KREEMO

Data Sheet

Antenna Development Kit for 5G mmWave Applications

ADK360°

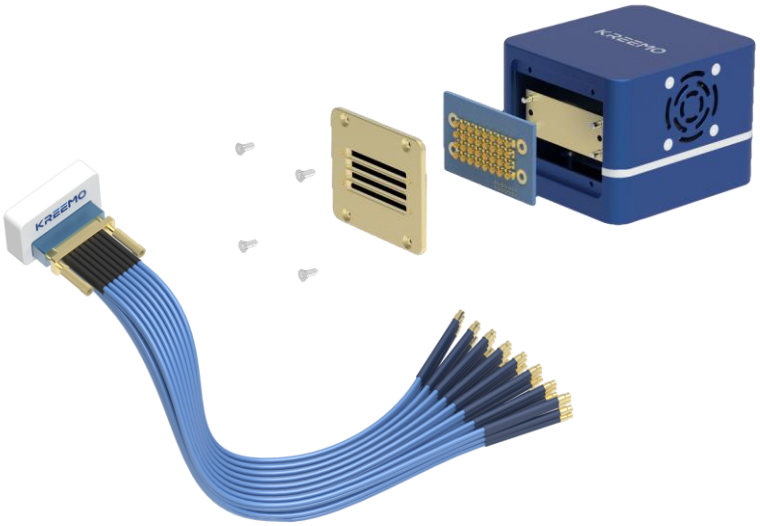
ADK360° Datasheet

DEC. 15, 2022

Revision 1.0

Part No: ADK360°

Description: 5G mmWave Antenna Development Kit



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1. General Description

KREEMO offers the Ka-band mmWave phased-array antenna development kit, ADK360° featuring dual-polarization and 32 electronically controllable RF channels. The ADK360° can efficiently emulate 5G mmWave RF front-end. This new class of ADK360° includes ADK RF module featuring 32 TRX RF ports, Type-C cable, and PC software. The overall size of the ADK360° is 89.72 mm x 112 mm x 76.8 mm. In addition, we provide 1 x 4 SPA prototype which can radiate in three orthogonal directions (normal and parallel).

2. Product Features

- The Module Operating Frequency: 26.5 to 29.5 GHz
- Controllable 16 RF channels of each polarization (32 Total Channels)
- Each Channel provides
  - ✓ 15dB Tx Gain, 10dB RX Gain
  - ✓ 360° phase shifter coverage with 11.25° per step
  - ✓ RMS phase error: 5°
  - ✓ 12dB attenuation range with 0.8dB per step
  - ✓ RMS attenuation error: 1dB
- On-chip Temperature Sensor
- PC software control via RJ-45 Ethernet interface or C-type

2.1 Functional Block Diagram

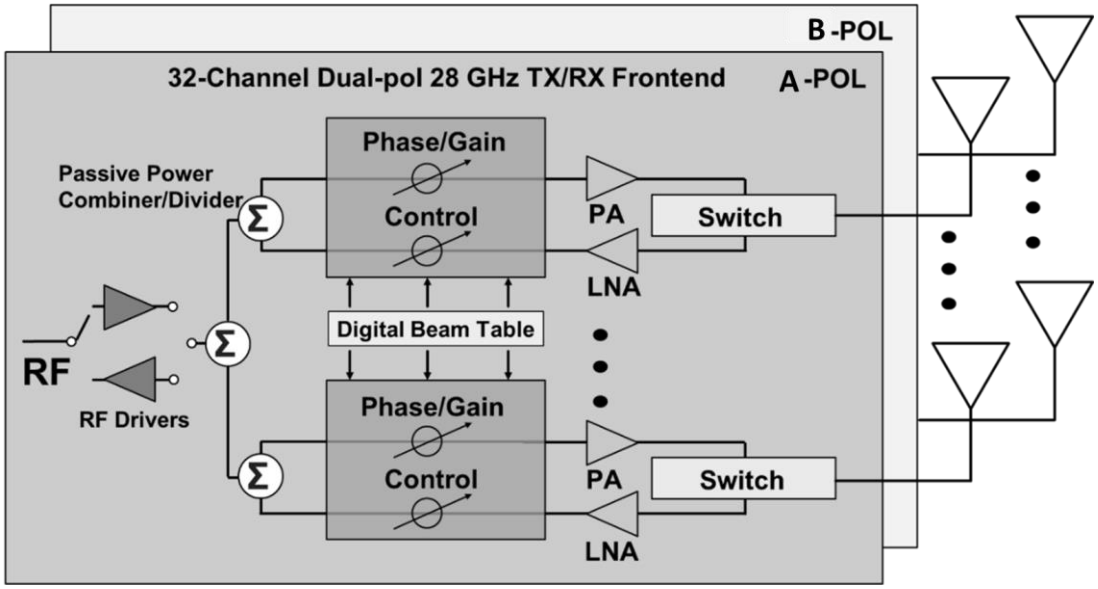


Figure 1. Block diagram for ADK360°

- Number of A-pol RF ports: 16
- Number of B-pol RF ports: 16

3. Specifications

3.1 Electrical Details

Operation conditions: Freq. = 28GHz, ZL = 50Ω, Pin = -30dBm

TX Mode

Parameter	Unit	Min.	Typ.	Max.
Freq. Range	GHz	26.5	28	29.5
Gain	dB		15	20
OP1dB	dBm		13	
Phase Shifting Range	Deg	0		348.75
Phase Shifting Step	Deg		11.25	
RMS Phase Error	Deg		5	
Attenuator Range	dB	0		12
Attenuator Step	dB		0.8	
RMS Attenuation Error	dB		1	
Return Loss	dB		-10	

RX Mode

Parameter	Unit	Min.	Typ.	Max.
Freq. Range	GHz	26.5	28	29.5
Gain	dB		10	
IP1dB	dBm		-3.5	
Phase Shifting Range	Deg	0		348.75
Phase Shifting Step	Deg		11.25	
RMS Phase Error	Deg		5	
Attenuator Range	dB	0		12
Attenuator Step	dB		0.8	
RMS Attenuation Error	dB		1	
Return Loss	dB		-10	

3.2 Operational Details

Parameter	Unit	Min.	Typ.	Max.
Supply Voltage	V		5	
Temperature Sensing Range	°C	-4.4		111.1

3.3 Mechanical Details

Parameter	Location	
RF Port	Front Panel	Port A1 ~ A16, B1 ~ B16
RJ-45	Back Panel	Ethernet
C-type1	Back Panel	Power
C-type2	Back Panel	Power / Data
RF A	Back Panel	Port A1 ~ A16
RF B	Back Panel	Port B1 ~ B16
Power Switch	Back Panel	Power on / off

3.4 Dimension Details

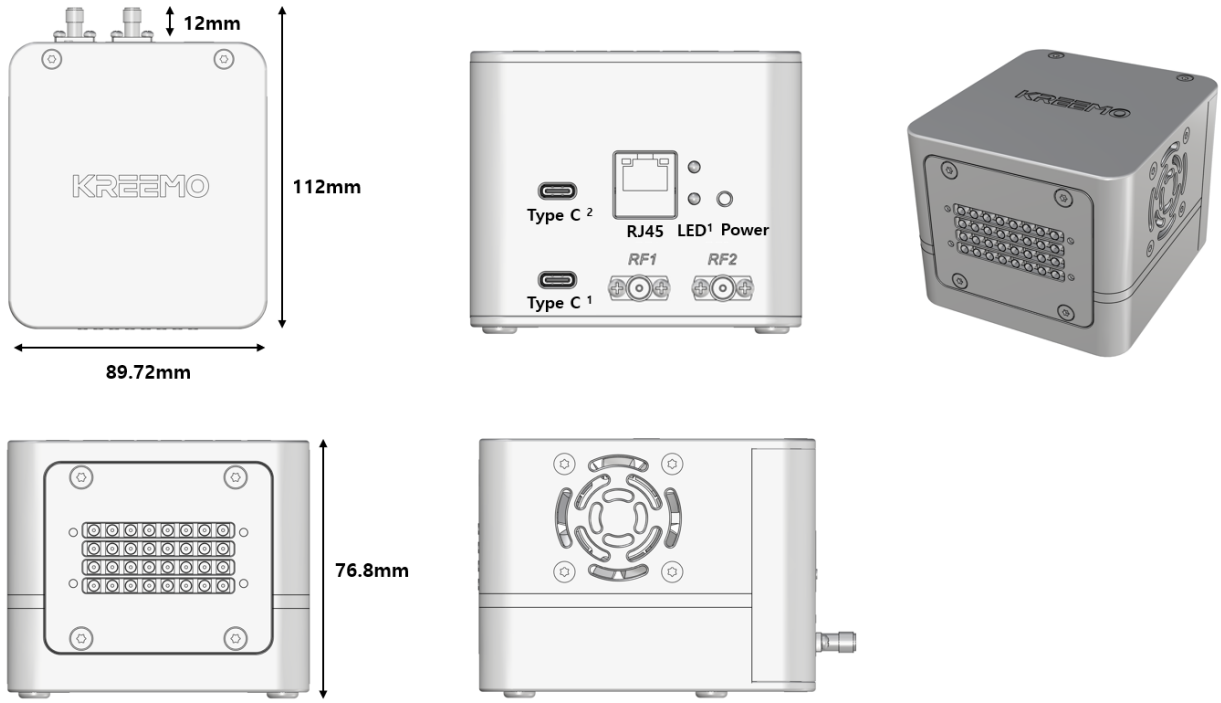


Figure 2. ADK360° Dimension

3.5 SPA Specifications

The antenna package for SPA consists of eight dual diagonal polarized antenna elements. By separately controlling the magnitude and phase of each RF port, the antenna package can radiate in three orthogonal directions, which are normal or parallel to the antenna package.

Operation conditions: with WMX Cable, Freq. = 28GHz, ZL = 50Ω

Parameter	Unit	Value
Impedance Bandwidth (S11 < -10 dB)	GHz	26.5 – 29.5
Broadside Gain at 28 GHz (- Z Axis)	dBi	10
Endfire Gain at 28 GHz (+ X Axis)	dBi	10
Beam Steering Range in H-plane	deg	± 30

Table 3-1: Specification for SPA

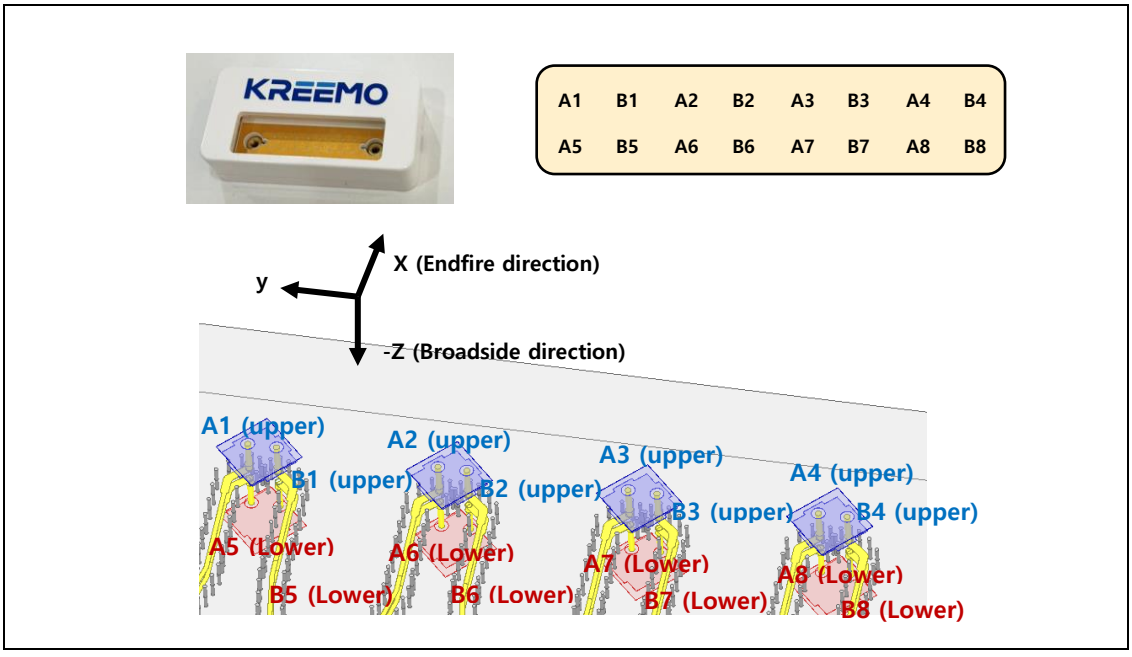
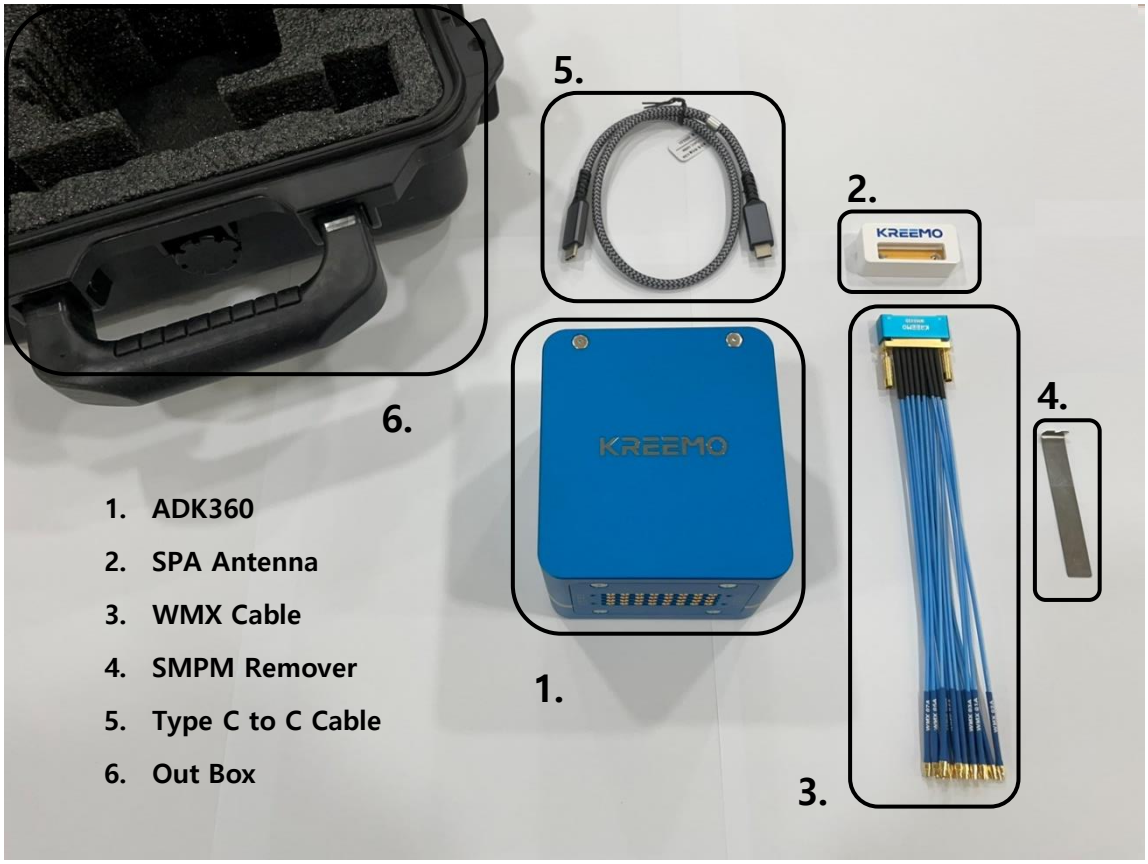


Figure 3. Coordinate system and RF ports assignment for SPA Prototype (Top View)

4. Package Includes

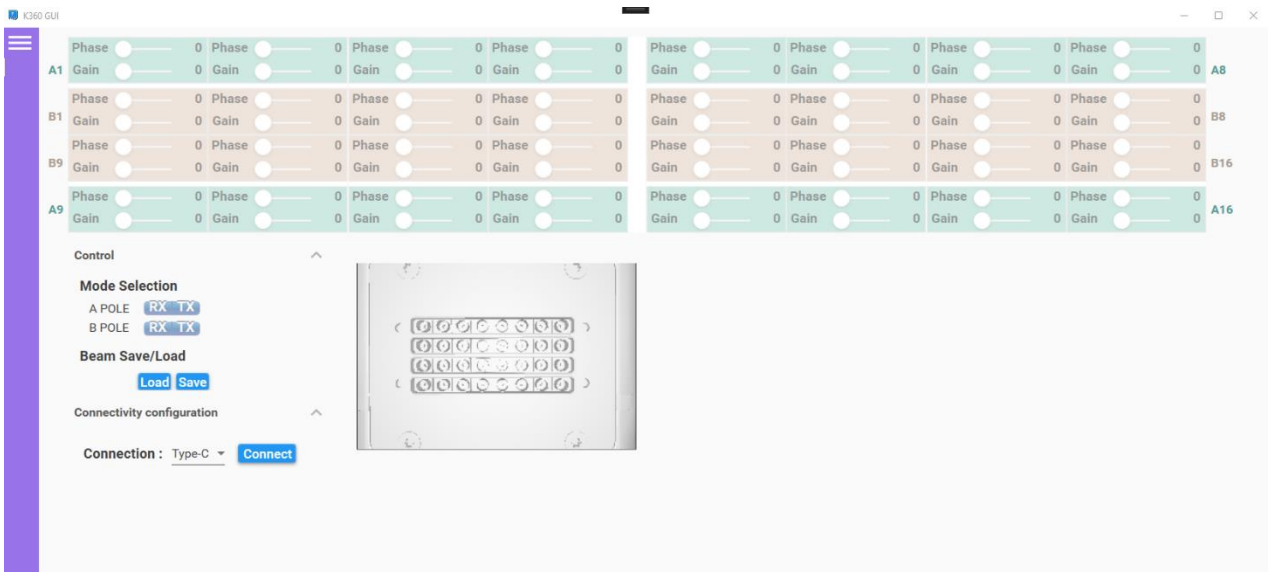
4.1 Configuration



Please Note:
1) The RF connector can be damaged when it is not used correctly. Always use the dedicated RF connector remover tool (see part. 4 in the above figure).

2) It is recommended to supply power of less -10 dBm in TX mode to alleviate heat dissipation issues.

4.2 GUI



ADK 360° provides the KREEMO graphic user interface (GUI) to easily adjust the magnitude and phase of each RF signal. Two RF channels consisting of 16 RF ports are integrated in ADK 360° to generate two orthogonal beamforming with independent control.

KREEMO GUI can be connected to PC via Type C or Ethernet cable to control the magnitude and phase of all 32 RF ports in RX/TX mode. In addition, users can save/load setting values on the GUI to perform design-specific antenna calibration and beamforming operations. Please refer the GUI software user guide for more detail.

5. Typical Performance Characteristics

Measurement and Simulation Conditions

All measurements, unless specified, were done with Vector Network Analyzer and Ka-band horn antenna in a KREEMO inhouse M360 far-field measurement system at room temperature. Unless otherwise specified, all measurements are referenced at 50Ω.

3.1 Tx Mode

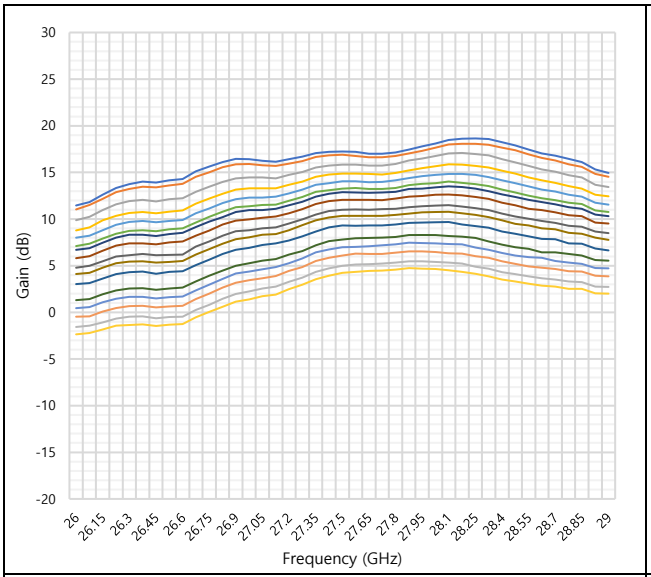


Figure 8. Tx Gain vs. Frequency[1]

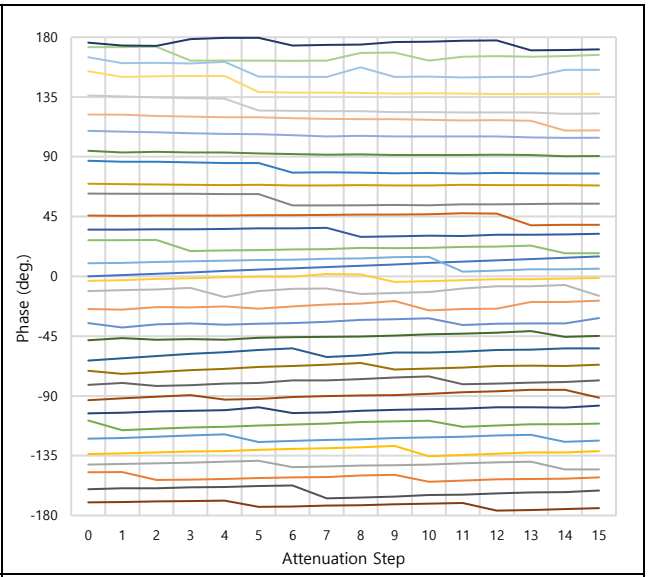


Figure 9. Phase sweep for Attenuation States[2]

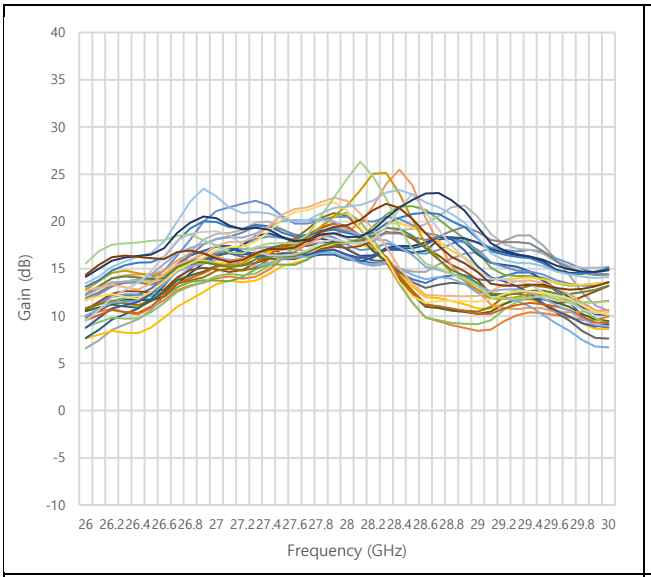


Figure 10. Tx Gain of All RF Ports vs. Frequency[3]

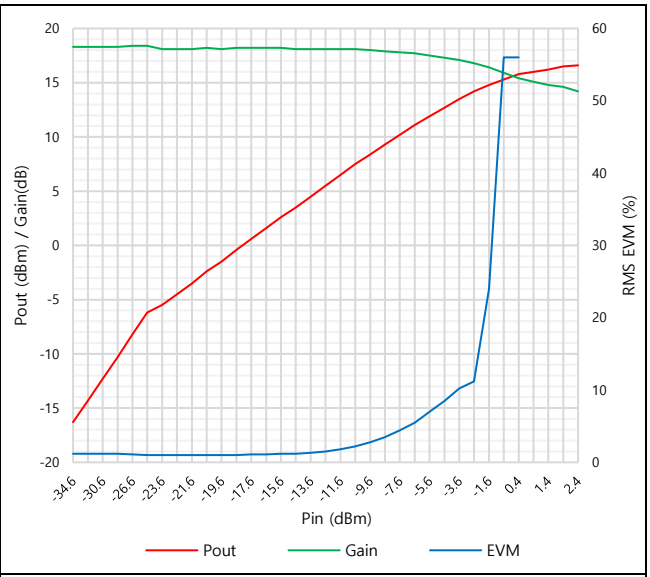


Figure 11. Pin for Pout / Gain / EVM[4]

3.2 Rx Mode

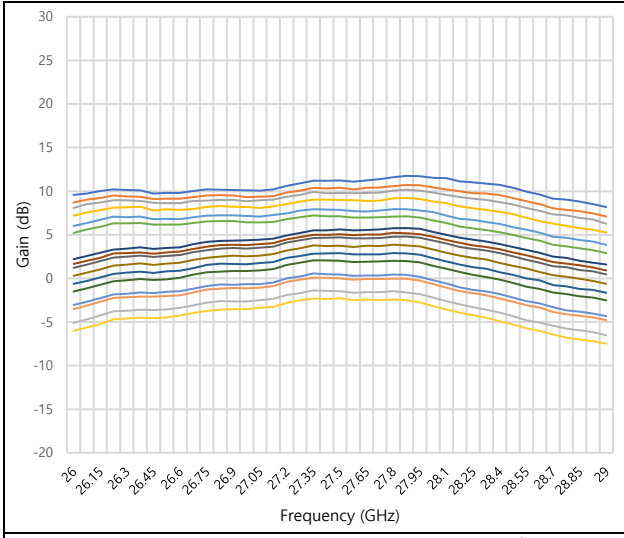


Figure12. Rx Gain vs. Frequency[1]

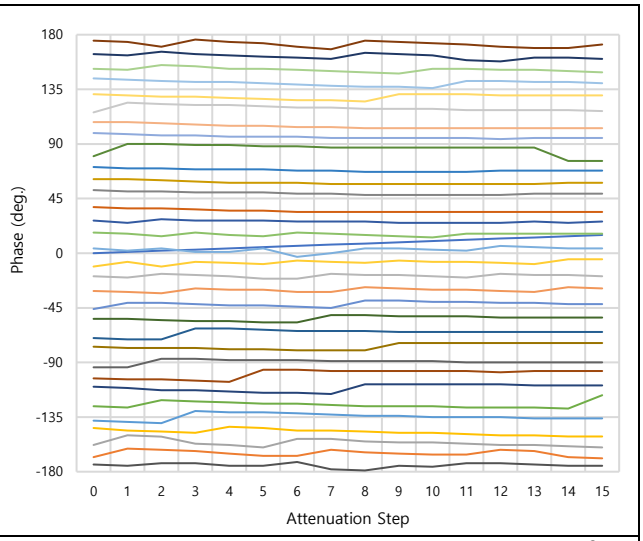


Figure 13. Phase sweep for Attenuation States[2]

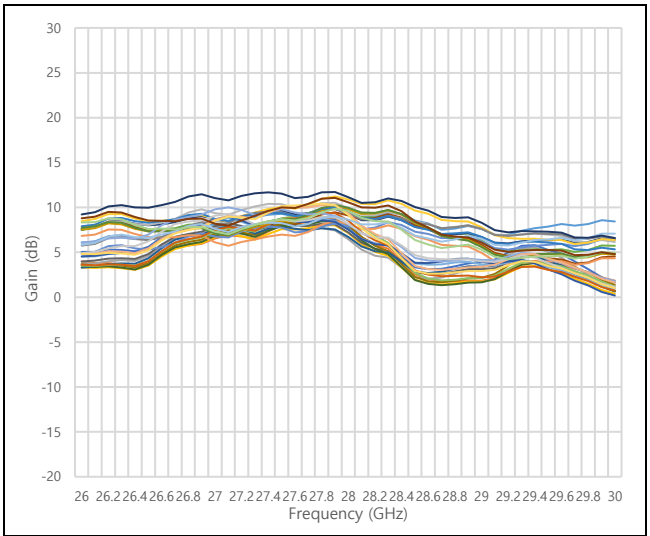


Figure 14. Rx Gain of All RF Ports vs. Frequency[3]

Notes :

1. Gain for 16 attenuation states
2. Phase for 32 phase states
3. Gain for 32 RF Ports
4. 64-QAM Modulation, 100MHz bandwidth, 120KHz subcarrier freq.

6. Appendix

Abbreviations and Acronym Definitions

Acronym	Definition
SPA	Stackable Patch Antenna

Revision History

Revision	Data	Comment
1.0	Sep 19, 2022	First Created.