HALswitch R8
Galvanically Insulated Relay Board

Users Manual

Table of Contents

1 Copyright

2 History

Date	Changes in document
04/2022	Description of pinout of encoder inputs of IntelliIO-connector corrected
09/2021	Description of RASPIbase added
09/2021	Added specification of MOTF/quadrature encoder wiring
09/2021	Initial version

3 Safety

The hardware described here is an electrostatic sensitive device. This means it can be damaged by common static charges which build up on people, tools and other non-conductors or semiconductors. To avoid such a damage, the hardware has to be handled with care and including all relevant procedures (like proper grounding of people handling the device, shielding/covering to not to let a person touch the device unwanted, proper packaging in ESD-bags, ...). For more information please refer to related regulations and standards regarding handling of ESD devices.

The EMC Directive (2014/30/EU) does not apply to this hardware as it is not intended for an end user (a person without knowledge of EMC) and as it is not otherwise made available on the market.

The Low Voltage Directive (2014/35/EU) does not apply to this hardware as the voltage used and supplied is below the 50VAC / 75VDC limit.

The hardware described here is not a stand-alone, ready-to-be-used device, but a component which is intended to be used as part of a larger device, e.g. for integration in a machine with own housing or within an electrical cabinet.

This document describes the HALswitch relay board but may contain errors or may be changed without further notice.

4 Overview

This document describes the HALswitch R8 relay board, its electrical characteristics and usage.
This board is designed to be connected to the low-voltage, digital interface of a scanner controller card directly. Using this device the outputs of this digital interface can be used to switch up to 7A (12A peak) and up to 50VAC/30VDC (optionally up to 250VAC but in full responsibility of the user and by using additional security measures) via a set of galvanically insulated relays.
The digital inputs of that digital interface can be driven by 12..24V signals directly, here also a galvanic insulation between the 24V rail and the 5V digital inputs of the scanner controller card is active.

The installation of the HALswitch relay board is easy. It provides a set of connectors for different types of scanner controller cards which have to be connected via a simple 1:1 cable only. Choose the connector which fits to the used controller model and establish a connection via flat-belt-cable (using IDC connectors). After establishing this connection and applying 24V power to the controller, the HALswitch board is fully functional.

This board is not a ready-to-use device but a component which is intended to be integrated in larger devices or to be operated with an own housing.

4.1 Features

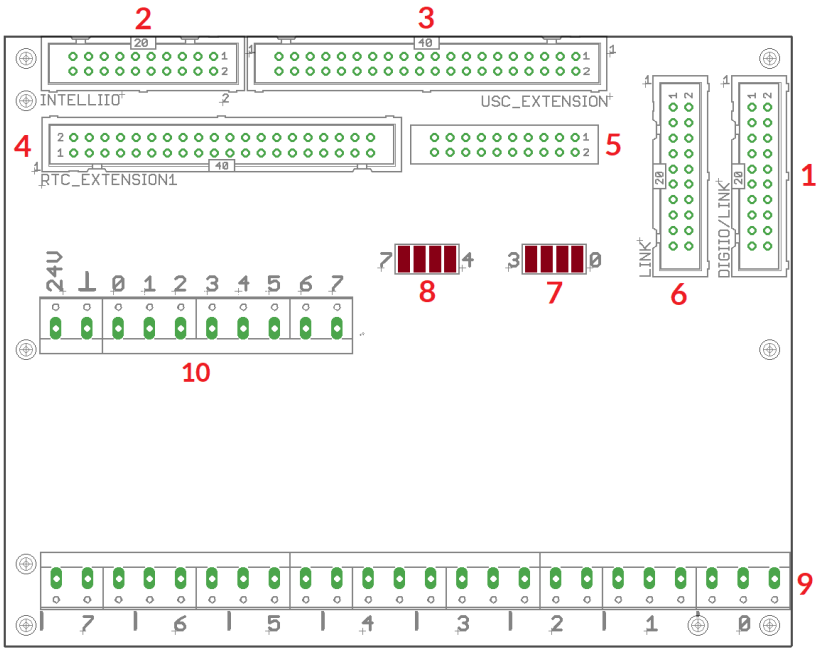
The HALswitch relay board provides the following features:

- 8 galvanically insulated outputs and inputs
- inputs can be operated with 12..24V directly
- outputs act on relays with a normally opened and a normally closed contact
- outputs can switch up to 7A permanent / up to 12A peak and up to 50VAC/30VDC directly (outputs technically can be operated with up to 250VAC too, but this is up to the full responsibility of the user)
- dielectric strength between 5V rail (scanner controller card) and 24V rail (digital input signals) is 250V at least
- dielectric strength between 24V rail and 50V rail (digital outputs via relays) is 1000V at least (on the surface of the PCB, requires additional security measures to avoid bridging of the voltage via the solder points of the PCB), for details please refer to section “APPENDIX A - HALswitch Board Sections” below
- can be connected to the Digital IO extension of the E1701A, E170C, E1701D scanner controller directly
- can be connected to the Digital Interface of the E1803D scanner controller directly or
- can be connected to the IntelliIO extension of the E1803D scanner controller directly or
- can be connected to the EXTENSION interface of the SCAPS® USC-2®, USC-3® scanner controller directly or
- can be connected to the EXTENSION1 interface of the Scanlab® RTC5®, RTC6® scanner controller directly or
- can be connected to the GPIO header of a Raspberry Pi single-board computer directly[1]
- a second HALswitch relay board can be connected via the LINK-interface to use the upper digital ports of a scanner controller card (applies for DIGITAL IN 8..15/DIGITAL OUT 8..15 of RTC5® and RTC6® and DIGI_IN_8..9/DIGI_OUT_8..9 of USC-2® and USC-3®)
- single relays can be disabled via jumpers (e.g. to use the related port for shutter control instead for switching of larger voltages)
- mapping of digital outputs and assigned relays can be changed easily by using cross-connection cables instead of these 1:1 jumpers

[1)] with Raspberry Pi only digital outputs are supported, the inputs are not used

5 HALswitch Board And Connectors

The HALswitch board provides the following connectors and related functions:



1. Interface to one of DigiIO extension of E1701A/C/D or digital interface of E1803D or to LINK of previous HALswitch board
2. Interface to IntelliIO extension of E1803D
3. Interface to EXTENSION connector of SCAPS® USC-2® or USC-3®
4. Interface to EXTENSION1 connector of Scanlab® RTC5® or RTC6®
5. Interface to Raspberry Pi GPIO header
6. Link to next HALswitch board (in case a digital interface with more than 8 IOs is used)
7. Jumpers to optionally turn off DOut0..DOut3 output or wires to change mapping of outputs
8. Jumpers to optionally turn off DOut4..DOut7 output or wires to change mapping of outputs
9. Screw connectors for contacts of relays that are linked to digital outputs
10. Screw connectors for 12..24V digital inputs and to supply 24V power to the HALswitch board

5.1 Interface to Digital IO extension / Digital interface

This interface can be used to connect the HALswitch with

- the digital Interface of the E1803D scanner controller card or
- with the interface of the DigiIO extension board of the E1701A/C/D controller card or
- with the LINK-interface of a previous HALswitch board

In every of these cases this requires a plain 1:1 connection via a 20-pin flat-belt cable between controller card and HALswitch connector only, so no special wiring is necessary.

5.1.1 Connection of marking on-the-fly encoder inputs

Both the Digi IO extension board of the E1701-controller series and the digital interface of the E1803D controller come with inputs for quadrature encoders, that can be used for 1D and 2D marking on-the-fly-applications. Such encoders typically provide a 5V signal. When the HALswitch board is used and the digital extension/digital interface is connected with (1), these encoders still can be used. Here following steps are necessary:

- connect input 0 and 1 of screw terminal (10) with GND from same terminal
- connect input 2 and 3 of screw terminal (10) with GND from same terminal (in case of 2D marking on-the-fly with two encoders used)

- extend the flat-belt-cable from connector (1) to forward the signals from pins 2, 4, 6 (1D MOTF) and optional 8, 10 (2D MOTF) to your encoders … or:
- use the connector (2) to feed in the encoder signals there according to the given pinout:

Pin number	Name	Remark	Pin number	Name	Remark
1		Do not connect!	2		Do not connect!
3			4		
5			6		
7			8		
9	DIn0	Encoder 1 input A	10	DIn1	Encoder 1 input B
11	DIn2	Encoder 2 input A	12	DIn3	Encoder 2 input B
13		Do not connect!	14		Do not connect!
15			16		
17			18		
19			20	GND	Ground for encoder inputs

5.2 Interface to IntelliIO extension of E1803D

This interface can be used to connect the HALswitch with the IntelliIO extension board of the E1803D scanner controller. This is a plain 1:1 connection via a 20-pin flat-belt cable, so no special wiring is necessary.

5.3 Interface to EXTENSION of USC-2/3

This interface can be used to connect the HALswitch with

- the EXTENSION interface of the USC-2® board from SCAPS® or
- with the EXTENSION interface of the USC-3® board from SCAPS®

In every of these cases this is a plain 1:1 connection via a 40-pin flat-belt cable, so no special wiring is necessary. As the USCs EXTERNAL interface provides more than 8 digital IOs, a second HALswitch board can be used to access the upper two digital in-/outputs. This second board is connected via the LINK-interface, here a direct 1:1 connection with a 20-pin flat-belt cable has to be established between connector (6) of the first HALswitch board and connector (1) of the second HALswitch board (for more details please refer to section “5.6 Link to next HALswitch board” below).

5.4 Interface to EXTENSION1 of RTC5/6

This interface can be used to connect the HALswitch with

- the EXTENSION1 interface of the RTC5® board from Scanlab® or
- with the EXTENSION1 interface of the RTC6® board from Scanlab®

In every of these cases this is a plain 1:1 connection via a 40-pin flat-belt cable, so no special wiring is necessary. It is recommended to operate the EXTENSION1 interface on 5V. Please refer to the manual of the RTC5/6 scanner control card: the voltage of the RTCs EXTENSION1 interface can configured with the Jumper JP1 which can be found on the bottom side of the RTC5/6 and has to be set to position 1-2.

As the interface of the RTC5/6 controller card provides more than 8 digital IOs, a second HALswitch board can be used to access the upper eight digital in- and outputs. This second board is connected via the LINK-interface, here a direct 1:1 connection with a 20-pin flat-belt cable has to be established between connector (6) of the first HALswitch board and connector (1) of the second HALswitch board (for more details please refer to section “5.6 Link to next HALswitch board” below).

5.5Link to Raspberry Pi GPIO header

Using this interface the HALswitch board can be connected to the GPIO header of a Raspberry Pi. All current

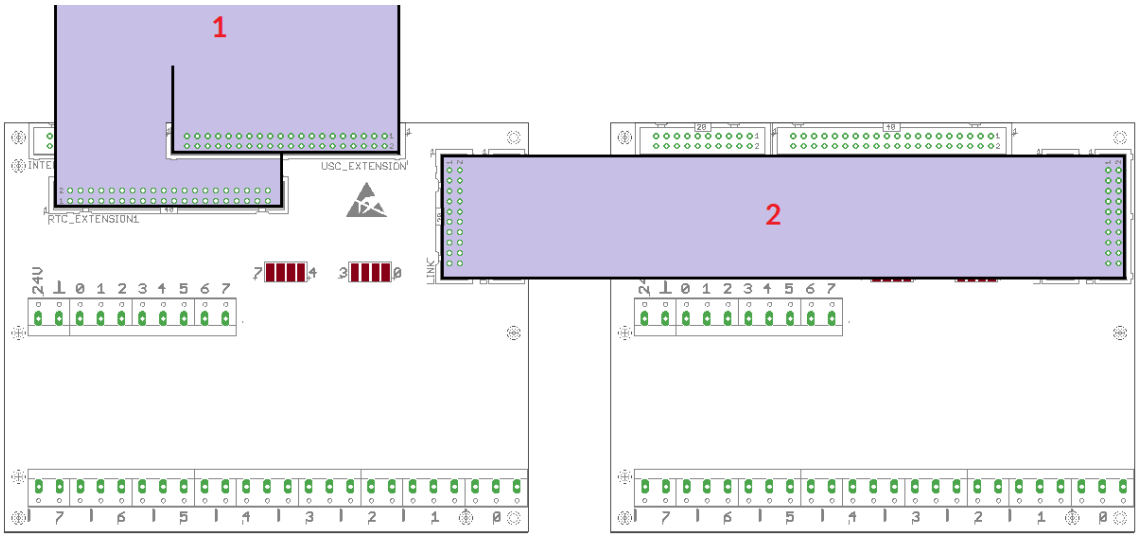
versions of the Ras Pi are supported including the ones with the 40 pin and 26 pin headers. In both cases from these headers only the lower 20 pins are used, so a split cable is required which connects only the pins 1..20 to the HALswitch board.
The remaining upper 6 / upper 20 pins of the Raspberry Pi header are not required to be connected to the HALSwitch board and can be used freely for other purposes.
The GPIOs and signals of the lower 20 pins that are not used as outputs for the HALswitch board (please refer to the table below), can be used for other purposes freely.
This interface currently makes use of digital outputs only, the input-pins of the HALswitch board are not yet supported when the Raspberry Pi connector is used.

Following GPOs are mapped to following HALswitch-outputs:

Raspberry Pi GPO	Pin number	HALswitch output
GPIO2	3	DOut0
GPIO3	5	DOut1
GPIO4	7	DOut2
GPIO17	11	DOut3
GPIO22	15	DOut4
GPIO23	16	DOut5
GPIO24	18	DOut6
GPIO27	13	DOut7

5.6 Link to next HALswitch board

One HALswitch relay board can handle up to 8 digital in- and outputs. To use it with controller cards that provide more than 8 IOs on a single extension connector, a second HALswitch board can be connected to handle the upper digital IOs:



The first HALswitch board is connected via one of the two connectors (1) with the scanner controller card (one of USC-2/3® or RTC5/6®) that provides all the digital signals. From this connection the lower 8 digital in- and outputs are handled by this first HALswitch relay board.
An other connection (2) is established from the first HALswitch card (LINK-connector) to the second HALswitch board (DIGIIO/LINK-connector) via a 1:1 20-pin flat-belt cable. This second HALswitch board does NOT need any additional connection to the source scanner controller card, everything is done via this LINK-interface.
Now the second HALswitch card handles the upper digital signals of the controller card, means DIn8/DOut8 of the scanner controller are accessible as DIn0/DOut0 at the second HALswitch board, DIn9/DOut9 of the scanner controller are accessible as DIn1/DOut1 at the second HALswitch board and so on. The remaining wiring (connection of 24V power supply, 12..24V-inputs and relay-outputs) is the same as for the first

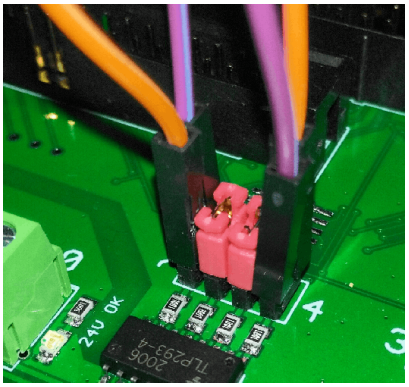
HALswitch card and described below.
A third HALswitch relay board can not be connected in the same way.

5.7 Jumpers to detach DOut0..DOut3

When using the HALswitch board, the digital outputs drive some relays. Such relays can switch high loads but are typically slower than a plain electronic connection. So when some of the digital outputs of a scanner controller card shall not be used to drive a relay and/or are intended to be toggled with a higher frequency than it is usable with a relay (e.g. to send pulses to a stepper motor driver), single outputs can be separated by removing the related jumpers. Here the position (7) gives the possibility to disconnect one or more of the outputs DOut0, DOut1, DOut2 and DOut3 from the relay. When the input flat-belt cable, that comes from the scanner controller card is split, these outputs then can be used for other purposes.
Alternatively it is also possible to use these sets of jumper-connectors to map the outputs of the controller card to other relays by using some cables cross-connecting them. For details please refer to the next section.

5.8 Jumpers to detach DOut4..DOut7

When using the HALswitch board, the digital outputs drive a relay each. Such relays can switch high loads but are typically slower than a plain electronic connection. So when some of the digital outputs of a scanner controller card shall not be used to drive such a relay and/or switching with a higher frequency is intended, single outputs can be separated by removing the related jumpers. Here the position (8) gives the possibility to disconnect one or more of the outputs DOut4, DOut5, DOut6 and DOut7 from the related relay. When the input flat-belt cable is split, these separated outputs then can be used for other purposes in parallel.
Alternatively it is also possible to use these sets of jumper-connectors to map the outputs of the controller card to other relays by using some cables cross-connecting them. In this case these cables replace the jumpers:



In this example the outputs 5 and 6 of the controller are mapped 1:1 to the relays 5 and 6 via normal jumpers. The outputs 4 and 7 are exchanged via short cables: Output 4 of the controller card is connected via the orange cable to output relay 7 and output number 7 of the controller is mapped via the purple cable to relay number 4. This allows fast and easy reconfiguration of the hardware.

5.9 Relay-switched digital outputs

The lower row of screw-terminal belongs to the relays that are switched via the digital interface of the connected scanner controller card. They consist of a common (input) pin, one normally closed and one normally opened contact for each output. These relays allow a maximum load of 7A permanent, 12A peak and 50VAC/30VDC (optionally 250VAC but in full responsibility of the user).
From left to right the pinout is as follows:

Label	Name	Pin	Description

7	DOut7	1	DOut7 normally open
		2	DOut7 common (voltage input)
		3	DOut7 normally closed
6	DOut6	4	DOut6 normally open
		5	DOut6 common (voltage input)
		6	DOut6 normally closed
5	DOut5	7	DOut5 normally open
		8	DOut5 common (voltage input)
		9	DOut5 normally closed
4	DOut4	10	DOut4 normally open
		11	DOut4 common (voltage input)
		12	DOut4 normally closed
3	DOut3	13	DOut3 normally open
		14	DOut3 common (voltage input)
		15	DOut3 normally closed
2	DOut2	16	DOut2 normally open
		17	DOut2 common (voltage input)
		18	DOut2 normally closed
1	DOut1	19	DOut1 normally open
		20	DOut1 common (voltage input)
		21	DOut1 normally closed
0	DOut0	22	DOut0 normally open
		23	DOut0 common (voltage input)
		24	DOut0 normally closed

5.10 Galvanically insulated digital inputs

The middle row of screw terminals is used as power supply for the HALswitch board and can be used to set the digital inputs of the connected scanner controller card by using a 12..24V voltage directly. Galvanic insulation and conversion to the 5V logic level of the scanner card is done by the HALswitch relay board.
The power supply via 24V is mandatory also when only the outputs are intended to be used.
From left to right the pinout is as follows:

Label	**Description**
24V	24V power input to drive the 24V-rail of the relay board
GND	GND related to the 24V power supply of previous pin and related to the voltage of the input
0	Input signal for DIn0 of the controller card in range 12..24V and in respect to GND
1	Input signal for DIn1 of the controller card in range 12..24V and in respect to GND
2	Input signal for DIn2 of the controller card in range 12..24V and in respect to GND
3	Input signal for DIn3 of the controller card in range 12..24V and in respect to GND
4	Input signal for DIn4 of the controller card in range 12..24V and in respect to GND
5	Input signal for DIn5 of the controller card in range 12..24V and in respect to GND
6	Input signal for DIn6 of the controller card in range 12..24V and in respect to GND
7	Input signal for DIn7 of the controller card in range 12..24V and in respect to GND

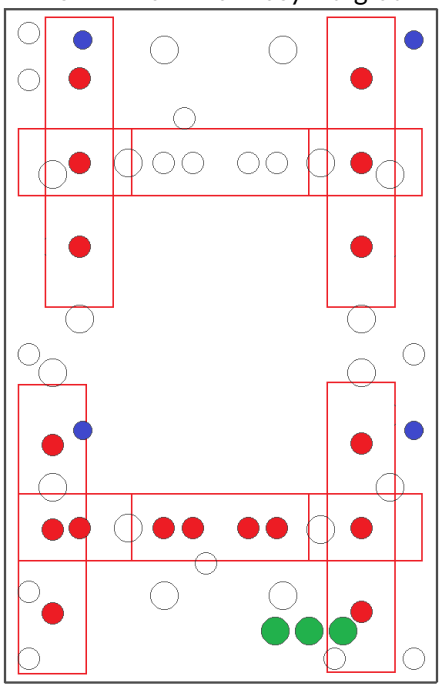
Inputs that are not connected on 12..24V side or which are permanently pulled to GND there, can still be used as 5V inputs. This is necessary e.g. in case of the marking on-the-fly encoder inputs of the Digital Interface (E1803D) or the Digi I/O extension (E1701): in this case the quadrature encoder signals can be fed into DIn0/DIn1 (DIn2/DIn3 optional) on 5V-side as usual but the inputs 0/1 (2/3) on 24V-side have to be left open to avoid overlapping signals.

6 RASPIbase Mounting Kit

The RASPIbase extension is a mounting help for easy installation on DIN rails and other possibilities of mechanical integration into machines. It can be used together with a Raspberry Pi to mount it either

- directly on such a DIN rail or
- on top of an E1803D controller card or
- on top of an E1803dock or
- on top of an HALswitch R8 relay board

For this it offers different predefined holes which allow an easy integration in all these scenarios:



RED – mounting positions for DIN rail locks/DIN rail adapters (bottom side). Here pairs of locks can be mounted in one of 5 possible positions and one of two possible orientations (horizontal or vertical). Here locks of type Phoenix Contact 1201578 or similar can be used. With these locks the board then can be clamped on a DIN rail.
GREEN – holes to give access to the screw clamps of E1803D controller card when the RASPIbase is mounted on top of it right aligned (here the RASPIbase would cover these screws otherwise)
BLUE – mounting holes for the Raspberry Pi itself, they fit to all common variants (excluding tiny boards and compute modules like Pi Zero). Here hex-stands/distance bolts can be screwed in where the Raspberry Pi is mounted on top.

All the remaining holes can be used to mount the RASPIbase in one of the following situations:

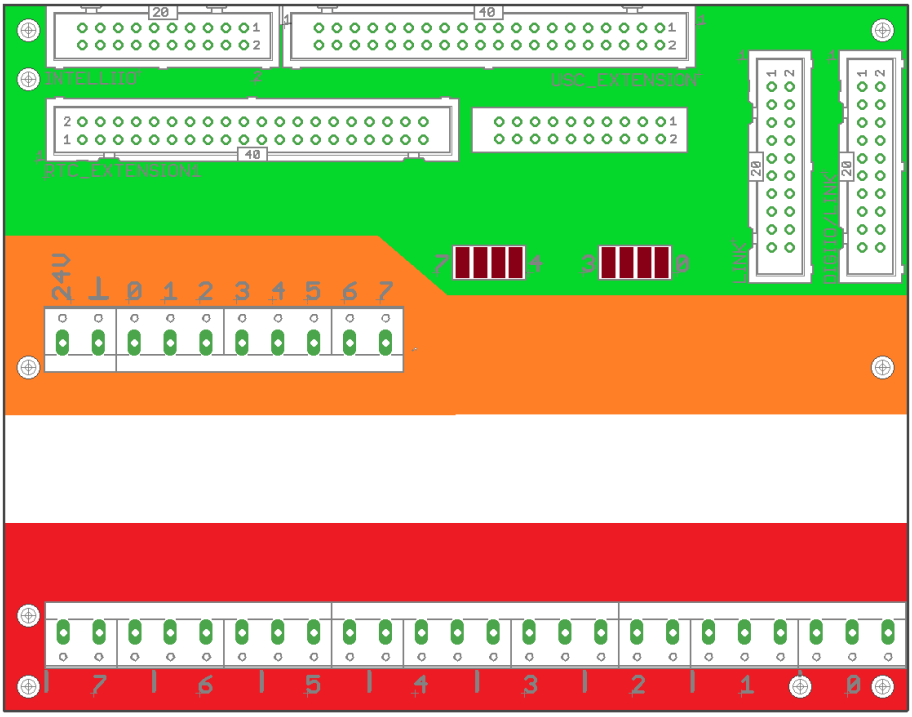
- on top of an E1803D scanner controller card, right aligned
- on top of an E1803D scanner controller card, left aligned
- on top of an E1803dock laser signal breakout board, right aligned
- on top of an E1803dock laser signal breakout board, left aligned
- on top of an HALswitch R8 relay board, right aligned
- on top of an HALswitch R8 relay board, left aligned

They also can be used with hex-stands/distance bolts.

APPENDIX A - HALswitch Board Sections

The HALswitch R8 relay board consists of different sections which are galvanically insulated from each other. The conversion of the input and output voltages between these sections are done by the board. So no matter if 24V are applied to an input screw terminal or if an output is intended to switch up to 50VAC/30VDC, the scanner controller is separated from that completely and deals only with the signal levels it really supports. The GND-lines of these sections are separated from each other too, there is no connection between them and there

should no connection be established between them in order to keep the galvanic insulation.
Following sections of the controller card exist and are separated from each other:



GREEN – 5V logic section of the scanner controller card (electrostatic sensitive section)
ORANGE – 24V level section (standard voltage for signals in industrial environments and electrical cabinets; electrostatic sensitive section)
RED – 50V/250V level section[1]

The dielectric strength between GREEN (5V) and ORANGE (24V) is 250V at least. The dielectric strength between ORANGE (24V) and RED (50V/250V) is 1000V at least.
But **PLEASE NOTE: this dielectric strength is guaranteed only for the surface of the HALswitch relay board! Depending on mounting of the PCB and resulting from that, depending on the distance to other possibly electrically conductive parts of used housing or used electrical cabinet, one may fall below these insulation values!**
For additional insulation and/or contact protection e.g. a E1803dock may be used and mounted below of the HALswitch relay board to protect and insulate the lower PCB surface.

ATTENTION! All screws, hex-stands and distance bolts in ORANGE and RED area have to be non-metallic and non-conducting! Elsewhere the insulation between the different sections is broken resulting in potential dangerous electrical connections! Thus for security reasons and to avoid mistakes during mounting, it is recommended to use plastic/nylon material for all screws/hex-stands/distance bolts as soon as the HALswitch board is involved!

[1]) The HALswitch board is designed and specified to operate 50VAC/30VDC at max (red section). However it is technically able to switch up to 250VAC. As this requires additional security measures and extended insulation of the surface of the PCB, operating the board with these voltages is out of its intended purpose and done in full responsibility of the user only.

APPENDIX B - Test certificate

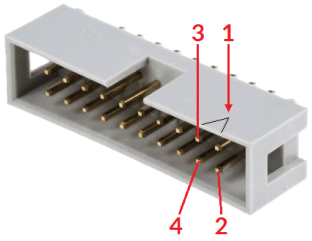
Test certificate sample examination for dielectric strength:

Hardware revision: 1.0

	Tested signals	**Voltage without flashover**	**Resistance**	**Test result**
Between 5V (green) and 24V (orange) section (expected/nominal)	5 V GND ↔ 24 V GND	>250 V	>250 kOhm	PASS
Between 5V (green) and 24V (orange) section (measured)		2500 V	2,6 GOhm	
Between 24V (orange) and 50V/250V (red) section (expected/nominal)	24 V GND ↔ 50 V GND	>1000 V	>1 MOhm	PASS
Between 24V (orange) and 50V/250V (red) section (measured)		5000 V	12,2 GOhm	

APPENDIX C – IDC connector pin numbering

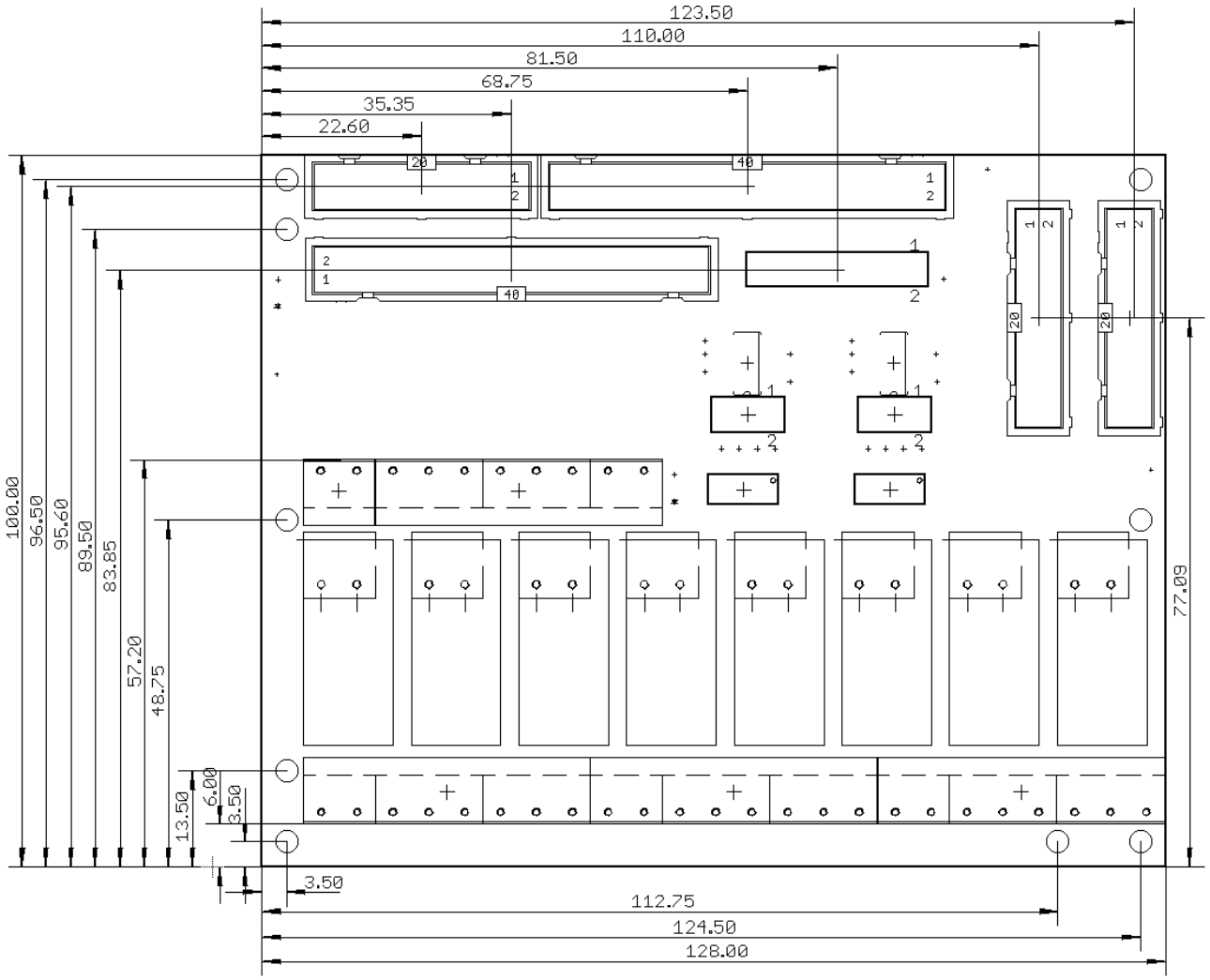
Pin numbering of the IDC connectors (according to pinout-tables shown in hardware description sections above) can be seen in below image:



The first pin is marked by a small arrow in connector. Second pin is below of it, counting continues column-wise.

APPENDIX D – Board dimensions

Board dimension drawing, all values are given in unit mm.



Alphabetical Index

S

U