Note that the fans need lubricating every six months or so.

## Circuit

As with previous reviews, it is not intended to do a full circuit analysis, other than an overview, so as to leave more space for the on-the-air results which are hopefully of more interest to the average reader.

The *TS-930S* uses a quadruple conversion technique for receive and triple conversion for CW, with IFs at 44.93, 8.83MHz, 455 and 100kHz, with the latter only used on receive. All received signals are up-converted to the first if via the VCO output, which is itself controlled in 10Hz steps (and thus sounds virtually continous).

The claimed dynamic range of 100dB (two-tone, 20 metres, 500Hz bandwidth, 0.25uV, S/N 10dB) is not designed in by omitting RF amplification ahead of the 1st mixer, as with the *FT-102* and others, but by using 2SK125 JFETs in a parallel RF amplifier circuit, with similar devices in the 1st mixer, buffer amp, and second mixer in order to achieve high signal level handling capability. The variable bandwidth controls use two variable carrier oscillators at 8.83 and 8.375MHz.

The notch filter works at the 100kHz IF, with the noise blanker operation taking place at the 2nd IF (8.83MHz) — this uses a 4 diode switch immediately ahead of the main filters.

The RF output is solid state switched to achieve full break-in operation on CW, with only a few relays to be heard for the TX lockout and attenuator switching. The PA is broadband it and the aerial for removal of any spurious signals. Another bank of nine bandpass filters is used on receive ahead of the RF amplifier.

## The *TS-930S* on the air

The rig was used over a period of 4 weeks on most of the bands available — both transmit and receive — except on the WARC bands for reasons already explained. Conditions on 10 metres were poor for the majority of the time so few contacts were made on this band. You will have to be very careful trying to keep the power down on Top Band (if you bother!). As far as the transmit side goes, not one adverse quality report was received, even with the processing wound right up, although a level of around 10dB indicated seems about best.

The PA showed no signs of stress except when a piece of paper had fallen over the rear of the unit, and caused the heatsink to overheat and bring the protection circuits into operation (at least proving they work). The rig stays

## TRIO TS-930S LAB TEST RESULTS

All tests were carried out using the equipment in upper sideband mode

### RECEIVER SECTION

Receiver sensitivity for a measured receiver SINAD of 12dB. Voltage quoted as PD

| | |
|---|---|
| 2MHz | 0.2uV |
| 3.5MHz | 0.2uV |
| 7MHz | 0.22uV |
| 14MHz | 0.22uV |
| 21MHz | 0.18uV |
| 28MHz | 0.18uV |
| 29MHz | 0.2uV |

Test for dynamic range of equipment. The intermodulation performance was measured by connecting two generators through a hybrid combiner. Generator 1 was set to 7.051MHz and generator 2 to 7.101 MHz. The equipment was tuned to 7.000MHz. The generator levels were increased until an intermod product was observed equivalent to an S4 (2uV) input signal.

The generator output levels required to induce this were 14.2mV. This is equivalent to a dynamic range of 77dB. The same test was carried out with the noise blanker switched in. No adverse effect was noted

Susceptibility to internally generated spurious signals.

The aerial input was loaded with a 50 ohm resistive source and the receiver tuned over its entire range and all spurious whistles and birdies noted. All were below AGC threshold, ie no meter indication. The frequency given was that indicated by the display

| | |
|---|---|
| 498.5kHz | 13.634MHz |
| 4.638MHz | 16.745MHz |
| 4.804MHz | 18.179MHz |
| 6.146MHz | 18.440MHz |
| 8.370MHz | 19.998MHz |
| 8.829MHz | 25.119MHz |
| 9.138MHz | 29.764MHz |
| 9.998MHz | |

The S meter calibration was checked at 7MHz

| Meter reading | input level | dB change |
|---|---|---|
| S1 | 1.1uV | 0 |
| S3 | 2.0uV | 5 |
| S5 | 3.8uV | 6 |
| S7 | 10uV | 8 |
| S9 | 32uV | 10 |
| S9+20dB | 280uV | 19 |
| S9+40dB | 2mV | 17 |
| S9+60dB | 18mV | 19 |

### TRANSMITTER SECTION

Measurements carried out with either a single 1kHz tone or two tones of 1100, 1700Hz
Intermod products quoted as dB below each tone and harmonic products dB below fundamental

| Frequency | power | intermod products (3rd, 5th order) | | harmonics (2nd, 3rd) | |
|---|---|---|---|---|---|
| 1.8MHz | 105W | 27 | 37 | 40 | 60 |
| 3.5MHz | 130W | 35 | 40 | 58 | 47 |
| 7.0MHz | 130W | 40 | 47 | 60 | 63 |
| 14 MHz | 135W | 34 | 35 | 70 | – |
| 18 MHz | 135W | 30 | 35 | – | – |
| 21 MHz | 140W | 33 | 35 | – | – |
| 24 MHz | 140W | 28 | 34 | – | – |
| 28 MHz | 140W | 28 | 31 | – | – |
| 29 MHz | 140W | 38 | 32 | – | – |

Blanks indicate that measurements have been limited by analyser range

*Ham International of Bucklands Road, Leicester supplied the review unit*

*The engineering tests were carried out by Redifusion Radio Systems, Crawley, Sussex*

### *OUR OBSERVATIONS*

The practical aspect of the review conducted by G3WPO showed that the TS-930S performed immaculately. As the man said, he almost shed a tear when it went. I have used the equipment myself and confirm that it is a beautiful and desirable piece of gear. However the lab test (conducted independently and impartially) showed up a discrepancy between perceived and measured performance.

In every electrical parameter bar one, the machine showed itself to justify the praise from those who used it. However, the measured dynamic range fell considerably short of the manufacturer's stated figure of 100dB. We measured 77dB to be precise. It is possible but doubtful that we have made a measurement error. The manufacturer specified his figure at 14MHz, CW, 10dB SINAD. We measured ours at 7MHz, SSB, 2uV intermod product. After all, 40m at night is where it counts. Having said that this crucial measurement doesn't compare well with an FT-102 (90dB) night-time 40m operation didn't show up any nasties or even mandatory use of the attenuator.

As I said at the beginning, the perceived performance is flawless.

G4JST