Product Reviews

December 2023

WA3RNC Penntek TR-45L QRP CW Transceiver

Oscilloscope - Owon SDS1102

Oscilloscope - Hanmatek DOS1102

Oscilloscope Hantek DSO5102P

Product Review

WA3RNC Penntek TR-45L QRP CW Transceiver

Reviewed by Mark Wilson, K1RO
k1ro@arrl.net

The TR-45L QRP CW transceiver from John Dillon, WA3RNC, offers a significant upgrade to his earlier TR-25 and TR-35 QRP CW transceivers. Reviewed in the December 2022 issue of *QST*, the TR-35 covers 40, 30, 20, and 17 meters and is compact and simple to operate, yet offers good performance. The new radio adds a fifth band — 75/80 meters. Like the TR-35, the TR-45L receives and transmits over the full frequency range of each band and receives SSB voice as well as CW. The correct sideband is chosen automatically for each band. You can switch to the opposite sideband if desired, but the instructions warn of decreased image rejection and additional spurious signals. Transmit power is adjustable from about 0.5 to 5 W.

The TR-45L is aimed at the portable operator. It retains the best attributes of the TR-35, such as the use of hardware switches and knobs for all functions (no menus), but adds a number of useful features. There are also two very welcome options: an internal rechargeable 5.2 Ah lithium-ion battery and a Z-match tuner that will handle antennas fed with coaxial cable or balanced line. The review unit included both options and was purchased, assembled, and tested (more on this later).

Features and Controls

The TR-45L is significantly larger than the TR-35 in all dimensions. The case has a carrying handle on top, and two rails on the front protect the controls from damage if the radio tips over. There are two feet on the bottom of the case, near the front edge, so the radio tilts back slightly for easier access to the controls. Including the optional internal battery and Z-match tuner, the TR-45L weighs about 3 pounds, compared to 11 ounces for the TR-35. Of course, adding a battery for the TR-35 will add a pound or more.

The TR-45L requires a nominal 12 V dc, 1.5 A power source. The manufacturer's specifications state that the power requirements are between 9.5 and 14 V dc (see Table 1). The manual specifically states, "Do not apply more than 14.5 V dc to the TR-45L." The rear panel has a red coaxial power jack for charging the internal battery (if installed), and a separate black coaxial power jack for an external battery or power supply. The two jacks are different sizes, so you can't plug the supplied charger into the wrong jack. A cable with the correct plug for external power is included. The internal battery won't power the radio while it's charging, but you can operate the radio from an external battery during that time.

A significant upgrade is a 2-inch speaker on the left side of the case that provides plenty of volume for listening in most environments (see Figure 1). You can also connect an external speaker to a rear-panel jack

Bottom Line

The WA3RNC TR-45L QRP CW transceiver works very well and is easy to use. The built-in speaker and forward/reflected power meter, along with the optional internal battery and Z-match tuner, make it an attractive package for QRP portable CW operation. Just add your favorite CW paddle and an antenna, and start making contacts.

Table 1
WA3RNC Penntek TR-45L QRP CW Transceiver

Manufacturer's Specifications	Measured in the ARRL Lab
Frequency coverage: 80 – 75-, 40-, 30-, 20-, and 17-meter amateur bands with extended receive coverage above and below.	As specified.
Power requirement: 9.5 – 14 V dc.	At 13.8 V dc: receive, 118 mA; transmit, 1.49 A (max).
Mode of operation: CW transmit and receive. SSB receive only.	As specified.
Receiver	**Receiver Dynamic Testing**
Sensitivity: –125 dBm MDS or better.	Noise floor (MDS), CW Narrow (CWN) 370 Hz bandwidth: 3.52 MHz, –130 dBm / 0.07 µV; 7.02 MHz, –134 dBm / 0.04 µV; 10.12 MHz, –133 dBm / 0.05 µV; 14.02 MHz, –128 dBm / 0.09 µV; 18.088 MHz, –128 dBm / 0.09 µV;
Noise figure: Not specified.	3.52 MHz, 17 dB; 7.02 MHz, 13 dB; 10.12 MHz, 14 dB; 14.02 MHz, 19 dB; 18.088 MHz, 19 dB.
Blocking gain compression dynamic range: Not specified.	Blocking gain compression dynamic range: *20/5/2 kHz offset* 3.5 MHz 101/101/* 14 MHz 103/103/*
Reciprocal mixing dynamic range: Not specified.	Not measured.†

ARRL Lab Two-Tone IMD Testing

Band	*Spacing*	*Measured IMD Level*	*Measured Input Level*	*IMD DR*
3.5 MHz	20 kHz	–130 dBm	–55 dBm	75 dB
3.5 MHz	5 kHz	–130 dBm	–54 dBm	76 dB
3.5 MHz	2 kHz	–130 dBm	–51 dBm	79 dB
14 MHz	20 kHz	–128 dBm	–51 dBm	77 dB
14 MHz	5 kHz	–128 dBm	–50 dBm	78 dB
14 MHz	2 kHz	–128 dBm	–49 dBm	79 dB

IF/audio response: <370 Hz at –6 dB CWN setting, <200 Hz with AF filter on.	CW wide, 1.8 kHz; CWN, 355 Hz; CWN + AF filter, 200 Hz.
Transmitter	**Transmitter Dynamic Testing**
Power output: 0 – 5 W at 12 V dc.	As specified.
Spurious-signal and harmonic suppression: >53 dB at 5 W.	>53 dB. Meets FCC emission standards.
CW keyer speed range: 5 – 40 WPM iambic mode B.	As specified.
CW keying characteristics: Not specified.	See Figures A and B.
Transmitted phase noise: Not specified.	See Figure C.
Audio output: 1 W into 8 Ω.	As specified. THD 1.05% at 1 V_{RMS}.
Transmit-receive turnaround time: Not specified.	S-9 signal, 25 ms.

Size (height, width, depth): 6.25 × 8.25 × 5.15 inches.

Weight: 3 pounds 2 ounces, with internal battery and Z-match tuner.

*2 kHz blocking dynamic range tests not performed due to filter bleed-through.
†Measurement could not be made due to audio noise dominating RF noise (limited to blocking gain compression dynamic range levels).

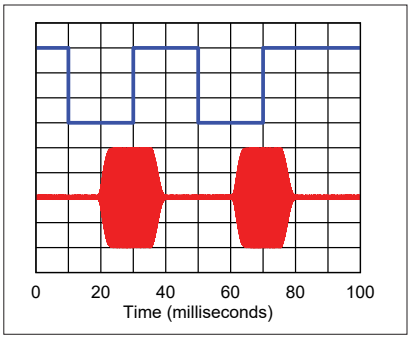


Figure A — CW keying waveform for the TR-45L showing the first two dits using external keying. Equivalent keying speed is 60 WPM. The upper trace is the key closure; the lower trace is the RF envelope. Horizontal divisions are 10 ms. The transceiver was being operated at 5 W output on the 14 MHz band. The first-dit rise time is 2.5 ms; the fall time is 2.9 ms. The second-dit rise time is 2.4 ms; the fall time is 2.9 ms. The first-dit on delay is 10.7 ms; the off delay is 7.5 ms. The second dit on delay is 12.1 ms; the off delay is 7.5 ms.

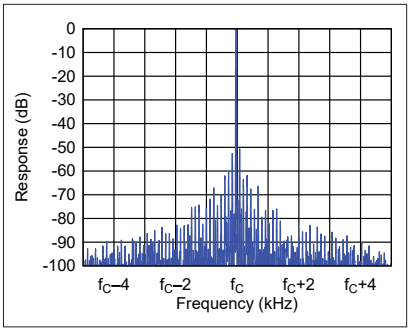


Figure B — The spectral display of the TR-45L transmitter during keying sideband testing. Equivalent keying speed is 60 WPM using external keying. Spectrum analyzer resolution bandwidth is 10 Hz, and the sweep time is 30 seconds. The transmitter was being operated at 5 W PEP output on the 14 MHz band, and this plot shows the transmitter output ±5 kHz from the carrier. The reference level is 0 dBc, and the vertical scale is in dB.

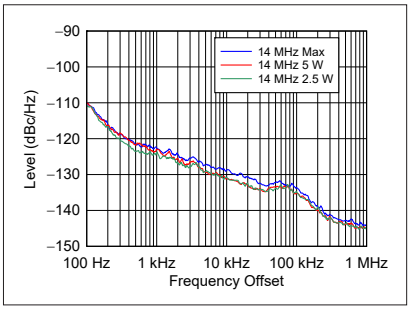
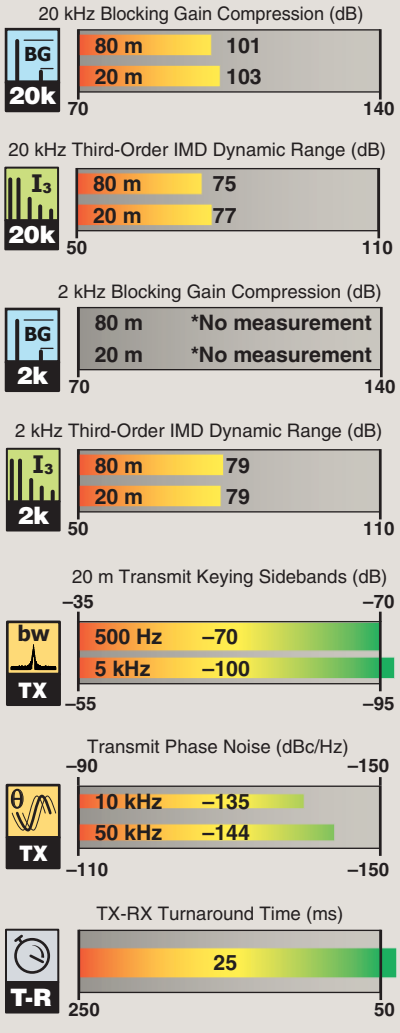


Figure C — The spectral display of the TR-45L transmitter output during phase-noise testing. Power output is max W on the 14 MHz band (blue trace), 5 W (red trace), and 2.5 W (green trace). The carrier, off the left edge of the plot, is not shown. This plot shows phase noise 100 Hz to 1 MHz from the carrier. The reference level is –90 dBc/Hz, and the vertical scale is 10 dB per division.

WA3RNC Penntek TR-45L QRP Transceiver Key Measurements Summary



or plug headphones into a front-panel jack. The **SPKR** switch shuts off the internal speaker.

An illuminated analog meter on the TR-45L's front panel displays received signal strength, RF power output, and internal battery charge. A switch to the right of the meter selects forward or reflected power, and a red **HIGH SWR** LED lights when SWR approaches 2:1. **TX POWER** sets the RF power output.

Pressing up on the **BAND SEL/VFO A/B** switch cycles through 80/40/30/20/17 meters. Pressing down on that switch selects one of the two VFOs (A or B) for each band. You can store one operating frequency/mode combination as the initial setting for each VFO for each band with a long press of the **VFO A/B** switch.

The **TUNE** encoder smoothly adjusts the operating frequency, with 10 Hz, 100 Hz, and 1 kHz tuning steps selected by pressing the encoder knob. It's a precision optical encoder, which is optional on the TR-35.

Engage receiver incremental tuning (RIT) by pushing the **RIT/RX MODE** toggle up, and then turn the **TUNE** knob to adjust the offset in 10 Hz steps. The RIT range is ±5 kHz, and the orange **RIT** LED lights when active. Although the receiver tuning range extends beyond the ham bands, the TR-45L will not transmit past the band edges.

Pressing down on the **RIT/RX MODE** switch toggles between narrow and wide CW filters, and a longer press selects SSB reception. In addition to the wide and narrow CW filters, the radio includes a 700 Hz audio filter activated by the **AUDIO FILTER** switch. The **NOTCH** knob controls a notch filter adjustable from about 200 to 3000 Hz. The notch filter and **RF GAIN** control were helpful when the bands were crowded with loud signals.

The TR-45L's internal iambic keyer range is about 5 to 40 WPM, adjusted with the **KEYER** knob. The polarity (dot/dash connections) of the **PADDLES** jack is fixed, but it matched the way my paddle is wired, so I didn't have to change anything. The ability to switch paddle polarity without rewiring a paddle might be helpful for some operators. The **KEY** jack is for use with an external keyer or hand key. You can

Figure 1 — The 2-inch speaker on the side of the TR-45L offers plenty of volume in most indoor and outdoor settings.

connect both an external key and a paddle for the internal keyer at the same time and switch back and forth.

The **REC/PLAY** switch controls record and playback functions for the internal keyer's two memories. To record, push the switch momentarily to the left and then select memory 1 or 2 by tapping the dit or dah paddle. Record the message (up to 125 characters) using the paddle. To play a memory, push the switch momentarily to the right and select the memory to play with the dit or dah paddle. Although memory playback is a bit cumbersome compared to the single button press on a typical memory keyer, I found this feature useful for calling CQ during portable activations.

The two-line backlit LCD displays frequency and band on the top line. The bottom line shows receiver mode (CW with wide/narrow filter or SSB) and the selected VFO (A or B). With RIT enabled, the bottom line changes to display the offset frequency. When you adjust the CW **KEYER SPEED** control, the bottom

line momentarily shows speed in WPM. The **DIAL DIM** switch controls display and meter illumination. Most of the time I used the **DIM** setting, which saves about 20 mA of battery current.

Options

One reason the TR-45L is significantly larger than the TR-35 is to make room for an optional internal battery and antenna tuner. Along with the internal speaker, these options are a useful addition for portable operations, eliminating several accessory items and associated cables from my kit. Add an antenna, feed line, and paddle or key, and the TR-45L is ready to go.

Controls for the Z-match tuner are located on the rear panel, as shown in Figure 2. Switches allow you to bypass the tuner when it's not needed and to select balanced line (the red and black binding posts) or coax (the BNC connector). Tuner adjustment is straightforward. Turn the **TUNE** and **LOAD** controls for maximum received noise, then transmit at reduced power, and adjust the controls for minimum reflected power on the meter. The instructions caution you to limit transmit times to 5 or 10 seconds, followed by short rest times while making the adjustments. It does take a little practice to adjust the knobs while reaching around to the back of the radio.

The rechargeable 5.2 Ah lithium-ion battery will run the TR-45L for many hours. My park activations typically run an hour or two, so I could easily do several activations on a single charge. If you'll be away from ac power for the charger for a long time, you can always pack a second battery and use the external power jack on the rear panel.

Figure 2 — The Z-match controls, power/charging jacks, antenna connections, and external speaker jack are on the rear panel. With a little practice, it wasn't hard to reach over the radio to adjust the tuner controls while observing reflected power on the front-panel meter.

On the Air

On the air, the TR-45L incorporates and expands upon many of the things I like about the TR-35. Even when the bands are busy, the receiver does a good job of separating closely spaced, strong signals. Most of the time I used the narrow CW filter setting and slowest tuning rate. The notch filter works well for attenuating nearby signals, and reducing the RF gain helps when signals are strong.

The solid-state full break-in (QSK) and internal keyer work great, with no relay clatter and no problem monitoring the received frequency between sent characters. In early units, the TR-45L's sidetone level was an internal adjustment, requiring disassembly to access the control. Starting with radios shipped February 28, 2023, the sidetone level control was relocated to the rear panel, below the binding posts. We sent our early-version radio to WA3RNC to add this feature. It is a welcome improvement because there are times I wanted more sidetone volume to overcome strong nearby signals while I was trying to send. If you have an early unit, contact WA3RNC about having your radio updated.

The display is easy to read, even outdoors in bright sunlight and from a variety of viewing angles. I love the small analog meter in place of the LEDs often found on QRP field radios. The ability to measure forward and reflected power is especially useful in the field, where it's easy to run into an antenna or feedline issue.

On a warm, sunny day, I set up at a picnic table at the lake (see Figure 3) and threw a simple 25-foot random wire over a tree branch, with a counterpoise wire on the ground. I tuned around 17 and 20 meters for some enjoyable CW contacts. Another day, I headed out for

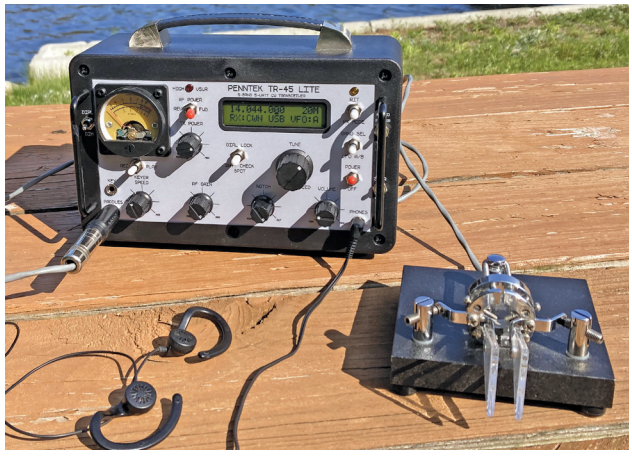


Figure 3 — Operating portable with the TR-45L. Just add a paddle and antenna, and earphones if desired.

a couple of Parks on the Air (POTA) and World Wide Flora and Fauna (WWFF) activations. Although a series of solar flares made for disturbed band conditions, I was able to make contacts across the country with the TR-45L and my Hustler mobile antenna. A few European hunters called in as well.

Most of my portable activity is during the day, so I didn't try 80 meters with my portable antennas. I used the TR-45L on 80 meters at home and made a number of contacts with my 135-foot inverted **v** fed with balanced line. Using the TR-45L's balanced line setting and binding posts, the optional Z-match tuner had no trouble finding a match with that antenna on any of the bands the radio covers.

As of August 2023, WA3RNC offers two versions of this radio, both available assembled and tested (no kits). The TR-45L, reviewed here, uses a thicker case that can accommodate the internal battery and antenna tuner options. If you don't need the options, check out the TR-45L "skinny" version that uses a much thinner case with the speaker on the rear panel. See the WA3RNC website for more information.

Manufacturer: WA3RNC, **www.wa3rnc.com**. Price: TR-45L assembled and tested, $600; optional internal 5.2 Ah battery and charger, $70; optional Z-match tuner, $70.

Oscilloscopes — Owon SDS1102, Hanmatek DOS1102, and Hantek DSO5102P

Reviewed by Paul Danzer, N1II
n1ii@arrl.net

In the November 2023 issue of *QST*, two oscilloscopes that cost less than $500 — the Rigol DS1202Z-E and the Siglent Technologies SDS1104X-E —were reviewed. Here you will find three additional models: the Owon SDS1102, the Hanmatek DOS1102, and the Hantek DSO5102P.

The three digital oscilloscopes reviewed here are made by three different companies. The prices range from $200 to $300, and they are comparable in size and weight. One unit is listed as 110 MHz, and the other two are listed as 100 MHz bandwidth. All other performance capabilities appear to be similar or the same. For all three manufacturers' specifications, see Table 2.

The front-panel layouts are so similar that you might assume the designer and the component suppliers for all three are the same. Instructions and available documentation vary. Other differences include the number, type, and location of connecting ports. The 1X/10X probes supplied with each oscilloscope appear to have come from the same source.

While the two units presented in the November 2023 issue of *QST* came with specified accuracies and traceability, this information was not available for these three units. However, it appears to be suitable enough for most use in the amateur's workshop.

Owon SDS1102 Digital Oscilloscope

After unpacking this oscilloscope, I was faced with a front panel approximately 11.5 inches wide and 5.5 inches high — no great surprise. What did surprise me is that the unit looked like someone cut off the rear section of the enclosure. Compared to the usual analog oscilloscope, it's small, measuring only 2.75 inches deep and weighing slightly less than 2.5 pounds.

Two feet on the bottom edge flip out to tilt the scope face up for easier viewing, if needed. In addition, a handle can be raised from the top edge, which allows

Bottom Line

The Owon SDS1102 features a nice 7-inch color display and is fairly straightforward to use.

Table 2
Oscilloscopes (3 units) (not tested in the ARRL Lab)

Models	Owon SDS1102	Hanmatek DOS1102	Hantek DSO5102P
Bandwidth (sine wave)	100 MHz	110 MHz	100 MHz
Rise time	≤3.5 nS	≤3.5 nS	5 nS
Horizontal scale	2 nS/div – 1000 S/div	2 nS/div – 1000 S/div	4 nS/div – 40 S/div
Sample rate	1 GSa/S	1 GSa/S	1 GSa/S
Display	7-inch color LCD	7-inch color LCD	7-inch color LCD
Display resolution	800 × 400 pixels	800 × 480 pixels	800 × 480 pixels
Channels	2	2	2
Max record length	10,000	10,000	40,000
Sampling rate/time accuracy	±100 ppm	±100 ppm	±50 ppm
Input coupling	dc, ac, ground	dc, ac, ground	dc, ac, ground
Input impedance	1 MΩ in parallel with 20 pF	1 MΩ in parallel with 20 pF	1 MΩ in parallel with 20 pF
Max input voltage	400 V	400 V	300 V
Gain accuracy	±3%	±3%	±3%
Vertical sensitivity	3 mV/div – 5 V/div	5 mV/div – 5 V/div	2 mV/div – 5 V/div
Trigger types	Selectable	Selectable	Selectable
Trigger modes	Auto, normal, single	Auto, normal, single	Auto, normal, single
Automatic measurement	More than 20 types	More than 20 types	32 types, display 8 at a time
Waveform math	+, –, ×, ÷, FFT	+, –, ×, ÷, FFT	+, –, ×, ÷, FFT
Waveform storage	16 waveforms	16 waveforms	Not specified
I/O ports	USB 2.0	USB 2.0, USB flash drive	USB to PC, USB flash drive
Calibrator	Yes	Yes	Yes
Built-in help menu	If connected to a PC	Yes	Yes

you, without exaggeration, to carry the (unplugged) scope on one finger.

The front panel (see the lead photo) has a 7-inch color LCD with a display resolution of 800 × 480 pixels capable of more than 64,000 colors. After the unit was reviewed and it was time to take a professional photograph, the Owon SDS1102 display stopped working, which is why the lead photo shows a black screen. The unit should still be under warranty, and we are working on either getting a replacement or having the unit repaired.

On the rear panel there's nothing to be seen except for some ventilation openings and a hidden USB type B port to connect the unit to a PC (see Figure 4); there's also nothing to see on the unit's sides except for a standard ac line socket identical to that found on most personal computers.

Figure 4 — The Owon SDS1102 rear panel.

Included in the Package

In addition to the main oscilloscope unit, several accessories are included: a standard power cord commonly used for personal desktop computers and other 120 V ac-powered equipment; a CD containing information on many of this manufacturer's products (two files applicable to this scope can be found by going through the CD selections sorted by model/series); a "Quick Guide" paper copy (more on this later); a USB cable with a type A plug on one end and a type B plug on the other; two probes, whose wires have interchangeable color tags — many new probes have the compensation adjustment in the probe handle itself, but these probes have the compensation circuit and adjustment screw in a small barrel at the wire end that connects to the input BNC (this is a similar arrangement to that used in older scopes); and a miniature screwdriver to be used to turn the probe's compensation adjustment.

Instructions and Guidance

The Quick Guide is supplied as a printed version, a smaller version of the two files discussed previously, and a larger User Manual version of the file. In addition, there is a one-page summary of the scope's technical specifications. The one-page summary also serves to compare the capabilities of the SDS1000 series of oscilloscopes.

In addition to briefly introducing the controls, the Quick Guide provides an initial inspection procedure. It al-

lows you to make a fast function check to verify the normal operation of the instrument. Following this are instructions to adjust the probe compensation and select a probe attenuator of 1 or 10.

The manual states that if the probe attenuator is set to 1, the bandwidth will be limited to 5 MHz. This is obviously an important limitation. When connecting the probes to the front-panel BNC connectors, make sure the small hole for the compensation adjustment screwdriver is accessible. If the hole is positioned downward, you will not be able to adjust the compensation. An additional instruction details the steps to run a self-calibration routine.

Before You Start

There are several things that you might want to do before you use the oscilloscope for the first time and perhaps periodically afterward. The Quick Guide suggests starting with a function inspection. This short procedure makes a quick check of the scope operation. Following this are some steps to set the probe compensation, which is a good idea, as there is no assurance the probe compensation was preset at the factory.

Next, self-calibration is briefly discussed. You might want to run this fast procedure from time to time. There are a few paragraphs of material designed to familiarize yourself with the oscilloscope. This section is divided into three segments: Introduction to the Vertical System, Introduction to the Horizontal System, and Introduction to the Trigger System. The material ends with a short introduction to using the built-in automatic measuring system and communication with a PC.

Front-Panel Controls

The unit tested here has a unique feature related to keeping the unit powered up. At the lower edge, on the far left is an **ON/OFF** button with a printed legend above it, reminding you that pushing in and out turns the scope on and off. A single button on the upper right corner lights up when the power is on. The warning symbol above the power button is not explained.

Below the screen is a USB jack for digital storage, followed on its right by the two-probe BNC connectors. In a line to the right of the screen are a set of five "soft switch" pushbuttons, whose function is to allow setting various sub-modes and values when selected by the main controls in the right third of the panel.

If you are used to older oscilloscopes, the knobs look quite different. They have no numbers to select your vertical (voltage scale) and horizontal (time) choices. Instead, the settings are read out on the bottom of the display. There are typically three lines; the top line provides the horizontal setting, and the two bottom lines provide the vertical settings.

Two colors are used — yellow for **CH1** (channel 1) and blue for **CH2** (channel 2). On the screen, each waveform and numerical readout is associated with one of the two colors (channels).

The trigger type is also shown in the lower screen position. As an example of the many available settings with the use of the right-side panel and the soft switches, if you press the **MENU** button in the trigger section, legends for the trigger type selection display on the pop-up on the right edge of the display near the soft switches.

The User Manual provides complete instructions for setting the controls. Following these detailed descriptions, there are six examples of common uses for the scope, demonstrating the horizontal, vertical, and trigger adjustment and selection capabilities.

The top section of the right-hand panel is called the **FUNCTION MENU**. It serves to select samples, screen persistence, XY format frequency measurement with the counter function, storing and recalling waveforms, and other functions and settings.

There is also a math capability, which can be selected by the **MATH** button in the center of the vertical outline section. Pressing this button brings up choices on the soft keys, allowing selection of simple waveform math operations with the two channels: CH1-CH2, CH2-CH1, CH1+CH2, CH1*CH2, CH1/CH2, and FFT.

The **MEASURE** button allows automatic measurement of period, frequency, mean, PK-PK, RMS, max, min, top, base, amplitude, overshoot, preshoot, rise time, fall time, +pulse width, –pulse width, +duty cycle, –duty cycle, delay A→B, delay B→A, cycle RMS, cursor RMS, and screen duty. Again, the documentation provides a detailed definition of each of these functions.

The button in the top right-hand corner is labeled **RUN/STOP**. This is a reminder that these digital scopes use stored data; at any time, you can press **RUN/STOP** and freeze the display for further examination and analysis. If, however, this button is red, the display is frozen at what you see at that time. The display will not change until you press the button and go back to the run position.

On the upper right is a rotary knob, called the **M KNOB** (a multipurpose knob). When its symbol appears in

the menu, it indicates you can turn the **M KNOB** to select the menu or set the value.

There are six buttons in the upper right corner. They are labeled **UTILITY**, **AUTOSET**, **MEASURE**, **ACQUIRE**, **RUN/STOP**, and **CURSOR**. The User Manual devotes the equivalent of 20 pages of instructions (Chapter 4) to the use of these buttons for both measurements, such as how to measure a waveform automatically, and system functions, such as how to update the unit software. Sampling rate and settings for saving and recalling waveforms are covered in these 20 pages and controlled or called up by these buttons. While this oscilloscope can be used with a bit of familiarization of the horizontal (sweep speed, vertical, and trigger) settings, the User Manual states, "It is recommended that you read this chapter carefully to get acquainted with the various measurement functions and other operation methods of the oscilloscope."

In Summary

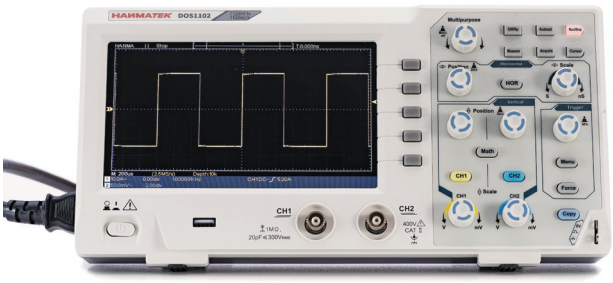
The Owon SDS1102 is fairly straightforward to use. It has a nice display and, for the most part, well-organized instructions.

Manufacturer: Lilliput (Owon), Fujian Lilliput Optoelectronics Technology Co., Ltd., No. 19 Heming Road, Lantian Industrial Zone, Zhangzhou 363005 P.R., China, **www.owontech.com**. Price: $299.

Hanmatek DOS1102 Digital Oscilloscope

If you have been around amateur radio for a few years, you have seen full-featured oscilloscopes go from weights of several tens of pounds to a few pounds. The Hanmatek DOS1102 has a 7-inch color display and weighs in at slightly less than 2.5 pounds — most people can lift it with one finger. The case, excluding the built-in handle and extendable feet, measures 11.85 × 5.98 × 2.75 inches. The manufacturer claims a bandwidth of 110 MHz. This makes it stand out a bit from the usual 100 MHz units.

If you want a scope to put in your luggage, its light weight is certainly attractive. Generally, its specifications match most other 100 MHz units tested in this review.



Included in the Package

First, what is not included in the package: There is no paperwork, no shipping slip, no link to more information, no email address, and no accuracy certification or warranty information — only a 17-page printed Quick Guide (more on this later). If you need any help, none is provided. The return policy is between you and the distributor from whom you received the unit. Keep in mind that this unit is the least expensive one of the five we've reviewed.

The following are included in the shipping container: the oscilloscope itself, a USB jumper to connect the scope to a computer, and a 120 V ac power cord. The cord plug jack is slightly unstable — not an uncommon situation with some imports. There's also a CD with several files, some of which are in English (more on this later). Also included are two probes, with a small screwdriver for adjusting the probes, and colored rings to show which probe you have connected to which input channel.

Before You Start

Plug in the power cord, and attach the probes. To tilt the unit for better visibility, you can set the bottom feet up. Next, flip the power on — the **ON/OFF** switch is located at the bottom left corner of the front panel.

There is a square wave source and accompanying ground pin on the lower right corner of the panel. Select **CH1** (input channel 1), and connect the test probes to the input connectors. Use the included miniature screwdriver to adjust the probe compensation, if necessary. Repeat the process for **CH2**, and you are finished.

More Information and Support

Fortunately, the controls, panel layout, and panel labels are very similar to many other imported oscilloscopes in this price class. The included CD contains installation information, but there is no comprehensive instruction file for using the system or specific directions for using some of the built-in features. A search of the brand name, Hanmatek, or the corporate name

Bottom Line

The Hanmatek DOS1102 is an affordable 110 MHz digital oscilloscope, but the lack of detailed documentation may represent a challenge for beginners.

(as printed on the CD), Shenzhen Hanma Precision Technology Co., Ltd., doesn't provide more information than the already-included 17-page Quick Guide. The few online comments from users did not provide any more help. Addresses taken from the corporate website are included at the end of this section.

Common Controls

The front panel of the Hanmatek DOS1102 is divided into two main sections. The display section has five soft switches on the right side using approximately 2/3 of the panel area. The other third from the right (see the lead photo) contains the controls and settings. Generally, these items work together in sequence. If your selection is made on the right 1/3 side with a pushbutton switch, an additional menu may come up on the right side of the display next to the soft switch. This menu may bring up only one "page" of choices, or the bottom button may send you to page 2. If a further choice is needed within the soft switch selection, the **MULTIPURPOSE** rotary control at the top left of the right side is used to make selections from this submenu. In addition, the rotary control has a push/click action, labeled **MENU OFF**, which is used to clear the menu settings shown on the display.

The common controls are in three sections: vertical, horizontal, and trigger. Because there are two channels or inputs, there are two vertical stacks of controls — one stack for each channel. The top rotatable knob adjusts vertical position, and the bottom rotatable knob adjusts voltage scale. Between these two knobs is the channel sector button, which lights up when a channel is selected.

The two small arrowheads on the left edge of the display are the zero axes of the waveform to be displayed on the screen. One of the largest differences in operation between this digital scope and the old analog scopes is that here the vertical selection, often called "sensitivity" or perhaps V/centimeter, does not come from calibration of the rotary control. Instead, the sensitivity setting is shown by the two values, color-coded to each channel, on the lower left edge of the display.

The center button (**MATH**) in the vertical section sets the unit up to do various math functions with either one or both channel inputs. These are selectable with the soft switches and are add, subtract, multiply, divide, and FFT.

The horizontal controls are in a horizontal row above the vertical controls. The leftmost control is **POSITION**, and the rightmost is **SCALE**, previously called "sweep speed" or time (s, ms, or µs) per centimeter. The **HOR** button brings up the zoom controls and sweep delay. Again, to see your setting, you must read the values on the screen. Pages 6, 7, and 8 of the Quick Guide are invaluable to find and understand the values shown.

Finally, on the lower right of this section are the **TRIGGER** controls. The **MENU** button brings up the control selections (type of trigger), and the **MULTIPURPOSE** rotary controls the voltage point where the trigger is activated. At the bottom of the screen, just to the right of the center, is text that tells you what kind of trigger has been selected and at what voltage value. At the bottom of the trigger section is the **FORCE** button. Pressing this button generates an immediate scan trigger.

Unrelated to the trigger controls is a button located just below this section. It functions in conjunction with the **UTILITY** button (one of the six system control buttons to be discussed next).

Some of the rotary controls on the right side of the panel have a reset function. For example, if you have moved the axis of an incoming waveform from the vertical zero position, you can bring the axis back to zero by pressing the vertical position control.

On the rear panel (see Figure 5), you will find a USB type B connector and nothing else except ventilation vents.

More System Buttons

The online description of the Hanmatek DOS1102, as supplied by the manufacturer, lists the following available functions: four modes of automatic cursor selection; automatic range setting function, for horizontal and vertical settings with either single waveform or multi-waveform inputs; probe attenuation that can be scaled to 1X, 10X, 100X, and 1000X; a 6-bit hardware frequency meter, which can measure 2 Hz to 20 MHz; current measurement, with a measurement range of 100.0 mA/V ~ 1 kA/V; and 30 different automatic measurement functions.

Figure 5 — The Hanmatek DOS1102 rear panel.

Function Menus and Automation

There are several other automatic measurements and customization functions built in, but a comprehensive instruction document is lacking. These functions are controlled by the set of pushbuttons on the top right of the front panel, to the right of the **MULTIPURPOSE** rotary control.

The first of these is the **RUN/STOP** button on the very top right. Remember that the waveform you see on the display is a set of digitally encoded points, held in memory. As each point is read out of memory, it is refilled by new values coming in. At any time, if the replacement of these points is stopped, the set of loaded points remains constant. The **RUN/STOP** control does this; the displayed waveform freezes and remains fixed on the screen. Thus, the stored values of the equivalent of one sweep across the screen are now fixed and available for both display and further processing.

When pressed, this button lights up. To confirm the stop condition, a legend is printed on the screen at the top, a short distance from the left edge. This stored waveform may then be used to fix the input values for additional measurement.

Below the **RUN/STOP** button, there is a **CURSOR** button. When pressed, several choices of cursor types (voltage, time, or both) can be selected. The position of the selected cursor(s) is shown at the bottom left of the screen.

The **AUTOSET** button can be considered the "lazy man's setup." After connecting the probe(s), a press of this button sets the vertical and time scale to what the unit decides is an optimized set of values, including a stable trigger setting. From this point, you can change the setting to values more to your liking.

A single press of the **UTILITY** button brings up a set of choices on the right side of the display. Selecting the top soft switch of this list (**CONFIGURE**) results in a second set of items on the left side of the display. This list lets you select and adjust various units or system values, such as brightness.

The **MEASURE** button brings up a list on the right display side that is used to select the channel to be measured, and a list on the left — the parameter (voltage, time, and so on) — to be measured.

There are other measurements and automation capabilities that, without a comprehensive instruction source, are not obvious. Most of these capabilities require a set of selections and button presses.

In Summary

This Hanmatek DOS1102 oscilloscope worked similarly to others in this price class. In addition to the standard problem of connecting one of these oscilloscopes to a personal computer, the lack of information and lack of support do not make this the most desired unit tested in this evaluation and comparison.

Manufacturer: Shenzhen Hanma Precision Technology Co., Ltd., 2nd Floor, Building B, Wanda Industrial Zone, Shiyan Street, Baoan District, Shenzhen, China, **www.hanmatek.cn/en**. Price: $169.99.

Hantek DSO5102P Digital Oscilloscope

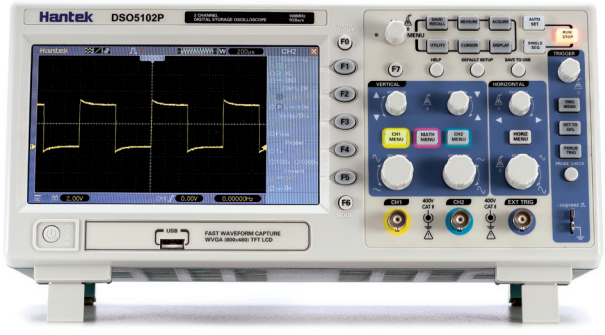
The unit is packaged in a case approximately 12.5 × 5.25 × 4.5 inches (see the lead photo). Weighing about 4.5 pounds, the case includes a handle and snap-in feet to set the viewing angle.

The front-panel colors are slightly different from similar units in this price range, with bright illuminated buttons in eye-catching colors. Many of these colored buttons are exercised when power is turned on. The front-panel display is a 7-inch LCD with variable brightness. The key numbers act to define the performance ability.

Five selectable math functions and several different trigger types can be selected, as well as five trigger modes. One unusual built-in trigger source is the ac line. This used to be a standard capability in older analog scopes.

Included in the Package

In addition to the main scope unit, there are a number of other items supplied in the shipping container: two



The Hantek DSO5102P comes with straightforward instructions, which make it suitable for use by those with little or no experience with digital oscilloscopes.

probes, each packaged in a plastic envelope, with a tiny screwdriver to adjust the probe compensation and replaceable colored rings for probe identification; a USB type A-to-B jumper line; an installation CD; an ac power cord; a package containing a set of test leads and miscellaneous parts whose use is not readily known; and a warranty card.

Instructions and Guidance

The set of instructions is easier to navigate than that which is often found with these units. First, it is readily available without searching. The CD supplied with the oscilloscope contains a file with the readily recognizable name of the "DSO5000S Series Digital Storage Oscilloscope User's Manual." Consisting of approximately 70 pages, it is organized in a helpful way. Other files on the disk relate to connecting the scope to external networks and equipment, and are not needed for the internal oscilloscope functions.

Following the main part of the manual, 11 application examples demonstrate how certain things can be done. This is followed by a brief troubleshooting and problem-solving section and, at the end, a full listing of specifications.

Before You Start

As usual with a small desktop piece of test equipment, the first two steps are mechanical — set the legs for a better viewing angle (if needed), and plug the unit into the ac line. Turn it on, and look for a positive click. Connect a probe to channel 1 (**CH1**), and set the probe to 10X. Now you are ready to test the unit.

Press the **DEFAULT SETUP** button, which is located on the right side of the front panel, in the middle of the top row of buttons. On the lower edge, right side, are two metal studs. The top one is a 5 V test point, and the bottom one is a ground connection. Connect the probe to the 5 V test point. Finally, press the **AUTOSET** button at the top right corner. The result should be a synchronized 5 V square wave.

This is a good time to adjust the probe compensation and test the probe. Using the small screwdriver that was packaged with the probe, adjust the probe compensation control (through a small hole on the probe base). Patience may be needed to make this adjustment. Finish the first probe's installation by pressing the **PROBE CHECK** button just above the 5 V test point. Now follow the on-screen directions, using the soft switch buttons on the right side of the display as directed. When finished, repeat this probe installation and alignment with the second probe. From this point on, you can just use the oscilloscope, occasionally checking the probe function if you wish and remembering to reset the probe to 10X if, for any reason, you reset it to 1X.

One additional step — to make sure you are using the probe and channel you want, you can change the small plastic rings on the probe and on the probe base unit. Because **CH1** is color-coded yellow, you might want to change the rings on one probe to yellow and change the rings on the second probe to blue to match the **CH2** color code.

Basic Front-Panel Controls

The bottom edge of the front panel has one USB connector, used for external storage, and three BNC connectors. The first two, color-coded yellow and blue, are the input connectors for **CH1** and **CH2**. Both are marked for 400 V maximum. The third BNC is used for external triggering. Finally, to the right of the BNC connectors is the 5 V test point noted previously.

On the right of the display is a set of five soft switches (**F1** to **F5**), used to make selections for various features. Two other pushbuttons, marked **F0** and **F6**, are also used for various systems and display functions. The balance of the panel area is used for three groups of functions: **VERTICAL**, **HORIZONTAL**, and **TRIGGER**. Above these three areas is a set of buttons used for various functions.

The **VERTICAL** area allows selection and control of the vertical or voltage sensitivity. The top rotary control sets the waveform vertical position, and the lower rotary control sets the vertical sensitivity or voltage calibration. The sensitivity knob is not calibrated; instead, you can read the voltage setting on the lower left of the display. Two buttons are used to select channel 1 or 2 (or for some functions, use both). With the channel button (marked **CH1 MENU** or **CH2 MENU**), the various voltage options appear as a column, correlated to the soft switches on the right side of the display. Note that the markings on the panel for **POSITION** and **VOLTS/DIVISION** are not consistent. Both channel 1 and channel 2 respond in the same direction of rotation, which may be incorrectly marked on some units.

The center pushbutton is marked **MATH MENU**; pressing it brings up a choice of math functions that can be controlled by the soft switches. Usually, the voltage scale settings and horizontal settings are displayed along the bottom of the display.

The **HORIZONTAL** section is similar. A rotary control is on the top for horizontal position (or selection for a delayed expansion), and a bottom rotary controls

horizontal timing or sweep speed. In a manner similar to the channel menu buttons, pressing the **HORIZ MENU** button brings you to a variety of application choices, selected through the soft switches.

Pressing the **F0** button clears the display soft-switch labels. Pressing the **F6** button brings up more menu choices, depending on which menu is currently displayed. Neither the **F0** nor the **F6** button changes the displayed waveform.

The last area, on the right side of the panel, is the **TRIGGER** area. The top rotary knob is used to set the voltage at which trigger occurs. The next switch down allows selection of the trigger mode, with the selection made by the **F1** to **F5** soft switches. The trigger level is shown as a horizontal line on the display. One handy feature is the next button, **SET TO 50%**. Pressing this button automatically sets the trigger level to 50% of the waveform height.

System Buttons and Function Menus

The remaining buttons and controls are located in the upper right section of the front panel. Six of the rectangular buttons, in an area outlined with the title **MENU**, control various setups to be used. For example, pressing the **UTILITY** button brings up a set of selectable functions in a list on the monitor next to the soft switches. There are three such selections available, organized into pages. The pages are selectable by pressing the **F6** button.

As an example, pressing the **DISPLAY** button brings up two pages of settings that can be changed, such as contrast and persistency. The **CURSOR** button allows selection of a cursor on the voltage axis or time (horizontal) axis, or no cursor at all.

The **MEASURE** button first asks for the source (channel 1 or channel 2) and then allows picking one of 32 possible items to be measured by cycling between **F6**, **F0**, and the rotary control. The choices include period, peak to peak, maximum, minimum, and rise time.

The three round buttons below the rectangular buttons are called **FAST ACTION** buttons. The **HELP** button brings up the help menu. It is context sensitive; that is, it jumps to the help section of the last command button or selection you made. Control of the **HELP** menu is on the right edge of the display and includes an **EXIT** button to get out of help.

The right-hand button, **SAVE TO USB**, connects the scope to the USB jack In the rear of the unit (see Figure 6). The remaining button, **DEFAULT SETUP**, changes the vertical, horizontal, and almost all other

Figure 6 — The Hantek DSO5102P rear panel.

settings to a default condition. Initially, these conditions are those that were set in the factory (you probably used these settings in the initial setup of the scope), but each is changeable according to an extensive list in the instructions.

The instruction material includes 11 examples of scope procedures and settings to accomplish a particular task. The first example is listed as "Taking simple measurements using **AUTOSET**." This is the same set of steps that were recommended for the initial scope setup (i.e., set the probe connected to channel 1 to 10X). Next, connect the probe to the point of the circuit to be measured. Finally, press **AUTOSET**. After a few seconds, the display will change to an optimized view of the waveform, which can be expanded and changed manually.

The second example is titled "Taking Auto Measurements." Pressing **F0** or the rotary control **V0** clears the right side of the display. The next two steps are pressing the **MEASURE** button followed by **F6**. The source (channel 1 or 2) is selected by pressing **F1**. The parameter to be measured is selected by buttons **F3** and **F4**. Finally, the result is numerically shown by pressing **F6**. A total of eight parameter measurements can be seen at once.

In Summary

While more than 11 examples of possible selections and operations would be nice, the ones given, plus the straightforward instructions in the online file, make the scope suitable for use by those with little or no experience with digital oscilloscopes. The panel layout is clear, and most labels — with the exception of the two sets in the vertical section noted before — make many selections intuitive.

Manufacturer: Qingdao Hantek Electronic Co., Ltd., #35 Building, No. 780 Baoyuan Road, High-Tech Zone, Qingdao, Shandong, China 266114, **www.hantek.com**. Price: $259.98.