



RED (2014/53/EU)
ETSI EN 300 328 v2.2.2: 2019
TEST REPORT

FOR

Applicant: Texas Instruments Incorporated
12500 TI BLVD., Dallas Texas, 75243, USA

Product Name: BLE and 802.15.4 module

Brand Name: Texas Instruments Incorporated

Model No.: CC2650MODA

Model Difference: N/A

Report Number: E2/2016/40062-02

Issue Date: February 25, 2021

Date of Test: November 11, 2020 ~ November 30, 2020

Date of EUT Received: November 11, 2020

We hereby certify that:

The above equipment was tested by SGS Taiwan Ltd., Central RF Lab for compliance with the requirements set forth in the European Standard ETSI EN 300 328 v2.2.2: 2019 under RED 2014/53/EU. The results of testing in this report apply to the product system that was tested only. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Approved By:

Jay Lin / Asst. Supervisor



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Revision History

Report Number	Revision	Description	Issue Date	Remark
E2/2016/40062	Rev.00	Original.	June 17, 2016	Revised By: Violetta Tang
E2/2016/40062-01	Rev.01	Upgrade to EN 300 328 V2.1.1	May 24, 2017	Revised By: Stefanie Yu
E2/2016/40062-02	Rev.02	1. Upgrade to EN 300 328 V2.2.2 2. Change applicant information	February 25, 2021	Revised By: Violetta Tang

Note:

- 1、Test data is referenced from original report
Measurement results in the original test report **E2/2016/40062-01** are fully leveraged in this test report with new evaluation on Receiver Blocking and updated limit for spurious emission to demonstrate compliance.
- 2、Disclaimer
Antenna information is provided by the applicant, the test results of this report are applicable to the sample EUT received.
- 3、The test data in this test report is fully leveraged from the original test report E2/2016/40062-01 with TAF code 0513. Since the laboratory's TAF code has been updated to 3702, this test report is being issued by the laboratory of TAF code 3702.

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1 DESCRIPTION OF EQUIPMENT UNDER TEST (EUT)

1.1 Product Description:

Product Name:	BLE and 802.15.4 module
Brand Name:	Texas Instruments Incorporated
Model No.:	CC2650MODA
Model difference:	N/A
Hardware Version:	Rev 1.0
Software Version:	N/A
Power Supply:	3.3Vdc from Power supply

1.2 Zigbee:

Frequency Range:	2405 – 2480MHz
Channel Number:	16 channels
Channel Space:	5MHz
Modulation Type:	O-QPSK
Transmit Power(EIRP):	5.056dBm EIRP
Antenna Designation:	Chip Antenna, Gain: 1.256dBi

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2 DESCRIPTION OF TEST MODES

The EUT has been tested under Operating and standby condition. And used to control the EUT for staying in engineering mode that enables selectable of channel, and capable of continuous transmitting and constant receiving mode.

Remark: All applicable test items were tested based on the combination of modulation scheme that generates the worst case.

Operated in 2405 ~ 2483.5MHz Band

16 channels are provided for Zigbee

CHANNEL	FREQUENCY	CHANNEL	FREQUENCY	CHANNEL	FREQUENCY	CHANNEL	FREQUENCY
1	2405 MHz	5	2425 MHz	9	2445 MHz	13	2465 MHz
2	2410 MHz	6	2430 MHz	10	2450 MHz	14	2470 MHz
3	2415 MHz	7	2435 MHz	11	2455 MHz	15	2475 MHz
4	2420 MHz	8	2440 MHz	12	2460 MHz	16	2480 MHz

RF Output Power, Power Density

MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION
Zigbee	1 to 16	1,8,16	O-QPSK

**Occupied Bandwidth,
Transmitter unwanted emissions in the out-of-band domain,
Transmitter unwanted emissions in the spurious domain,
Receiving Spurious Emission:**

MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION
Zigbee	1 to 16	1,16	O-QPSK

Note:

The field strength of radiation emission was measured as EUT stand-up position (H mode) and lie down position (E1, E2 mode). Transmitter for channel Low, Mid and High, the worst case H position for Build-in antenna and E2 position for External antenna was reported.

*** The selection of modulation scheme is based on output power that reveals the highest value**

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3 TEST CONDITIONS:

Normal Temperature	15 °C to 35 °C
Normal Voltage	3.3 V
Extreme Temperature	-40 °C to 85 °C

Note: The extremes of the operating temperature range as declared by the manufacturer

4 GENERAL DESCRIPTION OF APPLIED STANDARDS

The EUT According to the Specifications, it must comply with the requirements of the following standards:

ETSI EN 300 328 v2.2.2:2019 – Wideband transmission systems; Data transmission equipment operating in the 2,4 GHz band; Harmonised Standard for access to radio spectrum.

5 TEST FACILITY

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Central RF Lab.

No.2, Keji 1st Rd., Guishan District, Taoyuan City, Taiwan 333

A 11m*6m*6m fully anechoic chamber was used for the radiated spurious emissions test.

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6 SUMMARY OF TEST RESULTS

Reference Clause No	Description	Condition	Result
4.3.2.2	RF Output Power	unconditionally applicable	Compliant
4.3.2.3	Power Spectral Density	unconditionally applicable	Compliant
4.3.2.4	Duty cycle, Tx-Sequence, Tx-gap	Only for non-Adaptive equipment. This item does not apply for equipment with RF Output power level of less than 10 dBm e.i.r.p.	Non applicable
4.3.2.5	Medium Utilization	Only for non-Adaptive equipment. This item does not apply for equipment with RF Output power level of less than 10 dBm e.i.r.p.	Non applicable
4.3.2.6	Adaptivity	Only for Adaptive equipment. This item does not apply for equipment with RF Output power level of less than 10 dBm e.i.r.p.	Non applicable
4.3.2.7	Occupied Channel Bandwidth	unconditionally applicable	Compliant
4.3.2.8	Transmitter unwanted emissions in the OOB domain	unconditionally applicable	Compliant
4.3.2.9	Transmitter unwanted emissions in the spurious domain	unconditionally applicable	Compliant
4.3.2.10	Receiver spurious emissions	unconditionally applicable	Compliant
4.3.2.11	Receiver Blocking	unconditionally applicable	Compliant
4.3.2.12	Geo-location capability	Only for equipment with geo-location capability	Non applicable

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7 SUPPORT EQUIPMENT

Fig. 7-1 Conducted Emission Configuration

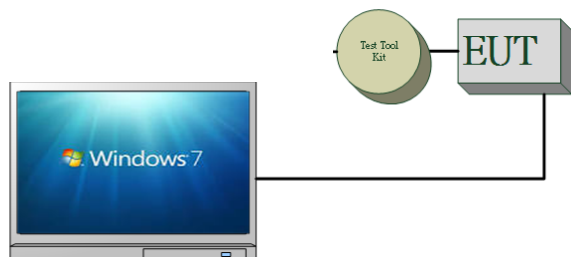


Fig 7-2 Radiated Emission Configuration

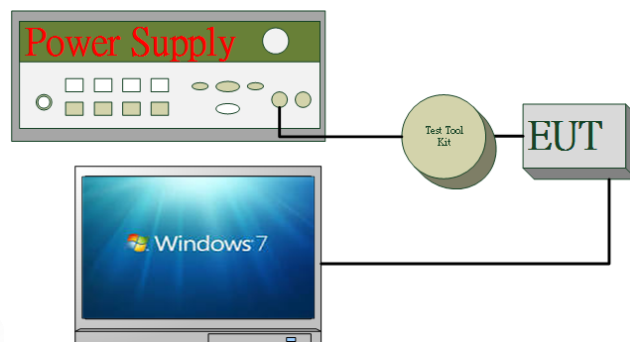


Table 7-1 Equipment Used in Tested System

Item	Equipment	Mfr/Brand	Model/ Type No.	Series No.	Data Cable	Power Cord
1	Zigbee Test Software	N/A	N/A	N/A	N/A	N/A
2	DC Power Supply	Agilent	E3640A	MY53130054	N/A	Un-Shielded
3	Notebook	Lenovo	L440	R9-007LAZ	Shielded	Un-Shielded
4	Notebook	Lenovo	L430	P0000195	Shielded	Un-Shielded
5	Test Tool Kit	N/A	N/A	N/A	N/A	N/A

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8 MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been calculated in accordance with TR 100 028-1

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of $k=2$.

The conformity assessment statement in this report is based solely on the test results, measurement uncertainty is excluded.

This lab's measurement uncertainty ULab, is low than Table 7: Maximum measurement uncertainty of ETSI EN 300 328, therefore compliance is deemed to occur if no measured disturbance exceeds the disturbance limit.

Parameter	Uncertainty Criterion	Measurement Uncertainty
Occupied Channel Bandwidth	$\pm 5\%$	$\pm 0.4\%$
RF Output Power, conducted	± 1.5 dB	± 1.13 dB
Power Spectral Density, conducted	± 3 dB	± 2.35 dB
Unwanted Emission, conducted	± 3 dB	± 2.39 dB
All emissions, radiated	± 6 dB	± 5.04 dB
Temperature	$\pm 1^{\circ}\text{C}$	$\pm 0.8^{\circ}\text{C}$
Supply voltages	$\pm 3\%$	$\pm 1.0\%$
Time	$\pm 5\%$	$\pm 0.585\%$

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9 MEASUREMENT EQUIPMENT USED

9.1 Conducted Emission

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	R&S	FSV 40	101059	12/15/2015	12/14/2016
Power Meter	R&S	OSP 120	26591986	07/01/2015	07/02/2016
Coaxial Cables	R&S	RF21	W1	12/12/2015	12/11/2016
Attenuator	Marvelous	MVE2213-10	RF30	12/12/2015	12/11/2016
Coaxial Cables	R&S	RF22	W2	12/12/2015	12/11/2016
Attenuator	Marvelous	MVE2213-10	RF76	12/12/2015	12/11/2016
Splitter	WOKEN	DOM35LW1A2	RF36	12/12/2015	12/11/2016
Coupler	MIDISCO52335	MDC2044-20	RF42	12/12/2015	12/11/2016
DC Power Supply	Agilent	E3640A	MY53140006	05/04/2016	05/03/2017
Temperature Chamber	TERCHY	MHK-120LK	1020582	06/17/2015	06/16/2016
Test Software	R&S	EMC32	Ver. 9.12.00	N.C.R.	N.C.R.

NOTE: N.C.R refers to Not Calibrated Required.

9.2 Receiver Blocking

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Signal Generator	R&S	SMU200A	105303	01/06/2020	01/05/2021
Attenuator	Woken	WRF53AYM2B7	RF08	11/19/2020	11/18/2021
Splitter	Marvelous Microwave	MVE8586	RF260	11/19/2020	11/18/2021
Coaxial Cables	Woken	00100A1F1A185C	RF80	11/19/2020	11/18/2021
Coaxial Cables	Woken	00100A1F1A185C	RF81	11/19/2020	11/18/2021
Coaxial Cables	Woken	00100A1F1A185C	RF82	11/19/2020	11/18/2021
Coaxial Cables	Woken	00100A1F2A196C	RF95	11/19/2020	11/18/2021

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9.3 Radiated Emission

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	R&S	FSV 40	101059	12/09/2015	12/08/2016
Broadband Antenna	TESEQ	CBL 6112D	35243	11/06/2015	11/05/2016
Broadband Antenna	TESEQ	CBL 6112D	35240	10/28/2015	10/27/2016
Horn Antenna	ETS-Lindgren	3117	143279	11/05/2015	11/04/2016
Horn Antenna	ETS-Lindgren	3117	143272	12/16/2015	12/15/2016
Horn Antenna	Schwarzbeck	BBHA9170	184	12/11/2015	12/10/2016
Horn Antenna	Schwarzbeck	BBHA9170	185	07/24/2015	07/23/2016
Pre Amplifier	EMC Instruments	EMC330	980163	12/12/2015	12/11/2016
Pre Amplifier	R&S	SCU-18	10195	12/12/2015	12/11/2016
Pre Amplifier	EMC Instruments	EMC184045B	980135	12/12/2015	12/11/2016
Signal Generator	R&S	SMB100A	175936	12/08/2015	12/07/2016
Signal Generator	R&S	SMU200A	105303	12/10/2015	12/09/2016
Coaxial Cable	Huber+Suhner	RG 214/U+SUCCOFLEX 104	1166Rx 9K-1G	12/12/2015	12/11/2016
Coaxial Cable	Huber+Suhner	SUCCOFLEX 104	1166Rx 1G-18G	12/12/2015	12/11/2016
Coaxial Cable	Huber+Suhner	mini 141-12+SUCCOFLEX 104	1166Rx 18G-40G	12/12/2015	12/11/2016
Coaxial Cable	Huber+Suhner	SUCCOFLEX 104	1166Tx 30M-18G	12/12/2015	12/11/2016
Coaxial Cable	Huber+Suhner	MWX241-KMSKMS/B	1166Tx 18G-40G	12/12/2015	12/11/2016
Attenuator	WOKEN	218FS-10	RF33	12/12/2015	12/11/2016
Controller	MF	MF-7802	N/A	N.C.R.	N.C.R.
Antenna Master	MF	N/A	N/A	N.C.R.	N.C.R.

NOTE: N.C.R refers to Not Calibrated Required.

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10 ETSI EN 300 328 SUB-CLAUSE 4.3.2.2 RF OUTPUT POWER

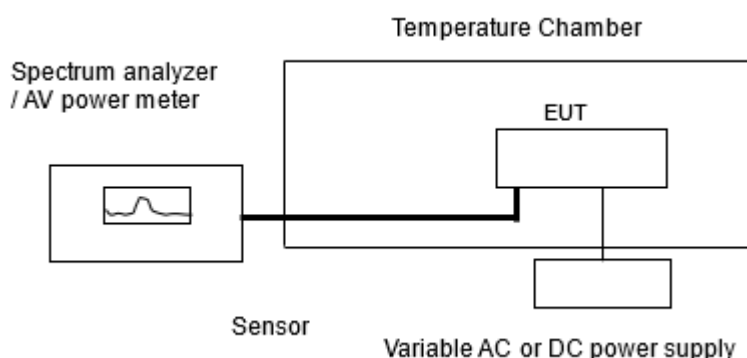
10.1 Limit:

The RF output power for non-FHSS equipment shall be equal to or less than 20 dBm.

10.2 Measurement Equipment Used:

Refer to section 9.1 in this report.

10.3 Test Setup:



10.4 Test Procedure:

See Sub-Clause 5.4.2.1 of ETSI EN 300 328 for the test conditions

See Sub-Clause 5.4.2.2.1 of ETSI EN 300 328 for conducted measurement method.

Note:

1. **E.I.R.P.** shall be calculated from the above measured power output A, and the applicable antenna assembly gain "G" in dBi.
2. **Pburst** is the Pburst Value at antenna port.

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10.5 Test Result

Test Mode: 2.4GHz ZigBee

Antenna assembly gain:

1.256 dBi

EIRP = Pburst (Burst Power) + Gain

TEST CONDITIONS		TRANSMITTER POWER (dBm)			
		Lowest Frequency		Middle Frequency	
		(CH Low)		(CH Mid)	
Temp (-40)°C	Vnom 3.3 V	EIRP = 4.456 dBm	Pburst= 3.20 dBm	EIRP = 4.256 dBm	Pburst= 3.00 dBm
Temp (25)°C	Vnom 3.3 V	EIRP = 5.056 dBm	Pburst= 3.80 dBm	EIRP = 4.956 dBm	Pburst= 3.70 dBm
Temp (85)°C	Vnom 3.3 V	EIRP = 4.756 dBm	Pburst= 3.50 dBm	EIRP = 4.556 dBm	Pburst= 3.30 dBm
Limit		20dBm			

***offset: 10.57dB being set in compensation for the cable loss**

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11 ETSI EN 300 328 SUB-CLAUSE 4.3.2.3 POWER SPECTRAL DENSITY

11.1 Limit:

The maximum Power Spectral Density for non-FHSS equipment is 10 dBm per MHz.

11.2 Measurement Equipment Used:

Refer to section 9.1 in this report.

11.3 Test Setup:

Refer to section 10.3 in this report.

11.4 Test Procedure:

See Sub-Clause 5.4.3.1 of ETSI EN 300 328 for the test conditions

See Sub-Clause 5.4.3.2.1 of ETSI EN 300 328 for conducted measurement method.

11.5 Test Result:

Test Mode: 2.4GHz ZigBee

TEST CONDITIONS				Power Density			
					CH Low	CH Mid	CH High
Temp(25)°C	Vnom	3.3	V	Measured power density Reading(A) / dBm	3.73	4.24	3.98

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12 ETSI EN 300 328 SUB-CLAUSE 4.3.2.4 DUTY CYCLE, TX-SEQUENCE, TX-GAP

12.1 Limit:

The Duty Cycle shall be equal to or less than the maximum value declared by the manufacturer.

The Tx-sequence time shall be equal to or less than 10 ms. The minimum Tx-gap time following a Tx-sequence shall be equal to the duration of that proceeding Tx-sequence with a minimum of 3,5 ms.

12.2 Measurement Equipment Used:

Refer to section 9.1 in this report.

12.3 Test Setup:

Refer to section 10.3 in this report.

12.4 Test Procedure:

See Sub-Clause 5.4.2.1 of ETSI EN 300 328 for the test conditions

See Sub-Clause 5.4.2.2.1.3 of ETSI EN 300 328 for conducted measurement method.

12.5 Test Result:

N/A, The RF output power of this equipment is less than 10 dBm e.i.r.p.

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13 ETSI EN 300 328 SUB-CLAUSE 4.3.2.5 MEDIUM UTILISATION

13.1 Limit:

The maximum Medium Utilization factor for non-adaptive non-Frequency Hopping equipment shall be 10%.

13.2 Measurement Equipment Used:

Refer to section 9.1 in this report.

13.3 Test Setup:

Refer to section 10.3 in this report.

13.4 Test Procedure:

See Sub-Clause 5.4.2.1 of ETSI EN 300 328 for the test conditions

See Sub-Clause 5.4.2.2.1.3 of ETSI EN 300 328

13.5 Test Result:

N/A, The RF output power of this equipment is less than 10 dBm e.i.r.p.

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14 ETSI EN 300 328 SUB-CLAUSE 4.3.2.6 ADAPTIVITY (ADAPTIVE EQUIPMENT USING MODULATIONS OTHER THAN FHSS)

14.1 Requirement & Limits:

Frame Based Equipment shall comply with the following requirements:

- 1) Before transmission, the equipment shall perform a Clear Channel Assessment (CCA) check using energy detect. The equipment shall observe the operating channel for the duration of the CCA observation time which shall be not less than 18 μ s. The channel shall be considered occupied if the energy level in the channel exceeds the threshold given in step 5 below. If the equipment finds the channel to be clear, it may transmit immediately. See figure 2.
- 2) If the equipment finds the channel occupied, it shall not transmit on this channel during the next Frame Period.
The equipment is allowed to switch to a non-adaptive mode and to continue transmissions on this channel providing it complies with the requirements applicable to non-adaptive equipment. See clause 4.3.2.6.1.
Alternatively, the equipment is also allowed to continue Short Control Signalling Transmissions on this channel providing it complies with the requirements given in clause 4.3.2.6.4.
- 3) The total time during which an equipment has transmissions on a given channel without re-evaluating the availability of that channel, is defined as the Channel Occupancy Time. The Channel Occupancy Time shall be in the range 1 ms to 10 ms followed by an Idle Period of at least 5 % of the Channel Occupancy Time used in the equipment for the current Frame Period. See figure 2.
- 4) An equipment, upon correct reception of a transmission which was intended for this equipment can skip CCA and immediately (see also next paragraph) proceed with the transmission of management and control frames.
A consecutive sequence of such transmissions by the equipment without a new CCA shall not exceed the maximum Channel Occupancy Time.
For the purpose of multi-cast, the ACK transmissions (associated with the same data packet) of the individual devices are allowed to take place in a sequence.
- 5) The energy detection threshold for the CCA shall be proportional to the transmit power of the transmitter: for a 20 dBm e.i.r.p. transmitter the CCA threshold level (TL) shall be equal to or less than -70 dBm/MHz at the input to the receiver assuming a 0 dBi (receive) antenna assembly. This threshold level (TL) may be corrected for the (receive) antenna assembly gain (G); however, beamforming gain (Y) shall not be taken into account. For power levels less than 20 dBm e.i.r.p. the CCA threshold level may be relaxed to:
$$TL = -70 \text{ dBm/MHz} + 10 \times \log_{10} (100 \text{ mW} / P_{\text{out}}) \text{ (} P_{\text{out}} \text{ in mW e.i.r.p.)}$$
- 6) The equipment shall comply with the requirements defined in step 1 to step 4 in the present clause in the presence of an unwanted CW signal as defined in table 10.

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Table 10: Unwanted Signal parameters

Wanted signal mean power from companion device	Unwanted signal frequency (MHz)	Unwanted signal power (dBm)
sufficient to maintain the link (see note 2)	2 395 or 2 488,5 (see note 1)	-35 (see note 3)
<p>NOTE 1: The highest frequency shall be used for testing operating channels within the range 2 400 MHz to 2 442 MHz, while the lowest frequency shall be used for testing operating channels within the range 2 442 MHz to 2 483,5 MHz. See clause 5.4.6.1.</p> <p>NOTE 2: A typical conducted value which can be used in most cases is -50 dBm/MHz.</p> <p>NOTE 3: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the (in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density in front of the UUT antenna.</p>		

An example of the timing for Frame Based Equipment is provided in figure 2.

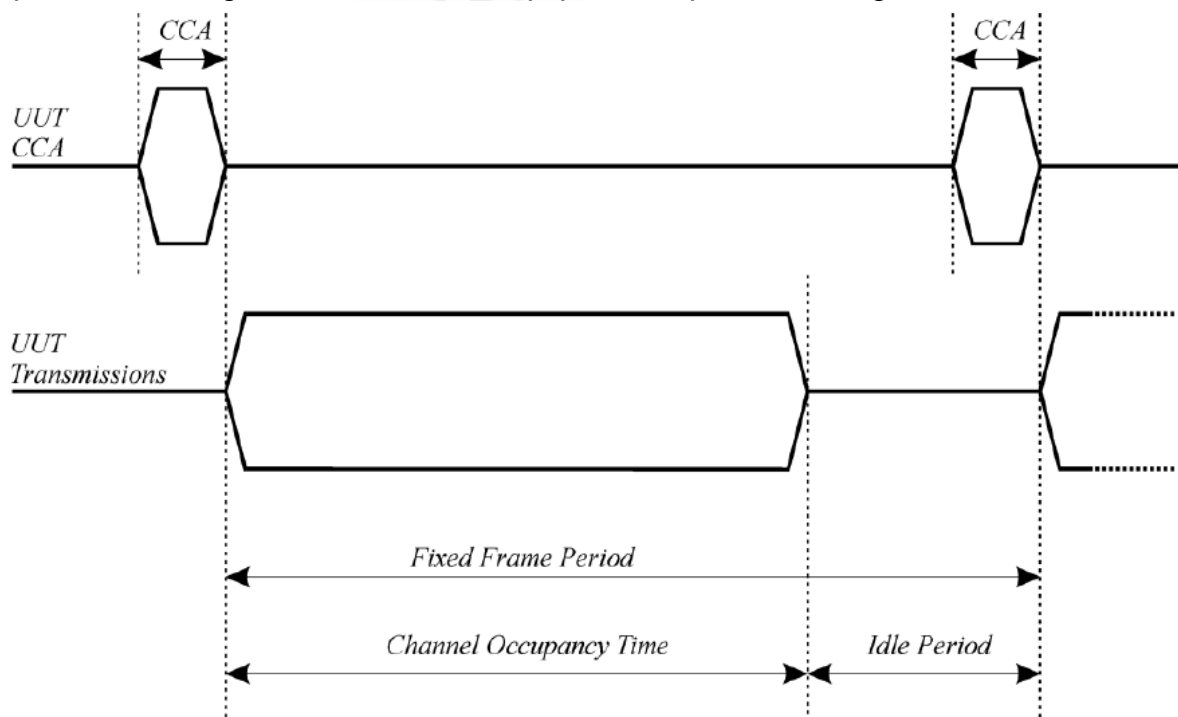


Figure 2: Example of timing for Frame Based Equipment

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Load Based Equipment may implement an LBT based spectrum sharing mechanism based on the Clear Channel.

Assessment (CCA) mode using energy detect as described in IEEE 802.11™ [i.3], clause 10 clause 11, clause 15, clause 16, clause 18 and clause 19, or in IEEE 802.15.4™ [i.4], clause 5, clause 6 and clause 10 providing the equipment complies with the conformance requirements referred to in clause 4.3.2.6.3.4. Load Based Equipment not using any of the mechanisms referenced above shall comply with the following minimum set of requirements:

- 1) Before a transmission or a burst of transmissions, the equipment shall perform a Clear Channel Assessment (CCA) check using energy detect. The equipment shall observe the operating channel for the duration of the CCA observation time which shall be not less than 18 µs. The channel shall be considered occupied if the energy level in the channel exceeds the threshold given in step 5 below. If the equipment finds the channel to be clear, it may transmit immediately.
- 2) If the equipment finds the channel occupied, it shall not transmit on this channel (see also the next paragraph). The equipment shall perform an Extended CCA check in which the channel is observed for a random duration in the range between 18 µs and at least 160 µs. If the extended CCA check has determined the channel to be no longer occupied, the equipment may resume transmissions on this channel. If the Extended CCA time has determined the channel still to be occupied, it shall perform new Extended CCA checks until the channel is no longer occupied.

NOTE: The Idle Period in between transmissions is considered to be the CCA or the Extended CCA check as there are no transmissions during this period.

The equipment is allowed to switch to a non-adaptive mode and to continue transmissions on this channel providing it complies with the requirements applicable to non-adaptive equipment.

Alternatively, the equipment is also allowed to continue Short Control Signalling Transmissions on this channel providing it complies with the requirements given in clause 4.3.2.6.4.

- 3) The total time that an equipment makes use of a RF channel is defined as the Channel Occupancy Time. This Channel Occupancy Time shall be less than 13 ms, after which the device shall perform a new CCA as described in step 1 above.
- 4) The equipment, upon correct reception of a transmission which was intended for this equipment can skip CCA and immediately (see also next paragraph) proceed with the transmission of management and control frames. A consecutive sequence of transmissions by the equipment without a new CCA shall not exceed the maximum channel occupancy time as defined in step 3 above. For the purpose of multi-cast, the ACK transmissions (associated with the same data packet) of the individual devices are allowed to take place in a sequence.
- 5) The energy detection threshold for the CCA shall be proportional to the transmit power of the transmitter: for a 20 dBm e.i.r.p. transmitter the CCA threshold level (TL) shall be equal to or less than -70 dBm/MHz at the input to the receiver assuming a 0 dBi (receive) antenna assembly. This threshold level (TL) may be corrected for the (receive) antenna assembly gain (G); however, beamforming gain (Y) shall not be taken into account. For power levels less than 20 dBm e.i.r.p., the CCA threshold level may be relaxed to:

$$TL = -70 \text{ dBm/MHz} + 10 \times \log_{10} (100 \text{ mW} / P_{\text{out}}) \quad (P_{\text{out}} \text{ in mW e.i.r.p.})$$

- 6) The equipment shall comply with the requirements defined in step 1 to step 4 of the present clause in the presence of an unwanted CW signal as defined in table 11.

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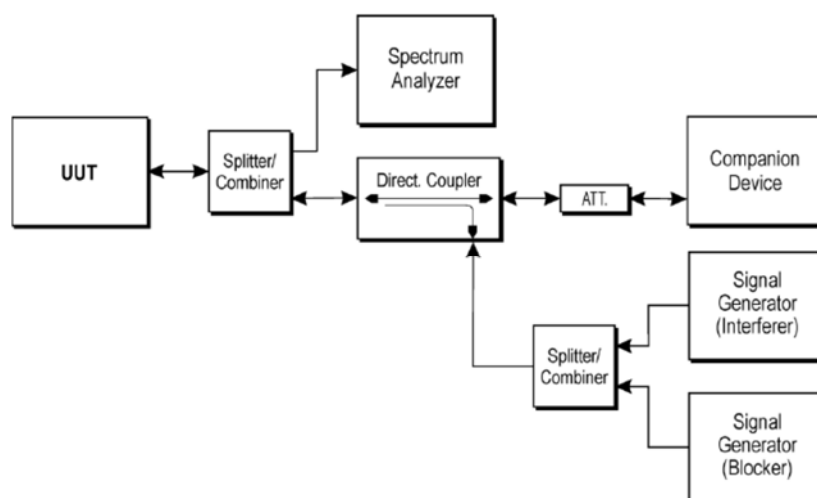
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Table 11: Unwanted Signal parameters

Wanted signal mean power from companion device	Unwanted signal frequency (MHz)	Unwanted signal power (dBm)
sufficient to maintain the link (see note 2)	2 395 or 2 488,5 (see note 1)	-35 (see note 3)
<p>NOTE 1: The highest frequency shall be used for testing operating channels within the range 2 400 MHz to 2 442 MHz, while the lowest frequency shall be used for testing operating channels within the range 2 442 MHz to 2 483,5 MHz. See clause 5.4.6.1.</p> <p>NOTE 2: A typical conducted value which can be used in most cases is -50 dBm/MHz.</p> <p>NOTE 3: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the (in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density (PFD) in front of the UUT antenna.</p>		

14.2 Measurement Equipment Used:

N/A

14.3 Test Setup:**14.4 Test Procedure:**

See Sub-Clause 5.4.6.1 of ETSI EN 300 328 for the test conditions

See Sub-Clause 5.4.6.2.1 of ETSI EN 300 328 conducted measurement method.

For Zigbee:

Calibration is adjusted properly, and correspondingly from SG2 so as for the power of level from the blocking signal at UE's end = -30Bm

Interference signal is digital modulated with 100% duty cycle, and BW = 1MHz for Zigbee.

14.5 Result:

N/A for Zigbee, The RF output power of this equipment is less than 10 dBm e.i.r.p..

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15 ETSI EN 300 328 SUB-CLAUSE 4.3.2.7 OCCUPIED CHANNEL BANDWIDTH**15.1 Limits:**

The Occupied Channel Bandwidth shall fall completely within the band given in 2400MHz ~ 2483.5 MHz.

In addition, for non-adaptive equipment using wide band modulations other than FHSS and with e.i.r.p. greater than 10 dBm, the occupied channel bandwidth shall be less than 20 MHz.

15.2 Measurement Equipment Used:

Refer to section 9.1 in this report.

15.3 Test Setup:

Refer to section 10.3 in this report.

15.4 Test Procedure:

See Sub-Clause 5.4.7.1 of ETSI EN 300 328 for the test conditions

See Sub-Clause 5.4.7.2 of ETSI EN 300 328 conducted measurement method.

15.5 Result:

Test Mode: 2.4GHz ZigBee

TEST CONDITIONS				99%Bandwidth		
					CH Low	CH High
Temp(25)°C	V nom	3.3	V	Measured 99%Bandwidth MHz	2.5512	2.5459

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16 ETSI EN 300 328 SUB-CLAUSE 4.3.2.8 TRANSMITTER UNWANTED EMISSIONS IN THE OOB DOMAIN

16.1 Limits:

The transmitter unwanted emissions in the out-of-band domain shall not exceed the values provided by the mask in figure 3.

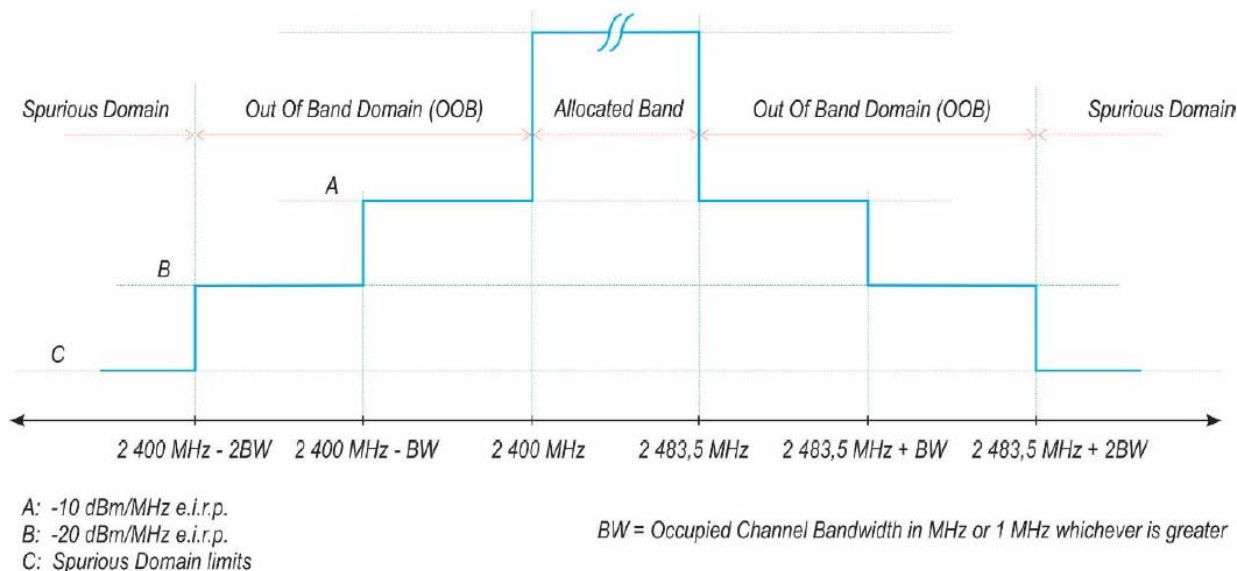


Figure 3: Transmit mask

16.2 Measurement Equipment Used:

Refer to section 9.1 in this report.

16.3 Test Setup:

Refer to section 10.3 in this report.

16.4 Test Procedure:

See Sub-Clause 5.4.9.1 of ETSI EN 300 328 for the test conditions

See Sub-Clause 5.4.9.2.1 of ETSI EN 300 328 conducted measurement method.

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16.5 Result:

Test Mode: 2.4GHz ZigBee

Transmitter unwanted emissions in the out-of-band domain result						
Test Condition		Frequency	-40°C	25°C	85°C	Limit
			Measure Power Result	Measure Power Result	Measure Power Result	
Channel/Freq.	Voltage	MHz	dBm / MHz (e.i.r.p)	dBm / MHz (e.i.r.p)	dBm / MHz (e.i.r.p)	dBm / MHz (e.i.r.p)
CH 11 /2405 MHz	3.3	2395.3976	-58.90	-58.80	-59.00	-20
		2395.9488	-59.10	-58.80	-58.90	-20
		2396.9488	-54.00	-57.50	-52.20	-20
		2397.9488	-57.00	-52.20	-51.30	-10
		2398.5000	-48.40	-50.90	-51.10	-10
		2399.5000	-48.80	-48.40	-48.50	-10
CH 26 /2480 MHz	3.3	2484.0000	-44.30	-44.00	-44.20	-10
		2485.0000	-49.20	-48.50	-48.70	-10
		2485.5459	-50.20	-49.30	-49.70	-10
		2486.5459	-50.60	-51.70	-52.20	-20
		2487.5459	-57.70	-50.60	-57.40	-20
		2488.0919	-58.40	-57.70	-58.00	-20

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17 ETSI EN 300 328 SUB-CLAUSE 4.3.2.9 TRANSMITTER UNWANTED EMISSIONS IN THE SPURIOUS DOMAIN

17.1 Limit:

The transmitter unwanted emissions in the spurious domain shall not exceed the values given in table 12.

In case of equipment with antenna connectors, these limits apply to emissions at the antenna port (conducted). For emissions radiated by the cabinet or emissions radiated by integral antenna equipment (without antenna connectors), these limits are e.r.p. for emissions up to 1 GHz and as e.i.r.p. for emissions above 1 GHz.

Table 12: Transmitter limits for spurious emissions

Frequency range	Maximum power	Bandwidth
30 MHz to 47 MHz	-36 dBm	100 kHz
47 MHz to 74 MHz	-54 dBm	100 kHz
74 MHz to 87,5 MHz	-36 dBm	100 kHz
87,5 MHz to 118 MHz	-54 dBm	100 kHz
118 MHz to 174 MHz	-36 dBm	100 kHz
174 MHz to 230 MHz	-54 dBm	100 kHz
230 MHz to 470 MHz	-36 dBm	100 kHz
470 MHz to 694 MHz	-54 dBm	100 kHz
694 MHz to 1 GHz	-36 dBm	100 kHz
1 GHz to 12,75 GHz	-30 dBm	1 MHz

17.2 Measurement Equipment Used:

Refer to section 9.3 in this report.

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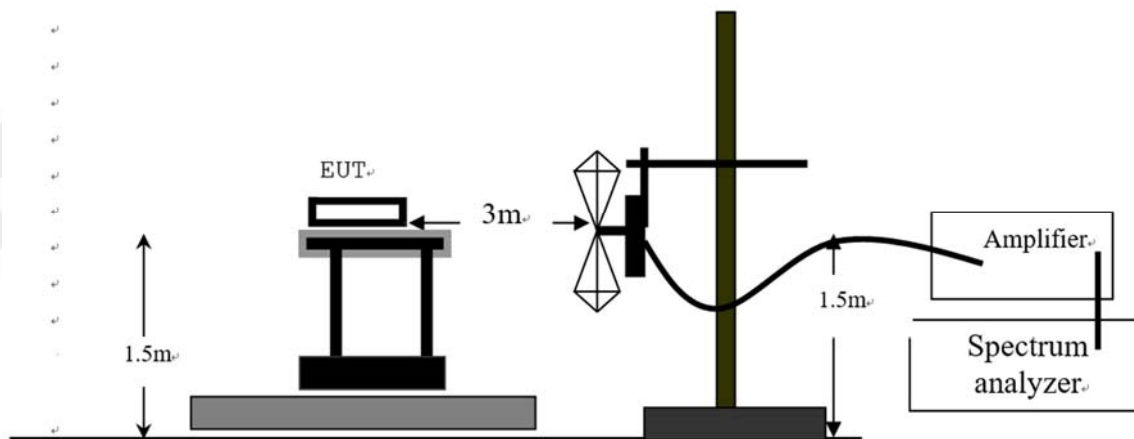
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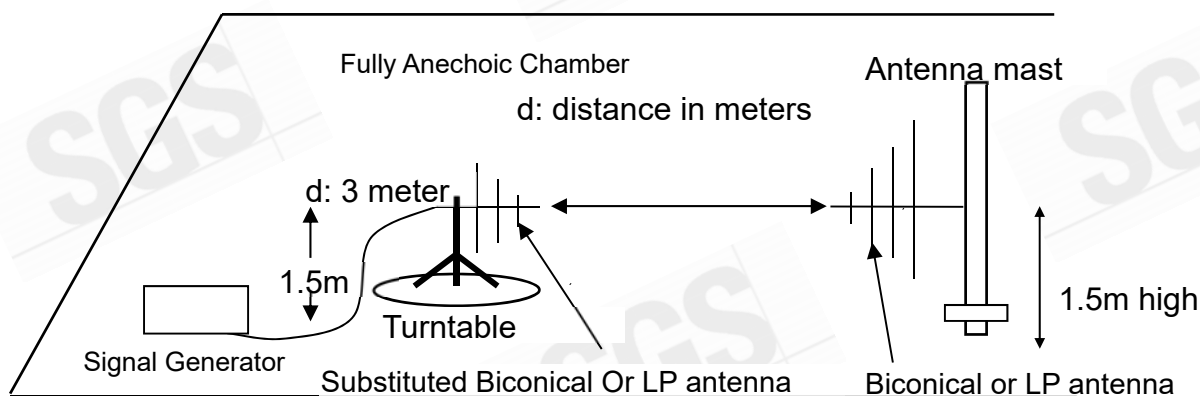
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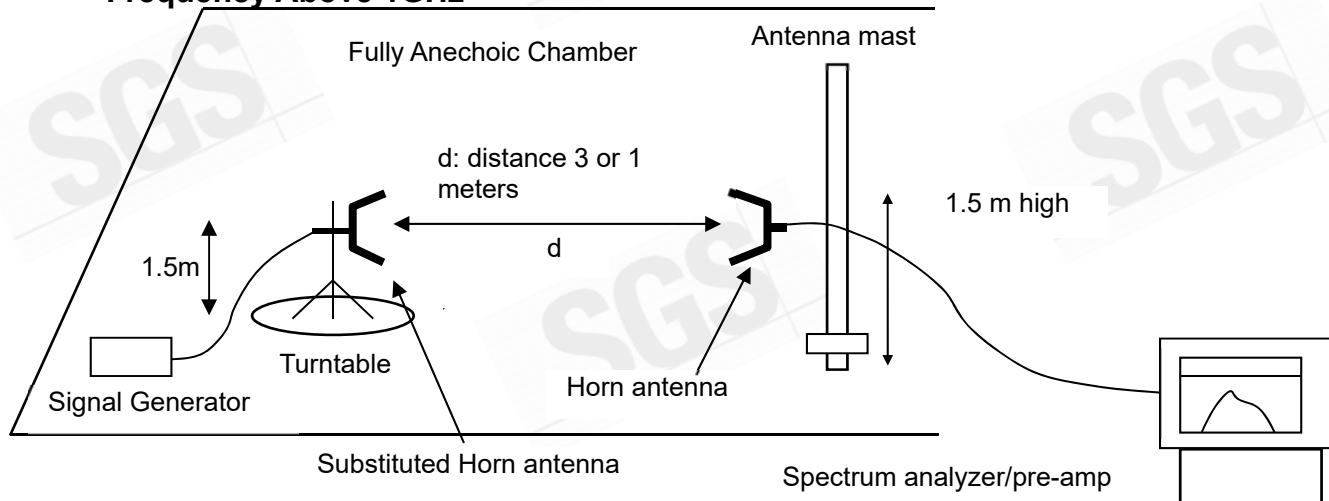
17.3 Test Setup: Step1. Field Strength Measurement



Step2. Substitution Measurement Frequency Below 1GHz



Step 3. Substitution Measurement Frequency Above 1GHz



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17.4 Test Procedure:

See Sub-Clause 5.4.9.1 of ETSI EN 300 328 for the test conditions

See Sub-Clause 5.4.9.2.2 of ETSI EN 300 328 for transmitter spurious emissions for radiated test method.

17.5 The Observation of the Test Results:

No value of the measurement limit is within 6dB, and therefore no further investigation and identification to measure emission with point of measurement is required.

$ERP / EIRP(dBm) = SG \text{ Level}(dBm) + \text{Antenna Gain}(dBi / dBd) + \text{Cable Loss}(dB)$

Note: Frequency below 1GHz with ERP (dBm), Antenna Gain (dBd);

Frequency above 1GHz with EIRP (dBm), Antenna Gain (dBi).

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17.6 Transmitter Spurious Emissions Test Results:

Operation Mode :	ZIGBEE	Test Date :	2016/5/9
Fundamental Frequency :	2405 MHz	Temp. / Humi. :	23.6/58
Operation Band :	Tx CH Low	Test Engineer :	Aken
EUT Pol. :	E2	Measurement Antenna Pol. :	Vertical

Freq.	Note	EIRP	SG Output	Antenna	Cable	Limit	Margin
MHz	F/H/E/S	dBm	Level dBm	Gain dBi	Loss dB	@3m dBm/m	dB
107.99	S	-58.06	-50.32	-6.29	-1.45	-54	-4.06
479.98	S	-59.09	-56.65	0.66	-3.10	-54	-5.09
599.97	S	-56.78	-54.76	1.47	-3.50	-54	-2.78
699.98	S	-69.91	-68.57	2.31	-3.65	-54	-15.91
799.99	S	-59.86	-58.20	2.47	-4.13	-36	-23.86
899.99	S	-60.80	-59.53	2.69	-3.96	-36	-24.80
4810.00	H	-55.59	-55.53	9.68	-9.74	-30	-25.59

Operation Mode :	ZIGBEE	Test Date :	2016/5/9
Fundamental Frequency :	2405 MHz	Temp. / Humi. :	23.6/58
Operation Band :	Tx CH Low	Test Engineer :	Aken
EUT Pol. :	E2	Measurement Antenna Pol. :	Horizontal

Freq.	Note	EIRP	SG Output	Antenna	Cable	Limit	Margin
MHz	F/H/E/S	dBm	Level dBm	Gain dBi	Loss dB	@3m dBm/m	dB
59.97	S	-60.65	-54.04	-5.54	-1.07	-54	-6.65
240.01	S	-62.81	-61.02	0.41	-2.21	-36	-26.81
479.98	S	-58.86	-56.42	0.66	-3.10	-54	-4.86
599.97	S	-56.17	-54.14	1.47	-3.50	-54	-2.17
799.99	S	-61.24	-59.59	2.47	-4.13	-36	-25.24
960.04	S	-64.38	-62.76	2.77	-4.39	-36	-28.38
4810.00	H	-51.83	-51.77	9.68	-9.74	-30	-21.83

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Operation Mode :	ZIGBEE	Test Date :	2016/5/9
Fundamental Frequency :	2480 MHz	Temp. / Humi. :	23.6/58
Operation Band :	Tx CH Low	Test Engineer :	Aken
EUT Pol. :	E2	Measurement Antenna Pol. :	Vertical

Freq.	Note	EIRP	SG Output	Antenna	Cable	Limit	Margin
MHz	F/H/E/S	dBm	Level dBm	Gain dBi	Loss dB	@3m dBm/m	dB
107.99	S	-58.00	-50.27	-6.29	-1.45	-54	-4.00
240.01	S	-65.30	-63.51	0.41	-2.21	-36	-29.30
479.98	S	-59.07	-56.63	0.66	-3.10	-54	-5.07
599.97	S	-56.83	-54.80	1.47	-3.50	-54	-2.83
799.99	S	-59.99	-58.33	2.47	-4.13	-36	-23.99
899.99	S	-60.96	-59.70	2.69	-3.96	-36	-24.96
4960.00	H	-56.21	-56.34	10.01	-9.88	-30	-26.21

Operation Mode :	ZIGBEE	Test Date :	2016/5/9
Fundamental Frequency :	2480 MHz	Temp. / Humi. :	23.6/58
Operation Band :	Tx CH High	Test Engineer :	Aken
EUT Pol. :	E2	Measurement Antenna Pol. :	Horizontal

Freq.	Note	EIRP	SG Output	Antenna	Cable	Limit	Margin
MHz	F/H/E/S	dBm	Level dBm	Gain dBi	Loss dB	@3m dBm/m	dB
59.97	S	-59.73	-53.12	-5.54	-1.07	-54	-5.73
240.01	S	-62.39	-60.59	0.41	-2.21	-36	-26.39
479.98	S	-59.61	-57.17	0.66	-3.10	-54	-5.61
599.97	S	-56.07	-54.04	1.47	-3.50	-54	-2.07
799.99	S	-61.42	-59.77	2.47	-4.13	-36	-25.42
899.99	S	-61.24	-59.98	2.69	-3.96	-36	-25.24
4960.00	H	-55.11	-55.24	10.01	-9.88	-30	-25.11

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18 ETSI EN 300 328 SUB-CLAUSE 4.3.2.10 RECEIVER SPURIOUS EMISSIONS**18.1 Limit:**

The spurious emissions of the receiver shall not exceed the values given in table 13

Table 13: Spurious emission limits for receivers

Frequency range	Maximum power	Bandwidth
30 MHz to 1 GHz	-57 dBm	100 kHz
1 GHz to 12,75 GHz	-47 dBm	1 MHz

18.2 Measurement Equipment Used:

Refer to section 9.3 in this report.

18.3 Test Setup:

Refer to section 17.3 in this report.

18.4 Test Procedure:

See Sub-Clause 5.4.10.1 of ETSI EN 300 328 for the test conditions

See Sub-Clause 5.4.10.2.2 of ETSI EN 300 328 for transmitter spurious emissions for radiated test method.

$$\text{ERP / EIRP(dBm)} = \text{SG Level(dBm)} + \text{Antenna Gain(dBi / dBd)} + \text{Cable Loss(dB)}$$

Note: Frequency below 1GHz with ERP (dBm), Antenna Gain (dBd);
Frequency above 1GHz with EIRP (dBm), Antenna Gain (dBi).

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18.5 Receiver Spurious Emissions Test Results:

Operation Mode :	ZIGBEE	Test Date :	2016/5/9
Fundamental Frequency :	2405 MHz	Temp. / Humi. :	23.6/58
Operation Band :	Rx CH Low	Test Engineer :	Aken
EUT Pol. :	E2	Measurement Antenna Pol. :	Vertical

Freq.	Note	EIRP	SG Output	Antenna	Cable	Limit	Margin
MHz	F/H/E/S	dBm	Level dBm	Gain dBi	Loss dB	@3m dBm/m	dB
71.61	S	-66.19	-59.66	-5.33	-1.19	-57	-9.19
240.01	S	-68.98	-67.18	0.41	-2.21	-57	-11.98
479.98	S	-59.47	-57.03	0.66	-3.10	-57	-2.47
599.97	S	-57.83	-55.80	1.47	-3.50	-57	-0.83
799.99	S	-60.09	-58.43	2.47	-4.13	-57	-3.09
899.99	S	-62.25	-60.99	2.69	-3.96	-57	-5.25
4810.00	H	-55.75	-55.69	9.68	-9.74	-47	-8.75

Operation Mode :	ZIGBEE	Test Date :	2016/5/9
Fundamental Frequency :	2405 MHz	Temp. / Humi. :	23.6/58
Operation Band :	Rx CH Low	Test Engineer :	Aken
EUT Pol. :	E2	Measurement Antenna Pol. :	Horizontal

Freq.	Note	EIRP	SG Output	Antenna	Cable	Limit	Margin
MHz	F/H/E/S	dBm	Level dBm	Gain dBi	Loss dB	@3m dBm/m	dB
121.28	S	-66.33	-58.79	-6.02	-1.52	-57	-9.33
242.72	S	-61.87	-59.95	0.29	-2.21	-57	-4.87
479.98	S	-58.97	-56.53	0.66	-3.10	-57	-1.97
599.97	S	-57.88	-55.86	1.47	-3.50	-57	-0.88
799.99	S	-61.30	-59.64	2.47	-4.13	-57	-4.30
899.99	S	-60.26	-58.99	2.69	-3.96	-57	-3.26
4810.00	H	-55.55	-55.49	9.68	-9.74	-47	-8.55

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Operation Mode :	ZIGBEE	Test Date :	2016/5/9
Fundamental Frequency :	2480 MHz	Temp. / Humi. :	23.6/58
Operation Band :	Rx CH High	Test Engineer :	Aken
EUT Pol. :	E2	Measurement Antenna Pol. :	Vertical

Freq.	Note	EIRP	SG Output	Antenna	Cable	Limit	Margin
MHz	F/H/E/S	dBm	Level dBm	Gain dBi	Loss dB	@3m dBm/m	dB
240.01	S	-68.41	-66.61	0.41	-2.21	-57	-11.41
479.98	S	-59.35	-56.91	0.66	-3.10	-57	-2.35
499.97	S	-60.26	-57.79	0.79	-3.26	-57	-3.26
599.97	S	-57.91	-55.89	1.47	-3.50	-57	-0.91
799.99	S	-59.70	-58.04	2.47	-4.13	-57	-2.70
899.99	S	-62.45	-61.19	2.69	-3.96	-57	-5.45
4960.00	H	-55.93	-56.07	10.01	-9.88	-47	-8.93

Operation Mode :	ZIGBEE	Test Date :	2016/5/9
Fundamental Frequency :	2480 MHz	Temp. / Humi. :	23.6/58
Operation Band :	Rx CH High	Test Engineer :	Aken
EUT Pol. :	E2	Measurement Antenna Pol. :	Horizontal

Freq.	Note	EIRP	SG Output	Antenna	Cable	Limit	Margin
MHz	F/H/E/S	dBm	Level dBm	Gain dBi	Loss dB	@3m dBm/m	dB
179.96	S	-64.98	-63.76	0.61	-1.83	-57	-7.98
240.01	S	-64.11	-62.32	0.41	-2.21	-57	-7.11
479.98	S	-58.85	-56.41	0.66	-3.10	-57	-1.85
599.97	S	-57.91	-55.88	1.47	-3.50	-57	-0.91
799.99	S	-61.25	-59.59	2.47	-4.13	-57	-4.25
899.99	S	-59.69	-58.42	2.69	-3.96	-57	-2.69
4960.00	H	-56.30	-56.43	10.01	-9.88	-47	-9.30

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19 ETSI EN 300 328 SUB-CLAUSE 4.3.2.11 RECEIVER BLOCKING

19.1 Limit:

While maintaining the minimum performance criteria as defined in clause 4.3.1.12.3, the blocking levels at specified frequency offsets shall be equal to or greater than the limits defined for the applicable receiver category provided in table 14, 15 and 16.

Table 14: Receiver Blocking parameters for Receiver Category 1 equipment

Wanted signal mean power from companion device (dBm) (see notes 1 and 4)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 4)	Type of blocking signal
(-133 dBm + 10 × log ₁₀ (OCBW)) or -68 dBm whichever is less (see note 2)	2 380 2 504	-34	CW
(-139 dBm + 10 × log ₁₀ (OCBW)) or -74 dBm whichever is less (see note 3)	2 300 2 330 2 360 2 524 2 584 2 674		
NOTE 1: OCBW is in Hz.			
NOTE 2: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to P _{min} + 26 dB where P _{min} is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.			
NOTE 3: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to P _{min} + 20 dB where P _{min} is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.			
NOTE 4: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the (in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density (PFD) in front of the UUT antenna with the UUT being configured/positioned as recorded in clause 5.4.3.2.2.			

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Table 15: Receiver Blocking parameters receiver Category 2 equipment

Wanted signal mean power from companion device (dBm) (see notes 1 and 3)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 3)	Type of blocking signal
$(-139 \text{ dBm} + 10 \times \log_{10}(\text{OCBW}) + 10 \text{ dB})$ or $(-74 \text{ dBm} + 10 \text{ dB})$ whichever is less (see note 2)	2 380 2 504 2 300 2 584	-34	CW
<p>NOTE 1: OCBW is in Hz.</p> <p>NOTE 2: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to $P_{\min} + 26 \text{ dB}$ where P_{\min} is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.</p> <p>NOTE 3: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the (in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density (PFD) in front of the UUT antenna with the UUT being configured/positioned as recorded in clause 5.4.3.2.2.</p>			

Table 16: Receiver Blocking parameters receiver Category 3 equipment

Wanted signal mean power from companion device (dBm) (see notes 1 and 3)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 3)	Type of blocking signal
$(-139 \text{ dBm} + 10 \times \log_{10}(\text{OCBW}) + 20 \text{ dB})$ or $(-74 \text{ dBm} + 20 \text{ dB})$ whichever is less (see note 2)	2 380 2 504 2 300 2 584	-34	CW
<p>NOTE 1: OCBW is in Hz.</p> <p>NOTE 2: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to $P_{\min} + 30 \text{ dB}$ where P_{\min} is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.</p> <p>NOTE 3: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the (in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density (PFD) in front of the UUT antenna with the UUT being configured/positioned as recorded in clause 5.4.3.2.2.</p>			

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19.2 Measurement Equipment Used:

Refer to section 9.2 in this report.

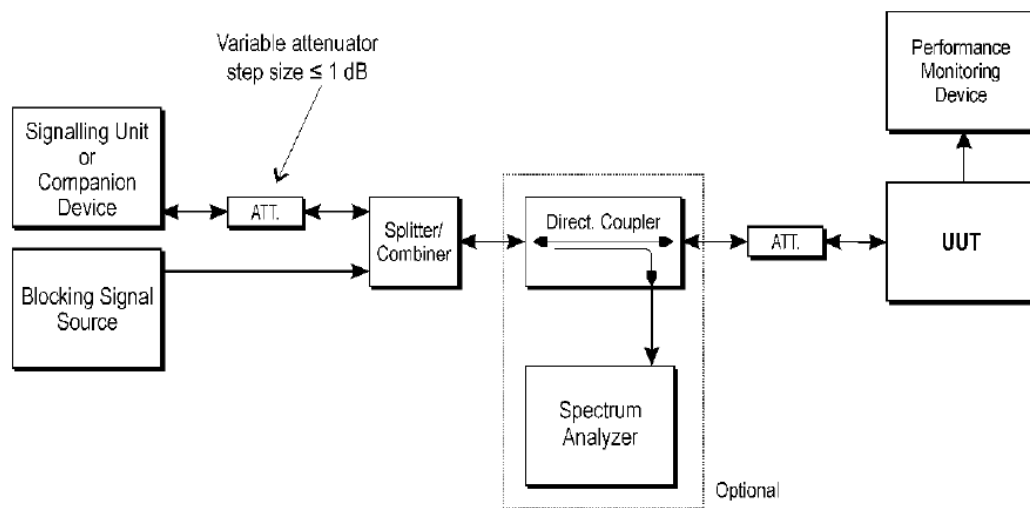
19.3 Test Setup:

Figure 6: Test Set-up for receiver blocking

19.4 Test Procedure:

See Sub-Clause 5.4.11.1 of ETSI EN 300 328 for the test conditions

See Sub-Clause 5.4.11.2.1 of ETSI EN 300 328 for conducted measurement method.

19.5 Test Result:

Receiver Blocking Result for V2.2.2 category 2

Wanted signal mean power from companion device (dBm)	Blocking signal frequency (MHz)	Blocking signal power (dBm)	Packet Error Rate (%)	
			Zigbee	
			2405MHz	2480MHz
(-139 dBm + 10 × log10(OCBW)+10dB)= -64.94 or (-74 dBm+10dBm) whichever is less	2380	-34	0.0	0.0
	2504		0.1	0.0
	2300		0.0	0.2
	2584		0.0	0.0
Limit	<10			
Result	PASS			

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20 ETSI EN 300 328 SUB-CLAUSE 4.3.2.12 GEO-LOCATION CAPABILITY

20.1 Requirements

This requirement only applies to non-FHSS equipment with geo-location capability as defined in clause 4.3.2.12.2.

20.2 Definition:

Geo-location capability is a feature of the equipment to determine its geographical location with the purpose to configure itself according to the regulatory requirements applicable at the geographical location where it operates.

The geo-location capability may be present in the equipment or in an external device (temporary) associated with the equipment operating at the same geographical location during the initial power up of the equipment. The geographical location may also be available in equipment already installed and operating at the same geographical location.

20.3 Test Result:

N/A for equipments that does not support the geo-location capability

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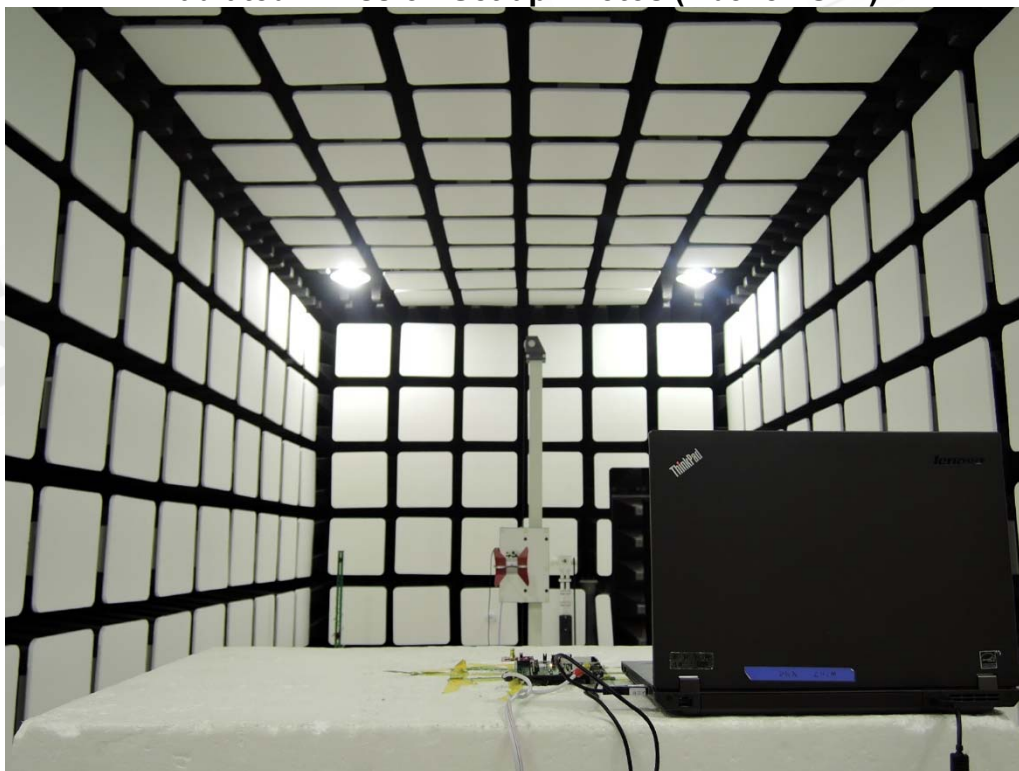
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PHOTOGRAPHS OF SET UP

Radiated Emission Set up Photos (Below 1GHz)



Radiated Emission Set up Photos (Above 1GHz)



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Radiated Emission Set up Photos (Front View)



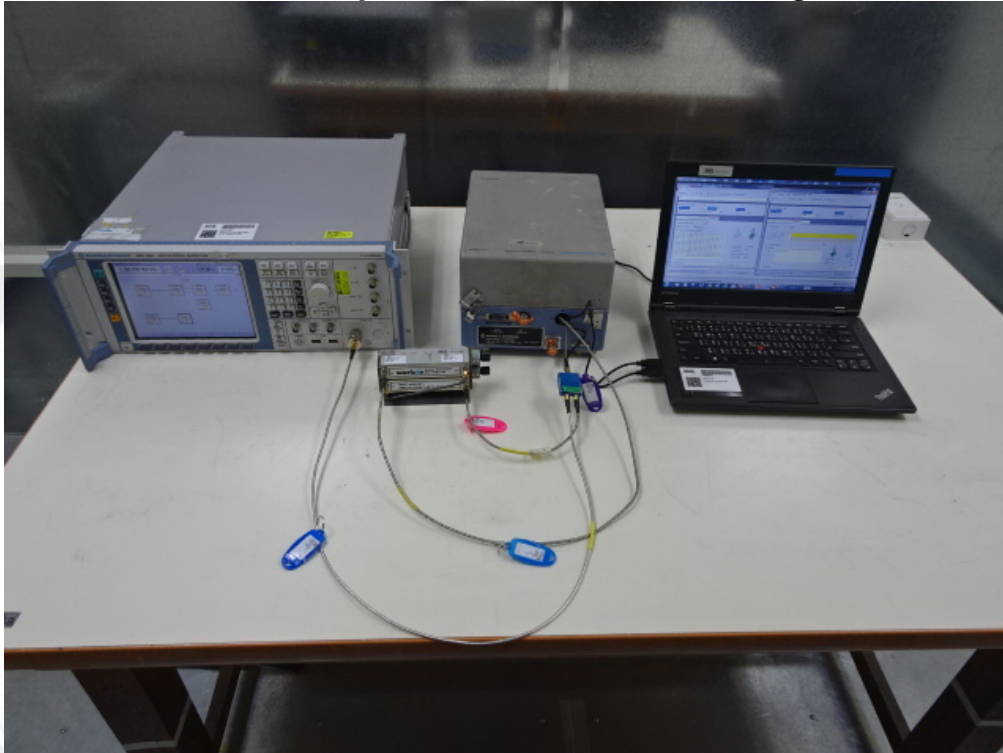
Test Set up Photos – Conducted



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Test Set up Photos – Receiver Blocking**PHOTOGRAPHS OF EUT**

Please refer to the attached file (EUT Photo)

~ End of Report ~

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