Quick Start Guide

Overview:

The PLUTOSDR NANO Software Defined Radio (SDR) development board is a derivative of the ADALM-PLUTO by Analog Devices. Both utilize a design scheme based on the AD9363 RF transceiver and the ZYNQ7010 FPGA. It is a powerful SDR device providing users with wide frequency coverage and robust processing capabilities. This guide covers unboxing inspection, device connection, basic functional testing, and communication verification.

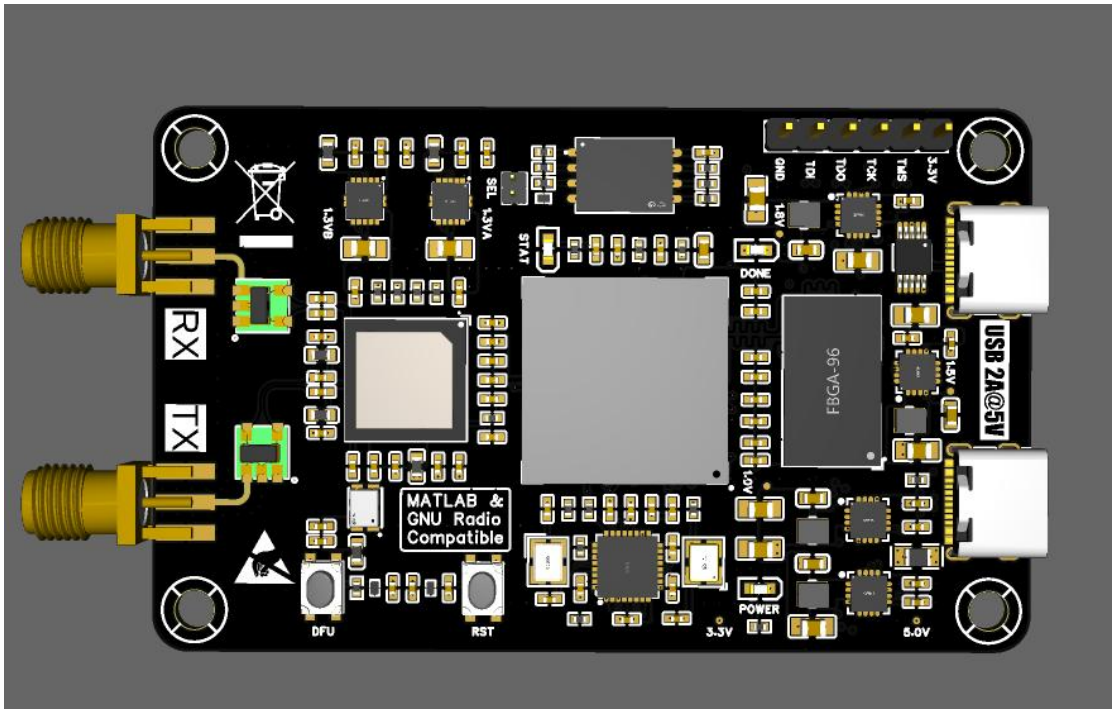

Figure 1: Front View

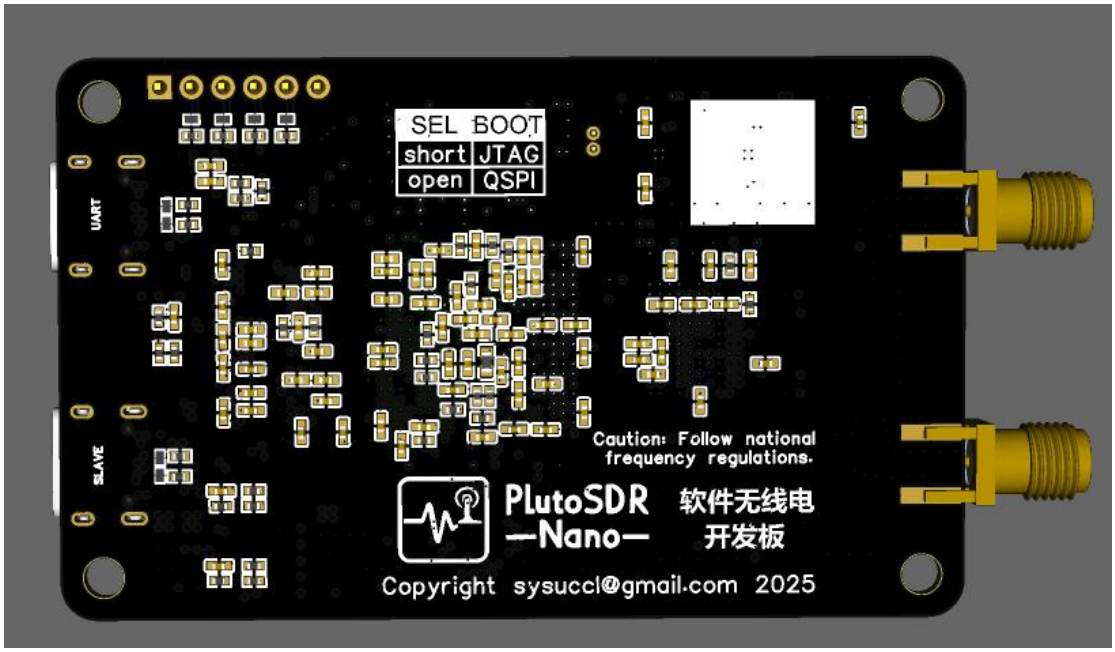

Figure 2: Back View

1. Unboxing Inspection

The PLUTOSDR NANO package includes:

* **Mainboard**: The core device featuring the AD9363 RF transceiver and the ZYNQ7000 series XC7Z010CLG-400C SoC.
* **Data Cable**: A Type-C cable used to connect the device to a computer.
* **Antennas**: 700 MHz – 2700 MHz antennas for transmitting and receiving radio signals.

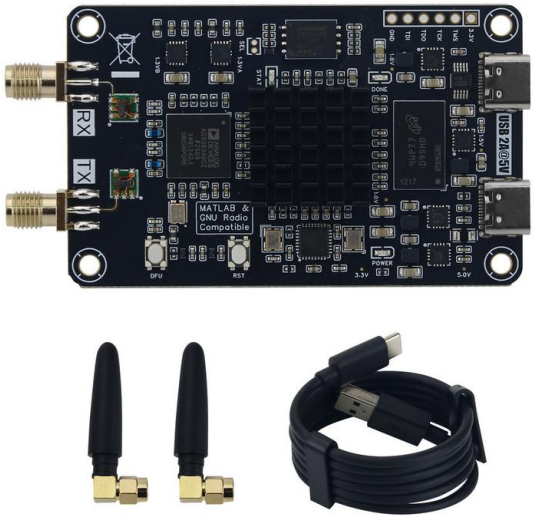

Figure 3: Unboxing Contents

2. Device Connection

2.1. Driver Installation: Double-click to execute PlutoSDR-M2k-USB-Drivers.exe to install the

Pluto SDR USB driver. After installation, restart the computer.

2.2. Connecting the Data Cable: Connect the Type-C port on the PLUTOSDR NANO mainboard, labeled as Slave (the other one is the UART port, which will be used later), to the computer's USB port using the supplied data cable. It is recommended to use a USB 3.0 port on the computer (blue, with higher power capacity). Additionally, prepare another Type-C data cable to connect the UART port to the computer.

2.3. Device Recognition: In the Windows environment, after a short wait, the STAT indicator on the mainboard will blink, and the DONE indicator will stay on, indicating that the device is operating normally. PLUTOSDR NANO will be recognized by the computer as a mass storage device, as shown in Figure 4. In the Device Manager, you will also find the newly added PlutoSDR USB Ethernet/RNDIS Gadget virtual network card, PlutoSDR Serial Console virtual serial port, USB-SERIAL CH340, and General Serial Communication Device IIO, as shown in Figure 5.

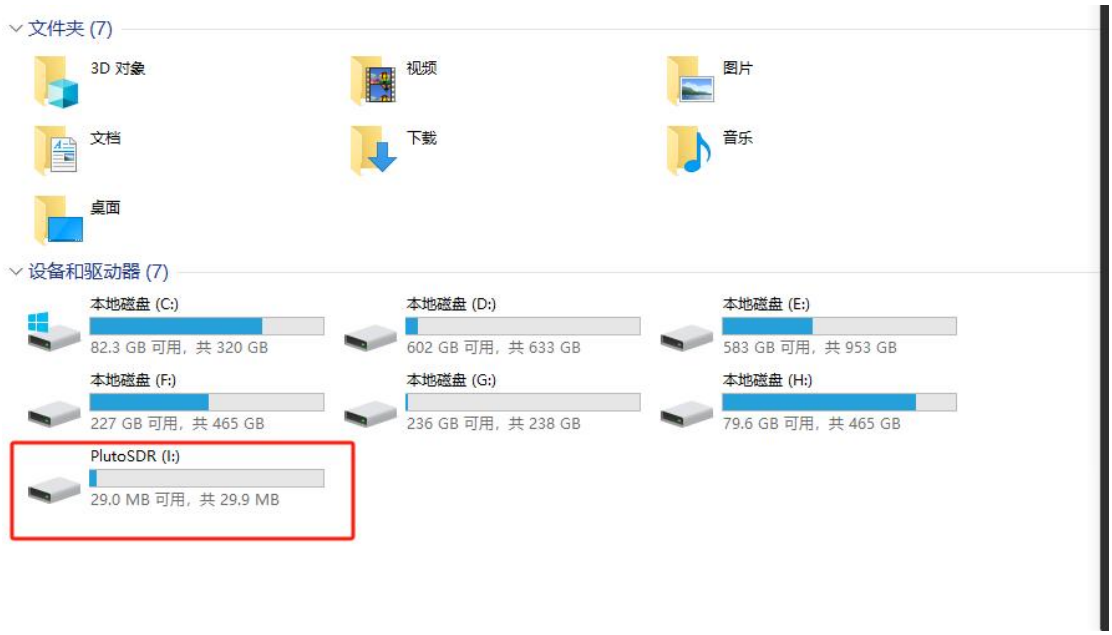

Figure 4: Virtual Disk Drive

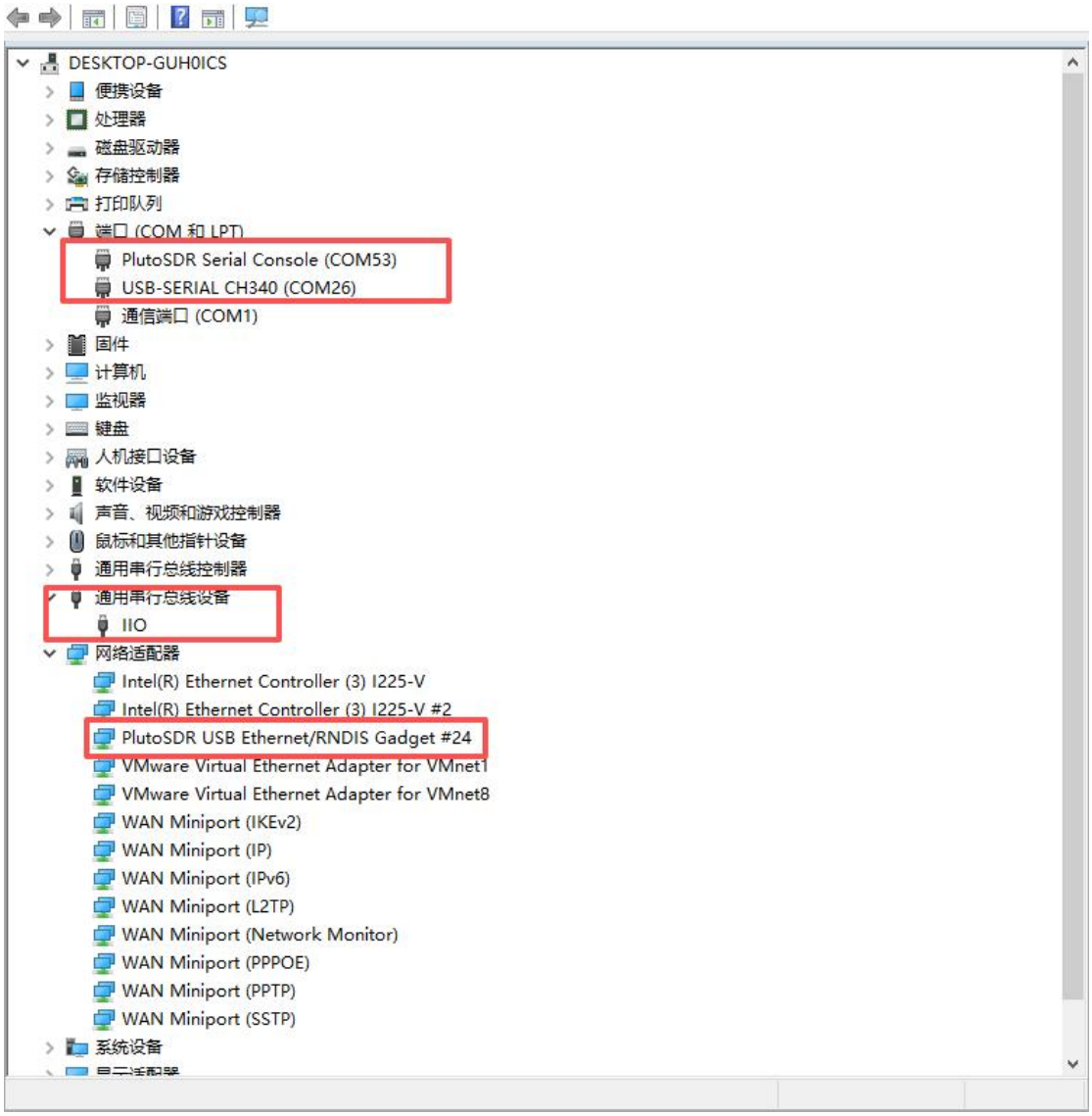

Figure 5: Device Manager

3. Basic Functional Testing

3.1. Disk Functionality: Double-click the info.html file in the root directory of the mass storage device to open it in a browser. This will display the usage instructions and related information for PLUTOSDR NANO, as shown below:

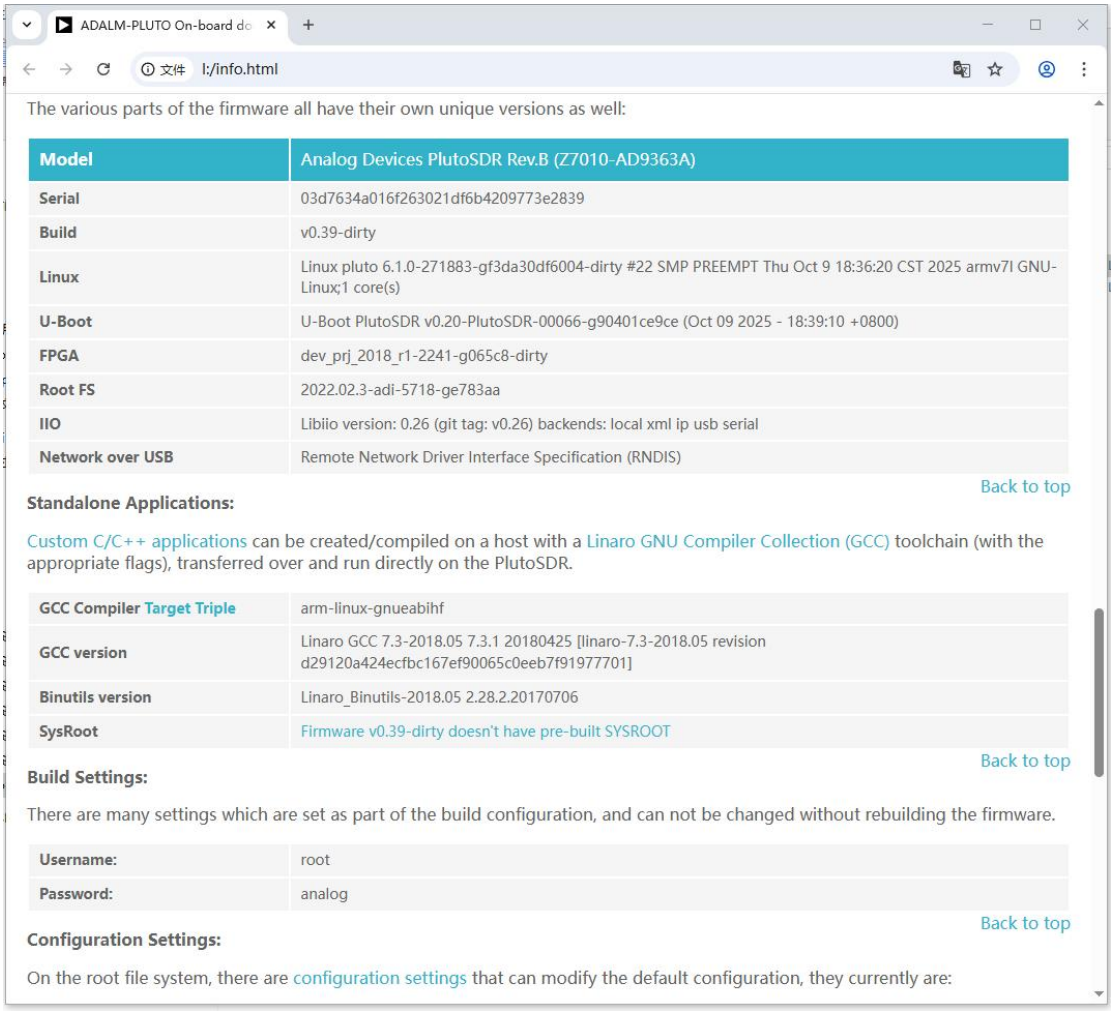

Figure 6: Information Page

3.2. Virtual Serial Port: Open the Device Manager to check the COM port assigned by the system to the virtual serial port. Use a serial communication tool (e.g., PUTTY) to connect to the corresponding COM port. Press the Enter key to trigger the login prompt. Log in to the mainboard console with the username: root and password: analog, as shown below:

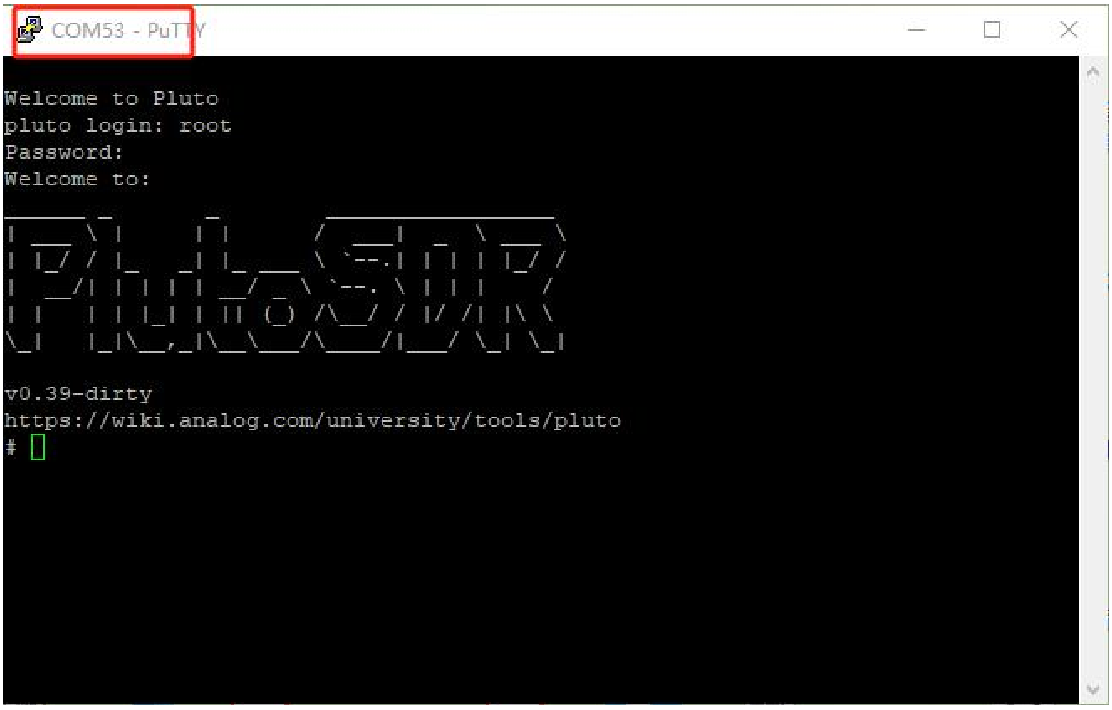

Figure 7: Logging in via Virtual Serial Port

3.3. Virtual Network Card: The default IP address of the virtual network card is 192.168.2.1. Open your browser and navigate to http://192.168.2.1/index.html to view the usage instructions and relevant information for the PLUTOSDR NANO. This page is identical in content to the index.html file found on the disk in Step 1. Alternatively, you can execute a ping command in the command console as shown in the figure below:

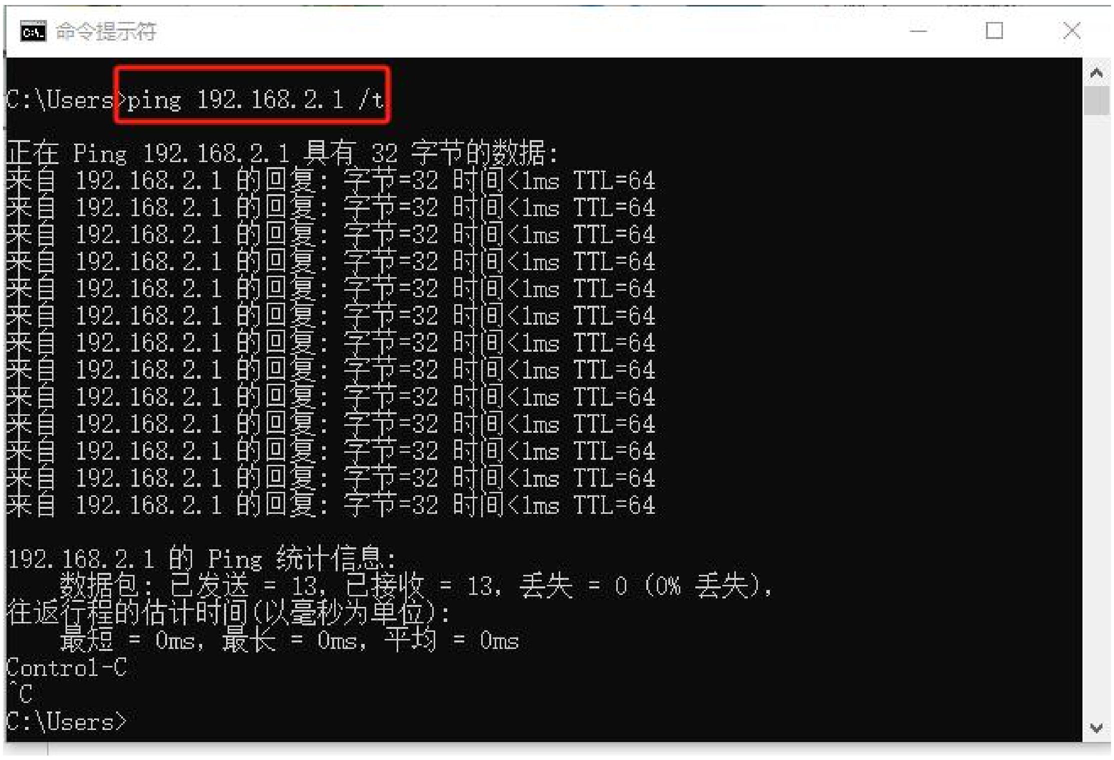

Figure 8: Network Connectivity Test

At this point, the basic functions of the SDR, such as disk functionality, virtual serial port, and virtual network card, are working normally. If the disk disappears automatically and keeps re-enumerating, it may be due to insufficient power supply from the computer's USB port. In this case, you can connect another Type-C port (USB to UART) to the computer and use dual USB ports for power supply.

4. Communication Function Test (Loopback Test)

4.1. Download and Install IIO Oscilloscope: IIO Oscilloscope is an official software from Analog Devices used to test the hardware integrity of SDR devices. After double-clicking the adi-osc-setup.exe to complete the installation, the following interface will appear when you run the software:

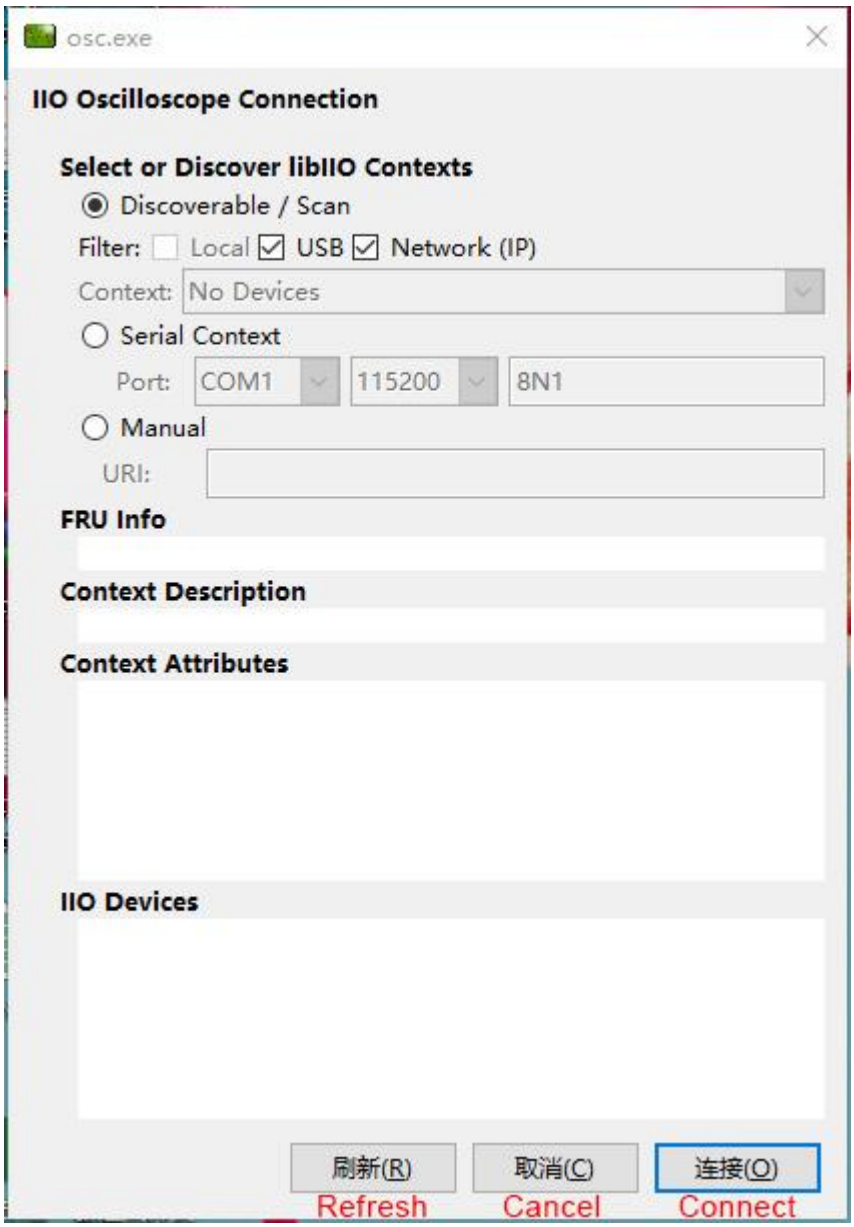

Figure 9: IIO Oscilloscope Device Scanning Interface

IIO Oscilloscope typically runs with two windows. One window is titled "ADI IIO Oscilloscope", which is used to set the working parameters, referred to as the control window hereafter. The other window is titled "ADI IIO Oscilloscope – Capture", which is used to display signal waveforms and spectra, referred to as the plotting window hereafter.

4.2. Device Recognition: Connect the PLUTOSDR NANO to the computer. When the device's STAT indicator starts blinking and a mass storage device appears, click the "Refresh" button in Figure 9. The software will detect the device and display related information, including the device serial number (within the red box, which is the device's unique identifier), as shown in Figure 10.

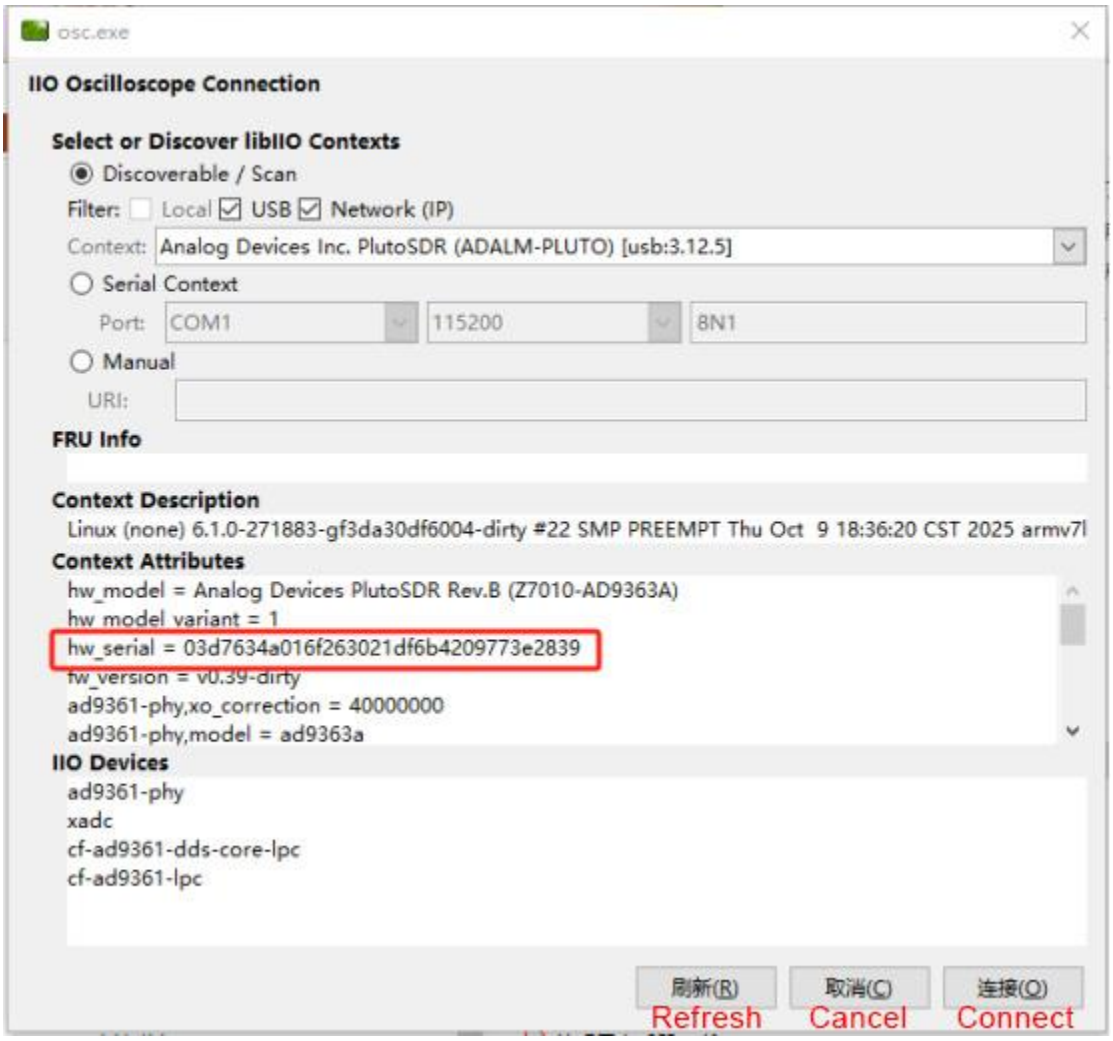

Figure 10

4.3. Device Connection: Click the "Connect" button in Figure 10 to enter dual-window mode.

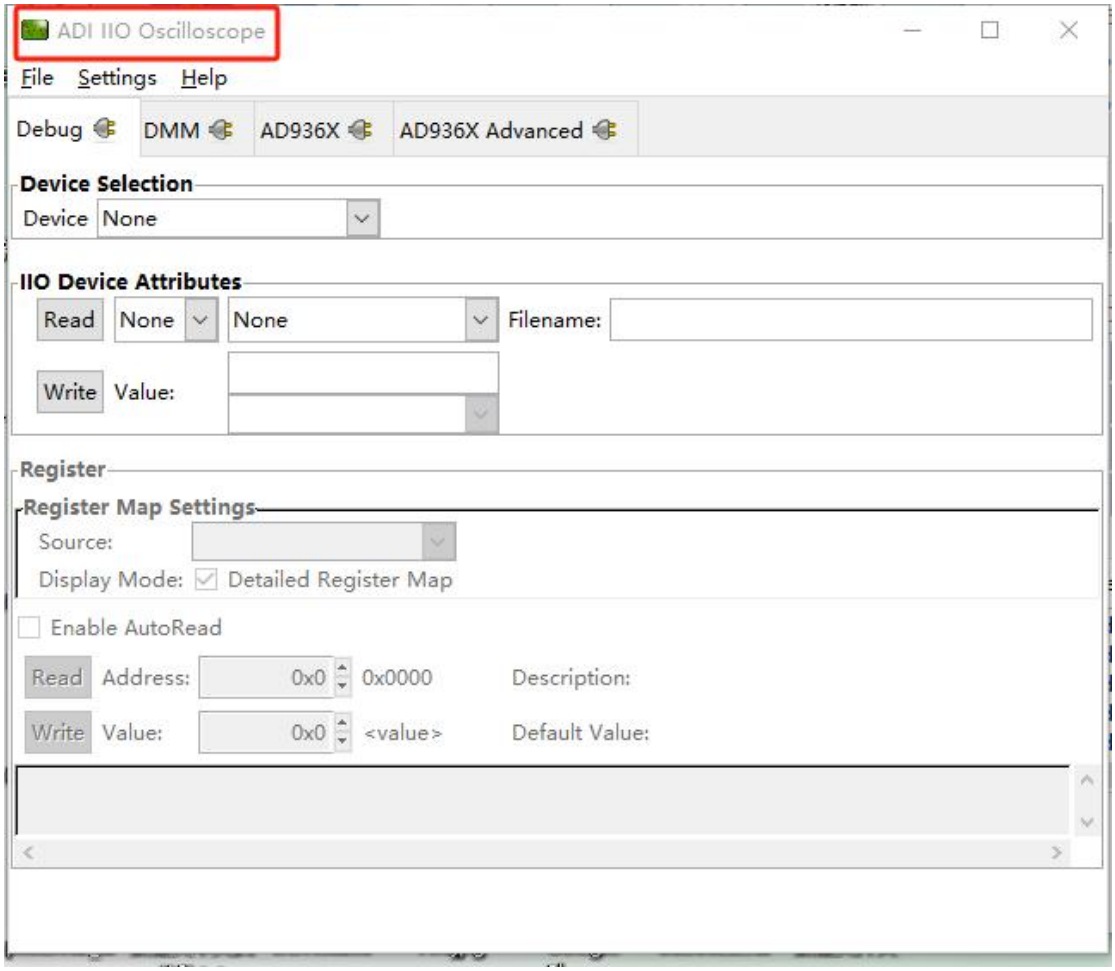

Figure 11: IIO Oscilloscope Control Window

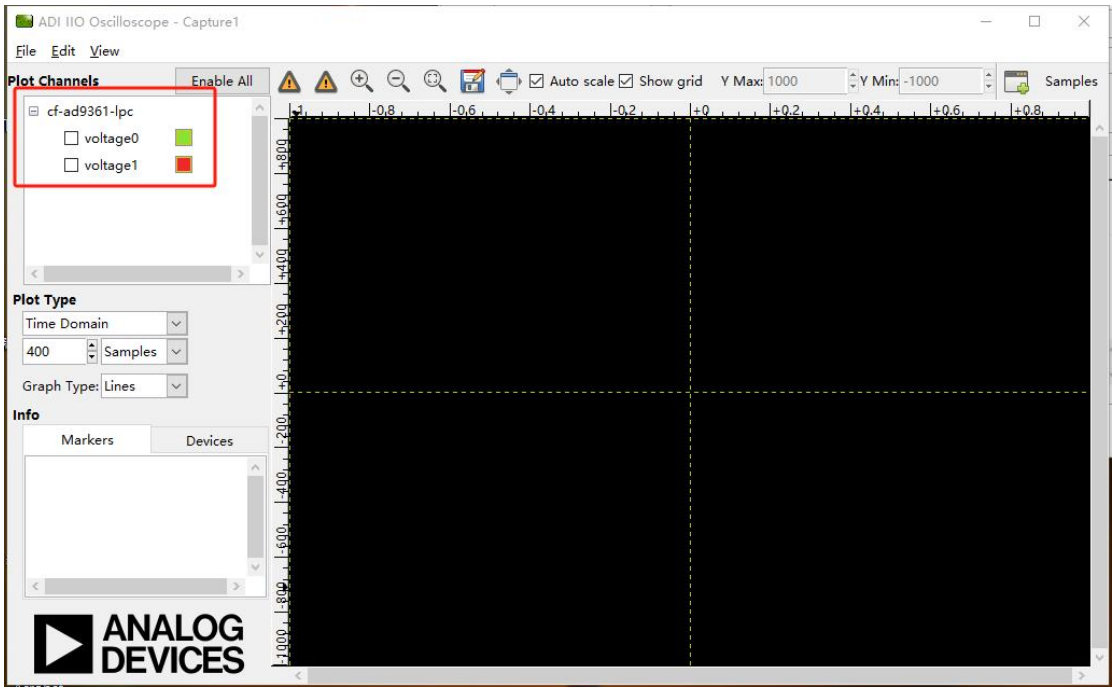

Figure 12: IIO Oscilloscope Plotting Window

In Figure 11, switch to the DMM tab, check the relevant options as shown in the image, and then click the triangle symbol button to view real-time sensor data from the AD936X and ZYNQ 7010 chips:

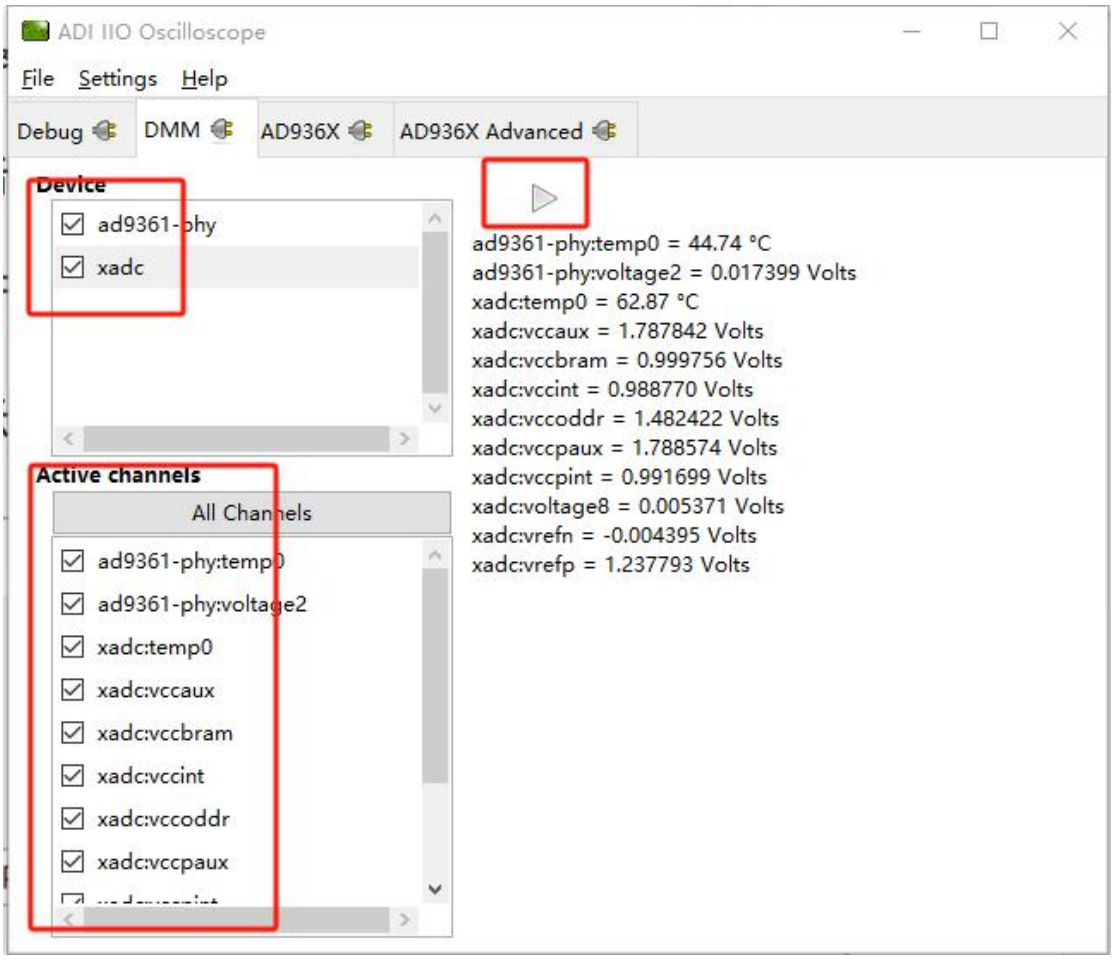

Figure 13: IIO Oscilloscope Control Window DMM Tab

4.4. Install Antennas: Properly install the two antennas for transmission and reception onto the SMA connectors on the SDR mainboard, and gently tighten the nuts. When installing for the first time, be careful to align the pinholes and avoid using excessive force to prevent damaging the antenna or SMA connector.

4.5. Pay attention to the content in the red box in the plotting window: voltage0 and voltage1. Click the "Enable All" button, then click the triangle icon (the run button) to display the waveform, as shown below:

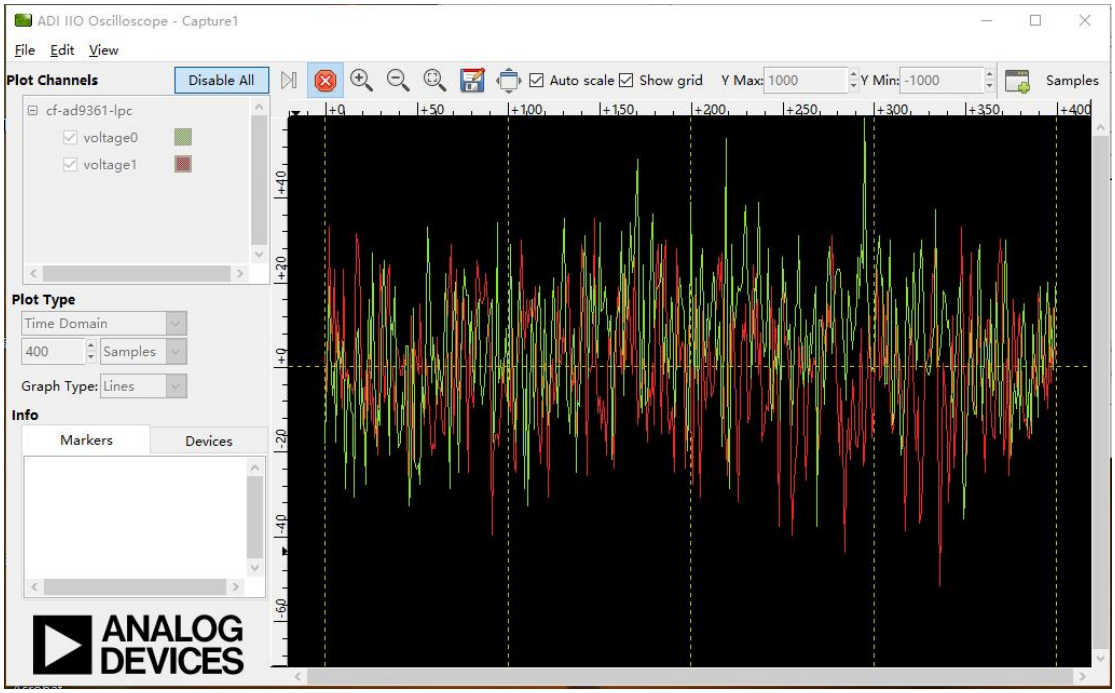

Figure 14: IIO Oscilloscope Plotting Window

4.6. Switch to the control window and select the AD936X tab. Set the parameters as shown in the image:

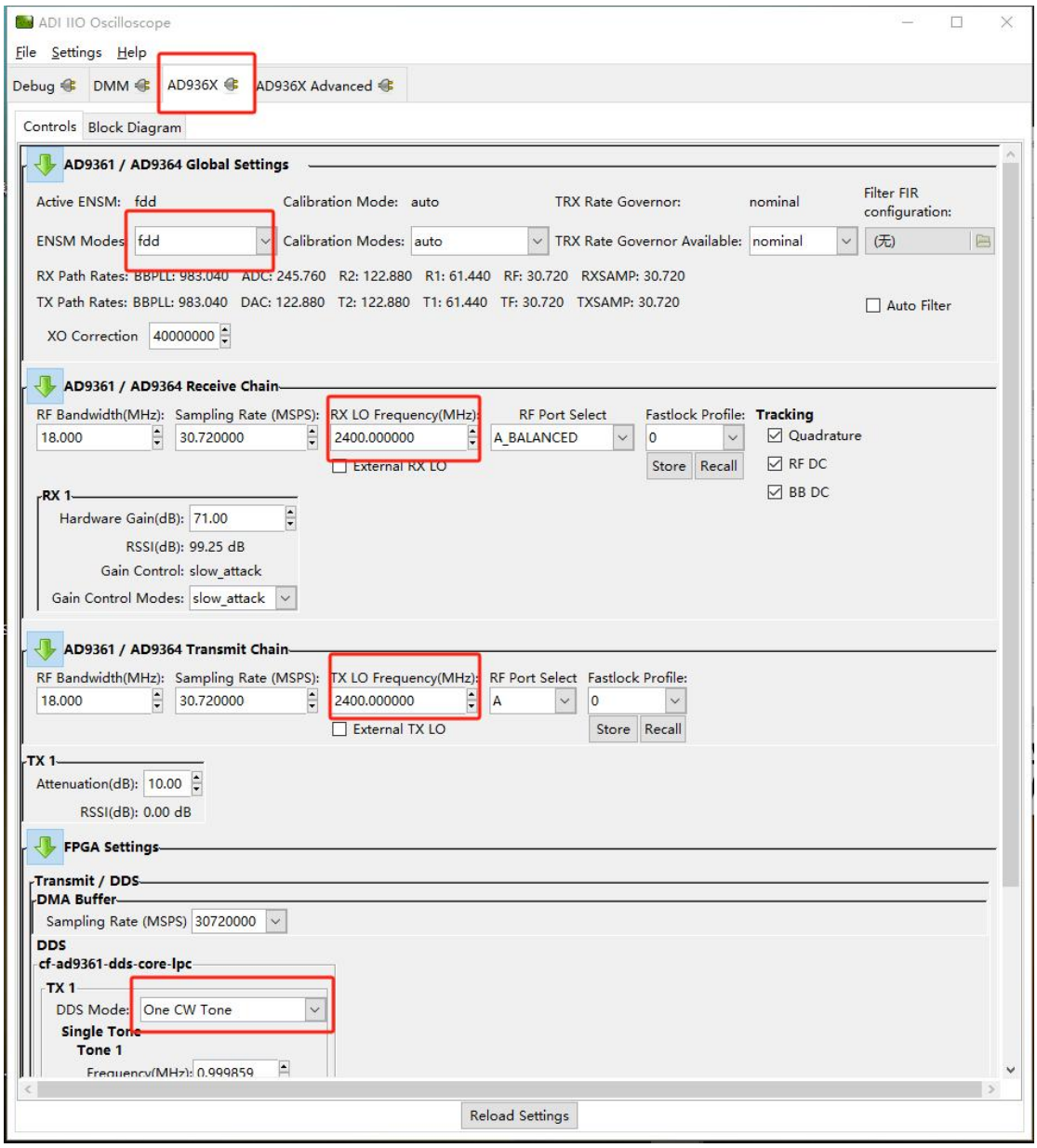

Figure 15: IIO Oscilloscope Control Window

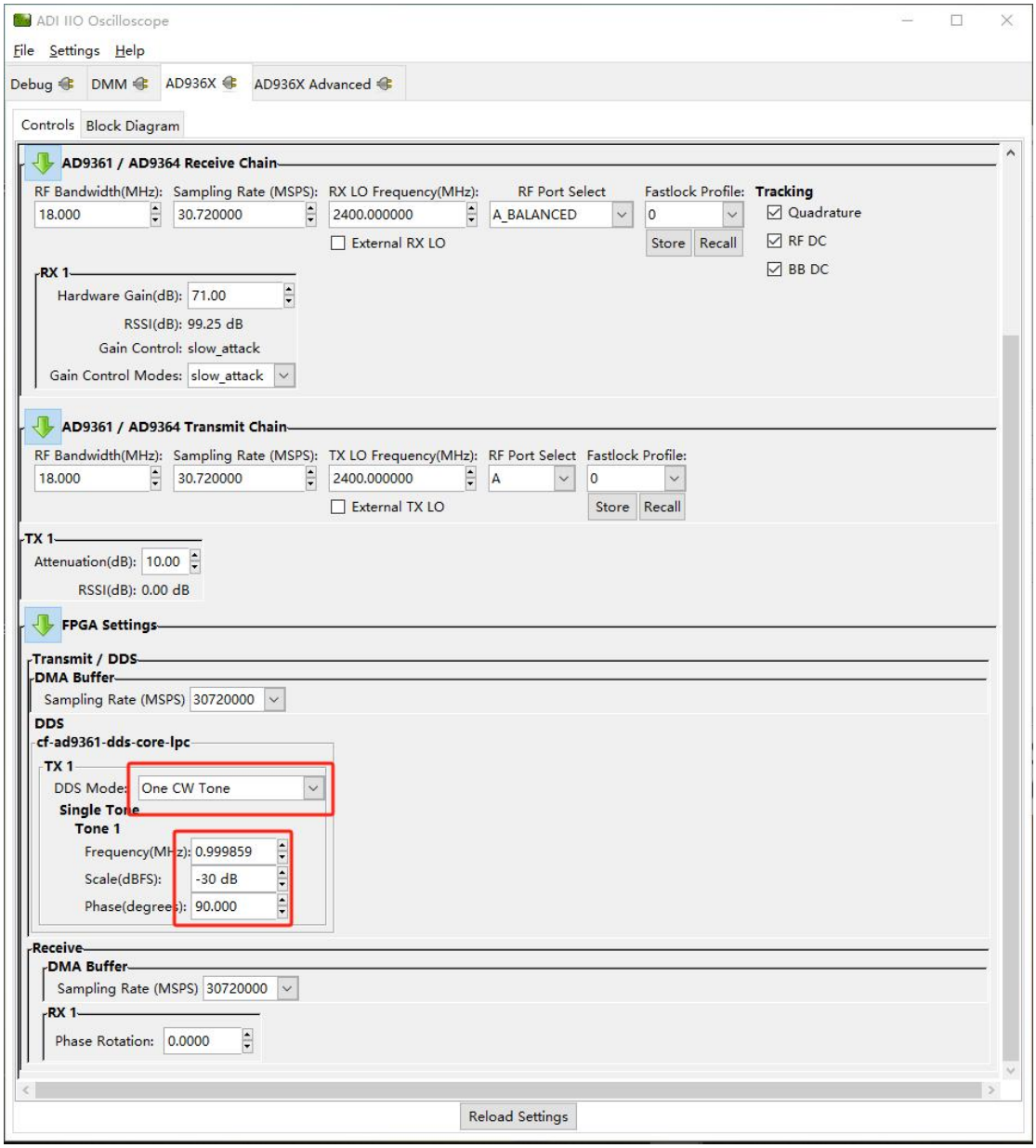

Figure 16: IIO Oscilloscope Control Window

4.7. Observe the plotting window; the expected waveform should appear, as shown below:

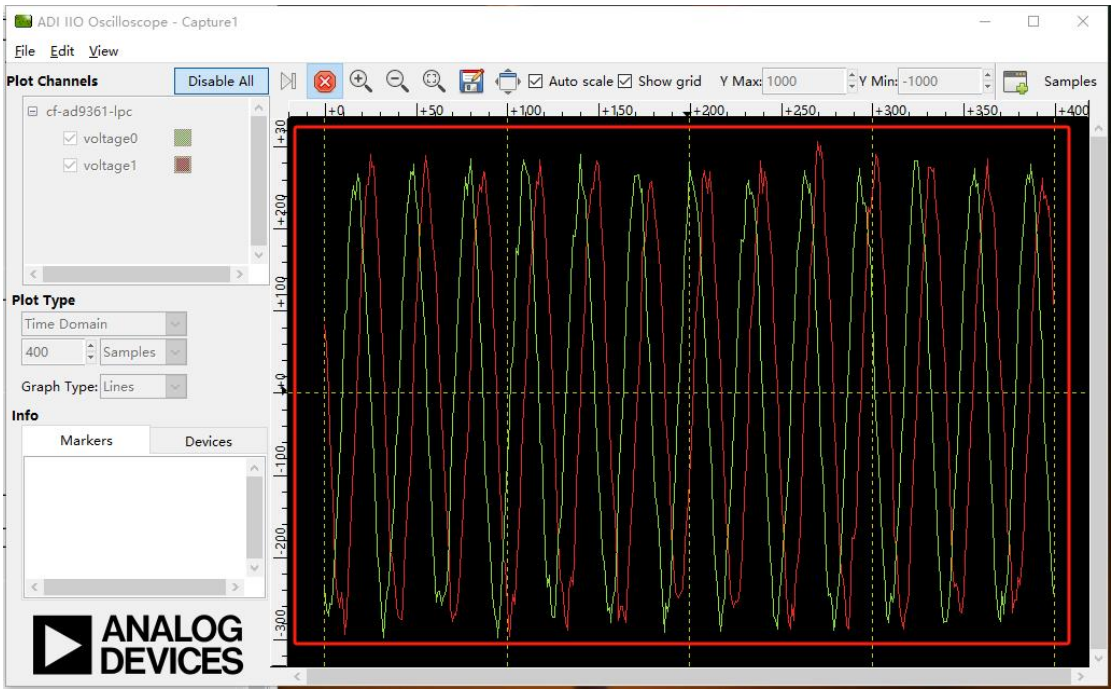

Figure 17: IIO Oscilloscope Plotting Window

At this point, the communication loopback test is complete, and the expected waveform is visible, indicating that the device's transmission and reception functions are normal.

5. Communication Function Test (Receiving GSM Signal)

To further verify the SDR's receiving performance, try receiving a GSM signal around 940MHz. Switch to the control window, under the AD936X tab, change the receive frequency to 930MHz, as shown below:

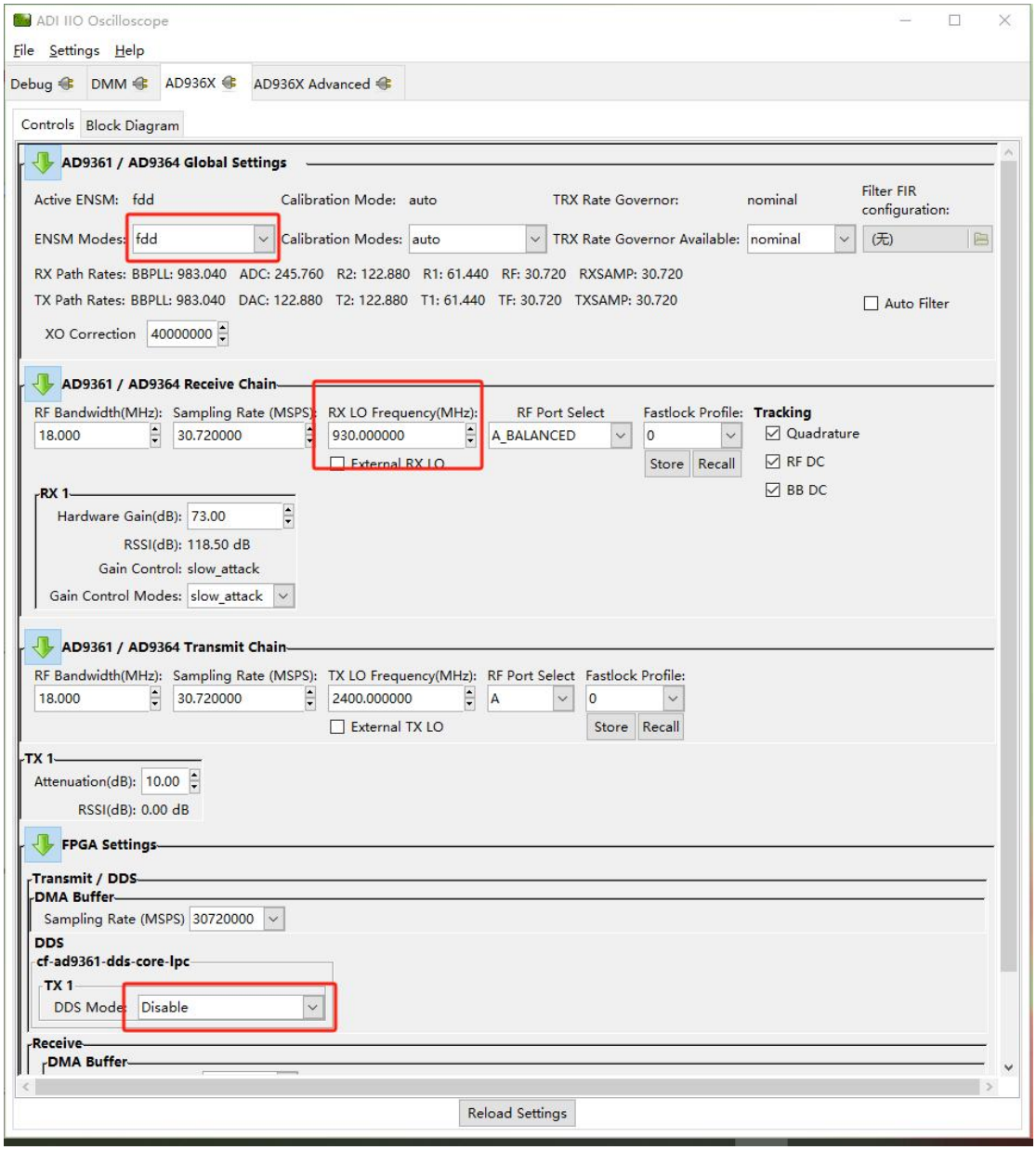

Figure 18: IIO Oscilloscope Control Window

Click the red stop button in the plotting window, set the plotting options as shown in the image, and then click the triangle symbol run button again. If everything is functioning correctly, you should be able to receive a clear GSM signal, as shown below:

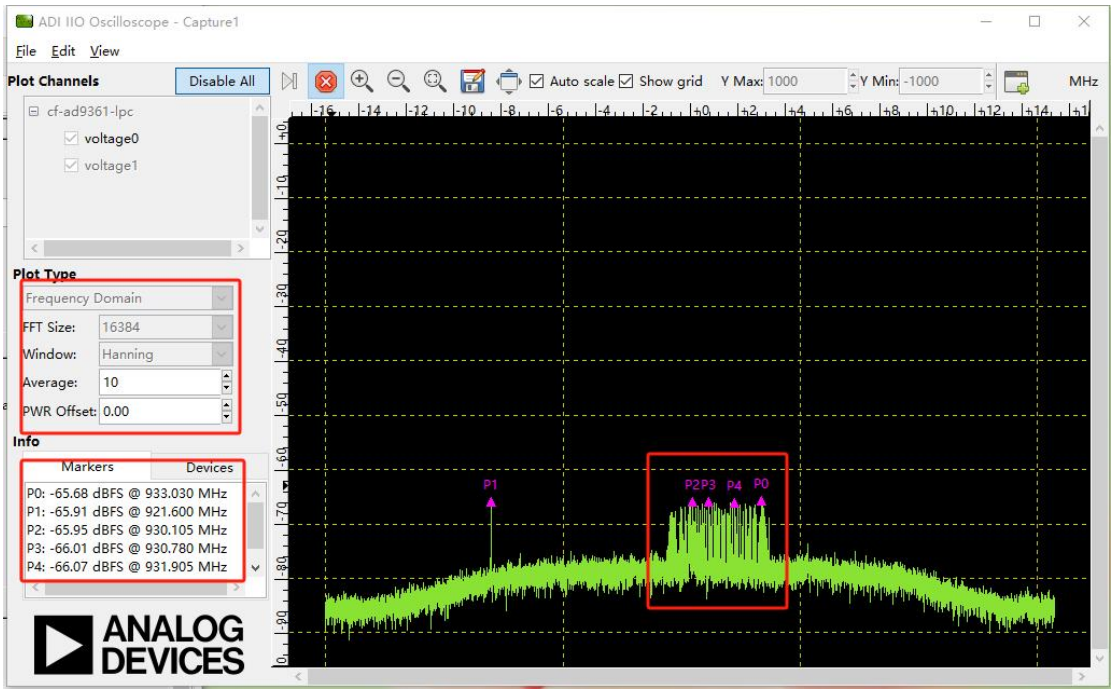

Figure 19: IIO Oscilloscope Plotting Window GSM Signal Spectrum

At this point, the unpacking test is complete, and the device is functioning normally. The journey into the world of radio communication begins here.

6. Summary

Through the above steps, we completed the unpacking inspection, device connection, basic functionality test, and communication function test of the SDR. These steps lay a solid foundation for future SDR experiments and applications. With its powerful performance and wide range of functions, SDR will become an important tool for students in telecommunications, radio enthusiasts, and engineers.

Appendix 1: Development Materials (Functional Block Diagram)

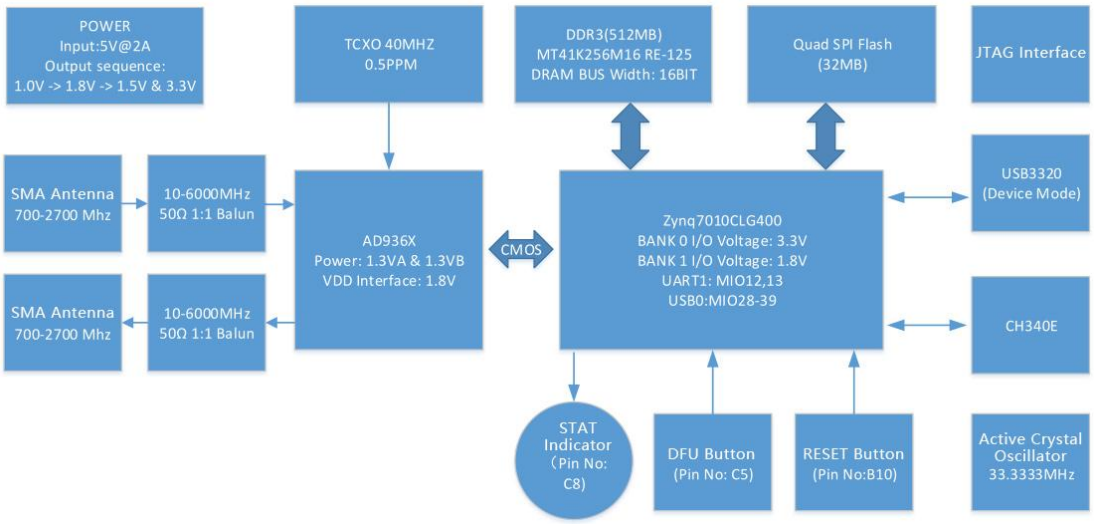

Figure 20: Overall Block Diagram

Appendix 2: Development Materials (Pin Constraints)

AD936X		XC7Z010CLG400
Mnemonic	Pin No.	Pin No.
DATA_CLK_P	G11	H16
RX_FRAME_P	G8	K19
P1_D0/RX_D0_N	K11	E17
P1_D1/RX_D0_P	J12	G18
P1_D2/RX_D1_N	K10	E18
P1_D3/RX_D1_P	J11	G19
P1_D4/RX_D2_N	K9	B20
P1_D5/RX_D2_P	J10	F20
P1_D6/RX_D3_N	K8	H20
P1_D7/RX_D3_P	J9	C20
P1_D8/RX_D4_N	K7	A20
P1_D9/RX_D4_P	J8	D19
P1_D10/RX_D5_N	J7	B19
P1_D11/RX_D5_P	H8	J20
FB_CLK_P	F10	K17
TX_FRAME_P	G9	D20
P0_D0/TX_D0_N	E12	G17
P0_D1/TX_D0_N	D11	H18
P0_D2/TX_D0_N	E11	G20
P0_D3/TX_D0_N	D10	J18
P0_D4/TX_D0_N	E10	D18
P0_D5/TX_D0_N	D9	J19

P0_D6/TX_D0_N	E9	K16
P0_D7/TX_D0_N	D8	K18
P0_D8/TX_D0_N	E8	L20
P0_D9/TX_D0_N	D7	L19
P0_D10/TX_D0_N	F8	E19
P0_D11/TX_D0_N	E7	L16
CTRL_OUT0	D4	P20
CTRL_OUT1	E4	R18
CTRL_OUT2	E5	R17
CTRL_OUT3	E6	N18
CTRL_OUT4	F6	T17
CTRL_OUT5	F5	N17
CTRL_OUT6	F4	R19
CTRL_OUT7	G4	T19
CTRL_IN0	C5	N20
CTRL_IN1	C6	P15
CTRL_IN2	D6	P14
CTRL_IN3	D5	P16
EN_AGC	G5	U18
RESETB	K5	W19
ENABLE	G6	T20
TXNRX	H4	U20
SPI_ENB	K6	Y19
SPI_CLK	J5	W20
SPI_DI	J4	V20
SPI_DO	L6	Y18

Figure 21: ZYNQ Pin Constraints Data

Appendix 3: Physical Dimensions

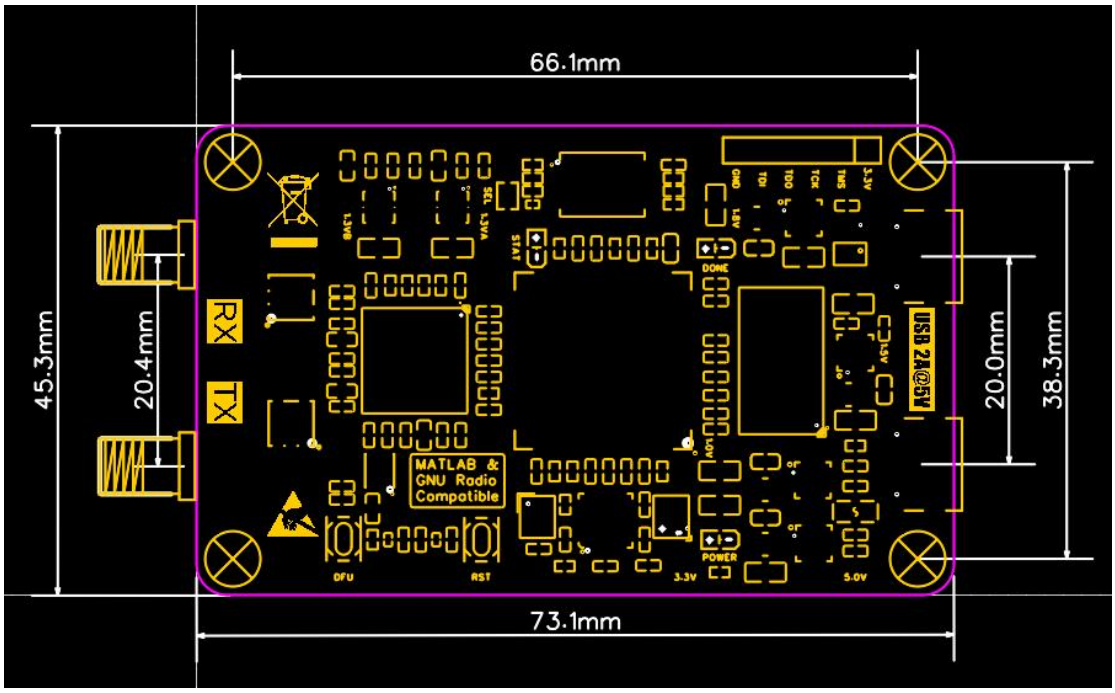

Figure 22: Device Physical Dimensions

Appendix 4: PlutoSDR Nano vs ADALM-PLUTO

	PlutoSDR Nano	ADALM-PLUTO
Main Chip	XC7Z010CLG400	XC7Z010CLG225
RF Chip	AD9363ABCZ	AD9363ABCZ
Memory	DDR3 512MB	DDR3 512MB
Current Limiting Scheme	FUSE 2A	adm1177
USB PHY	USB3320	USB3320
Storage Chip	QSPI 32MB	QSPI 32MB
Balun	10MHz-6GHz	10MHz-6GHz
TCXO	40MHz ±0.5PPM	40MHz ±25PPM

Figure 23: PlutoSDR Nano vs ADALM-PLUTO Feature Comparison

Appendix 5: Officially Provided Methods for Expanding Frequency Range (Original Text)

https://wiki.analog.com/university/tools/pluto/users/customizing

Updating to the AD9364

RF Transceiver	LO tuning range	Bandwidth	Number Channels
AD9363 (Default ADALM-PLUTO)	325 - 3800 MHz	20 MHz	2 Rx, 2 Tx
AD9364	70 - 6000 MHz	56 MHz	1 Rx, 1 Tx
AD9361	70 - 6000 MHz	56 MHz	2 Rx, 2 Tx

There were some early PlutoSDR devices which use the AD9364, which is nearly identical to the AD9363 used the production builds. If you have one of the AD9364 based PlutoSDR devices, it's a quick matter of using the U-Boot's fw_printenv and fw_setenv commands to get that device's larger tuning range (70-6000 MHz) and larger bandwidth (56MHz).

From your favorite serial application (Windows, Linux or macos), just open a serial connection (or ssh to 192.168.2.1, Windows, Linux or macos) to the PlutoSDR. The username is `root` and the password is `analog`.

`fw_setenv` takes a `name` and `value` pair. Depending on the revision of firmware/hardware that you have, different `name` and `values` are enabled.

Revision B / All Firmware versions

Control	Default	min FW Version	HW Rev	`name` `value` pairs	configuration meaning
Tuning Range	Y	All	B/C	`attr_name` `<blank>`	tuning range is 325 - 3800 MHz

Control	Default	min FW Version	HW Rev	name value pairs	configuration meaning
				attr_val <blank>	1r1t or 2r2t
		All	B/C	attr_name compatible attr_val ad9364	tuning range is 70 - 6000 MHz 1r1t only
		0.32	C	attr_name compatible attr_val ad9361	tuning range is 70 - 6000 MHz 1r1t or 2r2t
Number of channels	Y	0.32	B/C	mode 1r1t	1 Rx, 1 Tx, 61.44 MSPS max data rate
		0.32	C	mode 2r2t	2 Rx, 2 Tx, 30.72 MSPS max data rate (requires ad9363 or AD9361 settings)

To learn more about how these are managed, and other settings, check out the Boot Magic Explained docs.

Example

This will be the default (based on the AD9363):

This specifies any shell prompt running on the target. The # is the prompt, and the bold is what you type

```
# fw_printenv attr_name
## Error: "attr_name" not defined
# fw_printenv attr_val
## Error: "attr_val" not defined
#
```

To change things to the AD9364 configuration:

This specifies any shell prompt running on the target. The # is the prompt, and the bold is what you type

```
# fw_setenv attr_name compatible
```

```
# fw_setenv attr_val ad9364
# reboot
```

Starting with PlutoSDR firmware revision **v0.32** an additional variable should be set:

This specifies any shell prompt running on the target. The `#` is the prompt, and the `bold` is what you type

```
# fw_setenv compatible ad9364
# reboot
```

Note that when setting the mode of a Rev. C PlutoSDR to `2r2t`, the following would be sequence of commands:

This specifies any shell prompt running on the target. The `#` is the prompt, and the `bold` is what you type

```
# fw_setenv attr_name compatible
# fw_setenv attr_val ad9361
# fw_setenv compatible ad9361
# fw_setenv mode 2r2t
# reboot
```

To learn more about resetting, check out the developer documentation.

After rebooting the device, this is what the AD9364 configuration looks like:

This specifies any shell prompt running on the target. The `#` is the prompt, and the `bold` is what you type

```
Welcome to Pluto
pluto login: root
Password: analog
# fw_printenv attr_name
attr_name=compatible
# fw_printenv attr_val
attr_val=ad9364
#
```