■ Equipment Review

Yaesu FT-847 12 Band All Mode HF-VHF-UHF Transceiver

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Yes, that's right, twelve bands! All the way from 1.8 MHz through to the 432 MHz band.

Yaesu call it the "Earth Station" and that's a very appropriate name because the FT-847 can operate in full duplex mode for satellite work. Throw in a bit of EME (earth-moon-earth), as well as a full featured HF transceiver, and you start to get the picture.

The transmitter has 100 watts output on all HF bands up to 50 MHz and a healthy 50 watts output on two metres and 70 cm.

Normal filtering for SSB is via excellent ceramic filters but these can be replaced with optional Collins mechanical filters. We will see later just how effective these mechanical filters are.

Of course, this is not the first HF plus VHF and UHF transceiver for Yaesu. Go back a few years and try to remember the FT-767. This was a 100 watt HF transceiver to which six metre, two metre and seventy centimetre modules could be fitted. These modules were sold as options and were not fitted as standard. It had full general coverage receive up to 30 MHz but reception in the VHF and UHF bands was limited to the amateur bands only.

The transceiver was quite large, had a built-in AC power supply and really looked the part. It had a lot going for it, but for some reason it wasn't popular. Perhaps the VHF modules were too low in power at only 10 watts output. Perhaps the whole idea was too early. I don't know.

Well, here is the new FT-767, it's called the FT-847, and I predict it will sell like hot cakes.

FT-847 Features and Facilities

The FT-847 is a compact but not miniature transceiver. It is almost a third of the size of the FT-920 and roughly the same size as the old FT-757 and 747 transceivers, However, it is a different shape.

It is both wider and lower than the earlier models and this, in isolation, makes it appear much larger than it actually is. Finished in jet black (that must be the "in" colour at the moment) with a blue illuminated display, the FT-847 looks very smart indeed. The overall size is 260 mm wide, 86 mm high and 270 mm deep. The total weight is 7 kg.

The FT-847 requires an external 13.8 volt power source rated at 22 amps. As we shall see later, the maximum current drain recorded is 20 amps so your standard 20 amp supply should do the job. All of my on-air testing was done with a Yaesu FP-707 power supply and this worked very well. My bench testing was done with a Dick Smith D-3800 25 amp supply.

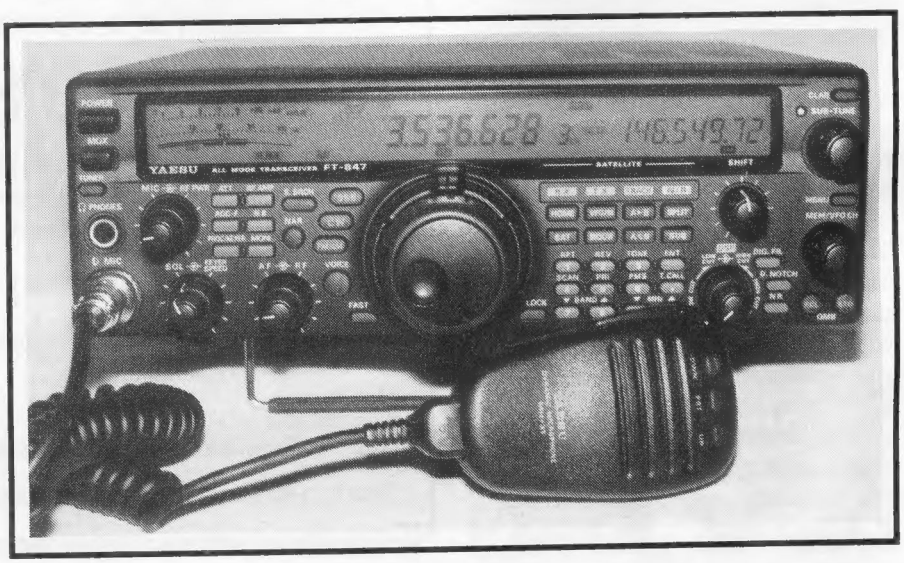
The receiver covers from 100 kHz to 76 MHz, 108 to 174 MHz, and from 420 to 512 MHz. So, in addition to an all band transceiver you also get an almost full coverage receiver.

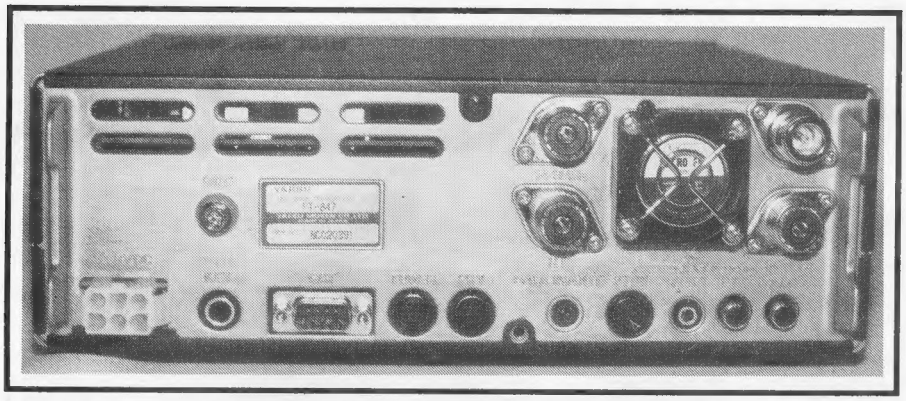
Of course, the transceiver has digital signal processing for the receiver and this works in several different ways. Firstly there is variable digital filtering. Two concentric controls shift the high or low frequency cut up or down the audio band pass. These filters have very steep sides and can really cut interference.

Next is a digital automatic notch filter which can remove heterodynes without the need for manual tuning. For the CW operator there is selectable filtering with band widths of 25, 100, 200 and 400 Hz. There is also a noise reduction setting with adjustable level. To aid all of these in fighting QRM is an IF shift and, of course, those magical Collins mechanical filters for both CW and SSB which are available as an option.

Once upon a time when you bought a transceiver you got a tuning control. Then later they added a clarifier. Later again, with the advent of synthesised transceivers you got variable tuning rates. Well, now you get even more.

The main tuning control has three selectable tuning rates. You can enter frequencies via the front panel key board. There is a VFO channel stepping control. This is mode dependent so you can choose different steps for each. For example you might want 1.0 or 2.5 kHz





Rear panel view of the FT-847. Note the four separate antenna sockets.

steps for CW and SSB, 9 kHz for the AM broadcast band and perhaps 25 kHz steps for VHF FM. Then, of course, there is a good old clarifier although, as we will see later, even this is slightly different.

Then, just to put the icing on the cake, there is Yaesu's wonderful "shuttle-jog-tuning". First seen on the FT-1000MP and then later on the FT-920, this spring loaded ring behind the main tuning control allows for slow, fast and extremely fast scanning up and down the bands. Moving the ring from its central position engages scanning which becomes faster the further the ring is held over. It seems that Yaesu must have a patent on this as it is yet to appear on other makes. It seems that the days of the single tuning control are long gone.

In addition to all of this there are two VFOs and again, carried over from the FT-920, both frequencies are displayed at the same time with the VFO B frequency tuneable independently at any time. As I said with the FT-920, this is not as good as having two receivers but it sure beats the old straight VFO A, VFO B switching.

In order to cope with the wide frequency coverage there are four coaxial antenna feedline connectors, one for HF, one for six metres, one for two metres, and one for 70 cm. The first three are standard SO-239 types and the 70 cm connector is an "N" type which is much more suitable for this frequency. Another nice feature is a dedicated control for a linear amplifier on each of the four band segments.

For the first time in a long time Yaesu are offering a voice frequency read out. I am not sure if they have ever had one on an HF transceiver before. My research indicates not, but they did have one on the multi-band VHF/UHF FT-736.

The one supplied for the FT-847 is, in fact, the same module. Even the instructions supplied in the box are for the 736. But, no worries, the fitting instructions are explained fully in the FT-847 manual. I seem to remember mentioning in my review of the FT-1000 that this was an obvious omission. Even the HF brother of the 736, the 767, did not have provision for one. Anyway, Yaesu, on behalf of sight impaired operators, thanks!

To help the enthusiastic VHF/UHF operator, Yaesu have provided for 12 volts DC to be fed up the coax to operate a mast head pre-amplifier for both 144 and 432 MHz. This can be switched on and off via the menu. Be sure it's not switched on if you are using an antenna that is at ground potential such as the popular Ringo vertical.

FT-847 On the Air

The most obvious thing you note when the FT-847 is switched on is the display. It's blue! Not as vivid as the colour advertising photos would have you believe, but quite impressive just the same.

The next thing noticed was the noise of the back panel cooling fan. This runs all the time with a larger internal fan switching on when the transmitter warms up. It's much quieter.

Consulting the menu chart, a few slight changes to tuning rates are suggested and then it's away. Most of the buttons on the front panel are very small and are best operated with a finger nail rather than the finger. Some of them require a fair bit of pressure, too.

The main tuning knob has a rubbery feel but, thankfully, a finger hole has been included. Of course, as mentioned above, there are other ways to zip up and down the bands and, once programmed to your requirements, the VFO/Ch control gets a lot of use.

Audio quality from the internal speaker is satisfactory but a good external speaker does wonders to the sound.

Now to the DSP. The low cut/high cut filter is most effective. This can be switched in and out but, for most of the time, I preferred to leave it in so it could be adjusted at any time. If you have used

The Yaesu FT-847 with the matching FC-20 automatic ATU.

the similarly labelled control on the FT-990 you will note that this one is vastly superior. That's because this one is really digital. The one on the FT-990 was only digital because you used fingers to operate it.

The digital notch filter is also impressive in the way it operates. Pity there is no manual notch filter for CW operators but I guess there is a limit to what can be fitted. Of course, you can overcome most heterodyne problems on CW by using those sharp digital filters which can be taken down to 25 Hz bandwidth. The old reliable IF shift is fitted and this works very well, particularly when used in conjunction with the digital filtering.

The clarifier on the FT-847 needs some explanation. Firstly, there is no offset readout provided which makes it hard to know where you are. If you switch the clarifier off, the offset remains until the main tuning control is changed by one segment. The offset then returns to zero. It takes a while to get used to.

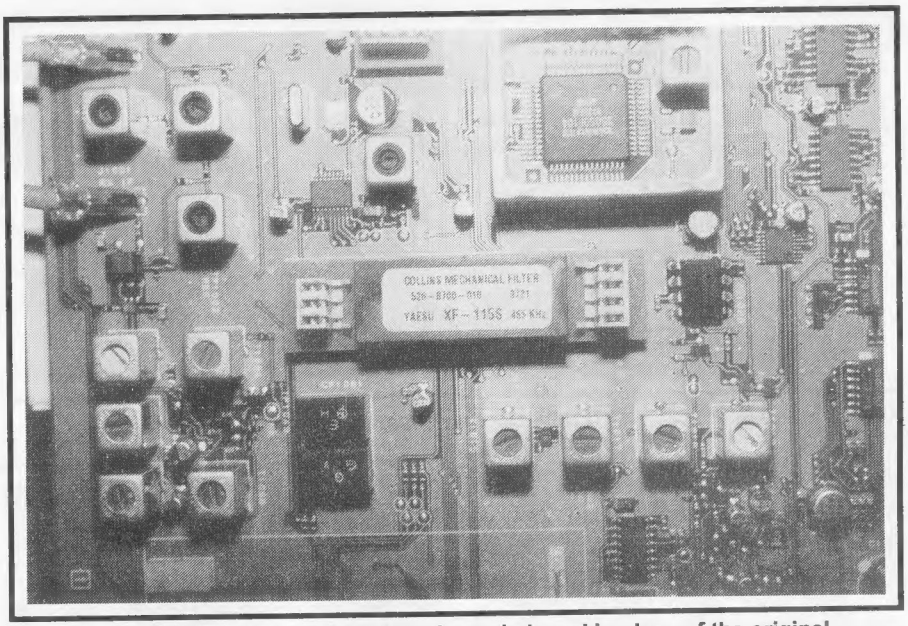
Now it's time to install the Collins filters. As the FT-847 can operate in full duplex mode you need two of these filters, one for the receive channel and one for the transmit channel. Fitting is very easy with no soldering or cutting required. Just remove the bottom half of the cabinet, unplug the ceramic filters and plug in the Collins filters. They can only go in one way so you cannot go wrong. I will leave comments on their performance to John Patterson a little later in the review.

One thing omitted is VOX control for SSB. I must say that I would not miss this at all but I have heard comments from some active DXers that this a drawback when operating in contests with hands-free microphones.

One thing we have become used to in modern transceivers is the memories. The FT-847 has the usual 100 or so channels available.

There are even 12 special memories for satellite operation. There is one (only) quick memory selected and recalled with the two small buttons at the bottom right corner of the front panel

The scanning facilities are quite amazing. For instance, if you are scanning FM memories on two metres, it is possible to program via the menu the scanning to restart 3, 5 or 10 seconds after the signal has gone off. Memory channel one can be utilised as a priority channel which is checked every five seconds. Is there anything this little transceiver cannot do?



A Collins mechanical filter plugged into the main board in place of the original ceramic filter makes a worthwhile difference to performance (see text).

For transmit tests on SSB and FM, I used both the supplied MH-31B8 hand microphone and my own MD-1 desk microphone. Both performed very well but in different areas. Most preferred the hand microphone on HF and most preferred the desk microphone on FM. So, that was the way I tended to use them. The RF speech processor was effective providing a small increase in talk power.

It is possible to monitor your own signal via the "Moni" button. Of course, if you want to avoid feedback a pair of headphones is essential, but you will certainly get a good idea of how things sound. This is also handy if you are feeding audio in from, say, a tape recorder or other external source. You will be able to hear what is going on.

One thing noted when operating two metre FM was some slight pager interference when the pre-amp is switched on. Now, I am not in an area where this is normally a problem so the interference might well be worse in a built up area. Switching the pre-amp off eliminated the problem at my location and there was still plenty of sensitivity for normal FM operating.

FC-20 Automatic Antenna Tuner

The FC-20 is a matching antenna tuner for the FT-847 transceiver and covers the HF bands and 6 metres. It is enclosed in a plain but attractive cabinet with a plastic front panel that has a bow window effect. The rear panel has a small cooling fan, an input SO-239 connector and two SO-239 output connectors. The front panel is even more Spartan with one small LED indicator and a very small push-on switch to select either output coax connector. A connecting cable is supplied to run to the dedicated socket on the FT-847.

The ATU is an unbalanced to unbalanced type, that is coax in and coax out. It is not suitable to use with balanced line feeders.

The only antenna I have that I could use to test the AT-20 is an 80/40 metre trap dipole which has a rather high SWR on 20 metres.

The AT-20 coped with this in short time, however there is one small problem. Neither the FT-847 nor the FC-20 has an SWR meter so you will need one in between the two units to see what is going on. The FC-20 is switched from the 'Tuner" button on the front panel of the FT-847. The FC-20 is priced at $649.

I also note that Yaesu have a multi-band mobile antenna available, called the ATAS-100. It is designed to operate on 7, 14, 21, 28, 50, 144 and 432 MHz. The

tuning is motorised with the control voltage fed through the coax line from the transceiver. Sounds very interesting.

FT-847 On Test

Once again I want to thank John Patterson VK3ATQ for his expert evaluation on the VHF and UHF performance of the FT-847. John's report includes a lot of on-air evaluation but I have decided to include it all in the "Test" section to maintain the continuity of his report. Over to John.

The following noise floor measurements were obtained using a noise source traceable to National Standards.

	Pre-amp -	Out	In
6 m	(50.110 MHz)	9.3 dB	6.0 dB
2 m	(144.100 MHz)	3.5 dB	1.6 dB
70 cm	(432.100 MHz)	3.6 dB	1.2 dB

The above noise floor measurements translate to the following sensitivity ratings, assuming an SSB bandwidth of 2.4 kHz:

Pre-amp -	Out	In
6 m	-130.9 dBm	-134.2 dBm
2 m	-136.7 dBm	-138.6 dBm
70 cm	-136.6 dBm	-139.0 dBm

The sensitivity figures are more than respectable in the case of 2 m and 70 cm, and a little on the low side for 6 metres.

The on-air testing was done using the 50.057 and 144.474 MHz VK7RAE beacons. A/B testing was done using a coax switch in the antenna line to alternate the feed between the reference receiver and the FT-847.

On six metres I was unable to utilise the full sensitivity of the FT-650 reference receiver due to a power line leakage. However, the FT-847 did acquit itself well even if the sensitivity was not quite up to the reference receiver sensitivity (2 dB noise figure).

With the Collins mechanical filters installed, the audio was unbelievably crisper and cleaner than the FT-650. There was no noticeable ringing or hollowness in the recovered audio when using the SSB setting and, when the DSP bandpass filtering was turned on, the overall crispness remained. This is probably due to the combination of the Collins filters having a very low pass band ripple and also a more "linear phase" response. Feeding the unadulterated (filtered by the Collins SSB filter) IF down stream to the DSP certainly helped the DSP perform better than others I have tested. With the 25 Hz bandwidth setting I did notice some VERY weak (hardly audible) drifting birdies.

On SSB the rig received outstanding reports on the transmitted audio. This was not the case with the ceramic filters installed. The reports with the ceramic filters were that it was "just another rig".

The speech processor, when activated, did very little to improve the "punch" of the signal. Reports from distant stations (400 km plus) indicate that the FT-650 processor is still miles ahead in the "punch" stakes.

On two metres the FT-847 sensitivity was excellent and it performed well ahead of my reference receiver (an Icom IC-275A, noise figure 1.5 dB). Even though there is very little difference in the sensitivity figures between the two rigs, the clarity and crispness of the FT-847 was outstanding and tended to make the same signal much more readable than on the IC-275.

Yaesu have obviously taken a lot of trouble to allocate the gain distribution within the FT-847 as the receiver is very quiet when there is no signal present (ie no audio hiss generated from unfiltered later IF stages and audio stages; also, the local oscillator/synthesiser appeared not to contribute any noticeable noise).

I did not carry out on-air tests on 70 cm but could probably assume the same characteristics for this band.

All the usual DSP notch and high/low cut filters worked as well as other brands. However, the noise reduction did not produce a noticeable improvement in readability.

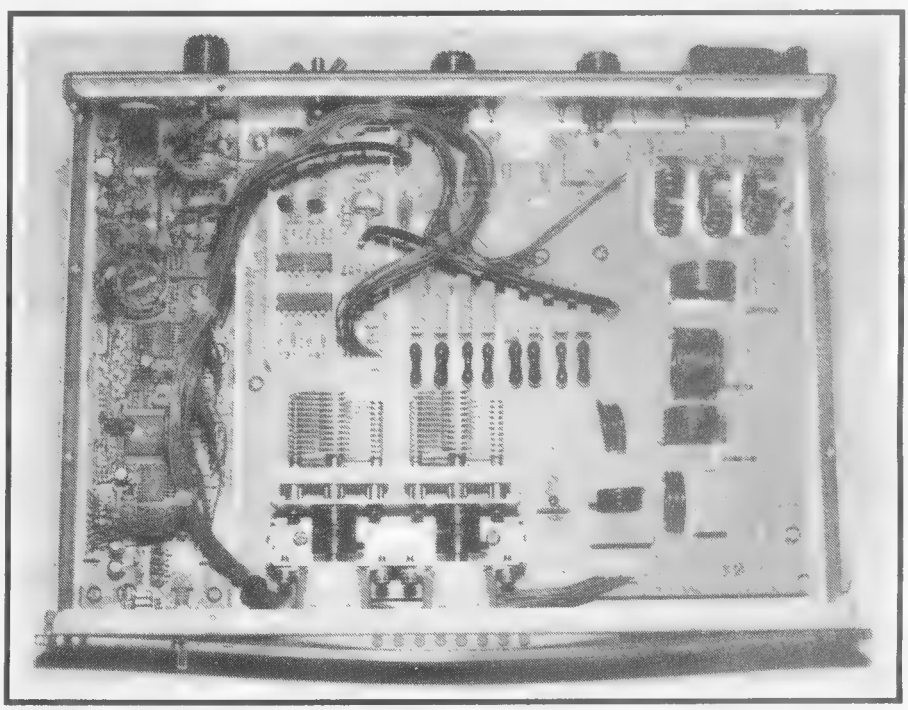
Overall, I would say that this is the first transceiver to come out for some time that I could say was fit for the purpose on VHF/UHF.

Thanks, John, for your comments. Now, on with our usual tests.

First, transmitter power output and current drain, band by band:

1.8 MHz	110 watts	18.5 amps
3.6 MHz	115 watts	17.0 amps
7.1 MHz	105 watts	18.0 amps
10.1 MHz	103 watts	16.0 amps
14.2 MHz	100 watts	19.0 amps
18.1 MHz	100 watts	16.0 amps
21.1 MHz	100 watts	19.5 amps
24.8 MHz	95 watts	20.0 amps
28.5 MHz	97 watts	17.5 amps
29.5 MHz	95 watts	19.0 amps
50.1 MHz	97 watts	16.0 amps
145 MHz	50 watts	11.0 amps
432 MHz	49 watts	12.0 amps

The above figures were taken in the CW mode with a supply of 13.8 volts.



Inside view of the FC-20 automatic ATU.

The same output could be expected in the FM mode. PEP output on SSB would be just a shade higher, ie about 2%.

The next test was to check the transmit intermodulation distortion for SSB. This is the stuff that produces sideband splatter. Better than average amateur transceivers should produce figures of around -40 dB. Top quality commercial equipment will do slightly better than this. Let's see how the FT-847 makes out.

The tests were carried out on 3.5, 14 and 28 MHz. Unfortunately, I was unable to check the VHF and UHF bands due to lack of suitable equipment. However, we are working on this. Commercial testing usually gives figures for 3rd and 5th order distortion. My testing cannot differentiate between the two so the figures are the sum of the two:

3.6 MHz	-20 dB
14.2 MHz	-15 dB
28.5 MHz	-15 dB

I suspect that the higher bands would produce similar results. I did find that the figures improved quite a bit with lower power output. However, these figures are, unfortunately, not in the top class.

Transmit SSB frequency response measurements were interesting. Although there is a sharp cut off in the low frequency end, the audio quality was acceptable. It would be possible to change the high/low balance by adjusting the transmit carrier point (Menu No 92 and 93) but I found the default setting produced the best balance using the supplied hand microphone

Receiver Tests

The first test on the receiver was at the audio end. The output impedance of the FT-847 is specified as 8 ohms, so my Marconi output meter was set to this and connected to the extension speaker socket of the transceiver.

Maximum output was 2.9 watts, but with plenty of distortion. The specified output with 10% distortion is 1.5 watts. At this power I measured only 1.25% distortion. The 10% reading did not come up until 2 watts was reached. At a normal listening level of around 100 milli-watts the distortion had dropped to 0.45% which is as low as I have ever measured.

The audio gain control had an unusual characteristic. For the first quarter rotation nothing happened and then the output came up in steps. The minimum output measured was 2 milli-watts (quite loud into a good speaker); the next step increased 10 dB, then 5 dB and then in 3 dB steps up to full output

For the broadcast listeners out there, I checked the response on AM. This was done with the usual 30% modulation:

100 Hz	-5 dB
200 Hz	-1 dB
300 Hz	0 dB
500 Hz	0 dB
1.0 kHz	0 dB
2.0 kHz	-2 dB
2.5 kHz	-3 dB
3.0 kHz	-5 dB
4.0 kHz	-9 dB

While this might not please a dedicated hi-fi buff, it will, none-the-less, produce quite pleasing audio with a good speaker.

SSB bandwidth was measured with both the ceramic filter and the Collins mechanical filter. It is interesting to note that the Collins had a slightly wider -6 dB response than the ceramic filter. The ceramic filter bandwidth was 2.4 kHz and the Collins was 2.7 kHz. This was possibly the reason for the crisper sound mentioned earlier by John Patterson.

Next, let's take a look at the 'S' meter calibration for the various bands. I have done a complete calibration for 14 MHz and noted the S9 level for other bands:

Meter Reading	Input Required (Pre-amp Off)
S1	2.5 µV
S3	5.5 µV
S5	7.0 µV
S7	25.0 µV
S9	55.0 µV
+20 dB	200 µV
+40 dB	700 µV
+60 dB	5.8 mV

Now for S9 readings on each band:

Band	Input Required
1.8 MHz	100 µV
3.6 MHz	85 µV
7.1 MHz	92 µV
10.1 MHz	55 µV
14.2 MHz	55 µV
18.0 MHz	60 µV
21.0 MHz	65 µV
24.0 MHz	60 µV
28.0 MHz	60 µV
50.0 MHz	30 µV
144.0 MHz	40 µV
430.0 MHz	40 µV

All of the above measurements were done in the SSB mode. For FM on VHF frequencies the readings are much more generous with decibels about 0.2 of their usual size. Be wary of giving signal reports on antennas to your friends using the normal HF S meter calibration.

Receiver sensitivity was checked and was found to be in excess of the specification right throughout the range. As an old aviator I was very interested to see how the aircraft band shaped up. I loaded a few of the local frequencies into memory and did some A/B switching between the FT-847 and my usual receiver. It was no contest, the Yaesu won hands down. My usual receiver is a Kenwood R2000 fitted with a VHF converter, and a somewhat off-resonance two metre antenna was used

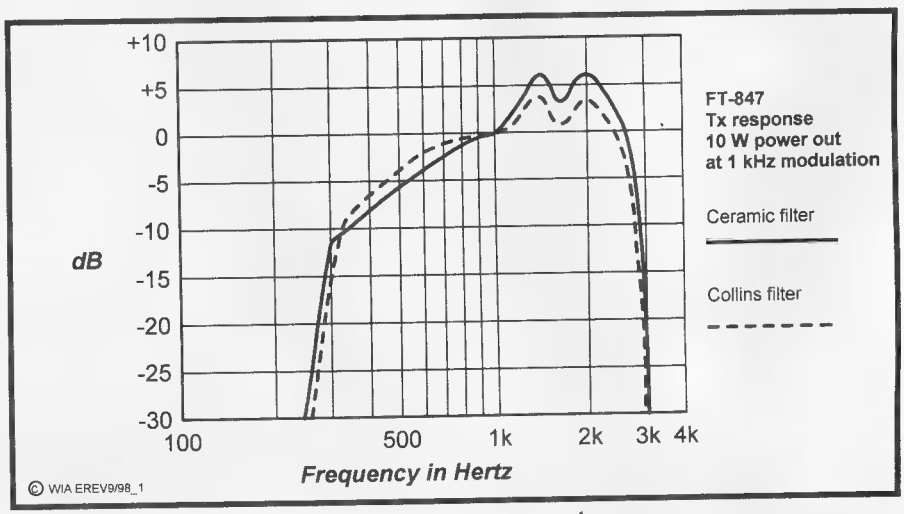


Fig 1 - SSB transmit frequency response measurements.

FT-847 Operating Manual

There is no doubt that Yaesu are producing the best manuals in the business. The FT-847 manual covers subjects that you will not find readily anywhere else.

For instance, there is a chapter on "high-speed CW meteor scatter operation". How about trying a bit of EME operation? All the basics are covered right here in your FT-847 manual. Of course, you will need to be a dedicated VHF/UHF enthusiast to make a start but I am sure there are a few of you out there. Reading this book just might start you off.

There is a lengthy chapter all about the 'Menu' system. However, to simplify things, Yaesu have supplied a laminated concise single-page guide to the menu system. You will be able to keep this handy, perhaps in your log book for quick reference

Operating and installation are covered in a very comprehensive way and, by the way, Yaesu have supplied a full circuit diagram and a block diagram. Now, if only the book had a better quality cover I would vote it the best instruction manual around.

FT-847 Conclusions

I have to vote the FT-847 the transceiver of the year. It is well in the running for the best transceiver of the decade but we will have to wait a couple of years to find the answer to this one.

The FT-847 is in a class of its own at the moment. At the current price of $2995 it represents unbeatable value. Just look at what you get. First off, a top line HF transceiver with all mode operation. Next, a tri-band VHF/UHF transceiver with all mode operation, and finally a receiver with coverage from 100 kHz to above 500 MHz.

Add all of those up in separate units and my guess is that you would be spending around $10,000.

If you do decide to buy an FT-847, do yourself a favour and put in the Collins filters. They are not cheap at around $200 each but very worthwhile.

My thanks to Dick Smith Electronics for the loan transceiver. All enquiries should be directed to them. I would also like to thank John Patterson VK3ATQ for his help in preparing this review.

BT

In the Workshop

A Simple Sheet-Metal Bender

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New Column

Nowadays, we no longer have to build our own radio equipment. If you have the cash, a multi-band transceiver and all the necessary additional equipment (including antennas) may be purchased off-the-shelf. And if you do not have much money, then quite good radio equipment may be obtained second or third hand. So, what's the point of home-building radio gear?

It must be remembered that ours is basically a technical hobby (some might say vocation). It is in our own best interest, and of society at large, that we should have a pool of persons who, in addition to their operating prowess, are skilled in the various branches of radio craft.

Not least of these is an ability to make or repair things. Moreover, time spent in the workshop also offers relief from care, with the pleasing reward of actually producing something of lasting personal value with our hands and brain.

Hence this new bi-monthly column. In future issues we hope to have a look at such topics as metalwork for radio electronics, construction techniques, interesting faults and solutions, making and applying test instruments, photos of member's finished projects (for "show and tell", and to enthuse others), coils, parts sources, etc and, hopefully, re-print some classic articles from other journals.

But please don't make me do all the talking! Let's hear if you have something useful to share. Circuits, troubleshooting tips, photos, tricks of the trade, parts sources. Send them to me at the address shown. All contributions will be acknowledged.

Simple Sheet-Metal Bender

Here are details of a home-fabricated bender which should suit many of the routine light bending jobs around the amateur's workshop. Because of the nature of things, off-the-shelf and scrap

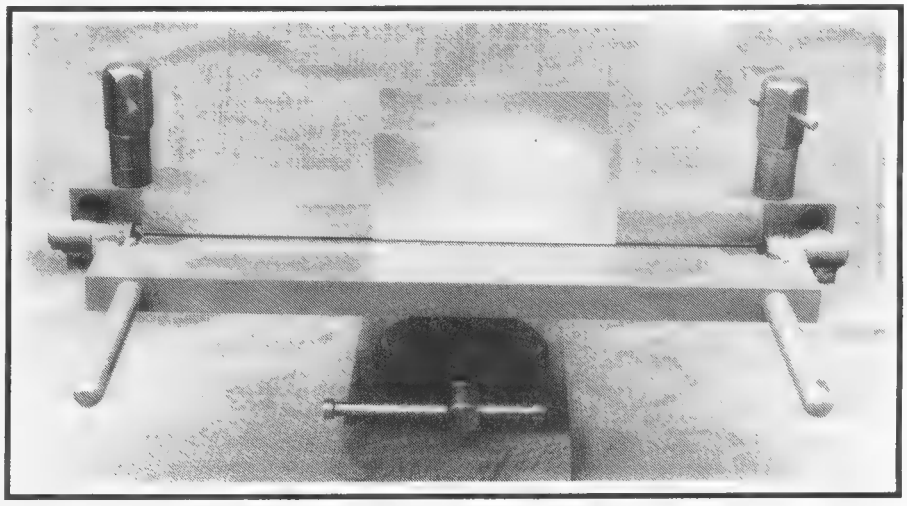

Photo 1 - Plain right-angled bends are obtained by using the top clamp.