

REVIEW: TRIO TS-930S HF TRANSCEIVER

By Tony Bailey G3WPO



When this rig arrived for review, I had been looking forward to the event for some time, as the few people I had heard who had the transceiver seemed very impressed by it with such comments as "The best rig I have laid my hands on so far". Having had the opportunity to use it for some time, I can now say I have 'joined the club', and am also very impressed with its facilities and performance from a user's point of view.

So, if you are thinking of buying this box of tricks, and have around £1000 to spare — read on.

The review unit was a basic transceiver, without any of the extras available. Judging by the comments in the manual, it is a late model which has some extras, although whether early versions were ever available here is not known (these 'extras' are Noise Blanker 2, Auto SWR Meter, and Full Break-in).

For the record, the additional accessories available for internal fitting are an Automatic Antenna Tuning Unit (AT-930), which fits in a space behind the front right hand panel with the

necessary control switch and indicator already present on the front panel; and a selection of extra filters such as 500Hz and 250Hz bandwidths for CW use. There are a number of additional out-board accessories designed to match the transceiver, such as a linear amplifier (TL-922A), station monitor, external speaker and a 'digital world clock' (for the avid DX chaser). The unit comes well packed with accessory plugs, but yet again, no microphone. The mic used was a Trio MC-50 — if you use this then the plug has to be changed for the special 8-pin version needed — the correct mic is the MC-60.

A manual is supplied which explains the operation well, but it is let down by the presentation of the circuit diagrams (try to follow them!) and lack of any servicing data whatsoever. Trio could learn from Yaesu in this respect.

Basic facilities

The transceiver is all solid-state, mains powered (no 12V input) unit with

facilities for transceive operation on all amateur bands between 1.8 and 30MHz, including the new 'WARC' bands. It also functions as a general coverage receiver between 100kHz and 30MHz, using 1MHz synthesised increments in conjunction with the 1MHz coverage digital VFO.

In order to prevent transmission on other than amateur frequencies, the rig locks out the transmit function out-of-band. Unfortunately the WARC bands were also locked out and on mention was given in the handbook of how to reinstate these. As the rig was on loan, no attempt was made to do this, and hence no transmission was possible on 10, 18 or 24MHz.

(NB: just as this review was being finished, and the unit about to disappear, the method of enabling the WARC bands was found hidden inside a folded page under Section 8 at the back of the manual. The statement that transmission on the WARC bands is not possible as supplied, and that a minor wiring adjustment is needed is preceded by how to do

the adjustment! A few hours were spent on 10MHz and 18MHz with satisfactory results.

The usual facilities of VOX, RIT, RF attenuator, selectable AGC, RF processor, full metering, noise blanker (2 actually) and a sort of passband tuning are included. In addition, the TS-930S is one of, I believe, only two readily available rigs that feature full break-in (QSK) operation on CW. Other useful extras are variable CW bandwidth tuning, CW audio filter, 100kHz calibrator (for setting up the display), CW pitch control, and an IF notch filter.

Modes of operation are SSB, CW, FSK and AM. There is no FM facility even as an add-on. The transmitter uses a solid-state PA (2 x Motorola MRF-422 in push-pull) running at 250 watts input on all modes except AM where it is 80 watts. The output power can be monitored on an automatic VSWR/power meter built into the rig. An aerial matching unit can be correctly adjusted using the VSWR bridge. There is no RF output power adjustment other than by varying the mic gain or carrier injection.

Caution!

One point to note. The manual warns against operating the transmitter into a VSWR of greater than 1.5:1, which is to be expected with a solid state PA, and like most solid state designs, power reduction/protection circuitry for the final is built in if you exceed these limits. However, an additional leaflet comes with the manual repeating the warning that "the power transistors might be damaged if the final stage is adjusted poorly" — by "final stage" it is assumed they mean the matching to the final stage. So it is reasonable to assume that some rigs have been returned with blown PAs — you have been warned — watch the VSWR (do your initial tuning at the lowest power possible).

Front panel

Keeping up with modern traditions, there are some 50 controls to play with on the front panel. However, they seem to be sensibly arranged and proved easy to get the hang of. Especially the frequency changing arrangements — if you have battled with the controls on an FT-ONE, then this rig is child's play by comparison.

The most impressive thing is the pleasant off-white fluorescent 6-digit display, which doesn't glare like LEDs, and shows up well in bright light. An additional smaller display alongside the main one shows the RIT status in kHz/100Hz.

There is also a digital analogue display, if such a thing is not a contradiction in terms. It comprises a

fluorescent analogue type scale with a moving red bar graphic type vertical bar underneath which increments at 20kHz intervals, and is very useful when tuning rapidly across the band (the VFO also speeds up at fast knob tuning rates so this is quite easy).

Metering

A range of metering functions are provided — processing level (in dB), ALC level, power output (only of real use on AM or CW), SWR (from the automatic device provided, so no calibration is required), PA current (12A max) and PA voltage (nominally 28V). Plus of course S-meter on receive, calibrated to S9+60dB.

Moving to the top left of the panel, we find pushbutton switches for VOX/MANUAL, FULL or SEMI break-in (for CW), MONITOR ON/OFF (for listening to your transmit audio (this one works well), and a brightness control (2 levels) for the display, the latter being useful at night.

Underneath these are rocker switches for SEND/RECEIVE, AUTO/THRU (for automatic antenna matching control if fitted, otherwise inoperative), PROCESSOR ON/OFF, and NARROW/WIDE if extra filters are fitted. To the right of these are the METER switch and AGC control (OFF/FAST/SLOW).

The benefits of switching the AGC off may not be immediately apparent. If a very strong signal appears in the passband when listening to a weak station, it will activate the AGC and cause unwanted gain reduction. If you then turn the RF GAIN down, until the meter reading just starts to increase, then turn off the AGC, you should find that the wanted signal is then much easier to copy.

The remaining controls on this side are the PROCESSOR IN/OUT levels, MIC/CARRIER level, and mode selection switch (TUNE/CW USB/LSB/AM/FSK).

Frequency control

The main tuning knob is pleasant to use with a rubber surface, and can be spun easily (one MHz in about 5-6 seconds) for rapid QSYing — as you spin in excess of about 5 revs per second the VCO step rate increases. The standard tuning rate is 10kHz per revolution. One note for any blind operators who are considering this transceiver — there is no way of resetting to the band edge for reference, other than switching off all power to the rig. Nor are there any markings on the main tuning knob to identify one complete revolution.

To change bands, there are two choices. You can either select an amateur band of interest from a set of 10 momentary push buttons, or move up or

down in 1MHz steps from the STEP UP/DOWN buttons (these are also accessible from the mic socket). This seems a much easier arrangement than keying in via a keypad, unless you prefer it.

There are in fact two VFOs (A and B) with facilities for transfer of frequencies between the two (A=B). Because of the broadband tuning, it is possible to instantly change from Top Band to 10 metres if you wish (always assuming that your antenna also switches, or is a good match on all the bands you want). Used in conjunction with the memory facilities, this feature could be very helpful in contests.

Eight memories are provided, and transferring frequencies to and from these is just a matter of using three pushbuttons (VFO/MEMO, M IN and MR (recall), plus the MEMORY CHANNEL switch. A further switch is provided which allows the VFOs to be mixed for transmit and receive, ie. you can receive on VFO A and transmit on VFO B, or vice-versa. Memory backup facilities are provided by a battery, and the rig will store all the memory and last VFO frequencies until next switched on. If you don't have the battery fitted, then you still retain everything provided the AC power plug is not removed.

Which reminds me — the rig comes with a European type mains plug which needs changing for UK use.

The remainder

An RF attenuator is provided (0/10/20/30dB) should you need it. The dynamic range of the TS930S seems good enough not to require much use of this, even on 40 metres at night. Either the calibration of this control, or the S-meter is adrift however, as they do not agree. Inserting 10dB on the attenuator reduces the S meter by about 18 — 20dB, if it is calibrated at 6dB per S-point as would be expected.

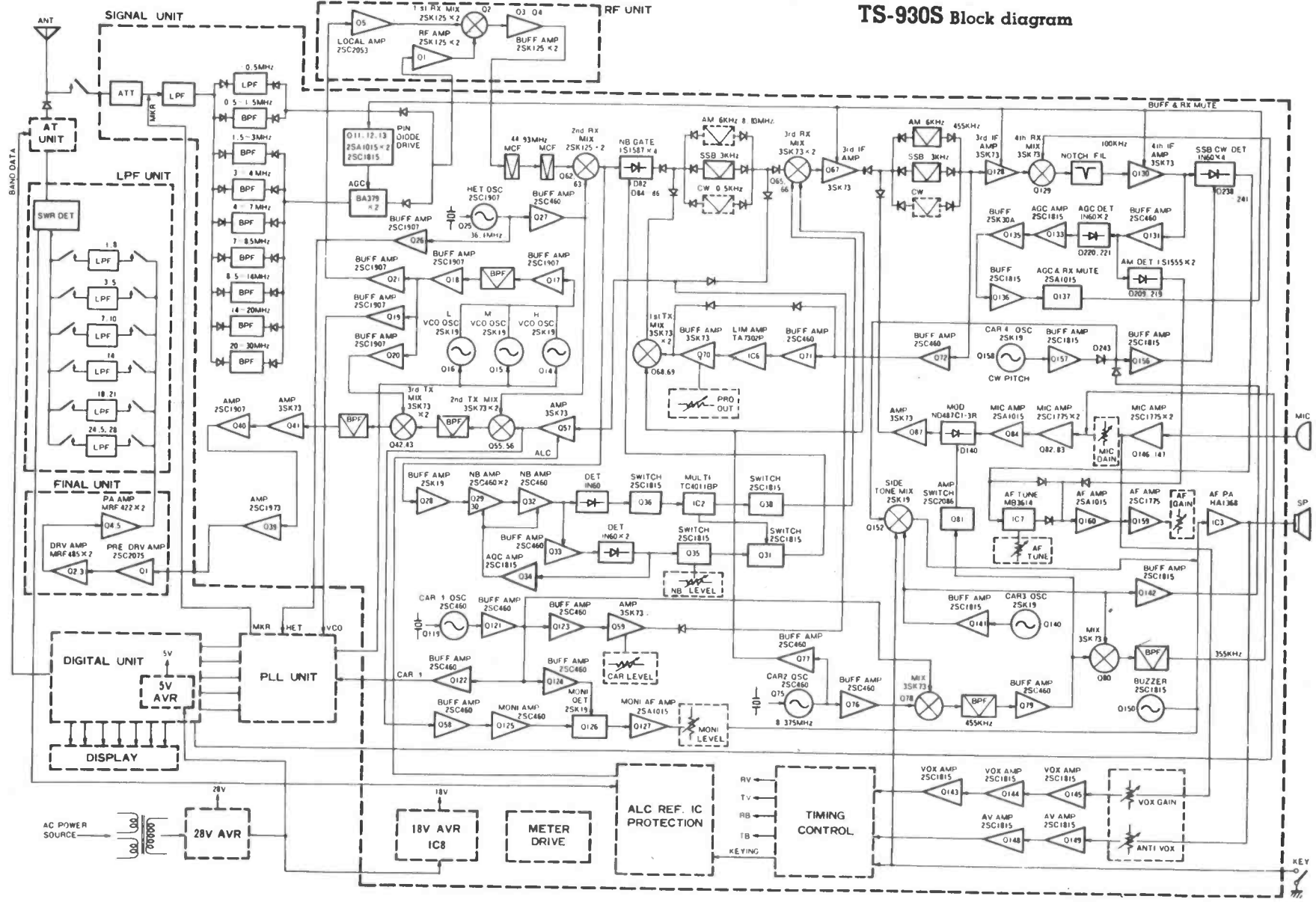
Noise blankers

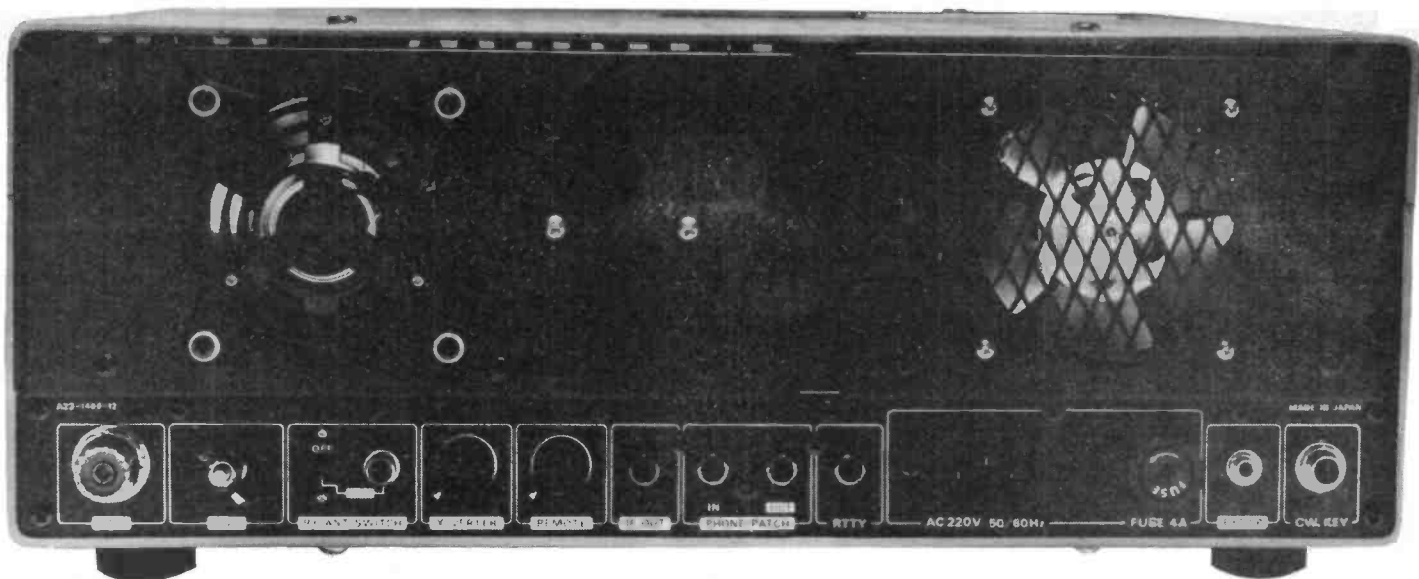
There are two types fitted — the first (NB1) suppresses impulse noise such as ignition interference, and is fairly effective. A variable blanking level control sets the threshold for this. The other blanker (NB2) is intended to cope with the 'woodpecker' radar pulses and provides a longer blanking pulse (also switching in NB1 at the same time).

NB2 is reasonably effective providing the woodpecker is fairly strong (above about S7) which is when you really need it. The effectiveness of this blanking does depend on the type of woodpecker being received, being much better on the one pulse type than the multiple pulse version.

Both blankers reduce the dynamic range of the receiver considerably if ad-

TS-930S Block diagram





vanced above about setting 6/7, and introduce lots of distortion products. Until this was realised, one station was about to get told he was occupying 50kHz bandwidth on 80 metres — switching off the blanker solved the problem!

A further row of pushbutton switches control T-F SET (allows momentary listening on the transmit frequency when both VFOs are in use), the IF notch filter (claimed at better than 40dB and effective, it is very critical to tune indicating a narrow notch), AF TUNE (selects the AF audio filter for CW), and a DIAL LOCK facility which disables the tuning knob.

RIT is controlled by two of these pushbuttons. One selects/deselects the function by repeated pushing, and the other is a CLEAR control. A rotary control beneath varies the RIT offset up to $\pm 9.9\text{kHz}$ maximum, a useful range for DX-pedition split frequency working without involving the dual VFOs. If an RIT offset has been set, the original frequency can be returned by pressing RIT again, but the offset is held and displayed — it can be reactivated by pressing the control again. Pressing CLEAR either deletes the offset from memory, or, if RIT is active, resets to the nominal frequency and also clears the offset.

Further rotary controls set NOTCH FILTER frequency, and AF and RF gain (concentric).

Passband tuning

The remaining controls are concerned with the various forms of passband tuning and CW reception facilities.

CW VBT (CW Variable Bandwidth Tuning) allows reduction of the bandwidth in the CW mode, but does not affect the centre frequency. The actual bandwidths obtainable depend on the filter in use. The review rig came without any CW filter as such so the SSB filter (2.4kHz) is used. This gives control over 2.4kHz-600Hz bandwidth. If you have a CW filter fitted, then the control allows 500Hz-150Hz bandwidth. This control is

also effective in the AM position with the same bandwidth control!

As it stands the CW received beat note is around 800Hz, which suits most people. If you want to use a different pitch then there is a PITCH control, which allows you to alter the pitch to suit and varies the filters centre frequency to match. It also adjusts the sidetone frequency to be the same as that of the received signal.

Effective only in the SSB mode are the SSB SLOPE TUNE controls (HIGH/LOW) arranged as two independent concentric controls. One sets the upper edge frequency of the filter, and the other the lower, so that the bandwidth can be set to suit the conditions. These controls are easier to use than the Yaesu FT-102 equivalents which are friction locked together and very stiff to operate. Being able to set the bandwidth with the upper and lower cutoff frequencies defined is a very useful operating aid, especially when as effective as this version.

The back panel

Having disposed of the front, we move to the back, via a small slider panel on top which covers the memory back-up battery compartment, and the VOX controls, plus a calibrator on/off switch.

The first thing that is very noticeable is the presence of two cooling fans. One is for the power supply (and this one comes on a lot even on receive) and the other for the PA. The latter has two speeds — the fan first comes on at a heatsink temperature of 45°C. If you manage to get the PA heatsink above 75 — 80°C, probably because you have insufficient convection cooling, the fan speeds up, the TX circuits are disabled, and will only be re-enabled when the temperature has dropped below 65-70°C.

Both fans are quiet and unobtrusive, except when the PA one is running at fast speed, although still acceptable and both are guarded against prying fingers.

Along the lower rear apron, left to

right, are the SO-239 aerial connector, an earth terminal, RX aerial switch (for using an external receiver rather than the TS-930S itself), and the external RX socket (phono). Output for a transverter is provided (no output level quoted) via an 8-pin DIN socket, and for external accessories such as linear amplifier via another 8-pin DIN.

If you have a monitor scope, you can view the received signal waveform via the IF OUT jack, taken just before the product detector, and if you are going to the USA, you have the usual phone-patch facilities. Of course, these IN/OUT jacks also enable you to transmit tape recordings (of the right kind!), and take AF output from the rig for recording, SSTV, AFSK etc (at 600 ohms impedance).

The remaining connectors are for RTTY keying (low level only — not current loop), AC power, external speaker (3.5mm) and CW key jack (0.25"). Plus of course a fuse (AC, 4 amps).

Construction

Externally the TS-930S is a very impressive unit to look at, finished in two-tone grey (light case, dark panel) with a faultless finish. The controls are all smooth and easy to use, with no excessive pressure needed for the switches.

Internally, the standard of workmanship is high, with most of the circuit boards arranged on the underside. The PA, output filters and PSU are on the top. Some screening of individual sections is provided, which must help towards eliminating sprogies, as there are very few to be found. Some adjustment points are marked in the manual, for sidetone, monitor and buzzer levels, Mic impedance (high or low) and notch filter adjust).

As noted earlier, there is little service info provided if you do want to tackle this yourselves, but there may possibly be another manual available. This is akin to buying Lotus or Ferrari and not being able to get hold of a service manual!

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 continuous).

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 2SK 125 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 readinginput leveldB 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

reasonably cool, even after extended periods of operation and as noted earlier, the cooling fans are quiet.

Tuning up is of course no problem with the broadband PA, but a matching unit is almost a necessity if you are using any form of multiband antenna. All tuning was done at low power (around 10 watts) before increasing to full output for final tweaking. The presence of the automatic VSWR meter is of considerable assistance here, although I have some doubt as to the accuracy of the actual readings, although the null seems OK.

On SSB, it is necessary to get the ALC reading well up when transmitting — if the meter is only just kicking off the stop you will be losing a lot of available distortion-free power output. Several stations commented on the noticeable increase in received signal strength with the ALC well into its allowable limits, against a low reading, with no degradation of the signal quality, either on or off frequency. You can use the MONITOR facility to set up the processor level effectively and convince yourself that things sound OK. Power output was virtually constant across all the bands, the meter indicating in excess of 100 watts.

One of the joys of this rig is for the CW addict, as the benefits of full break-in working level the semi-break-in method (which this rig can also do) a long way behind. With full QSK, it is possible to return to receive between the individual dots and dashes of the transmission, allowing the other station to break-in (just like VOX working on SSB) or alert you to interference on the frequency. The lack of TX/RX relays makes this a very quiet operation and most enjoyable in practice.

Receive

Most of the subjective evaluation of the transceiver was done on receive, and considering that you will spend a far longer period receiving than transmitting, it is the more important mode.

The sensitivity of the rig is such that one need not consider any extra RF amplification, and it is quite feasible to operate with the attenuator in on the lower bands without realising it. Dynamic range appears to live up to its claimed specification, with little sign of any problem except on 40 metres on occasions. The only untoward signs occur when the noise blanker is in use, and the blanking level above setting 6 or 7, when the dynamic range is greatly reduced, and distortion products become very apparent.

Suppression of the static clicks which abound most days using NB1 was effective, and this blanker was usually left on about setting 4 most of the time. Switching it out after a period of use showed how effective it was.

Selectivity

Selectivity from the fitted standard filters was excellent, and the various passband tuning controls did their job very effectively. The SSB controls enabled virtually any interfering signal to be reduced or removed completely by varying the upper and lower filter cut-off frequencies which appear to be sharp, and in conjunction with the deep notch filter, anything left within the passband of the actual signal being received could be mostly eliminated. On CW, the VBT control is fairly effective, but the steepness of the skirts in the narrower positions could have been better. Reciprocal mixing from adjacent stations was non-existent unless the stations themselves were wide in the first place.

The AGC coped with all signals well, using SLOW for SSB and FAST for CW. Attack and recovery times were adequate with little 'pumping' on strong signals. When an unwanted strong signal was within the passband of a wanted weak signal, it was necessary to switch the AGC off, and reduce the RF gain to allow proper reception, but this is not a fault with the rig itself.

Good audio

The audio system is one of the best I have heard, with no detectable distortion, even at volume levels from the internal speaker way above that possible with other rigs. You are unlikely to want an extension speaker even in a large room! The tone of the audio is pleasant and not tiring, although no adjustments such as tone control are provided.

Tuning around

One of the other little extras is a bleeper! Well, no modern rig is complete without one. This one is not too obtrusive, and gives a stomachable utterance each time any frequency change is made with the select buttons, the RIT is selected or cleared, or the MEMORY button pushed.

Using the memories and dual VFOs is fairly easy after a few attempts, and besides split frequency working, it allows you to jump round bands and frequencies keeping an ear on QSOs, pile-ups etc, ready to jump in when the time comes.

Frequency stability is excellent, with just a slight shift during the first few minutes after switch on, but within specification. The 10Hz step rate of the VFO makes you think you have continuous tuning — you can only just detect the steps if you listen carefully. The only slight criticism is a clicking noise every even 2kHz as you tune rapidly, more apparent on AM than any other mode. The nicely balanced tuning mechanism is a treat compared to some

rigs with stiff controls, and although you can spin the dial effortlessly, it stops with a positive action, then only needs a light touch to get things just right.

General coverage receive

Although I have no particular interest in general Short Wave DXing, the general coverage mode on receive makes this rig a natural for the purpose. You can hop around in 1MHz steps easily, using the amateur band buttons for rapid QSY near the band you want. Incidentally, continual pressing the UP/DOWN 1MHz buttons does not result in stepping, just a continuous bleep.

On AM, many DX stations were copied on the MW band, and the variable selectivity sorted them out at night with no problem. The reproduction quality of broadcast stations was adequate, although if you want to relax and use the RX for Radio 2, 3, or 4, you could do with a better speaker. It will go down to 100kHz, although the manual says 150kHz.

For frequency checking all the Standard Frequency and Time Transmissions are available of course. The receiver as supplied checked out accurately (within the digital readout resolution) on WWV and other transmissions.

Conclusions

In my opinion there is no doubt that this transceiver is the best to pass through the shack so far. It is effortless to use and importantly, very quiet in operation with no RX/TX relay clatter. It has all the facilities you are likely to want and these all seem to perform as required, the only possible exception being the noise blanker, and even then only when blanking level is set high.

For the CW user, it is one of only a few rigs designed with CW in mind, and with the addition of one of the optional CW filters should please all but those who don't want to pay for SSB facilities.

I would criticise the manual in terms of lack of servicing info, but there again, the transceiver is a complex machine, and not suited to anything but expert twiddling. The lack of FM facilities may annoy some, especially if you want to use it for VHF transverting.

Bearing in mind the warnings about keeping the VSWR down, there appear to be no problems on transmit, and very few to receive.

If you want to spend the money, then if the review sample is representative, you should be very happy with your choice for some time to come. I shed a tear when it had to go. ●

(Our thanks to Ham International for the loan of the review sample — Ed.)