



LUSWAVE

PUPradar DEVELOPMENT KIT

USER MANUAL

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1 Getting started

1.1 Introduction

Luswave Technology develops low-power, low-cost, and easy using radar development kits, which offers great flexibility for applications in academic research, industry automation, public safety, and DIY project.

PUP_DUAL24P_T2R4 is a K-band development kit. This model integrates an RF module and a powerful FPGA-based processor module together. The RF front end consists of two transmitters and four receiver channels, which makes it a multiple in multiple out (MIMO) radar. This supports direction of arrival (DOA) measuring, which is suitable for target tracking, movement sensing, site surveillance, occupancy sensing, people counting, fall detection, and many other uses. Its FPGA-based micro control unit (MCU) and eight-channel 65Msps pipeline LVDS ADC module offers ultimate design flexibility and accuracy with industry-leading programmable logic.

A user-friendly graphical user interface (GUI) allows great flexibility. Users can easily select desired center frequency and bandwidth, signal waveforms, sampling rates, display parameters, etc.

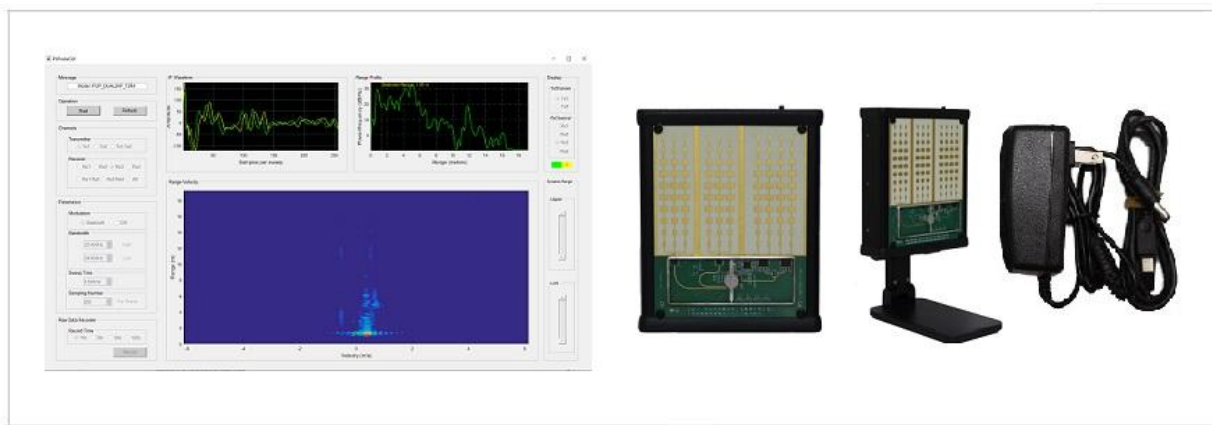


Figure 1. PUP_DUAL24P_T2R4

1.2 Key Features

- Support both FMCW and CW modulations
- PLL controlled waveform creating
- Reliable Tx channel switching
- Antenna array for beamforming.
- 65MHz eight-channel LVDS pipeline AD converters
- Real-time complex (I & Q) data acquiring
- User-friendly graphical user interface (GUI)
- Adjustable parameter setting
- Long recording time for raw data
- USB 2.0 high speed (480Mb/s) interface to host computer

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1.3 Kit Contents

The PUP_DUAL24P_T2R4 Development Kit comes with an enclosed radar device and a mounting base. The complete list of the SDR development kit includes:

- PUP_DUAL24P_T2R4 Development Kit
- AC/DC power adapter.
- USB 2.0 A to Mini-B cable.
- Mounting stand
- A USB flash drive with software and documents.

2 Hardware Specifications

2.1 Functional Block Diagram

Figure 2 is a block diagram of the PUP_DUAL24P_T2R4 MIMO radar development Kit. PLL controlled frequency sweep is configured by FPGA-based MCU whenever parameter settings are changed. Through a low pass filter bank, eight channels of IF signals are acquired by a single chip 65Mpsps eight-channel LVDS AD converter and then streamed to host computer via a high-speed USB interface (up to 480Mb/s) for further processing. A graphical user interface (PUPradarGUI) is used to control the parameter configuration of the kit.

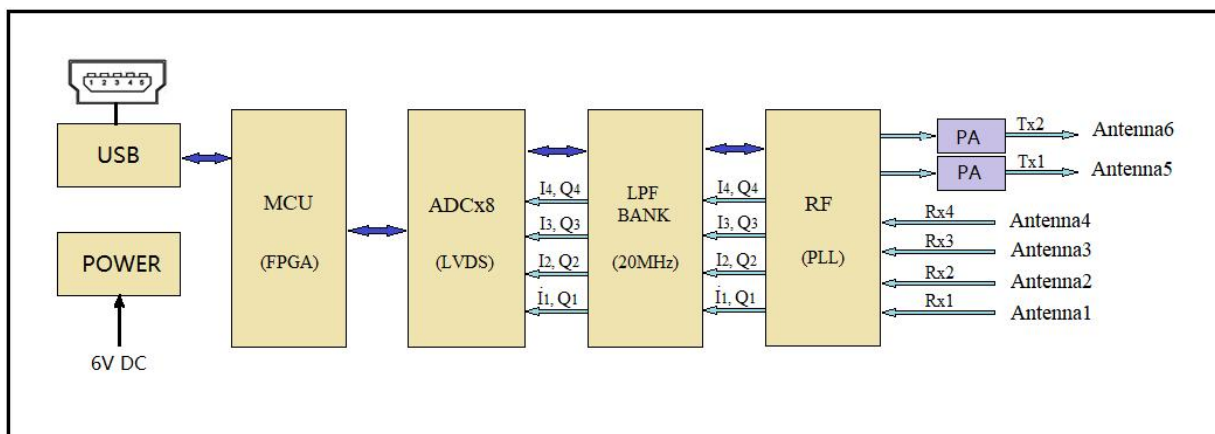


Figure 2. Block Diagram

2.2 Specifications

PUP_DUAL24P_T2R4 has two transmitters and four receivers with six onboard patch antennas. Its specifications are shown in Table 1.

Table 1. Specifications of the Multichannel PUP_DUAL24P_T2R4

Model	PUP_DUAL24P_T2R4
Antennas	6 Onboard Patch Antennas
RF Channels	2 Transmitters, 4 Receivers
Modulations	FMCW, CW

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Typical Frequency	24GHz-25GHz (Expandable to 23.5GHz-26GHz)
Typical Bandwidth	0.25GHz-1GHz (Expandable to 2.5GHz)
Tx Output Power	17dBm
Rx Noise Figure	10dB
Detectable Range	People: 25m, middle sized vehicle: 50m
Supply Voltage	6V
Supply Current	1.2A
Operating Temperature	-40°C - 85°C
Dimensions	L: 130mm, W: 108mm, H: 32mm
Weight	12oz

2.3 Antennas

The six patch antennas on PUP_DUAL24P_T2R4 (Figure 3) are configured as a MIMO beamforming array (Figure 4).

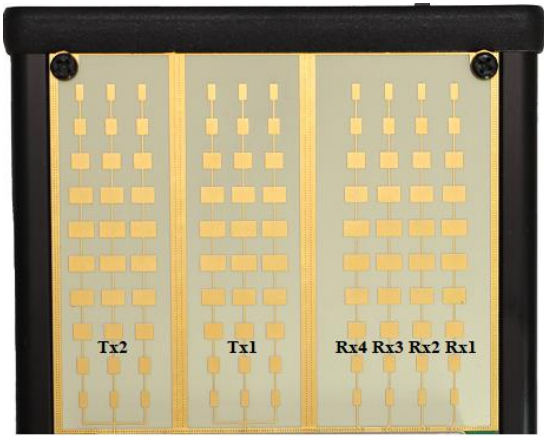


Figure 3. Patch antennas

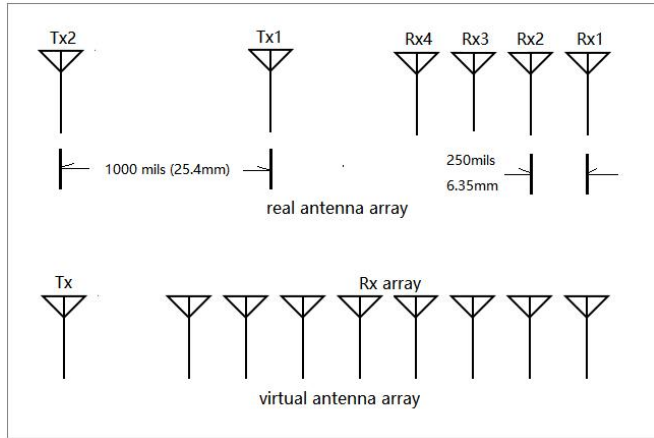


Figure 4. Antenna array

2.4 Data Stream Sequences

The transmitter channel can be set as one channel or two channels. . The receiver channel can be set as one channel, two channels, and four channels. When only one transmitter is activated, the data stream sequences are illustrated in figure 5.

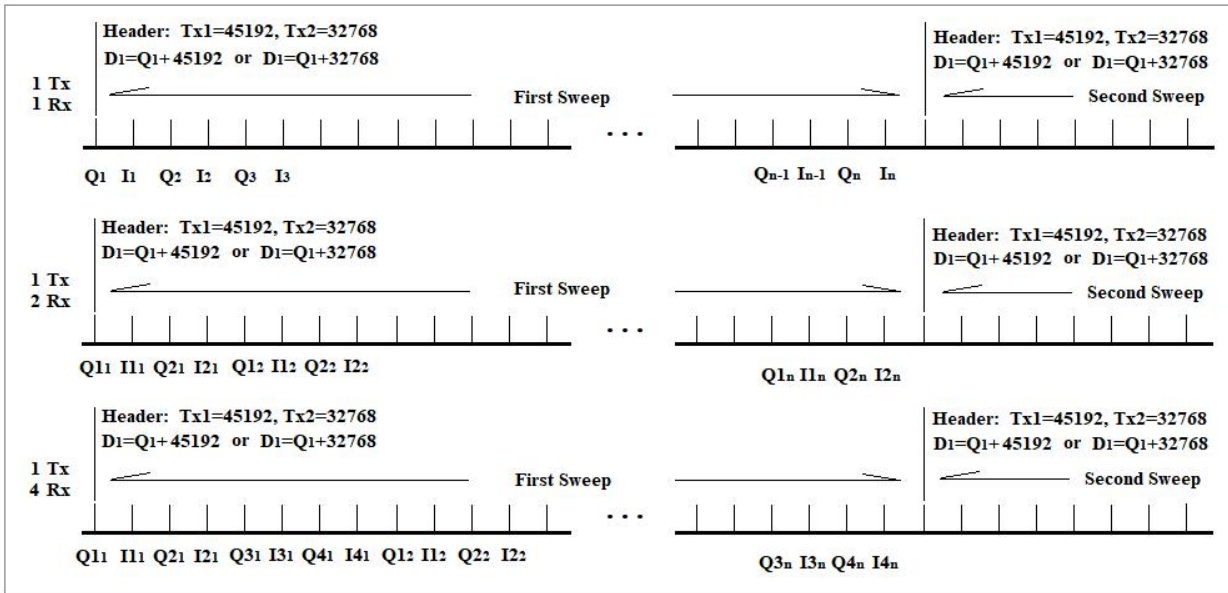


Figure 5. Single Transmitter data stream sequences

When the device works in MIMO mode (Tx1.Tx2), both transmitters are alternately activated each sweep where only one is activated each sweep. A header of 45192 (Tx1) or 32768 (Tx2) is always added to the first sample Q1 of each sweep. So when the value of the first sample is greater than 45192, then the data stream of this sweep comes from Tx1. When the value of the first sample is greater than 32768 and less than 45192, then the data stream of this sweep comes from Tx2. Subtracting 45192 or 32768 from the first sample value, the value of Q1 remains. Figure 6 are the two transmitter data stream sequences.

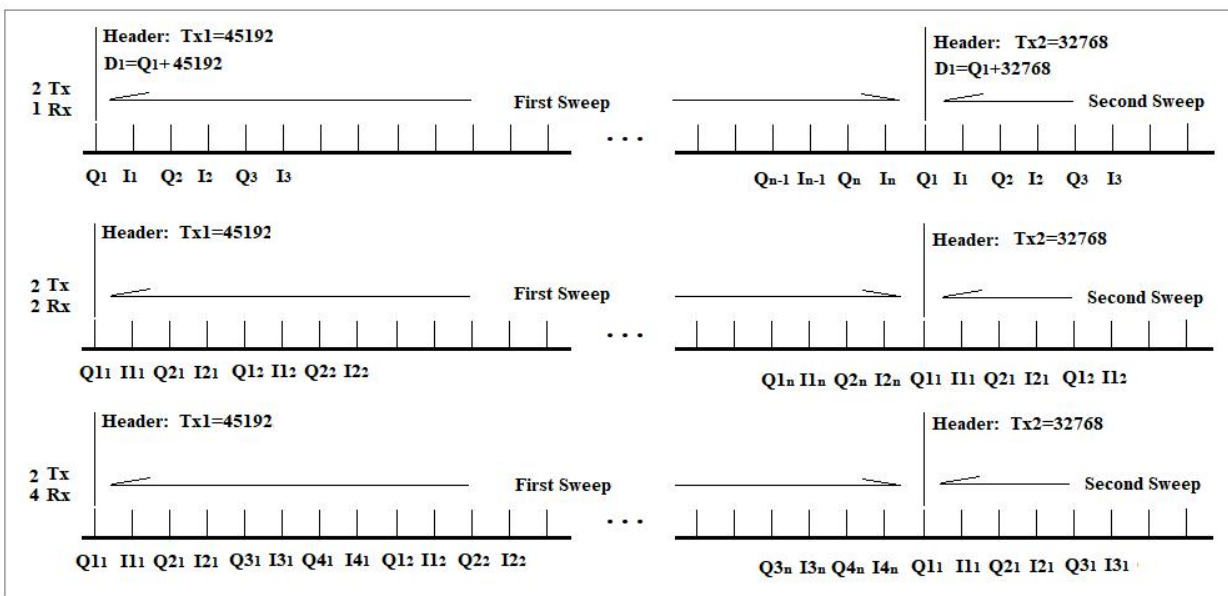


Figure 6. Two transmitter data stream sequences

3 System Setup

3.1 Mounting Base

The device is mounted on the mounting stand. With the mounting stand, the height and antenna directions are easy to adjust. The power socket and the USB connector is on the top of the device.



Figure 7. Device on stand and top view

3.2 USB Driver Setup

Find the Driver folder in the include USB flash drive (Figure 8), and copy it to your computer.

<input type="checkbox"/>	DOCs	12/9/2020 8:28 PM	File folder
<input type="checkbox"/>	Driver	12/9/2020 8:29 PM	File folder
<input type="checkbox"/>	PUPradarGUI	12/9/2020 10:06 PM	File folder
<input type="checkbox"/>	PUPradarGUI_standalone	12/9/2020 10:25 PM	File folder

Figure 8. USB Driver

Plug the 6V power into the power socket, slide the power switch towards the socket, and then connect your computer and the device with USB A to USB mini cable.

Open the Device Manager window on your computer, “Unknown Device” is shown (Figure 9) when the device is first connected.

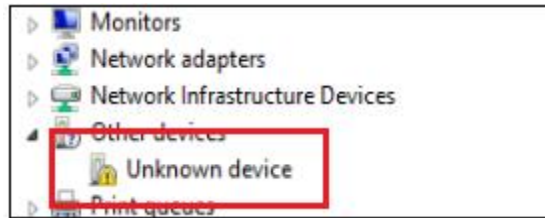


Figure 9. Device Manager Window.

When you install the driver for this device using the file in the Driver folder and “Cypress FX2LP No EEPROM Device” is shown, the driver is installed successfully.



Figure 10. Driver Software Installed Successfully

3.3 PUPradarGUI Setup

3.3.1 GUI app install

In the USB flash drive, you can find two folders “PUPradarGUI” and “PUPradarGUI_standalone”.

Name	Date modified	Type
DOCs	12/9/2020 8:28 PM	File folder
Driver	12/9/2020 8:29 PM	File folder
PUPradarGUI	12/9/2020 10:06 PM	File folder
PUPradarGUI_standalone	12/9/2020 10:25 PM	File folder

Figure 11. included documents folders

If you are already a Matlab User, copy the folder “PUPradarGUI” into your Matlab workspace, set the path to this folder, and run PUPradarGUI.m.

If you want to use the standalone version, you can either run PUPradarGUI.exe in the folder “PUPradarGUI_standalone” or run “MyAppInstaller_mcr.exe” and follow the guide to install the standalone GUI. When using standalone version, you may need a couple of minutes to start up, please be patient.

3.3.2 PUPradarGUI user's guide

When running the PUPradarGUI, the GUI window (Figure 12) will appear. First hitting the “Refresh” button, the software will automatically detect the device. When the device is successfully recognized, its model name will show in the message window. you can hit the “start” toggle button to run the software. The GUI gives users access to selecting modulations and other parameters. Anytime you want to record the raw data, select the record time, and then hit the “record” button to start.

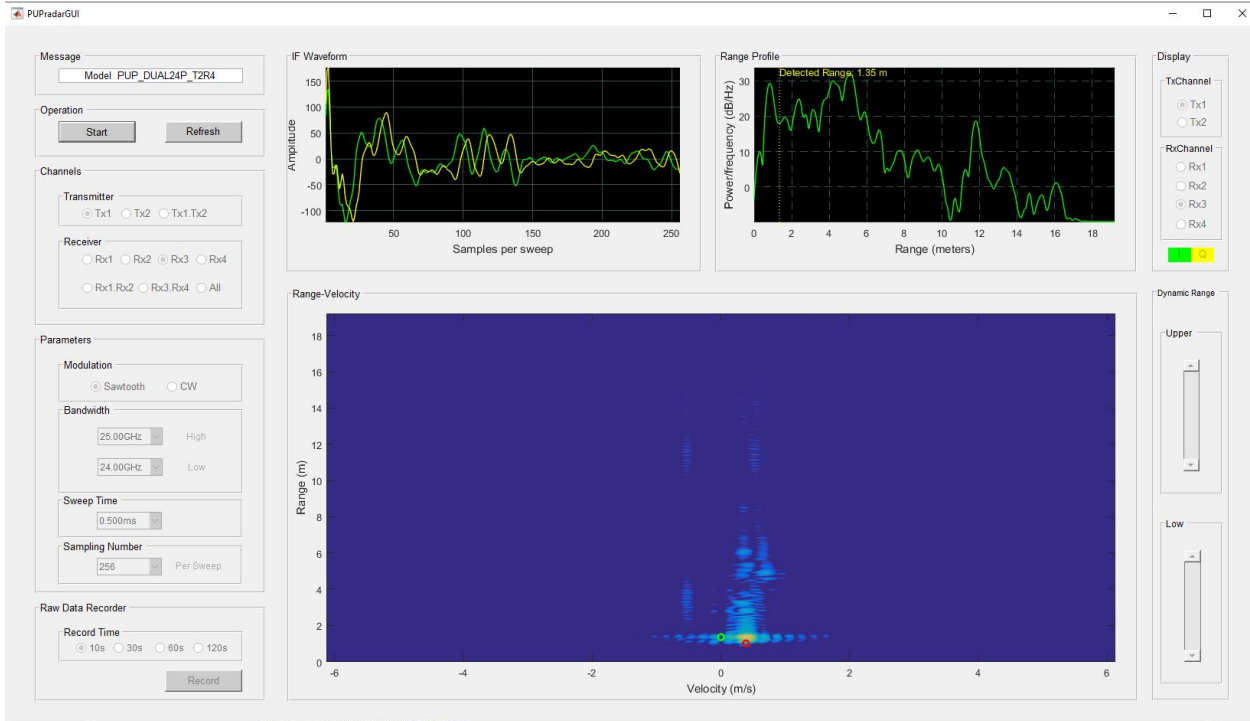


Figure 12. PUPradarGUI

- **Message Window**

When the device is detected, the message window will show the device model name, otherwise, it will show an error message or ask you to refresh.

- **Operation Panel**

There are two buttons in the operation panel. The start/stop button is a toggle button. The refresh button resets the software to its default status.

- **Channel Panel**

In the channel panel, you can activate any Tx channels or Rx channels. When “Tx1.Tx2” is selected, the device automatically works in the MIMO mode. When “Rx1.Rx2” or “Rx3.Rx4” is selected, the device receives Rx1 and Rx2 signals or Rx3 and Rx4 signals.

- **Parameter Panel**

In the parameter panel, you can select your desired modulations, lower and upper frequencies, sweep time, and sampling number per sweep.

- **Raw Data Recorder**

When the GUI is running, the buttons in the Raw Data Recorder panel are active. You can activate the record function at any time. Push record to start the recording and a save file window will appear after the recording time is over. The default file format is *.mat, but you can save the file in the.txt format.

- **Display Panel**

When one Rx channel is activated, the three default display windows are for that channel. When both the Tx channels or more than one Rx channels are activated, this panel switches from the three display window to the selected display channel combination.

- **Dynamic Range Panel**

The two sliders in the Dynamic Range Panel control the signal threshold in the lower display window. When the slider is lower, it shows more target detail. When the slider is higher, less noise is shown from the image.