Estech Co., Ltd.
97-1, Hoeeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea
TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

# Test Report for FCC

FCC ID : ZGB-IPBT-300

| | | | | |
|---|---|---|---|---|
| Report Number | | ESTF151410-008 | | |
| Applicant | Company name | PNF CO, LTD | | |
| | Address | (Sangdaewon-dong, Dayou-A-tech), 509, Dunchon-daero, Jungwon-gu, Seongnam-si, Gyeonggi-do , 462-807 South Korea | | |
| | Telephone | +82-31-8022-9820 | | |
| | Contack Person | Jin-gu KIM | | |
| Product | Product name | Equil SmartMarker | | |
| | Model No. | IPBT-300 | Manufacturer | PNF CO, LTD |
| | Serial No. | NONE | Country of origin | KOREA |
| Test date | 2014-09-18 ~ 2014-09-31 | | Date of issue | 31-Oct-14 |
| Testing location | ESTECH Co., Ltd.<br>97-1, Hoeeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea | | | |
| Standard | FCC PART 15 Subpart C (15.247):2010 , ANSI C 63.4(2009) , DA 00-705 | | | |
| Measurement facility registration number | 659627 | | | |
| Tested by | Engineer S.B.Lee (Signature) | | | |
| Reviewed by | Engineering Manager J.M.Yang (Signature) | | | |
| Abbreviation | OK, Pass = Passed, Fail = Failed, N/A = not applicable | | | |

* Note

- This test report is not permitted to copy partly without our permission
- This test result is dependent on only equipment to be used
- This test result based on a single evaluation of one sample of the above mentioned

# Contents 1

# Contents 2

# 1. Laboratory Information

## 1.1 General

This EUT (Equipment Under Test) has been shown to be capable of compliance with the applicable technical standards and is tested in accordance with the measurement procedures as indicated in this report.
ESTECH Lab attests to accuracy of test data. All measurement reported herein were performed by ESTECH Co., Ltd.
ESTECH Lab assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

## 1.2 Test Lab.

Corporation Name : ESTECH Co., Ltd.

Head Office : Rm 1015, World Venture Center II, 426-5, Gasan-dong, Geumcheon-gu, Seoul, Korea

EMC/Telecom/Safety Test Lab : 97-1, Hoeeok-ri, Majang-myeon, Icheon-si, Gyeonggi-do, Korea

## 1.3 Official Qualification(s)

KCC : Granted Accreditation from Ministry of Information & Communication for EMC, Safety and Telecommunication
KOLAS : Accredited Lab By Korea Laboratory Accreditation Schema base on CENELEC requirements
FCC : Conformity Assessment Body(CAB) with registration number 659627 under APEC TEL MRA between the RRA and the FCC
VCCI : Granted Accreditation from Voluntary Control Council for Interference from ITE

# 2. Description of EUT

## 2.1 Summary of Equipment Under Test (Bluetooth)

| | |
|---|---|
| Modulation Type | : GFSK |
| Transfer Rate | : 1 Mbps |
| Number of Channel | : 79 ch |
| Channel Spacing | : 1 MHz |
| PEAK Output Power | : GFSK : 0.7656 mW |
| Rating | : <ADAPTER><br>- INPUT : AC (100 ~ 240) V, (50 ~ 60) Hz, 0.15 A<br>- OUTPUT : DC 5 V, 1.0 A<br><BATTERY><br>- DC 3.7 V |
| Receipt Date | : 20-Aug-14 |
| X-tal list(s) or Frequencies generated | : The highest operating frequency is 2480 MHz(Bluetooth)<br>XTAL : 12 MHz : 2 ea ,32.768 MHz : 1ea, Blutooth : 2.4 GHz |

## 2.2 General descriptions of EUT

The Bluetooth frequency hopping transceiver is designed to operate between 2400 and2483.5MHz.
For the detailed features, please refer to the manufacturer's specifications or User's Manual.
The system is designed to comply with all of the regulations in Section 15.247 when the transmitteris presented with a continuous data (or information) stream. It is also comply with FHSS requirements in Section 15.247(a)(1).: Its hopping sequence is pseudo random, all channels used equally on average. The receiver input bandwidth approximately equal the transmit band bandwidth, and its hop insequence with the transmit signal.- the system does not coordinate its channel selection/hopping sequence with other frequency hopping systems for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters.

# 3. Test Standards

Test Standard : FCC PART 15 Subpart C (15.247) : 2010

This Standard sets out the regulations under which an intentional, unintentional, or incidental radiator may be operated without an individual license. It also contains the technical specifications, administrative requirements and other conditions relating to the marketing of Part 15 devices.

Test Method : ANSI C 63.4 (2009) & DA 00-705

This standard sets forth uniform methods of measurement of radio-frequency (RF) signals and noise emitted from both unintentional and intentional emitters of RF energy in the frequency range 9 kHz to 40 GHz. Methods for the measurement of radiated and AC power-line conducted radio noise are covered and may be applied to any such equipment unless otherwise specified by individual equipment requirements. These methods cover measurement of certain decides that deliberately radiate energy, such as intentional emitters, but does not cover licensed transmitters. This standard is not intended for certification/approval of avionic equipment or for industrial, scientific, and medical (ISM) equipment These method apply to the measurement of individual units or systems comprised of multiple units

Summary of Test Results

| Applied Satandard : 47 CFR Part 15 Subpart C | | | | remark |
|---|---|---|---|---|
| FCC Standard | Test Type | Result | Remark | Limit |
| 15.207 | AC Power Conducted Emission | N/A | Meet the requirement | |
| 15.205 & 15.209 | Intentional Radiated Emission | Pass | Meet the requirement | |
| 15.247(a)(1) | Carrier Frequency Separation & 20 Bandwidth ,99% Bandwidth | Pass | Meet the requirement | >25 kHz |
| 15.247(b) | Maximum Peak ouput power | Pass | Meet the requirement | 30dBm(1W) |
| 15.247(a)(1)(ii) | Number of Hopping Frequency | Pass | Meet the requirement | >75 |
| 15.247(c) | Transmitter Radiated Emission | Pass | Meet the requirement | |
| 15.247(a)(1)(iii) | Time of Occupancy (Dwell Time) | Pass | Meet the requirement | <400ms |
| 15.247(d) | Band Edge Measurement | Pass | Meet the requirement | |

# 4. Measurement Condition

## 4.1 EUT Operation

a. Channel

| Ch. | Frequency | Ch. | Frequency |
|---|---|---|---|
| 0 | 2402 MHz | 40 | 2442 MHz |
| 1 | 2403 MHz | 41 | 2443 MHz |
| 2 | 2404 MHz | 42 | 2444 MHz |
| 3 | 2405 MHz | 43 | 2445 MHz |
| 4 | 2406 MHz | … | … |
| … | … | 78 | 2480 MHz |
| 39 | 2441 MHz | | |

b. Measurement Channel :Low(2402 MHz), Middle(2441 MHz),High(2480 MHz)

c. Test Mode : GFSK(worst case)

d. Test rate :1 Mbps

## 4.2 EUT Operation.

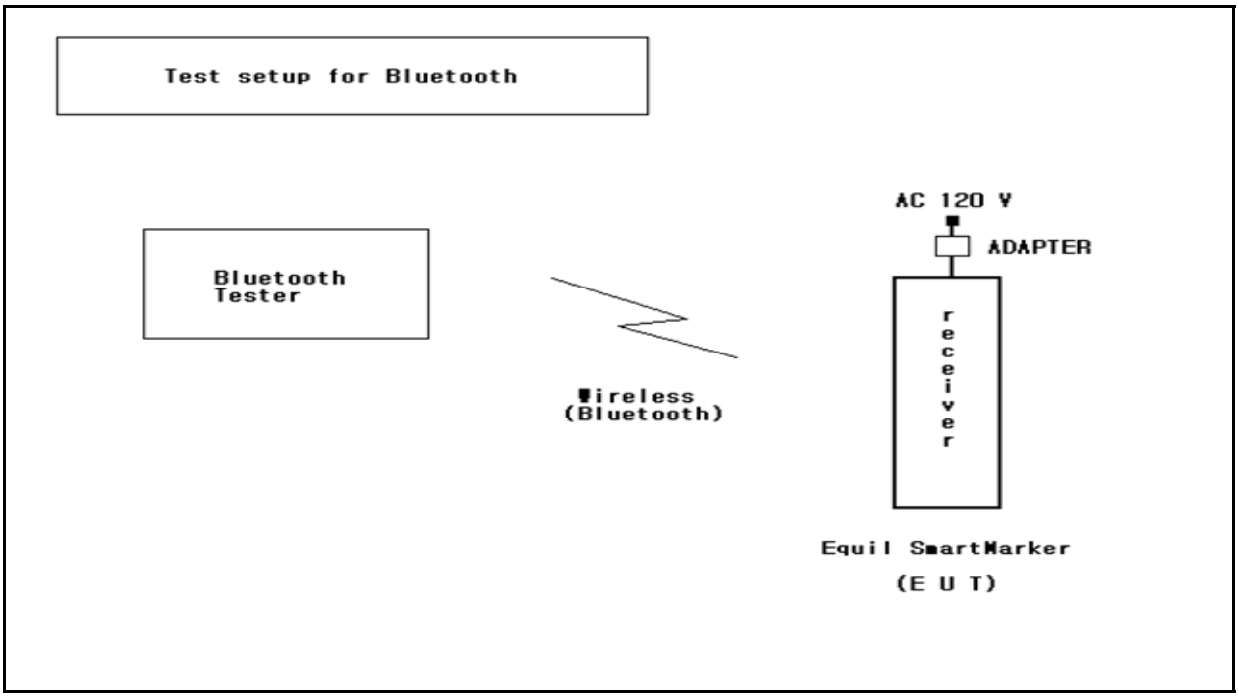
* The EUT was in the following operation mode during all testing

* The operational conditions of the EUT was determined by the manufacturer according to the typical use of the EUT with respect to the expected highest level of emission

* The EUT was measured under transmitting / receiving condition continuously at specific channel frequency.

* The EUT was measured up to tenth harmonic or 40 GHz of the highest operating frequencies.

## 4.3 Configuration and Peripherals



## 4.4 EUT and Support equipment

| Equipment Name | Model Name | S/N | Manufacturer | Remark (FCC ID) |
|---|---|---|---|---|
| Equil SmartMarker | IPBT-300 | NONE | PNF CO, LTD | EUT |
| ADAPTER | HDP-QB05010U | NONE | HDP | |
| Bluetooth Tester | TC-3000A | 3000A570224 | TESCOM | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

## 4.5 Cable Connecting

| Start Equipment | | End Equipment | | Cable Standard | | Remark |
|---|---|---|---|---|---|---|
| Name | I/O port | Name | I/O port | Length | Shielded | |
| Equil SmartMarker | Wireless (Bluetooth) | Bluetooth Tester | Wireless (Bluetooth) | - | - | |
| Equil SmartMarker | Micro USB | ADAPTER | USB | 3.0 | Shielded | with ferrite core |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

# 5. Carrier Frequency Separation

## 5.1 Test procedure

According to §15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by minimum of 25kHz or the 20dB bandwidth of the hopping channel, whichever is greater.

## 5.2 Test instruments and measurement setup

The spectrum analyzer is set to as following.

. RBW= 30KHz

. VBW= 300KHz

. Span= 3MHz

. Sweep= suitable duration based on the EUT specification.

20dB Bandwidth Test Instruments

| Description | Model | Serial Number | Cal. Due Date |
|---|---|---|---|
| Spectrum Analyzer | E4440A | US41421291 | 2015-01-23 |
| -Spectrum Analyzer <=> EUT | Loss: 11.0dB | - | |

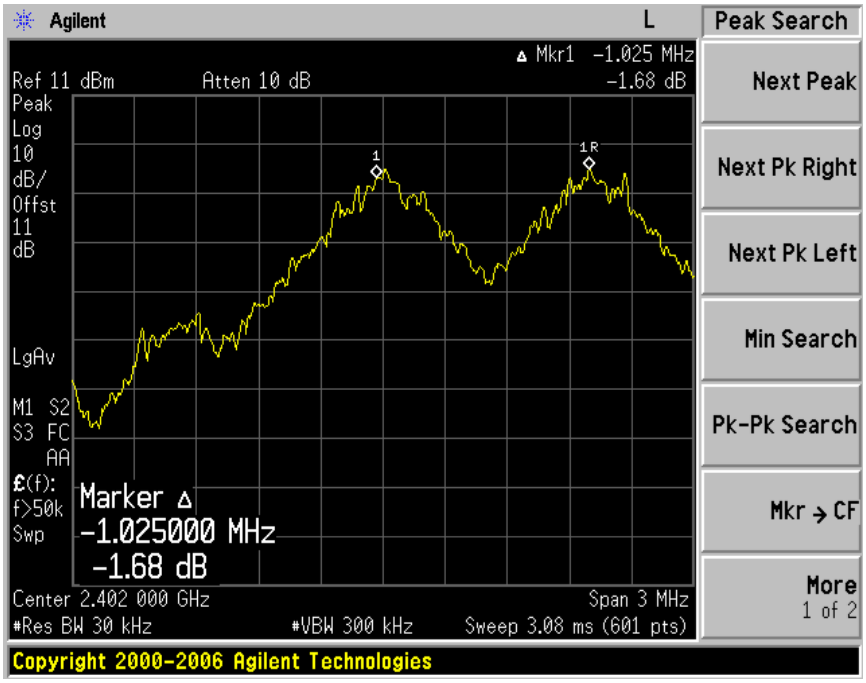
## 5.3 Measurement results

| EUT | Equil SmartMarker | MODEL | IPBT-300 |
|---|---|---|---|
| MODE | GFSK | ENVIRONMENTAL CONDITION | 26.0 ℃, 43.0 % R.H. |
| INPUT POWER | 5Vd.c. | | |

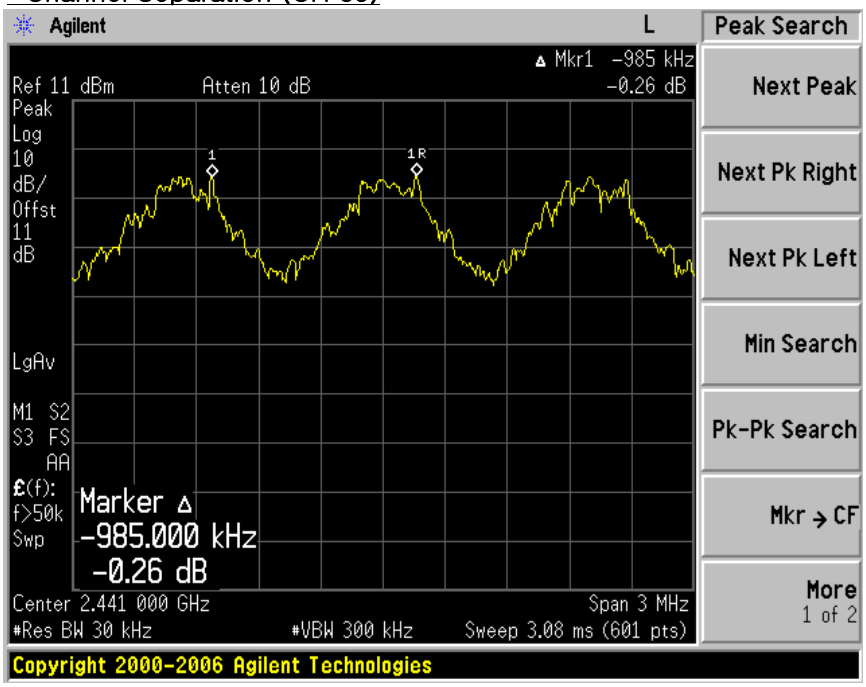
| CHANNEL | Channel Frequency (MHz) | Bandwidth at 99% (kHz) | Bandwidth at 20dB below(kHz) | Channel Separation (kHz) | Limit (kHz) | PASS/FAIL |
|---|---|---|---|---|---|---|
| 0 | 2402 | 995 | 1127 | 1025 | 751 | PASS |
| 39 | 2441 | 1007 | 1126 | 985 | 751 | PASS |
| 78 | 2480 | 998 | 1132 | 1020 | 755 | PASS |

## 5.4 Trace data ( GFSK )

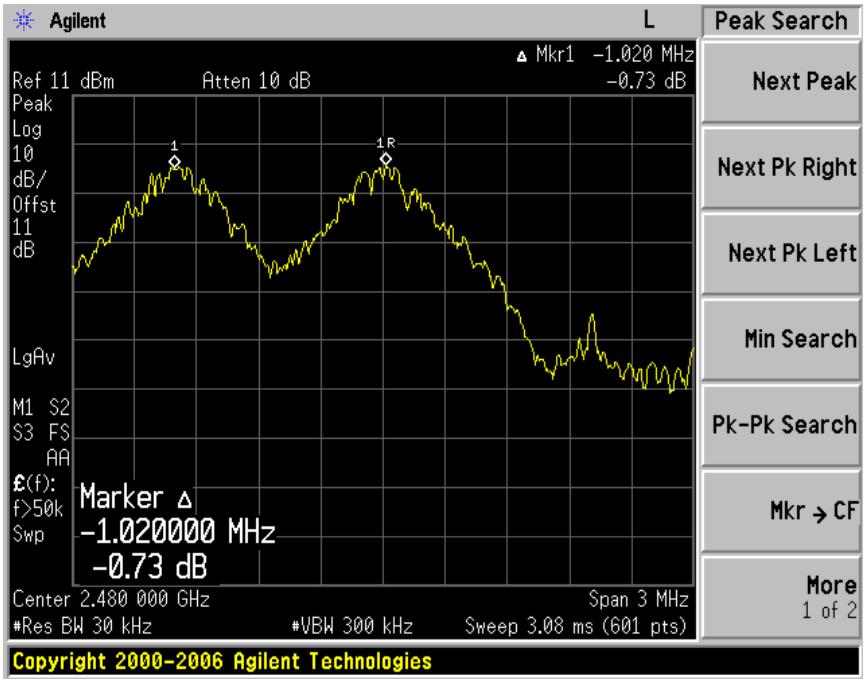
Channel Separation (CH 0)



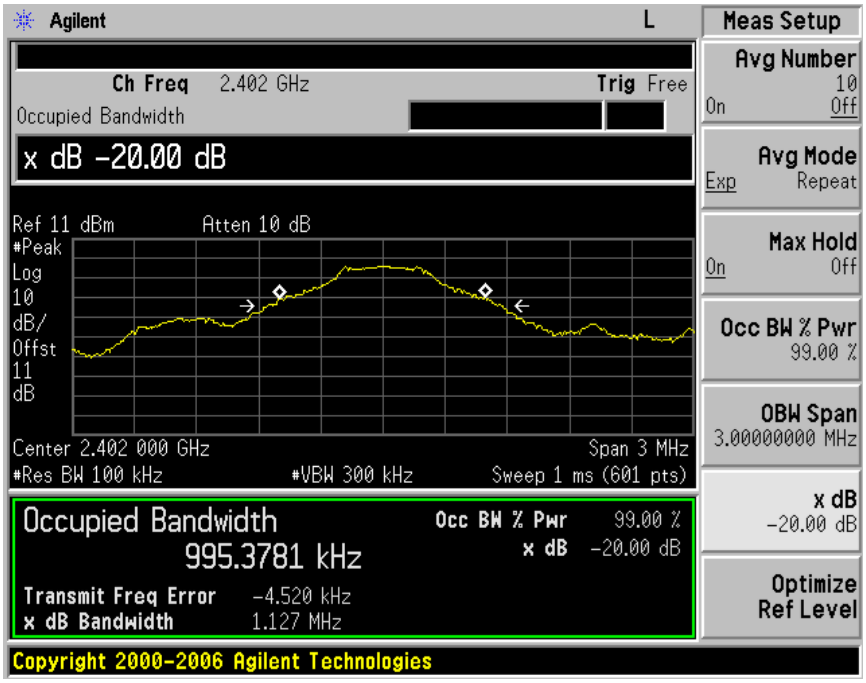

Channel Separation (CH 39)



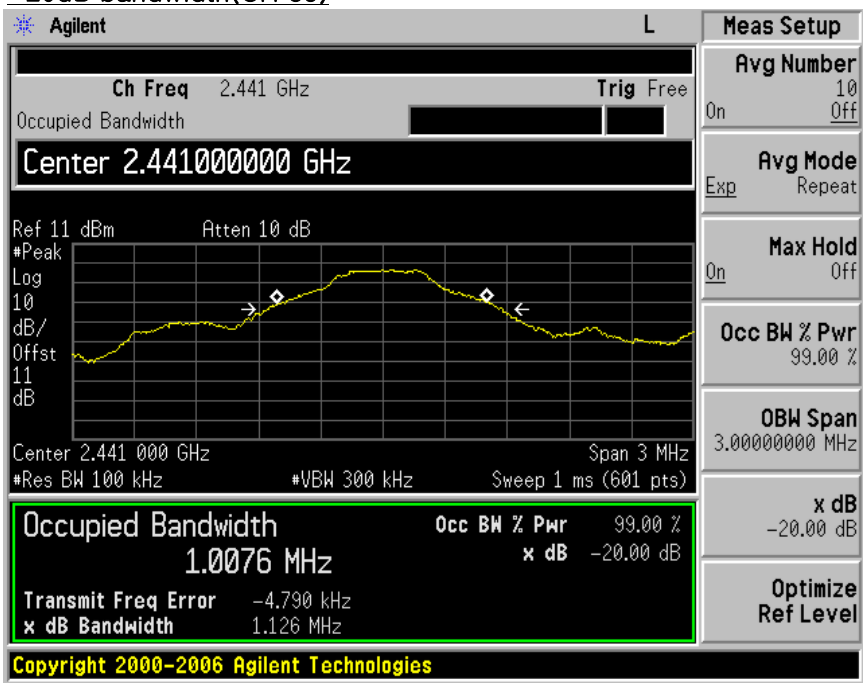
Channel Separation (CH 78)



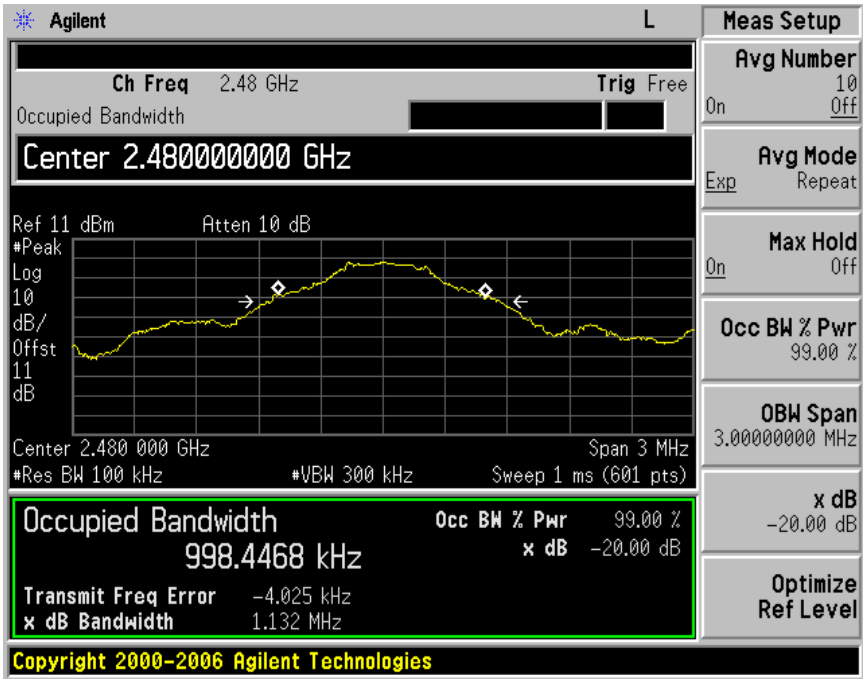
20dB bandwidth(Ch 0)




20dB bandwidth(CH 39)



20dB bandwidth(CH 78)



# 6. MAXIMUM PEAK OUTPUT POWER

## 6.1 Test procedure

The transmitter antenna terminal is connected to the input of a Power Sensor. Measurement is made while EUT is operating in transmission mode at the appropriate center frequency. The maximum peak output power measurement is 30dBm.

| Description | Model | Serial Number | Cal. Due Date |
|---|---|---|---|
| Power Meter | NRVS | 849622/045 | 2015-01-13 |
| Power Sensor | NRV-251 | 325948/013 | 2015-01-13 |
| -Spectrum Analyzer <=> EUT | Loss: 11.0dB | - | |

## 6.2 Measurement results

| EUT | Equil SmartMarker | MODEL | IPBT-300 |
|---|---|---|---|
| MODE | GFSK DH5 | ENVIRONMENTAL CONDITION | 24.0 ℃, 43.0 % R.H. |
| INPUT POWER | 5Vd.c. | | |

GFSK

| CHANNEL | Channel Frequency (MHz) | Peak Power Output(dBm) | | Limit[mW] | PASS/ FAIL |
|---|---|---|---|---|---|
| | | (dBm) | (mW) | | |
| 0 | 2402 | -2.79 | 0.5260 | 125 | PASS |
| 39 | 2441 | -2.12 | 0.6138 | 125 | PASS |
| 78 | 2480 | -1.16 | 0.7656 | 125 | PASS |

Note : GFSK mode is max power in three different modulations.

# 7. Number of Hopping Frequency

## 7.1 Test procedure

According to §15.247(a)(1)(ii), Frequency hopping systems operating in the 2400MHz-2483.5MHz bands shall use at least 75 hopping frequencies.

## 7.2 Test instruments and measurement setup

The spectrum analyzer is set to as following.

. RBW= 100KHz

. VBW= 300KHz

. Span= the frequency band of operation

. Sweep= suitable duration based on the EUT specification.

The Number of Hopping Frequency Test Instruments

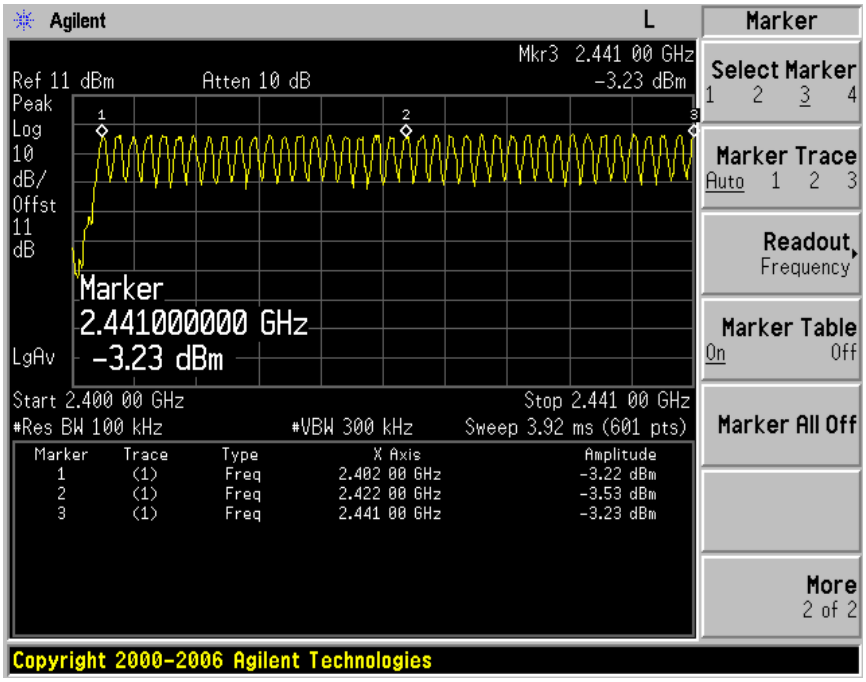
| Description | Model | Serial Number | Cal. Due Date |
|---|---|---|---|
| Spectrum Analyzer | E4440A | US41421291 | 2015-01-23 |
| -Spectrum Analyzer <=> EUT | Loss: 11.0dB | | |

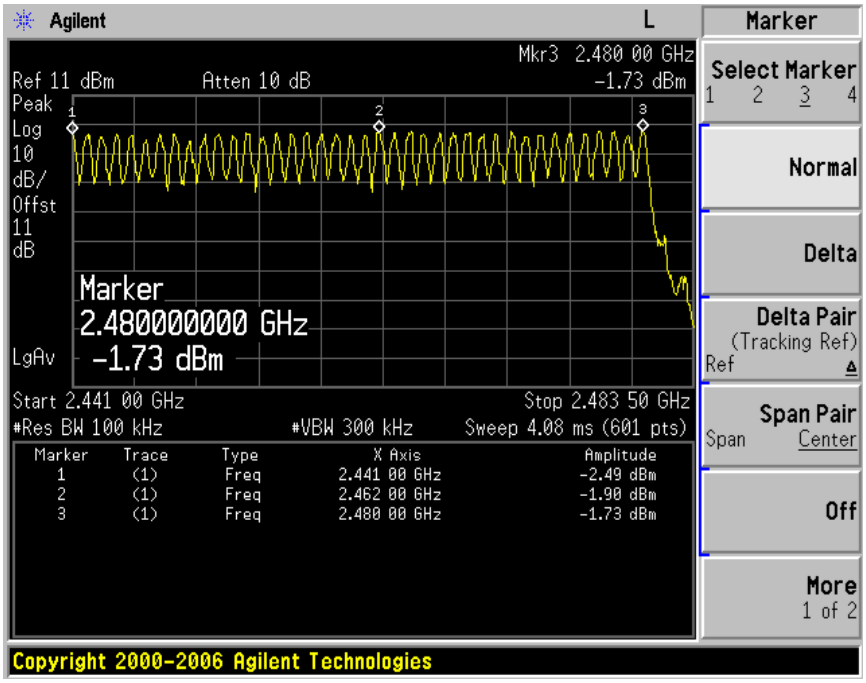
## 7.3 Measurement results

| EUT | Equil SmartMarker | MODEL | IPBT-300 |
|---|---|---|---|
| MODE | GFSK | ENVIRONMENTAL CONDITION | 26.0 ℃, 43.0 % R.H. |
| INPUT POWER | 5Vd.c. | | |

| Number of CH | Limit (Number of CH) | PASS/FAIL |
|---|---|---|
| 79 | >75 | PASS |

## 7.4 Trace data(GFSK)



# 8. Time of Occupancy (Dwell Time)

## 8.1 Test procedure

According to §15.247(a)(1)(iii), Frequency hopping systems operating in the 2400MHz-2483.5 MHz bands. The average time of occupancy on any channels shall not greater than 0.4 s within a period 0.4 s multiplied by the number of hopping channels employed.

## 8.2 Test instruments and measurement setup

The spectrum analyzer is set to as following.

. RBW= 1MHz

. VBW=300kHz

. Span= zero span, centered on a hoppong channel

. Sweep = as necessary to capture the entire dwell time per hoppong channel

. Detector function = Peak

. Trace = Max hold

The Time of Occupancy Test Instruments

| Description | Model | Serial Number | Cal. Due Date |
|---|---|---|---|
| Spectrum Analyzer | E4440A | US41421291 | 2015-01-23 |
| -Spectrum Analyzer <=> EUT | Loss:1.0dB | - | |

## 8.3 Measurement results

| EUT | Equil SmartMarker | MODEL | IPBT-300 |
|---|---|---|---|
| MODE | GFSK | ENVIRONMENTAL CONDITION | 26.0 ℃, 43.0 % R.H. |
| INPUT POWER | 5Vd.c. | | |

A. DH1 Mode
One period for each particular channel : 0.413 ms X 320.1 = 132.14 ms

| Channel | Pulse Time(ms) | Limit(ms) | PASS/FAIL |
|---|---|---|---|
| 39 | 132.14 | 400 | PASS |

Calculation:The Bluetooth system hops at a rate of 1600 times per second. This means there are 1600 timeslots in one second, the DH1 data rate operates on a one-slot transmission and one-slot receiving basis. Thus there are 1600/(1+1)=800 transmissions per second. In one period for each particular channel there are 10.13x31.6=320.1 times of tramsmissions.

B. DH3 Mode
One period for each particular channel : 1.665 ms X 159.9 = 266.2335 ms

| Channel | Pulse Time(ms) | Limit(ms) | PASS/FAIL |
|---|---|---|---|
| 39 | 266.23 | 400 | PASS |

Calculation: The Bluetooth system hops at a rate of 1600 times per second. This means there are 1600 timeslots in one second, the DH3 data rate operates on a three-slot transmission and one-slot receiving basis. Thus there are 1600/(3+1)=400 transmissions per second. In one period for each particular channel there are 5.06x31.6=159.9 times of tramsmissions.

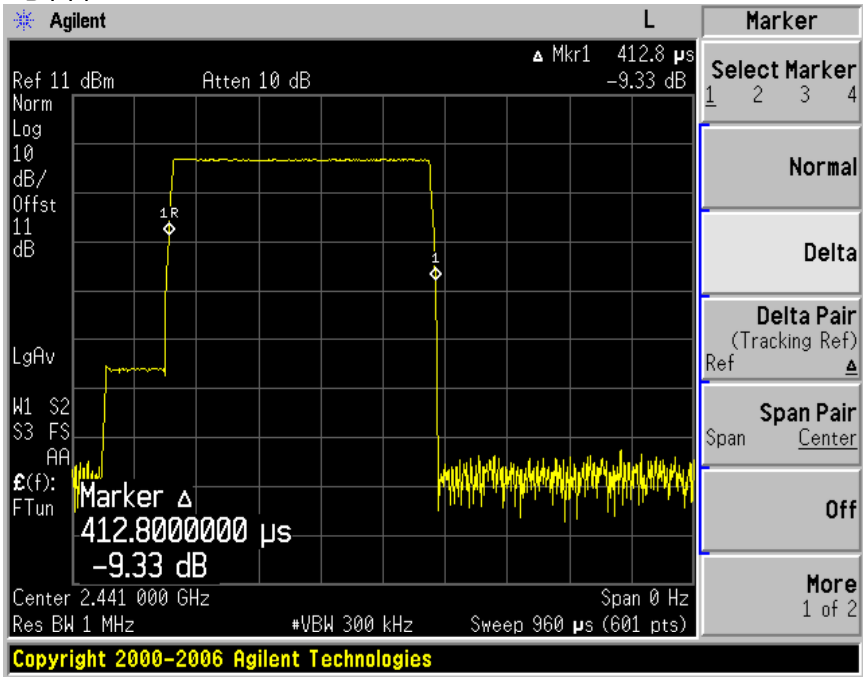
C. DH5 Mode
One period for each particular channel : 2.9192 ms X 106.81 = 311.7998 ms

| Channel | Pulse Time(ms) | Limit(ms) | PASS/FAIL |
|---|---|---|---|
| 39 | 311.80 | 400 | PASS |

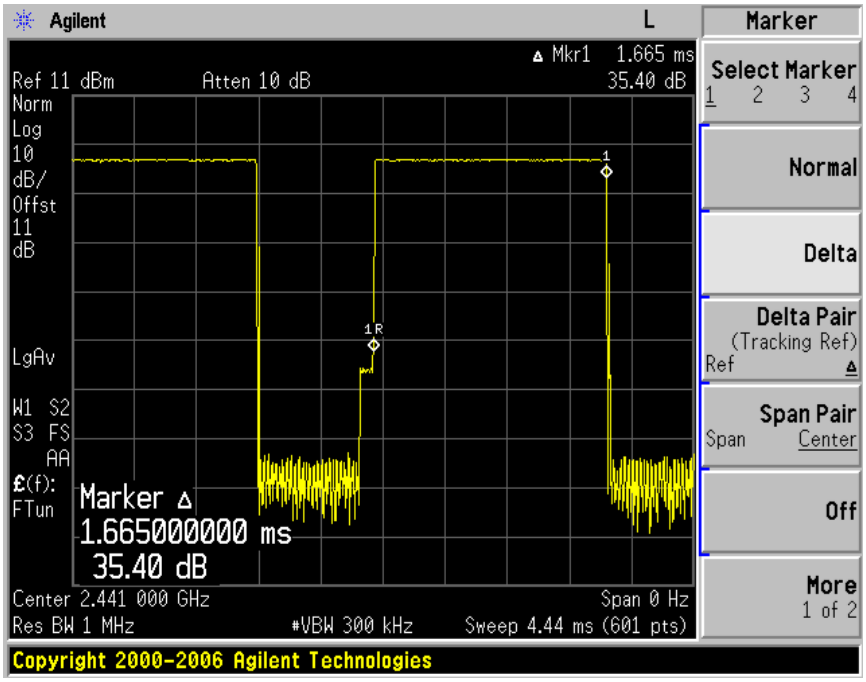
Calculation: The Bluetooth system hops at a rate of 1600 times per second. This means there are 1600 timeslots in one second, the DH5 data rate operates on a five-slot transmission and one-slot receiving basis. Thus there are 1600/(5+1)=266.7 transmissions per second. In one period for each particular channel there are 3.38x31.6=106.81 times of tramsmissions.

## 8.4 Trace data

DH1



DH3


Agilent
L
Marker
Mkr1 1.665 ms
Ref 11 dBm
Atten 10 dB
35.40 dB
Norm
Log
10
dB/
Offst
11
dB
LgAv
W1 S2
S3 FS
AA
£(f):
FTun
Marker Δ
1.665000000 ms
35.40 dB
Center 2.441 000 GHz
Span 0 Hz
Res BW 1 MHz
#VBW 300 kHz
Sweep 4.44 ms (601 pts)
Select Marker
1 2 3 4
Normal
Delta
Delta Pair
(Tracking Ref)
Ref
Span Pair
Span Center
Off
More
1 of 2
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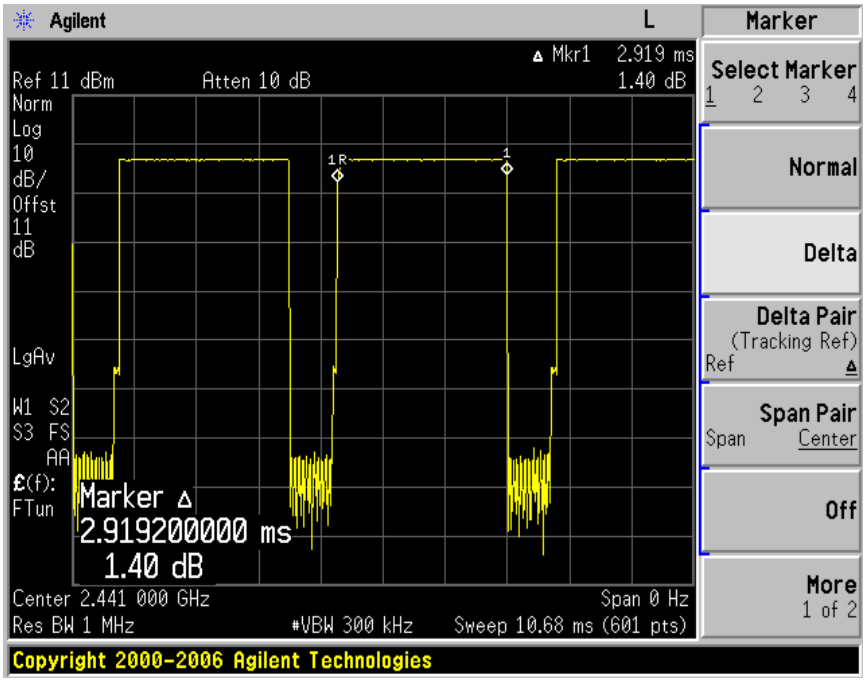
DH5


Agilent
L
Marker
Mkr1 2.919 ms
Ref 11 dBm
Atten 10 dB
1.40 dB
Norm
Log
10
dB/
Offst
11
dB
LgAv
W1 S2
S3 FS
AA
£(f):
FTun
Marker Δ
2.919200000 ms
1.40 dB
Center 2.441 000 GHz
Span 0 Hz
Res BW 1 MHz
#VBW 300 kHz
Sweep 10.68 ms (601 pts)
Select Marker
1 2 3 4
Normal
Delta
Delta Pair
(Tracking Ref)
Ref
Span Pair
Span Center
Off
More
1 of 2
Copyright 2000-2006 Agilent Technologies

# 9. band-edge and out of band emissions.

## 9.1 Test procedure

The radio frequecy power at 20dB down from the highest inband power level is measured with a spectrum analyzer connected to the antenna terminal, while EUT is operating in transmission mode at the appropriate center frequency. The band edge&out of band emission shall be at least 20dB below of the highest inband power level.

## 9.2 Test instruments and measurement setup

The spectrum analyzer is set to as following.

. RBW= 100KHz

. VBW= 300KHz

. Span= suitable frequency span

. Sweep= suitable duration based on the EUT specification.

Band Edge&Out of Emission Test Instruments

| Description | Model | Serial Number | Cal. Due Date |
|---|---|---|---|
| Spectrum Analyzer | E4440A | US41421291 | 2015-01-23 |
| Signal Analyzer | FSV | 100939 | 2015-01-23 |
| -Spectrum Analyzer <=> EUT | Loss: 11.0dB | | |

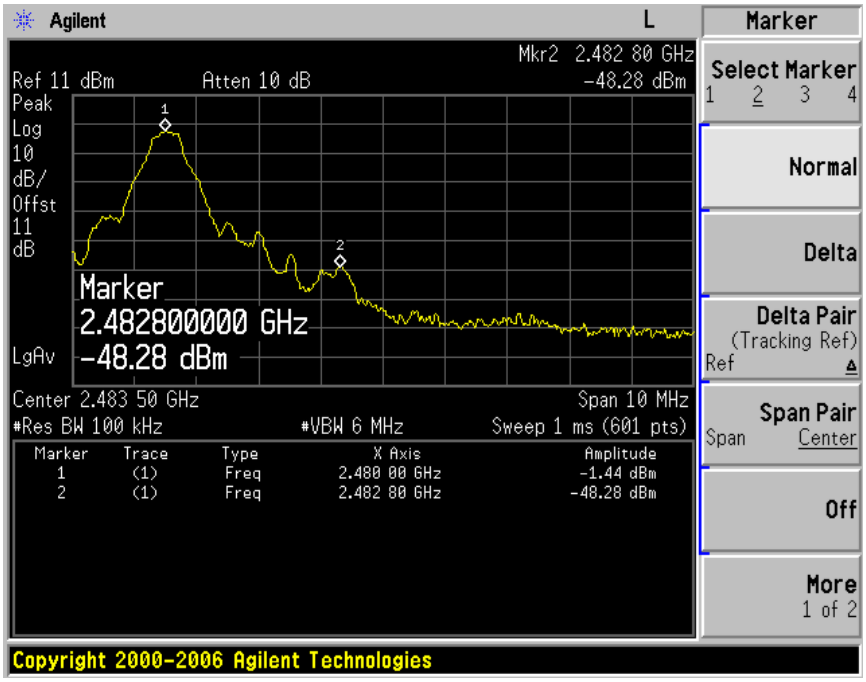
## 9.3 Measurement results of band-edge & out of emission

| EUT | Equil SmartMarker | MODEL | IPBT-300 |
|---|---|---|---|
| MODE | GFSK | ENVIRONMENTAL CONDITION | 24.0 ℃, 43.0 % R.H. |
| INPUT POWER | 5Vd.c. | | |

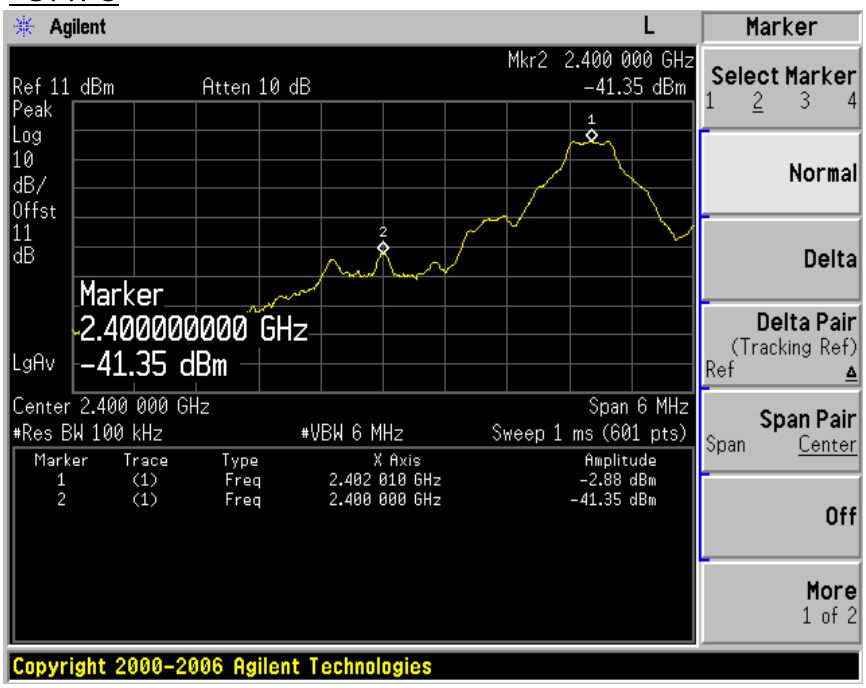
* Refer to attach spectrum analyzer data chart.

## 9.4 Trace data of band-edge & Out of Emission

CH0

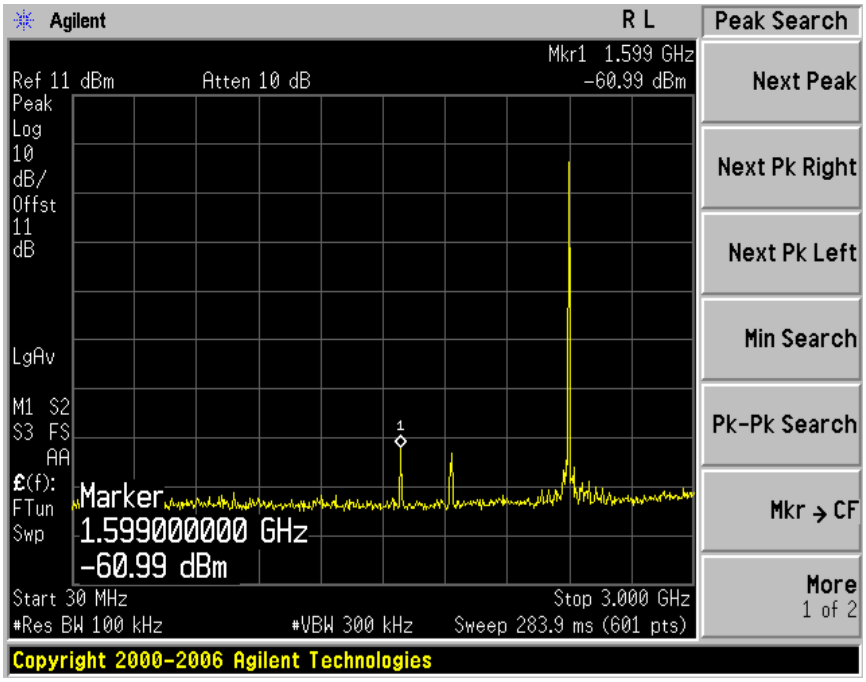


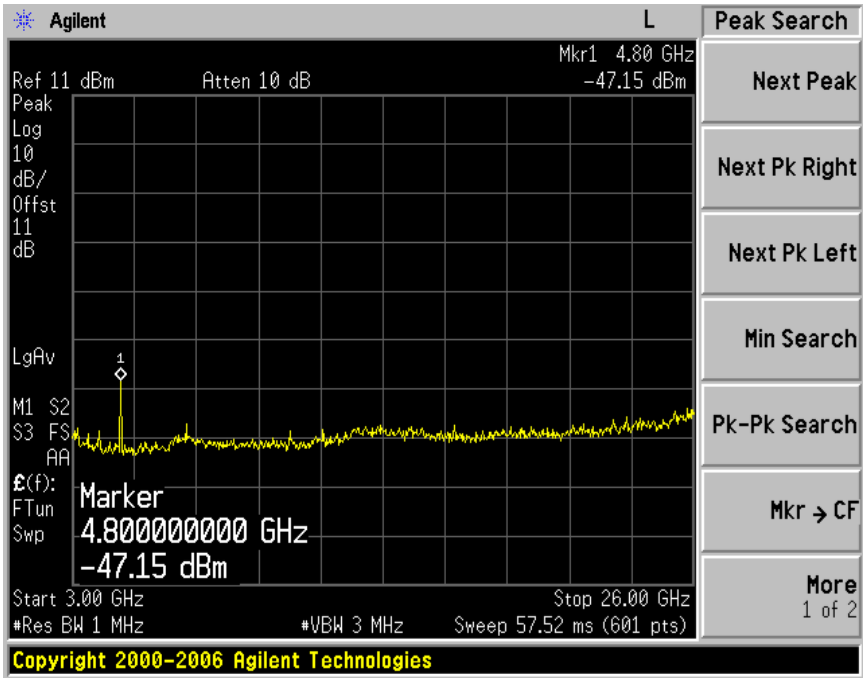

CH78



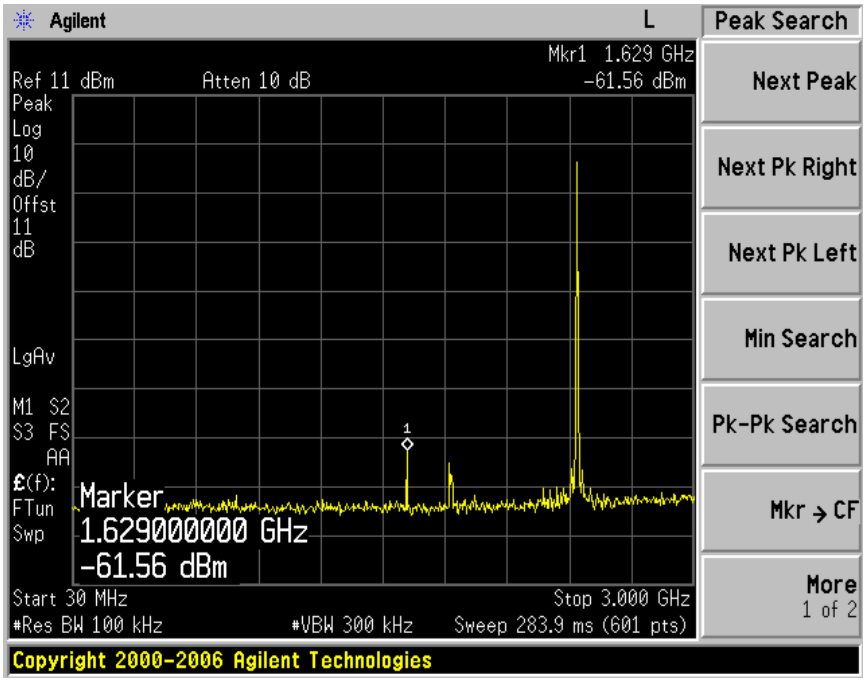
GFSK

CH 0


Agilent
R L
Peak Search
Mkr1 1.599 GHz
Ref 11 dBm
Atten 10 dB
-60.99 dBm
Next Peak
Peak
Log
10
dB/
Offst
11
dB
Next Pk Right
Next Pk Left
Min Search
LgAv
M1 S2
S3 FS
AA
Pk-Pk Search
£(f):
FTun
Swp
Marker
1.599000000 GHz
-60.99 dBm
Mkr → CF
More
1 of 2
Start 30 MHz
Stop 3.000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Sweep 283.9 ms (601 pts)
Copyright 2000-2006 Agilent Technologies


Agilent
L
Peak Search
Mkr1 4.80 GHz
Ref 11 dBm
Atten 10 dB
-47.15 dBm
Next Peak
Peak
Log
10
dB/
Offst
11
dB
Next Pk Right
Next Pk Left
Min Search
LgAv
M1 S2
S3 FS
AA
Pk-Pk Search
£(f):
FTun
Swp
Marker
4.800000000 GHz
-47.15 dBm
Mkr → CF
More
1 of 2
Start 3.00 GHz
Stop 26.00 GHz
#Res BW 1 MHz
#VBW 3 MHz
Sweep 57.52 ms (601 pts)
Copyright 2000-2006 Agilent Technologies

CH 39


Agilent
L
Peak Search
Mkr1 1.629 GHz
Ref 11 dBm
Atten 10 dB
-61.56 dBm
Peak
Log
10
dB/
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11
dB
LgAv
M1 S2
S3 FS
AA
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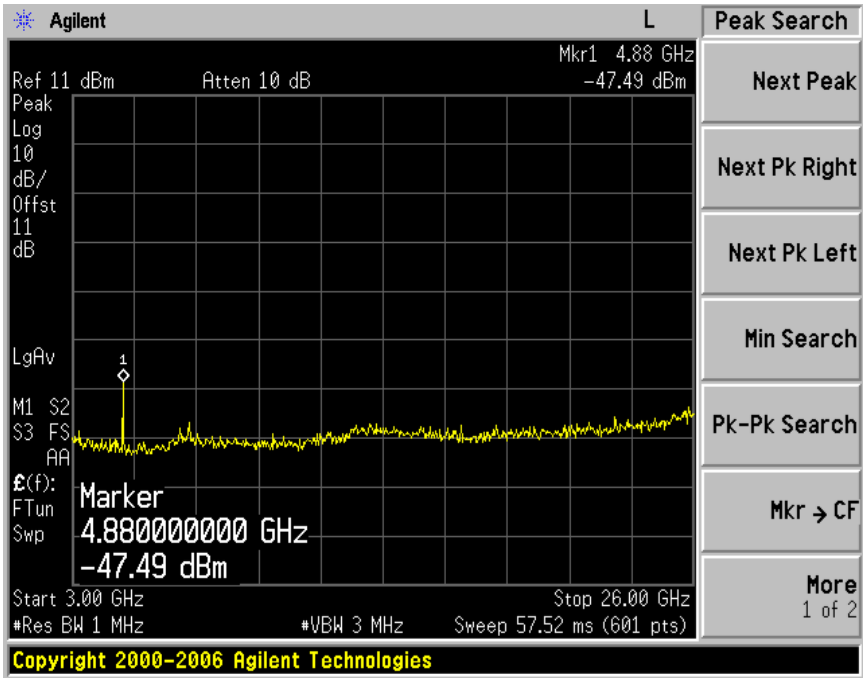
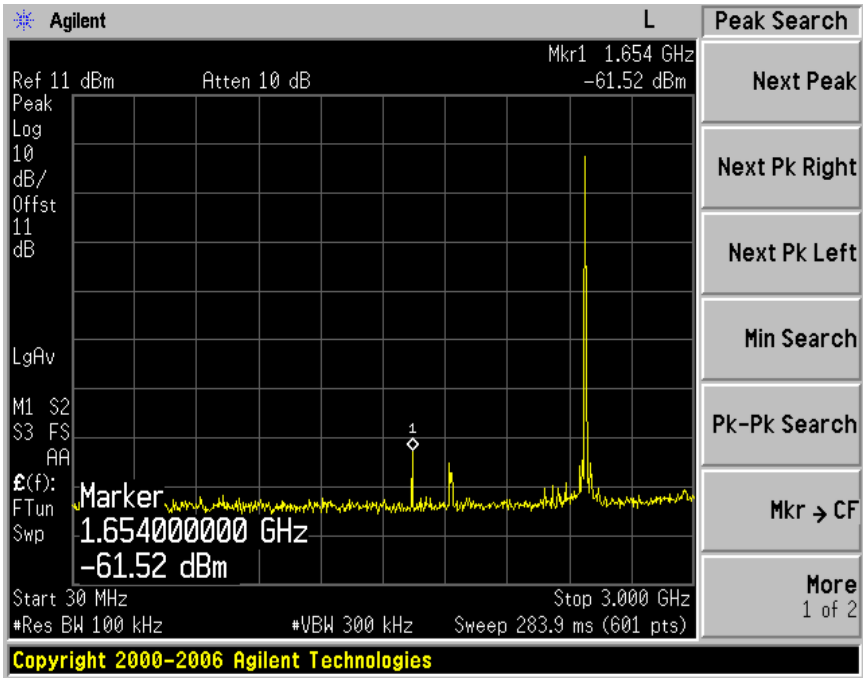
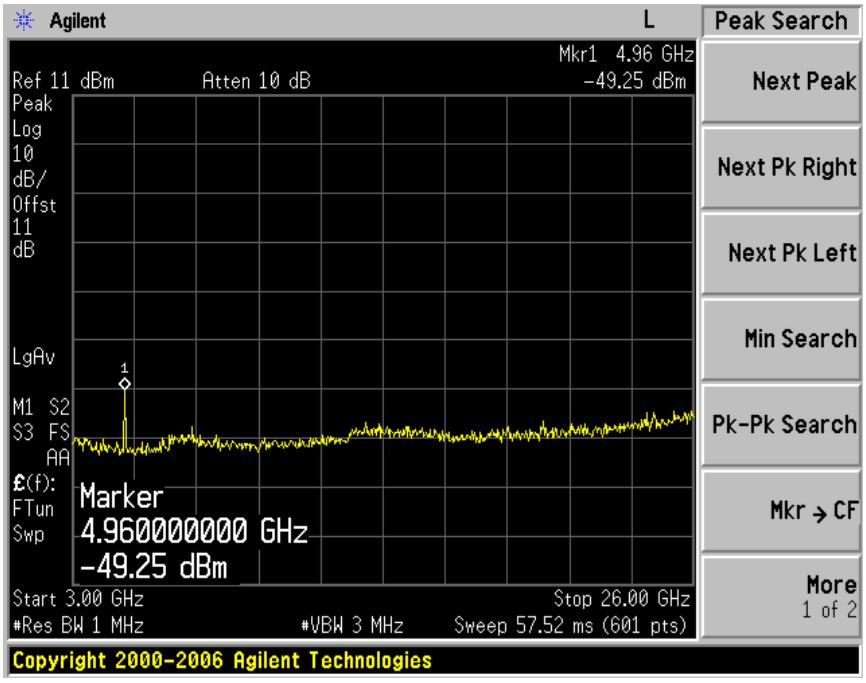
FTun
Swp
Marker
1.629000000 GHz
-61.56 dBm
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
Mkr → CF
More
1 of 2
Start 30 MHz
Stop 3.000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Sweep 283.9 ms (601 pts)
Copyright 2000-2006 Agilent Technologies


Agilent
L
Peak Search
Mkr1 4.88 GHz
Ref 11 dBm
Atten 10 dB
-47.49 dBm
Peak
Log
10
dB/
Offst
11
dB
LgAv
M1 S2
S3 FS
AA
£(f):
FTun
Swp
Marker
4.880000000 GHz
-47.49 dBm
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
Mkr → CF
More
1 of 2
Start 3.00 GHz
Stop 26.00 GHz
#Res BW 1 MHz
#VBW 3 MHz
Sweep 57.52 ms (601 pts)
Copyright 2000-2006 Agilent Technologies

CH 78


Agilent
L
Peak Search
Mkr1 1.654 GHz
Ref 11 dBm
Atten 10 dB
-61.52 dBm
Peak
Log
10
dB/
Offst
11
dB
LgAv
M1 S2
S3 FS
AA
£(f):
FTun
Swp
Marker
1.654000000 GHz
-61.52 dBm
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
Mkr → CF
More
1 of 2
Start 30 MHz
Stop 3.000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Sweep 283.9 ms (601 pts)
Copyright 2000-2006 Agilent Technologies


Agilent
L
Peak Search
Mkr1 4.96 GHz
Ref 11 dBm
Atten 10 dB
-49.25 dBm
Peak
Log
10
dB/
Offst
11
dB
LgAv
M1 S2
S3 FS
AA
£(f):
FTun
Swp
Marker
4.960000000 GHz
-49.25 dBm
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
Mkr → CF
More
1 of 2
Start 3.00 GHz
Stop 26.00 GHz
#Res BW 1 MHz
#VBW 3 MHz
Sweep 57.52 ms (601 pts)
Copyright 2000-2006 Agilent Technologies

# 10. Measurement of radiated disturbance

Above 30 MHz Electric Field strength was measured in accordance with FCC PART 15.205, 15.209. The test setup was made according to ANSI C 63.4 (2009) & DA 00-705 Semi-anechoic chamber, which allows a 3 m distance measurement. The EUT was placed in the center of styrofoam. turntable. The height of this table was 0.8 m. The measurement was conducted with both horizontal and vertical antenna polarization. The turntable has fully rotated. For further description of the configuration refer to the picture of the test setup.

## 10.1 Measurement equipments

| Equipment Name | Type | Manufacturer | Serial No. | Next Calibration date |
|---|---|---|---|---|
| TEST Receiver | ESCI7 | ROHDE & SCHWARZ | 100916 | 23-Jan-15 |
| Logbicon Antenna | VULB 9168 | SCHWARZBECK | 237 | 13-Jan-15 |
| Turn Table | DT3000-2t | Innco System GmbH | N/A | - |
| Antenna Mast | MA4000-EP | Innco System GmbH | N/A | - |
| PREAMPLIFIER | 8449B | AGILENT | 3008A00595 | 13-Jan-15 |
| Horn Antenna | BBHA9120D | SCHWARZBECK | 469 | 11-Nov-14 |
| Test Receiver | ESPI7 | ROHDE & SCHWARZ | 100185 | 13-Jan-15 |
| Spectrum Analyzer | R3273 | ADVANTEST | 110600592 | 13-Jan-15 |
| Turn Table | DT1500-S | Innco System GmbH | N/A | - |
| Antenna Mast | MA4000-EP | Innco System GmbH | N/A | - |
| Pyramidal Horn Antenna | 3160-09-01 | EST-LINDGREN | 102642 | 14-Nov-14 |
| Antenna Master & Turn table controller | C02000-P | Innco System GmbH | CO2000/642 /28051111/L | - |
| Bluetooth Tester | TC-3000A | TESCOM | 3000A570224 | 13-Jan-15 |

## 10.2 Environmental Condition

Below 1 GHz -Test Place : 10 m Semi-anechoic chamber

BT Basic Rate Mode
Temperature (°C) : 21.4 ℃
Humidity (% R.H.) : 57.2 % R.H.

Above 1 GHz-Test Place : 3 m Semi-anechoic chamber

BT Basic Rate Mode
Temperature (°C) : 21.4 ℃
Humidity (% R.H.) : 57.0 % R.H.

## 10.3 Test Data for Bluetooth (Basic Rate)

Test Date : 18-Sep-14 Measurement Distance : 3 m

| Frequency (MHz) | Reading (dBμV) | Position (V/H) | Height (m) | Correction Factor | | Result Value | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Ant Factor (dB) | Cable (dB) | Limit (dBμV/m) | Result (dBμV/m) | Margin (dB) |
| 49.30 | 15.48 | V | 1.0 | 12.95 | 1.21 | 40.00 | 29.63 | 10.37 |
| 88.00 | 20.01 | V | 1.0 | 7.99 | 1.56 | 40.00 | 29.56 | 10.44 |
| 96.90 | 18.22 | H | 1.5 | 8.10 | 1.64 | 43.50 | 27.95 | 15.55 |
| 138.30 | 9.74 | H | 1.4 | 12.05 | 1.92 | 43.50 | 23.70 | 19.80 |
| 150.00 | 18.08 | V | 1.0 | 12.52 | 1.98 | 43.50 | 32.57 | 10.93 |
| 157.30 | 14.75 | V | 1.0 | 12.74 | 2.01 | 43.50 | 29.50 | 14.00 |
| 301.60 | 12.73 | V | 1.0 | 13.59 | 2.73 | 46.00 | 29.04 | 16.96 |
| 360.00 | 17.09 | H | 1.0 | 14.91 | 2.97 | 46.00 | 34.97 | 11.03 |
| 540.27 | 6.19 | V | 1.0 | 18.87 | 3.60 | 46.00 | 28.67 | 17.33 |
| 720.00 | 8.92 | V | 1.0 | 21.38 | 4.20 | 46.00 | 34.51 | 11.49 |
| | | | | | | | | |

| Remark | H : Horizontal, V : Vertical Bluetooth (Basic Rate , 39 CH , 2441 MHz)<br><br>*Checked in all 3 axis and the maximum measured data were reported.<br>*CL = Cable Loss(In case of below1 000 MHz)<br>*The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-peak detection at frequency below 1 GHz.<br>*Result Value = Reading + Ant Factor + Cable loss<br>*Margin= Limit - Result |
|---|---|

# 10.3-1 Test Data for Bluetooth(Basic Rate)

Test Date : 18-Sep-14 Measurement Distance : 3 m

| Frequency (MHz) | Reading (dBμV) | Position (V/H) | Height (m) | Correction Factor | | Duty Cycle Correction (dB) | Result Value | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Ant Factor (dB) | Cable (dB) | | Limit (dBμV/m) | Result (dBμV/m) | Margin (dB) |
| PEAK(RBW:1 MHz VBW:3 MHz) | | | | | | | | | |
| 2312.20 | 26.98 | H | 1.2 | 27.32 | 5.60 | 0.00 | 74.00 | 59.90 | 14.10 |
| 2341.40 | 26.24 | V | 1.1 | 27.39 | 5.60 | 0.00 | 74.00 | 59.23 | 14.77 |
| 2390.00 | 24.64 | H | 1.0 | 27.51 | 5.60 | 0.00 | 74.00 | 57.75 | 16.25 |
| 2390.00 | 25.16 | V | 1.3 | 27.51 | 5.60 | 0.00 | 74.00 | 58.27 | 15.73 |
| 4804.00 | 49.97 | H | 1.2 | 31.36 | -24.66 | 0.00 | 74.00 | 56.67 | 17.33 |
| 4804.00 | 47.62 | V | 1.2 | 31.36 | -24.66 | 0.00 | 74.00 | 54.32 | 19.68 |
| | | | | | | | | | |
| | | | | | | | | | |
| Average (RBW:1 MHz VBW:1 kHz) | | | | | | | | | |
| 2312.20 | 13.25 | H | 1.2 | 27.32 | 5.60 | -30.69 | 54.00 | 15.48 | 38.52 |
| 2341.40 | 13.24 | V | 1.1 | 27.39 | 5.60 | -30.69 | 54.00 | 15.54 | 38.46 |
| 2390.00 | 13.14 | H | 1.0 | 27.51 | 5.60 | -30.69 | 54.00 | 15.56 | 38.44 |
| 2390.00 | 13.07 | V | 1.3 | 27.51 | 5.60 | -30.69 | 54.00 | 15.49 | 38.51 |
| 4804.00 | 42.32 | H | 1.2 | 31.36 | -24.66 | -30.69 | 54.00 | 18.33 | 35.67 |
| 4804.00 | 38.31 | V | 1.2 | 31.36 | -24.66 | -30.69 | 54.00 | 14.32 | 39.68 |
| | | | | | | | | | |
| | | | | | | | | | |

| Remark | H : Horizontal, V : Vertical TEST MODE : Bluetooth Basic Rate-CH0(2402 MHz)<br><br>*The TX signal wasn't detected from 3th harmonics.<br>*Checked in all 3 axis and the maximum measured data were reported.<br>*Result Value = Reading + Ant Factor + Cable loss - Amplifier Gain + Duty Cycle Correction Factor<br>*Margin= Limit - Result<br>*The resolution bandwidth and video bandwidth of spectrum analyzer is 1 MHz and 1 kHz for average detection at frequency above 1 GHz.<br>FYI : Duty Cycle Correction Factor (79 channel hopping)<br>a. Worst Case Dwell Time = 2.92 ms<br>b. Duty Cycle Correction = 20log (Worst Case Dwell Time/ 100ms) dB = - 30.69 dB |
|---|---|

## 10.3-2 Test Data for Bluetooth(Basic Rate)

Test Date : 18-Sep-14 Measurement Distance : 3 m

| Frequency (MHz) | Reading (dBμV) | Position (V/H) | Height (m) | Correction Factor | | Duty Cycle Correction (dB) | Result Value | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Ant Factor (dB) | Cable (dB) | | Limit (dBμV/m) | Result (dBμV/m) | Margin (dB) |
| PEAK(RBW:1 MHz VBW:3 MHz) | | | | | | | | | |
| 4882.00 | 49.16 | H | 1.3 | 31.49 | -24.27 | 0.00 | 74.00 | 56.38 | 17.62 |
| 4882.00 | 47.39 | V | 1.2 | 31.49 | -24.27 | 0.00 | 74.00 | 54.61 | 19.39 |
| | | | | | | | | | |
| | | | | | | | | | |
| Average (RBW:1 MHz VBW:1 kHz) | | | | | | | | | |
| 4882.00 | 41.67 | H | 1.3 | 31.49 | -24.27 | -30.69 | 54.00 | 18.20 | 35.80 |
| 4882.00 | 39.40 | V | 1.2 | 31.49 | -24.27 | -30.69 | 54.00 | 15.93 | 38.07 |
| | | | | | | | | | |
| | | | | | | | | | |

Remark

H : Horizontal, V : Vertical TEST MODE : Bluetooth Basic Rate-CH39(2441 MHz)

*The TX signal wasn't detected from 3th harmonics.
*Checked in all 3 axis and the maximum measured data were reported.
*Result Value = Reading + Ant Factor + Cable loss - Amplifier Gain + Duty Cycle Correction Factor
*Margin= Limit - Result
*The resolution bandwidth and video bandwidth of spectrum analyzer is 1 MHz and 1 kHz for average detection at frequency above 1 GHz.
FYI : Duty Cycle Correction Factor (79 channel hopping)
a. Worst Case Dwell Time = 2.92 ms
b. Duty Cycle Correction = 20log (Worst Case Dwell Time/ 100ms) dB = - 30.69 dB

# 10.3-3 Test Data for Bluetooth(Basic Rate)

Test Date : 18-Sep-14 Measurement Distance : 3 m

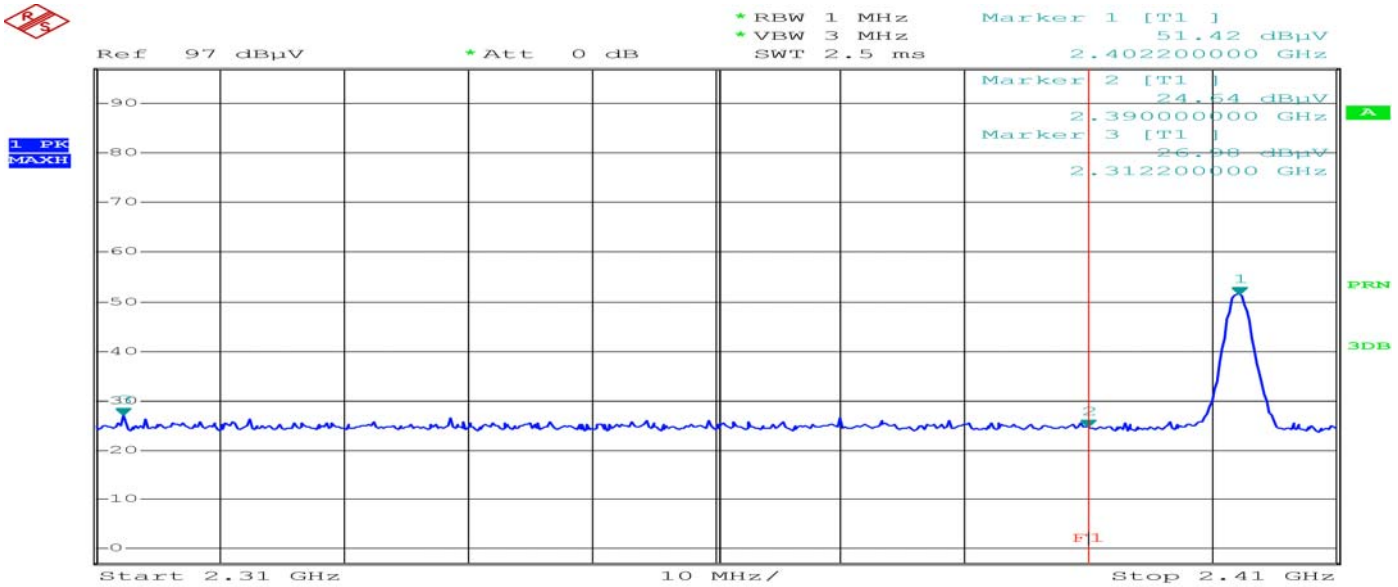
| Frequency (MHz) | Reading (dBμV) | Position (V/H) | Height (m) | Correction Factor | | Duty Cycle Correction (dB) | Result Value | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Ant Factor (dB) | Cable (dB) | | Limit (dBμV/m) | Result (dBμV/m) | Margin (dB) |
| PEAK(RBW:1 MHz VBW:3 MHz) | | | | | | | | | |
| 2483.50 | 25.01 | H | 1.1 | 27.74 | 5.60 | 0.00 | 74.00 | 52.75 | 21.25 |
| 2483.50 | 26.84 | V | 1.3 | 27.74 | 5.60 | 0.00 | 74.00 | 60.18 | 13.82 |
| 2487.85 | 26.97 | H | 1.2 | 27.75 | 5.60 | 0.00 | 74.00 | 60.32 | 13.68 |
| 2486.35 | 25.62 | V | 1.0 | 27.75 | 5.60 | 0.00 | 74.00 | 58.97 | 15.03 |
| 4960.00 | 50.54 | H | 1.2 | 31.62 | -23.93 | 0.00 | 74.00 | 58.23 | 15.77 |
| 4960.00 | 48.02 | V | 1.0 | 31.62 | -23.93 | 0.00 | 74.00 | 55.71 | 18.29 |
| | | | | | | | | | |
| | | | | | | | | | |
| Average (RBW:1 MHz VBW:1 kHz) | | | | | | | | | |
| 2483.50 | 14.09 | H | 1.1 | 27.74 | 5.60 | -30.69 | 54.00 | 16.74 | 37.26 |
| 2483.50 | 17.41 | V | 1.3 | 27.74 | 5.60 | -30.69 | 54.00 | 20.06 | 33.94 |
| 2487.85 | 13.04 | H | 1.2 | 27.75 | 5.60 | -30.69 | 54.00 | 15.70 | 38.30 |
| 2486.35 | 12.93 | V | 1.0 | 27.75 | 5.60 | -30.69 | 54.00 | 15.59 | 38.41 |
| 4960.00 | 44.08 | H | 1.2 | 31.62 | -23.93 | -30.69 | 54.00 | 21.08 | 32.92 |
| 4960.00 | 41.02 | V | 1.0 | 31.62 | -23.93 | -30.69 | 54.00 | 18.02 | 35.98 |
| | | | | | | | | | |
| | | | | | | | | | |

| Remark | H : Horizontal, V : Vertical TEST MODE : Bluetooth Basic rate-CH78(2480 MHz)<br><br>*The TX signal wasn't detected from 3th harmonics.<br>*Checked in all 3 axis and the maximum measured data were reported.<br>*Result Value = Reading + Ant Factor + Cable loss - Amplifier Gain + Duty Cycle Correction Factor<br>*Margin= Limit - Result<br>*The resolution bandwidth and video bandwidth of spectrum analyzer is 1 MHz and 1 kHz for average detection at frequency above 1 GHz.<br>FYI : Duty Cycle Correction Factor (79 channel hopping)<br>a. Worst Case Dwell Time = 2.92 ms<br>b. Duty Cycle Correction = 20log (Worst Case Dwell Time/ 100ms) dB = - 30.69 dB |
|---|---|

## 10.4 Restricted Band Edges for BT(Basic Rate)

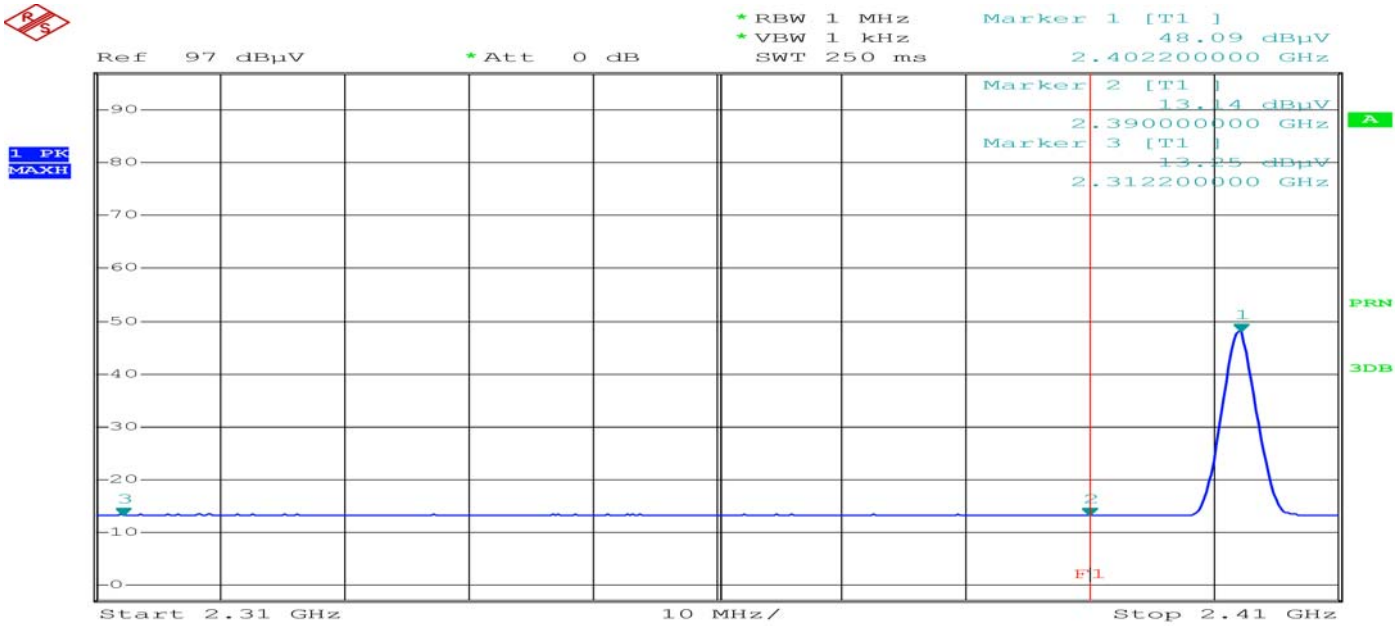
Band Edges(CH Low)

Detector mode:Peak Polarity:Horizontal




Comment: HOR_PK
Date: 18.SEP.2014 13:52:24

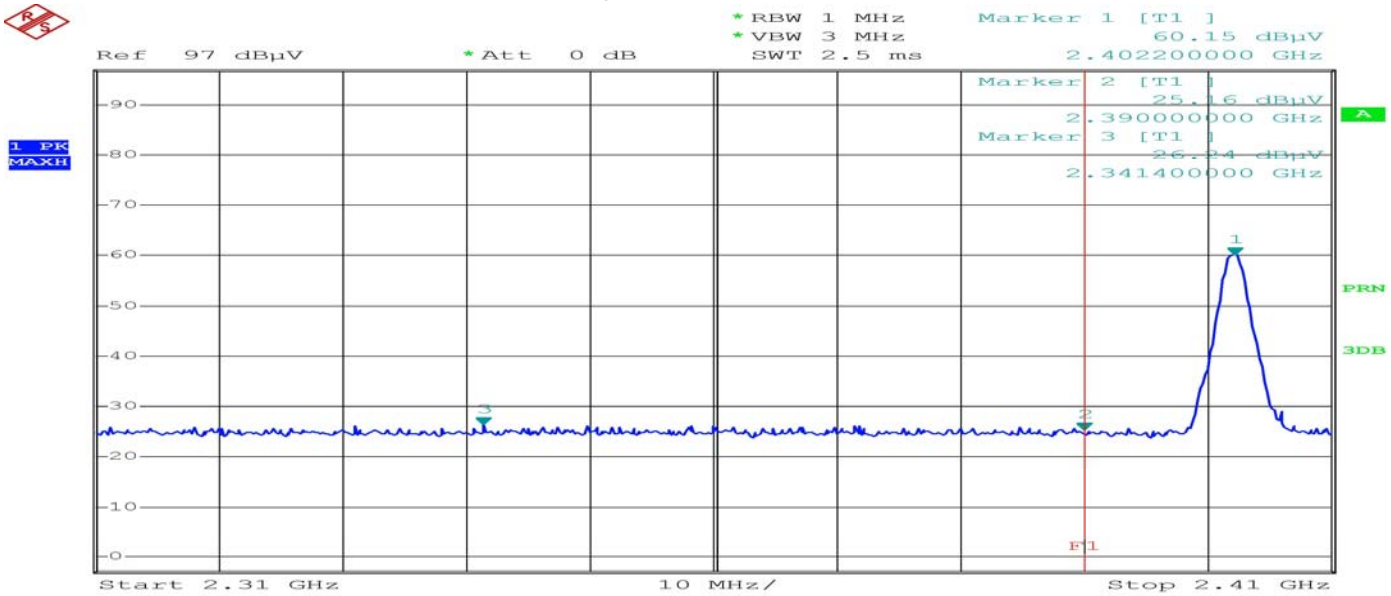
Detector mode:Average Polarity:Horizontal




Comment: HOR_AV
Date: 18.SEP.2014 13:55:37

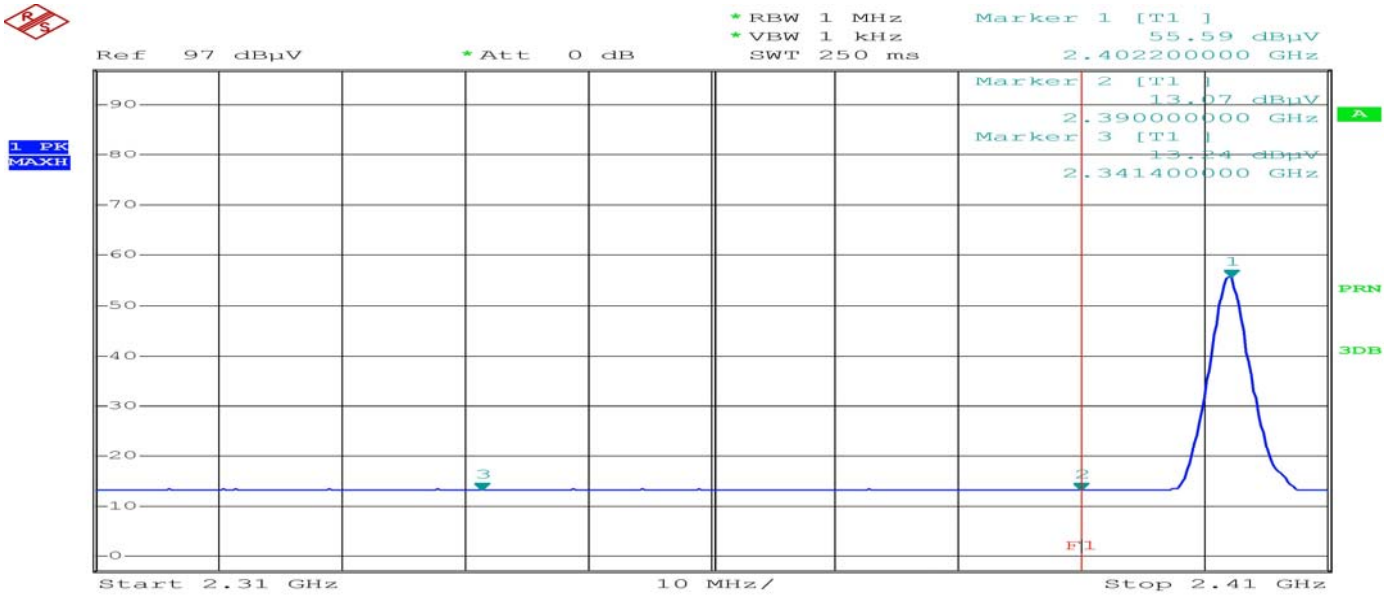
Band Edges(CH Low)

Detector mode:Peak Polarity:Vertical




Comment: VER_PK
Date: 18.SEP.2014 14:33:48

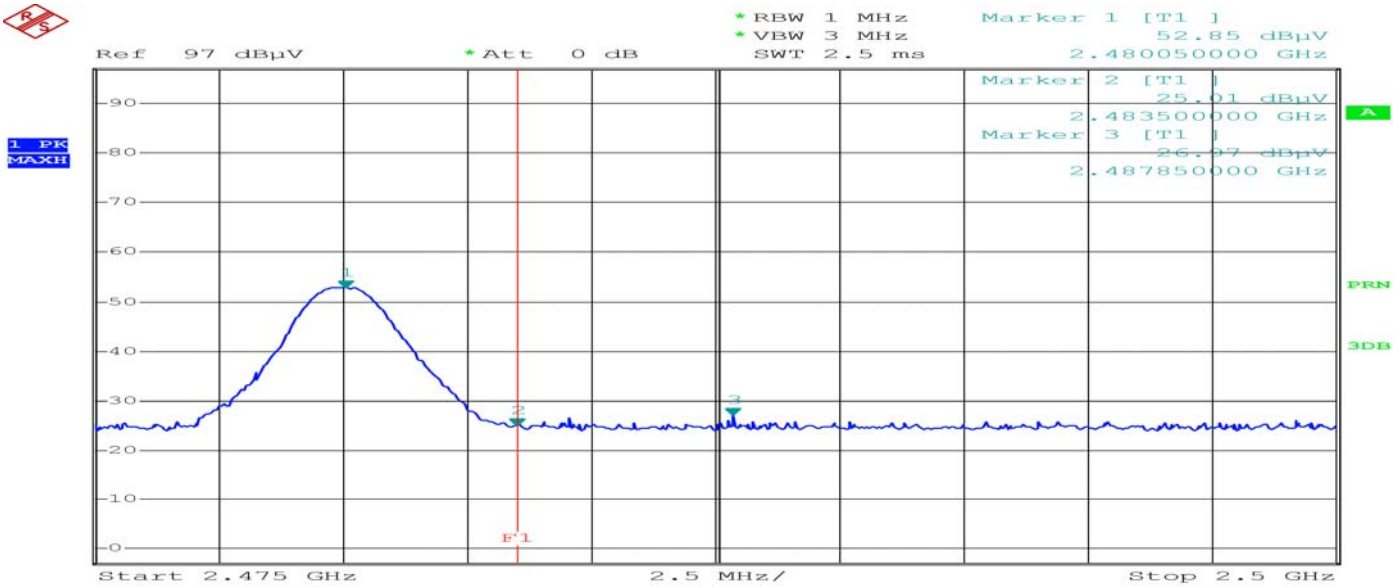
Detector mode:Average Polarity:Vertical




Comment: VER_AV
Date: 18.SEP.2014 14:35:40

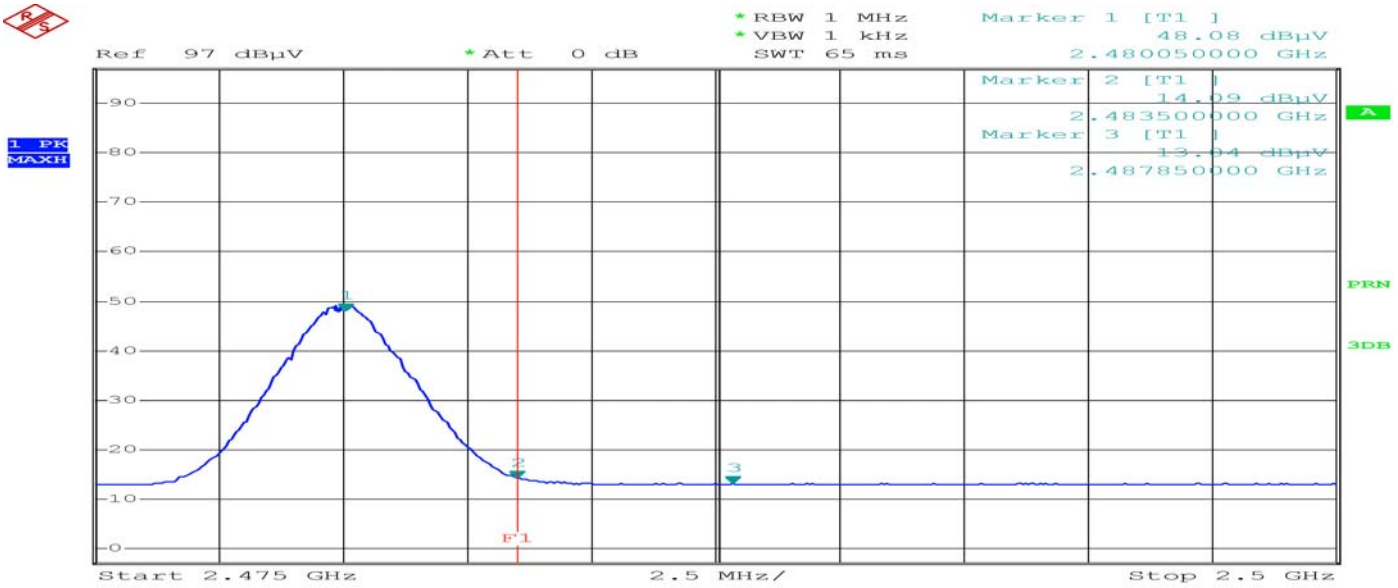
Band Edges(CH High)

Detector mode:Peak Polarity:Horizontal




Comment: HOR_PK
Date: 18.SEP.2014 15:43:39

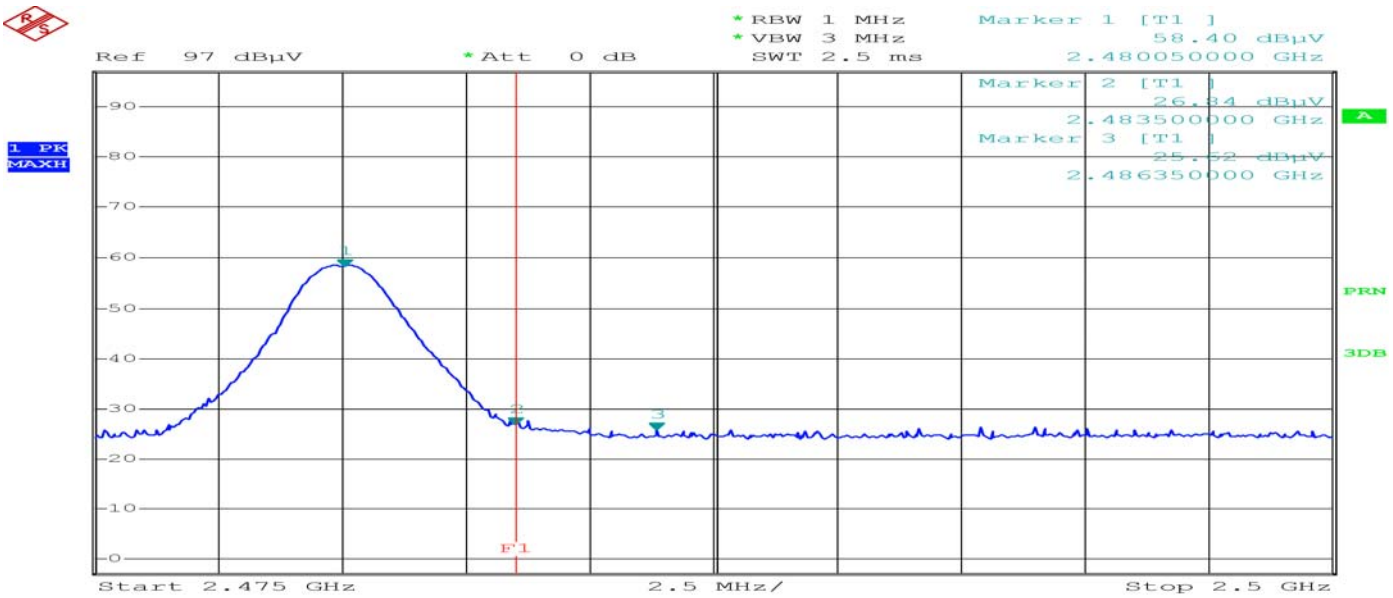
Detector mode:Average Polarity:Horizontal




Comment: HOR_AV
Date: 18.SEP.2014 15:47:00

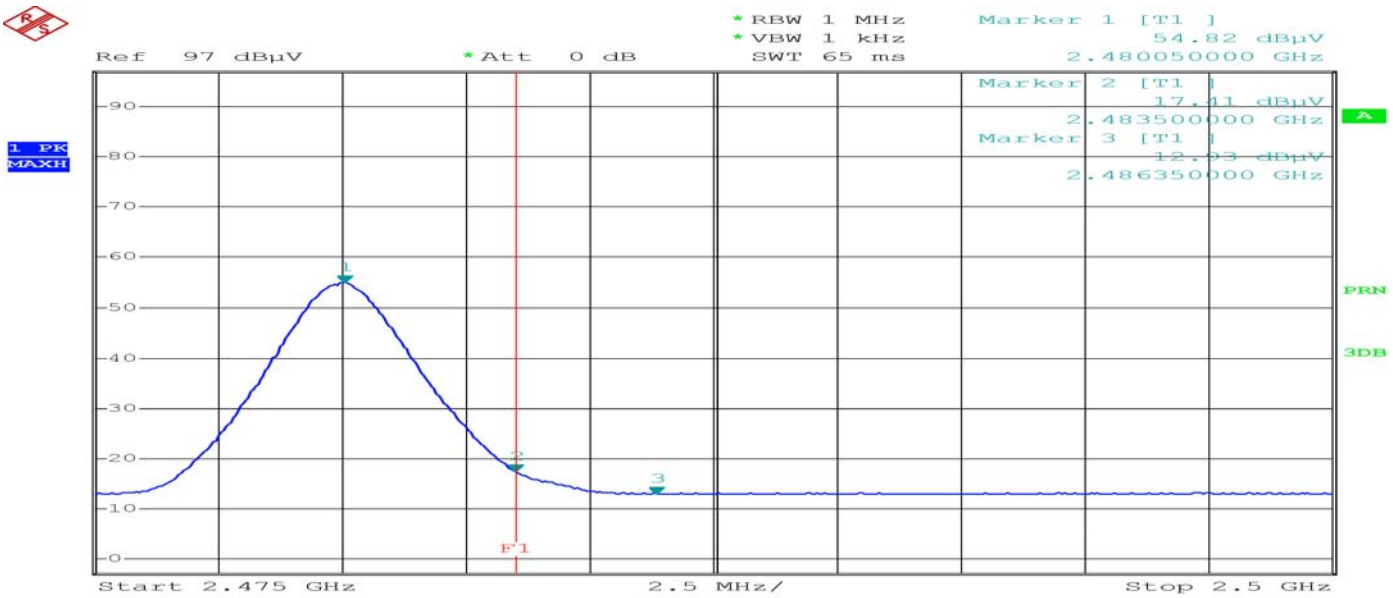
Band Edges(CH High)

Detector mode:Peak Polarity:Vertical




Comment: VER_PK
Date: 18.SEP.2014 15:51:42

Detector mode:Average Polarity:Vertical




Comment: VER_AV
Date: 18.SEP.2014 15:55:51

# 11. Measurement of conducted disturbance

The continuous disturbance voltage of AC Mains in the frequency from 0.15 MHz to 30 MHz was measured in accordance to FCC PART 15.207. The test setup was made according to ANSI C 63.4 (2009) in a shielded room. The EUT was placed on a non-conductive table at least 0.8 m above the ground plan. A grounded vertical reference plane was positioned in a distance of 0.4 m from the EUT. The distance from the EUT to other metal surfaces was at least 0.8 m. The EUT was only earthen by its power cord through the line impedance stabilizing network. The power cord has been bundled to a length of 1.0 m. The test receiver with Quasi Peak detector complies with CISPR 16.

## 11.1 Measurement equipments

| Equipment Name | Type | Manufacturer | Serial No. | Next Calibration date |
|---|---|---|---|---|
| TEST Receiver | ESHS 30 | Rohde & Schwarz | 828765/002 | 13-Jan-15 |
| LISN | ENV216 | Rohde & Schwarz | 101231 | 26-Aug-14 |
| LISN | ESH3-Z5 | Rohde & Schwarz | 836679/025 | 13-Jan-15 |
| Pulse Limiter | ESH3Z2 | Rohde & Schwarz | NONE | 13-Jan-15 |
| Bluetooth Tester | TC-3000A | TESCOM | 3000A570224 | 13-Jan-15 |

## 11.2 Environmental Condition

Test Place : Shielded Room

Temperature (°C) : 22.0 ℃

Humidity (% R.H.) : 55.0 % R.H.

## 11.3 Test Data for Bluetooth (Basic Rate)

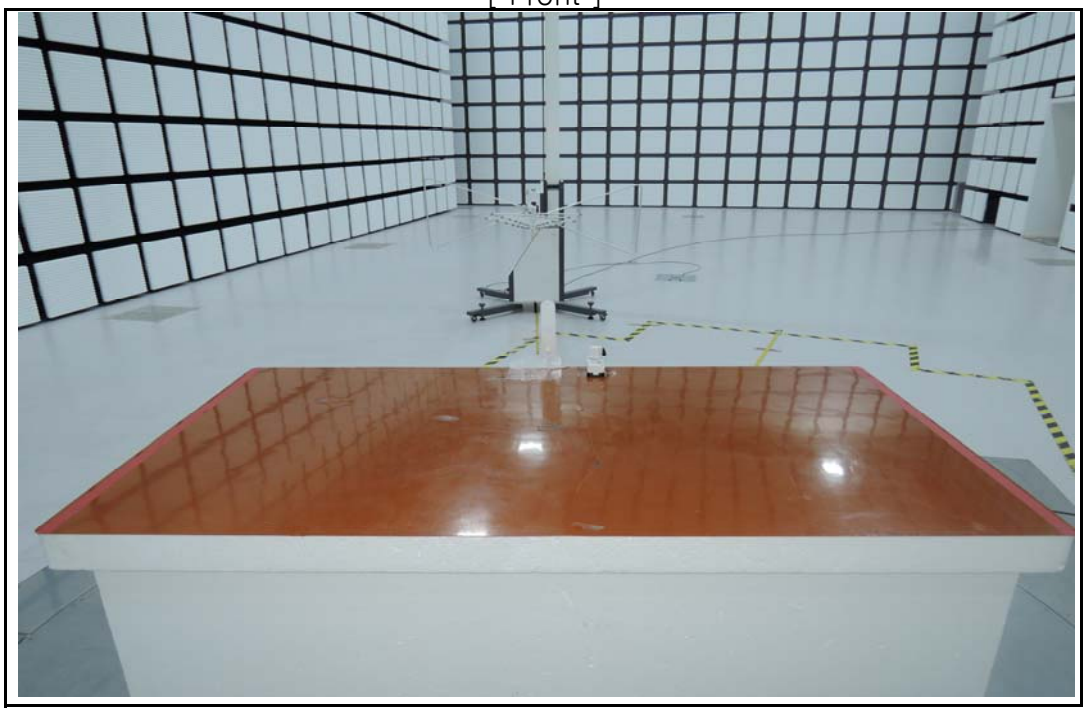
Test Date : 18-Sep-14

| Frequency (MHz) | Correction Factor | | Line (H/N) | Quasi-peak Value | | | Average Value | | |
|---|---|---|---|---|---|---|---|---|---|
| | Lisn (dB) | Cable (dB) | | Limit (dBμV) | Reading (dBμV) | Result (dBμV) | Limit (dBμV) | Reading (dBμV) | Result (dB) |
| 0.17 | 0.14 | 0.19 | H | 64.96 | 43.83 | 44.16 | 54.96 | 27.27 | 27.60 |
| 0.18 | 0.15 | 0.19 | N | 64.49 | 42.12 | 42.46 | 54.49 | 27.91 | 28.25 |
| 0.27 | 0.14 | 0.19 | H | 61.12 | 41.66 | 42.00 | 51.12 | 26.42 | 26.76 |
| 0.28 | 0.15 | 0.20 | N | 60.82 | 40.43 | 40.78 | 50.82 | 310.39 | 30.74 |
| 0.45 | 0.16 | 0.21 | N | 56.88 | 33.48 | 33.85 | 46.88 | 29.26 | 29.63 |
| 0.48 | 0.15 | 0.21 | H | 56.34 | 36.15 | 36.51 | 46.34 | 24.02 | 24.39 |
| 0.62 | 0.15 | 0.2 | H | 56.00 | 33.63 | 33.99 | 46.00 | 26.18 | 26.54 |
| 0.74 | 0.17 | 0.21 | N | 56.00 | 37.24 | 37.62 | 46.00 | 32.20 | 32.58 |
| 0.75 | 0.15 | 0.21 | H | 56.00 | 31.28 | 31.64 | 46.00 | 21.55 | 31.91 |
| 0.77 | 0.17 | 0.21 | N | 56.00 | 31.64 | 32.03 | 46.00 | 26.38 | 26.77 |
| 0.98 | 0.16 | 0.22 | H | 56.00 | 27.09 | 27.47 | 46.00 | 17.32 | 17.70 |
| 1.13 | 0.19 | 0.22 | N | 56.00 | 28.91 | 29.33 | 46.00 | 24.23 | 24.65 |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| Remark | H : Hot Line, N : Neutral Line<br><br>*Correction Factor = Lisn + Cable<br>*Result = Correction Factor + Reading | | | | | | | | |

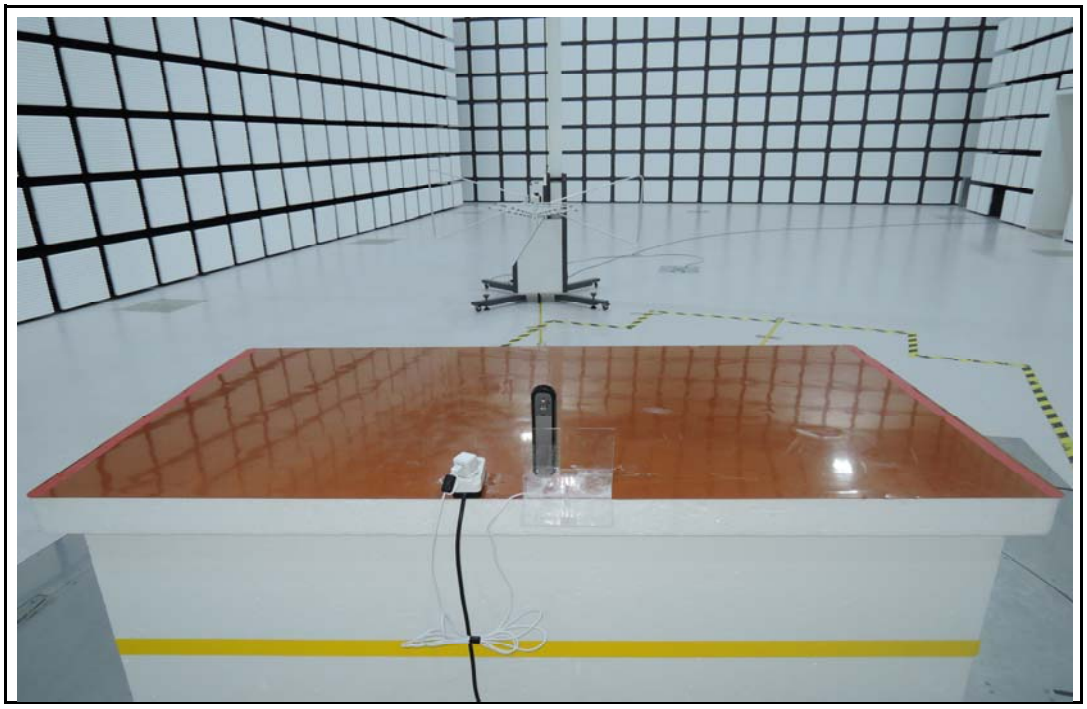
# 12. Photographs of test setup

## 12.1.Setup for Radiated Test : 30 ~ 1 000 MHz

[ Front ]



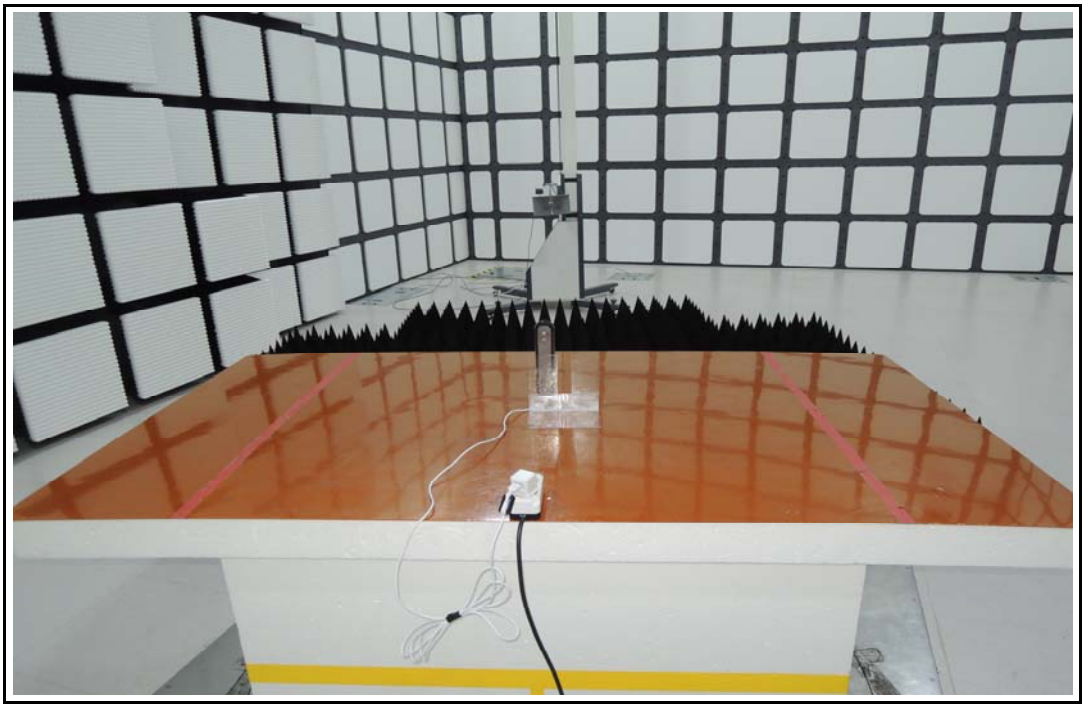
[ Rear ]



## 12.2. Setup for Radiated Test :Above 1 000 MHz

[ Front ]

[ Rear ]



## 12.3. Setup for Conducted Test : 0.15 ~ 30 MHz

[ Front ]

[ Rear ]

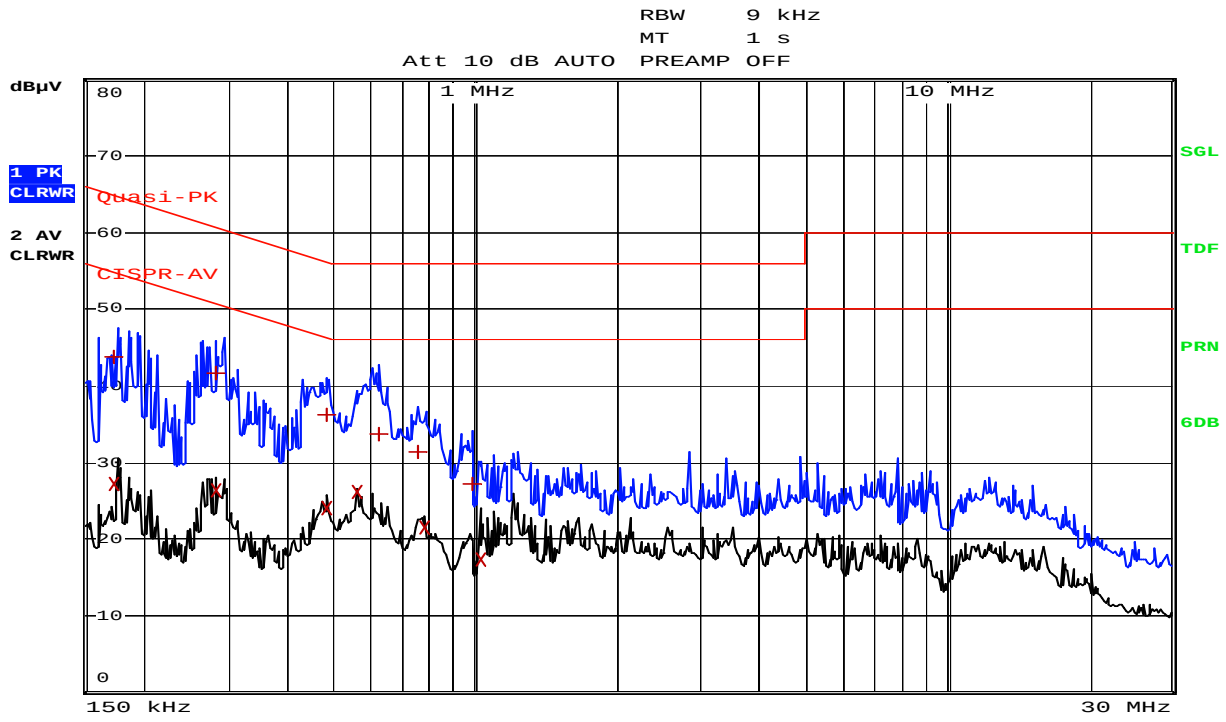
# 12.4. Photographs of EUT

[ Front ]

[ Rear ]

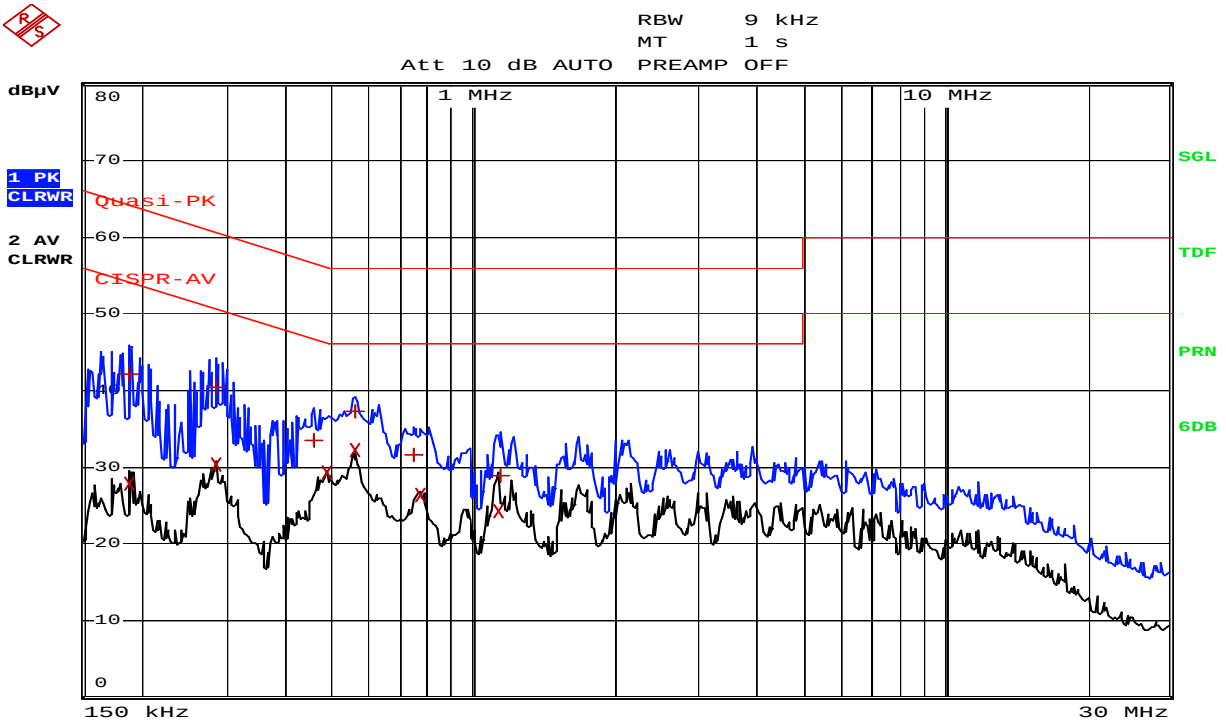
# Appendix 1. Special diagram for Bluetooth (Basic Rate)

* HOT LINE




Comment: 01468_HOT
Date: 18.SEP.2014 08:06:20

* NEUTRAL LINE




Comment: 01468_NEUTRAL
Date: 18.SEP.2014 08:09:24

# Appendix 2. Antenna Requirement

# 1. Antenna Requirement

## 1.1 Standard Applicable

For intentional device, according to FCC 47 CFR Section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

And according to FCC 47 CFR Section 15.204

## 1.2 Antenna Connected Construction

The antenna types used in this product are Chip Antenna. The maximum Gain of this antenna is 3.10 dBi. (Polarization : Linear)