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Modules

EM91 Series

Customer Production Test Guide

February 2025

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Sales information and technical support, including warranty and returns	Web: sierrawireless.com/company/contact-us/ Global toll-free number: 1-877-687-7795 6:00 am to 5:00 pm PST
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Revision History

Revision number	Release date	Changes
1.0	February 24, 2020	Creation
1.1	May 12, 2020	Added 3G/4G/5G AUX port checking; Added 4G/5G MIMO ports checking; Added 5G mmW IF ports checking; Updated GNSS part; Added note for DV4 MIMO index change; Updated Tx and Rx power range; Removed LTE B21.
1.2	July 23, 2020	Added one action (AT!DASUB6TECHACT) for 5G-Sub6 RF test; Updated the usage of AT!DAUPDATEPARAM for sub-band B; Added notes for WCDMA B6 and LTE B46; Added LTE band support; Added MIMO support in Table 1.
1.3	September 02, 2020	Added some band supports that are under planning for future release. Changed Tx/Rx channel for n258. Corrected some typos for mmW Tx. Changed bandwidth support for n77/n79. Added a step for RF device scanning in production test procedure.
1.4	November 04, 2020	Added B41B. Changed Tx/Rx channel for B28/N28. Removed references to earlier hardware versions, adding applicability statement to Overview.
1.5	November 30, 2020	Changed RX center channel/frequency for B66/n66.
2	November 2021	Removed !DAMMWACT & !DAMMWDEACT commands from procedures. Updated formats for AT!DARCONFIG and AT!DATXCONTROL.

Revision number	Release date	Changes
3	May 2023	Updated Overview Updated Production Testing: ▪ Updated introduction ▪ Updated Suggested Testing Platform Equipment ▪ Updated Functional Production Test ▪ Added Table 3-2, RF Receptacles — RF Technology Support ▪ Updated Functional Production Test Plan Updated WCDMA RF Tests ▪ Updated Table 3-3, Test Parameters — WCDMA (format; removed Band 3) ▪ Updated WCDMA test procedures wording Updated LTE RF Tests ▪ Updated Table 3-4, Test Parameters — LTE (format/footnotes; added B18, updated B41A/B41B/B46/B66) ▪ Updated LTE test procedures wording Updated 5GSub6 RF Tests ▪ Updated Table 3-5, Test Parameters — 5G Sub6 (format, footnotes, added n41B, updated n48) ▪ Updated 5G Sub6 test procedures wording Added mmW procedures Updated terminology (antenna connectors → antenna receptacles)
4	February 2025	Removed references to !DAUPDATEPARAM (command has been deprecated) Replaced all !DAFTMACT calls with +CFUN calls Updated Table 3-1, Suggested Testing Platform Equipment (example power supply) Updated Table 3-3, Test Parameters — WCDMA (updated Rx test channels) Updated LTE RF Transmission Path Test (updated usage description, command format and example for !DARCONFIG step; updated details for repeating test for the next LTE band) Updated LTE RF Receive Path Test (updated usage description for !DARCONFIG step) Updated Table 3-5, Test Parameters — 5G Sub6 (added Resource Block Settings; updated n48/n79 Tx and Rx test channels) Updated 5G Sub6 RF Transmission Path Test (updated usage description, command format and examples for !DARCONFIG step; updated !DATXCONTROL examples and notes) Updated 5G Sub6 RF Receive Path Test (updated usage description for !DARCONFIG step) Updated 5G mmW RF Transmission Path Test (added !RESET step) Updated 5G mmW RF Receive Path Test (added !RESET step)

Contents

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1: Overview

Developers integrating Sierra Wireless embedded modules into OEM devices should test the integration in their factory to make sure their devices work properly with the modules.

This document aims to help developers set up a factory production test procedure for products containing EM91 series embedded modules:

- EM9190 ES3 and newer
- EM9191
- EM7690

Note: In this document:

- *EM91 refers to the EM91 module series, which includes EM9190, EM9191, and EM7690.*
- *EM919x refers to EM9190 and EM9191.*

Important: *The tests in this document are performed using AT commands as implemented in firmware version SWIX55C_03.17.02.00 (Release 7).*

Suggested test procedures are described for each supported technology as indicated in Table 1-1:

Table 1-1: Test Procedures

RAT test cases	EM7690	EM9190	EM9191
WCDMA RF Tests	Y	Y	Y
LTE RF Tests	Y	Y	Y
5G Sub6 RF Tests	—	Y	Y
5G mmW RF Tests	—	Y	—
Shared GNSS RF Receive Path Test	Y	Y	Y

For supported bands, GNSS specifications, etc., refer to *[2] EM919X/EM7690 Product Technical Specification (Doc# 41113174)*.

Note: The procedures and values identified in this document are intended for testing at room temperature.

2: AT Command Entry Timing Requirement

Some commands require time to process before additional commands are entered. For example, the modem returns OK when it receives **AT+CFUN=5**. If **AT!DARCONFIG** is received too soon after this, the modem returns an error.

When building automated test scripts, ensure that sufficient delays are embedded where necessary to avoid these types of errors.

3: Production Testing

Use an appropriate test station for your testing environment (e.g., a minimal platform configuration for test bench usage, a full test fixture for factory production testing, etc.), and use AT commands to control the module.

Note: Production testing typically continues for the life cycle of the product.

Typical items to test include:
- Host connectivity
- Baseband (host/module connectors)
- RF assembly (Tx and/or Rx, as appropriate)
- Network availability
- Host/device configuration issues

Note: Tests described in this chapter are suggestions only. Make sure the type and quantity of tests you perform exercises functionality to the degree that your situation requires.

Your test station must be protected from ESD to avoid interference with the module and antenna(s), assuming that your test computer is in a disassembled state. Also, consider using an RF shielding box, since local government regulations may prohibit unauthorized transmissions.

3.1 Suggested Testing Platform Equipment

To perform production tests, use an appropriate testing platform.

Table 3-1: Suggested Testing Platform Equipment

Equipment	Details
PC with Windows	Windows 11 22H2 or later
Power supply	e.g., Rohde & Schwarz HMP2020
Shielded test box	▪ Required for mmW modules ▪ mmW beam characterization requires a CATR chamber
Call box	▪ For WCDMA / LTE / 5G Sub-6 — CMW500 (or equivalent) for basic RF functions such as generating or receiving required frequency signal ▪ For mmW frequencies up to 40 GHz — CMX500 (or equivalent)

Note: Procedures in this document describe general required callbox configurations (e.g., for CMW500 and CMW100, and (for mmW) CMX500). Adapt the procedures as necessary based on the callbox type(s) used in your testing platform.
You can also use a Power Meter and Signal Generator to replace the call box. (e.g., Power Meter Gigatronics 8651A (with Option 12 and Power Sensor 80701), and Signal Generator Agilent 8648C)

3.2 Functional Production Test

This section presents a suggested basic manual functional test procedure for a host platform with an EM91 embedded module. As you become familiar with the testing method, use it to develop your own automated production testing procedures.

Note: This document describes radiated (over the air) testing for 5G mmW, and conducted power testing for WCDMA, LTE and 5G NR Sub-6G GHz. For radiated testing of WCDMA, LTE and 5G NR Sub-6G GHz, modify the suggested procedures as appropriate to your requirements.

3.2.1 RF Receptacles

EM91 modules include several receptacles for use with host-supplied antennas. The host must mate the RF receptacles (PCB connectors) with corresponding RF plugs (cable connectors).

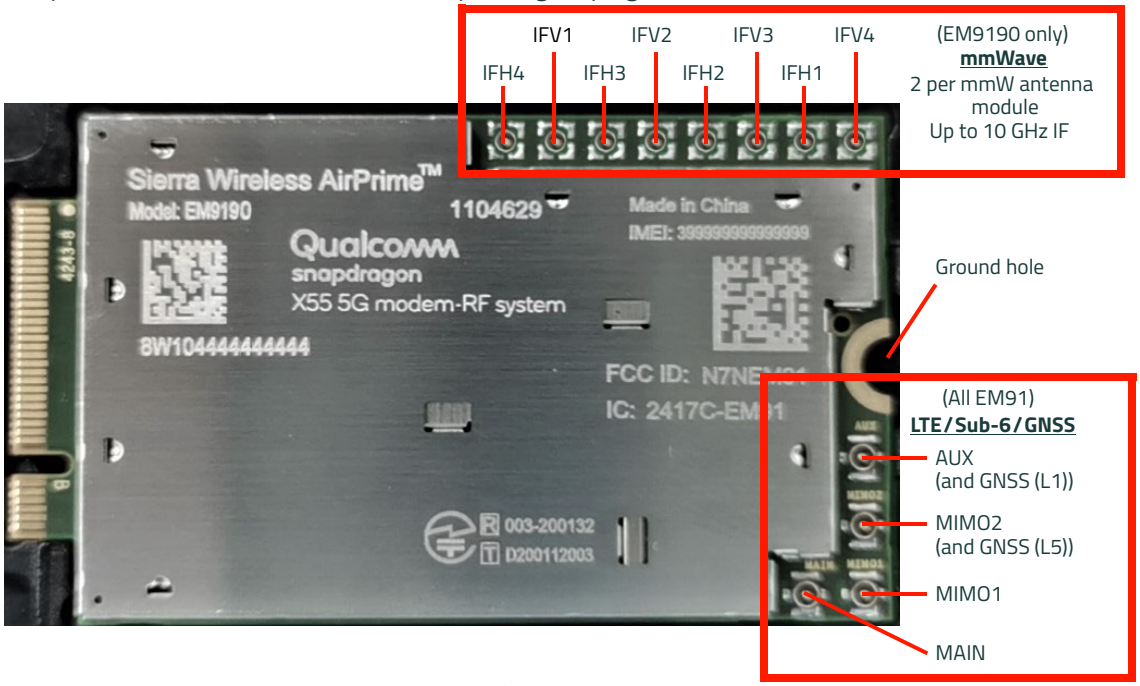


Figure 3-1: EM91 Module RF Receptacles (EM9190 shown)

Table 3-2: RF Receptacles — RF Technology Support

RAT	Receptacle					
	MAIN	MIMO1	MIMO2	AUX	GNSS	IFH1–IFH4 / IFV1–IFV4
LTE/Sub-6 TRx	LB, B41, MB, HB, UHB	n41	–	–		–
LTE/Sub-6 Rx	LB, MB, HB, UHB, LAA	MB, HB, UHB	MB, HB, UHB	LB, MB, HB, UHB, LAA		–
5G mmW	–	–	–	–		One V/H pair per module (Up to four mmW modules)
GNSS	–	–	L5	L1		–

3.2.2 Functional Production Test Plan

The following is a suggested test plan using a Windows PC with an EM91 Development Kit substituting as the host platform device under test (DUT).

Note:

- You must decide which tests are appropriate for your product.
- You can also add additional tests that fully exercise your product's capabilities.

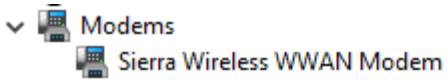
To perform these tests, use an appropriate hardware connection on the host platform under test (e.g., the development kit's USB-C connector CN204), and refer to *[1] EM9 Series AT Command Reference (Doc# 41113480)* for command details:

1. Before installing the module in the host platform, visually inspect the module's connectors and RF assemblies for obvious defects.
2. Install the module in the host platform.
3. Make sure the module is powered off (i.e., no voltage on VCC).
4. Provide power to the module.

   Note — For EM91 power on/off details, refer to the *[2] EM919X/EM7690 Product Technical Specification (Doc# 41113174)* sections "Full_Card_Power_Off# and RESET#" and "Power Interface".
5. Test host platform functionality — Check that the module enumerates correctly.

   Note — In this test example, check the port enumeration with Windows Device Manager. In Device Manager, the module appears under Modems as a Sierra Wireless WWAN Modem port.

   For example:

   Note: Windows drivers are available from the module's device page at source.sierrawireless.com.
6. Determine the COM port used for the modem.

   Note — In this test example, check the enumerated port's device properties.
7. Set up a serial connection to the modem COM port (speed = 115200 baud, or set as appropriate) using a terminal emulator (e.g., HyperTerminal, TeraTerm, PuTTY, etc.).
8. In the emulator, confirm the connection established correctly:

   ```
   AT
   ```

   If the connection is established, the command returns `OK`.

   *Note: Use **ATE1** to enable echo if necessary.*
9. Display the firmware version to confirm the module is loaded with the expected firmware:

   ```
   ATI
   ```
10. Unlock the extended AT command set:

    ```
    AT!ENTERCND="<key>"  ← <key>—Unlock key code
    ```

11. Scan for any RF device problems:

```
AT!RFDEVSTATUS?
instance, manufacture id, product id, present
0 ,<manufacture id>,<product id>, <present> ← Instance list for 3G/4G/5G Sub6
…
x ,<manufacture id>,<product id>, <present>
0 ,<manufacture id>,<product id>, <present> ← Instance list for 5G mmW
…
8 ,<manufacture id>,<product id>, <present>
```

The response displays two 'instance' lists: (0~x) for 3G/4G/5G Sub6, and (0~8) for 5G mmW.

If there are no RF device problems:

- First list (3G/4G/5G Sub6) — Each <present> will be "TRUE".
- Second list (5G mmW) — Instance 0 <present> will be "TRUE".

12. Enter test mode:

```
AT+CFUN=5
```

13. Use the test platform (see Suggested Testing Platform Equipment) to perform RF tests:

    a. Test RF transmission:
    - WCDMA — See WCDMA RF Transmission Path Test.
    - LTE — See LTE RF Transmission Path Test.
    - (EM919x only) 5G Sub6 — See 5G Sub6 RF Transmission Path Test.
    - (EM9190 only) 5G mmW — See 5G mmW RF Transmission Path Test.

    b. Test RF reception:
    - WCDMA — See WCDMA RF Receive Path Test.
    - LTE — See LTE RF Receive Path Test.
    - (EM919x only) 5G Sub6 — See 5G Sub6 RF Receive Path Test.
    - (EM9190 only) 5G mmW — See 5G mmW RF Receive Path Test.

    c. Test standalone GNSS functionality — see Shared GNSS RF Receive Path Test.

3.3 WCDMA RF Tests

WCDMA RF tests apply to EM9190/EM9191/EM7690.

3.3.1 WCDMA Test Parameters

Use the parameters in Table 3-3 for the WCDMA Tx and Rx tests described below.

Table 3-3: Test Parameters — WCDMA

Band		Tx		Rx	
Number	Name	Test Channel	Test Frequency[a] (MHz)	Test Channel	Test Frequency[b] (MHz)
1 (B1)	2100	9750	1950	Use Tx test channel[c]	2141.2
2 (B2)	1900 PCS	9400	1880		1961.2
4 (B4)	1700 AWS-1	1450	1740		2141.2
5 (B5)	850	4175	835		881.2
5 (B6[d])	850 Japan	4175	835		881.2
8 (B8)	900 GSM	2788	897.6		943.8
9 (B9)	1800 Japan	8837	1767.4		1863.6
19 (B19)	800 Japan	412	837.5		883.7

a. Testing Tx frequency to set on the callbox.
b. Testing Rx frequency to set on the callbox.
This frequency includes a required 1.2 MHz offset on the call box from the Rx channel, for testing with an unmodulated (continuous wave (CW)) waveform. (e.g., for band B1, use 2141.2 MHz)
If testing with a modulated waveform, remove the offset. (e.g., for band B1, use 2140 MHz)
c. The WCDMA receive path test uses the Tx channel with the **!DARCONFIG** command. (The module firmware automatically calculates the Rx channel based on the Tx channel.)
d. WCDMA B6 is a sub-band of B5 — use WCDMA B5 instead (B6 will return ERROR).

3.3.2 WCDMA RF Transmission Path Test

This test applies to EM9190/EM9191/EM7690.

Note: For details of each AT command used in this test (including usage, format and parameter details), refer to [1] EM9 Series AT Command Reference (Doc# 41113480).

To test the DUT's transmitter (Tx) path:

1. Connect the RF cable from the call box (e.g., the CMW500) to the module's MAIN receptacle — see Figure 3-1 on page 11. (Note — Do not turn on the RF transmitter yet.)

   Do not connect MIMO1, MIMO2, or AUX.

2. Set up the callbox for Tx testing — make sure to set:
   - Initial Tx frequency being tested
   - Expected Tx power (corresponds to <power_dbm10> in step 2)
   - Filter type — Gauss
   - Pathloss (i.e., cable loss from antenna port of the module to the callbox)
   - Signal receiving path — ON (e.g., on the CMW500, press On/Off button)

Note: WCDMA has only one bandwidth (3.84 MHz), which is set by default (i.e., the value cannot be changed on the callbox).

For examples using a CMW500, see CMW500 Setup on page 38.

3. Set up and test the DUT using the following AT commands:
   a. Unlock the extended AT command set:
      AT!ENTERCND="<key>" ← *<key>—Unlock key code*
   b. Enter test mode:
      AT+CFUN=5
   c. Configure the Tx channel for the selected band:
      AT!DARCONFIG=<carrier>,<technology>,<band>,<tx_channel>

      e.g.:
      AT!DARCONFIG=0,1,2,9400 ← *Tx channel 9400. For values, see Table 3-3.*
   d. Set the Tx power and enable the transmitter (<enable>=1):

      Note: <power_dbm10> = 10 × power must be an integer.)

      AT!DATXCONTROL=<carrier>,<technology>,<enable>,<power_dbm10>

      e.g.:
      AT!DATXCONTROL=0,1,1,-505 ← *Transmit with -50.5 dBm Tx power.*

      Caution: *To avoid possible damage to the module, do not transmit above the module's conducted maximum Tx power (for values, refer to [2] EM919X/EM7690 Product Technical Specification (Doc# 41113174)).*
   e. Take the measurement.

      If the measured value is not close to the expected value, make sure the CMW500 options and the configurations above are set properly.

      Important: *The measured (output power) value is significantly influenced by the test setup (e.g., host RF cabling loss, choice of shield box, etc.).*

      Note: This procedure is for conducted power testing. If the same test is performed over the air in an RF chamber (i.e., radiated power testing), the measured values are likely to be significantly lower, and will also be influenced by various test antenna characteristics (e.g., antenna gain, position, efficiency, pattern).
   f. Disable the transmitter — Set <enable>=0 and make sure all other configuration parameters are the same as in step d.)
      AT!DATXCONTROL=<carrier>,<technology>,<enable>,<power_dbm10>

      e.g.:
      AT!DATXCONTROL=0,1,0,-505
   g. Drop the current WCDMA configuration.
      AT!DARCONFIGDROP=<technology>

      e.g.:
      AT!DARCONFIGDROP=1

h. To test the next WCDMA band:

i. Change appropriate settings (e.g., Tx frequency, expected power, etc.) on the callbox for the next band to test.

ii. Go back to step c.

3.3.3 WCDMA RF Receive Path Test

This test applies to EM9190/EM9191/EM7690.

Note: For details of each AT command used in this test (including usage, format and parameter details), refer to [1] EM9 Series AT Command Reference (Doc# 41113480).

To test the DUT's receive (Rx) path:

1. Connect RF cables to the MAIN and AUX receptacles — see Figure 3-1 on page 11.
   (Do not connect MIMO1 or MIMO2.)
2. Set up the callbox for Rx testing — make sure to set:
   - Signal generator (select the appropriate signal generator)
   - Initial Rx frequency being tested
   - Expected Rx power level (corresponds to <expected_AGC> in step 3)
   - Signal transmit path — ON

   For examples using a CMW500, see CMW500 Setup on page 38.
3. Set up and test the DUT using the following AT commands:

   a. Unlock the extended AT command set:
   ```
   AT!ENTERCND="<key>"  ← <key>—Unlock key code
   ```

   b. Enter test mode:
   ```
   AT+CFUN=5
   ```

   c. Configure the channel for the selected band:
   ```
   AT!DARCONFIG=<carrier>,<technology>,<band>,<tx_channel>

   e.g.:
   AT!DARCONFIG=0,1,2,9400  ← Rx channel 9400. For values, see Table 3-3.
   ```

   d. Repeat this step for each Rx path that you want to test — Set the expected Rx power (<expected_AGC>) and check that the measured *<rssi>* = *<expected_AGC>* (i.e., actual FTM AGC matches the expected AGC).

   Note: <expected_AGC> = 10 × power must be an integer.

   ```
   AT!DAGFTMRXAGC=<carrier>,<technology>,<expected_AGC>,<path>
   <rssi>
   OK
   ```

   e.g. To test an Rx path for -50.5 dBm:
   - Check the MAIN path Rx (i.e., when the MAIN receptacle (path index 0) is connected to the CMW500):
     ```
     AT!DAGFTMRXAGC=0,1,-505,0
     -50.5
     OK
     ```

- Check the AUX path Rx (i.e., when the AUX antenna port (path index 3) is connected to the CMW500.):

```
AT!DAGFTMRXAGC=0,1,-505,3
-50.5
OK
```

e. Drop the current WCDMA configuration:

```
AT!DARCONFIGDROP=<technology>
```

e.g.:

```
AT!DARCONFIGDROP=1
```

f. To test the next WCDMA band:

i. Change appropriate settings (e.g., Rx frequency, expected power, etc.) on the callbox for the next band to test.

ii. Go back to step c.

3.4 LTE RF Tests

LTE RF tests apply to EM9190/EM9191/EM7690.

3.4.1 LTE Test Parameters

Use the parameters in Table 3-4 for the LTE Tx and Rx tests described below.

Table 3-4: Test Parameters — LTE

Band Number	Bandwidth Index[a]	Tx		Rx	
		Test Channel[b]	Test Frequency[c] (MHz)	Test Channel[b]	Test Frequency[d] (MHz)
1 (B1)	3 (10 MHz)	18300	1950	300	2142
2 (B2)	3 (10 MHz)	18900	1880	900	1962
3 (B3)	3 (10 MHz)	19575	1747.5	1575	1844.5
4 (B4)	3 (10 MHz)	20175	1732.5	2175	2134.5
5 (B5)	3 (10 MHz)	20525	836.5	2525	883.5
7 (B7)	3 (10 MHz)	21100	2535	3100	2657
8 (B8)	3 (10 MHz)	21625	897.5	3625	944.5
12 (B12)	3 (10 MHz)	23095	707.5	5095	739.5
13 (B13)	3 (10 MHz)	23230	782	5230	753
14 (B14)	3 (10 MHz)	23330	793	5330	765
17 (B17)	3 (10 MHz)	23790	710	5790	742
18 (B18)	3 (10 MHz)	23925	822.5	5925	869.5
19 (B19)	3 (10 MHz)	24075	837.5	6075	884.5
20 (B20)	3 (10 MHz)	24300	847	6300	808
25 (B25)	3 (10 MHz)	26365	1882.5	8365	1964.5
26 (B26)	3 (10 MHz)	26865	831.5	8865	878.5
28 (B28A)	5 (20 MHz)	27310	713	9310	770
28 (B28B)	5 (20 MHz)	27560	738	9560	795
29 (B29)[e]	N/A[e]	N/A[e]	N/A[e]	9715	722.5
30 (B30)	3 (10 MHz)	27710	2310	9820	2357
32 (B32)[e]	N/A[e]	N/A[e]	N/A[e]	10140	1474
34 (B34)	3 (10 MHz)	36275	2017.5	36275	2019.5
38 (B38)	3 (10 MHz)	38000	2595	38000	2597
39 (B39)	3 (10 MHz)	38450	1900	38450	1902

Table 3-4: Test Parameters — LTE (Continued)

Band Number	Bandwidth Index[a]	Tx		Rx	
		Test Channel[b]	Test Frequency[c] (MHz)	Test Channel[b]	Test Frequency[d] (MHz)
40 (B40)	3 (10 MHz)	39150	2350	39150	2352
41 (B41A)	3 (10 MHz)	39700	2501	39700	2503
41 (B41B)	3 (10 MHz)	41540	2685	41540	2687
42 (B42)	3 (10 MHz)	42590	3500	42590	3502
43 (B43)[f]	3 (10 MHz)	44590	3700	44590	3702
46 (B46)[g]	3 (10 MHz)	0	N/A	50690	5542
48 (B48)	3 (10 MHz)	55990	3625	55990	3627
66 (B66)	3 (10 MHz)	132322	1745	66786	2147
71 (B71)	3 (10 MHz)	133297	680.5	68761	636.5

a. Bandwidth index values are defined in the **!DARCONFIG** command — refer to *[1] EM9 Series AT Command Reference (Doc# 41113480).*
b. Tx and Rx channel values shown are based on the test frequency, and are used by **!DARCONFIG** command.
c. Testing Tx frequency to set on the call box.
d. Testing Rx Frequency to set on the callbox.
This frequency includes a required 2 MHz offset on the call box from the Rx channel, for testing with an unmodulated (continuous wave (CW)) waveform. (e.g., for band B1, use 2142 MHz)
If testing with a modulated waveform, remove the offset. (e.g., for band B1, use 2140 MHz)
e. B29/B32 are downlink only. No Tx test required.
f. B43 support is firmware and SKU-dependent.
g. LTE-LAA B46 (Downlink only; i.e., no transmission path, no Tx test required)

3.4.2 LTE RF Transmission Path Test

This test applies to EM9190/EM9191/EM7690.

Note: For details of each AT command used in this test (including usage, format and parameter details), refer to [1] EM9 Series AT Command Reference (Doc# 41113480).

To test the DUT's transmitter (Tx) path:

1. Connect the RF cable from the call box (e.g. the CMW500) to the module's MAIN receptacle — see Figure 3-1 on page 11. (Note — Do not turn on the RF transmitter yet.)

   Do not connect MIMO1, MIMO2, or AUX.

2. Set up the callbox for Tx testing — make sure to set:
   - Initial Tx frequency being tested
   - Expected Tx power (corresponds to <power_dbm10> in step 3)
   - Bandwidth (corresponds to <bw> in step 3)
   - Filter type — Gauss
   - Pathloss (i.e., cable loss from antenna port of the module to the callbox)
   - Signal receiving path — ON (e.g., on the CMW500, press On/Off button)

   For examples using a CMW500, see CMW500 Setup on page 38.

3. Set up and test the DUT using the following AT commands:

   a. Unlock the extended AT command set:

   ```
   AT!ENTERCND="<key>"  ← <key>—Unlock key code
   ```

   b. Enter test mode:

   ```
   AT+CFUN=5
   ```

   c. Use the !DARCONFIG command shown below to configure the Tx/Rx channels and bandwidth for the selected band.

   Note:

   - <rx_channel>, <tx_channel> — Either:
     [a] set the specific Rx channel, or
     [b] set the channel to '1' (which calculates the actual Rx channel from the Tx channel — note that this behavior applies only to LTE).
   - <beam_ID> — Leave this blank. (It is used only for 5G mmW.)
   - <continuous_mode> — Set the appropriate transmission mode (0=burst mode; 1 (or blank) = continuous mode (default))
   - <mimo_mode>:
     Important: <mimo_mode> parameter must be set to 0 or left blank, which configures the Tx path). Do not set another value, otherwise the module will crash in step d (below) when !DATXCONTROL is called.

   ```
   AT!DARCONFIG=<carrier>,<technology>,<band>,<tx_channel>,<bw>,<rx_channel>
   [,<mimo_mode>[,<beam_ID>[,<continuous_mode>]]]
   ```

   e.g.:

   ```
   AT!DARCONFIG=0,3,28,27560,5,1,0  ←Technology 3 (LTE), Tx channel 27560, bandwidth 5,
                                     Rx channel 1 (see note below for Rx channel),
                                     MIMO disabled 0
                                     For values, see Table 3-4.
   ```

   d. Set the Tx power and enable the transmitter (<enable>=1):

   Note: <power_dbm10> = 10 × power must be an integer.)

   ```
   AT!DATXCONTROL=<carrier>,<technology>,<enable>,<power_dbm10>,<waveform>,
   <mod>,<ns_value>,<start_RB>,<num_RB>[,<beam_ID>[,<duty_cycle>]]
   ```

   e.g.:

   ```
   AT!DATXCONTROL=0,3,1,-505,1,0,1,0,10,,2
                          ←Technology 3 (LTE); Transmit with -50.5 dBm Tx power,
                            20% duty cycle (see table below)
   ```

<duty_cycle>	Duty Cycle
1	10%
2	20%
3	30%
4	40%
5	50%
6	60%
7	70%
8	80%
9	90%

Caution: *To avoid possible damage to the module, do not transmit above the module's conducted maximum Tx power (for values, refer to [2] EM919X/EM7690 Product Technical Specification (Doc# 41113174)).*

e. Take the measurement.

If the measured value is not close to the expected value, make sure the CMW500 options and the configurations above are set properly.

Important: *The measured (output power) value is significantly influenced by the test setup (e.g., host RF cabling loss, choice of shield box, etc.).*

Note: This procedure is for conducted power testing. If the same test is performed over the air in an RF chamber (i.e., radiated power testing), the measured values are likely to be significantly lower, and will also be influenced by various test antenna characteristics (e.g., antenna gain, position, efficiency, pattern).

f. Disable the transmitter — Set <enable>=0 and make sure all other configuration parameters are the same as in step d.

```
AT!DATXCONTROL=<carrier>,<technology>,<enable>,<power_dbm10>,<waveform>,
<mod>,<ns_value>,<start_RB>,<num_RB>[,<beam_ID>[,<duty_cycle>]]
```

e.g.:

```
AT!DATXCONTROL=0,3,0,-505,1,0,1,0,10,,2
```

g. Drop the current LTE configuration:

```
AT!DARCONFIGDROP=<technology>
```

e.g.:

```
AT!DARCONFIGDROP=3
```

h. To test the next LTE band:

i. Change appropriate settings (e.g., Tx frequency, expected power, etc.) on the callbox for the next band to test.

ii. If the next band uses the same antenna receptacle or if it uses a different receptacle that is already connected (directly or via a combiner), go back to step c.

iii. Otherwise (i.e., the next band uses a different antenna receptacle that is not already connected, either through direct connection or via a combiner):

i. Power off the DUT and any signal generators.

ii. Connect the RF cable from the call box to the correct receptacle.

iii. Power on the DUT.

iv. Go back to step a.

3.4.3 LTE RF Receive Path Test

This test applies to EM9190/EM9191/EM7690.

Note: For details of each AT command used in this test (including usage, format and parameter details), refer to [1] EM9 Series AT Command Reference (Doc# 41113480).

To test the DUT's receive (Rx) paths:

1. Connect RF cables to all four antenna receptacles (MAIN, AUX, MIMO1, MIMO2) — see Figure 3-1 on page 11.

2. Set up the callbox for Rx testing — make sure to set:
   - Signal generator (select the appropriate signal generator)
   - Initial Rx frequency being tested
   - Expected Rx power level (corresponds to <expected_AGC> in step 3)
   - Signal transmit path — ON

   For examples using a CMW500, see CMW500 Setup on page 38.
3. Set up and test the DUT using the following AT commands:
   a. Unlock the extended AT command set:
   ```
   AT!ENTERCND="<key>"  ← <key>—Unlock key code
   ```
   b. Enter test mode:
   ```
   AT+CFUN=5
   ```
   c. Configure the channels and related parameters for the selected band:
   ```
   AT!DARCONFIG=<carrier>,<technology>,<band>,<tx_channel>,<bw>,<rx_channel>
   [,<mimo_mode>]
   ```
   Note:
   - <rx_channel>, <tx_channel> — Either:
     [a] set the specific Rx channel and Tx channel, or
     [b] set the <rx_channel> to '1' and set the specific <tx_channel>. In this case, the actual Rx channel is calculated from the Tx channel — note that this behavior applies only to LTE.
   - **Important:** For Rx-only bands (e.g., bands like B29 that do not have a Tx path), the Tx channel must be set to 0 and the Rx channel must be specified.
     For example, to test B46: AT!DARCONFIG=0,3,46,**0**,3,**50670**
   - **Important:** Make sure to set <mimo_mode> correctly for the receive path being tested.

   e.g., To configure band B4 with MIMO, enable MIMO mode (set <mimo_mode>=1):
   ```
   AT!DARCONFIG=0,3,4,20175,3,1,1  ← Technology 3 (LTE), Band 4, Tx channel 20175, bandwidth 3,
                                     Rx channel 1 (see note below for Rx channel), enable the
                                     MIMO flag (1).
                                     For values, see Table 3-4.
   ```
   e.g., To configure band B28 without MIMO, disable MIMO mode (set <mimo_mode>=0 or omit the parameter):
   ```
   AT!DARCONFIG=0,3,28,27560,5,1  ← Technology 3 (LTE), Band 28,Tx channel 27560, bandwidth 5,
                                    Rx channel 1 (see note below for Rx channel), disable the
                                    MIMO flag (omitted in this example).
                                    For values, see Table 3-4.
   ```
   d. Repeat this step for each path that you want to test (see Table 3-2) — Set the expected Rx power (<expected_AGC>) and check that the measured *<rssi>* = *<expected_AGC>* (i.e., actual FTM AGC matches the expected AGC).

   Note: <expected_AGC> = 10 × power must be an integer.

   ```
   AT!DAGFTMRXAGC=<carrier>,<technology>,<expected_AGC>,<path>
   <rssi>
   OK
   ```
   e.g. To test Rx paths for -50.5 dBm:
   - Check the MAIN path Rx (i.e., when the MAIN receptacle (path index 0) is connected to the CMW500.):
   ```
   AT!DAGFTMRXAGC=0,3,-505,0
   -50.5
   OK
   ```

- Check the AUX path Rx (i.e., when the AUX receptacle (path index 3) is connected to the CMW500.):

```
AT!DAGFTMRXAGC=0,3,-505,3
-50.5
OK
```

- If the test band supports MIMO mode, check the MIMO1 path Rx (i.e., when the MIMO1 receptacle (path index 1) is connected to the CMW500.)

```
AT!DAGFTMRXAGC=0,3,-505,1
-50.5
OK
```

- If the test band supports MIMO mode, check the MIMO2 path Rx (i.e., when the MIMO2 receptacle (path index 2) is connected to the CMW500.):

```
AT!DAGFTMRXAGC=0,3,-505,2
-50.5
OK
```

e. Drop the current LTE configuration:

```
AT!DARCONFIGDROP=<technology>
```

e.g.:

```
AT!DARCONFIGDROP=3
```

f. To test the next LTE band:

i. Change appropriate settings (e.g., Rx frequency, expected power, etc.) on the callbox for the next band to test.

ii. Go back to step c.

Note: The value measured from the DUT is significantly influenced by the test setup and DUT design (host RF cabling loss, antenna efficiency and pattern, test antenna efficiency and pattern, and choice of shield box).

3.5 5G Sub6 RF Tests

5G Sub6 tests apply to EM9190/EM9191.

3.5.1 5G Sub6 Test Parameters

Use the parameters in Table 3-5 for the 5G Sub6 Tx and Rx tests described below.

Table 3-5: Test Parameters — 5G Sub6

Band Number	Bandwidth Index[a]	Tx		Rx		Resource Block Settings[b]	
		Test Channel[c]	Test Freq[d] (MHz)	Test Channel[c]	Test Freq[e] (MHz)	Start_RB	Num_RB
1 (n1)	5 (20 MHz)	390000	1950	428000	2142	25	50
2 (n2)	5 (20 MHz)	376000	1880	392000	1962	25	50
3 (n3)	5 (20 MHz)	349500	1747.5	368500	1844.5	25	50
5 (n5)	5 (20 MHz)	167300	836.5	176300	883.5	25	50
7 (n7[f])	5 (20 MHz)	507000	2535	531000	2657	25	50
8 (n8[f])	5 (20 MHz)	179500	897.5	188500	944.5	25	50
12 (n12[f])	3 (10 MHz)	141500	707.5	147500	739.5	12	25
20 (n20[f])	5 (20 MHz)	169400	847	161200	808	25	50
25 (n25[f])	5 (20 MHz)	376500	1882.5	392500	1964.5	25	50
28 (n28A)	5 (20 MHz)	142600	713	153600	772.5	25	50
28 (n28B)	5 (20 MHz)	147600	738	158600	795	25	50
38 (n38[f])	5 (20 MHz)	519000	2595	519000	2597	12	25
40 (n40[f])	8 (40 MHz)	470000	2350	470000	2352	25	50
41 (n41A)	5 (20 MHz)	518601	2593.005	518601	2595	12	25
41 (n41B)	5 (20 MHz)	525000	2625	525000	2627	12	25
48 (n48[f])	5 (20 MHz)	641667	3625	641667	3627	12	25
66 (n66)	5 (20 MHz)	349000	1745	429000	2147	25	50
71 (n71)	5 (20 MHz)	136100	680.5	126900	636.5	25	50
77 (n77)	13 (100 MHz)	650000	3750	650000	3752	67	135
78 (n78)	9 (50 MHz)	636667	3550.005	636667	3551.99	32	64
79 (n79)	13 (100 MHz)	713334	4699.995	713334	4701.995	67	135

a. Bandwidth index values are defined in the !DARCONFIG command — refer to *[1] EM9 Series AT Command Reference (Doc# 41113480).*
b. Recommended resource block settings for use in the !DATXCONTROL command in the 5G Sub6 RF Transmission Path Test procedure.
c. Tx and Rx channel values shown are based on the test frequency, and are used by **!DARCONFIG**.
d. Testing Tx frequency to set on the call box.

e. Testing Rx frequency to set on the call box. This frequency includes a 2 MHz offset on the call box from the Rx channel for testing with an unmodulated (continuous wave (CW)) waveform. (e.g., for band n1, use 2142 MHz)
If testing with a modulated waveform, remove the offset. (e.g., for band n1, use 2140 MHz)
f. Band support is firmware and SKU-dependent.

3.5.2 5G Sub6 RF Transmission Path Test

Test applies to EM9190/EM9191.

Note: For details of each AT command used in this test (including usage, format and parameter details), refer to [1] EM9 Series AT Command Reference (Doc# 41113480).

To test the DUT's transmitter (Tx) path:

1. Connect the RF cable from the call box (e.g. the CMW500) to the module's MAIN receptacle — see Figure 3-1 on page 11. (Note — Do not turn on the RF transmitter yet.)

   The other receptacles (MIMO1, MIMO2, AUX) can be left connected.

2. Set up the callbox for Tx testing — make sure to set:
   - Initial Tx frequency being tested
   - Expected Tx power (corresponds to <power_dbm10> in step 3)
   - Bandwidth (corresponds to <bw> in step 3)
   - Filter type — Gauss
   - Pathloss (i.e., cable loss from antenna port of the module to the callbox)
   - Signal receiving path — ON (e.g., on the CMW500, press On/Off button)

   For examples using a CMW500, see CMW500 Setup on page 38.

3. Set up and test the DUT using the following AT commands:

   a. Unlock the extended AT command set:
   ```
   AT!ENTERCND="<key>"  ← <key>—Unlock key code
   ```

   b. Enter test mode:
   ```
   AT+CFUN=5
   ```

   c. Enable 5G Sub6 technology (<enable>=1):
   ```
   AT!DASUB6TECHACT=<enable>

   e.g.,
   AT!DASUB6TECHACT=1
   ```

   d. Use the !DARCONFIG command shown below to configure the Tx/Rx channels, bandwidth and related parameters for the selected band.

      Note:
      - <beam_ID> — Leave this blank. (It is used only for 5G mmW.)
      - <continuous_mode> — Set the appropriate transmission mode (0=burst mode; 1 (or blank) = continuous mode (default))
      - <mimo_mode>:
        Important: <mimo_mode> must be set to 0 or left blank, which configures the Tx path). Do not set another value, otherwise the module will crash in *step e* (below) when !DATXCONTROL is called.

```
AT!DARCONFIG=<carrier>,<technology>,<band>,<tx_channel>,<bw>,<rx_channel>
[,<mimo_mode>[,<beam_ID>[,<continuous_mode>]]]
```

e.g.:

```
AT!DARCONFIG=0,6,28,147600,5,158600,0,,0
```

← *Technology 6 (5G Sub6), Tx channel 147600, bandwidth 5, Rx channel 158600, MIMO disabled 0, burst mode enabled 0 For values, see Table 3-5.*

e. Set the Tx power and enable the transmitter (<enable>=1):

Note:
- *For <start_RB> and <num_RB>, use the band-specifc values in Table 3-5.*
- *<power_dbm10> = 10 × power must be an integer.)*

```
AT!DATXCONTROL=<carrier>,<technology>,<enable>,<power_dbm10>,<waveform>,
<mod>,<ns_value>,<start_RB>,<num_RB>[,<beam_ID>[,<duty_cycle>]]
```

e.g., assuming band n28 was selected in step d above:

```
AT!DATXCONTROL=0,6,1,-505,10,0,1,25,50,,0
```

← *Technology 6 (5G Sub6), Transmit with -50.5 dBm Tx power, Start RB 25, Num RB 50, 20% duty cycle (see table below)*

<duty_cycle>	Duty Cycle
0	20%
1	25%
2	40%
3	50%

Caution: *To avoid possible damage to the module, do not transmit above the module's conducted maximum Tx power (refer to [2] EM919X/EM7690 Product Technical Specification (Doc# 41113174).*

f. Take the measurement.

If the measured value is not close to the expected value, make sure the CMW500 and the configurations above are set properly.

Important: *The measured (output power) value is significantly influenced by the test setup (e.g., host RF cabling loss, choice of shield box, etc.).*

Note: This procedure is for conducted power testing. If the same test is performed over the air in an RF chamber (i.e., radiated power testing), the measured values are likely to be significantly lower, and will also be influenced by various test antenna characteristics (e.g., antenna gain, position, efficiency, pattern).

g. Disable the transmitter — Set <enable>=0 and make sure all other configuration parameters are the same as in step e.

```
AT!DATXCONTROL=<carrier>,<technology>,<enable>,<power_dbm10>,<waveform>,
<mod>,<ns_value>,<start_RB>,<num_RB>[,<beam_ID>[,<duty_cycle>]]
```

e.g., assuming band n28 was selected in step d above:

```
AT!DATXCONTROL=0,6,0,-505,10,0,1,25,50,,0
```

h. Drop the current 5G Sub6 configuration:

```
AT!DARCONFIGDROP=<technology>
```

e.g.:

```
AT!DARCONFIGDROP=6
```

i. To test the next 5G Sub6 band:

i. Change appropriate settings (e.g., Tx frequency, expected power, etc.) on the callbox for the next band to test.

ii. If the next band uses the same antenna receptacle or if it uses a different receptacle that is already connected (directly or via a combiner), go back to step d.

iii. Otherwise (i.e., the next band uses a different antenna receptacle that is not already connected through either a direct connection or via a combiner):

i. Power off the DUT.

ii. Connect the RF cable from the call box to the correct receptacle.

iii. Power on the DUT.

iv. Go back to step a.

j. When there are no more bands to test, disable 5G Sub6 technology (<enable>=0):

```
AT!DASUB6TECHACT=<enable>
```

e.g.:

```
AT!DASUB6TECHACT=0
```

3.5.3 5G Sub6 RF Receive Path Test

This test applies to EM9190/EM9191.

Note: For details of each AT command used in this test (including usage, format and parameter details), refer to [1] EM9 Series AT Command Reference (Doc# 41113480).

To test the DUT's receive (Rx) paths:

1. Connect RF cables to all four antenna receptacles (MAIN, AUX, MIMO1, MIMO2) — see Figure 3-1 on page 11.
2. Set up the callbox for Rx testing — make sure to set:
   - Signal generator (select the appropriate signal generator)
   - Initial Rx frequency being tested
   - Expected Rx power level (corresponds to <expected_AGC> in step 3)
   - Signal transmit path — ON

   For examples using a CMW500, see CMW500 Setup on page 38.

3. Set up and test the DUT using the following AT commands:

   a. Unlock the extended AT command set:

   ```
   AT!ENTERCND="<key>"  ← <key>—Unlock key code
   ```

   b. Enter test mode:

   ```
   AT+CFUN=5
   ```

   c. Enable 5G Sub6 technology (<enable>=1):

   ```
   AT!DASUB6TECHACT=<enable>

   e.g.,
   AT!DASUB6TECHACT=1
   ```

   d. Configure the channels and related parameters for the selected band:

   ```
   AT!DARCONFIG=<carrier>,<technology>,<band>,<tx_channel>,<bw>,<rx_channel>
   [,<mimo_mode>]
   ```

   Note:

   - **Important:** Make sure to set <mimo_mode> correctly for the receive path being tested.

   e.g., To configure band n3 with MIMO, enable MIMO mode:

   ```
   AT!DARCONFIG=0,6,3,349500,5,368500,1  ←Technology 6 (5G Sub6), Band 3,
                                          Tx channel 349500, bandwidth 5, Rx channel 368500,
                                          MIMO enabled (1)
                                          For values, see Table 3-5.
   ```

   e.g., To configure band n28 without MIMO, disable MIMO mode (set <mimo_mode>=0 or omit the parameter):

   ```
   AT!DARCONFIG=0,6,28,147600,5,158600
                                  ← Technology 6 (5G Sub6), Band 28, Tx channel 147600,
                                    bandwidth 5, Rx channel 158600, MIMO disabled (omitted in
                                    this example)
                                    For values, see Table 3-5.
   ```

   e. Repeat this step for each path that you want to test (see Table 3-2) — Set the expected Rx power (<expected_AGC>) and check that the measured *<rssi>* = *<expected_AGC>* (i.e., actual FTM AGC matches the expected AGC).

   (Note — *<expected_AGC>* = *10* × *power* must be an integer.)

   ```
   AT!DAGFTMRXAGC=<carrier>,<technology>,<expected_AGC>,<path>
   <rssi>
   OK
   ```

   e.g. To test Rx paths for -50.5 dBm:

   - Check the MAIN path Rx (i.e., when the MAIN receptacle (path index 0) is connected to the CMW500.):

     ```
     AT!DAGFTMRXAGC=0,6,-505,0
     -50.5
     OK
     ```

   - Check the AUX path Rx (i.e., when the AUX receptacle (path index 3) is connected to the CMW500.):

     ```
     AT!DAGFTMRXAGC=0,6,-505,3
     -50.5
     OK
     ```

   - If the test band supports MIMO mode, check the MIMO1 path Rx (i.e., when the MIMO1 receptacle (path index 1) is connected to the CMW500.):

     ```
     AT!DAGFTMRXAGC=0,6,-505,1
     -50.5
     OK
     ```

- If the test band supports MIMO mode, check the MIMO2 path Rx (i.e., when the MIMO2 antenna port (path index 2) is connected to the CMW500.):

```
AT!DAGFTMRXAGC=0,6,-505,2
-50.5
OK
```

f. Drop the current 5G Sub6 configuration:

```
AT!DARCONFIGDROP=<technology>
```

e.g.:

```
AT!DARCONFIGDROP=6
```

g. Disable 5G Sub6 technology (<enable>=0):

```
AT!DASUB6TECHACT=<enable>
```

e.g.:

```
AT!DASUB6TECHACT=0
```

h. To test the next 5G Sub6 band:

i. Change appropriate settings (e.g., Rx frequency, expected power, etc.) on the callbox for the next band to test.

ii. Go back to step c.

Note: The value measured from the DUT is significantly influenced by the test setup and DUT design (host RF cabling loss, antenna efficiency and pattern, test antenna efficiency and pattern, and choice of shield box).

3.6 5G mmW RF Tests

5G mmW tests apply to EM9190 only.

3.6.1 5G mmW Test Platform Hardware Configuration

To perform the 5G mmW radiated RF tests:

- Make sure the mmW module is properly connected to the EM9190 module and the test platform:
  - High power mmW module (QTM527) — Refer to *[4] EM9190 High Power mmWave RF Customization File Preparation (Doc# 2174282)*.
  - Low power mmW module (QTM525) — Refer to *[5] EM9190 Low Power mmWave RF Customization File Preparation (Doc# 2174286)*.
- Make sure the mmW module that is being tested is pointed toward the receiving (measuring) antenna (for transmission tests) or the transmitting antenna (for receive tests) in the shielded box.
- In the AT commands described in this section, make sure to use the beam ID(s) that correspond to the mmW module being tested.

3.6.2 5G mmW Test Parameters

Use the parameters in Table 3-6 and Table 3-7 for the 5G mmW RF Transmission Path Test and 5G mmW RF Receive Path Test.

Table 3-6: Test Parameters — 5G mmW

Band Number	Bandwidth Index[a]	Tx		Rx	
		Test Channel[b]	Test Frequency[c] (MHz)	Test Channel[b]	Test Frequency[d] (MHz)
257 (n257)	13 (100 MHz)	2079167	28000.08	2079167	28002.08
258 (n258)	13 (100 MHz)	2043759	25875.6	2043759	25877.6
260 (n260)	13 (100 MHz)	2254167	38500.08	2254167	38502.08
261 (n261)	13 (100 MHz)	2077949	27927	2077949	27929

a. Bandwidth index values are defined in the **!DARCONFIG** command – refer to *[1] EM9 Series AT Command Reference (Doc# 4111 3480)*.
b. 5G mmW Tx path and Rx path tests use the same channel values. The channel values shown are at the center frequencies of the corresponding bands, and are used by **!DARCONFIG**
c. Testing Tx frequency to set on the callbox.
d. Testing Rx frequency to set on the callbox.
This frequency includes a required 2 MHz offset on the call box from the Rx channel for testing with an unmodulated (continuous wave (CW)) waveform. (e.g., for band n257, use 28002.08 MHz)
If testing with a modulated waveform, remove the offset. (e.g., for band n257, use 2800.08 MHz)

Table 3-7: Test Parameters — 5G mmW Beam ID to IF Port Mapping[a]

QTM527 (High Power)			QTM525 (Low Power)		
Beam ID[b]	IF Port ↔ QTM	Gain (dB)	Beam ID[b]	IF Port ↔ QTM	Gain (dB)
0	IFV4 ↔ QTM0_V	7 (Beam ID 0/128) to 17 (Peak beam ID)[c]	0	IFV4 ↔ QTM0_V	13 (Beam ID 0/128) to 37 (Peak beam ID)[c]
128	IFH1 ↔ QTM0_H		128	IFH1 ↔ QTM0_H	
1	IFV3 ↔ QTM1_V		2	IFV3 ↔ QTM2_V	
129	IFH2 ↔ QTM1_H		130	IFH2 ↔ QTM2_H	
2	IFV2 ↔ QTM2_V		3	IFV2 ↔ QTM3_V	
130	IFH3 ↔ QTM2_H		131	IFH3 ↔ QTM3_H	
3	IFV1 ↔ QTM3_V		1	IFV1 ↔ QTM1_V	
131	IFH4 ↔ QTM3_H		129	IFH4 ↔ QTM1_H	

a. Beam ID to IF port mappings are different for each QTM mmW module type.
b. Beam ID is determined by the RFC (Radio File Configuration) that follows your HW design.
Beam ID ranges are 0–59 (IFV) and 128–187 (IFH).
In this example, beam IDs 0–3 are vertical, and beam IDs 128–131 are horizontal. For actual beam IDs and to identify the beam ID to use for max power testing (the 'peak' beam ID), refer to the codebook (.csv) file.
c. The Peak beam ID is host platform-dependent and is identified through beam verification. (Note — Beam ID 0/128 always has the lowest gain.)

3.6.3 5G mmW RF Transmission Path Test

This test applies to EM9190.

Note: For details of each AT command used in this test (including usage, format and parameter details), refer to [1] EM9 Series AT Command Reference (Doc# 41113480).

Testing recommendations:

- Test at least one beam (vertical or horizontal) for each mmW module.
  If also testing antenna polarization, test both beams (vertical and horizontal) for each mmW module.
- Test using the mmW module's Peak beam ID.
  (Note — The example procedure below uses beam ID 0 — replace this with the appropriate beam ID.)

To test the DUT's transmitter (Tx) path:

1. Set up the DUT using the following AT commands:
   a. Unlock the extended AT command set:
   ```
   AT!ENTERCND="<key>"  ← <key>—Unlock key code
   ```
   b. Enter test mode:
   ```
   AT+CFUN=5
   ```
2. Test the first mmW module:
   a. Test the first antenna beam (vertical or horizontal) — Sierra Wireless recommends using the Peak beam ID. (Note — Examples in this procedure use beam ID 0 — replace this with the Peak beam ID):
      i. Make sure the mmW module that is being tested is pointed toward the receiving antenna in the shielded box.

ii. Configure the technology (6 — 5G mmW), 5G mmW band, channels, and related parameters for the antenna beam to be tested:

Important: *The <mimo_mode> parameter must be set to 0 to configure the Tx path, otherwise the module will crash in step iii (below) when !DATXCONTROL is called. (<mimo_mode> does not configure the module's Tx path.)*

```
AT!DARCONFIG=<carrier>,<technology>,<band>,<tx_channel>,<bw>,
<rx_channel>,<mimo_mode>,<beam_ID>[,<continuous_mode>]
```

e.g.:

```
AT!DARCONFIG=0,6,261,2077949,13,2077949,0,0
```

← *Technology 6 (5G mmW), Band 261, Tx/Rx channels 2077949, bandwidth 13, <mimo_mode> = 0, Vertical beam (beam id 0) For values, see Table 3-6.*

Note: By default, <continuous_mode>=1 (continuous mode). To perform TDD burst mode testing, set <continuous_mode>=0.)
To switch back to continuous mode from burst mode, set <continuous_mode>=1.

iii. Set the Tx power and enable the transmitter (<enable>=1):
(Note — <*power_dbm10*> = *10* × *power* must be an integer.)

```
AT!DATXCONTROL=<carrier>,<technology>,<enable>,<power_dBm10>,
<waveform>,<mod>,<ns_value>,<start_RB>,<num_RB>,<beam_ID>[,
<duty_cycle>]
```

e.g. (with duty cycle parameter specified):

```
AT!DATXCONTROL=0,6,1,100,10,0,1,0,66,0,3
```

← *Transmit with +10 dBm Tx power, Duty cycle (see table below): 50%*

e.g. (with default duty cycle):

```
AT!DATXCONTROL=0,6,1,100,10,0,1,0,66,0,3
```

← *Transmit with +10 dBm Tx power, Duty cycle (see table below: Default (50%)*

<duty_cycle>	Duty Cycle
0	20%
1	25%
2	40%
3 (Default)	50%

Caution: *To avoid possible damage to the EM9190 module, do not transmit above the mmW module's maximum input Tx power (13 dBm).*

iv. Take the measurement to verify that the transmission path is functioning.

Note: If power is measured at the Tx frequency, the transmission path is functioning. The actual measured Tx power will be higher than the <power_dBm10> used in the !DATXCONTROL command because of the mmW module's antenna array gain. The antenna gain changes per beam ID depending on the number of elements used for each beam.

v. Disable the transmitter. Set <enable>=0 and make sure all other configuration parameters are the same as in step i (Note — <duty_cycle> is not specified).

```
AT!DATXCONTROL=<carrier>,<technology>,<enable>,<power_dBm10>,
<waveform>,<mod>,<ns_value>,<start_RB>,<num_RB>,<beam_ID>
```

e.g.:

```
AT!DATXCONTROL=0,6,0,100,10,0,1,0,66,0
```

vi. Drop the current 5G mmW configuration:

```
AT!DARCONFIGDROP=<technology>
```

e.g.:

```
AT!DARCONFIGDROP=6
```

vii. Optionally, to test the other beam orientation (horizontal or vertical), go back to step ii.

viii. Optionally, to test another 5G mmW band on the same mmW module, reset the module and go back to step 1.

```
AT!RESET
```

b. To test the next mmW module, go back to step a.

3.6.4 5G mmW RF Receive Path Test

This test applies to EM9190.

Note: For details of each AT command used in this test (including usage, format and parameter details), refer to [1] EM9 Series AT Command Reference (Doc# 41113480).

The described procedure tests:

- Low power mmW modules individually (i.e., the test must be run separately for each module),

  or
- High power mmW modules all at the same time

Testing recommendations:

- Test at least one beam (vertical or horizontal) for each mmW module.
  If also testing antenna polarization, test both beams (vertical and horizontal) for each mmW module.
- For high power mmW modules, select a beam that has all the modules active. (The described procedure uses a beam that has four modules active.)

To test the DUT's receive (Rx) path:

1. Set up the DUT using the following AT commands:

   a. Unlock the extended AT command set:

   ```
   AT!ENTERCND="<key>"  ← <key>—Unlock key code
   ```

b. Enter test mode:

```
AT+CFUN=5
```

2. Test the module(s) — either a single low power mmW module, or all high power mmW modules simultaneously:

a. Test an antenna beam (vertical or horizontal):

i. Make sure the mmW module(s) under test are pointed toward the transmitting antenna in the shielded box.

ii. Configure the technology (6 — 5G mmW), 5G mmW band, channels, and related parameters for the antenna beam to be tested:

```
AT!DARCONFIG=<carrier>,<technology>,<band>,<tx_channel>,<bw>,
<rx_channel>,<mimo_mode>,<beam_ID>
```

Note:

- **Important:** Make sure to set <mimo_mode> correctly for the receive path being tested.

e.g.:

```
AT!DARCONFIG=0,6,261,2077949,13,2077949,0,0
                                  ← Technology 6 (5G mmW), Band 261,
                                    Tx/Rx channels 2077949, bandwidth 13,
                                    Vertical beam (beam id 0)
                                    For values, see Table 3-6.
```

iii. Set the expected Rx power, factoring in the mmW module's antenna array gain.

(Note — <*expected_AGC*> = *10* × *power* must be an integer.)

For example, if testing QTM527 high power mmW modules:

- Beam ID 0 / 128 antenna gain = +7 dB
- Assume generator output = -20 dBm, and radiated pathloss = 60 dB

Without considering the antenna gain, the signal at the receiving mmW module(s) should be approximately -80 dBm.

With the antenna gain factored in, the expected Rx power (<expected_AGC>) should be approximately -73 dBm.

```
AT!DAGFTMRXAGC=<carrier>,<technology>,<expected_AGC>,<path>,<beam_ID>
<rssi>
OK
```

e.g.:

```
AT!DAGFTMRXAGC=0,6,-730,4,0  ← Test -73.0 dBm expected Rx power,
-73.0 ←Received Rx power       Vertical beam (beam id 0)
OK                             For values, see Table 3-6.
```

Compare the expected Rx power (<expected_AGC>) and received Rx power match. (e.g., in the example above, both values are -73.0 dBm)

iv. Drop the current 5G mmW configuration:

```
AT!DARCONFIGDROP=<technology>
```

e.g.:

```
AT!DARCONFIGDROP=6
```

v. Optionally, to test the other beam orientation (horizontal or vertical), go back to step ii.

vi. Optionally, to test another 5G mmW band on the same mmW module, reset the module and go back to step 1.

```
AT!RESET
```

b. To test another antenna beam, go back to step a.

3. If there are more modules to test, go back to step 2.

3.7 GNSS Tests

3.7.1 Shared GNSS RF Receive Path Test

This test applies to EM9190/EM9191/EM7690.

Note: For details of each AT command used in this test (including usage, format and parameter details), refer to [1] EM9 Series AT Command Reference (Doc# 41113480).

Shared GNSS receive paths use the RF receptacles indicated in Table 3-8.

Table 3-8: Test Parameters — GNSS L1 and L5 Paths

GNSS Path	Receptacle[a]	Test Frequency[b] (MHz)	Notes
L1	AUX	1575.52	TestFreq = 1575.42 MHz + 100 KHz
L5	MIMO2	1177.45	TestFreq = 1176.45 MHz + 1000 KHz

a. For receptacle locations, see Figure 3-1 on page 11.
b. Includes offset from center (as indicated in Notes column)

To test one or both GNSS receive paths (L1, L5):

1. Set up the DUT using the following AT commands:
   a. Unlock the extended AT command set:
      ```
      AT!ENTERCND="<key>"  ← <key>—Unlock key code
      ```
   b. Enter test mode:
      ```
      AT+CFUN=5
      ```
   c. Start CGPS (Continuous Global Positioning System) diagnostic task mode:
      ```
      AT!DACGPSTESTMODE=1
      ```
   d. Enter standalone RF mode:
      ```
      AT!DACGPSSTANDALONE=1
      ```
2. Connect the RF cable to the appropriate receptacle for the path to test (L1 — AUX, or L5 — MIMO2).
3. Set up the callbox — Refer to Table 3-8 and configure the callbox's signal generator to inject a -110 dBm carrier signal (using the indicated test frequency) into the GNSS Rx path at the receptacle.
4. Test the signal carrier-to-noise (CTN) level at the GNSS receiver:
   a. Connect the module's <GNSS_PATH> to the signal generator and check the returned signal-to-noise (<CtoN>) and frequency (<freq>) measurements:
      ```
      AT!DACGPSCTON=<GNSS_PATH>
      CtoN=<CtoN>, Freq=<freq>
      OK
      ```
      e.g.:
      - Check the GNSS L1 path (example output shown):
        ```
        AT!DACGPSCTON=1
        CtoN=60.7, Freq=99945
        OK
        ```

- Check the GNSS L5 path (example output shown):

```
AT!DACGPSCTON=5
CtoN=60.1, Freq=999963
OK
```

Note: The frequency returned by !DACGPSCTON should be within the following limits:
- *L1: 100,000 ± 1000 Hz*
- *L5: 1,000,000 ± 1000 Hz*

b. Repeat step a 5–10 times to ensure the measurements are repeatable and stable.

c. Keep the RF connection to the module device intact, and turn off the signal generator.

d. Repeat the **!DACGPSCTON** command several times to demonstrate a bad signal, to set limits for testing if needed.

e. Optionally, simulate marginal / poor signals:

i. Turn on the signal generator and reduce the level to -120 dBm.

ii. Optionally, repeat the **!DACGPSCTON** command several times to obtain results to use as references for marginal / poor signals.

e.g.:

- Check the GNSS L1 path (example output shown):

```
AT!DACGPSCTON=1
CtoN=50.8, Freq=99946
OK
```

- Check the GNSS L5 path (example output shown):

```
AT!DACGPSCTON=5
CtoN=50.0, Freq=999969
OK
```

iii. Turn off the signal generator.

f. To test a different GNSS receive path, go back to step 2.

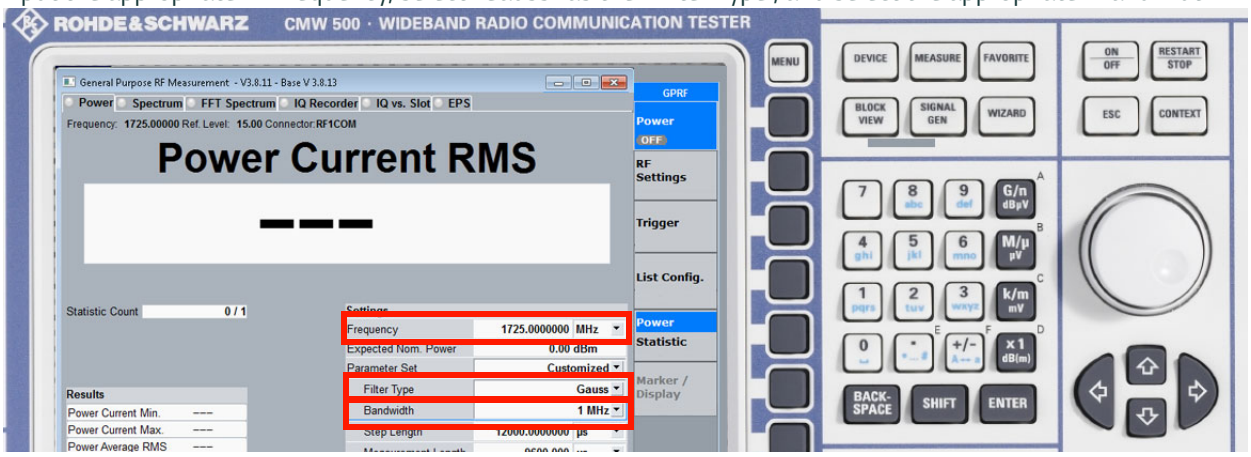
A: CMW500 Setup

This chapter briefly describes how to set up the CMW500 callbox for the WCDMA, LTE, and 5G Sub6 Rx and Tx measurements described in Production Testing.

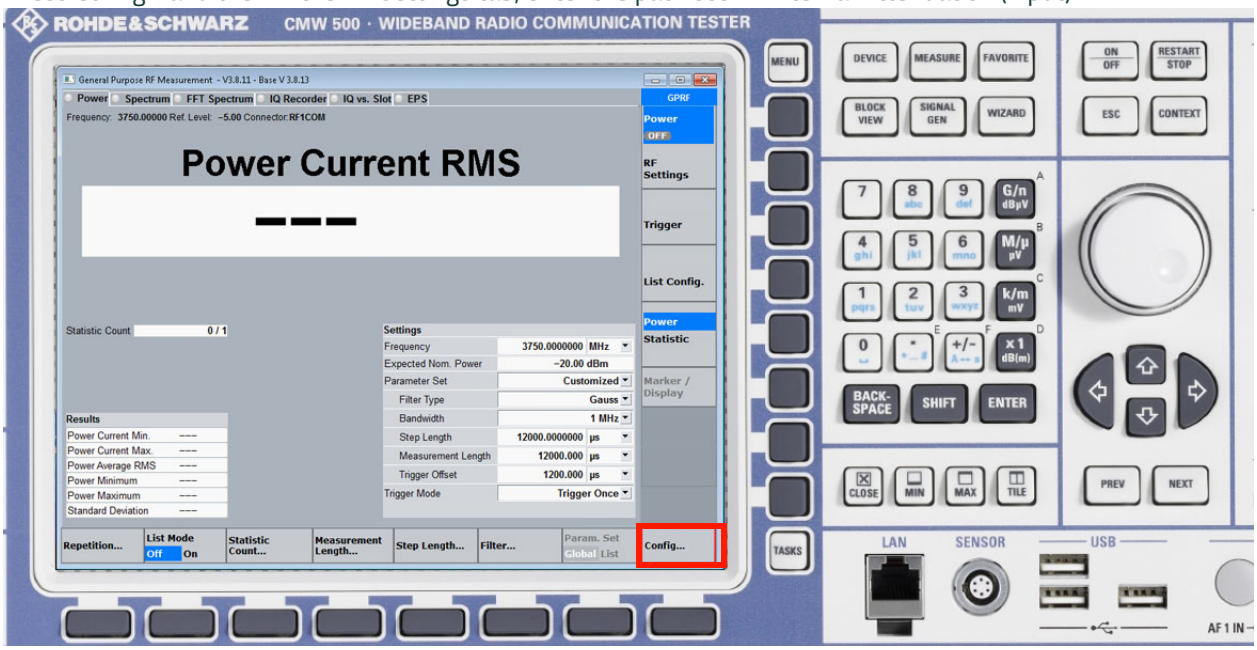
A.1 CMW500 Transmission Path Test Setup

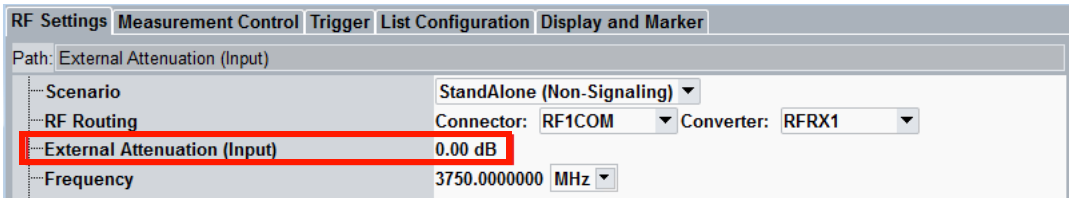
1. Press the MEASURE button and select “Measurements”.

2. Input the appropriate Tx Frequency, select "Gauss" as the “Filter Type”, and select the appropriate “Bandwidth”.

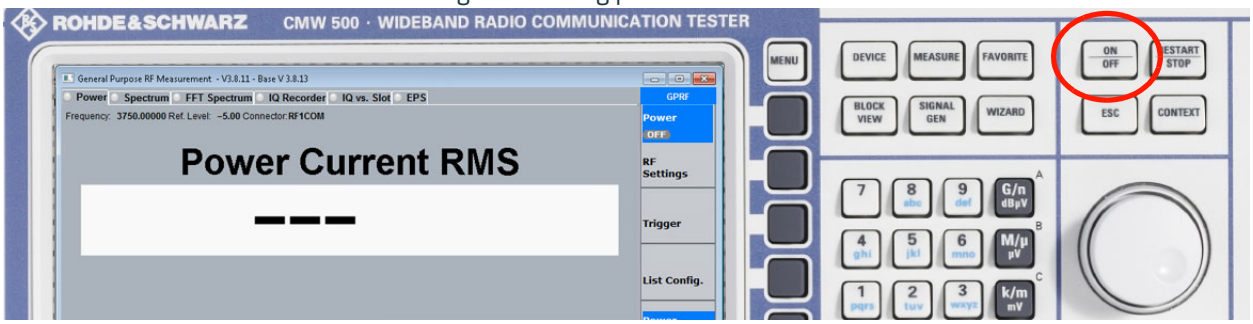


3. Press Config... and then in the RF Settings tab, enter the pathloss in External Attenuation (input).





4. Press the On/Off button to turn on the signal receiving path.



A.2 CMW500 Receive Path Test Setup

1. Press the SIGNAL GEN button and select “Generator 1”.

2. Press the Frequency button and input the appropriate Rx frequency, then press the Level button and input the required power level value.

3. Press the On/Off button to turn on this signal (the transmit path) and direct the output to the device's RF path.

B: References

B.1 Sierra Wireless Documents

The Sierra Wireless documents listed below are available from source.sierrawireless.com.

[1] EM9 Series AT Command Reference (Doc# 41113480)

[2] EM919X/EM7690 Product Technical Specification (Doc# 41113174)

[3] Sierra Wireless EM919x / EM7690 Development Kit User Guide (Doc# 41113875)

The Sierra Wireless documents listed below are available on request from your Sierra Wireless representative:

[4] EM9190 High Power mmWave RF Customization File Preparation (Doc# 2174282)

[5] EM9190 Low Power mmWave RF Customization File Preparation (Doc# 2174286)

C: Abbreviations

Table C-1: Abbreviations

Abbreviation	Description
5G mmW	5G millimeter Wave
GNSS	Global Navigation Satellite System
IF	Intermediate Frequency
LTE	Long Term Evolution
RFC	Radio Frequency Card
RFM	Radio Frequency Module
WCDMA	Wideband Code Division Multiple Access
FTM	Factory Test Mode