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Electromagnetic Emissions Test Report and Application for Grant of Equipment Authorization pursuant to FCC Part 15, Subpart C (15.247) DTS Specifications on the Crossbow Technology Model: Mica Z

FCC ID:	SHU001MPR2400V01
GRANTEE:	Crossbow Technology 41 East Daggett Drive San Jose, CA. 95134
TEST SITE:	Elliott Laboratories, Inc. 684 W. Maude Avenue Sunnyvale, CA 94086
REPORT DATE:	September 1, 2004
FINAL TEST DATE:	August 30, 2004

AUTHORIZED SIGNATORY: Mark Briggs

Mark Briggs
Vice President of Engineering

ACCREDITED

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SCOPE

An electromagnetic emissions test has been performed on the Crossbow Technology model Mica Z pursuant to Subpart C of Part 15 of FCC Rules for intentional radiators. Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in ANSI C63.4-1992 as outlined in Elliott Laboratories test procedures.

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant FCC performance and procedural standards.

Final system data was gathered in a mode that tended to maximize emissions by varying orientation of EUT, orientation of power and I/O cabling, antenna search height, and antenna polarization.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

The test results recorded herein are based on a single type test of the Crossbow Technology model Mica Z and therefore apply only to the tested sample. The sample was selected and prepared by Bill Fereira of Crossbow Technology

OBJECTIVE

The primary objective of the manufacturer is compliance with Subpart C of Part 15 of FCC Rules for the radiated and conducted emissions of intentional radiators. Certification of these devices is required as a prerequisite to marketing as defined in Part 2 the FCC Rules.

Certification is a procedure where the manufacturer or a contracted laboratory makes measurements and submits the test data and technical information to the FCC. The FCC issues a grant of equipment authorization upon successful completion of their review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units which are subsequently manufactured.

SUMMARY OF RESULTS

FCC Part 15 Section	RSS 210 Section	Description	Measured Value	Comments	Result
15.247(a)	6.2.2(o)(b)	Digital Modulation	Systems uses DSSS techniques	System must utilize a digital transmission technology	Complies
15.247 (a) (2)	6.2.2(o)(b)	6dB Bandwidth	1.58 MHz (1580 kHz)	Minimum allowed is 500kHz	Complies
	RSP 100	99% Bandwidth	N/A	For information only	N/A
15.247 (b) (3)	6.2.2(o)(b)	Output Power, 2400 - 2483.5 MHz	-1.4 dBm (0.0007 Watts) EIRP = < 0.0007W	Multi-point applications: Maximum permitted is 1Watt, with EIRP limited to 4 Watts.	Complies
15.247(d)	6.2.2(o)(b)	Power Spectral Density	-15.8 dBm / 3KHz	Maximum permitted is 8dBm/3kHz	Complies
15.247(c)	6.2.2(o)(e1)	Antenna Port Spurious Emissions – 30MHz – 25GHz	All spurious emissions < -20dBc	All spurious emissions < -20dBc.	Complies
15.247(c) / 15.209		Radiated Spurious Emissions – 30MHz – 25 GHz	48.1dBuV/m @ 4876.2MHz (-5.9dB)	Emissions in restricted bands must meet the radiated emissions limits detailed in 15.207. All others must be < -20dBc	Complies
15.207		AC Conducted Emissions	N/A	EUT is battery powered	N/A
	6.6	AC Conducted Emissions	N/A	EUT is battery powered	N/A
15.247 (b) (5)		RF Exposure Requirements	Output power < 5mW	No warnings required due to low output power, refer to RF Exposure exhibit	Complies
15.203		RF Connector	Antenna connector is an MMCX non-standard connector	Unique antenna connection required for user-installed applications.	Complies

EIRP calculated using antenna gain of 0dBi for the highest EIRP point-to-multipoint system.

MEASUREMENT UNCERTAINTIES

ISO Guide 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level and were calculated in accordance with NAMAS document NIS 81.

Measurement Type	Frequency Range (MHz)	Calculated Uncertainty (dB)
Conducted Emissions	0.15 to 30	± 2.4
Radiated Emissions	30 to 1000	± 3.6

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

GENERAL

The Crossbow Technology model Mica Z is a spread spectrum radio used for industrial control purposes. In use, the EUT could be placed in any position. The EUT was, therefore, treated as table-top equipment during testing. The electrical rating of the EUT is 3V supplied by a battery.

Three samples were received on August 30, 2004 and tested on August 30, 2004. One of the samples was configured to operate on the high channel, one on the lowest channel and one on the center channel. The EUT consisted of the following component(s):

Manufacturer	Model	Description	Serial Number	FCC ID
Crossbow Technoloty	Mica Z	Spread Spectrum Radio	none	TBD

OTHER EUT DETAILS

The device transmits data based on its programmed parameters and is not intended to be connected to other devices during normal operation. An additional circuit board can be plugged into the MicaZ to provide sensor data to be transmitted by the MicaZ, but such sensor boards do not transmit, nor do they have processors on board.

The device transmits once per second with a maximum on time of 12.7 ms. Average correction factor is therefore 17.9 dB.

ENCLOSURE

The EUT enclosure is primarily constructed of plastic. It measures approximately 2.2 cm wide by 3.6 cm deep by 6.3 cm high.

MODIFICATIONS

The EUT did not require modifications during testing in order to comply with the emission specifications.

SUPPORT EQUIPMENT

No support equipment was used for emissions testing:

EUT INTERFACE PORTS

The EUT does not have any interface ports for connection to another device. It does have an expansion slot for connection to an optional sensor board. The sensor board was not connected to the sample provided. Digital device emissions will be verified with the sensor board connected, but as this board contains no rf or control circuitry it was not necessary.

EUT OPERATION DURING TESTING

The EUT was set to transmit on the select channel during testing. The transmission was pulsed with a transmission occurring at a rate of 1 per second. The transmission time was ~ 12ms (the same transmission length that would be used in normal operation).

ANTENNA REQUIREMENTS

The antenna port is a non standard, MMCX connector, not accessible to the end user, which meets the requirements of 15.203. The connector is not accessible to the end user.

The antenna (monopole antenna consisting of a wire cut to a 1.2 inch length) has a nominal gain of less than 0dBi -the field strength measurements of the fundamental signal using a peak detector were ~ 90dBuV/m in a 1MHz band. Correcting this value for actual signal bandwidth of 1.7 MHz (90dBuV/m + 10Log(1.7)) would give a peak output field strength for the complete signal of 92.3dBuV/m. This corresponds to a theoretical eirp of -3dBm. As the output power (measured) was - 1.4dBm the theoretical antenna gain would be ~ -1.6dBi, consistent with the manufacturer's statement.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on August 30, 2004at the Elliott Laboratories Open Area Test Site #Chamber #4 located at 684 West Maude Avenue, Sunnyvale, California. The test site contains separate areas for radiated and conducted emissions testing. Pursuant to section 2.948 of the Rules, construction, calibration, and equipment data has been filed with the Federal Communications Commission. In accordance with Industry Canada rules detailed in RSS 210 Issue 5 and RSS-212, construction, calibration, and equipment data for the test sites have been filed with the Federal Communications Commission.

The FCC recommends that ambient noise at the test site be at least 6 dB below the allowable limits. Ambient levels are below this requirement with the exception of predictable local TV, radio, and mobile communications traffic. The test site contains separate areas for radiated and conducted emissions testing. Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent FCC requirements.

CONDUCTED EMISSIONS CONSIDERATIONS

Conducted emissions testing is performed in conformance with ANSI C63.4-1992. Measurements are made with the EUT connected to the public power network through a nominal, standardized RF impedance, which is provided by a line impedance stabilization network, known as a LISN. A LISN is inserted in series with each current-carrying conductor in the EUT power cord.

RADIATED EMISSIONS CONSIDERATIONS

The FCC has determined that radiation measurements made in a shielded enclosure are not suitable for determining levels of radiated emissions. Radiated measurements are performed in an open field environment. The test site is maintained free of conductive objects within the CISPR defined elliptical area incorporated in ANSI C63.4 guidelines.

MEASUREMENT INSTRUMENTATION

RECEIVER SYSTEM

An EMI receiver as specified in CISPR 16-1 is used for emissions measurements. The receivers used can measure over the frequency range of 9 kHz up to 2000 MHz. These receivers allow both ease of measurement and high accuracy to be achieved. The receivers have Peak, Average, and CISPR (Quasi-peak) detectors built into their design so no external adapters are necessary. The receiver automatically sets the required bandwidth for the CISPR detector used during measurements.

For measurements above the frequency range of the receivers, a spectrum analyzer is utilized because it provides visibility of the entire spectrum along with the precision and versatility required to support engineering analysis. Average measurements above 1000MHz are performed on the spectrum analyzer using the linear-average method with a resolution bandwidth of 1 MHz and a video bandwidth of 10 Hz.

INSTRUMENT CONTROL COMPUTER

The receivers utilize either a Rohde and Schwarz EZM Spectrum Monitor/Controller or contain an internal Spectrum Monitor/Controller to view and convert the receiver measurements to the field strength at an antenna or voltage developed at the LISN measurement port, which is then compared directly with the appropriate specification limit. This provides faster, more accurate readings by performing the conversions described under Sample Calculations within the Test Procedures section of this report. Results are printed in a graphic and/or tabular format, as appropriate. A personal computer is used to record all measurements made with the receivers.

The Spectrum Monitor provides a visual display of the signal being measured. In addition, the controller or a personal computer run automated data collection programs which control the receivers. This provides added accuracy since all site correction factors, such as cable loss and antenna factors are added automatically.

LINE IMPEDANCE STABILIZATION NETWORK (LISN)

Line conducted measurements utilize a fifty microhenry Line Impedance Stabilization Network as the monitoring point. The LISN used also contains a 250 uH CISPR adapter. This network provides for calibrated radio frequency noise measurements by the design of the internal low pass and high pass filters on the EUT and measurement ports, respectively.

POWER METER

A power meter and peak power sensor are used for all direct output power measurements from transmitters as they provide a broadband indication of the power output.

FILTERS/ATTENUATORS

External filters and precision attenuators are often connected between the receiving antenna or LISN and the receiver. This eliminates saturation effects and non-linear operation due to high amplitude transient events.

ANTENNAS

A biconical antenna is used to cover the range from 30 MHz to 300 MHz and a log periodic antenna is utilized from 300 MHz to 1000 MHz. Narrowband tuned dipole antennas are used over the entire 30 to 1000 MHz range for precision measurements of field strength. Above 1000 MHz, a horn antenna is used. The antenna calibration factors are included in site factors programmed into the test receivers.

ANTENNA MAST AND EQUIPMENT TURNTABLE

The antennas used to measure the radiated electric field strength are mounted on a non-conductive antenna mast equipped with a motor-drive to vary the antenna height.

ANSI C63.4 specifies that the test height above ground for table mounted devices shall be 80 centimeters. Floor mounted equipment shall be placed on the ground plane if the device is normally used on a conductive floor or separated from the ground plane by insulating material from 3 to 12 mm if the device is normally used on a non-conductive floor. During radiated measurements, the EUT is positioned on a motorized turntable in conformance with this requirement.

INSTRUMENT CALIBRATION

All test equipment is regularly checked to ensure that performance is maintained in accordance with the manufacturer's specifications. All antennas are calibrated at regular intervals with respect to tuned half-wave dipoles. An exhibit of this report contains the list of test equipment used and calibration information.

TEST PROCEDURES

EUT AND CABLE PLACEMENT

The FCC requires that interconnecting cables be connected to the available ports of the unit and that the placement of the unit and the attached cables simulate the worst case orientation that can be expected from a typical installation, so far as practicable. To this end, the position of the unit and associated cabling is varied within the guidelines of ANSI C63.4, and the worst case orientation is used for final measurements.

CONDUCTED EMISSIONS

Conducted emissions are measured at the plug end of the power cord supplied with the EUT. Excess power cord length is wrapped in a bundle between 30 and 40 centimeters in length near the center of the cord. Preliminary measurements are made to determine the highest amplitude emission relative to the specification limit for all the modes of operation. Placement of system components and varying of cable positions are performed in each mode. A final peak mode scan is then performed in the position and mode for which the highest emission was noted on all current carrying conductors of the power cord.

RADIATED EMISSIONS

Radiated emissions measurements are performed in two phases as well. A preliminary scan of emissions is conducted in which all significant EUT frequencies are identified with the system in a nominal configuration. At least two scans are performed from 30 MHz up to the frequency required by the regulation specified on page 1. One or more of these is with the antenna polarized vertically while the one or more of these is with the antenna polarized horizontally. During the preliminary scans, the EUT is rotated through 360°, the antenna height is varied and cable positions are varied to determine the highest emission relative to the limit.

A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

Final maximization is a phase in which the highest amplitude emissions identified in the spectral search are viewed while the EUT azimuth angle is varied from 0 to 360 degrees relative to the receiving antenna. The azimuth which results in the highest emission is then maintained while varying the antenna height from one to four meters. The result is the identification of the highest amplitude for each of the highest peaks. Each recorded level is corrected in the receiver using appropriate factors for cables, connectors, antennas, and preamplifier gain. Emissions which have values close to the specification limit may also be measured with a tuned dipole antenna to determine compliance.

CONDUCTED EMISSIONS FROM ANTENNA PORT

Direct measurements are performed with the antenna port of the EUT connected to either the power meter or spectrum analyzer via a suitable attenuator and/or filter. These are used to ensure that the front end of the measurement instrument is not overloaded by the fundamental transmission.

Measurement bandwidths (video and resolution) are set in accordance with FCC procedures for the type of radio being tested.

SPECIFICATION LIMITS AND SAMPLE CALCULATIONS

The limits for conducted emissions from the AC power port are given in units of microvolts, the limits for radiated electric field emissions are given in units of microvolts per meter at a specified test distance and the output power limits are given in temrs of Watts, milliwatts or dBm. Data is measured in the logarithmic form of decibels relative to one microvolt, or dB microvolts (dBuV). For radiated emissions, the measured data is converted to the field strength at the antenna in dB microvolts per meter (dBuV/m). The results are then converted to the linear forms of uV and uV/m for comparison to published specifications.

Where the radiated electric field strength is expressed in terms of the equivalent isotropic radiated power (eirp) the following formula is used to determine the field strength limit in terms of microvolts per meter at a distance of 3m from the equipment under test:

$$E = \frac{1000000 \text{ v } 30\ P}{3} \quad \text{microvolts per meter}$$

where P is the eirp (Watts)

For reference, converting the voltage and electric field strength specification limits from linear to decibel form is accomplished by taking the base ten logarithm, then multiplying by 20. Conversion of power specification limits from linear units (in milliwatts) to decibel form (in dBm) is accomplished by taking the base ten logarithm, then multiplying by 10.

FCC 15.407 (a)and RSS 210 (o) OUTPUT POWER LIMITS

The table below shows the limits for output power and output power density. Where the signal bandwidth is less than 20 MHz the maximum output power is reduced to the power spectral density limit plus 10 times the log of the bandwidth (in MHz).

Operating Frequency (MHz)	Output Power	Power Spectral Density
902 – 928	1 Watts (30 dBm)	8 dBm/3kHz
2400 – 2483.5	1 Watts (30 dBm)	8 dBm/3kHz
5725 – 5850	1 Watts (30 dBm)	8 dBm/3kHz

The maximum permitted output power is reduced by 1dB for every dB the antenna gain exceeds 6dBi. Fixed point-to-point applications using the 5725 – 5850 MHz band are not subject to this restriction.

RSS 210 (o) AND FCC 15.247 SPURIOUS RADIATED EMISSIONS LIMITS

T limits for unwanted (spurious) emissions from the transmitter falling in the restricted bands detailed in Part 15.205 and for all spurious emissions from the receiver are:

Frequency Range (MHz)	Limit (uV/m @ 3m)	Limit (dBuV/m @ 3m)
30 to 88	100	40
88 to 216	150	43.5
216 to 960	200	46.0
Above 960	500	54.0

All other unwanted (spurious) emissions shall be at least 20dB below the level of the highest in-band signal level.

FCC 15.205 AC POWER PORT CONDUCTED EMISSIONS LIMITS

The table below shows the limits for emissions on the AC power line as detailed in FCC Part 15.205.

Frequency (MHz)	Average Limit (dBuV)	Quasi Peak Limit (dBuV)
0.150 to 0.500	Linear decrease on logarithmic frequency axis between 56.0 and 46.0	Linear decrease on logarithmic frequency axis between 66.0 and 56.0
0.500 to 5.000	46.0	56.0
5.000 to 30.000	50.0	60.0

RSS-210 SECTION 6.6 AC POWER PORT CONDUCTED EMISSIONS LIMITS

The table below shows the limits for emissions on the AC power line as detailed in Industry Canada RSS-210 section 6.6.

Frequency Range (MHz)	Limit (uV)	Limit (dBuV)
0.450 to 30.000	250	48

SAMPLE CALCULATIONS - CONDUCTED EMISSIONS

Receiver readings are compared directly to the conducted emissions specification limit (decibel form) as follows:

$$R_r - B = C$$

and

$$C - S = M$$

where:

R_r = Receiver Reading in dBuV

B = Broadband Correction Factor*

C = Corrected Reading in dBuV

S = Specification Limit in dBuV

M = Margin to Specification in +/- dB

* Broadband Level - Per ANSI C63.4, 13 dB may be subtracted from the quasi-peak level if it is determined that the emission is broadband in nature. If the signal level in the average mode is six dB or more below the signal level in the peak mode, the emission is classified as broadband.

SAMPLE CALCULATIONS - RADIATED EMISSIONS

Receiver readings are compared directly to the specification limit (decibel form). The receiver internally corrects for cable loss, preamplifier gain, and antenna factor. The calculations are in the reverse direction of the actual signal flow, thus cable loss is added and the amplifier gain is subtracted. The Antenna Factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements. A distance factor, when used for electric field measurements, is calculated by using the following formula:

$$F_d = 20*LOG_{10} (D_m/D_s)$$

where:

F_d = Distance Factor in dB

D_m = Measurement Distance in meters

D_s = Specification Distance in meters

Measurement Distance is the distance at which the measurements were taken and Specification Distance is the distance at which the specification limits are based. The antenna factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

The margin of a given emission peak relative to the limit is calculated as follows:

$$R_c = R_r + F_d$$

and

$$M = R_c - L_s$$

where:

R_r = Receiver Reading in dBuV/m

F_d = Distance Factor in dB

R_c = Corrected Reading in dBuV/m

L_s = Specification Limit in dBuV/m

M = Margin in dB Relative to Spec

EXHIBIT 1: Test Equipment Calibration Data

1 Page

Radiated Emissions, 30 - 24,800 MHz, 30-Aug-04
Engineer: David Bare

Manufacturer	Description	Model #	Asset #	Cal Due
Miteq	Preamplifier, 1-18GHz	AFS44	1346	08-Jan-05
EMCO	Horn Antenna D. Ridge 1-18 GHz (SA40 horn)	3115	1386	24-Mar-05
Hewlett Packard	EMC Spectrum Analyzer 9kHz - 40 GHz, Fremont	8564E (84125C)	1393	26-Mar-05
Rohde & Schwarz	Peak Power Sensor 100uW - 2 Watts	NRV-Z32	1536	22-Apr-05
Rohde & Schwarz	Power Meter, Single Channel	NRVS	1290	22-Apr-05

EXHIBIT 2: Test Data Log Sheets

ELECTROMAGNETIC EMISSIONS

TEST LOG SHEETS

AND

MEASUREMENT DATA

T56371 21 Pages

Elliott

EMC Test Data

Client:	Crossbow Technology	Job Number:	J56310
Model:	Mica Z	T-Log Number:	T56371
		Account Manager:	
Contact:	Bill Fereira		
Emissions Spec:	FCC 15.247	Class:	Radio
Immunity Spec:		Environment:	

EMC Test Data

For The

Crossbow Technology

Model

Mica Z

Date of Last Test: 8/30/2004

Client:	Crossbow Technology	Job Number:	J56310
Model:	Mica Z	T-Log Number:	T56371
		Account Manager:	
Contact:	Bill Fereira		
Emissions Spec:	FCC 15.247	Class:	Radio
Immunity Spec:	Enter immunity spec on cover	Environment:	

EUT INFORMATION

General Description

The EUT is a spread spectrum radio used for industrial control purposes. In use, the EUT could be placed in any position. The EUT was, therefore, treated as table-top equipment during testing. The electrical rating of the EUT is 3V supplied by the a battery.

Equipment Under Test

Manufacturer	Model	Description	Serial Number	FCC ID
Crossbow Technoloty	Mica Z	Spread Spectrum Radio	none	TBD

Other EUT Details

Three samples were provided, one configured to operate on the high channel, one on the lowest channel and one for the center channel.

The device transmits data based on its programmed parameters and is not intended to be connected to other devices during normal operation. An additional circuit board can be plugged into the MicaZ to provide sensor data to be transmitted by the MicaZ, but such sensor boards do not transmit, nor do they have processors on board.

The antenna port is a non standard, MMCX connector, not accessible to the end user, which meets the requirements of 15.203. The connector is not accessible to the end user. The antenna (monopole antenna consisting of a wire cut to a 1.2 inch length) has a nominal gain of less than 0dBi -the field strength measurements of the fundamental signal using a peak detector were ~ 90dBuV/m in a 1MHz band. Correcting this value for actual signal bandwidth of 1.7 MHz (90dBuV/m + 10Log(1.7)) would give a peak output field strength for the complete signal of 92.3dBuV/m. This corresponds to a theoretical eirp of -3dBm. As the output power (measured) was - 1.4dBm the theoretical antenna gain would -1.6dBi.

EUT Enclosure

The EUT enclosure is primarily constructed of plastic. It measures approximately 2.2 cm wide by 3.6 cm deep by 6.3 cm high.

Modification History

Mod. #	Test	Date	Modification
1	-	-	None made

Modifications applied are assumed to be used on subsequent tests unless otherwise stated as a further modification.

Client:	Crossbow Technology	Job Number:	J56310
Model:	Mica Z	T-Log Number:	T56371
		Account Manager:	
Contact:	Bill Fereira		
Emissions Spec:	FCC 15.247	Class:	Radio
Immunity Spec:	Enter immunity spec on cover	Environment:	

Test Configuration #1

Local Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
None				

Remote Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
None				

Interface Cabling and Ports

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)

The EUT does not have any interface ports for connection to another device. It does have an expansion slot for connection to an optional sensor board. The sensor board was not connected to the sample provided. Digital device emissions will be verified with the sensor board connected, but as this board contains no rf or control circuitry it was not necessary.

EUT Operation During Emissions

The EUT was set to transmit on the select channel during testing. The transmission was pulsed with a transmission occuring at a rate of 1 per second. The transmission time was ~ 12ms (the same transmission length that would be used in normal operation).

Client:	Crossbow Technology	Job Number:	J56310
Model:	Mica Z	T-Log Number:	T56371
		Account Manager:	-
Contact:	Bill Fereira		
Spec:	FCC 15.247	Class:	N/A

Radiated Emissions

Test Specifics

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 8/30/2004
Test Engineer: David Bare
Test Location: Fremont Chamber #4
Config. Used: 1
Config Change: None
EUT Voltage: Battery

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated spurious emissions testing.

For radiated emissions testing the measurement antenna was located 3 meters from the EUT.

When measuring the conducted emissions from the EUT's antenna port, the antenna port of the EUT was connected to the spectrum analyzer or power meter via a suitable attenuator to prevent overloading the measurement system. All measurements are corrected to allow for the external attenuators used.

Ambient Conditions:

Temperature: 22 °C
Rel. Humidity: 47 %

Summary of Results

Run #	Test Performed	Limit	Result	Result
1 - 5	RE, 30 - 24801 MHz - Spurious Emissions In	FCC Part 15.209 / 15.247(c)	Pass	-5.9dB @ 4876.2MHz
6	6dB Bandwidth	15.247(a)	Pass	1.58 MHz minimum
7	Output Power	15.247(b)	Pass	-1.4 dBm maximum
8	Power Spectral Density (PSD)	15.247(d)	Pass	-15.8 dBm maximum
9	Out of Band Spurious Emissions	15.247(c)	Pass	more then 35 dBc for all emissions

Modifications Made During Testing:

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	Crossbow Technology	Job Number:	J56310
Model:	Mica Z	T-Log Number:	T56371
		Account Manager:	-
Contact:	Bill Fereira		
Spec:	FCC 15.247	Class:	N/A

Run #1: Radiated Spurious Emissions, 30 - 24052 MHz. Low Channel @ 2405.2 MHz
EUT flat on table with antenna perpendicular to board (I.e. vertical)

	H	V	
Fundamental emission level @ 3m in 1MHz RBW:	83.4	85.6	Peak Measurement (RBW=VBW = 1MHz)
Fundamental emission level @ 3m in 1MHz RBW:	65.5	67.7	Average Calculated level

	H	V	
Fundamental emission level @ 3m in 100kHz RBW:	77.1	79.5	Peak detector
Limit for emissions outside of restricted bands:	59.5 dBµV/m		

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4806.202	47.5	V	54.0	-6.5	AVG	309	1.5	CW
4806.202	52.5	V	74.0	-21.5	PK	309	1.5	CW
4806.133	43.7	H	54.0	-10.3	AVG	312	1.6	CW
4806.133	48.6	H	74.0	-25.4	PK	312	1.6	CW
7215.600	41.6	H	54.0	-12.4	PK	269	1.0	Peak reading, Average Limit
7215.600	41.2	V	54.0	-12.8	PK	269	1.0	Peak reading, Average Limit
4810.400	32.7	V	54.0	-21.3	AVG	110	1.0	Average value calculated
4810.400	50.6	V	74.0	-23.4	PK	110	1.0	
4810.400	25.9	H	54.0	-28.1	AVG	110	1.9	Average value calculated
4810.400	43.8	H	74.0	-30.2	PK	110	1.9	
2390.000	33.8	V	54.0	-20.2	AVG	0	1.0	Average value calculated
2390.000	51.7	V	74.0	-22.3	PK	0	1.0	
2390.000	35.7	H	54.0	-18.3	AVG	62	1.0	Average value calculated
2390.000	53.6	H	74.0	-20.4	PK	62	1.0	

Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20 dB
Note 2:	Above measured emissions were all that were obseved from the EUT.
Note 3:	Average measurements calculated by applying a duty cycle correction factor to the peak reading.

EMC Test Data

Client:	Crossbow Technology	Job Number:	J56310
Model:	Mica Z	T-Log Number:	T56371
		Account Manager:	-
Contact:	Bill Fereira		
Spec:	FCC 15.247	Class:	N/A

Run #2: Radiated Spurious Emissions, 30 - 24052 MHz. Low Channel @ 2405.2 MHz
EUT standing vertical on table with antenna perpendicular to board (I.e. horizontal)

	H	V	
Fundamental emission level @ 3m in 1MHz RBW:	85.1	88.9	Peak Measurement (RBW=VBW = 1MHz)
Fundamental emission level @ 3m in 1MHz RBW:	67.2	71	Average Calculation

	H	V
Fundamental emission level @ 3m in 100kHz RBW:	78.3	79.5
Limit for emissions outside of restricted bands:	59.5 dBµV/m	

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4806.215	47.5	H	54.0	-6.5	AVG	231	1.6	CW
4806.215	49.7	H	74.0	-24.3	PK	231	1.6	CW
4806.150	45.4	V	54.0	-8.6	AVG	350	1.4	CW
4806.150	48.5	V	74.0	-25.5	PK	350	1.4	CW
7215.600	41.4	H	54.0	-12.6	PK	0	1.0	Peak reading, Average Limit
7215.600	41.9	V	54.0	-12.1	PK	0	1.0	Peak reading, Average Limit
4810.400	27.6	V	54.0	-26.4	AVG	347	1.3	Average value calculated
4810.400	45.5	V	74.0	-28.5	PK	347	1.3	
4810.400	33.0	H	54.0	-21.0	AVG	230	1.6	Average value calculated
4810.400	50.9	H	74.0	-23.1	PK	230	1.6	
2390.000	34.0	V	54.0	-20.0	AVG	26	1.0	Average value calculated
2390.000	51.9	V	74.0	-22.1	PK	26	1.0	
2390.000	30.1	H	54.0	-23.9	AVG	63	1.0	Average value calculated
2390.000	48.0	H	74.0	-26.0	PK	63	1.0	

Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20 dB
Note 2:	Above measured emissions were all that were obseved from the EUT.

EMC Test Data

Client:	Crossbow Technology	Job Number:	J56310
Model:	Mica Z	T-Log Number:	T56371
		Account Manager:	-
Contact:	Bill Fereira		
Spec:	FCC 15.247	Class:	N/A

Run #3: Radiated Spurious Emissions, 30 - 24052 MHz. Low Channel @ 2405.2 MHz
EUT standing horizontal on table with antenna perpendicular to board (I.e. horizontal)

	H	V	
Fundamental emission level @ 3m in 1MHz RBW:	85.9	85.5	Peak Measurement (RBW=VBW = 1MHz)
Fundamental emission level @ 3m in 1MHz RBW:	68	67.6	Average Calculation

	H	V
Fundamental emission level @ 3m in 100kHz RBW:	80.3	78.2
Limit for emissions outside of restricted bands:	60.3 dBµV/m	

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4806.100	46.2	V	54.0	-7.8	AVG	156	1.4	CW
4806.100	49.1	V	74.0	-24.9	PK	156	1.4	CW
4806.125	38.2	H	54.0	-15.8	AVG	135	1.4	CW
4806.125	44.0	H	74.0	-30.0	PK	135	1.4	CW
7215.600	42.1	H	54.0	-11.9	PK	0	1.0	Peak reading, Average Limit
7215.600	42.0	V	54.0	-12.0	PK	0	1.0	Peak reading, Average Limit
4810.400	30.0	V	54.0	-24.0	AVG	174	1.1	Average value calculated
4810.400	47.9	V	74.0	-26.1	PK	174	1.1	
4810.400	24.9	H	54.0	-29.1	AVG	130	1.4	Average value calculated
4810.400	42.8	H	74.0	-31.2	PK	130	1.4	
2390.000	29.7	V	54.0	-24.3	AVG	233	1.0	Average value calculated
2390.000	47.6	V	74.0	-26.4	PK	233	1.0	
2390.000	28.8	H	54.0	-25.2	AVG	98	1.3	Average value calculated
2390.000	46.7	H	74.0	-27.3	PK	98	1.3	

Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20 dB
Note 2:	Above measured emissions were all that were obseved from the EUT.

Client:	Crossbow Technology	Job Number:	J56310
Model:	Mica Z	T-Log Number:	T56371
		Account Manager:	-
Contact:	Bill Fereira		
Spec:	FCC 15.247	Class:	N/A

Run #4: Radiated Spurious Emissions, 30 - 24400 MHz. Center Channel @ 2440 MHz
EUT placed in maximum orientation from previous tests (EUT standing vertical on table)

	H	V
Fundamental emission level @ 3m in 100kHz RBW:	74.3	77.2
Limit for emissions outside of restricted bands:	57.2 dBµV/m	

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4880.000	32.2	V	54.0	-21.8	AVG	6	1.4	Average value calculated
4880.000	50.1	V	74.0	-23.9	PK	6	1.4	
4880.000	34.0	H	54.0	-20.0	AVG	52	1.6	Average value calculated
4880.000	51.9	H	74.0	-22.1	PK	52	1.6	
4876.165	48.1	H	54.0	-5.9	AVG	25	1.4	CW
4876.165	49.9	H	74.0	-24.1	PK	25	1.4	CW
4876.180	42.2	V	54.0	-11.8	AVG	341	1.4	CW
4876.180	45.5	V	74.0	-28.5	PK	341	1.4	CW
7320.000	43.8	H	54.0	-10.2	PK	0	1.0	Peak reading, Average limit
7320.000	43.2	V	54.0	-10.8	PK	0	1.0	Peak reading, Average limit

Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20dB below
Note 2:	Above measured emissions were all that were obseved from the EUT.

Client:	Crossbow Technology	Job Number:	J56310
Model:	Mica Z	T-Log Number:	T56371
		Account Manager:	-
Contact:	Bill Fereira		
Spec:	FCC 15.247	Class:	N/A

Run #5: Radiated Spurious Emissions, 30 - 24801 MHz. High Channel @ 2480.1 MHz
EUT placed in maximum orientation from previous tests (EUT standing vertical on table)

	H	V	
Fundamental emission level @ 3m in 1MHz RBW:	83.3	81	Peak Measurement (RBW=VBW = 1MHz)
Fundamental emission level @ 3m in 1MHz RBW:	65.4	63.1	Average Calculation

	H	V
Fundamental emission level @ 3m in 100kHz RBW:	77.2	75.6
Limit for emissions outside of restricted bands:	57.2 dBµV/m	

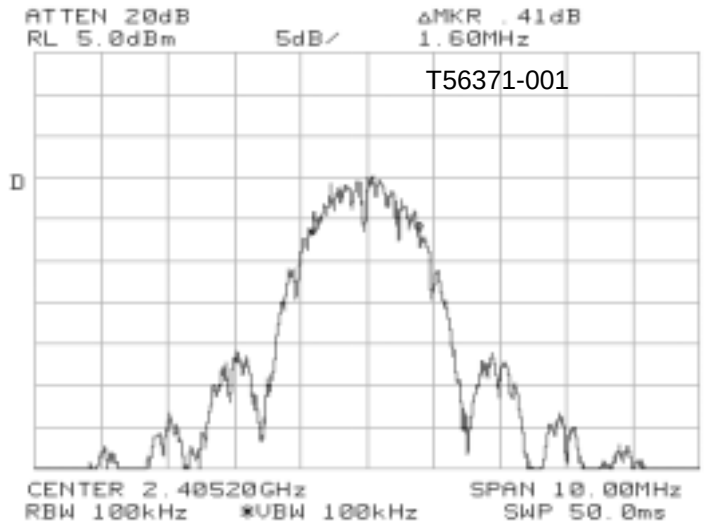
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4960.200	32.8	V	54.0	-21.2	AVG	22	1.1	Average value calculated
4960.200	50.7	V	74.0	-23.3	PK	22	1.1	
4960.200	36.3	H	54.0	-17.7	AVG	298	1.4	Average value calculated
4960.200	54.2	H	74.0	-19.8	PK	298	1.4	
4955.700	47.1	V	54.0	-6.9	AVG	34	1.4	
4955.700	50.2	V	74.0	-23.8	PK	34	1.4	
4956.205	46.1	H	54.0	-7.9	AVG	55	1.7	
4956.205	48.0	H	74.0	-26.0	PK	55	1.7	
7440.300	43.9	H	54.0	-10.1	PK	0	1.0	Peak reading, Average limit
7440.300	43.7	H	54.0	-10.3	PK	0	1.0	Peak reading, Average limit
2483.500	45.6	V	54.0	-8.4	AVG	272	1.1	
2483.500	63.5	V	74.0	-10.5	PK	272	1.1	
2483.500	44.0	H	54.0	-10.0	AVG	253	1.4	
2483.500	61.9	H	74.0	-12.1	PK	253	1.4	

Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20dB below
Note 2:	Above measured emissions were all that were obseved from the EUT.

Client:	Crossbow Technology	Job Number:	J56310
Model:	Mica Z	T-Log Number:	T56371
		Account Manager:	-
Contact:	Bill Fereira		
Spec:	FCC 15.247	Class:	N/A

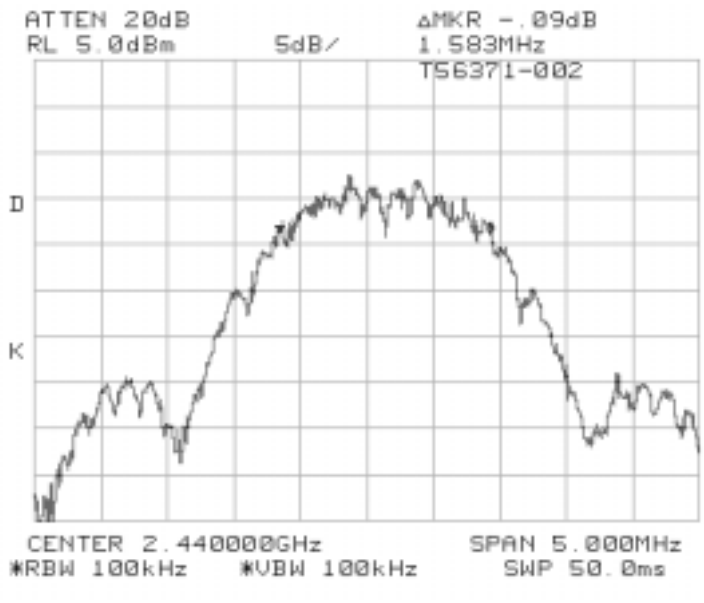
Run #6: Signal Bandwidth

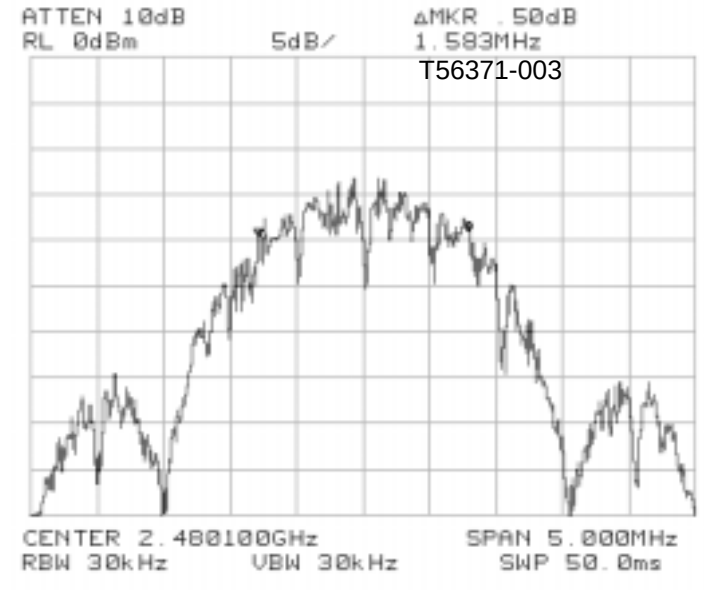
Channel	Frequency (MHz)	Resolution Bandwidth	6dB Signal Bandwidth	Graph reference #
Low	2405.2	100 kHz	1.6	T56371-001
Mid	2440.0	100 kHz	1.58	T56371-002
High	2480.1	101 kHz	1.58	T56371-003



Client:	Crossbow Technology	Job Number:	J56310
Model:	Mica Z	T-Log Number:	T56371
		Account Manager:	-
Contact:	Bill Fereira		
Spec:	FCC 15.247	Class:	N/A

Run #6: Signal Bandwidth





Client:	Crossbow Technology	Job Number:	J56310
Model:	Mica Z	T-Log Number:	T56371
		Account Manager:	-
Contact:	Bill Fereira		
Spec:	FCC 15.247	Class:	N/A

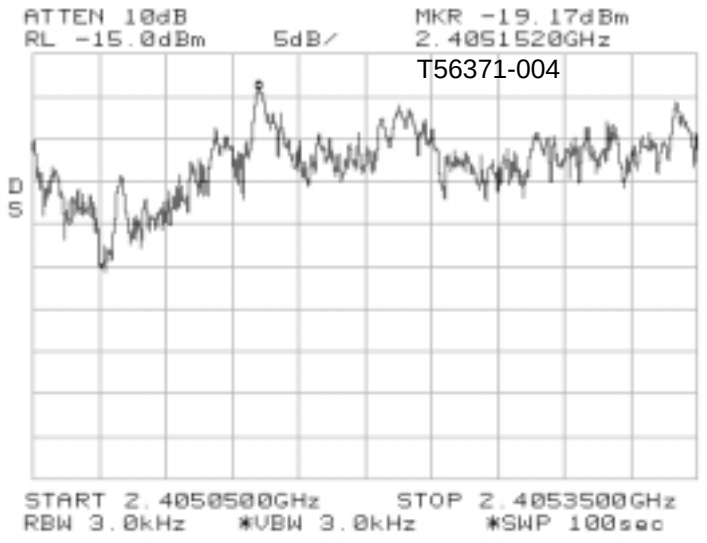
Run #7: Output Power

Measured with peak power meter

Channel	Frequency (MHz)	Res BW	Output Power	Output Power (mW)
Low	2405.2	N/A	-2.2 dBm	0.60
Mid	2440.0	N/A	-1.4 dBm	0.72
High	2480.1	N/A	-6.8 dBm	0.21

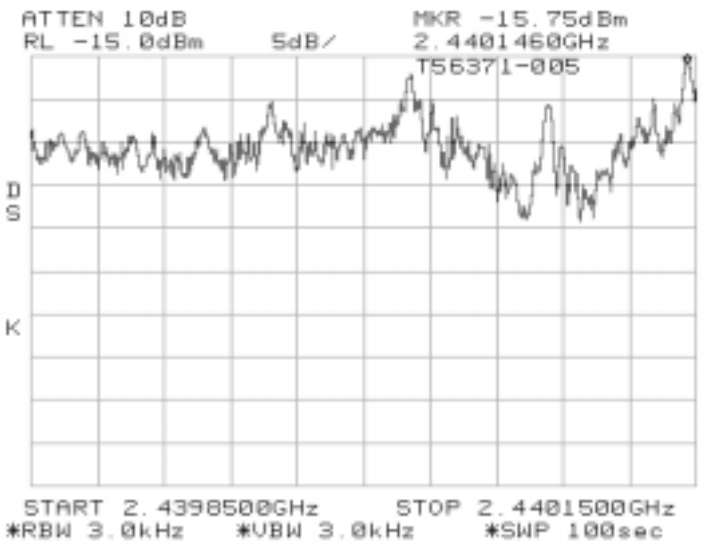
Run #8: Power Spectral Density

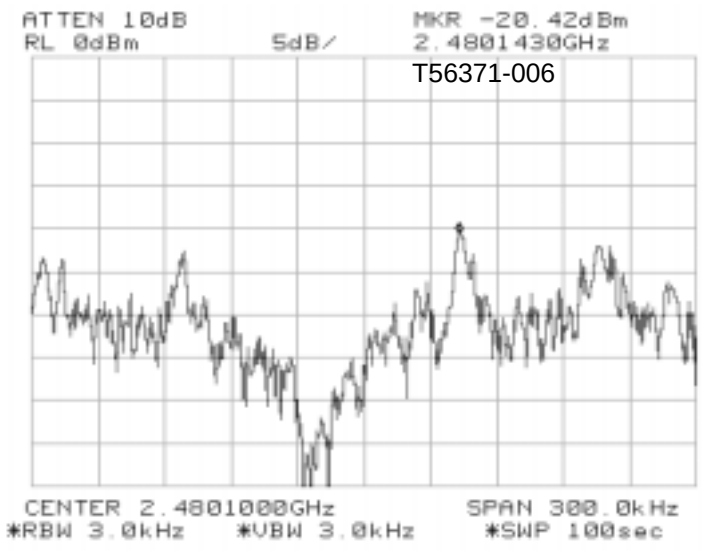
Channel	Frequency (MHz)	Res BW	P.S.D. (averaged over 1 second in a 3kHz	Graph reference #
Low	2405.2	3 kHz	-19.2 dBm	T56371-004
Mid	2440.0	3 kHz	-15.8 dBm	T56371-005
High	2480.1	3 kHz	-20.4 dBm	T56371-006



Client:	Crossbow Technology	Job Number:	J56310
Model:	Mica Z	T-Log Number:	T56371
		Account Manager:	-
Contact:	Bill Fereira		
Spec:	FCC 15.247	Class:	N/A

Run #8: Power Spectral Density

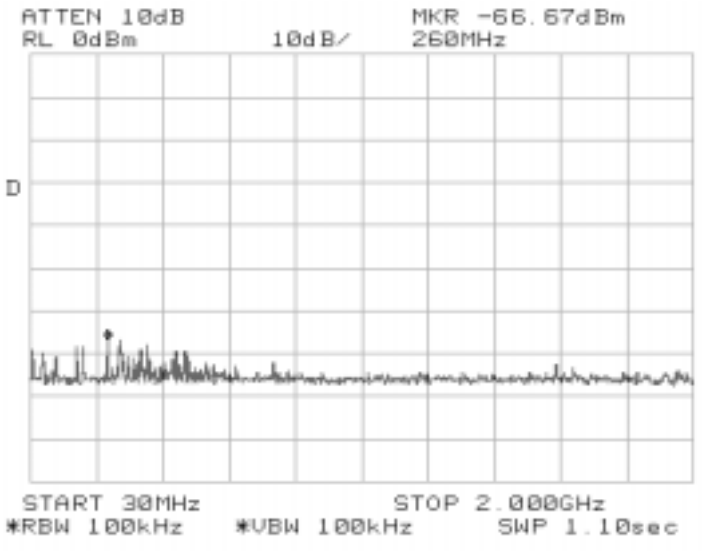


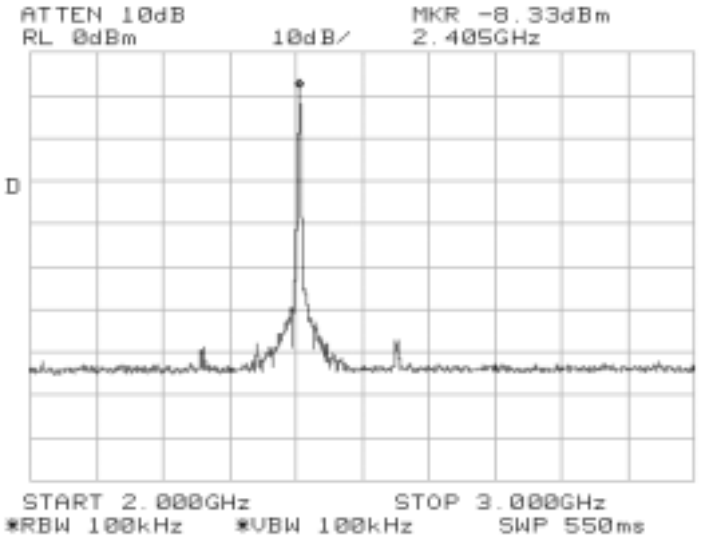


Client:	Crossbow Technology	Job Number:	J56310
Model:	Mica Z	T-Log Number:	T56371
		Account Manager:	-
Contact:	Bill Fereira		
Spec:	FCC 15.247	Class:	N/A

Run #9a: Out of Band Conducted

Low channel at 2405.2 MHz

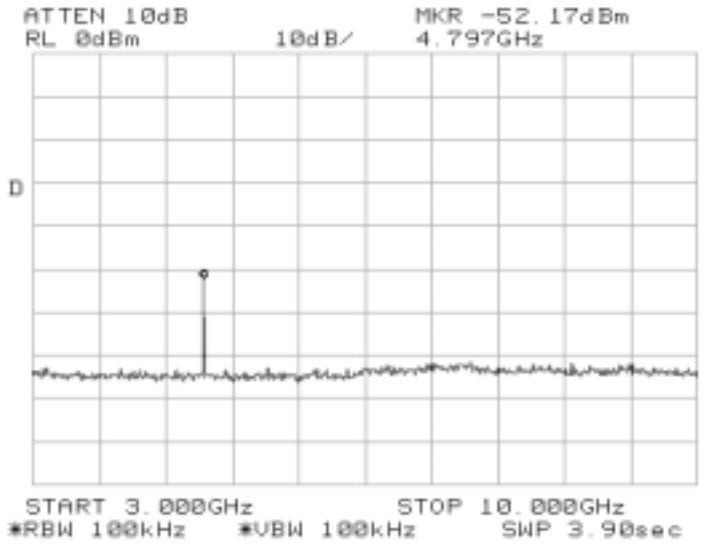


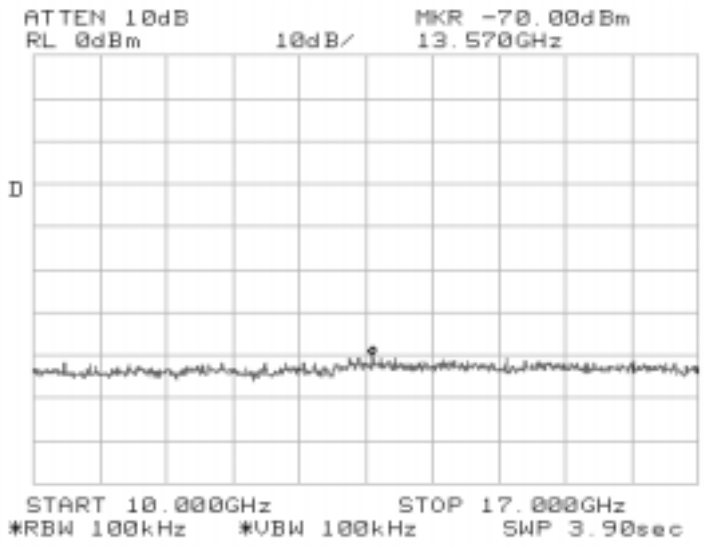


Client:	Crossbow Technology	Job Number:	J56310
Model:	Mica Z	T-Log Number:	T56371
		Account Manager:	-
Contact:	Bill Fereira		
Spec:	FCC 15.247	Class:	N/A

Run #9a: Out of Band Conducted

Low channel at 2405.2 MHz

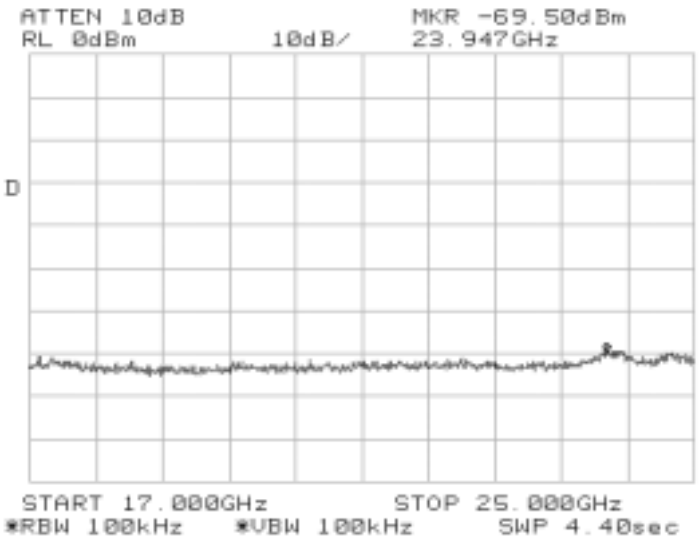




Client:	Crossbow Technology	Job Number:	J56310
Model:	Mica Z	T-Log Number:	T56371
		Account Manager:	-
Contact:	Bill Fereira		
Spec:	FCC 15.247	Class:	N/A

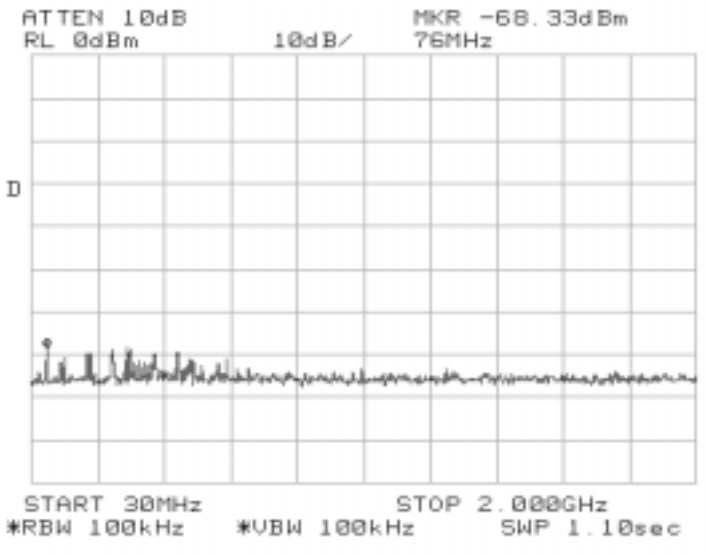
Run #9a: Out of Band Conducted

Low channel at 2405.2 MHz



Run #9b: Out of Band Conducted

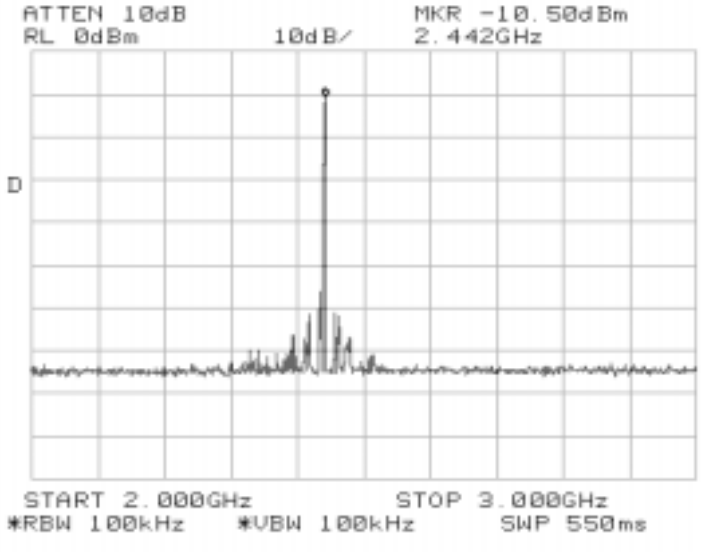
Mid channel at 2440 MHz

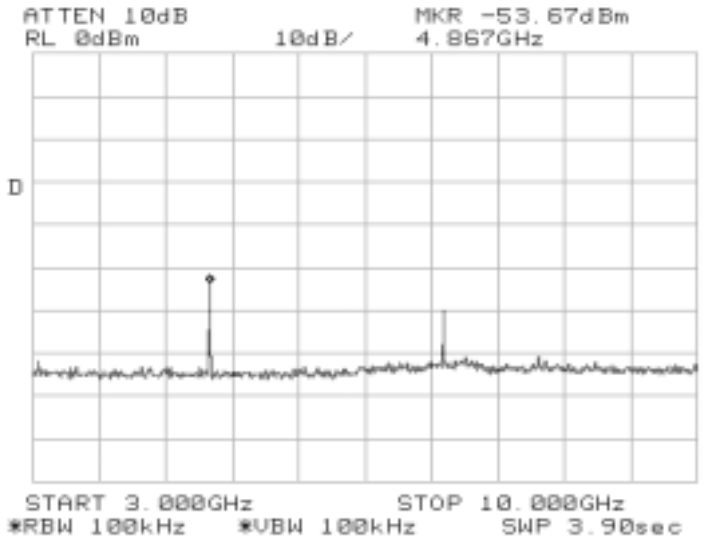


Client:	Crossbow Technology	Job Number:	J56310
Model:	Mica Z	T-Log Number:	T56371
		Account Manager:	-
Contact:	Bill Fereira		
Spec:	FCC 15.247	Class:	N/A

Run #9b: Out of Band Conducted

Mid channel at 2440 MHz

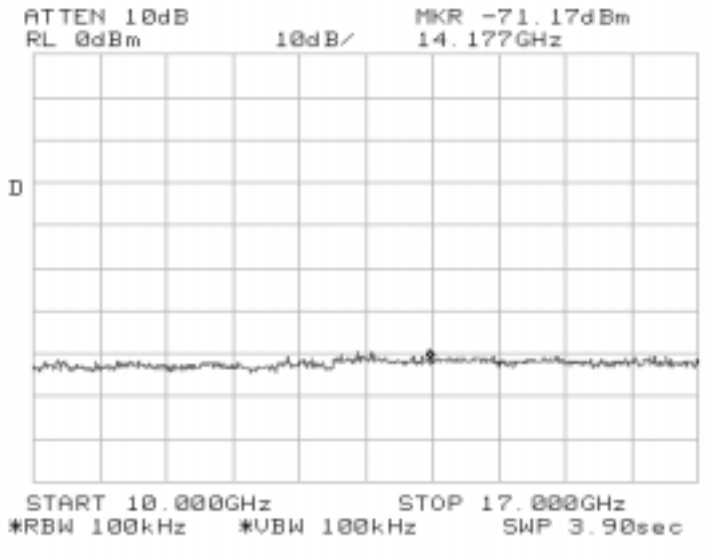


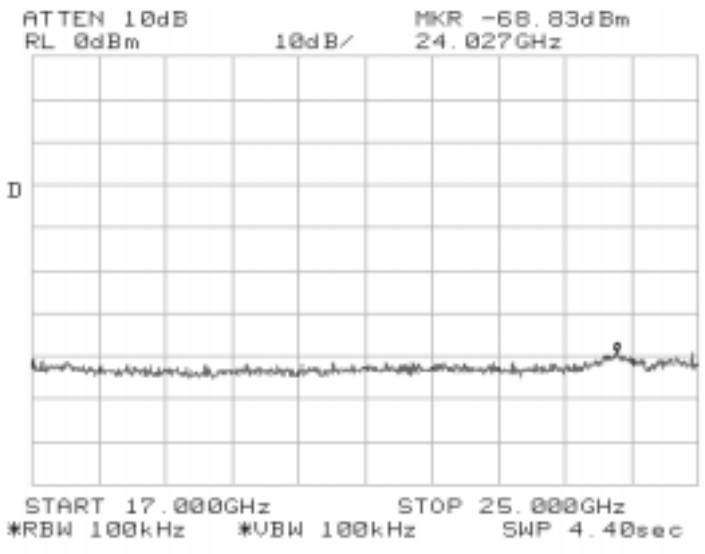


Client:	Crossbow Technology	Job Number:	J56310
Model:	Mica Z	T-Log Number:	T56371
		Account Manager:	-
Contact:	Bill Fereira		
Spec:	FCC 15.247	Class:	N/A

Run #9b: Out of Band Conducted

Mid channel at 2440 MHz

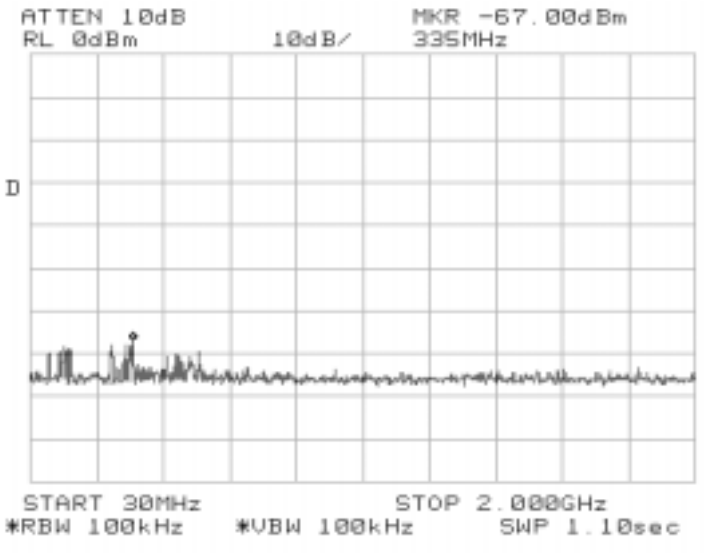


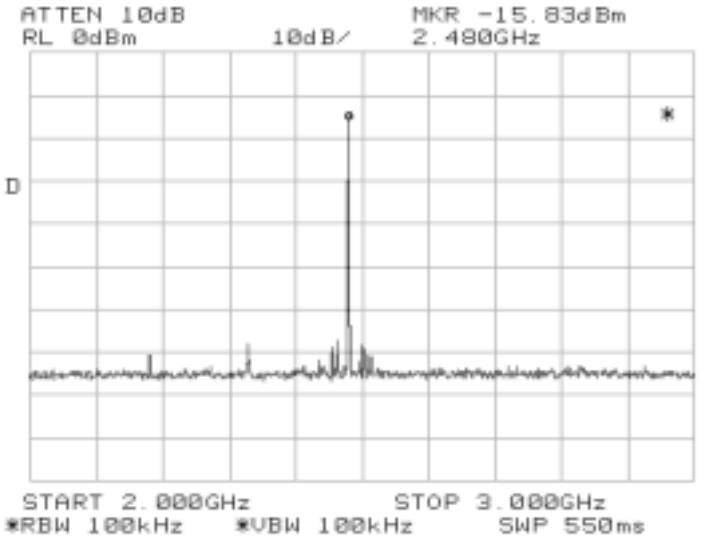


Client:	Crossbow Technology	Job Number:	J56310
Model:	Mica Z	T-Log Number:	T56371
		Account Manager:	-
Contact:	Bill Fereira		
Spec:	FCC 15.247	Class:	N/A

Run #9c: Out of Band Conducted

High channel at 2480.1 MHz

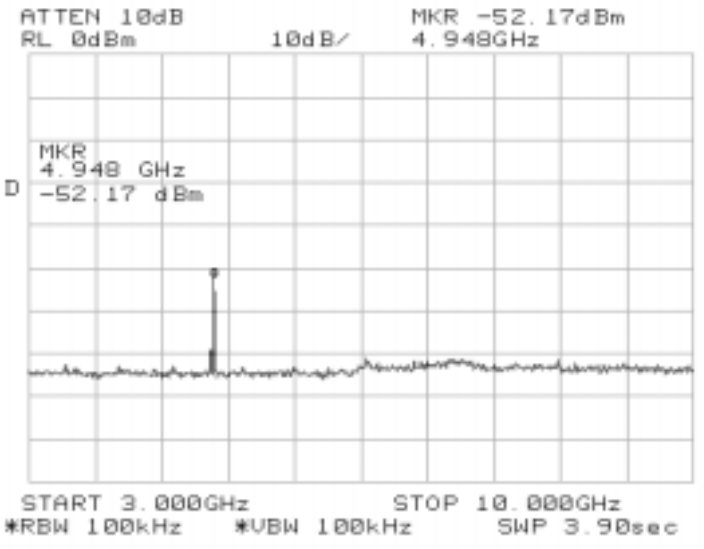


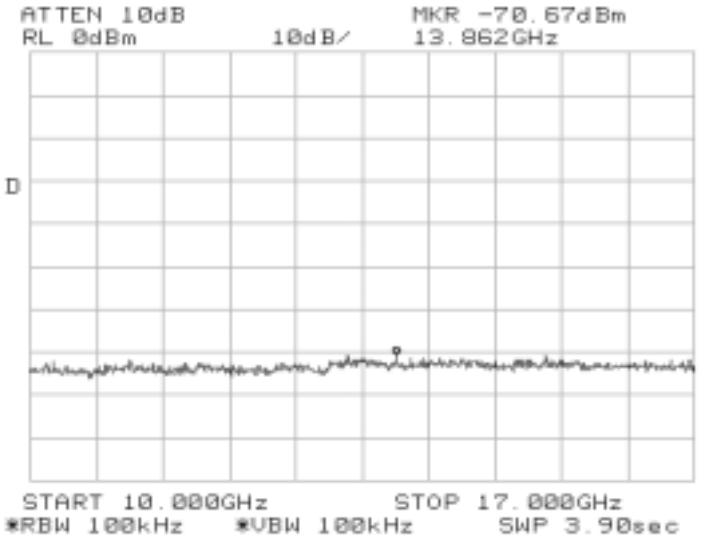


Client:	Crossbow Technology	Job Number:	J56310
Model:	Mica Z	T-Log Number:	T56371
		Account Manager:	-
Contact:	Bill Fereira		
Spec:	FCC 15.247	Class:	N/A

Run #9c: Out of Band Conducted

High channel at 2480.1 MHz





Client:	Crossbow Technology	Job Number:	J56310
Model:	Mica Z	T-Log Number:	T56371
		Account Manager:	-
Contact:	Bill Fereira		
Spec:	FCC 15.247	Class:	N/A

Run #9c: Out of Band Conducted

High channel at 2480.1 MHz

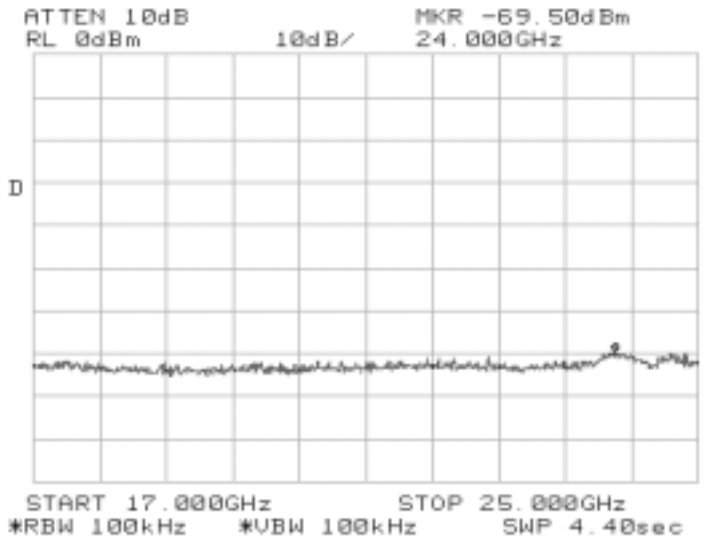


EXHIBIT 3: Test Configuration Photographs

2 Pages

EXHIBIT 4: Proposed FCC ID Label & Label Location

EXHIBIT 5: Detailed Photographs of Crossbow Technology Model Mica ZConstruction

External Photographs 2 Pages
Internal Photographs 4 Pages

EXHIBIT 6: Operator's Manual for Crossbow Technology Model Mica Z

54 Pages

EXHIBIT 7: Block Diagram of Crossbow Technology Model Mica Z

1 Page

EXHIBIT 8: Schematic Diagrams for Crossbow Technology Model Mica Z

4 Pages

EXHIBIT 9: Theory of Operation for Crossbow Technology Model Mica Z

3 Pages

EXHIBIT 10: RF Exposure Information

The module meets the requirements for a portable device that may be used at separation distances of less than 2.5cm from the human body because its output power is below the threshold of $60/f_{GHz}$ mW (25mW for a 2.4GHz device).

The maximum output power to the antenna was measured to be -1.4dBm (0.7mW). As the antenna gain is less than 0dBi the eirp is less than 0.7mW. As the output power is less than 5mW no co-location warnings are required.