LUSWAVE

PUPradar--SMART RADAR PLATFORM

USER MANUAL

luswave.com

Luswave Technology LLC
Sales: +1-703-338-8380 **Technical:** +1-571-296-6435 **Fax:** +1-571-223-5483 **Email:** service@luswave.com

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1 Getting started

1.1 Introduction

Luswave Technology develops low-power, low-cost, and easy to use radar development platforms, which offer great flexibility for applications in academic research, industrial automation, public safety, and DIY projects.

PUP_EN24C_T1R4 is a K-band development platform. This device integrates an RF module and a powerful FPGA-based processor module together. The RF front end consists of two transmitting and four receiving channels, which makes it a Multiple In Single Out (MISO) radar. This device can connect either horn antennas or patch antennas as external antennas. When using patch antennas, the device supports direction of arrival (DOA) measurement, which is suitable for target tracking, movement sensing, site surveillance, occupancy sensing, people counting, fall detection, and many other uses. Its FPGA-based microcontroller unit (MCU) and eight-channel 65Msps pipeline LVDS ADC module offer ultimate design flexibility and accuracy with industry-leading programmable logic.

A user-friendly graphical user interface (GUI) allows great flexibility. Users can easily configure the desired center frequency and bandwidth, signal waveform, sampling rates, display parameters, etc. After signal processing, waveform, range-Doppler map and velocity waterfall map are displayed.

Figure 1. PUP_EN24C_T1R4

1.2 Key Features

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

1.3 Kit Contents

The PUP_EC24C_T1R4 Development Kit comes with an enclosed radar device and mounting brackets. The development platform includes:

- PUP_EN24C_T1R4 Development Kit.
- AC/DC power adapter.
- USB 2.0 A to Mini-B cable.
- 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_EN24C_T1R4 MISO radar development platform. PLL controlled frequency sweep is configured by FPGA-based MCU. Eight channel of IF signals are acquired by a 50Msps eight-channel single chip 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.

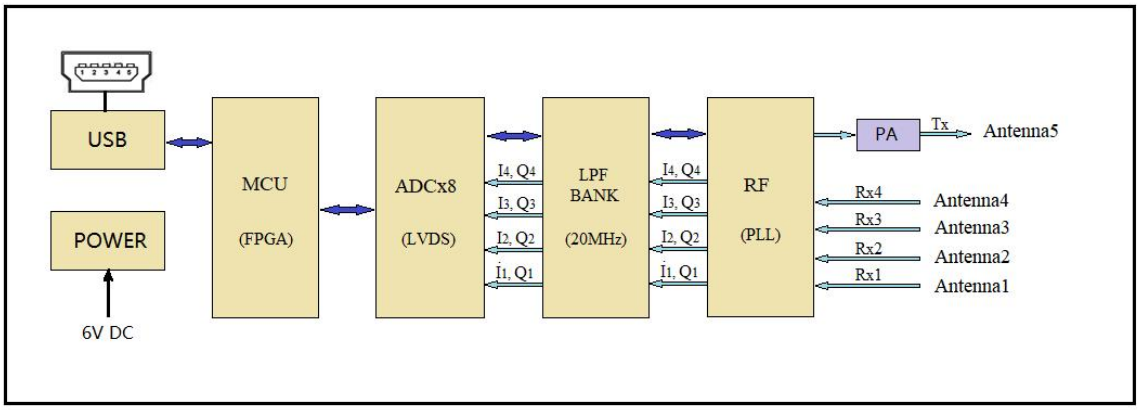


Figure 2. Block Diagram

2.2 Specifications

PUP_EN24C_T1R4 has one transmitter and four receivers with six SMA connectors for external antennas. Its specifications are shown in Table 1.

Table 1. Specifications of the Multichannel PUP_EN24C_T2R4

Model	PUP_EN24C_T2R4
Antennas	5 External Antenna Connectors
RF Channels	1 Transmitters, 4 Receivers
Modulations	FMCW, CW
Typical Frequency	24GHz-25GHz (Expandable to 24GHz-26GHz)
Typical Bandwidth	0.25GHz-1GHz (Expandable to 2GHz)

Tx Output Power	19-21dBm
Rx Noise Figure	10dB
Detectable Range	People: 15-20m, middle sized vehicle: 40-60m
Supply Voltage	6V
Supply Current	1.2A
Operating Temperature	-40°C - 85°C
Dimensions	L: 130mm, W: 108mm, H: 32mm
Weight	14oz

2.3 Antennas

No antenna was included with PUP_EN24C_T1R4 , RF cables and external antennas should be purchased separately.

External Horn antennas (Figure3) or other forms of antennas (Figure 4) can be connected to the device according to the user's specific needs. Active transmitters and receivers can be configured through GUI. Due to their larger size, horn antennas are not easy to configure as beamforming array.

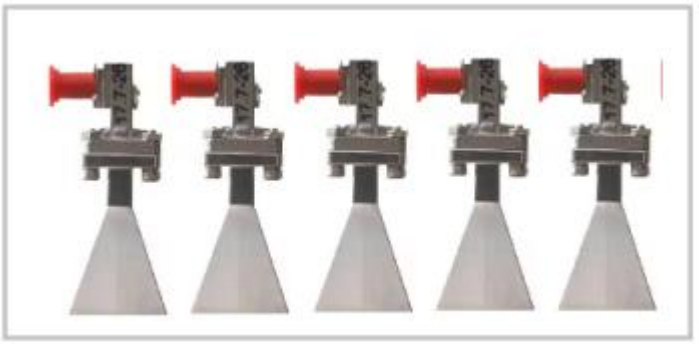


Figure 3. Standard horn antenna

Figure 4. Patch antenna

2.4 Data Stream Sequences

The transmitter has only one channel(Tx2 is disabled for PUP_EN24C_T1R4). The receiver channel can be configured as one channel, two channels, and four channels. Working at single transmitter channel, the data stream sequences are illustrated in figure 5.

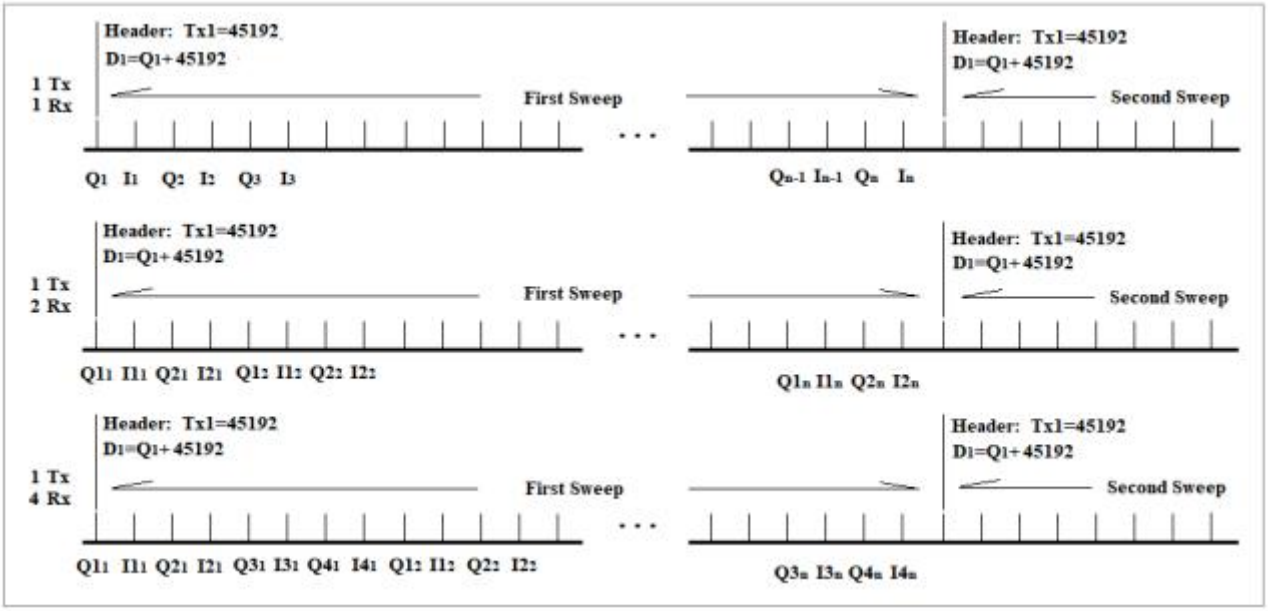


Figure 5. Single transmitter data stream sequences

A header of 45192 (Tx1) is always added to the first sample 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. Subtracting 45192 from the first sample value, the value of Q1 remains. Figure5 are the two transmitter data stream sequences.

3 System Setup

3.1 Panels

The front and back panels of PUP_EN24C_T2R4 are shown in Figure 6.

Figure 6. PUP_EN24C_T2R4

3.2 USB Driver Setup

Find the Driver folder in the include USB flash drive (Figure 7), and copy it to your computer.

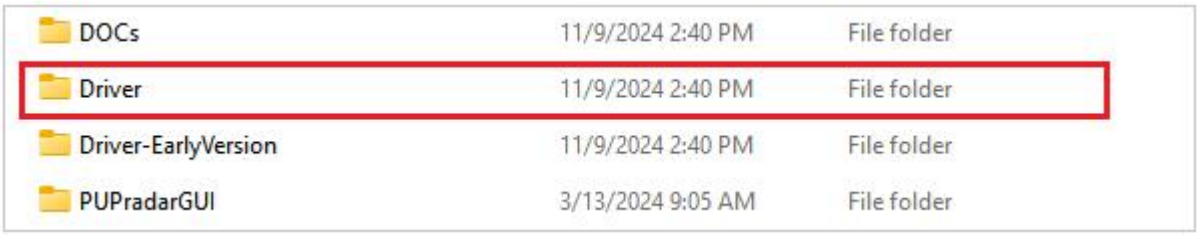


Figure 7. USB Driver

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 8) when the device is first connected.

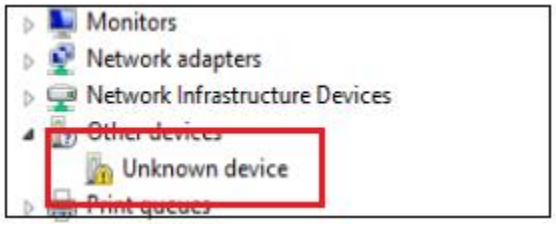
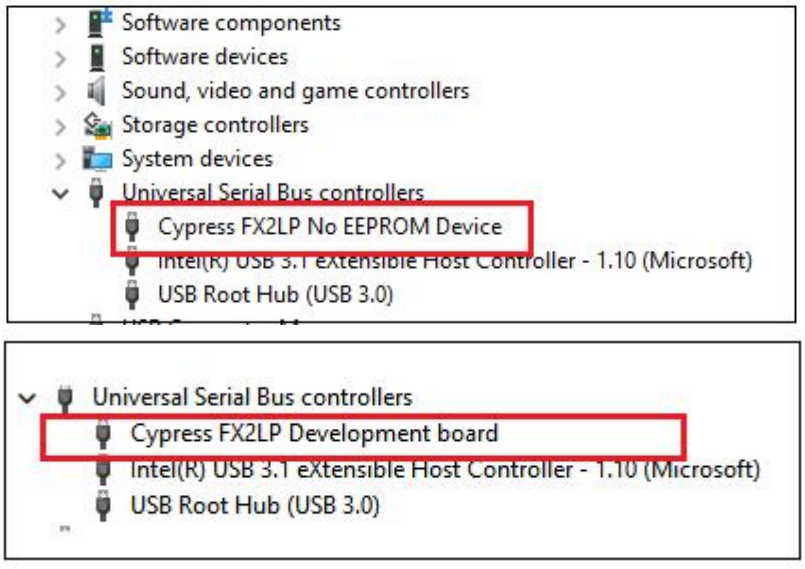


Figure 8. Device Manager Window.

When you install the driver for this device using the file in the Driver folder and it shows "**Cypress FX2LP No EEPROM Device**" (platform bought before Feb. 2025), or " **Cypress FX2LP Development board**" (platform bought after Feb. 2025), the driver is installed successfully.



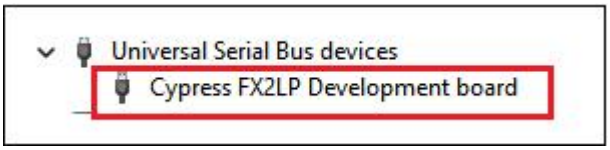


Figure 9. Driver Software Installed Successfully

In case the USB driver can not be installed, try the earlier version in the folder " Driver-EarlyVersion", and try win7 if Win10 won't work.

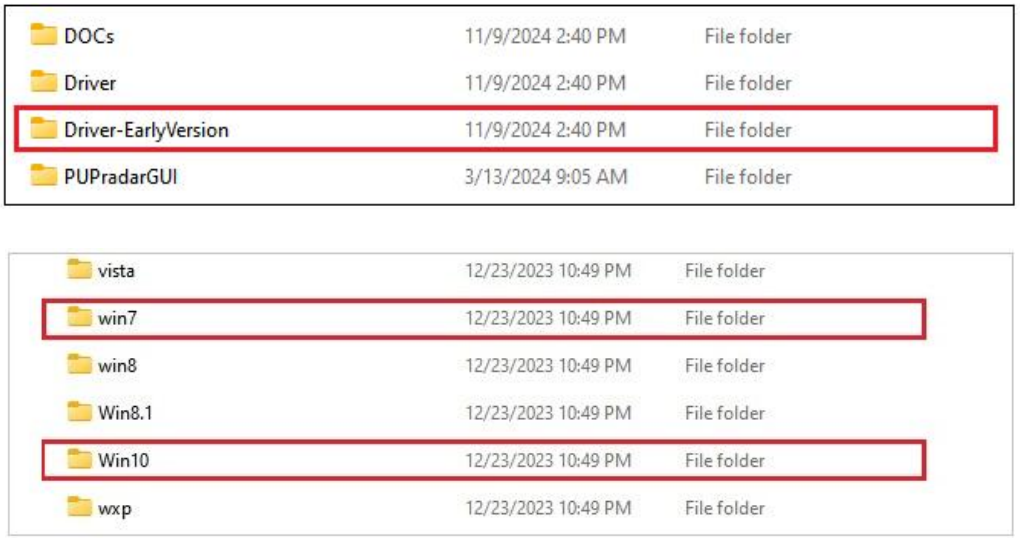


Figure 10. USB Driver Early Version

3.3 PUPradarGUI Setup

3.3.1 GUI app install

In the USB flash drive, you can find a folder "PUPradarGUI" .

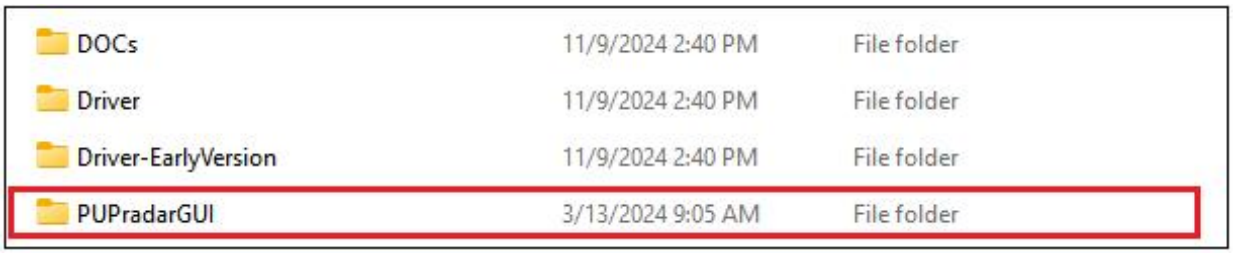


Figure 11. included documents folders

Copy the folder "PUPradarGUI" into your Matlab workspace, set the path to this folder, and run PUPradarGUI.m.

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 select modulations and other parameters. Anytime you want to record the raw data, select the record time, and then hit the "record" button to start.

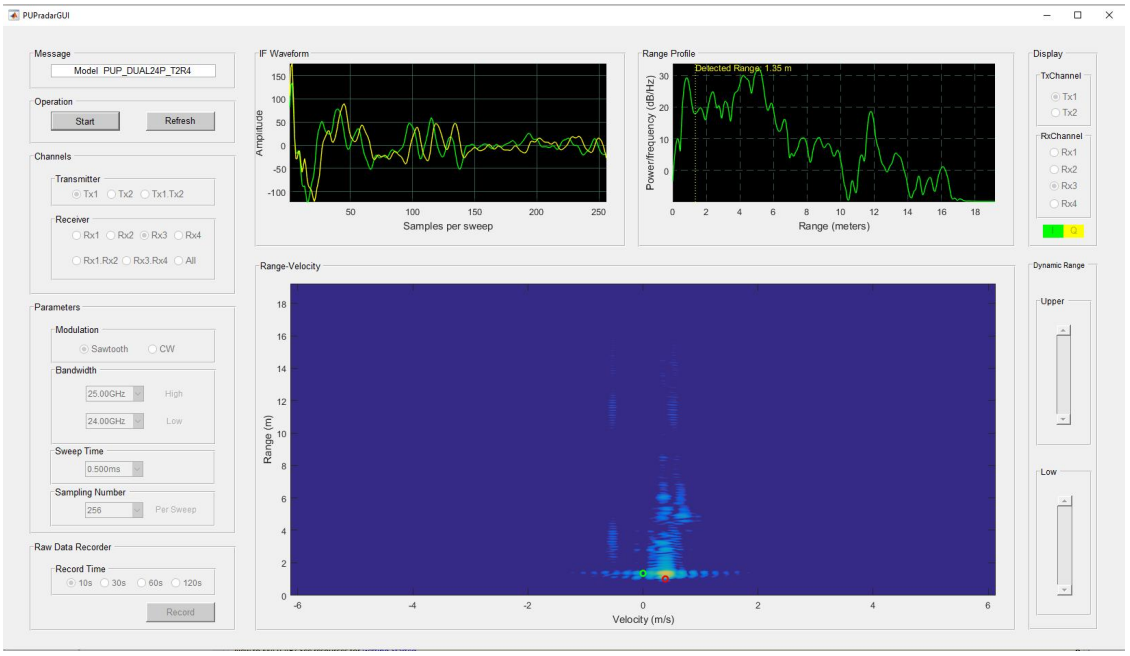


Figure 12. PUPradarGUI

- **Message Window**

  When the device is detected, the message window will show the 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, Tx1 is enabled, Tx2 and Tx1·Tx2 is disabled for PUP_EN24C_T1R4.When "Rx1.Rx2" or "Rx3.Rx4" is selected, Rx1 and Rx2 data or Rx3 and Rx4 data are transferred to host PC . When "all" is selected, all Rx channel acquiring data will be transferred to host PC.

- **Parameter Panel**

  In the parameter panel, modulations, lower and upper frequencies, sweep time, and sampling number per sweep can be configured.

- **Raw Data Recorder**

When the GUI is running, the buttons in the Raw Data Recorder panel are active, allowing you to start recording at any time. Click the Record button to begin; once the recording duration is complete, a save dialog window will appear.
The default file format is .mat, but you also have the option to save the data in .txt format. For additional details, please refer to DataRecordingManual.pdf.

- **Display Panel**

  When one Rx channel is activated, the three display windows are for that channel. When two or more Rx channels are activated, one channel in this panel should be selected for display.

- **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.