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The Ten-Tec Jupiter HF transceiver

A DSP transceiver that may easily be PC controlled, the Jupiter is the latest from the US Ten-Tec stable.

In 1999 Ten-Tec introduced the Pegasus transceiver, a fully featured HF radio for use with a Windows PC. There was no front panel as such, just a box fitted with sockets and a power switch and with all control via the PC monitor, keyboard and mouse. In 2000 Ten-Tec took the Pegasus design and added a conventional front panel, controls and display to make a standalone radio. Thus was born the Jupiter. The same feature set is retained and also the PC interface so the radio can also emulate the Pegasus in PC control mode with software freely downloadable from the Ten-Tec website. The transceiver's firmware is held in flash memory and can be updated at any time by downloads from the Ten-Tec website. New features can be added: a recent update provides for 5MHz transmit coverage. Although the Jupiter has been available in the USA for some time, it has only recently received CE approval for sales within Europe. It is available in two versions, model 538 without auto ATU and model 538AT with internal auto ATU fitted. The ATU can be fitted at a later date if needed. The non-ATU version was the model supplied for review.

BASIC FUNCTIONS

The Jupiter is a table-top sized 12V operated radio measuring 308W x 144H x 350Dmm and weighs about 5.5kg. The receiver tuning range is specified from 100kHz to 30MHz but it continues to tune all the way down to DC although the sensitivity at low frequencies is very much reduced. The transmit segments are confined to the amateur bands with a bit to spare and the transmit power is nominally 100W maximum. Modes covered are USB, LSB, CW, AM and FM. Digital modes make use of the SSB modes with AFSK input. A menu item toggles the transmit audio source between the microphone and the accessory jack on the rear panel. The receiver bandwidth can be tailored to suit the different tone standards by suitable adjustment of the bandwidth and PBT (passband tuning) controls but no frequency display offset is provided.

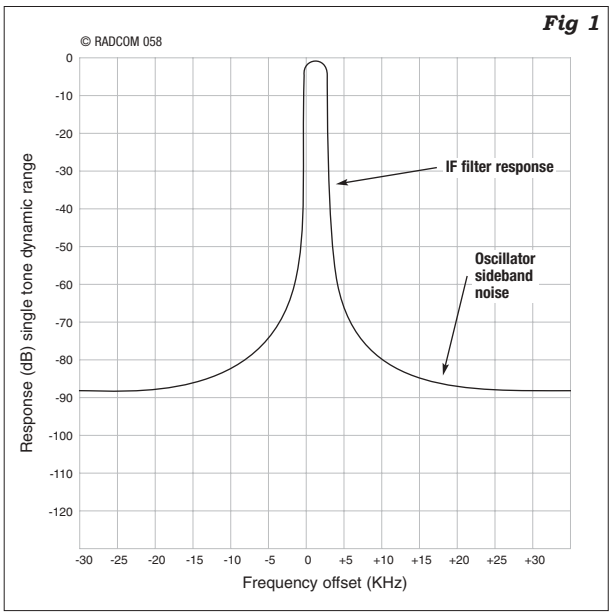
The Jupiter front panel is clearly laid out with spacious buttons and good-sized controls. As every control except the power on/off switch may be computer operated, the rotary controls are all digital encoders. Dedicated rotaries are used for the main tuning, RIT, bandwidth and PBT and a multifunction rotary control is switchable to other functions such as RF and AF gain, power output, microphone gain and squelch. Surprisingly, the AF gain control is not a dedicated rotary so I left the

The Jupiter's rear panel.

multifunction control normally set to this position. A large green backlit LCD panel is used for the display giving a clear indication of the frequencies of the twin VFOs and the state of the switchable functions. A bargraph meter for the S-meter function and transmit power or VSWR also gives the numerical value and a separate slide rule bargraph shows the levels associated with the multifunction rotary also with a numerical percentage of the maximum.

The rear panel carries the usual interface connectors. Phono sockets are used for T/R functions including handshaking support for QSK linears, two auxiliary 12V outlets and a spare for custom use. DIN connectors are provided for interfacing accessories such as data terminals, sound card connections and an optional keypad. A 9-pin D connector interfaces directly to the PC serial COM port without the need for level conversion. I was surprised at how much space there is inside the cabinet but note that a Torx driver is needed to remove the screws. The radio could have been made significantly smaller but for a radio intended for home station use that is not necessarily an advantage. A 75mm speaker fits in the upper case top. There is a heatsink on the rear panel but no fan is fitted, the radio shutting down if the heatsink temperature exceeds 85°C. An optional fan is available but is claimed not to be necessary unless transmitting key down for extended periods such as in RTTY contests.

Fig 1: Jupiter effective selectivity curve on USB (bandwidth 2.4kHz).



The receiver is a triple superhet with IFs of 45MHz, 455kHz and 12kHz. Most of the signal processing including receiver IF filtering functions is implemented by DSP at the 12kHz IF. The receiver front end uses a push-pull FET first mixer and three parallel FETs in the RF amplifier. The RF amplifier is in-circuit all the time but there is a switchable 20dB attenuator for very strong signal situations. Conversion to the second and third IFs uses diode balanced mixers and gain is carefully controlled up-front of the DSP with AGC applied to the RF amplifier and first IF stages. AGC detection is done partly by the DSP but also at the second IF so there can be some AGC control from big signals outside of the main filter passband but inside the roofing filter bandwidth. 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. A built-in TCXO reference ensures good frequency accuracy and stability.

As standard, the Jupiter transceiver is provided with various plugs and leads including a full accessory jack lead and a microphone plug, but the microphone is an extra. The radio accommodates most microphone types including electret and Ten-Tec supply hand and desk models. The radio is shipped with a comprehensive operator's manual covering the installation and operation and a full set of circuit descriptions, schematics and part lists. However, I did come across numerous errors in the manual.

FEATURES

Most of the features of the radio are clearly implemented and easy to select. Some of the lesser-used functions are accessed via the menu system but this is also easy to access. A band button scrolls through the bands and a mode button through the modes. The 50mm diameter rotary tuning knob tunes in a variety of step sizes from 1Hz to 100kHz but at only 120 steps per knob revolution. The usual twin A/B VFOs are provided with facilities for split operation and the frequencies of both are continuously displayed. 128 memories are available for storing frequencies and mode and RIT and XIT are both provided giving offset tuning up to ±8kHz.

All selectivity related features are implemented in DSP. 34 different receiver bandwidth settings between 300Hz and 8kHz may be selected by a rotary control on all modes and a separate PBT rotary control shifts the bandwidth by up to ±8kHz in 10Hz steps. This is useful for combating QRM and optimising the passband on data modes. The effective selectivity curve on USB, with the bandwidth set at 2.4kHz, is shown in **Fig 1**. DSP noise reduction may be selected which is effective at removing broadband noise by up to 15dB and an automatic notch operates at audio which is reasonably effective at removing continuous heterodynes. Other receive functions include an impulse noise blanker selected via the menu sys-

TEN-TEC JUPITER MEASURED PERFORMANCE

RECEIVER MEASUREMENTS

FREQUENCY	SENSITIVITY SSB 10dBs+n:n	INPUT FOR S9
1.8MHz	0.56µV (-112dBm)	63µV
3.5MHz	0.40µV (-115dBm)	40µV
5.4MHz	0.32µV (-117dBm)	35µV
7MHz	0.32µV (-117dBm)	35µV
10MHz	0.35µV (-116dBm)	40µV
14MHz	0.35µV (-116dBm)	45µV
18MHz	0.40µV (-115dBm)	50µV
21MHz	0.49µV (-115dBm)	50µV
24MHz	0.45µV (-114dBm)	56µV
28MHz	0.50µV (-113dBm)	70µV

AM sensitivity (28MHz): 2.2µV for 10dBs+n:n at 30% mod depth

FM sensitivity (28MHz): 0.45µV for 12dB SINAD 3kHz pk deviation

AGC threshold: 18µV

100dB above AGC threshold for <0.5dB audio output increase

AGC attack time: 2ms (see text)

AGC decay time: 100ms (fast), 1s (medium), 8s (slow)

Max audio at 5% distortion: 1.0W into 4Ω (see text)

Inband intermodulation products: -20dB to -40dB

S-READING (7MHz)	INPUT LEVEL SSB
S3	0.5µV
S5	2.2µV
S7	9.0µV
S9	35µV
S9+20	350uV
S9+40	2.5mV
S9+60	100mV

FILTER	IF BANDWIDTH -6dB	-60dB
6kHz	5675Hz	see text
3.9kHz	3710Hz	see text
2.4kHz	2418Hz	see text
1.8kHz	1837Hz	see text
900Hz	988Hz	see text
525Hz	660Hz	see text
300Hz	472Hz	see text

INTERMODULATION (50kHz Tone Spacing)

Frequency	3rd order intercept	2 tone dynamic range
1.8MHz	+6.5dBm	86dB
3.5MHz	+6.5dBm	88dB
7MHz	+6dBm	89dB
14MHz	+9dBm	90dB
21MHz	+10dBm	90dB
28MHz	-3dBm	80dB

CLOSE-IN DYNAMIC RANGE MEASUREMENTS ON 7MHz BAND

FREQUENCY SPACING	3rd ORDER INTERCEPT	TWO TONE DYNAMIC RANGE	BLOCKING	RECIPROCAL MIXING FOR 3dB NOISE
3kHz	-26dBm	67dB	-34dBm	68dB
5kHz	-14dBm	75dB	-33dBm	71dB
7kHz	-10dBm	78dB	-23dBm	74dB
10kHz	-5dBm	81dB	-13dBm	78dB
15kHz	+1.5dBm	86dB	-8dBm	82dB
20kHz	+4dBm	87dB	-6dBm	84dB
30kHz	+5dBm	88dB	-6dBm	88dB
40kHz	+6dBm	89dB	-6dBm	90dB
50kHz	+6dBm	89dB	-6dBm	92dB
100kHz	+6dBm	89dB	-6dBm	99dB
200kHz	+6dBm	89dB	-6dBm	106dB

TRANSMITTER MEASUREMENTS

FREQUENCY	CW POWER OUTPUT	HARMONICS	INTERMODULATION PRODUCTS 3rd order	5th order
1.8MHz	100W	-56dB	-32 (-26)dB	-41 (-35)dB
3.5MHz	100W	-57dB	-28 (-22)dB	-39 (-33)dB
5.4MHz	91W	-62dB	-28 (-22)dB	-41 (-35)dB
7MHz	98W	-49dB	-30 (-24)dB	-38 (-32)dB
10MHz	99W	<-75dB	-28 (-22)dB	-36 (-30)dB
14MHz	99W	-67dB	-35 (-29)dB	-36 (-30)dB
18MHz	100W	-54dB	-36 (-30)dB	-38 (-32)dB
21MHz	100W	-63dB	-30 (-24)dB	-38 (-32)dB
24MHz	101W	-62dB	-36 (-30)dB	-38 (-32)dB
28MHz	101W	-60dB	-32 (-26)dB	-35 (-29)dB

Two-tone transmitter intermodulation product levels are quoted with respect to PEP, figures in brackets are with respect to either tone.

Carrier suppression: 50dB approx

Sideband suppression: >70dB @ 1kHz

Transmitter AF distortion: <1%

Microphone input sensitivity: 7 - 40mV

FM deviation: see text

SSB T/R switch speed: mute-TX 20ms, TX-mute 12ms, mute-RX 40ms, RX-mute 4ms

NOTE: All signal input voltages given as PD across antenna terminal. Unless stated otherwise, all measurements were made on USB with a 13.8V supply and 2.4kHz bandwidth setting.

tem, three selectable AGC speeds, an all-mode squelch and high boost tone control.

On transmit, the power output is adjustable from a few watts to 100W, a selectable speech processor is provided and the transmit audio response may be tailored to suit individual preferences. DSP filtering provides 18 bandwidth settings from 900Hz to 3900Hz and the low frequency roll-off is adjustable. This last menu item was added during a firmware update and post-dates the current manual. An audio monitor and VOX facilities are also provided but to use the Ten-Tec hand microphone on VOX the short across the mic insert on receive should be removed from the PTT switch. A tune button transmits a carrier on all modes at either the selected power level or at the 10W level.

On CW, full QSK with adjustable delay and support for both QSK and non-QSK linears is provided. CW sidetone and pitch may be set over a wide range and a spot button provides an accurate netting tone. A built-in keyer for external paddles may be selected operating over the wide range of 1 to 63WPM. The dot/dash weighting is fixed but the dot/space weighting is adjustable. There are no memories or contest modes.

The Jupiter includes a sweep and spectrum display facility with eight selectable sweep widths from 240Hz to 2.4MHz. These are displayed at a high resolution of 240 frequency steps per scan and the receiver is briefly muted whilst the sweep is in progress. An auto mode can select a fresh sweep when changing bands or frequencies outside the scan range.

PC CONTROL

Software downloads to update the firmware and for Pegasus emulation control are available free of charge from the Ten-Tec technical support website (see 'Websearch' below). Both downloads are about 750KB each and are executable files which install easily and link to the radio via a serial COM port. During the period I had the radio, I upgraded the firmware from v1.24 to v1.26 which took about 40 seconds. The Pegasus control software seemed fairly undemanding and I had it running satisfactorily in Windows 3.1, 98 and XP with machine speeds from 25MHz to 2GHz.

When the Pegasus control software is started, the radio switches automatically to PC control mode showing a virtual front panel on the PC monitor. Local front panel settings are stored and the remote Pegasus settings enabled. Similarly exiting Pegasus mode stores the

Top: The 'virtual transceiver' on the monitor when the Jupiter is controlled from a PC.

Below right: The Jupiter transceiver under the top cover, showing the RF board.

remote settings and returns the local settings, settings cannot be shared. Emulation of the rotary tuning knob is rather slow and cumbersome but an optional remote keypad and tuning knob directly equivalent to that on the front panel is available. Sliders are used instead of rotary controls and a fast tuning slider speeds rapid frequency changes. Many facilities are better implemented, eg separate buttons for modes and also for bands and there are a number of additional features not available on the Jupiter alone. Memory stores are much more comprehensive with various text fields and sweep functions are more informative. Overall a worthwhile addition and a different operating experience.

MEASUREMENTS

Measurements shown in the table were made with the review radio powered from a 13.8V supply and the receiver bandwidth set to 2400Hz. The supplied power cable looks rather thin but only dropped 0.2V under full transmit output.

The receive sensitivity is lower than most radios but still entirely adequate for practical antennas. Below 500kHz the sensitivity drops away sharply, measuring 140µV at 136kHz for 10dB s+n:n. The overall gain is also quite low with the AGC threshold set at about S8 (18µV). This yields a quiet background noise level but weak signals give less audio than strong ones unlike many radios. S-meter range and linearity are excellent and spurii and images fairly low. A number of low level 'birdies' can be heard across the tuning range but none are of consequence within the amateur bands. The third order intercept is reasonable but the lower sensitivity yields a below average two tone dynamic range. Reciprocal mixing is also fairly poor. The DSP IF filters have excellent flatness and steep sides but meaningful measurements at -60dB were compromised by the effects of oscillator noise (reciprocal mixing) and AGC action. A wide range of AGC decay times are provided but the attack time suffered 10ms or more overshoot. The audio output could be driven to at least 2W but at this level it overheated and collapsed after a few seconds. Note that the speaker drive is balanced and neither side of the external speaker output should be grounded. When tuning close to carriers strong clicks could be heard every 2.5kHz. This is a consequence of the synthesiser architecture adopted in this radio and was also observed during on air testing.

Transmit SSB intermodulation products were generally quite reasonable and not significantly degraded by the speech processor. CW keying was clean with low distortion and reasonable rise and fall times although the first attack edge was noticeably sharper. Full QSK and delayed QSK gave identical results. On FM there did not appear to be a deviation limiter but deviation was about 1.5kHz with the microphone gain set as for SSB use.

ON THE AIR

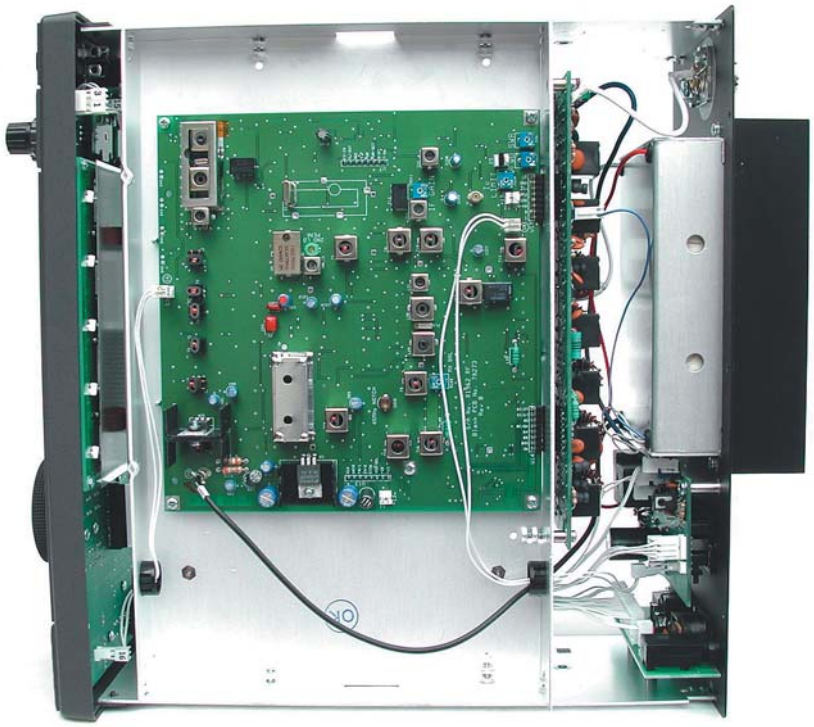
I found the Jupiter generally easy to use with its spacious well laid out panel and a good all round performer. On transmit good quality reports were received on SSB with the Ten-Tec hand microphone and the CW QSK was very effective. Receive sensitivity seemed just about adequate and I experienced no serious strong signal problems on 40m although slight overload could be heard with exceptional signals. The audio quality on headphones in particular was excellent. However, I did find tuning clicks every 2.5kHz near strong signals, most noticeable on the broadcast bands. DSP filter selection was excellent but I think that other implementations may have narrower skirts particularly on the lower bandwidth filters. It would be better if mode selection returned the last used filter bandwidth on that mode rather than link this to the band selection. DSP noise reduction was very effective in removing background noise on armchair copy signals but did not improve readability on weak signals. The automatic notch was not as effective as some other DSP implementations of this feature.

Generally the user ergonomics are very good but there are a couple of areas for improvement. The rotary tuning knob has only 120 steps per revolution. Tuning in 10Hz steps is smooth but tediously slow, 100Hz steps are too coarse. Constant switching between step sizes is needed to navigate the bands effectively. Even 20 years ago 1000 step/revolution rotary encoders were the norm. Band and mode keys only scroll in one direction although the band key will step backwards if two keys are pressed. True bidirectional scrolling would be an advantage. The AGC setting defaults to medium at switch-on and some other front panel settings to their default (off) value.

CONCLUSIONS

The Jupiter is a good all-round mid range radio, easy to use and a good CW performer. A major strength is the ability to upgrade the firmware and the ease of operating under PC control. The current list price is £1159, or £1439 with internal ATU, and it is available from Ten-Tec Direct (4E East Mill, Bridgefoot, Belper, Derbyshire DE56 2UA; tel: 01773 880788) and UK agents.

My thanks to Ten-Tec Direct for the loan of the review radio. ◆



WEB SEARCH

Ten-Tec technical support:	www.rfsquared.com
Ten-Tec Direct UK:	www.aoruk/tentec