

Wireless Communication with RF Transmitter and Receiver

Case Study

Contents

1. Overview	2
2. Hardware Setup	3
3. Background Information	5
4. Circuit Design – step by step instructions	5
4.1 Description	5
4.2 Step by step instructions	6
4.3 Assembled Circuit	7
5. Software Setup - step by step instructions	8
5.1 Wireless communication using NI LabVIEW WaveForms Toolkit	8

1. Overview

Short description: This **Case study** explores how wireless communication can be implemented using a simple RF transmitter and receiver pair. Participants send digital data from one **Analog Discovery Product Line** device to another device using RF modules. The transmitter device generates a digital bit sequence through a DIO line, which is sent wirelessly using the RF transmitter module. The receiver device reads the incoming signal through a DIO line, detects the transmitted bit pattern, converts the received bits into a digital value, and displays the result in the terminal. Based on the received value, a virtual LED indicator is turned ON or OFF, demonstrating basic wireless digital control.

Objectives

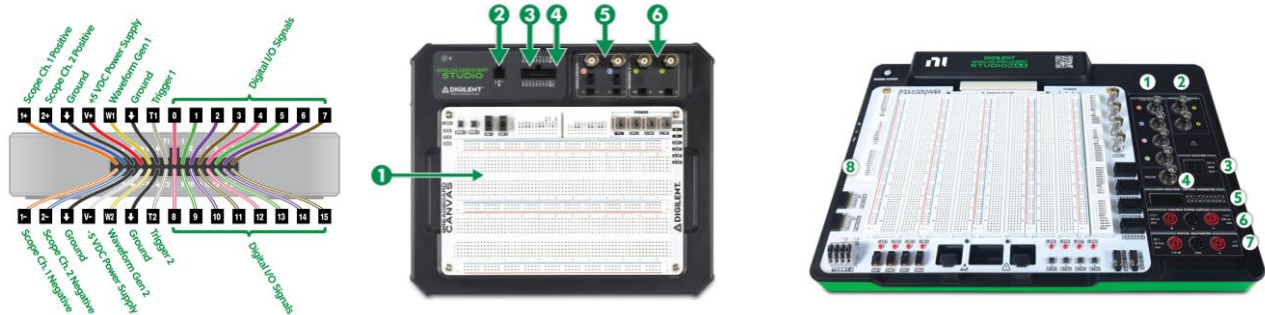
- Understand the basic working principle of RF transmitter and receiver modules for wireless digital communication.
- Configure the Device digital output line to generate and transmit a predefined bit sequence through the RF transmitter module.
- Configure the second Device digital input line to read the received RF signal and detect the transmitted data pattern.
- Convert received digital bits into an integer value and use this value to control a virtual LED indicator.
- Observe how simple digital data can be transferred wirelessly between two devices using DIO lines and RF communication modules.

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	
Option 2	Digilent Analog Discovery Studio	
Option 3	Digilent Analog Discovery Studio MAX	2
List of Components		Quantity
Canvas Breadboard		1
RF 433Mhz Transmitter and Receiver		1
Jumper wires		-

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.¹



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

¹ 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	+Vs
AD 3	Digital Channel 0	+VDC Power Supply (Pin V+)
AD Studio ²		+5.0V (on canvas board)
AD Studio MAX		+5.0V (on canvas board)

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

Identifier Device	Device name	Digital Line
AD 3	Discovery3	dig/0
AD Studio	DiscoveryStudio	
AD Studio MAX	ADS_Max	

² 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

Wireless communication allows digital data to be transferred between two devices without a physical signal wire. In this case study, a simple RF transmitter and RF receiver module pair is used to send a digital bit sequence from one **Device** to another. The transmitter **Device** generates a predefined digital signal through **DIO0**, which is connected to the DATA input of the RF transmitter module. The RF transmitter converts this digital signal into a radio-frequency signal and sends it wirelessly. On the receiver side, the RF receiver module detects the transmitted radio signal and converts it back into a digital signal. This signal is read by the second **Device** through **DIO0**. If the received value is greater than zero, a virtual **LED** is turned **ON**; otherwise, it remains **OFF**.

4. Circuit Design – step by step instructions

4.1 Description

The circuit consists of two separate parts: the transmitter side and the receiver side. The transmitter side uses one **Analog Discovery Product Line device**, connected to an RF transmitter module. The receiver side uses a second **Analog Discovery Product Line device**, connected to an RF receiver module.

Both the RF transmitter module and RF receiver module are powered from the corresponding **Device** supply output. The **VCC** pins of the RF modules are connected to the **Device** positive supply output (**+Vs**), and the **GND** pins are connected to the **Device GND**. The **DATA** pin of the RF transmitter module is connected to the **DIO0** channel of the **transmitter Device**. The **DATA** pin of the RF receiver module is connected to the **DIO0** channel of the **receiver Device**.

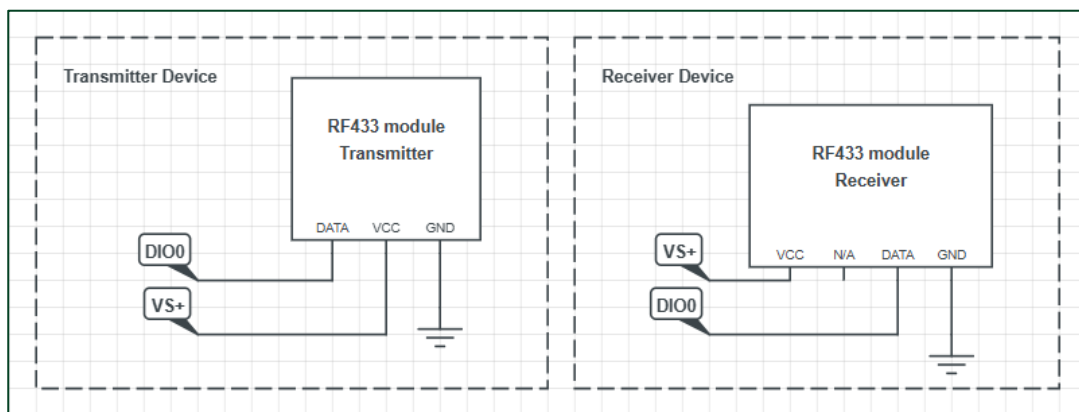


Figure 3. RF Transmitter and Receiver Connection Circuit

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.

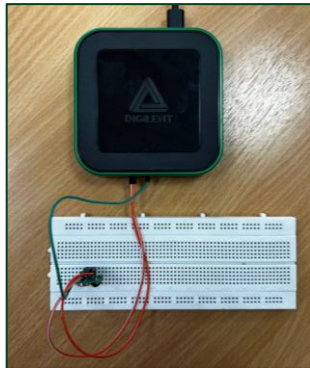
4.2 Step by step instructions³

1. Place the RF transmitter and receiver modules on the corresponding Canvas breadboards.
2. Connect the **VCC** pin of the RF transmitter module to the **transmitter Device** positive supply (**+Vs**).
3. Connect the **GND** pin of the RF transmitter module to the **transmitter Device GND**.
4. Connect the **DATA** pin of the RF transmitter module to the **DIO0** channel of the **transmitter Device**.
5. Connect the **VCC** pin of the RF receiver module to the **receiver Device** positive supply (**+Vs**).
6. Connect the **GND** pin of the RF receiver module to the **receiver Device GND**.
7. Connect the **DATA** pin of the RF receiver module to the **DIO0** channel of the **receiver Device**.
8. If external antennas are used, connect a suitable antenna wire to the antenna pin of the RF transmitter and RF receiver modules.
9. Ensure that each RF module is connected and powered from its corresponding **Device**.

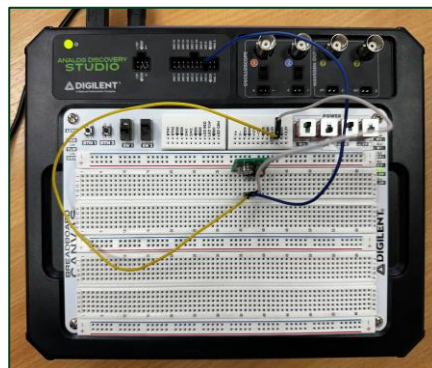
³ Given on Figure 3.

4.3 Assembled Circuit

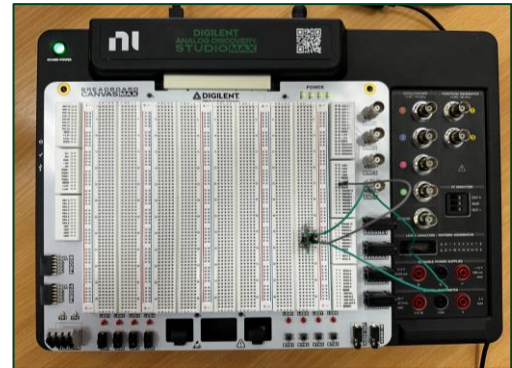
Figure 4 presents complete experimental circuits on different Digilent devices.



a. Analog Discovery 3

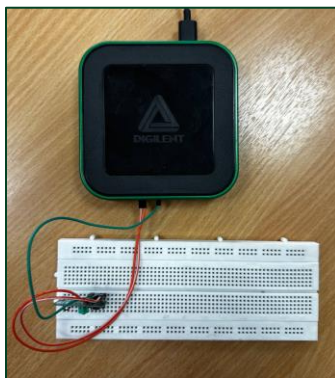


b. Analog Discovery Studio

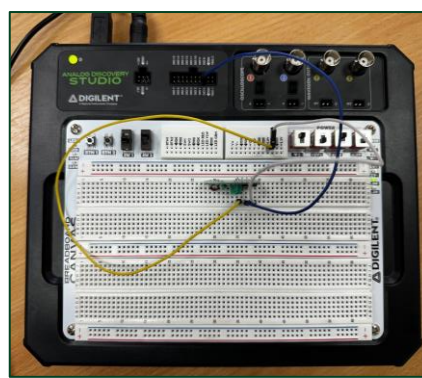


c. Analog Discovery Studio MAX

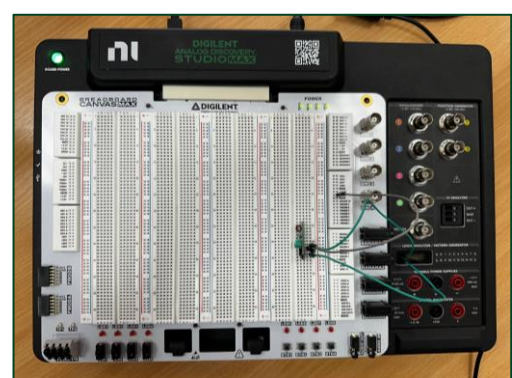
Figure 4a. Assembled circuits for transmitter Devices



a. Analog Discovery 3



b. Analog Discovery Studio



c. Analog Discovery Studio MAX

Figure 4b. Assembled circuits for receiver Devices

1. **Device Name** - specify the name of your **Device**. Use **Table 2** for your **Device**.
2. **WF-DIO Initialize** - this VI initializes the digital lines.
3. **WF-DIO Write** – sets the initial state of the selected digital output line. In this VI, **DIO0** is used as the digital output channel for transmitting data to the RF transmitter module.
4. **Select Function** – selects which Boolean bit sequence should be transmitted based on the **Button** state.
5. **For Loop** – sends the selected Boolean array bit by bit. Each element of the selected bit sequence is passed into the loop one at a time.
6. **WF-DIO Write inside For Loop** – writes each Boolean bit to **DIO0**. This digital signal is connected to the **DATA** pin of the RF transmitter module.
7. **Stop Button and Stop Logic** – stops the While Loop when the user presses the Stop button. The loop can also be stopped if an error occurs during execution.
8. **WF-DIO Close** – closes the digital input/output session and releases the DIO resources after the VI stops.
9. **While Loop** – continuously generates and transmits the selected digital bit sequence while the VI is running.
10. **WF-PS Initialize** – initializes the power supply session for the **Device**.
11. **WF-PS Enable** – enables the selected power supply output. In this VI, the positive supply output is enabled to power the RF transmitter module.
12. **WF-PS Voltage** – configures the positive supply output voltage and current limit. For this setup, the positive supply is configured as +5 V for the RF transmitter module.
13. **WF-PS Close** – closes the power supply session and releases the power supply resources after the VI stops.

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

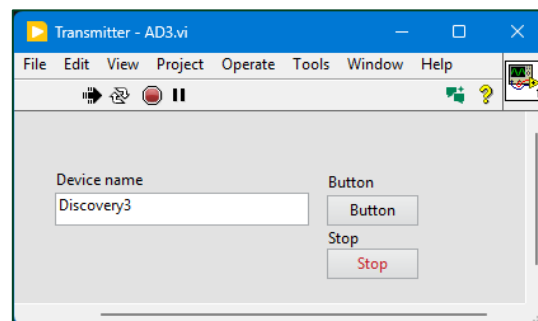


Figure 8. Transmitter VI Front Panel

- 2.4. Save the VI.
- 2.5. Create a new NI LabVIEW VI (**File->New VI**) for **receiver Device**.
- 2.6. Modify the block diagram as shown in **Figure 9**.

Figure 9a Receiver VI Block Diagram for ADS and ADS MAX

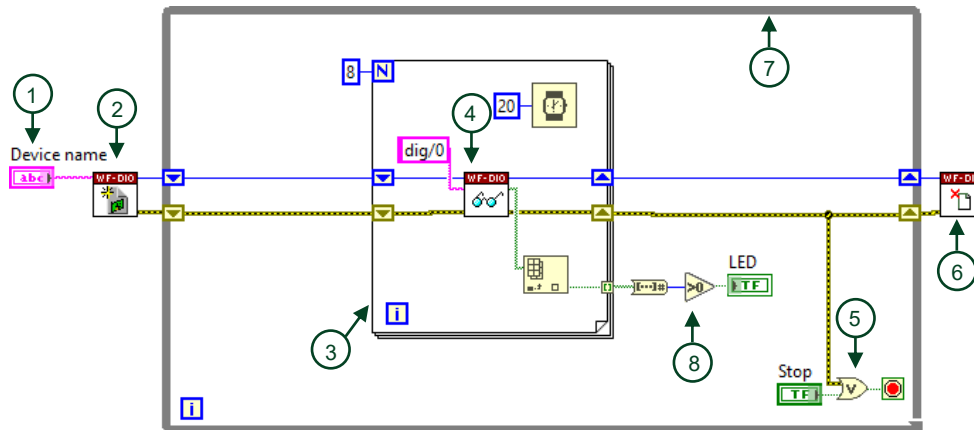
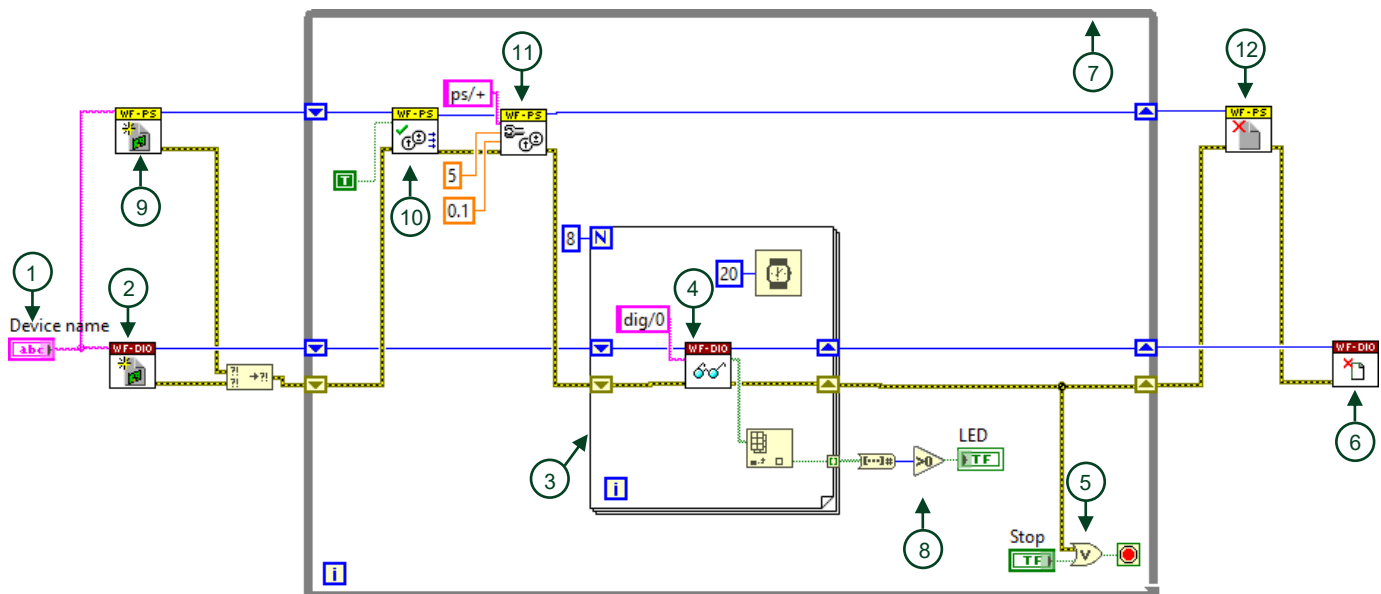


Figure 9b Receiver VI Block Diagram for AD 3



1. **Device Name** - specify the name of your **Device**. Use **Table 2** for your **Device**.
2. **WF-DIO Initialize** – initializes the digital input/output session for the **Device**. In this VI, **DIO0** is used as the digital input channel for reading data from the RF receiver module.
3. **For Loop** – reads a fixed number of received bits from **DIO0**. In this VI, the loop runs 8 times to collect 8 digital bits from the receiver module.
4. **WF-DIO Read** – reads the digital state of **DIO0** during each iteration of the For Loop. Each read value represents one received bit from the RF receiver module. The Wait function inside the loop adds a 20 ms delay between bit readings.
5. **Stop Button and Stop Logic** – stops the While Loop when the user presses the Stop button. The loop can also be stopped if an error occurs during execution.
6. **WF-DIO Close** – closes the digital input/output session and releases the DIO resources after the VI stops.

7. **While Loop** – continuously reads incoming digital data from the RF receiver module while the VI is running.
8. **Boolean Array to Number and LED Indicator** – converts the received 8-bit Boolean array into a numeric value. If the converted value is greater than zero, the LED indicator turns ON; otherwise, the LED indicator remains OFF.
9. **WF-PS Initialize** – initializes the power supply session for the **Device**.
10. **WF-PS Enable** – enables the selected power supply output. In this VI, the positive supply output is enabled to power the RF receiver module.
11. **WF-PS Voltage** – configures the positive supply output voltage and current limit. For this setup, the positive supply is configured as +5 V for the RF receiver module.
12. **WF-PS Close** – closes the power supply session and releases the power supply resources after the VI stops.

-
- 2.7. Modify the front panel shown in **Figure 10**. Inside **Device name** String Control write your corresponding **Device** name from **Table 2**.

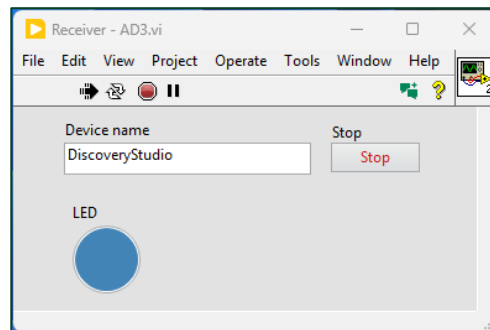


Figure 10. Receiver VI Front Panel

- 2.8. Save the VI.

Step 3. Run the code and test wireless communication in LabVIEW

- 3.1. Run the transmitter VI by clicking on the **Run button**.
- 3.2. Run the receiver VI by clicking on the **Run button**.
- 3.3. On the transmitter VI front panel, click the **Button** control to change the transmitted digital command.
- 3.4. Observe the receiver VI front panel and check that the received data is detected correctly.
- 3.5. When the transmitted value is greater than zero, observe that the virtual LED indicator on the receiver VI turns ON.
- 3.6. When the transmitted value is zero, observe that the virtual LED indicator on the receiver VI turns OFF.
- 3.7. **Optional:** connect a physical push button to the transmitter side instead of using the virtual Button control in LabVIEW.
- 3.8. **Optional:** connect a physical LED with a current-limiting resistor to the receiver side instead of using only the virtual LED indicator.
- 3.9. Stop both VIs using the **Stop buttons**.