Minipuls 6

kit for efficiently generating high frequency high voltage

Manual

GBS Elektronik GmbH
Bautzner Landstraße 22
01454 Radeberg
Germany

Tel.: 0049 (0)351 21 70 07 - 0
Fax.: 0049 (0)351 21 70 07 - 21
E-Mail: kontakt@gbs-elektronik.de
Website: www.gbs-elektronik.de

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Appendix

1. Safety

Attention!
This device works with high voltage to 35 000 V, possible in the short-circuit currents up to 250 mA.
Do never touch the output or anything connected to it while in operation.

Attention: Also at Maintenance and adjustment works, do never touch the transformer cascade.
The primary voltages are limited to 40 V and harmless.
The bridge converter should never operate without fuse (max. 20A!).

2. Principle of operation

The assembly Minipuls 6 is developed to generate high AC voltages up to 30 kV peak (=60 kVpp or 21 kV RMS). The operation frequency range is 5-20 kHz. The device consists of a full bridge converter and a transformer cascade. Input voltages can be supplied by a standard laboratory power supply. The converter delivers a powerful low voltage square wave, and the cascade transforms this up and filters out a sine-like waveform. Control is by an external control signal. For monitoring, there is a high voltage divider and a current monitor. The device is protected against overvoltages by a spark gap.

3. Operation

At first connect supply voltage 15-35V on terminal X5-1 (GND: X5-2).

Choice the operating mode:

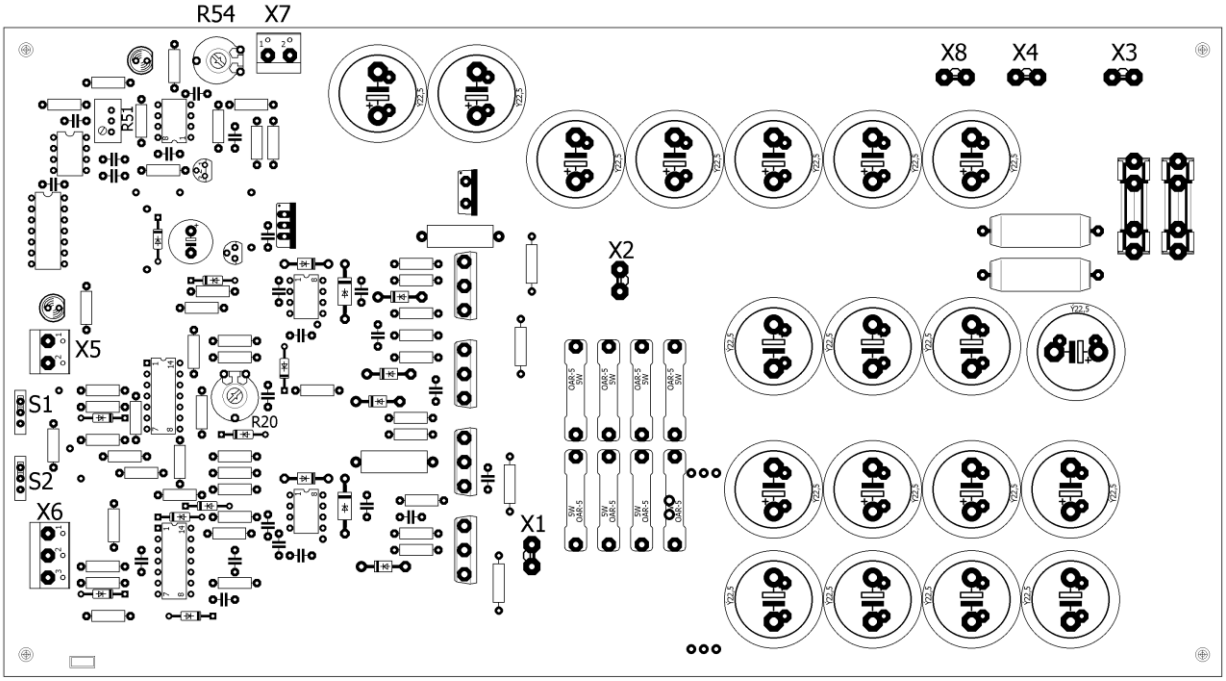
Mode	Microswitch S2		Generator mode	Switch S1
TTL	on		Extern	on
+/- 5V	off		Internal	off

Connect external control pulse generator to the signal input on terminal X6-1 (GND: X6-3).
Connect power supply bridge 0-45V over 6.3mm plug X3 (GND: X4).

In case of unknown load to start with low bridge voltage (3-5V) and choose a higher frequency (30 kHz). **It is important to connect the ground from transformer cascade with the ground of the full bridge.**

3.1 Connection

3.1.1 bridge converter



output bridge converter X1 and X2
The transformer cascade (X9, X10) is connected here by means of a 6.3mm plug (twisted black cable).

power supply X3 (+), X4 (-)
Connect a external bridge voltage of 0-40V (twisted black/red cable).

supply voltage X5-1 (+), X5-2 (-)
Connect a external supply voltage of nominal 24V (possible 17-35V).

control input X6-1, X6-3 (GND)
The pulse generator is controlled by the signal input with a TTL or +5V/0V/-5V signal. The switching thresholds are available in the following table.

control input:

	logic:+/- 5V	logic: TTL
T1 on	5V>U>3V	5V>U>3V
off	2V>U>-2V	2V>U>1.2V
T2 on	-3V>U>-5V	1V>U>0V

voltage control open:1.8V: input current control input: < 1.5mA.
allowed input voltage range: +/-5V.

inhibit-input (X6-2)
The Inhibit-Input disables the generator at input voltages of > 1.5V and enables it at < 1.5V.

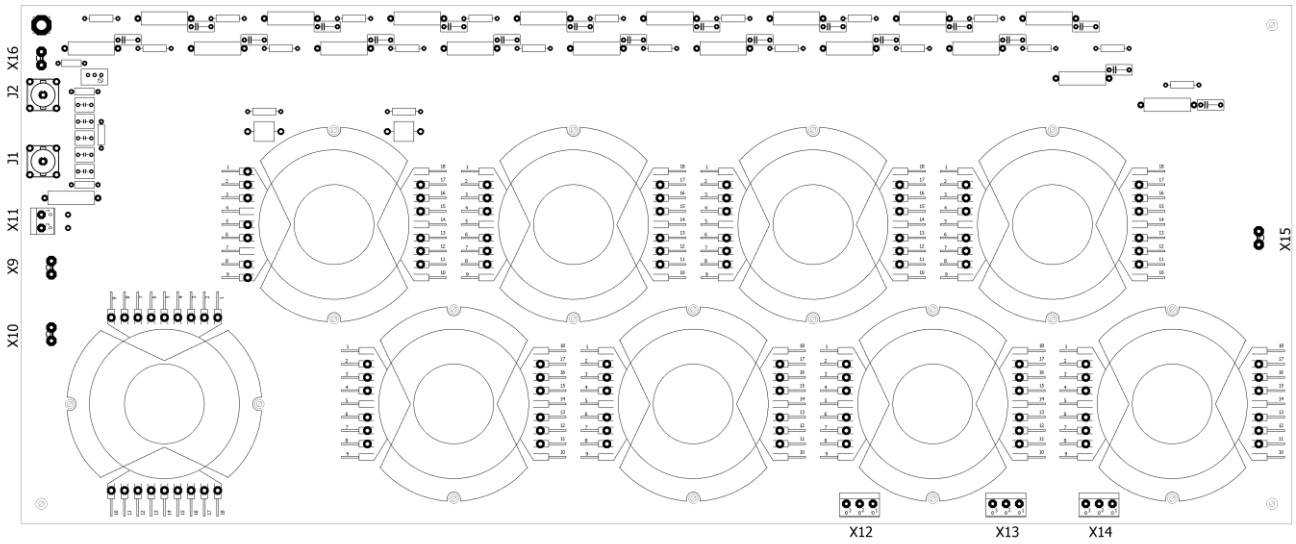
enabled	Input open or U<1.5V
disabled	U>1.5V

Current into signal inputs <0.5mA.

terminal X7 – NTC thermistor (10k)
Connect the gray twisted pair cable with the terminal X11 of the transformer cascade. Monitoring the temperature at the first transformer and switches off by overtemperature.

Ground Connection X8
The ground of the transformer cascade must be connected here.

3.1.2 transformer cascade



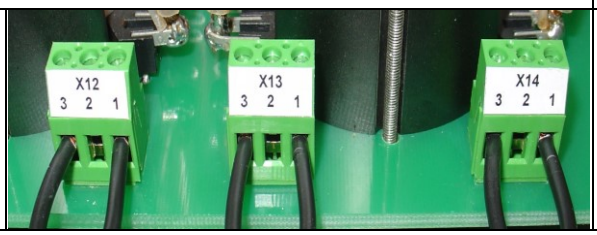
transformer cascade input X9 and X10
The bridge converter (X1, X2) is connected here by means of a 6.3mm plug.

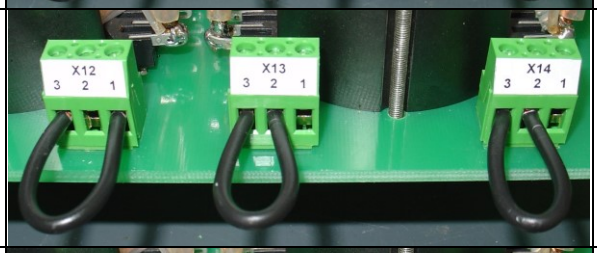
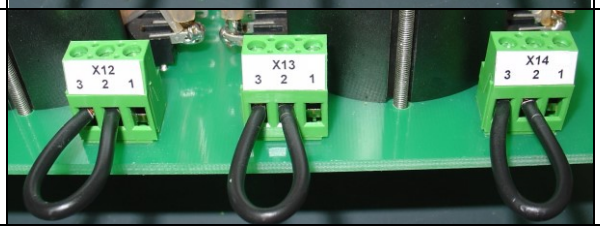
terminal X11 – NTC thermistor 10k
see above 3.1.1 bridge converter – connect the NTC thermistor.

terminals X12, X13, X14
Over the Terminals X12, X13, X14 the last 3 transformers can be disabled by shorting. This results in maximum output voltage reduced to 19 kV peak, but nominal load increased to 250 pF. Normally all stages active and the cable between X12-1 and X12-3; X13-1 and X13-3; X14-1 and X14-3.

Connections	active stages
X12-1 and X12-3, X13-1 and X13-3, X14-1 and X14-3	**8**
X12-3 and X12-2, X13-3 and X13-2, X14-3 and X14-2	**5**

Attention: Do not remove any cables, as this could be destructive to the uppermost transformers!

cable connections		active stages	bridge voltage	output voltage (peak)
X12-1 and X12-3 X13-1 and X13-3 X14-1 and X14-3		8	**30 V**	30 kV

X12-1 and X12-3 **X13-1 and X13-3** **X14-3 and X14-2**		7	**30 V**	27 kV
X12-1 and X12-3 **X13-3 and X13-2** **X14-3 and X14-2**		6	**30 V**	24 kV
X12-3 and X12-2 **X13-3 and X13-2** **X14-3 and X14-2**		5	**30 V**	21 kV

Remark: In an earlier version of this manual, the markings of pin 1 and pin 3 of X12, X13 and X14 were exchanged. Relevant for connection is however not the marking, but the position.
Generally: Connecting 3 and 1 connects the secondary of the lower transformer to the primary of the higher transformer, this is standard.
Connecting 3 and 2 shorts the primary of the higher transformer, so this will have a low impedance and behave as if non existent.
Wrongly connecting 1 and 2 will short the secondary of the lower transformer. This will cause that there is only marginal output voltage, but will not harm.
Doing no connections will leave the primary of the higher transformer open. So this will behave as a high impedance series inductor. This may cause a weird and small output signal. I worst case, the voltage generated by the first transformers will then be across the last transformer, and this overvoltage may cause destruction.

monitor output J1 (I) , J2 (U)
Output current and -voltage can be measured on the monitor output. J1 has a calibration of **10V/A**. The voltage monitor signal has a divider ratio of nominally **1:3000**. The accuracy of this is however limited. If an accuracy of better 10% is required, the divider should be recalibrated using the setup where it is acually used.

high voltage output X15
The load is connected directly at the end of the transformer cascade. A sufficient isolation distance (at least >7cm) is important, as the pulse generator delivers voltages up to 30 kV. If a wire is used to connect X15 and load, the minimum distance applies also to the wire. If an isolated high voltage cable is used, use one rated at least for 30 kV AC! Do not use shielded HV cables, as the capacity of these is too high, 1 m shielded HV cable is already the nominal load of the Minipuls 6. Keep cables anyway as short as possible. And keep clear of this while the unit is in operation, the output is dangerous!

Ground connection X16
The ground of the full bridge must be connected here.

3.2 Settings

R20 – primary maximum current
R20 is for adjusting the primary maximum input current and therefore also the output current.
R20 adjusts the maximum current from the bridge converter in a range from 0-100A. Standard settings should be about 60 A (~320 mV). Too high current may cause strange effects, drive some transformers into saturation or even destroy the converter!

R51 – internal frequency generator
adjust output frequency in the range 7 to 30 kHz. Important: Switch S1 must be set to internal.

temperature monitoring - calibration

R54 – temperature transformer cascade
With R54 calibration the minimum triggering level of the temperature sensor. Adjusts the maximum temperature of the transformer cascade in a range from 60-95°C (conforms ~2.4...~1.05V). The temperature sensor has a typical error of less than 5°C. Standard settings are about 85°C and should not be changed. Too high temperature destroy the transformer cascade!
If the temperature exceeds 85°C at the first transformer, the generator switches off. Red LED D18 on indicates overtemperature.

3.3 monitoring and limiting

To the destructive influence of unfavorable load or control input has the generator some security circuits.

primary current monitoring: If the primary current exceeds 60 A the pulse is switched off immediately (<0.5 µs).

overvoltage limiting: The device is protected against overvoltage by a spark gap. If the voltage in the first transformer exceeds 4.3 kV (approx. 35 kV output voltage) the spark gap will fire. Then the voltage should be reduced.

temperature monitoring bridge converter: If the temperature exceeds 70°C at the transistors, the generator switches off. Red LED D2 on indicates overtemperature.

fuse: If the input current is greater 20 A, the fuse will blow.

temperature monitoring transformer cascade: If the temperature exceeds 60°C at the first transformer, the generator switches off. Red LED D18 on indicates overtemperature.

4. Maintenance, troubleshooting

Danger!
The Pulse generator delivers voltages up to 30 kV with serious output power. So, it hazardous to touch the output or anything inside while the unit is in operation. All circuits of the pulse generator are fully documented, but because of the danger maintenance should be restricted to qualified personnel.

Nothing happens when switch on / control input:
- check the voltage.
- fuse okay?
- inhibit active?
- Microswitches S1, S2 in correct position?
- check output transistor, control circuit
- bug in the control input
- short-circuit in cable to temperature sensor at cascade, or too high temperature.

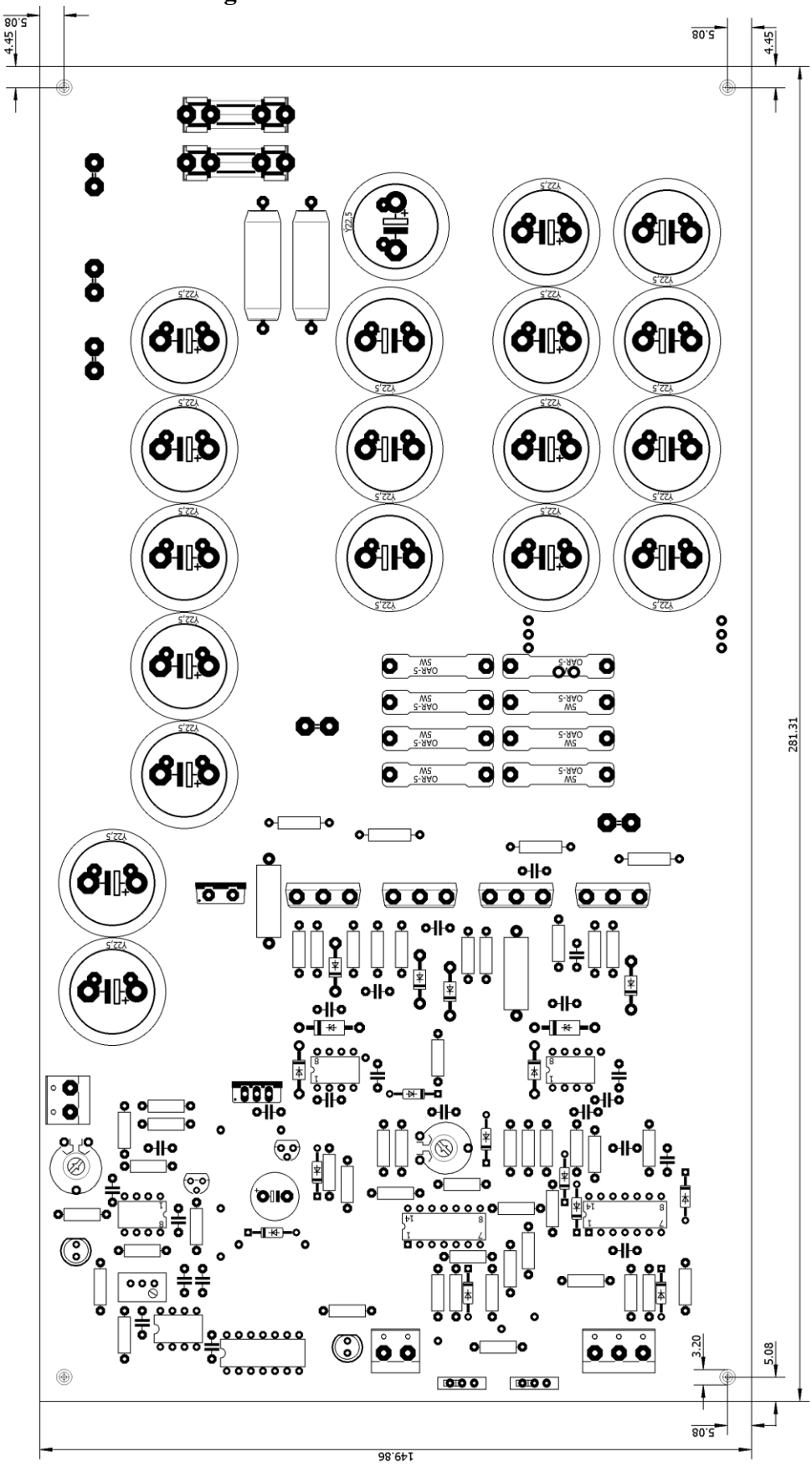
loud flashover, crackle noise:
- mistake in the high voltage assembly, voltage to high or ignited the spark cap

No pulses can be measured, but high primary current
-Control signal is asymmetric or even DC.
- Switch off device and check switching transistor.

unusual electric smell
- Something may be overheated. Switch of device. Check components (capacitor, transformer, transistor, semiconductor for overheating)

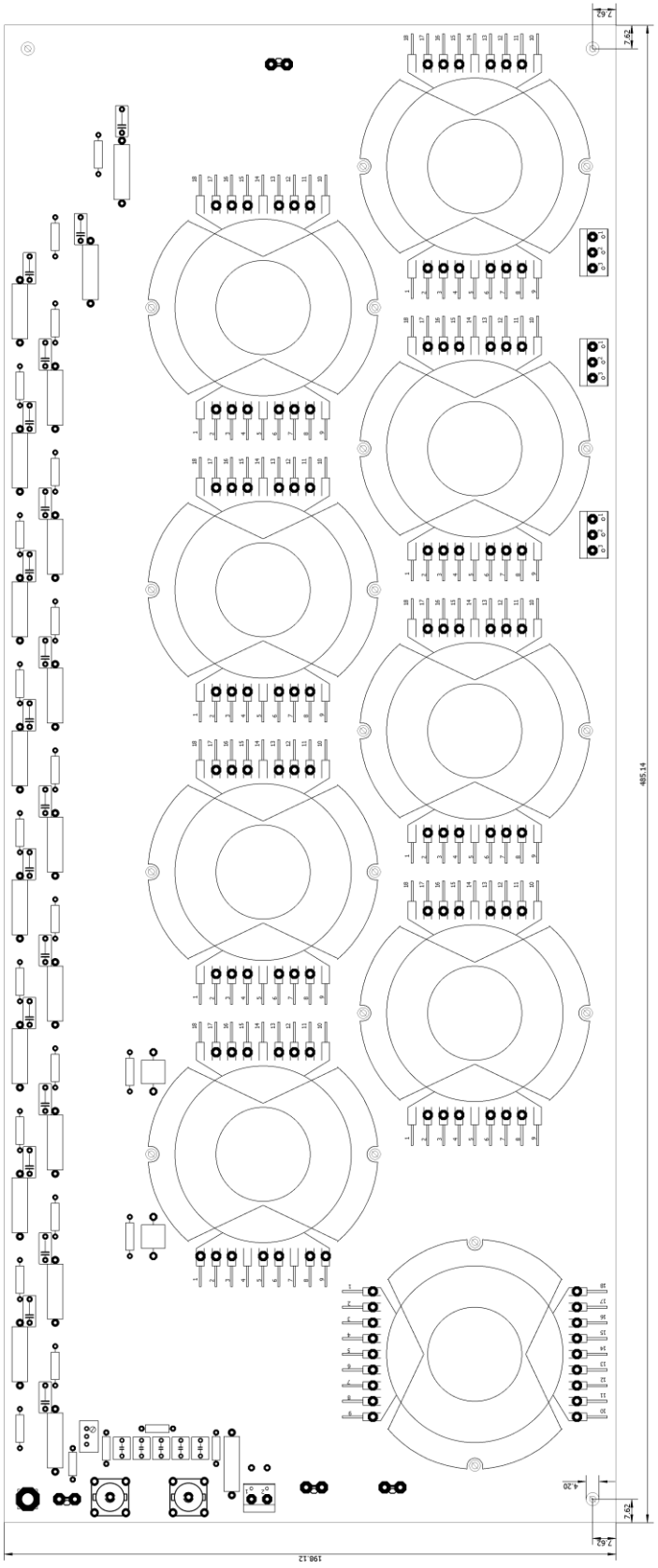
unstable operation at high voltage, maximum voltage cannot be achieved, strange waveform
Is the duty cycle 50%? If yes, try a slight variation of the duty cycle from the input signal, e.g. from 50% to 50.5%. Due to inaccuracies, the optimum may be not always at exactly 50%.

A. **Dimension bridge converter**



- height heatsink: 30mm

B. **Dimension transformer cascade**



Mounting Minipuls6 cascade