

RL9xxx

Certification Testing Support Guide

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VERSION	DATE	AUTHOR	UPDATES
1.0	2022.04.27	Wilson Lin	Initial version, based on AR759x Certification Testing Support Guide V1.0

Legal Notice

Important Notice

Due to the nature of wireless communications, transmission and reception of data can never be guaranteed. Data may be delayed, corrupted (i.e., have errors) or be totally lost. Although significant delays or losses of data are rare when wireless devices such as the Rolling Wireless modem are used in a normal manner with a well-constructed network, the Rolling Wireless modem should not be used in situations where failure to transmit or receive data could result in damage of any kind to the user or any other party, including but not limited to personal injury, death, or loss of property. Rolling Wireless accepts no responsibility for damages of any kind resulting from delays or errors in data transmitted or received using the Rolling Wireless modem, or for failure of the Rolling Wireless modem to transmit or receive such data.

Safety and Hazards

Do not operate the Rolling Wireless modem in areas where cellular modems are not advised without proper device certifications. These areas include environments where cellular radio can interfere such as explosive atmospheres, medical equipment, or any other equipment which may be susceptible to any form of radio interference. The Rolling Wireless modem can transmit signals that could interfere with this equipment. Do not operate the Rolling Wireless modem in any aircraft, whether the aircraft is on the ground or in flight. In aircraft, the Rolling Wireless modem **MUST BE POWERED OFF**. When operating, the Rolling Wireless modem can transmit signals that could interfere with various onboard systems.

NOTE: Some airlines may permit the use of cellular phones while the aircraft is on the ground and the door is open. Rolling Wireless modems may be used at this time.

The driver or operator of any vehicle should not operate the Rolling Wireless modem while in control of a vehicle. Doing so will detract from the driver or operator's control and operation of that vehicle. In some states and provinces, operating such communications devices while in control of a vehicle is an offence.

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Contact Information

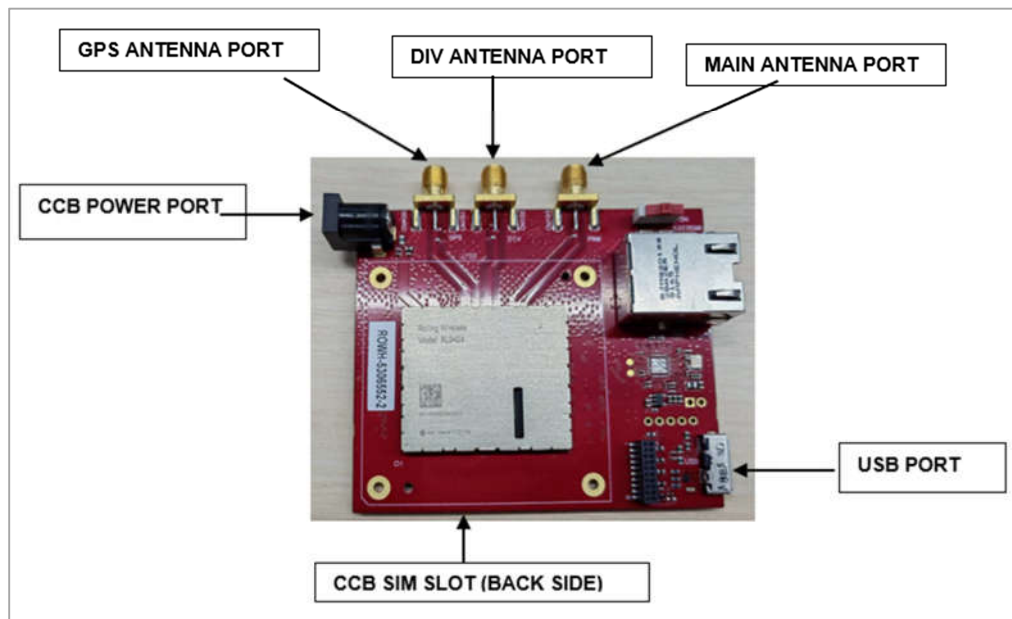
Sales information and technical support, including warranty and returns	Web: https://www.rollingwireless.com/en/support
Corporate and product information	Web: https://www.rollingwireless.com/

1 Purpose

This document was specifically written to support the RL9xxx product for certification testing.

2 Quick guide for HW setup

2.1 CCB Setup (for the testing without audio)



- WWAN/GNSS connectors:
- Main: Primary Tx/PRx path for 2G/3G/4G
- DIV: Diversity Rx for 2G/3G/4G

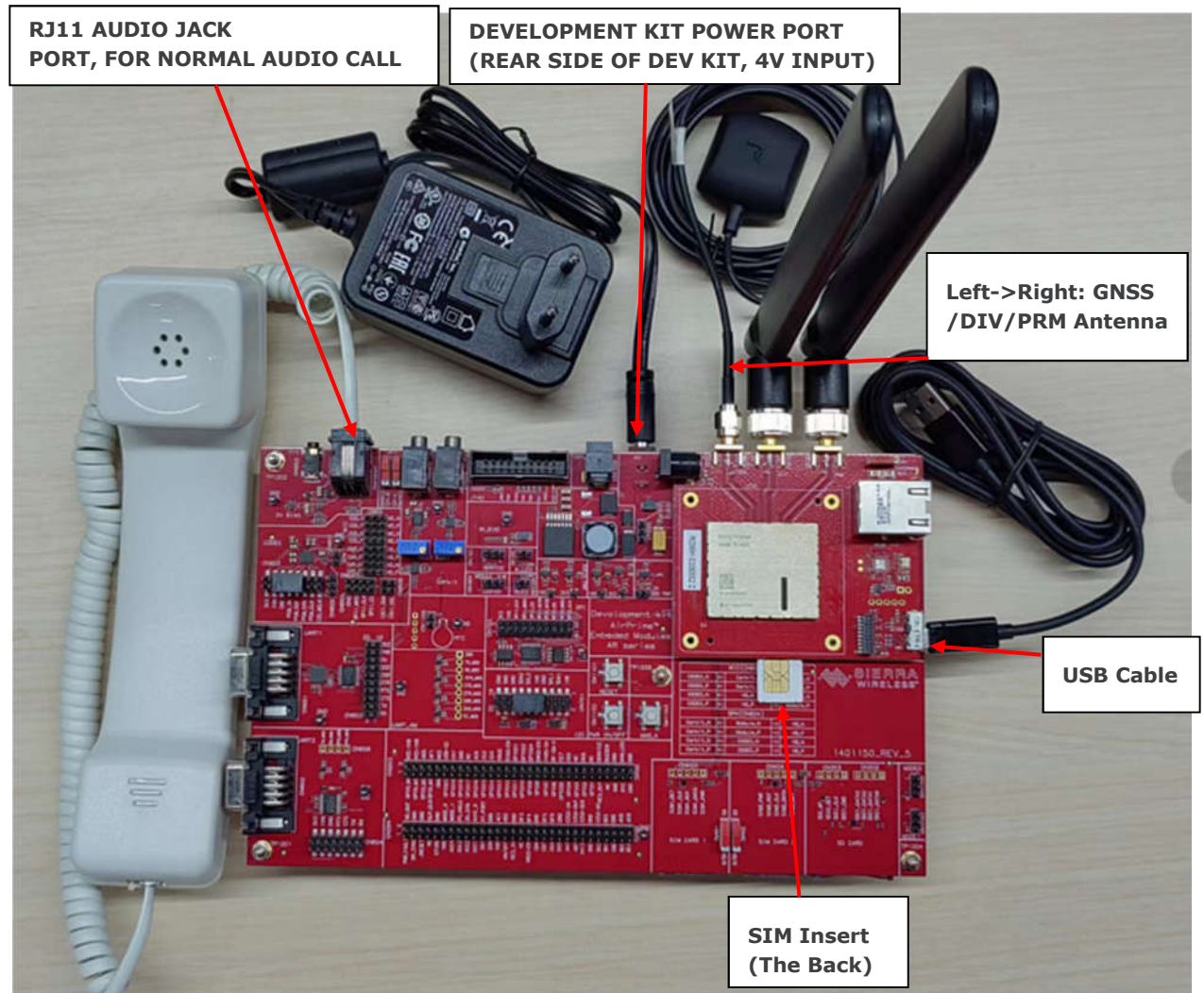
USB cable (Micro-USB)



2.2 CCB with antenna installed

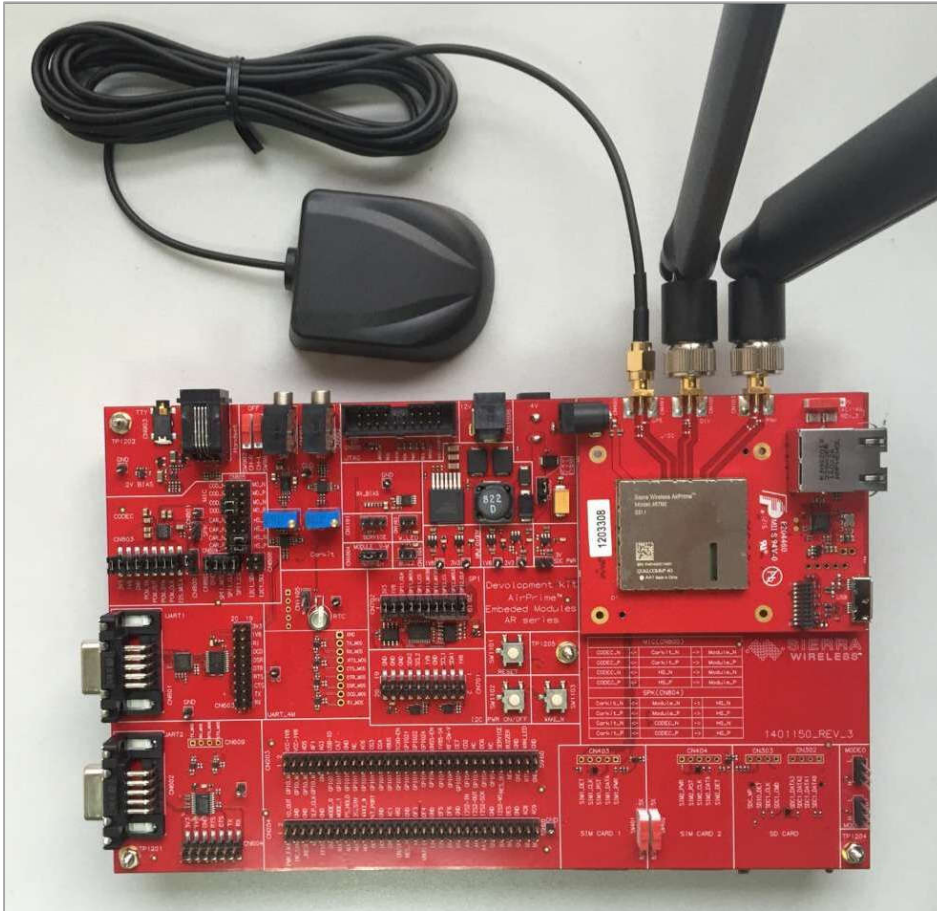


2.3 CCB with development kit (for voice and VOLTE relevant testing)



- NOTE:** For Testing, we suggest you use the ports listed below:
1. CCB POWER PORT (if use dev kit for audio test and VOLTE and field test, use DEVELOPMENT KIT POWER PORT instead)
 2. USB PORT
 3. CCB SIM SLOT
 4. Main Antenna Port
 5. DIV Antenna Port
 6. GPS Antenna Port

- 1) CCB with development kit and antenna installed (For Field testing):



NOTE: The antenna must be oriented at 90 degrees, to get the optimal performance.

- 2) Connect the handset into RJ11 port as below.



- 3) 4V Power Adaptor

Here is a photo of the 4V power adapter supplied with the Development Kit and CCB.



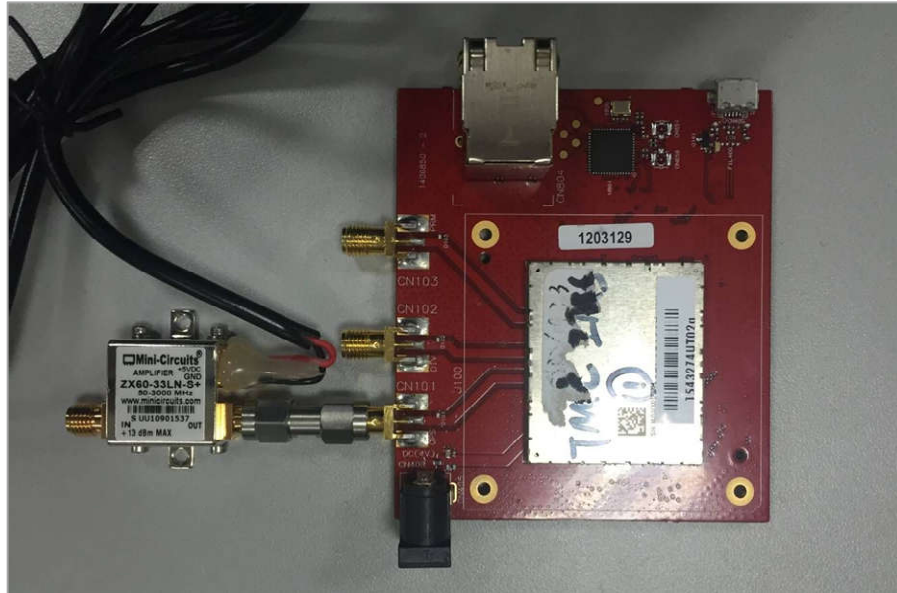
- 4) USB cable (Micro-USB)

Use default Micro-USB as the USB cable, as below.



2.4 CCB with ELNA for AGPS testing (ELNA is used to improve the GPS performance)

- 1) Please connect the below ELNA "out" port to the CCB GPS antenna port.



2.5 TTY test set up

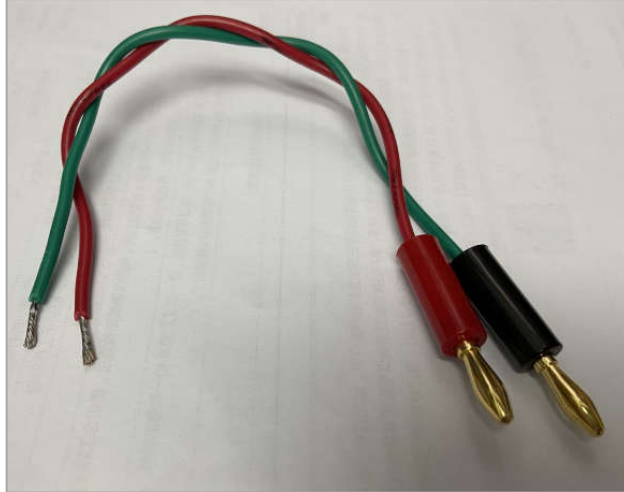
(Please use the green dev kit and CCB which has a 2.5mm audio jack)

Please connect the below TTY adapter to the 2.5mm audio jack on the development kit.



2.6 Others: Power supply with power cable

The power cable can be used to connect DC power support to the development kit.



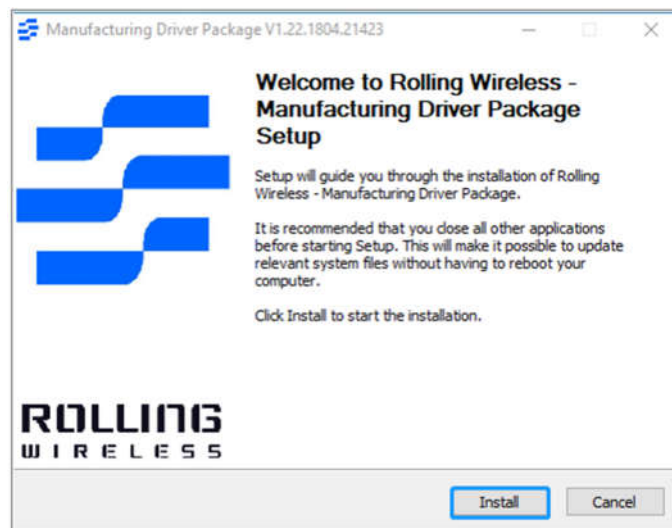
3 Install Device Drivers

3.1 Install the USB Device Drivers

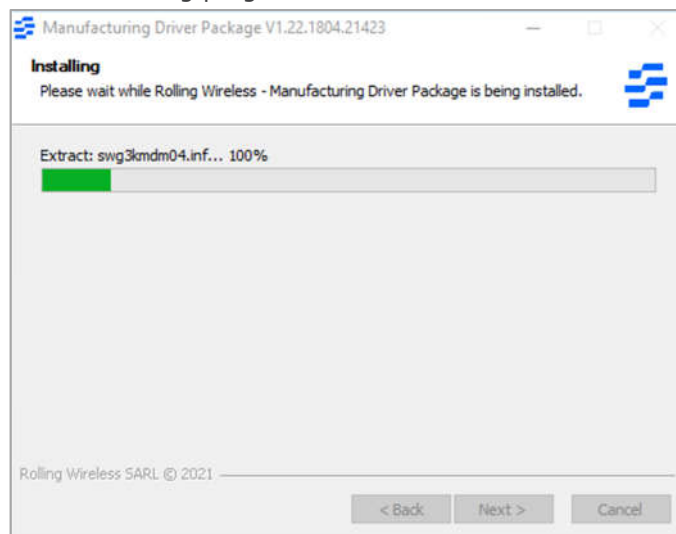
(Windows 10 1903 build and later)

In general, Rolling Wireless will provide the recommended device driver for you to install. You will find it easy to follow the instructions (UI) to install the drivers before connecting the Rolling Wireless device. It will be recognized automatically as below.

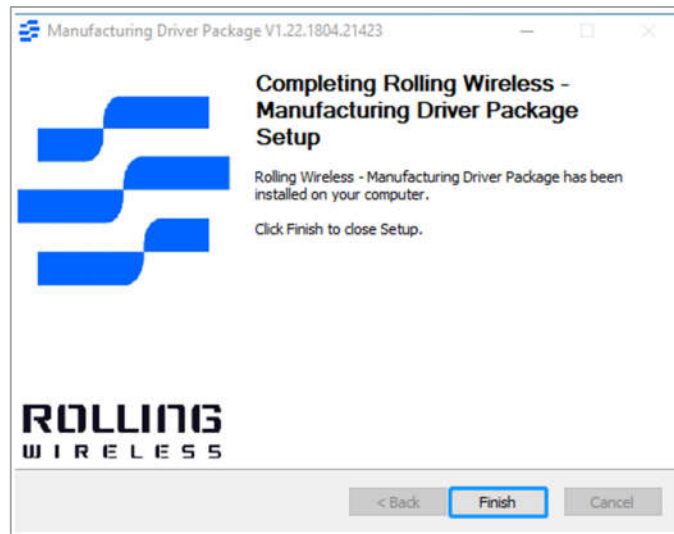
Step 1: Download the driver RWS provided, such as Build21423_Manufacturing.
Please ensure the DUT is connected to the PC USB port. (Suggest using USB3.0 port or higher)
To install drivers for RL9xxx, run the [ManufacturingDrivers.exe](#).



Step 2: You will see the following progress bar.



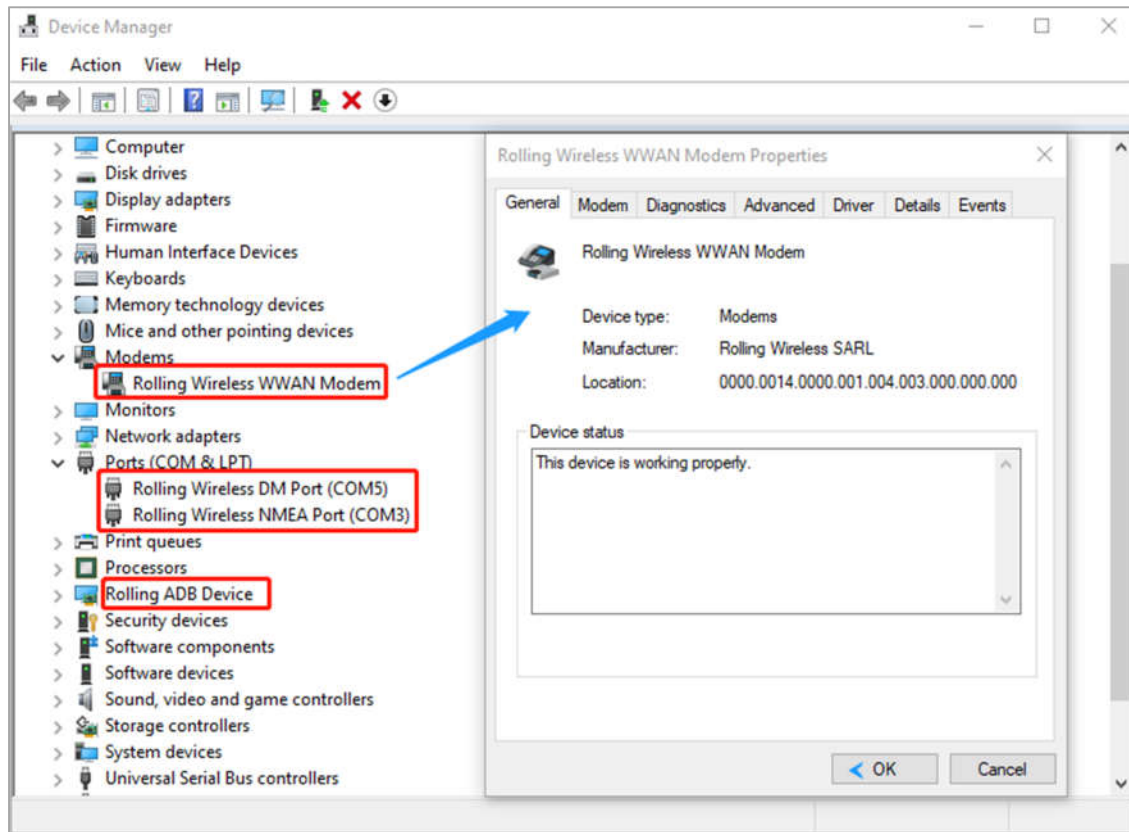
Step 3: Click **Finish** to complete the installation.



3.2 How to check the driver version

After the driver installation is complete, verify if the driver is operational by plugging the RL9xxx into your PC USB port. If you launch the device manager, you should see several USB ports (DM, NMEA...) in the PC device manager network adapter.

Right-click on the "Rolling Wireless WWAN Modem port", select "Properties", and then select the Driver Tab. The driver version will be shown as below.



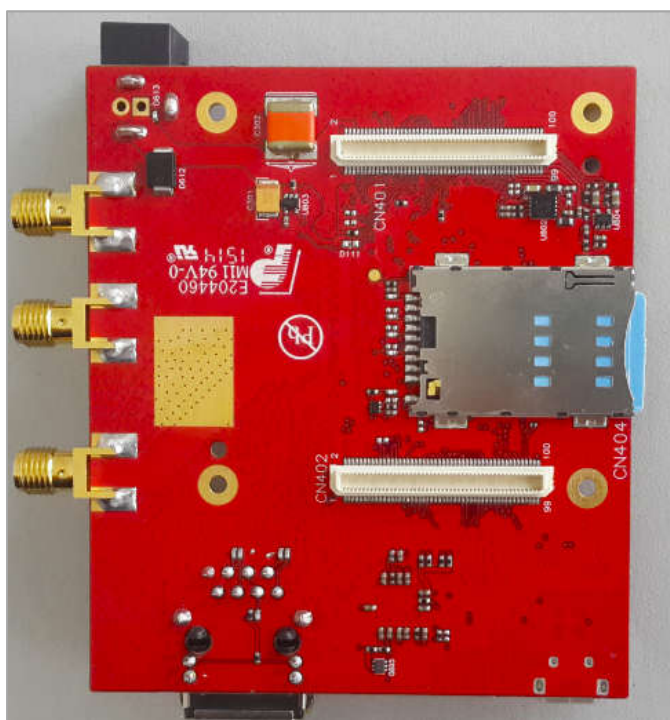
- Rolling Wireless WWAN Modem (for AT commands transmission)
- Rolling Wireless DM Port (For WWAN QXDM/EFS Explorer tools using)
- Rolling Wireless NMEA Port (For GNSS)
- Rolling ADB Device (For software upgrades)

4 Installing the SIM

Break the SIM out of the SIM Carrier.



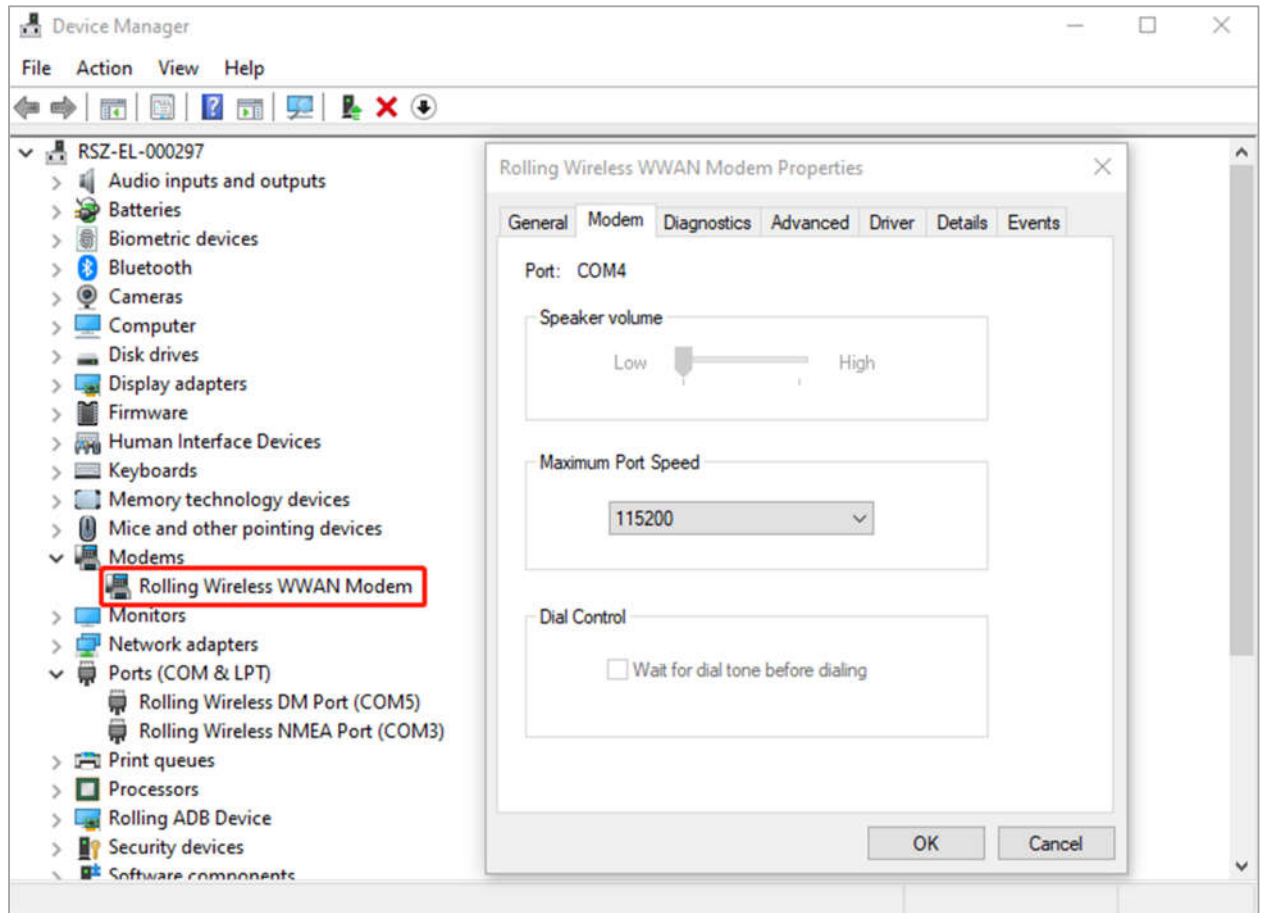
Install the SIM as the picture below.



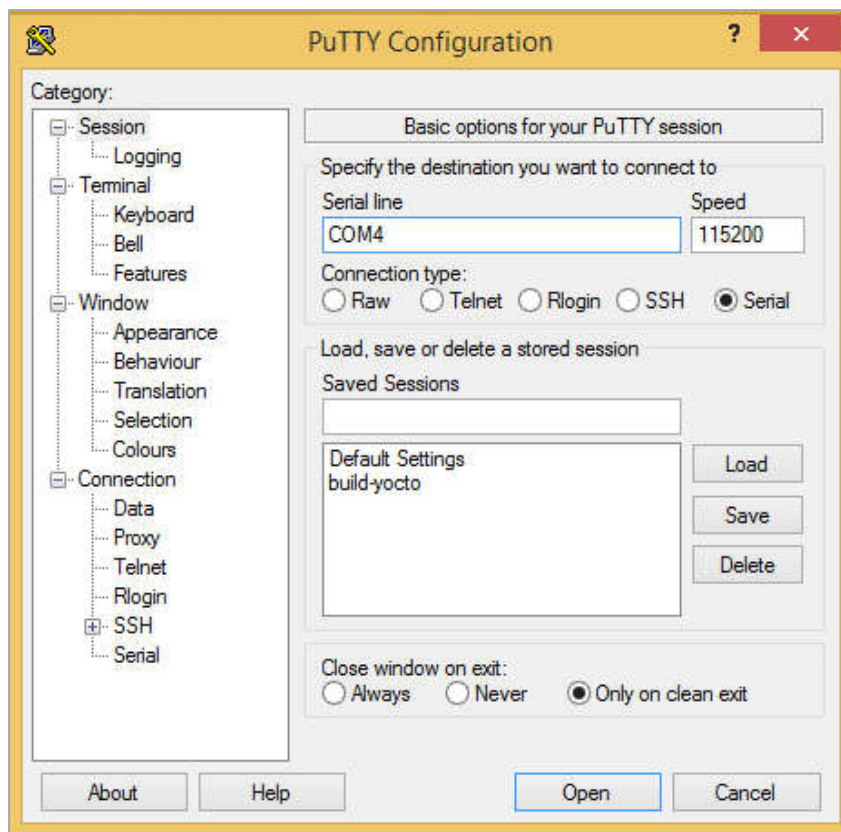
NOTE: The above picture is the SIM slot on CCB. If tested with dev. kit, the SIM slot on the dev. kit can also be used.

5 Accessing the modem AT Port

Find the modem AT port by checking the properties of the Rolling Wireless WWAN Modem in the Device Manager.



The properties show the WWAN Device is on COM4 (The modem enumeration port on your PC will vary). Launch your favourite terminal emulator program, select the correct port, and open the serial port.



Type "ATI" at the command prompt, to get the basic module information.

```
ATI

Manufacturer: Rolling Wireless
Model: RL9424
Revision: AFPQ9X40A_01.04.03.00 e72d5b jenkins 2022/04/06 04:17:59
IMEI: 001027009999999
IMEI SV: 1
FSN: 491484003408AD
+GCAP: +CGSM,+DS,+ES

OK
```

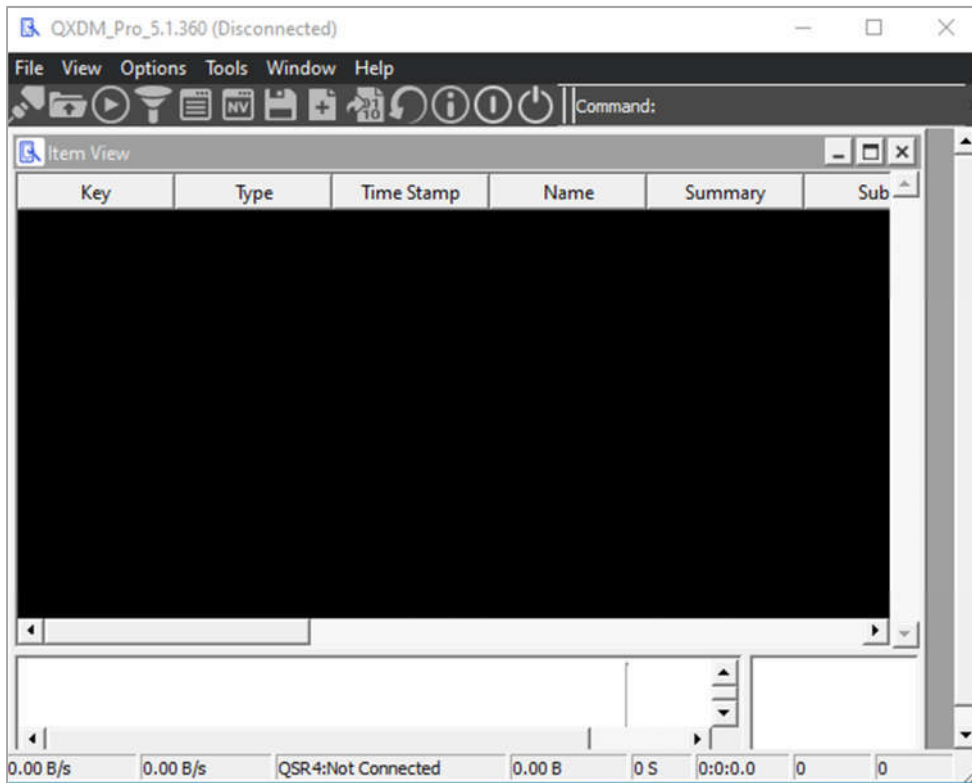
6 Firmware Upgrade Instructions

- 1) Check the firmware version prior to the upgrade using the AT command "ATI".
- 2) Close any applications connected to the "DM" COM port prior to upgrading firmware such as QPST/QXDM.
- 3) Run one-click upgrade by double-clicking executable.
- 4) Wait while the firmware downloads and the module resets.
- 5) Verify the firmware version after the upgrade using the AT command "ATI".

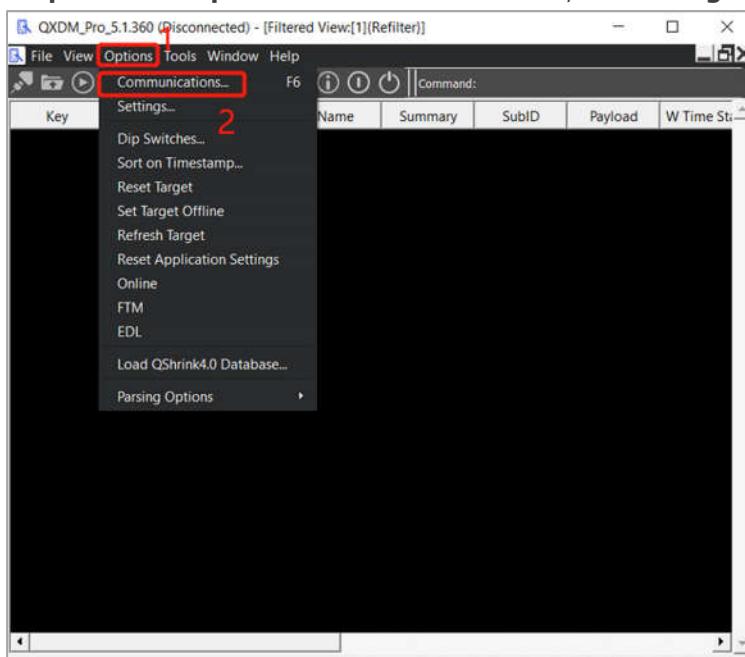
7 QXDM – Diagnostic Monitor

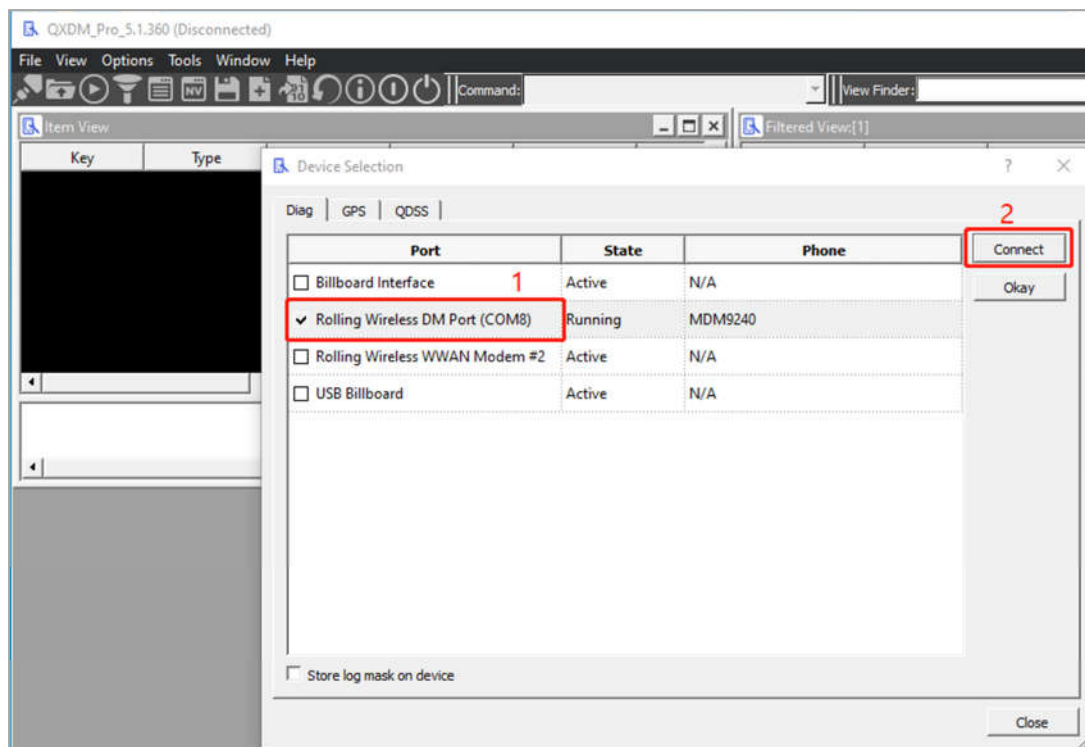
7.1 DM Logging

Step 1: Launch QXDM.

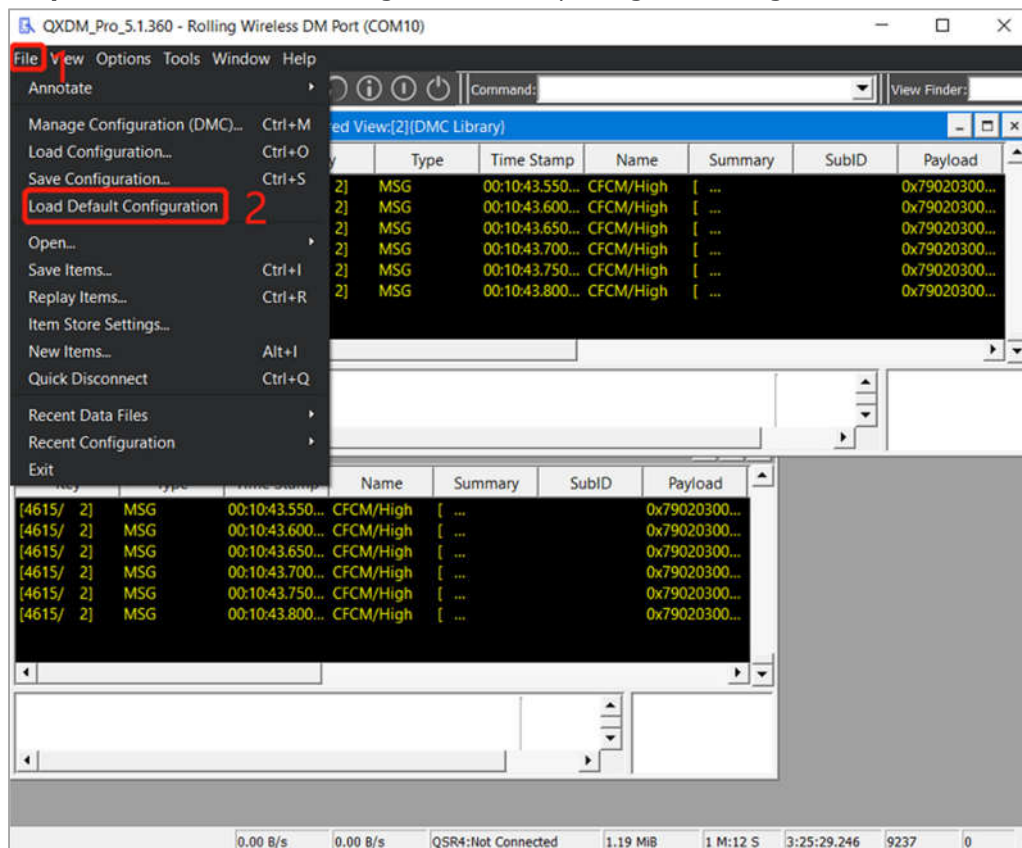


Step 2: Select **Options** -> **Communications**, select **Target DM Port**, and click **Connect**.

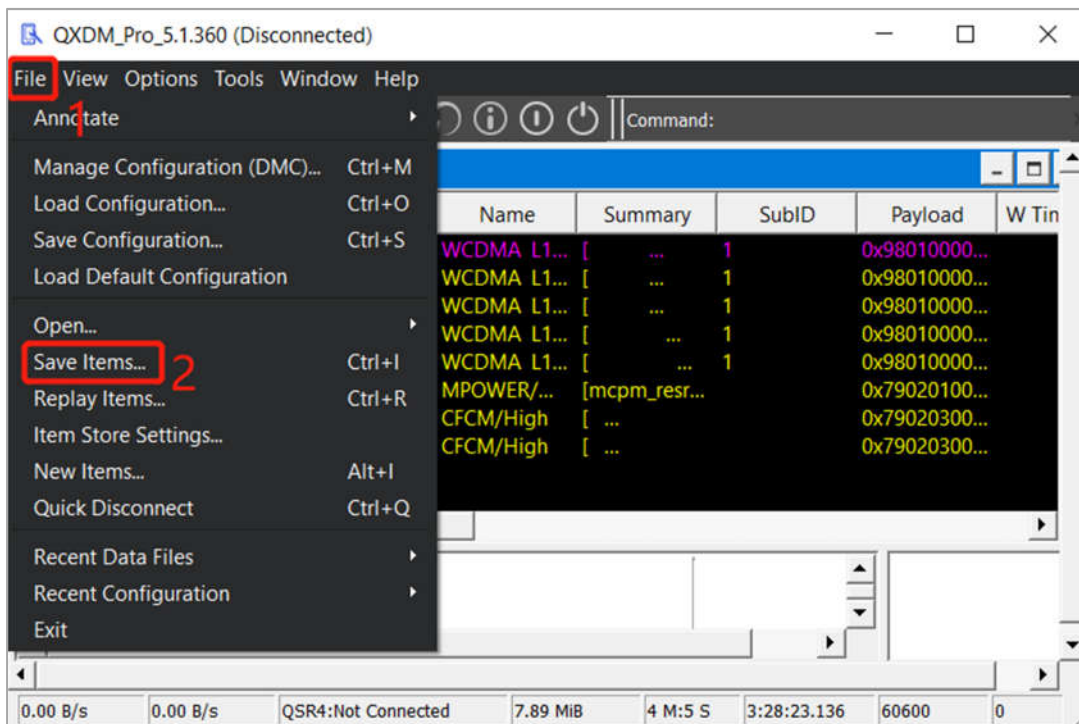
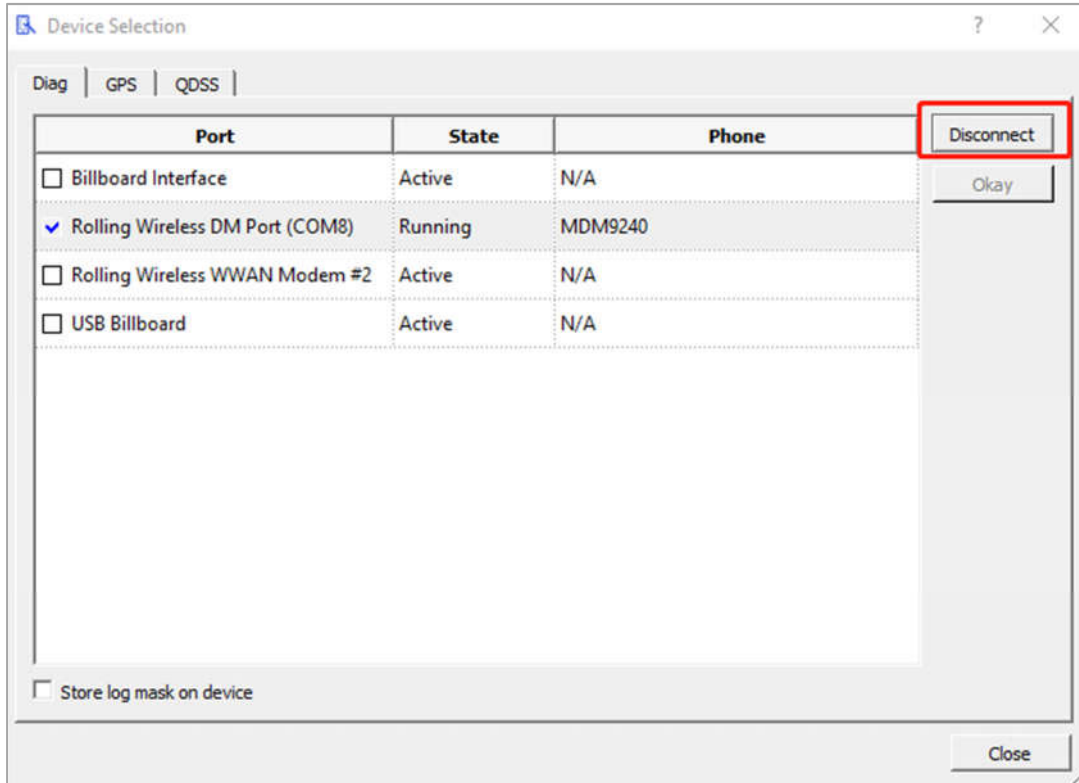




Step 3: Load the Default Configuration for capturing the DM log.

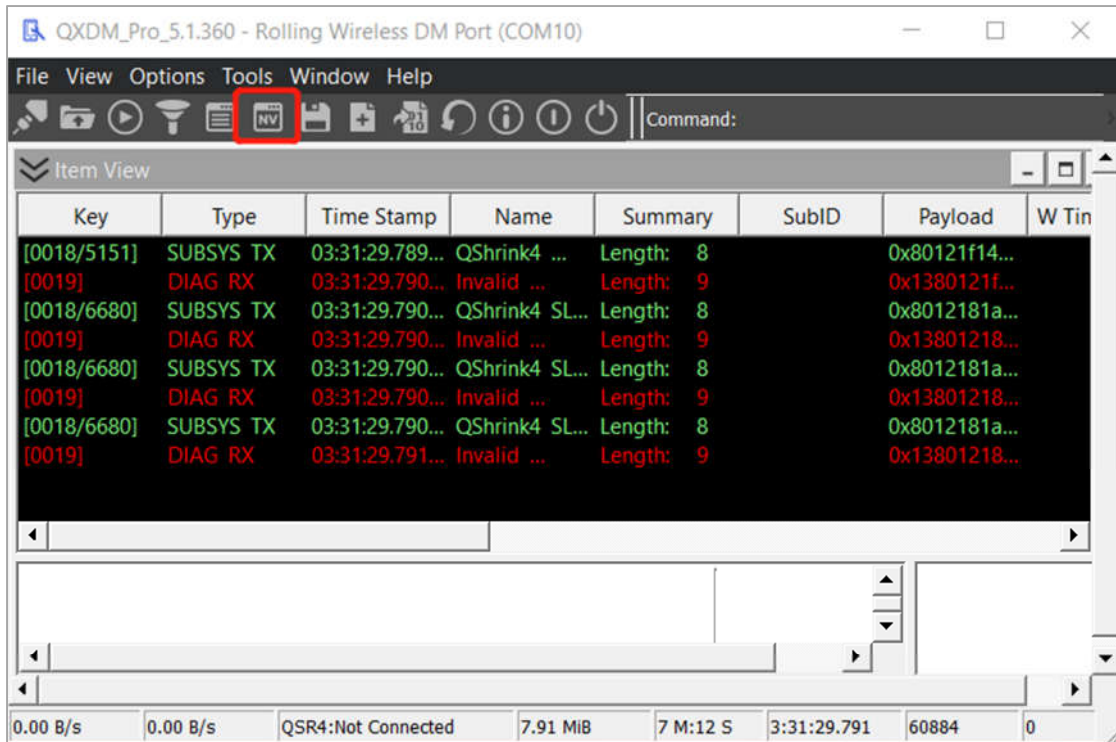


Step 4: When you complete the log capturing, you can **Disconnect** the DM port and then save the log into a local directory.

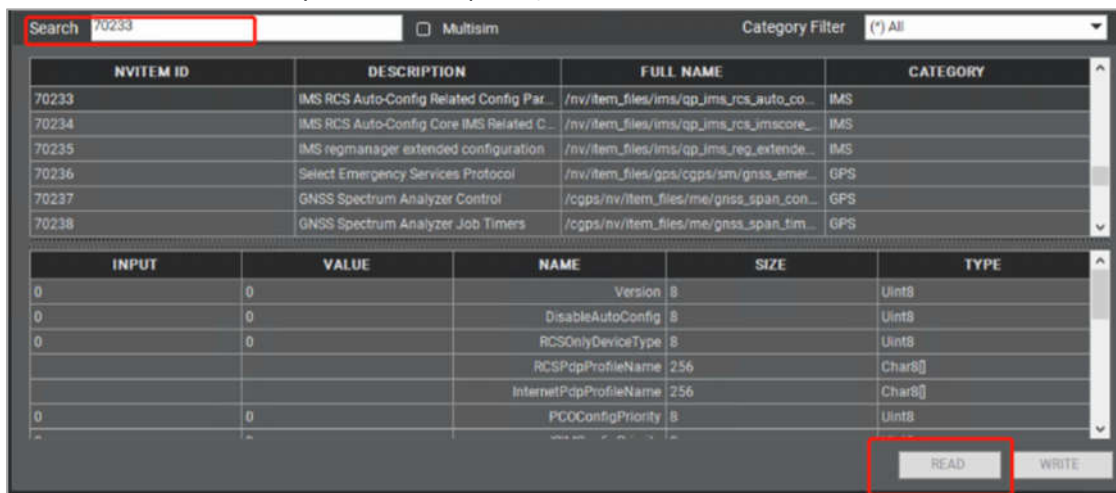


7.2 NVs modification

You also can modify the NVs in NV Browser by clicking the  when you have connected the DM port.



Search for the NV value you want to update, and click **READ**.



In the corresponding NAME line, enter the new NV value, and click **WRITE** to finish.

NV Browser

Search: ☐ Multisim Category Filter: (*) All

NVITEM ID	DESCRIPTION	FULL NAME	CATEGORY
70233	IMS RCS Auto-Config Related Config Par...	/nv/item_files/ims/qp_ims_rcs_auto_co...	IMS
70234	IMS RCS Auto-Config Core IMS Related C...	/nv/item_files/ims/qp_ims_rcs_imscore...	IMS
70235	IMS regmanager extended configuration	/nv/item_files/ims/qp_ims_reg_extende...	IMS
70236	Select Emergency Services Protocol	/nv/item_files/gps/cgpps/sm/gnss_emer...	GPS
70237	GNSS Spectrum Analyzer Control	/cgpps/nv/item_files/me/gnss_span_con...	GPS
70238	GNSS Spectrum Analyzer Job Timers	/cgpps/nv/item_files/me/gnss_span_tim...	GPS

INPUT	VALUE	NAME	SIZE	TYPE
0	0	Version	8	UInt8
0	0	DisableAutoConfig	8	UInt8
0	0	RCSOnlyDeviceType	8	UInt8
		RCSPdpProfileName	256	CharB[]
		InternetPdpProfileName	256	CharB[]
0	0	PCOConfigPriority	8	UInt8

NVITEM READ FAILED

READ **WRITE**

8 Reading the FSN and IMEI

AT command: ATI is for reading the FSN and IMEI

ATI

Manufacturer: Rolling Wireless

Model: RL9424

Revision: AFPQ9X40A_01.04.03.00 e72d5b jenkins 2022/04/06 04:17:59

IMEI: 001027009999999

IMEI SV: 1

FSN: 491484003408AD

+GCAP: +CGSM,+DS,+ES

OK

9 Changing Radio Mode Preference

AT!SELRAT is used to set/query mode preferences:

at!selrat=?

!SELRAT: Index, Name

00, Automatic

01, UMTS 3G Only

06, LTE Only

11, UMTS and LTE Only

OK

10 Making a Data Connection over windows 10 with cellular function

10.1 Establish a connection to the DUT and PC

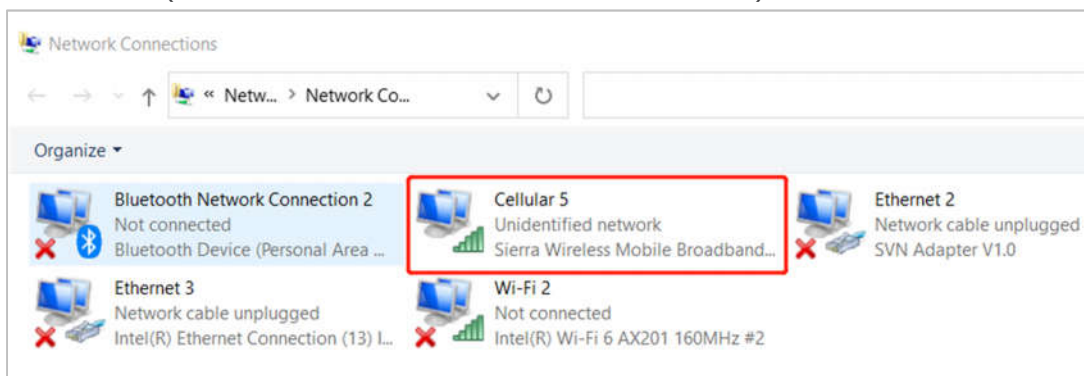
Insert the SIM card and connect the power supply and USB port.

10.2 Connect the data call over PC

10.2.1 To enable UE register to the network, you could use below two AT command to trigger a new search of network:

AT+CFUN=0 (when the script prompts you to switch off the device/radio.)

AT+CFUN=1 (when the script prompts you to switch on the device/radio.)



10.2.2 To check if DUT registration status, you could issue “at!gstatus?” to query.

AT!GSTATUS?

!GSTATUS:

Current Time: 39	Temperature: 28
Modem Mitigate Level: 0	ModemProc Mitigate Level: 0
Reset Counter: 2	Mode: ONLINE
System mode: LTE	PS state: Attached
IMS reg state: REGISTERED	IMS mode: Normal
IMS Srv State: FULL SMS,FULL VoIP	
LTE band: B1	LTE bw: 20 MHz
LTE Rx chan: 300	LTE Tx chan: 18300
LTE CA state: INACTIVE	
EMM state: Registered	Normal Service

RRC state: RRC Connected

PCC RxM RSSI: -87	RSRP (dBm): -112
PCC RxD RSSI: -90	RSRP (dBm): -116
Tx Power: 18	TAC: 2540 (9536)
RSRQ (dB): -5	Cell ID: 06F0C702 (116442882)
SINR (dB): 12.2	
OK	

10.2.3 For data connection, you may issue below AT command to trigger data connection between DUT and PC (windows10).

AT!SCACT =<action>,<profile_id>

NOTE: action can be "0" or "1", "0" means disconnected and "1" means connected.

Example: for normal testing, such as PTCRB/GCF/most of the carriers, profile id is "1":

AT!SCACT=1,1 (setup with profiles 1)
AT!SCACT=0,1 (disconnect profiles 1)

The profile id of the carriers below is special:

For **Verizon testing:**

AT!SCACT=1,3 (setup with profiles 3)
AT!SCACT=0,3 (disconnect profiles 3)

For **KT testing:**

AT!SCACT=1,2 (setup with profiles 2)
AT!SCACT=0,2 (disconnect profiles 2)

For **DCM(NTT) testing:**

AT!SCACT=1,2 (setup with profiles 2)
AT!SCACT=0,2 (disconnect profiles 2)

NOTE: To configure the APN on UE side, AT+CGDCONT (see the TS27.007 for the usage)

10.2.4 To make sure if the data call setup correctly between DUT and PC, issue "ipconfig" on cmd terminal(windows10).

Type "ipconfig", then click "Enter".

```
CA: Select Command Prompt
Connection-specific DNS Suffix . : rollingwireless.com
Mobile Broadband adapter Cellular 5:
Connection-specific DNS Suffix . :
IPv6 Address. . . . . : 2408:8456:3a10:3f2b:3475:8cf5:2c63:6969
IPv6 Address. . . . . : 2408:8456:3a10:3f2b:d04e:161a:98b0:bf17
Temporary IPv6 Address. . . . . : 2408:8456:3a10:3f2b:fd2d:4789:28cc:1a0e
IPv4 Address. . . . . : 10.67.250.246
Subnet Mask . . . . . : 255.255.255.252
Default Gateway . . . . . : 2408:8456:3a10:3f2b:f04a:1551:97dc:cb2c
                             fe80::f04a:1551:97dc:cb2c%52
                             10.67.250.245
```

10.2.5 Disconnect the data call over PC

AT!SCACT =<0>,<profile_id>

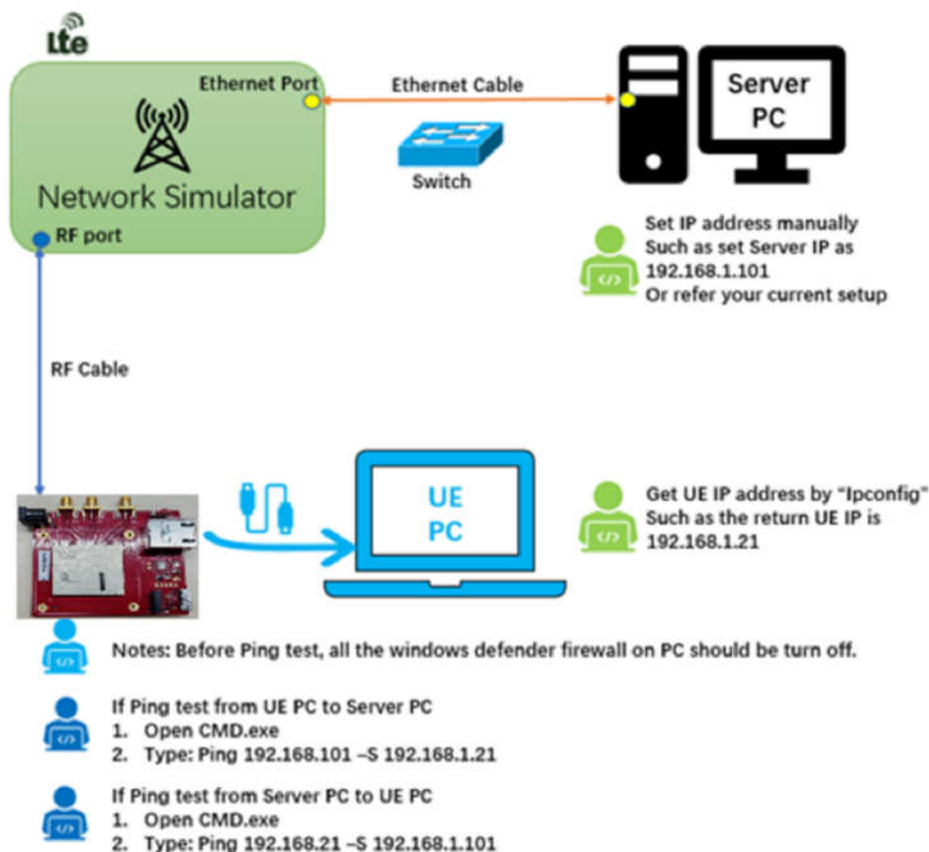
11 Ping between Simulation Network and UE

11.1 Ping destination IP address -S Source IP address

For example:

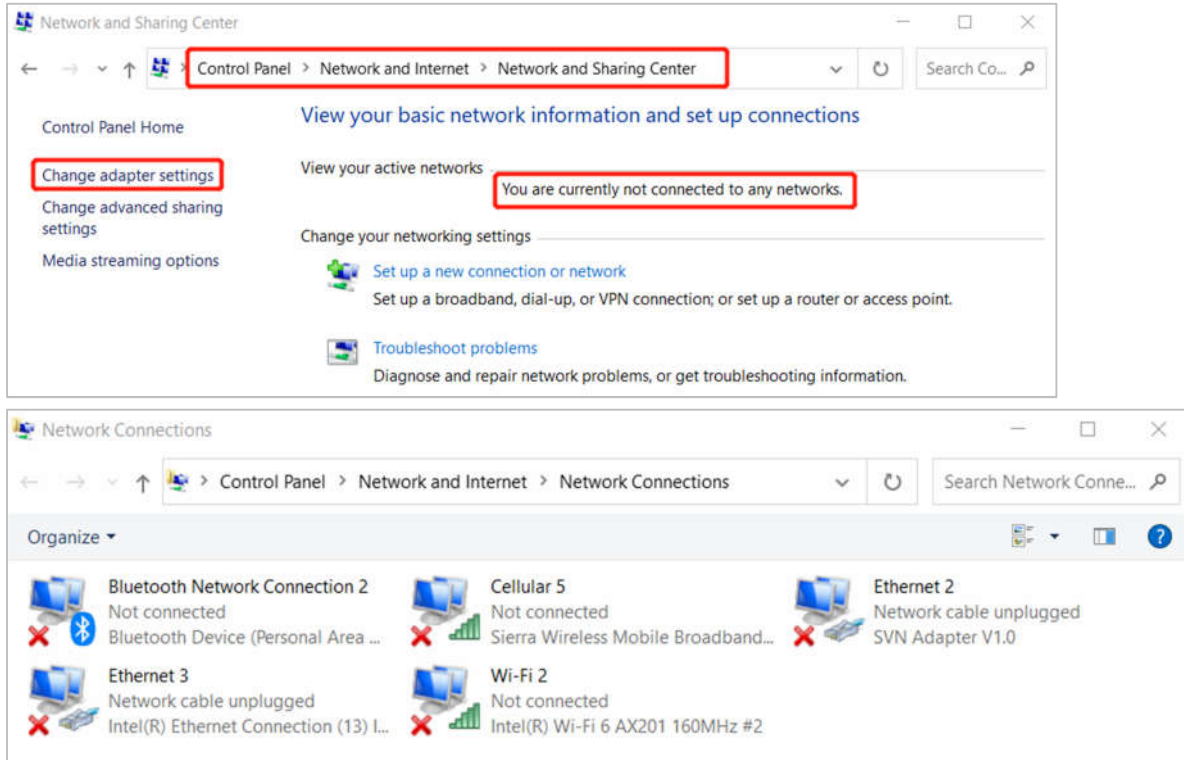
- Disable the other connection on UE PC, such as WIFI/Ethernet (refer session 14.2, don't use airplane mode)
- Disable all the firewall both on UE PC and Server PC (refer session 14.3)
- Power on UE and have UE register to network
- Make the Cellular connection and get connected
- Figure out the UE IP address on UE PC by Ipconfig command, such as 192.168.157.11
- Figure out the server PC IP address by Ipconfig command, such as 192.168.157.18
- If require the ping from UE PC to Server PC, then Type: Ping 192.168.157.18 -S 192.168.157.11

NOTE: All the Firewall need to be turn off on the destination side, and suggest disabling other network adapter before the testing, such as LAN & WIFI.



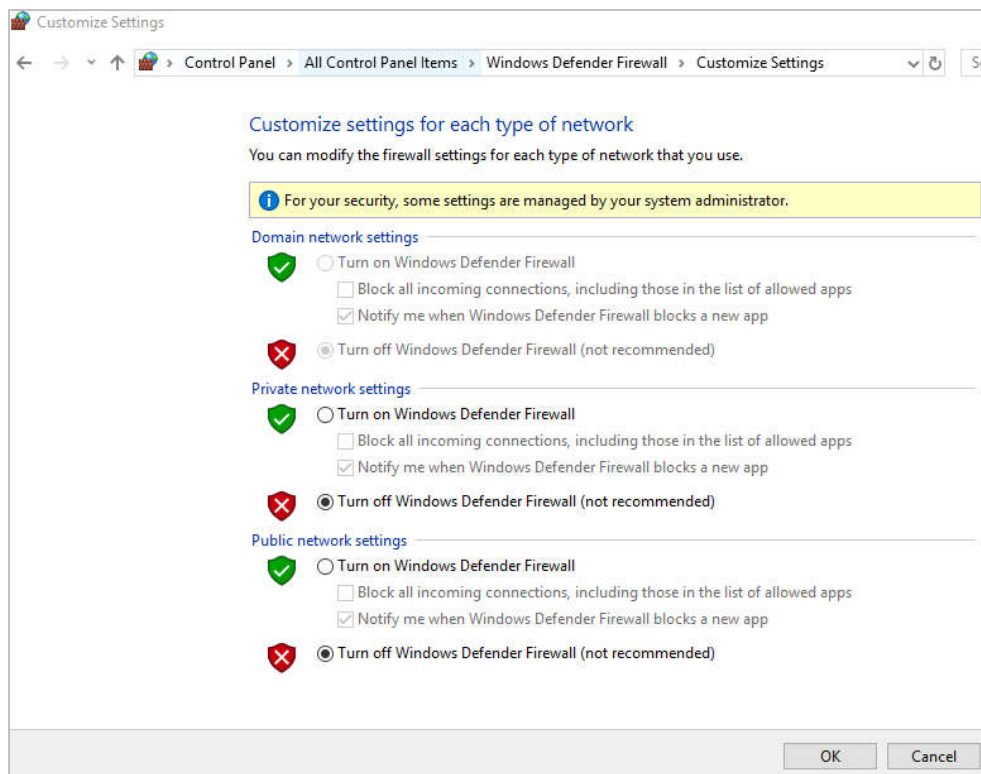
11.2 Disable the other networks

Control Panel\Network and Internet\Network and Sharing Center->click "Change adapter settings",
Disable the other connection on UE PC, such as WIFI/Ethernet (don't use airplane mode)



11.3 Turn off Windows Defender Firewall

All the Firewall need to be turn off on the destination side.



12 Setting for VOLTE testing

To check APN setting:

AT+ CGDCONT?

+CGDCONT: 1,"IPV4V6","nxtgenphone","0.0.0.0",0,0
+CGDCONT: 2,"IPV4V6","**ims**","0.0.0.0",0,0
+CGDCONT: 3,"IPV4V6","**sos**","0.0.0.0",0,0

OK

To check P-CSCF Flag setting:

AT\$QCPDPIMSCFGE?
AT\$QCPDPIMSCFGE?

\$QCPDPIMSCFGE: 1 , 0 , 0 , 0
\$QCPDPIMSCFGE: 2 , **1** , 0 , 0
\$QCPDPIMSCFGE: 3 , **1** , 0 , 0

To disable IMS

AT!UNLOCK="A710"

AT!IMSTESTMODE=1

AT!RESET

To Enable IMS

AT!UNLOCK="A710"

AT!IMSTESTMODE=0

AT!RESET

To Setup Normal or E911 Call:

ATDXXXXXXXXXX; or ATD911; /* XXXXXXXXXXXX is normal call number*/

To check if IMS VOLTE service is available:

AT!GSTATUS?

!GSTATUS:

Current Time: 401893	Temperature: 26
Bootup Time: 0	Mode: ONLINE
System mode: LTE	PS state: Attached

LTE band: B7 LTE bw: 15 MHz
LTE Rx chan: 3280 LTE Tx chan: 65535
EMM state: Reregistered Attached
EMM connection: RRC Idle

RSSI (dBm): -70 Tx Power: 0
RSRP (dBm): -70 TAC: 0002 (0)
RSRQ (dB): 0 Cell ID: 00000001 (0)
SINR (dB): -20.0

IMS Reg State: REGISTERED IMS Mode: Normal
IMS Srv State: FULL SMS, FULL VoIP

OK

13 Setting for Audio related test

Device supports analog voice calls with the Dev-kit.

Please follow below 3 steps:

- 1) Configure the jumpers correctly on Dev-kit.(The jumpers should be well configured by default)
- 2) Connect the handset into RJ11 port as below. (Refer to 2.3 CCB with development Kit)
- 3) Type the AT command as below.
 - I. AT!AVSETPROFILE=5,0,0,0,6,0
 - II. AT!AVMFTCODECMODE=5
 - III. **Note: Please set above two AT command again Once UE reset. (if audio needed)**

AT commands for audio call:

###To enquiry the current audio configuration:

AT!AVCFG?

!AVCFG: 0,0,1
!AVCFG: 1,0,1
!AVCFG: 2,0,1
!AVCFG: 3,0,1
!AVCFG: 4,0,1
!AVCFG: 5,0,1
!AVCFG: 6,0,1
!AVCFG: 7,0,1
!AVCFG: 8,0,1
!AVCFG: 9,0,1

OK

To set the Audio profile to 5

AT!AVSETPROFILE=5,0,0,0,6,0

OK

###To set the Audio codec mode to 5

******Must run after each reset or power cycle or there will be no sound******

AT!AVMFTCODECMODE=5

OK

14 Setting for GPS and AGPS testing:

14.1 For UP test cases:

14.1.1 UE parameter setting:

- (1). at!unlock="A710"
- (2). At!gpssuplurl="www.spirent-lcs.com:7275" -- replace the server URL if necessary.
- (3). At!gpsmomehtod = 1
- (4). At!gpsmtlrsettings = 0
- (5). at!gpsposmode=ff7f
- (6). at!gpstranssec=1
- (7). at!gpssuplver=2
- (8). At!reset

If the test case has an NI message, the NI message will display in the AT port.

If the test case requires a manual response to the NI message, you can use At!gpssendniresp = 0 (accept) 1 (deny) to respond, if not, wait 25 seconds, and our device will auto-reply. The auto-reply timer setting by At!gpssuplinitimeout = 15(waiting time).

14.1.2 Cert file setting

The cert file in the server and UE should correspond.

- (1). Update UE cert file:
 1. Delete all the files in /SUPL and /CERT folder.
 2. Copy the SuplRootCert to those two folders.
 3. Use At!reset to reset the device
- (2). Update the Server cert file if necessary:
 1. TLS Server Certificate(*.cer) use *.cer
 2. TLS privateKey(*.pen, *.pvk) use *.pem
 3. TLS root Certificat(*cer) use *.cer

Parameter	Value
Supported SUPL Version	1.0.0
SUPL Initiation Method	WAP PUSH
SMS Destination Port	7275
SLP Address Choice	IP Address
SLP IP Address Type	IPv4
SLP FQDN	www.spirent-lcs.com
SLP IPv4 Address	192.168.0.35
SLP IPv6 Address	0:0:0:0:ffff:c0a8:0023
SLP Port Number	7275
SLP Mode	ProxyMode
Authentication Mode	AlternativeClient Authentication
ST1 Timer (s)	10.0
ST2 Timer (s)	30.0
Content Type (including length)	application/vnd.oma-lcs-supl-init
Application ID	x-oma-application:ulp.ua
Turn On Secure Session	Yes
TLS Version	Auto
TLS CipherSuite	Any of the above listed suites
TLS Library	GNU TLS
TLS Server Certificate(*.cer)	...\\SERVER\\CERTIFICATES\\spirent-lcs2048.cer
TLS PrivateKey (*.pem,*.pvt)	...\\PRIVATEKEYS\\spirent-lcskey2048.pem
TLS Root Certificate(*.cer)	...\\SERVER\\CERTIFICATES\\spirentroot2048.cer
TLS Server Certificate Hostname	www.spirent-lcs.com
TLS PrivateKey's Password	Spirent

14.2 CP test case setting

14.2.1 UE parameter setting:

- (1). at!unlock="A710"
- (2). At!gpssuplurl="www.spirent-lcs.com:7275" -- replace the server URL if necessary.
- (3). At!gpsmomehtod = 0
- (4). At!gpsmtlrsettings = 0
- (5). at!gpsposmode=ff7f
- (6). at!gpstranssec=1
- (7). At!reset

If the test case has an NI message, the NI message will display in the AT port.

If the test case requires a manual response to the NI message, you can use At!gpssendniresp = 0 (accept) 1 (deny) to respond, if not, wait 25 seconds, and our device will auto-reply. The auto-reply timer setting by At!gpssuplinitimeout = 15(waiting time).

14.2.2 SBAS AT Command:

1. Unlock module
AT!UNLOCK="A710"
2. Enable GPS
AT!CUSTOM="GPSENABLE", 1
3. Reset the module for configuration activation
AT!RESET
4. Delete GPS Assistance Data
AT!GPSCOLDSTART
5. Enable all GNSS satellite capabilities
AT!GNSSCONFIG=1,1,1,1,1
6. Start GNSS fix

AT!GPSTRACK=1,255,255,1000,1

7. Check whether SBAS satellite found with
AT!GPSSATINFO?

SV ID 33-54 belongs to SBAS systems.

eg: SV:41 is SBAS satellite.

AT!GPSSATINFO?

Satellites in view: 4 (1980 01 06 6 00:09:08)

* SV: 5 ELEV: 49 AZI: 270 CN0: 36

* SV: 19 ELEV: 35 AZI: 136 CN0: 27

* SV: 20 ELEV: 60 AZI: 329 CN0: 34

* SV: 41 ELEV: 0 AZI: 0 CN0: 35

OK

15 Basic AT commands used for testing

15.1 Set Voice Auto Answer Mode

ITEMS	OPERATIONS	COMMENTS
AT commands	AT! NV=74, 1 ATS0=<value> /* Answers after the specified number of rings,*/	Note: You have to reset the device to make it work.

15.2 Programming Emergency Call Test Number

ITEMS	OPERATIONS	COMMENTS
AT commands	AT! NVENUM=1,"XXXXX" /* XXXXX means Emergency Number */	Note: You have to reset the device to make the Emergency number work.

15.3 Resetting the Device during Scripted Testing

ITEMS	OPERATIONS	COMMENTS
AT commands	Use AT+CFUN=0 when the script prompts you to switch off the device/radio. Use AT+CFUN=1 when the script prompts you to switch on the device/radio. AT!RESET is used for resetting the device. It will take longer to find service and initiate attach procedure.	Note: Close all Qualcomm tools (QXDM etc.) before performing AT!RESET. Keeping these tools running will sometime cause USB enumeration issues after AT!RESET is performed. If encounters a USB enumeration issue, rebooting OS will be required. All test cases that involve a refresh of the UICC or authentication information will need a full power-off reset. This is done by removing power from the Dev-Kit and waiting for 1 minute for the device to fully power off before applying power again.

15.4 Diversity Receiver Testing (for W and L)

ITEMS	OPERATIONS	COMMENTS
AT commands	AT!ENTERCND="A710" AT!RXDEN=0 AT!RESET	Enable Primary Receiver Only
AT commands	AT!ENTERCND="A710" AT!RXDEN=1 AT!RESET	Enable Both Receivers
AT commands	AT!ENTERCND="A710" AT!RXDEN=2 AT!RESET	Enable Secondary Receiver Only

15.5 Data Service

ITEMS	OPERATIONS	COMMENTS
AT commands	AT!SCACT = <action>,<profile_id> AT!SCACT? AT!SCACT =? Example: AT!SCACT=1,3	For SCACT Currently, this command supports both UMTS and CDMA profile id. For detail please check AT!SCACT=? Please check the response of AT!CGDCONT? for profile contents info. Note: AT! SCACT=1 is preferable.

15.6 Voice Call Service

ITEMS	OPERATIONS	COMMENTS
AT commands	ATD12345678;	Init MO voice call
	ATA	Answer MT voice call
	ATH	Hung up MT voice call



ITEMS	OPERATIONS	COMMENTS
	AT!ENTERCND="A710" AT!AVTTY = <profile>, <mode>	<profile>: 0-5, 6 audio profiles in total By default, profile 0 is for TTY purpose <mode>: 0-2 0: Full mode 1: Voice Carry Over (VCO) mode 2: Hearing Carry Over (HCO) mode

15.7 SMS Service

ITEMS	OPERATIONS	COMMENTS
AT commands	3GPP Mode SMS Command:	
	1. Send SMS	
	Text SMS:	
	AT+CMGF=1 OK	
	AT+CMGS="+31628870634" > This is the text message.<Ctrl>+<Z>	
	+CMGS: 45 OK	
	PDU SMS:	
	AT+CMGF=0 OK	For detailed usage of these AT commands please use "=?" to check.
	AT+CMGS=42 > 07915892000000F001000B915892214365F70000 21493A283D0795C3F33C88FE06CDCB6E32885EC 6D341EDF27C1E3E97E72E <Ctrl>+<Z> +CMGS: 12	Note: For IMS SMS, the device should register to IMS first, if the module is set to send 3GPP format SMS, AT+CMGS should be used, otherwise AT\$QCMGS should be used.
	2. Read SMS	
	AT+CMGR=<index>	
	3. List SMS	
	AT+CMGL=<stat>	
	4. Delete SMS	
	AT+CMGD=<index>	

ITEMS	OPERATIONS	COMMENTS
AT commands	at^hsmsss=1,0,1,0	/* First '1' indicates status: 0:FALSE, 1:TRUE */ /* Second '1' in red color indicates encoding type: 0:GSM 7 bit, 1: ASCII 7-bit */
QMI Interface	Skylight: Menu à SMS Express	Skylight will need to be used if need to send concatenated SMS.

15.8 DTMF Service

ITEMS	OPERATIONS	COMMENTS
AT commands	AT+VTS=<0~9,*,#> Example: ##### Test in GSM/WCDMA mode ### AT+VTD? +VTD: 20 OK AT+VTD=3000 OK ATD10086; OK AT+VTS=1 OK ATH OK	+VTS to issue continuous DTMF +VTD to configure continuous DTMF duration under GW mode. //current duration under GW mode //change the duration to 3000 milliseconds under GW mode if you want //input one digital continuous DTMF

15.9 Supplementary Services

The commands below are standard 3GPP AT commands. You can refer to TS 27.007 for detailed usage.

ITEMS	OPERATIONS	COMMENTS
AT commands	AT+CHLD = <n>	Control call hold functions
AT commands	AT+CCFC = <reason>, <mode>	Control call forwarding functions.

ITEMS	OPERATIONS	COMMENTS
AT commands	AT+CCWA = <n>	Check current module voltage.
AT commands	AT+CLIP = <n>	Control calling line identity (CLI) of the calling party when receiving a mobile terminated call
	AT+COLP = <n>	Control a calling subscriber to get the connected line identity (COL) of the called party after setting up a mobile originated call

15.10 Diag Commands

ITEMS	OPERATIONS	COMMENTS
AT commands	AT!GSTATUS?	Shows a snapshot of what rat/band/channel the device is on.
AT commands	AT!ENTERCND="A710" AT!PCTEMP?	Check current module temperature.
AT commands	AT!ENTERCND="A710" AT!PCVOLT?	Check current module voltage.
AT commands	AT+CGDCONT?	Check the profile contents.

15.11 Enable/Disable IMS

ITEMS	OPERATIONS	COMMENTS
AT commands	AT!UNLOCK="A710" AT!IMSTESTMODE=1 AT!RESET	Disable IMS.
AT commands	AT!UNLOCK="A710" AT!IMSTESTMODE=0 AT!RESET	Enable IMS.

15.12 Change IMS APN name per test purpose

To change the name of IMS APN, below AT command & NV change are required:

- at!unlock="A710"
- at+cgdcont?
(figure out the current IMS APN profile in used)
- at+cgdcont=2,"IPV4V6","ims"
(Take profile 2 as example and change IMS name as "ims")
- Configure NV71527 -> (0).CAPNNAME with value "ims" as below screenshot.
(How to configure NV? Please refer to chapter 7.2)
- Reset device.

Search NvItem ID 71527		☐ Multisim	
NVITEM ID	DESCRIPTION	FULL NAME	
71527	configuration related to registration parameters	/nv/item_files/ims/qp_ims_reg_config_db	
71528	Manufacturer Name to be sent in Auto Register Message	/nv/item_files/modem/mmode/manufacture_name	
71529	Manufacturer Code to be sent in Auto Register Message	/nv/item_files/modem/mmode/manufacture_code	
71530	Device Model Detail to be sent in Auto Register Message	/nv/item_files/modem/mmode/device_model	
71531	Software Version to be sent in Auto Register Message	/nv/item_files/modem/mmode/sw_version	
71532	Enable ric reestablish feature.	/nv/item_files/modem/tdscdma/rcc/tds_ric_reestablish_enable	
71533	TDS RRC Band Search Mask	/nv/item_files/modem/tdscdma/rcc/band_search_mask	
71534	FR 15544: TD-SCDMA UL power control mechanism to assist beam ...	/nv/item_files/modem/tdscdma/t1/tds1_tx_pwr_boost	
71535	PBM cache support config	/nv/item_files/pbm/features_status_list	
71536	t2l_cm_meas_periodicity_sgite	/nv/item_files/modem/tdscdma/t1/t2l_cm_meas_periodicity_sgite	
71537	t2l_cm_meas_periodicity	/nv/item_files/modem/tdscdma/t1/t2l_cm_meas_periodicity	
INPUT	VALUE	NAME	SIZE
0	0	[9] iServicePriorityWWAN	16
0	0	iAllowedIMSSrvOnWLAN	16
0	0	bAddAllFTs	8
0	0	iACSPriority	8
2	2	iISIMPriority	8
3	3	iNVPriority	8
1	1	iPCOPriority	8
132120583	132120583	iIMSServiceStatus	32
ims	ims	[0] cAPNName	24
		[1] cAPNName	0
		[2] cAPNName	0
00-QPE_ENABLE_REREG_ON2G3G_INVALID	☒ QPE_ENABLE_REREG_ON2G3G_INVALID	eEnableReregOn2G3G	8

NVITEM READ COMPLETED

15.13 TTY command

ITEMS	OPERATIONS	COMMENTS
AT commands	AT!AVCFG=5,2,1 (TTY device) AT!AVSETPROFILE=5 AT!AVMFTCODECMODE=5	Enable TTY, and deregister IMS.

ITEMS	OPERATIONS	COMMENTS
AT commands	AT! AVCFG? AT!AVSETPORFILE= 1 (chose a none TTY device profile index, prefer to set it back to 1 as it is the default audio setting)	Disable TTY, and register IMS.
AT commands	AT! AVSETPROFILE? (query the current audio profile index) AT! AVCFG? (Query the audio profile configure if the second parameter of the current profile is '2', that means it is a TTY profile)	Query the TTY state #### Reference ### AT!AVSETPROFILE? !AVSETPROFILE: 5 ,0,0,0,3,0 OK ## 5 as current profile in use; AT!AVCFG? !AVCFG: 0,0,2 !AVCFG: 1,0,2 !AVCFG: 2,0,0,1,0,0,0,4 !AVCFG: 3,0,1 !AVCFG: 4,0,3 !AVCFG: 5, 2 ,2 OK ## 2 mean current profile enable TTY;

NOTE: Do not forget to disable TTY after TTY testing is completed. Or else the module will fail to do IMS registration.

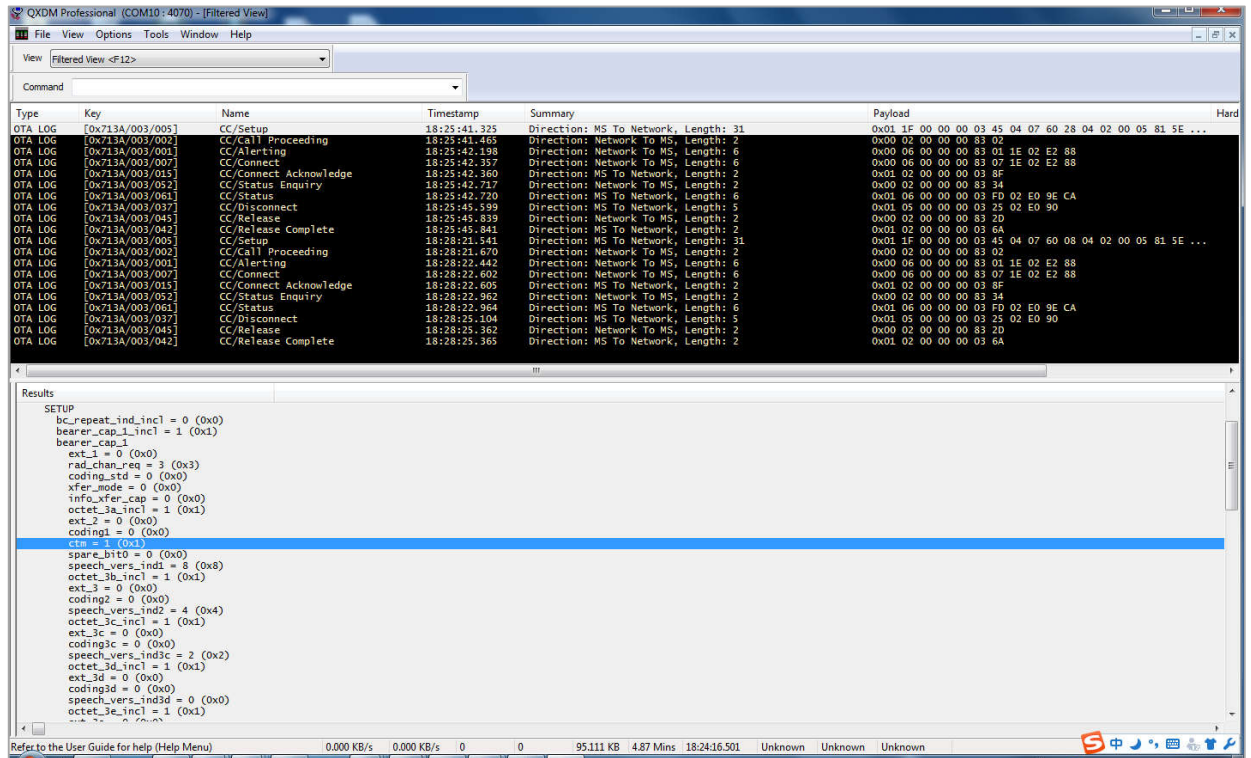
15.14 Caller ID display AT command

ITEMS	OPERATIONS	COMMENTS
AT commands	AT!IPCALLNAME?	To display caller ID per AT&T requirement.

16 Others

16.1 Get TTY state over QXDM

TTY state could be checked in the OTA message as below if the CTM in the CM setup message is set to "1", which means the TTY is enabled.



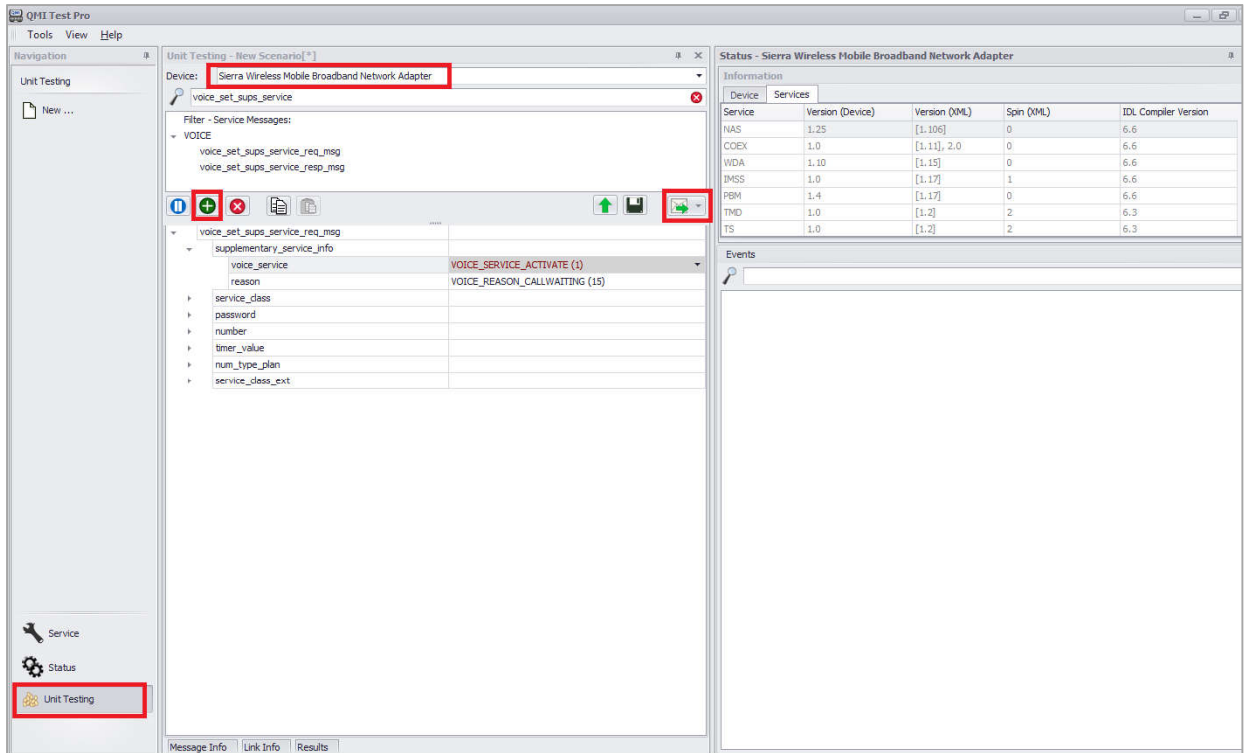
16.2 QMI Test Guide for UT interface Cases

For all Ut Interface Test Plan, keep NV70239 to 2 and use the QMI command "voice_set_sups_service_req_msg" with QMI test pro, but the QMI setting is different for all cases.

1. LTE-BTR-5-4200(TC5.1):

Set voice_service to VOICE_SERVICE_ACTIVATE (for *43#) or VOICE_SERVICE_DEACTIVATE(for #43#)

Set reason to VOICE_REASON_CALLWAITING



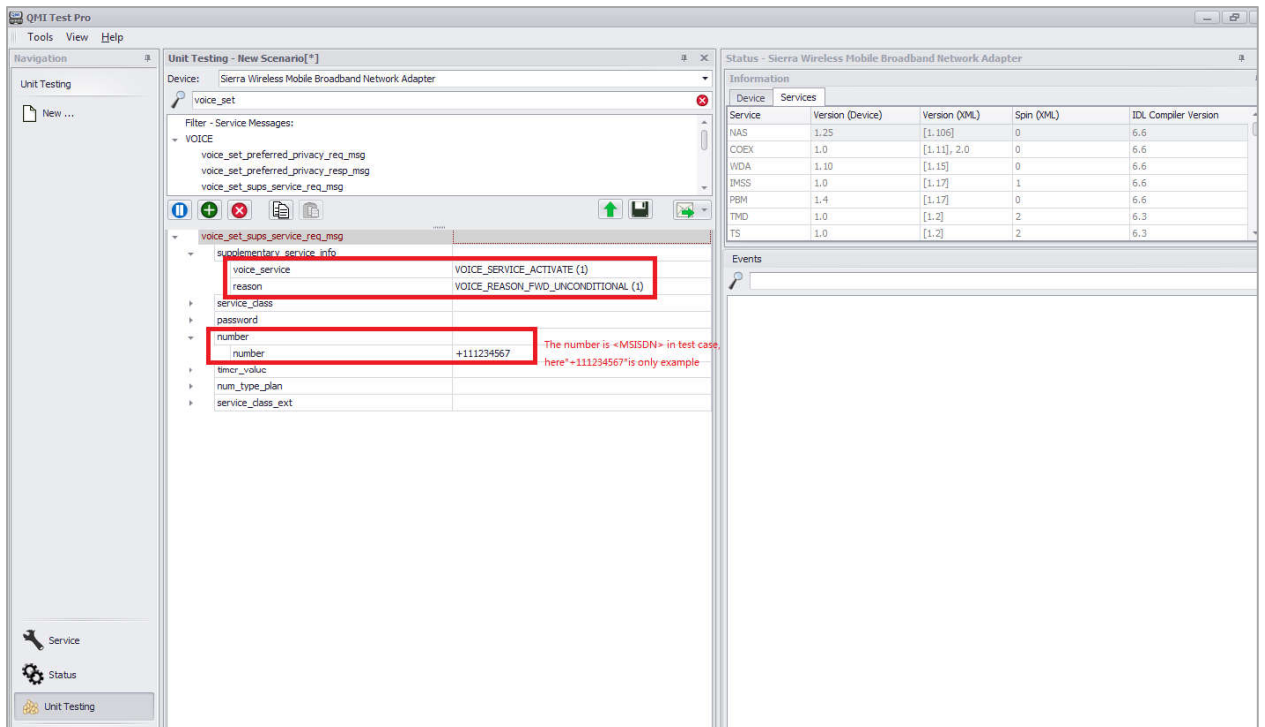
2. LTE-BTR-5-4212(TC5.2):

Dial *21*<MSISDN># from UE where <MSISDN> is in +11d format:

Set voice_service to VOICE_SERVICE_ACTIVATE

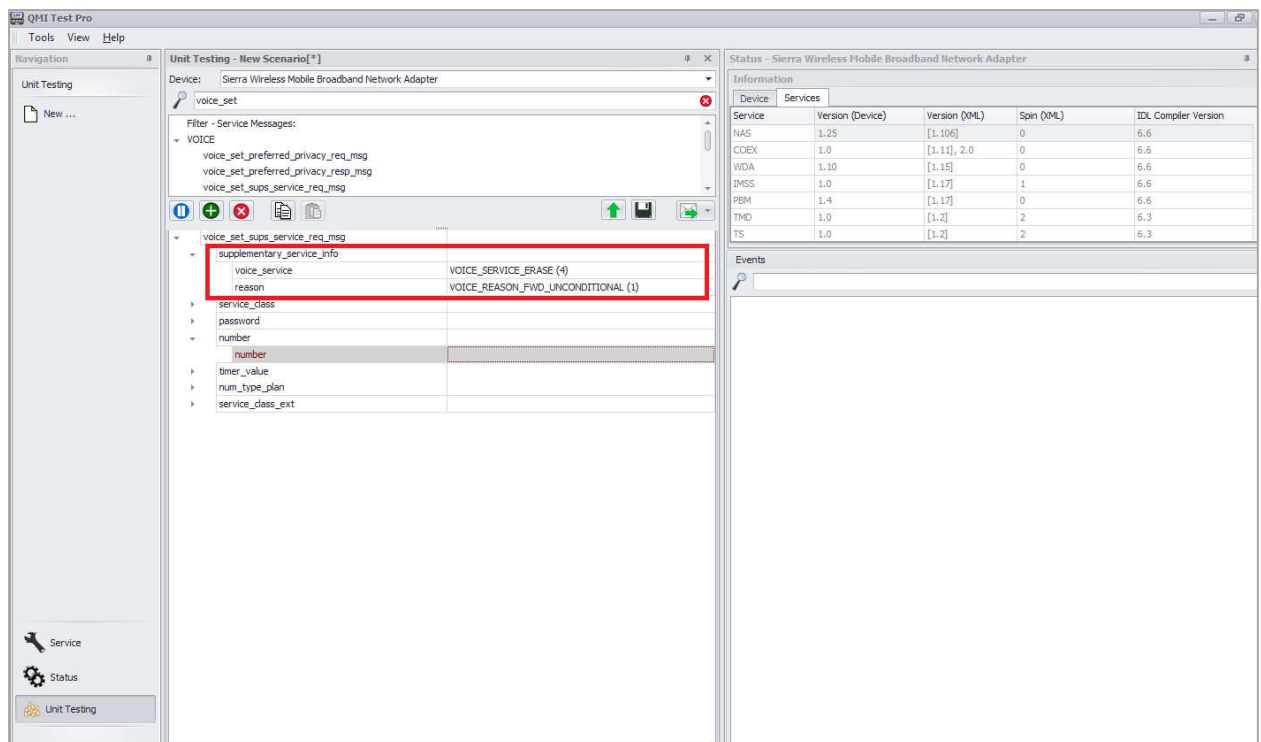
Set reason to VOICE_REASON_FWD_UNCONDITIONAL

Set number to <MSISDN> in test case.



Dial #21# from UE and allow transactions to complete:

[illegible]



3. LTE-BTR-5-4210(TC5.3):

Dial *67*<MSISDN># from UE where <MSISDN> is in 10d format
 Set voice_service to VOICE_SERVICE_ACTIVATE
 Set reason to VOICE_REASON_FWD_MOBILEBUSY
 Set number to <MSISDN> in test case.

Dial #67# from UE and allow transactions to complete
 Set voice_service to VOICE_SERVICE_DEACTIVATE
 Set reason to VOICE_REASON_FWD_MOBILEBUSY
 Do not set number

Dial ##67# from UE and allow transactions to complete
 Set voice_service to VOICE_SERVICE_ERASE
 Set reason to VOICE_REASON_FWD_MOBILEBUSY
 Do not set number

4. LTE-BTR-5-4202(TC5.4)

Dial *61*<MSISDN># from UE where <MSISDN> is in +11d format
 Set voice_service to VOICE_SERVICE_ACTIVATE
 Set reason to VOICE_REASON_FWD_NOREPLY
 Set number to <MSISDN> in test case.

Dial #61# from UE and allow transactions to complete
 Set voice_service to VOICE_SERVICE_DEACTIVATE
 Set reason to VOICE_REASON_FWD_NOREPLY
 Do not set number

Dial ##61# from UE and allow transactions to complete
Set voice_service to VOICE_SERVICE_ERASE
Set reason to VOICE_REASON_FWD_NOREPLY
Do not set number

5. LTE-BTR-5-4208(TC5.5)
Dial *61*<MSISDN>**25# from UE where <MSISDN> is in 10d format
Set voice_service to VOICE_SERVICE_ACTIVATE
Set reason to VOICE_REASON_FWD_NOREPLY
Set number to <MSISDN> in test case.
Set time_value to 25

Dial #61# from UE and allow transactions to complete
Set voice_service to VOICE_SERVICE_DEACTIVATE
Set reason to VOICE_REASON_FWD_NOREPLY
Do not set number and time_value

Dial ##61# from UE and allow transactions to complete
Set voice_service to VOICE_SERVICE_ERASE
Set reason to VOICE_REASON_FWD_NOREPLY
Do not set number and time_value

6. LTE-BTR-5-4204(TC5.6)
Dial *62*<MSISDN># from UE where <MSISDN> is in +11d format
Set voice_service to VOICE_SERVICE_ACTIVATE
Set reason to VOICE_REASON_FWD_UNREACHABLE
Set number to <MSISDN> in test case.

Dial #62# from UE and allow transactions to complete
Set voice_service to VOICE_SERVICE_DEACTIVATE
Set reason to VOICE_REASON_FWD_UNREACHABLE
Do not set number

Dial ##62# from UE and allow transactions to complete
Set voice_service to VOICE_SERVICE_ERASE
Set reason to VOICE_REASON_FWD_UNREACHABLE
Do not set number

7. LTE-BTR-5-4214(TC5.7)
Dial *004*<MSISDN># from UE where <MSISDN> is in 10d format
Set voice_service to VOICE_SERVICE_ACTIVATE
Set reason to VOICE_REASON_FWD_ALLCONDITIONAL
Set number to <MSISDN> in test case.

Dial #004# from UE and allow transactions to complete
Set voice_service to VOICE_SERVICE_DEACTIVATE
Set reason to VOICE_REASON_FWD_ALLCONDITIONAL
Do not set number

Dial ##004# from UE and allow transactions to complete

Set voice_service to VOICE_SERVICE_ERASE
 Set reason to VOICE_REASON_FWD_ALLCONDITIONAL
 Do not set number

8. LTE-BTR-5-4206(TC5.8)
 Dial *004*<MSISDN>**25# from UE where <MSISDN> is in +11d format
 Set voice_service to VOICE_SERVICE_ACTIVATE
 Set reason to VOICE_REASON_FWD_ALLCONDITIONAL
 Set number to <MSISDN> in test case.
 Set time_value to 25

Dial #004# from UE and allow transactions to complete
 Set voice_service to VOICE_SERVICE_DEACTIVATE
 Set reason to VOICE_REASON_FWD_ALLCONDITIONAL
 Do not set number and time_value

Dial ##004# from UE and allow transactions to complete
 Set voice_service to VOICE_SERVICE_ERASE
 Set reason to VOICE_REASON_FWD_ALLCONDITIONAL
 Do not set number and time_value

16.3 AT Test Guide for eCall Cases(only for europe)

1. How to check eCall enable/disable

AT!UNLOCK="A710"
 AT!NV?ECALL_ENABLED
 Return 00//disable
 01//enable

2. How to start/stop eCall

AT!MECALL=<ecall_session>[,<type_of_ecall>]

< ecall_session >	0-1	0: stop eCall session 1: start eCall session
<type_of_call>	0-3	0: test call 1: reconfiguration call eCall 2: manually initiated eCall 3: automatically initiated eCall

3. How to config eCall

AT!MECALLCFG=<voc_mode>,<host_build_msd>,<dial_type>,["<num>"],<modem_msd_type>[,<max_redial_attempt>[,<gnss_update_time>[,<nad_deregistration_time>[,<ecall_use_m_slot_id>]]]]

<voc_mode>	0-1	0: Deregister the (speaker) Rx input of the vocoder 1: Do not deregister Rx input of the vocoder
<host_build_msd>	0-1	0: This instructs the modem to build the MSD blob without involving the Host.

		1: The Host is entirely responsible to provide the MSD blob.
<dial_type>	0-1	0: NORMAL, i.e., Read the number to dial from the FDN/SDN, depending upon the eCall operating mode 1: OVERRIDE, i.e., Override the operating mode; the eCall modem dials the number specified in the <num> field
<num>	string	Indicates the number to dial; specified only when <dial_type> is set to OVERRIDE; this number must be the number of the PSAP
<modem_msd_type>	0-1	0: Send real MSD; look for the GPS fix 1: Send canned MSD
<max_redial_attempt>	0-10	The number of attempts for IVS to redial the call if the initial eCall attempt fails to connect, or the call is dropped for any reason other than by the PSAP operator clearing the call down or T2 (IVS Call Clear-down Fallback Timer) ends. Default value: 0
<gnss_update_time>	1-255	The number of seconds to allow to capture satellite information, also it is the timer to start GPS location fix. Default value: 5
<nad_deregistration_time>	1-12	The number of hours that the IVS NAD shall remain registered on the serving network and available to receive calls from the PSAP and rescue workers after the call clear-down by the PSAP. Default values: 8
ecall_usim_slot_id	1-2	Indicates on which SIM slot the ECALL is triggered. 1: Directs the request to the USIM inserted in Slot 1. 2: Directs the request to the USIM inserted in Slot 2 Default value: 1

4. How to set PULL/PUSH tx mode

AT!MECALLTXMODE=<tx_mode>

<tx_mode>	0-1	0: PULL mode 1: PUSH mode
-----------	-----	------------------------------

5. How to send MSD when host_build_msd is 1

AT!MECALLMSD="<msd_data>"

<msd_data>	string	Data as defined in the format as suggested in EN 15722. Must be enclosed in "".
------------	--------	---

6. How to update MSD block

AT!MECALLMSDBLK=<blockNumber>,<data>

<blockNumber>	1-12	valid block number values are 1-12
<data>	string	Data as defined in the format as suggested in EN 15722. Must be enclosed in "".

7. How to enable eCall/disable uslmsk and check eCall event

```
//enable eCall uslmsk
AT+WUSLSK=FFFFFFFF,0
AT+WUSLSK=FFFFFFFF,1
AT!MECALLUSLSK=FFFFFFFF
//disable eCall uslmsk
AT!MECALLUSLSK=0

//check eCall event
!MECALL:<ind>[,<timer_id>]
```

<ind>	0-28	0: eCall session started 1: Get GPS Fix 2: GPS Fix Received 3: GPS Fix Timeout 4: MO call connected 5: MO call Disconnected 6: MT call connected 7: MT call Disconnected 8: Waiting for PSAP START indication 9: PSAP START received but no MSD available 10: PSAP START received and MSD available 11: PSAP START received and MSD sent 12: LL ack received 13: 2LL acks received 14: LL nack received 15: HL ack received 16: IVS Transmission completed 17: 2AL acks received 18: eCall session completed 19: eCall clear-down received 20: eCall session reset 21: eCall session failure 22: MSD update request available 23: eCall session stop 24: eCall operating mode is eCall and normal call mode 25: eCall operating mode is eCall only mode
-------	------	--

		26: eCall transmission mode is PUSH mode 27: call transmission mode is PULL mode 28: eCall timer timeout reached
<timer_id>		2: T2 timer 5: T5 timer 6: T6 timer 7: T7 timer 9: T9 timer 10: T10 timer

16.4 AT Test Guide for Factory reset Cases (only for Verizon)

For some Verizon Motive test cases, need to execute Factory reset.

How to execute Factory reset,

1. at!unlock="A710"
2. at!mcfgselmode=0 //set it by manually mode
3. at!mcfgsel=0 //deactivate the Current MBN
4. at!mcfgsel=0 //deactivate the Current MBN

16.5 AT Command for MSB & MSA

16.5.1 GPS constant location

AGPS MSB: at!gpstrack=2,255,1000,1000,1

AGPS MSA: at!gpstrack=3,255,1000,1000,1

NOTE: As long as the power stays on, you only need to give a command once.

16.5.2 GPS stop location

AT!GPSEND=0

NOTE: If the power is not powered off, you need to send the GPS stop command before sending the GPS location command for the second time.

S

17 Rolling Wireless Lab Support Contacts

NAME	TITLE	PHONE NUMBER
Eva Zheng <eva.zheng@rollingwireless.com>	Certification Engineer	+86 755 8611 9884
Wilson Lin <Wilson.Lin@rollingwireless.com>	Certification Manager	+86 755 8611 9834

18 OEM/Integrators Installation Manual

Important Notice to OEM integrators

1. This module is limited to OEM installation ONLY.
2. This module is limited to installation in mobile or fixed applications, according to Part 2.1091(b).
3. The separate approval is required for all other operating configurations, including portable configurations with respect to Part 2.1093 and different antenna configurations
4. For FCC Part 15.31 (h) and (k): The host manufacturer is responsible for additional testing to verify compliance as a composite system. When testing the host device for compliance with Part 15 Subpart B, the host manufacturer is required to show compliance with Part 15 Subpart B while the transmitter module(s) are installed and operating. The modules should be transmitting and the evaluation should confirm that the module's intentional emissions are compliant (i.e. fundamental and out of band emissions). The host manufacturer must verify that there are no additional unintentional emissions other than what is permitted in Part 15 Subpart B or emissions are complaint with the transmitter(s) rule(s).

The Grantee will provide guidance to the host manufacturer for Part 15 B requirements if needed.

Important Note

notice that any deviation(s) from the defined parameters of the antenna trace, as described by the instructions, require that the host product manufacturer must notify to XXXX that they wish to change the antenna trace design. In this case, a Class II permissive change application is required to be filed by the USI, or the host manufacturer can take responsibility through the change in FCC ID (new application) procedure followed by a Class II permissive change application.

End Product Labeling

When the module is installed in the host device, the FCC label must be visible through a window on the final device or it must be visible when an access panel, door or cover is easily re-moved. If not, a second label must be placed on the outside of the final device that contains the following text:

"Contains FCC ID: 2AX2URL9424

The FCC ID can be used only when all FCC compliance requirements are met.

Antenna Installation

- (1) The antenna must be installed such that 20 cm is maintained between the antenna and users,
- (2) The transmitter module may not be co-located with any other transmitter or antenna.
- (3) Only antennas of the same type and with equal or less gains as shown below may be used with this module. Other types of antennas and/or higher gain antennas may require additional authorization for operation.

Antenna type	LTE Band7 Peak Gain (dBi)
Dipole Antenna	2dbi

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

Manual Information to the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warning as show in this manual.

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 interference 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 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 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.

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

List of applicable FCC rules

This module has been tested and found to comply with part 27 requirements for Modular Approval.

The modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. If the grantee markets their product as being Part 15 Subpart B compliant (when it also contains unintentional-radiator digital circuitry), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

This device is intended only for OEM integrators under the following conditions: (For module device use)

- 1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and
- 2) The transmitter module may not be co-located with any other transmitter or antenna.

As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

Radiation Exposure Statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20 cm between the radiator & your body.

19 Routing Constraints and Recommendations

Layout and routing of the AirPrime RL942x Series in the application is critical to maintaining the performance of the radio. The following sections provide guidance to the developer when designing their application to include an AirPrime RL942x Series and achieve optimal system performance.

19.1 RF Routing Recommendations

To route the RF antenna signals, the following recommendations must be observed for PCB layout: The RF signals must be routed using traces with a 50 Ω characteristic impedance. Basically, the characteristic impedance depends on the dielectric constant (ϵ_r) of the material used, trace width (W), trace thickness (T), and height (H) between the trace and the reference ground plane. In order to respect this constraint, Sierra Wireless recommends that a MicroStrip structure be used and trace width be computed with a simulation tool (such as AppCAD, shown in the figure below and available free of charge at <http://www.avagotech.com>).

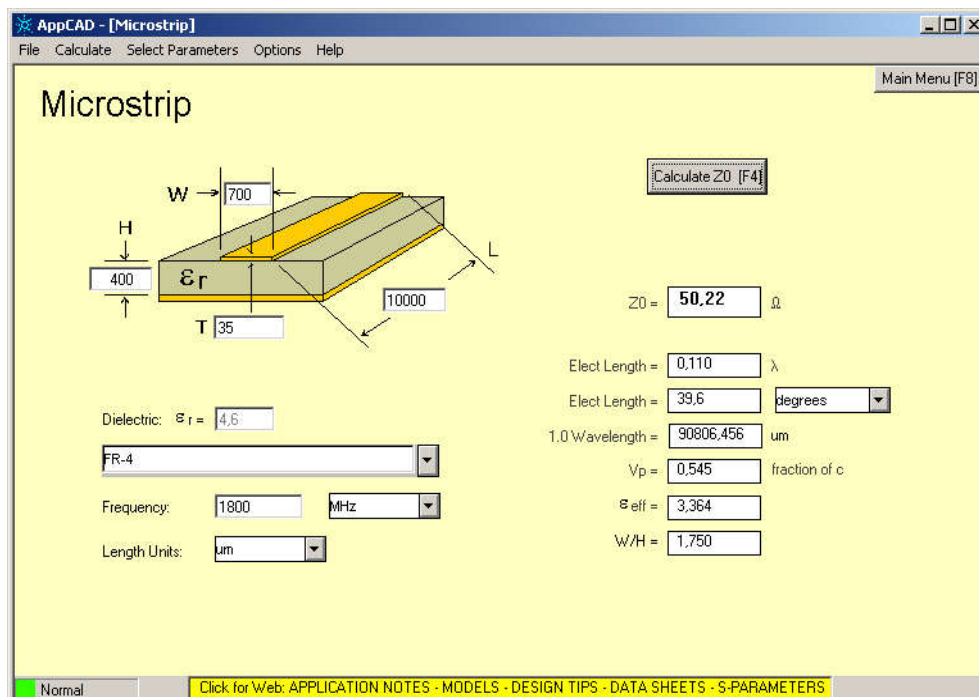


Figure 1. AppCAD Screenshot for Microstrip Design Power Mode Diagram

The trace width should be wide enough to maintain reasonable insertion loss and manufacturing reliability. Cutting out inner layers of ground under the trace will increase the effective substrate height; therefore, increasing the width of the RF trace.

Caution: *It is critical that no other signals (digital, analog, or supply) cross under the RF path. The figure below shows a generic example of good and poor routing techniques.*

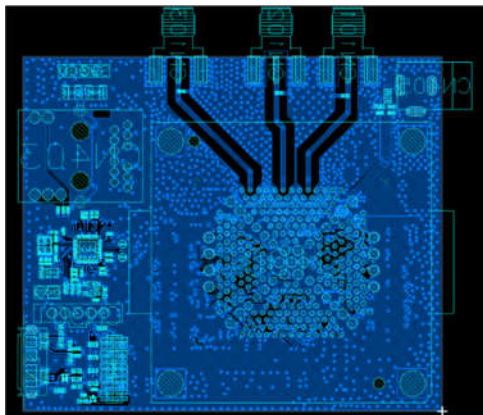


Figure 2. RF Routing Examples

- Fill the area around the RF traces with ground and ground vias to connect inner ground layers for isolation.
- Cut out ground fill under RF signal pads to reduce stray capacitance losses.
- Avoid routing RF traces with sharp corners. A smooth radius is recommended. E.g. Use of 45° angles instead of 90°.
- The ground reference plane should be a solid continuous plane under the trace.

- The coplanar clearance (G, below) from the trace to the ground should be at least the trace width (W) and at least twice the height (H). This reduces the parasitic capacitance, which potentially alters the trace impedance and increases the losses.
 E.g. If W = 100 microns then G = 200 microns in an ideal setup. G = 150 microns would also be acceptable if space is limited.

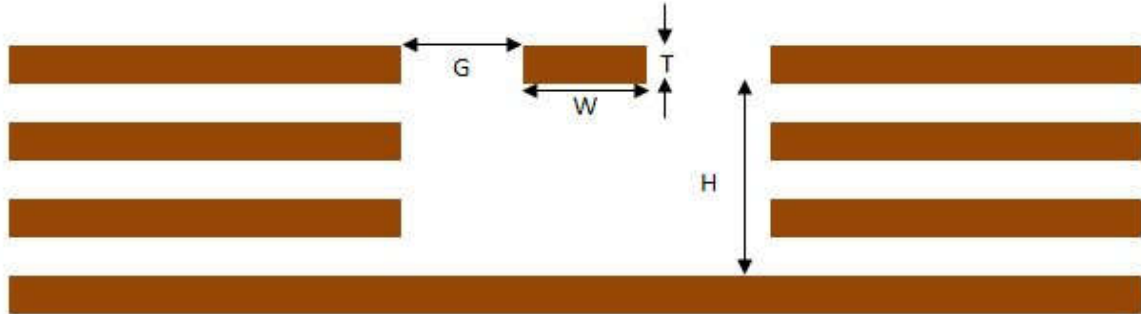


Figure 3. Coplanar Clearance Example

NOTE: The figure above shows several internal ground layers cut out, which may not be necessary for every application.

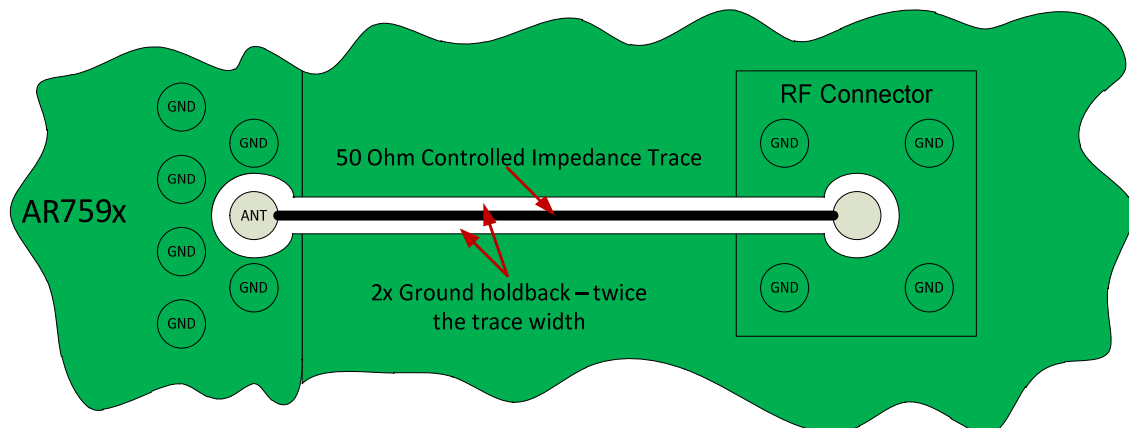


Figure 4. Antenna Microstrip Routing Example

19.2 USB Routing Recommendations

HighSpeed USB signals (USB_D_P / USB_D_M) are a differential pair and must be routed with the following considerations/constraints:

- 90 Ohm differential +/- 10% trace impedance,
- Differential trace length pair matching < 2mm (15 ps),
- Solid reference planes,
- Trace lengths < 120 mm,
- And 2x the trace width separation to all adjacent signals.

SuperSpeed USB adds two differential pairs (SSRX+ / SSRX- and SSTX+ / SSTX-). These pairs should be routed with the following considerations/constraints:

- 90 Ohm differential +/- 15% trace impedance,
- Differential trace length pair matching < 0.7mm (5 ps),
- Trace lengths < 112 mm,
- And GND isolation from other adjacent traces with minimum of 2x the SSRX/SSTX trace width.

19.3 Power and Ground Recommendations

Power and ground routing is critical to achieving optimal performance of the AirPrime RL942x Series when integrated into an application.

Recommendations:

- Do not use a separate GND for the Antennas.
- Connections to GND from the AirPrime RL942x Series should be flooded plane using thermal reliefs to ensure reliable solder joints.
- VBATT is recommended to be routed as a wide trace(s) directly from the power supply to the LGA pad.

19.4 Antenna Recommendations

Connecting the antenna ground reference to the vehicle chassis is not recommended since that has been known to cause noise from the engine to couple into the audio of the device. It is ultimately up to the integrator to evaluate this performance.