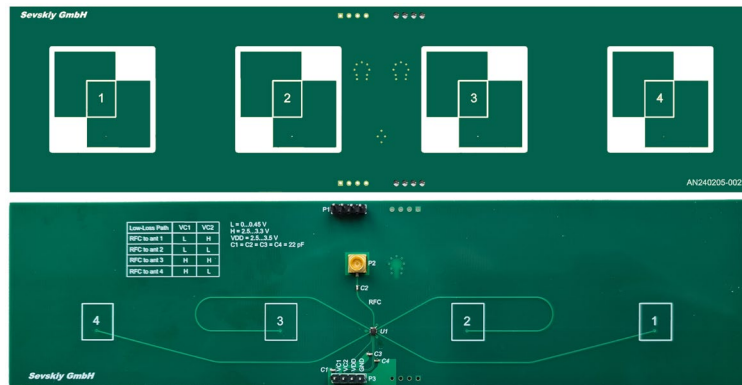


2400...2500 MHz Patch antenna array for direction finding applications (Bluetooth LE, AoA, AoD)



General information

The AN240205-002 is a compact 4x1 planar patch antenna array designed for direction-finding and localization applications in the 2.4...2.5 GHz ISM band, with primary focus on Bluetooth Low Energy (BLE) Angle of Arrival (AoA) systems.

The antenna array itself is fully passive and operates in conjunction with an external RF switching network. A single RF transceiver port is sequentially connected to each antenna element via an RF switch, controlled by digital control lines. This approach enables phase-coherent reception from individual antenna elements while keeping the RF front-end architecture simple and cost-effective.

In addition to Angle of Arrival (AoA), the antenna array concept is also compatible with Angle of Departure (AoD) systems, where a known antenna switching sequence is used on the transmitting side and the receiving device determines the direction based on phase variations. Both AoA and AoD techniques are standardized in modern BLE direction-finding solutions.

These features make the AN240205-002 well suited for indoor positioning systems, real-time location systems (RTLS), object and equipment tracking, proximity and presence detection, and other short-range wireless localization applications.

Electrical data

Antenna type	4x1 patch antenna array
Frequency bands	BLE 2450 MHz
Frequency range [MHz]	2400...2500
Return loss [dB]	-12
Peak gain of single array element [dBi]	0.3...1.5
Radiation efficiency [%]	28...32
Nominal input impedance [Ohm]	50
Polarization	Circular (RHCP)
Radiation pattern	directional
Maximum input power [dBm]	+32

Mechanical data

Antenna PCB dimensions [mm]	220 x 55 x 1.6
Connector type ¹⁾	SMP ¹⁾
PCB material	FR4
Weight [g]	100

Additional information

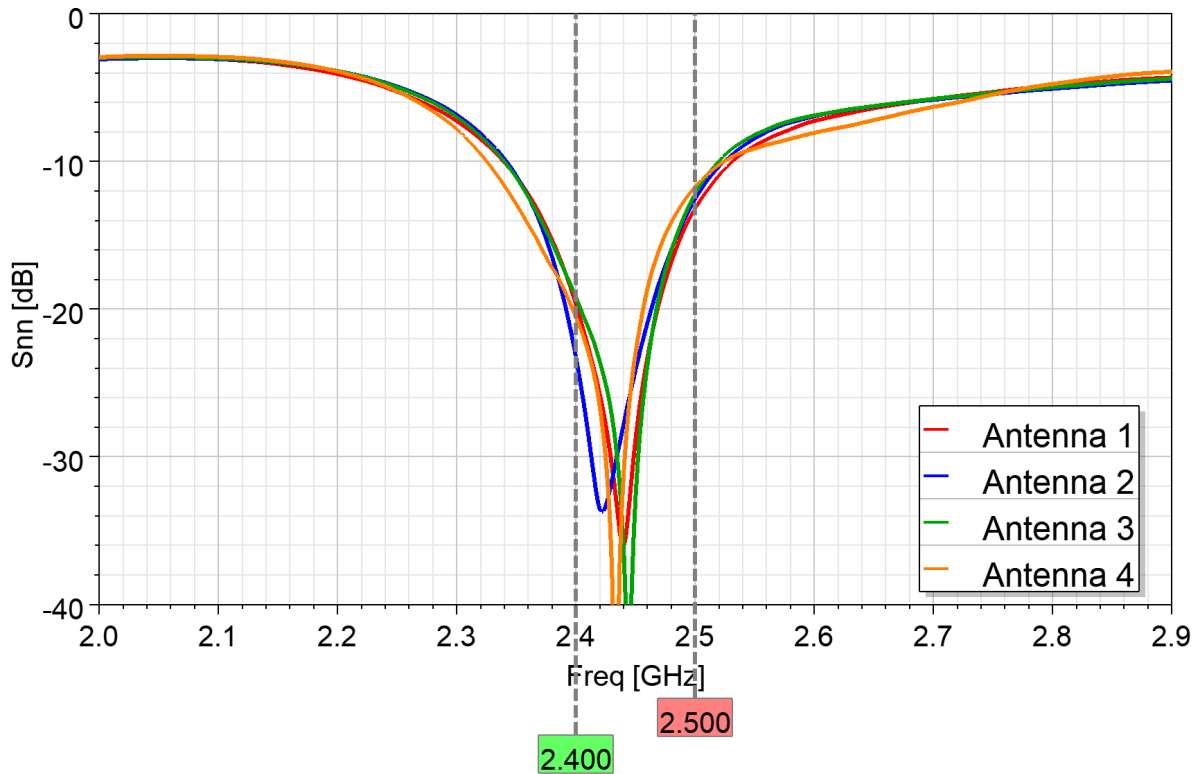
¹⁾ Other connector types can be offered on request.

Other designs, geometries or materials are possible on request.

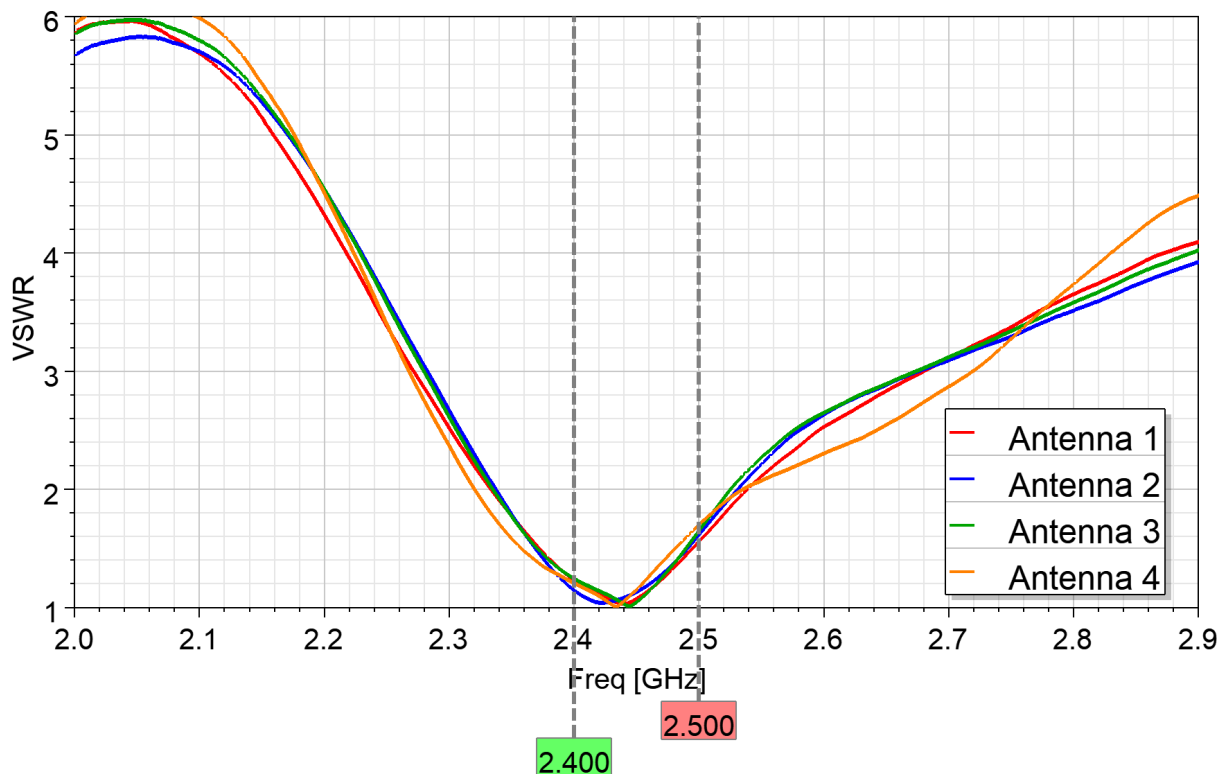
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Measured input impedance matching



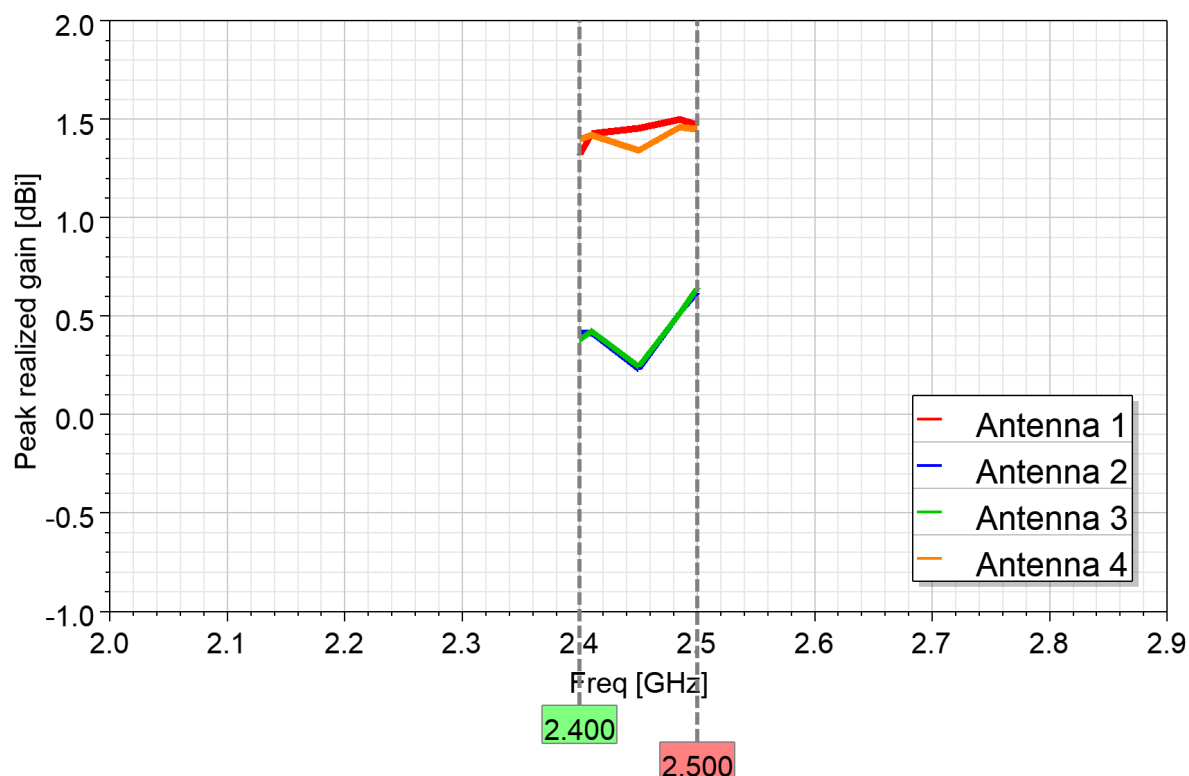
VSWR



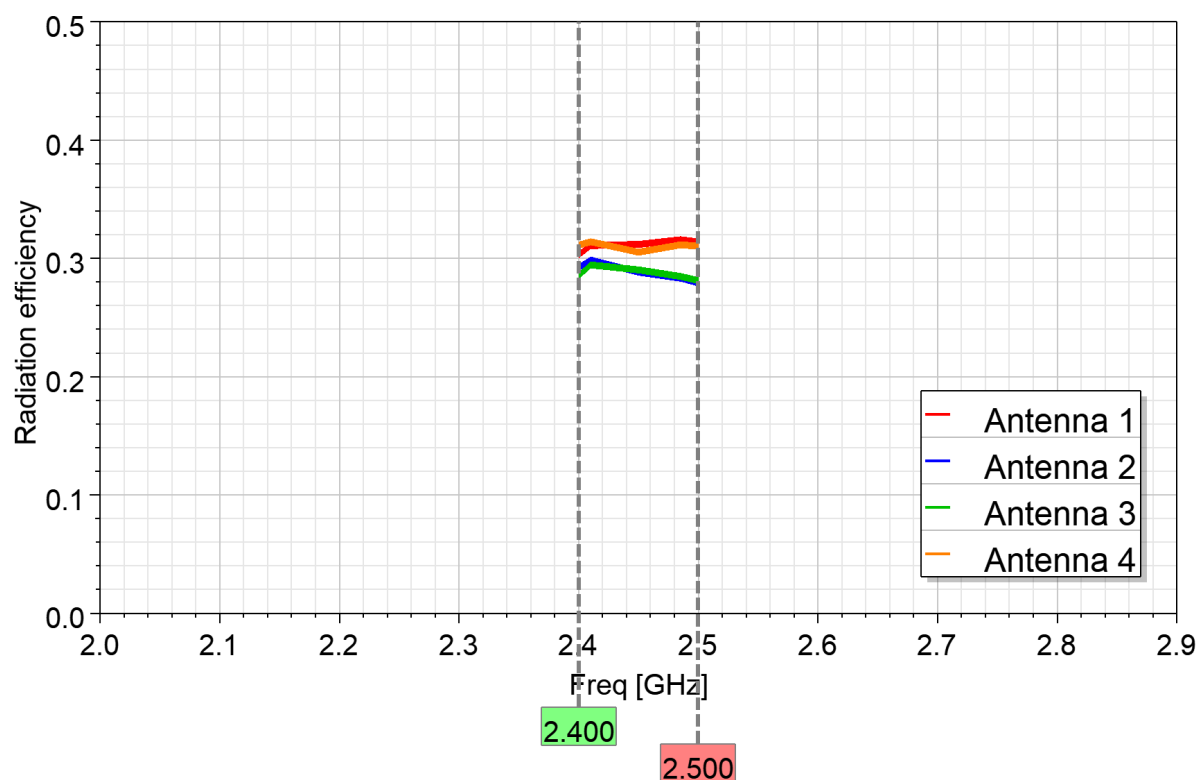
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Peak realized gain



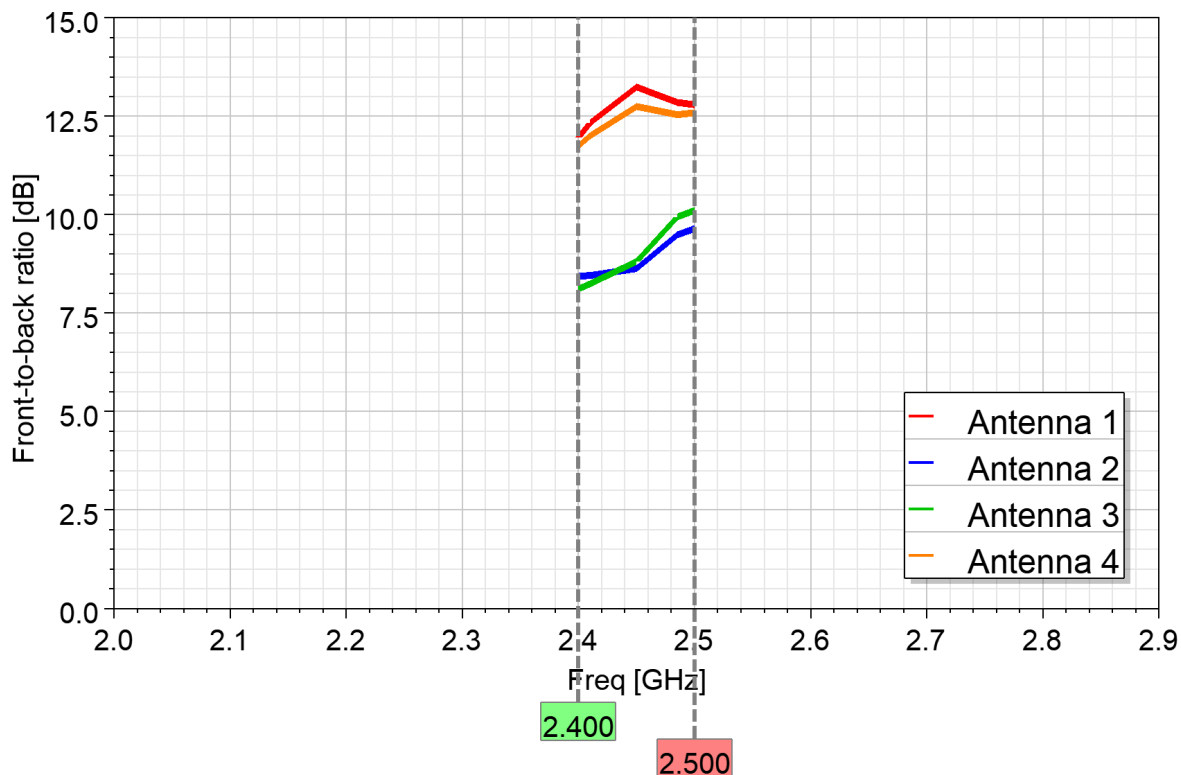
Radiation efficiency



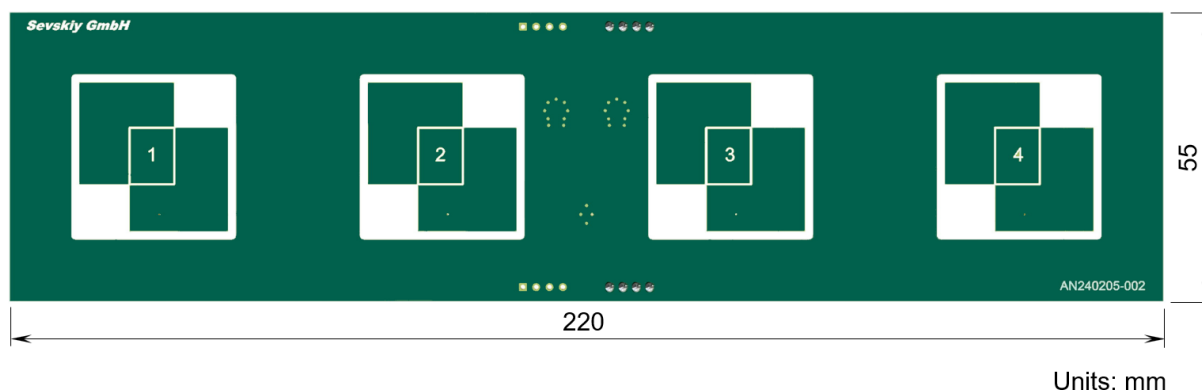
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Front-to-back ratio



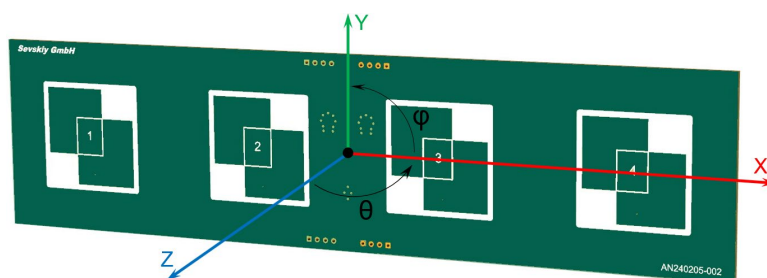
Product dimensions



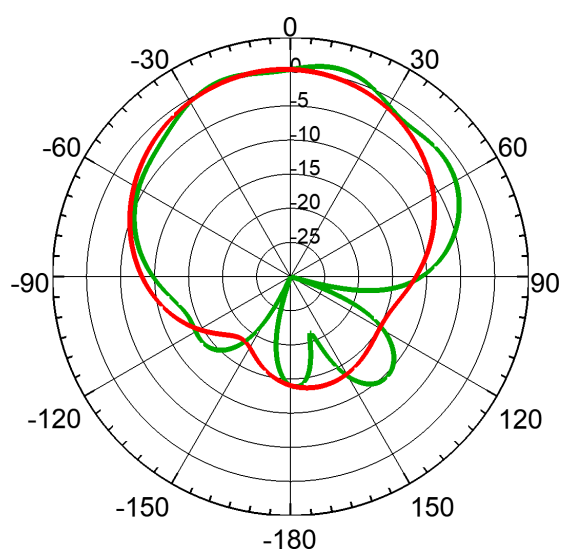
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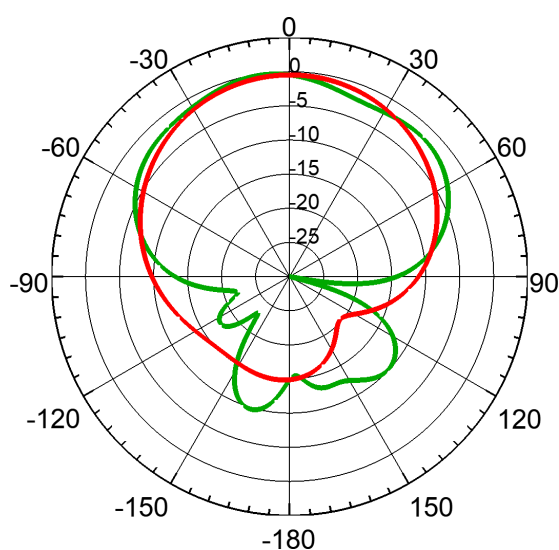
Radiation pattern at 2450 MHz



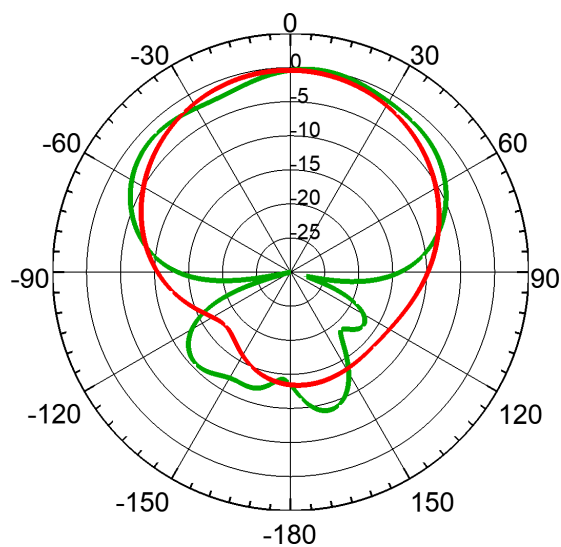
Total realized gain [dBi]
Phi=0°, plane XZ, green curve
Phi=90°, plane YZ, red curve



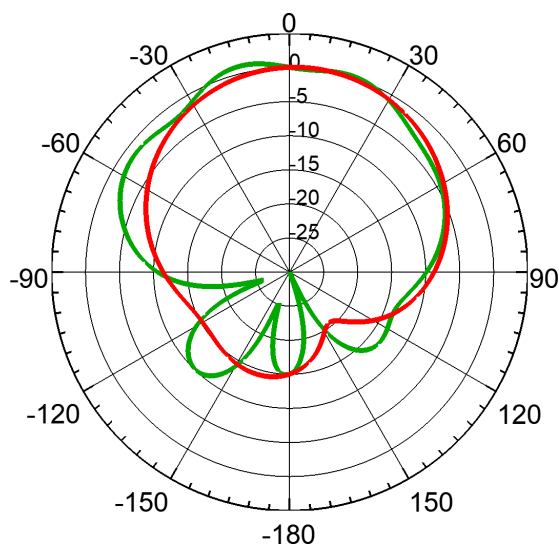
Antenna 1



Antenna 2



Antenna 3

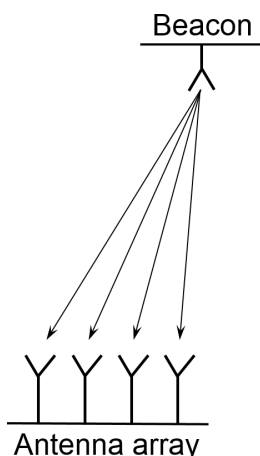


Antenna 4

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Angle of arrival (AoA) and angle of departure (AoD) principles



Angle of Arrival (AoA) is a direction-finding method in which a radio signal transmitted by a single-antenna device (beacon, not included) is received by a multi-element antenna array. The receiver sequentially switches between antenna elements using an RF switch and measures phase differences between adjacent, spatially displaced antenna elements. The incident signal angle is calculated based on these phase differences. The number of antenna elements and their geometry directly affect the achievable angular accuracy.

Angle of Departure (AoD) is a complementary method where the transmitting device sequentially switches between antenna elements and transmits a known signal sequence. The receiving device measures the phase of the received signal and determines the signal direction based on the known switching pattern.

Bluetooth® LE Direction Finding using Angle of Arrival (AoA) and Angle of Departure (AoD) 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), as well as compatible BLE direction-finding modules based on these platforms.

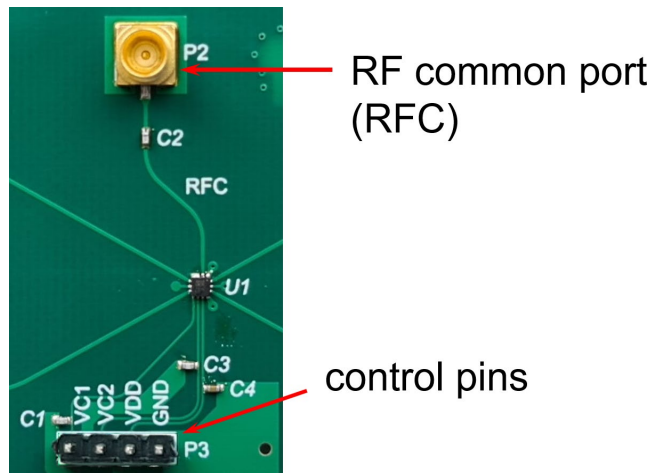
Electrical specifications of the RF switch

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			8	10
Switching speed [ns]	SS	50 % CTL to 90 % RF 50 % CTL to 10 % RF		400	500
Rise/fall time [ns]	t _{ON} /t _{OFF}	10% RF to 90 % RF 90 % RF to 10 % RF			500
Startup time [ns]	t _{START}	From VDD off to VDD on		500	1000

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Control pins description



Pin	Name	Description
1	VC1	Control voltage 1
2	VC2	Control voltage 2
3	VDD	Supply voltage
4	GND	Ground

Control signals table for switching individual antennas in antenna array

Low-Loss Path	VC1	VC2
RFC to antenna 1	L	H
RFC to antenna 2	L	L
RFC to antenna 3	H	H
RFC to antenna 4	H	L

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

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