

The
Peter Hart
Review

TS-690S

HF + 50MHz Transceiver

THERE ARE A NUMBER of transceivers available now which offer the combination of HF transceiver with added 50MHz coverage and this provides a convenient way of being operational on 50MHz as well as the HF bands. This option is popular with the medium to lower priced, smaller sized 12 volt operated radios and, curiously, not to the larger feature packed base stations. It remains to be seen whether, over the next few years, 50MHz will retain its popularity both for the user and the manufacturer, now that 50MHz band conditions are on the decline. The TS-690S is Kenwood's latest HF + 50MHz offering, also available without 50MHz as the TS-450S. In all other respects, these two small 12V operated radios are identical.

PRINCIPAL FEATURES

THE RECEIVER in the TS-690S tunes from 30kHz to 30MHz and from 50 to 54MHz. Transmitter operation is limited to the exact amateur allocation eg 18.068 to 18.168MHz. The review radio was the version normally sold in the UK with the transmitter inhibited above 3.8 and 7.1MHz. If operation in the USA is required or DXpeditions are part of your future plans, then you will need the version normally sold in the USA. Modes covered include USB, LSB, CW, AM, FM and FSK. In FSK operation, the shift can be set for 170, 200, 425 or 850Hz and either high tones (2125Hz) or low tones (1275Hz) may be used.

Band changes are selected using Up/Down keys or alternatively in 1MHz steps for general coverage operation. The usual band stores are provided, returning the last used frequency, mode, front-end setting, AGC speed and filter setting on each band. Tuning is in 10Hz steps on SSB, CW and FSK at 10kHz per revolution of the tuning knob and in 100Hz steps on AM and FM at 50kHz per revolution of the tuning knob. Extra fine tuning can be selected which gives 1kHz per revolution on CW, SSB and FSK in 1Hz steps. This can be useful on CW when very narrow filters are used or for careful tuning of RTTY.



The usual Kenwood rapid QSY facility is provided with a 24 position click-step rotary control stepping the frequency in 10kHz increments. Alternatively a 1, 2 or 5kHz increment may be selected or 9kHz for AM in the MW broadcast band. This click-step rotary control also switches between memory channels. 100 battery backed memory channels are provided, each storing frequency, mode, filter, front-end setting and AGC speed. For split frequency working both receive and transmit frequencies are stored and the usual VFO/memory transfer operations are provided including direct VFO from memory. The memory contents may be previewed whilst remaining tuned to normal VFO mode to allow for selection and checking of contents.

Memory locations 90 to 99 may be used to store up to 10 programmable scan limits. Comprehensive scanning features are provided to allow programmable band scan, memory scan, group scan (groups of 10 memory locations) with adjustable scan speed but no dwell on detected signal. Ten of the front panel keys provide a numeric keypad for the direct entry of frequency or memory number. The usual twin A/B VFOs are provided which may be operated in split frequency mode. In this mode, a single touch key (TF-SET) provides for checking and setting of the transmit frequency. This is particularly useful for finding and netting onto the working channel in a split frequency DX pile-up. In addition, the display may be set to indicate the difference between the receive

and transmit frequencies. Receiver and/or transmitter incremental tuning (RIT/XIT or clarifier) operates over the range of +/-1.1kHz in 10Hz steps or +/-2.2kHz in 20Hz steps. Larger offsets are handled using split frequency working.

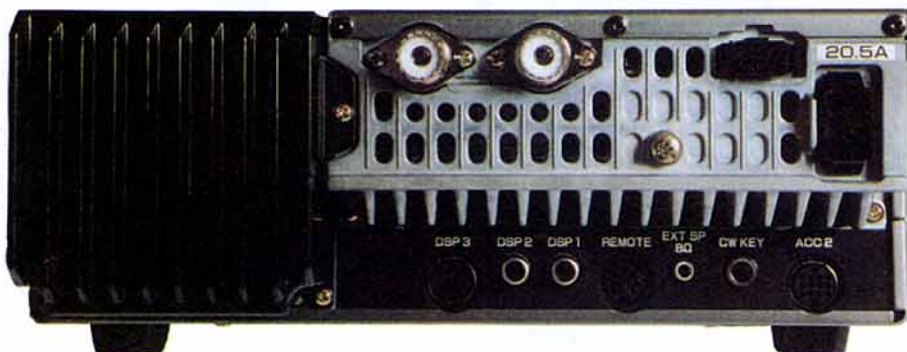
The receiver front-end is switchable between normal operation at full sensitivity and AIP (Advanced Intercept Point) giving reduced sensitivity but improved strong signal handling. An additional 20dB attenuator is also provided.

The IF filter switching arrangement is similar to the TS-950S and TS-850S models. Separate push buttons scroll through the available filters in both the 8.83MHz and 455kHz IFs. The available bandwidths at 8.83MHz are 6kHz and 'through' fitted as standard with optional 2.4kHz and 500Hz as extras, and at 455kHz, 12, 6 and 2.4kHz as standard with 500Hz as an extra. To help fight interference an IF shift is included, an audio notch filter, dual noise blankers and the ability to select reverse sideband on CW or FSK. This can be useful for eliminating close adjacent channel interference. Other receiver functions include dual speed AGC, all-mode squelch and CW pitch variable between 400 and 800Hz.

The transmitter power is variable up to a nominal 100W. For SSB, an AF type speech processor is included and VOX. On CW, only semi break-in is provided. There is no full break-in or keyer. A sub-audible tone encoder is available for FM repeaters.

As with the TS-850S, a multicoloured backlit liquid crystal display is used. This is most attractive and at least as clear and bright as the more commonly adopted fluorescent panel. The display indicates frequency to 10Hz resolution, RIT/XIT, memory number, mode, various status messages and filter bandwidth. Also included are two 30 segment bar meters. One indicates signal strength / transmit power and the other indicates audio level, ALC or VSWR. A peak hold function may be selected.

At power-on, some 32 of the radio's functions may be customised to suit individual



preferences. These include enabling/disabling of various functions, changing step sizes, display parameters etc. A basic operating mode may be selected, typically for mobile operation, where only a basic set of functions are enabled. As with other Kenwood radios, most of the functions of the radio may be controlled from a PC via the FIF-232C serial interface at 4800 bits/sec. In addition two transceivers may be linked together (TS-690S, TS-450S or TS-850S) and data transferred directly between them. Connectors on the rear panel provide dedicated interfaces to a DSP-100 DSP unit and AT-300 remote auto ATU. Two other connectors provide interfaces to a linear amplifier and data terminals but there is no provision for separate receiver antenna, transverter or IF outputs. Two antenna sockets are provided, one for HF and the other for 50MHz. A slide switch on the top of the case allows for a single combined antenna connection for HF and 50MHz.

Optional accessories include the IF filters previously mentioned, voice synthesiser, tone generator, high stability TCXO and auto ATU. The ATU functions over 3.5-28MHz with band stores and matches up to 2.5:1 VSWR.

The transceiver was supplied with three manuals. The operating manual comprised two thick volumes, each around 270 pages, with 90 pages each in English, French, Spanish, German, Italian and Dutch! This adequately covers the installation and use of the transceiver and includes a set of circuit diagrams. Computer control is covered in a separate 20 page manual.

DESCRIPTION

THE TS-690S is a convenient size for home and portable use, measuring 270mm(W) by 960mm(H) by 328mm(D) and weighing 6.9kg without ATU. The unit adopts a conventional modular form of construction with a steel frame and shielded units and a plastic overlay front panel. The PA is blown by two miniature axial fans. A 75mm diameter speaker faces

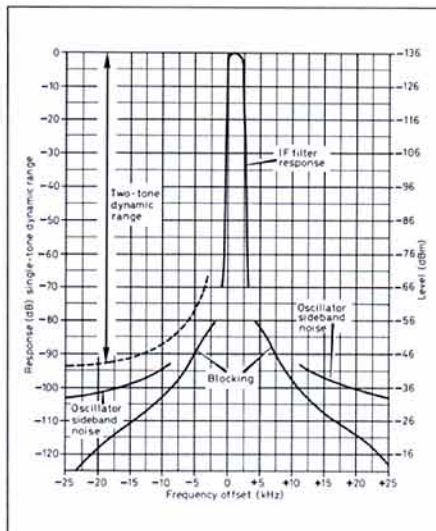


Fig 1: Dynamic range and IF filter response.

upwards through the top of the case. The receiver uses a triple conversion superhet with IFs of 73.05MHz, 8.83MHz and 455kHz. The main RF amplifier uses two parallel FETs and the first mixer, a bridge of four FETs. The main selectivity at 8.83MHz and 455kHz is achieved using low grade single section crystal and ceramic filters. The crystal filters which may be fitted as options are well worth considering for higher performance. The notch filter is implemented at audio which has the disadvantage that strong interfering signals will still capture the AGC.

On transmit, SSB is generated at 455kHz and mixed through the 8.83MHz and 73.05MHz IFs to final frequency. The speech processor is implemented as a fast acting audio compressor which is inherently good in terms of distortion. The frequency synthesiser uses a combination of DDS (direct digital synthesis) and PLL (phase locked loop) to give fast tuning and good spurious performance with a small step size. A second DDS is

used to generate the 455kHz carrier. The main CPU is lithium battery backed to retain memory contents on power down.

MEASUREMENTS

THE REVIEW RADIO was powered from the Kenwood PS-53 matching PSU and was also fitted with the 500Hz CW filter for the 8.83MHz IF. The measured performance is summarised in the table with additional comments.

RECEIVER MEASUREMENTS.

SENSITIVITY

At around 0.1µV, the radio is particularly sensitive.

S-METER CALIBRATION

The S meter calibration was similar on all modes except FM showing good linearity and range within the limits of the bar graph display. The FM performance was, as usual, poor.

SPURIOUS REJECTION

Rejection of the first mixer image was better than 80dB and IFs around 90dB with the exception of the 8.83MHz IF which was around 70dB on 7 and 10MHz. There were very few other responses and the receiver was generally very clean.

STRONG SIGNAL PERFORMANCE

The front-end signal handling was very good with a dynamic range in SSB bandwidths approaching 100dB. However, the close-in dynamic range due to the signal handling of the second mixer was a major problem. This occurred at relatively low levels and blocking of the second mixer prevented reciprocal mixing measurements of and even an accurate assessment of the -60dB IF filter bandwidth. Combined results are shown in Fig 1.

The inband intermodulation performance measured with 200Hz tone spacing was also poor and improved only marginally when the RF gain control was reduced.

FREQUENCY CALIBRATION

When measured at room temperature, the receive and transmit frequencies were accurate to within 190Hz. The CW frequency reads correctly for the selected beat note (800Hz default).

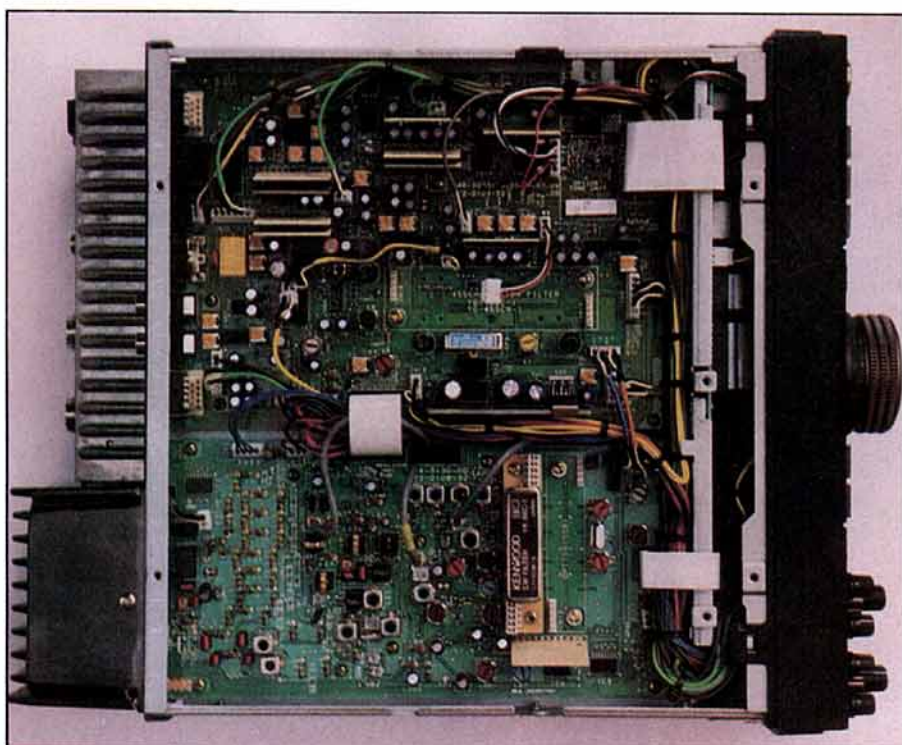
TRANSMITTER MEASUREMENTS.

POWER OUTPUT

The maximum transmit powers were slightly lower than most nominal 100W transceivers, but this may be more a function of the alignment of the ALC circuitry than of the capabilities of the PA. The power was variable down to 4W and the power reading remarkably accurate to within the resolution of the bar meter. With the auto-ATU in circuit, power levels were about 10% less. Into a mismatched load, 45-80W was produced into a 2:1 VSWR and 25-40W into a 3:1 VSWR. Into these mismatches, the ATU restored the power to about 70-80W although there were certain impedances even at 2:1 VSWR which the ATU failed to match.

SPURIOUS OUTPUTS

Non-harmonic spurious outputs were around 65-75dB down on the carrier although worse on 24MHz at around -56dB. The noise output



KENWOOD TS-690 MEASURED PERFORMANCE
RECEIVER MEASUREMENTS

| FREQUENCY | SENSITIVITY SSB 10dBs+n:n | | INPUT FOR S9 | |
|-----------|---------------------------|------------------|--------------|-------|
| | NORMAL | AIP | NORMAL | AIP |
| 1.8 MHz | 0.14µV (-124dBm) | 0.4µV (-115dBm) | 35µV | 160µV |
| 3.5 MHz | 0.11µV (-126dBm) | 0.32µV (-117dBm) | 32µV | 110µV |
| 7 MHz | 0.11µV (-126dBm) | 0.32µV (-117dBm) | 28µV | 100µV |
| 10 MHz | 0.11µV (-126dBm) | 0.32µV (-117dBm) | 28µV | 100µV |
| 14 MHz | 0.1µV (-127dBm) | 0.28µV (-118dBm) | 25µV | 100µV |
| 18 MHz | 0.11µV (-126dBm) | 0.28µV (-118dBm) | 28µV | 100µV |
| 21 MHz | 0.11µV (-126dBm) | 0.28µV (-118dBm) | 25µV | 100µV |
| 24 MHz | 0.1µV (-127dBm) | 0.28µV (-118dBm) | 25µV | 100µV |
| 28 MHz | 0.1µV (-127dBm) | 0.28µV (-118dBm) | 25µV | 100µV |
| 50 MHz | 0.11µV (-126dBm) | 0.71µV (-110dBm) | 16µV | 200µV |

| S-READING (14MHz) | INPUT LEVEL | |
|-------------------|-------------|-------|
| | SSB | FM |
| S1 | 1.1µV | 0.6µV |
| S3 | 2.5µV | 0.8µV |
| S5 | 5µV | 1.1µV |
| S7 | 10µV | 1.6µV |
| S9 | 25µV | 2.0µV |
| S9+20 | 250µV | 3.2µV |
| S9+40 | 2.5mV | 5µV |
| S9+60 | 25mV | 8.9µV |

AM sensitivity (28MHz): 0.56µV for 10dBs+n:n at 30% mod depth

FM sensitivity (28MHz): 0.13µV for 12dB SINAD 3kHz pk deviation

AGC threshold: 1µV

100dB above AGC threshold for +2dB audio output

AGC attack time: 2-3ms

AGC decay time: 0.5s (fast), 3s (slow)

Max audio before clipping: 1.4W into 8ohm at 1% distortion

Inband intermodulation products: -18 to -25dB (see text)

| MODE | FILTER (8.83/455) | BANDWIDTH | |
|------|-------------------|-----------|---------|
| | | -6dB | -60dB |
| SSB | 6/2.4 | 2530Hz | 4000Hz |
| CW | 0.5/2.4 | 540Hz | 3300Hz |
| AM | 6/6 | 6650Hz | 12.5kHz |
| FM | -/12 | 14kHz | 21.8kHz |

| Frequency | INTERMODULATION (50kHz Tone Spacing) | | AIP | |
|-----------|--------------------------------------|----------------------|---------------------|----------------------|
| | 3rd order intercept | 2 tone dynamic range | 3rd order intercept | 2 tone dynamic range |
| 1.8 MHz | +8dBm | 95dB | +10dBm | 90dB |
| 3.5 MHz | +8dBm | 96dB | +15dBm | 95dB |
| 7 MHz | +10dBm | 97dB | +17dBm | 96dB |
| 14 MHz | +12dBm | 99dB | +25dBm | 102dB |
| 21 MHz | +13dBm | 100dB | +24dBm | 101dB |
| 28 MHz | -2dBm | 90dB | +17dBm | 97dB |

| TONE SPACING (7MHz BAND) | 3rd ORDER INTERCEPT | 2 TONE DYNAMIC RANGE |
|--------------------------|---------------------|----------------------|
| 3 kHz | -36dBm | 67dB |
| 5 kHz | -20dBm | 77dB |
| 10 kHz | -6dBm | 87dB |
| 15 kHz | 0dBm | 91dB |
| 20 kHz | +3dBm | 93dB |
| 30 kHz | +5dBm | 94dB |

| FREQUENCY OFFSET | RECIPROCAL MIXING FOR 3dB NOISE | BLOCKING NORMAL | TX NOISE IN 2.5kHz BANDWIDTH |
|------------------|---------------------------------|-----------------|------------------------------|
| 3 kHz | see text | -56dBm | -70dBc |
| 5 kHz | see text | -50dBm | -77dBc |
| 10 kHz | see text | -35dBm | -82dBc |
| 15 kHz | 98dB | -25dBm | -85dBc |
| 20 kHz | 101dB | -20dBm | -88dBc |
| 30 kHz | 105dB | -5dBm | -88dBc |
| 50 kHz | 110dB | -5dBm | -88dBc |
| 100 kHz | 116dB | -5dBm | -90dBc |
| 200 kHz | 122dB | -5dBm | -92dBc |

TRANSMITTER MEASUREMENTS

| FREQUENCY | CW POWER OUTPUT | SSB(PEP) POWER OUTPUT | HARMONICS | INTERMODULATION PRODUCTS | |
|-----------|-----------------|-----------------------|-----------|--------------------------|-----------|
| | | | | 3rd order | 5th order |
| 1.8 MHz | 89W | 94W | -65dB | -30dB | -43dB |
| 3.5 MHz | 92W | 95W | -66dB | -30dB | -45dB |
| 7 MHz | 91W | 94W | -64dB | -29dB | -31dB |
| 10 MHz | 91W | 92W | -66dB | -24dB | -40dB |
| 14 MHz | 90W | 91W | -50dB | -28dB | -40dB |
| 18 MHz | 89W | 90W | -62dB | -27dB | -38dB |
| 21 MHz | 88W | 90W | -64dB | -30dB | -38dB |
| 24 MHz | 88W | 90W | -69dB | -29dB | -39dB |
| 28 MHz | 88W | 89W | -67dB | -30dB | -45dB |
| 50 MHz | 42W | 41W | -60dB | -26dB | -31dB |

Carrier suppression: 52dB Sideband suppression: 70dB Transmitter noise: see table above. Transmitter AF response at -6dB: 285-2700Hz Transmitter AF distortion: 0.5%. Microphone input sensitivity: 2mV for full output. T/R switching speed (SSB): mute-TX 25ms, TX-mute 1ms, mute-RX 25ms, RX-mute 2ms

NOTE: All signal input voltages given as PD across antenna terminal. Unless stated otherwise, all measurements made on SSB with the receiver front-end set to maximum sensitivity and operating from a 13.8V PSU. All two-tone transmitter intermodulation products quoted with respect to either originating tone.

from the transmitter was somewhat higher than most other radios.

SSB PERFORMANCE

The PA intermodulation performance is good compared with most 12V operated radios. This is probably related to the lower output power and the alignment of the ALC. The speech processor did not degrade the inter-modulation performance at all. It is based on an audio compressor rather than a limiter.

CW KEYING PERFORMANCE

The keying envelope and spectrum were observed at 40WPM. The waveform showed low keying distortion although the spectrum was a little wide.

ON-THE-AIR PERFORMANCE

I found the TS-690S very enjoyable to use. It generally handles very well, the tuning is smooth and click free and the ergonomics are good. The band and mode stores are well implemented. Apart from the usual band stores, each press of the mode keys returns the last used filter settings on that mode which simplifies switching between modes.

The receiver performed well and the audio quality was excellent. There was adequate sensitivity on all bands including 50MHz and the strong signal performance seemed good. Although the AIP front-end was normally selected on the LF bands, it was by no means essential and I never found it necessary to select the input attenuator. In crowded, noisy band conditions, the limited close-in dynamic range was noticeable at times when copying weak signals. The notch filter was narrow and effective but would not prevent strong carriers from reducing sensitivity by capturing the AGC, the problem with audio notch filters.

Good reports of the speech quality were received, particularly with the processor in circuit. Note that there are no adjustments required to set up the processor. On CW the keying was crisp and, although there is no QSK mode as such, reducing the recovery delay to a minimum effectively gives QSK. If the CW pitch is varied, the sidetone still remains at 800Hz. Hence netting cannot be done against the sidetone. In this situation, the best way to net is to switch back and forth between normal and reverse CW and set to give the same pitch.

CONCLUSIONS

THE TS-690S IS A SMALL 'go-anywhere' transceiver covering all the HF spectrum plus 50MHz. It is very friendly to use and a good overall performer, although the close-in signal handling could do with some improvement. The current price inc VAT is £1395 with an extra £149 for the AT-450 auto ATU. The TS-450S without 50MHz sells for £1220. Additional filters cost £49.95 for the 8.83MHz units or £115 for the 455kHz units. For mains powered use, a 12V PSU is needed, such as the PS-53 at £249.

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Peter Hart, G3SJK