

MMW smallcell user manual

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1、 Product overview

1.1Product appearance.

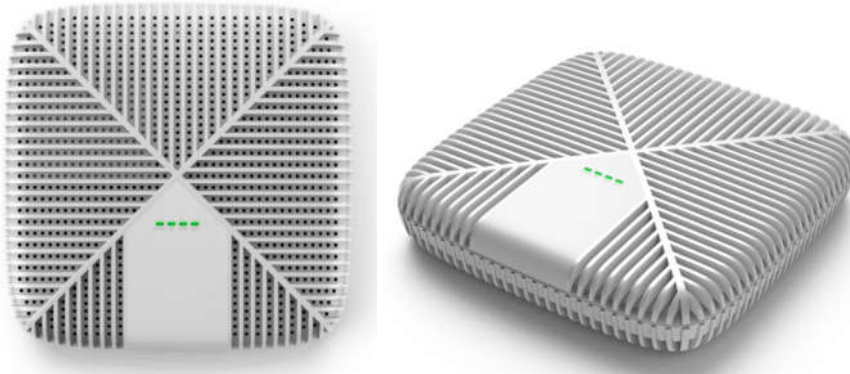


Figure 1-1 equipment appearance

Table 1-1 shows the interface description of mmWave small cell.

Interface name	number	Interface type	Interface definition	remarks
MGT	1	RJ45	1 1000Base-T, RJ45	
SFP	1	SFP	10G Optical interface SFP+	optional interface
DC 12V	1	DC socket	DC12V	
RGPS	1	RJ45	GPS / BeiDou synchronous input interface	

table 1-2 mmWave small cell indicator

LED	System LED	Green: on, the system starts normally Green: off, system not started
	Alarm LED	Red: on, Motherboard control failure Red: off, Motherboard is normal
	LAN management port	100 / 1000 adaptive, green and yellow LEDs Green (link): on, light port works normally Green (link): off, faulty or not working Red (ACT): flashing, with data transmission Red (ACT): off, no data transmission NOT support 10Mbps
	Backhaul port	Green (link): on, light port works normally Green (link): off, faulty or not working
	Synchronous port	Green: on, GPS or IEEE1588 synchronization successful Green: off, no synchronization or

		synchronization failure
--	--	-------------------------

1.2 technical specifications

1.2.1 Hardware specifications

project	describe
Installation mode	Indoor scene: ceiling and wall
Power dissipation	<65W
Power module	DC12V
CPU Spec	NXP LX2160A
Modem	1*FSM10055+1*QTM10028
FLASH	8GByte eMMC Nand
DDR	4GByte DDR4 for CPU
LAN management port	1 1000Base-T, RJ45
Debug port	1 RS232
Backhaul port	1 10G SFP+
Synchronous input interface	GPS / BeiDou synchronous input interface: RJ45

1.4.2 business specifications

project	description
performance	1. Support 1 radiation surface 2. Carrier bandwidth: single carrier 100MHz, 3. Backhaul: 10G Optical interface SFP+
Compatible design	Supports distributed base stations (option2, split in RLC)
Synchronization mode	1. RGPS synchronization 2. IEEE1588 V2 synchronization 3. SyncE synchronization
Key technology	1. High speed signal, RF requirements for PCB design 2. Large power consumption of the system, natural heat dissipation of the system
Band and bandwidth	Support standard 3GPP 5g-nr rel-15 Support TDD Spectrum: 27500~28350Mhz, Bandwidth: single carrier 100MHz, 4*100MHz follow-up support Antenna: 128 Rx / TX Rate: DL6. 5Gps, UL3. 2Gps

Tx Spec	All requirements in the agreement shall be met, and the requirements for key index margin are as follows in full load operation, 64QAM modulation, and ACLR and EVM meet the requirements: EIRP$\geq$37dBm. The worst beam: ID 123 AZ -45° EL-38° EIRP -38.2dBm
Rx Spec	All requirements in the agreement shall be met, and the requirements for key index margin are as follows Throughput loss shall not exceed 5%, uplink signal g-fr2-a1-3: - 95dbm

1.4.3 Environmental specifications

project	description
Storage temperature / humidity	The equipment shall be able to work or store normally within the following temperature and humidity range: Operating temperature: - 5 ° C to + 45 ° C Storage temperature: - 40 ° C to + 70 ° C Relative humidity: 5% ~ 95% (no condensation)
Heat dissipation mode	Natural convection heat dissipation
Noise	NA
Atmospheric pressure	86 Kpa~106 Kpa
Protection level	IP30
Surge	Indoor products, no surge requirements

2 Configuration

2. 1Ip address configuration

The default configuration is static with IP address 192.168.1.10, and you can change this IP following below operations.

Logon on board with SSH or serial tool user:root password:root

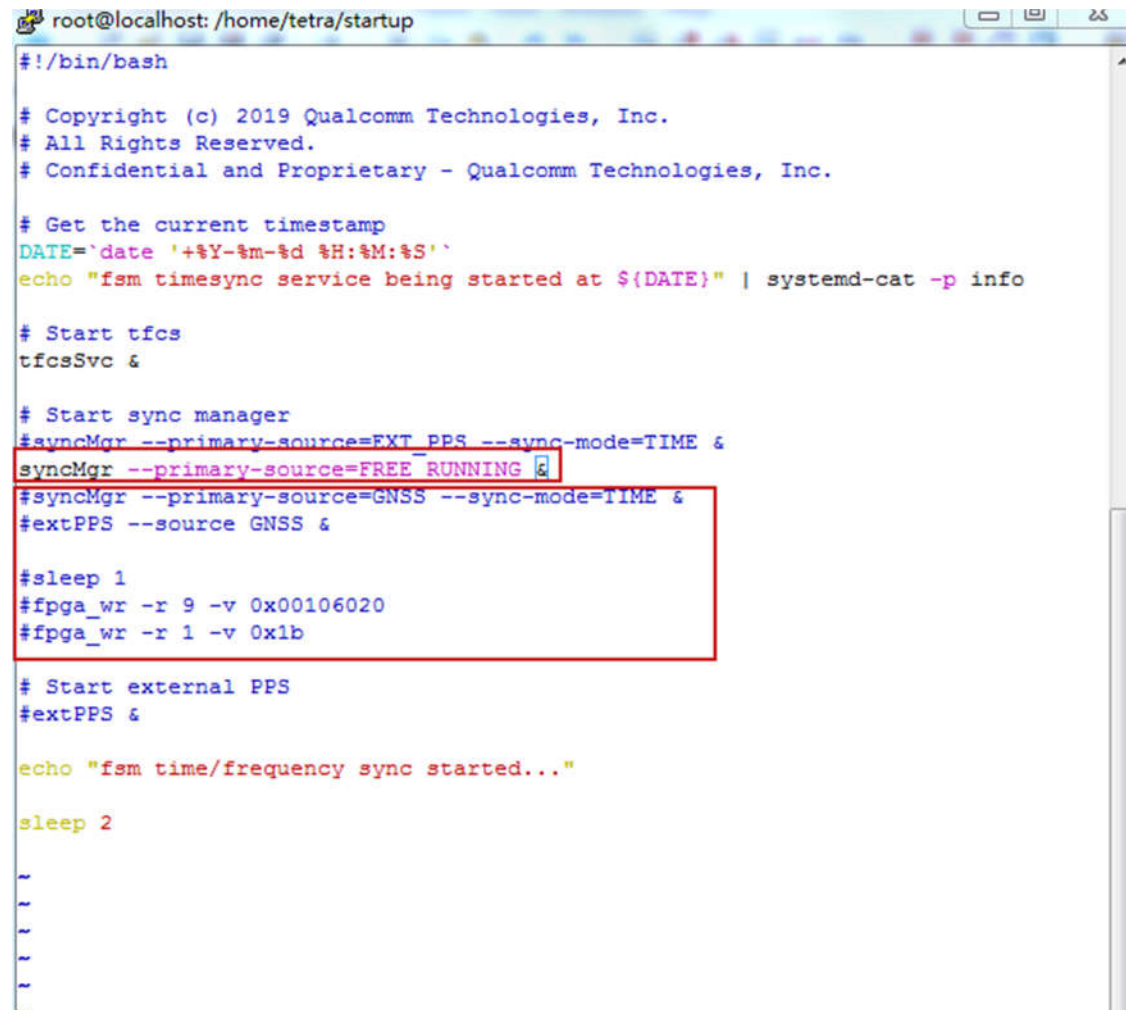
Vi /etc/netpaln/01-netcfg.yaml Edit 01-netcfg.yaml and enter the static ip address.

Eth0 is for SFP interface Eth1 is for Ethernet interface.

Execute ‘netplan apply’ and ‘sync’ command will save this configuration.

2.2 Synchronization configuration

Freedom configuration is as below



```
root@localhost: /home/tetra/startup
#!/bin/bash

# Copyright (c) 2019 Qualcomm Technologies, Inc.
# All Rights Reserved.
# Confidential and Proprietary - Qualcomm Technologies, Inc.

# Get the current timestamp
DATE=`date +%Y-%m-%d %H:%M:%S`
echo "fsm timesync service being started at ${DATE}" | systemd-cat -p info

# Start tfcs
tfcsSvc &

# Start sync manager
#syncMgr --primary-source=EXT_PPS --sync-mode=TIME &
syncMgr --primary-source=FREE RUNNING &
#syncMgr --primary-source=GNSS --sync-mode=TIME &
#extPPS --source GNSS &

#sleep 1
#fpga_wr -r 9 -v 0x00106020
#fpga_wr -r 1 -v 0x1b

# Start external PPS
#extPPS &

echo "fsm time/frequency sync started..."

sleep 2

~
~
~
~
~
```

When GNB connect to a GPS you can set GPS synchronization
GPS configuration is as below

```
#!/bin/bash

# Copyright (c) 2019 Qualcomm Technologies, Inc.
# All Rights Reserved.
# Confidential and Proprietary - Qualcomm Technologies, Inc.

# Get the current timestamp
DATE='date '+$Y-$m-$d %H:%M:%S`
echo "fsm timesync service being started at ${DATE}" | systemd-cat -p info

# Start tfcs
tfcsSvc &

# Start sync manager
#syncMgr --primary-source=EXT_PPS --sync-mode=TIME &
#svncMgr --primary-source=FREE_RUNNING &
syncMgr --primary-source=GNSS --sync-mode=TIME &
extPPS --source GNSS &

sleep 1
fpga_wr -r 9 -v 0x00106020
fpga_wr -r 1 -v 0x1b
# Start external PPS
#extPPS &

echo "fsm time/frequency sync started..."

sleep 2

~
~
~
~
~
```

3 Upgrading

3.1 Upgrading Preparation

3.1.1 Upgrading Scenario

5G mmWave Small Cell product is a low-power and low-cost 5G mmW gNB. In this document, it's briefed as 5GmmW gNB.

This document and corresponding MP1.7.2s package only apply to 5G mmW gNB whose login prompt shows it's MP1.6、MP1.7.2 as the followings:

```
...
TW 5GmmW Devel MP1.6 //MP1.6 Version login prompt
localhost login:root
Password:root
...
=====
...
TW 5GmmW Devel MP1.7.2 //MP1.7.2 Version login prompt
localhost login:root
```

Password:root

...

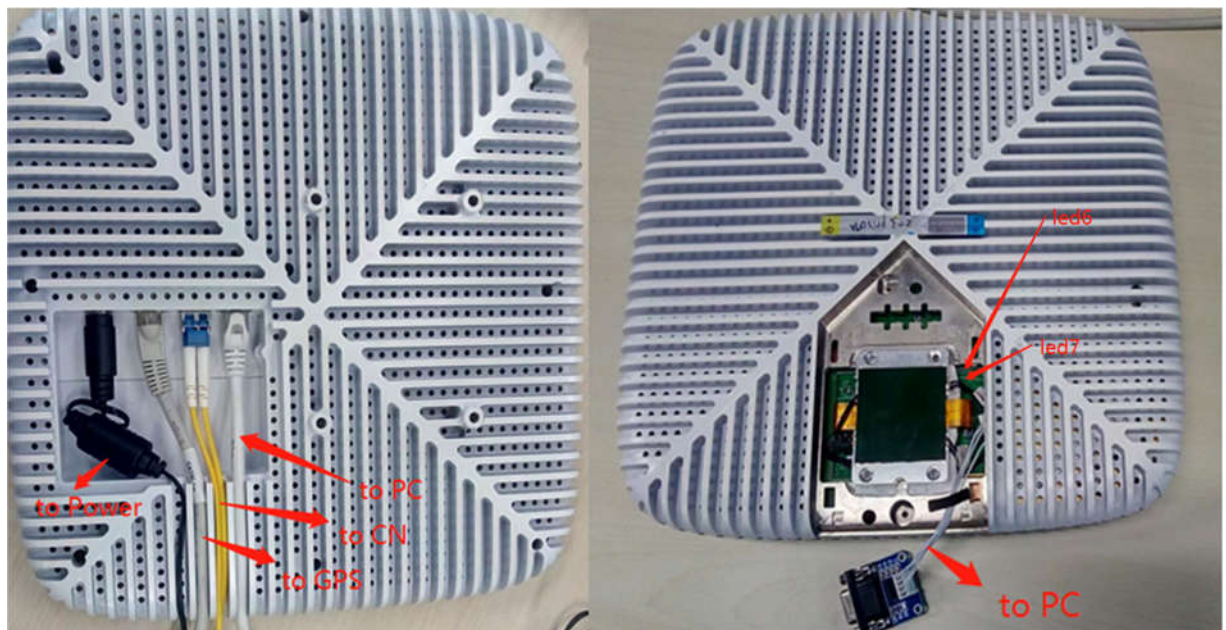
3.1.2 Upgrading Procedure

Procedure: ① Preparation-> ② Upgrading uboot-> ③ Upgrading system application and running validation tests.

3.1.3 Tools

These tools will be used while upgrading system: WinSCP、PC (above windows 7) 、Tera Trem or Xshell 6.

3.1.4 5GmmW gNB Interface Configuration



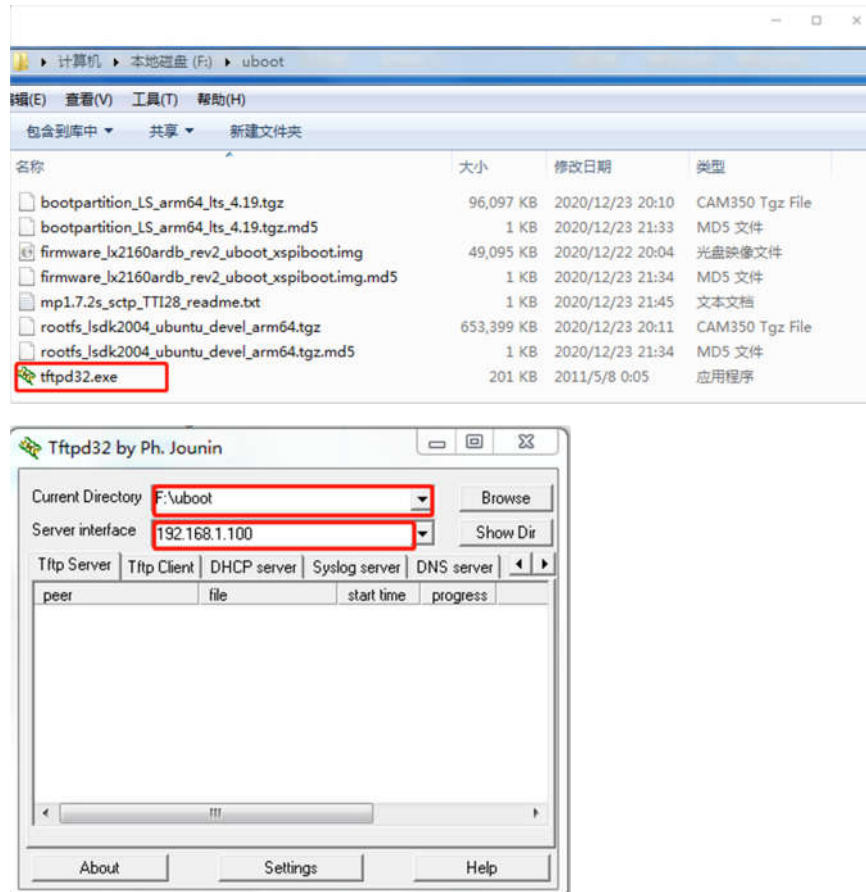
The parameters of COM connecting 5GmmW gNB and PC should be configured as:
Baud rate:115200、Data: 8bit、Parity: none、Stop: 1bit、Flow control: none、Transmit delay: 1msec/char 0 & msec/line,

The IP of GE/FE of PC should be configured as: 192.168.1.100.

The IP of GE/FE of 5GmmW gNB should be configured as: 192.168.1.10 (default setting of the system) .

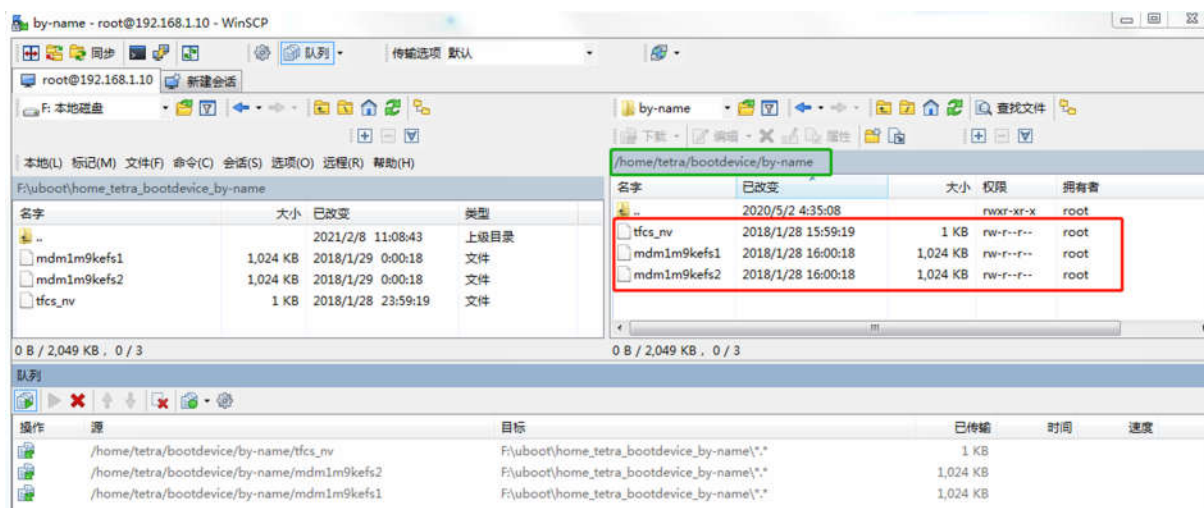
3.1.5 Creating tftpd32 Serving in PC

Uppack the MP1.7.2s package in PC and run tftpd32.exe. The GUI of tftp server will be shown as following:



3.1.6 Backup 5GmmW gNB Calibration files

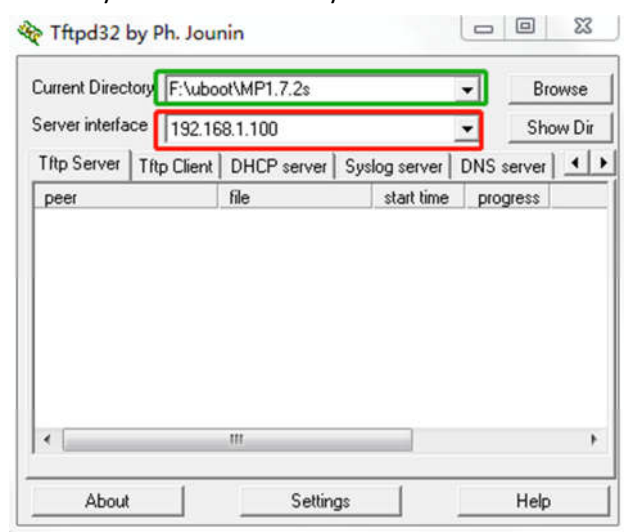
Connect PC and 5GmmW gNB via GE, run WinSCP in PC, and backup calibration files “mdm1m9kefs1”, “mdm1m9kefs2”, “tfcs_nv” located under /home/tetra/bootdevice/by-name in 5GmmW gNB to MP 1.7.2s software directory, directory in PC, for example, F:\uboot\bootdevice\by-name.



3.2 Upgrading u-boot

3.2.1 Checking tftpserver

Make sure there is a file named "firmware_lx2160ardb_rev2_uboot_xspiboot.img" under directory "Current Directory".



Current Directory: uboot image file directory

Server interface: tftpserverip.

3.2.2 Operaton on u-boot interface

Step 1.

As gNB is booting, when there is a prompt "Hit any key to stop autoboot:", press anykey to enter u-boot command line.

```

SF: 524288 bytes @ 0x640000 Read: OK
device 0 offset 0xa00000, size 0x300000
SF: 3145728 bytes @ 0xa00000 Read: OK
device 0 offset 0xe00000, size 0x100000
SF: 1048576 bytes @ 0xe00000 Read: OK
crc32+
fsl-mc: Booting Management Complex ... SUCCESS
fsl-mc: Management Complex booted (version: 10.20.4, boot status: 0x1)
Hit any key to stop autoboot: 0
=>

```

Step 2.

Setting the ethernet interface, local IP of the board, and tftpserverIP.

=>setenv ethact DPMAC17@rgmii-id # set an available Ethernet interface.

=>setenv ipaddr 192.168.1.10 # set local IP of the board.

=>setenv serverip 192.168.1.100 # set server IP

=>saveenv # saveenv the variables

```

=> setenv ethact DPMAC17@rgmii-id
=> setenv ipaddr 192.168.1.10
=> setenv serverip 192.168.1.100
=> saveenv
Saving Environment to SPI Flash... Erasing SPI flash...Writing to SPI flash...done
OK

```

Step 3.

Test if the tftp server can connect to the board.

=>ping \$serverip

The text in the red box means the the connection is successfully setup.

```

DPMAC counters ..
DPMAC_CNT_ING_BYTE=15
DPMAC_CNT_ING_FRAME_DISCARD=11
DPMAC_CNT_ING_ALIGN_ERR =10
DPMAC_CNT_ING_BYTE=15
DPMAC_CNT_ING_ERR_FRAME=22
DPMAC_CNT_EGR_BYTE =23
DPMAC_CNT_EGR_ERR_FRAME =27
host 192.168.1.100 is alive
=>

```

The text in the red Box in the following figure means the tftp server does not work.

Please check the network or configuration.

```

DPMAC counters ..
DPMAC_CNT_ING_BYTE=15
DPMAC_CNT_ING_FRAME_DISCARD=9
DPMAC_CNT_ING_ALIGN_ERR =10
DPMAC_CNT_ING_BYTE=15
DPMAC_CNT_ING_ERR_FRAME=20
DPMAC_CNT_EGR_BYTE =21
DPMAC_CNT_EGR_ERR_FRAME =25
ping failed; host 192.168.1.100 is not alive
=>

```

Step 4.

Probe flash.

=>sf probe 0:0

SF: Detected mt35xu512g with page size 256 Bytes, erase size 128 KiB, total 64 MiB
or

SF: Detected mt25u51245g with page size 256 Bytes, erase size 64 KiB, total 64 MiB

=>

```
=> sf probe 0:0
SF: Detected mx25u51245g with page size 256 Bytes, erase size 64 KiB, total 64 MiB
=>
```

or

```
=> sf probe 0:0
SF: Detected mx25u51245g with page size 256 Bytes, erase size 64 KiB, total 64 MiB
=>
```

Step 5.

Download u-boot image. Please note the name of the image file should not be changed.

=>tftp 0xa0000000firmware_lx2160ardb_rev2_uboot_xspiboot.img

```
=> tftp 0xa0000000 firmware_lx2160ardb_rev2_uboot_xspiboot.img
debug 1209-: detected phy at DPMAC17,
1209, phy function enter: genphy_startup
debug 1209-: can't detected phy at DPMAC17, current phy_num = 1, max phy num =2, driver exited!
debug 1209, get dpmac state err = 0x0
ldpaa_dpmac_bind, DPMAC Type= dpmac
ldpaa_dpmac_bind, DPMAC ID= 17
ldpaa_dpmac_bind, DPMAC State= 0
ldpaa_dpmac_bind, DPNI Type= dpni
ldpaa_dpmac_bind, DPNI ID= 0
ldpaa_dpmac_bind, DPNI State= 0
DPMAC link status: 1 - up
DPNI link status: 1 - up
Using DPMAC17@rgmii-id device
TFTP from server 192.168.1.100; our IP address is 192.168.1.10
Filename 'firmware_lx2160ardb_rev2_uboot_xspiboot.img'.
Load address: 0xa0000000
Loading: #####
#####
#####
```

If it succeed, the prompt will show the following information:

```
#####
#####
6.1 MiB/s
done
bytes transferred = 50273180 (2ff1b9c hex)
DPNI counters ..
DPNI_CNT_ING_ALL_FRAMES= 98194
DPNI_CNT_ING_ALL_BYTES= 54790190
DPNI_CNT_ING_MCAST_FRAMES= 0
DPNI_CNT_ING_MCAST_BYTES= 0
DPNI_CNT_ING_BCAST_FRAMES= 0
DPNI_CNT_ING_BCAST_BYTES= 0
DPNI_CNT_EGR_ALL_FRAMES= 98193
DPNI_CNT_EGR_ALL_BYTES= 4516944
DPNI_CNT_EGR_MCAST_FRAMES= 0
DPNI_CNT_EGR_MCAST_BYTES= 0
DPNI_CNT_EGR_BCAST_FRAMES= 8
DPNI_CNT_EGR_BCAST_BYTES= 336
DPNI_CNT_ING_FILTERED_FRAMES= 0
DPNI_CNT_ING_DISCARDED_FRAMES= 0
DPNI_CNT_ING_NOBUFFER_DISCARDS= 0
DPNI_CNT_EGR_DISCARDED_FRAMES= 0
DPNI_CNT_EGR_CNF_FRAMES= 0

DPMAC counters ..
DPMAC_CNT_ING_BYTE=15
DPMAC_CNT_ING_FRAME_DISCARD=9
DPMAC_CNT_ING_ALIGN_ERR =11
DPMAC_CNT_ING_BYTE=15
DPMAC_CNT_ING_ERR_FRAME=21
DPMAC_CNT_EGR_BYTE =21
DPMAC_CNT_EGR_ERR_FRAME =25
=> 
```

Step 6.

Erase all contents in flash. Please note this step cannot be rolled back, so please make sure your commands are exactly the same as the following example. Please make sure the power is kept on and do not press enter key repeatedly (otherwise, the u-boot will run the command repeatedly). The time of executing the whole step is estimated about 1 min.

```
=>sf erase 0 +$filesize
```

```
=> sf erase 0 +$filesize
SF: 50331648 bytes @ 0x0 Erased: OK
```

Step 7.

Writing the downloaded u-boot image to the flash. Please note this step cannot be rolled back, so please make sure your commands are exactly the same as the following example. Please make sure the power is kept on and do not press enter key repeatedly (otherwise, the u-boot will run the command repeatedly). The time of executing the whole step is estimated about 1 min.

```
=>sf write 0xa0000000 0x0 $filesize
```

```
=> sf write 0xa0000000 0x0 $filesize  
device 0 offset 0x0, size 0x2ff1b9c  
SF: 50273180 bytes @ 0x0 Written: OK  
=> █
```

Step 8.

Power off 5GmmW gNB and then turn on it. Please note the “no link” warning in the following picture is a normal log.

[illegible]

Enter the u-boot command, and put the following command to set the MAC address, making sure the MAC address is unique in a subnet:

:

```
=>setenv ethaddr 00:04:9F:06:10:71
```

```
=>setenv eth1addr 00:04:9F:06:10:70
```

=>saveenv

```

crc32+
fsl-mc: Booting Management Complex ... SUCCESS
fsl-mc: Management Complex booted (version: 10.20.4, boot status: 0x1)
Hit any key to stop autoboot: 0
=> setenv ethaddr 00:04:9F:06:10:71
=> setenv eth1addr 00:04:9F:06:10:70
=> saveenv
Saving Environment to SPI Flash... Erasing SPI flash...Writing to SPI flash...done
OK
=>

```

Power off the gNB and restart it. Make sure the mac address is correct in Linux, otherwise, repeat step 8.

root@localhost:~#ifconfig -a

```

root@localhost:~#
root@localhost:~# ifconfig -a
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet6 fe80::204:9fff:fe06:1071 prefixlen 64 scopeid 0x20<link>
    ether 00:04:9f:06:10:71 txqueuelen 1000 (Ethernet)
    RX packets 0 bytes 0 (0.0 B)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 2 bytes 412 (412.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

eth1: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 192.168.1.10 netmask 255.255.255.0 broadcast 192.168.1.255
    inet6 fe80::204:9fff:fe06:1070 prefixlen 64 scopeid 0x20<link>
    ether 00:04:9f:06:10:70 txqueuelen 1000 (Ethernet)
    RX packets 26 bytes 3419 (3.4 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 7 bytes 586 (586.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

```

3.3 Upgrad system application and run validation tests

3.3.1 TinyLinuxlogin

Restart gNB, and input the following command under u-boot command line.

```

=>setenv boot_targets "usb0 mmc0 scsi0"
=>setenv bootcmd_mmc0 "devnum=0; run mmc_boot"
=>boot

```

```

=> setenv boot_targets "usb0 mmc0 scsi0"
=> setenv bootcmd_mmc0 "devnum=0; run mmc_boot"
=> boot

```

Input user name: root

NXP LSDK tiny 2004 (based on Yocto)

TinyLinux login:root

3.3.2 Run upgrading script

root@TinyLinux:~# /bin/twupdate

```
root@TinyLinux:~# /bin/twupdate
```

After about 8 min, if it's shown "Installation completed successfully", the upgrading is successful.

```
Downloading rootfs_ksdk...LS_arm64_main.tgz .....
total 732M
drwxrwxrwt 2 root root 100 May 2 04:38 ./
drwxrwxrwt 4 root root 80 May 2 04:31 ../
-rw-r--r-- 1 root root 430 May 2 04:39 .1
-rw-r--r-- 1 root root 94M May 2 04:45 bootpartition_LS_arm64_lts_4.19.tgz
-rw-r--r-- 1 root root 639M May 2 04:48 rootfs_ksdk1906_LS_arm64_main.tgz
/dev/mmcblk1: 124 GB
Partitioning /dev/mmcblk1 ...
[ 1016.03685] mmcblk1:
Formatting partitions ...
/dev/mmcblk1p1 contains a ext4 file system labelled 'misc'
last mounted on Sat May 2 04:38:30 2020
/dev/mmcblk1p2 contains a ext4 file system labelled 'boot'
last mounted on /mnt/mmcblk1p2 on Sat May 2 04:38:30 2020
/dev/mmcblk1p3 contains a ext4 file system labelled 'backup'
last mounted on Sat May 2 04:38:30 2020
/dev/mmcblk1p4 contains a ext4 file system labelled 'system'
last mounted on /mnt/mmcblk1p4 on Sat May 2 04:38:30 2020
[ 1160.395956] EXT4-fs (mmcblk1p1): mounted filesystem with ordered data mode. Opts: (null)
[ 1160.432506] EXT4-fs (mmcblk1p2): mounted filesystem with ordered data mode. Opts: (null)
[ 1160.468632] EXT4-fs (mmcblk1p3): mounted filesystem with ordered data mode. Opts: (null)
[ 1160.507885] EXT4-fs (mmcblk1p4): mounted filesystem with ordered data mode. Opts: (null)
Model: MMC S0J59X (sd/mmc)
Disk /dev/mmcblk1: 127GB
Sector size (logical/physical): 512B/512B
Partition Table: msdos
Disk Flags:

Number Start End Size Type File system Flags
 1 71.3MB 176MB 105MB primary ext4
 2 177MB 2325MB 2147MB primary ext4
 3 2326MB 7694MB 5369MB primary ext4
 4 7695MB 127GB 120GB primary ext4

partition and format /dev/mmcblk1 [Done]
Installing TW_5Gmm_version .....
Installing /tmp/bootpartition_LS_arm64_lts_4.19.tgz to /dev/mmcblk1p2, waiting ...
Install /tmp/bootpartition_LS_arm64_lts_4.19.tgz in /dev/mmcblk1p2 [Done]
Installing /tmp/rootfs_ksdk1906_LS_arm64_main.tgz to /dev/mmcblk1p4, waiting ...
Install /tmp/rootfs_ksdk1906_LS_arm64_main.tgz in /dev/mmcblk1p4 [Done]
setting PARTUUID for boot partition ...
Installation completed successfully
root@TinyLinux:~#
```

3.3.3 Restart 5GmmW gNB

root@TinyLinux:~#reboot

When the command prompt is shown, input user name/password as root/root

...

TW 5GmmW Devel MP1.7.2s

localhost login:root

Password:root

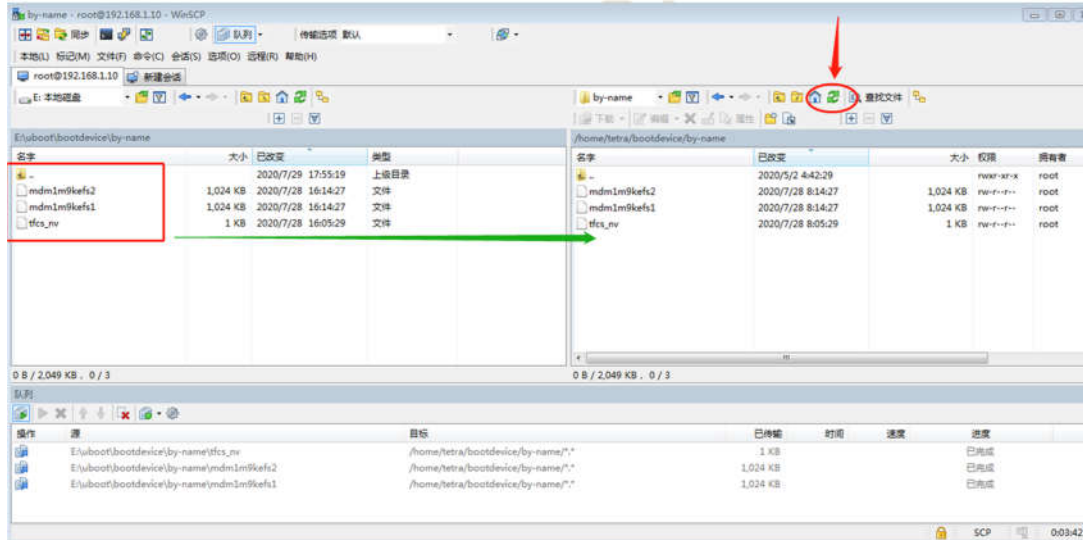
Last login: Sun Jan 28 15:58:20 UTC 2018 on tty7

Welcome to TW 5GmmW Devel MP1.7.2s (GNU/Linux 4.19.90-rt35-dirty aarch64)

...

3.3.4 Import 5GmmW gNBcalibrations files

Download the calibration files “mdm1m9kefs1”, “mdm1m9kefs2” and “tfcs_nv” which are formerly backed up from PC to the gNB, under the directory “/home/tetra/bootdevice/by-name”



Check the calibration files status

[Precautions]

After importing the calibration file, in order to avoid the error caused by the synchronization failure between the wcp tool and the operating system file, you need to

double-click the  icon button on the right window of the wcp tool. The specific operation is shown in the above figure. At the same time, check and confirm the import of calibration files on 5gmmw GNB, and execute the sync command. The specific operation is shown in the figure below.

```
root@localhost:~#ls /home/tetra/bootdevice/by-name/ -pla
```

```
root@localhost:~# sync
```

```
root@localhost:/home/tetra/bootdevice/by-name# ls -pla
total 2060
drwxr-xr-x 2 root root    4096 Jan 28 17:34 ./
drwxr-xr-x 3 root root    4096 May  2 2020 ../
-rw-r--r-- 1 root root 1048576 Jan 28 16:00 mdm1m9kefs1
-rw-r--r-- 1 root root 1048576 Jan 28 16:00 mdm1m9kefs2
-rw-r--r-- 1 root root      28 Jan 28 15:59 tfcs_nv
root@localhost:/home/tetra/bootdevice/by-name#
root@localhost:/home/tetra/bootdevice/by-name# sync
```

3.3.5 Restart 5GmmW gNB

```
root@localhost:~#reboot
```

When the command prompt is shown, input user name/password as root/root

TW 5GmmW Devel MP1.7.2s

localhost login:root

Password:root

...

Welcome to TW 5GmmW Devel MP1.7.2s (GNU/Linux 4.19.90-rt35-dirty aarch64)

...

The green light near the center of the board (led 6) keeping green means the FSM10055 is running normally.

root@localhost:~# ps -ef | grep syncMgr //The fsmver check and mac-e test can be performed only after syncmgr process appears

```
root@localhost:/usr/local/bin# ps -ef | grep syncMgr
root      6442      1  0 15:59 ?        00:00:00 syncMgr --primary-source=FREE_RUNNING --default-log-level=DEVEL
root      6675  6349  0 16:04 ttyAMA0 00:00:00 grep --color=auto syncMgr
root@localhost:/usr/local/bin#
```

3.3.6 Validation

root@localhost:~# fsmver

```
root@localhost:~# fsmver
Unable to open /Ver_Info.txt
-----
NPU VERSION INFO :
-----
NPU Version      : -ENG
Build Machine    : linux-THUNDERBOT-PC
Build User       : root
Build Machine OS : Ubuntu 18.04(MP1.7.2s)
Build Time       : Wed Dec 23 19:38:40 CST 2020
-----
SBL VERSION INFO:
-----
QC Version       : BOOT.FSM.2.0-00021
Image Variant    : MAAHANAZA
OEM Version      : CRM
-----
TZ VERSION INFO:
-----
QC Version       : TZ.FSM.2.0-00019
Image Variant    : KALANBAA
OEM Version      : CRM
-----
APPS VERSION INFO:
-----
QC Version       : TN.FSM.1.0-00028-FSM10055ACIMAAZA-1
Image Variant    : ACIMAAZA
OEM Version      : CRM
-----
MPSS VERSION INFO:
-----
QC Version       : MPSS.FSM.1.0.c9-00038-FSM10055_RMTEFS_PACK-1
Image Variant    : fsm10055.rmtefs.pro
OEM Version      : CRM
-----
root@localhost:~#
```

When the version information is the same as the figure above, the upgrading is successfully completed.

FCC Regulations:

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 interference that may cause undesired operation.

This device 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 radiated 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.

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

RF Exposure Information

This device meets the government's requirements for exposure to radio waves.

This device is designed and manufactured not to exceed the emission limits for exposure to radio frequency (RF) energy set by the Federal Communications Commission of the U.S. Government.

This device complies with FCC radiation exposure limits set forth for an uncontrolled environment. In order to avoid the possibility of exceeding the FCC radio frequency exposure limits, human proximity to the antenna shall not be less than 87cm (34 inches) during normal operation.

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This mmWave small cell, model no: 5GTP202MMN261 requires training professionals qualified by Service Provider to configure and install the product. This device complies with FCC rules and regulations for fixed-mounted on indoor permanent structure in commercial/business premises excluding private resident/property. This device is distributed through controlled distribution channel and requires that trained professionals to install this product, and this device will not be sold directly to the general public through retail stores.

This mmWave small cell, model no:5GTP202MMN261 must be installed to provide at least 87cm separation distance from bystanders to comply with the General Population / Uncontrolled MPE limit and requirements. RF exposure compliance may need to be addressed at the time of licensing, as required by the responsible FCC bureau(s) including mitigation actions for fixed RF sources to the extent necessary to ensure compliance with FCC exposure limits per section § 1.1307(b)(4).