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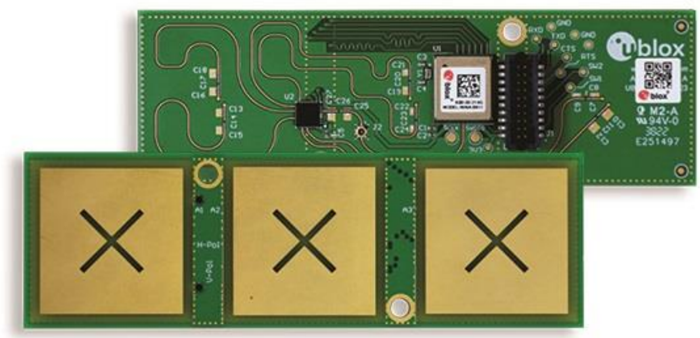
ANT-B11

ANT-B11 Bluetooth LE 5.1 direction finding antenna board

Data sheet



Abstract

ANT-B11 is a compact BLE 5.1 antenna board for 2-D indoor positioning and direction finding. Based on its orientation, ANT-B11 calculates and outputs the final Azimuth or Elevation angles. Featuring small pcb size, ANT-B11 can fit in devices where size footprint is top priority. Fully compliant with the Bluetooth 5.1 standard, the board hosts the NINA-B411 standalone Bluetooth module running the u-locateEmbed software that implements the u-blox angle-of-arrival (AoA) algorithm. This technical datasheet provides an overview and full functional description of the antenna board. Aimed towards developers and other technical staff, this document provides the critical information necessary for the design of customer applications based on the board.

UBX-22037630 - R02
C2-Restricted

Document information

Title	**ANT-B11**	
Subtitle	ANT-B11 Bluetooth LE 5.1 direction finding antenna board	
Document type	Data sheet	
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Revision and date	R02	7-Feb-2024
Disclosure restriction	C2-Restricted	

Product status	Corresponding content status	
Functional sample	Draft	For functional testing. Revised and supplementary data will be published later.
In development / Prototype	Objective specification	Target values. Revised and supplementary data will be published later.
Engineering sample	Advance information	Data based on early testing. Revised and supplementary data will be published later.
Initial production	Early production information	Data from product verification. Revised and supplementary data may be published later.
Mass production / End of life	Production information	Document contains the final product specification.

This document applies to the following products:

Product name	Type number	IN/PCN reference	Product status
ANT-B11	ANT-B11-00C-00	N/A	In Development
ANT-B11	ANT-B11-10C-00	N/A	Engineering sample

Contents

1 Functional description

1.1 Overview

The ANT-B11 is a compact antenna board designed specifically for Bluetooth angle of arrival (AoA) direction finding systems. Featuring three dual polarized patch-antenna elements in a row, ANT-B11 measures the angle of arrival for an incoming Bluetooth Low Energy (LE) radio signal on a single plane (azimuth or elevation) depending on the way it is oriented. The board features the NINA-B411 Bluetooth LE 5.1 standalone module, which is programmed with u-locateEmbed software that implements a unique u-blox direction-finding algorithm.

1.2 Product features

☞ This document aims to describe the features of the ANT-B11 board specifically. For more information about the NINA-B411 module, see the NINA-B41 series data sheet [1].

☞ Table 1 describes the key features of the ANT-B11 antenna board.

Item	**ANT-B11**
Bluetooth version	5.1
Band support	2.402 GHz – 2.480 GHz
Typical conducted output power	+8 dBm
Number of physical antennas	3 (designated as A1, A2, A3)
Polarization of physical antennas	Dual-linear (horizontal and vertical)
Total number of antenna polarizations	6
ANT-B11 patch antenna max gain	-7.8dBi to -3.8dBi (depending on polarization; includes the RF switch)
Antenna1 gain (Low)	-31dBi
Antenna1 gain (Middle)	-11.5dBi
Antenna1 gain (High)	-3.8dBi
Antenna2 gain (Low)	-25dBi
Antenna2 gain (Middle)	-10dBi
Antenna2 gain (High)	-4.6dBi
Antenna3 gain (Low)	-31dBi
Antenna3 gain (Middle)	-12dBi
Antenna3 gain (High)	-4.2dBi
Antenna manufacturer	U-blox
RX sensitivity (conducted, NINA input)	-95 dBm
RX sensitivity (ANT-B11 board) [1]	-50 dBm
RX sensitivity, long range mode (conducted, NINA input)	-102 dBm
Supported 2.4 GHz radio modes	Bluetooth Low Energy
Supported Bluetooth LE data rates	1 Mbps 2 Mbps
Native USB	N/A
4 – wire UART	1 Mbit/s
4 – wire SPI	N/A
GPIOs	N/A
Status LEDs	N/A

RF Calibration in OTP	Yes
Board Size	93.5 x 29.5 mm

[1] Conditions: At 1 m distance from the ANT-B11 board, azimuth, and elevation 0 degrees. Assuming Rx to be A2H excitation and Tx antenna gain 0dBi.

Table 1: Key features of the ANT-B11 Bluetooth LE 5.1 board

1.3 Product description

Product name	Description
ANT-B11	Bluetooth 5.1 direction-finding antenna board with NINA-B411 standalone Bluetooth module and eight-element antenna array

Table 2: Product description

1.4 Block diagram

Figure 1: ANT-B11 block diagram

Figure 1 shows a block diagram of the ANT-B11 Bluetooth LE 5.1 antenna board. Including a 20-pin header connector that provides the physical interface for any external device, the board also features an RF switch that is controlled by the NINA-B411 using five control signals. The board has three dual polarized antenna elements connected to the RF switch. See also Control signals.

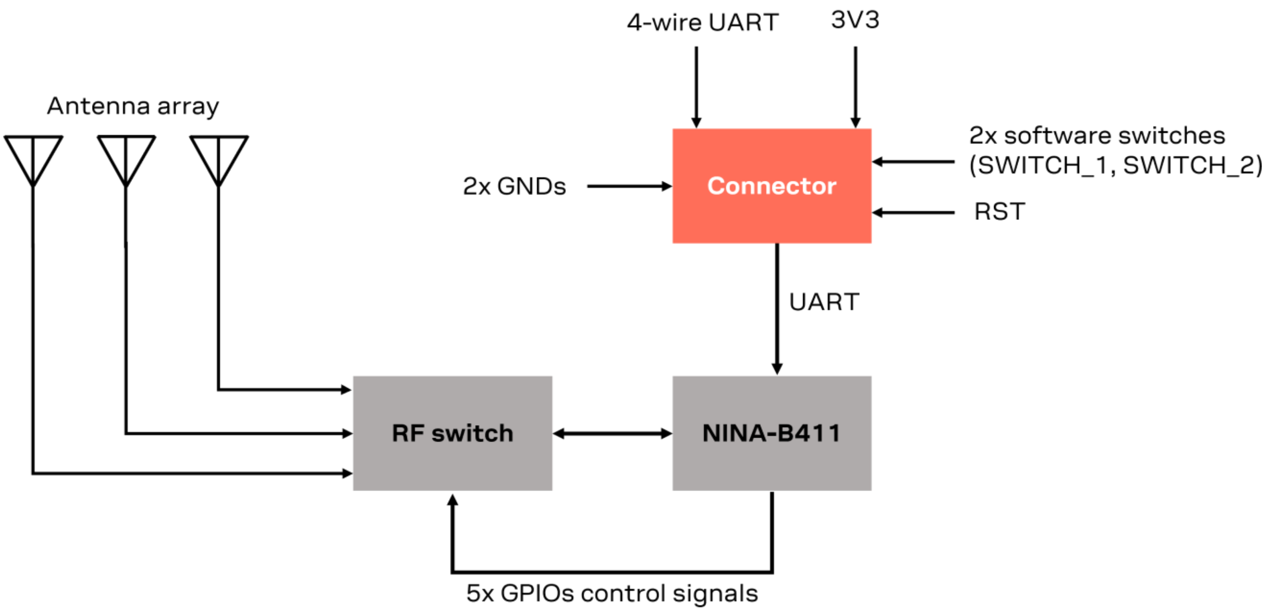


Figure 1: ANT-B11 block diagram

2 Interfaces and IOs

2.1 Connectivity to host interfaces

ANT-B11 uses a 4–wire UART to connect to a host through a 20-pin header (J1).

2.1.1 UART

The UART high-speed interface supports hardware flow control with baud rates up to 1 Mbps. UART can be used to connect to other external devices, such an application board, Arduino open-source platform, Raspberry Pi single-board computers, and so on.

The characteristics of the UART interface include:

- Pin configuration:
  - **TXD**, data output pin
  - **RXD**, data input pin
  - **RTS**, Request To Send, flow control output pin (optional)
  - **CTS**, Clear To Send, flow control input pin (optional)
- Hardware flow control or no flow control is supported.
- Programmable baud rate generator allows most industry standard rates, as well as rates up to 1 Mbps.
- Default frame configuration (not changeable):
  - 8 data bits
  - No parity bit
  - 1 stop bit
- Default frame configuration is 8N1 means eight (8) data bits, no (N) parity bit, and one (1) stop bit.
- Frames are transmitted in such a way that the least significant bit (LSB) is transmitted first.

2.2 GPIOs

ANT-B11 does not support external GPIOs that can be used by a host device.

2.3 Test points

ANT-B11 supports ten test points that provide direct access to the power, digital interfaces, and GND, specifically:

- 3V3
- GND x 3
- RXD
- TXD
- CTS
- RTS
- SW1
- SW2

Figure 2 shows location of test points on the board.

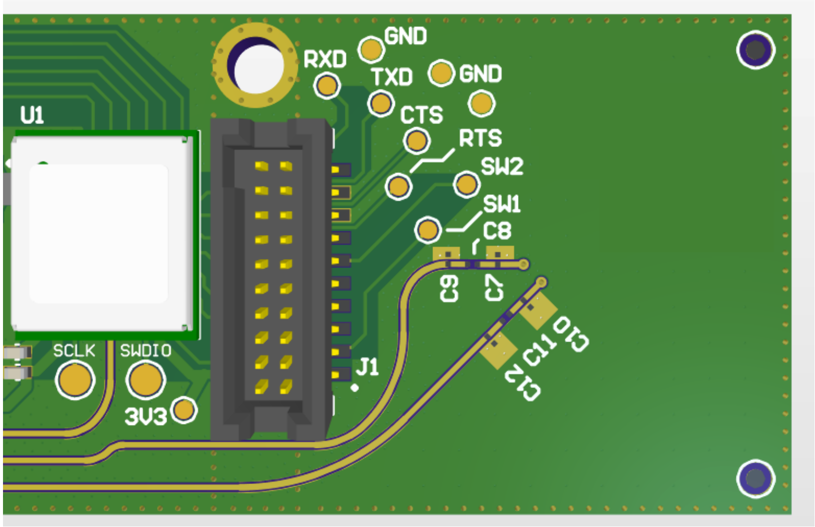


Figure 2: Power, digital interface, and GND test points

3 System control signals

ANT-B11 supports system control signals that are used specifically for programming.

3.1 Control signals

ANT-B11 uses the following control signals for programming/updating through the UART interface.

- **SWITCH_1** and **SWITCH_2** input control signals
- Bootloader mode: To enter bootloader mode, **SWITCH_2** must be driven low during startup.
- Factory reset: To restore all settings to their factory default, **SWITCH_1** must be driven low during start up and then held low for 10 seconds.

☞ **SWITCH_1** and **SWITCH_2** are controlled by the software.

Table 3 describes the pin definitions and system control signals used by NINA-411 and ANT-B11.

ANT-B11 header pin	Description
3	SWITCH_1
11	SWITCH_2

Table 3 ANT-B11 system control signals

4 Pin definition

ANT-B11 implements a PTSHSM-510-D-06-T-C, 20-pin header connector (J1) from Major League Electronics. The connector, shown in Figure 3, provides the physical interface for the ANT-B11 signals. The pins that are not used are marked as No Connect (NC). These pins are left floating at the connector side.

4.1 Pin assignment

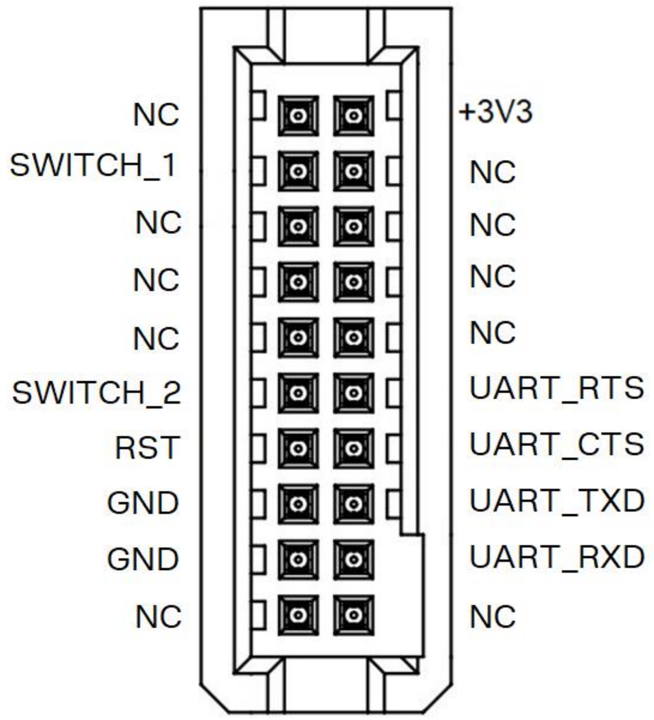


Figure 3: ANT-B11 Bluetooth LE 5.1 board pin assignment

4.2 Pin description

Table 4 describes the ANT-B11 pins located on the bottom side of board.

Pin#	Description	Pin#	Description
2	+3V3	3	SWITCH_1
11	SWITCH_2	12	UART_RTS
13	RST	14	UART_CTS
15	GND	16	UART_TXD
17	GND	18	UART_RXD

Table 4: ANT-B11 pinout

5 Electrical specifications

⚠ Stressing the device above one or more of the Absolute maximum ratings can cause permanent damage. These are stress ratings only. Operating the module at these or at any conditions other than those specified in the Operating conditions should be avoided. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

☞ Where application information is given, it is only advisory and does not form part of the specification.

5.1 Absolute maximum ratings

TBD

5.2 Maximum ESD ratings

TBD

5.3 Operating conditions

Unless otherwise specified, all operating condition specifications are given for an ambient temperature of 25 °C and a supply voltage of +3.3 V.

Operation beyond the specified operating conditions is not recommended and extended exposure beyond these parameters may affect device reliability.

5.3.1 Operating temperature range

Parameter	Min	Typ	Max	Unit
Storage temperature	–40		+105	°C
Operating temperature	–40		+85	°C

Table 5: Temperature range

5.3.2 Supply/Power pins

Symbol	Parameter	Min	Typ	Max	Unit
VCC	Input supply voltage	3.0	3.3	3.6	V
t_RVCC	Supply voltage rise time			60	ms
VCC_IO	I/O reference voltage		VCC		V

Table 6: Input characteristics of voltage supply pins

5.3.3 Current consumption

Table 7 shows the current consumption of ANT-B11 during several typical use cases using the u-locateEmbed software.

		2.97 V (VCC)		3.3 V (VCC)		3.63 V (VCC)	
Mode	**Condition**	**Average**	**Peak**	**Average**	**Peak**	**Average**	**Peak**
Active	Receiver on						
		6.8 mA	15.9 mA	7.2 mA	15.9 mA	7.3 mA	16 mA
Standby	Receiver off						
		473 uA	12.7 mA	461 uA	11.9 mA	456 uA	10.7 mA
Power Save using UART Rx wake up[1]	Receiver off UART off						
		3 uA	-	3 uA	-	3 uA	-
Power Save using GPIO_1 wake up[1]	Receiver off UART off						
		3 uA	-	3 uA	-	3 uA	-

[1] u-locateEmbed 3.0 implements power saving functionality with significantly reduced power consumption.

Table 7: Current consumption during typical use cases

6 Antenna radiation patterns

There are three physical antennas on the board as shown in Figure 4. Each physical antenna includes two antenna polarizations (horizontal and vertical), making a total of six antenna polarizations.

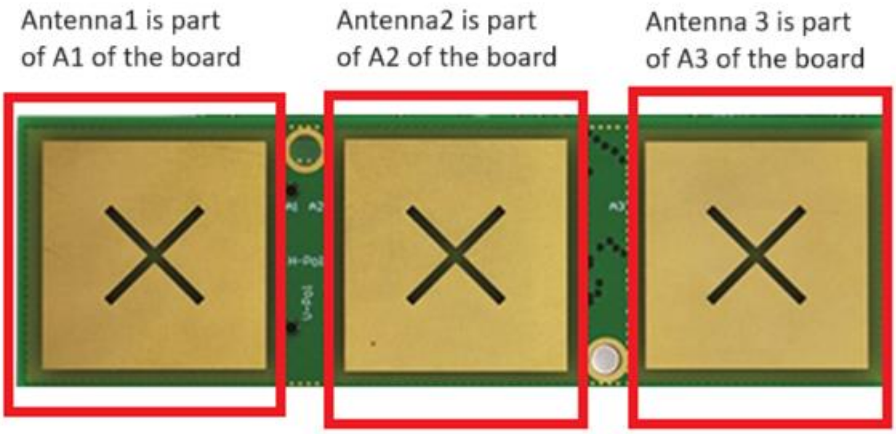


Figure 4: Three physical antennas, six antenna polarizations in total

Radiation patterns are measured in a far-field anechoic chamber with a measurement distance of 3 m. The device under test (DUT) is positioned using a two-axis positioning system, allowing rotation along azimuth (phi φ) and elevation (theta θ). Specifically for the radiation patterns measurements, the coordinate system used is shown in Figure 5. The input power is provided at the Murata connector, meaning that gain measurements include the RF switch loss.

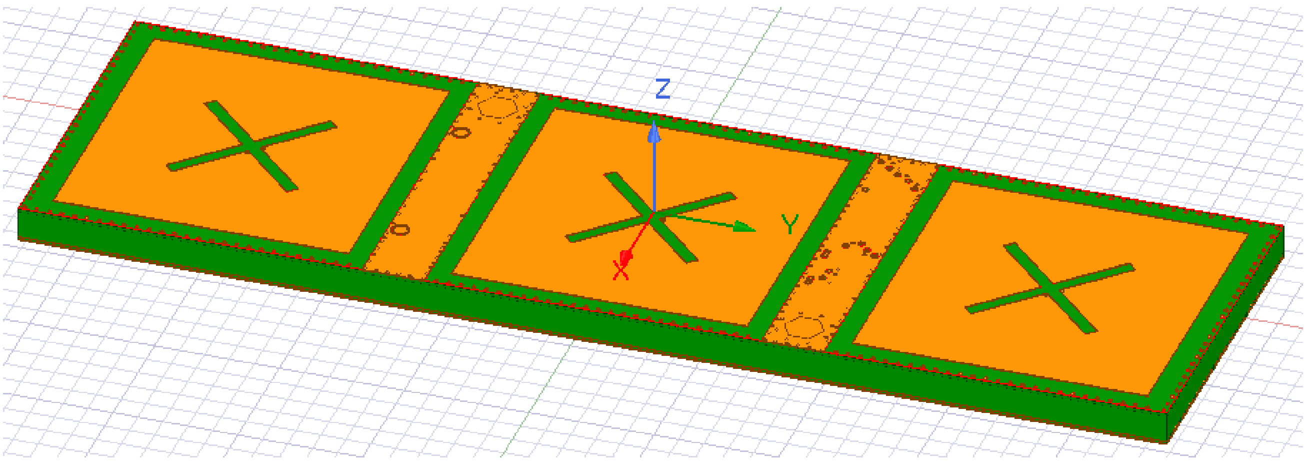


Figure 5: Spherical coordinate system

Figure 6 shows the 2D, Y-Z plane, gain pattern for Antenna1 (horizontal polarization).

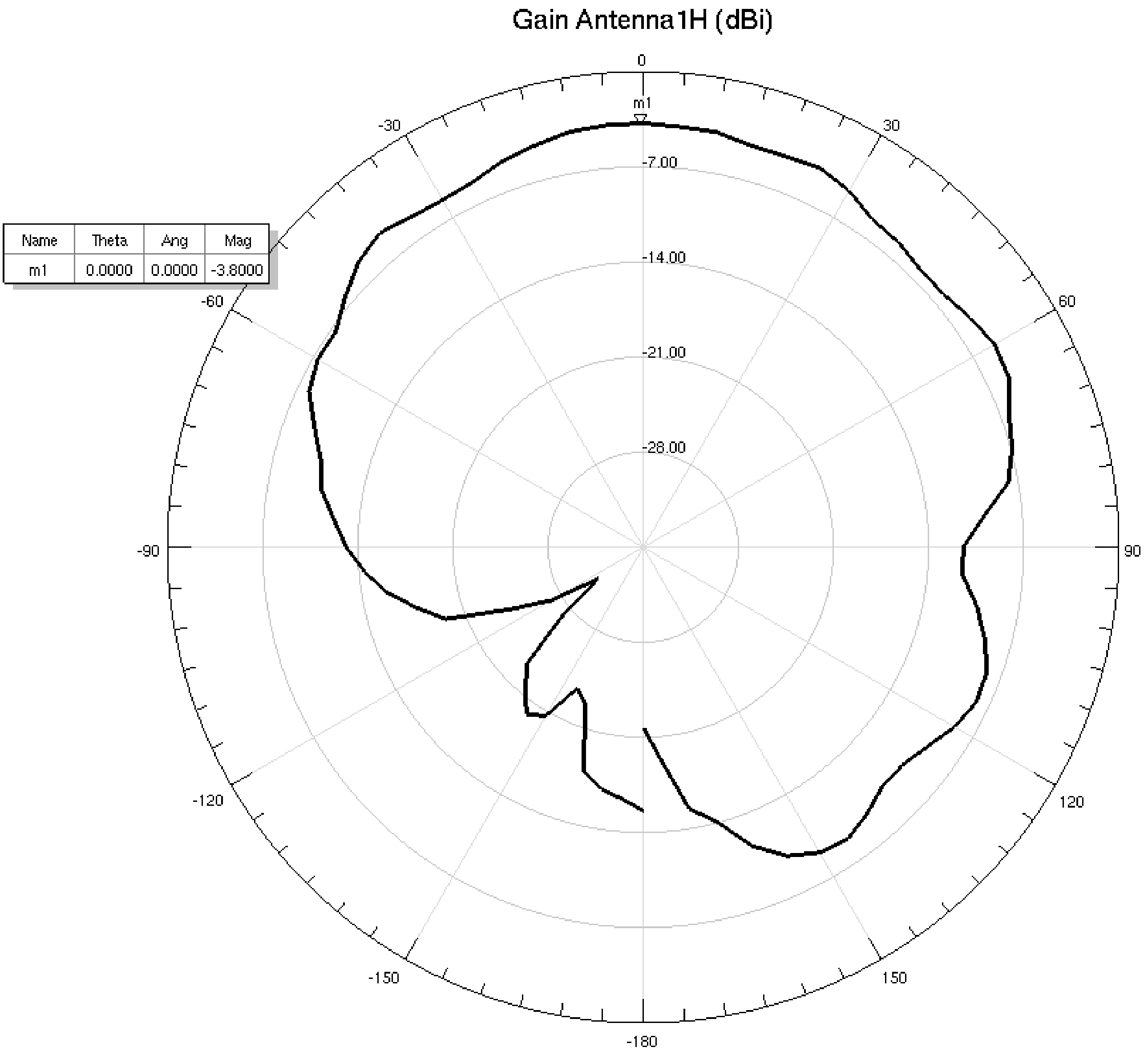


Figure 6: ANT-B11 Antenna1 (horizontal polarization), Y-Z plane

Figure 7 shows the 2D, Y-Z plane, gain pattern for Antenna1 (vertical polarization).

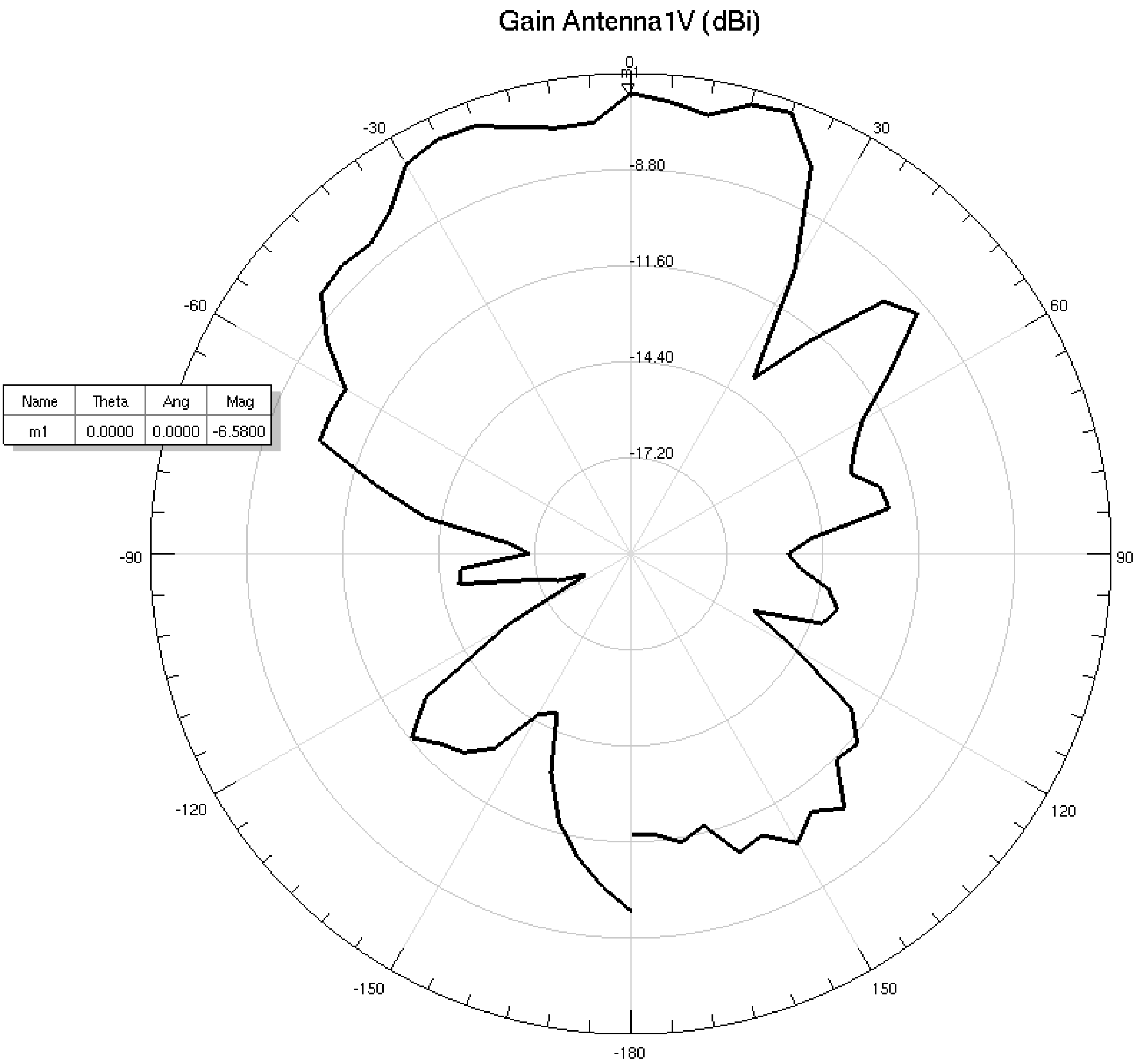


Figure 7: ANT-B11 Antenna1 (vertical polarization), Y-Z plane

Figure 8 shows the 2D, Y-Z plane, gain pattern for Antenna2 (horizontal polarization).

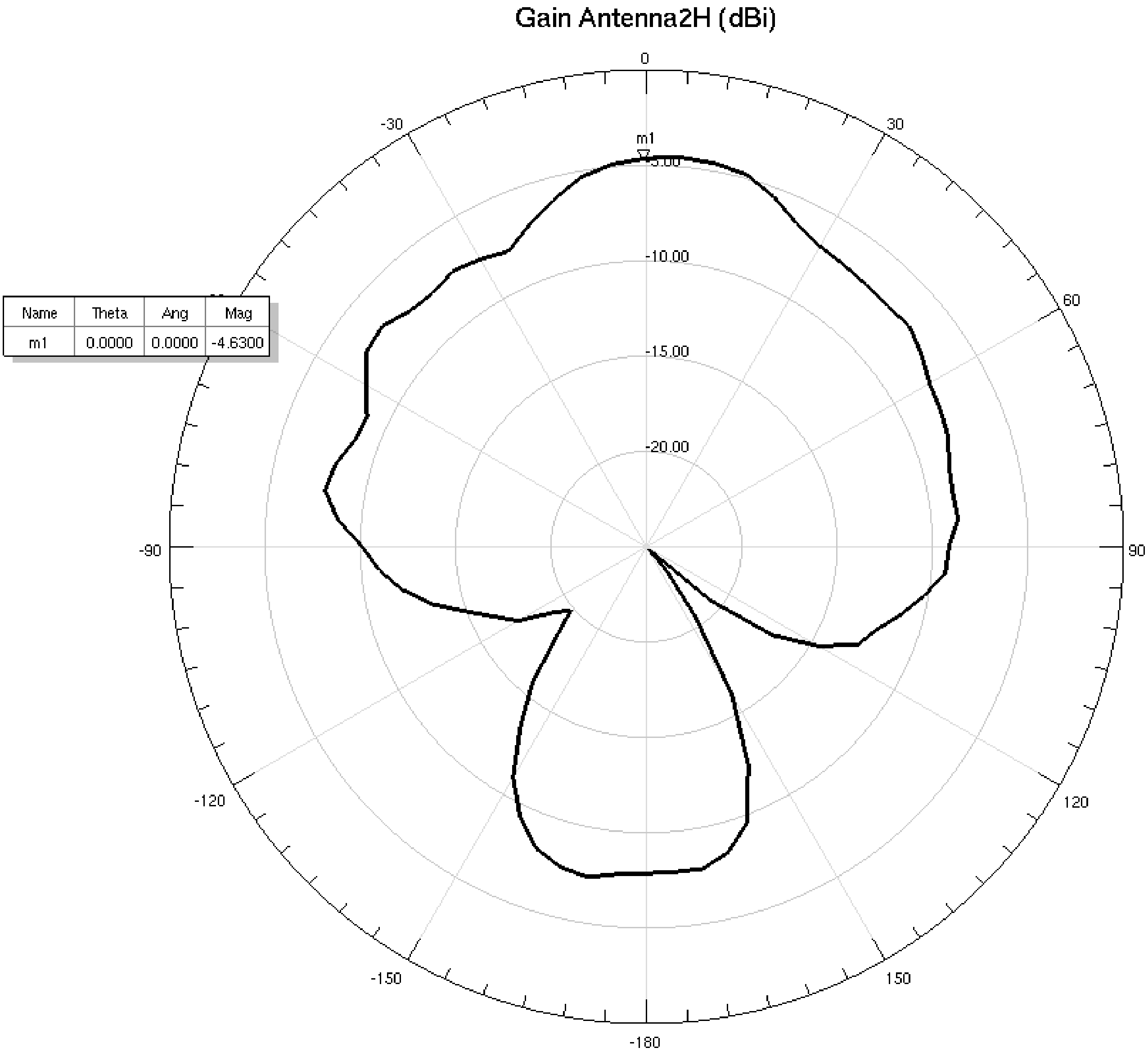


Figure 8: ANT-B11 Antenna2 (horizontal polarization), Y-Z plane

Figure 9 shows the 2D, Y-Z plane, gain pattern for Antenna2 (vertical polarization).

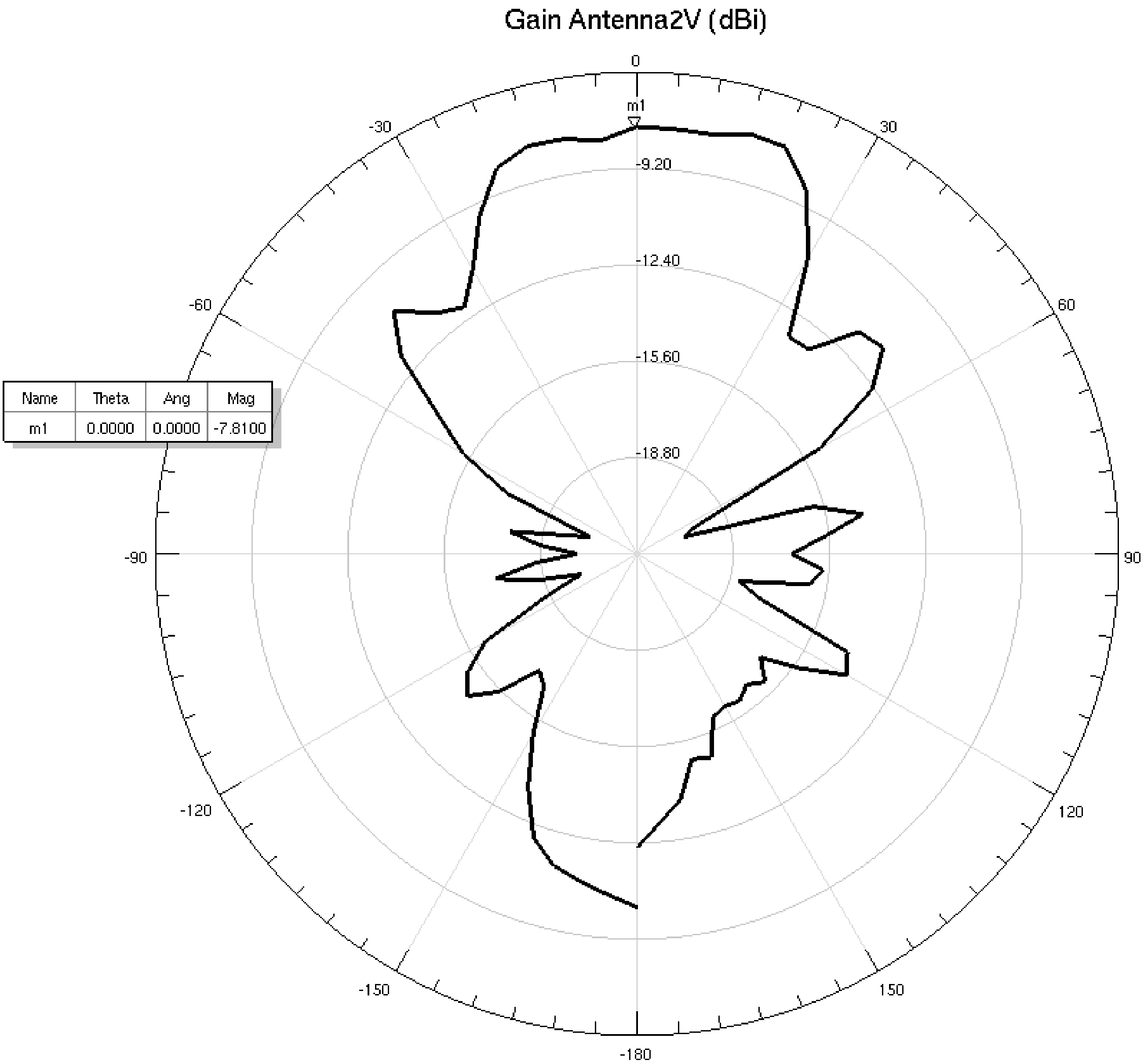


Figure 9: ANT-B11 Antenna2 (vertical polarization), Y-Z plane

Figure 10 shows the 2D, Y-Z plane, gain pattern for Antenna3 (horizontal polarization).

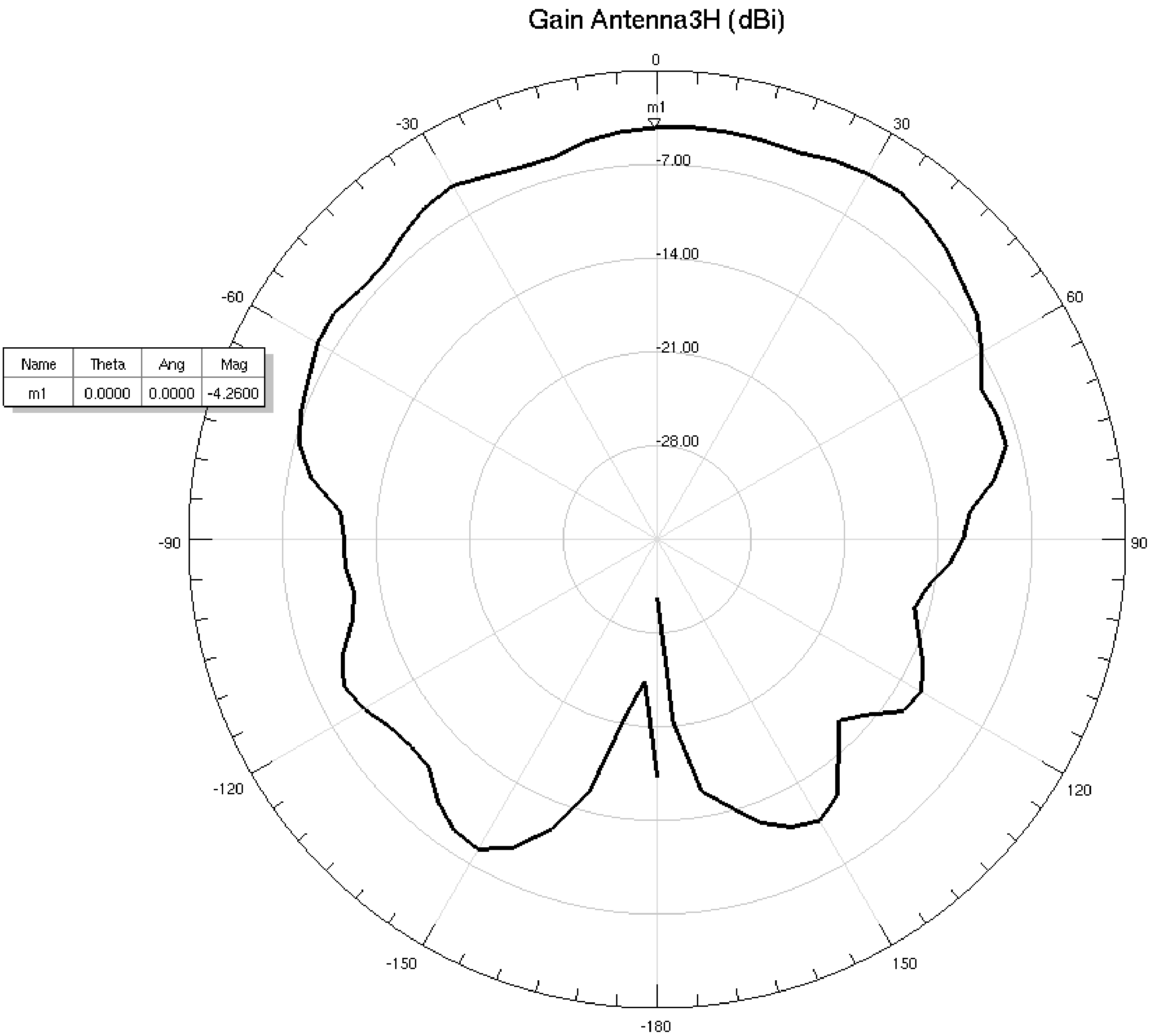


Figure 10: ANT-B11 Antenna3 (horizontal polarization), Y-Z plane

Figure 11 shows the 2D, Y-Z plane, gain pattern for Antenna3 (vertical polarization).

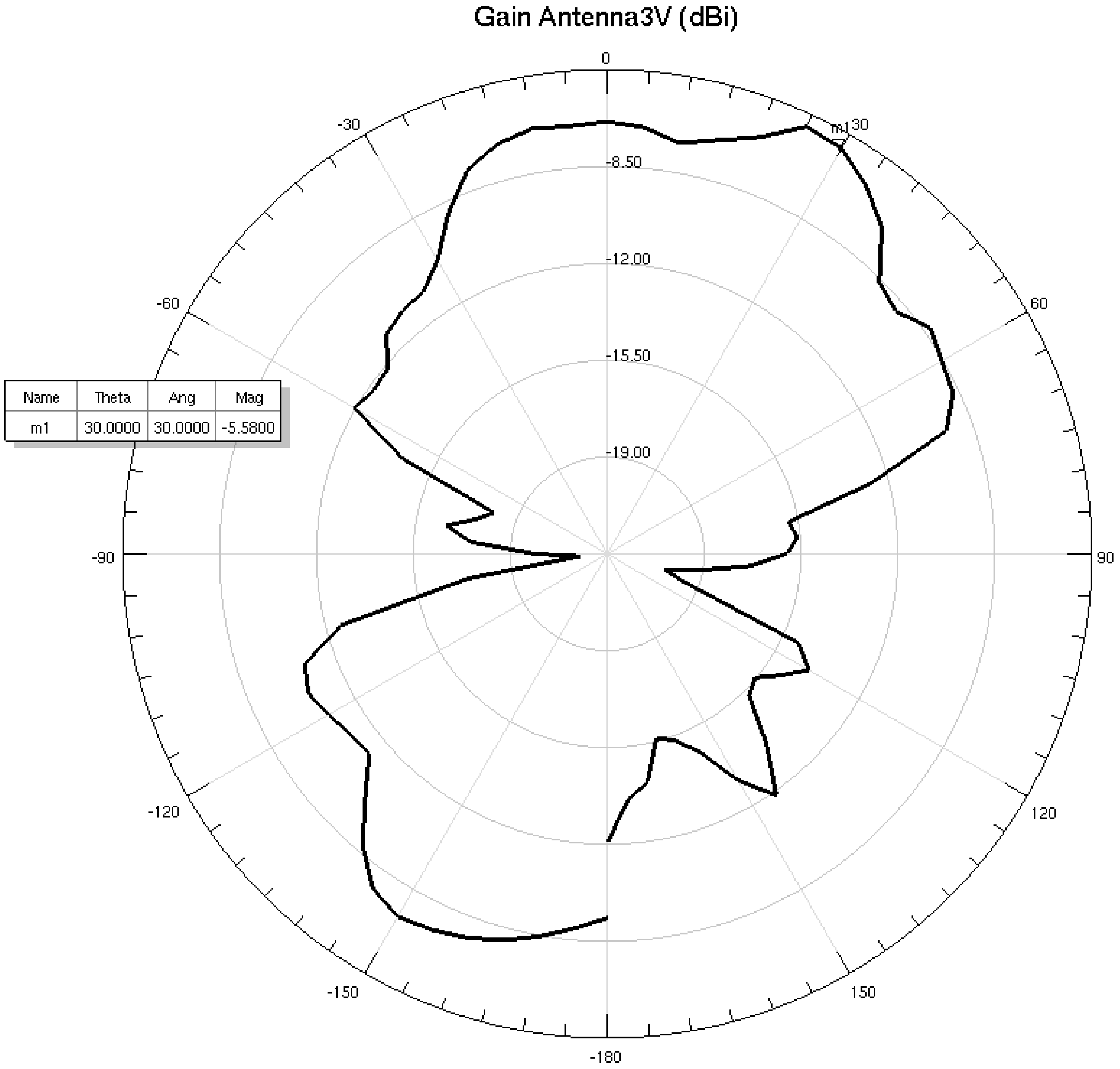


Figure 11: ANT-B11 Antenna3 (vertical polarization), Y-Z plane

7 Mechanical specification

7.1 Physical dimensions

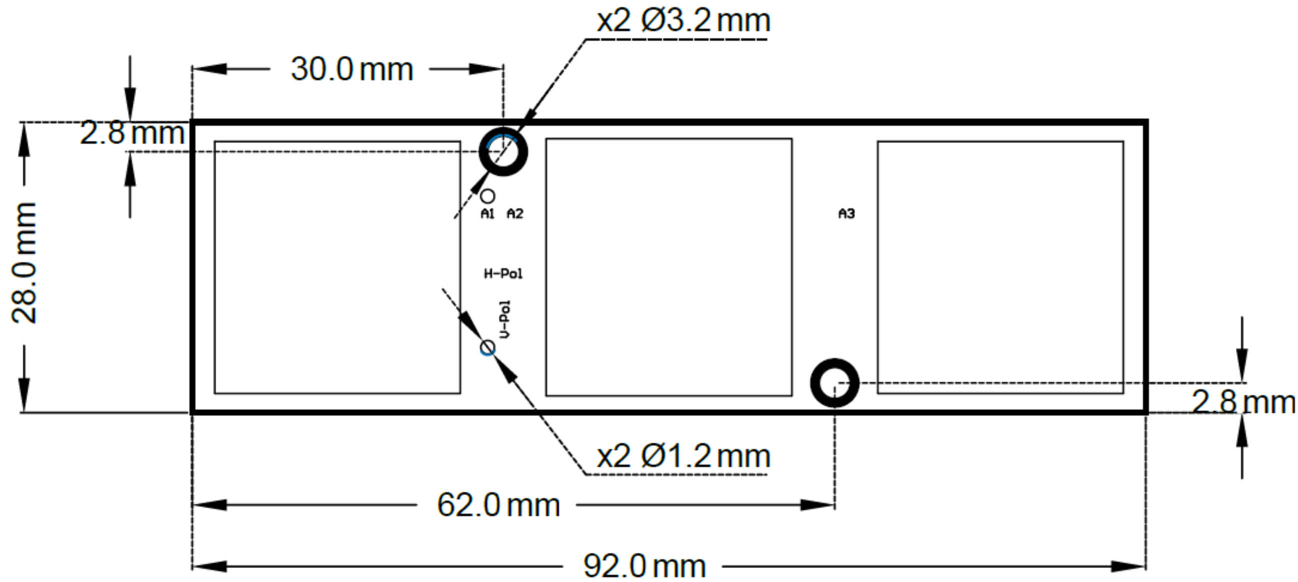


Figure 12: Physical dimensions of the ANT-B11 board (Top view)

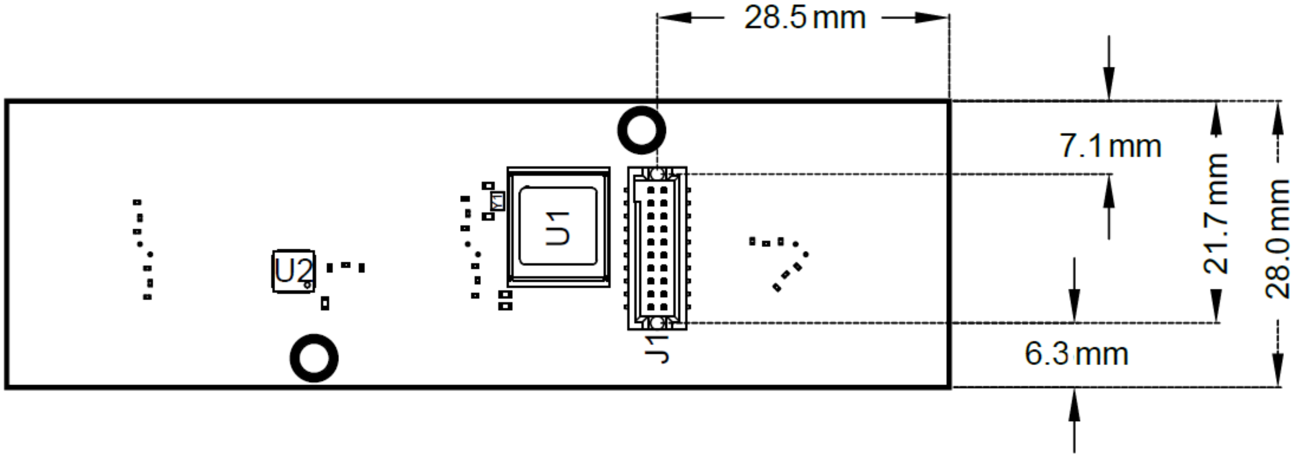


Figure 13:ANT-B11 connector position (bottom view)

7.2 Pin header dimensions

Figure 14 shows the top and side views of the pin header.

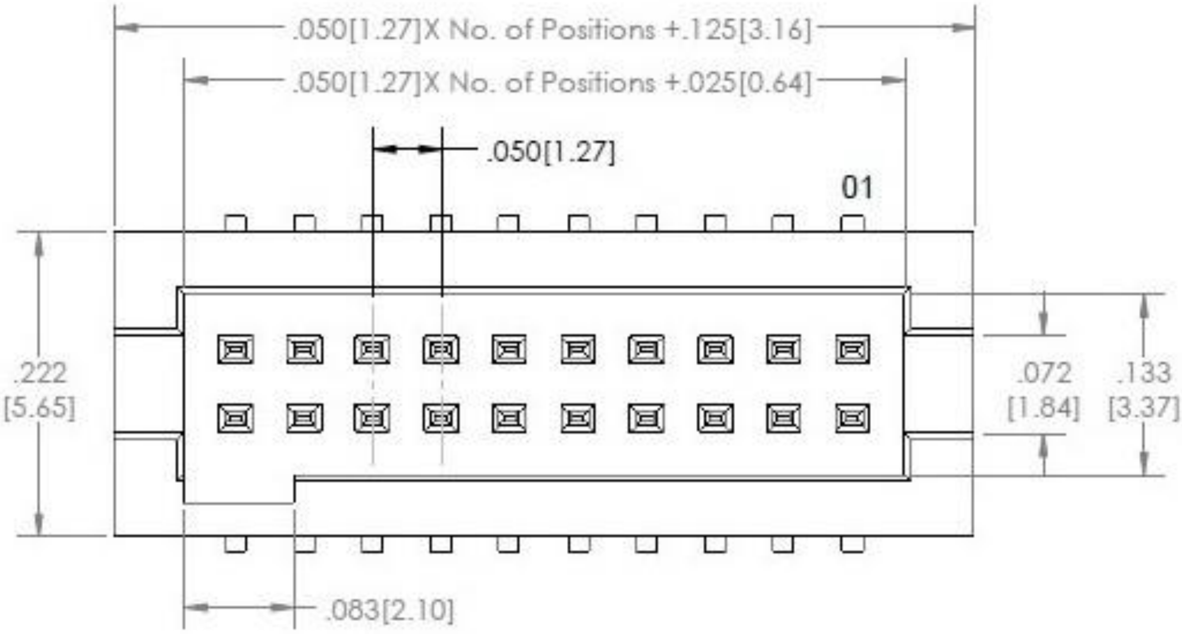
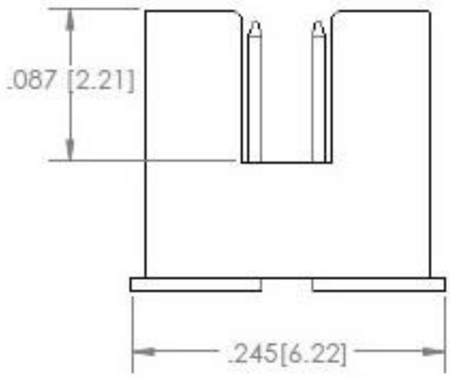


Figure 14 shows the physical dimensions of the pin header with dimensions given in inches and millimeters.



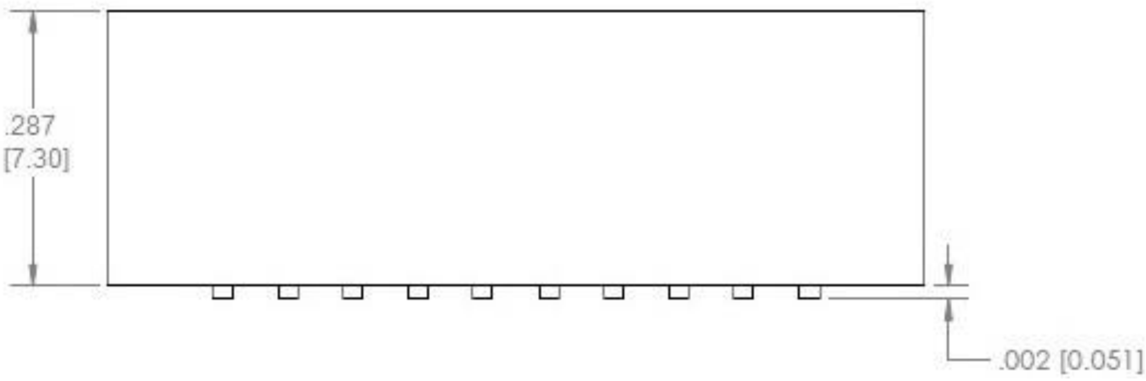


Figure 14: Pin header physical dimensions (dimensions are in inches [millimeters])

8 Approvals

⚠ Approval for ANT-B11 is pending.

The ANT-B11 antenna board will be certified for use with the NINA-B4 module. For more information see the NINA-B41 series data sheet [1].

☞ For detailed information about the regulatory requirements that must be met when using NINA-B4 modules in an end product, see the NINA-B4 series certification application note [3].

9 Product handling

9.1 Packaging

Depending on the ordering code, ANT-B11 is packaged and shipped in trays containing multiple boards, or in individual carton boxes.

9.2 Shipment, storage, and handling

For more information about shipment, storage, and handling, see the Product packaging guide [2].

9.3 ESD precautions

⚠ ANT-B11 antenna boards are Electrostatic Sensitive Devices that demand the observance of special handling precautions against static damage. Failure to observe these precautions can result in severe damage to the product. See also Maximum ESD ratings.

Proper ESD handling and packaging procedures must be applied throughout the processing, handling, and operation of any application that incorporates ANT-B11.

10 Labeling and ordering

The labels displayed on all u-blox products include important product information.

Figure 15 shows the label applied to ANT-B11 antenna boards, which include the model name, revision, production date, and data matrix that bears a unique serial number and the u-blox logo.

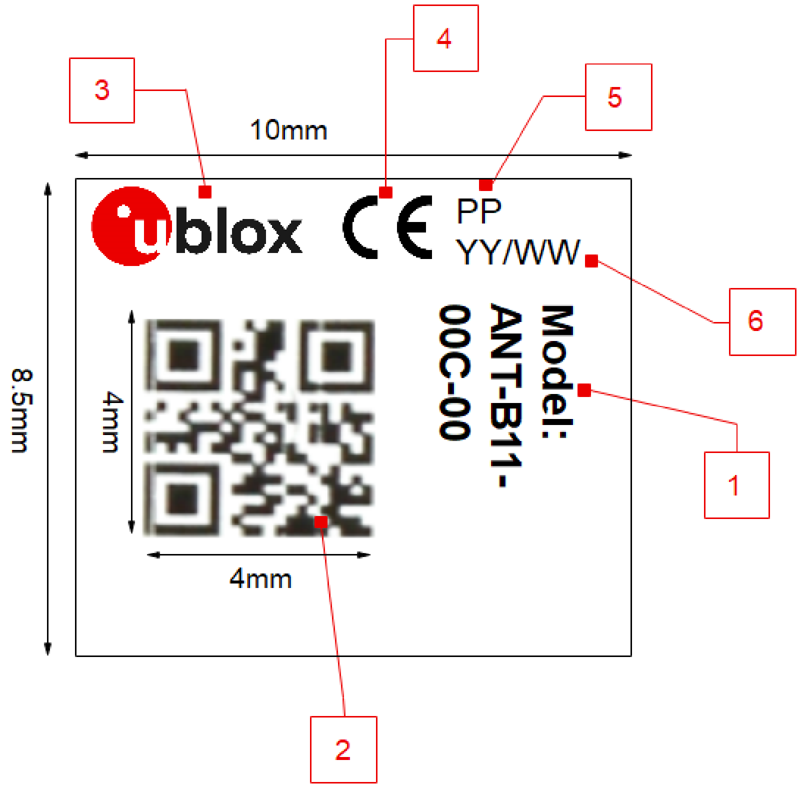


Figure 15: Product label format with dimensions for ANT-B11

Reference	Description	Source	Type
1	Type number (format ANT-TGVV-MMQ-XX), e.g. ANT-B11-00C-00	PSP	
	"Model:" ANT-B11-00C-00		Font type: Arial Narrow Font style: Bold Font size: 3pt
2	Data matrix (product identifier, serial number, datacode) • Product identifier: 3 digits defined by EMS • Serial number Datacode: 4 digits, defined in the PSP	EMS flow and PSP	DataMatrix
3	Company logo and trademark	Preprinted on label	
4	Placeholder for CE marking (when certified)	EMS Flow	
5	Panel position number	EMS Flow	Font type: Arial Narrow Font style: Regular Font size: 3pt
6	Production date YY/WW (year/week)	EMS Flow	Font type: Arial Narrow Font style: Regular Font size: 3pt

Table 8: Label references

10.1 Ordering codes

Ordering Code	Product name	Product
ANT-B11-00C	ANT-B11	Bluetooth 5.1 direction-finding antenna board with NINA-B411 standalone Bluetooth module and three-element antenna array. Packaged in trays containing multiple antenna boards
ANT-B11-10C	ANT-B11	Bluetooth 5.1 direction-finding antenna board with NINA-B411 standalone Bluetooth module and three-element antenna array. Packaged in carton box containing one antenna board

Table 9: Product ordering codes

☞ Product changes affecting form, fit, or function are documented by u-blox. For a list of Product Change Notifications (PCNs), visit www.u-blox.com.

Appendix

A Glossary

Abbreviation	Definition
BR/EDR	Bluetooth Basic Rate / Enhanced Data Rate
BT	Bluetooth
DNI	Do Not Insert
I2S	Inter-IC-Sound
IC	Integrated Circuit
PCM	Pulse Code Modulation
SDIO	Secure Digital Input Output
UART	Universal Asynchronous Receiver-Transmitter
USB	Universal Serial Bus
VIO	Input /Output Voltage
SPI	Serial Peripheral Interface

Table 10: Explanation of the abbreviations and terms used

Related documentation

[1] NINA-B41 series data sheet, UBX-20035327
[2] Product packaging guide, UBX-14001652
[3] NINA-B4 series certification, application note, UBX-20037320

☞ For product change notifications and regular updates of u-blox documentation, register on our website, www.u-blox.com.

Revision history

Revision	Date	Name	Comments
R01	27-Jun-2023	igou, mape	Initial release
R02	07-Feb-2024	igou	Updated values for u-locateEmbed v3.0 in Current consumption. Added measurements in Antenna radiation patterns.

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For further support and contact information, visit us at www.u-blox.com/support.