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Icom IC-7851 HF & 50MHz transceiver

A new flagship is born: the current market leader in terms of performance

PHOTO 1: IC-7851 front view.

INTRODUCTION. In 2004, Icom launched their IC-7800 top-of-the-range flagship transceiver, raising the bar on what was available at that time in terms of performance and level of built-in features. It has remained their flagship for the past 10 years and is still one of the top-flight transceivers available today. Icom has now unveiled its successor, the IC-7851. Based heavily on the previous model, it adopts significant technological advances to further improve performance and enhance the high level of features that are incorporated.

SUMMARY OF KEY CHANGES AND SIMILARITIES. At a first glance, the outward appearance of the IC-7851 is very similar to the IC-7800. The size and weight are the same, the styling and front panel layout are the same, but the rear panel shows a number of changes. The same RF, control and accessory interfaces are provided but the RF cable links are no longer needed. Improved support is provided for computer connected equipment and peripherals but the RS-232 connector has been removed. The CI-V interface has been retained but the CT-17 level converter is required if RS-232 is needed. The RF architecture is essentially the same as with the IC-7800 but a new design for the local oscillators results in significantly improved noise characteristics. The RF functions and transmit power level are the same but there is a greater choice of narrow roofing filters.

It is in the DSP area where other major advances have been made. Three DSP devices are employed instead of the four used in the IC-7800 but the new devices are considerably faster and more powerful. The scope display has been redesigned, offering a dual display for simultaneous monitoring of both receivers, higher speeds with better sensitivity and resolution. Spectrum and waterfall displays, audio spectrum and waveform, and mouse click tuning are all provided.

Data modes now include PSK63. Compact Flash card support has been replaced by SD card and all settings and message stores can be saved to SD or USB flash drive. The voice recorder function has been expanded to allow continuous recording of receive and transmit audio, limited only by external memory size, and transmit message stores provide eight channels on all operating modes. The setup screens have been greatly expanded and many other little tweaks and additions have been incorporated into the various operating functions.

BASIC FUNCTIONS. The IC-7851 is a mains powered base station radio covering LF, MF, HF and 6m. Measuring 425mm (w) x 149mm (h) x 435mm (d) and weighing a heavy 23.5kg, it is also supplied with attachable front facing handles for rack mounting operation or carriage. It incorporates two totally independent and identical receivers each tuning continuously from 30kHz to 60MHz. The transmitter is rated at 200W output and is enabled only within the amateur bands. The version sold in Europe also transmits in the 136kHz band but only at a level of –20dBm via the transverter socket on the rear panel. 5MHz operation, standard on US-sold models, can be enabled by Icom agents.

Individual buttons select the bands with a triple band stacking register and separate buttons also select the modes LSB, USB, CW, FM, AM, RTTY and PSK, with both sidebands (normal/reverse) available on CW, RTTY and PSK modes. There is extensive support for data modes, including dedicated modems and display for RTTY and PSK and three different selectable settings for data operation on SSB, AM and FM modes. This enables different audio lines to be switched between alternative accessory connectors on the rear panel.

The extensive functions provided in the radio are accessed in most cases by dedicated controls rather than multifunctional layered menus. There are over 100 controls on the front panel. Access to functions is straightforward and intuitive and user setup rarely involves more than one long button push. The amount of information displayed on the large LCD panel is most impressive. This uses a 7-inch full-colour active matrix TFT display and may also be displayed on an external monitor via a DVI-I connector on the rear panel. Apart from the most informative setup screens, the display gives a high-resolution spectrum plot, memory data lists of various types, incoming and outgoing RTTY/PSK data messages and two large meters. Three different meter formats are selectable – a very realistic analogue lookalike needle display with excellent resolution, an edgewise meter and a bar meter. In addition, a multifunction meter may be selected, which displays seven items of transmit data simultaneously including heatsink temperature.

The rear panel carries an enormous number of connectors. There are four antenna sockets that may be selected from the front panel or automatically assigned according to band. The receive path for both receivers allows for receive-only antennas, external receivers or external in-line filters. The usual accessory sockets are duplicated to allow more than one data terminal unit, linear amplifier or external auto ATU to be connected simultaneously. A keyboard,

mouse and external flash memory may be connected via two USB-A connectors and PC interfacing via a USB-B connector or Icom CI-V interface. An Ethernet LAN connector is provided for remote access, there are S/P DIF fibre optic digital audio jacks, sockets to connect external meter readout and a keypad for transmit memory stores. There is a transverter drive capability giving about -20dBm on transmit and switching for linear amplifiers accommodates a wide range of switching voltages and currents together with ALC. Twin key jacks are fitted, one on the front panel and the other on the rear.

Each radio is provided with a comprehensive instruction manual contained within a ring binder and with circuit diagrams and a PDF version of the manual on CD-ROM.

PHOTO 2: The rear panel carries an enormous number of connectors.

RADIO DESIGN AND ARCHITECTURE.

The receivers used in the IC-7851 adopt a double superhet architecture with a first IF of 64.455MHz (A receiver) or 64.555MHz (B receiver) and then converting down to a second IF of 36kHz with an image rejection mixer to feed the DSP for all further processing. All channel filtering is performed at the 36kHz IF by DSP. Four selectable roofing filters are incorporated at the first IF in both receiver paths with bandwidths of 15, 6, 3 and 1.2kHz. The 1.2kHz filter is a new design and a calibration routine is built in to optimise the filter passband. This operates by slightly shifting the first and second local oscillators to position the filter passband at the correct point and allow for any variation due to ageing or other factors. Calibration is simply performed automatically or manually as needed.

Each receiver uses a total of 13 switched front end filters to provide the signal frequency filtering and a separate sharply tuned preselector, the Digi-Sel unit, may also be enabled. Mechanical relays are used entirely for signal switching in the front end avoiding the use of switching diodes that can generate intermodulation products with very high level signals. A separate front end is used for frequencies above 30MHz. The first local oscillator uses a DDS / PLL arrangement optimised for low noise. The transmit path adopts triple conversion, interspersing a 455kHz IF between the 36kHz DSP generated transmit signal and the 64.455MHz final IF. The MOSFET PA operates from a 48V supply for good linearity.

Three separate 32-bit floating point DSP units are used with 24-bit AD/DA converters. Two are used for the receivers and the transmit signal and these are powerful 2400 MFLOP devices clocked at 393MHz. The third is dedicated to the spectrum scope, a 2250 MFLOP device clocked at 370MHz. AGC is applied mainly within the DSP but an auxiliary loop reduces the gain of the first IF amplifier on strong signals. An ultra high stability oven controlled crystal oscillator is used for the synthesiser reference signal source. This is specified as stable to within ±0.05ppm over the operating temperature range of the radio, which equates to just 2.5Hz at 50MHz. This 10MHz reference frequency output is also available on the back panel of the radio for other uses or alternatively an external reference can also be used.

The radio is constructed on fully screened circuit boards housed in a substantial compartmentalised diecast chassis. A large internal finned heatsink cools the power amplifier and is blown by two internal fans. Considering the size of the radio, a single very small speaker is fitted, just 60mm diameter. However, it is a hi-fi style unit fitted into an acoustic box and gives better than average quality with no unwanted rattles and resonances that result from the usual open mounted unit.

RECEIVER FEATURES. The radio is fitted with two VFOs, one controlling each receiver, and two tuning knobs. The main is 55mm in diameter and the sub is 35mm in diameter. This is the only difference between the two receivers. The transmitter uses the main VFO for normal operation and the sub VFO for split frequency working. A quick split feature enables split frequency operation and equalises the VFOs. Tuning is in 1Hz steps at 500Hz per revolution or 10Hz steps at 5kHz per revolution. A faster rate of selectable kHz step sizes enables more rapid navigation and auto speed-up is selectable for fast sustained tuning. The frequency may also be entered directly from the band keypad and a ¼ tuning rate function is selectable for fine-tuning data signals. An auto-tune feature may be enabled for CW and AM modes.

101 memory channels are included with the usual access facilities. Memories can be tagged with a 10 character alphanumeric label. The memory list screen is very convenient for scrolling through and searching memories and displays up to 15 memory contents at one time. A separate memo-pad feature allows frequencies to be quickly stored and recalled by a simple key press, on the basis of last-in, first-out. RIT and transmitter independent tuning operate over a range of ±9.99kHz and various scan modes are implemented.

All controls for the two receivers are duplicated and independent and logically laid out. The receiver paths are kept separate right through to the audio output with left and right channels on stereo headphones or external speakers, or combined for the internal speaker. The usual receiver functions are provided. The receiver front end configuration may be optimised to suit different requirements with two selectable preamplifiers, seven levels of signal attenuation, RF gain and squelch controls. Preamp 1 has a gain of about 12dB and preamp 2 about 20dB. This higher gain preamp is primarily intended for use on the higher frequency bands but can be useful on the lower frequencies when low output receive antennas are used such as small loops or Beverages.

To improve further the front end signal handling with very strong out of band signals experienced for example in a multi-multi contest site, a sharply tuned preselector termed Digi-Sel may be enabled at the receiver input covering frequencies from 1.5 to 30MHz. Two units are fitted, one in each receiver path, using relay switched capacitors and inductors to track automatically the tuning of the receiver. A front panel control provides fine peaking if needed.

FILTERS. With the exception of the roofing filters, all filtering, demodulation and audio processing functions are implemented in DSP. The channel filtering provides 41 different passband widths on SSB, CW and PSK from 50Hz to 3600Hz, 32 passband widths on RTTY (50-2700Hz) and 50 passband widths on AM (200Hz-10kHz). On FM three bandwidths are provided (7, 10 and 15kHz). Three separate bandwidths are immediately available for each mode selectable by a simple push of a front panel key, from the available menu of bandwidths. In addition, two filter profiles are selectable on CW and SSB modes, a sharp profile with a flat passband and a soft profile with

a more rounded passband. The DSP also provides the twin passband tuning function, which enables the filter sides to be both independently moved and narrowed. The filter set-up screen on the display shows all the filter adjustments in a friendly and graphical way.

The AGC is also implemented by the DSP with three separate time constants (Fast, Mid, Slow) plus constantly variable selectable from the front panel. These three values may be set from a menu of 13 different values (0.1 to 6s SSB/CW) and are set separately for all modes except FM. The AGC can also be turned off. Two very effective notch functions are provided in this transceiver, both using the DSP. A manually tuned IF notch with a depth of 70dB and three selectable widths is included within the AGC loop and hence does not result in desensitising with strong carriers. An auto-notch is implemented at AF and will automatically attenuate several beat notes, even if they are moving. An adjustable DSP noise reduction system is also included and there is a separate adjustable noise blanker for pulse type interference such as car ignition noise.

DSP also provides audio filtering and shaping functions. A narrow audio peak filter is available on CW with selectable bandwidths and a twin peak filter sharply tuned to the 2125Hz and 2295Hz mark and space tones on RTTY. Extensive audio tailoring for both receive and transmit is also provided, with adjustable high pass and low pass cut-offs, treble and bass shaping and all separately adjustable for each mode.

TRANSMIT FEATURES. The IC-7851 contains a 200W power amplifier adjustable down to less than 5W. VOX, speech processor and a transmission monitor are provided on SSB and the transmission filter bandwidth can be set to wide, mid or narrow as preferred in addition to audio frequency response tailoring. On CW there is the usual provision for full and semi break-in with a front panel control for drop-back delay and the keying envelope rise and fall times are adjustable between 2 and 8ms to accommodate both fast CW and minimum radiated bandwidth.

The CW keyer operates over a wide range of speeds with adjustable weighting and a variety of keying paddle arrangements. Eight memories will each store messages up to 70 characters in length with a provision to send automatically incrementing serial numbers and auto-repeat after a time delay. The message stores are programmed in text either from front panel controls or directly from a PC USB keyboard connected to the relevant rear panel socket. Messages can be played back from front panel pushbuttons, from the keyboard function keys or from a custom 8-key keypad plugged into

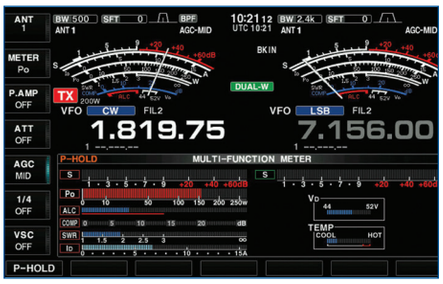

PHOTO 3: Multi-function meter display.

the rear panel. Surprisingly, Icom do not offer this keypad as an accessory, but it is straightforward to construct your own and details are provided in the manual. Separate message stores are also provided for RTTY, PSK and voice modes. For each mode eight stores are available, access being broadly similar to the CW store. 70 characters may be stored in each RTTY and PSK memory and 200 seconds of audio in each voice store. Keypad or keyboard access is particularly convenient. The CW and voice stores can be set to repeat after a brief delay.

An auto ATU is built-in covering all bands including 50MHz and matching up to 3:1 VSWR (2.5:1 on 50MHz). Tuning settings every 100kHz are stored to enable rapid and accurate reselection.

DATA MODES. The IC-7851 is fully equipped for receiving and sending RTTY, PSK31 and PSK63 data modes as a stand-alone unit without the need to be connected to a PC running data mode software. A USB keyboard needs to be connected to the relevant rear panel socket for transmitting messages but is not needed if used only on receive.

When using the internal modem, the display window is divided into two areas, the receive contents area and the transmit buffer area. These areas allow for 48 characters per line and, depending on whether a wide or narrow display window has been selected, either 14 or 8 lines in the receive area and 3 or 2 lines in the transmit buffer area. The wide setting is best for any serious data operation. With this setting the frequency readout size is reduced and metering is displayed in bar or edge format. Two audio spectrum tuning indicators are provided for both RTTY and

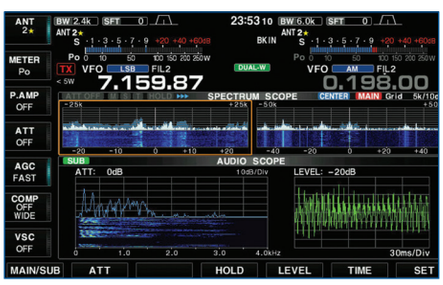

PHOTO 4: Spectrum and audio scope displays.

PSK modes; an FFT display that shows the amplitude of the received components against frequency and a waterfall display that shows this information colour coded also against time. The twin peaks of an RTTY signal or the narrower spread of a PSK-31 signal can be clearly seen. For the PSK decoder, a vector tuning indicator is also provided to allow accurate fine tuning of the signal, as a line for a BPSK signal or as a cross for a QPSK signal. Both BPSK and QPSK modes are supported.

AFC and transmit netting are provided on PSK modes to help with fine tuning. A host of options are also included for setting time stamps, display colours, scope waveform averaging, RTTY parameters such as unshift on space and more. RTTY Log and PSK Log enables received and transmitted data to be stored to USB flash memory or SD card in either text or HTML format.

AUXILIARY FEATURES. All the settings of the radio, the contents of the various memories and message stores, the receive and transmit audio and data mode messages can all be saved to USB flash memory or an SD card. The contents can then be used to reset the radio to the stored settings at any time in the future. This can be particularly useful in a multi-operator contest or DXpedition where each operator can store their own preferred settings or CQ calls in their own voice and instantly configure the radio for the duration of their operating period.

The IC-7851 includes a built-in digital voice recorder. As well as providing message stores on transmit, the voice recorder also stores the receive and transmit audio. There are essentially two modes of operation. Up to 30 seconds of receive audio is always stored for both receivers and is available for instant replay without any prior setting needed. Hence any badly copied information can be replayed over and over again if necessary. In the second mode, the audio is recorded to external memory, SD or USB, limited in time only by the amount of available memory. Four hours of audio occupy less than one gigabyte. Both receivers are recorded as left and right channels of a .WAV file. It can be played back on the radio or externally on a PC.

The spectrum scope in the IC-7851 is a significant enhancement over the earlier radio. It has 100dB of displayed dynamic range and an additional associated waterfall. A dual mode can selected to cover both receivers on separate displays. These may be side by side or one above the other and all settings are independent. There are two modes of operation. The centre mode will display the spectrum on either side of the on-tune frequency with spans selectable from ±2.5kHz to ±500kHz. The Fix mode will display the spectrum between two

fixed points, these points being separately programmable for each band. In both modes there are a number of settings that select sweep speed, colours, VFO markers, peak hold etc. The spectrum scope can be used in conjunction with other display screens by using the mini-scope mode.

When a mouse is connected, a cursor appears on the spectrum display and the radio can be set to the selected frequency by left-clicking or tuning by dragging. Right clicking will temporarily change frequency, returning to the original frequency when the button is released. This is useful if you just want to check a signal that you observe but want to retain your working frequency.

An audio scope display is also included. This shows the audio spectrum with associated waterfall and a waveform display. This functions on both receive and transmit and can help in setting up the transmitter audio levels.

Other features include calendars, clocks and timers of various types, a voice synthesiser for audible readout of frequency, mode and S-meter level, a CTCSS tone encoder and decoder for repeater access and tone squelch operation, and quick access splits separately programmable for HF and 50MHz repeater operation. When used with a transverter, the displayed frequency can be offset up to 99.999MHz in 1kHz steps but this is insufficient to allow the full transverted frequency to be displayed above 100MHz.

When Icom releases firmware updates these are installed by transferring the data file to the radio using USB or SD card. PC control of the radio uses the CI-V interface in conjunction with the CT-17 level converter and the command set is described in the manual. Full remote control of the radio via a LAN, Wi-Fi or the internet uses the Ethernet interface to a router in conjunction with the RS-BA1 software package running on the PC at the remote end. Client software is included in the IC-7851 firmware so a PC is not needed at the radio end of the link. Control and audio are both transferred.

MEASUREMENTS. The full set of measurements is given in the table. Two preamplifiers are selectable across the whole tuning range of the radio although a different front end with associated preamplifiers is selected above 30MHz. Sensitivity figures are excellent and hold well down into the LF region, achieving less than 0.5μV at 50kHz. The 6kHz, 3kHz and 1.2kHz roofing filters reduce sensitivity by 1, 2 and 7dB respectively but only with the preamplifier off. Digi-Sel adds negligible loss. Dual receiver operation (dual watch) reduces sensitivity very slightly. The S-meter calibration is the same on all modes and is very linear, holding closely to 2.5dB per S-point from S1 to S9 and then within 1dB linearity up to 60dB over S9.

PHOTO 5: IC-7851 RTTY decoder display.

The rejection of all images and IFs was exceptionally good, in excess of 100dB. Apart from a buzzing sound around 75kHz and its harmonics at LF the receiver is exceptionally clean and clear of other spurious responses. The AGC response was very clean but a brief hole was observed in the attack characteristic.

The third order intercept measured with 50kHz generator spacings exceeded +40dBm over most of the HF range, yielding dynamic ranges in excess of 110dB on SSB with 2.4kHz bandwidth. On CW with 500Hz bandwidth even higher dynamic ranges are achieved and still measure over 100dB at 1kHz spacing, well inside the roofing filter bandwidth. Inband linearity with 200Hz spaced tones also showed exceptionally good performance and audio noise and distortion was low.

Reciprocal mixing figures also showed outstanding results. Phase noise close-in is some 20 to 30dB better than the IC-7800 and beats other top-end radios currently on the market. The new synthesiser design certainly lives up to its claims. Low phase noise allowed the IF filter skirts to be measured down to the –80dB level with relative ease. These showed a clean response with tight skirts. Front end blocking was in excess of +20dBm with the preamp off, about +15dBm with preamp 1 and about +4dBm with preamp 2. Overall, the strong signal results position this radio as the current market leader in terms of performance.

The transmit power output was well up to specification and the metered power level was very accurate above 20W. The ATU introduced an additional loss of about 5 to 10%. Wideband distortion products on SSB fell away rapidly and the speech compressor made little difference to the distortion levels. The CW rise and fall times are adjustable and clean with low character distortion. Character shortening was about 15% at 40wpm with full break-in but no shortening with semi break-in. No first character shortening or power overshoot at low power levels was seen and with full break-in, listening between characters at 30wpm is just possible. An adjustable delay is provided to allow for linear amplifier switching. On AM, carrier levels are set correctly and modulation is clean at all power levels but the carrier takes 0.5s to stabilise on pressing the PTT. On data modes, receive to transmit switching times are limited as it takes 50ms for the transmit power level to ramp up to maximum. Transmit wideband noise is better than most radios and indeed only just behind the Elecraft K3, the current top performer in this respect. Surprisingly, the noise is slightly higher at low power levels, CW key-up or SSB with zero modulation.

ON THE AIR PERFORMANCE. In operation the IC-7851 is very similar to the IC-7800. Despite having so many features and controls, it is very easy and intuitive to use. The controls are where you would expect to find them and the main and sub receiver controls are closely associated, unlike some other top end radios. The display is excellent, crisp and clear, and the various access and set-up screens most helpful and informative.

The radio performed impeccably in both weak signal and high-level crowded conditions. Audio quality was excellent on all modes and the various IF filters, notches, noise reduction and other functions all performed extremely well.

I could find little to fault on any of the features. The memories, message stores, keyers etc all functioned very well. Built-in operation on data modes was effective, particularly for casual operation, although the more serious user will generally prefer the extra convenience of PC based applications. The scope screen with the extra waterfall and audio functions is a big improvement over earlier Icom models. One of the more useful functions is the ability to set the frequency from the scope display using a mouse and in particular right-clicking to temporarily checkout an off-channel signal observed on the display.

On transmit, the radio runs quite cool and the fans are very quiet. The CW transmission was narrow with clean QSK operation. Quality reports on SSB with the HM-36 hand microphone were good. Similarly the SM-50 desktop microphone showed good audio quality, particularly with the low cut button pressed, but this microphone was rather susceptible to acoustic handling noise.

CONCLUSIONS. The IC-7851 is a worthy successor to the IC-7800. At the top of the performance league with an unsurpassed set of well-implemented features and ease of use, it is a most impressive radio. Priced at around £9,000 it is aimed at the serious enthusiast who wants nothing but the best.

ACKNOWLEDGEMENTS. I would like to thank Icom (UK) Ltd for the loan of the equipment.

ICOM IC-7851 MEASURED PERFORMANCE

RECEIVER MEASUREMENTS

	SENSITIVITY SSB 10dB s+n:n			INPUT FOR S9		
Frequency	Preamp off	Preamp 1	Preamp 2	Pre off	Preamp 1	Preamp 2
1.8MHz	0.4μV (-115dBm)	0.1μV (-127dBm)	0.08μV (-129dBm)	56μV	18μV	8μV
3.5MHz	0.4μV (-115dBm)	0.11μV (-126dBm)	0.1μV (-127dBm)	50μV	16μV	8μV
7MHz	0.35μV (-116dBm)	0.1μV (-127dBm)	0.08μV (-129dBm)	50μV	16μV	7μV
10MHz	0.35μV (-116dBm)	0.1μV (-127dBm)	0.08μV (-129dBm)	50μV	16μV	8μV
14MHz	0.4μV (-115dBm)	0.13μV (-125dBm)	0.1μV (-127dBm)	56μV	16μV	8μV
18MHz	0.45μV (-114dBm)	0.11μV (-126dBm)	0.09μV (-128dBm)	63μV	18μV	9μV
21MHz	0.45μV (-114dBm)	0.11μV (-126dBm)	0.09μV (-128dBm)	56μV	16μV	9μV
24MHz	0.5μV (-113dBm)	0.11μV (-126dBm)	0.09μV (-128dBm)	56μV	16μV	9μV
28MHz	0.45μV (-114dBm)	0.11μV (-126dBm)	0.1μV (-127dBm)	63μV	14μV	9μV
50MHz	0.35μV (-116dBm)	0.13μV (-125dBm)	0.1μV (-127dBm)	63μV	20μV	13μV

AM sensitivity (28MHz) Preamp1: 0.5μV for 10dBs+n:n at 30% mod depth
FM sensitivity (28MHz) Preamp 1: 0.15μV for 12dB SINAD 3kHz pk deviation
AGC threshold Preamp 1: 1.2μV
100dB above AGC threshold for <1dB audio output increase

AGC attack time: 3-4ms
AGC decay time: approx as specified
Max audio at 1% distortion: 2.3W into 8Ω, 4.0W into 4Ω
Inband intermodulation products: better than -60dB

S-READING	INPUT LEVEL USB	
(7MHz)	PRE OFF	PREAMP 1
S1	5μV	1.8μV
S3	8μV	2.8μV
S5	14μV	4.7μV
S7	25μV	8.5μV
S9	50μV	16μV
S9+20	500μV	160μV
S9+40	5mV	1.6mV
S9+60	50mV	16mV

FILTER	IF BANDWIDTH (SHARP)		
	-6dB	-60dB	-80dB
10kHz FM	10.4kHz	13.8kHz	14.8kHz
6kHz AM	6.4kHz	10.4kHz	11.5kHz
2.4kHz USB	2530Hz	3466Hz	3859Hz
500Hz CW	516Hz	669Hz	812Hz
250Hz CW	254Hz	345Hz	545Hz
100Hz CW	108Hz	193Hz	396Hz
50Hz CW	64Hz	135Hz	264Hz

INTERMODULATION (50kHz tone spacing), 2400Hz bandwidth, 15kHz roof, USB

	PREAMP OFF		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	+33.5dBm	106dB	+26dBm	109dB	+16.5dBm	104dB
3.5MHz	+39.5dBm	110dB	+28dBm	109dB	+17dBm	103dB
7MHz	+44.5dBm	114dB	+32dBm	113dB	+19.5dBm	106dB
14MHz	+45.5dBm	114dB	+32.5dBm	112dB	+21.5dBm	106dB
21MHz	+45dBm	113dB	+31.5dBm	112dB	+19dBm	105dB
28MHz	+45dBm	113dB	+31.5dBm	112dB	+18.5dBm	104dB
50MHz	+31dBm	105dB	+17.5dBm	102dB	+12.5dBm	100dB

CLOSE-IN INTERMODULATION ON 7MHz BAND, 500Hz bandwidth, CW, Preamp off

	INTERMODULATION LIMITED DYNAMIC RANGE			
Spacing	15kHz ROOF	6kHz ROOF	3kHz ROOF	1.2kHz ROOF
1kHz	101dB	101dB	102dB	105dB
2kHz	101dB	102dB	102dB	109dB
3kHz	101dB	103dB	104dB	110dB
4kHz	101dB	104dB	106dB	110dB
5kHz	103dB	106dB	108dB	110dB
7kHz	106dB	108dB	110dB	110dB
10kHz	110dB	111dB	113dB	110dB
20kHz	117dB	115dB	115dB	110dB
30kHz	117dB	116dB	116dB	110dB
50kHz	118dB	117dB	116dB	110dB

FREQUENCY OFFSET	RECIPROCAL MIXING DYNAMIC RANGE 500Hz BW 7MHz	TRANSMIT NOISE 7MHz 100W O/P
1kHz	114dB (-141dBC/Hz)	-117dBC/Hz
2kHz	117dB (-144dBC/Hz)	-117dBC/Hz
3kHz	118dB (-145dBC/Hz)	-122dBC/Hz
5kHz	118dB (-145dBC/Hz)	-127dBC/Hz
10kHz	124dB (-151dBC/Hz)	-129dBC/Hz
15kHz	126dB (-153dBC/Hz)	-137dBC/Hz
20kHz	127dB (-154dBC/Hz)	-140dBC/Hz
30kHz	127dB (-154dBC/Hz)	-140dBC/Hz
50kHz	128dB (-155dBC/Hz)	-140dBC/Hz
100kHz	129dB (-156dBC/Hz)	-140dBC/Hz
200kHz	130dB (-157dBC/Hz)	-140dBC/Hz

TRANSMITTER MEASUREMENTS

	CW POWER		INTERMODULATION PRODUCTS	
FREQUENCY	OUTPUT	HARMONICS	3rd order	5th order
1.8MHz	197W	-66dB	-30dB	-42dB
3.5MHz	199W	-70dB	-34dB	-48dB
7MHz	197W	-70dB	-34dB	-48dB
10MHz	200W	<-70dB	-32dB	-47dB
14MHz	198W	<-70dB	-30dB	-46dB
18MHz	200W	<-70dB	-34dB	-46dB
21MHz	202W	<-70dB	-40dB	-47dB
24MHz	202W	<-70dB	-42dB	-46dB
28MHz	202W	<-70dB	-40dB	-48dB
50MHz	195W	<-70dB	-35dB	-51dB

Carrier suppression: >80dB
Sideband suppression: >75dB
Transmitter AF distortion: much less than 1%
Microphone input sensitivity: 1.5mV for full output
FM deviation: 4.4kHz (wide), 2.2kHz (narrow)
SSB-data T/R switch speed: mute-Tx 10-50ms, Tx-mute 5ms, mute-Rx 35ms, Rx-mute 1ms

Intermodulation product levels are quoted with respect to PEP.

NOTE: all signal input voltages given as PD across antenna terminal. Unless stated otherwise, all measurements made on USB with receiver preamp switched out, 2.4kHz bandwidth sharp filter selected and 15kHz roofing filter.