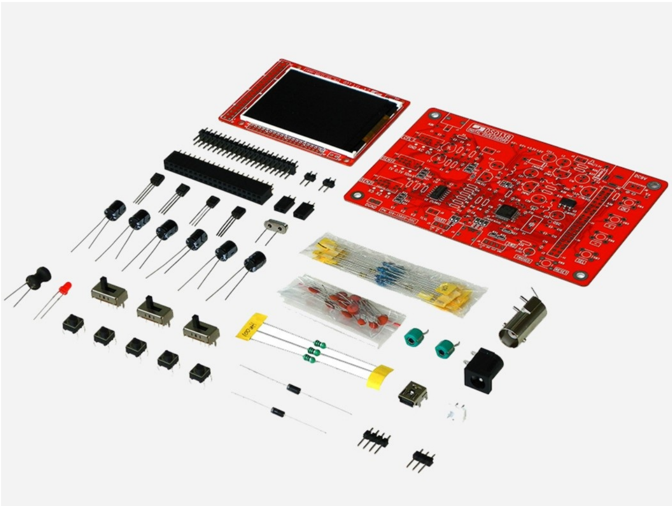

DSO138 Oscilloscope Kit & Manual

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DSO138 Oscilloscope Kit Description:

The DSO138 Oscilloscope is an inexpensive low-speed miniature oscilloscope with 2.4" LCD display. Based on the STM32F103 MCU, it was developed by JYE Tech, but it has been cloned and is distributed by a few other manufacturers. It is sold as a kit, or already assembled for nearly the same price, about $20.00 on Amazon.com.

Designed as a training oscilloscope, the DSO138 contains only the basic oscilloscope functions with no fancy features. The heart of the DSO138 is a Cortex-M3 ARM processor (STM32F103C8). It uses a 2.4" TFT LCD (320 X 240 dot matrix, 262K colors) that displays crisp and clear waveforms.

Simplicity in structure and easiness in assembly and operation are the main highlights of the design. For these purposes, DSO138 uses mostly through-hole parts, and the kit can be purchased with the surface mount parts already installed. The MCU for both configurations has already been pre-programmed and no reprogramming is required.

As both the kit and assembled versions could be purchased for the same price, I elected to purchase the assembled version and this manual will therefore not cover assembly. However, there are two excellent sources of on-line assembly instructions, pictures, and schematic. They are from the websites of JYE Tech Ltd - www.jyetech.com and from Jean-Matthieu Dechriste of IoT Experiments at iot-experiments.com/dso138-assembly/.

Please note that a 9Vdc power supply must be purchased separately.

The DSO138 is partially open-sourced, which opens the possibility for users to add different features or develop new applications on the hardware.

DSO138 Features:

- Analog bandwidth: 0 – 200KHz
- Sampling rate: 1Msps max
- Vertical Sensitivity: 10mV/Div to 5V/Div
- Sensitivity error: < 5%
- Vertical resolution: 12-bit
- Timebase: 10us/Div to 500s/Div
- Record length: 1024 points
- Built-in 1KHz/3.3V test signal
- Waveform frozen (HOLD) function available
- Save/recall waveform (I could find NO means of doing either)
- Automatically calculate and report on-screen measurements including: Vmax, Vmin, Vavr, Vpp, Vrms, Frequency, Cycle, Pulse Width, & Duty Cycle.

Specifications:

Vertical

Number of Channel:	1
Analog Bandwidth:	0 - 200KHz
Sensitivity:	10mV/Division - 5V/Division
Resolution:	12 bits
Input Impedance:	1M ohm / 20pF
Max Input Voltage:	50Vpk (1x probe)
Coupling:	DC, AC, GND

Horizontal

Max Real-time Sampling Rate:	1MSa/second
Timebase:	10us/Div - 500s/Div
Record Length:	1024 points

Trigger

Trigger Modes:	Auto, Normal, and Single
Trigger Types:	Rising/falling edge
Trigger Position:	½ of buffer size fixed

Display

2.4" color TFT LCD with 320x240 resolution

Power Supply

Supply Voltage:	9Vdc (8-12Vdc acceptable, Do NOT exceed 12Vdc)
Supply Current:	120mA
Barrel Size:	2.1mm x 5.5mm x 9.5mm

Physical

Dimensions:	4.6 x 3 x 0.6" (117mm x 76mm x 15mm)
Weight:	2.5 Ounces (70g) (without probe)

Physical Layout of the Finished Oscilloscope:

Power:

The DSO138 Oscilloscope requires power from an external 9Vdc AC/DC power supply or 9V battery (NOT included). When the power is ON, the current is about 120mA.

ATTENTION:

DO NOT exceed +12Vdc or U5 will get hot, or burn out completely!

The maximum allowed signal input voltage is 50 volts peak (100Vpp) with the clip probe.

Assembly:

All the parts needed to construct the JYE Tech Ltd DSO138 Oscilloscope are provided, along with an excellent set of detailed step-by-step instructions with color photographs. Additional information can be found at the JYE website:
www.jyetech.com

I also found an excellent source of assembly instructions from Jean-Matthieu Dechriste at:
iot-experiments.com/dso138-assembly/

Thank you to Jean-Matthieu for your excellent work.

Both the assembled product and the kit include instructions and a color schematic.

Assembly will require the following tools:

Volt-Ohmmeter to check voltages and for shorts (recommended)
Capacitor Checker (recommended)
Needle tip soldering iron or gun
Thin electronics solder w/flux core
Fine solder wick or de-soldering braid for mistakes
Needle nose pliers
Diagonal side cutters
Phillip's head screwdriver
Small flat-head screwdriver
9Vdc AC/DC power adapter or 9Vdc battery (with adapter)

Note: Before beginning construction, identify and compare the parts you received with the enclosed parts list. I also suggest that you check those parts that you can with an ohmmeter and capacitor checker, if they are available. All parts are new; however, in other China kits that I have constructed, I found I was missing a 3-pin header and had an extra push button switch. I also found a shorted capacitor and a resistor included in one kit of the wrong value. A little extra time here to check components now, will save considerable time trying to troubleshoot a malfunctioning assembly.

Assembly Procedures:

As I would be unable to improve upon the assembly procedures provided by Jean-Matthieu Dechriste at IoT Experiments, please visit his website for his assembly procedures:
iot-experiments.com/dso138-assembly/

Just a few comments:

- Begin assembly by inspecting the bare board. Get a feel for the layout of the parts, part numbers, and what is going to go where. The component side is the side with the silk screening, and while there may be some silk screening on the solder side, for our small kits, all the parts will be installed on the component side of the circuit board.

- I always suggest installing those components with the lowest vertical profile first. This keeps the circuit board flat and stable for as long as possible during the assembly and soldering process. So, start with any surface mounted components, while the board is empty and most stable.

- Using a spare cotton towel under the circuit board helps protect the work surface and stabilize the board during soldering.

- All the solder pins on this board are adequately separated, however, if you accidently create a solder bridge across 2 or 3 pins, place solder wick over the solder bridge and carefully heat the wick only until solder flows into the wick. Take care not to overheat the component!

- While you can install components one at a time, I recommend installing all like components at the same time. For example, insert all the resistors, bending the leads slightly to keep them in place. For a small project such as this, the group method ensures that all of the resistors are of the correct value, used correctly and in their proper location, BEFORE soldering any in place! When you have found that all is as it should be, turn the board over and solder all the leads at once, clipping off the excess leads as you go.

- When you install multi-pin components, such as an IC socket, always solder one lead at each end of the component first, check to insure the component is fully inserted in the board (not tilted to one side or one end is not fully seated), before soldering the remaining pins. It is much easier to fix a tilted socket with only one pin to heat to reposition the socket.

- When all the parts have been installed, it is time to visually check your work looking for solder bridges, parts with cold solder joints (meaning a poor connection, not having the same appearance of smooth solder flow as the other solder joints), or open, unsoldered joints. If you have an ohmmeter, check joints near each other for shorts.

- Finally, clean the solder side of the board. Many use a special flux cleaner product to clean the soldering side. Personally, I check each solder connection and use a fine screwdriver or dental pick to scrape away any flux residue, then use a slightly moistened toothbrush to remove the scraped residue. Do NOT get moisture on any sensitive parts, such as switches, sockets, the display circuitry, etc.

- The assembled units I received did not have step 20, the Test Signal Ring installed. This step is unnecessary, as you can just touch the red signal-in lead directly to either test pad of J2 for the square wave signal. If you would rather have a wire to attach to, you will need to install one yourself.

- Another difference noted between the kit described and my assembled unit is that the ‘Trigged’ LED may be either red or green.

Calibration:

Whether you assembled the kit, or bought one already assembled, you should check the calibration. Because there is always some capacitance between the scope input and the ground probe, the unit needs to be calibrated to achieve better measurement results for high frequency signals. If you change probes or probe cables to something of a different length, this becomes particularly important. The calibration can be easily done with the help of the built-in test signal at jumper J2.

The procedures are included with the kit, with color pictures, but in case you lost your instructions or the web sites are removed, I have included them here with a few pictures of my own:

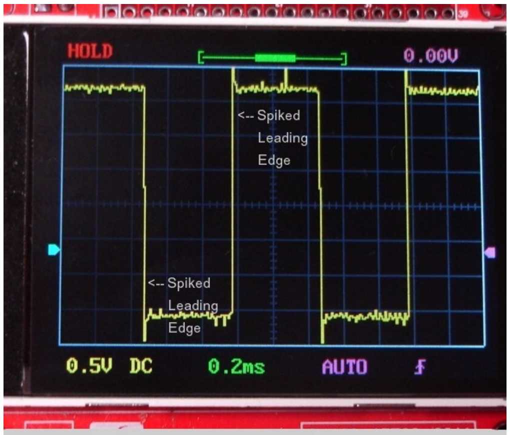
Calibration Procedures:

1. Set the [SEN1] switch to 0.1V and [SEN2] switch to X5.
2. Set the [CPL] switch to AC or DC.
3. Connect the red clip to the test signal terminal, J2, near the power connector in the upper right corner of the unit. Leave the black ground clip un-connected.
4. Adjust Timebase to 0.2ms. You should see a square waveform similar to that shown in the following photos. If the trace is not stable, adjust the Trigger Level (the pink triangle in the right screen border) until you get a stable display.
5. Turn the trimmer capacitor, C4, with a small non-metallic screwdriver, so that the waveform displays a sharp right angle in the upper and lower left corners (leading edge) of the square wave. Too much and a spike will appear at the leading edge of the waveform. Not enough and the leading edge will appear rounded.

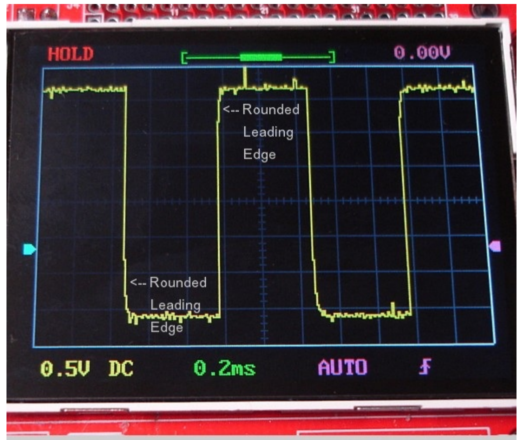
Note: These trimmer capacitors rotate through 360 degrees, generally giving two locations where the setting will be correct; one while increasing capacitance, the other while decreasing capacitance. Either location will be fine.

6. Set the [SEN1] switch to 1V and [SEN2] switch to X1. Leave all other settings unchanged.
7. Adjust the trimmer capacitor, C6, with a small non-metallic screwdriver, so that the waveform displays a sharp right angle in the upper and lower left corners (leading edge) of the square wave.

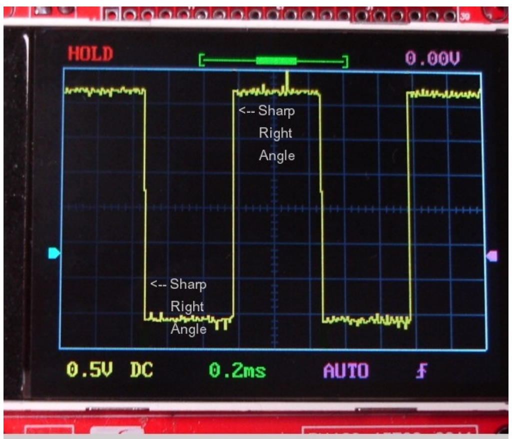
The first pictures show the affect of the trimmer capacitors on the waveform and at what point the waveform has a right angle leading edge.



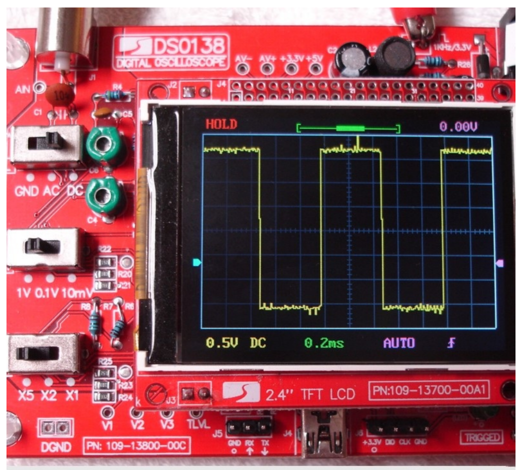
Trimmer Capacitor C4 or C6 trimmed too much.
Note the spiked leading edge of the curve.
Too Much!



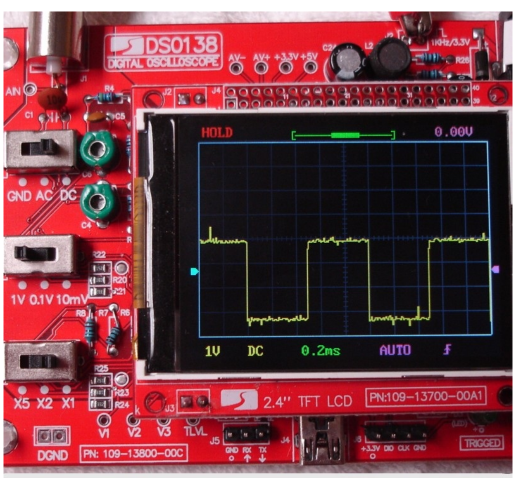
Trimmer Capacitor C4 or C6 not trimmed enough.
Note the rounded leading edge of the curve.
Not Enough!



Trimmer Capacitor C4 or C6 trimmed just right.
Note the sharp right angle to the leading edge of the curve.
Ok!

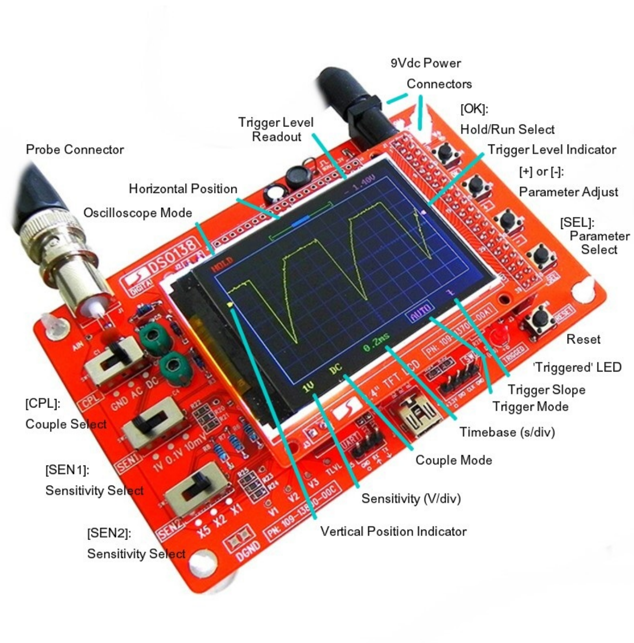


Calibrate C4 - Set [SEN1] switch to 0.1V and [SEN2] switch to X5.
Set [CPL] switch to AC or DC. Set Timebase to 0.2 ms.



Calibrate C6 - Set [SEN1] switch to 1V and [SEN2] switch to X1.
Set [CPL] switch to AC or DC. Set Timebase to 0.2 ms.

Connections and Controls:



DC Power: Connect a 9-12Vdc power source to the DC jack or attach a 9Vdc battery's leads to the white connector beside the power jack.
Do NOT exceed +12Vdc, or U5 will get hot!

Probe: Connect the oscilloscope probe to the Probe Connector. The probe is 1x and the maximum signal input voltage is 50Vpeak (100Vpp) with the clip probe.

[CPL]: The [CPL] switch sets the oscilloscope coupling to DC, AC, or GND (Ground).

Most oscilloscopes have two types of input coupling to handle both alternating current and direct current signals. Typically, a switch lets you select AC or DC to suit your measurement needs. When you set an input to DC coupling, the oscilloscope displays both AC and DC signals, although AC signals may pose a problem. By switching to AC coupling, the scope displays only AC signals; this simplifies measuring certain electronic circuits.

DC Coupling
The DC coupling setting provides a direct electrical path into the scope. It accepts all types of signals, including unchanging DC voltages, time-varying DC voltages, AC, and combinations of AC and DC. In the last case, technicians call it an AC signal with a DC offset. Sometimes, DC offsets can be bothersome; the total signal voltage may push the signal waveform past the top or bottom of the display, hiding the parts you want to see. However, under most other circumstances, DC coupling is all you need.

AC Coupling
With AC coupling, the oscilloscope's input has a capacitor in the signal path, removing DC offset from any mixed signal and letting you see the AC part more easily. For example, some transistor and vacuum-tube amplifiers have a significant DC offset; removing it with AC coupling helps you troubleshoot these circuits. Although it is most helpful with mixed signals, AC coupling also works with pure AC signals. Because it blocks DC, it is not suitable for DC signals.

GND Coupling
When GND is selected, the scope input is isolated from the input signal and is connected to ground (0V input), disabling the waveform.

[SEN1]: The [SEN1] switch adjusts the Input sensitivity between 1V, 0.1V, and 10mV (0.01V) scale. The oscilloscope's display is divided into dotted boxes, with each dotted box representing a division. The vertical scale represents the signal strength in volts; the horizontal scale represents time in seconds (more on this later). So, each box vertically represents the signal strength selected; 1 volt per division (dotted box) if 1V is selected. Each division is further divided by 5 marks and each dot represents 0.2 of a division on the display. Always start on the 1V scale, and select lower until the signal waveform fills as much of the display as possible, without losing the top or the bottom of the waveform. This improves the accuracy of signal measurements. Example: If the upper trace covers 2 divisions and 2 marks above that, on the 1V scale, the signal would be 2.4 volts peak; and if the signal were symmetric (the same above and below the center, brighter horizontal line on the display), the signal would be 4.8 volts peak to peak.

[SEN2]: The [SEN2] switch also adjusts the Input sensitivity, but uses the settings X5, X2 and X1. Some oscilloscopes use 5x or 10x probes that reduce the signal 5 times or 10 times. This switch performs the same function, allowing the oscilloscope to handle higher voltage signals. X1 feeds the Input directly (Times 1), and the signals selected by [SEN1] are as set (that is, a 1V signal is 1 volt/division). X2 feeds the Input divided by 2, so each division is doubled (that is, a 2 volt signal is scaled to only 1 division and each display division is 2 volts). Likewise X5 divides the signal by 5 and 1 division on the display becomes 5 volts.

[OK]: Along the right edge, from the top, the [OK] push button freezes waveform refresh, entering the HOLD state. The HOLD state allows you to freeze the waveform while you study it and take voltage readings. Pressing it again will unfreeze the waveform. Pressing and holding the [OK] button for about 2 seconds will turn ON or OFF the on-screen display of measurements including: Vmax, Vmin, Vavr, Vpp, Vrms, Frequency, Cycle, Pulse Width, and Duty Cycle. **Note:** You must have the Timebase active (within a blue box) for this function to work.

[+] & **[-]:** The [+] and [-] parameter adjustment push buttons are used to adjust the parameters selected by the [SEL] Select push button, the next button down.

[SEL]: The [SEL] Parameter Selection push button selects the parameter to be adjusted. The selected parameter is highlighted. It will be discussed in great detail later.

[RESET]: The Reset button at the lower right performs a system reset and re-boots the oscilloscope.

More Available Functions:

0V Line Alignment

Sometimes you may find the 0V line (the trace corresponding to 0V input voltage) does not match with the VPOS indicator at the screen's left margin. This can easily be fixed by performing the "0V Line Alignment" function.

- First, set the Couple Switch [CPL] to the GND position.
- Press the [SEL] button to make the VPOS indicator highlighted (blue)
- Hold down the [OK] button for about 2 seconds.
- The trace will align to the VPOS indicator when you release the [OK] button.

Note: You may see some residue mismatch remains at the highest sensitivity settings. This is normal.

Measurements (On / OFF)

- Timebase must be active (Value is green in a blue box)
- Hold down [OK] button for about 3 seconds.
- This will turn ON or OFF the on-screen display of measurements including: Vmax, Vmin, Vavr, Vpp, Vrms, Frequency, Cycle, Pulse Width, and Duty Cycle.

Save or Recall Waveform

Note: While this capability was listed as a feature on nearly every website I checked, I could NOT get this feature to work using any combination of switch presses. If someone has found this to work, please contact me so that I can publish an update to this capability.

Oscilloscope Waveform Display:

The waveform displayed on an oscilloscope is nothing more than a waveform's voltage over time. Hence the vertical axis shows the voltage (discussed earlier), and the horizontal axis represents time, generally in fractions of a second.

And while most waveforms are repetitive, such as the sine wave AC (Alternating Current) electrical power in our homes, the audio signal in our radios, or the picture signal in our televisions, some can be single-shot, like closing a switch in a circuit. All these signals are nothing more than a voltage value over time. However, unless there is some way to tell an oscilloscope where or when to begin displaying a repetitive waveform, the resulting signal is a very confusing changing measure of that voltage over time.

Oscilloscope Triggering

An oscilloscope's trigger function is important to synchronizing the horizontal sweep of the oscilloscope to a chosen point of the signal. The trigger control enables users to stabilize repetitive waveforms as well as capture single-shot waveforms. By repeatedly displaying the similar portion of the input signal, the trigger makes repetitive waveforms look static, giving us the opportunity to make measurements and analyze the signal.

Most oscilloscopes offer various types of trigger functions. Edge triggering is the most basic and common type, but threshold triggering is another type of trigger function that is offered both in analog and digital oscilloscopes.

Digital oscilloscopes, however, feature numerous specialized trigger settings not otherwise available in analog oscilloscopes. These triggers enable users to easily detect, for instance, a pulse that is narrower than usual. Such a condition would not be detected by a voltage threshold trigger only. Advance trigger controls allow users to isolate events of interest to enhance the oscilloscope's record length and sample rate. Some oscilloscopes even offer advanced triggering capabilities with highly selective control, allowing users to trigger on pulses defined by time (such as glitch, pulse width, setup-and-hold, slew rate and time-out), defined by amplitude (runt pulses), and delineated by pattern or logic state (such as logic triggering). Other advanced triggering functions may include serial pattern triggering, A&B triggering, trigger correction, search and mark triggering, parallel bus triggering and serial triggering on specific standard signals.

However, our simple oscilloscope can only trigger on a voltage that we set. Triggers are events that indicate signal voltage crossing a set level (i.e. trigger level) along a specified direction (i.e. trigger slope, rising or falling).

Our oscilloscope has three trigger modes:

Auto Mode - In Auto Mode our oscilloscope will perform display refresh no matter if triggers happen or not. When triggers are detected, the waveform display will be displayed with reference to trigger points. Otherwise, it will display whatever waveform is detected, but at random reference points.

Normal Mode - In Normal Mode our oscilloscope will only perform display refresh when there are triggers. If no triggers happen, the waveform display will stay unchanged.

Single Mode - In Single Mode our oscilloscope works in Normal Mode, except that the display will enter HOLD state after a trigger has been detected and the waveform display has been updated.

Note: Both Normal and Single Modes are useful for capturing sparse or single waveforms.

Note: The LED at the bottom-right corner (labeled 'Triggered' above, or 'Trigged' on the board) is the trigger indicator. It blinks when triggers are detected.

DSO138 Oscilloscope Operation:

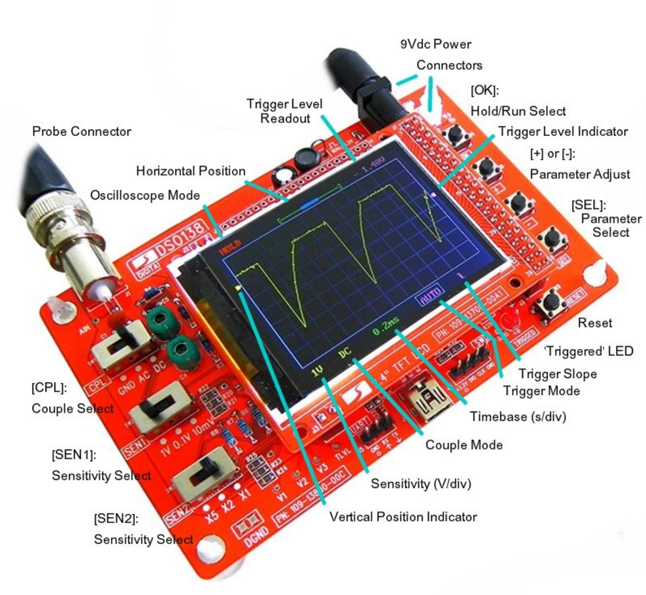
Operation is simple, but will take some getting used to. There is no ON/OFF switch. Plug in the 5-9Vdc power supply or a 9v battery (you may need to construct or modify a 2-pin adapter) and the device turns ON. The DSO138 Oscilloscope will display two screens while powering up (booting):

And then display whatever waveform that may be present at the Oscilloscope's Input.

With my old analog oscilloscope, I just had to adjust a few knobs and I was in business. However, with this and I guess most, if not all, digital units, you need to select the parameter you wish to adjust, then adjust it with the up & down controls, and select the next parameter. On this oscilloscope you find the Parameter Select [SEL] button located at the lower right edge of the board.

This important button gives you the ability to change the several screen display parameters. Each press of the [SEL] button changes the screen display parameter to the next parameter in a counterclockwise direction. As each parameter is selected, that parameter turns to a blue color or is placed in a blue box.

We will begin with the Timebase at the bottom center of the screen.



Timebase (s/div): Timebase is the horizontal axis of the display. As we discussed regarding the voltage (Vertical) axis, each division is the dotted square, but horizontally, and each dot represents 0.2 of the next division. When selected, Timebase appears green in a blue box. When the Parameter Adjust buttons are pressed, its value changes from the lowest of 10us to the highest of 500s, in the following values:

10us, 20us, 50us,
0.1ms, 0.2ms, 0.5ms,
1ms, 2ms, 5ms,
10ms, 20ms, 50ms,
0.1s, 0.2s, 0.5s,
1s, 2s, 5s,
10s, 20s, 50s,
100s, 200s, 500s

Where us is microseconds, ms is milliseconds, and s is seconds.

Trigger Mode: The Trigger Mode, [AUTO], [NORM], or [SING], is displayed in pink on the bottom row of the display any time a Trigger Mode has been set. When selected, Trigger Mode appears pink in a blue box.

Trigger Slope: A Trigger Slope symbol (rising or falling) will be displayed in the lower right corner of the display to show the desired slope of the trigger. When selected, the Trigger Slope symbol appears pink in a blue box.

Trigger Level Indicator: In addition to the Trigger Level Readout displayed in the upper right corner of the screen, a Trigger Level Indicator (triangle marker) is displayed in the right margin of the screen at the appropriate voltage selected. When selected, the Trigger Level Indicator (triangle marker along the right edge of the screen) changes color from pink to blue. The **Trigger Level Readout** in the top right corner of the screen remains pink, but will change to display the trigger level we have selected.

Horizontal Position Indicator: Located at the top center of the screen display, the Horizontal Position can be adjusted along the horizontal axis so the first point the waveform curve crossing the horizontal centerline is at the left margin of the display. This permits easier calculation along the horizontal (Time) axis for determining period, or frequency of the waveform. One cycle period occurs from the first crossing of the center horizontal axis (set at the left margin, either up or down) to the next time the curve crosses the horizontal axis while headed in the same direction. When selected, the Horizontal Position Indicator (the long, thick bar in the center of a long line representing the horizontal axis) at the top center of the display will change color from green to blue. Pressing the [+] or [-] Parameter Adjustment buttons will move the waveform left or right until the waveform is beginning at the desired place at the display's left edge.

Vertical Position Indicator: Located at the left edge of the display screen, the Vertical Position Indicator is a triangle in the left margin of the display and can be adjusted up or down in an attempt to be able to see the entire waveform. If the waveform is still too tall to see, change [SEN1] or [SEN2]. When selected, the Vertical Position Indicator (triangle marker along the left edge of the screen) changes color from yellow to blue. Pressing the [+] or [-] Parameter Adjustment buttons will move the waveform up or down until both the top and bottom of the waveform can be seen at the same time.

The next press of the Select Switch brings us back to the Timebase parameter. However, we still have a few remaining display parameters around the screen:

Oscilloscope Mode: The Oscilloscope Mode is at the top left corner of the screen. It will display HOLD in orange or Running in green and alternates between the two settings when the [OK] button is pressed.

Trigger Level Readout: Located in the top right corner of the screen, the Trigger Level Readout reflects the voltage level selected by adjustment of the Trigger Level Indicator in the right margin of the display screen.

Couple Mode: The Couple Mode is displayed in the bottom left corner of the display. It is set by the [CPL] switch to DC, AC, or GND (Ground). Please see the [CPL] switch discussion above for further information on oscilloscope coupling.

Sensitivity (V/div): The Sensitivity of the vertical axis, as set by [SEN1] and [SEN2], is displayed in the bottom left corner of the display. The sensitivity is adjusted to show as much of the waveform vertically as possible, the goal being to display the waveform as tall as possible without cutting off the top or the bottom. You can adjust the Vertical Position Indicator, using the [SEL] button and [+] or [-] Adjustment buttons, to move the waveform up or down as needed.

Finally, we have one other important indicator:

Triggered LED: A 'Trigged' LED at the bottom edge of the board will light any time that the Trigger Level has been reached and the new waveform displayed.

What is a Waveform?

As we briefly mentioned earlier, the waveform displayed on an oscilloscope is nothing more than a waveform's voltage over time. Hence the vertical axis shows the voltage, and the horizontal axis represents time, generally in fractions of a second.

Most waveforms are repetitive. For example, a sine wave (such as 120VAC house voltage) crosses the horizontal axis in a positive direction, then at the positive peak, starts down again, crosses the axis and heads to a negative peak, where it starts heading up again to cross the axis for a second time, but in a positive direction again. A half cycle covers just the positive side (upper part of the curve) or the negative side (lower part of the curve). The entire cycle or period of the wave is the length of time to cover both the positive AND the negative part of the curve (to the exact same position in the next cycle). It does not matter which part of the curve is first (negative or positive), nor does it matter if the negative portion has the same appearance as the positive portion, as long as the period covers both segments of the curve. Also, the cycle can begin at any point in the curve to the next corresponding similar point in the curve.

As another example, the period or cycle of the wave in our picture showing the oscilloscope controls, is the time between each negative peak (the wave has both positive going and negative going signal, but need not actually go negative in voltage), and the waveform is similar at each of these points.

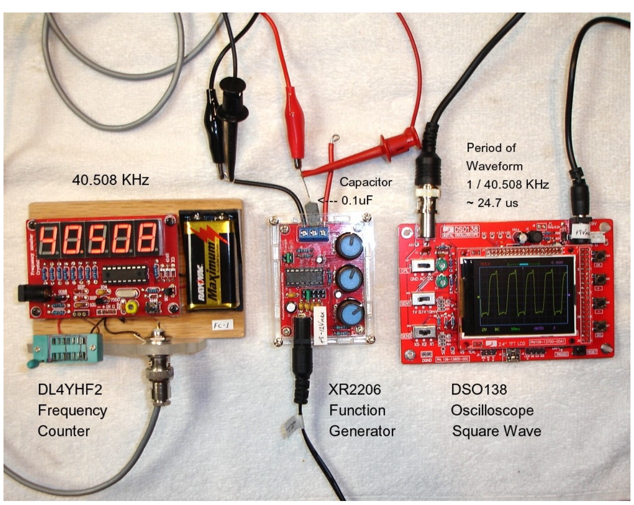
The oscilloscope allows us to measure a waveform using a time scale (the horizontal axis) with the scale determined by the Timebase, measured in us (microsceonds), ms (milliseconds) or s (seconds). The cycle mentioned above is called the period of the wave. From the period of a wave, we can determine the wave's frequency, using the formula:

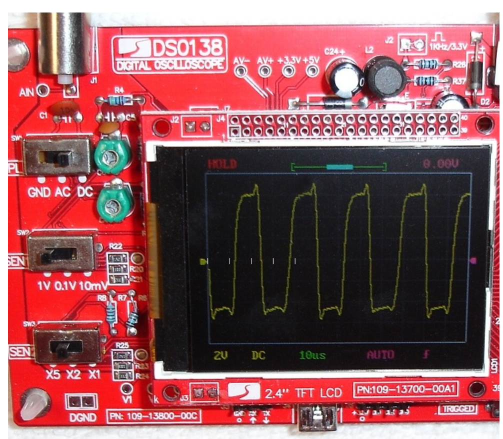
Frequency = 1/Period(or cycle)	or	Hertz = 1 Cycle/1 second (s)
		KHertz = 1/millisecond (ms)
		MHertz = 1/microsecond (us)

Similarly:

Period = 1/Frequency	or	Period (seconds) = 1/Hertz
		Period (mseconds) = 1/Khertz
		Period (useconds) = 1/Mhertz

For example, let us try out our new oscilloscope with some of our previous kits:





The 40.508 KHz Square Wave is heavily distorted from the capacitor added to the Function Generator (see text), but you can still figure the waveform period, ~ 24.7 us.
Note: I added the white marks for clarity.

As you can see, I'm using our DL4YHF2 Frequency Counter, our XR2206 Function Generator (set for a 40.5 KHz square wave), and our new DSO138 Oscilloscope to show the waveform. However, when I first put this circuit together, I was very disappointed with the DL4YHF2 Frequency Counter. While the oscilloscope showed that the waveform was nicely square and stable, the frequency counter would not stabilize, if I got a frequency at all. Yet when I used the frequency counter to test an oscillator, it was nicely stable at the correct value.

Looking at the circuit diagram for the DL4YHF Frequency Counter, I saw that the circuit for the crystal & oscillator tester used a 0.1 uF capacitor to eliminate any unwanted DC voltage. But for the input of external frequencies, a capacitor was not included. Perhaps a cyclic DC voltage was confusing the counter? So, on a whim, I included the 0.1 uF capacitor at the output of the generator.

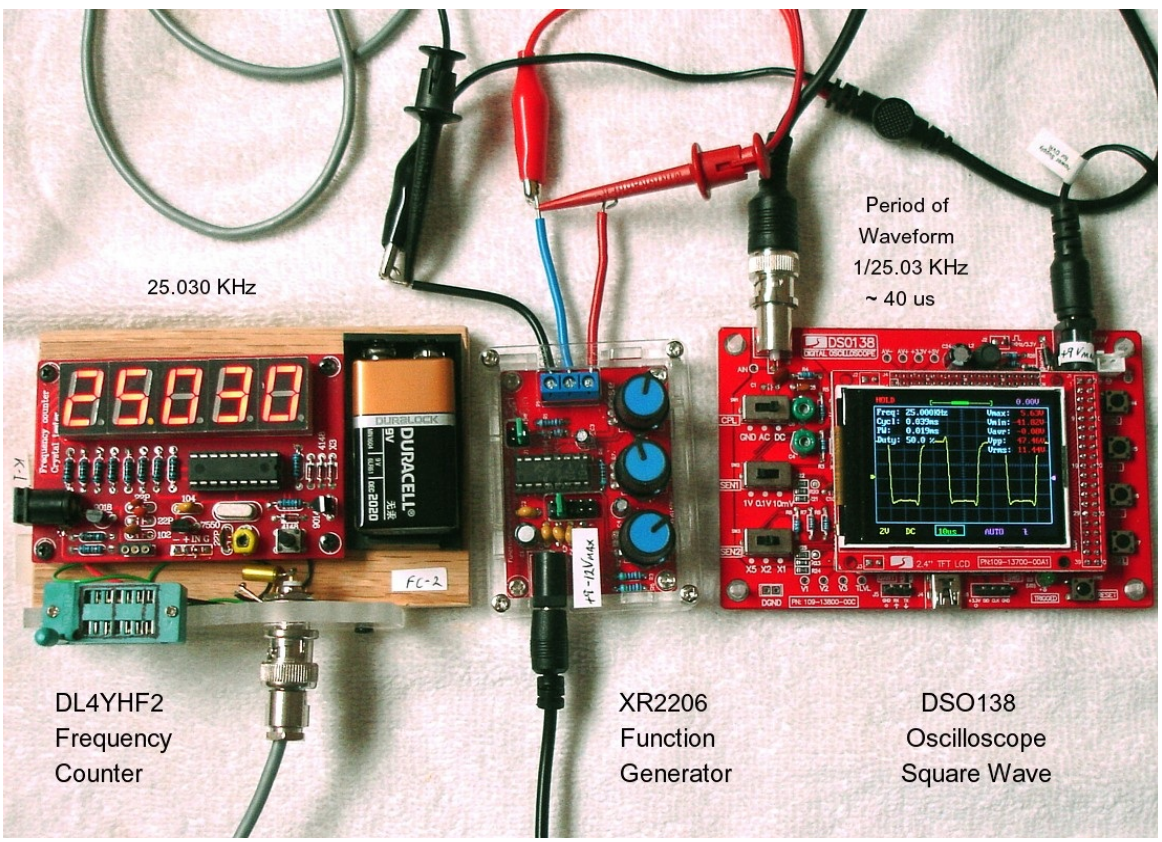
The capacitor fixed the unstable counter, as you can see - a nice solid 40.508 KHz display, but the waveform was distorted by the charging and discharging capacitor.

When I moved the capacitor to the input of the frequency counter, between the input jack and the circuit board, both the counter and the oscilloscope were happy. I have corrected the DL4YHF2 article to reflect this new information.

Regarding the frequency and period? As you can see, the frequency is 40.508 KHz and from the oscilloscope with the Timebase on the 10us scale, we get about 24.7us.
Our formula shows:

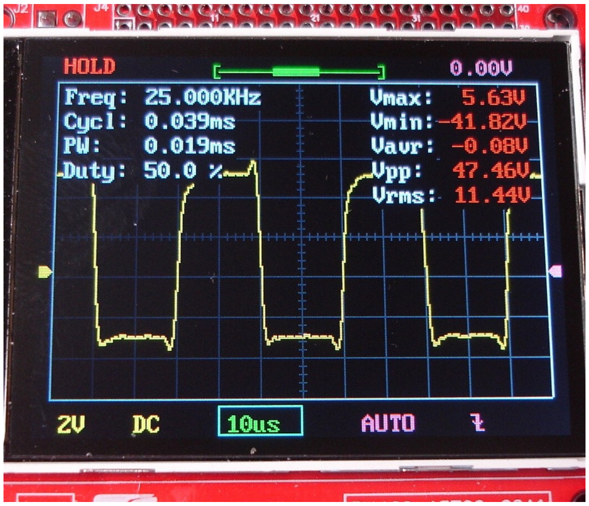
Period = 1/Frequency or 24.7us = 1/40.508 KHz

But, the DSO138 Scope has the capability to report these measurements and more, automatically! I saved this capability for last, because I did not believe that such a low priced piece of test equipment could provide this. Here is an example of 25KHz.



I'm sorry I forgot to set the waveform horizontally for getting the period in our photo, but our calculations show that at 25KHz, our period should be about 40us.

Here's a closeup of the wave and the automatic measurements:



To display the stats, you must be in Timebase mode, as shown, then press the [OK] button for two seconds.

As you can see, my manual calculation of the period was reasonably correct. The difference being the frequency displayed by either the frequency counter or this scope is slightly different.

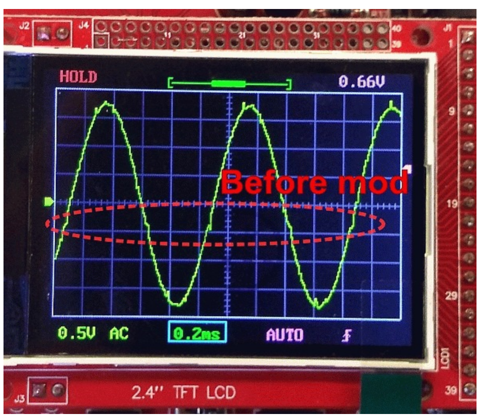
To remove the stats from the display, press the [OK] button for 2 seconds again.

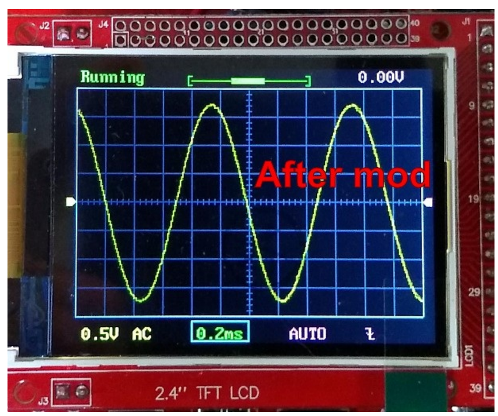
Note: As you can see, both of my units would display an excessive negative Vmin when I first turned the units on. I have found that if you change the Timebase to something longer - 50us minimum, the display will become correct and remain so thereafter, and you can return to 10us.

Final Considerations:

Modification to Reduce Waveform Glitches:

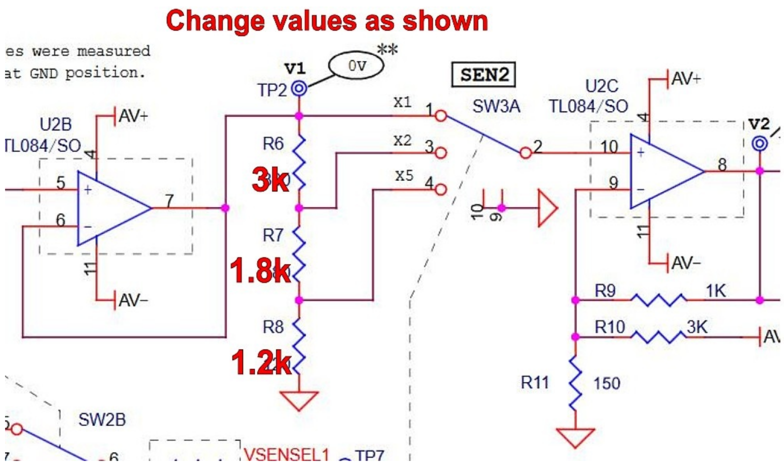
When viewing large signals you may have noticed glitches on the waveform - left photo.





This is caused by excessive loading of U2B by the potential divider R6/7/8. The solution is easy: Replace R6, R7 and R8 with resistors ten times greater in value, i.e. R6 = 3k, R7 = 1.8k, R8 = 1.2k. The right photo shows the waveform after the modification.

Note: I found this modification on the internet, with a few other modifications. I have performed this mod and the photo showing the measurements on the display was taken after the mod was complete. The new resistors are not popular sizes and the old resistors were a pain to remove. So, I do not consider the improvement in the waveform was worth the effort, especially if you do not have excellent soldering skills.



Acrylic Case:

Once the calibration is complete, you are ready to go. There is an excellent acrylic case available on line for about $15.00 that provides a finished look to the project and provides some protection for the exposed parts. As before, IoT experiments provides excellent assembly procedures at:

iot-experiments.com/dso138-acrylic-case/

Save or Recall Waveform:

While this capability was listed as a feature on nearly every website I checked, I could NOT get this feature to work using any combination of switch presses. If someone has found this to work, please contact me so that I can publish an update to this capability.

Summary: The DSO138 Oscilloscope makes an excellent, useful addition to your electronic toolbox for a reasonable price. I hope you find this document helpful.

Steven W. Vagts, Editor, "*Z-100 LifeLine*"

If you have any comments, corrections, changes, or thoughts, feel free to contact me at:

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