ER2035

OpenRAN Radio Unit

Start Guide

Table of Contents

This document has generalized instructions for installing and operating the ER2035 radio in a laboratory setting.

Hardware Assembly Guide

Required Materials

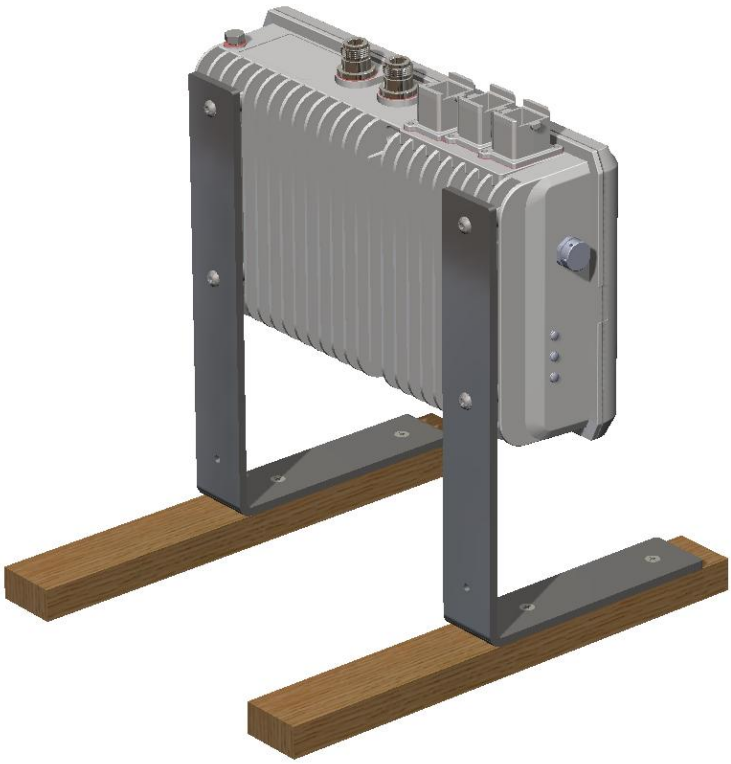
The following components are required to complete bring-up the ER2035:

- PC (Windows or Linux) with an ethernet port (or ethernet adapter)
- ER2035 with provided Accessory Kit
  - Fiber optic cable (Single Mode OS2 LC/LC)
  - Fiber optical connector (OCTIS)
  - Two 10G SFP+ Single Mode Fiber Transceivers
  - OCTIS LAN connector
  - Pre-terminated power cable (OCTIS DC Power Connector, Banana plugs)
  - Ground wire
  - Ground lug
  - Vertical stand
- Ethernet cable
- Two RF cables with N-type connectors
- 48V DC/2A Power Supply
- Measurement equipment(s) or antenna(s)
- Attenuator(s) – if not connecting RF ports to antenna or measurement equipment

Assembly

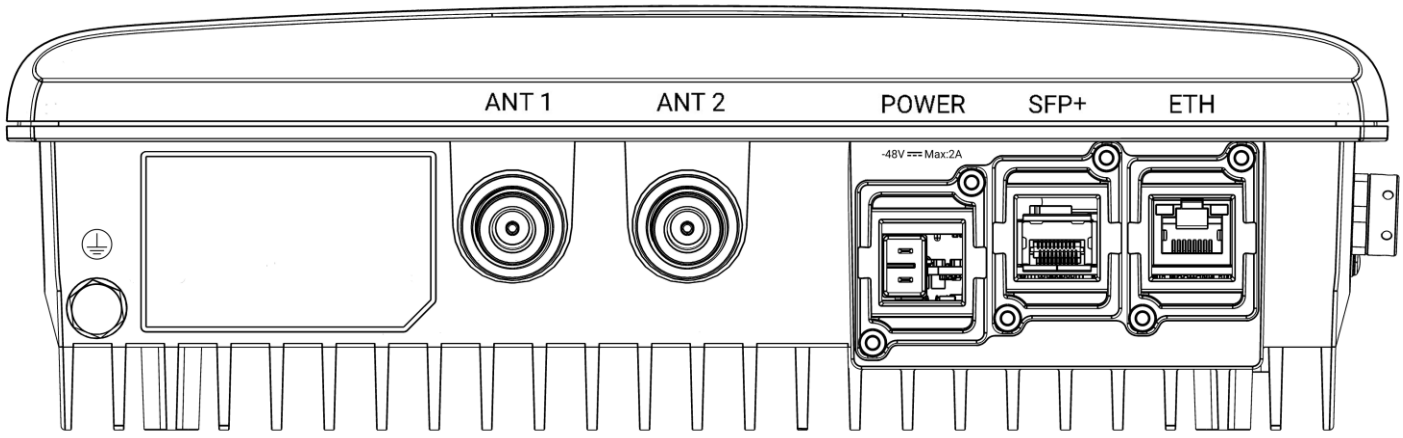
Do not turn on power sources prior to full assembly. The set-up diagram is available on the next page; all ports are labeled on the radio unit for ease of assembly. Ensure all required personnel have proper training regarding ESD, high voltage electronics and RF equipment, and all personnel are properly grounded while working with the radio unit.

The ER2035 is designed for passive cooling; there are no fans inside the radio. Therefore, the back of the enclosure, the fins, are designed to cool the unit with free convection when mounted in a vertical position. A stand is provided to test the unit in the vertically mounted position.



RU mounted on the provided stand for optimal airflow.

See **Appendix H**: Vertical Stand Installation for stand installation instructions. If the stand is not utilized and the radio is tested horizontally (with the radio laid on its fins on a lab bench for example), a fan with at least 45 CFM must be applied directly toward the fins for optimal heat dispersion.



Bottom side of the RU with ports pointed toward you.

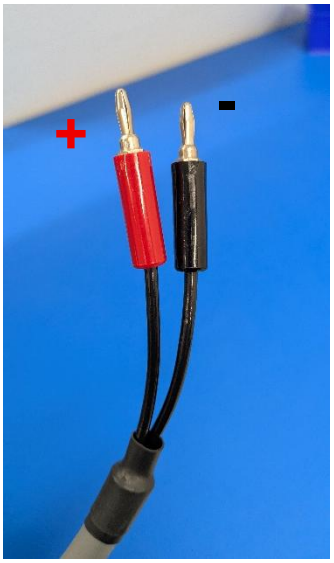
1. Remove all protective caps from the radio unit's ports.

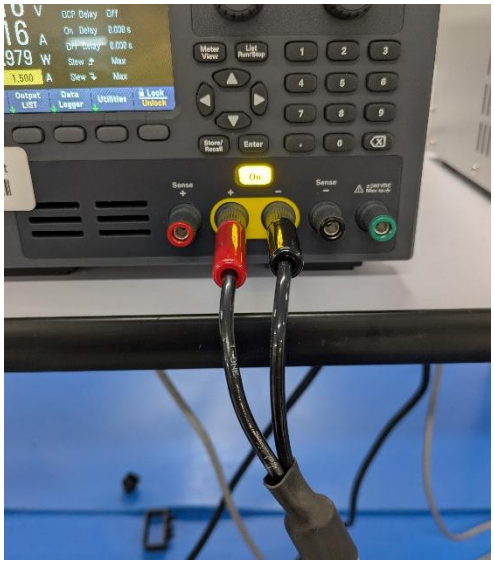
2. Remove the Ground Lug from the GND screw terminal on the radio. Thread the eyelet end of the provided ground wire through the lug and tighten the lug back into the enclosure. Connect the other end of the ground wire to earth ground.

3. Assemble the SFP+ transceiver, optical cable and OCTIS SFP Connector following the instructions included with the OCTIS SFP Connector. Connect the assembled OCTIS SFP Connector with the radio SFP+ port. Connect the other end of the optical cable with the second SFP+ transceiver and insert into the allocated port of the Distributed Unit (DU).
   Note: Eridan cannot ensure performance if non-approved transceivers are used.

4. Connect RF cables to the ANT1 and ANT2 N-type ports on the radio. Connect the other ends to the antenna(s), test equipment, attenuation or termination.
   Note: Be sure to protect equipment with attenuators as necessary as the ER2035 transmits at a peak-envelope-power of 37 dBm.

5. Connect the provided power cable's DC Power Connector to the POWER port on the radio. Connect the other end, with banana plugs, to the 48V DC/2A power supply; see the images below for reference. Leave the power supply off for now.





6. The radio connects to the PC via IPv4 configuration. Assemble the OCTIS LAN Connector and LAN cable following the instructions included with the OCTIS LAN Connector. Connect the assembled OCTIS LAN Connector with the radio ETH port. Connect the other end of the cable to the PC.

7. Either mount the radio in the vertical position for free convection heat dispersion with provided stand or point a fan with at least 45 CFM directly at the radio unit's fins. Either option will allow for optimal heat dispersion. See Appendix H for stand installation instructions.
   Note: If neither option is utilized, RF performance may diminish.

8. The radio is now ready for initialization and configuration.

Radio Configuration Guide

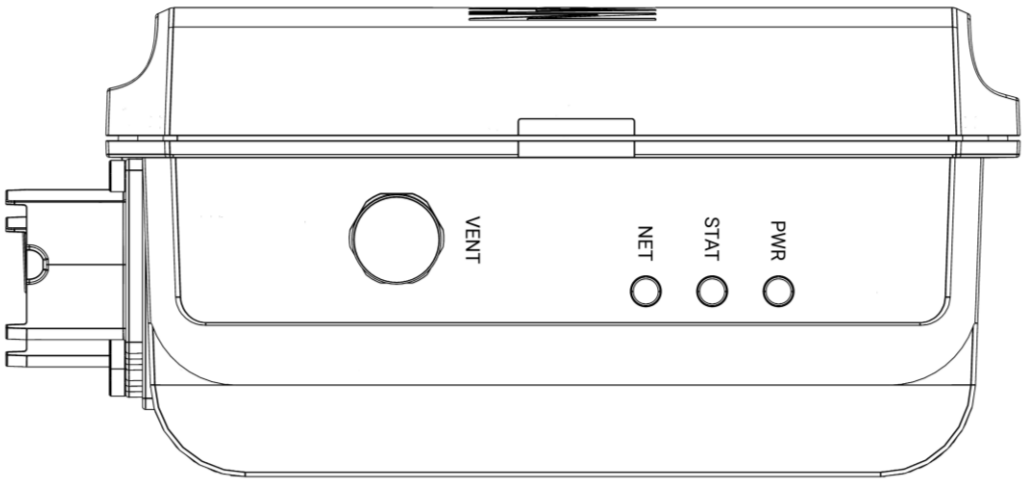
Initialization

Initialization is done through the PC's command line interface with an SSH connection to the radio. See the SSH section in Appendix Appendix B: Windows SSH setup or

Appendix C: Linux SSH setup for instruction.

LED Table

The status of the radio can be determined by the LEDs on the right side of the radio.



Description	LED color indication				
	Off	Green, blinking at 1Hz	Green, solid	Green, blinking at 5Hz	Red, solid
No power supplied to the unit	PWR NET STAT				
Unit is booting up and initializing PTP sync. Sync state is “synchronizing”	STAT	NET	PWR		
Unit is fully booted and initializing PTP sync. Sync state is “synchronizing”	STAT	PWR NET			
Unit is ready for operation and synced with PTP source. Sync state is “synchronized”	STAT	PWR	NET		
Unit lost sync source, still synced. Sync state is “holdover”	STAT	PWR		NET	
Unit has no valid sync source. Sync state is “free”	STAT	PWR			NET

1. Turn on the power supply to the radio. The PWR LED indicator will turn green. Once the radio has fully booted, the PWR LED indicator will blink green.

2. Open the SSH session with the radio unit. Ensure the PC is properly set up with a static IP; see the SSH section in Appendix Appendix B: Windows SSH setup or

3. Appendix C: Linux SSH setup for more information. Credentials are as follows:

   Radio IP Address: `10.0.0.101`

   Username: `root`
   Password: `polar`

4. The NET LED indicator begins to blink green. Run the following command to confirm the software version:

```
cat /etc/os-release
```

   The radio will respond with its current software image information. These details should match the software details on the packing slip provided with the radio. If the details do not match the packing slip, please contact your Eridan point of contact. See the Software Upgrade Section in Appendix Appendix D: Software Upgrade using Windows or Appendix E: Software Upgrade using Linux for instructions to perform a software upgrade if needed.

5. Run the following command to determine the radio's MAC address:

```
ru-serial --sfpmac1
```

   Validate the radio MAC address with the Distributed Unit (DU) configuration.

6. Prior to modifying the radio configuration, confirm that both ANT ports are terminated either with an analyzer (with proper attenuation), attenuators, or an antenna. If at any point you want to disconnect equipment from the radio's RF ports, **ensure traffic to the radio is paused or power down the radio** (see **Shut Down** section, page 10). Do not attempt to swap ANT port connections while running traffic to the radio. Irreparable damage may be done to the radio if both ANT ports are not 50-ohm loaded when the radio is on and transmitting.

7. Obtain the DU MAC address and modify the radio configuration by editing the default JSON file either via the built-in Linux visual editor or by downloading, editing, and then reuploading the JSON file (see Appendix Appendix F: JSON File using Windows or Appendix G: JSON File using Linux for instructions).

   To use vi, run the following command:

```
vi /usr/share/oran-scripts/default_settings.json
```

9. Press `i` to edit the file. See the

10. **If you** would like to reboot the radio unit, run the following command:

```
reboot
```

O-RAN Configuration Table on page 11 for suggested parameter values. Then press `esc`, enter `:wq` to save and exit, then press `enter`.

8. Edit following parameters for standard configuration:

   1. Set the correct DU MAC address:
      - destinationMacAddress: [DU's MAC address] (under "FH")
   2. Set the instantaneous bandwidth:
      - To 40MHz:
        - bandwidth: "40MHz" (under "RF")
      - To 20MHz:
        - bandwidth: "20MHz" (under "RF")

9. To set the configuration of the radio unit using the default JSON file and begin transmission, run the following command:

```
ru_app writeConfig
```

10. The radio will set its configuration, go through PTP sync, and will begin transmitting assuming data is provided from the DU. The NET LED indicator will turn solid green (indicating successful PTP synchronization). If the radio does not begin transmitting, please contact your Eridan Point of Contact for technical support.

11. If you want to reconfigure the radio, repeat steps 6-8 to edit the configuration file and re-run the configuration command. After a power reboot of the radio, you must reconfigure the radio (by editing the JSON file).

12. To read the status of the radio, run the following command:

```
ru_app readStatus
```

See Appendix

Appendix I: Understanding data from `readStatus` command and

Appendix J: Using power and saturation values to configure DU power levels for an in-depth explanation of the logs and for any troubleshooting.

Shut Down

Prior to turning off the power supply, you must shut down the radio. To shut down the radio, run the following command in SSH:

```
poweroff
```

Power consumption of the radio will drop, and the PWR LED indicator will turn off. Then the power supply to the radio can now be safely disconnected.

If you would like to reboot the radio unit, run the following command:

```
reboot
```

O-RAN Configuration Table

The table below includes descriptions, default value, and format for all the default JSON file's parameters. These parameters are used for configuration of the radio in accordance with its controller. Please ensure when editing the JSON file, the format of the values is maintained.

Type	Parameter	Description	Value	Format, Range, Increment
FH	destinationMacAddress	DU/DU emulator MAC address	98:03:9B:9A:7E:DA	String, XX:XX:XX:XX:XX:XX
	cuPlaneExternalVlanId	Assigns the VLAN ID	100	Integer, [2 - 4094]
	bfpDecompressionIqWidthDl	BFP decompression (DL) algorithm level	0	0: No comp, 8, 9, 12, 14
	bfpCompressionIqWidthUl	BFP compression (UL PRACH and PUSCH) algorithm level	0	0: No comp, 8, 9, 12, 14
RF	bandwidth	Occupied bandwidth (OBW)	40MHz	String, MHz, [20MHz, 40MHz]
	rfFrequency	Carrier frequency (Fc)	3.65178 GHz	String, GHz, [3.5GHz, 3.7GHz]

Type	Parameter	Description	Value	Format, Range, Increment
	phaseCompDlEnable	Enable RU DL phase compensation	true	true/false
	phaseCompUlEnable	Enable RU UL phase compensation	true	true/false
	ruPortsData	Antenna IDs for PUSCH and PDSCH (eAxC ID)	[1, 2]	[X, X], X: [0, 15]
	ruPortsPrach	Antenna IDs for PRACH (eAxC ID)	[1, 2]	[X, X], X: [0, 15]
Scaling	dlGain4AnalogRfOutput1	TX output power: maximum power is 0dB; no power is -90dB.	0dB	String, dB, [-90.3090dB, 0dB]
	dlGain4AnalogRfOutput2	TX output power: maximum power is 0dB; no power is -90dB.	0dB	String, dB, [-90.3090dB, 0dB]
Enable	dl1Enable	Turns on or off TX1	true	true/false
	dl2Enable	Turns on or off TX2	true	true/false
	ul1Enable	Turns on or off RX1	true	true/false
	ul2Enable	Turns on or off RX2	true	true/false

Appendix

Appendix A: Power Connector Configuration

Only use the Eridan-provided power cable with OCTIS DC power connector compatible with the POWER port on the radio. Using a different cable and/or connector may do irreparable damage to the radio. The radio's power port is configured to receive -48V DC.

Appendix B: Windows SSH setup

When setting up SSH, ensure static IPv4 settings have been properly enabled for your PC. The static IP should match the following:

IP Address: 10.0.0.1
Subnet Mask: 255.255.255.0

PuTTY is a free and open-source terminal emulator, serial console, and network file transfer application. It supports several network protocols, including SCP, SSH, Telnet,

rlogin, and raw socket connection. You can download the PuTTY latest version here.
To use PuTTY to create an SSH connection, follow these instructions:

1. Plug the ethernet cable from the radio into your PC.
2. Open PuTTY. Select “SSH” for connection type. Enter the following IP address: 10.0.0.101
3. Press “Open” to open the connection.
4. When prompted, enter the following login credentials:

   Username: `root`
   Password: `polar`

You are now connected.

Appendix C: Linux SSH setup

When setting up SSH, ensure static IP settings have been properly enabled for your PC. The static IP should match the following:

IP Address: 10.0.0.1
Subnet Mask: 255.255.255.0

Most Linux distributions support SSH natively. To create an SSH connection using Linux, do the following:

1. Plug the ethernet cable into your PC.
2. Open a terminal. Type the following command:

   ```
   ssh root@10.0.0.101
   ```

3. When prompted, enter the following login credentials:

   Username: `root`
   Password: `polar`

You are now connected.

Appendix D: Software Upgrade using Windows

Download WinSCP, a free and open-source SFTP client that allows secure file transfer between a computer and remote server (the radio in this case). Download and set up the program.

1. Download the new image file (ex. “ER-m1-oran-vX.Y.Z.zip”) onto your PC.

2. Plug the ethernet cable from the ETH port of the radio into your PC. Set up the SSH connection. See **Appendix B**: Windows SSH setup in appendix B.

3. Open WinSCP; a Login pop-up will appear. Select “SCP” as the file protocol. Set “10.0.0.101” as the Host name. Use the following credentials:

   Username: `root`
   Password: `polar`

   Click “Login”.

4. In the left panel, navigate to the downloaded image file. Ensure the right panel is navigated to the /tmp directory.

5. Drag the image file from the left panel to the right panel. This copies the file from the PC to the radio.

6. In the command line interface, run the following command to apply the new image file:

   ```
   upgrade_firmware.sh /tmp/ER-m1-oran-vX.Y.Z.zip
   ```

   Where `ER-m1-oran-vX.Y.Z.zip` refers to the file name.

7. Let the radio update its image and reboot. Then the radio will be ready with the new software version.

Appendix E: Software Upgrade using Linux

1. Download the new image file (ex. “ER-m1-oran-vX.Y.Z.zip”) onto your PC.

2. Plug the ethernet cable from the ETH port of the radio into your PC. Set up the SSH connection. See

3. **Appendix** C: Linux SSH setup in appendix C. The radio should be on the same subnet as the PC and reachable via `ping`.

   Change your directory to where you downloaded the new image file, and run the following command to copy the file to the /tmp directory of the radio unit:

   ```
   scp -o UserKnownHostsFile=/dev/null -o StrictHostKeyChecking=no ER-m1-oran-vX.Y.Z.zip root@10.0.0.101:/tmp
   ```

   Where `ER-m1-oran-vX.Y.Z.zip` refers to the file name. The `root@10.0.0.101` password is `polar`.

4. In the SSH connection, run the following command to apply the new image file:

   ```
   upgrade_firmware.sh /tmp/ER-m1-oran-vX.Y.Z.zip
   ```

   where `ER-m1-oran-vX.Y.Z.zip` refers to the file name.

5. Let the radio update its image and reboot. Then, the radio will be ready with the new software version.

Appendix F: JSON File using Windows

1. Set up an SCP connection between the PC and radio unit. This will require WinSCP; download and set up that application. See

2. **Appendix** D: Software Upgrade using Windows in appendix D, steps 2 and 3.

3. On the right panel (the radio), navigate to the `/usr/share/oran-scripts/` directory. The file “default_settings.json” should be visible.

4. Copy and paste the “default_settings.json” file to the PC (left panel).

5. Use a text editor program on the PC (such as Notepad) to open and edit the parameter values in the JSON file. Save the edited JSON file under the same name (“default_settings.json”).

6. Copy the edited JSON file from the PC (left panel) back onto the radio (right panel) under the same directory (`/usr/share/oran-scripts/`).

7. Set up the SSH connection to the radio unit (see Error! Reference source not found. appendix B for instruction).

8. Run the following command to view the JSON file and confirm new edited values appear:

```
cat /usr/share/oran-scripts/default_settings.json
```

9. To set the configuration of the radio using the default JSON file and begin transmission, run the following command:

```
ru_app writeConfig
```

Appendix G: JSON File using Linux

1. Set up the SSH connection to the radio (see

2. **Appendix** C: Linux SSH setup in appendix C for instruction). The radio should be on the same subnet as the PC and reachable via `ping`.

11. Run the following command to copy the default JSON file from the radio to the PC:

```
scp -o UserKnownHostsFile=/dev/null -o StrictHostKeyChecking=no
root@10.0.0.101:/usr/share/oran-scripts/default_settings.json [PC
directory]
```

Where `[PC directory]` is the directory you want to download the JSON file to.

3. Use a text editor program on the PC to open and edit the parameter values in the JSON file. Save the edited JSON file under the same name ("default_settings.json").

4. Run the following command to copy the edited default JSON file from the PC back to the radio:

```
scp -o UserKnownHostsFile=/dev/null -o StrictHostKeyChecking=no
root@default_settings.json 10.0.0.101:/usr/share/oran-scripts
```

5. Run the following command to view the JSON file and confirm new edited values appear:

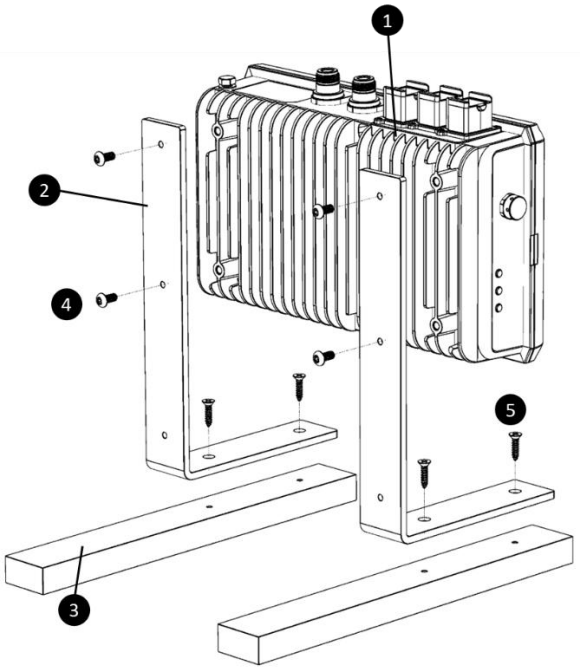
```
cat /usr/share/oran-scripts/default_settings.json
```

6. To set the configuration of the radio using the default JSON file and begin transmission, run the following command:

```
ru_app writeConfig
```

Appendix H: Vertical Stand Installation

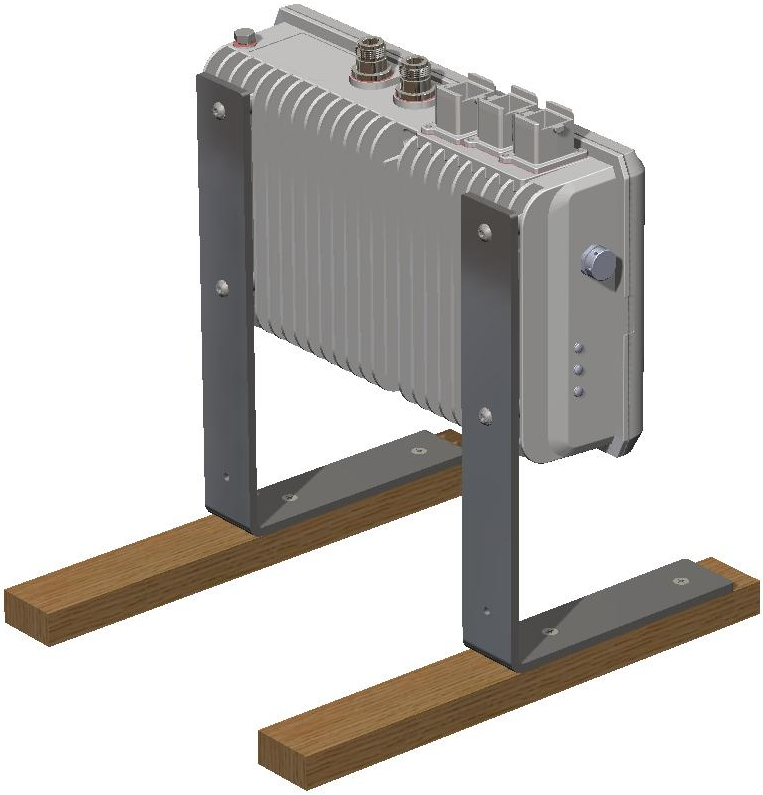
1. Provided are following materials: two (2) stand legs and four (4) screws. You will need a Philips head screwdriver to complete the installation. Complete this installation prior to installing any cabling to the RU's ports.



#	DESCRIPTION	QTY
1	RU	1
2	BRACKET, METAL, L10" x H6" x W1.5"	2
3	WOOD, 1.5IN x 2IN, L 12IN	2
4	SCREW, PAN, M5, L 12MM	4
5	SCREW, WOOD, #8, L 0.75IN	4

Required materials to install the stand.

2. Place the RU logo face-down with ports pointed away from you.
3. Install one leg at a time. Line up the stand leg's top two holes with the vertical screw holes on the back of the RU. Ensure the stand's metal foot is pointed downward.
4. Thread in the top screw halfway and ensure the hole for the bottom screw is still aligned. Thread in the bottom screw fully.
5. Repeat steps 3 and 4 for the second stand leg. Test both legs for stability – neither should have any movement when screwed in fully.
6. Stand up the RU. The RU is now ready for cable installation and operation.



Appendix I: Understanding data from `readStatus` command

Command `ru_app readStatus` provides a snapshot of packet flow, timing synchronization, and signal power. It is divided into two main sections: Downlink (DL) and Uplink (UL).

---

1. Packet Processing Chains

The top of the DL and UL sections display the processing pipeline (e.g., MAC → SMIC → ...).

- **Packet Counters:** These lines show the volume of packets passing through each stage. Value is reset to 0 every time this command is run.
- **Discrepancies:** As noted in the output, slight differences between stages are normal due to the time it takes to read the registers while data is flowing.

a. ORAN Timing Statistics

This table indicates if packets are arriving synchronized with the network clock.

Column	Meaning
On time	Healthy packets arrived within the correct window.
Early / Late	Packets arrived outside the window. High numbers indicate network sync/latency issues. Packets will still be processed.
Corrupted	Malformed packets that could not be processed.

2. Digital Power Measurement

This section provides an instantaneous snapshot of signal amplitude for one slot in **dBFS** (Decibels relative to Full Scale). Average and peak values per slot are shown.

- **Values:** Typical negative values (e.g., -30 dBFS) representing signal strength.

- **-inf (Negative Infinity):** This is **normal**. Because 5G switches rapidly between Transmit and Receive, a value of -inf means the command tried to measure Downlink power while the radio was in Uplink mode (or vice versa).

3. **Saturation Counters**

Used to detect signal clipping (distortion).

- **Overflow/Underflow:** Indicates if the signal calculation exceeded mathematical limits.
- **Auto-Clear:** These counters reset to 0 every time this command is run. If you see 0, no saturation has occurred *since the last read*.

Appendix J: Using power and saturation values to configure DU power levels

Since saturation registers **clear on read**, the time elapsed between commands is critical for interpretation.

- **Sampling Interval:** Establish a fixed, consistent read period (recommended: **1–5 seconds**). Always record the interval alongside the count.
- **Acceptable Thresholds:** Small amounts of clipping (non-zero values) are normal.
    - **Short Interval (1-5s):** Counts should remain in the **low two-digit range** (<99).
    - **Long Interval:** Do not use raw counts. Either calculate a rate (count/sec) or perform a burst of short-interval reads to verify.
- **Action:** If counts consistently exceed two digits during frequent sampling, reduce levels or adjust gain.

1. Measurement Points & Power Targets

a. Downlink (DL)

Measure at the IFFT Input and the Low PHY Output. Note that the per-layer output readings represent the same physical point.

Parameter	Target Power	Notes
Low PHY IFFT Input	**-3 dBFS**	Input to IFFT transformation.
Low PHY Output	**-24 dBFS**	Post-IFFT (measured per layer).

b. Uplink (UL)

The critical measurement point for the Uplink path is the FFT Output.

Parameter	Target Power	Notes
Low PHY FFT Output	**-3 dBFS**	Output from FFT transformation

```
================================================================================================================
DL Instantaneous Digital Power Measurement
----------------------------------------------------------------------------------------------------------------
NOTE: Values represent an instant snapshot, depends on TDD pattern.
A value of -inf means DL was measured during the RX part of TDD pattern.
----------------------------------------------------------------------------------------------------------------
Measure spot |  Low PHY IFFT Input | Low PHY IFFT Output |             Low PHY Output
             |     Layer 0 + 1     |     Layer 0 + 1     |       Layer 0       |       Layer 1
----------------------------------------------------------------------------------------------------------------
Power [dBFS] |           -15.3009 |           -34.165 |           -36.2735 |           -36.3407
Peak  [dBFS] |           -3.80865 |           -24.1166 |           -24.7051 |           -25.4692
================================================================================================================


================================================================================================================
DL Saturation Counters
----------------------------------------------------------------------------------------------------------------
NOTE: Registers are automatically cleared after this read.
----------------------------------------------------------------------------------------------------------------
Measure spot |  Low PHY IFFT Input | Low PHY IFFT Output |             Low PHY Output
             |     Layer 0 + 1     |     Layer 0 + 1     |       Layer 0       |       Layer 1
----------------------------------------------------------------------------------------------------------------
Overflow     |                   0 |                   0 |                  14 |                   7
Underflow    |                   0 |                   0 |                  26 |                   5
================================================================================================================


================================================================================================================
UL Instantaneous Digital Power Measurement
----------------------------------------------------------------------------------------------------------------
NOTE: Values represent an instant snapshot, depends on TDD pattern.
A value of -inf means UL was measured during the TX part of TDD pattern.
----------------------------------------------------------------------------------------------------------------
Measure spot |             Low PHY Input                 | Low PHY RX Filter  | Low PHY FFT Output
             |       Layer 0       |       Layer 1       |     Layer 0 + 1     |     Layer 0 + 1
----------------------------------------------------------------------------------------------------------------
Power [dBFS] |           -41.4507 |           -37.0536 |           -28.452 |           -22.1527
Peak  [dBFS] |           -27.5885 |           -23.9784 |           -15.4438 |           -3.45208
================================================================================================================


================================================================================================================
UL Saturation Counters
----------------------------------------------------------------------------------------------------------------
NOTE: Registers are automatically cleared after this read.
----------------------------------------------------------------------------------------------------------------
             |                    PUSCH                    |        PRACH
Measure spot |  Low PHY IFFT Input | Low PHY IFFT Output |  Low PHY IFFT Input
             |     Layer 0 + 1     |     Layer 0 + 1     |     Layer 0 + 1
----------------------------------------------------------------------------------------------------------------
Overflow     |                   0 |                   0 |                   0
Underflow    |                   0 |                   0 |                   0
================================================================================================================
```

Example of the readStatus command print with properly tuned DU power level values