3.5 Power Spectral Density

3.5.1 Specification Reference

Test according to FCC title 47 part 15 §15.247(a),(e), KDB 558074 D01 DTS Meas Guidance v05 F and ANSI C63.10-2013

3.5.2 Equipment Under Test and Modification State

MBAC BM V001, S/N: XD10201011 - Modification State 0

3.5.3 Date of Test

2019-12-06

3.5.4 Test Method

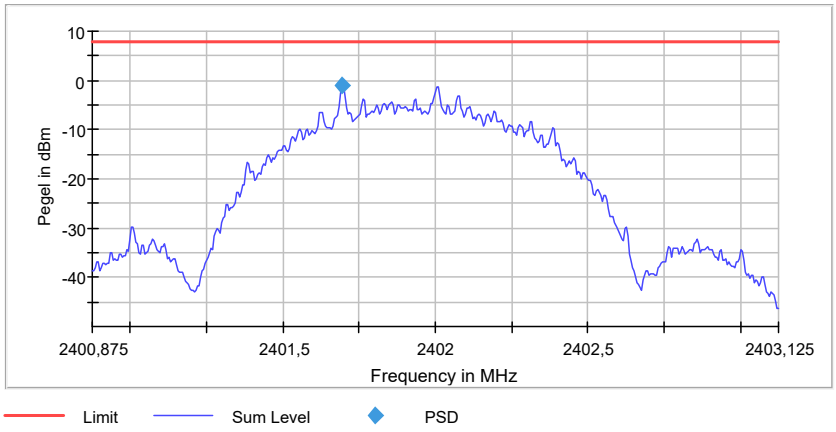
This test was performed in accordance with ANSI C63.10, clause 11.10.2.

3.5.5 Environmental Conditions

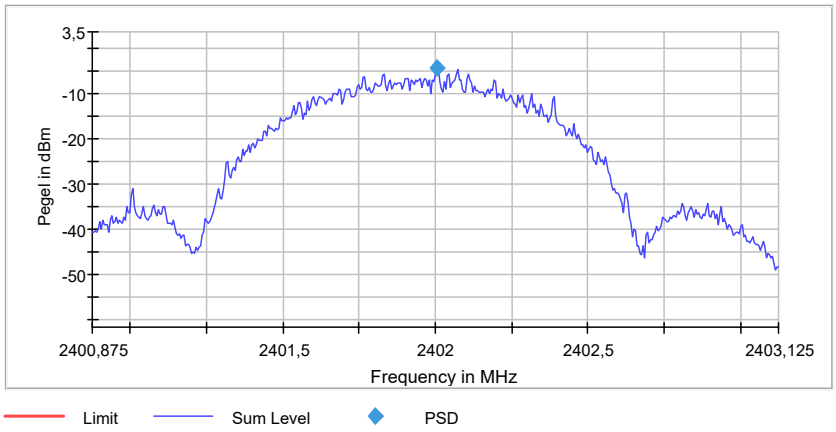
Ambient Temperature	20.0 °C
Relative Humidity	36.0 %

3.5.6 Test Results

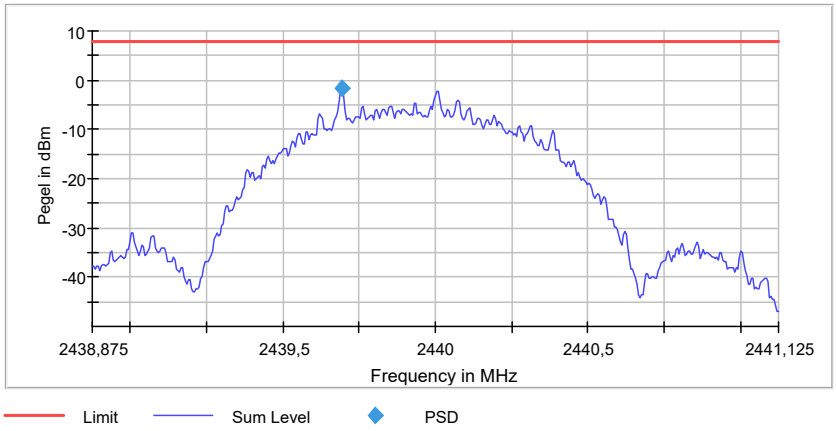
Frequency (MHz)	Peak PSD (dBm)	PSD (dBm)	Limit (dBm)
2402	-0.918	-4.377	8.0
2440	-1.757	-2.806	8.0
2480	-1.752	-2.276	8.0



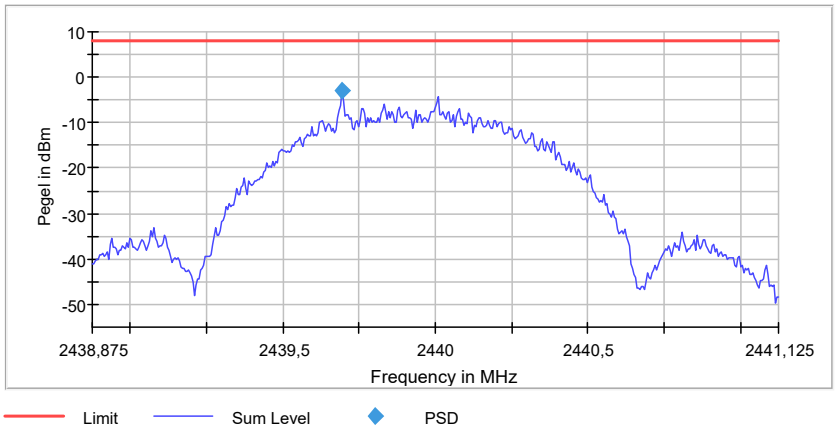
Peak PSD, Lowest Channel, 2402 MHz



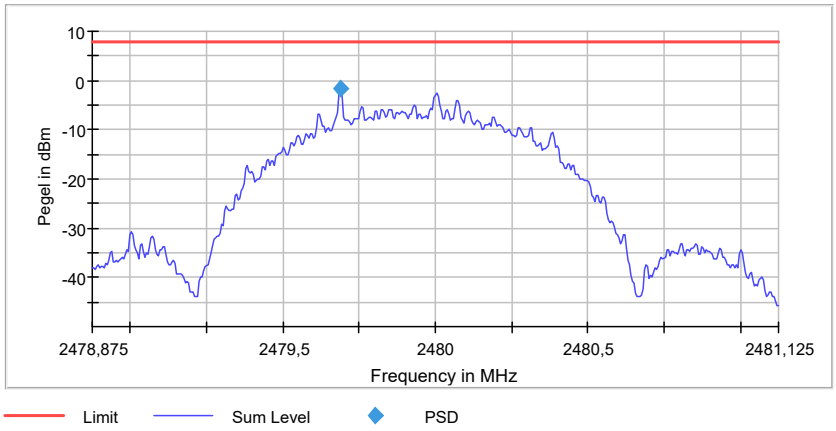
PSD, Lowest Channel, 2402 MHz



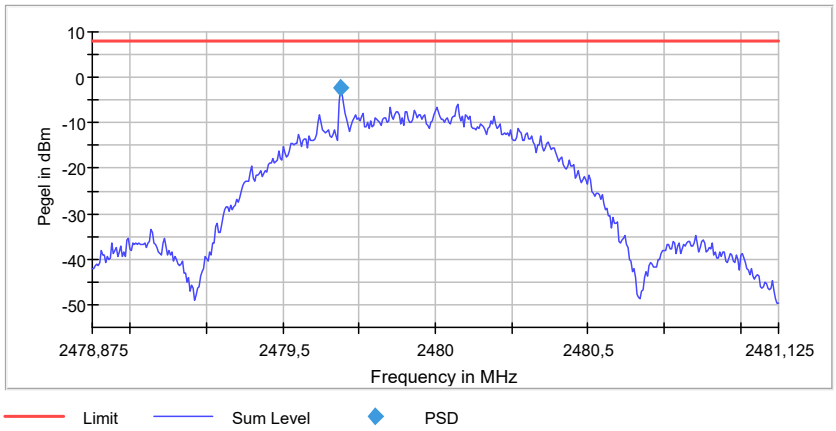
Peak PSD, Middle Channel, 2440 MHz



PSD, Middle Channel, 2440 MHz



Peak PSD, Highest Channel, 2480 MHz



PSD, Highest Channel, 2480 MHz

FCC 47 CFR Part 15, Limit Clause 15.247 (e)

The power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

ISED Canada RSS-247, Limit Clause 5.2(b)

The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

3.5.7 Test Location and Test Equipment Used

Conducted test was carried out in Non-shielded room with Test system TS8997.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Spectrum Analyzer	Rohde&Schwarz	FSV40	20219	12	2020-01-31
Vector Signal Generator	Rohde&Schwarz	SMBV100A	20238	36	2022-11-30
Signal Generator	Rohde&Schwarz	SMB100A	20215	36	2021-03-31
Switching Device	Rohde&Schwarz	OSP120 I	20248	24	2020-01-31
Switching Device	Rohde&Schwarz	OSP120 II	38807	24	2020-09-30
EMC Measurement Software	Rohde&Schwarz	EMC32	19719	---	---

Table 8

TU - Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment
N/A - Not Applicable

3.6 Maximum Conducted Output Power

3.6.1 Specification Reference

Test according to FCC title 47 part 15 §15.247(b), KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013 11.9.2.3.2

3.6.2 Equipment Under Test and Modification State

MBAC BM V001, S/N: XD10201011 - Modification State 0

3.6.3 Date of Test

2019-12-06

3.6.4 Test Method

This test was performed in accordance with ANSI C63.10, clause 11.9.1.1.

This test was performed conducted.

3.6.5 Environmental Conditions

Ambient Temperature	20.0 °C
Relative Humidity	36.0 %

3.6.6 Test Results

With Antenna A205 905 11 17 / 002

Frequency (MHz)	Gated RMS (dBm)	Antenna Gain (dBi)	Gated EIRP (dBm)	DutyCycle (%)	Limit Max (dBm)
2402	3.7	1.5	5.2	100	30.0
2440	3.4	1.5	4.9	100	30.0
2480	3.4	1.5	4.9	100	30.0

With Antenna A177 905 29 02 / 002

Frequency (MHz)	Gated RMS (dBm)	Antenna Gain (dBi)	Gated EIRP (dBm)	DutyCycle (%)	Limit Max (dBm)
2402	3.7	2.0	5.7	100	30.0
2440	3.4	2.0	5.4	100	30.0
2480	3.4	2.0	5.4	100	30.0

FCC 47 CFR Part 15, Limit Clause 15.247 (b)(3)

For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt.

ISED Canada RSS-247, Limit Clause 5.4 (b)

For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e) of the specification.

3.6.7 Test Location and Test Equipment Used

Conducted test was carried out in Non-shielded room with Test system TS8997.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Spectrum Analyzer	Rohde&Schwarz	FSV40	20219	12	2020-01-31
Vector Signal Generator	Rohde&Schwarz	SMBV100A	20238	36	2022-11-30
Signal Generator	Rohde&Schwarz	SMB100A	20215	36	2021-03-31
Switching Device	Rohde&Schwarz	OSP120 I	20248	24	2020-01-31
Switching Device	Rohde&Schwarz	OSP120 II	38807	24	2020-09-30
EMC Measurement Software	Rohde&Schwarz	EMC32	19719	---	---

Table 9

TU - Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment
N/A - Not Applicable

3.7 AC Power Line Conducted Emissions

3.7.1 Specification Reference

FCC 47 CFR Part 15C, ISED Canada RSS-247 and ISED Canada RSS-GEN, Clause 15.207, N/A and 8.8

3.7.2 Equipment Under Test and Modification State

MBAC BM V001, S/N: XD10201011 - Modification State 0

3.7.3 Date of Test

2019-12-11

3.7.4 Test Method

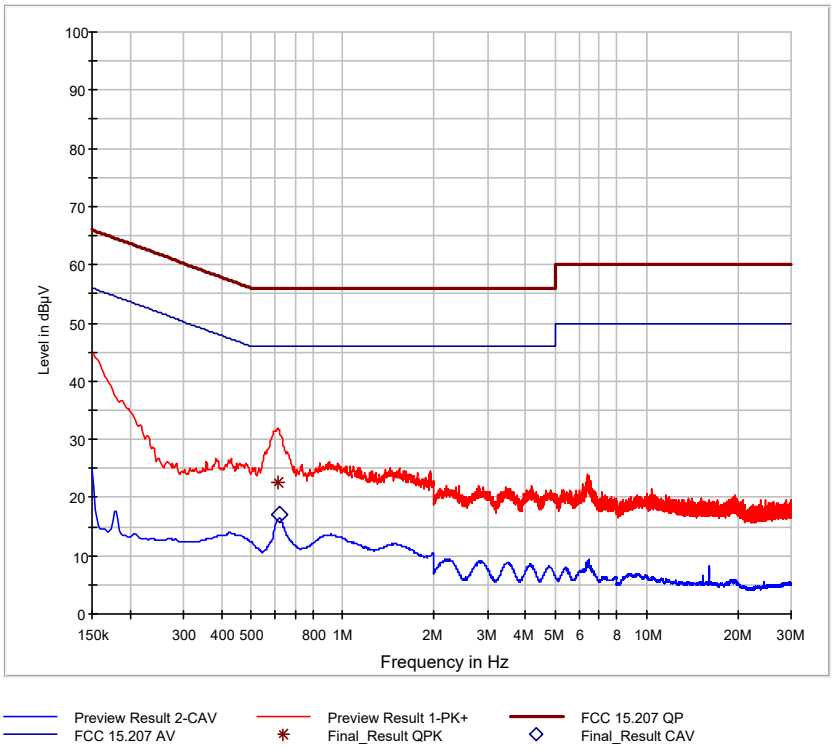
The test was performed in accordance with ANSI C63.10, clause 6.2.

3.7.5 Environmental Conditions

Ambient Temperature	22.0°C
Relative Humidity	29.0 %

3.7.6 Test Results

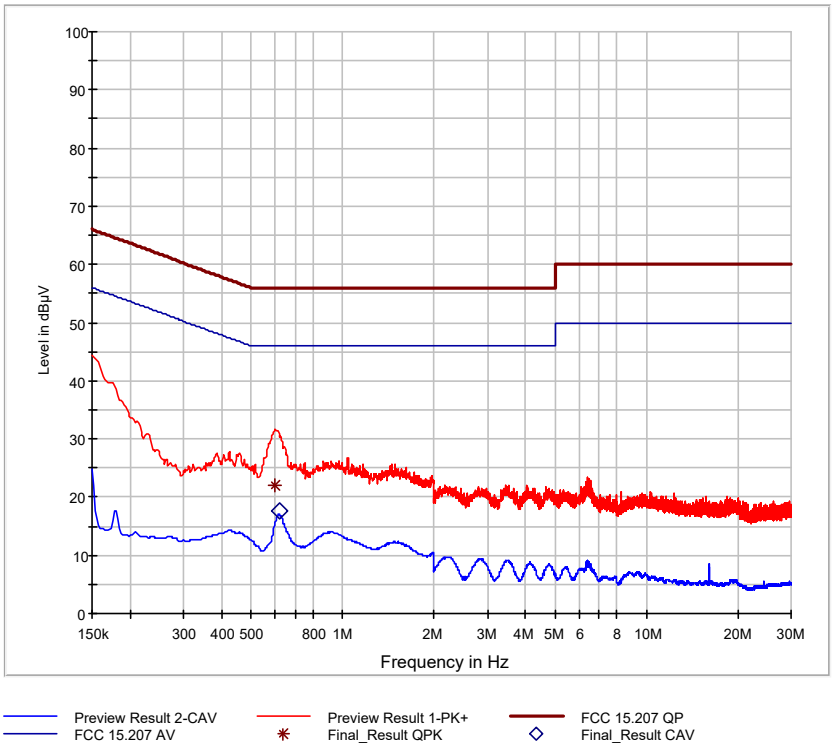
Lowest Channel, 2402 MHz
L and N Line



Final Results:

Frequency MHz	*QuasiPeak dBµV*	*CAverage dBµV*	*Limit dBµV*	*Margin dB*	*Meas. Time ms*	*Bandwidth kHz*	*Line*	*Filter*	*Corr. dB*
0.611250	22.50	---	56.00	33.50	1000.0	9.000	L1	ON	10.0
0.620250	---	17.08	46.00	28.92	1000.0	9.000	N	ON	10.0

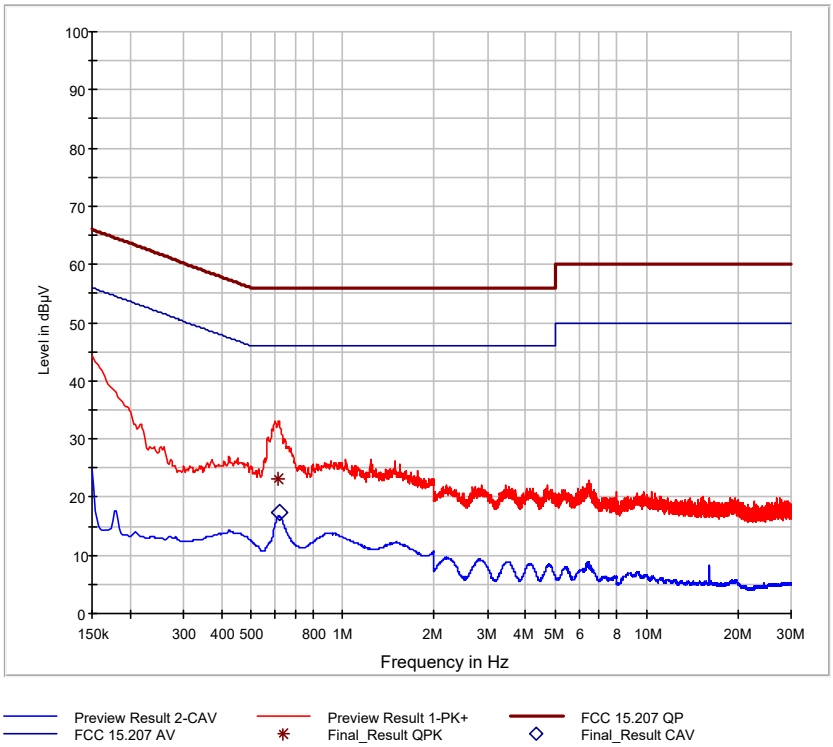
Middle Channel, 2440 MHz
L and N Line



Final Results:

Frequency MHz	*QuasiPeak dBµV*	*CAverage dBµV*	*Limit dBµV*	*Margin dB*	*Meas. Time ms*	*Bandwidth kHz*	*Line*	*Filter*	*Corr. dB*
0.600000	21.92	---	56.00	34.08	1000.0	9.000	N	ON	10.0
0.620250	---	17.59	46.00	28.41	1000.0	9.000	N	ON	10.0

Highest Channel, 2480 MHz
L and N Line



Final Results:

Frequency MHz	*QuasiPeak dBµV*	*CAverage dBµV*	*Limit dBµV*	*Margin dB*	*Meas. Time ms*	*Bandwidth kHz*	*Line*	*Filter*	*Corr. dB*
0.615750	23.12	---	56.00	32.88	1000.0	9.000	L1	ON	10.0
0.622500	---	17.32	46.00	28.68	1000.0	9.000	N	ON	10.0

FCC 47 CFR Part 15, Limit Clause 15.207 and ISED Canada RSS-GEN, Limit Clause 8.8

Frequency of Emission (MHz)	Conducted Limit (dBµV)	
	Quasi-Peak	Average
0.15 to 0.5	66 to 56*	56 to 46*
0.5 to 5	56	46
5 to 30	60	50

Table 10

*Decreases with the logarithm of the frequency.

3.7.7 Test Location and Test Equipment Used

This test was carried out in Shielded room - cabin no. 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
EMI test receiver	Rohde & Schwarz	ESCI3	19730	18	2020-11-30
V-network	Rohde & Schwarz	ENV216	39909	12	2020-02-29
Shielded room	Albatross	Cabin no. 1	19311	---	---
EMC Measurement Software	Rohde&Schwarz	EMC32 V9.26.01	20090	---	---

Table 11

TU - Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment
N/A - Not Applicable

3.8 Transmitter frequency stability

3.8.1 Specification Reference

RSS-Gen, Issue 5, 2019 (General Requirements for Compliance of Radio Apparatus)

3.8.2 Equipment Under Test and Modification State

MBAC BM V001, S/N: XD10201011 - Modification State 0

3.8.3 Date of Test

2019-12-10

3.8.4 Test Method

RSS-Gen, Issue 5, April 2018, chapter 6.11

3.8.5 Environmental Conditions

Ambient Temperature	21.0 °C
Relative Humidity	39.0 %

3.8.6 Test Results

Operating Frequency	Temperature (°C)	Voltage (V)	Measured Lower 99% - BW Frequency (MHz)	Measured Upper 99% - BW Frequency (MHz)
Lower, 2402 MHz	20.0	11.48 V DC	2401.415000	2402.475000
Lower, 2402 MHz	20.0	13.50 V DC	2401.415000	2402.465000
Lower, 2402 MHz	20.0	15.53 V DC	2401.415000	2402.475000
Lower, 2402 MHz	-30.0	13.50 V DC	2401.435000	2402.485000
Lower, 2402 MHz	50.0	13.50 V DC	2401.375000	2402.435000
Middle, 2440 MHz	20.0	11.48 V DC	2439.405000	2440.475000
Middle, 2440 MHz	20.0	13.50 V DC	2439.405000	2440.475000
Middle, 2440 MHz	20.0	15.53 V DC	2439.415000	2400.475000
Middle, 2440 MHz	-30.0	13.50 V DC	2439.435000	2440.485000
Middle, 2440 MHz	50.0	13.50 V DC	2439.375000	2440.425000
Upper, 2480 MHz	20.0	11.48 V DC	2479.405000	2480.475000
Upper, 2480 MHz	20.0	13.50 V DC	2479.405000	2480.475000
Upper, 2480 MHz	20.0	15.53 V DC	2479.405000	2480.475000
Upper, 2480 MHz	-30.0	13.50 V DC	2479.425000	2480.495000
Upper, 2480 MHz	50.0	13.50 V DC	2479.355000	2480.435000

Operating Frequency	Temperature (°C)	Voltage (V)	Measured Lower 6dB BW Frequency (MHz)	Measured Upper 6dB BW Frequency (MHz)
Lower, 2402 MHz	20.0	11.48 V DC	2401.554455	2402.326733
Lower, 2402 MHz	20.0	13.50 V DC	2401.584158	2402.326733
Lower, 2402 MHz	20.0	15.53 V DC	2401.584158	2402.326733
Lower, 2402 MHz	-30.0	13.50 V DC	2401.613861	2402.326733
Lower, 2402 MHz	50.0	13.50 V DC	2401.524752	2402.267327
Middle, 2440 MHz	20.0	11.48 V DC	2439.554455	2440.326733
Middle, 2440 MHz	20.0	13.50 V DC	2439.554455	2440.326733
Middle, 2440 MHz	20.0	15.53 V DC	2439.554455	2440.326733
Middle, 2440 MHz	-30.0	13.50 V DC	2439.584158	2440.326733
Middle, 2440 MHz	50.0	13.50 V DC	2439.524752	2440.297030
Upper, 2480 MHz	20.0	11.48 V DC	2479.554455	2480.326733
Upper, 2480 MHz	20.0	13.50 V DC	2479.554455	2480.256436
Upper, 2480 MHz	20.0	15.53 V DC	2479.554455	2480.356436
Upper, 2480 MHz	-30.0	13.50 V DC	2479.584158	2480.356436
Upper, 2480 MHz	50.0	13.50 V DC	2479.524752	2480.297030

Note: - Measured Frequency Error does not affect any band edge requirements.
- Measurement was performed with modulated transmitter signal

3.8.7 Test Location and Test Equipment Used

Conducted test was carried out in Non-shielded room with Test system TS8997.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Spectrum Analyzer	Rohde&Schwarz	FSV40	20219	12	2020-01-31
Vector Signal Generator	Rohde&Schwarz	SMBV100A	20238	24	2019-10-31
Signal Generator	Rohde&Schwarz	SMB100A	20215	36	2021-03-31
Switching Device	Rohde&Schwarz	OSP120 I	20248	24	2020-01-31
Switching Device	Rohde&Schwarz	OSP120 II	38807	24	2020-09-30
Radio Communication Tester	Rohde&Schwarz	CMW500	38845	12	2019-09-30
EMC Measurement Software	Rohde&Schwarz	EMC32	19719	---	---

Table 12

TU - Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment
N/A - Not Applicable

3.9 Exposure of Humans to RF Fields

3.9.1 Specification Reference

IC RSS-GEN Issue 5, section 3.4 and
IC RSS-102, Issue 5, section 2.5
KDB 447498 D01 General RF Exposure Guidance v06, chapter 4.3.1

3.9.2 Equipment Under Test and Modification State

MBAC BM V001, S/N: XD10201011 - Modification State 0

3.9.3 Date of Test

2019-12-06

3.9.4 Test Results

acc. to KDB 447498 D01:

Maximum Radiated Power (EIRP) Pmax:	5.7 dBm = 3.7 mW	(Max. CP Test Result is 5.7 dBm including 2.0 dBi antenna gain. See chapter 3.6.6,
Compliance Boundary d:	40 mm	
Frequency f:	2402 MHz = 2.402 GHz	
Numeric Threshold (Pmax / d) $(f)^{0.5}$	0.14	
Numeric Threshold Limit (1 g SAR):	3.0	

IC RSS-GEN Issue 5, section 3.4 and IC RSS-102, Issue 5, section 2.5:

Exposure of Humans to RF Fields	Applicable	Declared by applicant	Measured	Exemption
The antenna is				
☒ detachable				
The conducted output power (CP in watts) is measured at the antenna connector: CP = 3.3 mW = 5.2 dBm (Max. CP Test Result is 5.7 dBm including 2.0 dBi antenna gain. See chapter 3.6.6)			☒	
The effective isotropic radiated power (EIRP in watts) is calculated using				
☒ the numerical antenna gain: G = 2.0 dBi $EIRP = G \cdot CP \Rightarrow EIRP$ = 3.7 mW		☒		
☐ the field strength[1] in V/m: FS = ... V/m $EIRP = \frac{(FS \cdot D)^2}{30} \Rightarrow EIRP$ = mW			☐	
with: Distance between the antennas in m: D = 40 mm		☒		
☐ not detachable				
A field strength measurement is used to determine the effective isotropic radiated power (EIRP in watts) given by: $EIRP = \frac{(FS \cdot D)^2}{30} \Rightarrow EIRP$ = W with: Field strength in V/m: FS = dBµV/m = mV/m Distance between the two antennas in m: D = m			☒ ☒	
Selection of output power				
The output power TP is the higher of the conducted or effective isotropic radiated power (e.i.r.p.): TP = 3.7 mW				

[1] The conversion formula is valid only for properly matched antennas. In other cases the transmitter output power may have to be measured by a terminated measurement when applying the exemption clauses.
If an open area test site is used for field strength measurement, the effect due to the metal ground reflecting plane should be subtracted from the maximum field strength value in order to reference it to free space, before calculating TP.

Exposure of Humans to RF Fields (continued)		Applicable	Declared by applicant	Measured	Exemption
Separation distance between the user and the transmitting device is					
☒ less than or equal to 20 cm	☐ greater than 20 cm		☒		
Transmitting device is					
☐ in the vicinity of the human head	☐ body-worn		☐		

Product Service

SAR evaluation				
SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in the table. For controlled use devices where the 8 W/kg for 1 gram of tissue applies, the exemption limits for routine evaluation in the table are multiplied by a factor of 5. For limb-worn devices where the 10 gram value applies, the exemption limits for routine evaluation in the table are multiplied by a factor of 2.5. If the operating frequency of the device is between two frequencies located in the table, linear interpolation shall be applied for the applicable separation distance. For test separation distance less than 5 mm, the exemption limits for a separation distance of 5 mm can be applied to determine if a routine evaluation is required. For medical implants devices, the exemption limit for routine evaluation is set at 1 mW. The output power of a medical implants device is defined as the higher of the conducted or e.i.r.p to determine whether the device is exempt from the SAR evaluation.				

Frequency (MHz)	Exemption limits (mW)[2] at separation distance of									
	≤5 mm	10 mm	15 mm	20 mm	25 mm	30 mm	35 mm	40 mm	45 mm	≥50 mm
450	52	70	88	106	123	141	159	177	195	213
835	17	30	42	55	67	80	92	105	117	130
1900	7	10	18	34	60	99	153	225	316	431
2450	4	7	15	30	52	83	123	173	235	309
3500	2	6	16	32	55	86	124	170	225	290
5800	1	6	15	27	41	56	71	85	97	106

Carrier frequency:	f	=	2402 MHz	
Distance:	d	=	40 mm	☒
Transmitter output power:	TP	=	3.7 mW	
Limit:	TP_{limit}	=	173 mW	☒

[2] The excemption limit in the table are based on measurements and simulations on half-wave dipole antennas at separaton distances of 5 mm to 25 mm from a flat phantom, providing a SAR value of approximately 0.4 W/kg for 1 g of tissue. For low frequencies (300 MHz to 835 MHz), the exemption limits are derived from a linear fit. For high frequencies (1900 MHz and above), the exemption limits are derived from a third order polynomial fit.

4 Measurement Uncertainty

For a 95% confidence level, the measurement uncertainties for defined systems are:

Radio Testing			
Test Name	kp	Expanded Uncertainty	Note
Occupied Bandwidth	2.0	±1.14 %	2
RF-Frequency error	1.96	±1 · 10-7	7
RF-Power, conducted carrier	2	±0.079 dB	2
RF-Power uncertainty for given BER	1.96	+0.94 dB / -1.05	7
RF power, conducted, spurious emissions	1.96	+1.4 dB / -1.6 dB	7
RF power, radiated			
25 MHz – 4 GHz	1.96	+3.6 dB / -5.2 dB	8
1 GHz – 18 GHz	1.96	+3.8 dB / -5.6 dB	8
18 GHz – 26.5 GHz	1.96	+3.4 dB / -4.5 dB	8
40 GHz – 170 GHz	1.96	+4.2 dB / -7.1 dB	8
Spectral Power Density, conducted	2.0	±0.53 dB	2
Maximum frequency deviation			
300 Hz – 6 kHz	2	±2,89 %	2
6 kHz – 25 kHz	2	±0.2 dB	2
Maximum frequency deviation for FM	2	±2,89 %	2
Adjacent channel power 25 MHz – 1 GHz	2	±2.31 %	2
Temperature	2	±0.39 K	4
(Relative) Humidity	2	±2.28 %	2
DC- and low frequency AC voltage			
DC voltage	2	±0.01 %	2
AC voltage up to 1 kHz	2	±1.2 %	2
Time	2	±0.6 %	2

Table 13

Radio Interference Emission Testing			
Test Name	kp	Expanded Uncertainty	Note
Conducted Voltage Emission			
9 kHz to 150 kHz (50Ω/50µH AMN)	2	± 3.8 dB	1
150 kHz to 30 MHz (50Ω/50µH AMN)	2	± 3.4 dB	1
100 kHz to 200 MHz (50Ω/5µH AMN)	2	± 3.6 dB	1
Discontinuous Conducted Emission			
9 kHz to 150 kHz (50Ω/50µH AMN)	2	± 3.8 dB	1
150 kHz to 30 MHz (50Ω/50µH AMN)	2	± 3.4 dB	1
Conducted Current Emission			
9 kHz to 200 MHz	2	± 3.5 dB	1
Magnetic Fieldstrength			
9 kHz to 30 MHz (with loop antenna)	2	± 3.9 dB	1
9 kHz to 30 MHz (large-loop antenna 2 m)	2	± 3.5 dB	1
Radiated Emission			
Test distance 1 m (ALSE)			
9 kHz to 150 kHz	2	± 4.6 dB	1
150 kHz to 30 MHz	2	± 4.1 dB	1
30 MHz to 200 MHz	2	± 5.2 dB	1
200 MHz to 2 GHz	2	± 4.4 dB	1
2 GHz to 3 GHz	2	± 4.6 dB	1
Test distance 3 m			
30 MHz to 300 MHz	2	± 4.9 dB	1
300 MHz to 1 GHz	2	± 5.0 dB	1
1 GHz to 6 GHz	2	± 4.6 dB	1
Test distance 10 m			
30 MHz to 300 MHz	2	± 4.9 dB	1
300 MHz to 1 GHz	2	± 4.9 dB	1
Radio Interference Power			
30 MHz to 300 MHz	2	± 3.5 dB	1
Harmonic Current Emissions			4
Voltage Changes, Voltage Fluctuations and Flicker			4

Table 14

Immunity Testing			
Test Name	kp	Expanded Uncertainty	Note
Electrostatic Discharges			4
Radiated RF-Field			
Pre-calibrated field level	2	+32.2 / -24.3 %	5
Dynamic feedback field level	2.05	+21.2 / -17.5 %	3
Electrical Fast Transients (EFT) / Bursts			4
Surges			4
Conducted Disturbances, induced by RF-Fields			
via CDN	2	+15.1 / -13.1 %	6
via EM clamp	2	+42.6 / -29.9 %	6
via current clamp	2	+43.9 / -30.5 %	6
Power Frequency Magnetic Field	2	+20.7 / -17.1 %	2
Pulse Magnetic Field			4
Voltage Dips, Short Interruptions and Voltage Variations			4
Oscillatory Waves		a	4
Conducted Low Frequency Disturbances			
Voltage setting	2	± 0.9 %	2
Frequency setting	2	± 0.1 %	2
Electrical Transient Transmission in Road Vehicles			4

Table 15

Note 1:
The expanded uncertainty reported according to CISPR 16-4-2:2003-11 is based on a standard uncertainty multiplied by a coverage factor of kp = 2, providing a level of confidence of p = 95.45%
Note 2:
The expanded uncertainty reported according to UKAS Lab 34 (Edition 1, 2002-08) is based on a standard uncertainty multiplied by a coverage factor of kp = 2, providing a level of confidence of p = 95.45%
Note 3:
The expanded uncertainty reported according to UKAS Lab 34 (Edition 1, 2002-08) is based on a standard uncertainty multiplied by a coverage factor of kp = 2.05, providing a level of confidence of p = 95.45%
Note 4:
It has been demonstrated that the used test equipment meets the specified requirements in the standard with at least a 95%confidence.
Note 5:
The expanded uncertainty reported according to IEC 61000-4-3 is based on a standard uncertainty multiplied by a coverage factor of kp = 2, providing a level of confidence of p = 95.45%
Note 6:
The expanded uncertainty reported according to IEC 61000-4-6 is based on a standard uncertainty multiplied by a coverage factor of kp = 2, providing a level of confidence of p = 95.45%
Note 7:

The expanded uncertainty reported according ETSI TR 100 028 V1.4.1 (all parts) to is based on a standard uncertainty multiplied by a coverage factor of kp = 1.96, providing a level of confidence of p = 95.45%

Note 8:

The expanded uncertainty reported according to ETSI TR 102 273 V1.2.1 (all parts) is based on a standard uncertainty multiplied by a coverage factor of kp = 1.96, providing a level of confidence of p = 95.45%