QRPLABS QDX RF POWER AMPLIFIER MOSFET MODIFICATION

QDX is a HF Digital Modes Transceiver produced as a kit by QRP LABS.

Here is the link for QDX:

https://qrp-labs.com/qdx.html

I am a QDX Transceiver user for almost a year now and it's a perfect portable digital modes Transceiver for me. As a Portable operator small size and full feature rig with decent rf power is a plus for me.

So why I go through with this PA MOD detailed here?

QDX uses BS170 mosfets in parallel as a pair of two. BS170 is a decent mosfet and dirt cheap so including me all of us who are designing or building kits use this favorite Mosfet as a first choice.

While operating my QDX I had three incidents of PA mosfet failure which all of them are my fault and nothing to do with QDX design. In all incidents BS170 mosfets failed due to unfavorable antenna conditions such as no antenna TX, High SWR antenna conditions etc.

When I met Hans Summers, founder of QRPLABS and designer, we had a pleasant chat over a dine and wine session this year past June in Friedrichshafen Hamfest about Class D RF PA stages and advantages of them over Class E. I had the opinion that I am happy with Class E PA design and Hans totally changed my opinion to Class D!

So I started to design my own Class D rig using mostly Hans's Class D design elements.

Though I followed a slightly deviated path with PA mosfet selection, I designed mine around FDT86256 Mosfet. I used two of these mosfets in push pull instead of two parallel BS170s.

The results were promising and I thought maybe I can adapt the same FDT86256 mosfet to my QDX.

FDT86256 has couple advantages over BS170. The most significant advantage is it's breakdown voltage (Vds) which is 150V! BS170 is 60V. This higher breakdown voltage might be beneficial in adverse SWR conditions when compared to BS170 with a lower breakdown voltage.

The second advantage of FDT86256 over BS170 is the max power it can withstand, FDT86256 is 10 watts and BS170 is 800 mW.

The disadvantage of FDT 86256 over BS170 is it's higher input capacitance (Ciss) which is 55 pf which can effect it's performance on higher frequencies. Though in Class D configuration it is comparable to BS170 pair. BS170 Ciss capacitance is typically 24pf. When it is used in parallel pairs the total capacitance is 48pf which is not so much different than one FDT86256 which encouraged me as a replacement of BS170 pair.

To adapt FDT86256 to fit on QDX PCB was a challenge as BS170 has a TO-92 footprint and FDT86256 has SOT-223 smd footprint. So they are not compatible replacements.

After some head scratching, I came up with an adapter pcb that can fit on BS170 area of QDX and carry two FDT86256 mosfets with some heatsink pcb area.

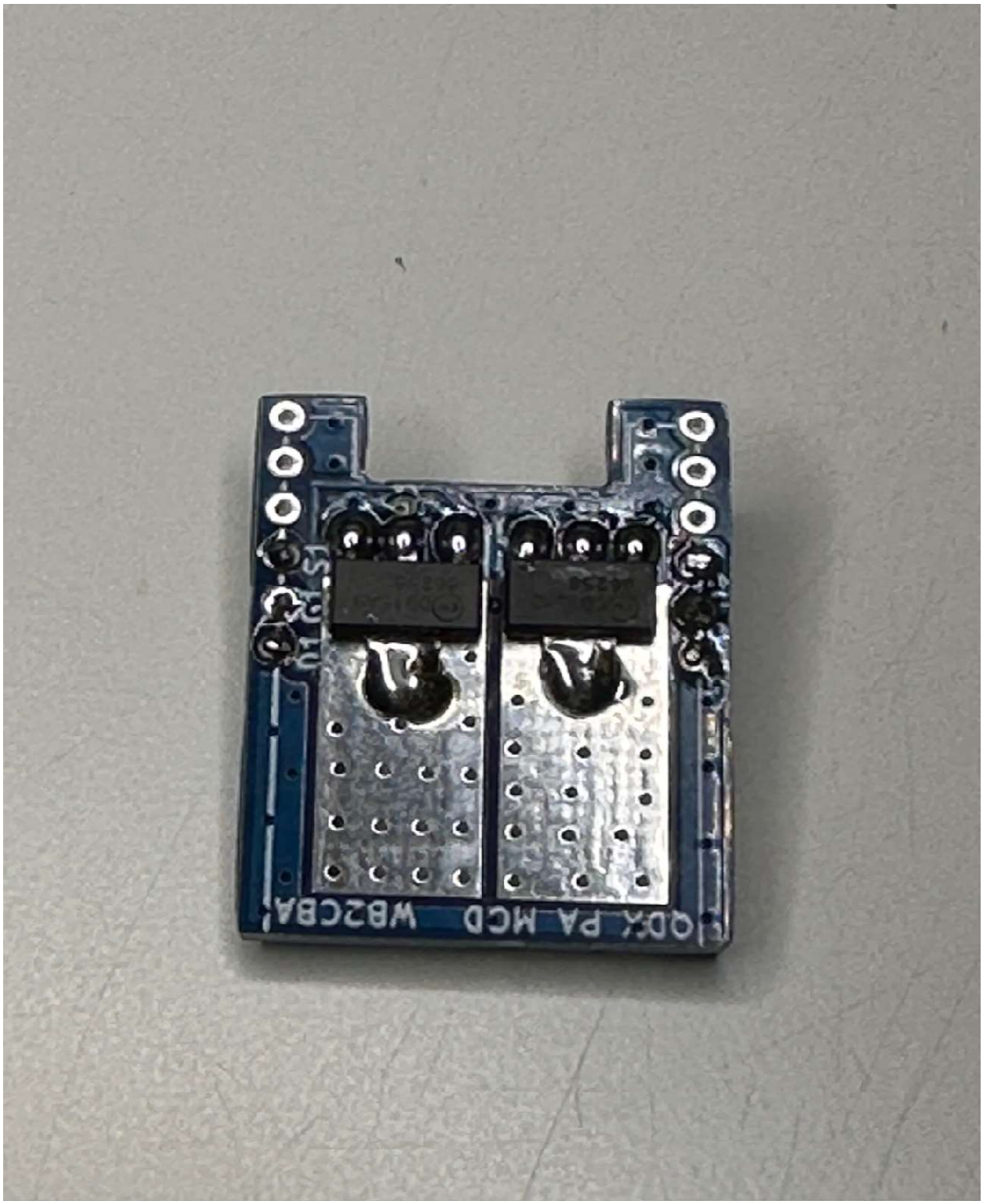
Another good news of this PA Mod is that now I can operate QDX under 13.8 Volts too! Under 13.8V I can pass 5 watt limit without fear of blowing finals. Though there is a caveat, the 5 Volt regulator on QDX board gets hot! So be cautious on 13.8V!

I performed my tests with a 12 Volts version built QDX.

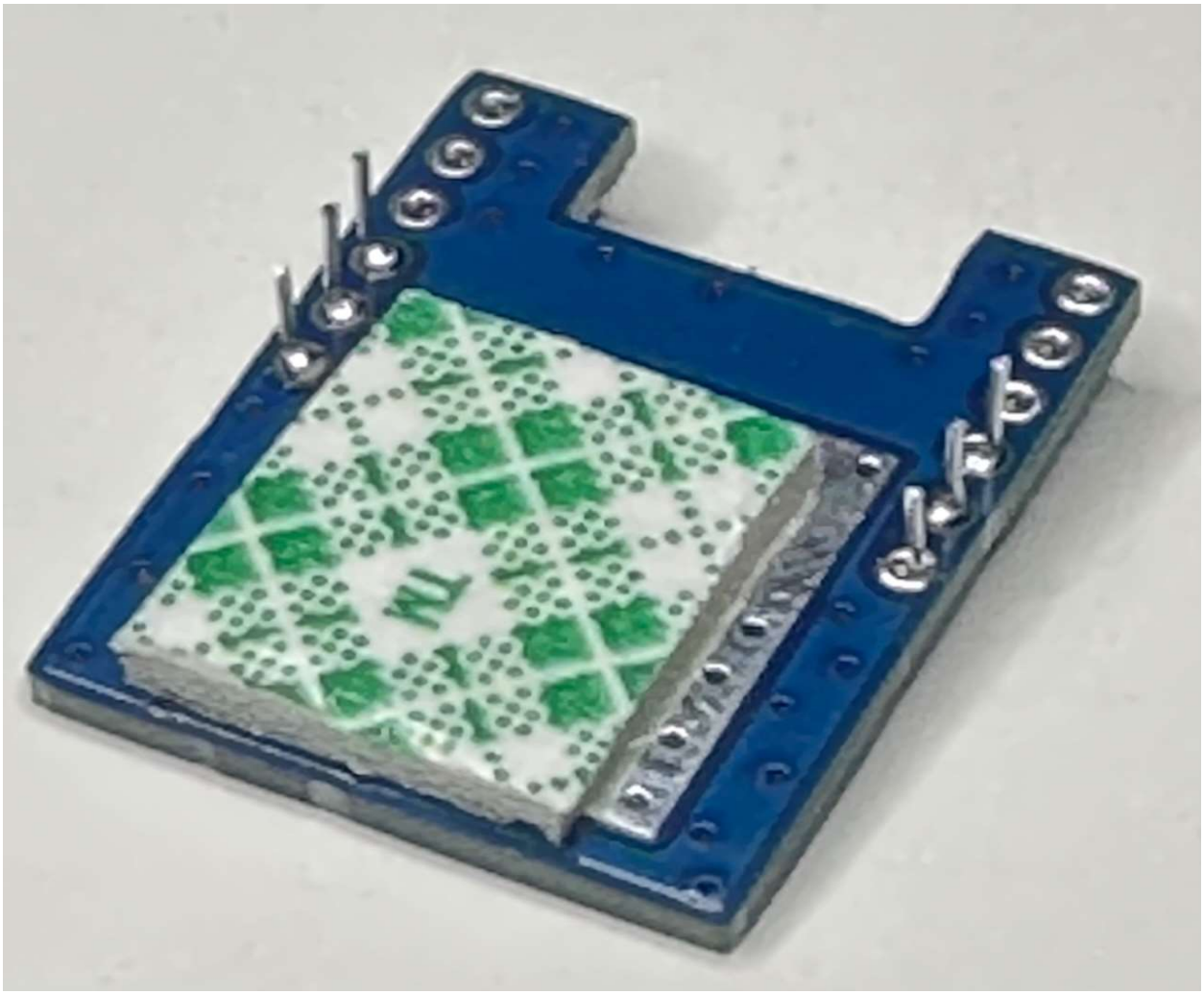
This PA Mod can be used both in 9 Volts version QDX and 12 Volts version QDX. There is no need to change anything else in both versions other than replacing BS170s with this PA MOD PCB populated with FDT86256 Mosfets.

After testing on High bands I can confirm that this PA MOD is suitable also for high band QDX as it is.

This is the adapter PCB:

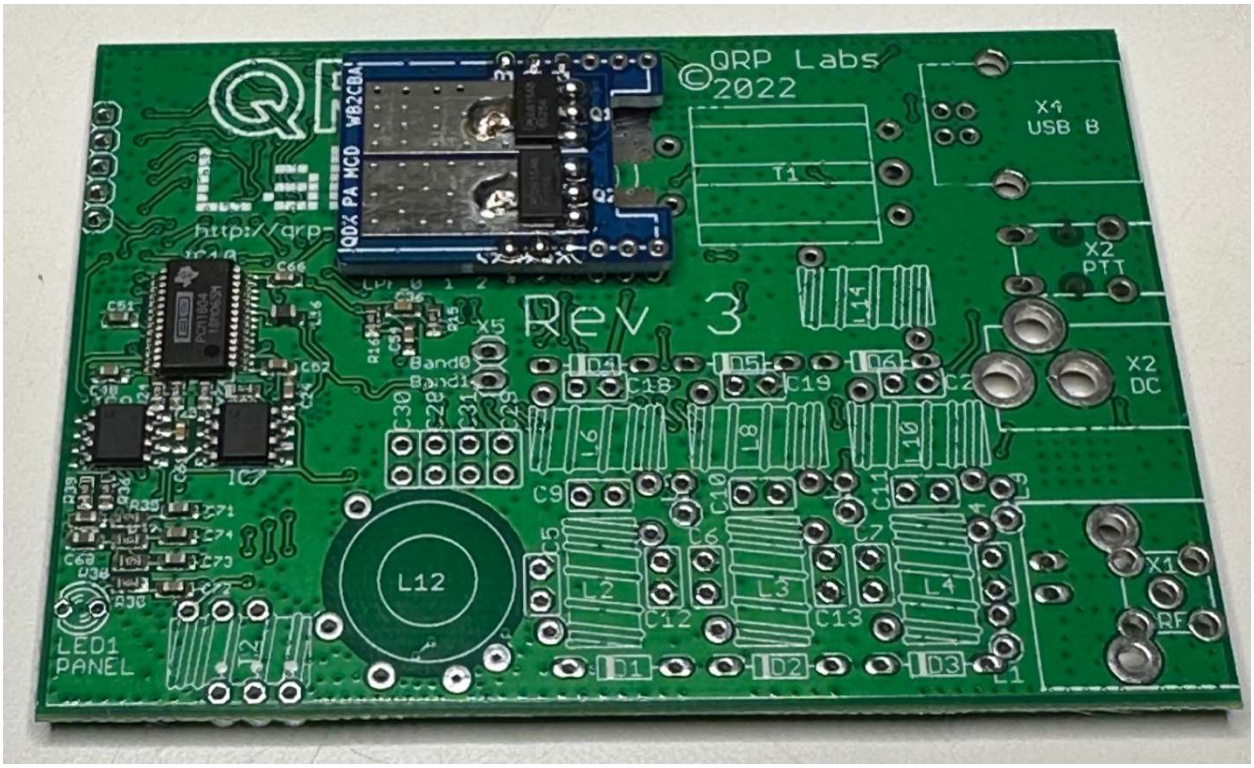


Bottom view up of adapter pcb:



I used a double sided tape to stick it on QDX pcb as an insulator from QDX pcb surface for any possible shorts. I used 3 points at each side as connection solder joints to QDX pcb bs170 solder holes. I used surplus leads of components.

It fits on QDX PCB like this:



Instead of dissecting my perfectly working QDX to try out this modification I used a Version 3 unbuilt QDX which a ham friend donated to try this mod. I built only the TX portion of QDX and left out RX section toroids as my whole aim is to verify if TX works.

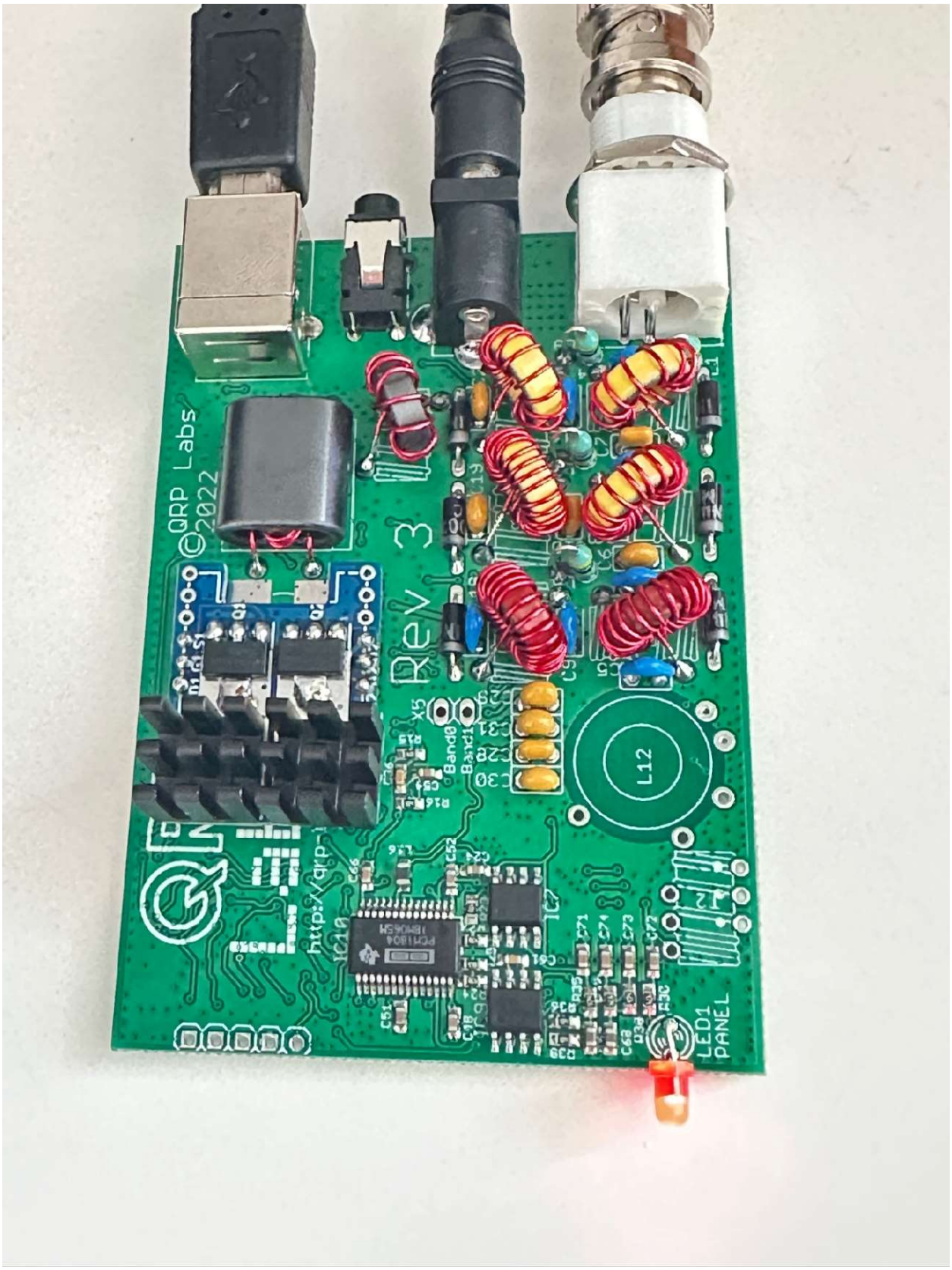
I built the Binocular transformer for the standard 3/2 turn 12V version. I'd like to try Ross's Twisted Sisters version too just to satisfy my curiosity! :)

I added a pair of silicon sticky tape Raspberry PI processor heatsinks which I got from amazon. They help a lot to cool mosfets. Any type of miniature heatsink can work. Just be careful not to short those heatsink pads as they are drain of mosfets.

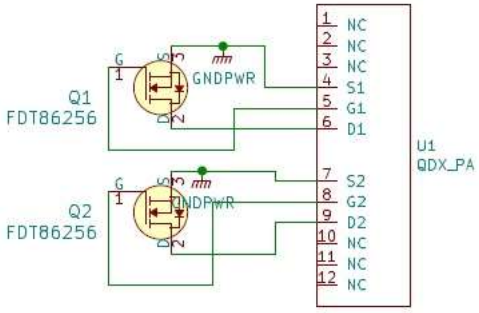
Here is the link for heatsinks:

https://www.amazon.com/Easycargo-Heatsink-Conductive-Adhesive-10x10x10mm/dp/B07KD44Z5Y/ref=sr_1_4?crid=3R3JPJJMWJOBJ&keywords=easycargo+10mm+heatsink&qid=1695225898&sprefix=easycargo+10mm+heatsink%2Caps%2C95&sr=8-4

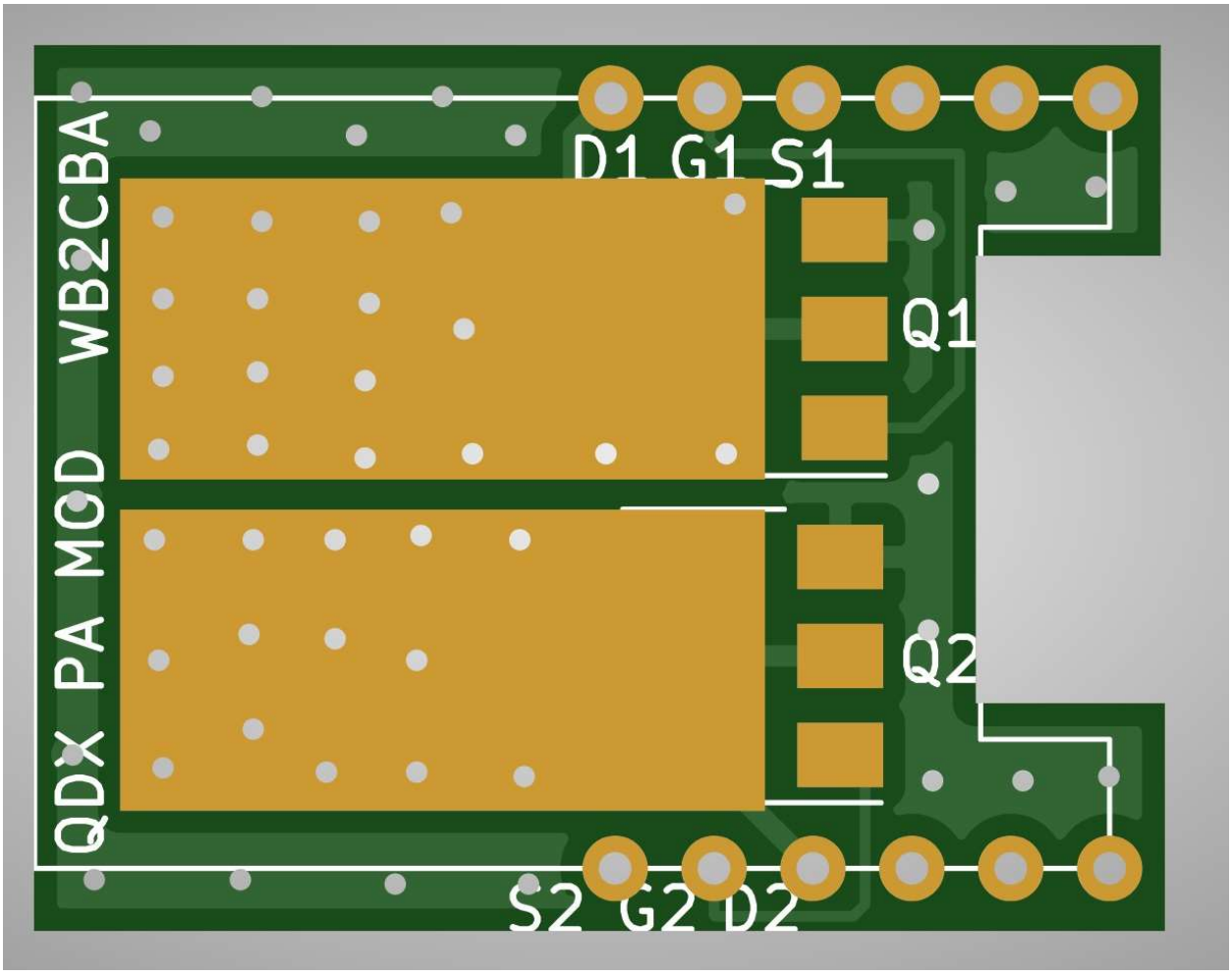
Here is completed QDX with FDT86256 Modification:

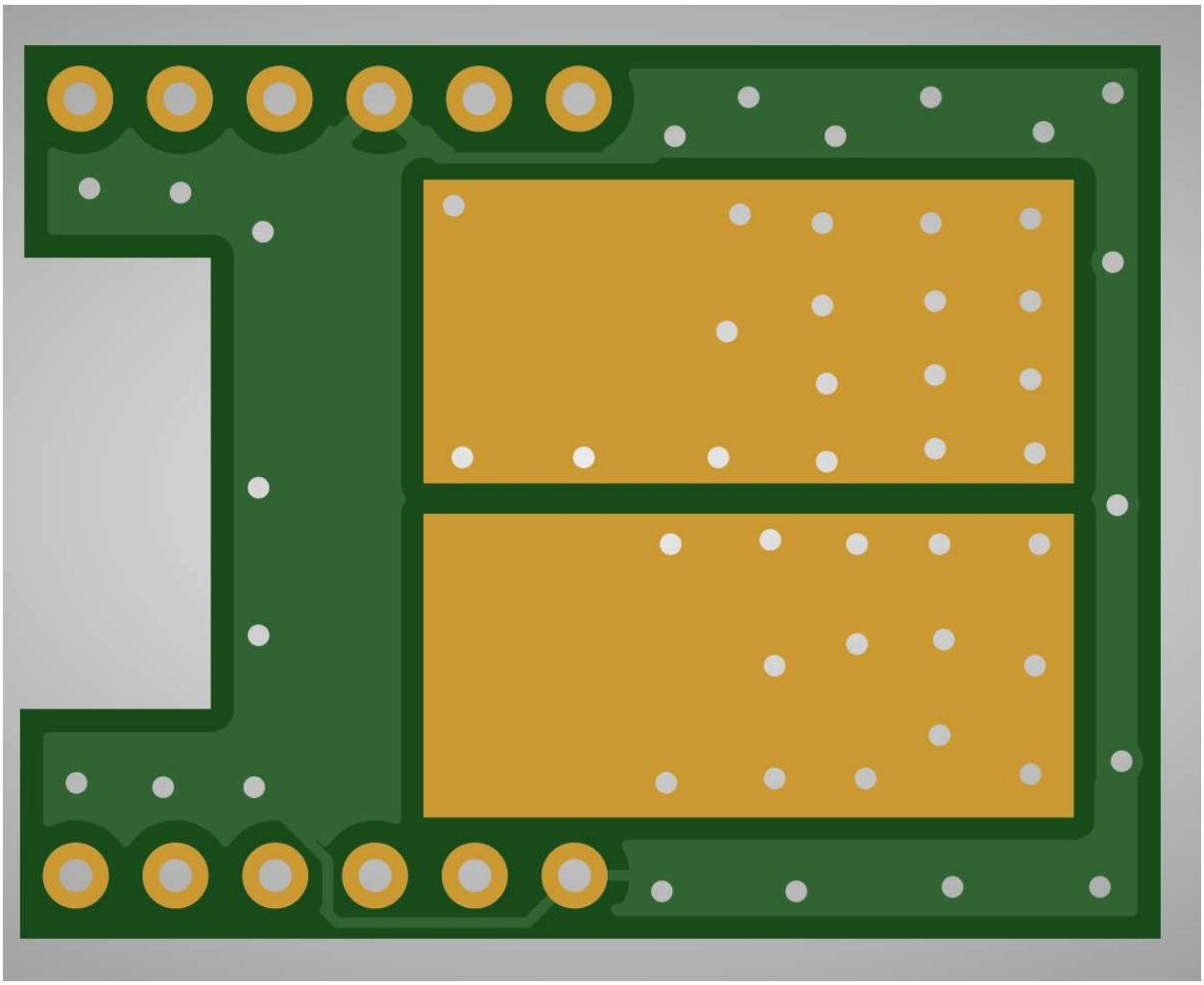


Here is the schematic of this mod:

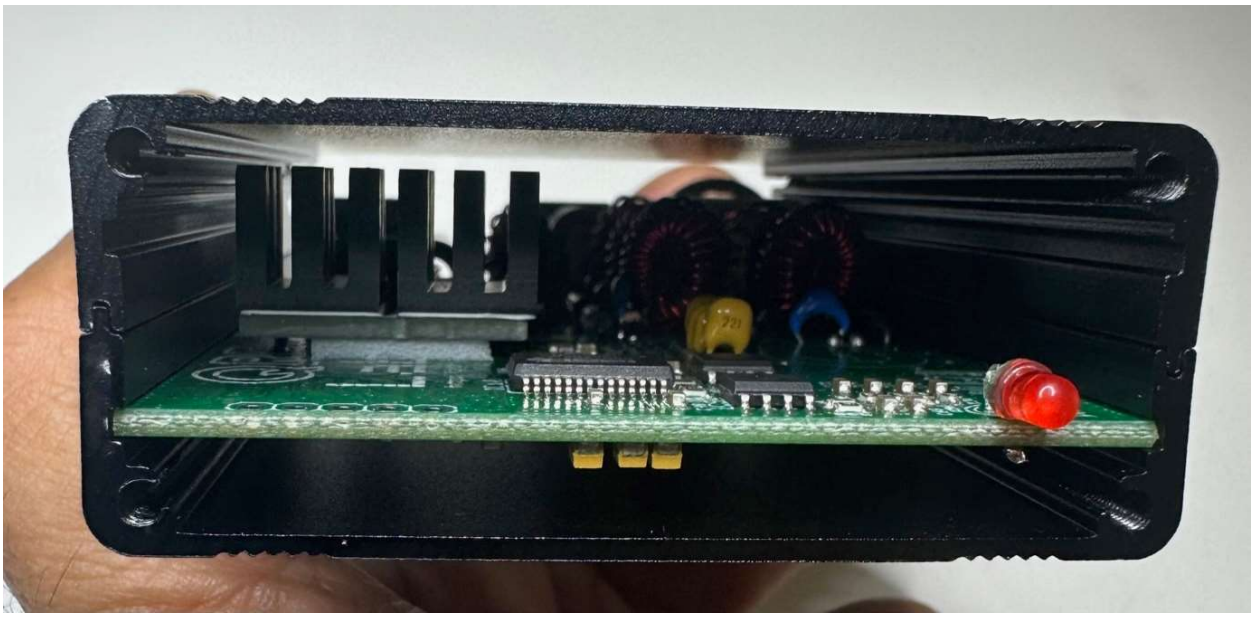


PCB Layouts:





With my choice of heatsinks QDX fits nicely in it’s dedicated case:



I performed some tests after completing the mod:

QDX FDT86256 PA MOD TX TEST RESULT

BAND	PSU VOLTAGE	Current(mA)	PA RF POWER(W)	2nd Harmonic	3rd Harmonic
80m	12	630	4.7	-50dbm	-63dbm
80m	13.8	710	5.9		
40m	12	530	4	-59dbm	-68dbm
40m	13.8	610	5.1		
30m	12	690	5.1	-48.5dbm	-60dbm
30m	13.8	780	6.3		
20m	12	510	3.5	-58dbm	not significant
20m	13.8	570	4.6		

NOTE: ALL TX current are net calculated current consumption by subtracting
140 ma RX Current consumption from QDX total current consumption

For testing this PA mod I used these instruments:

- Circuit Specialists Inc 3644 DC 0-18V 0-5A POWER SUPPLY
- Barb-A-Watt POWER/SWR Meter and Bird Model 43 with 25H 2-30 Mhz 25W slug
- OWON HSA1016TG Spectrum Analyzer with 40 db Weinschel Attneuator
- MICSIG TO1004 100mhz 4 Channel Oscilloscope

All necessary files including gerber file for the PA mod pcb is included in my github directory:

- https://github.com/WB2CBA/QDX-PA-MODIFICATION/tree/main

Barbaros (Barb) Asuroglu, WB2CBA, September 2023