NanoCom ANT2000

Datasheet

S-band active antenna

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1 Table of Contents

2 Changelog

Date	Revision	Author	Description
19-5-2017	1.0	HKK/KLK	First release
8-8-2017	1.1	KLK	Changed drawing in chapter 4.3

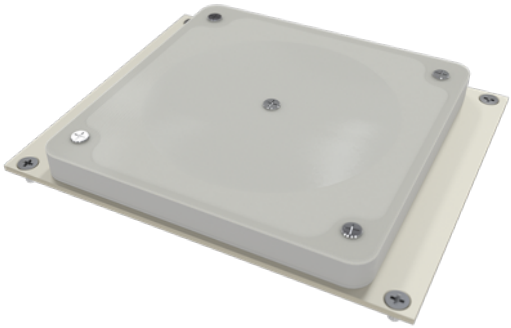
3 Overview

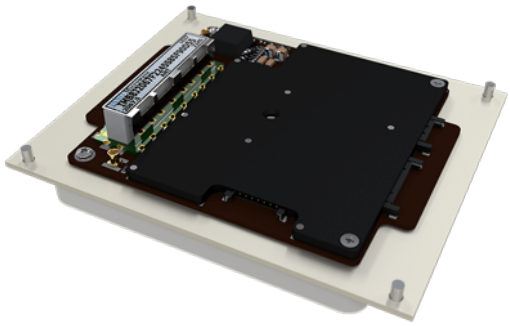
GomSpace NanoCom ANT2000 is an active antenna specifically designed for interfacing with GomSpace SDR transceivers.

Several versions are available depending on usage and placement on a nano-satellite.

The active antenna is built as a sandwich around a shield/mounting plate. The RF signal connection between the antenna and electronics PCBs are made with RF compression connectors. This construction allows flexible mounting on several different satellite structures – just by changing the shield/mounting plate.

Below is shown a CAD of the top and the bottom of the ANT2000.

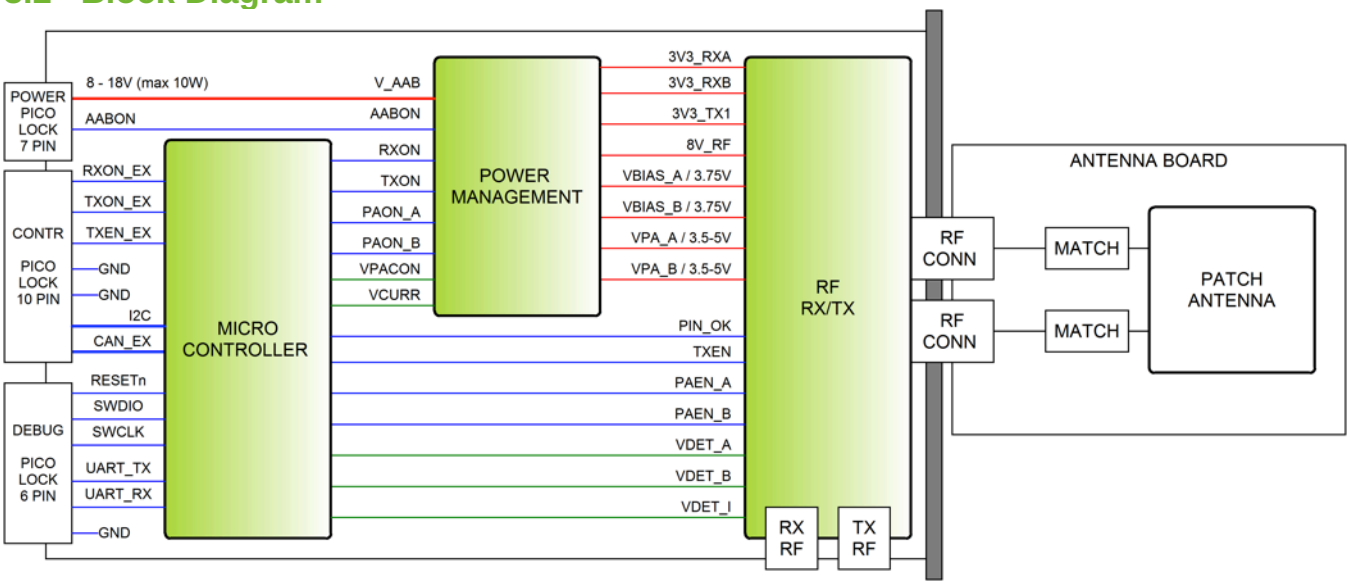




3.1 Highlighted Features

- Integrated antenna and PA/LNA results in low loss and optimum RF performance.
- Duplex filter based design results in optimum co-existence with other RF transceivers on-board.
- Flexible sandwich construction allows flexible mounting on different satellite structures – just by changing the shield/mounting plate.
- Shielded electronics.
- Flexible power interface (8-18 V).
- Default CAN-bus control interface.
- Medium gain (8 dBi) patch antenna with circular polarization.
- ANT2000-ISL-2150 version supports time division duplex (TDD) in 2200–2290 MHz frequency band.
- ANT2000-DUP-2150 version supports full duplex with RX in 2025-2110 MHz and TX in 2200-2290 MHz.
- ANT2000-DUP-2090 version supports full duplex with RX in 1980-2010 MHz and TX in 2170-2200 MHz.
- Temperature sensors (one sensor for PA and one in the microcontroller).
- Input current sensor.
- PCB material:
    - Electronics Board: Glass/Polyimide IPC 6012C cl. 3
    - Antenna Module: Rogers RO4003C
- IPC-A-610 Class 3 assembly

3.2 Block Diagram



3.3 Functional Description

The ANT2000 contains: a transmit power amplifier, a receive low noise amplifier, transmit/receive switch (ISL version), and necessary support circuits.

The antenna section includes matching components and the RF compression connectors. Stated antenna gain includes loss in matching circuit and in the RF connectors.

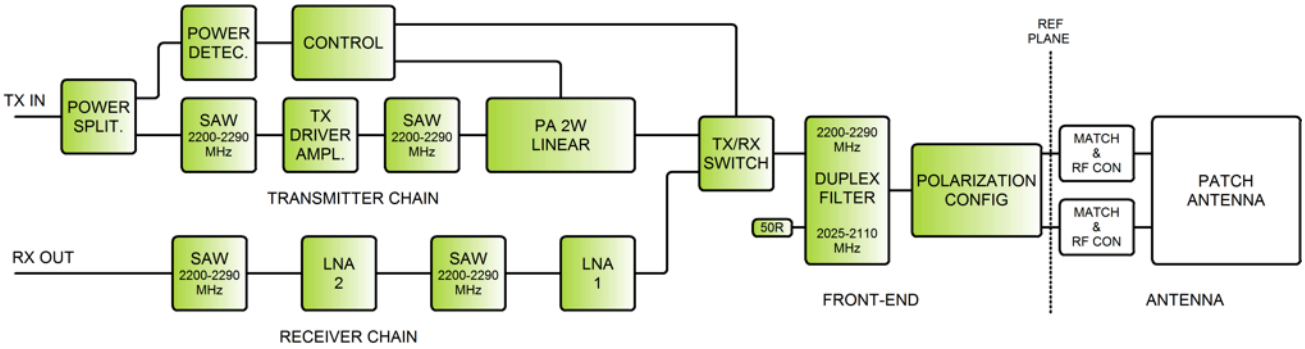
The transmitter chain includes a (pre) driver amplifier stage and a multistage balanced PA. Interstage SAW filters reduce broadband noise and provides stage isolation.

The receiver chain contains two LNAs again with interstage SAW filters to protect following stages from out-of-band interference.

All performance parameters for the electronics board and for the antenna module are given at the reference plane.

3.3.1 ISL Version

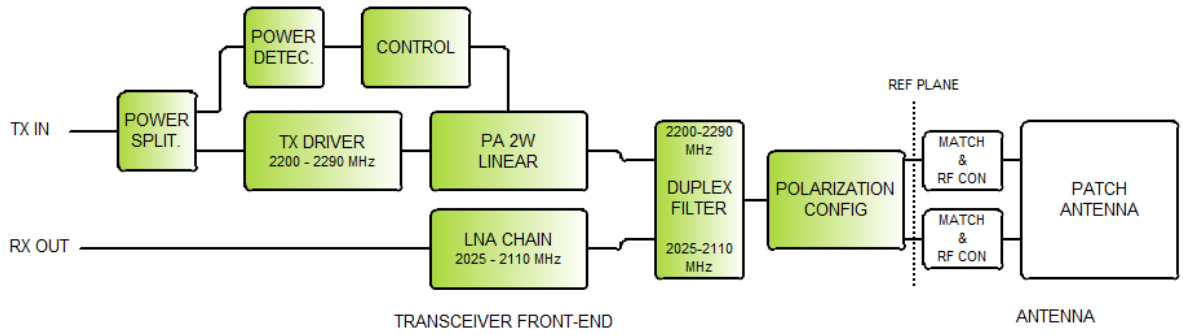
This front-end uses the same frequency band for RX and TX, which allows two ISL radio board to communicate using time division duplex.



The ISL front-end has a TX/RX switch and uses a bandpass filter (half of duplex-filter) that reduces transmitter noise (broadband) significantly. During production/checkout it can be configured if the antenna should use RHCP or LHCP.

3.3.2 DUP Version

The DUP version is the same as the ISL version except for the TX/RX switch and the filters on the Receiver chain. This version is available for two different frequency bands (see section 4.2).



3.4 Calibration and Setup

During production check-out, several calibration values are stored in the board.

For the receiver calibration values describe the RX gain at 7 frequencies across the RX band. These values can be used to implement a compensated RSSI function. (Antenna gain is not included). The RSSI values can also be temperature compensated using stored calibration values for gain temperature dependency.

The transmitter calibration values are primarily used to setup the correct input power to reach a given output power (compensated for frequency and temperature). One calibration value describes the input power detector level for a -10 dBm center frequency carrier, which will allow the SDR platform to set this level independently of cable loss. All other input levels should be set relative to the calibrated -10 dB level.

The PA has three predefined bias levels, which are optimized for 2 W, 1 W, and 0.5 W (se chapter 11.3). All levels are setup for approximately -25 dBc adjacent channel power for a 500 ksymbol/s QPSK a (RC 0.35) modulated signal.

4 Versions

When ordering the customer has to make a choice of:

- PCB version – ANT2000-ISL-2150, ANT2000-DUP-2150 or ANT2000-DUP-2090
- Antenna polarization (ISL default LHCP and DUP default RHCP)
- Mounting plate - depends on where the antenna is to be mounted
- Profile height – a special low profile of the antenna is available for the ISL version

4.1 Inter Satellite Link (ISL) and Profile

	ANT2000-ISL-2150	Unit
TX band	2200 - 2290	MHz
RX band	2200 - 2290	MHz

The ISL antenna module version comes with either a standard profile or a low profile. The low profile is intended for type D mounting (see chapter 4.3).

4.2 Duplex (DUP) and Profile

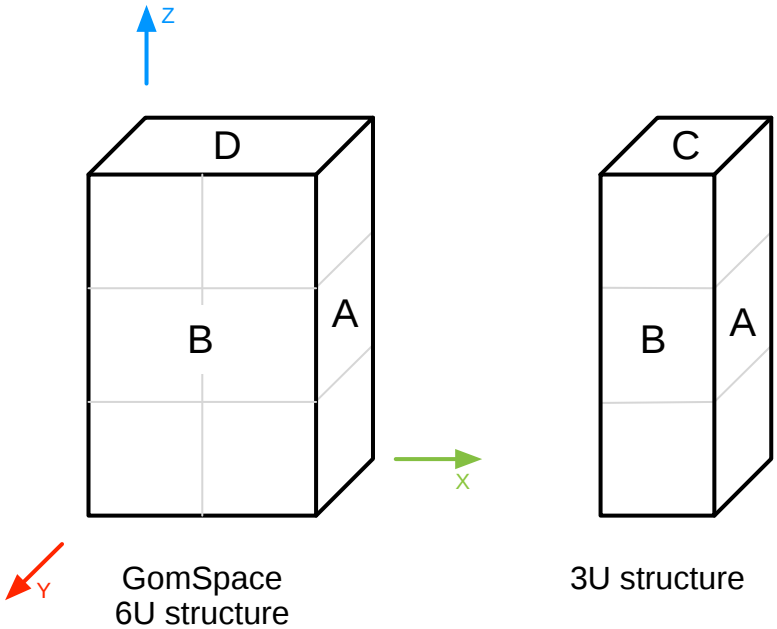
DUP comes in two versions.

	ANT2000-DUP-2150	ANT2000-DUP-2090	Unit
TX band	2200 - 2290	2170 - 2200	MHz
RX band	2025 - 2120	1980 - 2010	MHz

The DUP is only available in the standard profile version.

4.3 Mounting Plate

Four different mounting plates are available, depending on where the ANT2000 is placed on a nano-satellite. They are all 1.5 mm aluminum. The 3U is used as an example; the plates can also be mounted on 1U and 2U nano-satellite.



GomSpace 6U structure

3U structure

Type A

Used in a 3U structure on the A-sides and on the 6U structure A-sides.

Type B

Used in 3U structure on the B-sides.

Type C

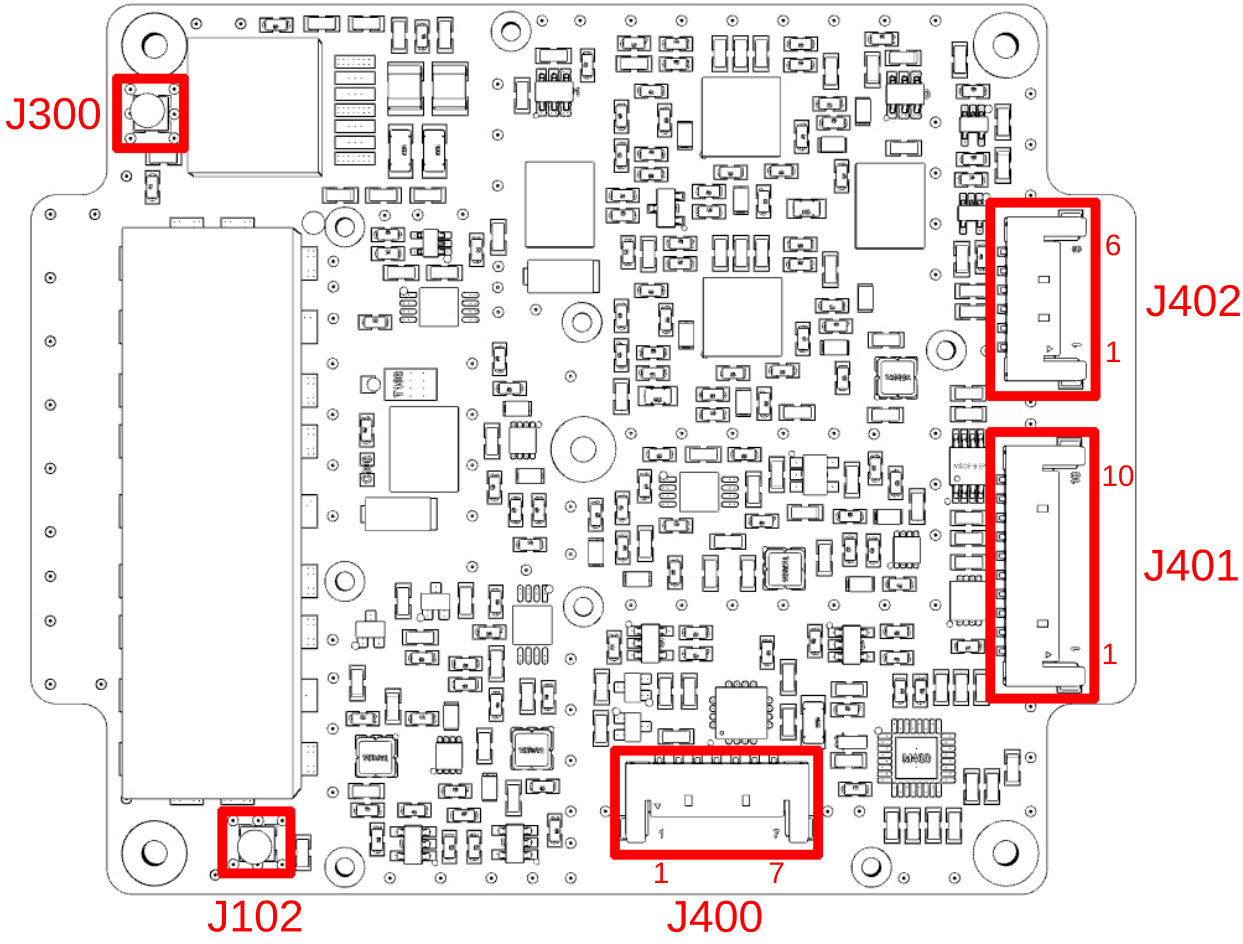
Used in the top or bottom of a 3U structure and not exceed the height of the structure rails.

Type D

Designed for use with the GomSpace NanoCom ANT-6F, which is mounted on the top or bottom of a 6U structure and not exceeds the height of the structure rails.

5 Connector Pinout

5.1 Connector Location Top



5.1.1 J102 - RX RF COAXIAL CONNECTOR

Molex SSMCX

Pin	Name	Description
1	RX RF	Amplified received signal
2	GND	

5.1.2 J300 - TX RF COAXIAL CONNECTOR

Molex SSMCX

Pin	Name	Description
1	TX RF	Transmitter input signal
2	GND	

5.1.3 J400 - Power Connector

Molex Pico-Lock 1.50 mm pitch 504050-0791

Pin	Name	Description
1	AABON	Low < 0.4 V, Active High > 2.5 V (max 18V)
2	GND	
3	GND	
4	GND	
5	VIN	8 – 18 V externally switchable
6	VIN	8 – 18 V externally switchable
7	VIN	8 – 18 V externally switchable

5.1.4 J401 - Control Connector

Molex Pico-Lock 1.50 mm pitch 504050-1091

Pin	Name	Description
1		n.c.
2	GND	
3	I2C_SCL	I^2C backup communication bus (not supported by current firmware)
4	I2C_SDA	I^2C backup communication bus (not supported by current firmware)
5	CANL	CAN bus (ATSAM21C series MCU used)
6	CANH	CAN bus (ATSAM21C series MCU used)
7	GND	
8	TXEN_EX	Select TX mode in manual duplex mode
9	TXON_EX	Power on TX circuit
10	RXON_EX	Power on RX circuit

5.1.5 J402 - Debug

Molex Pico-Lock 1.50 mm pitch 504050-0691

Pin	Name	Description
1	GND	
2	UART RX	GOSH serial communication
3	UART TX	GOSH serial communication
4	SWCLK	Firmware upload/debug
5	SWDIO	Firmware upload/debug
6	RESETn	Firmware upload/debug

6 Data Interface

The NanoCom ANT2000 uses the CubeSat Space Protocol (CSP) to transfer data to and from CSP nodes on-board the main system bus. CSP is a routed network protocol that can be used to transmit data packets between individual subsystems on the satellite bus and between the satellite and ground station. For more information about CSP please read the documentation on libcsp.org and on Wikipedia: http://en.wikipedia.org/wiki/Cubesat_Space_Protocol

Default control interface is a CAN-bus. I^2C is being implemented later.

7 Debug Interface

The debug interface is a USART that uses the GomSpace Shell (GOSH) to present a console-like interface to the user. GOSH is a general feature present on all GomSpace products.

The console can be used during checkout and satellite integration of the ANT2000 to send commands and inspect/set parameters.

8 Absolute Maximum Ratings

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the ANT2000. Exposure to absolute maximum rating conditions for extended periods may affect the reliability.

Symbol	Description	Min.	Max.	Unit
VIN	Input Supply voltage	8.0	18.0	V
PIN	Supply power draw	-	11	W
P_{in}	Absolute maximum input power at TX and RX ports		5	dBm
T_{amb}	Operating Temperature	-40	85	°C
T_{stg}	Storage Temperature	-40	85	°C

9 Electrical Characteristics

Symbol	Description	Min.	Max.	Unit
P_{sup_off}	Supply power, OFF	-	1.8	mW
P_{sup_idle}	Supply power, IDLE	-	200	mW
P_{sup_rx}	Supply power, RX mode	-	800	mW
P_{sup_tx}	Supply power, TX STANDBY	-	600	mW
P_{sup_tx}	Supply power, TX ACTIVE	-	10700	mW

10 Physical Characteristics

Description	Value	Unit
Mass (approximate – depends on mounting etc)	~ 110	g
Size (see chapter 13)	98 x 98 x 20.1	mm

11 RF Performance Characteristics

11.1 Receiver ISL

Symbol	Description	Min.	Max.	Unit
Gain,rx	RX Avg. Gain, 25°C	35	39	dB
	Gain ripple 25°C	-3	3	dB
	Gain ripple -40°C to 85°C	-3	-3	dB
NF,rx	RX Noise Figure, 25°C	2.5 (typ)	2.8	dB
	RX Noise Figure, -40°C to 85°C		3.5	dB
Freq, rx	RX frequency band	2200	2290	MHz

11.2 Receiver DUP

Symbol	Description	Min.	Max.	Unit
Gain,rx	RX Avg. Gain, 25°C	39	45	dB
	Gain ripple 25°C	-4	4	dB
	Gain ripple -40°C to 85°C	-5	-5	dB
NF,rx	RX Noise Figure, 25°C	2.0 (typical)	2.2	dB
	RX Noise Figure, -40°C to 85°C		2.8	
Freq, rx	RX band (ANT-2150-DUP)	2025	2110	MHz
	RX band (ANT-2090-DUP)	1980	2010	MHz

11.3 Transmitter

Symbol	Description	Min.	Max.	Unit
Pow.level 2	Pout	32.0 (typ)		dBm
	Pout ripple	-1.5	0.5	dB
	Pin (typical)	-8	-4	dBm
	DC Power (typical) (Vin 10V)	8.9	10.0	W
Pow.level 1	Pout	29.8 (typ)		dBm
	Pout ripple	-1.5	0.5	dB
	Pin (typical)	-11	-7	dBm
	DC Power (typical) (Vin 10V)	6.1	7.1	W
Pow.level 0	Pout	26.8 (typ)		dBm
	Pout ripple	-1.5	0.5	dB
	Pin (typical)	-14	-10	dBm
	DC Power (typical) (Vin 10V)	4.0	4.5	W
Pin,thr	Threshold for input detector – rising		-28	dBm
Pin,thr,hys	Hysteresis for input power det.	2		dB
Pout,min	Min. power for automatic TX	Pin: -26	Pout: 14	dBm

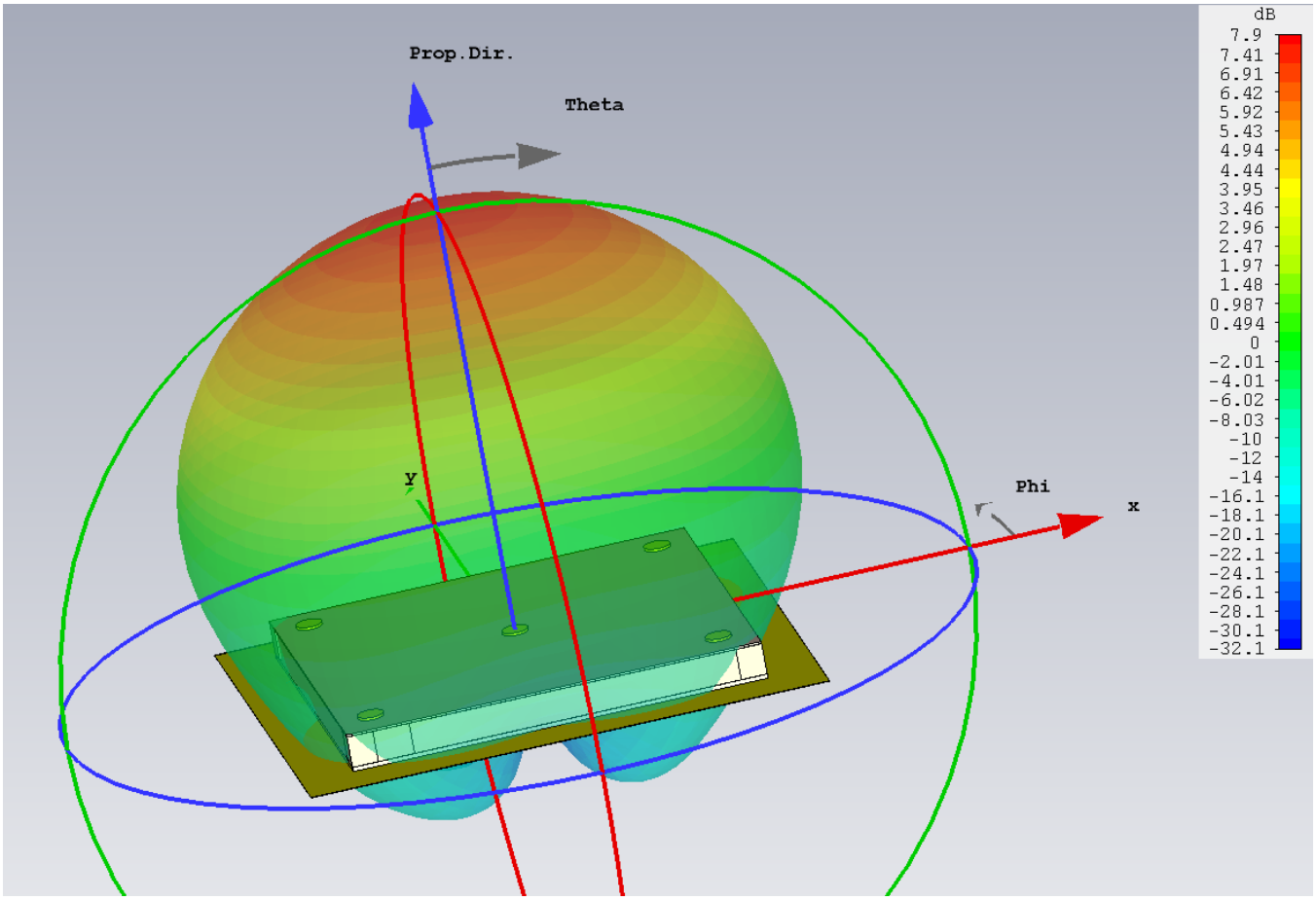
12 Antenna Performance

Figure below is a typical simulated radiation pattern, and a definition of the Phi and Theta angles used to describe the general antenna performance.

The antenna module includes connectors and matching circuit and has two feed ports which must be driven 90° out of phase to generate a circular polarized radiation.

On the electronics board a hybrid coupler generates the necessary quadrature signals. For the antenna measurements an adaptor board with the same hybrid coupler is used as test interface and the adaptor board loss (~0.30 dB) is compensated in the measurements.

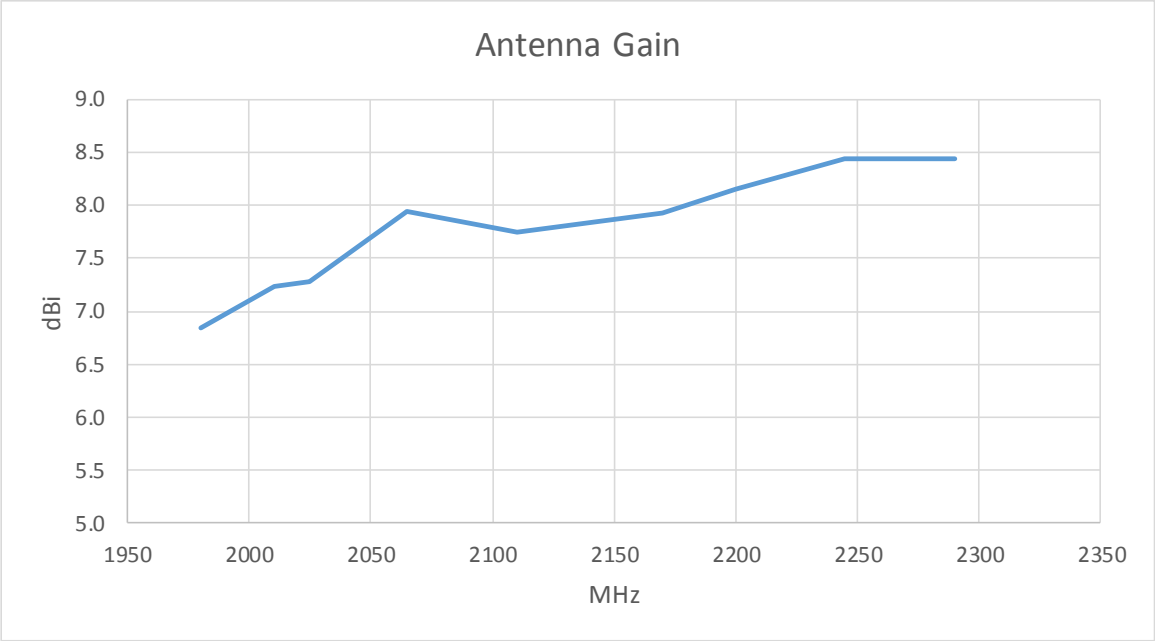
Due to symmetry of the feed ports both circular polarizations will have the same performance and the results shown in this section with be based on RHCP data.

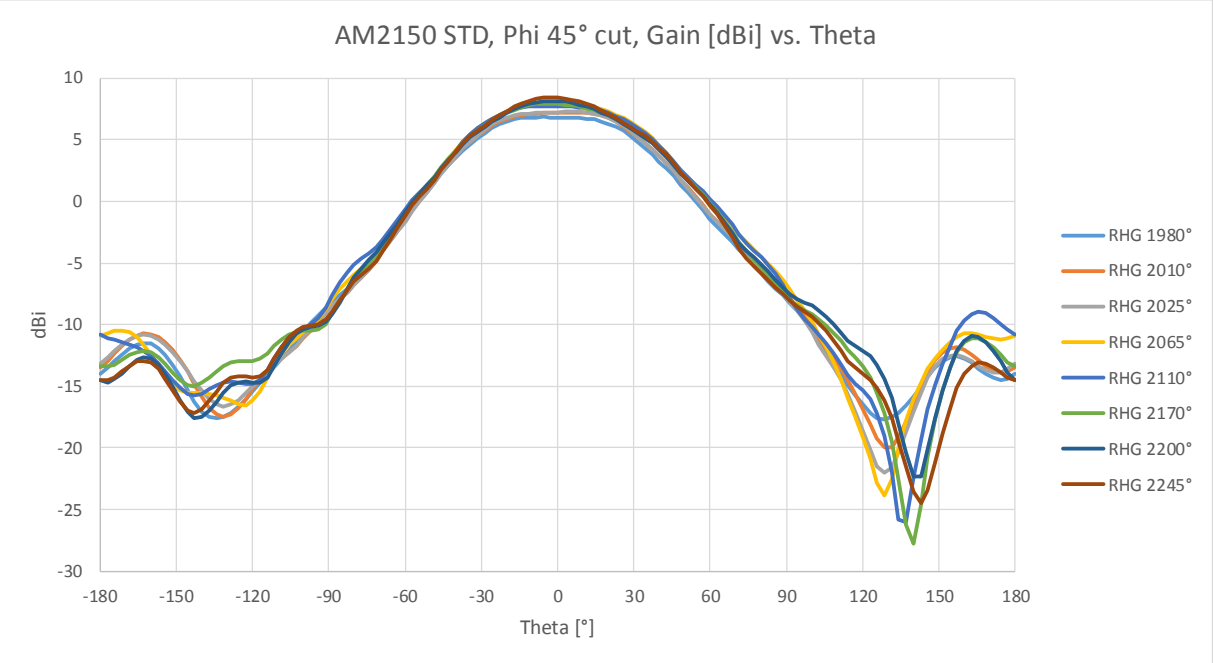


12.1 Standard Profile

12.1.1 Antenna Gain

All antenna radiation measurements are with a Satimo Ring setup using a 98 x 98 mm aluminum ground plane. Below antenna gain (including connector) and radiation pattern for Phi=45° (diagonal across ground plane) is shown.



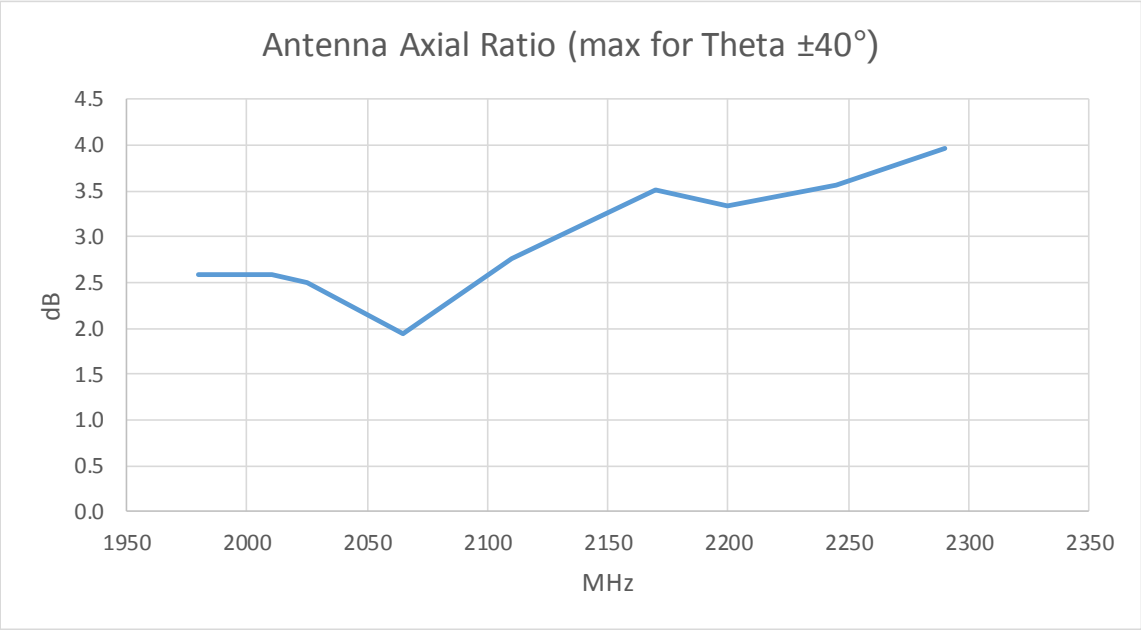


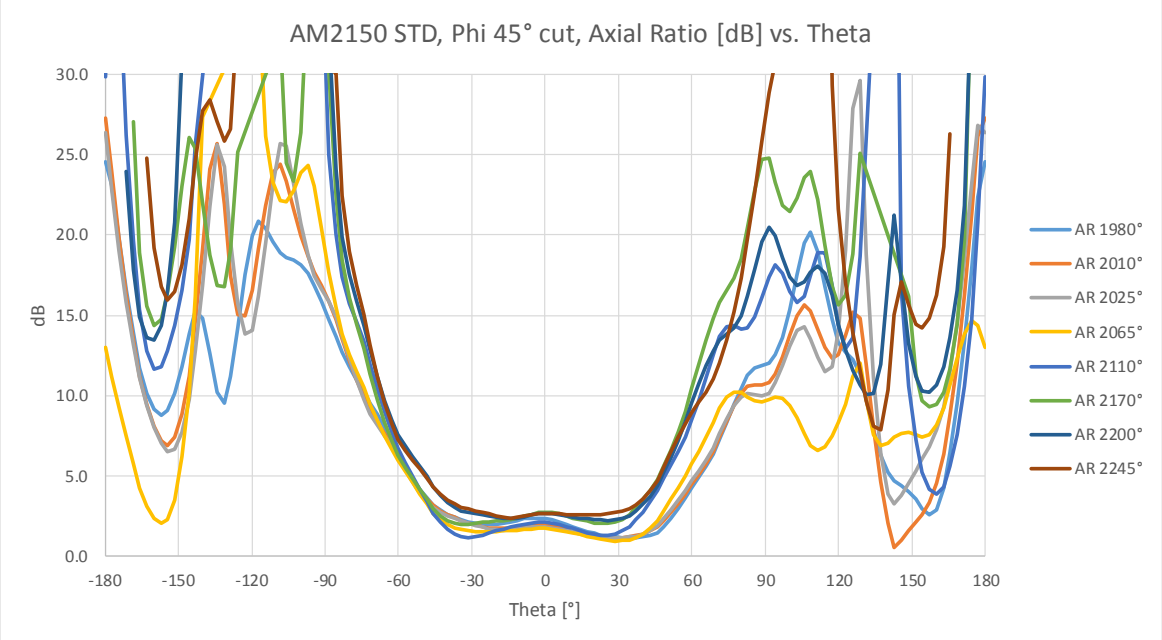
12.1.2 Axial ratio

All ANT2000 antennas are circular polarized, and product polarization is determined by the electronics PCB.

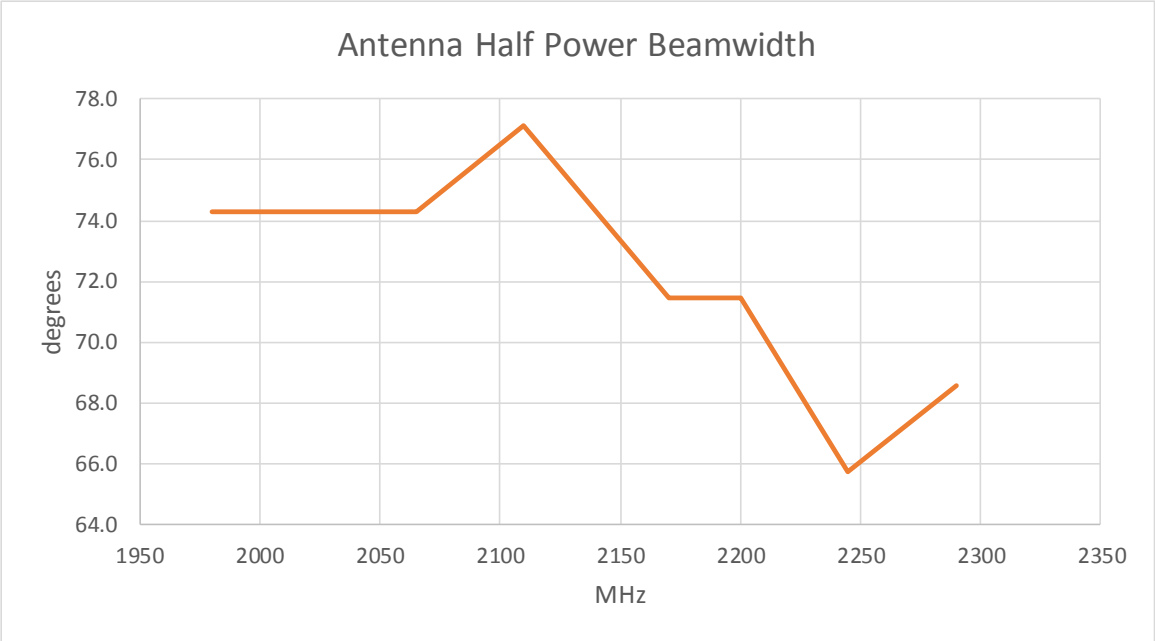
Below the maximum axial ratio for -40...40° elevation is shown as a function of frequency, and the axial ratio as a function of Theta for a Phi angle of 45°.

As seen the axial ratio is quite good within the halfpower beamwidth.

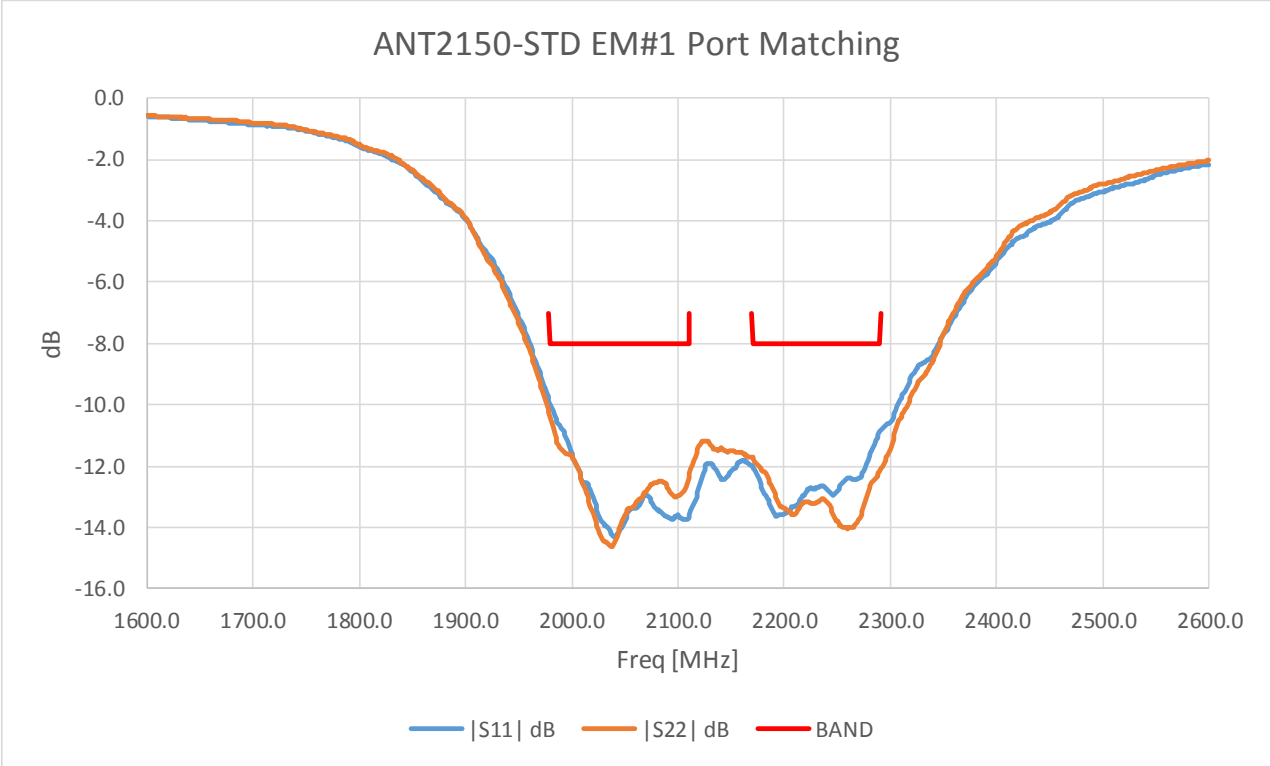




12.1.3 Half Power Beamwidth



12.1.4 Port Matching



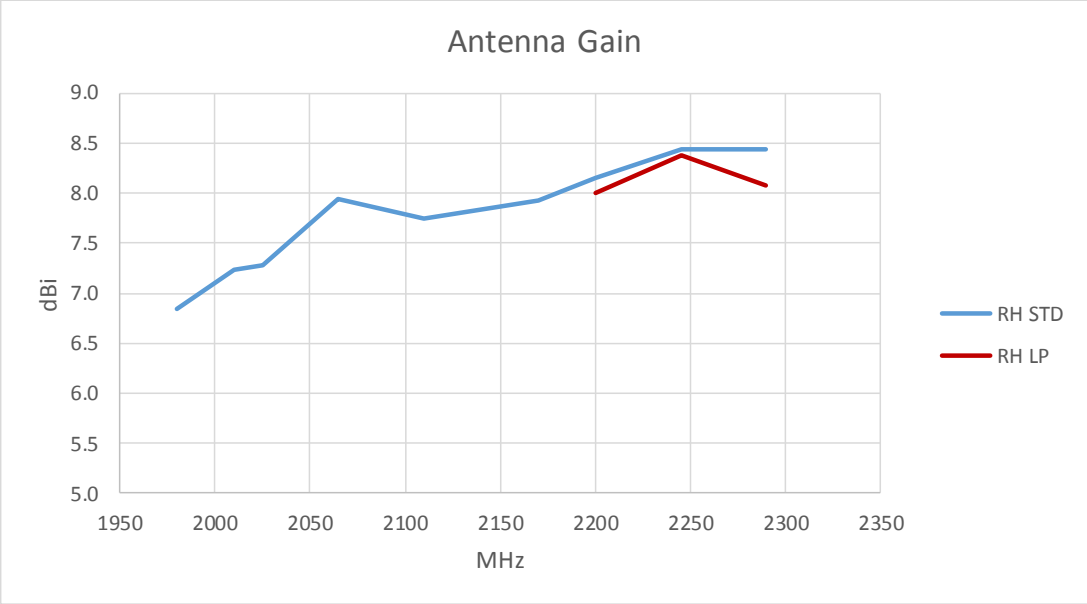
12.2 Low Profile

Only the ANT2000-ISL-2150 in the 2200-2290 MHz frequency band can use the low profile antenna.

The Half power beamwidth and the axial ration is virtually the same as for the standard antenna.

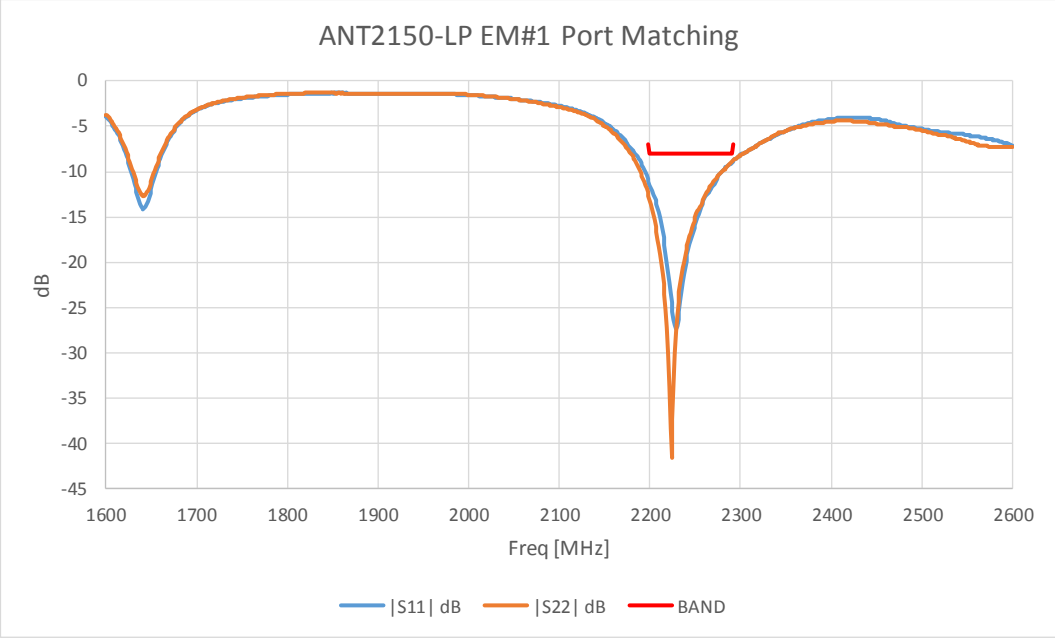
12.2.1 Antenna Gain

Performance within this band is marginally lower than the standard antenna primarily due to matching losses. Below the gain [dBi] is shown in comparison with the standard profile antenna.



12.2.2 Port Matching

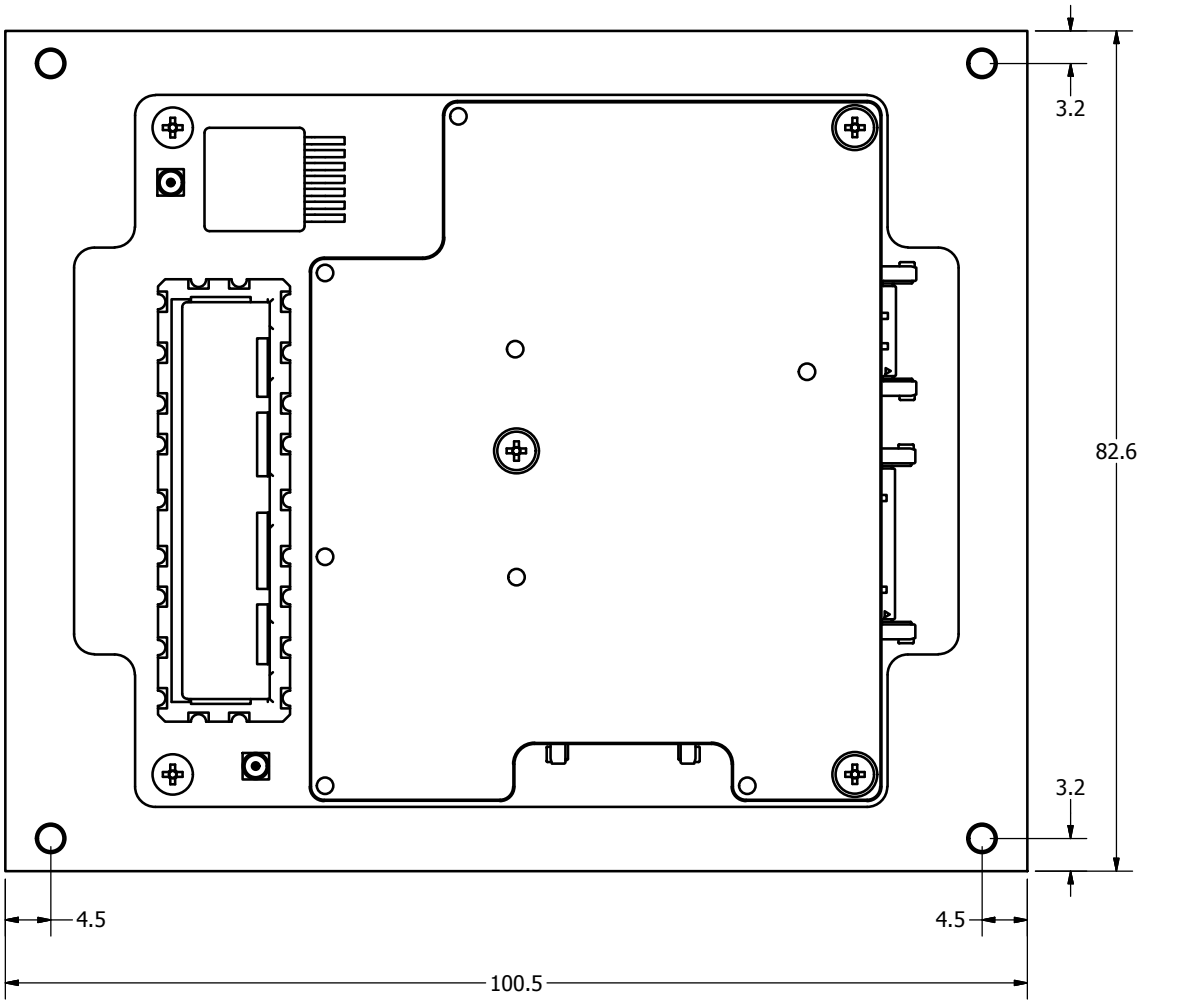
The matching of the ports is significantly more narrowband than the standard antenna as shown below.

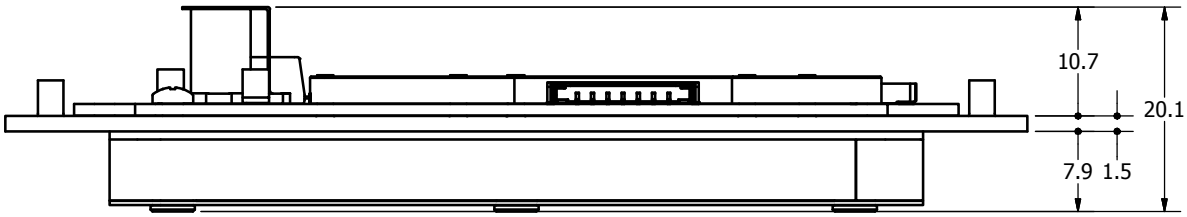


13 Mechanical Drawing

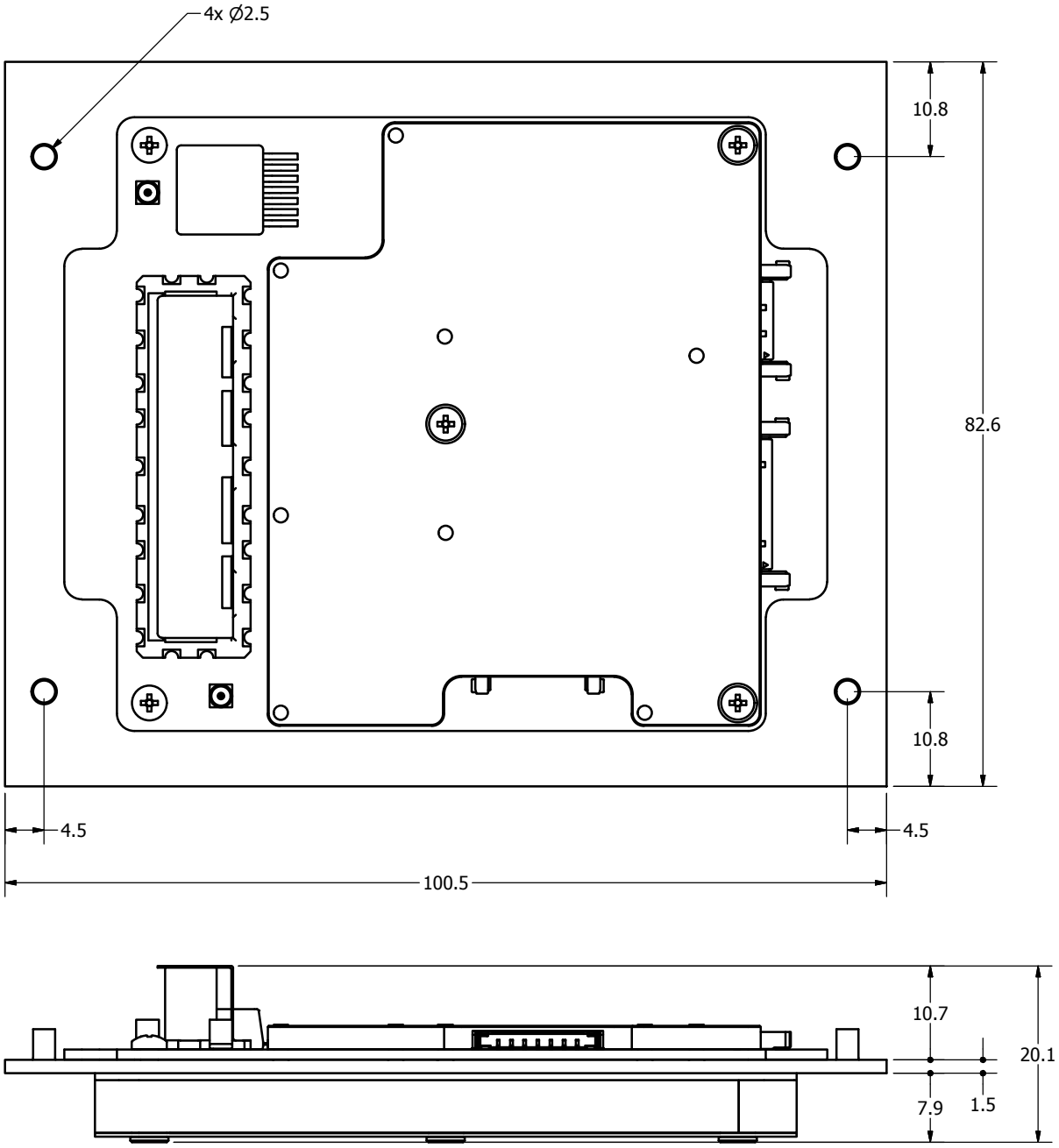
All dimensions in mm.

13.1 Type A

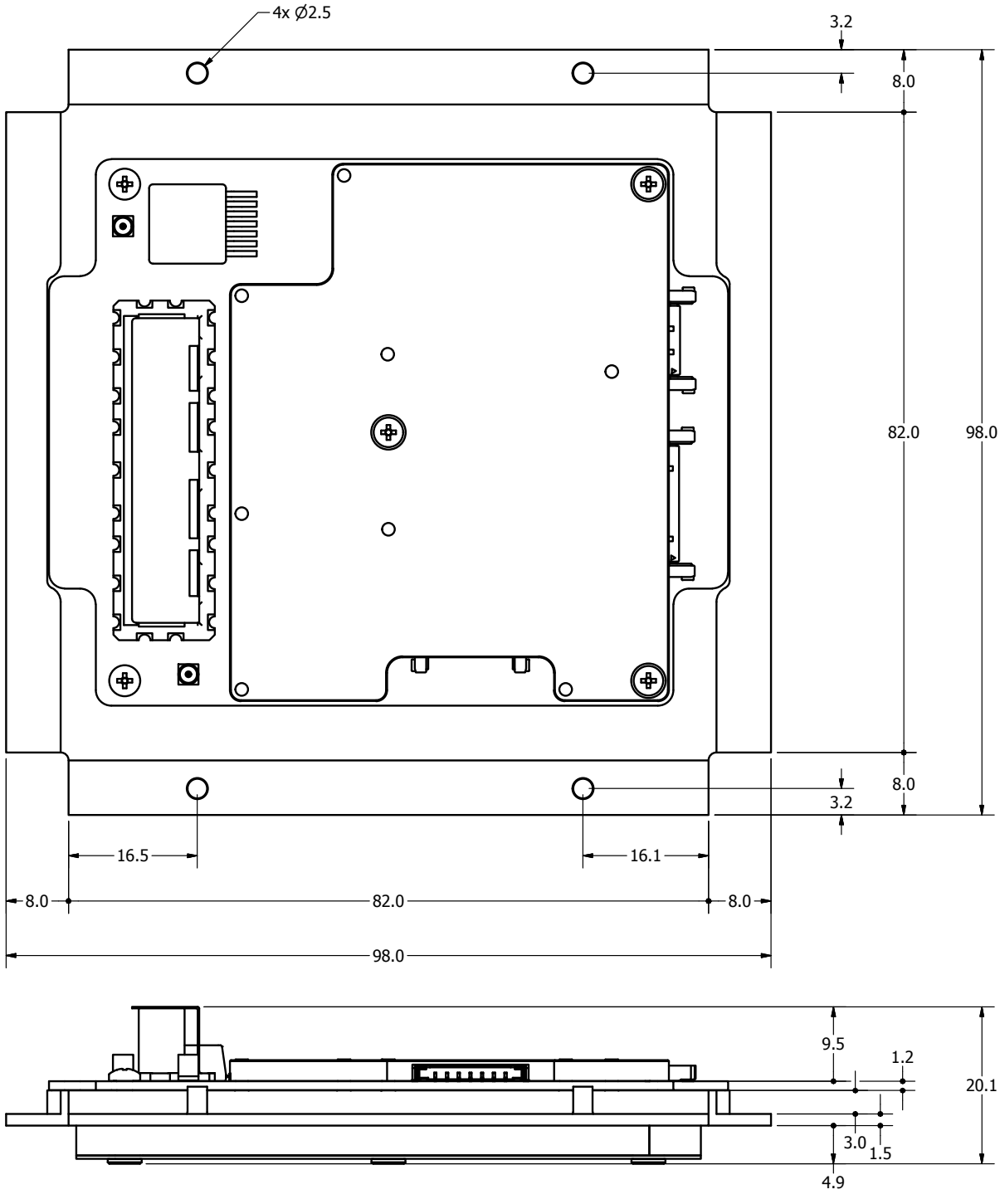




13.2 Type B



13.3 Type C



13.4 Type D