

Test report

according to ISO/IEC 17025:2017

FCC (Federal Communications Commission) Test Firm Registration Number: 768032 Designation Number DE0022

ISED (Inovation, Science and Economic Development) CAB identifier: DE0012 ISED#: 6155A

Electromagnetic compatibility

Intentional Radiators



DAkkS

Deutsche Akkreditierungsstelle D-PL-17379-01-00 D-PL-17379-01-02 D-PL-17379-01-03 Bundesnetzagentur

BNetzA-CAB-18/21-19



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Test report no .:

18/11-0061b

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Location of test facility:



STC Germany GmbH Ohmstrasse 1 84160 Frontenhausen Germany 2.1 Identification of the EUT

1. Client information

Name:	Viessmann Elektronik GmbH
Address:	Beetwiese 2; 35108 Allendorf; Germany
Name of contact:	Mr. Michael Weppler
Telephone:	+49 6452 70 2577
Fax:	+49 6452 70 5577
E-mail:	WepM@viessmann.com

2. Equipment under test (EUT)

Equipment:	RF MODUL
Model:	TCU 200
Brand name:	Viessmann
Serial no.:	#24, #23, #12, #15, #14, #16, #18, #19
Manufacturer:	Viessmann Elektronik GmbH Beetwiese 2, 35108 Allendorf; Germany
Country of origin:	Germany
Power rating:	nominal 24 V =-, +/- 10 %
Highest frequency generated or used in the device or on which the device operates or tunes (MHz):	2.48 GHz
Date Sample Received:	29.11.2018
Tests were performed:	10.01.2019 – 06.04.2020

2.2 Additional information about the EUT:

The EUT has an additional RF-function (W-LAN) which is reported in the STC FCC-ISED report No.: 18/11-0061a

To duplicate parts of this test report needs the written confirmation of the test laboratory.

The test results relate only to the above mentioned test sample(s).

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3. Description of the Equipment under test and test conditions

FCC-ID:	2AIZ9-RF0119			
IC:	21680-RF0119			
HVIN:	RF Modul TCU 200			
Power:	nominal 24 V =, +/- 10 %			
Cables:	USB cable to PC (programming) 13 cm USB to PCB (Ribbon) 18 cm USB cable 100 cm DC cable 135 cm			
Approx. Size (I x w x h):	(60 x 90 x 11) mm			
Test conditions:	The "RF-module – TCU 200" (= equipment under test – EUT) had been tested, where applicable with test software Node Test and with maximum RF-output power in the following modes:			
	 Ping/Pong communication with ZigBee stick Continues TX on lowest, middle and highest Channel Continues Tx (802.11b 20MHz) / ZigBee active PING/PONG communication with ZigBee stick 			
	The tested configuration represents (based on the product specification) with the tested operation modes the worst case.			
Additional information:	Conducted RF Measurements were carried out on a temporary SMA socket			
Type of modulation (ITU designation):	2M26G1D			
Operating frequencies:	2.405 GHz – 2.480 GHz			
Transmission protocol:	ZigBee			
Channel separation:	5 MHz			
Number of channels:	16 - See below			
Operating temperature range:	0 °C +60 °C			
Operating voltage range:	24 V =, +/- 10 %			
Output power:	radiated: -/- dBm (normal conditions) conducted: 9.39 dBm (normal conditions)			
Environmental conditions	Ambient temperature: 20 °C			
during tests:	Relative humitity 40 %			
	Atmospheric pressure 965 mbar			
Antenna specification:	Model: Printed PCB Antenna Gain: max. 2dB Type: External (with accessible antenna socket)			
	🛛 Internal (integrated, PCB antenna 24 mm)			
Test standard:	 e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C §15.247: Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz 			
	 RSS-247 issue 02 February 2017 Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices 			

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Channel List

ZigBee:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
11	2405	19	2445
12	2410	20	2450
13	2415	21	2455
14	2420	22	2460
15	2425	23	2465
16	2430	24	2470
17	2435	25	2475
18	2440	26	2480

4. Performed measurements and results

The complete list of measurements required in e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C §15.247 is given below.

Standard:	Standard:	Test Method:		Test requirements:			
				applic	able:	fulfilled:	
				yes	no	yes	no
§ 15.207	RSS-Gen issue 5	ANSI 63.10 Section 6.2	AC Mains Conducted Emissions	\boxtimes		\boxtimes	
§ 15.209	RSS-Gen issue 5	ANSI 63.10 Section 6.3 - 6.6	Radiated Emissions	\boxtimes		\boxtimes	
§15.247	RSS-247 issue 2	ANSI 63.10 Section 11.8.1	6 dB DTS Bandwidth	\boxtimes		\boxtimes	
§15.247	RSS-247 issue 2	ANSI 63.10 Section 11.9.1	Output Power of Fundamental Emissions				
§15.247	RSS-247 issue 2	ANSI 63.10 Section 11.10.2	Maximum Power Spectral Density			\boxtimes	
§15.247	RSS-247 issue 2	ANSI 63.10 Section 11.13.2	Band Edges Measurement Out-of-Band Emission			\boxtimes	
	RSS-Gen issue 5	ANSI 63.10 Section 6.9.3	99% Power Bandwidth	\boxtimes		\boxtimes	

All required / applicable tests according to the following standards were performed under Ref-No. 18/11-0061.

- e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C §15.247 with test Method according to ANSI C63.10-2013

- RSS-247 issue 02 February 2017 Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

- e-CFR data is current as of June 22, 2020

Remark: -/-



5. AC Mains conducted emissions

Applied standards

-e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C, § 15.207 Conducted limits -RSS-Gen issue 05 section 8.8

Test site

Measurements of conducted emission from EUT was made in the shielded chamber (DC - 10GHz) located in the test facility.

Test equipment and test set up

Test equipment used for conducted measurements on Mains as given in clause Test equipment of this report.

Test setup used for conducted measurements on Mains as given in clause Test setups of this report.

Detector function selection and bandwidth

In conducted emissions measurement CISPR quasi-peak- and average-detector were used. The bandwidth of the detector of instrument is 10 kHz over the frequency range of 150 kHz to 30 MHz.

Frequency range to be scanned

For conducted emission measurements, the spectrum in the range of 150 kHz to 30 MHz was investigated.

Test conditions and configuration of EUT

The EUT was configured and operated under following operation modes:

- 1. Ping/Pong communication with ZigBee stick
- 2. Continues TX

All modes are investigated by operating the EUT in a range of typical modes of operation, with typical cable positions, and with a typical system equipment configuration and arrangement. For each mode of operation and for each ac power current-carrying conductor, cable manipulation are performed within the range of likely configurations. The highest values measured are shown in the table below. The corresponding configuration is shown in the "Photo(s) of test setup".

The EUT was placed on a 80 cm high non metallic table. Measurements were performed on the AC terminals of the Host AC-Adaptor, on neutral (N)- and live (L1)-wire had been performed.

Requirements

Frequency Range	Quasi-Peak Limits	Average Limits			
[MHz]	[dBµV]	[dBµV]			
0.15 - 0.5	66 to 56 Note 1	56 to 46 Note 1			
0.5 - 5.0	56	46			
5.0 - 30.0 60 50					
Note 1: The level decreases linearly with the logarithm of the frequency					

Measurement

Measruement performened on 08.01.2019

As worst cases the Ping/Pong communication with ZigBee stick powered by $120V \sim / 60$ Hz was found and documented in this report.

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		Т	Τ	1 /	2	
	Int	acc. F	CC PART	tage 150 KH 15.107(a) ES-003	IZ - 30 M Class B	HZ
110 dBuV 100			the highe: freq. v. [MHz] [d] No point: than 20 QP and A	st points found: alue limit det. BuV] [dBuV] s found greater dB below limit ver. measurement	RefNo. Product: Sample: Date: 8	: 18/11-0061 Transm./Receiv.Sys 07 Jan 2019
90			upper li lower li	mit for QP meas. mit for Av meas.	Operator Test equ	: Gi
80					Rohde & Rohde &	Schwarz ESHS 30 Schwarz ESH 2-Z5
70					Connecte Input Vo AC-Adapt	d sets: 1tage 120 V / 60 Hz or SUN-1200200
60						
50					Operatin ZigBee a Comm. wi with Zig Tested o	ng mode: nctive th ping signal nBee-Stick nn N
40			N			pression parts:
30					* two dB	3 safety margin for
10					Result:	pass [X] fail []
0.01		. 1	1.0	10	Э0 f [MHz]	electronic GmbH Frontenhausen



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The six highest emissions for each port (L/N)/detector are as following:

Frequency [MHz]	Reading of test receiver [dBµV]	Detector	Port	loss of cable between LISN and test receiver [dB]	LISN correction [dB]	AC power line conducted emission [dBuV]	Limit [dBµV]	Result
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
-/-	-/-	QP	Ν	0.10	0.10	-/-	-/-	Pass
-/-	-/-	QP	Ν	0.10	0.10	-/-	-/-	Pass
-/-	-/-	QP	Ν	0.10	0.10	-/-	-/-	Pass
-/-	-/-	QP	Ν	0.10	0.10	-/-	-/-	Pass
-/-	-/-	QP	Ν	0.10	0.10	-/-	-/-	Pass
-/-	-/-	QP	Ν	0.10	0.10	-/-	-/-	Pass
-/-	-/-	AV	Ν	0.10	0.10	-/-	-/-	Pass
-/-	-/-	AV	Ν	0.10	0.10	-/-	-/-	Pass
-/-	-/-	AV	Ν	0.10	0.10	-/-	-/-	Pass
-/-	-/-	AV	N	0.10	0.10	-/-	-/-	Pass
-/-	-/-	AV	Ν	0.10	0.10	-/-	-/-	Pass
-/-	-/-	AV	Ν	0.10	0.10	-/-	-/-	Pass
-/-	-/-	QP	L1	0.10	0.10	-/-	-/-	Pass
-/-	-/-	QP	L1	0.10	0.10	-/-	-/-	Pass
-/-	-/-	QP	L1	0.10	0.10	-/-	-/-	Pass
-/-	-/-	QP	L1	0.10	0.10	-/-	-/-	Pass
-/-	-/-	QP	L1	0.10	0.10	-/-	-/-	Pass
-/-	-/-	QP	L1	0.10	0.10	-/-	-/-	Pass
-/-	-/-	AV	L1	0.10	0.10	-/-	-/-	Pass
-/-	-/-	AV	L1	0.10	0.10	-/-	-/-	Pass
-/-	-/-	AV	L1	0.10	0.10	-/-	-/-	Pass
-/-	-/-	AV	L1	0.10	0.10	-/-	-/-	Pass
-/-	-/-	AV	L1	0.10	0.10	-/-	-/-	Pass
-/-	-/-	AV	L1	0.10	0.10	-/-	-/-	Pass

(1) = test frequency

(2) = Reading of test receiver in $dB\mu V$ without correction factors

(3) = used detector

(4) = tested port Phase (live, L1) or Neutral (N)

(5) = loss of cable between LISN and test receiver in dB

(6) = correction factor of LISN in dB

(7) = Reading of test receiver [dBµV] (2) + loss of cable between Line impedance stabilisation network (LISN) and test receiver (dB) (5) + LISN correction [dB] (6)

(8) = relevant limit in $dB\mu V$

(9) = comparison between Limit [dBµV] (7) / (8) and AC power line conducted emission [dBµV]

Result 0.15 MHz – 30 MHz

All emissions in the frequency range 0.15 MHz – 30 MHz are at least 20 dB below the relevant limit.

Results

From the measurement data obtained, the tested sample was considered to have **COMPLIED** with the requirements for the **Conducted Emission**.



6. Radiated emission measurements

Test site

Measurement of radiated emissions from EUT was made in the semi-anechoic chamber SAC3 (DC to 40 GHz) located in the test facility.

Test equipment and test set up

Test equipment used for radiated measurements as given in clause Test equipment of this report. Test setup used for radiated measurements as given in clause Test setups of this report.

Detector function selection and bandwidth

In radiated emissions measurement, an EMI test receiver that have CISPR detectors was used.

Frequency range	Resolution Bandwidth
9KHz – 150kHz (Quasi Peak & Average* Detector)	200Hz
150KHz – 30MHz (Quasi Peak & Average* Detector)	9kHz
30MHz – 1GHz (Quasi Peak Detector)	120kHz
Above 1GHz (Peak & Average Detector)	1MHz

*Average Detector only in specify frequency range.

Antennas

Measurements were made using a calibrated loop antenna in the range 9 kHz - 30 MHz, as well as a calibrated bilog antenna in the range of 30 to 1000 MHz to determine the emission characteristics of the EUT. Measurements were also made for both horizontal and vertical polarization.

The horizontal distance between the receiving antenna and the EUT was 3 meters.

In the range of 1 GHz to 26 GHz measurements were made using a calibrated horn antenna to determine the emission characteristics of the EUT. Measurements were also made for both horizontal and vertical polarization. The horizontal distance between the receiving antenna and the EUT was 3 meters.

Frequency range to be scanned

For radiated emissions measurements, the spectrum in the range of 9kHz MHz to 26 GHz was investigated as the highest frequency generated in the EUT is 2.480 GHz.

Test conditions and configuration of EUT

The EUT was configured and operated under following operation modes:

- 1. Ping/Pong communication with ZigBee stick
- 2. Continues Tx
- 3. EUT continues Tx (802.11b 20MHz) / ZigBee active communication with PING/PONG

During test the EUT was operated as specified in the user manual of the EUT. For frequencies below 1000 MHz the EUT was placed on a 80 cm and for frequencies above 1000 MHz the RF Transmitter modul was placed on a 150 cm high non metallic table placed on the turntable. The EUT was rotated and the antenna height was varied between 1 m to 4 m to find the maximum RF energy generated from EUT. The procedure according to ANSI C63.10:2013 is used and all modes are investigated by operating the EUT in a range of typical modes of operation, with typical cable positions, and with a typical system equipment configuration and arrangement. For each mode of operation, cable manipulation are performed within the range of likely configurations. The highest values measured are shown in the table below.

As worst cases the mode. No. 2 with Ping/Pong communication with ZigBee and the mode No. 3 with continues Tx (802.11b 20MHz) / ZigBee active communication with PING/PONG powered by $120V \sim / 60$ Hz was found and documented in this report.

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Remarks:

-Correction factor included antenna factor and cable attenuation.

-In the frequency range 1 GHz – 7 GHz the Band Reject Filter 2,4 GHz (ID11243) was used to attenuate the fundamental emission.

Applied standards

-e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C, § 15.209 Radiated emission limits -RSS-Gen issue 05 section 8.9

Requirements

acc. e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C, § 15.209 Radiated emission limits

Frequency MHz	Limits [µV/m] Quasi-peak	Limits [dBµV/m] Quasi-peak	Limits [µV/m] Average	Limits [dBµV/m] Average	Test distance [m]
0.009 - 0.090	-/-	-/-	2400/F (kHz)	48.5 – 28.5	300
0.090 - 0.110	2400/F (kHz)	28.5 – 26.8	-/-	-/-	300
0.110 – 0.490	-/-	-/-	2400/F (kHz)	26.8 – 13.8	300
0.490 - 1.705	24000/F (kHz)	33.8 - 23.0	-/-	-/-	30
1.705 - 30.0	30	29.5	-/-	-/-	30

acc. RSS-Gen issue 05 section 8.9

Frequency MHz	Limits [µA/m] Quasi-peak	Limits [dBµA/m] Quasi-peak	Limits [µA/m] Average	Limits [dBµA/m] Average	Test distance [m]
0.009 - 0.090	-/-	-/-	6.37/F (kHz)	-323.0	300
0.090 - 0.110	6.37/F (kHz)	-23.0 – -24.7	-/-	-/-	300
0.110 - 0.490	-/-	-/-	6.37/F (kHz)	-24.7 – -37.7	300
0.490 - 1.705	63.7/F (kHz)	-17.7 – -28.5	-/-	-/-	30
1.705 - 30.0	0.08	-22	-/-	-/-	30

acc. e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C, § 15.209 Radiated emission limits and RSS-Gen issue 05 section 8.9

Frequency MHz	Limits [µV/m] Quasi-peak	Limits [dBµV/m] Quasi-peak	Limits [µV/m] Average	Limits [dBµV/m] Average	Test distance [m]
30 - 88	100	40	-/-	-/-	3
88 - 216	150	43.5	-/-	-/-	3
216 - 960	200	46	-/-	-/-	3
960 - 1000	500	54	-/-	-/-	3
Above 1000	-/-	-/-	500	54	3

Measurements

The Measurement was performed on: 10.01.2019, 30.01.2020 and 01.04.2020

Result 9 kHz – 30 MHz

In the frequency range 9 kHz – 30 MHz the EUT had been scanned in a distance of 3 m and the limit was corrected to the test distance of 3 m using a factor of 40 dB/decade.

All emissions in the frequency range 9 kHz – 30 MHz are at least 20 dB below the relevant limit.



Result 30 MHz – 1000 MHz

Operation Mode: Mode No.: 2 with Ping/Pong communication with ZigBee stick



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Frequency [MHz]	Detector	Antenna polarization	Radiated emission [dBµV/m]	Radiated emission [µV/m]	Limit [dBµV/m] (3 m)	Limit [µV/m] (3 m)	Result
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
950,04	QP	V	37,29	73,20	46,00	200	Pass
937,60	QP	V	37,16	72,11	46,00	200	Pass
913,72	QP	V	36,77	68,94	46,00	200	Pass
916,52	QP	v	36,77	68,94	46,00	200	Pass
889,24	QP	V	36,47	66,60	46,00	200	Pass
-/-	QP	V	-/-	-/-	-/-	-/-	-/-
957,96	QP	Н	37,19	72,36	46,00	200	Pass
947,48	QP	Н	37,10	71,61	46,00	200	Pass
931,52	QP	Н	37,02	70,96	46,00	200	Pass
913,24	QP	Н	36,69	68,31	46,00	200	Pass
897,28	QP	Н	36,42	66,22	46,00	200	Pass
-/-	QP	Н	-/-	-/-	-/-	-/-	-/-

The six highest emissions for each polarization (H/V) in the frequency range 30 MHz – 1000 MHz are as following:

- (1) = test frequency
- (2) = used detector quasi peak (QP), peak, average (AV)
- (3) = polarization of the test antenna (Horizontal/Vertical)
- (4) = Reading of test receiver [dBµV] + correction factor
- $(5) = 10 \wedge ((Radiated emission [dBµV/m] (5))/20)$
- (6) = relevant limit in $dB\mu V/m$
- (7) = relevant limit in μ V/m
- (8) = comparison between Limit $[dB\mu V/m]$ (6) and Radiated emission $[dB\mu V/m]$ (4)

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Operation Mode: Mode No.: 3 with 802.11b 20MHz / ZigBee active communication with PING/PONG

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Frequency [MHz]	Detector	Antenna polarization	Radiated emission [dBµV/m]	Radiated emission [µV/m]	Limit [dBµV/m] (3 m)	Limit [µV/m] (3 m)	Result
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
937.16	QP	V	35.32	58.34	46.00	200	Pass
949.12	QP	V	35.16	57.28	46.00	200	Pass
922.12	QP	V	35.08	56.75	46.00	200	Pass
902.64	QP	V	34.82	55.08	46.00	200	Pass
890.32	QP	V	34.60	53.70	46.00	200	Pass
-/-	QP	V	-/-	-/-	-/-	-/-	-/-
958.76	QP	Н	35.26	57.94	46.00	200	Pass
931.08	QP	Н	35.19	57.48	46.00	200	Pass
944.76	QP	Н	35.17	57.35	46.00	200	Pass
908.24	QP	Н	34.87	55.40	46.00	200	Pass
886.64	QP	Н	34.58	53.58	46.00	200	Pass
-/-	QP	Н	-/-	-/-	-/-	-/-	-/-

The six highest emissions for each polarization (H/V) in the frequency range 30 MHz - 1000 MHz are as following:

- (1) = test frequency
- (2) = used detector quasi peak (QP), peak, average (AV)
- (3) = polarization of the test antenna (Horizontal/Vertical)
- (4) = Reading of test receiver $[dB\mu V]$ + correction factor
- $(5) = 10^{(Radiated emission [dBµV/m] (5))/20)}$
- (6) = relevant limit in $dB\mu V/m$
- (7) = relevant limit in μ V/m
- (8) = comparison between Limit $[dB\mu V/m]$ (6) and Radiated emission $[dB\mu V/m]$ (4)

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Result 1 GHz – 7 GHz

Mode: Continues TX on Channel 18

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IT 5/6 Interference radiation



Interference radiation according to FCC §15.209 RSS-Gen

Ref.-No.: 18/11-0061

Operation mode: Zigbee Tx CH.18

Receiver		
RBW (EMI) 1 MHz MT	1 s	IT56-1-6GHz.TDF
Input 1 AC Att 0 dB Preamp	OFF Step TD Scan	
Scan 🕒 1Av Max 🕒 2Pk Max		
Limit Check	PASS	
Line IT56-1-7GHZ-AV-FCC-Class B	PASS	
90 dBjtv/mT56-1-7CHZ-PEAK-FGG-CLA8	PA88	
80 dBx4/m		
IT56-1-7GHZ-PEAK-ECC-CLASS B		
70 uBµV/m		
60 dBµV/m		
IT56-1-7GHZ-AV-FCC-Class B		
зо аврул		a manufacture of the stand of the
		and the state of t
40 dBµV/m	Munham When the wards	- the state of the
My Maper W. Nullimmen of harding		and the second s
30 dBµV/m	h an and and	and a second
and mound		
20 dBuV/m		
10 dBµV/m-		
	TE	
Start 1.0 GHz	17	Stop 7.0 GH

Polarisation: V									
Detector Average				Detector Peak					
Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result	Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result
6,9990	39,57	-14,43	54,00	pass	1-7	/	>20	74	pass
6,5118	39,13	-14,87	54,00	pass					
6,1435	38,06	-15,94	54,00	pass					
5,5190	37,30	-16,70	54,00	pass					



TESTED

IT 5/6



Interference radiation according to FCC §15.209 RSS-Gen

Ref.-No.: 18/11-0061

Operation mode: Zigbee Tx CH.18

Receiver	
RBW (EMI) 1 MHz MT 1 s IT56-1-6GHz.TDF	
Input 1 AC Att 0 dB Preamp OFF Step TD Scan	
Scan 🕒 1Av Max 🔁 2Pk Max	
Limit Check PASS	
Line IT56-1-7GHZ-AV-FCC-Class B PASS	
90 dBjrvjniT56-1-7CHZ-PEAK-FGG-GLA8 PA88	
80 dBµV/m	
IT56-1-7GHZ-PEAK-FCC-CLASS B	
60 dBµV/m	
IT56-1-7GHZ-AV-FCC-Class B	the state of the s
and	shine and a start of the start
10 double	
40 dBpv/m	montinutra
1 Mar Bar Manustan March Contraction of the Contrac	
30 dBµV/m	
A a commentation and a second and	
20 dBuV/m	
10 db 4/m	
10 dBpv/m-	
т	
Start 1.0 GHz	Stop 7.0 GHz
	2100 110 2110

Polarisation: H									
Detector Average							Detector Peak		
Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result	Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result
6,9910	39,88	-14,12	54,00	pass	1 - 7	/	>20	74	pass
6,5120	39,00	-15,00	54,00	pass					
5,9023	38,16	-15,84	54,00	pass					

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Mode No.: 3 with 802.11b 20MHz / ZigBee active communication with PING/PONG

TESTED	IT 5/6	ПСТС
IN GERMANY	Interference radiation	
	according to FCC §15.209 RSS-Gen	

Ref.-No.: 18/11-0061

Product:	Transmitting/Receiving System			
Sample:	07 (#18)			
Date:	01.04.2020			
Operator:	BI		pass	fail
Remarks:	All cables connected; Input Voltage System 24V/DC	Result:	\boxtimes	
0	1			

Operation mode: Tx Wifi (802.11b 20MHz/CH11 – 2462MHz); Zigbee (Communication with ping/pong) Band Stop Filter 2,4GHz (ID11243) used

Spectrum Receiver (x)
RBW (EMI) 1 MHz MT 1 s IT56-1-6GHz.TDF
Input 1 AC Att 0 dB Preamp OFF Step TD Scan
Scan 🕒 1Av Max 🗠 2Pk Max
Limit Check PASS
Line IT56-1-7GHZ-AV-FCC-Class B PASS
90 dBjrymT56-1-7CHZ-PEAK-FGG-GLA8 PA88
80 dBuV/m-
IT56-1-7GHZ-PEAK-FCC-Class B.LIN
60 dBµV/m
IT56-1-7GHZ-AV-FCC-Class B.LIN
All and a second a
the transmission of the tr
the
Very musical film to manufacture
30 dBµV/m-
and the manufacture of the second s
20 dBµV/m-
10 dB+0//m
10 uphylin
Start 1.0 GHz Stop 7.0 GHz

Polarisation: V									
Detector Average					Detector Peak				
Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result	Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result
2,3213	42,09	-11,91	54,00	pass	1-7	/	>20	74,00	pass
6,4988	39,91	-14,09	54,00	pass					
6,9883	39,28	-14,72	54,00	pass					
2,3828	38,74	-15,26	54,00	pass					
6,5118	38,57	-15,43	54,00	pass					
6,1453	37,98	-16,02	54,00	pass					



TESTED

IT 5/6



Interference radiation according to FCC §15.209 RSS-Gen

Ref.-No.: 18/11-0061

Operation mode: Tx Wifi (802.11b 20MHz/CH11 – 2462MHz); Zigbee (Communication with ping/pong) Band Stop Filter 2,4GHz (ID11243) used

Spectrum Receiver 🗴	
RBW (EMI) 1 MHz MT	1 s IT56-1-6GHz.TDF
Input 1 AC Att 0 dB Pream	p OFF Step TD Scan
Scan 🔵 1Av Max 🎯 2Pk Max	
Limit Check	PASS
Line IT56-1-7GHZ-AV-FCC-Class	B PASS
90 dBjrv/m T56-1-7CHZ-PEAK-EGG-GLA	8-0468
80 dBuV/m	
IT56-1-7GHZ-PEAK-FCC-Class B.LIN	
60 dBµV/m	
IT56-1-7GHZ-AV-FCC-Class B.LIN	
	it. +
N Wh	My have many many many
HevdBhv/m	when the sound the sound the
Man A Mar march and	M m
30 dBµV/m	1 martine and and a second sec
which the manufacture	unit V
20 dBuV/m	
10 dBµV/m	
Start 1.0 CHz	Ptop 2.0 OUp
Loran T.O. CHZ	stop 7.0 GHz

Polarisation: H									
Detector Average				Detector Peak					
Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result	Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result
6,4988	45,84	-8,16	54,00	pass	1-7	/	>20	74,00	pass
6,9928	39,57	-14,43	54,00	pass					
6,5120	39,51	-14,49	54,00	pass					
6,1458	38,38	-15,62	54,00	pass					
4,8808	38,36	-15,64	54,00	pass					
2,3463	36,54	-17,46	54,00	pass					

Result 7GHz – 26GHz

All emissions in the frequency range 7 GHz – 26 GHz are at least 20 dB below the relevant limit

Results

From the measurement data obtained, the tested sample was considered to have **COMPLIED** with the requirements for the **Radiated Emissions**.



7. Operation within the band 902-928 MHz, 2400-2483,5 MHz and 5725-5850 MHz

Applied standards

-e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C §15.247 -RSS-247 issue 2

7.1. 6 dB DTS Bandwidth Measurement

Applied standards

-e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C §15.247 (a) (2) -RSS-247 issue 2 Section 5.2 (a)

Limit

The minimum 6 dB bandwidth shall be at least 500 kHz.

Test equipment and test set up

Test equipment used for conducted measurements as given in clause Test equipment of this report. Test setup used for conducted measurements as given in clause Test setups of this report.

Description

Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

Measurement

The Measurement was performed on: 03.02.2020

⊡STC	TESTED

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Lowest operating frequency

MultiView 😁	Spectrum	1							
Ref Level 20.00	dBm		• RBW 100	<hz< td=""><td></td><td></td><td></td><td></td><td></td></hz<>					
Att 3	30 dB SWT 4	41.84 µs (~7.3 ms)) VBW 300 l	KHz Mode Aut	o FFT				
1 Frequency Swo	еер								1Pk Max
								M1[1]	5.58 dBm
								2,	40515980 GHz
hand and a								M2[1]	-0.27 dBm
10 dBm					100			2.	40407590 GHz
			42/	~~~~		~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~			
0 dBm	-0.460 dBm	~	y	8	8	N3			
		2							
-10 dBm		1							
-20 dBm		/		-	- 	8		~~~	
-38 dBm							V		~
									J
-40 dBm									
CF 2.405 GHz			1001 pts	6	50)0.0 kHz/			Span 5.0 MHz
2 Marker Table									1
Type Ref	Trc	X-Value		Y-Value		Function		Function Re	esult
M1 M2 D3 M2	1 2 1 2	4051598 GH 4040759 GH 1.6633 MH	z - z -	5.58 dBm 0.27 dBm -0.14 dB					
Channel	Freque	ency [MHz]		6 dB Band	width [MHz	z]	Limit [MHz] F	Result
11		2405		1.	6633		0.5		Pass

Middle Operating Frequency

MultiView 😁	Spectrun	n)							
Ref Level 20.00	dBm	41.04.00 (7.2 mg	• RBW 100	kHz kHz Mada Aut	- CCT				20.000 A2
1 Erequency Swe		41.84 µs (~7.5 ms) VBW 300	KHZ MOUE AU	OFFI				●1Pk Max
								D3[1]	-0.15 dB
								and the second second	1.65330 MHz
								M1[1]	5.56 dBm
10 dBm					541			2.	44015480 GHz
			M2			~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~			
0 dBm	-0.440 dBm		y			23			
-10 dBm						h			
-10 (16)(1-							\mathcal{A}		
-20 dBm		/						~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	
-30/dBm		×					V	<u>_</u>	
									~
-40 abm									
CF 2.44 GHz			1001 pt	s	50	0.0 kHz/			Span 5.0 MHz
2 Marker Table									
Type Ref	Trc	X-Value	1.00	Y-Value		Function		Function Re	esult
M1 M2 D3 M2	1 2 1 2	2.4401548 GH 2.4390759 GH 1.6533 MH	iz - Iz -	5.56 dBm 0.19 dBm -0.15 dB					
Channel	Frequ	iency [MHz]		6 dB Band	width [MHz	z]	Limit [MHz	2] F	Result
18		2440		1.	6533		0.5		Pass

ESTC TESTED	
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Highest Operating Frequency



Results

From the measurement data obtained, the tested sample was considered to have **COMPLIED** with the requirements for the **6 dB Bandwidth**.



7.2. Output Power of Fundamental Emissions Maximum Conducted Output Power

Applied standards

-e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C §15.247 (b) (3) -RSS-247 Issue 2 section 5.4 (d)

Limits for Peak Output Power of Fundamental (EIRP)

The maximum peak conducted output power of the intentional radiator shall not exceeded: 1 Watt As an alternative to the maximum peak conducted output power the (average) output power is measured to show compliance to the limit.

Test equipment and test set up

Test equipment used for conducted measurements as given in clause Test equipment of this report. Test setup used for conducted measurements as given in clause Test setups of this report.

Description

For the conducted measurement, the RF output of the EUT was connected to the Analyzer. All the attenuation or cable loss will be added to the measured maximum output power. The results are recorded in Watt.

Measurement

The Measurement was performed on: 03.02.2020

⊡STC	TESTED
	IN GERMANY

Page 25 of 51 pages

Lowest operating frequency

MultiView 😁 S	pectrum								
Ref Level 20.00 dB	m	• RBW	2 MHz						
Att 30 c	B SWT 1.01	l ms 🗢 VBW	10 MHz Mode	Auto Sweep					
1 Frequency Sweep	C C								●1Pk Max
								M1[1]	9.39 dBm
								2.	40439100 GHz
10 dBm-				MI					
			· · · · · · · · · · · · · · · · · · ·						
0 dBm	-	/					1		
o dom		/							
	/	Contraction 1					1		
							1		
-10 dBm								~	
- 10 ubiti-	1							Y	
and a second	/								
June								×.	
-20 dam					1			1	
20 doni w								1.4	Lug
1. John Martin									W
WWW Not									Minimu
- 20 dBm									mult
-30 ubiii-	1								11
10 -10									
-40 UBM-									
CF 2.405 GHz			1001 pts	i	1	.0 MHz/		S	pan 10.0 MHz

Middle Operating Frequency

MultiView	8 Spectrum								
Ref Level 20	.00 dBm	• RBW	2 MHz						
Att	30 dB SWT	1.01 ms 🗢 VBW	10 MHz Mode	Auto Sweep					
1 Frequency	Sweep								.●1Pk Max
								M1[1]	9.38 dBm
								2.	43928100 GHz
10 dBm				M1					
10 0.011									
0 dBm					4		/		
o dom							\searrow		
							\mathbf{X}		
	/								
10 dBm								~	
-10 uBm-	1							1	
	1							No.	
	1							Xy	
20 d0m 📈	1							Mark 1	
-20 ubiii-								1.	N. Contraction of the second s
man									man
Market									mole
									with men
-30 dBm-		2			i i i i i i i i i i i i i i i i i i i	S			
-40 dBm									
CF 2.44 GHz	1	1	1001 pt	S	1	.0 MHz/		5	pan 10.0 MHz

Page 26 of 51 pages

Highest Operating Frequency

MultiView 😁 Spectrum						
Ref Level 20.00 dBm	• RBW 2 MHz					
Att 30 dB SWT 1	1.01 ms 🗢 VBW 10 MHz Mod	e Auto Sweep				
1 Frequency Sweep					N41517	
					MILII	9.35 dBm
					Ζ.	48038000 GHZ
			MI			
10 dBm-	10-			· · · · · · · · · · · · · · · · · · ·		
				<		
0 dBm				1		
					<	
-10 dBm					1 march	
and						Marken work
-30 dBm						
-40 dBm	1001 p		1.0		c	pop 10.0 MHz

Maximum output power conducted measurement:							
Channel	Frequency	Output Power		Limit		Posult	
Channer	[MHz]	[dBm]	[mW]	[dBm]	[mW]	Result	
11	2405	<mark>9.39</mark>	8.69	30	1000	Pass	
18	2440	9.38	8.67	30	1000	Pass	
26	2480	9.35	8.61	30	1000	Pass	

Results

From the measurement data obtained, the tested sample was considered to have **COMPLIED** with the requirements of **Output Power of Fundamental Emissions**.



7.3. Power Spectral Density

Applied standards

-e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C §15.247 (e) -RSS-247 issue 2 Section 5.2 (b)

Limit

For digitally modulated systems, 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.

Test equipment and test set up

Test equipment used for conducted measurements as given in clause Test equipment of this report. Test setup used for conducted measurements as given in clause Test setups of this report.

Description

The maximum peak conducted output power was used to determine compliance to the fundamental output power limit. So the maximum peak conducted PSD level is measured with a peak detector.

Measurement

The Measurement was performed on: 11.02.2020

Test report no.: 18/11-0061b	Page 28 of 51 pages
	Test report no.: 18/11-0061b

Lowest operating frequency



Middle Operating Frequency



ESTC TESTED IN GERMANY	Test report no.: 18/11-0061b	Page 29 of 51 pages
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Highest Operating Frequency



Maximum power spectral density						
Channel	Frequency [MHz]	Power Spectral Density [dBm / 3 kHz]	Limit [dBm / 3 kHz]	Result		
11	2405	-4.91	8	Pass		
18	2440	-5.12	8	Pass		
26	2480	-5.16	8	Pass		

Results

From the measurement data obtained, the tested sample was considered to have **COMPLIED** with the requirements for the **Power Spectral Density**.



7.4. Band-Edges Measurement / Out of Band Emissions

Applied standards

-e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C §15.247 (d) -RSS-247 issue 2 Section 5.5

Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 30 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power. Emissions which fall in the restricted bands, as defined in §15.205 Restricted Bands of operation as well as in restricted bands of the RSS-Gen Issue 5 (see Section 8.10 Restricted Frequency Bands) and must also comply with the radiated emission limits specified in §15.209 Radiated emission limits as well as the limits specified in RSS-Gen Table 5.

Test equipment and test set up

Test equipment used for Band Edge measurements as given in clause Test equipment of this report. Test setup used for Band Edge measurements as given in clause Test setups of this report.

Description

The band edge is measured at an amplitude level reduced from the reference level by a specified ratio. The reference level is the level of the highest amplitude signal observed from the transmitter at the fundamental frequency.

Detector function

For the measurement, an EMI test receiver that have CISPR peak and avearge detector was used.

Measurement

The Measurement was performed on: 06.04.2020

Higher Band Edge - ZigBee CH. 26 - radiated

TESTED	FCC 3	ПСТС
IN GERMANY	Band edge emission	Man
	according to	
	FCC §15.247, RSS-247, FCC §15.209 RSS-Gen	

Ref.-No.: 18/11-0061

Operation mode: Zigbee CH.26; High edge

Spectrum Recei	ver 🙁						
RBW (EMI) 1	LMHZ MT	1 s	I	F56-1-7GHz (hne Amp	TDF	
Input 1 AC Att	0 dB Preamp	OFF Step	TD Scan		-		
Scan 🕤 1Av Max 🔵 2Pk Ma	ах						
IT56-LIAGHCREAK-WLAN-2-	4GHZ_FCC.LIN	PASS		M1[1]		5	i3.61 dBµ∀/m
120 UBp/v/m 56-1-6CHZ-A	V-WLAN-2-1GF	PASS		-0.000 s		2.48	33500000 GHz
Line IT56-1-6GHZ-PI	EAK-WLAN-2-4	PASS					
110 dBµV/m							
100 /0.1//-		1 6					
100 dBµV/m							
90 dBµV/m							
80 dBµV/m							
70 dBµV/m							
60 dBµV/m			No ×				
montenen	mon	₩ /	(— ~	m	mm	mm	m
50 dBµV/m							
		 [∨]				+	*-++-*-
30 dBµV/m							
Start 2.433 GHz		1	1			Ste	op 2.533 GHz

	Polarisation: V									
		Detector Average			Detector Peak					
Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result	Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result	
2,4835	53,61	-0,39	54,00	pass	2,4868	56,82	-17,18	74,00	pass	
2,4865	46,22	-7,78	54,00	pass						
2,4898	42,40	-11,60	54,00	pass						
2,5098	42,28	-11,72	54,00	pass						
2,5095	42,21	-11,79	54,00	pass						
2,5190	41,92	-12,08	54,00	pass						

TESTED IN GERMANY	FCC 3 Band edge emission according to	迅STC
	FCC §15.247, RSS-247, FCC §15.209 RSS-Gen	

Ref.-No.: 18/11-0061

Operation mode: Zigbee CH.26; High edge

Spectrum Receiver 🗵						
RBW (EMI) 1 MHz MT	1 s	II	56-1-7GHz	ohne Amp	TDF	
Input 1 AC Att 0 dB Preamp	OFF Step	TD Scan				
Scan 🔵 1 Av Max 😋 2 Pk Max						
IT56-LIGGHOREAK-WLAN-2-4GHZ_FCC.LIN	PASS		M1[1]		1	53.06 dBµ∀/m
120 HBpw/m56-1-6CHZ-AV-WLAN-2-4CH	PASS		-0.000 s		2.4	83500000 GHz
Line IT56-1-6GHZ-PEAK-WLAN-2-4	PASS					
110 dBµV/m						
	1	h I				
100 dBµV/m						
90 gBhAlw						
80 dBx0//m						
70 dBuV/m						
60 dBµV/m	4					
		N T				
50 dBµV/m	r	~~		min	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	m
		<u>∖</u>				
40 dBpV/m	٢	<u> </u>	<u> ++</u>	***	++	-+*+
20 dBμV/m						
Start 2.433 GHz	1			1	St	op 2.533 GHz

Polarisation: H									
Detector Average							Detector Peak		
Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result	Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result
2,4835	53,06	-0,94	54,00	pass	2,4865	58,46	-15,54	74,00	pass
2,4865	45,84	-8,16	54,00	pass					
2,5098	42,32	-11,68	54,00	pass					
2,4898	42,27	-11,73	54,00	pass					
2,5095	42,17	-11,83	54,00	pass					
2,5143	41,85	-12,15	54,00	pass					

Image: Street	Page 33 of 51 pages
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Lower Band Edge - ZigBee CH. 11 - radiated

TESTED	FCC 3	RECTC
IN GERMANY	Band edge emission	EDIL
	according to	
	FCC §15.247, RSS-247, FCC §15.209 RSS-Gen	

Ref.-No.: 18/11-0061

Operation mode: Zigbee CH.11; Low edge

Spectrum Receiver 💥 🗵						
RBW (EMI) 1 MHz MT 1	1 s	IT56-1-7GHz	ohne Amp	TDF	``````````````````````````````````````	_
Input 1 AC Att 0 dB Preamp 0	FF Step TD So	can				
Scan 🕤 1Av Max 🎯 2Pk Max						
Limit Check F	PASS	D2[2]			-46.80 di	в
120 UBUW/M56-1-6CHZ-AV-WLAN-2-4CH F	ASS			-9	9.500000 MH	Iz
Line IT56-1-66HZ-PEAK-WLAN-2-4	PASS	M1[2]		10)5.98 dBµV∕n	n
110 dBuV/m		0.000 s		2.40	05500000 GH	iz
		6				
100 dBµV/m						-
90 dBµý/m						_
80 dBu0//m						
IT56-1-66H7-PEAK-WLAN-2-46H7_ECCLIN						
Instruction 2 PEAK-WEAK-2-TON2_POCIEIN						
70 dBµV/m						-
60 dBµV/m						_
IT56-1-6GHZ-AV-WLAN-2-4GHZ_FCC.LIN	A I	$\Lambda \mathcal{N} = 1$	\sim			
	man m	~ * /		m		\sim
50 dBpV/m						
		~~~		~ I		
40 dBpv/m						-
30 dBuV/m		F1				_
TF TF						
Start 2.343 GHz				St	op 2.443 GHz	: ]

Polarisation: V									
Detector Average				Detector Peak					
Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result	Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result
all emissions are 10dB below limit			pass	all emissions are 10dB below limit					

# TESTED

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## FCC 3 Band edge emission



according to

FCC §15.247, RSS-247, FCC §15.209 RSS-Gen

Ref.-No.: 18/11-0061

Operation mode: Zigbee CH.11; Low edge

Spectrum Receiver 💥 🕱						
RBW (EMI) 1 MHz MT	1 s	ΓI	56-1-7GHz	ohne Amp	TDF	
Input 1 AC Att 0 dB Preamp	OFF Step	TD Scan				
Scan 😑 1Av Max 🕒 2Pk Max						
Limit Check	PASS		M1[2]		10	02.64 dBµV/m
120 HBUW/M56-1-6CHZ-AV-WUAN-2-4CH	PASE		-0.000 s		2.4	05500000 GHz
Line IT56-1-6GHZ-PEAK-WLAN-2-4	PASS		D2[2]		_	-46.36 dB
110 dBµV/m			0.000 5	1		0.230000 MHZ
			M1			
100 dBuV/m			M			
90 aBµV/m						
80 dBµV/m						
IT56-1-6GHZ-PEAK-WLAN-2-4GHZ_FCC.LIN						
70 dBµV/m						
60 dBµV/m		D2	$H \rightarrow \mathbb{N}$			
IT56-1-6GHZ-AV-WLAN-2-4GHZ_FCC.LIN		A		the com	mana .	
50 dBµV/m		~~~	$ \downarrow                                   $			
			/ ``	L.		
40 dBuv/m				m		
20 dB 4/m		F	1			
Start 2.343 GHz Stop 2.443 GHz						

Polarisation:	Η
---------------	---

Detector Average					Detector Peak				
Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result	Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result
all emissions are 10dB below limit			pass	all emissions are 10dB below limit Pa					

	Test report no.:	Dage 25 of 51 pages	
E S I C IN GERMANY	18/11-0061b	Page 55 of 51 pages	

Higher Band Edge - 802.11n 40MHz / HT MixMode – MCS=0; 6.5 MBps / ZigBee CH 26 - radiated

TESTED IN GERMANY	FCC 3 Band edge emission according to	团STC
	FCC §15.247, RSS-247, FCC §15.209 RSS-Gen	

Ref.-No.: 18/11-0061

Operation mode: WLAN CH.09; BW = 40MHz; HT Mix Mode; 802.11n40; Power level 1E; Zigbee CH.26; High edge

Spectrum Receiver 🕱	
RBW (EMI) 1 MHz MT 1 s IT56-1-7GHz ohne AmpTDF	
Input 1 AC Att 0 dB Preamp OFF Step TD Scan	
Scan @1Av Max@2Pk Max2.48325 GHz	
IT56-LifGHCREAK-WLAN-2-4GHZ_FCC.LIN PASS M1[1] 53.74 d	Bµ <b>V</b> ∕m
120 HBps/m56-1-6CHZ-AV-WLAN-2-1CH PASE 0.000 s 2.4832500	00 GHz
Line IT56-1-66HZ-PEAK-WLAN-2-4 PASS	
110 dBuV/m	
100 BB VAL	
190 dBµV/m	
80 dBuV/m	
60 dBµV/m	
50 dBuV/m	~~~~
10 do utra	-++
411 dKj1V/m	
20 dBµV/m	
Start 2.433 GHz Stop 2.53	33 GHz

Polarisation: V									
Detector Average					Detector Peak				
Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result	Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result
2,4835	53,74	-0,26	54,00	pass	2,4865	60,81	-13,19	74,00	pass
2,4865	47,25	-6,75	54,00	pass	2,4905	58,00	-16,00	74,00	pass
2,4898	44,64	-9,36	54,00	pass	2,4930	56,56	-17,44	74,00	pass
2,4943	43,59	-10,41	54,00	pass	2,4990	54,94	-19,06	74,00	pass
2,4975	43,22	-10,78	54,00	pass	2,5043	54,16	-19,84	74,00	pass
2,5110	42,70	-11,30	54,00	pass					

TESTED

FCC 3



Band edge emission according to

FCC §15.247, RSS-247, FCC §15.209 RSS-Gen

Ref.-No.: 18/11-0061

Operation mode: WLAN CH.09; BW = 40MHz; HT Mix Mode; 802.11n40; Power level 1E; Zigbee CH.26; High edge

Spectrum Receiver 🗵						[	
RBW (EMI) 1 MHz MT	1 s	I.	T56-1-7GHz	ohne Amp	TDF		
Input 1 AC Att 0 dB Preamp	OFF Step	TD Scan					
Scan 🕤 1Av Max 🎯 2Pk Max							
IT56-LIGHTOREAK-WLAN-2-4GHZ_FCC.LIN	PASS		M1[1]		1	51.90 dBµV,	/m
120 UBUW/M56-1-6CHZ-AV-WLAN-2-1CH	PASS		-0.000 s		2.4	83500000 G	Hz
Line IT56-1-6GHZ-PEAK-WLAN-2-4	PASS						
110 dBµV/m							
		n					
100 dBµV/m	+ <i>(</i>						
month annu		Ŋ					
90 dBµV/m							
( minut )	1) 👔						
RD dBull/m							
/U dBµV/m							
	IL Y						
60 dBµV/m		I I~~₹	×				
	$  \mathcal{M}  $	N <u>l</u> 1	-XX-		× X		A - A
50 dBµV/m	×			-462			
			the second				
40 dBuV/m					*****	-+++	*
20 dB 4/m							
Start 2.433 GHz					St	op 2.533 Gl	Ηz

Polarisation: H									
Detector Average					Detector Peak				
Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result	Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result
2,4835	51,90	-2,10	54,00	pass	2,4885	60,38	-13,62	74,00	pass
2,4865	48,02	-5,98	54,00	pass	2,4903	57,78	-16,22	74,00	pass
2,4898	45,85	-8,15	54,00	pass	2,4945	56,41	-17,59	74,00	pass
2,4938	44,65	-9,35	54,00	pass	2,4965	55,71	-18,29	74,00	pass
2,4973	43,69	-10,31	54,00	pass	2,5193	54,16	-19,84	74,00	pass
2,5095	42,64	-11,36	54,00	pass	2,5108	54,07	-19,93	74,00	pass

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Lower Band Edge - 802.11n 40MHz / HT MixMode – MCS=0; 6.5 MBps / ZigBee CH 11 - radiated

TESTED	FCC 3	RSTC
	Band edge emission	
	according to	
	FCC §15.247, RSS-247, FCC §15.209 RSS-Gen	

Ref.-No.: 18/11-0061

Operation mode: WLAN CH.03; BW = 40MHz; HT Mix Mode; 802.11n40; Power level 1E; Zigbee CH.11; Low edge

Spectrum Receiver 💥 🖲								
RBW (EMI) 1 MHz MT	1 s	IT	56-1-7	GHz	ohne Amp	TDF	· · · · ·	_
Input 1 AC Att 0 dB Preamp	OFF Step	TD Scan						
Scan 🕒 1Av Max 🎯 2Pk Max								
Limit Check	PASS		D2[2]				-41.91 (	dB
120 UBUW/M56-1-6CHZ-AV-WLAN-2-1CH	PASS		-0.000	s		-	6.500000 MI	Hz
Line IT56-1-6GHZ-PEAK-WLAN-2-4	PASS		M1[2]			10	)7.31 dBµV∕	m
110 dBuV/m			0.000	s		2.40	05500000 GI	Hz
			- A					
			10					
100 dBµV/m				~~	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	June	man	_
						Ň		
90 dBµV/m					~~~~	<		_
			1	~ ]			~ ~~~~	$\setminus$
80 dBuV/m						V	\	$\setminus$
IT56-1-6GHZ-PEAK-WLAN-2-4GHZ_ECC.LIN			11					$\left  \right\rangle$
		1	$\Pi$					
70 dBµV/m		D2						$\square$
		~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~						$\setminus$
60 dBµV/m	tran	~~~						+
IT56-1-6GHZ-AV-WLAN-2-4GHZ_FCC.LIN			2					
50 dBuV/m	**	~~~						
	the contraction of the contracti							
40 dBµV/m								_
30 dBµV/m		FF	1		T			_
Start 2.343 GHz					<u> </u>	St	op 2.443 GH	z

	Polarisation: V										
Detector Average							Detector Peak				
Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result	Frequ. [GHz]	Result					
2,3895	50,70	-3,30	54,00	pass	all e	emissions are	10dB below	w limit	pass		
2,3858	50,54	-3,46	54,00	pass							
2,3808	47,92	-6,08	54,00	pass							
2,3783	46,75	-7,25	54,00	pass							
2,3760	45,77	-8,23	54,00	pass							
2,3718	44,44	-9,56	54,00	pass							

TESTED

FCC 3



Band edge emission according to

FCC §15.247, RSS-247, FCC §15.209 RSS-Gen

Ref.-No.: 18/11-0061

Operation mode: WLAN CH.03; BW = 40MHz; HT Mix Mode; 802.11n40; Power level 1E; Zigbee CH.11; Low edge

Spectrum Receiver 🔆 🗵							
RBW (EMI) 1 MHz MT	1 s	IT	56-1-7	'GHz	ohne Amp	TDF	· · · · ·
Input 1 AC Att 0 dB Preamp	OFF Step	TD Scan					
Scan 🔵 1 Av Max 🎯 2 Pk Max							
Limit Check	PASS		M1[2]]		10	04.69 dBµV/m
120 HBUW/M56-1-66HZ-AV-WLAN-2-16F	PASS		-0.000	l s 👘		2.4	05500000 GHz
Line IT56-1-66HZ-PEAK-WLAN-2-4	PASS		D2[2]	l s		-	-38.94 dB 6.500000 MHz
110 dBµV/m			M	1			
			R				
100 dBµV/m				\vdash	0.00	n nor	
				\sim	m	v .	m
90 dBµV/m				\vdash	~~~	- more	
				\sim	~~~~	$ \rangle$	
80 dBµV/m			-11			V V	
IT56-1-6GHZ-PEAK-WLAN-2-4GHZ_FCC.LIN							
70 dBµV/m			<u> </u>				
		~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~					
60 dBµV/m	[		)				
IT56-1-6GHZ-AV-WLAN-2-4GHZ_FCC.LIN		$\sim$	~				
50 dBµV/m		$\sim$					
- mat the the	~~						
40 dBµV/m							
30 dBµV/m		F	1				
L Start 2.343 GHz						St	op 2.443 GHz

	Polarisation: H									
Detector Average							Detector Peak			
Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result	Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result	
2,3895	51,13	-2,87	54,00	pass	alle	emissions are	10dB below	v limit	pass	
2,3858	50,67	-3,33	54,00	pass						
2,3828	47,23	-6,77	54,00	pass						
2,3783	45,93	-8,07	54,00	pass						
2,3758	45,29	-8,71	54,00	pass						
2,3718	44,38	-9,62	54,00	pass						

#### Results

From the measurement data obtained, the tested sample was considered to have **COMPLIED** with the requirements for the **Band Edges / Out of Band Emission**.



#### 7.5. 99% Power Bandwidth

#### **Aplied standards**

-RSS-Gen issue 5 Section 6.7

#### Test equipment and test set up

Test equipment used for conducted measurements as given in clause Test equipment of this report. Test setup used for conducted measurements as given in clause Test setups of this report.

#### Description

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. The 99% power bandwidth function of the instrument was used for the measurement.

#### Measurement

The Measurement was performed on: 11.02.2020

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### Lowest operating frequency

MultiView 😁	Spectrum								
Ref Level 20.00	dBm	140	BBW 30 kH	Z Mada Autol	CCT				2000
1 Occupied Band	width	140 µs (~7.9 ms)	VBVV 100 KF	12 Mode Auto	EFJ				●1Pk Max
r occupied build	a where the							M1[1]	2.01 dBm
								2.	40481270 GHz
200 200									io ioite, o one
10 dBm-						14			
				MI					
0 dBm				and the man	mmm				
0 ubm			m	soll or he dle	A no low M	-			
			1 m		11 IV	A			
-10 dBm-			24	1		MZ			
10 dbm			1						
			Nº 1			· hy			
-20 dBm-			/						
		man	1						
		m				1.1	m		
-30 dBm	9	m Y				V	12		
	لم کر						Vh		
							i V.		
-40 dBm	/V*				2	0	<u> </u>	- 24 - 158K	8
mm	n m							non	0
mun								V	manny
-50 dBm									
CF 2.405 GHz		11	1001 pts	6	75	0.0 kHz/			Span 7.5 MHz
2 Marker Table									
Type Ref	Trc	X-Value		Y-Value		Function	F	unction Re	esult
M1	1 2	2.4048127 GH	Iz	2.01 dBm	Occ Bw	15 70 <b>1</b> 0	2.2	2539374	43 MHz
	1	2.40377272 GH	HZ	-10.34 dBm	Occ Bw Cer	ntroid a Offect		2,40489	99693 GHz
12	1 T	2.40002000 GF	12	-10.00 UDM	OUL DW FIE	y onset		-100.3073	/ 41U4 K⊟Z
Channel	Frequ	ency [MHz]	99	% Power B	andwidth [N	/Hz]	Limit [MHz]	F	Result
11		2405		2.253	937443		-/-		Pass

### Middle Operating Frequency

MultiView 8	Spectrum	<u> </u>							
	) opeed an	·	- DDH - 2011	105					
Att 3	abm 30 db <b>SWT</b>	140 us (~7.9 ms)	• RBW 30 KF	iz <b>Mode</b> Auto I	FT				
1 Occupied Band	dwidth	140 µ3 (47.5 m3)	VB11 100 Ki	iz mode Add	1.1				1Pk Max
								M1[1]	2.04 dBm
								2	43980520 GHz
10 dBm								305	
TO OBIN-									
				M1					
0 dBm				Amman	man				
			n m		1 how	0			
			The	V V	v	T2			
-10 dBm		-	7		8	M			-
						V V			
			f"			μ vη			
-20 dBm-		-	1		8				
		mmy	/			1 m	my an		
		L Con W	(			L W	10		
-30 dBm-							Im		
	M	V					m m		
-40 dBm-	M							Ly	
10 10	n							man	
mannen	V							No V	Ma man an
-50 dBm-		-							AMMAN COMMA
CE 2.44 GHz			1001 pt	\$	75	50.0 kHz/	3		Span 7.5 MHz
2 Marker Table				-					opant the total and
Type   Ref	Trc	X-Value		Y-Value		Function		Function R	esult
M1	1	2.4398052 G	Hz	2.04 dBm	Occ Bw	67 70 KI		2.2525530	007 MHz
T1	1	2.43877251	3Hz	-10.46 dBm	Occ Bw Cer	ntroid		2.4398	98783 GHz
12	-1 	2.44102506 0	172 	-10,26 aBM	UCC BW Fre	eq Offset		-101.21/3	99735 KHZ
Channel	Frequ	ency [MHz]	99	% Power B	andwidth [I	MHz]	Limit [MH:	z]   I	Result
18		2440		2.252	553007		-/-		Pass

#### **Highest Operating Frequency**



#### Results

From the measurement data obtained, the tested sample was considered to have **COMPLIED** with the requirements for the **99% Power Bandwidth**.



## 8. Test equipment

### Test equipment used for Conducted Mains emissions:

Kind of equipment	Manufacturer	Туре	Ident no.	Serial no.	Calibrated on (y-m)	Calibration interval
Test-Receiver	Rohde &	ESHS30	10571	842053/008	2016 – Mar.	3 years
	Schwarz				2019 – Mar.	3 years
Software	PKM	PKM U5/6	-/-	V1.01.03	-/-	-/-
Line impedance	Rohde &	ESH2-Z5	10100	070075/000	2017 – Okt.	3 years
(LISN)	Schwarz		10139	879675/028	2019 – Jan.	3 years
Shielded room	Siemens	(6,2 x 4,7 x 3,3) m (I x w x h) DC – 10 GHz	10113	1	-/-	-/-

#### Test equipment used for radiated Measurements:

Kind of equipment	Manufacturer	Туре	Ident no.	Serial no.	Calibrated on (y-m)	Calibration interval
Signal Spectrum Analyzer 2Hz – 26.5 GHz	Rohde & Schwarz	FSW 26 Instrument FW 2.60	11571	102047	2019-Jan.	3 years
ESR7 EMI Testreceiver 7GHz	Rohde & Schwarz	ESR7	11676	101694	2018-March	3 years
Test-Receiver	Rohde & Schwarz	ESVS30	10572	833825/010	2017-Mar. 2020-April	3 years 3 years
Antenna 9 kHz – 30 MHz	EMCO	6502	10546	2018	2017-Nov.	3 years
Antenna 30 MHz – 1 GHz	Chase	CBL6111C	10022	1064	2017-Jan. 2019-Dec.	2 years 3 years
Antenna 1GHz – 18 GHz	Electro Metric	RGA50/60	10273	2753	2017-Nov.	3 years
Broadband- Hornantenne	Schwarzbeck	BBHA 9170	11580	BBHA91706	2017-Jan.	2 years
15 - 26,5 (40) GHz				21	2019-Dec.	3 years
Broadband- Preamplifier 1-18 GHz	Schwarzbeck	BBV9718	11231	9718-002	2017-Okt.	3 years
Preamplifier	CERNEX	CBM18403523	11679	29711	2017 - May	3 years
18 - 40 GHz					2019 - July	3 years
Cable	el-spec GmbH	FlexCore-SMA11- SMA11-8000-ARM	11625	-/-	2017-Dec.	3 years
Shielded	Frankonia	SAC3 "SEMI- ANECHOIC-	11609	004/16	2016-March	3 years
room/Chamber		CHAMBER"			2019-March	3 years
Band Reject Filter	Telemeter	BRF-2450-150- 7-N (0441)	11243	-/-	-/-	-/-

#### Test equipment used for Band Edge Measurements:

Kind of equipment	Manufacturer	Туре	ldent no.	Serial no.	Calibrated on (y-m)	Calibration interval
ESR7 EMI Testreceiver 7GHz	Rohde & Schwarz	ESR7	11676	101694	2018-March	3 years
Antenna 1GHz – 18 GHz	Electro Metric	RGA50/60	10273	2753	2017-Nov.	3 years
Cable	el-spec GmbH	FlexCore-SMA11- SMA11-8000-ARM	11625	-/-	2017-Dec.	3 years
Shielded room/Chamber	Frankonia	SAC3 "SEMI-	11600	004/16	2016-March	3 years
		CHAMBER"	11009	004/10	2019-March	3 years

#### Test equipment used for conducted measurements:

Kind of equipment	Manufacturer	Туре	Ident no.	Serial no.	Calibrated on (y-m)	Calibration interval
Signal Spectrum Analyzer 2Hz – 26.5 GHz	Rohde & Schwarz	FSW 26 Instrument FW 2.60	11571	102047	2019 - Jan.	3 years
EMI-Test-Receiver	Rohde & Schwarz	ESR7 Instrument FW 3.36	11505	101103	2017 - Nov.	3 years
Automatisation unit RF switch and power meter	Rohde & Schwarz	OSP120 and OSP B157	11573	101282	2017 - Dec.	3 years
Cable	el-spec GmbH	FlexCore-SMA11- SMA11-8000-ARM	11625	-/-	2017 - Dec.	3 years

All measurements were made with measuring instruments, including any accessories that may affect test results, calibrated according to the requests of ISO/IEC 17025 according to which the test site is accredited from DAkkS. Measurement of conducted mais emissions was made with instruments conforming to American National Standard Specification, ANSI C63.4-2014.

#### Test equipment to support EUT functions:

Kind of equipment	Manufacturer	Туре	Ident no.
Laptop	HP	EliteBook	11742
AC-Adaptor 120 V ~ / 24 V	-/-	AC1200200	-/-
Router	AVM	Fritz!Box 4020	Client
ZigBee Stick	-/-	ZM3588S-USB-LR	Client

## 9. Test Setups

Block diagram Conducted Mains emissions



Groundplane



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#### Block diagram Radiated emissions



Test receiver

Semi anechoic chamber with absorber and ferrite tiles

tested frequency range 9 kHz - 30 MHz

**Block diagram Radiated emissions** 



tested frequency range 30 MHz - 1000 MHz





tested frequency range > 1000 MHz

### **Block diagram Band Edge emissions**



Semi anechoic chamber with absorber and ferrite tiles

Spectrum analyzer



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## Block diagram for conducted measurements





#### **10. Measurement uncertainty**

according to CISPR 16-4-2 Edition 2.0 2011-06

Measurement	calculated uncertainty U _{lab}	Specified CISPR uncertainty according CISPR 16-4-2 Edition 2.0 2011-06, table 1 UCISPR
Conducted disturbance at mains		
port using AMN	3.6 dB	3.8 dB
9 kHz – 150 kHz		
Conducted disturbance at mains		
port using AMN	3.2 dB	3.4 dB
150 kHz – 30 MHz		
Magn. fieldstrength	3 4 dB	_/_
9kHz - 30MHz	5.4 dB	-/-
Radiated disturbance (electric field		
strength in the SAC)	4.7 dB	6.3 dB
30 MHz to 1 000 MHz		
Radiated disturbance (electric field		
strength in the SAC)	4.1 dB	-/-
1 GHz to 26.5 GHz		

Measurement	calculated uncertainty U _{lab}	Maximum measurement uncertainty	
Channel Bandwidth	1.17 %	±5 %	
RF output power, conducted	±1.36 dB	±1.5 dB	
Power Spectral Density, conducted	±1.99 dB	±3 dB	
Unwanted Emissions, conducted	±1.71 dB	±3 dB	
All emissions, radiated	±4.8 dB	±6 dB	
Temperature	±0.72 °C	±3 °C	
Curran have been a	±0.76 % (DC up to 40V)		
Supply voltages	±1.74 % (AC 50Hz up to 400V)	±3 %	
Time	±0.012 %	±5 %	

The measurement uncertainty describes the overall uncertainty of the given measured value during the operation of the EUT in the above mentioned way.

The measurements uncertainty was calculated in accordance with CISPR 16-4-2 Edition 2.0 2011-06.

The measurement uncertainty was given with a confidence of 95 % (k = 2).

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## 11. Photos setup

Refer to "0061-fcc-ised-photos test setup.pdf" file

## 12. Conclusions

From the measurement data obtained, the tested sample was considered to have **COMPLIED** with the requirements for the relevant §15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

From the measurement data obtained, the tested sample was considered to have **COMPLIED** with the requirements for the relevant RSS-247 issue 02 Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices.

Following specific modifications and/or special attributes are necessary to pass the above mentioned requirements:

none

25.06.2020 Erstellt am/prepared on M. Beindl, Laboratory Engineer (Name/name / Stellung/position)

Being yahrel

(Unterschrift/signature)

25.06.2020 Freigabe am/released on A. Tropmann, Head of Laboratory (Name/name / Stellung/position)

(Unterschrift/signature)



13. Photos of tested sample



End of test report