RG5x&RG6x&RM5x Series
5G Network Status Judgement Introduction

5G Module Series

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About the Document

Revision History

Version	Date	Author	Description
-	2021-04-01	Yosef ZHANG	Creation of the document
1.0	2021-06-10	Yosef ZHANG	First official release
1.1	2022-01-20	Yosef ZHANG	1. Updated the applicable modules. 2. Redefined the value of <endc_rstr> of AT+QENDC.
2.0	2024-06-25	Amos ZHANG/ Zhenghua XIN/ Lin QIU/ Xuehong WANG/ Shuang WANG/ Amiee JI	1. Incorporated the information of RG520x&RM520N series 5G network status judgement introduction into this document. 2. Added applicable modules RG525F-NA, RG530F series, RM521F-GL, RM530N-GL, RG650E series, RG651E-NA, RG650V series, RM550V-GL and RM551E-GL. 3. Added the following commands: AT+CEREG (Chapter 3.3.1)； AT+C5GREG (Chapter 3.3.2)； AT+QNWPREFCFG (Chapter 3.3.2–3.3.10)； AT+QRSRP (Chapter 3.3.12)； AT+QSINR (Chapter 3.3.13)； AT+QCAINFO (Chapter 3.3.14)； AT+QSCAN (Chapter 3.3.15). 4. Updated related information of 5G icon display rules (Chapter 4.1). 5. Added the typical cases troubleshooting (Chapter 5).

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1 Introduction

The document outlines the network application note of Quectel 5G modules, including software initialization process, 5G network-related AT commands, 5G network status judgement and typical cases troubleshooting.

1.1. Applicable Modules

Table 1: Applicable Modules

Module Family	Module
RG5x	RG500Q Series/RG501Q-EU/RG502Q Series
	RG520N Series/RG520F Series/RG525F-NA/RG530F Series
RM5x	RM500Q Series/RM502Q-AE/RM505Q-AE/RM510Q-GL
	RM520N Series/RM521F-GL/RM530N-GL
	RM550V-GL/RM551E-GL
RG6x	RG650E Series/RG651E-NA/RG650V Series

2 Software Initialization Process

It is recommended to use the software initialization process and exception handling process for the daemon described in the figure below, which includes the usage process of AT commands to facilitate the program design and minimize errors.
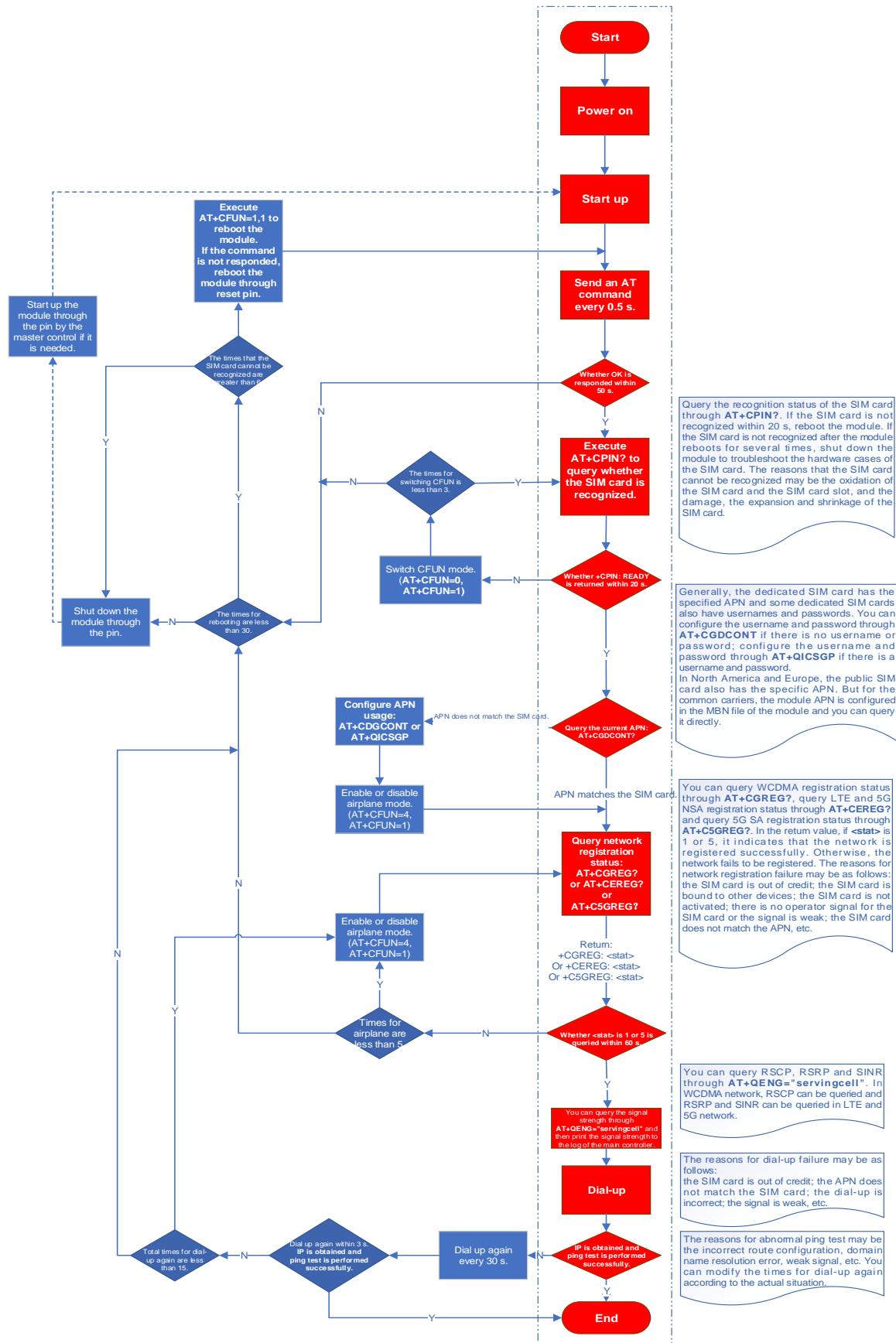
Figure 1: Initialization Flowchart

NOTE

1. It is recommended not to reboot the module frequently, and the time interval for rebooting the module in abnormal design should be gradually increased. For example, when you reboot the module for the first time, you need to wait for 5 minutes before rebooting the module for the second time. Then, wait for 10 minutes before rebooting the module for the third time, and so on. You need to increase the time intervals gradually. Additionally, the operation of rebooting the module should not exceed 30 times per day.

2. The module supply needs to be powered on or off by the master control.

3. It is recommended not to perform PING test in short time frequently. For example, do not perform PING test and then end the test every 10 seconds. If you perform the operations above, the SIM card is authenticated frequently and the fixed flash area of the SIM card is erased, thereby the SIM card may be damaged.

4. For more details about AT commands, see *Chapter 3.3* and *documents [1]*, *[2]* or *[3]*.

3 5G Network Related AT Commands

3.1. AT Command Introduction

3.1.1. Definitions

- **<CR>** Carriage return character.
- **<LF>** Line feed character.
- **<...>** Parameter name. Angle brackets do not appear on the command line.
- **[...]** Optional parameter of a command or an optional part of TA information response. Square brackets do not appear on the command line. When an optional parameter is not given in a command, the new value equals its previous value or the default settings, unless otherwise specified.
- **Underline** Default setting of a parameter.

3.1.2. AT Command Syntax

All command lines must start with **AT** or **at** and end with **<CR>**. Information responses and result codes always start and end with a carriage return character and a line feed character: **<CR><LF><response><CR><LF>**. In tables presenting commands and responses throughout this document, only the commands and responses are presented, and **<CR>** and **<LF>** are deliberately omitted.

Table 2: Types of AT Commands

Command Type	Syntax	Description
Test Command	**AT+<cmd>=?**	Test the existence of the corresponding command and return information about the type, value, or range of its parameter.
Read Command	**AT+<cmd>?**	Check the current parameter value of the corresponding command.
Write Command	**AT+<cmd>=<p1>[,<p2>[,<p3>[...]]]**	Set user-definable parameter value.
Execution Command	**AT+<cmd>**	Return a specific information parameter or perform a specific action.

3.2. Declaration of AT Command Examples

The AT command examples in this document are provided to help you learn about the use of the AT commands introduced herein. The examples, however, should not be taken as Quectel's recommendations or suggestions about how to design a program flow or what status to set the module into. Sometimes multiple examples may be provided for one AT command. However, this does not mean that there is a correlation among these examples, or that they should be executed in a given sequence.

3.3. Description of AT Commands

3.3.1. AT+CEREG   EPS Network Registration Status

This command queries whether the module is registered on EPS domain of LTE and controls the presentation of the following URC.

- **+CEREG: <stat>** is reported when **<n>**=1 and there is a change in the MT's EPS network registration status in E-UTRAN.
- **+CEREG: <stat>[,[<tac>],[<ci>],[<AcT>]]** is reported when **<n>**=2 and there is a change of the network cell in E-UTRAN.

AT+CEREG EPS Network Registration Status	
Test Command **AT+CEREG=?**	Response **+CEREG: (**range of supported **<n>**s**)** **OK**
Read Command **AT+CEREG?**	Response **+CEREG: <n>,<stat>[,<tac>,<ci>[,<AcT>]]** **OK**
Write Command **AT+CEREG=[<n>]**	Response **OK** Or **ERROR**
Maximum Response Time	300 ms
Characteristics	-
Reference *3GPP TS 27.007*	

Parameter

\<n\>	Integer type.	
	0	Disable network registration URC
	1	Enable network registration URC **+CEREG: \<stat\>**
	2	Enable network registration and location information URC
		+CEREG: \<stat\>[,[\<tac\>],[\<ci\>],[\<AcT\>]]
\<stat\>	Integer type. EPS registration status.	
	0	Not registered, MT is not currently searching an operator to register to.
	1	Registered, home network.
	2	Not registered, but MT is currently trying to attach or searching an operator to register to.
	3	Registration denied.
	4	Unknown.
	5	Registered, roaming.
\<tac\>	String type in hexadecimal format. Two-byte tracking area code.	
\<ci\>	String type in hexadecimal format. Four-byte cell ID.	
\<AcT\>	Integer type. Access technology selected.	
	7	E-UTRAN
	13	E-UTRAN-NR dual connectivity

Example

```
AT+CEREG=?
+CEREG: (0-2)

OK
AT+CEREG=2
OK
AT+CEREG?
+CEREG: 2,1,"DE10","5A29C0B",7

OK

+CEREG: 1,"DE10","5A29C0B",7
```

3.3.2. AT+C5GREG   5GS Network Registration Status

This command queries the network registration status and controls the presentation of following URC.

● **+C5GREG: \<stat\>** is reported when **\<n\>**=1 and there is a change in the module's network registration status in 5GS,

● **+C5GREG: \<stat\>[,[\<tac\>],[\<ci\>],[\<AcT\>],[\<Allowed_NSSAI_length\>],[\<Allowed_NSSAI\>]]** is reported when **\<n\>**=2 and there is a change of the network cell in 5GS or the network provides an

Allowed NSSAI. The parameters **<AcT>**, **<tac>**, **<ci>**, **<Allowed_NSSAI_length>** and **<Allowed_NSSAI>** are provided only if available.

AT+C5GREG 5GS Network Registration Status	
Test Command **AT+C5GREG=?**	Response **+C5GREG: (**range of supported **<n>**s**)** **OK**
Read Command **AT+C5GREG?**	Response **+C5GREG: <n>,<stat>[,[<tac>],[<ci>],[<AcT>],[<Allowed _NSSAI_length>],[<Allowed_NSSAI>]]** **OK**
Write Command **AT+C5GREG=[<n>]**	Response **OK** Or **ERROR**
Maximum Response Time	300 ms
Characteristics	-
Reference *3GPP TS 27.007*	

Parameter

<n>	Integer type. 0 Disable network registration URC 1 Enable network registration URC **+C5GREG: <stat>** 2 Enable network registration and location information URC **+C5GREG: <stat>[,[<tac>],[<ci>],[<AcT>],[<Allowed_NSSAI_le ngth>],[<Allowed_NSSAI>]]**
<stat>	Integer type. NR5G registration status. 0 Not registered, the module is not currently searching an operator to register to. 1 Registered, home network. 2 Not registered, but the module is currently trying to attach or searching an operator to register to. 3 Registration denied. 4 Unknown. 5 Registered, roaming. 8 Registered for emergency services only.
<tac>	String type in hexadecimal format. Three-byte tracking area code.
<ci>	String type in hexadecimal format. Five-byte NR5G cell ID.

\<AcT\>	Integer type. Access technology selected.
	10 E-UTRAN connected to a 5GCN
	11 NR connected to a 5GCN
\<Allowed_NSSAI_length\>	Integer type. The number of octets of the **\<Allowed_NSSAI\>** information element.
\<Allowed_NSSAI\>	String type in hexadecimal format. Dependent of the form, the string can be separated by dot(s), semicolon(s) and colon(s). This parameter indicates the list of allowed S-NSSAIs received from the network. The **\<Allowed_NSSAI\>** is coded as a list of **\<S-NSSAI\>**s separated by colons. See **\<S-NSSAI\>** in *3GPP 27.007 subclause 10.1.1*. This parameter shall not be subject to conventional character conversion as per **AT+CSCS**.
\<S-NSSAI\>	String type in hexadecimal character format. Depending on the form, the string can be separated by dot(s) and semicolon(s). This parameter is associated with the PDU session for identifying a network slice in 5GS, see *3GPP TS 23.501 and 3GPP TS 24.501*. For the format and the encoding of S-NSSAI, see also *3GPP TS 23.003*. This parameter is not subject to conventional character conversion as per **AT+CSCS**. The parameter takes one of the following forms:

sst	Only slice/service type (SST) is present.
sst;mapped_sst	SST and mapped configured SST are present.
sst.sd	SST and slice differentiator (SD) are present.
sst.sd;mapped_sst	SST, SD and mapped configured SST are present.
sst.sd;mapped_sst.mapped_sd	SST, SD, mapped configured SST and mapped configured SD are present.

Example

```
AT+C5GREG=?
+C5GREG: (0-2)

OK
AT+C5GREG=2
OK
AT+C5GREG?
+C5GREG: 2,1,"690E0F","9013B004",11,4,"01.000000"

OK
+C5GREG: 1,"690E0F","9013B004",11,4,"01.000000"
```

3.3.3. AT+QENG Query Serving Cell and Neighbor Cell Information

This command queries the serving cell and neighbor cell information, such as band, frequency, signal strength and signal-to-noise ratio.

AT+QENG Query Serving Cell and Neighbor Cell Information	
Test Command **AT+QENG=?**	Response **+QENG: (**list of supported **<cell_type>**s**)** **OK**
Write Command Query the serving cell information **AT+QENG="servingcell"**	Response In SA mode: **+QENG: "servingcell",<state>,"NR5G-SA",<duplex_mode>,<MCC>,<MNC>,<cellID>,<PCID>,<TAC>,<ARFCN>,<band>,<NR_DL_bandwidth>,<RSRP>,<RSRQ>,<SINR>,<scs>,<srxlev>** **OK** In NSA mode: **+QENG: "servingcell",<state>** **+QENG: "LTE",<is_tdd>,<MCC>,<MNC>,<cellID>,<PCID>,<earfcn>,<freq_band_ind>,<UL_bandwidth>,<DL_bandwidth>,<TAC>,<RSRP>,<RSRQ>,<RSSI>,<SINR>,<CQI>,<tx_power>,<srxlev>** **+QENG: "NR5G-NSA",<MCC>,<MNC>,<PCID>,<RSRP>,<SINR>,<RSRQ>,<ARFCN>,<band>,<NR_DL_bandwidth>,<scs>** **OK** In LTE mode: **+QENG: "servingcell",<state>,"LTE",<is_tdd>,<MCC>,<MNC>,<cellID>,<PCID>,<earfcn>,<freq_band_ind>,<UL_bandwidth>,<DL_bandwidth>,<TAC>,<RSRP>,<RSRQ>,<RSSI>,<SINR>,<CQI>,<tx_power>,<srxlev>** **OK** In WCDMA mode: **+QENG: "servingcell",<state>,"WCDMA",<MCC>,<MNC>,<LAC>,<cellID>,<uarfcn>,<PSC>,<RAC>,<RSCP>,<ecio>,<phych>,<SF>,<slot>,<speech_code>,<comMod>**

	OK
Write Command Query the neighbor cell information **AT+QENG="neighbourcell"**	Response In LTE mode: **[+QENG: "neighbourcell intra","LTE",<earfcn>,<PCID>,<RSRQ>,<RSRP>,<RSSI>,<SINR>,<srxlev>,<cell_resel_priority>,<s_non_intra_search>,<thresh_serving_low>,<s_intra_search>]** **[…]** **[+QENG: "neighbourcell inter","LTE",<earfcn>,<PCID>,<RSRQ>,<RSRP>,<RSSI>,<SINR>,<srxlev>,<cell_resel_priority>,<threshX_low>,<threshX_high>]** **[…]** **[+QENG:"neighbourcell","WCDMA",<uarfcn>,<cell_resel_priority>,<thresh_Xhigh>,<thresh_Xlow>,<PSC>,<RSCP><ecno>,<srxlev>]** **[…]** **OK** In WCDMA mode: **[+QENG:"neighbourcell","WCDMA",<uarfcn>,<srxqual>,<PSC>,<RSCP>,<ecno>,<set>,<rank>,<srxlev>]** **[…]** **[+QENG: "neighbourcell","LTE",<earfcn>,<PCID>,<RSRP>,<RSRQ>,<srxlev>]** **[…]** **OK**
Maximum Response Time	300 ms
Characteristics	-

Parameter

<cell_type>	String type. The information of different cells.	
	"servingcell"	The information of 3G/4G/5G serving cells
	"neighbourcell"	The information of 3G/4G neighbor cells
<state>	String type. UE state.	
	"SEARCH"	UE is searching but could not (yet) find a suitable 3G/4G/5G cell.
	"LIMSRV"	UE is camping on a cell but has not registered on the network.

"NOCONN"	UE is camping on a cell and has registered on the network, and it is in idle mode.
"CONNECT"	UE is camping on a cell and has registered on the network, and a call is in progress.
<duplex_mode>	String type. The NR5G SA network mode. "TDD" "FDD"
<MCC>	Integer type. Mobile Country Code (first part of the PLMN code).
<MNC>	Integer type. Mobile Network Code (second part of the PLMN code).
<cellID>	Integer type. Cell ID. 28-bit (UMTS, LTE) or 36-bit (5G) cell ID. Range: 0–0xFFFFFFFFF.
<PCID>	Integer type. Physical cell ID.
<TAC>	String type. Two-byte tracking area code for LTE or three-byte tracking area code for 5G SA in hexadecimal format without double quotes (see *3GPP 23.003 Section 19.4.2.3*).
<ARFCN>	Integer type. SA-ARFCN of the cell that was scanned.
<band>	32-bit unsigned integer. NR5G SA band.
<NR_DL_bandwidth>	Integer type. DL bandwidth. It is only valid in RRC connected state. 0 5 MHz 1 10 MHz 2 15 MHz 3 20 MHz 4 25 MHz 5 30 MHz 6 40 MHz 7 50 MHz 8 60 MHz 9 70 MHZ 10 80 MHz 11 90 MHz 12 100 MHz 13 200 MHz 14 400 MHz 15 35 MHz 16 45 MHz
<RSRP>	16-bit signed integer. - In LTE mode: Signal strength of LTE Reference Signal Received Power (see *3GPP 36.214*). Range: -140 to -44; Unit: dBm. The closer to -44, the better the signal is. The closer to -140, the worse the signal is. - In NR5G mode: Signal strength of NR5G Reference Signal Received Power. Range: -140 to -44; Unit: dBm. The closer to -44, the better the signal is. The closer to -140, the worse the signal is.

\<RSRQ\>	16-bit signed integer.
	- In LTE mode:
	Signal strength of current LTE Reference Signal Received Quality (see *3GPP 36.214*). Range: -20 to -3; Unit: dB. The closer to -3, the better the signal is. The closer to -20, the worse the signal is.
	- In NR5G mode:
	Signal strength of current NR5G Reference Signal Received Quality. Range: -20 to -3; Unit: dB. The closer to -3, the better the signal is. The closer to -20, the worse the signal is.
\<SINR\>	16-bit signed integer.
	- In LTE mode:
	LTE Signal-to-Interface plus Noise Ratio. The conversion formula for actual SINR is $Y = (1/5) \times X \times 10 - 20$ (**X** is **\<SINR\>** queried by **AT+QENG**. **Y** is the actual value of LTE SINR after calculating with the formula). Range: -20 to 30; Unit: dB.
	- In NR5G mode:
	NR5G Signal-to-Interface plus Noise Ratio. Range: -23 to 40; Unit: dB.
\<scs\>	Integer type. NR5G sub operator spacing.
	0 15 KHz
	1 30 KHz
	2 60 KHz
	3 120 KHz
	4 240 KHz
\<srxlev\>	Integer type. Reception level value for the selected base station in dB (see *3GPP 25.304*).
\<is_tdd\>	String type. The LTE network mode.
	"TDD"
	"FDD"
\<earfcn\>	Integer type. E-UTRA-ARFCN of the cell that was scanned.
\<freq_band_ind\>	Integer type. E-UTRA frequency band (see *3GPP 36.101*).
\<UL_bandwidth\>	Integer type. UL bandwidth.
	0 1.4 MHz
	1 3 MHz
	2 5 MHz
	3 10 MHz
	4 15 MHz
	5 20 MHz
\<DL_bandwidth\>	Integer type. DL bandwidth.
	0 1.4 MHz
	1 3 MHz
	2 5 MHz
	3 10 MHz
	4 15 MHz
	5 20 MHz

\<RSSI\>	Integer type. LTE Received Signal Strength Indication.
\<CQI\>	Integer type. Channel Quality Indication. Range: 1–30.
\<tx_power\>	Integer type. TX power value in 1/10 dBm. It is the maximum of all UL channel TX power. **\<tx_power\>** is only meaningful when the device is in traffic.
\<LAC\>	Integer type. Location Area Code. Range: 0–65535. The parameter determines the two bytes location area code in hexadecimal format (e.g. 00C1 equals 193 in decimal) of the cell that was scanned.
\<uarfcn\>	Integer type. UTRA-ARFCN of the scanned cell.
\<PSC\>	Integer type. Primary scrambling code of the scanned cell.
\<RAC\>	Integer type. Routing Area Code. Range: 0–255.
\<RSCP\>	Integer type. Received Signal Code Power level of the cell that is scanned.
\<ecio\>	Integer type. Operator to noise ratio in dB = measured Ec/Io value in dB.
\<phych\>	Integer type. Physical channel.
	0 DPCH
	1 FDPCH
\<SF\>	Integer type. Spreading factor.
	0 SF_4
	1 SF_8
	2 SF_16
	3 SF_32
	4 SF_64
	5 SF_128
	6 SF_256
	7 SF_512
	8 UNKNOWN
\<slot\>	Integer type.
	0–16 Slot format for DPCH.
	0–9 Slot format for FDPCH
\<speech_code\>	Integer type. Destination number on which call is to be deflected.
\<comMod\>	Integer type. Compress mode.
	0 Not support compress mode
	1 Support compress mode
\<cell_resel_priority\>	Integer type. Cell reselection priority. Range: 0–7.
\<s_non_intra_search\>	Integer type. Threshold to control non-intra frequency searches.
\<thresh_serving_low\>	Integer type. Suitable reception level threshold in dB used by the UE on the serving cell when reselecting towards a lower priority RAT/frequency.
\<s_intra_search\>	Integer type. Cell selection parameter for the intra frequency cell.
\<threshX_low\>	Integer type. To be considered for reselection. The suitable receive level value of an evaluated lower priority cell must be greater than this value.
\<threshX_high\>	Integer type. To be considered for reselection. The suitable receive level value of an evaluated higher priority cell must be greater than this value.
\<thresh_Xhigh\>	Integer type. Reselection threshold for high priority layers.
\<thresh_Xlow\>	Integer type. Reselection threshold for low priority layers.

<srxqual>	Integer type. Receiver automatic gain control on the camped frequency.
<ecno>	Integer type. Operator to noise ratio in dB = measured Ec/Io value in dB.
<set>	Integer type. 3G neighbor cell set.
	1 Active set
	2 Synchronous neighbor set
	3 Asynchronous neighbor set
<rank>	Integer type. Rank of this cell as neighbor for inter-RAT cell reselection.

NOTE

1. If "**-**" is returned, it indicates that the parameter is invalid when you execute the command.
2. When you read the response information of this command, it is recommended to read the information based on the first negative value, which is the RSRP value. For example, in LTE mode, the fourth parameter value before RSRP value represents the band, and the third parameter value after RSRP value represents SINR value. In SA mode, the second parameter value before RSRP value represents the band, and the second parameter value after RSRP value represents SINR value.

Example

AT+QENG="servingcell"
//Query the serving cell information. The current UE is registered under LTE network.
+QENG: "servingcell","NOCONN","LTE","FDD",460,01,5F1EA15,12,1650,3,5,5,DE10,-100,-12,-68,11,-,-,27

OK
AT+QENG="servingcell"   //Query the serving cell information. The current UE is registered under NSA network.
+QENG: "servingcell","NOCONN"
+QENG: "LTE","FDD",460,01,5F1EA15,12,1650,3,5,5,DE10,-99,-12,-67,11,9,230,-
+QENG:"NR5G-NSA",460,01,747,-71,33,-11,627264,78,12,1

OK
AT+QENG="servingcell"   //Query the serving cell information. The current UE is registered under SA network.
+QENG: "servingcell","NOCONN","NR5G-SA","TDD",460,01,19013B004,299,690E0F,633984,78,12,-107,-13,2,1,-

OK
AT+QENG="neighbourcell"   //Query the neighbor cell information.
+QENG: "neighbourcell intra","LTE",38950,276,-3,-88,-65,0,37,7,16,6,44
+QENG: "neighbourcell inter","LTE",39148,-,-,-,-,-,37,0,30,7
+QENG: "neighbourcell inter","LTE",37900,-,-,-,-,-,0,0,30,6

OK

3.3.4. AT+QNWPREFCFG="lte_band"　Configure LTE Band

This command configures the preferred LTE bands to be searched by UE.

AT+QNWPREFCFG="lte_band"　Configure LTE Band	
Write Command **AT+QNWPREFCFG="lte_band"[,<LTE _band>]**	Response If the optional parameter is omitted, query the current setting: **+QNWPREFCFG: "lte_band",<LTE_band>** **OK** If the optional parameter is specified, configure the preferred LTE bands to be searched: **OK** If there is any error: **ERROR**
Maximum Response Time	300 ms
Characteristics	The command takes effect immediately. The configuration is saved automatically.

Parameter

<LTE_band>	String type without double quotes. LTE bands to be configured. Format: **<band1>:<band2>:…:<band*n*>**.
<band>	Integer type. LTE bands supported by the module.
	1–5　　B1–B5
	7　　　B7
	8　　　B8
	12–14　B12–B14
	17–20　B17–B20
	25　　　B25
	26　　　B26
	28–30　B28–B30
	32　　　B32
	34　　　B34
	38–43　B38–B43
	48　　　B48
	66　　　B66
	71　　　B71

1. See the specific module specification for the bands that are supported.
2. When the module locks to LTE, an **ERROR** is reported if **<LTE_band>** is set to null.
3. Executing **AT+QNWPREFCFG="lte_band",<LTE_band>** writes data to NVM. Please proceed with caution.

Example

AT+QNWPREFCFG="lte_band"	//Query the currently configured LTE bands of the UE.
+QNWPREFCFG: "lte_band",1:2:3:4:5:7:8:12:13:14:17:18:19:20:25:26:28:29:30:32:34:38:39:40:41:42:66:71	
OK	
AT+QNWPREFCFG="lte_band",1:2	//The preferred LTE bands to be searched by UE in LTE mode are LTE B1 and LTE B2.
OK	

3.3.5. AT+QNWPREFCFG="nsa_nr5g_band"　Configure NR5G NSA Band

This command configures the preferred NR5G NSA bands to be searched by UE.

AT+QNWPREFCFG="nsa_nr5g_band"　Configure NR5G NSA Band	
Write Command **AT+QNWPREFCFG="nsa_nr5g_band"** **[,<NSA_NR5G_band>]**	Response If the optional parameter is omitted, query the current configuration: **+QNWPREFCFG: "nsa_nr5g_band",<NSA_NR5G_band>** **OK** If the optional parameter is specified, configure the preferred NR5G NSA bands to be searched: **OK** If there is any error: **ERROR**
Maximum Response Time	300 ms
Characteristics	The command takes effect immediately. The configuration is saved automatically.

Parameter

\<NSA_NR5G_band>	String type without double quotes. 5G NSA bands to be configured. Format: **\<NSA_band1>**:**\<NSA_band2>**:…:**\<NSA_band*n*>**
\<NSA_band>	Integer type. 5G NSA band. The configurable 5G NSA bands supported by the module.

1–3	n1–n3
5	n5
7	n7
8	n8
12	n12
20	n20
25	n25
28	n28
38	n38
40	n40
41	n41
48	n48
66	n66
71	n71
77–79	n77–n79
257	n257
258	n258
260	n260
261	n261

NOTE

1. See the specific module specification for the bands that are supported.
2. When the module locks to NR5G NSA, an **ERROR** is reported if **\<NSA_NR5G_band>** is set to null.
3. Executing **AT+QNWPREFCFG="nsa_nr5g_band",\<NSA_NR5G_band>** writes data to NVM. Please proceed with caution.

Example

AT+QNWPREFCFG="nsa_nr5g_band"   //Query the currently configured NR5G NSA bands of UE.
+QNWPREFCFG: "nsa_nr5g_band",1:3:7:20:28:40:41:71:77:78:79

OK
AT+QNWPREFCFG="nsa_nr5g_band",1:2//The preferred NR5G NSA bands to be searched by UE in
                              NR5G NSA mode are n1 and n2.

OK

3.3.6. AT+QNWPREFCFG="nr5g_band"　Configure NR5G SA Band

This command configures the preferred NR5G SA bands to be searched by UE.

AT+QNWPREFCFG="nr5g_band"	Configure NR5G SA Band
Write Command **AT+QNWPREFCFG="nr5g_band"[,<SA_NR5G_band>]**	Response If the optional parameter is omitted, query the current setting: **+QNWPREFCFG: "nr5g_band",<SA_NR5G_band>** **OK** If the optional parameter is specified, configure the preferred NR5G SA bands to be searched: **OK** If there is any error: **ERROR**
Maximum Response Time	300 ms
Characteristics	The command takes effect immediately. The configuration is saved automatically.

Parameter

<SA_NR5G_band>	String type without double quotes. 5G NSA bands to be configured. Format: **<SA_band1>:<SA_band2>:…:<SA_bandn>**.
<SA_band>	Integer type. SA 5G band. The configurable SA 5G bands supported by the applicable modules.

1–3	n1–n3
7	n7
8	n8
12	n12
20	n20
25	n25
28	n28
38	n38
40	n40
41	n41
48	n48
66	n66
71	n71
77–79	n77–n79
257	n257

Parameter

<mode_pref>	String type without double quotes. Use the colon as a separator to list the RATs to be configured. Format: **<mode_pref1>:<mode_pref2>:…:<mode_pref$n$>**.
	The RATs supported by the module are as follows:
	AUTO WCDMA & LTE & NR5G
	WCDMA WCDMA only
	LTE LTE only
	NR5G NR5G only

Example

AT+QNWPREFCFG="mode_pref"	//Query the current network search mode.
+QNWPREFCFG: "mode_pref",AUTO	
OK	
AT+QNWPREFCFG="mode_pref",LTE	//Set RAT to LTE only.
OK	
AT+QNWPREFCFG="mode_pref",LTE:NR5G	//Set RAT to LTE & NR5G.
OK	

3.3.8. AT+QNWPREFCFG="nr5g_disable_mode"　Disable NR5G

This command disables NR5G.

AT+QNWPREFCFG="nr5g_disable_mode"　Disable NR5G	
Write Command **AT+QNWPREFCFG="nr5g_disable_ mode"[,<disable_mode>]**	Response If the optional parameter is omitted, query the current setting: **+QNWPREFCFG: "nr5g_disable_mode",<disable_mode>** **OK** If the optional parameter is specified, disable NR5G: **OK** If there is any error: **ERROR**
Maximum Response Time	300 ms
Characteristics	The command takes effect immediately. The configuration is saved automatically.

Parameter

<disable_mode>	Integer type. Disable NR5G SA/NSA.
	0 Neither is disabled
	1 Disable SA
	2 Disable NSA

NOTE

Executing **AT+QNWPREFCFG="nr5g_disable_mode",<disable_mode>** writes data to NVM. Please proceed with caution.

Example

AT+QNWPREFCFG="nr5g_disable_mode"	//Query the current NR5G.
+QNWPREFCFG: "nr5g_disable_mode",0	
OK	
AT+QNWPREFCFG="nr5g_disable_mode",1	//Disable NR5G SA.
OK	

3.3.9. AT+QNWPREFCFG="policy_band" Query Operator Policy Band

This command queries the band configured in the operator policy.

AT+QNWPREFCFG="policy_band" Query Operator Policy Band	
Write Command **AT+QNWPREFCFG="policy_band"**	Response **+QNWPREFCFG: "gw_band",<gw_band>** **+QNWPREFCFG: "lte_band",<LTE_band>** **+QNWPREFCFG: "nsa_nr5g_band",<NSA_NR5G_band>** **+QNWPREFCFG: "nr5g_band",<SA_NR5G_band>** **OK**
Maximum Response Time	300 ms
Characteristics	-

Parameter

<gw_band>	String type without double quotes. WCDMA bands to be configured. Format: **<WCDMA_band1>:<WCDMA_band2>:…:<WCDMA_band*n*>**
<WCDMA_band>	Integer type. WCDMA band.

	1	WCDMA 2100 band
	2	WCDMA 1900 band
	3	WCDMA 1800 band
	4	WCDMA 1700 band
	5	WCDMA 850 band
	6	WCDMA 800 band
	8	WCDMA 900 band
	19	WCDMA Japan 850 band
<LTE_band>	String type without double quotes. LTE bands to be configured. Format: **<band1>:<band2>:…:<band*n*>**.	
<band>	Integer type. LTE band. See **<band>** in *Chapter 3.3.4*.	
<NSA_NR5G_band>	String type without double quotes. 5G NSA bands to be configured. Format: **<NSA_band1>:<NSA_band1>:…:<NSA_band*n*>**	
<NSA_band>	Integer type. 5G NSA band. See **<NSA_band>** in *Chapter 3.3.5*.	
<SA_NR5G_band>	String type without double quotes. 5G SA bands to be configured. Format: **<SA_band1>:<SA_bandx>:…:<SA_band*n*>**	
<SA_band>	Integer type. 5G SA band. See **<SA_band>** in *Chapter 3.3.6*.	

Example

> **AT+QNWPREFCFG="policy_band"**
> **+QNWPREFCFG: "gw_band",1:8**
> **+QNWPREFCFG: "lte_band",1:3:8**
> **+QNWPREFCFG: "nsa_nr5g_band",78**
> **+QNWPREFCFG: "nr5g_band",78**
>
> **OK**

3.3.10. AT+QNWPREFCFG="ue_capability_band"   Query UE Capability Band

This command queries the band configured in the UE capability information.

AT+QNWPREFCFG="ue_capability_band" Query UE Capability Band	
Write Command **AT+QNWPREFCFG="ue_capabilit y_band"**	Response **+QNWPREFCFG: "gw_band",<gw_band>** **+QNWPREFCFG: "lte_band",<LTE_band>** **+QNWPREFCFG: "nsa_nr5g_band",<NSA_NR5G_band>** **+QNWPREFCFG: "nr5g_band",<SA_NR5G_band>** **OK**
Maximum Response Time	300 ms
Characteristics	-

Parameter

\<gw_band\>	String type without double quotes. Use the colon as a separator to list the WCDMA bands to be configured. The parameter format is: **\<WCDMA_band1\>:\<WCDMA_band2\>:…:\<WCDMA_band*n*\>**
\<WCDMA_band\>	Integer type. WCDMA band. 1 WCDMA 2100 band 2 WCDMA 1900 band 3 WCDMA 1800 band 4 WCDMA 1700 band 5 WCDMA 850 band 6 WCDMA 800 band 8 WCDMA 900 band 19 WCDMA Japan 850 band
\<LTE_band\>	String type without double quotes. Use the colon as a separator to list the LTE bands to be configured. The parameter format is: **\<band1\>:\<band2\>:…:\<band*n*\>**.
\<band\>	Integer type. LTE band. See **\<band\>** in *Chapter 3.3.4*.
\<NSA_NR5G_band\>	String type without double quotes. Use the colon as a separator to list the NR5G NSA bands to be configured. The parameter format is: **\<NSA_band1\>:\<NSA_band1\>:…:\<NSA_band*n*\>**
\<NSA_band\>	Integer type. NR5G NSA band. See **\<NSA_band\>** in *Chapter 3.3.5*.
\<SA_NR5G_band\>	String type without double quotes. Use the colon as a separator to list the NR5G SA bands to be configured. The parameter format is: **\<SA_band1\>:\<SA_bandx\>:…:\<SA_band*n*\>**
\<SA_band\>	Integer type. NR5G SA band. See **\<SA_band\>** in *Chapter 3.3.6*.

Example

```
AT+QNWPREFCFG="ue_capability_band"
+QNWPREFCFG: "gw_band",1:8
+QNWPREFCFG: "lte_band",1:3:8
+QNWPREFCFG: "nsa_nr5g_band",78
+QNWPREFCFG: "nr5g_band",78


OK
```

3.3.11. AT+QENDC   Query EN-DC Status

This command queries EN-DC status.

AT+QENDC Query EN-DC Status	
Read Command **AT+QENDC?**	Response **+QENDC: \<mode\>**

	OK
Write Command **AT+QENDC=<mode>**	Response **OK**
Execution Command **AT+QENDC**	Response **+QENDC: <endc_avl>,<plmn_info_list_r15_avl>,<endc_rstr>,<5G_basic>[,<5G_UWB>]** **OK**
Maximum Response Time	300 ms
Characteristics	The command takes effect immediately. The configuration is saved automatically.

Parameter

<mode>	Integer type. Disable or disable the following URC: **+QENDC: <endc_avl>,<plmn_info_list_r15_avl>,<endc_rstr>,<5G_basic>,<5G_UWB>** <u>0</u> Disable 1 Enable
<endc_avl>	Integer type. Indicate whether the current cell supports the EN-DC mode. 0 Not support 1 Support
<plmn_info_list_r15_avl>	Integer type. Indicate whether the currently registered PLMN supports the EN-DC mode. 0 Not support 1 Support
<endc_rstr>	Integer type. EN-DC capability delivered by the network. 0 Not Restricted 1 Restricted
<5G_basic>	Integer type. Indicate whether to show 5G Icon information. 0 Not show 1 Show
<5G_UWB>	Integer type. Indicate whether to show 5G UWB Icon information. The parameter is valid only under Verizon network. 0 Not show 1 Show

Example

AT+QENDC
+QENDC: 1,1,0,1,0

```
OK
AT+QENDC=1      //Enable ENDC URC.
OK

// URC Report.
+QENDC: 1,1,0,0,0

+QENDC: 1,1,0,1,0
```

3.3.12. AT+QRSRP   Query RSRP

The command queries RSRP of each antenna of the module under the current service network.

AT+QRSRP Query RSRP	
Test Command **AT+QRSRP=?**	Response **OK**
Read Command **AT+QRSRP?**	Response **+QRSRP: <PRX>,<DRX>,<RX2>,<RX3>,<sysmode>** **[…]** **OK**
Maximum Response Time	300 ms
Characteristics	--

Parameter

<PRX>	Integer type. PRX path RSRP value. Range: -140 to -44; Unit: dBm.
<DRX>	Integer type. DRX path RSRP value. Range: -140 to -44; Unit: dBm.
<RX2>	Integer type. RX2 path RSRP value. Range: -140 to -44; Unit: dBm.
<RX3>	Integer type. RX3 path RSRP value. Range: -140 to -44; Unit: dBm.
<sysmode>	String type without double quotes. Service network mode.
	LTE LTE mode
	NR5G NR5G mode

> **NOTE**
>
> 1. The command takes effect only under LTE and NR5G network.
> 2. If the queried **<PRX>**, **<DRX>**, **<RX2>** and **<RX3>** is -32768, it indicates that the RSRP value is invalid.
> 3. This command is strongly related to the RF link and is generally only used for user reference and cannot be used as a sensitivity test. In addition, it is best to use it when there is the data service and the results are more accurate.

Example

AT+QRSRP?   //Query RSRP of each antenna of the module under the current service network.
+QRSRP: -101,-105,-105,-99,LTE

OK

3.3.13. AT+QSINR   Query SINR

The command queries SINR of each antenna of the module under the current service network.

AT+QSINR Query SINR	
Test Command **AT+QSINR=?**	Response **OK**
Read Command **AT+QSINR?**	Response **+QSINR: <PRX>,<DRX>,<RX2>,<RX3>,<sysmode>** **[…]** **OK**
Maximum Response Time	300 ms
Characteristics	-

Parameter

<PRX>	Integer type. PRX path SINR value. Range: -20 to 30 in LTE, -23 to 40 in NR5G. Unit: dB.
<DRX>	Integer type. DRX path SINR value. Range: -20 to 30 in LTE, -23 to 40 in NR5G. Unit: dB.
<RX2>	Integer type. RX2 path SINR value. Range: -20 to 30 in LTE, -23 to 40 in NR5G. Unit: dB.
<RX3>	Integer type. RX3 path SINR value. Range: -20 to 30 in LTE, -23 to 40 in NR5G. Unit: dB.
<sysmode>	String type without double quotes. Service network mode.
	LTE LTE mode
	NR5G NR5G mode

NOTE

1. The command takes effect only under LTE and NR5G network.
2. The invalid SINR value is -32768.
3. This command is strongly related to the RF link and is generally only used for customer reference and cannot be used as a sensitivity test. In addition, it is best to use it when there is the data service and the results are more accurate.

Example

AT+QSINR?   //Query SINR of each antenna of the module under the current service network.
+QSINR: -3,-7,-1,-2,LTE

OK

3.3.14. AT+QCAINFO   Query Carrier Aggregation Parameters

This command queries carrier aggregation parameters.

AT+QCAINFO Query Carrier Aggregation Parameters	
Test Command **AT+QCAINFO=?**	Response **+QCAINFO:** (list of supported **<5G_signal_ext>**s) **OK**
Read Command **AT+QCAINFO?**	Response **+QCAINFO: <5G_signal_ext>** **OK**
Write Command **AT+QCAINFO=<5G_signal_ext>**	Response **OK** Or **ERROR**
Execution Command **AT+QCAINFO**	In LTE mode: **+QCAINFO: "PCC",<freq>,<bandwidth>,<band>,<pcell_state>,<PCID>,<RSRP>,<RSRQ>,<RSSI>,<RSSNR>** **[+QCAINFO: "SCC",<freq>,<bandwidth>,<band>,<scell_state>,<PCID>,<RSRP>,<RSRQ>,<RSSI>,<RSSNR><UL_configured>,<UL_bandwidth>,<UL_EARFCN>]** **[…]** **OK** In EN-DC mode: **+QCAINFO: "PCC",<freq>,<bandwidth>,<band>,<pcell_state>,<PCID>,<RSRP>,<RSRQ>,<RSSI>,<RSSNR>** **[+QCAINFO: "SCC",<freq>,<bandwidth>,<band>,<scell_state>,<PCID>,<RSRP>,<RSRQ>,<RSSI>,<RSSNR><UL_configured>,<UL_bandwidth>,<UL_EARFCN>]** **[…]** **[+QCAINFO: "SCC",<freq>,<NR_DL_bandwidth>,<NR_band>,<PCID>]** **[+QCAINFO: "SCC",<freq>,<NR_DL_bandwidth>,<NR_b**

	and>,<scell_state>,<PCID>,<UL_configured>,<NR_UL_b andwidth>,<UL_ARFCN>[,<NR_RSRP>,<NR_RSRQ>[,<N R_SNR>]]] **[…]** **OK** In SA mode: **+QCAINFO: "PCC",<freq>,<NR_DL_bandwidth>,<NR_ba nd>,<PCID>** **[+QCAINFO: "SCC",<freq>,<NR_DL_bandwidth>,<NR_b and>,<scell_state>,<PCID>,<UL_configured>,<NR_UL_b andwidth>,<UL_ARFCN>[,<NR_RSRP>,<NR_RSRQ>[,<N R_SNR>]]]** **[…]** **OK** If there is any error: **ERROR**
Maximum Response Time	300 ms
Characteristics	The command takes effect immediately. The configuration is saved automatically.

Parameter

<5G_signal_ext>	Integer type. Hide or show extension parameters **<NR_RSRP>**, **<NR_RSRQ>** and **<NR_SNR>**.
	<u>0</u> Hide
	1 Show
<freq>	Integer type. EARFCN.
<bandwidth>	Integer type. Bandwidth.
	6 1.4 MHz
	15 3 MHz
	25 5 MHz
	50 10 MHz
	75 15 MHz
	100 20 MHz
<band>	String type. LTE band.
	"LTE BAND 1"–"LTE BAND 5"
	"LTE BAND 7"
	"LTE BAND 8"
	"LTE BAND 12"–"LTE BAND 14"

	"LTE BAND 17"–"LTE BAND 20"	
	"LTE BAND 25"	
	"LTE BAND 26"	
	"LTE BAND 28"–"LTE BAND 30"	
	"LTE BAND 32"	
	"LTE BAND 34"	
	"LTE BAND 38"–"LTE BAND 43"	
	"LTE BAND 48"	
	"LTE BAND 66"	
\<pcell_state\>	Integer type. Primary cell state.	
	0	Not registered, not searching
	1	Registered on home network
	2	Not registered, searched
	3	Registration denied
	4	Unknow registration state
	5	Registered on roaming network
\<scell_state\>	Integer type. Secondary cell state.	
	0	Deconfigured
	1	Configuration deactivated
	2	Configuration activated
\<PCID\>	Integer type. Physical Cell ID.	
\<RSRP\>	Integer type. Reference Signal Received Power (see *3GPP 36.214*).	
\<RSRQ\>	Integer type. Reference Signal Received Quality (see *3GPP 36.214*).	
\<RSSI\>	Integer type. Received Signal Strength Indication.	
\<RSSNR\>	Integer type. Logarithmic value of RSSNR. Range: -10 to +30; Unit: dB.	
\<UL_configured\>	Integer type. Whether the UL of secondary cell is configured by network.	
	0	Not configured by the network
	1	Configured by the network
\<UL_bandwidth\>	Integer type. UL bandwidth. "-" will be displayed if **\<UL_configured\>**=0.	
	6	1.4 MHz
	15	3 MHz
	25	5 MHz
	50	10 MHz
	75	15 MHz
	100	20 MHz
\<UL_EARFCN\>	Integer type. UL EARFCN. "-" will be displayed if **\<UL_configured\>**=0.	
\<NR_DL_bandwidth\>	Integer type. NR5G DL bandwidth.	
	0	5 MHz
	1	10 MHz
	2	15 MHz
	3	20 MHz
	4	25 MHz
	5	30 MHz
	6	40 MHz

	7 50 MHz
	8 60 MHz
	9 70 MHz
	10 80 MHz
	11 90 MHz
	12 100 MHz
	13 200 MHz
	14 400 MHz
	15 35 MHz
	16 45 MHz
<NR_band>	String Type.NR5G band.
	"NR5G BAND 1"–"NR5G BAND 3"
	"NR5G BAND 7"
	"NR5G BAND 8"
	"NR5G BAND 12"
	"NR5G BAND 20"
	"NR5G BAND 25"
	"NR5G BAND 28"
	"NR5G BAND 38"
	"NR5G BAND 40"
	"NR5G BAND 41"
	"NR5G BAND 48"
	"NR5G BAND 66"
	"NR5G BAND 71"
	"NR5G BAND 77"–"NR5G BAND 79"
	"NR5G BAND 257"
	"NR5G BAND 258"
	"NR5G BAND 260"
	"NR5G BAND 261"
<NR_UL_bandwidth>	Integer type. "-" will be displayed if **<UL_configured>**=0. The value of **<NR_UL_bandwidth>** is the same as that of **<NR_DL_bandwidth>**.
<UL_ARFCN>	Integer type. UL ARFCN. "-" will be displayed if **<UL_configured>** is 0.
<NR_RSRP>	Integer type. Signal strength of NR5G reference signal received power. Range: -140 to -44. Unit: dBm. The closer to -44, the better the signal is. The closer to -140, the worse the signal is.
<NR_RSRQ>	Integer type. Signal strength of current NR5G reference signal received quality. Range: -20 to -3. Unit: dB. The closer to -3, the better the signal is. The closer to -20, the worse the signal is.
<NR_SNR>	Integer type. Current NR SNR. Range: -2300 to 4000. The actual value of NR SNR is calculated via the formula: NR SNR = **<NR_SNR>** / 100 Range of NR SNR: -23 to 40; Unit: dB.

> **NOTE**
>
> The command takes effect after the module is registered on the network.

Example

```
AT+QCAINFO
+QCAINFO: "PCC",300,100,"LTE BAND 1",1,23,-66,-12,-34,30
+QCAINFO: "SCC",1575,100,"LTE BAND 3",2,43,-64,-7,-24,30,0,-,-

OK
```

3.3.15. AT+QSCAN   Search Nearby Cells

This command searches nearby LTE cells and NR5G cells.

AT+QSCAN Search Nearby Cells	
Test Command **AT+QSCAN=?**	Response **+QSCAN: (**range of supported **<mode>**s**)** **OK**
Write Command **AT+QSCAN=<mode>[,<ext>[,<scan_LTE_band>[,<scan_NR5G_band>]]]**	Response **[+QSCAN: "LTE",<MCC>,<MNC>,<freq>,<PCI>,<RSRP>,<RSRQ>,<srxlev>,<squal>[,<cellID>,<TAC>,<bandwidth>,<LTE_band>[,<short_name>,<full_name>]]]** **[…]** **[+QSCAN: "NR5G",<MCC>,<MNC>,<freq>,<PCI>,<RSRP>,<RSRQ>,<srxlev>,<SCS>[,<cellID>,<TAC>,<carrierBandwidth>,<NR_band>,<offsetToPointA>,<SSB_subcarrier_offset>,<SSB_SCS>,[<short_name>,<full_name>]]]** **[…]** **OK** If there is any error: **ERROR** Or **+CME ERROR: <err>**
Maximum Response Time	360 s, determined by the network.
Characteristics	-

Parameter

<mode>	Integer type. Cell searching mode.
	1 Search only for LTE cells
	2 Search only for NR5G cells
	3 Search for LTE cells and NR5G cells at the same time
<ext>	Integer type. Hide or show the extension parameter options or show the extension parameters (support 5G cell without TAC).
	0 Hide extension parameters
	1 Show extension parameters (**<cellID>**, **<TAC>**, **<bandwidth>**, **<LTE_band>**, **<carrierBandwidth>**, **<NR_band>**, **<offsetToPointA>** and **<SSB_subcarrier_offset>** and **<SSB_SCS>**)
	3 Show extension parameters (**<cellID>**, **<TAC>**, **<bandwidth>**, **<LTE_band>**, **<carrierBandwidth>**, **<NR_band>**, **<offsetToPointA>**, **<SSB_subcarrier_offset>**, **<SSB_SCS>**, **<full_name>** and **<short_name>**)
<scan_LTE_band>	String type without double quotes. Use the colon as a separator to list the NR5G bands to be configured. The parameter format is **<LTE_band1>**:**<LTE_band2>**:…:**<LTE_band*n*>**.
<LTE_band>	Integer type. LTE band. See **<band>** in *Chapter 3.3.4*.
<scan_NR5G_band>	String type without double quotes. Use the colon as a separator to list the NR5G bands to be configured. The parameter format is **<NR5G_band1>**:**<NR5G_band2>**:…:**<NR5G_band*n*>**.
<NR5G_band>	Integer type. NR5G band.
<MCC>	Integer type. Mobile Country Code (first part of the PLMN code).
<MNC>	Integer type. Mobile Network Code (second part of the PLMN code).
<freq>	Integer type. Cell frequency.
<PCI>	Integer type. Physical Cell ID.
<RSRP>	Integer type. Reference Signal Received Power (see *3GPP 36.214*). Range: -140 to -44; Unit: dBm.
<RSRQ>	Integer type. The current Reference Signal Received Quality (see *3GPP 36.214*). Range: -20 to -3; Unit: dB.
<srxlev>	Integer type. Cell selection RX level value. Unit: dB.
<squal>	Integer type. Cell selection quality value. Unit: dB.
<cellID>	String type in hexadecimal format without double quotes. Cell ID.
<TAC>	String type in hexadecimal format without double quotes. TAC.
<bandwidth>	Integer type. Bandwidth.
	6 1.4 MHz
	15 3 MHz
	25 5 MHz
	50 10 MHz
	75 15 MHz
	100 20 MHz
<SCS>	Integer type. Sub-carrier space.

	0 15 KHz
	1 30 KHz
	2 60 KHz
	3 120 KHz
<carrierBandwidth>	Integer type. Carrier bandwidth, the number of the RBs in sub-carrier.
<NR_band>	Integer type. NR5G band.
<offsetToPointA>	Integer type. Offset to Point A.
<SSB_subcarrier_offset>	Integer type. SSB sub-carrier offset.
<SSB_SCS>	Integer type. SSB SCS value.
	0 15 KHz
	1 30 KHz
	2 60 KHz
	3 120 KHz
<short_name>	String type. The short name of the network operator. Only output when **<ext>** is 3.
<full_name>	String type. The full name of the network operator. Only output when **<ext>** is 3.

NOTE

1. This command returns "-" for the parameters if the cell information is not obtained.
2. In NSA mode, this command will not display NR5G cell information.
3. It is recommended to use the command when there is no SIM card.

Example

```
AT+QSCAN=1,1          //Search only for LTE cells and show extension parameters.
+QSCAN: "LTE",460,00,3590,207,-128,-13,-1,115,848459E,550B,50,8
+QSCAN: "LTE",460,11,1850,378,-135,-20,-7,109,DD8A33F,691D,100,3

OK
AT+QSCAN=2,1          //Search only for NR5G cells and show extension parameters.
+QSCAN: "NR5G",460,00,504990,901,-95,-11,26,1,170C23000,46550B,273,41,30,6,1
+QSCAN: "NR5G",460,11,633984,441,-112,-13,9,1,690133003,690E0F,273,78,28,4,1
+QSCAN: "NR5G",460,01,633984,441,-112,-13,9,1,690133003,690E0F,273,78,28,4,1
+QSCAN: "NR5G",460,11,633984,223,-112,-15,9,1,69034E007,690E0F,273,78,28,4,1
+QSCAN: "NR5G",460,01,633984,223,-112,-15,9,1,69034E007,690E0F,273,78,28,4,1

OK
AT+QSCAN=1,1,1        //Search only for LTE cells, show extension parameters and configure LTE
                       Band 1.
+QSCAN: "LTE",001,01,100,1,-97,-13,43,116,1A2D001,1,100,1

OK
```

AT+QSCAN=2,1,1,78   //Search only for NR5G cells, show extension parameters and configure LTE Band 1 and NR5G Band 78.
+QSCAN: "NR5G",460,11,633984,841,-74,-11,46,1,6909DB085,690E0F,273,78,28,4,-
+QSCAN: "NR5G",460,01,633984,841,-74,-11,46,1,6909DB085,690E0F,273,78,28,4,-

OK
AT+QSCAN=3,1,3,1   //Search for LTE cells and NR5G cells at the same time, show extension parameters and configure LTE Band 3 and NR5G Band 1.
+QSCAN: "NR5G",460,11,427210,810,-123,-16,-3,0,69067E483,690E0F,106,1,20,6,-
+QSCAN: "NR5G",460,01,427210,810,-123,-16,-3,0,69067E483,690E0F,106,1,20,6,-
+QSCAN: "LTE",460,11,1850,378,-83,-13,46,115,DD8A33F,691D,100,3
+QSCAN: "LTE",460,00,1300,123,-75,-7,51,122,D6B5C0,550B,100,3
+QSCAN: "LTE",460,01,1506,157,-122,-17,6,112,5AC820C,DE10,50,3
+QSCAN: "LTE",460,01,1650,465,-85,-6,37,119,5A29C0B,DE10,100,3

OK
AT+QSCAN=2,3   //Search only for NR5G cells and show extension parameters.
+QSCAN:"NR5G",460,00,504990,631,-83,-11,38,1,170C23000,46550B,273,41,30,6,-,"CMCC","CHINA MOBILE"
+QSCAN: "NR5G",460,15,504990,631,-83,-11,38,1,170C23000,46550B,273,41,30,6,-,"-","-"
+QSCAN:"NR5G",460,00,152650,30,-121,-14,-,0,175E7A001,46550B,160,28,15,10,0,"CMCC","CHINA MOBILE"
+QSCAN: "NR5G",460,15,152650,30,-121,-14,-,0,175E7A001,46550B,160,28,15,10,0,"-","-"
+QSCAN:"NR5G",460,11,633984,841,-68,-11,52,1,6909DB085,690E0F,273,78,28,4,1,"CT","CHN-CT"
+QSCAN:"NR5G",460,01,633984,841,-68,-11,52,1,6909DB085,690E0F,273,78,28,4,1,"UNICOM","CHN-UNICOM"
+QSCAN: "NR5G",460,11,633984,223,-92,-12,28,1,69034E007,690E0F,273,78,28,4,1,"CT","CHN-CT"
+QSCAN:"NR5G",460,01,633984,223,-92,-12,28,1,69034E007,690E0F,273,78,28,4,1,"UNICOM","CHN-UNICOM"

OK

3.3.16. AT+COPS   Operator Selection

This command returns the current operators and their status, and allows automatic or manual network selection. This chapter only introduces the Read Command under SA and NSA, for more details about this command, see *document [1]*. You can judge whether the SA has been registered on through the value of **<AcT>** returned by the Read Command.

AT+COPS Operator Selection	
Read Command AT+COPS?	Response +COPS: <mode>[,<format>[,<oper>][,<AcT>]]

	OK If there is any error related to MT functionality: **+CME ERROR: <err>**

Parameter

<mode>	Integer type.
	0 Automatic operator selection (**<oper>** field is ignored)
	1 Manual operator selection (**<oper>** field shall be present and **<AcT>** optionally)
	2 Deregister from network
	3 Set only **<format>** (for **AT+COPS?** Read Command), and do not attempt registration/deregistration (**<oper>** and **<AcT>** fields are ignored). This value is invalid in the response of Read Command.
	4 Manual/automatic selection. **<oper>** field shall be presented. If manual selection fails, automatic mode (**<mode>**=0) will be entered.
<format>	Integer type. The format of **<oper>**.
	0 Long format alphanumeric of **<oper>** which can be up to 16 characters long
	1 Short format alphanumeric of **<oper>**
	2 Numeric format of **<oper>**, GSM location area identification number
<oper>	String type. Operator in format as per **<format>**.
<AcT>	Integer type. Access technology selected. Values 4, 5, 6 occur only in the response of Read Command while MS is in data service state and is not intended for the **AT+COPS** Write Command.
	2 UTRAN
	4 UTRAN W/HSDPA
	5 UTRAN W/HSUPA
	6 UTRAN W/HSDPA and HSUPA
	7 E-UTRAN
	10 E-UTRAN connected to a 5GCN
	11 NR connected to 5GCN
	12 NG-RAN
	13 E-UTRAN-NR dual connectivity
<err>	Error codes. See *document [1]*, *[2]* or *[3]* for more details.

4 5G Network Status Judgement

4.1. 5G Icon Display Rules

Since 5G network popularizes rapidly, there are defects existed in the network configuration and terminals in some areas, especially, the protocol does not clearly stipulate and allow network customization. GSMA does not clearly stipulate the 5G icon display standard under the NSA network, but proposes four display strategies for reference. Operators can choose or combine them according to the local network deployment. Currently, most operators choose to use Config. A + D in the following figure. The standards defined by GSMA are shown in the *Figure 2*.

State	Config. A	Config. B	Config. C	Config. D
1 (IDLE under or Connected to LTE cell not supporting NSA)	4G	4G	4G	4G
2 (IDLE under or Connected to LTE cell supporting NSA and no detection of NR coverage)	4G	4G	4G	5G
3 (Connected to LTE only under LTE cell supporting NSA and detection of NR coverage)	4G	4G	5G	5G
4 (IDLE under LTE cell supporting NSA and detection of NR coverage)	4G	5G	5G	5G
5 (Connected to LTE + NR under LTE cell supporting NSA)	5G	5G	5G	5G
6 (IDLE under or connected to NG-RAN while attached to 5GC)	5G	5G	5G	5G

Figure 2: 5G Icon Display Strategies Defined by GSMA

From *Figure 2*, different Config. strategies have different 5G icon display requirements. From Config. A to Config. D, 5G icon display requirements are gradually relaxed. State 1 to State 5 define the display standard under NSA; State 6 defines the display standard under SA.

When the UE is in the idle state (IDLE), the 5G status should be judged according to the indicator of upperLayerIndication-r15; when the UE is in the connected state (CONNECTED), the 5G status should be judged according to whether the UE has a 5G SCG (Secondary Cell Group). Generally, Config. A + D means referring to the Config. A standard when the UE is in the IDLE state, and referring to the Config. D standard when the UE is in the CONNECTED state.

Since the strategies of each operator are different, the 5G icon display strategy can be configured into the corresponding MBN file according to the requirements of each operator. At present, for the three Chinese operators (CMCC, CUCC and CTCC), the strategy is Config. A + D, and for ROW MBN, it is also Config. A + D; for overseas MBNs, it is Config A by default.

In order to facilitate users to accurately determine whether to display a 5G icon, Quectel has summarized the following rules. When using a 5G module, you can refer to these rules to design your own code.

4.1.1. State 1–6 Judgment Rules

For State 1 to State 6, the rules are as follows:

State 1:
1. LTE cells are registered and **<state>** is "NOCONN" through the execution of **AT+QENG="servingcell"**.
2. **<endc_avl>** is 0 through the execution of **AT+QENDC**.

State 2:
1. LTE cells are registered and **<state>** is "NOCONN" through the execution of **AT+QENG="servingcell"**.
2. **<endc_avl>** is 1 through the execution of **AT+QENDC**.
3. If NR5G cells of the current PLMN are not searched through the execution of **AT+QSCAN=2**, it indicates that there is no NR5G band cell supported by the current module.

State 3:
1. LTE cells are registered and **<state>** is "CONNECT" through the execution of **AT+QENG="servingcell"**.
2. **<endc_avl>** is 1 through the execution of **AT+QENDC**.
3. If NR5G cells of the current PLMN are searched through the execution of **AT+QSCAN=2**, it indicates that NR5G band cell is supported by the current module.

State 4:
1. LTE cells are registered and **<state>** is "NOCONN" through the execution of **AT+QENG="servingcell"**.

2. **<endc_avl>** is 1 through the execution of **AT+QENDC**.
3. If NR5G cells of the current PLMN are searched through the execution of **AT+QSCAN=2**, it indicates that NR5G band cell is supported by the current module.

State 5:

LTE cells and NR5G cells are registered through the execution of **AT+QENG="servingcell"**.

State 6:

If only NR5G SA cells are registered through the execution of **AT+QENG="servingcell"** or **<AcT>** is 11 through the execution of **AT+COPS?**, it indicates that 5G icon is displayed.

4.1.2. Reference Flow Charts for 5G Icon Display (Config. A–D & Verizon)
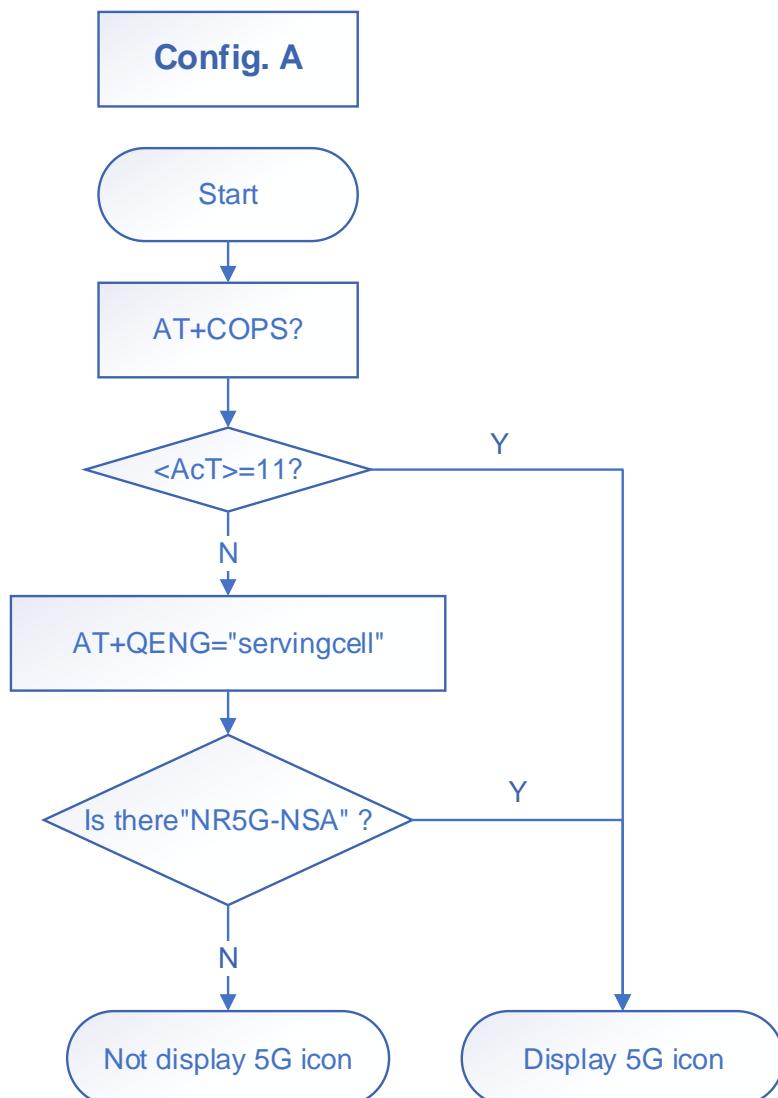
Figure 3: Reference Flow Chart for 5G Icon Display (Config. A)
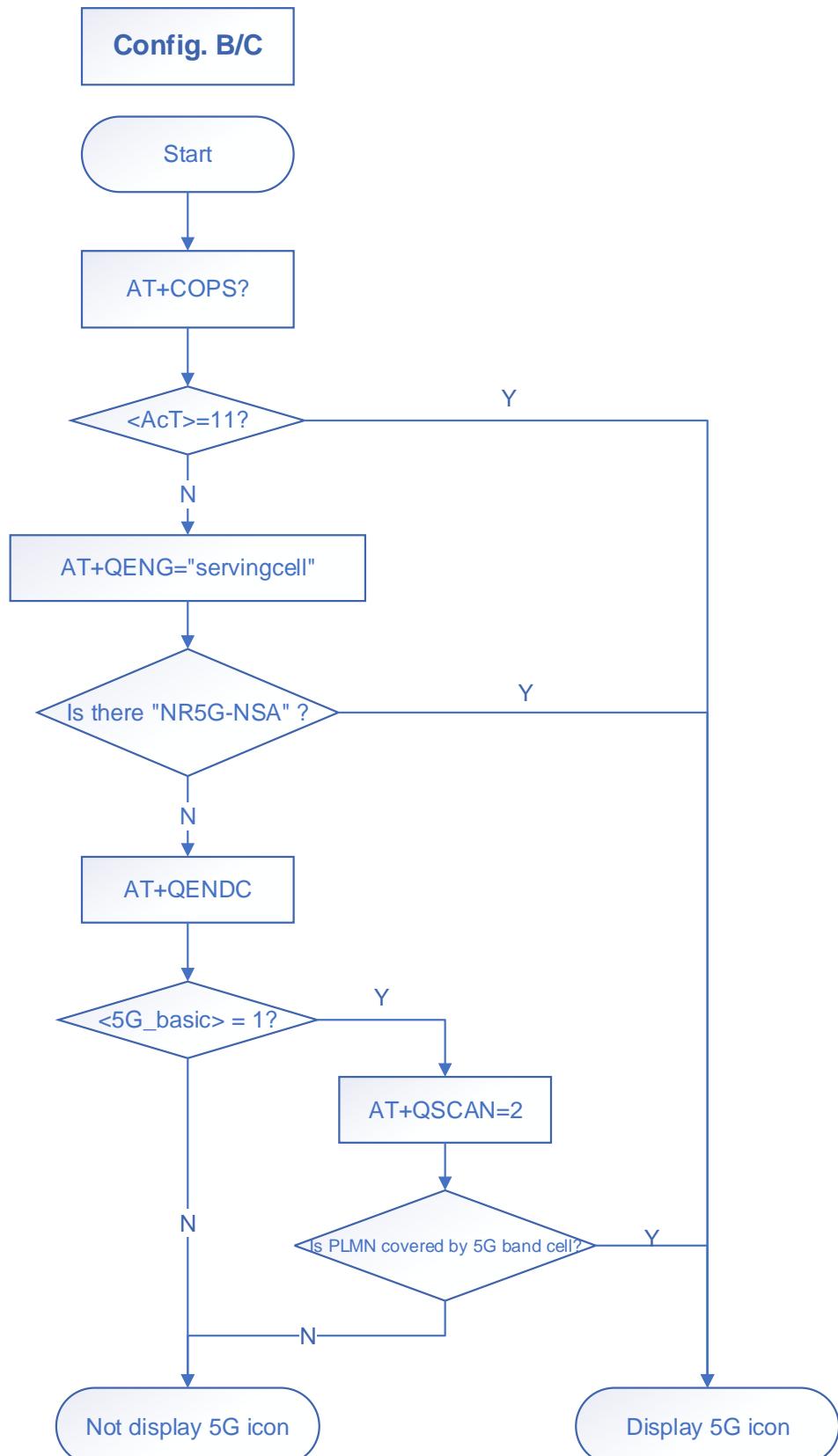
**Figure 4: Reference Flow Chart for 5G Icon Display (Config. B/C)**
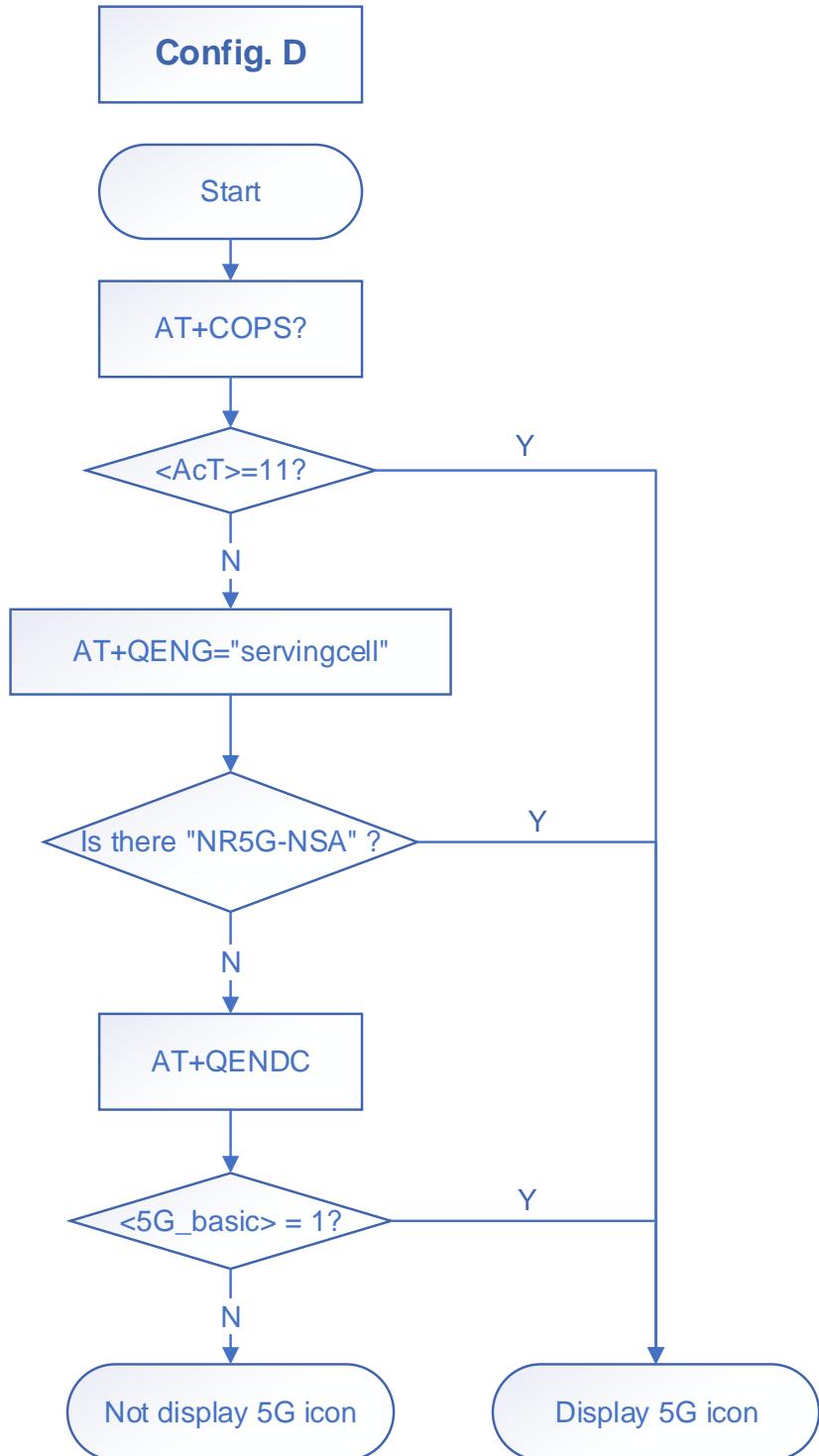
**Figure 5: Reference Flow Chart for 5G Icon Display (Config. D)**
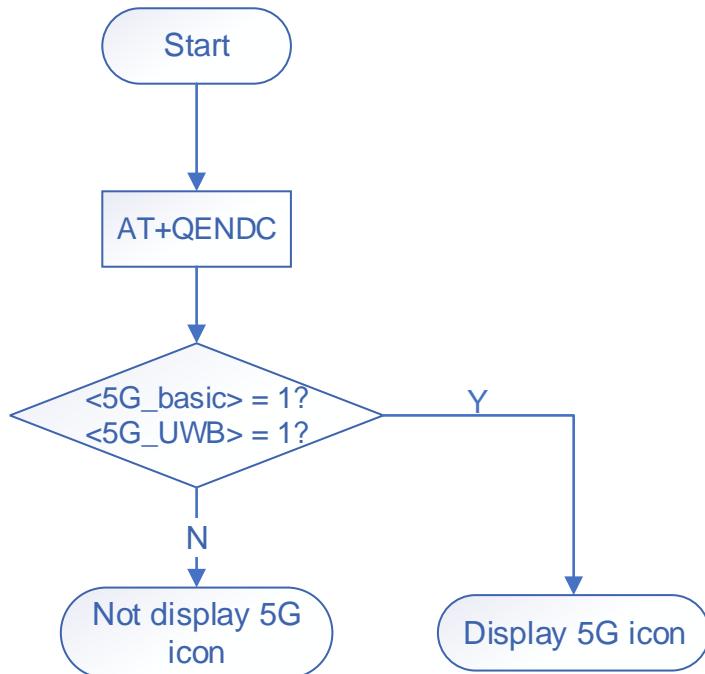
Figure 6: Reference Flow Chart for 5G Icon Display (Verizon)

4.2. 5G Icon Display Rules Under NSA

Under NSA, the following factors affect the 5G icon display.

1. The terminal and subscribed users support the EN-DC feature.
●   "DCNR=1" is indicated in Attach Request
●   "RestrictDCNR=0" is indicated in Attach Accept

2. The LTE cell currently camped on supports NSA.
●   "plmn-InfoList-r15" IE is carried in SIB2
●   "upperLayerIndication-r15" in "plmn-InfoList-r15" IE indicates "true"

3. The terminal has successfully accessed to the 5G cell.
●   The terminal has successfully accessed to the 5G cell, and finished the uplink synchronization. 5G cell information can be queried.

4.3. 5G Icon Display Rules Under SA

Execute **AT+COPS** to query the network status, if SA has been registered to, it means that 5G icon can be displayed.

5 Typical Cases Troubleshooting

5.1. Network Environment Troubleshooting

Problem analysis

1. The signal in the current network environment is weak.
2. There is no band that can be used by the module under the current network environment.
3. IMEI is illegal or the network access is not allowed by the operator.

- **Troubleshooting 1**

You need to confirm whether it is under private network environment or public network environment, and know the information that the band combination and bandwidth are supported by the base station.

- **Solution 1**

You need to confirm the current network environment with the terminal operator. If you cannot confirm with the operator, you can test it through your mobile phone.

- **Troubleshooting 2**

You can confirm whether the network can be registered by the same SIM card on other device under the same network environment, and the device specification should be as consistent as possible with the specification of the currently used module.

- **Solution 2**

You can install application CellularZ on your mobile phone and then open it to check the network registration information. The network registration status example is as follows.
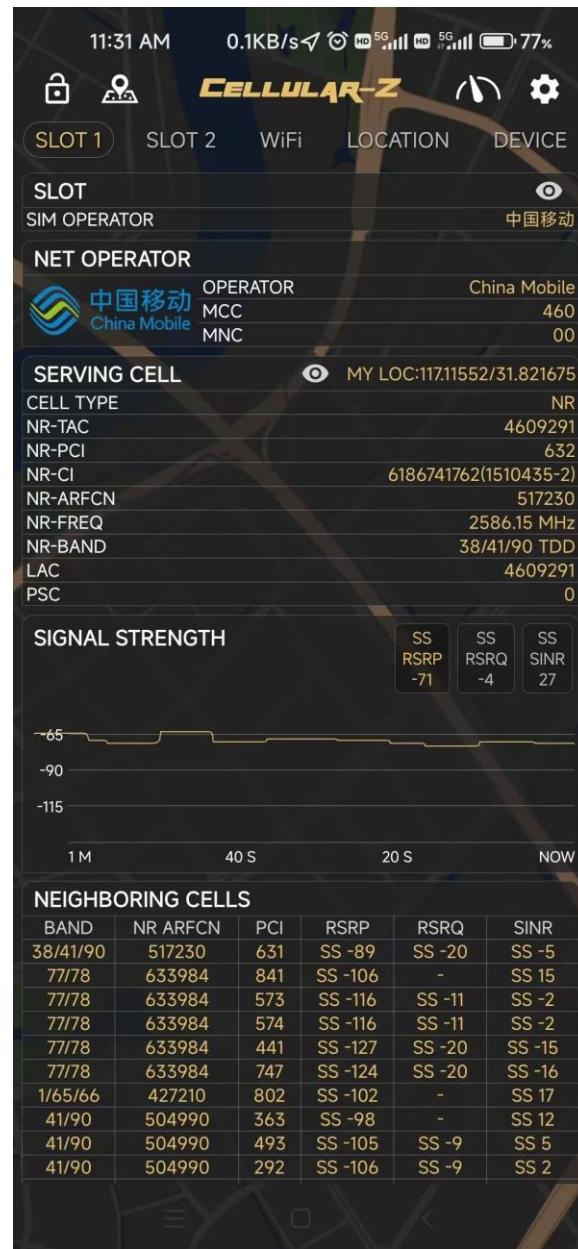
**Figure 7: NR5G Network Registration Information (CTCC)**
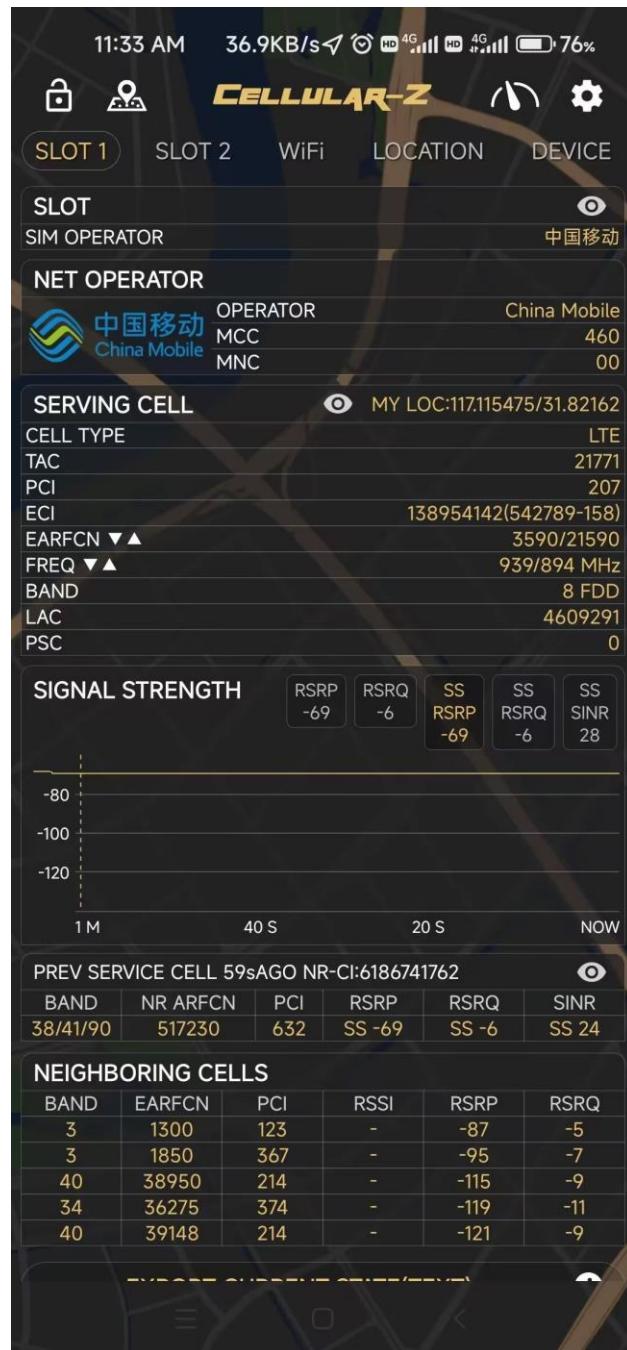
Figure 8: LTE Network Registration Information (CMCC)

- **Troubleshooting 3**

You can query the signal status through AT commands under the current network environment.

- **Solution 3**

1. If the module is registered on the network.

AT+QENG="servingcell": Query the signal status of the serving cell under the current network.

AT+QRSRP?: Query RSRP of each antenna under the current network.
AT+QSINR?: Query SINR of each antenna under the current network.

2. If the module is not registered on the network.

AT+QSCAN=1,1: Search the available LTE cells.
AT+QSCAN=2,1: Search the available NR5G cells.
AT+QSCAN=3,1: Search the available LTE cell and NR5G cells.

5.2. (U)SIM Card Troubleshooting

Problem analysis

1. The (U)SIM card cannot be detected or is bound to IMEI or the (U)SIM card charge is overdue.
2. The preferred network of the device and APN configuration does not match that of the (U)SIM card.

● **Troubleshooting 1**

If the (U)SIM card cannot be detected, you need to check the hardware, the hot-swap configuration of the module and RF status.

● **Solution 1**

1. Hardware: Check the schematic diagram of the hardware, PCB, (U)SIM card slot and the (U)SIM card.
2. Software: Check whether RF feature of the module is normal. Check whether the hot-swap configuration of the (U)SIM card is consistent with that of the hardware configuration and whether PIN/PUK is locked.

   AT+CFUN? : Query RF status and CFUN: 1 is expected to be returned.
   AT+QSIMDET?: Query the hot-swap configuration and the configuration needs to be consistent with that in the hardware design.
   AT+CPIN?: Query the (U)SIM card status.

● **Troubleshooting 2**

If the (U)SIM card is detected, you need to check whether the (U)SIM card charge is overdue or the (U)SIM card is bound to IMEI. You should also check whether the mobile phone inserted with the (U)SIM card can connect to the network normally. If all described above are fine, you can check whether the preferred network of the device and APN configuration match the (U)SIM card via AT commands.

● **Solution 2**

AT+QMBNCFG="list": Query the activated MBNs.
AT+CGDCONT?: Query the configured APN information.

5.3. Entire Device Troubleshooting

Problem analysis

1. The signal is weak due to some cases, such as untuned antenna, incorrect antenna connection, improper antenna placement, isolation and interference.
2. There is RF interference on PCB traces.

● **Troubleshooting**

1. Troubleshoot hardware RF.
2. Replace the antenna or the entire device and perform more comparison tests.
3. Perform the comparison test with the EVB in the same environment if possible.

● **Solution**

1. Hardware: Perform the conduction test of the entire device to troubleshoot the PCB or module; Perform the antenna OTA test of the entire device to troubleshoot the antenna performance.
2. Software: Query whether multiple antennas meet the network access standard through AT commands and adjust antenna orientation to achieve balance if necessary.

   AT+QRSRP?: Query RSRP of each antenna under the current network.
   AT+QSINR?: Query SINR of each antenna under the current network.

5.4. Typical Cases Troubleshooting

5.4.1. NSA/SA/LTE Network Registration Failure

Troubleshoot cases through the following AT commands.

● **AT+CPIN?**: Check whether the (U)SIM card is recognized normally and **"+CPIN: READY"** is expected to be returned.
● **AT+CFUN?**: Check whether RF feature is normal and 1 is expected to be returned.
● **AT+QNWPREFFG="mode_pref"**: Query whether the network mode is locked. NR5G, LTE and WCDMA are supported in AUTO mode by default.
● **AT+QNWPREFCFG="nsa_nr5g_band"** / **AT+QNWPREFCFG="nr5g_band"** / **AT+QNWPREFCFG="lte_band"**: Query whether the band is locked. All bands in the module specification are supported by default.
● **AT+COPS=?**: Search available cells.
● **AT+QSCAN=1,1**: Search available LTE cells.
● **AT+QSCAN=2,1**: Search available NR5G cells.
● **AT+QSCAN=3,1**: Search available LTE cells and NR5G cells.
● **AT+QNWPREFCFG="policy_band"**: Query the band supported by PLMN, which is selected by the module.
● **AT+QNWPREFCFG="ue_capability_band"**: Query the supported band that is reported to the

network by the module.

- **AT+QNWPREFCFG="nr5g_disable_mode"**: Query whether NSA/SA is disabled.

5.4.2. Module Falls Back to LTE After Registered to NSA Network

1. Check whether the module has not been performing data services for a period of time. If not, the module may be disconnected from NSA network by the base station.
2. Check whether the four antennas are balanced. If the antenna signal is weak or the four antennas are not balanced (the signal strength among the four antennas exceeds 10 dBm), the network registration is affected.

   - **AT+QENG="servingcell"**: Query the signal status of the serving cell under the current network environment.
   - **AT+QRSRP?**: Query RSRP of each antenna under the current network environment.
   - **AT+QSINR?**: Query SINR of each antenna under the current network environment.

5.4.3. Dial-up Failure After Registered to SA Network

APN is not needed when the module is registered on SA network. But you need to verify APN when you dial up, especially under private network environment. Therefore, APN may not be configured correctly when the module is registered on SA network successfully.

You can query the configured APN through the execution of **AT+CGDCONT?**, or check whether the dial-up is performed after SA network is registered successfully on other devices.

5.4.4. Register to LTE First Rather than SA Network or NSA Network in AUTO Mode

1. The network registration includes network searching and registration.

   - Network searching: it includes SIM card recognition, PLMN & RAT selection, band scanning, cell searching, system message decoding, cell selection and cell camping.
   - Registration: it includes attach, random access, authentication, security mode and UE capability reporting.

2. The automatic network searching priority of the module is RPLMN > HPLMN/EHPLMN > UPLMN > OPLMN. In automatic network searching mode, whether the module can prioritize being registered to NR5G band depends on the network environment. See the following scenarios.

   Scenario 1: If no available cells under the NR5G SA network are searched, then search available cells under the LTE network.

   Scenario 2: If LTE network is registered and NR5G secondary cells are not added to the network, NR5G NSA network fails to be registered.

   Scenario 3: If the SIM card and network environment are not changed, and the network camps on

LTE cell in the last network registration, the last LTE cell is first registered after the startup. If you do not want to make the last LTE cell first to be registered, you can clear historical frequency. For more details, please contact Quectel Technical Support.

5.4.5. Automatic Switching to LTE After Unstable SA Network Registration

1. The band signal configured under NR5G network is weak. If it meets the reselection configuration strategy of the base station, the network reselection is performed.
2. The reselection depends both on signal strength and parameters configured by the base station.
3. The purpose of the reselection is to allow the terminal to choose a better cell for camping on in idle state and the reselection is controlled by the base station.

6 Appendix References

Table 3: Related Documents

Document Name
[1] Quectel_RG50xQ&RM5xxQ_Series_AT_Commands_Manual
[2] Quectel_RG520N&RG525F&RG5x0F&RM5x0N&RM521F_Series_AT_Commands_Manual
[3] Quectel_RG65xE&RG650V&RM550V&RM551E_Series_AT_Commands_Manual

Table 4: Terms and Abbreviations

Abbreviation	Description
5GCN	5G Core Network
5GS	5G System
APN	Access Point Name
ARFCN	Absolute Radio-Frequency Channel Number
CQI	Channel Quality Indicator
DL	Downlink
EARFCN	E-UTRA Absolute Radio Frequency Channel Number
EHPLMN	Equivalent Home PLMN
EN-DC	E-UTRA New Radio Dual Connectivity
E-UTRAN	Evolved Universal Terrestrial Radio Access Network
HPLMN	Home PLMN
IE	Information Element

IMEI	International Mobile Equipment Identity
LTE	Long-Term Evolution
MBN	Modem Software Configuration Binary
MCC	Mobile Country Code
MNC	Mobile Network Code
MT	Mobile Termination
NR	New Radio
NSA	Non-Standalone
NSSAI	Network Slice Selection Assistance Information
OPLMN	Operator Controlled PLMN
OTA	Over-The-Air Technology
PCB	Printed Circuit Board
PLMN	Public Land Mobile Network
PSC	Primary Scrambling Code
RAT	Radio Access Technology
RPLMN	Register PLMN
RSRP	Reference Signal Received Power
RSRQ	Reference Signal Received Quality
RSSI	Received Signal Strength Indicator
RSSNR	Received Signal Strength to Noise Ratio
SA	Standalone
SCG	Secondary Cell Group
SIB	System Information Block
SINR	Signal to Interference plus Noise Ratio
TAC	Tracking Area Code

UART	Universal Asynchronous Receiver/Transmitter
UARFCN	UTRA Absolute RF Channel Number
UE	User Equipment
UL	Uplink
UMTS	Universal Mobile Telecommunications System
UPLMN	User Controlled PLMN
URC	Unsolicited Result Code
UTRAN	UMTS Terrestrial Radio Access Network
UWB	Ultra Wide Band
WCDMA	Wideband Code Division Multiple Access