Construction Manual of the 70cm-FM-Power Amplifier **P40F**

Holger Eckardt
DF2FQ
Kirchstockacherstr. 33
D-85662 Hohenbrunn

1401HE

Introduction

This manual explains the construction of a power amplifier for the 430MHz band. It is designed only for FM/FSK operation SSB operation is not possible. The most interesting feature is it's high-speed RX/TX turn-around time which makes the device suitable for packet radio applications up to 76800 bps.

Technical data

Output power:	35 Watts at 12V, 40W at 13,5V
Input power:	0,2 ... 7 Watts (see text)
Spurious transmissions:	< -70dBc
RX/TX turn-around time:	2ms
RX loss:	< 0,7dB
Operation voltage:	9 ... 14 Volts
Current consumption:	approx. 8 A
Size:	100x120x67mm with heatsink

Circuit description

Fig. 2 shows the circuit diagram. As long as there is no input signal (receive operation) there is no DC current through D1, D2 and D3. I.e. they have high impedance. In this case the receive signal goes from the antenna connector P2 through the microstrip lines L1 an L2 to the transceiver port P1. The capacitors C3, C4 and C5 complete the lines to a low pass filter and care for good matching. The path loss is limited by the conductive loss of the PCB traces and the coax connectors and adds up to less than a dB.

As soon as a signal with more than 100mW reaches the transceiver connector the amplifier switches to TX mode. Die diodes D4 and D5 rectify a small part of the incoming energy. The DC signal opens T1 which pulls the base of T2 on ground. T2 supplies the pin diodes so that they become conductive. The microstrip lines have an electrical length of a quarter wavelength so the low-Z short of D2 is transformed to a high impedance at both BNC connectors. The RF energy reaches the input of the PA module through D1 and the amplified signal the output port through D3.

The PA module accepts a maximum input power of 500mW. If a higher source power is used the attenuator formed by R1, R2 and R3 are necessary to protect it. To keep a good matching low-inductance metal-oxide resistors are used. The PA module itself does not have very good harmonics suppression so there is a 5-pole lowpass filter included on the PCB formed by the microstrip lines L3 and L4 and the capacitors C12 to C14.

Construction

Fig 1. shows the place plan of the PCB. All components which are critical to RF are surface mountable devices (SMD) of size 0805. Before you mount a SMD you should solder one of the PCB pads first. Then hold the part with the tweezers and solder it to that pad. After it is fix you can solder the second pad. Please notice that the capacitors don't have any value printed on it. If you once removed any from the package there is no way to find out the value except measuring. The cathodes of D2 and D3 are marked by a red dot.

The PA module is mounted from the rear of the PCB. The heat flange looks away from the PCB. Bend the connection wires for 90 degrees stuck them through the holes on the PCB and solder it.

Next is to mount the PCB into the cabinet. All procedures step by step:

- Mount both BNC connectors on the side parts of the housing. Tighten it really hard but without destroying the connector (nothing is more annoying the a loose BNC connector because you cannot fix it any more once everything is mounted). Cut that side of the connector's plastic with a knife that will later lay on the PCB.
- Solder the feed-through capacitor and the ground connector.
- Stick both side parts together and solder the edges. Use the cover plate as a fixture. Remove the cover plate.
- Insert the PCB so that the center conductors of the BNC connectors touch the traces and the PCB fits to the support nipples of the side parts. Watch for the wire of the feed-trough capacitor sitting in it's hole.
- Solder the PCB to the housing at the two pads of each BNC connector from the rear and at each of the support nipples on the component side. Solder the center conductors of the BNC connectors and the feed capacitor. Insert the LED (short pin is ground) so that it looks out of the hole of the wall and solder it.
- Stick the rear cover on the housing so that the flange of the PA module fits through the hole. The flange and the surface of the cover must form one plane.
- Mount the heatsink with the 10mm screws and tighten them. Stick the cover plate on the housing.

Operation

There is no tuning necessary. Depending on the output power of the transceiver the resistors of the attenuator have to be selected. See the table for the value. Do not put too much power to the module. It is very sensitive against overloading.

Source power	R1, R3	R2
0,2 – 0,5 W	Do not stuff	Short
0,5 – 2 W	150 Ohms	39 Ohms
2 – 7 W	100 Ohms	82 Ohms

For a first test attach the transceiver to the PA input and a wattmeter to the output. Don't connect any power supply. If you key the transceiver you should see the source power on the wattmeter. Up to 20% less is acceptable due to the loss of the T/R switch.

Now connect the power supply and key the transceiver again. You should see the full power on the wattmeter. Check the current consumption. It should not exceed 8A.

Thermal design

With full output the PA dissipates a power of 60W. The heat sink has a thermal resistance of 0.9K/W. This means that 100% duty cycle of the PA is not possible if the ambient temperature exceeds 25°C. However a receive transmit ratio of 50% like it is usual on packet radio is no problem at all. If you intend to do heavy duty operation with the PA use a small fan blowing onto the heatsink.

Part list

Component	Value	Size
C1	1p	RM2,5
C2	100p	0805
C3	5p6	0805
C4	10p	0805
C5	2p2	0805
C6	100p	0805
C7	100p	0805
C8	10n	RM2,5
C9	10n	RM2,5
C10	10n	RM2,5
C11	10n	RM2,5
C12	8p2	0805
C13	12p	0805
C14	8p2	0805
C15	100p	0805
C16	10µ	RM2,5
D1	BA479	RM5
D2	MA4P1250	1210
D3	MA4P1250	1210

Component	Value	Size
D4	1N4148	RM5
D5	1N4148	RM5
D6	LED	RM2,5
L5	0.22µH	RM7,5
L6	Ferroxcube	6-hole
Q1	M57729	H3
R1	100R/3W	RM17,5
R2	82R/3W	RM17,5
R3	100R/3W	RM17,5
R4	4k7	RM10
R5	4k7	RM10
R6	10k	RM10
R7	560R	RM10
R8	330R/0.5W	RM15
R9	1k	RM10
R10	100R	RM10
T1	BC547A	TO92
T2	BC557A	TO92

RM = Raster in mm

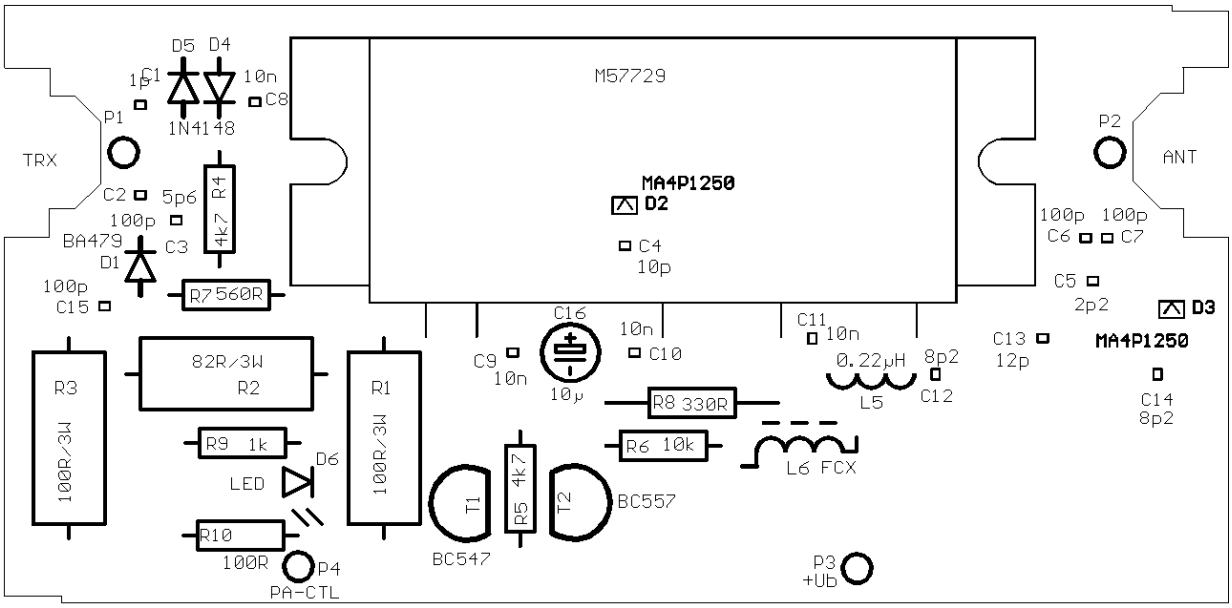

Figure 1, placeplan

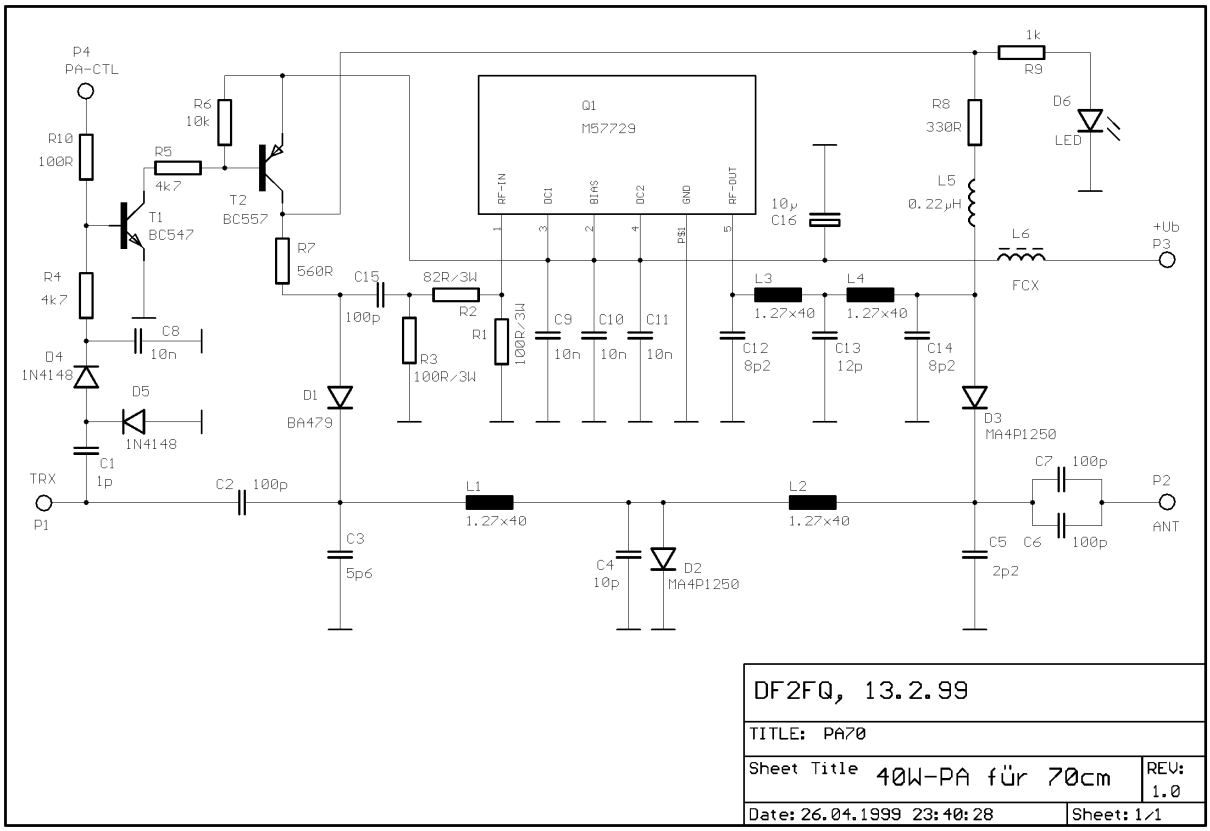

Figure 2, circuit diagram

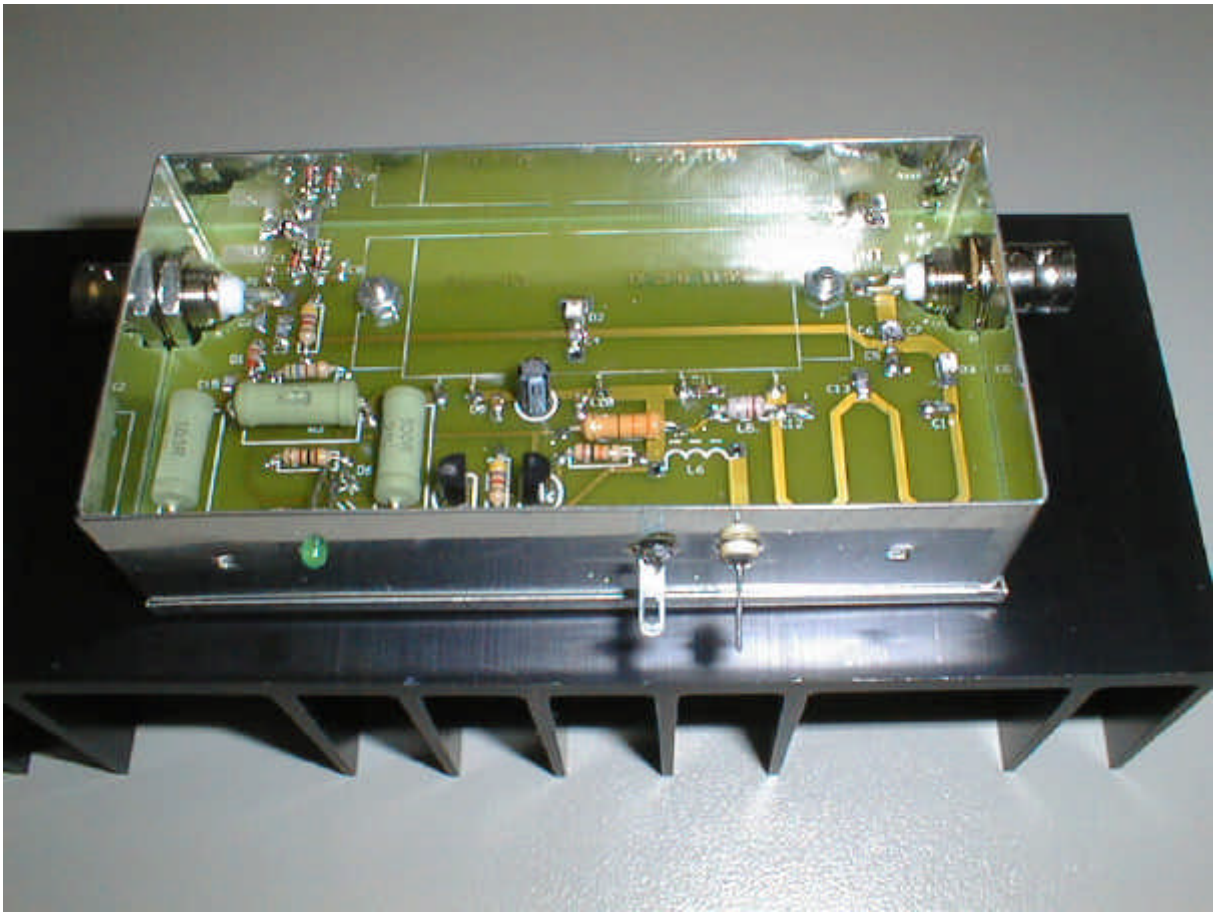

Figure 3, photo of the PA