays
- Galvanically isolated inputs and outputs
- Configurable over USB
- Drag And Drop firmware upgrade over USB
- RS485 communication
- LED input / output indications, + Data transmission (Rx and Tx) indication.
- Spring contact connectors
- Small sized case with removable front panel
- DIN rail mount
- Operating temperature
- Power Requirements: 12-24 VDC

Device operational information

IOMOD 8DI8DO uses Modbus (RTU) or IEC 60870-5-103 protocol over RS485 interface. Protocol used by device can be changed by uploading corresponding firmware. Default communication settings are: 9600 baudrate, 8N1, Slave address - 1.

MODBUS operational information

To read output status, send 01 Modbus command (Read Coils) with resolution of first register (0), and size of 8. Returned value will show all 8 output states (1 - turned On, 0 - turned Off).

To read input status, send 02 Modbus command (Read Discrete Inputs) with resolution of first register (0) and size of 8. Returned value will show 8 input states.

To read input counter values, send 04 Modbus command (Read Input Registers) or 03 Modbus command (Read Holding Registers) with resolution of first register (0) and size of 24. Returned data will show pulse count (first register) and ON time (2nd and 3rd registers) for each input - pulse count of input #2 will be at register # n , and so on. ON time will be shown as seconds. ON time and pulse count will increase when input pulse is longer than Filter time, which is configured by user in USB terminal menu. Shorter pulses will be ignored in both pulse and ON time registers. From software version 1.10, as capacity of input counter expanded to 32-bits, additional 16 registers depict such wider values in registers 00023-00039.

These input counter values can be changed by using 06 Modbus command.

To turn single output on or off, send command 05 (Write Single Coil), with output address (0 to 7). To turn output on - send hex value FF00; to turn off - hex value 0000.

To turn multiple outputs on or off, use command 15 (Write Multiple Coils), and send binary coded value for 8 coils at address (0) and length 8.

To invert input states by software, or to use pull-up resistors on inputs, configure device over USB terminal. Useable Modbus commands shown in table below.

Supported MODBUS functions

01 (0x01) Read Coil Status

Reads status of relays (Off or On). IOMOD 8DI8DO has 8 digital outputs from address 0 to address 7.

02 (0x02) Read Discrete Inputs

Reads status of digital inputs (Off or On). IOMOD 8DI8DO has 8 digital inputs from address 0 to address 7; These inputs are active-high by default; user can turn on pull-up resistors (through USB) to these inputs to make them active-low.

03 (0x03) Read Holding Registers

Lets user read counter/timer values dedicated to digital inputs. There are 40 MODBUS registers. Values held in these registers are explained in a table below. There are two types of values - Pulse Counter and On Timer, the latter calculating the time that respective input was held in its active state.

04 (0x04) Read Input Registers

Lets user read counter/timer values dedicated to digital inputs. There are 80 MODBUS registers. Values held in these registers are explained in a table below. There are two types of values - Pulse Counter and On Timer, the latter calculating the time in seconds that respective input was held in its active state. This function is deprecated and mirrors function 0x03 to conform to past versions of IOMOD 16DI.

05 (0x05) Write Single Coil

Sets single digital output On or Off. Output addresses from 0 to 7 (first output - address 0, last output - address 7).

06 (0x06) Preset Single Register

Sets single register. Register addresses is identical to "Read Input Registers" addresses.

15 (0x0F) Write Multiple Coils

Sets multiple digital output On or Off. Output addresses from 0 to 7 (first output - address 0, last output - address 7).

Modbus register mapping table

Register	Description	Value range
	Read coil status (01)	
00000-00007	Reading digital outputs DO1-DO8	0-255
	Read discrete inputs (02)	
00000-00007	Reading digital inputs DI1-DI8	0-255
	Read holding register (03), Read input register (04), Preset Single Register (06)	
00000	Pulse count for DI1, Least Significant Word	0-65535
00001-00002	On time, in seconds, for DI1, Least Significant Word first*	0-65535
...
00021	Pulse count for DI8, Least Significant Word	0-65535
00022-00023	On time, in seconds, for DI8, Least Significant Word first*	0-65535
00024-00039	Pulse count for DI1-DI8, Least Significant Word first*	0-65535
	Write single coil (05)	
00000-00007	Writing digital outputs DO1-DO8	0x0000 / 0xFF00
	Write multiple coils (15)	
00000-00007	Writing multiple digital outputs DO1-DO8	0-255

*It is advised to set most significant word of counter/timer first

IEC 60870-5-103 operational information

IOMOD uses standard communication scheme. Initiation, control messages and queries are initiated by master (controlling station), while IOMOD device (controlled station) only answers requests and statuses. First message sent by master is RESET CU to restart communication. When device answers with ACK, master proceeds with acquiring General Interrogation and sending time synchronization.

When this initialization is complete, master polls IOMOD device with class 1 and class 2 requests. Class 2 is used when master polls for cyclic data. Controlled device responds when spontaneous data exists and master then sends request for Class 1. Controlled station responds with time tagged message.

To control device outputs, master (controlling station) sends command (ASDU type - 20; Cause of Transmission - 20;). Info number represents number of output pin, while info elements shows DPI information of output state (1 - off, 2 - on, 0 and 3 - not used (define error)).

When input status changes, device filters input glitches with user configurable filter time. When filter is passed device sends "spontaneous" message with "Function type" as input address (default function type of inputs - 160), and "Info number" as input pin number.

IEC 60870-5-103 telegram description

To initialize communication Master (controlling station) sends "Link Reset CU" or "Link Reset FCB" commands, which is function code "0" or "7" within fixed frame telegram.

Example: | 0x10 | 0x40 | 0x01 | 0x41 | 0x16 |

Device (controlled station) responds with ACK.

Master, requesting Link status must send fixed frame telegram with function code "9". Device then responds with "Access Demand" (function code "11").

On first "Class 1" request, device will send its identification string. If there is spontaneous messages to send, they will be sent first.

Master, initiating time synchronization, must send variable frame, with function code "User data with ACK" , ASDU type "6" and Cause of Transmission "8". Info elements must contain 7-byte time structure.

GI is initiated by master with variable frame, including function code "3" (User data with ACK) , ASDU type "7" and Cause of Transmission "9". Slave device then responds with ACK. Master gets GI data by polling with Class 2 request till slave transmits "End of GI" (Cause of Transmission - "10"). IOMOD device responds with time tagged message, including DPI states of inputs and outputs (Outputs is sent first). Output and input numbers is represented by "Info number" in protocol.

To control IOMOD outputs, controlling station sends variable frame, with function code "User data with ACK" , ASDU type "20" and Cause of Transmission "20". Info Number shows output pin number whilst info elements shows DPI information of output state (1 - off, 2 - on, 0 and 3 - not used (define error)). Slave device then responds with ACK and confirms changed state when master sends Class 2 request. Output numbers is represented by "Info number" in protocol.

Device configuration for IEC-60870-103-5

When active low signaling is needed, user can configure input polarity. When internal pull-up resistors are turned on, all input statuses are turned on. When low signal is connected to input, status of that input is turned off. If user desires to turn input status on, when that input signal is low, user then does logic inversion. All input indication LEDs stay the same (are not inverted).

Sometimes two inputs or two outputs must be captured as one DPI input or output. Inputs and outputs can be grouped into pairs of two. This allows outputs to be controlled by one DPI command (of address of first output in the group). Only two neighboring pins can be grouped into pair, while first pin in pair must be odd number pin. When grouped, second pin in the pair is not used anymore - all approaches to this pin generate an error. For example - OUT1 and OUT2 can be grouped, after that OUT2 is not used; OUT2 and OUT3 *cannot* be grouped; OUT3 and OUT4 can be grouped, but OUT4 then is not used, etc.

Fig. 3.1 shows outputs and inputs ungrouped and controlled independently. In this mode, General Interrogation will be composed of 8 output states and 8 input states.

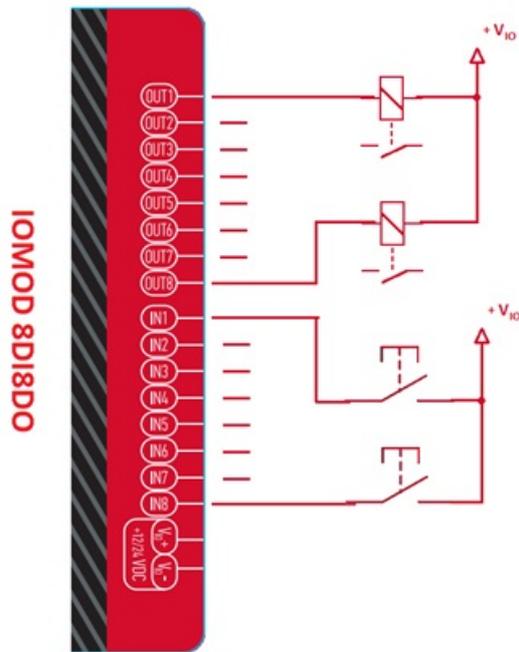


Fig. 3.1

In addition to this, Fig. 3.2 shows first two outputs grouped into pair, while 3rd and 4th inputs are grouped into pair. Now, General interrogation will be composed of 7 output states (with OUT2 missing), and 7 input states (with IN4 missing). Output and input numbers is represented by "Info number" in protocol.

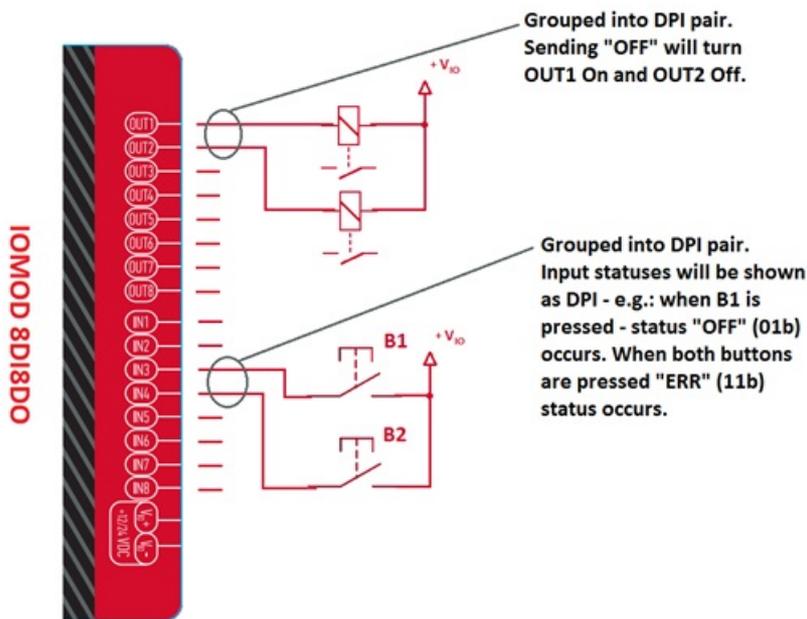


Fig. 3.2

Input filter is simple glitch filter with time input. This filter time corresponds to stable time that input must achieve before sending status change.

User can configure outputs to be pulse controlled - it means that output will be turned on for configured amount of time. When this time runs out, output is turned off. This is useful when pulse toggle relays are used. Output pulse is independent from output grouping option and can be used on both grouped and ungrouped outputs. When output is grouped, device will allow only one command completion at a time - when output is already turned ON, other "turn ON" requests will be responded with NACK. If user desires latching outputs to be used, output pulse time is set to 0.

Fig. 3.3 shows example of pulse output usage. In this example inputs and outputs are grouped, and output pulse time is set to 1s. When user sends ON command, OUT2 is pulsed for 1s, and relay is set. This will connect NO contact and IN2 will turn on (assuming it is not inverted). When user sends OFF command, OUT1 is pulsed, and relay is reset, turning IN1 on.

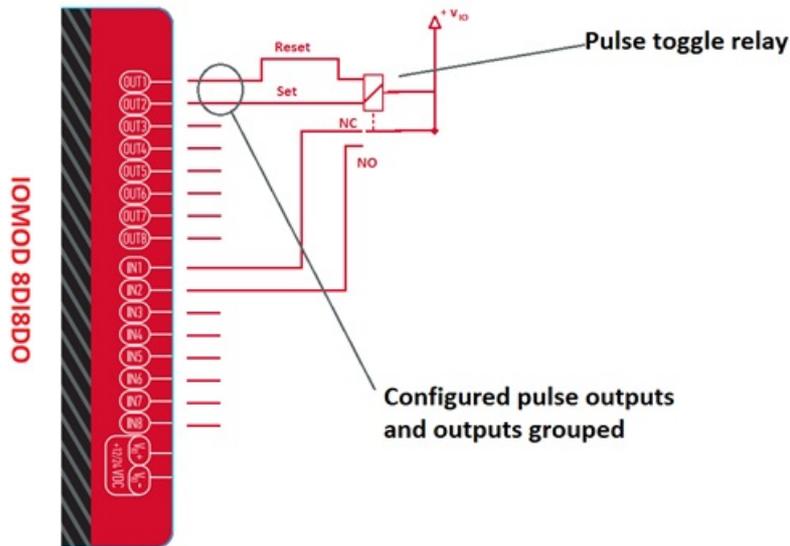


Fig. 3.3

User can detect output change with inputs (example shown in Fig. 3.4).

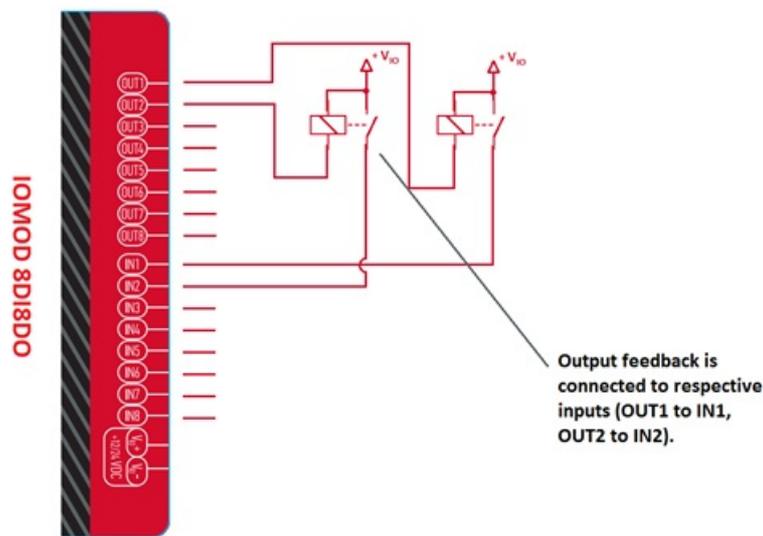


Fig. 3.4

To be informed when relays are turned on, user can connect relay outputs to IOMOD inputs (maximum allowed voltage must be taken into account). When relays are turned on, device responds with IEC-60870-5-103 protocol message "Remote Operation". If inputs are never turned on or off, device will send "Remote Operation" message after time-out period, with current input statuses. Time-out period is configured by user.

Devices Output, Input and Output feedback addresses are configurable. These addresses in IEC-60870-5-103 protocol are considered as "Function Type". Output address and Output feedback address are 128 by default. Input address is 160 by default.

Device is addressed by "Link address", which is 1 by default.

Testing With "THE VINCI" software

To test IOMOD with default settings for Modbus, user connects device through RS485 to Modbus master. Example using "The Vinci Expert" device as serial interface converter and adapter to PC with "The Vinci" software. Default settings for Modbus - 9600 baudrate; 8 data, no parity, 1 stop bit. When opening "The Vinci" software, choose Modbus serial - Master mode. In settings tab, choose station number (default - 1); configure tags (as described in section 3.A. Modbus working information); Press start and go to "Statistic" tab:

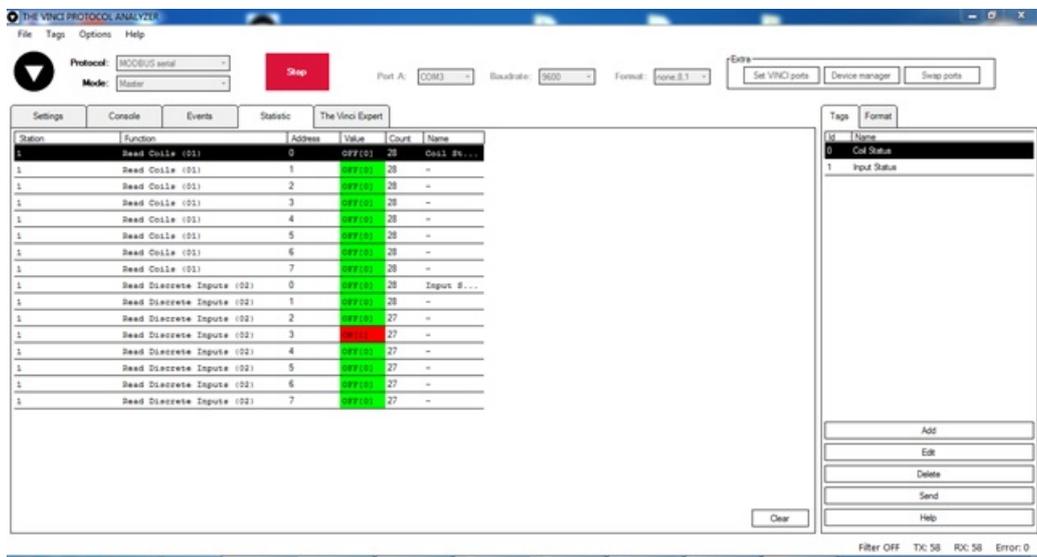


Fig. 3.1. Statistic Tab in “The Vinci” software

To test IOMOD with default settings, user connects device through RS485 to IEC 60870-5-103 master. Example using “The Vinci Expert” as serial interface converter and adapter to PC with “The Vinci” software. When opening “The Vinci” software, choose IEC 60870-5-103 – Master mode. Initial settings – 9600 baudrate; 8 data, no parity, 1 stop bit. Press start, send time synchronization, General interrogation and go to “Statistic” tab:

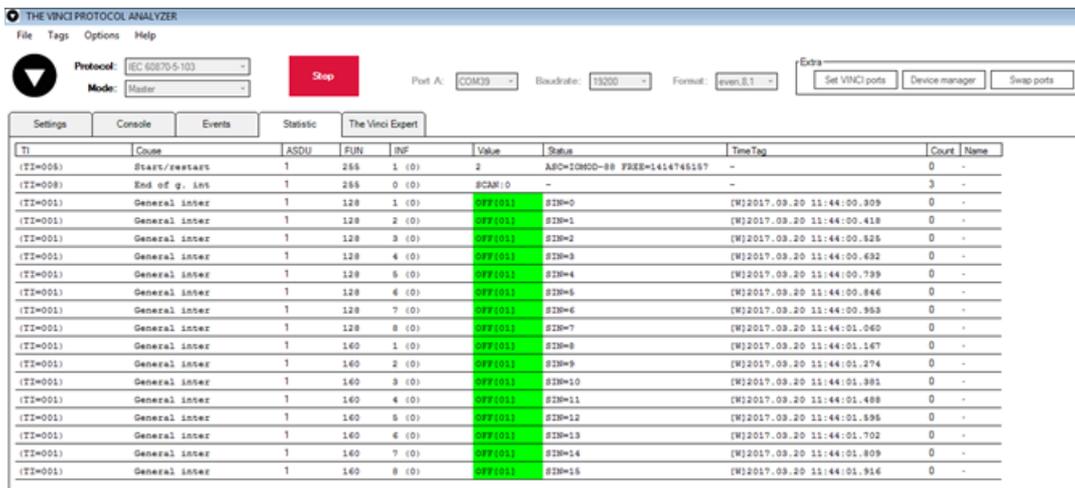


Fig. 3.5

As seen in Fig. 3.5, Outputs and inputs are shown with info numbers 1-8, and function type is 128 and 160 respectively.

GI, time synchronization and general command options can be found at right side of the program, in “System” tab.

Output commands are controlled by “General command” window at right side of the program, in “System” tab, with Output address (Function type) 128, and output number (Info number). Fig. 3.6 shows 1st and 6th output command sent and “CMD ACK” response received.

Fig. 3.7 shows first 4 Outputs and last 4 Inputs grouped (notice order of info numbers).

THE VINCI PROTOCOL ANALYZER
File Tags Options Help

Protocol: IEC 60870-5-103 - Stop Port A: COM39 - Baudrate: 19200 - Format: even.8.1 - Extra: Set VINCI ports Device man

Mode: Master -

Settings Console Events Statistic The Vinci Expert

TI	Cause	ASDU	FUN	INF	Value	Status	TimeTag	Count	Nr
(TI=006)	Start/restart	1	255	1 (0)	2	ASD=ICM...	-	0	-
(TI=008)	End of g. int	1	255	0 (0)	SCAN:0	-	-	3	-
(TI=001)	CHD ACK pos	1	128	1 (0)	ON(101)	SIN=0	[W]2017.03.20 11:47...	2	-
(TI=001)	General inter	1	128	2 (0)	OFF(101)	SIN=1	[W]2017.03.20 11:44...	0	-
(TI=001)	General inter	1	128	3 (0)	OFF(101)	SIN=2	[W]2017.03.20 11:44...	0	-
(TI=001)	General inter	1	128	4 (0)	OFF(101)	SIN=3	[W]2017.03.20 11:44...	0	-
(TI=001)	General inter	1	128	5 (0)	OFF(101)	SIN=4	[W]2017.03.20 11:44...	0	-
(TI=001)	CHD ACK pos	1	128	6 (0)	ON(101)	SIN=0	[W]2017.03.20 11:47...	2	-
(TI=001)	General inter	1	128	7 (0)	OFF(101)	SIN=6	[W]2017.03.20 11:44...	0	-
(TI=001)	General inter	1	128	8 (0)	OFF(101)	SIN=7	[W]2017.03.20 11:44...	0	-
(TI=001)	General inter	1	160	1 (0)	OFF(101)	SIN=8	[W]2017.03.20 11:44...	0	-
(TI=001)	General inter	1	160	2 (0)	OFF(101)	SIN=9	[W]2017.03.20 11:44...	0	-
(TI=001)	General inter	1	160	3 (0)	OFF(101)	SIN=10	[W]2017.03.20 11:44...	0	-
(TI=001)	General inter	1	160	4 (0)	OFF(101)	SIN=11	[W]2017.03.20 11:44...	0	-
(TI=001)	General inter	1	160	5 (0)	OFF(101)	SIN=12	[W]2017.03.20 11:44...	0	-
(TI=001)	General inter	1	160	6 (0)	OFF(101)	SIN=13	[W]2017.03.20 11:44...	0	-
(TI=001)	General inter	1	160	7 (0)	OFF(101)	SIN=14	[W]2017.03.20 11:44...	0	-
(TI=001)	General inter	1	160	8 (0)	OFF(101)	SIN=15	[W]2017.03.20 11:44...	0	-

System Tags

Address
 Custom ASDU ASDU: 1
 Custom Cause Cause: 1

General interrogation
Send SCAN number: 0

Clock synchronisation
Send IV SM SB
 PC time 2017/03/20 11:43:42

General command
FUN: 128 INF: 6 RI: 0
ON OFF

Fig. 3.6

THE VINCI PROTOCOL ANALYZER
File Tags Options Help

Protocol: IEC 60870-5-103 - Stop Port A: COM39 - Baudrate: 19200 - Format: even.8.1 - Extra: Set VINCI ports Device man

Mode: Master -

Settings Console Events Statistic The Vinci Expert

TI	Cause	ASDU	FUN	INF	Value	Status	TimeTag	Count	Nr
(TI=006)	Start/restart	1	255	1 (0)	2	ASD=ICM...	-	0	-
(TI=008)	End of g. int	1	255	0 (0)	SCAN:0	-	-	3	-
(TI=001)	General inter	1	128	1 (0)	OFF(101)	SIN=0	[W]2017.03.20 12:00...	0	-
(TI=001)	General inter	1	128	3 (0)	OFF(101)	SIN=2	[W]2017.03.20 12:00...	0	-
(TI=001)	General inter	1	128	5 (0)	OFF(101)	SIN=4	[W]2017.03.20 12:00...	0	-
(TI=001)	General inter	1	128	6 (0)	OFF(101)	SIN=5	[W]2017.03.20 12:00...	0	-
(TI=001)	General inter	1	128	7 (0)	OFF(101)	SIN=6	[W]2017.03.20 12:00...	0	-
(TI=001)	General inter	1	128	8 (0)	OFF(101)	SIN=7	[W]2017.03.20 12:00...	0	-
(TI=001)	General inter	1	160	1 (0)	OFF(101)	SIN=8	[W]2017.03.20 12:00...	0	-
(TI=001)	General inter	1	160	2 (0)	OFF(101)	SIN=9	[W]2017.03.20 12:00...	0	-
(TI=001)	General inter	1	160	3 (0)	OFF(101)	SIN=10	[W]2017.03.20 12:00...	0	-
(TI=001)	General inter	1	160	4 (0)	OFF(101)	SIN=11	[W]2017.03.20 12:00...	0	-
(TI=001)	General inter	1	160	5 (0)	INTERIM(00)	SIN=12	[W]2017.03.20 12:00...	0	-
(TI=001)	General inter	1	160	7 (0)	INTERIM(00)	SIN=14	[W]2017.03.20 12:00...	0	-

System Tags

Address
 Custom ASDU ASDU: 1
 Custom Cause Cause: 1

General interrogation
Send SCAN number: 0

Clock synchronisation
Send IV SM SB
 PC time 2017/03/20 11:43:42

General command
FUN: 128 INF: 6 RI: 0
ON OFF

Fig. 3.7

Technical information

	System	
1.	Dimensions	101 x 119 x 17.5, mm
2.	Case	ABS, black
3.	Working environment	Indoors
4.	Working temperature	-30 +70°C
5.	Recommended operating conditions	5 - 60°C and 20 - 80%RH;
6.	Configuration	USB
7.	Firmware upgrade	USB - mass storage device
	Electrical specifications	
8.	Inputs	8 X 2kV isolated 12-24VDC; Selectable inversion.
9.	Outputs	8 X 2kV isolated open collector outputs (300mA each, Max 50V);

	Power	
10.	Power Supply	9V to 33V
11.	Current consumption	38mA @ 12VDC, 20mA @ 24VDC

Mounting and installation guide

IOMOD 8DI8DO RS485 interface

IOMOD 8DI8DO has integrated 120Ω termination resistor which can be enabled or disabled over USB configuration. It is recommended to use termination at each end of the RS485 cable. See typical connection diagram on Fig. 5.1.

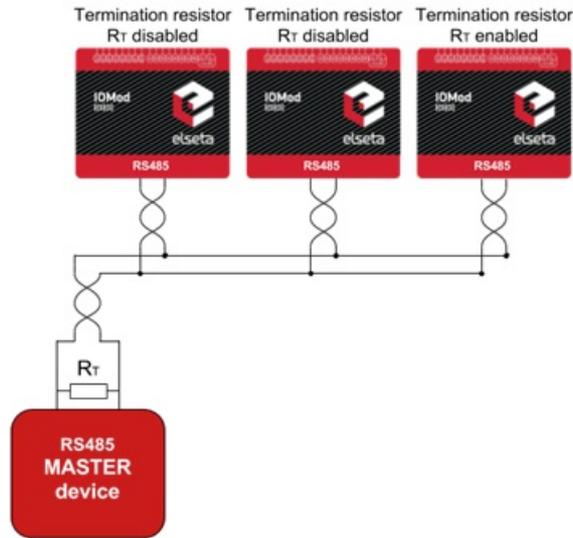


Fig. 5.1. Connection example of RS485 interface

IOMOD 8DI8DO has 1/8 Unit load receiver which allows to have up to 256 units on line (compared to standard 32 units). To reduce reflections, keep the stubs (cable distance from main RS485 bus line) as short as possible when connecting device.

IOMOD 8DI8DO inputs

Typical application of IOMOD 8DI8DO inputs is shown on Fig. 5.2. When default configuration for inputs is applied, user will see inputs connected to +12/24V as “high” or state “1” and input status LED will glow.

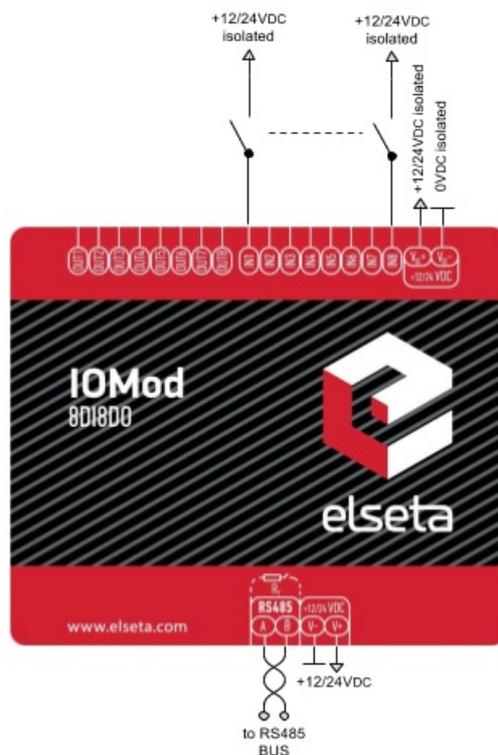


Fig. 5.2. Typical application

User also can configure to enable internal input pull-up resistors (function is applied for all inputs) and software input inversion. With this configuration, user will see inputs connected to 0V (see Fig. 5.3) as “high” or state “1”, input status LED will NOT glow.

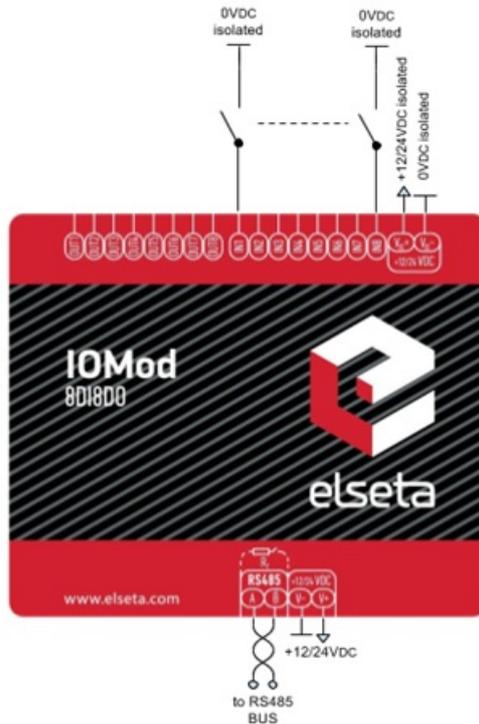


Fig. 5.3. Input configuration

IOMOD 8DI8DO outputs

IOMOD 8DI8DO has 8 open collector digital outputs. Internal clamp diodes are connected to each output which makes IOMOD 8DI8DO ideal for driving inductive loads like relays. Maximum 300mA per output is allowed. For higher loads outputs can be connected in parallel. Make sure your power supply can provide enough power. Typical application of outputs is shown on Fig. 5.4

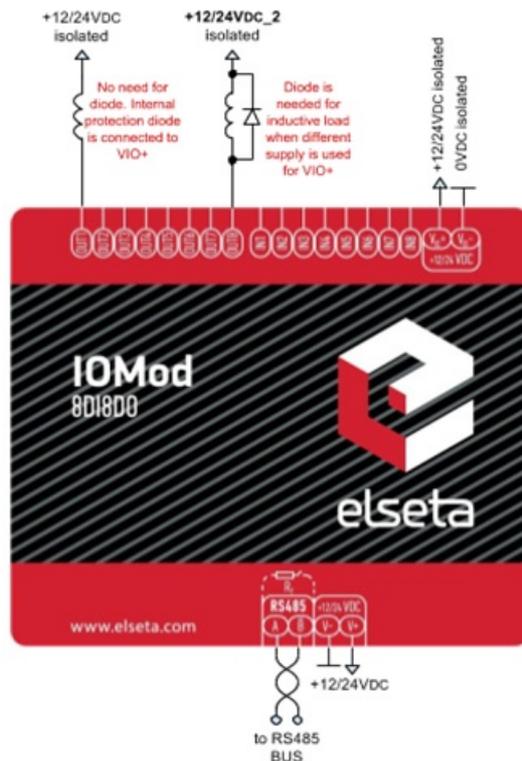


Fig. 5.4. Output configuration

Configuration over USB

Driver installation

Device requires USB drivers to work as virtual com port. First-time connection between device and computer could result in “Device driver software was not successfully installed” error.

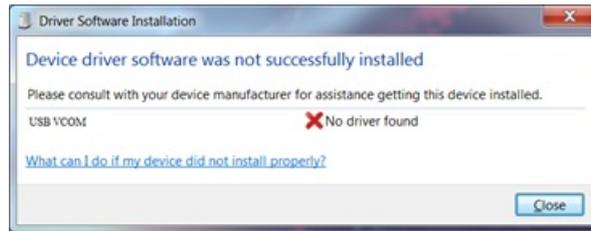


Fig. 6.1. Device driver error

User then manually installs drivers by selecting downloaded driver folder:
Go to Control Panel -> Device Manager;
Select failed device;
Press “Update driver software”; following screen should appear:

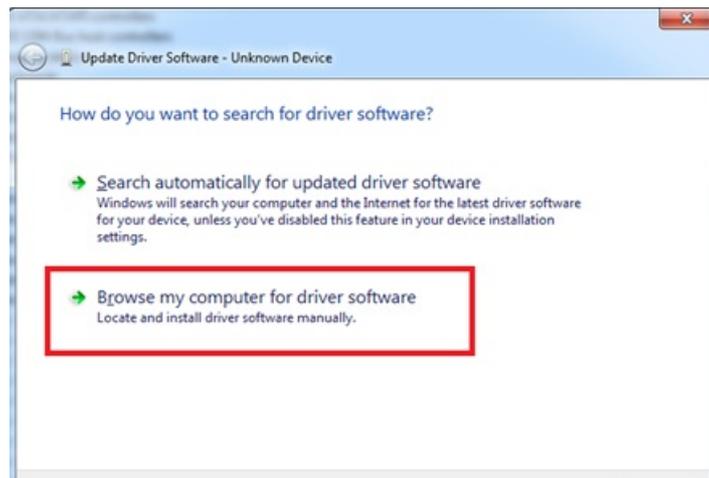


Fig. 6.2. Driver update screen

Select “x86” driver for 32bit machine, or x64 for 64bit machine. If not sure, select root folder (folder in which x64 and x86 lays inside).

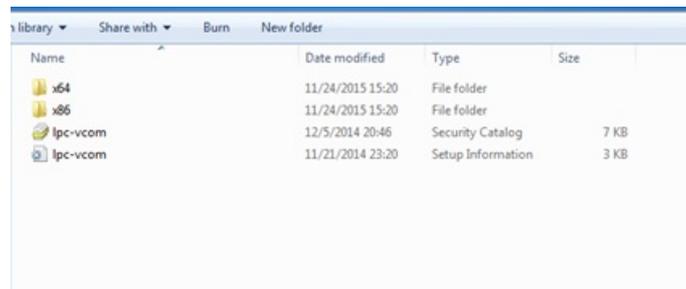


Fig. 6.3. Driver folder for IOMOD device

IOMOD configuration with PuTTY terminal

Configuration of IOMOD device is done through CLI (Command Line Interface) on virtual COM port. Drivers needed for MS Windows to install VCOM will be provided. To open up CLI simply connect to specific V-COM port with terminal software (advised to use PuTTY terminal software. If other software is being used, user might need to send <return> symbol after each command). When connected user should immediately see main screen (Fig. 6.4.)

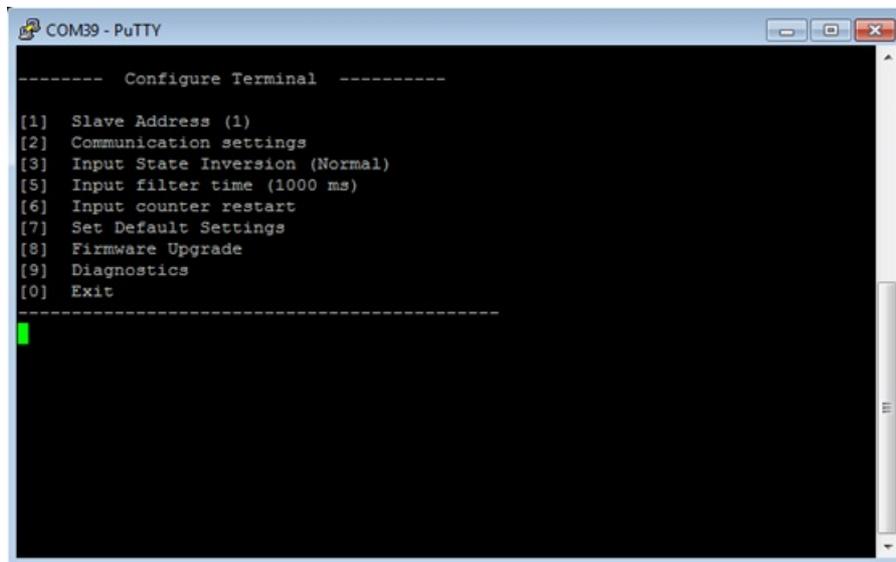


Fig. 6.4. Main configuration menu

Navigation is performed by sending number to terminal. User then proceeds by following further on-screen instructions. For example, to set Baudrate, press [2] to enter Baudrate screen; press [1] to edit; enter new configuration; press [RETURN] to save, or [ESC] to cancel changes. When done, press [0] (exit) before disconnecting device. Default values is set by pressing [6] on main screen, and confirming changes [1].

If accidentally closed the terminal window, user can connect terminal program again, and press any key on keyboard to show up main menu.

Main Menu

Modbus

	Menu Name	Function	Values	Default Values
1.	Slave Address	Modbus Slave address / ID	1-247	(default: 1)
2.	Communication settings	Enters baudrate, data and parity bit screen	-	(default: 9600; 8+1+N)
3.	Input pull-up enable	Enables input pull-up resistor. Inputs then activated by low signal	0 - 1 (off/on)	(default: 1)
4.	Input State Inversion	Input inversion (Inverts input states in modbus)	0 - 1 (off/on)	(default: 0)
5.	Input filter time	Filter for short input pulses	0 - 256000 (ms)	(default: 100)
6.	Input counter restart	Restarts all input counter registers to 0	(1 to confirm, 0 to cancel)	-
7.	Set Default Settings	Sets Default Settings	(1 to confirm, 0 to cancel)	-
8.	Firmware Upgrade	Mass Storage Device Firmware Upgrade	(1 to confirm, 0 to cancel)	-
9.	Diagnostics	Input / Output states	-	-
0.	Exit	Exit and disconnect	-	-

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	Menu Name	Function	Values	Default Values
1.	Link Address	Setts Link address	1-255	1
2.	Baudrate, Parity and stop bits	Enters configuring screen for communication settings	8+1 or 8+2 (Data+Stop), None, Odd, Even, Mark, Space (Parity)	9600, 8+1, Parity -None
3.	Data addressing config	Enters configuring screen for Input/ Output address (function type)	1 - 255 each	160 - Inputs; 128 - Outputs; 128 - Output feedback
4.	RS485 Terminating Resistor	RS485 120 Ohms Terminating Resistor	0 - 1 (off/on)	1

5.	Input pull-up enable and state inversion	Enables input pull-up resistor. Inputs then activated by low signal; Input inversion (Inverts input states in protocol logic)	0 - 1 (off/on)	0 (both off)
6.	Input / Output configure	Configuration of parameters below	-	-
6.1	Input grouping	Groups or ungroups inputs	8 inputs ungrouped or 4 pairs grouped max	All inputs ungrouped by default
6.2	Output grouping	Groups or ungroups outputs	8 outputs ungrouped or 4 pairs grouped max	All outputs ungrouped by default
6.3	Input filter time	Input glitch filter - minimum stable time to detect input	1 - 60000 milliseconds	100
6.4	Output pulse time	Sets output pulse time	0 - 60000 milliseconds (0 if not used)	0
6.5	Output detection with inputs (feedback)	Attach and detach inputs to outputs for detection; Set detection timeout (timeout to send "Remote Operation" if inputs not triggered)	0 - 60000 milliseconds (0 if not used)	0
7.	Set Default Settings	Sets Default Settings	(1 to confirm, 0 to cancel)	-
8.	Firmware Upgrade	Mass Storage Device Firmware Upgrade	(1 to confirm, 0 to cancel)	-
9.	Diagnostics	Input / Output states	-	-
0.	Exit	Exit and disconnect	-	-

Protocol simulator

After entering diagnostics screen user can turn on protocol simulator by pressing [9]. When protocol simulator is turned on, device will communicate through USB port rather than RS-485 line. Communication on RS-485 line is closed and all Modbus commands will be accepted only from USB. To exit this mode user must restart device.

Firmware upgrade over USB

To update device firmware user must enter main configuration menu.

Enter Firmware update screen by pressing [4];

Confirm update by pressing [1];

Device now enters Firmware Upgrade mode. Device reconnects as mass storage device (Fig 6.5.).



It is recommended to close terminal window after entering firmware upgrade mode.



Fig. 6.5. Mass storage device warning

User then must delete existing file "firmware.bin", and simply upload new firmware file by drag and drop.

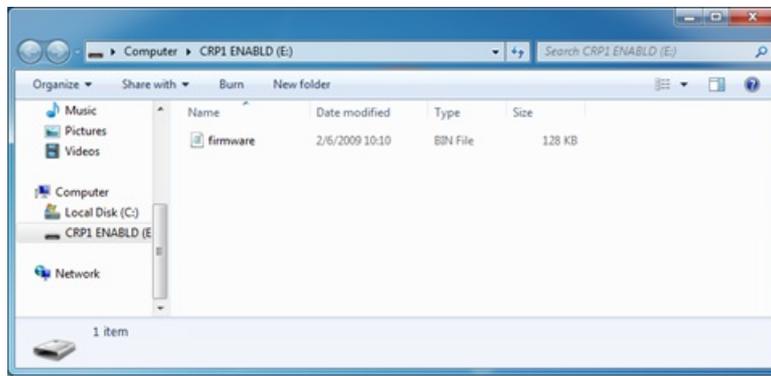


Fig. 6.5. Dragging and dropping new firmware file

Reconnect device and check firmware version. It should now represent the one it was updated to.

🕒Revision #1

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