SEEING THE FUTURE
mmWave Imaging Solutions

Mini-Circuits and Vayyar bring 3D millimeter wave imaging and sensing to the global market

The IMAGEVK-74 is a revolutionary tool incorporating Vayyar's highly integrated RFIC technology and radar IP into a compact evaluation kit. This kit enables researchers around the world to explore and realize millimeter wave imaging and sensing applications without the cost and overhead that would otherwise be associated with developing the required hardware.
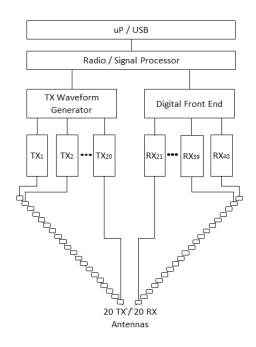
- Includes 20 Tx and 20 Rx on-board antennas that can be configured to transmit and receive signals anywhere within the 62 to 69 GHz range.

- Provides unmatched flexibility for hardware developers and researchers with three performance-optimized transmit profiles and direct access to the Tx/Rx pair phasors for each swept frequency point.

- The High resolution profile uses 20 Tx and 20 Rx antennas ideal for high-resolution 3D imaging.

- Medium and fast scan profiles using 10 or 4 Tx antennas are ideal for applications such as 2D imaging or object tracking, which don't require high angular resolution.
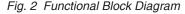

Fig. 1 IMAGEVK-74 RF Sensor

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Fig. 2 Functional Block Diagram

Fig. 3 IMAGEVK-74 RF Sensor Unit PCB Bottom View

Functional Description

The IMAGEVK-74 mmWave sensor evaluation kit (EVK) includes the entire mmWave front-end and analog base-band signal chain for paths up to 40 antennas. A high performance synthesizer generates frequency stepped CW waveforms and sweeps over frequencies and Tx antennas. The Rx resolution bandwidth, start and stop frequency points, number of frequency points, are fully adjustable with 3 transmit profiles, allowing for maximum flexibility to the user.

The Vayyar Application Programming Interface (API) when installed on a PC provides programmatic access to the Vayyar EVK engine, allowing for integration of Vayyar's non-contact RF sensors into user-developed systems[1]. This easy-to-use tool (API) operates on Windows and is compatible with both Python and Matlab to accommodate a wide range of university and research settings.

Warnings and Notices:

1. THE EVK IS NOT DESIGNED, MANUFACTURED, OR INTENDED FOR USE OR RESALE AS OR IN CONNECTION WITH ANY APPLICATION OR USE NOT EXPRESSLY AUTHO-RIZED BY MINI-CIRCUITS' APPLICABLE END USER LICENSE AGREEMENT PROVIDED IN CONNECTION WITH THE PURCHASE OF THE EVK, A COPY OF WHICH MAY BE FOUND AT https://www.minicircuits.com/WebStore/imagevk_74.html (THE "EULA*"), INCLUDING, WITHOUT LIMITATION, IN CONNECTION WITH ANY REAL-LIFE APPLICATIONS, ON-LINE CONTROL EQUIPMENT IN HAZARDOUS OR HIGH RISK ENVIRONMENTS, OR ACTIVITIES REQUIRING FAIL-SAFE PERFORMANCE INCLUDING, WITHOUT LIMITATION, IN THE OPERATION OF NUCLEAR FACILITIES, AIRCRAFT NAVIGATION OR COMMUNICATION SYSTEMS, AIR TRAFFIC CONTROL, DIRECT LIFE SUPPORT MACHINES, WEAPONS SYSTEMS, NIGHT VISION, RADAR OR AUTONOMOUS DRIVING. THE FAILURE OF THE EVK IN CONNECTION WITH ITS USE IN ANY SUCH SITUATION OR ACTIVITY OR OTHER SITUATION OR ACTIVITY NOT EXPRESSLY AUTHORIZED BY THE EULA COULD LEAD DIRECTLY TO DEATH, PERSONAL INJURY, OR SEVERE PHYSICAL OR ENVIRONMENTAL DAMAGE.

2. FCC NOTICE: THE EVK IS DESIGNED TO ALLOW PRODUCT DEVELOPERS TO EVALUATE ELECTRONIC COMPONENTS, CIRCUITRY, OR SOFTWARE ASSOCIATED WITH THE EVK TO DETERMINE WHETHER TO INCORPORATE SUCH ITEMS IN A FINISHED PRODUCT AND SOFTWARE DEVELOPERS TO WRITE SOFTWARE APPLICATIONS FOR USE WITH THE END PRODUCT. THIS EVK IS NOT A FINISHED PRODUCT AND WHEN ASSEMBLED MAY NOT BE RESOLD OR OTHERWISE MARKETED UNLESS ALL REQUIRED FCC EQUIPMENT AUTHORIZATIONS ARE FIRST OBTAINED. OPERATION IS SUBJECT TO THE CONDITION THAT THIS PRODUCT NOT CAUSE HARMFUL INTERFERENCE TO LICENSED RADIO STATIONS AND THAT THIS PRODUCT ACCEPT HARMFUL INTERFERENCE. UNLESS THE ASSEMBLED EVK IS DESIGNED TO OPERATE UNDER PART 15, PART 18 OR PART 95 OF THIS CHAPTER, THE OPERATOR OF THE EVK MUST OPERATE UNDER THE AUTHORITY OF AN FCC LICENSE HOLDER OR MUST SECURE AN EXPERIMENTAL AUTHORIZATION UNDER PART 5 OF THIS CHAPTER.

*End-user license agreement.

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The following components are embedded in the sensor unit PCB:

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

- 40 embedded Tx/Rx linear polarized 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.

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

Sensor Unit Specification

Parameter	Specification	Notes
Transceivers	40 Tx/Rx	Up to 20TX and 20 RX
Frequency Band	62 - 69 GHz	
Field of View (FoV)	Refer to Antenna and RF Characteristics	
RBW	10-800 KHz	
# of points	2-151 Frequency points	
Stop-Start min step	150MHz	
EIRP (Typ.)	-5 dBm	
Max Range Resolution	$\dfrac{C}{2BW} = \dfrac{3e^8}{2 \cdot 7e^9} = 2.14\text{cm}$	BW dependent
Range Accuracy	< < Range Resolution	Depends on the target strength and shape
Max Angular Resolution	$\Delta\theta \approx \dfrac{\lambda}{D} \approx \dfrac{3e^8}{64e^9 \cdot 0.04} \approx 0.117\,rad \approx 6.7\,deg$	λ – Wavelength [@64GHz] D – Length of the array [0.04m] Profile dependent
Angular Accuracy	<< Angular Resolution	Depends on the target strength and shape
Dimensions	PCB: 80 mm x 80 mm Perspex Cover: 90 mm x 90 mm	

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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 powerful data processing and 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 (up to 480 Mbps).

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.
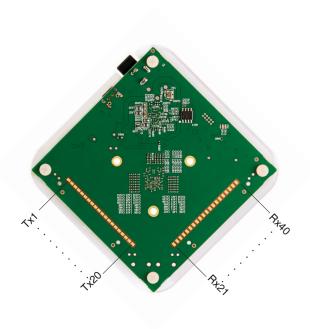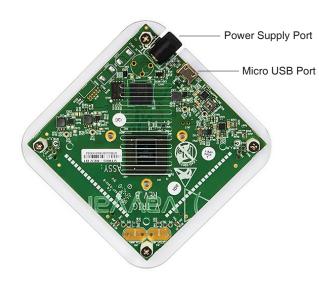

Fig. 4 Back View

Fig. 5 Front View

For each transmitting (TX) antenna, there are 20 receiving (RX) antennas for collecting and recording the received RF signals. Each RX antenna and its associated TX antenna serve as an antenna pair.

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Recording Profiles

IMAGEVK-74 supports 3 predefined user-selectable recording profiles.
Each profile can be used for different user applications. Following general profile description.

Profile Name	# of Transmitting Antennas	Frame rate	Transmitting Antenna numbers	Example User Applications
LOW_RATE	20	Low	1-20	High resolution 3D imaging
MED_RATE	10	Med	1-10	Medium resolution 3D imaging
HIGH_RATE	4	High	1-4	2D imaging, People tracking

Table 2

Sensor Unit DC Electrical Specifications

Parameter	Value
Vcc supply voltage (Typ.)	5 VDC
Max current consumption (Typ.)	1.3A
Average current consumption (Typ.)	1A

Table 3

Antenna and RF Characteristics

Parameter	Value	Comment
Gain (Typ.)	5.8 dBi @64 GHz	At 0° Elevation, 0° Azimuth
Antenna - 3dB Beamwidth (Typ.)	180 deg. @64 GHz (E-plane) 82 deg. @64 GHz (H-plane)	
Polarization	Linear	
Tx Power (Max)	-10 dBm	On chip output

Table 4

Fig. 5 below depicts an antenna and its E and H planes:

E-plane – plane Y`Z` (red)
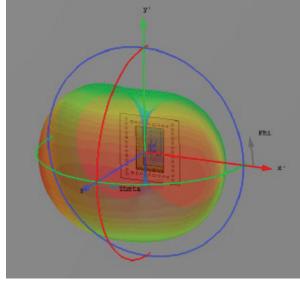H-plane – plane X`Z` (green)

Fig. 5

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Kit Components

Name	Qty
IMAGEVK-74 RF Sensor Unit (EVK) with Perspex plastic Cover	1
3M Hanging strips (pairs)	2
DC Power Supply	1
Type A to micro USB v2.0 Cable	1

vSDK – Vayyar's SDK enabling communication and control of the sensor unit available for download on Mini-Circuits Website: https://www.minicircuits.com/WebStore/imagevk_74.html

Additional Notes:

A. Performance and quality attributes and conditions not expressly stated in this specification document are intended to be excluded and do not form a part of this specification document.

B. Electrical specifications and performance data contained in this specification document are based on Mini-Circuit's applicable established test performance criteria and measurement instructions.

C. The EVK covered by this specification document shall be subject to Mini-Circuits' standard limited warranty and terms and conditions (collectively, "Standard Terms"); Purchasers of the EVK are entitled to the rights and benefits contained therein. For a full statement of the Standard Terms and the exclusive rights and remedies thereunder, please visit Mini-Circuits' website at www.minicircuits.com/MCLStore/terms/jsp.

D. The EVK and the API shall be subject to and used only in accordance with the EULA. For a full statement of the EULA, please visit Mini-Circuits' website at https://www.minicircuits.com/WebStore/imagevk_74.html

E. The EVK shall only be used with the power supply model included with EVK. The power supply included in the EVK TE10A0503B01 manufactured by SL Power Electronics.

About Mini-Circuits
Mini-Circuits is a global leader in the design, manufacturing and distribution of RF, IF, and microwave components and integrated modules covering the DC to 65 GHz band. With over 25 different product lines and over 10,000 active models, their rapid response, demanding quality standards, value pricing, on-time delivery, and top-notch customer service have helped make Mini-Circuits the world's preferred supplier of RF and microwave products for over 50 years.

About Vayyar
Founded in 2011, Vayyar started with the vision to develop a new modality for breast cancer detection by using RF to quickly and affordably look into human tissue to detect malignant growths. As the technology matured and evolved, Vayyar leveraged it to develop a unique System-on-Chip (SOC) to open up new capabilities and widen its original application scope to additional markets including robotics, smart home, retail, and testing.

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