

LDR Light Sensor - Measuring Light Intensity through Voltage Using Diligent Measurement Platforms

Case Study

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1. Overview

Short description: This **Case study** introduces the foundational concepts of measurement and sensor-based data acquisition. Step-by-step instructions explain how to build a simple, interactive program using Analog Discovery Product Line ([AD3](#) or [AD Studio](#) / [Studio MAX](#), hereby **Device**) to measure light intensity via voltage readings from an LDR. The **Case study** utilizes Oscilloscope in conjunction with NI LabVIEW to read and visualize the relationship between light intensity and voltage ([WaveForms software](#)).

Objectives

- Understand the operating principle of LDR sensors
- Analyze voltage divider behavior under changing illumination
- Configure Digilent device power supply and analog input channels
- Acquire and visualize real-time voltage signals
- Interpret measurement results and sensor characteristics

Software & Hardware Requirements

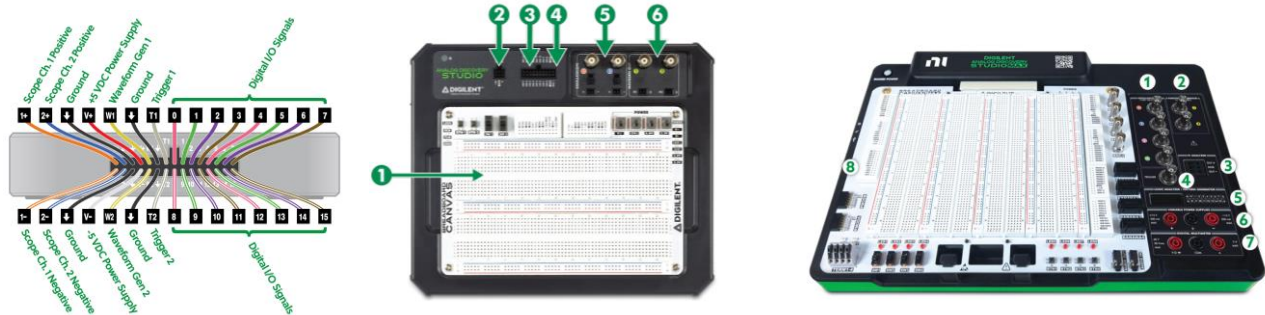
Software		Version
Digilent WaveForms (Runtime + SDK)		Latest (64-bit)
NI LabVIEW		2025 64-bit
WaveForms Toolkit for LabVIEW		Latest
Hardware		Quantity*
Digilent Analog Discovery Product Line		
Option 1	Digilent Analog Discovery 3	1
Option 2	Digilent Analog Discovery Studio	1
Option 3	Digilent Analog Discovery Studio MAX	1
List of Components		Quantity*
Canvas Breadboard		1
LDR (≈10 kΩ nominal)		1
Resistor 10 kΩ		1
LED (5mm, 2-2.5V) ¹		1
Resistor 220 Ω		1
Jumper wires		-
BNC to BNC cable ²		1

¹ The LED with a current-limiting resistor ($220\ \Omega$) can optionally be added to the circuit to provide a visual indication of light intensity changes during the experiment.

² 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.³



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

³ 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

<i>Channel Device</i>	<i>Scope Ch.1 Positive</i>	<i>Scope Ch.1 Negative</i>	<i>Scope Ch.2 Positive</i>	<i>Scope Ch.2 Negative</i>	<i>+V</i>
AD 3	Scope Ch.1 Positive (Pin 1+)	Scope Ch.1 Negative (Pin 1-)	Scope Ch.2 Positive (Pin 2+)	Scope Ch.1 Negative (Pin 2-)	+VDC Power Supply (Pin V+)
AD Studio ⁴	OSCILLOSCOPE 1 (Pin + or BNC Positive Cable)	OSCILLOSCOPE 1 (Pin - or BNC Negative Cable)	OSCILLOSCOPE 1 (Pin + or BNC Positive Cable)	OSCILLOSCOPE 2 (Pin - or BNC Negative Cable)	+5.0V (on canvas board)
AD Studio MAX ⁴	OSCILLOSCOPE 1 (BNC Positive Cable)	OSCILLOSCOPE 1 (BNC Negative Cable)	OSCILLOSCOPE 2 (BNC Positive Cable)	OSCILLOSCOPE 2 (BNC Negative Cable)	+5.0V (on canvas board)

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

<i>Identifier Device</i>	<i>Device name</i>	<i>Scope Ch.1</i>	<i>Scope Ch.2</i>	<i>PS</i>
AD 3	Discovery3	mso/1	mso/2	Ps/+
AD Studio ⁴	DiscoveryStudio			
AD Studio MAX ⁴	ADS_Max			

⁴ 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 LDR (Light Dependent Resistor) is a passive resistive sensor whose resistance decreases as light intensity increases. To convert resistance variation into a measurable electrical quantity, the LDR is placed in a voltage divider circuit:

$$V_{out} = V_{in} \cdot \frac{R_{LDR}}{R_{fixed} + R_{LDR}}$$

As illumination changes:

1. More light → lower LDR resistance → lower output voltage
2. Less light → higher resistance → higher output voltage

This voltage is measured using the **Device** Scope input channel.

4. Circuit Design – step by step instructions

4.1 Description

The measurement circuit is based on a simple voltage divider configuration. The LDR is connected between the **+5V** power supply and the measurement node, while a fixed 10 kΩ resistor is connected between the measurement node and **GND**. The output voltage at the midpoint varies according to light intensity and is measured using the oscilloscope of the **Device**.

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.

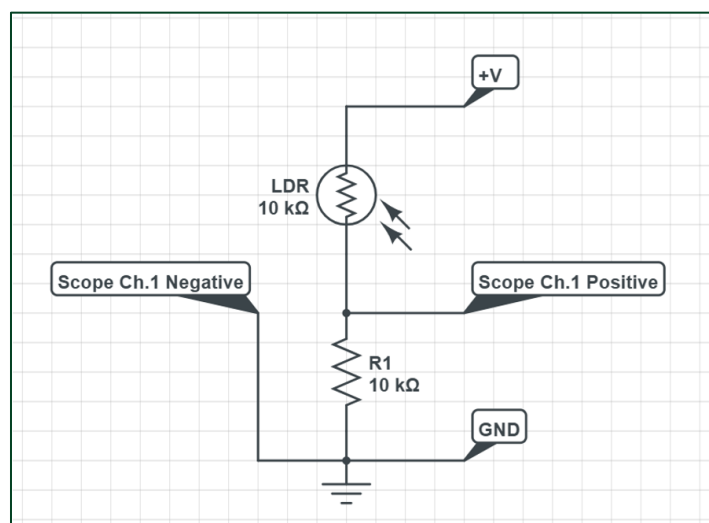


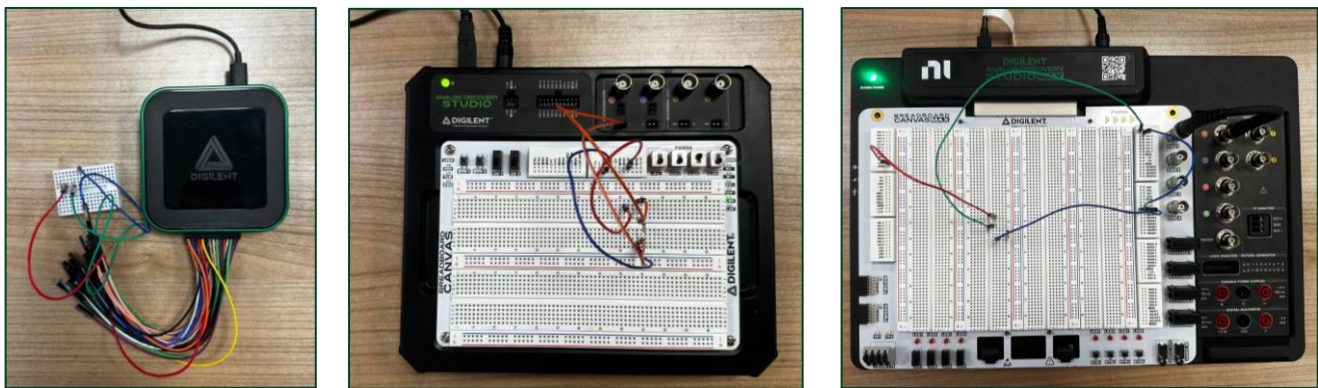
Figure 2. LDR Voltage Divider Circuit Diagram

4.2 Step by step instructions⁵

1. Place the LDR on the Canvas breadboard⁶, ensuring that its two terminals are inserted into different rows.
2. Connect one terminal of the LDR to the **Device +V** supply (see **Table 1**).
3. Connect the other terminal of the LDR to a breadboard row, which will serve as the measurement node.
4. Place the 10 kΩ resistor on the Canvas breadboard and connect one terminal of the resistor to the measurement node (the same row as the second terminal of the LDR).
5. Connect the other terminal of the 10 kΩ resistor to the **Device GND**.
6. Connect the measurement node to **Scope Ch.1 Positive** on the **Device** using a jumper wire or a BNC cable (if available).
7. Connect **Scope Ch.1 Negative** to **GND**.

4.3 Assembled Circuit

Figure 3 presents complete experimental circuits on different Digilent devices.



a. Analog Discovery 3

b. Analog Discovery Studio

c. Analog Discovery Studio MAX

Figure 3. Assembled circuits for different Devices

⁵ Given on Figure 2.

⁶ Use external breadboard in the case of Analog Discovery 3.

5. Software Setup - step by step instructions

5.1 Data Visualization and Analysis in Waveforms

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. Configure the Power Supply in WaveForms⁷

- 2.1. Open the **Supplies** instrument in **WaveForms**.
- 2.2. Enable the **Positive Supply (V+)**.
- 2.3. Set the output voltage to **+5.000 V DC**.
- 2.4. Enable the **Master Enable** switch to activate the power output.
- 2.5. Keep the **Negative Supply (V-)** disabled (a single positive voltage is only required for the LDR voltage divider circuit).

Figure 4 shows the configuration of the **Device** power supply using the Digilent WaveForms environment.

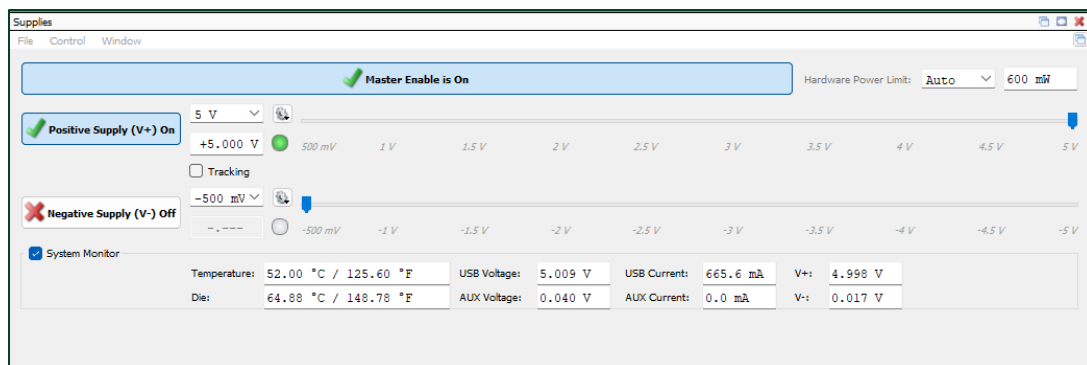


Figure 4. Power Supply Configuration in WaveForms Software

Step 3. Acquire the signal using the Oscilloscope⁸

- 3.1. Open the **Scope** instrument on WaveForms.
- 3.2. Enable **Channel 1**.
- 3.3. Adjust the **Range to 1 V/div** so the signal fits clearly on the screen.
- 3.4. Adjust the **Time Base to 100 ms/div** to observe stable voltage changes.

Figure 5 shows the real-time voltage signal acquired from the LDR voltage divider using the Scope tool in Digilent WaveForms. The displayed waveform represents voltage variations at the measurement node as the light intensity incident on the LDR changes, demonstrating the dynamic response of the sensor.

⁷ This step is mandatory for the Digilent Analog Discovery 3. Skip if you are using another device.

⁸ In the case of AD Studio turn the 5.0V switch on. In the case of AD Studio MAX turn Board Power on.

Note: During the experiment, the light intensity incident on the LDR is manually varied by partially covering or exposing the sensor with a hand, allowing direct observation of the effect of illumination changes on the measured voltage.

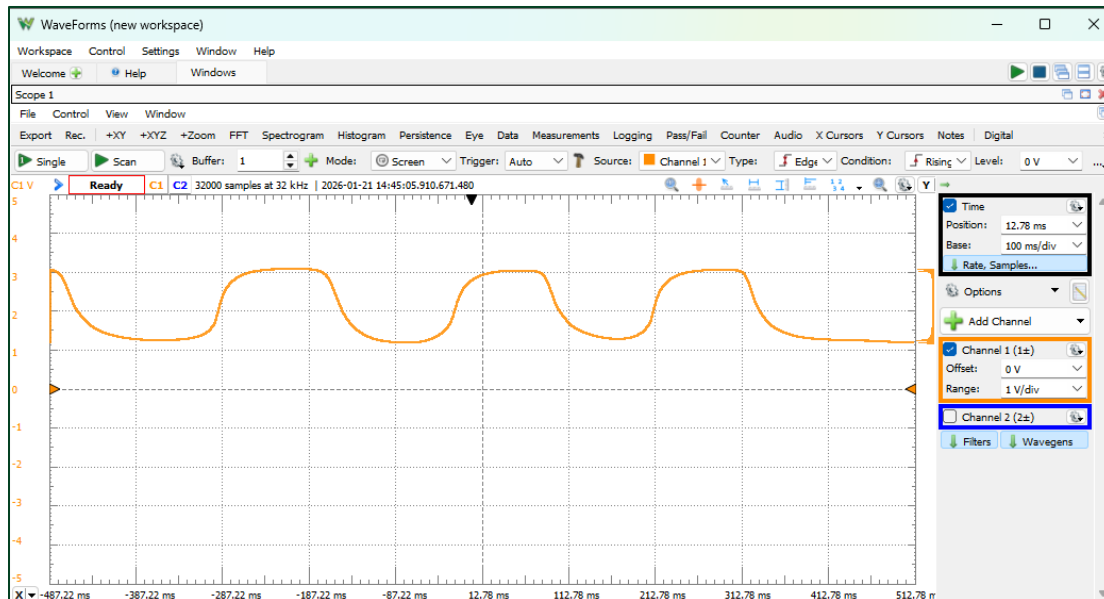


Figure 5. Real-Time Voltage Measurement Using WaveForms Oscilloscope

Step 4. Measure voltage levels using cursors

- 4.1. Click on the **Quick measure: Vertical** tool in the **Scope** window.
- 4.2. Use **Quick measure: Vertical** tool to mark the minimum and maximum voltage levels on the graph.
- 4.3. Read the corresponding voltage values displayed by the cursor indicators.

Figure 6 illustrates voltage level measurement using cursor tools in the WaveForms Oscilloscope. The cursors are used to determine minimum and maximum voltage values corresponding to different illumination conditions, enabling quantitative analysis of the LDR sensor response.

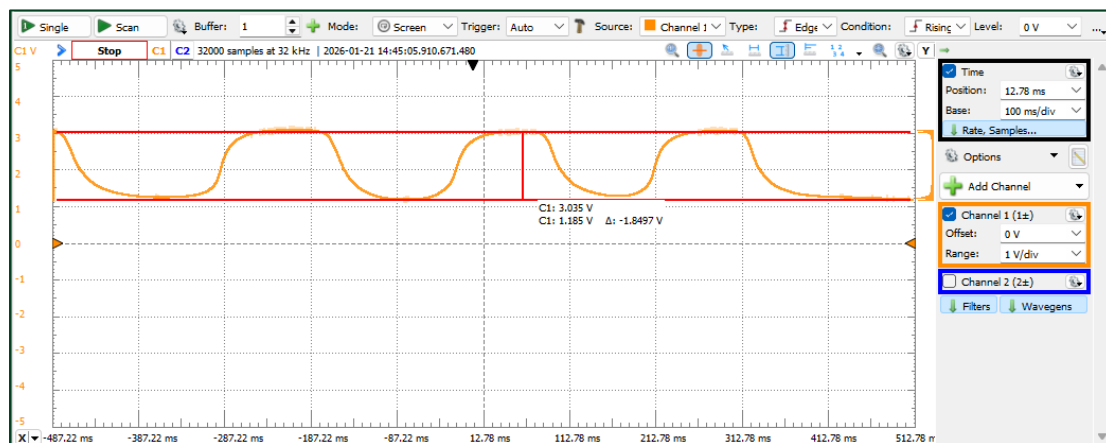


Figure 6. Voltage Level Measurement using WaveForms Cursor tools

1. **Device Name** - specify the name of your **Device**. Use **Table 2** for your **Device**.
2. **WF-MSO Initialize** - this VI initializes the scope.
3. **Scope Channel** - specify your **Device Scope Ch.1** channel. Use **Table 2** for your **Device**.
4. **WF-MSO Configure Analog Channel** - this VI configures the settings for the measurement channel. Connect Enable Channel to True constant.
5. **Merge Errors** (only for AD3) - used to combine error lines from the PS and MSO.
6. **WF-MSO Run** - Run the acquisition.
7. **WF-MSO Read** - Transfer data from the **Device** to NI LabVIEW. **Analog Waveforms** output connected to **Convert to Dynamic Data** function then to **Waveform Chart** to visualize the measured data.
8. **WF-MSO Close** - Remove the session and reset all values for scope.
9. **WF-PS Initialize** (only for AD3) - this VI initializes the power supply.
10. **PS Channel** (only for AD3) - specify your **Device PS** channel. Use **Table 2** for your **Device**.
11. **WF-PS Enable All Outputs** (only for AD3) - this VI enables all outputs for power supply.
12. **WF-PS Enable All Outputs** (only for AD3) - this VI configures voltage outputs for power supply.
13. **WF-PS Close** (only for AD3) - Remove the session and reset all values for power supply.
14. **Wait (ms)** - connect it to an integer constant and set the value to 30 ms.
15. **While Loop** - used to enable continuous data acquisition.
16. **OR** - Allow the code to stop using the **Stop** button or automatically when an error occurs.

- 2.2. Modify the front panel shown in **Figure 8**. Inside **Device name** String Control write your corresponding **Device** name from **Table 2**.

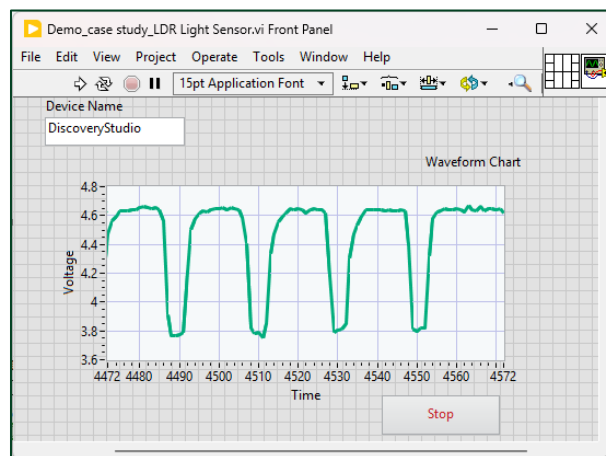


Figure 8. VI Front Panel

- 2.3. Save the VI.

Step 3. Run the code and do measurements in LabVIEW

- 3.1. Run the code by clicking on the **Run button**.
- 3.2. Right click on **Waveform Chart** and disable X axis autoscaling, by unchecking **X Scale-> AutoScale X** option.
- 3.3. Change light intensity to see the changes on the **Waveform Chart**. During the experiment, the light intensity incident on the LDR is manually varied by partially covering or exposing the sensor with a hand, allowing direct observation of the effect of illumination changes on the measured voltage.