

Interactive LED Array Visualizer

Case Study

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1. Overview

Short description: This **Case study** explores how an LED array can be controlled using the digital I/O channels of the Analog Discovery Product Line (AD 3 or AD Studio / Studio MAX, hereby **Device**). The project demonstrates how digital signals can be used to turn LEDs on and off in different patterns. Using WaveForms scripting and an interactive LabVIEW interface, participants can visualize binary counting, where the LED states represent increasing binary numbers over time. This creates an interactive LED array visualizer that helps users understand digital outputs, binary representation, and basic logic control.

Objectives

- Configure digital I/O lines in WaveForms to drive an LED array.
- Develop a binary counter where the LED array updates automatically over time.
- Use WaveForms scripting and LabView to create a more interactive user interface for controlling and visualizing LED patterns.

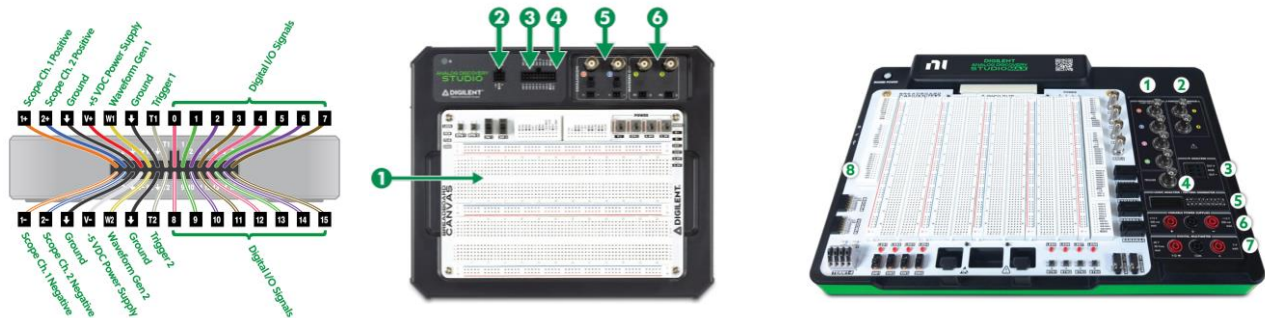
Software & Hardware Requirements

Software		Version
Diligent WaveForms (Runtime + SDK)		Latest (64-bit)
NI LabVIEW		2025 64-bit
WaveForms Toolkit for LabVIEW		Latest
Hardware		Quantity*
Diligent Analog Discovery Product Line		
Option 1	Diligent Analog Discovery 3	1
Option 2	Diligent Analog Discovery Studio	1
Option 3	Diligent Analog Discovery Studio MAX	1
List of Components		Quantity*
Canvas Breadboard		1
LED		10
Resistor 220Ω		10
Jumper wires		-
BNC to BNC cable ¹		1

¹ BNC cable required only for the Analog Discovery Studio MAX.

2. Hardware Setup

This section describes the **Digilent Analog Discovery Product Line** hardware setup for **Case studies**. Before assembling the measurement circuit, it is essential to understand the pinout and available connections of the **Devices**. **Figure 1** highlights the pinouts and instrumentations of the Digilent Analog Discovery product line.²



a. Analog Discovery 3

- Power Supplies
- Logic Analyzer and Pattern Generator
- Triggers
- Oscilloscope Waveform Generator

b. Analog Discovery Studio

1. Breadboard Canvas
2. Power Supplies
3. Logic Analyzer and Pattern Generator
4. Triggers
5. Oscilloscope
6. Waveform Generator

c. Analog Discovery Studio MAX

1. Oscilloscope
2. Waveform Generator
3. IV Analyzer
4. Trigger
5. Logic Analyzer and Pattern Generator
6. Variable Power Supplies
7. Digital Multimeter
8. Breadboard Canvas

Figure 1. Digilent Analog Discovery Products Pinout and Instrumentations

Table 1 provides a common reference for physical channels' names across the **Digilent Analog Discovery product line**. The **Case studies** are designed to work with all supported devices, so the generic channels' names shown in the first row are used consistently in all circuit diagrams and wiring instructions.

Table 2 provides a common reference for device names and instrument identifiers used in NI LabVIEW with the WaveForms Toolkit across the **Digilent Analog Discovery product line**. The Case studies are designed to work with all supported devices; therefore, the generic instruments and

² For detailed electrical specifications, pin descriptions, and operating limits, always refer to the official datasheets of each device (Analog Discovery 3, Analog Discovery Studio, and Analog Discovery Studio MAX). The latest datasheets are available on the Digilent website:

- [Analog Discovery 3](#)
- [Analog Discovery Studio](#)
- [Analog Discovery Studio MAX](#)

channels identifiers shown in Table 2 are used consistently throughout the LabVIEW block diagrams and configuration steps.

Table 1 Physical Channels Mapping for Digilent Analog Discovery Devices

Channel Device	D0-D9
AD 3	Digital Channels 0-9
AD Studio ³	
AD Studio MAX	

Table 2 Device Names and Instruments Identifiers in NI LabVIEW (WaveForms Toolkit)

Identifier Device	Device name	Digital Lines
AD 3	Discovery3	dig/0:9
AD Studio	DiscoveryStudio	
AD Studio MAX	ADS_Max	

³ For the Analog Discovery Studio and Analog Discovery Studio MAX, ensure the devices are powered by turning ON the main power switch before use.

3. Background Information

An interactive LED array visualizer is a simple digital electronics application that uses LEDs to represent digital output states. In this Case study, an LED array is connected to the digital input/output pins of the **Device**. Each LED represents one digital output channel and can be turned on or off through WaveForms and LabVIEW.

The **Device** sends digital HIGH and LOW signals to the LEDs. A HIGH signal turns the corresponding LED on, while a LOW signal turns it off. By changing the output states in sequence, different LED patterns can be displayed. One example is binary counting, where the LEDs represent binary numbers using ON and OFF states. As the number increases, the LED pattern changes according to its binary value.

4. Circuit Design – step by step instructions

4.1 Description

The interactive LED array visualizer circuit uses LEDs connected to the digital input/output channels of the **Device**. Each DIO channel is connected to an LED through a current-limiting resistor.

4.2 Step by step instructions⁴

1. Place ten LEDs, L1 – L10, on the Canvas breadboard, ensuring that each LED is inserted with the correct polarity.
2. Place ten current-limiting resistors, R1 – R10, in series with the LEDs to protect them from excessive current.
3. Connect D0 - D9 of the **Device** to the corresponding resistors R1 – R10.
4. Connect the other side of each resistor to the positive terminal of the corresponding LED.
5. Connect the negative terminal of each LED to the breadboard ground rail.
6. Connect the **Device** GND to the breadboard ground rail to provide a common reference for all LEDs.
7. Check that each DIO channel is connected to only one LED circuit and that there are no short circuits between adjacent breadboard rows.

Important! Refer to **Table 1** to determine the exact physical pin, connector, or cable that corresponds to each generic connection on the specific Digilent Analog Discovery device being used. The remaining rows in the table show how each generic channel maps the actual hardware connections for each device.

⁴ Given on Figure 3.

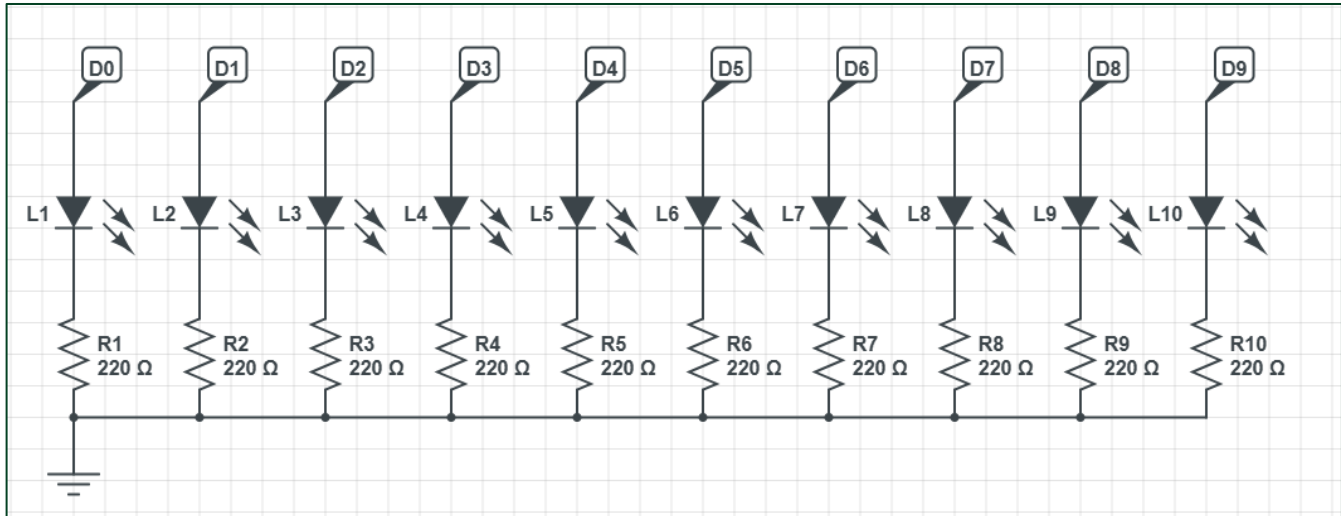
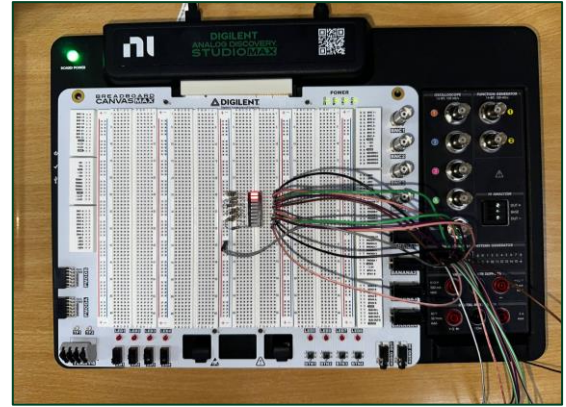
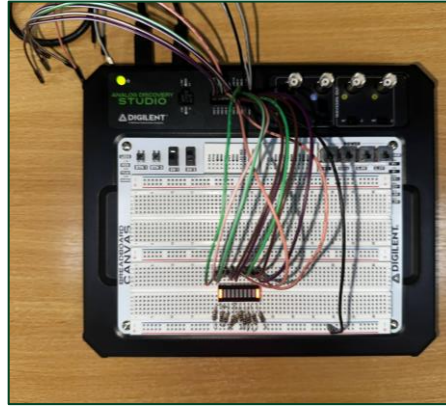
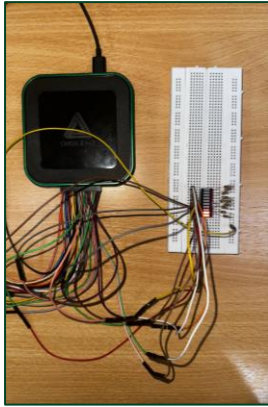


Figure 3. Interactive LED Array Visualizer Circuit

4.3 Assembled Circuit

Figure 4 presents complete experimental circuits on different Digilent devices.



a. Analog Discovery 3

b. Analog Discovery Studio

c. Analog Discovery Studio MAX

Figure 4. Assembled circuits for different Devices

5. Software Setup - step by step instructions

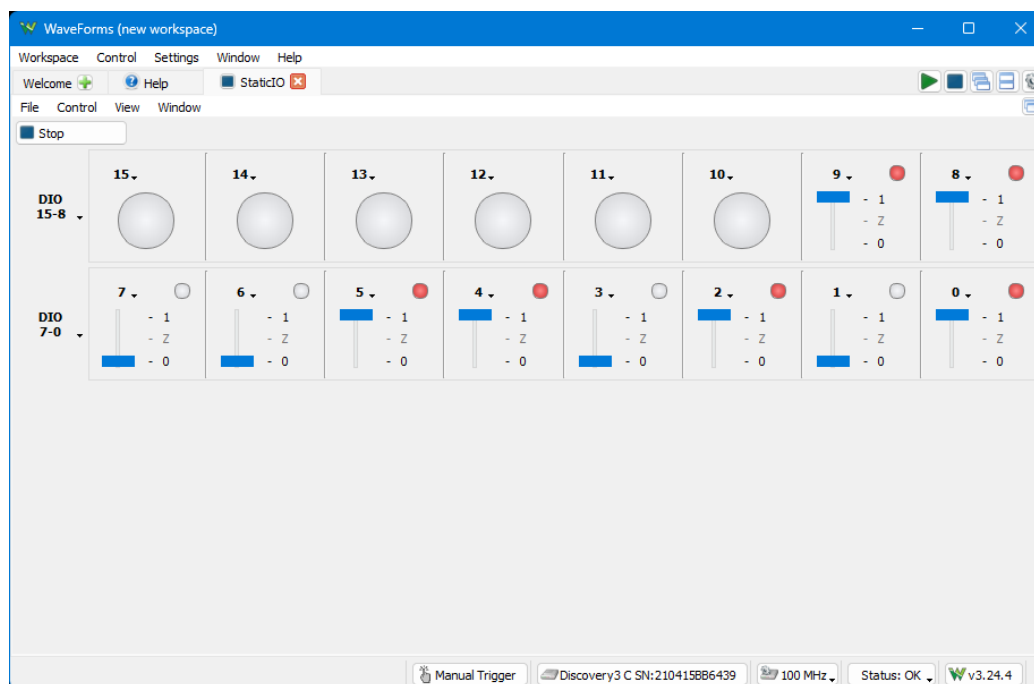
5.1 Mini Digital Piano Control in WaveForms Using Script

Step 1. Launch WaveForms and connect the device

- 1.1. Connect the **Device** to the computer via USB.
- 1.2. Open the **Digilent WaveForms** software.
- 1.3. Verify that the device is detected and shown as *Currently Selected* in the **Device Manager** (Settings -> Device Manager).

Step 2. Open the StaticIO instrument

- 2.1. From the **WaveForms** main window, open **StaticIO**.
- 2.2. Configure digital channels **DIO0–DIO9** for LED control.
- 2.3. Set the channels as output controls, as shown in Figure 5.



Step 3. Figure 5. Power Supply Configuration in WaveForms Software

Step 4. Test individual LED control

- 4.1. Set **DIO0** to logic **1** and confirm that the corresponding LED turns on.
- 4.2. Set **DIO0** to logic **0** and confirm that the LED turns off.
- 4.3. Repeat the same test for **DIO1–DIO9**.

Step 5. Optional: Control LEDs using WaveForms Script - As an extension, participants can use the WaveForms Script instrument to automate LED control. The WaveForms documentation⁵ can be used to check the exact **StaticIO** scripting commands supported by the selected **Device** and WaveForms version.

⁵ [Using the script editor](#)

5.2 Interactive LED Array Visualizer Using NI LabVIEW WaveForms Toolkit

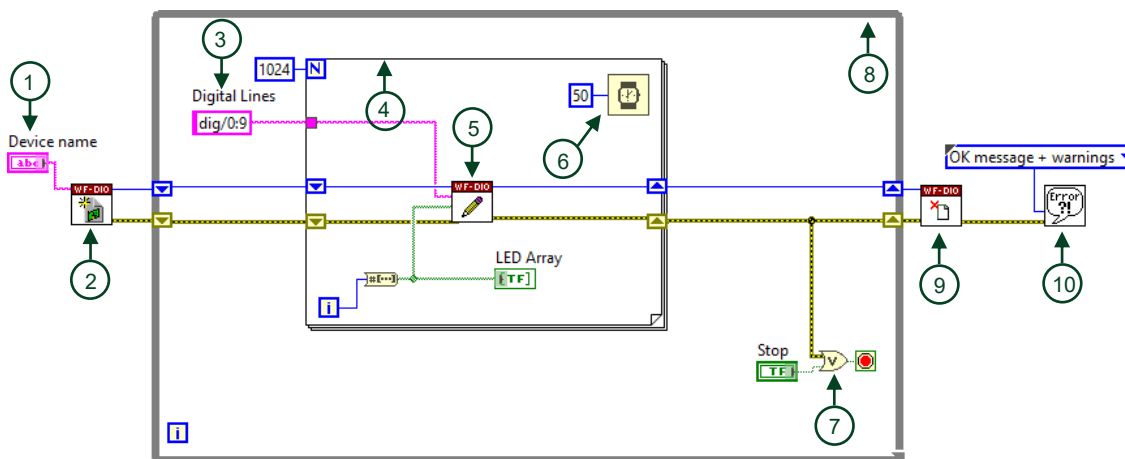
Step 1. Launch NI LabVIEW and connect the Device

- 1.1. Connect the **Device** to the computer via USB.
- 1.2. Open **Diligent Waveforms** and verify that **Device** is detected and shown as *Currently Selected* in the **Device Manager** (Settings -> Device Manager), then close **Diligent Waveforms** software⁶.
- 1.3. Open the **NI LabVIEW** software.
- 1.4. Create a new NI LabVIEW VI (**File->New VI**)

Step 2. Create Block Diagram and Front Panel in NI LabVIEW

- 2.1. Modify the block diagram as shown in **Figure 6**.

Figure 6 VI Block Diagram



1. **Device Name** – specifies the connected **Device** name. Use the correct device name according to the connected hardware.
2. **WF-DIO Initialize** – initializes the digital I/O session for the selected **Device**.
3. **Digital Lines** – defines the digital output lines used for the LED array. In this VI, dig/0:9 is used to control DIO0–DIO9.
4. **For Loop for Binary Counting** – generates binary values from 0 to 1023. Each iteration represents one binary number to be displayed on the LED array.
5. **WF-DIO Write** – writes the generated Boolean array to the selected digital lines and updates the physical LED states.
6. **Wait (ms)** – adds a short delay between LED updates. In this VI, the value is set to 50 ms.
7. **Stop Control / Error Stop Logic** – stops the While Loop when the Stop button is pressed or when an error occurs.
8. **While Loop** – keeps the VI running continuously until the user presses Stop or an error is detected.
9. **WF-DIO Close** – closes the digital I/O session and releases the DIO resources.
10. **Simple Error Handler** – displays possible errors or warnings after the VI execution.

⁶ Before running NI LabVIEW, please ensure that the Diligent WaveForms software is closed.

- 2.2. Modify the front panel shown in **Figure 7**. Inside **Device name** String Control write your corresponding **Device** name from **Table 2**.

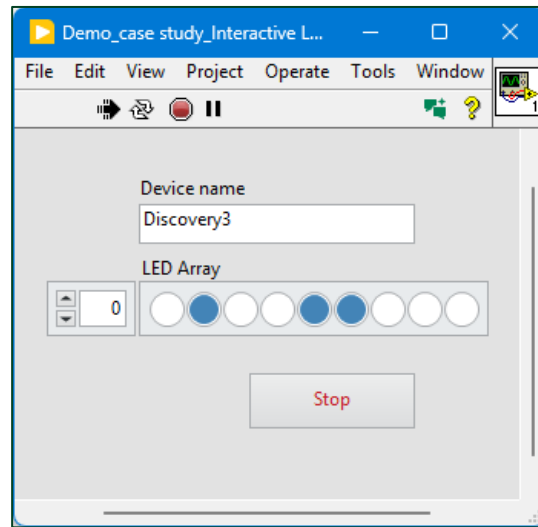


Figure 7. VI Front Panel

- 2.3. Save the VI.

Step 3. Run the code and test interactive LED array in LabVIEW

- 3.1. Observe the LED array as it displays the binary counting sequence.
- 3.2. Check that the LEDs connected to **DIO0–DIO9** turn on and off according to the generated binary values.
- 3.3. Stop the VI using the **Stop** button.

Optional: Try modifying the delay value to make the LED sequence faster or slower. Participants can also change the counting logic to create different LED patterns, such as left-to-right shifting, blinking, or custom visual sequences.