

Siglent SDS1102X Oscilloscope

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The Siglent SDS1102X is a 100 MHz, two channel digital storage oscilloscope. It features an 8-inch color LCD screen and includes a number of features that are useful in the amateur workshop.

The first thing you might notice after unpacking the SDS1102X is the front panel layout. There is a branch of engineering known as *human factors*, which is devoted to ensuring that equipment is designed so it can be operated accurately, safely, and within the limits of two hands and one set of eyes. For example, the main tuning knob on a transceiver is most likely the largest knob, easily selected. Functions used less often have smaller knobs, and the least used may have very tiny knobs, rear panel locations, or be assigned to menus.

This oscilloscope was definitely designed with human factors in mind! In addition to the supplied 160-page PDF manual, there's a *Quick Start* booklet that is laid out almost as a software flowchart — and without this guidance you might miss being able to take advantage of some of the scope's capabilities.

First Steps

The SDS1102X comes with two probes. In addition to the “grabbing” probe hook ends, several other probe ends are enclosed. As with any scope, the first step is to make sure the probes are adjusted correctly. The front panel square wave test point allows you to make this quick adjustment — if needed.

The next step is to check the manufacturer's website for any firmware updates, as there may have been a new release since the scope was manufactured (it originates in China). The review unit did not come with clear update instructions, but according to Siglent, better instructions will be available by the time this review reaches print. The firmware is downloaded from Siglent's website as a compressed .rar file. If your compression software won't uncompress a .rar file, download a copy of 7-ZIP (www.7-zip.org). After uncompressing the file, search for a file with the suffix .ads. Copy this file (and only this file) to a flash drive and then follow the manufacturer's

instructions. Updating is done through the UTILITY menu. The process may take a while, so stay hands-off until you get a message that the update is complete.

Siglent supplies a USB cable and *EasyScopeX* software to allow control of the scope from your PC as well as capture and storage of screen shots of the scope display (see the sidebar, “*EasyScopeX* Utility Software”). *EasyScopeX* is not required to operate the scope, so you can, if you wish, skip the software installation. I installed the software and used it to capture the screens shown in this review. Another 160-page PDF manual details commands for programming and controlling the scope from your PC. Don't worry — only one page was needed to explain how to use *EasyScopeX*. Once it is up and running, the screens are relatively self-explanatory.

Let's Look at the Screen

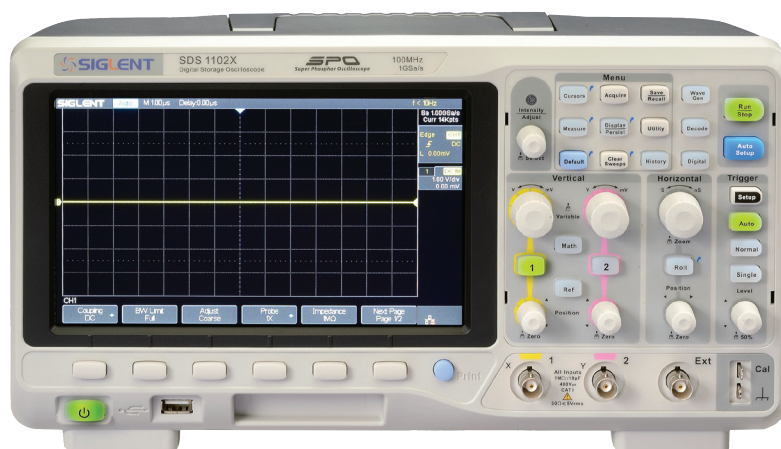
The scope screen in Figure 4 is probably the best way to explain how to operate this scope. The waveform displayed is channel 1 (one of the two channels) with its probe connected to the calibration square wave output on the scope front panel. All you have to

do to get this picture is press the blue AUTO SETUP button, wait a second or two, and your waveform appears, perfectly scaled to a matching horizontal sweep rate and vertical gain. You can, of course, set the sweep rate, vertical gain, trigger mode, and trigger point manually, but the automatic function is valuable for a fast look.

The display tells the rest of the story. Starting at the top left, the legend shows the display is triggered (that is synchronized to the waveform), and the horizontal scale is 200 μ s per division. The next legend on the top is the trigger delay, and the zero means there is no delay set. The delay and other trigger settings are adjustable from the front panel.

On the right-hand side of the screen, the square wave frequency is measured as 1 kHz. For irregular but repetitive waveforms, the circuits pick up an identical point on each “cycle” that may not correspond to the base frequency, so a little caution is in order. Below the frequency, the sample rate is shown as 5 Ms/S (mega-samples/second) and the number of sample points across the screen is 14,000. Press the RUN/STOP button and these values will be saved for further examination.

If you are used to older analog oscilloscopes, you might notice that there are no controls or settings for ALTERNATE or CHOPPED for the two input channels. If you change the setting to use both probes, a second box opens to show the status of channel 2. In addition, the sample rate goes



Bottom Line

This 100 MHz oscilloscope has a knockout color display but requires a great deal of learning to use its many features. There is very little around your shack or workbench that the scope cannot do.

Table 3
Siglent SDS1102X Key Parameters

Bandwidth: 100 MHz
Real-time sampling rate up to 1 Gigasamples/second
Rise time: approximately 3.5 ns maximum
Vertical resolution – 8 bits (1 part in 256)
DC gain accuracy: 3% to 4%
Horizontal (time base) accuracy: ± 25 ppm
Record length: 14 megapoints
Trigger modes: Edge, Pulse, Window, Runt, Interval, Time out (Dropout), and Pattern
Serial bus triggering and decode (supports data protocols such as UART and RS-232)
Video triggers for HDTV
Vertical scale 500 μ V/div to 10 V/div
History waveform record function; maximum recorded waveform length is 80,000 frames
36 automatic measurement functions including statistics calculations, gating measurement, math measurement, history measurement, reference display and measurement
Waveform math function (FFT, addition, subtraction, multiplication, division, integration, differentiation, square root)
Multiple interfaces: USB Host, USB Device (USBTMC), LAN (VXI-11), Pass/Fail, Trigger Out
Price: \$500

from 5 Ms/S to 2.5 Ms/S and the number of points goes from 14,000 to 7000. In other words, the same hardware is now shared between the two channels automatically.

Continuing down the right side, the trigger mode is shown as using the rising edge and occurring at a level of 152 mV. Again, these are the automatic settings and every one of them can be changed. Further down, the readout says only channel 1 has been selected and dc coupling is set for the channel input, at a scale of 100 mV per division.

Below the bottom of the screen is a set of six unlabeled pushbuttons. These are soft keys that correspond to labels shown at the bottom of the screen. Their functions change in response to other switch selections. The scope is currently in AUTO SETUP mode, with a measured amplitude of a bit over 300 mV peak to peak.

In the MENU section of the front panel are nine pushbuttons. Pressing one changes the functions of the soft keys along the bottom of the screen and brings up extensive menus in some cases. For example pressing the MEASURE button brings up a choice of over 30 parameters to be measured. Only the voltage peak-to-peak (V_{pp}) and the period were selected.

Specifications

The full set of specifications for this scope can be found online at the Siglent website.

The key numbers are shown in Table 3.

Perhaps the one number most likely to be noticed is the bandwidth.⁴ In summary, the bandwidth is a single number that tells you where the scope response falls off by 3 dB — to about 70% of its initial display amplitude. The specification for this scope is a flat response within ± 3 dB out to the 100 MHz bandwidth frequency. This does not mean that beyond the bandwidth frequency you cannot use the scope; it simply means the amplitude of the waveform will not be the value shown, but will be somewhat less.

Bandwidth is more of a limitation when you are looking at digital pulses, where you may be interested in rise and fall time. As an example, suppose you are looking at a square wave. You will need a multiple of the square wave frequency to be able to see the shape properly — at a minimum three times the square wave frequency and perhaps as much as five or seven times the sinusoidal bandwidth frequency.⁵

The scope's bandwidth also limits the observed rise time of a rectangular pulse. A generally accepted rule of thumb is rise time = $0.35/\text{bandwidth}$, and the SDS1102X is rated at 3.5 ns.

After bandwidth, perhaps the next most important scope capability is sweep triggering. Without a solid trigger selection, the displayed waveform will be jittery. This

scope has a very large selection of triggers in addition to the usual choices — rising edge, falling edge, adjustable voltage level, ac coupling, and dc coupling. It also has advanced trigger choices: pulse, window, runt, interval, time out (dropout), and pattern. There's also serial bus triggering and decode and video triggering for HDTV. Most of these are not of much interest for Amateur Radio applications unless you are working with digital data streams and data protocols. Runt (yes, just like the runt of the litter) is a bit unusual. You can select a level on the incoming channel and measure a stream of pulses. If one of the pulses is less than the level you select, it will trigger the sweep!

Other Interesting Gadgets and Capabilities

Unlike old analog scopes, individual pieces of the incoming waveform are converted to digital words (in this case 8 bits) and stored. On the scope screen at the top right is a legend that tells you the number of samples across the entire screen. At the maximum sweep rate, 2 ns/division, this scope takes 14 samples.

If you suspect you are missing something (and that would probably only occur at this maximum sweep rate), you can actually see each sample. It takes three button presses. If you want to examine the intervals between samples, you can put the scope back into RUN and move the trigger delay a bit, then repeat the entire process.

Mimicking an old analog scope, there is a ZOOM function. With the older scopes, you would put a "bug" on the waveform and then pick "expansion" to see the selected area around the bug at a higher sweep speed. This digital scope goes a bit further. The ZOOM function gives you the same capability, but the scope goes into dual trace. You will see both the expanded area and the original trace, so if you missed the area of interest by a bit you can see directly how to move the zoom (or expansion) point in time to see what you want to see.

If you would like to keep a record of what is on the screen without using the *Easy ScopeX* software, you can connect a conventional printer to the USB port, press a few buttons, and out comes a print of the scope face. While this does not provide a computer file for digital storage, it certainly is quick and easy.

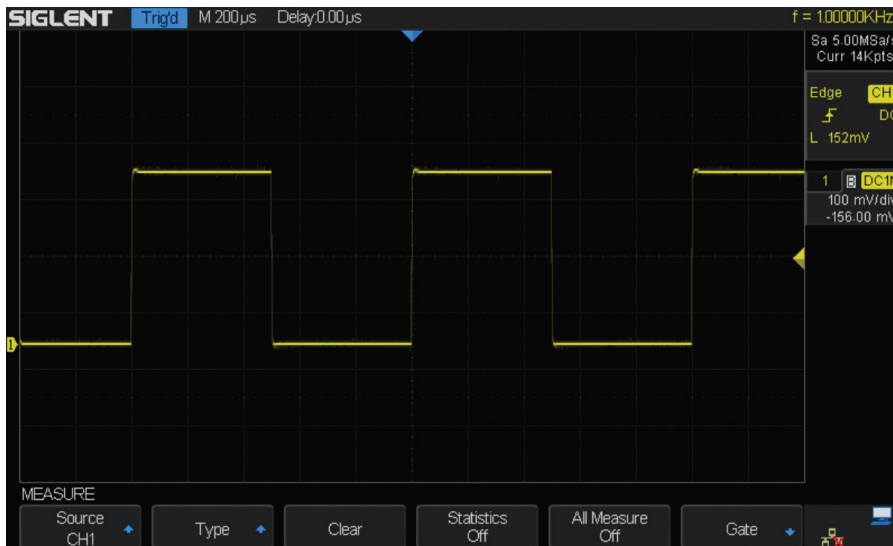


Figure 4 — This waveform was set up automatically by pressing the AUTO SETUP button. Notice that the legends on the right side tell you what is going on.

Did you ever make a change to a circuit and want to see what happened, as compared to what it was before the change? The REF function stores the “before” waveform (the reference waveform). Make your change, display the new waveform on the screen, then press a few buttons and the reference waveform also appears simultaneously for direct comparison.

Of course, as a digital instrument, self-test and calibrate routines are included. While this compares only the performance with internal references, it does allow you to confirm that your measurements are within the scope performance parameters.

Putting the Scope to Work

The SDS1102X has a bandwidth that

covers all of the amateur HF bands, so I connected it to a signal generator set to 28.250 MHz in the amateur 10 meter band. Although the signal generator is old, I expected to see relatively clean sine waves. There was a little surprise. As shown in Figure 5, the sine wave was not clean and showed a modulation envelope — totally unexpected. Since the signal generator is powered from the 60 Hz line, my first assumption was that if the horizontal sweep rate were slowed down, I would see a 60 or 120 Hz hum envelope.

Instead the waveform (see Figure 6) measured approximately 1 ms between peaks — corresponding to a 1 kHz modulation. This was unexpected, so to confirm the

picture I selected the MATH button on vertical panel and pressed the FFT soft key so that the scope functioned as a spectrum analyzer. The spectrum on the screen (see Figure 7) with the accompanying legends shows 10 kHz per division as the horizontal scale. A count of energy spikes between each division is 10, corresponding to the envelope measurement of 1 kHz in Figure 6.

The result: “By accident” I found that this old signal generator had a serious problem, noticed and measured with the capabilities of an advanced digital scope! Perhaps it is time to buy a new signal generator.

Checking an Audio Amplifier

During the preparation of this review another project on the workbench used a 386 chip as the audio amplifier. This very common chip usually requires just a few additional components to produce acceptable audio into a small speaker or headphones. In this case the audio output was fuzzy and slightly distorted. I fed a 2 kHz square wave into the amplifier and examined the input and output simultaneously using the Siglent scope in the dual channel mode (see Figure 8). The answer became obvious — the amplifier was taking off at several high frequencies at once. The problem was caused by non-optimal layout and the need for additional bypass capacitors. With the addition of several bypass capacitors the oscillation disappeared and the audio became, if not high fidelity, at least acceptable from a one-chip circuit.

Of course this review just hit the highlights of this capable scope. The user manual is available for download from the Siglent



Figure 5 — This was supposed to be a nice clean sinusoidal waveform. The result was a surprise.

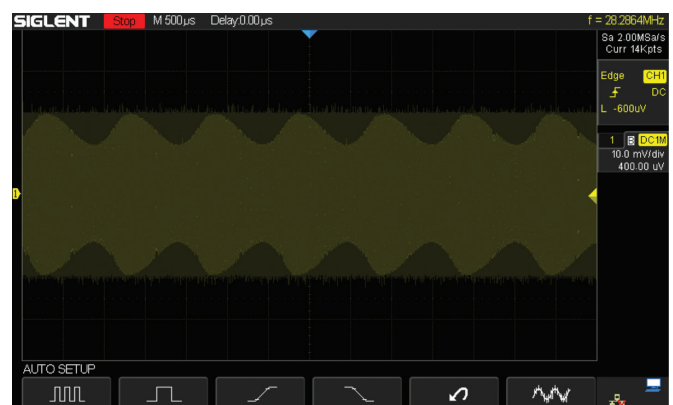


Figure 6 — Changing the sweep speed showed a modulation envelope instead of a nice flat output. The horizontal sweep (shown on top of the screen) gave a time of approximately 1 ms from one peak to another, suggesting a 1 kHz modulation.

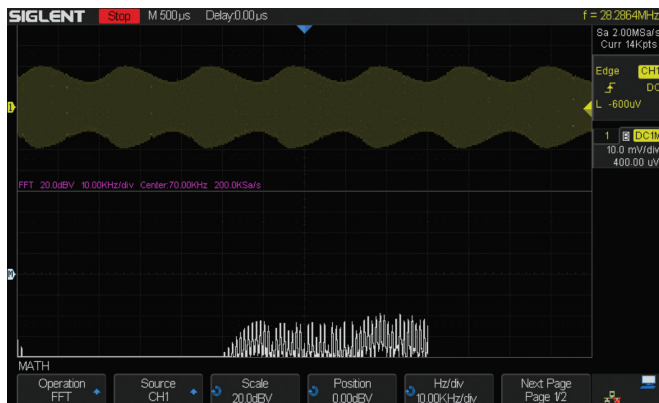


Figure 7 — Turning on the FFT function showed a horizontal scale of 10 kHz/division and approximately 10 energy bands per division — confirming the previous measurement of 1 kHz modulation.

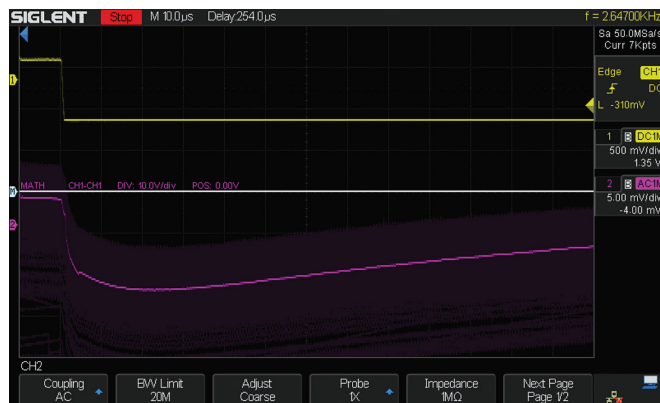


Figure 8 — Fuzzy and distorted audio was tracked down by this screen shot. Poor bypassing made the amplifier “take off” at several high frequencies at once, causing the problem.

website and is worth a look if you’re interested. Also note that Siglent offers a wide range of scopes with different capabilities and prices.

Manufacturer: Siglent Technologies America, 6557 Cochran Rd, Solon, OH 44139; tel 877-515-5551; www.siglent-america.com.

Notes

⁴P. Danzer, N1II, *Oscilloscopes for Radio Amateurs*, ARRL Item no. 0976, available from your ARRL dealer or from the ARRL Store. Telephone toll free in the US 888-277-5289, or 860-594-0355, fax 860-594-0303; www.arrl.org/shop/; pubsales@arrl.org. Bandwidth is discussed starting on page 8-5.

⁵*Oscilloscopes for Radio Amateurs*, page 7-11.

EasyScopeX Utility Software

EasyScopeX offers the capability to display and store the contents of the scope screen, or program and control the scope through your PC. As noted in the text, it is very easy to use, but installation takes a little effort. In summary you have to:

1) Download the current version of *EasyScopeX* for the SDS1000 series scopes — but don’t install it yet! (It’s a compressed .rar file.)

2) From the Siglent website, go to the National Instruments web address given, and download and install the National Instruments Visa driver. During the installation, you will be directed to allow installation of Microsoft .NET Framework software if you don’t already have it on your PC.

At this point the installation is automatic. On a new Windows 8.1 PC, it took most of an hour, and on an older machine it took several hours. During the installation you will be required to agree to several license agreements. National Instruments will also put update request software on your PC, which can be difficult to remove — and some of which may be a security risk, as is any automatic update situation.

Finally, after these preliminary steps you can install the *EasyScopeX* software itself.

In addition to allowing you to capture the scope screenshots, with this software you can also display a copy of the scope’s screen and front panel with controls as they appear on the scope itself. You can then control the scope functions with the PC mouse — no programming knowledge required!