

RF-EXPOSURE ASSESSMENT REPORT

FCC 47 CFR Part 2.1091
Industry Canada RSS-102

RF-Exposure evaluation of mobile equipment

Report Reference No.: G0M-1305-2854-TFC091M-V01

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Accreditation:



A2LA Accredited Testing Laboratory, Certificate No.: 1983.01
FCC Filed Test Laboratory, Reg.-No.: 96970
IC OATS Filing assigned code: 3470A

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Test specification:

Standard: 47 CFR 1.1310 / 47 CFR 2.1091 / 47 CFR 2.1093
OET Bulletin 65:1997
RSS-102, Issue 4:2010
Safety Code 6:2009

Equipment under test (EUT):

Product description 2.4 GHz IEEE 802.15.4 compliant radio module

Model No. deRFmega256-23M12

Hardware version REV0

Firmware / Software version REV1

FCC-ID: XVV-MEGA23M12 IC: N/A

Test result Passed

Possible test case verdicts:

- not applicable to test object: N/A
- test object does meet the requirement.....: P (Pass)
- test object does not meet the requirement.....: F (Fail)

Testing:

Date of receipt of test item: 2013-06-12

Date (s) of assessment: 2013-08-19

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Total number of pages: 13

General remarks:

The test results presented in this report relate only to the object tested.

The results contained in this report reflect the results for this particular model and serial number. It is the responsibility of the manufacturer to ensure that all production models meet the intent of the requirements detailed within this report.

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Additional comments:

Version History

Version	Issue Date	Remarks	Revised by
01	2013-08-19	Initial Release	

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1 Equipment (Test item) Description

Description	2.4 GHz IEEE 802.15.4 compliant radio module
Model	deRFmega256-23M12
Serial number	None
Hardware version	REV0
Software / Firmware version	REV1
FCC-ID	XVV-MEGA23M12
IC	N/A
Equipment type	Radio module

1.1 Reference Documents

Document type	Document No.	Issued by	Date
FCC 15.247 Radio Report	G0M-1305-2854-TFC247Z-V01	Eurofins Product Service GmbH	2013-08-02

1.2 Radiation Sources

Mode #	Description	
IEEE 802.15.4 Module Antenna 1	Frequency range [MHz]	2405 – 2480
	Channels	16
	Modulations	O-QPSK
	Maximum conducted power [dBm]	19.0
	Maximum radiated power [dBm]	20.3
	Maximum transmission duty cycle [%]	100 % (worst case assessment)
	Antenna gain [dBi]	1.3
	Antenna diameter [cm]	1
IEEE 802.15.4 Module Antenna 2	Frequency range [MHz]	2405 – 2475
	Channels	15
	Modulations	O-QPSK
	Maximum conducted power [dBm]	17.9
	Maximum radiated power [dBm]	22.9
	Maximum transmission duty cycle [%]	100 % (worst case assessment)
	Antenna gain [dBi]	5.0
	Antenna diameter [cm]	22

2 Result Summary

FCC 47 CFR Part 2.1091, IC RSS-102			
Product Specific Standard Section	Requirement	Result	Remarks
47 CFR 2.1091	Maximum permissible exposure @ 20cm below limit	PASS	
RSS-102 2.5.2	Maximum permissible exposure @ 20cm below limit	PASS	
Remarks:			

3 RF-Exposure Classifications

Device Types	
Fixed	A fixed device is defined as a device physically secured at one fixed location and cannot be easily re-located.
Mobile	A mobile device is defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons. (47 CFR 2.1091)
Portable	A portable device is defined as a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the body of the user. (47 CFR 2.1093)

Exposure Categories	
Occupational / Controlled	Limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.
General population / uncontrolled	Exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure.

4 Assessment

4.1 MPE Assessment – 47 CFR 2.1091 / RSS-102

MPE Assessment acc. to 47 CFR 2.1091 / IC RSS-102			Verdict: PASS			
Assessment according to reference		Reference Method				
		FCC OET Bulletin 65 / RSS-102 & Safety Code 6				
Device type		mobile				
Exposure category		General public				
IC Limits – Occupational / Controlled Exposure						
Frequency range [MHz]	Electric field strength [V/M]	Magnetic field strength [A/M]	Power density [W/m ²]	Averaging time [min]		
0.003 – 1.0	600	4.9	N/A	6		
1 – 10	600/f	4.9/f	N/A	6		
10 – 30	60	4.9/f	N/A	6		
30 – 300	60	0.163	10.0*	6		
300 – 1500	3.54·f ^{0.5}	0.0094·f ^{0.5}	f/30	6		
1500 - 15000	137	0.364	50	6		
15000 - 150000	137	0.364	50	616000/f ^{0.5}		
150000 - 300000	0.354·f ^{0.5}	9.4·10 ⁻⁴ ·f ^{0.5}	3.33·10 ⁻⁴ ·f	616000/f ^{0.5}		
IC Limits – General Population / Uncontrolled Exposure						
Frequency range [MHz]	Electric field strength [V/M]	Magnetic field strength [A/M]	Power density [W/m ²]	Averaging time [min]		
0.003 – 1.0	280	2.19	N/A	6		
1 – 10	280/f	2.19/f	N/A	6		
10 – 30	28	2.19/f	N/A	6		
30 – 300	28	0.073	2.0*	6		
300 – 1500	1.585·f ^{0.5}	0.0042·f ^{0.5}	f/150	6		
1500 - 15000	61.4	0.163	10	6		
15000 - 150000	61.4	0.163	10	616000/f ^{0.5}		
150000 - 300000	0.158·f ^{0.5}	4.21·10 ⁻⁴ ·f ^{0.5}	6.67·10 ⁻⁵ ·f	616000/f ^{0.5}		

* = Power density is applicable at frequencies greater than 100 MHz; f in MHz

FCC Limits – Occupational / Controlled Exposure				
Frequency range [MHz]	Electric field strength [V/M]	Magnetic field strength [A/M]	Power density [mW/cm ²]	Averaging time [min]
0.3 – 3.0	614	1.63	(100)*	6
3.0 - 30	1842/f	4.89/f	(900/f ²)*	6
30 - 300	61.4	0.163	1.0	6
300 - 1500	N/A	N/A	f/300	6
1500 - 100000	N/A	N/A	5.0	6
FCC Limits – General Population / Uncontrolled Exposure				
Frequency range [MHz]	Electric field strength [V/M]	Magnetic field strength [A/M]	Power density [mW/cm ²]	Averaging time [min]
0.3 – 1.34	614	1.63	(100)*	30
1.34 - 30	842/f	2.19/f	(180/f ²)*	30
30 - 300	27.5	0.073	0.2	30
300 - 1500	N/A	N/A	f/1500	30
1500 - 100000	N/A	N/A	1.0	30

* = Plane wave equivalent power density; f in MHz

Assessment Relations
$\lambda[m] = \frac{c \left[\frac{m}{s} \right]}{f[Hz]} ; R_{FF}[m] \geq \frac{2 \cdot D[m]^2}{\lambda[m]}$
$S[mW/cm^2] = \frac{P_{E.I.R.P.}[mW]}{4\pi R[cm]^2} ; R[cm] = \sqrt{\frac{P_{E.I.R.P.}[mW]}{4\pi S[mW/cm^2]}}$
$P_R[mW] = P_C[mW] \cdot G ; P_R[dBm] = P_C[dBm] + G[dBi]$
$DCC [dB] = 10 \cdot \log_{10} \left(\frac{DC[\%]}{100} \right)$

Assessment procedure
For each radio and frequency band the worst case transmission mode with the highest peak conducted or radiated power is evaluated at the frequency that results in the most restrictive rf-exposure limit. From the peak power values, antenna gains and duty cycles taken from the reference documents, the source average radiated power values are calculated. From the average radiated power the power densities at antenna far-field distance, at 20cm separation distance from the radiation source is calculated. Compliance with the RF-Exposure limit is determined at 20cm separation distance.

Assessment results – IEEE 802.15.4 Module Antenna 1		
Transmission mode		
Operating mode frequency range [MHz]	2405 – 2480	
Assessment frequency (f) [MHz]	2480	
Transmission duty cycle (DC) [%]	100	
Peak conducted power (P _c) [dBm]	19.0	
Peak radiated power (P _R) [dBm e.i.r.p.]	20.3	
Peak Antenna gain (G) [dBi]	1.3	
Maximum Antenna Diameter D [cm]	1.0	
Antenna far-field distance		
Transmission frequency wavelength (λ)	0.121 m	12.10 cm
Antenna far-field distance (R _{FF})	0.002 m	0.17 cm
Power evaluation		
Peak conducted power (P _c)	79.43 mW	19.00 dBm
Peak Antenna Gain (G)	1.35	1.30 dBi
Calculated peak radiated power (P _{R-Calc})	107.15 mW	20.30 dBm
Measured peak radiated power (P _R)	107.15 mW	20.30 dBm
Source average Power		
Maximum transmission duty cycle (DC)	100.0 %	
Duty cycle correction (DCC)	1.00	0.00 dB
Measured peak radiated power (P _R)	107.15 mW	20.30 dBm
Averaged peak radiated power (P _{RAVG})	107.15 mW	20.30 dBm
Power density		
Compliance power density limit	1.000 mW/cm ²	10.00 W/m ²
Power density @ Antenna far-field distance	311.939 mW/cm ²	3119.387 W/m ²
Power density @ 20cm	0.021 mW/cm ²	0.213 W/m ²
Distance for compliance power density	0.029 m	2.92 cm
Verdict		
The power density of the EUT at 20 cm is below the FCC/IC MPE limit!		
Comments:		

Assessment results – IEEE 802.15.4 Module Antenna 2		
Transmission mode		
Operating mode frequency range [MHz]	2405 – 2475	
Assessment frequency (f) [MHz]	2475	
Transmission duty cycle (DC) [%]	100	
Peak conducted power (P _c) [dBm]	17.9	
Peak radiated power (P _R) [dBm e.i.r.p.]	22.9	
Peak Antenna gain (G) [dBi]	5.0	
Maximum Antenna Diameter D [cm]	22.0	
Antenna far-field distance		
Transmission frequency wavelength (λ)	0.121 m	12.12 cm
Antenna far-field distance (R _{FF})	0.799 m	79.86 cm
Power evaluation		
Peak conducted power (P _c)	61.66 mW	17.90 dBm
Peak Antenna Gain (G)	3.16	5.00 dBi
Calculated peak radiated power (P _{R-Calc})	194.98 mW	22.90 dBm
Measured peak radiated power (P _R)	194.98 mW	22.90 dBm
Source average Power		
Maximum transmission duty cycle (DC)	100.0 %	
Duty cycle correction (DCC)	1.00	0.00 dB
Measured peak radiated power (P _R)	194.98 mW	22.90 dBm
Averaged peak radiated power (P _{RAVG})	194.98 mW	22.90 dBm
Power density		
Compliance power density limit	1.000 mW/cm ²	10.00 W/m ²
Power density @ Antenna far-field distance	0.002 mW/cm ²	0.024 W/m ²
Power density @ 20cm	0.039 mW/cm ²	0.388 W/m ²
Distance for compliance power density	0.039 m	3.94 cm
Verdict		
The power density of the EUT at 20 cm is below the FCC/IC MPE limit!		
Comments:		