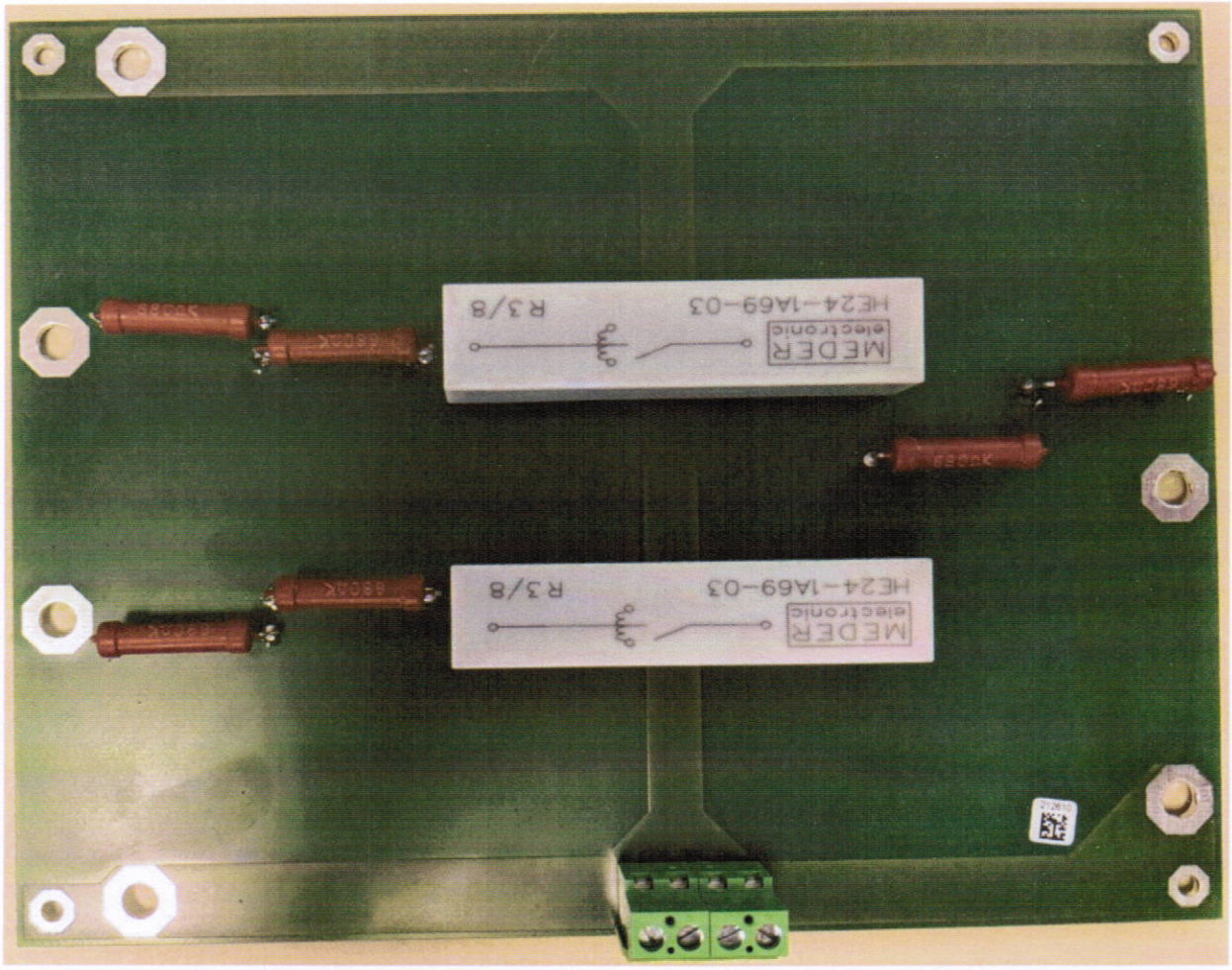
HV relais 10

OEM circuit board for switching between two voltages up to 10 kV



Manual

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Content

Revision: 1.9.2023

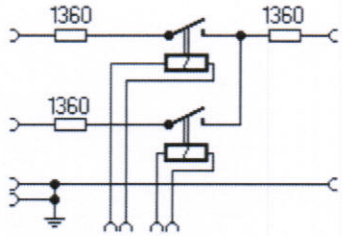
1. Safety

Warning!
Do not touch the board in operation at it is designed to work with external power supplies up to 10 kV. Make sure that it can't be touched during operation.
Do not use higher voltages than rated voltage for the board.
Mount the board with at least 25 mm long bolts. Keep at least 25 mm distance to anything else.

Notice
Do not use power supplies capable of delivering more than 50 mA, especially if short circuits are possible. This may burn the current limiting resistors.
Do not drive the relays with more than 24VDC, otherwise the coils may be destroyed.

2. Principle of operation

The board HV relais 10 ist designed to switch two different high voltages to one output. It is also possible to switch on HV input potential to two different outputs. As both switches are independent, it is also possible to switch on both switches at the same time or none of them.
In series to each input/output, there is a 1360 Ω resistor (actual 2*680 Ω in series), so in on state, between any input and output, there will be at least 2720 Ω.
The reason for the resistors is to limit short circuit currents (~3.7A@10 kV) so that the relay contacts will not be damaged by high peak currents and the relay is still able to switch off while current is flowing. Further, mechanical switching can be extremely fast (~ns rise time) which may cause ringing on cables and electromagnetic disturbances. The resistors limit this to a minimum. The drawback of this is that with any current flowing, a voltage drop has to be considered; and the current must be limited to 50 mA RMS.



Principal schematic

The advantage of using reed relays for switching is that the setup is rather simple and quite compact, and the open state impedance is extremly high (> 10 GOhm, <1pF).

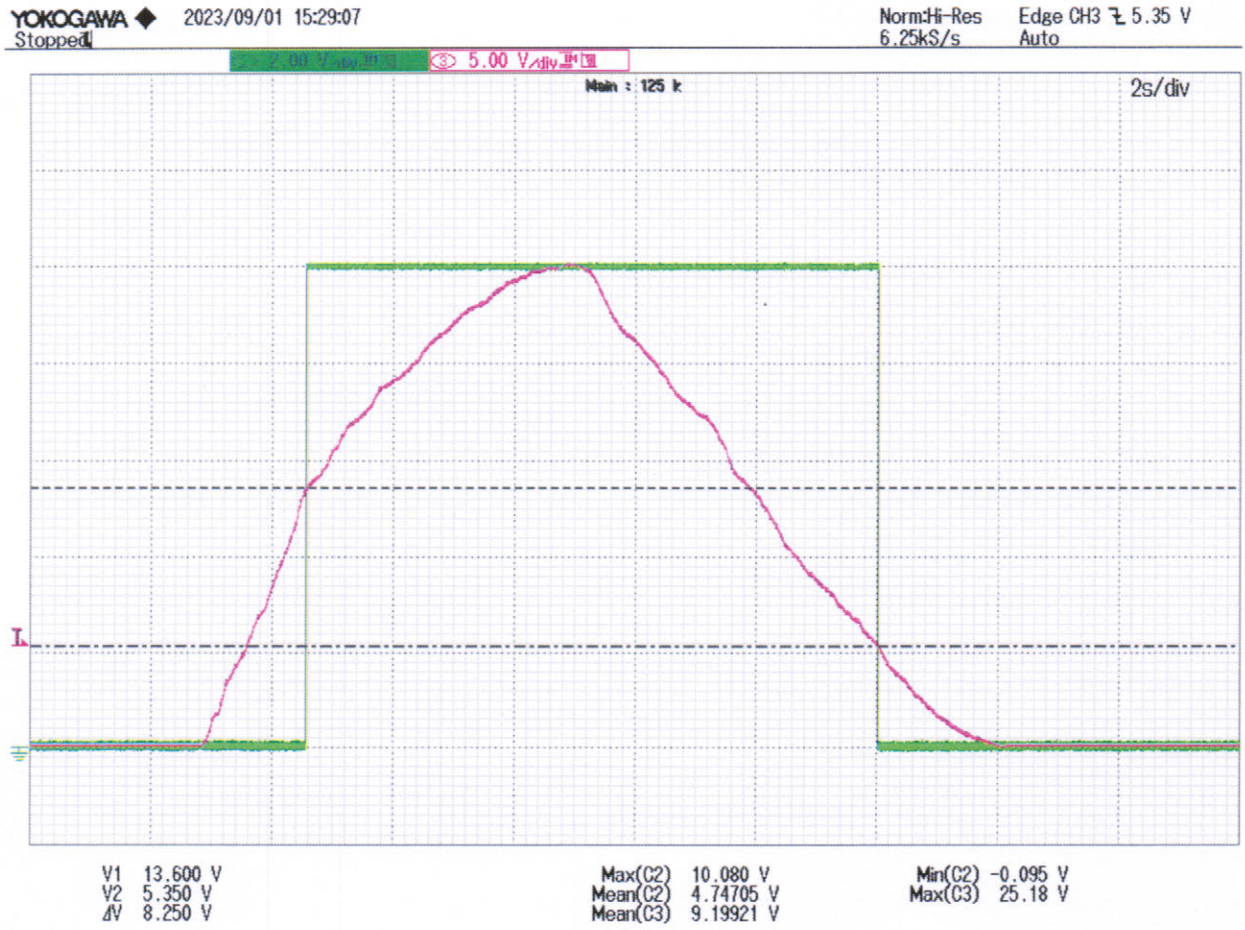
3. Connection

At first, mount the board with the 25 mm bolts to some ground potential. Mount this inside some housing, so that the board cannot be touched during operation.
Connect input and output voltage cables using M5 screws.
Connect the coil driving voltages to the screw clamp connectors. Its recommended to have a diode antiparallel to the coil, especially if driving the coil with a bipolar transistor.

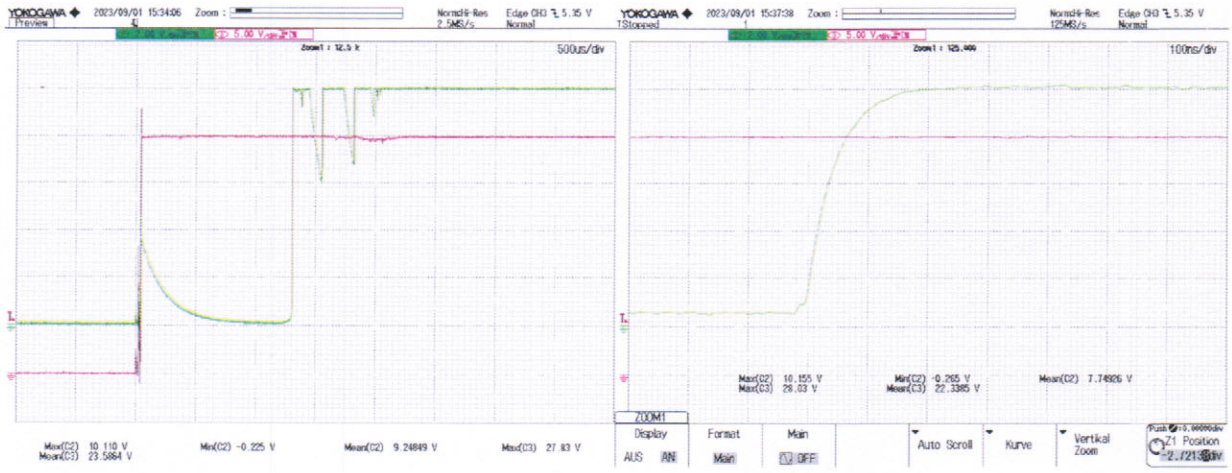
4. Operation

Apply the desired voltages to the inputs/outputs. Any voltage is suitable, positive or negative does not matter, as long as voltage to ground or voltage between inputs does not exceed rated voltage (10 kV).
Apply a suitable voltage to any coil, and it will switch. The coil voltages should not deviate more than 100V from ground. Use an antiparallel diode at the coil to prevent overvoltages during switching off. However, switching off with an avalance-rated MOSFET is also ok.

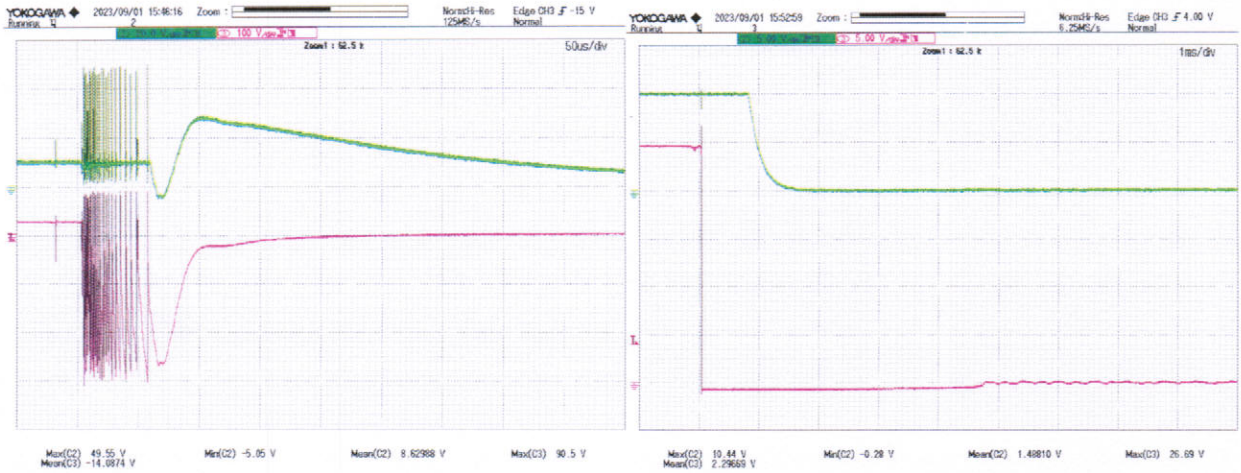
5. Example waveforms



Purple: coil voltage, Green: Output switching. Here the coil voltage is slowly adjusted from zero to 25V and back to zero. The relay switches on at 13.6V and switches off at 8.2V. The datasheet values are 18V maximum for switching on and 2V minimum to switch off.



Fast switching on with 24V. Left: 500µs/div, right 100 ns/div. The coil needs about 1.3 ms to react, then there may be some bouncing, but latest after 3 ms the relay should be stable.



Switching off the coil. Left: mechanical switch off without diode, 50 µs/div, Right: switch off with antiparallel diode, 1ms/div. Hard switching off may be quite fast (~50µs) but due to the inductance of the coil, this will generate voltage spikes of up to 300V and this can be disturbing and damaging. Therefore it is recommended to have an antiparallel diode in place. This delays switching off to about 1 ms, and current may still flow for 5 ms, but overvoltages/disturbances are avoided.

7. technical data

The HV relais 10 is designed to switch two diffent HV input signals to an output. It is intended for small currents and voltages up to 10 kV. It comes as a single OEM circuit board. It is intended to be integrated within a device or mounted in a housing.

Function, high voltage side

The board consists mainly of two high voltage reed relais which switch two inputs to one output. The reed relais are controlled by separate 24 V coils.
As mechanical switching causes extremly fast transients, there are 2*680 Ohm in series which each input, so in total there are always 2.7 kOhm between any input and output. These resistors, which are special high voltage proof resistors, limit the current and reduce eletromagnetic disturbances caused by switching.

- Maximum voltage at any input/output: 10 kV
- Maximum RMS current: 50 mA
- Maximum stored energy in any input /output: ~100 J max., which corresponds to 2 µF at 10 kV.
- Impedance across open relais: 0.8 pF, >10GOhm.

Relais control

The relais are controlled by a nominal 24 VDC coil with a 465 Ohm resistance, resulting in 52 mA current at nominal voltage.

- Minimum pull in voltage: 18V
- Minimum drop out voltage: 2 V
- Operate time inc. bounce: 3 ms
- Release time: 1.5 ms

Connections, mechanical

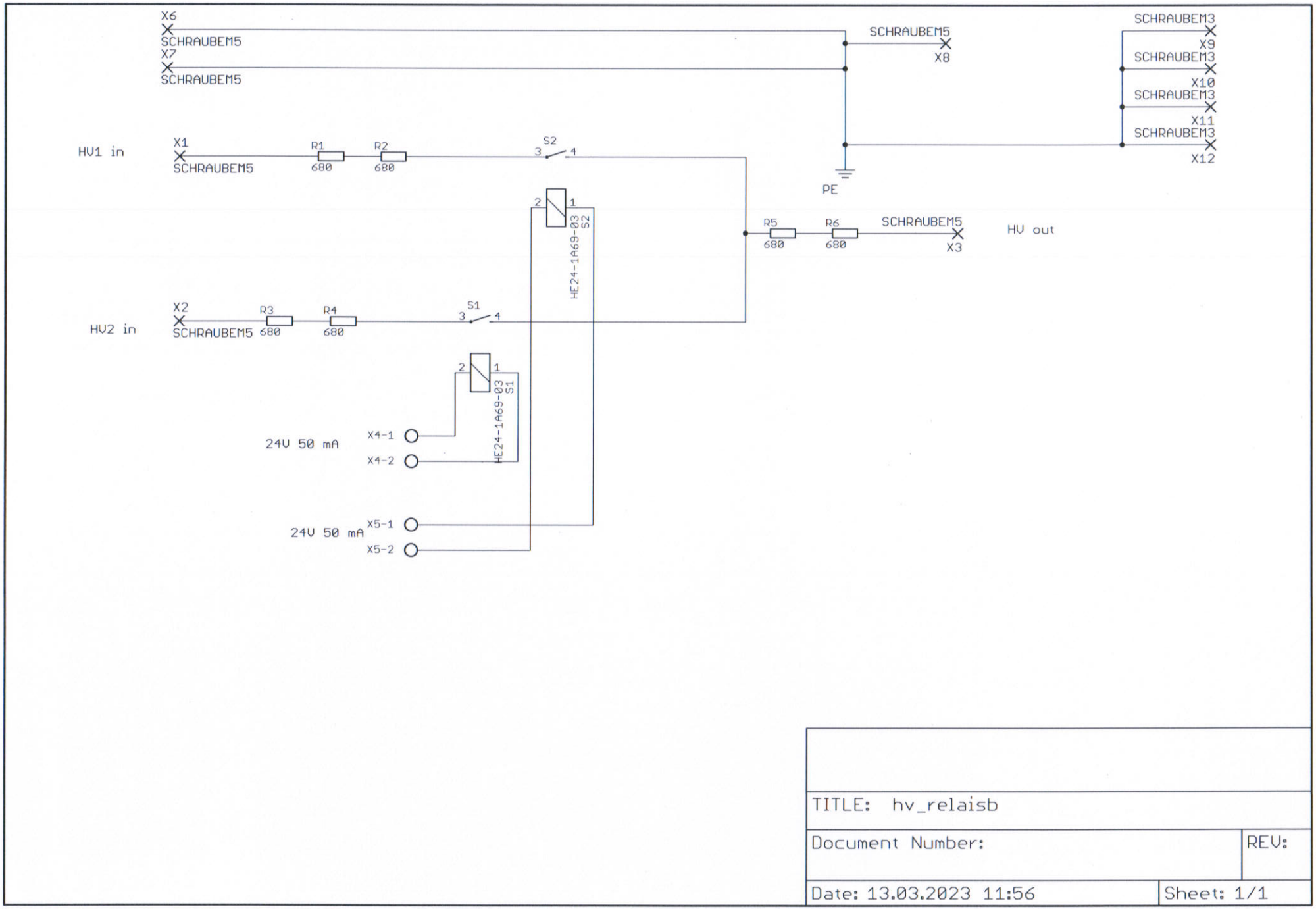
- Circuit board, size 175*135mm.
- Mechanical fastening to bolts with M3 screws in the edges, distances 165.1 *124.46 mm. These screws are on ground potential.
- Inputs and output connections by holes for M5 screws.
- 3 additional screw holes M5 for ground connection.
- 2*2 screw cable clamps for relais coils.

Environmental

- Operation temperature range 0-50 °C
- humidity 0-80%, the board is intended for use in dry laboratory rooms within a housing.

Safety

- The board can handle dangerous voltages up to 10kV. It should be mounted inside a housing such that it cannot be touched during operation.
- For isolation, the recommended distance for voltages up to 10 kV is 20 mm, preferably a bit larger. So also the mounting bolts for the board should have a length of at least 20 mm.
- Do not switch large capacitor banks with this. Otherwise the current limiting resistors will be destroyed.



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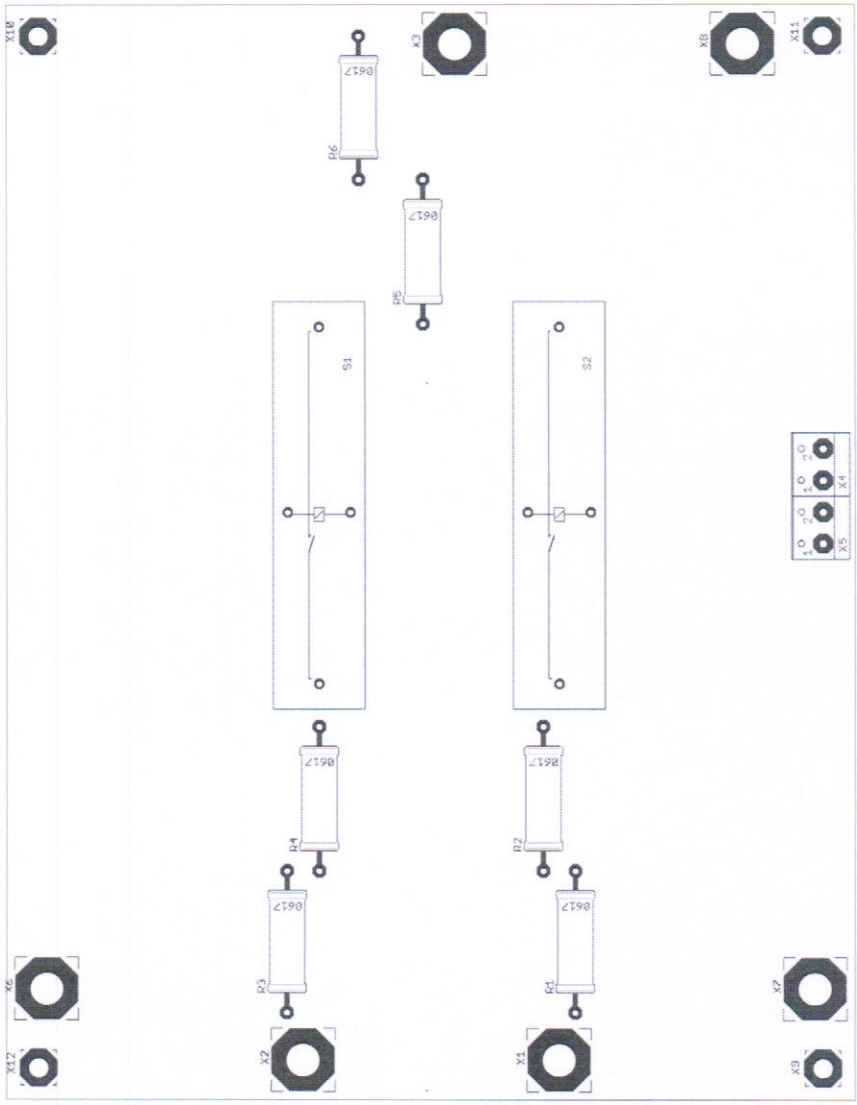
X10
X3
X8
X11
0617
R6
0617
R5
S1
S2
X4
X5
0617
R4
0617
R2
0617
R3
0617
R1
X6
X12
X2
X1
X7
X9

Test sheet HV relais 10:

Test performed by:	date:	board serial #
JB	4.9.2023	212610

	Expected	Switch S1, between X1 and X3	Switch S2, between X2 and X3
Switch on voltage	<18V	13,5V	13,3V
Switch off voltage	>2V	5V	5,3V
coil current @24V	47 ... 58 mA	51,3mA	51,4mA
resistance input-output, contact closed	2.61 ... 2.84 kOhm	2568 Ω	2603 Ω
12 kV applied	no sparkover	✓	✓

OK: JB