## EQUIPMENT REVIEW


# The Yaesu FT7 hf transceiver

by I. H. CROWTHER, G3KLF*

WHEN the reviewer ordered his Yaesu FT7 in April 1978, very little information about it was available, apart from the fact that it was a 10W ssb/cw transceiver working directly from 12V dc, designed for mobile use on the 3·5 to 28MHz bands. First impressions, subsequently confirmed, were of delight when the FT7 was revealed to be physically all that was expected; a very sturdy dark-grey case 3in high, 9in wide and 11in deep, complete with mobile mounting bracket, small accessories and microphone. The whole cabinet can be rested on a tilt-up foot arrangement to present the front panel conveniently to the user.

The controls are all easily operated and clearly marked. The tuning mechanism is superb, with a clear 1kHz resolution on a linear 500kHz scale. Inset into the tuning dial the letters CLAR/FIX indicate which facility is in use. The pa current/S-meter is easy to read and is illuminated. Plug-in boards are used extensively for ease of servicing. A feature of the FT7 is the single knob tune-up facility, made possible by an all-solid-state pa unit and lpf in the final rf amplifier stage.

The specification shows the transmitter to be basically a 10W rf output unit, covering 3·5–28MHz with ssb and cw capability. On the receive side, a single conversion plus a pre-mixer is reasonably conventional, with an added bonus that the rf stage uses a dual-gate mosfet followed by a hot carrier Schottky diode mixer. Spurious emissions from the transmitter are quoted at better than −40dB, and receiver sensitivity 0·25μV for 10dB s/n, providing some 3W audio output.

The reviewer began his tests by connecting the FT7 to a 25W dummy load and switching on the 100kHz built-in calibrator labelled MARK. The calibrator is interesting as it employs a 12·6MHz crystal which is divided down by ttl to give 100kHz calibration pips of constant amplitudes on all bands covered.

The FT7 was switched from 3·5 to 28MHz. Note that on the 28MHz section the 10B crystal only is fitted, and three extra crystals have to be purchased to cover the full 28MHz band. The desired crystal replaces the 10B crystal, as only one 28MHz position is provided on the front panel bandswitch, and only one crystal holder is available inside the cabinet. Thus, to operate 28 to 28·5MHz the top cover must be removed (two screws) and the 10A crystal inserted.

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The S-meter readings noted after peaking the tune knob, and setting rf gain to maximum were:

| Band | Reading | |
|---|---|---|
| 3·5MHz | 9 | +15dB |
| 7MHz | 9 | +30dB |
| 14MHz | 9 | +27dB |
| 21MHz | 9 | +25dB |
| 28MHz | 9 | +25dB |

This was very satisfactory, and a pleasant change from many receivers where the markers tend to disappear as higher frequencies are tuned. Next, the hf signal generator was connected and the bands were checked for sensitivity and signal/noise; 10dB s/n was obtained on all bands for 0·5μV pd.

Testing the transmitter followed, with a commercial 25W 50Ω absorption wattmeter again used to absorb the rf output. The FT7 was connected to a 13·8V dc supply, switched to the cw position, and keyed. The FT7 employs automatic key-operated t/r on cw, with a variable delay on return to receive. The tuning was peaked and the process repeated for the remaining bands. Power output obtained was:

| Band | Output (W) | PA current (A) |
|---|---|---|
| 3·5MHz | 15·5 | 3·0 |
| 7MHz | 15·5 | 3·5 |
| 14MHz | 14·0 | 3·7 |
| 21MHz | 14·2 | 3·5 |
| 28MHz | 11·5 | 3·7 |

Note: pa current is for pa transistor and driver combined; therefore, pa current is actually 0·5A below that indicated on the meter.

The manual describes at length the alc technique employed to protect the pa transistors, and this is worthy of special notice. In effect, a directional wattmeter is housed in the FT7 pa section, measuring forward and reflected power to the load. Forward power is sampled and rectified to feed back via a level setting potentiometer (accessible through the rear panel). The transmitter output is therefore presetable to the desired level by adjustment of the alc potentiometer. Reflected power is also sampled simultaneously and is fed back to the same point as forward power. The reflected power, therefore, also reduces the transmitter output: in theory this should protect the pa against mismatch.

It was decided at this stage to check the alc setting according to the method outlined in the manual. The check is easily carried out as only a 1:1 swr into the load is required.

Following the instructions to the letter for setting alc allowed the transmitter to supply power to the load as follows:

| Band | Output (W) | Ipa (A) |
|---|---|---|
| 3·5MHz | 25 | 4·0 |
| 7MHz | 25 | 3·8 |
| 14MHz | 23 | 3·8 |
| 21MHz | 23 | 3·5 |
| 28MHz | 20 | 3·8 |

This allows the alc to just operate on speech peaks, as is usual. The waveform was clean and undistorted. So it seemed that the reviewer had bought a 25W transceiver, not 10W as advertised. The specification for the output devices was checked and this indicated that 25W was the correct ssb or cw output for a 13·8V supply.

This was at such variance with the 10W figure quoted in the specification, that Yaesu were contacted by letter and asked to comment. They replied by return of post that this sort of figure was perfectly ok into a dummy load, and that they used the alc to reduce the power to around 12 to 15W in the factory to protect the pa when working into an indifferent antenna such as might be found on a mobile installation. At first this sounded sensible, and the transmitter power was accordingly reduced to 15W output. The manual does, in fact, stress that antennas or atus should be pretuned to 50Ω with another transmitter prior to connecting the FT7.

On reflection though, it seemed that there was a degree of confusion between alc derived from forward power, and alc from reflected power. Yaesu seemed to be saying that forward derived alc was being used to protect the pa from mismatch, when in fact this would appear to be the function of reverse alc. Experiments into a mismatched load showed that less forward power reduced forward power alc, thus causing the output to rise towards the previously mentioned 25W to the point where reverse power derived alc came into action and reduced pa drive and rf output. Therefore, the pa settled down at an intermediate level which was determined by the degree of mismatch.

This in itself is acceptable, once understood, although it could be sudden death to the pa if the mismatch were very large, ie atu on wrong band or far off tune. In practice this can cause the meter to go to fsd before the tuning is peaked. This serves to emphasize to other users that Yaesu mean what they say about only transmitting into a matched antenna.

In the reviewer's opinion there is actually no harm in setting the alc as per the manual, which results in 25W in the load. The pa transistors are within limits and no heating is noticed

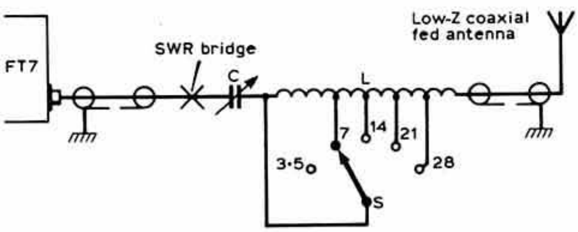
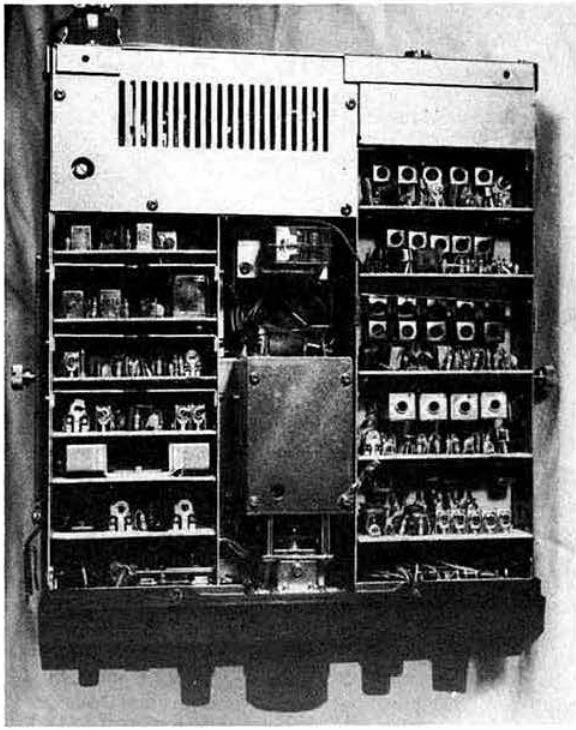



**Fig 1. ATU circuit diagram for coaxial trap dipole. C: 50pF air-spaced variable; plate spacing of 1mm satisfactory. S: low-loss ceramic five-way single pole rotary. L: 3·5cm outside diameter, 8cm long, wound 6t/cm 22swg bare tinned copper, tapped in from capacitor (depending on whether cw or ssb end of band is preferred) 3 to 5t for 3·5MHz, 7t for 7MHz, 25t for 14MHz, 40t for 21MHz, 46t for 28MHz. Note that C must be isolated from chassis on both sides with, for preference, a paxolin or nylon drive shaft to minimise hand capacitance**



**Interior view of the FT7**

around the case vents. If an antenna is mismatched, reverse power derived alc will reduce pa drive and hence rf output. However, Yaesu recommend that forward alc be used to reduce power to 12–15W if continuous carrier is contemplated.

The transmitter was checked for spurious emissions using a spectrum analyser with the following results:

| Band | Ref dB | Harmonic (dB down) | | | |
|---|---|---|---|---|---|
| | | 2nd | 3rd | 4th | 5th |
| 3·5MHz | 0 | 32 | 50 | 40 | > 60 |
| 7MHz | 0 | 35 | 35 | 45 | 35 |
| 14MHz | 0 | > 60 | 43 | 50 | 45 |
| 21MHz | 0 | > 60 | 40 | 40 | > 60 |
| 28MHz | 0 | 58 | > 60 | > 60 | > 60 |

On 28MHz two spurii were noted: −50dB at 30MHz and −55dB at 21MHz.

An atu was then connected between the transmitter and load. The following table indicates the improvement in unwanted harmonics etc:

| Band | Ref dB | Harmonic (dB down) | | | |
|---|---|---|---|---|---|
| | | 2nd | 3rd | 4th | 5th |
| 3·5MHz | 0 | > 60 | > 60 | > 60 | > 60 |
| 7MHz | 0 | 50 | > 60 | > 60 | > 60 |
| 14MHz | 0 | 40 | > 60 | > 60 | > 60 |
| 21MHz | 0 | > 60 | > 60 | > 60 | > 60 |
| 28MHz | 0 | > 60 | > 60 | > 60 | > 60 |

Obviously the atu is worthwhile considering if a pure transmitted signal is the objective. The circuit of the atu used by the reviewer to match his FT7 to the coaxial-fed trap dipole used for all bands 3·5 to 28MHz is shown in Fig 1. It will match the FT7 to any low impedance antenna presenting a feed impedance in the range 20 to 300Ω. It was found necessary to use two tapping points for 3·5MHz in order to bring the swr to a minimum anywhere in that band.

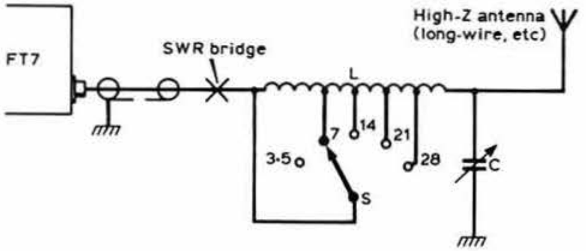


Fig 2. ATU circuit diagram for end-fed high impedance antenna. Note that tapping points will give fewer turns for any band in this configuration

Without the atu, the trap dipole only drew full power from the FT7 at its resonant point for each band, where it presents an swr of about 1·5 to 1. Away from the resonant point, the swr increased to a worse case of 3:1 on 3·5MHz, and the alc circuit in the FT7 reduced power output to less than half.

However, with the atu in circuit, and an swr bridge, a 1:1 swr could be obtained anywhere on any band, thus greatly increasing the capability of the antenna and securing the full output power from the FT7.

For anyone using an end-fed high impedence antenna, the same atu can be reconnected (and new tap points found by experiment), as shown in Fig 2.

An atu is recommended at all times, as −30dB is another way of saying 1mW/W. Thus, for 25W on 3·5MHz there will be 25mW second harmonic, and a glance at the results, using this sort of power level by a QRP station, should serve to remind the user that his harmonic will radiate quite well!

The pa tank is an lpf not bpf, and the existence of a subharmonic on 28MHz was noted. The transmitter has no vox, and Yaesu justify this by explaining that it could cause difficulties by spurious operation while mobile; this point is valid, although the option would have been worthwhile, if only for fixed station use.

USB and lsb are selected on all bands by a front panel switch, and the standard Yaesu technique of using a crystal offset by 800Hz from the carrier crystal frequency is employed for cw working. It is here that a major operating anomaly was discovered. During a QSO with a friend on 3·5MHz using his FT101E on ssb, it was decided to change to cw to obtain reports on the FT7 keying characteristic. On both stations switching to cw, it was noticed that the FT101E had to be tuned with the irt about 1·5kHz away from the original frequency to receive a 1kHz beat note from the FT7.

Careful reading of both manuals revealed that the FT7 used lsb for cw reception, and the FT101E usb. As the cw crystal in each case is displaced about 800Hz to 1kHz from the appropriate sideband crystal, it follows, for 3·5MHz only, that the FT101 and FT7 are not compatible for single frequency cw working. It was necessary to switch on the FT7 clarifier and off-set the receiver about 1·5kHz before working cw to the FT101E. This is a great inconvenience, as the unclarified offset is outside the bandpass of the FT101 cw filter.

This problem does not arise on any other band, as the other sideband crystal is used for reception of cw by the FT7, and thus the two equipments can work single frequency cw without any clarifier adjustment. Once understood, this does not present a great problem, but it could cost many dx QSOs on 3·5MHz if neglected.

A further related point disclosed itself while attempting to calibrate the dial and check the transmitter frequency. The manual instructs that the marker should be tuned for zero beat and the dial adjusted for the exact frequency. This is fine on ssb, but the reviewer chose to carry out this technique on 7MHz cw—only to find that the transmitter was 800Hz out of band! It is important that on cw the marker is tuned for a 1kHz note, not zero beat, if the user does not want to call "CQ" just below 7MHz!

CW keying is rather special. The key enables a flip-flop, thus ensuring perfect shaping of the cw waveform. The keying line is +8V at 400μA, and is easily compatible with electronic keys.

The receiver was tested on air. Selectivity seemed a good compromise between ssb and cw. An outboard audio filter would sharpen the response for those preferring keyhole operation. The reviewer prefers to hear a little of the adjacent activity, and was well pleased with the bandwidth of 2kHz.

To check cross-mode, the FT7 was used on 7MHz after dark. CW and ssb were resolved without difficulty and with good rejection of broadcast stations.

Side-tone is fixed in frequency at about 800Hz, variable in level by an internal potentiometer. Side-band suppression exceeds specification, as does carrier suppression (−60dB). On-air quality reports were exceptionally good. Stability is better than specification, and drift is hardly noticeable when compared with the marker oscillator.

**The FT7 at a special offer price of £299 incl VAT represents good value at today's prices, giving excellent communication in compact space, with good design and pleasing appearance.** □

# NEW PRODUCT

## Albol SB15M portable oscilloscope

The new SB15M lightweight portable oscilloscope from Albol Electronic is claimed by the makers to be exceedingly cost-effective for a professional/amateur instrument. They say that the bandwidth goes up to 15MHz within 3dB limits, and nine ranges of deflection give, with an accuracy of five per cent, from 10mV to 20V/cm on the 45 by 60mm measuring area of the crt. Input impedance is 1MΩ ±three per cent in parallel with 30pF, and the input voltage maximum is 400.

The time-base can be free-running or triggered, and is displayed on 19 calibrated ranges from 0·5s/cm to 0·5μs/cm. Synchronization can be either internal or external, with the ac mode giving 20Hz to 1MHz, and the hf mode 1 to 15MHz. Trigger sensitivity is said to be 0·5cm of the display on "internal", or 0·5V p-p on "external".

Bandwidth of the X amplifier, within 3dB, goes from dc to 3MHz, with an input impedance of 1MΩ in parallel with 45pF. The X deflection coefficient varies from 0·3 to 1·5V/cm. An attractive feature of this truly portable 'scope is that it can operate from 220 to 240V mains (using the optional adapter) at 50 to 400Hz, with a power consumption of 40VA, or else from internal 1·5V cells giving 12V dc (rated then at 27W).

The width of the SB15M is 150mm, depth 340mm, and height 280mm, and it weighs 7·6kg. Price is £150 plus VAT. Further information from Albol Electronic & Mechanical Products Ltd, 3 Crown Buildings, Crown Street, London SE5 0JR. Tel 01-703 2311.