Yaesu FT726 VHF/UHF multimode transceiver

Marketing an all-singing all-dancing transceiver can be a risky business — it takes only one bad section to let the whole rig down. Has Yaesu's risk paid off? Angus McKenzie investigates the FT726R.

Just occasionally we have seen rigs developed which could be described as 'all eggs in one basket' machines. After years of development, Yaesu have now introduced their more amazing new box, the FT726R into which can be put three seperate bands in the form of modules, the review sample incorporating 70cm, 2m and 6m. USB, LSB, CW and FM modulation us included, and several methods of tuning are available. The normal VFO covers either 10KHz of 100KHz per rotation in 20Hz or 200Hz steps, the VFO being available for all modes. A conventional click position rotary can be selected for FM and programmed to either 12.5 or 25KHz channelling on 2m or 70cm, but the 6m module has 5 and 10KHz channelling.

For the UK market, models sold by official Yaesu dealers will have the previously mentioned channelling, but a hugh variety of alternative modules are available with different frequency ranges and/or different channelling and repeater shifts. You may need to watch out for 'parallel' imports and check to see if they have the correct modules which are better suited to the UK situation. (SMC, who supplied the review model, have pointed out that Japanese home market models, possibly available in this country as 'black imports', are *not* readily convertible to UK specifications.)

There are also up and down buttons which can be used either to step FM channels, or to start a scan, this latter option cutting in when the button is held on for more than 0.5 second. Audible pip tones show the commencement of scanning, etc. Three buttons on the microphone also select up/down and 12.5KHz steps if the FST button in the middle is depressed at the same time, this FST button duplicating the large/small steps button on the front panel.

Scanning speeds vary from 2KHz/20KHz per second for SSB/CW and FM/VFO to 100/200KHz per second on FM channels. A repeater switch selects either the appropriate up and down repeater shifts on the band selected, or user programmable shifts. A seperate button selects normal or reverse repeter mode, operating properly on both RX and TX.

Two VFOs are incorporated with facilities for splitting them on RX and TX. Ten memories allow mode, frequency and band to be stored. A sweeping function with frequency limits selected by the first and last normal memories allows any required portion of a band to be swept. Buttons control the selection of VFO, call with tone, memory recall, priority channel, memory/VFO changeover and memory write. The two VFOs can be set onto the same frequency by pressing one button.

On the left side of the box, there are two rows of pushbuttons for selecting mode, clarifier with clear (the FM channel knob becomes a clarifier when this is selected), up/down scanning etc., processor on/off, AGC fast/slow, narrow CW filter (optional), FM channels or VFO, noise blanker, and dial lock. A rotary switch selects meter-read discriminator, ALC, or power out. Two meters are provided which have normal modes of S-meter and power out, although indications were not too accurate from these.

The frequency displayed is to the nearest 100Hz, and thus seven digits. Various other functions are also displayed on the meter panel. Along the bottom are split concentric pots for mic gain and drive (variable on all modes from extremely low to full power), shift and bandwidth (centre indented), AF RX gain and squelch, and RF gain and RX tone.

The review sample was supplied with an additional satellite plug in, which, rather astonishingly, allows the user to transmit on one band at the same time as receiving on another. This is quite

uncanny, and there was only a barely preceptible blocking, thus allowing very efficient duplex or satellite working.

You will certainly need a cold wet towel round your head when you are getting to know all the facilities, and after my lengthy perusal I needed a long think in order to find what was actually missing! The supplied microphone, of course, has PTT, which is duplicated on a socket on the rear panel, but no PTT MOX button is provided on the front panel, which is inconvenient for a long over. A desk mic is available which has a MOX button on it, but I was surprised to see that VOX is also missing from the rig; many will consider this a pity, although I personally do not like VOX. CW keying is semi 'break-in', however, and this worked well.

The only other serious omission that I found is that you cannot turn the AGC off. The rig has an odd little foible on SSB in that even with squelch at minimum, ie. off (squelch works on SSB and FM), the RF gain control will, when turned back beyond a certain point, causes squelch action which is very inconvenient when you want to peak up on a *very* strong signal or increase the receive dynamic range on such a signal.

Well Connected

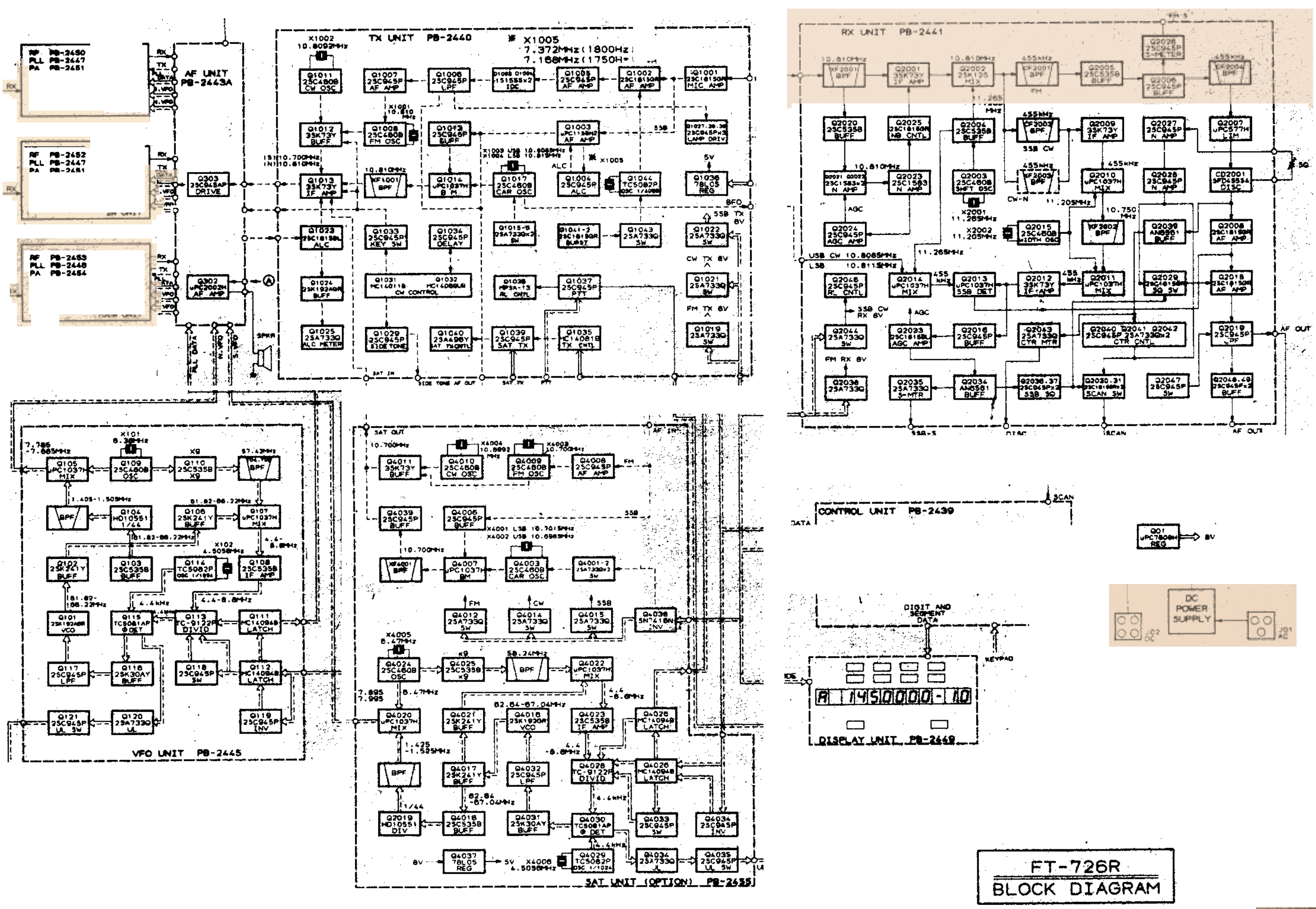
Each band module on the back has its own individual antenna socket, SO239s for 6m and 2m, and an N for 70cm. Beside each socket is a standby 3.5mm jack for interconnecting linears so that the appropriate linear is selected for each band, the sockets applying a short circuit on TX and open RX, which is just how we want it for most linears. Other back panel sockets include a 3.5mm speaker jack, AF out on a phono socket (around 0.5V from 600 ohms from the top of the volume control, and therefore independent of the control setting), PTT on phono, CW ¼" key back, 13.8V DC (chassis socket requiring a 4-pin plug). An IEC mains socket is complemented by its fuse and a large grounding post with wing nut.

Inside a well on the top are four switches selecting scan for busy, manual or clear, scan stop or pause, tone squelch (optional accessory but of no interest in UK) and repeater toneburst on/off (unfortunately this also works on simplex, I don't mind this as you can switch it off, but some will find it irritating and might well forget that it is on when transferring to simplex). A lithium battery is provided internally for holding the memories when mains is unplugged and this facility is switchable.

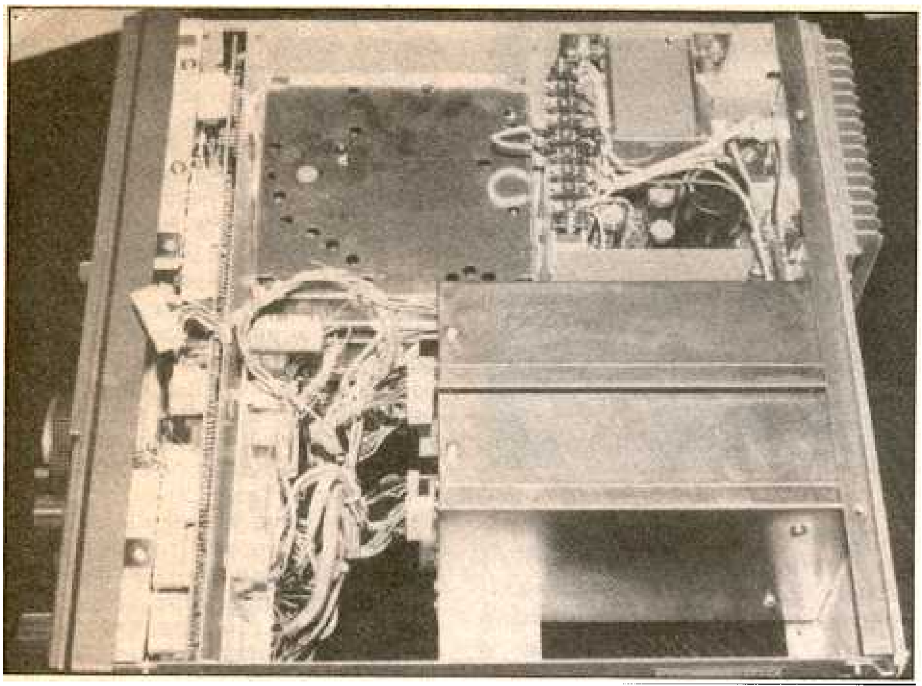
Mere Niggles?

At this stage perhaps I should mention a few more niggles, but please realise that this is my opinion, though it is shared by one or two other 726 users.

When using VFO on say 2m, it is very easy to knock the band up or down buttons accidentally and when you step back again, you find that you have lost your frequency which requires you to find the station again. You can lock the rig on a frequency but then you cannot VFO from this lock position easily. I



FT-726R
BLOCK DIAGRAM



Top view of FT726R showing the general layout. The Motherboard is mounted vertically parallel to the front panel (LHS). PSU at top RHS.

got over this problem, which kept on occuring because my fingers are rather large, by inserting the frequency in use into a memory and then recalling it, followed by memory to VFO. At any time I could then re-establish frequency with VFO in a second or two. I feel that Yaesu should have had seperate memories on the VFO automatically switched on for each module. If you just shunt 1MHz within a band, incidentally, you do not lose the KHz frequency, and just the MHz changes.

The frequency readout can easily be read at a distance, and it is set back from the front panel slightly thus helping to reduce the effects of glare from the sun for example; however, if you move your head vertically off axis, it becomes difficult to read.

And There's More....

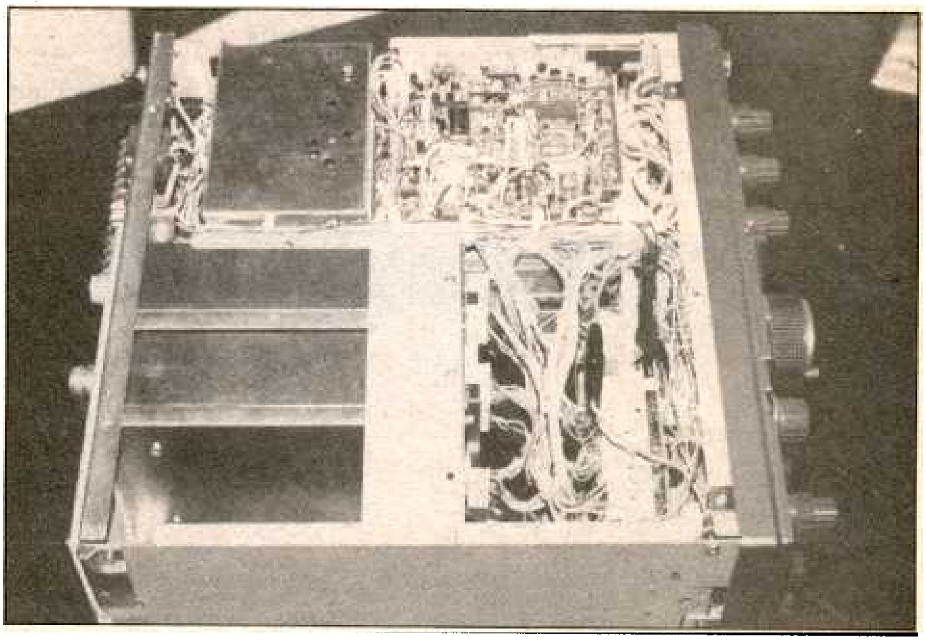
I do not want to bore the reader by detailing the facilities any further, so suffice it to say that it provides almost every requirement except preparing coffee (or beer), although one could possibly fix this too! But how did it all work out in practice?

I used the rig on and off for several weeks, and found the RF performance to be very good in almost all areas. On 2m for example, I found the VFO to be smooth and convenient for SSB/CW, but I preferred to use the channel click switch on 12.5 or 25KHZ spacings for FM; however, just occasionally I used the VFO for FM to cope with the very occasional station who insisted on using 10KHz offsets. Scanning worked superbly well either from the mic or rig, and in the pause mode it stopped for just about the right time for me to decide whether to stop it or not.

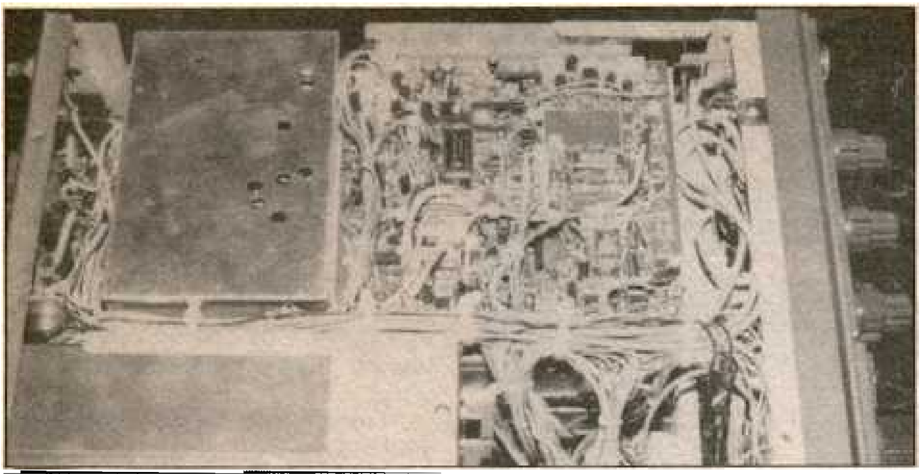
The facility for transferring from memory to VFO is marvellous, allowing you to return at an instant to a calling frequency, or beacon, and then VFO from it. RF input sensitivity was excellent on 6m, and good, but not outstanding, on 2m and 70cm. The RIFM performance was good on all three bands, and so an RF preamp external to the rig could be used quite frequently, provided that nobody was belting RF at me within very close range! Selectively on all modes was most certainly better than average, coping well with 12.5KHz spacing on FM for example, whilst the CW narrow optional filter was most useful, although I would have preferred a slightly flatter top and steeper skirts.

Transmitted audio was particularly good on all modes, but you will need to watch the position of the power control on SSB, for strange things seem to happen when this was advanced beyond the point where ALC is just beginning to act. A number of stations reported that not only was I producing audible clicks on transients up to 50KHz either side of the transmission on 2m, but there was a tendency to roughness on the channel. These transcient clicks could muck up somebody else's DX QSO. I had to reduce the power control to half way before the clicks virtually went, so clearly the module itself had too much gain. After correction, the PEP reading had only reduced by 0.5dB, so no significant peak power was lost.

Other 726 users that I contacted did not have this clicking problem, so presumably my 2m module was slightly faulty. I much prefer a power control which starts cutting back almost from the mo-



Bottom view of FT726R. VFO (in screened box) top LHS. Receive board top RHS. 2m and 70cm modules centre and lower LS.



Close up of VFO and Receive PCB.

ment of turning down from maximum.

The compressor action was almost inaudible unless I was being received extremely weakly, and in a way this is a good point since it was not obvious when I was using the compressor at all. I would have preferred, though, to have the availability of more control on the degree of compression and clipping.

Received audio was definitely better than average on FM, although I have heard better. On SSB however, the audio just did not seem clean, for whilst a continuous tone was acceptable, but not good, speech transient seemed to be surprisingly rough from stations that I know always put out very clean sounding signals as heard on my normal station equipment. I suggest that something is not quite right with the attack time of the AGC, or the transcient performance of the product detector. Other 726 users tended to agree on this.

I would also have preferred a better quality built-in speaker on such an expensive rig, for it is often inconvenient to use an external one. An external speaker improved matters, but I would have liked a little more power reserve when using the rig in the open air as a demonstration station.

The IF shift and bandwidth controls are easy to use. I tuned the receiver over the entire width of each band and to my amazement found only one minute spurious tone equivalent to around 0.05uV on 50.926MHz, which I don't think could possibly worry anyone. This is outstandingly good, especially because of the rig's complexity. Oh yes, I almost forgot, I particularly liked the power variation facility — which could be set to give as low as a few mW of RF output on all modes.

All the repeater normal and reverse shifts operated perfectly, reverse repeater being extremely useful, especially on 70cm.

Hot Stuff

The large heat sink on the back left hand corner does get very hot, so you will need to allow plenty of air behind the rig on your bench. I can't see you using this rig in the car unless you have a ginormous parcel shelf, but it would be fabulous for Field day.

I have a personal prejudice against plastic bodies and front panels, and I would have much preferred this machine to have a nice shiny metal front rather than its plastic one which could become rather tatty after a while.

The front panel layout could have been better thought out; for example, would it not have been better to have the RF gain with the AF gain, and the squelch with the tone? The up and down band buttons are very inconveniently positioned, and I would have preferred these much higher up.

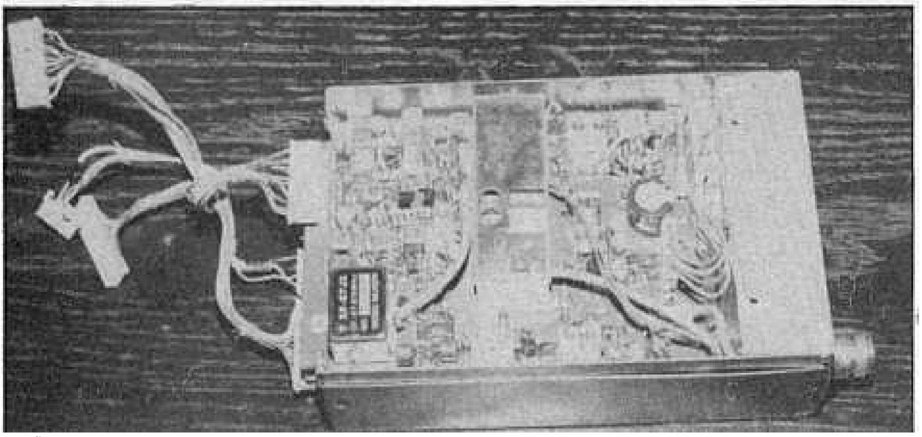
Many have found the satellite duplex provision to be quite awkward to use, but I would have thought that after a few times most users would find the procedures almost instinctive, although it is not always clear what the frequency readout is indicating during setting up this mode.

Laboratory Tests

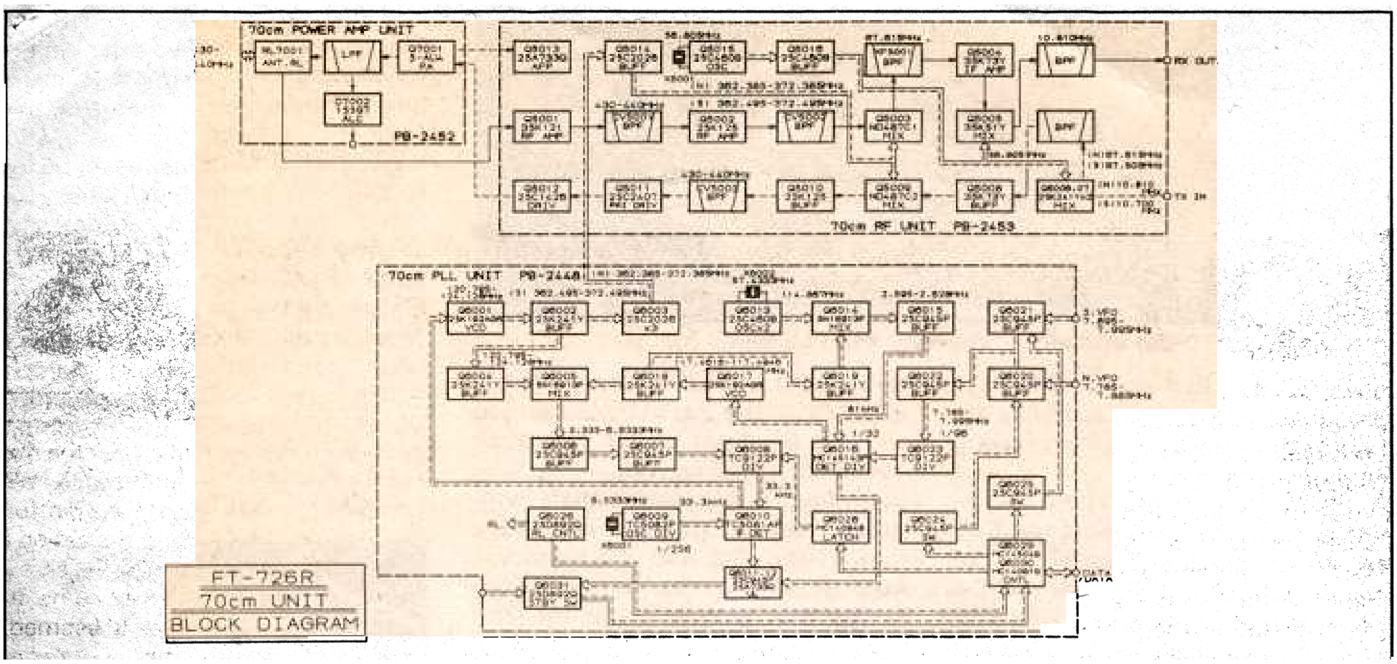
Looking over all the vast array of figures from the lab. tests, we can see that the RF sensitivity on all bands is better than average on both FM and SSB, although not quite 'state-of-the-art'. I am particularly impressed with the 70cm performance, as normally one would expect it to be slightly worse than that on 2m. The SSB performance was virtually identical to that of FM, the CW narrow bandwidth with the optional filter of course giving more sensitivity still.

Two-tone radio frequency intermodulation (RFIM) on each of the bands. All the results were reasonably good on 6m, very good on 2m and excellent on 70cm in comparison with other raw black boxes. I gain the impression that Yaesu designers have at last realised the importance of giving a good RFIM performance combined with a good sensitivity, although they could have achieved even better, as was shown in the recent IC251E/Mutek review.

In practice, I did not on any occasion hear any IM products developed from stations outside the 2m band, no problems being noted from the hundreds of police transmitters around my area, which are above 146MHz. Very strong signals on SSB caused no serious problems quite close to a received



70cm module — showing the RF circuitry.



FT-726R 70cm UNIT BLOCK DIAGRAM

frequency provided that the adjacent signals were themselves clean.

Selectivity

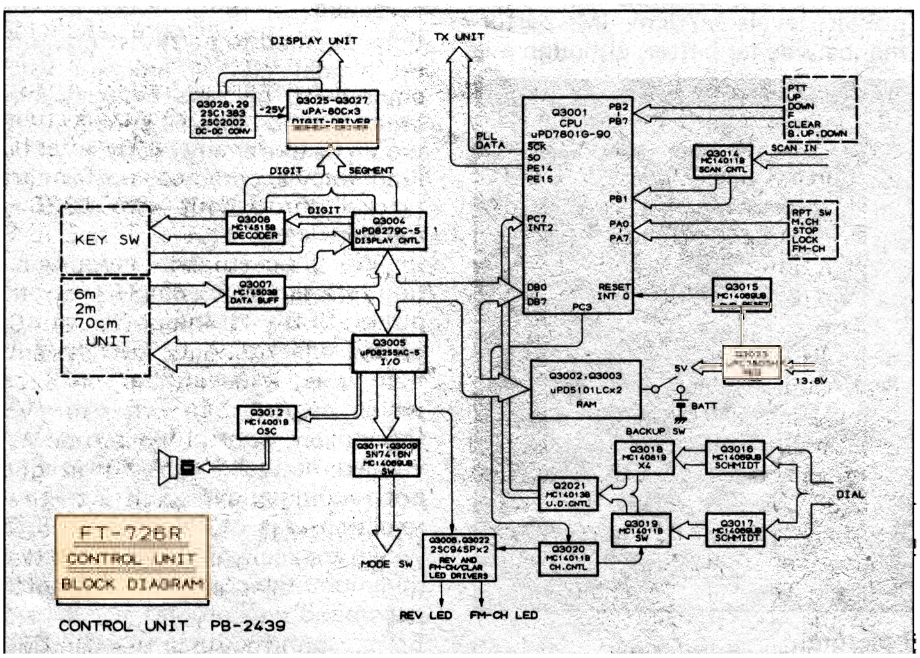
The selectivity on all bands on FM was very slightly lopsided, but very good on 12.5kHz channelling and superb on 25kHz channelling. On SSB the 3dB bandwidth was just about right, the skirts being quite sharp down to −60dB, thus giving a very good shape factor. The passband ripple was minimal on the SSB filter, thus helping received audio to be better than on the IC251E. I quite liked the optional CW narrow filter for it did have less loss than usual, although its shape was not ideal.

The S-meter on FM offers a very poor performance from S3 to 9+20dB, the actual difference being only round 10dB between these points. On SSB and CW the S-meter scale covers a far greater range, and this is very useful.

Frequency Accurancy

We checked frequency accuracy on receive on both SSB and CW. The 50MHz band was excellent, whereas 2m and 70cm were up to only 300Hz out. The intended frequency is that indicated when a carrier is zero beat on SSB, but with a beat note of 700Hz on CW. This CW offset could be annoying for some users whilst convenient for others and I cannot really show any preference in the case of the 726. I was a little annoyed by a slight shift from USB to LSB on SSB of 100Hz. We used our Marconi 2019 generator with an external standard synchronised to Rugby on 60kHz for checking frequency accuracy. On FM best SINAD was always obtained right on channel which shows excellent alignment of the discriminator.

The reciprocal mixing performance was checked 20kHz and 100kHz off channel on 6m and 2m, and just as 100kHz off, on 70cm, since my lab. equipment is itself not good enough for testing this parameter close in on UHF, and there is no point in quoting meaningless readings. I am just slightly unhappy with the 20kHz figures for they show some synthesiser noise present on the local oscillator, the ratio between noise and reciprocal mixing level averaging at 94dB (82dB ref. 12dB SINAD point). This figure is certainly not bad, though, and better than many other rigs, but what is rather fascinating is the exceptionally good figure on the same two bands at 100kHz spacing, 6m representing an overall dynamic range from this parameter of 110dB, and 2m being around 104dB. I am not altogether happy about some crictics giving receiver dynamic range calculated just from the reciprocal mixing ratio for, as you can see, the figure depends upon how near the carrier you get to make the measurement. The



FT-726R CONTROL UNIT BLOCK DIAGRAM

CONTROL UNIT PB-2439

Other side of 70 cm module — showing the PLL unit.

main receiver IF is at 10.8MHz approximately, the three modules acting as transverters, 70cm having an extra higher IF.

We looked at the static distortion of the product detector on SSB and the discriminator on FM for an audio output level of 125mW. On both modes the distortion was a little high, but whilst FM was acceptable, the SSB measurement did not correlate with the audible transient distoration on speech, whereas ordinary carriers sounded moderately clean, this showing that the AGC attack time was not quite right, and/or there was possibly insufficient overload margin in the entire IF chain to accomodate transients before the AGC could take hold. Fast AGC as very fast indeed, whilst slow AGC is just about how I like it, full recovery taking many seconds. The maximum available output from the rig into 8 ohms was about average and I really would like to see more available.

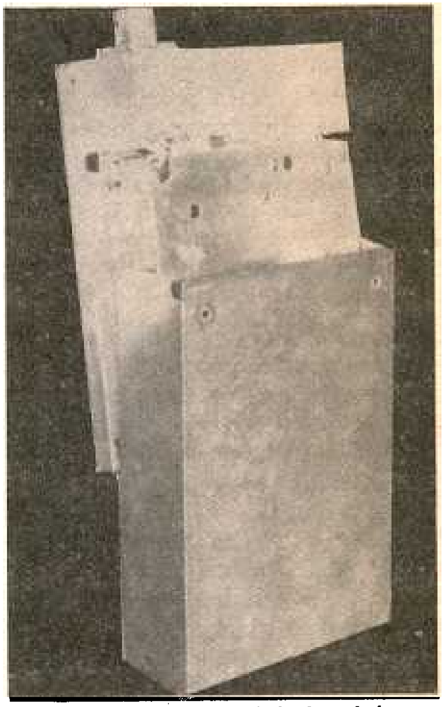
Output Powers

We checked FM, SSB and CW output powers on all three modules, and whilst I was happy with 6m and 70cm, the 2m module seemed to have been set up for too much available output power, which was confirmed in subjective trials with golden eared listeners! We had a look at the 2nd and 3rd harmonic outputs on all the bands and the only one that worries me is the 2nd harmonic of 52MHz at −59dB, which of course is well within Band II. When the band is opened up to 104MHz in the next few years, we shall have to pay very close attention to 2nd harmonic distortion if we get 50MHz; this should not be a major problem but just a nuisance, because we will all need good output filters.

We carried out two tone IM tests at two power levels on each of three bands. The 6m results were good for a black box, the higher orders falling down well below the lower orders quite rapidly. At lower power levels the IM performance was excellent. On 2m at high power levels, higher order harmonics were worse than they should have been, and these did not fall rapidly enough at lower power levels. 70cm IM performance was far better, although it is odd that the third order product at low levels was higher than I might have expected it, although not of any concern. Note that the two tone PEP levels are somewhat lower than those for speech, as the former was continuous, whilst the latter represented transients.

Optional satellite unit (PCB in centre of picture).

The deviation level of the tone burst of all frequencies was slightly high, but absolute peaks of modulation very high when measured with wide bandwidth on a Marconi 2305 peak reading deviation meter. In practice, the maximum deviation seemed full but not excessive within a communication bandwidth, but high total deviations seemed to be rather common on almost all FM amateur radio equipment, perhaps because very steep audio filters above 2kHz would be extremely costly to instal. Frequency accuracy coincided pretty well throughout with received frequencies.



Each VHF/UHF module is triple screened.

We checked the carrier rejection referred to full single tone output on SSB with the power control on the onset of ALC. Carrier rejection was excellent at −60dB, which degraded to −51dB when the power control was fully advanced, so well into ALC, which is not recommended. SSB side-band rejection was better than −49dB, which is excellent. With mic gain at minimum, the noise within the filter pass-band was around −70dB per 50Hz bandwidth, which thus shows 52dB dynamic range after the gain control. Noise at + or − 5kHz from the carrier was below − 90dB within a 50Hz bandwidth, which is excellent.

Conclusions

There can be no doubt that this is an amazing new box. It seems unique in having so many bells and whistles, almost all which are most useful, although I personally would not use the programmable abnormal repeater shift function. It is certainly recommendable, and although it is very expensive, three separate multi-band rigs would cost a lot more. I also very much enjoyed using it, and I do appreciate that many readers will regard some of my minor criticisms as niggles, but I feel that they are all worth pointing out. The two worst points are probably the 2m SSB transmit performance (probably a sample fault) and the general SSB received distortion, presumably due to insufficient clipping margin in the final IFs before the product detector, perhaps in combination with an insufficiently fast AGC attack time on long AGC.

Yaesu are to be congratulated for producing such a wonder box, and it is not surprising that so many people have already purchased it, despite its cost, thus proving that there are many amateurs prepared to dig deeply into their pockets to put all their eggs in one basket. There is so much that is right about this rig, the tuning ergomonics and memory facilities being excellent.

Quite often the first production of a new rig has teething problems, and the review sample was an early one. So frequently Japanese manufacturers improve some of the early problem areas in later production, and this will probably occur in the case of the FT726, which is now way beyond the early production stage. I have just received news of a new module covering 21, 24 and 28 to 30MHz, which will give 10W output, and contain switchable 100kHz repeater shift, thus allowing one to access US 10m repeaters. This gilds the lily, and I really look forward to trying the new module when it arrives one day.

I found the instruction book excellent, and well up to the high Yaesu standard. The equipment was very well put together, and it is possible to work on the modules as the connecting leads are reasonably long to assist in this. I would like to thank SMC for providing the rig for review, including the one and only 6m module at the time of writing, and also my colleage Simon Roberts, G8UQX, and many friends who have helped me with all the measurements and subjective evaluations.

RECEIVER MEASUREMENTS

Sensitivity FM

Rf level (in uV pd) for 12dB SINAD; 1kHz modulation, 4kHz deviation.

@ 432.000MHz	0.14
@ 435.000MHz	0.14
@ 439.000MHz	0.13
@ 144.000MHz	0.14
@ 145.000MHz	0.14
@ 145.975MHz	0.13
@ 50.000MHZ	0.12
@ 52.000MHz	0.1
@ 54.000MHz	0.13

Sensitivity, USB

RF level (in uV pd) for 12dB SINAD; 1kHz modulation,

@ 432.000MHz	0.14
@ 435.000MHZ	0.14
@ 439.000MHz	0.13
@ 144.000MHz	0.14
@ 145.000MHZ	0.14
@ 145.975MHz	0.13
@ 50.000MHz	0.11
@ 52.000MHz	0.12
@ 54.000MHZ	0.14

Selectivity, FM

Ration of on channel signal to off channel interfering signal (in dB), to degrade SINAD 3dB. Interfering signal high/low of on-channel.

@ 12.5kHz offset	66.5/43.5
@ 25 kHz offset	78 /77
@ 50 kHz offset	78.5/78.5

Selectivity, USB

3dB bandwidth (kHz)	2.0
60dB bandwidth (kHz)	2.4
60dB bandwidth (kHz)	3.5

Shape factor (60dB Bw/3dB Bw) 1.8

Selectivity, CW (with optional narrow filter)

3dB bandwidth (kHz)	0.24
6dB bandwidth (kHz)	0.62
60dB bandwidth (kHz)	1.15

Shape factor 4.8

S meter calibration

Rf levels (uV pd) (@ 145 MHz) on FM/SSB to give the following readings:

S1	0.3/ 0.5
S3	1.4/ 1.2
S5	2.1/ 2.2
S7	2.7/ 3.8
S9	3.2/ 5.9
S9 + 20dB	4.7/ 35
S9 + 40dB	6.7/ 316
S9 + 60dB	10.0/3300

RF intermodulation distortion, FM

RF levels at the quoted offsets to give 12dB

SINAD/S5 products at the quoted frequencies:

435MHz

+25, +50kHz	2.3/3.5
+100, +200kHz	1.5/3.3

145MHz

+25, +50kHz	1.1/2.7
+100, +200kHz	1.1/2.4

52MHz

+25, +50kHz	0.5/1.5
+100, +200kHz	0.5/1.5

RF intermodulation distortion, USB

RF levels (mV pd) at the quoted offsets to give S5 product at the quoted frequencies:

435MHz

+25, +50kHZ	4.2
+100, +200kHz	4.0

145MHz

+25, +50kHz	3.3
+100, +200kHz	3.7

52MHz

+25, +50kHz	2.3
+100, +200kHz	2.3

Reciprocal mixing performance

Levels (mV pd) @ +20 & +100kHz to degrade SINAD on USB by 3dB.

@ 435MHz	- /3.3
@ 145MHz	1.0/5.3
@ 52MHz	1.8/9.8

Accuracy of frequency display on USB RX (Hz)

@ 425MHz	+200
@ 145MHz	+200
@ 52MHZ	0

Distortion

with 125mW audio output into 8 ohms

FM/SSB (%)	5.1/2.8

Audio output power

@ 10% THD (W)	2.3

TRANSMITTER MEASUREMENTS

Maximum Power Output

FM (W)/USB (W PEP)/CW (W)

432MHz	12.8/14/12.4
435MHz	13.2/14/12.9
439MHz	13.8/14/13.7
144MHz	12.5/20/12.3
145MHz	12.5/20/12.3
146MHz	12.4/20/12.2
50MHz	10.4/15/10.4
52MHz	10.3/15/10.2
54MHz	10.1/15/10.1

Harmonic, spurious output, FM

Levels of 2nd/3rd harmonics relative to full power (dBc) followed by level and offset (MHz) from carrier of worst spurious.

435MHz	−63/−68/−70
145MHz	−68/ −70/−60@+/−10.8MHz
52MHz	−59/−60/ −70

Intermodulation distortion

2.2kHz & 500Hz injected into mic. socket at equal levels. 3rd/5th/7th/11th/15th/19th order products given in dB relative to level of causatory tones.

435MHz

10W PEP output*	−25/−31/−41/−60/−70/−70
1W PEP output	−20/−40/−60/−70/−70/−70

145MHz

15W PEP output*	−27/−39/−42/−50/−54/−60
1W PEP output	−28/−45/−64/−70/−70/−70

52MHz

16W PEP output*	−23/−45/−42/−60/−70/−72
1W PEP output	−29/−48/−51/−80/−80/−80

Carrier level

With drive set so that ALC is just on threshold (dBc)	−60
With drive maximum (dBc)	−51

Unwanted sideband

(relative to wanted sideband) (dBc)	−40

FM deviation	**Maximum (kHz)**	**Tone burst (kHz)**
435MHz	7.5	5.1
145MHz	7.5	5.2
52MHz	7.3	5.2

Deviation figures are peak-to-peak ÷ 2 not RMS.