TEST REPORT

EN 300 328 V2.1.1

Equipment under test	HOME CAMERA
Model name	SNH-P6415BN
Derivative model	SNH-P6416BN, SNH-C6415BN, SNH-C6415BNB, SNH-C6416BN, SNH-C6416BNB
Applicant	Hanwha Techwin Co., Ltd.
Manufacturer	Hanwha Techwin (Tianjin) Co., Ltd. Hanwha Techwin Security Vietnam Co.,Ltd. D-TECH Co.,Ltd.
Date of test(s)	2018.12.03 ~ 2018.12.17
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Issued to

Hanwha Techwin Co., Ltd.

6, Pangyo-ro 319 Beon-gil, Bundang-gu Seongnam-si,
Gyeonggi-do, 13488, Korea
Tel: +82-70-7147-8361/ Fax: +82-31-8108-3717

Issued by

KES Co., Ltd.

C-3701, 40, Simin-daero 365beon-gil, Dongan-gu, Anyang-si,
Gyeonggi-do, 14057, Korea
473-21, Gayeo-ro, Yeoju-si, Gyeonggi-do, Korea
Tel: +82-31-425-6200 / Fax: +82-31-424-0450

Test and report completed by :	Report approval by :
Young-Jin Lee Test engineer	Hyeon-Su, Jang Technical manager

This test report is not related to KOLAS.

Revision history

Revision	Date of issue	Test report No.	Description
-	2018.12.18	KES-RF-18T0121	Initial

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1. General information

Applicant:	Hanwha Techwin Co., Ltd.
Applicant address:	6, Pangyo-ro 319 Beon-gil, Bundang-gu Seongnam-si, Gyeonggi-do, 13488, Korea
Test site:	KES Co., Ltd.
Test site address:	C-3701, 40, Simin-daero 365beon-gil, Dongan-gu, Anyang-si, Gyeonggi-do, 14057, Korea 473-21, Gayeo-ro, Yeoju-si, Gyeonggi-do, Korea
Rule part(s):	EN 300 328 V2.1.1
Test device serial No.:	☒ Production ☐ Pre-production ☐ Engineering

1.1. EUT description

Equipment under test	WISENET SMARTCAM
Frequency range	2 402 ㎒ ~ 2 480 ㎒ (LE) 2 412 ㎒ ~ 2 472 ㎒ (11b/g/n_HT20) 2 422 ㎒ ~ 2 462 ㎒ (11n_HT40) 5 180 ㎒ ~ 5 240 ㎒ (11a/n_HT20, 11ac_VHT20) 5 190 ㎒ ~ 5 230 ㎒ (11n_HT40 , 11ac_VHT40) 5 210 ㎒ (11ac_VHT80) 5 260 ㎒ ~ 5 320 ㎒ (11a/n_HT20, 11ac_VHT20) 5 270 ㎒ ~ 5 310 ㎒ (11n_HT40 , 11ac_VHT40) 5 290 ㎒ (11ac_VHT80) 5 500 ㎒ ~ 5 720 ㎒ (11a/n_HT20, 11ac_VHT20) 5 510 ㎒ ~ 5 710 ㎒ (11n_HT40 , 11ac_VHT40) 5 530 ㎒ ~ 5 690 ㎒ (11ac_VHT80)
Model:	SNH-P6415BN
Derivative model	SNH-P6416BN, SNH-C6415BN, SNH-C6415BNB, SNH-C6416BN, SNH-C6416BNB
Modulation technique	WIFI : DSSS, OFDM BT : GFSK
Antenna specification	Antenna type(2.4㎓ WIFI) : Chip antenna, Peak gain : 3.50 dBi Antenna type(BT, 5㎓ WIFI) : Chip antenna, Peak gain : 3.94 dBi
Power source	AC 230 V Adaptor (Output : DC 5.0V//2.0A)
Number of channels	LE : 40 ch

Note:

1. The manufacturer is declared the extremes of operating temperature range and Operating voltage range as follows:

Operating voltage range	DC 207 V ~ AC 240 V
Operating temperature rang	-10 ℃ to +50 ℃

1.2. Frequency/channel operations

Ch.	Frequency (㎒)	Mode
0	2 402	LE
. .	. .	. .
19	2 440	LE
. .	. .	. .
39	2 480	LE

1.3. Device modifications

N/A

1.4. Information about derivative model

The difference between basic and derivative model is braket and external color, the other circuit diagram and software are fundamentally the same.

- Basic model(SNH-P6415BN) : Metal braket, White color
- Derivative model(SNH-P6416BN) : Metal braket, Black color
- Derivative model(SNH-C6415BN) : Metal braket, White color
- Derivative model(SNH-C6415BNB) : Metal braket, Black color
- Derivative model(SNH-C6416BN) : Plastic braket White color
- Derivative model(SNH-C6416BNB) : Plastic braket Black color

2. Summary of tests

Reference	Parameter	Test results
EN 300 328 4.3.2.9	Transmitter unwanted emissions in the spurious domain	Pass
EN 300 328 4.3.2.10	Receiver spurious emissions	Pass
EN 300 328 4.3.2.2	RF Output Power	Pass
EN 300 328 4.3.2.3	Power Spectral Density	Pass
EN 300 328 4.3.2.6	Adaptivity	N/A Note.1
EN 300 328 4.3.2.7	Occupied Channel Bandwidth	Pass
EN 300 328 4.3.2.8	Transmitter unwanted emissions in the out-of-band domain	Pass
EN 300 328 4.3.2.11	Receiver Blocking	Pass
EN 300 328 4.3.2.12	Geo-location capability	N/A Note.2

Note:

1. This requirement does not apply for equipment with the maximum declared RF Output power level of less than 10 dBm e.i.r.p. or for equipment when operating in a mode where the RF Output power is less than 10 dBm e.i.r.p.

2. This device has not support geo-location capability.

3. Application form for testing

3.1. Information as required by EN 300 328 V2.1.1, clause 5.4.1

In accordance with EN 300 328, clause 5.4.1, the following information is provided by the manufacturer.

a) The type of modulation used by the equipment:

☐ FHSS

☒ Other forms of modulation

b) In case of FHSS modulation: (N/A)

- In case of non-Adaptive Frequency Hopping equipment
  The number of Hopping Frequencies: ______________________
- In case of Adaptive Frequency Hopping equipment
  The maximum number of Hopping Frequencies: ______________________
  The minimum number of Hopping Frequencies: ______________________
- The (average) Dwell Time: ______________________

c) Adaptive / non-adaptive equipment:

☐ Non-adaptive Equipment

☒ Adaptive Equipment without the possibility to switch to a non-adaptive mode

☐ Adaptive Equipment which can also operate in a non-adaptive mode

d) In case of adaptive equipment: (N/A)

The maximum Channel Occupancy Time implemented by the equipment: ______________________

☐ The equipment has implemented an LBT based DAA mechanism

- In case of equipment using modulation different from FHSS:
  - ☐ The equipment is Frame Based equipment
  - ☐ The equipment is Load Based equipment
  - ☐ The equipment can switch dynamically between Frame Based and Load Based equipment

  The CCA time implemented by the equipment: ______________________

☐ The equipment has implemented an non-LBT based DAA mechanism

☐ The equipment can operate in more than one adaptive mode

e) In case of non-adaptive Equipment: (N/A)

The maximum RF Output Power (e.i.r.p.): ______

The maximum (corresponding) Duty Cycle: ______

Equipment with dynamic behaviour, that behaviour is described here. (e.g. the different combinations of duty cycle and corresponding power levels to be declared): N/A

f) The worst case operational mode for each of the following tests:

- RF Output Power
  LE
- Power Spectral Density
  LE
- Duty cycle, Tx-Sequence, Tx-gap
  N/A
- Accumulated Transmit time, Frequency Occupation & Hopping Sequence (only for FHSS equipment)
  N/A
- Hopping Frequency Separation (only for FHSS equipment)
  N/A
- Medium Utilisation:
  N/A
- Adaptivity & Receiver Blocking
  Receiver Blocking : LE (1Mbps)
- Nominal Channel Bandwidth
  LE
- Transmitter unwanted emissions in the OOB domain
  LE
- Transmitter unwanted emissions in the spurious domain
  LE
- Receiver spurious emissions
  LE

g) The different transmit operating modes (tick all that apply):

☒ Operating mode 1: Single Antenna Equipment

- ☒ Equipment with only one antenna
- ☐ Equipment with two diversity antennas but only one antenna active at any moment in time
- ☐ Smart Antenna Systems with 2 or more antennas, but operating in a (legacy) mode where only one antenna is used. (e.g. IEEE 802.11™ [i.3] legacy mode in smart antenna systems)

☐ Operating mode 2: Smart Antenna Systems - Multiple Antennas without beam forming

- ☐ Single spatial stream / Standard throughput / (e.g. IEEE 802.11™ [i.3] legacy mode)
- ☐ High Throughput (> 1 spatial stream) using Nominal Channel Bandwidth 1
- ☐ High Throughput (> 1 spatial stream) using Nominal Channel Bandwidth 2

NOTE 1: Add more lines if more channel bandwidths are supported.

☐ Operating mode 3: Smart Antenna Systems - Multiple Antennas with beam forming

- ☐ Single spatial stream / Standard throughput (e.g. IEEE 802.11™ [i.3] legacy mode)
- ☐ High Throughput (> 1 spatial stream) using Nominal Channel Bandwidth 1
- ☐ High Throughput (> 1 spatial stream) using Nominal Channel Bandwidth 2

NOTE 2: Add more lines if more channel bandwidths are supported.

h) In case of Smart Antenna Systems: (N/A)

The number of Receive chains: ____________________

The number of Transmit chains ____________________

- ☐ symmetrical power distribution
- ☐ asymmetrical power distribution

In case of beam forming, the maximum beam forming gain: ____________________

NOTE: Beam forming gain does not include the basic gain of a single antenna.

i) Operating Frequency Range(s) of the equipment:

Operating Frequency Range 1: 2 402 ㎒ to 2 480 ㎒

Operating Frequency Range 2: -

NOTE: Add more lines if more Frequency Ranges are supported.

j) Nominal Channel Bandwidth(s):

Nominal Channel Bandwidth 1: 1.052 ㎒

Nominal Channel Bandwidth 2: -

NOTE: Add more lines if more channel bandwidths are supported.

k) Type of Equipment (stand-alone, combined, plug-in radio device, etc.):

☒ Stand-alone
☐ Combined Equipment (Equipment where the radio part is fully integrated within another type of equipment)
☐ Plug-in radio device (Equipment intended for a variety of host systems)
☐ Other

l) The normal and the extreme operating conditions that apply to the equipment:

Normal operation conditions (if applicable)

Operating temperature	-	
Other (please specify if applicable)	-	

Extreme operating conditions

Operating temperature range:	Minimum: -10° C	Maximum: 55° C
Other (please specify if applicable)	Minimum: -	Maximum: -

Details provided are for the:
☐ stand-alone equipment
☐ combined (or host) equipment
☒ test jig

m) The intended combination(s) of the radio equipment power settings and one or more antenna assemblies and their corresponding e.i.r.p. levels:

- Antenna Type:

☒ Integral Antenna (information to be provided in case of conducted measurements)

Antenna Gain: 3.94 dBi

If applicable, additional beamforming gain (excluding basic antenna gain): N/A

☒ Temporary RF connector provided
☐ No temporary RF connector provided

☐ Dedicated Antennas (equipment with antenna connector)

☐ Single power level with corresponding antenna(s)
☐ Multiple power settings and corresponding antenna(s)

Number of different Power Levels:

Power Level 1: dBm
Power Level 2: dBm
Power Level 3: dBm

NOTE 1: Add more lines in case the equipment has more power levels
NOTE 2: These power levels are conducted power levels (at antenna connector).

- For each of the Power Levels, provide the intended antenna assemblies, their corresponding gains (G) and the resulting e.i.r.p. levels also taking into account the beamforming gain (Y) if applicable

Power Level 1: 8.56 dBm

Number of antenna assemblies provided for this power level: 1

Assembly#	Gain(dBi)	e.i.r.p. (dBm)	Part number or model name
1	3.94	8.56	
2			
3			
4			

NOTE 3: Add more rows in case more antenna assemblies are supported for this power level.

Power Level 2: N/A

Number of antenna assemblies provided for this power level: N/A

Assembly#	Gain(dBi)	e.i.r.p. (dBm)	Part number or model name
1			
2			
3			
4			

NOTE 4: Add more rows in case more antenna assemblies are supported for this power level.

Power Level 3: N/A

Number of antenna assemblies provided for this power level: N/A

Assembly#	Gain(dBi)	e.i.r.p. (dBm)	Part number or model name
1			
2			
3			
4			

NOTE 5: Add more rows in case more antenna assemblies are supported for this power level.

n) The nominal voltages of the stand-alone radio equipment or the nominal voltages of the combined (host) equipment or test jig in case of plug-in devices:

Details provided are for the: ☒ stand-alone equipment
☐ combined (or host) equipment
☐ test jig

Supply Voltage ☒ AC mains State AC voltage 230 V
☐ DC State DC voltage

In case of DC, indicate the type of power source
☐ Internal Power Supply
☒ External Power Supply or AC/DC adapter
☐ Battery
☐ Other:

o) Describe the test modes available which can facilitate testing:

Bluetooth Low Energy

p) The equipment type (e.g. Bluetooth®, IEEE 802.11™ [i.3], IEEE 802.15.4™ [i.4], proprietary, etc.):

Bluetooth 4.0

q) If applicable, the statistical analysis referred to in clause 5.4.1 q) (N/A)

(to be provided as separate attachment)

r) If applicable, the statistical analysis referred to in clause 5.4.1 r) (N/A)

(to be provided as separate attachment)

s) Geo-location capability supported by the equipment:

☐ Yes
☐ The geographical location determined by the equipment as defined in clause 4.3.1.13.2 or clause 4.3.2.12.2 is not accessible to the user
☒ No

t) Describe the minimum performance criteria that apply to the equipment (see clause 4.3.1.12.3 or clause 4.3.2.11.3):

Receiver category 2

3.2. Combination for testing (see clause 5.3.2.3 of EN 300 328 V2.1.1) (N/A)

From all combinations of conducted power settings and intended antenna assembly(ies) specified in clause 3.1 m), specify the combination resulting in the highest e.i.r.p. for the radio equipment.

Unless otherwise specified in EN 300 328, this power setting is to be used for testing against the requirements of EN 300 328. In case there is more than one such conducted power setting resulting in the same (highest) e.i.r.p. level, the highest power setting is to be used for testing. See also EN 300 328, clause 5.3.2.3.

Highest overall e.i.r.p. value: ________ dBm	
Corresponding Antenna assembly gain: ________ dBi	Antenna Assembly #: ________
Corresponding conducted power setting: ________ dBm (also the power level to be used for testing)	Listed as Power Setting #: ________

3.3. Additional information provided by the manufacturer

Modulation

ITU Class(es) of emission: F1D

Can the transmitter operate unmodulated? ☒ yes ☐ no

Duty Cycle

The transmitter is intended for
☒ Continuous duty
☐ Intermittent duty
☐ Continuous operation possible for testing purposes

About the UUT

☒ The equipment submitted are representative production models

☐ If not, the equipment submitted are pre-production models?

☐ If pre-production equipment are submitted, the final production equipment will be identical in all respects with the equipment tested

☐ If not, supply full details

____

____

Additional items and/or supporting equipment provided

- ☒ Spare batteries (e.g. for portable equipment)
- ☐ Battery charging device
- ☒ External Power Supply or AC/DC adapter
- ☐ Test jig or interface box
- ☐ RF test fixture (for equipment with integrated antennas)
- ☐ Host System
  - Manufacturer: ____________
  - Model #: ____________
  - Model name: ____________
- ☐ Combined equipment
  - Manufacturer: ____________
  - Model #: ____________
  - Model name: ____________
- ☒ User Manual
- ☒ Technical documentation (Handbook and circuit diagrams)

4. Test results

4.1. Transmitter unwanted emissions in the spurious domain

Measurement Condition

Ambient temperature : 22.2 ℃

Relative humidity : 39.5 % R.H.

Test procedure

EN 300 328 clause 5.4.9.2

5.4.9.2.1.2 Pre-scan

Step 2:
The emissions over the range 30 ㎒ to 1 000 ㎒ shall be identified.
Spectrum analyser settings:

1. RBW : 100 ㎑
2. VBW : 300 ㎑
3. Filter type : 3 ㏈ (Gaussian)
4. Detector mode : Peak
5. Trace mode : Max hold
6. Sweep points : ≥19 400; for spectrum analysers not supporting this high number of sweep points, the frequency band may need to be segmented.
7. Sweep time :
   For non continuous transmissions (duty cycle less than 100 %), the sweep time shall be sufficiently long, such that for each 100 ㎑ frequency step, the measurement time is greater than two transmissions of the UUT, on any channel

   For Frequency Hopping equipment operating in a normal operating (hopping not disabled) mode, the sweep time shall be further increased to capture multiple transmissions on the same hopping frequency in different hopping sequences.

   The above sweep time setting may result in long measuring times in case of frequency hopping equipment. To avoid such long measuring times, an FFT analyser may be used

   Allow the trace to stabilize. Any emissions identified during the sweeps above and that fall within The 6 ㏈ range below the applicable limit or above, shall be individually measured using the Procedure in clause 5.4.9.2.1.3 and compared to the limits given in table 4 or table 12.

Step 3:
The emissions over the range 1 GHz to 12.75 GHz shall be identified.
Spectrum analyser setting:

1. RBW : 1 MHz
2. VBW : 3 MHz
3. Filter type : 3 dB (Gaussian)
4. Detector mode : Peak
5. Trace mode : Max hold
6. Sweep points: ≥23 500; for spectrum analysers not supporting this high number of sweep points, the frequency band may need to be segmented.
7. Sweep time :
   For non continuous transmissions (duty cycle less than 100 %), the sweep time shall be sufficiently long, such that for each 100 kHz frequency step, the measurement time is greater than two transmissions of the UUT, on any channel

   For Frequency Hopping equipment operating in a normal operating (hopping not disabled) mode, the sweep time shall be further increased to capture multiple transmissions on the same hopping frequency in different hopping sequences.

   The above sweep time setting may result in long measuring times in case of frequency hopping equipment. To avoid such long measuring times, an FFT analyser may be used

   Allow the trace to stabilize. Any emissions identified during the sweeps above and that fall within The 6 dB range below the applicable limit or above, shall be individually measured using the Procedure in clause 5.4.9.2.1.3 and compared to the limits given in table 4 or table 12.

   Frequency Hopping equipment may generate a block (or several blocks) of spurious emissions anywhere within the spurious domain. If this is the case, only the highest peak of each block of emissions shall be measured using the procedure in clause 5.4.9.2.1.3.

5.4.7.2.1.2 Measurement of the emissions identified during the pre-scan

Step 1:
The level of the emissions shall be measured using the following spectrum analyser settings:

1. Measurement mode : Time domain power
2. Centre frequency : Frequency of the emission identified during the pre-scan
3. RBW : 100 kHz (< 1 GHz) / 1 MHz (>1 GHz)
4. VBW : 300 kHz (< 1 GHz) / 3 MHz (>1 GHz)
5. Frequency span : Zero span
6. Sweep mode : Single sweep
7. Sweep time : >120 % of the duration of the longest burst detected during the measurement of the RF Output Power
8. Sweep points : Sweep time [µs] / (1 µs) with a maximum of 30 000
9. Trigger : Video (for burst signals) or Manual (for continuous signals)
10. Detector : RMS

Test results

<u>Mode: LE</u>

Mode: LE

Distance of measurement: 3 meter

Lowest frequency				Highest frequency			
Frequency(㎒)	**Ant Pol**	**Bandwidth(㎑)**	**Level(㏈m)**	**Frequency(㎒)**	**Ant Pol**	**Bandwidth(㎑)**	**Level(㏈m)**
4 804.00	H	1 000	-54.86	4 960.00	H	1 000	-57.90
4 804.00	V	1 000	-54.41	4 960.00	V	1 000	-55.39

Limit (Clause 4.3.2.9.3)
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 ㎓ and as e.i.r.p. for emissions above 1 ㎓.

Table 12: Transmitter limits for spurious emissions

Frequency Range	Maximum power,	Bandwidth
30 ㎒ to 47 ㎒	-36 dBm	100 ㎑
47 ㎒ to 74 ㎒	-54 dBm	100 ㎑
74 ㎒ to 87.5 ㎒	-36 dBm	100 ㎑
87.5 ㎒ to 118 ㎒	-54 dBm	100 ㎑
118 ㎒ to 174 ㎒	-36 dBm	100 ㎑
174 ㎒ to 230 ㎒	-54 dBm	100 ㎑
230 ㎒ to 470 ㎒	-36 dBm	100 ㎑
470 ㎒ to 862 ㎒	-54 dBm	100 ㎑
862 ㎒ to 1 ㎓	-36 dBm	100 ㎑
1 ㎓ to 12.75 ㎓	-30 dBm	1 ㎒

4.2. Receiver spurious emissions

Measurement Condition

Ambient temperature : 22.2 ℃
Relative humidity : 39.5 % R.H.

Test procedure

EN 300 328 clause 5.4.10.2 – Step 2 and Step 3

Step 2:
The emissions over the range 30 ㎒ to 1 000 ㎒ shall be identified.
Spectrum analyser settings:

1. RBW : 100 ㎑
2. VBW : 300 ㎑
3. Filter type : 3 ㏈ (Gaussian)
4. Detector mode : Peak
5. Trace mode : Max hold
6. Sweep points : ≥19 400
7. Sweep time : Auto

Wait for the trace to stabilize. Any emissions identified during the sweeps above and that fall within the 6 ㏈ Range below the applicable limit or above, shall be individually measured using the procedure in clause 5.4.10.2.1.3 and compared to the limits given in table 5 or table 13.

Step 3 :
The emissions over the range 1 ㎓ to 12.75 ㎓ shall be identified.
Spectrum analyser settings:

1. RBW : 1 ㎒
2. VBW : 3 ㎒
3. Filter type : 3 ㏈ (Gaussian)
4. Detector mode : Peak
5. Trace mode : Max hold
6. Sweep points : ≥ 23 500; for spectrum analysers not supporting this high number of sweep points, the frequency band may be segmented
7. Sweep time : Auto

Wait for the trace to stabilize. Any emissions identified during the sweeps above that fall within the 6 ㏈ range below, the applicable limit or above, shall be individually measured using the procedure in clause 5.4.10.2.1.3 and compared to the limits given in table 5 or table 13.

Frequency Hopping equipment may generate a block (or several blocks) of spurious emissions anywhere within the spurious domain. If this is the case, only the highest peak of each block of emissions shall be measured using the procedure in clause 5.4.10.2.1.3.

Test results
Mode: LE

Mode: LE

Distance of measurement: 3 meter

Lowest frequency				Highest frequency			
Frequency(㎒)	**Ant Pol**	**Bandwidth(㎑)**	**Level(dBm)**	**Frequency(㎒)**	**Ant Pol**	**Bandwidth(㎑)**	**Level(dBm)**
Emission levels are not reported much lower than the limits by over 20 dB							

Limit (Clause 4.3.2.10.3)

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

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

Table 13: Spurious emission limits for receivers

Frequency Range	Maximum power	Measurement bandwidth
30 ㎒ to 1 ㎓	-57 dBm	100 ㎑
1 ㎓ to 12.75 ㎓	-47 dBm	1 ㎒

4.3. RF output power

Measurement Condition

Ambient temperature : 24.0 ℃

Relative humidity : 40.2 % R.H.

Test procedure

EN 300 328 clause 5.4.2.2.1.2

Step 1 :

Use a fast power sensor suitable for 2.4 ㎓ and capable of minimum 1MS/s.

Use the following settings:

- Sample speed 1 MS/s or faster.
- The samples shall represent the RMS power of the signal.
- Measurement duration : For non-adaptive equipment : equal to the observation period defined in clause 4.3.1.3.2 or clause 4.3.2.4.2. For adaptive equipment, the measurement duration shall be long enough to ensure a minimum number of bursts (at least 10) is captured.

  For adaptive equipment, to increase the measurement accuracy, a higher number of bursts may be used.

Step 2 :

For conducted measurements on devices with one transmit chain:

- Connect the power sensor to the transmit port, sample the transmit signal and store the raw data. Use these stored samples in all following steps.

For conducted measurements on devices with multiple transmit chains:

- Connect one power sensor to each transmit port for a synchronous measurement on all transmit ports.
- Trigger the power sensors so that they start sampling at the same time.

  Make sure the time difference between the samples of all sensors is less than 500 ㎱.
- For each individual sampling point (time domain), sum the coincident power samples of all ports and store them. Use these summed samples as the new stored data set.

Step 3 :

Find the start and stop times of each burst in the stored measurement samples.

The start and stop times are defined as the points where the power is at least 30 ㏈ below the highest value of the stored samples in step 2.

In case of insufficient dynamic range, the value of 30 ㏈ may need to be reduced appropriately.

Step 4 :

Between the start and stop times of each individual burst calculate the RMS power over the burst using the formula below. The start and stop points shall be included. Save these P_{burst} values, as well as the start and stop times for each burst.

$$P_{burst} = \frac{1}{k}\sum_{n=1}^{k} P_{sample}(n)$$

with k being the total number of samples and n the actual sample number.

Step 5 :

The highest of all P_{burst} values (value A in dBm) will be used for maximum e.i.r.p. calculations.

Step 6 :

Add the (stated) antenna assembly gain G in dBi of the individual antenna.
If applicable, add the additional beamforming gain Y in dB.
If more than one antenna assembly is intended for this power setting, the maximum overall antenna gain (G or G + Y) shall be used.
The RF Output Power (P) shall be calculated using the formula below:

$$P = A + G + Y$$

This value, which shall comply with the limit given in clause 4.3.1.2.3 or clause 4.3.2.2.3, shall be recorded in the test report.

Test results

Mode: LE

Temperature (°C)	Nominal Voltage(V)	Measurement item	E.I.R.P power (dBm)		
			Frequency (2 402 MHz)	Frequency(2 440 MHz)	Frequency(2 480 MHz)
-10.0	DC 4.5	Burst RMS power	4.02	4.50	4.62
		E.I.R.P power	7.96	8.44	8.56
24.0		Burst RMS power	3.64	4.14	4.22
		E.I.R.P power	7.58	8.08	8.16
50.0		Burst RMS power	3.35	3.85	3.90
		E.I.R.P power	7.29	7.79	7.84

Note.

1. E.I.R.P power (dBm) = Average Power(dBm) + Ant Gain(dBi)
2. Antenna gain: 3.94 dBi

Limit (Clause 4.3.2.2.3)

For adaptive equipment using wide band modulations other than FHSS, the maximum RF output power shall be 20 dBm.

The maximum RF output power for non-adaptive equipment shall be declared by the manufacturer and shall not exceed 20 dBm. See clause 5.4.1 m). For non-adaptive equipment using wide band modulations other than FHSS, the maximum RF output power shall be equal to or less than the value declared by the manufacturer.

This limit shall apply for any combination of power level and intended antenna assembly.

4.4. Power spectral density

Measurement Condition

Ambient temperature : 24.0 ℃
Relative humidity : 40.2 % R.H.

Test procedure

EN 300 328 clause 5.4.3.2.1 – Option 1 or 2
Used test method is option 2.

Option 1 : For equipment with continuous and non-continuous transmissions.

The transmitter shall be connected to a spectrum analyser and the Power Spectral Density (PSD) as defined in clause 4.3.2.3 shall be measured and recorded.

The test procedure shall be as follows:

Step 1:
Connect the UUT to the spectrum analyser and use the following settings:

1. Start frequency : 2 400 ㎒
2. Stop frequency : 2 483.5 ㎒
3. RBW : 10 ㎑
4. VBW : 30 ㎑
5. Sweep points : > 8 350; for spectrum analysers not supporting this number of sweep points, the frequency band may be segmented
6. Detector : RMS
7. Trace mode : Max hold
8. Sweep time :
   For non-continuous transmissions : 2 × Channel Occupancy Time × number of sweep points.
   For continuous transmissions : 10 s; the sweep time may be increased further until a value where the sweep time has no further impact anymore on the RMS value of the signal.

For non-contimuous signals, wait for the trace to stabilize.
Save the data (trace data) set to a file.

Step 2 :
For conducted measurements on smart antenna systems using either operating mode 2 or operating mode 3 (see clause 5.3.2.2), repeat the measurement for each of the transmit ports. For each sampling point (frequency domain), add up the coincident power values (in ㎽) for the different transmit chains and use this as the new data set.

Step 3 :
Add up the values for power for all the samples in the file using the formula below.

$$P_{Sum} = \sum_{n=1}^{k} P_{sample}(n)$$

with k being the total number of samples and n the actual sample number

Step 4 :
Normalize the individual values for power (in ㏈m) so that the sum is equal to the RF Output Power (e.i.r.p.) measured in clause 5.4.2 and save the corrected data. The following formulas can be used:

$$C_{Corr} = P_{Sum} - P_{e.i.r.p.}$$

$$P_{Samplecorr}(n) = P_{Sample}(n) - C_{Corr}$$

with n being the actual sample number

Step 5 :
Starting from the first sample *PSamplecorr(n)* (lowest frequency), add up the power (in ㎽) of the following samples representing a 1 ㎒ segment and record the results for power and position (i.e. sample #1 to sample #100).
This is the Power Spectral Density (e.i.r.p.) for the first 1 ㎒ segment which shall be recorded.

Step 6 :
Shift the start point of the samples added up in step 5 by on sample and repeat the procedure in step 5 (i.e. sample #2 to sample #101).

Step 7 :
Repeat step 6 until the end of the data set and record the Power Spectral Density values for each of the 1 ㎒ segments.

From all the recorded results, the highest value is the maximum Power Spectral Density (PSD) for the UUT. This value, which shall comply with the limit given in clause 4.3.2.3.3, shall be recorded in the test report.

Option 2 : For equipment with continuous transmission capability or for equipment operating (or with the capability to operate) with a constant duty cycle (e.g. Frame Based equipment)

This option is for equipment that can be configured to operate in a continuous transmit mode (100% DC) or with a constant Duty Cycle (DC).

Step 1 :
Connect the UUT to the spectrum analyser and use the following settings:

1. Centre frequency : The centre frequency of the channel under test
2. RBW : 1 ㎒
3. VBW : 3 ㎒
4. Frequency span : 2 × Nominal Bandwidth (e.g. 40 ㎒ for a 20 ㎒ channel)
5. Detector mode : peak
6. Trace mode : Max hold

Step 2 :
When the trace is complete, find the peak value of the power envelope and record the frequency.

Step 3 :
Make the following changes to the settings of the spectrum analyser :

1. Centre frequency : Equal to the frequency recorded in step 2
2. Frequency span : 3 ㎒
3. RBW : 1 ㎒
4. VBW : 3 ㎒
5. Sweep time : 1 minute
6. Detector mode : RMS
7. Trace mode : Max hold

Step 4 :
When the trace is complete, the trace shall be captured using the “Hold” or “View” option on the spectrum analyser.

Find the peak value of the trace and place the analyser marker on this peak. This level is recorded as the highest mean power (power spectral density) D in a 1 ㎒ band.

Alternatively, where a spectrum analyser is equipped with a function to measure power spectral density, this function may be used to display the power spectral density D in ㏈m/㎒.

In case of conducted measurements on smart antenna systems operating in a mode with multiple transmit chains active simultaneously, the power spectral density of each transmit chain shall be measured separately to calculate the total power spectral density (value D in ㏈m/㎒) for the UUT.

Step 5 :
The maximum Power Spectral Density (PSD) e.i.r.p is calculated from the above measured power spectral density D, the observed Duty Cycle(DC) (see clause 5.4.2.2.1.3, step 4), the applicable antenna assembly gain G in ㏈i and if applicable the beamforming gain Y in ㏈, according to the formula below. This value shall be recorded in the test report. If more than on antenna assembly is intended for this power setting, the gain of the antenna assembly with the highest gain shall be used.

$$PSD = D + G + Y + 10 \times \log(1 / DC) \text{ (dBm/MHz)}$$

Test results

Mode: LE

Temperature (°C)	Nominal Voltage(V)	Test mode	Power spectral density (㏈m/㎒)		
			Frequency (2 402 ㎒)	Frequency(2 440 ㎒)	Frequency(2 480 ㎒)
24.0	AC 230	LE	-1.45	-0.40	-0.03

Note.

1. Power spectral density (㏈m/㎒) = Measurement power spectral density (㏈m/㎒) + Ant. gain(㏈i)+ 10 × log(1 / DC)
2. Antenna gain: 3.94 ㏈i
3. Duty Cycle(Linear) : 0.627 8

Limit (Clause 4.3.2.3.3)

For equipment using wide band modulations other than FHSS, the maximum Power Spectral Density is limited to 10 ㏈m per ㎒

4.5. Occupied Channel Bandwidth

Measurement Condition

Ambient temperature :	24.0 ℃
Relative humidity :	40.2 % R.H.

Test procedure

EN 300 328 clause 5.4.7.2.1

The measurement procedure shall be as follows:

Step 1 :
Connect the UUT to the spectrum analyser and use the following settings:

1. Centre frequency : The centre frequency of the channel under test
2. RBW : ~ 1 % of the span without going below 1 %
3. VBW : 3 × RBW
4. Frequency span : 2 × Nominal Channel Bandwidth
5. Detector mode : RMS
6. Trace mode : Max hold
7. Sweep time : 1s

Step 2 :
Wait for the trace to stabilize.
Find the peak value of the trace and place the analyser marker on this peak.

Step 3 :
Use the 99 % bandwidth function of the spectrum analyser to measure the Occupied Channel Bandwidth of the UUT.
This value shall be recorded.

Make sure that the power envelope is sufficiently above the noise floor of the analyser to avoid the noise signals left and right from the power envelope being taken into account by this measurement.

Test results
Mode: LE

Channel	Test item		
	99 % Bandwidth (㎒)	F_L @ 99 % BW (㎒)	F_H @ 99 % BW (㎒)
Lowest	1.052	2 401.47	2 402.52
Highest	1.044	2 479.45	2 480.50

Limit (Clause 4.3.2.7.3)
The Occupied Channel Bandwidth shall fall completely within the band given in table 1.

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

4.7. Transmitter unwanted emissions in the out-of-band domain

Measurement Condition

Ambient temperature : 24.0 ℃

Relative humidity : 40.2 % R.H.

Test procedure

EN 300 328 clause 5.4.8.2.1

The applicable mask is defined by the measurement results from the tests performed under clause 5.4.7 (Occupied Channel Bandwidth).

The Out-of-band emissions within the different horizontal segments of the mask provided in figure 1 and figure 3 shall be measured using the procedure in step 1 to step 6 below. This method assumes the spectrum analyser is equipped with the Time Domain Power option.

Step 1 :

Connect the UUT to the spectrum analyser and use the following settings:

1. Centre frequency : 2 484 ㎒
2. Span : 0 ㎐
3. RBW : 1 ㎒
4. Filter mode : Channel filter
5. VBW : 3 ㎒
6. Detector mode : RMS
7. Sweep mode : Continuous
8. Sweep points : Sweep time [s] / (1 ㎲) or 5 000 whichever is greater
9. Trigger mode : Video trigger; in case video triggering is not possible, an external trigger source may be used.
10. Sweep time : >120% of the duration of the longest burst detected during the measurement of the RF Output Power

Step 2 (segment 2 483.5 ㎒ to 2 483.5 ㎒ + BW) :

Adjust the trigger level to select the transmissions with the highest power level.

For frequency hopping equipment operating in a normal hopping mode, the different hops will result in signal bursts with different power levels. In this case the burst with the highest power level shall be selected.

Set a window (start and stop lines) to match with the start and end of the burst and in which the RMS power shall be measured using the Time Domain Power function.

Select RMS power to be measured within the selected window and note the result which is the RMS power within this 1 ㎒ segment (2 483.5 ㎒ to 2 484.5 ㎒). Compare this value with the applicable limit provided by the mask.

Increase the centre frequency in steps of 1 ㎒ and repeat this measurement for every 1 ㎒ segment within the range 2 483.5 ㎒ to 2 483.5 ㎒ + BW. The centre frequency of the last 1 ㎒ segment shall be set to 2 483.5 ㎒ + BW – 0.5 ㎒ (which means this may partly overlap with the previous 1 ㎒ segment).

Step 3 (segment 2 483.5 ㎒ + BW to 2 483.5 ㎒ + 2BW) :

Change the centre frequency of the analyser to 2 484 ㎒ + BW and perform the measurement for the first 1 ㎒ segment within range 2 483.5 ㎒ + BW to 2 483.5 ㎒ + 2BW. Increase the centre frequency in 1 ㎒ steps and repeat the measurements to cover this whole range. The centre frequency of the last 1 ㎒ segment shall be set to 2 483.5 ㎒ + 2BW -0.5 ㎒ (which means this may partly overlap with the previous 1 ㎒ segment).

Step 4 (segment 2 400 ㎒ – BW to 2 400 ㎒) :

Change the centre frequency of the analyser to 2 399.5 ㎒ and perform the measurement for the first 1 ㎒ segment within range 2 400 ㎒ – BW to 2 400 ㎒ Reduce the centre frequency in 1 ㎒ steps and repeat the measurements to cover this whole range. The centre frequency of the last 1 ㎒ segment shall be set to 2 400 ㎒ – BW + 0.5 ㎒ (which means this may partly overlap with the previous 1 ㎒ segment).

Step 5 (segment 2 400 ㎒ – 2BW to 2 400 ㎒ - BW) :

Change the centre frequency of the analyser to 2 399.5 ㎒ and perform the measurement for the first 1 ㎒ segment within range 2 400 ㎒ – 2BW to 2 400 ㎒ – BW. Reduce the centre frequency in 1 ㎒ steps and repeat the measurements to cover this whole range. The centre frequency of the last 1 ㎒ segment shall be set to 2 400 ㎒ – 2BW + 0.5 ㎒ (which means this may partly overlap with the previous 1 ㎒ segment).

Step 6 :

In case of conducted measurements on equipment with a single transmit chain, the declared antenna assembly gain G in ㏈i shall be added to the results for each of the 1 ㎒ segments and compared with the limits provided by the mask given in figure 1 or figure 3. If more than on antenna assembly is intended for this power setting, the antenna with the highest gain shall be considered.

In case of conducted measurements on smart antenna systems (equipment with multiple transmit chains), the measurements need to be repeated for each of the active transmit chains. The declared antenna assembly gain G in ㏈i For a single antenna shall be added to these results. If more than one antenna assembly is intended for this power setting, the antenna with the highest gain shall be considered. Comparison with the applicable limits shall be done using any of the options given below:

- Option 1 : the results for each of the transmit chains for the corresponding 1 ㎒ segments shall be added. The additional beamforming gain Y in ㏈ shall be added as well and the resulting values compared with the limits provided by the mask given in figure 1 or figure 3.
- Option 2 : the limits provided by the mask given in figure 1 or figure 3 shall be reduced by $10 \times \log_{10}(A_{ch})$ and the additional beamforming gain Y in ㏈. The results for each of the transmit chains shall be individually compared with these reduced limits.

Note : A_{ch} refers to the number of active transmit chains.

It shall be recorded whether the equipment complies with the mask provided in figure 1 or figure 3.

Test results

Mode: LE

Temperature(℃)		OOB Range	Low Frequency		High Frequency	
			Measured frequency (㎒)	E.I.R.P. (㏈m/㎒)	Measured frequency (㎒)	E.I.R.P. (㏈m/㎒)
Min.	-10.0	A	2 399.50	-47.53	2 484.00	-48.02
		B	2 398.45	-51.16	2 485.10	-47.71
Nom.	24.0	A	2 399.50	-48.05	2 484.00	-47.82
		B	2 398.45	-51.22	2 485.04	-47.99
Max.	50.0	A	2 399.50	-48.59	2 484.00	-48.92
		B	2 398.50	-51.98	2 485.05	-48.72

Note:

1. E.I.R.P (㏈m/㎒) = OOB emission(㏈m/㎒) + Ant Gain(㏈i)
2. Antenna gain: 3.94 ㏈i

Limit (Clause 4.3.2.8.3)

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

Within the band specified in table 1, the Out-of-band emissions are fulfilled by compliance with the Occupied Channel Bandwidth requirement in clause 4.3.2.7.

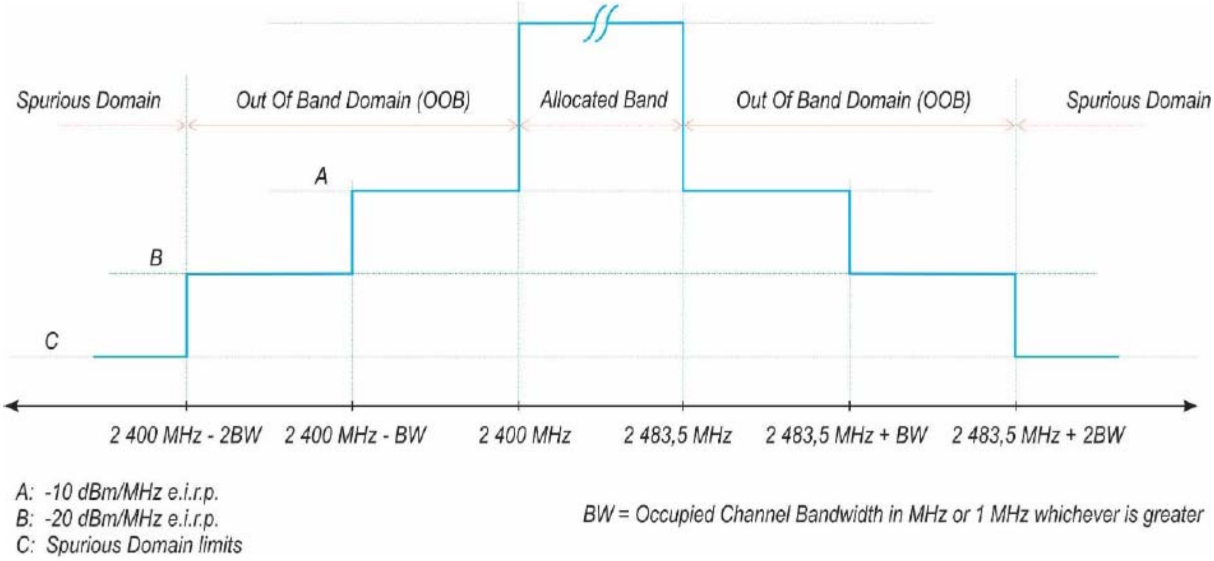


Figure: 3: Transmit mask

4.8. Receiver blocking

Measurement Condition

Ambient temperature : 24.0 ℃

Relative humidity : 40.2 % R.H.

Test procedure

EN 300 328 clause 5.4.11.2.1

For systems using multiple receive chains only on chain (antenna port) need to be tested. All other receiver inputs shall be terminated.

Figure 6 shows the test set-up which can be used for performing the receiver blocking test.

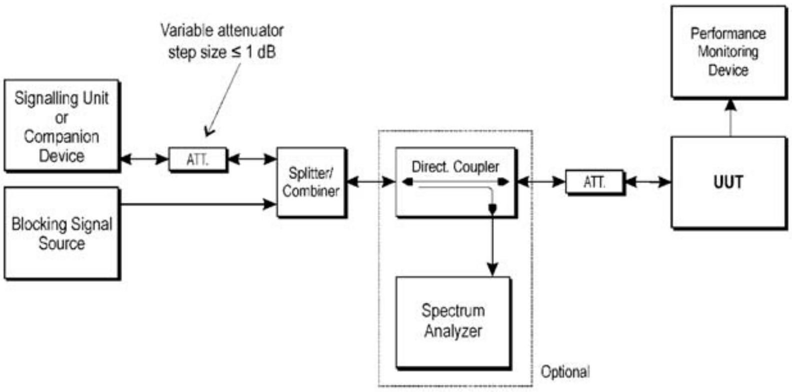


Figure 6: Test Set-up for receiver blocking

The procedure in step 1 to step 6 below shall be used to verify the receiver blocking requirement as described in clause 4.3.1.12 or clause 4.3.2.11.

Table 6, table 7 and table 8 in clause 4.3.1.12.4 contain the applicable blocking frequencies and blocking levels for each of the receiver categories for testing Receiver Blocking on frequency hopping equipment.

Table 14, table 15 and table 16 in clause 4.3.2.11.4 contain the applicable blocking frequencies and blocking levels for each of the receiver categories for testing Receiver Blocking on equipment using wide band modulations other than FHSS.

Step 1 :

For non-frequency hopping equipment, the UUT shall be set to the lowest operating channel.

Step 2 :

The blocking signal generator is set to the first frequency as defined in the appropriate table corresponding to the receiver category and type of equipment.

Step 3:

With the blocking signal generator switched off, a communication link is established between the UUT and the associated companion device using the test setup shown in figure 6. The attenuation of the variable attenuator shall be increased in 1 dB steps to a value at which the minimum performance criteria as specified in clause 4.3.1.12.3 or clause 4.3.2.11.3 is still met. The resulting level for the wanted signal at the input of the UUT is P_{min}.

This signal level (P_{min}) is increased by the value provided in the table corresponding to the receiver category and type of equipment.

Step 4 :
The blocking signal at the UUT is set to the level provided in the table corresponding to the receiver category and type of equipment. It shall be verified and recorded in the test report that the performance criteria as specified in clause 4.3.1.12.3 or clause 4.3.2.11.3 is met.

Step 5 :
Repeat step 4 for each remaining combination of frequency and level for the blocking signal as provided in the table corresponding to the receiver category and type of equipment.

Step 6 :
For non-frequency hopping equipment, repeat step 2 to step 5 with the UUT operating at the highest operating channel.

Test results
Mode: LE(1Mbps)

RX Channel	Int. Freq. (㎒)	Int. Lev. (dB m)	Int. Signal	Verdict
Lowest	2380.0	-57	CW	Pass
Lowest	2503.5	-57	CW	Pass
Lowest	2300.0	-47	CW	Pass
Lowest	2583.5	-47	CW	Pass
Highest	2380.0	-57	CW	Pass
Highest	2503.5	-57	CW	Pass
Highest	2300.0	-47	CW	Pass
Highest	2583.5	-47	CW	Pass

Note.
1. This device applies to receiver category 2.

Limit (Clause 4.3.2.11.4.1)

While maintaining the minimum performance criteria as defined in clause 4.3.2.11.3, 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, table 15 or table 16.

Receiver Category 1

Table 14 contains the Receiver Blocking parameters for Receiver Category 1 equipment.

Table 14: Receiver Blocking parameters for Receiver Category 1 equipment

Wanted signal mean power from companion device (dBm)	**Blocking signal frequency(㎒)**	**Blocking signal power (dBm) (see note 2)**	**Type of blocking signal**
P_{min} + 6 dB	2380 2503.5	-53	CW
P_{min} + 6 dB	2300 2330 2360	-47	CW
P_{min} + 6 dB	2523.5 2553.5 2583.5 2613.5 2643.5 2673.5	-47	CW
NOTE 1: P_{min} is the minimum level of the wanted signal (in dBm) required to meet the minimum performance criteria as defined in clause 4.3.2.11.3 in the absence of any blocking signal. NOTE 2: The levels specified are levels in front of the UUT antenna. In case of conducted measurements, the levels have to be corrected by the actual antenna assembly gain.			

Receiver Category 2

Table 15 contains the Receiver Blocking parameters for Receiver Category 2 equipment.

Table 15: Receiver Blocking parameters receiver category 2 equipment

Wanted signal mean power from companion device (dB m)	Blocking signal frequency (MHz)	Blocking signal power (dB m) (see note 2)	Type of blocking signal
P_{min} + 6 dB	2380 2503.5	-57	CW
P_{min} + 6 dB	2300 2583.5	-47	CW

NOTE 1: P_{min} is the minimum level of the wanted signal (in dBm) required to meet the minimum performance criteria as defined in clause 4.3.2.11.3 in the absence of any blocking signal.

NOTE 2: The levels specified are levels in front of the UUT antenna. In case of conducted measurements, the levels have to be corrected by the actual antenna assembly gain.

Receiver Category 3

Table 16 contains the Receiver Blocking parameters for Receiver Category 3 equipment.

Table 16: Receiver Blocking parameters receiver category 3 equipment

Wanted signal mean power from companion device (dB m)	Blocking signal frequency (MHz)	Blocking signal power (dB m) (see note 2)	Type of blocking signal
P_{min} + 12 dB	2380 2503.5	-57	CW
P_{min} + 12 dB	2300 2583.5	-47	CW

NOTE 1: P_{min} is the minimum level of the wanted signal (in dBm) required to meet the minimum performance criteria as defined in clause 4.3.2.11.3 in the absence of any blocking signal.

NOTE 2: The levels specified are levels in front of the UUT antenna. In case of conducted measurements, the levels have to be corrected by the actual antenna assembly gain.

Appendix A.
Measurement equipment

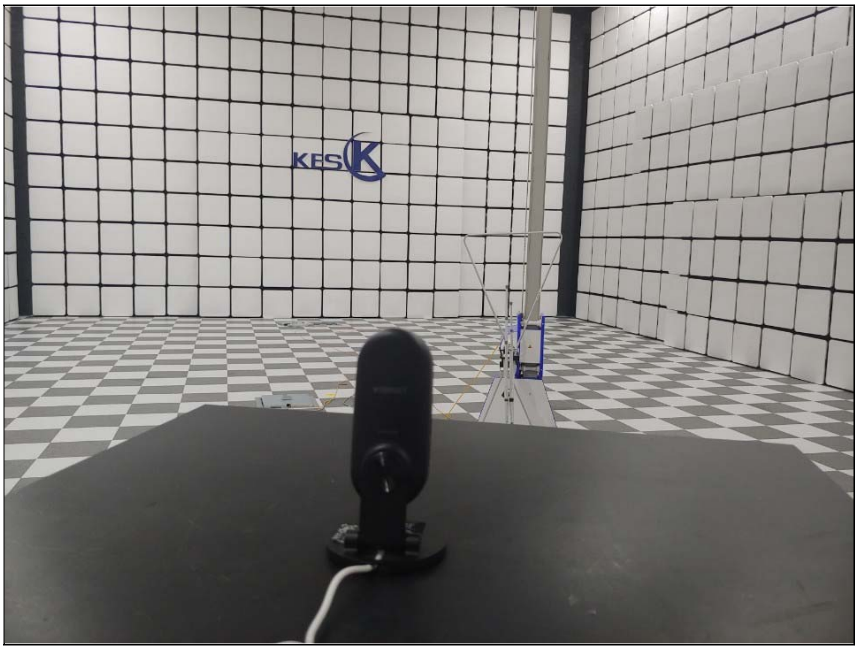
Equipment	Manufacturer	Model	Serial No.	Calibration interval	Calibration due.
Spectrum analyzer	R&S	FSV40	101002	1 year	2019.06.29
Spectrum analyzer	Agilent	N9020A	MY52091086	1 year	2019.01.19
USB Wideband Power Sensor	Agilent	U2021XA	MY54260004	1 year	2019.01.19
USB Wideband Power Sensor	Agilent	U2021XA	MY54340004	1 year	2019.01.19
USB Wideband Power Sensor	Agilent	U2021XA	MY54390010	1 year	2019.01.19
USB Wideband Power Sensor	Agilent	U2021XA	MY54390009	1 year	2019.01.19
Signal generator	Agilent	N5182A	MY50143493	1 year	2019.01.18
Signal generator	Agilent	N5182A	MY50143829	1 year	2019.01.18
8360B Series Swept Signal Generator	HP	83630B	3844A00786	1 year	2019.01.22
DC Power Supply	Agilent	6632B	US36351824	1 year	2019.01.18
Trilog-broadband antenna	SCHWARZBECK	VULB 9163	714	2 years	2020.11.26
Dipole antenna	SCHWARZBECK	VHA9103	3093	2 years	2019.05.19
Dipole antenna	SCHWARZBECK	UHA9105	2703	2 years	2019.05.19
Dipole antenna	SCHWARZBECK	VHA9103	3101	2 years	2019.05.19
Dipole antenna	SCHWARZBECK	UHA9105	2702	2 years	2019.05.19
Horn Antenna	A.H.	SAS-571	781	2 years	2019.05.02
Horn Antenna	A.H SYSTEMS	SAS-571	414	2 years	2019.02.15
Preamplifier	R&S	SCU01	100603	1 year	2019.11.26
Preamplifier	HP	8447F	2805A02570	1 year	2019.01.18
Attenuator	KEYSIGHT	8493C	82506	1 year	2019.01.18
High Pass Filter	WAINWRIGHT INSTRUMENT	WHJS3000-10TT	1	1 year	2019.06.29
Low Pass Filter	WEINSCHEL	WLK1.0/18G-10TT	1	1 year	2019.06.29
Splitter	MINI-CIRCUITS	ZFSC-2-10G+	F679501347-1	1 year	2019.06.28
Splitter	MINI-CIRCUITS	ZFSC-2-10G+	F679501347-2	1 year	2019.06.28
Dual Directional Coupler	KRYTAR	152613	153577	1 year	2019.06.28

Peripheral devices

Device	Manufacturer	Model No.	Serial No.
Notebook Computer	Samsung Electronics Co., Ltd.	RV518	HTK991NC600207R

Appendix B.
Test setup photos

Below 1 ㎓

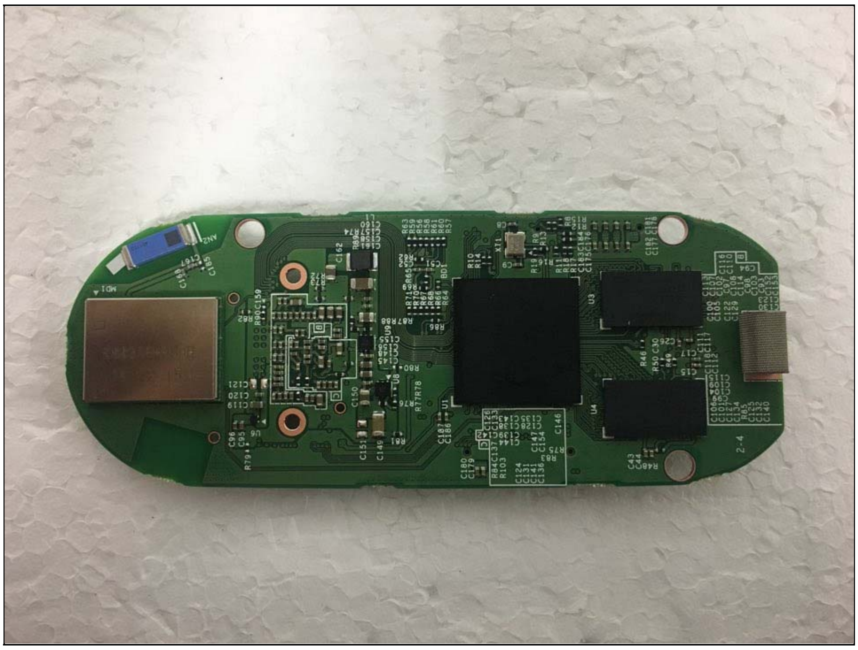


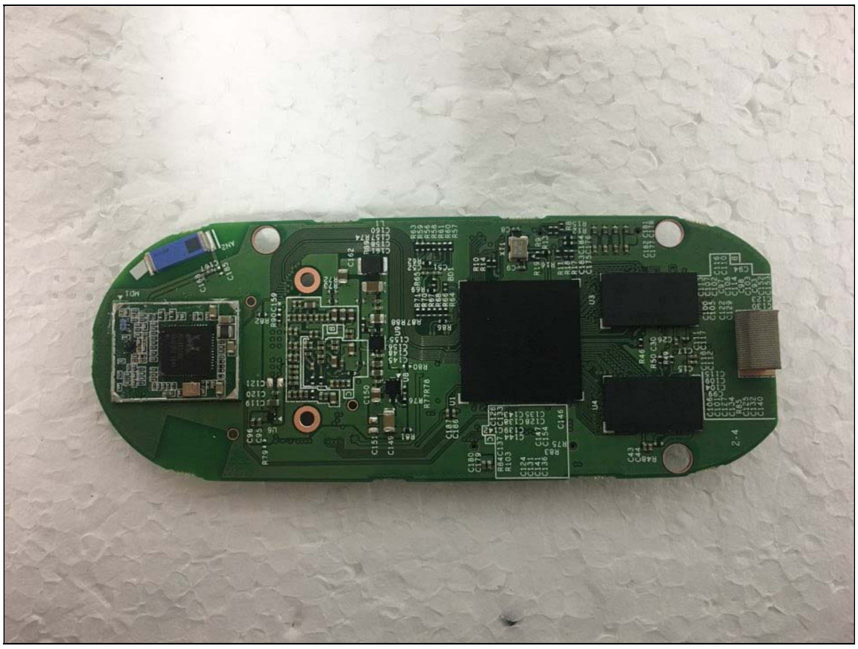
Above 1 ㎓

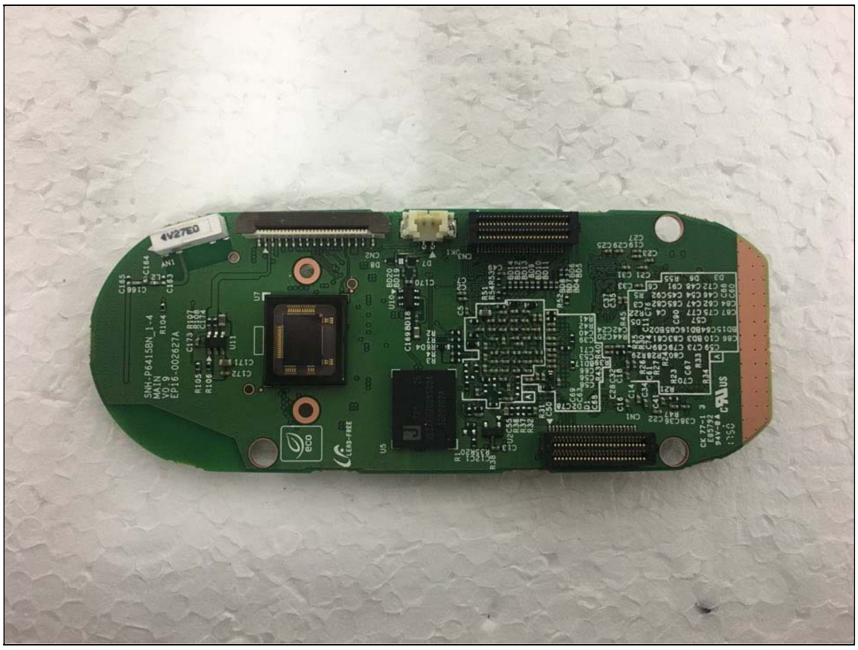
Appendix C.
EUT photos

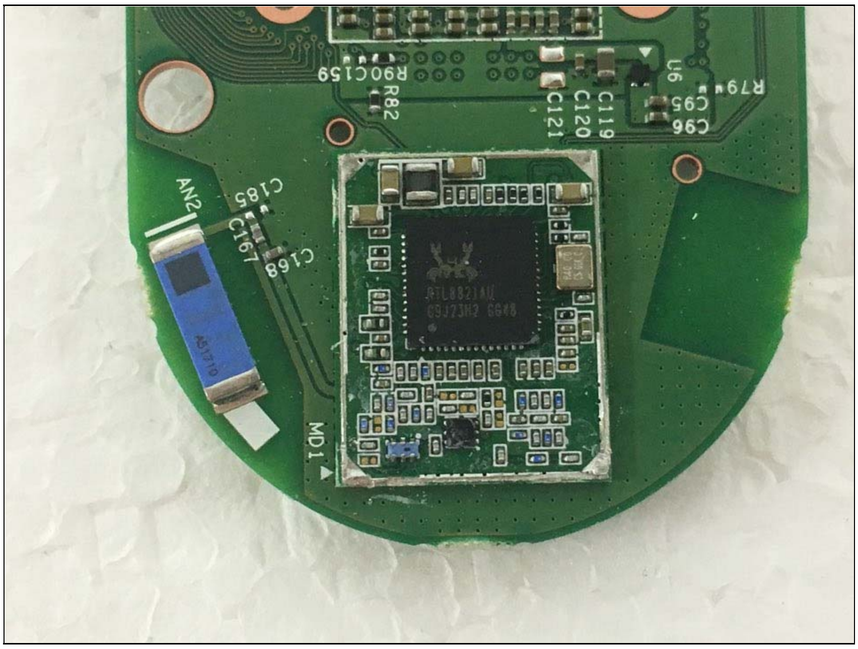

WISENET


WISENET

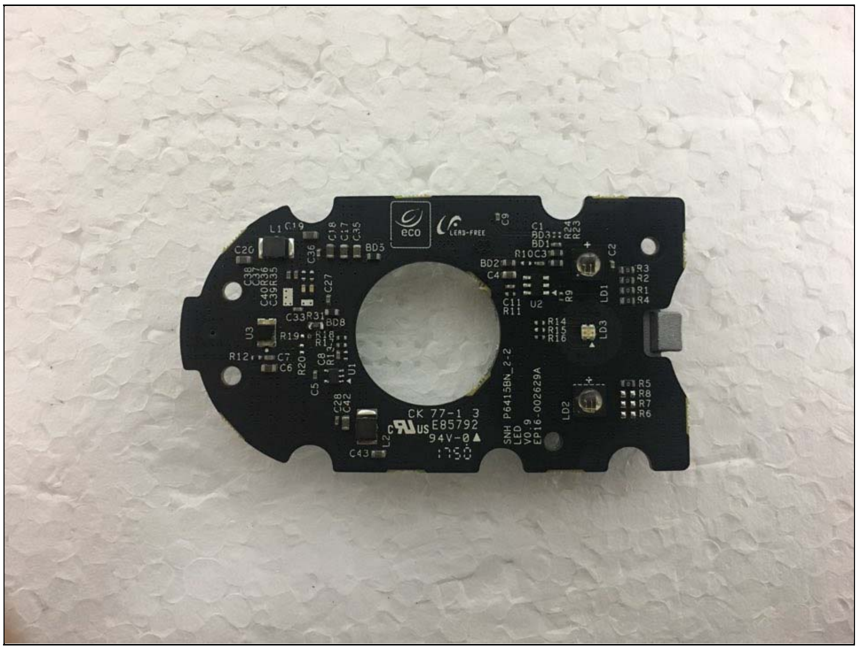




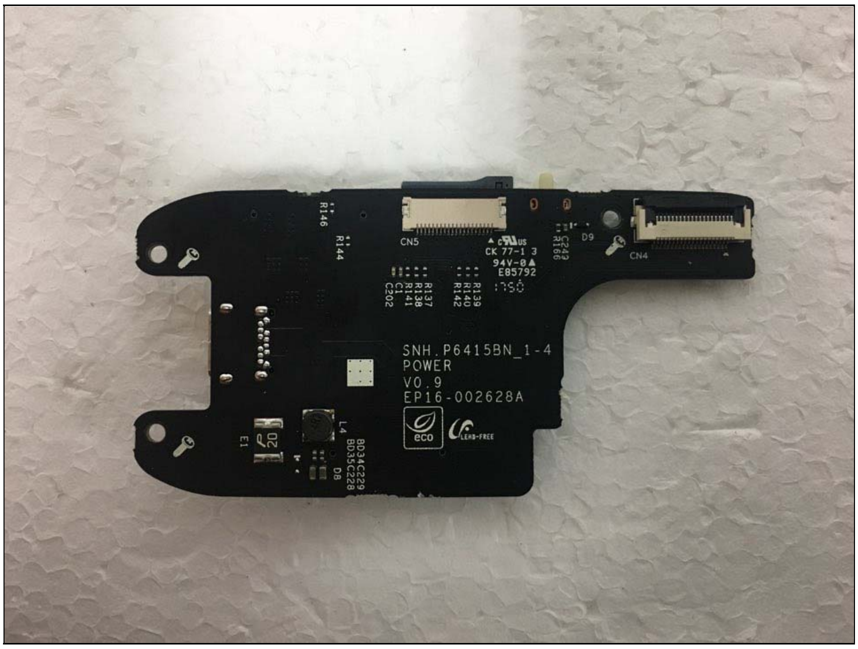


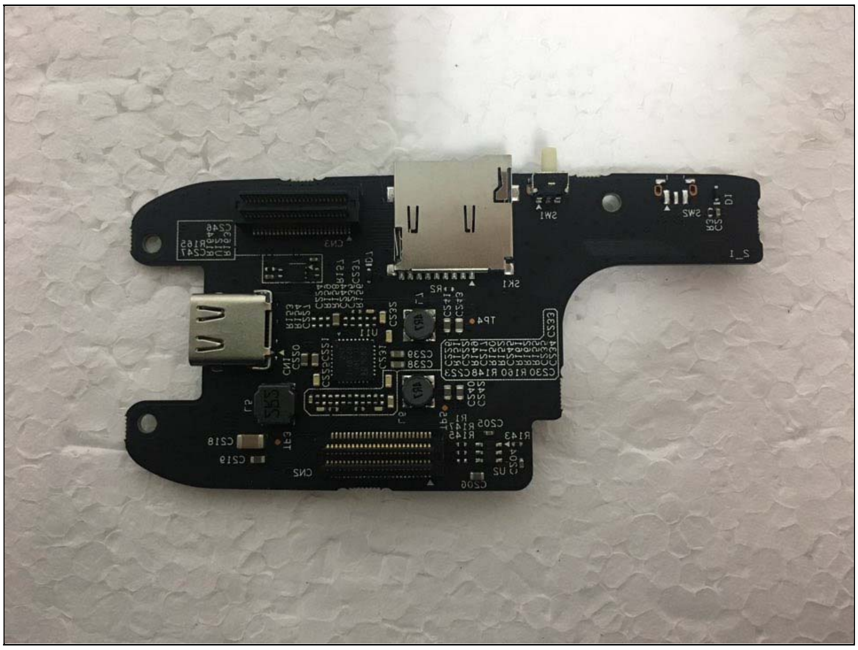


AN2
C185
C167
C168
R90
C159
R82
C121
C120
C119
U6
C95
C96
R79
MD1



CK 77-1 3
E85792
94V-0
SNH P6415BN_2-2
LED





The end of test report.