FCC TEST REPORT No. 09/08-244/100	10 March 2009
for 47 CFR Part 15 Subpart C	date of issue

Model name:	Transmitter Module 2.4 Dual FHSS 12 channels Typ-D
Product description	Transceiver
FCC ID	
Applicant	Weatronic GmbH, Seidenstraße 57, 70174 Stuttgart, Germany
Manufacturer	Weatronic GMBH, SeidenstraЯe 57, 70174 Stuttgart, Germany

The results in this report apply only to the samples tested.

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Deputy manager of Testing Laboratory

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1 EQUIPMENT UNDER TEST

1.1 Basic description

Equipment Category	Transceiver
Model name	Typ-D
Serial numbers	30108060019

1.2 Technical characteristics declared by manufacturer

Frequency range	2,401 GHz - 2,4835 GHz
Number of channels	81
Carrier frequency of each channel	2402 + n×1 MHz, n=0…78
Channel spacing	1 MHz
Maximum output power	20 dBm (100 mW)
Modulation form	FHSS
Modulation type	QPSK
Data rate	1 Mbps
Antenna type	2 patch antennas
Temperature range	from minus 10^{o}C till +60 ^{o}C
Supply voltage	5 V – 10 V

1.3 Photos

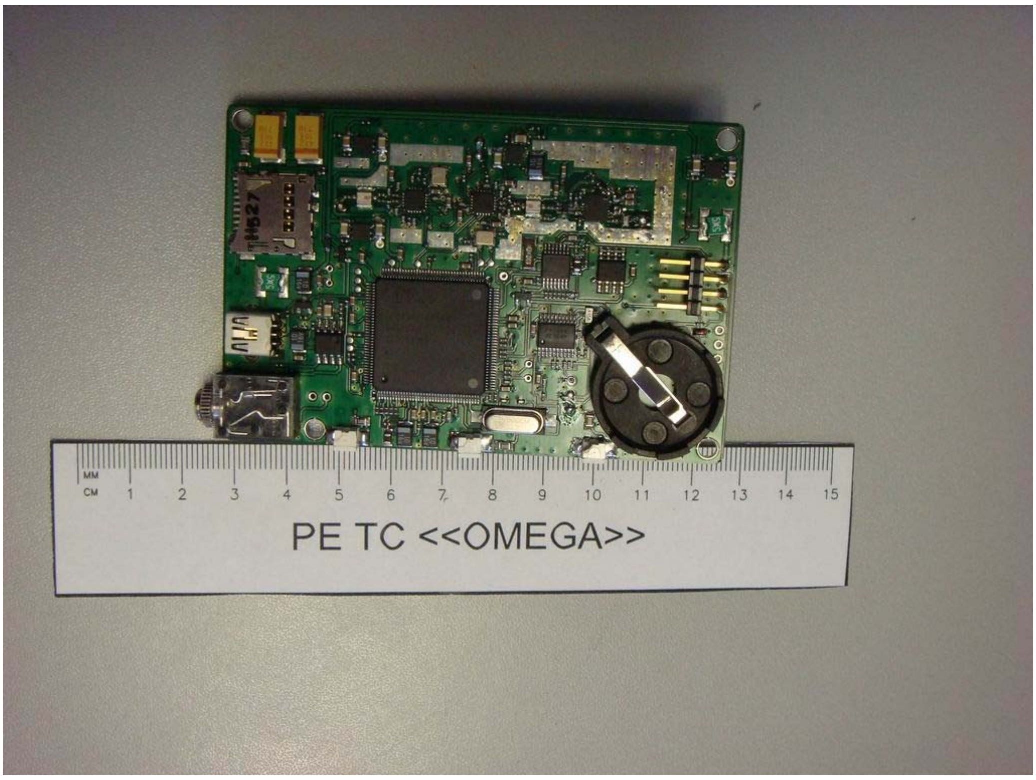


Figure 1 – Model Typ-D. Front view.

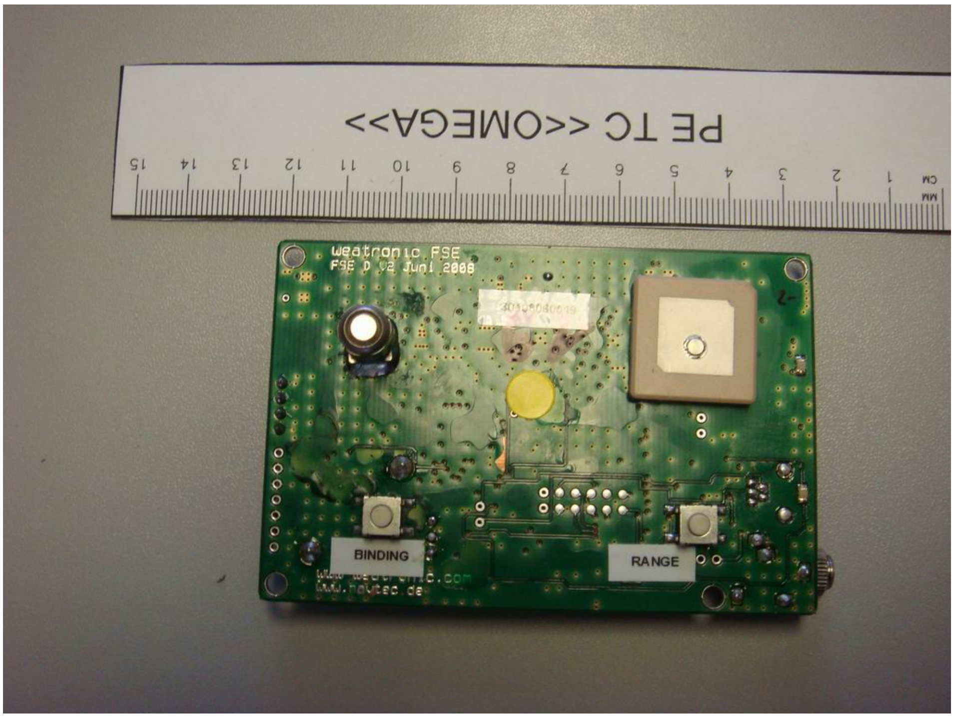


Figure 2 – Model Typ-D. Rear view.

2 GENERAL INFORMATION ABOUT TESTS

2.1 Test program and results of the tests

Number of test	FCC rule	Description of test	Result (Pass, Fail, N/A)
1	15.247(a)(1)	Hopping channel separation	Pass
2	15.247(a)(1)(iii)	Number of hopping frequencies used	Pass
3	15.247(a)(1)	Hopping channel bandwidth	Pass
4	15.247(a)(1)(iii)	Dwell time of each frequency	Pass
5	15.247(b)(1)	Output power	Pass
6	15.247(d)	Band edge emissions	Pass
7	15.209	Radiated emission	Pass
8	15.203	Antenna requirement	Pass

Tested by:

tests No. 1-6: Laboratory engineer Boris Trifonov

tests No. 7-8: Laboratory engineer Vladimir Osaulko

Checked by:

Laboratory manager Alexander Spektor

2.2 Test manner

The EUT was programmed to transmit signal continuously for all testing.
The EUT consists from two identical transmitter chains with two transmitters and two antennas. The chain with the maximum output power was chosen for the tests.
For organization of connection was used ancillary transceiver Typ-F.
The test distance of radiated emission from antenna to EUT is 3 m.
Methods of measurement - according to ANSI C63.4-2003.

2.3 Test conditions and test modes

Normal temperature and humidity:
- temperature: from +15 ºC to +35 ºC;
- relative humidity: from 20 % to 75 %

Normal power source:
- Unom = 6 V DC.

The frequencies for the testing

Channel, No.	Frequency, MHz
0	2402
39	2440
78	2480

2.4 Test equipment used

№	Name	Model	Inventory or serial No.
1.	Spectrum analyzer	HP8593E	3831U02306
2.	Attenuator	HP8498A	7781
3.	Wattmeter of absorbed power	M3-56	4738
4.	Oscillograph	TDS1002	C041673
5.	Coaxial detector	8471E	100104
6.	Directional coupler	778D	100100
7.	Power supply	TEC-5010	117
8.	Barometer	M67	25870
9.	Climatic chamber	КРК-400 V	015
10.	Psychrometer	ВИТ-2	Г224
11.	Test site	EMI Semi Anechoic Chamber “DON” (Fig. 4.2)	
12.	Test receiver	ESPC ROHDE & SCHWARTZ	84855/024
13.	Measurement Biconical antenna	UBAA 9114-214 SCHWARZBECK	214
14.	Measurement Biconical antenna	HK – 116 ROHDE & SCHWARTZ	20248181
15.	Double Ridge Horn Antenna	HP11966E модель 3115 ROHDE & SCHWARTZ	5701
16.	Double Ridge Horn Antenna	BBHA9170 ROHDE & SCHWARTZ	9170304

All listed above test equipment is calibrated and certified in accordance with established procedure. The equipment has certificates currently in force.

Ancillary equipment

№	Name	Model	Serial number
1.	TX-Modul	Typ-F	31408060010
2.	Typ-D Adapter	WFT 09	-
3.	servo-mechanism	DS1015	-
4.	Nickel Metal Hydride Battery Sanyo Ni-MH 1850 mAh	model hr-3u 1,2 V x 4	-
5.	Laptop “ACER”	TravelMate 2413C series	102509-00248

2.5 Measurement uncertainty

Parameter	Maximum uncertainty
Output power	± 1.24 dB
Frequency range	$\pm 6\times10^{-7}$
Spurious emissions	± 2.7 dB
Radiated emission	± 5.2 dB

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

Measurement uncertainty complies with the requirements of the normative documents and is guaranteed by the test procedures and test equipment.

2.6 Photo of test site

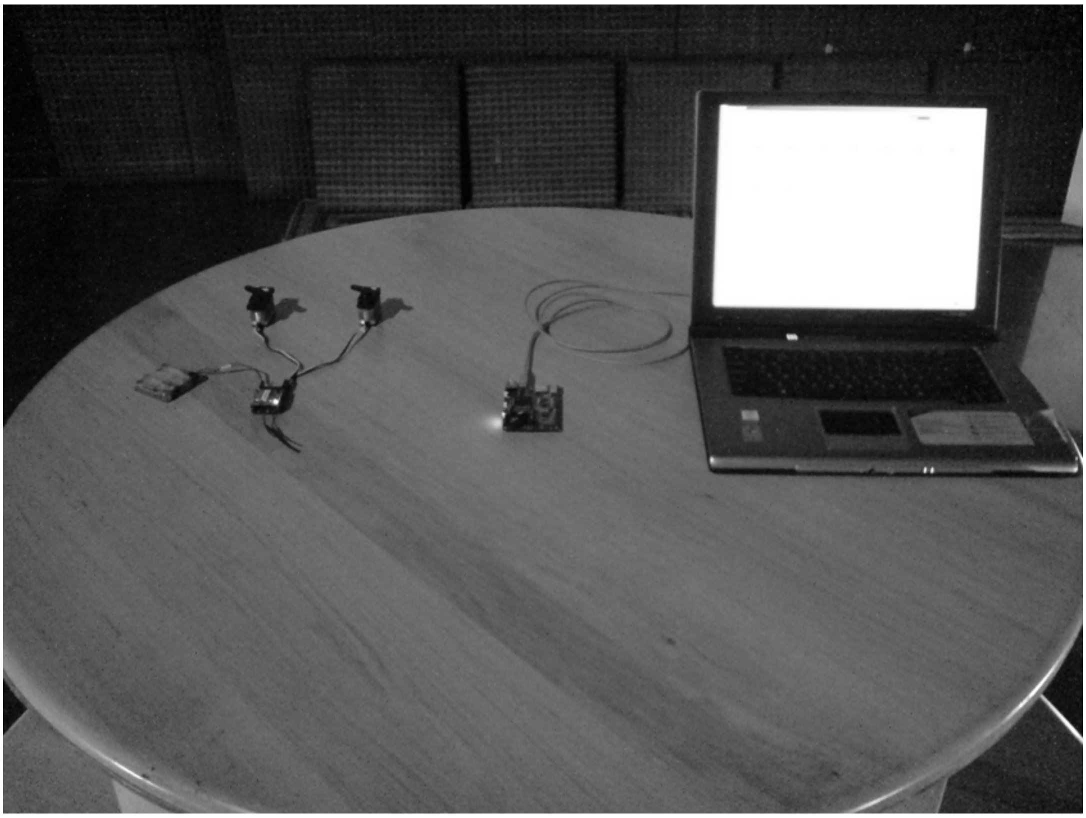


Figure 3 - Set-up 1

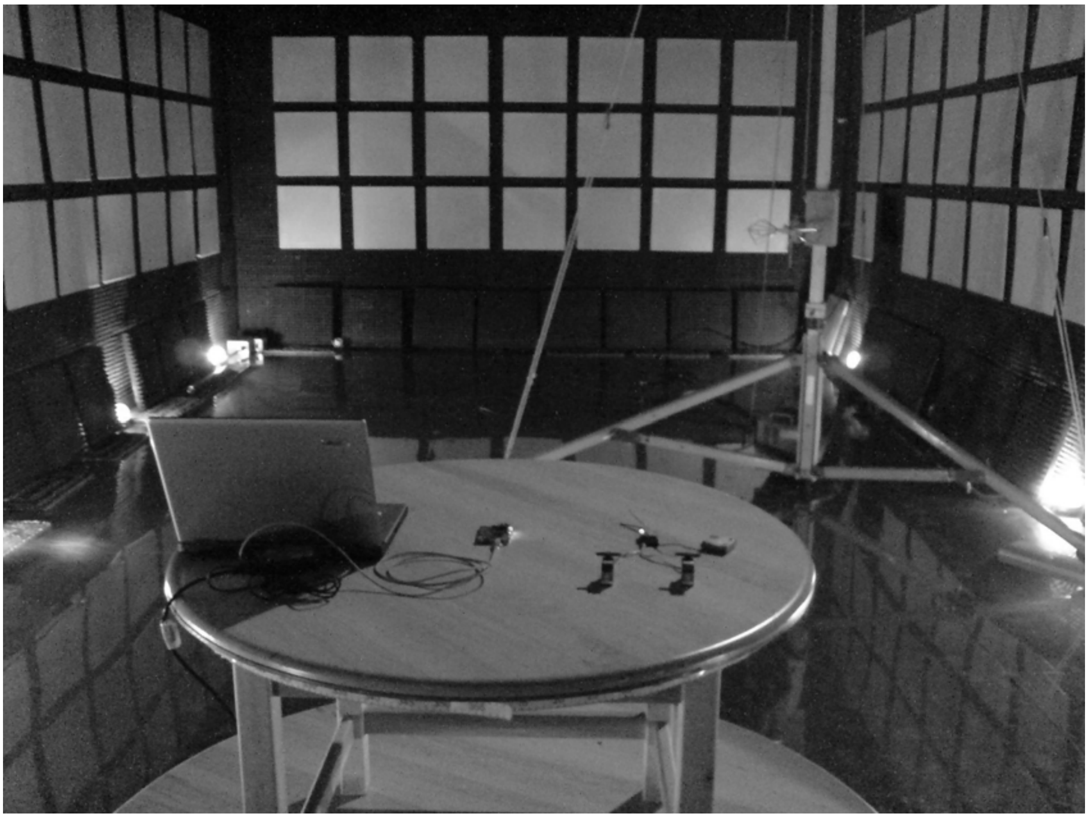


Figure 4 - EMI Radiated interference field strength measurement

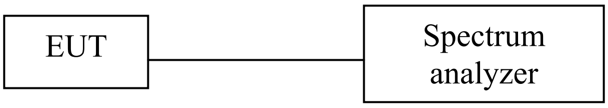
3 REPORT OF MEASUREMENTS AND EXAMINATIONS.

3.1 Hopping channel separation

3.1.1 Test procedure

1) The transmitter output was connected to the spectrum analyzer directly.
2) Set RBW of spectrum analyzer to 100 kHz and VBW to 100 kHz.
3) The Hopping channel separation is defined as the channel is separated with the next channel.

3.1.2 Test setup layout



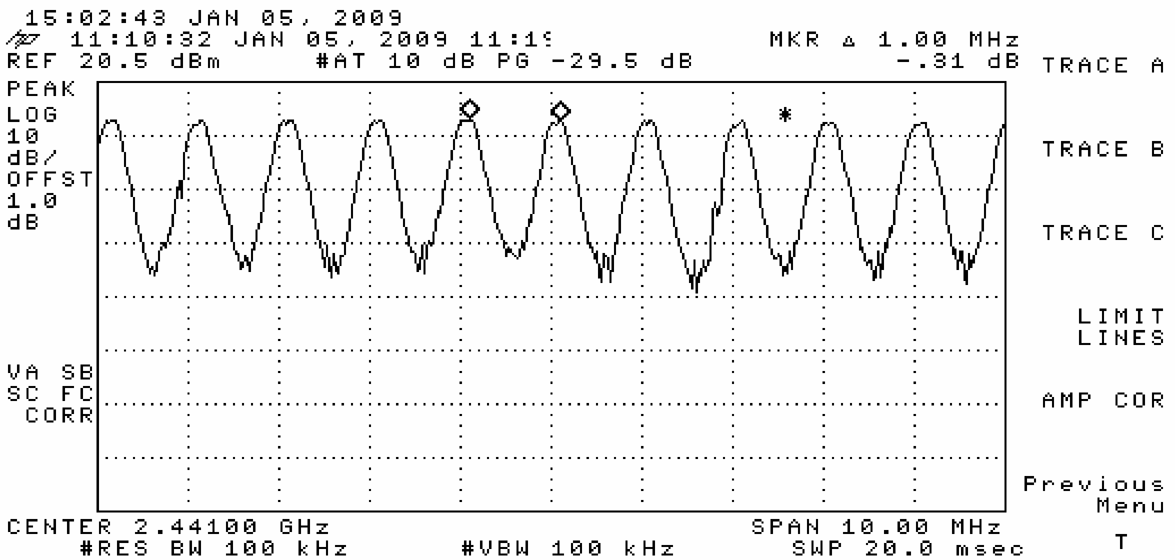
3.1.3 Test result

Temperature: +18°C Relative humidity: 60 %

Channel	Frequency, MHz	Hopping channel separation, MHz	Limit, MHz	Result (Pass, Fail, N/A)
0	2402	1,0	0.824	Pass
39	2440	1,0	0.826	Pass
78	2480	1,0	0.824	Pass

Remark: frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

3.1.4 Plot

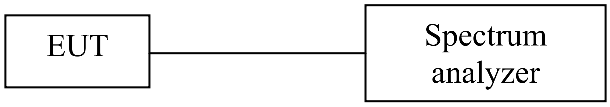


<u>3.2 Number of hopping frequencies used</u>

3.2.1 Test procedure

1) The transmitter output was connected to the spectrum analyzer directly.
2) Set RBW of spectrum analyzer to 300 kHz and VBW to 300 kHz.
3) The Number of hopping frequencies used is defined as the device has numbers of total channel.

3.2.2 Test setup layout



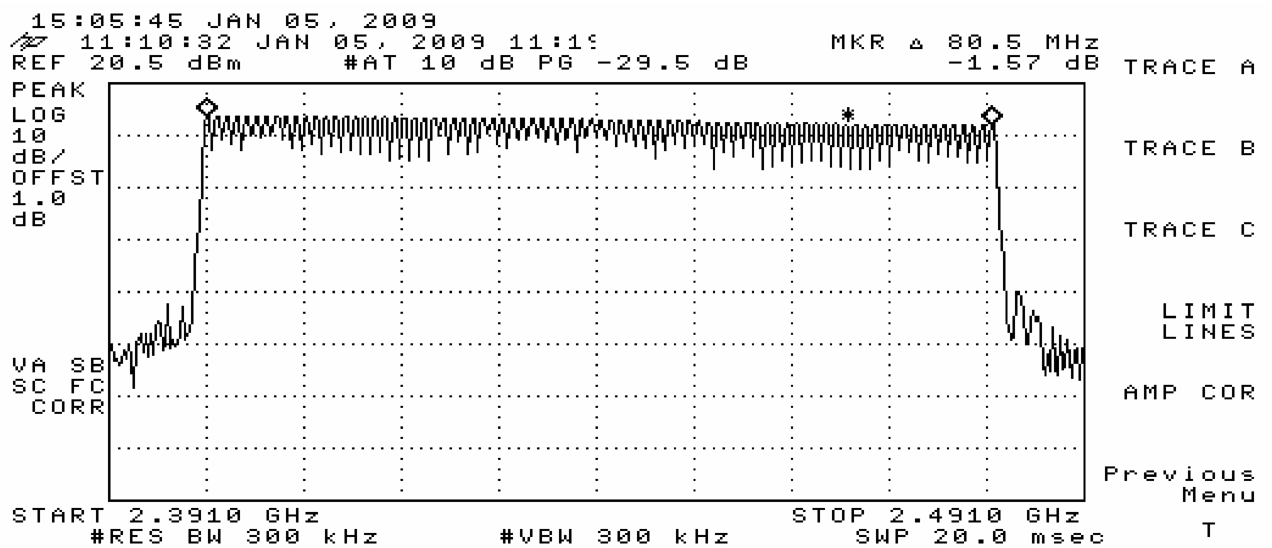
3.2.3 Test result

Temperature: +18°C Relative humidity: 60 %

Number of hopping frequencies	**Limit**	**Result (Pass, Fail, N/A)**
79	15	Pass

Remark: The hopping sequence of a FHSS system is the sequence of the hopping channels used by the equipment. Non-adaptive Frequency Hopping systems shall make use of a hopping sequence(s) that contains at least 15 hopping channels. Adaptive Frequency Hopping systems shall make use of a hopping sequence(s) that is capable of operating over a minimum of 90 % of the band specified in table, from which at any given time a minimum of 20 hopping channels shall be used. Each hopping channel of the hopping sequence shall be occupied at least once during a period not exceeding four times
the product of the dwell time per hop and the number of channels.

3.2.4 Plot

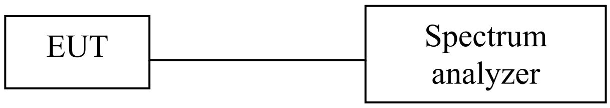


3.3 Hopping channel bandwidth

3.3.1 Test procedure

1) The transmitter output was connected to the spectrum analyzer directly.
2) Set RBW of spectrum analyzer to 100 kHz and VBW to 100 kHz.
3) The Hopping channel bandwidth is defined as the frequency range where the power is higher than peak power minus 20 dB.

3.3.2 Test setup layout



3.3.3 Test result

Temperature: +18°C Relative humidity: 60%

Channel	Frequency, MHz	Hopping channel bandwidth, MHz	Limit, MHz	Result (Pass, Fail, N/A)
0	2402	0,89	1.0	Pass
39	2440	0,89	1.0	Pass
78	2480	0,89	1.0	Pass

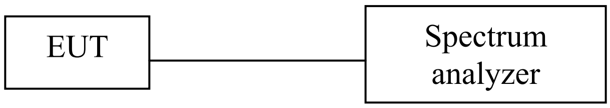
Remark: Non-adaptive Frequency Hopping systems shall make use of non-overlapping hopping channels separated by the channel bandwidth as measured at 20 dB below peak power.
The hopping channels defined within a hopping sequence shall be at least 1 MHz apart (channel separation).

3.4 Dwell time of each frequency within a 30 seconds period

3.4.1 Test procedure

1) The transmitter output was connected to the spectrum analyzer directly.
2) Set RBW of spectrum analyzer to 1 MHz and VBW to 1 MHz.
3) Set the center frequency on any frequency would be measured and set the frequency span to zero span.
4) The equation = 30×(1600/79) × t, "t" is the time duration of one single pulse.

3.4.2 Test setup layout



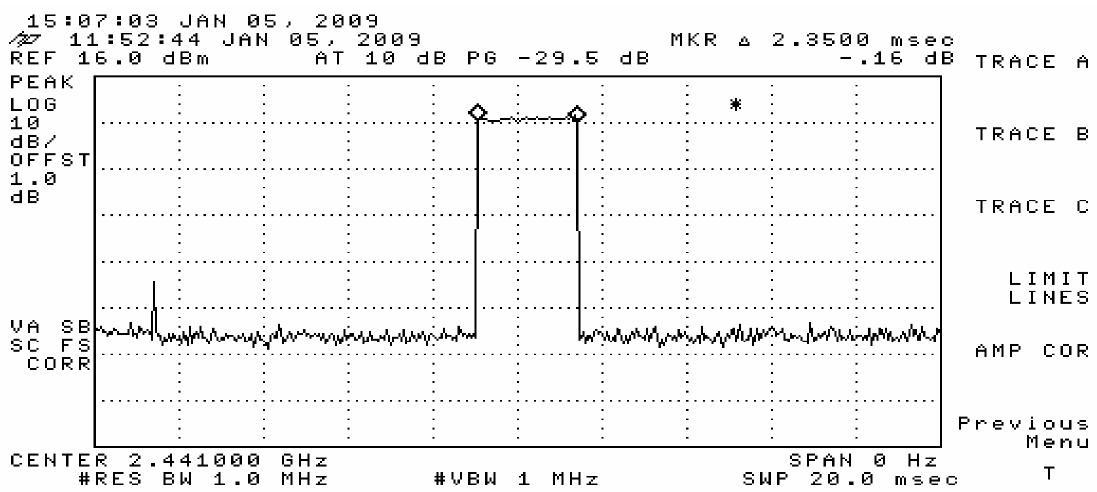
3.4.3 Test result

Temperature: +18°C Relative humidity: 60 %

Channels	Dwell time, ms	Limit, s	Result (Pass, Fail, N/A)
0	2,35	0.4	Pass
39	2,35	0.4	Pass
78	2,35	0.4	Pass

Remark:
1. Dwell time = 79 (channels) × 0.4 (s) × average hopping channel × package transfer time.
2. 79 channels come from the Hopping channel number.
3. Average hopping channel = hops/sweep time.
4. Package transfer time (us).

3.4.4 Plots

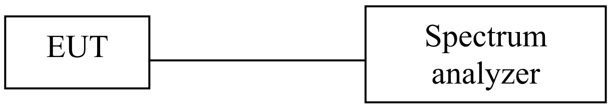


3.5 Output power

3.5.1 Test procedure

1) The transmitter output was connected to the spectrum analyzer directly.
2) The center frequency of the spectrum analyzer was set to the fundamental frequency and set RBW to 1MHz and VBW to 1MHz.

3.5.2 Test setup layout



3.5.3 Test result

Temperature: +18°C Relative humidity: 60 %

Channel	Frequency, MHz	Measured output power, mW	Limit, W	Result (Pass, Fail, N/A)
0	2402	48,6	1	Pass
39	2440	50,1	1	Pass
78	2480	50,8	1	Pass

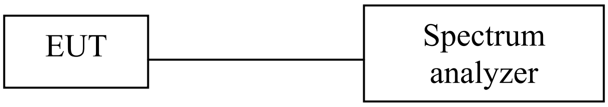
Remark: For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2401-2483.5 MHz band: 0.125 watts.
So the Limit is 1 watt.

3.6 Band edge emissions

3.6.1 Test procedure

1) The transmitter output was connected to the spectrum analyzer via a low lose cable.
2) Set both RBW and VBW of spectrum analyzer to 100 kHz with suitable frequency span for the conducted measurement
3) The band edges were measured and recorded.

3.6.2 Test setup layout



3.6.3 Test result

Temperature: +18°C Relative humidity: 60 %

Narrowband spurious emissions (the transmitter is operating)

Channel 0

Frequency, MHz	Level, dBm	Over limit, dBm	Limit line, dBm
300	- 58,6	22,6	- 36
465	- 52,4	16,4	- 36
1875	- 56,7	9,7	- 47
2290	- 47,1	17,1	- 30
3080	- 55,1	25,1	- 30
5170	- 55,6	8,6	- 47
7900	- 47.5	17.5	- 30
11040	- 46,6	16.6	- 30

Channel 78

Frequency, MHz	Level, dBm	Over limit, dBm	Limit line, dBm
320	- 59,1	23,1	- 36
525	- 56,8	20,8	- 36
1870	- 58,0	11,0	- 47
2270	- 51,4	21,4	- 30
2730	- 55,8	25,8	- 30
5185	- 55,2	12,2	- 47
7460	- 47,2	17,2	- 30
11140	- 47,0	17,0	- 30

Remark: The above limit values apply to narrowband emissions, e.g. as caused by local oscillator leakage. The measurement bandwidth for such emissions may be as small as necessary to achieve a reliable measurement result.

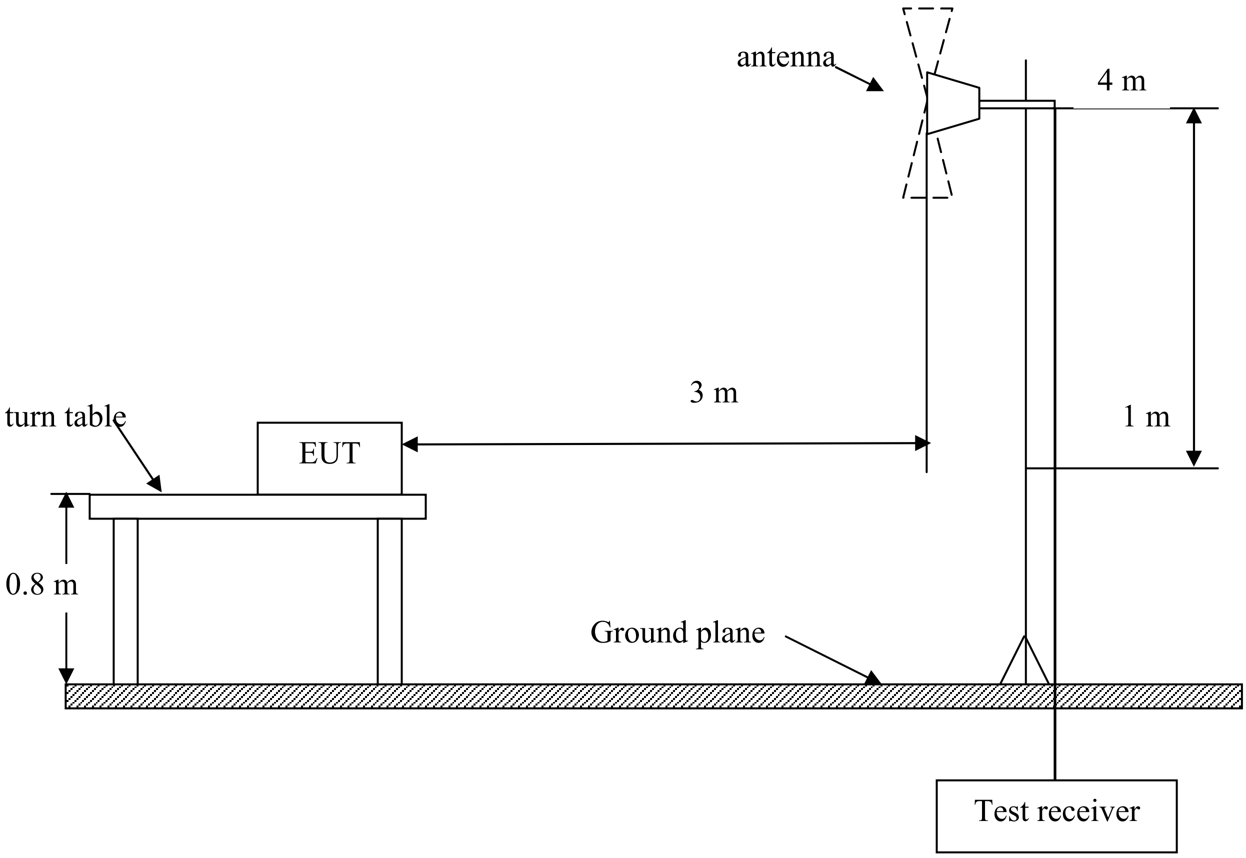
Test result in lower band (Channel 0) - Pass
Test result in higher band (Channel 78) - Pass

3.7 Radiated emission

3.7.1 Test procedure

1) The EUT was placed on a rotatable table top 0.8 m above the floor.
2) The EUT was set 3 meters from the interference receiving antenna which was mounted on the top of a variable height antenna tower.
3) The table was rotated 360 degrees to determine the position of the highest radiation.
4) The antenna is a broadband antenna and its height is varied between 1 meter and 4 meters above the floor to find the maximum value of the shield strength for both horizontal polarization and vertical polarization of the antenna.
5) For each suspected emission, the EUT was arranged to its worst case.
6) The test-receiver was set to Peal or Quasi-peak detect function with specified bandwidth with maximum hold mode.
7) For testing below 1 GHz, if the emission level of EUT in peak mode was 3 dB lower than the specified limit, the testing stopped and peak values of EUT were noted, otherwise, the emissions were repeating one by one using the quasi-peak method and noted.
8) For testing above 1 GHz, if the emission level of EUT in peak mode was 20 dB lower than average limit (it means the emission level in average mode also complies with the limit in average mode), then testing was stopped and peak values of EUT were noted, otherwise, the emissions were measured in average mode again and noted.

3.7.2 Test setup layout



3.7.3 Test result

Temperature: 20 °C Relative humidity: 65 %

The test that passed with a minimum margin is marked with the bold font in the following tables.

Horizontal

Frequency, MHz	Level, dBuV/m	Over limit, dB	Limit line, dBuV/m	Antenna pos, cm	Table pos., deg	Detect mode
180,0	33,8	-9,7	43,5	100	0	peak
220,0	32,7	-10,8	43,5	100	90	peak
300,0	32,6	-13,4	46,0	100	0	peak
450,0	34,2	-11,8	46,0	100	90	peak
1000,0	35,4	-18,1	53,5	100	90	peak

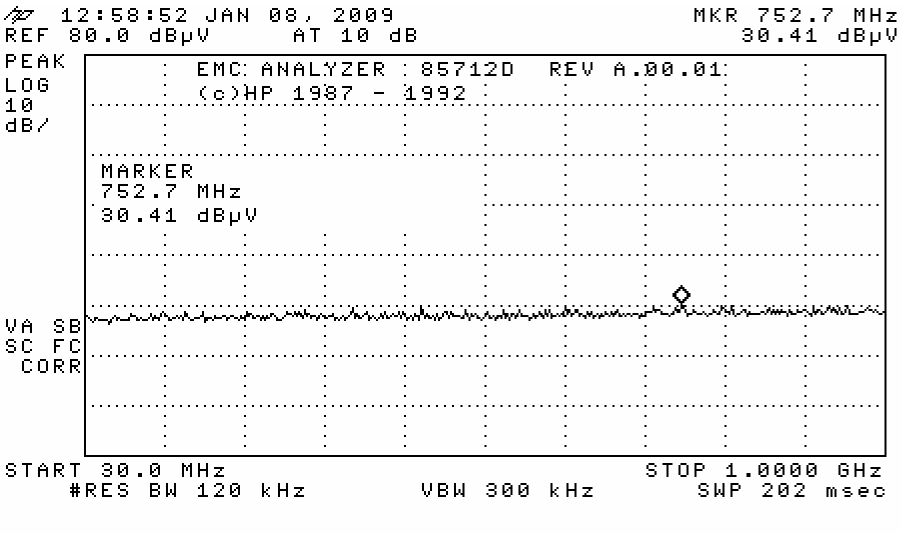
Frequency, MHz	Level, dBuV/m	Over limit, dB	Limit line, dBuV/m	Antenna pos, cm	Table pos., deg	Detect mode
2000,0	48,5	-25,5	74,0	100	0	peak
2000,0	38,0	-16,0	54,0	100	90	average
7500,0	56,5	-17,5	74,0	100	0	peak
7500,0	45,4	-8,6	54,0	100	90	average
22000,0	48,2	-25,8	74,0	100	90	peak

Vertical

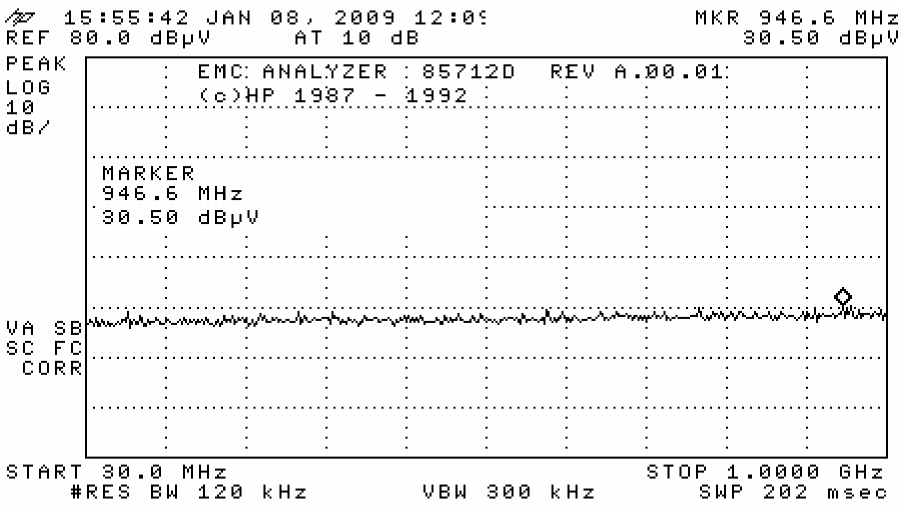
Frequency, MHz	Level, dBuV/m	Over limit, dB	Limit line, dBuV/m	Antenna pos, cm	Table pos., deg	Detect mode
30,0	29,9	-13,6	43,5	100	0	peak
45,0	25,6	-17,9	43,5	100	90	peak
65,0	23,5	-22,5	46,0	100	0	peak
90,0	31,8	-14,2	46,0	100	90	peak
150,0	31,5	-8,5	46,0	100	90	peak
600,0	28,0	-18,0	46,0	100	90	peak
750,0	26,9	-19,1	46,0	100	90	peak
900,0	31,7	-21,8	53,5	100	90	peak

Frequency, MHz	Level, dBuV/m	Over limit, dB	Limit line, dBuV/m	Antenna pos, cm	Table pos., deg	Detect mode
2000,0	43,4	-30,6	74,0	100	0	peak
2000,0	35,2	-18,8	54,0	100	90	average
7500,0	52,7	-21,3	74,0	100	0	peak
7500,0	41,3	-12,7	54,0	100	90	average
22000,0	45,8	-28,2	74,0	100	90	peak

3.7.4 Plots



The results test EMI radiated interference field (horizontal polarization; Pk – detector, without antenna factor)



The results test EMI radiated interference field (vertical polarization; Pk – detector, without antenna factor)

3.8 Antenna requirement

3.8.1 Applicable standards

According to FCC 47 CFR Section 15.203 an intentional radiator shall be designed to ensure that no other antenna except assembled by the responsible party must be used with the device. And according to FCC 47 CFR Section 15.247 (b) if directional gain of transmitting antennas is greater than 6 dBi the power must be reduced by the same level in dB comparing to gain minus 6 dBi.

3.8.2 Construction of antenna connector

The antenna used in the product is 2 patch antennas and it is considered to meet antenna requirement of FCC.

3.8.3 Antenna gain

The antenna gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum output power.