ENGINEERING TEST REPORT

Polaris
MODEL NO.: VICRA

FCC ID: TJ8-VICRA

Applicant:

Northern Digital Inc.
103 Randall Drive
Waterloo, Ontario
Canada N2V 1C5

Tested in Accordance With

FCC Part 15, Subpart C, Section 15.249
Low Power Transmitters
Operating in the Frequency Band 2400 - 2483.5 MHz

UltraTech's File No.: NDI-056F15C249

This Test report is Issued under the Authority of Tri M. Luu, Professional Engineer, Vice President of Engineering UltraTech Group of Labs Date: October 20, 2005	
Report Prepared by: JaeWook Choi, RF Engineer Issued Date: October 20, 2005	Tested by: Mr. Hung Trinh, EMC/RFI Technician Test Dates: August 16-17, 2005

- *The results in this Test Report apply only to the sample(s) tested, and the sample tested is randomly selected.*
- *This report must not be used by the client to claim product endorsement by NVLAP or any agency of the US Government.*

UltraTech

3000 Bristol Circle, Oakville, Ontario, Canada, L6H 6G4
Tel.: (905) 829-1570 Fax.: (905) 829-8050
Website: www.ultratech-labs.com, Email: vic@ultratech-labs.com, Email: tri@ultratech-labs.com

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EXHIBIT 1. SUBMITTAL CHECK LIST

Annex No.	Exhibit Type	Description of Contents	Quality Check (OK)
--	Test Report	Test Report	OK
1	Test Setup Photos	• Radiated Emission Setup Photos • AC Conducted Emissions Setup Photos	OK
2	External Photos of EUT	External EUT Photos	OK
3	Internal Photos of EUT	Internal EUT Photos	OK
4	Cover Letters	Letter from Ultratech for Certification Request	OK
5	Attestation Statements	• Letter from the Applicant to appoint Ultratech to act as an agent • Letter from the Applicant to request for Confidentiality Filing	OK OK
6	ID Label/Location Info	• ID Label • Location of ID Label	OK
7	Block Diagrams	Block Diagram	OK
8	Schematic Diagrams	Schematic Diagram	OK
9	Parts List/Tune Up Info	-	N/A
10	Operational Description	Operational Description	OK
11	RF Exposure Info	-	N/A
12	Users Manual	Polaris Vicra User Guide	OK

EXHIBIT 2. INTRODUCTION

2.1. SCOPE

Reference:	FCC Part 15, Subpart C, Section 15.249
Title:	Code of Federal Regulations (CFR), Title 47 – Telecommunication, Part 15
Purpose of Test:	To gain FCC Certification Authorization for Low Power Licensed-Exempt Transmitters operating in the Frequency Band 2400 - 2483.5 MHz.
Test Procedures:	Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute ANSI C63.4 - American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
Environmental Classification:	Commercial, industrial or business environment residential

2.2. RELATED SUBMITTAL(S)/GRANT(S)

None.

2.3. NORMATIVE REFERENCES

Publication	Year	Title
FCC CFR Parts 0-19	2004	Code of Federal Regulations – Telecommunication
ANSI C63.4	2003	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
CISPR 22 +A1 EN 55022	2003-04-10 2004-10-14 2003	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
CISPR 16-1-1	2003	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus
CISPR 16-2-1	2003	Specification for radio disturbance and immunity measuring apparatus and methods. Part 2-1: Conducted disturbance measurement
CISPR 16-2-3	2003	Specification for radio disturbance and immunity measuring apparatus and methods. Part 2-3: Radiated disturbance measurement

EXHIBIT 3. PERFORMANCE ASSESSMENT

3.1. CLIENT INFORMATION

APPLICANT	
Name:	Northern Digital Inc.
Address:	103 Randall Drive Waterloo, Ontario Canada N2V 1C5
Contact Person:	Michael Palmer Phone #: (519) 884-5142 Fax #: (519) 884 5184 Email Address: mpalmer@ndigital.com

MANUFACTURER	
Name:	Northern Digital Inc.
Address:	103 Randall Drive Waterloo, Ontario Canada N2V 1C5
Contact Person:	Michael Palmer Phone #: (519) 884-5142 Fax #: (519) 884 5184 Email Address: mpalmer@ndigital.com

3.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information (with the exception of the Date of Receipt) has been supplied by the applicant.

Equipment Identification:	Northern Digital Inc.
Brand or Trade Name:	Polaris
Model Name or Number:	Vicra
Serial Number:	Test Sample
Type of Equipment:	Low Power RF Transceiver
Input Power Supply Type:	System: Ault MW160XA2403F01 Medical grade AC/DC (24 Vdc output) Radio Module: 3.3 Vdc regulated on main board
Primary User Functions of EUT:	Medical, light-industrial, laboratory. Precision optically-based measurement

3.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	Transceiver
Intended Operating Environment:	Residential Commercial, light industry & heavy industry
Power Supply Requirement:	System: 24.0 Vdc Radio Module: 3.3 Vdc regulated on main board
RF Output Power Rating:	-5.90 dBm EIRP
Operating Frequency:	2402 ~ 2480 MHz
RF Output Impedance:	50 Ohms
20 dB Bandwidth:	797.60 kHz
Modulation Type:	IQ-modulation with bit-stream data that is Gaussian filtered
Mode of Operation:	Duplex
Duty Cycle:	≈ 75.5 %
Antenna Connector Type:	Hirose Electric U.FL-R-SMT ultra-miniature coaxial
Antenna Description:	Manufacturer: GigaAnt Type: Mica 2.4 GHz SMD antenna Frequency Range: 2.4-2.5GHz Gain: 2.7 dBi MAX

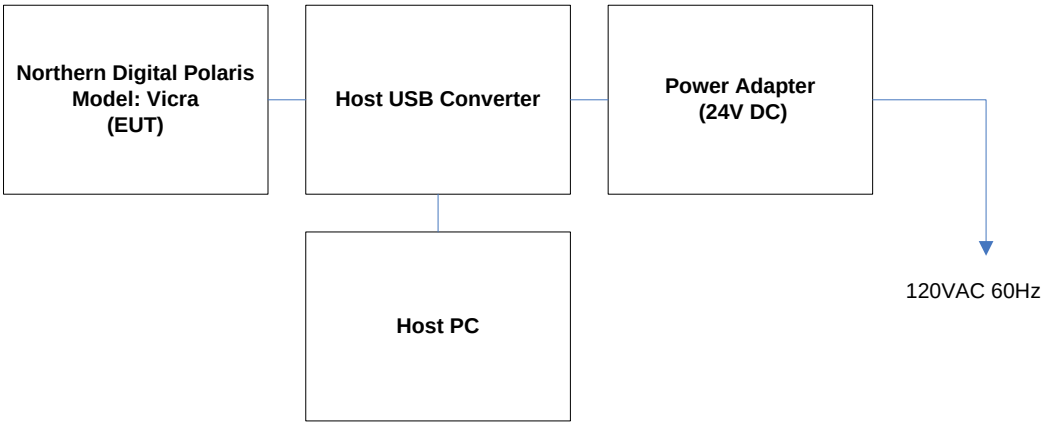
3.4. LIST OF EUT'S PORTS

Connector (LEMO) - A 14 pin connector that provides power to the Position Sensor and allows communications to/from the Position Sensor

3.5. ASSOCIATIVE DEVICE

Associative Device # 1	
Description:	Host USB Converter - Provide connections for data and power
Model Number:	Polaris USB Converter
Serial Number:	Test Sample
Connected to EUT's Port:	Connector (LEMO)

3.6. GENERAL TEST SETUP



All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

EXHIBIT 4. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

4.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21°C
Humidity:	55%
Pressure:	102 kPa
Power input source:	4.5 V DC

4.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

Operating Modes:	EUT was configured and put into built-in RF test mode to transmit burst with the designated duty cycle for measurements.
Special Test Software:	None
Special Hardware Used:	None
Transmitter Test Antenna:	The EUT is tested with the antenna fitted in a manner typical of normal intended use as integral antenna equipment.

Transmitter Test Signals:	
Frequency Band(s):	2402-2480 MHz
Test Frequency(ies):	2402, 2441, 2480 MHz
Transmitter Wanted Output Test Signals:	
• RF Power Output (measured maximum output power):	-5.90 dBm EIRP
• Normal Test Modulation:	Bluetooth
• Modulating signal source:	Internal (either payload pattern data of 11110000 or PRBS-9 sequence)

EXHIBIT 5. SUMMARY OF TEST RESULTS

5.1. LOCATION OF TESTS

- All of the measurements described in this report were performed at Ultratech Group of Labs located in the city of Oakville, Province of Ontario, Canada.

- AC Powerline Conducted Emissions were performed in UltraTech's shielded room, 24'(L) by 16'(W) by 8'(H).

- Radiated Emissions were performed at the Ultratech's 3-10 TDK Semi-Anechoic Chamber situated in the Town of Oakville, province of Ontario. This test site been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville 3-10 TDK Semi-Anechoic Chamber has been filed with FCC office (FCC File No.: 31040/SIT 1300B3) and Industry Canada office (Industry Canada File No.: IC2049-1). Last Date of Site Calibration: June. 20, 2005.

5.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC Section(s)	Test Requirements	Compliance (Yes/No)
15.107(a) & 15.207	Power Line Conducted Emissions	Yes
--	20 dB Bandwidth	Yes
15.249(a), 15.209, 15.205	Transmitter Radiated Emissions, Harmonic Emissions and Band Edge Radiated Emissions	Yes

5.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None.

EXHIBIT 6. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS

6.1. TEST PROCEDURES

This section contains test results only. Details of test methods and procedures can be found in ANSI C63.4 and ULTR-P001-2004.

6.2. MEASUREMENT UNCERTAINTIES

The measurement uncertainties stated were calculated in accordance with requirements of UKAS Document LAB 34 with a confidence level of 95%. Please refer to Exhibit 6 for Measurement Uncertainties.

6.3. MEASUREMENT EQUIPMENT USED

The measurement equipment used complied with the requirements of the Standards referenced in the Methods & Procedures ANSI C63.4 and CISPR 16-1.

6.4. ESSENTIAL/PRIMARY FUNCTIONS AS DECLARED BY THE MANUACTURER

The EUT is a remote control with 916.289 MHz RF link. The battery powered remote unit sends commands to an interface unit and receives command acknowledges and data from the same interface via RF link. The interface unit communicates via a serial link (I2C) with IQ2020 spa controller made by Invensys for Watkins. The interface unit is powered from the spa controller. The EUT incorporates and LCD graphic screen and 3 keys allowing spa control.

6.5. Power Line Conducted Emissions [§ 15.107 (A) & 15.207]

6.5.1. LIMITS

The equipment shall meet the limits of the following table:

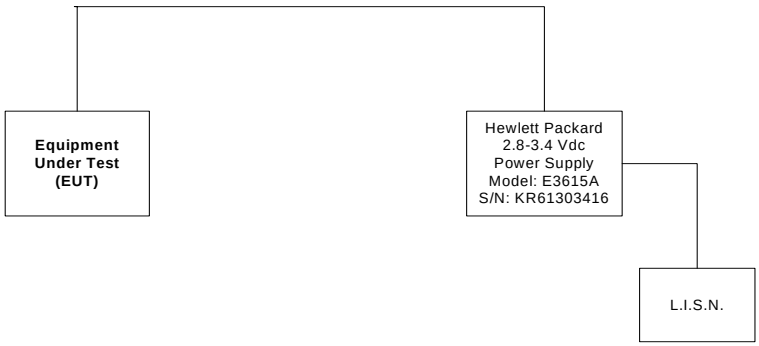
Frequency of emission (MHz)	Class B Conducted Limits (dBμV)		Measuring Bandwidth
	Quasi-peak	Average	
0.15–0.5 .....……..	66 to 56*	56 to 46*	RBW = 9 kHz
0.5–5 .....……..	56	46	VBW ≥ 9 kHz for QP
5-30 ……..	60 ..……..	50	VBW = 1 Hz for Average

* Decreases linearly with logarithm of the frequency

6.5.2. METHOD OF MEASUREMENTS

Refer to Section 8.2 of this test report & ANSI C63.4.

6.5.3. TEST ARRANGEMENT



6.5.4. TEST EQUIPMENT LIST

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Hewlett Packard	HP 8593EM	3412A00103	9 kHz – 26.5 GHz
Transient Limiter	Hewlett Packard	11947A	310701998	9 kHz – 200 MHz 10 dB attenuation
L.I.S.N.	EMCO	3825/2	89071531	9 kHz – 200 MHz 50 Ohms / 50 μH
24'(L) x 16'(W) x 8'(H) RF Shielded Chamber	Braden Shielding	…	…	…

6.5.5. TEST DATA

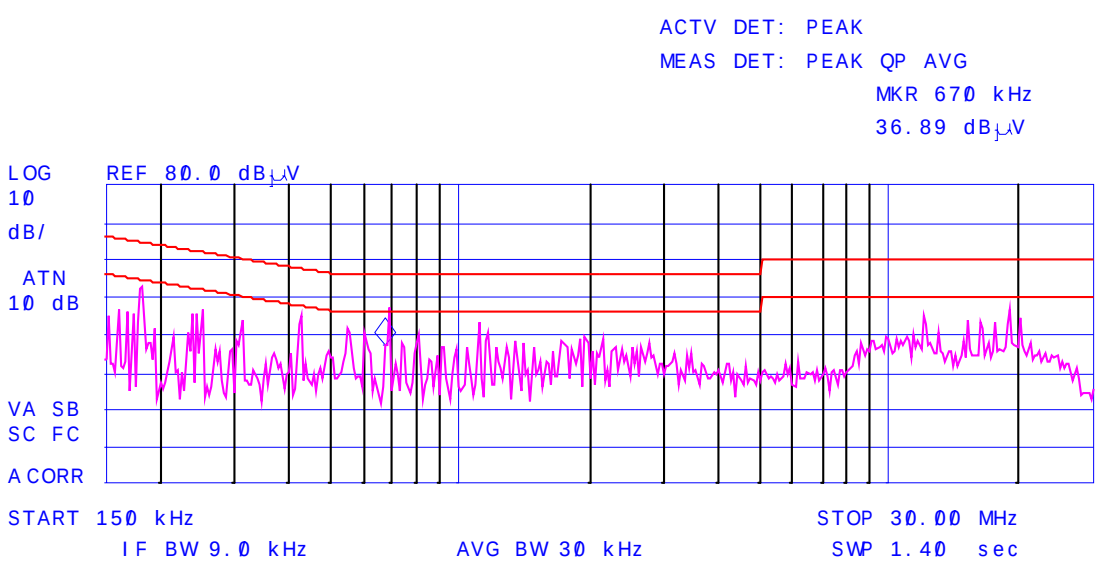
Frequency (MHz)	RF Level (dBμV)	Receiver Detector (P/QP/AVG)	QP Limit (dBuV)	AVG Limit (dBuV)	Margin (dB)	Pass/ Fail	Line Tested (L1/L2)
Test Configuration : Transmitter Mode							
0.18	55.8	QP	64.4	54.4	-8.6	Pass	L1
0.18	43.0	AVG	64.4	54.4	-11.4	Pass	L1

0.67	42.4	QP	56.0	46.0	-13.6	Pass	L1
0.67	31.1	AVG	56.0	46.0	-14.9	Pass	L1
18.15	37.3	QP	60.0	50.0	-22.7	Pass	L1
18.15	27.3	AVG	66.0	50.0	-22.7	Pass	L1
0.18	52.5	QP	56.0	46.0	-3.5	Pass	L2
0.18	44.4	AVG	56.0	46.0	-1.6	Pass	L2
18.15	45.2	QP	60.0	50.0	-20.8	Pass	L2
18.15	25.4	AVG	66.0	50.0	-24.6	Pass	L2

Note: See the following test data plots for detailed measurements.

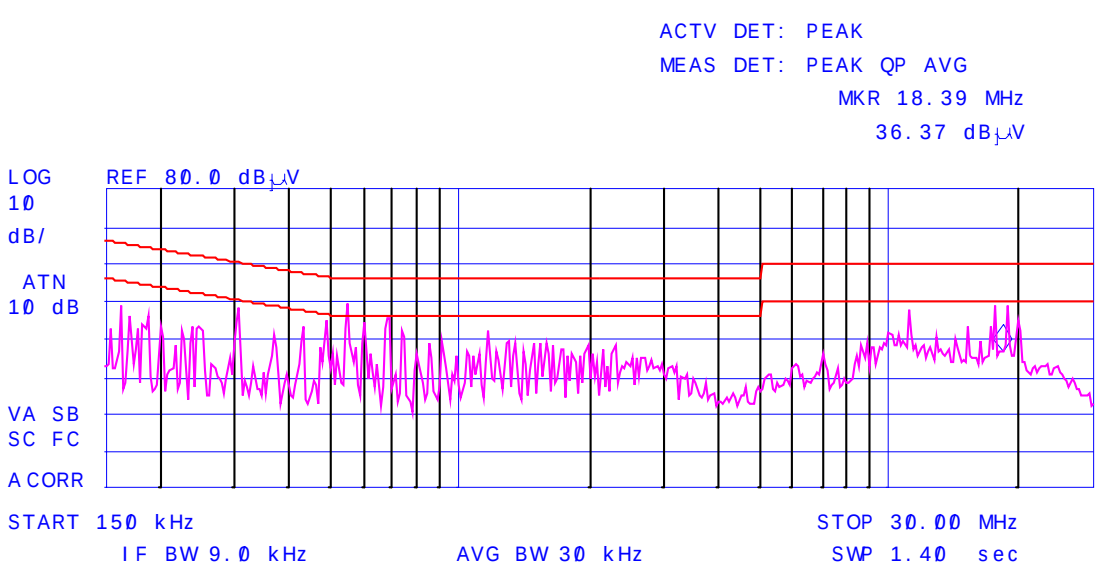
Plot 1:
AC Power Line Conducted Emissions
Test Configuration : Transmitter Mode
Line Voltage : 120 VAC
Line Tested: L1

Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	QP△L1
1	0.181575	60.2	55.8	43.0	-8.6
2	0.670035	48.5	42.4	31.1	-13.6
3	18.151135	45.1	37.3	27.3	-22.7



Plot 2:
AC Power Line Conducted Emissions
Test Configuration : Transmitter Mode
Line Voltage : 120 VAC
Line Tested: L2

Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	QP△L1
1	0.558060	54.2	52.5	44.4	-3.5
2	18.325090	49.7	45.2	25.4	-14.8



6.6. 20 dB BANDWIDTH

6.6.1. LIMITS

No limit. Test is performed for information only.

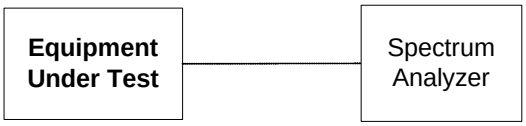
6.6.2. METHOD OF MEASUREMENTS

The transmitter output was loosely coupled to the spectrum analyzer through a receiving antenna and the bandwidth of bandwidth of the fundamental frequency was measured with the spectrum analyzer with the resolution bandwidth of the spectrum analyzer set per ANSI 63.4

6.6.3. TEST EQUIPMENT LIST

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Rohde & Schwarz	FSEK20/B4/B21	834157/005	9 kHz- 40 GHz
Log Periodic	EMCO	3148	23845	200 MHz – 2 GHz

6.6.4. TEST ARRANGEMENT



6.6.5. TEST DATA

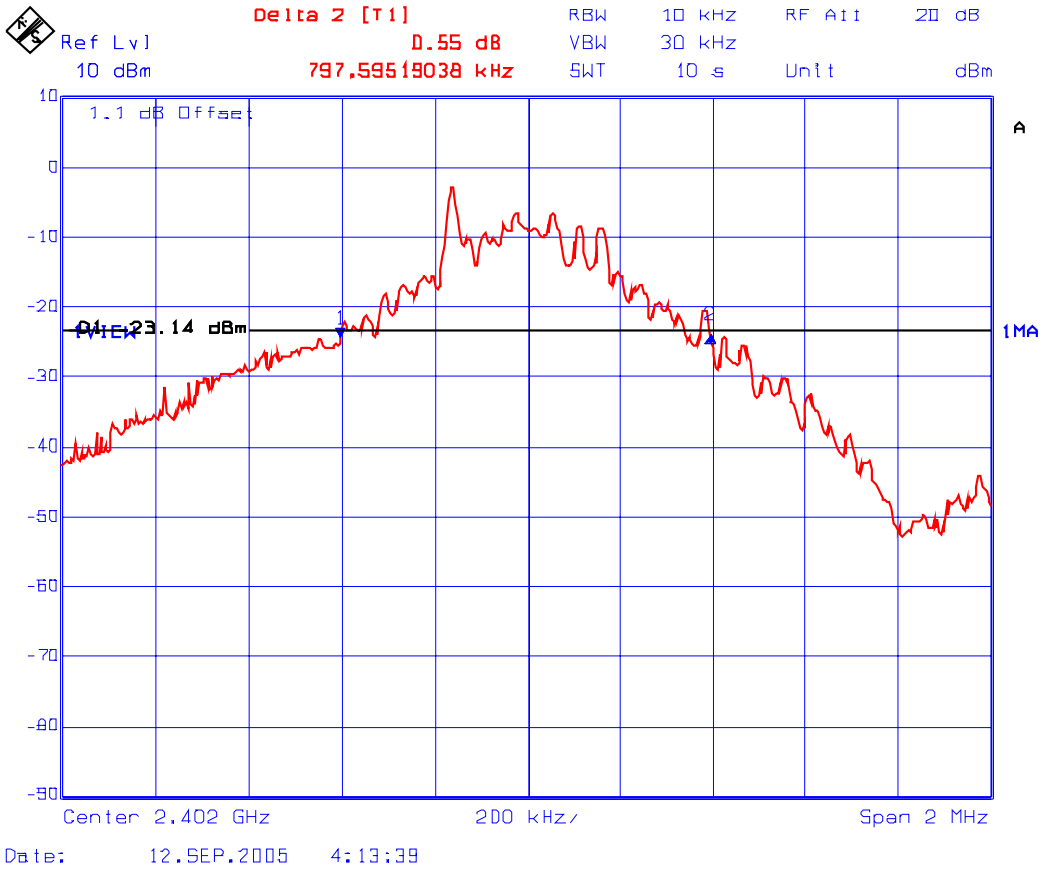
Burst Transmit use PRBS-9 sequence

Bandwidth	Channel Frequency (MHz)	(kHz)
20 dB	2402	797.60
	2441	793.59
	2480	793.59
99 %	2402	961.92
	2441	1002.00
	2480	849.70

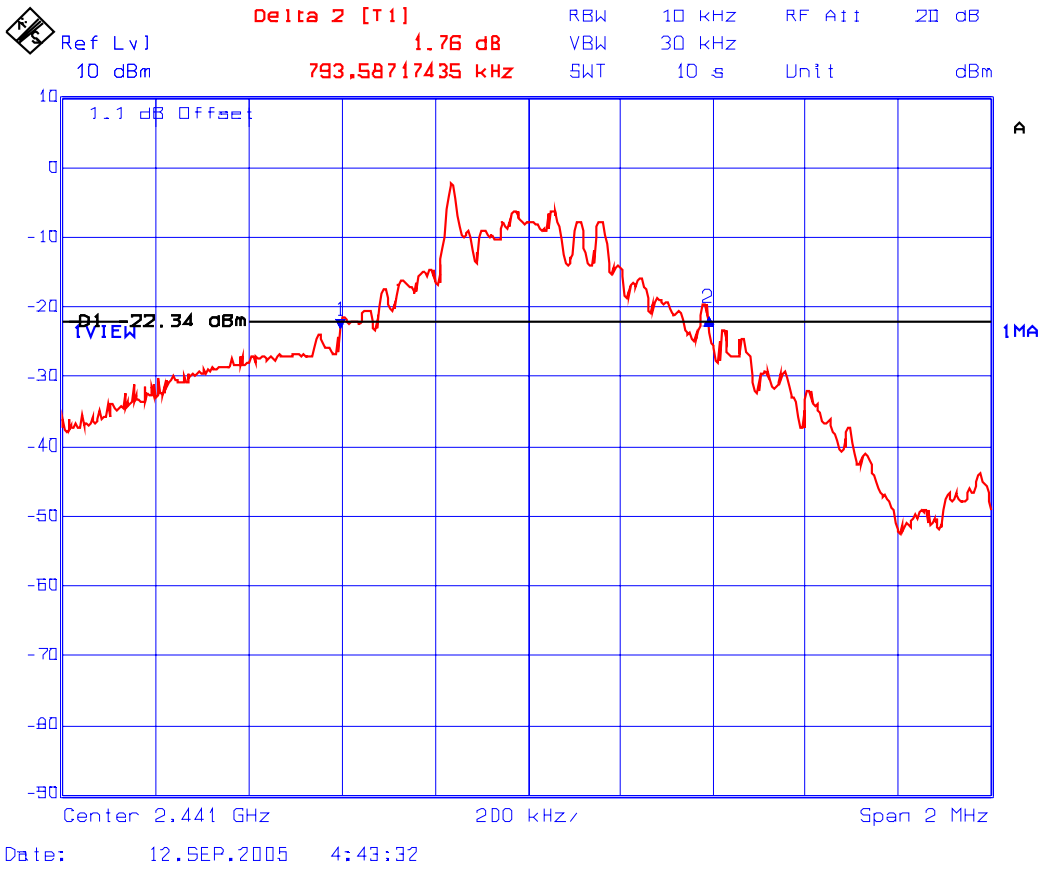
Burst Transmit take payload data 11110000 pattern

Bandwidth	Channel Frequency (MHz)	(kHz)
20 dB	2402	561.12
	2441	553.11
	2480	553.11
99 %	2402	909.82
	2441	905.81
	2480	673.35

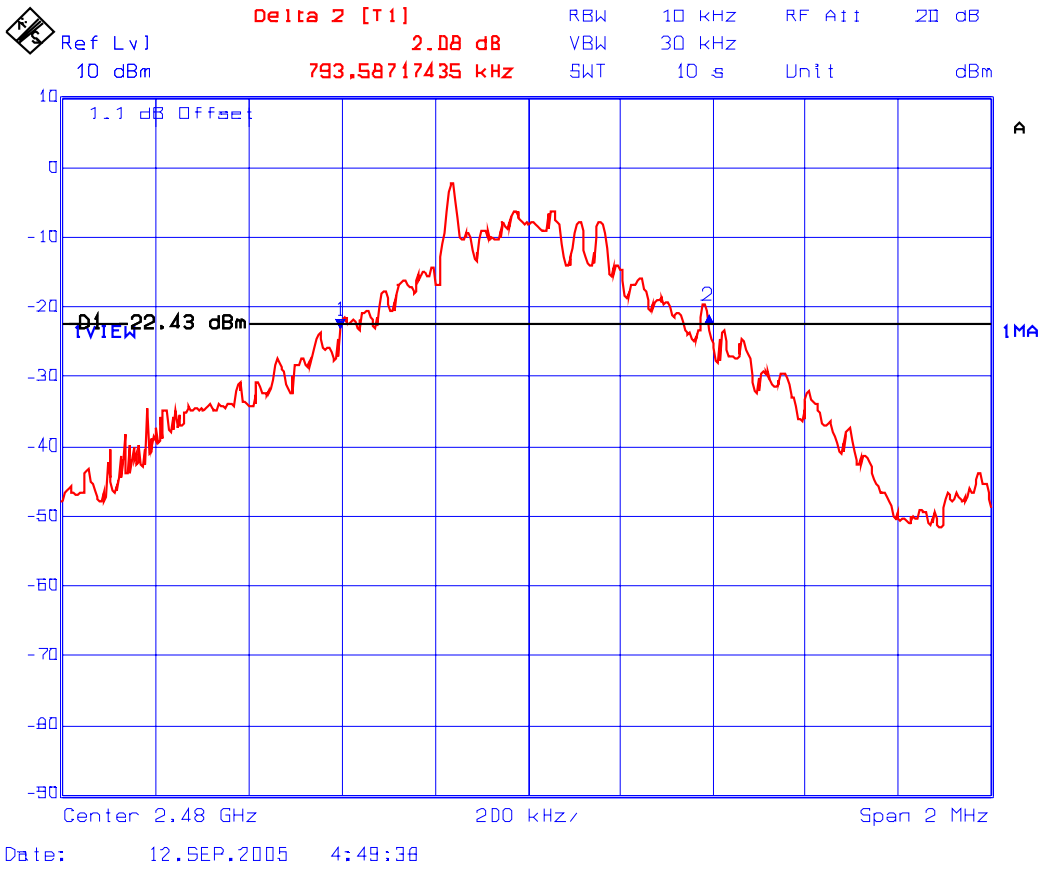
Plot 3: 20 dB Bandwidth
Test Frequency: 2402 MHz
Burst Transmit use PRBS-9 sequence



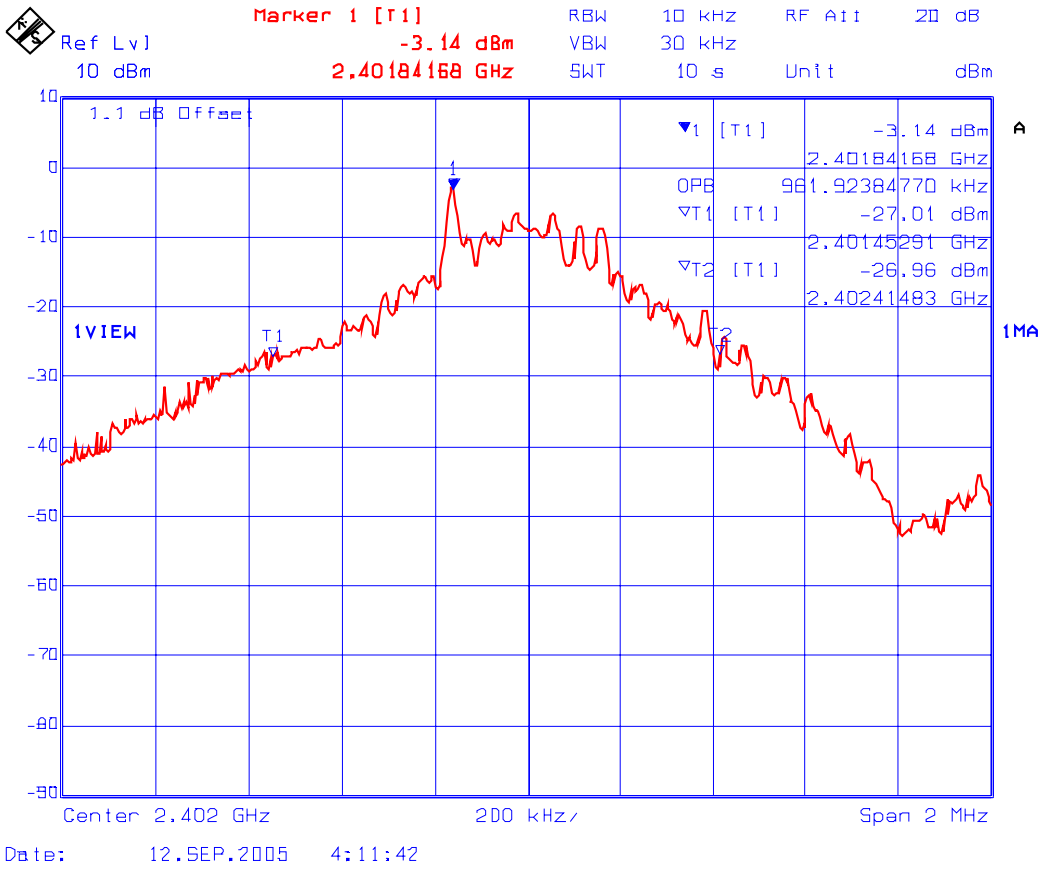
Plot 4: 20 dB Bandwidth
Test Frequency: 2402 MHz
Burst Transmit use PRBS-9 sequence



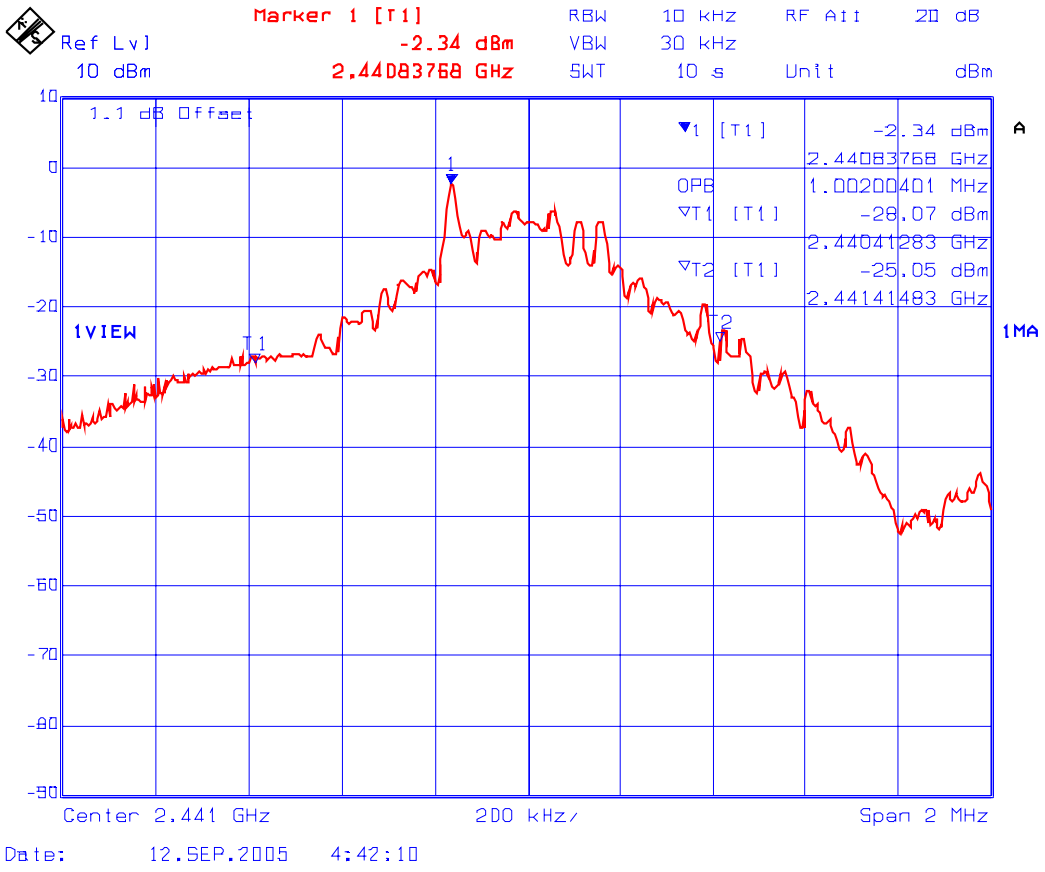
Plot 5: 20 dB Bandwidth
Test Frequency: 2402 MHz
Burst Transmit use PRBS-9 sequence



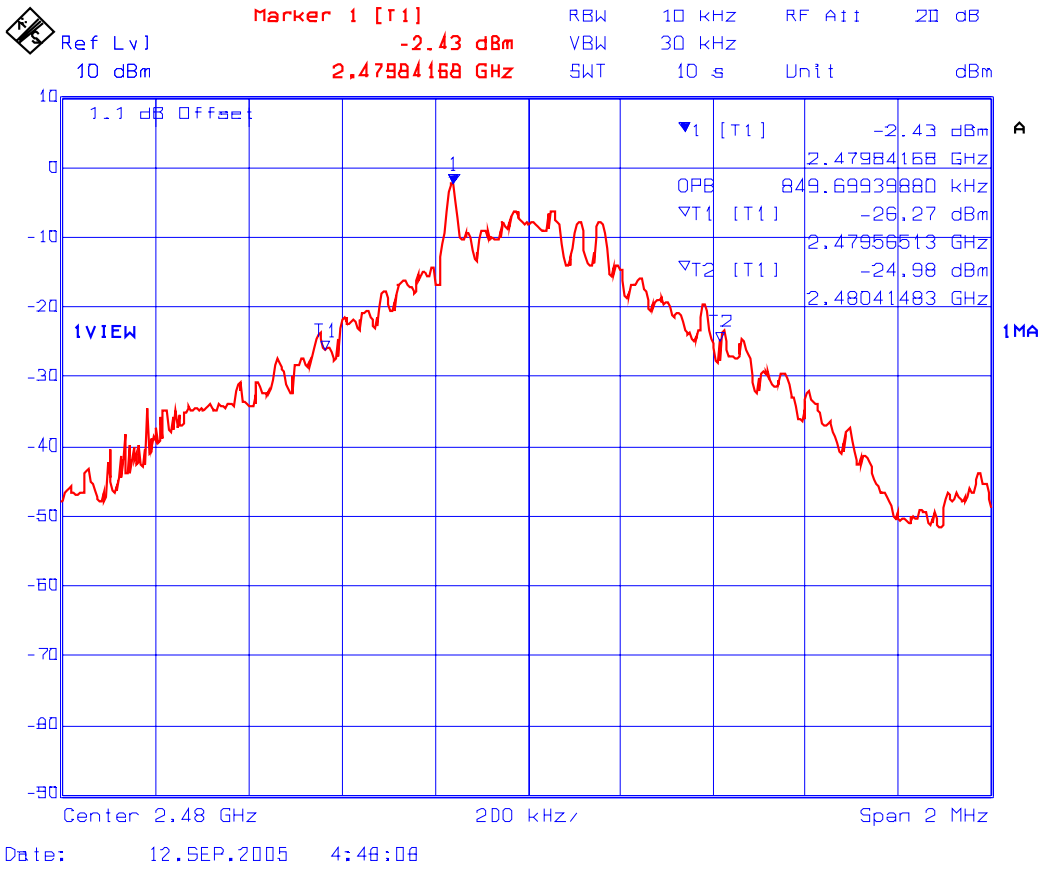
Plot 6: 99 % Occupied Bandwidth
Test Frequency: 2402 MHz
Burst Transmit use PRBS-9 sequence



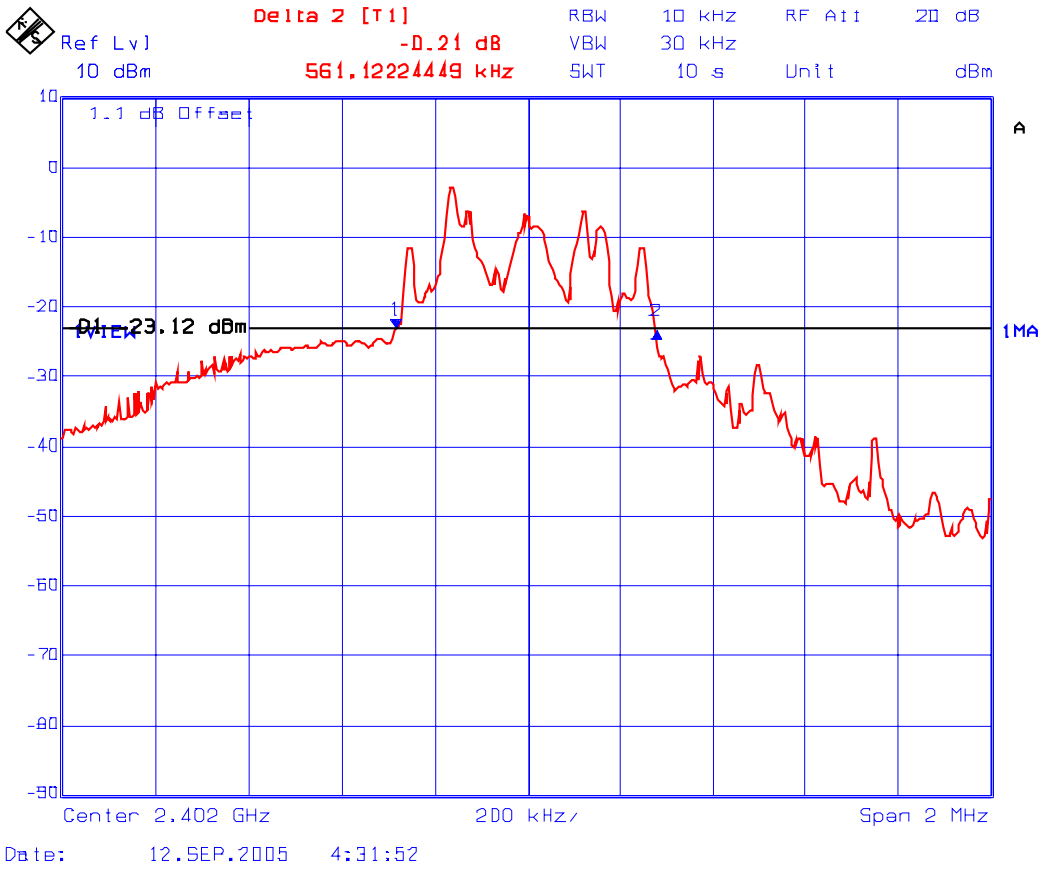
Plot 7: 99 % Occupied Bandwidth
Test Frequency: 2402 MHz
Burst Transmit use PRBS-9 sequence



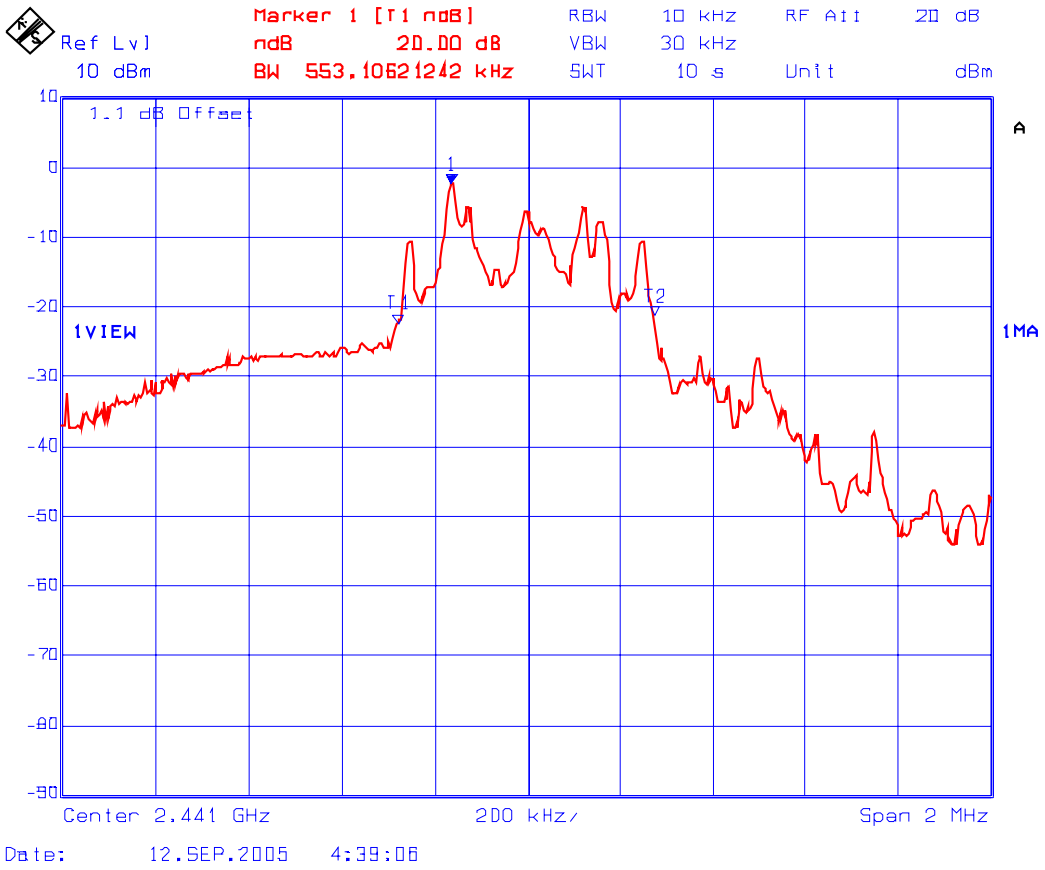
Plot 8: 99 % Occupied Bandwidth
Test Frequency: 2402 MHz
Burst Transmit use PRBS-9 sequence



Plot 9: 20 dB Bandwidth
Test Frequency: 2402 MHz
Burst Transmit take payload data 11110000 pattern

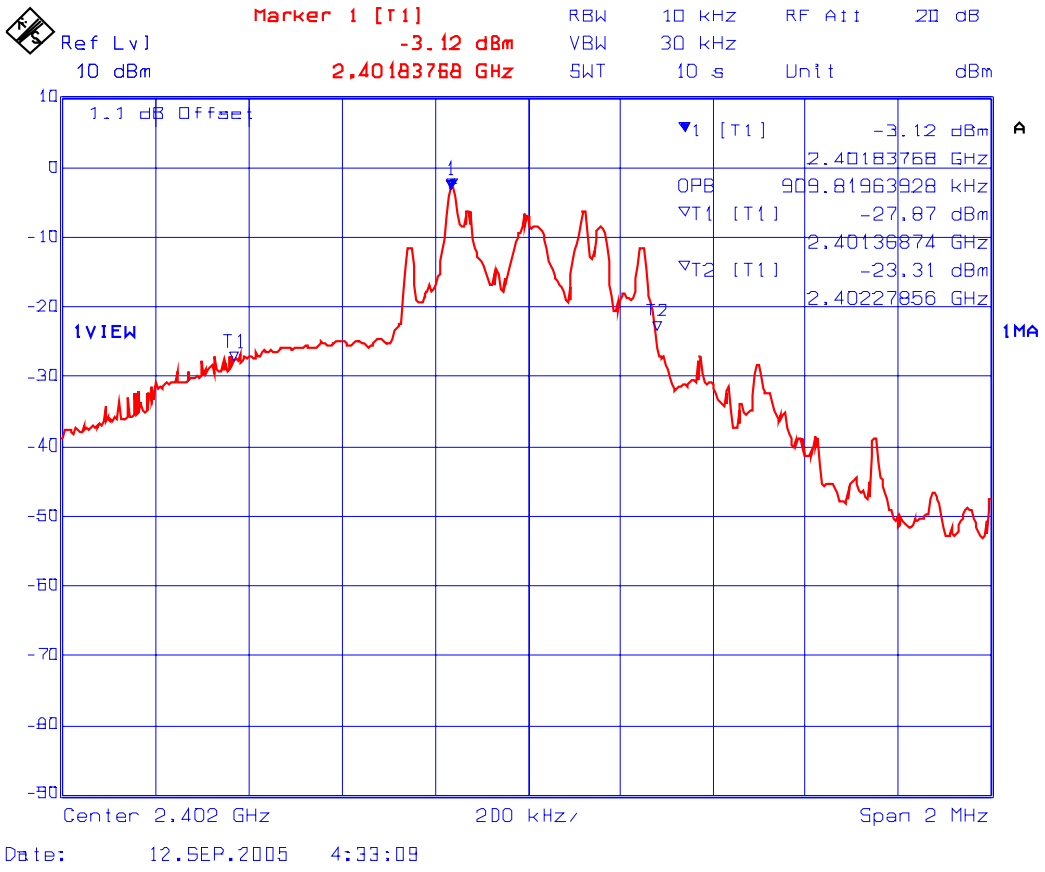


Plot 10: 20 dB Bandwidth
Test Frequency: 2402 MHz
Burst Transmit take payload data 11110000 pattern

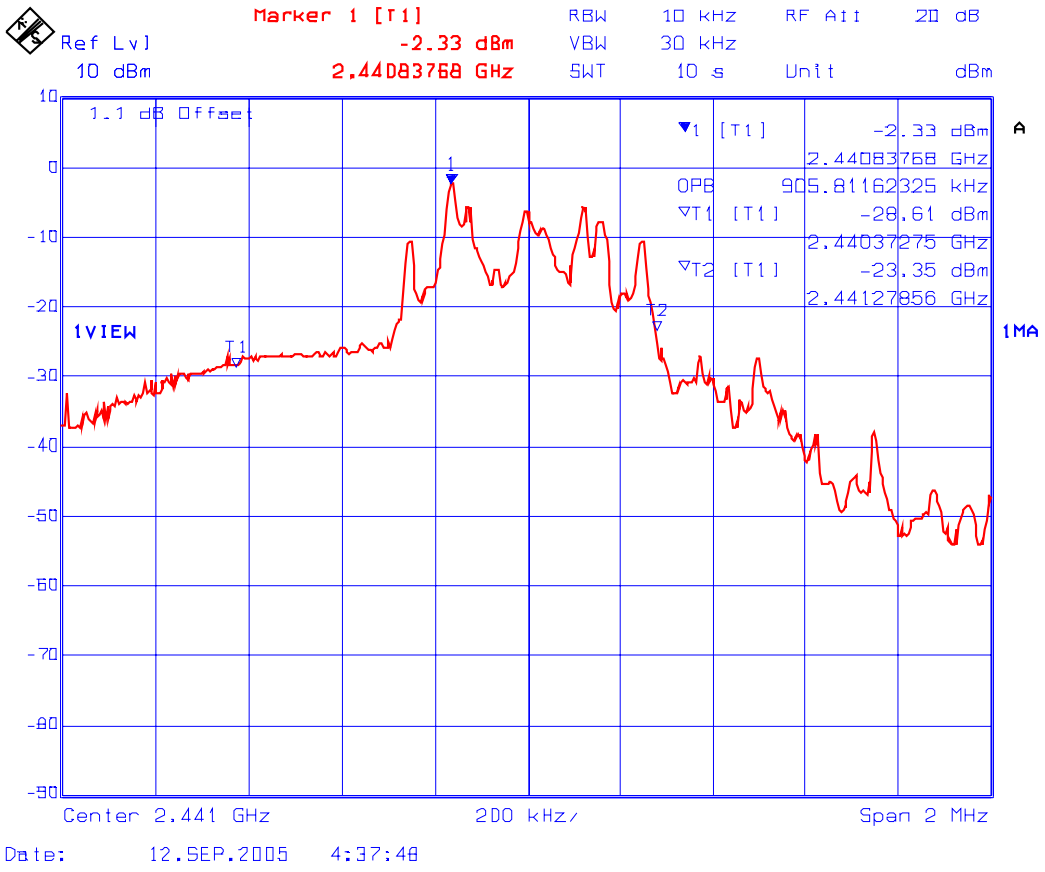


Plot 11: 20 dB Bandwidth
Test Frequency: 2402 MHz
Burst Transmit take payload data 11110000 pattern

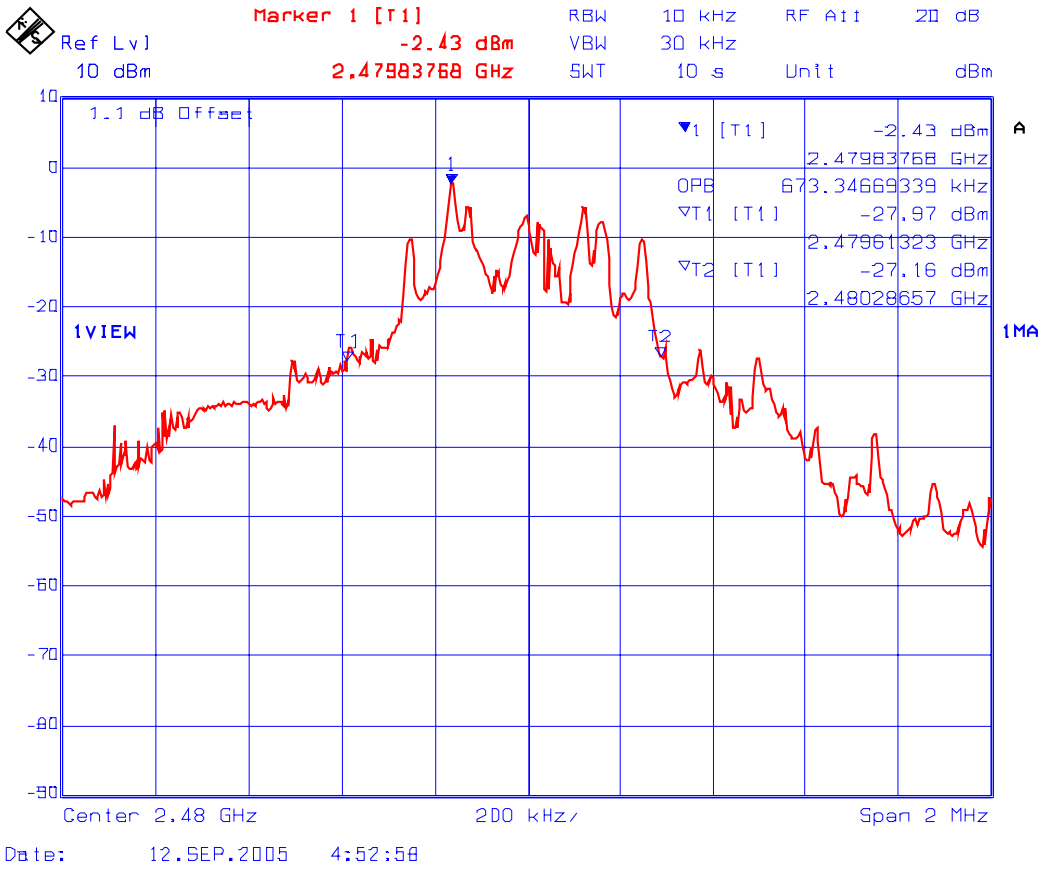
Plot 12: 99 % Occupied Bandwidth
Test Frequency: 2402 MHz
Burst Transmit take payload data 11110000 pattern



Plot 13: 99 % Occupied Bandwidth
Test Frequency: 2402 MHz
Burst Transmit take payload data 11110000 pattern



Plot 14: 99 % Occupied Bandwidth
Test Frequency: 2402 MHz
Burst Transmit take payload data 11110000 pattern



6.7. FUNDAMETAL FIELD STRENGTH AND HARMONIC EMISSIONS AND BAND-EDGE RADIATED EMISSONS (RADIATED @ 3 METERS) [§ 15.249(a), 15.209 & 15.205]

6.7.1. LIMITS

- The Field Strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental Frequency (MHz)	Field Strength of Fundamental (mV/m)	Field Strength of Harmonics (μV/m)
2400 - 2483.5	50	500

- The fundamental frequency shall not fall within any restricted frequency band specified in 15.205 All rf other emissions that fall in the restricted bands shall not exceed the general radiated emission limits specified in @ 15.209(a).

FCC 47 CFR 15.205(a)
-- Restricted Frequency Bands --

MHz	MHz	MHz	GHz
0.090 - 0.110	162.0125 - 167.17	2310 - 2390	9.3 - 9.5
0.49 – 0.51	167.72 - 173.2	2483.5 - 2500	10.6 - 12.7
2.1735 - 2.1905	240 - 285	2655 - 2900	13.25 - 13.4
8.362 - 8.366	322 - 335.4	3260 - 3267	14.47 - 14.5
13.36 - 13.41	399.9 - 410	3332 - 3339	14.35 - 16.2
25.5 – 25.67	608 - 614	3345.8 - 3358	17.7 - 21.4
37.5 – 38.25	960 - 1240	3600 - 4400	22.01 - 23.12
73 - 75.4	1300 - 1427	4500 - 5250	23.6 - 24.0
108 – 121.94	1435 - 1626.5	5350 - 5460	31.2 - 31.8
123 – 138	1660 - 1710	7250 - 7750	36.43 - 36.5
149.9 – 150.05	1718.8 - 1722.2	8025 - 8500	Above 38.6
156.7 – 156.9	2200 – 2300	9000 - 9200	

FCC 47 CFR 15.209(a)
-- Field Strength Limits within Restricted Frequency Bands --

Frequency (MHz)	Field Strength Limits (μV/m)	Distance (Meters)
0.009 - 0.490	2,400 / F (KHz)	300
0.490 - 1.705	24,000 / F (KHz)	30
1.705 - 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3
Above 960	500	3

6.7.2. METHOD OF MEASUREMENTS

Refer to Ultratech Test Procedures, File # ULTR P001-2004 and ANSI C63.4 for measurement methods

6.7.3. TEST EQUIPMENT LIST

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Rohde & Schwarz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz with external mixer
Microwave Amplifier	Hewlett Packard	HP 83017A		1 GHz to 26.5 GHz
Biconilog Antenna	EMCO	3143	1029	20 MHz to 2 GHz
Horn Antenna	EMCO	3155	9701-5061	1 GHz – 18 GHz

6.7.4. TEST DATA

Duty Cycle Measurements: 75.5 % or Peak-Average Conversion factor = -2.44 dB
Please refer o the Plot # 23 for Plots of duty cycle measurements

CH00, Frequency 2402

Frequency (MHz)	Peak E-Field @3m (dBµV/m)	Average E-Field @3m (dBµV/m)	Antenna Plane (H/V)	Field Strength Limit of Fundamental/Harmonic (dBµV/m)	Field Strength Limit of § 15.209 (dBµV/m)	Margin (dB)
2402	88.23	85.79	V	94.0	--	-8.21
2402	91.40	88.96	H	94.0	--	-5.04
4804	48.89	46.45	V	54.0	54.0	-7.55
4804	49.26	46.82	H	54.0	54.0	-7.18
The emissions were scanned from 30 MHz to 25 GHz and all emissions within 20 dB below the limits were recorded.						

CH39, Frequency 2441

Frequency (MHz)	Peak E-Field @3m (dBµV/m)	Average E-Field @3m (dBµV/m)	Antenna Plane (H/V)	Field Strength Limit of Fundamental/Harmonic (dBµV/m)	Field Strength Limit of § 15.209 (dBµV/m)	Margin (dB)
2441	88.47	86.03	V	94.0	--	-7.97
2441	92.42	89.98	H	94.0	--	-4.02
4882	49.94	47.50	V	54.0	54.0	-6.50
4882	50.43	47.99	H	54.0	54.0	-6.01
The emissions were scanned from 30 MHz to 25 GHz and all emissions within 20 dB below the limits were recorded.						

CH78, Frequency 2480

Frequency (MHz)	Peak E-Field @3m (dBµV/m)	Average E-Field @3m (dBµV/m)	Antenna Plane (H/V)	Field Strength Limit of Fundamental/Harmonic (dBµV/m)	Field Strength Limit of § 15.209 (dBµV/m)	Margin (dB)
2480	90.70	88.26	V	94.0	--	-5.74
2480	93.97	91.53	H	94.0	--	-2.47
4960	50.91	48.47	V	54.0	54.0	-5.53
4960	50.93	48.49	H	54.0	54.0	-5.51
The emissions were scanned from 30 MHz to 25 GHz and all emissions within 20 dB below the limits were recorded.						

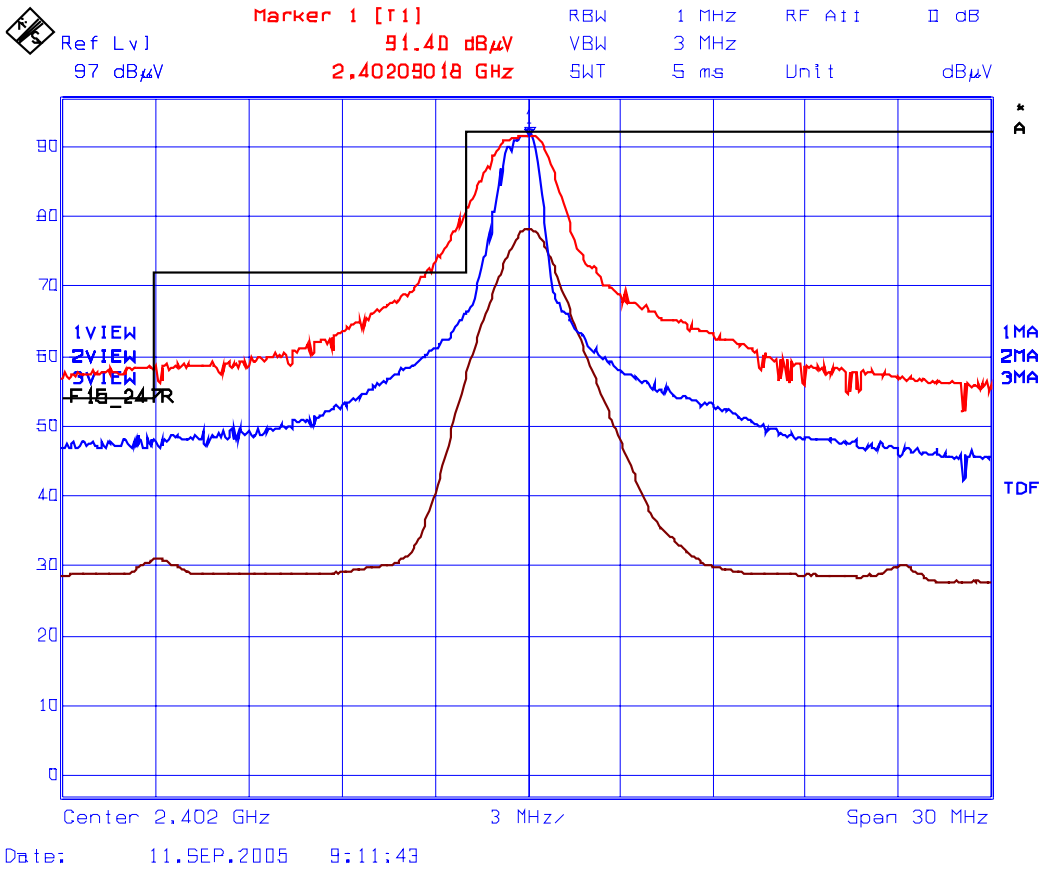
EIRP (Sustitution)

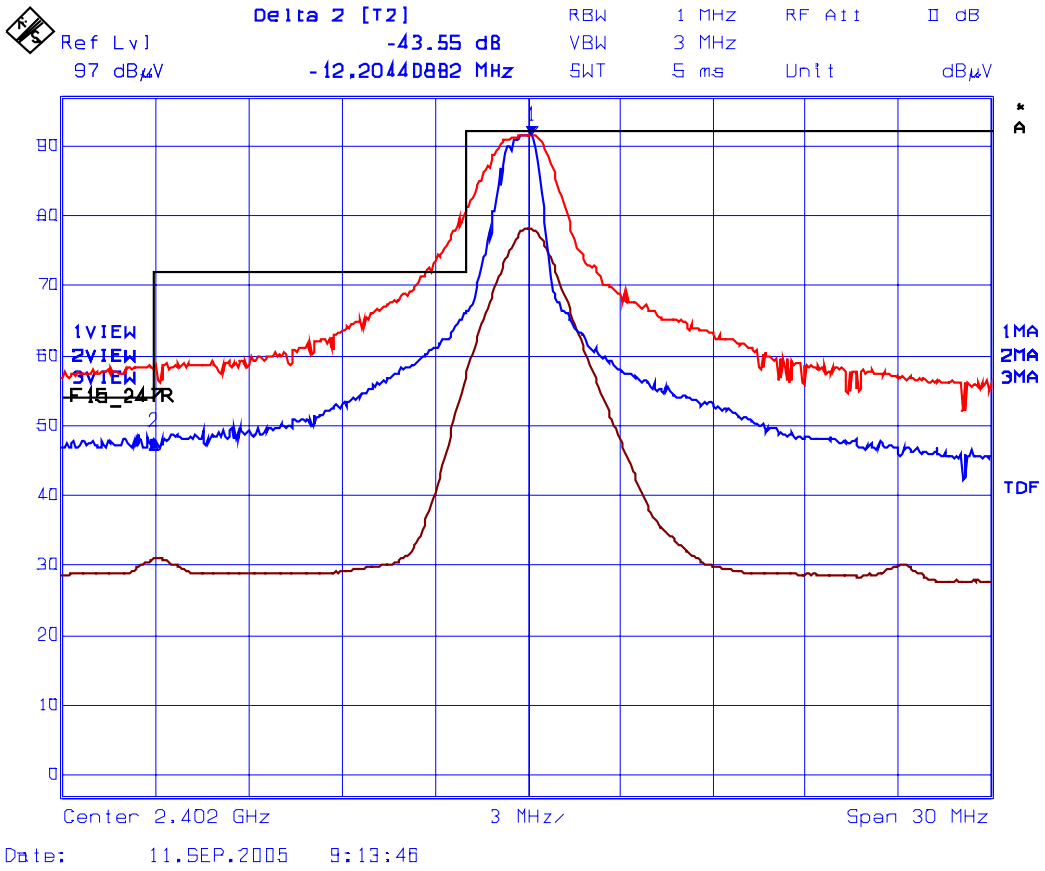
Frequency (MHz)	E-Field per 1 MHz @ 3m (dBµV/m)	EMI Detector (Peak/QP)	Antenna Plane (H/V)	Measured EIRP (Peak) Per 1 MHz (dBm)
2402	88.23	Peak	V	-10.60
2402	91.40	Peak	H	-8.47
2441	88.47	Peak	V	-10.49
2441	92.42	Peak	H	-7.98
2480	90.70	Peak	V	-7.93
2480	93.97	Peak	H	-5.90

Plot 15: Band-Edge RF Radiated Emissions, Horizontal Polarization
Lower End of Frequency Band, Hopping Mode Disabled
Transmitter Frequency: 2402 MHz

Note:

- Trace 1: RBW=1MHz, VBW=3 MHz
- Trace 2: RBW=300 kHz, VBW=1 MHz, Delta (Peak to Band-Edge): 43.55 dB
- Trace 3: RBW=1 MHz, VBW=10 Hz
- Band-Edge Level at 2390 MHz: 93.88 dBµV/m – 43.55 dB = 47.85 dBµV/m



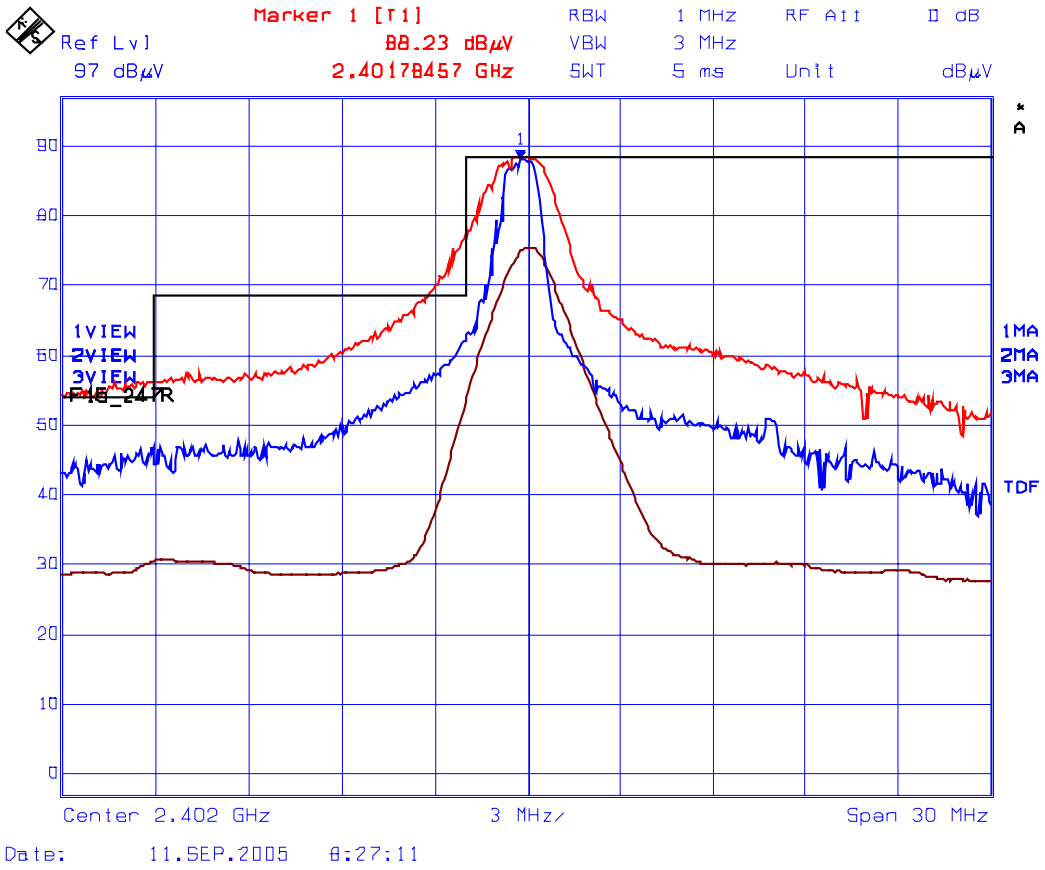


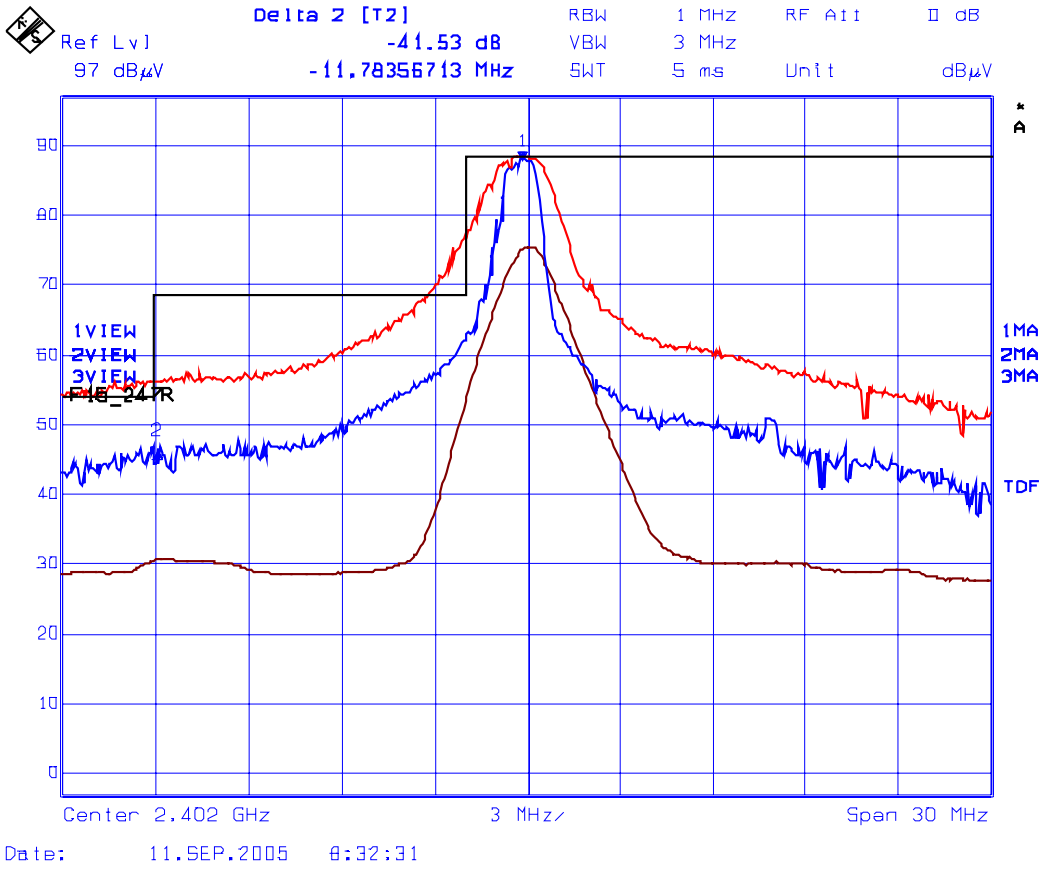
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot 16: Band-Edge RF Radiated Emissions, Vertical Polarization
Lower End of Frequency Band, Hopping Mode Disabled
Transmitter Frequency: 2402 MHz

Note:

- Trace 1: RBW=1MHz, VBW=3 MHz
- Trace 2: RBW=300 kHz, VBW=1 MHz, Delta (Peak to Band-Edge): 41.53 dB
- Trace 3: RBW=1 MHz, VBW=10 Hz
- Band-Edge Level at 2390 MHz: 88.23 dBµV/m – 41.53 dB = 46.70 dBµV/m



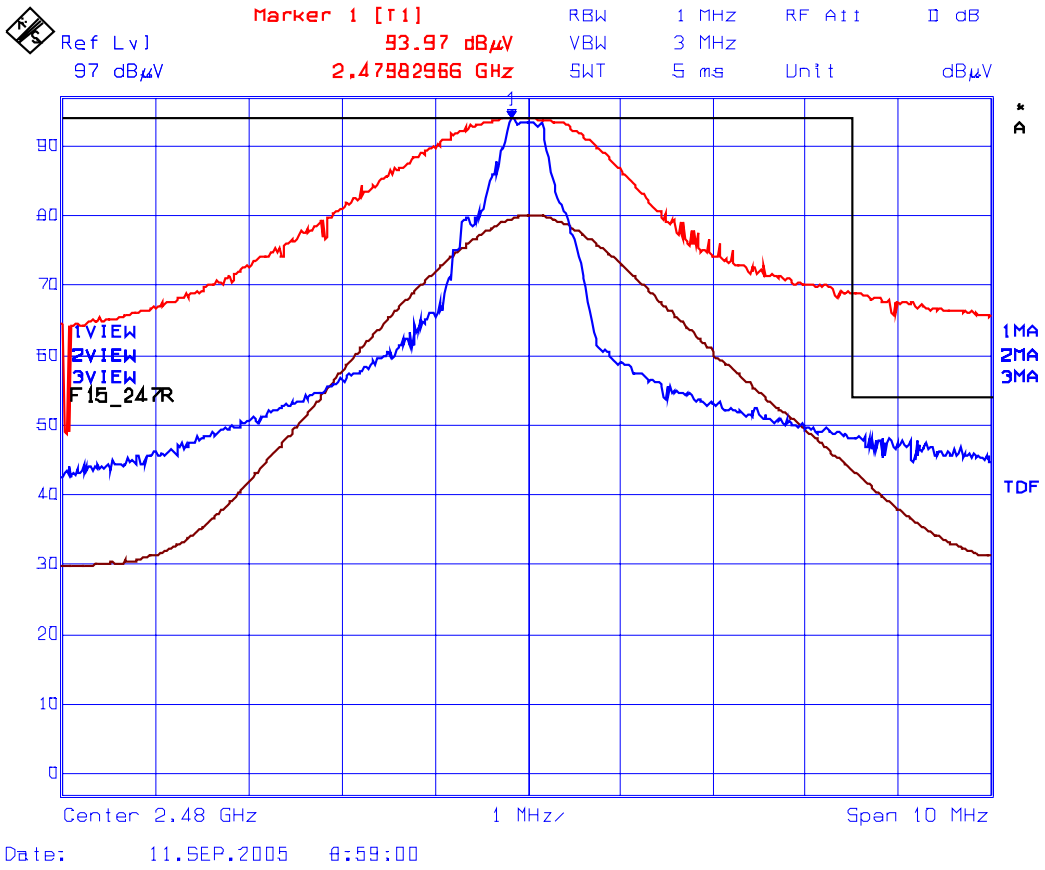


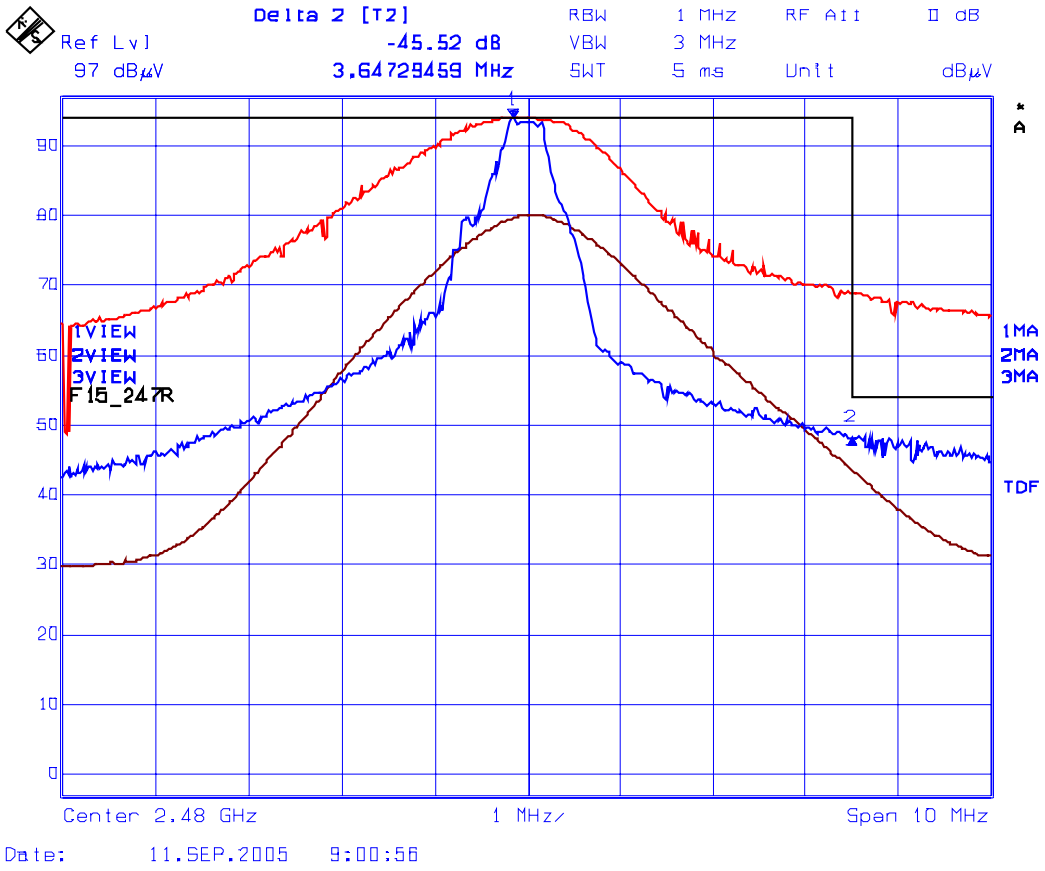
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot 17: Band-Edge RF Radiated Emissions, Horizontal Polarization
Upper End of Frequency Band, Hopping Mode Disabled
Transmitter Frequency: 2480 MHz

Note:

- Trace 1: RBW=1MHz, VBW=3 MHz
- Trace 2: RBW=300 kHz, VBW=1 MHz, Delta (Peak to Band-Edge): 45.52 dB
- Trace 3: RBW=1 MHz, VBW=10 Hz
- Band-Edge Level at 2483.5 MHz: 93.97 dBµV/m – 45.52 dB = 48.45 dBµV/m

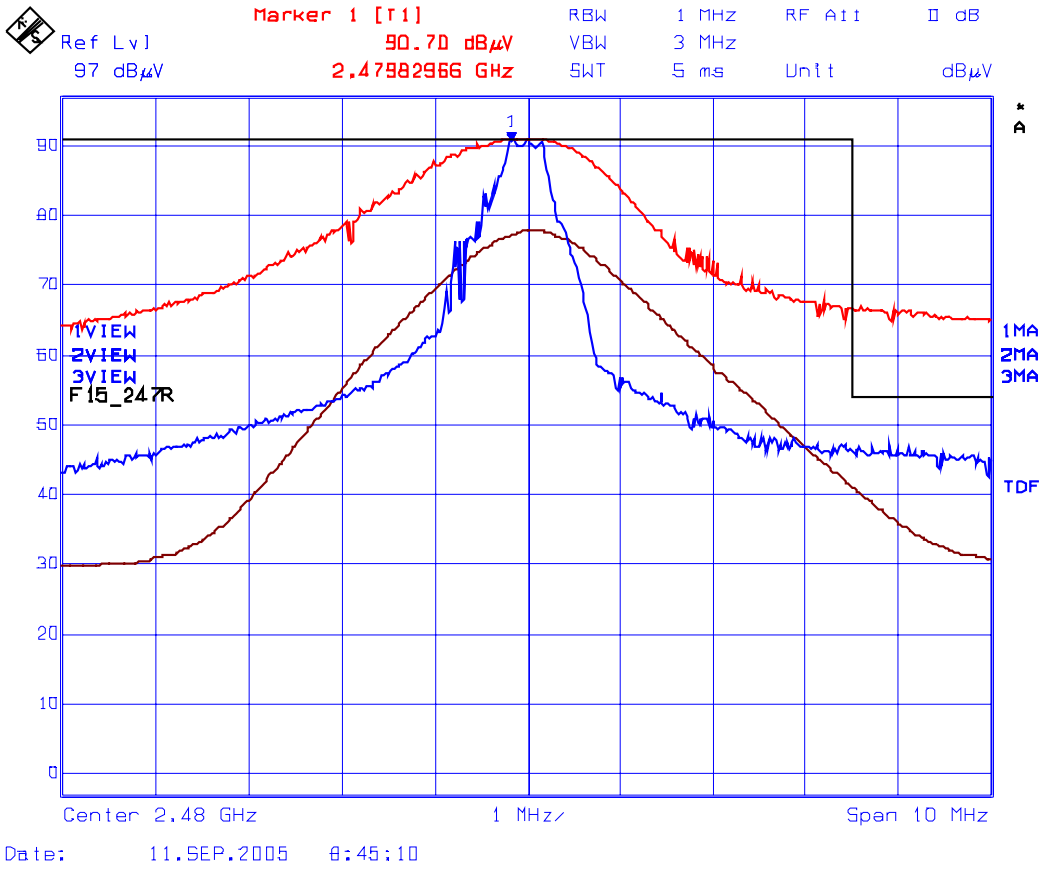


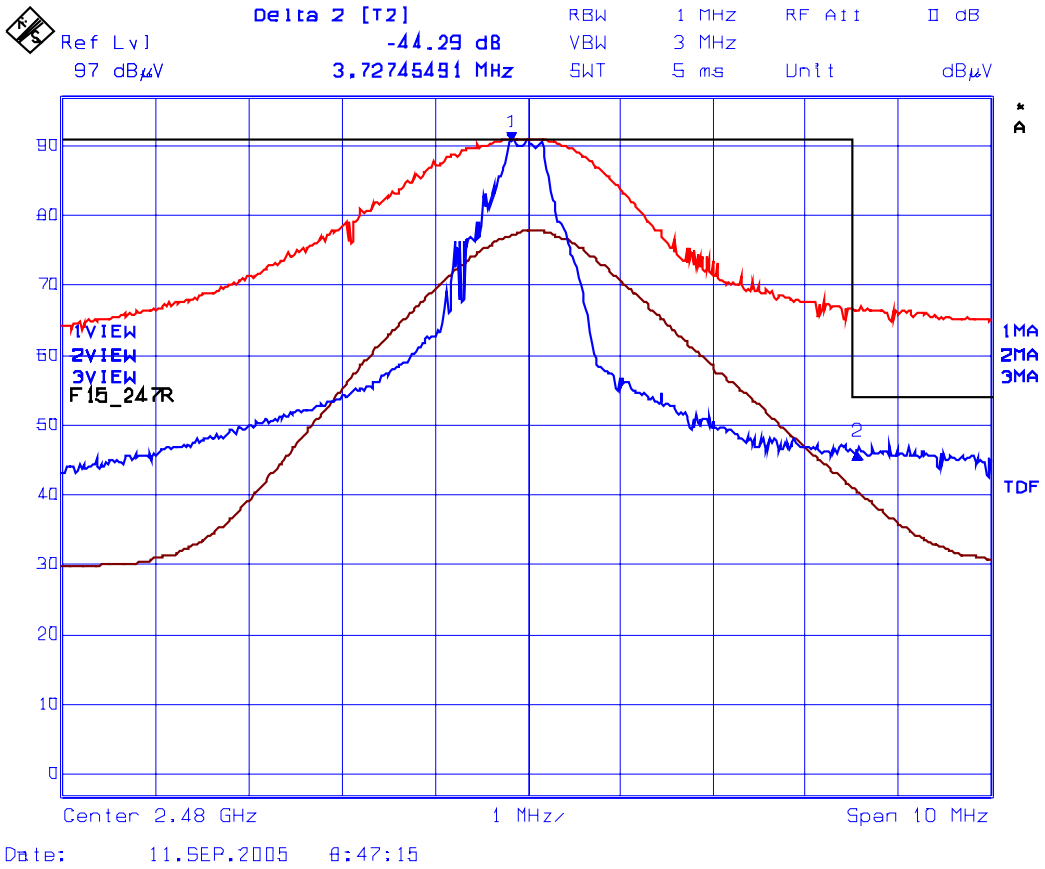

Delta 2 [T2]
-45.52 dB
3.64729459 MHz
Ref Lvl
97 dBµV
RBW 1 MHz
VBW 3 MHz
SWT 5 ms
RF Att 0 dB
Unit dBµV
1VIEW
2VIEW
3VIEW
F15_247R
1MA
2MA
3MA
TDF
Center 2.48 GHz
1 MHz/
Span 10 MHz
Date: 11.SEP.2005 9:00:56

Plot 18: Band-Edge RF Radiated Emissions, Vertical Polarization
Upper End of Frequency Band, Hopping Mode Disabled
Transmitter Frequency: 2480 MHz

Note:

- Trace 1: RBW=1MHz, VBW=3 MHz
- Trace 2: RBW=300 kHz, VBW=1 MHz, Delta (Peak to Band-Edge): 44.29 dB
- Trace 3: RBW=1 MHz, VBW=10 Hz
- Band-Edge Level at 2483.5 MHz: 90.70 dBµV/m – 44.29 dB = 46.41 dBµV/m



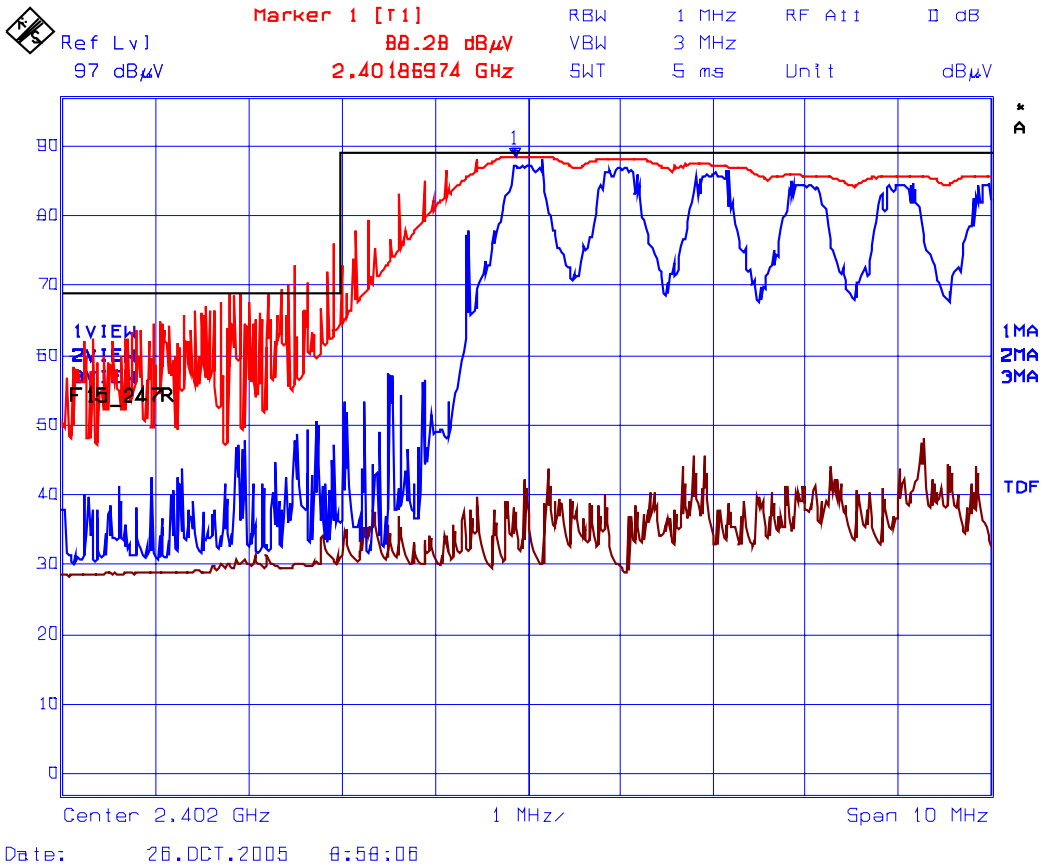


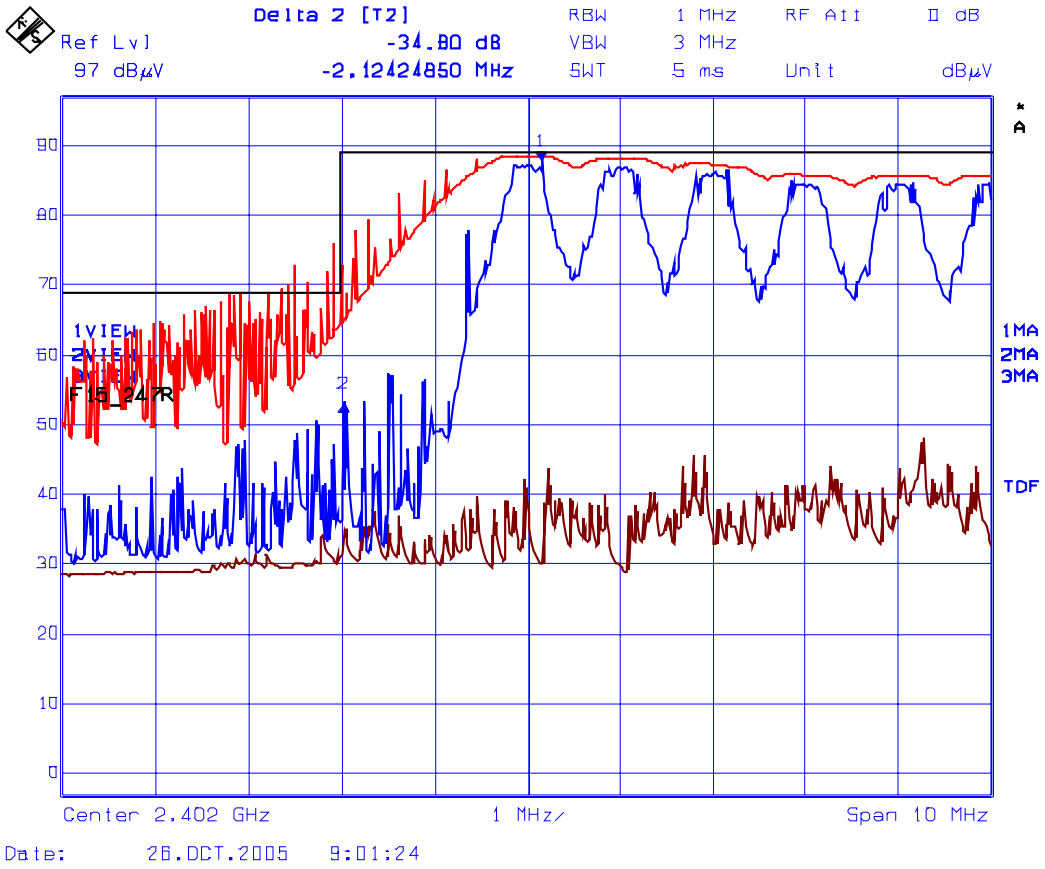
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot 19: Band-Edge RF Radiated Emissions, Horizontal Polarization
Lower End of Frequency Band, Hopping Mode Enabled
Transmitter Frequency: 2402 MHz

Note:

- Trace 1: RBW=1MHz, VBW=3 MHz
- Trace 2: RBW=300 kHz, VBW=1 MHz, Delta (Peak to Band-Edge): 34.80 dB
- Trace 3: RBW=1 MHz, VBW=10 Hz
- Band-Edge Level at 2390 MHz: 88.28 dBµV/m – 34.80 dB = 53.48 dBµV/m



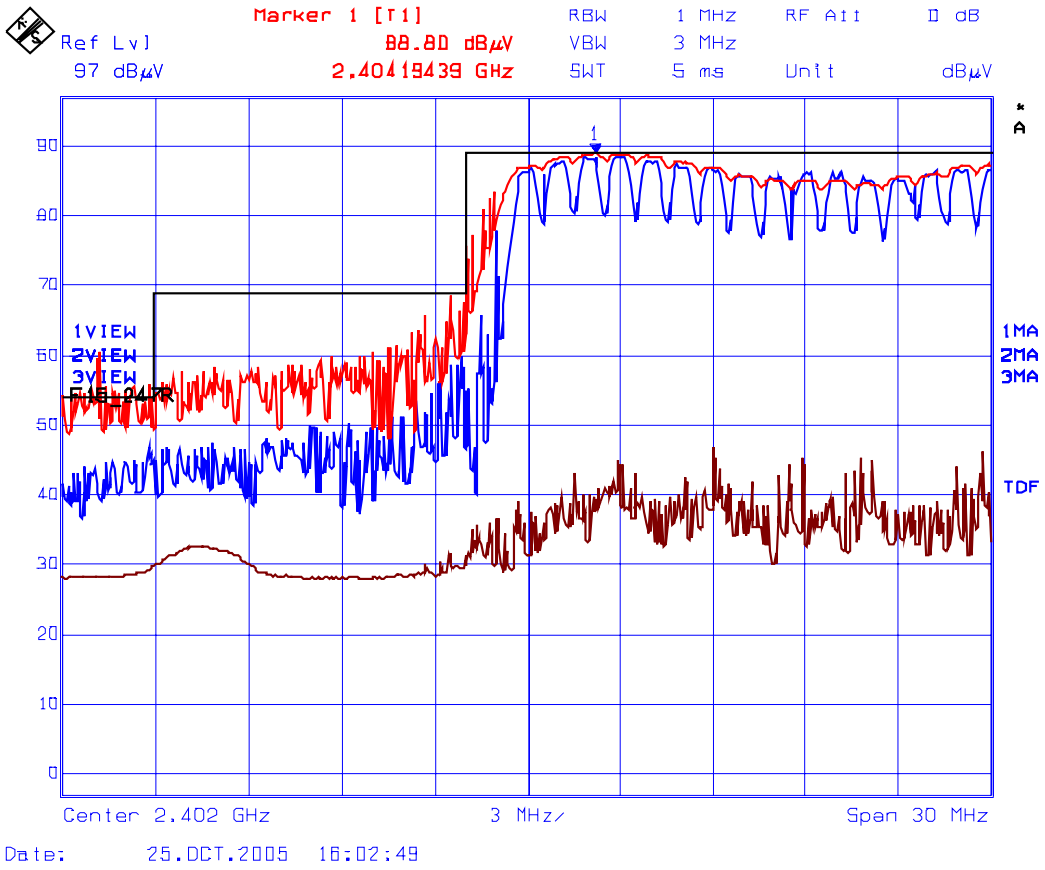


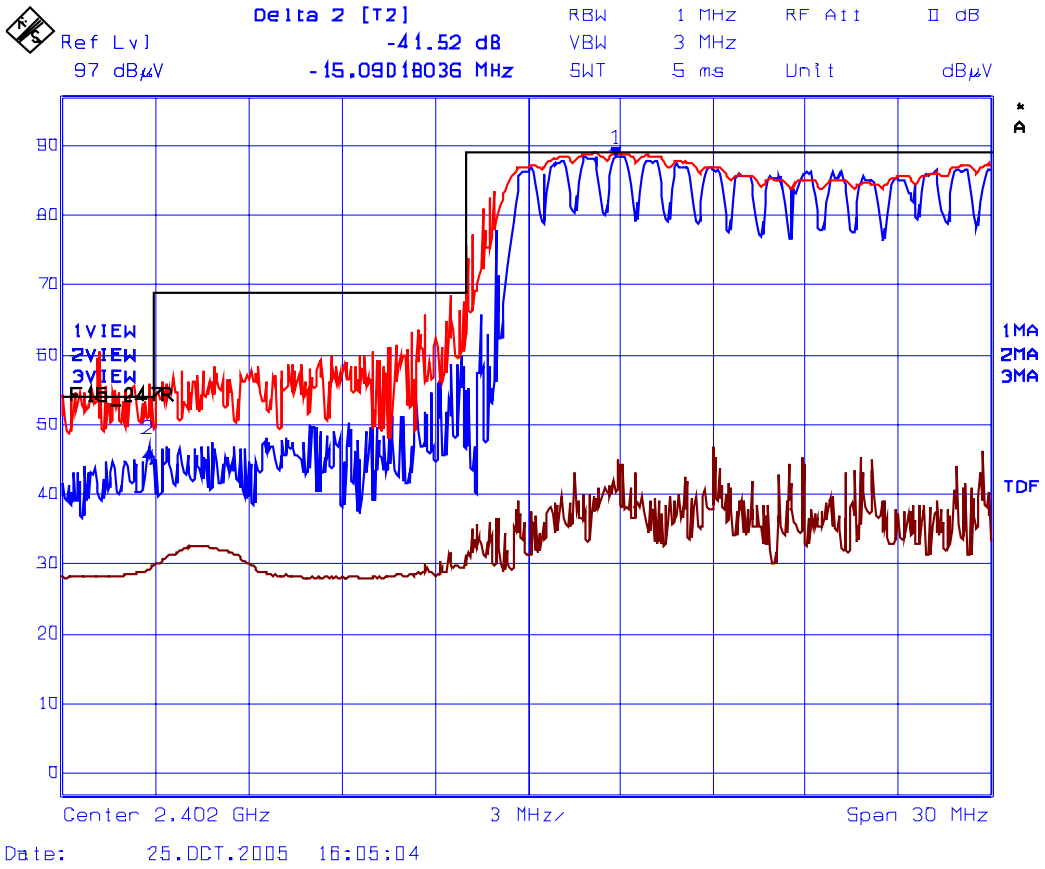
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot 20: Band-Edge RF Radiated Emissions, Vertical Polarization
Lower End of Frequency Band, Hopping Mode Enabled
Transmitter Frequency: 2402 MHz

Note:

- Trace 1: RBW=1MHz, VBW=3 MHz
- Trace 2: RBW=300 kHz, VBW=1 MHz, Delta (Peak to Band-Edge): 41.52 dB
- Trace 3: RBW=1 MHz, VBW=10 Hz
- Band-Edge Level at 2390 MHz: 88.80 dBµV/m – 41.52 dB = 47.28 dBµV/m

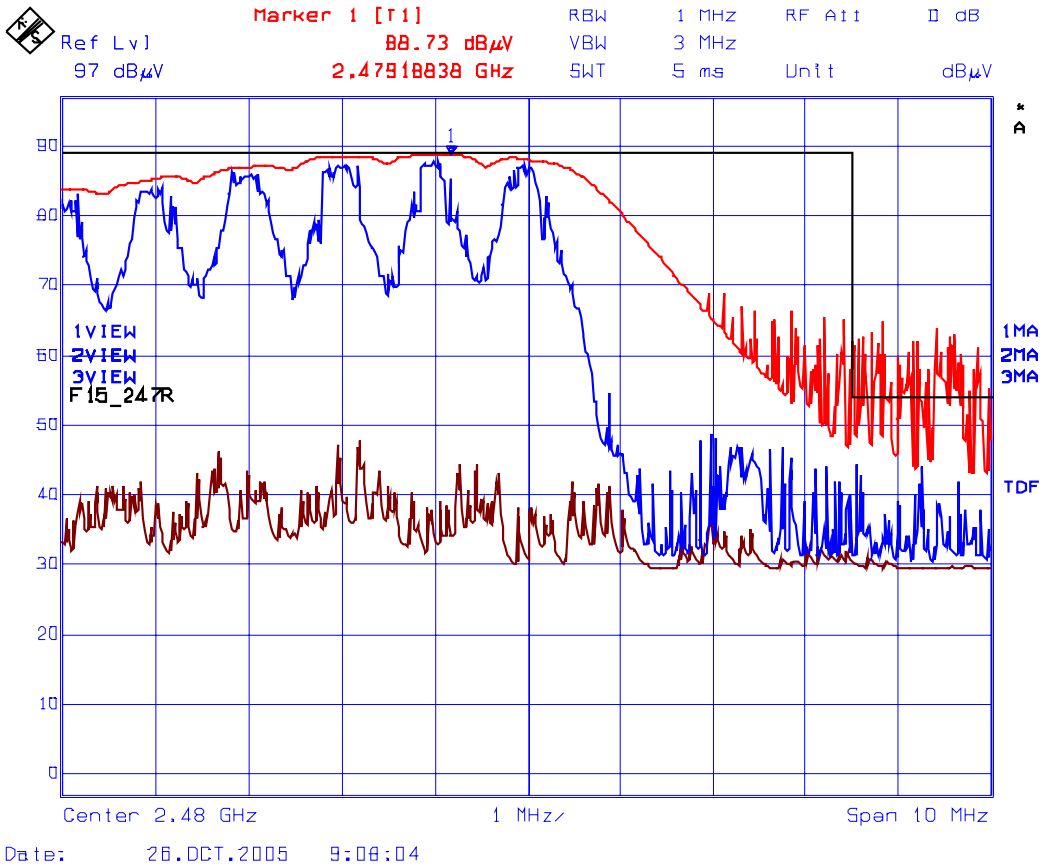


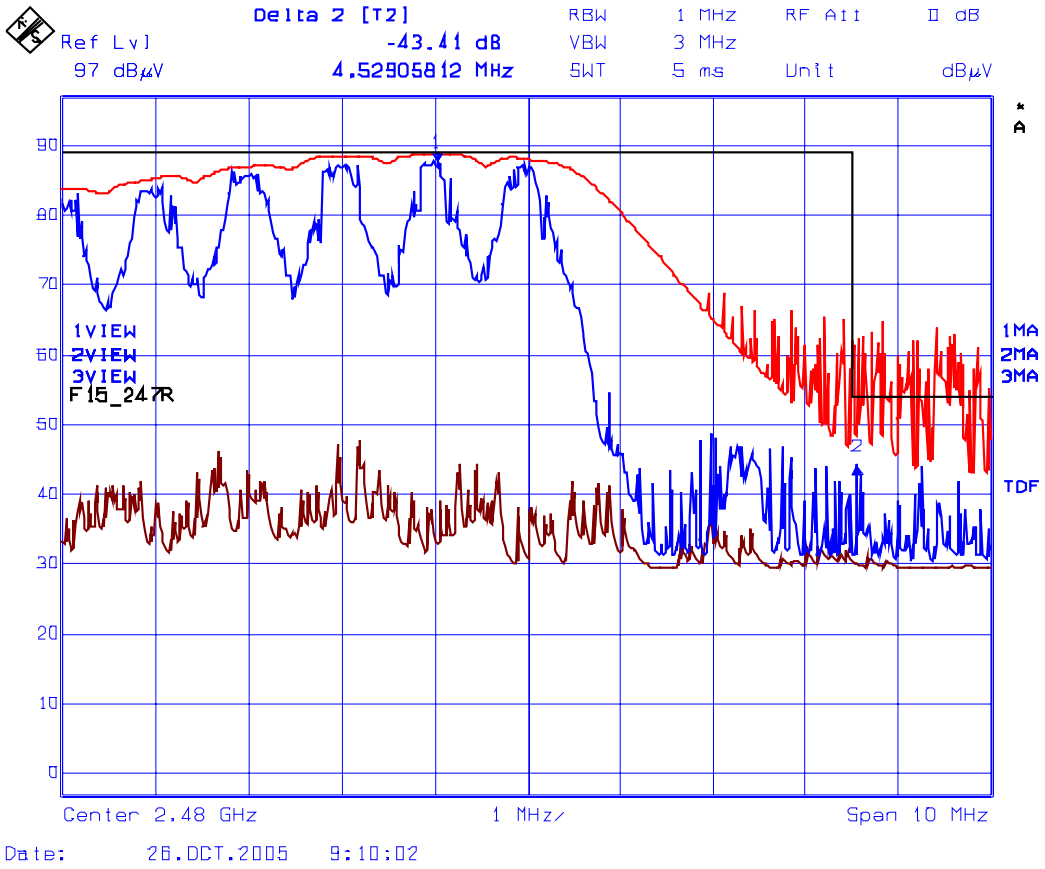


Plot 21: Band-Edge RF Radiated Emissions, Horizontal Polarization
Upper End of Frequency Band, Hopping Mode Enabled
Transmitter Frequency: 2480 MHz

Note:

- Trace 1: RBW=1MHz, VBW=3 MHz
- Trace 2: RBW=300 kHz, VBW=1 MHz, Delta (Peak to Band-Edge): 43.41 dB
- Trace 3: RBW=1 MHz, VBW=10 Hz
- Band-Edge Level at 2483.5 MHz: 88.73 dBµV/m – 43.41 dB = 45.32 dBµV/m



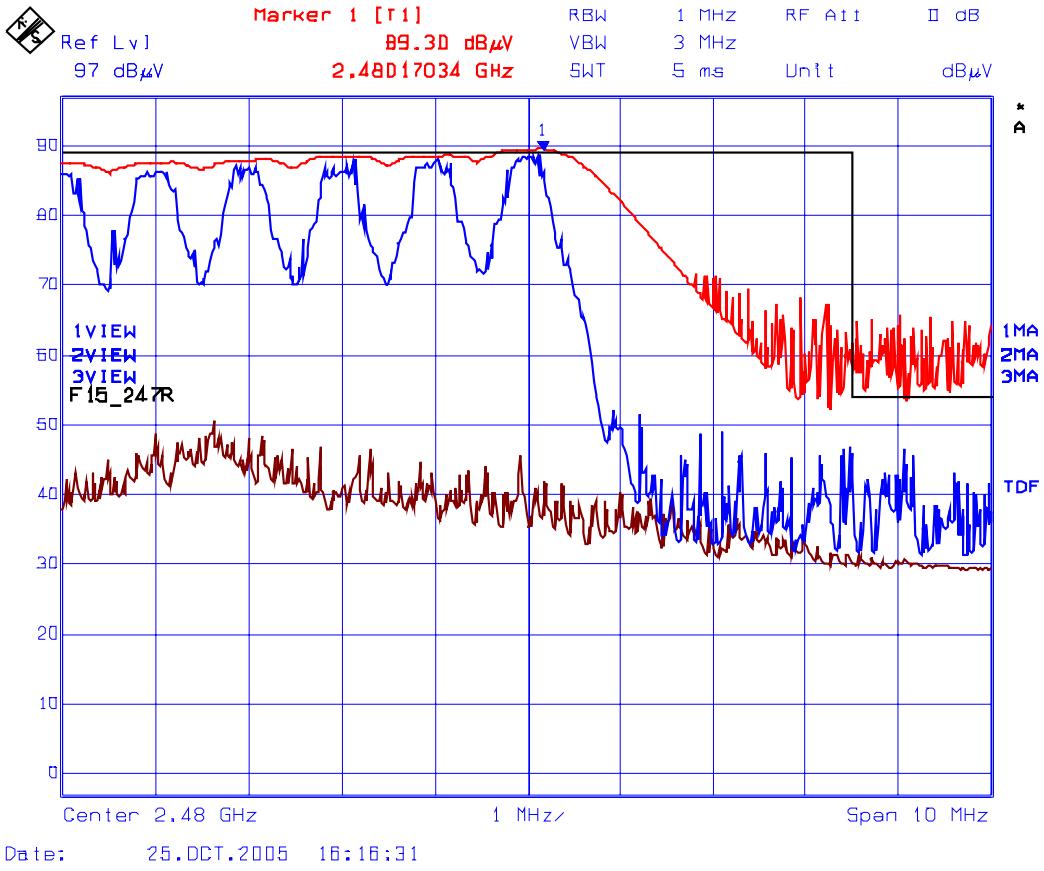


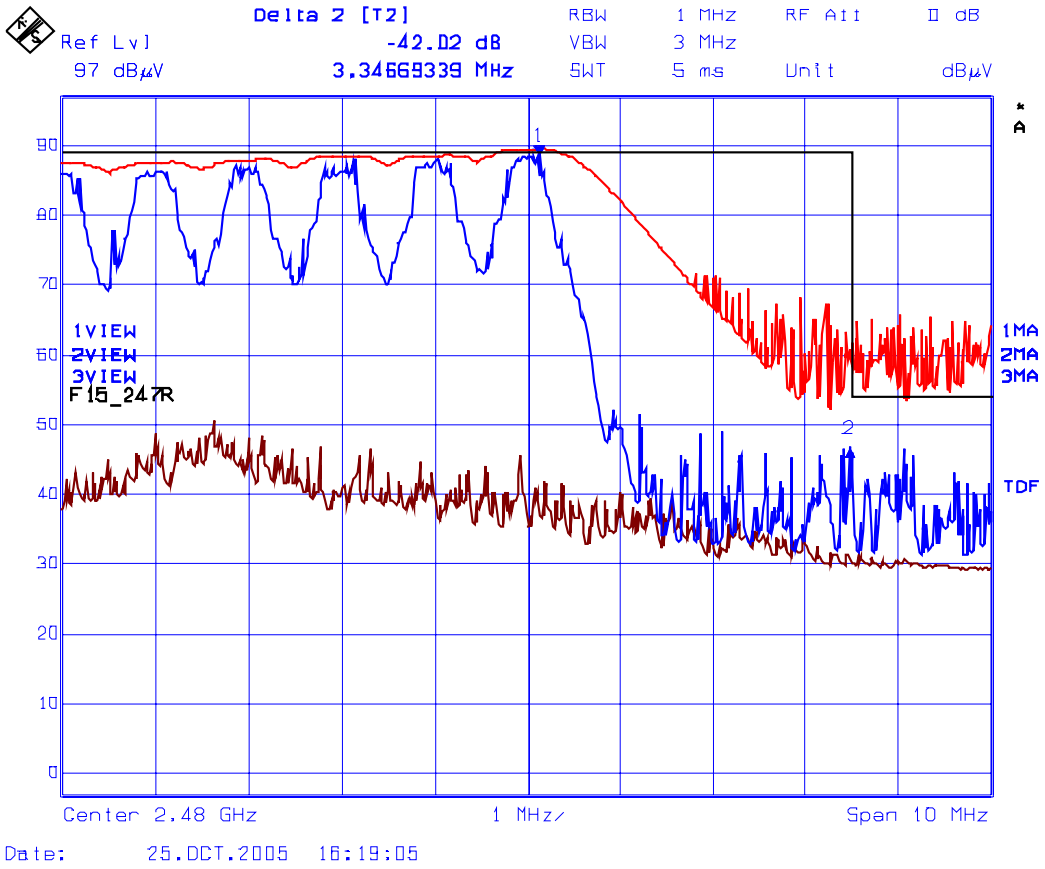
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot 22: Band-Edge RF Radiated Emissions, Vertical Polarization
Upper End of Frequency Band, Hopping Mode Enabled
Transmitter Frequency: 2480 MHz

Note:

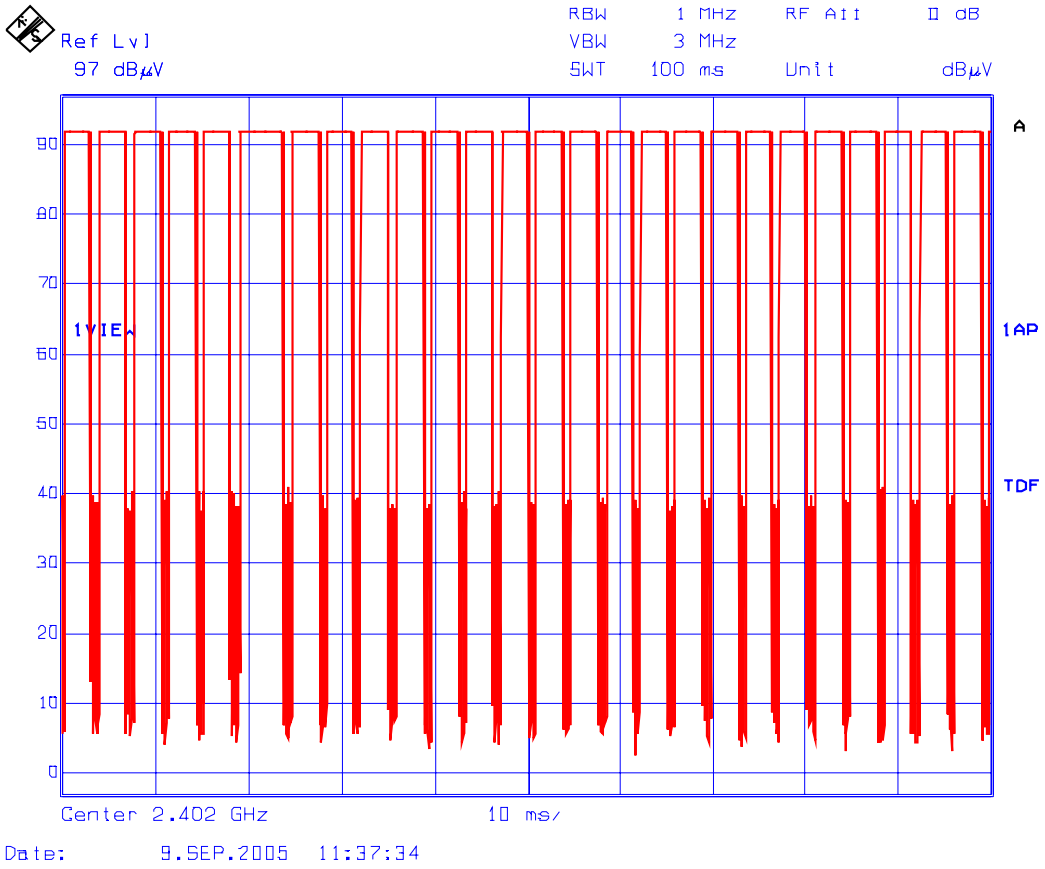
- Trace 1: RBW=1MHz, VBW=3 MHz
- Trace 2: RBW=300 kHz, VBW=1 MHz, Delta (Peak to Band-Edge): 42.02 dB
- Trace 3: RBW=1 MHz, VBW=10 Hz
- Band-Edge Level at 2483.5 MHz: 89.30 dBµV/m – 42.02 dB = 47.27 dBµV/m





All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot 23 : Duty cycle analysis



TX_{ON} / (TX_{ON} + TX_{OFF}) = (26 x 2.905812 ms) / 100 ms= 0.75551112 ≈ 20 log (0.75551112) = -2.44 dB

EXHIBIT 7. MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of NIST Technical Note 1297 and LAB 34

7.1. LINE CONDUCTED EMISSION MEASUREMENT UNCERTAINTY

CONTRIBUTION (Line Conducted)	PROBABILITY DISTRIBUTION	UNCERTAINTY (dB)	
		9-150 kHz	0.15-30 MHz
EMI Receiver specification	Rectangular	±1.5	±1.5
LISN coupling specification	Rectangular	±1.5	±1.5
Cable and Input Transient Limiter calibration	Normal (k=2)	±0.3	±0.5
Mismatch: Receiver VRC Γ_1 = 0.03 LISN VRC Γ_R = 0.8(9 kHz) 0.2 (30 MHz) Uncertainty limits 20Log(1±$\Gamma_1\Gamma_R$)	U-Shaped	±0.2	±0.3
System repeatability	Std. deviation	±0.2	±0.05
Repeatability of EUT	--	--	--
Combined standard uncertainty	Normal	±1.25	±1.30
Expanded uncertainty U	Normal (k=2)	±2.50	±2.60

Sample Calculation for Measurement Accuracy in 450 kHz to 30 MHz Band:

$u_c(y) = \sqrt{\sum_{I=1}^{m} u_i^2(y)} = \pm \sqrt{(1.5^2 + 1.5^2)/3 + (0.5/2)^2 + (0.05/2)^2 + 0.35^2} = \pm 1.30$ dB

$U = 2u_c(y) = \pm 2.6$ dB

7.2. RADIATED EMISSION MEASUREMENT UNCERTAINTY

CONTRIBUTION (Radiated Emissions)	PROBABILITY DISTRIBUTION	UNCERTAINTY (± dB)	
		3 m	10 m
Antenna Factor Calibration	Normal (k=2)	±1.0	±1.0
Cable Loss Calibration	Normal (k=2)	±0.3	±0.5
EMI Receiver specification	Rectangular	±1.5	±1.5
Antenna Directivity	Rectangular	+0.5	+0.5
Antenna factor variation with height	Rectangular	±2.0	±0.5
Antenna phase center variation	Rectangular	0.0	±0.2
Antenna factor frequency interpolation	Rectangular	±0.25	±0.25
Measurement distance variation	Rectangular	±0.6	±0.4
Site imperfections	Rectangular	±2.0	±2.0
Mismatch: Receiver VRC Γ_1 = 0.2 Antenna VRC Γ_R = 0.67(Bi) 0.3 (Lp) Uncertainty limits 20Log(1±$\Gamma_1\Gamma_R$)	U-Shaped	+1.1 -1.25	±0.5
System repeatability	Std. Deviation	±0.5	±0.5
Repeatability of EUT		-	-
Combined standard uncertainty	Normal	+2.19 / -2.21	+1.74 / -1.72
Expanded uncertainty U	Normal (k=2)	+4.38 / -4.42	+3.48 / -3.44

Calculation for maximum uncertainty when 3m biconical antenna including a factor of k = 2 is used:

$U = 2u_c(y) = 2x(+2.19) = +4.38$ dB And $U = 2u_c(y) = 2x(-2.21) = -4.42$ dB