

# muTek limited

## FT221/225GT front end

Our front-end board has been designed to bring the receiver performance of the FT221 and FT225 series transceivers up to a very high standard. The design has evolved from work done by Ian White, G3SEK, and has been used extensively for advanced experimental work, and routine communication.

The original rf board fitted by Yaesu suffers from several deficiencies. The chief of these are a distinct deafness (noise figures of 8 - 10dB are not unusual in unmodified transceivers!) and a considerable susceptibility to strong-signal overload problems. Fitting a preamplifier can help with the first problem but at the expense of dynamic range. Of course, strong signal problems are not always recognised as such, but with the present level of 144MHz activity there can be few operators who are able to completely disregard signal handling problems. Of course there will always be those people (including some manufacturers!) who will remain convinced that a little extra low noise preamplification can only do good.....

The muTek rf board has been designed to eliminate the need for preamplifiers while vastly improving the dynamic range of the system. To overcome the design problems presented has required careful attention to the linearity of the mixer and amplifiers with particular care being given to proper gain distribution.

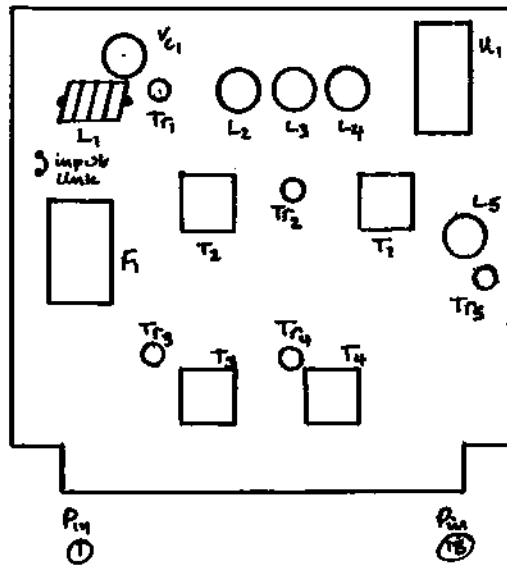
The rf stage is a very low noise ion-implanted dual-gate mosfet (3SK88) This device is capable of a genuine (device) noise figure of around 1dB. We have chosen to trade nf with dynamic range resulting in a system nf of perhaps 2dB or a little less. This

band termination for the input port of the ring mixer.

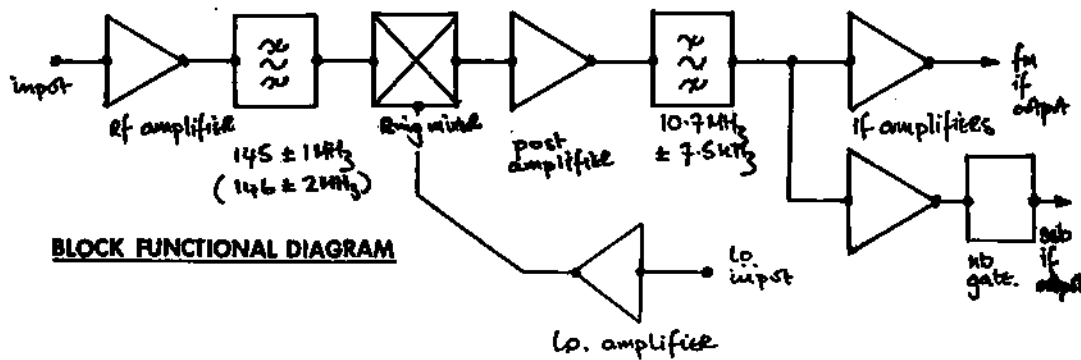
A ring mixer was chosen in preference to the more usual fet for two reasons: the most obvious is that it is much easier to achieve adequate dynamic range with the ring. A second, possibly more subtle reason, is that the inherently balanced structure of the ring results in cancellation of local oscillator am noise. As the phase locked translation loop lo in the 221 and 225 series generates quite large am noise sidebands, a balanced mixer is mandatory.

Proper termination of the mixer is essential for reproducible high performance operation. The lo is terminated with a 5dB pad: this ensures a good broadband match. There is enough power available at the output of the class-A lo buffer to ensure proper mixer performance. The mixer port which requires most careful termination is the if output. The network here has several functions: it must transform the 50Ω output impedance of the diode ring to the optimum source impedance required by the mosfet post amplifier; it must ensure that the mixer has a dc earth return, and most importantly, it must provide a satisfactory termination for the vhf and uhf products generated in the mixing process. The 10.7MHz impedance transformation is accomplished with an L-network, while the rf choke provides the earth return. The series RC network on the mixer output provides a monotonically increasing return-loss with frequency, thus ensuring proper termination of the vhf and uhf mixing products.

The mixer post-amp is a low noise mosfet which is operated at a high drain current for good intermodulation performance. Although some degradation of the noise figure can be seen, it is still very low and has a minimal effect upon the mixer nf. The device also



**MAJOR COMPONENT LOCATIONS**



**BLOCK FUNCTIONAL DIAGRAM**

C <sub>1</sub>	1n0 pc	CA-00-130
C <sub>2</sub>	1n0 pc	CA-00-130
C <sub>3</sub>	8p2 pc	CA-00-802
C <sub>4</sub>	1n0 pc	CA-00-130
C <sub>5</sub>	1n0 pc	CA-00-130
C <sub>6</sub>	12p pc	CA-00-112
C <sub>7</sub>	n10 pc	CA-00-120
C <sub>8</sub>	12p pc	CA-00-112
C <sub>9</sub>	n10 pc	CA-00-120
C <sub>10</sub>	68p pc	CA-00-618
C <sub>11</sub>	1n0 pc	CA-00-130
C <sub>12</sub>	10n pc	CA-00-140
C <sub>13</sub>	10n pc	CA-00-140
C <sub>14</sub>	10p pc	CA-00-110
C <sub>15</sub>	10n pc	CA-00-140
C <sub>16</sub>	10n pc	CA-00-140
C <sub>17</sub>	10n pc	CA-00-140
C <sub>18</sub>	1u5 tb	CD-00-165
C <sub>19</sub>	1n0 pc	CA-00-130
C <sub>20</sub>	1n0 pc	CA-00-130
C <sub>21</sub>	1n0 pc	CA-00-130
C <sub>22</sub>	1n0 pc	CA-00-130
C <sub>23</sub>	47p pc	CA-00-417
C <sub>24</sub>	10p pc	CA-00-110
C <sub>25</sub>	1u5 pc	CD-00-165
C <sub>26</sub>	1n0 pc	CA-00-130
C <sub>27</sub>	10n pc	CA-00-140
C <sub>28</sub>	10n pc	CA-00-140
C <sub>29</sub>	1n0 pc	CA-00-130
VC <sub>1</sub>	10p pf	
L <sub>1</sub>		LA-00-003
L <sub>2</sub> ...L <sub>5</sub>		LA-00-002
L <sub>6</sub>	47u rfc	LB-00-417
L <sub>7</sub>	22u rfc	LB-00-212
L <sub>8</sub>	m22 rfc	LB-00-222
L <sub>9</sub>	22u rfc	LB-00-212

R <sub>1</sub>	82k	RA-00-842
R <sub>2</sub>	100R	RA-00-120
R <sub>3</sub>	39k	RA-00-349
R <sub>4</sub>	100R <sup>§</sup>	RA-00-120
R <sub>5</sub>	100R	RA-00-120
R <sub>6</sub>	100R	RA-00-120
R <sub>7</sub>	470R	RA-00-427
R <sub>8</sub>	11R	RA-00-111
R <sub>9</sub>	470R	RA-00-427
R <sub>10</sub>	51R	RA-00-511
R <sub>11</sub>	39k	RA-00-349
R <sub>12</sub>	1M0	RA-00-160
R <sub>13</sub>	39k	RA-00-349
R <sub>14</sub>	1k5	RA-00-135
R <sub>15</sub>	10R	RA-00-110
R <sub>16</sub>	3k3	RA-00-333
R <sub>17</sub>	39k	RA-00-349
R <sub>18</sub>	1M0	RA-00-160
R <sub>19</sub>	39k	RA-00-349
R <sub>20</sub>	100R	RA-00-120
R <sub>21</sub>	3k9	RA-00-339
R <sub>22</sub>	5k1	RA-00-531
R <sub>23</sub>	4k7	RA-00-437
R <sub>24</sub>	33k	RA-00-343
R <sub>25</sub>	150R	RA-00-125
R <sub>26</sub>	10k	RA-00-140
R <sub>27</sub>	100R	RA-00-120
R <sub>28</sub>	180R	RA-00-128
R <sub>29</sub>	27R	RA-00-217
R <sub>30</sub>	180R	RA-00-128
R <sub>31</sub>	10k	RA-00-140
R <sub>32</sub>	39k	RA-00-394
R <sub>33</sub>	82k	RA-00-842
R <sub>34</sub>	100R	RA-00-120
R <sub>35</sub>	1k5	RA-00-135
R <sub>36</sub>	39R	RA-00-319
R <sub>37</sub>	100R	RA-00-120
F <sub>1</sub>		FA-00-001

These component values are given for guidance; § denotes a component which may be adjusted on test.

Tr <sub>1</sub>	Bf984 3SK88	QA-00-088	D <sub>1</sub>	1N914	ED-00-914
Tr <sub>2</sub>	3SK74	QA-00-074	D <sub>2</sub>	1N914	ED-00-914
Tr <sub>3</sub>	3SK74	QA-00-074	D <sub>3</sub>	1N914	ED-00-914
Tr <sub>4</sub>	3SK74	QA-00-074	D <sub>4</sub>	1N914	ED-00-914
Tr <sub>5</sub>	BF274	QA-00-274	D <sub>5</sub>	BA182	ED-00-182
				BA374	

Edge connector pin allocations

Pin 1	gnd	Pin 7	mkr/nc	Pin 13	nc
Pin 2	agc	Pin 8	gnd	Pin 14	ssb if
Pin 3	+13.5V	Pin 9	fm if	Pin 15	blanker
Pin 4	gnd	Pin 10	gnd	Pin 16	gnd
Pin 5	antenna	Pin 11	nc	Pin 17	lo
Pin 6	mkr/nc	Pin 12	gnd	Pin 18	gnd

Installation

There are two small internal modifications that are required in order to make the muTek rf board compatible with the unmodified FT221/225. They are both reversible.

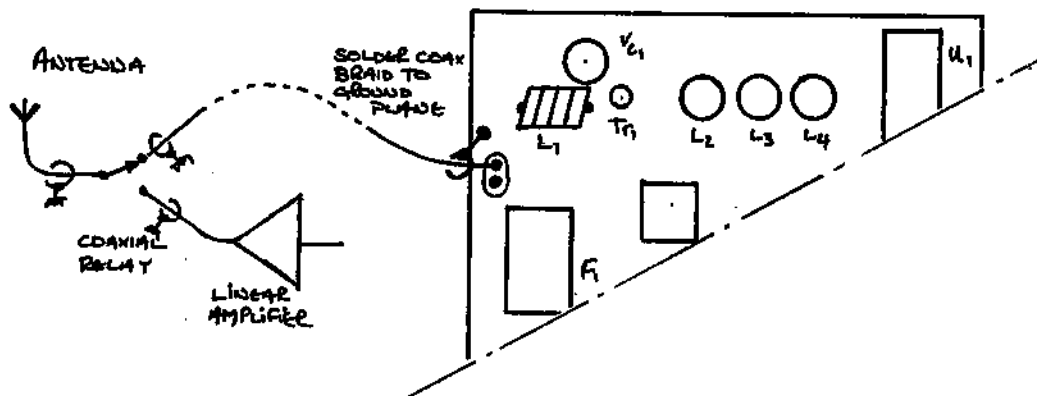
The first provides a switched 13.5V line to power the new rf board on receive only. The original board operates from an 8V rail which potentially limits dynamic range.

The second is to switch the 8V supply to the noise blanker if

~~the muTek rf board has a noise blanker as a slide switch for the~~

- 5) Turn the transceiver over to expose the underside.
- 6) Locate Pin 18 on the ssb if unit edge connector - this may also be labelled Pin 9B - it has 13.5V on receive and 0V on transmit.
- 7) Locate Pin 3 on the rf unit edge connector.
- 8) If Pin 3 has a lead connected to it, remove the lead and insulate the free end.
- 9) Run the longer of the two leads supplied between Pin 18 (9B) of the ssb if unit edge connector and Pin 3 of the rf unit edge connector.
- 10) Locate Pin 13 on the fm if unit - this will have 8V on it.
- 11) Remove the leads soldered to this pin (if there is a decoupling capacitor soldered to the pin, don't remove it.) Insulate the bare ends of the leads, which should remain soldered together.
- 12) Locate Pin 9 - this may also be labelled Pin 5A - on the ssb if unit edge connector. This has 8V on receive and 0V on transmit.
- 13) Run the shorter of the two leads supplied between Pin 13 of the fm unit edge connector and Pin 9 (5A) of the ssb unit edge connector.
- 14) Turn the transceiver the right way up.
- 15) Plug-in the muTek rf board. (The track side of the board faces the front)
- 16) Check the receiver performance on an antenna.
- 17) Refit the top and bottom covers.
- 18) Now get in amongst the dx!

3) In circumstances where the lowest possible noise figure is required, the transceiver's internal antenna change-over circuit losses may be unacceptable. In order to bypass the antenna relay, we have provided a link (INPUT LINK) in the antenna input microstripline which may be broken to allow a direct connection to be made to the rf stage gate circuit.

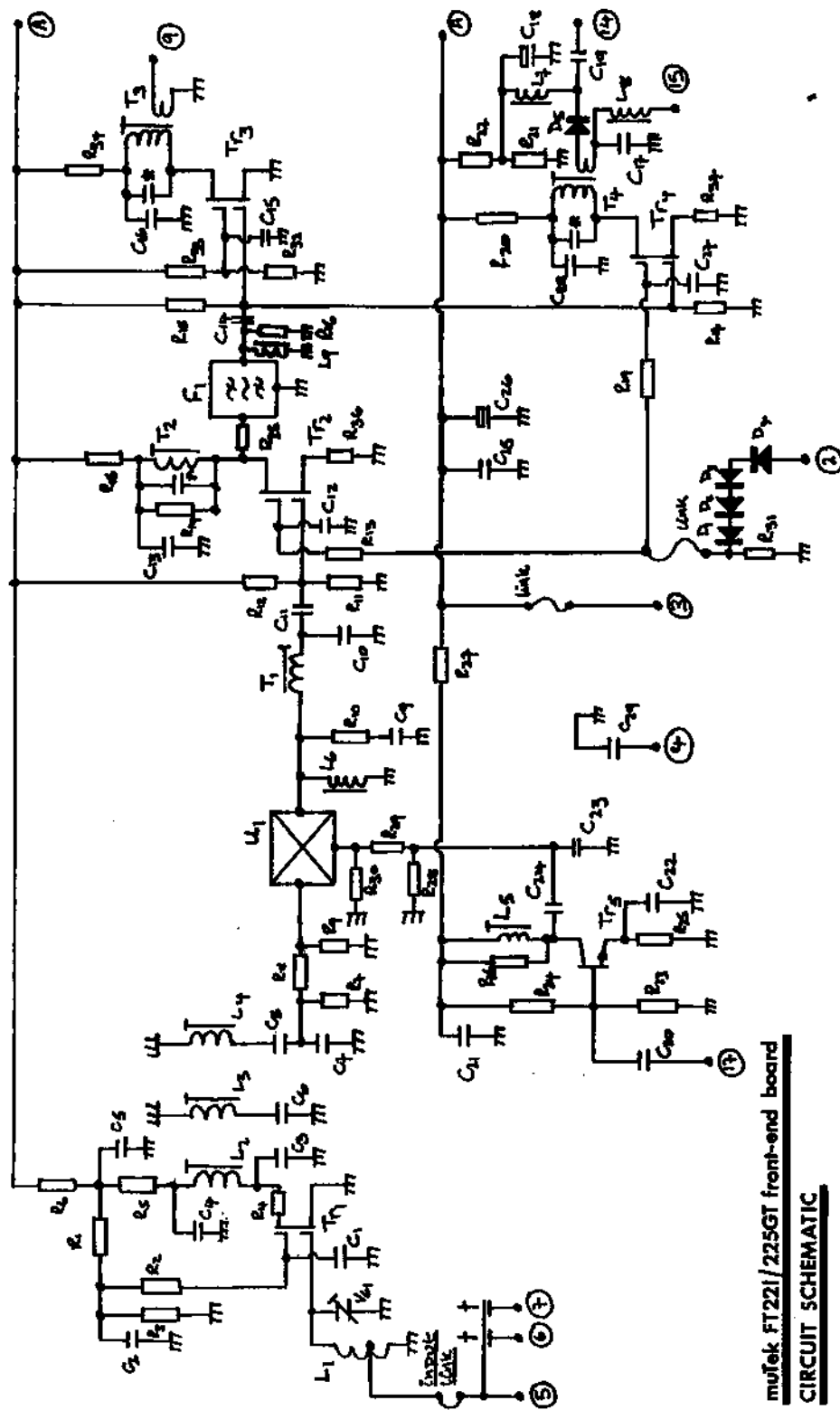


Test data

Serial Number: XXXXXXXXXX

Date: 6 September 1980

Noise figure 2.0 ± 0.5dB



**muTek FT221/225GT front-end board  
CIRCUIT SCHEMATIC**

Yaesu FT221/225 series

August 1983

Improved noise blanker performance.

The design of the noise blanker in both transceivers is virtually identical although component designations may vary. In essence the modification involves increasing the size of the blanking pulse applied to the diode gate driver circuit (Q03/Q04).

The two circuit diagrams show the relevant parts of PB1463 before and after modification. The new shunt diode Dn1 can be the 1S1555 removed from the secondary detector position whilst the series diode should be a silicon switching diode such as a 1N4148. The 33k resistor should be a reasonable quality 0.25w carbon film resistor such as a Mullard/Philips CR25 or a Piher PR25 although this is obviously not critical!

Before modification

