For a Few Dollars - 40 More Watts at 3400 MHz

Manfred Ploetz DL7YC

Many articles has been written in the past how to modify Toshiba`s UM2683A and UM2683B SSPAs for use in amateur radio applications [1-5]. One can find a lot of information in these papers and they are all more or less useful. But from my perspective the published information does not explain the main differences of these amplifiers in detail.

Hopefully this paper will improve 3400 MHz EME activity because there are probably dozens of these unused low-power SSPAs UM2683B which can be converted to deliver high power for EME. The details given here will maybe bring many of these amplifiers out of the junk box in countries with a 9cm amateur frequency allocation.

Spending a few dollars, it is possible to convert the “40-50 W” **UM2683A** model into a more reliable version with slightly increased output power, about 65 W. But it is also possible to convert the “20-25 W” **UM2683B model** to deliver 65-70 W! By modifying and combining two of these “20 W” devices I have been able to generate more than 125 W of RF output power for EME.

All modifications are **easy** and **cheap** because they are made in the DC/bias part of the amplifiers only. No changes to the RF part are necessary. Full practical details are given in this Conference DVD paper. Here I will highlight the main points of my experience.

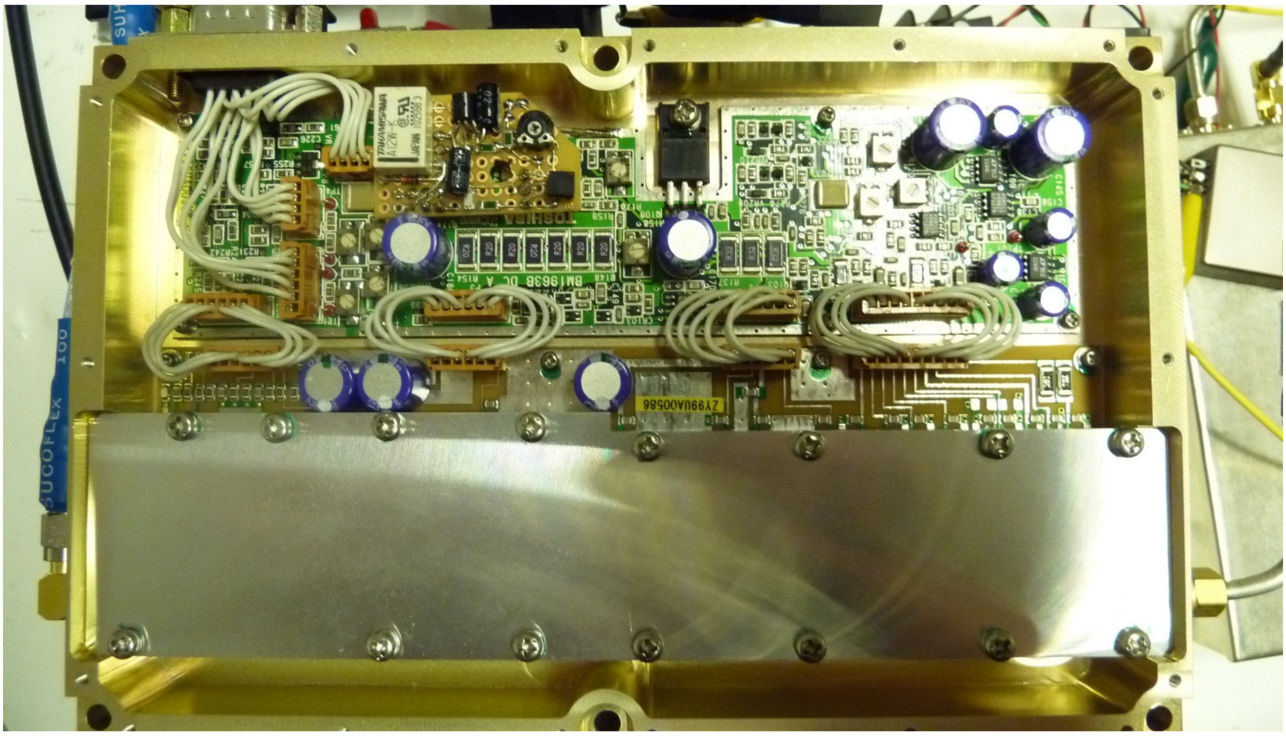
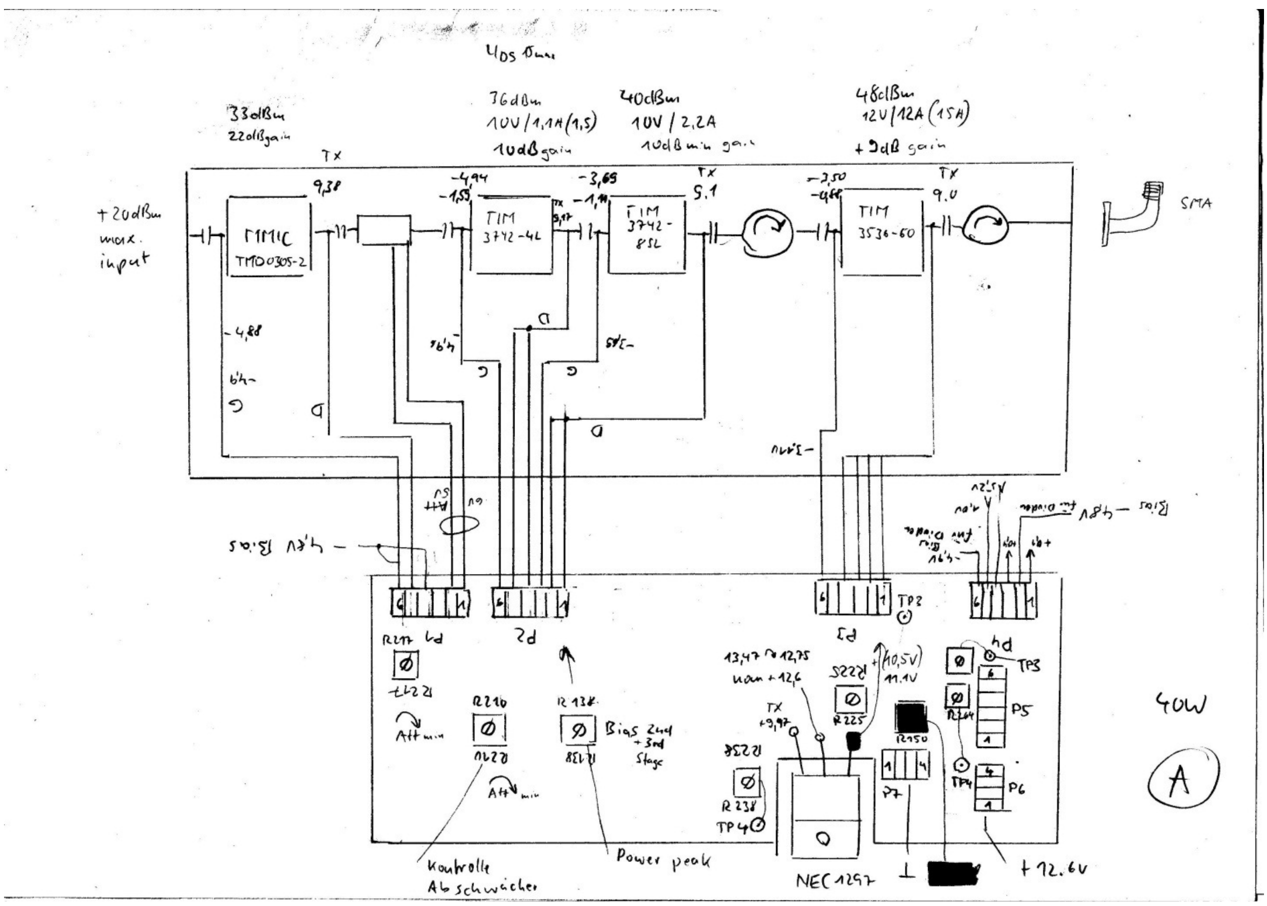


Figure 1: UM2683B SSPA with DC and bias modifications (small board near top)

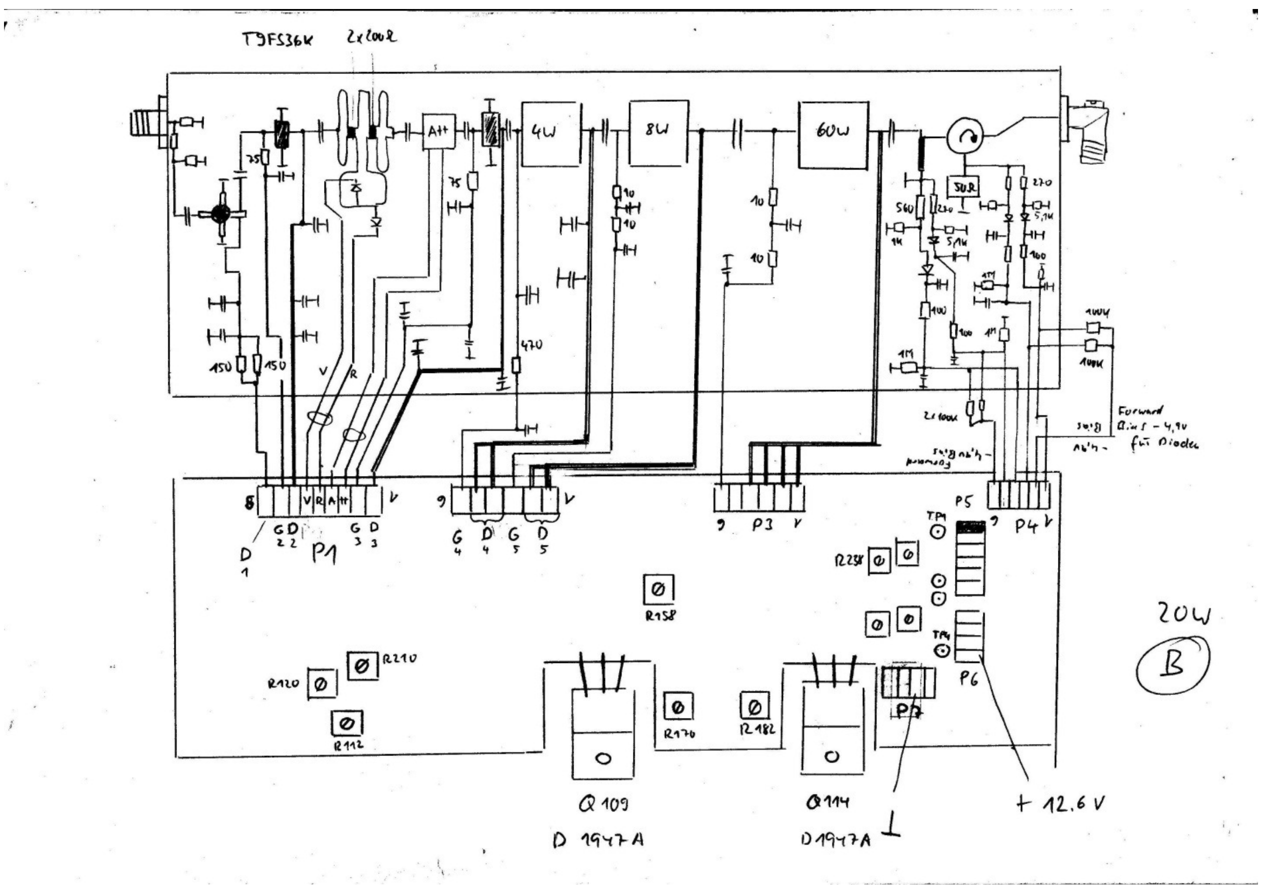


Drawing 6: "Raw" schematic of Toshiba`s UM2683A

Both models are using the same pre-driver, driver and final power transistors, but the rated RF output of the UM2683A is 40 W, compared with only 20 W for the UM2683B. Given the opportunity to choose, most Hams around the world have made the obvious choice, the "40 W" model. This was my first choice, too, but **the "20 W" UM2683B version is the better one to modify for higher output power!**

The difference in output power between the two models is due to the driver stages and the DC/bias circuits. Only the original UM2683A bias supply can deliver the currents necessary to generate higher output power up to 55 W. But the bias regulator in the "A" model has two major flaws: it sets the same fixed voltage level for all internal stages - there is no possibility in UM2683A to adjust the bias voltages separately for different stages. Also the bias voltage is difficult to adjust (in the A model) and is sensitive to small changes in the DC input voltage [1 - 3]. "Foldback" of the internal power supply (with the Darlington transistor 2SD1297 build in by TOSHIBA`s engineers) will be seen very easily!

The UM2683B has two independent bias supplies and only the one for the final has to be modified to enable higher RF output power. It is easy to do this, with RF results far beyond the original values. It only takes a few hours to modify one of these beautiful amplifiers and the parts cost only a few dollars.



Drawing 7: "Raw" schematic of Toshiba`s UM2683B

First Steps

My own experience started with one UM2683A, the "40-50 W" model with the <u>swept</u> right angled SMA-output connector; bought from „Pyrojoe" on eBay. I had his written guidelines on hand: "How to connect the amplifier and how to "tune" all the pots for the optimized result of >50 watts output at 3400 MHz".

The heat-sink I used was large…. but as things turned out, not large enough. During the optimization process a phone call disturbed me; I switched of the RF drive only, but forgot to cut the high current DC power line. After 30 min I returned to the bench and it smelled very warm! The SSPA was still idling at 16A and was now at approximately 100deg C, but it wasn´t amplifying any more. I thought I had killed the big, expensive transistors, but luckily only the first RF-MMIC and the high current regulator transistor had burned out. I cut out both devices from the board and soldered a thin semi-rigid cable from the input connector to the coupling capacitor of the first **transistor** (behind the input MMIC).

To replace the 2SD1297 regulator device was a bit harder due to availability problems, so I decided it would be better to relocate a new regulator better outside the case due to the extra heat if inside. Because this DC Darlington transistor had been reported to be the most "sensitive" device in the entire amplifier [1-3], I connected an **external** high-current DC supply. Outside the amplifier, I replaced the original regulator transistor 2SD1297with a RFP60-P03 PMOS FET switch, with some additional parts like a small relay, a transistor, a diode, etc, all on a small piece of circuit board.

Therefore I drilled 3 holes in the case´s sidewall and a solid wire connection was made to the new high-current DC supply (containing the PMOS switch) mounted on a small external heat-sink. The main reason for the replacement with a totally different device and a “reconstruction” of the whole high current regulator was based on the reports of Dave Robinson WW2R, Tom Haddon K5VH and John Jaminet, W3HMS.

Like in my observations, they all found out a tight dependency of the DC input voltage, bias settings and “foldback” characteristics of the output power. **The NEC D1297 in his surrounding is the most critical device in this microwave amplifier.**

To overcome the limits of NECs D1297, the idea was born to make something much different!

After both replacements made (regulator transistor and semi-rigid cable), the adjustment of TIM3536-60`s drain voltage in respect to the DC input-voltage, was much less critical. I set this voltage to 11.0 volts at pin #1 of the interconnection P3 and there were no more problems from variations in the DC input voltage. I could vary now the DC input voltage in a wide range without any influence of the output power.

Everything now worked as before, apart from requiring 22db more drive power because of the failed first amplifier MMIC. I had enough drive power available anyway, so this was no problem. But the best result of all was to discover that the **first MMIC had been a power limiting factor.** Without that MMIC, and with the new bias supply, I could continue to increase the drive power without saturating the whole SSPA, resulting in an output of about **60 W or more**! (with the first MMIC in place I had < 55 W saturated power from the same amplifier) This modified amp works great for some years in my 9 cm tropo station, including a lot of contests.

The Next Step

In summer 2008, after a 10min full power carrier test at 3400 MHz, this SSPA failed again. Due to the summer heat in combination with insufficient cooling, the power transistor got too hot delivering 60 W. The printed output line had burned away, the DC choke line had de-soldered, and the result was typical: no more power!

After careful inspection of the damage I scratched away all the “charcoal”, resulting in a big hole in the printed circuit board! After replacement of the printed output line by a bit wider “airline”, (because no more PC-board exists underneath, epsilon r is lower now) and a new connection of the DC choke for biasing, the amplifier worked as before – that TIM 3536-60 is a **very rugged output transistor!!!**

To prevent this from happening again, I modified my second UM2683A to the more rugged model too, as described before. This time I implemented the new regulator inside the original case (see Figure 1), which works quite well too when given sufficient cooling!

More Power for EME

Having the idea of 3400 MHz EME in mind, in fall 2010 I had the chance to buy four pieces of the UM2683B SSPAs. This model has a rectangular output connector (not bended) and is designed originally for 20 watts output.

This is where I had the chance to discover that the “B” model is easier to modify and can deliver even more power than the UM2683A. After the modifications, they are showing output levels between 68 and 73 W.

Figure 15: PSU and Power Meter setup showing 68.3 W RF

What I know from that time [1 - 3], it is possible to get out 30 watts each from UM2683B and therefore I want to combine several amplifiers by rat-race-couplers to end up > 100 watts output with four of these amplifiers.

The first inspection of the RF-part of these SSPA`s showed similar pre-driver, driver and output transistors (Drawing 6) compared to the UM2683A having much more output power. Only the input solution was different.  In the so-called low power model one will find three transistors (or probably single-stage MMIC`s?) compared to a solution with one larger MMIC in the 40 watts model UM2683A. All other transistors are similar devices!! (Drawing 7)

Interestingly the low power model UM2683B has **TWO** DC-regulators (for biasing the final power transistor and the driver transistors together with the three pre-stages around the attenuator separately). This is a real advantage against the High Power Model UM2683A. At the end – the “cheaper” one model UM2683B is the better amplifier! To modify the 20 W model UM2683B into a 65-70 W model it is necessary to exchange the second DC-regulator **NEC D1947A** by a **RFP60-P03** PMOS transistor (or similar SUB/SUP65P06-20) and to allow higher DC voltages (and currents) at the driver and final collector than widely recommended!

This can be done by cutting out the original device and a replacement by the PMOS FET switch. Additionally a small piece of circuit board is needed to fix some extra parts to operate the new FET-Regulator. (Drawing #1a and 1b) The original connection to the 2SD1947As base, now feeds the coil of a tiny low drive current relay (R182 must be in full CW position!). This turns the modified amplifier into a device working like the old one. No changes at “outside “connections are necessary and the PTT-line works as described in all publications.

The **NEW** small board contains a potentiometer to vary the output voltage of the power PMOS FET. This opens the possibility to use DC input voltages in the range from 12.5 volts to 15 volts having a stable COLLECTOR voltage (measured at the collector of the high-power RF transistor!!) of 12.0 volts. The data sheet will allow this higher voltage at the output transistor collector– why we don`t use this feature in the amateur surrounding!! [11] [Datasheet TIM 3536-60, page 1]

The modified SSPA is now no longer more Ub sensitive and is NOT critical against drops on DC power line! No RF tuning is necessary – only the12.0 volts PMOS FET regulator has to be set. It is a good way to do this with disconnected INTERNAL connectors P2 and P3. If successful pre-tuned to 12.0 volts, the final bias adjustment under full output power (with sufficient heat-sink / blower forced cooling) can be made later!

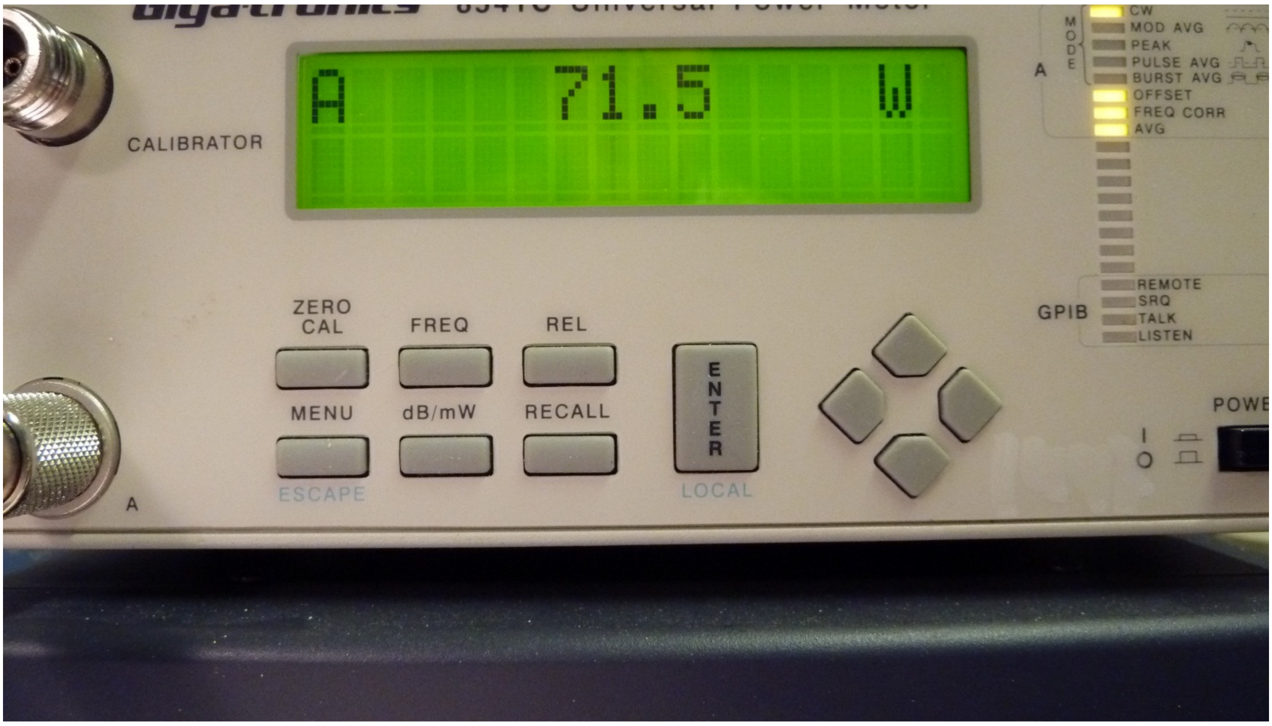


Figure 14: RF Power output @ 3400 MHz from a modified UM2683B

I modified four of these amplifier, they are all showing output levels between 68 and 73 watts, as pointed out before. I mounted two of them on a special high-efficiency heat-sink with a very large effective surface (Fig. 18) and blower cooled. The inputs are fed from a resistive -6dB coupler with a variable delay line in one leg to set the correct phase, and the outputs are combined by an airline rat-race coupler (Fig. 23 - 26) [Datasheet RF HAMDESIGN]

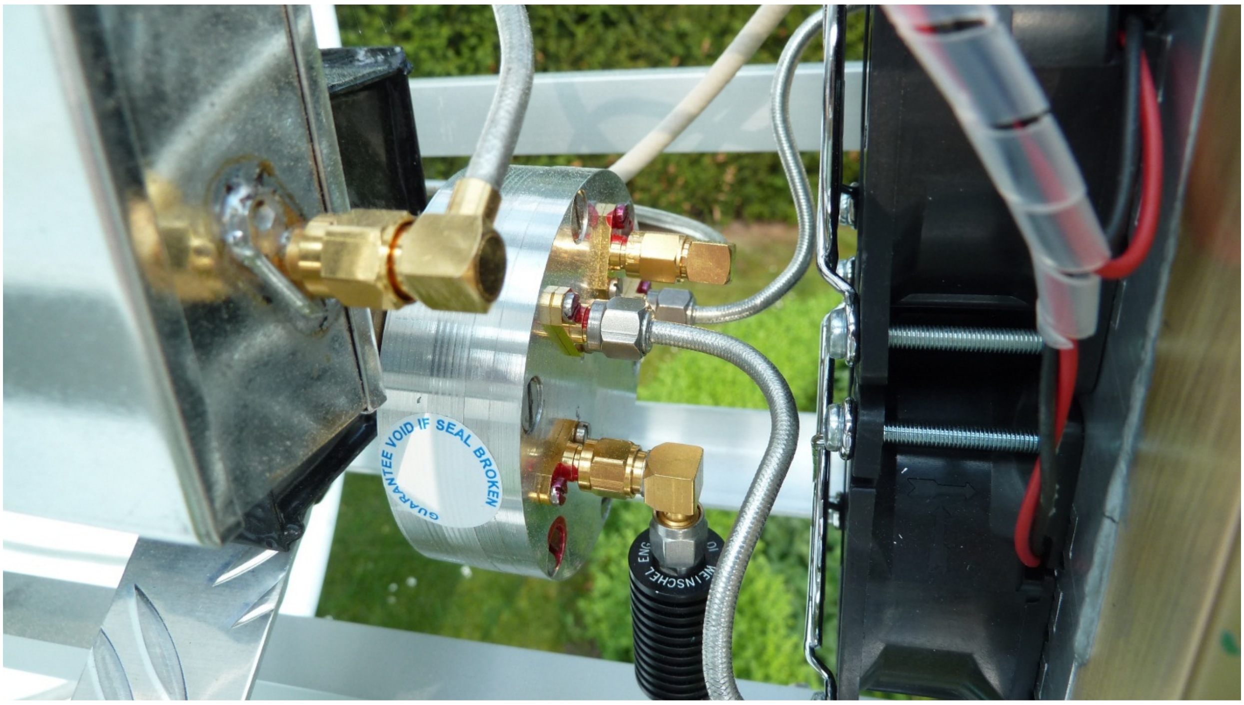


Figure 23: Detail view of Rat-race coupler 3400 MHz in the center
Left: VLNA2+ Right: 2x high power blower

(Figures 23 and 25): Rat-race coupler, 50Ohm resistive load, semi-rigid cables

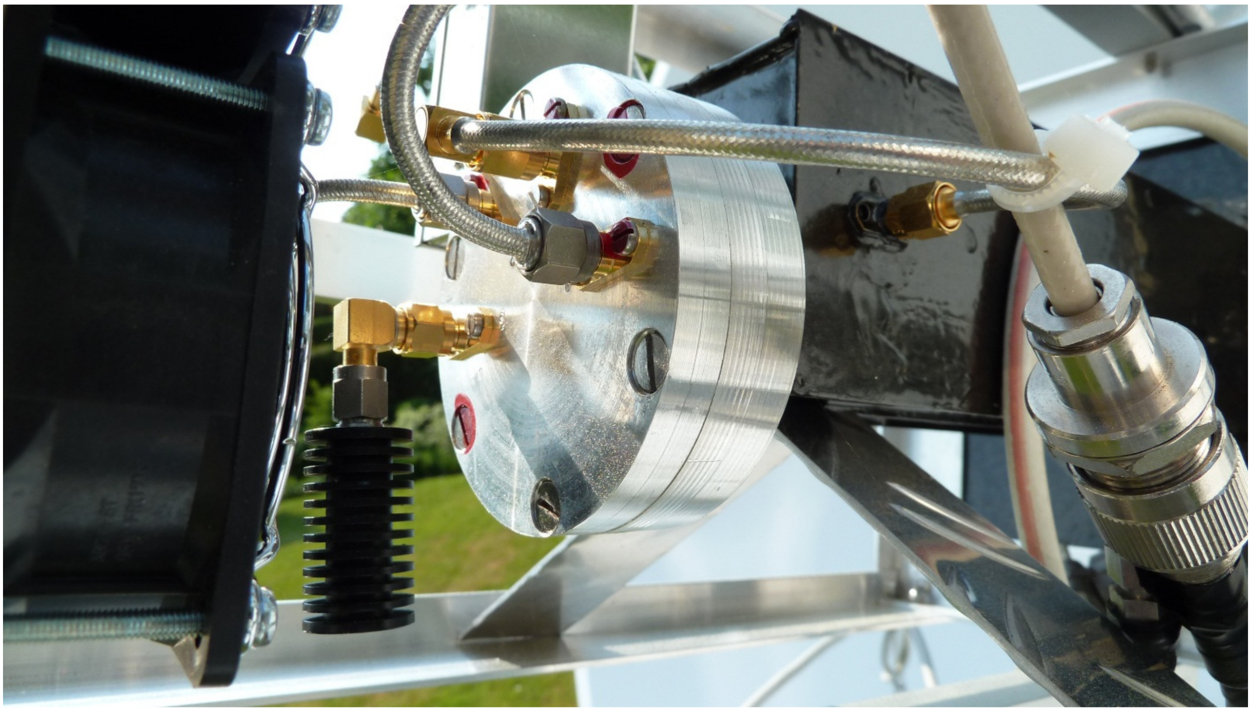


Figure 25: Detail of the Rat-race coupler from a different view
Left: 2x blower Right: rear of septum feed

These rat-race couplers [High-Power 3dB HYBRID RING COUPLER 3400MHz] are available from RF-HAMDESIGN. (http://www.rfhamdesign.com) The resulting output power is more than 125 W which is very effective for EME work.

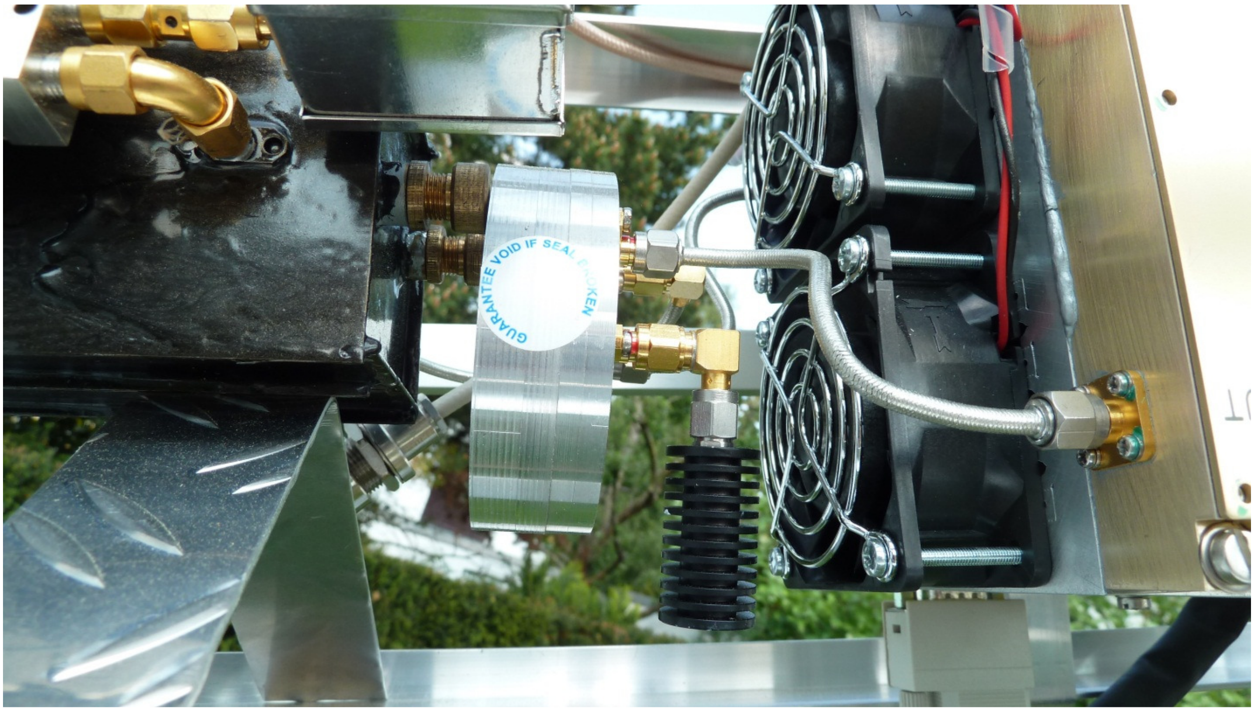


Figure 26: 125 W for 9 cm EME
Right: 2x UM2683B SSPA`s, above and below the blower cooled heat-sink.
Centre: Rat-race coupler. Left: rear of septum feed

Internal, external and control signals

15-pin SUB-connector

1: +13.8 volts Ub
2. +13.8 volts Ub
3: Ground
4: High Output Alarm (1-38dBm = +5volts / >42dBm = 0volts)
5: VSWR Alarm (>12dB return loss = +5V / <6dB return loss = 0volts)
6: if internal connected to internal connector P4 / pin #4 (counted from the left) this is FORWARD Power (measured at the "cold end" of a stub at the PA`s collector)
7: Ground
8: Low Output Alarm (6dBm-40dBm = +5volts / <6dBm = 0volts) i.e. OVERHEATING
> 90 deg. Celsius initiate auto shutdown?? (returns after -15deg drop) [3]
9: TX switch (Open or HIGH = Stand By / Closed to ground or LOW = TX ON)
10: Ground
11: Ground
12: +13.8 volts Ub

13: +13.8 volts Ub

14: if internal connected to internal connector P4 / pin #3 (counted from the left) this is REFLECTED Power (measured at the termination leg of the output circulator)

15: connect a “normal” LED via 820 ohm resistor to monitor internal +5volts

Internal connectors of TOSHIBA UM2683B

(counted from the left, if RF-section is close to your body. With good eyes you can see Pin #5 and Pin #6 tiny marked on each connector body!)

P1:

1=Drain voltage IC3;	+10.9volts @ TX
2=Gate voltage IC3;	-4.93volts @ STBY; -0.72 @ TX
3=Attenuator2 voltage;	+9.53volts @ TX
4=Attenuator2 voltage	+4.04volts
5=Attenuator1 voltage;	-3.63volts
6=Attenuator1 voltage;	+5.0volts
7=Drain voltage IC2;	+4.89volts @ TX
8=Gate voltage IC2;	-4.93volt @ STBY; -0.8volts @ TX
9=Drain voltage IC1;	+9.55volts

P2:

1 and 2= Drain Driver transistor TIM3742-8SL-341;	+10.55volts @ TX
3= Gate bias Driver transistor TIM3742-8SL-341;	-4.93volts @ STBY; -0.8volts @ TX
4 and 5=Drain Pre-driver TIM3742-4L;	+10.56volts @ TX
6=Gate bias Pre-driver TIM3742-4L;	-4.93volts @ STBY; -1.37volts @ TX

P3:

1,2,3 and 4= Drain Final TIM 3536-60;	+11.0volts @ TX (>>>> tune max. +12.0volts)
5=NC;	
6= Gate-bias TIM 3536-60;	-1.76volts @ STBY; -0.71volts @ TX

P4:

1= Reflected PWR for internal use:	-0.18volts / -0.07volts
2= Bias voltage for reflection measurement diodes;	-4.9volts
3= Reflected PWR;	-0.18volts / +0.08volts (>20dB RL)
4= Forward PWR;	-0.18volts / +6.4volts @TX
5= Forward PWR for internal use;	-0.18volts / +1.63volts @ 60 watts
6= Bias voltage for forward measurement diodes;	-4.9 volts

P5:

1= Low Output Alarm - connects to DB-15/pin #8	0.0volts / 4.6 volts @ TX
2= TX On - connects to DB-15/pin #9	+4.9volts / 0.0volts (ground) @ TX
3= VSWR Alarm - connects to DB-15/pin #4	+4.6volts / 0.0volts @ 60watts
4= High Output Alarm - connects to DB-15/pin #5	4.6volts
5= +5V for external LED - connects to DB-15/pin #15;	0.0volts /2.12volts @ 60watts

6= NC

P6: all Pins **+Ub**
P7: all Pins **Ground**

Original functions of UM 2683A internal potentiometers:

R 210: Attenuator setting (full CW position respects to zero attenuation)
R 217: Attenuator setting (full CW position respects to zero attenuation)
R 138: CW until power peaks, back off slightly (-Bias voltage setting for Pre-drivers)
R 238: Bias for drivers and final transistors (CCW until power peaks and stop)
R 225: Internal function unknown!!
R 150: Output voltage setting of NEC 2SD1297 (10.3volts)
R 264: and one other unnamed potentiometer around: for internal measurements and thresholds (don`t touch!)

Original functions of UM 2683B internal potentiometers:

R 120: Attenuator bias (full CCW position = recommended position)
R 112: Attenuator bias (full CCW position = recommended position)
R 210: Attenuator setting (full CW position respects to zero attenuation)
R 158: Common bias for TIM3742-4L and TIM3742-8SL and final transistor TIM3536-60
R 170: Collector setting Q109 (10.0 V) – D1947A (for TIM3742-4L and TIM3742-8SL)
R 182: Collector setting Q114 (11.0 V) – D1947A (for final transistor TIM3536-60)
R 238: ….and three other unnumbered pots around**: for internal measurements and thresholds (don`t touch !)**

"Step by Step" modification:

1. Put the amplifier flat at a table in front of you (rectangle output connector left)

2. Open the case with a small screwdriver and preserve all tiny screws in a box

3. Unscrew the big, black power transistor **2SD1297**

4. **Turn R182 full !! CW now (...for later usage; don`t forget !!!)**

5. Cut off all three legs from the transistor close to the transistors body. Grab each transistor leg with forceps separately and re-solder it from the board

6. Mount the new RFP60-P03 P-MOS **<u>insolated</u>** at the same place instead

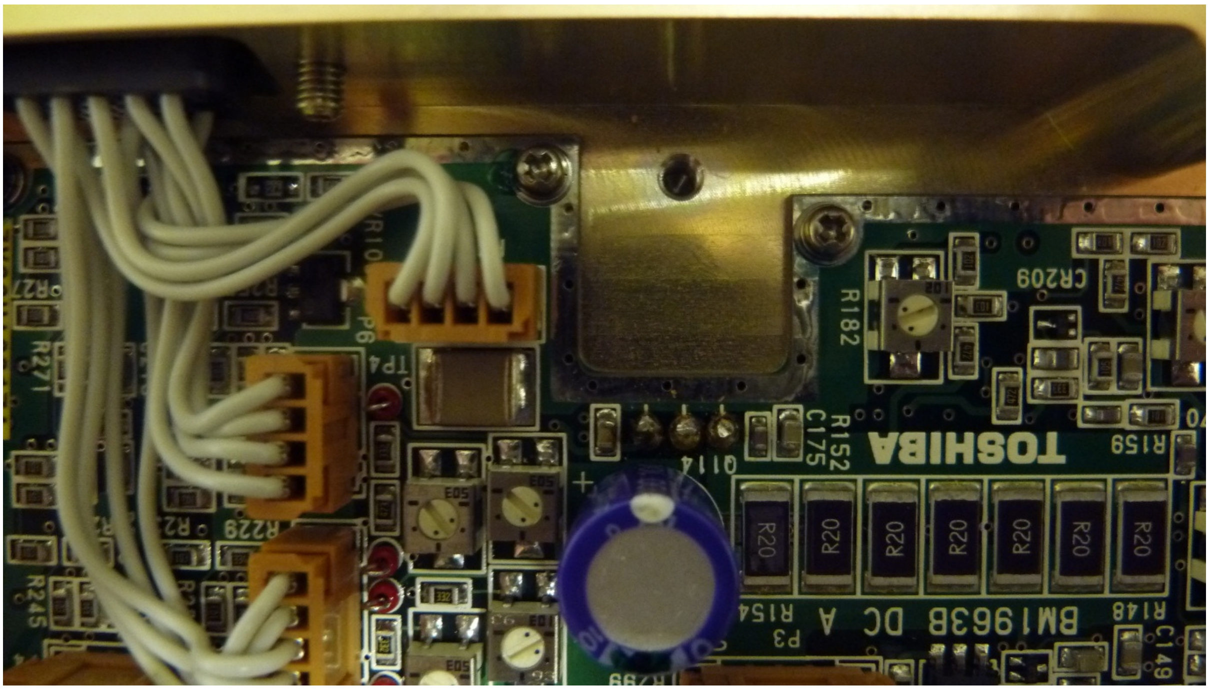


Figure 2: UM2683 B final series regulator removed

7. Bend the Source (right pin) and Drain leg (middle pin) of the FET crossed over as shown in the Figure 3 and Figure 4

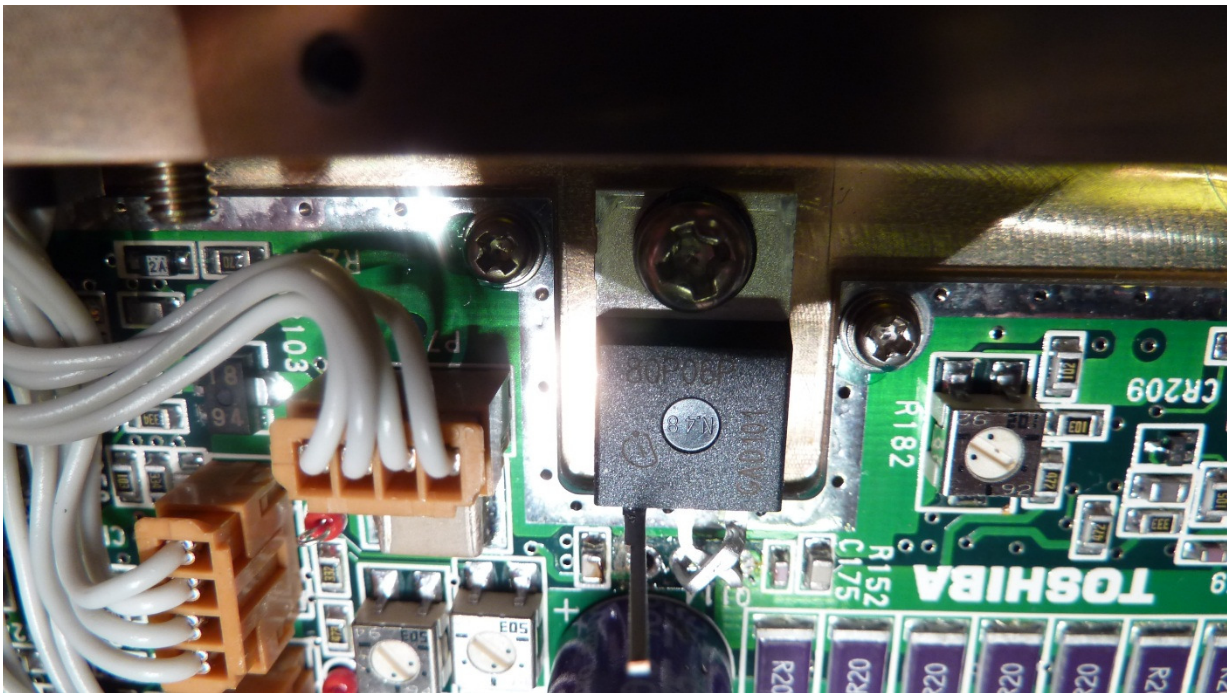


Figure 3: UM2683 B – new PMOS series regulator in place

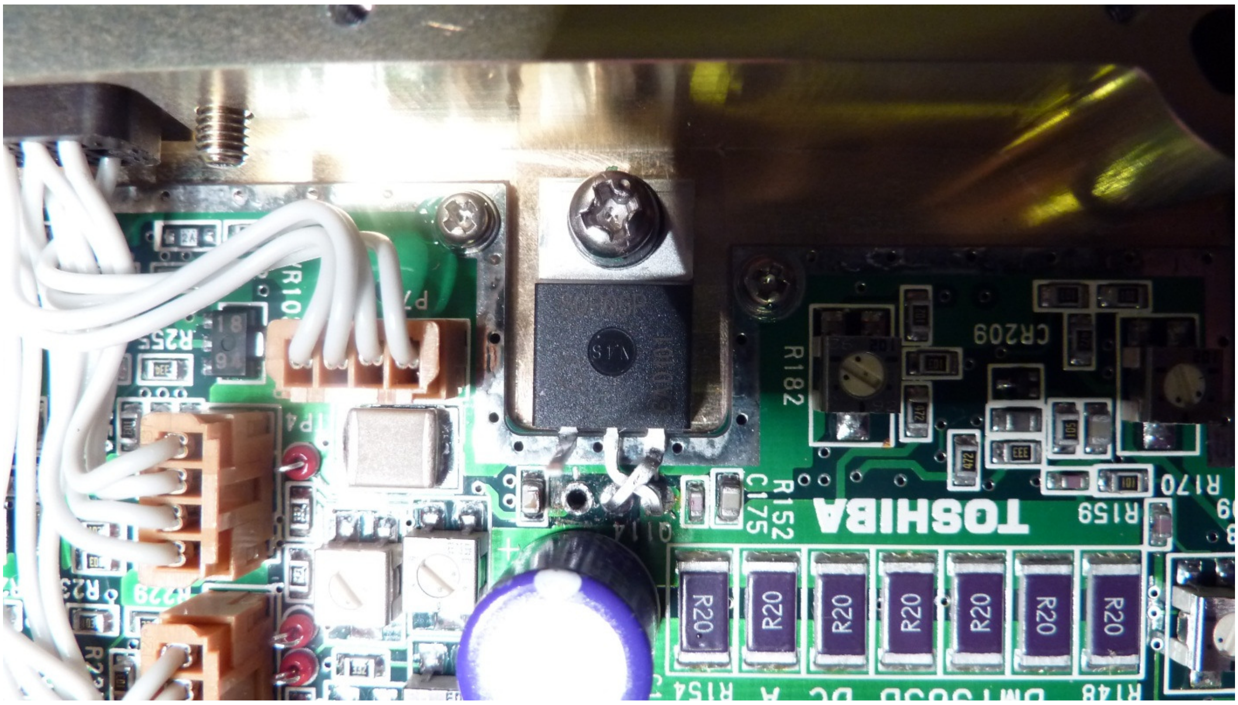


Figure 4: UM2683 B – new PMOS series regulator in place

8. Cut leg length <u>later</u> when necessary!!

9. Solder the Source-leg to the middle and Drain-leg to the right into the via holes under the new leg`s position

10. The Gate-leg is bend upright and remain unsolder at that time (for later use)

11. Solder a 1mm diameter, 25mm long solid wire additionally to the middle via-hole, together with the Source-leg, upright “in the air” (for later use); see Figure 5

12. Solder a 1mm diameter, 25mm long solid wire additionally to the right via hole, together with the Drain-leg, upright “in the air” (for later use); see Figure 5

13. Solder a 0.5mm diameter, 25mm long solid into the left via-hole (for later use); see Figure 5

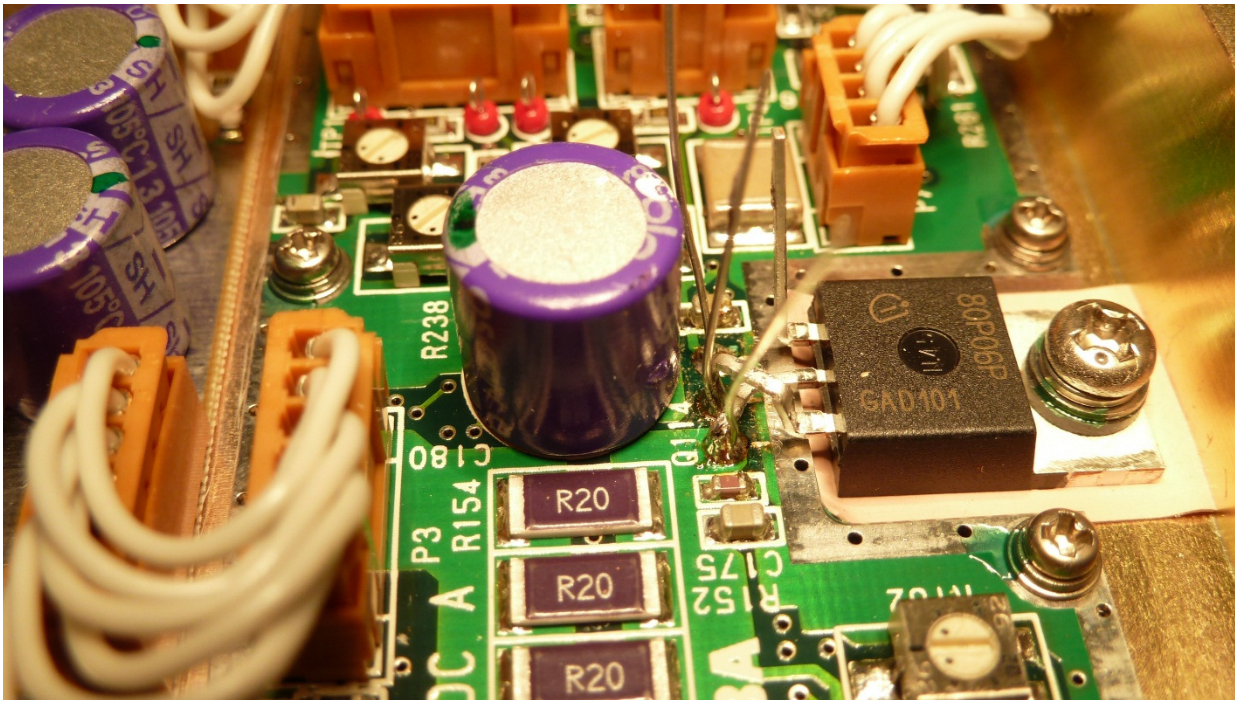
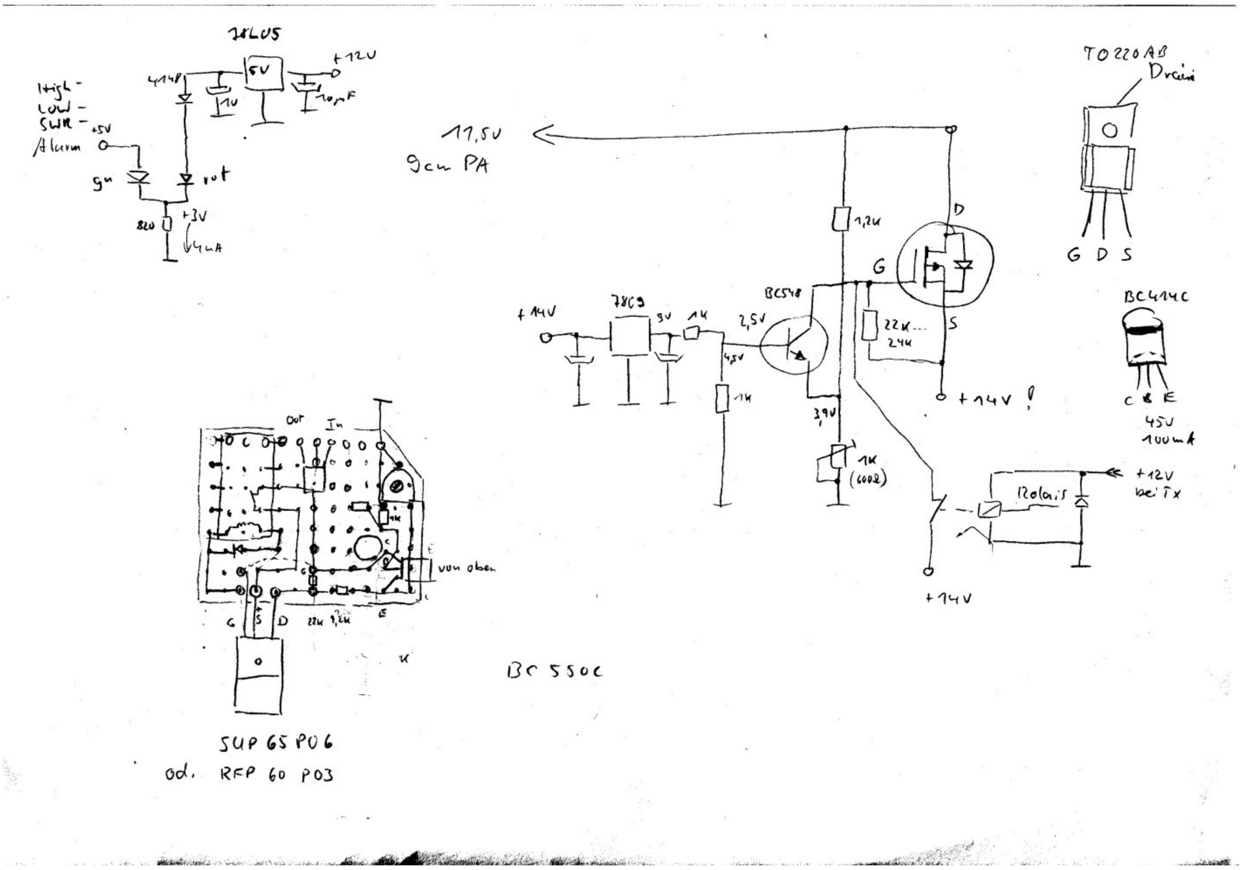


Figure 5: Power PMOS FET mounted and wires prepared

15. Prepare the small experimental board with the relay, a BC550 transistor, the 7809 regulator, a potentiometer and the other parts as shown in the schematic (Drawing #1a and #1b) and Figure 6.



Drawing 1a: 12.0 Volt MOS-FET power supply NEW

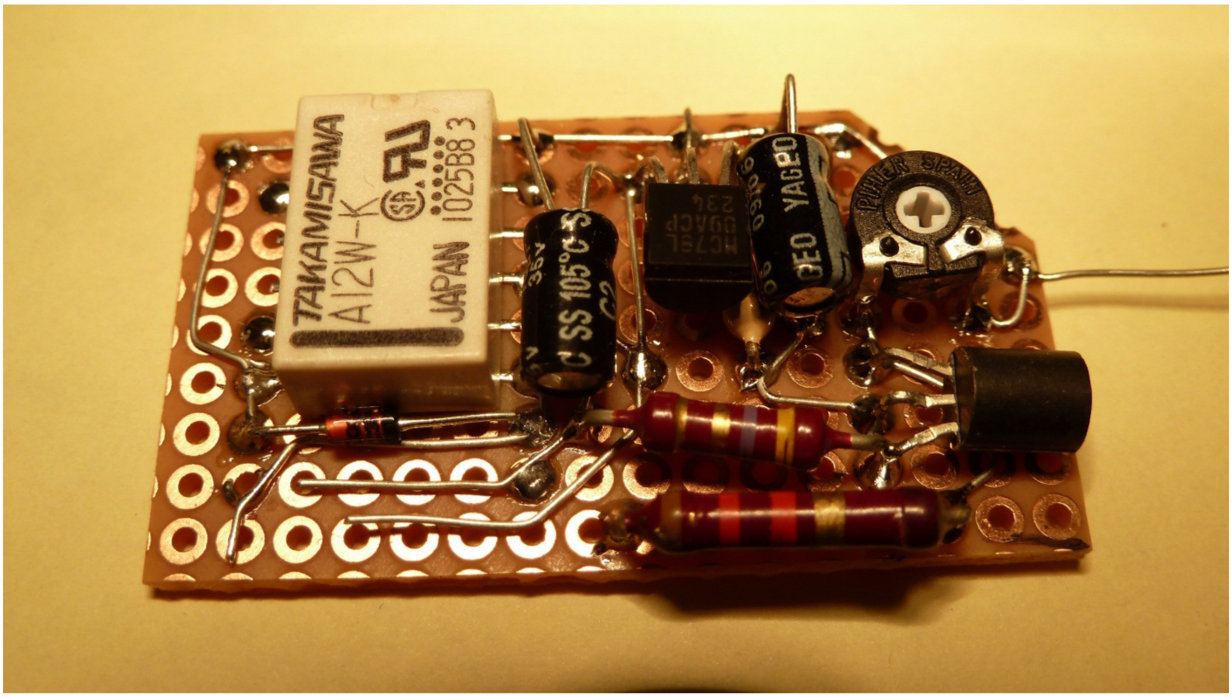
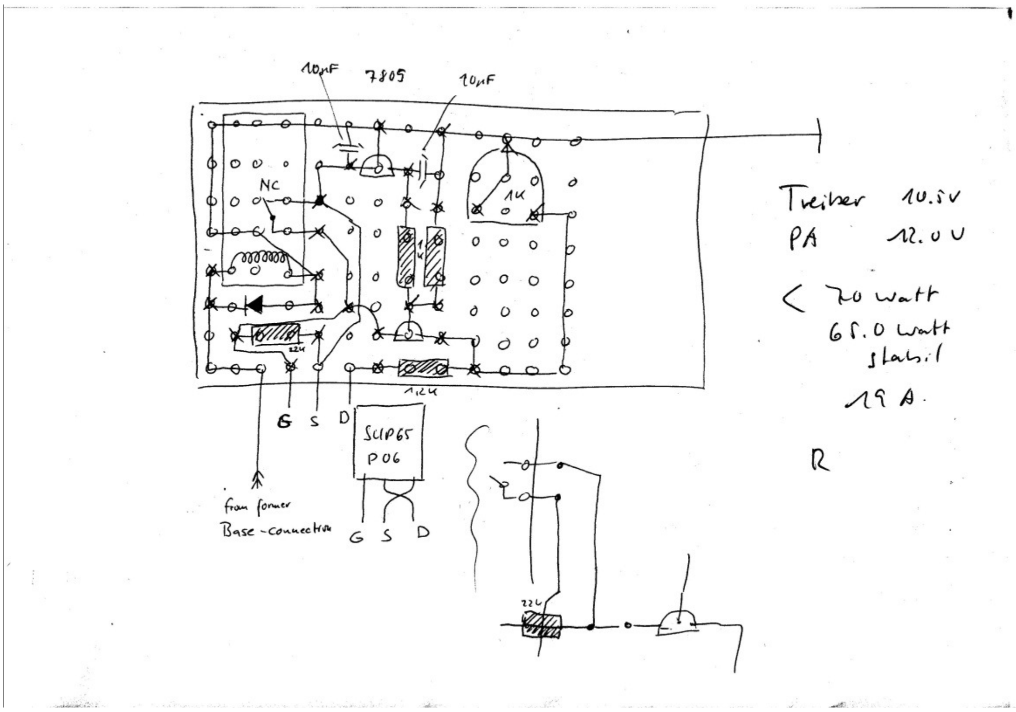


Figure 6: New simple circuit board with relay and 7805 regulator



Drawing 1b: TIM 3536-60 NEW power supply – possible circuit board layout

16. **Turn R182 full clockwise now!!!** (If you have forgotten to do in step #4) The “old” base connection of transistor 2SD1297 now drives the 12volts relay at the new board (activated in TX mode). But the new board will hide R182 completely and if R182 is not set CW properly before, the relay oscillates in TX mode!

17. Assemble the finalized board “on top” of the P-MOS FET , allow all wires and the MOS-FET`s Drain-leg passing through the corresponding holes in the board and solder the Ground-wire from the new board down to the main boards first.

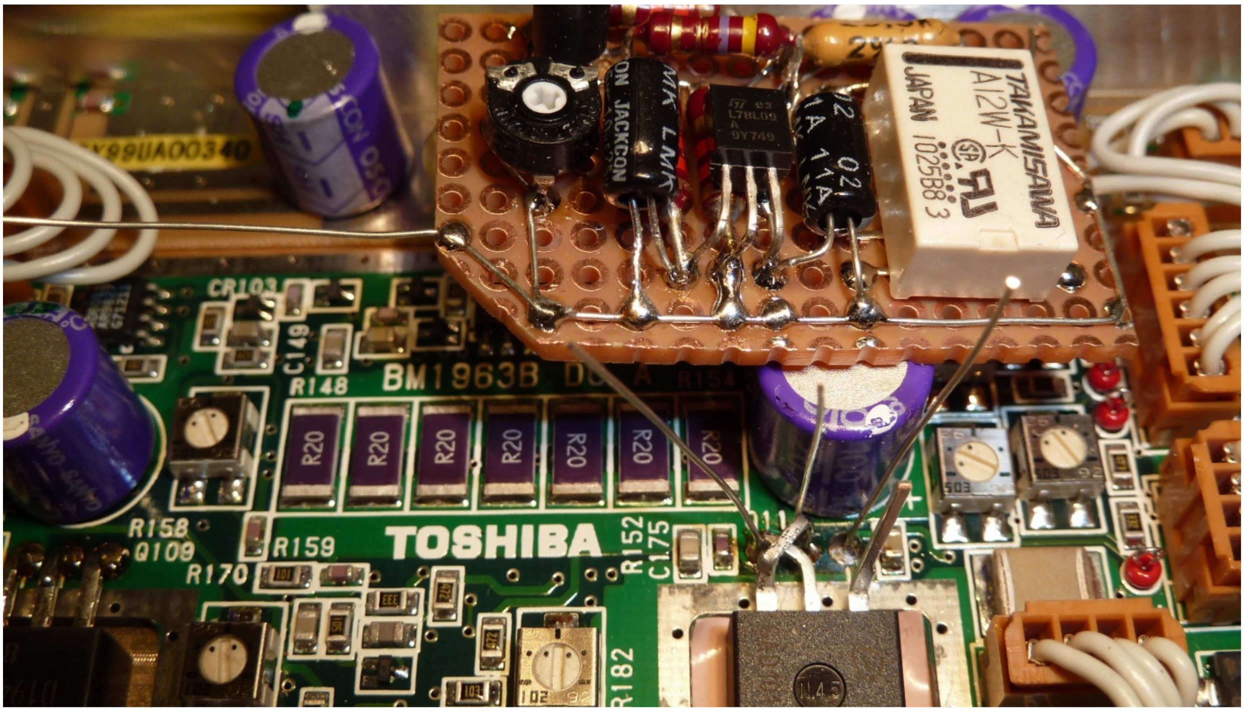


Fig 8: NEW simple board – ready to solder

18. Solder four other connections now. Be aware, all parts on the board where “below” the cases sidewall edges and the cover will not touch any part later.

Figure 10: Macro picture of the new PSU board in place

19. Cut all wires protruding from as short as possible to prevent from short circuits with the cover.

20. Disconnect internal connectors P2 and P3 and “fire up” the amp with 14.0 (+/- 0.5volts) volts at least

21. Turn the potentiometer from the new board (former pot # 182) to +12.0volts, measured at one of the 4 leftmost pins of internal connector P3.

22. Turn the potentiometer R170 to +10.5volts, measured at the leftmost pin of internal connector P2.

23. No RF input power applied at that time. If the voltages can be set to this level, everything at the new board works well and the connectors P2 and P3 can be put into his place again.

24. It could be a good idea to exchange now the angled SMA output connector with the SMA straight input connector vice versa due to its better VSWR and high power performance, but this is not essentially necessary!

25. Therefore open the RF-part of the amplifier.

26. Unscrew 4 small screws from the SMA connectors completely and lay them on the side

27. Unsolder QUICKLY both middle pins of the SMA connectors. Do not damage the PC-board!

28. Mount the output connector to the input and mount the input connector at the output position by 4 screws each before soldering!!

29. Re-solder both middle pins again.

30. Close the RF-part by its cover using the original screws. This finalizes the exchange of the SMA connectors.

How to set up the modified amplifier for > 65watts output @ 3400 MHz

1.) Connect an appropriate output load , including some power measurement equipment

2.) Connect a drive source of 10mW max via step attenuator

3.) Connect a power supply via the 15-pin SUB-D connector. Pins 1, 2,12, and 13 transfers +14 volts and 3, 7, 10 and 11 transfers -14 volts (or ground). Use all 4 pins due to the heavy current of 20A max. Each wire has to handle 5 A ! Solder all wires, do not crimp!

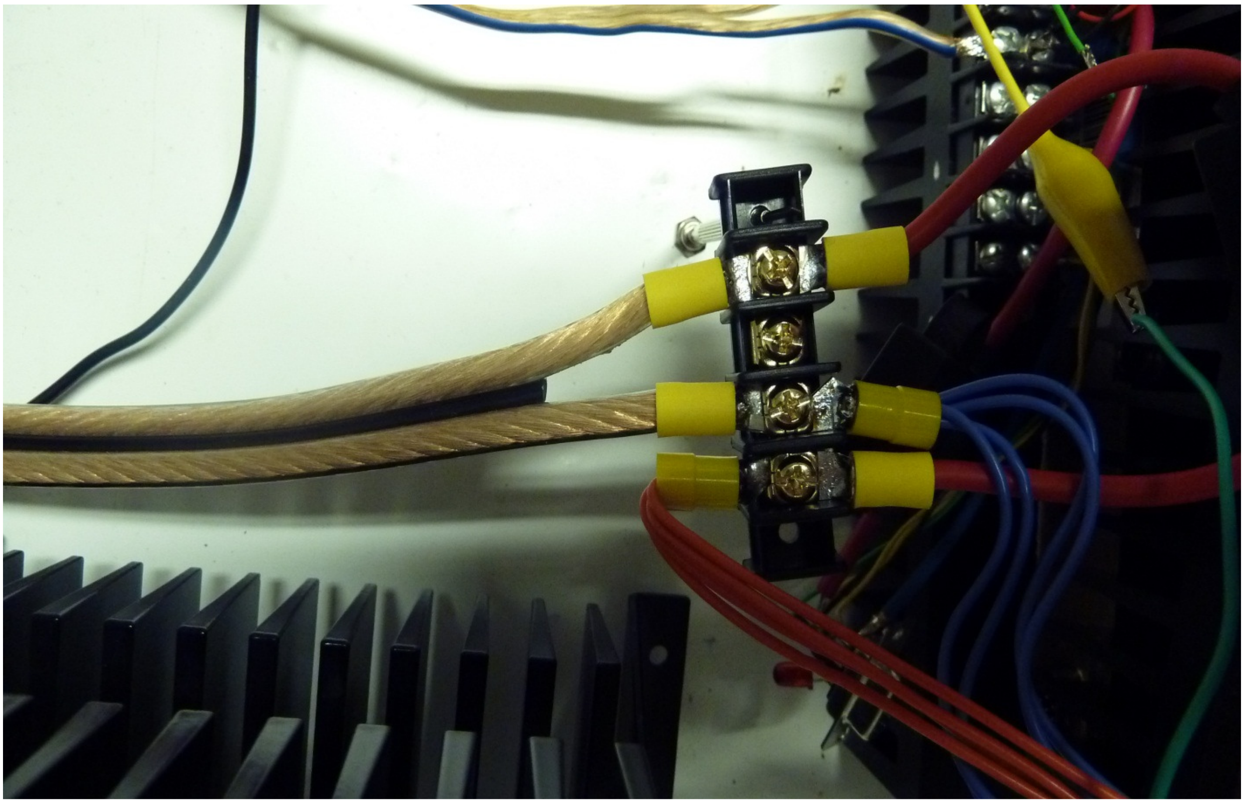


Figure 12: Connection to the external High current PSU by heavy LS-cable

4.) Lay or mount the amp on a LARGE heat-sink and/or use enforced air cooling. Use a thin layer of silver filled thermal grease between amp and heat-sink!

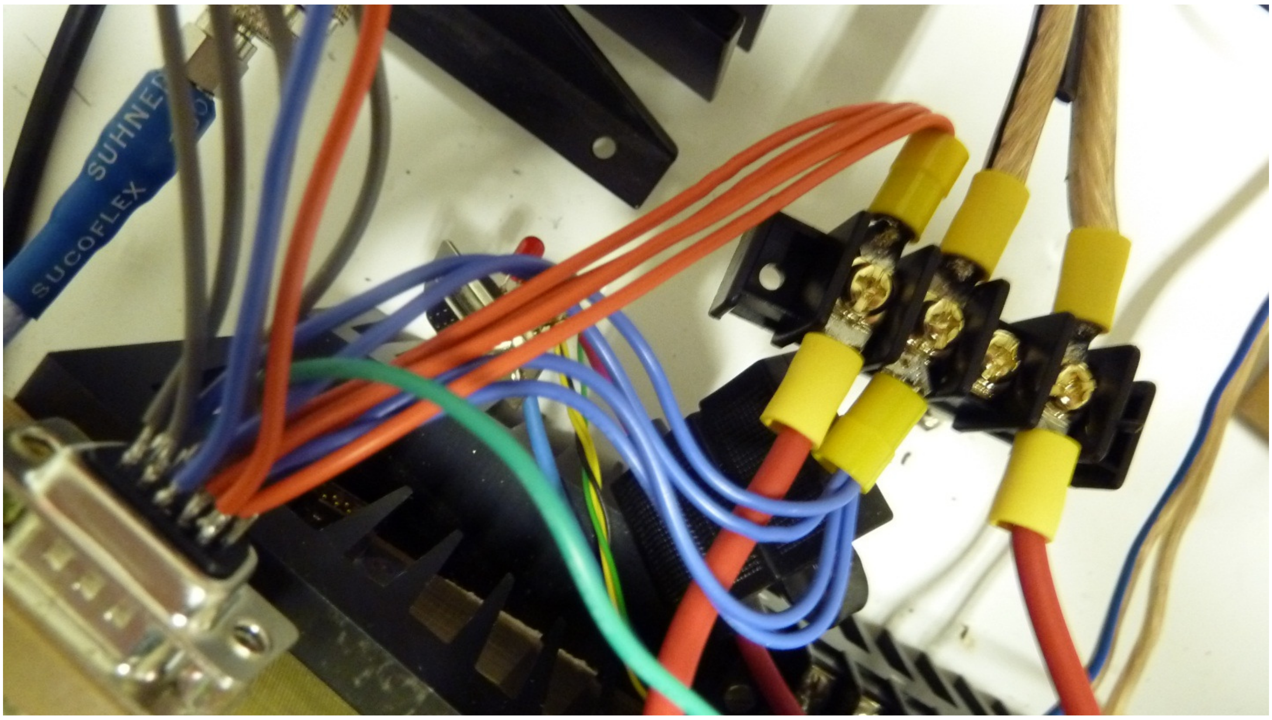


Figure 11: Toshiba UM 2683 DC-wire connection outside the amplifier

5.) **Switch to TX by grounding pin 9 of 15-pin SUB-D**

6.) Adjust the small pot at the new board, now under load, to a voltage level of 11.8 to 12.0 volts, measured at the four leftmost pins (#1- #4) of internal connector P3. This is the collector voltage for the final transistor.

7.) **Switch off the amp for "cooling" breaks any time if possible!**

8.) Adjust potentiometer R170 for 10.5-10.7 volts at leftmost pin #1 of internal connector P2. This is the collector voltage for the driver and pre-driver transistors.

9.) Apply 1mW RF to the input and measure the output power. Now you can try to readjust the potentiometer to 11.8 – 12.0 volts again, but mostly it`s not necessary to do this. The procedure is not unsafe due to excessive collector voltage, referring to the data sheet of TIM 3536-60!

10.) Turn R58 carefully (without RF-power at the input) to a total DC input current of 19 A **Allow sufficient breaks between TX phases** if the cooling (heat-sink) is not finalized.

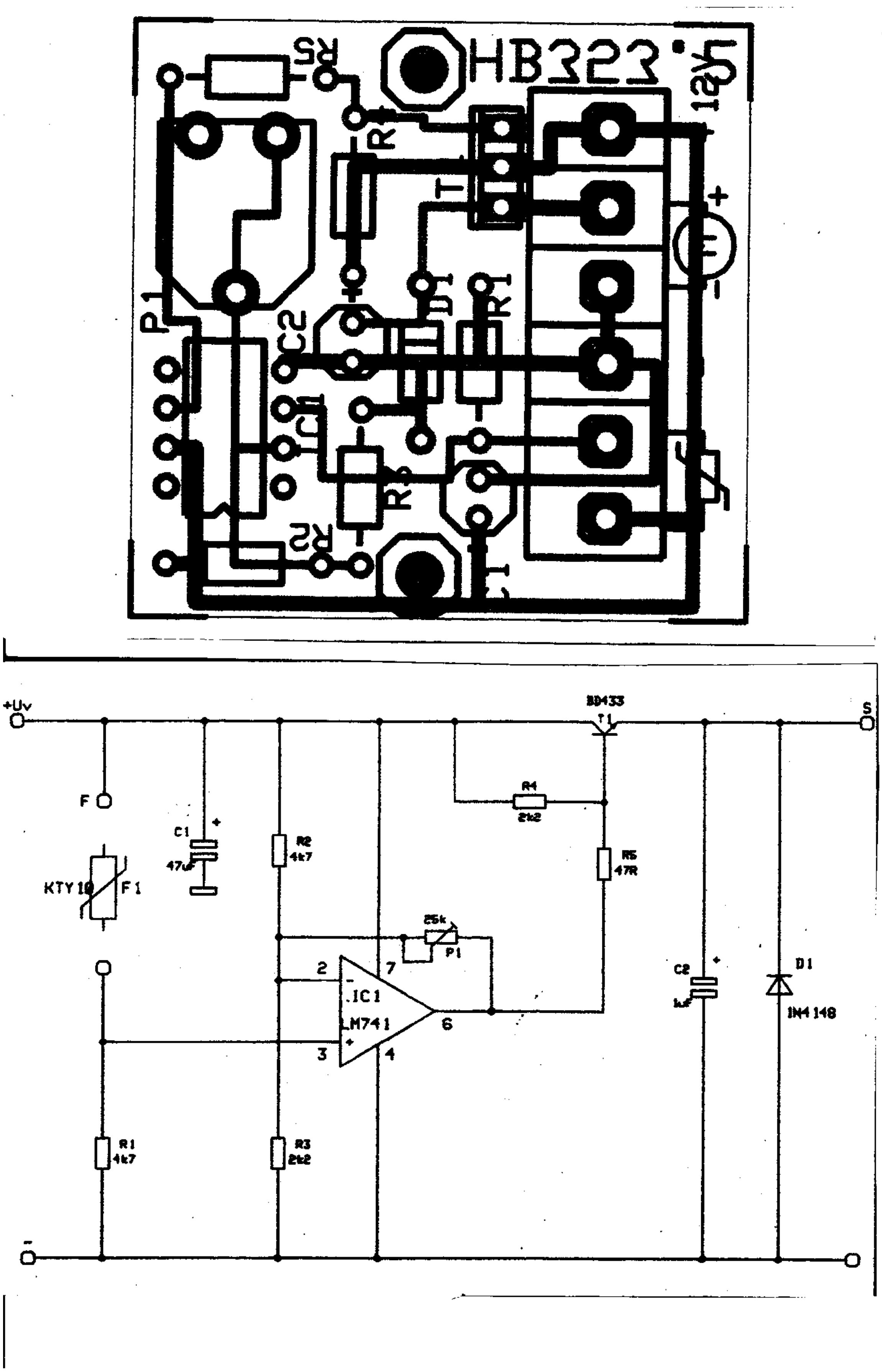
11.) Increase input power to a maximum level of +6dBm (4mW). But mostly 3dBm – 4dBm is sufficient for > 70 watts at the output connector. Toshiba`s data sheet described 60 watts @ -1db compression only. Amateur usage is much different!

12.) Close the cover using the screws preserved before.

Heat sink, blower and temperature regulator VBS1

(adaptive blower speed)

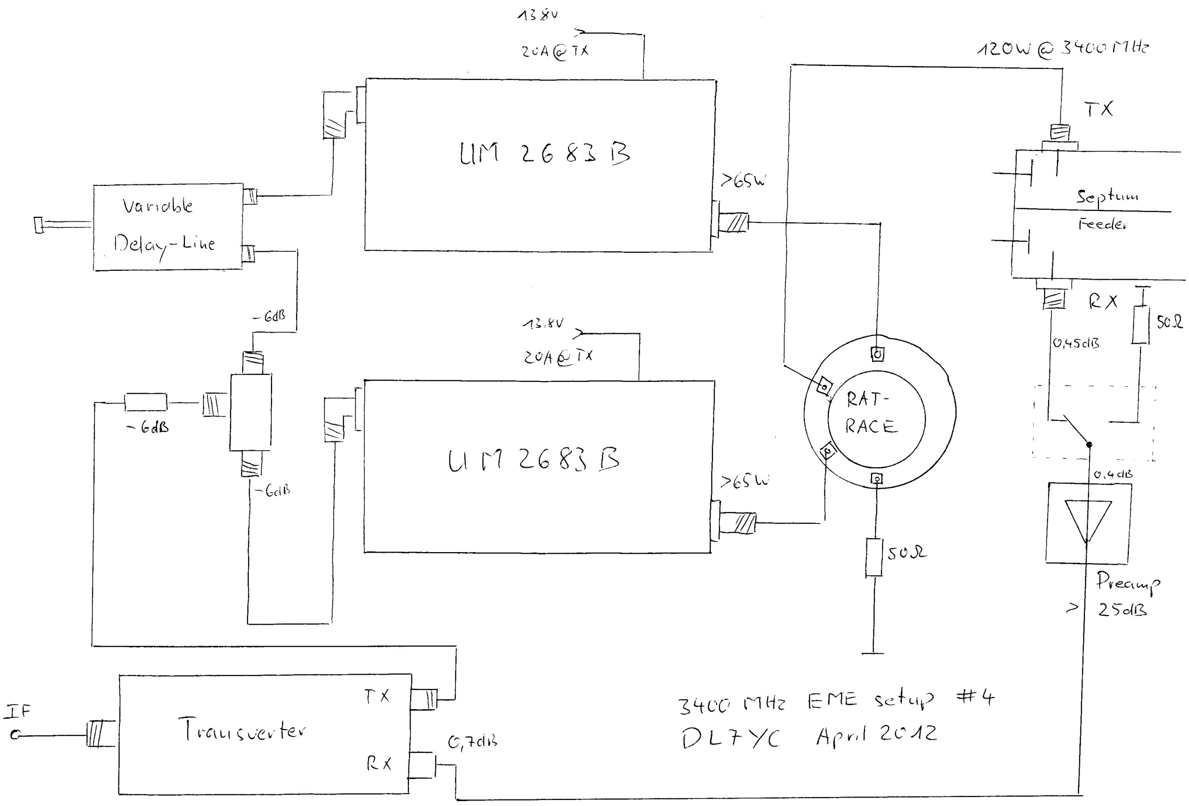
To establish a safe TX, sufficient cooling is a MUST. The amplifier will draw 20 amps @13.8volts. This corresponds to a DC input power of 276 W! If one subtract the output power of 70 W from this high value, round about 200 W of generated heat has to be removed (in TX state).



Drawing 2: Fan controller VBS1 –Schematic and Layout

To be aware of this fact, it is a good idea to use a heat-sink with VERY high efficiency The model SK200-125 from **KUHNE electronic** in Germany is a good example for a sufficient solution, especially if one mount two 60x60mm high speed fan´s at the final`s side too. Regulated by a small controller board (see Drawing # 2), this fan`s will speed up if more heat is detected at the outer walls of the amplifier by a PTC KTY10. The variation of the resistance is amplified and feed into a silicon driver in series with the two blower.

Coupling two 2683B amplifiers for a powerful EME transmitter



Drawing 3: 9 cm EME system using 2x UM2683B SSPA`s

For the close setup of two amplifiers, the couplers and the 9cm-Transverter, I use a special heat-sink (KUHNE electronic, part # SK200-125) and two high speed, high power fans (dimensions 60x60mm), as described before. 400 watts of heat has to be transported under TX condition!; in RX state nearly nothing!!

To be a bit more advanced one can use a simple circuit (VBS 1; see before) to monitor the heat-sink temperature generated in the TX-periods and regulate the blower speed accordingly. Please refer to the drawing # 2. The thermistor has to be placed (insolated, but with good thermal connection) at the sidewall of <u>one</u> amplifier, close to its final stage. It is assumed, that the second amplifier will generate the same amount of heat.

To “install” a 3400 MHz Power-Meter for less, use the following procedure

Disconnect internal connectors P5, P6 and P7. REMEMBER THE POSITION !! Remove carefully the bolts holding the outside DB-15 connector in place. Be careful, they are glued in. Use solvents or heat (or both) to release the bolts. Don`t damage them, it hard to fix the connecter later. Unscrew the bolts completely. Remove the connector with the three cable ties and internal connectors. Now you can solder additional wires to the unused pins #6 and #14.

Put the DB-15 in place and reconnect internal connectors P5, P6 and P7 into their original place.

Connect the first wire from SUB-D/pin #6 to internal connector P4/pin #4 (counted from the left). Therefore remove carefully the outer insulation of the Teflon insulated wire at pin #4 partially. This is the connection to a voltage representing the FORWARD Power.

Connect the second wire from SUB-D pin #14 to internal connector P4/pin #3 (counted from the left). Therefore remove carefully the outer insulation of the Teflon insulated wire at pin #3 partially. This is the connection to a voltage representing the REFLECTED power.

Now you can put an instrument (i.e.100uA) in series with a resistor (R-value depends at the instrument(s) used at DB-15 / pins #6 and #14 to measure **Forward** and **Reflected** power. For the first time calibration can be done with any external Power Meter.

Using the SUB-D DB-15 connector pin #4, #5, #8 and #15 control-signals for MAA1 and MAA2

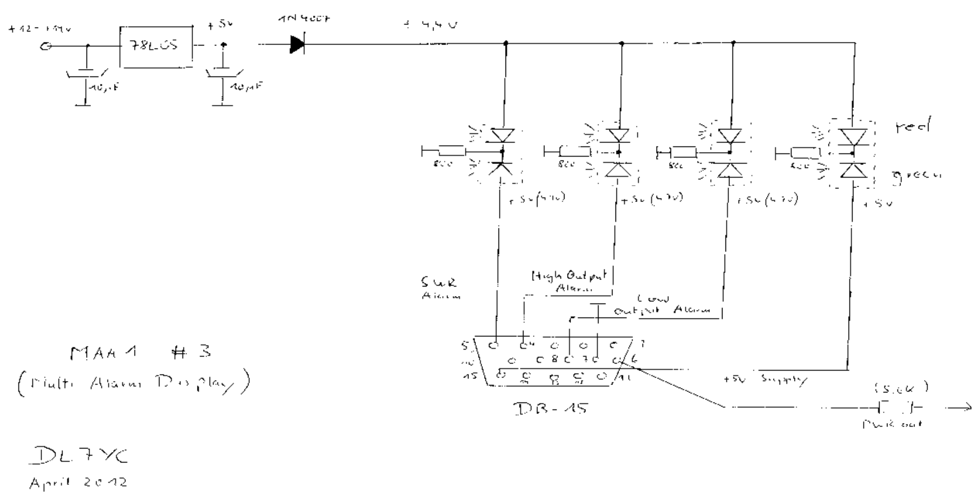


Figure 4: Multi Alarm Display MAA1

The amplifier UM2683A and UM2683B having the possibility to monitor several different working conditions. This can be watched out as logical “1” = false (+5volts) or logical “0” = true (0volts) at four different pins of the 15pin connector.

Pin #4 (High Output Alarm): If the amplifier is generating RF in the range of +1dBm to +38dBm (or 1.3mW – 6.31Watts) a logical “1” (false) is seen at this output; if higher than +42dBm (or 15.85watts) a logical ”0” show up.

Pin #5 (SWR Alarm): The return loss from a corresponding load, connected to the amplifier, should be better than 12dB. This is shown by a logical “1” at pin #5. If the return loss falls below 6dB, due to changed load conditions, the output will switch to logical “0” or “true” and come back to “1” if the return loss is better 12dB again.

Pin #8 (Low Output Alarm): If the amplifier`s output falls below 6dBm (or 4mW) this +5volts output will switch from logical “1” to logical “0” (true).

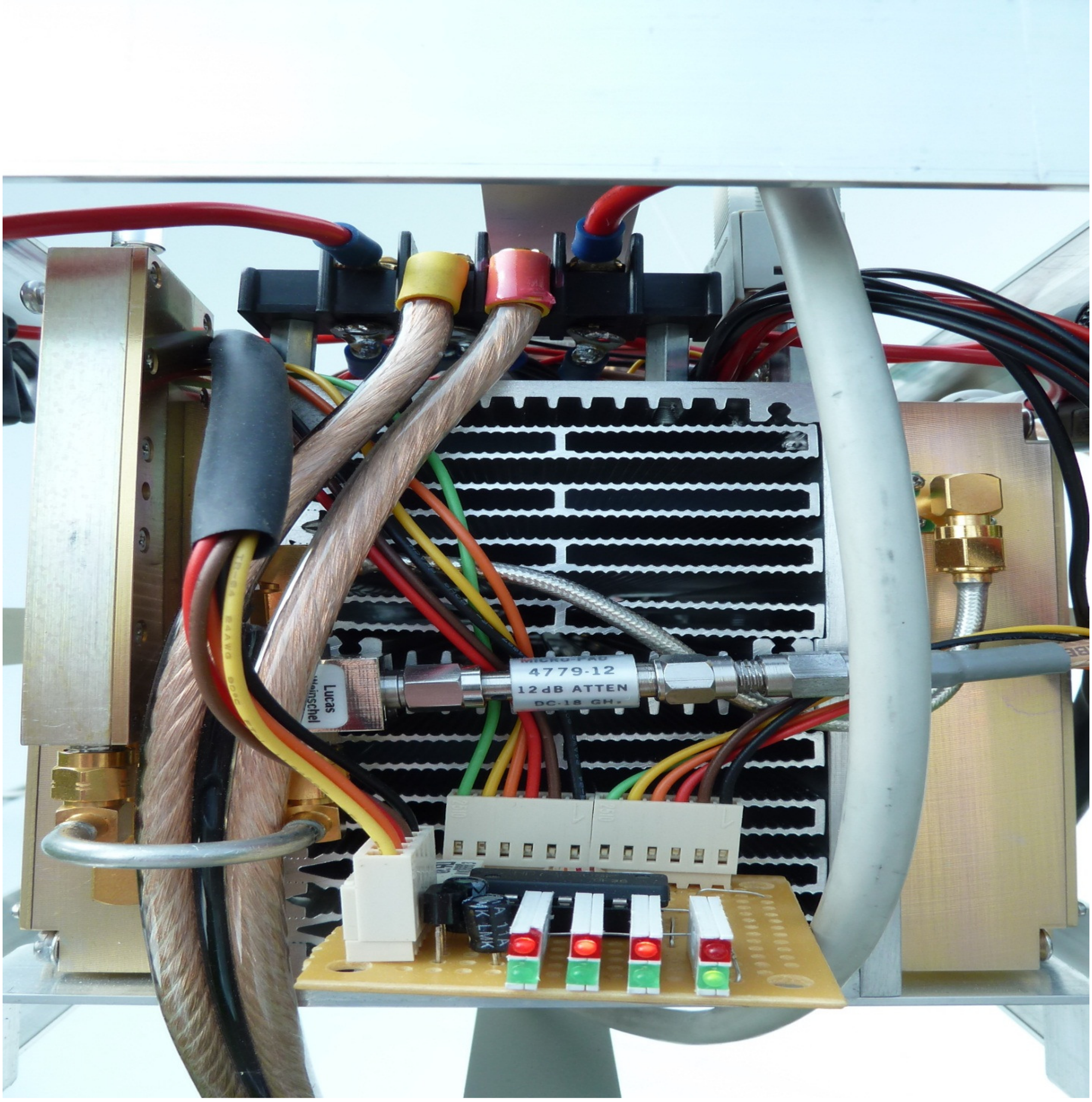


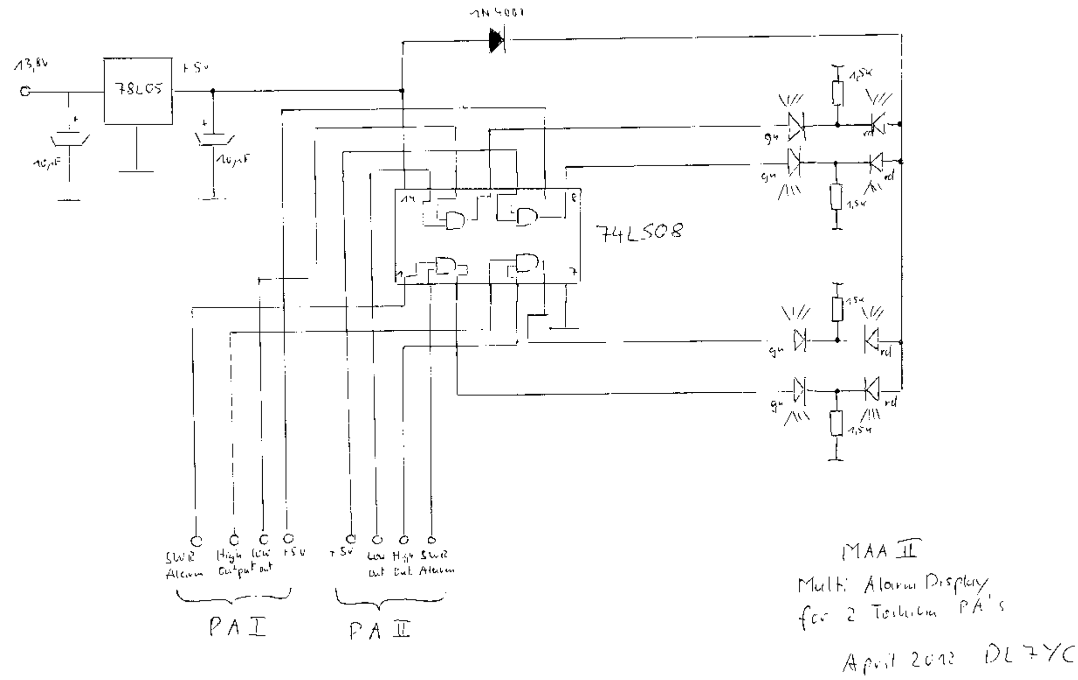
Figure 18: Cage (rear side) MAA2 – Delay-line - 2x UM2683B – Power connection

Tom, K5VH, pointed out a second function of this output: If the case temperature exceeds 90deg Celsius (85deg. C max. working temperature) this output will show “true” (logical 0) low output due to internal shut down.
John, W3HMS pointed out: “there is a function providing temperature alarm but the amp is NOT self-protected, i.e. shutdown. So, be careful!!! “

I personally did NOT verify, if both sayings where true or not!! I did not want to “overheat” my amps to check out any thermal functions!!

Pin #15 (+LED): If the amplifier`s internal 5volts are present (which is the case under +Ub connected condition), any LED connected in series with a 820 ohm resistor to this port, will show up “Power ON”.

Cover all states with one look, a small PC-board with four 2-colored LED`s and a 7805 regulator has been developed. The common lead of this three-lead diode`s are connected each via a resistor (1k ohm) to ground. One of the other leads of this diodes are connected by a 1N4007 diode to the +5volts supply (refer Drawing 4 and 5) on this board, the other leads to pin #4, #5, #8 and #15 of the 15-pin SUB-D connector.



Drawing 5: Multi-Alarm-Display MAA2

Regarding what is important to you (red or green color for “false” or “true”), the polarity of the LED should be chosen in each case. The LED color changes in the case of a malfunction or if one of the pre-defined values is “out of range”. Without any sophisticated measurement setup its possible now, to know a lot more about the amplifier`s working condition, much better than without this permanent detailed view.

Hopefully this article is suitable to increase the 9cm EME activity and can activate the number of “sleeping” Toshiba UM2683 SSPA`s

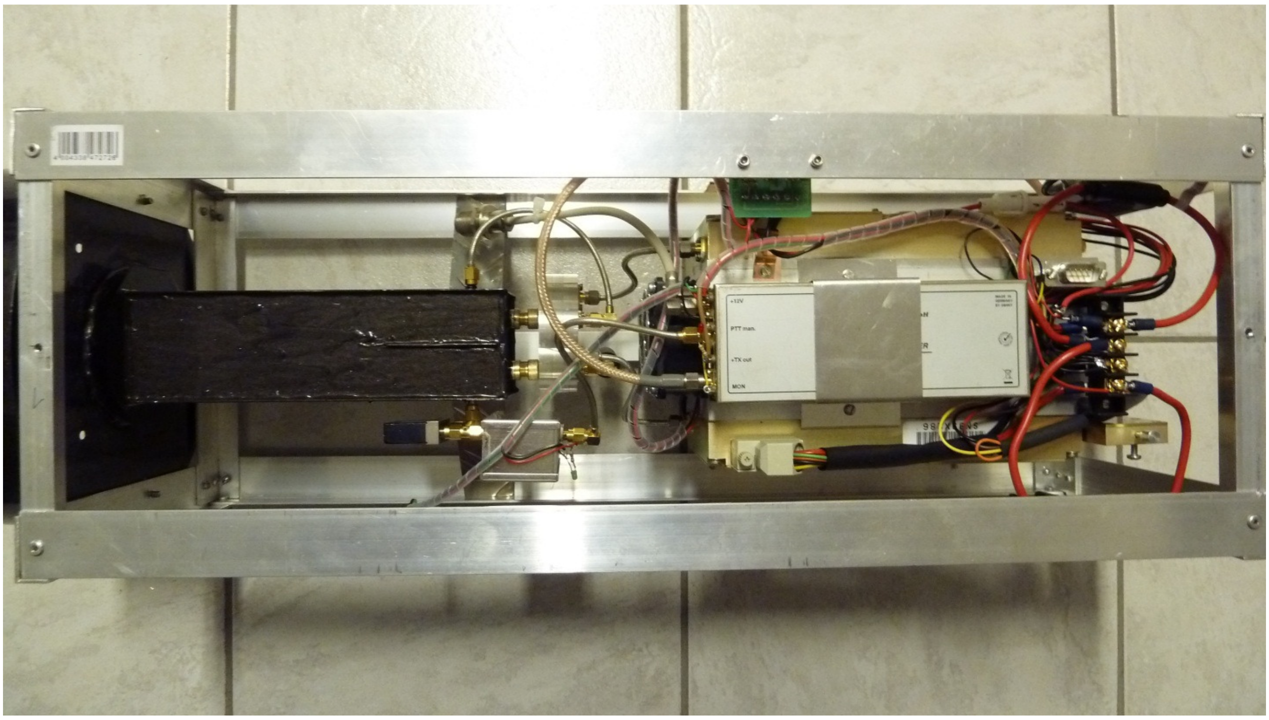


Figure 30: 3400MHz EME “cage”, including 2x Toshiba SSPA`s – Transverter – G4DDK VLNA2+ - RA3AQ Septum-Feed

ADDITIONAL Pictures

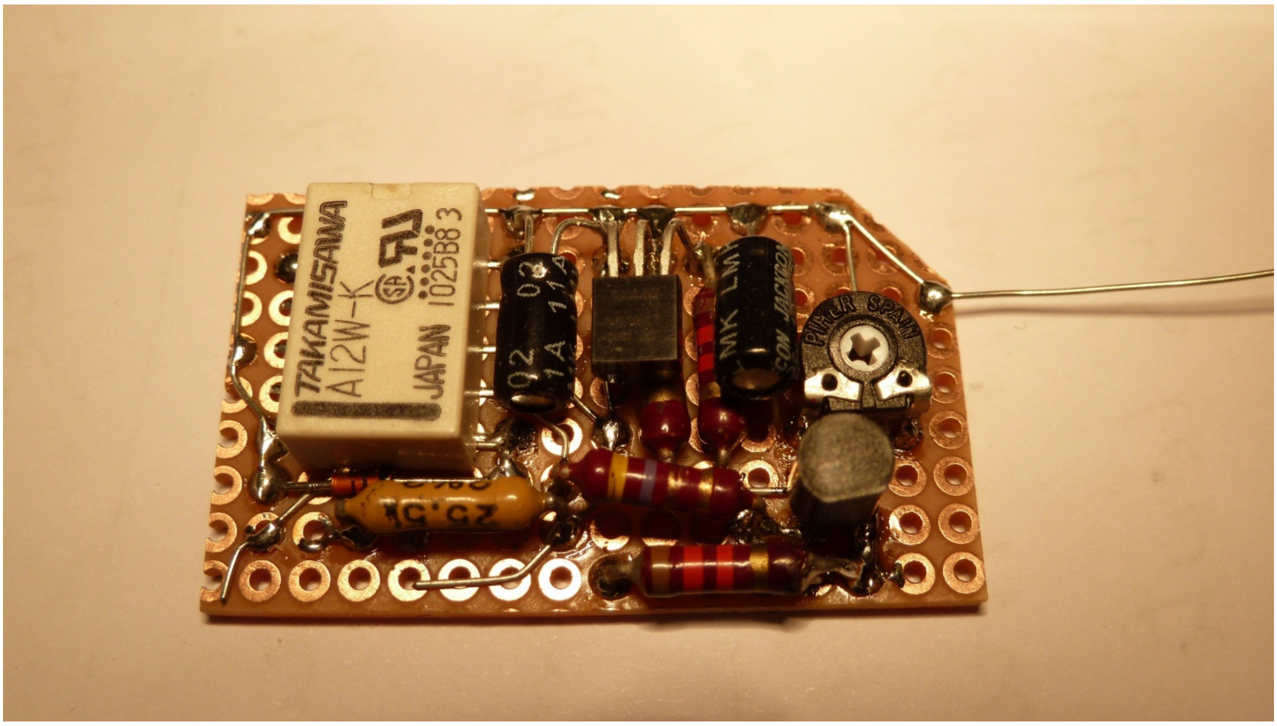


Figure 7: New simple board ready to install – different picture

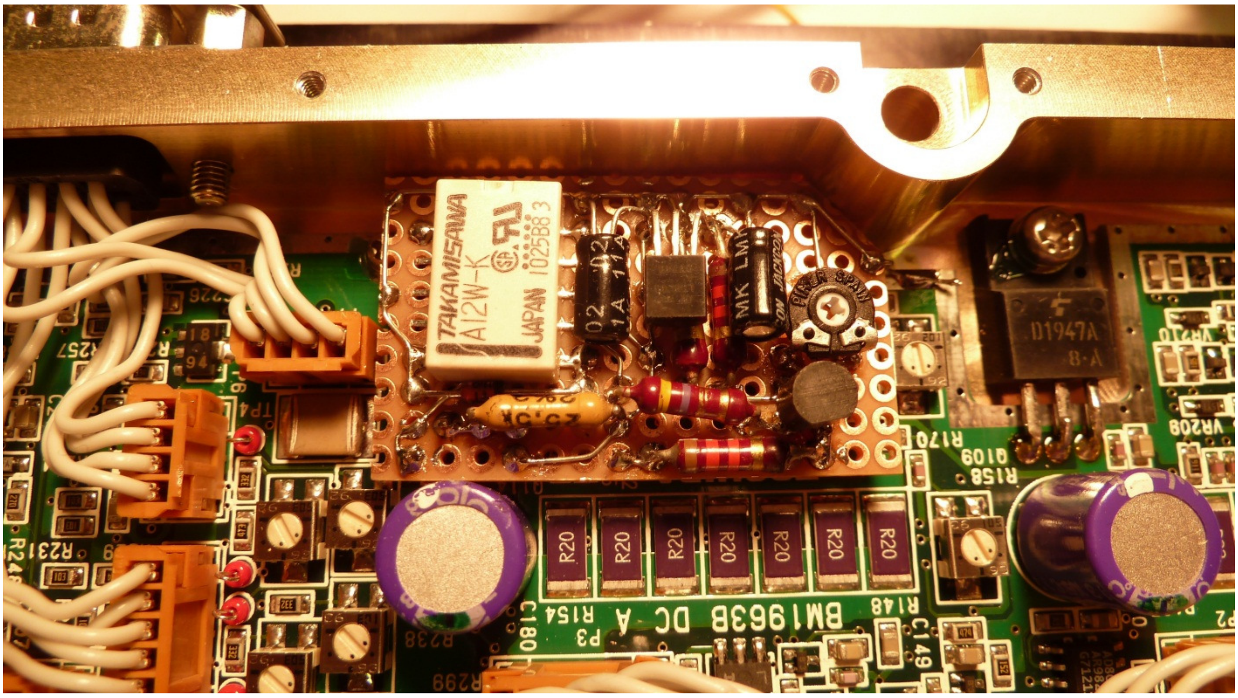


Figure 9: New simple board soldered in place

Fig 13: High current PSU – typical values for one UM2683 SSPA under load

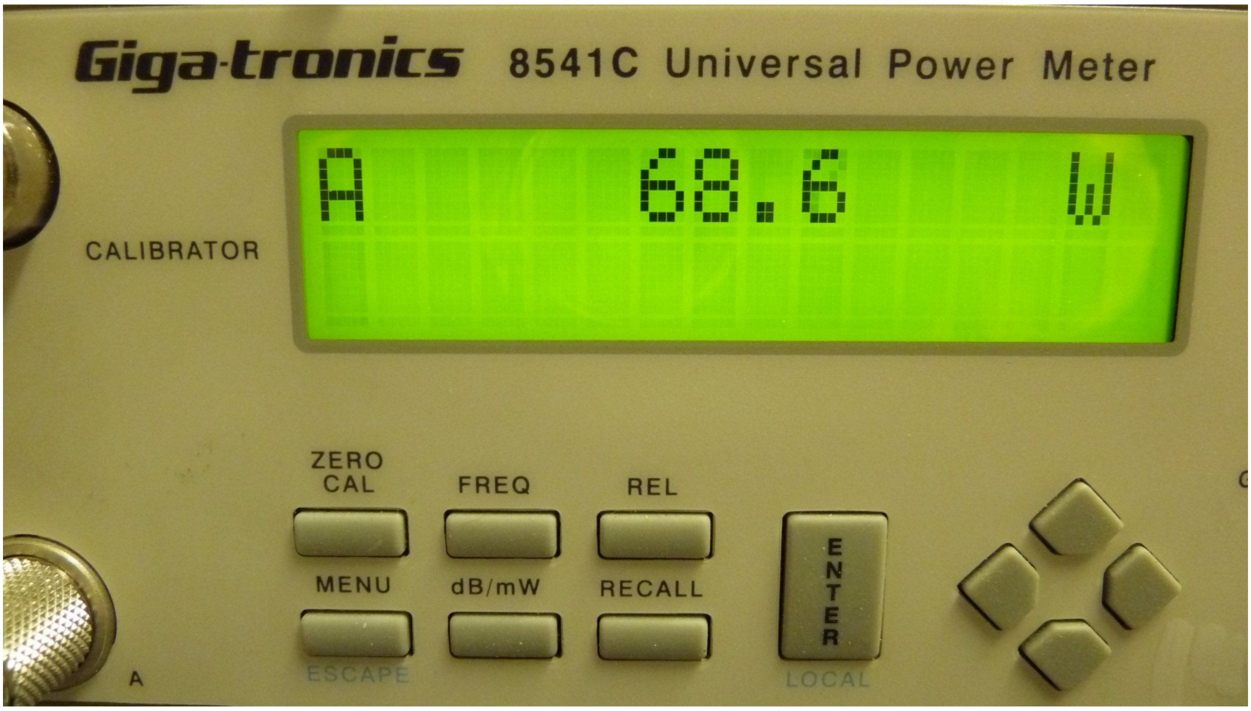


Figure 16: Different amplifier – different output; but high anyway

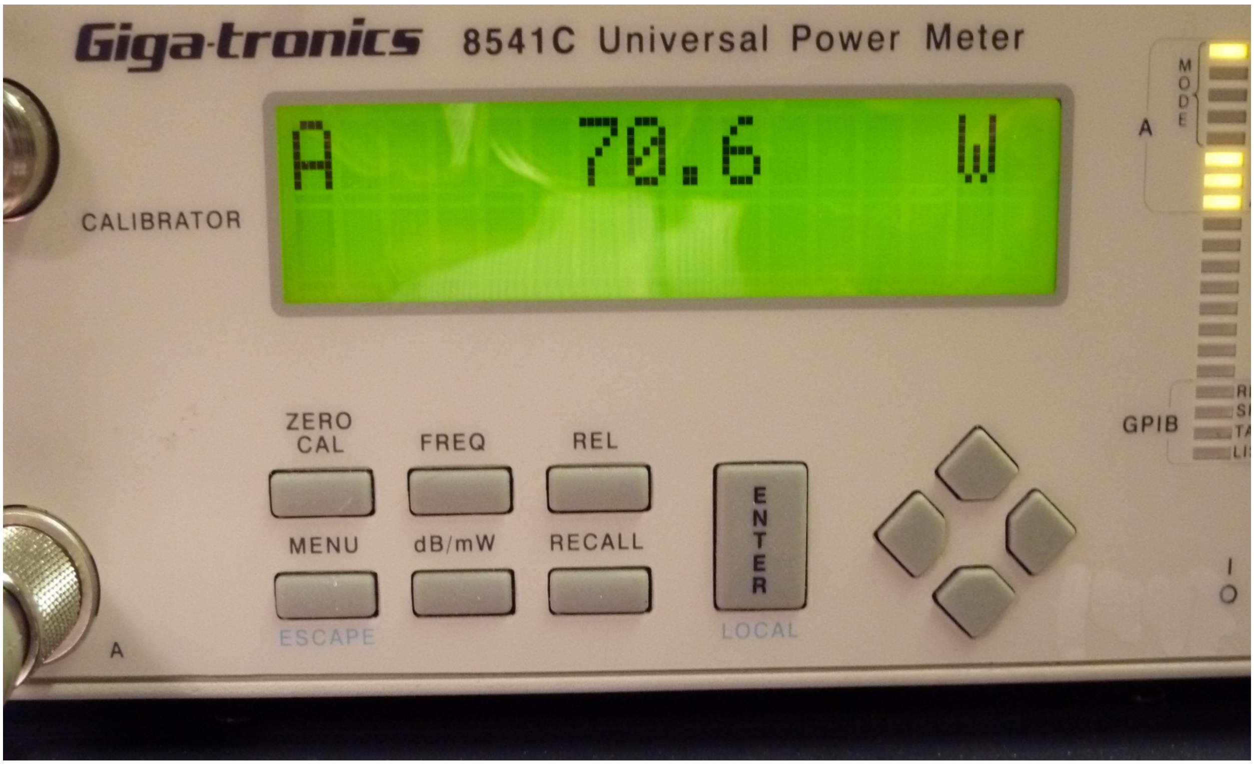


Figure 17: Different amplifier – high output again

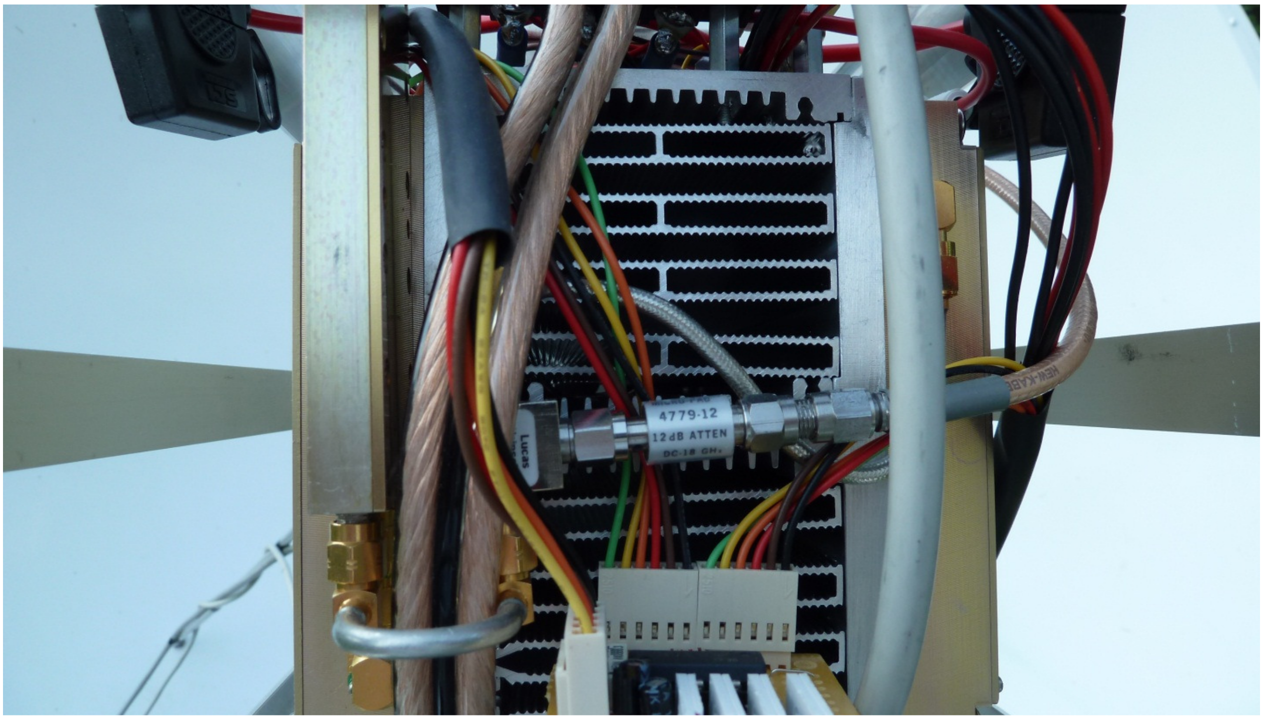


Figure 19: Macro view to the cage`s rear side showing amplifiers, heat-sink and other components

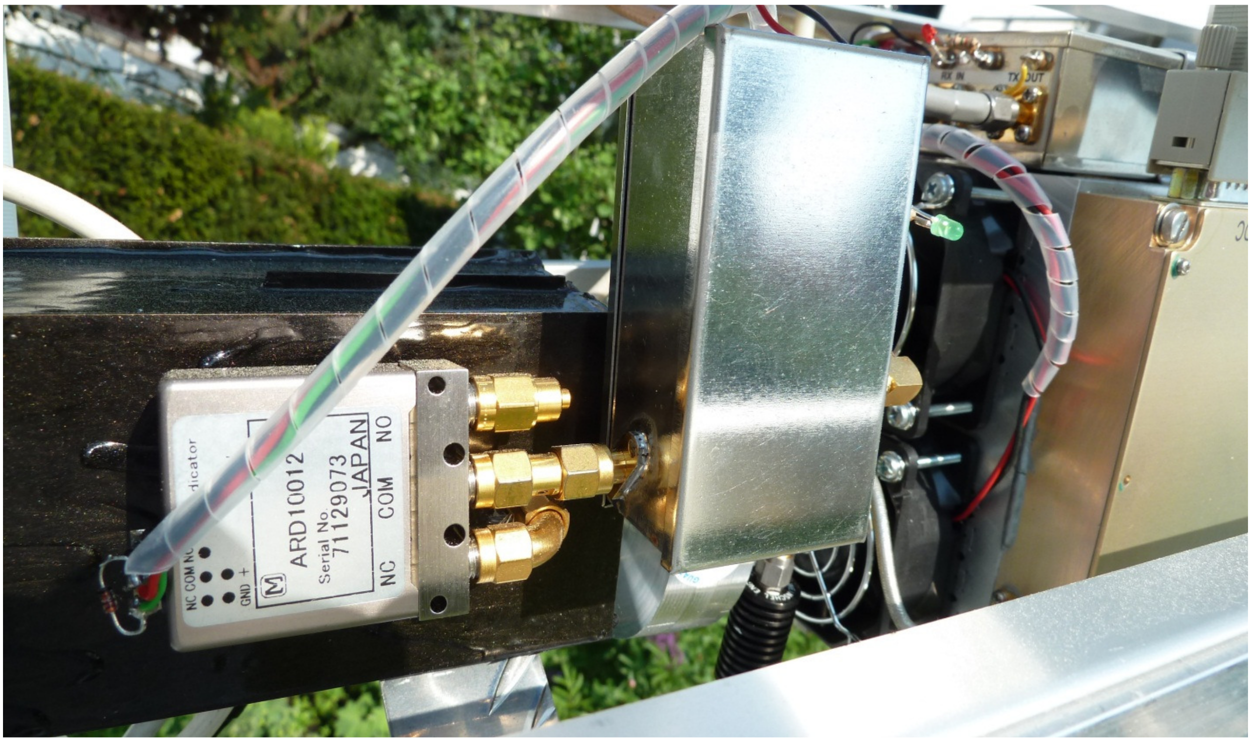


Figure 20: G4DDK`s ***V****ery* ***L****ow* ***N****oise* ***A****mplifier and relay*

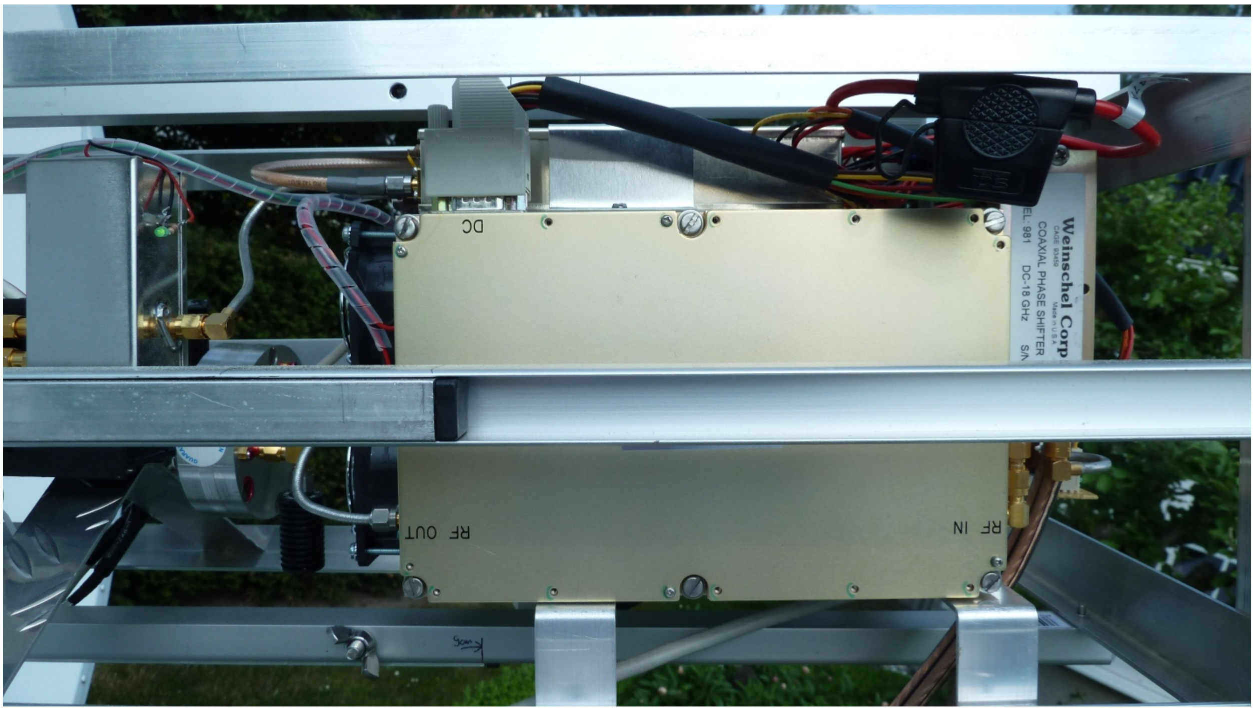


Figure 21: Left side of cage with SSPA, preamp and delay-line

Figure 22: RA3AQ 9cm Septum feed in front of cage

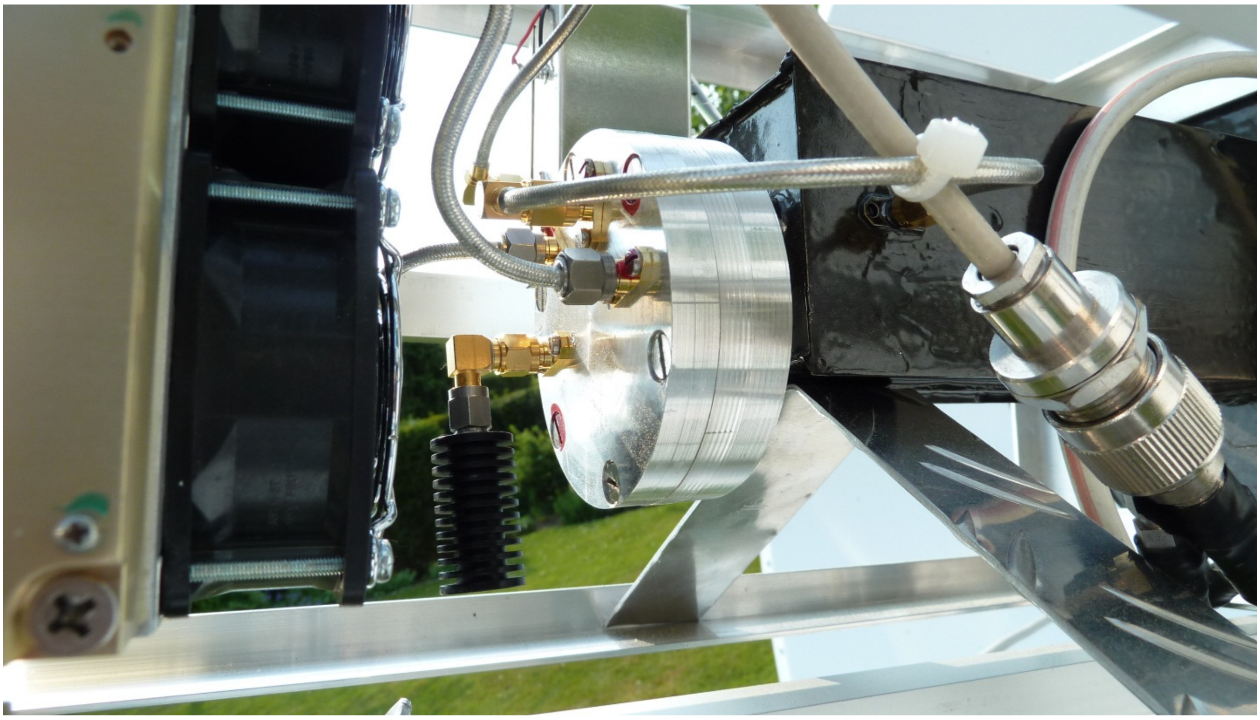


Figure 24: Rat-race coupler – septum feed TX side

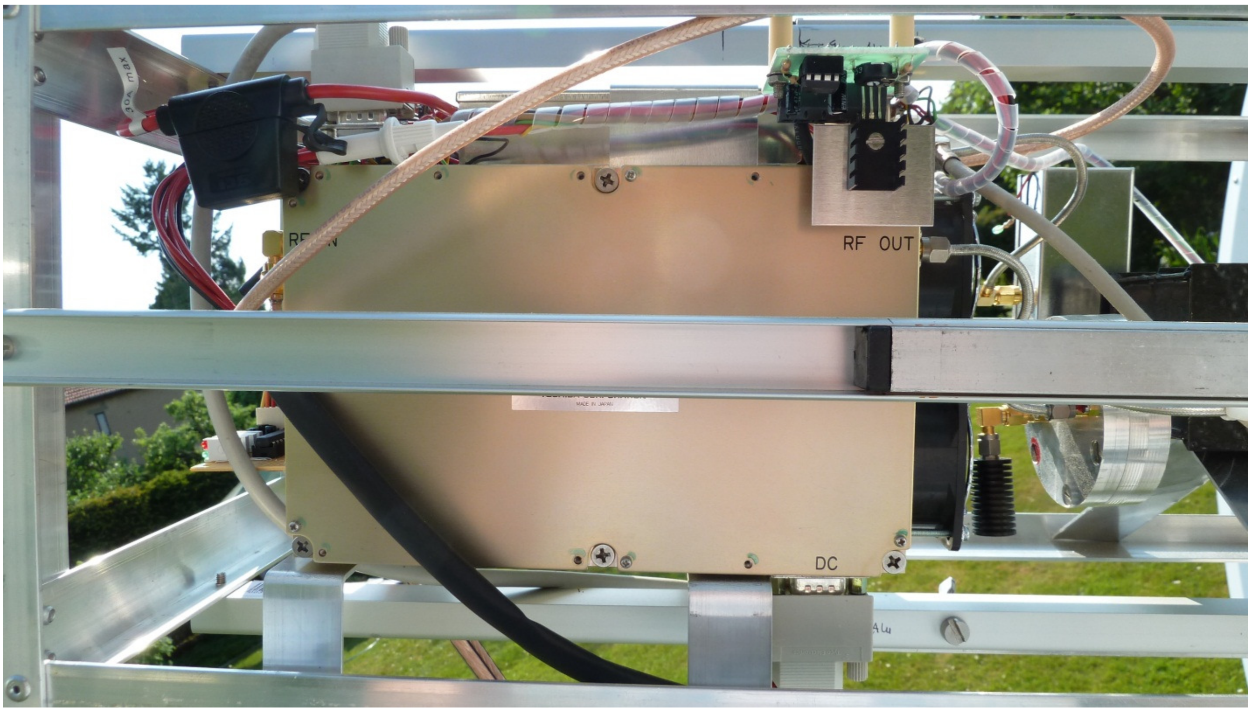


Figure 27: SSPA with Fan-controller VBS1

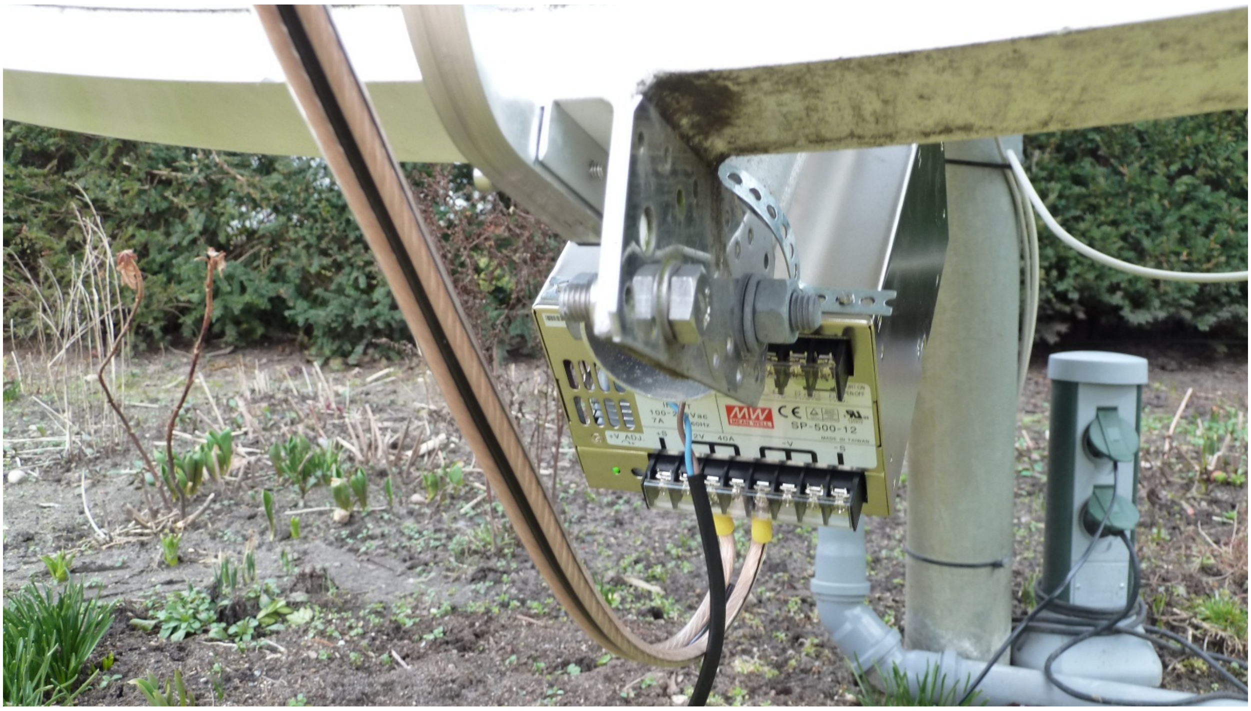


Figure 28: 12V DC / 500W Switching PSU behind dish – only 1.5m far from SSPA`s

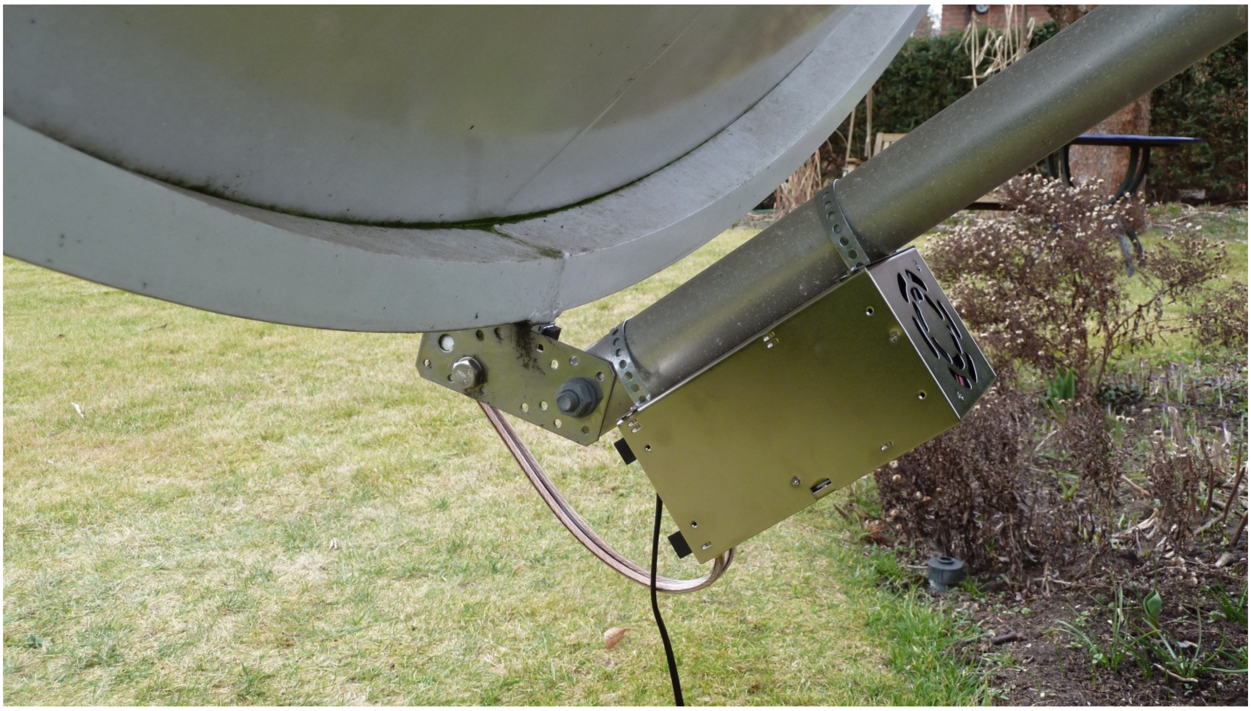


Figure 29: 12V Switching PSU – dish “protects” from rain

Manfred Ploetz, DL7YC

FIGURES 1 - 30:

#26 Dual high efficiency heat-sink with fans, part of feed, preamp, coupler and UM2683B. Please note the changed SMA-connector!!

#27 Right side UM2683B, Fan-controller VBS1 and 20A fuse

#28 Switched 13.8V PSU behind the dish; front side. The PSU is capable to run both amps!!

#29 Switched 13.8V PSU behind the dish

#30 3400 MHz EME „cage“ including RA3AQ-Feed, VLNA with „fail-save“ relay, 2 x UM2683B (modified), DB6NT 3400 MHz Transverter and Multi-Alarm Display MAA1

DRAWINGS 1 - 7:

#1a 12.0 Volt MOS-FET power supply NEW

#1b TIM 3536-60 NEW power supply – possible circuit board layout

#2 Fan controller VBS1

#3 Combination of 2x TOSHIBA UM2683B amplifiers

#4 Multi-Alarm-Display MAA1

#5 Multi-Alarm-Display MAA2

#6 Circuit schematic Toshiba UM2683A

#7 Circuit schematic Toshiba UM2683B

REFERENCES: [ ]

1**. Toshiba Linear Microwave Amplifier for 3400 MHz** by John Jaminet, W3HMS

2**. Toshiba Linear Microwave Amplifier** by Tom Haddon, K5VH

3**. Using the Toshiba UM2683A amplifier**, by Dave Robinson, WW2R

4**. Wiring the 3.4GHz Toshiba amp..... a better way!,** by W7DHC, NP VHF Society

5**. Instructions how to connect and setup 50 watt power amps**, by Joe Ruggieri (pyrojoe @ ebay)

6. SavantIC Semiconductors: Datasheet Silicon NPN Power Transistors 2SD1297

7. Vishay Siliconix: Datasheet P-Channel 60-V(D-S), 175 deg. C MOSFET SUP/SUB65P06-20

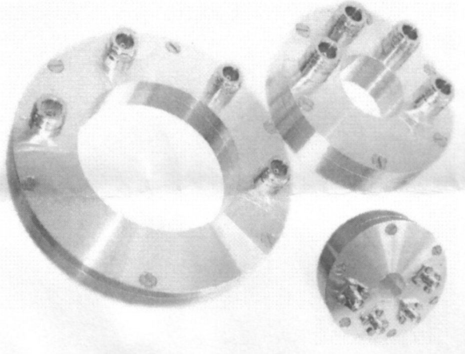
8. Fairchild Semiconductor. Datasheet 60A, 30V, 0.027 Ohm, P-Channel Power MOSFET`s RFG60P03, RFP60P03, RF1S60P03SM

9. Toshiba Microwave semiconductor Technical Data, Microwave MMIC TMD0305-2

10. Toshiba Microwave Semiconductor Technical Data, Microwave Power GaAs-FET TIM3742-8SL-341

11. Toshiba Microwave Semic.Technical Data, Microwave Power GaAs-FET TIM3536-60

High-Power 3dB HYBRID RING COUPLER 1296, 2320, 3400 MHz



This 3 dB Hybrid Ring Coupler (0°/180°), also called a **"rat-race coupler"**, is a high-power capable, four-port device optimized to sum two in-phase combined signals **with essentially no loss** or to equally split an input signal with no resultant phase difference between out and inputs. The fourth port is terminated.

But it is also possible to configure the hybrid ring coupler as a 180° phase-shifted output divider or to sum two 180° phase-shifted combined signals with almost no loss.
The fourth port is terminated.

Combine RF Power Amplifier:
So this is the right solution to combine power amplifiers up to 1000 Watts.
To combine 2 Power amplifiers you will need 2 couplers which can handle 0° or 180° phase shift.

PORT CONFIGURATIONS:

PORT	**0°/in-phase divider**	**0°/in-phase combiner**	**0°/180° divider**	**0°/180° combiner**
1	0° output	0° input	Input	Sum
2	0° output	0° input	Isolated *	Isolated *
3	Isolated *	Isolated *	180° output	180° input
4	Input	Sum	0° output	0° input

*The loads must be able to take a 1/100 of the total power under normal working conditions.

Specifications:
(Spec. can also be found at: www.rfhamdesign.com)

Frequency range:	1100-1600 / 2100-2600 / 3350-3500 MHz
Impedance:	50 ohms
Insertion loss (max.):	0.2 dB
Phase balance (when used as 180 dgr device):	+/- 2 dgr
Isolation dB (min.):	45 dB
Port symetry:	>0.1 dB
Power (avg):	1000 Watts (peak 4000 Watts) 1296 + 2320MHz 300 Watts 3400MHz

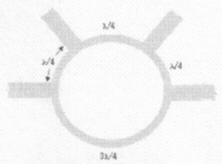


Diagram of the Hybird ring coupler.

TOSHIBA

MICROWAVE SEMICONDUCTOR

TECHNICAL DATA

MICROWAVE POWER GaAs FET

TIM3536-60

FEATURES :

- HIGH POWER
  P1dB=48dBm at 3.5GHz to 3.6GHz
- HIGH GAIN
  G1dB=9dB at 3.5GHz to 3.6GHz
- INTERNALLY MATCHED TYPE
- HERMETICALLY SEALED PACKAGE

RF PERFORMANCE SPECIFICATIONS (Ta= 25°C)

CHARACTERISTICS	SYMBOL	CONDITION	UNIT	MIN.	TYP.	MAX.
Output Power at 1dB Compression Point	P1dB	VDS= 12 V f=3.5-3.6 GHz I_{DS}(RF Off) ≒ 9A	dBm	47.0	48.0	—
Power Gain at 1dB Compression Point	G1dB		dB	8.0	9.0	—
Drain Current	IDS		A	—	12.0	15.0
Power Added Efficiency	ηadd		%	—	38	—
Channel-Temperature Rise	ΔTch	Note1	°C	—	—	100

Note 1 : ΔTch=(VDS × IDS + Pin − Po) × Rth(c-c)

ELECTRICAL CHARACTERISTICS (Ta= 25°C)

CHARACTERISTICS	SYMBOL	CONDITION	UNIT	MIN.	TYP.	MAX.
Transconductance	gm	VDS= 3V IDS= 12.0A	S	—	20	—
Pinch-off Voltage	VGSoff	VDS= 3V IDS= 300mA	V	-0.5	-1.8	-2.5
Saturated Drain Current	IDSS	VDS= 3V VGS= 0V	A	—	38	46
Gate-Source Breakdown Voltage	VGSO	IGS= -500μA	V	-5	—	—
Thermal Resistance	Rth(c-c)	Channel to Case	℃/W	—	0.6	0.8

Recommended Gate Resistance(Rg) : Rg=Rg1(10 Ω) + Rg2(18 Ω)=28 Ω (MAX.)

TOSHIBA

MICROWAVE SEMICONDUCTOR

TECHNICAL DATA

MICROWAVE POWER GaAs FET

TIM3742-4L-341

FEATURES :

- LOW INTERMODULATION DISTORTION
  IM_3 = −45 dBc at Po = 25 dBm, Single Carrier Level
- HIGH POWER
  P_{1dB} = 36 dBm at 3.3 GHz to 3.6 GHz
- HIGH GAIN
  G_{1dB} = 10.0 dB at 3.7 GHz to 3.6 GHz
- BROAD BAND INTERNALLY MATCHED
- HERMETICALLY SEALED PACKAGE

RF PERFORMANCE SPECIFICATIONS (Ta = 25°C)

CHARACTERISTICS	SYMBOL	CONDITION	UNIT	MIN.	TYP.	MAX.
Output Power at 1dB Compression Point	P_{1dB}	V_{DS}= 10 V f = 3.3~3.6GHz	dBm	35.0	36.0	-
Power Gain at 1dB Compression Point	G_{1dB}		dB	9.0	10.0	-
Drain Current	I_{DS1}		A	-	1.1	1.5
Gain Flatness	ΔG		dB	-	-	±0.6
Power Added Efficiency	η_{add}		%	-	33	-
3rd Order Intermodulation Distortion	IM_3	Note 1	dBc	-42	-45	-
Drain Current	I_{DS2}		A	-	1.1	1.5
Channel-Temperature Rise	ΔTch	$V_{DS} \times I_{DS} \times R_{th(c-c)}$	°C	-	-	80

ELECTRICAL CHARACTERISTICS (Ta = 25°C)

CHARACTERISTICS	SYMBOL	CONDITION	UNIT	MIN.	TYP.	MAX.
Transconductance	gm	V_{DS}=3V I_{DS}=1.5A	mS	-	900	-
Pinch-off Voltage	V_{GSoff}	V_{DS}=3V I_{DS}=20mA	V	-2	-3.5	-5.0
Saturated Drain Current	I_{DSS}	V_{DS}=3V V_{GS}=0V	A	-	2.9	3.8
Gate-Source Breakdown Voltage	V_{GSO}	I_{GS}=-60μA	V	-5	-	-
Thermal Resistance	$R_{th(c-c)}$	Channel to Case	°C/W	-	4	6

Note 1: 2 tone Test Pout=25dBm Single Carrier Level.