



UNICORN

5G-NR Millimeter-Wave Antenna



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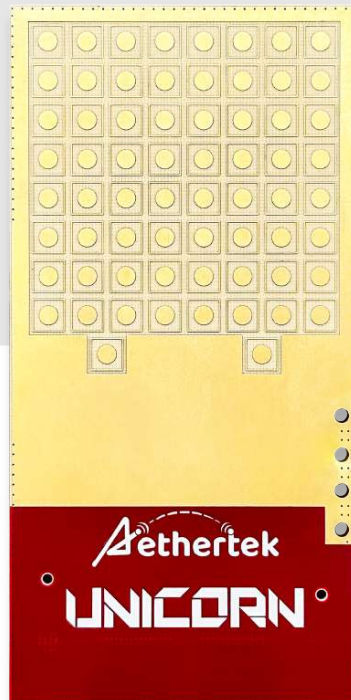
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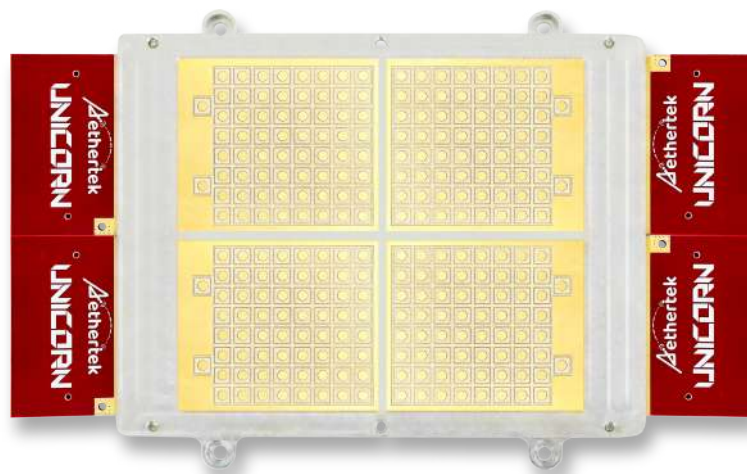
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8X8 (64 Elements)



16X16 (256 Elements)



1. AiM Overview

The “Unicorn” is an active phased array antenna module that is designed to support the 5G FR2-1 band.

It can be controlled by any processor supporting the SPI interface. Additionally, users can easily configure key parameters to customize their experience.

The module design intent is to create flexible antenna configuration, such as 8×8, 16×8, and 16×16, to accommodate various application scenarios.

2. Key Features

- Supports 5G NR FR2 n257, n258 & n261
- Compliant with 3GPP Rel 16 5G-NR standards
- Operates in mmWave TDD mode
- 256QAM DL / UL modulation
- Features an 8x8 phased antenna array with integrated IF up-down converter
- Dual polarization
- Maximum bandwidth of 400MHz for DL / UL
- Module dimensions: 95.00 x 58.04 x 16.91 mm

3. AiM Application

The AiM consists of BFIC (beamformer chips, up-down converter chips, physical circuitry, antenna element array, memory, etc.), offering seamless integration with a radio transceiver and baseband platform to create remote radio heads, ORUs and FWA. Additionally, Aethertek has developed an RF control board designed for integration with Metanoia or NXP platforms, simplifying and expediting the development process for customers.



4. AiM Overview

Table1 : Key Features of AiM

Feature	Unicorn capability
Operating Frequency	24.25 GHz to 27.5 GHz (n258), 26.5 GHz to 29.5 GHz (n257) 27.5 GHz to 28.35 GHz (n261)
IF Frequency Range	3.2GHz to 7.0GHz
LO Frequency Range	5.0 GHz to 7.5 GHz (LO × 4 mode) 8.0 GHz to 15 GHz (LO × 2 mode)
Duplexing Mode	TDD only
Maximum Channel Bandwidth	Up to 400 MHz
Beamforming Support	Independent amplitude and phase control.
Carrier Aggregation Support (Contiguous)	DL 2×2 MIMO : Up to four 100Mz component carriers UL 2×2 MIMO : Up to four 100MHz component carriers
Radio Interface	U.FL (I-PEX)
Digital Control Interfaces	SPI, I2C, GPIO
Power Supplies	See Chapter 3. Electrical Specifications.
Dimension	95.00 × 58.04 × 16.91 mm (included heat spreader)

Table2 : Radio Specifications

Parameter	Condition	I/O	Min	Typ.	Max	Unit
Operating Frequency	-	I/O	24.25	-	29.5	GHz
IF Frequency	-	I/O	3.2	-	7.0	GHz
LO Frequency × 2 Mode	-	I	8	-	15	GHz
LO Frequency × 4 Mode	-	I	5.0	-	7.5	GHz
LO Input Power	-	I	-10	-6	-2	dBm
TDD Switching Time	-	-	-	-	150	ns



Feature	Gelato capability
mmWave Transmitter	<u>IF-V</u> vertical polarization and <u>IF-H</u> Horizontal polarization receiver signal paths Each receiver chain provides amplitude / phase weighting translation.
mmWave Receiver	<u>IF-V</u> vertical polarization and <u>IF-H</u> Horizontal polarization transmit signal paths Each transmitter chain provides amplitude / phase weighting translation.

5. Electrical Specifications - Part1

Table3 : Power supply DC characteristics

Parameter	Symbol	Min	Typ.	Max	Unit	Note
Analog supply Voltage	VDD_DRV_1P8_xx, VDD_TX_1P8_xx, VDD_RX_1P8_xx, VDD_BD_1P8	1.7	1.80	1.9	V	
Digital supply Voltage	DVDD_1P8	1.7	1.8	1.9	V	
Digital supply Voltage	VDD_TXRX_1P2_x, VDD_LDO_1P2, VDD_ADC_1P2	1.14	1.2	1.26	V	

Table4 : SPI DC Characteristics

Parameter	Symbol	Min	Typ.	Max	Unit	Note
Input High Voltage (VINH)	SCLK, SDIO, <u>CS</u>	1.2	1.8	-	V	
Input High Voltage (VINL)	SCLK, SDIO, <u>CS</u>	-	0	0.63	V	
Input High Voltage (VOH)	SDO, SDIO	1.35	-	1.8	V	
Input High Voltage (VOL)	SDO, SDIO	-	0.16	-	V	

The Unicorn features two SPI interfaces that manage all functionalities, including beam steering and gain control. The maximum clock rate for these interfaces is 100 MHz.



Table5 : Logic DC Characteristics

Parameter	Symbol	Min	Typ.	Max	Unit	Note
Digital control (VIH)	TRX_V, TEX_H RST, CHIP_EN, Channel_EN Load_H, Load_V, CHIP_ADD0 to CHIP_ADD3	1.2	1.8	-	V	
Digital control (VIL)	TRX_V, TEX_H RST, CHIP_EN, Channel_EN Load_H, Load_V, CHIP_ADD0 to CHIP_ADD3	-	0	0.63	V	

6. Electrical Specifications - Part2

Table6 : Power Supply DC Characteristics

Parameter	Symbol	Min	Typ.	Max	Unit	Note
Analog supply Voltage	VDD_xx_1P8	1.7	1.80	1.9	V	
Digital supply Voltage	VDD_BB	1.7	1.8	2.3	V	

Table7 : SPI DC characteristics

Parameter	Symbol	Min	Typ.	Max	Unit	Note
Input High Voltage (VINH)	SCLK,SDIO, <u>CS</u>	1.2	-	1.8	V	
Input High Voltage (VINL)	SCLK,SDIO, <u>CS</u>	-	0	0.63	V	
Input High Voltage (VOH)	SDO, SDIO	1.35	-	1.8	V	
Input High Voltage (VOL)	SDO, SDIO	-	0.16	-	V	



Table8 : Logic DC characteristics

Parameter	Symbol	Min	Typ.	Max	Unit	Note
Digital control (VIH)	RX_EN, TX_EN, RST, SWTR CEN LOAD	1.2	-	1.8	V	
Digital control (VIL)	RX_EN, TX_EN, RST, SWTR CEN LOAD	-	0	0.63	V	

Table9 : Power consumption

Parameter	Min	Typ.	Max	Unit	Note
Supply Voltage	-	17.59	-	V	-
Supply Current	-	TBD	-	A	1.8V
Supply Voltage	-	1.2	-	V	-
Supply Current	-	6.4	-	A	1.2V
Total power consumption	-	43	-	W	[1]

[1] Test conditions : 5G NR FR2 TM3.1 with 120 kHz SCS and 100 MHz bandwidth, dual polarization mode enabled (both vertical and horizontal polarizations)



7. Absolute Maximum Ratings

Table10 : DC Absolute Maximum Ratings

Parameter	Symbol	Min	Typ.	Max	Unit	Note
Power supply Voltage	1.8V Supply	-	-	1.98	V	-
Power supply Voltage	1.2V Supply	-	-	1.32	V	-
Power supply Voltage	VDD_BB	-	-	2.3	V	-
Digital Input Voltage	Logic Input High	-	-	1.95	V	-
Digital Output Voltage	Logic Input Low	0.63	-	-	V	-
Operating Temperature	-	-40	25	60	Deg	[1]

Table11 : Radio Absolute Maximum Ratings

Parameter	Type	Min	Typ.	Max	Unit	Note
RF Ports	I	-	-	-7	dBm	[1]
IF Ports	I	-	-	-5	dBm	[1]
LO	I	-	-	-3	dBm	-

[1] If the signal source is a modulated signal and PAPR is a concern, do not exceed the limits to avoid damaging the AiM unless otherwise stated.

Table12 : Thermal Maximum Ratings

Parameter	Min	Typ.	Max	Unit	Note
Operating Temperature Tc	-40	25	95	°C	[1]
Die Temperature Tj	-	-	125	°C	[1]
Storage Temperature	-	-	85	°C	-

[1] Aethertek provides a command for users to read the chipset's die temperature and monitor its status. It is recommended to avoid exceeding the maximum die temperature to ensure optimal performance and prevent damage to AiM.



8. General Specifications of AiM

Table13 : Radio Performance Summary

Parameter	Condition	Min	Typ.	Max	Unit
Max EIRP (V+H) ⁽¹⁾⁽²⁾⁽³⁾	256 QAM, 100MHz, 400MHz	-	-	50	dBm
Beam Scan angle	-	-	+/- 60	-	Deg
Min EIRP across scan angles ⁽⁴⁾	256 QAM, 100MHz, 400MHz	44	-	-	dBm
EVM	-	-	< 3.5	4.5	%
ACLR	TM1.1, 100MHz, 400MHz	-	-	-28	dBc
Cross-pol Leakage	0 deg Az / 0 deg El	-	-30	-35	dBc
Noise Figure	0 deg Az / 0 deg El	-	6	-	dB
Transmitter Gain ⁽⁵⁾	0 deg Az / 0 deg El	-	64	-	dB
Receiver Gain ⁽⁵⁾	0 deg Az / 0 deg El	-	43	-	dB

(1) The test results are based on specific test equipment and an external LO board.

(2) The test waveform followed the 3GPP definition.

(3) Test equipment: R&S ATS1800C.

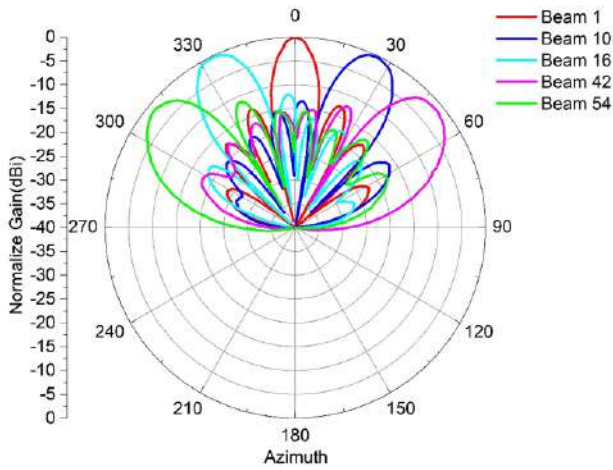
(4) All test results are based on the Beam ID diagram.

(5) Maximum gain mode.

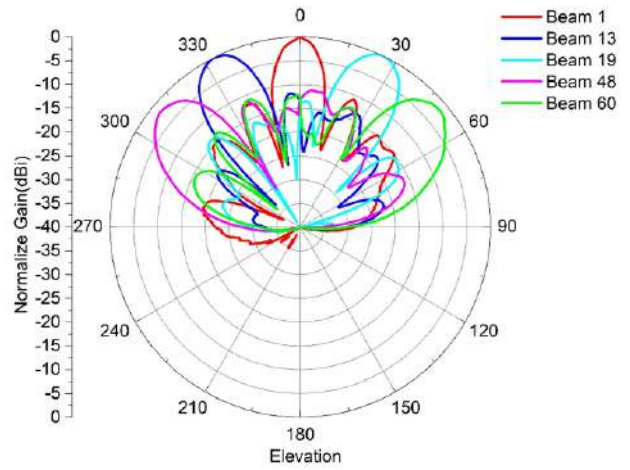


9. Free Space Antenna Pattern

9.1 Vertical polarization antenna pattern@27.4GHz

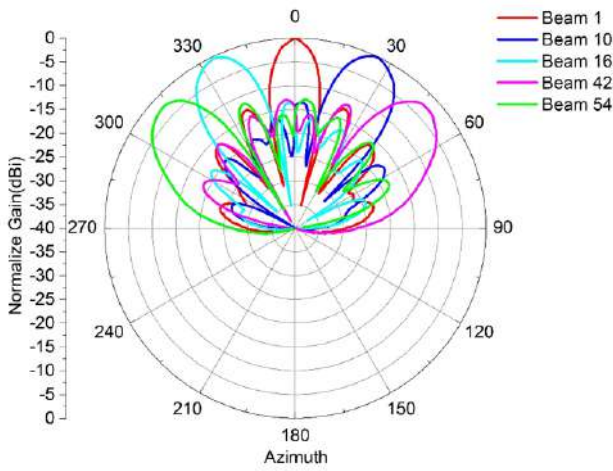


Azimuth antenna pattern

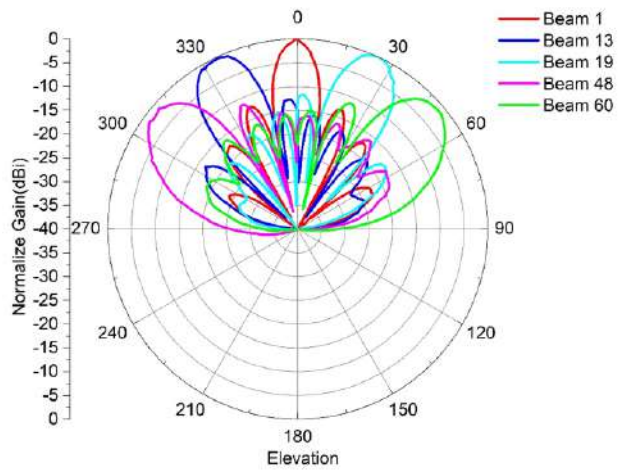


Elevation antenna pattern

9.2 Horizontal polarization antenna pattern@27.4GHz



Azimuth antenna pattern



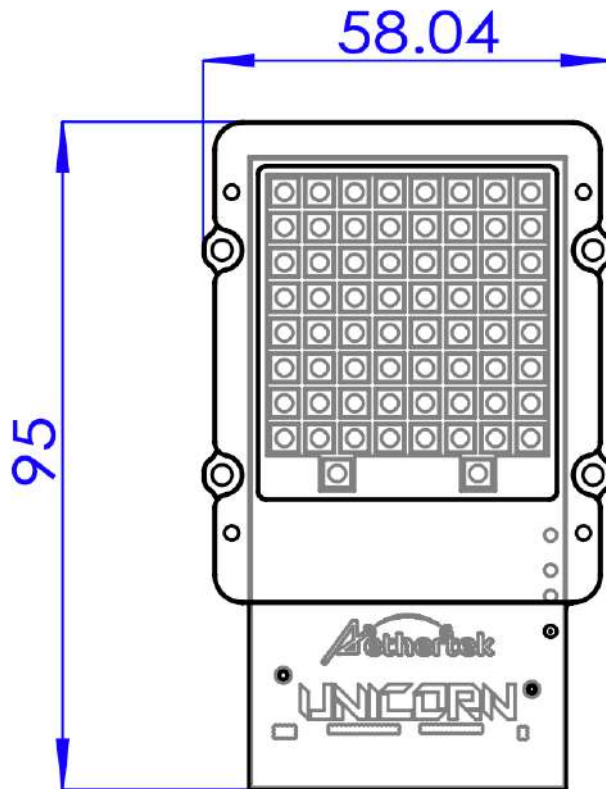
Elevation antenna pattern



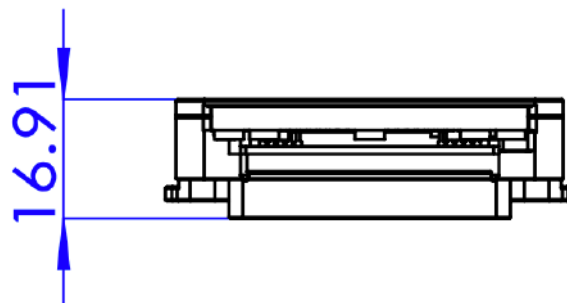
10. Mechanical Specifications

(Unit : mm)

8x8 Elements



Unicorn Top view

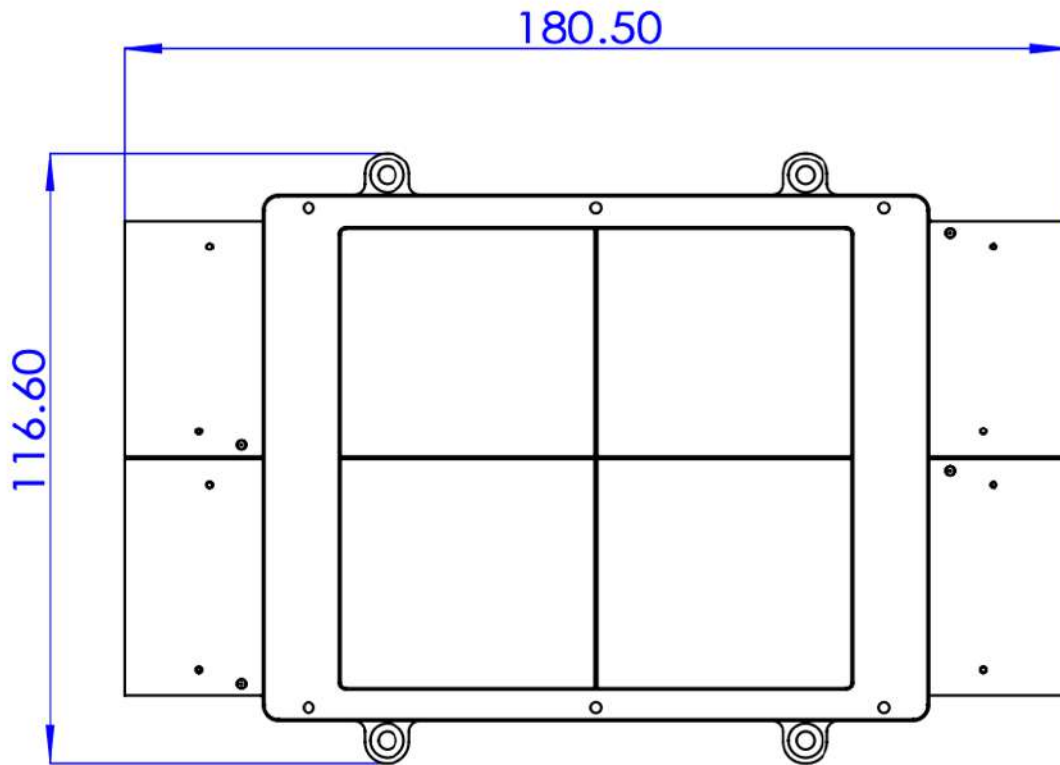


Unicorn Front view

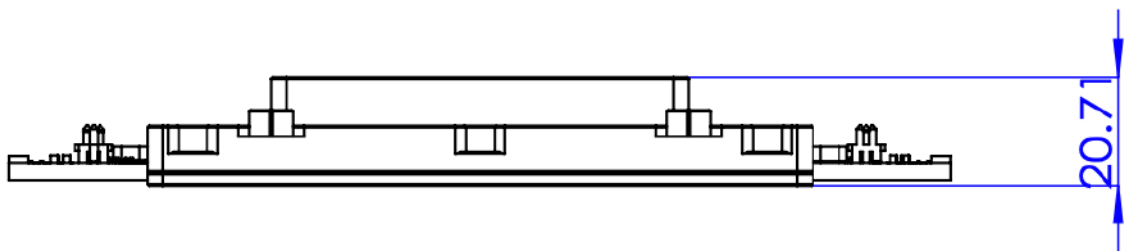


(Unit : mm)

16×16 Elements



Unicorn Top view



Unicorn Front view

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