

# Foxconn RPQN O-RU RPQN-4800 Installation and O perating Guide

#### $\equiv$ Property

Project name	Local 5G NR System
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#### Version History

Version	Date	Description of revision
v1.0	2024/5/6	Initial version of O-RU RPQN-4800 Installation and Operating Guide

#### Relevant documents

DOC-ID	Brief
[RP0-415]	Foxconn RPQN O-RU Firmware Upgrade Guide
[RP0-407]	Foxconn Sample App Operation Guide
[RP0-406]	Foxconn O-RU-RPQN Mounting Bracket Installation Guide
[RP0-416]	Foxconn RPQN O-RU Operating instruction for V1 firmware
[RP0-417]	Foxconn RPQN O-RU Operating instruction for V2 firmware





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# 1. List of Packages

- Indoor RPQN O-RU
- Model name:
  - RPQN-4800E, RPQN-4800I: 3550 ~ 3700 MHz
- Antenna x 4 (For external antenna type O-RU)
- Accessories: Following items are not included in the default package. Order separately.
  - 10Gb SFP+ GBIC
  - 1Gb Copper SFP
  - 12VDC power adapter and AC power cord
  - Mounting kit

### 1.1 Overview of RPQN O-RU

Pico Remote	Radio Unit
Highlight	
Radio	56 NR TOD
MSR	Band n48
FPGA	intel Arria10
Throughput	up to 1.6Gbps
Dimension	260mm×242mm×76.5mm (L×W×H)
Weight	< 4.5Kg
Power	< 60W
e	

lardware Configuration	<u>n</u>
ronthaul Interface ower Supplier femory stemal interface	O-RAN option 7.2 over 10Gbps SFP+ 12V DC/SA input and PoE++ DDBA 8Gb, micro5D/emmc Power Jack, Reset Button
GPP R15 requency hBW x/Rx Paths tax Output Power ntenna Gain oise Figure X Sensitivity	3.55-3.7Ghz 10, 20, 40, 100 MHz 4T4R; 4 data streams 24dBm (per RF connector) = 5dBi <5dB comply to 3GPP 75 138.141 spec.
ynchronization requency Stability requency Synchronization	±0.1ppm PTP(IEE1588v2)
letwork Features	SSH, IPv4
vironmental ress protection arking temperature	Class IP50 D*C*+40*C

Figure 1 RPQN O-RU Specifications



### 1.2 Overview

1.2.1 Indoor RPQN O-RU



Figure 2 RPQN O-RU Interfaces

- Right (Power): Power status
  - Solid Blue light: normal.
  - Red light: abnormal, currently known: maybe related power adapter.
- Middle (Service): Service status
  - Solid Green light:
    - Operational
  - Solid Red light:
    - Call Home connecting
    - Fault alarms
- Left (System): System status
  - Solid Blue light: normal
  - Solid Red color: abnormal, currently known: maybe load FPGA fail file system crash or SD card abnormal.
  - Blinking Red color: abnormal, currently known: maybe power on sequence is not complet



- e  $\,\cdot\,$  power IC broken.
- Blinking Red color: normal, load FPGA during boot.



Figure 3 RPQN O-RU Interfaces

- Power jack of 12VDC power adapter
- Reset button
- Micro USB
- 10Gbps SFP+ (support C/U/S/M-Plane)
- LAN1: 1 Gbps Ethernet RJ-45 connector (support S/M-Plane)
- LAN2: 10 Gbps Ethernet RJ-45 connector (PoE++ power supply purpose only)

1.2.2 10Gb SFP+ optics (GBIC)





Figure 4 Accessories - 10Gb SFP+ optics, multi-mode



Figure 5 Accessories - 10Gb SFP+ optics, single-mode

NOTE: Only use Laser Class 1 optical transceiver



### 1.2.3 1Gb Active Copper SFP



Figure 6 Accessories - 1Gb Copper SFP

### 1.2.4 12VDC AC Power Adapter



Figure 7 Accessories - 12VDC AC Power Adapter

This product is supplied with a Listed Power Adapter or DC power source marked "L.P.S." (or "Limited Power S ource"), rated 12 Vdc, 5 A minimum or 56 Vdc 1.2 A minimum (For PoE), Tma = 40 degrees C minimum. If you need further assistance, please contact Foxconn for further information.

#### NOTE: If using a Class I adaptor, you must connect the power cord to a grounded-outlet.

DC output power characteristics (CC MODE)	
1. OUTPUT VOLTAGE	+12 V
2. MAXIMUM OUTPUT CURRENT	5.5 A (full load)
3. LINE REGULATION	+/-2 %
4. LOAD REGULATION	+/-5 %



### 1.2.5 Mounting Kit

Please refer to:

• [RP0-406] Foxconn O-RU-RPQN Mounting Bracket Installation Guide

### 1.3 Software Version

Please refer to:

• [RP0-417] Foxconn RPQN O-RU Operating instruction for V2 firmware

To show the current software version of RPQN O-RU:

- Execute command "cat /home/root/test/version.txt" .
- The response may looks like below:

```
root@arria10:~/test# cat version.txt --
b_branch: (no branch)--
b_commit: 2239975f0470be2778ce95f1e32e9df56d70c212--
s_commit: 5adf7c5091d7b94f85cafc78da5772d7d7ef4ae3--
tag: v3.1.10q.524--
build_time: 202301161136--
```

In this example, the software version tag was v3.1.10q.524.



# 2. Regulation and Certification

### 2.1 Environmental and safety requirement

Environmental and safety requirements for RPQN O-RU hardware installation.

#### □ Warning: Electric Shock.

Please notice that the RF ports should be connected to a 50  $\Omega$  load (for example, feeder with an antenna) before powering on the RPQN O-RU.

#### □ Warning: Hot parts.

To avoid the risk of hot parts, please use the RPQN O-RU with caution, and wait at least 30 minutes before handling the RPQ N O-RU after powering off.

Only trained and qualified personnel are recommended to install, operate, maintain or handle the RPQN O-ORU, and plea se carefully read the safety information applicable to this product.

Only install RPQN O-RU in a restricted access location, and meet the minimum requirements of RF exposure compliance distance.

### 2.2 Federal Communication Commission Interference Statement

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including int erference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 1 5 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when t he equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio freq uency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interfere nce to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

However, there is no guarantee that interference will not occur in a particular installation. If this equipment does c ause harmful interference to radio or television reception, which can be determined by turning the equipment off a nd on, the user is encouraged to try to correct the interference by one 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.



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

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

#### Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment shoul d be installed and operated with a minimum distance 35 cm between the radiator & your body.

### 2.3 Conformité Européenne (CE) Interference Statement

This device complies with Directive 2014/53/EU and UK Radio Equipment Regulations 2017 SI 2017/1206. issued by the Commission of the European Community.

#### Declaration of Conformity

• Hereby, Foxconn declares that the radio equipment type 5G NR base station is in compliance with Directi ve 2014/53/EU and UK Radio Equipment Regulations 2017 SI 2017/1206.

The frequency and maximum transmitted power in EU are listed as below:

- RPQN-4800E: 3550 ~ 3700 MHz, 24 dBm
- RPQN-4800I: 3550 ~ 3700 MHz, 24 dBm



# 3. Cabling and Assembly Instruction



Figure 8 SA L5G System Architecture

### 3.1 RPQN O-RU cabling instruction



### 3.1.1 For O-RAN C/U/S/M-plane connection

10Gb SFP+ fiber cabling options:

- Intel 10Gb Short Range Optics (model: E10GSFPSR, 850 nm wavelength) + multi-mode fiber
- Intel 10Gb Long Range Optics (model: E10GSFPLR, 1310 nm wavelength) + single-mode fiber.

3.1.2 External Antenna port number (SMA connector)



### 3.1.3 RF Isolation

If your O-RU is an external antenna model, then suggest the following antenna direction to get better isolation. (On ly old HW SKU before S4 had this issue.)





### 3.1.4 Power supply

There are 2 options:

- PoE++ via LAN2 (10Gb RJ-45 Ethernet port): recommend to use Cat 6A Ethernet cable.
- 12V DC INPUT:
  - Maximum rating: +12 V (+/-10 %), 5 A
    - Recommendation is to use the same spec. with optional AC Power adapter (See section <u>1.2.4 12 VDC AC Power adapter</u> for more information.)
      - +12 V +/-5 %, 5.5 A
  - DC INPUT jack:



#### 3.1.4.1 Power backup system

The base station is recommended to be equipped with a backup power supply system which would include a batter y system to support the system for more than four hours to avoid AC power suddenly damaging the wireless system.

Additionally, Site engineers can prepare power generators to site to keep system operation in normal. At the same t ime, engineers need to contact relatives to fix the AC power down problem.

### 3.1.5 Micro USB

Micro USB: for RPQN O-RU debug console.





Figure 9 Example of Cable Assembly



# 4. Operating Instruction

### 4.1 Operating instruction

Please refer to:

- [RP0-416] Foxconn RPQN O-RU Operating instruction for V1 firmware.pdf
- [RP0-417] Foxconn RPQN O-RU Operating instruction for V2 firmware.pdf

### 4.2 Firmware upgrade

Please refer to:

• [RP0-415] Foxconn RPQN O-RU Firmware Upgrade Guide.pdf

### 4.3 How to use the sample app to verify O-RU working properly?

Please refer to:

- [RP0-407] Foxconn Sample App Operation Guide.pdf
  - for using sample-app to verify the FH connection (C/U-plane), S-plane and RF TX power.



# 5. FAQ

### 5.1 How to check if the O-RU is booted up and running normally?

• RRH RAM logs will be saved in /var/log/rrh\_log\_print/rrh\_log\_print.log\*.

This log might be useful for real-time debugging and rebooting issues troubleshooting.

tail -f /var/log/rrh\_log\_print/rrh\_log\_print.log

5017-07-91-11-30-51-097	[10] 10] A. T. MAN (214) T. MAN (115) - 22(0): 1315 [200] 1414 (1200) 2118 [200] 2118 [200] 2118 [200] 2118
2613-07-01 11:38 01 107	Latch later ippe-dutingtion evidence/institution eran_esc-dution ippe_dsizesoon evidence.ippe_dsi
5523-67-51 11 38 51:397	Curr #0271 01 00 + 36000 14500 55500 56000
3023-07-31 13 30 91 107	Rear FDG_ADR015_FC_DVPADD_ADDR to 0x000001
2023-07-31 21:38 51 107	Tpea 880 XB40 SYR-DL JG_SCALING 90019391
2023-07-31 11:38 52.000	100: secold boxvid tib-1707 attails/algo tabal-4107 ani-0 uni gt_1155-0 malti-4107 erg_arr+0
2023-07-31 L1 30 12 00W	107. secold tours)d datellin fitellinit totalellin unted uningt_dition sultiplii cro_seron status) of
2022-07-31 11 38 12 006	(x80) total=0 m.emily=0 m.on=0 m.late=0 err.tmi=0 err.ecpri=0 err.port=0 err.stt=0 err.tutal=0
2023-07-31 11 30 12 008	REPL state=HEARY FOR DWTA
20230-07-01 11 38.92.008	ptp: staturi seculd raph aspit traps-20 delaysis
2013-07-31 11.30.02.058	pros 1110 (juli 1217 1, mil 1213 - 7, avg. 2312 1, avg. 1408 - 7, mil 4983 1, mil 12818
2023-07-01 11:08:32 108	Latch later type-04765chda7 ee(4010-05765chda1 mrss_eec-05785chda1 tpns_0-1222070000 ge)4010_tpps_0-1-1
2023-07-31 11 38 11 109	corr #0090 u1 Rg + 15500 55100 54500
2023-07-31 11:30 12 109	Peep BEG_AE9025_EC_PTPACE_AEEE IN #s000001
5023-07-31 51:38 92.10M	1pga 885_3840_299_38_10_5641105 19011001
2022507-31 11 38:53 010	100: seculy specify sebury74 Altoist-Jeas foral-4127 uni-0 uni-pt.1155-0 aulti-6227 dri.arr+7
20113-07-01 11 38 83 016	(10): secol) history (40-1141 0)thilt(1) hits/0101 union union/(1150-0 multist)) crimerto statusi at
2413-07-31 11:30 13:020	(198) totaled c_earlyed c_oned c_later0 err_score err_score) err_ported err_schel err_totaled
2022-07-01 11:00:53 010	REE, state-REEX_ROP_DATA
2013-07-31 11:30 33.010	ptp://atatev2/wede15/rmpet/mmetil_frequ-23/delaye04
2023-07-01 11 30 13-000	prior Entry (Legin 2233) Linit 8322 (Leng-2330 Linit 8408), (Linit 8778 Linit 2795)
IEIJ-07-31 41 38 93 11E	Latch latar 1ggs-0x7da1bda7 swi4010-0x5da1bda7 xras_asc+0x70a1bda7 lpps_d-111880050 swi4010_lpps_d-0
2023-07-31 51 38:53 130	-dpdfreueCode = ==================================
2023-07-51 11 30 53 330	apply estimate a second s
1017-07-31 11.30 93.110	dpdindirotters
2022-07-01 11.00 43.115	100389440010E1N447 -2147482848 -2147483648 -2147483648 -2147483648 million
2023-07-31 11 38 13 111	dpdFwinPDtdErevert ~2147403448 ~2147483648 ~2147482648 ~2147403648 will set
2022-07-21 31 20:13:111	http://www.stub.com/stub.co
2023-07-91 11:38:53 311	(dp/07/08/748/04/05 -2147483848 -2147483648 -2147483648 -2147483648 million
2020-07-01 11:00:00:111	CODEMMONOTOPOMAT -2147483840 -2147483648 -2147483648 -2147483648 -3147483648
20123-07-01 21:39:85.115	ADMINARTH2004481 - 22147455648 - 22147482648 - 22147482648 - 22147482648 - 22147482688

- When "Latch xxx 1pps" strings appear, the O-RU is synchronized with a GM/BC and finishes the initia lization.
- Execute command "/usr/utils/get/get\_ru\_diag.sh", RU will automatically collect the log file "/tmp/ru\_diag.tar.gz", if RU reboot then ru\_diag.zip will disappear.
- Value definition:
  - 10R…means number of packets received from BBU.
  - 10T…means number of packets transmitted to BBU.
  - 64b: number of c-plane packets with size 64 bytes.
  - 65to128: number of packets with size between 65 bytes to 128 bytes.
  - uni>1158: number of u-plane packets with size greater than 1158.
  - total: total number of packets.
  - uni: number of unicast packets.
  - multi: number of multicast packets.
  - crc\_err: number of packets with CRC error.
  - state = 1 : RU is waiting for the 1st c-plane message.
  - state = 2 : RU has received the 1st c-plane and started working.
  - c\_early: Number of c-plane packets arrived early.



- c\_on: Number of c-plane packets arrived on time.
- c\_late: Number of c-plane packets arrived late.
- err\_tci: is the packet being dropped due to TCI mismatch
- err\_ecpri: is the packet being dropped due to eCPRI mismatch
- err\_port: is the packet being dropped due to RU\_port mismatch.
- err\_sct: is the packet being dropped due to section type mismatch.
- atick: keep receiving c-plane packets every second.
- $\circ$  iatick: how long has RU not received the c-plane packet, 0 is normal.
- ptp state: ptp state=3 is locked.

### 5.2 Log "xran 10GbE is not ready... d6fff000" is normal or abnormal?

No. Please check 10GbE connectivity and make sure 10GbE is linkup at DU server.

### 5.3 Can I add a Switch between O-RU and GM?

Yes. But, please make sure Switch supports IEEE 1588 PTPv2.

### 5.4 Can I add a Switch to connect O-RU and O-DU?

Yes. Please make sure the switch supports the following items:

- The L2 switch should support VLAN with tag.
- Those ports (connected to BBU and RU) should be in trunk mode.
- Both VLAN 1 and VLAN 2 should be in those trunk ports.
- Keep VLAN tag in those ports (DO NOT set untag).
- Enable jumbo frames. Set frame size more than 9000 Bytes.



Figure 10 O-RU O-DU connectivity with Switch and GM



### 5.5 How to enable Auto Running?

If you want to make RU running automatically after power on, please add below lines into the bottom of file: "/et c/profle" : (To configure IP and launch CU plane)



- How to change configuration after enabling auto boot up?
  - If you can remote SSH to O-RU using account: root, password: e/4g;4uh/6x.6
    - i. Make changes in *RRHconfig\_xran.xml*.
    - ii. Run /home/root/test/reboot.sh.
    - If you **can not** remote SSH to RRH, you can:
      - i. Connect to O-RU via the USB Serial Port.
      - ii. Unplug power cord and plug in again.
      - iii. Once the prompt appears, press "Ctrl+C" to stop the running process.
      - iv. Make changes in *RRHconfig\_xran.xml*.
      - v. Run /home/root/test/reboot.sh.
- How to disable auto boot up?
  - Just remove the above command in */etc/profile*.

### 5.6 How to configure IP permanently?

RPQN works as DHCP client as default at OAM image. You must prepare a DHCP server.

#### FW type:

- ENG FW installer file: install\_**eng**\_v3xxxxx.run
- OAM FW installer file: install\_**oam**\_v3xxxxx.run
- Enable OAM: "./set\_oam\_mode -e"
- Disable OAM: "./set\_oam\_mode -d"
- ./set\_oam\_mode -h for help

#### How to config IP:

- OAM FW and OAM is enabled:
  - 1G interface: eth0
    - Static IP:

# Append below lines into bottom but top of line "exit 0" in file



# "/etc/rc.local"
.....
ifconfig eth0 192.168.19.19/24 # config any IP
exit 0

- 10G interface: **gse-eth** 
  - Static IP: "./set\_oam\_mode -e {\$IP}"
  - DHCP: "./set\_oam\_mode -e"

if [ \$(tty) = "/dev/ttyS0" ]; then
./set_gse.sh 100 # 100 depends on your subnet setting
./init_rrh_config_enable_cuplane
fi



- Eng FW or OAM is disabled:
  - v1.x.x FW:
    - 1G interface: eth0
      - Static IP:



- 10G interface: Won't show up in v1.x.x FW
- v2.x.x FW or newer:
  - 1G interface: eth0 and 10G interface: qse-eth
    - Static IP:
      - Before v3.1.2q.524



• After v3.1.2q.524 (included)





### 5.7 How to check PTP/RRH timing log?

tail -f /var/log/rrh\_timing\_service.log

### 5.8 Which PRACH format does RU support?

RU only supports short PRACH format  $\mathbf{B4}$ .

### 5.9 How to calculate Tx power?

- With HW SKU S4, which is a calibrated unit, Tx power is fixed to 24 dBm based on Max(I,Q) r.m.s **512** s ending from DU to RU.
- Peak antenna gain is 5.15 dBi (RPQN-4800E: External antenna).

### 5.10 How to disable/enable DPD?

- In O-RU path /home/root/test/RRHconfig\_xran.xml:
  - Disable DPD: **RRH\_RF\_GENERAL\_CTRL = 0x0**, 0x0, 0x0, 0x0
  - Enable DPD: **RRH\_RF\_GENERAL\_CTRL = 0x3**, 0x0, 0x0, 0x0
- Note: This setting affects all 4 ports.
- CLGC (Closed Loop Gain Control), RRH\_RF\_GENERAL\_CTRL 2nd word set to 0x1
  - **RRH\_RF\_GENERAL\_CTRL** = 0x3, 0x1, 0x0, 0x0

# 5.11 Is RU PTP profile compliant with ITU-T G.8273.2? (T-TSC) – please c onfirm?

• Yes, RU is compliant with ITU-T G.8273.2 T-TSC

### 5.12 What is the T-TSC clock class for RU? Is it class B or class C?

• Class B



### 5.13 What is the max ITEI for the RU?

• 80 ns

### 5.14 TX\_POWER invalid value

When the O-RU goes into a weird state like the phenomenon below, Please backup the calibration table and re-inst all the software again.then the calibration mean table with multiple power points will be installed, O-RU can config

ure different TX power (24 to 9)

```
RRH_PTPV2_IP_MODE = IPv4

Read RRH_PTPV2_GRAND_MASTER_IP = 192.167.27.150

RRH_PTPV2_SUB_DOMAIN_NUM = 24

RRH_PTPV2_ACCEPTED_CLOCK_CLASS = 135

RRH_TRACE_PERIOD = 10

Read MAC address from /usr/src/addr.xml = 6C:AD:AD:00:06:44

Bead ifconfig qse.eth = 6C:AD:AD:00:06:44

Head ifconfig qse.eth = 6C:AD:AD:00:06:44

Head if config qse.eth = 6C:AD:AD:00:06:44

Head if config qse.eth = 6C:AD:AD:00:06:44

Head if config qse.eth = 6C:AD:AD:00:06:44

Result RRH_RX_TOTAL_GAIN = FIXED

Result RRH_RX_TOTAL_GAIN = FIXED

Result RRH_RX_ATTENUATION = 1.7, 1.7, 1.7, 1.7

Result PA Protection: Enabled

Result Thermal compensation: Disabled. Because there is no thermal compensation data

Result RRH_PTPV2_GRAND_MASTER_IP = ND needed
```

- 1. cd /usr/src/
- **2.** mkdir backup\_cal
- 3. mv cal\_\* backup\_cal/
- 4. cd /home/root/test/
- 5. ./install\_eng\_v3xxx.run