

QST Compares HF/VHF Wattmeters

By Steve Ford, WB8IMY

One of the most important pieces of test gear you'll ever own is your wattmeter. With a wattmeter you can measure the output of your transceiver and adjust it accordingly. A wattmeter can alert you to a problem with your antenna system by displaying the forward and reflected power at a particular point. With the forward and reflected power values, you (or the meter) can calculate the Standing Wave Ratio (SWR). You can even use a wattmeter to calculate feed line loss—just compare the power at the input of the feed line to the power at the output.

Many modern radios and antenna tuners include wattmeters, but these are tied to the equipment in which they are installed. In contrast, a stand-alone wattmeter can be used anywhere. This is convenient when you're trying to troubleshoot a problem—especially when you need to take a measurement at the feedpoint of an antenna, or in a mobile station.

Wattmeters differ in several ways. Some models display forward power, re-

flected power and SWR simultaneously. Some display only forward and reflected power, leaving it up to you to “ask” for the SWR by flipping a switch or twisting a calibration knob. Other wattmeters display *only* forward or reflected power—you have to jot down the measurements and calculate the SWR yourself.

Many wattmeters claim to be *peak reading*. That is, they can display power levels that are present at extremely brief periods of time. A good example is an SSB signal that can have a relatively low *average* power, but include numerous bursts of higher peak power that exist for only fractions of a second.

There are two types of peak-reading meters: *active* and *passive*. The active wattmeters sample peak power levels electronically and then amplify and display the results. These meters require an external dc power source. Passive models use unamplified meter-damping circuits for peak-power readings. As you might guess, active wattmeters provide the most accurate peak-power readings. In most in-

stances you'll be concerned with *average* power readings, and passive meters often do an adequate job in this department.

The ARRL Laboratory tested the meters at 2, 14, 28, 50 and, for those meters with extended coverage, 144 MHz. Power accuracy tests were conducted at 5, 100 and 1000 W (for those meters rated at 1 kW) in key-down CW (100% duty cycle), 50% duty cycle CW (60 WPM keying), two-tone SSB (700 and 1900 Hz) and standard voice SSB. SWR accuracy testing was performed with resistive loads that created 1:1 and 2:1 SWRs.

The wattmeters chosen for this review are *not* laboratory-grade meters. Although we measured them against calibrated ARRL Lab equipment, it isn't fair to expect the same level of performance. If you require extreme accuracy, you have to pay for it, often to the tune of hundreds or even thousands of dollars. But for most Amateur Radio applications you can tolerate *reasonable* accuracy; you don't need to split hairs at tiny fractions of watts.



DIAMOND SX-200

The Diamond SX-200 uses vertically stacked scales and a single meter movement to measure power and SWR. The display is lighted, but you have to supply an external 12-V power source (Diamond includes the power cable, though). To operate the SX-200 you have to use the front-panel switches to jump between forward power, reflected power and SWR functions as necessary. The SX-200 is a passive peak-reading meter with a switch to select either average or peak-power modes. To measure SWR, you must first calibrate the SX-200 in the calibrate mode using the front-panel CALIBRATE control, then switch to the SWR mode. The SX-200 specifies a frequency range of 1.8 to 200 MHz and power scales of 5, 20 and 200 W. The minimum power required to obtain an SWR reading is 1 W. Primarily a desktop meter, the SX-200 measures 6 × 2 × 4 inches and weighs 2 pounds, making it one of the heftier meters of the bunch.

The SWR accuracy of the SX-200 was quite good in our Lab tests, but the forward power accuracy could have been better. From a user standpoint, we found the need to frequently change switch settings a little cumbersome. The meter is ruggedly built, however, with a sleek, attractive appearance.

Manufacturer: Diamond Antenna, 435 South Pacific St, San Marcos, CA 92069; tel 760-744-0900; www.rfparts.com/diamond/. \$99.95.

DIAMOND SX-20C

The SX-20C is a compact meter ($3\frac{5}{16} \times 3\frac{5}{16} \times 3\frac{3}{4}$ inches) designed to be as “hands off” as possible. The SX-20C is intended for mobile use, but it works just as well in the shack or just about anywhere else. This passive meter uses two meter movements that sweep across each other (the so-called “cross needle meter” design). When you apply RF, the SX-20C displays forward and reflected power simultaneously. Beneath the arcing forward and reflected power scales there is an SWR nomograph. Just watch where the needles cross and that’s your SWR. The

DIAMOND SX-200

Frequency Range: 1.8-200 MHz

Power Range(s): 5/20/200 W

PEP Measurement: Passive†

Actual Forward Power (Average/Peak)

Frequency (MHz)	2	14	28	50	144
5 W CW*	6.0/6.0	6.0/6.0	5.8/5.8	5.2/5.2	4.5/4.5
5 W 50%	-4.7	-4.7	-4.8	-4.3	-3.5
100 W CW	130/130	125/125	125/125	120/120	100/100
100 W 50%	-130	-120	-125	-100	-90
100 W Two-Tone	-100	-90	-100	-95	-85
100 W Voice	-110	-90	-90	-80	-80

SWR Accuracy

1:1 SWR	1:1	1:1	1.1:1	1.1:1	1.1:1
2:1 SWR	2:1	2:1	2:1	1.9:1	2:1

Insertion Loss – <0.1 dB – <0.1 dB <0.1 dB

Notes

†For PEP monitoring, “Active” indicates that a circuit requiring external power is used. “Passive” indicates a circuit that requires only RF.

*Used 20-W scale for 5-W tests.



SX-20C has two power settings that are selected with a front-panel pushbutton: 30 and 300 W (average reading only). The minimum power necessary for a reading is 5 W. The SX-20C is rated for operation over three frequency ranges: 3.5-30 MHz, 50-54 MHz and 130-150 MHz.

The SX-20C seems not to be as ruggedly built as the Diamond SX-200. In performance, however, the SX-20C turned in impressive results with good forward power and SWR accuracy.

Manufacturer: Diamond Antenna, 435 South Pacific St, San Marcos, CA 92069; tel 760-744-0900; www.rfparts.com/diamond/. \$89.95.

PALSTAR WM150

The WM150 is the only active peak-reading wattmeter in the group. The WM150 is also one of the few meters in

this review to boast the ability to measure up to 3 kW. The WM150 display uses the cross-needle approach that allows forward power, reflected power and SWR to be measured at the same time. There are two pushbutton-selectable power ranges: 300 W and 3 kW. Another pushbutton selects average or peak power displays. The frequency range of the WM150 is 1.8 to 150 MHz.

The WM150 is a durable instrument housed in a $4\frac{1}{2} \times 3\frac{1}{4} \times 3\frac{1}{4}$ -inch aluminum case. The display is illuminated and, unlike many wattmeters in this price range, the WM150 package includes a 12-V dc “wall wart” supply to power the lamp and the active circuits.

The WM150 provided reasonably accurate forward measurements on HF, but seemed to suffer on VHF. The same was true for SWR accuracy. Although the

DIAMOND SX-20C

Frequency Range: 3.5-150 MHz

Power Range(s): 30/300 W

PEP Measurement: None

Actual Forward Power (Average only)

Frequency (MHz)	2	14	28	50	144
5 W CW	–	4.9	5.0	4.8	4.8
100 W CW	–	100	100	97	98

SWR Accuracy

1:1 SWR	–	1:1	1:1	1.1:1	1.1:1
2:1 SWR	–	2.2:1	2:1	2:1	2:1

Insertion Loss – <0.1 dB – <0.1 dB <0.1 dB



PALSTAR WM150

Frequency Range: 1.8-150 MHz
 Power Range(s): 300/3000 W
 PEP Measurement: Active[†]

Actual Forward Power (Average/Peak)

Frequency (MHz)	2	14	28	50	144
5 W CW	8/-	7/-	7/-	6/-	110/90*
100 W CW	103/105	103/102	102/101	103/102	110/90
100 W 50%	-/102	-/102	-/102	-/102	-/70
100 W Two-Tone	-/100	-/102	-/100	-/100	-/90
100 W Voice	-/100	-/98	-/100	-/100	-/90
1 kW CW	900/1250	950/1260	900/1250	-/±	-/±
1 kW 50%	-/1250	-/1250	-/1250	-/-	-/-
1 kW Two-Tone	-/1250	-/1250	-/1250	-/-	-/-
1 kW Voice	-/1250	-/1250	-/1250	-/-	-/-
SWR Accuracy					
1:1 SWR	1:1	1:1	1:1	1.2:1	2.5:1
2:1 SWR	2:1	2:1	1.7:1	1.4:1	-
Insertion Loss	-	<0.1 dB	-	<0.1 dB	<0.1 dB

Notes

*Input SWR at 100 W on 144 MHz was 1.7:1 (2.5:1 indicated on meter), possibly affecting accuracy.

**Peak detector circuit in this unit requires more than 5 W for proper operation.

[†]For PEP monitoring, "Active" indicates that a circuit requiring external power is used. "Passive" indicates a circuit that requires only RF.

[‡]Amplifiers for 6 meters or 2 meters were not available at the time of testing.



DAIWA CN-101L

Frequency Range: 1.8-150 MHz
 Power Range(s): 15/150/1500 W
 PEP Measurement: Passive[†]

Actual Forward Power (Average/Peak)*

Frequency (MHz)	2	14	28	50	144
5 W CW	4.6/4.6	5/5	5/5	4.2/4.2	4.8/4.8
5 W 50%	-/2.2	-/2.5	-/2.3	-/2.1	-/2.2
100 W CW	90/90	95/95	93/93	88/88	100/100
100 W 50%	-/63	-/68	-/65	-/62	-/70
100 W Two-Tone	-/55	-/52	-/60	-/55	-/70
100 W Voice	-/30	-/30	-/30	-/25	-/30
1 kW CW	1050/1050	1100/100	1050/1050	-/±	-/±
1 kW 50%	-/900	-/1070	-/900	-/-	-/-
1 kW Two-Tone	-/750	-/800	-/720	-/-	-/-
1 kW Voice	-/900	-/800	-/900	-/-	-/-
SWR Accuracy					
1:1 SWR	1:1	1:1	1:1	1:1	1:1
2:1 SWR	2.2:1	2.3:1	2.3:1	2.2:1	1.6:1
Insertion Loss	-	<0.1 dB	-	<0.1 dB	0.1 dB

Notes

*According to the CN-101L manual, "For monitoring PEP, a condenser is placed into detector circuit. This function can not hold peak envelope power."

[†]For PEP monitoring, "Active" indicates that a circuit requiring external power is used. "Passive" indicates a circuit that requires only RF.

[‡]Amplifiers for 6 meters or 2 meters were not available at the time of testing.

WM150 is specified to function at VHF, Palstar states that the meter is not specifically designed for accuracy above 50 MHz.

Manufacturer: Palstar Inc, 9676 N Looney Rd, PO Box 1136, Piqua, OH 45356; 937-773-6255; www.palstarinc.com/. \$89.95.

DAIWA CN-101L

Daiwa Industry Company pioneered the cross-needle meter design more than 20 years ago, and it has been showing up in their wattmeters ever since. The CN-101L is a desktop meter with three switch selectable power levels: 15, 150 and 1500 W. The frequency range is 1.8 to 150 MHz. You can toggle between average and peak power (passive) readings.

The cross-needle meters provide simultaneously forward power, reflected power and SWR displays, which is extremely convenient. No calibration or other adjustments are necessary. The meter face is backlit and a power cable is included.

The enclosure is quite attractive with a large, easy-to-read meter. The front panel switches, however, lacked a solid feel. We found the CN-101L to be accurate on average power, but unacceptably inaccurate when attempting to measure peak envelope power (PEP). The CN-101L isn't well designed for peak power measurement, and the manual says as much (see the note in the data table).

Manufacturer: Daiwa Industry Company, 60 9th Floor, TOC Building, 22-17-7 chome, Nishi-Gotanda Shinagawa-ku, Tokyo, Japan. Available from several US dealers. Typical street price \$94.75.

DAIWA CN-410M

The CN-410M is a compact wattmeter that also features Daiwa's famous cross-needle design. Being able to read power and SWR at a glance is a boon to portable and mobile operators—and it is a pleasant experience in the shack as well. The CN-410M is designed for operation from 3.5 to 150 MHz at pushbutton-selectable 15- or 150-W power levels (peak or average). The CN-410M comes with a mobile mounting bracket. According to its specifications, the CN-410M can provide readings with as little as 3 W, but this aspect of its performance was not tested.

It is important to point out that the CN-410M has been discontinued. However, this meter is still quite popular at hamfest fleamarkets and on-line auctions.

The CN-410M held its own on HF, but we noticed that its accuracy declined at the high end of its range. Also, on 2 meters, the CN-410M presented an SWR of 2:1, a significant figure at this frequency.



DAIWA CN-410M

Frequency Range: 3.5-150 MHz
Power Range(s): 15/150 W
PEP Measurement: None

Actual Forward Power (Average only)

Frequency (MHz)	2	14	28	50	144
5 W CW	—	5.2	5.0	4.3	4.6
100 W CW	—	110	105	90	*

SWR Accuracy

1:1 SWR	—	1:1	1:1	1:1	1.2:1
2:1 SWR	—	2:1	2:1	2:1	2.7:1

Insertion Loss	—	<0.1 dB	—	0.1 dB	—
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Note

*SWR on input was 2:1 at 100 W on 144 MHz, so test was not performed.

MFJ ENTERPRISES MFJ-860

Frequency Range: 1.8-54 MHz
Power Range(s): 30/300 W
PEP Measurement: None

Actual Forward Power (Average/Peak)

Frequency (MHz)	2	14	28	50
5 W CW	4.6	4.6	4.8	4.3
100 W CW	110	110	115	110

SWR Accuracy

1:1 SWR	1:1	1:1	1:1	1.3:1
2:1 SWR	2:1	2:1	2:1	2.2:1

Insertion Loss	—	<0.1 dB	—	<0.1 dB
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Manufacturer: Daiwa Industry Company, 60 9th Floor, TOC Building, 22-17-7 chome, Nishi-Gotanda Shinagawa-ku, Tokyo, Japan. Available from several US dealers. Typical street price \$98.75.

VECTRONICS PM-30

The PM-30 is the second wattmeter in the group to include the ability to measure up to 3 kW

output. With its large cross-needle display, the PM-30 can simultaneously measure forward power, reflected power and SWR. The power is selected by pushbutton in two ranges: 300 and 3000 W with average or peak power display (selectable). The frequency range is 1.8

to 60 MHz. The meter can be backlighted if you connect an external 12-V dc source. You can turn the backlighting on or off from the front panel.

The PM-30's construction is sturdy and at $5 \times 3\frac{1}{2} \times 5$ inches it is the largest meter tested for this review. A Lexan face protects the meter movements.

The PM-30's forward power accuracy varied considerably according to the power level and frequency. SWR accuracy was fair.

Manufacturer: Vectronics, 300 Industrial Park Rd, Starkville, MS 39759; 800-363-2922; www.vectronics.com/. \$79.95.



VECTRONICS PM-30

Frequency Range: 1.8-60 MHz
Power Range(s): 300/3000 W
PEP Measurement: Passive†

Actual Forward Power (Average/Peak)

Frequency (MHz)	2	14	28	50
5 W CW	8/8	8/7	8/8	7/8
100 W CW	125/125	125/125	130/130	125/120
100 W 50%	-/120	-/120	-/125	-/115
100 W Two-Tone	-/92	-/90	-/100	-/100
100 W Voice	-/80	-/85	-/90	-/80

1 kW CW	1000/1000	920/900	920/900	-/—‡
1 kW 50%	-/900	-/900	-/900	-/—
1 kW Two-Tone	-/800	-/800	-/750	-/—
1 kW Voice	-/900	-/800	-/1000	-/—

SWR Accuracy

1:1 SWR	1.2:1	1:1	1.1:1	1.3:1
2:1 SWR	1.7:1	1.7:1	1.5:1	1.5:1

Insertion Loss	—	<0.1 dB	—	<0.1 dB
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Notes

†For PEP monitoring, "Active" indicates that a circuit requiring external power is used.

"Passive" indicates a circuit that requires only RF.

‡Amplifiers for 6 meters or 2 meters were not available at the time of testing.

MFJ ENTERPRISES MFJ-860

The MFJ-860 is the least expensive wattmeter in this group. At about $4\frac{1}{2} \times 3\frac{1}{2} \times 2\frac{1}{2}$ inches, it is also among the smallest. It sports the convenient cross-needle meters for instant SWR and power readings. In fact, the only switch on the meter is a pushbutton to select one of two power ranges: 30 and 300 W. The MFJ-860 is average-reading only. The frequency range is 1.8 to 60 MHz.

Despite the lower cost, the MFJ-864 was surprisingly accurate. Its insertion loss was also acceptable and well within specifications. The only criticism was related to the small size of the meter display itself. It can be difficult to read under some lighting conditions.

Manufacturer: MFJ Enterprises, PO Box 494, Starkville, MS 39759; 800-674-1800; www.mfjenterprises.com/. \$44.95.