Minipuls 6

kit for efficiently generating high frequency high voltage

Manual

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Content

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).

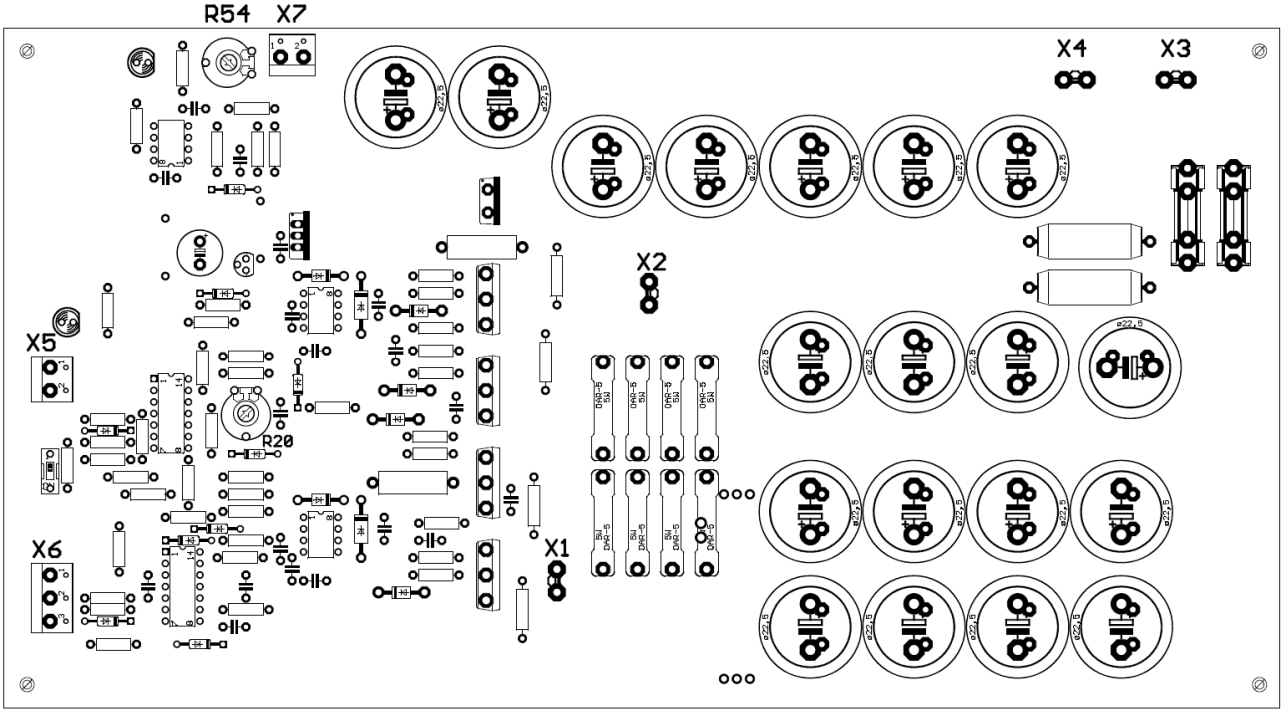
Choice the operating mode:

Mode	**microswitch SW1**
TTL	on
+/- 5V	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).

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.

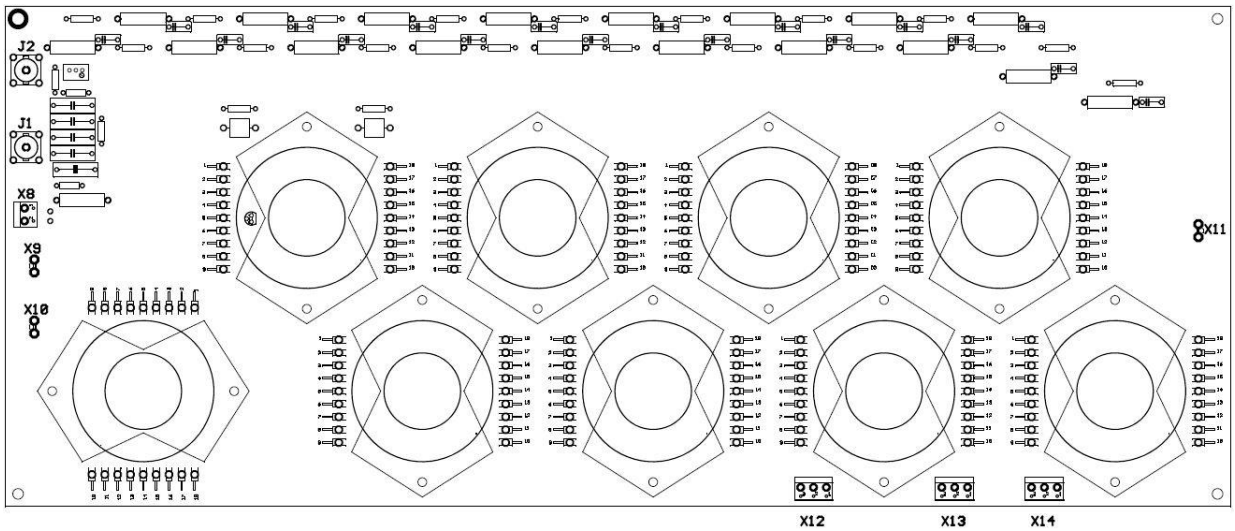
enabled	Input open or U<1.5V
disabled	U>1.5V

Current into signal inputs <0.5mA.

terminal X7 ï external temperatur sensor LM335
Connect a twisted pair cable with the terminal X8 of the transformer cascade. Monitoring the temperature at the first transformer and switches off by overtemperature.

X7 ï 1	+ (red ï positive)
X7 ï 2	- (black ï ground)

3.1.2 transformer cascade



terminal X8 ï external temperatur sensor LM335
see above 3.1.1 bridge converter ï connect temperature sensor

X8 ï 1	+ (red ï positive)
X8 ï 2	- (black ï ground)

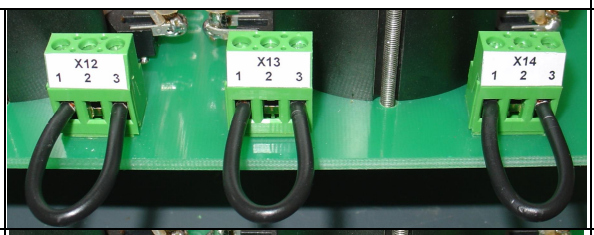
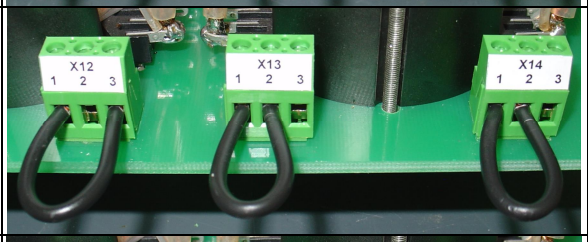
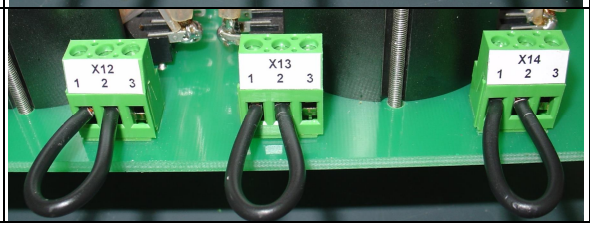
transformer cascade input X9 and X10
The bridge converter (X1, X2) is connected here by means of a 6.3mm plug.

high voltage output X11
The load is connected directly at the end of the transformer cascade. A sufficient isolation (to least >7cm) is important, because the pulse generator delivers voltages up to 30 kV. So it hazardous to touch the output while the unit is in operation.

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**
X12-1 and X12-2, X13-1 and X13-2, X14-1 and X14-2	**5**

Attention: Donât remove all cables!

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

monitor output J1 (I) , J2 (U)
Output current and -voltage can be measured on the monitor output. J1 has a relation of **10V/A**. The voltage monitor signal has a divisor relation from nominally **1:3000**. If a cable connected to the exit, the capacity has influence on the divisor relation. The divisor relation should be postcalibrated.

3.2 Settings

R20 ï 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!

<u>temperature monitoring - calibration</u>

R54 ï 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 25-105°C (conforms ~2.8...~3.8V). The temperature sensor has a typical error of less than 5°C. Standard settings are about 85-90°C and should not be changed. Too high temperature destroy the transformer cascade!

If the temperature exceeds 85-90°C at the first transformer, the generator switches off. Red LED D7 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 overvoltages 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 90-95°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 dangers maintenance should be restricted to qualified personell.

Nothing happens when switch on / control input:

- check the voltage.
- fuse okay?
- inhibit activ?
- logic adjusted correct?
- check output transistor, control circuit
- bug in the control input
- short-circuit.

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

- 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)

5. test results Minipuls 6

by:	date:	serial number

voltage divider 1:3000

test voltage 20Vpp	
5 kHz sinus	[1:3000 +/- 10%]
10 kHz sinus	[1:3000 +/- 10%]
20 kHz sinus	[1:3000 +/- 10%]

delay time full bridge

	IC3		IC4 (negative)	
	TTL-signal	**+/-5V**	**TTL-signal**	**+/-5V**
rising edge input ï > falling LO	µs	µs	µs	µs
rising edge input ï > rising bridge	µs	µs	µs	µs
rising edge input ï > rising HO	µs	µs	µs	µs
falling edge input ï > rising LO	µs	µs	µs	µs
falling edge input ï > falling bridge	µs	µs	µs	µs
falling edge input ï > falling HO	µs	µs	µs	µs

transformer cascade
operation with different conditions (capacative)

frequency	**bridge voltage**	**supply current**	**step**	**load**	**output voltage (peak)**	**time**	**comments**
resonance: kHz	30V		8	idle			
resonance: kHz	30V		7	idle			
resonance: kHz	30V		6	idle			
resonance: kHz	30V		5	idle			
13 kHz	30V		8	125 pF			
resonance: kHz	30V		8	125 pF			
13 kHz	30V		8	104 pF			
resonance: kHz	30V		8	104 pF			
13 kHz	30V		8	90 pF			
resonance: kHz	30V		8	90 pF			

function Inhibit-input:

calibration temperature monitoring

	adjusted voltage-value	temperature
transformer cascade		

operation with different conditions (capacative and resistance)

frequency	**bridge-voltage**	**supply current**	**load**	**output voltage**	**pulse current**	**output current**
resonance : kHz	30V		R=4,9MΩ , C=104pF			
resonance: kHz	30V		R=2,8MΩ , C=104pF			
resonance: kHz	30V		R=4,9MΩ , C=0pF			
resonance: kHz	30V		R=2,8MΩ , C=0pF			
resonance: kHz	30V		R=300 KΩ , C=104pF			
resonance: kHz	30V		R=300 KΩ , C=90pF			

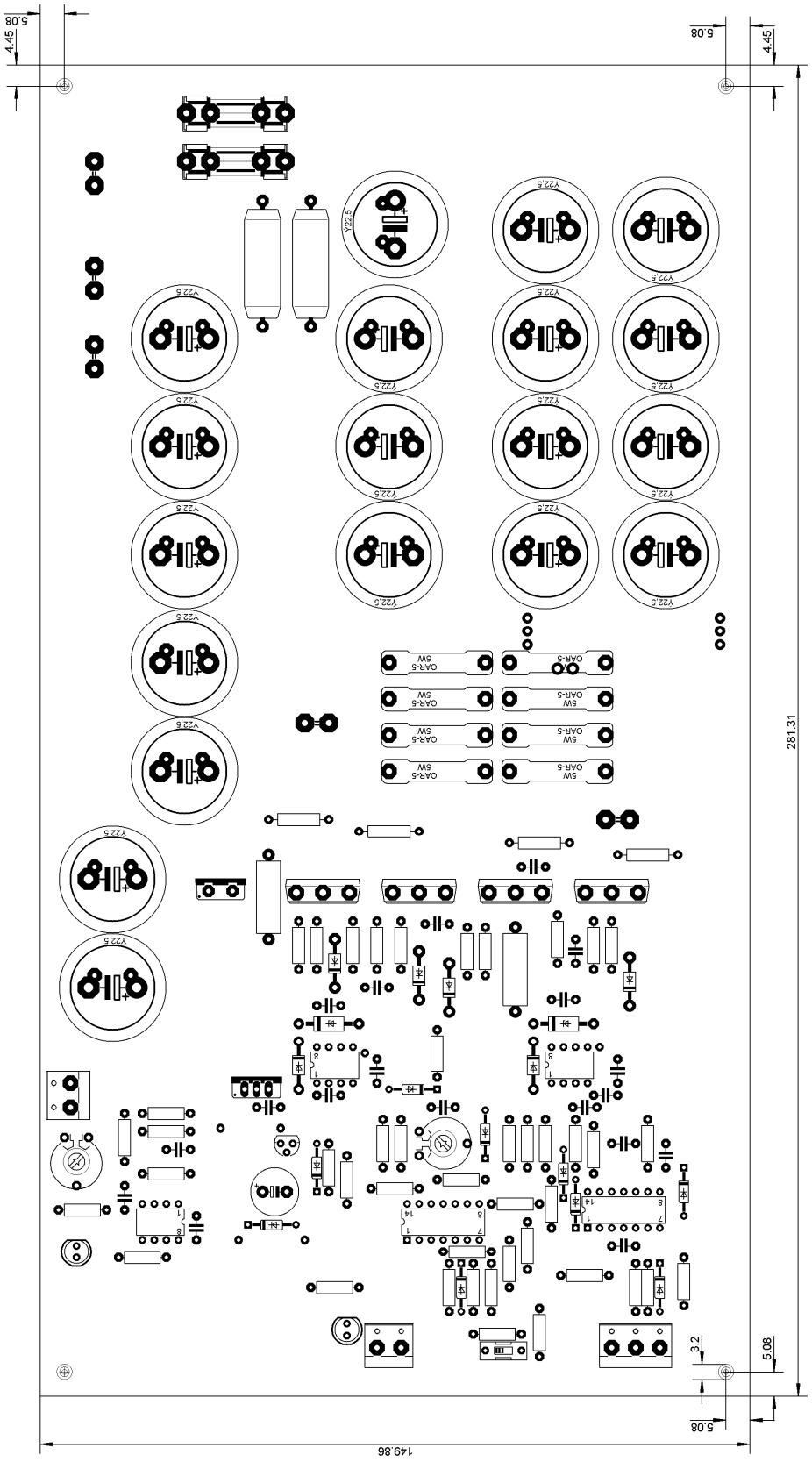
maximum voltage by overvoltage protection (idle)	kV
Ue=30V, output shorted, maximum output current by overcurrent detection (measure on 5mΩ shunt)	A

Thermal

supply voltage	supply current	time	What components get warm?
30 V	**~ 10 A**	**5 min**	
		10 min	
		~15 min	

OK:

A. **Dimension bridge converter**



- height heatsink: 30mm

B. **Dimension transformer cascade**