BOM for one half bridge SystemD_2k4 V1.3

Open Design by ChocoHolic

Safety Warning: Circuit operates at high voltages. Lethal injury possible. Only for skilled persons!

Please note: This is an DIY project for advanced enthusiasts. No warranties.

Rated power of one half bridge: 1200W into 2R

Rated power of two half bridges in bridged mode: 2400W into 4R

The project requires an advanced level of know how.

Ref	Value	Tolerance	El. min. requirements	Footprint	Type/Style	Comment
C201	47p		16V	8X5 RM5	MKP, FKP	Any other film or foil type will work, but less premium
C202	47p		16V	8X5 RM5	MKP, FKP	Any other film or foil type will work, but less premium
C203	470pF		16V	SM0805	NPO / COG	X7R will work, but less premium
C204	470pF		16V	SM0805	NPO / COG	X7R will work, but less premium
C205	1uF		25V	SM0805	X7R	Anything between 100nF...1uF should work
C206	1uF		25V	SM0805	X7R	Anything between 100nF...1uF should work
C207	NIP		16V	8x7 RM5	MKP, FKP	Any other film or foil type will work, but less premium
C208	Jumper		16V	8x7 RM5	MKP, FKP	Any other film or foil type will work, but less premium
C209	NIP					
C210	1nF	+/- 5%	100V	8X5 RM5	MKP, FKP	Any other film or foil type will work, but less premium
C211	1nF	+/- 5%	100V	8X5 RM5	MKP, FKP	Any other film or foil type will work, but less premium
C212	2u2	+/- 5%	16V	32x16 RM27.5	MKP	Any other film or foil type will work, but less premium
C213	2u2	+/- 5%	16V	32x16 RM27.5	MKP	Any other film or foil type will work, but less premium
C214	47p	+/- 10%	16V	8X5 RM5	MKP, FKP	Any other film or foil type will work, but less premium
C215	NIP		16V	8x7 RM5	MKP, FKP	Any other film or foil type will work, but less premium
C216	47pF	+/- 10%	16V	8X5 RM5	MKP, FKP	Any other film or foil type will work, but less premium
C217	10n	+/- 5%	16V	8x7 RM5	MKP, FKP	Any other film or foil type will work, but less premium
C218	1uF		25V	SM0805	X7R	Anything between 100nF...1uF should work
C219	1uF		25V	SM0805	X7R	Anything between 100nF...1uF should work
C220	4u7	- 30% / +50%	16V	8x8 RM5	MKT	E-cap will also work, but less premium
C221	4u7	- 30% / +50%	16V	8x8 RM5	MKT	E-cap will also work, but less premium
C222	1uF		25V	SM0805	X7R	Anything between 100nF...1uF should work
C223	1uF		25V	SM0805	X7R	Anything between 100nF...1uF should work
C224	NIP		16V	SM0805	NPO / COG	X7R will work, but less premium
C301	470uF					
C302	470uF					
C303	1u		25V	SM0805	X7R	
C304	470uF					
C305	470uF					
C306	47uF	- 30% / +50%	16V	8x8 RM5	E-cap	E-cap will also work, but less premium
C307	NIP			SM0805		
C308	470uF					
C309	470uF					
C310	470p		25V	SM0805	X7R	
C311	1u		25V	SM0805	X7R	
C312	1u		25V	SM1210	X7R	Simply use 100V like C319
C313	1000uF	- 30% / +50%	25V	D11 RM7.5	- 30% / +50%	
C314	100uF	- 30% / +50%	25V	D7 RM2.5	- 30% / +50%	

C315	1u		25V	SM0805	X7R	
C316	1u		25V	SM0805	X7R	
C317	4n7		50V	SM0805	X7R	
C318	4n7		50V	SM0805	X7R	
C319	2x 1u		100V	SM1210	X7R	Double stacked / back pack
C320	330p	+/- 10%	500V	SM1206	NPO / COG	
C321	1u		50V	SM1210	X7R	Simply use 100V like C319
C322	330p	+/- 10%	500V	SM1206	NPO / COG	
C323	2x 1u		100V	SM1210	X7R	Double stacked / back pack
C324	1u		50V	SM1210	X7R	Simply use 100V like C319
C325	2x 1u		100V	SM1210	X7R	Double stacked / back pack
C326	330p	+/- 10%	500V	SM1206	NPO / COG	
C327	0.33uF	+/-5% for the sum 1.98uF of C327+...+C332	100V	8x9 RM5	MKP	If MKP not available, check for MKT with 400V
C328	0.33uF	+/-5% for the sum 1.98uF of C327+...+C332	100V	8x9 RM5	MKP	If MKP not available, check for MKT with 400V
C329	0.33uF	+/-5% for the sum 1.98uF of C327+...+C332	100V	8x9 RM5	MKP	If MKP not available, check for MKT with 400V
C330	0.33uF	+/-5% for the sum 1.98uF of C327+...+C332	100V	8x9 RM5	MKP	If MKP not available, check for MKT with 400V
C331	0.33uF	+/-5% for the sum 1.98uF of C327+...+C332	100V	8x9 RM5	MKP	If MKP not available, check for MKT with 400V
C332	0.33uF	+/-5% for the sum 1.98uF of C327+...+C332	100V	8x9 RM5	MKP	If MKP not available, check for MKT with 400V
C333	47p		500V	SM1206	NPO / COG	
C334	47p		500V	SM1206	NPO / COG	
C335	2x 1u		100V	SM1210	X7R	Double stacked / back pack
C336	2x 1u		100V	SM1210	X7R	Double stacked / back pack
C337	2x 1u		100V	SM1210	X7R	Double stacked / back pack
C338	2x 1u		100V	SM1210	X7R	Double stacked / back pack
C339	330p	+/- 10%	500V	SM1206	NPO / COG	
C340	2x 1u		100V	SM1210	X7R	Double stacked / back pack
C341	1n		16V	SM0805	X7R	
C342	2x 1u		100V	SM1210	X7R	Double stacked / back pack
C343	1n		16V	SM0805	X7R	
C344	2x 1u		100V	SM1210	X7R	Double stacked / back pack
C401	100uF	- 30% / +50%	25V	D7 RM2.5		
C402	100uF	- 30% / +50%	25V	D7 RM2.5		
C403	1u		25V	SM0805	X7R	Anything between 100nF...1uF should work
C404	1u		25V	SM0805	X7R	Anything between 100nF...1uF should work
C405	1u		25V	SM0805	X7R	
C406	1u		25V	SM0805	X7R	
C407	1000uF	- 30% / +50%	25V	D11 RM7.5		
C408	1000uF	- 30% / +50%	25V	D11 RM7.5		
D201	Z33V	+/-5%	0.5W	D6_slim (DO-35)		Also 1W types or 1.3W types in DO-41 will work.
D202	Z33V	+/-5%	0.5W	D3 (DO-35)		Also 1W types or 1.3W types in DO-41 will work.
D203	BAV21			D3 (DO-35)		
D204	BAV21			D3 (DO-35)		
D205	1N4148			D3 (DO-35)		
D206	1N4148			D3 (DO-35)		
D301	BAT42			D3 (DO-35)		
D302	Z12V	+/-5%	0.5W	D4 (DO-35)		Also 1W types or 1.3W types in DO-41 will work.
D303	BAV21			D3 (DO-35)		
D304	1N4148			D3 (DO-35)		
D305	MBR1100			D5 (DO-41)		

D306	MBR1100			D5 (DO-41)		
D307	MBR1100			D5 (DO-41)		
D308	MBR1100			D5 (DO-41)		
D309	1N4148			D3 (DO-35)		
D310	MBR7030WT			TO247		
D311	MBR7030WT			TO247		
D312	MBR40250					
D313	MBR40250					
D401	Z15V	+/-5%	1W or 1.3W	D4 (DO-41)		If not available, then place any Z15V you can get.
D402	Z15V	+/-5%	1W or 1.3W	D4 (DO-41)		If not available, then place any Z15V you can get.
D403	MBR1100			D5 (DO-41)		
D404	5V6	+/-5%	0.5W	D3 (DO-35)		Also 1W types or 1.3W types in DO-41 will work.
D405	5V6	+/-5%	0.5W	D3 (DO-35)		Also 1W types or 1.3W types in DO-41 will work.
D406	LED			LED-3mm		
D407	LED			LED-3mm		
D410	Z13V	+/-5%	0.5W	D4 (DO-35)		Also 1W types or 1.3W types in DO-41 will work.
D411	MBR1100			D5 (DO-41)		
D412	MBR1100			D5 (DO-41)		
F401	8AT			Vertical	i.e. fuse holder Buerklin.com 46G5840	Sand filled high breaking types
F402	0.2AT			Vertical	i.e. fuse holder From Buerklin 46G5840	
F403	0.2AT			Vertical	i.e. fuse holder From Buerklin 46G5840	
F404	0.5AT			Vertical	i.e. fuse holder From Buerklin 46G5840	
F405	8AT			Vertical	i.e. fuse holder From Buerklin 46G5840	Sand filled high breaking types
JP301	CuBar			RM 10.8		
JP302	ThermoSwitch		Normally conductive, opens at 65C	TO220		
JP303	CuBar			RM 10.8		
L301	15uH			T157-2		Verified in proto: Amidon: T157-2, 33 turns of 1.32CuI
Q201	2N5401			TO92		
Q202	2N5551			TO92		
Q203	BC550C			TO92		
Q204	BC560C			TO92		
Q205	BC560C			TO92		
Q206	BC550C			TO92		
Q301	2N5551			TO92		
Q302	AnyPWRtype		20V/5A	TO220	N Chanel Power MosFet	
Q303	2N5551			TO92		
Q304	FZT853			SOT223		

Q305	FZT953			SOT223	150mm² Cu-sheet Needed as heat sink	
Q306	FZT853			SOT223		
Q307	FZT953			SOT223	150mm² Cu-sheet Needed as heat sink	
Q308	IRFP4668			TO247		
Q309	IRFP4668			TO247		
Q401	BD243C			TO220	Heat sink: 20K/W or less	
R201	6k8	+/- 2%		SM0805		
R202	6k8	+/- 2%		SM0805		
R203	47k	+/- 10%		SM0805		
R204	47k	+/- 10%		SM0805		
R205	47k	+/- 2%		SM0805		
R206	47k	+/- 2%		SM0805		
R207	2k2	+/- 2%		SM0805		
R208	2k2	+/- 2%		SM0805		
R209	39k	+/- 2%	1/4W	R5 (0207)		
R210	27k	+/- 2%	1/4W	R5 (0207)		
R211	27k	+/- 2%	1/4W	R5 (0207)		
R212	39k	+/- 2%	1/4W	R4 (0207)		
R213	10	+/- 10%		SM0805		
R214	1k	+/- 2%		SM1206		
R215	10	+/- 10%		SM0805		
R216	10k	+/- 2%	1W	R6		
R217	NIP			SM0805		
R218	2k2	+/- 2%		SM0805		
R219	2k2	+/- 2%		SM0805		
R220	NIP			SM0805		
R221	1k5	+/- 2%		SM0805		
R222	Jumper			SM0805		
R223	1k	+/- 1%	1/4W	R4 (0207)		
R224	1k	+/- 1%	1/4W	R4 (0207)		
R225	270	+/- 1%	1/4W	R4 (0207)		
R226	270	+/- 1%	1/4W	R4 (0207)		
R227	4k7	+/- 1%		SM0805		
R228	4k7	+/- 1%		SM0805		
R229	10	+/- 10%	1/4W	R4 (0207)		
R230	47k	+/- 1%	1/4W	R5 (0207)		
R231	470	+/- 1%		SM0805		
R232	NIP			SM0805		
R233	390	+/- 1%		SM0805		
R234	10	+/- 10%	1/4W	R4 (0207)		
R235	470	+/- 10%		SM0805		
R236	68	+/- 1%		SM0805		
R237	68	+/- 1%		SM0805		
R238	10	+/- 10%		SM0805		
R239	10	+/- 10%		SM0805		
R301	330k	+/- 1%	1/4W	R4 (0207)		

R302	33k	+/- 1%		SM0805		
R303	10k	+/- 1%		SM0805		
R304	47	+/- 10%		SM0805		
R305	15k	+/- 2%		SM0805		
R306	47k	+/- 10%		SM0805		
R307	680	+/- 2%		SM0805		
R308	39k	+/- 10%	1/4W	R4 (0207)		
R309	10k	+/- 10%	1/4W	R4 (0207)		
R310	6k8	+/- 1%		SM0805		
R311	4k7	+/- 1%		SM0805		
R312	560	+/- 1%		SM0805		
R313	3k3	+/- 1%		SM0805		
R314	5k6	+/- 1%		SM0805		
R315	8k2	+/- 1%		SM0805		
R316	10	+/- 10%	1/4W	R4 (0207)		
R317	10	+/- 10%	1/4W	R4 (0207)		
R318	6R8	+/- 10%	1/4W	R4 (0207)		
R319	6R8	+/- 10%	1/4W	R4 (0207)		
R320	68	+/- 10%	1/4W	R4 (0207)		
R321	68	+/- 10%	1/4W	R4 (0207)		
R322	2R35 (2x4R7)	+/- 10%		SM1206	double stacked 4R7	
R323	2R35 (2x4R7)	+/- 10%		SM1206	double stacked 4R7	
R324	33k	+/- 10%	1W	R5 (0207)		
R325	100	+/- 10%	1/4W	R4 (0207)		
R326	100	+/- 10%	1/4W	R4 (0207)		
R327	5R6	+/- 5%	1/4W	R4 (0207)		
R328	5R6	+/- 5%	1/4W	R4 (0207)		
R329	5R6	+/- 5%	1/4W	R4 (0207)		
R330	5R6	+/- 5%	1/4W	R4 (0207)		
R331	6R8	+/- 10%	2W	RM15		
R332	6R8	+/- 10%	2W	RM15		
R333	120k	+/- 10%		SM0805		
R334	120k	+/- 10%		SM0805		
R335	120k	+/- 10%		SM0805		
R336	120k	+/- 10%		SM0805		
R337	120k	+/- 10%		SM0805		
R338	120k	+/- 10%		SM0805		
R398	1R5	+/- 10%	1W	R4 (0207)		
R399	1R5	+/- 10%	1W	R4 (0207)		
R401	1k5	+/- 10%	1/4W	R4 (0207)		
R402	1k5	+/- 10%	1/4W	R4 (0207)		
R403	390	+/- 10%	1/4W	R4 (0207)		
R404	1k65	+/- 1%		SM0805		
R405	3k3	+/- 1%		SM0805		
R406	1k65	+/- 1%		SM0805		
R407	470	+/- 10%		R4 (0207)		
R408	470	+/- 10%		R4 (0207)		
R409	3k3	+/- 1%		SM0805		

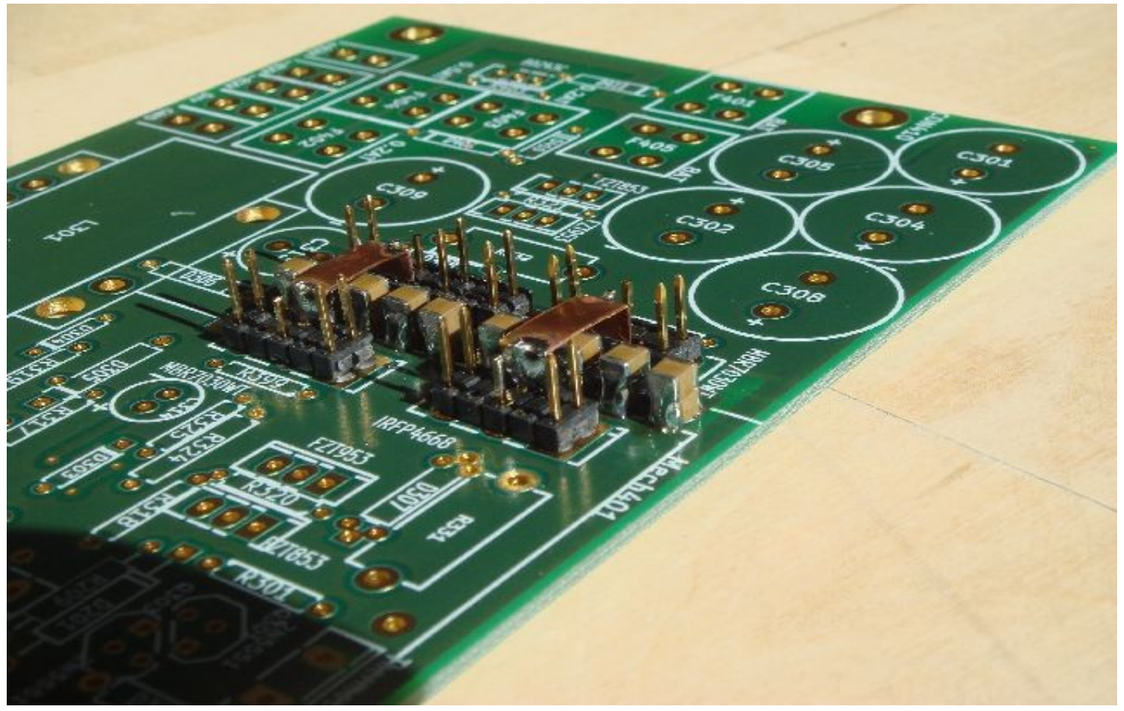
R410	68	+/- 10%		SM0805		
R411	68	+/- 10%		SM0805		
U201	DUAL_OP			DIP8	LT1364, LM4562, NE5532	
U202	LT1016			DIP8	LT1016 or MAX913	Place only one out of U202/203/204
U203	LM306			DIP8	LM306	Place only one out of U202/203/204
U204	LM361			DIP14	LM361	Place only one out of U202/203/204
U301	IRS20957					
U401	DUAL_OP			DIP8	NE5532	
CON301	Out-					
CON302	Out-					
CON303	Out+					
CON401	+82V					
CON402	+12V					
CON403	GND					
CON404	GND					
CON405	-12V					
CON406	Drv					
CON407	-82V					
CON408	-82V					
P201	CONN_3X2			3x2, 0.1”		
Mech401	ANGUPIE2	Aluminium, L-profile, each tail 50mm, height: 40mm				
Mech402		Aluminium, 95mmx195x1.5				
PCB	V1.0				Cu: 70um (2Oz) Double sided	35um (1Oz) possible, but close to melt down when hottrodding into 2R unbridged or 4R bridged
Misc1		Cu-Foil: 0.3mm (Cu-bars, mini heat sinks, MosFet shield, diode shield)				
Misc2		Isolation material for transistors and diodes				
Misc3		Main heat sink. Rth<1 K/W (for full power operation without fan)				
Misc4		Heat sink for Q401. Rth<20 K/W				

Change History from V1.2 to V1.3

V1.3	March 9th 2013	OCP lifted to approx. 53A Speed adjusted to avoid overshoot at any load and signal level Component tolerances reworked R327 = R328 = R329 = R330 = 5R6 (Formerly: R327 = R328 = R329 = R330 = 8R2) R331 = R332 = 6R8 (Formerly: 331 = R332 = 10) R322 = R323 =2R35 (Formerly: R322 = R323 =4R7) R223 = R224 = 1k (Formerly: R223 = R224 = 820) R233 = 390 (Formerly: R233 = 560) R230 = 47k (Formerly: R230 = 82k) R307 = 680 (Formerly: R307 = 4k7) R310 = 6k8 (Formerly: R310 = 2k2) R231 = 470 (Formerly: R231 = 680) C339 = C320 = C322 = C326 = 330pF (Formerly: C339 = C320 = 220pF C322 = C326 = 100pF) C317 = C318 = 4n7 (Formerly: C317 = C318 = 1n) C210 = C211 = 1nF (Formerly: C210 = C211 = 680pF) C306 = 47uF (Formerly: C306 = 4u7)

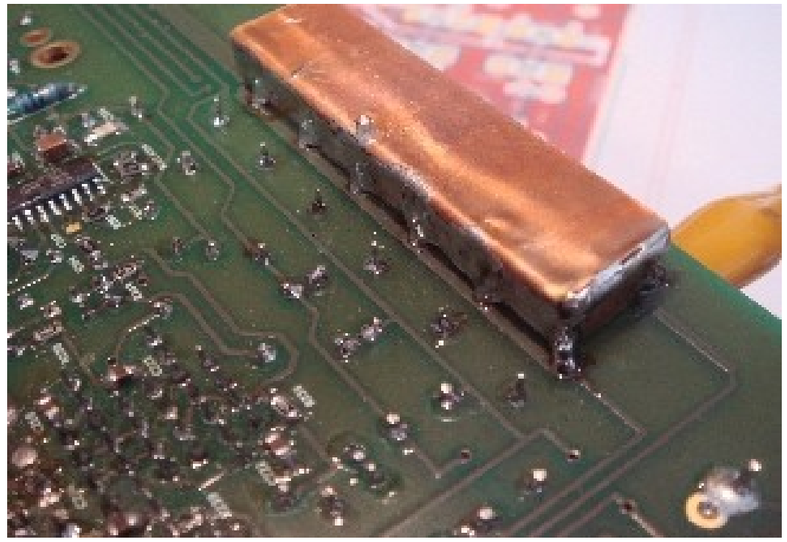
CuBars, dual pin rows, X7R caps

Double stacked means, just put a second X7R cap on top of each, like a back pack.
Ensure at least 1mm distance between the CuBars and the Caps.
The dual pin rows are standard items with a 2.54mm spacing, but we need pins only every 5.08mm.
Simply pull out the pins which are not needed.



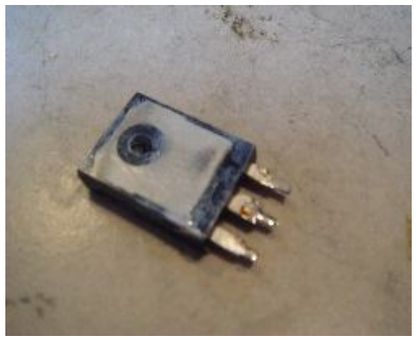
Copper piece at output caps

A very low inductive connection of all output caps is necessary to achieve lowest distortion.
The picture shows the folded and soldered copper piece.
Note: The amp also works without this. Only needed for lowest distortion.

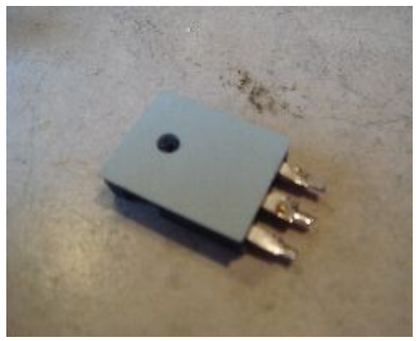


In order to avoid building an EMI vulcano a GND shield is necessary between the heat sinks and the following components: Q309, D311, D313
Here a picture sequence how these shields are build for TO247.

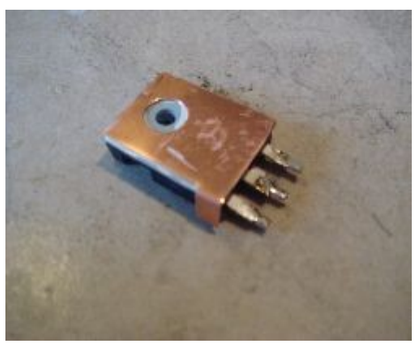
1. Q309 naked



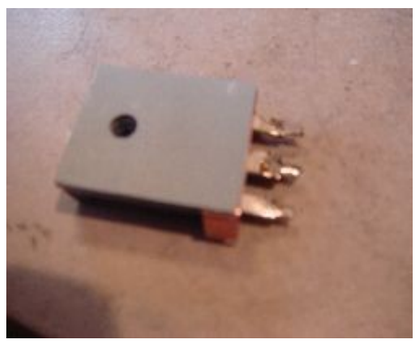
2. ..a first silicone isolator..



3. ..now the shield...
The hole in the shield must be 6mm to ensure that the screw does not touch the copper.

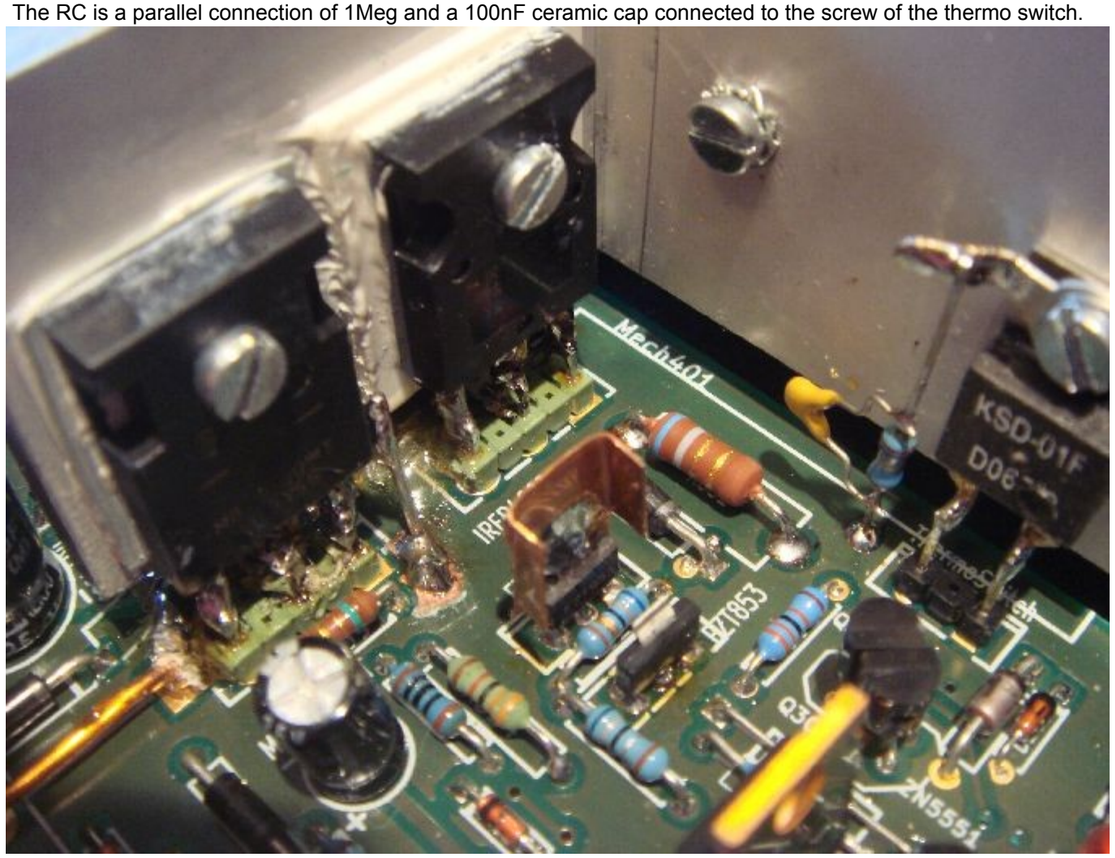


4. .. the second silicone pad..
The bend corner of the cooper is the solder pad of the shield.

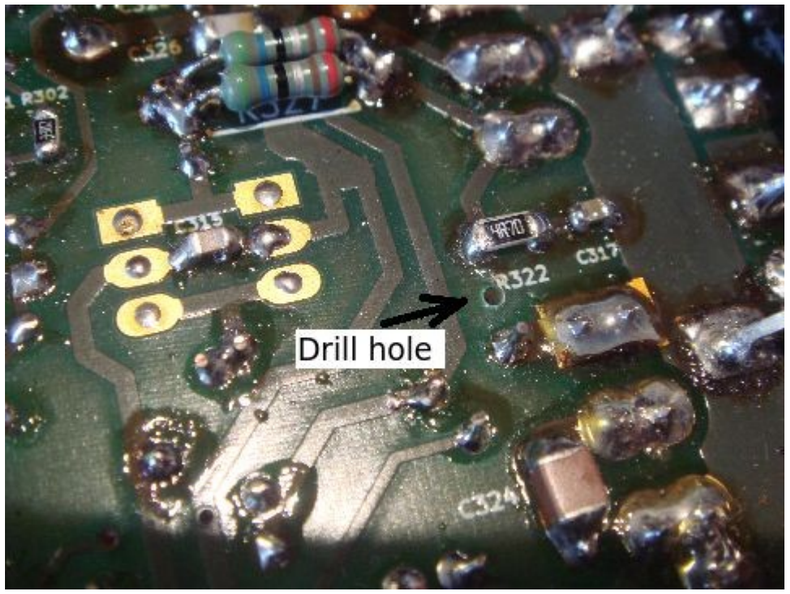


For TO220 it is similar, but instead of a huge hole in the shield – better drill 4mm and use the screw isolators for TO3.
These isolators provide a long enough isloation through the metal of the semiconductor, silicone pad and shield.

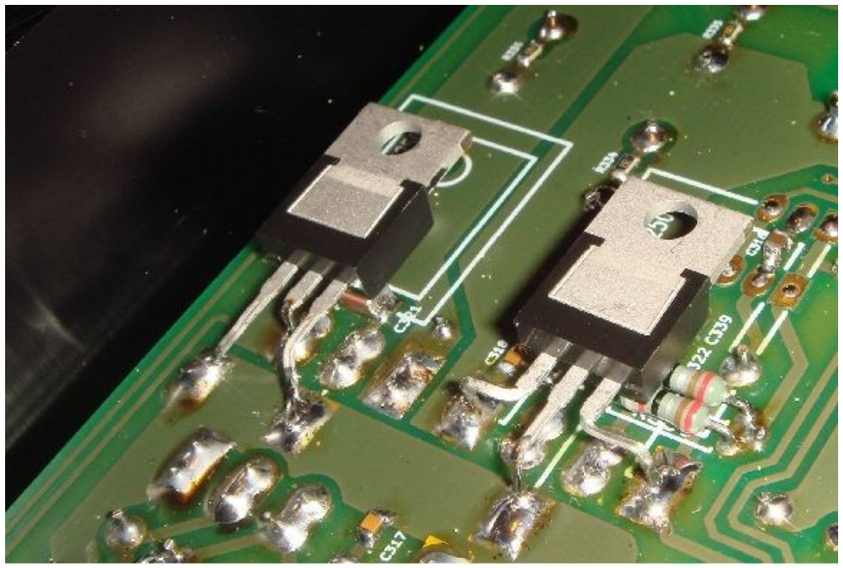
The shields must be connected to GND close at the switching stage.
For Q309 and D311 you can directly put a wire from the solder pad of the shield to the GND plane on the PCB.
Just scratch away some varnish from the PCB to create a solder pad on the GND plane of the PCB.
The picture shows such GND connection and also the RC-connection between the heat sink and GND.
The RC is a parallel connection of 1Meg and a 100nF ceramic cap connected to the screw of the thermo switch.



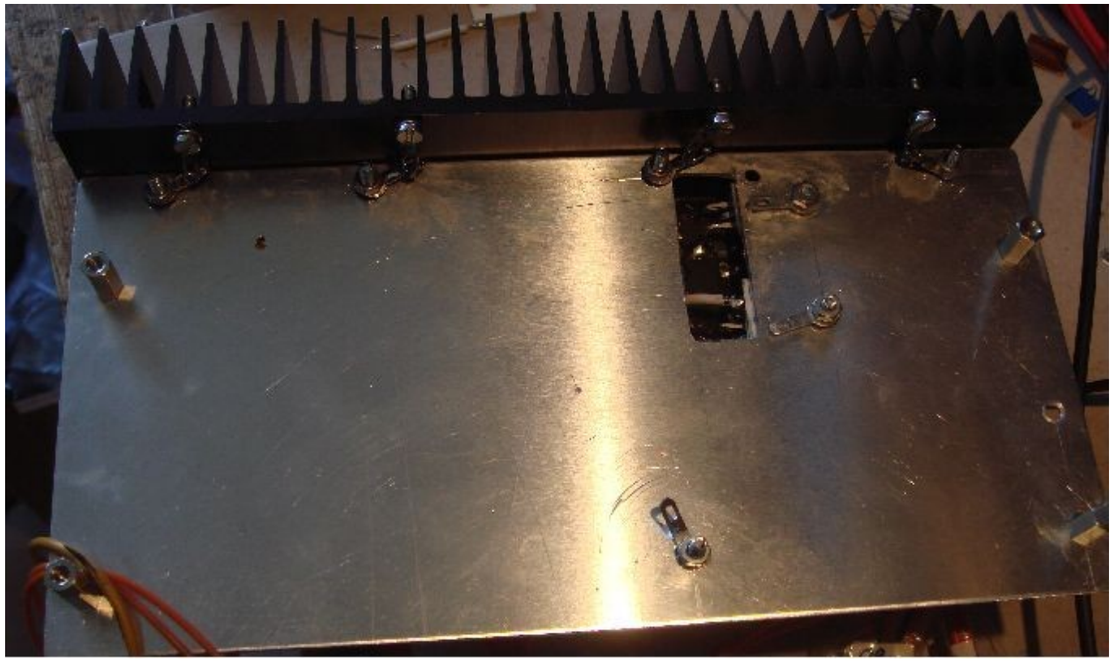
For D313 you need to drill a small hole in the PCB next to R322.
This allows you to connect a wire through this hole from GND to the shield of D313.
Make sure that the drill hole has at least 1.2mm distance from all surrounding tracks and pads.



Solder connections of D312 and D313.
The shield does not change these connections and must be isolated from the diode!



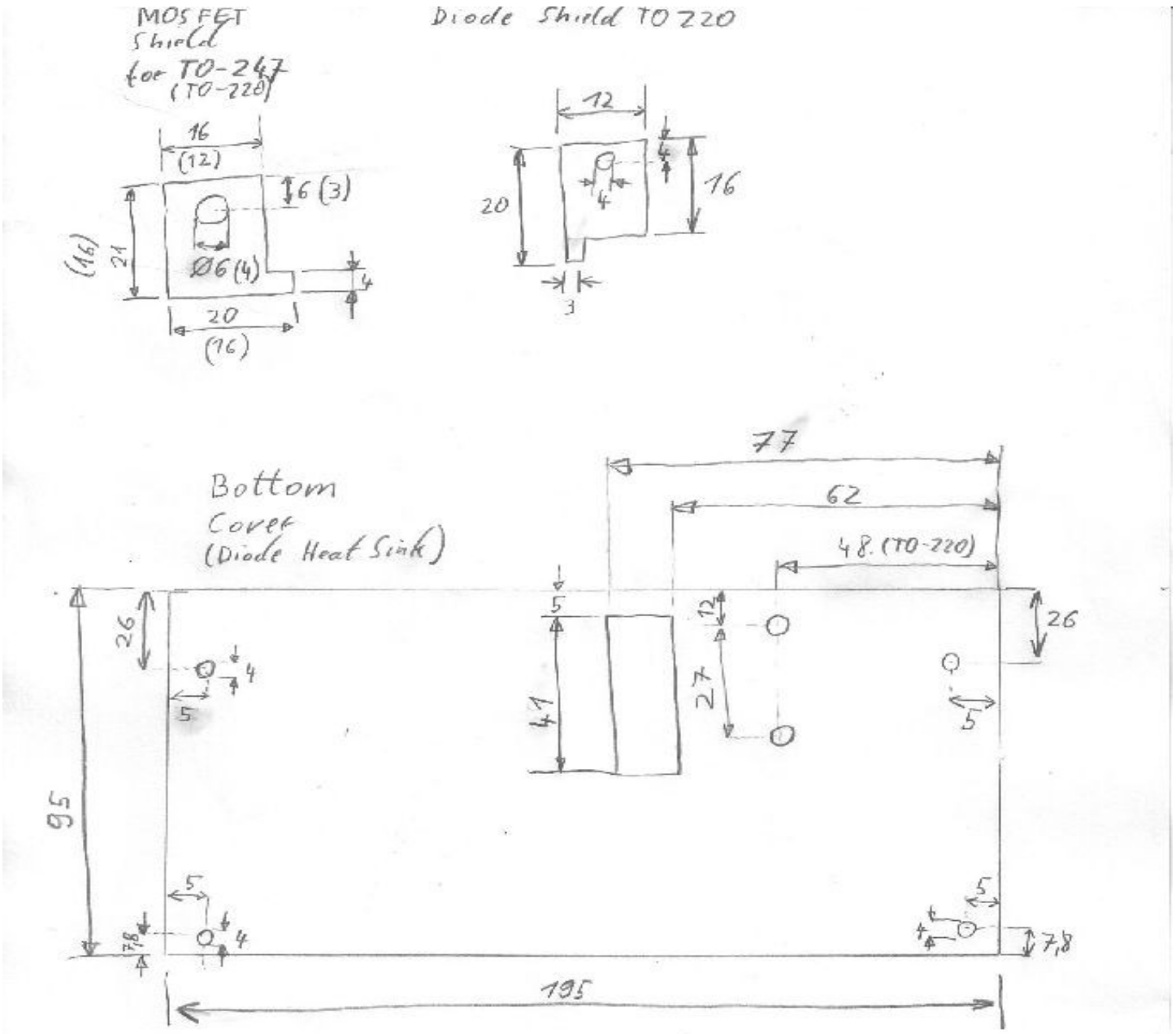
Here you can see the diodes with heat sink and shield.
I assembled the diodes first on the heat sink with preformed pins and shield and isolation.
The heat sink back plane has a cut out which allows to connect the diodes as in the picture above.
The white wire is the GND wire towards the shield, not connected to the diode itself!



The attached sketch shows figures for:

Copper shields for Q309, D311 and D313

Aluminium back plane which is the heat sink for D313 and D312.
The back plane shall be electrically connected to the main heat sink with at least four connections.
The drawing does not show the drill holes for the connections, you can comfort this according to your main heat sink.



In order to get it going you will need some patience and follow the described small steps below.
Any short cut bears a high risk to fry your work.

1. 12V operation
The circuit can operate from +/-12V with very minor preparation.
Connect a 1k8 resistor parallel to R308.
Connect a 3k3 resistor parallel to R324.
Now you can power the high power rails (normally +/-65V...+/-83V) from +/-12V.
Power up the amp from +/-12V and the auxiliary Drv.

a) Both LEDs on?
b) +/-12V still stable?
c) Drv vs -82V connector correct? Should be 15V...25V
d) Are +/-1.65V OK? Should be 1.6V..1.75V.
e) Are +/-5V OK? Should be 4.8V...5.25V.
f) Does the amp operate properly ? Switching frequency should be 310kHz...360kHz.

2. Limited power operation
Remove the 1k8.
Remove the 3k3.
Connect +/-82V through light bulbs. Type 220V/100W or 110V/60W.
If you cannot get light bulbs anymore then use two series resistors of 47Ohms / 50W
a) Both LEDs on?
b) Current consumption on +/-82V rails Ok? Should be 75mA...110mA (my first proto draws 90mA).
c) Does the amp operate properly ? Switching frequency should be 310kHz...360kHz.

3. Full power operation
Connect also the +/-82V without bulbs or resitors.
a) Both LEDs on?
b) Current consumption on +/-82V rails Ok? Should be 75mA...110mA (my first proto draws 90mA).
c) Does the amp operate properly ? Switching frequency should be 310kHz...360kHz.
d) Test according your taste.
e) Calm down your neighbours.