Product Review and Short Takes from *QST* Magazine

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Analog HF/VHF wattmeters
High end dual-lever keyer paddles

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PRODUCT REVIEW

QST Compares Analog HF/VHF Wattmeters

Reviewed by Bob Allison, WB1GCM
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A standalone wattmeter is a "must have" in any Amateur Radio station and is the first piece of test equipment that many hams own. Whether you're operating in your shack, car, boat or out in the field, your wattmeter shows you at a glance how much power your transmitter is putting out. Many models display power and standing wave ratio (SWR) simultaneously, so you can keep an eye on antenna system conditions too.

Wattmeters are common on many modern radios, but standalone wattmeters can be used at any point between the transmitter and antenna to help with troubleshooting. For example, you can calculate feed line loss by comparing the power into and out of a length of coax.

My first "wattmeter" as a young Novice (WN1TDN) was a 60 W light bulb, used as a dummy load and made bright by my Heathkit DX-60B's RF output. Many hams simply tuned their transmitters for a dip in plate current and hoped for the best. I burned out my final amplifier tube twice before I purchased my first SWR meter. Fortunately, today's hams have a lot of good choices, many at reasonable prices.

Bottom Line

These reasonably priced HF/VHF wattmeters offer power and SWR measurements at several power levels. Each model offers something different, but one is sure to be a match to your station requirements.

Features and Testing

Four of the five units tested for this review are "cross needle" type, employing two movements on a single meter for simultaneous display of forward power, reflected power and SWR. The other has a single movement and a switch to choose forward or reflected power or SWR.

Four of the units reviewed here display both average and peak power (PEP). There are two different types of peak reading wattmeters: *active* and *passive*. Active models use some type of circuit requiring an external dc supply or internal battery. Passive models require no power supply and use damping circuits for peak readings — usually charging a small capacitor quickly and discharging it slowly. PEP mode is good for measuring the peak power of an SSB transmission.

The tables show ARRL Laboratory test results at several frequencies and power levels. The "CW" measurements are with a steady carrier (100% duty cycle), and the "50%" (for 50% duty cycle) measurements are made with the transmitter sending a string of CW dits at 60 WPM. Two-tone SSB testing (700 and 1900 Hz tones) was performed at 14 MHz. SWR accuracy testing used resistive loads that created 1:1 and 2:1 SWR through 50 MHz. We did not have an amplifier available for 1 kW tests at 50 and 144 MHz.

Each meter was measured against a calibrated, laboratory grade power meter with attenuators (see July 2006 *QST*, page 63, for a description of the ARRL Lab test setup). It is important to remember that even with a calibrated lab-grade setup, accuracy of ±5% is typical. For most Amateur Radio applications, a wattmeter with *reasonable* accuracy is sufficient. In actual operation, a few watts higher or lower makes no difference at all. Ease of operation and SWR accuracy are more important to most users. The wattmeters tested are all good tools for any ham and are a far cry from my light bulb wattmeter. In alphabetical order, here they are.

AMERITRON AWM-30

A cross needle meter, the Ameritron AWM-30 is the most compact meter in this review except for the Comet CMX-1 that has a separate sensor. With just two forward power ranges of 300 W and 3 kW, this meter is more suitable for high power operation. Tick marks on the 2.5 × 2 inch meter face are at 5 W; in 10 W steps from 10 to 200 W; and 25 W steps from 200 to 300 W. Multiply by 10 for the high power range.

Front panel pushbuttons include HIGH/LOW power, PEAK/AVG and power ON/OFF. The AWM-30's manual does not state its frequency range. I inquired about that, and while waiting for a call back from the factory I tested at 50 MHz. The results were reasonable and consistent with HF readings even though the factory specified 1.8 to 30 MHz.

This meter will not function without a power source — either 12 V dc via the back panel or (unique in this group) an internal 9 V battery. The battery does not light the meter lamps but powers the meter's active circuit for portable operation. To prolong battery life,

Ameritron AWM-30, serial number 01620

Frequency range	1.5-30 MHz
Power range	1-3000 W
Power requirement	12 V dc or 9 V battery
PEP measurement	Active
Size (height, width, depth)	4.5 × 4.25 × 5.25"
Price	$135

Actual Power (W)	Indicated Power (W)			
Frequency (MHz)	*2*	*14*	*28*	*50*
5 W CW	8.5	7.6	7.6	7.6
5 W 50%	8.5	7.6	7.6	7.6
100 W CW	104	105	100	96
100 W 50%	104	105	100	96
100 W two-tone	–	96	–	–
1 kW CW	1130	1150	1050	–
1 kW 50%	1180	1240	1140	–
1 kW two-tone	–	1190	–	–
SWR Accuracy				
1:1 SWR	1.0:1	1.0:1	1.0:1	1.1:1
2:1 SWR	1.8:1	2.0:1	2.0:1	2.3:1
Insertion loss (dB)	<0.1	<0.1	<0.1	<0.1

– = Not measured.

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an RF sensing circuit disconnects the battery when the AWM-30 is not measuring power. The ON/OFF switch controls only power to the lamps.

The instruction sheet is four pages and includes a schematic diagram. Out of the box, the AWM-30 didn't work because the meter lugs were shorted to the chassis. It worked fine after I moved them, and Ameritron told me they would look out for this problem.

Accuracy at the 5 W level was not as good as the other meters tested, perhaps because the AWM-30's lowest power range is 300 W. It's fine at the 100 W level and slightly high at 1 kW. The SWR accuracy was good.

Manufacturer: Ameritron, 116 Willow Rd, Starkville, MS 39759; tel 622-323-8211; **www.ameritron.com**.

COMET CMX-1

This cross needle meter reads average power only. A separate power sensor and lightweight, compact construction make the CMX-1 a good choice for mobile work. Its colorful backlit meter face and dark gray plastic case make the CMX-1 a fine decoration on any dashboard. Rear panel channels allow you to neatly tuck in the sensor cable for flush mounting, and adhesive hook-and-loop strips are included. The bottom of the meter unit accepts a threaded mounting post with the same dimensions as a common camera tripod, but you provide the mounting hardware.

Specified to work at 1.8 to 60 MHz, the CMX-1 offers forward power ranges of 30, 300 and 2000 W. The meter face has forward power tick marks in 1 W steps up to 15 W and 2.5 W steps from 15 to 30 W. Multiply by 10 or 100 for the higher power ranges.

There are four unobtrusive pushbuttons to the right of the meter. Three select the power range. The other is a momentary contact VOLTAGE, switch for quick measurement of the supply voltage. A small sliding switch on the right side turns the meter illumination on and off. The meter housing is compact, but the meter face is 2.5 × 2 inches — large enough for easy and quick readings. It's also rendered in color, with green lines for SWRs of 1.5:1 or lower and red lines for higher readings.

The CMX-1's 6 foot cable detaches at the sensor with a 5 pin DIN connector, and Comet offers an optional sensor extension cable. A single fused red wire from the sensor connects to 12 V dc for the meter lamps.

I was puzzled by the name "All Time Multi Media Monitor" that adorns the front panel. The 4 page Japanese language instruction manual did not help my understanding of this term, but the illustrations were sufficient to hook up and use the meter. This was the only unit tested that lacked a mechanical adjustment on the front panel to zero the meter movement.

Accuracy could have been a bit better at the lower ranges but it still gives reasonable power indication and importantly, a good SWR reading at a glance — perfect for a mobile environment.

US distributor: NCG Company, 15036 Sierra Bonita Ln, Chino, CA 91710; tel 909-393-6133; **www.cometantenna.com**.

Comet CMX-1

Frequency range	1.8-60 MHz
Power range	1-2000 W
Power requirement	11-15 V dc, 200 mA (lamps only)
PEP measurement	None
Size (height, width, depth)	3 × 4.25 × 1.5"
Price	$170

Actual Power (W)	**Indicated Power (W)**			
Frequency (MHz)	*2*	*14*	*28*	*50*
5 W CW	4.0	4.0	3.8	3.8
5 W 50%	N/A for non-PEP meter			
100 W CW	93	94	91	92
100 W 50	N/A for non-PEP meter			
100 W two-tone	N/A for non-PEP meter			
1 kW CW	1070	1140	1050	–
1 kW 50%	N/A for non-PEP meter			
1 kW two-tone	N/A for non-PEP meter			
SWR Accuracy				
1:1 SWR	1.0:1	1.0:1	1.0:1	1.0:1
2:1 SWR	1.9:1	1.9:1	1.9:1	1.8:1
Insertion loss (dB)	<0.1	<0.1	<0.1	<0.1

– = Not measured.

Daiwa CN-801 HP, serial number 2003

Frequency range	1.8-200 MHz
Power range	1-2000 W
Power requirement	13.8 V dc, 70 mA
PEP measurement	Active
Size (height, width, depth)	4.5 × 6.125 × 4.5"
Price	$155

Actual Power (W)	**Indicated Power (W)**				
Frequency (MHz)	*2*	*14*	*28*	*50*	*144*
5 W CW	4.9	4.9	4.8	4.7	5.4
5 W 50%	6.2	5.5	5.3	5.3	6.3
100 W CW	98	99	94	97	98
100 W 50%	106	101	97	102	103
100 W two-tone	–	96	–	–	–
1 kW CW	1030	1040	990	–	–
1 kW 50%	1180	1300	1130	–	–
1 kW two-tone	–	1050	–	–	–
SWR Accuracy					
1:1 SWR	1.0:1	1.0:1	1.0:1	1.0:1	1.0:1
2:1 SWR	2.1:1	2.0:1	2.1:1	2.0:1	2.0:1
Insertion loss (dB)	<0.1	<0.1	<0.1	<0.1	0.13

– = Not measured.

DAIWA CN-801 HP

The CN-801 HP uses a large cross needle meter with pleasing pale blue meter lamps, making it stand out in any ham shack. Fairly heavy as wattmeters go, this giant size gray metal unit is ruggedly built and comes with removable rubber side bumpers, a useful feature that may prevent damage in the field.

Its range of 1.8 to 200 MHz is the widest in this group, with forward power scales of 20, 200 and 2000 W selected by the front panel RANGE switch. This active wattmeter must be connected to a dc supply for PEP measurements but will read average power

and SWR with the power disconnected. I was surprised that it does not measure reflected power or display SWR in the PEP mode. Power accuracy is very good, though I did notice a jump up of a few watts when switching from AVG to PEP in the key-down CW test.

The large 3.75 × 3.25 inch meter face is easy to read and provides good resolution with tick marks every 0.5 W up to 20 W (multiply by 10 or 100 for higher power ranges). A rear panel receptacle accepts 13.8 V dc (power cord is included), and a meter lamp switch is located on the rear panel.

I wished the case had more than its two rubber feet. The front feet are smooth plastic brackets that secure the front panel to the case — they prop up the front of the meter but provide no grip. Even with the meter's weight, the front end slides a little when switching the RANGE or AVG/PEP toggle switches. A couple of stick-on feet will fix that.

The 4 pages of instructions are in English on one side and Japanese on the other. There are plenty of illustrations and even some technical information on power measurement.

The CN-801 HP is a good choice for home stations but a little large for mobile work. Note that there are several other instruments in the CN-801 family that cover different frequency ranges and power levels.

US distributor: NCG Company, 15036 Sierra Bonita Ln, Chino, CA 91710; tel 909-393-6133; **www.cometantenna.com**.

MFJ-870 GRANDMASTER

The MFJ-870 is the least expensive wattmeter of this group. It's the only one without a cross needle meter, and the only one to use passive circuitry for PEP readings. (MFJ does offer a wide selection of other models, some with cross needle meters.) This meter's frequency range is specified as 1.6 to 60 MHz with forward power ranges of 30, 300 and 3000 W. It has a single meter movement with a FUNCTION switch to choose FWD (forward power), REV (reflected power), SWR SET and SWR. To check SWR, switch to SWR SET, adjust the SWR SET knob until the meter needle hits the CAL mark, and switch to SWR to read the value directly from the SWR scale.

The 3.375 × 1.75 inch meter face is easy to read and has scales for all three power ranges. It has tick marks in 1/10/100 W steps up to 10/100/1000 W, and in 2/20/200 W steps from there to full scale. The orange AVG/PEP pushbutton is hard to miss, even in a dimly lit ham shack.

PEP circuitry is passive, so the rear panel 12 V dc receptacle is for the pale green meter lamps only. A six foot power cord is included. The black and charcoal gray metal case is heavy but can move around the table with its two rubber and two plastic feet. Again, two extra stick-on feet would solve this minor problem.

Although the meter needle responded nicely to voice peaks, power accuracy varied with power level and frequency. The meter has two different SWR scales, LOW and HIGH. The manual is not clear if the 300 W range is considered low or high. A courteous MFJ technician informed me that the HIGH scale must be used for the 300 W range.

With the unit initially purchased, SWR accuracy was poor, reading 1.3:1 across the spectrum with our 2:1 resistive load. Another '870 gave the same results. I contacted MFJ about this, and after some checking they discovered that an incorrect component value was inserted on the production line. MFJ supplied a corrected meter that gave much closer readings, as shown in the accompanying table. Customers with units that have this problem should contact MFJ for warranty repair at no charge. After repair, the MFJ-870 is a useful meter at a budget price.

Manufacturer: MFJ Enterprises, PO Box 494, Mississippi State, MS 39762, tel 800-647-1800; **www.mfjenterprises.com**.

PALSTAR PM2000A

Palstar's PM2000A is a cross needle wattmeter specified to work from 1.8 to 60 MHz. Like the Ameritron AWM-30, the PM2000A has just two forward power ranges of 300 W and 3 kW. Maximum forward power is specified at 2000 W.

The red pushbuttons select PEAK-HOLD, PEAK/AVG, RANGE (300/3000 W) and POWER on/off. A sturdy aluminum case is finished in flat black. It blends in with most radio gear, while the red pushbuttons stood out in my monochromatic ham shack. The attractive 2.5 × 1.75 inch backlit meter face has tick marks at 5 W; in 10 W steps from 10 to 200 W; and 25 W steps from 200 to 300 W. Multiply by 10 for the high power range.

I was glad to see a wall mounted dc supply included to run the active PEP circuitry and meter lamps. Even better, a sturdy grounding post and butterfly nut provide the PM2000A with a station ground connection.

This is an active PEP reading meter and Palstar has provided a PEAK-HOLD function that can be switched on and off. When engaged, peak power measurement is held for one second, providing enough time to get a reading. (Other meters hold the peaks during SSB transmission but this function

MFJ-870

Frequency range	1.6-60 MHz
Power range	1-3000 W
Power requirement	12 V dc (meter lamps only)
PEP measurement	Passive
Size (height, width, depth)	3.25 × 7.5 × 4.5"
Price	$100

Actual Power (W)	**Indicated Power (W)**			
Frequency (MHz)	*2*	*14*	*28*	*50*
5 W CW	4.9	5.5	5.5	5.5
5 W 50%	3.0	3.5	3.5	3.7
100 W CW	105	109	109	109
100 W 50%	83	95	95	97
100 W two-tone	–	88	–	–
1 kW CW	1140	1180	1180	–
1 kW 50%	1110	1130	1130	–
1 kW two-tone	–	1000	–	–
SWR Accuracy				
1:1 SWR	1.1:1	1.0:1	1.0:1	1.3:1
2:1 SWR	2.3:1	2.3:1	2.3:1	3.0:1
Insertion loss (dB)	<0.1	<0.1	<0.1	<0.1

– = Not measured.

can't be switched off.) The PM2000A reads average power and SWR with the dc power disconnected.

The accuracy of the meter tested was reasonable except for 1 kW peak power readings, which were quite high compared to the Lab equipment. The 4 page manual gives instructions for calibrating the PM2000A to match readings from a known power meter, and an easy screwdriver adjustment brought the errant readings into agreement. The PM2000A is equally at home in the shack or in the field.

Manufacturer: Palstar, 9676 N Looney Rd, Piqua, OH 45356; tel 937-773-6255; **www.palstar.com**.

Palstar PM2000A, serial number 9209

Frequency range	1.8-60 MHz
Power range	1-2000 W
Power requirement (ac adapter included)	12 V dc, 50 mA
PEP measurement	Active
Size (height, width, depth)	4.5 × 3.5 × 4.5"
Price	$160

Actual Power (W)	**Indicated Power (W)**			
Frequency (MHz)	*2*	*14*	*28*	*50*
5 W CW	4.7	5.7	5.7	5.8
5 W 50%	4.7	5.7	5.7	5.8
100 W CW	89	96	97	98
100 W 50%	89	96	96	98
100 W two-tone	–	100	–	–
1 kW CW	850	960	900	–
1 kW 50%*	1410	1430	1610	–
1 kW two-tone*	–	1620	–	–
SWR Accuracy				
1:1 SWR	1.15:1	1.15:1	1.25:1	1.45:1
2:1 SWR	1.9:1	1.85:1	1.9:1	2.3:1
Insertion loss (dB)	<0.1	<0.1	<0.1	<0.1

*1 kW PEP readings shown are prior to user calibration; see text.
– = Not measured.

High End Dual-Lever Keyer Paddles

Reviewed by Bruce Prior, N7RR
ARRL Technical Advisor

Dual-lever paddles control electronic keyers by using two levers that can be moved independently, normally toward the center. The operator causes the keyer to produce a series of Morse dits by closing one paddle lever contact and Morse dahs by closing the other. Other paddle designs use a single lever that the operator moves to one side for dits and the other side for dahs.

A dual-lever paddle offers some interesting possibilities for sending technique. In *iambic* modes, closing contacts with both levers simultaneously yields an alternating series of dits and dahs. With keyers featuring *dit and dah insertion* modes, holding the dit lever while tapping the dah lever inserts one dah into a series of dits — for example, to produce the Morse letter L. Similarly, you can produce the letter Q by holding the dah lever closed for two dahs, then tapping the dit lever to insert one dit before the final dah.

This review highlights six high end dual-lever keyer paddles with quality pivot systems that rotate on a vertical plane.[1] Prices range from around $300 to $600. Three of the paddles use repelling magnetic return, two have attracting magnets, and one employs springs to provide return force. Four paddles sport long levers and plastic or acrylic fingerpieces. The other two have short, lightweight alloy levers and carbon fiber fingerpieces.

This review attempts to answer some important practical questions: How easy is it to adjust the paddle? How high above the operating surface are the fingerpieces placed? How does the paddle action feel to either heavy-fisted or light-fingered operators? How well does the paddle stay put on the operating surface? What is involved in ordering the paddle?

The accompanying table shows paddle characteristics. The "Dislodging Pressure" column shows the amount of lateral finger pressure needed on a fingerpiece to make the whole paddle move on the operating surface. ARRL Test Engineer Bob Allison, WB1GCM, carried out the measurements using a strain gauge while each paddle was resting directly on a typical laminate operating surface, and again with a thin high-friction pad between the paddle and the table surface.

Bottom Line

Finely crafted from top quality materials, these high end dual-lever keyer paddles are designed for the discerning CW operator. Some are better suited to heavy fisted operators, while others reward a light touch.

[1]There are some other high-end paddles with waiting lists too long to qualify for this review. These include the March R-3a (**www.qsl.net/k4qu/**) and the ON4MAC MacPaddle (**www.xs4all.nl/~pa0fri/Diversen/Paddlekey/paddlekey.htm**). Top-rated vertical paddles like the Begali Graciella (**www.i2rtf.com**) and the N3ZN ZN-10 (**www.n3znkeys.com**) deserve a separate review.

Thanks to Stan Schmidt, N7OC, and Wayne McFee, NB6M, for their helpful input while trying out the reviewed paddles, and to Dave Yarnes, W7AQK, for helpful comments about the text of this review. We'll start with the long lever paddles.

N2DAN MERCURY

Steve Nurkiewicz, WA2YBR (later N2DAN), described his prototype Mercury keyer paddle in April 1968 *QST* before the paddle series even had a name.[2] His article inaugurated the idea of using magnets, rather than springs, for tensioning, and the Mercury set a decades-long standard for handcrafted paddles.

A professional machinist, Steve retired to Florida, where he divided his time between fishing and building Mercury paddles. His waiting list was long, and although his inconsistent serial number system is not a

[2]S. Nurkiewicz, WA2YBR, "Magnetic Keyer Paddles," *QST*, Apr 1968, pp 35-36.

Table 1

High End Dual Lever Paddle Summary

Model	*Return, Bearings and Base*	*Hardware and Contacts*	*Dislodging Pressure**	*Fingerpieces*	*Weight (lb)*	*Price*
N2DAN Mercury	Attracting magnetic return; Four race bearings; Chrome-plated steel base	Coarse threads, locknuts; Long and heavy levers; Flat rhodium-plated silver contacts	1.6 oz/ 2.8 oz	Long flecked dark purple rounded plastic; 1.1 to 2" above operating surface	3.78 (incl mem buttons)	n/a
Bencher Mercury	Attracting magnetic return; Four race bearings; Chrome-plated brass base	Coarse threads, locknuts; Chrome-plated brass levers; Convex gold-plated silver contacts	1.6 oz/ 2.3 oz	Long black rounded plastic; 1.1 to 2" above operating surface	3.49	$495 (plus s/h)
GHD GN599DX	Compression spring return; Four race bearings; Chrome-plated steel base	Medium threads, locknuts; Long and heavy levers; Flat gold-plated silver contacts at a 45° angle	1.4 oz/ 1.6 oz	Long rounded clear acrylic; 0.9 to 2" above operating surface†	2.84	$400 (plus s/h)
Frattini Professional Deluxe	Repelling magnetic return; Spherical bearings; Coated brass base	Medium threads, locknuts; Brass levers; Flat sterling silver contacts	2.5 oz/ 2.1 oz	Long red rounded triangular plastic; 0.6 to 2" above operating surface	3.48	$425 (incl s/h)
Begali Sculpture	Repelling magnetic return; Four sealed race bearings; Stainless steel base	Fine threads (no locknuts); Light alloy levers; Convex solid gold contacts	1.6 oz/ 1.9 oz	Short rounded black carbon fiber; 0.4 to 1.9" above operating surface†	2.87	€400 (incl s/h)
N3ZN Bronze Model ZN-9A	Repelling magnetic return; Six ball bearings; Coated bronze base	Fine threads (no locknuts); Aluminum levers; Points touching convex gold-plated silver contacts	1.1 oz/ 1.2 oz	Short rounded trapezoidal black carbon fiber; 0.8 to 1.8" above operating surface†	2.11	$295 (plus s/h)

*Lateral finger pressure required to move the paddle on a laminate surface and with a friction mat. See text.
†Optional fingerpieces are available. See manufacturer's Web site for details.

reliable indicator, he probably produced only a few hundred paddles during his lifetime. I acquired #241, made in January 1994, and supplemented it with a bracket of four pushbuttons to control keyer memories. Steve passed away in 1997, but his legacy lives on through the fists of the fortunate operators who have acquired an N2DAN Mercury.

During a period when most paddle users had learned lateral motion Morse on semi-automatic bugs, Steve's philosophy combined close-tolerance machining with heavy weight. My Mercury weighs 3.78 pounds including the supplemental button bracket. Heavy paddling demands an instrument that responds smoothly but doesn't budge on the operating surface under the pressure of a spirited conversation or a fast-paced contest.

The Mercury uses two strong magnets and two magnetic-metal attracting surfaces. Each paddle stroke moves the magnet farther away from the other surface, so its magnetic force decreases through the stroke. Contact spacing and magnetic attraction are adjusted with coarse finger screws held into position with locknuts. The adjustments are stable, but fine tuning them can be tricky because both finger screws and locknuts must be manipulated. The fingerpieces are installed at a rather high fixed height ranging from 1.1 to 2 inches above the operating surface.

My Mercury is adjusted for light magnetic return force and such a razor-thin gap that the thinnest paper in my library cannot be inserted between its flat rhodium-plated silver contacts. Only a high quality paddle attains that standard. Rhodium is expensive, highly resistant to corrosion, and very hard.

Even with extremely close adjustment, the levers are long enough to set up a noticeable vibration, rather like the dying oscillations of a bell. That vibration shouldn't interfere with good keying; it is simply a constantly present characteristic of a heavy and lengthy paddle lever. A long-levered heavy paddle like the Mercury is probably the best choice for operators with heavy fists. Having never passed through the stage of being a skilled bug operator, I prefer light-touch keying.

Finger pressure of 1.56 ounces on the levers is required to dislodge the N2DAN Mercury on a laminate operating surface. Supplemented with a thin high-friction shelf pad, that increases to 2.82 ounces — a substantial improvement.

Very rarely does a classic N2DAN Mercury paddle appear on the used market, and when one shows up, it can command a very high price.

BENCHER MERCURY

Fortunately, Steve Nurkiewicz's widow sold his Mercury patent and tooling to Bencher, and so this classic key is still available. Over its long history, the N2DAN Mercury changed somewhat. The Bencher Mercury follows the pattern of the later models quite closely. The major difference is that the Bencher version uses gold-plated silver contacts rather than the rhodium-plated silver

contacts in the N2DAN originals. The contacts are very slightly convex, an improvement over the original with its flat contacts. The two separate ground wires connected to the levers in the Bencher Mercury are braided and more robust than those in my N2DAN Mercury.

The Bencher Mercury arrived from the factory with its anisotropic (directional) attracting magnets set for very strong return action. The combination of its cork bottom and 3.49 pounds of weight makes it rock-solid, even using a heavy fist. Finger pressure of 1.62 ounces on the levers is required to dislodge the Bencher Mercury on a laminate operating surface, increasing to 2.33 ounces with a friction pad.

Tension can be reduced so low that tilting the paddle 90° to the left or right triggers the dit or dah circuits. Just like the original N2DAN Mercury, the long levers produce a slight vibration when paddling. The fixed fin-

gerpiece height above the operating surface is identical to my original, ranging from 1.1 to 2 inches. Contacts for a cable to the keyer are recessed on the bottom of the paddle, with an exit hole in the back for the cord. I tied a knot for strain relief before soldering the wires to the three terminals.

With one exception, everything about this Bencher Mercury exudes quality. That exception is inherent in the design of the original N2DAN Mercury: the adjustment screws are coarse-threaded and require locknuts to keep adjustments in place. Adjusting for extremely close contact spacing was quite tricky. I found a close match at the point where there is almost no sound when the contacts are closed. After adjustment, keying with either Mercury model is equally pleasurable.

Although they can be adjusted for close spacing and light touch, both the original and this beautiful mirror-finished Bencher Mercury are better choices for operators with a heavier touch.

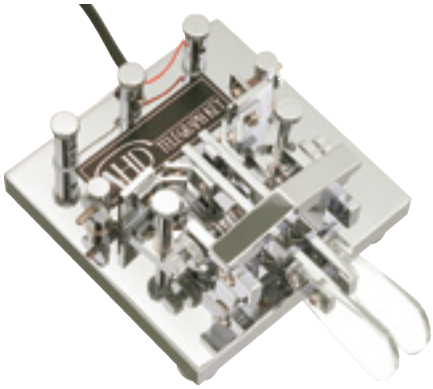
Manufacturer: Bencher, 241 Depot St, Antioch, IL 60002, **www.bencher.com**.

GHD GH-GN599DX

This sparkling chrome paddle was made by Toshihiko Ujiie, JA7GHD, from the main Japanese island of Honshu. The product arrived promptly and nicely packaged from Morse Express, a long-time Colorado distributor of CW products.

With some patience, I was able to understand the English translation of the original Japanese instructions. The keyer cable connects to prominent widely spaced top posts at the rear of the paddle rather than being hidden beneath. The posts are far apart, so the three wires of a connecting cable must be separated, leaving them vulnerable to bending stress in normal operation.

The GN599DX is the only model in this review to use compression springs rather than magnets for lever tensioning. Spring tension for each lever is adjustable separately. The flat gold-plated silver contacts are offset at a 45° angle, allowing them to strike one another with a subtle sliding action and making them automatically self-cleaning. That feature effectively prevents adjustment of the contacts for very close spacing. When adjusted too closely, the contacts operate inconsistently, initiating a series of dits or dahs spontaneously.



The GN599DX is a complex design, and that complexity turns the adjustment process into a fussy trial. Four tiny race bearings govern the lever pivots. The ample-sized acrylic fingerpieces sit from 0.9 to 2 inches above the operating surface.

As delivered, the paddles were a bit loose on their vertical axes. I fixed that in a few minutes using wrenches from my toolbox. The levers are made of heavy chrome-plated steel, and they are relatively long, making them vibrate slightly during keying action like both Mercury models.

At 2.84 pounds, the GN599DX is comparable in weight to the Begali Sculpture, but with a larger footprint. Three rubber feet give this paddle acceptable stability, but they are higher profile than necessary since there is no wiring beneath the paddle. This paddle is not a candidate for outdoor use, so four high-friction, low-profile feet would be better for operation on a flat surface. Finger pressure of 1.38 ounces on the levers is required to dislodge the GN599DX on a laminate operating surface, increasing to 1.56 ounces with a friction pad.

The GN599DX paddle is a reasonable choice for operators who prefer heavy keying action and wide contact spacing. Operators who want the virtually-silent operation of close contact spacing and light return action will probably want to choose a different paddle.

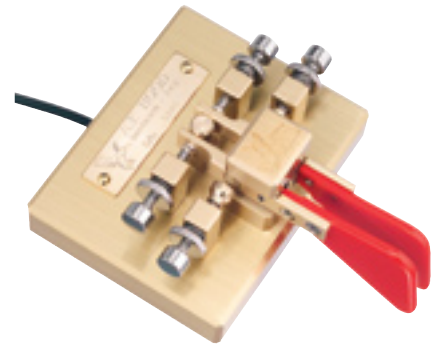
Manufacturer: GHD Key Co Ltd, Simomukouda 24-14, Tomiya-Cho Akashi, Kurokawa-gun, Miyagi, Japan 981-3326; **www.ghdkey.com**. *US distributor*: Morse Express, 10691 E Bethany Dr, Suite 800, Aurora, CO 80014; **www.mtechnologies.com**.

FRATTINI PROFESSIONAL DELUXE

Alberto Frattini, I1QOD, is a retired aircraft factory manager as well as a champion high-speed CW master and DXer. His machine shop is in a small town by the Ligurian Sea near the Italian Maritime Alps.

The Frattini product line includes five dual-lever paddles, five straight keys and three semiautomatic bugs. His dual-lever paddles use Sterling silver contacts, OT 58 UNI 5705-65 brass for the base (coated to resist corrosion) and levers, and neodymium ($Nd_2Fe_{14}B$) repelling magnets for return tension. A characteristic of repelling magnetic paddles is that the magnetic force increases as the stroke progresses, producing a snappy action. Instead of race bearings, Frattini uses a tiny steel sphere above and below each pivoting lever in his paddles. The wide-bodied design is a gleaming beauty.

Our review paddle arrived elaborately packaged in 44 days. The Professional Deluxe weighs 3.48 pounds, almost as heavy as the Bencher Mercury. This heavy weight renders a friction mat unnecessary. A very impressive 2.5 ounces of finger pressure on the levers is required to dislodge the paddle on a laminate operating surface. Oddly, the paddle moved from its original place under less finger pressure — 2.12 ounces — with the friction pad. The Frattini is by far the most immovable of the these six paddles.



The I1QOD paddle has the smoothest action of the long-levered paddles in this collection, probably because the brass levers have relatively low mass and are well balanced. Its four low-profile and high-friction feet, elevated by round brass risers, give the paddle extra stability.

Even when adjusted for wide contact spacing and heavy return tension, the vibrations characteristic of the other long-levered paddles are pleasantly absent. The large, red triangular fingerpieces droop down from 2 inches to 0.6 inch above the operating surface, making this paddle adaptable to different keying styles.

The return tension and contact gap screws have medium threads, but they include locknuts so adjustment is a two-handed process that is hard to accomplish on the fly. Finer threads and a friction system would eliminate the locknuts and make adjustment easier. Once tightened, the adjustments don't budge.

Patch cord contacts are nestled in the midst of four feet on the bottom surface and are not recessed in channels. The Professional Deluxe is a better choice for fixed station use, rather than for portable operation where the operating surface could be irregular.

After making careful adjustments, high-speed operator Wayne McFee, NB6M, chose the Frattini paddle as his favorite among these six for sending in the 35-40 WPM range. Wayne also liked the action and simple adjustment systems of the Begali Sculpture and the N3ZN ZN-9A, but he would have preferred longer fingerpieces (optional) for fast sending.

Manufacturer: Alberto Frattini, Via S. Domenico, 183, 1-17027 Pietra Ligure (SV), Italy; **www.i1qod.it**; e-mail **i1qod@inwind.it**. (I haven't spoken with Alberto on the telephone, but he handled my English-language e-mail communications just fine.)

BEGALI SCULPTURE

The Begali Sculpture has captured center stage as a state-of-the-art dual-lever paddle. The Sculpture is like an exceptionally fine musical instrument. It can be played by people at any skill level, but it's no wonder that experts have snapped up this engineering and artistic masterpiece. Begali makes nine regular paddle models and three straight-keys, plus limited editions.

Because the electrical connections are recessed in a machined bottom channel, the four high-friction feet on the Sculpture are low profile, adding to its stability. The Sculpture thrives with light-touch keying, but at 2.87 pounds it is just heavy enough to remain stationary when used with a heavier style. Finger pressure of 1.56 ounces on the levers is required to dislodge the Sculpture on a laminate operating surface, the same as for my much heavier N2DAN Mercury. (My Mercury has seen almost 15 years of service, so its cork bottom has likely become more slippery.) Supplemented with a friction pad, 1.94 ounces of finger pressure moves the Sculpture.

The Sculpture's race-bearing action is so smooth that the instrument begs to be petted gently, especially when operated at high speeds. The paddle allows a wide range of contact-space and paddle-tension adjustments using fine-thread finger screws. There are no locknuts for the adjustment screws, and I don't think they are needed. Cleverly, the space between the paddles is adjustable from 0.4 to 0.6 inch. My year-long experience with the Sculpture has taught me the joy of paddling with extremely close contact spacing and feather-light tension.

Pietro Begali has rendered the Sculpture in AISI-304 stainless steel, an austenitic (nonmagnetic) material considered more challenging to machine than the brass used for most paddles. The Sculpture's tension mechanism uses neodymium magnets embedded in the end of the two tension-adjustment screws. Turning a screw moves the magnet closer to, or farther from, its repelling magnet mate mounted out of sight on the paddle lever.

Fingerpieces extend from 0.4 to 1.9 inches above the operating surface, allowing a variety of finger positions without adjustment. The Begali Sculpture Web page offers links to videos of accomplished high-speed CW operators manipulating the Sculpture's fingerpieces.

The Sculpture's aluminum-alloy levers and stiff but lightweight carbon fiber fingerpieces are quite short horizontally. With a 1:1 leverage ratio, it takes very little motion to close its 14 karat solid-gold convex contacts. Begali is now offering optional red or blue aluminum fingerpieces ⅛ inch longer than standard for operators who prefer more finger contact.

My Sculpture paddle arrived from Italy in an exceedingly well-padded package. A thin plastic dust cover is standard, but the cover limits the travel of the contact-space adjustment screws, requiring wider spacing than I prefer. A wider plexiglass dust cover would offer a significant enhancement.

The Sculpture came equipped with a 3.5 mm stereo socket in the rear, wired so that the right-hand paddle governs the tip contact rather than the more-usual ring. In the process of reversing the paddle wiring, I damaged the socket. So, I removed the socket and hard-wired the cord to the paddle. It would be helpful if Begali clearly indicated the plug connections.

Manufacturer: Officina Meccanica Pietro Begali, Via Badia 22, I-25060 Cellatica, Italy; **www.i2rtf.com**; e-mail **pibegali@tin.it**. (Pietro Begali's daughter Bruna handles friendly communications with English-speaking amateurs via e-mail or telephone.)

N3ZN BRONZE MODEL ZN-9A

Tony Baleno, N3ZN, is a civil engineer and a life-long amateur machinist. He makes a variety of high quality keyer paddles, all of which share similar features including lightweight 6061-T6 aluminum levers and shimmering stiff carbon fiber fingerpieces to minimize the mass to be moved while keying. They also include neodymium repelling magnetic return mechanisms.

The ZN-9A is intended for operators who prefer short and low fingerpieces, which come in several styles and range from 0.8 to 1.8 inches above the operating surface. Those short fingerpieces are calibrated to offer a 1:1 leverage ratio, like the Begali Sculpture. Customers may opt for ¼ inch longer fingerpieces when ordering, and several optional styles and colors are also available.

Each finger screw on N3ZN paddles is fine-threaded and controlled with additional friction provided by an internal plastic ball and a vertical set screw. No locknuts are needed, so adjusting the key, even in the midst of a QSO, is very straightforward.

Our ZN-9A arrived in a well-packaged double carton. It is the only paddle is this review group equipped with a cord — 68 inches long with a 3.5 mm stereo plug, soldered to the paddle. Out of the box, the ZN-9A was adjusted perfectly to my taste,

with light tension, very close contact spacing and no vertical play.

Minus the cord, the Bronze Model ZN-9A weighs 2.11 pounds, plenty of weight to stay put while operating with light tension. With heavier tension, adding a friction mat helps keep the paddle from migrating on the operating surface. Finger pressure of 1.06 ounces on the levers is required to dislodge the ZN-9A on a laminate operating surface, increasing to 1.16 ounces with a friction mat.

The ZN-9A is optimized for low-position and light-touch keying. It's the most movable of the paddles in this group. This key uses three rubber feet, which makes it more stable when operating on an irregular surface. For a flat surface, however, four feet would offer better stability. In addition, the feet are high enough to allow significant rocking movement even when the paddle is not sliding across the operating surface.

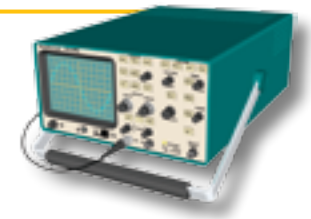
In response to customer requests, N3ZN Keys has added a heavier version, the ZN-9B, which weighs just over 3 pounds. That paddle has a larger base, and it includes four larger diameter high-friction, low-profile feet. The feet can be installed with added washers for operators who prefer a taller fingerpiece height.

Although the ZN-9A is smallest, lightest, and least expensive paddle in this group, its quality is first class. At first glance, the modest ZN-9A design seems unremarkable. The big surprise is hidden. Unique among these six paddles, the ZN-9A is equipped with three race bearings for each lever, one at the top and two at the bottom. Probably because of those extra bearings, its keying action is the smoothest of all the paddles in this review. That silky action makes the ZN-9A a serious rival to the Frattini and Begali paddles. The improved high-friction foot system for the ZN-9B model, which I was not able to test for this review, will likely seal the bargain.

When I ordered the review paddle last year, Tony was making each paddle to order and it took 38 days to arrive. He says he is ramping up production, so waiting time should go down.

Manufacturer: N3ZN Keys, 74 Green Meadow Ct, Pittsburgh, PA 15239; **www.n3znkeys.com**. QST

SHORT TAKES



RPC Electronics RTrak All-In-One APRS Tracker

Larry Wolfgang, WR1B
QEX Editor
lwolfgang@arrl.org

Many readers are familiar with the Automatic Packet/Position Reporting System (APRS), first developed by Bob Bruninga, WB4APR. Bob's recent *QST* article describes the many ways we can use APRS.[1]

The RTrak unit is a complete APRS tracker package, but does not receive or decode APRS data. Instead, it receives Global Positioning System data, encodes the position information into APRS-compatible data packets and transmits the packets on 2 meters. Receiving stations decode the packets and display your movements with icons on computer-generated maps.

What's In The Box?

Inside the package I found the RTrak unit, an external GPS magnet-mount antenna, a car-lighter power cord and a programming cable to connect a computer serial port to the RTrak. A CD contains the RTrak configuration software and operating manual, along with the operating manual PDF files for the various circuits in the RTrak.

The RTrak is packaged in a 4¾ × 3 × 1 inch extruded aluminum box that looks like you could safely drive over. (Maybe in a tank!) The magic, of course, is inside that box.

Remove the four screws holding the solid end panel and the circuit board slides out easily. On that circuit board you will find an Argent Data Systems SMT Open Tracker +, a Small RF Budget SRB-MX146 transmitter and a Trimble Copernicus GPS receiver. All of the connectors to interface the RTrak with the outside world are lined up along the back edge of the main circuit board. You may need an SMA to BNC adapter to connect the transmitter antenna.

The Argent Data Systems SMT Open Tracker + is a small plug-in daughter board that includes the full functionality of the ADS Open Tracker + unit. The Copernicus GPS unit is a full-featured GPS receiver on a ¾ inch square SMD IC.

The Small RF Budget SRB-MX146 block transmits with a minimum of 500 mW of power, and is capable of operating on any frequency from 144 to 148 MHz at 2.5 kHz channel spacing. You can program up to eight different operating frequencies into the RTrak. A 16 position rotary switch allows you to select one of the eight frequencies programmed using the configuration software. The other switch positions are reserved for future firmware features. The SRB-MX146 was designed with APRS tracker applications in mind.

Since you will be transmitting without listening for activity on the frequency first, the low power seems most appropriate. This will limit the probability of interference from packet collisions with other stations. It also limits the effective range of the tracker, but in an area with significant APRS activity there should be stations to relay your position beacons. For operation in an ARES event or other public service activity, this transmit power should be adequate, especially since some of the other participating stations could be set up as secondary relay stations.

Programming the RTrak

Plug the programming cable into a serial port on your computer (or a USB-to-serial adapter) and the RTrak programming jack. Slide the PROG/RUN switch to PROG, add power and start the configuration software. The first screen will ask you to select the appropriate COM port, and when the connection has been established, you will see the programming screen. I won't go through all of the possible configuration steps; suffice it to say the options are plenty. Set your call sign, transmission path, and other options such as beacon frequency, Smart Beacon features and which GPS data to include in your transmissions. When programming the operating frequencies for the SRB-MX146, you can choose the switch setting or a fixed frequency. (If you might want to change transmit frequencies in the field, set this to *Switch*, and then be sure to write down the programmed frequencies.) One interesting option is to tell the RTrak to transmit on an alternate frequency every x number of transmissions. Save the configuration file on your computer so that several alternate configurations can be reloaded later, simply by calling up a file.

Is 500 mW Really Enough Power?

I was concerned that ½ W may not be enough power as I travel up and down the low hills in eastern Connecticut, so I conducted a two-part experiment. For the first part, my wife, Jean, WB3IOS, sat in her car with a portable APRS receiving station and watched my progress as I drove "around the block" with the RTrak. Jean didn't decode every transmission from the RTrak, but she captured enough information to roughly track my movements. In general, if I was more than about ¾ of a mile away, she was not able to decode my beacons directly. The second experiment was to get on the Web and go to **wulfden.org/APRSQuery.shtml** and see if my transmissions had been picked up by any local APRS nodes and relayed to the Internet. Sure enough, I was "in the system." My signal made it to the Internet via the W1DX node on a hilltop about 4½ miles away. The route took me up and down some low hills near my home, but not over any substantial hilltops. The relayed packets covered about half of my 4 mile loop.

The RTrak's relatively low output power is more than compensated by its rugged construction and operational convenience. If you're looking for a plug-and-play APRS tracker, the RTrak is definitely worth considering.

Manufacturer: RPC Electronics, 4408 Running Brook Dr #104, Virginia Beach, VA 23462; **www.rpc-electronics.com**. *$250.*

[1]B. Bruninga, WB4PRS, "Maximizing the Mobile Motorist Mission," *QST*, Sep 2008, pp 30-33.