

General Purpose SWR/Power Meters for 220 Mhz



Those amateurs like myself who have dabbled in the 220 MHz band, already know that there is a limited choice of 220 transceivers available. Other than older equipment, only Alinco and Jetstream currently manufacture 220 radios that I know of. Not surprisingly then, it appears that there are also few SWR/Power meters available, at least those that are actually claimed to function on the 220 band.

You could ask why bother having an in-line SWR/Power meter at all?

There are a number of reasons I can think of;

1. to provide a "comfort level" when operating. You get used to seeing some nominal swr and rf power reading, so that any change from that can indicate problems with antenna, cable or radio.
2. to confirm that the SWR is suitably low and safe for your radio
3. to confirm that the rf power output of your rig is what you expect vs the manufacturers rating
4. to set up the rf power level on the radio after a repair of the finals.

Reason #4 is what got me into the investigation leading to this article.

It started with my acquisition of the new Jetstream JT220M transceiver, which is rated for 50 watts output. (Most other rigs around, older ADI's, and the Alinco DR235 are rated for 30 watts or less).

Being a curious sort, I wanted to know if the JT220M radio would indeed put out 50 watts into a 50 ohm load as claimed.

I have 2 Daiwa CN -103L meters in my shack that are marked as covering the range of 140 ~ 525 MHz. I also have a lower cost Workman SX-144/430.

Note the subtle difference here in the markings. The Daiwa, marked as 140 ~ 525 MHz, suggests that it could also be useful at 220, or anywhere in between, whereas the Workman marking suggests only the 2 bands.

Anyway, I hooked up one of the CN -103L meters in-line with the Jetstream JT220M radio and a 50 ohm load.

I was surprised to see the meter reading 80 watts at 224.500 MHz !! So I tried the second CN-103L meter and it read 70 watts!

The Daiwa published specification, said accuracy was +/- 10% of full-scale, which for these meters would be +/- 20 watts on the 200W range, or +/- 2 watts on the 20 W range. So the remaining question was - what was the actual rf output power when the meters were indicating either 70 or 80 watts?

Note that the radio DC input power at the time was only about 104 watts (8.0 amps at 13.0 V) so it seemed to me that 70 or 80 watts of rf output was not likely.

Unfortunately at the time, I was unsuccessful to contact Daiwa or its North American distributor, in order to verify their specification at 220.

More disturbing to me, was that I had previously used one of the CN -103L meters to adjust the drive and rf power output of my old ADI AR247, that I had replaced the power amplifier "brick" on. Since I had used an obviously inaccurate meter, I needed to know whether I had set the drive too low or worse, too high!

To shorten a long story, I eventually compared 4 models of SWR/wattmeters for RF power performance on both 220 and 440. For a reference, I used a calibrated Bird 43 wattmeter. I did not get into verifying reflected power accuracy, only forward.

Due to the amount of raw data accumulated, I have tried to summarize as much as possible. Note that although the meters have accuracy specs given as a % of full scale deflection (FSD), my % error measurements are % of reading, referenced to the standard.

Table 2 below summarizes my findings.

Table 2

Band / Scale	% error Daiwa # 1	% error Daiwa #2	% error MFJ-862	% error Workman SX-144/430
224 Low	39%	50%	33%	122%
224 High	81%	43%	20%	67%
445 Low	-6%	0%	0%	10%
445 High	35%	6%	-17%	-2%
FSD	200/20	200/20	300/30	100/20

Results summary:

1. One of my 2 Daiwa meters, (#1), obviously has a calibration problem on the 200 watt scale, as compared to #2

2. All the meters except Daiwa #1, give reasonable results on 445 Mhz
3. The exception to this is the MFJ-862, where the small cramped meter scale, as well as being the only one with 300 watts full scale, made a meaningful reading of the power level very difficult and I am sure introduced significant errors.
4. Ignoring Daiwa #1 results, it appears that 220 rf power levels will be indicated approximately 40-50% higher than actual. Or in other words, if the reading on 220 was multiplied by 0.7, the result will be close to actual.
5. The Workman was quite good on 440, and the worst on 220

Discussion of error sources:

1. I think the major source of error on the 220 readings, are simply due to the fact that the units tested, except the MFJ-862, have no means to adjust at 220. I have recently received acknowledgement of this from Daiwa. Although they do not calibrate at 220, Daiwa suggested that the expected accuracy there would be less than +/- 20 % of FSD. (ie: 40/4 watts)
2. The next most significant source of error is, I think, the power scales used on the meters themselves. A 200 watt full scale is bad enough to try and accurately read say 40 or 50 watts. Its almost impossible to do so on a 300 watt full scale, at least with the small size of the MFJ-862.
3. All of the meters have an insertion loss, that I observed but did not measure. At first I thought that I could series connect all the meters, but that proved quite impractical. I wound up in each case, series connecting only one meter under test as close as possible to the Bird wattmeter.
4. I also opened up all of the meters and looked at the "strip-line" used as a line section/directional coupler to pick up the forward and reverse signals. I will just say that for each of the 3 manufacturers, there was a significant physical difference in how this was done. I have no idea how well each may have replicated a 50 ohm transmission line.
5. As I said earlier, I did not try to verify reflected power as well. Primarily due to limitations in equipment and time. Note however that these meters use separate directional couplers for forward and reverse power and that SWR accuracy will be affected by how accurate the forward and reverse power adjustments are made.
6. Connectors also gave me problems from the start. The "UHF" connectors on all the meters except the Bird, leave a lot to be desired. At VHF and above, their non-constant impedance is well known to introduce errors in both vswr and power readings. A good topic for another time.

What's out there:

I did a search of product literature from various SWR/Power meter manufacturers to locate only meters advertised to be 220 specific. There are really only a few such models out there, which I have summarized in the table that follows.

I am sure that there may well be some that I am not aware of. (I also did not include some of the simpler SWR meters, where you must set a forward power reference before reading SWR)

Table 2

Manufacturer	Model	Type	Specification
Diamond ₁	SX 40C	Cross-needle meter	144-470 MHz, (220 MHz w/ correction factor), 30, 300 watts
Diamond ₁	SX240C	Cross-needle meter	1.8-54, and 140-470 MHz (220 MHz w/ correction factor), 30, 300, 3000 watts
Elecraft ²	W2	Digital	144-450 MHz 200 watts, 1-54 MHz 200/2000 watts
Jetstream ³	JTWXVU	Cross-needle meter	125-525 MHz, 2/20/200 watts
MFJ	MFJ 862	Cross-needle meter	144/220/440 MHz, in 3 switch selectable bands, 30/300 watts
MFJ	MFJ817C	Cross-needle meter	144/220/440 MHz, 30/300 watts, has "true-peak" reading
Vectronics	PM-30UV	Cross-needle meter	100-500 MHz, in 3 switch selectable bands, 30/300 watts

Notes:

1. These meters will function on 220, but the manufacturer clearly points out that readings must be multiplied by a correction factor of approximately 0.7
2. The Elecraft W2 is something quite new. It uses remote sensor heads, of which 2 may be attached at any one time. Available as a kit as well as assembled. Claimed accuracy is +/- 0.5 db
3. Jetstream literature was not specific about 220, however their sales department responded to me and confirmed that the JTWX models only work on 220. No claim of accuracy was given for 220. The large meter size on the Jetstream should improve the reading accuracy.

Conclusions:

We have to recognize that these meters are not laboratory grade, but rather are general purpose. I was not surprised to be told by one of the manufacturers that higher accuracy is swapped for lower cost.

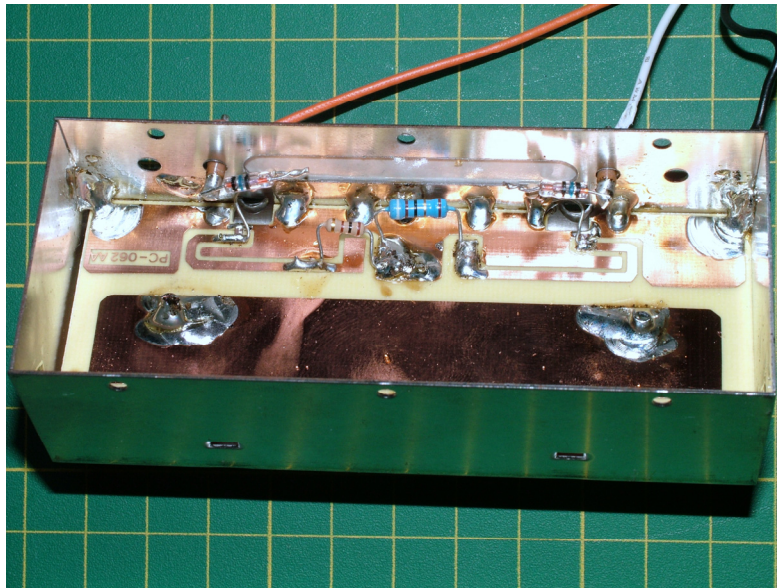
I have found that one must be careful in choosing an Swr/Power meter, to ensure that the particular meter is in fact calibrated for the 220 band.

My findings are that unless an SWR/Power meter is clearly described or marked for 220 use, then in fact it may not perform well on that band.

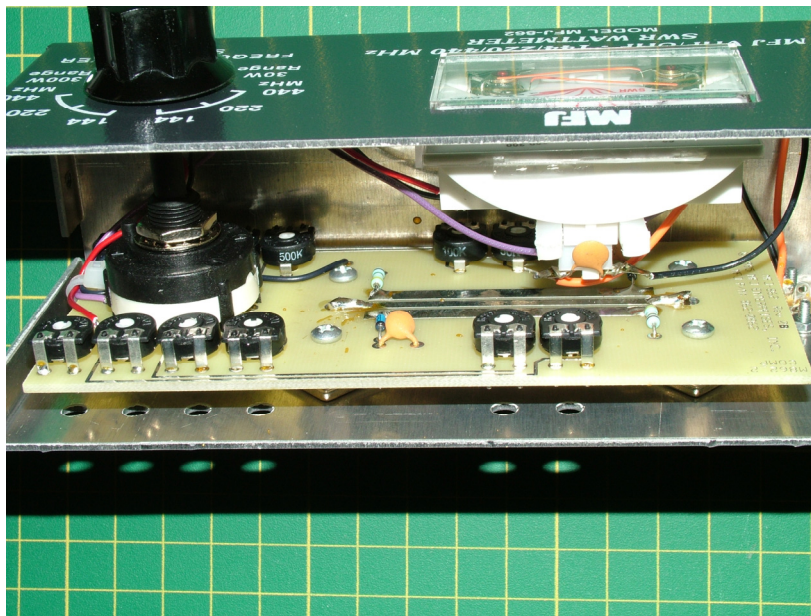
(Note that I am not talking about the highly regarded Bird 43 wattmeter types, that many consider to be industry standards)

It also follows, that if the

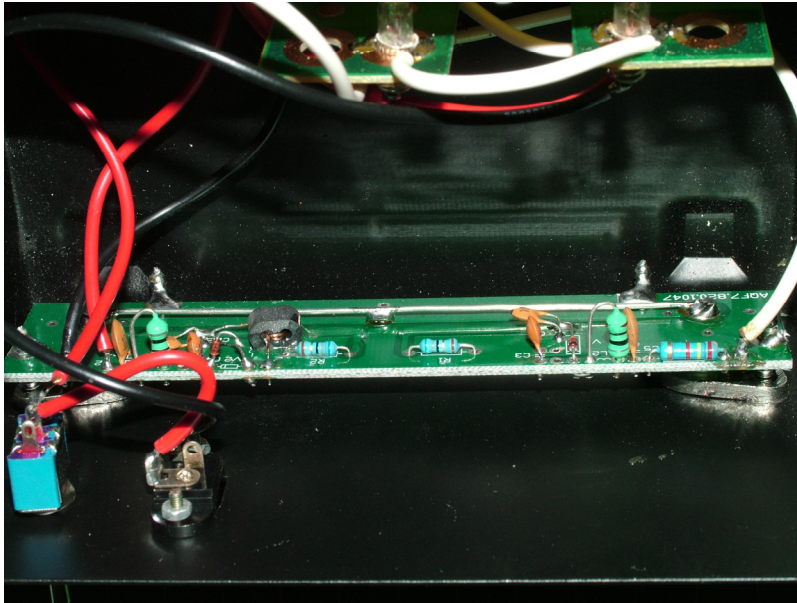
Inside photos:



DAIWA 1



MFJ 1



WORKMAN 1

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