

RG50xQ&RM5xxQ Series

5G Network Searching

Scheme Introduction

5G Module Series

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Quectel Wireless Solutions Co., Ltd.

Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai 200233, China

Tel: +86 21 5108 6236

Email: info@quectel.com

Or our local office. For more information, please visit:

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About the Document

Revision History

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1 Introduction

This document takes RG500Q-EA as an example to introduce 5G network searching scheme, including network registration flow, FAQs and typical network searching failure cases analysis, as well as AT commands related to network searching to obtain the network registration status and network service quality parameters.

1.1. Applicable Modules

Table 1: Applicable Modules

Modules Series	Model
RG50xQ	RG500Q Series
	RG501Q-EU
	RG502Q-EA
RM5xxQ	RM500Q Series
	RM502Q Series
	RM505Q-AE
	RM510Q-GL

1.2. Band Information

5G networking modes are divided into NSA and SA. Taking the RG500Q-EA module as an example, the supported bands are shown in the following table.

Table 2: Bands Supported by RG500Q-EA

RATs	Supported Bands
NSA	n41/n77/n78/n79/n1/n3/n5/n7/n8/n20/n28/n38/n40
SA	n41/n77/n78/n79/n1/n3/n5/n7/n8/n20/n28/n38/n40

NOTE

For band information of other modules of Quectel RG50xQ and RM5xxQ series, see the specification of the corresponding module.

2 5G Network Registration Flow

This chapter introduces network registration flow of NSA and SA respectively.

2.1. NSA Network Registration Flow

In NSA network registration, LTE is registered first, and then 5G cell is added. See the figure below for details.

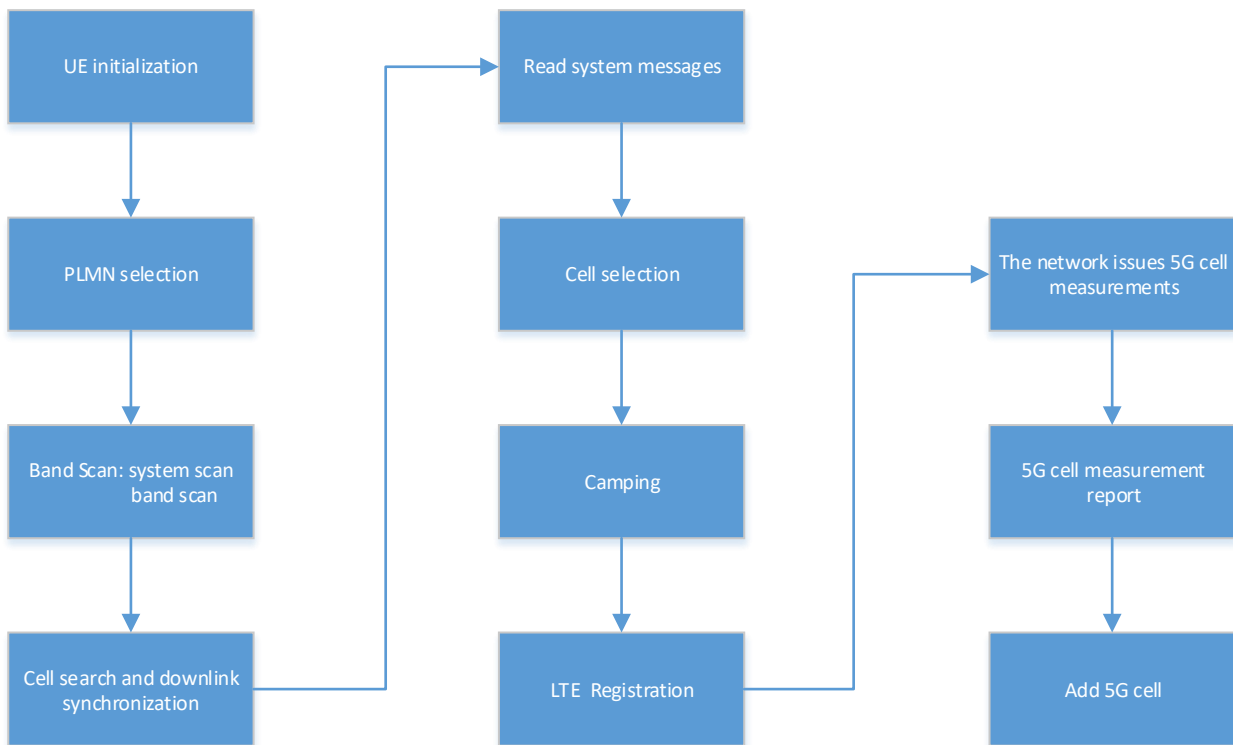


Figure 1: NSA Network Registration Flow

2.2. SA Network Registration Flow

See the figure below for details about SA network registration.

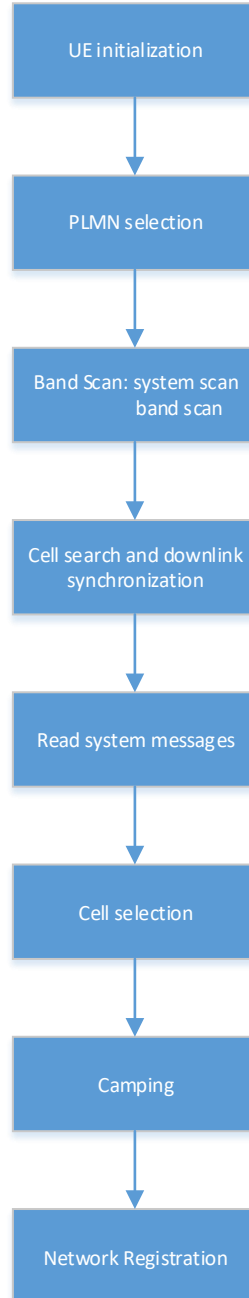


Figure 2: SA Network Registration Flow

3 AT Command Introduction

3.1. Network Searching Configuration Commands

3.1.1. AT+C5GREG 5GS Network Registration Status

This command queries the network registration status and controls the presentation of following URCs:

- When **<n>=1**, **+C5GREG: <stat>** is presented. This URC indicates that there is a change in the MT's network registration status in 5GS.
- When **<n>=2** or the network provided an Allowed NSSAI, **+C5GREG: <stat>[,<tac>,<ci>,<AcT>,<Allowed_NSSAI_length>,<Allowed_NSSAI>]** is presented. This URC indicates that there is a change of the network cell in 5GS. The parameters **<tac>**, **<ci>**, **<AcT>**, **<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. <ul style="list-style-type: none"> <u>0</u> Disable network registration unsolicited result code. 1 Enable network registration unsolicited result code +C5GREG:<stat>. 2 Enable network registration and location information unsolicited result code +C5GREG:<stat>[,<tac>],[<ci>],[<AcT>],[<Allowed_NSSAI_length>],[<Allowed_NSSAI>].
<stat>	Integer type. Indicate the NR registration status. <ul style="list-style-type: none"> 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. 8 Registered for emergency services only.
<tac>	String type. Three-byte tracking area code in hexadecimal format.
<ci>	String type. Five-byte (NR) cell ID in hexadecimal format.
<AcT>	Integer type. Access technology selected. <ul style="list-style-type: none"> 10 E-UTRAN connected to a 5GCN 11 NR connected to a 5GCN
<Allowed_NSSAI_length>	Integer type. Indicates 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 <i>3GPP 27.007 subclause 10.1.1</i> . This parameter shall not be subject to conventional character conversion as per AT+CSCS .

3.1.2. AT+QNWPREFCFG="nsa_nr5g_band" 5G NR NSA Band Configuration

This command specifies the preferred 5G NR NSA bands to be searched by UE.

AT+QNWPREFCFG="nsa_nr5g_band" 5G NR NSA Band Configuration	
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_ban

	<p>d></p> <p>OK</p> <p>If the optional parameter is specified, configure the preferred 5G NR NSA bands to be searched:</p> <p>OK</p> <p>Or</p> <p>ERROR</p>
Maximum Response Time	300 ms
Characteristics	<p>The command takes effect immediately.</p> <p>The configuration will be saved automatically.</p>

Parameter

<NSA_NR5G_band>	String type. Use the colon as a separator to list the 5G NR NSA bands to be configured. The parameter format is n1:n2:...:nx .
-----------------	--

NOTE

The configurable 5G NR NSA bands supported by the applicable modules for this command are: n1, n2, n3, n5, n7, n8, n12, n20, n25, n28, n38, n40, n41, n48, n66, n71, n77, n78, n79, n257, n258, n260 and n261.

Example

```
AT+QNWPREFCFG= "nsa_nr5g_band" //Query the currently configured 5G NR 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 //Set 5G NR NSA n1 and 5G NR NSA n2.
OK
```

3.1.3. AT+QNWPREFCFG="nr5g_band" 5G NR SA Band Configuration

This command specifies the preferred 5G NR SA bands to be searched by UE.

AT+QNWPREFCFG="nr5g_band" 5G NR SA Band Configuration	
Write Command	Response
AT+QNWPREFCFG="nr5g_band"[,<NR5G_band>]	<p>If the optional parameter is omitted, query the current configuration:</p> <p>+QNWPREFCFG: "nr5g_band",<NR5G_band></p>

	<p>OK</p> <p>If the optional parameter is specified, configure the preferred 5G NR SA bands to be searched:</p> <p>OK</p> <p>Or</p> <p>ERROR</p>
Maximum Response Time	300 ms
Characteristics	The command takes effect immediately. The configuration will be saved automatically.

Parameter

<NR5G_band>	String type. Use the colon as a separator to list the 5G NR SA bands to be configured. The parameter format is n1:n2:...:nx .
--------------------------	---

NOTE

The configurable SA 5G NR bands supported by the applicable modules for this command are: n1, n2, n3, n5, n7, n8, n12, n20, n25, n28, n38, n40, n41, n48, n66, n71, n77, n78, n79.

Example

```
AT+QNWPREFCFG= "nr5g_band" //Query the currently configured 5G NR SA bands of the UE.
+QNWPREFCFG: "nr5g_band",1:3:7:20:28:40:41:71:77:78:79

OK
AT+QNWPREFCFG= "nr5g_band",1:2 //Set 5G NR SA n1 and 5G NR SA n2.
OK
```

3.1.4. AT+QNWPREFCFG="mode_pref" Network Search Mode Configuration

This command specifies the network search mode.

AT+QNWPREFCFG="mode_pref" Network Search Mode Configuration	
Write Command AT+QNWPREFCFG="mode_pref" [<mode_pref>]	Response If the optional parameter is omitted, query the current configuration: +QNWPREFCFG: "mode_pref", <mode_pref> OK

	If the optional parameter is specified, configure the network search mode: OK Or ERROR
Maximum Response Time	300 ms
Characteristics	The command takes effect immediately. The configuration will be saved automatically.

Parameter

<mode_pref>	String type. Use the colon as a separator to list the RATs to be configured. The parameter format is: RAT1:RAT2:...RATN. The RATs supported by the module are as follows: AUTO WCDMA & LTE & 5G NR WCDMA WCDMA only LTE LTE only NR5G 5G NR only
--------------------------	--

Example

```
AT+QNWPREFCFG= "mode_pref" //Query the current configuration.
+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 and 5G NR.
OK
```

3.1.5. AT+QNWPREFCFG="policy_band" Read Carrier Policy Band

This command reads the band configured in the carrier policy.

AT+QNWPREFCFG="policy_band" Read Carrier Policy Band	
Write Command	Response
AT+QNWPREFCFG="policy_band"	+QNWPREFCFG: "gw_band",<gw_band> +QNWPREFCFG: "lte_band",<LTE_band> +QNWPREFCFG: "nsa_nr5g_band",<NSA_NR5G_band> +QNWPREFCFG: "nr5g_band",<NR5G_band>

	OK
Maximum Response Time	300 ms
Characteristics	/

Parameter

<gw_band>	String type. Use the colon as a separator to list the WCDMA bands to be configured. The parameter format is B1:B2:...:BN.
<LTE_band>	String type. Use the colon as a separator to list the LTE bands to be configured. The parameter format is B1:B2:...:BN.
<NSA_NR5G_band>	String type. Use the colon as a separator to list the 5G NR NSA bands to be configured. The parameter format is n1:n2:...:nx
<NR5G_band>	String type. Use the colon as a separator to list the 5G NR SA bands to be configured. The parameter format is n1:n2:...:nx .

NOTE

- RG50xQ and RM5xxQ series support the following WCDMA bands:
 - B1 WCDMA 2100 band
 - B2 WCDMA 1900 band
 - B3 WCDMA 1800 band
 - B4 WCDMA 1700 band
 - B5 WCDMA 850 band
 - B6 WCDMA 800 band
 - B8 WCDMA 900 band
 - B19 WCDMA Japan 850 band
- RG50xQ and RM5xxQ series support the following LTE bands:
 - B1, B2, B3, B4, B5, B7, B8, B12, B13, B14, B17, B18, B19, B20, B25, B26, B28, B29, B30, B32, B34, B38, B39, B40, B41, B42, B43, B48, B66 and B71.
- RG50xQ and RM5xxQ series support the following 5G NR NSA bands:
 - n1, n2, n3, n5, n7, n8, n12, n20, n25, n28, n38, n40, n41, n48, n66, n71, n77, n78, n79, n257, n258, n260 and n261.
- RG50xQ and RM5xxQ series support the following 5G NR SA bands:
 - n1, n2, n3, n5, n7, n8, n12, n20, n25, n28, n38, n40, n41, n48, n66, n71, n77, n78 and n79.

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

3.1.6. 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_capability_band"	Response +QNWPREFCFG: "gw_band",<gw_band> +QNWPREFCFG: "lte_band",<LTE_band> +QNWPREFCFG: "nsa_nr5g_band",<NSA_NR5G_band> +QNWPREFCFG: "nr5g_band",<NR5G_band> OK
Maximum Response Time	300 ms
Characteristics	/

Parameter

<gw_band>	String type. Use the colon as a separator to list the WCDMA bands to be configured. The parameter format is B1:B2:...:BN.
<LTE_band>	String type. Use the colon as a separator to list the LTE bands to be configured. The parameter format is B1:B2:...:BN.
<NSA_NR5G_band>	String type. Use the colon as a separator to list the 5G NR NSA bands to be configured. The parameter format is n1:n2:...:nx .
<NR5G_band>	String type. Use the colon as a separator to list the 5G NR SA bands to be configured. The parameter format is n1:n2:...:nx.

NOTE

- RG50xQ and RM5xxQ series support the following WCDMA bands:
 - B1 WCDMA 2100 band
 - B2 WCDMA 1900 band
 - B3 WCDMA 1800 band
 - B4 WCDMA 1700 band
 - B5 WCDMA 850 band
 - B6 WCDMA 800 band
 - B8 WCDMA 900 band
 - B19 WCDMA Japan 850 band
- RG50xQ and RM5xxQ series support the following LTE bands:

B1, B2, B3, B4, B5, B7, B8, B12, B13, B14, B17, B18, B19, B20, B25, B26, B28, B29, B30, B32, B34, B38, B39, B40, B41, B42, B43, B48, B66 and B71.

3. RG50xQ and RM5xxQ series support the following 5G NR NSA bands:
n1, n2, n3, n5, n7, n8, n12, n20, n25, n28, n38, n40, n41, n48, n66, n71, n77, n78, n79, n257, n258, n260 and n261.
4. RG50xQ and RM5xxQ series support the following 5G NR SA bands:
n1, n2, n3, n5, n7, n8, n12, n20, n25, n28, n38, n40, n41, n48, n66, n71, n77, n78 and n79.

Example

AT+QNWPRECFG="ue_capability_band"

```
+QNWPRECFG: "gw_band",1:8
+QNWPRECFG: "lte_band",1:3:8
+QNWPRECFG: "nsa_nr5g_band",78
+QNWPRECFG: "nr5g_band",78
```

OK

3.1.7. AT+QNWPRECFG="nr5g_disable_mode" Disable 5G NR Configuration

This command disables 5G NR.

AT+QNWPRECFG="nr5g_disable_mode" Disable 5G NR Configuration

Write Command	Response
AT+QNWPRECFG="nr5g_disable_mode"[,<disable_mode>]	If the optional parameter is omitted, query the current configuration: +QNWPRECFG: "nr5g_disable_mode",<disable_mode>
	OK
	If the optional parameter is specified, disable 5G NR configuration: OK Or ERROR
Maximum Response Time	300 ms
Characteristics	The command takes effect immediately. The configuration will be saved automatically.

Parameter

<disable_mode> Integer type. Disable 5G NR SA/NSA.

- 0 Neither is disabled
- 1 Disable SA
- 2 Disable NSA

Example

```

AT+QNWPREFCFG="nr5g_disable_mode" //Query the current configuration.
+QNWPREFCFG: "nr5g_disable_mode",0

OK
AT+QNWPREFCFG="nr5g_disable_mode",1 //Disable 5G NR SA.
OK
    
```

3.2. Get Network Status

3.2.1. AT+QNWCFG="nr5g_csi" Read 5G NR CSI information

This command reads 5G NR CSI information, including MCS, CQI, RI and PMI.

AT+QNWCFG="nr5g_csi" Read 5G NR CSI information	
Write Command AT+QNWCFG="nr5g_csi"	Response +QNWCFG: "nr5g_csi",<mcs>,<ri>,<cqi>,<pmi> OK Or ERROR
Maximum Response Time	300 ms
Characteristics	/

Parameter

<mcs>	Integer type. Modulation and coding scheme of PDSCH. Range: 0–31.
<ri>	Integer type. Indicates the effective number of data layers of PDSCH.
<cqi>	Integer type. Indicates the quality of the downlink channel.
<pmi>	Integer type. Indicates the index of the codebook set.

Example

```

AT+QNWCFG="nr5g_csi" //Read 5G NR CSI information.
+QNWCFG: "nr5g_csi"0,1,15,0
    
```

OK

3.2.2. AT+QNWCFG="nr5g_cell_id" Get the Cell Identification under 5G NR SA

This command gets cell information under 5G NR SA, including NCGI, NCI, and gNodeB.

AT+QNWCFG="nr5g_cell_id" Get the Cell Identification under 5G SA

Write Command AT+QNWCFG="nr5g_cell_id"	Response +QNWCFG: "nr5g_cell_id",<NCGI>,<NCI>,<gNodeB_ID> OK
Maximum Response Time	300 ms
Characteristics	/

Parameter

<NCGI>	Integer type. 5G NR Cell Global Identification (MCC + MNC + NCI)
<NCI>	Integer type. 5G NR Cell Identification (gNodeB ID + cell ID).
<gNodeB_ID>	Integer type. 5G NR base station ID.

Example

```
AT+QNWCFG="nr5g_cell_id" //Get NCGI, NCI, and gNodeB under 5G NR SA.
+QNWCFG: "nr5g_cell_id",64F000170C23000,170C23000,170C23
OK
AT+QNWCFG="nr5g_cell_id" //Execute this command under non-NR-5G-SA.
OK
```

3.2.3. AT+QENG Query Primary Serving Cell and Neighbour Cell Information

This command obtains the network information, such as primary serving cell and neighbour cells.

AT+QENG Query Primary Serving Cell and Neighbour Cell Information

Test Command AT+QENG=?	Response +QENG: (list of supported <cell_type>s) OK
Write Command Query the primary serving cell	Response In SA mode:

<p>information AT+QENG="servingcell"</p>	<p>+QENG: "servingcell",<state>,"NR5G-SA",<duplex_mod e>,<MCC>,<MNC>,<cellID>,<PCID>,<TAC>,<ARFCN>,<ba nd>,<NR_DL_bandwidth>,<RSRP>,<RSRQ>,<SINR>,<sc s>,<srlev></p> <p>OK In EN-DC mode: +QENG: "servingcell",<state> +QENG: "LTE",<is_tdd>,<MCC>,<MNC>,<cellID>,<PCI D>,<earfcn>,<freq_band_ind>,<UL_bandwidth>,<DL_ban dwidth>,<TAC>,<RSRP>,<RSRQ>,<RSSI>,<SINR>,<CQI>,< tx_power>,<srlev> +QENG: "NR5G-NSA",<MCC>,<MNC>,<PCID>,<RSRP>,< SINR>,<RSRQ>,<ARFCN>,<band>,<NR_DL_bandwidth>,< scs></p> <p>OK In LTE mode: +QENG: "servingcell",<state>,"LTE",<is_tdd>,<MCC>,< MNC>,<cellID>,<PCID>,<earfcn>,<freq_band_ind>,<UL_b andwidth>,<DL_bandwidth>,<TAC>,<RSRP>,<RSRQ>,<R SSI>,<SINR>,<CQI>,<tx_power>,<srlev></p> <p>OK In WCDMA mode: +QENG: "servingcell",<state>,"WCDMA",<MCC>,<MN C>,<LAC>,<cellID>,<uarfcn>,<PSC>,<RAC>,<RSCP>,<eci no>,<phychn>,<SF>,<slot>,<speech_code>,<comMod></p> <p>OK</p>
<p>Write Command Query the information of neighbour cells AT+QENG="neighbourcell"</p>	<p>Response In LTE mode: [+QENG: "neighbourcell intra","LTE",<earfcn>,<PCID>,< RSRQ>,<RSRP>,<RSSI>,<SINR>,<srlev>,<cell_resele_p riority>,<s_non_intra_search>,<thresh_serving_low>,<s _intra_search> ...] [+QENG: "neighbourcell inter","LTE",<earfcn>,<PCID>,< RSRQ>,<RSRP>,<RSSI>,<SINR>,<srlev>,<cell_resele_p riority>,<threshX_low>,<threshX_high> ...] [+QENG:"neighbourcell","WCDMA",<uarfcn>,<cell_resele _priority>,<thresh_Xhigh>,<thresh_Xlow>,<PSC>,<RSC P>,<ecno>,<srlev></p>

	<p>...]</p> <p>OK</p> <p>In WCDMA mode:</p> <p>[+QENG:"neighbourcell","WCDMA",<uarfcn>,<srxqual>,<PSC>,<RSCP>,<ecno>,<set>,<rank>,<srxlev></p> <p>...]</p> <p>[+QENG: "neighbourcell","LTE",<earfcn>,<PCID>,<RSRP>,<RSRQ>,<s_rxlev></p> <p>...]</p> <p>OK</p>
Maximum Response Time	300 ms
Characteristics	/

Parameter

<cell_type>	String type. The information of different cells. "servingcell" The information of 3G/4G/5G primary 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 5G NR SA network mode. "TDD" "FDD"
<is_tdd>	String type. The LTE network mode. "TDD" "FDD"
<MCC>	16-bit unsigned integer. Mobile Country Code (first part of the PLMN code).
<MNC>	16-bit unsigned integer. Mobile Network Code (second part of the PLMN code).
<ARFCN>	Indicates the SA-ARFCN of the cell that was scanned.
<band>	32-bit unsigned integer. Frequency band of 5G NR SA network mode.
<NR_DL_bandwidth>	Integer type. Downlink bandwidth. (The value 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
<LAC>	Integer type. Location Area Code. 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. Range: 0–65535.	
<cellID>	Integer type. Cell ID. The parameter determines the 28-bit (UMTS and LTE) or 36-bit (5G NR) cell ID. Range: 0–0xFFFFFFFF.	
<PCID>	Number format. Physical cell ID.	
<uarfcn>	The parameter determines the UTRA-ARFCN of the cell that was scanned.	
<earfcn>	The parameter determines the E-UTRA-ARFCN of the cell that was scanned.	
<freq_band_ind>	Integer type. E-UTRA frequency band (see <i>3GPP 36.101</i>).	
<UL_bandwidth>	Integer type. Uplink bandwidth.	
	0	1.4 MHz
	1	3 MHz
	2	5 MHz
	3	10 MHz
	4	15 MHz
	5	20 MHz
<DL_bandwidth>	Integer type. Downlink bandwidth.	
	0	1.4 MHz
	1	3 MHz
	2	5 MHz
	3	10 MHz
	4	15 MHz
	5	20 MHz
<TAC>	Tracking Area Code (see <i>3GPP 23.003 Section 19.4.2.3</i>).	
<PSC>	The parameter determines the primary scrambling code of the cell that was scanned.	
<RAC>	Integer type. Routing Area Code. Range: 0–255.	
<RSCP>	The parameter determines the Received Signal Code Power level of the cell that was scanned.	
<ecio>	Carrier to noise ratio in dB = measured E_c/I_0 value in dB.	

<RSRP>	<p>16-bit signed integer.</p> <p>In LTE mode: It indicates the signal of LTE Reference Signal Received Power (see <i>3GPP 36.214</i>). Range: -140 to -44. Unit: dBm. The closer to -44, the better the signal is. The closer to -140, the worse the signal is.</p> <p>In 5G NR mode: It indicates the signal of 5G NR 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.</p>
<RSRQ>	<p>In LTE mode: It indicates the signal of current LTE Reference Signal Received Quality (see <i>3GPP 36.214</i>). Range: -20 to -3. Unit: dB. The closer to -3, the better the signal is. The closer to -20, the worse the signal is.</p> <p>In 5G NR mode: It indicates the signal of current 5G NR 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.</p>
<RSSI>	LTE Received Signal Strength Indication.
<SINR>	<p>In LTE mode: It indicates LTE Signal-to-Interface plus Noise Ratio. The conversion formula for actual SINR is $Y = (1/5) \times X \times 10 - 20$ (X is the <SINR> value queried by AT+QENG and Y is the actual value of LTE SINR after calculating with the formula). Range: -20 to 30. Unit: dB.</p> <p>In 5G NR mode: It indicates the signal of 5G NR Signal-to-Interface plus Noise Ratio. Range: -20 to 30. Unit: dB.</p>
<CQI>	Integer type. Channel Quality Indication. Range: 1-30.
<tx_power>	The value of transmission power in 1/10 dBm. It is the maximum value of transmission power of all Uplink channels. The <tx_power> value is only meaningful when the device is in traffic.
<phych>	<p>Integer type. Physical channel.</p> <p>0 DPCH 1 FDPCH</p>
<SF>	<p>Integer type. Spreading factor.</p> <p>0 SF_4 1 SF_8 2 SF_16 3 SF_32 4 SF_64 5 SF_128 6 SF_256</p>

	7	SF_512
	8	UNKNOWN
<slot>		Integer type.
	0-16	Slot format for DPCH
	0-9	Slot format for FDPCH
<speech_code>		Destination number on which call is to be deflected.
<comMod>		Integer type. Number format. Compress mode.
	0	Compress mode is not supported
	1	Compress mode is supported
<srxqual>		Receiver automatic gain control on the camped frequency.
<ecno>		Integer type. Carrier 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>		Rank of this cell as neighbor for inter-RAT cell reselection.
<srxlev>		Suitable reception level for inter frequency cell. Unit: dB.
<threshX_low>		To be considered for re-selection. The suitable receive level value of an evaluated lower priority cell must be greater than this value.
<threshX_high>		To be considered for re-selection. The suitable receive level value of an evaluated higher priority cell must be greater than this value.
<thresh_Xhigh>		Reselection threshold for high priority layers.
<thresh_Xlow>		Reselection threshold for low priority layers.
<s_rxlev>		Select reception level value for base station (see 3GPP 25.304). Unit: dB.
<cell_resel_priority>		Integer type. Cell reselection priority. Range: 0-7.
<s_non_intra_search>		Threshold to control non-intra frequency searches.
<thresh_serving_low>		Specifies the suitable reception level threshold used by the UE on the serving cell when reselecting towards a lower priority RAT/frequency. Unit: dB.
<s_intra_search>		Cell selection parameter for the intra frequency cell.
<scs>		Integer type. NR sub-carrier space.
	0	15 kHz
	1	30 kHz
	2	60 kHz
	3	120 kHz
	4	240 kHz

NOTE

"-" or - indicates the parameter is invalid under current condition.

Example

```

AT+QENG="servingcell"
+QENG: "servingcell","NOCONN","LTE","FDD",460,01,5F1EA15,12,1650,3,5,5,DE10,-100,-12,-68,1
1,0,-32768,27
AT+QENG="servingcell"
+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,-71,13,-11,627264,78,12,1
AT+QENG="servingcell"
+QENG: "servingcell","NOCONN","NR5G-SA","TDD", 460,01,9013B004,299,690E0F,633984,78,12,
-107,-13,2,1,-

OK
AT+QENG="neighbourcell"
+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

```

4 Typical Cases Analysis

4.1. Network Searching Failure in NSA

1. Problem Description

During the process of registering the RG500Q-EA module to China Unicom's NSA network, SA cell may not be added successfully, for example, repeated addition of cells resulting in RACH failure, as shown in the log below:

LOG	07:55:00.309296	NR5G ML1 Searcher Measurement Database Update Ext	Length: 424
OTA LOG	07:55:00.347373	UL_DCCH / MeasurementReport	Radio Bearer ID: 1, Freq: 1300, SFN: 0
OTA LOG	07:55:00.377251	IMS SIP Message	Length: 1500
OTA LOG	07:55:00.392821	DL_DCCH / RRCConnectionReconfiguration	Radio Bearer ID: 1, Freq: 1300, SFN: 609
OTA LOG	07:55:00.393748	NR5G RRC OTA Packet	RRC_RECONFIG
OTA LOG	07:55:00.393764	NR5G RRC OTA Packet	RADIO_BEARER_CONFIG
OTA LOG	07:55:00.407989	NR5G RRC OTA Packet	RRC_RECONFIG_COMPLETE
OTA LOG	07:55:00.408588	UL_DCCH / RRCConnectionReconfigurationComplete	Radio Bearer ID: 1, Freq: 1300, SFN: 0
LOG	07:55:00.442207	NR5G ML1 Searcher Measurement Database Update Ext	Length: 468
LOG	07:55:00.456345	NR5G MAC RACH Trigger	Length: 48
LOG	07:55:00.483318	NR5G MAC RACH Attempt	Length: 124
LOG	07:55:00.503311	NR5G MAC RACH Attempt	Length: 124
LOG	07:55:00.523310	NR5G MAC RACH Attempt	Length: 124
OTA LOG	07:55:00.537164	IMS SIP Message	Length: 739
OTA LOG	07:55:00.537317	IMS Registration	Length: 171
LOG	07:55:00.543310	NR5G MAC RACH Attempt	Length: 124
LOG	07:55:00.563310	NR5G MAC RACH Attempt	Length: 124
LOG	07:55:00.583312	NR5G MAC RACH Attempt	Length: 124
LOG	07:55:00.603307	NR5G MAC RACH Attempt	Length: 124
LOG	07:55:00.605402	NR5G ML1 Searcher Measurement Database Update Ext	Length: 468
LOG	07:55:00.623306	NR5G MAC RACH Attempt	Length: 124
LOG	07:55:00.643311	NR5G MAC RACH Attempt	Length: 124
LOG	07:55:00.663307	NR5G MAC RACH Attempt	Length: 124
LOG	07:55:00.665738	NR5G MAC RACH Attempt	Length: 124
OTA LOG	07:55:00.694020	NR5G RRC OTA Packet	MEAS_RESULT_SCG_FAILURE
OTA LOG	07:55:00.694337	UL_DCCH / Extension_c2_scgFailureInformationNR_r15	Radio Bearer ID: 1, Freq: 1300, SFN: 0
OTA LOG	07:55:00.892767	DL_DCCH / RRCConnectionReconfiguration	Radio Bearer ID: 1, Freq: 1300, SFN: 659
OTA LOG	07:55:00.893507	NR5G RRC OTA Packet	RRC_RECONFIG
OTA LOG	07:55:00.903372	NR5G RRC OTA Packet	RRC_RECONFIG_COMPLETE
OTA LOG	07:55:00.903510	UL_DCCH / RRCConnectionReconfigurationComplete	Radio Bearer ID: 1, Freq: 1300, SFN: 0
OTA LOG	07:55:00.937488	DL_DCCH / RRCConnectionReconfiguration	Radio Bearer ID: 1, Freq: 1300, SFN: 663
LOG	07:55:00.958486	NR5G ML1 Searcher Measurement Database Update Ext	Length: 468
OTA LOG	07:55:00.958490	NR5G RRC OTA Packet	BCCH_BCH / Mib
OTA LOG	07:55:00.983289	NR5G RRC OTA Packet	RADIO_BEARER_CONFIG
OTA LOG	07:55:01.005720	IMS SIP Message	Length: 1808
OTA LOG	07:55:01.014628	UL_DCCH / RRCConnectionReconfigurationComplete	Radio Bearer ID: 1, Freq: 1300, SFN: 0
OTA LOG	07:55:01.031706	PCCH / Paging	Radio Bearer ID: 0, Freq: 1300, SFN: 672
OTA LOG	07:55:01.037887	DL_DCCH / RRCConnectionReconfiguration	Radio Bearer ID: 1, Freq: 1300, SFN: 673
OTA LOG	07:55:01.039683	UL_DCCH / RRCConnectionReconfigurationComplete	Radio Bearer ID: 1, Freq: 1300, SFN: 0
OTA LOG	07:55:01.168308	IMS SIP Message	Length: 1015
OTA LOG	07:55:01.168429	IMS Registration	Length: 171
OTA LOG	07:55:01.188018	IMS SIP Message	Length: 916
OTA LOG	07:55:01.228870	IMS SIP Message	Length: 802

2. Problem Analysis

1) After LTE registration, RRC reassigns messages to add SA cell measurement, as shown below.

OTA LOG	07:55:00.650941	LTE_NAS_EMM_Plain_OTA_Incoming_Message	EMM information Msg
OTA LOG	07:55:00.001770	DL_DCCH / RRCConnectionReconfiguration	Radio Bearer ID: 1, Freq: 1300, SFN: 569
OTA LOG	07:55:00.004305	UL_DCCH / RRCConnectionReconfigurationComplete	Radio Bearer ID: 1, Freq: 1300, SFN: 0
OTA LOG	07:55:00.004520	UL_DCCH / MeasurementReport	Radio Bearer ID: 1, Freq: 1300, SFN: 0
LOG	07:55:00.082285	NR5G ML1 Searcher Measurement Database Update Ext	Length: 364
OTA LOG	07:55:00.112535	LTE_NAS_EMM_Plain_OTA_Incoming_Message	EMM information Msg

```

01 00 00 00 10 00 69 01 ^
C7 C6 F0 00 1A 0F 50 01
99 23 09 00 00 00 00 48
8A 52 18 10 CE 03 DA 41
01 81 14 21 C2 90 07 42
10 0B 41 81 13 00 0D F2
6E 30 00 01 00 44 11 00
C0
    },
    {
      measObjectId 2,
      measObject measObjectNR-r15 :
      {
        carrierFreq-r15 504990,
        rs-ConfigSSB-r15
        {
          measTimingConfig-r15
          {

```

2) After the module completes the cell measurement, it reports the cell with strongest signal 278, as shown in the figure below.

07:55:00.17455	UL_DCCH / InformationTransfer	Radio Bearer ID: 1, Freq: 1300, SFN: 0
07:55:00.309296	NR5G ML1 Searcher Measurement Database Update Ext	Length: 424
07:55:00.347373	UL_DCCH / MeasurementReport	Radio Bearer ID: 1, Freq: 1300, SFN: 0
07:55:00.377251	IMS SIP Message	Length: 1500
07:55:00.383631	DL_DCCH / RRCConnectionReconfiguration	Radio Bearer ID: 1, Freq: 1300, SFN: 569

```

10 00 3F 01 ^
1A 0F 50 01
00 00 00 11
59 51 54 A1
10 D2 90
message c1 : measurementReport :
{
  criticalExtensions c1 : measurementReport-r8 :
  {
    measResults
    {
      measId 3,
      measResultPCell
      {
        rsrpResult 76,
        rsrqResult 22
      },
      measResultNeighCells measResultNeighCellListNR-r15 :
      {
        {
          pci-r15 278,
          measResultCell-r15
          {
            rsrpResult-r15 87
          },
          measResultRS-IndexList-r15
          {
            {
              ssb-Index-r15 1,
              measResultSSB-Index-r15
              {
                rsrpResult-r15 89
              }
            }
          }
        },
        {
          pci-r15 277,
          measResultCell-r15
          {
            rsrpResult-r15 84
          },
          measResultRS-IndexList-r15
          {
            {
              ssb-Index-r15 6,
              measResultSSB-Index-r15

```

- 3) However, the network configures the cell with signal 277 for the module accessing to, as shown in the figure below.

07:55:00.392821	DL_DCH / RRCConnectionReconfiguration	Radio Bearer ID: 1, Freq: 1300, SFN: 609
07:55:00.393748	NR5G RRC OTA Packet	RRC_RECONFIG
07:55:00.393764	NR5G RRC OTA Packet	RADIO_BEARER_CONFIG
07:55:00.407989	NR5G RRC OTA Packet	RRC_RECONFIG_COMPLETE
07:55:00.408588	UL_DCH / RRCConnectionReconfigurationComplete	Radio Bearer ID: 1, Freq: 1300, SFN: 0
07:55:00.413207	NR5G M1.5 Service Measurement Database Update Failure	Length: 458


```

reconfigurationWithSync
{
  spCellConfigCommon
  {
    physCellId 277,
    downlinkConfigCommon
    {
      frequencyInfoDL
      {
        absoluteFrequencySSB 504990,
        frequencyBandList
        {
          41
        },
        absoluteFrequencyPointA 503172,
        scs-SpecificCarrierList
        {
          {
            offsetToCarrier 0,
            subcarrierSpacing kHz30,
            carrierBandwidth 273
          }
        }
      }
    }
  }
}
    
```

In MR, the module reports all cells that reach the threshold to the network, including the cell with strongest signal 278. The cell with signal 277 reassigned by RRC is issued by the network. NR cell which is added to is determined by the configuration and algorithm on the network. For example, if LTE does not configure a cell with a stronger signal as an SN neighbor cell, it is necessary to contact the operator to optimize the network.

4.2. Network Searching Failure in SA

1. Problem Description

RG500Q-EA module fails to register to China Unicom’s SA network, for example, after RRCSetup Complete, the network performs RRC release immediately, resulting in unable to access to the network.

As shown in the log below:

Key	Type	Time Stamp	Name	Summary
[0x8821]	OTA LOG	01:57:47.471167	NRSR RRC OTA Packet	BCCH_DL_SCH / SystemInformationBlockType1
[0x8821]	OTA LOG	01:57:47.691266	NRSR RRC OTA Packet	BCCH_DL_SCH / SystemInformationBlockType1
[0x8821]	OTA LOG	01:57:47.705294	NRSR RRC OTA Packet	BCCH_BCH / Mib
[0x8821]	OTA LOG	01:57:47.715241	NRSR RRC OTA Packet	BCCH_DL_SCH / SystemInformation
[0x8821]	OTA LOG	01:57:48.435539	NRSR RRC OTA Packet	BCCH_DL_SCH / SystemInformation
[0x8821]	OTA LOG	01:57:51.520672	NRSR RRC OTA Packet	PCCH / Paging
[0x8821]	OTA LOG	01:57:52.487268	NRSR RRC OTA Packet	BCCH_DL_SCH / SystemInformationBlockType1
[0x8821]	OTA LOG	01:57:52.631476	NRSR RRC OTA Packet	BCCH_DL_SCH / SystemInformationBlockType1
[0x8821]	OTA LOG	01:57:52.812699	NRSR RRC OTA Packet	BCCH_DL_SCH / SystemInformationBlockType1
[0x8821]	OTA LOG	01:57:53.127372	NRSR RRC OTA Packet	BCCH_DL_SCH / SystemInformationBlockType1
[0x8821]	OTA LOG	01:57:53.187468	NRSR RRC OTA Packet	BCCH_DL_SCH / SystemInformationBlockType1
[0x8808]	OTA LOG	01:57:53.250812	NRSR NAS MM5G Plai...	Registration request
[0x8821]	OTA LOG	01:57:53.251036	NRSR RRC OTA Packet	UL_CCCH / RRC Setup Req
[0x8821]	OTA LOG	01:57:53.378482	NRSR RRC OTA Packet	DL_CCCH / RRC Setup
[0x8821]	OTA LOG	01:57:53.390502	NRSR RRC OTA Packet	UL_DCCH / RRCSetup Complete
[0x8821]	OTA LOG	01:57:53.396756	NRSR RRC OTA Packet	DL_DCCH / RRC Release
[0x8821]	OTA LOG	01:57:53.832707	NRSR RRC OTA Packet	BCCH_DL_SCH / SystemInformationBlockType1
[0x8821]	OTA LOG	01:57:53.989713	NRSR RRC OTA Packet	BCCH_DL_SCH / SystemInformationBlockType1
[0x8821]	OTA LOG	01:57:54.389300	NRSR RRC OTA Packet	BCCH_DL_SCH / SystemInformationBlockType1
[0x8821]	OTA LOG	01:58:49.111180	NRSR RRC OTA Packet	BCCH_DL_SCH / SystemInformationBlockType1
[0x8821]	OTA LOG	01:58:50.435271	NRSR RRC OTA Packet	BCCH_DL_SCH / SystemInformation
[0x8821]	OTA LOG	01:58:51.155656	NRSR RRC OTA Packet	BCCH_DL_SCH / SystemInformation
[0x8821]	OTA LOG	01:58:55.007506	NRSR RRC OTA Packet	BCCH_DL_SCH / SystemInformationBlockType1
[0x8821]	OTA LOG	01:58:55.552509	NRSR RRC OTA Packet	BCCH_DL_SCH / SystemInformation
[0x8821]	OTA LOG	01:58:55.692518	NRSR RRC OTA Packet	BCCH_DL_SCH / SystemInformation
[0x8808]	OTA LOG	01:58:55.854197	NRSR NAS MM5G Plai...	Registration request
[0x8821]	OTA LOG	01:58:55.854661	NRSR RRC OTA Packet	UL_CCCH / RRC Setup Req
[0x8821]	OTA LOG	01:58:55.957008	NRSR RRC OTA Packet	DL_CCCH / RRC Setup
[0x8821]	OTA LOG	01:58:55.970419	NRSR RRC OTA Packet	UL_DCCH / RRCSetup Complete
[0x8821]	OTA LOG	01:58:55.976748	NRSR RRC OTA Packet	DL_DCCH / RRC Release
[0x8821]	OTA LOG	01:58:56.167424	NRSR RRC OTA Packet	BCCH_DL_SCH / SystemInformationBlockType1
[0x8821]	OTA LOG	01:58:56.309868	NRSR RRC OTA Packet	BCCH_DL_SCH / SystemInformationBlockType1
[0x8821]	OTA LOG	01:58:56.829865	NRSR RRC OTA Packet	BCCH_DL_SCH / SystemInformationBlockType1
[0x8821]	OTA LOG	01:58:58.389840	NRSR RRC OTA Packet	BCCH_DL_SCH / SystemInformationBlockType1
[0x8821]	OTA LOG	02:00:12.491318	NRSR RRC OTA Packet	BCCH_DL_SCH / SystemInformationBlockType1
[0x8821]	OTA LOG	02:00:13.611187	NRSR RRC OTA Packet	BCCH_DL_SCH / SystemInformationBlockType1
[0x8821]	OTA LOG	02:00:13.625277	NRSR RRC OTA Packet	BCCH_BCH / Mib

2. Problem Analysis

In network searching, HPLMN is 460-31. But, PLMN residing in the CM management unit of the NAS layer is 460-11, as shown in the log below:

Key	Type	Time Stamp	Name	Summary	SubID	Payload	Time Stamp
[87/ 0/2]	QTRAC	01:57:53.187665	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc 5812 CSP: Req PLMN in list, reserved	1	0x9801ff00100...	
[87/ 0/2]	QTRAC	01:57:53.187666	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc 6315 CSP: Do not bar the cell as there is a non reserved PLMN	1	0x9801ff00100...	
[87/ 0/2]	QTRAC	01:57:53.187667	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc 5221 CSP: Copying PLMN from SIB1 to Found PLMN list	1	0x9801ff00100...	
[87/ 0/2]	QTRAC	01:57:53.187669	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc 5270 CSP: Forbidden TA list is empty	1	0x9801ff00100...	
[87/ 0/2]	QTRAC	01:57:53.187671	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc 5339 CSP: NAS req PLMN cannot be added to found PLMN list	1	0x9801ff00100...	SIM card PLMN
[87/ 0/2]	QTRAC	01:57:53.187672	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc 5270 CSP: Forbidden TA list is empty	1	0x9801ff00100...	
[87/ 0/2]	QTRAC	01:57:53.187673	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc 5355 CSP: Adding found PLMN with signal strength = -8471	1	0x9801ff00100...	
[9512/ 1]	MSG	01:57:53.187707	Unrecognized	nrsg_rrc_cspc 5359 CSP: Adding Found PLMN: MCC: [4 6 0] MNC: [3 1]	1	0x79000000c31f...	
[87/ 0/2]	QTRAC	01:57:53.187719	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc 5394 CSP: Found PLMN length = 3	1	0x9801ff00100...	
[87/ 0/2]	QTRAC	01:57:53.187721	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc 6507 CSP: EHPLMN camping enabled	1	0x9801ff00100...	
[87/ 0/2]	QTRAC	01:57:53.187727	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc 5483 CSP: PLMN does not match for index 0	1	0x9801ff00100...	
[87/ 0/2]	QTRAC	01:57:53.187729	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc 5442 CSP: Plmn matched is present in group index 1	1	0x9801ff00100...	
[87/ 0/2]	QTRAC	01:57:53.187731	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc 5473 CSP: TA list present tac(0)[1]/2] = 0x4b 12 0	1	0x9801ff00100...	EHPLMN
[87/ 0/2]	QTRAC	01:57:53.187732	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc 5270 CSP: Forbidden TA list is empty	1	0x9801ff00100...	
[87/ 0/2]	QTRAC	01:57:53.187733	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc 3928 CSP: Cell is suitable	1	0x9801ff00100...	
[9512/ 1]	MSG	01:57:53.187749	Unrecognized	nrsg_rrc_cspc 6584 CSP: PLMN match from EHPLMN list= MCC: [4 6 0] MNC: [1 1]	1	0x79000000626a...	
[87/ 0/2]	QTRAC	01:57:53.187761	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc 6616 CSP: Cell Suitable for EHPLMN/HPLMN/REQ PLMN 0	1	0x9801ff00100...	
[9512/ 1]	MSG	01:57:53.187780	Unrecognized	nrsg_rrc_cspc 6620 CSP: Found Suitable PLMN from EHPLMN/HPLMN/REQ PLMN: MCC: [4 6 0] MNC: [1 1]	1	0x7900000062a...	
[87/ 0/2]	QTRAC	01:57:53.190321	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc_utils.c 2808 CSP: MCC returned 460	1	0x9801ff00100...	
[87/ 0/2]	QTRAC	01:57:53.219869	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc 5442 CSP: Plmn matched is present in group index 0	1	0x9801ff00100...	
[87/ 0/2]	QTRAC	01:57:53.219871	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc 5480 CSP: CellIdentity is 0x57e0b1b1	1	0x9801ff00100...	
[87/ 0/2]	QTRAC	01:57:53.219872	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc 5473 CSP: TA list present tac(0)[1]/2] = 0x4b 12 0	1	0x9801ff00100...	
[87/ 0/2]	QTRAC	01:57:53.219874	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc 5781 CSP: populating TAC(0)[1]/2], 0x4b 12 0 to camped cell tac	1	0x9801ff00100...	
[87/ 0/2]	QTRAC	01:57:53.219878	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc 11605 CSP: Copying camped PLMN into NAS-requested PLMN	1	0x9801ff00100...	
[87/ 0/2]	QTRAC	01:57:53.219880	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc 11625 CSP: Camped on physical cell ID 705 on earfcn 633984	1	0x9801ff00100...	
[87/ 0/2]	QTRAC	01:57:53.219884	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc 6854 CSPtac(0) = 0x 4b	1	0x9801ff00100...	
[87/ 0/2]	QTRAC	01:57:53.219955	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc 6854 CSPtac(1) = 0x 12	1	0x9801ff00100...	
[87/ 0/2]	QTRAC	01:57:53.219956	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc 6854 CSPtac(2) = 0x 0	1	0x9801ff00100...	
[87/ 0/2]	QTRAC	01:57:53.219962	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc 7294 CSP: RRC sent NAS Service Ind NRSR_RRC_SERVICE_IND - Service Status1, no_svc_cause= 0 acc...	1	0x9801ff00100...	
[87/ 0/2]	QTRAC	01:57:53.219963	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc 7305 CSP: selected PLMN ID (0x64 0x0 0x11 selected_band 78 phy_cell_id 705 earfcn 633984 cell_acc...	1	0x9801ff00100...	
[87/ 0/2]	QTRAC	01:57:53.219965	RRC/HighFreq/High/NRSRGRRC	nrsg_rrc_cspc 7208 CSP: Found PLMN list num 0	1	0x9801ff00100...	
[47/ 1/2]	QTRAC	01:57:53.223236	MM/HighFreq/High/REG	reg_state.c 1309 DS: SUB 0 -REG- Received message MS: 10 MSG_ID: 136	1	0x9801ff00100...	Actual camped PLMN
[47/ 1/2]	QTRAC	01:57:53.223255	MM/HighFreq/High/REG	reg_state.c 303 DS: SUB 0 -REG- REG_STATE_REGISTERING	1	0x9801ff00100...	
[47/ 1/2]	QTRAC	01:57:53.223255	MM/HighFreq/High/REG	reg_sim.c 3642 DS: SUB 0 -REG- Found PLMN(460-31)	1	0x9801ff00100...	
[47/ 1/2]	QTRAC	01:57:53.223268	MM/HighFreq/High/REG	reg_send.c 509 DS: SUB 0 -REG- CM_CAMPED_IND PLMN (460 - 11) Primary PLMN (460 - 11)	1	0x9801ff00100...	
[47/ 1/2]	QTRAC	01:57:53.223274	MM/HighFreq/High/REG	reg_state.c 1313 DS: SUB 0 -REG- sent message MS: 7 MSG_ID: 73	1	0x9801ff00100...	
[47/ 1/2]	QTRAC	01:57:53.223265	MM/HighFreq/High/REG	reg_send.c 7351 DS: SUB 0 -REG- REG_SERVICE_STATE_IND	1	0x9801ff00100...	
[47/ 1/2]	QTRAC	01:57:53.223267	MM/HighFreq/High/REG	reg_state.c 1313 DS: SUB 0 -REG- sent message MS: 48 MSG_ID: 0	1	0x9801ff00100...	
[47/ 1/2]	QTRAC	01:57:53.223273	MM/HighFreq/High/REG	reg_sim.c 4907 DS: SUB 0 -REG- FPLMN list length = 20	1	0x9801ff00100...	
[47/ 1/2]	QTRAC	01:57:53.223791	MM/HighFreq/High/REG	reg_state.c 7981 DS: SUB 0 -REG- force pref pending set to 0	1	0x9801ff00100...	
[0x8808]	OTA LOG	01:57:53.250812	NRSR NAS MM5G Plan...	Registration request	1	0x98010000100...	0
[0x8821]	OTA LOG	01:57:53.251036	NRSR RRC OTA Packet	UL_CCCH / RRC Setup Req	1	0x98010000100...	0
[0x8821]	OTA LOG	01:57:53.378482	NRSR RRC OTA Packet	DL_CCCH / RRC Setup	1	0x98010000100...	0

This station is shared by China Unicom and China Telecom, China Telecom as primary PLMN, China Unicom as secondary PLMN. In the OTA log below, PLMN on the NAS layer is 460-31, rrcSetupComplete reports selectedPLMN-Identity 1 which represents primary PLMN. And selectedPLMN-Identity 2 represents secondary PLMN.

```

[ 47/ 1/2] QTRACE 01:57:53.223574 MM/HighFreq/High/REG [ reg_stat.c 1313] DS: SUB 0 =REG= sent message MS: 7 MSG_ID: 73
[ 47/ 1/2] QTRACE 01:57:53.223605 MM/HighFreq/High/REG [ reg_send.c 735] DS: SUB 0 =REG= REG_SERVICE_STATE_IND
[ 47/ 1/2] QTRACE 01:57:53.223607 MM/HighFreq/High/REG [ reg_stat.c 1313] DS: SUB 0 =REG= sent message MS: 48 MSG_ID: 0
[ 47/ 1/2] QTRACE 01:57:53.223732 MM/HighFreq/High/REG [ reg_sim.c 4907] DS: SUB 0 =REG= FPLMN list length = 20
[ 47/ 1/2] QTRACE 01:57:53.223781 MM/HighFreq/High/REG [ reg_stat.c 7981] DS: SUB 0 =REG= force pref pending set to 0
[0xB808] OTA LOG 01:57:53.250812 NR5G NAS MM5G Plain OTA Outgoing Msg Registration request
[0xB821] OTA LOG 01:57:53.251036 NR5G RRC OTA Packet UL_DCCH / RRC Setup Req
[0xB821] OTA LOG 01:57:53.378482 NR5G RRC OTA Packet DL_CCCH / RRC Setup
[ 87/ 0/2] QTRACE 01:57:53.379736 RRC/HighFreq/High/NR5GRRC [ nr5g_rrc_csp_utils.c 2808] CSP: MCC returned 460
[ 87/ 0/2] QTRACE 01:57:53.380182 RRC/HighFreq/High/NR5GRRC [ nr5g_rrc_csp.c 13343] CSP: Proceed with resel ind received from proc 3
[ 87/ 0/2] QTRACE 01:57:53.380183 RRC/HighFreq/High/NR5GRRC [ nr5g_rrc_csp.c 15473] CSP: Status is FALSE
[ 13/ 0/2] QTRACE 01:57:53.381496 LRRC/HighFreq/High/LRRC [ lte_rrc_csp.c 28690] CSP: Processing acq db earfcn request
[ 13/ 0/2] QTRACE 01:57:53.381575 LRRC/HighFreq/High/LRRC [ lte_rrc_csp.c 28742] CSP: Sent Acq DB earfcn response message
[0xB821] OTA LOG 01:57:53.390502 NR5G RRC OTA Packet UL_DCCH / RRCSetup Complete
[ 87/ 0/2] QTRACE 01:57:53.390569 RRC/HighFreq/High/NR5GRRC [ nr5g_rrc_csp.c 11989] CSP: CFG confirmation received
[ 87/ 0/2] QTRACE 01:57:53.390571 RRC/HighFreq/High/NR5GRRC [ nr5g_rrc_csp.c 12003] CSP: Config confirmation proc did not match
[0xB821] OTA LOG 01:57:53.396756 NR5G RRC OTA Packet DL_DCCH / RRC Release
[ 87/ 0/2] QTRACE 01:57:53.441948 RRC/HighFreq/High/NR5GRRC [ nr5g_rrc_csp.c 11989] CSP: CFG confirmation received

```

```

01:57:53.250812 [0xB808] NR5G NAS MM5G Plain OTA Outgoing Msg
pkt_version = 1 (0x1)
rel_number = 15 (0xf)
rel_version_major = 4 (0x4)
rel_version_minor = 0 (0x0)
prot_disc_type = 14 (0xe)
ext_protocol_disc = 126 (0x7e)
security_header = 0 (0x0)
msg_type = 65 (0x41) (Registration request)
nr5g_mm_msg
  registration_req
    ngKSI
      tac = 0 (0x0) (native see context)
      nas_key_set_id = 7 (0x7)
    reg_type
      FOR = 1 (0x1)
      _sqs_reg_type = 1 (0x1) (Initial reg)
      _sqs_mob_id
        ident_type = 1 (0x1)
        supi_id = 1 (0x1) (0x0)
        mcc_1 = 4 (0x4)
        mcc_2 = 6 (0x6)
        mcc_3 = 0 (0x0)
        mnc_3 = 15 (0xf)
        mnc_1 = 3 (0x3)
        mnc_2 = 1 (0x1)

```

Figure 3: Log of Registration Request

```

[ 47/ 1/2] QTRACE 01:57:53.223607 MM/HighFreq/High/REG [ reg_stat.c 1313] DS: SUB 0 =REG= sent message MS: 48 MSG_ID: 0
[ 47/ 1/2] QTRACE 01:57:53.223791 MM/HighFreq/High/REG [ reg_sim.c 4907] DS: SUB 0 =REG= FPLMN list length = 20
[0xB808] OTA LOG 01:57:53.250812 NR5G NAS MM5G Plain OT... Registration request
[0xB821] OTA LOG 01:57:53.251036 NR5G RRC OTA Packet UL_DCCH / RRC Setup Req
[0xB821] OTA LOG 01:57:53.378482 NR5G RRC OTA Packet DL_CCCH / RRC Setup
[ 87/ 0/2] QTRACE 01:57:53.379736 RRC/HighFreq/High/NR5GRRC [ nr5g_rrc_csp_utils.c 2808] CSP: MCC returned 460
[ 87/ 0/2] QTRACE 01:57:53.380182 RRC/HighFreq/High/NR5GRRC [ nr5g_rrc_csp.c 13343] CSP: Proceed with resel ind received from proc 3
[ 87/ 0/2] QTRACE 01:57:53.380183 RRC/HighFreq/High/NR5GRRC [ nr5g_rrc_csp.c 15473] CSP: Status is FALSE
[ 13/ 0/2] QTRACE 01:57:53.381496 LRRC/HighFreq/High/LRRC [ lte_rrc_csp.c 28690] CSP: Processing acq db earfcn request
[ 13/ 0/2] QTRACE 01:57:53.381575 LRRC/HighFreq/High/LRRC [ lte_rrc_csp.c 28742] CSP: Sent Acq DB earfcn response message
[0xB821] OTA LOG 01:57:53.390502 NR5G RRC OTA Packet UL_DCCH / RRCSetup Complete
[ 87/ 0/2] QTRACE 01:57:53.390569 RRC/HighFreq/High/NR5GRRC [ nr5g_rrc_csp.c 11989] CSP: CFG confirmation received
[ 87/ 0/2] QTRACE 01:57:53.390571 RRC/HighFreq/High/NR5GRRC [ nr5g_rrc_csp.c 12003] CSP: Config confirmation proc did not match
[0xB821] OTA LOG 01:57:53.396756 NR5G RRC OTA Packet DL_DCCH / RRC Release
[ 87/ 0/2] QTRACE 01:57:53.441948 RRC/HighFreq/High/NR5GRRC [ nr5g_rrc_csp.c 11989] CSP: CFG confirmation received
[ 87/ 0/2] QTRACE 01:57:53.441949 RRC/HighFreq/High/NR5GRRC [ nr5g_rrc_csp.c 12003] CSP: Config confirmation proc did not match

```

```

01:57:53.390502 [0xB821] NR5G RRC OTA Packet
Pkt Version = 9
RRC Release Number.Major.minor = 15.9.0
Radio Bearer ID = 1, Physical Cell ID = 705
Freq = 633904
Sfn = N/A, SubFrameNum = N/A
slot = 0
PDU Number = UL_DCCH Message, Msg Length = 27
SIB Mask in SI = 0x00

Interpreted PDU:

value UL-DCCH-Message ::=
{
  message c1 : rrcSetupComplete :
  {
    rrc-TransactionIdentifier 0,
    criticalExtensions rrcSetupComplete :
    {
      selectedPLMN-Identity 1,
      dedicatedNAS-Message '7E004179000D0164F013F0FF000009214375212E02F070'H
    }
  }
}

```

Figure 4: Log of RRC Establishment Completed

5 Appendix References

Table 3: Related Documents

Document Name
[1] Quectel_RG50xQ&RM5xxQ_Series_AT_Commands_Manual

Table 4: Terms and Abbreviations

Abbreviation	Description
5GCN	5G Core Network
5GS	5G System
CM	Call Manager
CQI	Channel Quality Indicator
CSI	Channel State Information
EN-DC	E-UTRA New Radio Dual Connectivity
EUTRAN	Evolved Universal Terrestrial Radio Access Network
HPLMN	Home Public Land Mobile Network
LTE	Long-Term Evolution
MCC	Mobile Country Code
MCS	Modulation and Coding Scheme
MNC	Mobile Network Code
MR	Measure Report
MT	Mobile Termination
NAS	Non-Access Stratum

NCI	NR Cell Identification
NCGI	NR Cell Global Identification
NR	New Radio
NSA	Non-Standalone
OTA	Over-The-Air Technology
PMI	Precoding Matrix Indicator
PDSCH	Physical Downlink Shared CHannel
PLMN	Public Land Mobile Network
RACH	Random Access Channel
RAT	Radio Access Technology
RI	Rank Indication
RRC	Radio Resource Control
SA	Standalone
SN	Service Network
UE	User Equipment
URC	Unsolicited Result Code
WCDMA	Wideband Code Division Multiple Access
