

# DIY.EDU Labor SCOPE

**THANK YOU FOR PURCHASING THE MKI x ERICA SYNTHS DIY.EDU Labor Scope!** This DIY.EDU Labor add-on, featuring the oscilloscope, the voltmeter, the spectrometer and the tuner, turns the Labor into self-contained electronics development and experimentation station. Enjoy!

## FEATURES:

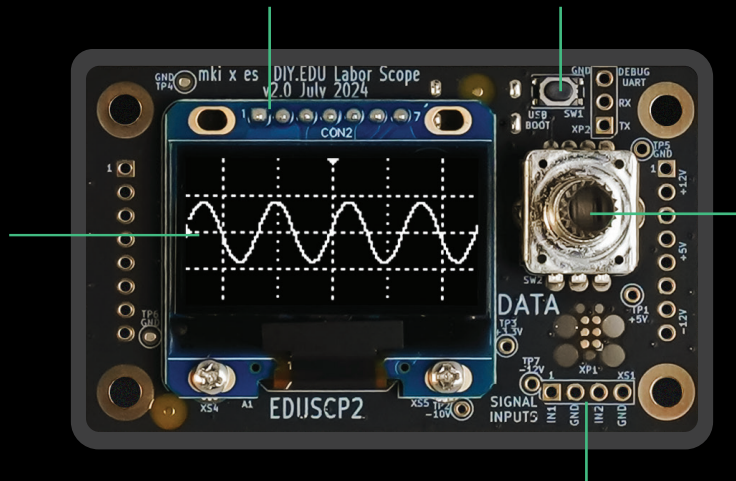
- The 3-channel oscilloscope. Two channel inputs are available on female connector, the third channel is hard wired to the audio output of the Labor.
- Lissajous curves visualizer.
- The voltmeter, 10V range, 0.1V accuracy.
- The spectrometer, with configurable representation.
- The chromatic tuner.

NB! The DIY.EDU Labor Scope is intended for use exclusively with the Labor platform, and other applications and modifications may lead to permanent damage of the instrument.

The USB connector allows to update the firmware and provides access to extended functionality of the Labor Scope.

The small pushbutton is used for firmware updates.

The OLED screen gives visual representation of data.



The encoder allows for navigating through menu and settings. LED on the encoder indicates status on the device – in the oscilloscope mode green LED means, the oscilloscope is in RUN mode, red LED – STOP mode. In the tuner mode the green LED indicated exact tuning of currently played note.

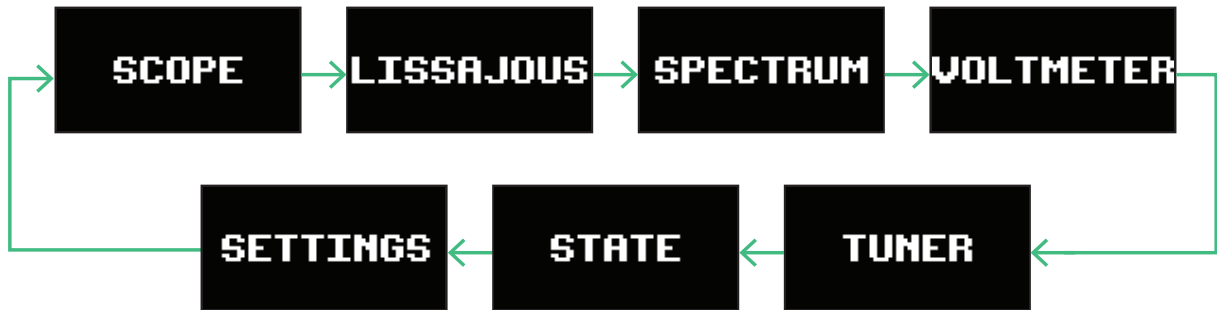
This is the input for the first two channels of the Labor Scope. Use only one cable to connect the signal to the inputs, because the ground connection is secured through the connectors.

# INSTALLATION

Start with completing assembly of the Labor Scope – solder two male pinholders (XS2 and XS4) and the input female pinheader XS1. Then power the DIY.EDU Labor OFF and install the Labor Scope; pay close attention to pin and hole alignment - all connectors on the Labor Scope have to align with headers on the Labor main board. Then power the Labor ON and the OLED will advance to the main menu (SCOPE, LISSAJOUS, VOLTMETER, SPECTRUM, TUNER and SETTINGS) indication. Every time you replace add-on boards, including the Labor Scope, make sure the pin headers are aligned with connectors.

# THE MAIN MENU

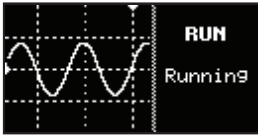
Rotate the encoder to navigate through the main menu. Short press the encoder to enter a specific operating mode and long press the encoder to return to the main menu.



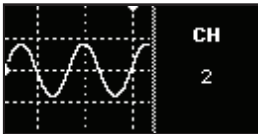
# THE OSCILLOSCOPE



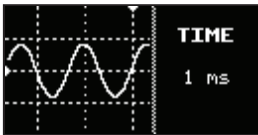
The first menu is dedicated to the OSCILLOSCOPE settings. Once in the oscilloscope menu, short press the encoder to access the oscilloscope submenus. Submenus will appear as a popup on the right side of the screen. Rotate the encoder to select the submenu and short press it to access a selected submenu. Once in a submenu, selection of settings will appear as a popup on the bottom of the screen.



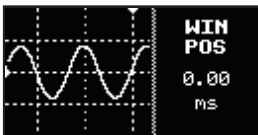
The first submenu is RUN. Rotate the encoder to choose between RUN and STOP. When measurement is stopped you can examine the waveform and parameters (time, amplitude, etc.) in detail. Short press the encoder to return to the oscilloscope submenu.



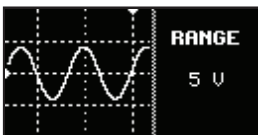
The CHANNEL submenu lets you select the active channel for the oscilloscope. Rotate the encoder to select between CH 1 and CH 2 available on the female header or CH 3 which is hard wired to the audio output of the Labor.



The TIME submenu lets you set the timescale of the oscilloscope. Rotate the encoder to set the optimal timescale for the best waveform representation.

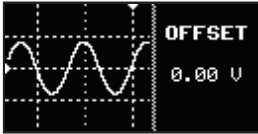


The WINDOW POSITION submenu lets you to move the scope window, in case window width is larger than 1 (see the SETTINGS menu). Rotate the encoder to find the optimal window position.

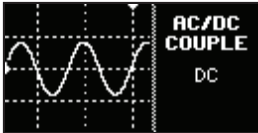


The RANGE submenu lets you set the amplitude division of the oscilloscope. Rotate the encoder to set the optimal division for the best waveform representation.

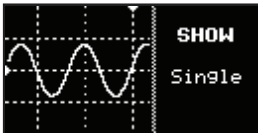
# THE OSCILLOSCOPE



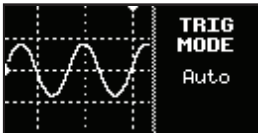
In case your signal has a DC offset, the OFFSET submenu lets you to adjust offset in order to center the oscilloscope image. Rotate the encoder to set a desired offset; a popup menu will indicate the offset applied.



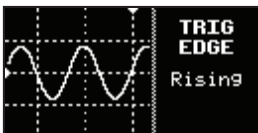
The Scope inputs can be set for AC or DC coupling. With the AC coupling ON, no DC voltage component is passed thru the inputs, which means there will be no DC offset of waveforms on the oscilloscope. Rotate the encoder to select between AC and DC coupling. NB! In many cases for electronics calibration DC component (or getting rid of DC component by adjusting the trim pots) is critically important, so make sure your Scope has AC coupling OFF in such occasions.



The SHOW submenu allows to select between single channel or two channel oscilloscope representation. Rotate the encoder to select between SINGLE, CH 1 + CH 2, CH 1 + CH 3 and CH 2 + C3.

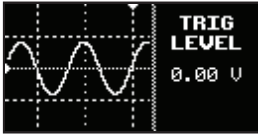


In a TRIGGER submenu you can select trigger conditioning. Options are AUTO (the oscilloscope will keep running event the trigger is not present and the representation can become unreadable), NORMAL (the oscilloscope will run only, when a trigger is present) and SINGLE (the oscilloscope will make a single snapshot and stop. This is particularly useful mode for short, one burst events.) If a SINGLE mode is used, in order to “activate” the oscilloscope you need to go to RUN submenu and rotate CW to RUN.

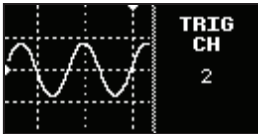


The TRIG EDGE submenu lets you select the trigger actuation on RISING, FALLING or BOTH edges of the waveform.

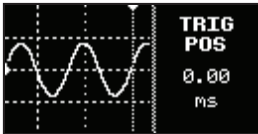
# THE OSCILLOSCOPE



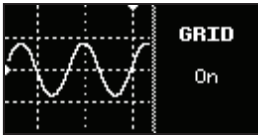
The TRIG LEVEL submenu lets you set the trigger level, a threshold on which the oscilloscope is triggered. We recommend to set it slightly above 0V otherwise a background noise can be interpreted as a trigger. As you rotate the encoder a horizontal marker will show a trigger position and a popup menu on the bottom of the screen will indicate trigger level.



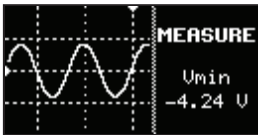
The TRIG CH submenu lets you select which channel is used for trigger conditioning. Options are CH 1, CH 2 and CH 3. In a single channel mode (SHOW menu) the trigger channel is automatically set to the selected channel.



The TRIG POS submenu lets you offset the trigger position on time scale. As you rotate the encoder a vertical marker will show a trigger position on time scale and a popup menu on the bottom of the screen will indicate trigger offset time.

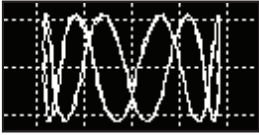


For more clear waveform representation you can configure the background grid. Short press the encoder rotate it to select among grid ON, DOTS, CROSS and OFF.



The MEASURE submenu lets you precisely measure amplitude of the waveform. Rotate the encoder to select between Vmin (minimum voltage), Vmax (maximum voltage), Vavg (difference between Vmin and Vmax), Vpp (peak to peak voltage or amplitude of the signal) and Vrms (root-mean-square voltage). Long press the encoder to return to the main menu.

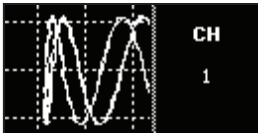
# THE LISSAJOUS MODE



One of cool applications of the oscilloscope is generation of Lissajous curves. In the LISSAJOUS mode relationship between signals, applied to two channels is represented as 2D curve. For example, if two phase-shifted sinusoid inputs applied to the scope in the LISSAJOUS mode and the phase relationship between the signals is presented as a Lissajous figure. In a professional audio world, this method is used for realtime analysis of the phase relationship between the left and right channels of a stereo audio signal.



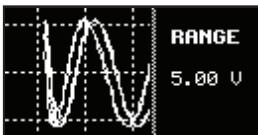
The first submenu is RUN. Rotate the encoder to choose between RUN and STOP. When measurement is stopped you can examine the Lissajous in detail. Short press the encoder to return to the Lissajous submenu.



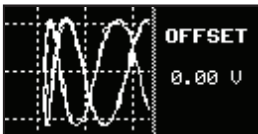
The CHANNEL submenu lets you select the active channel for the Lissajous mode, meaning, which channel is affected by time, range and offset adjustment. Rotate the encoder to select between CH 1 and CH 2 available on the female header or CH 3 which is hard wired to the audio output of the Labor.



The TIME submenu lets you set the timescale of the Lissajous curves. Rotate the encoder to set the optimal timescale for the best curve representation.



The RANGE submenu lets you set the amplitude division of the Lissajous curve. Rotate the encoder to set the optimal division for the best curve representation.

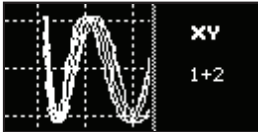


In case your signal has a DC offset, the AC/DC COUPLE submenu lets you to adjust offset in order to center the Lissajous curve. Rotate the encoder to set a desired offset; a popup menu will indicate the offset applied.

# THE LISSAJOUS MODE



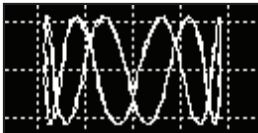
The Scope inputs can be set for AC or DC coupling. With the AC coupling ON, no DC voltage component is passed thru the inputs, which means there will be no DC offset of waveforms on the Lissajous curves. Rotate the encoder to select between AC and DC coupling.



The XY submenu allows you to choose combination of two channels (1+2, 1+3, 2+3), involved in Lissajous curve generation. Rotate the encoder to choose desired combination.



In the DRAW submenu, you can choose to display the signal as either dots (individual measurement points) or lines connecting the points. If the sampling period set by the TIME parameter is long, drawing lines may be slower than drawing only dots.

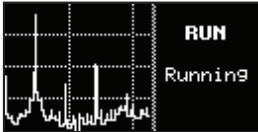


The GRID submenu allows you to configure background of the Lissajous curve representation. Rotate the encoder to choose between ON (dotted lines), DOTS, CROSS and OFF. Long press the encoder to return to the main menu.

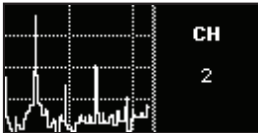
# THE SPECTROMETER



The SPECTROMETER menu allows you to explore the harmonic content of the signal.



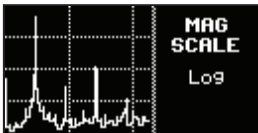
The first submenu is RUN. Rotate the encoder to choose between RUN and STOP. When measurement is stopped you can examine the spectrum of the signal and parameters (amplitude of relevant frequency) in detail. Short press the encoder to return to the spectrometer submenu.



The CHANNEL submenu lets you select the active channel for the spectrometer. Rotate the encoder to select between CH 1 and CH 2 available on the female header or CH 3 which is hard wired to the audio output of the Labor.



The Scope inputs can be set for AC or DC coupling. With the AC coupling ON, no DC voltage component is passed thru the inputs, which means there will be no DC offset of signal applied. Rotate the encoder to select between AC and DC coupling.



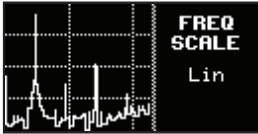
In a MAG SCALE submenu you can select between linear and logarithmic representation of amplitudes of the spectrum.



In a MAG TOP submenu you can you can set the scale of amplitude measurement: in Lin scale magnitude can be adjusted from 1V to 10V, in Log scale magnitude is fixed to 20dB.



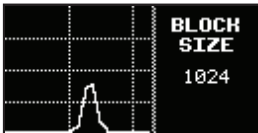
# THE SPECTROMETER



In a FREQ SCALE menu you can set a frequency distribution scale. Choose between LIN and LOG distribution.



In a FREQ MAX menu you can set the maximum plotted frequency of the spectrometer. Available options are 1500 Hz, 3000 Hz, 6000Hz, 12 kHz, 24 kHz.



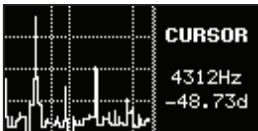
In the BLOCK SIZE submenu, you can adjust the number of data points used for spectrum analysis. A larger block size improves frequency accuracy but takes longer to process.



The GRID submenu allows you to configure background of the spectrum representation. Rotate the encoder to choose between ON (dotted lines), DOTS, CROSS and OFF.



The PEAK submenu displays the frequency component of the signal with the highest amplitude, allowing you to quickly identify the dominant frequency in the spectrum.



In a CURSOR submenu you can explore the spectrum by moving a cursor along the spectrum of the signal. Rotate the encoder to move a cursor along the spectrum of the signal. The popup menu on a top of the screen will indicate the frequency and the amplitude of the harmonic content of the signal. Long press the encoder to return to the main menu.

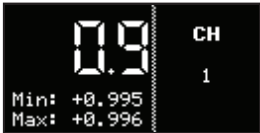
# THE VOLTMETER



The VOLTMETER allows to measure AC and DC voltage between the input and ground with 0.1 V accuracy. The indication of the voltage is with 0.001 V accuracy, but we can not guarantee this accuracy.



The indication of the voltage is with 0.001 V accuracy, but we can not guarantee this accuracy in real life measurements. Besides momentary voltage, the Labor voltmeter indicates minimum and maximum voltage over time.



The CHANNEL submenu lets you select the active channel for the voltmeter. Rotate the encoder to select between CH 1 and CH 2 available on the female header or CH 3 which is hard wired to the audio output of the Labor. Short press the encoder to return to the voltmeter submenu.



The next selection is choice between AC (alternating current) or DC (direct current). In AC selection, the voltmeter indicates RMS (Root mean square) value, in DC selection, obviously, mean value. AC/DC choice is indicated in the bottom right corner of the voltmeter screen.



The RESET submenu allows you to reset Min and Max values of the voltmeter. Just rotate the encoder to reset values. Long press the encoder to return to the main menu.

# THE TUNER



The TUNER is handy tool for identifying the frequency of the signal and tuning VCOs. It's straight-forward chromatic tuner.



The CHANNEL submenu lets you select the active channel for the tuner. Rotate the encoder to select between CH 1 and CH 2 available on the female header or CH 3 which is hard wired to the audio output of the Labor. Short press the encoder to return to the tuner submenu.

# STATE SAVING



For user comfort eight STATE saving slots are available on the Labor Scope. State means all settings of the Scope are saved and afterwards can be easily recalled. Short press the encoder to access state slots.



As the STATE mode is selected, you have an option to SAVE or LOAD the settings. Rotate the encoder to make a selection and push it to confirm.



Once save/load selection is done, a list of slots will appear. Rotate the encoder to select the slot and push it to confirm. SAVED or LOADED pup-up will appear to confirm selection.

NB! Slots with saved information are not indicated by any means - you need to remember the settings. You can override the state settings by saving different settings in the same slot.

# THE SETTINGS



In the SETTINGS submenu general configuration of the Labor Scope is performed.



The BRIGHTNESS submenu lets you adjust brightness of the OLED. Short press the encoder to enter the brightness adjustment submenu, and rotate the encoder to set desired brightness. Short press the encoder to return to the settings submenu.

The DIM submenu lets you to turn the OLED dimming time, if no action is taken. Short press the encoder to enter dimmer settings submenu, and rotate the encoder to set desired dimming time.

The SCREENSAVER submenu lets you to active the screensaver and set its activation time. Short press the encoder to enter screensaver settings submenu, and rotate the encoder to set desired screensaver on time.

The FINE TIME menu allows you to select between fine and coarse adjustment of timescale in the oscilloscope mode. Short press the encoder to enter the timescale submenu, and rotate the encoder to choose between fine or coarse timescale adjustment.



The TRIGG OFF T menu allows you to set trigger disable treshold time in oscilloscope mode. This is useful for observing slow signals. If Time scale is above threshold, it does not try to find trigger in the signal, but redraws screen immediately with incoming signal. Short press the encoder to enter the trigger off time submenu, and rotate the encoder to choose the trigger off time.

The SCOPE WIDTH menu allows you to select, how many windows are scanned in the oscilloscope mode. If set greater than 1x (2x or 4x), it samples more samples than it can show on the screen, and you can move around the buffer using "Win Pos". Short press the encoder to enter the trigger off time submenu, and rotate the encoder to choose the trigger off time.

In the CALIBRATE menu you can recalibrate the Labor Scope. The device comes calibrated from the factory, but you may want to recalibrate it. We recommend to do recalibration only, if you have precise voltemeter and voltage source with at least  $\pm 5V$  range, as described in the next page of this manual.

# THE SETTINGS



In the FACTORY RESET menu you can perform the factory reset. Push the encoder to enter reset mode, rotate the encoder to select YES, and push it to confirm.

The VERSION indicates the firmware version.

# CALIBRATION



To perform calibration, you will need a voltmeter and a stable voltage source capable of outputting at least -5V to +5V.



## Step 1: Select a Channel

You will be prompted to select a channel for calibration. Rotate the encoder to choose between channels 1 and 3. Press the encoder to confirm your selection.



## Step 2: Zero Voltage Calibration

Connect the selected input channel to 0V (ground). Press the encoder to perform 0V calibration. Rotate the encoder to select "Continue", then press the encoder to proceed.



## Step 3: Negative Voltage Calibration

You will be prompted to apply a negative voltage to the input. Connect a stable voltage between -1V and -9V (-5V is recommended for best results). Measure the applied voltage using an external voltmeter (not the EDU SCOPE's internal meter). Enter the measured voltage on the screen: Rotate the encoder to select a digit. Short press to highlight or unhighlight the digit (highlighted digits will be inverted). When highlighted, rotate the encoder to adjust the digit. Once the voltage is entered correctly, select "Continue" and press the encoder to proceed.

# CALIBRATION



## Step 4: Positive Voltage Calibration

You will now be prompted to apply a positive voltage to the input. Connect a stable voltage between +1V and +9V (+5V is recommended for best results). Measure the applied voltage using an external voltmeter. Enter the measured voltage on the screen following the same procedure as in Step 3. Once the voltage is entered correctly, select "Continue" and press the encoder to proceed.



## Step 5: Finalizing Calibration

The calibration process is now complete. Press the encoder to return to the main menu.



## Cancelling Calibration

If you want to cancel the calibration process at any time: Long-press the encoder until a popup menu appears. Rotate the encoder to choose "No" (to continue calibration) or "Yes" (to cancel). Press the encoder to confirm your selection.

# FIRMWARE UPDATE

Download the latest firmware file (.uf2) and save it on your computer. Install the Oscilloscope on the Labor, but do not turn the power on, yet. Now connect the USB-C port on the bottom of the oscilloscope via a USB cable to your computer. Push and hold a small button above the encoder and power the Labor on. The Labor will appear as an external drive on your computer. Drag and drop the firmware file into this drive and the oscilloscope will automatically update.

# Safety instructions

Please follow the instructions for the use of the mki x es.edu Labor Scope below, because only this will guarantee the proper operation of the module and ensure the warranty from Erica Synths.



Use the Labor Scope exclusively with the Labor board and install it in designated place on the Labor. Using it with other power supplies and performing measurements of signals generated externally may cause permanent damage to the device.



Water is lethal for most electric devices unless they have been rendered waterproof. The Labor Scope is NOT intended for use in a humid or wet environment. No liquids or other conducting substances should be allowed into the module. Should this happen, the module should be disconnected from mains power immediately, dried, examined and cleaned by a qualified technician.



Do not expose the instrument to temperatures above +50° C or below -20° C. If you have transported the instrument in extremely low temperatures, leave it at room temperature for an hour before plugging it in.



Transport the instrument carefully. Never let it drop or fall over. The Warranty does not apply to instruments with visual damage.



The Labor Scope must be shipped in the original packaging only. Any instrument shipped to us for return, exchange and/or warranty repair must be in its original packaging. All other deliveries will be rejected and returned to you. Ensure that you keep the original packaging and technical documentation.

# Disposal

This device complies with EU guidelines and is manufactured and confront RoHS without the use of lead, mercury, cadmium or chrome. Nevertheless, this device is special waste and disposal in household waste is not recommended.

User manual by Girts Ozolins@Erica Synths.  
Design by Ineta Briede@Black8.

Copying, distribution or any commercial use in any way is prohibited and needs the written permission of Erica Synths.

The specifications are subject to change without notice. If you have any questions, feel free to contact us via SUPPORT section on [www.ericasynths.lv](http://www.ericasynths.lv)

You will find the Erica Synths terms of warranty at [www.ericasynths.lv](http://www.ericasynths.lv)

Items for return, exchange and/or warranty repair should be sent us according to the guidelines on SUPPORT section on [www.ericasynths.lv](http://www.ericasynths.lv)

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