CELLULAR

End User Test

+UTEST AT command guideline for cellular modules

Application Note

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Abstract

This document provides guidelines for the usage of the +UTEST AT command during end user tests.

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Document Information		
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This document applies to the following products:

Product name	Notes
LEON-G1 series	Except LEON-G100-05S / LEON-G200-05S and previous versions
SARA-G3 series	
SARA-U2 series	
LISA-U2 series	
TOBY-L1 series	
TOBY-L2 series	
MPCI-L1 series	
MPCI-L2 series	
TOBY-R2 series	
LARA-R2 series	

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Preface

u-blox Technical Documentation

As part of our commitment to customer support, u-blox maintains an extensive volume of technical documentation for our products. In addition to our product-specific technical data sheets, the following manuals are available to assist u-blox customers in product design and development.

- **AT Commands Manual**: This document provides the description of the AT commands supported by the u-blox cellular modules.
- **System Integration Manual**: This document provides the description of u-blox cellular modules' system from the hardware and the software point of view, it provides hardware design guidelines for the optimal integration of the cellular modules in the application device and it provides information on how to set up production and final product tests on application devices integrating the cellular modules.
- **Application Notes**: These documents provide guidelines and information on specific hardware and/or software topics on u-blox cellular modules.

How to use this Application Note

This application note describes the software and hardware configurations to get the diagnostic trace log information from u-blox cellular modules.

The following symbols highlight important information within the application note:

☞ An index finger points out key information pertaining to module integration and performance.

⚠ **A warning symbol indicates actions that could negatively influence or damage the module.**

Questions

If you have any questions about u-blox cellular modules, please:

- Read this application note and the available technical documentation carefully.
- Contact our information service on the homepage .

Technical Support

Worldwide Web

Our website (HYPERLINK "http://www.u-blox.com/"www.u-blox.com) is a rich pool of information. Product information and technical documents can be accessed 24h a day.

By E-mail

If you have technical problems or cannot find the required information in the provided documents, contact the closest Technical Support office. To ensure that we process your request as soon as possible, use our service pool email addresses rather than personal staff email addresses. Contact details are at the end of the document.

Helpful Information when Contacting Technical Support

When contacting Technical Support please have the following information ready:

- Module type (e.g. LISA-U200) and firmware version
- Module configuration
- Clear description of your question or the problem
- A short description of the application
- Your complete contact details

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1 Introduction

This application note provides guidelines for the use of the End User Test AT command, +UTEST, in u-blox cellular modules.

The +UTEST AT commands give users a simple interface to perform the following actions:

- Set the cellular module in transmitting and receiving states, while ignoring the cellular signaling protocol.
- Set some of the pins of the cellular module as generic digital input or output pins. This is especially useful during customer production tests aimed to verify the response of the module pins.

When the +UTEST interface is activated, the module is temporally set in test mode. If the module is reset or a power cycle is performed, the module is automatically set in normal mode with normal functionality.

Throughout this document the following definitions are used:

- **Normal mode / Signaling mode**: the cellular module is able to access cellular networks. All the functionalities are enabled according to the normal operation status (idle mode, active mode, connected mode); this is the typical operating mode of the cellular modules
- **Test mode / Non-signaling mode**: the test interface is activated. The cellular module is set in a state in which it is not able to access the cellular network. The main software providing support to the network signaling protocols is not running. The test interface provides direct access to the basic transceiver and chipset subsystem functionalities, only for testing the hardware and the RF performance of the module.

Figure 1 describes the transitions between the different modes.

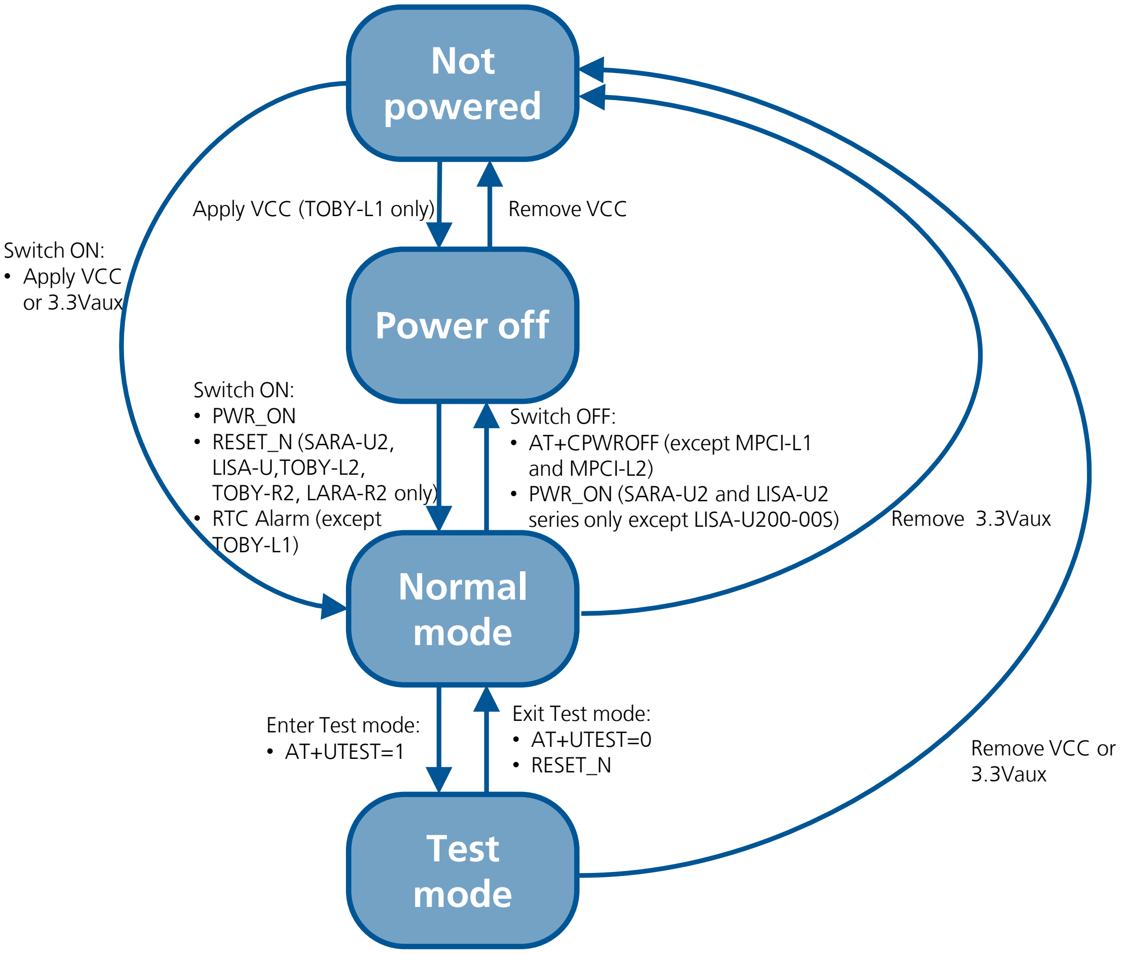

Figure 1: Operating modes transition

Table 1 shows the applicability of the testing modes to the u-blox cellular modules.

Cellular module series	RF testing	Digital pin testing
LEON-G1 series	•	
SARA-G3 series	•	•[1]
SARA-U2 series	•	•[2]
LISA-U2 series	•	•[3]
TOBY-L1	•	
MPCI-L1 series	•	
TOBY-L2	•	•[4]
MPCI-L2 series	•	
TOBY-R2 series	•	•
LARA-R2 series	•	•

Table 1: Applicability of the testing mode of +UTEST AT command

This application note is organized as follows:

- Section 2 describes the settings and the syntax of +UTEST AT command for RF testing, with possible tests setup and recommendations. Some examples are also given.
- Section 3 describes typical use cases of RF prototype and production tests for the OEM manufacturers.
- Section 4 describes the usage of +UTEST AT command to test the digital pins of the module.

1.1 Enabling and disabling test mode

1.1.1 AT+UTEST command syntax

Type	Syntax	Response	Example
Set	AT+UTEST=<mode>	If <mode>=0 or 1 OK	AT+UTEST=0 OK
Read	AT+UTEST?	+UTEST: <mode> OK	+UTEST: 1 OK
Test	AT+UTEST=?	+UTEST: (list of supported <mode>s) OK	+UTEST: (0-3,10) OK

1.1.1.1 Defined values

Parameter	Type	Description
<mode>	Number	Test mode setting: • 0: the module returns to normal mode • 1: the module enters non-signaling mode • 2: RX test mode (used to measure the received RF power level at the antenna ports) • 3: TX test mode (GSMK/8-PSK burst or 3G/4G signal transmission) • 10: digital pin test mode

[1] Not supported by "00" and "01" product versions
[2] Not supported by "00" product version
[3] Not supported by "01" and "x2" product versions
[4] Not supported by "x0" and "01" product versions

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1.1.2 Test mode enable (AT+UTEST=1)

Setting AT+UTEST=1 causes the module to enter non-signaling mode. Only the +UTEST AT commands are available in non-signaling mode. Since no other AT commands are allowed during non-signaling mode, the AT+CMEE=2 command should be issued before activating the test interface so that the error description can also be displayed during non-signaling mode.

☞ Before entering non-signaling mode, set the <mode> parameter of the AT+COPS command to 2 to avoid automatic registration attempts and force network deregistration. If AT+UTEST=1 is entered when +COPS=2 is not set, an error result code will be provided: "+CME ERROR: operation not allowed". (The verbose error result code will only be seen if +CMEE has been set to 2).

☞ On LEON-G1 series the error result code is not provided if +COPS=2 AT command is not set.

☞ On TOBY-L2 / MPCI-L2 series modules the command AT+COPS=2 is not needed before entering the non-signaling mode.

Example:

Command	Response	Description
`AT+CMEE=2`	`OK`	Enables error result code verbose
`AT+COPS?`	`+COPS: 0` `OK`	Check the network registration status.
`AT+COPS=2`	`OK`	Deregister the module from the network.
`AT+COPS?`	`+COPS: 2` `OK`	Check the network registration status.
`AT+UTEST=1`	`OK`	Set the module in the non-signaling mode.
`AT+UTEST?`	`+UTEST: 1` `OK`	Check the end user test mode.

1.1.3 Test mode disable (AT+UTEST=0)

Send the AT+UTEST=0 command to exit the test mode and restore the module normal mode.

Other ways to return to the normal mode include:

- Module switch off
- Module reset

The settings and the operations performed with the +UTEST AT commands have no impact on the module configuration once the normal mode is restored. When the module returns to the normal mode, the network registration status saved in the profile will be restored.

☞ In non-signaling mode the AT+CPWROFF command cannot be used to switch off the module.

☞ On LEON-G1 series an error result code is not provided when other AT commands are entered in non-signaling mode.

After sending AT+UTEST=0, wait until the normal switch-on boot sequence initializes the AT interface before entering any other AT commands.

Example:

Command	Response	Description
`AT+UTEST?`	`+UTEST: 1` `OK`	Check the end user test mode.
`AT+UTEST=0`	`OK`	Exits test mode
`AT+UTEST?`	`+UTEST: 0` `OK`	Check the end user test mode.

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2 RF testing of the antenna interface

2.1 Introduction

The purpose of this section is to illustrate how to use the +UTEST AT command is order to:

- Perform several measurements that normally require a GSM/WCDMA/LTE network simulator
- Execute prototype and production tests on devices integrating u-blox cellular modules

Using the +UTEST AT command, the user can activate the test interface and set the cellular module into these test modes:

- Transmit mode, to transmit a 2G, 3G or 4G signal, selecting:
  - Channel / frequency
  - Output power level
  - Training sequence (where applicable)
  - Modulation
  - Time period of the TX signal generation
- Receive mode, to measure the 2G, 3G or 4G received signal, selecting:
  - Channel / frequency
  - Time period of the RX signal measurement
  - RX path (if diversity or secondary antenna is supported)

⚠ **The usage of the +UTEST AT command shall be restricted to controlled (shielded chamber/box) environments and for test purposes only. Do not use the feature outside of testing and production conditions. Precautions must be taken to avoid module damage.**

⚠ **Improper usage of the +UTEST AT command on real network could disturb other users and the network itself. The use of this feature is only intended for testing purposes in controlled environments by qualified users and must not be used during normal module operation.**

⚠ **u-blox assumes no responsibilities for the inappropriate use of this feature.**

☞ For the complete syntax description of the +UTEST AT command, see the u-blox AT commands manual [1], u-blox TOBY-L1 / MPCI-L1 AT commands manual [2].

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2.2 Test setup

Depending on the instrument availability, two main setups are used for test executions throughout this document.

2.2.1 Setup 1

The RF module performance is tested using a GSM/WCDMA/LTE network simulator. Module antenna ports are connected to the network simulator input/output ports with 50 Ω RF cables. Instrument settings (band, channel, frequency, power level, etc.) should be set according to the module test parameters.

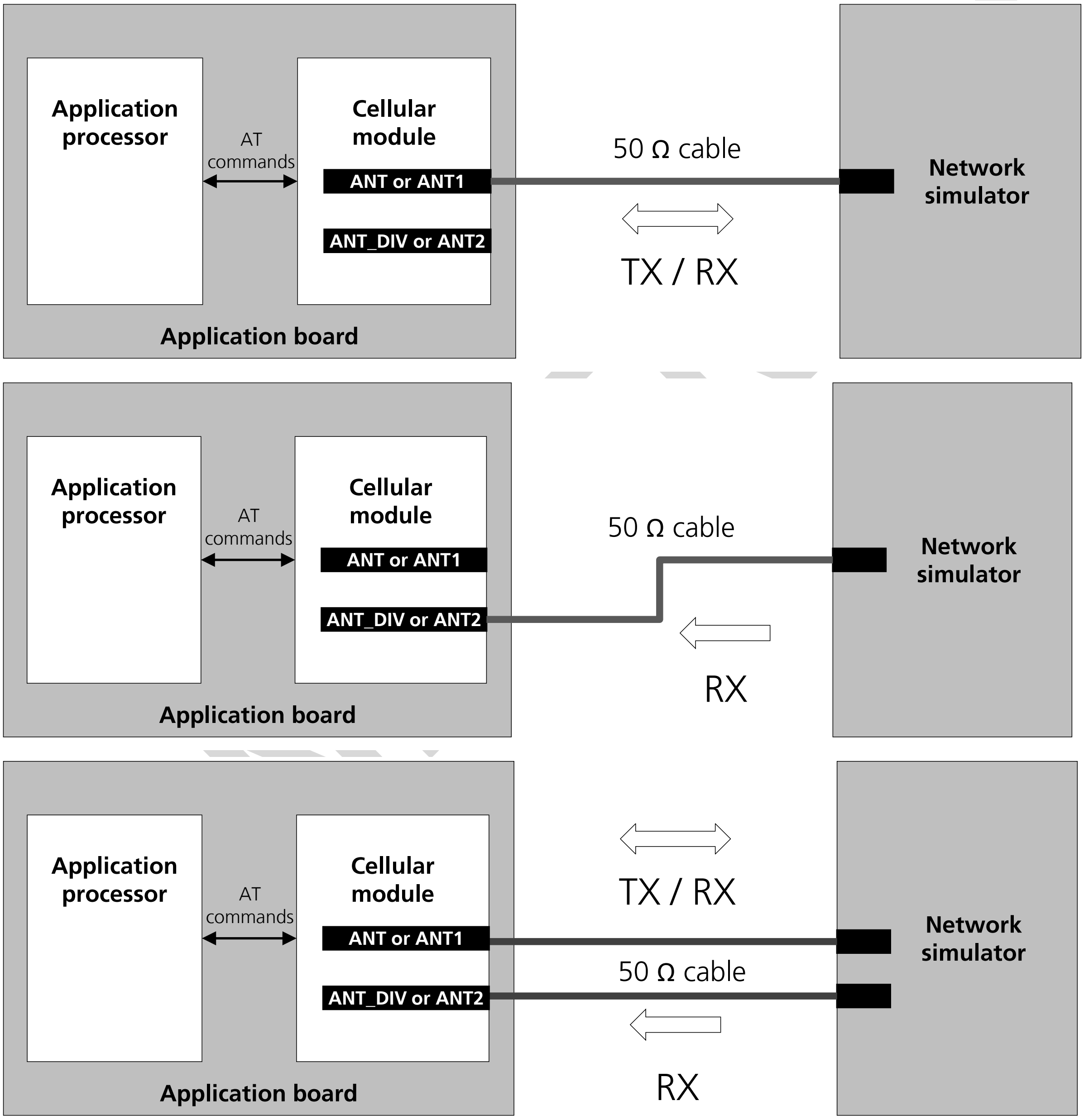

Figure 2: Setup for testing the primary and/or the secondary (or diversity) port using a GSM/WCDMA/LTE network simulator

2.2.2 Setup 2

The RF module performance is tested using a spectrum analyzer or a power meter and a signal generator. Module antenna ports are connected to the instruments through 50 Ω RF cables or antennas.

⚠ **The module's maximum output power can damage the spectrum analyzer or power meter. Avoid exceeding the maximum rated RF level specified by the equipment manfuacture.**

⚠ **The signal generator's output power level can damage the module (see the data sheet of the specific module [3], [4], [5], [6], [7], [8], [9], [10], [11], [12]).**

Attenuators, power splitters and filters can be used to arrange a suitable measurement setup. They are not highlighted in the figures below.

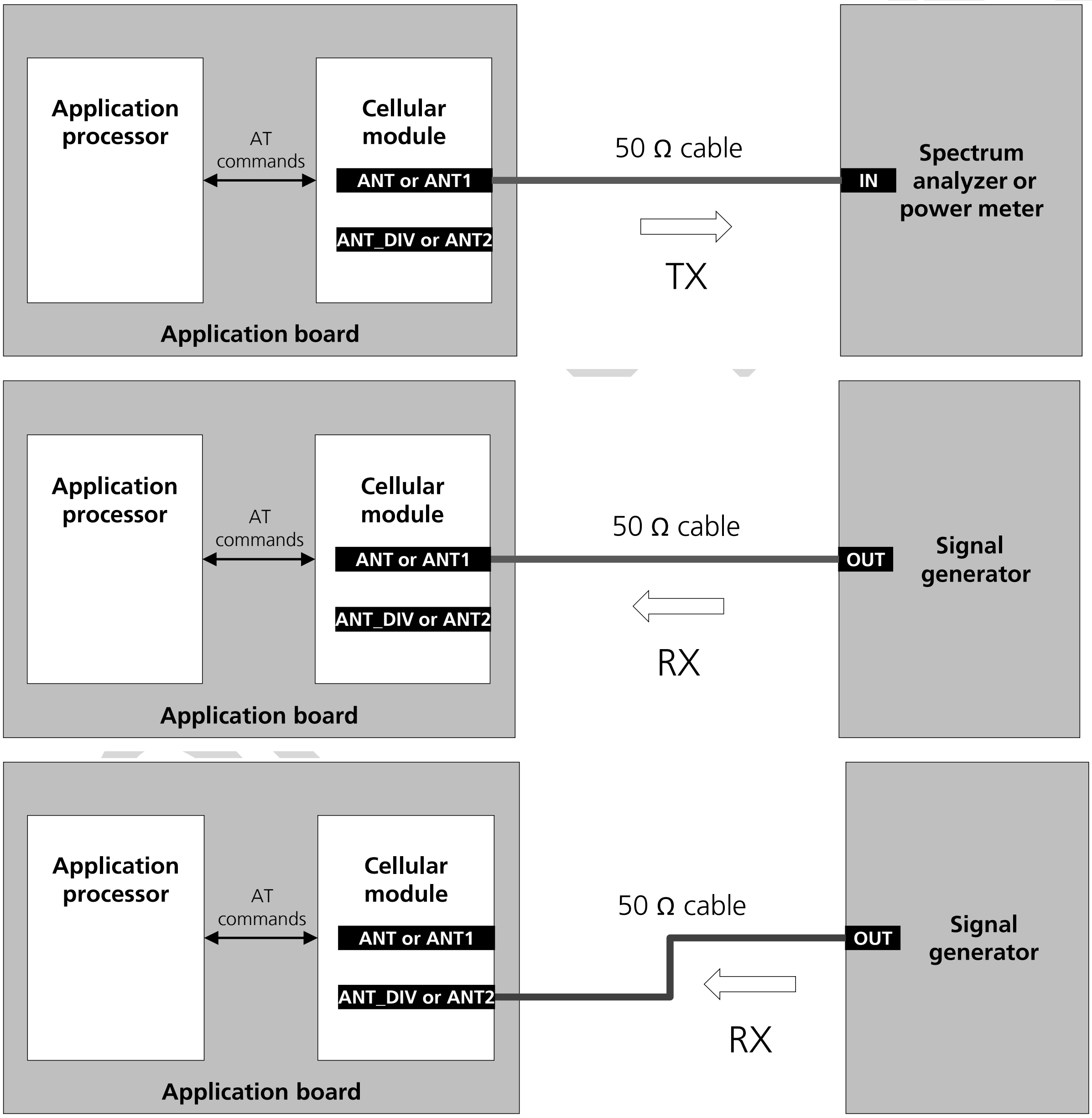

Figure 3: Setup for conducted testing of module antenna ports using a spectrum analyzer or power meter and signal generator

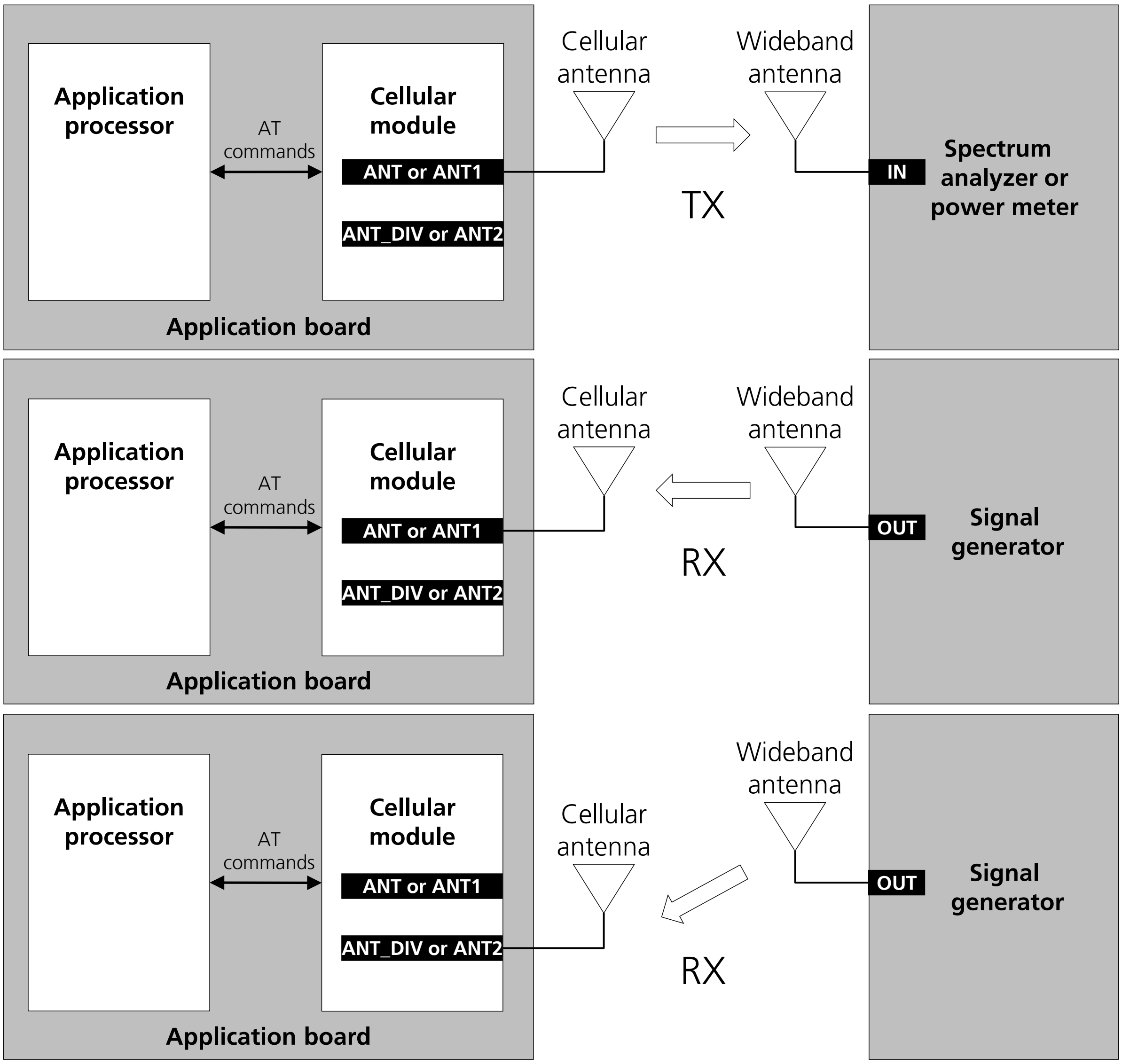

Figure 4: Setup for radiated testing of module antenna ports using a spectrum analyzer or power meter and signal generator

2.3 AT+UTEST command syntax for RF testing

Type	Syntax	Response	Example
Set	AT+UTEST=<mode>,[<par1>],[<par2>],[<par3>],[<par4>],[<par5>]	If <mode>=2 or 3 +UTEST: [<par1>,<par2>][,<par3>,<par4>,<par5>][,<min>,<avg>,<max>] OK	AT+UTEST=2,124,250 +UTEST: 124,250,-80,-80,-80 OK
Read	AT+UTEST?	+UTEST: <mode> OK	+UTEST: 1 OK
Test	AT+UTEST=?	+UTEST: (list of supported <mode>s) OK	+UTEST: (0-3) OK

2.3.1 Defined values

Parameter	Type	Description
<mode>	Number	Test mode setting: • 0: the module returns to normal mode • 1: the module enters non-signaling mode • 2: RX test mode (used to measure the received RF power level at the antenna ports) • 3: TX test mode (GSMK/8-PSK burst or 3G/4G signal transmission) • 10: digital pin test mode
<par1>..<par5>	Number	Parameters used to configure the selected test mode (see next sections)

2.4 Transmission test (AT+UTEST=3)

⚠ **To avoid module damage during transmitter testing, an antenna meeting module specifications (check module's system integration manual) or a 50 Ω RF cable must be connected to the antenna pins.**

The module can be triggered to transmit any of the following supported RF signals:

- 2G transmission of a GSM burst sequence on the desired channel and power level (only 1 time slot configuration is available)
- 2G transmission of a 8-PSK modulation burst sequence on the desired channel and power level (only 1 time slot configuration is available)
- 3G transmission of a WCDMA signal on the desired channel and power level
- 4G transmission of a LTE SC-FDMA OFDM signal (5 MHz bandwidth) on the desired channel and power level

2.4.1 AT+UTEST=3 command syntax

RF signal transmission can be triggered with this command:

```
AT+UTEST=3,<par1>,<par2>,<par3>,<par4>,<par5>
```

where <par1>,…<par5> are optional command parameters. If not set, the default value is used for each parameter.

Examples:

- AT+UTEST=3,<par1>,<par2>
- AT+UTEST=3,,<par2>,,,<par5>

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☞ See sections 2.4.1.1 to 2.4.1.5 for the lists of the allowed values. If an out-of-range value is issued, then an error result code will be provided (“+CME ERROR: operation not supported” if +CMEE is set to 2).

☞ If the TX channel parameter values belong to an unsupported technology RAT (2G, 3G or 4G RAT) or band, then an error result code will be provided (“+CME ERROR: operation not supported” if +CMEE is set to 2).

☞ An OK result code will be sent after a certain time interval when the transmitter is turned off. After the OK result code any other test command can be sent.

☞ On TOBY-L1 / MPCI-L1 series, the <par1>,…,<par5> optional parameters allow different values than the other cellular modules. See the corresponding tables for the allowed values.

2.4.1.1 <par1>, channel

```
AT+UTEST=3,<par1>[,<par2>,<par3>,<par4>,<par5>]
```

The <par1> parameter defines the channel of the transmitting signal. See Table 3 for the definition of the allowed parameter values according to the specific band and technology. For each technology, the band is automatically selected depending on the channel used.

Par	Description	Range	Default	Notes
<par1>	Tx channel	0 ÷ 165535	32	Tx channel for 2G RAT; for 850, 900, 1800 bands the value corresponds to the ARFCN while for 1900 band an offset of 32768 is added: • [0-124]: GSM 900 MHz • [128-251]: GSM 850 MHz • [512-885]: DCS 1800 MHz • [975-1023]: EGSM 900 MHz • [33280-33578]: PCS 1900 MHz (corresponding to ARFCN 512-810) Tx channel for 3G RAT; the value corresponds to the UARFCN, additional channels available in some 3G bands are not supported: • [1312 - 1513]: Band 4 (1700 MHz) • [2712-2863]: Band 8 (900 MHz) • [4132-4233]: Band 5 (850 MHz) (Band 6 is a subset) • [9262-9538]: Band 2 (1900 MHz) • [9612-9888]: Band 1 (2100 MHz) Tx channel for 4G RAT; the value corresponds to the EARFCN with an offset of 100000: • [120750 – 121449]: FDD Band 7 (EARFCN range 20750 – 21449) • [119950 – 120399]: FDD Band 4 (EARFCN range 19950 – 20399) • [118000 – 118599]: FDD Band 1 (EARFCN range 18000 – 18599) • [118600 – 119199]: FDD Band 2 (EARFCN range 18600 – 19199) • [119200 – 119949]: FDD Band 3 (EARFCN range 19200 – 19949) • [121450 – 121799]: FDD Band 8 (EARFCN range 21450 – 21799) • [120400 – 120649]: FDD Band 5 (EARFCN range 20400 – 20649) • [123010 – 123179]: FDD Band 12 (EARFCN range 23010 – 23179) • [123180 – 123279]: FDD Band 13 (EARFCN range 23180 – 23279) • [124150 – 124449]: FDD Band 20 (EARFCN range 24150 – 24449) • [127210 – 127659]: FDD Band 28 (EARFCN range 27210 – 27659) • [123730 – 123849]: FDD Band 17 (EARFCN range 23730 – 23849)

Table 2: <par1> parameter definition for all u-blox modules except for TOBY-L1 / MPCI-L1 series

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Par	Description	Range	Default	Notes
<par1>	Channel	100001 ÷ 199999	120286	TX channel 4G RAT: the value corresponds to the EARFCN with an offset of 100000. • [123180-123279]: Band 13 • [119950-120399]: Band 4

Table 3: TOBY-L1 / MPCI-L1 <par1> parameter definition

☞ In 2G, only one time slot burst sequence is supported; in this case a slot burst of 577 μs is transmitted every 4.6 ms.

☞ In 4G, only 5 MHz bandwidth of the SC-FDMA signal is supported.

☞ When a channel in LTE TDD band is selected, the burst signal SC-FDMA OFDM will be transmitted in standard time slot sequence.

Table 25 in Annex B lists the ARFCN channel arrangement.

Table 26 and Table 27 in Annex C list the UARFCN channel arrangement.

Table 28 and Table 29 in Annex D list the EARFCN channel arrangement.

2.4.1.2 <par2>, power level

```
AT+UTEST=3,[<par1>],<par2>[,<par3>,<par4>,<par5>]
```

<par2> controls the power of the transmitting signal. See Table 3 for the list of the <par2> allowed values.

Par	Description	Range	Default	Notes
<par2>	Power Control Level	-56 ÷ 24	5, 23 for TOBY-L1 / MPCI-L1 series	For 2G RAT: PCL (power control level). The allowed values depend on the related <par1> value: lower numbers mean higher power level: • [0-19]: for GSM 850 and 900, if <par2> is less than 5 the handling is the same for <par2>=5 • [0-15]: for DCS 1800 and PCS 1900 In case <par4> is set to 2 (8-PSK modulation), the range is as below: • [0-19]: for GSM 850 and 900, if <par2> is less than 8 the handling is the same for <par2>=8 • [0-15]: for DCS 1800 and PCS 1900, if <par2> is less than 2 the handling is the same for <par2>=2 For 3G RAT: absolute output power [dBm] • [-56 ÷ 24] for all the bands For 4G RAT: absolute output power [dBm] • [-40 ÷ 24] for all the bands

Table 4: <par2> parameter definition

☞ On TOBY-L2 series modules, the minimum value of the output power level <par2> is -50 dBm in 3G RAT.

☞ For the typical maximum output power values of each module in a specific band and technology, see the related data sheet [3], [4], [5], [6], [7], [8], [9], [10], [11], [12].

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2.4.1.3 <par3>, training sequence or BW

```
AT+UTEST=3,[<par1>],[<par2>],<par3>[,<par4>,<par5>]
```

Except for TOBY-L1 / MPCI-L1 series modules, the <par3> parameter defines the training sequence used during a 2G signal transmission test. If a network simulator is used during the measurement, the same training sequence must be set on the instrument to properly trigger the measurement. If a spectrum analyzer is used, the default value of <par3> can be used.

In 3G and 4G the <par3> parameter is unused. The default value or a value within the defined range can be used.

On TOBY-L1 / MPCI-L1 series, the <par3> parameter selects the bandwidth of the transmitted SC-FDMA OFDM signal.

Par	Description	Range	Default	Notes
<par3>	Training Sequence (TSC)	0 ÷ 7	5	Training sequence of the transmitted signal (to be changed only in case of link with network simulator, otherwise use the default value) In 3G and 4G RAT the value is unused.

Table 5: <par3> parameter definition for all u-blox modules except for TOBY-L1 / MPCI-L1 series

Par	Description	Range	Default	Notes
<par3>	BW	0 ÷ 5	2	Bandwidth of the transmitted SC-FDMA OFDM signal expressed in MHz: • 2: 5 MHz Only 2 (5 MHz) is supported. All other values will return ERROR.

Table 6: TOBY-L1 / MPCI-L1 <par3> parameter definition

2.4.1.4 <par4>, modulation mode

```
AT+UTEST=3,[<par1>],[<par2>],[<par3>],<par4>[,<par5>]
```

In all u-blox modules except for TOBY-L1 / MPCI-L1 series modules the <par4> parameter defines the modulation mode during a 2G transmission as defined in Table 7. The burst is transmitted in PRBS, therefore the RF power spectrum has the same shape as in normal operating mode.

On TOBY-L1 / MPCI-L1 series, the only value allowed for <par4> parameter is 0, corresponding to SC-FDMA modulation.

Par	Description	Range	Default	Notes
<par4>	Modulation mode	1 ÷ 2	1	Modulation mode • 1: GMSK normal modulation including TSC • 2: 8-PSK normal modulation including TSC In 3G and 4G RAT the parameter is unused. In LTE SC-FDMA OFDM modulation (5 MHz bandwidth) is automatically set

Table 7: <par4> parameter definition for all u-blox modules except for TOBY-L1 / MPCI-L1 series

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Par	Description	Range	Default	Notes
<par4>	Modulation mode	0	0	Modulation mode • 0: SC-FDMA

Table 8: TOBY-L1 / MPCI-L1 <par4> parameter definition

2.4.1.5 <par5>, time interval

```
AT+UTEST=3,[<par1>],[<par2>],[<par3>],[<par4>],<par5>
```

<par5> configures the time interval of the signal transmission (expressed in milliseconds). The transmitted signal can be: a 2G burst sequence, a 3G signal or a 4G signal.

Par	Description	Range	Default	Notes
<par5>	Time	0 ÷ 600000	1000	Time interval for TX test expressed in ms • 0: signal is continuously transmitted. In this case the command will immediately return the response. The command line is immediately available for any +UTEST command.

Table 9: <par5> parameter definition

☞ If <par5>= 0, the sequence is continuously transmitted and an OK result code will be sent soon after the command execution. After the OK result code, any another test command can be sent. The transmission can be stopped by sending the commands AT+UTEST=1. If another AT+UTEST=3 command with different parameters is sent, the transmission is changed, updating the used parameters.

☞ On TOBY-L2 / MPCI-L2 series, if the <par5> parameter is set to 0 and the user wants to change the used RAT with the next command, the execution of the current transmission must be stopped before proceeding.

2.4.2 Examples

2.4.2.1 Example 1: entering test mode and setting a transmission test

Command	Response	Description
`AT+COPS=2`	`OK`	
`AT+UTEST=1`	`OK`	
`AT+UTEST?`	`+UTEST: 1` `OK`	
`AT+UTEST=3,37,5,0,1,20000`	`+UTEST: 37,5,0,1,20000` `OK`	OK result code will be sent after 20 s. After OK result code another +UTEST command can be sent.

2.4.2.2 Example 2: GMSK bursts transmission test

Command	Response	Description
`AT+UTEST=3,699,3,2,1,4000`	`+UTEST: 699,3,2,1,4000` `OK`	The module will transmit for 4 s at channel 699 (frequency 1747.6 MHz in DCS 1800 band) with PCL = 3 (power level around 24 dBm) and training sequence = 1 in GMSK modulation.

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2.4.2.3 Example 3: sequence of continuous transmission tests (except for TOBY-L2 / MPCI-L2 series)

Command	Response	Description
AT+UTEST?	+UTEST: 1 OK	
AT+UTEST=3,37,5,0,1,0	+UTEST: 37,5,0,1,0 OK	
AT+UTEST=3,37,10,0,1,0	+UTEST: 37,10,0,1,0 OK	
AT+UTEST=3,975,10,0,1,0	+UTEST: 975,10,0,1,0 OK	
AT+UTEST=3,33428,0,0,1,0	+UTEST: 33428,0,0,1,0 OK	
AT+UTEST=3,33428,0,7,1,0	+UTEST: 33428,0,7,1,0 OK	
AT+UTEST=0	OK	
AT+UTEST?	+UTEST: 0 OK	

2.4.2.4 Example 4: 8-PSK bursts transmission test

Command	Response	Description
AT+UTEST=3,124,,3,2,5000	+UTEST: 124,5,3,2,5000 OK	The module transmits for 5 s at channel 124 (frequency 914.8 MHz in E-GSM 900 band) with PCL = 5 (maximum supported gamma is 6 (PCL8) corresponding to 27 dBm) and training sequence = 3 in 8-PSK modulation.

2.4.2.5 Example 5: WCDMA signal transmission test

Command	Response	Description
AT+UTEST=3,9750,23,,,10000	+UTEST: 9750,23,5,1,10000 OK	The module transmits for 10 s at channel 9750 (freq. 1950.0 MHz in band I) with power level 23 dBm in WCDMA modulation. <par3> and <par4> are not used

2.4.2.6 Example 6: LTE signal transmission test (except for TOBY-L1 / MPCI-L1)

Command	Response	Description
AT+UTEST=3,120174,23,,,10000	+UTEST: 120174,23,5,1,10000 OK	The module transmits for 10 s at channel 20174 (freq. 1732.4 MHz in LTE FDD band 4) with power level 23 dBm in SC-FDMA OFDM (5 MHz bandwidth) modulation. <par3> and <par4> are not used.

2.4.2.7 Example 7: LTE signal transmission test with TOBY-L1 / MPCI-L1

Command	Response	Description
AT+UTEST=3,123230,7,2,0,3000	+UTEST: 123230,7,2,0,3000 OK	The module transmits for 3 s at channel 23230 (freq. 782.0 MHz in LTE FDD band 13) with power level 7 dBm in SC-FDMA OFDM (5 MHz bandwidth) modulation.

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2.4.2.8 Example 8: sequence of LTE signal transmission tests (except for TOBY-L1 / MPCI-L1)

Command	Response	Description
AT+UTEST=3,124300,24	+UTEST: 124300,24,5,1,1000 OK	The module transmits for 1 s at channel 24300 (freq. 847.0 MHz in LTE FDD band 20) at maximum power level (see the corresponding module data sheet) in SC-FDMA OFDM (5 MHz bandwidth) modulation. <par3> and <par4> are not used, for <par5> the default value is used.
AT+UTEST=3,124300,23	+UTEST: 124300,23,5,1,1000 OK	The module transmits for 1 s at channel 24300 with power level 23 dBm.
AT+UTEST=3,124300,10	+UTEST: 124300,10,5,1,1000 OK	The module transmits for 1 s at channel 24300 with power level 10 dBm.
AT+UTEST=3,124300,-20	+UTEST: 124300,-20,5,1,1000 OK	The module transmits for 1 s at channel 24300 with power level -20 dBm.

2.4.2.9 Example 9: sequence of generic signal transmission tests with TOBY-L2 / MPCI-L2

Command	Response	Description
AT+UTEST=3,190,5,,,0	+UTEST: 190,5,5,1,0 OK	The module continuously transmits at channel 190 (freq. 836.6 MHz in GSM 850 MHz band) with maximum power level (PCL 5) in GMSK modulation.
AT+UTEST=3,190,8,,2,0	+UTEST: 190,8,5,2,0 OK	The module continuously transmits at channel 190 in 8-PSK modulation with maximum power level (PCL 8 / gamma 6).
AT+UTEST=1	OK	This command is used to stop the execution of the previous command and allows the user to change the RAT in the next command.
AT+UTEST=3,9400,23	+UTEST: 9400,23,5,1,1000 OK	The module transmits for 1 s at channel 9400 (freq. 1880.0 MHz in band 2) with power level 23 dBm in WCDMA modulation.
AT+UTEST=3,4182,23,,,0	+UTEST: 4182,23,5,1,0 OK	The module continuously transmits at channel 4182 (freq. 836.4 MHz in band 5) with power level 23 dBm in WCDMA modulation.
AT+UTEST=1	OK	This command is used to stop the execution of the previous command and allows the user to change the RAT in the next command.
AT+UTEST=3,119574,23,,,0	+UTEST: 119574,23,5,1,0 OK	The module continuously transmits at channel 19574 (freq. 1747.4 MHz in FDD band 3) with power level 23 dBm in LTE modulation.
AT+UTEST=3,121100,23	+UTEST: 121100,23,5,1,1000 OK	The module transmits for 1 s at channel 21100 (freq. 2535.0 MHz in FDD band 7) with power level 23 dBm in LTE modulation.

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2.5 Reception test (AT+UTEST=2)

To avoid module damage during receiver testing, the maximum power level received at ANT / ANT1 pin and at ANT_DIV / ANT2 pin must comply with module specifications (see the specific module data sheet [3], [4], [5], [6], [7], [8], [9], [10], [11], [12]). Do not exceed a power level of -15 dBm at the antenna ports.

2.5.1 AT+UTEST=2 command syntax

Measurement of the received power level can be done using this command syntax:

```
AT+UTEST=2,<par1>,<par2>
```

If diversity or a secondary antenna is supported, the command syntax is:

```
AT+UTEST=2,<par1>,<par2>,<par3>
```

where <par1>, <par2>, <par3> are optional command parameters. If a parameter is omitted, the default value is used.

The information text response provides the receiver measurement report, respectively:

```
+UTEST: <par1>,<par2>,<min>,<avg>,<max>
+UTEST: <par1>,<par2>,<par3>,<min>,<avg>,<max>
```

where <min>, <avg> and <max> values are antenna RF level estimates.

See sections 2.5.1.1 to 2.5.1.4 for the lists of the allowed values. If an out of range value is issued an error result code will be provided ("+CME ERROR: operation not supported" if +CMEE is set to 2).

An error result code will be provided ("+CME ERROR: operation not supported" if +CMEE is set to 2) if the RX channel parameter values belong to a not supported technology RAT (2G, 3G or 4G RAT) or band.

2.5.1.1 <par1>, channel

```
AT+UTEST=2,<par1>[,<par2>]
```

<par1> defines the channel of the received signal. Table 10 and Table 11 define the values of <par1> according to the specific band and technology. For each technology, the band is automatically selected depending on the used channel.

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Par	Description	Range	Default	Notes
<par1>	Channel	0 ÷ 165535	32	Rx channel for 2G RAT; for 850, 900, 1800 bands the value corresponds to the ARFCN while for 1900 band an offset of 32768 is added: • [0-124]: GSM 900 MHz • [128-251]: GSM 850 MHz • [512-885]: DCS 1800 MHz • [975-1023]: EGSM 900 MHz • [33280-33578]: PCS 1900 MHz (corresponding to ARFCN 512-810) Rx channel for 3G RAT; the value corresponds to the UARFCN, additional channels available in some 3G bands are not supported: • [1537 – 1738]: band 4 (1700 MHz) • [2937-3088]: band 8 (900 MHz) • [4357-4458]: band 5 (850 MHz) (Band 6 is a subset) • [9662-9938]: band 2 (1900 MHz) (additional not supported) • [10562-10838]: band 1 (2100 MHz) Rx channel for 4G RAT; the value corresponds to the EARFCN with an offset of 100000: • [102750 – 103449]: FDD Band 7 (EARFCN range 2750 – 3449) • [101950 – 102399]: FDD Band 4 (EARFCN range 1950 – 2399) • [100000 – 100599]: FDD Band 1 (EARFCN range 0 – 599) • [100600 – 101199]: FDD Band 2 (EARFCN range 600 – 1199) • [101200 – 101949]: FDD Band 3 (EARFCN range 1200 – 1949) • [103450 – 103799]: FDD Band 8 (EARFCN range 3450 – 3799) • [102400 – 102649]: FDD Band 5 (EARFCN range 2400 – 2649) • [105010 – 105179]: FDD Band 12 (EARFCN range 5010 – 5179) • [105180 – 105279]: FDD Band 13 (EARFCN range 5180 – 5279) • [106150 – 106449]: FDD Band 20 (EARFCN range 6150 – 6449) • [109210 – 109659]: FDD Band 28 (EARFCN range 9210 – 9659) • [105730 – 105849]: FDD Band 17 (EARFCN range 5730 – 5849)

Table 10: <par1> parameter definition for all u-blox modules except for TOBY-L1 / MPCI-L1 series

Par	Description	Range	Default	Notes
<par1>	Channel	100001 ÷ 199999	102286	RX channel 4G RAT: the value corresponds to the EARFCN with an offset of 100000. • [105180-105279]: band 13 • [101950-102399]: band 4

Table 11: TOBY-L1 / MPCI-L1 <par1> parameter definition

Table 25 in Annex B lists the ARFCN channel arrangement.

Table 26 and Table 27 in Annex C list the UARFCN channel arrangement.

Table 28 and Table 29 in Annex D list the EARFCN channel arrangement.

When the measurement is performed using a signal generator, as described in section 2.2.2, set the frequency of the instrument with an offset of +30 kHz (or -30 kHz) from the desired frequency (e.g. if the desired frequency is 942400 kHz, then set the frequency to 942430 kHz) for a correct power level measurement. Modulation setting on the signal generator is not required.

If a network simulator is used to perform the measurement, as described in section 2.2.1, the same frequency offset of +30 kHz (or -30 kHz) should be set. Make sure to set the transmission to continuous mode and switch off bit modulation on the instrument.

☞ On TOBY-R2 / LARA-R2 series, an offset of +500 kHz (or -500 kHz) should be set.

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2.5.1.2 <par2>, time interval

```
AT+UTEST=2,[<par1>],<par2>
```

The <par2> configures the time interval (in milliseconds) for the measurement of the received signal power. After the command is sent, the module is triggered to measure the receiving carrier power level within the time interval.

Par	Description	Range	Default	Notes
<par2>	Time	1 ÷ 600000, 50 ÷ 600000 for TOBY-L2 / MPCI-L2 series	1000	Time interval for RX test measurement expressed in ms

Table 12: <par2> parameter definition

2.5.1.3 <par3>, antenna path

```
AT+UTEST=2,[<par1>],[<par2>],<par3>
```

The <par3> parameter configures the measurement path: main / primary or diversity / secondary antenna can be selected. After the command is sent, the module is triggered to measure the received carrier power level within the time interval through the selected path.

Par	Description	Range	Default	Notes
<par3>	Rx_Antenna	0 or 1	0	Receiver path: • 0: main / primary antenna • 1: diversity / secondary antenna

Table 13: <par3> parameter definition

☞ The <par3> parameter is available only on modules supporting antenna diversity or secondary antenna.

2.5.1.4 <min>,<avg>,<max> parameters definition

```
+UTEST: <par1>,<par2>,<min>,<avg>,<max>
+UTEST: <par1>,<par2>,<par3>,<min>,<avg>,<max>
```

After the time interval defined by <par2>, the command returns the minimum, average and maximum RMS of the received power level expressed in dBm. The average level is calculated during the whole time interval.

Table 14 defines the receiver power level range for <min>, <avg> and <max> parameters.

Par	Description	Range	Default	Notes
<min>, <avg>, <max>	Minimum, average and maximum antenna RF level estimation	-100 ÷ -20		Power level expressed in dBm 2G measurement, reported level range: • [-100 ÷ -20] for all u-blox modules except for TOBY-L2 / MPCI-L2 series • [-100 ÷ -30] for TOBY-L2 / MPCI-L2 series 3G and 4G measurement, reported level range: • [-90 ÷ -20] for all u-blox modules except for TOBY-L2 / MPCI-L2 series • [-90 ÷ -30] for TOBY-L2 / MPCI-L2 series

Table 14: <min>, <avg> and <max> parameters definition

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The power level estimate (<min>, <avg> and <max>) corresponds to the RXLEV value: signal strength reported by the mobile in the normal operating mode. Accuracy and tolerance specified in 3GPP TS 05.05 [17], 3GPP TS 25.101 [18] and 3GPP TS 36.101 [19] are not applicable, since in normal operating mode a correction algorithm is used. Nevertheless <min>, <avg> and <max> can be assumed to be a good estimate of the average received power. An extracted table for 3GPP tolerance is shown in Table 30 of Annex E.

2.5.2 Examples

2.5.2.1 Example 1: entering test mode and setting a reception test

Command	Response	Description
AT+COPS=2	OK	
AT+UTEST=1	OK	
AT+UTEST?	+UTEST: 1 OK	
AT+UTEST=2,37,5000	+UTEST: 37,5000,-80,-80,-80 OK	The module measures the receiver power level for 5 s at channel 37 (frequency 942.4 MHz in E-GSM 900 band). After a time interval, the information text response contains: the channel number, the time interval and the minimum, average, maximum power levels.

The signal generator used during this test (see section 2.2.2) transmits a carrier at 942.430 MHz with power level -80 dBm, while the module measures the RF level at the expected GSM frequency 942.4 MHz over 5 s.

After the OK result code another +UTEST command can be sent.

2.5.2.2 Example 2: sequence of reception tests

Command	Response	Description
AT+UTEST=2,37,250	+UTEST: 37,250,-80,-80,-80 OK	
AT+UTEST=2,124,250	+UTEST: 124,250,-80,-80,-80 OK	
AT+UTEST=2,124,250	+UTEST: 124,250,-60,-60,-60 OK	
AT+UTEST=2,699,250	+UTEST: 699,250,-68,-68,-68 OK	

2.5.2.3 Example 3: reception tests with signal generator switched off or with wrong settings

Command	Response	Description
AT+UTEST=2,37,5000	+UTEST: 37,5000,-100,-100,-100 OK	

The signal generator was switched off or was transmitting a carrier at a different frequency. The module response is -100 dBm as the lower level limit.

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2.5.2.4 Example 4: WCDMA signal reception test

Command	Response	Description
`AT+UTEST?`	`+UTEST: 1` `OK`	
`AT+UTEST=2,9800,2000`	`+UTEST: 9800,2000,-60,-60,-60` `OK`	

The signal generator transmits a carrier at 1960.03 MHz with a power level of -60 dBm while the module measures the RF level at the expected WCDMA band 2 channel 9800 frequency 1960.0 MHz over 2 s.

2.5.2.5 Example 5: reception test at the ANT_DIV port

Command	Response	Description
`AT+UTEST=2,698,500,1`	`+UTEST: 698,500,1,-74,-75,-75` `OK`	

The signal generator connected to the diversity antenna transmits a carrier at 1842.43 MHz with a power level of -75 dBm while the module measures the RF level at the expected DCS 1800 band channel 698 frequency 1842.4 MHz over 500 ms.

2.5.2.6 Example 6: LTE signal reception test

Command	Response	Description
`AT+UTEST=2,101950,5000`	`+UTEST: 101950,5000,-70,-70,-70` `OK`	
`AT+UTEST=2,105230,500`	`+UTEST: 105230,500,-60,-60,-60` `OK`	

During the first command the signal generator transmits a carrier at 2110.03 MHz with a power level of -70 dBm while the module measures the RF level at the expected LTE FDD band 4 channel 1950 frequency 2110.0 MHz over 5 s.

During the second command the signal generator transmits a carrier at 751.03 MHz with a power level of -60 dBm while the module measures the RF level at the expected LTE FDD band 13 channel 5230 frequency 751.0 MHz over 0.5 s.

2.5.2.7 Example 7: LTE signal reception test at the ANT2 port

Command	Response	Description
`AT+UTEST=2,101200,2000,1`	`+UTEST: 101200,2000,1,-75,-75,-75` `OK`	

The signal generator connected to the secondary antenna transmits a carrier at 1805.03 MHz with a power level of -75 dBm while the module measures the RF level at the expected LTE FDD band 3 channel 1200 frequency 1805.0 MHz over 2 s.

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3 RF testing use cases

When the cellular module operates in normal conditions with a real GSM (and all the supported systems) network, the base station controls the power level. The full control of the power levels is reproducible only using a GSM/WCDMA/LTE network simulator with signaling capabilities.

Transmitting a GSM burst (GMSK / 8-PSK), a WCDMA signal or a LTE signal at maximum (or predefined) power levels is useful in some tests when a GSM/WCDMA/LTE network simulator with signaling capabilities is not available (see section 2.2). In the following sections, the use of the +UTEST AT command during the execution of several prototype check and production tests is described.

3.1 Prototype check: VCC or 3.3Vaux voltage drop and ripple

To check the application board power supply performance, the module can be triggered for an RF signal transmission without GSM/WCDMA/LTE network simulator aiding. The voltage drop and ripple can be checked at the **VCC** or **3.3Vaux** module pins. The voltage drop should be tested in the worst case, forcing a maximum transmitted power: use the +UTEST AT command in transmission mode, setting a channel in one of the lower bands (850 MHz or 900 MHz), GMSK modulation, maximum PCL (5) and continuous time interval (0). These are the most suitable parameters for the measurement if the module supports 2G networks; otherwise set the maximum power and a channel in any of the supported bands. If the RF power measurement is not needed, connect a 50 Ω termination at the **ANT** or **ANT1** pin during the test execution.

The power supply performance can also be tested connecting the actual antenna (compliant with the recommendations reported in the module's system integration manual) at the **ANT** or **ANT1** pin or simulating a mismatching condition (with VSWR up to 3:1) using a tunable stub.

3.1.1 Example: TX power and VCC or 3.3Vaux voltage drop during GMSK burst

Use, for example, the setup reported in the first image of Figure 3, with a 10 dB attenuator at the **ANT** or **ANT1** pin and a 50 Ω cable for the connection to the spectrum analyzer (or power meter) input port. Connect a probe of an oscilloscope to the **VCC** or **3.3Vaux** module pins.

Command	Response	Description
`AT+COPS=2`	`OK`	
`AT+UTEST=1`	`OK`	
`AT+UTEST=3,37,5,,1,0`	`+UTEST: 37,5,5,1,0` `OK`	

Figure 5 shows the GMSK time slot burst sequence at the maximum power level in the middle channel of E-GSM 900 MHz band.

The power level is measured with the spectrum analyzer.

Figure 6 shows the corresponding VCC (or 3.3Vaux) voltage profile measured with the oscilloscope.

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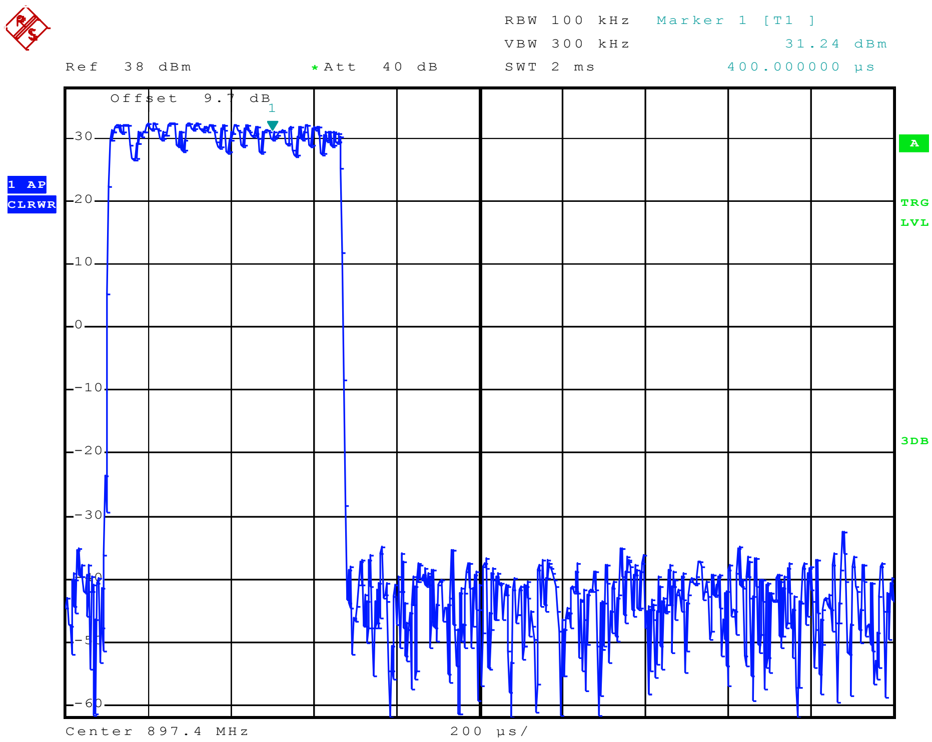

Figure 5: Measurement of the GMSK TX burst power level with a spectrum analyzer (PCL 5, E-GSM 900 band)

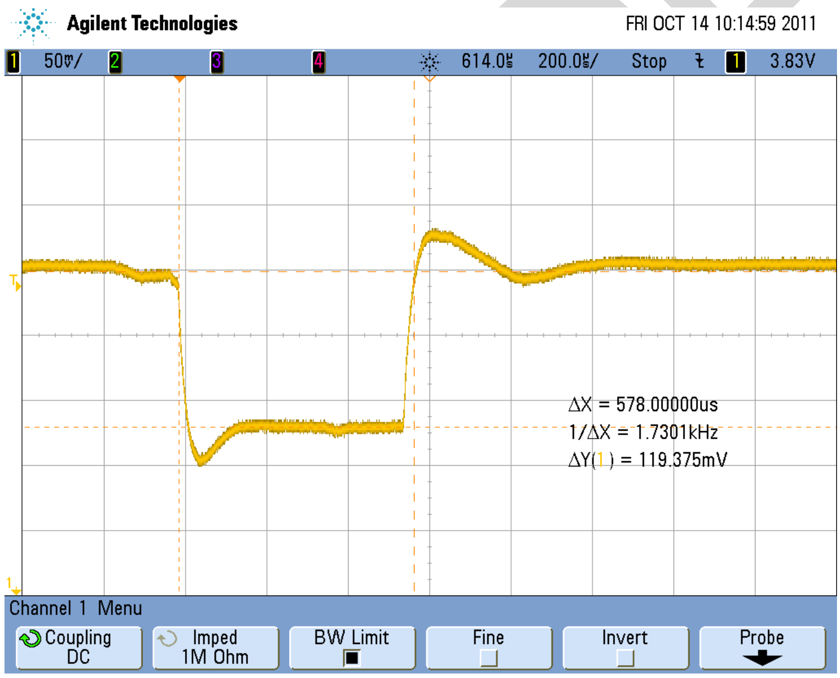

Figure 6: VCC (or 3.3Vaux) profile during a GMSK TX burst at PCL 5 in E-GSM 900 band

3.2 Prototype check: VCC or 3.3Vaux current consumption during transmission burst

To check the power supply current consumption from the **VCC** or **3.3Vaux** pins, the module can be triggered to transmit an RF signal without GSM/WCDMA/LTE network simulator aiding. If the RF power measurement is not needed, connect a 50 Ω termination at the **ANT** or **ANT1** pin during the test execution.

The current consumption can also be tested connecting an antenna (compliant with the recommendations reported in the module's system integration manual) at the **ANT** or **ANT1** pin or simulating a mismatching condition (with VSWR up to 3:1) using a tunable stub.

To measure the current consumption, force the module to transmit in test mode at a specific power level using the +UTEST AT command.

3.3 Prototype check: Transmitted RF signal

The module can be triggered to transmit a 2G burst (GMSK/8-PSK), a 3G WCDMA signal and a LTE signal without GSM/WCDMA/LTE network simulator aiding to check the following items:

- Application board RF circuitry
- Module soldering on the application board
- Module damage during soldering reflow

The target is to measure the RF power in all the supported bands and modulation modes. For example, use the setup reported in the first image of Figure 3 for conducted measurements, with a 10 dB attenuator at the **ANT** or **ANT1** pin and a 50 Ω cable for the connection to the spectrum analyzer (or power meter) input port.

Otherwise use the setup reported in the first image of Figure 4 for radiated measurements, using an antenna compliant with the recommendations reported in the module's system integration manual at the **ANT** or **ANT1** pin.

3.3.1 Example: maximum TX power of GMSK and 8-PSK bursts

Command	Response	Description
`AT+UTEST=3,37,5,,1,0`	`+UTEST: 37,5,5,1,0` `OK`	GMSK measurement
`AT+UTEST=3,37,5,,2,0`	`+UTEST: 37,5,5,2,0` `OK`	8-PSK measurement

Figure 7 and Figure 8 show measurements of GMSK and 8-PSK bursts in the middle channel of the E-GSM 900 MHz band.

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For precise measurements of the power levels according to 3GPP specifications TS 05.05 [17] and TS 25.101 [18], use a spectrum analyzer with these settings:

- Manual attenuation = 40 dB
- Reference level offset = external attenuator + cable loss
- Reference level = 38 dBm
- Center frequency = 897.4 MHz
- Span = ZERO SPAN
- Sweep time = 800 µs
- Resolution bandwidth RBW = 1 MHz
- Video bandwidth VBW = 3 MHz
- RBW filter type = Normal 3 dB
- Trigger = VIDEO
- Trigger level = -12 dBm
- Trigger offset = -100 µs
- Trace detector = sample
- Trace = AVERAGE
- Trace average mode = POWER
- Sweep count = 200
- Marker position = 400 µs

Figure 9 and Figure 10 show power level measurements performed in the middle channel of E-GSM 900 MHz band at maximum control power level in GMSK and 8-PSK respectively, using the spectrum analyzer settings defined above.

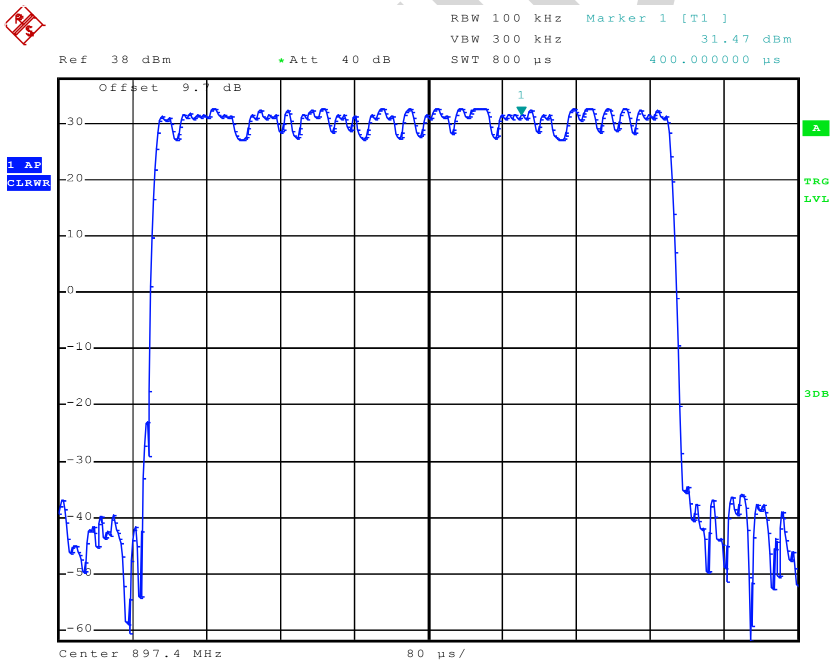

Figure 7: GMSK TX burst (PCL 5, E-GSM 900 band)

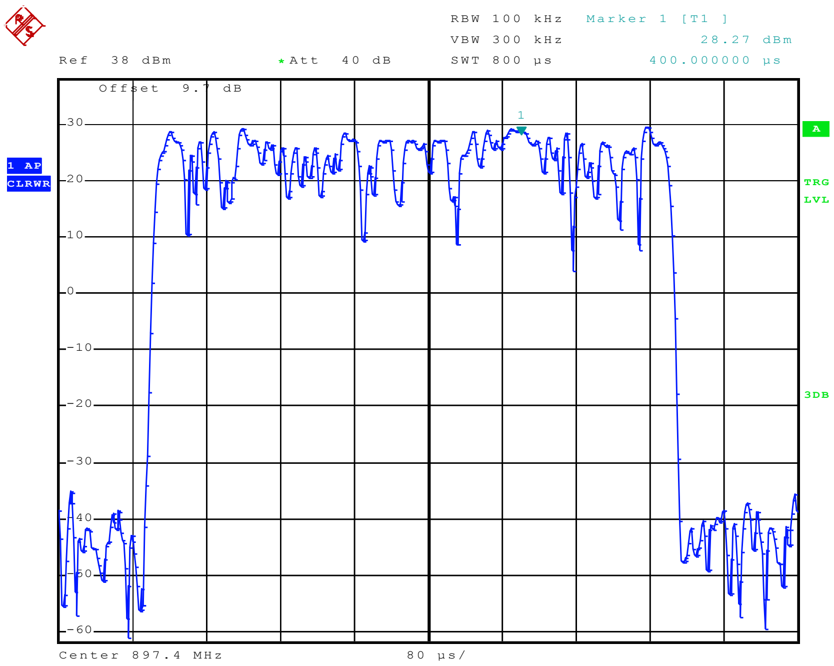

Figure 8: 8-PSK TX burst (PCL 5, E-GSM 900 band)

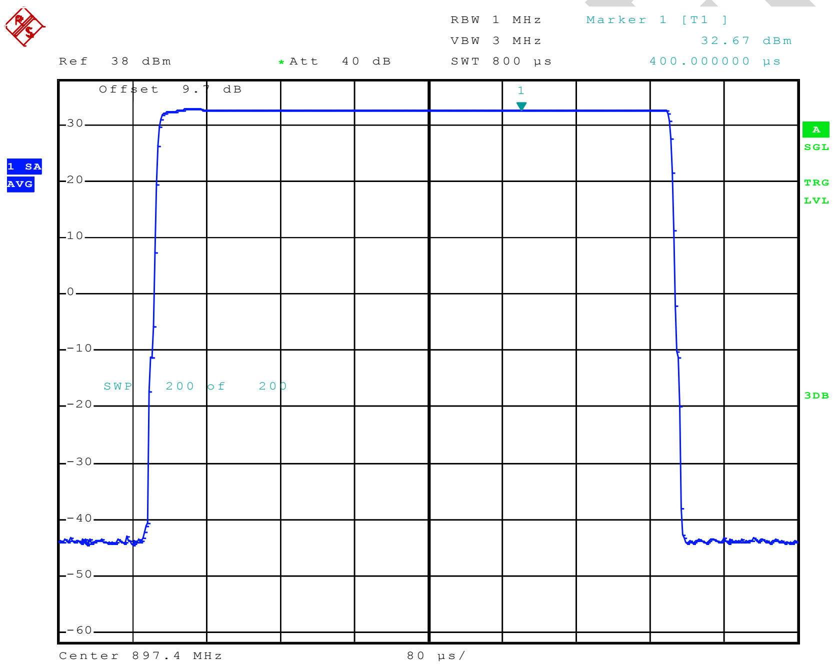

Figure 9: Power level measurement of a GMSK TX burst (PCL 5, E-GSM 900 band) using a spectrum analyzer and the settings defined in 3GPP specifications *TS 05.05* [17] and *TS 25.101* [18]

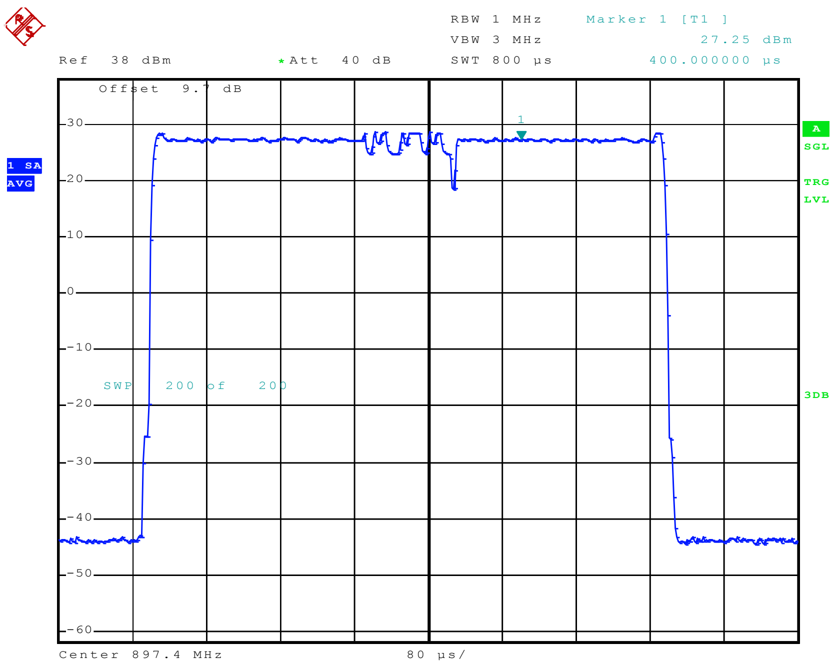

Figure 10: Power level measurement of a 8-PSK TX burst (PCL 5, E-GSM 900 band) using a spectrum analyzer and the settings defined in 3GPP specifications *TS 05.05* [17] and *TS 25.101* [18]

3.3.2 Example: maximum TX power of WCDMA signals

Command	Response	Description

`AT+UTEST=3,9750,23,,,0`	`+UTEST: 9750,23,5,1,0`
	
	`OK`
		WCDMA measurement

Figure 11 shows the measurement of a WCDMA signal transmitted in the middle channel of band 1 (1950 MHz).

For precise measurements of the power levels according to 3GPP specifications TS 05.05 [17] and TS 25.101 [18], use a spectrum analyzer with the following settings:

- Reference level offset = external attenuator + cable loss
- Reference level = 38 dBm
- Center frequency = 1950.0 MHz
- Span = 30 MHz
- Sweep time = 2.5 ms
- RBW filter type = RRC (Root Raise Cosine)
- Resolution bandwidth RBW = 3.84 MHz
- Video bandwidth VBW = 10 MHz
- Trigger = FREE RUN
- Trace detector = sample
- Trace = AVERAGE
- Trace average mode = POWER
- Sweep count = 200
- Marker position = 1950 MHz

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Figure 12 shows a power level measurement performed in the middle channel of band 1 (1950 MHz) at maximum power level (23 dBm) in WCDMA modulation, using the spectrum analyzer settings defined above.

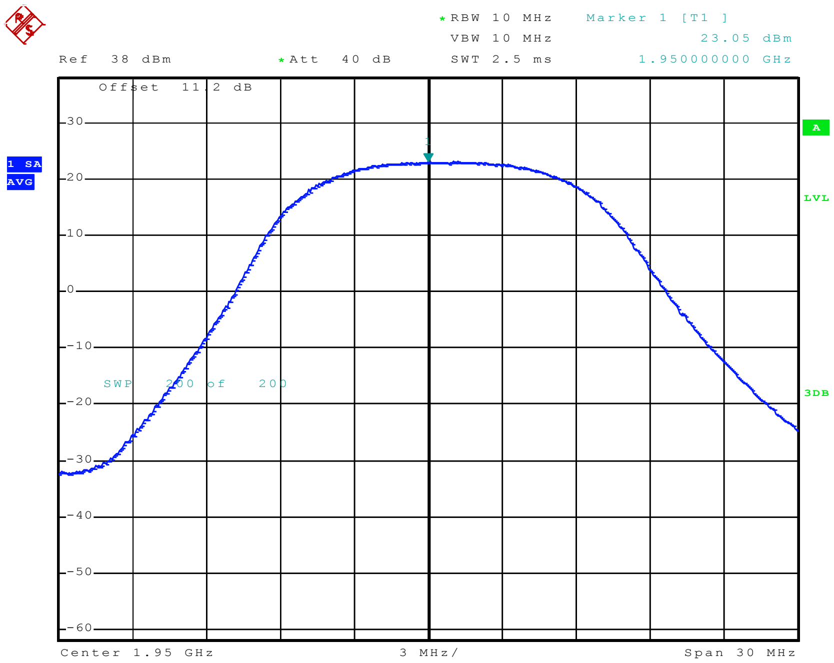

Figure 11: WCDMA TX signal (band 1, maximum power)

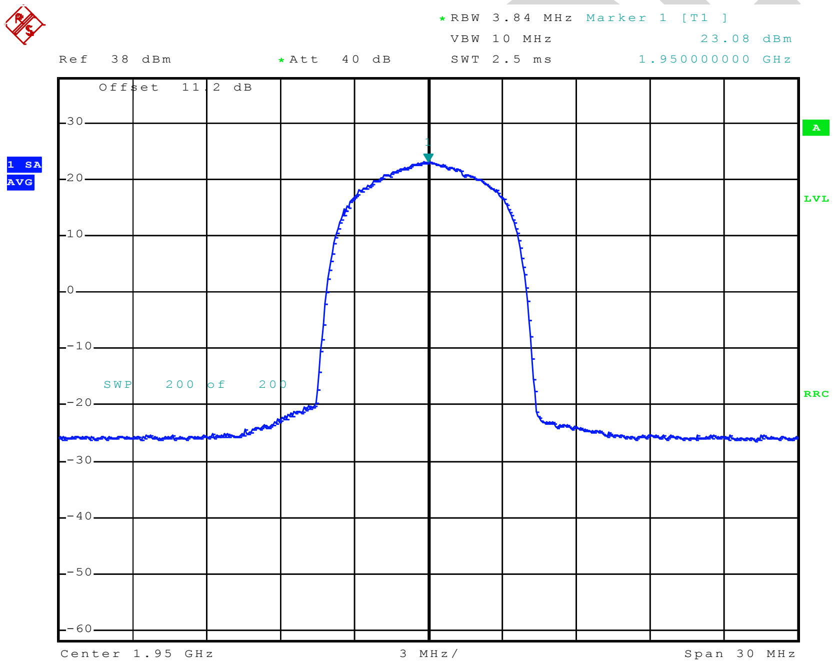

Figure 12: Power level measurement of a WCDMA signal (band 1, maximum power) using a spectrum analyzer and the settings defined in 3GPP specifications *TS 05.05* [16] and *TS 25.101* [17]

3.3.3 Example: maximum TX power of LTE signals

Command	Response	Description
`AT+UTEST=3,1412,23,,,0`	`+UTEST: 1412,23,5,1,0` `OK`	LTE FDD measurement

Figure 13 shows the measurement of a LTE SC-FDMA OFDM signal (5 MHz bandwidth) transmitted in the middle channel of FDD band 4 (1732.4 MHz).

For precise measurements of the power levels according to 3GPP specification TS 36101 [19], use a spectrum analyzer with the following settings:

- Manual attenuation = 40 dB
- Reference level offset = external attenuator + cable loss
- Reference level = 38 dBm
- Center frequency = 1732.4 MHz
- Span = 30 MHz
- Sweep time = 2.5 ms
- RBW filter type = RRC (Root Raise Cosine)
- Resolution bandwidth RBW = 3.84 MHz
- Video bandwidth VBW = 10 MHz
- Trigger = FREE RUN
- Trace detector = sample
- Trace = AVERAGE
- Trace average mode = POWER
- Sweep count = 200
- Marker position = 1732.4 MHz

Figure 14 shows a power level measurement performed in the middle channel of FDD band 4 (1732.4 MHz) at maximum power level (23 dBm) in LTE SC-FDMA OFDM modulation (5 MHz bandwidth), using the spectrum analyzer settings defined above.

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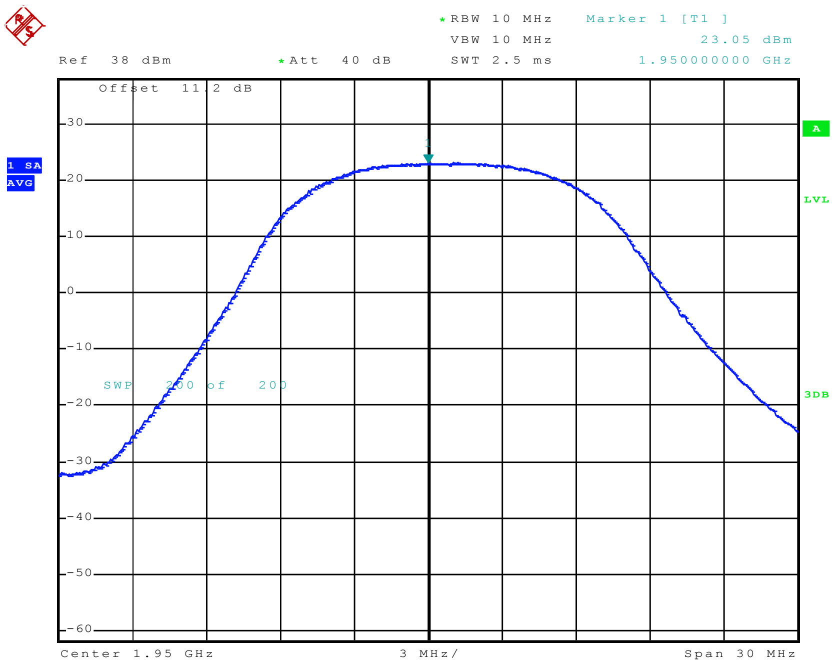

Figure 13: LTE FDD signal (band 4, maximum power)

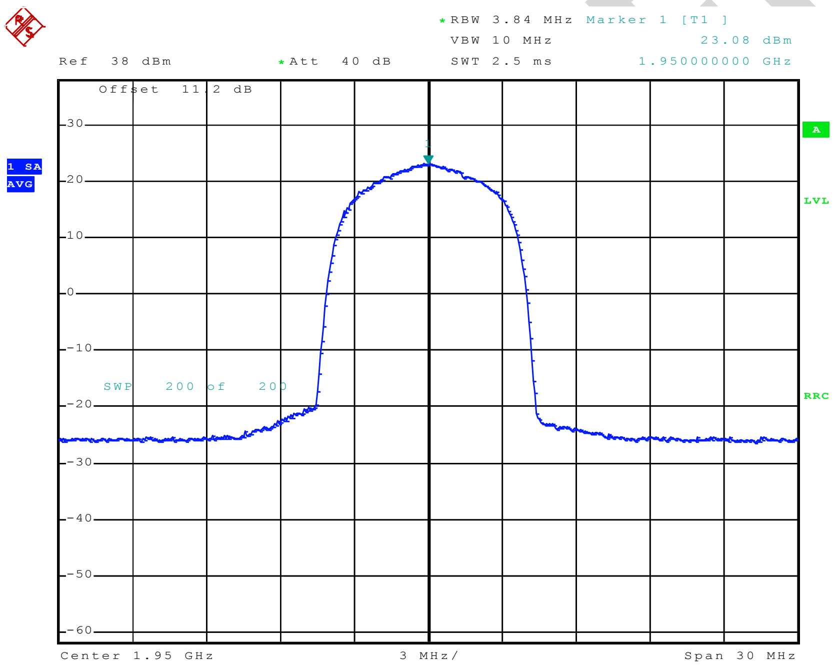

Figure 14: Power level measurement of a LTE FDD signal (band 4, maximum power) using a spectrum analyzer and the settings defined in 3GPP *TS 36101* [19]

3.4 Prototype check: spurious emission

To check if the application board maintains the module RF performance and if EM interference with application board electronic components causes spurious emissions outside of the specifications, the module can be triggered to transmit an RF signal without GSM/WCDMA/LTE network simulator aiding (see section 2.2). In this case it is typically necessary to measure the level of the emitted power at specific frequencies or at frequencies that are multiples of the carrier (harmonic signals). Spurious emission tests can be performed in two ways: conducted or radiated. In order to perform these measurements use a spectrum analyzer or a power meter.

When measuring conducted spurious emissions, use the setup reported in the first image of Figure 3, adding a high pass filter before the spectrum analyzer (or power meter) to cut the carrier power and better use the instrument dynamic range. To avoid module antenna mismatch insert a 10 dB attenuator between the **ANT** or **ANT1** pin and the filter input. Conducted spurious emission should be controlled up to 12.75 GHz as per 3GPP specifications TS 05.05 [17], TS 25.101 [18], TS 36.101 [19].

To evaluate the radiated spurious emissions, use the setup reported in the first image of Figure 4, adding a high pass filter between a wideband receiving antenna and the spectrum analyzer (or power meter) input port. In this case an attenuator is not needed since the **ANT** or **ANT1** pin is terminated with the antenna and the filter is placed at the instrument input. Radiated emissions should be checked up to 4 GHz as per 3GPP specifications TS 05.05 [17], TS 25.101 [18], TS 36.101 [19], up to 6 GHz according to FCC rules. The setup described allows user to carry out qualitative measurements; in order to correctly test radiated spurious emission, according to FCC and 3GPP specifications, an anechoic chamber and a precise testing setup are needed.

3.4.1 Example: conducted spurious evaluation and harmonic measurement during GMSK burst

The setup reported in the first image of Figure 3 is used, adding a 10 dB attenuator at the **ANT** or **ANT1** pin and a high pass filter (cutoff frequency 1.4 GHz). The module is set to transmit a GSMK burst in the E-GSM 900 MHz band, ch37 (897.4 MHz) at maximum control power level (PCL 5) through the +UTEST AT command. Measurements are performed with a spectrum analyzer.

Command	Response	Description
`AT+UTEST=3,37,5,,1,0`	`+UTEST: 37,5,5,1,0` `OK`	GMSK spurious measurement

Figure 15 shows a conducted spurious emissions measurement from 800 MHz to 6 GHz. The used spectrum analyzer settings are as follows:

- Manual attenuation = 0 dB
- Reference level offset = external attenuator + High Pass filter insertion loss + cable loss
- Reference level = 0 dBm
- Start frequency = 800 MHz
- Stop frequency = 6 GHz
- Sweep time = AUTO
- Resolution bandwidth RBW = 3 MHz
- Video bandwidth VBW = 10 MHz
- RBW filter type = Normal 3 dB
- Trigger = FREE RUN
- Trace detector = sample
- Trace = MAX HOLD
- Marker position = peaks

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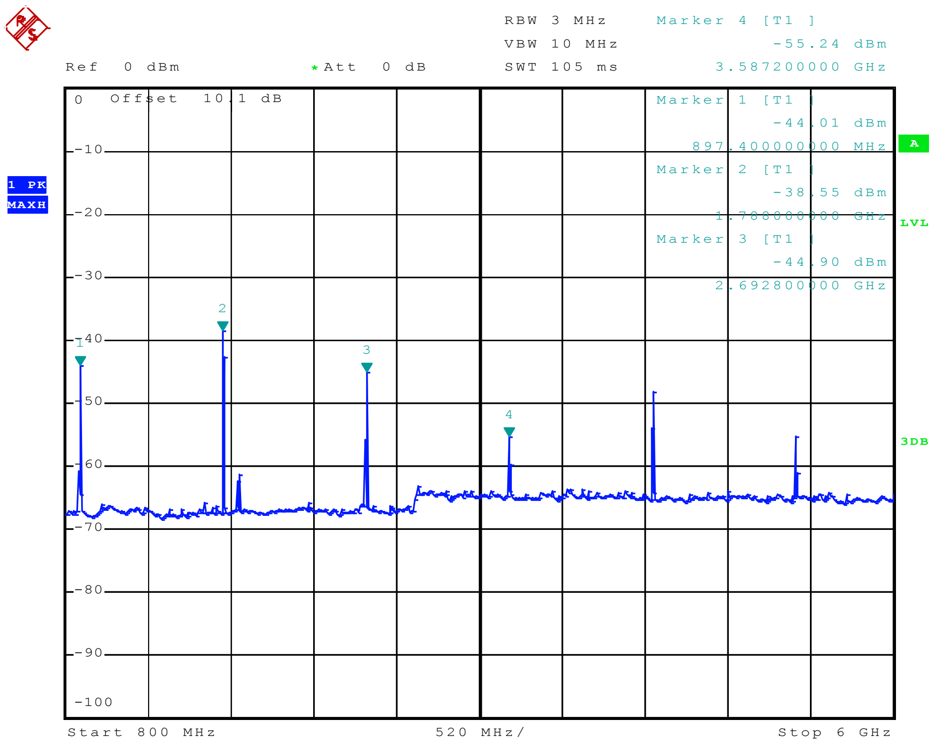

Figure 15: Conducted spurious emission measurement with GMSK carrier (PCL 5, E-GSM 900 band, ch37, 897.4 MHz)

When a precise measurement setup according to 3GPP TS 05.05 [17], 3GPP TS 25.101 [18] is used, the expected emissions should be lower than -36 dBm at frequencies below 1 GHz and lower than -30 dBm from 1GHz to 12.75 GHz.

Figure 16 shows the conducted spurious emission measurement of the 3rd harmonic frequency. The spectrum analyzer is set in zero span mode using the following parameters:

- Manual attenuation = 0 dB
- Reference level offset = external attenuator + HPF insertion loss + cable loss at 2692.2 MHz
- Reference level = 0 dBm
- Center frequency = 2692.2 MHz
- Span = ZERO SPAN
- Sweep time = 800 µs
- Resolution bandwidth RBW = 3 MHz
- Video bandwidth VBW = 10 MHz
- RBW Filter type = Normal 3dB
- Trigger = VIDEO
- Trigger level = -60 dBm
- Trigger offset = -100 µs
- Trace detector = sample
- Trace = MAX HOLD
- Sweep count = 200
- Marker position = Peak

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The expected result, according to 3GPP TS 05.05 [17], 3GPP TS 25.101 [18], should be lower than -30 dBm.

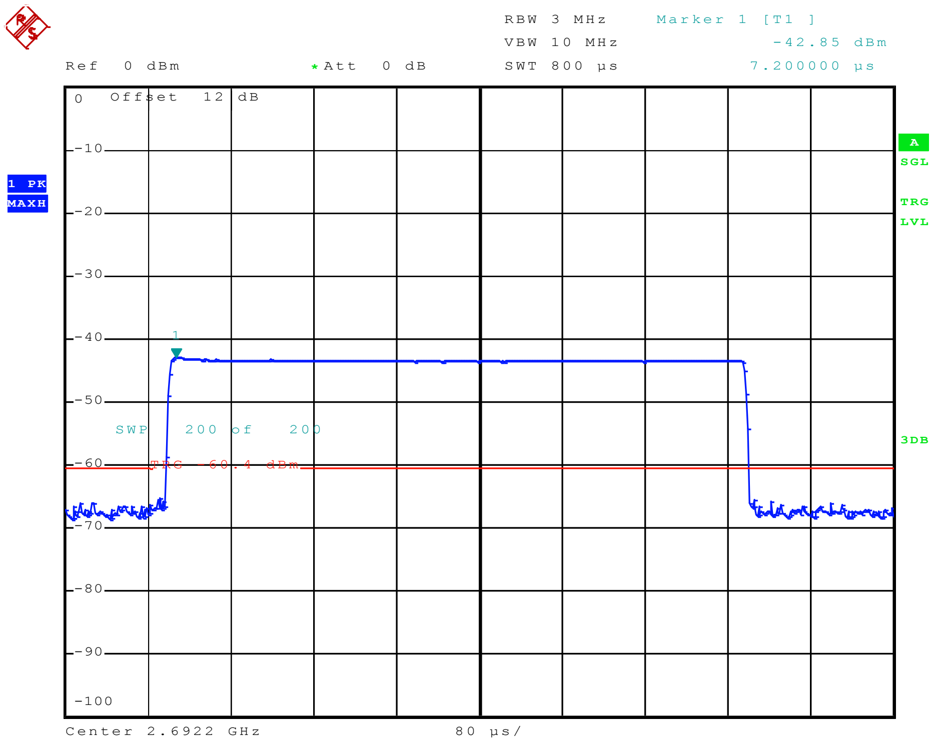

Figure 16: Conducted spurious emission measurement of the 3rd harmonic of the GSMK carrier (PCL 5, E-GSM 900 band, ch37, 897.4 MHz)

3.5 Prototype check: switching and modulation spectrum

To see if the application board preserves module RF performance, the module can be triggered to transmit an RF signal without GSM/WCDMA/LTE network simulator aiding. The modulation and switching spectrum can be measured with a spectrum analyzer according to 3GPP specifications TS 05.05 [17], TS 25.101 [18] and TS 36.101 [19]. Nevertheless, the easiest way is to use a network simulator with signaling capability (setup shown in Figure 2). See LEON-G100 / LEON-G200 series Prototype Checklist [14].

3.6 Prototype check: GNSS performance evaluation

In applications integrating GNSS and GSM/WCDMA/LTE technologies, the GNSS receiver performance can be evaluated by forcing the module to transmit a GSM/WCDMA/LTE signal through the +UTEST AT command. This measurement can help to evaluate:

- The GNSS and cellular antenna coupling
- The RF filters used
- The GNSS anti-jamming performance

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3.7 Prototype check: thermal evaluation

Thermal conditions and thermal dissipation of the application board with integrated cellular module can be evaluated by using the +UTEST AT command and forcing the module to transmit a GSM/WCDMA/LTE signal at maximum power. Repeat the test in all the useful operating bands and optimize the design in terms of thermal dissipation.

Perform these measurements with the antenna connected to the **ANT** or **ANT1** pin to take into account the thermal contribution caused by the antenna matching and radiation characteristics.

3.7.1 Testing thermal protection activation with SARA-U2 series

SARA-U2 series modules implement an integrated thermal protection algorithm when operating in 3G RAT to guarantee functionality and long life span of the application board (for more details see the SARA-G3 /SARA-U2 System Integration Manual [13]).

The thermal protection may be activated during long 3G connections with the module forced to transmit at maximum power. This scenario is extremely not common for a device operating on real networks but may occur during Total Radiated Power (TRP) OTA certification tests (according to CTIA test plan).

The customer that must perform TRP certification tests should accurately evaluate the thermal dissipation of the application board and avoid the activation of the thermal protection.

To verify the thermal protection activation, perform these operations:

- Refer to the setup reported in the first image of Figure 4, consisting of: the application board, a UMTS test antenna, and a power meter (or a spectrum analyzer).

  Perform the test in a stable and unchanging environment
- Set the module to continuously transmit at the maximum power in a 3G band using AT+UTEST=3 command (see section 2.4), for example:

Command	Response	Description
`AT+COPS=2`	`OK`	Force the module deregistration from the network
`AT+UTEST=1`	`OK`	The module enters non-signaling mode
`AT+UTEST=3,9400,23,,,0`	`+UTEST: 9400,23,5,1,0` `OK`	The module continuously transmits at channel 9400 (freq. 1880.0 MHz in band 2) with power level 23 dBm in WCDMA modulation.

- Measure the radiated power received by the UMTS test antenna immediately after the execution of AT+UTEST=3 command
- Leave the device to operate in this condition for an enough long period (at least 5 minutes).
- After at least 5 minutes, read the measured radiated power.
- If the measured power is not decreased from the previous reading, then the internal thermal protection has not activated. In this case the application board should not experience a power reduction caused by thermal protection activation during TRP testing.

  If the measured power is decreased from the previous reading, then the thermal protection is active. The customer should optimize the application board and improve the thermal dissipation.

Repeat the previous tasks for all the operating 3G bands.

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3.8 Prototype check: radiated performance tests (TRP and SAR)

The +UTEST AT command can be used during the pre-testing phase of a product to get an evaluation of the Total Radiated Power (TRP) and SAR (Specific Absorption Rate). During the measurement of these parameters, the module should be forced to transmit a GSM/WCDMA/LTE signal at maximum power.

Total Isotropic Sensitivity (TIS) measurements cannot be performed with the +UTEST AT command.

☞ The correct measurements of TRP, TIS and SAR can be done only in an anechoic chamber with a precise testing setup.

3.9 Production test

The cellular module RF performance can be checked during production tests with the +UTEST AT command.

Typical production tests are:

1. Trigger an RF transmission measurement as reported in section 3.3, forcing the module to transmit at a specific power level. With this test it is possible to check:
   - If **ANT** or **ANT1** pin is soldered
   - If **ANT** or **ANT1** pin is short circuited
   - If the module has been damaged during soldering process or during handling (ESD, mechanical shock…)
   - If antenna matching components on the application board are soldered
   - If integrated antenna is correctly connected

2. Trigger an RF transmission measurement as reported in section 3.3, forcing the module to transmit at maximum power levels. With this test it is possible to check:
   - If the power supply is correctly assembled and is able to deliver the required current

3. Measure current consumption during the transmission of a GSM burst (GMSK/8-PSK), a WCDMA signal and a LTE signal, as reported in section 3.2.

4. Measure the reception performance of the module using the setup shown in the second and third image of Figure 3 or Figure 4. With this test it is possible to check:
   - If the module has been damaged during soldering process or during handling (ESD, mechanical shock…)

3.10 Conclusion

- +UTEST AT command is useful in performing many prototype and production tests, to check most of the module RF performance without using an expensive GSM/WCDMA/LTE network simulator.
- Some of the tests listed and suggested in LEON-G100 / LEON-G200 series Prototype Checklist [14], LEON-G100 / LEON-G200 series Production Checklist [15], and LISA-U1 / LISA-U2 series Production Checklist [16] cannot be covered with the +UTEST AT command.
- Receiver sensitivity (TIS) cannot be evaluated with the +UTEST AT command since this only provides the reported received power level. The sensitivity measurement requires suitable setup with a GSM/WCDMA/LTE network simulator providing measurements about: received data, quality and BER in a close loop link.

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4 Digital pins testing

4.1 Introduction

This section describes how to perform verifications on the digital pins of the modules by means of the +UTEST AT command. The command can be used to configure a specific group of pins as:

- Digital input: once configured, it is possible to apply a voltage level to the pin;
- Digital output: the pin can be used to output a digital "high" or "low" voltage level.

Pins enabled for digital testing can be considered as generic digital input / output pins; the customer may configure a pin as a digital output with "high" logic level and then verify the voltage level present at the pin. Conversely, it is possible to apply a "high" or "low" logic level on a pin set as a digital input, and then check if the module is able to correctly measure the voltage level applied.

This test mode can be used during customer production testing to check the correct behavior of the module's digital pins and detect possible soldering or functional problems.

The number and the type of pins available for testing by means of the +UTEST AT command depends on the module as defined in Table 15 , Table 16 and Table 17.

See the Generic Digital Interface section of the module data sheet [4], [5], [6], [9], [11], [12] for a detailed description of the input / output levels characteristics of the pins.

SARA-G3 series			SARA-U2 series		
Pin No	Name	Interface	Pin No	Name	Interface
6	DSR	UART	6	DSR	UART
7	RI		7	RI	
8	DCD		8	DCD	
9	DTR		9	DTR	
10	RTS		10	RTS	
11	CTS		11	CTS	
16	GPIO1	GPIO	16	GPIO1	GPIO
19	CODEC_CLK	Audio	19	CODEC_CLK	Audio
23	GPIO2	GPIO	23	GPIO2	GPIO
24	GPIO3		24	GPIO3	
25	GPIO4		25	GPIO4	
26	SDA	DDC	26	SDA	DDC
27	SCL		27	SCL	
28	RXD_AUX	Auxiliary UART	34	I2S_WA	Audio
29	TXD_AUX		35	I2S_TXD	
34	I2S_WA	Audio	36	I2S_CLK	
35	I2S_TXD		37	I2S_RXD	
36	I2S_CLK		42	SIM_DET	SIM
37	I2S_RXD				
42	SIM_DET	SIM			

Table 15: List of testable pins using +UTEST AT command on SARA-G3 and SARA-U2 series modules

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LISA-U2 series			TOBY-L2 series		
Pin No	**Name**	**Interface**	**Pin No**	**Name**	**Interface**
9	DSR	UART	10	DSR	UART
10	RI		11	RI	
11	DCD		12	DCD	
12	DTR		13	DTR	
13	RTS		14	RTS	
14	CTS		15	CTS	
20	GPIO1	GPIO	21	GPIO1	GPIO
21	GPIO2		22	GPIO2	
23	GPIO3		24	GPIO3	
24	GPIO4		25	GPIO4	
39	I2S1_RXD/GPIO6	Audio/GPIO	26	HOST_SELECT0	System
40	I2S1_TXD/GPIO7		50	I2S_WA	Audio
41	I2S_WA	Audio	51	I2S_TXD	
42	I2S_TXD		52	I2S_CLK	
43	I2S_CLK		53	I2S_RXD	
44	I2S_RXD		54	SCL	DDC
45	SCL	DDC	55	SDA	
46	SDA		60	GPIO5	GPIO
51	GPIO5	GPIO	61	GPIO6	
52	CODEC_CLK	Audio	62	HOST_SELECT1	System
53	I2S1_CLK/GPIO8	Audio/GPIO	63	SDIO_D2	SDIO
54	I2S1_WA/GPIO9		64	SDIO_CLK	
55	SPI_SCLK/GPIO10	SPI/GPIO	65	SDIO_CMD	
56	SPI_MOSI/GPIO11		66	SDIO_D0	
57	SPI_MISO/GPIO12		67	SDIO_D3	
58	SPI_SRDY/GPIO13		68	SDIO_D1	
59	SPI_MRDY/GPIO14				

Table 16: List of testable pins using +UTEST AT command on LISA-U2 and TOBY-L2 series modules

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TOBY-R2 series			LARA-R2 series		
Pin No	**Name**	**Interface**	**Pin No**	**Name**	**Interface**
10	DSR	UART	6	DSR	UART
11	RI		7	RI	
12	DCD		8	DCD	
13	DTR		9	DTR	
14	RTS		10	RTS	
15	CTS		11	CTS	
21	GPIO1	GPIO	16	GPIO1	GPIO
22	GPIO2		19	GPIO6	
24	GPIO3		23	GPIO2	
25	GPIO4		24	GPIO3	
50	I2S_WA	AUDIO	25	GPIO4	
51	I2S_TXD		26	SDA	DDC
52	I2S_CLK		27	SCL	
53	I2S_RXD		34	I2S_WA	Audio
54	SDA	DDC	35	I2S_TXD	
55	SCL		36	I2S_CLK	
60	GPIO5	GPIO	37	I2S_RXD	
61	GPIO6		42	GPIO5	GPIO
63	SDIO_D2	SDIO	44	SDIO_D2	SDIO
64	SDIO_CLK		45	SDIO_CLK	
65	SDIO_CMD		46	SDIO_CMD	
66	SDIO_D0		47	SDIO_D0	
67	SDIO_D3		48	SDIO_D3	
68	SDIO_D1		49	SDIO_D1	

Table 17: List of testable pins using +UTEST AT command on TOBY-R2 and LARA-R2 series modules

If the UART is used as the AT interface, disable HW flow control before entering test mode for digital pin testing.

For the complete syntax description of the +UTEST AT command, see the u-blox AT commands manual [1].

The usage of the +UTEST AT command shall be restricted *to controlled environments* and for test purposes only. Do not use the feature outside of testing and production conditions. Precautions must be taken to avoid module damage.

u-blox assumes no responsibilities for the inappropriate use of this feature.

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4.2 AT+UTEST command syntax for digital pins testing

Type	Syntax	Response	Example
Set	AT+UTEST=<mode>,<par1>[,[<bit_padding>]<pin_seq>]	If <mode>=10 [[<bit_padding>]<pin_seq>] OK	AT+UTEST=10,3,"0000001000000300" OK
Read	AT+UTEST?	+UTEST: <mode> OK	+UTEST: 10 OK
Test	AT+UTEST=?	+UTEST: (list of supported <mode>s) OK	+UTEST: (0-3,10) OK

4.2.1 Defined values

Parameter	Type	Description
<mode>	Number	Test mode setting: • 0: the module returns to normal mode • 1: the module enters non-signaling mode • 2: RX test mode (used to measure the received RF power level at the antenna ports) • 3: TX test mode (GSMK/8-PSK burst or 3G/4G signal transmission) • 10: digital pin test mode
<par1>	Number	Parameter used to select the test mode operation: • 0: exits the test interface and restore the pins to the original configuration. • 2: defines the set of pins that will be tested • 3: configures the pins as input or output • 4: configures the logic value of the output pins • 5: applies the settings of defined with <par1> = 3 and <par1> = 4 • 6: returns the logic value detected at the pins under test
<bit_padding>	String	Bit padding (see section 4.3)
<pin_seq>	String	Configures module's pins for digital testing (see section 4.3)

4.3 Setting testable pins (AT+UTEST=10,2)

This command allows user to select which pins will be used during the digital testing. The pins listed in Table 15, Table 16 and Table 17 are available for testing and can be configured as digital input or output (see section 4.4).

4.3.1 AT+UTEST=10,2 command syntax

Selection of the pins for the digital testing can be done using the following command:

```
AT+UTEST=10,2,[<bit_padding>]<pin_seq>
```

where [<bit_padding>]<pin_seq> is a sequence of hexadecimal digits (0,1,…,E,F).

Perform these operations to construct the [<bit_padding>]<pin_seq> sequence:

- Consider the total number of module's pins available:
    - For SARA-G3 series: 64 pins
    - For SARA-U2 series: 64 pins
    - For LISA-U2 series: 76 pins
    - For TOBY-L2 series: 92 pins
    - For TOBY-R2 series: 92 pins
    - For LARA-R2 series: 68 pins

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The GND pins are not considered by AT+UTEST=10 command:
  - SARA-G3, SARA-U2 and LARA-R2 series modules: pins 65-96
  - TOBY-L2 and TOBY-R2 series modules: pins 93-152
- Represent each module pin with a binary digit (0 or 1) having this meaning:
  - 0: indicates that the pin will not be tested
  - 1: indicates that the pin will be tested (as digital input or output)

  Only the pins reported in Table 15, Table 16 and Table 17 can be set to 1. In case a non-testable pin is set to 1, the command does not return an error result code but the value is not considered and not applied.

  For example, with a SARA-U2 module there are 64 pins, so 64 binary digits can be used to represent the status of each pin. Figure 17 shows a possible sequence of 64 binary digits for a SARA-U2 module. Here the 6th and the 11th digits are set to 1; these enable pin 6 (DSR) and pin 11 (CTS) for the testing.

  There is no limit to the maximum number of pins that can be enabled.

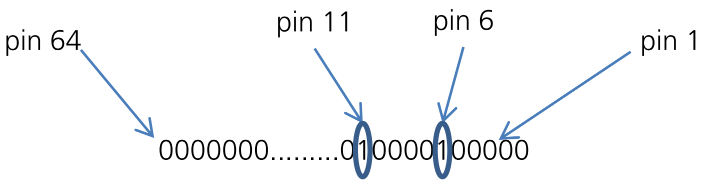

Figure 17: Example of pins binary representation with a SARA-U2 module; binary digit 1 identifies an enabled pin

- Once the binary sequence is defined, convert each group of four binary digits into its hexadecimal representation. Since a group of four binary digits can be represented by a single hexadecimal digit (0,1,...,E,F), the resulting length of the sequence will be:
  - For LISA-U2 series: 19 hexadecimal digits
  - For SARA-G3 series and SARA-U2 series: 16 hexadecimal digits
  - For TOBY-L2 and TOBY-R2 series: 23 hexadecimal digits
  - For LARA-R2 series: 17 hexadecimal digits
- Complete the resulting sequence of hexadecimal values with 0 padding as follows:
  - For LISA-U2 series: add one 0 digit at the beginning of the sequence
  - For SARA-G3 series SARA-U2 series: no additional digits are required
  - For TOBY-L2 series: add one 0 digit at the beginning of the sequence
  - For TOBY-R2 series: add one 0 digit at the beginning of the sequence
  - For LARA-R2 series: add three 0 digits at the beginning of the sequence

4.3.2 AT+UTEST=10,2 example

This is an example for a LISA-U2 module; only the pins RTS, CTS, SCL, SDA, CODEC_CLK, GPIO5 will be tested.

Command	Response	Description
`AT+UTEST=10,2,"0000000C300000003000"`	`OK`	Pins enabled for testing: RTS, CTS, SCL, SDA, CODEC_CLK, GPIO5

Analyzing the sequence "0000000C300000003000", it can be split in:

- 0: initial bit padding (1 digit)
- 000000C300000003000: 19 digits used to represent the 76 pins of the LISA-U2 module

Converting each hexadecimal value of the reduced sequence "000000C300000003000" into its binary representation, results in:

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- 0000 0000 0000 0000 0000 0000 1100 0011 0000 0000 0000 0000 0000 0000 0000 0011 0000 0000 0000

The digits set at 1 are the 13th, 14th, 45th, 46th, 51st and 52nd; so, comparing with Table 16, the enabled pins for digital testing are: RTS, CTS, SCL, SDA, GPIO5 and CODEC_CLK.

4.4 Digital pins configuration (AT+UTEST=10,3)

With this command it is possible to configure a previously enabled pin as a digital output or a digital input.

4.4.1 AT+UTEST=10,3 command syntax

Enabled pins can be set as digital input or digital output using the following command:

```
AT+UTEST=10,3,[<bit_padding>]<pin_seq>
```

where [<bit_padding>]<pin_seq> is a sequence of hexadecimal digits (0,1,…,E,F).

The sequence [<bit_padding>]<pin_seq> can be constructed using the same procedure outlined in section 4.3.

When representing each module pin with its binary digit, use this notation:

- 0: indicates that the pin will be set as an output
- 1: indicates that the pin will be set as an input

The command has effect only if AT+UTEST=10,2 has been previously issued. In case a not enabled pin is set as digital input or output, the command does not return an error result code and the setting is not applied.

4.4.2 AT+UTEST=10,3 example

Continuing the example proposed in section 4.3.2, the following command sets RTS, SDA and GPIO5 as digital input; CTS, SCL and CODEC_CLK as digital output.

Command	Response	Description
`AT+UTEST=10,3,"00000004200000001000"`	`OK`	Configuration of the pins: • RTS, SDA and GPIO5 as input • CTS, SCL and CODEC_CLK as output

Consider the command sequence "00000000004200000001000"; this can be split as:

- 0: initial bit padding (1 digit)
- 0000004200000001000: 19 digits used to represent the 76 pins of the LISA-U2 module

Converting each hexadecimal value of the reduced sequence "0000004200000001000" into its binary representation, results in:

- 0000 0000 0000 0000 0000 0000 0100 0010 0000 0000 0000 0000 0000 0000 0000 0001 0000 0000 0000

So, digits 13th, 46th and 51st are set to 1, digits 14th, 45th and 52nd are set to 0; it leads to the intended configuration of the enabled pins: RTS, SDA and GPIO5 are set as digital input; CTS, SCL and CODEC_CLK are set as digital output.

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4.5 Setting voltage level (AT+UTEST=10,4)

This command sets the logic value of the pins under test configured as digital output.

4.5.1 AT+UTEST=10,4 command syntax

Use this command to define the logic value of the output pins:

```
AT+UTEST=10,4,[<bit_padding>]<pin_seq>
```

where [<bit_padding>]<pin_seq> is a sequence of hexadecimal digits (0,1,…,E,F).

The sequence [<bit_padding>]<pin_seq> can be constructed using the same procedure outlined in section 4.3.

When representing each module pin with its binary digit, use this notation:

- 0: indicates that the pin will output a "low" logic level
- 1: indicates that the pin will output a "high" logic level

This command has effect only if AT+UTEST=10,3 has been previously issued.

☞ See the Generic Digital Interface section of the module data sheet [4], [5], [6], [9], [11], [12] for a detailed description of the input / output levels characteristics of the pins.

☞ If there are no output pins to be configured, AT+UTEST=10,4 command execution can be avoided.

4.5.2 AT+UTEST=10,4 example

Proceeding with the example described in sections 4.3.2 and 4.4.2, the following command sets a "high" logic value on CTS, SCL pins and a "low" logic value on CODEC_CLK pin.

Command	Response	Description
AT+UTEST=10,3,"000000001000000002000"	OK	Digital logic value of the output pins: • CTS, SCL set to "high" • CODEC_CLK set to "low"

Consider the command sequence "000000000000100000002000"; this can be split as:

- 0: initial bit padding (1 digit)
- 0000000100000002000: 19 digits used to represent the 76 pins of the LISA-U2 module

Converting each hexadecimal value of the reduced sequence "0000004200000001000" into its binary representation, results in:

- 0000 0000 0000 0000 0000 0000 0000 0001 0000 0000 0000 0000 0000 0000 0000 0010 0000 0000 0000

Digits 14th, 45th are set to 1, whereas digit 52nd is set to 0; this means that CTS and SCL pins are defined as a "high" digital output, whereas CODEC_CLK pin is defined as a "low" digital output.

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4.6 Execution of the digital testing (AT+UTEST=10,5)

This command applies the settings defined with commands AT+UTEST=10,2; AT+UTEST=10,3; AT+UTEST=10,4 and triggers the digital testing execution.

Before sending AT+UTEST=10,5 the intended pins must be enabled for testing (with AT+UTEST=10,2), configured as digital input or output (with AT+UTEST=10,3) and, for digital output pins, the logic value must be defined (with AT+UTEST=10,4).

☞ Digital testing of the pins is possible only after the execution of the AT+UTEST=10,5 command.

After the execution of the AT+UTEST=10,5 command, it is possible to externally apply a voltage level to the enabled input pins and / or measure the voltage level on the pins configured as digital input.

☞ See the Generic Digital Interface section of the module data sheet [4], [5], [6], [9], [11], [12] for a detailed description of the input / output levels characteristics of the pins.

⚠ **Do not exceed the values reported in the Generic Digital Interface section of the module data sheet [4], [5], [6], [9] when testing a pin as a digital input pin, since stressing the device above the listed ratings may cause a permanent damage of the module.**

4.6.1 AT+UTEST=10,5 command syntax

Use this command to trigger the execution of the digital testing on the enabled pins:

```
AT+UTEST=10,5
```

Command	Response	Description
`AT+UTEST=10,5`	`OK`	Configurations made by AT+UTEST=10,2; AT+UTEST=10,3 and AT+UTEST=10,4 are executed.

4.7 Digital value measurement (AT+UTEST=10,6)

This command returns the logic digital value, "high" or "low", measured on all those pins previously enabled (with AT+UTEST=10,2; AT+UTEST=10,3 and AT+UTEST=10,4 commands) and after the AT+UTEST=10,5 command execution.

The command returns the measured logic voltage level for both input and output pins.

4.7.1 AT+UTEST=10,6 command syntax

To measure the logic digital value of the enabled pins, send the following command:

```
AT+UTEST=10,6
```

The information text response has the following syntax:

```
<bit_padding>]<pin_seq>
OK
```

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where [<bit_padding>]<pin_seq> is a sequence of hexadecimal digits (0,1,…,E,F).
The sequence [<bit_padding>]<pin_seq> can decoded using the same procedure outlined in section 4.3.

When representing each module pin with its binary digit, use this notation to read the command response:

- 0: “low” logic digital level measured at the module pin
- 1: “high” logic digital level measured at the module pin

4.7.2 AT+UTEST=10,6 example

See the example of sections 4.3.2, 4.4.2 and 4.5.2; the voltage level at the enabled pins is measured using the following command

Command	Response	Description
`AT+UTEST=10,6`	`00000004100000003000` `OK`	Logic digital value measured at modules pins: • CTS, SCL: “high” level detected • CODEC_CLK: “low” level detected

Analyzing the command response, the retuned sequence “00000000000410000000300” can be split in:

- 0: initial bit padding (1 digit)
- 0000004100000003000: 19 digits used to represent the 76 pins of the LISA-U2 module

Converting each hexadecimal value of the reduced sequence “0000004100000003000” into its binary representation, results in:

- 0000 0000 0000 0000 0000 0000 0100 0001 0000 0000 0000 0000 0000 0000 0000 0011 0000 0000 0000

The voltage levels detected at the previously enabled pins are:

- RTS: “high” logic level (input pin configured in section 4.4.2)
- CTS: “high” logic level (as defined in section 4.5.2)
- SCL: “high” logic level (as defined in section 4.5.2)
- SDA: “low” logic level (input pin configured in section 4.4.2)
- GPIO5: “high” logic level (input pin configured in section 4.4.2)
- CODEC_CLK: “low” logic level (as defined in section 4.5.2)

4.8 Example of digital testing with SARA-G3 / SARA-U2 series modules

In this example, the digital pins testing is performed on the UART and the audio interface of a SARA-G3 or a SARA-U2 module. Referring to the Table 15, the following pins must be enabled for testing:

- DSR, pin 6
- RI, pin 7
- DCD, pin 8
- DTR, pin 9
- RTS, pin 10
- CTS, pin 11
- CODEC_CLK, pin 19

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- I2S_WA, pin 34
- I2S_TXD, pin 35
- I2S_CLK, pin 36
- I2S_RXD, pin 37

The goal of the test is to verify that all the pins of the UART (excluding TXD and RXD) and audio interface work correctly. To do so, all the listed pins will be enabled for digital testing and configured as input or output pins. The pins of the UART interface will be set as input or output according to the configuration they have in normal mode (outside the digital pins test mode); the settings of the audio interface pins are arbitrarily chosen.

All the pins set as digital input, will be driven "high" by an external application processor; all the pins set as digital output, will be configured with a "high" logic value.

Table 18 summarizes the intended configurations for this example.

Pin No	Name	Interface	I/O configuration	Output logic level	External logic level applied
6	DSR	UART	Output	High	-
7	RI		Output	High	-
8	DCD		Output	High	-
9	DTR		Input	-	High
10	RTS		Input	-	High
11	CTS		Output	High	-
19	CODEC_CLK	Audio	Output	High	-
34	I2S_WA		Output	High	-
35	I2S_TXD		Output	High	-
36	I2S_CLK		Output	High	-
37	I2S_RXD		Input	-	High

Table 18: Example of pins' configurations for digital testing with a TOBY-L2 series module

The preliminary commands to enter the test mode are:

Command	Response	Description
`AT+CMEE=2`	`OK`	Enable the verbose error result code
`AT+COPS=2`	`OK`	Deregister the module from the network
`AT+UTEST=1`	`OK`	Module enters test mode

The first step of the digital testing procedure is to enable the pins listed in Table 18. As mentioned in section 4.3, the total number of pins available with a SARA-G3 module or a SARA-U2 module is 64. Module pins can be represented with a sequence of 64 binary digits, the binary digits 1 indentify pins that must be enabled:

- 0000 0000 0000 0000 0000 0000 0001 1110 0000 0000 0000 0100 0000 0111 1110 0000

Converting each group of four binary digits into its hexadecimal notation, the sequence can be written as:

- 0000001E000407E0

The obtained sequence is the complete sequence [<bit_padding>]<pin_seq> required by the AT+UTEST=10,2 command, since no bit padding is required for SARA-G3 or SARA-U2 series modules (see section 4.3.1).

Pins can be then enabled sending the following command:

Command	Response	Description
`AT+UTEST=10,2,"0000001E000407E0"`	`OK`	Pins enabled for testing: DSR, RI, DCD, DTR, RTS, CTS, CODEC_CLK, I2S_WA, I2S_TXD, I2S_CLK, I2S_RXD.

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After this, specify the desired input or output capability for each enabled pin. The binary sequence representing the configurations reported in Table 18 is:

- 0000 0000 0000 0000 0000 0000 0001 0000 0000 0000 0000 0000 0000 0011 0000 0000

The hexadecimal representation of the binary sequence is:

- 0000001000000300

The following command sets each pin as a digital input or a digital output:

Command	Response	Description
`AT+UTEST=10,3,"0000001000000300"`	`OK`	Configuration of the pins: • DTR, RTS, I2S_RXD as input • DSR, RI, DCD, CTS, CODEC_CLK, I2S_WA, I2S_TXD, I2S_CLK as output

For each output pin configured by the previous command, it is required to define the logic digital value. In binary notation this is (according to requirements in Table 18):

- 0000 0000 0000 0000 0000 0000 0000 1110 0000 0000 0000 0100 0000 0100 1110 0000

The hexadecimal representation of the binary sequence is:

- 0000000E000404E0

The command issued to the module is:

Command	Response	Description
`AT+UTEST=10,4,"0000000E000404E0"`	`OK`	Digital logic value of the output pins: • DSR, RI, DCD, CTS, CODEC_CLK, I2S_WA, I2S_TXD, I2S_CLK set to "high"

It is possible to apply all the configurations provided by previous commands with this command:

Command	Response	Description
`AT+UTEST=10,5`	`OK`	Configurations made by AT+UTEST=10,2; AT+UTEST=10,3 and AT+UTEST=10,4 are executed

The user can now check the voltage level present at the pins configured as digital output and verify the "high" logic level set by previous commands.

The user can also apply a "high" voltage level to the pins set as digital input and verify the logic value detected by the module by means of the following command:

Command	Response	Description
`AT+UTEST=10,6`	`0000001E000407E0` `OK`	Logic digital value measured at modules pins: • DTR, RTS, I2S_RXD, DSR, RI, DCD, CTS, CODEC_CLK, I2S_WA, I2S_TXD, I2S_CLK: "high" level detected

To exit the test mode send:

Command	Response	Description
`AT+UTEST=0`	`OK`	Module exits test mode and normal pins configurations is restored.

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4.9 Example of digital testing with LISA-U2 series modules

This example guides the user for a digital pins testing of the UART and GPIO interfaces of a LISA-U2 module.

The goal of the test is to verify the correct behavior of the UART (excluding TXD and RXD) pins and GPIO pins. Table 19 reports the list of the intended test configurations for each pin. In this example it is supposed that all the pins configured as digital output are tested forcing them to a "high" logic level; whereas it is supposed that all the pins configured as digital input are externally driven with a "high" logic level (e.g. applied by an external application processor).

All the available GPIO pins are tested, even those that can be configured as part of the audio or SPI interface when the module is in normal mode.

Pin No	Name	Interface	I/O configuration	Output logic level	External logic level applied
9	DSR	UART	Output	High	-
10	RI		Output	High	-
11	DCD		Output	High	-
12	DTR		Input	-	High
13	RTS		Input	-	High
14	CTS		Output	High	-
20	GPIO1	GPIO	Output	High	-
21	GPIO2		Output	High	-
23	GPIO3		Input	-	High
24	GPIO4		Input	-	High
39	I2S1_RXD/GPIO6		Input	-	High
40	I2S1_TXD/GPIO7		Output	High	-
51	GPIO5		Input	-	High
53	I2S1_CLK/GPIO8		Input	-	High
54	I2S1_WA/GPIO9		Output	High	-
55	SPI_SCLK/GPIO10		Output	High	-
56	SPI_MOSI/GPIO11		Input	-	High
57	SPI_MISO/GPIO12		Output	High	-
58	SPI_SRDY/GPIO13		Output	High	-
59	SPI_MRDY/GPIO14		Input	-	High

Table 19: Example of pins' configurations for digital testing with a LISA-U2 series module

The preliminary commands to enter the test mode are:

Command	Response	Description
`AT+CMEE=2`	`OK`	Enable the verbose error result code
`AT+COPS=2`	`OK`	Deregister the module from the network
`AT+UTEST=1`	`OK`	Module enters test mode

The first step of the digital testing procedure is to enable the pins listed in Table 19. As mentioned in section 4.3, the total number of pins available with a LISA-U2 module is 76. Module pins can be represented with a sequence of 76 binary digits; the binary digit 1 indentifies pins that must be enabled:

- 0000 0000 0000 0000 0111 1111 0100 0000 0000 1100 0000 0000 0000 1101 1000 0011 1111 0000 0000

Converting each group of four binary digits into its hexadecimal notation, the sequence can be written as:

- 00007F400C000D83F00

According to section 4.3.1, it is required to a 0 digit as bit padding to complete the sequence [<bit_padding>]<pin_seq> required by the AT+UTEST=10,2 command.

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Pins can be then enabled sending the following command

Command	Response	Description
`AT+UTEST=10,2,"000007F400C000D83F00"`	`OK`	Pins enabled for testing: DSR, RI, DCD, DTR, RTS, CTS, GPIO1, GPIO2, GPIO3, GPIO4, I2S1_RXD/GPIO6, I2S1_TXD/GPIO7, GPIO5, I2S1_CLK/GPIO8, I2S1_WA/GPIO9, SPI_SCLK/GPIO10, SPI_MOSI/GPIO11, SPI_MISO/GPIO12, SPI_SRDY/GPIO13, SPI_MRDY/GPIO14

For each enabled pin, the desired input or output capability must be specified. The binary sequence representing the configurations reported in Table 19 is:

- 0000 0000 0000 0000 0100 1001 0100 0000 0000 0100 0000 0000 0000 1100 0000 0001 1000 0000 0000

The hexadecimal representation of the binary sequence is:

- 0000494004000C01800

The following command can be used to set pins as digital input or output (including the bit padding digit):

Command	Response	Description
`AT+UTEST=10,3,"00000494004000C01800"`	`OK`	Configuration of the pins: • DTR, RTS, GPIO3, GPIO4, I2S1_RXD/GPIO6, GPIO5, I2S1_CLK/GPIO8, SPI_MOSI/GPIO11, SPI_MRDY/GPIO14 as input • DSR, RI, DCD, CTS, GPIO1, GPIO2, I2S1_TXD/GPIO7, I2S1_WA/GPIO9, SPI_SCLK/GPIO10, SPI_MISO/GPIO12, SPI_SRDY/GPIO13 as output

For each output pin configured by the previous command, it is required to define the logic digital value. In binary notation this is (according to requirements in Table 19):

- 0000 0000 0000 0000 0011 0110 0000 0000 0000 1000 0000 0000 0000 0001 1000 0010 0111 0000 0000

The hexadecimal representation of the binary sequence is:

- 0000360008000182700

The command issued to the module is:

Command	Response	Description
`AT+UTEST=10,4,"00000360008000182700"`	`OK`	Digital logic value of the output pins: • DSR, RI, DCD, CTS, GPIO1, GPIO2, I2S1_TXD/GPIO7, I2S1_WA/GPIO9, SPI_SCLK/GPIO10, SPI_MISO/GPIO12, SPI_SRDY/GPIO13 set to “high”

It is possible to apply all the configurations provided by previous commands with this command:

Command	Response	Description
`AT+UTEST=10,5`	`OK`	Configurations made by AT+UTEST=10,2; AT+UTEST=10,3 and AT+UTEST=10,4 are executed

The user can now proceed to measure the voltage level present at the pins configured as digital output and verify the “high” logic level set by previous commands.

The user can also apply a “high” voltage level to the pins set as digital input and verify the logic value detected by the module through the following:

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Command	Response	Description
AT+UTEST=10,6	000007F400C000D83F00 OK	Logic digital value measured at modules pins: • DSR, RI, DCD, DTR, RTS, CTS, GPIO1, GPIO2, GPIO3, GPIO4, I2S1_RXD/GPIO6, I2S1_TXD/GPIO7, GPIO5, I2S1_CLK/GPIO8, I2S1_WA/GPIO9, SPI_SCLK/GPIO10, SPI_MOSI/GPIO11, SPI_MISO/GPIO12, SPI_SRDY/GPIO13, SPI_MRDY/GPIO14: "high" level detected

To exit the test mode send:

Command	Response	Description
AT+UTEST=0	OK	Module exits test mode and normal pins configurations is restored.

4.10 Example of digital testing with TOBY-L2 series modules

In this example, digital pins testing is performed on the UART and the SDIO interface of a TOBY-L2 module.

The goal of the test is to verify that the pins of the UART (excluding TXD and RXD) and audio interface work correctly. Table 20 reports the list of the intended test configurations for each pin. In this example it is supposed that all the pins configured as digital output are forced to the "high" logic level; whereas it is supposed that all the pins configured as digital input are externally driven with a "high" logic level (e.g. applied by an external application processor).

Pin No	Name	Interface	I/O configuration	Output logic level	External logic level applied
10	DSR	UART	Output	High	-
11	RI		Output	High	-
12	DCD		Output	High	-
13	DTR		Input	-	High
14	RTS		Input	-	High
15	CTS		Output	High	-
63	SDIO_D2	SDIO	Output	High	-
64	SDIO_CLK		Output	High	-
65	SDIO_CMD		Input	-	High
66	SDIO_D0		Output	High	-
67	SDIO_D3		Input	-	High
68	SDIO_D1		Input	-	High

Table 20: Example of pins' configurations for digital testing with a TOBY-L2 series module

The preliminary commands to enter the test mode are:

Command	Response	Description
At+CMEE=2	OK	Enable the verbose error result code
At+COPS=2	OK	Deregister the module from the network
AT+UTEST=1	OK	Module enters test mode

The first step of the digital testing procedure is to enable the pins listed in Table 20. As mentioned in section 4.3, the total number of pins available with a TOBY-L2 module is 92. Module pins can be represented with a sequence of 92 binary digits, the binary digits 1 indentify pins that must be enabled:

- 0000 0000 0000 0000 0000 0000 1111 1100 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0111 1110 0000 0000

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Converting each group of four binary digits into its hexadecimal notation, the sequence can be written as:

- 000000FC000000000007E00

According to section 4.3.1, it is required to add one 0 digit as bit padding to complete the sequence [<bit_padding>]<pin_seq> required by the AT+UTEST=10,2 command.

Pins can be then enabled sending the following command:

Command	Response	Description
`AT+UTEST=10,2,"0000000FC000000000007E00"`	`OK`	Pins enabled for testing: DSR, RI, DCD, DTR, RTS, CTS, SDIO_D2, SDIO_CLK, SDIO_CMD, SDIO_D0, SDIO_D3 and SDIO_D1

User must then specify, for each enabled pin, the desired input or output capability. The binary sequence representing the configurations reported in Table 20 is:

- 0000 0000 0000 0000 0000 0000 1101 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0011 0000 0000 0000

The hexadecimal representation of the binary sequence is:

- 000000D0000000000003000

The following command can be used to set pins as digital input or output (including the bit padding digit):

Command	Response	Description
`AT+UTEST=10,3,"0000000D0000000000003000"`	`OK`	Configuration of the pins: • DTR, RTS, SDIO_CMD, SDIO_3, SDIO_1 as input • DSR, RI, DCD, CTS, SDIO_D2, SDIO_CLK, SDIO_D0 as output

For each output pin configured by the previous command, it is required to define the logic digital value. In binary notation this is (according to requirements in Table 20):

- 0000 0000 0000 0000 0000 0000 0010 1100 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0100 1110 0000 0000

The hexadecimal representation of the binary sequence is:

- 0000002C000000000004E00

The command sent to the module is:

Command	Response	Description
`AT+UTEST=10,4,"00000002C000000000004E00"`	`OK`	Digital logic value of the output pins: • DSR, RI, DCD, CTS, SDIO_D2, SDIO_CLK, SDIO_D0 set to "high"

The user can now send the final command to apply all the configurations provided by previous commands

Command	Response	Description
`AT+UTEST=10,5`	`OK`	Configurations made by AT+UTEST=10,2; AT+UTEST=10,3 and AT+UTEST=10,4 are executed

The user can now check the voltage level present at the pins configured as digital output and verify the "high" logic level set by previous commands.

The user can also apply a "high" voltage level to the pins set as digital input and verify the logic value detected by the module by means of the following command:

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Command	Response	Description
AT+UTEST=10,6	0000000FC000000000007E00 OK	Logic digital value measured at modules pins: • DSR, RI, DCD, DTR, RTS, CTS, SDIO_D2, SDIO_CLK, SDIO_CMD, SDIO_D0, SDIO_D3, SDIO_D1: "high" level detected

To exit the test mode send:

Command	Response	Description
AT+UTEST=0	OK	Module exits test mode and normal pins configurations is restored.

4.11 Example of digital testing with TOBY-R2 series modules

In this example, the digital testing of the pins is performed on the UART and the audio interface of a TOBY-R2 module. Referring to the Table 17, the following pins must be enabled for testing:

- DSR, pin 10
- RI, pin 11
- DCD, pin 12
- DTR, pin 13
- RTS, pin 14
- CTS, pin 15
- I2S_WA, pin 50
- I2S_TXD, pin 51
- I2S_CLK, pin 52
- I2S_RXD, pin 53

The goal of the test is to verify that all the pins of the UART (excluding TXD and RXD) and audio interface work correctly. To do so, all the listed pins will be enabled for digital testing and configured as input or output pins. The pins of the UART interface will be set as input or output according to the configuration they have in normal mode (outside the digital pins test mode); the settings of the audio interface pins are arbitrarily chosen.

All the pins set as digital input, will be driven "high" by an external application processor; all the pins set as digital output, will be configured with a "high" logic value.

Table 18 summarizes the intended configurations for this example.

Pin No	Name	Interface	I/O configuration	Output logic level	External logic level applied
10	DSR	UART	Output	High	-
11	RI		Output	High	-
12	DCD		Output	High	-
13	DTR		Input	-	High
14	RTS		Input	-	High
15	CTS		Output	High	-
50	I2S_WA	Audio	Output	High	-
51	I2S_TXD		Output	High	-
52	I2S_CLK		Output	High	-
53	I2S_RXD		Input	-	High

Table 21: Example of pins' configurations for digital testing with a TOBY-R2 series module

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The preliminary commands to enter the test mode are:

Command	Response	Description
AT+CMEE=2	OK	Enable the verbose error result code
AT+COPS=2	OK	Deregister the module from the network
AT+UTEST=1	OK	Module enters test mode

The first step of the digital testing procedure is to enable the pins listed in Table 21. As mentioned in section 4.3, the total number of pins available with a TOBY-R2 module is 92. Module pins can be represented with a sequence of 92 binary digits, the binary digits 1 indentify pins that must be enabled:

- 0000 0000 0000 0000 0000 0000 0000 0000 0000 0001 1110 0000 0000 0000 0000 0000 0000 0000 0000 0111 1110 0000 0000

Converting each group of four binary digits into its hexadecimal notation, the sequence can be written as:

- 0000000001E000000007E00

The obtained sequence is the complete sequence [<bit_padding>]<pin_seq> required by the AT+UTEST=10,2 command.

Pins can be then enabled issuing the following command:

Command	Response	Description
AT+UTEST=10,2,"00000000001E000000007E00"	OK	Pins enabled for testing: DSR, RI, DCD, DTR, RTS, CTS, I2S_WA, I2S_TXD, I2S_CLK, I2S_RXD.

After this, specify the desired input or output capability for each enabled pin. The binary sequence representing the configurations reported in Table 21 is:

- 0000 0000 0000 0000 0000 0000 0000 0000 0000 0001 0000 0000 0000 0000 0000 0000 0000 0000 0000 0011 0000 0000 0000

The hexadecimal representation of the binary sequence is:

- 0000000001000000000003000

The following command sets each pin as a digital input or a digital output:

Command	Response	Description
AT+UTEST=10,3,"000000000010000000003000"	OK	Configuration of the pins: • DTR, RTS, I2S_RXD as input • DSR, RI, DCD, CTS, I2S_WA, I2S_TXD, I2S_CLK as output

For each output pin configured by the previous command, it is required to define the logic digital value. In binary notation this is (according to requirements in Table 21):

- 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 1110 0000 0000 0000 0000 0000 0000 0000 0000 0100 1110 0000 0000

The hexadecimal representation of the binary sequence is:

- 0000000000E000000004E00

The command issued to the module is:

Command	Response	Description
AT+UTEST=10,4,"00000000000E000000004E00"	OK	Digital logic value of the output pins: • DSR, RI, DCD, CTS, I2S_WA, I2S_TXD, I2S_CLK set to "high"

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To apply all the configurations provided by previous commands issue this command:

Command	Response	Description
AT+UTEST=10,5	OK	Configurations made by AT+UTEST=10,2; AT+UTEST=10,3 and AT+UTEST=10,4 are executed

The user can now check the voltage level present at the pins configured as digital output and verify the "high" logic level set by previous commands.

The user can also apply a "high" voltage level to the pins set as digital input and verify the logic value detected by the module by means of the following command:

Command	Response	Description
AT+UTEST=10,6	00000000000E00000004E00 OK	Logic digital value measured at modules pins: • DTR, RTS, I2S_RXD, DSR, RI, DCD, CTS, CODEC_CLK, I2S_WA, I2S_TXD, I2S_CLK: "high" level detected

To exit the test mode issue:

Command	Response	Description
AT+UTEST=0	OK	Module exits test mode and normal pins configurations is restored.

4.12 Example of digital testing with LARA-R2 series modules

In this example, the digital testing of the pins is performed on the UART and the audio interface of a LARA-R2 module. Referring to the Table 17, the following pins must be enabled for testing:

- DSR, pin 6
- RI, pin 7
- DCD, pin 8
- DTR, pin 9
- RTS, pin 10
- CTS, pin 11
- I2S_WA, pin 34
- I2S_TXD, pin 35
- I2S_CLK, pin 36
- I2S_RXD, pin 37

The goal of the test is to verify that all the pins of the UART (excluding TXD and RXD) and audio interface work correctly. To do so, all the listed pins will be enabled for digital testing and configured as input or output pins. The pins of the UART interface will be set as input or output according to the configuration they have in normal mode (outside the digital pins test mode); the settings of the audio interface pins are arbitrarily chosen.

All the pins set as digital input, will be driven "high" by an external application processor; all the pins set as digital output, will be configured with a "high" logic value.

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Table 22 summarizes the intended configurations for this example.

Pin No	Name	Interface	I/O configuration	Output logic level	External logic level applied
6	DSR	UART	Output	High	-
7	RI		Output	High	-
8	DCD		Output	High	-
9	DTR		Input	-	High
10	RTS		Input	-	High
11	CTS		Output	High	-
34	I2S_WA	Audio	Output	High	-
35	I2S_TXD		Output	High	-
36	I2S_CLK		Output	High	-
37	I2S_RXD		Input	-	High

Table 22: Example of pins' configurations for digital testing with a LARA-R2 series module

The preliminary commands to enter the test mode are:

Command	Response	Description
`AT+CMEE=2`	`OK`	Enable the verbose error result code
`AT+COPS=2`	`OK`	Deregister the module from the network
`AT+UTEST=1`	`OK`	Module enters test mode

The first step of the digital testing procedure is to enable the pins listed in Table 22. As mentioned in section 4.3, the total number of pins available with a LARA-R2 module is 68. Module pins can be represented with a sequence of 68 binary digits, the binary digits 1 indentify pins that must be enabled:

- 0000 0000 0000 0000 0000 0000 0000 0001 1110 0000 0000 0000 0000 0000 0111 1110 0000

Converting each group of four binary digits into its hexadecimal notation, the sequence can be written as:

- 00000001E000007E0

The obtained sequence is the complete sequence [<bit_padding>]<pin_seq> required by the AT+UTEST=10,2 command.

Pins can be then enabled issuing the following command:

Command	Response	Description
`AT+UTEST=10,2,"00000000001E000007E0"`	`OK`	Pins enabled for testing: DSR, RI, DCD, DTR, RTS, CTS, I2S_WA, I2S_TXD, I2S_CLK, I2S_RXD.

After this, specify the desired input or output capability for each enabled pin. The binary sequence representing the configurations reported in Table 22 is:

- 0000 0000 0000 0000 0000 0000 0000 0001 0000 0000 0000 0000 0000 0000 0011 0000 0000

The hexadecimal representation of the binary sequence is:

- 00000001000000300

The following command sets each pin as a digital input or a digital output:

Command	Response	Description
`AT+UTEST=10,3,"000000000010000000300"`	`OK`	Configuration of the pins: • DTR, RTS, I2S_RXD as input • DSR, RI, DCD, CTS, I2S_WA, I2S_TXD, I2S_CLK as output

For each output pin configured by the previous command, it is required to define the logic digital value. In binary notation this is (according to requirements in Table 22):

- 0000 0000 0000 0000 0000 0000 0000 0000 1110 0000 0000 0000 0000 0000 0100 1110 0000

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The hexadecimal representation of the binary sequence is:

- 00000000E000004E0

The command issued to the module is:

Command	Response	Description
AT+UTEST=10,4,"00000000000E000004E0"	OK	Digital logic value of the output pins: • DSR, RI, DCD, CTS, I2S_WA, I2S_TXD, I2S_CLK set to "high"

It is possible to apply all the configurations provided by previous commands with this command:

Command	Response	Description
AT+UTEST=10,5	OK	Configurations made by AT+UTEST=10,2; AT+UTEST=10,3 and AT+UTEST=10,4 are executed

The user can now check the voltage level present at the pins configured as digital output and verify the "high" logic level set by previous commands.

The user can also apply a "high" voltage level to the pins set as digital input and verify the logic value detected by the module by means of the following command:

Command	Response	Description
AT+UTEST=10,6	00000000000E000004E0 OK	Logic digital value measured at modules pins: • DTR, RTS, I2S_RXD, DSR, RI, DCD, CTS, CODEC_CLK, I2S_WA, I2S_TXD, I2S_CLK: "high" level detected

To exit the test mode issue:

Command	Response	Description
AT+UTEST=0	OK	Module exits test mode and normal pins configurations is restored.

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Appendix

A Power Control Level

Table 23 and Table 24 show the correspondence between 3GPP nominal output power and PCL values for GMSK and 8-PSK modulations.

GSM 850, E-GSM 900				DCS 1800, PCS 1900			
Power control level (PCL)	Nominal Output power (dBm)	Tolerance (dB) for conditions		Power control level (PCL)	Nominal Output power (dBm)	Tolerance (dB) for conditions	
		normal	extreme			normal	extreme
0-3	33	±2	±2.5	0	30	±2	±2.5
4	33	±2	±2.5	1	28	±3	±4
5	33	±2	±2.5	2	26	±3	±4
6	31	±3	±4	3	24	±3	±4
7	29	±3	±4	4	22	±3	±4
8	27	±3	±4	5	20	±3	±4
9	25	±3	±4	6	18	±3	±4
10	23	±3	±4	7	16	±3	±4
11	21	±3	±4	8	14	±3	±4
12	19	±3	±4	9	12	±4	±5
13	17	±3	±4	10	10	±4	±5
14	15	±3	±4	11	8	±4	±5
15	13	±3	±4	12	6	±4	±5
16	11	±5	±6	13	4	±4	±5
17	9	±5	±6	14	2	±5	±6
18	7	±5	±6	15	0	±5	±6
19	5	±5	±6				

Table 23: 3GPP nominal output power levels, GMSK modulation

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GSM 850, E-GSM 900		
Power control level (PCL)	Gamma	Nominal Output power (dBm)
0-3	0-1	27
4	2	27
5	3	27
6	4	27
7	5	27
8	6	27
9	7	25
10	8	23
11	9	21
12	10	19
13	11	17
14	12	15
15	13	13
16	14	11
17	15	9
18	16	7
19	17	5

DCS 1800, PCS 1900		
Power control level (PCL)	Gamma	Nominal Output power (dBm)
0	3	26
1	4	26
2	5	26
3	6	24
4	7	22
5	8	20
6	9	18
7	10	16
8	11	14
9	12	12
10	13	10
11	14	8
12	15	6
13	16	4
14	17	2
15	18	0
16-19	19	0

Table 24: 3GPP nominal output power levels, 8-PSK modulation

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B ARFCN and frequency

Table 25 lists frequency bands and channel arrangement in GSM. The carrier frequency is designated by the Absolute Radio Frequency Channel Number (ARFCN). The TX frequency refers to the uplink, the RX to the downlink. Each carrier frequency is spaced 200 kHz.

GSM 850		
ARFCN	**TX freq (MHz)**	**RX freq (MHz)**
128	824.2	869.2
129	824.4	869.4
...		
159	830.4	875.4
...		
189	836.4	881.4
...		
220	842.6	887.6
...		
251	848.8	893.8

E-GSM 900		
ARFCN	**TX freq (MHz)**	**RX freq (MHz)**
975	880.2	925.2
...		
999	885.0	930.0
...		
1023	889.8	934.8
0	890.0	935.0
1	890.2	935.2
...		
37	897.4	942.4
...		
80	906.0	951.0
...		
124	914.8	959.8

DCS 1800		
ARFCN	**TX freq (MHz)**	**RX freq (MHz)**
512	1710.2	1805.2
513	1710.4	1805.4
...		
605	1728.8	1823.8
...		
698	1747.4	1842.4
...		
792	1766.2	1861.2
...		
885	1784.8	1879.8

PCS 1900		
ARFCN	**TX freq (MHz)**	**RX freq (MHz)**
512	1850.2	1930.2
513	1850.4	1930.4
...		
586	1865.0	1945.0
...		
661	1880.0	1960.0
...		
736	1895.0	1975.0
...		
810	1909.8	1989.8

Table 25: 3GPP ARFCN

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C UARFCN and frequency

Table 26 and Table 27 list frequency bands and channel arrangement in WCDMA. The carrier frequency is designated by the WCDMA UTRA Absolute Radio Frequency Channel Number (UARFCN). The TX frequency refers to the uplink, the RX to the downlink. Each carrier frequency is spaced 200 kHz.

Band 1 (2100 MHz)			
UARFCN uplink	TX freq (MHz)	UARFCN downlink	RX freq (MHz)
9612	1922.4	10562	2112.4
9613	1922.6	10563	2112.6
…		…	
9680	1936.0	10630	2126.0
…		…	
9750	1950.0	10700	2140.0
…		…	
9820	1964.0	10770	2154.0
…		…	
9888	1984.8	10838	2167.6

Band 2 (1900 MHz)			
UARFCN uplink	TX freq (MHz)	UARFCN downlink	RX freq (MHz)
9262	1852.4	9662	1932.4
9613	1922.6	9663	1932.6
…		…	
9330	1866.0	9730	1946.0
…		…	
9400	1880.0	9800	1960.0
…		…	
9470	1894.0	9870	1974.0
…		…	
9538	1907.6	9938	1987.6

Band 5 (850 MHz)			
UARFCN uplink	TX freq (MHz)	UARFCN downlink	RX freq (MHz)
4132	826.4	4357	871.4
4133	826.6	4358	871.6
…		…	
4157	831.4	4382	876.4
…		…	
4182	836.4	4407	881.4
…		…	
4208	841.6	4432	886.4
…		…	
4233	846.6	4458	891.6

Band 8 (900 MHz)			
UARFCN uplink	TX freq (MHz)	UARFCN downlink	RX freq (MHz)
2712	882.4	2937	927.4
2713	882.6	2938	927.6
…		…	
2750	890.0	2975	935.0
…		…	
2788	897.6	3012	942.4
…		…	
2825	905.0	3050	950.0
…		…	
2863	912.6	3088	957.6

Table 26: 3GPP UARFCN band 1, 2, 5, 8

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Band 4 (1700 MHz)			
UARFCN uplink	TX freq (MHz)	UARFCN downlink	RX freq (MHz)
1312	1712.4	1537	2112.4
1313	1712.6	1538	2112.6
…		…	
1362	1722.4	1587	2122.4
…		…	
1412	1732.4	1637	2132.4
…		…	
1462	1742.4	1687	2142.4
…		…	
1513	1752.6	1738	2152.6

Band 6 (800 MHz)			
UARFCN uplink	TX freq (MHz)	UARFCN downlink	RX freq (MHz)
4162	832.4	4387	877.4
4163	832.6	4388	877.6
…		…	
4168	833.6	4394	878.8
…		…	
4175	835.0	4400	880.0
…		…	
4182	836.4	4407	881.4
…		…	
4188	837.6	4413	882.6

Table 27: 3GPP UARFCN band 4, 6

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D EARFCN and frequency

Table 28 and Table 29 list frequency bands and channel arrangement in LTE. The carrier frequency is designated by the LTE E-UTRA Absolute Radio Frequency Channel Number (EARFCN). The TX frequency refers to the uplink, the RX to the downlink. Each carrier frequency is spaced 100 kHz

Band FDD 4 (1700/2100 MHz)			
EARFCN uplink	TX freq (MHz)	EARFCN downlink	RX freq (MHz)
19950	1710.0	1950	2110.0
19951	1710.1	1951	2110.1
…		…	
20062	1721.2	2062	2121.2
…		…	
20174	1732.4	2174	2132.4
…		…	
20286	1743.6	2286	2143.6
…		…	
20399	1754.9	2399	2154.9

Band FDD 13 (750 MHz)			
EARFCN uplink	TX freq (MHz)	EARFCN downlink	RX freq (MHz)
23180	777.0	5180	746.0
23181	777.1	5181	746.1
…		…	
23205	779.5	5205	748.5
…		…	
23230	782.0	5230	751.0
…		…	
23255	784.5	5255	753.5
…		…	
23279	786.9	5279	755.9

Band FDD 3 (1800 MHz)			
EARFCN uplink	TX freq (MHz)	EARFCN downlink	RX freq (MHz)
19200	1710.0	1200	1805.0
19201	1710.1	1201	1805.1
…		…	
19387	1728.7	1387	1823.7
…		…	
19574	1747.4	1574	1842.4
…		…	
19761	1766.1	1761	1861.1
…		…	
19949	1784.9	1949	1879.9

Band FDD 7 (2600 MHz)			
EARFCN uplink	TX freq (MHz)	EARFCN downlink	RX freq (MHz)
20750	2500.0	2750	2620.0
20751	2500.1	2751	2620.1
…		…	
20925	2520.1	2925	2637.5
…		…	
21100	2535.0	3100	2655.0
…		…	
21275	2552.5	3275	2672.5
…		…	
21449	2569.9	3449	2689.9

Band FDD 28 (750 MHz)			
EARFCN uplink	TX freq (MHz)	EARFCN downlink	RX freq (MHz)
27210	703.0	9210	758.0
27211	703.1	9211	758.1
…		…	
27322	714.2	9322	769.2
…		…	
27435	725.5	9435	780.5
…		…	
27547	736.7	9547	791.7
…		…	
27659	747.9	9659	802.9

Band FDD 12 (750 MHz)			
EARFCN uplink	TX freq (MHz)	EARFCN downlink	RX freq (MHz)
23010	699.0	5010	729.0
23011	699.1	5011	729.1
…		…	
23035	701.5	5035	731.5
…		…	
23095	707.5	5095	737.5
…		…	
23156	713.6	5156	743.6
…		…	
23179	716.0	5179	746.0

Table 28: 3GPP EARFCN band FDD 4, 13, 3, 7, 28, 12

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Band FDD 1 (2100 MHz)			
EARFCN uplink	TX freq (MHz)	EARFCN downlink	RX freq (MHz)
18000	1920.0	0	2110.0
18001	1920.1	1	2110.1
…		…	
18150	1935.0	150	2125.0
…		…	
18300	1950.0	300	2140.0
…		…	
18450	1965.0	450	2155.0
…		…	
18599	1979.9	599	2169.9

Band FDD 2 (1900 MHz)			
EARFCN uplink	TX freq (MHz)	EARFCN downlink	RX freq (MHz)
18600	1850.0	600	1930.0
18601	1850.1	601	1930.1
…		…	
18750	1865.0	750	1945.0
…		…	
18900	1880.0	900	1960.0
…		…	
19050	1895.0	1050	1975.0
…		…	
19199	1909.9	1199	1989.9

Band FDD 5 (850 MHz)			
EARFCN uplink	TX freq (MHz)	EARFCN downlink	RX freq (MHz)
20400	824.0	2400	869.0
20401	824.1	2401	869.1
…		…	
20462	830.2	2462	875.2
…		…	
20525	836.5	2525	881.5
…		…	
20587	842.7	2587	887.7
…		…	
20649	848.9	2649	893.9

Band FDD 8 (900 MHz)			
EARFCN uplink	TX freq (MHz)	EARFCN downlink	RX freq (MHz)
21450	880.0	3450	925.0
21451	880.1	3451	925.1
…		…	
21537	888.7	3537	933.7
…		…	
21625	897.5	3625	942.5
…		…	
21712	906.2	3712	951.2
…		…	
21799	914.9	3799	959.9

Band FDD 17 (700 MHz)			
EARFCN uplink	TX freq (MHz)	EARFCN downlink	RX freq (MHz)
23730	704.0	5730	734.0
23731	704.1	5731	734.1
…		…	
23760	707.0	5760	737.0
…		…	
23790	710.0	5790	740.0
…		…	
23820	713.0	5820	743.0
…		…	
23849	715.9	5849	745.9

Band FDD 20 (800 MHz)			
EARFCN uplink	TX freq (MHz)	EARFCN downlink	RX freq (MHz)
24150	832.0	6150	791.0
24151	832.1	6151	791.1
…		…	
24225	839.5	6225	798.5
…		…	
24300	847.0	6300	806.0
…		…	
24375	854.5	6375	813.5
…		…	
24449	861.9	6449	820.9

Table 29: 3GPP EARFCN band FDD 1, 2, 5, 8, 17, 20

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E Received signal strength, RXLEV

In 2G, the RMS value of the signal level received by the MS may vary from -110 dBm to -48 dBm. The measured signal level shall be mapped to an RXLEV value between 0 and 63. Table 30 lists the absolute received RMS power level and the tolerances in normal conditions. For details see the 3GPP specifications TS 05.05 [17] and TS 25.101 [18].

Absolute level of lower level signal (dBm)				Tolerance (dB) for normal conditions	
GSM 850	E-GSM 900	DCS 1800	PCS 1900	Lower limit	Upper limit
≥ -90	≥ -90	≥ -86	≥ -88	2	2
≥ -103	≥ -103	≥ -99	≥ -101	3	2
<-103	<-103	<-99	<-101	4	2

Table 30: 3GPP Signal strength tolerance within the same frequency band in normal condition

In 3G, the RMS of the received power level (RSSI) obtained with the +UTEST command corresponds to the <REF$\hat{I}_{or}$> level (the total transmit power spectral density integrated in a bandwidth of (1+α) x chip-rate and normalized to the chip-rate); for details see the 3GPP TS 05.05 [17] and 3GPP TS 25.101 [18]).

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F List of Acronyms

Abbreviation / Term	Explanation / Definition
2G	Second Generation
3G	Third Generation
3GPP	Third Generation Partnership Project
8-PSK	8 – Phase Shift Keying Modulation
ARFCN	Absolute Radio Frequency Channel Number
AT	AT Command Interpreter Software Subsystem, or attention
EARFCN	E-UTRA Absolute Radio Frequency Channel Number
EM	Electromagnetic
E-UTRA	Evolved UMTS Terrestrial Radio Access
FCC	Federal Communications Commission
FDD	Frequency Division Duplex
GMSK	Gaussian Minimum Shift Keying Modulation
GNSS	Global Navigation Satellite System
GSM	Global System for Mobile Communication
LTE	Long Term Evolution
MS	Mobile Station
OEM	Original Equipment Manufacturer
OFDM	Orthogonal Frequency Division Multiplex
OFDMA	Orthogonal Frequency Division Multiple Access
OTA	Over The Air
PCL	Power Control Level
PRBS	Pseudo Random Binary Sequence
RAT	Radio Access Technology
RF	Radio Frequency
RMS	Root Mean Square
RSE	Radiated Spurious Emission
RSSI	Receiver Signal Strength Indicator
RX	Receiver
TIS	Total Isotropic Sensitivity
TRP	Total Radiated Power
TSC	Training Sequence
TX	Transmitter
SAR	Specific Absorption Rate
SC-FDMA	Single Carrier Frequency Division Multiple Access
UARFCN	UTRA Absolute Radio Frequency Channel Number
UMTS	Universal Mobile Telecommunications System
UTRA	Universal Terrestrial Radio Access
WCDMA	Wideband Code Division Multiple Access

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Related documents

[1] u-blox AT Commands Manual, Docu No UBX-13002752
[2] u-blox TOBY-L1 / MPCI-L1 AT Commands Manual, Docu No UBX-13002211
[3] u-blox LEON-G1 series Data Sheet, Docu No UBX-13004887
[4] u-blox SARA-G3 series Data Sheet, Docu No UBX-13000993
[5] u-blox LISA-U2 series Data Sheet, Docu No UBX-13001734
[6] u-blox SARA-U2 series Data Sheet, Docu No UBX-13005287
[7] u-blox TOBY-L1 series Data Sheet, Docu No UBX-13000868
[8] u-blox MPCI-L1 series Data Sheet, Docu No UBX-14001412
[9] u-blox TOBY-L2 series Data Sheet, Docu No UBX-13000868
[10] u-blox MPCI-L2 series Data Sheet, Docu No UBX-13004749
[11] u-blox TOBY-R2 series Data Sheet, Docu No UBX-16005785
[12] u-blox LARA-R2 series Data Sheet, Docu No UBX-16005783
[13] u-blox SARA-G3-U2 System Integration Manual, Docu No UBX-13000995
[14] u-blox LEON-G100 / LEON-G200 series Prototype Checklist, Docu No GB11.HW.HC.000001
[15] u-blox LEON-G100 / LEON-G200 series Production Checklist, Docu No GB11.HW.HC.000003
[16] u-blox LISA-U1 / LISA-U2 series Production Checklist, Docu No HB04.HW.HC.000001
[17] 3GPP TS 05.05, Technical Specification Group GSM/EDGE Radio Access Network; Radio transmission and reception (Release 1999)
[18] 3GPP TS 25.101 Technical Specification Group Radio Access Network; User Equipment (UE) radio transmission and reception (FDD) (Release 8)
[19] 3GPP TS 36.101 Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception. (Release 9)

Some of the above documents can be downloaded from u-blox web-site (http://www.u-blox.ch/).

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Revision history

Revision	Date	Name	Status / Comments
-	24-Feb-2012	lpah	Initial release (Last revision with document number WLS-CS-12002)
R02	20-Jun-2014	sfal	Extended compatibility with SARA-G3, SARA-U2, TOBY-L1, TOBY-L2, MPCI-L1, MPCI-L2, updated operating mode transitions and added UTEST parameters' syntax
R03	13-Jan-2015	sfal	Updated to latest TOBY-L2 / MPCI-L2 supported configurations; updated +UTEST parameter syntax
R04	15-Sep-2015	sfal	Added digital pins testing description (+UTEST=10)
R05	10-Mar-2017	sfal	Extended document applicability to LARA-R2 / TOBY-R2 Extended digital pins testing description (+UTEST=10) for SARA-G3

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