UTC Fire & Security Americas Corporation, Inc.

Assy, Bezel, WTI

Report No. SUPR0089

EMC Test Report

Report Prepared By

NORTHWEST EMC

www.nwemc.com
1-888-EMI-CERT

22975 NW Evergreen Parkway
Suite 400
Hillsboro, Oregon 97124

Certificate of Test

Last Date of Test: September 01, 2011
UTC Fire & Security Americas Corporation, Inc.
Model: Assy, Bezel, WTI

Emissions			
Test Description	**Specification**	**Test Method**	**Pass/Fail**
Spurious Radiated Emissions	FCC 15.247:2011	ANSI C63.10:2009	**Pass**

Modifications made to the product
See the Modifications section of this report

Test Facility

The measurement facility used to collect the data is located at:

Northwest EMC, Inc.
22975 NW Evergreen Parkway, Suite 400
Hillsboro, OR 97124
Phone: (503) 844-4066 Fax: (503) 844-3826

This site has been fully described in a report filed with and accepted by the FCC (Federal Communications Commission) and Industry Canada (Site filing #2834D-1).

Approved By:

Tim O'Shea, Operations Manager

NVLAP Lab Code: 200630-0

This report must not be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the federal government of the United States of America.

Product compliance is the responsibility of the client, therefore the tests and equipment modes of operation represented in this report were agreed upon by the client, prior to testing. This Report may only be duplicated in its entirety. The results of this test pertain only to the sample(s) tested. The specific description is noted in each of the individual sections of the test report supporting this certificate of test.

Revision History

Revision Number	Description	Date	Page Number
00	None		

Barometric Pressure

The recorded barometric pressure has been normalized to sea level.

Accreditations and Authorizations

FCC

Accredited by NVLAP for performance of FCC radio, digital, and ISM device testing. Our Open Area Test Sites, certification chambers, and conducted measurement facilities have been fully described in reports filed with the FCC and accepted by the FCC in letters maintained in our files. Northwest EMC has been accredited by ANSI to ISO / IEC Guide 65 as a product certifier. We have been designated by the FCC as a Telecommunications Certification Body (TCB). This allows Northwest EMC to certify transmitters to FCC specifications in accordance with 47 CFR 2.960 and 2.962.

NVLAP

Northwest EMC, Inc. is accredited under the National Voluntary Laboratory Accreditation Program (NVLAP) for satisfactory compliance with the requirements of ISO/IEC 17025 for Testing Laboratories. NVLAP is administered by the National Institute of Standards and Technology (NIST), an agency of the U.S. Commerce Department. The NVLAP accreditation encompasses Electromagnetic Compatibility Testing in accordance with the European Union EMC Directive 2004/108/EC, and ANSI C63.4. Additionally, Northwest EMC is accredited by NVLAP to perform radio testing in accordance with the European Union R&TTE Directive 1999/5/EEC, the requirements of FCC, and the RSS radio standards for Industry Canada.

Industry Canada

Accredited by NVLAP for performance of Industry Canada RSS and ICES testing. Our Open Area Test Sites and certification chambers comply with RSS-Gen, Issue 2 and have been filed with Industry Canada and accepted. Northwest EMC has been accredited by ANSI to ISO / IEC Guide 65 as a product certifier. We have been designated by NIST and recognized by Industry Canada as a Certification Body (CB) per the APEC Mutual Recognition Arrangement (MRA). This allows Northwest EMC to certify transmitters to Industry Canada technical requirements. (*Site Filing Numbers - Hillsboro: 2834D-1, 2834D-2, Sultan: 2834C-1, Irvine: 2834B-1, 2834B-2, Brooklyn Park: 2834E-1)*

CAB

Designated by NIST and validated by the European Commission as a Conformity Assessment Body (CAB) to conduct tests and approve products to the EMC directive and transmitters to the R&TTE directive, as described in the U.S. - EU Mutual Recognition Agreement.

Australia/New Zealand

The National Association of Testing Authorities (NATA), Australia has been appointed by the ACA as an accreditation body to accredit test laboratories and competent bodies for EMC standards. Accredited test reports or assessments by competent bodies must carry the NATA logo. Test reports made by an overseas laboratory that has been accredited for the relevant standards by an overseas accreditation body that has a Mutual Recognition Agreement (MRA) with NATA are also accepted as technical grounds for product conformity. The report should be endorsed with the respective logo of the accreditation body (NVLAP).

Accreditations and Authorizations

VCCI

Accepted as an Associate Member to the VCCI, Acceptance No. 564. Conducted and radiated measurement facilities have been registered in accordance with Regulations for Voluntary Control Measures, Article 8. *(Registration Numbers. - Hillsboro: C-1071, R-1025, G-84, C-2687, T-1658, and R-2318, Irvine: R-1943, G-85, C-2766, and T-1659, Sultan: R-871, G-83, C-3265, and T-1511, Brooklyn Park: R-3125, G-86, G-141, C-3464, and T-1634).*

BSMI

Northwest EMC has been designated by NIST and validated by C-Taipei (BSMI) as a CAB to conduct tests as described in the APEC Mutual Recognition Agreement (US0017).

GOST

Northwest EMC, Inc. has been assessed and accredited by the Russian Certification bodies Certinform VNIINMASH, CERTINFO, SAMTES, and Federal CHEC, to perform EMC and Hygienic testing for Information Technology Products. As a result of their laboratory assessment, they will accept test results from Northwest EMC, Inc. for product certification

KCC

Northwest EMC, Inc is a CAB designated by MRA partners and recognized by Korea. (*Assigned Lab Numbers: Hillsboro: US0017, Irvine: US0158, Sultan: US0157, Brooklyn Park: US0175)*

VIETNAM

Vietnam MIC has approved Northwest EMC as an accredited test lab. Per Decision No. 194/QD-QLCL (dated December 15, 2009), Northwest EMC test reports can be used for Vietnam approval submissions.

SCOPE

For details on the Scopes of our Accreditations, please visit:
http://www.nwemc.com/accreditations/

Northwest EMC Locations

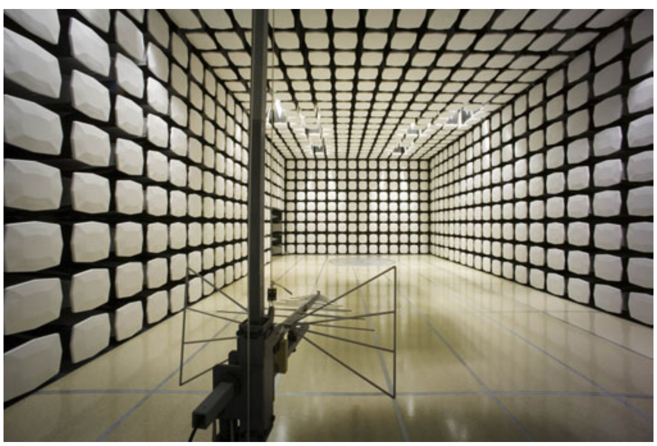
Oregon
Labs EV01-EV12
22975 NW Evergreen Pkwy
Suite 400
Hillsboro, OR 97124
(503) 844-4066

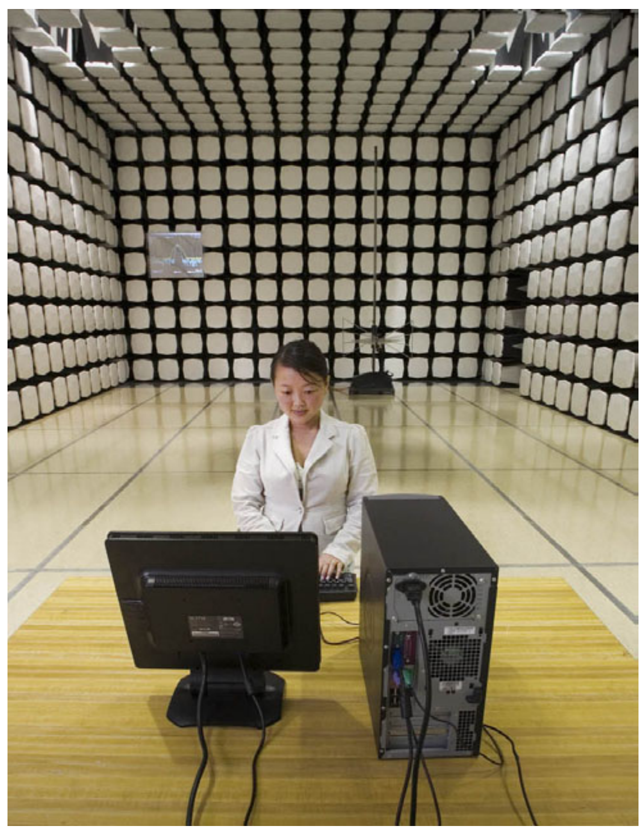
California
Labs OC01-OC13
41 Tesla
Irvine, CA 92618
(949) 861-8918

Minnesota
Labs MN01-MN08
9349 W Broadway Ave.
Brooklyn Park,
MN 55445
(763) 425-2281

Washington
Labs SU01-SU07
14128 339th Ave. SE
Sultan, WA 98294
(360) 793-8675

New York
Labs WA01-WA04
4939 Jordan Rd.
Elbridge, NY 13060
(315) 685-0796





Party Requesting the Test

Company Name:	UTC Fire & Security Americas Corporation, Inc.
Address:	4001 Fairview Industrial Drive SE
City, State, Zip:	Salem, OR 97302-0167
Test Requested By:	Dean Sinn
Model:	Assy, Bezel, WTI
First Date of Test:	9/1/2011
Last Date of Test:	9/1/2011
Receipt Date of Samples:	9/1/2011
Equipment Design Stage:	Production
Equipment Condition:	No Damage

Information Provided by the Party Requesting the Test

Functional Description of the EUT (Equipment Under Test):

Bluetooth EDR radio module - battery powered

Testing Objective:

To demonstrate compliance to FCC 15.247 spurious radiated emissions requirements. The other FCC 15.247 requirements are documented in a separate test report.

CONFIGURATION 1 SUPR0089

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Bluetooth EDR radio module	UTC Fire & Security Americas Corporation, Inc.	10102917G1	TX L

Peripherals in test setup boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Door Mechanism test fixture	UTC Fire & Security Americas Corporation, Inc.	None	None
Solonoid controller	UTC Fire & Security Americas Corporation, Inc.	Unknown	None

CONFIGURATION 2 SUPR0089

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Bluetooth EDR radio module	UTC Fire & Security Americas Corporation, Inc.	10102917G1	TX M

Peripherals in test setup boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Door Mechanism test fixture	UTC Fire & Security Americas Corporation, Inc.	None	None
Solonoid controller	UTC Fire & Security Americas Corporation, Inc.	Unknown	None

CONFIGURATION 3 SUPR0089

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Bluetooth EDR radio module	UTC Fire & Security Americas Corporation, Inc.	10102917G1	TX H

Peripherals in test setup boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Door Mechanism test fixture	UTC Fire & Security Americas Corporation, Inc.	None	None
Solonoid controller	UTC Fire & Security Americas Corporation, Inc.	Unknown	None

Equipment modifications					
Item	Date	Test	Modification	Note	Disposition of EUT
1	9/1/2011	Spurious Radiated Emissions	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed.

SPURIOUS RADIATED EMISSIONS

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data.

MODES OF OPERATION

Transmitting Basic Data Rate 1's modulated, firmware

CHANNELS TESTED

Low channel, 2402 MHz
Mid channel, 2451 MHz
High channel, 2480 MHz

POWER SETTINGS INVESTIGATED

Battery

FREQUENCY RANGE INVESTIGATED

Start Frequency	30 MHz	Stop Frequency	25 GHz

SAMPLE CALCULATIONS

Radiated Emissions: Field Strength = Measured Level + Antenna Factor + Cable Factor - Amplifier Gain + Distance Adjustment Factor + External Attenuation

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Interval
EV01 Cables	N/A	Standard Gain Horns Cables	EVF	3/2/2011	12
Spectrum Analyzer	Agilent	E4446A	AAQ	6/24/2011	12
High Pass Filter	Micro-Tronics	HPM50111	HFO	8/9/2010	24
Pre-Amplifier	Miteq	AM-1616-1000	AOL	6/28/2011	12
Antenna, Bilog	Teseq	CBL 6141B	AXR	11/29/2010	12
EV01 Cables	N/A	Bilog Cables	EVA	6/28/2011	12
Pre-Amplifier	Miteq	AMF-4D-010100-24-10P	APW	6/28/2011	12
Antenna, Horn	ETS	3115	AIZ	1/24/2011	24
EV01 Cables	N/A	Double Ridge Horn Cables	EVB	6/28/2011	12
Pre-Amplifier	Miteq	AMF-6F-12001800-30-10P	AVD	3/2/2011	12
Pre-Amplifier	Miteq	AMF-6F-08001200-30-10P	AVC	3/2/2011	12
Antenna, Horn	ETS	3160-07	AHU	NCR	0
Antenna, Horn	ETS	3160-08	AHV	NCR	0
Antenna, Horn	ETS Lindgren	3160-09	AIV	NCR	0
Pre-Amplifier	Miteq	AMF-6F-18002650-25-10P	AVU	9/15/2010	12
Cable	ESM Cable Corp.	KMKM-72	EVY	9/15/2010	12

MEASUREMENT BANDWIDTHS

Frequency Range (MHz)	Peak Data (kHz)	Quasi-Peak Data (kHz)	Average Data (kHz)
0.01 - 0.15	1.0	0.2	0.2
0.15 - 30.0	10.0	9.0	9.0
30.0 - 1000	100.0	120.0	120.0
Above 1000	1000.0	N/A	1000.0

Measurements were made using the bandwidths and detectors specified. No video filter was used.

MEASUREMENT UNCERTAINTY

A measurement uncertainty estimation has been performed for each test per our internal quality document WP 342. The estimation is used to compare the measured result with its "true" or theoretically correct value. Our measurement data meets or exceeds the measurement uncertainty requirements of CISPR 16-4. The measurement uncertainty estimation is available upon request.

TEST DESCRIPTION

The highest gain of each type of antenna to be used with the EUT was tested. The EUT was configured for low, mid, and high band transmit frequencies using three different EUT samples. For each configuration, the spectrum was scanned throughout the specified range. In addition, measurements were made in the restricted bands to verify compliance. While scanning, emissions from the EUT were maximized by rotating the EUT on a turntable, adjusting the position of the EUT and the EUT antenna in three orthogonal axis, and adjusting measurement antenna height and polarization, and manipulating the EUT antenna in 3 orthogonal planes (per ANSI C63.10:2009). A preamp and high pass filter were used for this test in order to provide sufficient measurement sensitivity.

NORTHWEST
EMC

SPURIOUS RADIATED EMISSIONS

PSA 2011.05.11
EMI 2008.1.9

EUT:	**Assy, Bezel, WTI**			**Work Order:**	**SUPR0089**
Serial Number:	**See configurations**			**Date:**	**09/01/11**
Customer:	**UTC Fire & Security Americas Corporation, Inc.**			**Temperature:**	**22**
Attendees:	**Dean Sinn**			**Humidity:**	**42%**
Project:	**None**			**Barometric Pres.:**	**30.19**
Tested by:	**Rod Peloquin**	**Power:**	**Battery**	**Job Site:**	**EV01**

TEST SPECIFICATIONS

FCC 15.247:2011

TEST METHOD

ANSI C63.10:2009

TEST PARAMETERS

Antenna Height(s) (m)	1 - 4	**Test Distance (m)**	3

COMMENTS

None

EUT OPERATING MODES

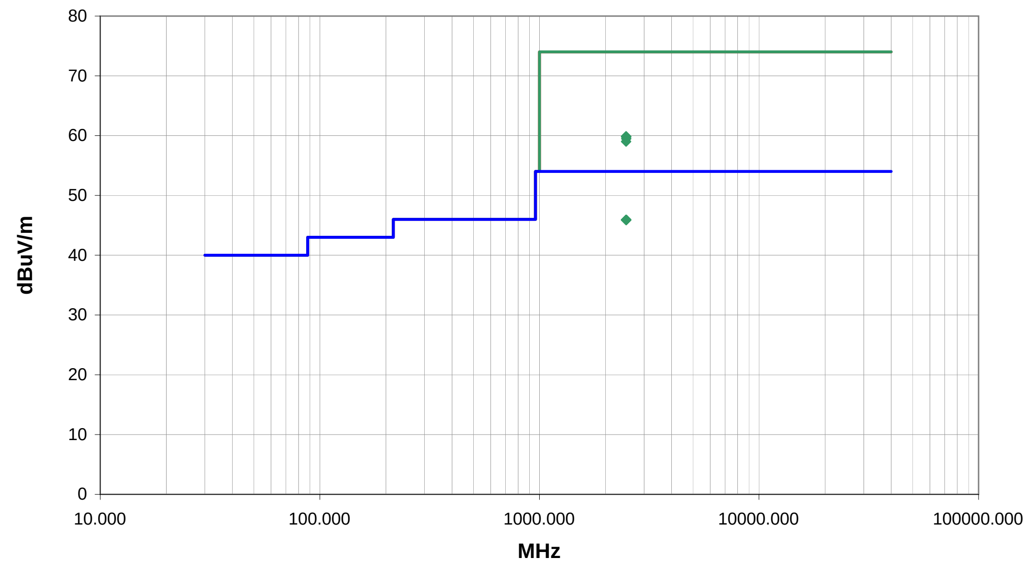
Transmitting Basic Data Rate 1's modulated firmware, high channel

DEVIATIONS FROM TEST STANDARD

No deviations.

Run #	**2**
Configuration #	**1, 2, 3**
Results	**Pass**

Signature



Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Azimuth (degrees)	Height (meters)	Distance (meters)	External Attenuation (dB)	Polarity	Detector	Distance Adjustment (dB)	Adjusted dBuV/m	Spec. Limit dBuV/m	Compared to Spec. (dB)	Comments
2483.500	23.6	2.3	72.0	1.0	3.0	20.0	H-Horn	AV	0.0	45.9	54.0	-8.1	High Channel, EUT typical orientation
2483.500	23.6	2.3	40.0	2.6	3.0	20.0	V-Horn	AV	0.0	45.9	54.0	-8.1	High Channel, EUT typical orientation
2483.500	23.6	2.3	161.0	1.0	3.0	20.0	H-Horn	AV	0.0	45.9	54.0	-8.1	High Channel, EUT on back
2484.372	23.6	2.3	272.0	3.1	3.0	20.0	V-Horn	AV	0.0	45.9	54.0	-8.1	High Channel, EUT on back
2484.458	23.6	2.3	303.0	1.0	3.0	20.0	H-Horn	AV	0.0	45.9	54.0	-8.1	High Channel, EUT side
2484.888	23.6	2.3	153.0	1.0	3.0	20.0	V-Horn	AV	0.0	45.9	54.0	-8.1	High Channel, EUT side
2483.692	37.6	2.3	303.0	1.0	3.0	20.0	H-Horn	PK	0.0	59.9	74.0	-14.1	High Channel, EUT side
2483.842	37.5	2.3	40.0	2.6	3.0	20.0	V-Horn	PK	0.0	59.8	74.0	-14.2	High Channel, EUT typical orientation
2483.912	37.5	2.3	161.0	1.0	3.0	20.0	H-Horn	PK	0.0	59.8	74.0	-14.2	High Channel, EUT on back
2484.015	37.5	2.3	72.0	1.0	3.0	20.0	H-Horn	PK	0.0	59.8	74.0	-14.2	High Channel, EUT typical orientation
2483.905	37.2	2.3	153.0	1.0	3.0	20.0	V-Horn	PK	0.0	59.5	74.0	-14.5	High Channel, EUT side
2483.707	36.7	2.3	272.0	3.1	3.0	20.0	V-Horn	PK	0.0	59.0	74.0	-15.0	High Channel, EUT on back

NORTHWEST
EMC

SPURIOUS RADIATED EMISSIONS

PSA 2011.05.11
EMI 2008.1.9

EUT:	**Assy, Bezel, WTI**			**Work Order:**	**SUPR0089**
Serial Number:	**See configurations**			**Date:**	**09/01/11**
Customer:	**UTC Fire & Security Americas Corporation, Inc.**			**Temperature:**	**22**
Attendees:	**Dean Sinn**			**Humidity:**	**42%**
Project:	**None**			**Barometric Pres.:**	**30.19**
Tested by:	**Rod Peloquin**	**Power:**	**Battery**	**Job Site:**	**EV01**

TEST SPECIFICATIONS	**TEST METHOD**
FCC 15.247:2011	**ANSI C63.10:2009**

TEST PARAMETERS

Antenna Height(s) (m)	1 - 4	**Test Distance (m)**	3

COMMENTS

None

EUT OPERATING MODES

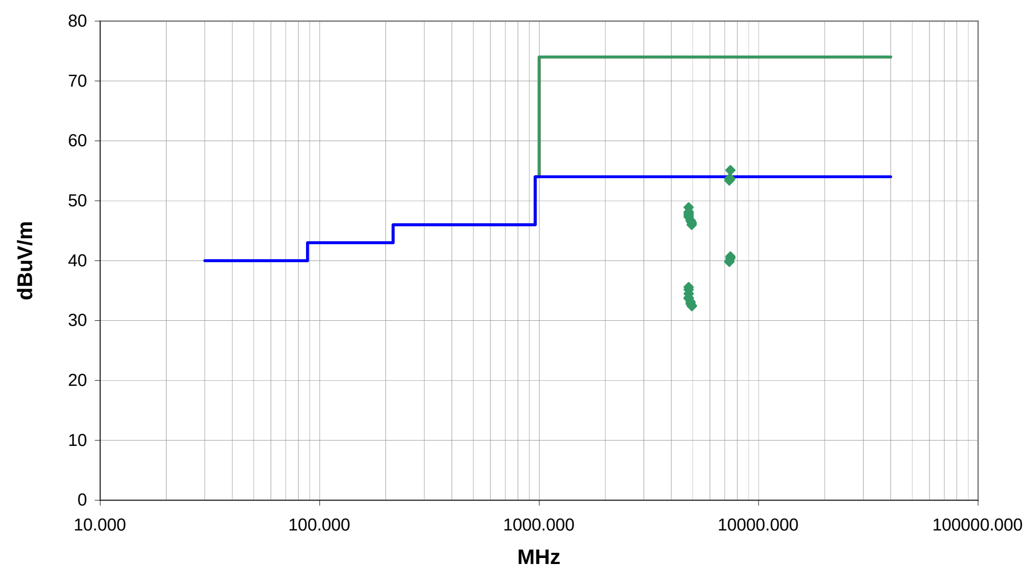
Transmitting Basic Data Rate 1's modulated, firmware

DEVIATIONS FROM TEST STANDARD

No deviations.

Run #	**1**
Configuration #	**1, 2, 3**
Results	**Pass**

Signature



Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Azimuth (degrees)	Height (meters)	Distance (meters)	External Attenuation (dB)	Polarity	Detector	Distance Adjustment (dB)	Adjusted dBuV/m	Spec. Limit dBuV/m	Compared to Spec. (dB)	Comments
7439.330	24.0	16.7	18.0	1.8	3.0	0.0	V-Horn	AV	0.0	40.7	54.0	-13.3	High Channel, EUT on back
7440.117	23.7	16.7	1.0	1.0	3.0	0.0	H-Horn	AV	0.0	40.4	54.0	-13.6	High Channel, EUT typical orientation
7352.170	23.3	16.6	173.0	1.4	3.0	0.0	V-Horn	AV	0.0	39.9	54.0	-14.1	Mid Channel, EUT on back
7352.607	23.2	16.6	270.0	1.0	3.0	0.0	H-Horn	AV	0.0	39.8	54.0	-14.2	Mid Channel, EUT typical orientation
4803.763	26.2	9.4	304.0	1.0	3.0	0.0	H-Horn	AV	0.0	35.6	54.0	-18.4	Low Channel, EUT typical orientation
4803.770	25.8	9.4	220.0	1.3	3.0	0.0	V-Horn	AV	0.0	35.2	54.0	-18.8	Low Channel, EUT on back
7439.197	38.4	16.7	18.0	1.8	3.0	0.0	V-Horn	PK	0.0	55.1	74.0	-18.9	High Channel, EUT on back
4803.803	25.1	9.4	211.0	1.1	3.0	0.0	V-Horn	AV	0.0	34.5	54.0	-19.5	Low Channel, EUT on side
4803.817	24.4	9.4	208.0	1.6	3.0	0.0	V-Horn	AV	0.0	33.8	54.0	-20.2	Low Channel, EUT typical orientation
4803.843	24.4	9.4	178.0	1.1	3.0	0.0	H-Horn	AV	0.0	33.8	54.0	-20.2	Low Channel, EUT on side
7353.133	37.1	16.6	270.0	1.0	3.0	0.0	H-Horn	PK	0.0	53.7	74.0	-20.3	Mid Channel, EUT typical orientation
7440.293	37.0	16.7	1.0	1.0	3.0	0.0	H-Horn	PK	0.0	53.7	74.0	-20.3	High Channel, EUT typical orientation
4803.857	24.3	9.4	185.0	1.0	3.0	0.0	H-Horn	AV	0.0	33.7	54.0	-20.3	Low Channel, EUT on back
7352.750	36.8	16.6	173.0	1.4	3.0	0.0	V-Horn	PK	0.0	53.4	74.0	-20.6	Mid Channel, EUT on back
4901.797	23.7	9.4	119.0	1.0	3.0	0.0	H-Horn	AV	0.0	33.1	54.0	-20.9	Mid Channel, EUT typical orientation
4901.527	23.4	9.4	223.0	1.0	3.0	0.0	V-Horn	AV	0.0	32.8	54.0	-21.2	Mid Channel, EUT on back
4959.927	23.0	9.5	341.0	1.0	3.0	0.0	V-Horn	AV	0.0	32.5	54.0	-21.5	High Channel, EUT on back
4960.193	22.9	9.5	320.0	1.0	3.0	0.0	H-Horn	AV	0.0	32.4	54.0	-21.6	High Channel, EUT typical orientation
4803.677	39.5	9.4	304.0	1.0	3.0	0.0	H-Horn	PK	0.0	48.9	74.0	-25.1	Low Channel, EUT typical orientation
4803.657	38.7	9.4	211.0	1.1	3.0	0.0	V-Horn	PK	0.0	48.1	74.0	-25.9	Low Channel, EUT on side
4804.493	38.7	9.4	220.0	1.3	3.0	0.0	V-Horn	PK	0.0	48.1	74.0	-25.9	Low Channel, EUT on back
4804.043	38.4	9.4	185.0	1.0	3.0	0.0	H-Horn	PK	0.0	47.8	74.0	-26.2	Low Channel, EUT on back
4804.080	38.2	9.4	178.0	1.1	3.0	0.0	H-Horn	PK	0.0	47.6	74.0	-26.4	Low Channel, EUT on side
4803.323	37.9	9.4	208.0	1.6	3.0	0.0	V-Horn	PK	0.0	47.3	74.0	-26.7	Low Channel, EUT typical orientation
4901.133	37.3	9.4	119.0	1.0	3.0	0.0	H-Horn	PK	0.0	46.7	74.0	-27.3	Mid Channel, EUT typical orientation
4901.933	37.2	9.4	223.0	1.0	3.0	0.0	V-Horn	PK	0.0	46.6	74.0	-27.4	Mid Channel, EUT on back
4960.727	36.8	9.5	320.0	1.0	3.0	0.0	H-Horn	PK	0.0	46.3	74.0	-27.7	High Channel, EUT typical orientation
4959.720	36.5	9.5	341.0	1.0	3.0	0.0	V-Horn	PK	0.0	46.0	74.0	-28.0	High Channel, EUT on back

BLUETOOTH APPROVALS

FCC Procedure Received from Joe Dichoso on 2-15-02

The following exhibit indicates the FCC Spread Spectrum requirements in Section 15.247 for devices meeting the Bluetooth Specifications in the 2.4 GHz band as of February 2001 operating in the USA. The purpose of this exhibit is to help expedite the approval process for Bluetooth devices. This exhibit provides items that vary for each device and also provides a list of items that are common to Bluetooth devices that explains the remaining requirements. The list of common items can be submitted for each application for equipment authorization. This exhibit only specifies requirements in Section 15.247, requirements in other rule Sections for intentional radiators such as in Section 15.203 or 15.207 must be also be addressed. A Bluetooth device is a FHSS transmitter in the data mode and applies as a Hybrid spread spectrum device in the acquisition mode.

For each individual device, the following items, 1-7 will vary from one device to another and must be submitted.

1) The occupied bandwidth in Section 15.247(a)(1)(ii).
2) Conducted output power specified in Section 15.247(b)(1).
3) EIRP limit in Section 15.247(b)(3).
4) RF safety requirement in Section 15.247(b)(4)
5) Spurious emission limits in Section 15.247(c).
6) Processing gain and requirements for Hybrids in Section 15.247(f) in the acquisition mode.
7) Power spectral density requirement in Section 15.247(f) in the acquisition mode.

For all devices, the following items, 1-12, are common to all Bluetooth devices and will not vary from one device to another. This list can be copied into the filing.

1 Output power and channel separation of a Bluetooth device in the different operating modes:

The different operating modes (data-mode, acquisition-mode) of a Bluetooth device don’t influence the output power and the channel spacing. There is only one transmitter which is driven by identical input parameters concerning these two parameters.
Only a different hopping sequence will be used. For this reason, the RF parameters in one op-mode is sufficient.

2 Frequency range of a Bluetooth device:

The maximum frequency of the device is: **2402 – 2480 M**Hz.
This is according the Bluetooth Core Specification V 1.0B (+ critical errata) for devices which will be operated in the USA. Other frequency ranges (e.g. for Spain, France, Japan) which are allowed according the Core Specification must **not be** supported by the device.

3 Co-ordination of the hopping sequence in data mode to avoid simultaneous occupancy by multiple transmitters:

Bluetooth units which want to communicate with other units must be organized in a structure called piconet. This piconet consist of max. 8 Bluetooth units. One unit is the master the other seven are the slaves. The master co-ordinates frequency occupation in this piconet for all units. As the master hop sequence is derived from it’s BD address which is unique for every Bluetooth device, additional masters intending to establish new piconets will always use different hop sequences.

4 Example of a hopping sequence in data mode:

Example of a 79 hopping sequence in data mode:
40, 21, 44, 23, 42, 53, 46, 55, 48, 33, 52, 35, 50, 65, 54, 67,
56, 37, 60, 39, 58, 69, 62, 71, 64, 25, 68, 27, 66, 57, 70, 59,
72, 29, 76, 31, 74, 61, 78, 63, 01, 41, 05, 43, 03, 73, 07, 75,
09, 45, 13, 47, 11, 77, 15, 00, 64, 49, 66, 53, 68, 02, 70, 06,
01, 51, 03, 55, 05, 04

5 Equally average use of frequencies in data mode and short transmissions:

The generation of the hopping sequence in connection mode depends essentially on two input values:

1. LAP/UAP of the master of the connection
2. Internal master clock

The LAP (lower address part) are the 24 LSB's of the 48 BD_ADDRESS. The BD_ADDRESS is an unambiguous number of every Bluetooth unit. The UAP (upper address part) are the 24 MSB's of the 48 BD_ADDRESS. The internal clock of a Bluetooth unit is derived from a free running clock which is never adjusted and is never turned off. For synchronization with other units, only the offsets are used. It has no relation to the time of the day. Its resolution is at least half the RX/TX slot length of 312.5 µs. The clock has a cycle of about one day (23h30). In most case it is implemented as 28 bit counter. For the deriving of the hopping sequence the entire LAP (24 bits), 4 LSB's (4 bits) (Input 1) and the 27 MSB's of the clock (Input 2) are used. With this input values different mathematical procedures (permutations, additions, XOR-operations) are performed to generate the sequence. This will be done at the beginning of every new transmission.

Regarding short transmissions, the Bluetooth system has the following behavior:
The first connection between the two devices is established, a hopping sequence is generated. For transmitting the wanted data, the complete hopping sequence is not used and the connection ends. The second connection will be established. A new hopping sequence is generated. Due to the fact that the Bluetooth clock has a different value, because the period between the two transmission is longer (and it cannot be shorter) than the minimum resolution of the clock (312.5 µs). The hopping sequence will always differ from the first one.

6 Receiver input bandwidth, synchronization and repeated single or multiple packets:

The input bandwidth of the receiver is 1 MHz.
In every connection, one Bluetooth device is the master and the other one is the slave. The master determines the hopping sequence (see chapter 5). The slave follows this sequence. Both devices shift between RX and TX time slot according to the clock of the master. Additionally the type of connection (e.g. single or multi-slot packet) is set up at the beginning of the connection. The master adapts its hopping frequency and its TX/RX timing is according to the packet type of the connection. Also, the slave of the connection uses these settings. Repeating of a packet has no influence on the hopping sequence. The hopping sequence generated by the master of the connection will be followed in any case. That means, a repeated packet will not be send on the same frequency, it is send on the next frequency of the hopping sequence

7 Dwell time in data mode

The dwell time of 0.3797s within a 30 second period in data mode is independent from the packet type (packet length). The calculation for a 30 second period is a follows:
Dwell time = time slot length * hop rate / number of hopping channels *30s
Example for a DH1 packet (with a maximum length of one time slot)
Dwell time = 625 µs * 1600 1/s / 79 * 30s = 0.3797s (in a 30s period)

For multi-slot packet the hopping is reduced according to the length of the packet.
Example for a DH5 packet (with a maximum length of five time slots)
Dwell time = 5 * 625 µs * 1600 * 1/5 *1/s / 79 * 30s = 0.3797s (in a 30s period)
This is according the Bluetooth Core Specification V 1.0B (+ critical errata) for all Bluetooth devices. Therefore, all Bluetooth devices **comply** with the FCC dwell time requirement in the data mode.
This was checked during the Bluetooth Qualification tests.
The Dwell time in hybrid mode is approximately 2.6 mS (in a 12.8s period)

8 Channel Separation in hybrid mode

The nominal channel spacing of the Bluetooth system is 1Mhz independent of the operating mode.
The maximum “initial carrier frequency tolerance” which is allowed for Bluetooth is fcenter = 75 kHz.
This was checked during the Bluetooth Qualification tests (Test Case: TRM/CA/07-E) for three frequencies (2402, 2441, 2480 MHz).

9 Derivation and examples for a hopping sequence in hybrid mode

For the generation of the inquiry and page hop sequences the same procedures as described for the data mode are used (see item 5), but this time with different input vectors:
**For the inquiry hop sequence, a predefined fixed address is always used. This results in the same 32 frequencies used by all devices doing an inquiry but every time with a different start frequency and phase in this sequence.
**For the page hop sequence, the device address of the paged unit is used as the input vector. This results in the use of a subset of 32 frequencies which is specific for that initial state of the connection establishment between the two units. A page to different devices would result in a different subset of 32 frequencies.
So it is ensured that also in hybrid mode, the frequency is used equally on average.
Example of a hopping sequence in inquiry mode:
48, 50, 09, 13, 52, 54,41, 45, 56, 58, 11, 15, 60, 62, 43, 47, 00, 02, 64, 68, 04, 06, 17, 21, 08, 10, 66, 70, 12, 14, 19, 23
Example of a hopping sequence in paging mode:
08, 57, 68, 70, 51, 02, 42, 40, 04, 61, 44, 46, 63, 14, 50, 48, 16, 65, 52, 54, 67, 18, 58, 56, 20, 53, 60, 62, 55, 06, 66, 64

10 Receiver input bandwidth and synchronization in hybrid mode:

The receiver input bandwidth is the same as in the data mode (1 MHz). When two Bluetooth devices establish contact for the first time, one device sends an inquiry access code and the other device is scanning for this inquiry access code. If two devices have been connected previously and want to start a new transmission, a similar procedure takes place. The only difference is, instead of the inquiry access code, a special access code, derived from the BD_ADDRESS of the paged device will be, will be sent by the master of this connection. Due to the fact that both units have been connected before (in the inquiry procedure) the paging unit has timing and frequency information about the page scan of the paged unit. For this reason the time to establish the connection is reduced.

11 Spread rate / data rate of the direct sequence signal

The Spread rate / Data rate in inquiry and paging mode can be defined via the access code. The access code is the only criterion for the system to check if there is a valid transmission or not. If you regard the presence of a valid access code as one bit of information, and compare it with the length of the access code of 68 bits, the Spread rate / Data rate will be 68/1.

12 Spurious emission in hybrid mode

The Dwell in hybrid mode is shorter than in data mode. For this reason the spurious emissions average level in data mode is worst case. The spurious emissions peak level is the same for both modes.