

FCC C2PC Test Report (Part 24)

GSM, WCDMA, LTE

Test Report no.:	EMC_BO_002246 (v1.0)	Date of Report:	07-Oct-2019
Number of pages:	21	Project support engineer:	Frank Wittmann
Test period:	09.Sep – 18.Sep.2019		

Applicant:	Molex CVS Bochum GmbH, Meesmannstraße 103, 44807 Bochum, Germany, Bernhard Bläcker		
Manufacturer:	Molex CVS Bochum GmbH, Meesmannstraße 103, 44807 Bochum, Germany		
EUT identification:	Molex, RCP-1g		
FCC ID:	XPY1EHQ37NN		

Testing Laboratory:	Molex CVS Lab, Molex CVS Bochum GmbH, Meesmannstr.103, 44807 Bochum, Germany		
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	FCC Designation number	DE0017	
	Laboratory manager:	Robert Müller	

Test result	The EUT complies with the requirements made in the referred test documents.
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Approver:	Jürgen Mitterer	Author:	Frank Wittmann
Title:	Validation and Test Engineering Manager	Title:	Senior Test Engineer EMC
Signature:		Signature:	





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Version History

Report Number	Date	Comment
EMC_BO_002246 (v1.0)	07-October-2019	First release version
-	-	-
-	-	-
-	-	-

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1. Summary for FCC Part 24 (Subpart E) Compliance Test Report

Date of receipt	17-06-2019
Testing completed	18-09-2019
The customer's contact person	Bernhard Bläcker
Notes	none

1.1. EUT and Accessory Information

The EUT is an Onboard Logic Unit (OLU) designed for automobiles with following features:

GSM, WCDMA, LTE, WLAN, Bluetooth, Bluetooth Low Energy.

The EUT is tested with maximum rated TX power, modulated with pseudo random bit sequence (PRBS9).

Radiated measurements were done with dedicated antenna from the customer.

Product	Manufacturer	Type	SN	HW	MV	SW	ID
Onboard Logic Unit	Molex	RCP-1g	PM81905800468	5373	-	12.0.1	BOC191094E
Onboard Logic Unit	Molex	RCP-1g	PM81905800531	5373	-	12.0.1	BOC191095E

Accessory Equipment

Product	Manufacturer	Type	SN	HW	MV	SW	ID
System Cable	Molex	-	-	-	-	-	BOC180655E
System Cable	Molex	-	-	-	-	-	BOC180376E
RF Cable (4x)	Molex	-	-	-	-	-	BOC180657E
RF Cable (4x)	Molex	-	-	-	-	-	BOC180377E
MBN Cellular Antenna	MBN	A231 905 08 02	-	-	-	-	BOC191041E
GNSS Antenna	Hirschmann	GLONASS 9 M	-	-	-	-	BOC190623E
1000Base-T1 Cable	Molex	-	-	-	-	-	BOC181025E
USB Cable	Molex	-	-	-	-	-	BOC180850E
USB Cable	Molex	-	-	-	-	-	BOC180847E

1.2. Technical Characteristics

Operating Voltage	$U_{nom} = +12 \text{ V DC}$	
Temperature Range	$T_{min} = -40 \text{ °C}$	$T_{max} = +80 \text{ °C}$
Operating Voltage Range	$U_{Bmin} = +9.0 \text{ V}$	$U_{Bmax} = +16.0 \text{ V}$
Type of Equipment	Portable	
CELLULAR Module	uBlox, Toby L4006	
GSM	E-GSM900, Power Class 4/E2 (33/27dBm) DCS1800, Power Class 1/E2 (30/27dBm)	
UTRA	WCDMA-HSPA+ FDD Band 1/8, Power Class 3 (24dBm)	
E-UTRA	LTE-A Rel10 (MIMO 2x2, 1x TX/RX +1x RX only, Cat6) FDD Bands 1/3/7/8/20 +TDD Band 38, Power Class 3 (23dBm) LTE-CA (RX) 3+20/7+20/3+3/3+7, No LTE-CA (TX)	
BT-WLAN Module	muRata, LBEE6ZZ1PY	
BT	Bluetooth 5 Dual Mode (2.4GHz, SISO, 1x TXRX) BDR (1 Mbit/s), EDR (2 Mbit/s, 3 Mbit/s), BLE (1 Mbit/s, 2 Mbit/s) 802.15: BT Classic: 2402-2480 MHz, 79, OFDM (1 MHz), AFH, (0<P<10dbm) 802.15: BT Low Energy: 2402-2480 MHz, 40, OFDM (1 MHz), AFH, (0<P<10dbm)	
WLAN	2.4 GHz, SISO, 1x TXRX, 38.4 MHz reference clock 802.11b: 2412-2472 MHz, 1, 2, 5.5, 11 Mbps, DSSS/CCK, (>10dbm) 802.11g: 2412-2472 MHz, 6, 9, 12, 18, 24, 36, 48, 54 Mbps, OFDM, (>10dbm) 802.11n: 2412-2472 MHz, MCS0-7, OFDM (20 MHz), (>10dbm)	
WLAN (U-NII-3) (U-NII-1, 2A and 2C deactivated)	5.8 GHz, SISO, 1x TXRX, 38.4 MHz reference clock, no DFS 802.11a: 5725-5825 MHz, 6, 9, 12, 18, 24, 36, 48, 54 Mbps, OFDM, (>10dbm) 802.11n: 5725-5825 MHz, MCS0-7, OFDM (40 MHz), (>10dbm) 802.11ac: 5725-5825 MHz, MCS0-9, OFDM (80 MHz), (>10dbm)	
GNSS Module (Galileo and Beidou deactivated)	uBlox, NEO-M8L-03A	
GPS	GPS, L1C/A (1575.42MHz)	
GLONASS	GLONASS, L1OF (1602MHz)	
Audio Interface (no audio call supported)	1x Mic-Input/Output 1x Line-Out	
Other CAR Interfaces	3x CAN (up to 500 kbit/s) 1x LIN 1x USB 1x 1000Base-T1 (1 Gbit/s) 4x HS-Switches (12 V) Digital I/O's	

1.3. Applied Standards

Standard / Rule Part	Version	Year
CFR 47, FCC Part 2 and Part 24	-	as of current date of e-CFR data
ANSI C63.26	-	Dec-2015

Deviations or clarifications to these standards are noted in the related test result under “test reference and limit”.

1.4. Measurement Uncertainties

Parameter	Measurement Uncertainty	Maximum Uncertainty
Radio Frequency	$\pm 3.6 \times 10^{-7}$	$\pm 1 \times 10^{-5}$
Total RF Power, conducted	± 0.79 dB	± 1.5 dB
RF Power density, conducted	± 0.79 dB	± 3.0 dB
Spurious emissions, conducted	± 1.67 dB	± 3.0 dB
All emissions, radiated	± 5.38 dB	± 6.0 dB
Temperature	± 1.0 °C	± 3 °C
Humidity	± 2.0 %	± 5.0 %

These uncertainties represent an expanded uncertainty expressed approximately at the 95% confidence level using a coverage factor of k=2

1.5. Summary of Test Results

GSM 1900

Section in CFR 47 (Part24 Subpart E)	Name of the test	Result
§24.232(c), §2.1046(a)	Conducted RF output power	NP
§24.232(c), §2.1046(a)	Radiated RF output power	NP
N/A	Peak to average power ratio	NP
§24.238(b), §2.1049(h)	99%/26dB occupied bandwidth	NP
§24.238(a), §2.1053	Band edge compliance	PASSED
§24.238(a), §2.1051	Spurious emissions at antenna terminals	NP
§24.238(a), §2.1053	Spurious radiated emissions	PASSED
§24.235, §2.1055(a)(1)	Frequency Stability, temperature variation	NP
§24.235, §2.1055(d)	Frequency Stability, voltage variation	NP

WCDMA Band 2

Section in CFR 47 (Part24 Subpart E)	Name of the test	Result
§24.232(c), §2.1046(a)	Conducted RF output power	NP
§24.232(c), §2.1046(a)	Radiated RF output power	NP
N/A	Peak to average power ratio	NP
§24.238(b), §2.1049(h)	99%/26dB occupied bandwidth	NP
§24.238(a), §2.1053	Band edge compliance	PASSED
§24.238(a), §2.1051	Spurious emissions at antenna terminals	NP
§24.238(a), §2.1053	Spurious radiated emissions	PASSED
§24.235, §2.1055(a)(1)	Frequency Stability, temperature variation	NP
§24.235, §2.1055(d)	Frequency Stability, voltage variation	NP

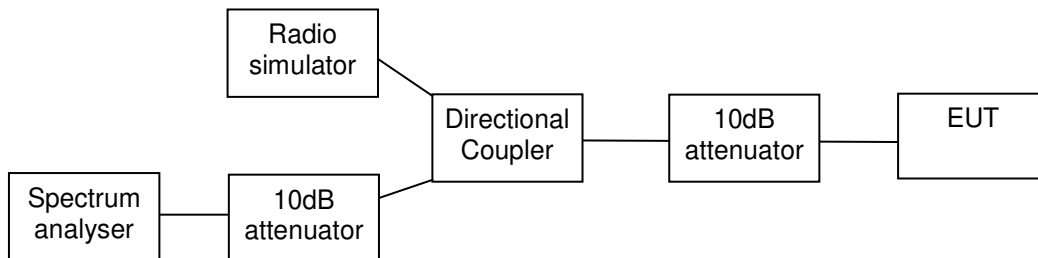
LTE Band 2

Section in CFR 47 (Part24 Subpart E)	Name of the test	Result
§24.232(c), §2.1046(a)	Conducted RF output power	NP
§24.232(c), §2.1046(a)	Radiated RF output power	NP
N/A	Peak to average power ratio	NP
§24.238(b), §2.1049(h)	99%/26dB occupied bandwidth	NP
§24.238(a), §2.1053	Band edge compliance	PASSED
§24.238(a), §2.1051	Spurious emissions at antenna terminals	NP
§24.238(a), §2.1053	Spurious radiated emissions	PASSED
§24.235, §2.1055(a)(1)	Frequency Stability, temperature variation	NP
§24.235, §2.1055(d)	Frequency Stability, voltage variation	NP

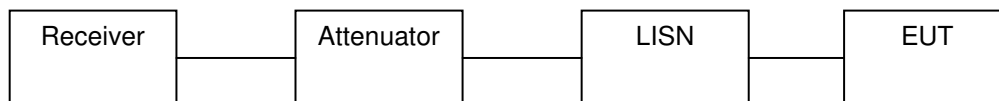
PASSED: The EUT complies with the essential requirements in the standard.
 FAILED: The EUT does not comply with the essential requirements in the standard.
 NP: The test was not performed.
 NA: The test was not applicable.

2. Test setups

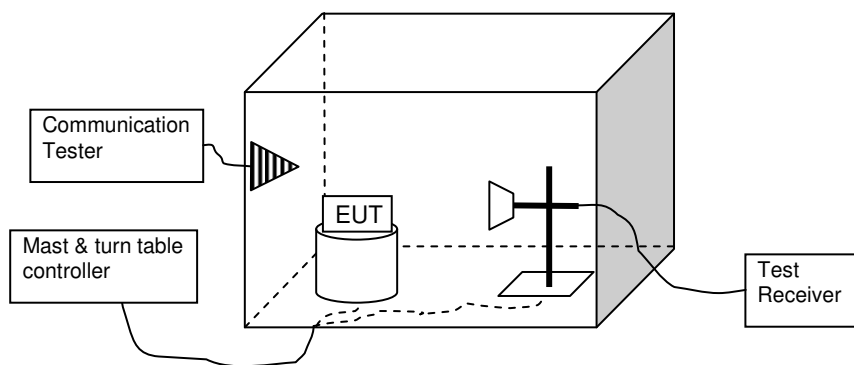
2.1. Conducted test setup (Setup 1)



2.2. Conducted AC power line conducted emissions test setup (Setup 2)



2.3. Radiated test setup (Setup 3)



4. Radiated Band edge compliance

DUT with ID number	BOC191095E
Accessories with DUT numbers	BOC180655E, BOC180657E, BOC190623E, BOC180850E, BOC181025E
Operation Voltage [V] / [Hz]	13.2 / DC
Test Setup	Setup 3
Result	PASSED
Remarks	None
Temp [°C] / Humidity [%RH]	22.9 / 43.5
Date of measurements	09.Sep.2019 – 18.Sep.2019
Measured by	Robert Müller
Test system SW version	1.7.1

4.1. Test reference and limit

The measurement is made according to FCC rules parts 24 and ANSI C63.26 section 5.7.

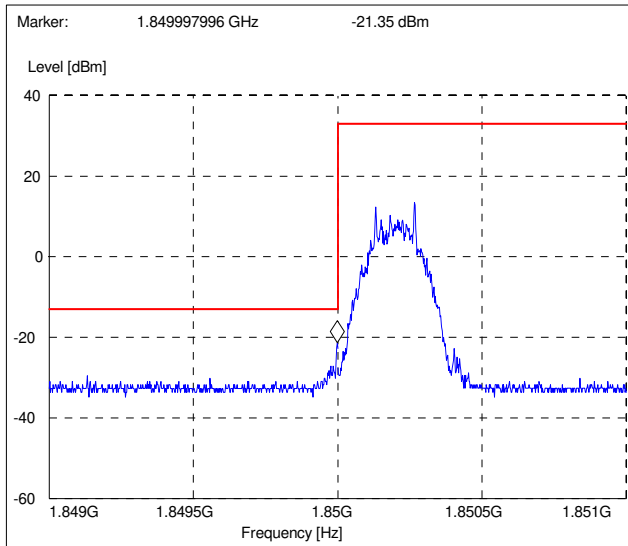
Limits for band edge compliance measurements

Frequency Bands	Frequency range [MHz]	FCC Limit [dBm]
GSM 1900	Below 1850 & Above 1910	-13
WCDMA 2	Below 1850 & Above 1910	-13
LTE 2	Below 1850 & Above 1910	-13

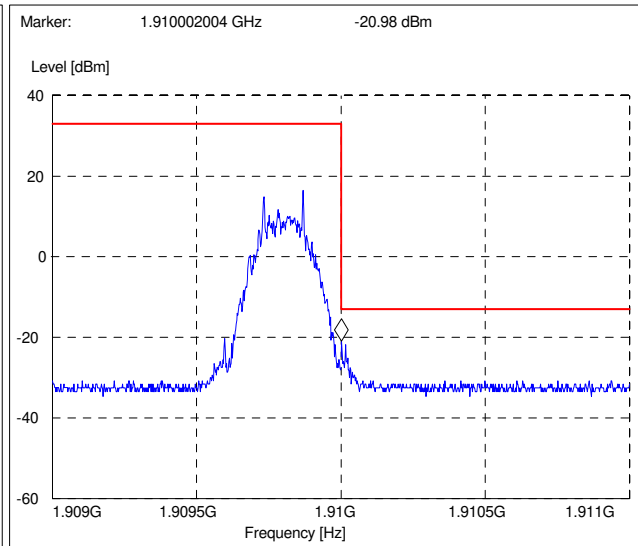
4.2. GSM1900 Test results

Operation Mode	Channel / f_c [MHz]	Level [dBm]	Margin [dBm]	Limit [dBm]	Result
GSM	512 / 1850.2	-21.35	8.35	-13	PASSED
GSM	810 / 1909.8	-20.98	7.98	-13	PASSED

GSM, 1850.2 MHz, RBW = 3kHz



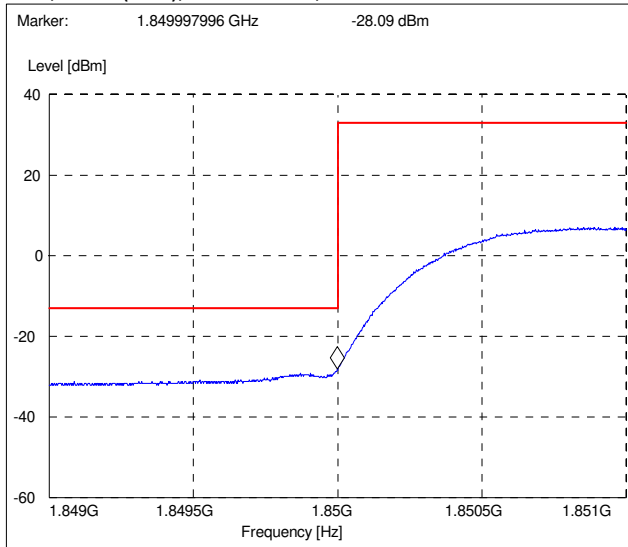
GSM, 1909.8 MHz, RBW = 3kHz



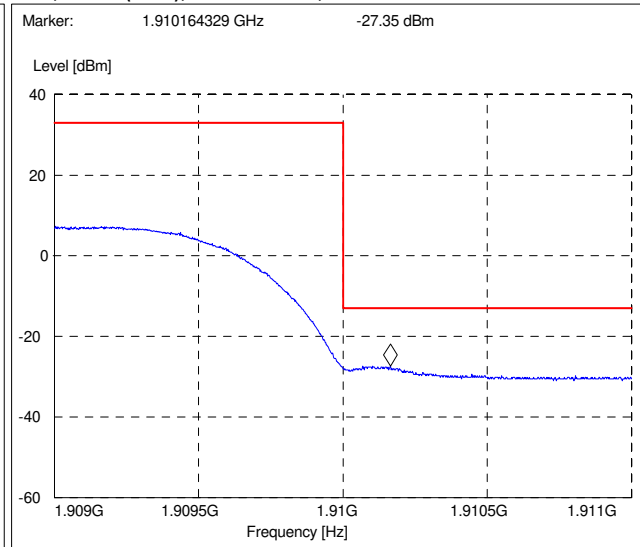
4.3. WCDMA2 Test results

Operation Mode	Channel / f_c [MHz]	Level [dBm]	Margin [dBm]	Limit [dBm]	Result
FDD, RMC	9262 / 1852.4	-28.09	15.09	-13	PASSED
FDD, RMC	9538 / 1907.6	-27.35	14.35	-13	PASSED
FDD, HSDPA (R05)	9262 / 1852.4	-28.42	15.42	-13	PASSED
FDD, HSDPA (R05)	9538 / 1907.6	-27.36	14.36	-13	PASSED
FDD, HSPA (R06)	9262 / 1852.4	-28.09	15.09	-13	PASSED
FDD, HSPA (R06)	9538 / 1907.6	-27.36	14.36	-13	PASSED

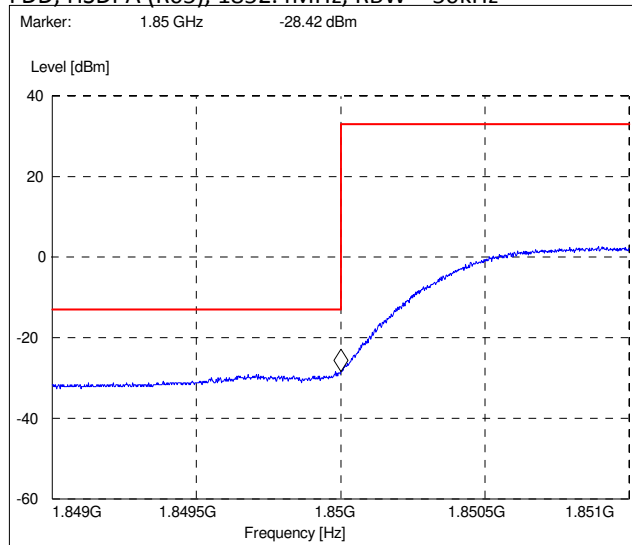
FDD, RMC (R99), 1852.4MHz, RBW = 50kHz



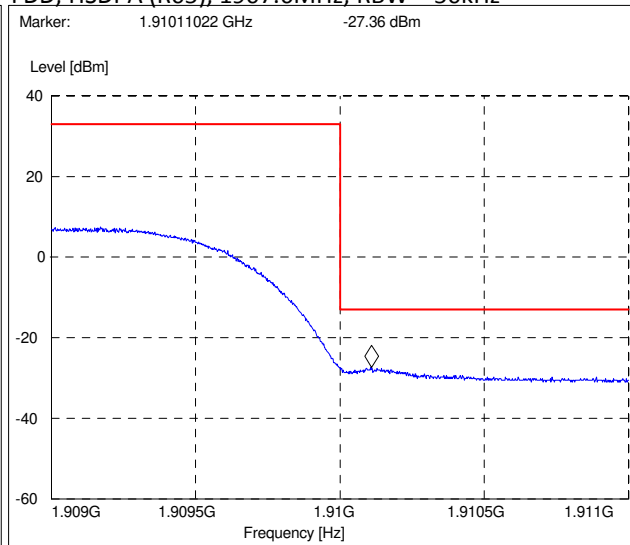
FDD, RMC (R99), 1907.6MHz, RBW = 50kHz



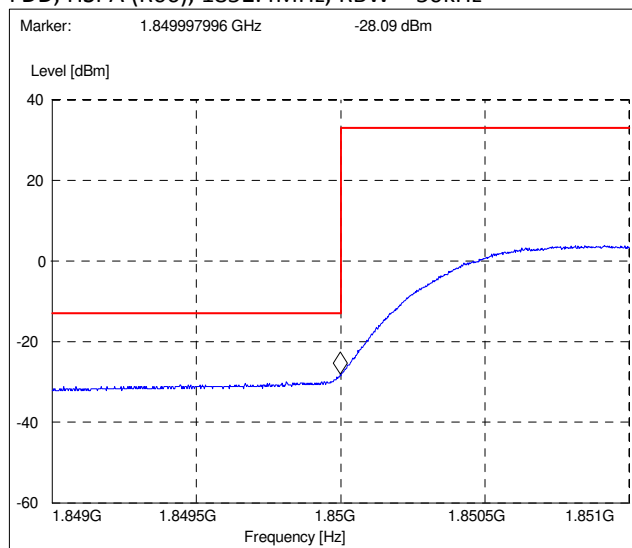
FDD, HSDPA (R05), 1852.4MHz, RBW = 50kHz



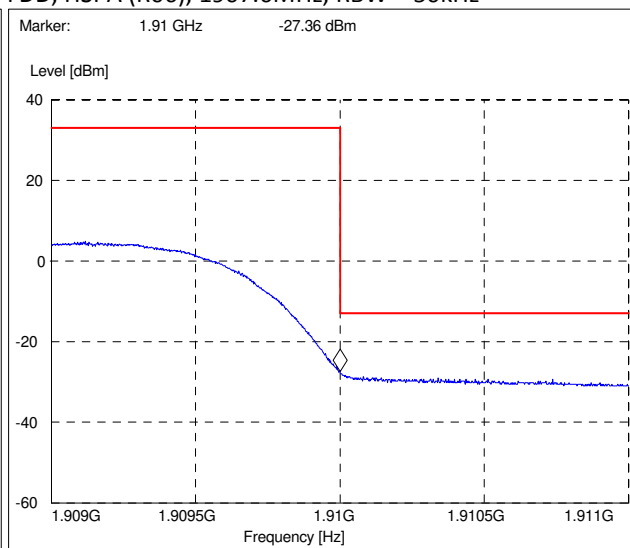
FDD, HSDPA (R05), 1907.6MHz, RBW = 50kHz



FDD, HSPA (R06), 1852.4MHz, RBW = 50kHz



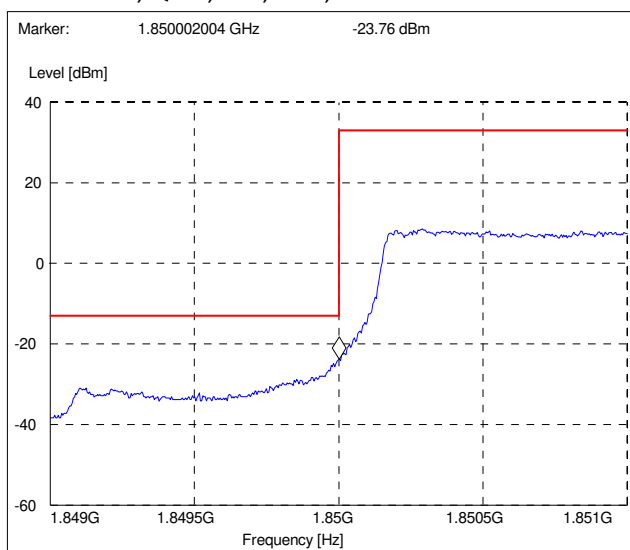
FDD, HSPA (R06), 1907.6MHz, RBW = 50kHz



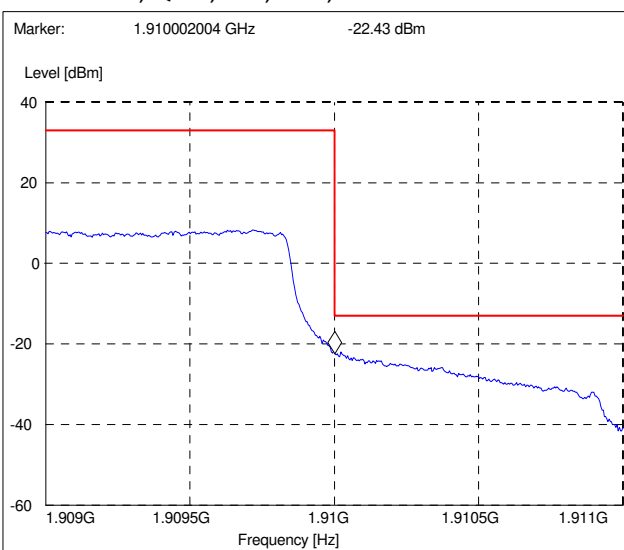
4.4. LTE2 Test results

Operation Mode	Channel / f_c [MHz]	Level [dBm]	Margin [dBm]	Limit [dBm]	Result
FDD, CBW 1.4MHz, QPSK, 6RB	18607/1850.7	-23.76	10.76	-13	PASSED
FDD, CBW 1.4MHz, QPSK, 6RB	19193/1909.3	-22.43	9.43	-13	PASSED
FDD, CBW 1.4MHz, 16QAM, 6RB	18607/1850.7	-23.99	10.99	-13	PASSED
FDD, CBW 1.4MHz, 16QAM, 6RB	19193/1909.3	-23.77	10.77	-13	PASSED

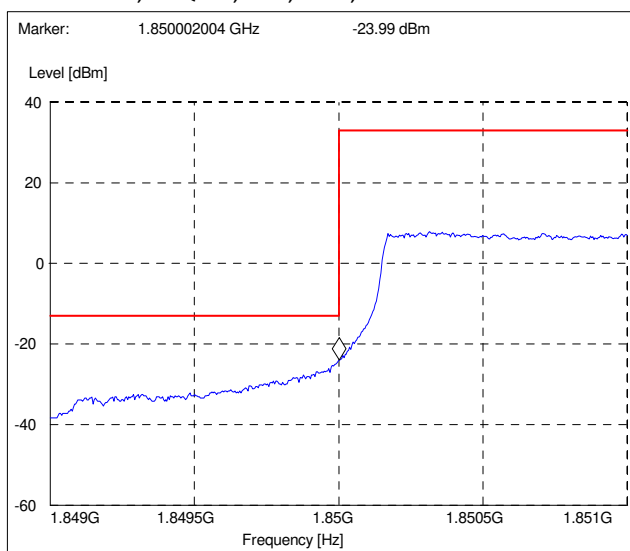
1850.7 MHz, QPSK, 6RB, RMS, RBW = 20kHz



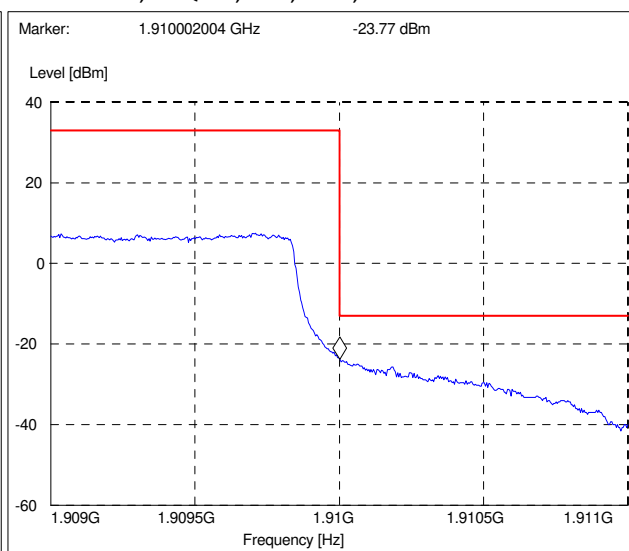
1909.3 MHz, QPSK, 6RB, RMS, RBW = 20kHz



1850.7 MHz, 16QAM, 6RB, RMS, RBW = 20kHz



1909.3 MHz, 16QAM, 6RB, RMS, RBW = 20kHz



5. Spurious radiated emissions

DUT with ID number	BOC191095E
Accessories with DUT numbers	BOC180655E, BOC180657E, BOC190623E, BOC180850E, BOC181025E
Operation Voltage [V] / [Hz]	13.2 / DC
Test Setup	Setup 3
Result	PASSED
Remarks	None
Temp [°C] / Humidity [%RH]	22.9 / 43.5
Date of measurements	05.Sep.2019 – 11.Sep.2019
Measured by	Robert Müller
Test system SW version	1.7.1

5.1. Test reference and limit

The measurement is made according to FCC rules parts 24 and ANSI C63.26, section 5.5, as follows:

Below 1GHz:

The Preliminary Measurement and the Final Measurement is performed in 3m distance by rotating the turntable of 360 degrees.

The Preliminary Measurement is performed with floor absorbers on the floor and measuring antenna at fixed height using 2-axis EUT position system.

The Final Measurement is performed if the Preliminary Measurement results are closer than 20 dB to the permissible limit.

The Final Measurement is performed without floor absorbers and antenna height between 1m and 4m.

Between 1-18GHz:

The Preliminary Measurement and the Final Measurement is performed in 3m distance by rotating the turntable of 360 degrees at fixed height.

The Preliminary Measurement and the Final Measurement is performed with absorbers on the floor and measuring antenna at fixed height using 2-axis EUT position system.

The Final Measurement is performed, if the Preliminary Measurement results are closer than 20 dB to the permissible limit.

Above 18GHz:

The Preliminary Measurement and the Final Measurement is performed in 1.5m distance by rotating the turntable of 360 degrees at fixed height.

The Preliminary Measurement and the Final Measurement is performed with absorbers on the floor and measuring antenna at fixed height using 2-axis EUT position system.

The Final Measurement is performed, if the Preliminary Measurement results are closer than 20 dB to the permissible limit.

General:

The emissions less than 20 dB below the permissible value are reported. The measurement results are obtained by using the direct field strength method and pre-test site path loss characterization.

$$\text{ERP (dBm)} = U_{\text{RX}} (\text{dB}\mu\text{V}) - 107 + A_{\text{CF}} (\text{dB}) + G_{\text{CF}} (\text{dB})$$

$$\text{EIRP (dBm)} = \text{ERP (dBm)} + 2.15$$

U_{RX} = is the receiver reading

A_{CF} = is the signal path correction factor including cable loss and preamplifier gain

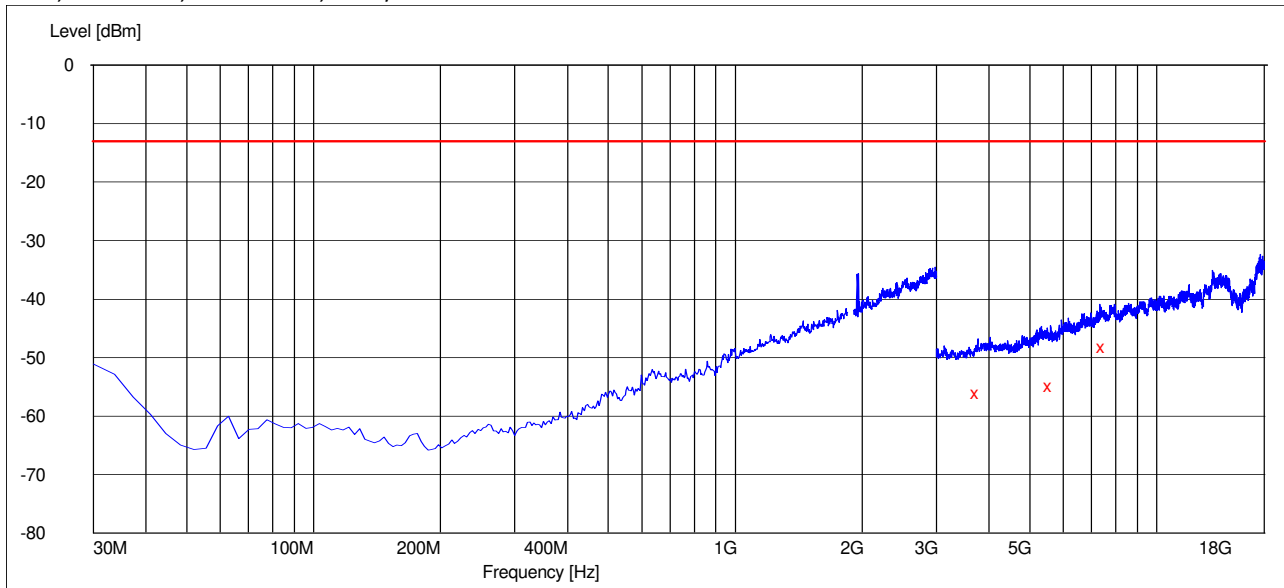
G_{CF} = is the pre-test site path loss characterization factor including site path loss and antenna gain.

Limits for spurious radiated emissions measurements

Frequency Band	Frequency range [MHz]	FCC Limit [dBm]
GSM 1900	30 – 18000	-13
WCDMA 2		-13
LTE 2		-13

5.2. GSM1900 test results

GSM, 1880 MHz, PK detector, RBW/VBW = 5MHz



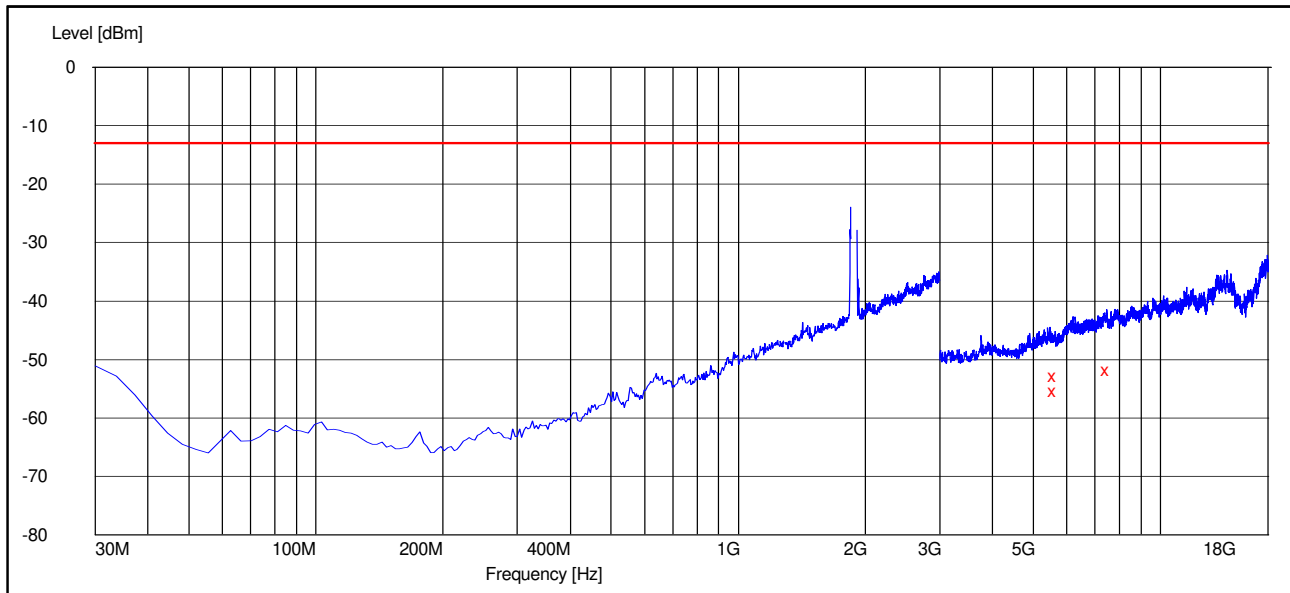
GSM, 1880 MHz, PK detector, RBW/VBW=1/3MHz

Frequency [MHz]	Pol.	Height [cm]	Azimuth (deg)	Elevation (deg)	Correction (dB)	Level [dBm]	Margin (dBm)	Limit (dBm)	Result
3766.53	VER	170	360	52	-109.9	-56.1	43.1	-13	PASSED
5625.75	VER	170	37	75	-104.6	-54.8	41.8	-13	PASSED
7520.04	VER	170	286	65	-101.5	-48.2	35.2	-13	PASSED
-									

No final measurement with RMS detector and 1/3MHz RBW/VBW done, due to more than 20dB margin to the limit.

5.3. WCDMA2 test results

FDD, RMC, 1880 MHz, PK detector, RBW/VBW = 5MHz



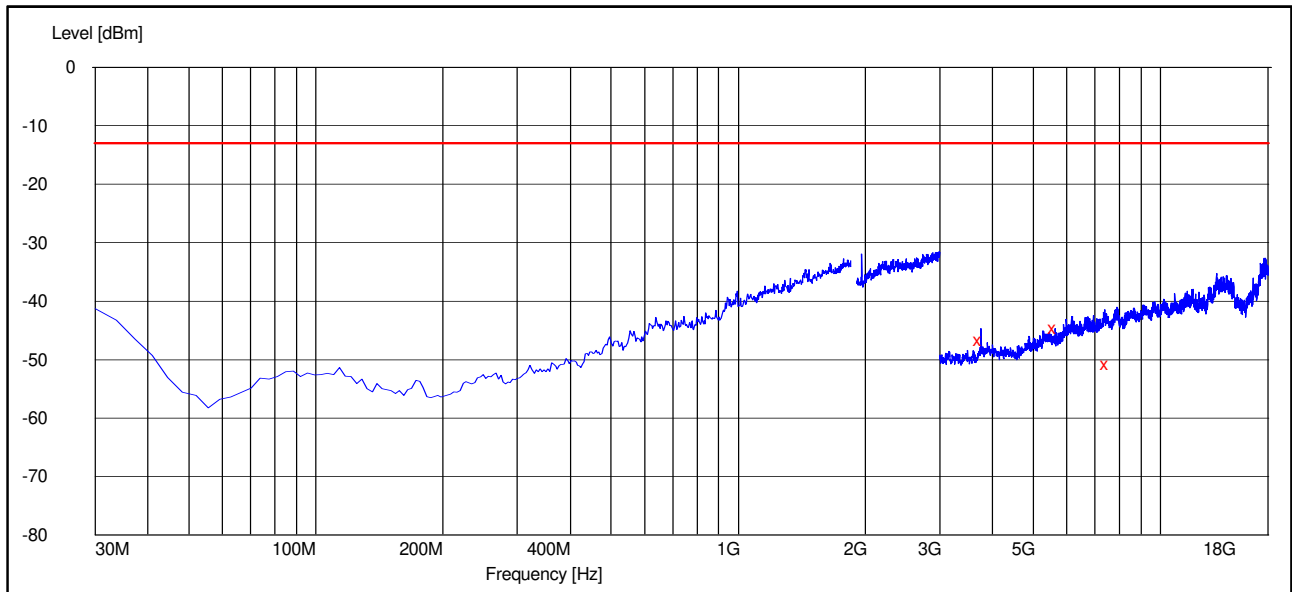
FDD, RMC, 1880 MHz, PK detector, RBW/VBW=1/3MHz

Frequency [MHz]	Pol.	Height [cm]	Azimuth (deg)	Elevation (deg)	Correction (dB)	Level [dBm]	Margin (dBm)	Limit (dBm)	Result
5632.75	VER	170	166	23	-104.6	-55.4	42.4	-13	PASSED
5642.27	VER	170	213	14	-104.7	-52.8	39.8	-13	PASSED
7524.55	VER	170	293	30	-101.5	-51.8	38.8	-13	PASSED
-									

No final measurement with RMS detector and 1/3MHz RBW/VBW done, due to more than 20dB margin to the limit.

5.4. LTE2 test results

FDD, CBW 1.4 MHz, QPSK, 1RBmid, 1880 MHz, PK detector, RBW/VBW = 5MHz



FDD, CBW 1.4 MHz, QPSK, 1RBmid, 1880 MHz, PK detector, RBW/VBW=1/3MHz

Frequency [MHz]	Pol.	Height [cm]	Azimuth (deg)	Elevation (deg)	Correction (dB)	Level [dBm]	Margin (dBm)	Limit (dBm)	Result
3760.02	VER	170	228	90	-109.5	-46.7	33.7	-13	PASSED
5640.28	VER	170	96	90	-104.6	-44.6	31.6	-13	PASSED
7500.50	VER	170	226	90	-101.8	-50.7	37.7	-13	PASSED
-									

No final measurement with RMS detector and 1/3MHz RBW/VBW done, due to more than 20dB margin to the limit.

6. Test Equipment

6.1. Conducted measurements

Equipment	Manufacturer	Type	SERIAL-NO.	Actual Calibration	Next Calibration	Calibration Service
Signal Generator	ROHDE & SCHWARZ	SMP02	828269/008	09.08.2017	09.08.2020	DAkks
BT-/W-Lan-Testsetup	Hewlett Packard - Agilent	N4010A	MY46320388	17.08.2017	17.08.2020	DAkks
Radio Communication Tester	ROHDE & SCHWARZ	CMU 200	101138	22.05.2018	22.05.2020	DAkks
Climatic Chamber	Vötsch	VT4002	521/85094	09.10.2018	09.10.2019	DAkks
EMI Test Receiver	ROHDE & SCHWARZ	ESU26	100077	20.05.2019	20.05.2020	DAkks
Power Supply	Hewlett Packard - Agilent	E3632A	MY40011318	23.05.2018	23.05.2020	DAkks
Powermeter	ETS	EMPower 7002-006	7202040	18.01.2019	18.01.2022	DAkks
Vector Signal Generator	ROHDE & SCHWARZ	SMBV100A	263158	16.05.2019	16.05.2020	DAkks
Wideband Radio Comm. Tester	ROHDE & SCHWARZ	CMW500	101674	22.05.2019	22.05.2020	DAkks

6.2. Radiated measurements

Equipment	Manufacturer	Type	SERIAL-NO.	Actual Calibration	Next Calibration	Calibration Service
Antenna	Schwarzbeck Mess-Elektronik	FMZB_1519	1519-056	14.07.2017	14.07.2020	DAkks
EMI Test Receiver	ROHDE & SCHWARZ	ESIB26	827769/010	23.05.2019	23.05.2020	DAkks
Signal Generator	ROHDE & SCHWARZ	SMP02	828269/008	09.08.2017	09.08.2020	DAkks
Signal Generator	ROHDE & SCHWARZ	SML01	100652	06.04.2018	06.04.2021	DAkks
Power Supply	Hewlett Packard - Agilent	E3632A	KR75303301	17.05.2018	17.05.2020	DAkks
Radio Communication Tester	ROHDE & SCHWARZ	CMU 200	101138	22.05.2018	22.05.2020	DAkks
Field Analyzer	Wandel & Goltermann	EMR20	P-0030	23.11.2017	23.11.2020	DAkks
Antenna	ROHDE & SCHWARZ	HL025	359012/006			n.a.
EMI Test Receiver	ROHDE & SCHWARZ	ESU26	100077	20.05.2019	20.05.2020	DAkks
Temp. / Humidity Logger	Lufft	Opus 10	13262	11.01.2017	11.01.2020	DAkks
Antenna	ROHDE & SCHWARZ	HL562	100191	26.10.2018	26.10.2021	DAkks
Antenna	ROHDE & SCHWARZ	HK-116: 20-300MHz	825177/0017	21.07.2017	21.07.2020	DAkks
Antenna	ROHDE & SCHWARZ	HK-116: 20-300MHz	100401	21.07.2017	21.07.2020	DAkks
Antenna	ROHDE & SCHWARZ	HL223	832369/006	26.04.2019	26.04.2022	DAkks
Antenna	Schwarzbeck	UBA 9116	9116-396	28.07.2017	28.07.2020	DAkks
Antenna	Emco	3115	9810-5588	24.04.2018	24.04.2021	DAkks
Antenna	Schwarzbeck	BBHA-9120-D	01617	09.04.2019	09.04.2022	DAkks
Antenna	ROHDE & SCHWARZ	HL223	100731	15.12.2016	15.12.2019	DAkks
H-Field Probe 100 cm ²	Narda Safety Test Solutions GmbH	Probe	M-0823	07.12.2017	07.12.2020	DAkks
H-field Probe 3cm ²	Narda Safety Test Solutions GmbH	2300/90.20	C-0150	23.04.2018	23.04.2021	DAkks
Antenna	Schwarzbeck Mess-Elektronik	VAMP 9243	9243-486	23.05.2018	23.05.2021	DAkks
Exposure Level Tester	Narda Safety Test Solutions GmbH	ELT-400	N-0385	07.12.2017	07.12.2020	DAkks
Antenna	Emco	3160-09	1232	07.08.2017	07.08.2020	DAkks
Isotropic Electric Field Probe	Wandel & Goltermann	Type 8	M-0082	23.11.2017	23.11.2020	DAkks
Signal Generator	ROHDE & SCHWARZ	SMB100A	181275	08.07.2019	08.07.2020	DAkks
EMI Test Receiver	ROHDE & SCHWARZ	ESW44	101733	19.08.2019	19.08.2020	DAkks
Vector Signal Generator	ROHDE & SCHWARZ	SMBV100A	263158	16.05.2019	16.05.2020	DAkks
Wideband Radio Comm. Tester	ROHDE & SCHWARZ	CMW500	101674	22.05.2019	22.05.2020	DAkks

End of Report