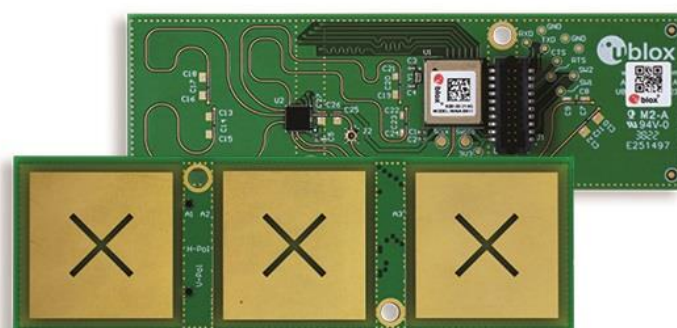# ANT-B11

Bluetooth® LE Direction Finding antenna board

Data sheet

Abstract

ANT-B11 is a compact Bluetooth® LE antenna board for 2D indoor positioning and direction finding. ANT-B11 calculates and outputs final angle, ready to be used at the user application. With a small PCB size, ANT-B11 can fit in devices where size footprint is a top priority. Fully compliant with Bluetooth LE, 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.

u-blox

Document information

Title	**ANT-B11**
Subtitle	Bluetooth® LE Direction Finding antenna board
Document type	Data sheet
Document number	UBX-22037630
Revision and date	R04 11-Apr-2025
Disclosure restriction	C1-Public

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	UBXDOC-465451970-3690	Initial Production

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 and indoor positioning 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. The board features the NINA-B411 Bluetooth LEstandalone module, which is programmed with u-locateEmbed software that implements the 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	Qualified against Bluetooth Core 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, scanned sequentially)
Total number of antenna polarizations	6
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, long range mode (conducted, NINA input)	-102 dBm
Supported 2.4 GHz radio modes	Bluetooth LE
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

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 three-element antenna array

Table 2: Product description

1.4   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.
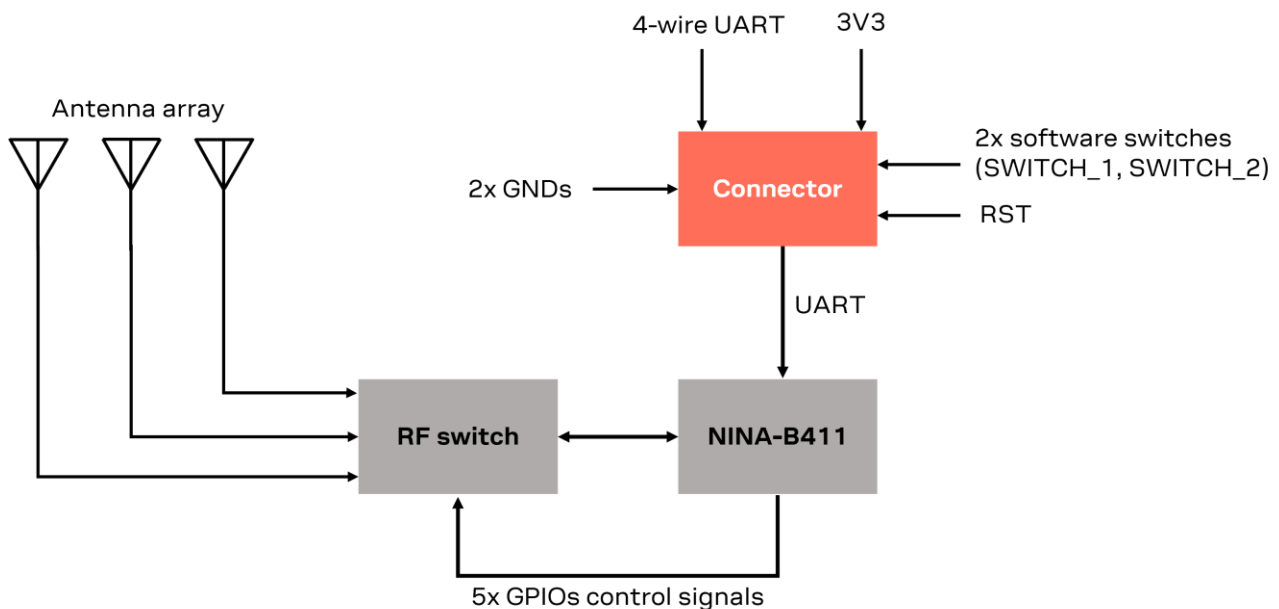

Figure 1: ANT-B11 block diagram

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:
  o **TXD**, data output pin
  o **RXD**, data input pin
  o **RTS**, Request To Send, flow control output pin (optional)
  o **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):
  o 8 data bits
  o No parity bit
  o 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

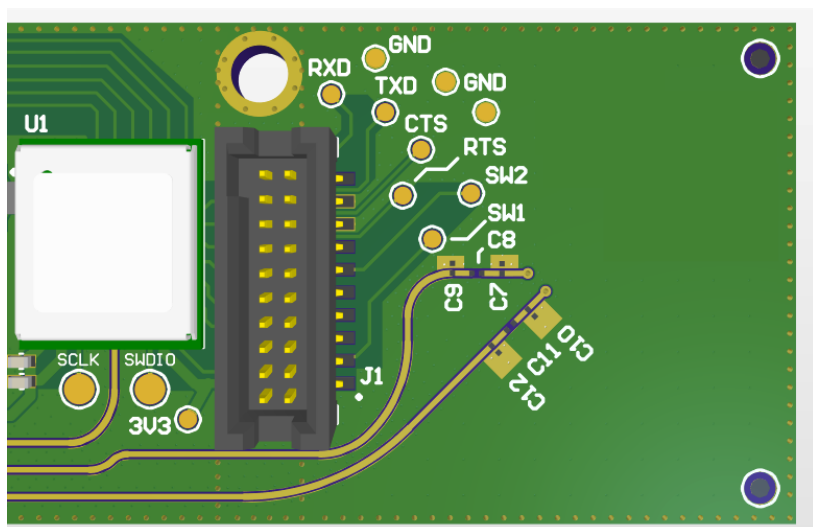Figure 2 shows the location of test points on the board.

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.
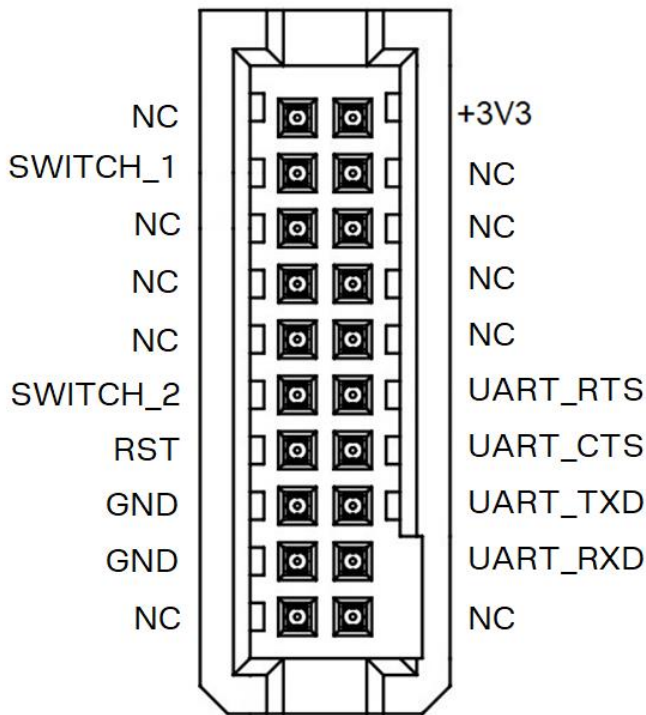
4.1   Pin assignment

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.

☞ Application information is only advisory and does not form part of the specification.

5.1 Absolute maximum ratings

Symbol	Description	Condition	Min	Max	Unit
VCC	Module supply voltage	Input DC voltage at VCC pin	–0.3	3.9	V
V_DIO	Digital pin voltage	Input DC voltage at any digital I/O pin, VCC ≤3.6 V	-0.3	VCC + 0.3	V
		Input DC voltage at any digital I/O pin, VCC > 3.6 V	-0.3	3.9	V
P_ANT	Maximum power at receiver	Input RF Power at antenna pin		+10	dBm

Table 5: Absolute maximum ratings

⚠ The ANT-B11 board is not protected against overvoltage or reversed voltages. Voltage spikes exceeding the power supply voltage parameters shown in Table 5 must be kept within the specified limits using appropriate protection devices.

5.2 Maximum ESD ratings

Parameter	Min	Typical	Max	Unit	Remarks
ESD indirect contact discharge			±4	kV	EN 301 489 conformant

Table 6: Maximum ESD ratings

ANT-B11 board hosts Electrostatic Sensitive Devices and require special precautions to be taken during handling. See also ESD precautions

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 7: 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 8: 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 v3.0.
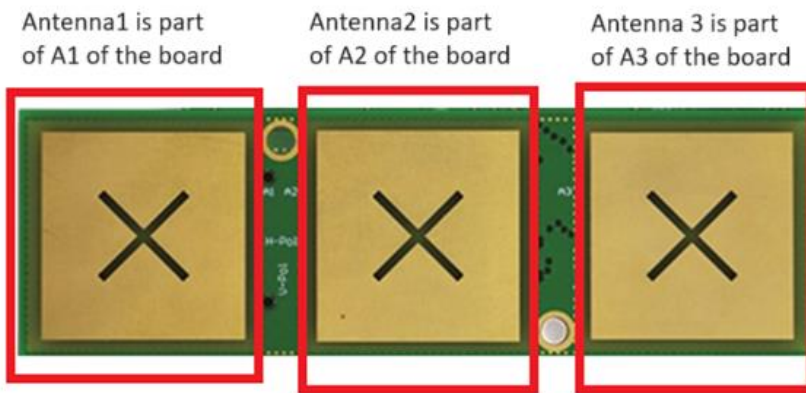
Mode	Condition	2.97 V (VCC)		3.3 V (VCC)		3.63 V (VCC)	
		Average	Peak	Average	Peak	Average	Peak
Active	Receiver on						
		6.7 mA	16.4 mA	6.4 mA	16.5 mA	7.3 mA	16.3 mA
Standby	Receiver off						
		430 uA	10.7 mA	425 uA	13.7 mA	420 uA	12.2 mA
Power Save using UART Rx wake up[1]	Receiver off UART off						
		2.6 uA	-	3.2 uA	-	3.3 uA	-
Power Save using GPIO_1 wake up[1]	Receiver off UART off						
		2.6 uA	-	3.2 uA	-	3.3 uA	-

[1] u-locateEmbed 3.0 and later releases implement power saving functionality with significantly reduced power consumption.

Table 9: 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), which makes a total of six antenna polarizations.


Antenna1 is part of A1 of the board

Antenna2 is part of A2 of the board

Antenna 3 is part of A3 of the board

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). The coordinate system used specifically for radiation patterns measurements is shown in Figure 5. The input power is provided at the Murata connector, which means that gain measurements include the RF switch loss.

OPTION #1
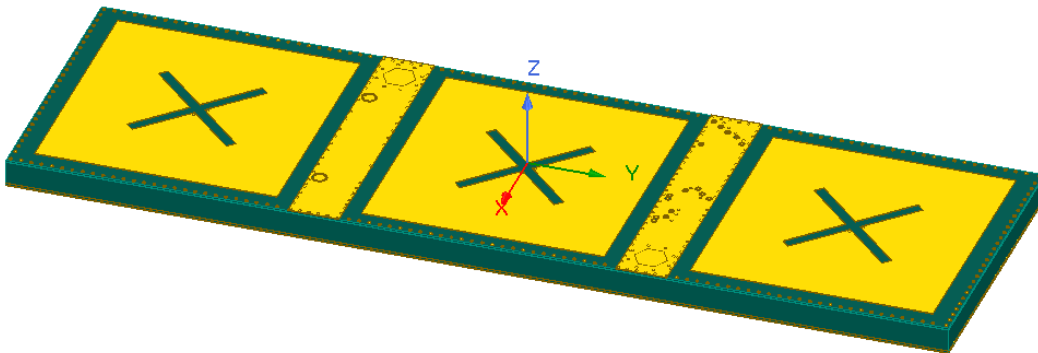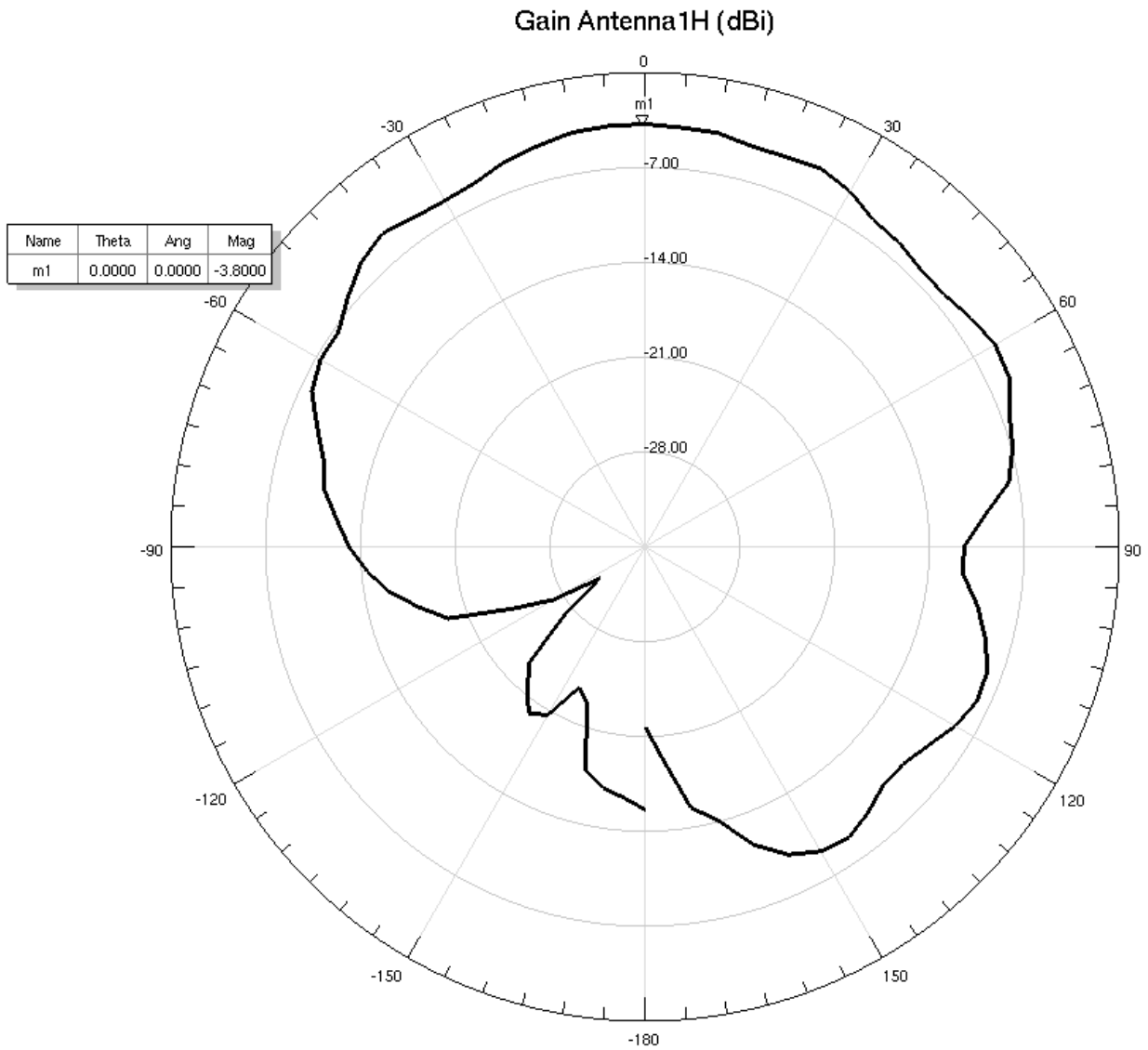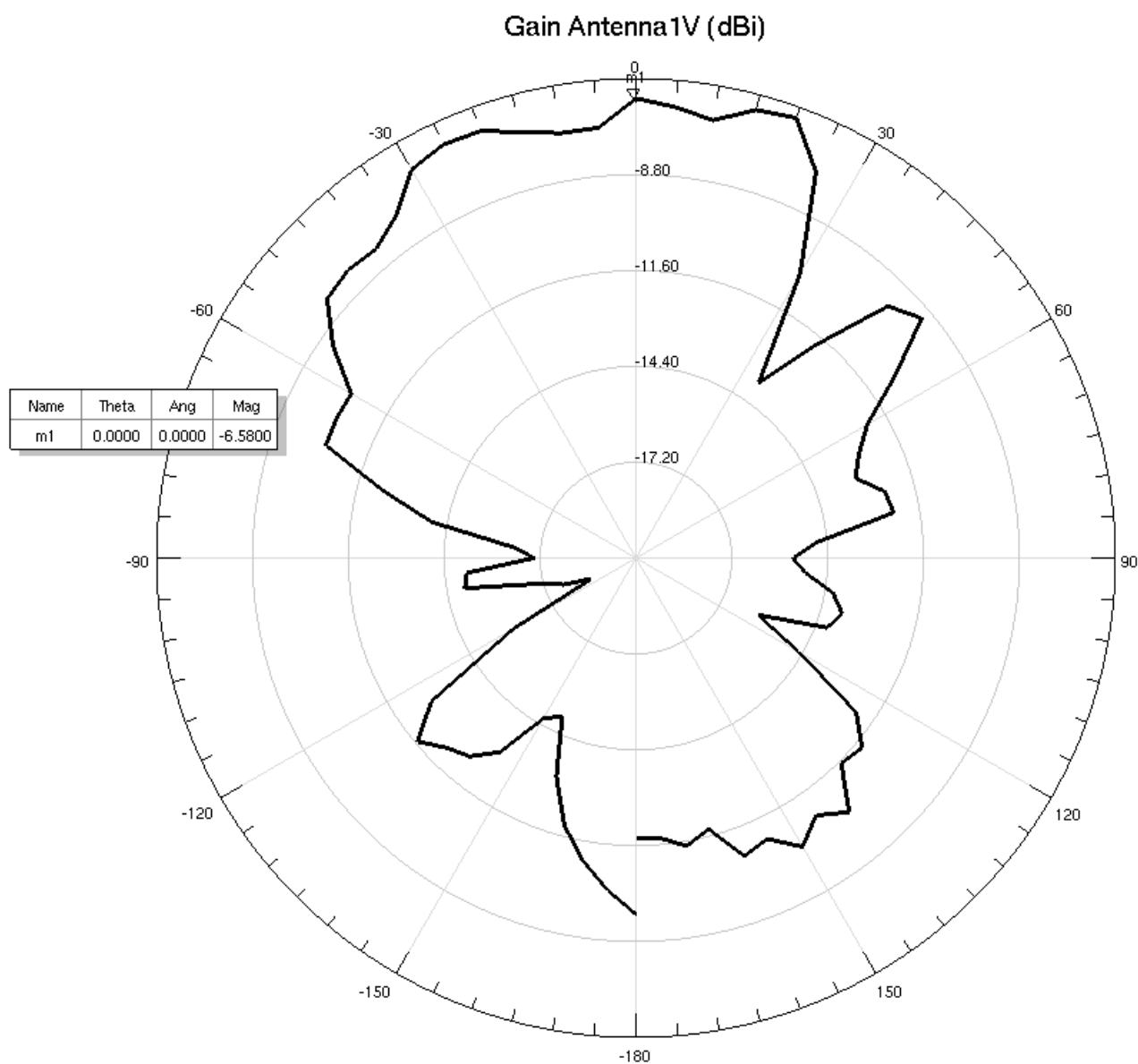

OPTION #2
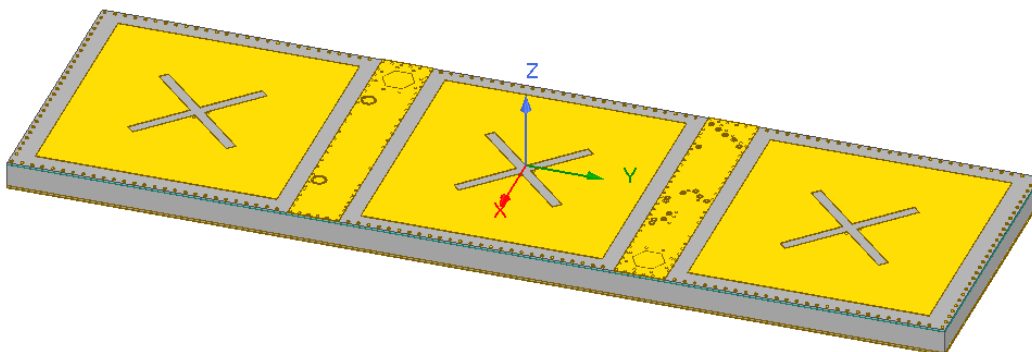
Figure 5: Spherical coordinate system

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

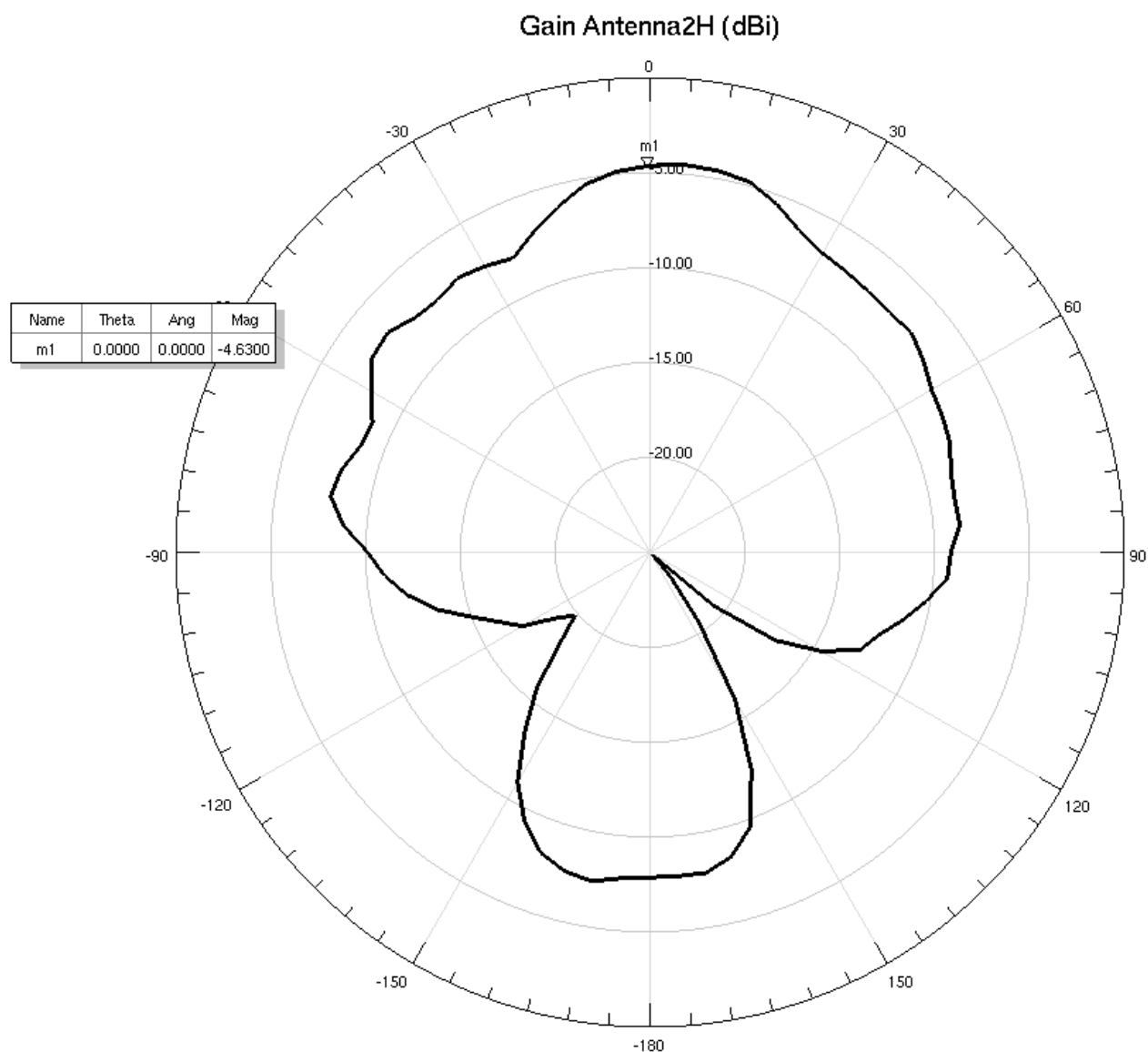Figure 8 shows the 2D, Y-Z plane, gain pattern for Antenna2 (horizontal polarization).

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

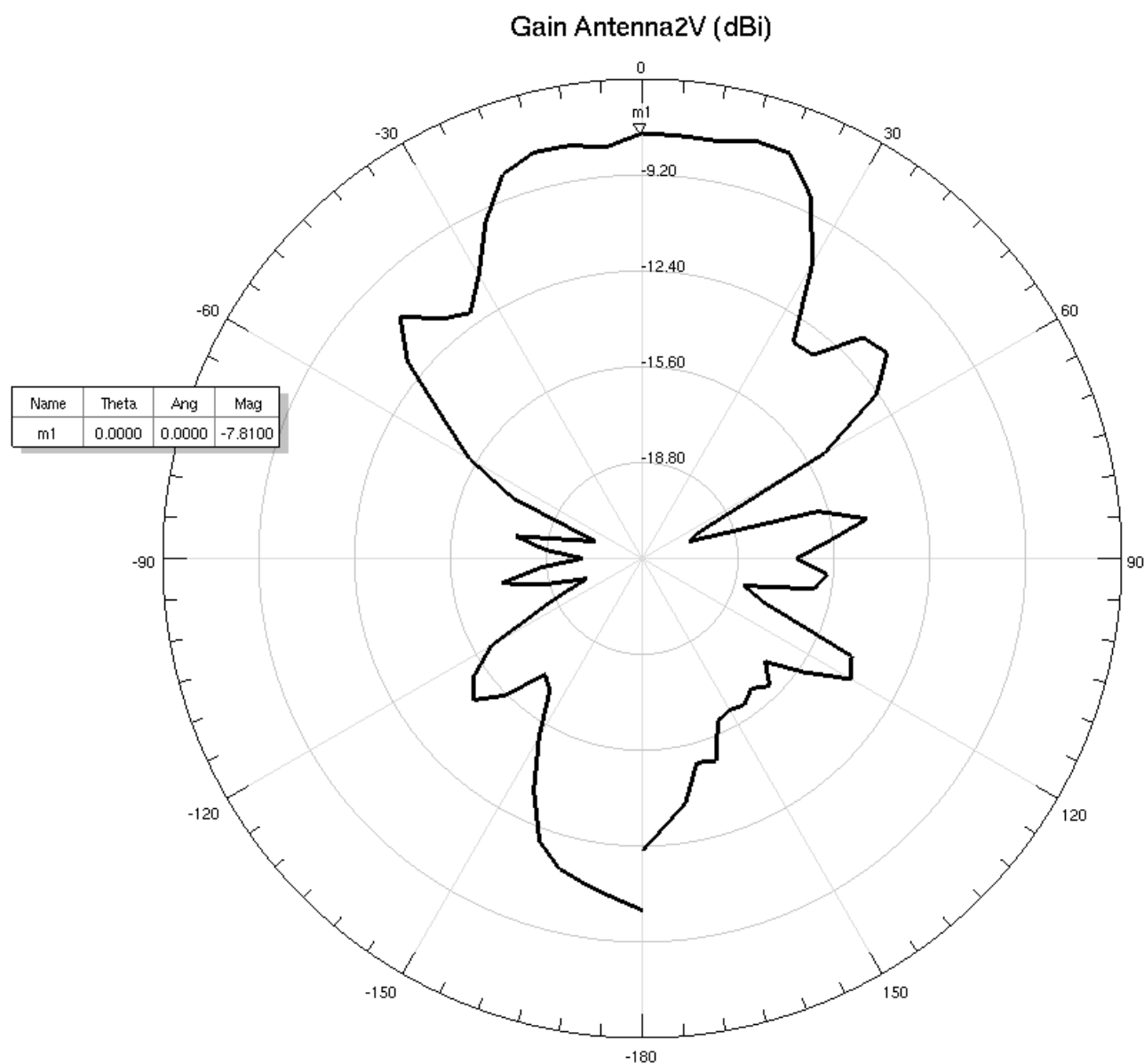Figure 9 shows the 2D, Y-Z plane, gain pattern for Antenna2 (vertical polarization).

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

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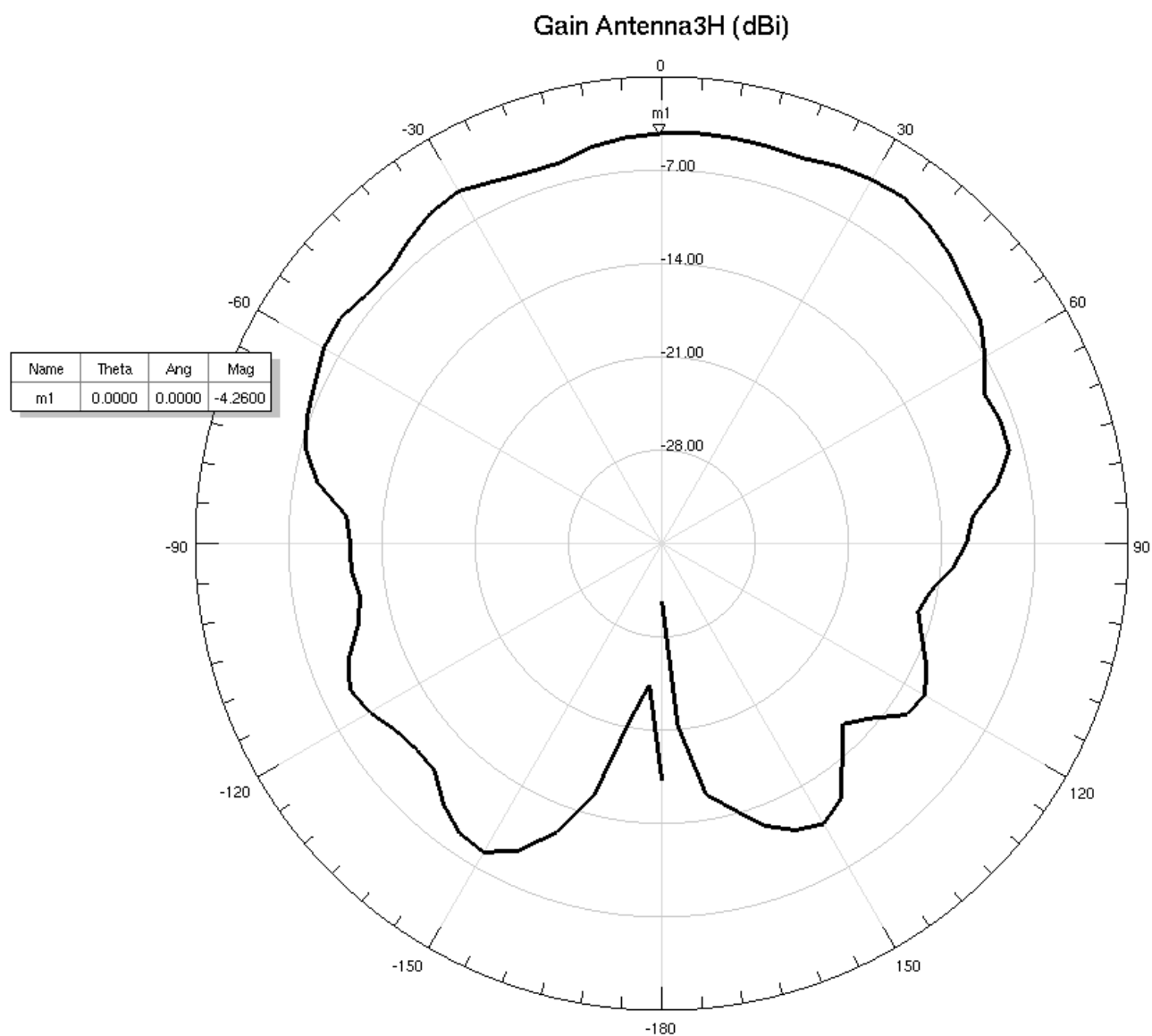

Figure 10: ANT-B11 Antenna3 (horizontal polarization), Y-Z plane

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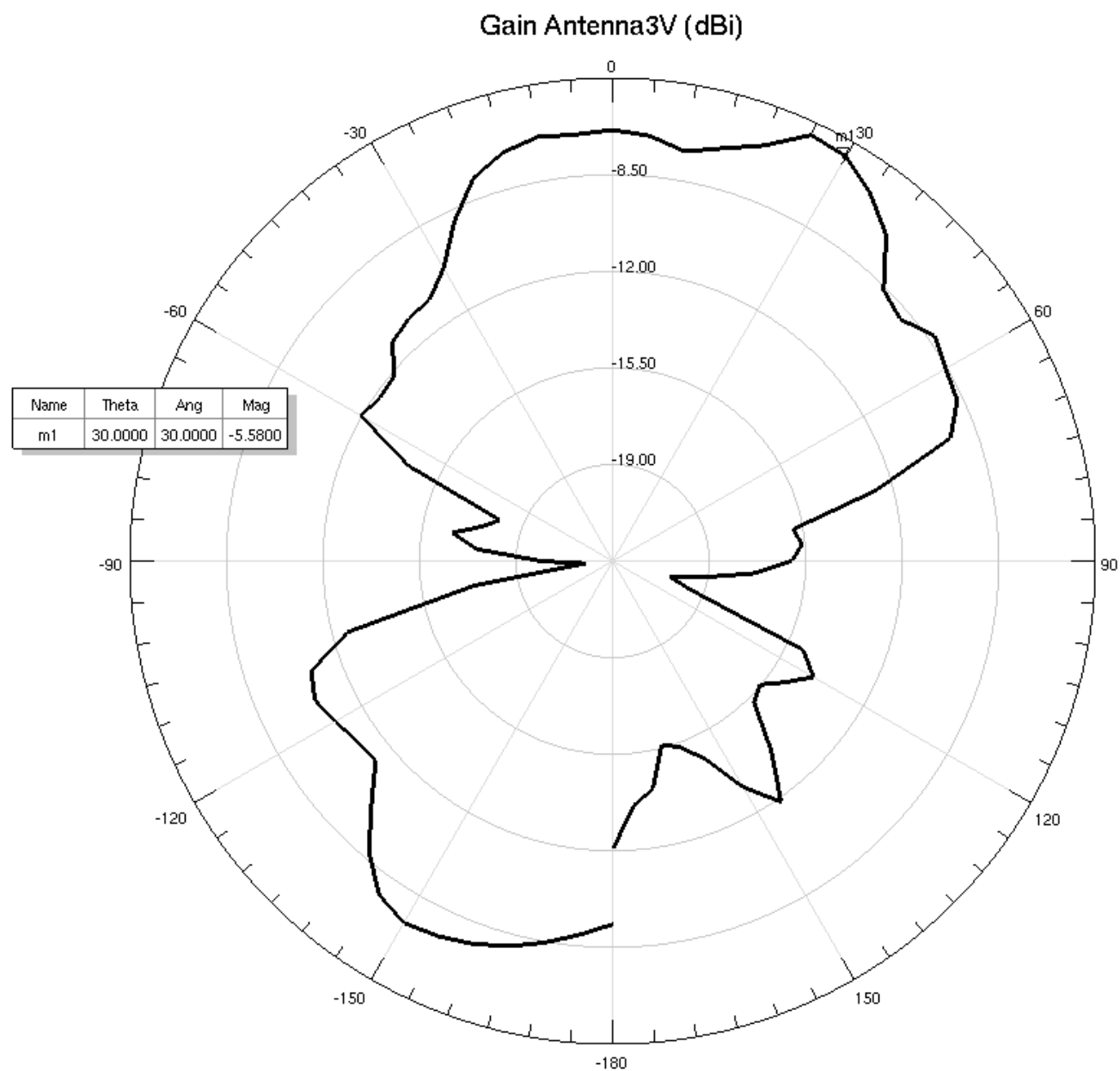

Figure 11: ANT-B11 Antenna3 (vertical polarization), Y-Z plane

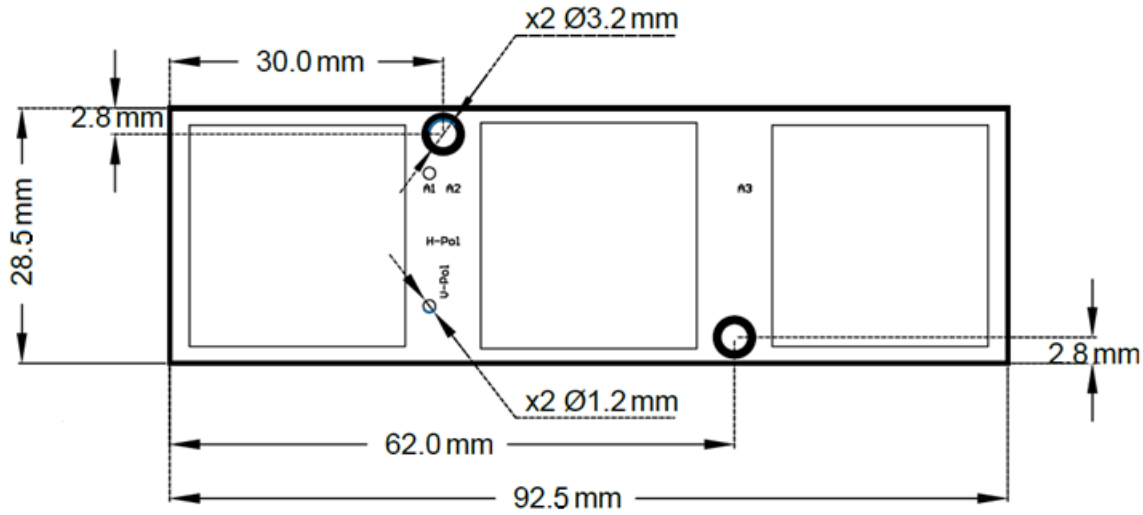# 7   Mechanical specification

7.1   Physical dimensions

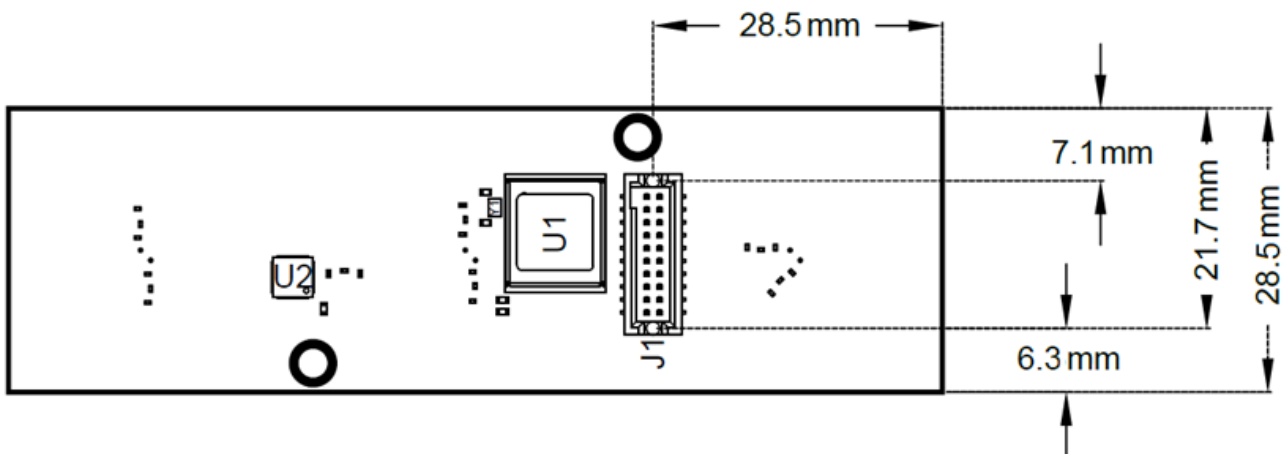Figure 12: Physical dimensions of the ANT-B11 board (Top view)

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

7.2   Pin header dimensions

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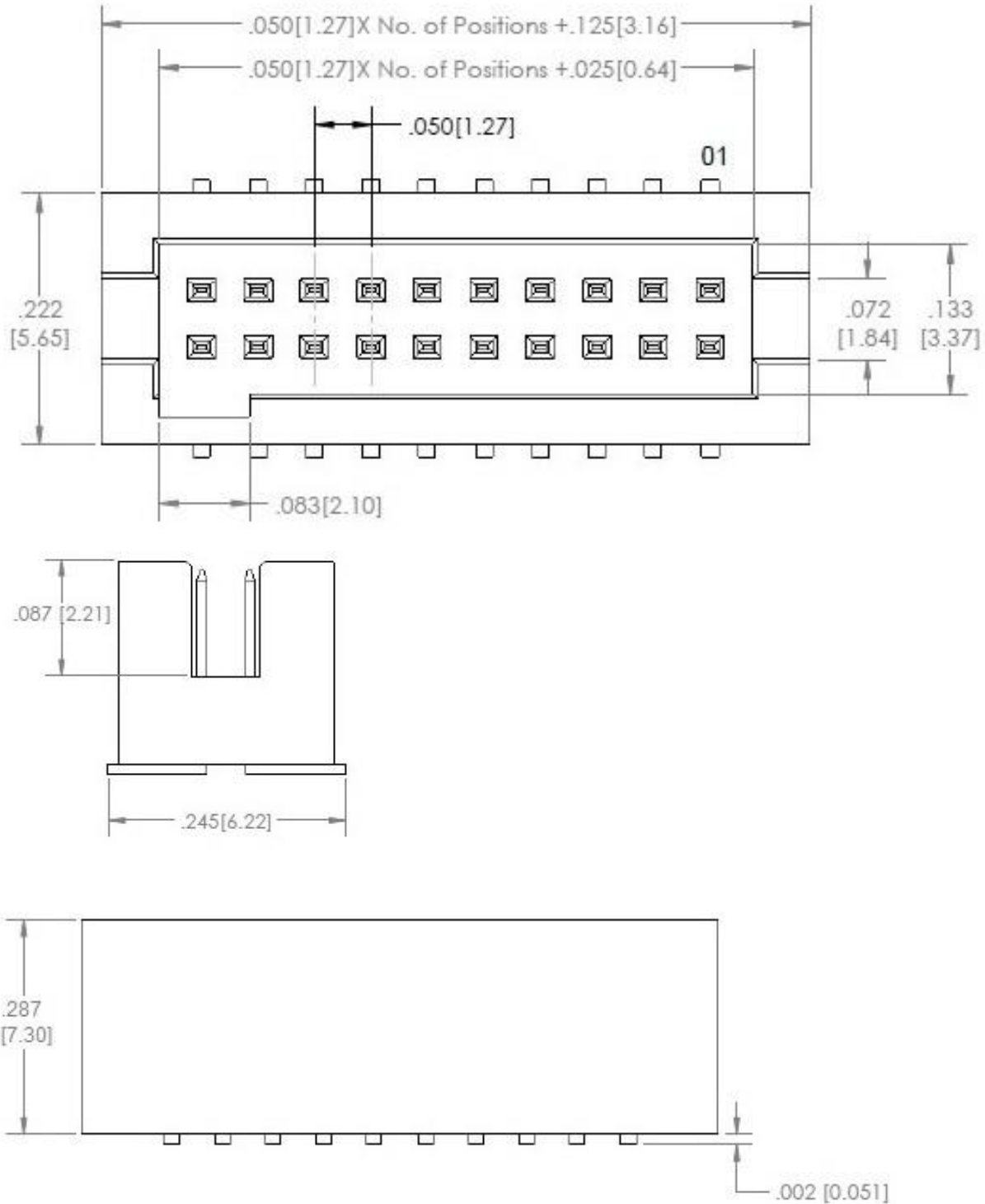

Figure 14: Pin header physical dimensions (dimensions are in inches [millimeters])

8 Approvals

The ANT-B11 antenna board is certified for use with the NINA-B4 module. See also the NINA-B41 series data sheet [1].

☞ For detailed information about the regulatory requirements and certifications, see also 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.
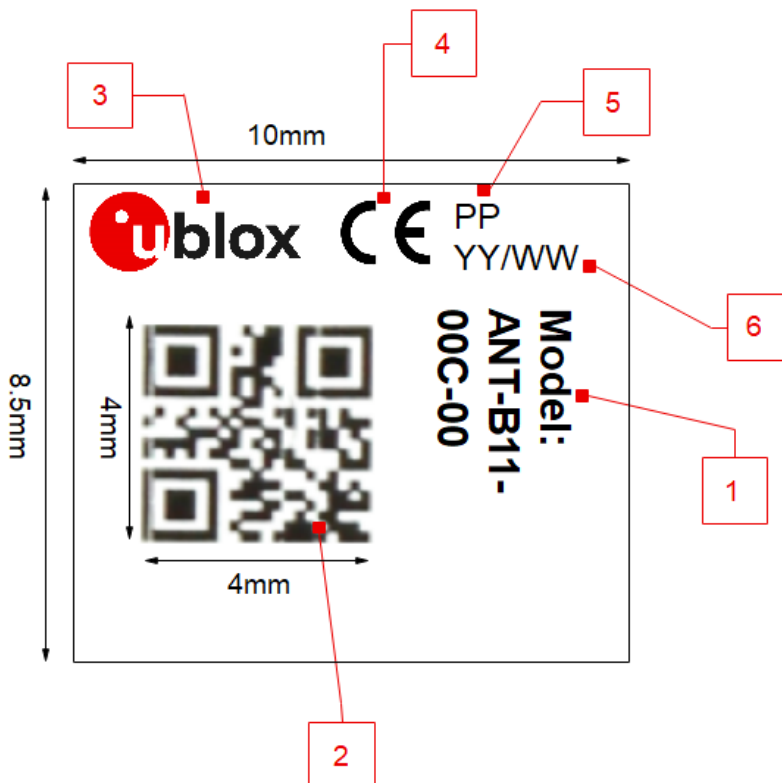

Figure 15: Product label format with dimensions for ANT-B11

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 10: 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

Table 11: 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 12: 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	23-Feb-2024	igou	Updated values for u-locateEmbed v3.0 in Current consumption. Added measurements in Antenna radiation patterns.
R03	14-Oct-2024	lliu	Added description and image of the three physical board antennas in Antenna radiation patterns. Added Absolute maximum ratings and maximum ESD ratings in Electrical specifications. Updated Approvals section.
R04	11-Apr-2025	gima	Removed obsolete ordering code ANT-B11-10C.

Contact

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