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RF-EXPOSURE ASSESSMENT REPORT

FCC 47 CFR Part 2.1091
Industry Canada RSS-102

RF-Exposure evaluation of mobile equipment

Report Reference No.....:	G0M-1505-4759-TFC091ME-V01
Testing Laboratory.....:	Eurofins Product Service GmbH
Address.....:	Storkower Str. 38c 15526 Reichenwalde Germany
Accreditation.....:	A2LA Accredited Testing Laboratory, Certificate No.: 1983.01 FCC Filed Test Laboratory, Reg.-No.: 96970 IC OATS Filing assigned code: 3470A
Applicant's name.....:	tado° GmbH
Address.....:	Lindwurmstr. 76 80337 München GERMANY
Test specification:	
Standard.....:	47 CFR 1.1310 / 47 CFR 2.1091 / 47 CFR 2.1093 OET Bulletin 65:1997 RSS-102, Issue 5:2015-03 Safety Code 6:2015-03
Equipment under test (EUT):	
Product description	tado Smart AC Control
Model No.	WR01
Additional Model(s)	None
Brand Name(s)	None
Hardware version	WR0101
Firmware / Software version	21.0
	FCC-ID: 2AE751 IC: 20406-1
Contains	FCC-ID: VPYLBZY IC: 772C-LBZY
Test result	**Passed**

Possible test case verdicts:

- neither assessed nor tested ..... : N/N
- required by standard but not appl. to test object..... : N/A
- required by standard but not tested..... : N/T
- not required by standard for the test object ..... : N/R
- test object does meet the requirement..... : P (Pass)
- test object does not meet the requirement..... : F (Fail)

Testing:

Test Lab Temperature..... : 20 – 23 °C

Test Lab Humidity ..... : 32 – 38 %

Date of receipt of test item ..... : 2015-06-02

Date (s) of assessment ..... : 2015-08-31

Compiled by ..... : Matthias Handrik

Assessed by (+ signature) ..... : Matthias Handrik .....
(Responsible for Assessment)

Approved by (+ signature) ..... : Christian Weber .....
(Head of Lab)

Date of issue ..... : 2015-08-31

Total number of pages ..... : 15

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.

Additional comments:

Version History

Version	Issue Date	Remarks	Revised by
01	2015-08-31	Initial Release	

REPORT INDEX

1 Equipment (Test item) Description

Description	tado Smart AC Control
Model	WR01
Additional Model(s)	None
Brand Name(s)	None
Serial number	None
Hardware version	WR0101
Software / Firmware version	21.0
FCC-ID	2AE751
IC	20406-1
Equipment type	End product

1.1 Reference Documents

Document type	Document No.	Issued by	Date
FCC Test Report	G0M-1505-4759-TFC247BL	Eurofins Product Service GmbH	2015-08-31
FCC Test Report	10300014H-A-R1	UL Japan, Inc Ise HQ EMC Lab	2014-06-04
FCC Test Report	264561-1TRFWL	Nemko Canada Inc	2014-09-25

1.2 Standalone Radiation Sources

Mode #	Description	
Bluetooth Low Energy	Frequency range [MHz]	2402 - 2480
	Transmission modes	GFSK
	Maximum conducted power [dBm]	0.10
	Maximum radiated power [dBm]	-0.50
	Maximum transmission duty cycle [%]	100
	Antenna gain [dBi]	-0.60
	Antenna diameter [cm]	1
	Assessment Frequency [MHz]	2440
IEEE 802.11b/g/n	Frequency range [MHz]	2412 - 2462
	Transmission modes	DSSS/OFDM
	Maximum conducted power [dBm]	14.64
	Maximum radiated power [dBm]	16.54
	Maximum transmission duty cycle [%]	100
	Antenna gain [dBi]	1.9
	Antenna diameter [cm]	1
	Assessment Frequency [MHz]	2437

1.3 Multi-transmitter Modes

The ability of all other transmitters to transmit simultaneously is given in the following table:

	Bluetooth	IEEE802.11 b/g/n
Bluetooth	Yes	Yes
IEEE802.11 b/g/n	Yes	Yes

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 Conditions – 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]
0.003-10*	170	180	-	Instantaneous*
0.1-10	-	1.6 / f	-	6**
1.29-10	193 / $f^{0.5}$	-	-	6**
10-20	61.4	0.163	-10	6
20-48	129.8 / $f^{0.25}$	0.3444 / $f^{0.25}$	44.72 / $f^{0.5}$	6
48-100	49.33	0.1309	6.455	6
100-6000	15.60 $f^{0.25}$	0.04138 $f^{0.25}$	0.6455 $f^{0.5}$	6
6000-15000	137	0.364	50	6
15000-150000	137	0.364	50	616000 / $f^{1.2}$
150000-300000	0.354 $f^{0.5}$	9.40 x 10^{-4} $f^{0.5}$	3.33 x 10^{-4} f	616000 / $f^{1.2}$
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]
0.003-10*	83	90	-	Instantaneous*
0.1-10	-	0.73 / f	-	6**
1.1-10	87 / $f^{0.5}$	-	-	6**
10-20	27.46	0.0728	2	6
20-48	58.07 / $f^{0.25}$	0.1540 / $f^{0.25}$	8.944 / $f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	3.142 $f^{0.3417}$	0.008335 $f^{0.3417}$	0.02619 $f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000 / $f^{1.2}$
150000-300000	0.158 $f^{0.5}$	4.21 x 10^{-4} $f^{0.5}$	6.67 x 10^{-5} f	616000 /$f^{1.2}$
* = Based on nerve stimulation ** = Bases on specific absorption rate				

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.

4.2 Single-Transmitter Assessment – 47 CFR 2.1091 / RSS-102

Assessment result - Bluetooth Low Energy		
Transmission mode		
Operating mode frequency range [MHz]	2402 - 2480	
Assessment frequency (f) [MHz]	2440	
Transmission duty cycle (DC) [%]	100	
Peak conducted power (P_C) [dBm]	0.10	
Peak radiated power (P_R) [dBm e.i.r.p.]	-0.50	
Peak Antenna gain (G) [dBi]	-0.60	
Maximum Antenna Diameter D [cm]	1	
Antenna far-field distance		
Transmission frequency wavelength (λ)	0.123 m	12.30 cm
Antenna far-field distance (R_{FF})	0.002 m	0.16 cm
Power evaluation		
Peak conducted power (P_C)	1.02 mW	0.10 dBm
Peak Antenna Gain (G)	0.87	-0.60 dBi
Calculated peak radiated power ($P_{R\text{-}Calc}$)	0.89 mW	-0.50 dBm
Measured peak radiated power (P_R)	0.89 mW	-0.50 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)	0.89 mW	-0.50 dBm
Averaged peak radiated power (P_{RAVG})	0.89 mW	-0.50 dBm
Power density		
Compliance power density limit FCC	1.000 mW/cm^2	10.00 W/m^2
Compliance power density limit IC	0.541 mW/cm^2	5.41 W/m^2
Power density @ Antenna far-field distance	2.680 mW/cm^2	26.804 W/m^2
Power density @ 20cm	0.000 mW/cm^2	0.002 W/m^2
Distance for compliance power density FCC	0.003 m	0.27 cm
Distance for compliance power density IC	0.004 m	0.36 cm
Verdict		
The power density of the EUT at 20cm is below the FCC MPE limit!		
The power density of the EUT at 20cm is below the IC MPE limit!		
Comments:		

Assessment result - IEEE 802.11b/g/n		
Transmission mode		
Operating mode frequency range [MHz]	2412 - 2462	
Assessment frequency (f) [MHz]	2437	
Transmission duty cycle (DC) [%]	100	
Peak conducted power (P_C) [dBm]	14.64	
Peak radiated power (P_R) [dBm e.i.r.p.]	16.54	
Peak Antenna gain (G) [dBi]	1.9	
Maximum Antenna Diameter D [cm]	1	
Antenna far-field distance		
Transmission frequency wavelength (λ)	0.123 m	12.31 cm
Antenna far-field distance (R_{FF})	0.002 m	0.16 cm
Power evaluation		
Peak conducted power (P_C)	29.11 mW	14.64 dBm
Peak Antenna Gain (G)	1.55	1.90 dBi
Calculated peak radiated power ($P_{R\text{-}Calc}$)	45.08 mW	16.54 dBm
Measured peak radiated power (P_R)	45.08 mW	16.54 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)	45.08 mW	16.54 dBm
Averaged peak radiated power (P_{RAVG})	45.08 mW	16.54 dBm
Power density		
Compliance power density limit FCC	1.000 mW/cm^2	10.00 W/m^2
Compliance power density limit IC	0.540 mW/cm^2	5.40 W/m^2
Power density @ Antenna far-field distance	135.913 mW/cm^2	1359.132 W/m^2
Power density @ 20cm	0.009 mW/cm^2	0.090 W/m^2
Distance for compliance power density FCC	0.019 m	1.89 cm
Distance for compliance power density IC	0.026 m	2.58 cm
Verdict		
The power density of the EUT at 20cm is below the FCC MPE limit!		
The power density of the EUT at 20cm is below the IC MPE limit!		
Comments:		

4.3 Multi-Transmitter Assessment – 47 CFR 2.1091 / RSS-102

Assessment result - Bluetooth Low Energy + IEEE 802.11b/g/n		
Concurrent Operating Modes		
Number of concurrent operating modes	2	
Compliance Distance		
Distance to EUT used for compliance evaluation [cm]	20	
Bluetooth Low Energy		
FCC limit ($S_{FCCLimit}$)	1.000 mW/cm^2	10.00 W/m^2
IC limit ($S_{ICLimit}$)	0.541 mW/cm^2	5.41 W/m^2
Power density @ compliance distance (S_{CD})	0.000 mW/cm^2	0.00 W/m^2
MPE Ratio (S_{CD} / $S_{FCCLimit}$) FCC	0.00	
MPE Ratio (S_{CD} / $S_{ICLimit}$) IC	0.00	
IEEE 802.11b/g/n		
FCC limit ($S_{FCCLimit}$)	1.000 mW/cm^2	10.00 W/m^2
IC limit ($S_{ICLimit}$)	0.540 mW/cm^2	5.40 W/m^2
Power density @ compliance distance (S_{CD})	0.009 mW/cm^2	0.09 W/m^2
MPE Ratio (S_{CD} / $S_{FCCLimit}$) FCC	0.01	
MPE Ratio (S_{CD} / $S_{ICLimit}$) IC	0.02	
Sum of MPE Ratios		
$\sum S_{CD}$ / $S_{FCCLimit}$ FCC	0.01	
$\sum S_{CD}$ / $S_{ICLimit}$ IC	0.02	
Verdict		
The EUT fulfils the FCC multi-transmitter MPE limit @ 20.00cm!		
The EUT fulfils the IC multi-transmitter MPE limit @ 20.00cm!		
Comments:		