

Product Reviews

May 2020

Product Reviews:

Icom IC-V86 2-Meter FM Handheld Transceiver,

Nano VNA Vector Network Analyzer,

mAT-Tuner mAT-10 Automatic Antenna Tuner,

Pacific Antenna Volt Tattler 2 Voltage Monitoring Kit,

K1EL Systems Morse Tutor Kit

Mark J. Wilson, K1RO, k1ro@arrl.org

Product Review

Icom IC-V86 2-Meter FM Handheld Transceiver



Bottom Line

The IC-V86 is a solidly built 2-meter FM handheld with great audio and a wide range of features and available accessories.

Reviewed by Dan Wall, W1ZFG
w1zfg@arrl.org

Icom's IC-V86 is an analog FM transceiver that covers 144 to 148 MHz on transmit and 136 to 174 MHz on receive. There are four power output levels: 0.5 W (Low), 2.5 W (Mid), 5.5 W (High), and 7.0 W (Extra High).

The radio is supplied with a flexible antenna, a belt clip, a connector cover (to seal the speaker/mic jack), and a 7.2 V, 2,250 mAh Li-ion battery pack. The supplied BC-240 rapid desktop charger can fully charge the battery in a few hours, using either the supplied ac adapter or an optional dc adapter. The charger has a selectable Extend Battery Life function, which stops charging at less than full capacity, in order to extend battery life.

The IC-V86 is well supported with optional accessories. As shown in the footnotes in Table 1, Icom offers four different battery packs compatible with this radio, as well as several different optional chargers and dc power cables. (There is no external power connector on the radio itself.) Several speaker/mics, headsets, programming cables, and cloning cables are available.

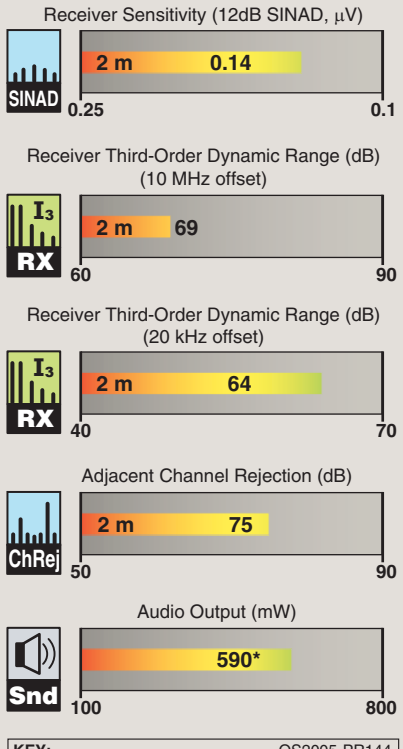
The included *Basic Manual* unfolds into a 16.5 × 23.5 inch sheet, printed on both sides. An *Advanced Manual* is available for free download from the Icom website, along with a color brochure.

Features

The IC-V86 has features often found in higher-priced radios, such as an integrated VOX function (voice-operated transmit), Continuous Tone-Coded Squelch System (CTCSS), and Digital-Coded Squelch (DCS).

The memory holds 207 channels (200 regular channels, six scan edge frequencies, and one call channel). There are also 10 preprogrammed NOAA Weather Radio channels in the US versions. Memories can be displayed by frequency, channel number, or alphanumeric name.

Icom IC-V86 Receiver Key Measurements Summary



KEY: QS2005-PR144
Measurements shown for FM mode. See Table 1 and expanded test results at **www.arrl.org/qst_in_depth** for additional measurements.
*Measured at the external speaker jack.

Table 1
Icom IC-V86, serial number 12001797-9

Additional ARRL Lab measurements are available at **www.arrl.org/qst_in_depth**.

Manufacturer's Specifications	Measured in the ARRL Lab
Frequency coverage: transmit, 144 – 148 MHz; receive, 136 – 174 MHz.	Receive and transmit as specified.
Modes: FM, FM narrow (FMN).	As specified.
Power requirements: Receive: 0.45 A (typical). Transmit, Ex Hi, 1.6 A; Hi, 1.4 A; Med, 1.0 A; Low, 0.5 A at 7.5 V dc.*	With 8.3 V dc (full charge): Receive, 400 mA (max volume, no signal, backlight on; 384 mA (backlight off); Standby, 53 mA. Battery saver on, 11 mA. Transmit: 1.66 A (Ex Hi); 1.42 A (Hi); 0.96 A (Med); 0.43 A (Low). Power off, 0 mA.
Receiver	**Receiver Dynamic Testing**
FM sensitivity: 12 dB SINAD, –124 dBm (0.14 µV).	For 12 dB SINAD: FM, as specified, FMN, –125 dBm (0.13 µV).
Adjacent-channel rejection: Not specified.	20 kHz offset: FM, 75 dB; FMN, 79 dB.
Squelch sensitivity: 0.22 µV (threshold).	At threshold, 0.21 µV (min), 0.69 µV (max).
S-meter sensitivity: Not specified.	1 bar, 0.27 µV; 2 bars, 0.52 µV; 3 bars, 1.19 µV.
Audio output: 550 mW into 8 Ω load (external speaker jack). 1.5 W with internal speaker).	At external speaker jack: 590 mW at 10% THD. THD at 1 V_{RMS}, 1.0 %.
Transmitter	**Transmitter Dynamic Testing**
Power output: Extra Hi/Hi/ Med/Low, 7.0/5.5/2.5/0.5 W.	Extra Hi/Hi/Med/Low power: At 8.3 V dc (full charge): 7.0/5.3/2.6/0.47 W. At 5.8 V dc: 5.0/4.1/2.3/0.47 W (shuts down at 5.7 V dc).
Spurious signal and harmonic suppression: >60 dB.	As specified. Meets FCC requirements.

Size (height, width, depth): 5.0 × 2.4 × 1.6 inches (with protrusions). Antenna, 7.5 inches. Weight, 11 ounces with belt clip and antenna.

*BP-298 2,200 mAh Li-ion battery, BC-240 desk charger, and BC-242 ac adapter included. Replacement BP-298, $60. BP-299 3,150 mAh Li-ion battery, $80. BP-264 1,400 mAh NiMH battery, $43. BP-263 alkaline battery case (6 AA cells), $30.

The radio supports a number of scanning modes, including various options for scanning selected VFO frequencies or memory channels. Details on the scanning modes can be found in the manual, which is available for download from the Icom website.

Frequency offset and duplex direction can be programmed manually, but the US versions have an automatic repeater offset function, which has priority over the manual duplex setting. There is also a reverse-duplex function to swap the normal transmit and receive frequencies.

By default, the **VOL** knob controls the volume of the received signal and the up/down arrow buttons change the frequency. That can be changed in a menu to swap the functions of those controls, so that the **VOL** knob controls the frequency and the arrow buttons control the volume.

One of the major features of this radio is the 1.5 W of audio output using the internal speaker. The speaker itself is larger than speakers in other handheld radios I have used. This feature does not disappoint. On-the-air testing demonstrated clear and crisp audio with no distortion, even at full volume.

However, the speaker takes up almost half of the front panel. This results in small display and keypad areas. The digits of the frequency display are large enough to be easily read, but the smaller icons that



Figure 1 — The IC-V86 LCD conveys a lot of information about transceiver settings and status. The frequency display is a good size and very readable, but the other icons are quite a bit smaller.

indicate other operating functions are difficult to read without additional magnification (see Figure 1). On the keypad, most of the keys are large enough for easy access, but I found the **MONI** and **PWR** keys to be quite small. For example, to change the squelch setting, you must press and hold the **MONI** key with one finger and press the up or down arrow with another finger. Given the small size of the **MONI** key and its close proximity to the up arrow key, I found it difficult to adjust the squelch level.

The LCD was very readable, in both sunlight and shadow. The backlight function can be set to always on, always off, or auto. In the auto mode, pressing any button will turn the backlight on for 4 seconds, and then it turns off. The display was still readable from an angle of around 45 degrees.

The manual indicates an impressive array of MIL-STD 810G and IP54 standards compliance for dust protection and water resistance. However, the manual states that these requirements are only met when the connector cover or optional speaker/microphone is connected, along with a battery pack and an antenna. The supplied connector cover is made of solid plastic and must be attached with two very tiny screws. This could make switching between internal and external speaker/microphones difficult in the field.

Final Thoughts

The IC-V86 is a solid performer. The radio has enough features that are found in higher-priced models to make it a good choice as a first unit for a new ham or an addition to an experienced ham's go-bag. The 7 W transmitter output, excellent audio, and high build quality make this analog 2-meter radio a standout in its price class. With the wide variety of optional accessories available, you can't go wrong.

Manufacturer: Icom America, 12421 Willows Rd. NE, Kirkland, WA 98034; **www.icomamerica.com**. Price: $125.

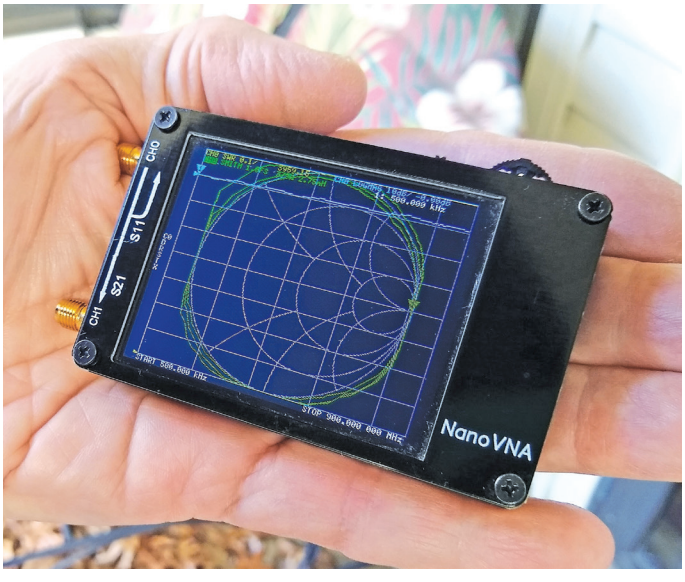
NanoVNA Vector Network Analyzer

Reviewed by Phil Salas, AD5X
ad5x@arrl.net

A two-port vector network analyzer (VNA) that covers 50 kHz to 900 MHz for about $50 to $75 seems too good to be true, and is worth a serious look. This review will focus on using the NanoVNA as an antenna analyzer. For a detailed description of the design and information on using the NanoVNA for other applications, see George

Bottom Line

The inexpensive NanoVNA is a true vector network analyzer that covers all ham bands from 1.8 to 500 MHz with a single, accurate instrument.



Steber's, WB9LVI, article, "An Ultra Low Cost Vector Network Analyzer," in the January/February 2020 issue of *QEX*.

Overview

The NanoVNA is available from numerous suppliers, including popular auction sites and Amazon. There are different manufacturers of this unit, and some amateurs have reported that the quality or operation of some NanoVNAs is sub-par. Look at the reviews for each supplier before ordering. The NanoVNA evaluated here came from a Chinese supplier on eBay and arrived in about 2 weeks.

The NanoVNA uses a 2.8-inch (320 × 240 pixel) color touchscreen display and includes an internal 400 mAh rechargeable Li-ion battery (battery capacity varies with supplier). You can display up to four different graphs simultaneously, including a Smith chart display. The NanoVNA does not include a case — it consists of three stacked printed circuit boards with soldered-on SMA RF connectors. (At least one eBay supplier offers a plastic case for this unit.) The review NanoVNA included two 13-inch SMA-to-SMA cables, an SMA barrel, and open, shorted, and 50 Ω SMA loads for calibration purposes. The kit also included a USB cable for charging, software updates, and computer interfacing. Everything is contained in a plastic box. Companion Windows software is available. Table 2 summarizes the NanoVNA's features and performance specifications.

Table 2
NanoVNA Manufacturer's Specifications

Measurement frequency range: 50 kHz to 900 MHz.

RF output: –13 dBm typical, –9 dBm maximum. Fundamental frequency used to 300 MHz; third harmonic from 300 to 900 MHz.

Dynamic range: 70 dB from 50 kHz to 300 MHz; 50 dB from 300 to 600 MHz; 40 dB from 600 to 900 MHz.

SWR accuracy: See Table 3.

Number of scanning points: 101 (fixed).

Display tracking: 4, markers: 4, calibration memories: 5.

Frequency tolerance: <2.5 ppm.

Frequency stability: <0.5 ppm.

Port SWR: <1.1:1.

Power: USB 5 V 120 mA; built-in 400 mAh lithium battery; maximum charging current: 0.8 A.

Dimensions: 2.1 × 3.4 × 0.4 inches without connectors, and switches. Weight: 3 ounces.

NanoVNA Testing

I began by measuring SWR accuracy. I first checked the NanoVNA against a precision 50 Ω load. Then I tested it with shorted microwave attenuators of 5 dB (1.92:1 SWR), 3 dB (3.01:1 SWR), 2 dB (4.42:1 SWR), and 1 dB (8.7:1 SWR). Because the pads are not perfect, I also compared the measurements to the results on my Array Solutions VNAuhf, which I reviewed in the July 2013 issue of *QST*. As you can see in Table 3, the NanoVNA SWR readings compare quite favorably to the VNAuhf readings.

I built lower impedance complex loads with an SWR of approximately 2:1 for 50, 146, and 222 MHz. Table 4 shows the measurements of these loads with the NanoVNA compared to VNAuhf measurements, which were almost identical.

Table 3
NanoVNA Resistive Load Measurements

NanoVNA compared to Array Solutions VNAuhf (see text)

Load (SWR)	1.0:1	1.9:1	3:1	4.4:1	8.7:1
Frequency	*Measurement with NanoVNA/VNAuhf*				
(MHz)	Nano	Nano/uhf	Nano/uhf	Nano/uhf	Nano/uhf
1.8	1.0	1.8/1.78	2.6/2.6	4.4/4.44	10.5/10.5
3.5	1.0	1.8/1.78	2.6/2.6	4.4/4.44	10.5/10.5
7	1.0	1.8/1.78	2.6/2.6	4.4/4.44	10.5/10.5
14	1.0	1.8/1.78	2.6/2.6	4.4/4.44	10.5/10.5
28	1.0	1.8/1.78	2.6/2.6	4.4/4.44	10.1/10.5
50	1.0	1.8/1.79	2.6/2.65	4.4/4.55	9.4/10.4
146	1.0	1.9/1.92	2.6/2.67	4.8/4.72	10.0/10.3
222	1.1	2.0/2.00	2.7/2.73	5.0/4.85	10.4/10.0
440	1.0	2.0/1.96	2.9/2.85	4.4/5.20	7.8/9.3
850	1.0	1.9/2.08	2.8/3.36	4.0/4.05	n/a

Using the NanoVNA

The NanoVNA user interface is not as friendly as many of the ham antenna analyzers on the market. I found it easier to use after going through the scan setup process once or twice. The device doesn't come with a manual, but the latest user guide, a quick-start manual, and other valuable information can be found in the Files section of the NanoVNA user group at **groups.io/g/nanovna-users**.

Also included in the Files section is information on firmware updates and computer interfacing with the downloadable *NanoVNASaver* Windows software. This program lets you control the NanoVNA from your computer, and it permits display and download of scans. *NanoVNASaver* even includes a time-domain reflectometer (TDR) function that is useful for locating faults in transmission lines.

Table 4
NanoVNA Complex Load Measurements

NanoVNA compared to Array Solutions VNAuhf measurements of SWR and series resistance/capacitance

Frequency (MHz)	------- *nanoVNA* ------- SWR	Rs/Cs	------- *VNAuhf* ------- SWR	Rs/Cs
50	1.95	47.4 Ω/96 pF	1.98	47.3 Ω/94 pF
146	1.81	45.2 Ω/38.7 pF	1.79	45.1 Ω/39 pF
222	1.75	42.2 Ω/29.2 pF	1.79	42.1 Ω/28.9 pF



Figure 2 — The adapters purchased for NanoVNA use.

Along the top side of the NanoVNA is a USB-C interface, an on/off switch, a momentary-contact rocker switch, and a power/charging LED. Charge the unit with the supplied USB cable before using it for the first time. The blue LED will flash during charging, and will light solid when charging is complete.

Because the SMA connectors are soldered to one of the PC boards and prone to damage, I don't recommend attaching any large adapters directly to these connectors. Always use the supplied 13-inch SMA/SMA cables. To interface with more common connectors, I purchased SMA-to-N, SMA-to-UHF, and SMA-to-BNC adapters — all readily available online (see Figure 2). SMA connectors are specified for 500 mate/unmate operations, so I attached SMA-male/SMA-female adapters to each port to protect the original SMA connectors.

The NanoVNA touchscreen is quite small, so a smartphone stylus may be helpful when using the device. The rocker switch can also be used for navigation, and I found it especially helpful for moving the markers on the screen. I prefer using the touchscreen for the settings and menu selections.

Out of the box, the NanoVNA is calibrated, but I recommend that you go through the calibration process. There are five calibration memory locations. In addition to a full-frequency calibration, which only takes a few seconds, I also calibrated and saved the configurations for the ham band ranges I am most interested in. I used my preferred adapters as part of the calibration procedure to eliminate any effect on measurements. I calibrated my NanoVNA and stored the settings for these ranges:

- C0: 50 kHz – 900 MHz (calibrated with the SMA connectors and cables only).
- C1: 1 – 55 MHz (calibrated with the UHF adapters and SMA cables).
- C2: 136 – 225 MHz (calibrated with the N adapters and SMA cables).
- C3: 410 – 460 MHz (calibrated with the N adapters and SMA cables).
- C4: Left unused for future custom calibration.

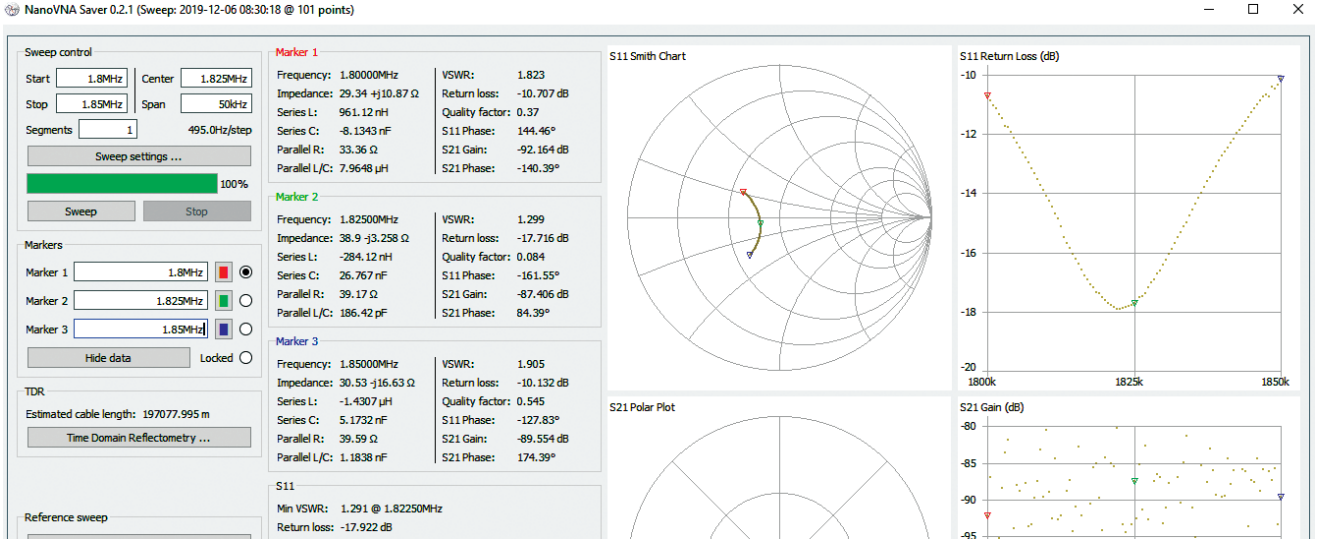


Figure 3 — The return loss and Smith chart swept-frequency measurements on 160 meters for the author's 43-foot vertical antenna with matching network, using the *NanoVNASaver* software.

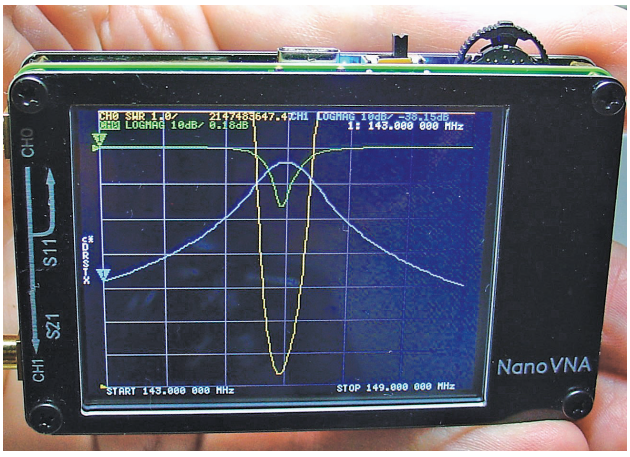


Figure 4 — SWR, return loss, and insertion loss measurements for a 2-meter band-pass filter, displayed on the NanoVNA.

Up to four graphs can be displayed at once, and either linear or logarithmic scaling can be selected. I always use linear displays for SWR, and logarithmic displays for return loss and insertion loss measurements. You can also select a Smith chart display.

My primary antenna is a 43-foot vertical with a 160/80-meter base-loaded matching network. Figure 3 shows *NanoVNASaver* screenshots of return loss measurements and Smith chart curves for this antenna on 160 meters. To read the data at any point, simply drag the cursor with your stylus to the desired frequency on the graph, or use the momentary rocker switch to move the cursor. The Smith chart data provides accurate impedance information, and this reading corresponded exactly with that of my RigExpert AA-55 ZOOM.

Finally, I wanted to provide a taste of what can be done with the two-port capabilities of this device. Figure 4 shows the NanoVNA display of the SWR (yellow), return loss (green), and transmission loss (blue) of a 2-meter band-pass filter. Figure 5 shows the *NanoVNASaver* scans of return loss, insertion loss, and Smith chart data for the same filter.

Conclusion

The NanoVNA is an inexpensive instrument that can be used as an antenna analyzer for all ham bands up to 450 MHz. And while small, the color LCD touchscreen provides easily read information over the swept frequency range. You can investigate the NanoVNA further by viewing the manual and reading through the discussion on the NanoVNA User Group. Typical prices range from $50 to $75 from eBay, Amazon, and other sources.

Larger versions of the *NanoVNASaver* screenshots are available on **www.arrl.org/qst_in_depth**.

The NanoVNA-F — Added Capability

During my review of the NanoVNA, the NanoVNA-F was introduced. The NanoVNA-F differs from the NanoVNA in several important ways. The first obvious difference is the larger 4.3-inch TFT LCD touchscreen, which also has a larger viewing angle and is easier to read in strong sunlight. (Figure A shows the NanoVNA and the NanoVNA-F side by side.) The upper frequency range has been increased to 1,000 MHz, so it includes the 902 MHz ham band. The NanoVNA-F also has a larger 5,000 mAh Li-ion battery, and the internal charger can handle up to a 2 A charging rate from higher-current USB chargers. A USB expansion port can be used for charging other items while simultaneously charging the NanoVNA-F.

A right-angle SMA adapter and a quick-start guide were also included with the NanoVNA-F, in addition to the regular NanoVNA loads and cables. Finally, the NanoVNA-F is enclosed in a metal case, which improves electromagnetic interference susceptibility and protects the SMA connectors and PC boards. The NanoVNA-F is a little over twice the price of the NanoVNA.

Operation of the NanoVNA-F is exactly the same as with the NanoVNA, so there was no learning curve. I re-ran several of my NanoVNA tests and found no difference in performance. However, I did find the larger display much easier to read, and I found it easier to drag the cursors on the touchscreen. The NanoVNA-F goes to 1,000 MHz, so I compared SWR measurements at 950 MHz to my Array Solutions VNAuhf and found the measurements very close.

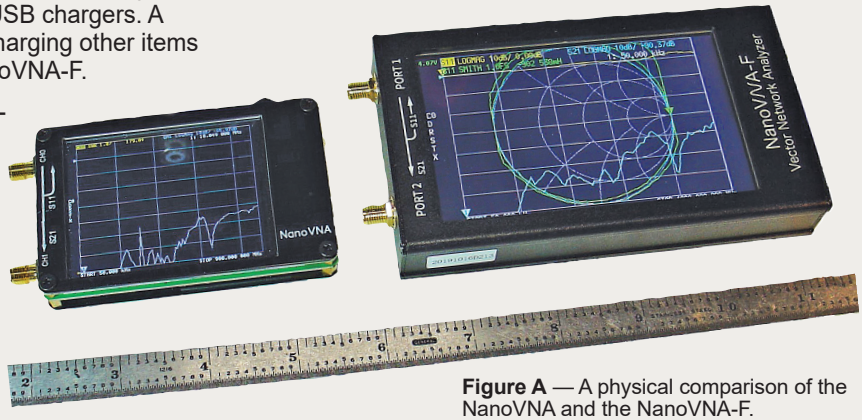


Figure A — A physical comparison of the NanoVNA and the NanoVNA-F.

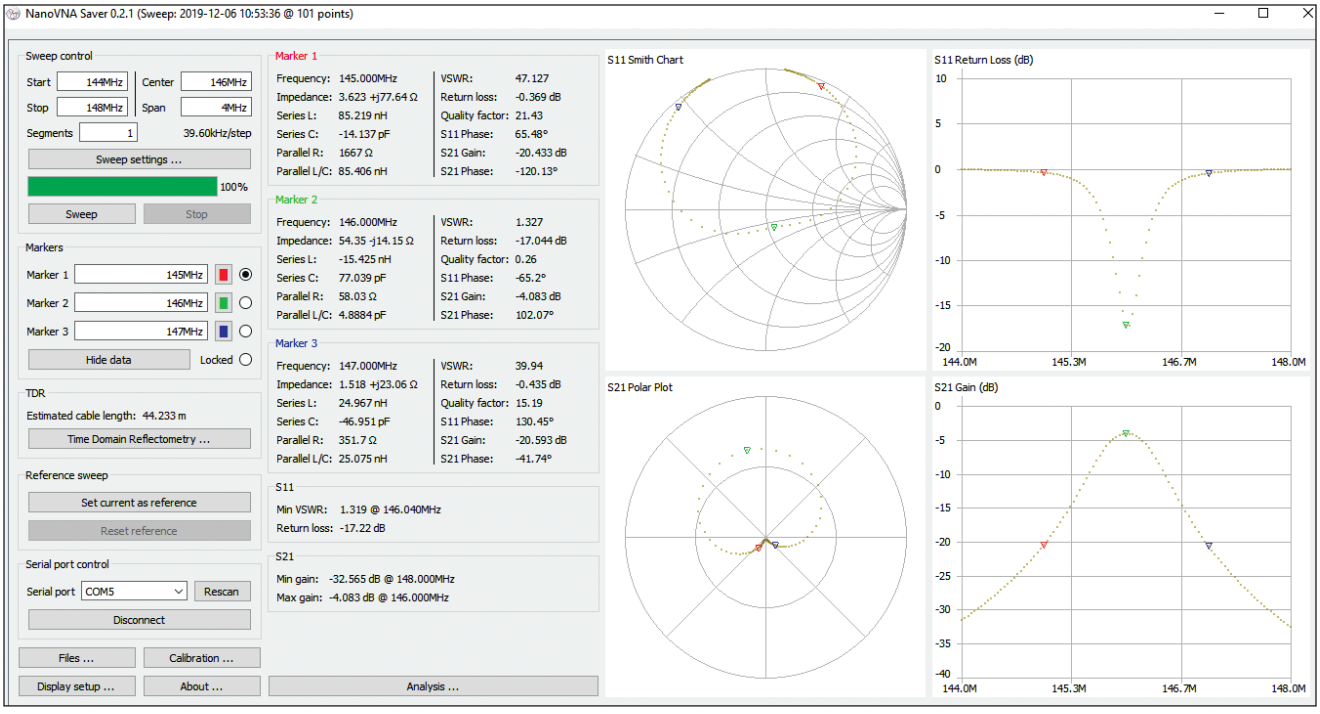
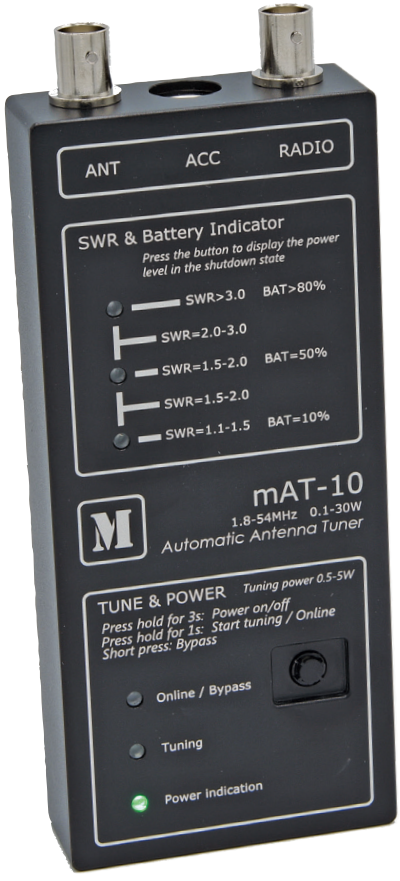


Figure 5 — The scans of the 2-meter band-pass filter displayed using the *NanoVNASaver* software.



mAT-Tuner mAT-10 Automatic Antenna Tuner

Reviewed by Sean Kutzko, KX9X
kx9x@yahoo.com

As a QRP (low-power, 5 W or less) operator, I love gadgets that make my portable work easier and lighter. One of the biggest debates among field QRPers is the need for an antenna tuner. Some operators think using a resonant antenna is lighter and tuners only add extra weight. But there is also a need for flexibility to help you deal with propagation or unexpected openings. Having a lightweight antenna tuner in your backpack can help you make adjustments in the field and allow you to make more contacts.

The mAT-10 tuner is designed with QRP field operation in mind. With a single push of a button, it can match nearly any type of coax-fed antenna, from dipoles to verticals to random-length wires and counterpoises, from

Bottom Line

The mAT-10 is a good addition to a QRP portable station. It can compensate for less than optimum portable antenna installations, and it allows for operation on several bands with one antenna. It's able to match a broad range of impedances, although loss increases at very low impedances.

Table 5
mAT-TUNER mAT-10 Automatic Antenna Tuner

Manufacturer's Specifications

Frequency range: 1.8 – 54 MHz.
Power handling: 30 W PEP, 5 W digital modes.
Matching range: 5 to 1,500 Ω.
Tuning time: 0.1 – 5 seconds for full tune cycle; 0.1 second to recall memories.
Power requirements: Internal rechargeable #10440 lithium batteries.
Size (height, width, depth): 0.9 × 2.4 × 6.0 inches; weight 9.6 oz with batteries.

mAT-10 Resistive Load and Loss Testing in the ARRL Lab

Untuned Load		Power Loss (%) and Tuned SWR by Band (meters)					
SWR	(Ω)	160	80	40	20	10	6*
9.1:1	5.5	42% 2.5	32% 2.0	20% 1.3	8% 1.6	18% 1.6	— 1.4
7.4:1	6.8	34% 2.3	27% 1.6	31% 1.9	26% 1.8	6% 1.4	— 4.1
3.8:1	13.1	16% 1.4	15% 1.2	15% 1.1	18% 1.2	21% 1.5	— 2.7
2.0	25	9% 1.2	12% 1.4	10% 1.1	10% 1.1	19% 1.3	— 2.2
1:1	50	2% 1.0	4% 1.0	4% 1.1	5% 1.1	7% 1.2	— 1.5
2:1	100	13% 2.0	11% 2.0	9% 1.9	4% 1.6	11% 2.1	— 2.2
4:1	200	3% 1.2	3% 1.4	1% 1.2	1% 1.2	1% 1.1	— 1.3
8:1	400	3% 1.3	4% 1.6	1% 1.0	1% 1.0	1% 1.5	— 1.4
16:1	800	20% 3.0	4% 1.6	3% 1.3	9% 1.8	4% 1.7	— 1.5

*Our resistive load box is limited to a maximum frequency of 30 MHz and a maximum resistance of 800 Ω. Efficiency tests were not performed on 6 meters. The SWR indicator 6 meters showed yellow when a 2.5:1 SWR is present, and red at 3.5:1 and above. It is supposed to be green at 1.1 to 1.5; yellow at 1.5 to 2.0, and red above 3:1.

With no load connected, the mAT-10 found a match on 20, 10, and 6 meters. With the antenna jack shorted, the mAT-10 found a match on 10 and 6 meters.



Figure 6 — The mAT-10 top panel has BNC connectors for the antenna and radio. The multi-pin ACC jack is for the cable for use with a Yaesu FT-817/818 transceiver.

160 through 6 meters. This all comes in a 10-ounce package about the size of an average smartphone.

The mAT-10 can handle up to 30 W on SSB and CW, and up to 5 W on full-duty-cycle modes, such as FT8, PSK, or RTTY. It has a specified matching range of 5 to 1,500 Ω, which exceeds the capability typical of most internal transceiver tuners. However, as shown in Table 5, tuner loss is significant with some low-impedance loads. The mAT-10 is powered by rechargeable Li-ion batteries and comes with its own charger. A single charge can last months, even for very active operators. While the mAT-10 can function with any QRP transceiver, it comes with an interface cable for the Yaesu FT-817/818 radios, making operation even easier (see Figure 6). With 16,000 memories, any time the mAT-10 is at or near a previously-visited frequency that has been tuned, the tuner will recall the settings for that frequency. With a new antenna, the tuner will use another memory to store the new configuration.

Operation couldn't be simpler. Three LEDs on the upper half of the front panel serve as SWR indicators and internal battery life indicators. The lower portion of the front panel has a single button to turn the unit on or off, and to engage the tuner or bypass it. Press the button until the **POWER INDICATION** LED lights. Then press the button again to put the tuner into **ONLINE** or **BYPASS** status. To use the tuner, press the button until the **TUNING** light comes on. If you're using an FT-817/818, the tuner will talk to the radio, read the frequency, and tune the antenna automatically. If you use a different radio, set your radio to FM, RTTY, or CW; ensure your power is less than 5 W; transmit a signal, and press the button on the mAT-10 until the **TUNING** light comes on. Continue transmitting until the **TUNING** light goes out.

The tuner will flash an LED indicating your antenna system's standing-wave ratio (SWR), which is indicated in ranges; the exact SWR is not shown. But you will know if your antenna has been properly tuned. Once tuned, you're ready to go.

Field Testing

During the November 2019 CQ World Wide CW Contest, I took the mAT-10 out to the central Illinois prairie (see Figure 7). For testing, I used a 30-meter dipole on a 20-foot pushup mast in an inverted-**V** configuration and ran it through the mAT-10 to use on other bands. I was able to get a match of 1.5:1 or better on 40 through 10 meters; 80 meters was between 1.5:1 and 2:1. Operating QRP with a simple wire

antenna, I opted for the last day of the contest to make DX contacts. By that time, the high-power home stations had likely contacted each other, increasing my chance of success with a weaker signal. Even with poor propagation, I was able to contact several Caribbean and Central American stations on 15 meters using the dipole with the mAT-10 tuner. On 20 meters, I was able to make contacts with stations in Europe, Africa, Central America, and Hawaii. Operation was smooth and effortless.

A couple weeks later, I set up my FT-817 with a 25-foot vertical radiator with a single 25-foot wire for a counterpoise elevated about 3 feet off the ground. Again, the mAT-10 matched the antenna on all bands from 10 through 40 meters with a 1.5:1 SWR; 80 meters matched at between 2:1 and 3:1. Again, conditions weren't very good. From the Illinois prairie, I was able to contact stations from Virginia to Kansas on 40-meter CW, and as far west as Colorado and Montana on 20 meters, with signal reports ranging from 579 to 449.

I appreciate that the mAT-10 covers 6 meters. While I did not catch an opening on 6 meters during my testing, it's nice to have the ability to transmit on that band with a simple wire antenna. Seasoned 6-meter operators know that you don't need much of a station to make contacts on 6 meters during a good opening. I look forward to giving the mAT-10 another try during the summer sporadic-E season.



Figure 7 — The author's portable setup with the mAT-10 antenna tuner and Yaesu FT-817 during the CQ World Wide CW Contest, operating from Barnhart Prairie Preserve south of Champaign, Illinois. [Sean Kutzko, KX9X, photo]

Final Thoughts

Successful backpack QRP operating requires adapting to a variety of operating conditions, and the mAT-10 automatic antenna tuner gave me that flexibility. It's ruggedly built, weighs very little, and matched two simple but effective field antennas. Whether you enjoy operating from parks, islands, mountain summits, or your backyard, the mAT-10 is a solid piece of gear that belongs in your bag.

Manufacturer: Hengshui mAT-Tuner Communication Equipment Company, Hebei, China. Available from Vibroplex, 1001 N. Broadway St., Knoxville, TN 37917; **www.vibroplex.com**. Price: $229.95.

Pacific Antenna Volt Tattler 2 Voltage Monitor Kit

Reviewed by Paul Danzer, N1II
n1ii@arrl.net

Much of the ham radio equipment we use at home, in the car, or portable is powered by 12 V dc. Most modern transceivers have a power supply specification of 13.8 V dc ±15% (about 11.7 to 16 V), and a typical supply is about 13.8 V with no load. While a great deal of comparison and care is used to select station equipment, often much less attention is paid to the dc power source that is quietly running in the background. Power supply voltages can be higher than expected, or batteries can fade well below 12 V as they discharge.

If the power source fails or its output voltage drifts, either higher or lower, the result can be reduced performance or even damage to the connected equipment. Power supplies sometimes have meters for monitoring the output voltage, but certainly no one is going to pay attention to a power supply meter full time while operating. Most batteries offer no way of

Bottom Line

The Volt Tattler 2 kit from Pacific Antenna is easy to assemble and offers an easy way to constantly monitor your 13.8 V dc power supply, battery, or other low-voltage power source.

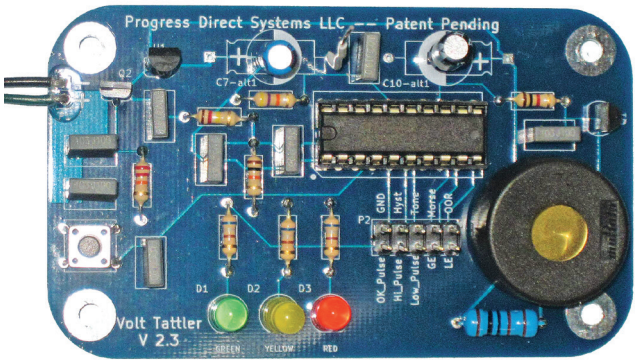


Figure 8— The assembled Volt Tattler 2 PC board. The kit includes a two-pin header to connect leads from the voltage source to be monitored, but I found it convenient to solder wires to the PC board at the upper left. At the very top, under the letters LLC, is a wire connected to the common side for circuit measurements.

knowing the voltage when the battery is fully charged or as it discharges.

Pacific Antenna/QRP Kits offers the Volt Tattler 2, a microcontroller-powered voltage monitor kit that tracks the power supply voltage. This 2 × 3.5 inch PC board (see Figure 8) assembles in one or two evenings and generates high- and low-voltage warnings. The warning threshold is adjustable with limits of 27.5 V on the high end, and 3.9 V on the low end. When the high- or low-voltage limit is reached, an LED begins to blink and an audible Morse code message sounds. If the voltage returns to a value within the limits, the audible alarm stops, but the LED continues to blink until you reset it. Thus, the voltage deviation can come and go, but it leaves a marker, so you will know there was a problem.

Building the Kit

There are a few things you should know ahead of time. You will need the usual 40 W soldering iron, but it must have a very narrow tip. The plated through holes on the board are very small, as are the surrounding solder pads. Thin-gauge solder is a must. The clear, well-illustrated instructions include many assembly tips. I recommend a thorough reading of the assembly instructions before starting the construction.

There are a few small things to note. The voltage regulator unit and transistor Q1 look alike, so examine them carefully. The pushbutton switch is not square. If the leads do not fit easily, rotate the switch 90 degrees, and see if that fixes it.

Many components come mounted on paper tape, and the tape residue has to be cleaned off completely for the leads to go into the holes. If you cut the leads just above the paper tape, you will have plenty of lead for insertion and won't have to deal with paper or glue residue.

Calibration and Use

The Volt Tattler 2 microcontroller integrated circuit comes preset with an upper warning limit of 16 V and a lower limit of 9 V — good values for typical 12 V ham gear. I tested my unit using a variable power supply and voltmeter and found that the preset values worked as expected.

As mentioned previously, you can change the upper and lower limits. A voltmeter and a variable power source make for the easiest calibration, but two fresh 9 V batteries and a few resistors can be used if a variable power supply is not readily available. The unit is calibrated (the high and low limits set) with a few long presses of the pushbutton and setting of the variable power supply for the desired limits, as measured by your voltmeter.

The Volt Tattler 2 samples voltage 20 times a second. Under normal conditions, the green LED blinks. Exceed the upper voltage limit, and the red LED blinks and sounds Morse letter H (for high). Go below the lower limit, and the yellow LED blinks and the Morse message is L (for low). If either limit is exceeded and then the voltage returns within limits, the corresponding LED keeps blinking, but the Morse message stops. To reset the Volt Tattler 2, press the button to shut off the red or yellow LED and restore operation to normal with the green LED blinking.

For a few hours' work and a few short measuring steps, you can protect expensive equipment — or at least find out that the equipment may be at risk.

Manufacturer: Pacific Antenna, P.O. Box 10301, Fayetteville, AR 72703; **www.qrpkits.com**. Price: $25 plus shipping.

K1EL Systems Morse Tutor Kit

Reviewed by Paul Danzer, N1II
n1ii@arrl.net

Though this kit functions as a very capable Morse code tutor with a number of practice modes, it is also a construction and soldering tutor. The very complete, well-illustrated manual makes it a good choice for an individual or club project.

The finished kit is a fully functional keyer, similar to the popular K1EL K16 keyer kit, which was reviewed in the February 2017 issue of *QST*. You can use the Morse Tutor to practice copying and sending Morse code, and you can even key a radio with it and use it on the air. In addition, you can network one or more kits for simulated contacts and on-the-air practice.

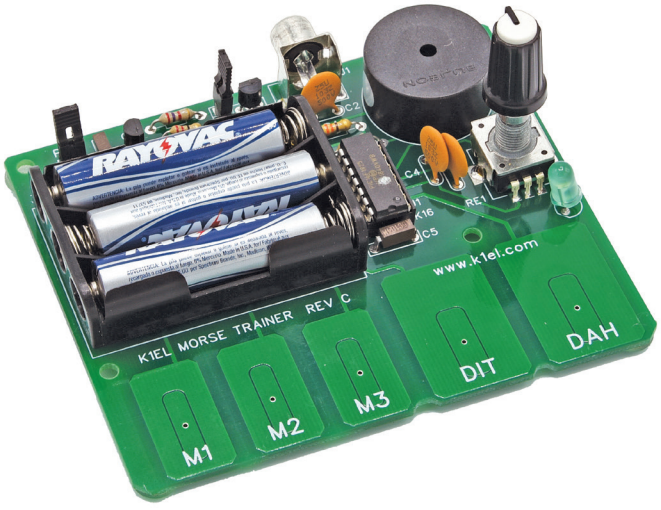
An interesting feature is the use of touch-sensitive pads on the PC board instead of an external paddle, simplifying setup and lowering the cost of a practice station. As with other K1EL keyers, the Morse Tutor includes a command mode to select a long list of options to customize the unit for your preferences.

Putting It Together

The K1EL Morse Tutor is built on a printed circuit board approximately 3⅞ × 3⅝ inches using through-hole components. The step-by-step instructions are thorough and well illustrated, with plenty of drawings and photos. This kit would be a good choice for first-time builders. It offers a good way to learn skills such as reading a functional block diagram, identifying parts and values, and installing components, such as integrated circuits and transistors correctly.

In addition to information specific to this kit, three appendices cover basic kit-building tips. Appendix A has general kit construction hints, including a list of useful tools. To that list, I would add a magnifying glass of some type to allow close inspection of solder joints. Appendix B offers several safety reminders. Appendix C, Soldering Basics, shows how to solder to a PC board and what a good solder joint looks like.

A preprogrammed microprocessor integrated circuit provides the "smarts" for the Morse Tutor. Five touch pads are used for the dit and dah inputs and to program and select message memories (M1, M2, and M3). A rotary encoder with an integral switch puts the unit in the command mode and controls the CW speed. Keyer output is through a transistor driver to a standard phono jack for use with a transceiver.



Another transistor amplifier feeds the sidetone to a miniature onboard speaker.

There are only a few parts to assemble. The review unit came with the battery holder and speaker already mounted to the board. Both of these have to be soldered during construction.

The PC board shown here is Revision C, Morse Tutor Version 1.1. K1EL Systems recently released Revision D, Version 2.0, which has a few changes to make the Morse Tutor easier to build and configure. In the new version, an on/off switch replaces the power jumper shown here, and a diode switch replaces the output configuration jumper.

Keyer Capabilities

Table 6 summarizes the key features and capabilities of the unit. The full feature list is quite impressive and worth a look. Full details are found in the manual, which is available online from K1EL Systems.

The keying modes and commands are very similar to those of the K1EL K16 keyer. Press and hold the knob on the rotary encoder, and Morse Tutor enters

Bottom Line

The Morse Tutor is a low-cost kit that is quickly assembled. In addition to learning and practicing Morse code, it offers a good introduction to soldering and kit building for individuals or as a club project.

Table 6
Selected Morse Tutor Features

- Keyer speed range: 5 – 99 WPM
- Built-in touch paddle with sensitivity calibration
- 34 different commands
- Continuously adjustable sidetone frequency
- Adjustable letter spacing and weighting
- Automatic letter space mode
- Non-volatile message memory with two banks of five slots
- Backspace supported on message entry
- Keying modes: Bug, Ultimatic, Iambic A or B, Straight Key
- Serial number generation
- Paddle swap command
- Speed control potentiometer
- Power consumption: 2 mA idle, 70 µA off

the command mode. Once in the command mode, enter a command letter in Morse on the paddles to select or change an option. For example, send A to toggle the sidetone off or on.

The memories have extended capabilities, such as inserting serial numbers. One feature I like in any keyer is the ability to back up and fix an error while loading a memory, rather than having to start again. The memories retain their contents when the power is shut off.

Using the Morse Tutor

Install three AAA cells and you are ready to go. The first step is calibrating the touch pads for your fingers. I followed the procedure in the manual, but later found that the default settings worked fine for me.

There are four levels for learning Morse code:

- Level 1 sends random letters using 14 letters of the alphabet.
- Level 2 adds the remaining letters.
- Level 3 adds numbers from zero to nine.
- Level 4 adds common punctuation, such as commas and periods, along with prosigns, such as **SK** and **AR**.

In addition to the four levels, there are two practice modes. In the receive practice mode, random characters are sent in groups of five, separated by two spaces. In the receive/respond mode, the Morse Tutor sends a random character from the selected level. You respond by sending that same character using the touch paddle. If you get it right, the Morse Tutor repeats the first character followed by a new character and you send both. The process repeats up to five characters and then starts again with a new group.

When using the Morse Tutor in practice mode or as a keyer, the speed, character spacing, word spacing, and other parameters can be adjusted. The Morse Tutor can be set for Farnsworth spacing, where the characters are sent at a higher speed with longer spacing between characters. The intent is to encourage recognition of Morse characters by their sound or rhythm, rather than trying to count individual dits and dahs.

One of the toughest things for hams new to CW is gaining the confidence to get on the air and make the first few contacts. In the QSO mode, two or more Morse Tutors can be tied together and everyone on this network can join in a practice contact.

Other Flavors

The Morse Tutor is intended to be a simple and inexpensive way to learn and practice Morse code. Although it can be used on the air with a transceiver, at some point you will probably want to move on to a keyer designed for on-air operation using external paddles. K1EL Systems offers a number of different keyers and kits, and they all use similar command sets, so you can build on the experience gained with the Morse Tutor. Additional photos are available online at **www.arrl.org/qst_in_depth**.

Manufacturer: K1EL Systems, **www.k1elsystems.com/K16tutor.html**. Price: $25 plus shipping.

