SDR-2400
SM-SDR-2400

User Guide

LILEE SYSTEMS

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Figure 1: SDR-2400



Figure 2: SM-SDR-2400



Figure 3: LMS-2450-ME-100 chassis with SM-SDR-2400

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1

Before You Begin

This chapter includes safety information and legally required disclosures.

Warning: Please adhere to the following safety precautions at all times. Failure to do so may result in harm to persons or property.

Safety considerations

- Follow electrostatic precautions whenever the SDR-2400/SM-SDR-2400 is installed. To prevent malfunction or damage which may be caused by electrostatic discharge, the SDR-2400/SM-SDR-2400 should be grounded.
- Before touching components or connecting/disconnecting cables, the installer should touch a metal object to dissipate body charge.
- Make sure the power is turned off and the power cord is disconnected whenever the SDR-2400/SM-SDR-2400 is being installed or moved.
- Do not apply voltage levels that exceed the specified voltage range. Doing so may cause fire and/or electrical shock.
- Do not open the chassis when the SDR-2400/SM-SDR-2400 is running: Electric shocks can occur.
- If considerable amounts of dust, water, or fluids enter the SDR-2400/SM-SDR-2400, turn off the power supply immediately, unplug the power cord, and contact the distributor or sales representative.
- Do not drop the SDR-2400/SM-SDR-2400 onto a hard surface.
- Do not use the SDR-2400/SM-SDR-2400 in a site where the ambient temperature exceeds the rated temperature.

ESD notice

To prevent malfunction or damage to this product, which may be caused by electrostatic discharge (ESD), the radio should be properly grounded at the time of installation. In addition, the installer or maintainer should follow proper ESD precautions, such as touching a bare metal object to dissipate body charge prior to touching components or connecting/disconnecting cables.

FCC/IC approval notice, Part 15 notice

Federal Communications Commission interference statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

15.21:

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

This device and its antenna(s) must not be co-located or operating in conjunction with any other antenna or transmitter.

Approved antennas

This radio transmitter (FCCID: XTC-SDR2400) has been approved by FCC to operate with the antenna types listed here, with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Number	Manufacturer	Part Number	Antenna Type	Peak Gain
1	JOYMAX ELECTRONICS	IAF-6491RS5X-991	Dipole	2dBi for 2.4 GHz
2	JOYMAX ELECTRONICS	IPX-026XNFX9-999	Patch	13dBi for 2.4 GHz

Equipment modifications

Be aware that any changes or modifications to this equipment not expressly approved by the party responsible for compliance (in the respective country of use) could void the user’s authority to operate the equipment.

RF exposure warning

This equipment must be installed and operated in accordance with provided instructions and the antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter. End-users and installers must be provided with antenna installation instructions and transmitter operating conditions for satisfying RF exposure compliance.

End product labeling

This transmitter module is authorized only for use in device where the antenna may be installed such that 20cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: "Contains FCC ID: XTC-SDR2400"

Information for OEMs and integrators

The following statement must be included with all versions of this document supplied to an OEM or integrator, but it should not be distributed to the end user.

1. This device is intended for OEM integrators only.
2. Please see the full Grant of Equipment document for other restrictions.

NCC Notice (NCC 警語)

經型式認證合格之低功率射頻電機，非經許可，公司、商號或使用者均不得擅自變更頻率、加大功率或變更原設計之特性及功能。

低功率射頻電機之使用不得影響飛航安全及干擾合法通信;經發現有干擾現象時，應立即停用，並改善至無干擾時方得繼續使用。

前項合法通信，指依電信法規定作業之無線電通信。低功率射頻電機須忍受合法通信或工業、科學及醫療用電波輻射性電機設備之干擾。

本模組於取得認證後將依規定於模組本體標示審驗合格標籤，並要求最終產品平台廠商 (OEM Integrator)於最終產品平台(End Product)上標示 “本產品內含射頻模組，其NCC型式認證號碼為: CCAH19LP1380T7 (SDR-2400), CCAH19LP1381T9 (SM-SDR-2400)

2

Introduction

The LILEE Systems SDR-2400/SM-SDR-2400 is a MIMO 4x4 software-defined radio module for LMS-2450-ME-100 or other compatible chassis. It can be configured in either base station mode or client mode. It operates in the 2.4G Hz ISM band, with typical bandwidth of 20 MHz and data rate up to 200 Mbps.

Key features

MIMO: Up to 4x4

- Achieve high data rate and longer range
- Supports multiple data stream modes and STBC/SFBC modes
- Configurable MIMO modes: 2x2, dual 2x2, 4x4

Worldwide operation

- 2.4 GHz ISM band
- Wide environmental operating range

Various modulation and data rates

- OFDM with BPSK, QPSK, 16-QAM, 64-QAM
- Supports forward error correction (FEC) (code rate= 1/2, 2/3, 3/4, and 5/6)
- 16 KHz sub-carrier tone spacing designed for outdoor environment

TDD/TDMA

- Configurable time slot length and super frame structure
- Designed for High Speed Rail application
- Typically with 32 slots per frame, 16 frames per second
- Dynamic time slot allocation to maximize system capacity

Cloud-based management

- Supported by LILEE Systems T-Cloud portal
- Access a variety of tools and stats

Specifications

Radio interfaces

- Frequency band: 2.4000-2.4835 GHz ISM Band
- Channel bandwidth: 20 MHz
- Mode of operation: TDD/TDMA
- MIMO: 4x4, dual 2x2 diversity
- Data rate: up to 200Mbps
- Modulation: OFDM with BPSK, QPSK, 16 QAM, 64 QAM
- FEC: Convolutional code with coding rate 1/2, 2/3, 3/4, and 5/6
- Power increments: 0.25 dB
- Transmitter stability into VSWR: 3:1
- RF ports impedance: 50 Ohms
- Frequency stability: +/- 2 ppm
- Receiver sensitivity: -89 dBm @ QPSK ½
- Mobility: 110 km/hr

Physical characteristics

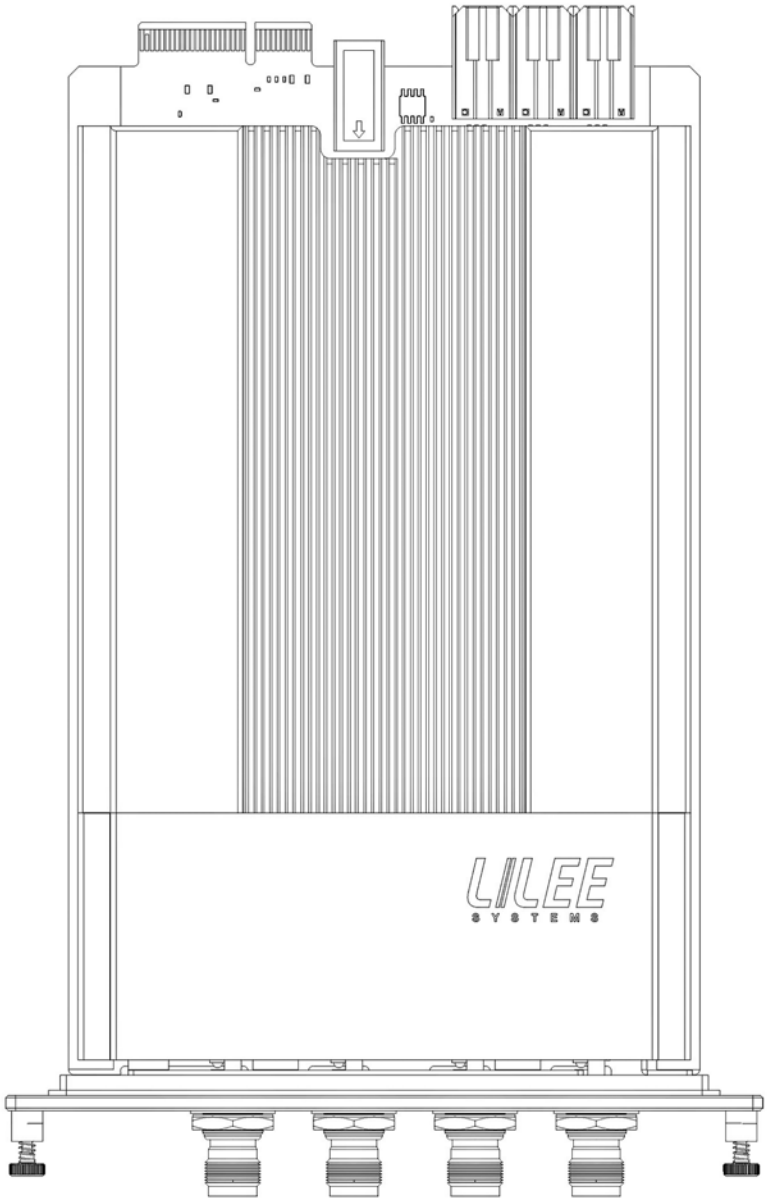
- Antenna port: TNC-Female x4
- LED indicators: PWR, link status

Environmental operating range

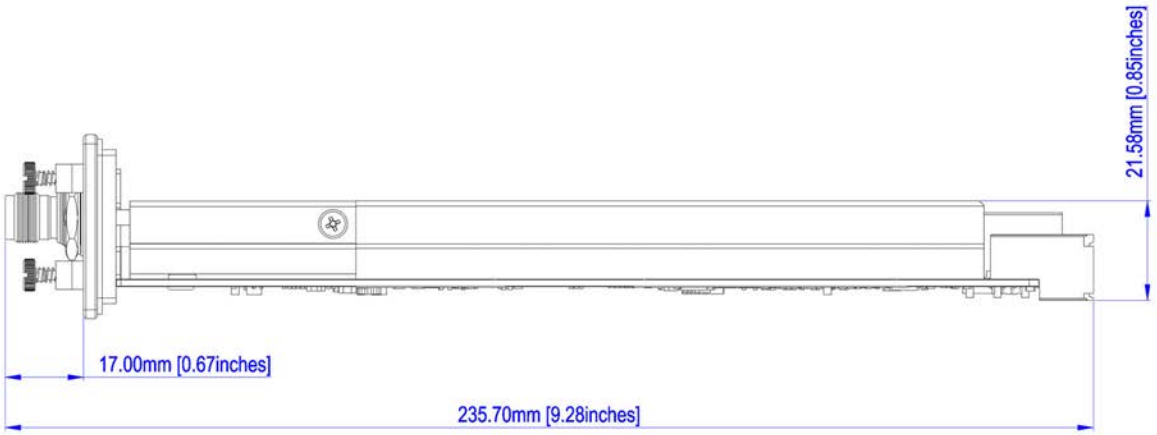
- Operating temperature: -40 to +70 °C (-40 to +158 °F)
- Storage temperature: -55 to +85 °C (-67 to 185 °F)
- Ambient relative humidity: 5% to 95% (non-condensing)

Mechanical drawings and dimensions

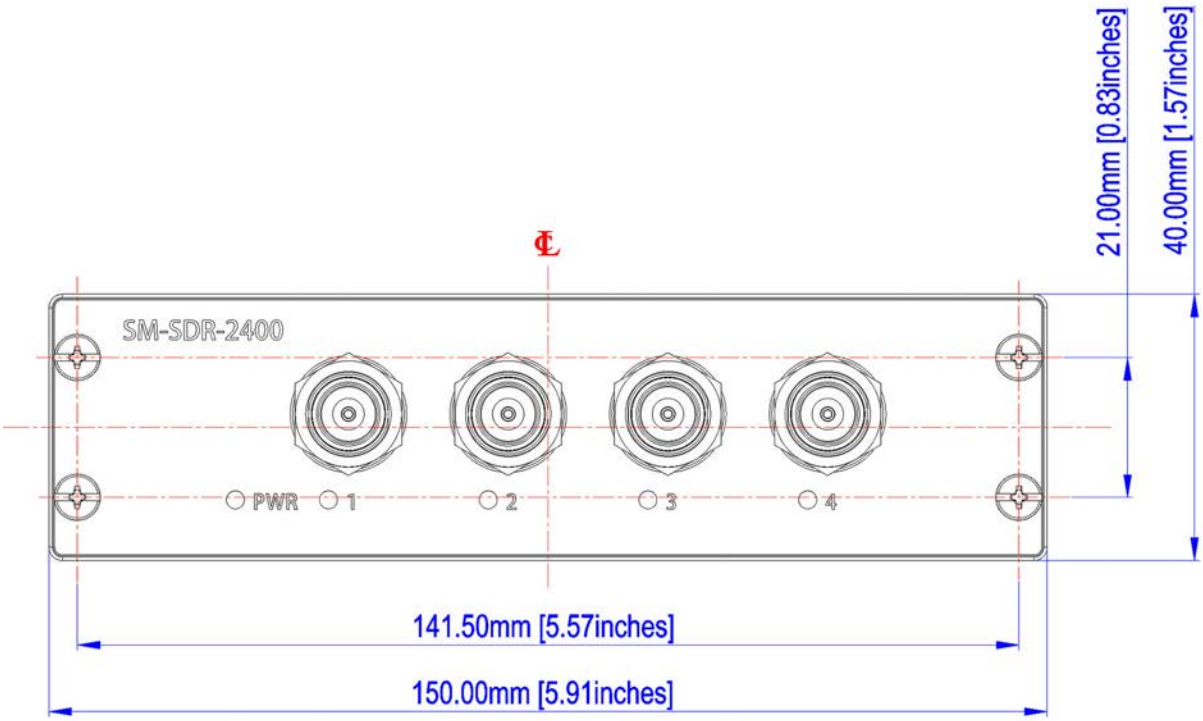
Top View



Side View (Right)



Front View



3

Interface Panel and Ports

This chapter presents illustrations of all connectors and ports on the SM-SDR-2400, as well as their descriptions.

SM-SDR-2400 front panel view



Antenna ports

There are 4 TNC-female antenna connectors on the front panel. For best performance, you should use four identical antennas with same cable type and cable length.

LED indicators

There are five LED indicators.

LED status light descriptions

The front panel of the SM-SDR-2400 has a number of LED indicators. The following tables explain the meaning of each light, according to which radio mode is in use.

MIMO 4x4 mode

Light	Description
Green, blinking @ 15 Hz (all ports)	Active T/R
Green, scanning all ports left to right @ 4 Hz	Scan mode
Orange, solid (all ports)	Initialization (1s maximum)
Orange, blinking @ 4 Hz (all ports)	PA disabled (test mode)

MIMO 2x2, all modes (dual, 1/2, or 3/4)

Light	Description
Green, solid	May mean either: • Initialization (all ports indicated, 1s maximum) • Indicated ports (1-2, 3-4, or all) ready but no active T/R
Green, blinking @ 15 Hz	Active T/R on the indicated antenna ports (1-2, 3-4, or all)
Orange, blinking @ 4 Hz	PA disabled (test mode) on the indicated antenna ports
Orange, scanning all ports left to right @ 4 Hz	Scan mode
Off	Indicated antennas (1-2 or 3-4) not in use in selected mode

Power (all MIMO 2x2 and 4x4 modes)

PWR Light	Description
Green	Power on
Off	No power

Tip: The term *initialization* means a driver is programming the time slot table and related registers. The process is very short, and the user should not see LED stay at initialization state for more than a second.

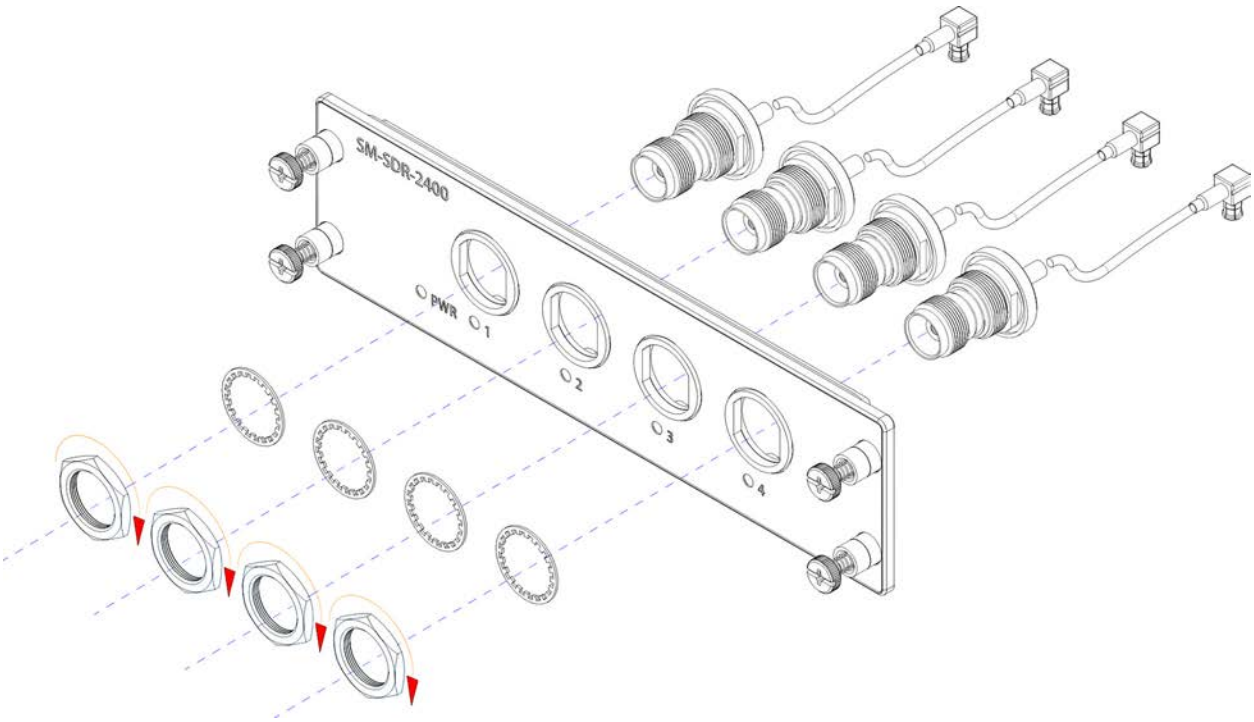
4

Assembly and Installation

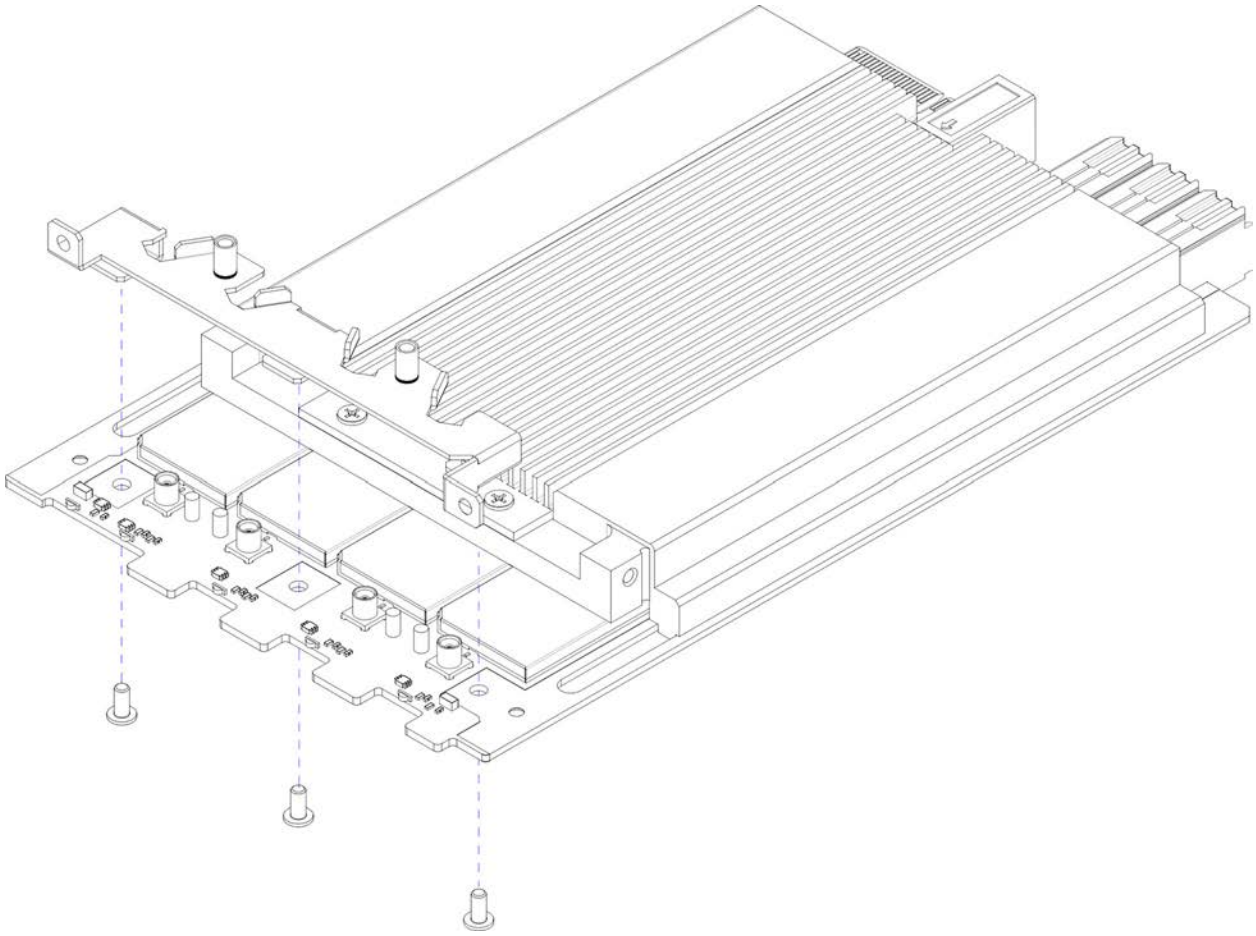
Faceplate assembly for SM-SDR-2400

Please refer to the following figures for faceplate installation.

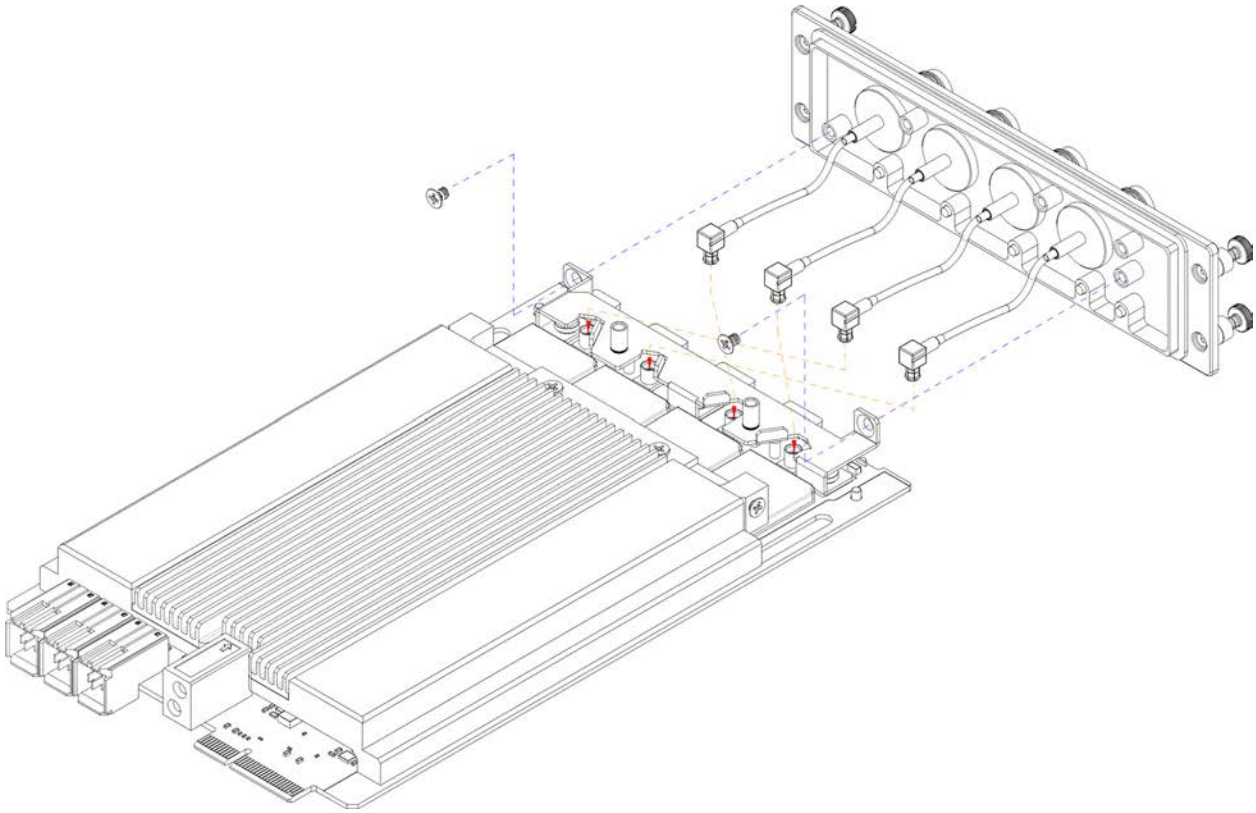
Front panel assembly



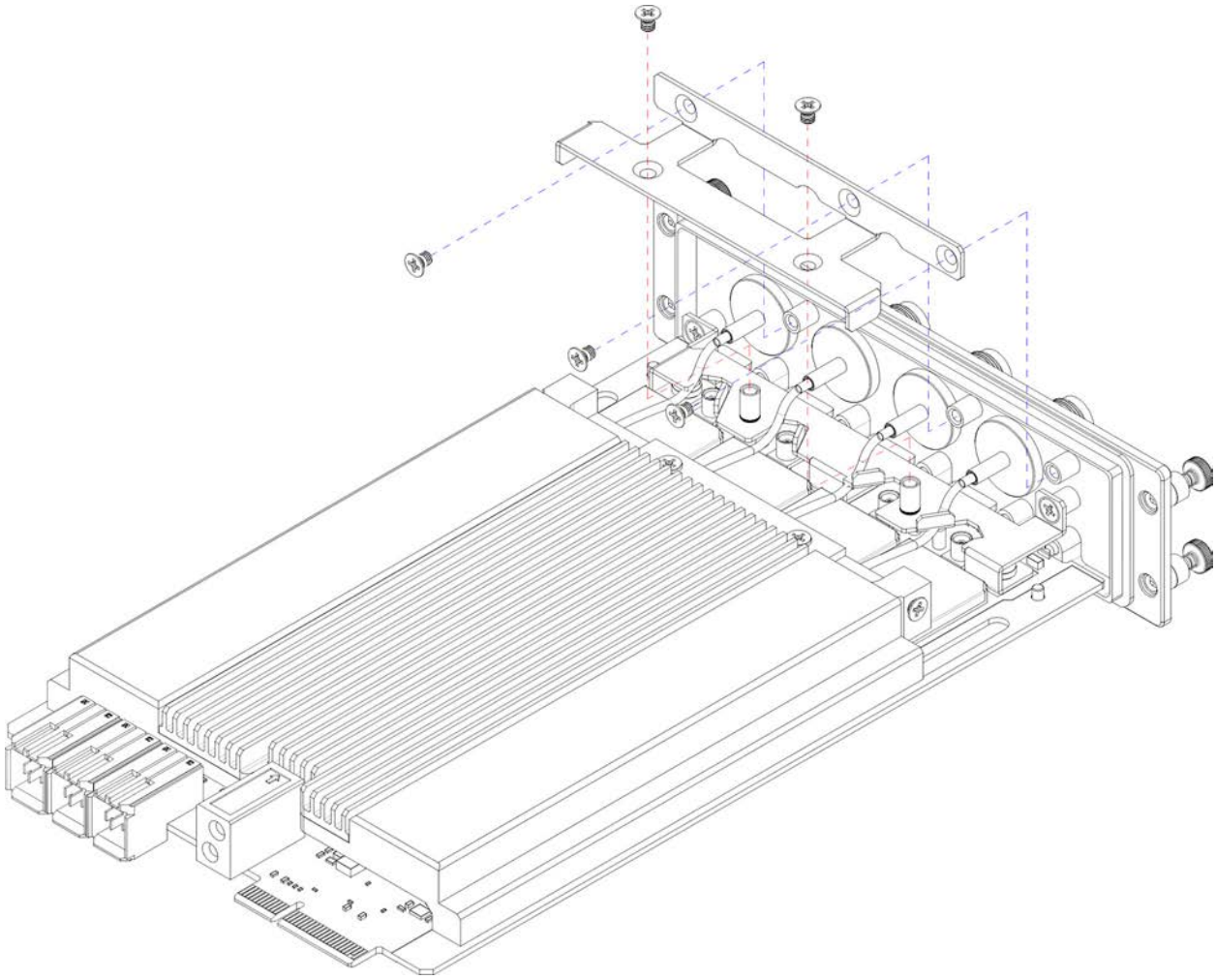
Bracket assembly



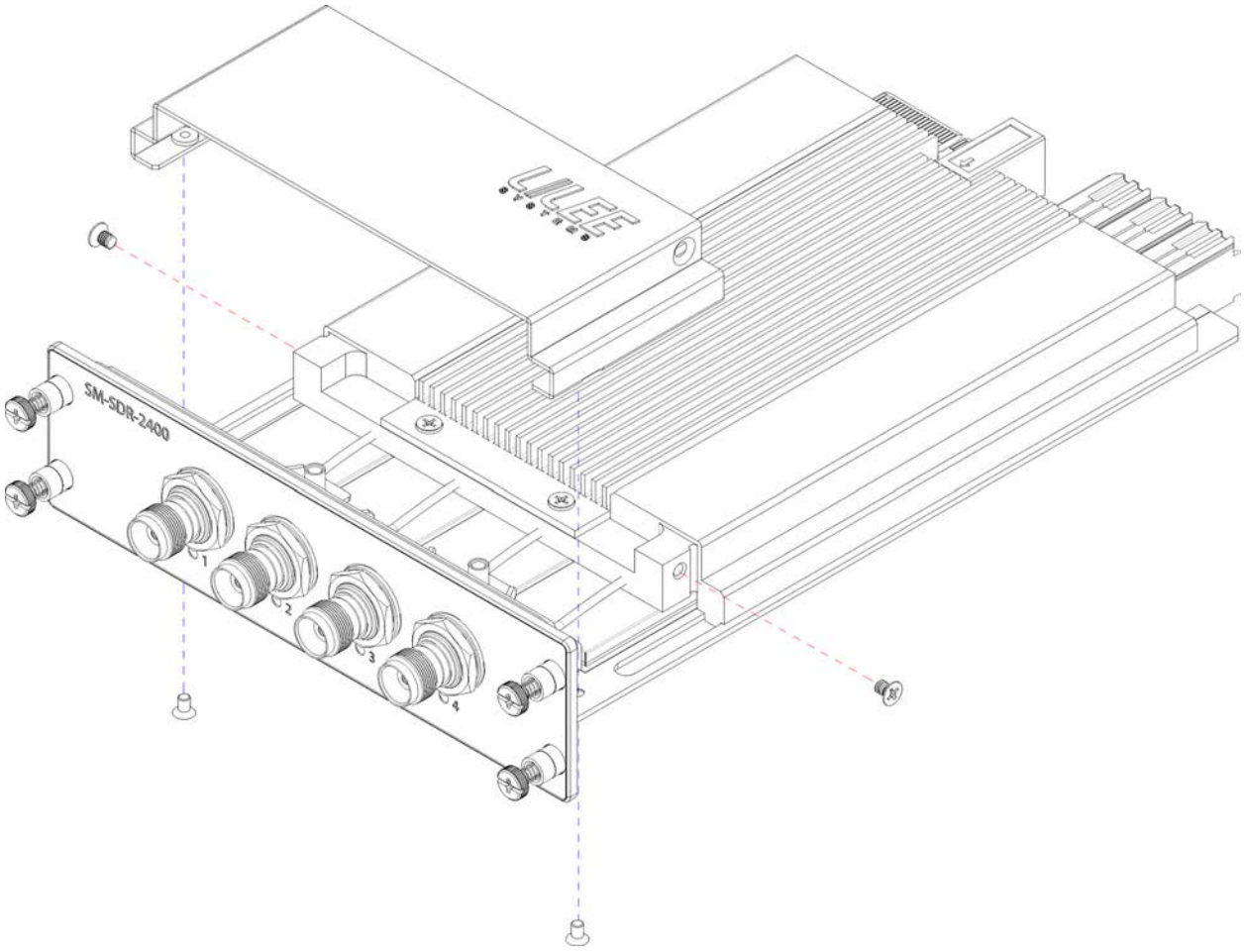
Connecting RF cables and attaching front panel



Bracket assembly

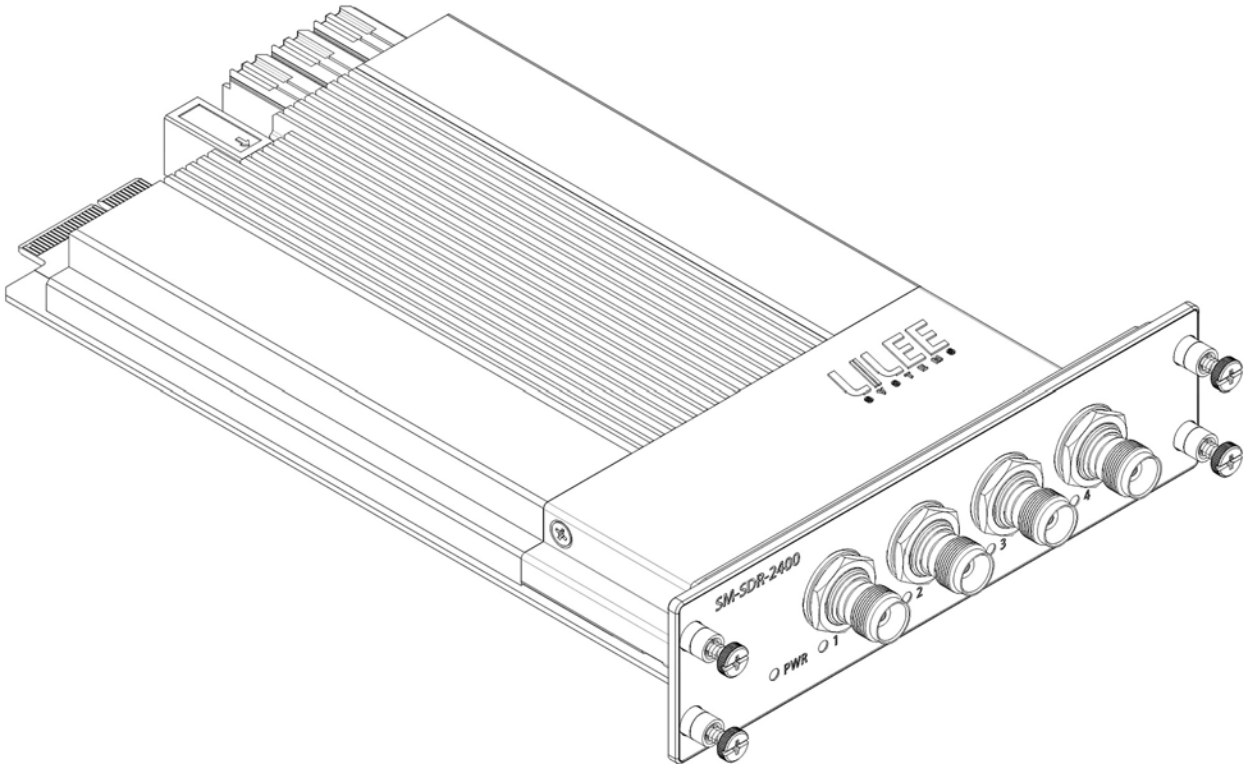


Cover assembly



Complete assembly

The unit should look like this when assembly is complete.



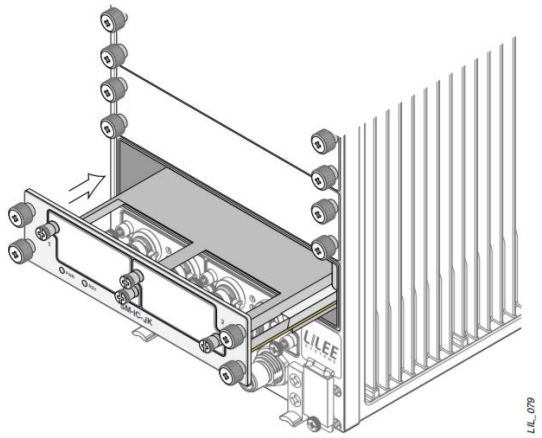
Chassis installation

Please refer to LMS-2450-ME-100 Hardware Installation Guide for chassis installation.

Smart module installation

To install the SM-SDR-2400 smart module, follow these steps:

1. Disconnect power from the LMS-2450-ME-100.
2. If you are replacing an existing smart module, remove all connections from any ports.
3. Unscrew the four captive screws on the existing module or blank plate.
4. Remove the module or blank plate.
5. Slide the new module into the empty bay, as shown below. The sides of the PCB rest inside the guide rails in the bay.



6. Push the module in gently until it seats. When seated correctly, the module faceplate is flush with the chassis faceplate.
7. Tighten the four captive screws on the module.
8. Power on the LMS-2450-ME-100.
9. After the chassis startup sequence, the PWR LED on the module turns green.

The module is installed and ready for use.

Tip: The module fits very tightly in the bay. If the module is difficult to insert, simply straighten the module and try again.

Configuring the SDR-2400/SM-SDR-2400

Linking up two units

To initialize and link-up two SDR-2400/SM-SDR-2400 units, follow these steps:

1. After booting up, log in and initialize RF components.
2. Configure SDR-2400/SM-SDR-2400 into base station or locomotive mode.

   For base station:

   Driver uses the command:

   ```
   SDR-2400 > cfg_ad9361
   ```

   Then it broadcasts time slot table information via beacon packets.

   For locomotive:

   Driver uses the command `reg_wr` to set bit 3 of $REG_CARRIER_CFG:

   ```
   SDR-2400 > reg_wr $REG_CARRIER_CFG 0x0001F0F8
   ```

3. The locomotive detects the beacon and uses it to program the time slot table, then sends association packets to request link-up.
4. The base station exchanges device information with the locomotive (MAC address, client ID, and so forth). Then the link-up process completes. Both SDR-2400 should be able to ping each other.

Base station and client modes

This is done by driver after bootup. Bit [24] of register $REG_FTA_CFG0 determines the role of a device. 0 = base station, 1 = locomotive.

Command	Action
`reg_wr $REG_FTA_CFG0 0x0036c20f`	Set as base station
`reg_wr $REG_FTA_CFG0 0x0136c20f`	Set as locomotive

MIMO modes

Setting MIMO modes involves configuring transceiver and RF components.

- Set bit[5] of register $REG_AD9361_CFG1 to turn on AD9361 transceiver for antenna port 1/2.
- Set bit[17] of register $REG_AD9361_CFG1 to turn on AD9361 transceiver for antenna port 3/4.
- The command `cfg_ad9361 pa` turn on/off four power amplifiers for four RF ports.

Command Sequences	Action
`> reg_wr $REG_AD9361_CFG1 0x110130` `> cfg_ad9361 pa 1100`	Set MIMO 2X2 mode, using antenna 1/2
`> reg_wr $REG_AD9361_CFG1 0x130110` `> cfg_ad9361 pa 0011`	Set MIMO 2X2 mode, using antenna 3/4
`> reg_wr $REG_AD9361_CFG1 0x130130` `> cfg_ad9361 pa 1111`	Set MIMO dual 2X2 mode
`> reg_wr $REG_AD9361_CFG1 0x130130` `> cfg_ad9361 pa 1111`	Set MIMO 4X4 mode

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