Korea Technology Institute Co., Ltd.

Test Report

Test Report No.:	**KTI13EF11006**		
Registration No.:	**KR0023**		
Applicant:	**ITVERS Corporation**		
Applicant Address:	**1224, Lifecombi Bldg, 61-4 Yeouido-dong, Yeongdeungpo-gu, Seoul, Korea 150-732**		
Product:	**RF 2.4GHz Wireless Remote**		
FCC ID:	**2ABLB-ITV-R01T**	**Model No.**	**ITV-R01T**
Receipt No.:	**13-11006**	**Date of receipt:**	**November 18, 2013**
Date of Issue:	**November 22, 2013**		
Testing location	**Korea Technology Institute Co., Ltd. 51-19, Sanglim3-Ri, Docheok-Myeon, Gwangju-Shi, Gyeonggi-Do, Korea**		
Test Standards:	**FCC/ANSI. C63.4: 2003**		
Rule Parts: FCC	**Part 15.247 Subpart C, ANSI C 63.4-2003**		
Method of Measurement	**FCC Public Notice DA 00-705**		
Test Result:	**The above-mentioned product has been tested with compliance.**		

Tested by: M. G. Ji
/ Engineer

Signature Date November 22, 2013

Approved by: S. H. Song
/Technical Manager

Signature Date November 22, 2013

Other Aspects:	
Abbreviations:	*** OK, Pass=passed * Fail=failed * N/A=not applicable**

☞ **- 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 is based on a single evaluation of one sample of the above mentioned.

- This test report must not be used by the client to claim product endorsement by NVLAP or any agency of the U.S Government.

- We certify this test report has been based on the measurement standards that is traceable to the national or international standards.

≫≫ Contents ≪≪

1. Verification of compliance

Applicant : ITVERS Corporation

Address : 1224, Lifecombi Bldg, 61-4 Yeouido-dong, Yeongdeungpo-gu, Seoul, Korea 150-732

FCC ID : 2ABLB-ITV-RO1T

Model Name : ITV-R01T

Brand Name : ITVERS

Serial Number : N/A

Date : November 21, 2013

Equipment Class	DSS – PART 15 SPREAD SPETRUM TRANSMITTER
Kind of Equipment	RF 2.4GHz Wireless Remote
Measurement Procedures	FCC Public Notice DA 00-705, ANSI C63.4-2003,
Type of Equipment Tested	Pre-Production
Kind of Equipment Authorization Requested	Certification
Equipment Will Be Operated Under FCC Rules Part(s)	FCC PART 15 SUBPART C Section 15.247
Modifications On The Equipment To Achieve Compliance	None
Final Test was Conducted On	10m Open area test site

- The above equipment was tested by Korea Technology Institute Co., Ltd. for compliance with the requirement set forth in the FCC Rules and Regulations. This said equipment in the configuration described in this report, shows the maximum emission levels emanation from equipment are within the compliance requirements.

2. General Information

2.1 Product Description

The ITVERS Corporation Model ITV-R01T (referred to as the EUT in this report) is used to remote controller which has a function of nRF24XX. The product specification described herein was obtained from product data sheet or user's manual.

Equipment Name	RF 2.4GHz Wireless Remote
Operating Frequency	2402 MHz ~ 2478 MHz
RF Output Power	-1.33 dBm
Number of Channel	39 Channels
Mode of Operation	Duplex
Modulation Type	GFSK
Antenna Type / Gain	PCB Pattern Antenna /1.70dBi(Max)
List of Each OSC. Or Crystal. Freq.	16 MHz Crystal Oscillator
Rated Supply Voltage	DC 3.0 V

3. EUT MODIFICATION

- NONE.

4. Information about the FHSS characteristics

4.1 Pseudorandom frequency hopping sequence

Nordic has developed Gazell, an RF protocol designed for efficiency, low power consumption and minimum latency. Gazell incorporates frequency agility technology; this employs a simplified frequency hopping scheme where the transmitting and receiving pair establish communication on a particular frequency and then only hop to a different frequency should interference be experienced. The channel on which the interference was experienced is marked and not reused during that particular communication cycle

➔Frequency hopping in Gazell

In Gazell, the frequency hopping as seen on the air is completely determined by the Devices. The Host will for any frequency hopping policy on a Device still listen on all channels in turn, rotating through the complete channel table. The Host is configured in the same way for all Device modes, and does not even know a Device's synchronization mode or hopping policy. A Device can select which channels to use and how often to use them. Different Devices can choose different channel hopping policies if wanted. The available channel selection policies are different for the asynchronous and semi-synchronous modes:

Channel selection policies in asynchronous mode

A Gazell Device in asynchronous mode can be set up with two channel selection policies:

-Frequency agility (FA)
-Frequency hopping spread spectrum (FHSS)

For the "frequency agility" policy, we first try the previous successful channel, assuming that this channel is still good. This is the channel that was used by the last acknowledged packet. We will stay on this channel as long as it is good. In a quiet environment we will then very seldom change channel. If we do not succeed transmitting on the previous good channel, a pseudo-random channel is selected from the channel table.

For the "frequency hopping" policy we select a new pseudo-random channel from the channel table each time. This gives us frequency hopping spread spectrum behavior. The transmitted radio power is then spread evenly among all channels in the channel table. This behavior is required by some radio regulations when transmitting at high power, as when using a power amplifier. If we do not succeed on the first random channel, a new pseudo-random channel is selected from the channel table.

Channel selection policies in semi-synchronous mode

A Gazell Device in semi-synchronous mode can be set up with three channel selection policies:

-Frequency agility (FA)

-Frequency hopping spread spectrum (FHSS)

-Low latency frequency hopping spread spectrum (smart FHSS)

For the first two policies the selection of the first channel to try is the same as in asynchronous mode. The difference lies in how the secondary channel choice is made.

In asynchronous mode, if the first channel choice in FA or FHSS mode fails, a pseudo-random channel will be tried. In synchronous mode, if the first channel choice in FA or FHSS mode fails, the estimated Host channel will be used instead. We have sync, so the Device knows the channel rotation at the Host, and just waits until the time slot for this channel comes up a the Host, before attempting to transmit. Details of Device channel selection and transmit operation are shown in the figure below.

The third policy - low latency frequency hopping, or smart FHSS - is only meaningful for a synchronized Device. With this policy the Device immediately starts transmitting at the channel that the Host is listening on. If the Device is still in sync with the Host, we will hit the correct timer the first time, reducing latency and saving power.

Frequency hopping spread spectrum is defined in the 2.4 GHz band and operates in around 39 frequencies ranging from 2.402 GHz to 2.478 GHz.
Every frequency is GFSK modulated with channel width of 2MHz and rates defined as 2 Mbps.

The frequency hopping code hops between 39 channels (channel 1 to channel 39) pseudo-randomly distributed in a 256-bytes constant table embedded in the code. The hopping functions as follows. Each time the transmitter sends a packet on a channel it starts waiting for an acknowledge packet (ACK) on the same channel.

If the ACK is received within a predefined time-out (3ms in this example) the transmitter selects the next channel in the hopping table and sends the next packet on the newly selected channel.

If an ACK is not received within the time-out period the packet is re-transmitted on the same channel. If this does not result in a valid ACK the transmitter hops to the next channel and repeats the procedure above.
This process is repeated until an ACK is received or a time-out (3 seconds in the demo applications) is reached and if the time-out is reached the function returns with an error.

For the Hop pattern of 2412MHz, 2414MHz, 2402MHz, 2406MHz ,2414MHz,
The sequential hops are +2MHz, -12MHz, +12MHz, +4MHz, +14MHz

You can use a channel number and it might look like channel 2,4,19,3,7,32,2,15,etc,etc.
These represent Channel numbers.

4.2 Equal Hopping Frequency Use

In normal operation, the initial pseudorandom list of frequency hopping locations is volatile in terms of the number of hopping frequencies in use and the sequence of which they occur. These elements combined result in an unpredictable hopping sequence with pseudorandom properties.
Hopping positions are used equally on average with even noise distribution in the band.

4.3 System Receiver Input Bandwidth

They match the bandwidth of the transmitted signal and that they shift frequencies in synchronization with the transmitted signals.
The RF channel frequency determines the center of the channel used by the RF transceiver.
The channel occupies a bandwidth of less than 1 MHz at 250kbps and 1Mbps and a bandwidth of less than 2 MHz at 2Mbps. The RF transceiver can operate on frequencies from 2.400 GHz to 2.525 GHz.
The programming resolution of the RF channel frequency setting is 1 MHz.
At 2Mbps the channel occupies a bandwidth wider than the resolution of the RF channel frequency setting. To ensure non-overlapping channels in 2Mbps mode, the channel spacing must be 2 MHz or more. At 1Mbps and 250kbps the channel bandwidth is the same or lower than the resolution of the RF frequency.
The RF channel frequency is set by the RF_CH register according to the following formula:
F0= 2400 + RF_CH MHz
The RX mode is an active mode where the RF transceiver is used as a receiver. To enter this mode, the RF transceiver must have the PWR_UP bit, PRIM_RX bit and the rfce bit is set high.
In RX mode the receiver demodulates the signals from the RF channel, constantly presenting the demodulated data to the baseband protocol engine. The baseband protocol engine constantly searches for a valid packet. If a valid packet is found (by a matching address and a valid CRC) the payload of the packet is presented in a vacant slot in the RX FIFOs. If the RX FIFOs are full, the received packet is discarded. The RF transceiver remains in RX mode until the MCU configures it to standby-I mode or power down mode. However, if the automatic protocol features (Enhanced ShockBurst™) in the baseband protocol engine are enabled, the RF transceiver can enter other modes in order to execute the protocol.

4.4 Equipment Description

Section 15.247 also applies for the 2.4GHz band. The nRF24xx series of radios have a channel spacing of 1MHz. This gives the following requirements for operation under section 15.247:

• 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.

• The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudorandomly ordered list of hopping frequencies.

• Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

• Maximum peak conducted power for systems with more than 39 non overlapping hopping channels is 1W (+30dBm) and 0.125W (+20.9dBm) Harmonics must be 20dB below the peak in-band emission in any 100 kHz bandwidth for FHSS systems.

•15.247(g): Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section

•15.247(h) The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

5. Test Summary

5.1 Test Items and results

SECTION	TEST ITEMS	RESULT
15.247(a)(1)	Carrier Frequency Separation	Compliance
15.247(a)(1)	20 dB Bandwidth	Compliance
15.247(a)(1)(iii)	Minimum Number of Hopping Channels	Compliance
15.247(a)(1)(iii)	Average Time of Occupancy	Compliance
15.247(b)(1)	Maximum Peak Conducted Output Power	Compliance
15.247(c)	Band-edge	Compliance
15.205(a) 15.209 15.247(d)	Radiated Emissions	Compliance
15.207	Conducted Emission	-
15.247(c)	Antenna Requirement	Compliance

Notes: Compliance/pass : The EUT complies with the essential requirements in the standard.

Not Compliance : The EUT does not comply with the essential requirements in the standard.

N/A : The test was not applicable in the standard.

5.2 Additions, deviations, exclusions from standard

No additions, deviations or exclusions have been made from standard.

5.3 Related Submittal(s) / Grant(s)

Original submittal only

5.4 Purpose of the test

To determine whether the equipment under test fulfills the requirements of the regulation stated in section 2.1.

5.5 Test Methodology

The radiated testing was performed according to the procedures in ANSI C63.4:2003 at a distance of 3 m from EUT to the antenna

5.6 Test Facility

The open area test site and conducted measurement facilities are located on at 51-19, Sanglim3-Ri, Docheok-Myeon, Gwangju-Shi, Gyeonggi-Do, Korea

6. System test Configuration

6.1 Characteristics of equipment

This equipment is RF 2.4GHz Wireless Remote. The ITV-R01T is an wireless remote implementing s nRF24XX communication standards, frequency hopping spread spectrum system(FHSS)used
frequency band is 2 402 ㎒ - 2 478 ㎒ Power source is supplied 3.0 Vdc.

6.2 Used Peripherals list

DEVICE TYPE	Manufacturer	Model	S/N
Notebook PC	SAMSUNG	NT-RV511-S16R	HHA793QB600206F

6.3 Mode of operation during the test

For nRF24XX function testing, software used to control the EUT for staying in continuous transmitting and receiving mode is programmed. The EUT was set at Low Channel (2 402 MHz), Middle Channel (2 440 MHz), and High Channel (2 478 MHz) with each data transfer rate. To get a maximum radiated emission levels from the EUT, the EUT was moved throughout the XY, XZ, and YZ planes and rotated. The worst data was recorded in this test report.

6.4 Uncertainty

1) Radiated disturbance

Uc (Combined standard Uncertainty) = ± 1.8dB

Expanded uncertainty U=KUc

K = 2

∴ U = ± 3.6dB

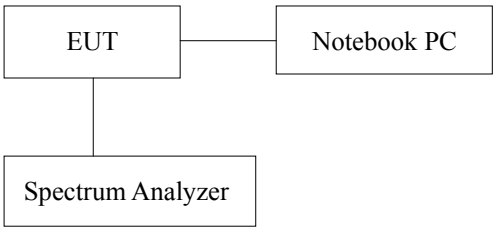
2) Conducted disturbance

Uc = ± 0.88dB

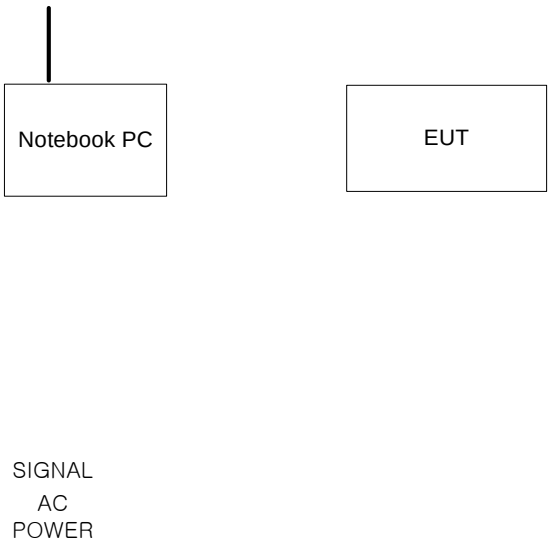
U = KUc=2 x Uc = ± 1.8dB

6.5 Test setup of EUT

6.5.1 Except Radiated Emissions and AC Conducted Emissions measurement, all measurements were taken in continuous transmit / receive mode using the TEST MODE.
For controlling the EUT as TEST MODE, the test program was provided by the applicant.
The jig board controlled EUT by Notebook PC in TEST MODE.



6.5.2 Radiated Emission and AC Conducted Emissions measurement setup



7. Measurement results

7.1 Carrier Frequency Separation

Temperature : 22℃

Relative Humidity : (44 - 45) % R.H.

Procedure

The carrier frequency separation was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled. After the trace being stable, the reading value between the peak of the adjacent channels using the marker-delta function was recorded as the measurement results.

The spectrum analyzer is set to:

Span = 3 MHz (wide enough to capture the peaks of two adjacent channels)

RBW = 30 kHz (1% of the span or more)

Sweep = auto

VBW = 30 kHz

Detector function = peak

Trace = max hold

Test equipment used

Model NO.	Mannufacturer	Description	S/N	Due to Cal. Date
8564E	H.P	Spectrum Analyzer	3745A01024	2014.04.03

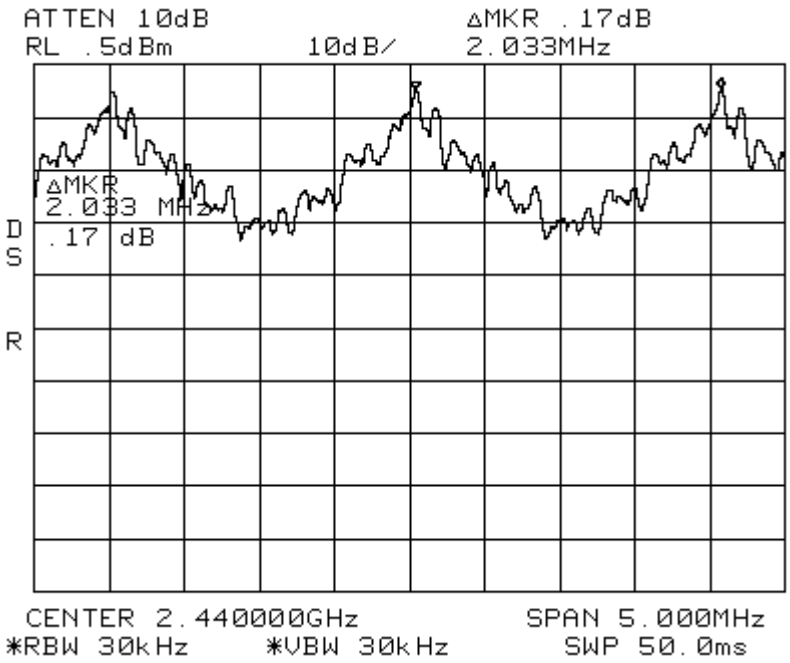
Measurement Result

Frequency of marker #1 (MHz)	Frequency of marker #2 (MHz)	Test Results	
		Carrier Frequency Separation (MHz)	Results
2440.000	2442.033	2.033	Compliance

- See next pages for actual measured spectrum plots.

Minimum Standard:

The EUT shall have hopping channel carrier frequencies separated by a minimum of 25kHz or the 20dB bandwidth of the hopping channel, whichever is greater.


ATTEN 10dB
RL .5dBm
10dB/
ΔMKR .17dB
2.033MHz
ΔMKR
2.033 MHz
.17 dB
D
S
R
CENTER 2.440000GHz
SPAN 5.000MHz
*RBW 30kHz
*VBW 30kHz
SWP 50.0ms

7.2 Number of Hopping Frequencies

Temperature : 22℃

Relative Humidity : (44 - 45) % R.H.

Procedure

The number of hopping frequencies was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled. To get higher resolution, four frequency ranges within the 2 400 ~ 2 482 MHz band were examined.

The spectrum analyzer is set to:

Frequency range 1: Start = 2 400 MHz, Stop = 2 480 MHz

RBW = 100 kHz (1% of the span or more) Sweep = auto

VBW = 100 kHz (VBW ≥ RBW) Detector function = peak

Trace = max hold Span = 60 MHz, 24 MHz

Test equipment used

Model NO.	Mannufacturer	Description	S/N	Due to Cal. Date
ESCI	R&S	EMI RECEIVER	100025	2013.09.19

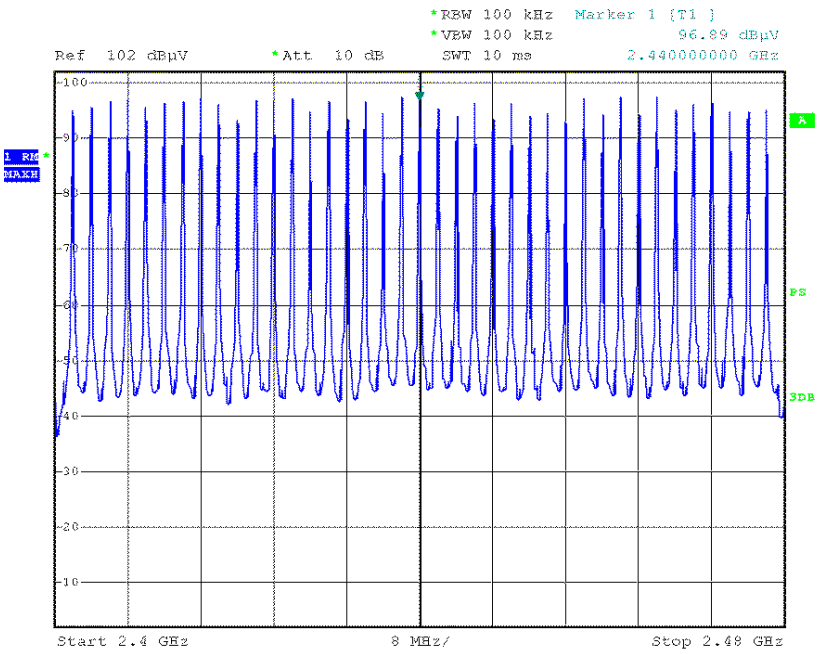
Measurement Data:

Total number of Hopping Channels	Result
39	Compliance

-See next pages of actual measured spectrum plots.

Minimum Standard:

At least 15 hopes


*RBW 100 kHz
Marker 1 [T1]
*VBW 100 kHz
96.89 dBµV
Ref 102 dBµV
*Att 10 dB
SWT 10 ms
2.440000000 GHz
1 RM
MAXH
A
PS
3DB
Start 2.4 GHz
8 MHz/
Stop 2.48 GHz

7.3 20 dB Bandwidth

Temperature : 22℃

Relative Humidity : (44 - 45) % R.H.

Procedure

The bandwidth at 20 dB below the highest inband spectral density was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function disabled at the highest, middle and the lowest available channels. After the trace being stable, Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker-delta function to measure 20dB down one side of the emission. Reset the marker-delta function, and move the marker to the other side of the emission, until it is) as close as possible to) even with the reference marker level. The marker-delta reading at this is the 20 dB bandwidth of the emission.

The spectrum analyzer is set to:

Center frequency = the highest, middle and the lowest channels

Span = 2 MHz (approximately 2 or 3 times of the 20 dB bandwidth)

RBW = 10 kHz (1% of the 20dB bandwidth or more) Sweep = auto

VBW = 30 kHz (VBW ≥ RBW) Detector function = peak

Trace = max hold

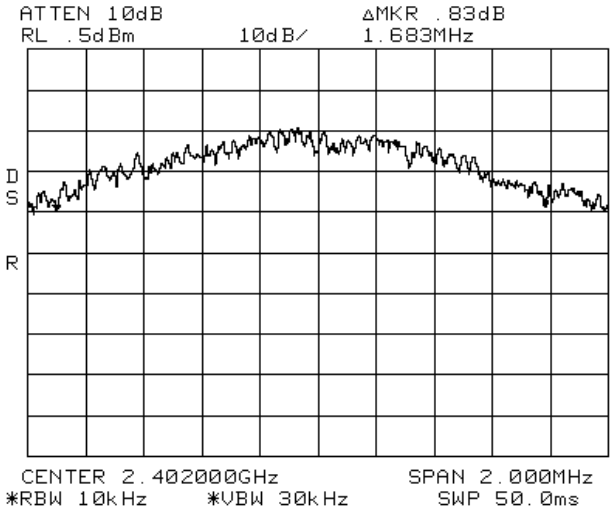
Test equipment used

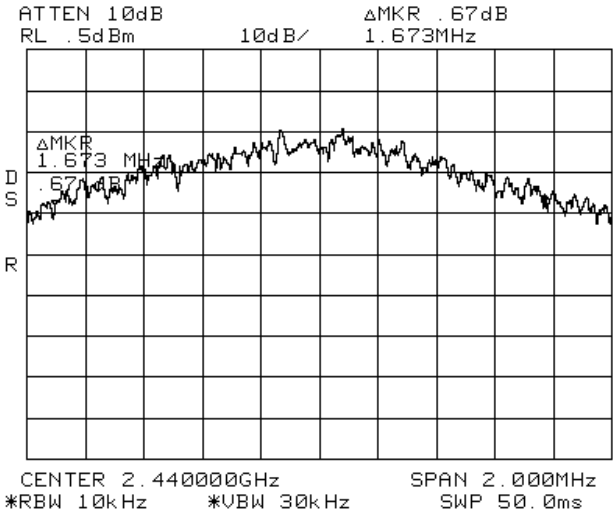
Model NO.	Mannufacturer	Description	S/N	Due to Cal. Date
8564E	H.P	Spectrum Analyzer	3745A01024	2014.04.03

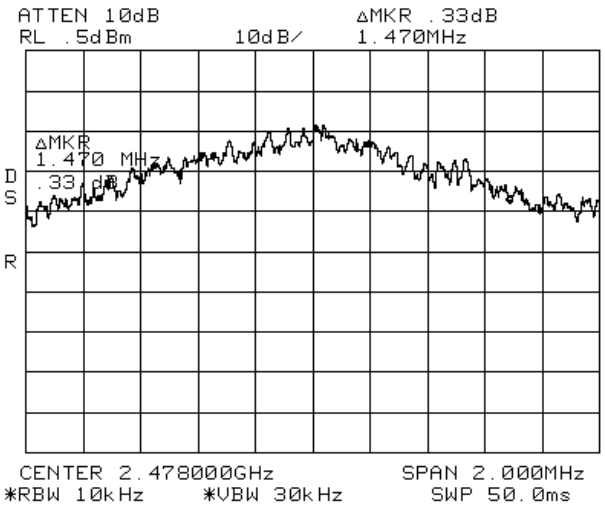
Measurement Data:

Frequency(MHz)	Channel No.	Test Results Measured Bandwidth (MHz)
2402	**1**	**1.683**
2440	**20**	**1.673**
2478	**39**	**1.470**

- See next pages for actual measured spectrum plots.


ATTEN 10dB
RL .5dBm
10dB/
ΔMKR .83dB
1.683MHz
D
S
R
CENTER 2.402000GHz
SPAN 2.000MHz
*RBW 10kHz
*VBW 30kHz
SWP 50.0ms


ATTEN 10dB
RL .5dBm
10dB/
ΔMKR .67dB
1.673MHz
ΔMKR
1.673 MHz
.67 dB
D
S
R
CENTER 2.440000GHz
SPAN 2.000MHz
*RBW 10kHz
*VBW 30kHz
SWP 50.0ms


ATTEN 10dB
RL .5dBm
10dB/
ΔMKR .33dB
1.470MHz
ΔMKR
1.470 MHz
.33 dB
D
S
R
CENTER 2.478000GHz
SPAN 2.000MHz
*RBW 10kHz
*VBW 30kHz
SWP 50.0ms

7.4 Time of Occupancy (Dwell Time)

Temperature : 22℃

Relative Humidity : (44 - 45) % R.H

Procedure

The dwell time was measured with a spectrum analyzer connected to the terminal, while EUT had its hopping function enabled.

The spectrum analyzer is set to:

Center frequency = 2440 MHz Span = zero

RBW = 1 MHz VBW = 1 MHz (VBW ≥ RBW)

Trace = max hold Detector function = peak

Test equipment used

Model NO.	Mannufacturer	Description	S/N	Due to Cal. Date
ESCI	R&S	EMI RECEIVER	100025	2014.09.19

Measurement Data

Burst duration in one hop (ms)	**Test Results**	
	Dwell Time (ms)	Result
0.184	**58.87**	Compliance

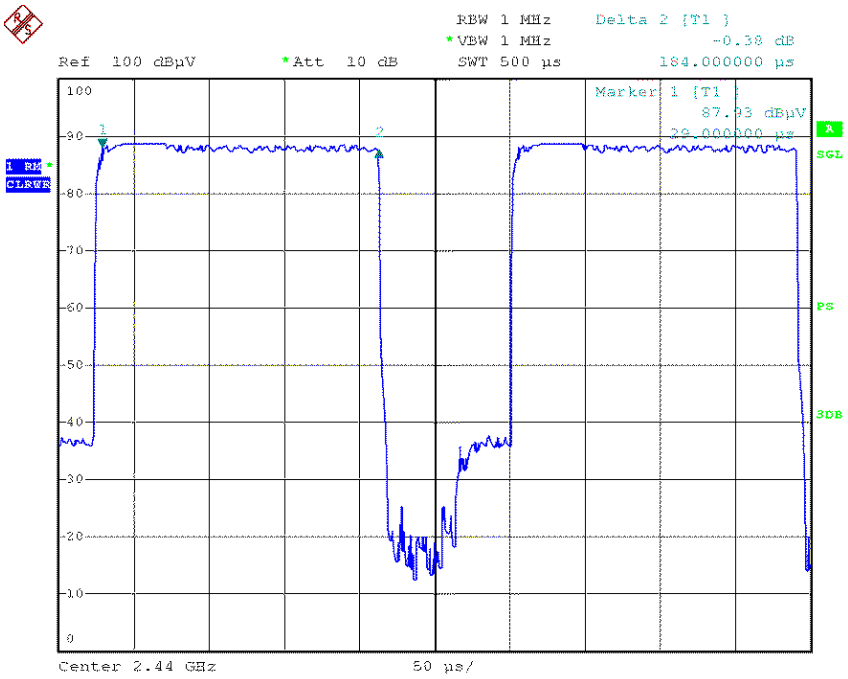
The system makes worst case 1 600 hops per second or 1 time slot has a length of 625μs with 39 channels. a one Packet need 1 time slot for transmitting and 1 time slot for receiving. Then the system makes worst case 1600/2 = 800 hops per second with 39 channels. so have a each channel 800/39 = 20.51 times.

and a period of 0.4 seconds multiplies by the number of hopping channels employed.

- See next pages of actual measured spectrum plots.

Minimum Standard:

0.4 seconds within a 30 second period per any frequency


RBW 1 MHz
*VBW 1 MHz
SWT 500 µs
Delta 2 [T1]
-0.38 dB
184.000000 µs
Ref 100 dBµV
*Att 10 dB
Marker 1 [T1]
87.93 dBµV
29.000000 µs
1 RM *
CLRWR
A
SGL
PS
3DB
100
90
80
70
60
50
40
30
20
10
0
Center 2.44 GHz
50 µs/

7.5 Peak Output Power

Temperature : 22℃

Relative Humidity : (44 - 45) % R.H

Procedure:

The peak output power was measured with a spectrum analyzer connected to the terminal, while EUT had its hopping function disable at the highest, middle and the lowest available channels.

After the trace being stable, Use the marker-to-peak function to set the marker to the peak of the emission.

The indicated level is the peak output power.

The spectrum analyzer is set to:

Center frequency = the highest, middle and the lowest channels

Span = 5 MHz (approximately 5 times of the 20 dB bandwidth)

RBW = 1 MHz (greater than the 20dB bandwidth of the emission being measured)

VBW = 1 MHz (VBW ≥ RBW) Detector function = peak

Trace = max hold Sweep = auto

Test equipment used

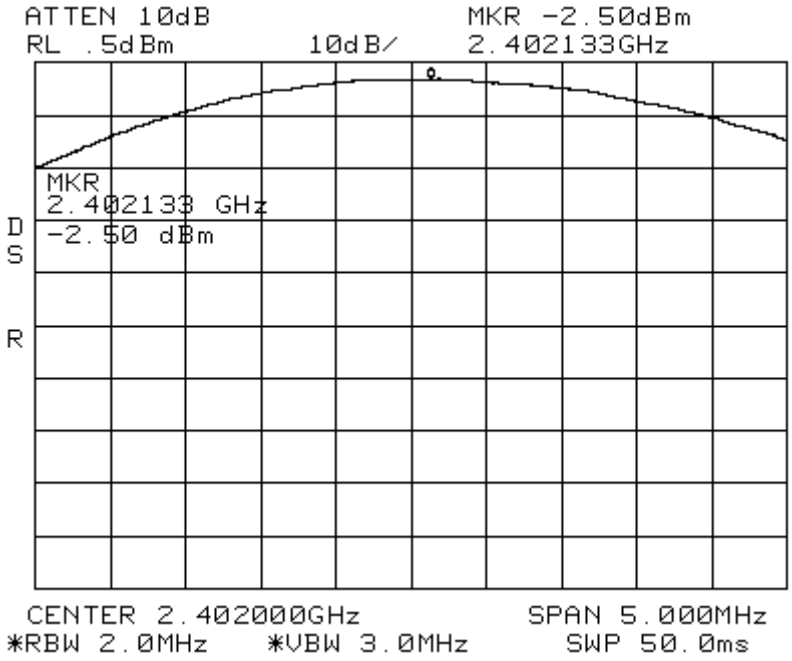
Model NO.	Mannufacturer	Description	S/N	Due to Cal. Date
8564E	H.P	Spectrum Analyzer	3745A01024	2014.04.03

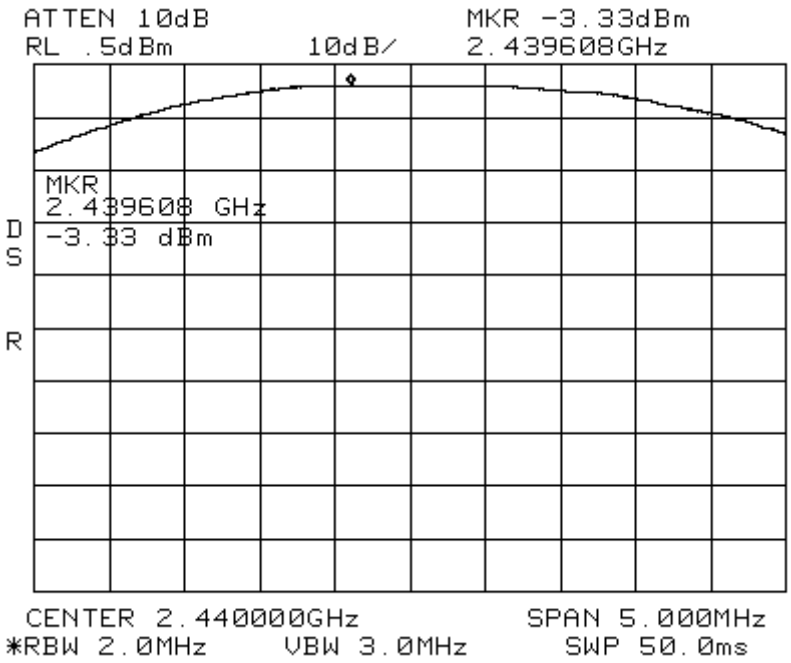
Measurement Data:

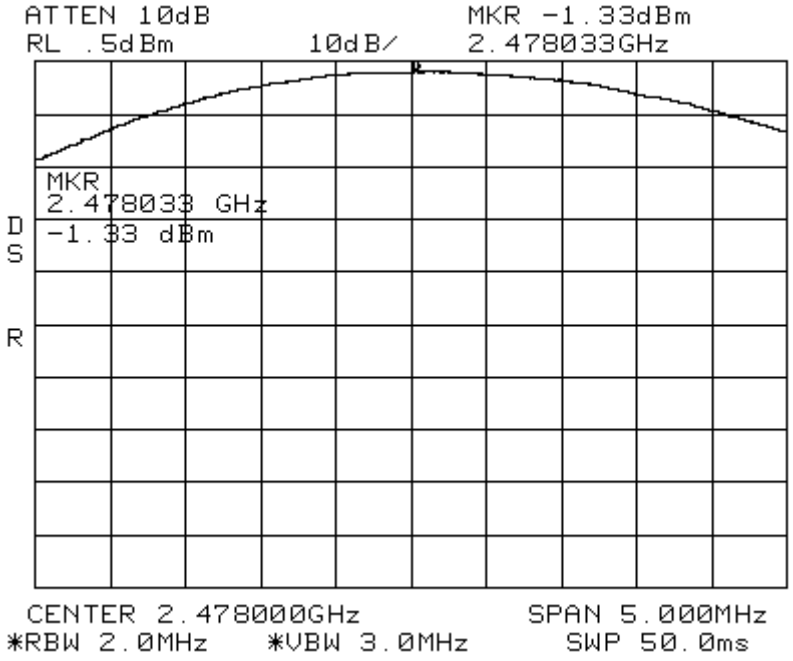
Frequency (MHz)	**Ch.**	**Test Results**		
		dBm	**W**	**Result**
2402	1	**-2.50**	**0.00056**	Compliance
2440	20	**-3.33**	**0.00046**	Compliance
2478	39	**-1.33**	**0.00074**	Compliance

- See next pages of actual measured spectrum plots.

Minimum Standard:	< 1W


ATTEN 10dB
RL .5dBm
10dB/
MKR -2.50dBm
2.402133GHz
MKR
2.402133 GHz
-2.50 dBm
D
S
R
CENTER 2.402000GHz
SPAN 5.000MHz
*RBW 2.0MHz
*VBW 3.0MHz
SWP 50.0ms


ATTEN 10dB
RL .5dBm
10dB/
MKR -3.33dBm
2.439608GHz
MKR
2.439608 GHz
-3.33 dBm
D
S
R
CENTER 2.440000GHz
SPAN 5.000MHz
*RBW 2.0MHz
VBW 3.0MHz
SWP 50.0ms


ATTEN 10dB
RL .5dBm
10dB/
MKR -1.33dBm
2.478033GHz
MKR
2.478033 GHz
-1.33 dBm
D
S
R
CENTER 2.478000GHz
SPAN 5.000MHz
*RBW 2.0MHz
*VBW 3.0MHz
SWP 50.0ms

7.6 Band – edge (at 20 dB below)

Temperature : 22℃

Relative Humidity : (44 - 45) % R.H

Procedure:

The bandwidth at 20 dB down from the highest inband spectral density is measured with a spectrum analyzer connected to the antenna terminal,, while EUT had its hopping function disabled at the highest, middle and the lowest available channels.

After the trace being stable, Use the marker-to-peak function to measure 20 dB down both sides of the intentional emission.

The spectrum analyzer is set to:

Center frequency = the highest, middle and the lowest channels

RBW = 100 kHz VBW ≥ RBW

Span = 100 MHz Detector function = peak

Trace = max hold Sweep = auto

Test equipment used

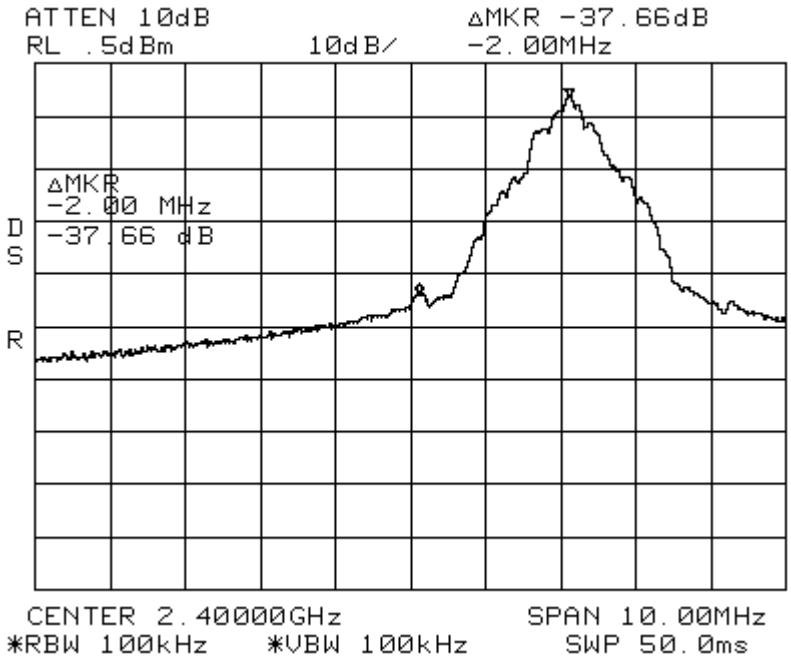
Model NO.	Mannufacturer	Description	S/N	Due to Cal. Date
8564E	H.P	Spectrum Analyzer	3745A01024	2014.04.03

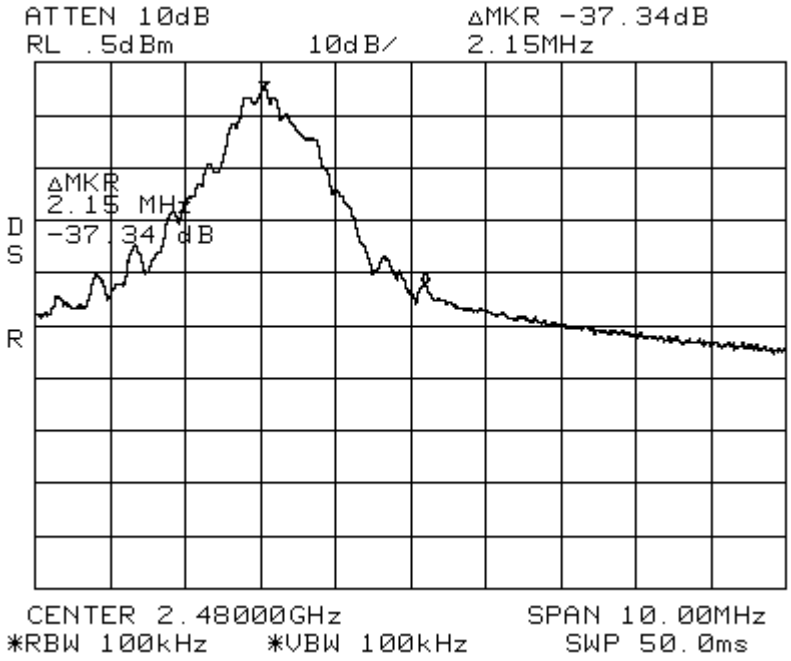
Measurement Data:

- All conducted emission in any 100kHz bandwidth outside of the spread spectrum band was at least 20dB lower than the highest inband spectral density. Therefore the applying equipment meets the requirement.
- See next pages of actual measured spectrum plots.

Frequency (MHz)	**Setting Channel (MHz)**	**Test Results**	
		Measured value (dBc)	**Result**
2402	~ 2400	**37.66**	Compliance
2478	2480 ~	**37.44**	Compliance

Minimum Standard:	> 20 dBc


ATTEN 10dB
RL .5dBm
10dB/
ΔMKR -37.66dB
-2.00MHz
ΔMKR
-2.00 MHz
-37.66 dB
D
S
R
CENTER 2.40000GHz
SPAN 10.00MHz
*RBW 100kHz
*VBW 100kHz
SWP 50.0ms


ATTEN 10dB
RL .5dBm
10dB/
ΔMKR -37.34dB
2.15MHz
ΔMKR
2.15 MHz
-37.34 dB
D
S
R
CENTER 2.48000GHz
SPAN 10.00MHz
*RBW 100kHz
*VBW 100kHz
SWP 50.0ms

7.7 Test data for radiated emission

Above 1 GHz Electric Field strength was measured in accordance with ANSI C 63.4 (2003). The test setup was made according to ANSI C 63.4 (2003) on an Anechoic chamber, which allows a 3m distance measurement. The EUT was placed in the center of wooden turntable. The height of this table was 0.8m. The measurement was conducted with both horizontal and vertical antenna polarization. The turntable has fully rotated.

7.7.1 Radiated Emission which fall in the Restricted Band

Temperature : 3 ℃

Relative Humidity : (55 - 56) % R.H

Center frequency = the highest and the lowest channels

RBW = 1 MHz for Peak and Average Mode

VBW = 1 MHz for Peak Mode, 10 Hz for Average Mode

Sweep = auto

Result : PASSED

Test equipment used

Model NO.	Mannufacturer	Description	S/N	Due to Cal. Date
ESIB40	R&S	RECEIVER	100093	2014.05.13
3115	ETS	HORN ANTENNA	6443	2014.10.21
KTI-HD-1080	KTI	HORN ANTENNA	130001	2015.04.10
6502	EMCO	LOOP ANTENNA	3434	2014.03.15
VULB9163	S/B	BI-LOG ANTENNA	281	2014.10.28

Measuremnet Data

Frequency (MHz)	Reading. (dBμV)	Detector Mode	Ant. Pol.	Ant. Factor	Cable Loss	Amp Gain	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
2138.40	28.86	Peak	H	27.84	6.95	23.05	40.60	74.00	33.40
	21.16	Average	H				32.90	54.00	21.10
	38.96	Peak	V				50.70	74.00	23.30
	16.56	Average	V				28.30	54.00	25.70
Test Data for High Channel									
2490.64	30.38	Peak	H	28.88	7.62	22.38	44.50	74.00	29.50
	16.48	Average	H				30.60	54.00	23.40
	32.08	Peak	V				46.20	74.00	27.80
	15.28	Average	V				29.40	54.00	24.60

Notes : “H” : Horizontal, “V” : Vertical

Each data transfer rate, BDR Mode and EDR Mode was tested, but the worst data was recorded.

7.7.2 Spurious Radiated Emission above 1 GHz

Temperature : 3 ℃

Relative Humidity : (55 - 56) % R.H

Center frequency = the highest, middle and the lowest channels

RBW = 1 MHz for Peak and Average Mode for the emissions fall in restricted band,

100 kHz for Peak Mode for the emissions outside restricted band

VBW = 1 MHz

z for Peak Mode, 10 Hz for Average Mode

Measurement distance : 3m

Frequency Range : 1 GHz ~ 25 GHz

Result : PASSED

Frequency (MHz)	Reading. (dBµV)	Detector Mode	Ant. Pol.	Ant. Factor	Cable Loss	Amp Gain	Total (dBµV/m)	Limits (dBµV/m)	Margin (dB)
Test Data for Low Channel									
2402.00	70.69	Peak	H	28.61	7.45	22.55	84.20	-	84.20
	60.19	Peak	V				73.70	-	73.70
4804.00*	27.42	Peak	H	33.58	10.35	19.65	51.70	74.00	22.30
	15.62	Average	H				39.90	54.00	14.10
	37.42	Peak	V				61.70	74.00	12.30
	10.22	Average	V				34.50	54.00	19.50
Test Data for Middle Channel									
2440.00	71.33	Peak	H	28.73	7.52	22.48	85.10	-	85.10
	63.33	Peak	V				77.10	-	77.10
4880.00*	30.01	Peak	H	33.67	10.36	19.64	65.40	74.00	8.60
	13.31	Average	H				37.70	54.00	16.30
	34.21	Peak	V				58.60	74.00	15.40
	9.41	Average	V				33.80	54.00	20.20

Frequency (MHz)	Reading. (dBμV)	Detector Mode	Ant. Pol.	Ant. Factor	Cable Loss	Amp Gain	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for high Channel									
2 478.00	67.45	Peak	H	28.85	7.60	22.40	81.50	-	81.50
	57.85	Peak	V				71.95	-	71.95
4 956.00*	25.72	Peak	H	33.74	10.37	19.63	50.20	74.00	23.80
	17.32	Average	H				41.80	54.00	12.20
	32.42	Peak	V				56.90	74.00	17.10
	7.32	Average	V				31.80	54.00	22.20

Notes: 1.All modes of operation were investigated.
And the worst-case emission are reported.

2.All other emission is non-significant.

3.All readings are calibrated by self-mode in receiver.

4.Measurements using CISPR peak mode.

5. Correction Factor(dB)= Cable Factor(dB) + Amp. Factor (dB)

6. H = Horizontal, V = Vertical Polarization

7."*" Frequency fall in restricted band

7.7.3 Spurious Radiated Emission below 1 GHz

Temperature : 3 ℃

Relative Humidity : (55 - 56) % R.H

RBW = 120 kHz

Measurement distance : 3m

Frequency Range : 30 MHz ~ 1 GHz

Result : PASSED

Frequency (MHz)	Reading. (dBμV)	Ant. Pol.	Ant. Height (m)	Angle (°)	Ant. Factor (dB/m)	Cable Loss (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)
48.28	**5.42**	**V**	**1.04**	**160**	**14.49**	**0.59**	**20.50**	**30.00**	**9.50**
124.56	**10.34**	**V**	**1.28**	**320**	**10.37**	**0.89**	**21.60**	**30.00**	**8.40**
243.28	**6.74**	**V**	**1.40**	**270**	**13.51**	**1.45**	**21.70**	**30.00**	**8.30**
340.52	**6.58**	**V**	**2.74**	**180**	**15.56**	**1.86**	**24.00**	**37.00**	**13.00**
681.20	**2.15**	**H**	**2.23**	**197**	**20.20**	**2.75**	**25.10**	**37.00**	**11.90**
800.00	**4.43**	**H**	**1.52**	**135**	**21.46**	**3.01**	**28.90**	**37.00**	**8.10**

Notes : “H” : Horizontal, “V” : Vertical,

7.7.4 Spurious Radiated Emission below 30 MHz

Temperature : 3 ℃

Relative Humidity : (55 - 56) % R.H

RBW = 200 Hz(from 9 kHz to 0.15 MHz), 9 kHz(from 0.15 MHz to 30 MHz)

Measurement distance : 3m

Frequency Range : 9 kHz ~ 30 MHz

Result : PASSED

Frequency (MHz)	Reading. (dBμV)	Ant. Pol.	Ant. Height (m)	Angle (°)	Ant. Factor (dB/m)	Cable Loss (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)
0.02	**36.7**	**V**	**1.68**	**178**	**14.4**	**0.34**	**51.44**	**121.71**	**70.27**
0.05	**30.6**	**V**	**1.89**	**180**	**10.8**	**0.34**	**41.74**	**109.14**	**67.40**
0.18	**20.4**	**V**	**1.20**	**178**	**10.2**	**0.34**	**30.94**	**71.89**	**40.95**

7.8 AC Conducted Emissions

Temperature : 22 ℃

Relative Humidity : (44 - 45) % R.H

Procedure

AC power line conducted emissions from the EUT were measured according to the dictates ANSI C64.4:2003.

The conducted emissions are measured in the shielded room with a spectrum analyzer in peak hold.

While the measurement, EUT had its hopping function disabled at the middle channels in line with Section 15.31(m).

Test equipment used

Equipment	Mannufacturer	S/N	Due to Cal. Date
Field Strength Meter	ESIB40	100093	05.2014
LISN	KNW407	8-1157-2	03.2014
LISN	Em-7823	115019	03.2014
Conducted Cable	N/A	N/A	11.2013

Measurement Data

Frequency (MHz)	**(1) Reading (dBμV)**		**Line**	**(2) Limit (dBμV)**		**(3) Margin (dB)**	
	QP	**AV**		**QP**	**AV**	**QP**	**AV**
It was not observed any emissions from the EUT.							

NOTES:

1. **All modes of operation were investigated and the worst-case emissions are reported.**
2. **All other emissions are non-significant.**
3. **All readings are calibrated by self-mode in receiver.**
4. **Measurements using CISPR quasi-peak mode.**
5. **L1 = LINE-PE, L2 = NEUTRAL-PE**
6. **The limit for Class B digital device is 66dBuV to 56dBuV from 150KHz to 500KHz, 56dBuV from 500KHz to 5MHz, 60dBuV Above 5MHz.**

♠ Margin Calculation

(3) Margin = (2) Limit – (1) Reading

7.9 Antenna Requirement

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

The use of a permanently attached antenna or of an antenna that user a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

The manufacturer may design the unit So that broken antenna can be replaced by the user, but the Use of a standard antenna jack or electrical connector is prohibited.

And according to §15.247(4)(1), the conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi

According to above requirement standard's This product's antenna type is an PCB type and it's gain is -1.0 dBi, So radiated emission field strength from EUT is below requirement standard limit

Frequency Band	Gain (dBi)	Limit (dBi)	Results
2400 ~ 2484 MHz	1.70	≤ 6	Compliance