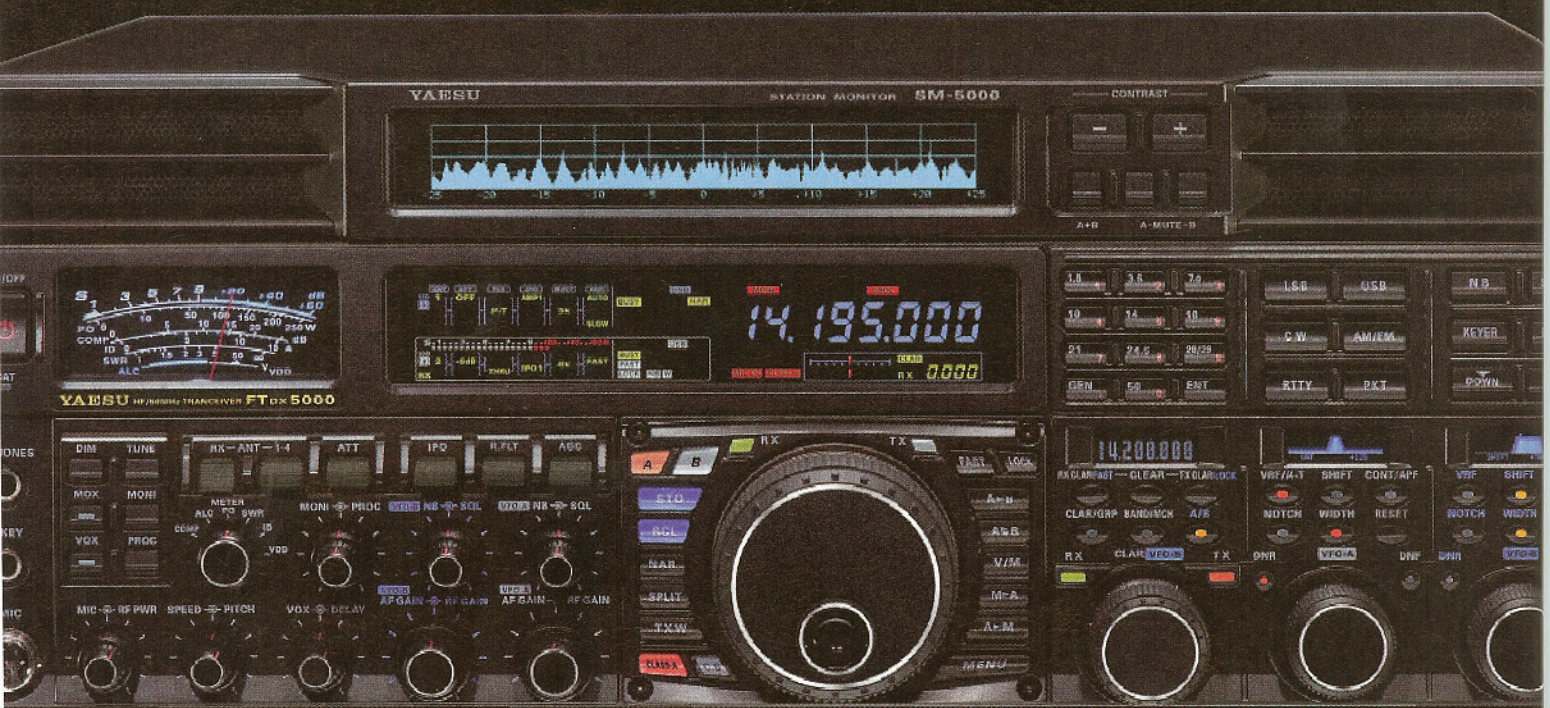
www.FTdx5000.com

Probably the very best endorsement of all;

"As a final postscript, I have been searching for some time for a new main station HF radio as my FT-1000MP is now 12 years old. I think I may have found it - roll on deliveries!!

Peter Hart, RadCom FTdx5000 Review, May 2010.



Last month Peter Hart reviewed the Perseus SDR Receiver and proclaimed to have found a new No.1 in receiver performance. The crown given to Perseus was short lived. The new FTdx5000 grabs the position, ahead of the Perseus SDR, Elecraft K3, Flex-5000, in that order.

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FTDX5000D HF + 6m transceiver

Yaesu's latest radio sets new performance standards.

The Yaesu FTDX5000 transceiver with SM-5000 Station Monitor look superb together.

INTRODUCTION. The FTDX5000 is Yaesu's latest transceiver, an elite class base station radio with a most impressive specification. Based on the FTDX9000 and FT-2000 models, Yaesu has clearly addressed feedback from users and reviewers to develop a radio with outstanding performance and user-friendly ergonomics. Both Ten-Tec with their Orion, and Elecraft with their K3 have been leading the pack for RF performance using down-conversion receiver architectures achieving exceptional levels of close-in dynamic range. Yaesu have now followed suit with a down conversion main receiver, their first for over 25 years, together with selectable high grade roofing filters.

This new model is available with three levels of fitted options. The FTDX5000 is the core radio common to all options. The FTDX5000D includes the separate SM-5000 station monitor that provides spectrum display and dual forward facing speakers. The FTDX5000MP also includes an oven stabilised reference oscillator and the narrowest 300Hz roofing filter. The extra roofing filter and station monitor can be added later to the basic core radio if desired.

The FTDX5000 covers the HF bands and 50MHz and is AC mains operated with a built-in PSU. Twin independent receivers are fitted that can operate on different bands, using different antennas. They can provide separate audio outputs. The transmitter provides 200W output.

The radio is currently undergoing CE qualification and will be available soon in Europe. I was fortunate, with the help of Martin Lynch, to gain access to an early non-CE model to conduct this review. There may be slight accessory or other detail differences for the CE qualified model but I would not expect these to alter the performance.

BASIC FUNCTIONS. The FTDX5000 is a substantial radio measuring 462mm (w) x 135mm (h) x 389mm (d) and it weighs about 21kg. It is somewhat larger and heavier than the FT-2000 but not as large or as heavy as the FTDX9000D. Both receivers tune continuously from 30kHz to 60MHz but the performance is only specified for the amateur bands. Individual buttons select the bands with a triple band stacking register where one of three last used combinations of frequency, mode and other settings is returned for each press of the band key. Separate sets are stored for each receiver. Individual buttons also select the usual modes with both sidebands available on CW, RTTY and PKT, and wide or narrow deviations on FM and FM-PKT.

The front panel is clearly laid out with virtually all functions available from dedicated controls of a good, manageable size. Both A- and B-receivers have separate and fully comprehensive controls for all filtering and signal processing functions and these are laid out in a logical way. The dual receivers, being fully independent through to stereo audio output, allow various diversity modes to be used.

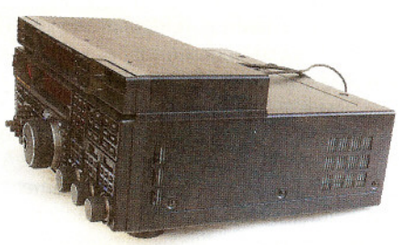
The main display is a multicoloured vacuum fluorescent type and there are three separate sub-displays. One indicates B-receiver frequency and the other two show the settings for channel bandwidth, shift, notch, contour etc for both the A- and B-receivers in graphical and numerical formats. This is a great improvement over the FT-2000. The S-meter for the A-receiver is a large analogue type and for the B-receiver it is a bargraph. Signal path functions for antenna, attenuator, amplifier, filter and AGC settings are portrayed as block diagrams. A handy tuning indicator is provided for accurate CW netting and both A and B frequencies are displayed to1Hz resolution. The displays and LED illuminations are rather dim but have a good viewing angle.

An extensive set-up menu system of 176 items allows for customisation of the various functions and features. This is particularly easy to set with comprehensive readout spread across the three sub-displays. As with other recent Yaesu radios, the built-in firmware is upgradeable. Full details are given on the Yaesu website and there have already been several code upgrades released.

The FTDX5000 can be used in conjunction with the DMU-2000 Data Management Unit that was first introduced for the FT-2000 and which can be connected at the same time as the SM-5000 station monitor. The sharp external μ-tune filters may also be connected.

There are four antenna sockets on the rear panel and additional sockets for separate receive antenna and separate receiver. Any combination of these may be selected for any band and either VFO. There are CW key jacks on both the front and rear panels and these may be configured independently for various internal or external keying options. A standard 8-pin microphone socket is located on the front panel and an MH-31 hand microphone is provided with the unit. An external remote control keypad, FH-2, is also provided and connects via the rear panel. This is used to control the CW memory keyer and voice stores.

Standard DIN connectors provide interfaces for Packet and RTTY purposes, band data for external ATUs and auto-bandswitched linears such as the VL-1000. Mini-DIN connectors provide interfaces to the SM-5000 or DMU, μ-tune filters and Yaesu rotators. Some Yaesu antenna rotators can be controlled from the radio front panel. An array of phono connectors provides PTT, linear control, ALC, audio recording jacks, microphone, transverter drive and other lines. One jack allows an external switch to output a tuning signal for linear amplifier or ATU tune-up independent of mode.



The SM-5000 sits neatly on top of the FTDX5000.

The rear panel holds an impressive array of connections yet is relatively uncluttered.

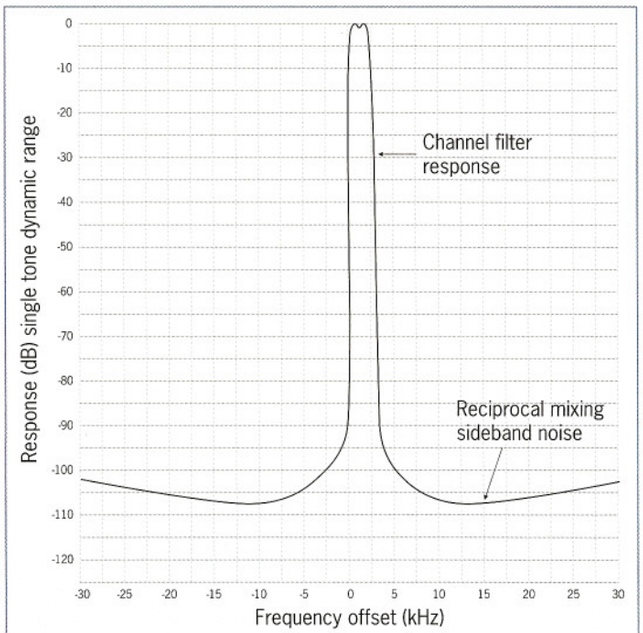


FIGURE 1: FTDX5000 composite selectivity curve on USB. Receiver bandwidth 2400Hz. Sharp response/medium slope. 3kHz roofing filter.

A transverter drive output at about –10dBm is available on the 14, 28 or 50MHz bands and the display can be offset over a limited range to indicate the last two MHz digits, eg '44' for 144MHz or '32' for 432MHz but other bands are not accommodated. The transverter receive path interfaces via the normal antenna connection. To avoid possible damage when not in transverter mode, this would best be connected to the receive-only antenna connection.

A 9-pin D connector interfaces directly to a PC serial COM port for computer control. Surely these days it would be better to provide a USB port for PC control and also allow audio for data modes and storage to be interfaced to a computer this way? Technology has moved on, not many new PCs have serial ports now but so far only Icom have moved with the times.

RADIO DESIGN AND ARCHITECTURE. The main receiver in the FTDX5000 using VFO-A adopts a down-conversion double superhet architecture with a first IF of 9MHz and a second IF of 30kHz, directly feeding the DSP for all further signal processing. There are five selectable roofing filters at the first IF with bandwidths of 300Hz, 600Hz and 3kHz using high-grade 6-pole filters, and 6kHz and 15kHz using 4 pole monolithic filters. The 300Hz filter is fitted as standard into the MP model and an optional extra for the others. A 32 bit DSP is used to provide all IF channel filtering, demodulation, noise reduction, audio processing and AGC functions.

The A-receiver front end has two switchable bipolar RF preamplifiers for high or low gain and two levels of straight mixer feed (IPO1 and IPO2) for best strong signal performance. The amplifiers are not selectable below 1.7MHz. Three levels of attenuation may also be inserted. There are 15 input bandpass filters covering the total frequency range of the receiver and a sharply tuned preselector, VRF, for each of the amateur bands except 50MHz. The VRF filters are preset to the centre of the bands but may be manually tuned by a front panel control. The first mixer uses 8 dual-gate FETs in a D quad double balanced configuration for high dynamic range. An IF output prior to the roofing filter is made available for external use such as for spectrum scans and monitoring based on SDR receivers.

The second or sub receiver using VFO-B is an up-conversion triple superhet with IFs of 40.455MHz, 455kHz and 30kHz and feeds a separate, identical DSP for remaining processing. The same DSP processing functions are provided for both A- and B-receivers. 15kHz, 6kHz and 3kHz roofing filters are fitted at the first IF and there is some additional selectivity at the second IF. The B-receiver front-end also contains two preamplifiers for use above 1.7MHz, one level of straight mixer feed (IPO1), 8 input bandpass filters and a separate VRF sharply tuned preselector. The first mixer uses 4 dual-gate FETs in a double balanced configuration.

An oven-stabilised 0.05ppm reference is fitted into the MP version, and a 0.5ppm TCXO into the other models, ensuring excellent frequency accuracy and stability. The various local oscillator feeds and signal sources are derived directly from DDS chips (mainly AD9951) without the usual PLLs. This can result in much better phase noise performance but low-level spurious outputs can be a problem.

The transmitter uses the B-receiver frequency scheme in reverse - 30kHz / 455kHz / 40.455MHz to final frequency. The power amplifier runs from 50V DC, delivering 200W output from a pair of VR150 FETs.

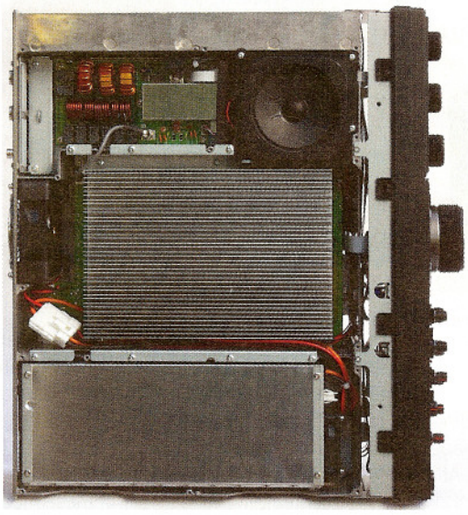
The radio is solidly constructed in typical Yaesu style using a substantial diecast frame on which the circuit boards are mounted, as is the wrap-around case. A single, reasonably sized 8cm speaker fits in the case top. The transmitter PA is fitted with a large finned heatsink and a single fan on the rear cools the unit. This only operates when the temperature rises and is very quiet in operation. Extensible front feet tilt the front panel to improve visibility and operating ease but no carrying handles are fitted.

RECEIVE FEATURES. Most of the receiver functions are similar to the FT-2000 and FTDX9000 but are in general more logically accessed and presented. The radio is fitted with an excellent main tuning drive, 60mm in diameter, with weighted flywheel action and adjustable drag. With 1000 steps per revolution and 10Hz steps it combines precise tuning with fast frequency navigation. 1Hz and 5Hz steps are also selectable with faster rates and different rates on AM and FM. A separate and rather small tuning knob sets the frequency of VFO B, with 1000 steps per revolution. This knob is multifunction, also providing clarifier, memory channel selection and stepping by bands. With band stepping you can skip bands, customising band access (termed MYBANDS) and access transverter operation. The frequency can also be entered directly through the band buttons. The radio provides the usual Yaesu Quick Split feature and TXW for quick monitoring and tuning the transmit frequency during split frequency operation.

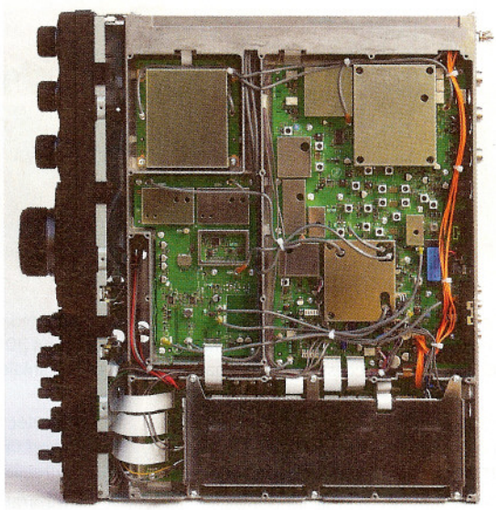
There are 99 regular memory channels that also store virtually every receiver setting. Up to six memory groups can be set up but labels are not used. A further nine memory channels hold programmable scan limits, and the usual scan facilities are provided. Another five provide the normal quick access memory bank feature. The US version accesses 60m channels via a separate set of memory channels and

I guess the UK version will do likewise, as is implemented in the FT-2000.

Three AGC speeds are selectable, each programmable in terms of hang time and decay time over wide limits including sloped AGC operation. Sloped AGC allows the audio volume to rise and fall according to signal level. The IF channel bandwidth is adjustable over wide limits, from 200Hz to 4000Hz on SSB, 50Hz to 2400Hz on CW and data modes, 6kHz or 9kHz on AM and 9kHz or 16kHz on FM. A 'Narrow' button selects a narrower bandwidth setting for each mode and the overall filter shape factor and roll-off transition may be tailored. There is the usual IF shift control and on CW a sharp audio filter may be selected. On voice modes, the Yaesu Contour filtering system allows a shallow notch or peak to be rolled over the filter passband, which can enhance readability in some situations. The depth and width of the contour notch/peak is adjustable from the set-up menu. An IF noise blanker is provided removing either short or long duration pulses and the level is adjustable from the front panel. A tuneable IF notch is provided with wide or narrow width setting and a separate digital auto notch. Digital noise reduction with 15 different digital noise reduction algorithms is also provided. Operation of the Contour filter and tuneable IF notch is particularly easy to view if the DMU-2000 accessory is connected.



Top view with covers removed showing filters, TX PA and power supply.



FTDX5000 underneath view with covers removed showing the main RF boards and synthesisers.

TRANSMIT FEATURES. The transmitter contains a 200W power amplifier, reducible down to about 10W. It has a Class A setting for low distortion operation on SSB at a maximum power level of 75W output. VOX, speech processor and a transmission monitor are provided on voice modes and the transmission bandwidth can be adjusted to provide for either higher fidelity or for lower bandwidth, higher talk power, contest operation. A highly configurable three-band parametric microphone equaliser is also included which will adapt to a wide range of microphone characteristics.

On CW there is the usual provision for full and semi break-in and a spot key for accurate netting with a front panel pitch control. The rise and fall times of the CW keying envelope are settable from 1 to 6ms. Switching between semi and full break-in requires menu access but semi break-in drop back delay is adjustable from the front panel control. A full CW message keyer is included with some useful features for contest operation. The keyer operates over the range 4 – 60 WPM with adjustable weighting and a variety of keying paddle arrangements. 5 memories will store 50 characters each with a provision to send automatically incrementing serial numbers and auto-repeat after a time delay in beacon mode. The message stores are programmed either using the keying paddle or in text from front panel controls or FH-2 remote keypad. Control of the keyer and message playback is via the keypad.

A digital voice memory is also provided controlled via the FH-2 keypad. Useful for SSB contest operation, there are five stores each holding up to 20 seconds of voice messages. The voice store can also be used on receive to record the last 15 seconds of audio, perhaps to confirm a missed callsign or serial number.

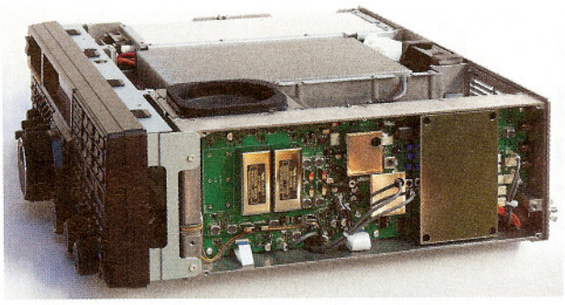
The radio includes a built-in auto ATU operating only on transmit over the bands 1.8 to 50MHz and will tune antennas with up to 3:1 VSWR. 100 memories store tuning settings to enable rapid and accurate reselection. Metering on transmit uses the analogue meter and indicates power output, SWR, ALC, compressor level, PA voltage or drain current. FM operation allows for separately configured shifts for 28MHz and 50MHz repeaters and includes a CTCSS tone encoder/decoder.

SM-5000 STATION MONITOR. The SM-5000 station monitor sits on top of the case, adding about 45mm to the height and connects via three lines on the rear panel. It provides a spectrum display and contains dual forward facing speakers to provide stereo outputs from the two receivers or mixed outputs as desired. There are four settings for sound quality and a phase inversion setting that claims to add depth to the sound.

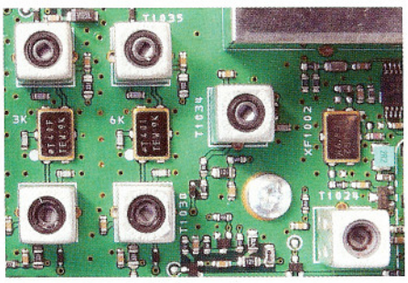
The spectrum display operates on the A-receiver and has a displayed range of 80dB. There are three basic modes of operation. In the FIX mode it will scan between two fixed points, separately programmable for each band. In the CTR mode it will scan a range either side of the receiver frequency with selections from ±25kHz to ±2500kHz. The Limited Bandwidth Sweep mode narrows down on the CTR mode to increase the scanning speed and reduce time delays.

MEASUREMENTS. The full set of measurements is given in the table for the main A-receiver with the 3kHz roofing filter selected in most cases unless otherwise stated. Compared with the no amplifier IPO1 setting, the two receiver preamplifiers showed gains of 12dB and 23dB, and the IPO2 setting a loss of 11dB. This is reflected in the sensitivity, S-meter calibration and dynamic range measurements. The receiver is very sensitive, particularly with amplifier 2. It is largely the same with the different roofing filters or with VRF in circuit but is 3dB lower with both receivers enabled. Sensitivity reduces just a little at lower frequencies to 2μV at 136kHz. The S-meter calibration closely followed 3dB per S-unit and was very linear up to at least S9+40. The B-receiver sensitivity was very similar and its S-meter read about 4dB lower than the main receiver.

The 9MHz IF rejection on most bands was greater than 100dB, but on 10MHz it was only 54dB, and on 7MHz it was 74dB. VRF front-end tuning improved these figures by 20dB. The first mixer image was only down by 55dB to 70dB but VRF improved this to better than 75dB. The B-receiver generally measured rather better on these figures with IF and image responses down by over 80dB. Spurs on the synthesiser resulted in a number of unwanted receiver responses, notably at approx ±425kHz from the received frequency at only 65dB



Removing the internal side shield reveals receiver A, mounted on the right side of the radio. The roofing filters (space for fitting 300Hz left) are readily accessible via a small hatch in the side shield.



Roofing filters in the B-receiver.

down on the A-receiver (90dB down on the B-receiver) and at ±40kHz down by 85dB. VRF improves these figures but only marginally on the higher bands.

The AGC performance of both receivers was generally quite clean and decay times reasonably close to the menu set values. A slight hole was observed in the attack response but is much better overall in this respect than the FT-2000 and FT-950 series of radios.

Third order intercept, dynamic range and blocking figures were outstanding with the appropriate roofing filters selected. With 108dB dynamic range in 500Hz CW bandwidth at 1kHz spacing, this is the best close-in figure I have measured for any radio. In IPO2 setting the 3rd order intercept was in excess of +45dBm but with reduced sensitivity the dynamic range was no higher than in IPO1 setting. Reciprocal mixing results were also superb, at least equal to the best I have ever measured, and exhibited a somewhat unconventional characteristic, gradually worsening away from the carrier. As a consequence of the excellent reciprocal mixing results, it was possible to measure at least 80dB down the channel filter skirts and showed that the DSP IF filters were excellent, some of the tightest figures measured for any radio. **Figure 1** shows the composite selectivity curve.

In my league table of receiver performance, based on close-in dynamic range, the FTDX5000 now sits at the number 1 position, ousting the Perseus SDR, Elecraft K3 and Flex-5000 into positions 2, 3 and 4 respectively.

The B-receiver dynamic range is not quite as good as the A-receiver but is still very respectable. 3rd order intercept measured +21dBm in the IPO1 setting outside of the roofing filter bandwidth and about 10dB less dynamic range than the A-receiver. Reciprocal mixing figures were 7dB worse close-in but rather better than the A-receiver further out.

On transmit, two-tone distortion products are generally quite low in Class AB and even lower in Class A. The processor adds some close-in distortion but negligible increase further out and distortion degraded very markedly with overdrive, so keep well within the ALC limit. Harmonic outputs were exceptionally low. The auto ATU introduced negligible loss and the power meter reading was fairly accurate. CW rise and fall shapes were clean with negligible distortion. At 40 WPM there was slight character shortening in full break-in mode but this was negligible with semi-break-in. AM transmit was clean with low distortion.

ON-THE-AIR PERFORMANCE. The FTDX5000 is an impressive-looking radio with a large number of front panel controls. However, the controls are very logical and learning time with the manual is kept to a minimum. As with all Yaesu manuals, descriptions are clear and comprehensive but there are a number of small errors in this early manual release. Control placement and size is excellent but the display and button illuminators in particular are difficult to see under bright lighting. The SM-5000 display is particularly dim. The right hand audio gain knob controls the left hand (A) channel and the left hand knob controls the right hand (B) channel, which is somewhat illogical.

The receiver performed extremely well under both weak and strong signal conditions. The filters were excellent and even at 50Hz bandwidth there was minimal ringing on CW. The notches were excellent, deep, and the auto-notch was fast acting. Digital noise reduction seemed quite aggressive and was effective in some situations as also was the Contour filtering. The audio quality with the internal speaker was good but better and more effective through the SM-5000. I found the Loudness setting gave the best overall sound. With a single receiver channel the audio is shared between both SM-5000 speakers. The phase inversion setting, which puts the two speakers in antiphase, resulted in lack of bass and an acoustic interference pattern as you move in front of the speakers that I found fatiguing. This is not surprising as it goes against all the rules on setting up stereo hi-fi speakers.

I searched for incidences of spurious signal breakthrough at 425kHz off-channel. I could just detect on 7005kHz a broadcast station on 7430kHz running 40 to 50dB over S9 during the evening. No other stations were strong enough for spurii to be heard. To put this into perspective, this is unlikely to cause a problem in practice as the number of such strong signals 425kHz away from the amateur bands is quite small. The VRF preselector should be used if such interference is suspected.

While carrying out the measurements I found that the two receivers, when set nominally to the same frequency (by pressing A=>B), were not quite on the same frequency but differed by a very small amount: about 0.2Hz on SSB and rather less than this on CW. This will however destroy any phase coherence in certain diversity modes and hence the effectiveness of these modes.

The spectrum display on the SM-5000 is quite useful but there is a noticeable delay when tuning in CTR mode and, like all other conventional radios, it is not up to the resolution available on SDR receivers. A combination of FTDX5000 with an SDR on the 9MHz IF output would be a most interesting combination, particularly if coupled with point and click tuning.

The AGC performance under noisy conditions was much better than earlier DSP radios. I found memory operation rather cumbersome compared with many other radios, with rather more button pressing needed. LF performance was clean but a little less sensitive than some other radios and broadcast band performance was generally excellent.

On transmit, audio quality was quite reasonable using the supplied microphone but noticeably better using my Heil. However, it is most important not to overdrive and to keep compression to a minimum. CW keying was clean; there was a slight thump on changeover, which was not distractive.

CONCLUSIONS. The FTDX5000 is a most impressive radio with an excellent set of features, excellent ergonomics and the highest close-in dynamic range of any radio to date. The only area for concern is the receiver spurious signal rejection. With so much effort to achieve unparalleled close-in performance, it is a shame that the out of band receiver spurious responses are not somewhat better. However, the real consequences of this are somewhat unproven.

With a top of the range price tag we will have to wait a little longer for the unit to be available in Europe and the UK.

As a final postscript, I have been searching for some time for a new main station HF radio as my FT-1000MP is now 12 years old. I think I may have found it - roll on deliveries!!

ACKNOWLEDGEMENTS. I would like to express my gratitude to Martin Lynch & Sons for the loan of this radio. For further information please see www.ftdx5000.com.

TABLE 1: Yaesu FTDX5000 measured performance.

RECEIVER MEASUREMENTS, VFO-A

	SENSITIVITY SSB 10dBs+n:n			INPUT FOR S9		
FREQUENCY	IPO1	PREAMP 1	PREAMP 2	IPO1	PREAMP 1	PREAMP 2
1.8MHz	0.8μV (-109dBm)	0.2μV (-121dBm)	0.14μV (-124dBm)	125μV	32μV	10μV
3.5MHz	0.6μV (-111dBm)	0.16μV (-123dBm)	0.09μV (-128dBm)	140μV	35μV	10μV
7MHz	0.7μV (-110dBm)	0.18μV (-122dBm)	0.1μV (-127dBm)	140μV	35μV	10μV
10MHz	0.9μV (-108dBm)	0.22μV (-120dBm)	0.11μV (-126dBm)	140μV	35μV	10μV
14MHz	0.6μV (-111dBm)	0.18μV (-122dBm)	0.09μV (-128dBm)	140μV	35μV	10μV
18MHz	0.7μV (-110dBm)	0.18μV (-122dBm)	0.1μV (-127dBm)	140μV	35μV	10μV
21MHz	0.7μV (-110dBm)	0.18μV (-122dBm)	0.09μV (-128dBm)	140μV	35μV	10μV
24MHz	0.8μV (-109dBm)	0.2μV (-121dBm)	0.09μV (-128dBm)	140μV	35μV	10μV
28MHz	0.8μV (-109dBm)	0.2μV (-121dBm)	0.09μV (-128dBm)	140μV	35μV	10μV
50MHz	1.1μV (-106dBm)	0.3μV (-118dBm)	0.11μV (-126dBm)	140μV	35μV	8μV

AM sensitivity (28MHz) Preamp 1: 1.3μV for 10dBs+n:n at 30% mod depth
FM sensitivity (28MHz) Preamp 1: 0.4μV for 12dB SINAD 3kHz pk deviation
AGC threshold Preamp1: 2μV
100dB above AGC threshold for <1dB audio output increase
AGC attack time: 1-2ms
AGC decay time: approx as specified
Max audio at 1% distortion: 3.5W into 4Ω
Inband intermodulation products: -40 to -50dB

S-READING		BANDWIDTH/ROOF	BANDWIDTH			
(7MHz)	PREAMP 1	SET TO	-6dB	-60dB	-70dB	-80dB
S1	2.8μV	*2.4kHz/3kHz roof*				
S3	5.6μV	Steep	2507Hz	3044Hz	3101Hz	3142Hz
S5	8.9μV	Medium	2561Hz	3249Hz	3344Hz	3442Hz
S7	18μV	Gentle	2683Hz	3710Hz	3889Hz	4097Hz
S9	35μV	*500Hz/600Hz roof*				
S9+20	350μV	Steep	525Hz	660Hz	683Hz	767Hz
S9+40	3.5mV	Medium	535Hz	709Hz	745Hz	849Hz
S9+60	28mV	Gentle	558Hz	788Hz	852Hz	1020Hz

INTERMODULATION (15kHz tone spacing) 2400Hz bandwidth 6kHz roof USB

	IPO1		PREAMP 1		PREAMP 2	
Frequency	3rd order intercept	2 tone dynamic range	3rd order intercept	2 tone dynamic range	3rd order intercept	2 tone dynamic range
1.8MHz	+33dBm	101dB	+21dBm	101dB	+1dBm	90dB
3.5MHz	+34.5dBm	104dB	+22.5dBm	104dB	+11dBm	99dB
7MHz	+37.5dBm	105dB	+26dBm	105dB	+18dBm	103dB
14MHz	+36dBm	105dB	+24dBm	104dB	+12dBm	100dB
21MHz	+36dBm	104dB	+24dBm	104dB	+13dBm	101dB
28MHz	+35dBm	103dB	+22.5dBm	102dB	+12dBm	100dB
50MHz	+38dBm	103dB	+25dBm	102dB	+12dBm	99dB

CLOSE-IN INTERMODULATION ON 7MHz BAND 500Hz bandwidth CW IPO1

	15kHz ROOFING		6kHz ROOFING		3kHz ROOFING		600Hz ROOFING	
Spacing	3rd order intercept	2 tone dyn range	3rd order intercept	2 tone dyn range	3rd order intercept	2 tone dyn range	3rd order intercept	2 tone dyn range
0.5kHz	-8.5dBm	77dB	-8.5dBm	77dB	-5dBm	80dB	+30.5dBm	104dB
1kHz	-8.5dBm	77dB	-8.5dBm	77dB	+6.5dBm	88dB	+36.5dBm	108dB
1.5kHz	-8.5dBm	77dB	-8.5dBm	77dB	null	null	+37dBm	109dB
2kHz	-8.5dBm	77dB	-4dBm	80dB	+33.5dBm	106dB	+37dBm	109dB
3kHz	-8.5dBm	77dB	+3.5dBm	85dB	+36.5dBm	108dB	+38dBm	109dB
4kHz	-2.5dBm	81dB	+24.5dBm	99dB	+37dBm	108dB	+38dBm	109dB
5kHz	null	null	+39.5dBm	109dB	+38dBm	109dB	+38dBm	109dB
7kHz	+21.5dBm	97dB	+39dBm	109dB	+38dBm	109dB	+38dBm	109dB
10kHz	+38dBm	108dB	+39dBm	109dB	+38dBm	109dB	+38dBm	109dB
15kHz	+38dBm	108dB	+38dBm	108dB	+38dBm	109dB	+38dBm	109dB
20kHz	+38dBm	108dB	+38dBm	108dB	+38dBm	109dB	+38dBm	109dB

FREQUENCY	RECIPROCAL MIXING FOR 3dB NOISE 500Hz BW		BLOCKING AMP1		
OFFSET	VFO-A	VFO-B	15 kHz ROOF	6kHz ROOF	3kHz ROOF
0.5kHz	86dB	not meas	-32dBm	-32dBm	-32dBm
1kHz	96dB	89dB	-32dBm	-32dBm	-32dBm
2kHz	104dB	97dB	-32dBm	-32dBm	+6dBm
3kHz	107dB	100dB	-32dBm	-32dBm	+14dBm
5kHz	112dB	104dB	-32dBm	-15dBm	+14dBm
10kHz	114dB	108dB	0dBm	+14dBm	+14dBm
15kHz	112dB	109dB	+4dBm	+15dBm	+15dBm
20kHz	111dB	109dB	+13dBm	+15dBm	+15dBm
30kHz	106dB	109dB	+15dBm	+15dBm	+15dBm
50kHz	103dB	108dB	+15dBm	+15dBm	+15dBm
100kHz	98dB	106dB	+15dBm	+15dBm	+15dBm
200kHz	96dB	107dB	+15dBm	+15dBm	+15dBm

TRANSMITTER MEASUREMENTS

			INTERMOD. PRODUCTS		
FREQUENCY	CLASS AB POWER OUTPUT	CLASS A POWER OUTPUT	--CLASS AB-- 3rd/5th order	---CLASS A--- 3rd/5th order	HARMONICS
1.8MHz	200W	75W	-34/-46dB	-40/-56dB	<-70dB
3.5MHz	208W	76W	-40/-45dB	-40/-58dB	<-70dB
7MHz	202W	76W	-42/-44dB	-42/-54dB	<-70dB
10MHz	204W	76W	-43/-43dB	-42/-54dB	<-70dB
14MHz	204W	75W	-50/-50dB	-41/-56dB	<-70dB
18MHz	208W	77W	-34/-43dB	-40/-54dB	<-70dB
21MHz	208W	77W	-32/-47dB	-42/-54dB	<-70dB
24MHz	207W	76W	-36/-43dB	-38/-52dB	<-70dB
28MHz	205W	77W	-40/-44dB	-41/-55dB	<-70dB
50MHz	205W	76W	-30/-46dB	-40/-56dB	<-70dB

Intermodulation product levels are quoted with respect to PEP.

Microphone input sensitivity: 0.2mV for full output
FM deviation: 2kHz narrow / 4kHz wide
SSB T/R switch speed: mute-TX 40ms, TX-mute 4ms, mute-RX 60ms, RX-mute 4ms

NOTE:
All signal input voltages given as PD across antenna terminal. Unless stated otherwise, all measurements made on USB with receiver preamp switched out (IPO1), 2.4kHz IF bandwidth and 6kHz roofing filter.