GS SDR-Rack

Alén Space Ground Station kit

Datasheet

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1. Changelog

Table 1 - Changelog

Date	Revision	Author	Description
07/07/2021	1.0	BFA	Initial release
02/06/2022	2.0	BFA	In 2: - Added rack side In 5: - Removed S-Band transmission information
16/11/2022	2.1	BFA	Updated document name

2. Overview

The SDR-rack is the solution provided by Alen Space as a ground station transceiver for the VHF and UHF bands, which integrates the SDR and the frontends necessary for communications with satellites in these bands.

The SDR-rack requires a computer or server in which the radio data is processed digitally. In transmission, this information is transmitted to the SDR-rack by a USB cable and it converts this digital information into the analog RF signal that is sent through the ANT1 or ANT2 ports. In reception, the analog signal is received through the ANT1, ANT2 and/or ANT3 ports. The SDR-rack converts it into digital information by sending it via USB to the processing unit (computer or server).

The SDR rack enclosure dimension is a 3U of 19” rack.

3. Architecture

The SDR rack is composed of 2 independent SDRs, one for ANT1 and ANT2 bidirectional ports, and the other for reception in ANT3 and transmission in SDR2 RF Output port.

The ANT3 reception port can be bypassed to the “External Transceiver” port.

The SDR-rack has 2 different architectures, depending on the number of bands needed.

3.1 Single PA Architecture

There is only one transmission chain with a power amplifier (PA) in the SDR-rack. There is also a switch to select which antenna port is used (ANT1 or ANT2). The communication of this option is half-duplex.

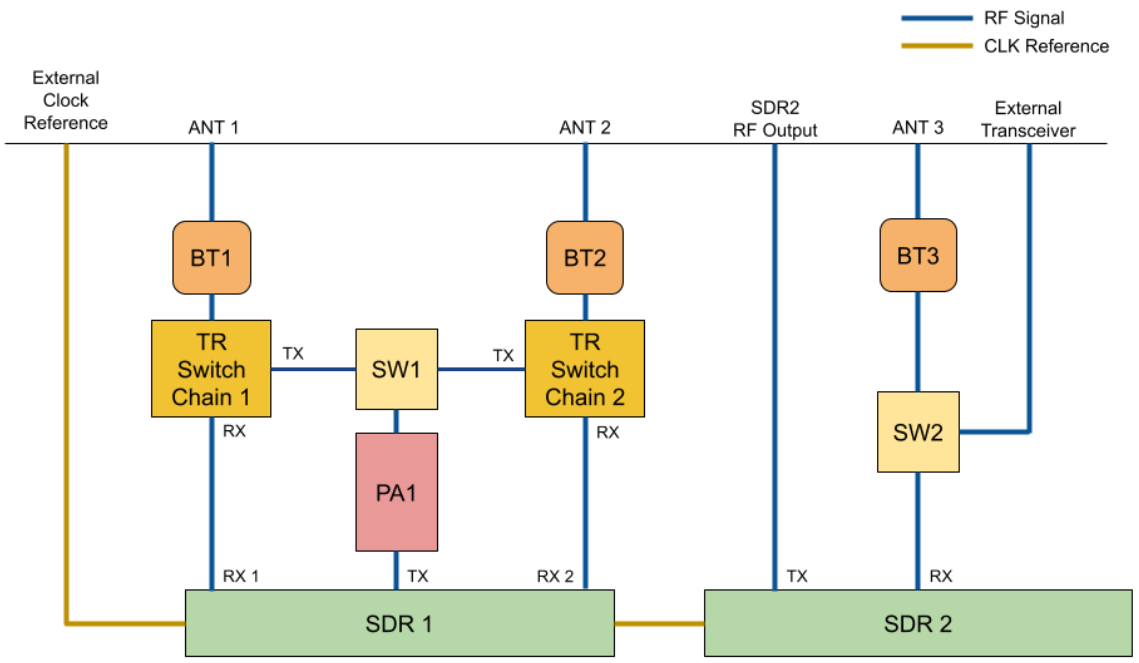

Figure 1 - Single PA configuration SDR-rack diagram

3.2 Dual PA Architecture

There are two different transmission chains with two PAs. Depending on the PAs configuration, this option can provide full duplex communication.

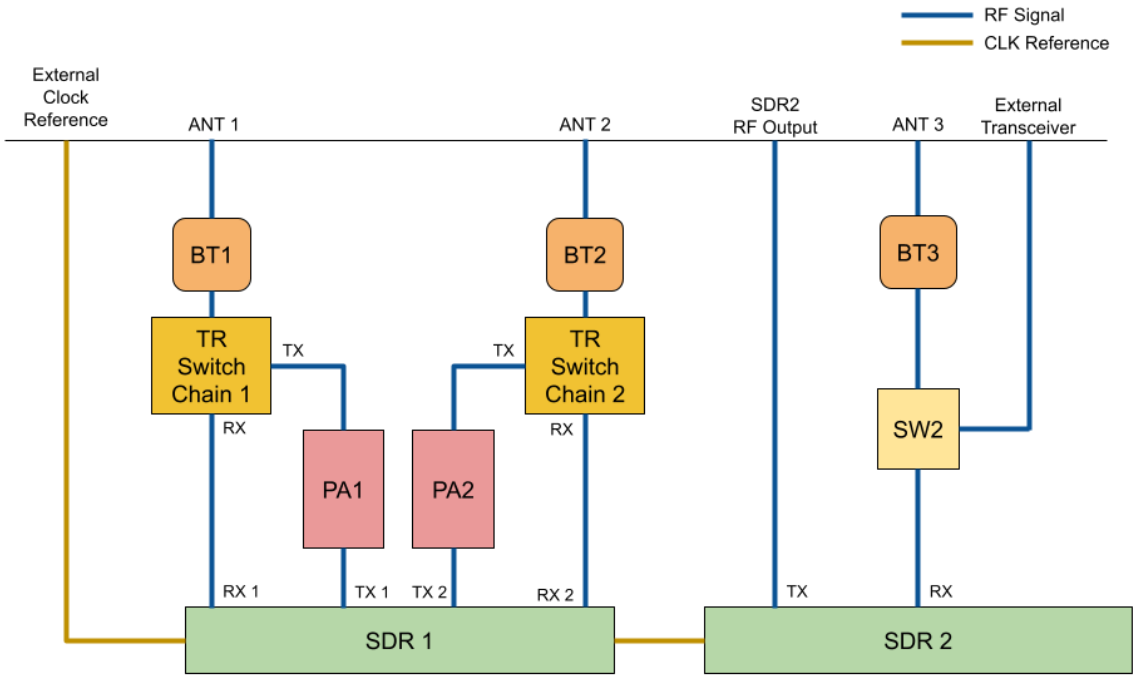

Figure 2 - Dual PA configuration SDR-rack diagram

3.3 Components

This section explains the different blocks in the previous diagrams.

3.3.1 SDR

Both SDR are connected through USB to the server or computer.

SDR1 is used for the transmission and reception of signals through the ANT1 and ANT2 ports..

SDR2 is used for the reception of signals through ANT3 port. SDR2 controls switch SW2 that selects the receive chain. A transmit port of SDR2 is directly connected to the "SDR2 RF Out" port as a low power output.

3.3.2 PA

Depending on the option, there can be one or two PAs. The PAs available are in VHF, UHF.

- VHF:
  - Frequency range: 140 - 180 MHz
  - Maximum transmission power: 50W (47dBm)
- UHF:
  - Frequency range: 400 - 480 MHz
  - Maximum transmission power: 50W (47dBm)

The PAs are protected against over temperature with 2 automatic systems: the first with a circuit that turns on the fans if the temperature starts to rise; the second with a thermoswitch, which cuts the current delivered to the PA if it is very hot.

3.3.3 Selection Switches

These devices are low loss RF switches. Depending on the option there can be one or two.

- Selection Switch SW1: Only integrated in Single PA option. This switch selects which port (ANT1 or ANT2) is used for transmission. It is controlled by SDR1 automatically.
- Selection Switch SW2: This switch selects the reception of ANT3. By default, this switch bypasses the ANT3 with the “External Transceiver” port. SDR2 controls this switch, so if you want SDR2 to be the receiver of the ANT3 port, this is done automatically.

3.3.4 TX/RX Switch

Transmit-Receive (TX/RX) switches are low loss and high speed RF switches. They are used to change the transmission to the reception chain, and vice versa, as fast as the channel requires. Both are controlled by the SDR1.

3.3.5 Bias-T

There is one Bias-T for each ANT port. They are used to supply the possible preamplifier placed next to the communication antennas.

4. Interfaces

4.1 Front Panel

Figure 3 - SDR-Rack front panel

The SDR-rack front panel has the master power switch of the rack, some information LEDs and 3 Bias-T buttons with LED.

4.1.1 Master power switch

The master switch of the rack cuts all the current of the rack.

4.1.2 Information LEDs

There are two different blocks:

- **Main Status**: There are 2 LEDs:
  - Power: Power LED turns ON, in green, when the rack is ON.
  - Temperature Alarm: this LED has 3 states: OFF, when the power amplifier temperature is OK; ORANGE, when the temperature is between 55ºC and 65ºC; and RED, when the temperature is higher than 65ºC.
    When the Temperature Alarm LED is RED, it is recommended to stop the transmissions or even turn OFF the SDR-rack.

- **Switches and SDR status**: This block of LEDs is explained in the following table:
  - ANTx - TX/RX: These LEDs indicate if the SDR-rack is in transmit or receive status. RED indicates transmit, and green indicates receive.
  - ANTx - POL V: In green when Vertical polarization is enabled.
  - ANTx - POL H: In green when Horizontal polarization is enabled.
  - ANTx - POL R: In green when RHC polarization is enabled.

- ANTx - POL L: In green when LHC polarization is enabled.
- SDRx - Active: In green when the SDRx module is enabled.
- SDRx - Power: In green when the SDRx module is powered.
- SDRx - USB Act: Blinking when activity in the USB bus.
- SDRx - CLK Act: Blinking in presence of the VCTCXO clock. Blinking in green indicates both PLLs are locked; otherwise blinking green/red indicates that at least one PLL is not locked.
- SDRx - TCXO: VCTCXO control mode indicator; useful when using external reference clock. With no light, VCTCXO is controlled by the internal DAC. Blinking in red when it is controlled by the phase detector, but is not locked to an external reference. Blinking green when it is controlled by the phase detector and is locked to an external reference.

4.1.3 Bias-T buttons

Each of these buttons enables the Bias-T of an ANT port. Each button includes a LED that shows the status of the Bias-T. When the LED is ON (in BLUE) it indicates that the Bias-T is ON.

4.2 Back Panel

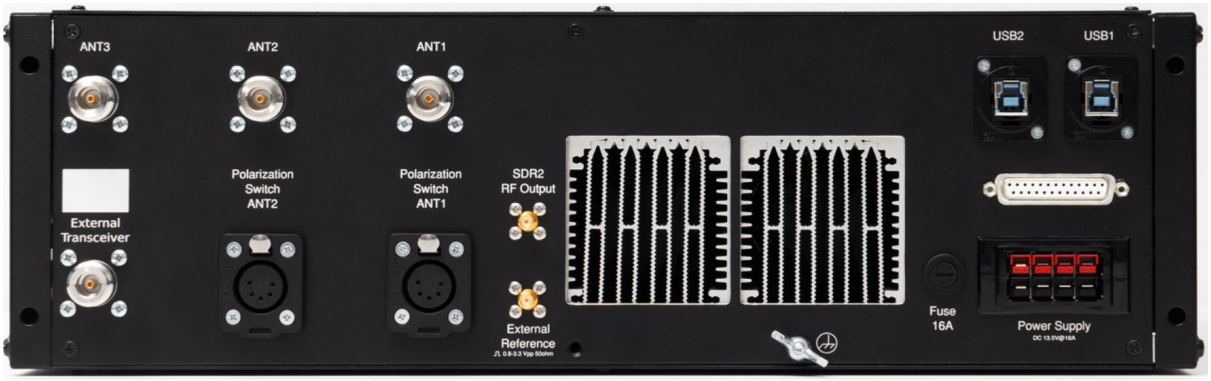

Figure 4 - SDR-Rack back panel

4.2.1 USB ports

These porst connect the computer/server to the SDRs.

- SDR1 ⟶ USB1
- SDR2 ⟶ USB2

4.2.2 Power supply control (DB-25)

This port shall be used with the external power supply unit (PSU) rack that Alen Space provides with the SDR-rack (can be ordered at the same time). This port enables the external PSU.

Table 2 - Power supply control pinout

Pin	Description	Pin	Description
1	Not Connected	14	Not Connected
2	Not Connected	15	Not Connected
3	Not Connected	16	Not Connected
4	Not Connected	17	Not Connected
5	Not Connected	18	Not Connected
6	Not Connected	19	Not Connected
7	Not Connected	20	Positive Sensing
8	Negative Sensing	21	Negative Sensing
9	Not Connected	22	Not Connected
10	Not Connected	23	Not Connected
11	Not Connected	24	Not Connected
12	Not Connected	25	Not Connected
13	Not Connected		

4.2.3 Power Supply

Connected to an external PSU. This connector is a PowerPole P45.

4.2.4 Fuse

Included a 16A fuse to protect the SDR-rack from overcurrents. The part number of this fuse is 0216016.MXP of Littelfuse.

4.2.5 Antenna ports (ANT)

There are 3 ANT ports. All of them are N-female connectors.
Each one has a Bias-T internally that can be enabled o disabled with a button placed in front panel of the SDR-rack. The maximum current provided by each Bias-T is 500mA.

ANT1 and ANT2 are dedicated for VHF and/or UHF bands and both are bidirectional. Both ports are connected to SDR1

ANT3 is only for reception and, by default, it is internally connected to the “External Transceiver” connector.

When SDR2 is configured to receive from this port, it can operate in the frequency range of 100 - 3000 MHz.

4.2.6 External transceiver

N-female connectors. This connector has no Bias-t option. By default, it is internally connected to the ANT3 connector.

4.2.7 Polarization Switch ports

These connectors shall be connected to the polarization switches next to the antennas (provided by Alen Space if selected). Both ports are intended to be for Antenna 1 and Antenna 2, then are controlled by SDR1.
The connector is a NC5FDX-TOP from Neutrik. The cable connector required shall be a NC5MX-TOP from Neutrik.

Table 3 - Polarization Switch pinout

Pin	Description
1	RHCP
2	LHCP
3	Not Connected
4	GND
5	Horizontal

The table of truth of this connector is:

Table 4 - Polarization Switch table of truth

Polarization	RHCP Pin	LHCP Pin	Horizontal Pin
Vertical	0	0	0
Horizontal	0	0	1
RHCP	1	0	0
LHCP	0	1	0

4.2.8 SDR2 RF Output

SDR2 RF Output port is connected directly to SDR2 TX port with a low transmission power. This connector can be used for different purposes. For example as a transmission component for testing in the laboratory, or it can be used for testing new GNUradio flowgraphs.

4.2.9 External reference

Both SDRs have internal clocks for oscillation generation to obtain the desired frequency. These clocks have a precision of +/- 4ppm. For high precision applications, SDR-rack allows the use of an external clock reference of 10MHz to achieve more accurate frequencies.

4.2.10 Grounding

The SDR-rack must be connected to a static energy discharge point. This connection is an M4 screw.

5. Characteristics

5.1 Electrical Characteristics

Table 5 - SDR-rack electrical characteristics

Description	Typ	Unit
Input power supply (VCC)	12 - 13.8	V
Current supply typical	4	A
Current supply maximum (fused)	16	A
ANT1, ANT2 and ANT3 output voltage (Bias-T)	13.8	V
ANT1, ANT2 and ANT3 output max current (Bias-T)	500	mA

5.2 RF Characteristics

Table 6 - SDR rack RF characteristics - SDR1

Description	Typ	Unit	Comments
Antenna 1 and 2 ports			
Transmission frequency range: - VHF - UHF	 140 - 180 400 - 480	 MHz MHz	
Maximum transmission bandwidth: - VHF - UHF	 40 61.44	 MHz MHz	
Máximum output power: - VHF - UHF	 47 47	 dBm dBm	
Reception frequency range: - VHF - UHF	 0.1 - 1500 0.1 - 1500	 MHz MHz	
Reception maximum bandwidth: - VHF - UHF	 61.44 61.44	 MHz MHz	
Máximum input power: - VHF - UHF	 +7 +7	 dBm dBm	

Table 4 - SDR rack RF characteristics - SDR2

Description	Typ	Unit	Comments
Antenna 3 port			
Reception range	0.1- 3000	MHz	
Reception maximum bandwidth	61.44	MHz	
Maximum input power	+7	dBm	
SDR2 RF Output port			
Transmission frequency range	0.1 - 3.8	GHz	
Transmission maximum bandwidth	61.44	MHz	
Transmission maximum output power (CW)	+10 +0 -12 -22	dBm	At 1.7 GHz At 2.5 GHz At 3.0 GHz At 3.5 GHz

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