ZC Analytics

Introduction to digital signal analysis with the iMSO-204x

In this exercise, you will learn how to acquire and visualize analog and digital electrical signals with the iMSO-204x and analyze the data using the iMSO software.

BACKGROUND

Mixed signal oscilloscopes like the iMSO 204x are used for a wide array of applications across a number of industries. These oscilloscopes incorporate analog signal acquisition with a logic analyzer to simultaneously display multiple signal types referenced to a common point in time. In it's most common mode of operation, an oscilloscope is a device that repeatedly captures a window of electrical events of a user specified time base and refreshes the display of a portion of it on a screen.

To complete todays exercise you will use the iMSO-204x oscilloscope to acquire and analyze digital signals and compare them to analog type signal you acquired in the previous exercise. The logic analyzer channels can be thought of as a scope with 1 bit vertical resolution on all channels. It displays signals as binary values, according to whether the detected voltage is above or falling below a 'threshold value'.

The wide spread use of microcontroller-based systems increased the need for tools like logic analyzers. The ability to "see" the signals the way logic circuit does, that is, at the sampling (threshold) events of the circuit, in the form of binary values. Combining this with analog measurements – especially for checking threshold levels, detecting runts and glitches and verifying the compliance of signals to specific I/O standards.

With electronic systems evolving towards more complexity, debugging involves a mix of analog and logic types of potential issues. In this exercise you will use the iMSO-204x ability to trigger on both types of signal. Using repetitive oscilloscope signal visualization combined with the binary logic analyzer of display can be extremely useful. Many professional technicians have noted that displaying analog and digital recording on the same screen as time-correlated data is essential for the completion of their daily jobs.
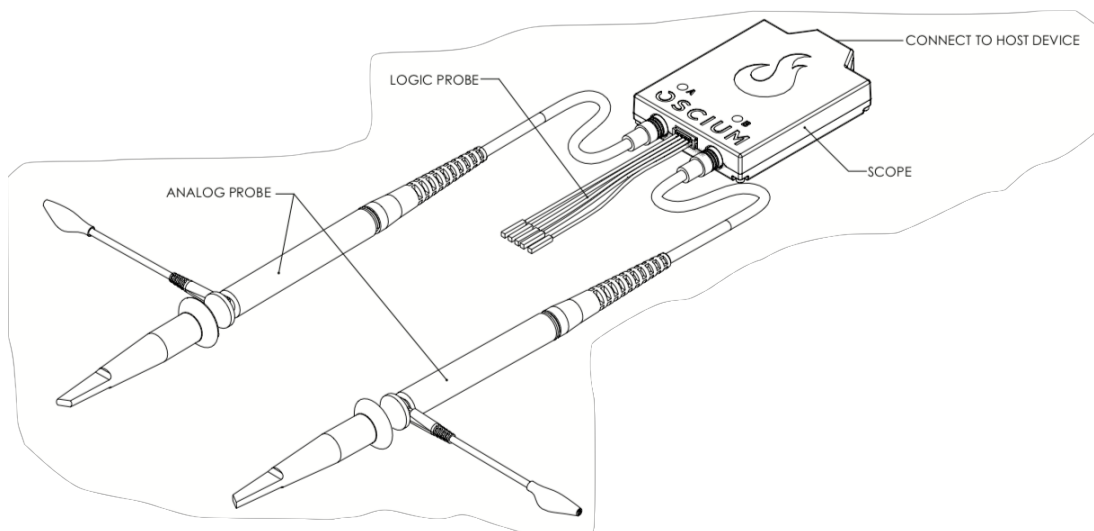

Figure 1. Principle components of the IMSO-204x digital storage oscilloscope.

Please identify these parts on the iMSO-204x

1. Power indicator light: illuminates when the iMSO-204x is connected to and recognized by a computer or mobile device.
2. Analog probe input channel A
3. Logic Probe input harness with grabbers on the D1 and Ground input.
4. Micro USB connector: connects a computer or mobile device to the IMSO-204x

The IMSO-204x should be connected to your computer or mobile device using the appropriate cable.

REQUIRED EQUIPMENT

- IMSO software installed on your PC, phone, or tablet.
- Analog probe in 1X mode on channel A.
- Digital signal generator.
1. Connect the IMSO-204x Digital oscilloscope to your device with the appropriate cable.
2. Connect the logic harness to the iMSO and attach grabbers to wires for D1 and ground (Figure 2).
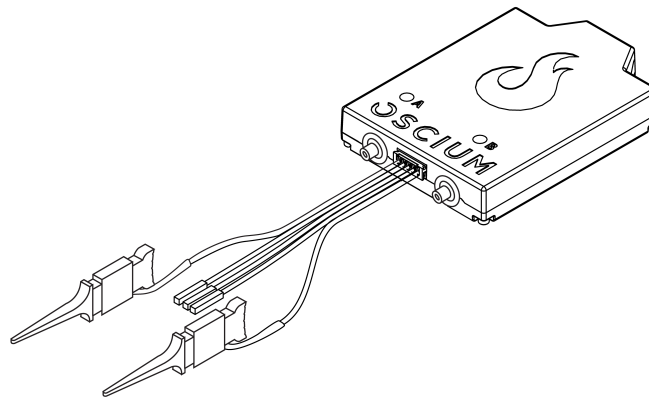

Figure 2. Digital logic input to connect the iMSO-204x with grabbers attached to the digital channel 1 and ground input.

SAFETY

1. ⚠️ **The maximum input voltage for the iMSO scope when using the digital logic inputs is -0.4v / +7v.**
2. The analog probe which has a sliding red lever that allows the user to move between 1x and 10x modes.
   a. The maximum voltage limit for the analog probe in 1X mode is -8v / +13v.
   b. The maximum voltage limit for the analog probe in 10x mode is -40V / +40V.
   c. To enable 10x mode, slide the red lever located on the probe itself.
      i. The 10x option located in software only changes the voltage scales in software; it does not actually divide the input voltage. Please remember to slide the red lever on the physical probe for all 10x measurements.

STARTING IMSO SOFTWARE

1. Find the Oscium icon on the desktop and launch IMSO software as you would any other computer program.
   a. If using a mobile device, launch the app.
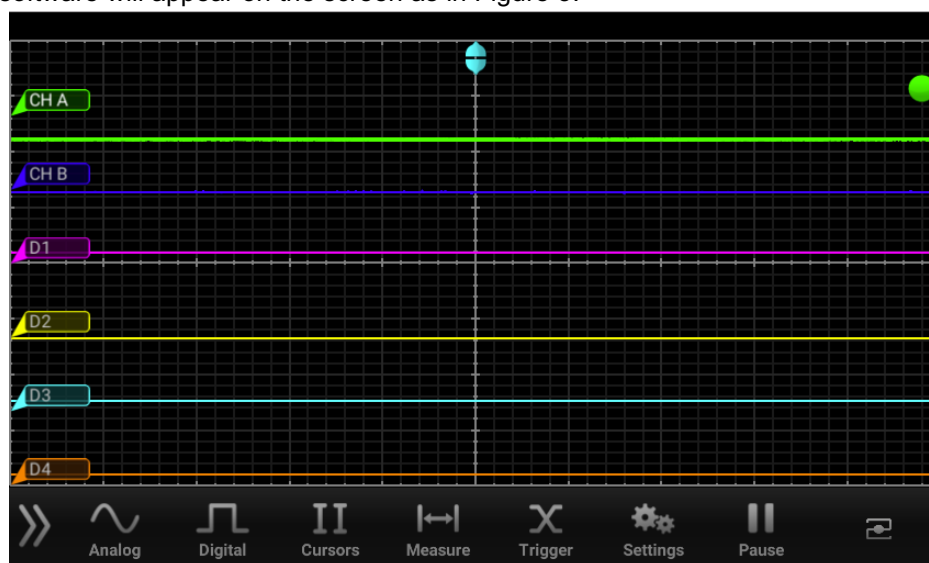
2. iMSO software will appear on the screen as in Figure 3.

Figure 3. Default iMSO software display.

SETTING UP THE SOFTWARE INTERFACE

In this exercise, you will navigate the appropriate menus to set the iMSO software to acquire and analyze digital and analog signals.

1. Locate the toolbar and select the Analog channel button on the menu bar. Channels can be turned either on or off by selecting the on or off button. Turn both channels A and B off for this portion of the exercise.

2. Open the Digital channel menu . For this exercise, Turn digital channel 1 on and 2-4 off. See figure 4:
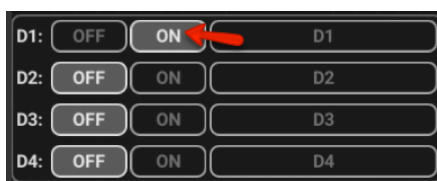

Figure 4: Digital channel one should be on, turn all others off. Check to make sure your settings match these before moving on with this exercise.

SETTING UP YOUR SIGNAL GENERATOR

Many different signal generators are available, but all will have the same fundamental controls. Please check with your instructor if your signal generator controls differ from these.

1. Select the following output parameters:
   - Waveform: square
   - Frequency: 10,000.00 Hz.
   - Offset: 0.00V
   - Duty Cycle: 50%
   - Amplitude 5.0V

2. Attach the output of the signal generator with a test cable to the grabbers of the digital input. Your device should have 1 red and one black clip, connect ground to **black** and channel D1 to **red**.
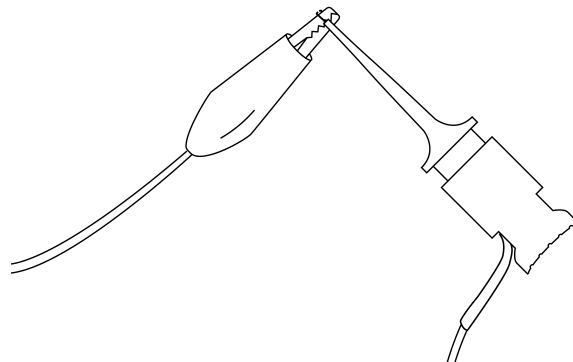

Figure 3. Use the grabbers on the digital logic harness to connect to the test cable from your signal generator. These grabbers are built to connect to pins on integrates circuits and other small circuit board wires.

VISUALIZING AND RECORDING DATA

Single digital channel visualization

If you have connected the cable and have your signal generator adjusted your signal should look similar to figure 4 .
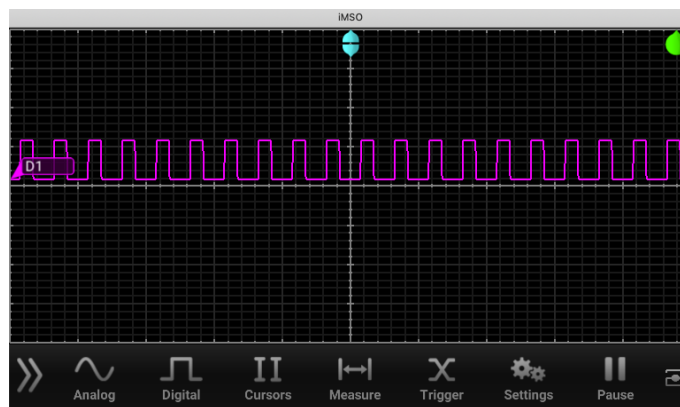

Figure 4. Example of a 10K digital signal without triggering adjusted.

Digital Triggering

1. Select ![Trigger] from the menu bar. Then touch ![DIGITAL] at the top of the menu to view advanced digital triggering options. All the options may be grayed out (because analog and digital triggering can't both be active at the same time). If analog is grayed out, digital is active and vice versa.
2. You can choose whether triggering occurs on a rising or falling edge of the waveform. Select ![FALL] for a falling edge or select ![RISE] for a rising edge.
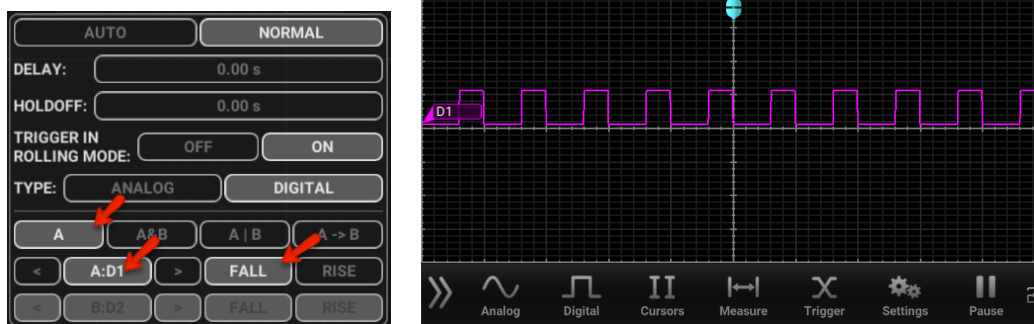
Figure 5. Typical setup for a digital signal triggering on the falling edge.

3. Adjust the time base and amplitude display by pinching on a touch screen device or using the arrow keys on your computer keyboard (figure 6). Adjust until the entire waveform is visible.
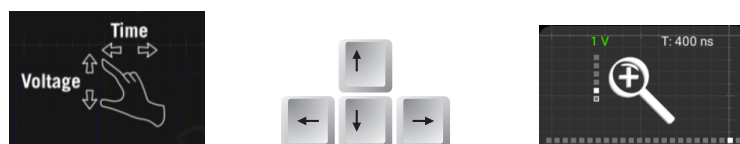

Figure 6. Adjust the screen by pinching a touchscreen (right) or by using the arrow keys (center) on a PC. The zoom dialog (left) will appear. Adjust until the entire waveform is visible.

Advanced Triggering

You may need to use a combination of triggering parameters to visualize your signal of interest:

- Single channel only **A**
- Simultaneous events on two channels **A&B**
- A single event on one of two channels **A | B** ,
- Concurrent events on two channels **A → B** .

For other combinations of triggering options please click the ⓘ in the corner of the triggering menu for a complete list.

THRESHOLD AND SIGNAL DISPLAY

If the signal on the digital channel fails to meet the threshold for the input your signal may appear to be a flat line or irregular.

1. Use the amplitude control on your signal analyzer to drop the output voltage until the signal becomes erratic.
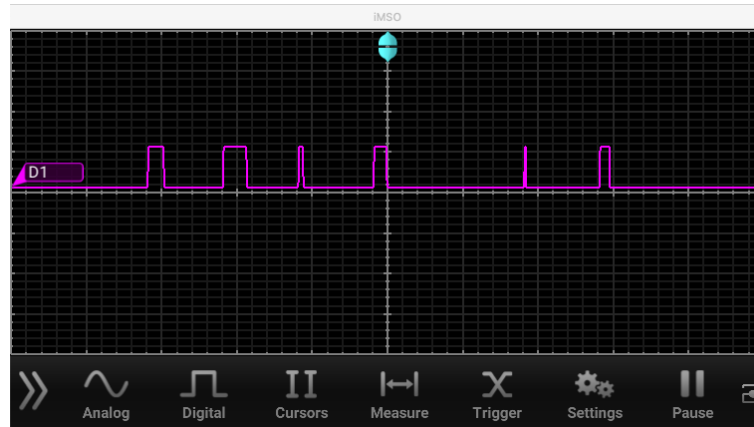
Figure 7. Adjust the output voltage down from 5V until the digital signal becomes erratic.

2. Note the voltage at which the signal become unstable and record it here: _____.
3. Continue to decrease the voltage until the signal flat lines and record it here: _____.

COMBINED ANALOG AND DIGITAL MEASUREMENTS

As you have seen, digital channels on the iMSO are converted straight into a digital format. These signals then appear on the screen as a high or low level, with no analogue information present. For many troubleshooting applications, analogue aspects of a digital signal are extremely useful. To accomplish this, you will connect an analog probe to the IMSO to the signal generator

1. Connect an analog probe to channel A on the iMSO.
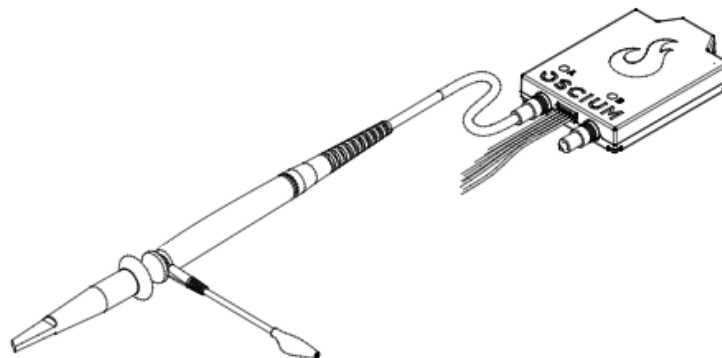
Figure 8. Attach the analog probe to the iMSO channel A.

2. Connect the active lead to the red alligator clip from the signal generator alongside the digital input clip. Connect the ground clip to the black alligator clip from the signal generator in the same way.
3. Adjust the amplitude the signal generator to a voltage below the threshold you discovered on the last exercise.
4. Change the triggering of the iMSO software to the Analog channel A and adjust your screen to look like figure 9.

Figure 9. Set the analog trigger to channel A and adjust the screen until your signal looks similar to this figure.

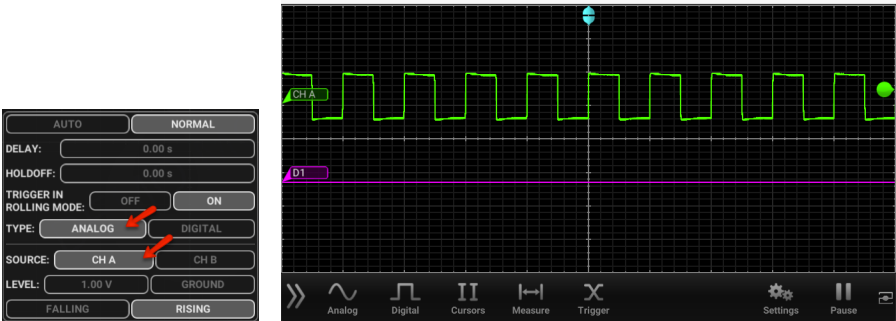5. Now adjust the amplitude of the signal generator back to 5V your screen should look like figure 10.
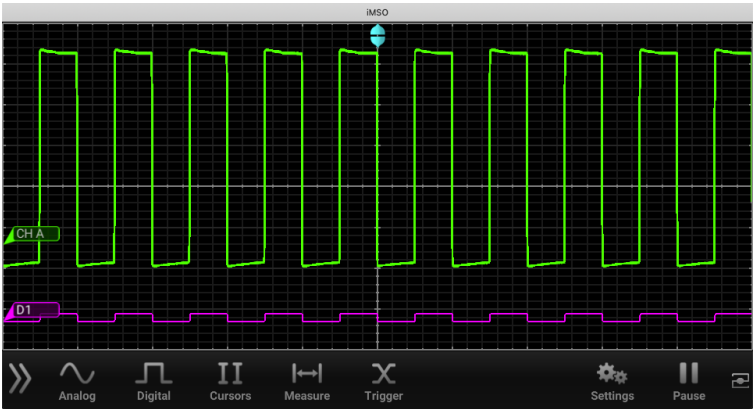
Figure 10. One of the most useful aspects of a mixed signal oscilloscopes is the ability to accurately time-correlate analog and digital channels.

You will notice the analog signal contains much more information than the "binary" digital channel. In this example you will see what are referred to as "runts":

Figure 11. By looking at both the analog and digital components of this signal, you can see that there are bits that fail to meet the threshold. This can be a failed "on" on the left and a failed "off" on the right

EXPORTING DATA

Screenshots:
1. Select the Settings menu and then SCREENSHOT will fade to from black to gray and the display will briefly change to full screen mode.
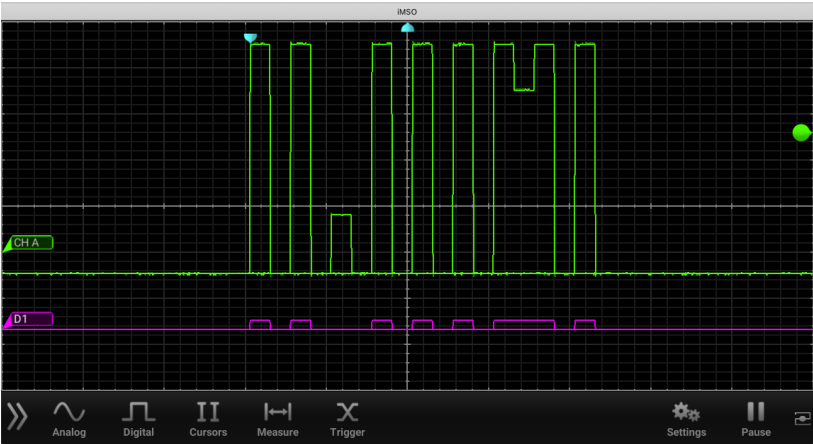   a. If using an Apple device simultaneously pressing the home and the power button. The screen will flash white while the picture is captured. When a picture is captured this way, everything visible on the LCD will be captured and available in photos.
2. On a mobile device, select email to send a copy of the screenshot to yourself.
3. On a Mac or PC Open a web browser, and launch your web mail or cloud storage site and upload your data. Your data log can be found here:
   a. Mac: Drive> Users>*user*>Document>iMSO
   b. PC: C:\Users*user*\AppData\Local\iMSO

Data logging:
The iMSO software has a built-in data logging feature that will allow you to export data as a .csv data file.
4. Select Settings from the menu bar. Then click or touch START from the data log option, DATA LOG START STOP . will then change to in order to indicate data is being logged. To stop data logging click or touch Stop

Figure 13: Data logging controls in the iMSO software (L) and pick wheel of captured screenshots and data logs from the manage files menu (R).

5. A pick wheel will appear with all of the data that has been previously logged.
6. On a mobile device, select email to send a copy of the logged data to yourself.
7. On a Mac or PC Open a web browser, and launch your web mail or cloud storage site and upload your data. Your data log can be found here:
   a. Mac: Drive> Users>*user*>Documents>iMSO
   b. PC: C:\Users*user*\AppData\Local\iMSO

Each column of the .csv (excluding the first) is the data point in time that is shown on the screen. When the time scale is set to less than 100ms, each row is a single screen capture. When the time scale is greater than or equal to 100ms, each row is a data point in time.

END OF LAB ACTIVITIES

Once you have successfully emailed yourself a screenshot and a data log; please clean up your workspace and power down all devices.

1. Please quit the iMSO software and close all other browsers and put computer to sleep.
2. Turn off the signal generator and disconnect all test cables from the iMSO scope.
3. Return all cables and leave the lab bench as you found it.
4. Discuss the following study questions with your group before leaving class unless your instructor gives additional instructions..

STUDY QUESTIONS

1. Find the email you just sent yourself from iMSO. Write the Subject here:

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2. Today you used a signal generator and made some recordings. In your own words, being as specific as you can, describe what is actually being recorded by the IMSO-204x and displayed in iMSO software.
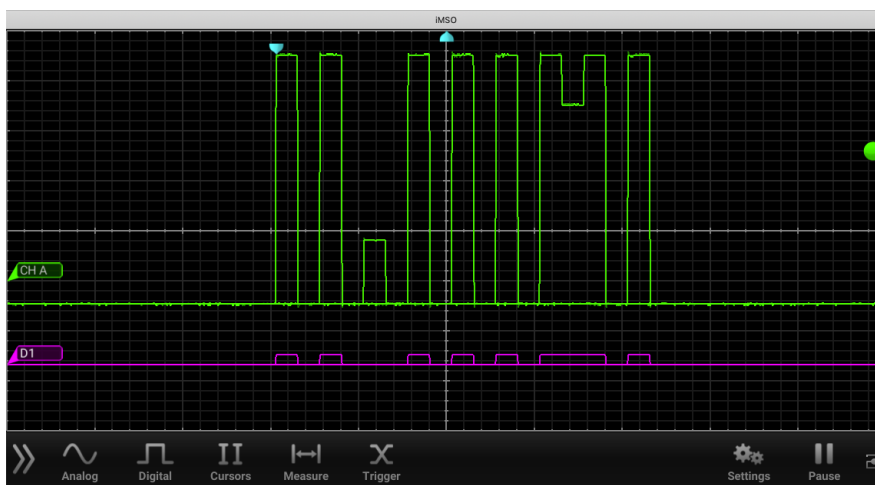

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3. In your own words, describe what is happening in the signals shown below.