■ Equipment Review

Kenwood TS-870 All Mode HF Transceiver

*Reviewed by Ron Fisher VK3OM**

The Kenwood TS-870 All Mode HF DSP Transceiver.

According to the advertising brochure, this is not a transceiver. It is an *Intelligent Digital Enhanced Communications System.* Further, *"You can talk to someone half way round the world and it'll feel like they're in the room with you".*

That's quite a claim to make. Of course, you might need a good antenna connected to achieve the above claim, but they don't mention that. Assuming that a good antenna is connected, will the equipment do as they say? Maybe yes, and maybe no!

So let's see what happens in the real world, particularly as we are now at the bottom of the sun spot cycle. By the way, from here on I am going to call the TS-870 a transceiver. The editor allocates just so much space for these reviews so if I used the full title each time, that would fill the article. Anyhow, with such an exalted title, the 870 must have something going for it, and indeed it does. Let's take a close look at just what the TS-870 has to offer.

TS-870 Features and Facilities

In a nut-shell, the TS-870 is a transceiver with digital signal processing and a "Bay Window" appearance. No, there is more to it than that; but that was my first thought when we first met.

The TS-870 is a mid-sized transceiver and is, in fact, exactly the same size as the TS-850S. I am not sure if the 870 will replace the 850 or if they will run side by side. However, for all practical purposes, it is an updated TS-850. Where the original Kenwood "8" series, the 820 and 830, had built in AC power supplies, the 850 and 870 do not. They both require external DC supplies. The nearest rival to these is the Yaesu FT-990 and this does come with a built-in AC power supply which, in my opinion, does give it a decided edge (it is also available without the built-in power supply if you prefer it that way).

For some unknown reason the TS-870 was available overseas several months before its release in Australia. *Amateur Radio* magazine was the first Australian publication to announce the TS-870 in our *"What's New"* column for December 1995. It was available in the UK at least three months earlier than that. Let's now see just what you get for your money.

As we might expect these days, the TS-870 produces 100 watts RF output, or thereabouts, on all the HF amateur bands. For some reason this doesn't include six metres which is included in many HF rigs these days.

The receiver has full general coverage capabilities from 100 kHz to 30 MHz. All current modes are available on both transmit and receive. From here on, things become somewhat different. The big feature of the TS-870 is the digital signal processing. This operates on both transmit and receive. It allows the operator to set the transmit and receive bandwidths independently, and to boost or cut the top or bottom audio frequencies when transmitting SSB. The big difference between the DSP system used with the TS-870 and other transceivers is that the 870 uses it at IF.

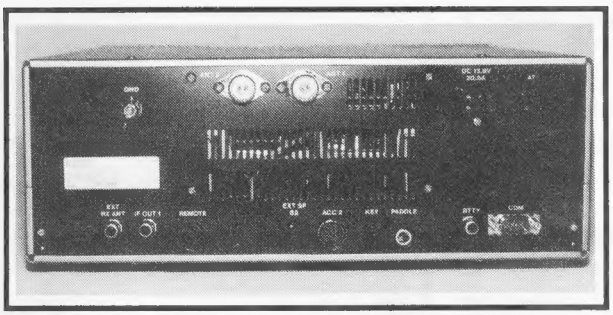
The TS-870 is multiple conversion with IFs at 73.05 MHz, 8.83 MHz, 455 kHz and a new one at 11.3 kHz. This is where the DSP all happens. The feature that first attracted my attention was the controls for the filter on the top right hand side of the panel. To those familiar with Kenwood transceivers, these act like the old SSB slope tuning on say the TS-850 or 940. As soon as an adjustment is made to either of these controls, the display instantly changes from the previous setting (RIT, etc) to show the bandwidth setting.

The bandwidth is also graphically displayed on the meter although there are no calibration points so this acts as an approximate indicator only. The meter is a coloured bar-graph type, similar to the one used on the TS-850 and 450. It has scales for S meter, power output, ALC, SWR, processor compression and the filter width as mentioned above.

The frequency display reads to the nearest 10 Hz and there are something like thirty status indicators built into the overall display. It provides all the information you will need, but I feel it is a bit on the dull side.

The menu system allows you to dim it even further but not to brighten it up. With bright external lighting it could be hard to see. Sunlight shining on it makes it impossible to see. However, I guess no one will be using the TS-870 mobile.

The menu system on the 870 is really something. There is a total of 68 functions that can be set up and all are



The uncluttered rear panel of the TS-870. Note the absence of the usual jutting heatsink on a rig of this size.

displayed on the multi-function display panel. This really enables you to get into the radio and customise it to suit your own requirements. It might take a little time to get used to it as the alpha-numeric display looks a bit strange at first sight; but the handbook explains things very well.

Just to finish off this section of the review, let's look at some of the other functions that the 870 has. There are two VFOs, 100 memories, an automatic antenna tuner, two antenna input connectors switchable from the front panel, selectable tuning rates down to one Hz steps for extra slow tuning, and split frequency operation with both frequencies displayed at the same time.

However, it does not have dual receive capability like its more expensive brothers. In addition to the normal 100 memories, there is a quick memory feature which stores five frequencies in succession. When the sixth frequency is entered the first frequency drops off. This is a useful feature for contests, DXing or just keeping interesting channels on tap.

Computer Control

The TS-870 is all set up for external computer control. According to some overseas information, Kenwood supplies Radio Control Program software with the TS-870 but there was none with our review transceiver. There is an RS232 port built into the transceiver so it's all ready to go. Contact your dealer for more information. It sounds like a great idea.

Rear Panel

Have you ever tried to plug in an external speaker or something at the back of a transceiver and found a large heat sink in the way? Well, no such trouble with the TS-870. There are no projections and all connectors and sockets are easy to get at. There is only one problem, a thirteen pin DIN socket used to connect a TNC or MCP. You will need good eyesight and a steady hand to solder connections to the plug.

General Appearance

I mentioned the Bay Window appearance before. I must admit, it takes time to get used to the look of the front panel. Nothing wrong with it, just different.

But the front feet are a different matter. They look as if they were left over from a job lot of old CD players. When I first spotted them I thought that by rotating them they would screw up or down to adjust the height. But no. If you want the front higher you have to unscrew the feet and add spacers. Really not appropriate for a transceiver in this price class.

On The Air

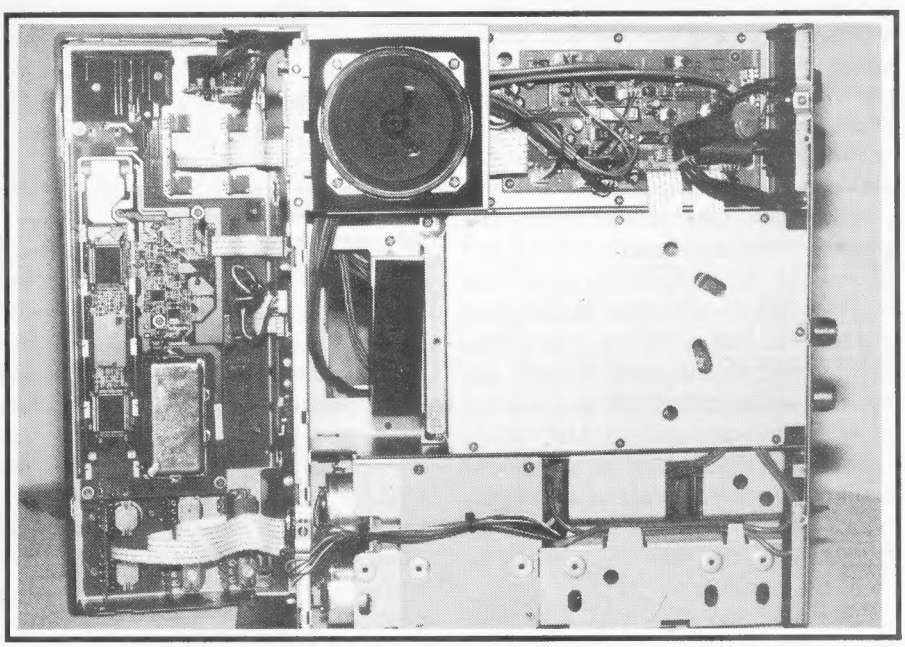
First connect your power supply. The DC connector is a now standard six pin plastic connector. Standard, that is, until you try to buy a spare and you will soon find there are plenty of six pin connectors available that look right but which won't plug in. Strange, isn't it?

You will also note that the specifications call for a power supply with a 20.5 amp rating. I am not sure where that extra 0.5 amp goes, but my ordinary 20 amp (peak) supplies seem to work fine.

One of the first things noted after connecting up is that Kenwood have at long last put a finger hole back in the tuning knob. I think the last Kenwood to have one was the old TS-430S. Let's hope it becomes a standard feature.

This was one time when reading the book came second. Most of the normal controls are very straightforward. Received audio was excellent through the internal speaker and superb through a good external one.

The Lo/width Hi/shift controls work in different ways for different modes. For SSB the "Lo" shifts the low frequency cut off usually in 100 Hz steps where the "Hi" control shifts in 200 Hz steps. The widest bandwidth obtainable on SSB receive is 0 Hz to 6 kHz. I am not sure if the response actually goes down to 0 Hz or not; I didn't make any measurements quite that low!



Top view of the TS-870 with the case removed and the front panel hinged down. Note the cooling fan in the centre, and the auto antenna tuner on the left. The cooling fan was very quiet in operation.

With CW selected, the controls take up their second function, that is width and shift. The width control selects the width of the bandpass and the shift control places that bandpass in the required portion of the audio spectrum. The effect can be followed on the visual bandwidth section of the meter and on the display which indicates the two frequencies selected.

Now to the anti-QRM features of the TS-870. To start with, the controls discussed above play a big part in reducing off-channel interference. The DSP filtering has vertical sided selectivity that can lop off interference with minimal effect on the audio response. The DSP noise and notch controls do the rest.

Of the three controls (auto notch, beat cancel and noise reduction) only one can be selected at a time. The auto notch can take out a single heterodyne with amazing ability. The beat cancel can reduce multiple heterodynes. Note, I said reduce! While very useful, it hasn't the effect of the auto notch. That leaves the noise reduction. Without doubt its main use is for CW and digital modes where it works like magic. For SSB I found that the normal noise blanker was as good and some times better. Of course, you can use the two together for possible improvements.

Note, too, that the auto notch can only be used on SSB while the beat cancel can be used on SSB and AM. The noise reduction can be used on all modes. One slight problem with the noise reduction is that there is no panel control to adjust the degree of reduction.

The fourth DSP button is for SSB transmit audio equalisation which I will discuss in the transmit section. The receiver AGC deserves a mention because of its extreme versatility. Firstly, through the menu system, you can customise each mode to have any desired characteristics of AGC decay time or even switched off all together. In addition, there is a front panel control which allows the decay time to be set from fast to very slow or to switch the AGC off completely.

The RIT on the 870 has been upgraded compared to the TS-850. It is now the +/- 9.99 kHz type as used on the TS-930/940/950 instead of a simple potentiometer with a centre detent. A great improvement.

Now let's start talking. The TS-870 is supplied with an MC-42S microphone so it's just a matter of plugging it in and away we go on SSB.

There are two key sockets, unfortunately both on the back panel. The one for a straight key, a bug or an electronic keyer is a 3.5 mm socket while the one for a paddle is a 6 mm or standard $^1/_4$ inch socket. The straight key socket is a two circuit while the paddle is a three circuit. The in-built keyer has a number of features that will keep the CW enthusiast happy for a very long time. I will run through just a few of its amazing facilities.

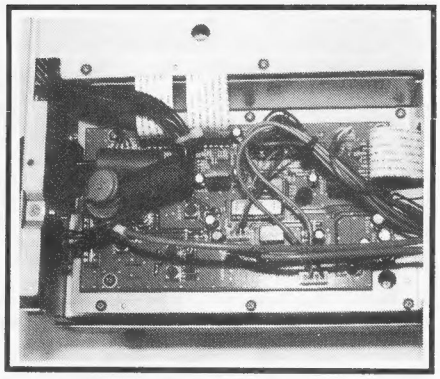
Selectable automatic character spacing, message loop capability for continuous replay, automatic contest serial number generation, and it is programmable via commands sent from the key. Even if you are not a CW enthusiast, try this out. You will be amazed.

There are just as many options available for the phone operator. You can select your transmitted bandwidth, speech processor plus response equalisation. Reports on the transmitted voice quality indicated it was good, but not outstanding. I tried several other microphones with much the same result. Some of the overseas reviews have given rave reports on the transmitted audio. I couldn't duplicate them. In all, a competent performer with more bells and whistles than we have ever seen before.

Kenwood MC-42S Microphone

It seems that this microphone has been around for a long time. Kenwood brought it out when they released their first synthesised transceivers around 1982. During the intervening years they have had both eight and six pin connectors fitted, although the six pin type has disappeared over the last few years. It is still one of the best hand-held microphones supplied with Japanese transceivers. The microphone element is a 600 ohm dynamic unit of better-than-normal quality.

The only thing that goes wrong is that the up/down buttons lose their "click" after a few years of use. Fortunately, the fix is easy. Under each button is a thin layer of rubber (about 1 mm thick) which goes hard. With a thin, sharp, pointed knife cut this rubber away and back comes the "click". There is no doubt this microphone has stood the test of time. It has also been used in slightly modified form with the TS-50S. There seems to be no reason why the MC-42 should not continue for a long time yet.



A close-up of the extensive filtering on the DC input lead to the TS-870.

Kenwood TS-870 On Test

I carried out the usual series of tests including two SSB transmit frequency response tests to check the action of the DSP variable transmit bandwidth control.

However, as usual, the transmit power output and current drain were measured on all bands.

Band	Power Out	Current Drain
1.8	120 watts	18.0 amps
3.6	120 watts	18.0 amps
7.1	115 watts	17.5 amps
10.1	115 watts	17.5 amps
14.2	110 watts	17.0 amps
18.1	110 watts	17.0 amps
21.1	107 watts	17.2 amps
24.9	105 watts	17.5 amps
28.5	108 watts	17.8 amps
29.5	108 watts	18.0 amps

With the power control set to minimum, the power output was 10 watts on all bands.

I then carried out tests to estimate the transmitter intermodulation distortion. As usual, this was done by comparing the test transceiver with a transceiver with known distortion figures. It is interesting to note that intermod tests reported in overseas magazines seem to

vary over wide parameters for the same type of transceiver. As I presume that these testers have access to professional spectrum analysers, I cannot give an answer as to why this occurs.

However, the TS-870 produced the best result of any transceiver so far tested with my standard method. My normal transceiver produces distortion of about -35 dB, but the TS-870 was at least a couple of dB better. It was so good that my reporter had trouble getting a figure because it was so far down.

The transmitter power output was also checked with the automatic antenna tuner in circuit. The loss through this averaged about five watts, although this was very dependent on the degree of mismatch and, in some cases, went as high as ten watts with a 5:1 mismatch on 29.5 MHz.

I decided to carry out two frequency runs on the transmitted SSB response. The first one was at a normal setting that would possibly be chosen by many operators, that is 300 to 2600 Hz. Maximum power was set at 15 watts output and the speech processor was turned off. As can be seen from Graph 1, the result was very smooth with a 3 dB peak at 2 kHz and a gentle drop-off at the low end. At 300 Hz the response was down 11 dB.

The next run was taken with the response set to 100 to 3000 Hz. Note from Graph 2 how the low frequency now extends well down with 100 Hz being -16 dB (referenced to 1 kHz), and how the top end is extended out to 3.5 kHz at -6 dB. The strange thing is that these tests did not show up any reason why the transmitted audio was generally not liked. Being able to set the response virtually to anything you want should produce superb quality.

Again, the few overseas reports I have been able to read about the TS-870 have all commented on the "excellent" transmit audio. No doubt time will tell who is right. By the way, I did try the rig out on the Travellers' Net control stations and they didn't like it either. I used several microphones in my on-air tests, including a Shure 444, Kenwood MC-60, Kenwood MC-50 and, of course, the supplied Kenwood hand microphone. Some were preferred to others but no one found the quality as good as my old Kenwood TS-940.

Carrier and sideband suppression were better than anything measured in the past. My estimate is that they were both in excess of -70 dB which, with the superb intermod distortion figure, all adds up to an extremely clean signal.

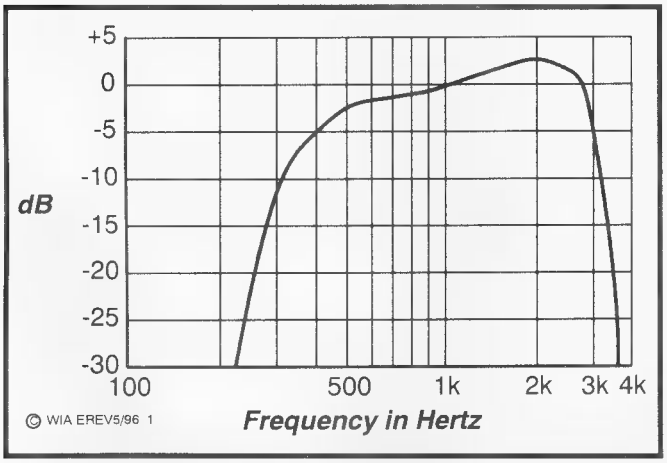
Receiver Tests

The first receiver test was to check the S meter calibration. The meter on the 870 is similar to the type used on the TS-850 and TS-450 and also on a few other Japanese transceivers. It is a fluorescent display with thirty segments between S0 and S9+60 dB. Calibration points are at S 1, 3, 5, 7, 9 and +20, 40 and 60 dB. My figures were taken with the AIP and attenuator off; in other words with full receiver gain and with the receiver tuned to 14.2 MHz.

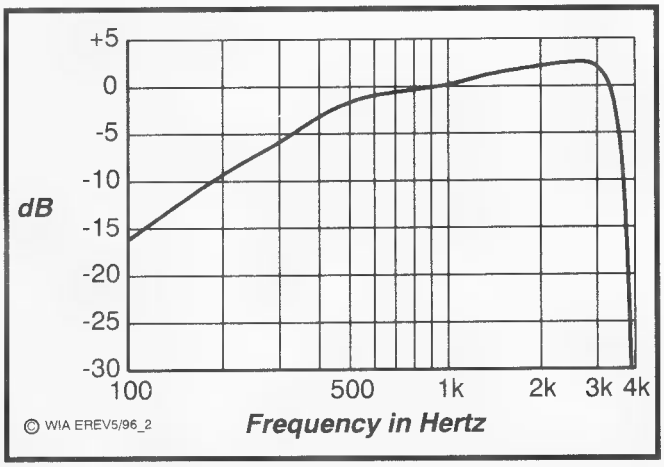
Reading	Voltage
S1	1.0 µV
S3	1.5 µV
S5	3.0 µV
S7	7.0 µV
S9	30.0 µV
S9+20 dB	200.0 µV
S9+40 dB	1200.0 µV
S9+60 dB	.02 volt

The receiver attenuator is switched for -6, -12 and -18 dB. These all measured spot-on, but again I would like to see the addition of at least a -24 dB position. For instance, -18 dB isn't enough attenuation to give meaningful reports on antenna front-to-back measurements.

The AIP gives a gain reduction of about 10 dB. I didn't carry out any receiver frequency response checks for SSB, but a few interesting observations might be in order. The bandwidth, like the transmitter, can be set for any requirement. I found that the best AM reception was obtained in the SSB position with the bandwidth set for 7 kHz. The received audio was flat to nearly 7 kHz and sounded very much better than using the AM mode with 6 kHz bandwidth which only gives a top response of about 3 kHz. However, with the widest bandwidth selected, the AM receive quality is almost Hi-Fi. Here are my measurements:



Graph 1 – Transmit audio response of TS-870 on 14.2 MHz, no compression, 15 watts output at 1 kHz, response set to 300 – 2600 Hz.



Graph 2 – Transmit audio response of TS-870 on 14.2 MHz, no compression, 15 watts output at 1 kHz, response set to 100 – 3000 Hz.

Frequency	Response
50 Hz	0 dB
100 Hz	+2.0 dB
400 Hz	+1.5 dB
1 kHz	0 dB
2 kHz	-1.5 dB
3 kHz	-3.0 dB
4 kHz	-6.0 dB
5 kHz	-12.0 dB

Just try your favourite AM broadcast receiver and see how it compares with that.

Receiver audio output was measured with an eight ohm load connected to the external speaker output. Maximum power was 2.35 watts at 25% distortion. At 2.1 watts the distortion had dropped to 10%, thus exceeding the specified 1.5 watts at 10% by a wide margin. At a normal listening level of 300 milliwatts, the distortion was down to 0.4% which makes it one of the best that I have measured.

The final check was for receiver sensitivity. At 14.2 MHz this measured 0.2 µV with a signal-to-noise ratio of 14 dB, which is slightly better than the specified S/N of 10 dB. The sensitivity actually improves at higher frequencies, going to better than 0.1 µV for 10 dB S/N at 29 MHz. These figures were taken with the AIP and attenuator off.

Of course the technical tests only tell half the story. The ability of the DSP to set the transceiver to suit any conditions or preference of the operator is quite amazing and really sets the TS-870 apart from other rigs.

TS-870 Instruction Manual

Kenwood have gone to a lot of trouble to put this book together. Its 100 plus pages cover subjects you might not expect to find. There is information on short wave listening, a list of the NCDX beacon network, and a full list of HF beacons. Operating instructions cover fourteen chapters and cover such subjects as installation, getting acquainted, operating basics, menu setup and communicating. A full circuit diagram and block diagram are included. I rate the TS-870 instruction 8 1/2 out of 10.

Conclusion

I guess the main feature of the 870 is the fact that you really don't need to buy any extras apart from a power supply. The DSP gives you an almost infinite array of filters that would cost a small fortune in a standard transceiver. In fact, it would be impossible to duplicate the 870 filtering in a normal transceiver. If you are a CW operator then you will find everything here you will need. The Logikey K-1 memory keyer would please the most ardent CW operator. On receive, the DSP noise reduction and selectivity options bring new heights to CW operating.

During my on-air tests with the TS-870, I was asked by two TS-850 owners if they should or should not trade up to a TS-870. As both were SSB operators and only spend a minimal time with CW, I was hard put to give them an answer. In the end, my advice was to stick with what they already had unless they were able to arrange a side-by-side test with a TS-870 to determine if the latest model provided the improvement that they hoped for. I guess this applies to all purchases.

Our review TS-870 was supplied to us by Daycom Communications of 44 Stafford Street, Huntingdale 3166. Current price for the TS-870 is $4,400; the matching SP31 speaker/filter unit is $209; a matching power supply is $720; and the DSP compatible desk microphone is $470. You can phone Daycom for further information on (03) 9543 6444.

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WIA News

EMC Standards and the Homebrewer

Many amateurs are keen on making electronic and communications equipment for themselves, either from kits provided by electronics suppliers, clubs or Divisions, or entirely from their own resources, from design to finished assembly.

This activity is an important aspect of self-training, which is fundamental to the Amateur Radio Service, and which the WIA actively supports.

However, some concerns have arisen within the amateur radio community as to how the new electromagnetic compatibility (EMC) standards might affect this aspect of amateur radio activities.

From 1 January next year, makers of electrical, electronic and communications equipment, assemblies and systems will have to comply with standards and regulations on EMC. There has been a "voluntary compliance" regime operating in Australia since 1 January, this year.

Basically, EMC is defined as the ability of electronic devices and systems to operate without harmful mutual interference with other electronic devices and systems.

In Australia, the new EMC compliance framework applies to completed products (whether components, subassemblies or self-contained) offered for open sale, according to Standards Australia.

Kits and home-built equipment are excluded. Ardent homebrewers can breathe a collective sigh of relief.

Compliance with EMC standards and regulations comes under the authority of the Spectrum Management Agency. Standards and regulations are developed in conjunction with Standards Australia and the Radiocommunications Consultative Council (RCC).

In Europe, the European Union's legislation on electromagnetic compatibility, known as the "EMC Directive", came into force on 1 January, this year. In the United Kingdom, the Radio Society of Great Britain (RSGB) had concerns that kits for home construction by radio amateurs would be affected by the EMC Directive to the extent of being subject to expensive independent testing and certification.

The RSGB recently obtained advice from the relevant local authority that kits assembled by UK radio amateurs do not have to comply with the European Union's EMC Directive.