



Test report No:
NIE: 59830RRF.008

Test Report

Reference Standard:
USA FCC Part 22
CANADA RSS-132

(*) Identification of item tested	TCAM: Telematics and Connectivity Antenna Module
(*) Trademark	Continental
(*) Model and /or type reference	TCAM1NA0
Other identification of the product	HW version: E4.2 SW version: PI007.1 FCC ID: KR5TCAM1NA0 IC: 7812D-TCAM1NA0
(*) Features	2G, 3G, LTE, GNSS, WLAN, BLE, ISM Receiver
Applicant	Continental Automotive GmbH Siemensstrasse 12, 93055 Regensburg, Germany
Test method requested, standard	USA FCC Part 22 (10-1-19 Edition). CANADA RSS-132 Issue 3, Jan. 2013. ANSI C63.26-2015. KDB 971168 D01 Power Meas License Digital Systems v03r01, April. 2018.
Summary	IN COMPLIANCE
Approved by (name / position & signature)	Rafael López Martín EMC Consumer & RF Lab. Manager  RAFAEL LÓPEZ MARTÍN 2020.07.16 08:50:13 +02'00'
Date of issue	2020-07-15
Report template No	FDT08_22 (*) "Data provided by the client"

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Competences and guarantees

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Uncertainty

Uncertainty (factor $k=2$) was calculated according to the DEKRA Testing and Certification S.A.U. internal document PODT000.

Data provided by the client

The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item tested", "Trademark", "Model and/or type reference tested").
2. The sample of the Telematics and Connectivity Antenna Module (TCAM) model Continental TCAM1NA0 is a vehicle antenna module for telematic and connectivity purposes.

It consists of a fin antenna with integrated telematics transceivers for different wireless services as well as several interfaces to the vehicle.

The TCAM1NA0 main parts are:

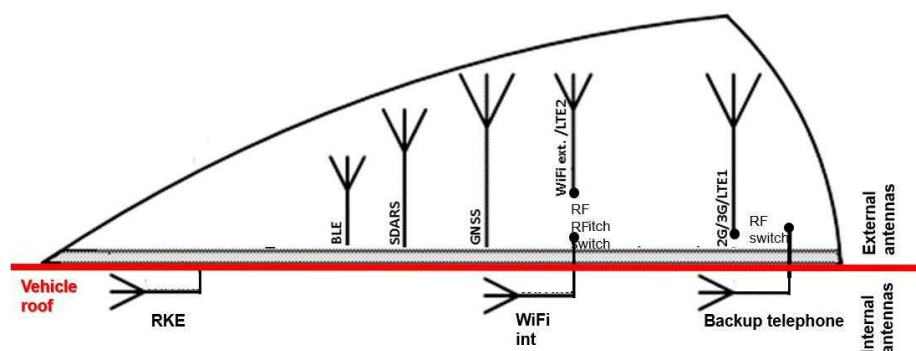
Antennas for cellular, WLAN, BLE, ISM receiver (RKE), SDARS with LNA
 GNSS with LNA for Navigation: Beidou, Galileo, GPS, Glonass
 Antenna selection via RF switches
 TCAM internal antennas (all are TCAM internal, no extern antenna connections):
 Tel1 ant: 2G, 3G, 4G/LTE1 (vehicle outside)
 Tel2 ant: LTE2 (Rx only) (vehicle outside)
 MIMO with LTE1- and LTE2-antenna. LTE2 is Rx only
 Backup telephone antenna: 2G, 3G, 4G/LTE (vehicle inside)
 Wi-Fi internal antenna (vehicle inside)
 Wi-Fi external antenna (vehicle outside)
 BLE antenna (vehicle outside)
 Stacked patch antenna featuring GNSS
 ISM receiver antenna
 SDARS antenna

CAT4 NAD with 2G/3G/4G/LTE and GNSS, FCC certified
 VoLTE

ISM receiver module (434MHz) for: RKE (Remote Keyless Entry), PASE (Passive Start and Entry, TPMS (Tire Pressure Monitoring System), FCC tested
 Wi-Fi chip
 BLE chip
 1st internal embedded Sim-IC
 Service calls

External interfaces:

Main power supply
 External backup battery
 External SIM card slot (2nd private customer SIM, optional)
 External microphone in the OHC (Overhead Compartment)
 A2B
 External backup speaker
 BroadR-Reach
 CEM connection (K-Line)
 Infotainment CAN
 Airbag input
 Debug interfaces (USB, UART)



DEKRA Testing and Certification S.A.U. declines any responsibility with respect to the information provided by the client and that may affect the validity of results.

Usage of samples

Samples undergoing test have been selected by: The client.

- Sample S/01 is composed of the following elements:

Control N°	Description	Model	Serial N°	Date of reception
59830B/010	Telematics and Connectivity Antenna Module	Continental TCAM1NA0	SNRD004291	2019-10-22
59830B/031	CAN-Box	CAN-STIN3	00255	2019-11-11
59830B/036	Harness	--	--	2019-11-11

Sample S/01 has undergone the following test(s): The radiated tests with the Backup Antenna indicated in Appendix A.

- Sample S/02 is composed of the following elements:

Control N°	Description	Model	Serial N°	Date of reception
59830B/011	Telematics and Connectivity Antenna Module	Continental TCAM1NA0	SNRD004290	2019-10-22
59830B/031	CAN-Box	CAN-STIN3	00255	2019-11-11
59830B/036	Harness	--	--	2019-11-11

Sample S/02 has undergone the following test(s): The radiated tests with the Tel1 Antenna indicated in Appendix A.

- Sample S/03 is composed of the following elements:

Control N°	Description	Model	Serial N°	Date of reception
59830B/004	Telematics and Connectivity Antenna Module	Continental TCAM1NA0	SNRD004295	2019-10-22
59830B/028	CAN-BOX TCAM	CAN-STIN3	00047	2019-10-30
59830B/036	Harness	--	--	2019-11-11

Sample S/03 has undergone the following test(s): All conducted tests indicated in Appendix A.

Test sample description

Ports..... :	Port name and description	Cable										
		Specified max length [m]	Attached during test	Shielded	Coupled to patient ⁽³⁾							
	USB diagnostic	~3m	☐	☐	☐							
	UART diagnostic	~3m	☐	☐	☐							
	BRR diagnostic	~3m	☐	☐	☐							
Supplementary information to the ports..... :	--											
Rated power supply	Voltage and Frequency		Reference poles									
			L1	L2	L3	N	PE					
	☐	AC:	☐	☐	☐	☐	☐					
	☒	DC: 12V										
Rated Power	4.2 W dc (cellular, Wi-Fi, BLE, GNSS active)											
Clock frequencies.....	32.768kHz, 16MHz, 19.2MHz, 24MHz, 25MHz, 27.6MHz, 48MHz											
Other parameters	Operating temperature Range: -40°C to 85°C Supply Voltage Range: 8 V to 16 V DC											
Software version	PI007.1											
Hardware version	E4.2											
Dimensions in cm (W x H x D)	10.5cm x 15.5cm x 9cm											
Mounting position	☐	Table top equipment										
	☐	Wall/Ceiling mounted equipment										
	☐	Floor standing equipment										
	☐	Hand-held equipment										
	☒	Other: Vehicular environment equipment										
Modules/parts.....	Module/parts of test item		Type		Manufacturer							
	Network Access Device (NAD), (cellular, GNSS)		Model: BL28NA-001		Continental Automotive Systems							

	ISM/RKE 434 MHz RF receiver module	Model: A2C38291300	Continental Automotive GmbH
Accessories (not part of the test item)	Description	Type	Manufacturer
	bracket		
	1x harness w/o USB		
	3x harness w USB		
	Inlay disc		
	Design cap		
Documents as provided by the applicant	Description	File name	Issue date
	TCAM_Testhouse_Manual_29Oct2019_V1		

⁽³⁾ Only for Medical Equipment

Identification of the client

Continental Automotive GmbH
Siemensstrasse 12, 93055 Regensburg, Germany

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2020-06-12
Date (finish)	2020-07-07

Document history

Report number	Date	Description
59830RRF.008	2020-07-15	First release

Environmental conditions

In the control chamber, the following limits were not exceeded during the test:

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

In the semianechoic chamber, the following limits were not exceeded during the test.

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

In the chamber for conducted measurements, the following limits were not exceeded during the test:

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 35 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

Remarks and comments

The tests have been performed by the technical personnel: José Manuel Jiménez, Verónica García, Cristina Calle, and Javier Miguel Nadales.

Used instrumentation:

Conducted Measurements

		Last Calibration	Due Calibration
1.	Shielded Room ETS LINDGREN S101	N.A.	N.A.
2.	Signal and Spectrum Analyzer ROHDE AND SCHWARZ FSV40	2020/03	2022/03
3.	Signal Analyzer 20 Hz to 8 GHz ROHDE AND SCHWARZ FSQ8	2018/08	2020/08
4.	Wideband Radio Communication Tester ROHDE AND SCHWARZ CMW500	2020/07	2021/07
5.	Wideband Radio Communication Tester ROHDE AND SCHWARZ CMW500	2019/09	2020/09
6.	Wideband Radio Communication Tester ROHDE AND SCHWARZ CMW500	2020/04	2021/04
7.	DC Power Supply, 30V, 5A KEYSIGHT TECHNOLOGIES U8002A	N.A.	N.A.
8.	Analog DC power supply 40V/40A ROHDE AND SCHWARZ NGPE 40/40	2018/03	2021/03
9.	Digital multimeter FLUKE 179	2019/09	2020/09
10.	Climatic chamber BINDER MK 56	2020/04	2021/04

Radiated Measurements

		Last Calibration	Due Calibration
1.	Semianechoic Absorber Lined Chamber ETS LINDGREN FACT 3 200 STP	N.A.	N.A.
2.	Shielded Room ETS LINDGREN S101	N.A.	N.A.
3.	Biconical/Log Antenna 30MHz - 6GHz ETS LINDGREN 3142E	2017/09	2020/09
4.	EMI Test Receiver 7 GHz ROHDE AND SCHWARZ ESR7	2018/10	2020/10
5.	RF Pre-amplifier 40 dB, 10 MHz - 6 GHz BONN ELEKTRONIK BLNA 0160-01N	2020/02	2021/02
6.	Broadband Horn antenna 1-18 GHz SCHWARZBECK BBHA 9120 D	2018/01	2021/01
7.	Signal and Spectrum Analyzer ROHDE AND SCHWARZ FSV40	2019/10	2021/10
8.	RF Pre-amplifier G>30dB, 1-18GHz BONN ELEKTRONIK BLMA 0118-3A	2019/11	2020/11
9.	Wideband Radio Communication Tester ROHDE AND SCHWARZ CMW500	2019/09	2020/09
10.	Wideband Radio Communication Tester ROHDE AND SCHWARZ CMW500	2020/07	2021/07
11.	DC Power Supply Keysight Technologies U8002A	N.A.	N.A.
12.	Digital multimeter FLUKE 175	2019/10	2020/10

Testing verdicts

Not applicable:	N/A
Pass:	P
Fail:	F
Not measured:	N/M

Summary

FCC PART 22 / RSS-132 PARAGRAPH		
Requirement – Test case	Verdict	Remark
Clause 22.913/RSS-132 Clause 5.4: RF output power	P	(1) (2)
Clause 2.1047/RSS-132 Clause 5.2: Modulation characteristics	P	(1) (2)
Clause 22.355/RSS-132 Clause 5.3: Frequency stability	P	(1) (2)
Clause 2.1049: Occupied Bandwidth	P	(1) (2)
Clause 22.917/RSS-132 Clause 5.5: Spurious emissions at antenna terminals	P	(1) (2)
Clause 22.917/RSS-132 Clause 5.5: Radiated emissions	P	(1) (2)
<u>Supplementary information and remarks:</u> 1. GSM mode has not been tested to prove USA FCC Part 22 compliance because the modulation scheme and the power maximum levels are the same as for GPRS mode. Taking into account the above comments, testing in GSM mode is redundant for FCC Part 22 as it is the same as GPRS mode. GPRS mode has been tested as indicated on the present test report. 2. HSDPA modulation mode has not been tested to prove USA FCC Part 22 compliance because it is an improved mode of operation only for Downlink (UE reception), but using the normal WCDMA mode for UL (Up Link, UE transmission). Therefore HSDPA has no associated a Power class or modulation scheme different than WCDMA mode for the UL transmission. Taking into account the above comments, testing in HSDPA modulation mode is redundant for FCC Part 22 as it is the same as WCDMA mode as long as UE transmission is concerned. WCDMA modulation mode has been tested as indicated on the present test report.		

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TEST CONDITIONS

POWER SUPPLY (V):

Vn: 12 Vdc
Vmin: 10.2 Vdc
Vmax: 13.8 Vdc

Type of Power Supply: External power supply (Car Battery).

The subscripts 'n', 'min' and 'max' indicate voltage test conditions (nominal, minimum and maximum respectively).

ANTENNA:

LOW Bands	GAIN	ANTENNA TYPE
2G Band 850 MHz	+4 dBi (Tel 1 antenna) +3 dBi (backup antenna)	Internal (3D)
3G Band V	+5 dBi (Tel 1 antenna) +5.9 dBi (backup antenna)	Internal (3D)
LTE Band 5	+5.9 dBi (Tel 1 antenna) +5.9 dBi (backup antenna)	Internal (3D)

TEST FREQUENCIES:

2G Band 850 MHz:

GPRS and EDGE MODULATIONS:

Lowest Channel (128): 824.2 MHz
Middle Channel (190): 836.6 MHz
Highest Channel (251): 848.8 MHz

3G Band V:

WCDMA and HSUPA MODULATIONS:

Lowest Channel (4132): 826.4 MHz
Middle Channel (4182): 836.4 MHz
Highest Channel (4233): 846.6 MHz

LTE. QPSK AND 16QAM MODULATION (BAND 5)

	Channel (Frequency, MHz)			
	BW = 1.4 MHz	BW = 3 MHz	BW=5 MHz	BW=10 MHz
Lowest	20407 (824.70)	20415 (825.50)	20425 (826.50)	20450 (829.00)
Middle	20525 (836.50)	20525 (836.50)	20525 (836.50)	20525 (836.50)
Highest	20643 (848.30)	20635 (847.50)	20625 (846.50)	20600 (844.00)

RF Output Power

SPECIFICATION:

FCC §2.1046 and FCC §22.913. The Effective Radiated Power (E.R.P.) of mobile transmitter and auxiliary test transmitter must not exceed 7 Watts (38.45 dBm E.R.P.).

RSS-132. Clause 5.4. The equivalent isotropically radiated power (e.i.r.p.) for mobile equipment shall not exceed 11.5 watts (38.45 dBm E.R.P.).

In addition, the peak-to-average power ratio (PAPR) of the transmitter shall not exceed 13 dB for more than 0.1% of the time using a signal corresponding to the highest PAPR during periods of continuous transmission.

METHOD:

The conducted RF output power measurements were made at the RF output terminals of the EUT using the power meter of the Universal Radio Communication tester R&S CMW500, selecting maximum transmission power of the EUT and different modes of modulation.

The peak-to-average power ratio (PAPR) is measured using an attenuator, power splitter and spectrum analyser with a Complementary Cumulative Distribution Function implemented.

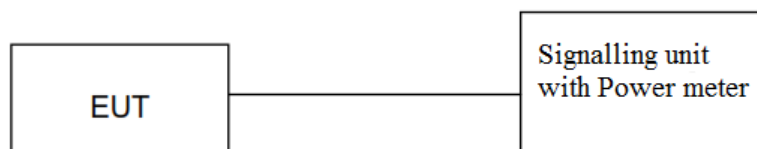
The maximum equivalent isotropically radiated power (e.i.r.p.) is calculated by adding the declared maximum antenna gain (dBi).

The maximum effective radiated power e.r.p. is calculated from the maximum equivalent isotropically radiated power (e.i.r.p.) by subtracting 2.15 dB:

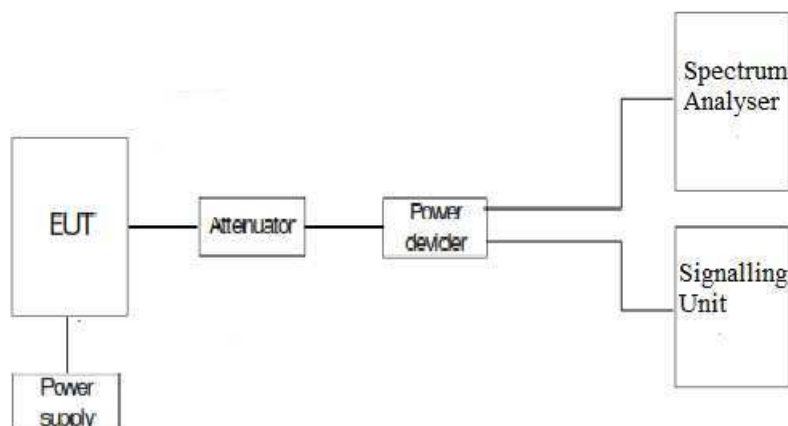
$$E.R.P. = E.I.R.P. - 2.15 \text{ dB}$$

TEST SETUP:

1. CONDUCTED AVERAGE POWER:



2. PEAK-TO-AVERAGE POWER RATIO (PAPR):



RESULTS:

1. CONDUCTED AVERAGE POWER.

2G Band 850 MHz:

GPRS MODULATION:

Channel	Lowest	Middle	Highest
Maximum declared antenna gain (dBi)	4.0	4.0	4.0
Measured maximum average power (dBm) at antenna port	30.71	30.92	30.96
Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm)	34.71	34.92	34.96
Maximum effective radiated power E.R.P. (dBm)	32.56	32.77	32.81
PAPR (dB)	0.18	0.17	0.21
Measurement uncertainty (dB)	<±1.58		

EDGE MODULATION:

Channel	Lowest	Middle	Highest
Maximum declared antenna gain (dBi)	4.0	4.0	4.0
Measured maximum average power (dBm) at antenna port	26.01	26.07	26.00
Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm)	30.01	30.07	30.00
Maximum effective radiated power E.R.P. (dBm)	27.86	27.92	27.85
PAPR (dB)	3.53	3.25	3.41
Measurement uncertainty (dB)	<±1.58		

3G Band V:

WCDMA MODULATION:

Channel	Lowest	Middle	Highest
Maximum declared antenna gain (dBi)	5.90	5.90	5.90
Measured maximum average power (dBm) at antenna port	22.05	22.08	22.13
Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm)	27.95	27.98	28.03
Maximum effective radiated power E.R.P. (dBm)	25.80	25.83	25.88
PAPR (dB)	2.79	2.70	2.76
Measurement uncertainty (dB)	<±1.58		

HSUPA MODULATION:

Channel	Lowest	Middle	Highest
Maximum declared antenna gain (dBi)	5.90	5.90	5.90
Measured maximum average power (dBm) at antenna port	19.24	19.34	19.53
Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm)	25.14	25.24	25.43
Maximum effective radiated power E.R.P. (dBm)	22.99	23.09	23.28
PAPR (dB)	6.11	5.79	6.17
Measurement uncertainty (dB)	<±1.58		

LTE Band 5:

LTE BAND 5. QPSK MODULATION. Bandwidth = 1.4 MHz.

Channel	Lowest	Middle	Highest
Maximum declared antenna gain (dBi)	5.90	5.90	5.90
Measured maximum average power (dBm) at antenna port	22.99	23.03	23.60
Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm)	28.89	28.93	29.50
Maximum effective radiated power E.R.P. (dBm)	26.74	26.78	27.35
PAPR (dB)	(*)	(*)	(*)
Measurement uncertainty (dB)	<±1.58		

Worst case AVERAGE POWER: Modulation QPSK. RB Size: 1. RB Offset: 0.
(*): Preliminary measurements determined that the modulation 16QAM, RB Size: 6, RB Offset: 0 as the worst case.
The results in the next tables shows the results for this configuration.

LTE BAND 5. 16QAM MODULATION. Bandwidth = 1.4 MHz.

Channel	Lowest	Middle	Highest
Maximum declared antenna gain (dBi)	5.90	5.90	5.90
Measured maximum average power (dBm) at antenna port	21.94	21.89	22.20
Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm)	27.84	27.79	28.1
Maximum effective radiated power E.R.P. (dBm)	25.69	25.64	25.95
PAPR (dB)	5.56	5.51	5.48
Measurement uncertainty (dB)	<±1.58		

Worst case AVERAGE POWER: Modulation 16QAM. RB Size: 4. RB Offset: 0.
Worst case PAPR: Modulation 16QAM. RB Size: 6. RB Offset: 0.

LTE BAND 5. QPSK MODULATION. Bandwidth = 3 MHz.

Channel	Lowest	Middle	Highest
Maximum declared antenna gain (dBi)	5.90	5.90	5.90
Measured maximum average power (dBm) at antenna port	23.16	23.25	22.98
Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm)	29.06	29.15	28.88
Maximum effective radiated power E.R.P. (dBm)	26.91	27.00	26.73
PAPR (dB)	(*)	(*)	(*)
Measurement uncertainty (dB)	<±1.58		

Worst case AVERAGE POWER: Modulation QPSK. RB Size: 1. RB Offset: 14.
(*): Preliminary measurements determined that the modulation 16QAM, RB Size: 15, RB Offset: 0 as the worst case.
The results in the next tables shows the results for this configuration.

LTE BAND 5. 16QAM MODULATION. Bandwidth = 3 MHz.

Channel	Lowest	Middle	Highest
Maximum declared antenna gain (dBi)	5.90	5.90	5.90
Measured maximum average power (dBm) at antenna port	21.97	21.95	22.25
Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm)	27.87	27.85	28.15
Maximum effective radiated power E.R.P. (dBm)	25.72	25.70	26.00
PAPR (dB)	5.75	5.77	5.71
Measurement uncertainty (dB)	<±1.58		

Worst case AVERAGE POWER: Modulation 16QAM. RB Size: 1. RB Offset: 0.
Worst case PAPR: Modulation 16QAM. RB Size: 15. RB Offset: 0.

LTE BAND 5. QPSK MODULATION. Bandwidth = 5 MHz.

Channel	Lowest	Middle	Highest
Maximum declared antenna gain (dBi)	5.90	5.90	5.90
Measured maximum average power (dBm) at antenna port	22.86	22.99	23.12
Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm)	28.76	28.89	29.02
Maximum effective radiated power E.R.P. (dBm)	26.61	26.74	26.87
PAPR (dB)	(*)	(*)	(*)
Measurement uncertainty (dB)	<±1.58		

Worst case AVERAGE POWER: Modulation QPSK. RB Size: 1. RB Offset: 0.
(*): Preliminary measurements determined that the modulation 16QAM, RB Size: 25, RB Offset: 0 as the worst case.
The results in the next tables shows the results for this configuration.

LTE BAND 5. 16QAM MODULATION. Bandwidth = 5 MHz.

Channel	Lowest	Middle	Highest
Maximum declared antenna gain (dBi)	5.90	5.90	5.90
Measured maximum average power (dBm) at antenna port	21.82	21.90	22.10
Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm)	27.72	27.80	28.00
Maximum effective radiated power E.R.P. (dBm)	25.57	25.65	25.85
PAPR (dB)	5.64	5.67	5.59
Measurement uncertainty (dB)	<±1.58		

Worst case AVERAGE POWER: Modulation 16QAM. RB Size: 1. RB Offset: 24.
Worst case PAPR: Modulation 16QAM. RB Size: 25. RB Offset: 0.

LTE BAND 5. QPSK MODULATION. Bandwidth = 10 MHz.

Channel	Lowest	Middle	Highest
Maximum declared antenna gain (dBi)	5.90	5.90	5.90
Measured maximum average power (dBm) at antenna port	23.05	23.67	23.36
Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm)	28.95	29.57	29.26
Maximum effective radiated power E.R.P. (dBm)	26.8	27.42	27.11
PAPR (dB)	(*)	(*)	(*)
Measurement uncertainty (dB)	<±1.58		

Worst case AVERAGE POWER: Modulation QPSK. RB Size: 1. RB Offset: 49.
(*): Preliminary measurements determined that the modulation 16QAM, RB Size: 50, RB Offset: 0 as the worst case.
The results in the next tables shows the results for this configuration.

LTE BAND 5. 16QAM MODULATION. Bandwidth = 10 MHz.

Channel	Lowest	Middle	Highest
Maximum declared antenna gain (dBi)	5.90	5.90	5.90
Measured maximum average power (dBm) at antenna port	22.00	22.22	22.02
Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm)	27.90	28.12	27.92
Maximum effective radiated power E.R.P. (dBm)	25.75	25.97	25.77
PAPR (dB)	5.58	5.75	5.61
Measurement uncertainty (dB)	<±1.58		

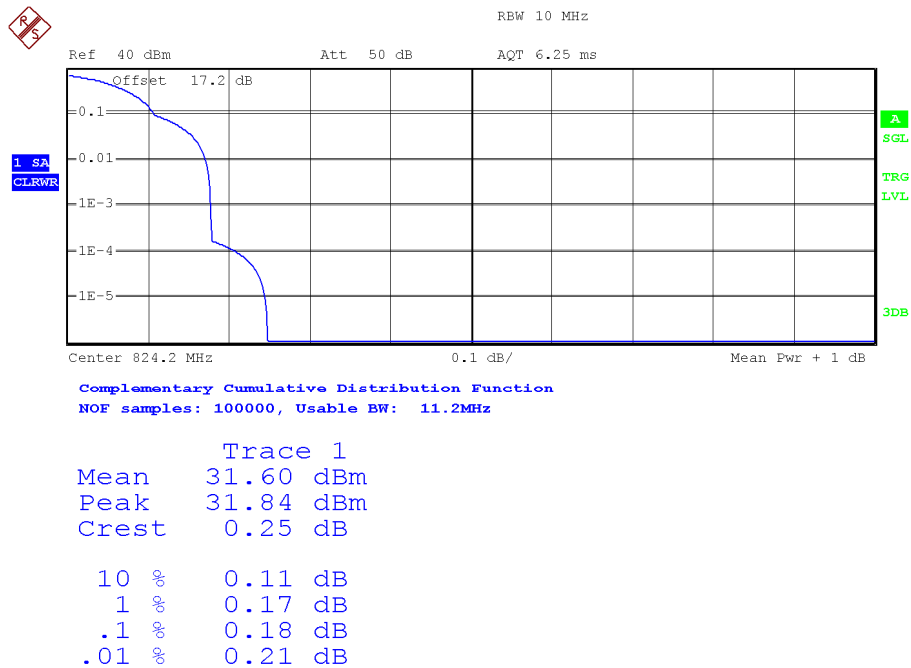
Worst case AVERAGE POWER: Modulation 16QAM. RB Size: 1. RB Offset: 49.
 Worst case PAPR: Modulation 16QAM. RB Size: 50. RB Offset: 0.

Verdict: PASS

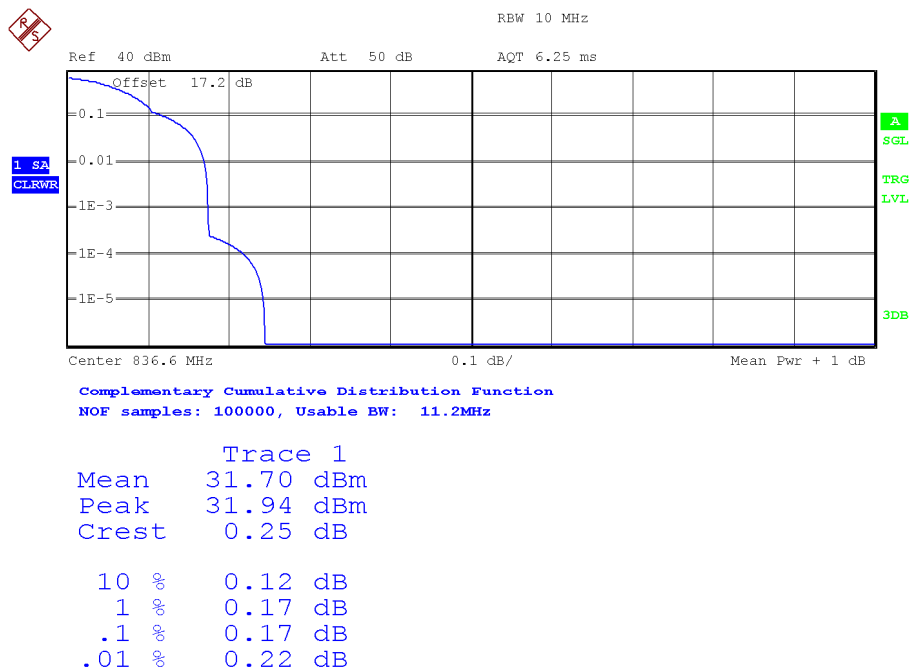
2. PEAK-TO-AVERAGE POWER RATIO (PAPR):

2G Band 850 MHz. GPRS MODULATION.

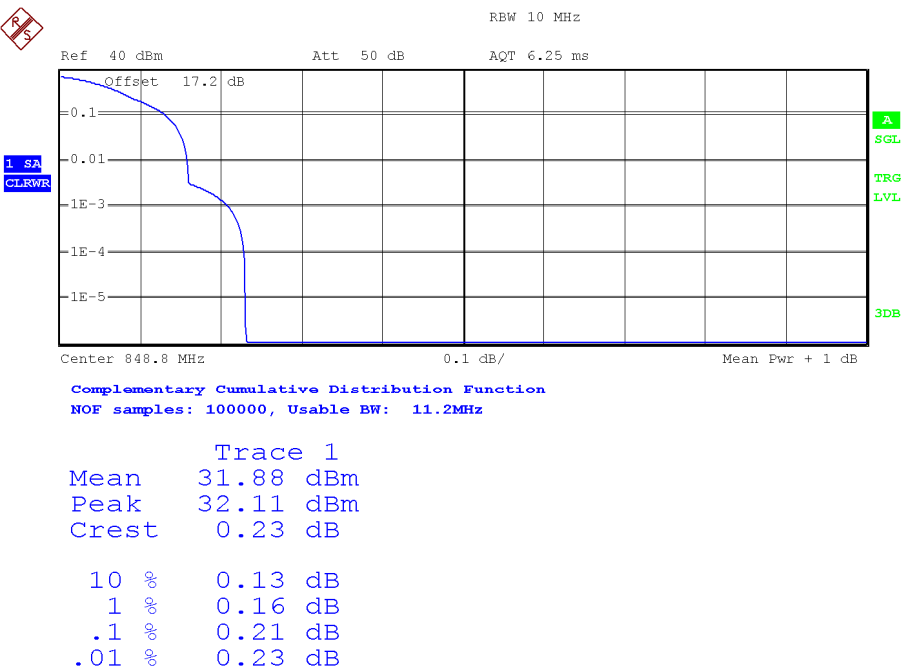
Low Channel:



Middle Channel:

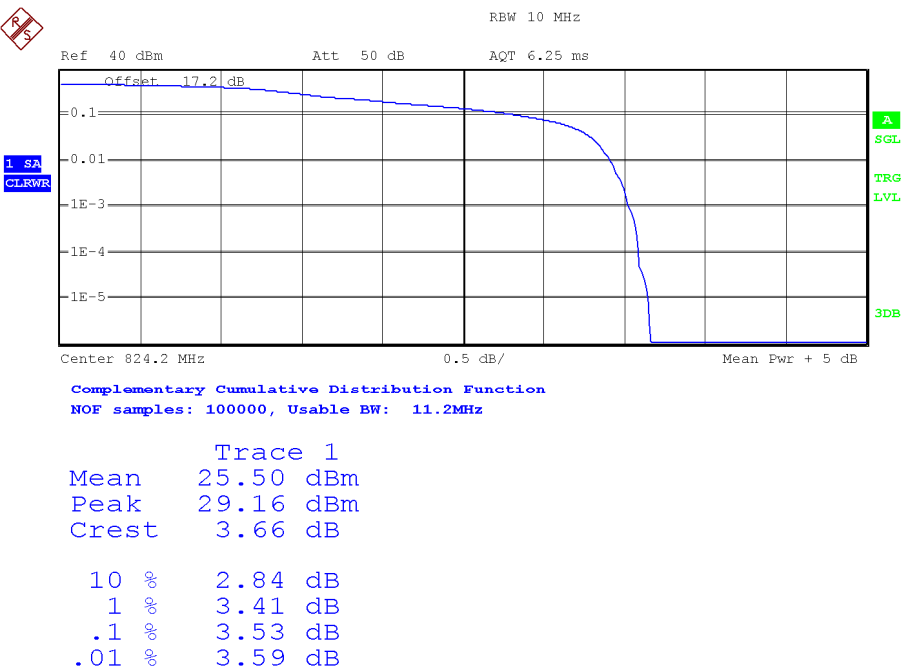


High Channel:

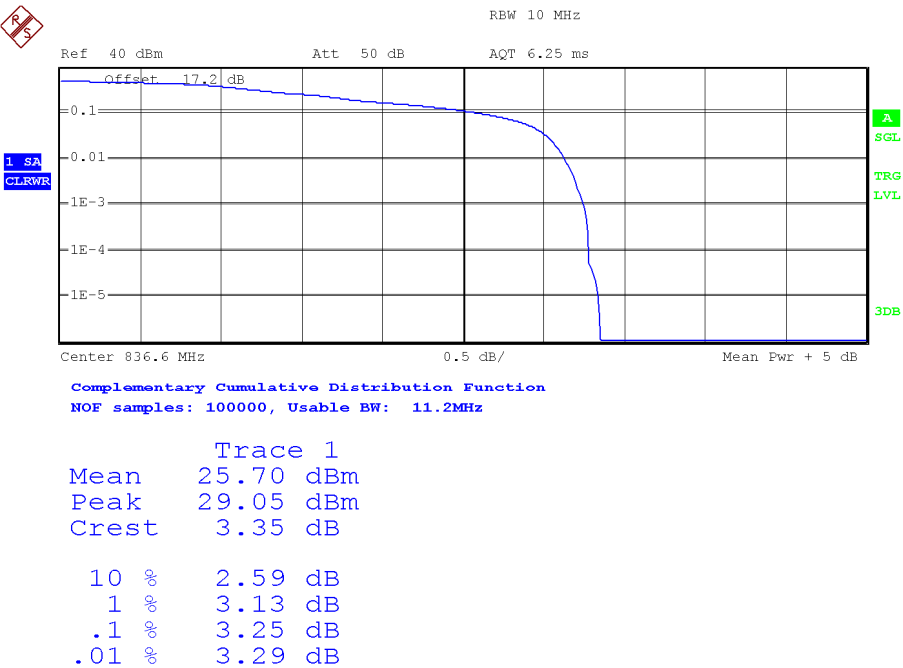


2G Band 850 MHz. EDGE MODULATION.

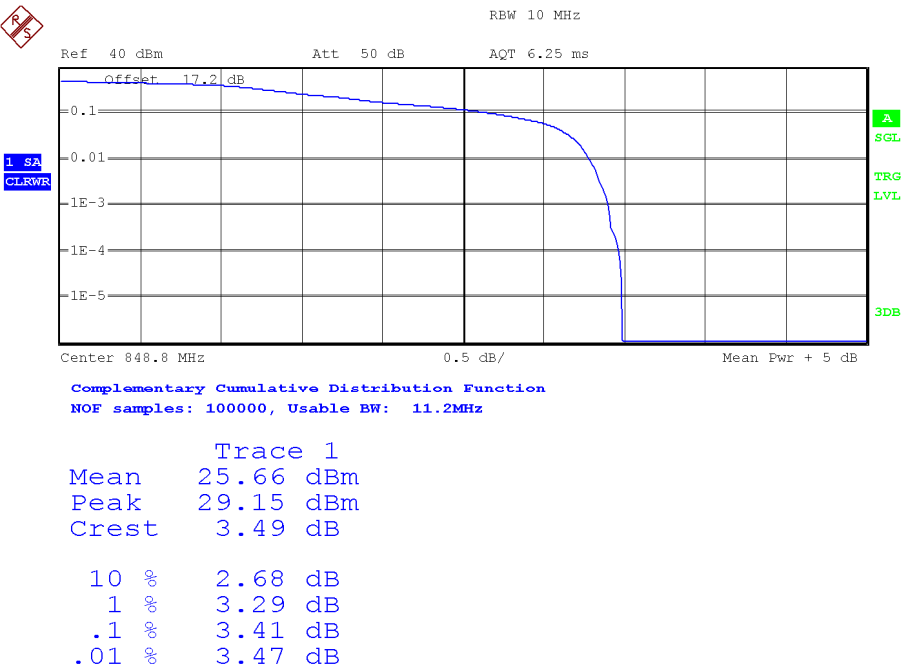
Low Channel:



Middle Channel:

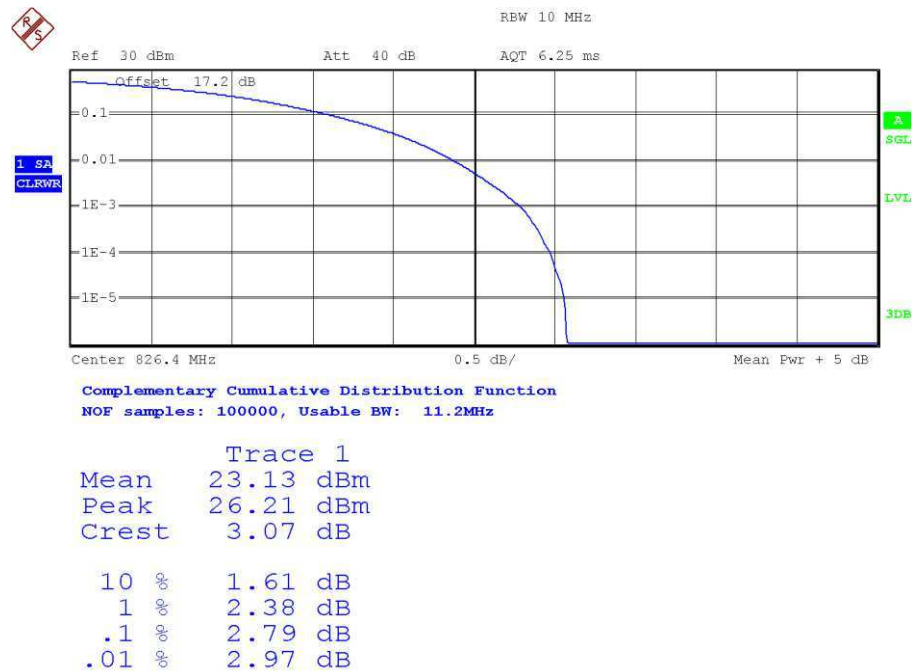


High Channel:

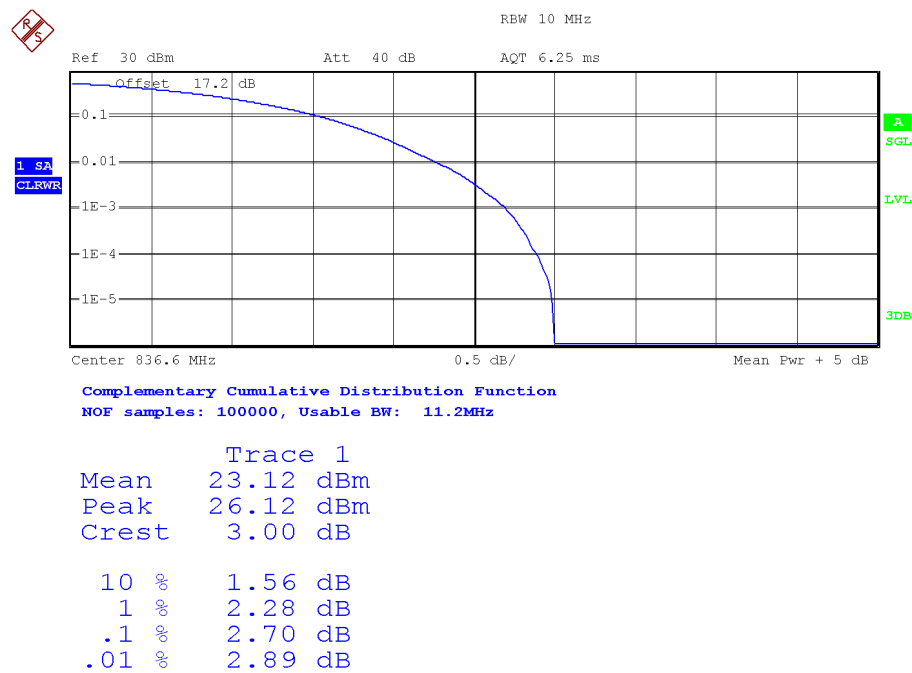


3G Band V. WCDMA MODULATION.

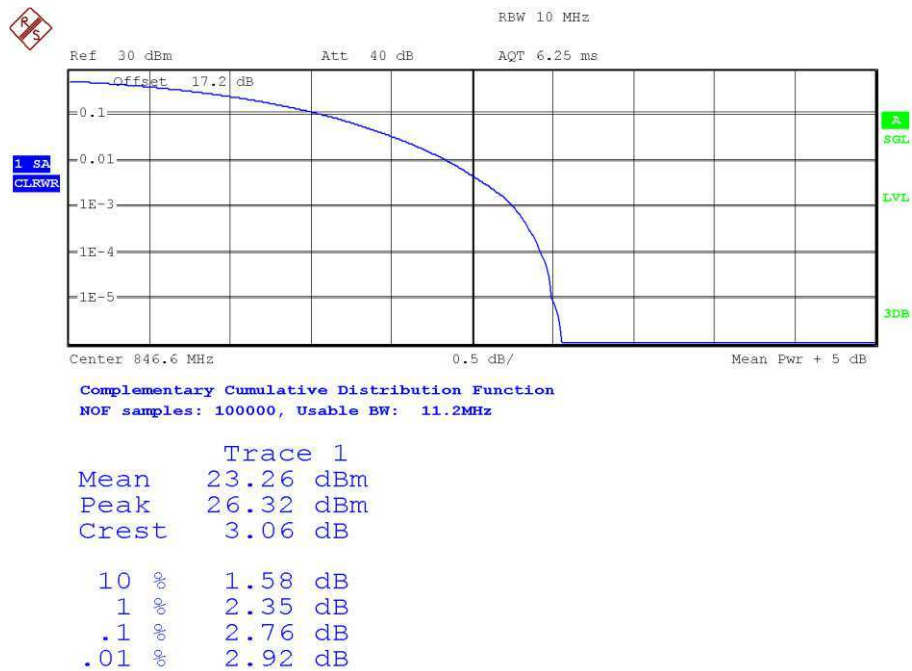
Low Channel:



Middle Channel:

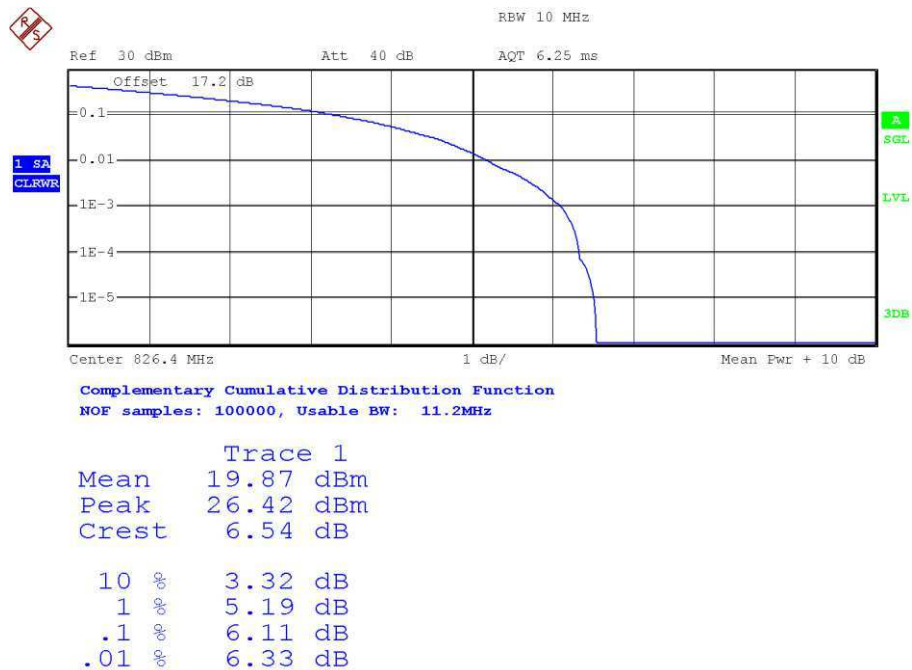


High Channel:

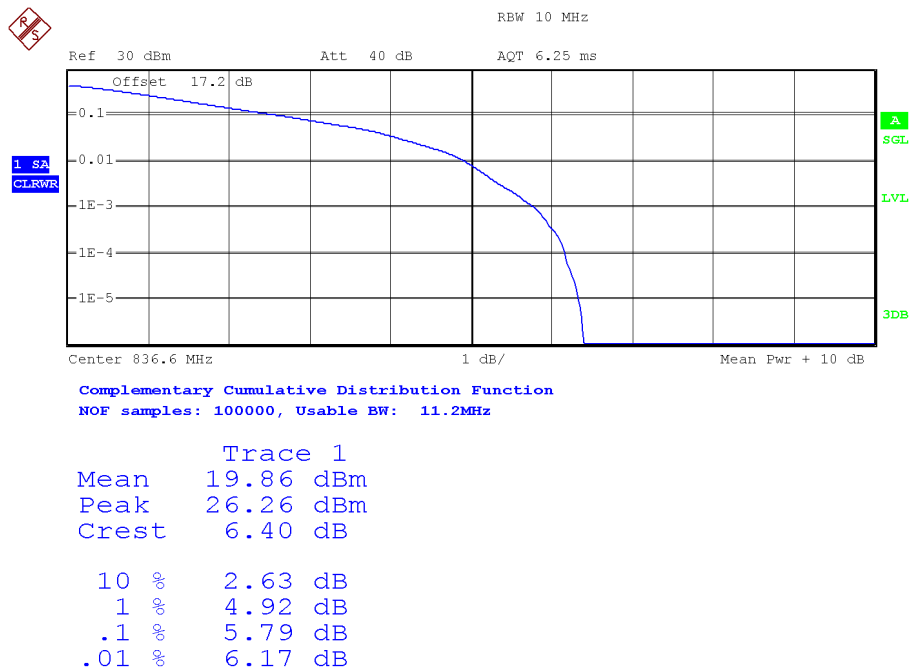


3G Band V. HSUPA MODULATION.

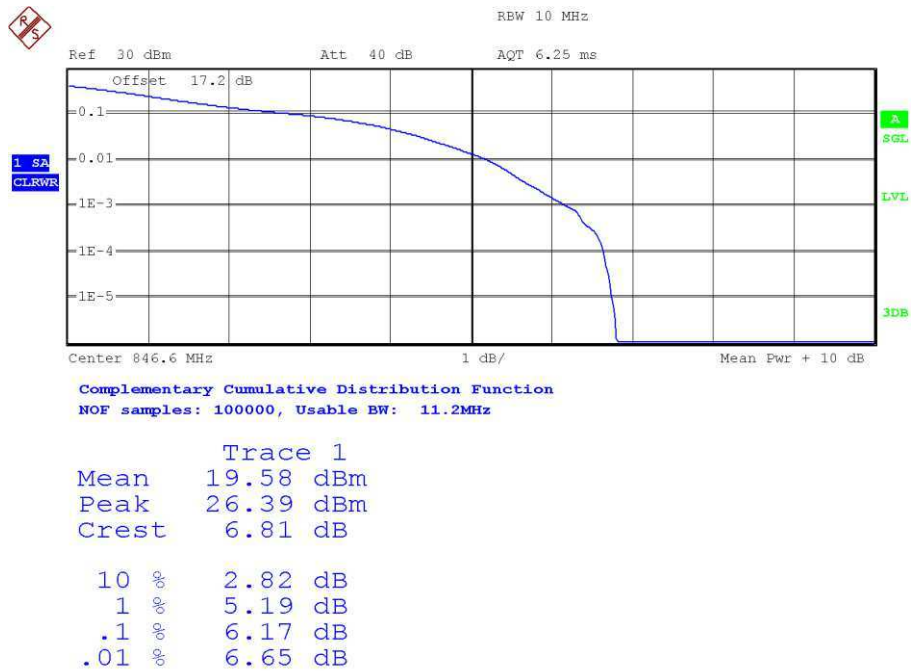
Low Channel:



Middle Channel:

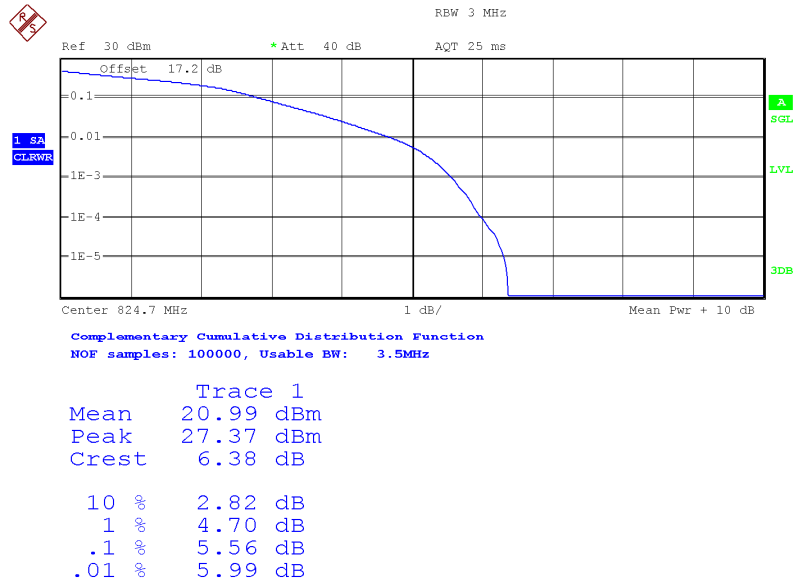


High Channel:

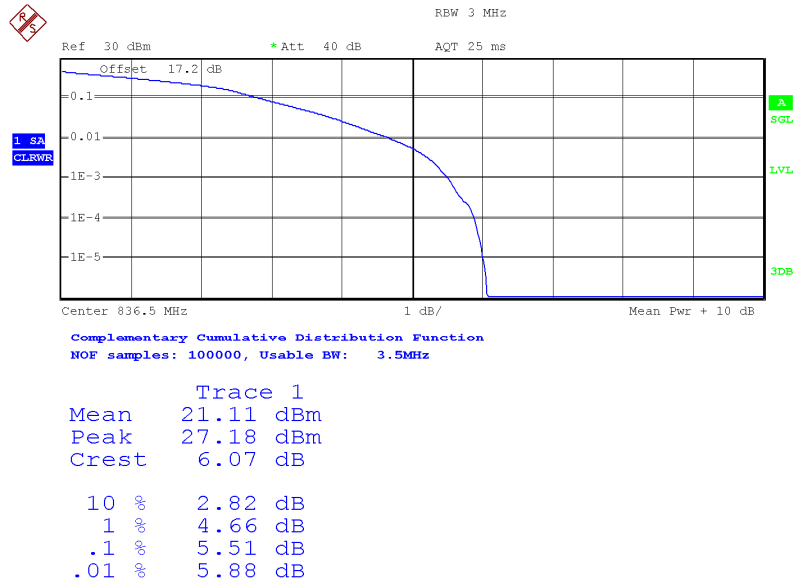


LTE Band 5. BW=1.4 MHz. 16QAM MODULATION. RB Size: 6. RB Offset: 0.

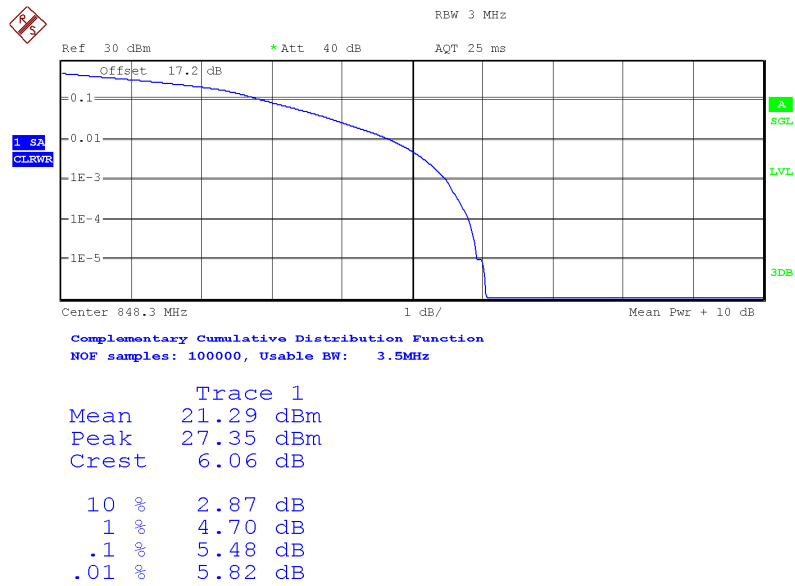
Low Channel:



Middle Channel:

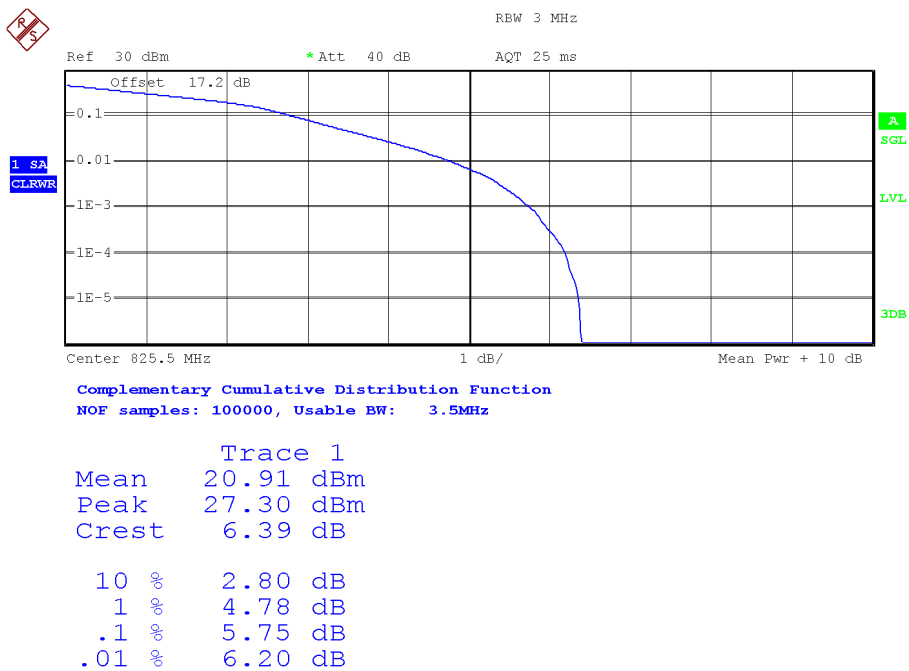


High Channel:

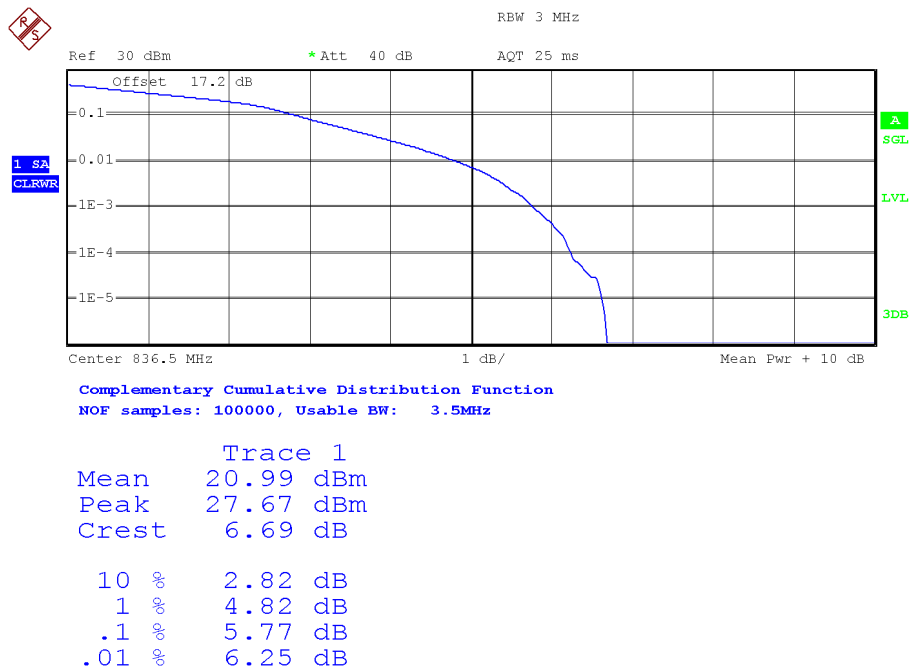


LTE Band 5. BW=3 MHz. 16QAM MODULATION. RB Size: 15. RB Offset: 0.

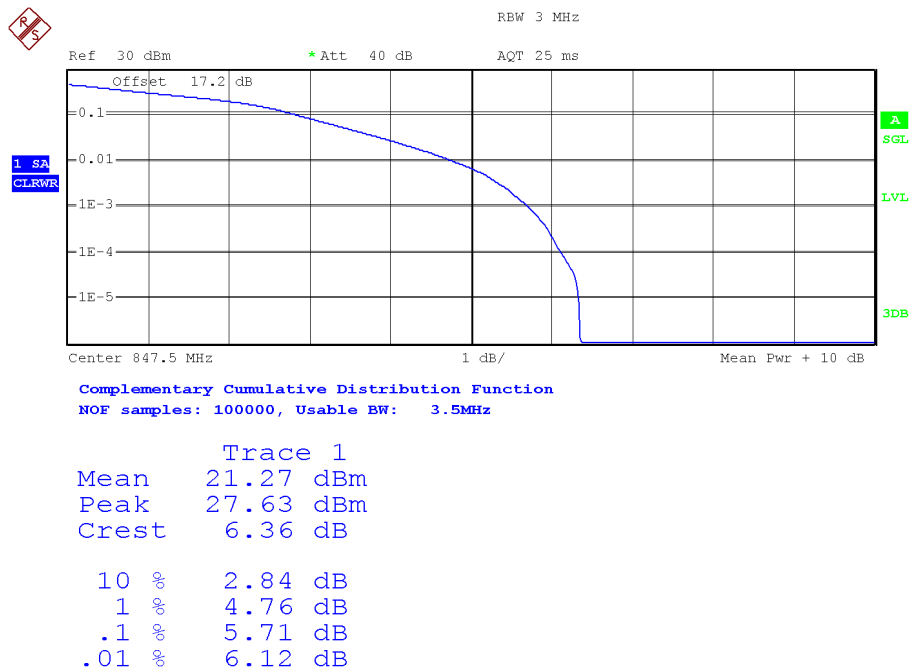
Low Channel:



Middle Channel:

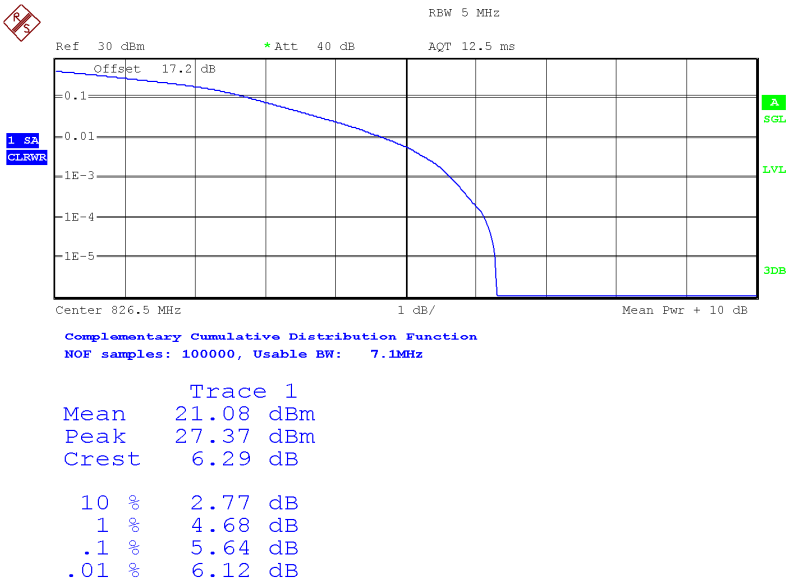


High Channel:

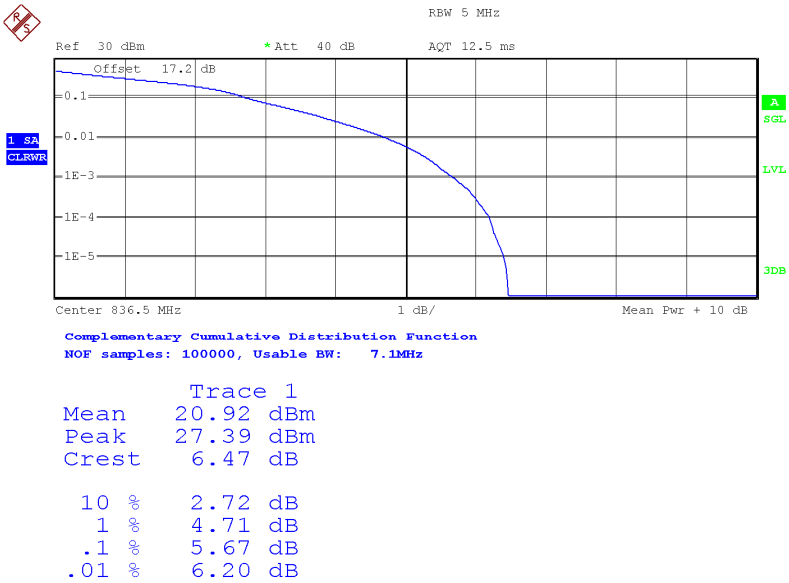


LTE Band 5. BW=5 MHz. 16QAM MODULATION. RB Size: 25. RB Offset: 0.

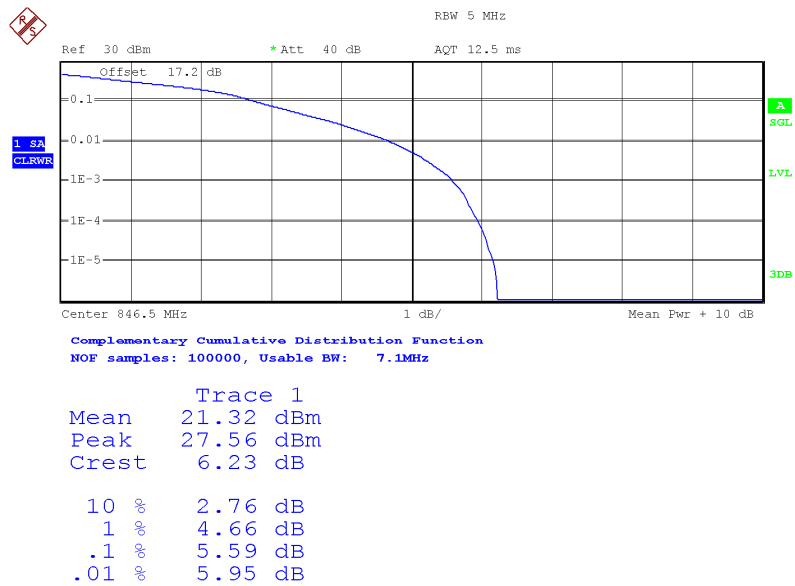
Low Channel:



Middle Channel:

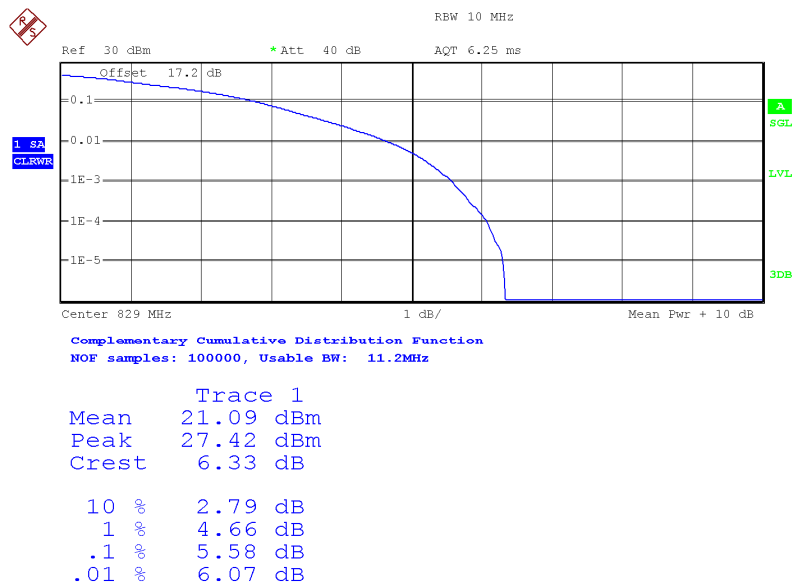


High Channel:

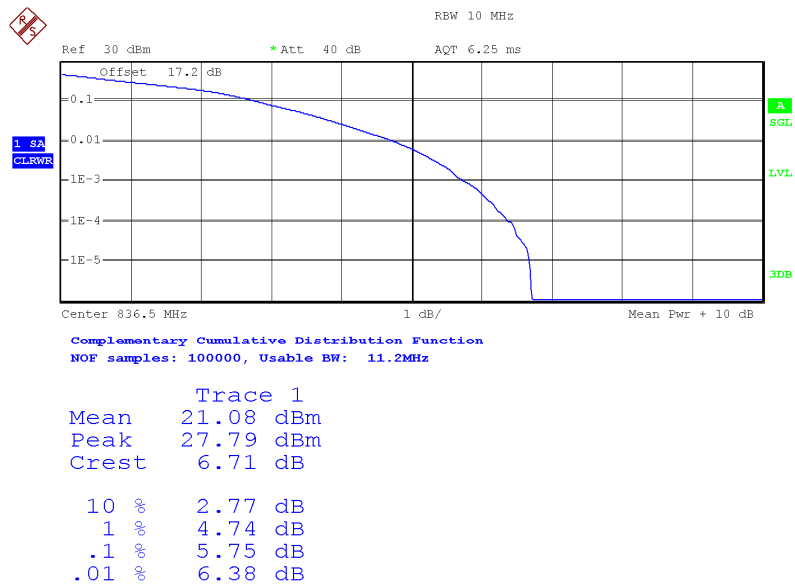


LTE Band 5. BW=10 MHz. 16QAM MODULATION. RB Size: 50. RB Offset: 0.

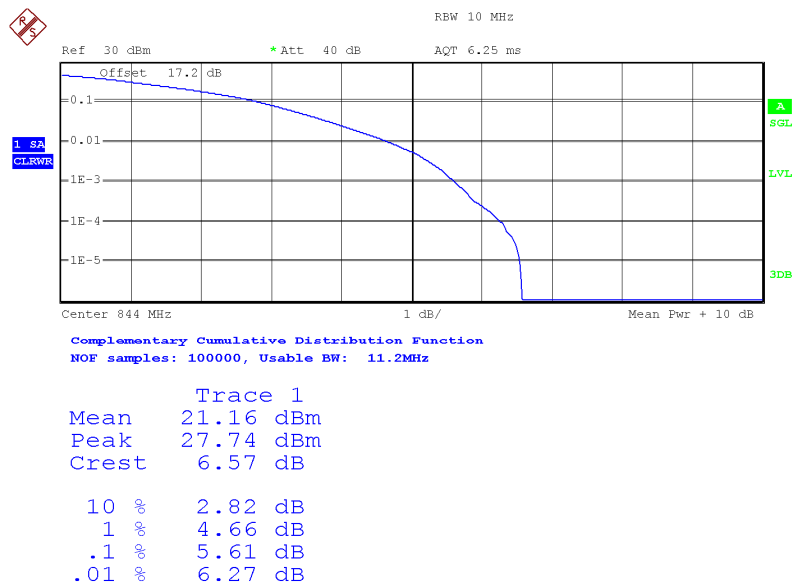
Low Channel:



Middle Channel:



High Channel:



Frequency Stability

SPECIFICATION:

FCC §2.1055 and §22.355. ± 2.5 ppm for mobile stations operating in the range 821 to 896 MHz.

RSS-132. Clause 5.3. The carrier frequency shall not depart from the reference frequency in excess of ± 2.5 ppm for mobile stations.

METHOD:

The frequency tolerance measurements over temperature variations were made over the temperature range of -30°C to $+50^{\circ}\text{C}$. The EUT was placed inside a climatic chamber and the temperature was raised hourly in 10°C steps from -30°C up to $+50^{\circ}\text{C}$.

The supply voltage was varied between 85% and 115% of nominal voltage.

The EUT was set in "Radio Resource Control (RRC) mode" in the middle channel using the Universal Radio Communication tester R&S CMW500 and the maximum frequency error was measured using the built-in calibrated frequency meter.

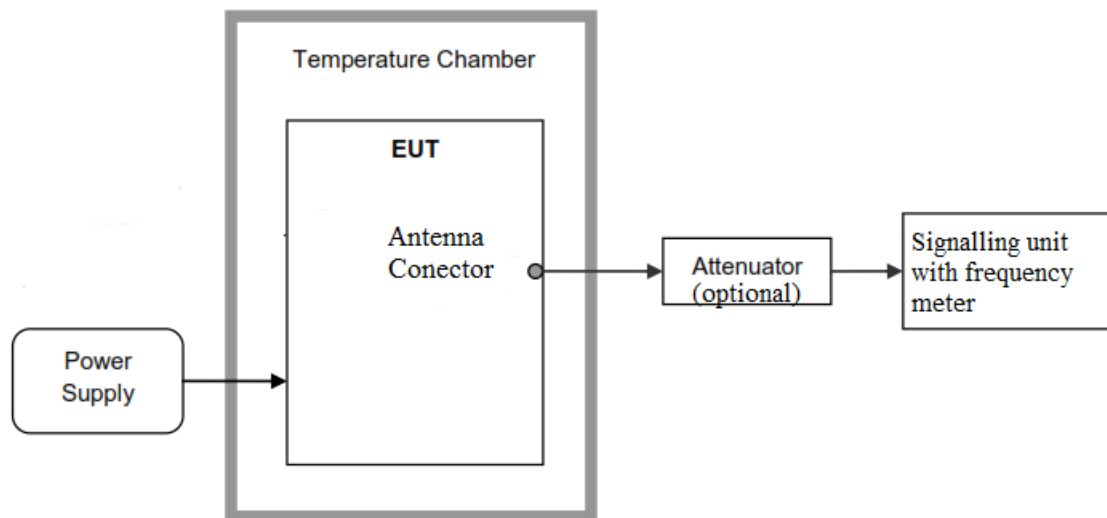
The worst case LTE mode for conducted power was used for the test.

In order to check that the frequency stability is sufficient such that the fundamental emissions stay within the authorized bands of operation, a reference point is established at the applicable unwanted emissions limit using a RBW equal to the RBW required by the unwanted emissions specification of the applicable regulatory standard. These reference points measured using the lowest and highest channel of operation are identified as fL and fH respectively. The worst-case frequency offset determined in the above methods is added or subtracted from the values of fL and fH to check that the resulting frequencies remain within the band.

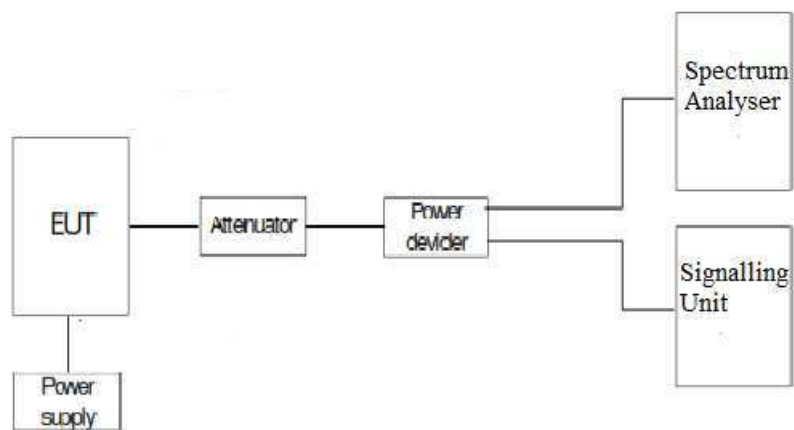
The reference point measurements were made at the RF output terminals of the EUT using an attenuator, power splitter and spectrum analyser. The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation.

TEST SETUP:

1. Frequency Tolerance:



2. Reference Frequency Points f_L and f_H :



RESULTS:

1. Frequency Tolerance:

- Frequency Stability over Temperature Variations:**

2G Band 850 MHz. GPRS and EDGE MODULATIONS.

Nominal Frequency: 836.6 MHz

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)
+50	-3.49	-0.004171647
+40	3.39	0.004052116
+30	-2	-0.002390629
+20	2.2	0.002629692
+10	-5.1	-0.006096103
0	-2.55	-0.003048052
-10	-3.89	-0.004649773
-20	-7.01	-0.008379154
-30	-7.75	-0.009263686

3G Band V. WCDMA and HSUPA MODULATIONS.

Nominal Frequency: 836.6 MHz

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)
+50	-2.02	-0.002414535
+40	-1.47	-0.001757112
+30	-1.65	-0.001972269
+20	-0.23	-0.000274922
+10	0.29	0.000346641
0	0.97	0.001159455
-10	0.31	0.000370547
-20	0.06	7.17189E-05
-30	-0.31	-0.000370547

LTE Band 5. BW=3 MHz. 16QAM MODULATION.

Nominal Frequency: 836.5 MHz

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)
+50	-1.6	-0.001912732
+40	0.73	0.000872684
+30	-0.17	-0.000203228
+20	0.67	0.000800956
+10	-0.43	-0.000514047
0	0.4	0.000478183
-10	1.1	0.001315003
-20	0.34	0.000406455
-30	0.74	0.000884638

- **Frequency Stability over Voltage Variations:**

2G Band 850 MHz. GPRS and EDGE MODULATIONS.

Battery Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
V _{max}	13.8	2.87	0.003430552
V _{min}	10.2	0.45	0.000537891

3G Band V. WCDMA and HSUPA MODULATIONS.

Battery Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
V _{max}	13.8	1.14	0.001362658
V _{min}	10.2	-4.24	-0.005068133

LTE Band 5. BW=3 MHz. 16QAM MODULATION.

Battery Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
V _{max}	13.8	-0.4	-0.000478183
V _{min} (*)	10.2	-2.45	-0.002928870

2. Reference Frequency Points f_L and f_H:

The worst-case frequency offsets added or subtracted per band and bandwidth:

2G Band 850 MHz:

	GPRS MODULATION
f _L (MHz)	824.0350922500
f _H (MHz)	848.9570033900

3G Band V:

	WCDMA MODULATION
f _L (MHz)	824.1063957600
f _H (MHz)	848.8811011400

LTE Band 5:

	16QAM MODULATION BW = 3MHz
f _L (MHz)	824.0169975500
f _H (MHz)	848.9827011000

Measurement uncertainty (kHz)	<±11.17
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The reference frequency points f_L and f_H stay within the authorized blocks for all the bands above.

Verdict: PASS

Modulation Characteristics

SPECIFICATION:

FCC §2.1047.

RSS-132. Clause 5.2: Equipment certified under this standard shall use digital modulation.

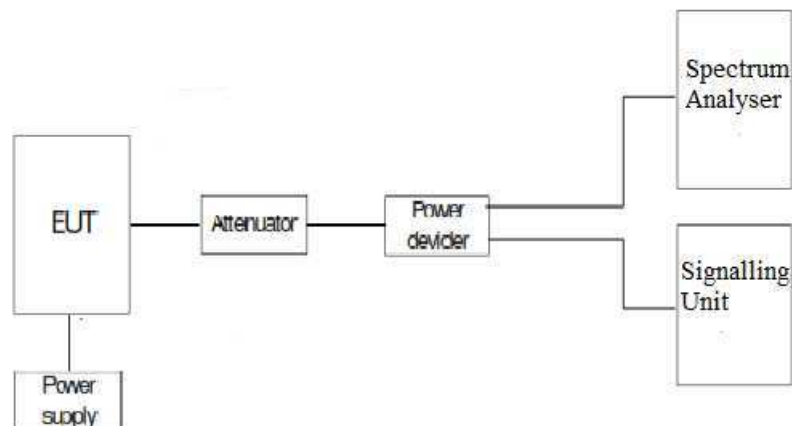
METHOD:

For 2G, the EUT operates with GPRS (GMSK) and EDGE (8PSK) modes, in which the information is digitized and coded into a bit stream.

For 3G, the EUT operates with WCDMA (QPSK) and HSUPA (QPSK) modes, in which the information is digitized and coded into a bit stream.

For LTE the EUT operates with QPSK and 16QAM modulation modes in which the information is digitized and coded into a bit stream. The RF transmission is multiplexed using *Orthogonal Frequency Division Multiplexing (OFDM)* using different possible arrangement of subcarriers (Resource Blocks RB).

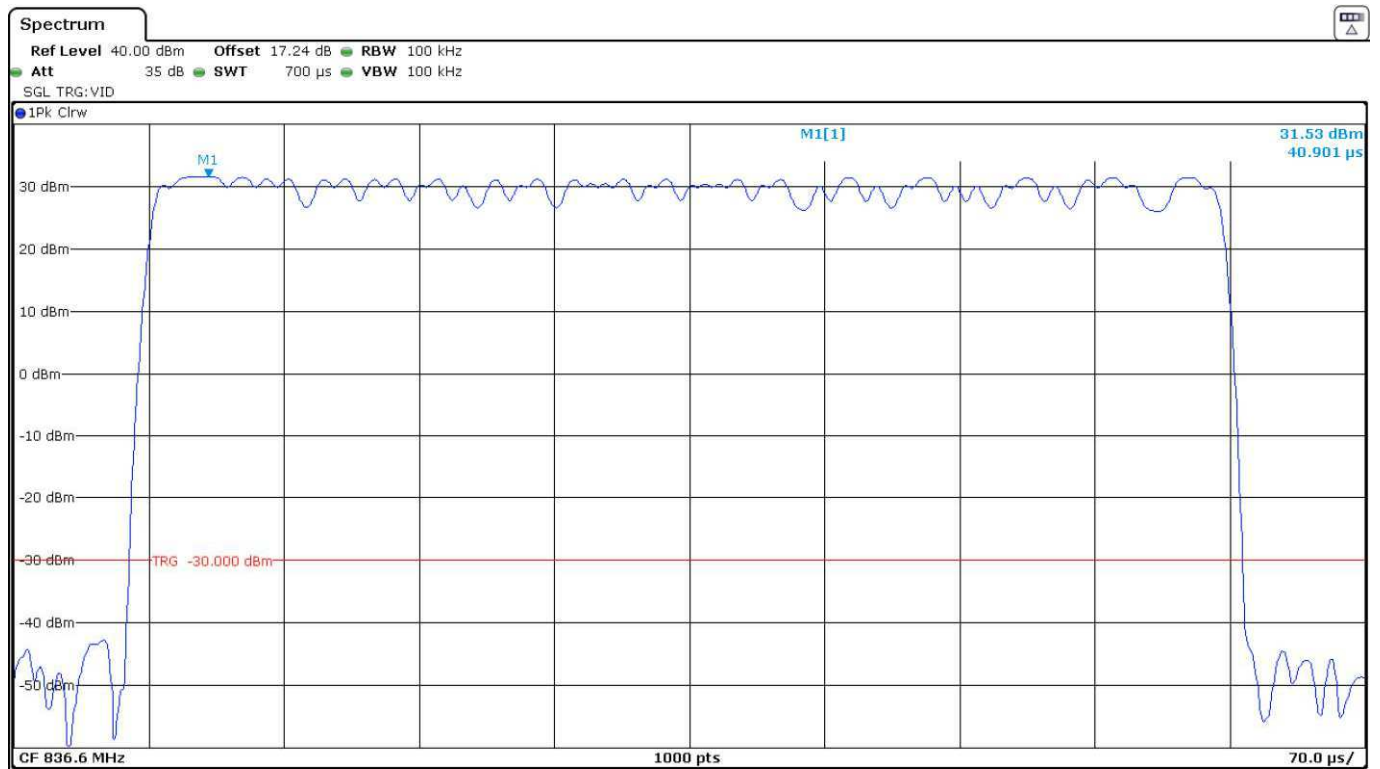
TEST SETUP:



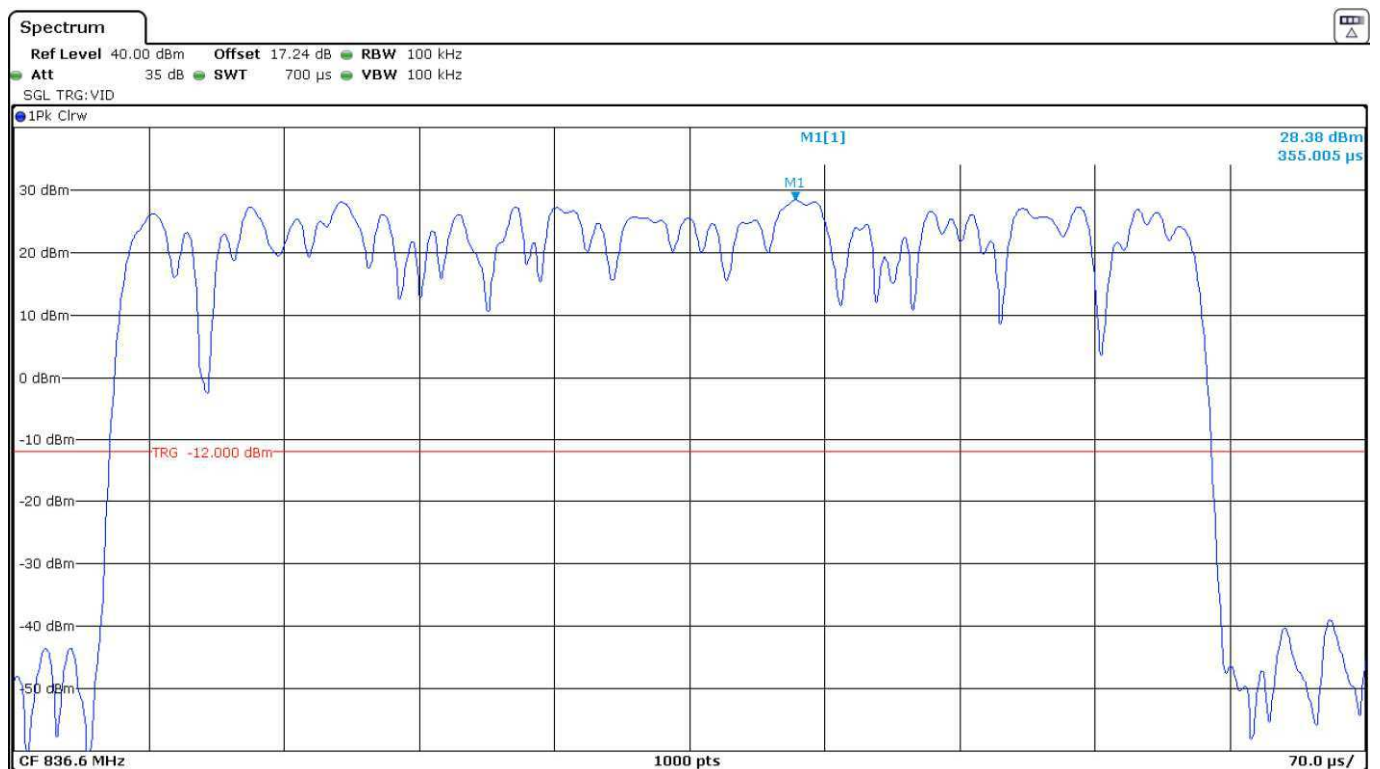
RESULTS:

The following plots show the modulation schemes of the EUT.

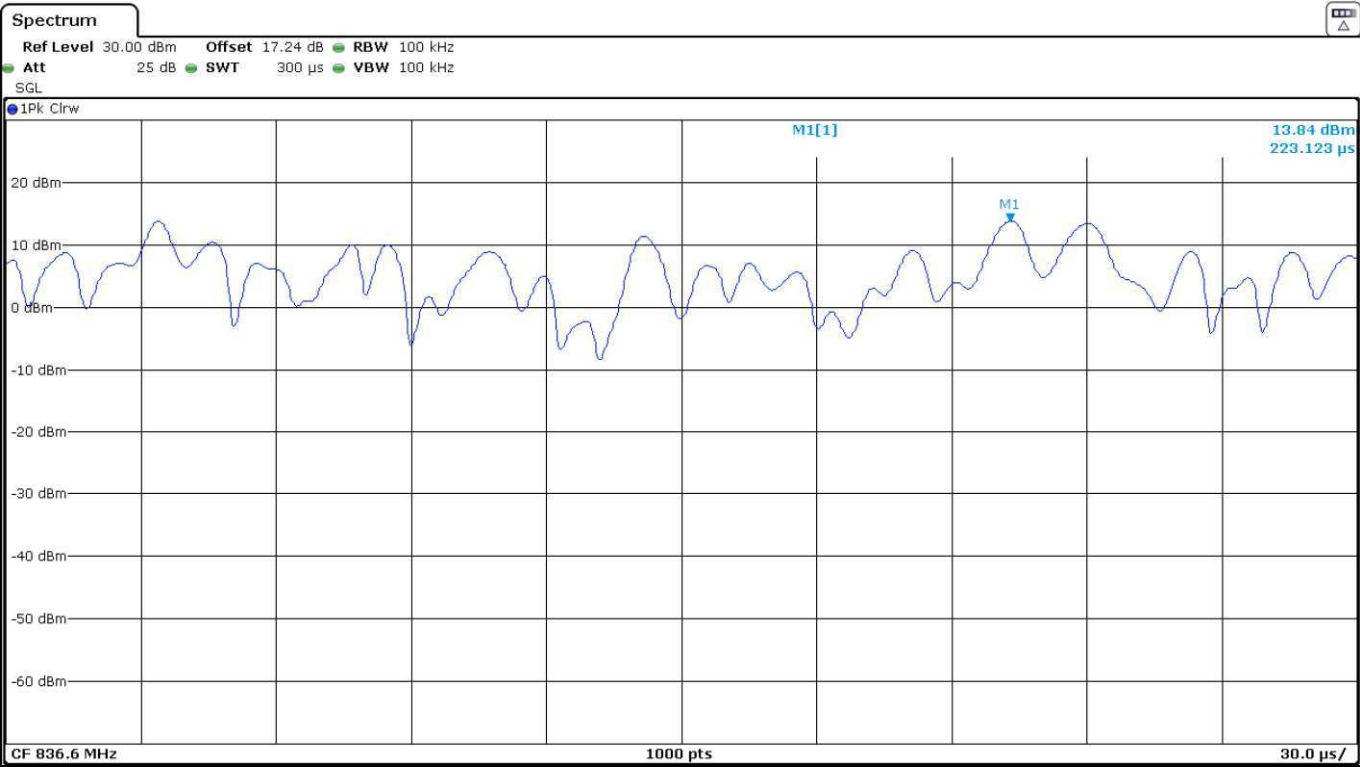
2G Band 850 MHz. GPRS MODULATION.



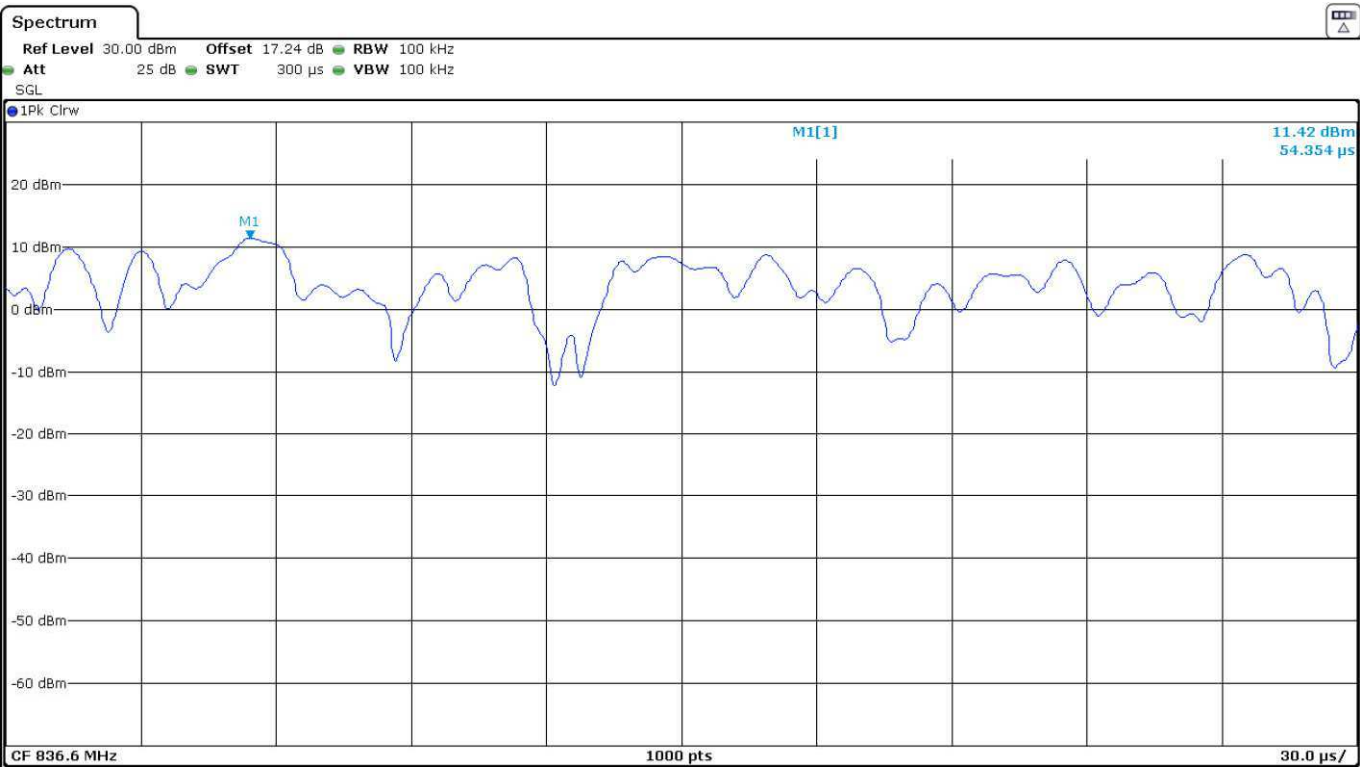
2G Band 850 MHz. EDGE MODULATION.



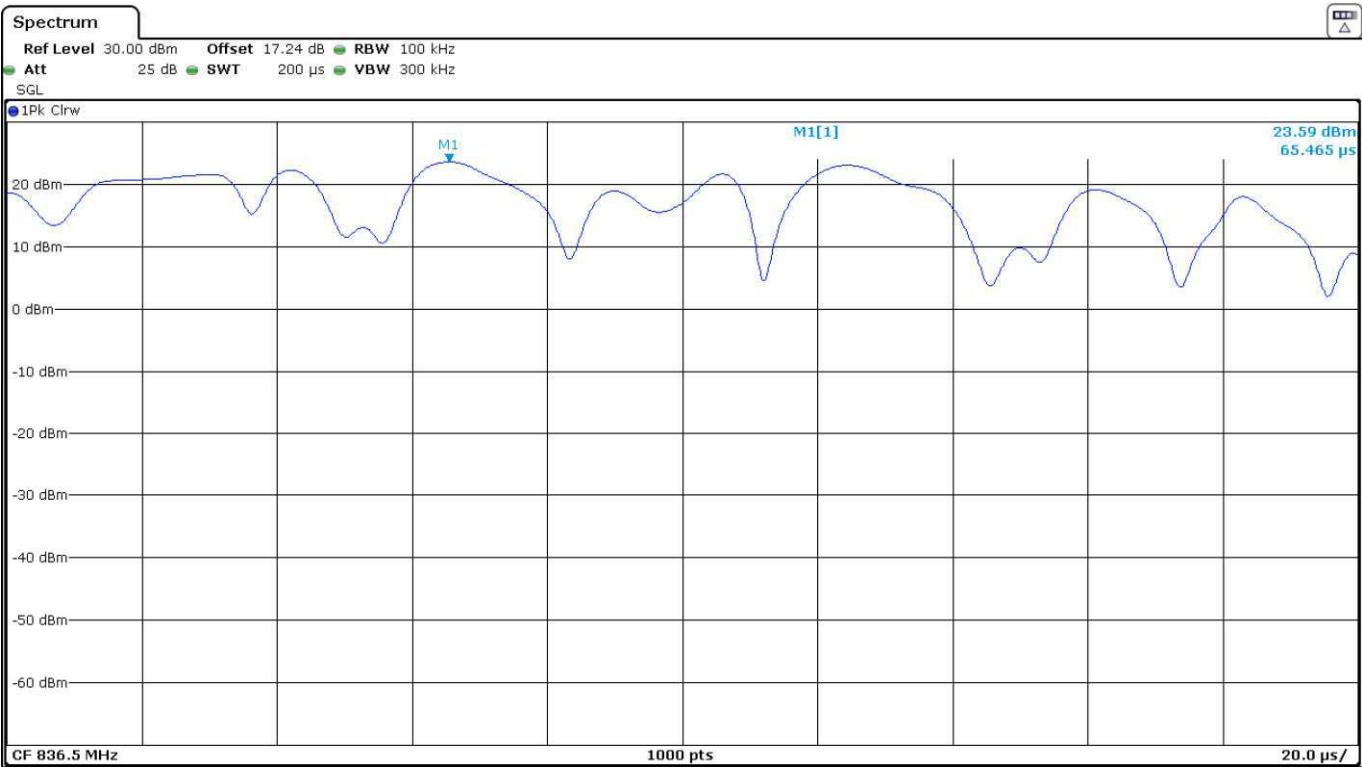
3G Band V. WCDMA MODULATION.



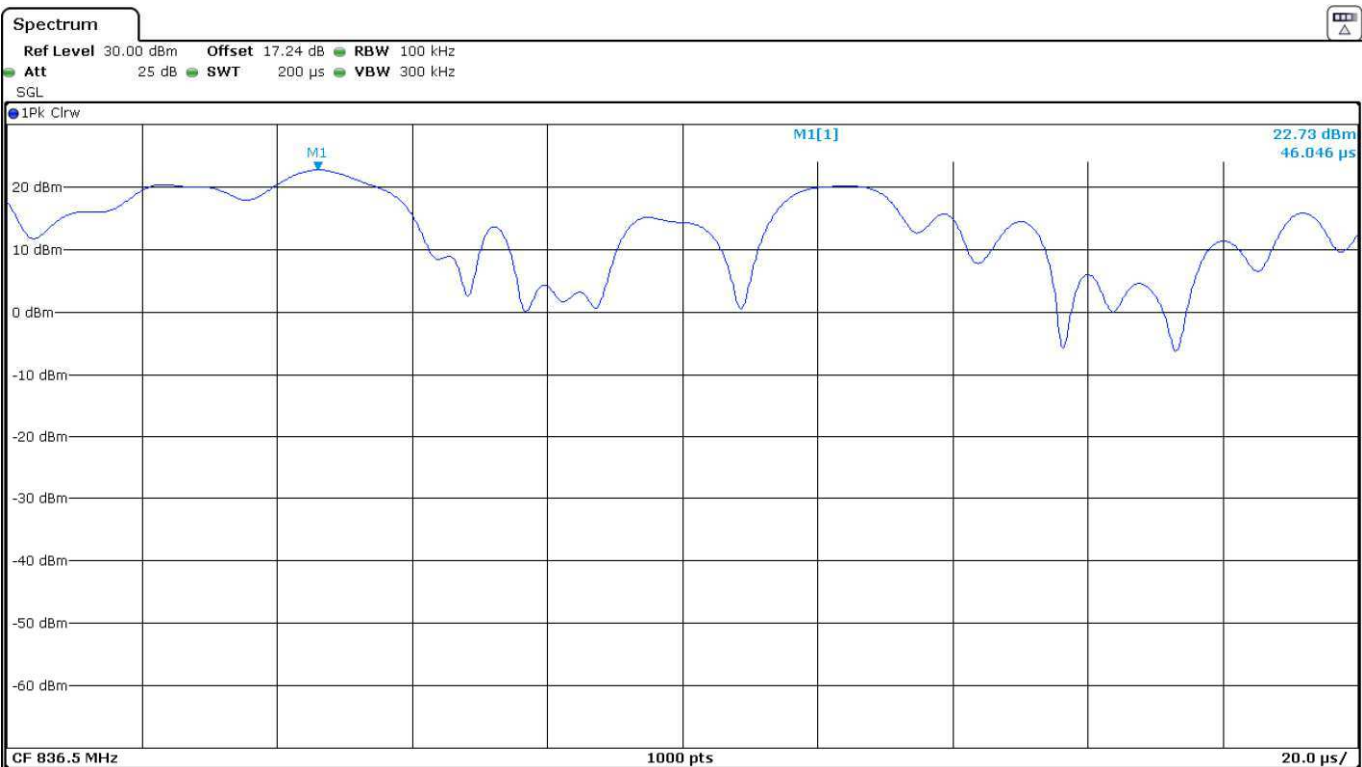
3G Band V. HSUPA MODULATION.



LTE Band 5. BW=10 MHz. QPSK MODULATION. Middle Channel. RB Size: 1. RB Offset: 25.



LTE Band 5. BW=10 MHz. 16QAM MODULATION. Middle Channel. RB Size: 1. RB Offset: 25.



Occupied Bandwidth

SPECIFICATION:

FCC §2.1049.

METHOD:

The occupied bandwidth measurement was performed at the output terminals of the EUT using an attenuator, power splitter and spectrum analyser. The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation. The 99% occupied bandwidth and the -26 dBc bandwidth were measured directly using the built-in bandwidth measuring option of spectrum analyser.

TEST SETUP:

