Intermec Technologies Corporation

DHIB in CN3

October 02, 2006

Report No. ITRM0139

Report Prepared By

NORTHWEST EMC

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

EMC Test Report

NORTHWEST EMC

22975 NW Evergreen Parkway
Suite 400
Hillsboro, Oregon 97124

Certificate of Test

Issue Date: October 02, 2006
Intermec Technologies Corporation
Model: DHIB in CN3

Emissions				
Test Description	**Specification**	**Test Method**	**Pass**	**Fail**
Spurious Radiated Emissions	FCC 15.247:2006 DTS	ANSI C63.4:2003, KDB No. 558074	☒	☐

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: 844-3826

This site has been fully described in a report filed with and accepted by the FCC (Federal Communications Commission) and Industry Canada.

Approved By:
Donald Facteau, IS Manager

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 Number	Description	Date	Page Number
00	None		

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 United States Department of Commerce, National Institute of Standards and Technology, and National Voluntary Laboratory Accreditation Program for satisfactory compliance with the requirements of ISO/IEC 17025 for Testing Laboratories. The NVLAP accreditation encompasses Electromagnetic Compatibility Testing in accordance with the European Union EMC Directive 89/336/EEC, ANSI C63.4, MIL-STD 461E, DO-160D and SAE J1113. 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.

NVLAP LAB CODE 200629-0
NVLAP LAB CODE 200630-0
NVLAP LAB CODE 200676-0

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 212, Issue 1 (Provisional) 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.

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.

TÜV Product Service: Included in TUV Product Service Group's Listing of Recognized Laboratories. It qualifies in connection with the TUV Certification after Recognition of Agent's Testing Program for the product categories and/or standards shown in TUV's current Listing of CARAT Laboratories, available from TUV. A certificate was issued to represent that this laboratory continues to meet TUV's CARAT Program requirements. Certificate No. USA0401C.

TÜV Rheinland: Authorized to carryout EMC tests by order and under supervision of TÜV Rheinland. This authorization is based on "Conditions for EMC-Subcontractors" of November 1992.

NEMKO: Assessed and accredited by NEMKO (Norwegian testing and certification body) for European emissions and immunity testing. As a result of NEMKO's laboratory assessment, they will accept test results from Northwest EMC, Inc. for product certification (Authorization No. ELA 119).

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).

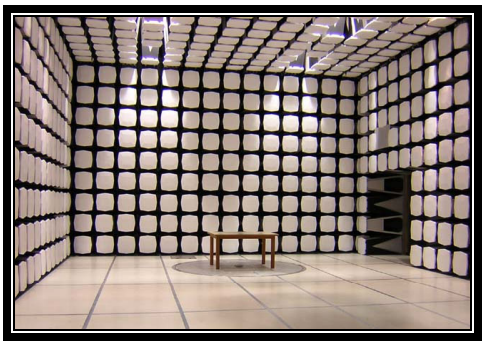
VCCI: Accepted as an Associate Member to the VCCI, Acceptance No. 564. Conducted and radiated measurement facilities have been registered in accordance with Regulations for Voluntary Control Measures, Article 8. *(Registration Numbers. - Hillsboro: C-1071, R-1025, and R-2318, Irvine: C-2094 and R-1943, Sultan: R-871, C-1784 and R-1761).*

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. License No.SL2-IN-E-1017.

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

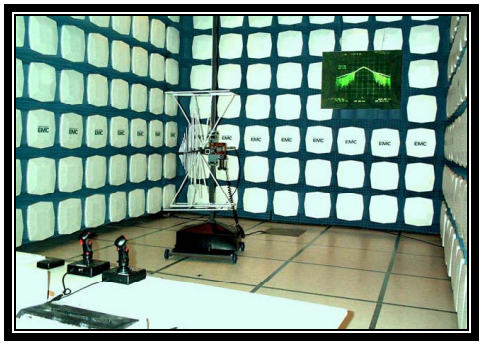
SCOPE

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



California – Orange County Facility
Labs OC01 – OC13

41 Tesla Ave. Irvine, CA 92618
(888) 364-2378 Fax: (503) 844-3826



Oregon – Evergreen Facility
Labs EV01 – EV11

22975 NW Evergreen Pkwy. Suite 400 Hillsboro, OR 97124
(503) 844-4066 Fax: (503) 844-3826

Washington – Sultan Facility
Labs SU01 – SU07

14128 339th Ave. SE Sultan, WA 98294
(888) 364-2378

Party Requesting the Test	
Company Name:	Intermec Technologies Corporation
Address:	550 Second St. SE
City, State, Zip:	Cedar Rapids, IA 52401-2023
Test Requested By:	Scott Holub
Model:	DHIB in CN3
First Date of Test:	September 29, 2006
Last Date of Test:	September 29, 2006
Receipt Date of Samples:	September 29, 2006
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 radio (DHIB).

Testing Objective:

The Bluetooth radio module (DHIB) will be installed in a small Intermec handheld device, the CN3. The objective is to demonstrate compliance of an integrated chip antenna for the Bluetooth portion of the radio and compliance to the FCC 15.247 requirements.

EUT Photo

CONFIGURATION 1 ITRM0139

Software/Firmware Running during test	
Description	**Version**
Windows Mobile	5.0 OS5.1.342
Broadtest	1.1

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Bluetooth Radio	Intermec Technologies Corp.	DHIB in CN3	21590600264

Peripherals in test setup boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
12VDC Power supply	Intermec Technologies Corp.	073573	496462
Base Unit	Intermec Technologies Corp.	AD10/871-025-001	Proto C (#47)

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
DC Power	No	1.9m	Yes	12VDC Power supply	Base Unit
USB	Yes	1.4m	No	Base Unit	Unterminated
USB	Yes	1.3m	No	Base Unit	Unterminated
AC Mains	No	1.7m	No	AC Mains	12VDC Power supply
PA = Cable is permanently attached to the device. Shielding and/or presence of ferrite may be unknown.					

Equipment modifications					
Item	Date	Test	Modification	Note	Disposition of EUT
1	9/29/2006	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
Bluetooth Transmitting Mid Channel
Bluetooth Transmitting Low Channel
Bluetooth Transmitting High Channel

MODE USED FOR FINAL DATA
Bluetooth Transmitting Low Channel
Bluetooth Transmitting Mid Channel
Bluetooth Transmitting High Channel

POWER SETTINGS INVESTIGATED
120VAC/60Hz

POWER SETTINGS USED FOR FINAL DATA
120VAC/60Hz

FREQUENCY RANGE INVESTIGATED			
Start Frequency	30MHz	Stop Frequency	26.5GHz

CLOCKS AND OSCILLATORS
2.402GHz, 2.440GHz, and 2.480GHz

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
Spectrum Analyzer	Agilent	E4446A	AAT	4/4/2006	12
Pre-Amplifier	Miteq	AM-1616-1000	AOL	7/6/2006	13
Antenna, Biconilog	EMCO	3141	AXE	12/28/2005	24
High Pass Filter	Micro-Tronics	HPM50111	HFO	4/4/2006	13
Pre-Amplifier	Miteq	AMF-4D-010100-24-10P	APW	7/6/2006	13
Antenna, Horn	EMCO	3115	AHC	8/24/2006	12
Antenna, Horn	EMCO	3160-08	AHK	NCR	0
Pre-Amplifier	Miteq	AMF-4D-005180-24-10P	APC	5/12/2006	13
Pre-Amplifier	Miteq	JS4-26004000-40-8P	APV	3/29/2006	13
Antenna, Horn	EMCO	3160-09	AHG	NCR	0

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

Measurement uncertainty is used to reflect the accuracy of the measured result as compared with its "true" or theoretically correct value. Our measurement data meets or exceeds the measurement uncertainty requirements of CISPR 16-4. In the case of transient tests our test equipment has been demonstrated by calibration to provide at least a 95% confidence that it complies with the test specification requirements. The measurement uncertainty for any test is available upon request.

TEST DESCRIPTION

Using the mode of operation and configuration noted within this report, a final radiated emissions test was performed. The frequency range investigated (scanned), is also noted in this report. Radiated emissions measurements were made at the EUT azimuth and antenna height such that the maximum radiated emissions level will be detected. This requires the use of a turntable and an antenna positioner. The preferred method of a continuous azimuth search is utilized for frequency scans of the EUT field strength with both polarities of the measuring antenna. A calibrated, linearly polarized antenna was positioned at the specified distance from the periphery of the EUT.

Tests were made with the antenna positioned in both the horizontal and vertical planes of polarization. The antenna was varied in height above the conducting ground plane to obtain the maximum signal strength. Though specified in the report, the measurement distance shall be 3 meters or 10 meters. At any measurement distance, the antenna height was varied from 1 meter to 4 meters. These height scans apply for both horizontal and vertical polarization, except that for vertical polarization the minimum height of the center of the antenna shall be increased so that the lowest point of the bottom of the antenna clears the ground surface by at least 25 cm.

NORTHWEST EMC

SPURIOUS RADIATED EMISSIONS

PSA 2006.09.07
EMI 2006.7.11

EUT:	DHIB in CN3			Work Order:	ITRM0139
Serial Number:	21590600264			Date:	09/29/06
Customer:	Intermec Technologies Corporation			Temperature:	23°C
Attendees:	None			Humidity:	40%
Project:	None			Barometric Pres.:	30.04
Tested by:	Dan Haas	Power:	120VAC/60Hz	Job Site:	EV01

TEST SPECIFICATIONS	Test Method
FCC 15.247:2006 DTS	ANSI C63.4:2003, KDB No. 558074

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

COMMENTS

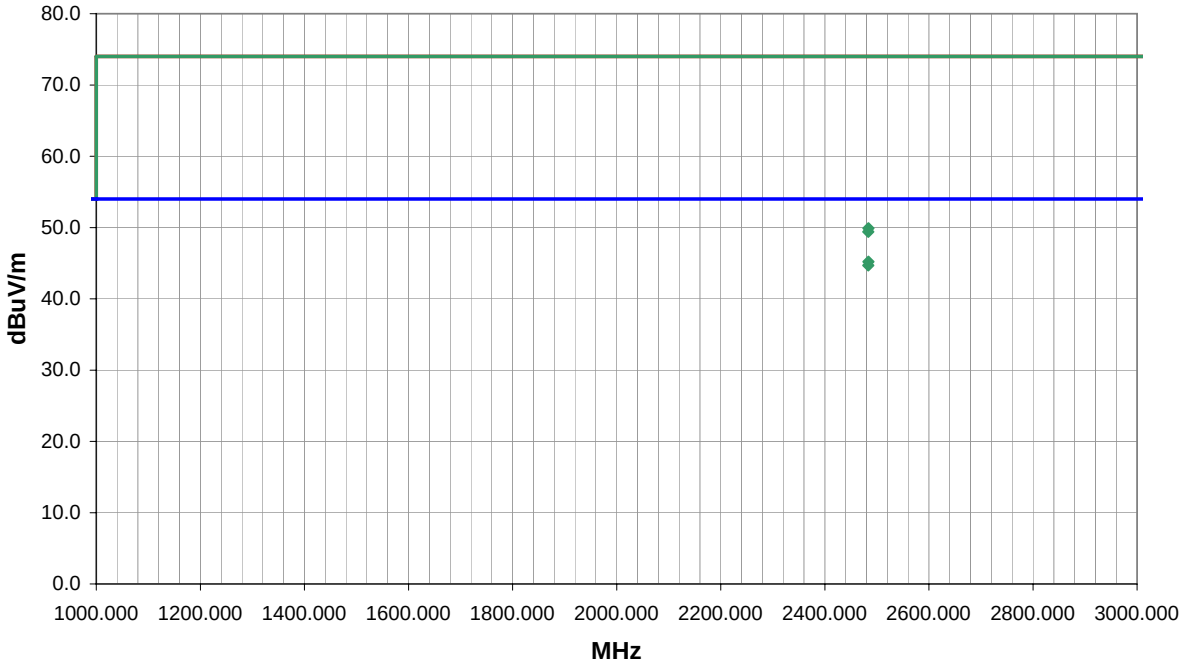
EUT OPERATING MODES

Bluetooth Transmitting High Channel

DEVIATIONS FROM TEST STANDARD

No deviations.

Run #	1		
Configuration #	1		
Results	Pass	NVLAP Lab Code 200630-0	*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)
2483.689	23.6	1.6	227.0	1.0	3.0	20.0	H-Horn	AV	0.0	45.2	54.0	-8.8
2483.549	23.1	1.6	79.0	1.0	3.0	20.0	V-Horn	AV	0.0	44.7	54.0	-9.3
2483.880	28.3	1.6	227.0	1.0	3.0	20.0	H-Horn	PK	0.0	49.9	74.0	-24.1
2483.560	27.8	1.6	79.0	1.0	3.0	20.0	V-Horn	PK	0.0	49.4	74.0	-24.6

NORTHWEST EMC

SPURIOUS RADIATED EMISSIONS

PSA 2006.09.07
EMI 2006.7.11

EUT:	DHIB in CN3			Work Order:	ITRM0139
Serial Number:	21590600264			Date:	09/29/06
Customer:	Intermec Technologies Corporation			Temperature:	23°C
Attendees:	None			Humidity:	40%
Project:	None			Barometric Pres.:	30.04
Tested by:	Dan Haas	Power:	120VAC/60Hz	Job Site:	EV01

TEST SPECIFICATIONS	Test Method
FCC 15.247:2006 DTS	ANSI C63.4:2003, KDB No. 558074

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

COMMENTS

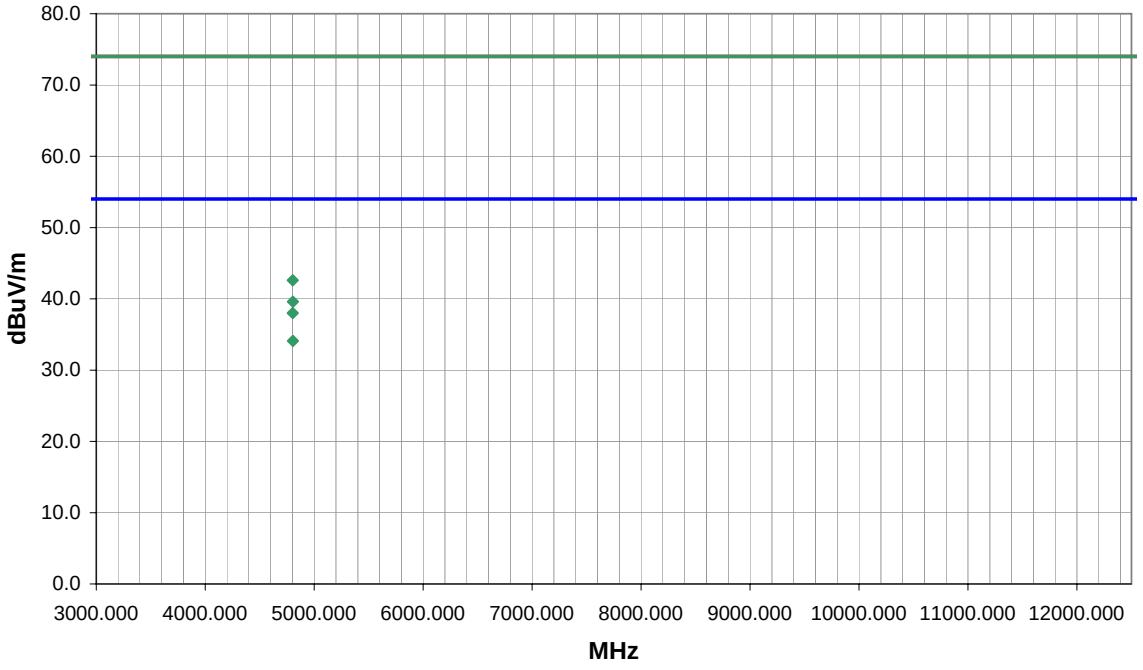
EUT OPERATING MODES

Bluetooth Transmitting Low Channel

DEVIATIONS FROM TEST STANDARD

No deviations.

Run #	2		
Configuration #	1		
Results	Pass	NVLAP Lab Code 200630-0	*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)
4804.012	31.3	8.3	271.0	1.3	3.0	0.0	H-Horn	AV	0.0	39.6	54.0	-14.4
4804.034	25.8	8.3	152.0	1.0	3.0	0.0	V-Horn	AV	0.0	34.1	54.0	-19.9
4803.253	34.3	8.3	271.0	1.3	3.0	0.0	H-Horn	PK	0.0	42.6	74.0	-31.4
4803.633	29.7	8.3	152.0	1.0	3.0	0.0	V-Horn	PK	0.0	38.0	74.0	-36.0

NORTHWEST EMC

SPURIOUS RADIATED EMISSIONS

PSA 2006.09.07
EMI 2006.7.11

EUT:	DHIB in CN3			Work Order:	ITRM0139
Serial Number:	21590600264			Date:	09/29/06
Customer:	Intermec Technologies Corporation			Temperature:	23°C
Attendees:	None			Humidity:	40%
Project:	None			Barometric Pres.:	30.04
Tested by:	Dan Haas	Power:	120VAC/60Hz	Job Site:	EV01

TEST SPECIFICATIONS	Test Method
FCC 15.247:2006 DTS	ANSI C63.4:2003, KDB No. 558074

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

COMMENTS

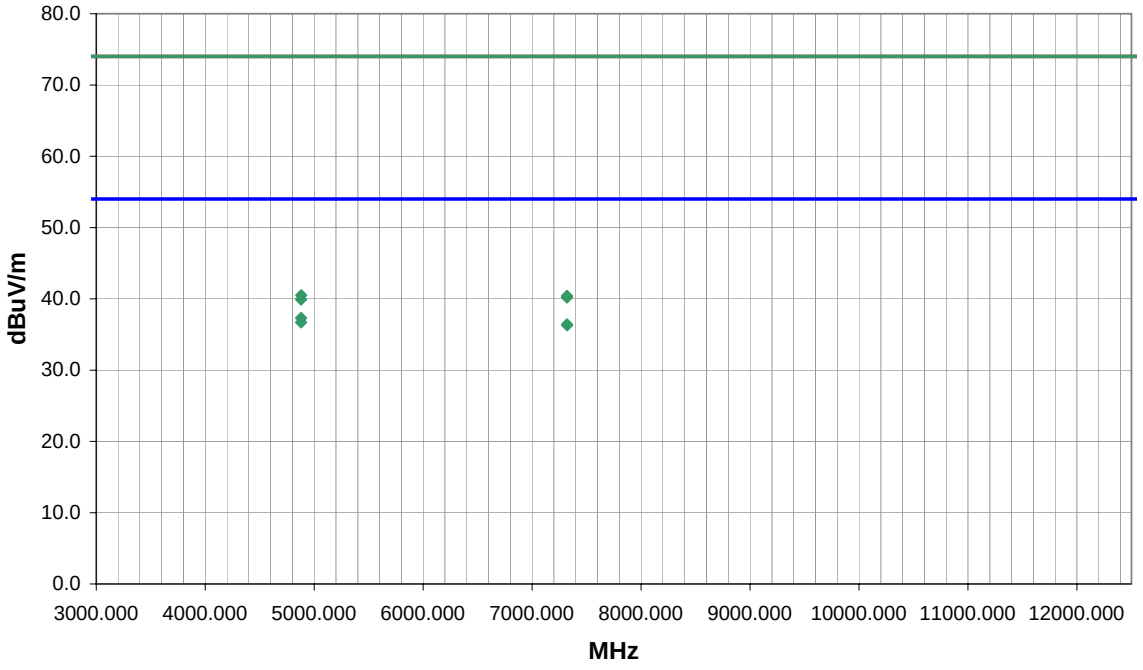
EUT OPERATING MODES

Bluetooth Transmitting Mid Channel

DEVIATIONS FROM TEST STANDARD

No deviations.

Run #	3		
Configuration #	1		
Results	Pass	NVLAP Lab Code 200630-0	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)
4880.020	28.7	8.6	219.0	1.0	3.0	0.0	H-Horn	AV	0.0	37.3	54.0	-16.7
4880.025	28.1	8.6	236.0	1.0	3.0	0.0	V-Horn	AV	0.0	36.7	54.0	-17.3
7320.219	22.0	14.4	259.0	1.0	3.0	0.0	H-Horn	AV	0.0	36.4	54.0	-17.6
7321.028	21.9	14.4	354.0	1.0	3.0	0.0	V-Horn	AV	0.0	36.3	54.0	-17.7
4880.611	31.9	8.6	219.0	1.0	3.0	0.0	H-Horn	PK	0.0	40.5	74.0	-33.5
7320.315	26.0	14.4	354.0	1.0	3.0	0.0	V-Horn	PK	0.0	40.4	74.0	-33.6
7320.200	25.8	14.4	259.0	1.0	3.0	0.0	H-Horn	PK	0.0	40.2	74.0	-33.8
4879.896	31.3	8.6	236.0	1.0	3.0	0.0	V-Horn	PK	0.0	39.9	74.0	-34.1

NORTHWEST EMC

SPURIOUS RADIATED EMISSIONS

PSA 2006.09.07
EMI 2006.7.11

EUT:	DHIB in CN3			Work Order:	ITRM0139
Serial Number:	21590600264			Date:	09/29/06
Customer:	Intermec Technologies Corporation			Temperature:	23°C
Attendees:	None			Humidity:	40%
Project:	None			Barometric Pres.:	30.04
Tested by:	Dan Haas	Power:	120VAC/60Hz	Job Site:	EV01

TEST SPECIFICATIONS	Test Method
FCC 15.247:2006 DTS	ANSI C63.4:2003, KDB No. 558074

TEST PARAMETERS			
Antenna Height(s) (m)	1 - 4	Test Distance (m)	0

COMMENTS

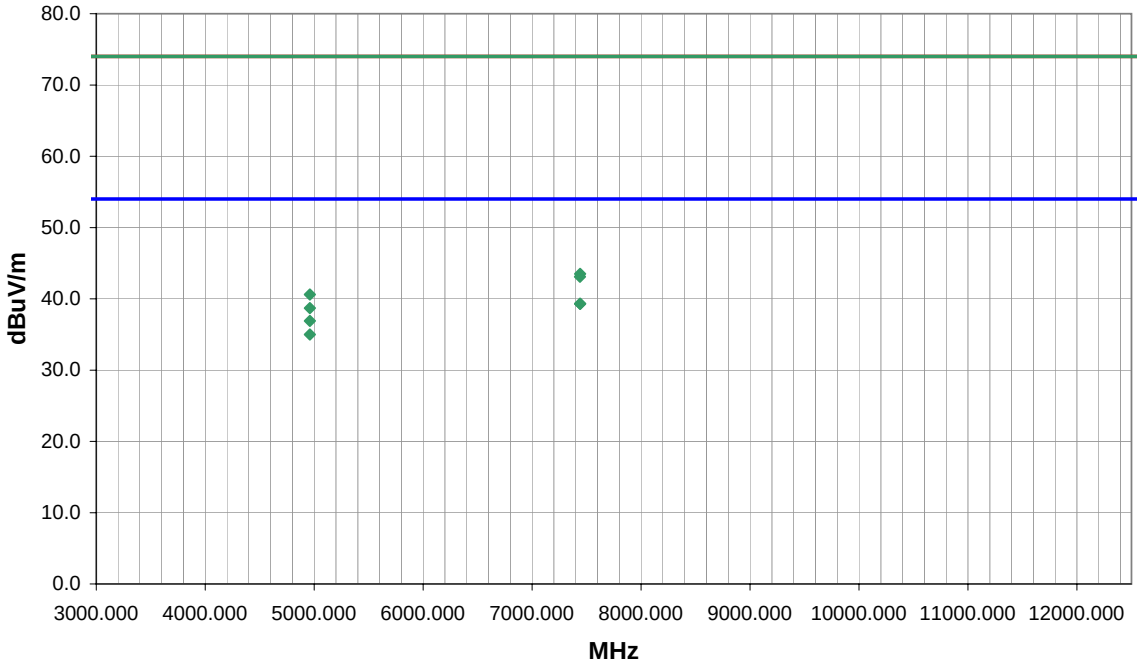
EUT OPERATING MODES

Bluetooth Transmitting High Channel

DEVIATIONS FROM TEST STANDARD

No deviations.

Run #	4		
Configuration #	1		
Results	Pass	NVLAP Lab Code 200630-0	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)
7440.023	24.4	14.9	152.0	1.0	0.0	0.0	V-Horn	AV	0.0	39.3	54.0	-14.7
7440.274	24.4	14.9	128.0	3.4	0.0	0.0	H-Horn	AV	0.0	39.3	54.0	-14.7
4960.045	28.0	8.9	247.0	1.0	0.0	0.0	V-Horn	AV	0.0	36.9	54.0	-17.1
4960.004	26.1	8.9	294.0	1.0	0.0	0.0	H-Horn	AV	0.0	35.0	54.0	-19.0
7440.895	28.6	14.9	128.0	3.4	0.0	0.0	H-Horn	PK	0.0	43.5	74.0	-30.5
7439.260	28.2	14.9	152.0	1.0	0.0	0.0	V-Horn	PK	0.0	43.1	74.0	-30.9
4960.165	31.7	8.9	247.0	1.0	0.0	0.0	V-Horn	PK	0.0	40.6	74.0	-33.4
4959.770	29.8	8.9	294.0	1.0	0.0	0.0	H-Horn	PK	0.0	38.7	74.0	-35.3


NORTHWEST
EMC


NORTHWEST
EMC


SN: 21590600264
BroadTest v1.1
BroadTest v1.1
ok
Select a Vendor-Specific HCI command
Set_Tx_Carrier_Frequency_2045
Enter command code
0x
14
Execute
Intermec
CN3
Unit No: 47


SN: 21590600264
Intermec
CN3


Intermec
CN3


Intermec
CN3

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.