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Second coming

Peter Hart described the original Orion transceiver as "truly awesome" in his June 2004 review. What does he have to say about its successor – the Orion II?

PHOTO 1. THE ORION II FRONT-ON, SHOWING THE CRISP NEW COLOUR DISPLAY

Ten-Tec launched the Orion HF transceiver in 2003 as a high performance radio, setting the state of the art for close-in dynamic range. The company has now released the Orion II with a number of enhancements.

Ten-Tec radios are invariably designed for good RF performance and I have measured five of their models. In my league table of measured performance based on about 60 radios, and ordered by close-in dynamic range, four Ten-Tec models feature in the top six with the Orion holding the top position. Much of this is down to the architecture focusing on the amateur bands only rather than wideband general coverage.

The Orion is targeted as a home station radio with a 100W transmitter and two independent and fully featured receivers. One receiver covers amateur bands only and is optimised for highest performance whereas the second receiver provides general coverage operation. The most obvious and striking difference with the new Orion II model is the full colour display in place of the original monochrome panel. Other changes include new roofing filters and associated circuitry with improved performance, better frequency stability, faster control processor, variable line output levels for digital modes, 8-pin microphone jack and changes to enhance and compact the DSP code.

It is available in two versions, model 566 without an auto ATU and model 566AT with an internal auto ATU. The feature set and architecture are virtually identical to the original Orion I reviewed in the June 2004 RadCom. The front and rear panel layouts and construction are also the same. Only a summary of the Orion II features will be covered in this review, refer to the earlier article for further details.

BASIC FUNCTIONS. The Orion II is a large table-top sized 12V operated radio measuring 432mm (W) x 133mm (H) x 476mm (D) and weighs about 9.2kg. The main receiver and transmitter tune the 160m to 10m amateur bands (including the 60m allocation) with a little overlap. The second or sub receiver tunes from 100kHz to 30MHz, although the sensitivity drops sharply below 1MHz, making the receiver unusable at the lower frequencies. Modes covered are USB, LSB, CW (upper and lower sideband), AM, FM and FSK.

Both receivers in the Orion II use triple superhet architecture. The main receiver covering just the amateur bands has IFs of 9MHz, 450kHz and 14kHz. Although the main channel selectivity is achieved by DSP at the 14kHz IF, a range of narrow 9MHz roofing filters are selectable immediately following the first mixer. This ensures the very best close-in dynamic range is achieved. 20kHz, 6kHz, 2.4kHz and 1kHz bandwidth filters are fitted as standard with 1.8kHz, 600Hz and 300Hz as optional extras.

All filters can be fitted simultaneously and can be selected manually or automatically according to selected channel bandwidth. Narrow preselection filters are used in the front end, a separate filter for each band with a switchable preamp and input attenuators. The main receiver's synthesiser uses a PLL operating in the 400-500MHz region with a DDS driven reference from a TCXO source. This is then divided down to the required first mixer local oscillator frequency using high-speed dividers. This technique ensures very low close-in phase noise.

The sub-receiver has IFs of 45MHz, 455kHz and 14kHz and uses circuitry similar to the Jupiter. The receiver front end uses half octave switchable bandpass filters, a non-switchable preamp and input attenuators. The local oscillator drive for the first mixer is derived from a single loop PLL tuning in 2.5kHz steps. The smaller tuning step sizes are accommodated within the DSP. Hence the signals within the IFs move by up to 2.5kHz.

Both receivers use identical DSP IF and back-end circuitry. 24-bit A/D converters are used to drive the two 32-bit floating point DSPs. The PA unit on the rear panel is fitted with a heatsink but no fan. The radio runs sufficiently cool under normal circumstances without a fan. The 4-inch speaker in the case top is much larger than is normally fitted in most radios.

The rear panel carries an extensive array of interface connectors. There are two main antenna sockets, a receive-only antenna socket, transverter output, interfacing to PC, QSK and non-QSK linear amplifiers, audio lines etc. The firmware in the radio can be upgraded from the Ten-Tec technical support website **www.rfsquared.com**, as can various application notes etc.

SUMMARY OF FEATURES. The radio is fitted with two 50mm-diameter VFO tuning knobs that may be assigned to either receiver or transmitter in any combination and with frequency readout continuously displayed to 1Hz resolution. 200 memories are provided. There is a conventional analogue S-meter for the main receiver but the sub-receiver is only provided with a small uncalibrated bargraph on the LCD panel.

Most of the receiver functions can be set independently for the two receivers. This includes all the bandwidth, filtering and noise reduction facilities, RIT/XIT, RF gain, squelch and AGC. The AGC has three preset settings of fast, medium and slow and a fully programmable setting. The two receivers have separate audio gain controls

and the audio outputs can be routed in a number of ways, either combined or kept separate to headphone or auxiliary outputs. One interesting feature is the binaural panoramic stereo feature when used with stereo headphones.

Two DSP circuits provide identical and separately controllable filtering and noise reduction facilities for the two receivers. A front panel rotary control allows the channel bandwidth to be set from 100Hz to 6kHz in 10Hz steps. The upper and lower passband edges can also be individually set and passband tuning allows the entire passband to be moved up or down in frequency.

Two notch filters are provided operating at IF upfront of the DSP AGC. A manual notch with adjustable centre frequency and width is particularly effective and deep. An auto-notch for voice modes will track and notch out multiple carriers and is also very effective. Adjustable DSP noise blanking and adjustable DSP noise reduction are also provided and can be effective in lowering background noise.

Transmit features include VOX, speech processor and fully configurable audio. On CW, the rise and fall characteristic of the keying envelope is adjustable and a keyer is built in with adjustable weighting and speed range. Three memory stores are provided for both CW and voice modes, easy to access via dedicated front panel buttons.

The Orion also provides a spectrum sweep showing signals up to +/-36kHz on either side of the main receiver frequency and unlike other implementations of this feature it is continuous and does not interrupt the operation of the receiver.

FIGURE 1

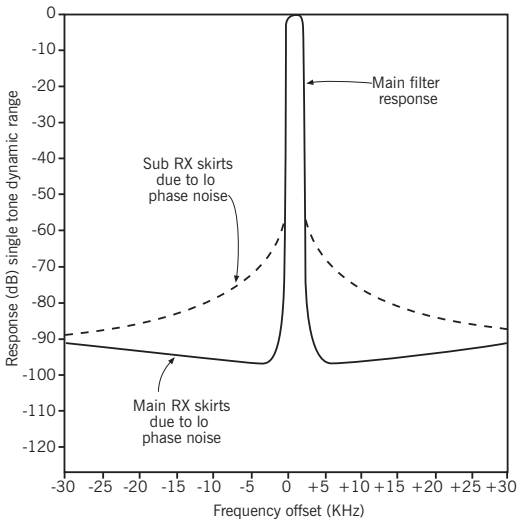

FIGURE 1. THE ORION II'S RECIPROCAL MIXING EXHIBITS THE UNUSUAL CHARACTERISTIC OF IMPROVING CLOSE TO THE CARRIER

MEASUREMENTS. Measurements in the accompanying table were made with the review radio powered from a 13.8V supply and in most cases with the receiver bandwidth set to 2,400Hz. Close-in dynamic range measurements were made with a 500Hz receive bandwidth. Receiver measurements relate to the main receiver unless sub-receiver is stated.

The measured figures for the Orion II were similar in most cases to the Orion but there were some differences. Sensitivity was slightly higher but the S-meter was noticeably less linear. The third order intercept and dynamic range figures of the main receiver at wide spacings were perhaps slightly worse but close-in significantly better than the original model. This is a result of the new roofing filters. With 1kHz spaced tones and the 1kHz roofing filter selected, 96dB intermodulation limited dynamic range was measured in 500Hz bandwidth (this equates to about 92dB in 2.4kHz bandwidth which I normally measure and publish). This is higher than any other radio I have measured. The sub-receiver also measures significantly better on both wideband and close-in dynamic range.

The reciprocal mixing results are very similar and exhibit the unusual characteristic of improving close to the carrier (**see Figure 1**). These figures were measured at 21.4MHz but a set of measurements made at 1.8MHz showed a significant improvement. This is a consequence of the dividing down system employed with the synthesiser and is not seen with up-conversion radio architectures. At 1.8MHz a reciprocal mixing level over 100dB was achieved at all spacings from 2kHz upwards. An oscillator phase noise result of -135dBC/Hz was measured at 2kHz offset.

The IF filter skirts at the narrower bandwidth settings were much improved over the original Orion with none of the spurious peaks seen on the stopband skirts. A spurious signal limited measurements of the higher bandwidth filters. The main receiver exhibited a spurious response 6kHz off-tune and only 48dB down but only on SSB modes and only with the 6kHz roofing filter selected. This was also seen on the original Orion.

ON THE AIR. The Orion II performed in a similar fashion to the original Orion. The receiver sounded extremely clean in all situations both with weak signals and when the band was crowded with strong signals. The ability to copy weak signals cleanly amongst stronger signals was impressive, helped by the ease of varying the bandwidth, PBT and the really effective notches. The audio quality was excellent both on headphones and on the internal speaker. The larger than normal hi-fi style speaker really helps. The performance on broadcast AM was also excellent. The new colour display is very bright and easy to read and makes the old monochrome display look dated. At the highest brightness setting, the display is fully readable in bright sunlight but a lower setting is preferred indoors. If the display is not viewed square-on some of the button labels can be obscured by the bezel, particularly those in the top row.

On transmit, audio quality reports were excellent and CW QSK performed well. As with the original Orion, I found a compromise setting for the linear drop-back delay between CW and SSB modes necessary with my non-QSK linear. The QSK drop back delay and the linear drop back delay are totally separate adjustments and I had some difficulty achieving a

PHOTO 2. UNDERNEATH THE TOP COVER SHOWING IF, LPF AND SUB RX BOARDS

suitable balance between the two. On CW, you do not want the linear dropping back to receive between words but on SSB when you release the PTT you want the linear to drop back to receive immediately. The linear drop back delay is applied to all modes but on CW should really only take effect after the QSK delay has finished.

Control ergonomics are generally a matter of personal taste and it takes a little time to get the best out of the Orion and become fully acquainted with all its facets. I largely prefer dedicated controls rather than the multipurpose rotary control and selector buttons used on the Orion. I often found myself setting the sub-receiver instead of the main or vice versa as the appropriate button had not been selected. It requires a minimum of two button presses to change modes and I observed some key bounce at times. The main receiver has separate band buttons but changing bands on the sub-receiver requires several key presses and there is no provision for quick-split setting.

My biggest disappointment concerns the VFO tuning knob resolution. These are nice and large and can tune in a variety of step sizes from 1Hz to 100kHz but at only 62 (default) or 250 steps per knob revolution. This may be fine for tuning the CW ends of the lower bands but is not ideal for the wider SSB sectors on the higher bands. Even 20 years ago, 1000 steps per knob revolution was the norm in top end radios and this degree of resolution has been used since then in the most popular models. It gives a good compromise between small step size for accurate tuning and fast band navigation. With the Orion, it is necessary to switch back and forth between step sizes when tuning across the SSB sectors. A button is provided for this purpose.

CONCLUSION. The Orion transceiver established the benchmark for close-in performance. The new Orion II improves further on this important parameter to achieve a performance figure currently unsurpassed by any other radio on the amateur market. With a bright new multicolour display and other enhancements, it will appeal particularly to the serious CW operator and technically minded DX chaser, or the contest operator who desires the very best in terms of performance. I have some doubts regarding certain ergonomic aspects but these tend to be down to individual preferences.

The Orion is available in the UK with a list price of £3349 or £3599 if fitted with the auto antenna tuner. This is a 30 per cent increase in price over the original Orion from two years ago.

TEN-TEC ORION II MEASURED PERFORMANCE
Receiver measurements

	SENSITIVITY SSB 10dBs+n:n			INPUT FOR S9	
FREQUENCY	PREAMP IN	PREAMP OUT	SUB RX	PREAMP IN	PREAMP OUT
1.8 MHz	0.28µV (-118dBm)	0.56µV (-112dBm)	0.45µV (-114dBm)	18µV	80µV
3.5 MHz	0.28µV (-118dBm)	0.63µV (-111dBm)	0.32µV (-117dBm)	16µV	70µV
5.4 MHz	0.28µV (-118dBm)	0.63uV (-111dBm)	0.28µV (-118dBm)	14µV	63µV
7 MHz	0.32µV (-117dBm)	0.70µV (-110dBm)	0.32µV (-117dBm)	18µV	70µV
10 MHz	0.40µV (-115dBm)	0.90µV (-108dBm)	0.35µV (-116dBm)	20µV	80µV
14 MHz	0.28µV (-118dBm)	0.70uV (-110dBm)	0.32µV (-117dBm)	18µV	80µV
18 MHz	0.28µV (-118dBm)	0.80µV (-109dBm)	0.35µV (-116dBm)	20µV	90µV
21 MHz	0.32µV (-117dBm)	0.90µV (-108dBm)	0.35µV (-116dBm)	22µV	100µV
24 MHz	0.32µV (-117dBm)	1.0µV (-107dBm)	0.32µV (-117dBm)	22µV	100µV
28 MHz	0.35µV (-116dBm)	1.0µV (-107dBm)	0.35µV (-116dBm)	22µV	100µV

AM sensitivity (28MHz): 1.6µV for 10dBs+n:n at 30% mod depth
FM sensitivity (28MHz): 1.0µV for 12dB SINAD 3kHz pk deviation
AGC attack time: 2-3ms
AGC decay time: 250ms (fast), 500ms (med), 1.5s (slow) + variable
Max audio at 10% distortion: 2.0W into 4Ω
Inband intermodulation products: -35dB to -50dB

S-READING	INPUT LEVEL SSB		BANDWIDTH	IF BANDWIDTH			
(7MHz)	PREAMP IN	PREAMP OUT	SET TO	-6dB	-60dB	-70dB	-80dB
S3	1.6µV	7µV	6000Hz	5922Hz	6339Hz	7053Hz	8738Hz
S5	3.5µV	14µV	4000Hz	3933Hz	see text	see text	see text
S7	7.0µV	28µV	2400Hz	2341Hz	2724Hz	2905Hz	3480Hz
S9	18µV	70µV	1800Hz	1745Hz	2120Hz	2158Hz	2611Hz
S9+20	63µV	250µV	1000Hz	934Hz	1307Hz	1337Hz	1476Hz
S9+40	320µV	1.3mV	500Hz	477Hz	809Hz	840Hz	960Hz
			250Hz	212Hz	477Hz	480Hz	582Hz
			100Hz	125Hz	447Hz	543Hz	612Hz

INTERMODULATION (50kHz Tone Spacing) 2400Hz bandwidth USB

	PREAMP IN		PREAMP OUT		SUB RX	
FREQUENCY	3rd order intercept	2 tone dynamic range	3rd order intercept	2 tone dynamic range	3rd order intercept	2 tone dynamic range
1.8 MHz	+2dBm	87dB	+15dBm	91dB	+12dB	91dB
3.5 MHz	+1dBm	86dB	+14dBm	90dB	+10.5dB	92dB
7 MHz	+2dBm	86dB	+14.5dBm	90dB	+10.5dB	92dB
14 MHz	+3.5dBm	88dB	+14.5dBm	90dB	+6dB	89dB
21 MHz	+4dBm	87dB	+15dBm	89dB	+13dB	93dB
28 MHz	+5.5dBm	88dB	+17.5dBm	90dB	+7dB	89dB

CLOSE-IN TWO TONE DYNAMIC RANGE ON 7MHz BAND 500Hz bandwidth CW

FREQUENCY	SUB	MAIN RX ROOFING FILTER BANDWIDTH			
SPACING	RX	20kHz	6kHz	2.4kHz	1kHz
1 kHz	85dB	82dB	82dB	89dB	96dB
2 kHz	85dB	82dB	82dB	96dB	96dB
3 kHz	86dB	82dB	82dB	96dB	96dB
4 kHz	89dB	82dB	86dB	96dB	96dB
5 kHz	91dB	82dB	89dB	96dB	96dB
7 kHz	94dB	83dB	95dB	96dB	96dB
10 kHz	96dB	87dB	96dB	96dB	96dB
15 kHz	98dB	89dB	96dB	96dB	96dB
20 kHz	98dB	95dB	96dB	96dB	96dB
25 kHz	98dB	95dB	96dB	96dB	95dB
30 kHz	98dB	95dB	95dB	95dB	95dB

	MAIN RX			SUB RX	
FREQUENCY OFFSET	RECIPROCAL MIXING FOR 3dB NOISE	BLOCKING PREAMP IN	BLOCKING PREAMP OUT	RECIPROCAL MIXING FOR 3dB NOISE	BLOCKING
2 kHz	95dB	-18dBm	-6dBm	64dB	-24dBm
3 kHz	95dB	-9dBm	>0dBm	68dB	-24dBm
5 kHz	95dB	>0dBm	>0dBm	72dB	-24dBm
10 kHz	94dB	>0dBm	>0dBm	77dB	-13dBm
15 kHz	93dB	>0dBm	>0dBm	81dB	-11dBm
20 kHz	92dB	>0dBm	>0dBm	83dB	-4dBm
30 kHz	89dB	>0dBm	>0dBm	87dB	0dBm
50 kHz	87dB	>0dBm	>0dBm	92dB	0dBm
100 kHz	100dB	>0dBm	>0dBm	98dB	0dBm
200 kHz	104dB	>0dBm	>0dBm	104dB	0dBm

TRANSMITTER MEASUREMENTS

	CW POWER		INTERMODULATION PRODUCTS	
FREQUENCY	OUTPUT	HARMONICS	3rd order	5th order
1.8 MHz	102W	-62dB	-38dB	-51dB
3.5 MHz	102W	-61dB	-38dB	-51dB
5.4 MHz	98W	-62dB	-38dB	-52dB
7 MHz	99W	-58dB	-36dB	-46dB
10 MHz	100W	-51dB	-36dB	-50dB
14 MHz	100W	-80dB	-32dB	-40dB
18 MHz	101W	-68dB	-34dB	-44dB
21 MHz	101W	-65dB	-30dB	-42dB
24 MHz	102W	-66dB	-30dB	-42dB
28 MHz	103W	-61dB	-36dB	-44dB

Two-tone transmitter intermodulation product levels are quoted with respect to PEP.
Transmitter AF distortion: 2%
Microphone input sensitivity: 3mV
FM deviation: 5kHz
SSB data T/R switch speed: mute-TX 26ms, TX-mute 10ms, mute-RX 36ms, RX-mute 14ms

NOTE:
All signal input voltages given as PD across antenna terminal. Unless stated otherwise, all measurements made on USB, preamp switched out, 2400Hz bandwidth, 2.4kHz roofing filter and with a 13.5V supply.