GOMSPACE

NanoCom

SR2000

Datasheet

High Speed S-Band Radio Transceiver

Release 2.3.0

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Product name: NanoCom SR2000

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Confidentiality Notice

Table of Contents

1. Overview

The NanoCom SR2000 consists of the following products:

- NanoDock SDR
- NanoMind Z7000
- NanoCom TR-600

It supports up to two TR-600. Fig.1.1 shows a SR2000 with a Z7000 and one TR-600.

Fig. 1.1: SR2000 (NanoDock SDR, NanoMind Z7000 and NanoCom TR-600)

The SR2000 is a software-defined point-to-point high-speed continuous-mode transceiver for S-band communications on nano-satellites. Concatenated FEC using convolutional coding and Reed-Solomon coding allows an operational link even under poor link conditions. The radio supports frequency-division duplex (full-duplex) and time-division duplex (half-duplex) in a fixed timeslot master-slave scheme.

1.1 Highlighted Features

- High-speed transceiver for point-to-point S-band communications
- Frequency and time division duplex
- Fully configurable in-orbit
- Dual-modem, allowing two independently configurable RF links
- Automatic frequency compensation
- Symbol rate 0.5 to 7 MBd
- S-band operation (1980-2290 MHz)

- High sensitivity: PER less than 1e-4 at Eb/No = 5 dB
- RF output frequency configurable in 10 Hz steps
- Concatenated coding: convolutional code plus Reed-Solomon
- Compatible with CCSDS 131.0-B-3 recommendation
- Adjustable output power, frequency, bandwidth, baud, sps and AGC-mode
- Compatible with GomSpace ANT2000 series antennas
- Configurable over-temperature protection
- UART/GOSH console interface for easy use in lab setup
- Flexible communication interfaces
  - RS422 interface for payload data transfer (either TCP/IP via PPP or CSP)
  - CAN interface for configuration and CSP datagram transfer
- SFCG recommendation 21-4R4 spectral mask compliance

1.2 Block Diagram

The NanoCom SR2000 is based on the GomSpace NanoCom SDR platform: The NanoMind Z7000, NanoCom TR-600 and NanoDock SDR. A custom Linux distribution is running on the processor system (PS) of the Zynq-Z7000 SoC, where two applications are running: The monitor application and the modem control application. For more details on these, please refer to the NanoMind Z7000 and NanoCom SR2000 manuals.

The two modems reside in the programmable logic (PL) of the Z7000, and data to and from these modems is transferred by DMA. Data and control to/from the TR-600 is transferred through interface logic in the PL. Two antennas may be connected to each TR-600. The modem control application can be used to switch between them - see Fig.1.2.

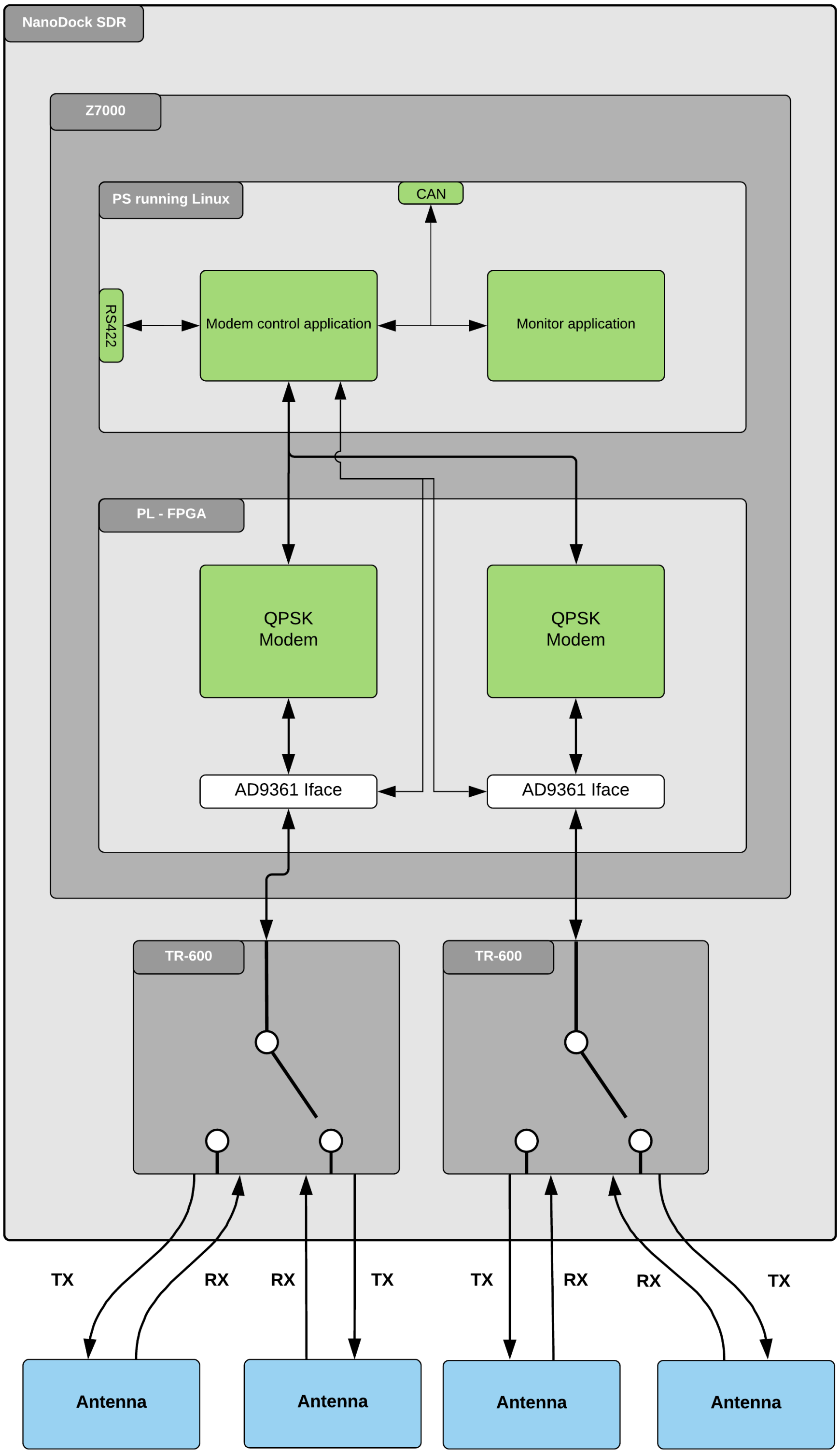

Fig. 1.2: SR2000 block diagram

1.2.1 Data Link Layer

On the data link layer, frames are structured as illustrated in Fig.1.3 in all modes.

- Reed-Solomon encoded datagrams
  - Block and message length $(n, k) = (255, 223)$
  - Fixed interleaving depth $L = 8$
- 4-byte attached synchronization marker (ASM)
- Time division duplex (optional)
  - Symmetric link with 100 ms time slots
  - 1 ms inter-frame spacing
  - Static time slot configuration

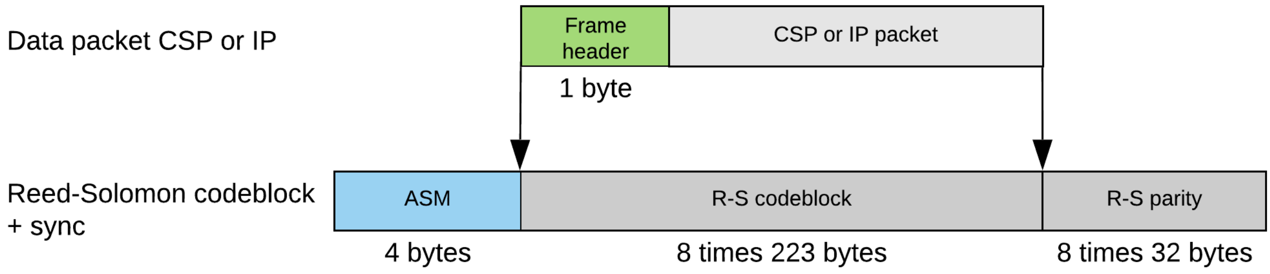

Fig. 1.3: Frame structure

In TDD mode, the slave device will synchronize to the master timeslots as illustrated on Fig.1.4.

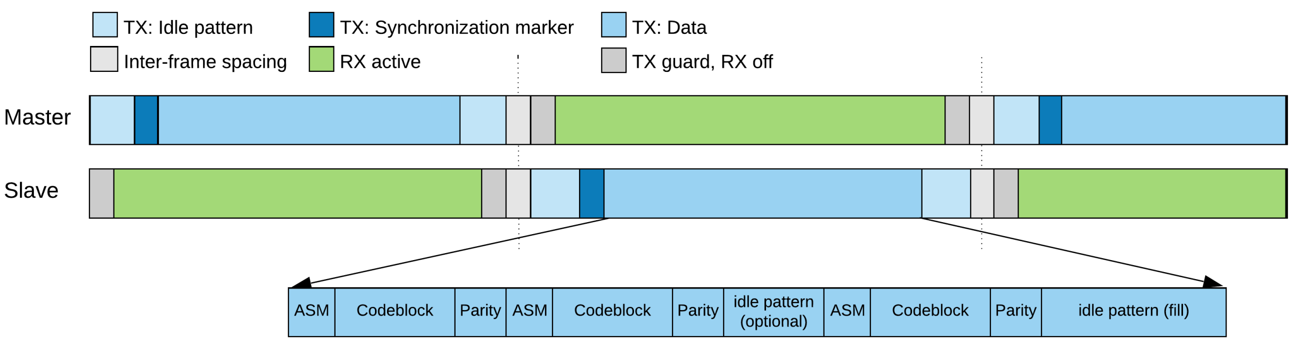

Fig. 1.4: Time-division duplex timing structure

1.2.2 Physical Layer

On the physical layer, frames from the data link layer are processed as illustrated below:

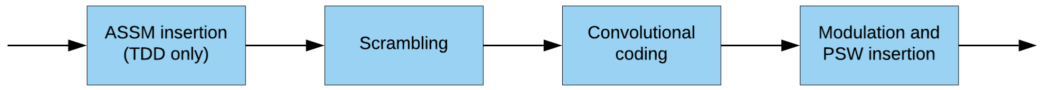

Fig. 1.5: Transmit chain

And on the receive side:

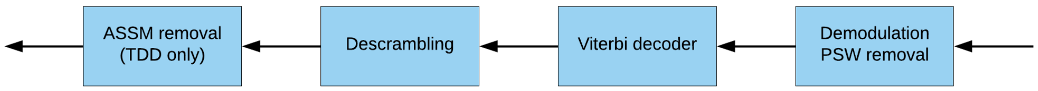

Fig. 1.6: Receive chain

- Filtered QPSK modulation
- Square root raised cosine filter, $\alpha = 0.2$
- Symbol rate $R_s = 500$ kBd $-$ 7 MBd
- Convolutional coding (constraint length $K = 7$, rate $R = 1/2$)
- Intelsat V.35 or CCSDS scrambling
- Framing
  - 32-bit attached slot synchronization marker (ASSM) for TDD burst detection
  - 32-symbol phase synchronization word (PSW) interleaved with encoded datagram every 256 symbols, for phase tracking
  - Idle pattern generator when no payload data is available

2. Connector Pinout

The pinouts of the NanoCom SR2000 are described in the following sub-sections.

2.1 NanoDock SDR Top

The connectors of the top side of the NanoDock SDR are shown in Fig.2.1. The TR-600 is placed in Slot A.

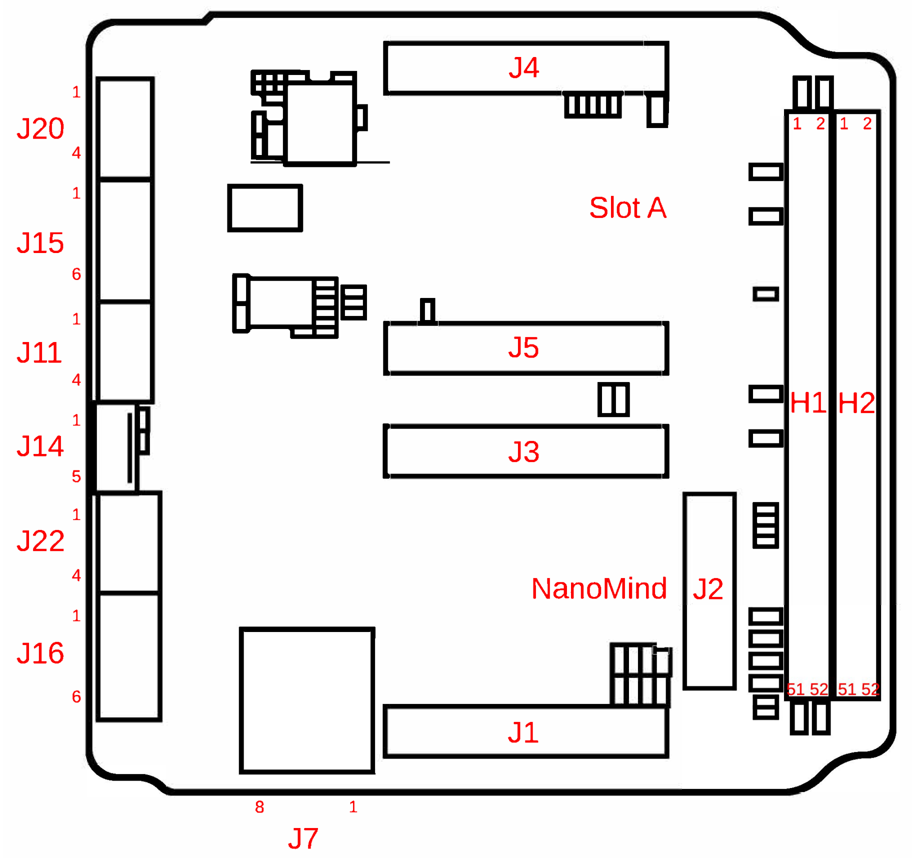

Fig. 2.1: NanoDock SDR (top)

2.1.1 H1/H2 - Stack Connector

The relevant pins are listed in the tables below.

It is recommended to use connector J16 to power the NanoDock SDR. Powering through the stack can be used as secondary option. Depending on the distance from the EPS to the NanoDock SDR in the stack the voltage loss varies quite a bit. This can be mitigated by using more pins, so the current and voltage are within limits.

Table 2.1: H1 Pins

Pin	Description
1	CANL*
3	CANH*
45	GND*
46	GND*
47	VCC input option*
48	VCC input option*
49	VCC input option*
50	VCC input option*
51	VCC input option*
52	VCC input option*

Table 2.2: H2 Pins

Pin	Description
1	VCC input option*
2	VCC input option*
3	VCC input option*
4	VCC input option*
5	VCC input option*
6	VCC input option*
7	GND*
8	GND*
27	VCC input option*
28	VCC input option*
29	GND
30	GND
32	GND
49	VCC input option*
51	VCC input option*

* Depending on option sheet choice

2.1.2 J11 - 3.3 V UART

Molex PicoBlade 1.25 mm Pitch. 53261-0471.

Table 2.3: Pinouts J11 - 3.3V UART

Pin	Description
1	GND
2	n.c
3	ARM_UART0_RX
4	ARM_UART0_TX

2.1.3 J14 - USB

Table 2.4: Pinouts J14 - USB

Pin	Description
1	VBUS
2	USB_N
3	USB_P
4	OTG_ID
5	GND

2.1.4 J15 - RS422

Molex PicoBlade 1.25 mm Pitch. 53261-0671.

Table 2.5: Pinouts J15 - RS422

Pin	Description
1	TX_N
2	TX_P
3	GND
4	n.a.
5	RX_N with 120 ohm onboard termination
6	RX_P with 120 ohm onboard termination

2.1.5 J16 - Power Input

Molex PicoLock 1.50 mm Pitch. 504050-0691.

Table 2.6: Pinouts J16 - EPS

Pin	Description
1	VCC
2	VCC
3	VCC
4	GND
5	GND
6	GND

2.1.6 J22 - Expansion

Molex PicoLock 1.50 mm Pitch. 504050-0491.

Table 2.7: Pinouts J22 - Expansion

Pin	Description
1	GND
2	CANL
3	CANH
4	VCC

2.2 NanoDock SDR Bottom

The connectors of the bottom side of the NanoDock SDR are shown in Fig. 2.2.

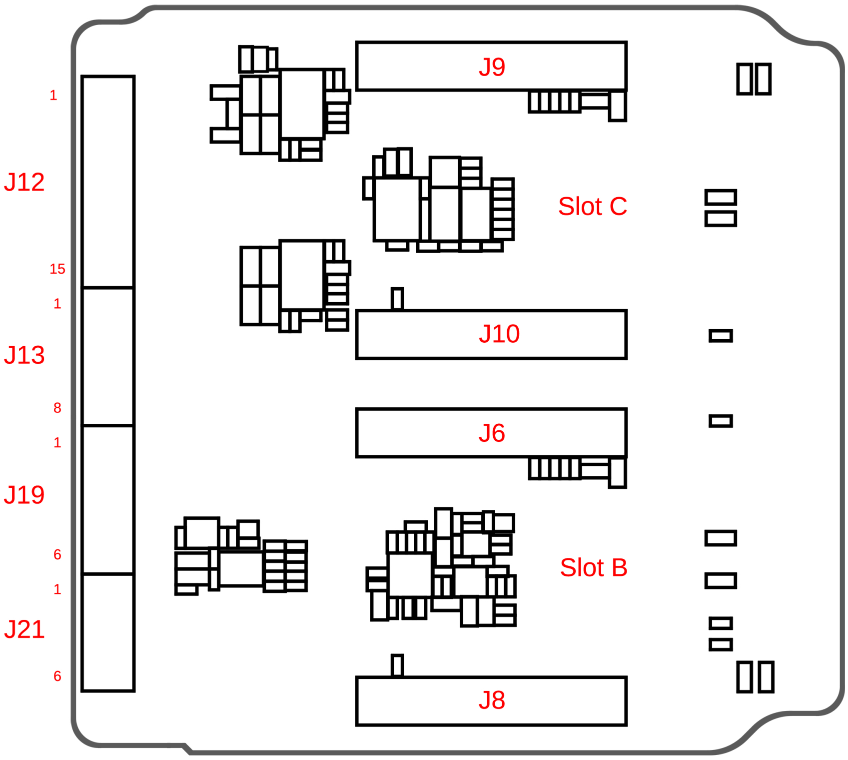

Fig. 2.2: NanoDock SDR (bottom)

2.2.1 J13 - JTAG

Molex PicoBlade 1.25 mm Pitch. 53261-0871.

Table 2.8: Pinouts J13

Pin	Description
1	JTAG_TD0
2	JTAG_TCK
3	JTAG_TMS
4	JTAG_TDI
5	PB_SRST_B
6	PB_SRST_B
7	3.3 V Supply output
8	GND

2.3 NanoMind Z7000

The Z7000 is connected to the SDR Dock through 2x 100 pin Samtec and the 1x Samtec LSHM-130-04.0-L-DV-A-S-K-TR connectors. The Z7000 is powered through the SDR Dock.

2.4 NanoCom TR-600

The TR-600 is connected to the SDR Dock through 2x 100 pin Samtec connectors. The TR-600 is powered through the SDR Dock.

The image below shows the top side of the TR-600, under the shield.

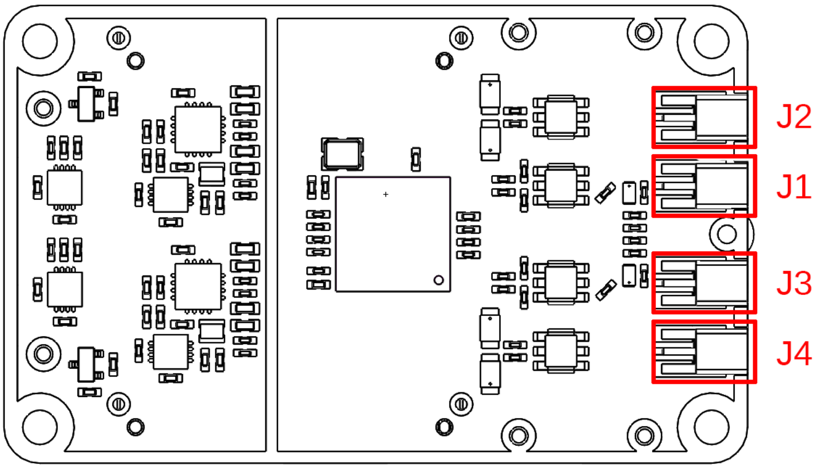

Fig. 2.3: TR-600 top side connectors

2.4.1 J1 - Rx 1

Molex SSMCX EDGE 73415-4670.

Table 2.9: Pinouts J1 - Rx 1

Pin	Description
1	Rx 1
2	GND

2.4.2 J2 - Tx 1

Molex SSMCX EDGE 73415-4670.

Table 2.10: Pinouts J2 - Tx 1

Pin	Description
1	Tx 1
2	GND

2.4.3 J3 - Rx 2

Molex SSMCX EDGE 73415-4670.

Table 2.11: Pinouts J3 - Rx 2

Pin	Description
1	Rx 2
2	GND

2.4.4 J4 - Tx 2

Molex SSMCX EDGE 73415-4670.

Table 2.12: Pinouts J4 - Tx 2

Pin	Description
1	Tx 2
2	GND

3. Interfaces and Protocols

3.1 Electrical Interfaces

The SR2000 supports the following electrical interfaces:

- CAN
- RS422
- USB

All the interfaces are described in the SR2000 manual.

3.2 Protocols

3.2.1 CubeSat Space Protocol (CSP)

CSP is a routed network protocol that can be used to transmit data packets between individual subsystems on the satellite bus or between the satellite and ground station. For more information about CSP please read the documentation on libcsp.org.

The CSP network is fully configurable using commands described in the GOSH manual. Contact GomSpace support, if the GOSH manual has not been shipped with the product.

The NanoCom SDR uses the CubeSat Space Protocol (CSP) to transfer data to and from nodes in the CSP network. CSP is supported over:

- CAN
- RS422 (KISS)

The CAN interface on the SDR uses the CSP CAN Fragmentation Protocol (CFP). CFP is a simple method to make CSP packets of up to 256 bytes, span multiple CAN messages of up to 8 bytes each.

If a third party component needs to communicate with one of GomSpace's products, then the easiest way to implement CSP/CFP over CAN is to download the CSP source code from http://libcsp.org and compile the CFP code directly into your own embedded system.

3.2.2 Internet Protocol (IP)

If a Point-to-Point connection is feasible, then the RS422 interface is better suited for large data transfers, than using FTP via CSP.

3.3 Debug Interface

GOSH (GomSpace Shell) is available on the SR2000 via the debug interface. It gives access to the Z7000 Monitor and the Space Link Control (SLC) application.

The Z7000 Monitor and SLC application are described in the SR2000 manual.

4. Software

GomSpace's products ship with product specific software and software common for all products. The SR2000 software package consists of:

- S-band Radio Firmware
- Csp-client

4.1 S-band Radio Firmware

The SR2000 ships with closed sourced S-band radio firmware and has been configured with factory default settings. The firmware is pre-installed. The factory default settings can be modified through GomSpace's parameter system.

Two services are running in the background after booting the SR2000:

- Z7000 Monitor Application
- Space Link Control Application

4.1.1 Z7000 Monitor Application

The Z7000 Monitor Application can be accessed using GOSH and gives access to debugging and running commands. The Z7000 Monitor Application also contains two Z7000 clients.

The SR2000 manual contains further information about the Z7000 Monitor Application.

4.1.2 Space Link Control Application

The Space Link Application is also accessible via GOSH and gives access to debugging and configuration of the modems.

The SR2000 manual contains further information about the Space Link Control Application.

4.2 Csp-client

The `csp-client` contains examples of how to use GomSpace's remote parameter system `rparam` and a Z7000 specific client. It includes libcsp (http://www.libcsp.org/).

`csp-client` is a scaled down version of `csp-term` and is a free application, that comes with almost all of GomSpace's products. It can be used as a stand-alone client to communicate with a GomSpace product or it can be used as a basis for implementing CSP on a third party product allowing it to communicate with GomSpace's products.

The configuration of `csp-client` is described in the GOSH manual.

4.3 Parameter System

GomSpace's products are based on a parameter system implemented in the library `libparam`. It is a light-weight parameter system designed for GomSpace satellite subsystems.

Each product has a number of parameter tables containing specific parameters, which allows for configuration of the product. The parameter tables also includes a telemetry table holding state information of the product/system.

An example parameter table is shown below.

Table 4.1: Example Parameter Table

Address	**Name**	**Type**	**Description**
0x00	param_1	U32	Description of param_1
0x04	param_2	U32	Description of param_2

All the parameter tables and their parameters are described in the product manual.

The parameter system allows the parameters to be modified both locally and remotely.

Locally: This enables sending parameter commands directly to a system using GOSH on the debug interface. The command used for accessing parameters locally (`param`) is described further in the GOSH manual.

Remotely: The parameters of a product can be accessed remotely from other nodes in the CSP network. This can be done either from a GOSH command interface (GOSH running on another hardware product or GOSH running in csp-client/csp-term) or from code using the remote parameter API.

5. Absolute Maximum Ratings

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

The temperatures of the SDR design is limited by the Zync chip and represents a junction temperature for the FPGA of -40 to 85 $^{\circ}C$ (Tj).

Table 5.1: Absolute Maximum Ratings

Symbol	Description	Min	Max	Unit
VCC	Supply voltage	4.0	6.5	V
I	Supply current		8.0	A
T_{amb}	Operating temperature	-40	85	$^{\circ}C$
T_{Storage}	Storage temperature	-40	85	$^{\circ}C$

6. Electrical Characteristics

For SR2000 with S-band radio firmware.

Table 6.1: Electrical Characteristics

Symbol	Description	Min	Typ	Max	Unit
VCC	Supply voltage	4.5	5.0	5.5	V
I	Supply current	750	560	1500	mA
RS422	Rx has onboard 120k ohm termination			3	Mbit/s
CAN	120 ohm termination - optional			1	Mbit/s
I^2C	200k pull-up to 3.3 V			400	kHz

The NanoDock is powered with 5V and powering the daughterboards, so you only need a single 5V supply for the NanoCom SR2000.

Power consumption can be seen in the table below:

Table 6.2: NanoCom SR2000 power consumption

# Modems	Mode	Avg. power consumption [W]
1	RX (idle)	3.88
	TX active (maximum output power)	4.10
	RX and TX active	4.13
2	RX (idle)	5.44
	TX active (maximum output power)	5.86
	RX and TX active	5.94

7. Physical Characteristics

7.1 Individual Components

NanoDock SDR

Description	Value	Unit
Mass	76.35	g
Size	Standard PC104 fit, 90 x 66	mm

NanoMind Z7000 (with shield)

Description	Value	Unit
Mass	76.8	g
Size	65.0 x 40.0 x 6.5	mm

NanoCom TR-600 (with shield)

Description	Value	Unit
Mass	65.25	g
Size	65.0 x 40.0 x 14.8	mm

Slot shield

Description	Value	Unit
Mass	26.3	g

7.2 Complete System

NanoCom SR2000 (SDR Dock + Z7000 + TR-600 + two slot shields)

Description	Value	Unit
Mass	~ 271	g

NanoCom SR2000 (SDR Dock + Z7000 + two TR-600 + one slot shields)

Description	Value	Unit
Mass	~ 310	g

Note: There are slot shields placed in every empty slot. Note: Numbers do not include rod, PIM, nuts, stack connector and foam.

8. Environment Testing

To simulate the harsh conditions of launch and space, the NanoDock SDR (SDR Dock, Z7000 and TR-600) has been exposed to a number of environment tests. For detailed information about the tests please contact GomSpace.

The NanoDock SDR has been in space and performed perfectly.

9. RF Characteristics

The key radio characteristics of the NanoCom SR2000 are shown in the table below. Further details are described in the following sections.

Table 9.1: RF Characteristics

Symbol	Description	Min	Typ	Max	Unit
f_c	Center frequency range [1]	1980		2290	MHz
L_{impl}	Demodulator implementation loss [2] [5]			0.35	dB
R_s	Symbol rate [3]	500		7000	kBd
R_b	Transmitted bitrate [4]	500		7000	kbit/s
F_{step}	Programmable frequency step		10		Hz
$F_{\mathrm{stability}}$	Frequency stability		27		ppm
R_{AFC}	AFC pull-in range	$-R_s/4$		$+R_s/4$	
	Layer-3 UDP throughput			6000	kbit/s (FDD) [6]
				620	kbit/s (TDD) [8]
	Round-trip time	8	12	17	ms (FDD) [7]
		44	152	272	ms (TDD) [8]

9.1 Bit Error Rate

The bit error rate is measured with a test setup as illustrated below:

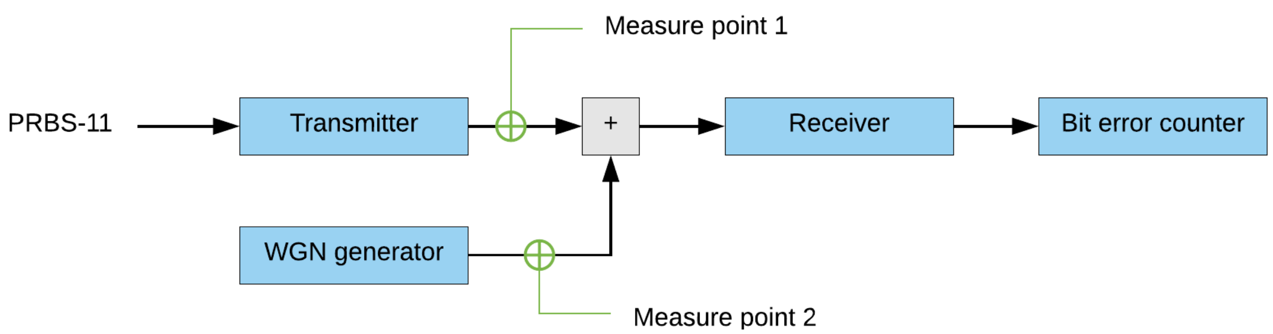

Fig. 9.1: BER measurement setup

The WGN generator generates white Gaussian noise with a bandwidth of approximately 4 times the symbol rate using the Box-Muller method. The transmitter is configured to transmit a standard pseudo-random test sequence (PRBS-11), and logic on the receive side detects and counts the number of erroneously decoded bits on the output of the receiver. The E_b/N_0 is estimated using the measured power of the signal and the noise before adding the two signals (Measure point 1 and 2).

The following configuration is used:

[1] With the GomSpace ANT2000 series antennas. For other frequency ranges, please contact GomSpace sales
[2] For $E_b/N_0 \in [0, 12]$
[3] For other symbol rates, please contact GomSpace sales
[4] Due to the rate half coder, $R_s = R_b$
[5] For Doppler $0:$ Hz/s
[6] At a symbol rate of 7 MBd in CCSDS compatibility mode
[7] At a symbol rate of 7 MBd in Classic mode
[8] At a symbol rate of 2 MBd

- V.35 scrambling disabled
- Reed-Solomon coding off
- Symbol rate 2 MBd
- Convolutional coding on or off
- Doppler frequency 0 Hz/s $-$ 750 Hz/s

The measured BER under this configuration is illustrated on Fig. 9.2.

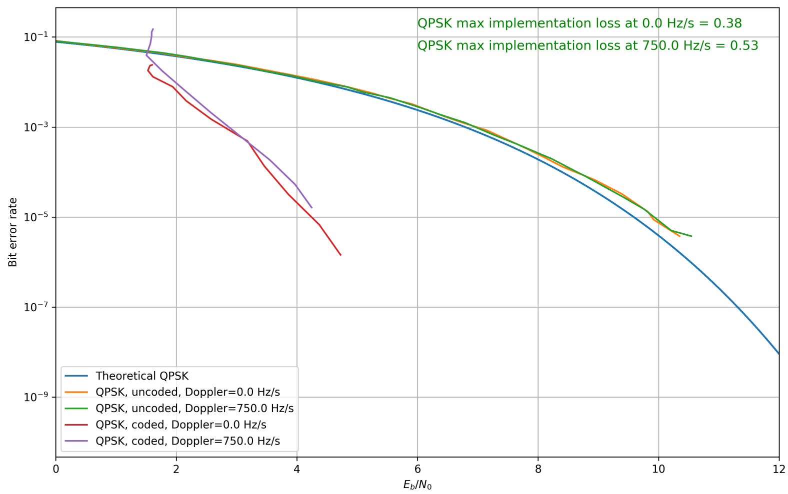

Fig. 9.2: NanoCom SR2000 bit error rate vs E_b/N_0 at 2 MBd

More information regarding Doppler can be found in Section 9.5.

9.2 Packet Error Rate

The packet error rate is measured while transferring UDP traffic using the same noise generator and power estimation as described in Section 9.1.

Configuration:

- V.35 scrambling
- Reed-Solomon coding $(n, k) = (255, 223)$, interleaving depth $L = 8$
- Convolutional coding $K = 7$, $R = 1/2$
- Symbol rate 500 kBd $-$ 7 MBd

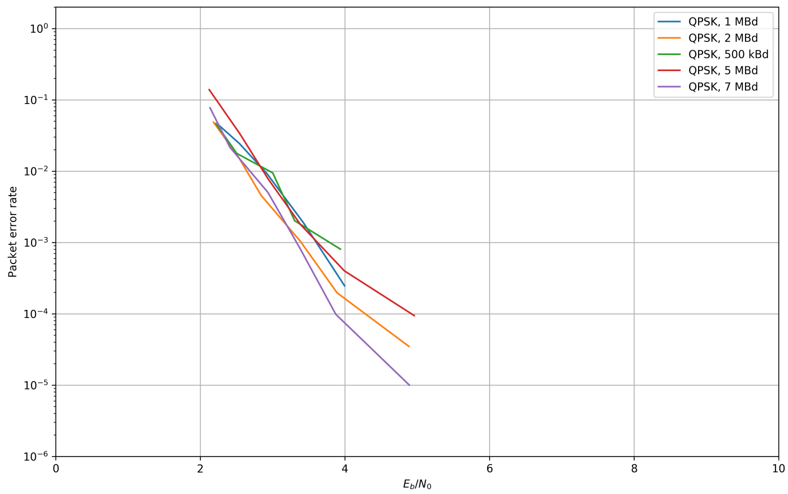

Fig. 9.3: NanoCom SR2000 FDD packet error rate at 500 kBd $- 7$ MBd

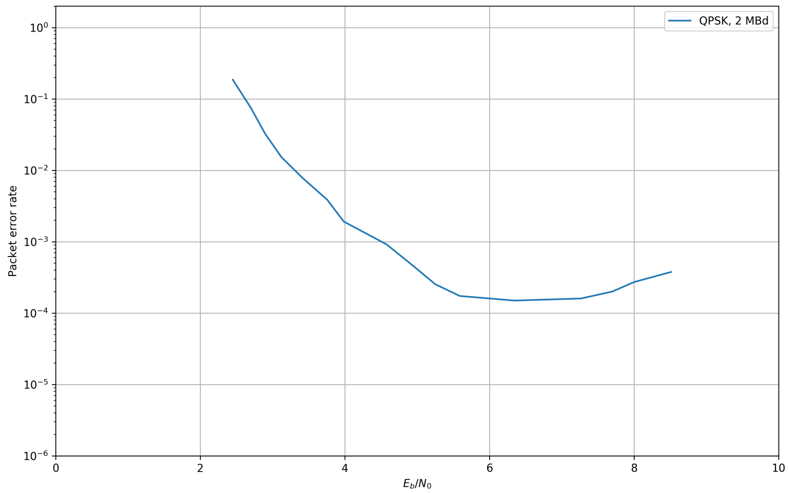

Fig. 9.4: NanoCom SR2000 TDD packet error rate at 2 MBd

9.3 Spectral Emission

The spectral emission is measured with a spectrum analyzer with worst-case configuration: maximum baseband scale and RF gain. The transmitter is configured to transmit random data.

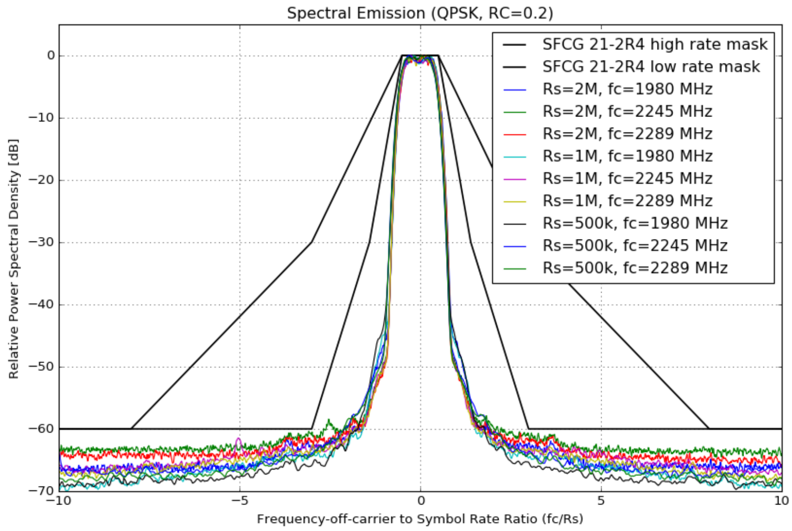

Fig. 9.5: NanoCom SR2000 spectral emission

9.4 Frequency Offset

The figure below illustrates the PER performance under a constant frequency offset f_o for typical values as incurred by Doppler shift for a satellite in LEO. PER is measured as described in Section 9.2.

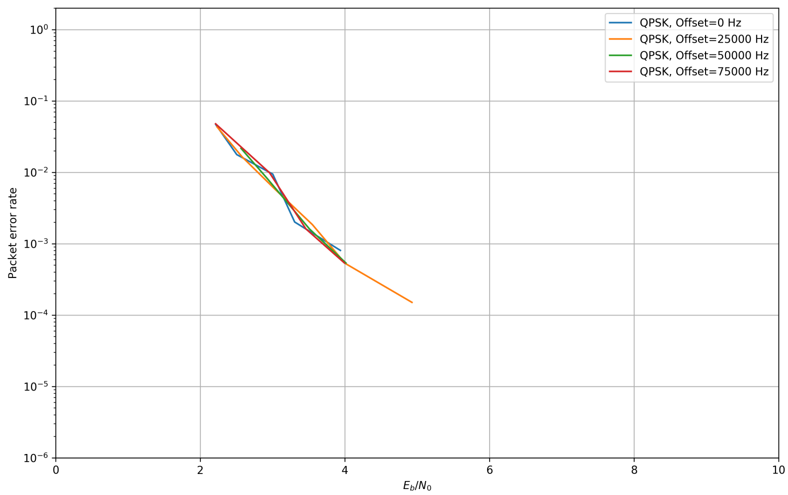

Fig. 9.6: Effects of constant carrier offset on FDD performance of NanoCom SR2000 at 500 kBd

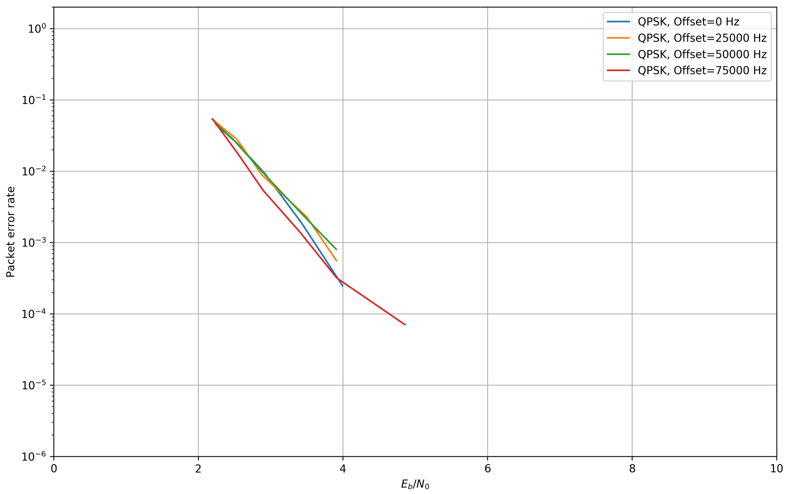

Fig. 9.7: Effects of constant carrier offset on FDD performance of NanoCom SR2000 at 1 MBd

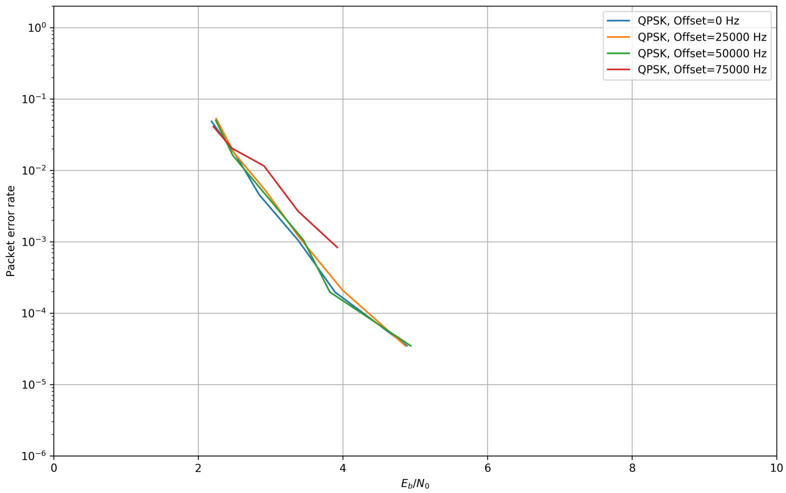

Fig. 9.8: Effects of constant carrier offset on FDD performance of NanoCom SR2000 at 2 MBd

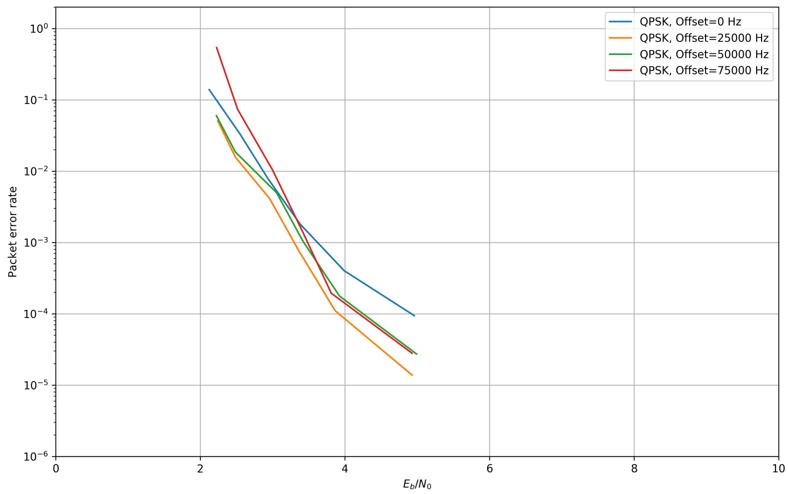

Fig. 9.9: Effects of constant carrier offset on FDD performance of NanoCom SR2000 at 5 MBd

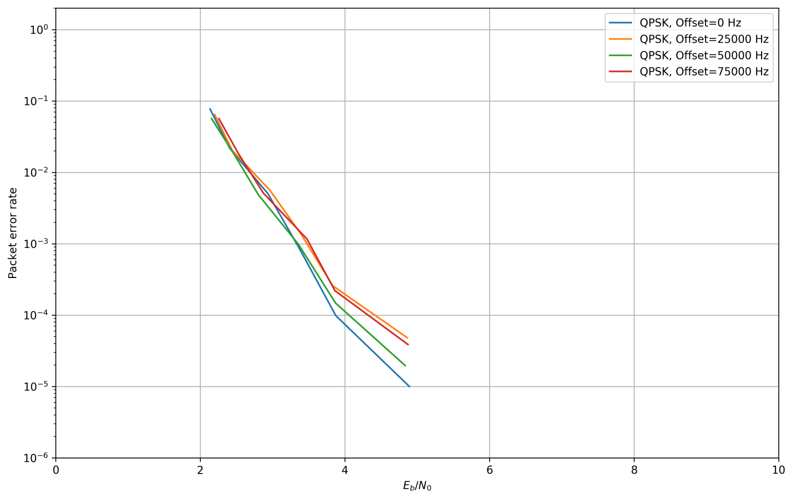

Fig. 9.10: Effects of constant carrier offset on FDD performance of NanoCom SR2000 at 7 MBd

9.5 Doppler

The packet error rate is measured under a constant frequency shift, 750 Hz/s is typically the maximum Doppler shift for a satellite in LEO. PER is measured as described in Section 9.2.

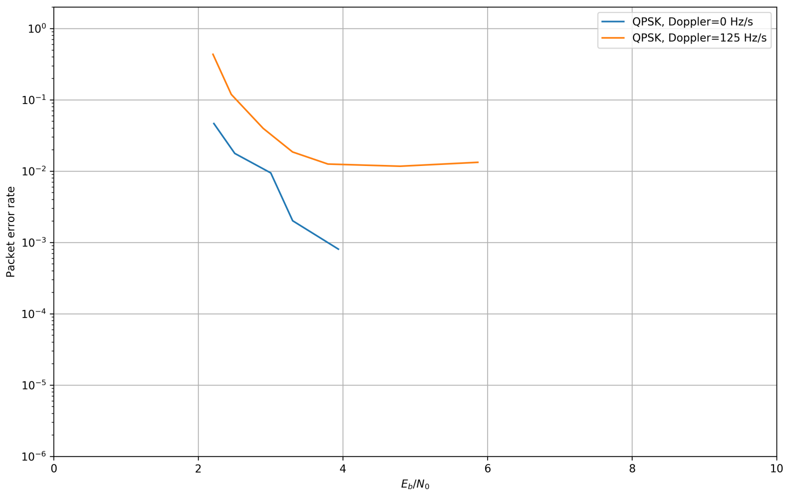

Fig. 9.11: NanoCom SR2000 FDD packet error rate at Doppler frequency 0 Hz/s $-$ 125 Hz/s at 500 kBd

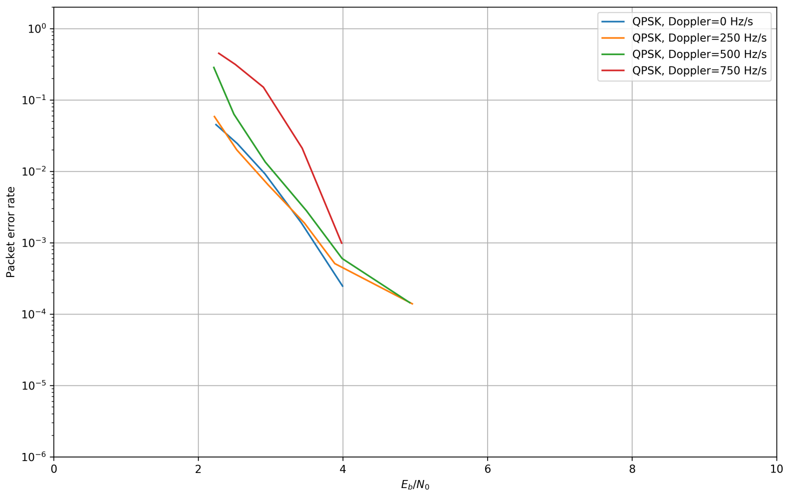

Fig. 9.12: NanoCom SR2000 FDD packet error rate at Doppler frequency 0 Hz/s $-$ 750 Hz/s at 1 MBd

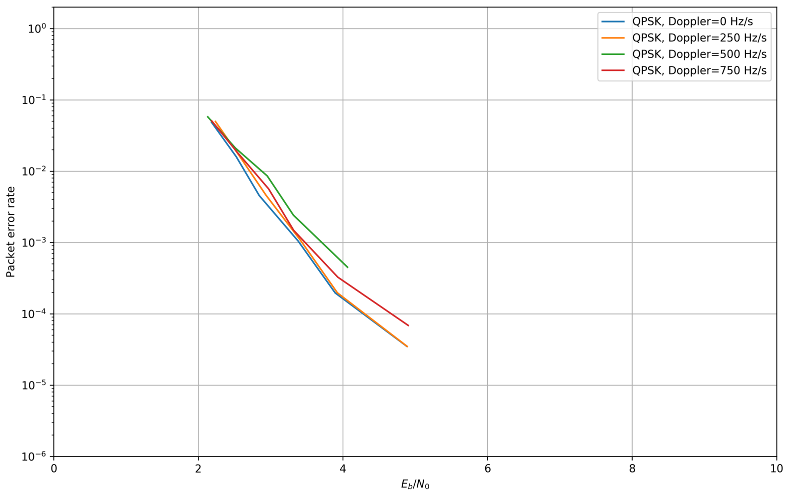

Fig. 9.13: NanoCom SR2000 FDD packet error rate at Doppler frequency 0 Hz/s $-$ 750 Hz/s at 2 MBd

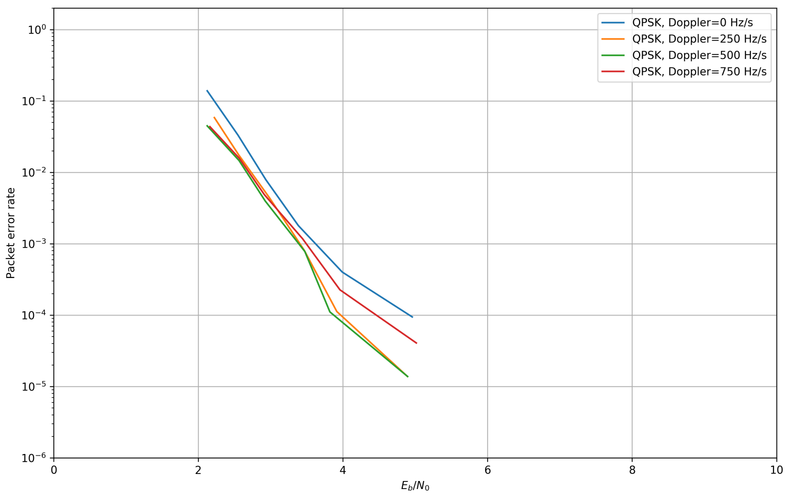

Fig. 9.14: NanoCom SR2000 FDD packet error rate at Doppler frequency 0 Hz/s $-$ 750 Hz/s at 5 MBd

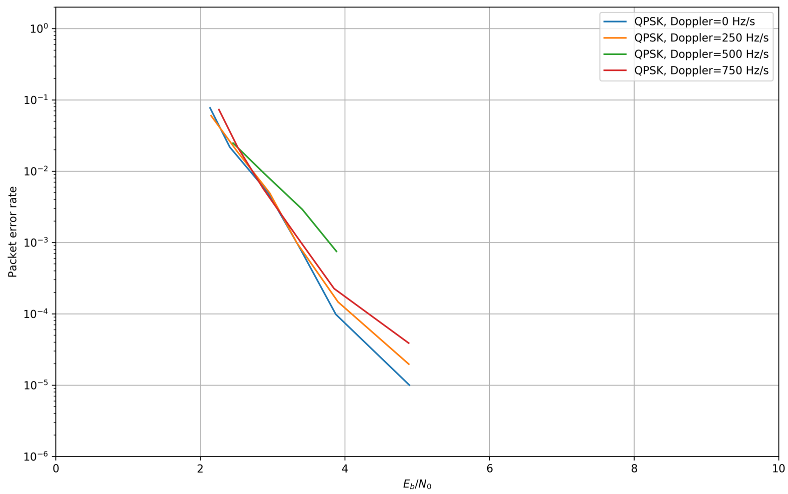

Fig. 9.15: NanoCom SR2000 FDD packet error rate at Doppler frequency 0 Hz/s $-$ 750 Hz/s at 7 MBd

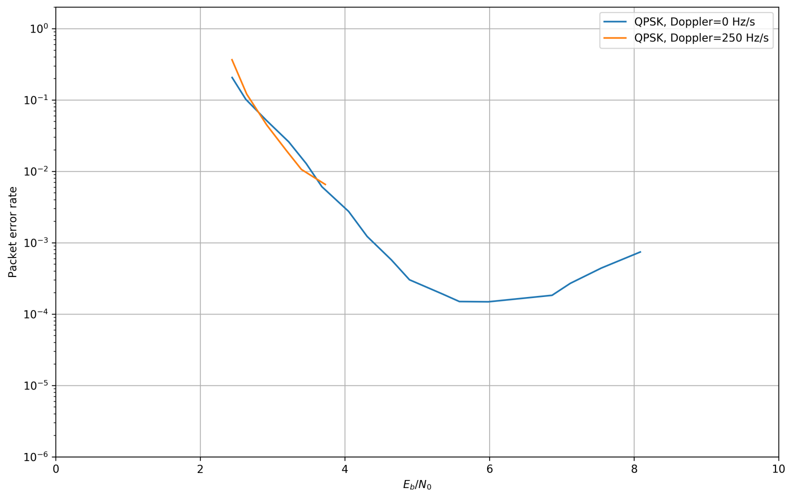

Fig. 9.16: NanoCom SR2000 TDD packet error rate at Doppler frequency 0 Hz/s $-$ 250 Hz/s at 2 MBd

9.6 Throughput (UDP)

Layer 3 throughput of the SR2000 is measured using UDP packets.

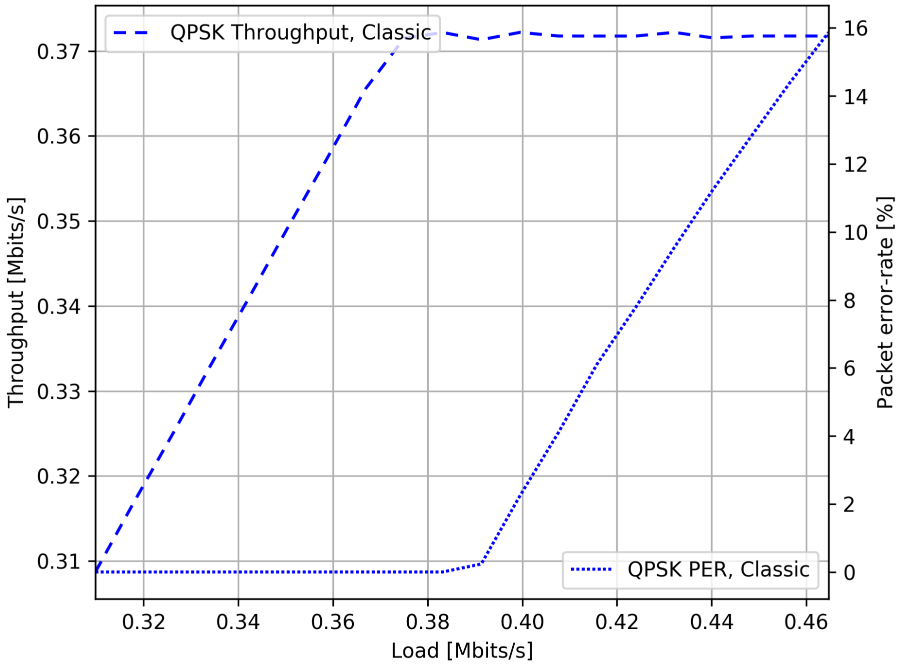

Fig. 9.17: NanoCom SR2000 FDD UDP throughput at 500 kBd

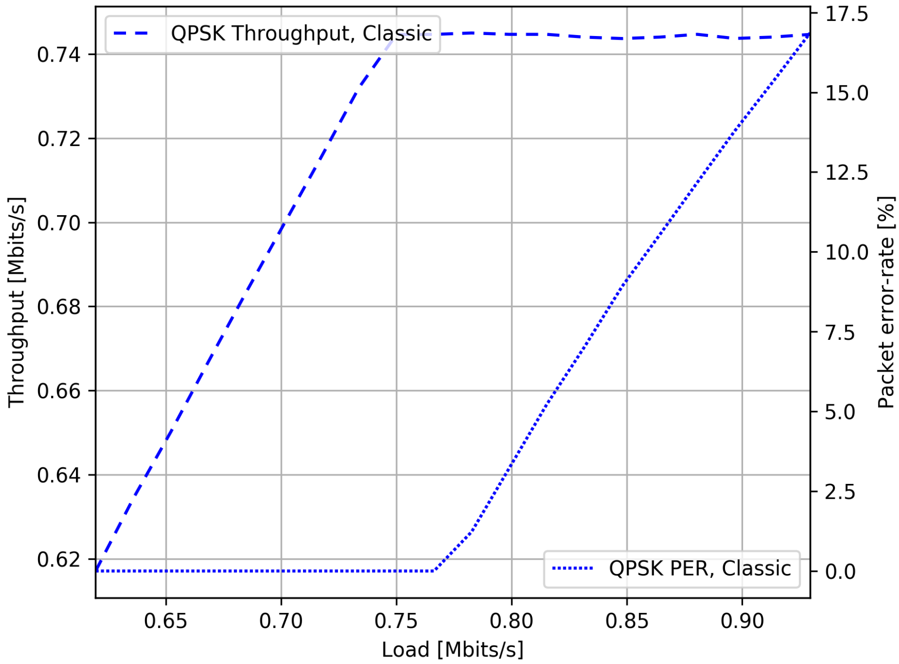

Fig. 9.18: NanoCom SR2000 FDD UDP throughput at 1 MBd

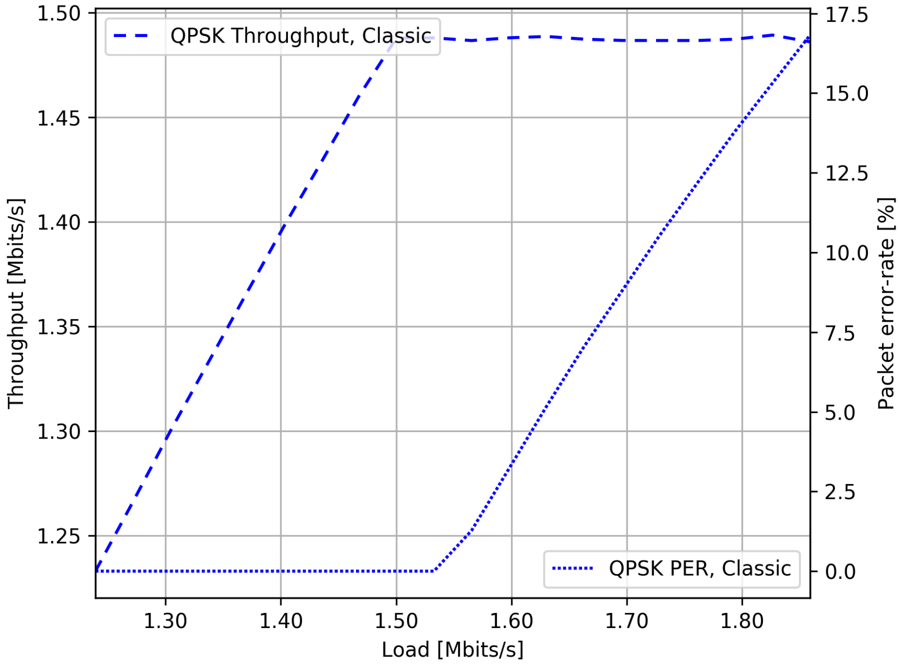

Fig. 9.19: NanoCom SR2000 FDD UDP throughput at 2 MBd

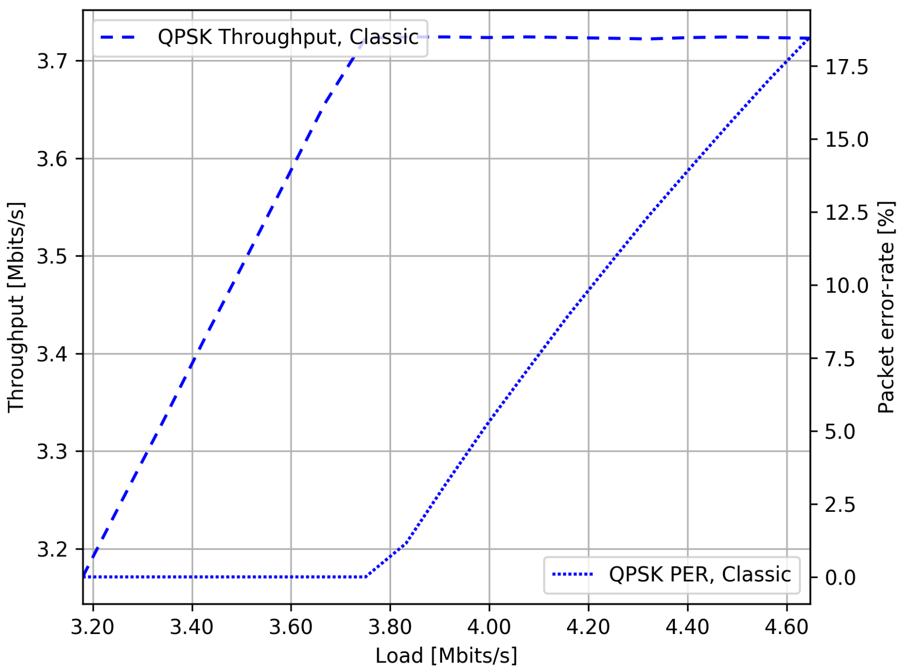

Fig. 9.20: NanoCom SR2000 FDD UDP throughput at 5 MBd

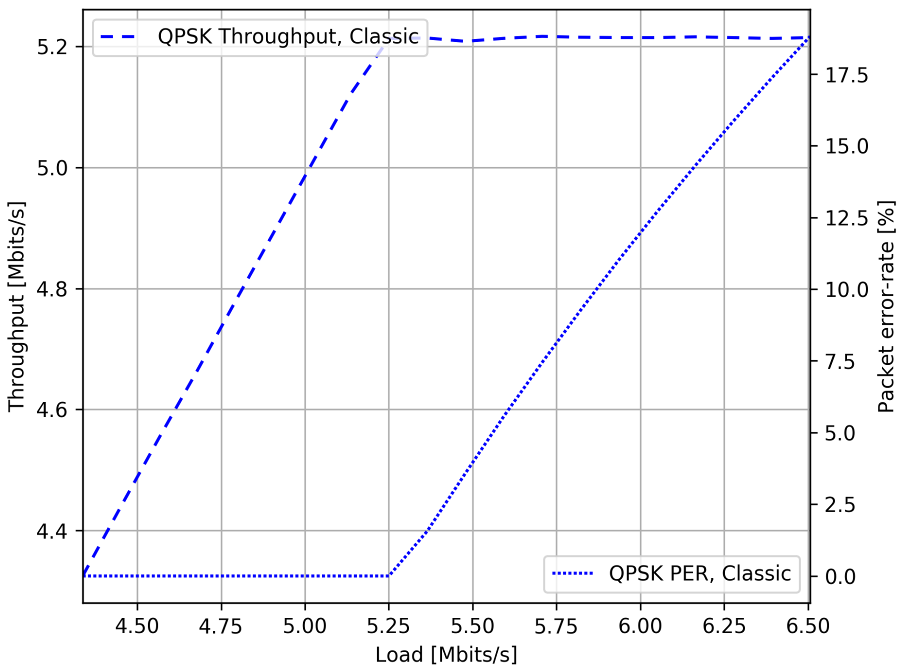

Fig. 9.21: NanoCom SR2000 FDD UDP throughput at 7 MBd

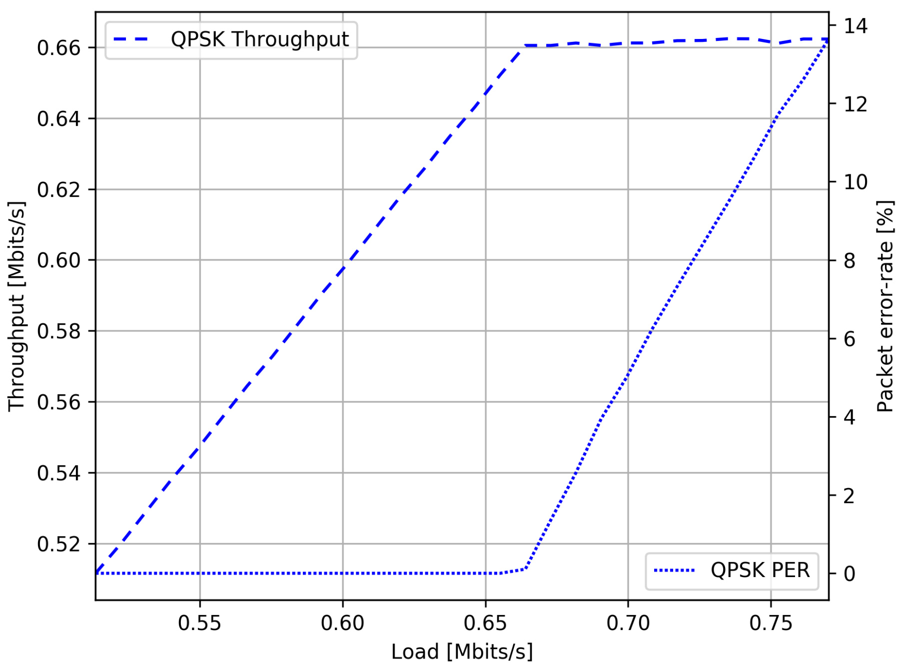

Fig. 9.22: NanoCom SR2000 TDD UDP throughput at 2 MBd

9.7 Throughput (TCP)

Layer 3 throughput of the SR2000 is measured using TCP packets.

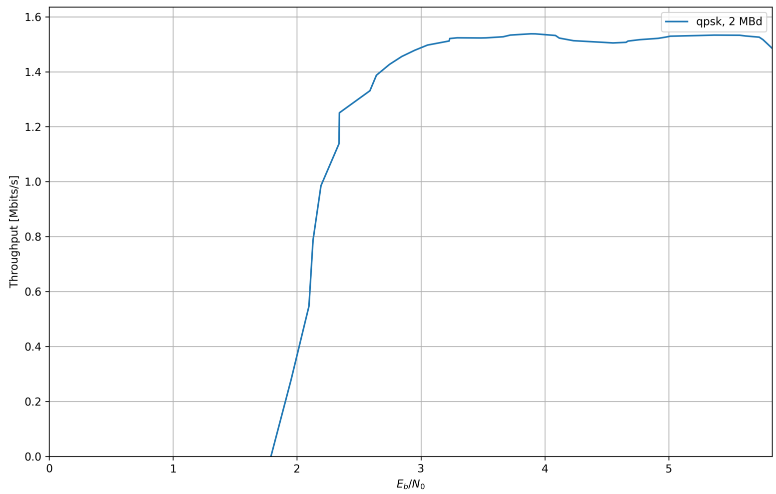

Fig. 9.23: NanoCom SR2000 FDD TCP throughput at 2 MBd

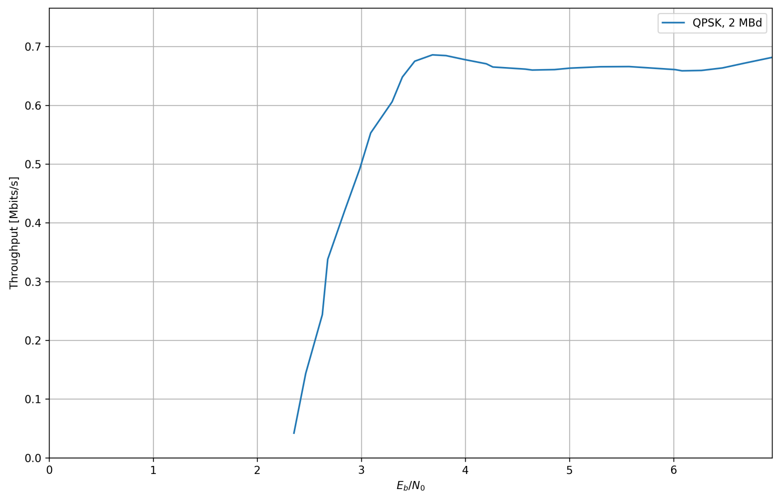

Fig. 9.24: NanoCom SR2000 TDD TCP throughput at 2 MBd

9.8 Round-trip Time

Layer 3 round-trip time is measured using 1000 ICMP (IP) pings at Symbol rate 500 kBd $- 7$ MBd for FDD and 500 kBd $- 2$ MBd for TDD. Both measurements are done in classic mode

Table 9.2: Nanocom SR2000 RTT characteristics in milliseconds

Duplex	Rate (MBd)	Min	Avg	Max
FDD	0.5	95.2	143.7	195.7
	1	44.8	79.9	114.9
	2	33.4	40	57.2
	5	11.1	14.9	19
	7	8.7	12.6	16.8
TDD	0.5	169.6	631.2	1018.9
	1	73.4	287.4	517.3
	2	43.8	152	271.9

10. Physical Layout

A mounted daughterboard will have its shield thermal connected with the gold on the NanoDock SDR. The gold has a thermal connection to the gold on the other side of the PCB to even out the thermal load.

Small islands of electronics have been placed inside the gold to individual shield it. Notice there is only one daughterboard slot with an extra Samtec connector, to fit a NanoMind Z7000.

The physical layout of the daughterboards can be found in their respective datasheets.

10.1 Top

Stack connector on the right. Connectors on the left edge. Bottom left is the SD card slot. Through the middle are the connectors to the daughterboards (4x Samtec LSHM-150-04.0-L-DV-A-S-K-TR and 1x Samtec LSHM-130-04.0-L-DV-A-S-K-TR). The NanoMind Z7000 is placed in the bottom slot, whereas the slot at the top is used for the NanoCom TR-600.

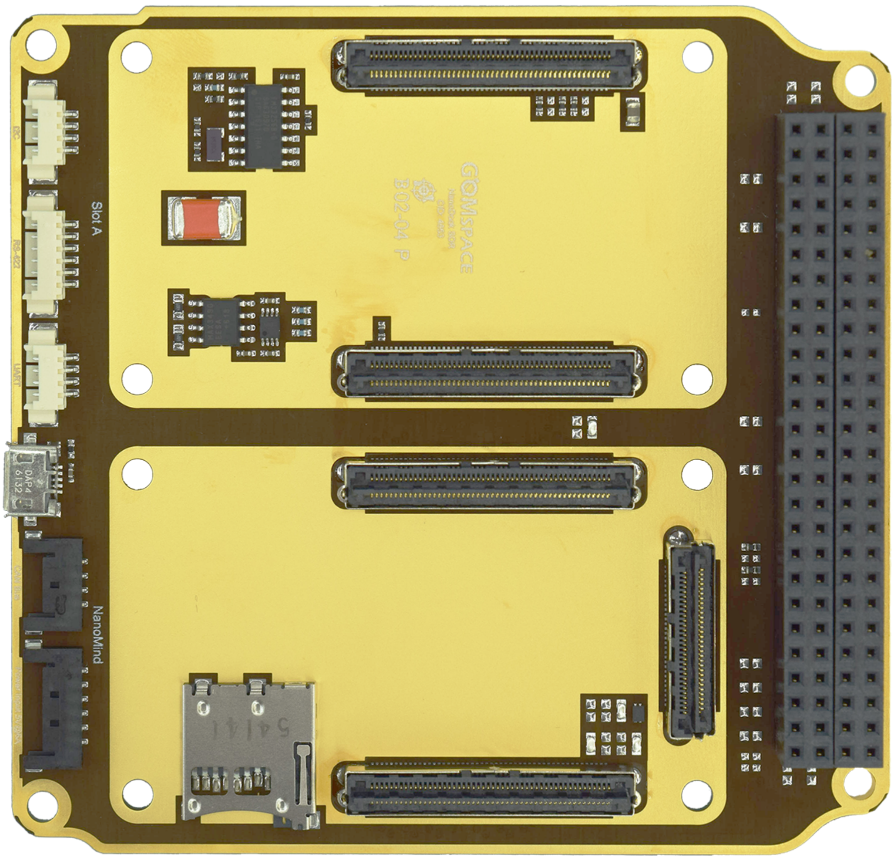

Fig. 10.1: NanoDock SDR (top)

In the top gold islands are the RTC and the RS422.

10.2 Bottom

Stack connector on the right. Connectors on the left side. Through the middle are the connectors to the daughterboards (4x Samtec LSHM-150-04.0-L-DV-A-S-K-TR). The two slots are for mounting two NanoCom TR-600s.

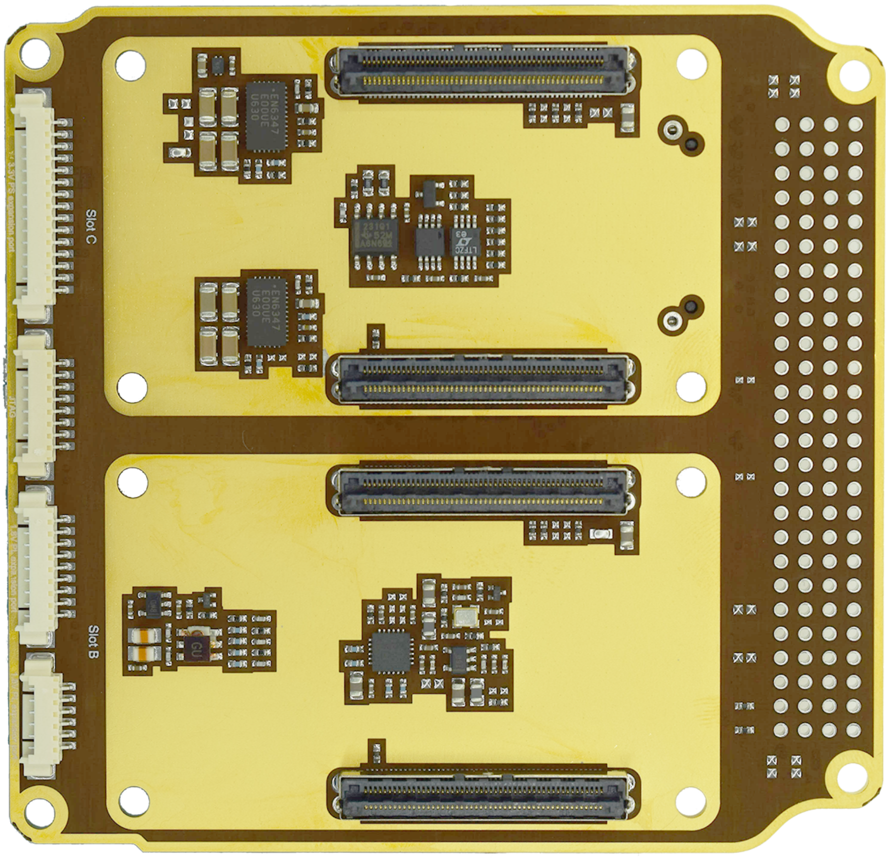

Fig. 10.2: NanoDock SDR (buttom)

In the top gold islands are the PSU (the two left most) and the CAN and I2C isolator in the middle. In the bottom island, mid is the clock fanout buffer.

11. Mechanical Drawings

All dimensions shown in the drawings below are in mm.

11.1 NanoDock SDR

A mechanical drawing of the NanoDock SDR is shown in Fig. 11.1.

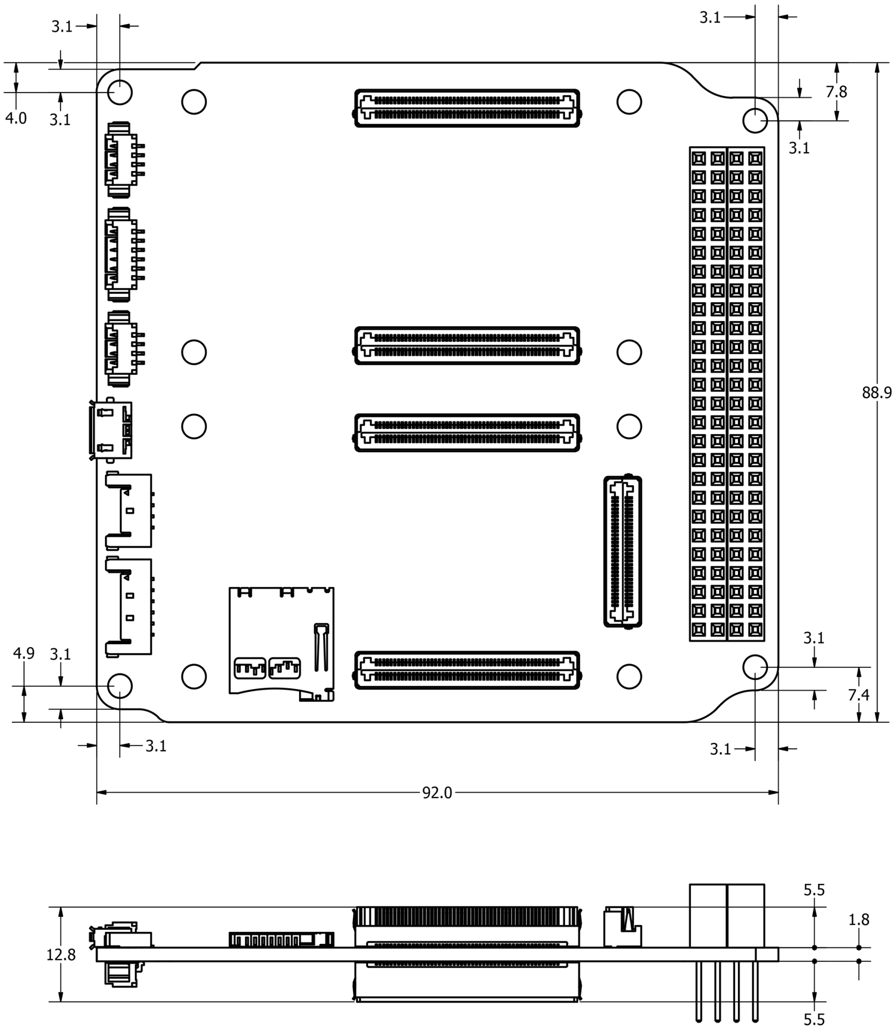

Fig. 11.1: Mechanical Drawing: NanoDock SDR

Fig. 11.2 shows a mechanical drawing of the NanoDock SDR with TR-600/Z7000 mounted.

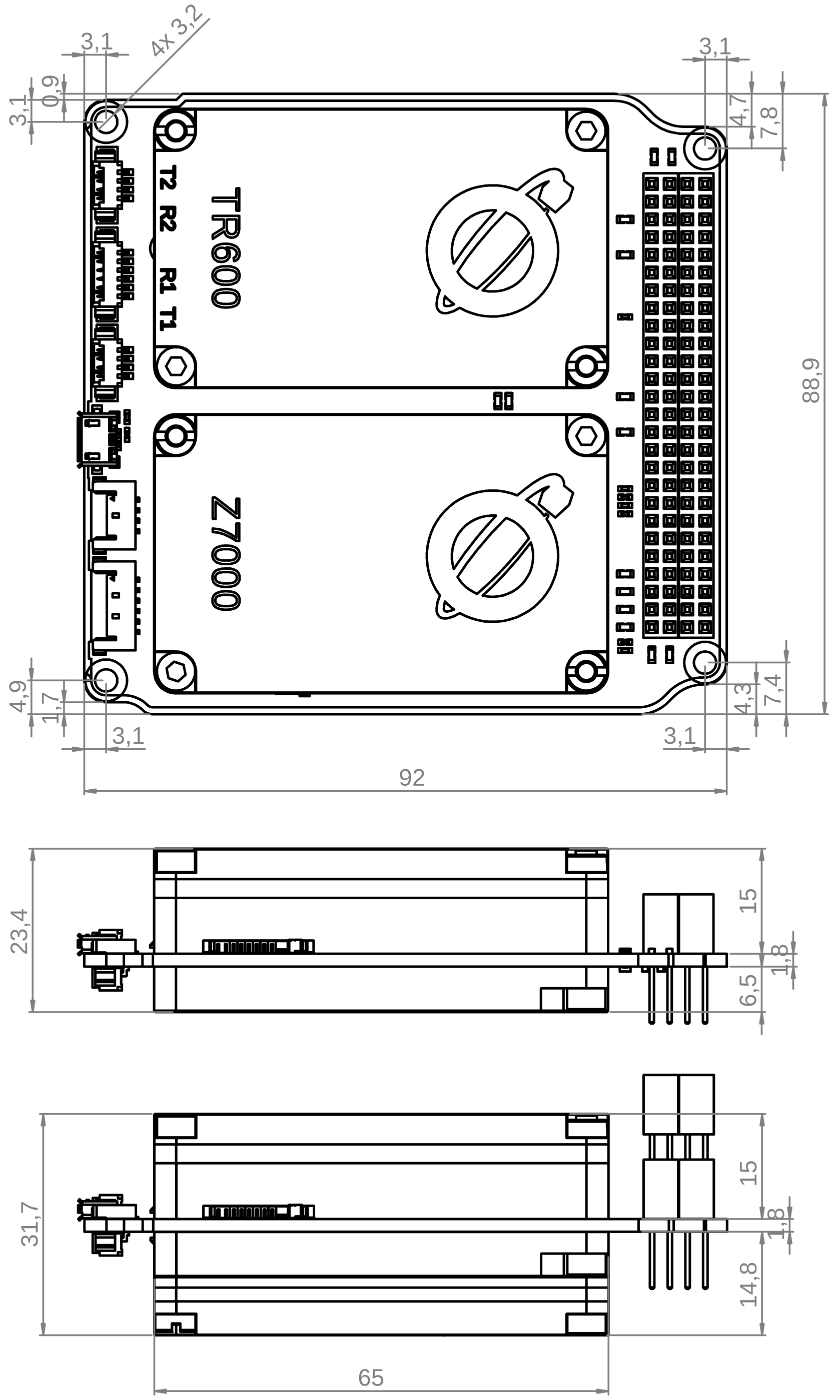

Fig. 11.2: Mechanical Drawing: NanoDock SDR with daughterboards

11.2 NanoMind Z7000

See Fig. 11.3 for a mechanical drawing of Z7000.

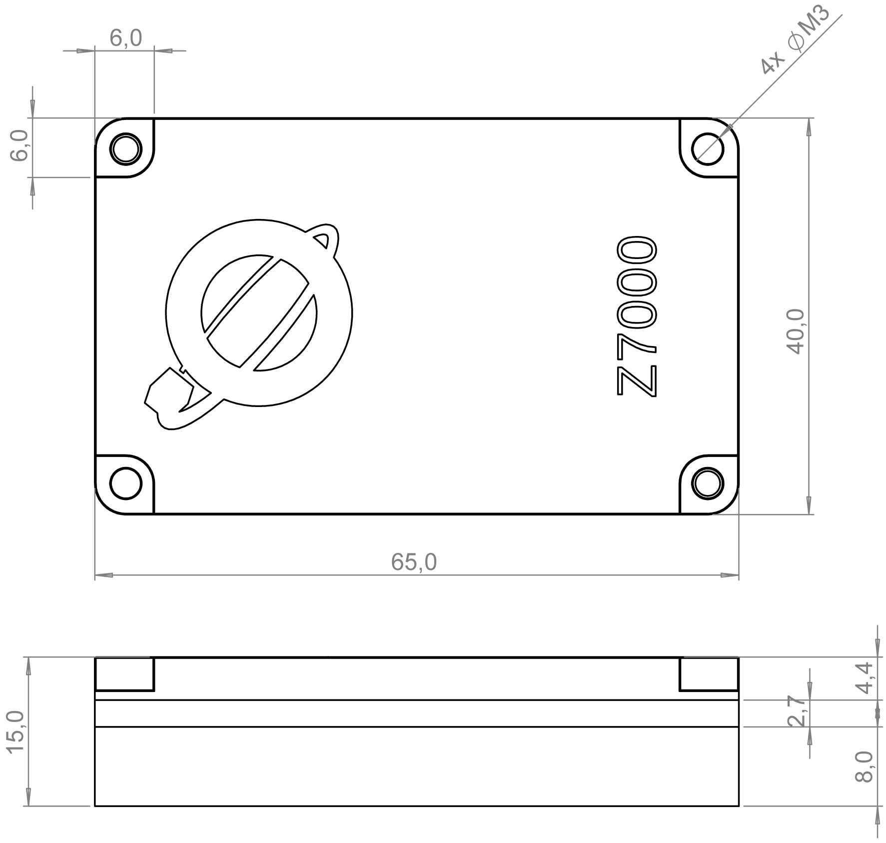

Fig. 11.3: Mechanical Drawing: Z7000

11.3 NanoCom TR-600

See Fig. 11.4 for a mechanical drawing of TR-600.

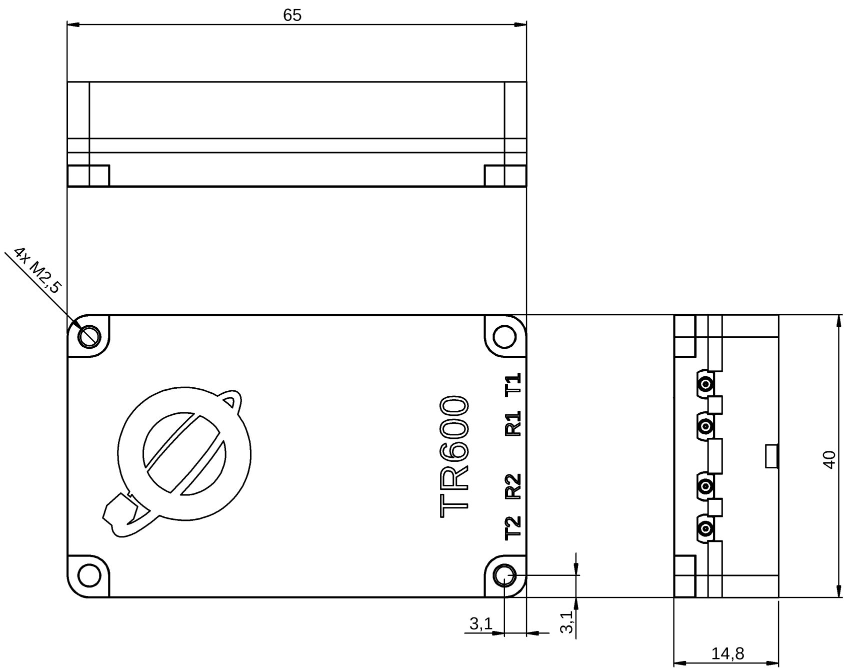

Fig. 11.4: Mechanical Drawing: TR-600

12. FAQ

```
Q: Which Ground Station modems are supported?

A: At the moment, we only support GomSpace's GS2000. We are looking into making changes
to layer 1 and 2 in the modem to make it easier to receive for standard modems.
```

```
Q: Which RS interleave depth is being used?

A: We use a RS interleave with depth=8. This is a fixed value, that can't be changed.
```

```
Q: What is the minimum bitrate that can be used with SR2000 radio?

A: We only support the data rates listed in the datasheet, but it is possible to configure
the radio for rates outside that range.
```

```
Q: Does the TR-600 have a diplexer?

A: No.
```

```
Q: What is the maximum input level of the TR-600 transceiver?

A: The SDR TR600 transceiver has an absolute maximum input level of +5dBm.
```

```
Q: On boot, does the SR2000 automatically start sending the IDLE sequence?

A: Yes, as soon as it's booted it will be transmitting at the configured output level.
```

```
Q: If no data is being sent, will it transmit an IDLE sequence?

A: When there is no user data the modem will transmit an IDLE sequence.
```

```
Q: What is the IDLE pattern bit sequence?

A: It is a QPSK sequence: 0xDEADBEEF. It passes through the convolutional encoder and
scrambler.
```

```
Q: Is transmit automatically enabled?

A: As soon as the radio receives a CSP packet, the packet will be sent immediately.
```

```
Q: Is it possible to change the IDLE sequence?

A: No.
```

```
Q: If you send data too quickly, what happens to this data?

A: If you send data faster than the link speed, some of the packets will be dropped.
```

```
Q: What will be the consequence of increasing the symbol rate beyond the 7 MBd stated in
the datasheet?

A: The SPS*symbol rate has to be below 56 MHz, so to go higher the SPS has to be adjusted
to a lower value. This can result in worse performance. Additionally the maximum receive
rate is limited by the CPU.
```

```
Q: Why does the TR-600 datasheet list a different bandwidth, than listed in the SR2000
datasheet?

A: The TR-600, which is basically a transceiver board, supports configurable bandwidth
and carrier frequencies as outlined in the datasheet. Like in SR2000 you can chose to
implement an S-band optimized solution with the combination of TR-600 and an RF
front-end and antenna (like ANT2000).
```

```
Q: Should return loss and noise figure from the TR-600 be used?

A: The return loss and noise figure of the TR-600 will not determine the SDR system
return loss and noise figure since the TR-600 always comes together with a front-end
RF HW and an antenna like ANT2000. The front-end will determine the system noise figure
and not TR-600.

To optimize RX noise figure, gain, TX output power, and provide proper filtering for
the specific application is exactly the reason why we need a front-end like ANT2000 in
front of TR-600.

So, RX noise figure, TX output power, filtering etc. data should be taken from the
front-end and not from TR-600.
```

```
Q: What is the maximum Doppler Shift that SR2000 can compensate?

A: It is the symbol rate/4, so for 2 MBd it can compensate up to 500 KHz.
```

```
Q: Does the SR2000 support I2C?

A: The SR2000 does not support I2C.
```

13. Disclaimer

Information contained in this document is up-to-date and correct as at the date of issue. As GomSpace A/S cannot control or anticipate the conditions under which this information may be used, each user should review the information in specific context of the planned use. To the maximum extent permitted by law, GomSpace A/S will not be responsible for damages of any nature resulting from the use or reliance upon the information contained in this document. No express or implied warranties are given other than those implied mandatory by law.