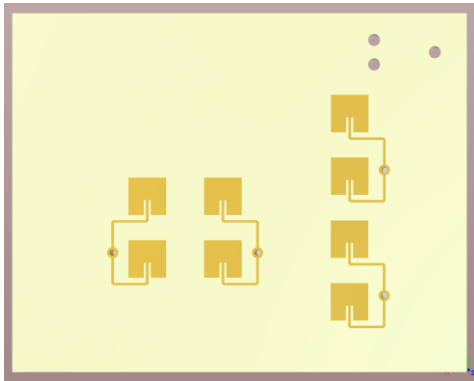
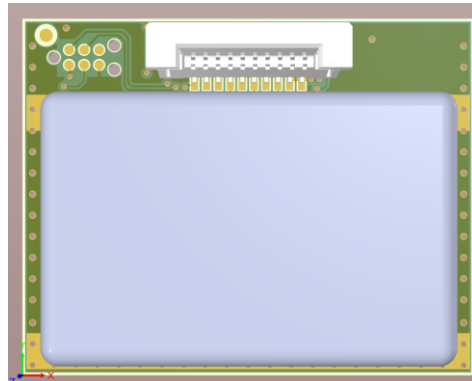


1 Overview



Top View



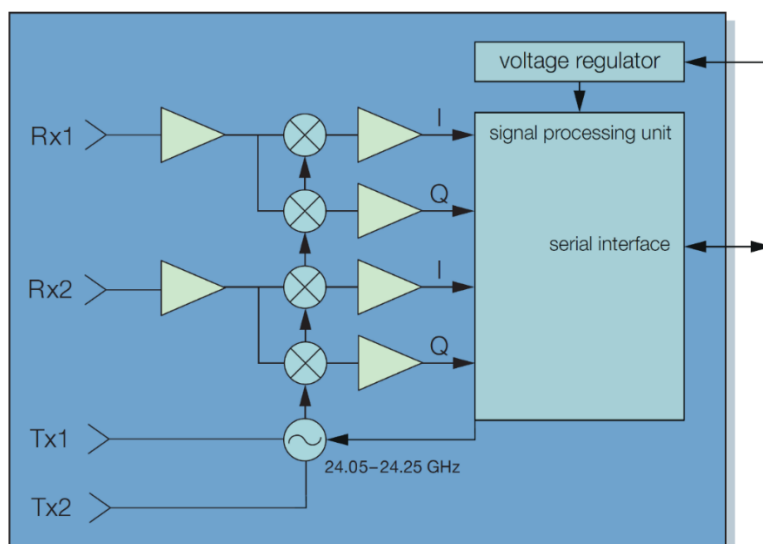
Bottom View

1.1 Operational description

The Phi-1 represents a state-of-the-art digital Doppler radar transceiver equipped with integrated planar patch antennas. At its core lies an advanced RF front end featuring dual transmit and dual receive channels, complemented by a dedicated IF amplifier section. Steering these components is a microcontroller unit (MCU) responsible for orchestrating RF front end operations and sampling IF channels via integrated analog-to-digital converters. The resultant sampled data is accessible to a host system through a serial interface, facilitating seamless integration into further signal processing pipelines.

Leveraging the Doppler frequencies it generates, the Phi-1 excels in the precise detection and speed measurement of moving objects within its antenna beam. Additionally, the inclusion of FSK modulation enhances its functionality, enabling accurate distance measurement to these dynamic targets. Thanks to its dual transmitting and receiving antenna setup, the Phi-1 enables precise determination of azimuth and elevation angles associated with detected objects.

1.2 Block diagram

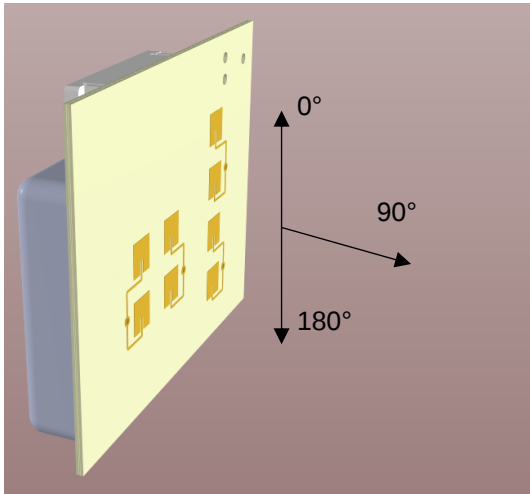


1.3 Characteristics

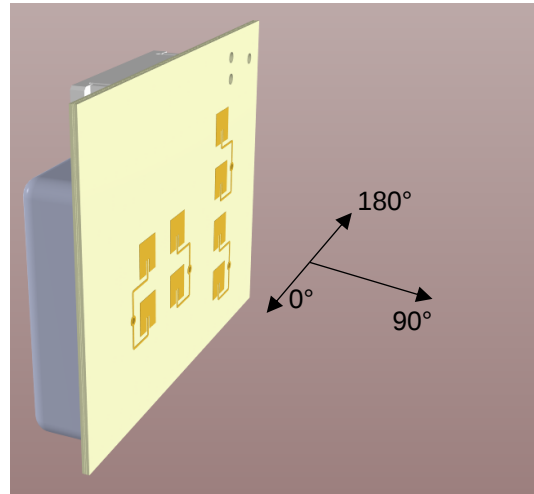
Parameter	Conditions / Notes	Symbol	Min	Typ	Max	Unit
<i>Operating conditions</i>						
Supply voltage		V _{CC}	3.2		5.5	V
Supply current		I _{CC}	25	160	250	mA
Operating temperature		T _{Op}	-40		+85	°C
Storage temperature		T _{St}	-40		+105	°C
<i>Transmitter</i>						
Transmitter frequency	T _{amb} =-40°C .. +85°C	f _{TX}	24.050		24.250	GHz
Output power	EIRP	P _{TX}		7		dBm
Spurious emissions	According to ETSI 300 440	P _{Spur}		-30		dBm
<i>Signal processing</i>						
Modulation				FSK		
Processing				256 point complex FFT		
Sample rate		f _{sample}	1119		2238	Hz
Speed range	Depending on sampling frequency	R _{Speed}	0.1		25	km/h
<i>Receiver</i>						
LNA gain		G _{LNA}		19		dB
Mixer conversion loss	f _{IF} =1kHz	D _{mixer}		10		dB
Antenna gain	f _{TX} =24.15GHz	G _{Ant}		5.6		dBi
Receiver sensitivity	f _{IF} =500Hz, B=1kHz, S/N=6dB	P _{RX}		-109		dBm
Overall sensitivity	f _{IF} =500Hz, B=1kHz, S/N=6dB	D _{system}		-124		dBc
Detection distance	σ=1 m ² (Person)	R		10		m
<i>Antenna</i>						
Horizontal -3dB beam width	E-Plane	W _φ		86		°
Vertical -3dB beam width	H-Plane	W _θ		63		°
Horiz. side lobe suppression		D _φ	-12	-20		dB
Vertical side lobe suppression		D _θ	-12	-20		dB
<i>Interface</i>						
Digital output high level voltage		V _{OH@8mA}	2.4		3	V
Digital output low level voltage		V _{OL@8mA}	0		0.4	V
Digital output high level voltage		V _{OH@20mA}	1.7		3	V
Digital output low level voltage		V _{OL@20mA}	0		1.3	V
Digital input high level voltage		V _{IH}	1.7		4	V
Digital input low level voltage		V _{IL}	-0.3		1.3	V
Digital I/O source/sink current		I _{OH} , I _{OL}	-20		20	mA
<i>Body</i>						
Outline dimensions				38 x 30 x 7		mm ³
Weight				10		g
Connector				10-pin FPC connector		
<i>ESD rating</i>						
Electrostatic discharge	Human body model class 2	V _{ESD}			2000	V

1.4 Antenna pattern

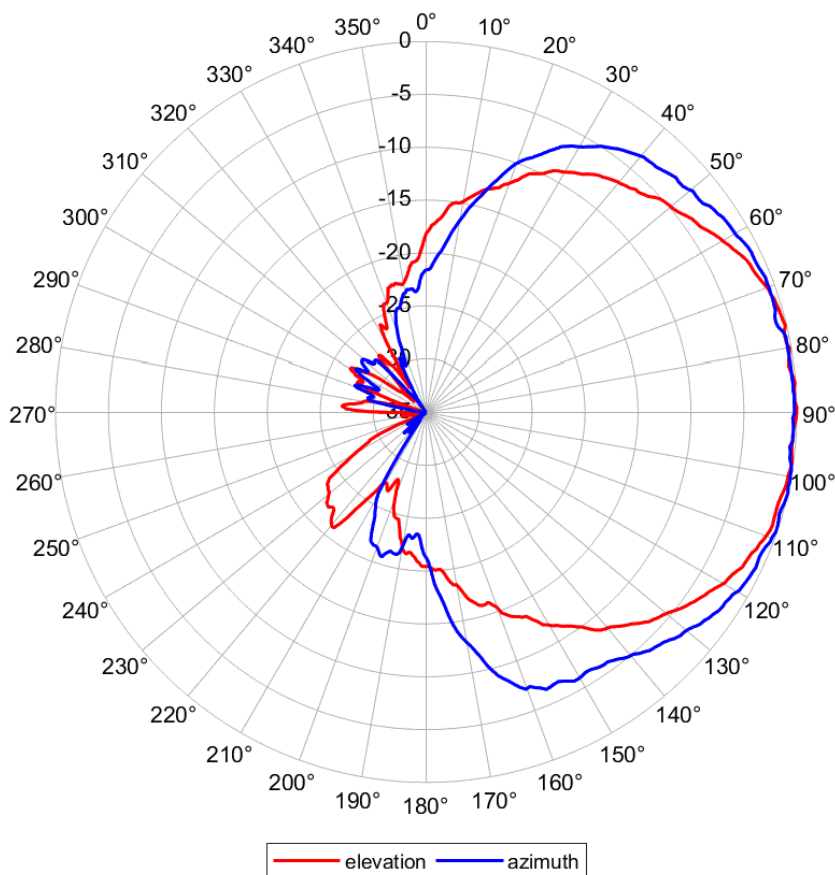
The 90° vector is aligned with the antenna boresight axis.



Radiation direction elevation



Radiation direction azimuth



2 Integrators Information

2.1 Installation Instruction

2.1.1 Mechanical enclosure

It is possible to hide the sensor behind a so called radome (short for radar dome) to protect it from environmental influences or to simply integrate it in the case of the end product. A radar sensor can see through different types of plastic and glass of any colour as long as it is not metallized. This allows for a very flexible design of the housing as long as the rules below are observed.

- Cover must not be metallic.
- No plastic coating with colors containing metallic or carbon particles.
- Distance between cover and front of Radar sensor should be $\geq 6.2\text{mm}$
- Cover thickness is very important and depends on the used material. Examples can be found in the application note "AN-03-Radome".
- Vibrations of the Radar antenna relatively to the cover should be avoided, because this generates signals that can trigger the output
- The cover material can act as a lens and focus or disperse the transmitted waves. Use a constant material thickness within the area used for transmission to minimize the effect of the radome to the radiated antenna pattern.

Note

Detailed information about the calculation and thickness for different cover materials can be found in the application note "AN-03-Radome".

2.2 United States (FCC)

This module has been granted modular approval for fixed and/or mobile applications by FCC.

Testing for the modular approval has been performed with the 10m range setting for all available frequency channels which represents the maximum TX emission configuration with the complete used bandwidth. This setup can easily be used by the customer for certification purposes.

This module meets the title 47 of the Code of Federal Regulations, part 15 section 15.249 for intentional radiators operating in the 24.00 to 24.25 GHz band.

Note

Modification to this product will void the users' authority to operate this equipment.

Warning

The OEM integrator is responsible for the final compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification.

2.2.1 Labelling and user information requirements

If the label of the module is not visible from the outside of the end product, it must include the following texts on the label of the host product:

Contains FCC ID: 2ASYV-PHI-1

In addition to marking the product with the appropriate ID's, the end product shall bear the following statement in a conspicuous location on the label or alternatively in the user manual:

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

2.2.2 RF Exposure

The radiated output power of the device is far below the FCC radio frequency exposure limits. Nevertheless, the device should be used in such a manner that the potential for human contact during normal operation is minimized.