

1 Product Description

1.1. Features

The isolated digital input-/output board IPC/DI4O3D-101E, DI4O4T-101E, DI4O4E-101E, DI4O2M-101E is used for the input and for the output of digital 12/24/36 VDC process signals. The boards IPC/DI4O3D-101E, IPC/DI4O4T-101E, DI4O4E-101E and IPC/DI4O2M-101E are functionally identical, they only differ in the connector type, DSUB-9 for DI4O3D, terminal block for DI4O4T, wire-to-board connector for DI4O4E-101E, M12 for DI4O2M and number of output channels (see technical data section).

The block diagram of the board is shown in Fig. 1.

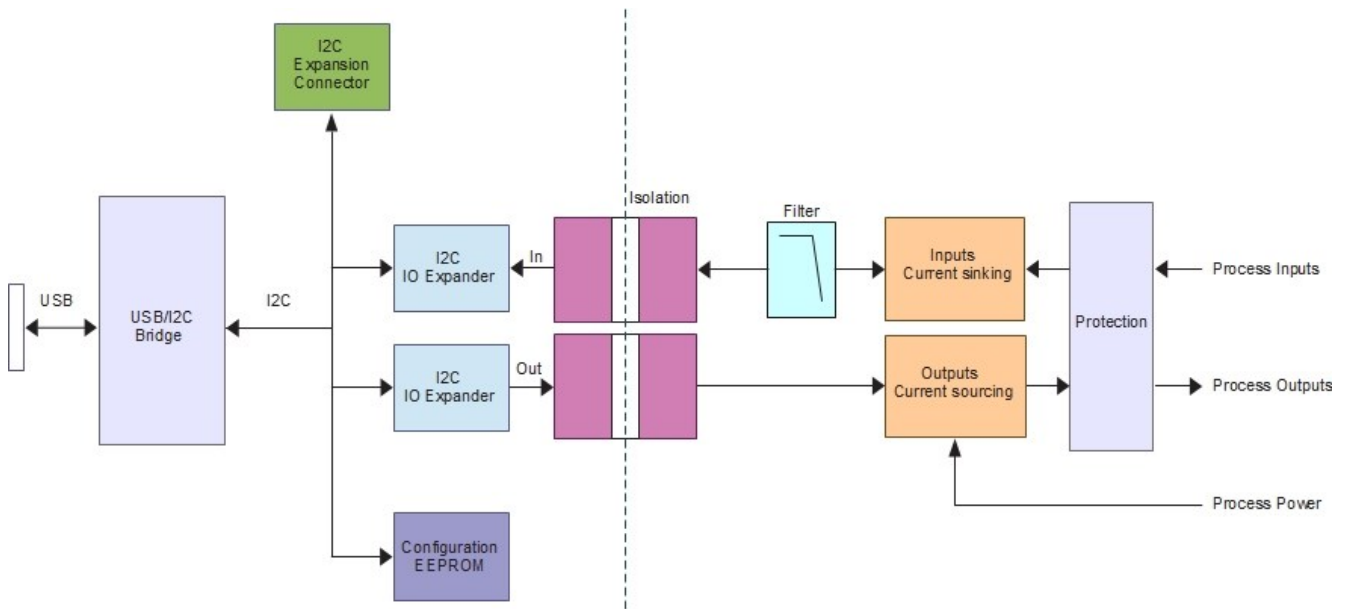


Fig. 1 Block Diagram

The main functional elements are:

- USB 2.0 local bus interface
- 4 isolated digital current sinking inputs
- 2 to 4 isolated digital current sourcing outputs

The outputs are overload protected (thermal). Any overloading of an output will cause an automatic shut-off to protect the output driver circuit on the board. The output driver will automatically switch on again, as soon as the cause of the overload disappears.

The simplified input circuitry of the board is shown in Fig. 2, that of the output circuitry in Fig. 3. The technical data of the board is listed in chapter 5.

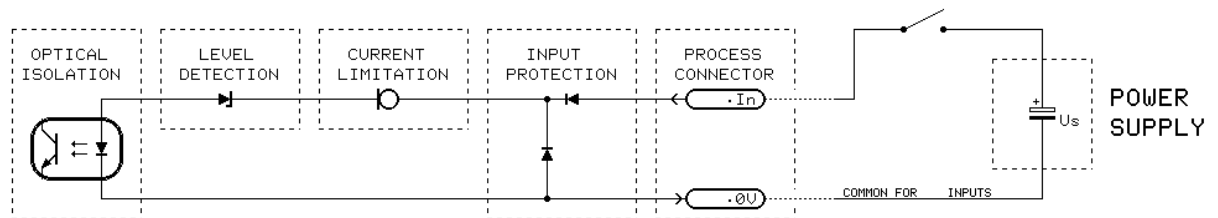


Fig. 2 Equivalent Input Circuit

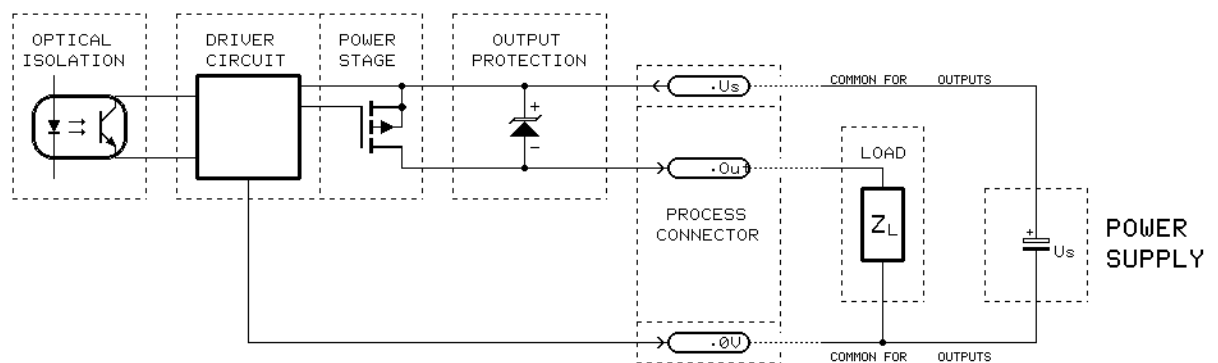


Fig. 3 Equivalent Output Circuit

2 Hardware Description

2.1. Overview

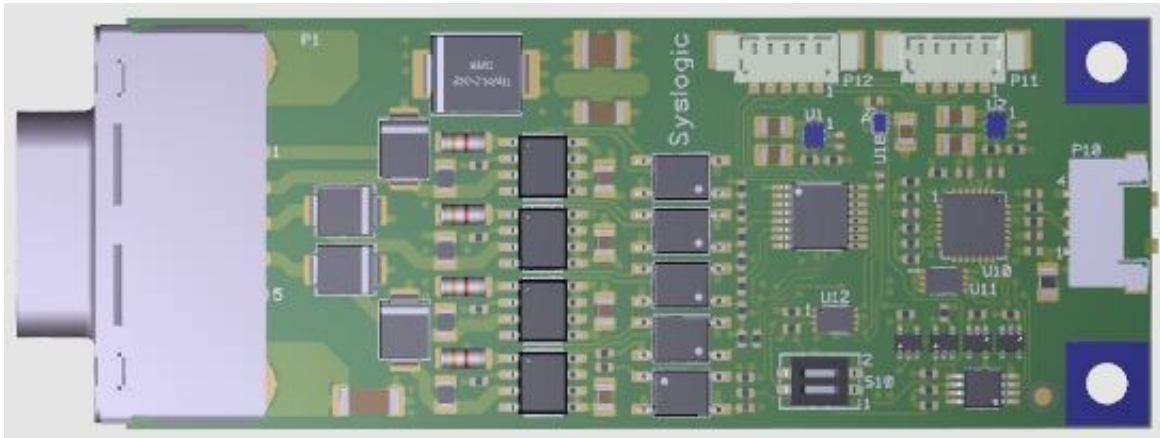


Fig. 4 Board Top View IPC/DI403D-101E

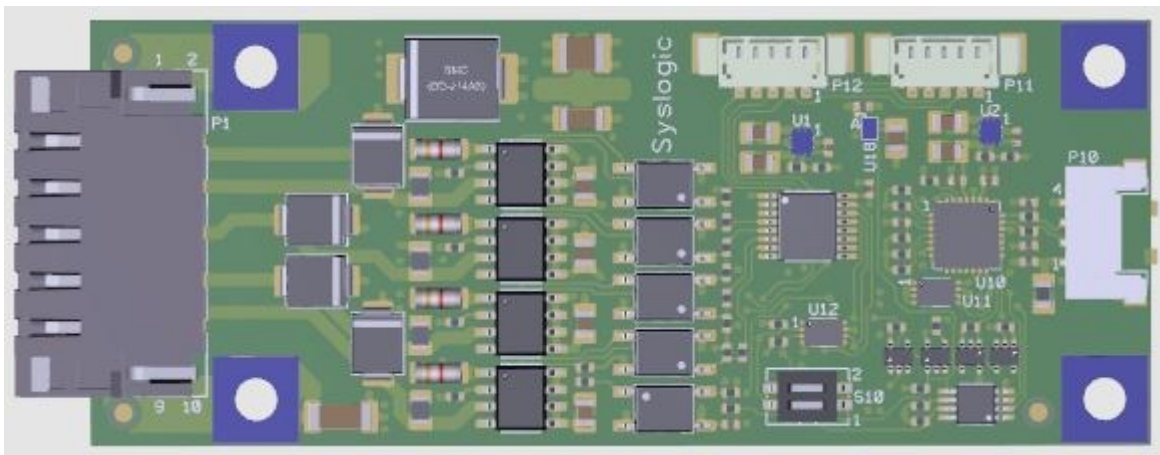


Fig. 5 Board Top View IPC/DI404T-101E

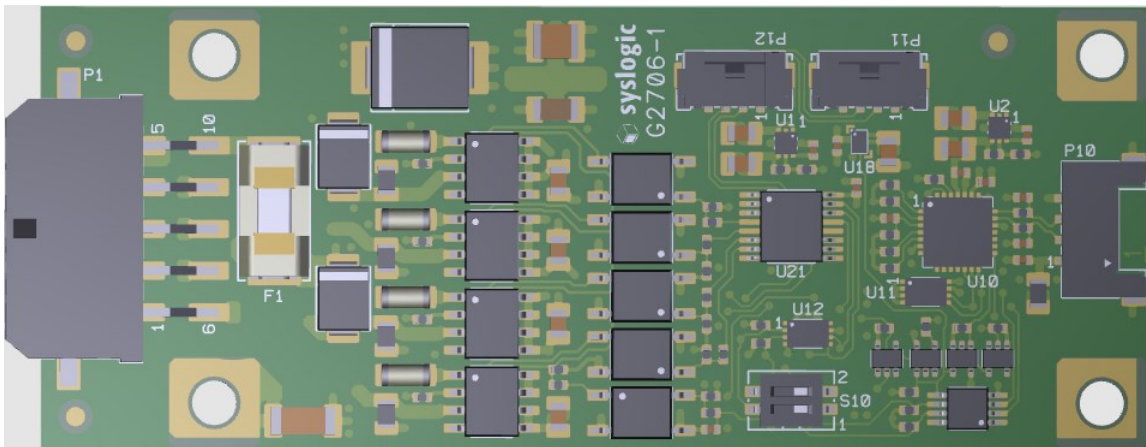


Fig. 6 Board Top View IPC/DI404E-101E

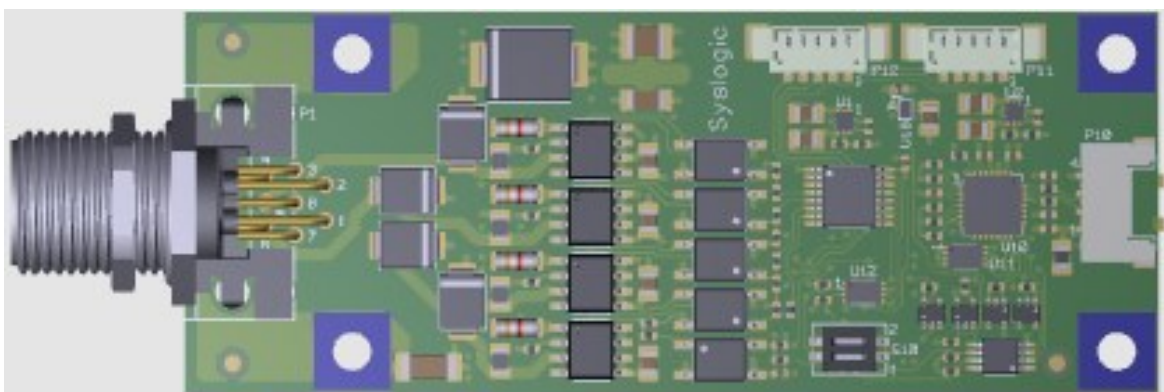


Fig. 7 Board Top View IPC/DI402M-101E

2.2. Protection

The DI40x boards integrate TVS diodes to protect the signals from high energy distortions and overcurrent/overtemperature circuits to protect the power switches from overload situations. Additionally the DI404E variant integrates a main fuse in the power input line which protects the system against destruction in case of high energy distortions or reverse voltage connection on the power line. For replacement, the system must be opened in an ESD protected environment. Only an entitled instructed person is allowed for this operation. Replacement fuse type is Littlefuse 0452004.MRL (4A slow-blow).

2.3. Addressing and Register Layout

Theoretical a maximum of four i/o boards can reside combined on the same physical I2C bus. One of them has to be connected to an USB or I2C host port (“Master”). The base configuration is done by setting switch S10 to the board address 0 to 3. This board address setting determines the final I2C address layout of the board.

Board Address	Device / Register	Remarks
S10 = 0x00 (1=off, 2=off)		
0x50	USB Configuration EEPROM	“Master” only
0x51	Board Configuration EEPROM	type AT24C02
0x20	Digital Input Port	type TCA9554
0x21	Digital Output Port	type TCA9554
S10 = 0x01 (1=on, 2=off)		
0x50	USB Configuration EEPROM	“Master” only
0x53	Board Configuration EEPROM	type AT24C02
0x22	Digital Input Port	type TCA9554
0x23	Digital Output Port	type TCA9554
S10 = 0x10 (1=off, 2=on)		
0x50	USB Configuration EEPROM	“Master” only
0x55	Board Configuration EEPROM	type AT24C02
0x24	Digital Input Port	type TCA9554
0x25	Digital Output Port	type TCA9554
S10 = 0x11 (1=on, 2=on)		
0x50	USB Configuration EEPROM	“Master” only
0x57	Board Configuration EEPROM	type AT24C02
0x26	Digital Input Port	type TCA9554
0x27	Digital Output Port	type TCA9554

Tab. 1 I/O Address Space Layout

Important Notes

Never configure multiple combined boards to the same S10 board address.
 Ensure that there is no I2C address overlapping between combined boards on the same I2C bus, otherwise the system may get damaged or may fail to operate.
 Only one of the combined boards may be connected to an USB or I2C host port.

2.4. Process Interface Connector Assignments

The input-/output connector pin assignment for the board is shown in Tab. 1 and 2. Please note that all inputs/outputs share a common external process signal ground and power supply. Sensors (input signals) are connected between process power US and the input pin of the IPC/DI4Ox (= current sink inputs). Actuators (output signals) are connected between the output pin of the IPC/DI4Ox and ground GNDS (= current source outputs).

Mating plug type IPC/DI4O3D-101E: any standard DSUB-9 female connector

I/O Connector Pin	Process Interface Signal	I/O Connector Pin	Process Interface Signal
1	Process Power (US)	6	Input A0
2	Output B0	7	Input A1
3	Output B1	8	Input A2
4	Output B2	9	Input A3
5	Process Ground (GNDS)		

Tab. 2 Process Interface Connector P1 (IPC/DI4O3D-101E)

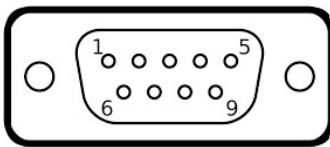


Fig. 8 Pinout IPC/DI4O3D-101E (DSUB-9 male, Front View)

Mating plug type IPC/DI4O4T-101E: Weidmüller B2CF 3.5/10/180F SN BK (Weidmüller ordering code 1277890000)

Field wiring solid or flexible H05 (07) V-U: AWG18...28 / 0.14-1.5 mm²

Field wiring with plastic collar ferrule, DIN 46228 pt 4: AWG18...28 / 0.14-1.0 mm²

I/O Connector Pin	Process Interface Signal	I/O Connector Pin	Process Interface Signal
1	Process Ground (GNDS)	2	Process Power (US)
3	Input A0	4	Output B0
5	Input A1	6	Output B1
7	Input A2	8	Output B2
9	Input A3	10	Output B3

Tab. 3 Process Interface Connector P1 (IPC/DI4O4T-101E)

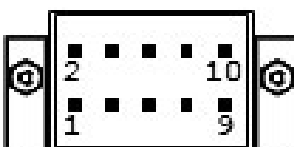


Fig. 9 Pinout IPC/DI4O4T-101E (2x5 Pin Terminal Block, Front View)

Mating plug type IPC/DI4O4E-101E: Molex MicroFit 3.0 plug housing 2x5 pin (Molex ordering code 43025-1000)

Crimp contact type: Molex 43030-0002/43030-0003/43030-0008/43030-0009 (gold plated, AWG20-24 / 0.21-0.60 mm²)

Crimp contact type: Molex 43030-0005/43030-0006/43030-0011/43030-0012 (gold plated, AWG26-30 / 0.05-0.15 mm²)

I/O Connector Pin	Process Interface Signal	I/O Connector Pin	Process Interface Signal
5	Process Ground (GNDS)	10	Process Power (US)
4	Input A0	9	Output B0
3	Input A1	8	Output B1
2	Input A2	7	Output B2
1	Input A3	6	Output B3

Tab. 4 Process Interface Connector P1 (IPC/DI4O4E-101E)

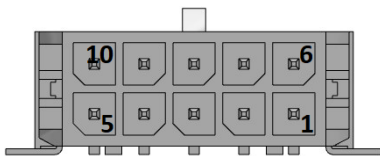


Fig. 10 Pinout IPC/DI4O4E-101E (2x5 Pin MicroFit, Front View)

Mating plug type IPC/DI4O2M-101E: any standard A-coded female threaded M12 conformal connector
 Field wiring: minimum 0.25 mm² recommended, depending on nominal load current.

Pin Number	Signal	Remarks
1	Input A0	
2	Input A1	
3	Input A2	
4	Input A3	
5	Output B0	
6	Output B1	
7	Process Power (US)	common for all outputs
8	Process Ground (GNDS)	common for all i/o's

Tab. 5 Process Interface Connector P1 (IPC/DI4O2M-101E)

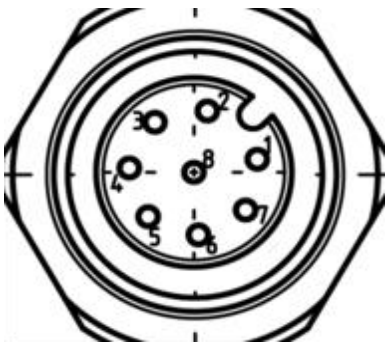


Fig. 11 Pinout IPC/DI4O2M-101E (M12 A-coded, male, front view)

2.5. Local Host Bus Interface (USB)

The USB interface of the IPC/DI4Ox allows connection to a wide range of processor boards with a standard USB 2.0 interface. The bus connector pinout is shown in Tab. 3.

Mating plug type: Molex Pico-Lock 504051-0401 with AWG24 contacts 504052-0098

Cable type: Use AWG24 wire, USB Data – and Data+ wires should be twisted for proper operation

Pin Number	Signal	Remarks
1	Vusb	USB Supply Voltage 5V
2	D-	USB Data -
3	D+	USB Data +
4	GNDusb	USB Supply Ground

Tab. 6 USB Local Bus interface P10 (1x4 pin, male)

2.6. Local/Expansion Bus Interface (I2C)

The I2C interface of the IPC/DI4Ox allows connection to a wide range of processor boards with a 3.3V I2C interface. It also may be used to chain up to four modules to one USB- or I2C-host.

The current versions of IPC/DI4O3D-101E, DI4O4T-101E, and DI4O2M-101E use 5 pin Molex Pico-Blade connectors, the DI4O4T-101E uses 4 pin Molex Micro-Lock Plus connectors. The connector pinouts are shown in Tab. 7,8.

Mating plug type: Molex Pico-Blade 51021-0500 with AWG26 contacts 50079-8100

Cable type: Use AWG26 wire

Pin Number	Signal	Remarks
1	Vcc	Supply Voltage 3.3V or 5V
2	SDA	I2C Data (3.3V CMOS level)
3	SCL	I2C Clock (3.3V CMOS level)
4	GND	Supply Ground
5	INT#	optional I2C interrupt line

Tab. 7 I2C Local/Expansion Bus interface Pico-Blade P11 and P12 (1x5 pin, male)

Mating plug type: Molex Micro-Lock Plus housing 505565-0401, Crimp contacts Molex 505431-1100

Cable type: Use AWG26 wire

Pin Number	Signal	Remarks
1	Vcc	Supply Voltage 3.3V or 5V
2	SDA	I2C Data (3.3V CMOS level)
3	SCL	I2C Clock (3.3V CMOS level)
4	GND	Supply Ground

Tab. 8 I2C Local/Expansion Bus interface Micro-Lock Plus P11 and P12 (1x4 pin, male)

Important Notes

Do not connect both, USB and I2C to a host. Leave USB connector P10 unconnected when using an I2C host.

Only one of the combined boards may be connected to an USB or I2C host port.

3 Programming Information

3.1. Overview

The programming of the DI4Ox board is done with USB or I2C read and write operations, depending on which host interface is used. For Windows and Linux operating systems an application programming library and sample code is available.

Check the library and sample code to see how the different I2C devices have to be set up for proper operation.

Do not modify the contents of the USB and board configuration EEPROMs otherwise you risk that the boards do not work anymore.

Note: The IOs are connected through an I2C IO Expander device. The required setup and programming information may be extracted from the library source code and application samples. The detailed programming information for the IO Expander may be found in the latest datasheet of the Texas Instruments TCA9554 device. The inputs A0-3 are connected to ports P0-3 of the first TCA9554, the outputs B0-3 are connected to ports P0-3 of the second TCA9554. The output failure feedback is connected to P7 of the second TCA9554. It detects short circuit and overtemperature situations of the digital output drivers (one common signal for all outputs).

(<http://www.ti.com/lit/gpn/tca9554>)

4 Technical Data

4.1. Electrical Data

Important Note

Do not operate the DI4Ox board outside of the recommended operating conditions. Otherwise lifetime and performance will degrade.
Operating the board outside of the absolute maximum ratings may damage the hardware.

Absolute Maximum Ratings (over free-air temperature range)

Parameter	Symbol	Min	Typ	Max	Unit
USB supply voltage	V _{cc}	-0.5		5.5	V _{dc}
process input voltage between inputs A0..3 and GNDS	V _{in}	-0.5		+45	V _{dc}
process voltage between US and GNDS	U _s	-0.5		+45	V _{dc}
isolation: process to chassis (AC, 60s, 500m a.s.l., Ta=25°C)		1000			V _{rms}
process to logic (AC, 60s, 500m a.s.l., Ta=25°C)		1500			V _{rms}
creepage distance: logic to chassis		1.8			mm
creepage distance: process to chassis		2.0			mm
process to logic (excluding chassis path)		4.3			mm
fuse current (DI4O4E only)	I _{og(fuse)}			4	A

Tab. 9 Absolute Maximum Ratings

Recommended Operating Conditions

parameter	Symbol	min	nom	max	Unit
USB supply voltage	Vcc(usb)	4.75	5.00	5.25	V
I2C supply voltage	Vcc(i2c)	3.0	5.00	5.25	V
high-level input voltage at A0..3 (=input ON)	Vih	10	24	45	V
low-level input voltage at A0..3 (=input OFF)	Vil	0		5	V
process voltage between US and GNDS	Us	10	24	45	V
output current at B0..3 (concurrent on all outputs)	Io	0	500	600	mA
output current at B0..3 (one single output)	Iomax			1.0	A
total output current group B (Us to B0..3) DI4O3D, DI4O4T, DI4O4E	Iog(max)			2.4	A
DI4O2M				2.0	A
operating free-air ambient temperature range	Ta	-40		+85	°C

Tab. 10 Recommended Operating Conditions

Electrical Characteristics

(over recommended operating range, unless otherwise noted)

parameter	Symbol	min	typ	max	Unit
USB supply current (Vcc=5.0V, all in/outputs off)	Icc			tbd	mA
(all in/outputs on)				tbd	mA
input current at A0..3 (Vin=Vih)	Iih	2.0		6.0	mA
input current at A0..3 (Vin=Vil)	Iil			0.5	mA
process supply current US to GNDS (Us=30V, all outputs on, no load, Ta=25°C)	Ius			50	mA
output on resistance (Us=24V, Io=1A, Ta=25°C)	Rds(on)		0.2	0.3	Ω
output off leakage current (Us=24V, Ta=25°C)	Io(off)		5		uA
output overcurrent limiting			4..9		A
over-temperature shutdown (junction temperature)			150		°C
incandescent lamp load (Us=24V)		5			W
output inductive clamping voltage	Vcl		US-63		V
output single pulse avalanche energy	Eas		125		mJ
process supply Us transient voltage protection, 1ms exponential (TVS-Diode Vbr=48V)			1500		W

Tab. 11 Electrical Characteristics

Switching Characteristics (nominal conditions)

parameter	Symbol	min	typ	max	Unit
input frequency (Vin=nom., duty ratio 1:1) note: effective max frequency is dependent on application/driver polling time capability	fimax	2			kHz
input pulse width (Vin=nom.)	tw	250			us
input pulse suppression (Vin=nom., duty ratio 1:20)		10			us
input on delay (Vin=nom.)	ton		tdb		us
input off delay (Vin=nom.)	toff		tdb		us
switching frequency (Us=24V, resistive load 500mA) note: effective max frequency is dependent on application/driver polling time capability	fomax	1			kHz
switch on delay (Us=24V, resistive load 500mA)	ton			tdb	us
switch off delay (Us=24V, resistive load 500mA)	toff			tdb	us

Tab. 12 Switching Characteristics

4.2. Mechanical Data

The DI4Ox board is available in three functionally identical variants, IPC/DI4O3D-101E, IPC/DI4O4T-101E, IPC/DI4O4E-101E and IPC/DI4O2M-101E. They only differ in the connector type, DSUB-9 for DI4O3D, terminal block for DI4O4T, wire-to-board connector for DI4O4E, M12 for DI4O2M and number of output channels (see connector assignment section and technical data section).

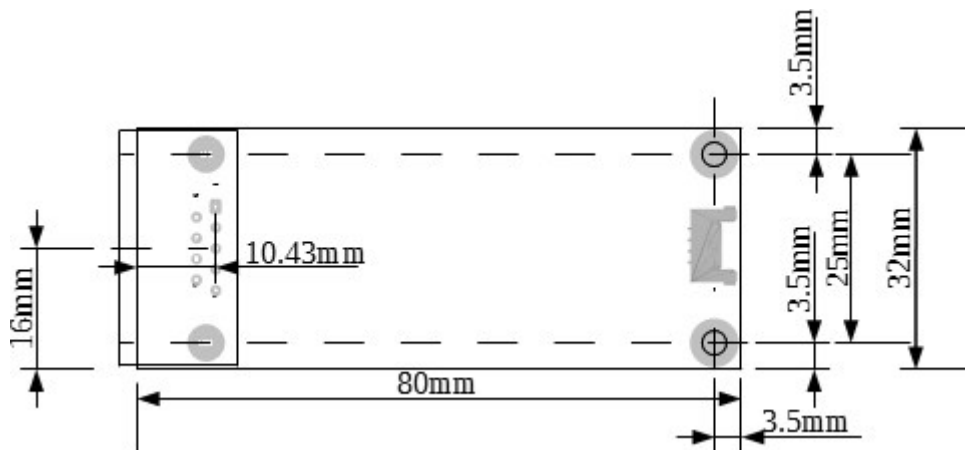


Fig. 12 Mechanical Dimensions IPC/DI403D-101E (9 Pin DSUB)

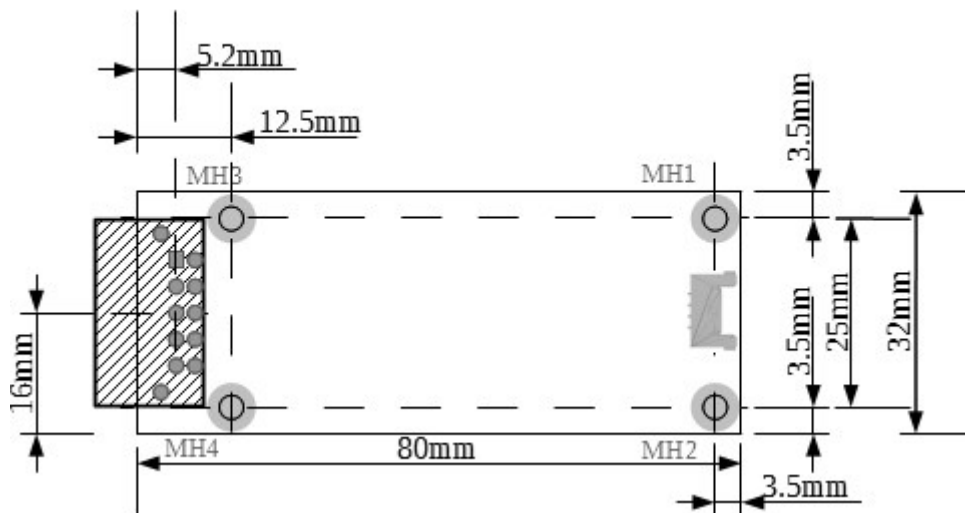


Fig. 13 Mechanical Dimensions IPC/DI404T-101E (2x5 Pin Terminal Block)

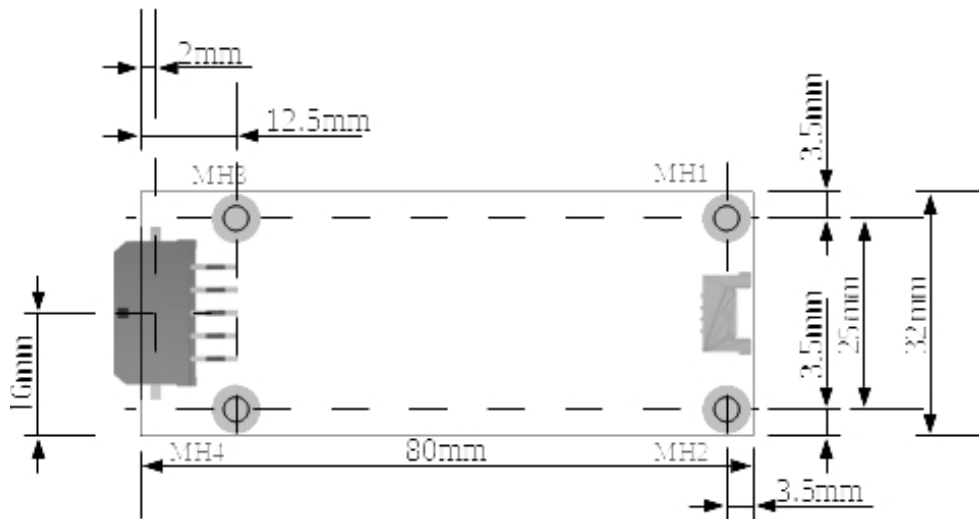


Fig. 14 Mechanical Dimensions IPC/DI404E-101E (2x5 Pin Wire-to-Board Connector)

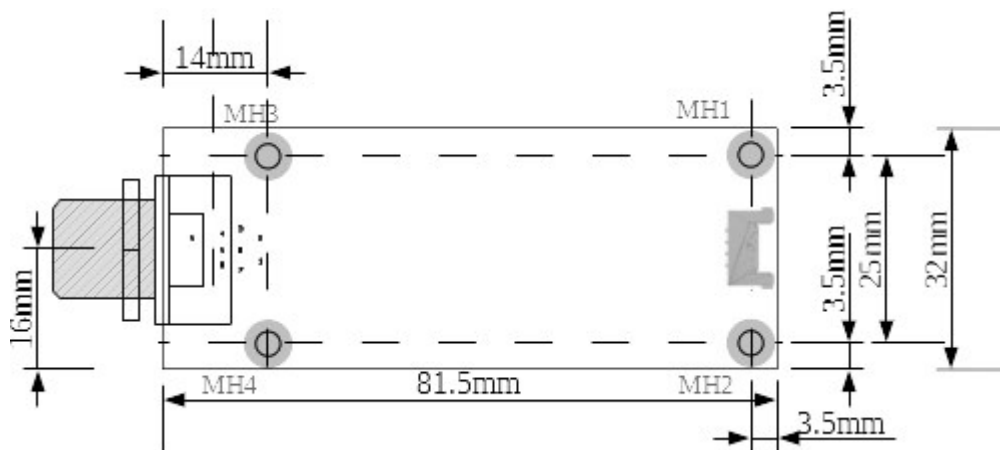


Fig. 15 Mechanical Dimensions IPC/DI402M-101E (8 Pin M12)