Measurement of RF Interference from an I2-IOC Transceiver

For : Freewave Technologies, Inc.
: 1880 S Flatiron Court
: Boulder, CO

P.O. No. : 30185
Date Tested : May 27, 2009 through June 10, 2009
Test Personnel : Mark E. Longinotti
Specification : FCC "Code of Federal Regulations" Title 47, Part 15,
: Subpart C, Section 15.247 for Frequency Hopping
: Spread Spectrum Intentional Radiators within
: The band 2400-2483.5MHz
: Industry Canada RSS-210
: Industry Canada RSS-GEN

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REVISION HISTORY

Revision	Date	Description
—	June 12, 2009	Initial release

Measurement of RF Emissions from an I2-IOC Transceiver

1 INTRODUCTION

1.1 Scope of Tests

This document represents the results of the series of radio interference measurements performed on a Freewave Technologies, Inc. Transceiver, Part No. I2-IOC, (hereinafter referred to as the test item). Serial No. 244-0036 was used for all tests except for time of occupancy and duty cycle correction measurements. Serial No. 244-0073 was used for time of occupancy and duty cycle correction measurements. The test item is a frequency hopping spread spectrum transceiver. The transmitter was designed to transmit in the 2400-2483.5 MHz band using either an Antenna Factory FO-2400-12 12dBi Omni directional antenna or an Antenna Factory YA2400-15 15dBi gain Yagi antenna. The test item was manufactured and submitted for testing by Freewave Technologies, Inc. located in Boulder, CO.

1.2 Purpose

The test series was performed to determine if the test item meets the conducted and radiated RF emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Sections 15.207 and 15.247 for Intentional Radiators. The test series was also performed to determine if the test item meets the conducted RF emission requirements of the Industry Canada Radio Standards Specification, RSS-Gen, Section 7.2.2 and the radiated RF emission requirements of the Industry Canada Radio Standards Specification, RSS-210, Annex 8 for transmitters. Testing was performed in accordance with ANSI C63.4-2003.

1.3 Deviations, Additions and Exclusions

There were no deviations, additions to, or exclusions from the test specification during this test series

1.4 EMC Laboratory Identification

This series of tests was performed by Elite Electronic Engineering Incorporated of Downers Grove, Illinois. The laboratory is accredited by the National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP). NVLAP Lab Code: 100278-0.

1.5 Laboratory Conditions

The temperature at the time of the test was temperature 21C and the relative humidity was 29%.

2 APPLICABLE DOCUMENTS

The following documents of the exact issue designated form part of this document to the extent specified herein:

- Federal Communications Commission "Code of Federal Regulations", Title 47, Part 15, Subpart C, dated 1 October 2008
- 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"
- FCC Public Notice, DA 00-705, "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems", Released March 30, 2000
- Industry Canada RSS-210, Issue 7, June 2007, “Spectrum Management and Telecommunications Radio Standards Specification, Low-power License-exempt radio communication devices (All Frequency Bands): Category I Equipment”
- Industry Canada RSS-GEN, Issue 2, June 2007, “Spectrum Management and Telecommunications Radio Standards Specification, General Requirements and Information for the Certification of radio communication equipment”

3 TEST ITEM SET-UP AND OPERATION

3.1 General Description

The test item is a Transceiver, Part No. I2-IOC. A block diagram of the test item setup is shown as Figure 1 and Figure 2.

3.1.1 Power Input

The test item obtained 12VDC from 2 each 1.8 meters long leads from the output of an AC adaptor, model: KSAC120008W1US. The 2 wires from the output of the AC adaptor were connected to the test item through 2 wires of the 85cm long wiring harness of the test item. The AC adaptor was powered with 115V, 60Hz power.

3.1.2 Peripheral Equipment

The following peripheral equipment was submitted with the test item:

Item	Description
Laptop computer	Used to place the test item in the proper mode. The computer was connected to the test item via the 85cm long, 10 wire wiring harness which included a DB9 connector. For all radiated emissions tests, the computer was disconnected from the test item after the test item was placed in the proper mode.
12dBi gain antenna	Antenna Factory FO-2400-12 dBi omni directional antenna
15dBi gain antenna	Antenna Factory YA2400-15 15dBi gain Yagi antenna

3.1.3 Interconnect Cables

The following interconnect cables were submitted with the test item:

Item	Description
Wiring harness	85cm long, 10 wire wiring harness. 2 wires were used to supply 12VDC to the test item. 8 wires were used to connect to the laptop computer which was used to place the test item in the proper mode.
Coaxial cable	Model No. ASC0504NN. 50 feet of coaxial cable used to connect the test item to the external antennas.

3.1.4 Grounding

The test item was not grounded during the test.

3.2 Operational Mode

For all radiated tests the test item was placed on an 80cm high non-conductive stand. The test item and all peripheral equipment were energized.

The test item could be programmed to operate in one of the following modes:

- Transmit at 2400.768MHz (CH. 01), power =10, ff (band edge tests only)
- Transmit at 2426.27MHz (CH. 4B), power = 10,ff
- Transmit at 2445.62MHz (CH. 83), power = 10,ff
- Transmit at 2464.98MHz (CH. BB), power = 10,ff
- Transmit at 2482.12MHz (CH. ED), power = 10,ff (band edge tests only)
- Frequency Hopping enabled

3.3 Test Item Modifications

No modifications were required for compliance.

4 TEST FACILITY AND TEST INSTRUMENTATION

4.1 Shielded Enclosure

All tests were performed in a 32ft. x 20ft. x 18ft. hybrid ferrite-tile/anechoic absorber lined test chamber. With the exception of the floor, the reflective surfaces of the shielded chamber are lined with ferrite tiles on the walls and ceiling. Anechoic absorber material is installed over the ferrite tile. The floor of the chamber is used as the ground plane. The chamber complies with ANSI C63.4-2003 for site attenuation.

4.2 Test Instrumentation

The test instrumentation and auxiliary equipment used during the tests are listed in Table 8-1. All equipment was calibrated per the instruction manuals supplied by the manufacturer.

Conducted emission tests were performed with a spectrum analyzer in conjunction with a quasi-peak adapter. Radiated emissions were performed with a spectrum analyzer. This receiver allows measurements with the bandwidths specified by the FCC and with the quasi-peak and average detector functions. The spectrum analyzer bandwidth was 120kHz for the 30MHz to 1000MHz radiated emissions data.

4.3 Calibration Traceability

Test equipment is maintained and calibrated on a regular basis. All calibrations are traceable to the National Institute of Standards and Technology (NIST).

4.4 Measurement Uncertainty

All measurements are an estimate of their true value. The measurement uncertainty characterizes, with a specified confidence level, the spread of values which may be possible for a given measurement system.

The measurement uncertainty for these tests is presented below:

Conducted Emission Measurements		
Combined Standard Uncertainty	1.07	-1.07
Expanded Uncertainty (95% confidence)	2.1	-2.1

Radiated Emission Measurements		
Combined Standard Uncertainty	2.26	-2.18
Expanded Uncertainty (95% confidence)	4.5	-4.4

5 TEST PROCEDURES

5.1 Powerline Conducted Emissions

5.1.1 Requirements

Since the test item is normally powered by 12VDC source which is not connected to AC mains, no conducted emissions tests are required.

5.2 20dB Bandwidth

5.2.1 Requirements

Per section 15.247 (a)(1), frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25kHz or the 20dB bandwidth of the hopping channel, whichever is greater.

Alternatively, per section 15.247(a)(1), frequency hopping systems operating in the 2400-2483.5MHz band may have hopping channel carrier frequencies that are separated by 25kHz or two-thirds of the 20dB bandwidth of the hopping channel, whichever is greater, provided the systems operate within an output power no greater than 125mW.

5.2.2 Procedures

The output of the test item was connected to the spectrum analyzer through 40 dB of attenuation. With the hopping function disabled, the test item was allowed to transmit continuously. The frequency hopping channel was set separately to low, middle, and high hopping channels. The span was set to 2 to 3 times the 20dB bandwidth and the resolution bandwidth (RBW) was set to > 1% of the 20dB bandwidth.

The 'Max-Hold' function was engaged. The analyzer was allowed to scan until the envelope of the transmitter bandwidth was defined. The analyzer's display was plotted using a 'screen dump' utility.

5.2.3 Results

The plots on pages 21 through 23 show that the maximum 20 dB bandwidth was 605kHz. The 99% bandwidth was measured to be 1.08MHz.

5.3 Carrier Frequency Separation

5.3.1 Requirements

Per section 15.247 (a)(1), frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25kHz or the 20dB bandwidth of the hopping channel, whichever is greater.

Per section 15.247(a)(1), alternatively, frequency hopping systems operating in the 2400-2483.5MHz band may have hopping channel carrier frequencies that are separated by 25kHz or two-thirds of the 20dB bandwidth of the hopping channel, whichever is greater, provided the systems operate within an output power no greater than 125mW.

5.3.2 Procedures

The output of the test item was connected to the spectrum analyzer through 40dB of attenuation. With the hopping function enabled, the test item was allowed to transmit continuously.

The resolution bandwidth (RBW) was set to > to 1% of the span. The peak detector and 'Max-Hold' function were engaged. The span was set wide enough to capture the peaks of at least two adjacent channels.
When the trace had stabilized after multiple scans, the marker-delta function was used to determine the separation between the peaks of the adjacent channels. The analyzer's display was plotted using a 'screen dump' utility.

5.3.3 Results

Page 24 shows the carrier frequency separation. As can be seen from this plot, the carrier frequency separation is 1.03MHz which is greater than the 20dB bandwidth of the hopping channel (605kHz).

5.4 Number of Hopping Frequencies

5.4.1 Requirements

Per section 15.247(a)(1)(iii), frequency hopping systems operating in the 2400-2483.5MHz band that employ at least 15 hopping channels must have a maximum peak conducted output power that does not exceed 0.125W (21dBm).

Per 14.247(b)(1), frequency hopping systems operating in the 2400- 2483.5MHz band that employ at least 75 non-overlapping hopping channels must have a maximum peak conducted output power that does not exceed 1W (30dBm).

5.4.2 Procedures

The output of the test item was connected to the spectrum analyzer through 40dB of attenuation. With the hopping function enabled, the test item was allowed to transmit continuously.

The resolution bandwidth (RBW) was set to > to 1% of the span. The peak detector and 'Max-Hold' function were engaged. The span was set wide enough to capture the entire frequency band of operation.

The test item’s signal was allowed to stabilize after multiple scans. The number of hopping frequencies was counted. The analyzer's display was plotted using a 'screen dump' utility.

5.4.3 Results

Pages 25 through 27 show the number of hopping frequencies. As can be seen from this plot, the number of hopping frequencies is 80 which is greater than 75 which is the minimum number of required hopping frequencies for systems operating in the 2400-2483.5MHz band that have a maximum peak conducted output power that does not exceed 1W (30dBm).

5.5 Time of Occupancy

5.5.1 Requirements

Per section 15.247(a)(1)(iii), for frequency hopping systems operating in the 2400-2483.5MHz band, the average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

5.5.2 Procedures

The output of the test item was connected to the spectrum analyzer through 40dB of attenuation. With the hopping function enabled, the test item was allowed to transmit continuously.

The resolution bandwidth (RBW) was set to 1MHz. The peak detector and 'Max-Hold' function were engaged. With the span set to 0Hz, the sweep time was adjusted to capture a single event in order to measure the dwell time per hop. The analyzer's display was plotted using a 'screen dump' utility. Then, the sweep time was expanded to 0.4 seconds multiplied by the number of hopping channels employed to capture the number of hops in the appropriate sweep time. A single sweep was made. The analyzer's display was plotted using a 'screen dump' utility.

The dwell time in the specified time period was then calculated from dwell time per hop multiplied by the number

of hops in the specified time period.

5.5.3 Results

Pages 28 and 29 show the plots for the time of occupancy (dwell time). As can be seen from the plots, the time of occupancy can be determined by 13.4msec per hop multiplied by 20 hops. This calculated value is equal to 0.268 seconds which is less than the 0.4 seconds maximum allowed.

5.6 Peak Output Power

5.6.1 Requirements

Per section 15.247(b)(1), for frequency hopping systems operating in the 2400-2483.5MHz band and employing at least 75 non-overlapping hopping channels, the maximum peak output conducted power shall not be greater than 1W (30dBm).

Per Freewave Technologies, Inc. personnel, the system will be used in point-to-point operation. The test item will be used with either a 15dBi gain antenna or a 12dBi gain antenna. Per section 15.247(c)(1)(i), system that operate in the 2400 – 2483.5MHz band that are used exclusively for fixed, point-to-point operations, may employ transmitting antennas with directional gain greater than 6dBi provided the maximum conducted output power of the intentional radiator is reduced by 1dB for every 3 dB that the directional gain of the antenna exceeds 6dBi. Since the 15dBi gain antenna exceeds the 6dBi gain antenna by 9dB, the output power must be reduced by 3dB (3dB = (15dBi-6dBi)/3). Therefore the maximum peak conducted output power must not exceed 27dBm (0.5W).
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5.6.2 Procedures

The output of the test item was connected to a power meter through 40dB of attenuation. The maximum meter reading was recorded. The peak power output was calculated for the low, middle and high hopping frequencies.

5.6.3 Results

The results are presented on page 30. The maximum peak conducted output power from the transmitter was 0.268W (24.29 dBm) which is below the 0.5 Watt limit.

5.7 Duty Cycle Factor Measurements

5.7.1 Procedures

The duty cycle factor is used to convert peak detected readings to average readings. This factor is computed from the time domain trace of the pulse modulation signal.

With the transmitter set up to transmit for maximum data rate, the time domain trace is displayed on the spectrum analyzer. This trace is obtained by tuning center frequency to the transmitter frequency and then setting a zero span width and a sweep time of 19.5msec. The amplitude settings are adjusted so that the on/off transitions clear the 4th division from the bottom of the display. The markers are set at the beginning and end of a pulse. The sweep time was then increased to 100msec to show the number of pulses in a 100msec period. The duty cycle is then computed as the On-time/ 100msec.

5.7.2 Results

The plots of the duty cycle are shown on data pages 31 and 32. The duty cycle correction factor was calculated to

be 20xlog(13.424msec/100msec) = -17.44dB.

5.8 Spurious Emissions

5.8.1 Antenna Conducted

5.8.1.1 Requirements

Per section 15.247(c), the spurious emissions in any 100 kHz BW outside the frequency band must be at least 20dB below the highest 100 kHz BW level measured within the band.

5.8.1.2 Procedures

The output of the test item was connected to the spectrum analyzer through 40dB of attenuation. The frequency hopping function was disabled. The resolution bandwidth (RBW) was set to 100kHz. The peak detector and 'Max-Hold' function were engaged. The emissions in the frequency range from 30MHz to 25GHz were observed and plotted separately with the test item transmitting at low, middle and high hopping frequencies.

5.8.1.3 Results

The results of the antenna conducted emissions levels were plotted. These plots are presented on pages 33 through 47. These plots show that the spurious emissions were at least 20 dB below the level of the fundamental.

5.8.2 Radiated Spurious Emissions

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must comply with the radiated emission limits specified in §15.209(a).

Paragraph 15.209(a) has the following radiated emission limits:

Frequency MHz	Field Strenght (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	3
30.0-88.0	100	3
88.0-216.0	150	3
216.0-960.0	200	3
Above 960	500	3

5.8.3 Procedures

Radiated measurements were performed in a 32ft. x 20ft. x 14ft. high shielded enclosure. The shielded enclosure prevents emissions from other sources, such as radio and TV stations from interfering with the measurements. All powerlines and signal lines entering the enclosure pass through filters on the enclosure wall. The powerline filters prevent extraneous signals from entering the enclosure on these leads.

Preliminary radiated emissions tests were performed to determine the emission characteristics of the test item. For the preliminary test, a broadband measuring antenna was positioned at a 3 meter distance from the test item.

The entire frequency range from 30MHz to 25GHz was investigated using a peak detector function.

The final open field emission tests were then manually performed over the frequency range of 30MHz to 25GHz.

1) For all emissions in the restricted bands, the following procedure was used:
   a) The field strengths of all emissions below 1 GHz were measured using a bi-log antenna. The bi-log antenna was positioned at a 3 meter distance from the test item. A peak detector with a resolution bandwidth of 100 kHz was used on the spectrum analyzer.
   b) The field strengths of all emissions above 1 GHz were measured using a double-ridged waveguide antenna. The waveguide antenna was positioned at a 3 meter distance from the test item. A peak detector with a resolution bandwidth of 1 MHz was used on the spectrum analyzer.
   c) To ensure that maximum or worst case emission levels were measured, the following steps were taken when taking all measurements:
      i) The test item was rotated so that all of its sides were exposed to the receiving antenna.
      ii) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.
      iii) The measuring antenna was raised and lowered for each antenna polarization to maximize the readings.
      iv) In instances were it was necessary to use a shortened cable between the measuring antenna and the spectrum analyzer. The measuring antenna was not raised or lowered to ensure maximized readings, instead the test item was rotated through all axis to ensure the maximum readings were recorded for the test item.
   d) For all radiated emissions measurements below 1 GHz, if the peak reading is below the limits listed in 15.209(a), no further measurements are required. If however, the peak readings exceed the limits listed in 15.209(a), then the emissions are remeasured using a quasi-peak detector.
   e) For all radiated emissions measurements above 1 GHz, the peak readings must comply with the 15.35(b) limits. 15.35(b) states that when average radiated emissions measurements are specified, there also is a limit on the peak level of the radiated emissions. The limit on the peak radio frequency emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test. Therefore, all peak readings above 1 GHz must be no greater than 20 dB above the limits specified in 15.209(a).
   f) Next, for all radiated emissions measurements above 1GHz, the resolution bandwidth was set to 1MHz. The analyzer was set to linear mode with a 10Hz video bandwidth in order to simulate an average detector. An average reading was taken. If the dwell time per channel of the hopping signal is less than 100msec, then the reading obtained with the 10 Hz video bandwidth may be further adjusted by a “duty cycle correction factor”, derived from 20*log(dwell time/100msec). These readings must be no greater than the limits specified in 15.209(a).

5.8.4 Results

Preliminary radiated emissions plots with the test item transmitting at 2426.27MHz, 2445.62MHz, and 2464.98MHz with the 12dBi gain antenna are shown on pages 48 through 71. Final radiated emissions data with the test item transmitting at 2426.27MHz, 2445.62MHz, and 2464.98MHz with the 12dBi gain antenna are presented on data pages 96 through 101. As can be seen from the data, all emissions measured from the test item were within the specification limits. The emissions level closet to the limit (worst case) occurred at 4852.5MHz. The emissions level at this frequency was 2.7dB within the limit.

Preliminary radiated emissions plots with the test item transmitting at 2426.27MHz, 2445.62MHz, and

2464.98MHz with the 15dBi gain antenna are shown on pages 72 through 95. Final radiated emissions data with the test item transmitting at 2426.27MHz, 2445.62MHz, and 2464.98MHz with the 15dBi gain antenna are presented on data pages 102 through 107. As can be seen from the data, all emissions measured from the test item were within the specification limits. The emissions level closet to the limit (worst case) occurred at 4852.5MHz. The emissions level at this frequency was 0.6dB within the limit.

Photographs of the test configuration which yielded the highest, or worst case, radiated emission levels are shown on Figure 3 through Figure 5.

5.9 Band Edge Compliance

5.9.1 Requirements

Per section 15.247(d), the emissions at the band-edges must be at least 20dB below the highest level measured within the band but attenuation below the general limits listed in 15.209(a) is not required. In addition, the radiated emissions which fall in the restricted band beginning at 2483.5 MHz must meet the general radiated emissions limits of 15.209(a).

5.9.2 Procedures

5.9.2.1 Low Band Edge

1) The output of the test item was connected to the spectrum analyzer through 40dB of attenuation.
2) The test item was set to transmit continuously at the channel closest to the low band-edge (hopping function disabled).
3) To determine the band edge compliance, the following spectrum analyzer settings were used:

    a. Center frequency = low band-edge frequency.
    b. Span = Wide enough to capture the peak level of the emission operating on the channel closest to the band-edge, as well as any modulation products which fall outside of the authorized band of operation.
    c. Resolution bandwidth (RBW) = at least 1% of the span.
    d. The 'Max-Hold' function was engaged. The analyzer was allowed to scan until the envelope of the transmitter bandwidth was defined.
    e. The marker was set on the peak of the in-band emissions. A display line was placed 20dB down from the peak of the in-band emissions. All emissions which fall outside of the authorized band of operation must be below the 20dB down display line. (All emissions to the left of the center frequency (band-edge) must be below the display line.)
    f. The analyzer's display was plotted using a 'screen dump' utility.

4) Step 3) was repeated with the frequency hopping function enabled.

5.9.2.2 High Band Edge

1) The test item was setup inside the test chamber on a non-conductive stand. The output of the test item was connected to the 12dBi gain antenna.
2) A broadband measuring antenna was placed at a test distance of 3 meters from the test item.
3) The test item was maximized for worst case emissions at the measuring antenna. A peak reading was taken with a resolution bandwidth of 1MHz and a video bandwidth of 1MHz or greater. An average reading was then taken with a resolution bandwidth of 1MHz and a video bandwidth of 10Hz. The maximum peak and average meter readings were recorded.
4) To determine the band edge compliance, the following spectrum analyzer settings were used:

a. Span = Wide enough to capture the peak level of the emission operating on the channel closest to the band-edge, as well as any modulation products which fall outside of the authorized band of operation.
b. Resolution bandwidth (RBW) = at least 1% of the span.
c. The 'Max-Hold' function was engaged. The analyzer was allowed to scan until the envelope of the transmitter bandwidth was defined.
d. The marker was set on the peak of the in-band emissions. This level corresponds to the maximized peak reading previously taken. The "marker-delta" method described in Public Notice DA 00-705 was then used to determine bandedge compliance. The delta between the marker and the general limit (74dBuV/m) was calculated by subtracting the general limit (74dBuV/m) from the maximum reading taken with a 1MHz bandwidth. This delta represents how far below the marker the emissions outside of the authorized band of operation must be. A display line was placed at this level. All emissions which fall outside of the authorized band of operation must be below the display line. (All emissions to the right of the band-edge must be below the display line.)
e. The analyzer's display was plotted using a 'screen dump' utility.

5) Step 4) was repeated with the frequency hopping function enabled.
6) Steps 1) through 4) were repeated with output of the test item connected to the 15dBi gain antenna.

5.9.3 Results

Pages 108 and 109 show the low frequency band-edge compliance results. As can be seen from these plots, the conducted emissions at the low end band edge are within the 20 dB down limits.

Pages 110 through 113 show the high frequency band-edge compliance results. As can be seen from the plots, the radiated emissions at the high end band-edge are within the general limits when tested with the 12dBi gain antenna and the 15dBi gain antenna.

6 CONCLUSIONS

It was determined that the Freewave Technologies, Inc. I2-IOC frequency hopping spread spectrum Transceiver, Serial No. 244-0036 (and Serial No. 244-0073 used for time of occupancy and duty cycle correction measurements) , did fully meet the conducted and radiated emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Sections 15.207 and 15.247 for Intentional Radiators Operating within the 2400-2483.5 MHz band, and Industry Canada’s RSS-210 for Low-power License-exempt radio communication devices when tested per ANSI C63.4-2003.

7 CERTIFICATION

Elite Electronic Engineering Incorporated certifies that the information contained in this report was obtained under conditions which meet or exceed those specified in the test specifications.

The data presented in this test report pertains to the test item at the test date. Any electrical or mechanical modification made to the test item subsequent to the specified test date will serve to invalidate the data and void this certification.

8 ENDORSEMENT DISCLAIMER

This report must not be used to claim product endorsement by NVLAP or any agency of the US Government.

EQUIPMENT LIST

Table 8-1 Equipment List

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Due Date
APW1	PREAMPLIFIER	PLANAR ELECTRONICS	PE2-30-20G20R6G-3R0	PL2927/0646	20GHZ-26.5GHZ	4/3/2009	4/3/2010
APW2	PREAMPLIFIER	PLANAR ELECTRONICS	PE2-35-120-5R0-10	PL2925	1GHZ-20GHZ	12/16/2008	12/16/2009
MPC1	DUAL POWER METER	HEWLETT PACKARD	EPM-442A	US37480258	0.1MHZ-50GHZ	2/11/2009	2/11/2010
MPCI	POWER SENSOR	HEWLETT PACKARD	8482A	US3318A27650	0.1-4200MHZ	4/28/2009	4/28/2010
NHG1	STANDARD GAIN HORN ANTENNA	NARDA	638	---	18-26.5GHZ	NOTE 1	
NTA1	BILOG ANTENNA	CHASE EMC LTD.	BILOG CBL6112	2054	0.03-2GHZ	9/2/2008	9/2/2009
NWI1	RIDGED WAVE GUIDE	AEL	H1498	154	2-18GHZ	10/25/2008	10/25/2009
RBA0	EMI TEST RECEIVER	ROHDE & SCHWARZ	ESIB26	100145	20HZ-26.5GHZ	2/18/2009	2/18/2010
RBB0	EMI TEST RECEIVER 20HZ TO 40 GHZ.	ROHDE & SCHWARZ	ESIB40	100250	20 HZ TO 40GHZ	3/11/2009	3/11/2010
RBD1	EMI TEST RECEIVER	ROHDE & SCHWARZ	ESU40	100009	20Hz-40GHz	9/10/2009	9/10/2010
SBA1	DC POWER SUPPLY	APLAB	ZS3205	99071032	0-32VDC;0-5A	NOTE 1	
T2DH	20DB, 25W ATTENUATOR	WEINSCHEL	46-20-34	BN1039	DC-18GHZ	1/22/2009	1/22/2010
T2DI	20DB, 25W ATTENUATOR	WEINSCHEL	46-20-34	BN1041	DC-18GHZ	12/4/2008	12/4/2009
T2DN	20DB, 25W ATTENUATOR	WEINSCHEL	46-20-34	BS2147	DC-18GHZ	8/29/2008	8/29/2009
T2S8	20DB 25W ATTENUATOR	WEINSCHEL	46-20-34	BV3541	DC-18GHZ	1/22/2009	1/22/2010
XPR0	HIGH PASS FILTER	K&L MICROWAVE	11SH10-4800/X20000	001	4.8-20GHZ	7/30/2008	7/30/2009

Create your equipment list using the database on the mainframe. Create a test equipment list. The output of this list will have a “J” prefix, followed by the job and phase number. FTP this output file to your local computer. Open the file using Word; select and copy the text here using Edit, then Paste Special, and finally Unformatted Text. That way, the text will take on the attributes of the Equipment List Text Style contained in this paragraph. Delete this paragraph when finished.

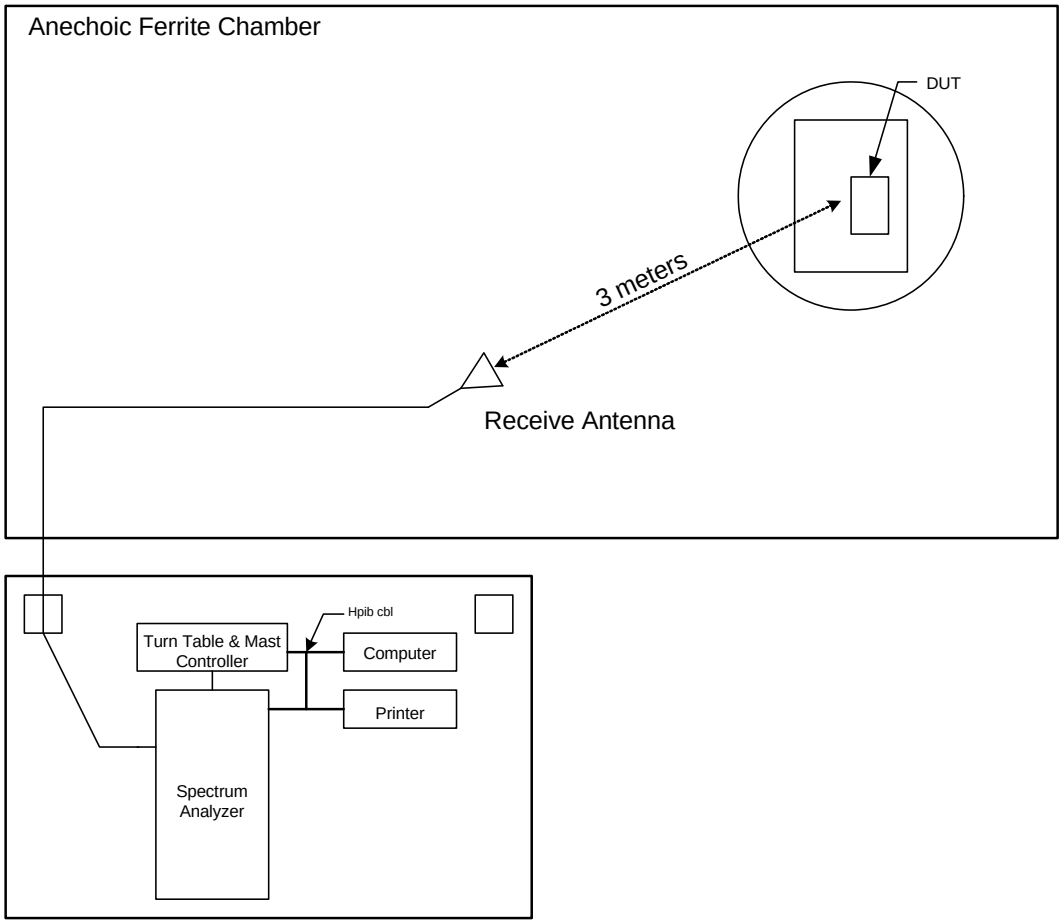


FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

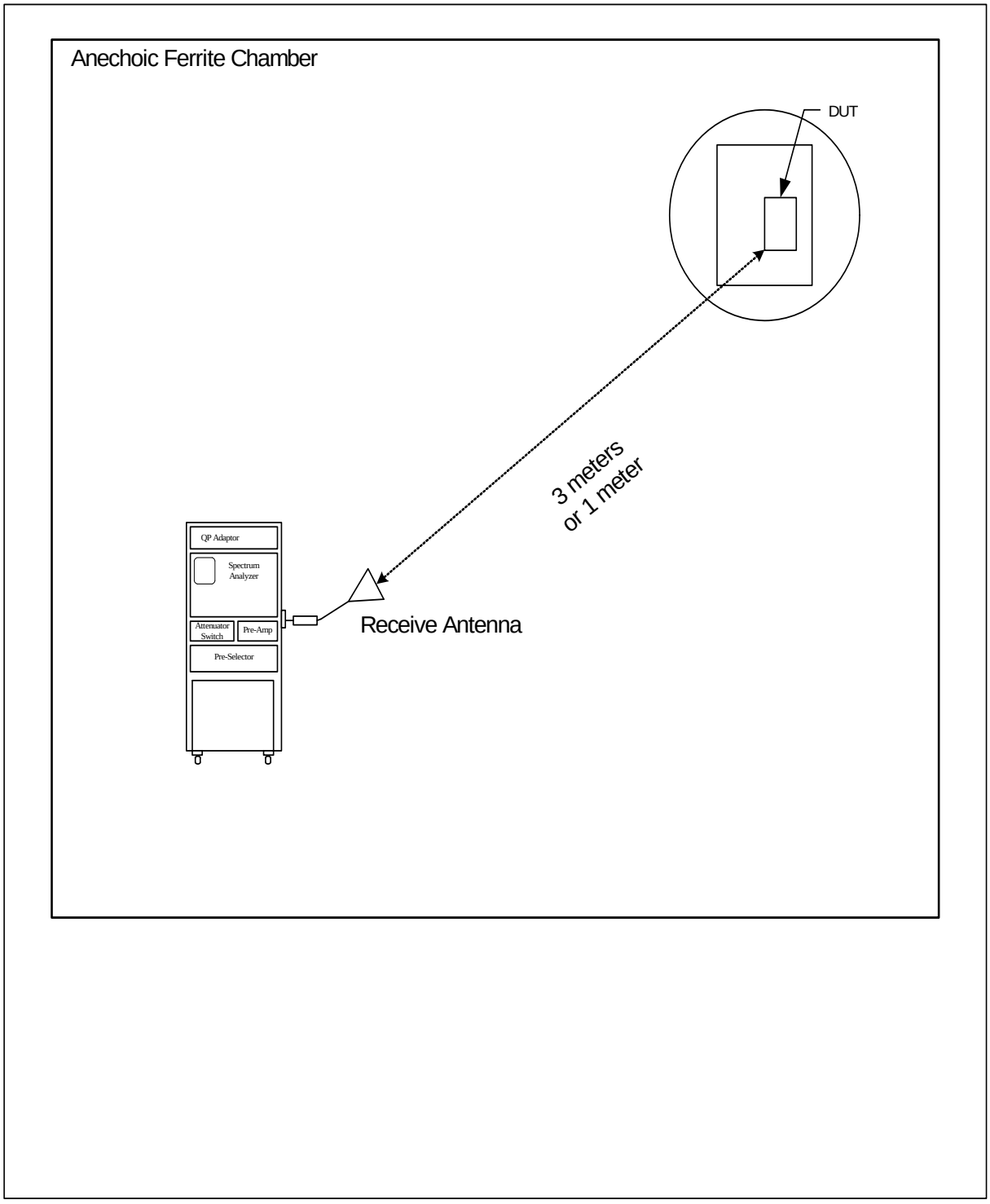
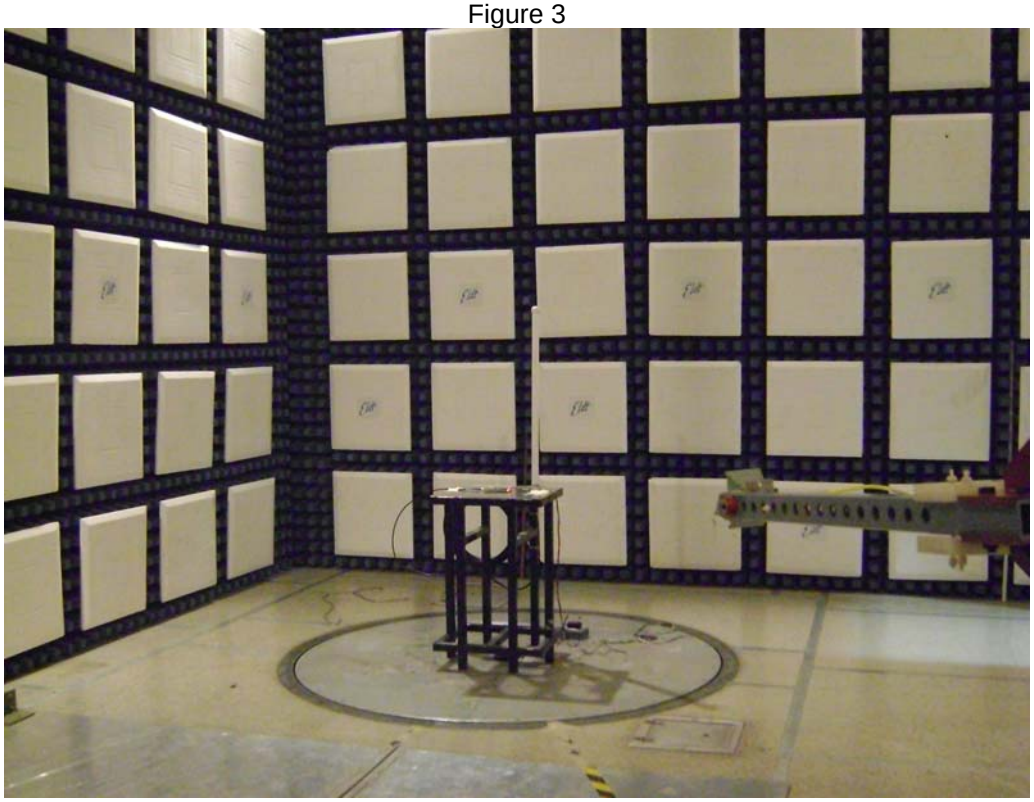
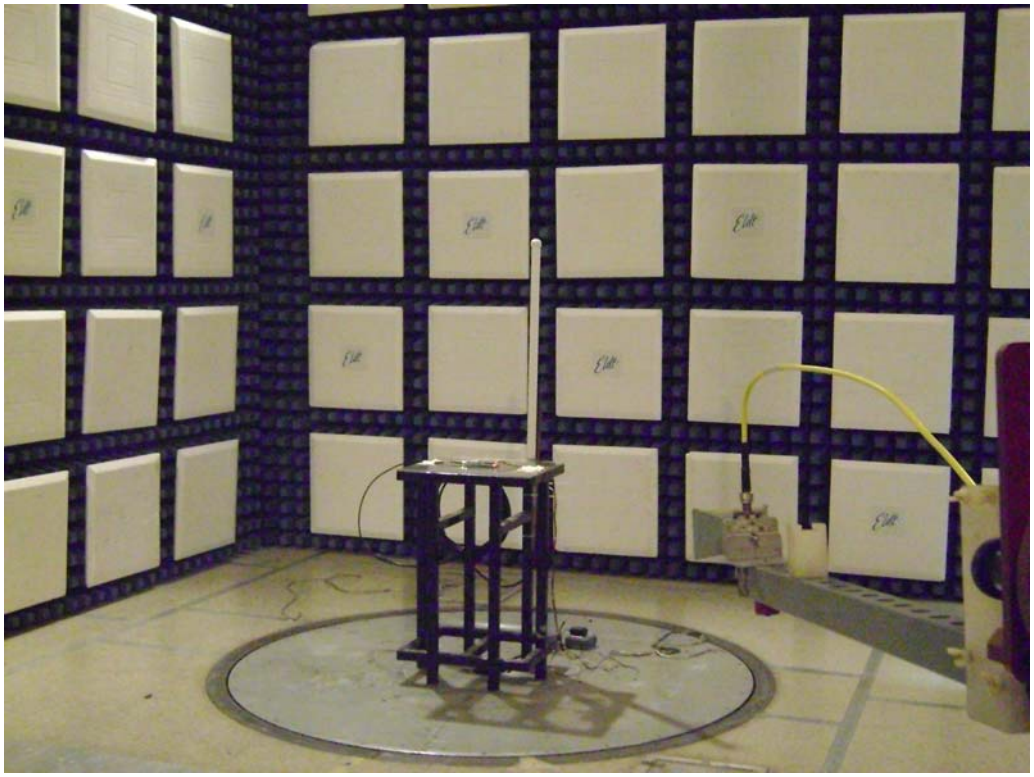


Figure 2: BLOCK DIAGRAM OF TEST SETUP FOR RADIATED EMISSIONS ABOVE 18GHZ

Figure 3

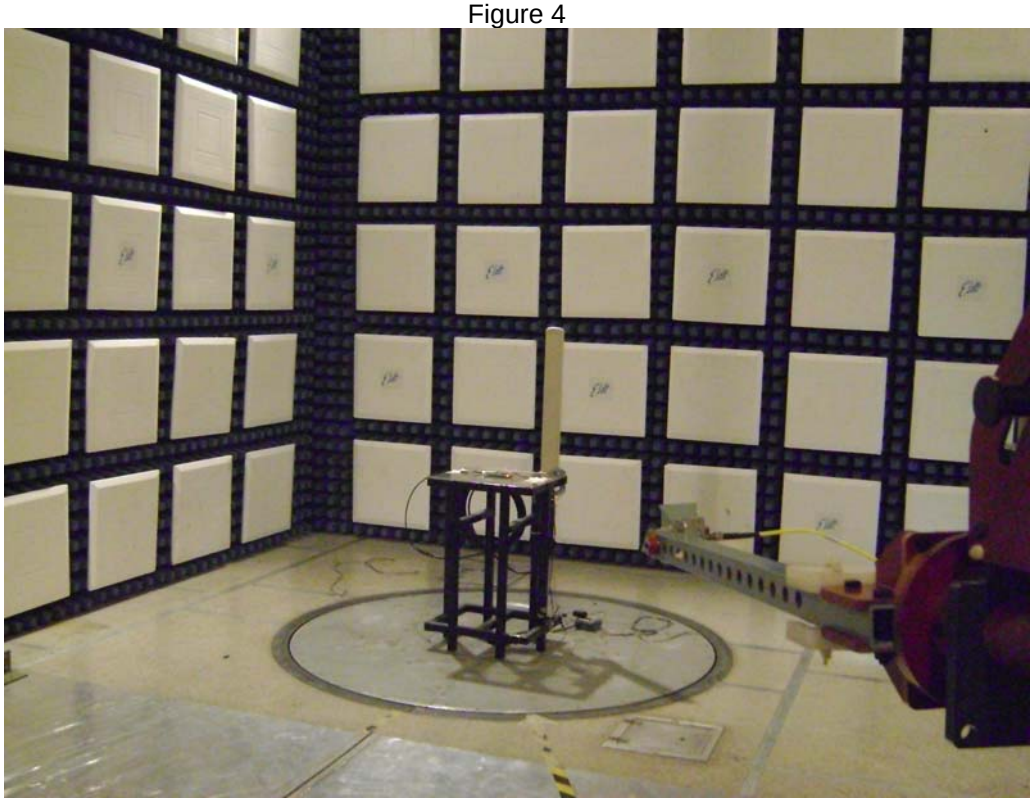


Test Setup for Radiated Emissions, 12dBi gain antenna – 2GHz to 18GHz, Horizontal Polarization

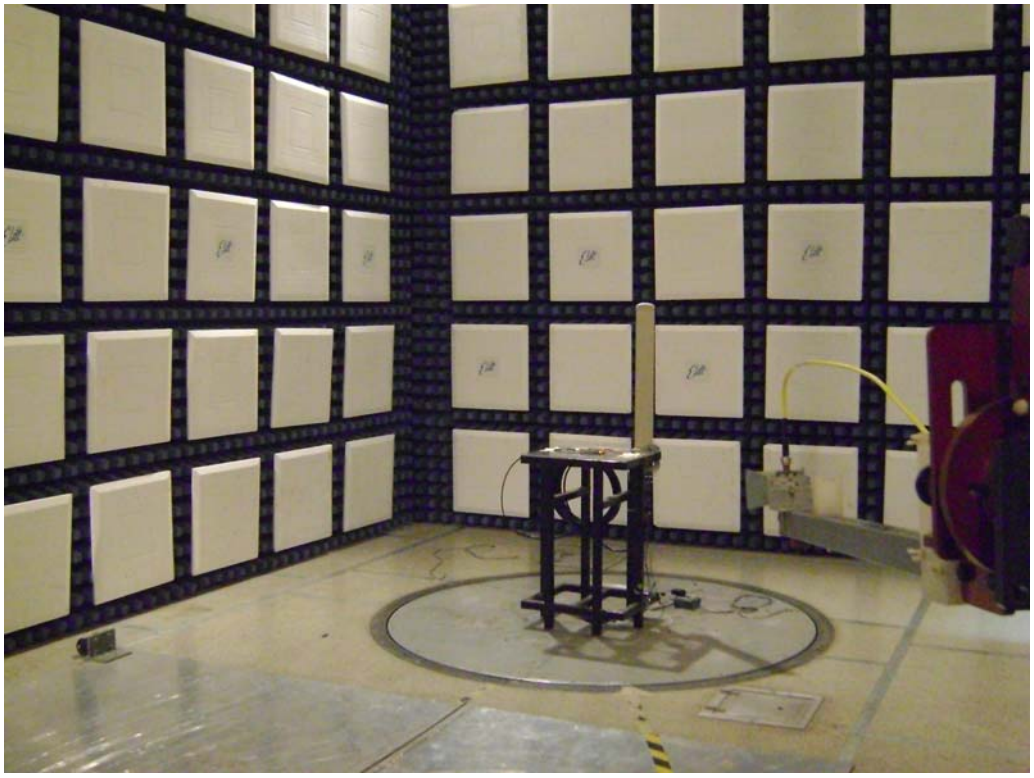


Test Setup for Radiated Emissions, 12dBi gain antenna – 2GHz to 18GHz, Vertical Polarization

Figure 4



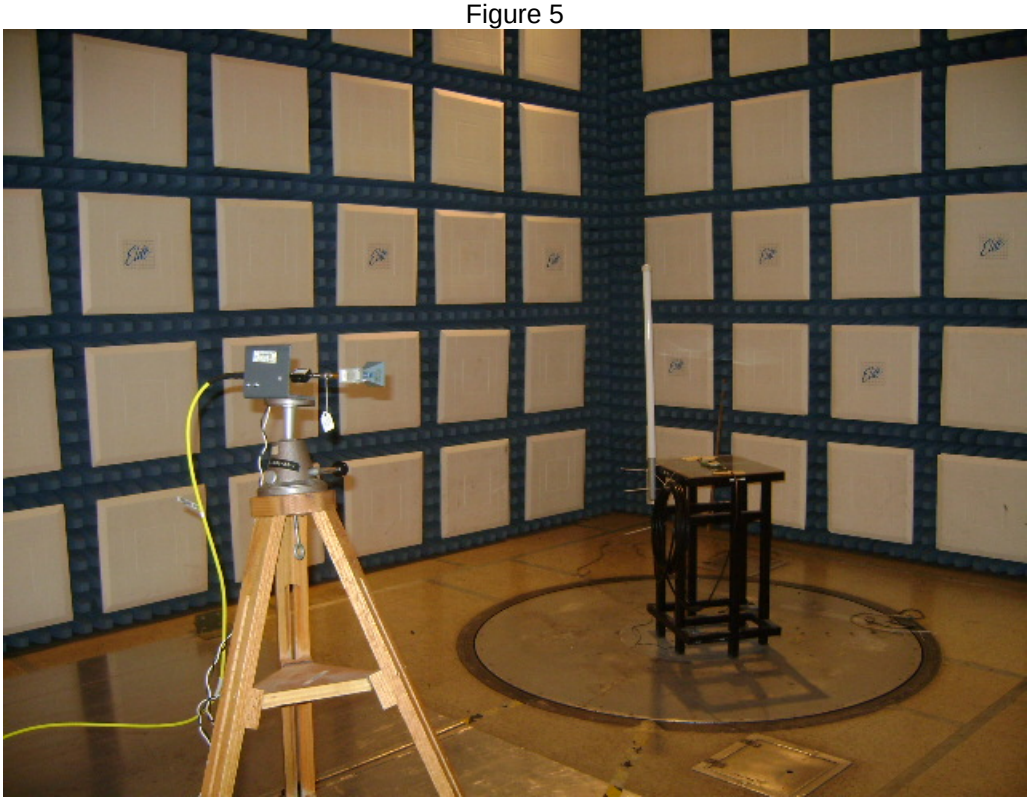
Test Setup for Radiated Emissions, 15dBi gain antenna – 2GHz to 18GHz, Horizontal Polarization



Test Setup for Radiated Emissions 15dBi gain antenna – 2GHz to 18GHz, Vertical

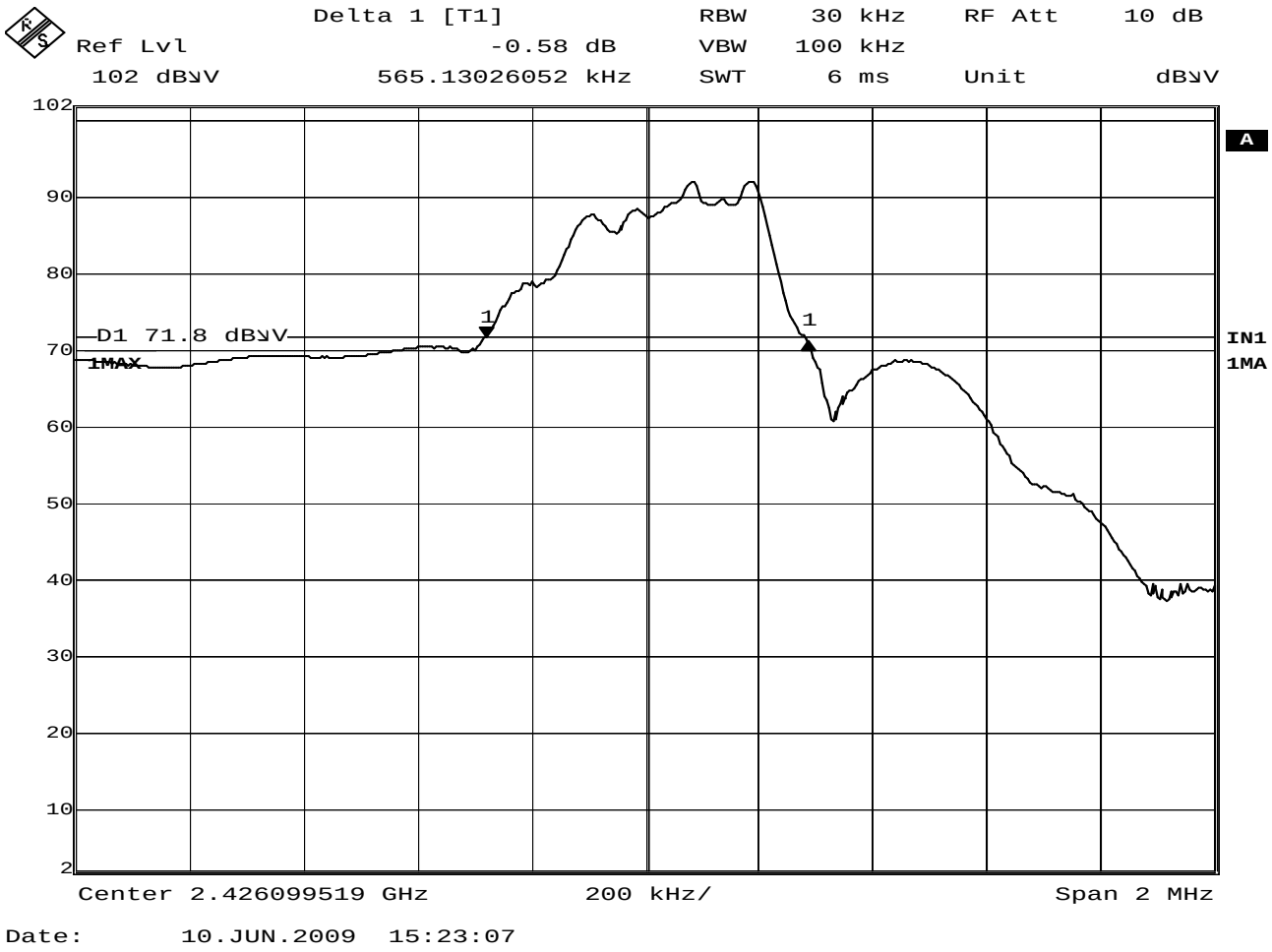
Polarization

Figure 5



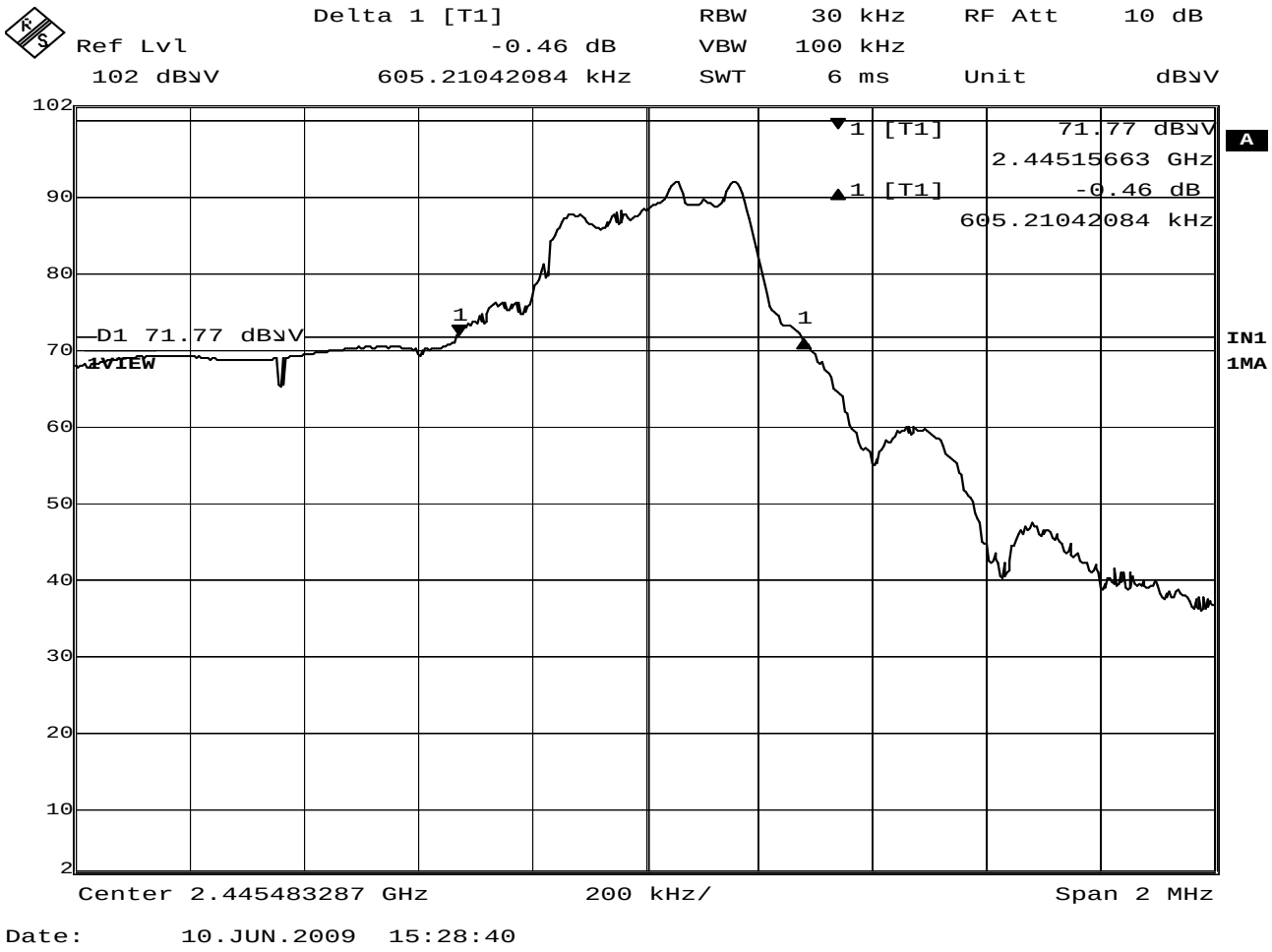
Test Setup for Radiated Emissions, 12dBi gain antenna – 18GHz to 25GHz, Horizontal Polarization

Test Setup for Radiated Emissions 12Bi gain antenna – 18GHz to 25GHz, Vertical Polarization



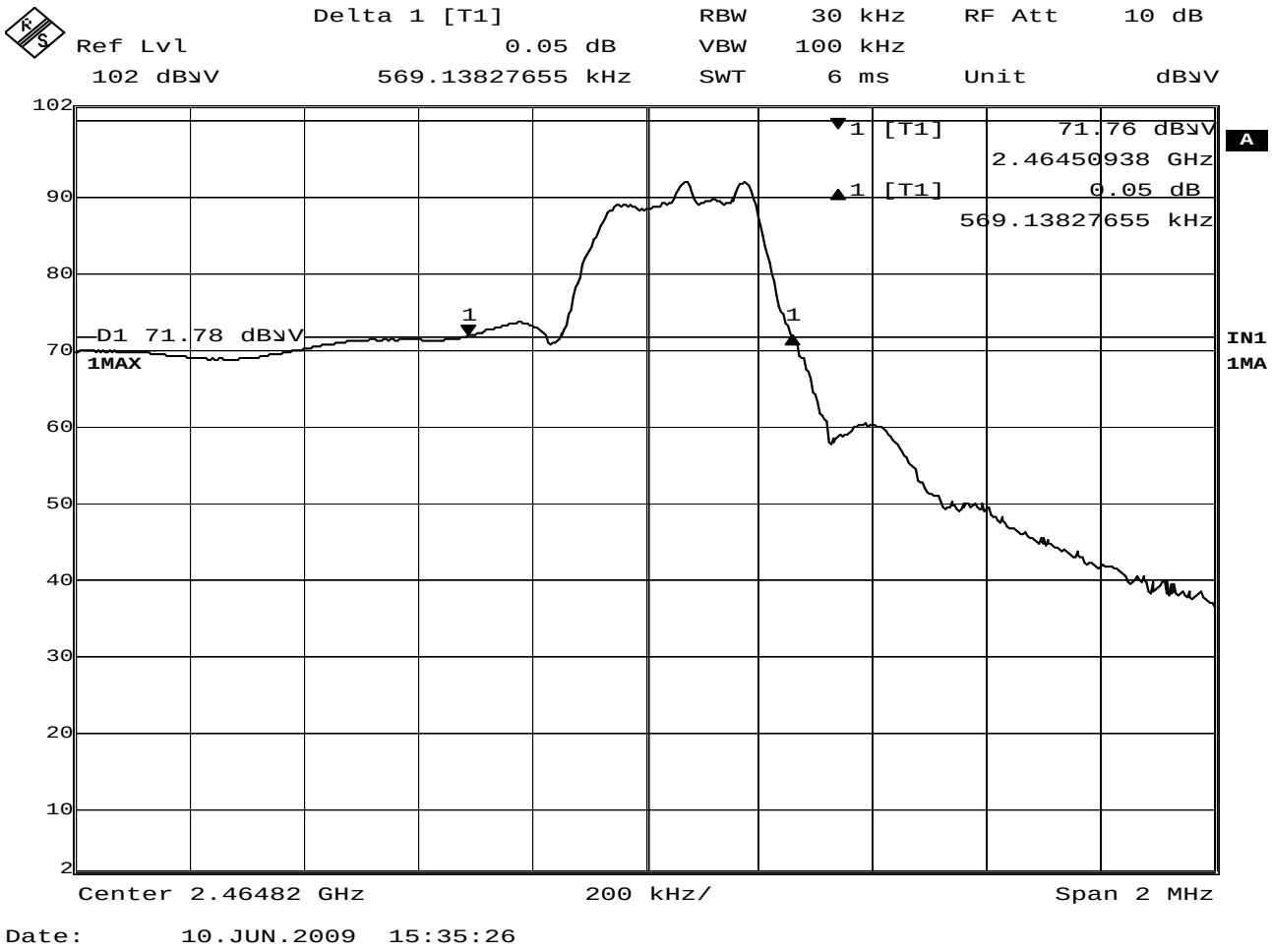
FCC 15.247 20dB Bandwidth

MANUFACTURER	: Freewave Technologies
PART NUMBER	: I2-IOC
SERIAL NUMBER	: 244-0036
TEST MODE	: Tx @ 2426.27MHz(Channel 4B)
TEST PARAMETER	: 20dB bandwidth = 565.13kHz
EQUIPMENT USED	: RBA0,T2DI,T2DH



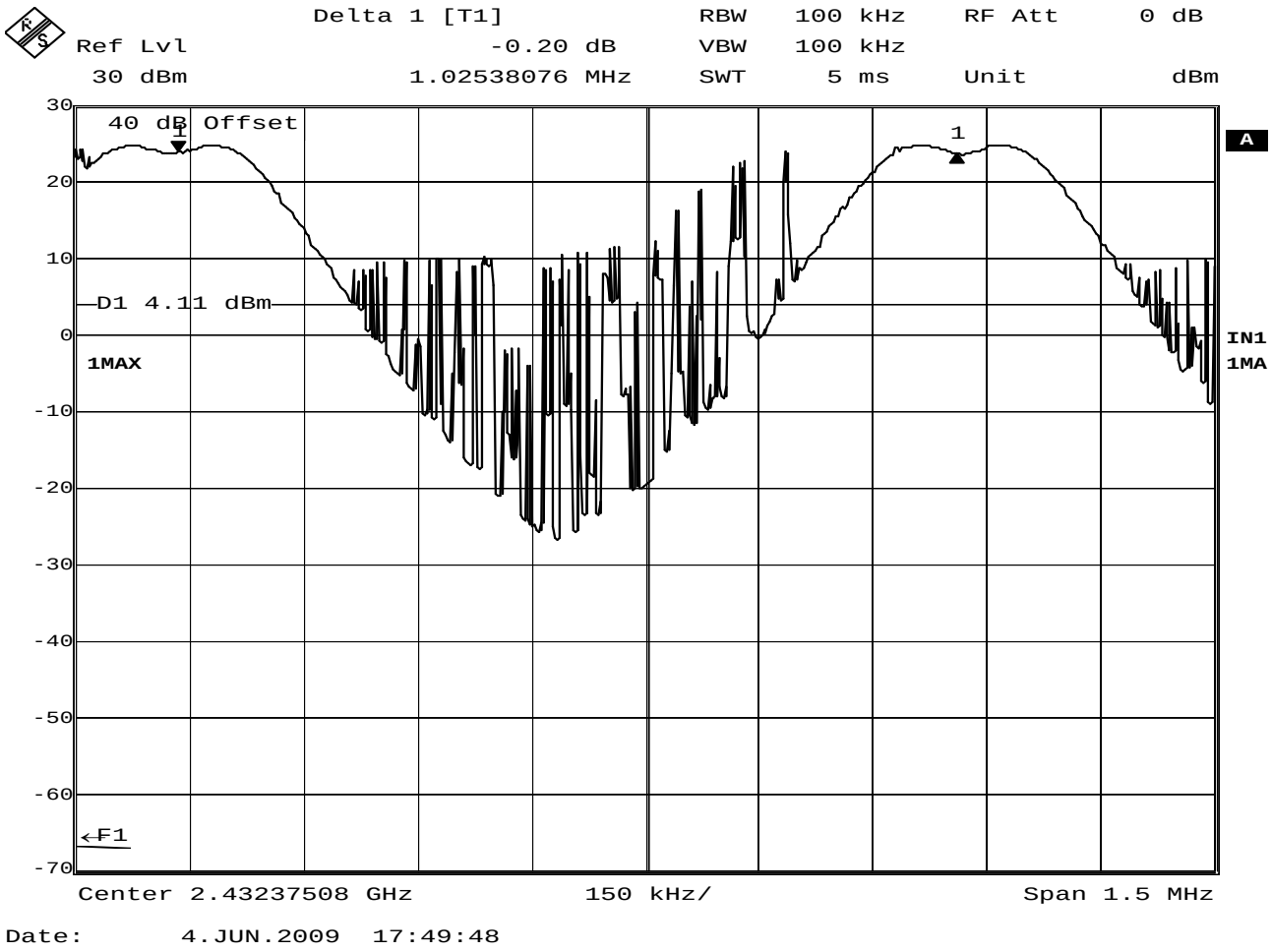
FCC 15.247 20dB Bandwidth

MANUFACTURER	: Freewave Technologies
PART NUMBER	: I2-IOC
SERIAL NUMBER	: 244-0036
TEST MODE	: Tx @ 2445.62MHz(Channel 83)
TEST PARAMETER	: 20dB bandwidth = 605.21kHz
EQUIPMENT USED	: RBA0,T2DI,T2DH



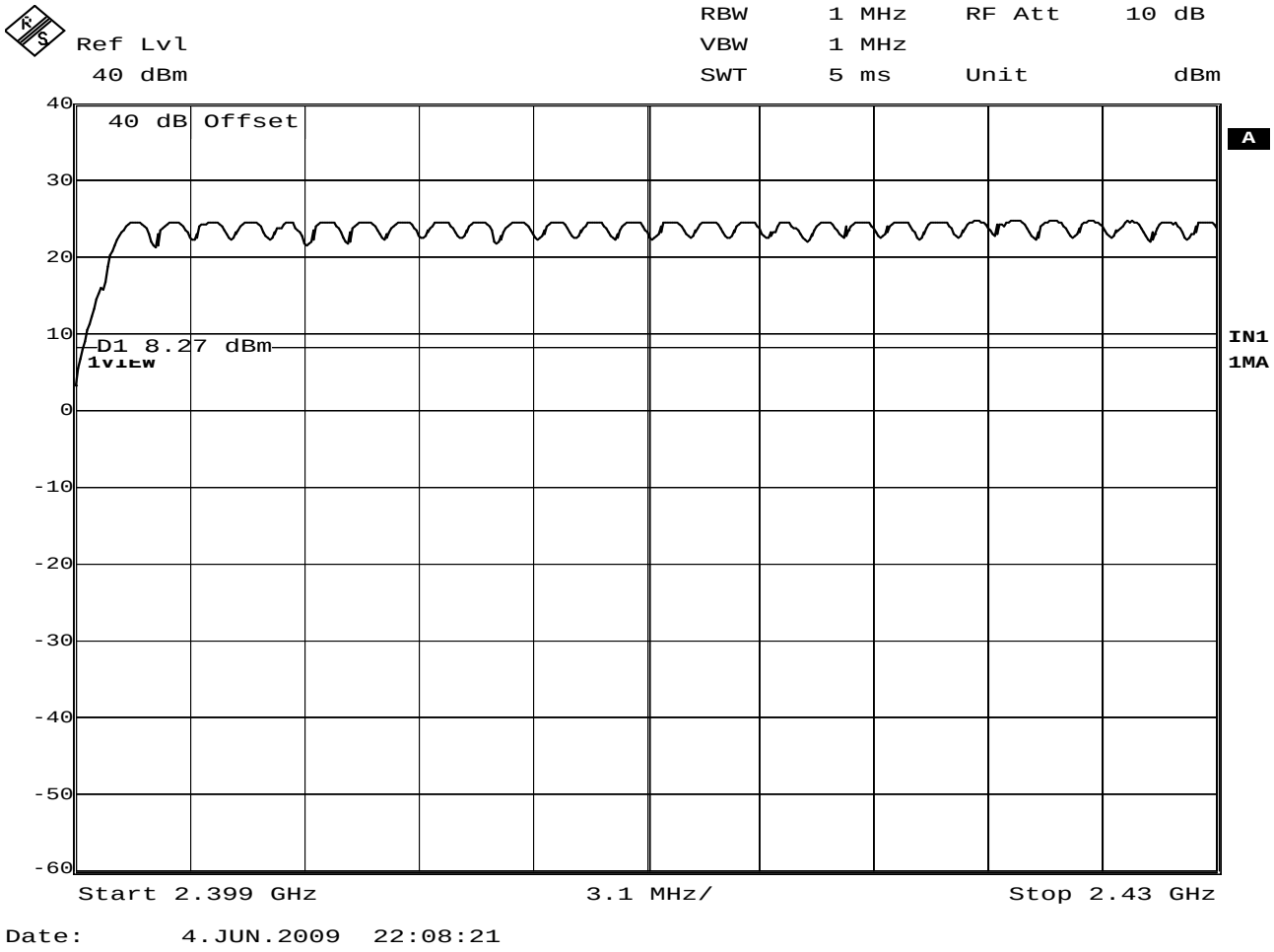
FCC 15.247 20dB Bandwidth

MANUFACTURER	: Freewave Technologies
PART NUMBER	: I2-IOC
SERIAL NUMBER	: 244-0036
TEST MODE	: Tx @ 2464.98MHz(Channel 83)
TEST PARAMETER	: 20dB bandwidth = 569.14kHz
EQUIPMENT USED	: RBA0,T2DI,T2DH



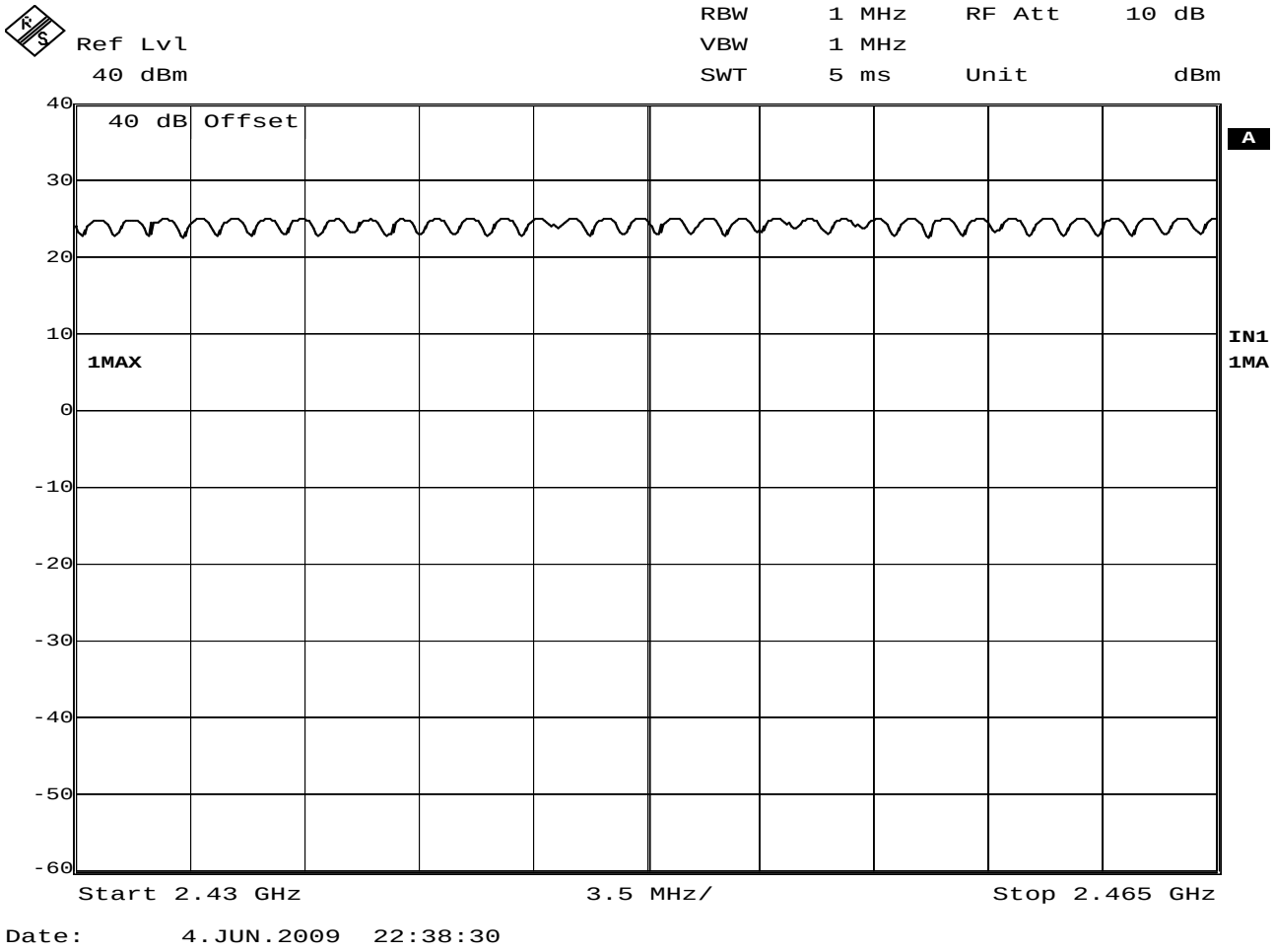
FCC 15.247 Carrier Frequency Separation

MANUFACTURER	: Freewave Technologies
PART NUMBER	: I2-IOC
SERIAL NUMBER	: 244-0036
TEST MODE	: Hopping Enabled
TEST PARAMETER	: Carrier Frequency Separation = 1.03MHz
EQUIPMENT USED	: RBB0,T2DH,T2DN



FCC 15.247 Number of Hopping Frequencies

MANUFACTURER	: Freewave Technologies
PART NUMBER	: I2-IOC
SERIAL NUMBER	: 244-0036
TEST MODE	: Hopping Enabled
TEST PARAMETER	: Number of Hopping Channels
	: from 2400-2430MHz = 29
EQUIPMENT USED	: RBB0,T2DH,T2DN



FCC 15.247 Number of Hopping Frequencies

MANUFACTURER : Freewave Technologies
PART NUMBER : I2-IOC
SERIAL NUMBER : 244-0036
TEST MODE : Hopping Enabled
TEST PARAMETER : Number of Hopping Channels
: from 2430-2465MHz = 34
EQUIPMENT USED : RBB0,T2DH,T2DN