UPennOSCOPE

A Low cost wireless Oscilloscope and Function Generator

(V0.2) January 2021

The UPennOSCOPE is an ESP32 based tool requiring only wires to act as probes and a smartphone or laptop with WiFi to interface wirelessly to the device.

Functions

The device supports all standard oscilloscope functions including:

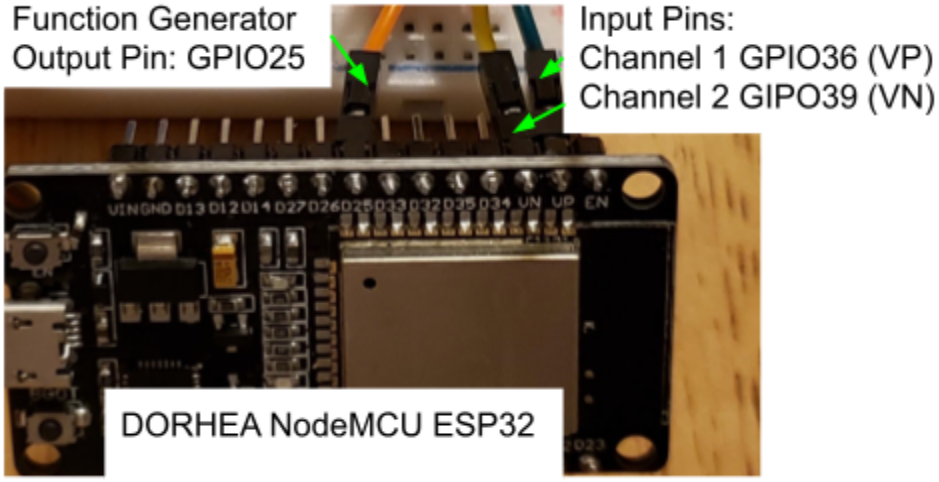
- Horizontal (time) scale adjustments (2uS per division to 100mS per division, where there are 10 divisions across the screen).
- Vertical (voltage) scale adjustments (10mV per division to 4V per division, where there are 8 divisions across the screen) for each channel
- AC coupled mode for each channel.
- Triggering on either channel on either rising or falling edge.

- Normal analog reading can measure up to 3KHz signals with 6KHz bandwidth. Digital (logic level) mode can measure up to 100KHz signals.

In addition, an integrated function generator can generate

- 3.3V logic level output square wave from 2Hz to 300KHz with varying duty cycle at 8bit resolution
- Sine wave from 16Hz to 300KHz at average 2Hz accuracy (off by 8Hz worst case) and varying resolution with varying amplitude and offset.

Using UPennOSCOPE



UPennOSCOPE input uses GPIO 36 (A0) labeled VP on DORHEA NodeMCU ESP32 and GPIO 39 (A3) labeled VN. The function generator uses GPIO 25 labeled D25 as the output.

The device creates a wifi access point labeled "**UPennOSCOPE**". Switching a smartphone or laptop wifi to that network, then setting a browser (known to work well on Chrome) to **192.168.1.2** will bring up the interface.

Hooking up the output pin 25 to one of the inputs, we can explore the function of both.

Adjusting the trigger level (the slider under the trigger section) such that the dotted red line crosses the selected channel line will align the signal with the trigger indicator (the small triangle at the top of the display). A red triangle indicates the trigger has not found the signal. A green triangle indicates the signal is triggered. The small number below the triangle indicates which channel is being used for the trigger.

Adjusting the slider on the horizontal panel shifts the trigger point which effectively slides the wave form left or right. Adjusting the slider on the vertical panel shifts the ground point, effectively moving the waveform up or down.

For 2-channel operation, the second channel should be selected (the radio button next to “Channel 2”. When Channel 2 is selected, all input on the voltage or trigger panels will apply to Channel 2. Turn the display on for channel 2 by pressing the “Run” button. It will be pink if that channel is not being displayed. It will turn green when that channel is being displayed.

The Function Generator has two waveforms. The square wave is a 3.3V logic level output with adjustable duty cycle. The sine wave has adjustable amplitude and offset.

Caveats

Fast signals (>3Khz) are not displayed well in the analog mode. The ADC cannot run fast enough to get faster resolution data. In digital mode (pressing the “Digital” button so it turns green on the display)

The wireless interface responsiveness is not perfect. Sometimes button presses will be missed. If buttons are pressed to quickly, the system may become desync’ed. Especially the channel select buttons.

Displaying two channels at once slows down the data acquisition significantly both due to the longer ADC and the wireless transfer of the data. Signals over 1Khz start to be rough.

The function generator sine wave has a trade-off between finding accurate frequencies and smooth curves (higher resolution). At integer multiples of about 15 or 16Hz the signal is at highest resolution. The amplitude has only 4 levels (100%, 50%, 25% and 12.5% of full (3.3V)). The square wave PWM at 100% has some glitches.

AC coupling puts a digital high pass filter on the signal. So, for slow signals (e.g. <10Hz signal) may show drooping lines (e.g., square waves should have horizontal lines but they may be sloped instead.)

The program relies heavily on javascript and html5. Modern browsers (only tested on Chrome so far) and capable processors (e.g., old smart phones may not work) on the display device are required.

A resolution slider is provided at the bottom of the oscilloscope display which can be used to change the refresh rate by changing the number of data points displayed. At short time scales (fast signals <2000 us/div) the resolution can be reduced, increasing the refresh rate without losing display resolutions. If the number next to data/frame is less than the data/sweep number, this indicates this situation where the resolution can be adjusted and refresh rate increased.