JYETech model 15001 Digital Storage Oscilloscope (DSO)

User's Manual

The model 15001 is a Digital Storage Oscilloscope (DSO) produced by JYETech (www.jyetech.com) apparently based on an open source design by others. It is available assembled from JYETech under that model number, and in different kit versions, including the 15001K (surface mount parts pre-soldered) and 15002K (surface mount parts must be soldered by the kit builder). Other sellers of this open source design offer variations on the same basic oscilloscope as bare boards (no case), and with possibly different software versions/features.

Specifications:

- Maximum real time sample rate: 1MSa/s (one million samples per second)
- Record length: 1024 points (capture buffer size)
- Resolution: 12 bits
- Analog bandwidth: 0 ~ 200kHz (author's suggested sampling bandwidth only ~ 20kHz)
- Input impedance: 1MΩ, 20pF
- Maximum input voltage: 50Vpk (using 1X probe) [100Vpp]
- Sensitivity range (vertical): 5mV/div ~ 20V/div
  - Per division: 5mV, 10mV, 20mV, 50mV, 0.1V, 0.2V, 0.5V, 1V, 2V, 5V, 10V, 20V
- Timebase range (horizontal): 10µs/div ~ 500s/div
  - Per division: 10µs, 20µs, 50µs, 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
- Trigger modes: Auto, Normal, Single
- Trigger position (default): Center of buffer
- Test signal output (1kHz square wave, either 0.1V or 3.3V, user selectable)
- Power supply: 9VDC (+/- 1V), ~120mA, via 5.5x2.1mm barrel connector (power supply is not included) – *power supply voltage in excess of 10V may damage internal circuitry*
- Dimensions (of case): 105 (H) x 75 (W) x 22 (D) mm [4.13 (H) x 3 (W) x 0.87 (D) inches]
- Weight (without probe/cable and power supply): 100g [3.5 oz]

Controls:

- Power switch (OFF/ON)
- Input coupling switch (GND/DC/AC)
- Vertical control pushbutton [V/DIV]
- Horizontal control pushbutton [SEC/DIV]
- Trigger control pushbutton [TRIGGER]
- Hold/Run/Measurements pushbutton [OK]
- Adjustment knob, also functions as a pushbutton [ADJ]
- Display: LED backlit color TFT LCD, 63mm [2.5"] diag., 51W x 38H mm [2W x 1.5H"]

Basic Operation

- Vertical
  - Attach a suitable scope probe (not included), or the included test cable, to the BNC connector on the top panel of the scope. The DSO comes with a simple test cable with short unshielded leads ending in insulated alligator clips. The user may also optionally connect a conventional oscilloscope probe to this BNC connector; an inexpensive 1X probe is probably best, although a more professional 1X/10X probe may also be used (just note that if the probe is set to 10X, that all voltage readings on the display will be 1/10 of the actual voltage at the probe….the scope does not have the ability to detect the 10X setting on the probe).
  - Connect the probe/cable to the desired voltage/signal source.
  - Select the appropriate input coupling, using the AC/DC/GND switch on the top panel of the scope. In most cases, the DC setting will be appropriate, and "DC" will appear on the bottom of the display and immediately to the right of the vertical sensitivity setting value; having the switch setting displayed here avoids the user needing to turn the scope so that the switch position on the top panel can be viewed. The "AC" setting will couple the signal from the input BNC connector via a small capacitor, effectively blocking any DC component of the signal and thus allowing only the AC component to be viewed; "AC" is displayed. The "GND" setting is mostly used when doing a vertical position alignment (see the fourth paragraph below); "GND" is displayed.
  - Press the V/DIV button once to highlight the vertical sensitivity value, which is located on the bottom edge of the display, directly above the V/DIV pushbutton.
  - Turn the ADJ knob to select from any of the 12 choices from 5mV/div ~ 20V/div; the highlighted value will change. The values do NOT roll over at the extremes.
  - Press the V/DIV button again to remove the highlight from the vertical sensitivity value. The scope remembers that the most recent activity was with 'vertical', so rotating the ADJ knob will now change the vertical position. *If you wish to change vertical position but the ADJ knob does not do this, press the V/DIV button to select vertical sensitivity and then press it again to de-selected it; the scope will now use the turning of the ADJ knob for vertical positioning.*
  - Note that at the extreme left edge of the display is a small arrowhead pointer, which always shows where the scope thinks 0 Volts is within the captured data. Normally, this pointer will be YELLOW, but when vertical position is adjustable using the ADJ knob, this pointer will be CYAN (light blue).
  - To reset the vertical position alignment, set the input coupling switch to GND, then press and hold the V/DIV button for approximately 3 seconds, after which a message will appear on the display about updating vertical position, and when the message disappears after a couple of seconds, the scope will return to operation.
  - Pressing and holding the OK button for approximately 3 seconds will overlay the measurements of the currently displayed waveform, so that the measurements appear on top of the waveform display. Measurements include values such as Frequency (Freq), Period (Cycl), Duty Cycle (Duty), Vmax (highest voltage level

of the current waveform), Vmin (lowest voltage of the current waveform), Vavr (average voltage of the current waveform), Vpp (voltage from top peak to bottom peak of current waveform), Vrms (RMS, Root-Mean-Square), or effective value of the total displayed waveform. This action will freeze the displayed waveform at the most recent sample, in order to provide the most stable and legible measurement text; the display will show the HOLD message in the upper left corner. Pressing the OK button briefly will return the scope to RUNNING (this replaces the HOLD message), but the measurements will remain; since the sampling is not continuous, the measurement values will appear somewhat jittery. Pressing OK again briefly will toggle between HOLD and RUNNING, and pressing and holding OK for a few seconds will remove the measurements from the display.

- Horizontal
    - Press the SEC/DIV button once to highlight the horizontal timebase value, which is located on the bottom edge of the display, directly above the SEC/DIV pushbutton.
    - Turn the ADJ knob to select from any of the 24 choices from 10µs/div ~ 500s/div; the highlighted value will change. The values do NOT roll over at the extremes.
    - Press the SEC/DIV button again to remove the highlight from the horizontal timebase value. The DSO remembers that the most recent activity was with 'horizontal', so rotating the ADJ knob will now change the horizontal position. Note that in most cases, there is more data stored in the capture buffer that what can be displayed with the currently selected horizontal timebase setting. At the top center of the display is a small bar-graph, which depicts the entire capture buffer as a thin horizontal line, and the part of that buffer which is currently displayed is depicted as a thicker portion of the line. As the horizontal position is changed by turning the ADJ knob, the thick portion of the bar-graph will slide left or right on the narrower portion of the line, depicting the portion of the capture buffer is currently being displayed. *If you wish to change horizontal position but the ADJ knob does not do this, press the SEC/DIV button to select horizontal timebase and then press it again to de-selected it; the scope will now use the turning of the ADJ knob for horizontal positioning.*
    - To center the horizontal position display, press and hold the SEC/DIV button for approximately 3 seconds, after which a message will appear on the display about updating horizontal position, and when the message disappears after a couple of seconds, the scope will return to operation. The data at the center of the data capture buffer will displayed until the user again adjusts horizontal position.

- Triggering
    - There are three aspects to triggering: Trigger Mode, Trigger Slope, and Trigger Level. Each aspect is addressed below. Pressing the TRIGGER button alternately selects from highlighting Mode, or highlighting Slope, or when neither Mode nor Slope is highlighted, the Level is selected.

- Trigger Mode: When highlighted, turn the ADJ knob to change the selection between AUTO, NORM, SING (Single 'sweep').
    - If trigger mode = SING (Single Sweep), press the OK button to reset, then the scope will show RUNNING at the upper left corner of the display, and WAITING at the upper right corner of the display; this means that the scope is actively looking for the specified trigger condition to be met. As soon as the specified trigger condition has been met, the scope will sample the input signal for one 'sweep', which in this case means until the 1024 point capture buffer is full, after which the scope will show HOLD on the display's upper left corner, and TRIGGED at the upper right corner, and the waveform of the captured data will be displayed. The scope will now remain in HOLD until the user resets this mode by pressing the OK button again. Repeat this process for each single sweep capture.
    - If trigger mode = NORM (Triggered Sweep), then the scope will show WAITING at the upper right corner of the display. As soon as the specified trigger condition has been met, the scope will sample the input signal for one 'sweep' (it fills the capture buffer with sampled input data) and displays it; TRIGGED replaces WAITING, but quickly the scope needs to see another trigger before repeating the above process and updating the capture buffer and the display with new data. Assuming that the scope is connected to a source of a regular AC signal, the re-triggering should occur regularly, and the scope will constantly re-sample, updating the capture buffer and display; this should produce a stable display of AC signals. NORM mode is what older analog scopes called 'Triggered Sweep', and as long as the signal at the scope's input is regular AC and periodic in nature, this is a good mode to be in for 'normal' visualization of the input signal. However, if a DC signal is present at the scope's input, then there can be no triggering, and NORM mode will result in no input data sampling and no displayed voltage/waveform (the display will show WAITING); use AUTO mode in this instance.
    - If trigger mode = AUTO (Automatic Sweep), then the scope automatically triggers itself on a periodic basis according to the horizontal timebase setting (ie, the automatic triggering will happen more frequently if the horizontal timebase is selected to a faster time interval). This mode is necessary when the input signal is a DC voltage, which will not trigger a 'sweep' (re-sample of input data). For many situations, AUTO will work just as well as NORM mode when measuring AC signals, however since the AUTOmatic triggering is arbitrarily occurring, the displayed waveform of an AC signal might look more jittery or unstable than would be the case if the scope were in NORM triggering mode.
- Trigger Slope: When highlighted (EDGE), turn the ADJ knob to change the selection between 'falling edge' (negative slope) [display icon looks like a short vertical line with a tiny arrow pointing down], or 'rising edge' (positive slope)

[display icon looks like a short vertical line with a tiny arrow pointing up]. Note that Trigger Slope cannot be changed while in some of the Trigger Modes.
    - If 'falling edge' is selected, then the scope will trigger on the input signal's falling edge; this is best for waveforms with a square shape.
    - If 'rising edge' is selected, the scope will trigger on the input signal's rising edge; this is best for waveforms with a square shape.
  - Trigger Level: When neither Trigger Mode (AUTO/NORM/SING) or Trigger Slope (EDGE) is highlighted, the user can turn the ADJ knob to adjust the Trigger Level. The specific trigger level voltage is displayed numerically at the lower right corner of the display, and a MAGENTA colored arrowhead pointer along the display's right edge shows the trigger level relative to the vertical display. At any time when the ADJ knob is NOT able to adjust the Trigger Level (because it has been selected to adjust some other setting), the pointer will be CYAN (light blue) in color. *If you wish to change trigger level but the ADJ knob does not do this, press the TRIGGER button once to select mode AUTO/NORM/SING, press it again to select EDGE and then press it again to de-selected either of those; the scope will now use the turning of the ADJ knob for trigger level positioning.*
  - In addition to the 'trigger state' descriptions of WAITING and TRIGGED above, the scope may also display HOLDOFF, which means that triggering is disabled until the portion of the sample buffer prior to the trigger point has been filled with new data; at slower horizontal timebase settings, this might take a while. Also, to clarify further, WAITING means that the trigger function is waiting for a valid signal slope (rising or falling) to occur.

- Adjustment Speed
  - When turning the ADJ knob to adjust a continuously varying level, such as vertical position, horizontal position, or trigger level, it normally takes many turns of the ADJ knob to make larger adjustments.
  - When larger adjustments are required, it can be more convenient to have the ADJ knob affect a greater speed of change of the value. A short press of the ADJ knob will toggle between normal speed and fast speed. When fast speed is selected, ">>" will appear at the top of the display to the left of center; when normal speed is selected, nothing will be shown at this display position.

- Storage
  - The data in the capture buffer is lost when the scope power is turned off. However, the scope has a non-volatile storage EEPROM which can store the full 1024 point capture buffer for later retrieval.
  - To save the currently displayed waveform (capture buffer contents) to EEPROM, press the ADJ knob and the SEC/DIV button simultaneously; any previously stored waveform data will be overwritten.
  - To recall the waveform data stored in the EEPROM, press the ADJ knob and the TRIGGER button simultaneously. The scope will be put into HOLD mode, and the

display will show the stored waveform. Pressing the OK button will return the scope to RUNNING mode, and the recalled stored waveform will be replaced with a waveform display of the newly sampled analog signal data, and the scope is back to normal operation.

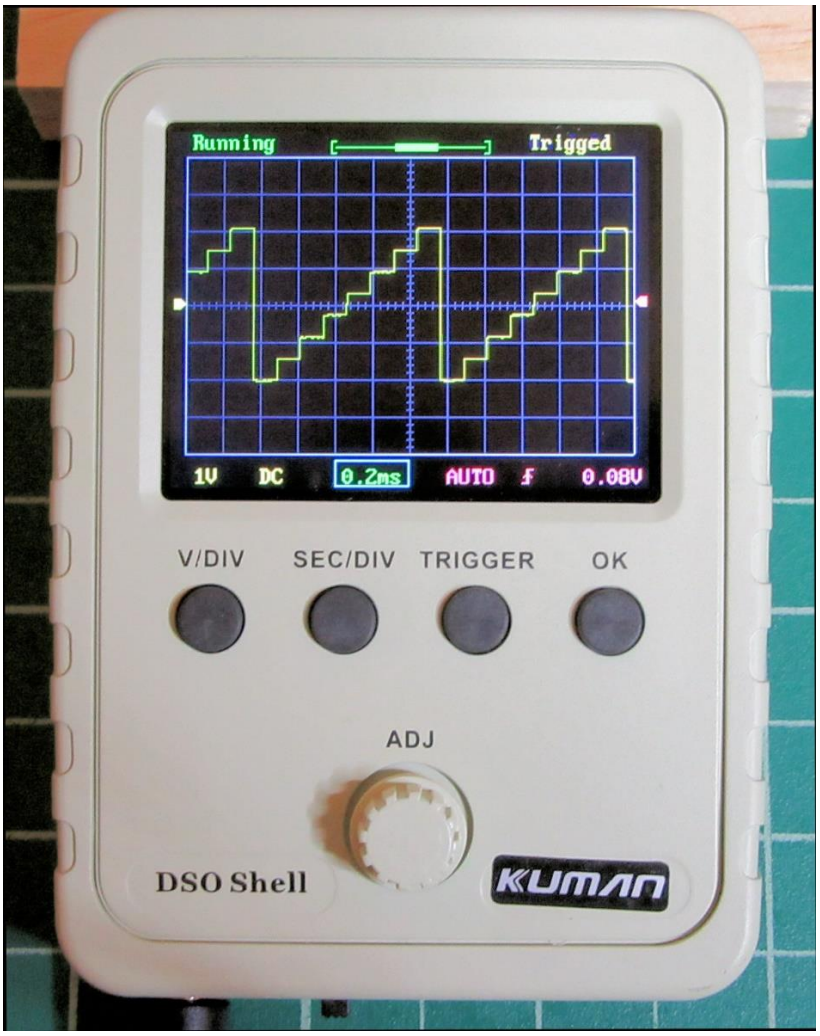
- Restore Defaults
  - Pressing and holding the SEC/DIV button and TRIGGER button simultaneously for about 3 seconds will result in all scope settings (except for input coupling, which is done using a physical switch) to their defaults.

- Serial
  - The 15001 kit does not come with a connector for the serial port, however there are four holes on the Main Board (printed circuit board) marked 'J5'. The user may optionally wire these four signals out to a connector on the scope's case. According to the JYETech included short-form manual, the serial port functionality is implemented, but since the kit does not seem to support this, and since the author of this enhanced User's Manual has not tried it, actual functionality/utility of this feature is uncertain.
  - Note that the voltage levels on the serial port are 3.3V instead of 5V. The user will need to obtain a suitable serial cable, such as the common USB-Serial cables often used for Arduino and other small single board computers, and a terminal emulator software application, or equivalent, for a personal computer to be connected to the scope via the serial port, and since most of those cables assume 5V logic level serial signals, the user will probably also need to add any of the common 5V-3.3V serial converter modules.
  - On Main Board 'J5', pin 1 is the 3.3V power to the adapter on the serial cable, pin 2 is circuit ground (GND), pin 3 is Receive (RX), and pin 4 is Transmit (TX).
  - The terminal emulator (or other application) running on the personal computer to which the USB-Serial cable is attached must be set for 115200 Baud, 8 data bits, No Parity, 1 Stop Bit (8N1).
  - On the scope, pressing the ADJ knob and the V/DIV button simultaneously will send a block of text out the serial port. The text will consist of the numerical values of the scope's entire 1024 point capture buffer. This data may be optionally saved, or formatted to appear as the signal waveform and printed, etc.

- Test Signal
  - The scope generates its own test signal, which is normally used during calibration, but which may be used to adjust a normal oscilloscope probe that may be used with the scope in place of the provided test cable, and/or which may be used as a signal source to demonstrate the scope (to give it something to display).
  - Connect the probe tip, or test cable's positive (red colored) clip, to the small metal tab located at the center of the scope case's top panel, and marked '1kHz'; it is not

necessary to connect the probe's/cable's ground clip to anything, since it is already electrically common with the scope's internal test signal generator circuitry.

- If already turned on, turn the scope off briefly. Turn the scope on, and wait for it to boot up and show the normal display. Press the hold the ADJ knob for about 3 seconds until the blue test signal message appears at the lower left of the display.
- Put the ADJ knob once so that the test signal message shows 0.1V; change the vertical sensitivity to 50mV, and the scope should now be monitoring and displaying its own 1kHz square wave test signal with an amplitude of 0.1V. The user may wish to further to adjust the vertical sensitivity to get the desired display of the waveform; the horizontal timebase and triggering should already be at appropriate settings by default, but adjust them if necessary.
- Push the ADJ knob again so that the test signal message shows 3.3V; change the vertical sensitivity to 1V, and the scope should now be monitoring and displaying its own 1kHz square wave test signal with an amplitude of 3.3V.



Colophon

This manual was written on May 3, 2020 by Paul Schmidt. Its content is all original, not borrowing verbatim from other sources. However, the details are based on information in the JYETech "DSO Shell DIY Kit User Manual Rev. 09", the JYETech website, and on empirical experimentation with an actual model 15001 DSO built by the author.

In general, the author assumes that the reader has at least a basic familiarity with the use of, operation of and features of typical oscilloscopes; this document is not intended to be a beginner's tutorial. However, basic descriptions are given for most functions in the course of discussing the use of the controls and display.

This document includes some of the author's personal opinions and thoughts, based on direct experience with this oscilloscope, e.g. the author's suggestion that limitations of this scope's relatively simple design result in it not being able to reliably, or meaningfully, display waveforms all the way up to the specified *analog* bandwidth of 200kHz; this is due to the scope's relatively low sampling rate and other factors. The author noticed some significant aliasing at signal frequencies above 50kHz, resulting in the suggestion that this scope be best used for lower bandwidths, such as audio frequencies. The author suggests that this scope NOT be used as a replacement for a proper commercially available full-sized oscilloscope, except perhaps for the most basic applications. Other individuals might come to different conclusions.

The author suggests that individuals reading this document prior to purchase of a scope of this type should make their own determinations based on all available information, not just this single document.