

# Technical Documentation



0534-DOC-M2M-ASTRO

## **Astronode Patch Antenna** Datasheet & Integration Guide

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## Document history

Issue/rev.	Date	Modifications
1/0	02.02.2022	First Release
0/1	01.06.2021	Initial preliminary version

## Reference documents

Document name	Document number
Astronode S Datasheet	0532
APN GNSS Antenna sharing	0558
REACH and RoHS Declaration	0627

## In this document



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## Acronyms

Acronym	Description
RHCP	Right Hand Circular Polarization
LHCP	Left Hand Circular Polarization
GNSS	Global Navigation Satellite System
LEO	Low Earth Orbit
PCB	Printed Circuit Board
SMD	Surface-Mounted Device
VSWR	Voltage Standing Wave Ratio
THT	Through Hole Technology

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## 1 Astronode Patch Antenna Overview

### 1.1 Features

- Ceramic patch antenna
- Dual-band RHCP performance
- Wide beamwidth (coverage)
- Very low profile (4 mm), reduced footprint (35 mm)
- Lightweight (18 g)
- Supports GNSS L1 band

### 1.2 Typical use cases

- Maritime
  - Container tracking
  - Fishing buoys
- Agriculture
  - Fuel management
  - Precision farming
- Environment
  - Weather data
  - Flow monitoring

### 1.3 Description

The Astronode Patch Antenna is a miniaturized antenna designed for communication with Astrocast's constellation of IoT satellites in LEO. The patch is manufactured on a high-permittivity ceramic substrate that results in a reduced antenna footprint, while maintaining good RF performance at the operating frequencies of the Astrocast network in L band. The antenna's extremely low profile allows for a seamless placement and device integration. The antenna supports GNSS reception at the L1 band (1575 MHz).



Simultaneous operation of Astrocast IoT uplink and GNSS reception is not possible

## 2 Product image



## 3 Detailed Description

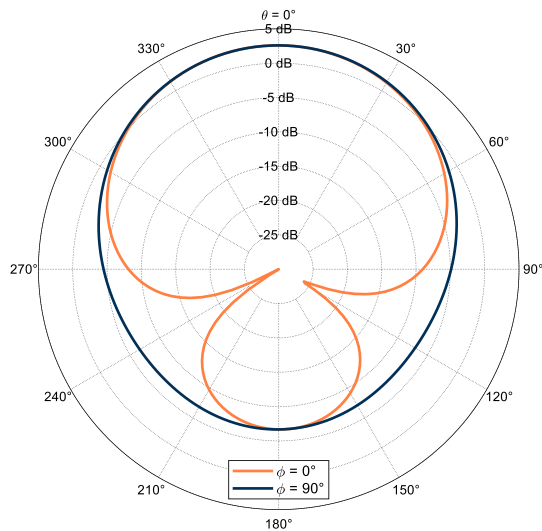
### 3.1 RF Specification

Parameter	Specification	
	Downlink	Uplink
Frequency	1525-1559 MHz	1626.5-1660 MHz
Realized Gain at Zenith <sup>2</sup>	3 dBic (max)	3.5 dBic (max)
Beamwidth <sup>2</sup>	100°	100°
Polarization	RHCP	
Impedance	50 Ω	
VSWR @ Frequency	3 (max)	
Dimensions	35 mm × 35 mm × 4 mm	
Weight	18 g	

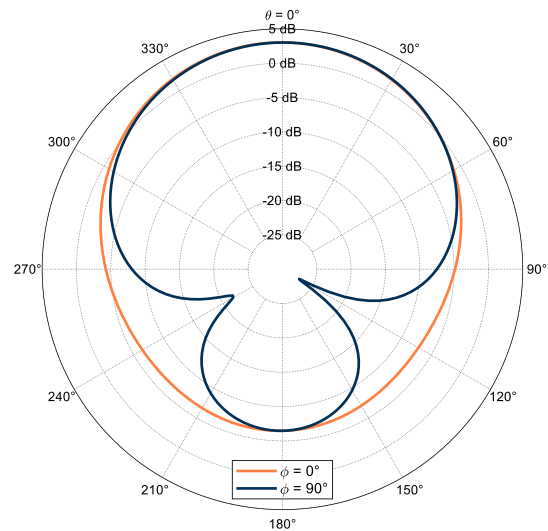
### 3.2 Radiation Pattern - Azimuth Cut

#### 3.2.1 Ground plane 65 mm × 65 mm

Downlink Frequency



Uplink Frequency



<sup>2</sup> Placed on a 65 mm × 65 mm ground plane.

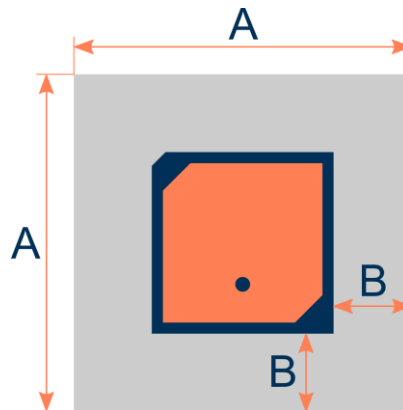
## 4 Layout and placement guidelines

The Astrocast Patch Antenna is a PCB-surface-mount ceramic patch with a single THT solder pin. The antenna must be placed on a ground plane with specific dimensions for a proper antenna operation. The guidelines for an antenna placement that will ensure an optimal antenna RF performance are given in this section.

### 4.1 Ground plane

The recommended dimensions of the ground plane are 65 mm × 65 mm, with the antenna centered on the ground plane. These dimensions and antenna position will ensure the antenna matching and radiation performance as specified in section 3.1. Antenna placement on smaller ground planes will cause the antenna frequency detuning of up to 15 MHz and a maximum gain reduction of up to 3 dB, which will inhibit nominal antenna performance. Therefore, it is not recommended.

Ground planes with dimensions larger than 65 mm × 65 mm can be suited for the antenna placement. The antenna will cover the nominal frequency bands in terms of matching if it is placed no closer than 15 mm from the ground plane edge:



Dimension	Value	Description
A	65mm x 65mm	Minimum recommended ground plane
B	15mm	Minimum recommended edge distance

Depending on the ground plane shape and size, as well as the antenna placement location, the radiation pattern can be different from the nominal one specified in section 3.1. As an example, the antenna was analyzed on several square and rectangular ground planes. The radiation patterns presented in the following sections can serve for guidance.

#### 4.1.1 Ground Plane features

The Astrocast Patch Antenna should be placed on a flat solid ground plane. The ground can either be a metallic plate or a copper-coated PCB layer. The ground plane below and in the vicinity of the patch antenna should be a continuous conductive plane, without any slots longer than ~5 mm. This rule should especially be followed in the critical region 15 mm around the patch antenna edges. Other features smaller than ~5 mm (metallized via pads etc.) do not interfere with the antenna and are allowed. Solder mask should be removed below the footprint of the antenna.

### 4.1.2 Placement of other components

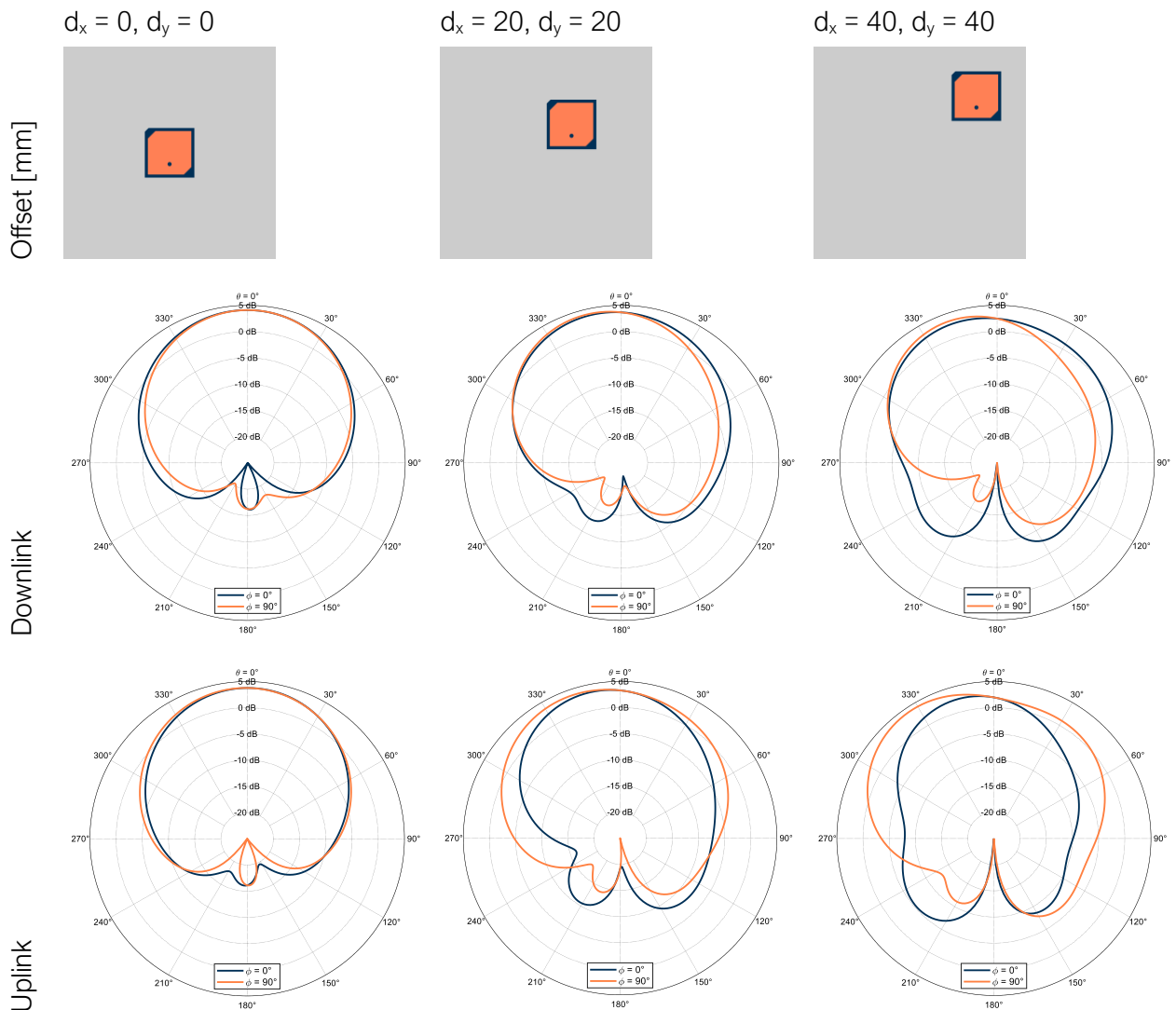
No metallic shield or vertical feature should be placed in a region around the antenna as it can obstruct the antenna radiation and/or cause frequency detuning. The antenna can be placed on the same layer alongside other RF/electronic SMD components if the rules from this section are respected.

### 4.1.3 Multi-Layer PCB

If the antenna is not sharing the same ground with the other RF components and transmission lines, the two ground layers should be interconnected with dense metallized vias. This is especially important in the antenna feeding region, around the transition between the feeding pin of the antenna and the transmission line of the RF circuit. For more guidelines about RF layout please refer to the *0532 Astronode S Datasheet*.

## 4.2 Asymmetric placement – Impact on gain

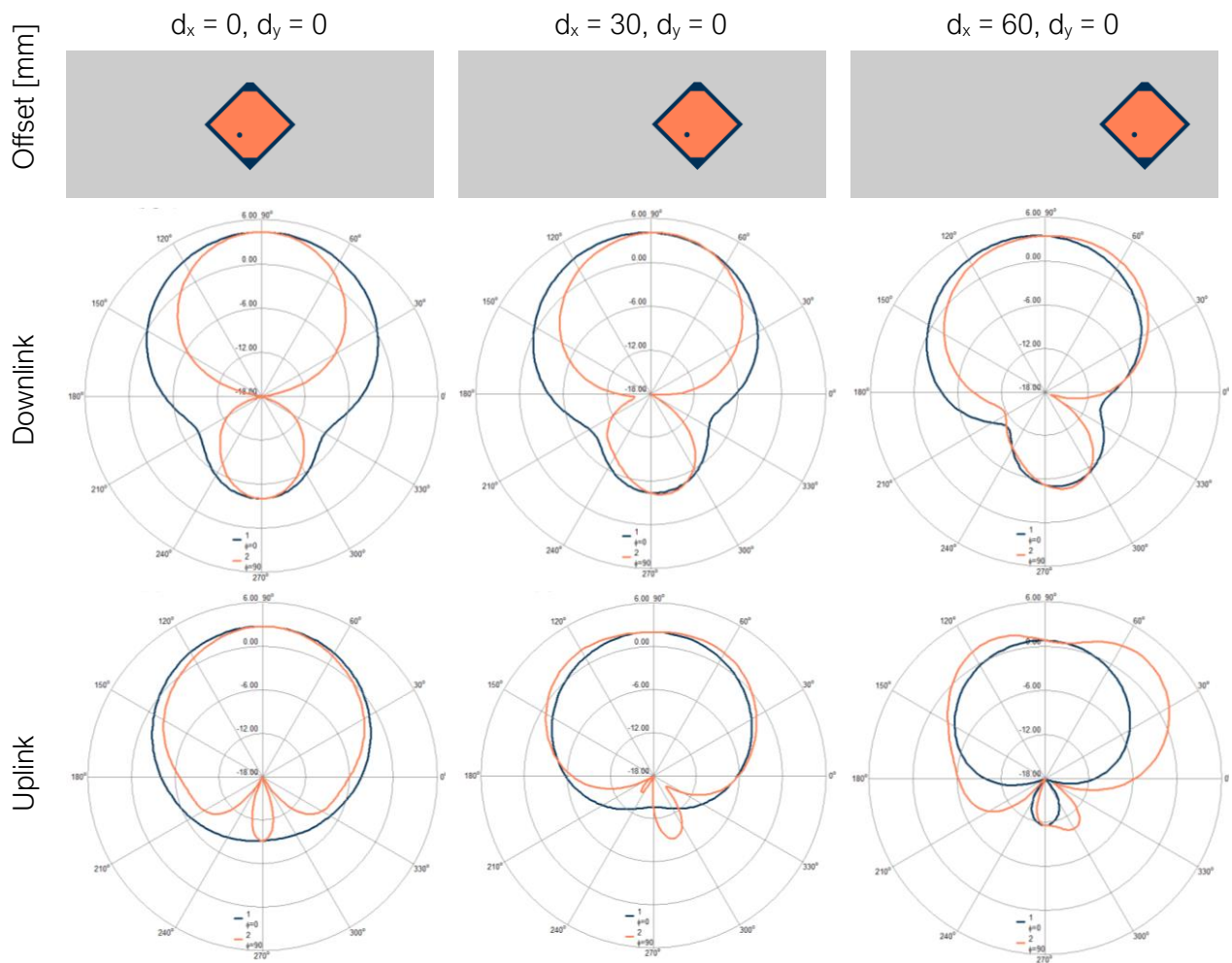
### 4.2.1 Ground plane 150 mm × 150 mm



### 4.3 Compensate asymmetric-ground-plane antenna placement with antenna rotation

Astrocast patch antenna operates simultaneously in two frequency bands and for nominal performance, it should be placed on a square 65 mm × 65 mm ground plane, as indicated in Section **Error! Reference source not found.** Placing the patch on a highly asymmetric ground plane or close to the edge of a large ground plane causes, in some cases, an increase of the undesired cross-polarized radiation component.

Rotating the antenna by 45° when placed in the center of asymmetric ground planes significantly improves the maximum realized RHCP gain levels and cross-pol levels across the frequency range. For offset placement, no rotation is recommended, and the antenna should be oriented as illustrated in section 4.2.1



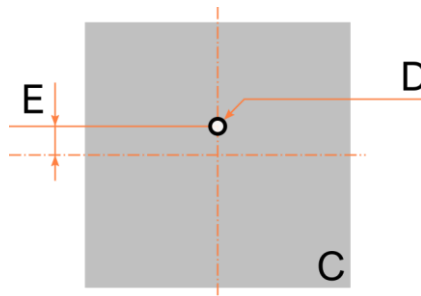


#### 4.3.1 Antenna Rotation Angles (degrees) vs. Ground Plane Shape and Position

Ground Plane Shape	Antenna Position on the Ground Plane *		
	Center	Edge	Corner
Symmetric	Arbitrary	45°	0°
Asymmetric	45°	45°	0°

\* Pin position is arbitrary.

#### 4.4 Recommended land pattern



Dimension	Value	Description
C	35mm x 35mm	Solder Mask keep-out
D	1.2mm	Feed via hole diameter, see 4.4.1
E	4.7mm	Feed via placement

##### 4.4.1 Feed via

The hole for the feeding pin should be a metalized via. Ground plane spacing must be designed to have a characteristic impedance of  $50 \Omega$  with respect to the feeding pin. For more guidelines about RF layout please refer to the *0532 Astronode S Datasheet*.

## 5 Mechanical and packaging

### 5.1 Mechanical Drawing

	<b>ROHS</b> ISO 9001 ISO 14001			
Frequency	1.54GHz 1.64GHz			
S11	< -15dB			

3-R1.5

1.5±0.3  
4.0±0.1

Adhesive sticker  
Feed needle  
4-R2.75

Adhesive Tape : F9473PC-1 X60YD

Material:		Treatment:	
Drawer	Design	Approx	Tolerance
			X=±0.5 X=±0.2 XX=±0.1 XXX=±0.05
		Unit: mm	
		Ver: A	Scale 1:1
		File ND: QR0402	Model ND
			52 10 50022 00
			Drawing ND
			100-27015-001
			RHCP PATCH ANTENNA

NO	DESCRIPTION	MATERIAL / FINISH	QTY
Part NO	GA-35X35X4-100		

## 5.2 Mechanical mount

The Astronode Patch Antenna comes with a pre-mounted double-sided sticker for mechanical mounting on the PCB.

The solder mask opening should be clean and free of dust when attaching the antenna to the board.

Peel off the protecting sheet from the sticker before posing the antenna on the PCB. Press it on before soldering the pin to the board for optimal mechanical connection.

## 5.3 Reliability Test Report

Number	Test Type	Test Conditions	Frequency Variation [MHz]	Bandwidth Variation [MHz]	Comment
1	Humidity	90% - 95% 60°C	0.27	0.4	Pass
2	High Temperature	105°C 96H	-0.69	0.4	Pass
3	Low Temperature	-40°C 96H	0.55	0.2	Pass
4	Temperature Cycle	-40°C 30 min 105°C 30 min 5 times	-0.13	-0.2	Pass
5	Vibration	XYZ axis Amplitude 1.5 mm Frequency 10-55 Hz 2 hours	-0.12	0.1	Pass
6	Soldering Test	350°C ± 10°C 5 s ± 0.5 s	0.24	0.1	Pass
7	Solderability	260-290°C 3 s ± 0.5 s >95% coated tin	-	-	Pass
8	Thrust Test	2 kg, 10 s ± 1 s	-	-	Pass Feed pin does not detach