QST

Product Reviews

March 2023

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Siglent SDG-1032X

Rigol DG1062Z Function/Arbitrary Waveform Generator

Product Review

QRP Labs QDX 5-Band HF QRP Digital Transceiver

Reviewed by Charles Powell, NK8O/VE3ISD/5H3DX
nk8o@arrl.net

The QRP Labs QDX Digital Transceiver is a low-power, low-cost radio for digital operations. The reviewed unit covers five HF bands — 80, 60, 40, 30, and 20 meters — and the maximum power output is 5 W, with support for digital modes only. It comes in a kit to be built, and you can buy a fully assembled unit for an extra $45. See Figure 1 for the kit parts packaging. The printed circuit board (PCB) comes with pre-installed surface-mount device (SMD) components (Figures 2 and 3 show each side of the PCB). It includes an embedded software-defined receiver (SDR), 24-bit 48 kilo samples per second (kS/s), a USB sound card, CAT control, and a synthesized VFO with TCXO reference. The QDX transmits a single, clean output signal, as it is not an SSB modulator with associated unwanted sideband and residual carrier, or intermodulation due to amplifier non-linearity (more on this later).

The QDX is suitable for single-tone operations. It is reported on the QDX forum that successful RTTY operation has been accomplished. It is not suitable for CW operation using *fldigi* or similar programs. It is my understanding that there is no waveform shaping that would prevent key clicks. Modes that require multiple simultaneous tones, such as Winlink, are not possible with the QDX. Also, the QDX is not capable of phase-shift keying, such as PSK31. Per the product description,

> QDX is suitable only for single tone FSK modes, which covers the majority of digital modes in use today. This includes everything in WSJT-X, JS8Call, some fldigi modes e.g. RTTY, Olivia and more. QDX is not suitable for on/off keyed modes such as CW because it does not have click-reducing RF envelope shaping; furthermore, it is not suitable for phase shift keyed modes such as PSK31 or modes involving multiple concurrent tones such as WinLink.

Description and Kit Assembly

While it does require a computer, the unit has only four connections on the rear panel: an antenna BNC port, a power connection, a 3.5-millimeter PTT, and a single USB type B port that handles both CAT control and audio (see Figure 4). When all the necessary physical connections are made, the unit becomes a "black box" that requires no other user intervention.

Figure 1 — The QDX kit with parts packaging.

Since Revision 3 (Rev3, now Rev4), QRP Labs added a standard 3.5-millimeter plug for an external PTT connection that can be used without modification between the QDX and the QRP Labs 50 W PA. The PTT output can also be configured for use with any other amplifier.

Bottom Line

The QRP Labs QDX is a low-cost digital transceiver with a clean RF output signal for the supported digital modes. Setting it up is fast and easy, perfect for portable and permanent installations.

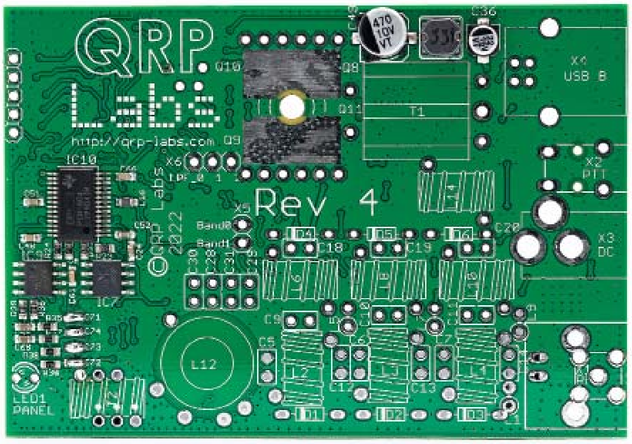

Figure 2 — The front view of the QDX's PCB.

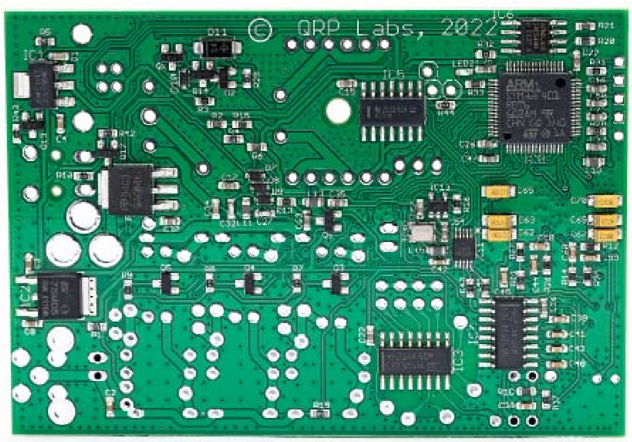

Figure 3 — The rear view of the QDX's PCB.

I have considerable experience with QRP Labs products. I assembled at least eight original QCX models, repaired several more, and built a QCX+. The QRP Labs instruction manuals are clear, they contain concise technical descriptions, and they are generally easy to follow. The QDX documentation is no exception. It is, perhaps, among the easiest of the QRP Labs kits to assemble. My assembly time was no more than a few hours.

Assembly is straightforward, and the parts count is low. Most of the board is pre-populated with the SMD components, so the user doesn't need special tools to complete the kit. There are 16 through-hole capacitors, six diodes, four transistors for the final amplifier, an LED, a transformer, and a series of toroids to wind and install. Finally, a few connectors complete the build. Depending on your level of experience, the kit can be assembled in a few hours. There is only one construction option, and that is whether to build the device to operate on 9 or 12 V dc. To quote the operating manual, "No test equipment is required to build, align, and operate this digi modes transceiver. There are no alignment tasks." For more details, you can download the manual from the manufacturer's website (**www.qrp-labs.com/qdx.html**).

Figure 4 — The rear panel of the QDX.

Linux (Xubuntu 22.04) is my operating system of choice. But as stated on the manufacturer's website, the drivers for these types of audio devices should be already present on your computer if you are using macOS, Linux, or Microsoft Windows 10 or 11. If you are using older versions of Windows, then you need to install a driver for the virtual COM port (audio and USB flash drivers are already present, even on older versions of Windows). The details can be found in the QDX manual. I made the connection between the QDX and my laptop via a USB A/USB C cable. Linux immediately recognized the built-in sound card, and it was easy to select the correct sound settings in *WSJT-X*. The serial device followed the typical naming scheme for Unix-like systems. The serial port test confirmed operation immediately, and after a brief check I was on the air. I selected the **KENWOOD TS-440S** configuration for CAT settings in *WSJT-X*. The sound card appears as **ALSA_INPUT.USB-QRP-LABS_QDX_TRANSCEIVER-02.ANALOG-STEREO** and **ALSA_OUTPUT.USB-QRP-LABS_QDX_TRANSCEIVER-02.ANALOG-STEREO**, respectively, for audio input and output. With the QDX designation in the sound card description, there is little possibility of making a mistake in selecting the device. The serial port appears as **/DEV/TTYACM1** on my laptop. I have not connected the radio to a Windows or Mac computer to date. Most importantly, the radio was not designed around a single operating system.

On the Air

With many hours of operation behind me, I can say with certainty that this transceiver is unparalleled in ease of operation within the scope of my experience. The radio's front panel has no controls and only a single

Table 1
QRP Labs QDX HF Digital Transceiver (Rev4)

Manufacturer's Specifications	Measured in the ARRL Lab
Frequency coverage: 80, 60, 40, 30, and 20 meters.	As specified.
Power requirement: 9 V or 12 – 13 V dc with modification.	At 12 V dc: transmit, 0.9 A; receive, 166 mA.
Receive	
Modes of operation: Digital only.	As specified.
Transmitter	**Transmitter Dynamic Testing**
Power output: Up to 5 W.	At 12 V dc: 3.5 MHz, 4.5 W; 5.3 MHz, 4.8 W; 7 MHz, 4.2 W; 10.1 MHz, 5.4 W; 14 MHz, 5.5 W.*
Spurious-signal and harmonic suppression: Not specified.	Typically >52 dB; worst case, 44 dB (60 meters). Complies with FCC emission standards.
Size (height, width, depth, including protrusions): 1 × 2.48 × 3.49 inches. Weight: 0.30 pounds/(135 grams).	

*RF power output was 3.0 W on 14 MHz with 9 V dc input voltage.

USB cable, power, and antenna connection on the back of the radio. While no adjustment or alignment is needed, it's possible to access configuration and test menus. To access these features, you will need to use terminal software like *PuTTY* or *Minicom*, which will give you access to several menus within the radio. The firmware is upgradable. The radio seems exceptionally stable, likely due to the TCXO that controls the reference oscillator.

There are no relays within the radio. All switching is done with PIN diodes. I have used the radio only for FT4, FT8, and JS8Call, but operations with these modes have been nearly trouble-free. Modes that will work shift frequencies one at a time. The QDX cannot be used for phase-shift keying, multi-tone modes, or CW. It is reported to work with RTTY (with some compromises), DominoEX, and Olivia.

There was one instance of a brief failure, but it was really a computer operating system problem, and it had nothing to do with the QDX. The USB port designation changed from **/DEV/TTYACM1** to **/DEV/TTYACM0**, but this was easily remedied in the field. This can happen with any operating system. With Linux-based systems it is possible to make a permanent port assignment to avoid this problem. While I have had some experience with Mac OS X, it has been quite a while, and I am unfamiliar with recent changes within the OS. I also have very little recent experience with Microsoft Windows.

I use the transceiver primarily for portable operations, as I am an avid activator for both World Wide Flora and Fauna and Parks on the Air® programs. Rapid deployment is a distinct advantage for field operations, and the QDX greatly facilitates this. Previous field setups included multiple peripherals, careful adjustment of sound and drive levels, and many extra wires that were easily misconfigured. The setup of the QDX is nearly foolproof. Due to the nature of propagation, portable operations, and the parks programs, the majority of my operating has been on 20 meters. I'm sure other bands would work well, but I typically do not spend a lot of time away from 14074 kHz. I have, however, tested the transceiver and made a few contacts on other bands.

Operating voltage and power output are supposed to be determined by the number of turns on the secondary winding of transformer T1. I chose the 12 V operation voltage, although I find that my transmitter is a bit more optimistic than one might like. The maximum recommended output is 6 W, and my transceiver puts out nearly this much and more on several bands. So far, I haven't encountered any difficulties, but there could be a replacement for the BS170s transistor in the future. My battery of choice is LiFePO4, and the voltage is a very steady 13.2 V under normal operating conditions. The power output of the QDX is strictly a function of input voltage and not related to audio drive. Manipulation of the input voltage in the field does present certain problems. The recommended input of 12 V can be obtained by placing a diode inline with the power source (see Table 1). I may try a LiPO4 pack (about 11.1 V) to see if that drops the power output to a more acceptable level.

There is a jack for operations with an external power amplifier, but I have not found it necessary to move to QRO operations. I have made thousands of contacts with plenty of DX using low power and a good antenna.

An LED indicator shows that the radio is powered up. In transmit, the LED has a medium blink rate. It shows a fast blink rate on boot-up, or very slow and steady blink rate if it is in the firmware upgrade mode. Boot time is less than 1 second, but the fast LED will blink for 5 seconds. For portable operations, setup takes a little longer than setting up the antenna. There are no settings to fiddle with. The transmit level in *WSJT-X* does not affect power output, and it is recommended to simply leave the transmit power at the maximum setting. I reduced the computer's audio input drive to keep the receive level indicator out of the red, but that was the only adjustment needed in my configuration.

My portable operations have taken me very far afield, at least through a swath of the central United States. My favorite portable operating position is from a picnic table, although the small size of the QDX makes it easy to set up nearly anywhere. I have a portable aluminum table that also works well. It is rare that I operate exclusively in digital modes, so I need enough room for a CW transceiver. I may be something of a heretic, but I rarely operate QRP when I am activating a park unless there is a considerable hike involved. Then the station is as light as possible. My "tailgate" and picnic table operations are usually accompanied by a Yaesu FT-991A for CW. There is always plenty of room for the QDX. Keep in mind that the QDX requires some sort of computer, although there are many configurations that can be used for this purpose. A Raspberry Pi, which is about the same size as the QDX, could be linked wirelessly to a tablet or iPad, making for a compact and versatile setup.

Hans Summers, GØUPL, founder of QRP Labs and the designer of the QDX, provides a better technical description of the operation of the radio, but here's my take. As a musician, I understand the term "transposition." To transmit, the radio uses an analog-to-digital conversion of the audio input signal, which is sampled. The sample of each audio frequency is then "transposed," or transformed, directly to appropriate RF frequencies. These are not sideband signals injected to produce a suppressed carrier SSB transmission. The transmitter produces pure frequency shift keying without any spurious mixing products.

The receiver is an SDR that uses an intermediate frequency for the final extraction of the tones — first in digital form, then fed as audio to a built-in sound card, and finally sent via USB to a computer. Anecdotally, the receiver passband is nearly devoid of noise. In very unscientific terms, the radio doesn't seem to "hear" much of anything aside from the intended signals. This may, in part, have to do with portable operations, but even still I find that, compared to other QRP FT4/FT8 setups I have used, the signal-to-noise ratio appears to be much better with the QDX. Compared to other QRP setups, my experience is that the QDX hears well enough that there is bigger spread in SNR readings, and because the QDX hears so well, a reply with the other station being unable to hear it seems to be more frequent than with other radios I have used.

The QDX does an excellent job of leveraging the modes available in *WSJT-X* and several other popular modes.

Conclusion

Overall, the QDX is an excellent transceiver. It is compact, easy to use, and nearly foolproof. I highly recommend purchasing the case unless you are highly skilled at fabricating your own enclosures, or if you have a 3D printer, as some templates are available online. The radio is a worthwhile addition to my go-box for portable operations, but it would function equally well as a dedicated radio in the shack.

Manufacturer: QRP Labs, **www.qrp-labs.com**. Available in two versions at the same price: 80, 60, 40, 30, and 20 meters (the reviewed unit), and the new 20, 17, 15, 12, and 10 meters. Price: $69 for the kit version, and $20 for the optional enclosure; an extra $45 for the assembled version.

Signal Generators

Reviewed by Paul Danzer, N1II
n1ii@arrl.net

You can no longer buy a signal generator like you used to. Although some manufacturers divide their products into two classes — analog signal generators whose primary output is CW (sine wave), and vector or digital signal generators whose primary output is complex digital waveforms — most analog signal generators can generate square, triangular, and various digital waveforms. Most digital signal generators also can generate CW.

Bottom Line

There are affordable signal generators out there that may be a good starting point for someone new to this kind of tool. For the most advanced users, or if you want to maximize your investment right from the start, it may be best to purchase a unit that also comes with a calibration certificate with traceability.

Table 2
Signal Generators Manufacturers' Specifications (not tested in the ARRL Lab)

Models	JDS2900 and JDS6600-60M	SDG 1032X	Rigol DG1062Z
Display	2.4-inch TFT color LCD	4.3-inch TFT color LCD	3.5-inch TFT color LCD
Max frequency of sine wave	60 MHz	60 MHz	60 MHz
Max frequency of square wave	25 MHz	Two channels 30 MHz	Two channels 60 MHz
Max frequency of triangular wave	25 MHz	Not specified	Not specified — ramp 1 MHz
Max frequency of pulse waveform	6 MHz	12.5 MHz	25 MHz
Max frequency of TTL waveform	6 MHz	For custom waveforms 30 MSa/S	25 MHz, custom 25 MHz
Pulse width range	25 nS to 4000 seconds	32.6 nS to 1000 ks	16 nS to >1000 seconds
Square wave rise time	≤10 nS	<4.2 nS	<10 nS
Square wave jitter	Not specified	300 ps+ 0.05 ppm of period	2 ppm +20 pS at <5 MHz
Frequency stability	±1 ppm/3 hours	Not specified	±1 ppm
Each waveform length	2048 points	16 kpts	16 Mpts per channel
Waveform sampling rate*	266 MSa/S	150 MSa/S	200 MSa/S
Waveform vertical resolution	14 bits	14 bits	14 bits
Operating temperature	0 – 40 °C	0 – 40 °C	0 – 50 °C
Waveform types	See text	See text	See text — 160 + arbitrary design

*Mega samples per second

The older-generation generators were capable of CW-only output. Drifting due to heat (vacuum tubes were very good at making heat) and drift in calibration were major problems, as was the aging of components with time. These problems drove the size and mechanical design, as well as the type of oscillator used in the unit. In turn, these considerations resulted in limits to the frequency range available with multiple range switch positions.

Nearly all such units had only one output channel and had to be recalibrated periodically. For high-accuracy frequency generation, many lab applications required a stand-alone frequency counter, which had its own stability problems.

Finally, some models became available at a low or moderate cost by sacrificing performance in the areas just listed as problems. Homebrewed models requiring selected parts often appeared as an exercise in art rather than electronic design!

In this review, I look at five different signal generators. There are major differences in the design and resulting capabilities between today's models and those of several years ago, before the availability of digital integrated circuits and microprocessors.

Digital Synthesis

Rather than being concerned with inductance-to-capacitance ratio and the temperature coefficient of capacitors, most generator manufacturers today look at a repetitive waveform as a set of points. Each point has an amplitude, and the more points read and convert to an analog voltage (or digital waveform) per second, the smoother the output waveform. Selecting a waveform to generate is really selecting a point-generating program. Picking the frequency selects how fast the points read out. Usually, a microprocessor controls the operation, and a digital readout (or a counter on the front panel) provides the frequency value being generated.

Each manufacturer has its own techniques in the design of the unit. For example, interpolation, smoothing, or encoding may be used to fill in between generated points. The digital number display may be offered as a freestanding counter, as an extra feature. When looking for a generator to use in your station, you may find that several units available online, especially imported units, have similar front panels and specifications. These similarities may lead you to wonder if they are not the same unit with a different name plaque! I selected a cross section of available generators for this review. At the low end are several similar units, and at the higher end are those with more availability or better capabilities. Table 2 summarizes the manufacturers' main specifications of the tested units.

JUNTEK JDS2900

This almost pocket-sized waveform generator front panel is approximately 4 × 1.5 × 4 inches. It has two modes of operation: functions that can be called up and their settings adjusted for the front panel, and functions that can be set up and adjusted only by software installed on a personal computer or laptop.

The package comes with the basic unit, a wall wart power supply, a mini CD, and a set of cables. The quick-start booklet included in the package is minimal; there is a full set of instructions and descriptions on the CD. The file is named **DDS_SETUP**. Drag it to your desktop and uncompress with a tool like *7Zip* or another uncompressing tool. Open the following folders/files in this order: **SIGNAL GENERATOR SOFTWARE**, **ENGLISH**, and **QUICK GUIDE**. The Quick Guide PDF has both the full instructions and a list of the manufacturer's specifications.

Inputs and Outputs

The left side panel has a socket labeled **DC5V** that mates with the cord from the power supply. Next to it is a **USB** (type B) socket for connection to a PC. Finally, to its right is the unit's **ON/OFF** switch (see Figure 5).

On the right side are four BNC connectors labeled **TTLIN**, **EXTIN**, **CH1**, and **CH2**. The last two have LEDs to indicate which channel is active (it may indicate that both are active). Unfortunately, the lettering for these four connectors may be difficult to see under poor lighting conditions.

The mini CD has all the buttons on the front panel shown in a pictorial with callouts of their names or functions. Not labeled are the two arrow keys just below the single rotary knob (to be described later).

Front Panel — Watch the Numbers, Not the Picture

For the most part, the waveforms on the front panel vary only with major changes in selection. For example, pressing the **WAVE** button to select a square wave will show a square wave, but adjusting the amplitude of the square wave will be reflected in the number on the screen, not the height of the picture. A white illuminated dot on the screen tells you which item is active and will respond to control changes.

The round knob changes the digit of whatever is being changed by your selection. Suppose the amplitude is set to 3.500 V and the **5** digit is shown with a red marker. Rotating the round knob clockwise will change the 5 value to 6, 7, 8, 9 in sequence. To jump quickly from one digit place to the next, you can use the arrow keys.

The selected output is shown on the right side. To make changes on channel 1, press the **1** button. To make changes on channel 2, press the **2** button. The associated LEDs remind you what selection you made when illuminated.

It is easy to forget where you are when making complex selections. To reset, slide the power switch off — this may be drastic, but it might be the only way to get back to where you want to select a signal.

There are 20 selectable waveforms from the front panel. This review covers only the front panel capabilities; there are 14 arbitrary programmable waveforms that can be set up and stored for immediate recall through a computer interface.

Available Waveforms

Per the list in the Quick Guide, the following fixed waveforms are selectable: sine, square pulse (with adjustable width and period), triangular wave, partial sine wave, TTL/CMOS wave, adjustable DC level, half sine wave, positive- and negative-going staircase wave, noise wave, up exponential rise, down exponential, and several others. There are more than 14 programmable slots for your choice of non-standard waveforms that can be stored.

A full explanation of each of the buttons for each mode or waveform would take several pages of instruction,

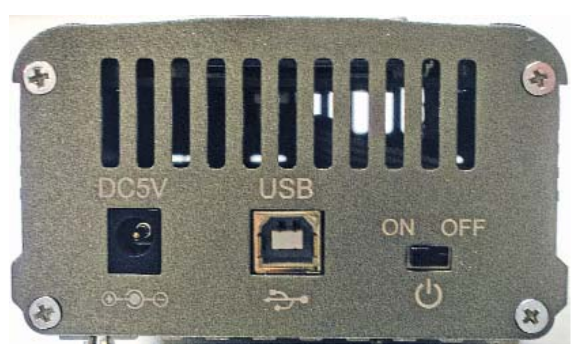

Figure 5 – The JUNTEK JDS2900 left side view, with the **ON/OFF** switch, the 5 V dc power connection, and the USB connector.

which is exactly what can be found in the Quick Guide. As an example, if you want a 3.1 V half sine wave with a 2.5 V offset, a frequency of 18 MHz, and output on channel 1, start with the turn-on screen, as shown in the lead photo of this unit, and press the channel 1 and 2 buttons until the display shows channel 1 on and channel 2 off. The channel screen should also have a white dot on the top left and no such dot on the screen next to the channel 2 legend. Select the waveform by pressing **WAVE** and the **SINE** selection on channel 1, and it should go red.

To select the waveform, press **WAVE** and then rotate the round knob until the legend says **HALF WAVE**. By pressing the frequency button, the value is selected by using the left arrow key to move the leftmost digit to a 1. Next, press the right arrow key so the second digit is selected, and rotate the round knob until the second digit reads 18. Because you want a frequency of exactly 18 MHz, use the arrow keys and round knob to set the rest of the digits to 0.

Finally, press the **AMPL** button followed by the arrow keys and the knob to select an amplitude of 3.1 V. The remaining item is the offset; press the **OFFS** button again followed by the arrow keys and knob so the **OFFS** legend on the screen reads the desired 2.5 V.

This sequence is typical for selecting a waveform from the front panel. The vertical line of buttons selects the item you want to adjust; the keys to the right have individual results.

Compare a Couple of Numbers

As described earlier, the output waveform is a set of programmed values coming out as a voltage whose value over time is made up of these points generating serially. According to the manufacturer, each waveform (presumably of a repetitive waveform) can consist of 2,048 points. The waveform sampling rate is stated as 266 mega samples per second (MSa/S). These values provide the limit for how accurate (or “smooth”) the output waveform will be. Because a digital-to-analog converter (and perhaps analog buffers) may be part of the design, these numbers are limits, with the actual specified values given by mode and setting, as appropriate, in the instruction manual.

Another number listed in Table 2 is the waveform vertical resolution (14 bits, or 214, which is equal to 16384 counts). Again, the actual specified accuracies in amplitude are given in the instruction file on the mini CD.

A Few More Keys

A few of the front panel keys are not discussed in the previous example. In brief, they are: **MEAS** (switches between measurement mode and a count function), **MOD** (controls modulation mode interface), **SYS** (switches between system selections, such as sounds, brightness, and save current settings), and **OK** (controls on/off for channels).

Several pages of instruction on the use of these buttons are again found in the Quick Guide.

In Summary

When I received this unit, I was not very impressed. It rattled — there was a screw loose and bouncing around in the enclosure. Fortunately, it took only a few minutes and four screws to open the enclosure and drop out the loose hardware. Nothing else was loose, so after closing it up, I proceeded with testing. The time it took to find the instruction file was also not impressive — it was located several steps from the main file, and a RAR decompression was needed to traverse the file structure.

What was impressive was that once you turned it on and tried to use it, you did not need many instructions. Most functions are self-explanatory, and the response to the labels was 100% for most direct functions. I ran a number of quantitative checks. I did not list them here, because the instrumentation I used, while typical of many ham workbenches, was not demonstratively accurate enough to prove the unit calibration. Certainly, all were within 5 – 10%, but how much of each was due to the unit and how much was due to the measuring instruments cannot be determined.

Manufacturer: Hangzhou Junce Instruments Co., Ltd. (Juntek), No. 18, Xiyuan 1st Road, Xihu District, Hangzhou City, Zhejiang Province, China, **www.junteks.com**. Price: $99.98. Available at **www.amazon.com**.

SeeSii JDS6600-60M

If you have ever searched online for an item from a conglomerate supplier such as Amazon, you have probably found a web page that hosts several similar items, from which you have to pick one. In order to compare two similar signal generators, I selected the JDS2900 (reviewed earlier) and the JDS6600.

Their similarities become obvious when you notice that the Quick Guide supplied with the JDS2900 does not list the several models of the JDS2900, but lists the models of the JDS6600. The JDS2900 comes from a company called JUNTEK, and the JDS6600 comes from a company called SeeSii.

There is a mechanical difference between the two. The SeeSii lead photo shows the front panel of the JDS6600. The layout is different from the JDS2900, but the controls are similar. The biggest difference is the size; the JDS2900 is approximately 4 × 1.5 × 4 inches, while the JDS6600 is approximately 7.6 × 2.7 × 7 inches.

The location of the connectors is also different. The JDS2900 has connectors on both sides. The JDS6600 has two channel outputs and the measurement port on the front panel, and the dc connector, a USB type B port, and a **TTL** connector on the rear (see Figure 6). The **TTL** connector on the JDS6600 is a rectangular 10-pin polarized male, while the JDS2900 uses a BNC connector.

Figure 6 – The SeeSii JDS6600 rear panel.

The documentation for the two models is slightly different. The JDS2900 comes with both a mini CD and a small quick-start booklet, and the JDS6600 comes with a larger instruction summary book. The CDs are similar, and the company name (Hangzhou Junce Instruments Co., Ltd.) is the same. Because the same Quick Guide apparently holds for both models, the manufacturer's host name on both PDF files holds for both JUNTEK and SeeSii — not an unusual situation for an electronic device imported from the Far East. While the units appear to be electrically similar, notice the price difference.

Manufacturer: SeeSii. Price: $139.99. Available at **www.amazon.com**.

SIGLENT SDG 1032X

The front panel of this industrial-strength waveform generator is labeled "Easy Pulse," and many of its functions are easy to set up, customize, and use. There are other capabilities for which you may need the online documentation. This 9 × 4 × 11.5-inch unit, including corner bumpers (but not including the handle), weighs slightly less than 10 pounds. It is capable of generating two separate outputs, but it displays the output settings and waveform pictures of only one channel at a time. The unit reviewed here is a 30 MHz model. It comes with a calibration certificate and calibration traceability, meeting several industry and government requirements and specifications. The shipping carton contains the main unit, a power cord, and a USB jumper.

The Quick Start Guide — Almost All You Need to Know

Included in the shipping carton is a small 16-page booklet. Between the information on its pages and the labels on the buttons (except for programming custom waveforms), you can quickly see how to use many of the

FeelElec FY8300-30M — An Example of Common Hardware in the Online Marketplace

I first chose this unit because of its price and the fact that it is a three-channel unit — that is, it has three independent generator outputs, but before you start looking for this interesting waveform generator, note that it may not be available and it is likely discontinued.

Looking at the front panel (see the lead photo), you immediately see a relationship between this unit and the other two reviewed previously. The two previously mentioned units are supposedly made by two different companies, but their common instruction manual shows that these companies are actually one, and the contact information for both preceding units is the same.

The FY8300 came without printed instructions or any electronic files. Several internet searches suggest that FeelElec may have stopped producing these units in 2019, and if you did get one, the matching software is not available and there is no support. If that is the case, why mention it here? Well, it's important to emphasize the risk that buyers take when purchasing electronics from an unknown brand over the internet. I shopped online for a low-cost signal generator, just like any ham would do, and found out after the fact that it was no longer supported.

The distributor sent this unit in place of another ordered unit. I bought the unit at Amazon, and there was no brand name advertised on the unit page — only the model number. This is another thing to pay attention to; it's important to double-check before you buy.

After a long search, I found a PDF file online that was placed there by another company with a similar name — FeelTech. There is no way to ensure that this file is intended for this unit. Although the manual is available for their FY8300 model, it's not on their product list anymore. Online discussion also suggests the FY8300 was first sold in 2019. The software available at the time was "buggy," and several owners were hoping for revised software.

Because this model is not generally available, I did not provide a full description and comparison; however, it shows what can be done with common hardware and a possibly common software base.

In summary, buying specialized equipment online can be tricky. Before buying any unknown or unspecified brand, even from a trusted website, ensure that the unit is still supported. If you want to maximize your investment, it may be best to buy from a known brand. Most importantly, do your research before making a purchase.

direct settings and functions. Unfortunately, the booklet does not include detailed instructions. For this, you must go online (more on this later).

One of the more interesting keys, the **WAVEFORMS** button, allows selection of six fixed waveforms, plus one that is programmable. These waveforms are shown in the bottom margin of the screen. By pressing the **WAVEFORMS** button, you can select a waveform and then modify its characteristics by pressing the **PARAMETER** button just above it. The fixed waveforms are sine, square, ramp, pulse, noise, dc, and arb. Arb includes an additional 10 built-in waveforms, plus the ability to interface with a PC to build your own.

When the **PARAMETER** button is selected, the waveform previously picked can have its amplitude, frequency, and a host of other characteristics changed. A small booklet is not enough to explain how to use many of the functions, but help comes from the SIGLENT website (**https://siglentna.com/resources/documents/waveform-generators/#sdg1000x-series**). Look for the "SDG1000X Series Function/Arbitrary Waveform Generators." From there you can find a listing of many things you might want to know, including a 168-page user manual and the "SDG Series Arbitrary Waveform Generator Programming Guide." A 12-page data sheet is also found on this page. On the same web page, a programming manual is also available (titled "EasyWave"). Programmed waveforms can be stored for later recall.

Many, if not all, of the fixed waveforms can be modulated. Modulation capability includes linear and log sweep, AM, DSB-AM, FM, PM, FSK, PSK, and PWM. The modulation can be selected as an internal function or from an external input.

A handy inclusion is the built-in help system. You access it by selecting the following buttons and selections: **UTILITY** — **SYSTEM** — **PAGE 2/2** — **HELP**. There may be a minor typo in some editions of the Quick Start Guide; follow this alternate suggested path to lead to the built-in help menu.

Figure 7 — The SIGLENT SDG 1032X rear panel. PC, LAN, and other input/output connections are made through this set of connectors.

Ins and Outs on the Rear Panel

Adding to the flexibility is a set of connectors on the rear panel (see Figure 7). Across the top row, from left to right, are a set of three BNC connectors. The first one, **COUNTER**, accepts a signal probe measured by the internal frequency counter. The next one, **AUX IN/OUT**, accepts various triggers or external modulation, depending on the units setting. The third BNC is a **10 MHZ IN/OUT** clock input and output. It can be used to output the internal 10 MHz clock or accept an external 10 MHz clock. The final top row terminal is a ground.

Along the bottom row is a **LAN** connector to be used with a network, and a **USB** connector that interfaces with a PC, if used to generate a custom waveform. Finally, at the bottom right is a dual-voltage power connector accepting line voltages from 100 to 240 V ac at 50 or 60 Hz, and perhaps of interest, it also accepts 100 to 120 V ac at 400 Hz, which may be handy for some military and industrial mobile applications.

In Summary

This is a laboratory-grade instrument that comes with specified accuracies and a note that suggests when the next calibration should be done to maintain its performance. In addition to the many built-in waveforms, you can design your own, point by point, using up to 14 kilo points per waveform. The built-in modulation selection increases by the ability to design your own. This particular unit was the SDG 1032X, whose data sheet can be downloaded from the manufacturer's website (**https://siglentna.com/download/2412/?tmstv=1670605809**).

Manufacturer: SIGLENT Technologies North America, Inc., 6557 Cochran Rd., Solon, OH 44139, **www.siglentna.com**. Price: $359. Available from several North American dealers.

RIGOL DG1062Z Function/Arbitrary Waveform Generator

This RIGOL product comes with all the information you need online but no hard copy booklet or CD. However, also included in the shipping box is a packing list. On the reverse side is a QR code that will download the quick guide in both Chinese and English to your email address. You can then pick it up on your PC. Be sure to look at the shipping papers. You can find both the email address and telephone number of US support, which is helpful.

The model reviewed here (DG1062Z) has dual 60 MHz sine wave capability and uses up to 200 MSa/S. There appears to be a similar model with the same capabilities but with slightly different packaging; it does not include the corner protective bumpers. The two channels are independent but can be tied together or synchronized.

The unit is a laboratory-grade model with certified calibration and suggested time for recalibration. A certificate of calibration is included in the box, as is traceability information.

The 3.5-inch (320 × 240-pixel) color display uniquely displays the selected waveforms and associated numbers for both channels simultaneously. If the waveforms are synced together, they can be modified simultaneously. The manufacturer claims that 160 different waveforms have been preset in the unit; this review did not verify that number.

Key parameters are included in Table 2. The arbitrary waveform generator is an interesting capability; the manufacturer calls it "signal fidelity." It can be used to generate an arbitrary waveform point by point. Depending on the model selected, each channel has

8 mega points (Mp) devoted to the waveform construction. Extra memory in some models increases this to 16 Mp. For some applications, the claimed stability of the square wave generated is jitter of less than 300 ps plus 5 ppm of the period — up to a 60 MHz frequency.

A word of caution: while just about all the numbers quoted in this review are impressive, occasionally there were conflicts between various pages of the manufacturer's posted material. Sometimes it was not apparent which model was being quoted.

Check carefully that the material you download applies to the model series in which you are interested. For example, the SDG1000X series has a completely different front panel than the SDG1000Z series. A "Z" series unit is the one examined for this review.

Front Panel Controls and Ports

Almost every control and setting on the front panel has an accuracy associated with it. Because this is a laboratory-type instrument, many of these numbers correspond to the industrial standards to which the unit is supposed to conform. The front panel layout (see the lead photo for this unit) may look familiar, as it resembles the front panel of several of the units reviewed in this comparison.

To the right of the display is a set of five soft keys — their use is not fixed but varies with the exact unit settings. On the right is the now-familiar rotary knob. When you want to change a value, the knob changes the digit value (from 0 to 9), and the left and right arrow buttons change the place of the digit selected. For example, for "----7----," the round knob varies the 7 and the left and right arrow buttons below the knob select the position. However, if you find this place/digit system tedious (as I did), the numerical keyboard gives you direct entry of a number.

There are a few unique features of this panel. Below the five soft keys is a similar-colored key with an arrowhead pointing down. For some settings, this key takes you to a menu sub-setting. To the right of this key is a key with a counterclockwise arrow. When the unit is in a submenu, pressing this key will return you to the previous menu. Not all settings have a controllable menu/submenu feature.

On the lower right is the power **ON/OFF** switch with the standard industry markings — the small 0 setting indicates off, and the small horizontal bar indicates on. To the right is a surprise — a USB socket. Because the unit can be programmed with your unique waveform (a full description of the programming language and technique is beyond the scope of this review), this connector can be used to insert the code for your unique waveform or to store and make available to a similar unit the current waveform.

The front panel USB connector has a unique ability. It can be used to store a BMP file of the display screen. It also is a port used with several other RIGOL products.

Along the bottom of the panel are three BNC connectors. The first two are outputs for the two channels of the generator. Above and in between these BNCs is a channel select switch. To either side are two buttons labeled **CH1 (**channel 1) and **CH2 (**channel 2). These turn on the selected channel outputs.

The select switch selects either channel for entry. When a channel is selected for output, it is highlighted at the top of the screen. The select button routes the commands to either channel 1 or 2.

A few of the internal stored waveforms are selected by the top row of buttons. In the left row, the next button down allows selection of various modulations, including AM, PM, ASK, PSK, and PWM. Below it are various sweep selections — **SINE**, **SQUARE**, **RAMP**, and programmable.

Finally, the bottom row selects one of several internal burst waveforms defined with the same names as the modulations. The three remaining buttons below the **SQUARE** button are system controls. **UTILITY** allows selection of various sync, polarity, and delay parameters for a currently selected waveform. **STORE** provides selection of storage place (internal or on the USB flash drive), and the **HELP** button provides text explaining a previously selected control. Depending on the button selected, there may be one or several help screens for the button. The return button exits help and returns you to the previous screen. Both this help file and the file downloaded from the QR noted before (**http://support.rigol.com/File/DC/DG1000Z_QuickGuide_CN&EN.PDF**) give you more front panel button explanation.

Figure 8 — The RIGOL DG1062Z rear panel.

In the lower right corner, a third BNC connector feeds an internal frequency counter. The counter is selected by a button just above and to the right of this BNC, and is listed as capable of measuring frequencies to 200 MHz with a seven-digit display.

Rear Panel Connections — Input, Output, and Control

On the rear panel (see Figure 8), there are three BNC connectors that have multiple uses, depending on how the generator is being used. The legend shown above each connector is a summary of the use of that connector. When channel 1 is selected on the front panel, the first (leftmost) connector puts out a corresponding sync signal. If channel 2 is selected, the second BNC puts out a corresponding sync signal.

The first BNC connector has several other uses. It accepts an external modulation signal, control of an FSK signal again if selected, and a port for trigger in and out. The second BNC connector has a similar set of uses when channel 2 is selected for output.

The third BNC connector, when configured, puts out the internal 10 MHz clock source or alternately accepts input from an external 10 MHz source. The next connector is a standard Ethernet LAN socket allowing the generator to be used and controlled as part of a complete test setup, meeting an industrial standard called out in the user's guide.

A standard USB connector completes the set. It can be used to control the generator externally from a PC. It can also be connected to a PictBridge printer (an industry standard) to print the contents of the screen. Finally, on the right is an ac power socket.

In Summary

Both the LAN and the USB connectors provide ports that can be used to configure and control the generator. RIGOL lists the following documents available on its website (**www.rigol.com**): DG1000Z User's Guide (explains functions, operation methods, and remote-control methods), DG1000Z Programming Guide (provides descriptions of SCPI commands and programming information), and DG1000Z Data Sheet (lists capabilities and technical specifications).

Manufacturer: RIGOL USA, 10220 SW Nimbus Ave. Suite K-7, Portland, OR 97223, **www.rigolna.com**. Price: $903. Available from several North American dealers.

Feedback

■ In the January 2023 issue of *QST*, Figure 2 in "Antenna Switch for Three Remote Operating Locations" in the "Hints & Hacks" column contains two incorrect connections. The Relay 2 connection to the yellow wire should be made to the green wire, and the junction of the S2 and LED4 connection to the yellow wire should also be made to the green wire. A corrected schematic has been added to the *QST* in Depth web page at **www.arrl.org/qst-in-depth**.

■ In the February 2023 "Product Review," two errors were made that have since been corrected in the digital edition. First, the placement of Figures B and C should be reversed. Please note that this refers to the images only; the captions are in the correct places. Second, in the caption for Figure C, the second sentence should read, "Third-order products are –28 dB_{PEP}, and fifth-order products are –39 dB_{PEP}." *QST* regrets these errors.

Strays

Service Academies Radio Group

The Service Academies Radio Group (SARG), consisting of amateur operators who are graduates of, or associated with, the five service academies — US Military Academy (USMA), US Naval Academy (USNA), US Air Force Academy (USAFA), US Coast Guard Academy (USCGA), and US Merchant Marine Academy (USMMA) — has recently been formed to support amateur radio activities among the group members and amateur radio clubs at the academies. Those interested in participating are invited to contact **w5cq@arrl.net**, **k9mbq@arrl.net**, or **k5mnz@arrl.net**.