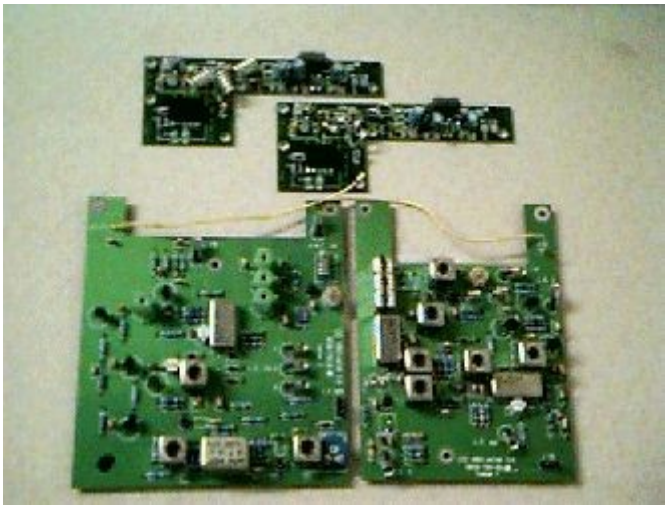
Edition 1

Early Replacement Front End for FT736R
RPCB736

a product produced by Mutek (up to mid about 1997)



Manual compiled by Clive Smith, GM4FZH for general circulation

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Compilers Note

This manual has been put together and designated Edition 1. The information has been obtained from various sources, including past owners and the Internet; **I cannot vouch for the accuracy of this information.** It is not intended to produce an updated version of this manual, if additional information becomes available it maybe provided as an addendum.

The products produced by Mutek were of high quality and many are still in service. However, please remember that this product came on to the market some 20-30 years ago and must now be regarded as obsolete.

This manual relates to the earliest of the FT736 replacement set of boards (RPCB736) which cover the 144MHz and 430MHz bands only. It is possible a separate kit was available for the 50MHz band.

It appears that the successor to this these pcbs were an SMD version which, hopefully, will be dealt with in its own manual and available if the information required is forthcoming. See History of PCB below.

 Please let me know if you have further details that would help with this or any other Mutek product.

****** PLEASE NOTE: ******

The information contained herein is provided in good faith and I will not be responsible for any outcomes arising from the use of it. I have put it together for use by the amateur radio fraternity.

The list of other manuals can be found on my website www.gm4fzh.co.uk (as they become available) where there are also details of how to contact me. I have no association with the firm Mutek and this manual has been produced at my own expense and without any payment.

Clive Smith, GM4FZH, Autumn 2020

The filename of this document is **RPCB736early*.pdf*.**

Specification

2m Section		Original FT736 Spec	Mutek spec
Noise figure		18 dB	<2 dB
Selectivity	+/- 12.5 kHz	-3 dB	-40 dB
	+/- 25 kHz	-16 dB	-84 dB
Image rejection		>60 dB	>70 dB
Intermodulation		80 dB	>90 dB
Free dynamic range			

70 cm Section		Original FT736 Spec	Mutek spec
Noise figure		18 dB	<1.5 dB
Selectivity	+/- 12.5 kHz	-3 dB	-25 dB
	+/- 25 kHz	-10 dB	-60 dB
Image rejection		>60 dB	>70 dB
Intermodulation		70 dB	>80 dB
Free dynamic range			

The above are based on the published specification and n measurements made on the prototype units, the production units are not expected to differ greatly from this specification.

History of the PCB

After some research, the history of this pcb (in bold) appears to be as follows, EOE.

PCB Type	**Notes**	**Approx. date of issue**
RPCB736 Iss 1.	**Early through hole components pcbs, a set of 4**	**Up to about mid 1997**
*RPCB736 Iss 1.	PCBs using SMD components, a set of 3 boards	After about mid 1997

* Denotes not covered by this manual.

Kit List

Your kit should contain the following parts, if any are missing please contact your supplier in the first instance.

1. RPCB 736_2_MN 2m main pcb
2. RPCB 736_70_MN 70 cms main pcb
3. RPCB 736 PA 2 2m PA pcb
4. RPCB 736_PA 70 70cms PA pcb
5. Fixings Kit consisting of:-

   i) M3 tap
   ii) 6 off M3 pillar
   iii) IF interconnection cable
   iv) N type chassis connector
   v) 6 off M3 X 6 screws
   vi) 13 off M3 X 5 taptite screws
   vii) 2 off ½ in lengths of silver plated wire
   viii) 10uf 35V capacitor
   ix) red and blue coded coax cables
   x) cable tie

Note: If the kit has been fitted for you by an approved installer then all parts will have been fitted, and you should have the two old PA pcb's and the old 430 MHz front end unit returned to you.

Tools Required

Soldering Iron (small)
Small pair pliers (long nose)
Cross-point screwdriver
Solder sucker (might be useful)
Flat blade screwdriver
Solder (thin multicore)

Introduction

Thank you for buying Mutek's RPBC736 transceiver optimised kit for your Yaesu FT736 transceiver. It is a development of Mutek's outstandingly successful front-end boards for various transceivers and offers a combination of excellent sensitivity combined with superb dynamic performance. This ensures that external noise sources provide the ultimate limitation to receiver sensitivity in terrestrial communications, whilst minimizing the effects of strong signals

There are usually two reasons for the less than adequate sensitivity of modern transceivers. Firstly, the receiver designer must balance strong signal handling against sensitivity. With the devices currently available and at the prices the manufacturer is prepared to pay, the balance usually comes out around 4 - 6dB noise figure and a 50 - 70dB dynamic range. The second point is that a typical economy is to use diode switching instead of an electromechanical relay. These diode switches are also usually run at low currents to save battery power and this inevitably leads to a greater insertion loss, often up to 4 dB. Hence it is not unusual for the noise figure to exceed 8dB

Sky noise limits the maximum useable sensitivity of a receiver used for terrestrial communications to about 2dB noise figure (This corresponds to about 0.05uV for 10dB s+n/n ratio in ssb bandwidths). Lower noise figures can be obtained but will not let you hear any more. However, there is an advantage to using a low noise preamplifier to improve the sensitivity of a transceiver - it reduces the gain required to achieve the desired effect and hence does not degrade the dynamic range as much.

Circuit Description

Overall The principle of the modification is to totally replace the front end of the original receiver with a new low noise circuit with greater linearity. In order to do this it was necessary to investigate the losses in the original PA circuit boards. The result of this was that any modification would be wasted unless the PA boards were replaced as well! This aspect having been resolved, a set of four boards have been designed and tested, to bring true Mutek performance to an otherwise excellent transceiver.

The FT 736 uses a common receive I.F. of 13.69 MHz for all of the units. The 70 cms receiver has an additional 1st IF of 47.43MHz. There are a succession of two pole filters of varying widths in the original receive chain. The result of this is that little filtering of adjacent channel signals take place before AGC is implemented. This together with low level mixers contribute to poor intermodulation performance and limited selectivity. The Mutek replacement uses an 8 pole monolithic crystal filter and AGC amplifier which is common to both the 2m and 70 cms receivers, and which can also be used to improve the selectivity of any other modules that are fitted (more details on this later).

The design of the VHF and UHF PA boards are very similar, and in fact are built on identical substrates. The pin allocations of the 70 cms pa brick are different to those of the 2m brick, so it is essential to get these the right way round. Both of the designs emulate the PA protection and S meter drive of the original design. The filtering and Tx/Rx switching functions have been redesigned using a 7 element low pass filter for harmonic rejection and the changeover is accomplished with an ultra fast low loss relay. This has reduced the loss in both the Transmit and Receive paths. The bias tap for phantom powering of masthead amplifiers has also been included, but component values have been selected for minimum loss.

The 2m main pcb is similar in design to many other Mutek front ends, consisting of a low noise dual gate mosfet amplifier, a band pass helical filter, a diode ring mixer with a high level LO injection and low noise IF amplification circuits. In order to achieve the maximum linearity, the mixer has been properly terminated at all ports, and the LO drive power has been optimised. The L.O. signal is derived from the synthesizer on the original receiver . This signal is combined with a D.C. bias which is used to control the power to the new receiver. The output from the mixer is connected to one port of a for way diode switch. This enables the low noise IF amplifier, 8 pole filter and AGC amplifier to be used by all of the receiver sections. The power to the IF processing sections is controlled by a bias voltage that is also used to polarise the diode switch. This can be done because the IF and AGC functions are common to all of the receiver modules.

The 70 cms receiver board is a completely new design. This receiver is a double conversion system and utilises a diode ring mixer for each conversion. The front end utilises a very low noise mosfet followed by a three pole helical filter. This is followed by the first mixer. The L.O. signal for this mixer is buffered by a BFR96s. The IF output at 47MHz is filtered to remove image products. No attempt at adjacent channel filtering is done at this stage. The filter is followed by a low noise wide dynamic range amplifier. This buffers the IF signal before the second conversion. This is important as it prevents spurious mixing between the two local oscillator signals. The LO for the second mixer is also buffered. Like the LO for the 2m amplifier, this LO signal also has a DC bias that controls the 70cros receiver. The output from the second mixer is combined with a dc bias and then connected to the common IF processing circuit on the 2m board.

Although the original IF and AGC connections for the 70cros receiver are not utilised, they are connected to the new board to eliminate any noise injection to the IF by the old receiver.

Fitting the RPCB 736 to the FT 736R

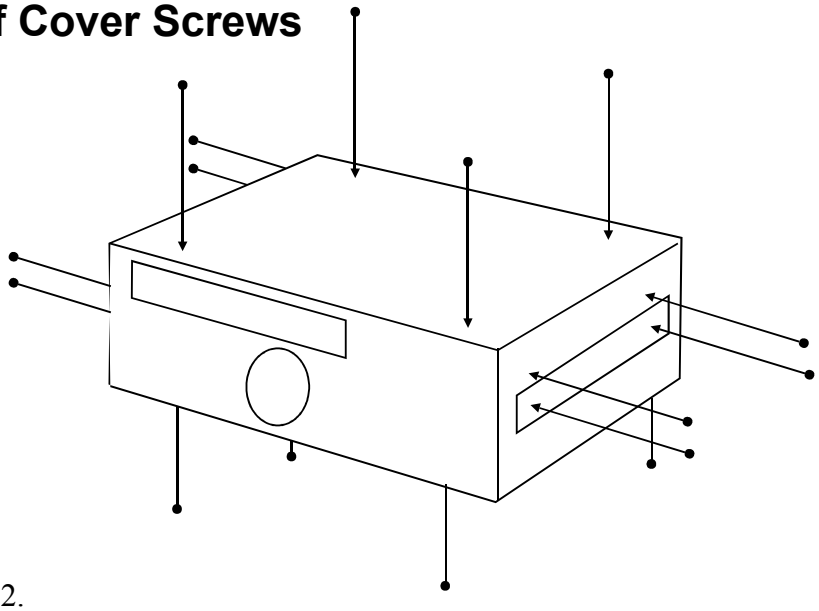
The fitting of the new boards to the transceiver is an extensive operation and should be carried out by an experienced person. Although there is no tuning to be carried out, some of the soldering work is of a delicate nature, and expensive damage can be caused if mistakes are made. Having said this, if care is taken the job is straightforward.

READ the instructions all the way through BEFORE you begin!

1. Disconnect all cables from the rear of the transceiver ESPECIALLY the mains cable. Under NO circumstances attempt to work on the transceiver with power connected.

2. Referring to Fig 1, remove the screws that secure the top and bottom covers of the transceiver. Remove the covers taking care not to strain the connection to the loud speaker, which should be unplugged form the RX unit pcb at the side of the transceiver. Store the covers where they will not be damaged.

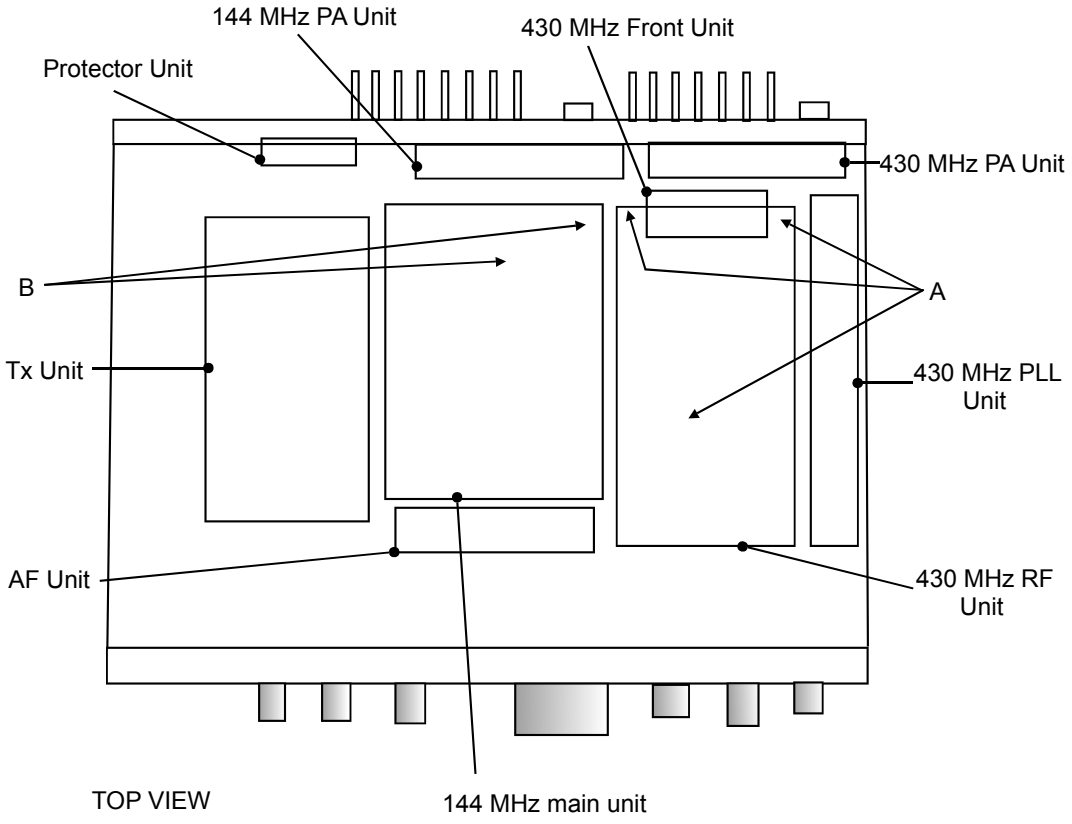
Figure 1: Location of Cover Screws



From now on please refer to Fig.2.

3. Continuing with the original 2 m board, remove:-
   - i) J04 Tx output
   - ii) J05 PA control
   - iii) J01 Rx input

Figure 2: Location of Units in FT736R



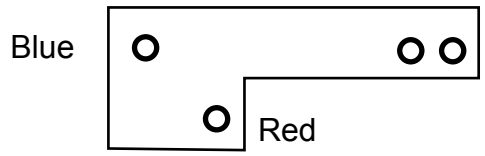
Continuing with the 70 cms original board remove:-

iv) J10 Tx output
v) J06 PA control

From the 430 MHz front end unit (this is the little can screwed to the back of the pa screen - see figure 2) remove:-

vi) J02 1st L.O input
vii) I.F. output

4. From the little PCB's soldered to the backs of the feed-throughs to the 2 and 70 PA units unsolder the blue and red wires, making note of where they connect.



5. Disconnect the 13.8 Volt power feed to the PA units.

6. Disconnect the two black earth cables to the PA screen by removing one screw from the 2m board and one screw from the PA screen.

7. Remove the connectors from the two 9 Volt regulators mounted on the PA screen.

8. Remove the rear right hand screw from each of the 2 and 70 main unit boards, releasing the solder tag connected to the PA screen.

9. If extension units are fitted ‘downstairs’ in the FT 736, remove the 4 screws that secure each unit to the heatsink.

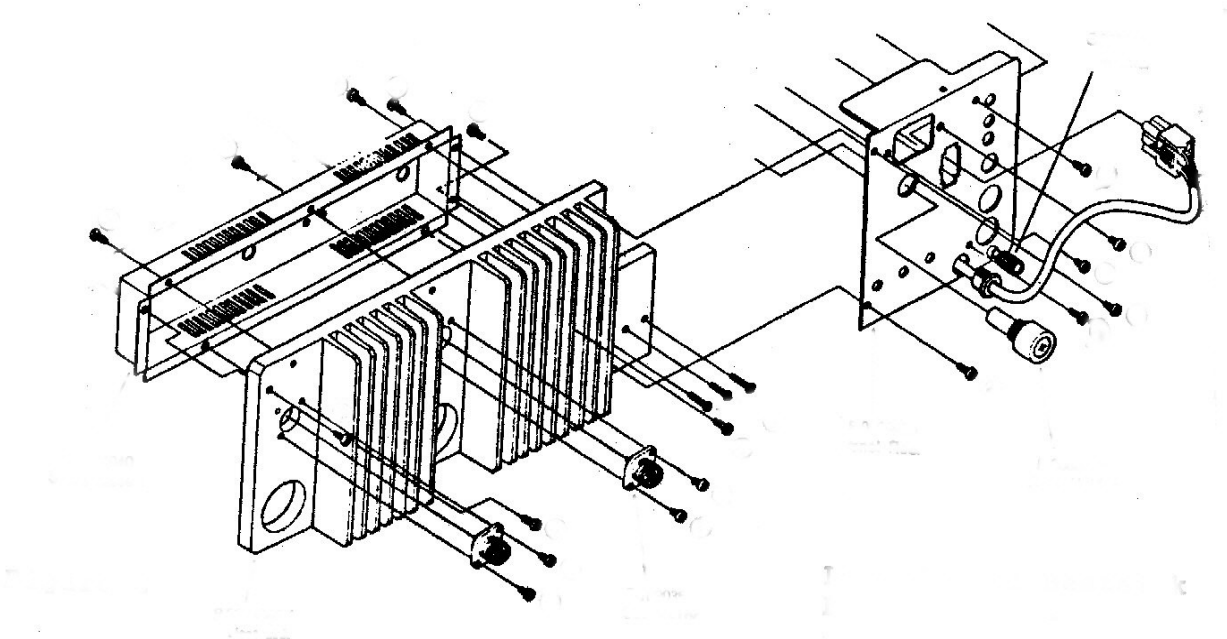
10. Remove the 3 screws ‘9’ (see fig 3) that secure, the power supply to the heatsink. Slacken the two screws marked ‘2’

11. Remove the 3 long self tappers ‘1’ (fig 3) that secure the heatsink to the rear of the chassis.

12. Remove the two short screws ‘2’ (fig 3) that secure the connector panel to the heatsink. You should now be able to gently remove the heatsink from the transceiver by easing it out from behind the connector panel. Beware of the heatsink compound from the back of the power supply.

13. Place the Transceiver to one side for the next few operations. Lay the heatsink on its fins on the bench. Remove the 6 screws that secure the PA screen to the heatsink. De-solder the 5 control wires from each of the PA pcb's. Disconnect the RF input to the 430MHz front end unit (J01). Feed the coaxial cables through the screen, this should free the screen and 430 MHz front end unit from the heatsink.

Figure 3: Heatsink Fixing Screws



14. Remove the two screws that hold the 430 MHz front end unit to the screen. Carefully separate the two units and place on one side.

15. Return to the Heatsink and PA assembly. Carefully de-solder the 5 wires from each PA Hybrid that connect it to the PA board. Also de-solder the connection to the Antenna connector Remove 5 screws that hold each PA board to the heatsink. Remove the old PA. pcb's and place on one side.

16. Clean the smudge of heatsink compound from under the 70cros PA board.

17. Turn the heatsink over and remove the SO 239. From the kit supplied, extract the N type connector, the packet of M3 X 5 taptite screws and the two new PA boards. Secure the N type connector to the heatsink in place of the S0239, using 3 of the taptite screws. Turn the heatsink back onto its fins. Solder the short length of 18swg silver wire to the centre of each N type. Make sure that this is approximately vertical.

18. Identify the 2m and 70cms PA boards by the circle round the 2 or 70 in the bottom left hand corner. Using 5 taptite screws for each board, secure to the heatsink in the appropriate position, making sure that the wire from the N type connector passes through the board.

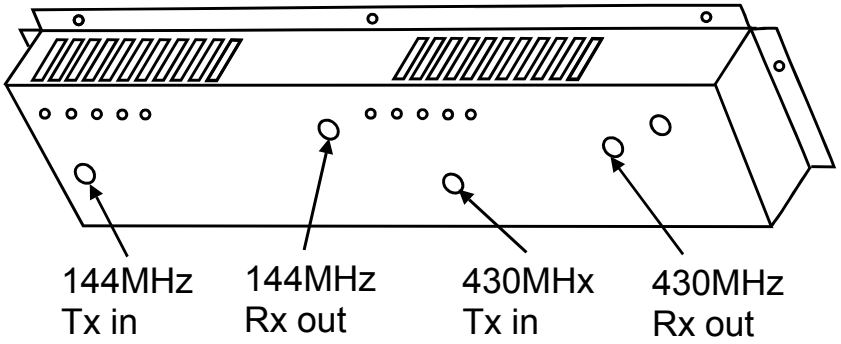
19. Carefully shorten the wires to each of the PA hybrids and solder to the pads on the new PA boards.

20. Recover the PA screen and carefully solder the 5 control wires to each board according to the following code:

Red	+13.8V	White	ALC
Orange	T9V	Blue	Preamp
Yellow	AFP		

21. Pass the new RF cables through the holes in the Screen, as shown Figure 4.

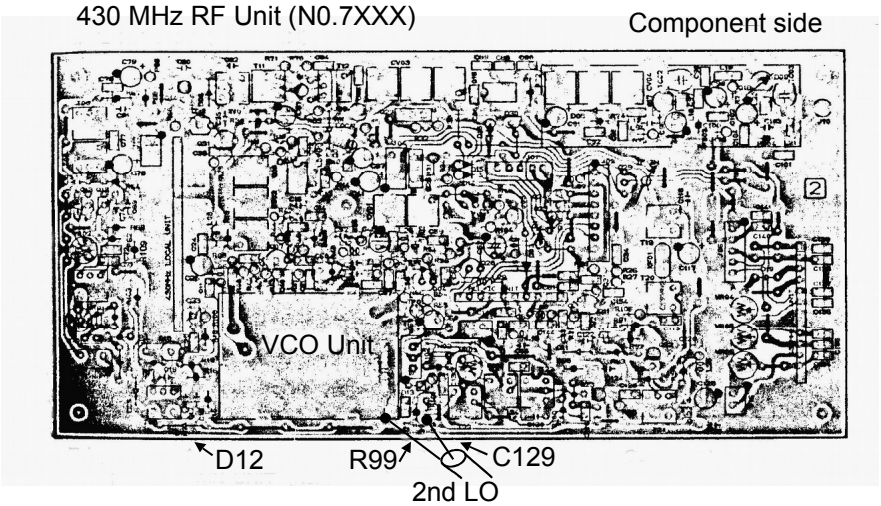
Figure 4: Screen and Cable Positions



22. Secure screen to the heatsink using the original screws. Remember that the centre top location is left blank for the earth wire when the heatsink is installed in the rig.

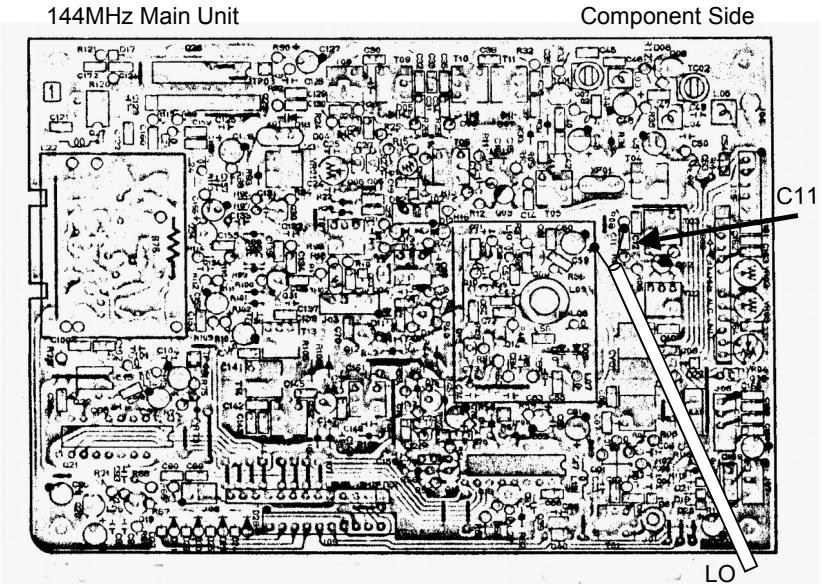
23. Place the heatsink assembly to one side. Return to the main chassis and remove the remainder of the plug in connectors from the 70 cms main unit. Remove the main unit pcb from the chassis. Using the M3 tap provided cut a thread in the three holes marked 'A' in fig 2. Remove C129 from the 70 cms main unit. See fig 5 for the location of this component. Solder the white coded coaxial cable to the main unit as shown, the screen of the cable should be soldered to the vco screen and the core to the junction of D12 and R99. De-solder the original 1st IF input cable - this is no longer required. Replace the main unit in the chassis and secure with 2 self-tappers and three of the nylon pillars, the pillars are fitted in the tapped holes. Reconnect all of the plug in cables except J15 which will be connected to the new board. Carefully unwind the wire loops that secure the first LO cable along side the Tx strip screen.

Figure 5: 430 MHz RF Unit



24. Carefully remove all of the plug in connectors from the 2m main unit and remove the unit from the chassis. With the M3 tap cut threads in the three holes marked ‘B’ in fig 2. De-solder and remove C11 from the 2m main unit. Solder the red coded coaxial cable as shown in fig 5, the screen should be soldered to the screen of the VCO. Replace the unit in the chassis, again securing the unit with 3 pillars and two of the original screws. The pillars are fitted to the holes marked 'B'. Replace all of the plug in connectors except J02 which will be connected to the new board.

Figure 6: 144 MHz Main Unit



25. (Carefully ease the heatsink back onto the main chassis and secure with the 3 long screws '1' and the two short screws ‘2’. from the kit supplied, locate the 6 M3 pillars and install these in the 2 m and 70 cm main units. Restore the black earth wire to the centre top of the PA screen. Restore the two connectors to the 9 Volt regulators. replace the main 13.8V feed to the PA units. Solder the 10uF capacitor to the tag strip at the rear of the transmit board, where the 13.8 volt wire is connected to a large toroid. OBSERVE POLARITY. this capacitor reduces a lot of broad band noise from the switch mode supply.

26. Reconnect the thin Blue and Red wires to the little pcb's mounted on the feed-throughs on the PA screen. (Reverse instruction 4).

27. Starting with the 2m main unit replace the following connectors:-
    - i) J04 Tx output
    - ii) J05 PA control

    Continuing with the 70 ems main unit replace:-
    - iii) J10 Tx output
    - iii) J06 PA control

28. At this point you are now ready to install the Mutek front end boards. These fit on top of the nylon pillars. Starting with the 2m board, secure the board to the pillars with the M3 X 6 screws provided. The central screw by the L.O. input should secure the remaining black earth wire from the PA screen. Plug the antenna connector in the socket marked VHF IN. The red coded coax should be connected to the socket marked L.O. in. Solder the flying lead from the +12V pad to the red +13.8 V wire on the P.A. feed through. connect the plug from J02. Ensure that the blue wire is towards the rear of the rig. A moderate amount of force will be required the first time this connector is inserted.

29. Secure the 70cms board to the pillars over the 430MHz main unit with the remaining M3 X 6 screws. Make sure that the white coded cable is lead between the side of the new board and the 430MHz PLL unit. Also make sure that the 1st L.O. and the J15 connectors are accessible. Connect the Antenna cable to the socket marked UHF in. Connect the 1st and

2nd L.O's to their appropriate connectors. Connect J15 to the 3 pin header, orientation is not important. Use the Blue coded I.F. link cable provided to connect the I.F. output on the 70 ems board to I.F. IN 1 on the 2m board. This completes the installation.

30. Replace the top and bottom covers, not forgetting to reconnect the loudspeaker connector.

Circuit Diagrams and Parts Lists

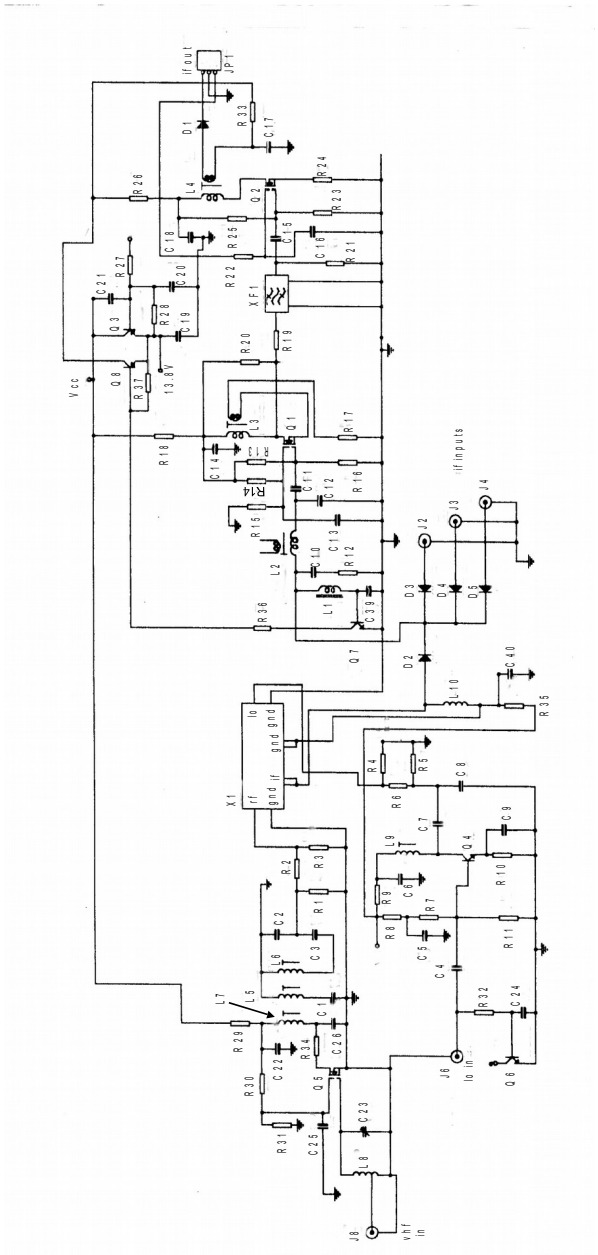


Table 1: 2 m Mutek Main Board Parts List

This relates to Revision 1: 04/02/1993

Cct. Ref.	Value	Cct. Ref.	Value	Cct. Ref.	Value
R1	470R	R34	150R	C40	10n
R2	10R	R35	390R		
R3	470R	R36	10k		
R4	220R	R37	2k7	L1	220µH
R5	220R			L2	KACS4520
R6	18R	C1	12p	L3	KACS4520
R7	4k7	C2	100p	L4	KACS4520
R8	100R	C3	12p	L5	5.5T
R9	10R	C4	1n0	L6	5.5T
R10	150R	C5	1n0	L7	5.5T
R11	3k3	C6	1n0	L8	Tap, Ind.
R12	51R	C7	6p8	L9	5.5T
R13	1M0	C8	33p	L10	220µH
R14	82k	C9	1n0		
R15	39k	C10	68p	X1	SBL-1
R16	39k	C11	1n0		
R17	100R	C12	39p	XF1	Filter
R18	100R	C13	1n0		
R19	1k5	C14	10n	Q1	BF988
R20	2k7	C15	1n	Q2	BF988
R21	3k3	C16	10n	Q3	2N3906
R22	39k	C17	10n	Q4	BF199
R23	39k	C18	10n	Q5	BF988
R24	100R	C19	1n0	Q6	MPSA18
R25	1M0	C20	1n0	Q7	MPSA18
R26	100R	C21	1n0	Q8	2N3906
R27	10k	C22	1n0		
R28	2k7	C23	1/5p	D1	1N4148
R29	100R	C24	1n0	D2	1N4148
R30	82k	C25	1n0	D3	1N4148
R31	39k	C26	8p2	D4	1N4148
R32	10k	C27-38	Not used	D5	1N4148
R33	100R	C39	10n		

Figure 8: 70 cm Mutek Main Board Circuit Diagram

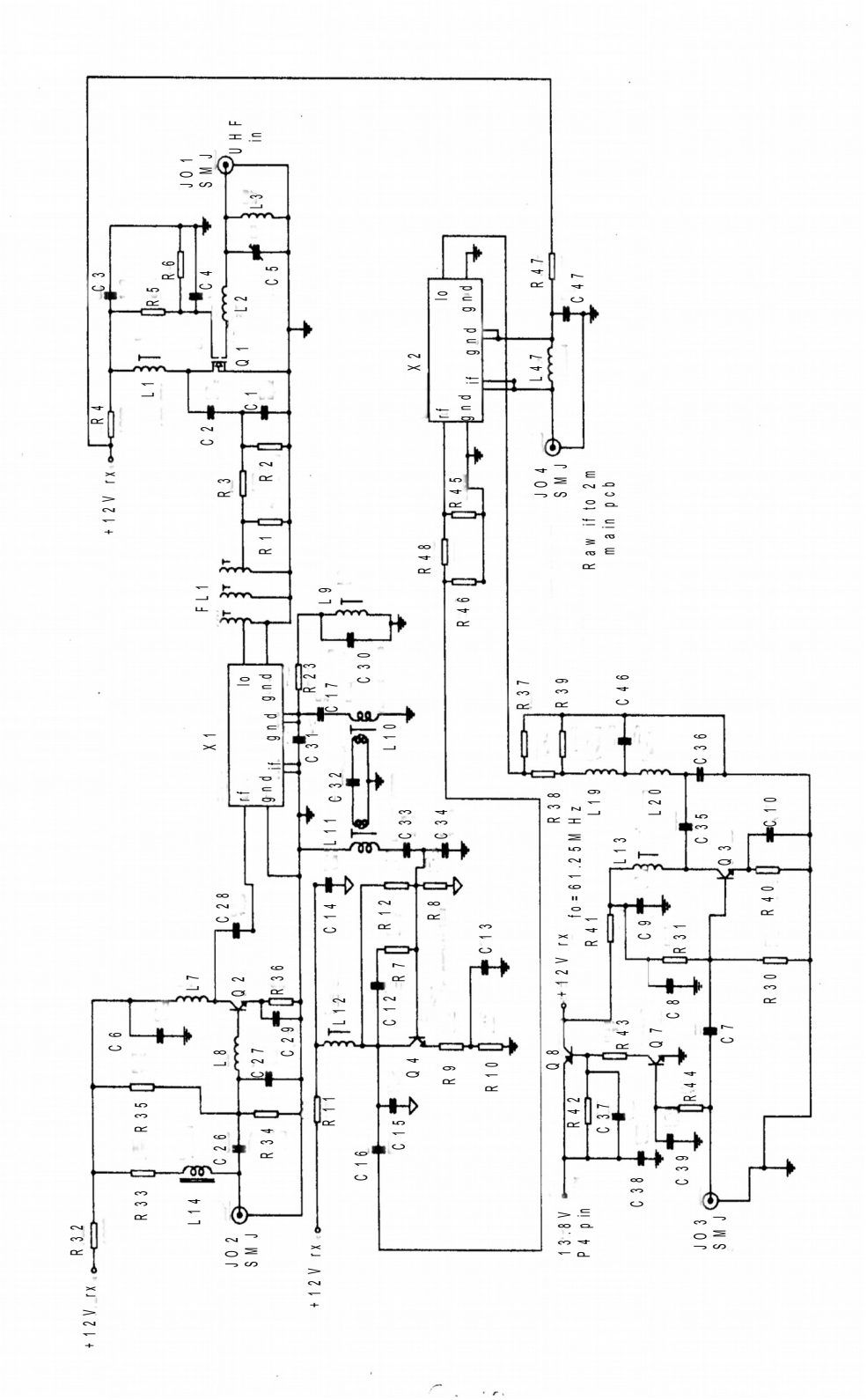


Table 2: 70 cm Mutek Main Board Parts List

This relates to Revision 1: 04/02/1993

Cct. Ref.	Value	Cct. Ref.	Value	Cct. Ref.	Value
R1	470R	R48	22R	C39	1n0
R2	470R			C40-C45	Not used
R3	10R	C1	8p2	C46	33p
R4	100R	C2	2p2	C47	10n
R5	82k	C3	1n0		
R6	39k	C4	1n0	L1	100-071
R7	2k2	C5	1n0	L2	3T
R8	390R	C6	1/5p	L3	3T
R9	8R2	C7	1n0	L4-L6	Not used
R10	22R	C8	1n0	L7	2T
R11	10R	C9	1n0	L8	0.5T
R12	2k2	C10	1n0	L9	BEKNK4028
R13-R22	Not used	C11	Not used	L10	BEKNK4028
R23	51R	C12	1n0	L11	BEKNK4028
R24-R29	Not used	C13	10n	L12	100-076
R30	4k7	C14	10n	L13	100-076
R31	33k	C15	100p	L14	0.33uH
R32	100R	C16	68p	L19	150uH
R33	330R	C17	33p	L20	150uH
R34	1k0	C18-C25	Not used	L47	150uH
R35	12k	C26	68p		
R36	27R	C27	10p	X1	SBL-1
R37	120R	C28	12p	X2	SBL-1
R38	47R	C29	1n0		
R39	120R	C30	33p	XF1	7HT
R40	100R	C31	120p		
R41	100R	C32	22p	Q1	BF988
R42	2k7	C33	33p	Q2	BFR96
R43	10k	C34	120p	Q3	BF199
R44	10k	C35	33p	Q4	BFR96
R45	220R	C36	100p	Q5, Q6	Not used
R46	220R	C37	1n0	Q7	MPSA18
R47	10k	C38	1n0	Q8	2N3906

Figure 9: PA Board Schematic for 2m and 70cm

NOTE: Pins 2 and 3 change functions between M57727 and M57245. The circuit is shown correctly for the 2m pcb, on the 70 cm PA the pins are reversed.

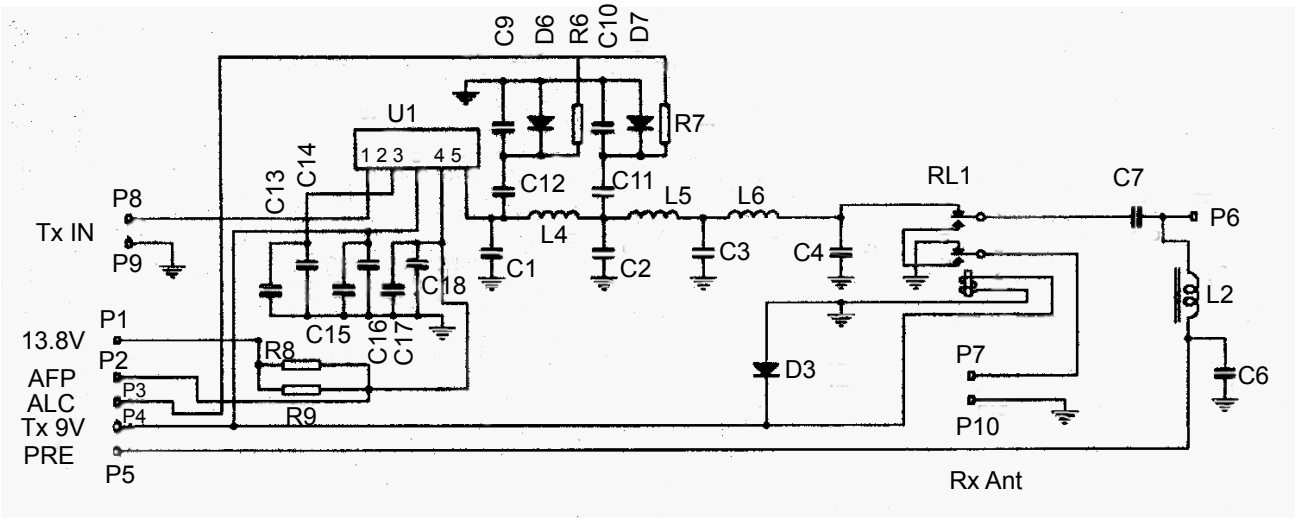
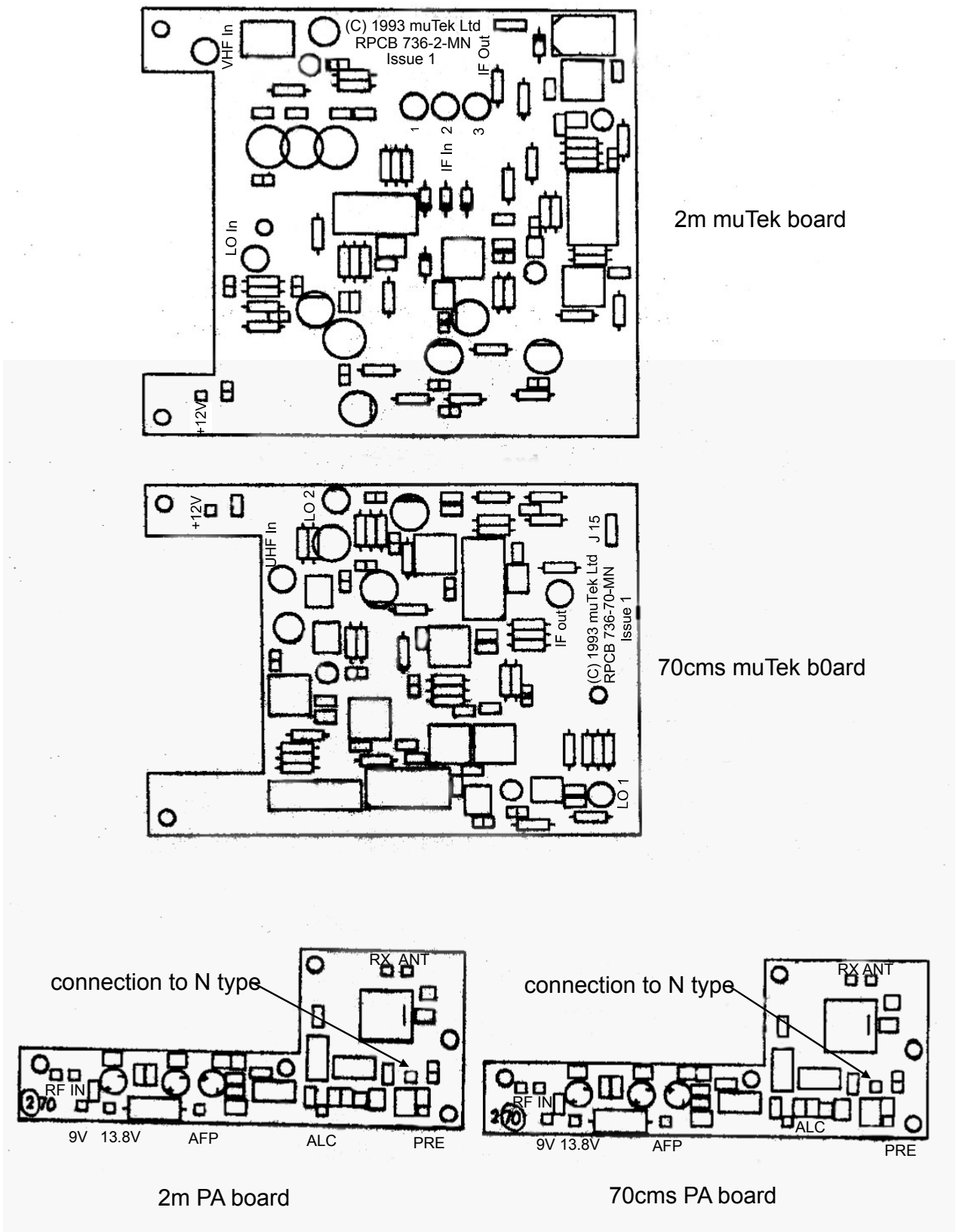


Table 3: 2 m and 70 cm PA Board Parts List

Cct. Ref.	2m PA	70 cm PA	Cct. Ref.	2m PA	70 cm PA
R1-R5	Not used	Not used	C16	1n0	1n0
R6	10k	10k	C17	10u	10u
R7	10k	10k	C18	1n0	1n0
R8	0R1	0R1			
R9	0R1	0R1	L1	Not used	Not used
			L2	1uH	1uH
C1	22p	4p7	L3	Not used	Not used
C2	39p	8p2	L5	5T Ag wire	1.5T Ag Wire
C3	39p	8p2	L5	5T Ag wire	1.5T Ag Wire
C4	22p	6p8	L6	5T Ag wire	1.5T Ag Wire
C5	Not used	Not used			
C6	1n0	1n0	RL1	Relay DPDT	Relay DPDT
C7	1n0	1n0			
C8	Not used	Not used	D1, D2	Not used	Not used
C9	10p	10p	D3	BAS16	BAS16
C10	10p	10p	D4, D5	Not used	Not used
C11	1p0	1p0	D6	BAS16	BAS16
C12	1p0	1p0	D7	BAS16	BAS16
C13	10u	10u			
C14	1n0	1n0			
C15	10u	10u	U1	M57727	M57745

Figure 10: Component Layout for PCBs



Additional Photographs

These photographs were supplied by Paul, G4DCV, they may help identification.