vTrig_CTPA0 Evaluation Kit

Hardware spec and User Manual

Revision 1.2

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Notice

Revision History

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1	August 2019		
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Chapter 1
Introduction

This guide provides information on the installation and operation of the **Vayyar vTrig-CTPA0 Evaluation Kit.** VTrig_CTPA0 is a three-dimensional mm-wave sensor used as a fixed field disturbance sensor or short-range device for interactive motion sensing. The device is installed on a wall or ceiling, and detects objects in a defined arena and displays a real-time image of their positions within the arena.

Typical applications for the device can be touchless input device (e.g. gesture-recognition interface), in-room people detection and monitoring for improving comfort and energy-utilization optimization (e.g. HVAC operation and airflow optimization), detection of abnormal conditions such as fall of elderly people and apnea in adults and babies, and in-cabin monitoring for detection of infants left in car.

1.1   Release Information

This is a first Hardware version for demonstration of system capabilities. Both algorithmic capabilities and features are under continuous development and improvement.

This document provides basic description of the system and it is operated. For more details – contact Vayyar LTD through – www.vayyar.com.

1.2   Glossary

Table 1: Glossary

Term	Definition
AC	Alternating Current
API	Application Programming Interface
DC	Direct Current
DLL	Dynamic Link Library
EVK	Evaluation Kit
GUI	Graphical User Interface
IP	Internet Protocol. An IP address is a numerical identifier assigned to a computing device or node in a TCP/IP network. The address is used to locate and identify the node in communications with other nodes on the network.
MCU	Micro-Controller Unit
PCB	Printed Circuit Board
RF	Radio Frequency
SoC	System-on-chip

Chapter 2
System Overview

The VTrig_CTPA0 system is designed to demonstrate Vayyar's 3D imaging non-contact RF sensors, which enable to identify multiple objects ("blob*s*") in a defined space ("*arena*").

2.1   System Architecture

The VTrig_CTPA0 system architecture and connectivity scheme is illustrated in the figure below.
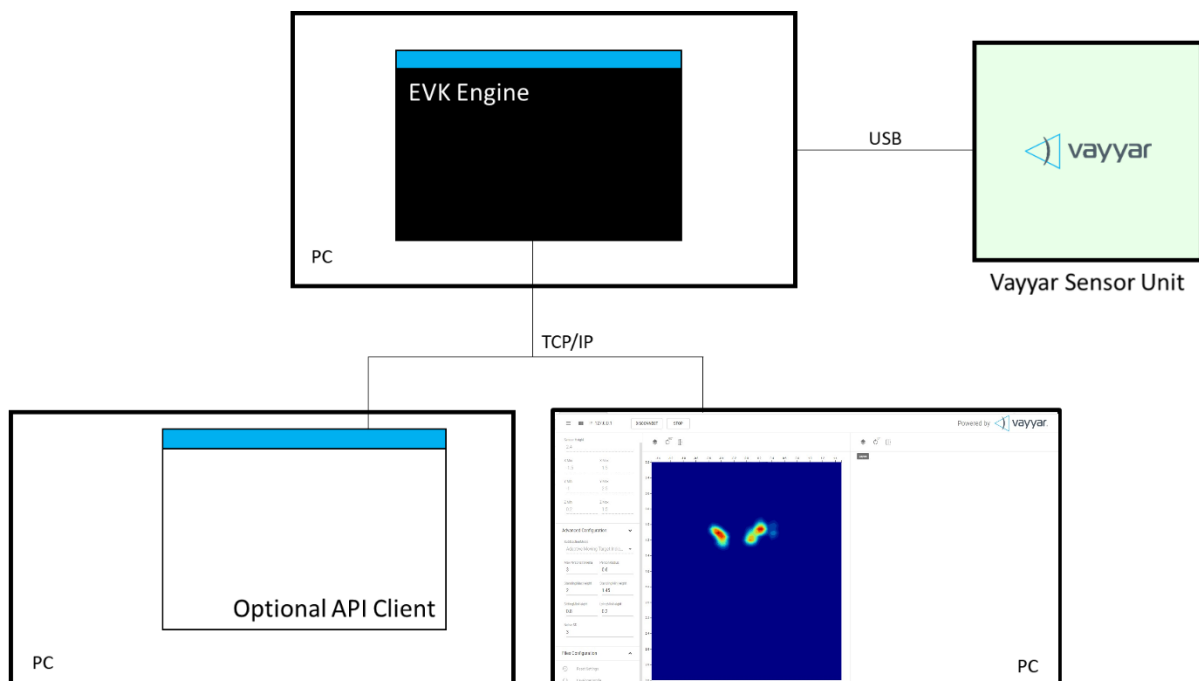
Figure 1: VTrig_CTPA0 System Architecture

The VTrig_CTPA0 system is comprised of the following components:

- **The VTrig_CTPA0 RF Sensor Unit.**

- **The EVK Engine.** Host software that performs signal processing functions. The software runs in a command window in a PC, which is connected to the VTrig_CTPA0 Sensor via a USB cable.

- **Web GUI.** User-interface client software that communicates with the EVK Engine via a TCP/IP connection. The Web GUI client is supported by the following browsers:

  - Google Chrome

  - Mozilla Firefox

- **API Client.** Optional, customer-developed software that communicates with the EVK Engine via a TCP/IP connection.

NOTE

The Web GUI and API Client software can run either on their own dedicated PC, or on the same PC as the EVK Engine.

2.2   Hardware

The figure below presents a high-level block diagram of the PCB that houses the EVK sensor unit:
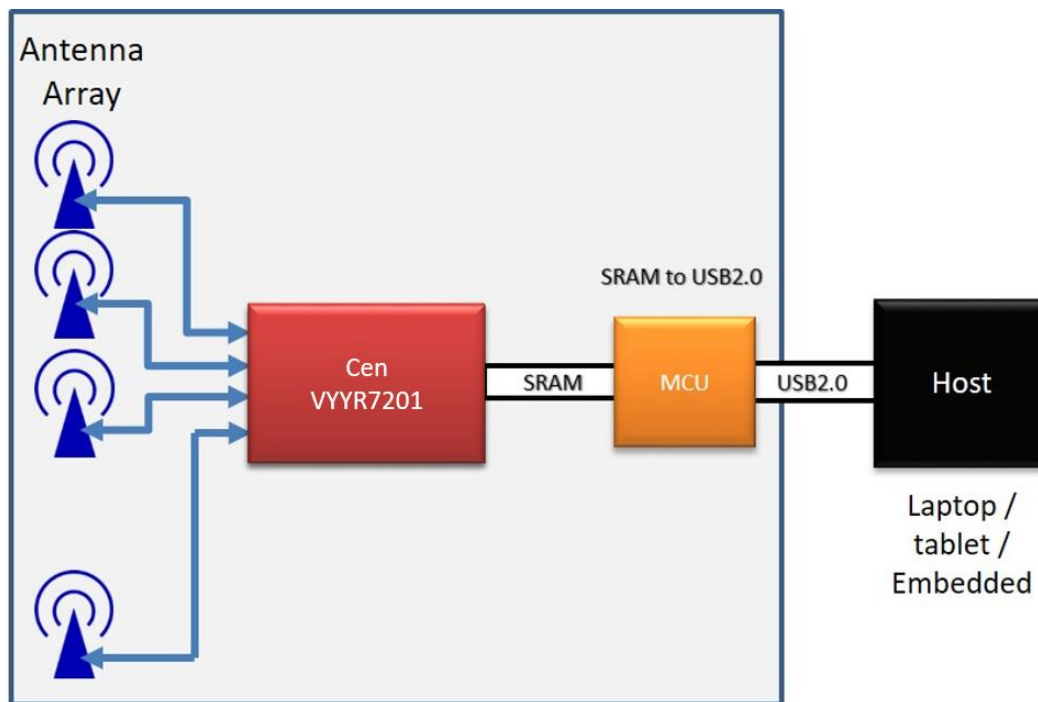
Figure 2: High-Level Block Diagram

The following components are embedded in the sensor unit PCB:

- Vayyar VYYR7201-A0 system-on-chip (SoC).

- 40 embedded Tx/Rx linear polarized PCB embedded, wide-band antennas.

- A digital interface that communicates with a host PC via a USB-2.0 connection. The interface is implemented using on-board Cypress micro-controller unit (MCU).

- A Crystal used as a clocking source for the Cypress MCU.

  A TCXO (Temperature Compensated Crystal Oscillator) used as a clocking source for the VYYR7201-A0 SoC.

- Power supply system supporting 3.3V, 2.5V, 1.27V and 1.2V DC/DC converters.

- Non Volatile Memory (NVM) used to store inventory and calibration information.

2.2.1   Sensor Unit Specification

Table 2: Sensor Unit Specification

Parameter	Specification	Notes
Transceivers	40 Tx/Rx	
Frequency Band	Within 57-64GHz	Configurable per few settings, for more details contact support
Field of View (FoV)	Refer to section 2.2.5 Antenna and RF Characteristics	
Range Resolution	$\frac{C}{2BW} = \frac{3e^8}{2 \cdot 2e^9} = 7.5\text{cm}$	Depends on the configured BW
Range Accuracy	< < Range Resolution	Depends on the target strength and shape
Angular Resolution	$\Delta\theta \approx \frac{\lambda}{D} \approx \frac{3e^8}{64e^9 \cdot 0.04} \approx 0.12rad$ $\approx 6.7deg$	λ – Wavelength [@64GHz] D – Length of the array [0.04m]
Angular Accuracy	<< Angular Resolution	Depends on the target strength and shape
Dimensions	Without case: 80 mm x 80 mm With case: 105 mm x 85 mm	Dimensions refer to VTrig_CTPA0 board, that support lots of Vayyar internal debug options and are not indicative to a final product size

2.2.2   Digital Interface

The digital interface connects the host PC with the EVK board. The interface is implemented on the EVK board using an MCU and a micro-USB connector.

Micro-Controller Unit (MCU)

Cypress's EZ-USB FX3™ MCU integrates the USB 2.0 physical layers (PHYs), and contains a 32-bit ARM926EJ-S microprocessor for building custom USB SuperSpeed applications. The integrated processor contains a unit called General Programmable Interface (GPIF), which provides easy connectivity to popular interfaces.

USB Connector

The onboard micro-USB-B 2.0 connector is used for power supply and for data transfer between the sensor unit and the host PC. The connector supports the USB 2.0 protocol in High-Speed Mode (480 Mbps).

Figure 3: VTrig_CTPA0 Connectivity

2.2.3   RF Interface - Antennas

The array of 40 antennas serves to connect the sensor unit with the environment. The antennas are embedded in the PCB, as depicted in the figure below.
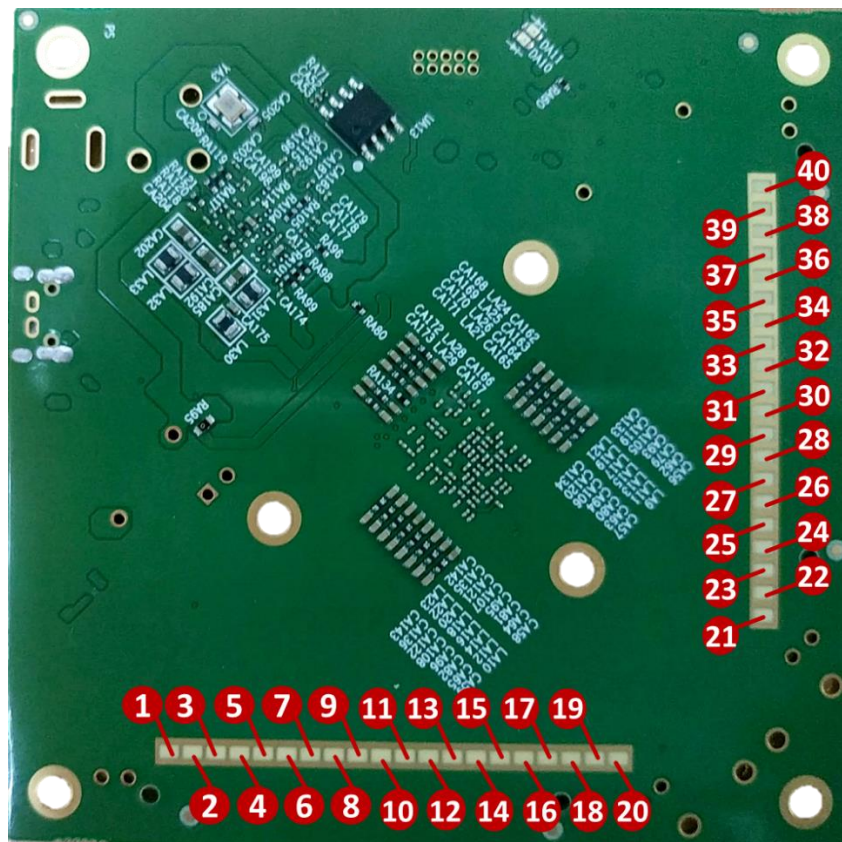

Figure 4: Antenna Positions and Numbering

For each transmitting (TX) antenna, there are multiple receiving (RX) antennas for collecting and recording the received RF signals. Each RX antenna and its associated TX antenna serve as an *antenna pair*.

2.2.4   Electrical Specifications

The following electrical specifications are for the sensor unit. The current consumption specifications are based on lab measurements performed by Vayyar.

Table 3: Sensor Unit Electrical Specification

Parameter	Value
Vcc supply voltage	5 VDC
Max current consumption	~1.3 A
Average current consumption	~1 A

2.2.5   Antenna and RF Characteristics

The following are antenna and RF characteristics, based on the simulation of a single antenna over an infinite ground plane:

Table 4: Antenna and RF Characteristics

Parameter	Value	Comment
Gain	5 dBi @62 GHz	At 0˚ Elevation, 0˚ Azimuth
Antenna -5dB beamwidth	160 deg. @62 GHz (E-plane) 120 deg. @62 GHz (H-plane)	
Polarization	Linear	
Max Tx Power	0 dBm	On chip output

The figure below depicts an antenna and its E and H planes:

- E-plane – plane XZ (green)

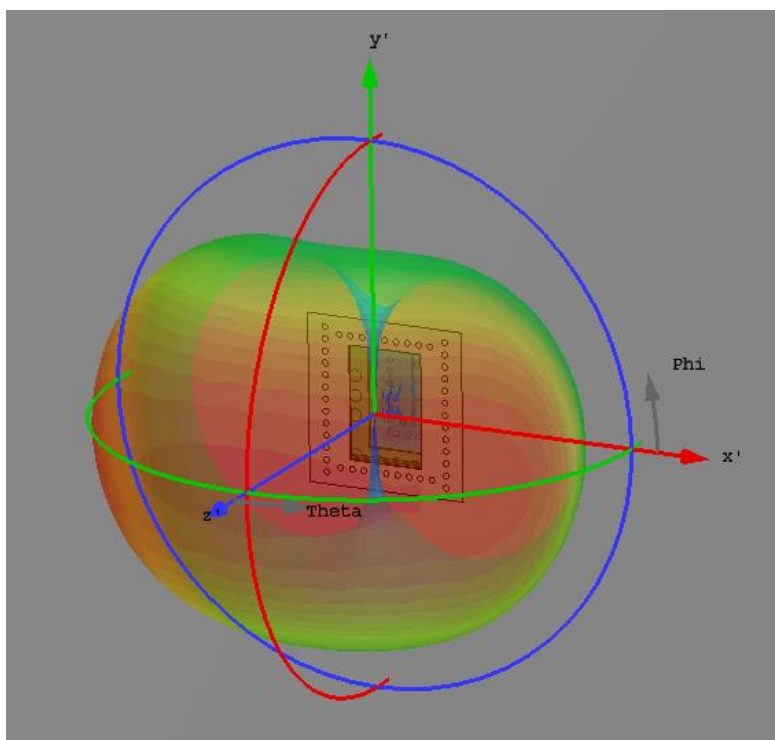- H-plane – plane YZ (red)

Figure 5: VTrig_CTPA0 Antenna Pattern

2.3   Software

The VTrig_CTPA0 system software performs signal processing and generation of the arena image.

The Graphical User Interface (GUI) provides images and blobs corresponding to the detected objects in the arena.

NOTE

The Graphical User Interface supports use of a single sensor only.

The software enables you to save the system data at multiple levels in files for further processing:

- Raw data
- Image data (3D/2D)

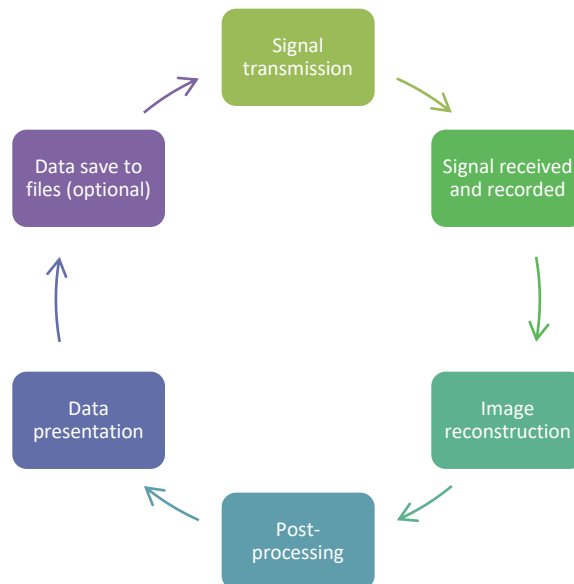The following diagram describes the processing flow of the software.

Figure 6: Processing Flow

Chapter 3
Outputs

Outputs from the sensor can be presented either through Web GUI or API. The data can be saved as MAT files and post-processed or analyzed in parallel to the saving.

The output data is available as a raw data or as a 3D/2D image data.

3.1   Web GUI

User-interface client software that communicates with the EVK Engine via a TCP/IP connection.

Heatmap (on the left presentation window in the figure below) shows the power reflected from each object in the arena.

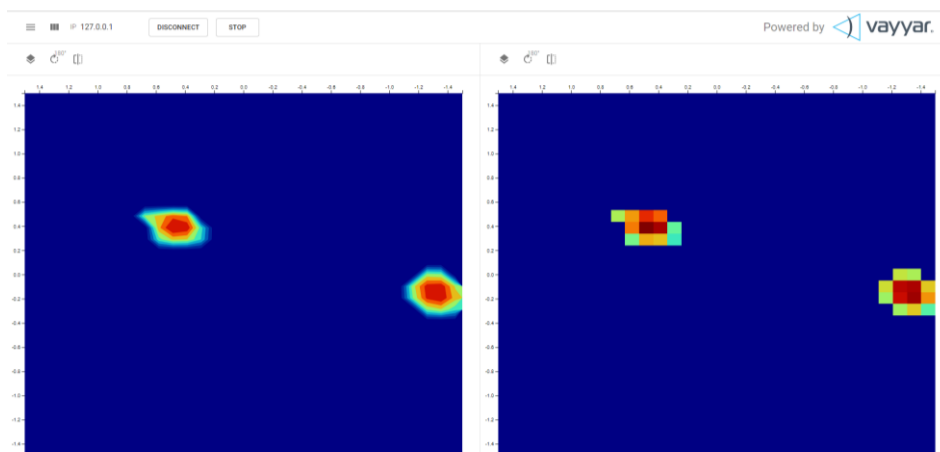Heatmap (Raw) is the same presentation pixelated (on the right presentation window).

Figure 7: Heatmap and Heatmap (Raw)

Other image formats include 3D\2D point cloud, people tracking and posture recognition, breathing monitoring and others.

3.2   API

The Vayyar Application Programming Interface (API) provides programmatic access to the Vayyar EVK Engine, allowing for integration of Vayyar's non-contact RF sensors into customer-developed systems.

The outputs (raw data or the 3D/2D Image data) can be received by API in parallel or instead of the Web GUI.

Some of the outputs available through API:

- 'rawImage_XYZ' – 3D image matrix

- 'rawImage_XY' – 2D image matrix (averaged over the Z axis)

- 'rawImage_XZ' – 2D image (averaged over the Y axis)

- 'rawImage_YZ' – 2D image (averaged over the X axis)

- 'I' – The 'I' segment of the raw I/Q data

- 'Q' – The 'Q' segment of the raw I/Q data

- 'pairs' – Transmit/receive antenna pairs of the I/Q data

- 'freqs' – Recorded frequencies of the I/Q data

Chapter 4
Regulatory section

The device is certified under FCC part 15 section 15.255, as - FCC-ID : 2AHIS-V60G.

This V60G device has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:
Reorient or relocate the receiving antenna.
Increase the separation between the equipment and receiver.
Connect the equipment into an outlet on a circuit different from that to which the receiver is connected. Consult the dealer or an experienced radio/TV technician for help.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

To maintain compliance with FCC's RF Exposure guidelines, this equipment should operated with a minimum distance of 20cm between the radiator and a human body.

The device shall not be used on an airplane while airborne.

This device complies with Part 15 of the FCC Rules.
Operation is subject to the following two conditions:
(1) This device may not cause harmful interference, and
(2) This device must accept any interference received, including interference that may cause undesired operation.

END OF DOCUMENT