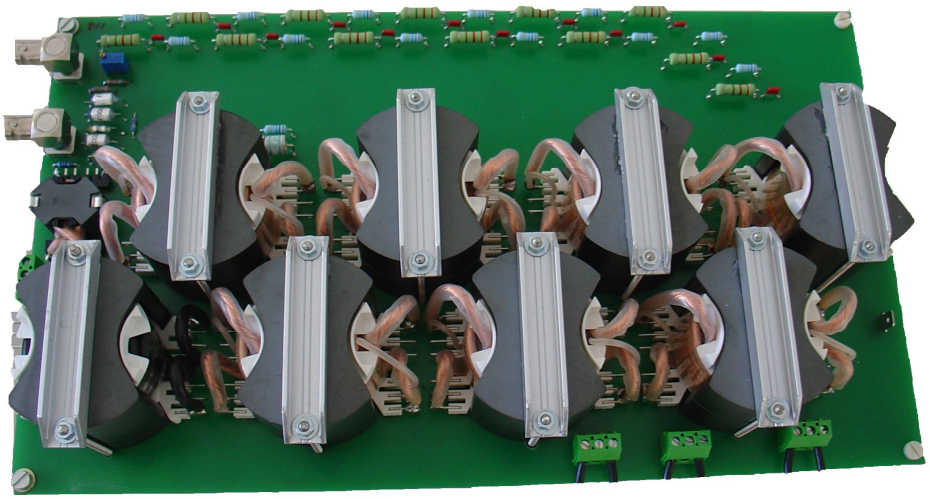
Minipuls 4

kit for efficiently generating high frequency high voltage



Manual

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Content

State: 25.09.2014

1. Safety

Attention!
This device works with high voltage to 24 000 V, possible in the short-circuit currents up to 50 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 harmles. The bridge converter should never operate without fuse (max. 10A)

2. Principle of operation

The assembly Minipuls 4 is developed to generate high AC voltages up to 20 kV peak (=40kVpp or 14 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 by an external control signal. For monitoring, there is a high voltage divider and a current monitor. The device is protected against over voltages by a spark gap.

3. Operation

At first connect supply voltage 15-35 V on terminal X3-1 (GND: X3-2).

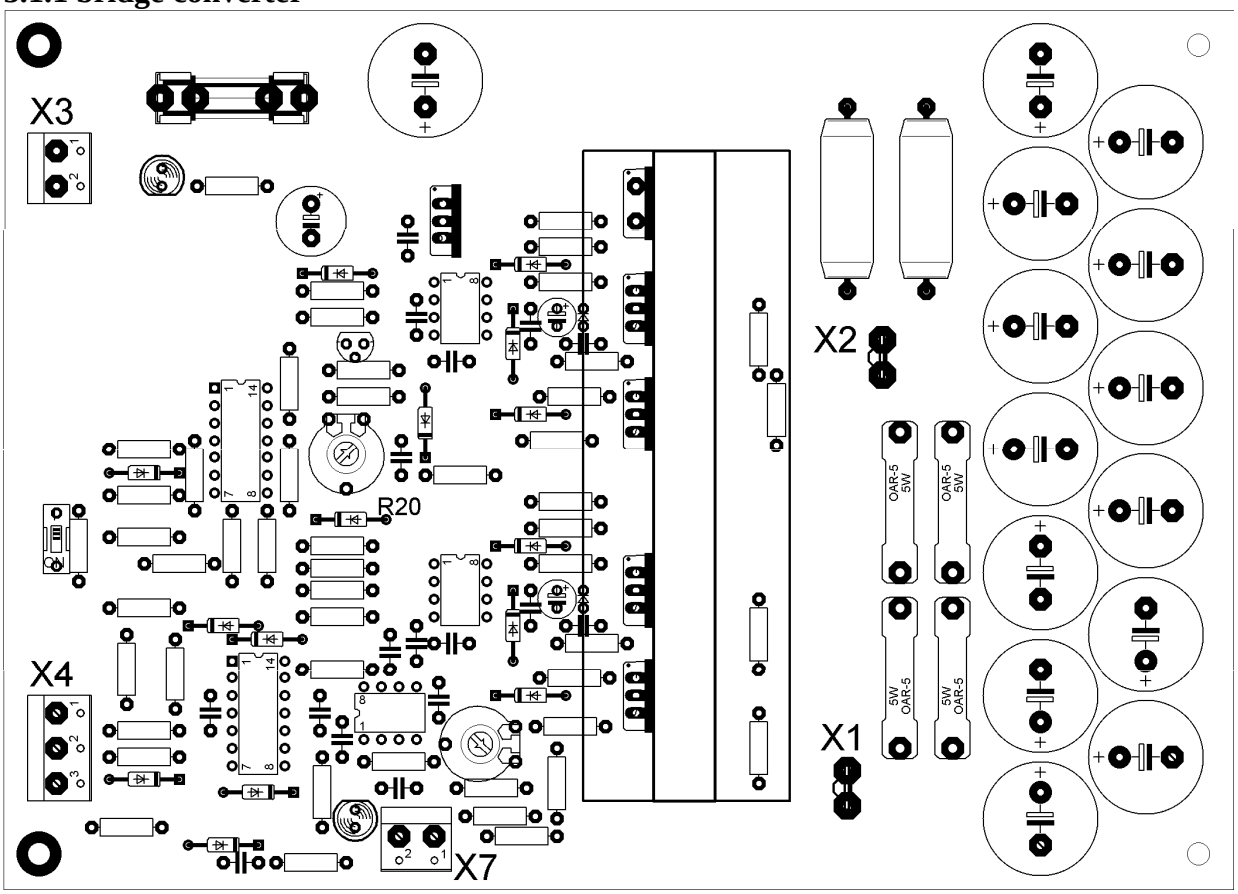
Choice the operating mode:

Mode	Microswitch SW1
TTL	on
+/- 5V	off

Connect external control pulse generator to the signal input on terminal X4-1 (GND: X4-3). In case of unknown load to start with low supply voltage (15V) 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 Connections

3.1.1 bridge converter



output bridge converter X1 and X2
The transformer cascade (X5) is connected here by means of a terminal.

supply voltage X3-1 (+) , X3-2 (-)
Connect a external supply voltage of nominal 24 V (possible 15-35V).

control input X4-1, X4-3 (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 (X4-2)
The Inhibit-Input disables the generator at input voltages >1.5V and enables it at <1.5V.

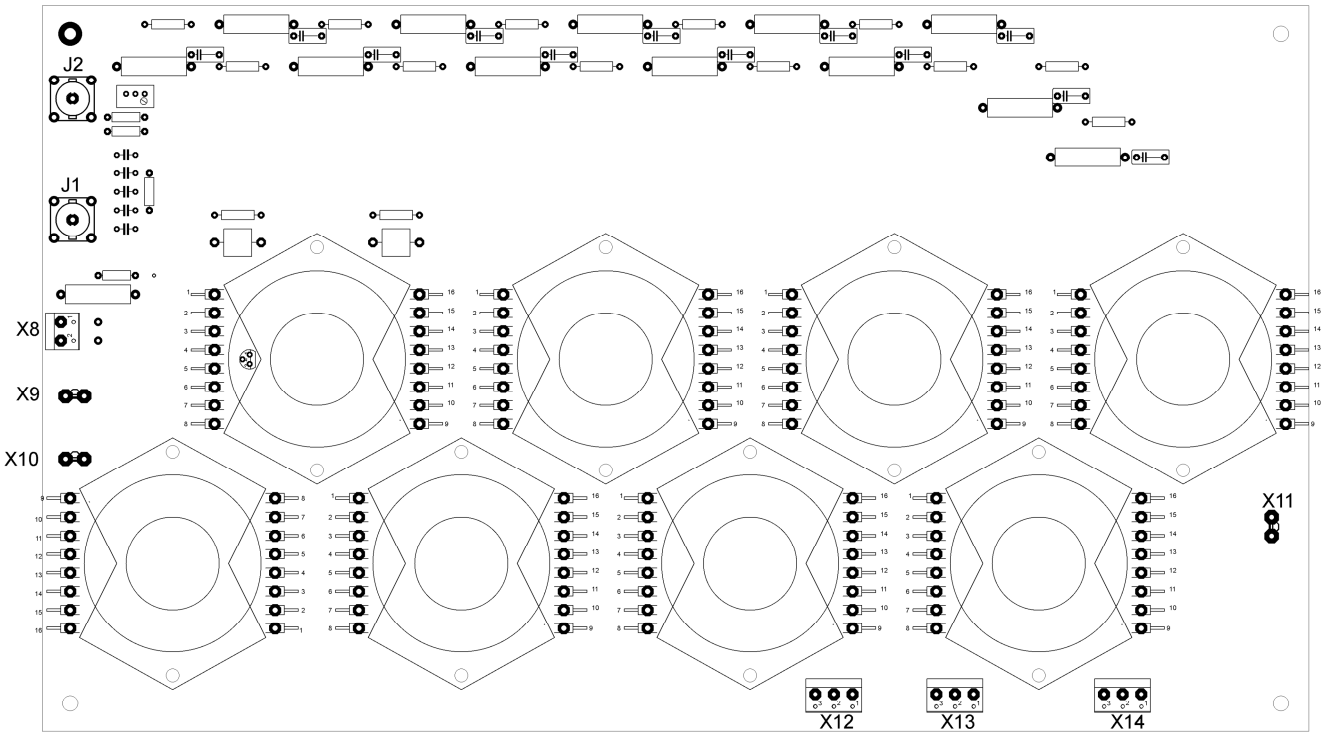
enabled	Input open or U < 1.5 V
disabled	U > 1.5 V

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 over temperature.

X7 ï 1	+ (red - positive)
X7 ï 2	- (black - 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 2	+ (red - positive)
X8 ï 1	- (black - ground)

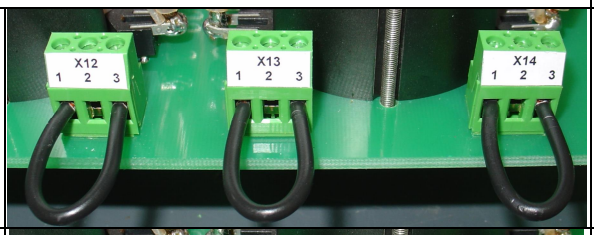
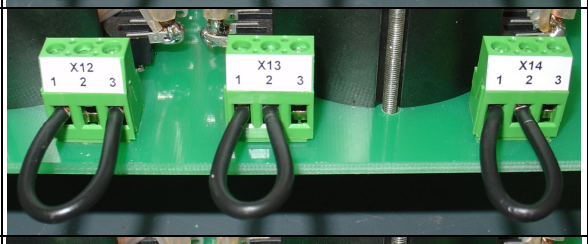
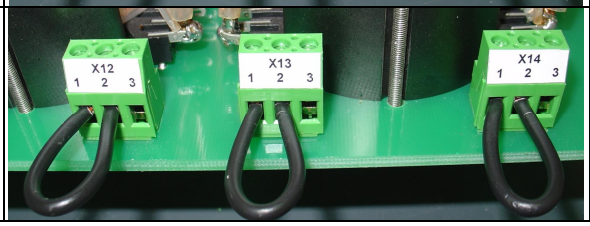
transformer cascade input X9 and X10
The bridge converter (X1, X2) is connected here by means of a terminal.

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 20 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 and shorted. This results in maximum output voltage reduced to 12 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	7
X12-1 and X12-2, X13-1 and X13-2, X14-1 and X14-2	4

Attention: Donâ 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**		7	**30 V**	20 kV
X12-1 and X12-3 **X13-1 and X13-3** **X14-1 and X14-2**		6	**30 V**	17 kV
X12-1 and X12-3 **X13-1 and X13-2** **X14-1 and X14-2**		5	**30 V**	14 kV
X12-1 and X12-2 **X13-1 and X13-2** **X14-1 and X14-2**		4	**30 V**	11 kV

monitor output J1 (I) , J2 (U)
Output current and ï voltage can be measured on the monitor output. J1 has a relation of 10V/A. The voltage monitor signal J2 has a divisor relation from nominally 1:2000. 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 0-60A. Standard settings should be about 40A. Too high current may cause strange effects, drive some transformers into saturation or even destroy the converter.

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 have a typical error of less than 5°C. Standard settings are about 75-80°C and should not be changed. Too high temperature destroys the transformer cascade! If the temperature exceeds 75-80°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 35A the pulse is switched off immediately (<0.5µs)
overvoltage limiting: The device is protected against overvoltages by a spark gap. If the voltage in the first transformer exceeds 3.4 kV (approx. 24 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 on indicates overtemperature.
fuse: If the current is greater 10 A, the fuse will blow.
temperature monitoring transformer cascade: If the temperature exceeds 70-75°C at the first transformer, the generator switches off. Red LED D18 on indicates overtemperature.

4.0 Maintenance, troubleshooting

Danger!

The pulse generator delivers up to 20 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 4

by:	date:	serial number:

voltage divider 1:2000

test voltage 20Vpp	
5 kHz sinus	[1:2000 +/- 10%]
10 kHz sinus	[1:2000 +/- 10%]
20 kHz sinus	[1:2000 +/- 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

maximum voltage by overvoltage protection (idle)	kV
Ue=30V, output shorted, maximum output current by overcurrent detection (measure on 10mÝ shunt)	A

operation with different conditions (capacative)

Frequency	**bridge voltage**	**supply current**	**step**	**load**	**output voltage**	**comments**
kHz	15V		7	idle		
kHz	15V		6	idle		
kHz	15V		5	idle		
kHz	15V		4	idle		
14 kHz	15V		7	125 pF		
kHz	15V		7	125 pF		
14 kHz	30V		7	125 pF		
kHz	30V		7	125 pF		
14 kHz	15V		7	90 pF		
kHz	15V		7	90 pF		
14 kHz	30V		7	90 pF		
kHz	30V		7	90 pF		

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

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5 kHz sinus	[1:2000 +/- 10%]
10 kHz sinus	[1:2000 +/- 10%]
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delay time full bridge

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

transformer cascade

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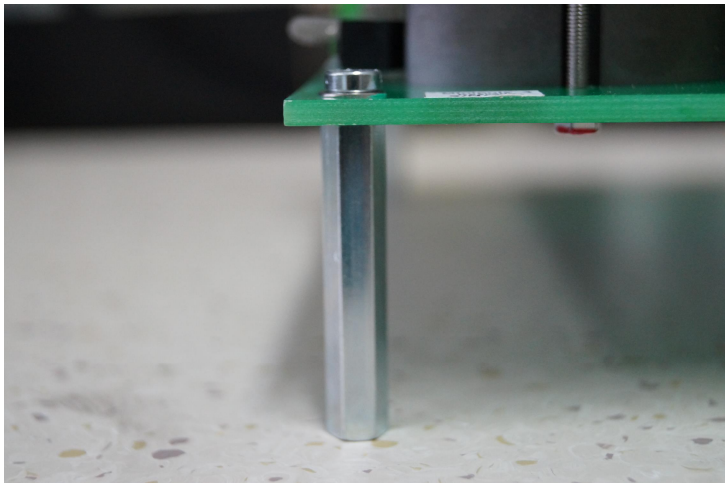
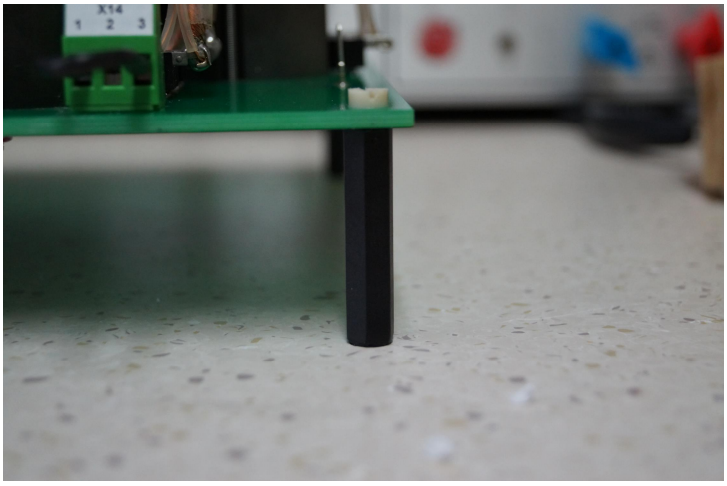
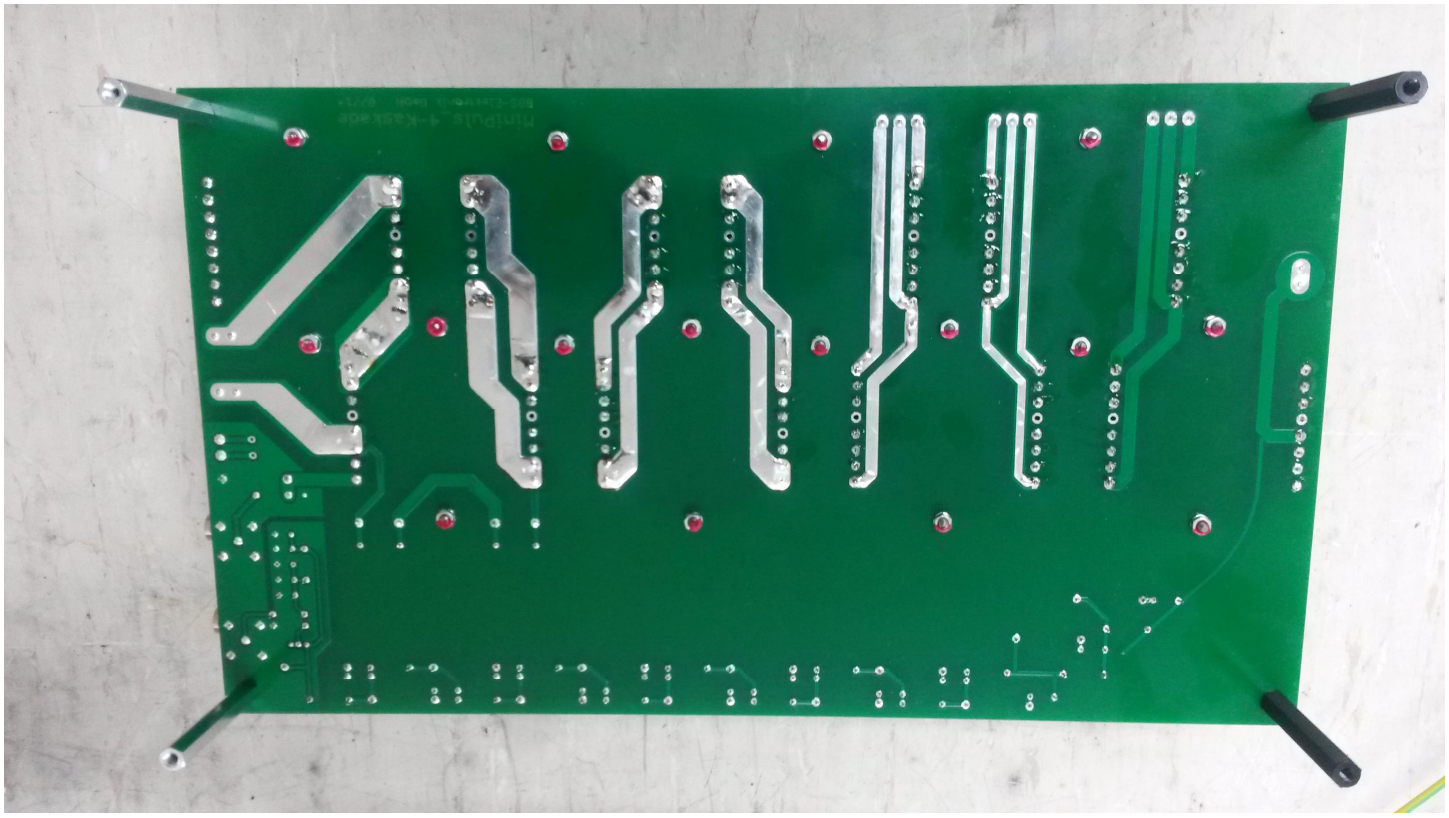
kHz	15V		6	idle		
kHz	15V		5	idle		
kHz	15V		4	idle		
14 kHz	15V		7	90 pF		
kHz	15V		7	90 pF		
14 kHz	30V		7	90 pF		
kHz	30V		7	90 pF		
20 kHz	V		4	50 pF		
20 kHz	V		4	50 pF		
20 kHz	V		5	50 pF		
20 kHz	V		5	50 pF		

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

Mounting Minipuls4 cascade







Reparaturen Minipuls4

#1
auf neusten Stand umgebaut (neue Kaskade, Drossel, Strommesstrafo)
#9 - Brücke
Kühlkörper schief - Pads beschädigt, KK entfernen + neu montieren Silikonpads erneuern
#8 - Kaskade
Ecke rechts oben hat starken Schlag bekommen -> abgebrochen! -> neu verharzt
Bolzen abgebrochen -> erneuert!

Inbetriebnahme 28.06.2010
Brücke:
Inhibit funktioniert nicht 100%, da immer nur ein Brückenteil abgeschalten wird!
-> Änderungen
R34 = 820Ω
2x BAT41 eingefügt bei Pin1 U4B, siehe auch MP6

Mit dem Generator von Rigol, kam es vor das bei TTL Signal 5V der Offset so groß war das IC4 nicht mehr richtig angesteuert wurde!

R31 etwas angepasst auf 1.6kΩ → Probleme im Bipolarmodus → wieder auf 1.2kΩ geändert!

Kaskade:
Spannungsteiler auf 1:2000 umgebaut!
C10 = 270p
C7 = 1.5nF
→ ca. 15.9 nF / 8.33pF
R3 = 56k
→ 120MΩ / **60k**Ω

Auftrag ï Indien ï 09.2014

- Kleine Zusatzplatine mit B555 gebaut um 20kHz zu erzeugen; Schaltplan: MP4_zusatz.sch
- Es wird empfohlen 2 Transformatoren zu Brücken → 4 Trafos @ 50pF ~13 kV Spitze bei Ue 35V!!
- **R5** dient dazu das Tastverhältnis auf genau 50% einzustellen (+/- 0,5%)
- Bei hohen Frequenzen (>20kHz) kann über die Feinjustage des Tastverhältnis die maximale Spannung variiert werden; Dabei erreicht man die höchste Spannung bei ca. 49,8% Tastverhältnis!
- Bei einer Eingangsspannung von <15V erreicht man nicht mehr exakt 20kHz.

Allgemein ï 09.2014

Trafo #1 eine Lage Mylarfolie unterlegen und bei Bedarf mit Antikorona lackieren.

Über die 1600V Funkenstrecke 10p/6kV