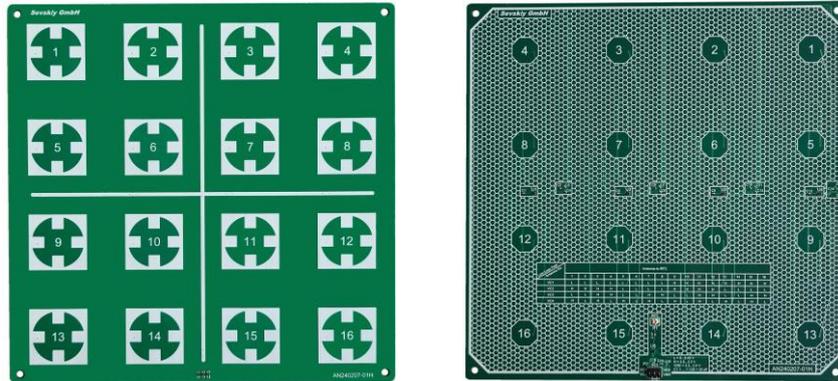


2.45 GHz Patch Antenna Array for Direction Finding Applications (Bluetooth LE, AoA)



General information

This two-dimensional antenna array is intended to be used in direction finding systems applying Angle of Arrival (AoA) protocol implemented in Bluetooth 5.x. On request, the antenna geometry can be optimized for customer's housing design and material properties. RF switches are integrated on the antenna board.

Typical applications

Bluetooth Low Energy, direction finding systems based on Angle of Arrival (AoA) protocol.

Electrical data

Antenna type	4x4 patch antenna array
Frequency bands	BLE 2450 MHz
Frequency range [MHz]	2400...2500
Return loss [dB]	-10
Peak gain of single array element [dBi]	-4...-1
Radiation efficiency [%]	20...25
Nominal input impedance [Ohm]	50
Polarization	Circular (RHCP)
Radiation pattern	directional
Maximum input power [dBm]	+32

Mechanical data

Antenna PCB dimensions [mm]	200 x 200 x 2
Connector type ¹⁾	IPEX MHF1 / Hirose U.FL (UMCC) compatible ¹⁾
Recommended cable type and thickness ²⁾ [mm]	micro coax 1.13 ²⁾
Recommended cable length ³⁾ [mm]	150 ³⁾
PCB material	FR4

Environmental data

Operating temperature [°C]	-40...+85
Storage temperature [°C]	-40...+85
Ambient relative humidity [%]	0...95
RoHS / REACH compliant	yes / yes

Additional information

¹⁾ Other connector types can be offered on request.

²⁾ Following cable thicknesses can be used with MHF1 connector: 0.81 mm, 1.13 mm, 1.32 mm, 1.37 mm.

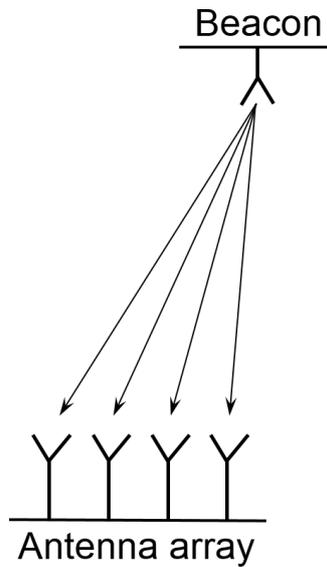
³⁾ Recommended length. Cable is not included. Other cable types and lengths can be used.

Other designs, geometries or materials are possible on request.

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Angle of Arrival (AoA) principle



A single-antenna transmit beacon (not included) sends a special direction-finding signal to the antenna array. Angle calculation is based on phase information (phase differences) between the adjacent array antenna elements. The number of antennas in array affects the angle estimation accuracy.

Bluetooth 5.x direction finding Angle of Arrival (AoA) protocol is supported by the following chipsets (not included): nRF5340, nRF52833, nRF52820, nRF52811 (Nordic Semiconductor), EFR32MG13, EFR32BG13, EFR32BG22, EFR32MG22 (Silicon Labs), CC2642, CC2652 (Texas Instruments), CYW54591 (Cypress), and others.

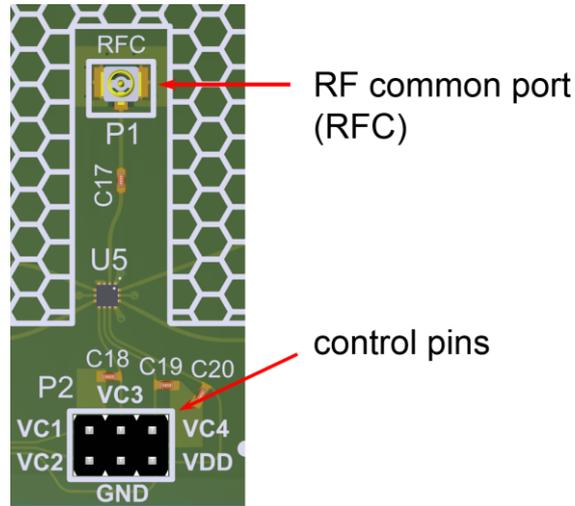
Electrical Specifications of the RF Switch

Parameter	Symbol	Description	Min	Typ	Max
Supply voltage [V]	VDD		2.5	3.3	3.5
Control voltage high [V]	H		2.5	3.0	3.3
Control voltage low [V]	L			0	0.45
Supply current [µA]	IDD			40	50
Switching speed [ns] (single switch)	SS	50 % CTL to 90 % RF 50 % CTL to 10 % RF		400	500
Rise/fall time [ns] (single switch)	t _{ON} /t _{OFF}	10% RF to 90 % RF 90 % RF to 10 % RF			500
Startup time [ns] (single switch)	t _{START}	From VDD off to VDD on		500	1000

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2.45 GHz Patch Antenna Array for Direction Finding Applications (Bluetooth LE, AoA)

Control pins descriptions



Pin	Name	Description
1	VC1	Control voltage 1
2	VC2	Control voltage 2
3	VC3	Control voltage 3
4	VC4	Control voltage 4
5	VDD	Supply voltage
6	GND	Ground

Control signals table for switching individual antennas in antenna array

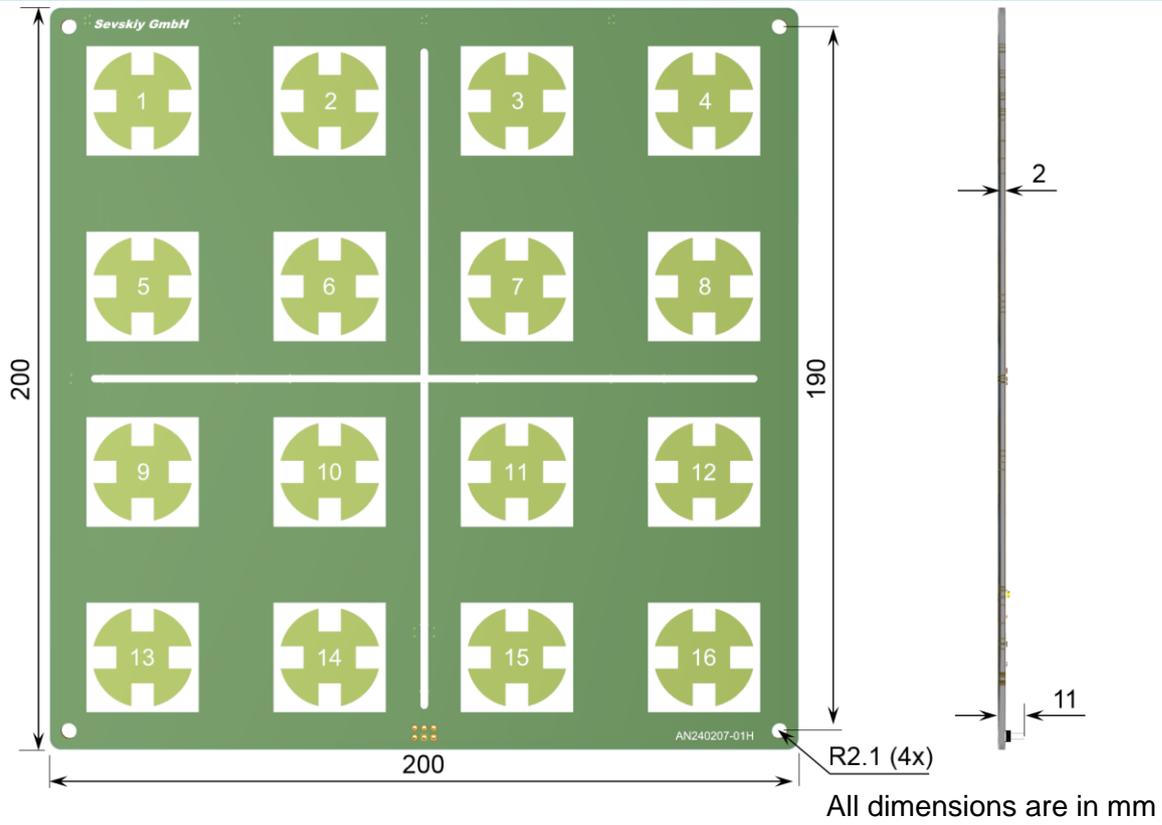
Low-Loss Path Antenna No	Antenna-to-RFC															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
VC1	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H
VC2	H	H	H	H	L	L	L	L	H	H	H	H	L	L	L	L
VC3	L	L	H	H	L	L	H	H	L	L	H	H	L	L	H	H
VC4	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L

*H = 2.5...3.3 V, L = 0...0.45 V

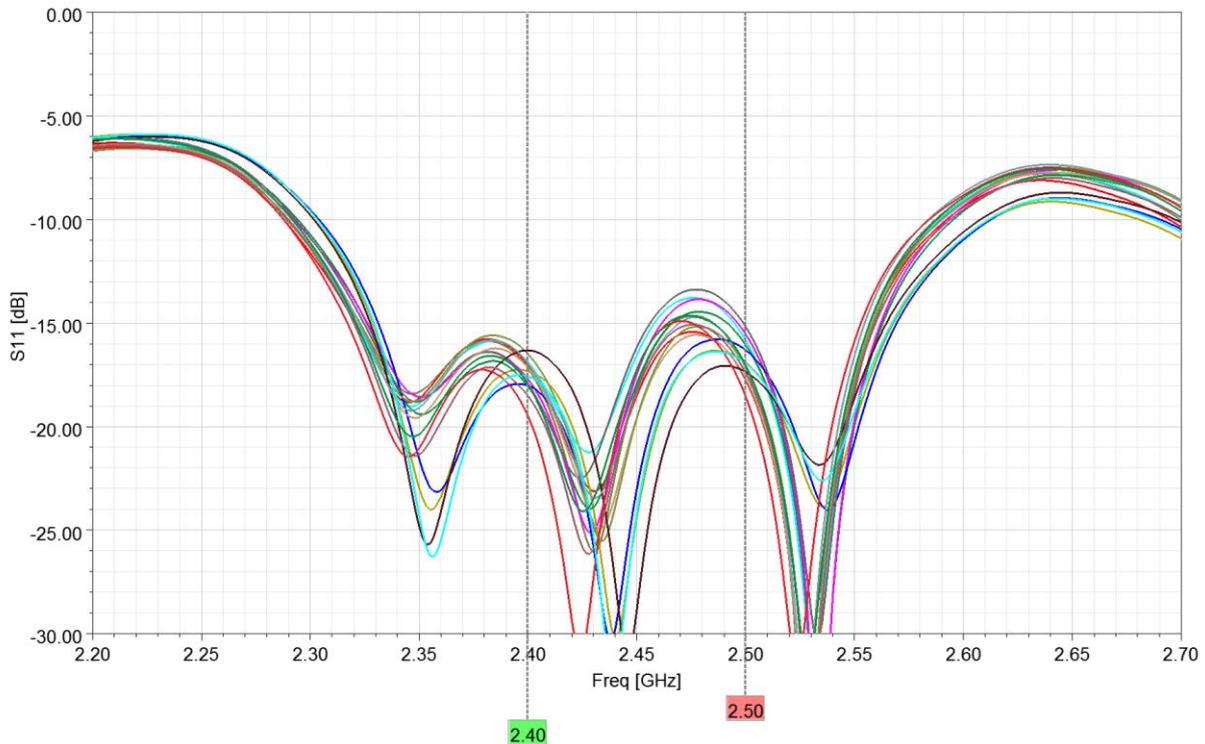
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2.45 GHz Patch Antenna Array for Direction Finding Applications (Bluetooth LE, AoA)

Product dimensions



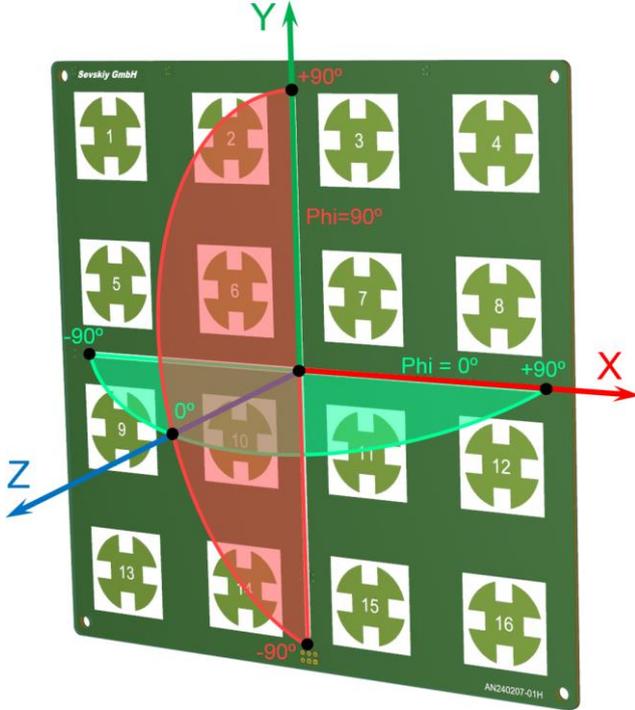
Measured input impedance matching (16 single elements)



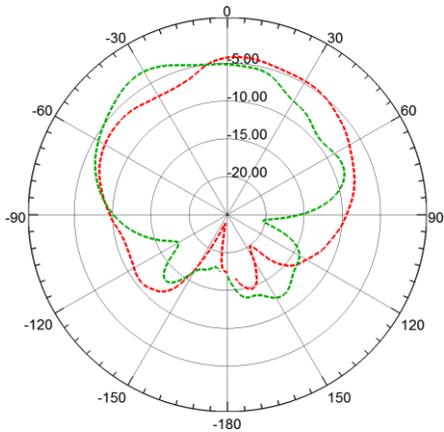
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2.45 GHz Patch Antenna Array for Direction Finding Applications (Bluetooth LE, AoA)

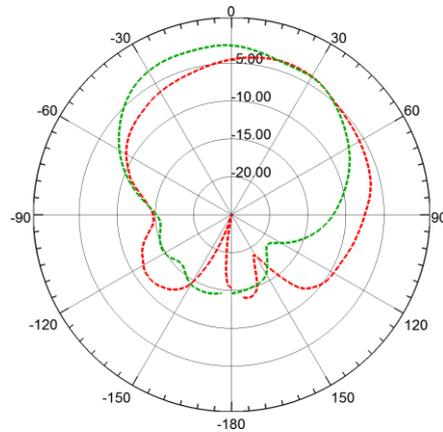
Measured radiation pattern (total realized gain) at 2450 MHz



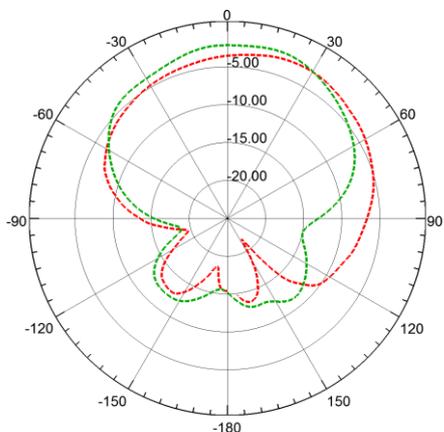
Phi=0°, plane XZ, green curve
Phi=90°, plane YZ, red curve



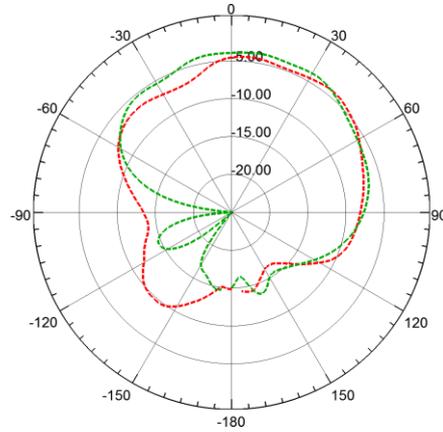
Antenna 1



Antenna 2



Antenna 3

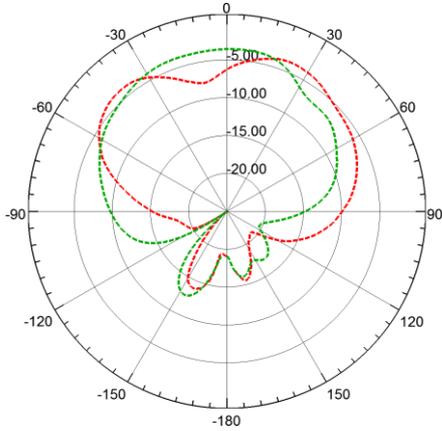


Antenna 4

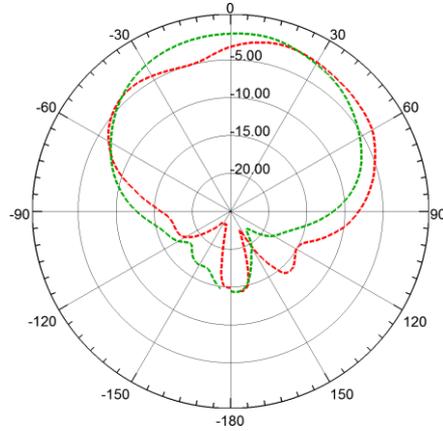
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2.45 GHz Patch Antenna Array for Direction Finding Applications (Bluetooth LE, AoA)

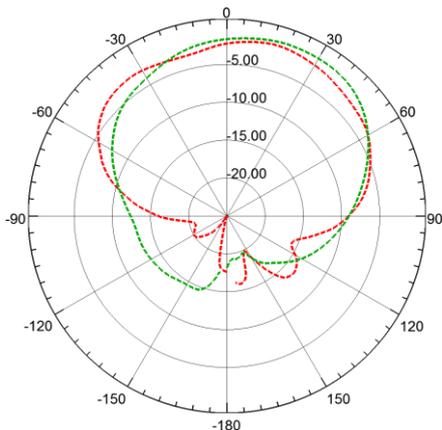
Measured radiation pattern (total realized gain) at 2450 MHz



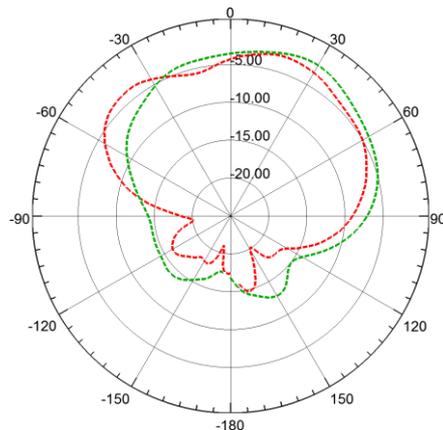
Antenna 5



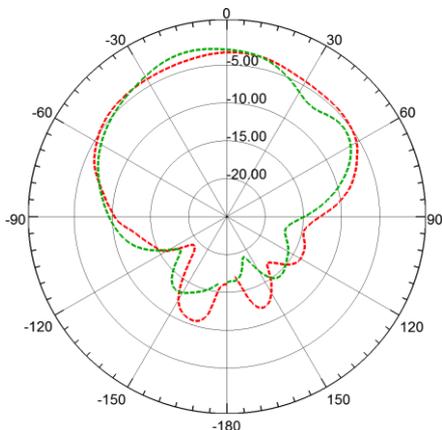
Antenna 6



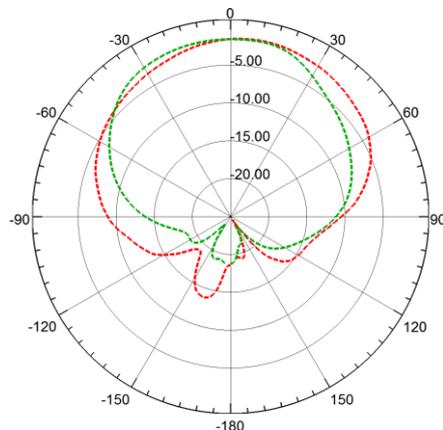
Antenna 7



Antenna 8



Antenna 9

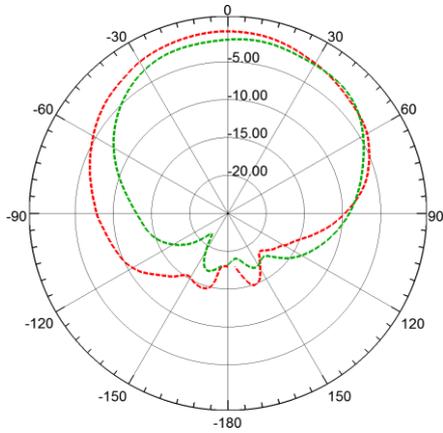


Antenna 10

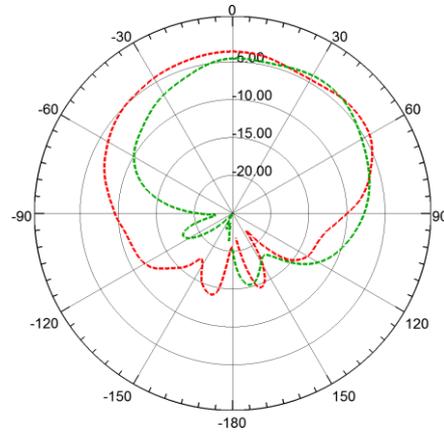
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2.45 GHz Patch Antenna Array for Direction Finding Applications (Bluetooth LE, AoA)

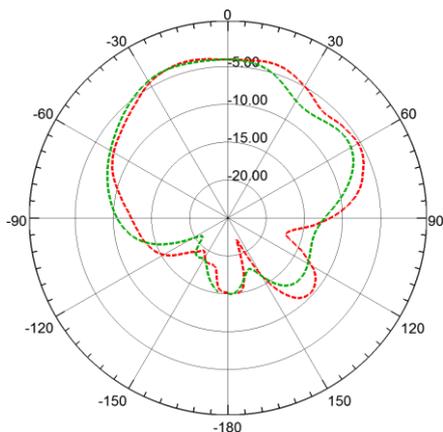
Measured radiation pattern (total realized gain) at 2450 MHz



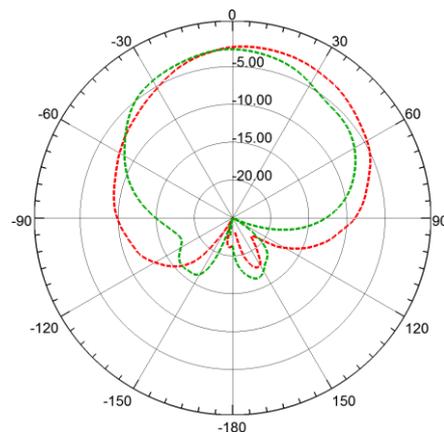
Antenna 11



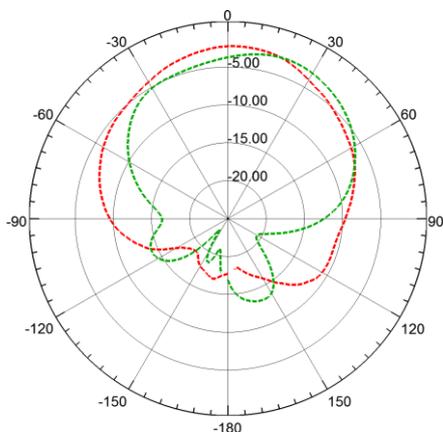
Antenna 12



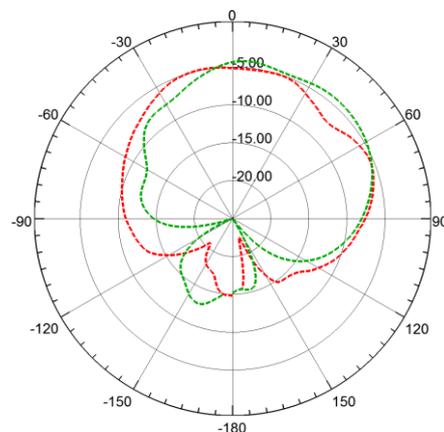
Antenna 13



Antenna 14



Antenna 15



Antenna 16

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