Review

YAESU FTDX10

HF, 50 and 70MHz

The FTDX10 is the latest mid-range radio from Yaesu.

Following on the heels of the FTDX101, the FTDX10 employs much of the same design philosophy but in a smaller size and has a single receiver. The same high performance RF architecture is used, and a similar approach to the display screens and menu driven functions but at less than half the cost. It is a 12V operated radio covering 1.8 to 50MHz at 100W transmit output power and 50W on 70MHz.

The front panel of the FTDX10, the latest mid-range radio from Yaesu.

A substantial and well-shielded diecast frame and integral heatsink with a fan on the rear panel.

Basic functions

The FTDX10 measures 266mm(w) x 91mm(h) x 263mm(d) and weighs 5.9kg. This is much smaller than the FTDX101 and broadly similar to many other medium-sized radios. The receiver tunes from 30kHz to 75MHz and the transmitter is enabled on the amateur bands only. Full transmit coverage of the 5MHz band (5.250 – 5.406MHz) as well as 70MHz (70.0 – 70.5MHz) in the UK is not enabled at the factory but this is simple to achieve by appropriate button presses if not already done by the dealer. There is no provision for a low-level output to drive transverters or for LF band operation.

The usual modes are provided; SSB, CW, RTTY (FSK), PSK, AM and FM, with wide or narrow operation on AM and FM, reverse sidebands selectable on SSB, CW and RTTY and with AFSK data on SSB and FM. Twin VFOs (A/B) allow split operation with the ability to easily check and tune the transmit frequency via TXW.

The radio is provided with a power cable and a hand microphone. The SSM-75E mic is similar to that provided for the FTDX101 but is fitted with an RJ-45 connector. As well as up/down keys, the mic has an audio mute button and four function keys that provide alternative access to front panel buttons for switching between VFOs and memories. The instruction manual is fairly comprehensive and well written and runs to 120 pages, although some descriptions are a little thin. No circuit diagrams are included.

Radio design and architecture

The FTDX10 uses what Yaesu terms is a hybrid SDR architecture, similar to that used in the FTDX101. After front-end filtering, the signal is mixed down to an IF at 9MHz and passes through a narrow roofing filter. This is then sampled by an A/D converter and passes to the FPGA device. This extracts an IF signal at 24kHz by a process of decimation, which feeds the DSP. The 32-bit DSP provides all channel filtering, demodulation, noise reduction, audio processing and AGC functions. The spectrum scope operates as a direct digital sampling SDR taking its input after the front-end filtering immediately prior to the mixer. Processing of the spectrum scope is performed by the FPGA.

The front-end has 15 input bandpass filters covering the total frequency range of the receiver. 10 cover the amateur bands and 5 provide general coverage filtering. The FTDX10 does not use a preselector as used in the FTDX101. Two switchable preamps for 20dB or 10dB gain and three levels of input attenuation, 6/12/18dB, are available. The mixer uses eight dual-gate FETs in a D quad double balanced switch configuration for high dynamic range. Three roofing filters are fitted as standard with bandwidths of 500Hz, 3kHz and 12kHz and these can be selected manually or automatically according to mode but not by channel bandwidth. An optional 300Hz bandwidth filter is also available and is easy to fit.

The transmit signal is generated directly at final frequency from a 16-bit D/A converter and not through a mixer. It is then amplified through to the final PA that uses a Mitsubishi RD70HUP2 dual MOSFET. This device is primarily intended as a linear amplifier for Tetra VHF and UHF mobile radio at the 70W power level.

The local oscillator in the FTDX10 uses a similar structure to that adopted in the FTDX101. A high-resolution direct digital synthesiser is used operating at 250MHz and this is divided down to give the required frequency for the mixers. The FTDX101 synthesiser operates at 400MHz with a higher division ratio so in theory is capable of somewhat lower noise. The oscillator runs high of the signal frequency for bands below 30MHz and low for frequencies above. A 0.5ppm TCXO reference ensures high stability.

The radio is solidly constructed in typical Yaesu style using a substantial and well-shielded diecast frame and integral heatsink with a fan on the rear panel. This is very quiet and only operates when the temperature rises. A 65mm loudspeaker fits in the case top, but there is no internal shrouding. Extensible front feet tilt the front panel to improve visibility and operating ease and a wrap-around case completes the unit. A side-carrying handle is available as an accessory.

Front panel and controls

With the display occupying half of the front panel area, the space available for the conventional push buttons and rotary controls becomes quite

Top view with covers removed showing TX PA and ATU.

limited and, as a consequence, many functions are accessed from the touch-screen display and menu. The main tuning drive is 45mm diameter with adjustable torque and is supported by an outer tuning ring (MPVD). Three dual concentric rotary controls provide AF/RF gain and the bandwidth controls, width/shift, notch/APF/contour filtering. Other top-level functions are selected via pushbuttons. Single buttons select the band or mode via the touch-screen display with three separate combinations of frequency, mode and other settings available for each band. The 70MHz band is included under the general coverage button and is best stored to memory as it can be overwritten if other general coverage frequencies are later selected.

The main tuning drive has up to 1000 steps per revolution and the secondary (MPVD) up to 500 with step sizes of 1, 5 or 10Hz. Rapid tuning is performed by the MPVD ring in various mode dependant channel step sizes, and this can also set the IRT, memory channel, or provide a custom key setting. Tuning in 1MHz or 1kHz steps is achieved by touching the relevant digits on the display and the frequency may also be entered directly from a pop-up numeric keypad.

Most functions are selected directly from the display or from the function menu using the FUNC selector click-step rotary control. These functions and their selection are largely similar to the FTDX101.

The high resolution TFT colour touch-screen LCD measures 5 inches diagonal and is clear, sharp and bright with a good viewing angle. All areas of the screen are touch-sensitive for setting displayed functions, often showing pop-up menus for choice selection. The upper part of the display shows the receiver set functions including both A and B VFO frequencies, a graphic indication of the channel bandwidth settings and a single analogue-style S-meter. The meter indicates one function on transmit, usually power output but SWR, ALC and compression level are also available. The simultaneous display of multiple functions as adopted on Icom radios is not provided.

The lower part of the display is devoted to the spectrum scope in its different formats. Six touch buttons along the bottom of the display select the various options. This provides a spectrum scan and waterfall display centred on the receive frequency or between fixed limits, and an audio waveform scope and spectrum display for both the receiver and the transmitter audio. Both scans may be displayed together or singly in normal or expanded formats. The waterfall may be conventional or in pseudo 3-dimensional format and various colours may be selected. Similar to the FTDX101, there is a huge amount to play with here. The receiver can be tuned to any frequency on the spectrum display by touching the screen.

As with all recent radios the setup menu system is extremely comprehensive with over 200 items split into five categories of every conceivable parameter available for user selection and adjustment. The display makes access very easy, straightforward and unambiguous, albeit rather busy.

A headphone jack (3.5mm) and a microphone socket (RJ-45) are provided on the front panel but the key jack is on the rear panel. An SD card slot is also fitted and is used to save various settings, memory contents and updating the firmware.

Rear panel

There is a single antenna socket on the rear panel but no provision for connecting a receive antenna or an additional receiver. A single CW key jack is configurable for paddles, straight keys or external keying and there are 3.5mm jacks for external speaker and FH-2 remote keypad. Mini-DIN connectors (not my personal favourite!) provide all non-computer interfacing to external units. I buy cheap mini-DIN patch leads from component suppliers such as Farnell and cut the cable in half to provide two leads for attaching to other connectors. A 6-pin connector provides audio and interfacing lines for the datamodes, an 8-pin connector for the FC-40 external ATU and a 10-pin connector for linear amplifiers. There are no phono jacks to provide alternative methods of connection. A 13-pin jack for specialised accessories is also included, in particular for the external SCU-LAN10 unit for full remote control via the internet.

A USB-B connector provides the CAT computer interface for logging programs as well as audio lines for data modes. A 9-pin D RS-232 jack is also provided for interfacing to older style computers. An external display can also be linked via a DVI-D connector. Two USB-A connectors allow the connection of a keyboard and mouse. The mouse provides an alternative to touching the screen and is more precise and accurate. The keyboard can be used for inputting text into the message stores, memory labelling and entering frequencies directly but not for keyboard sending on data modes.

Receive features

The usual receive functions are all provided in a similar fashion to most other radios. There are 100 easily accessed and name-labelled memory

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Underneath view with covers removed showing small signal circuits.

channels that can be ordered into groups, 5 or 10 quick access memories and the usual scan functions. The M button provides instant viewing of the stored memory channels. Three mode-dependant AGC speeds are selectable, programmable over wide limits and AGC can also be switched off. RIT and XIT (clarifier) are both provided and an auto-tune feature that fine-tunes the receiver on clear signals to give the correct CW pitch.

The IF channel bandwidth is set by the width and shift controls independently for each mode over quite wide limits and down to 50Hz on CW and data modes. On AM and FM, the bandwidth is fixed. There is no control over the shape or the slope as seen on some radios but the Yaesu contour system provides a rolling peak or cut over the passband and this can be effective in some difficult situations. An IF notch filter is provided with adjustable centre frequency. Operating inside the AGC loop, desensitisation with strong carriers is prevented. Implemented at audio is the auto-notch, a beat cancellation filter. This automatically locates and removes multiple tones but does not prevent strong carriers from desensitising the receiver and is activated from the menu system. Notches and Contour settings are graphically displayed most effectively on the display together with their effect on the passband spectrum.

The audio bandwidth can be tailored separately for each mode and on CW an audio peak filter can be enabled. This has three selectable bandwidths and is tuneable across the pitch frequency. Also included are a digital noise reduction system and a noise blanker. Both are adjustable.

Transmit features

The transmitter power output is variable in 1W steps down to about 5W with different levels on the HF, 50 and 70MHz bands. The radio includes a built-in auto ATU covering bands 1.8 to 50MHz and will tune antennas with VSWR up to 3:1 (2:1 on 50MHz).

On SSB, VOX, speech processor and a transmission monitor are provided. The processor operates in two modes. AMC (automatic microphone gain control) akin to AGC and also known as VOGAD prevents audio overdrive and a conventional compressor raises the average modulation level. The audio bandwidth may be tailored by one of five bandpass filters in conjunction with a three-stage parametric equaliser with separate settings for the processor on or off. On FM, repeater operation on the 29MHz and 50MHz bands is provided with appropriate shifts and CTCSS tone decoders and encoders.

On CW, the usual break-in modes are provided and a full contest message keyer with all the usual options and settings. Five message stores containing up to 50 characters each can be programmed either from the keying paddle or from text entry using an external keyboard or internal pop-up keypad. Messages can be played back from the front panel or more conveniently using the FH-2 remote keypad accessory.

The radio includes a voice store for use in SSB contests. There are five message stores, each capable of storing up to 90 seconds of audio and playback is similar to the CW stores, either from the front panel or using the FH-2 remote keypad. Unlike the FTDX101, the voice store can also be used to record and playback the receiver audio. This is stored as WAV files on the SD card at a rate of 64kB/s. This corresponds to 4.3 hours of recording per GB of storage, with a maximum file size of 35GB.

Datamodes

The FTDX10 includes built-in encoders and decoders for RTTY, PSK and also CW operation. The 5 inch display allows for 6 lines of received data with 40 characters per line and a single line is allocated to the transmit buffer store.

PSK is limited to 31 baud rate BPSK31 and QPSK31. Both RTTY and PSK have separate transmit message stores, similar in operation to the CW stores. Five message stores are provided containing up to 50 characters each and are programmed using an external keyboard or internal pop-up keypad. Messages can be played back from the front panel or more conveniently using the FH-2 remote keypad accessory. There is no provision to conduct QSOs directly from the keyboard; connection to a PC running appropriate software is required.

A recent firmware update has introduced a PRESET function for operation on FT8. This is selectable from the MODE screen and allows a more optimised set of menu functions for FT8 instead of USB voice mode. The principal differences are to allow a wider bandwidth for the receive and transmit audio. This enables a single button press to switch between FT8 and voice or SSB datamodes.

Measurements

As expected, the measured performance of the FTDX10 is similar to the FTDX101 in many areas. The full set of measurements is given in the table. The sensitivity figures were excellent as usual. An 8dB attenuation is inserted below 1.7MHz and then sensitivity rolls off further below 500kHz.

The S-meter calibration showed about 2.5 to 3dB per S-unit and was very linear across the whole range. All modes were broadly the same.

The rejection of the 9MHz IF was over 110dB on most bands. This reduced to around 65dB on 7MHz and 10MHz, the bands closest to the IF. The image rejection was around 80-90dB on most bands but less than 40dB on 70MHz. Other spurious responses and birdies were very low indeed, none of significance. The AGC attack characteristic was clean with no overshoot but a small hole of about 2 to 3ms was inserted in the attack characteristic, typical of most radios. The audio response appeared to have a slight downward slope across the higher frequencies but this could be corrected in the settings with a little treble gain.

The strong signal performance of the receiver is excellent. The intermodulation limited dynamic range measured around 105dB in SSB bandwidths or 110dB in CW bandwidths. These dynamic range figures held at close spacings right down to the skirts of the roofing filter with no degradation, yielding 109dB dynamic range with 1kHz spaced signals. Inband linearity was also excellent.

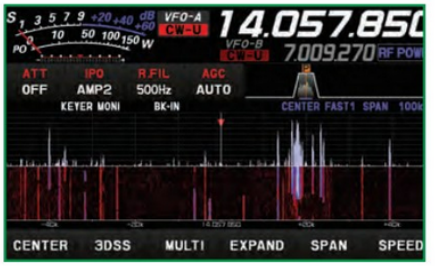
The reciprocal mixing phase noise figures were also excellent, particularly for radios in this price bracket. The low noise performance allowed the IF filter skirts to be measured down to a level of about –90dB with relative ease and the filters exhibited a clean response with excellent shape factor. The only exception was the AM filter that showed a spurious response to one side only 40dB down.

On transmit, the power output was well up to specification and the two-tone distortion products were generally quite reasonable. The audio was very clean with low distortion and quite tolerant of high ALC levels and overdrive. The processor, similarly, was clean with negligible effect on wideband products.

CW rise and fall shapes were clean with negligible distortion or character shortening at 40wpm even in full break-in mode. The default setting of 6ms for rise and fall time is fine and there was no power overshoot at any power levels. A recent firmware update removed selection of the sharper rise times and raised the default setting to reduce any likelihood of clicks. There is a menu-settable delay on keying (15-30ms) to allow for linear amplifier switching. The RF is correctly sequenced even for slow linears. AM transmit was clean with fairly low distortion but modulation was predominately in the downward direction. This resulted in overall power reduction with modulation.

The transmit composite noise output at full power is not as good as the FTDX101 but is still better than most radios on the bands. The noise at lower power and even key-up on CW does not reduce significantly and this is fairly normal with most radios. The key-up noise on CW measured -88dBm/Hz. This noise is largely AM noise which predominates over the phase noise element quoted in other reports and reviews.

Mode selection menu showing PRESET function.



Scope display showing spectrum and waterfall.

On-the-air performance

Overall the radio is easy to operate, with well-grouped controls and a clear and informative display. The buttons and controls are quite close together but this is an inevitable consequence of the benefits of providing a large display area. The tuning is smooth and positive and works well with the secondary tuning ring to move rapidly around the bands. My main concern is that menu items must be selected rapidly as these time-out after 2 seconds. Annoyingly, if you want to change band or mode and dwell too long, as your finger moves to the display the menu times-out and you change to an erroneous frequency as your finger touches the spectrum area.

As with all modern radios, the performance cannot be faulted. It handled strong signals well and in pileup conditions with clean results, and also with weak signals on the VHF bands. For a top-mounted speaker, the audio quality was good with no rattles. Performance in the AM broadcast band and down to the LF time-code transmissions was very clean although sensitivity was a little less. The filters and notches were excellent and the DNR digital noise reduction system effective. Also, the noise blanker worked well in removing electric fence and ignition noise from the receiver audio but does not function on the spectrum or waterfall scans.

On transmit, the audio quality was good using the supplied SSM-75E hand microphone and if needed there is a huge range of tailoring of the audio response available. The processor was clean and added extra punch. On CW, the keying and the sidetone were clean with no thumps in the headphones. With full break-in the relays were a bit noisy but it was possible to listen between characters up to around 15 WPM. As with the FTDX101, the process for setting the microphone gain and AMC levels as described in the manual is rather ambiguous, but setting these to give a moderate degree of compression (10dB max) with the ALC in the lower half of the meter display gave good results.

The various display options were well presented and very helpful but can be a bit small on the internal display with multiple functions selected. An external display can be a great help and most impressive. I used a 24-inch display and the smallest of details are easily readable. The 3D spectrum display gives a good impression of band activity but, overall, I personally prefer the conventional spectrum with waterfall scans. The touch screen worked well and tuning the radio from the spectrum display gave reasonably accurate results providing the span was kept fairly low. Using a mouse for this purpose is much more precise than using fat fingers and of course works on an external display but it is a shame that Yaesu have not implemented mouse wheel scrolling to fine tune precisely on wanted signals with one hand.

On data modes, the decoders worked well even with weak and noisy signals. The tuning indicators on the passband shapes are quite small but easier to view on an external display. However, without the ability to send other than pre-programmed messages, the decoders are really little more than a gimmick. The CW decoder also seemed quite effective, rather better than most, but as always intolerant of QRM or poorly sent code. Most decoders don't have any user adjustment but the speed tracking control in the FTDX10 results in much less gibberish being displayed.

For serious datamode use, including FT8, connection to a PC is needed via USB. It is first necessary to download drivers from the Yaesu website if not already installed on the PC. The process is very straightforward and I quickly had the radio up and running on FT8 using WSJT-X software.

During the period that I had the radio for review, a firmware upgrade became available. I downloaded and installed the upgrade easily with no problems. It improved a number of user functions and provided the PRESET function for FT8.

Conclusions

The FTDX10 is a real top-class performer at a much lower cost than some other top-end radios. It has an excellent balance of features and functions with good overall user ergonomics and is already proving very popular. It is currently priced around £1550 from the usual Yaesu stockists and this represents very good value for money.

Acknowledgements

I would like to express my gratitude to Yaesu UK for the loan of this radio.

Yaesu FTDx10 measured performance

Receiver measurements

	Sensitivity SSB 10dB s+n:n			Input for S9		
Frequency	IPO	Preamp 1	Preamp 2	IPO	Preamp 1	Preamp 2
1.8MHz	0.56µV (-112dBm)	0.2µV (-121dBm)	0.13µV (-125dBm)	110µV	40µV	16µV
3.5MHz	0.56µV (-112dBm)	0.2µV (-121dBm)	0.14µV (-124dBm)	110µV	40µV	16µV
7MHz	0.5µV (-113dBm)	0.18µV (-122dBm)	0.13µV (-125dBm)	100µV	35µV	14µV
10MHz	0.63µV (-111dBm)	0.22µV (-120dBm)	0.14µV (-124dBm)	130µV	45µV	16µV
14MHz	0.5µV (-113dBm)	0.18µV (-122dBm)	0.13µV (-125dBm)	110µV	35µV	14µV
18MHz	0.63µV (-111dBm)	0.22µV (-120dBm)	0.14µV (-124dBm)	100µV	35µV	13µV
21MHz	0.63µV (-111dBm)	0.2µV (-121dBm)	0.14µV (-124dBm)	100µV	35µV	13µV
24MHz	0.4µV (-115dBm)	0.14µV (-124dBm)	0.13µV (-125dBm)	56µV	18µV	7µV
28MHz	0.32µV (-117dBm)	0.11µV (-126dBm)	0.11µV (-126dBm)	50µV	18µV	7µV
50MHz	0.35µV (-116dBm)	0.13µV (-125dBm)	0.11µV (-126dBm)	56µV	20µV	8µV
70MHz	0.63µV (-111dBm)	0.2µV (-121dBm)	0.14µV (-124dBm)	100µV	32µV	11µV

AGC threshold PREAMP1: 2.2µV
100dB above AGC threshold for <1dB audio output increase
AGC attack time: 2-3ms

AGC decay time: adjustable 20ms to 4s
Max audio at 1% distortion: 1.0W into 8Ω, 1.8W into 4Ω
Inband intermodulation products: better than -55dB

S-Reading	Input Level USB		
(7MHz)	IPO	Preamp 1	Preamp 2
S1	8µV	2.8µV	1µV
S3	14µV	5µV	1.8µV
S5	25µV	9µV	3.2µV
S7	50µV	18µV	7µV
S9	100µV	35µV	14µV
S9+20	1mV	350µV	140µV
S9+40	10mV	3.5mV	1.4mV
S9+60	100mV	35mV	14mV

Bandwidth/roof	Bandwidth				
set to	-6dB	-60dB	-70dB	-80dB	-90dB
USB 2.4kHz/3kHz	2374Hz	3140Hz	3233Hz	3320Hz	3398Hz
CW 500Hz/500Hz	496Hz	715Hz	745Hz	777Hz	850Hz
CW 100Hz/500Hz	99Hz	220Hz	236Hz	255Hz	260Hz
AM 9kHz/12kHz	7560Hz	11090Hz	11490Hz	11800Hz	11900Hz
AM-N 6kHz/12kHz	5590Hz	8670Hz	8890Hz	9035Hz	9060Hz
FM 16kHz/12kHz	13060Hz	16450Hz	16690Hz	16880Hz	17080Hz
FM-N 9kHz/12kHz	10470Hz	15310Hz	15660Hz	15950Hz	16290Hz

	Intermodulation dynamic range 20kHz spacing, USB 2.4kHz bandwidth, 3kHz roof		
Frequency	IPO	Preamp 1	Preamp 2
1.8MHz	96dB	96dB	89dB
3.5MHz	104dB	104dB	98dB
7MHz	106dB	106dB	101dB
14MHz	106dB	106dB	101dB
21MHz	104dB	105dB	101dB
28MHz	102dB	102dB	94dB
50MHz	97dB	97dB	91dB
70MHz	92dB	92dB	87dB

Frequency offset	Reciprocal mixing dynamic range 500Hz bandwidth 7MHz	21MHz	Intermodulation dynamic range 500Hz BW 14MHz
1kHz	113dB (-140dBc/Hz)	not measured	109dB
2kHz	117dB (-144dBc/Hz)	not measured	109dB
3kHz	119dB (-146dBc/Hz)	not measured	110dB
4kHz	120dB (-147dBc/Hz)	120dB (-147dBc/Hz)	110dB
5kHz	120dB (-147dBc/Hz)	122dB (-149dBc/Hz)	110dB
10kHz	121dB (-148dBc/Hz)	124dB (-151dBc/Hz)	110dB
15kHz	121dB (-148dBc/Hz)	124dB (-151dBc/Hz)	110dB
20kHz	121dB (-148dBc/Hz)	124dB (-151dBc/Hz)	110dB
30kHz	121dB (-148dBc/Hz)	124dB (-151dBc/Hz)	110dB
50kHz	121dB (-148dBc/Hz)	124dB (-151dBc/Hz)	110dB
100kHz	121dB (-148dBc/Hz)	125dB (-152dBc/Hz)	110dB

Transmitter measurements

	CW power		Intermodulation products wrt PEP	
Frequency	output	Harmonics	3rd order	5th order
1.8MHz	104W	-65dB	-30dB	-40dB
3.5MHz	104W	-65dB	-36dB	-38dB
7MHz	105W	-78dB	-36dB	-36dB
10MHz	105W	-57dB	-40dB	-36dB
14MHz	105W	-74dB	-34dB	-36dB
18MHz	106W	-77dB	-32dB	-35dB
21MHz	106W	-72dB	-39dB	-36dB
24MHz	106W	-77dB	-40dB	-36dB
28MHz	106W	-73dB	-39dB	-37dB
50MHz	102W	-80dB	-34dB	-40dB
70MHz	51W	-80dB	-41dB	-44dB

Transmit frequency offset	Composite noise 7MHz 100W O/P
1kHz	-72 dBm/Hz (-122dBc/Hz)
2kHz	-74 dBm/Hz (-124dBc/Hz)
3kHz	-75 dBm/Hz (-125dBc/Hz)
4kHz	-76 dBm/Hz (-126dBc/Hz)
5kHz	-77 dBm/Hz (-127dBc/Hz)
10kHz	-79 dBm/Hz (-129dBc/Hz)
15kHz	-79 dBm/Hz (-129dBc/Hz)
20kHz	-79 dBm/Hz (-129dBc/Hz)
30kHz	-79 dBm/Hz (-129dBc/Hz)
50kHz	-81 dBm/Hz (-131dBc/Hz)
100kHz	-84 dBm/Hz (-134dBc/Hz)
150kHz	-86 dBm/Hz (-136dBc/Hz)

Intermodulation product levels are quoted with respect to PEP.

Microphone input sensitivity: 0.1mV for full output
Transmitter AF distortion: generally less than 0.1%
FM deviation: 2.0kHz narrow / 4.0kHz wide
SSB data T/xRx switch speed: mute-Tx 35ms, Tx-mute 5ms, mute-Rx 35ms, Rx-mute 1ms

NOTE: All signal input voltages given as PD across antenna terminal. Unless stated otherwise, all measurements made with receiver preamp switched out (IPO), on USB with 2.4kHz bandwidth and 3kHz roofing filter and on CW with 500Hz bandwidth and 500Hz roofing filter.