Measurement of RF Interference from a Master Station Transceiver

For : Twisthink, LLC
: 130 Central Avenue, Suite 400
: Holland, MI

P.O. No. : 267
Date Received : June 16, 2010
Date Tested : June 16, 2010 through July 20, 2010
Test Personnel : Mark E. Longinotti
Specification : FCC "Code of Federal Regulations" Title 47, Part 15,
: Subpart C, Section 15.247 Digital
: Modulation Intentional Radiators Operating within
: The band 2400-2483.5MHz
: FCC "Code of Federal Regulations" Title 47, Part 15,
: Subpart B, For Receivers

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REVISION HISTORY

Revision	Date	Description
—	July 20, 2010	Initial release

Measurement of RF Emissions from a Master Station Transceiver

1 INTRODUCTION

1.1 Scope of Tests

This document represents the results of the series of radio interference measurements performed on a Twisthink, LLC Master Station, transceiver (hereinafter referred to as the test item). Serial Number 1082 was assigned to the test item designed to operate at 2405MHz. This test item was fitted with an L-Com 2.4GHz Ultra High Q 8-Pole Indoor Bandpass Filter, Channel 1, M/N: BPF24-801, between the transmitter and the antenna. Serial Number 1085 was assigned to the test item designed to operate at 2425MHz. This test item was fitted with an L-Com 2.4GHz Ultra High Q 8-Pole Indoor Bandpass Filter, Channel 3, M/N: BPF24-803, between the transmitter and the antenna. Serial Number 1087 was assigned to the test item designed to operate at 2445MHz. This test item was fitted with an L-Com 2.4GHz Ultra High Q 8-Pole Indoor Bandpass Filter, Channel 6, M/N: BPF24-806, between the transmitter and the antenna

The test item is a digital modulation transceiver. The test item was designed to transmit and receive in the 2400-2483.5 MHz band using a Luxul Wireless 2.4GHz Flat Panel Antenna. The antenna was mounted to the outside of the door of the metal enclosure in which the test item was located. The test item was manufactured and submitted for testing by Twisthink, LLC located in Holland, MI.

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 and radiated RF emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart B, Sections 15.107 and 15.109 for Receivers. 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 22C and the relative humidity was 56%.

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 2009

- 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"

- Measurement of Digital Transmission Systems Operating under Section 15.247 March 23, 2005

3 TEST ITEM SET-UP AND OPERATION

3.1 General Description

The test item is a Master Station. A block diagram of the test item setup is shown as Figure 1.

3.1.1 Power Input

The test item was powdered by 48VDC via Power over Ethernet. Two wires of the 1.8m long CAT 5 cable were used to provide 48VDC to the Ethernet port of the test item. The other end of the CAT 5 cable was connected to the P+Data Out port of the Power over Ethernet (PoE) adapter, Air 802 LLC Model POEIJ-B. The Power In port of the PoE adapter was powered with 48VDC. The 48VDC to the PoE adapter was provided via a 1.7 meter long 2 wire cable from an AC adapter, M/N: SA06L48-V. The AC adapter was powered with 120V, 60Hz via a 1.7m long 3 wire input power cable.

3.1.2 Peripheral Equipment

The test item was submitted for testing with no peripheral equipment.

3.1.3 Interconnect Cables

The test item was submitted for testing with no interconnect cables.

3.1.4 Grounding

The test item was not grounded during the test.

3.2 Operational Mode

For all tests, the test item was placed on an 80cm high non-conductive stand. The test item was energized. The test item was programmed to operate separately in one of the following modes:

- Transmit at 2405MHz
- Transmit at 2425MHz
- Transmit at 2445MHz

3.3 Test Item Modifications

In order to meet the radiated RF emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Section 15.247 the following modification was made to the test item:

- A Steward HFA163090-0A2 ferrite bead was placed on the CAT5 cable at the Input port of the Bi-Directional Amp.

4 TEST FACILITY AND TEST INSTRUMENTATION

4.1 Shielded Enclosure

All radiated emissions 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 9-1. All equipment was calibrated per the instruction manuals supplied by the manufacturer.

Conducted emission tests and radaited emissions tests were performed with an EMI receiver. 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 9kHz for conducted emissions data, 120kHz for the 30MHz to 1000MHz radiated emissions data, and 1MHz for radiated emissions data above 1GHz.

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

Per the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Per 15.207(a), all radio frequency voltages on the power lines of a transmitter shall be below the values shown below when using a quasi-peak or average detector:

CONDUCTED LIMITS FOR AN INTENTIONAL RADIATOR

Frequency MHz	RFI Voltage dBuV(QP)	RFI Voltage dBuV(Average)
0.15-0.5	66 decreasing with logarithm of frequency to 56	56 decreasing with logarithm of frequency to 46
0.5 – 5.0	56	46
5.0 – 30.0	60	50

Note 1: The lower limit shall apply at the transition frequencies.

Note 2: If the levels measured using the QP detector meet both the QP and the Average limits, the test item is considered to have met both requirements and measurements do not need to be performed using the Average detector.

5.1.2 Procedures

The interference on each 115V, 60Hz power lead to the AC adapter used to provide 48VDC to the PoE adapter was measured by connecting the measuring equipment to the appropriate meter terminal of the Line Impedance Stabilization Network (LISN). The meter terminal of the LISN not under test was terminated with 50 ohms.

a) The test item was operated in the Transmit at 2425MHz mode.

b) Measurements were first made on the 115V, 60Hz high line to the AC adapter used to proved 48VDC to the PoE adapter.

c) The frequency range from 150 kHz to 30 MHz was broken up into smaller frequency sub-bands.

d) Conducted emissions measurements were taken on the first frequency sub-band using a peak detector.

e) The data thus obtained was then searched by the computer for the highest levels. Any emissions levels that were within 10dB of the average limit were then measured again using both a quasi-peak detector and an average detector. (If no peak readings were within 10dB of the average limit, quasi-peak and average readings were taken on the highest emissions levels measured during the peak detector scan.)

f) Steps (d) and (e) were repeated for the remainder of the frequency sub-bands until the entire frequency range from 150kHz to 30MHz was investigated. The peak trace was automatically plotted. The plot also shows quasi-peak and average readings that were taken on discrete frequencies. A table showing the quasi-peak and average readings was also generated. This tabular data compares the quasi-peak and average conducted emissions to the applicable conducted emissions limits.

g) Steps (c) through (f) were repeated on the 115V, 60Hz return line to the AC adapter used to proved 48VDC to the PoE adapter.

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5.1.3 Results

The plots of the peak, quasi-peak, and average conducted voltage levels acquired from each input power line with the test item operated in the transmit at 2425MHz mode are shown on pages 22 and 24. The tabular quasi-peak and average results from each input power line with the test item operated in the transmit at 2425MHz mode are shown on pages 21 and 23. All power line conducted emissions measured from the test item were within the specification limits for intentional radiators. The emissions level closest to the limit (worst case) occurred at 22.64MHz. The emissions level at this frequency was 6.4dB within the limit. A photograph of the test configuration which yielded the highest or worst case, conducted emission levels is shown on Figure 2.

5.2 6dB Bandwidth

5.2.1 Requirements

Per 15.247(a)(2),the minimum 6dB bandwidth shall be at least 500kHz for all systems using digital modulation techniques.

5.2.2 Procedures

The antenna output port of the test item was connected to the spectrum analyzer through 40dB of attenuation.

The test item was allowed to transmit continuously. The transmit channel was set separately to low, middle, and high channels. The resolution bandwidth (RBW) was set to 100kHz and the span was set to greater than the RBW.

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 25 through 27 show that the minimum 6 dB bandwidth was 1.67MHz which is greater than minimum allowable 6dB bandwidth requirement of 500kHz for systems using digital modulation techniques.

5.3 Peak Output Power

5.3.1 Requirements

Per section 15.247(b)(3), for systems using digital modulation, the maximum peak output conducted power shall not be greater than 1.0W (30dBm). The conducted output power is based on the use of antennas with directional

gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values by the amount in dB that the directional gain of the antenna exceeds 6 dBi. Since the limit allows for a 6dBi antenna gain, the maximum EIRP can be increased by 6dB to 4 Watt (36dBm).

5.3.2 Procedures – Conducted Output Power

The antenna output port of the test item was connected to the spectrum analyzer through 40dB of attenuation. The test item was set to transmit separately at the low, middle, and high channels. The resolution bandwidth (RBW) was set to greater than the 6dB bandwidth. The 'Max-Hold' function was engaged. The maximum meter reading was recorded. The peak power output was calculated for the low, middle and high channels.

5.3.3 Procedures – Effective Isotropic Radiated Power

The test item was placed on the non-conductive stand and set to transmit. A double ridged waveguide antenna was placed at a test distance of 3 meters from the test item. The resolution bandwidth (RBW) of the spectrum analyzer was set to greater than the 6dB bandwidth. The test item was maximized for worst case emissions (or maximum output power) at the measuring antenna. The maximum meter reading was recorded. The peak power output was measured for the low, middle and high channels.

The equivalent power was determined from the field intensity levels measured at 3 meters using the substitution method. To determine the emission power, a second double ridged waveguide antenna was then set in place of the test item and connected to a calibrated signal generator. The output of the signal generator was adjusted to match the received level at the spectrum analyzer. The signal level was recorded. The reading was then corrected to compensate for cable loss and antenna gain as required. The peak power output was calculated for low, middle, and high hopping frequencies.

5.3.4 Results

The conducted output power results are presented on pages 28 through 30. The maximum peak conducted output power from the transmitter was 209mW (23.3 dBm). Since the test item uses an 11dBi gain antenna, and the gain of the antenna exceeds the 6dBi gain antenna by 5dB, the output power must be reduced by 5dB (5dB = (11dBi-6dBi). Therefore the maximum peak conducted output power must not exceed 25dBm (25dBm = 30dBm – 5dBm).Since the maximum peak conducted output power from the transmitter was 23.3dBm, this limit is met.

The effective isotropic radiated power (EIRP) results are presented on page 31. The maximum EIRP measured from the transmitter was 29.6dBm or 912.0mW which is below the 4 Watt limit.

5.4 Duty Cycle Factor Measurements

5.4.1 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 pulse density, 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 with 200usec/div. The amplitude settings are adjusted so that the on/off transitions clear the 7th division from the bottom of the display. The markers are set at the beginning and end of the “on-time”. The trace is recorded.

Next the spectrum analyzer center frequency is set to the transmitter frequency with a zero span width and 10msec/div. This shows if the word is longer than 100msec or shorter than 100msec. If the word period is greater than 100msec, the display is set to show 100msec. The on-time is then measured. The on-time is total time signal level exceeds the 7th division. Off-time is time under for the word period. The duty cycle is then computed as the (On-time/100msec).

5.4.2 Results

The plots of the duty cycle are shown on data pages 32 and 33. The test item transmits approximately 30 each 861.7usec pulses every 100msec. The duty cycle correction factor was calculated to be -11.75dB (-11.75dB = 20*log((30*0.8617msec)/100msec).

5.5 Spurious Emissions

5.5.1 Antenna Conducted

5.5.1.1 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.

5.5.1.2 Procedures

The output of the test item was connected to the spectrum analyzer through 40dB of attenuation. 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 channels.

5.5.1.3 Results

The results of the antenna conducted emissions levels were plotted. These plots are presented on pages 34 through 48. These plots show that the spurious emissions were at least 20 dB below the level of the fundamental.

5.5.2 Radiated Spurious Emissions

5.5.2.1 Requirements

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

5.5.2.2 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 radiated emission tests were then manually performed over the frequency range of 30MHz to 25GHz.

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 where 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 emission is pulsed, the reading can be adjusted by a “duty cycle correction factor” derived from 20*log(on time/100msec). These readings must be no greater than the limits specified in 15.209(a).

5.5.2.3 Results

Preliminary radiated emissions plots with the test item transmitting at Low Frequency, Middle Frequency, and High Frequency are shown on pages 49 through 66. Final radiated emissions data are presented on data pages 67 through 84. As can be seen from the data, with a Steward HFA163090-0A2 ferrite bead placed on the CAT5 cable at the Input port of the Bi-Directional Amp, all emissions measured from the test item were within the specification limits. The emissions level closet to the limit (worst case) occurred at 1032.2MHz. The emissions level at this frequency was 0.2dB within the limit. See data pages 67 through 84 for details. Photographs of the test configuration which yielded the highest, or worst case, radiated emission levels are shown on Figure 3.

5.6 Band Edge Compliance

5.6.1 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 limits of 15.209(a).

5.6.2 Procedures

5.6.2.1 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.
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) ≥ 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.

5.6.2.2 High Band Edge

1) The test item was set to transmit continuously at the channel closest to the high band-edge.
2) A double ridged waveguide was placed 3 meters away from the test item. The antenna was connected to the input of a spectrum analyzer.
3) The center frequency of the analyzer was set to the high band edge (2483.5MHz)
4) The resolution bandwidth was set to 1MHz.

5) To ensure that the maximum or worst case emission level was measured, the following steps were taken:
   a. The test item was rotated so that all of its sides were exposed to the receiving antenna.
   b. Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.
   c. The measuring antenna was raised and lowered from 1 to 4 meters for each antenna polarization to maximize the readings.
6) The highest measured peak reading was recorded.
7) The highest measured average reading was recorded.

5.6.3 Results

Pages 85 through 87 show the band-edge compliance results. As can be seen from this data, the conducted emissions at the low end band edge are within the 20 dB down limits. The radiated emissions at the high end band edge are within the general limits for both the peak limits and the average limits.

5.7 Power Spectral Density

5.7.1 Requirement

Per section 15.247(d), the peak power spectral density from the intentional radiator shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

5.7.2 Procedures

1) The output of the test item was connected to the spectrum analyzer through 50dB of attenuation and the test item was set to transmit separately at a low, mid, and high channel.
2) To determine the power spectral density, the following spectrum analyzer settings were used for channel 2:
   a. Center frequency = transmit frequency
   b. Span = 1MHz
   c. Resolution bandwidth (RBW) = 3kHz
   d. Sweep time greater than span divided by RBW = 2MHz/3kHz = 667 seconds
   e. The peak detector and 'Max-Hold' function was engaged.
   f. The display line represents the 8 dBm limit
   g. The analyzer's display was plotted using a 'screen dump' utility.

5.7.3 Results

Pages 88 through 90 show the power spectral density results. As can be seen from these plots, the peak power density is less than 8dBm in a 3kHz band during any time interval of continuous transmission.

6 CONCLUSIONS

With a Steward HFA163090-0A2 ferrite bead placed on the CAT5 cable at the Input port of the Bi-Directional Amp, it was determined that the Twisthink, LLC Master Station, digital modulation transceiver, 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 the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart B, Sections 15.107 and 15.109 for Receivers.

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.

9 EQUIPMENT LIST

Table 9-1 Equipment List

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Due Date
APW0	PREAMPLIFIER	PLANAR ELECTRONICS	PE2-30-20G20R6G	PL2926/0646	20GHZ-26.5GHZ	7/28/2009	7/28/2010
APW2	PREAMPLIFIER	PLANAR ELECTRONICS	PE2-35-120-5R0-10	PL2925	1GHZ-20GHZ	7/28/2009	7/28/2010
CDV0	DESKTOP COMPUTER	COMPAQ	PRESARIO	MXK3391BPJ	2.5GHZ	N/A	
CMA1	Controllers	EMCO	2090	9701-1213	---	N/A	
GRE0	SIGNAL GENERATOR	AGILENT TECHNOLOGIES	E4438C	MY42083127	250KHZ-6GHZ	2/16/2010	2/16/2011
NHG0	STANDARD GAIN HORN ANTENNA	NARDA	638	---	18-26.5GHZ	NOTE 1	
NTA2	BILOG ANTENNA	TESEQ	6112D	28040	25-1000MHz	6/7/2010	6/7/2011
NWH0	RIDGED WAVE GUIDE	TENSOR	4105	2081	1-12.4GHZ	8/11/2009	8/11/2010
NWI0	RIDGED WAVE GUIDE	AEL	H1498	153	2-18GHZ	12/5/2009	12/5/2010
NWI1	RIDGED WAVE GUIDE	AEL	H1498	154	2-18GHZ	12/5/2009	12/5/2010
PLL5	50UH LISN 462D	ELITE ELECTRONIC ENG	462D/70A	006	0.01-400MHZ	1/12/2010	1/12/2011
PLLI	50UH LISN 462D - FL	ELITE ELECTRONIC ENG	462D/70A	019	0.01-400MHZ	12/9/2009	12/9/2010
RBB0	EMI TEST RECEIVER 20HZ TO 40 GHZ.	ROHDE & SCHWARZ	ESIB40	100250	20 HZ TO 40GHZ	3/16/2010	3/16/2011
RBD0	EMI TEST RECIEVER	ROHDE & SCHWARZ	ESU40	100010	20Hz-40GHz	3/11/2010	3/11/2011
SES1	24VDC POWER SUPPLY	P TRANS	FS-32024-1M	002	18-27VDC	NOTE 1	
T1N1	10DB 20W ATTENUATOR	NARDA	766-10	---	DC-4GHZ	8/24/2009	8/24/2010
T1N6	10DB 20W ATTENUATOR	NARDA	766-10	---	DC-4GHZ	8/24/2009	8/24/2010
T2DS	20DB, 25W ATTENUATOR	WEINSCHEL	46-20-34	BS0916	DC-18GHZ	8/24/2009	8/24/2010
T2S7	20DB 25W ATTENUATOR	WEINSCHEL	46-20-34	BU8139	DC-18GHZ	3/3/2010	3/3/2011
T2S8	20DB 25W ATTENUATOR	WEINSCHEL	46-20-34	BV3541	DC-18GHZ	1/5/2010	1/5/2011
TVH4	VARIABLE ATTENUATOR	HEWLETT PACKARD	8496B	3308A71145	DC-18GHZ	12/10/2009	12/10/2010
XOB1	ADAPTER	HEWLETT PACKARD	K281C	10422	18-26.5GHZ	NOTE 1	
XPR0	HIGH PASS FILTER	K&L MICROWAVE	11SH10-4800/X20000	001	4.8-20GHZ	7/19/2010	7/19/2011

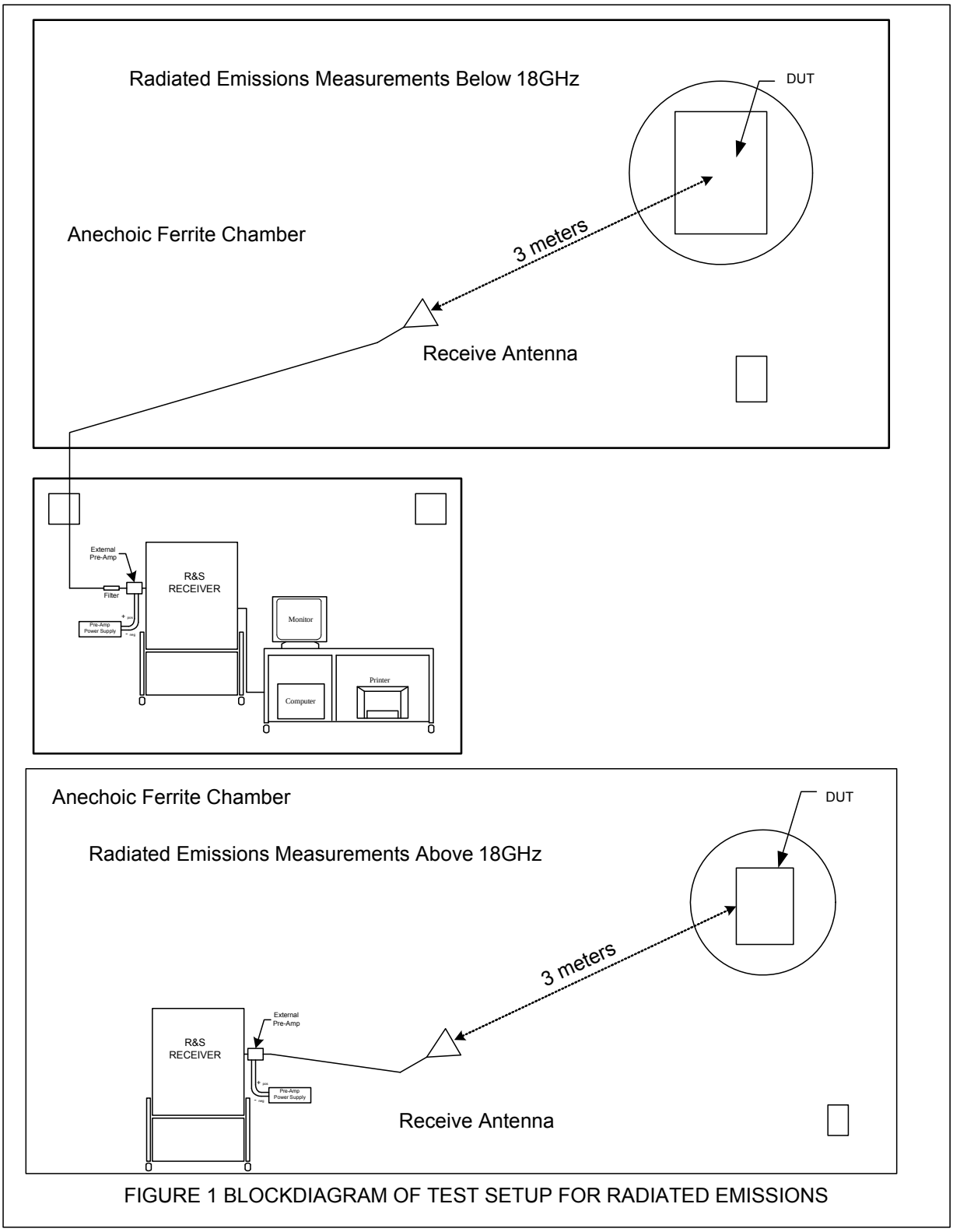
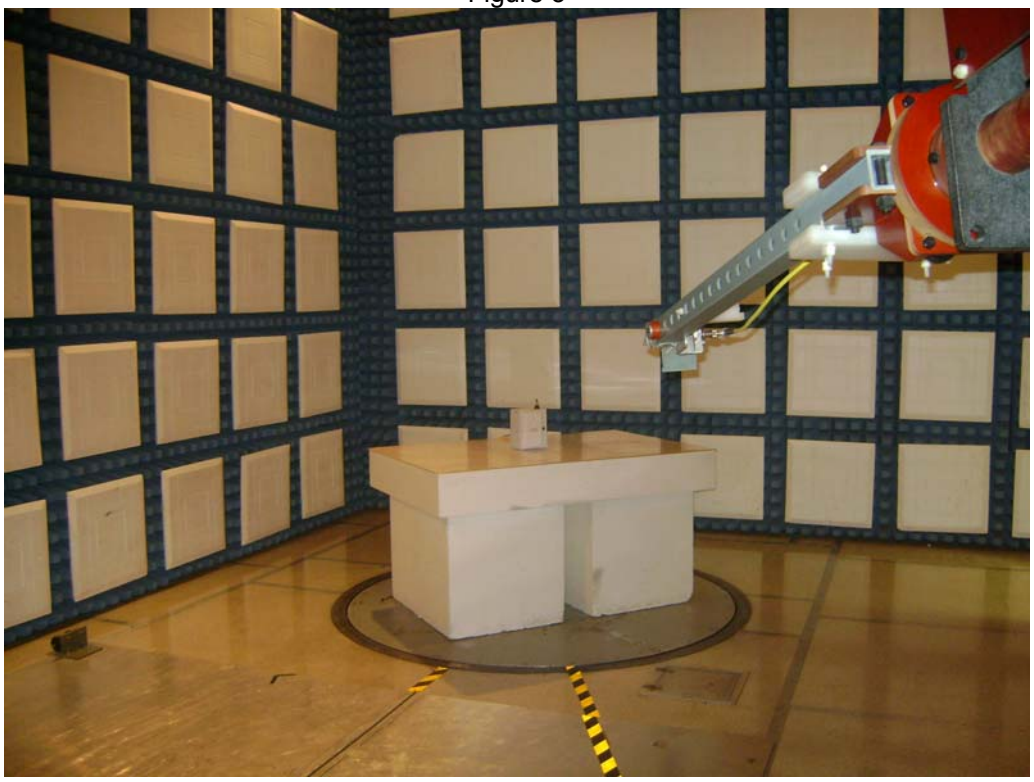


FIGURE 1 BLOCKDIAGRAM OF TEST SETUP FOR RADIATED EMISSIONS

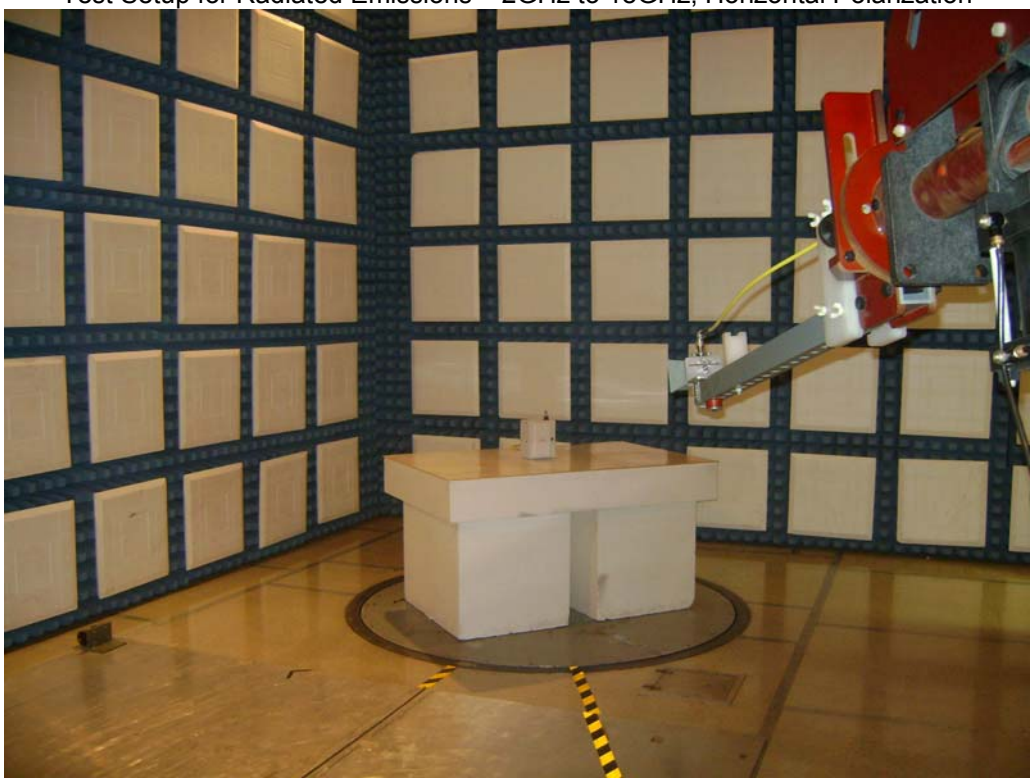
Figure 2

Test Setup for Conducted Emissions

Figure 3



Test Setup for Radiated Emissions – 2GHz to 18GHz, Horizontal Polarization



Test Setup for Radiated Emissions – 2GHz to 18GHz, Vertical Polarization

FCC Part 15 Subpart B Conducted Emissions Test

Significant Emissions Data

VB** 04/12/2010

Manufacturer	:	TWISTHINK
Model	:	MASTER STATION 803 FILTER
DUT Revision	:	
Serial Number	:	1085
DUT Mode	:	Tx @ 2425MHz (CH. 15)
Line Tested	:	115V, 60Hz HIGH
Scan Step Time [ms]	:	30
Meas. Threshold [dB]	:	-6
Notes	:	
Test Engineer	:	M. Longinotti
Limit	:	Class B
Test Date	:	Jul 08, 2010 01:18:51 PM
Data Filter	:	Up to 80 maximum levels detected with 6 dB level excursion threshold over 6 dB margin below limit

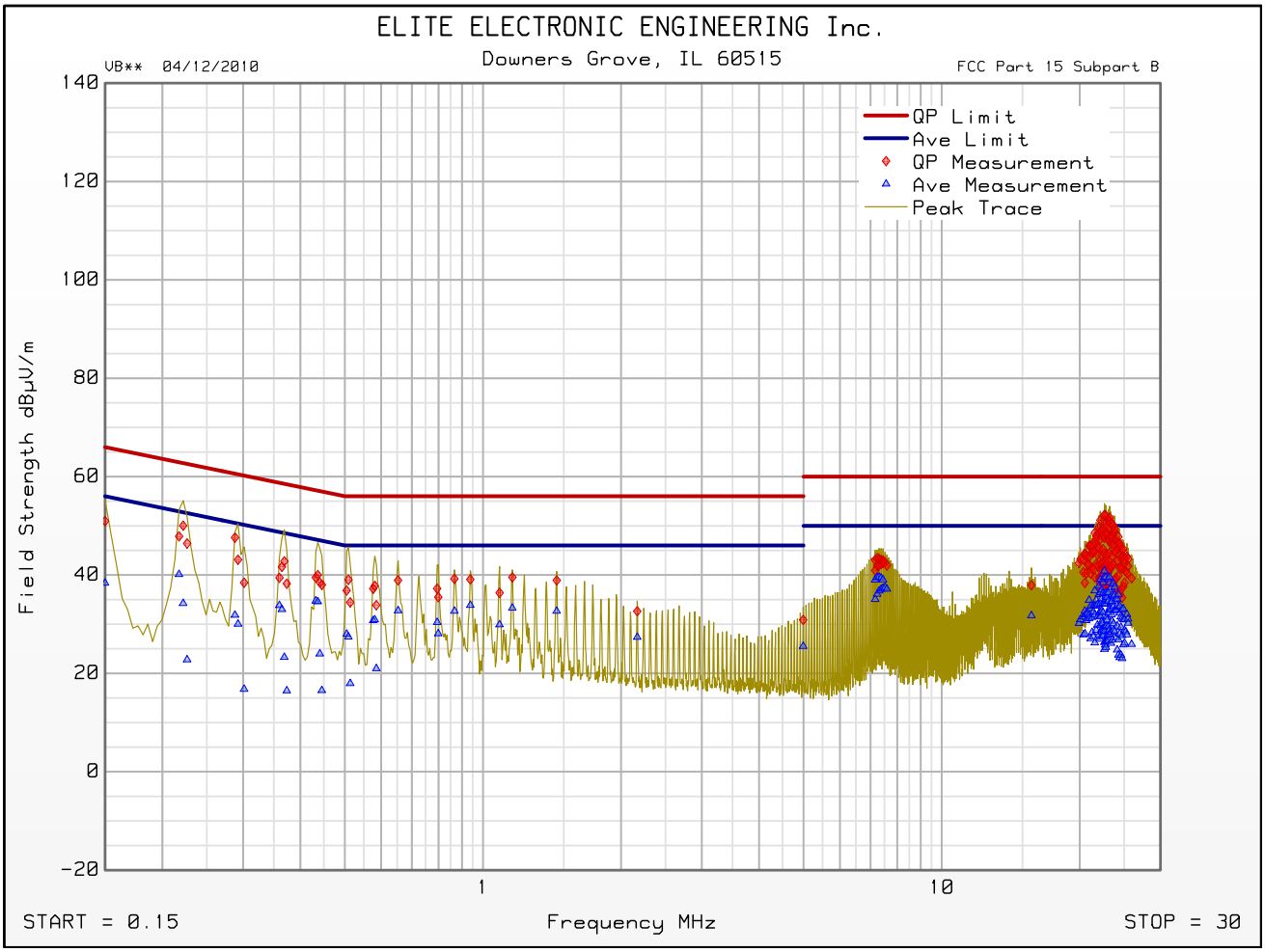
Freq MHz	Quasi-peak Level dBµV/m	Quasi-peak Limit dBµV/m	Excessive Quasi-peak Emissions	Average Level dBµV/m	Average Limit dBµV/m	Excessive Average Emissions
0.218	47.9	62.9		40.1	52.9	
0.432	39.5	57.2		34.7	47.2	
0.653	38.9	56.0		32.8	46.0	
0.939	39.1	56.0		33.8	46.0	
1.448	38.9	56.0		32.7	46.0	
2.169	32.6	56.0		27.4	46.0	
4.990	30.9	56.0		25.5	46.0	
7.304	43.3	60.0		39.6	50.0	
15.692	37.9	60.0		31.7	50.0	
22.631	52.2	60.0		40.8	50.0	

FCC Part 15 Subpart B Conducted Emissions Test

Cumulative Data

VB** 04/12/2010

Manufacturer	:	TWISTHINK
Model	:	MASTER STATION 803 FILTER
DUT Revision	:	
Serial Number	:	1085
DUT Mode	:	Tx @ 2425MHz (CH. 15)
Line Tested	:	115V, 60Hz HIGH
Scan Step Time [ms]	:	30
Meas. Threshold [dB]	:	-6
Notes	:	
Test Engineer	:	M. Longinotti
Limit	:	Class B
Test Date	:	Jul 08, 2010 01:18:51 PM



Emissions Meet QP Limit
Emissions Meet Ave Limit

FCC Part 15 Subpart B Conducted Emissions Test

Significant Emissions Data

VB** 04/12/2010

Manufacturer	:	TWISTHINK
Model	:	MASTER STATION 803 FILTER
DUT Revision	:	
Serial Number	:	1085
DUT Mode	:	Tx @ 2425MHz (CH. 15)
Line Tested	:	115V, 60Hz RETURN
Scan Step Time [ms]	:	30
Meas. Threshold [dB]	:	-6
Notes	:	
Test Engineer	:	M. Longinotti
Limit	:	Class B
Test Date	:	Jul 08, 2010 01:04:30 PM
Data Filter	:	Up to 80 maximum levels detected with 6 dB level excursion threshold over 6 dB margin below limit

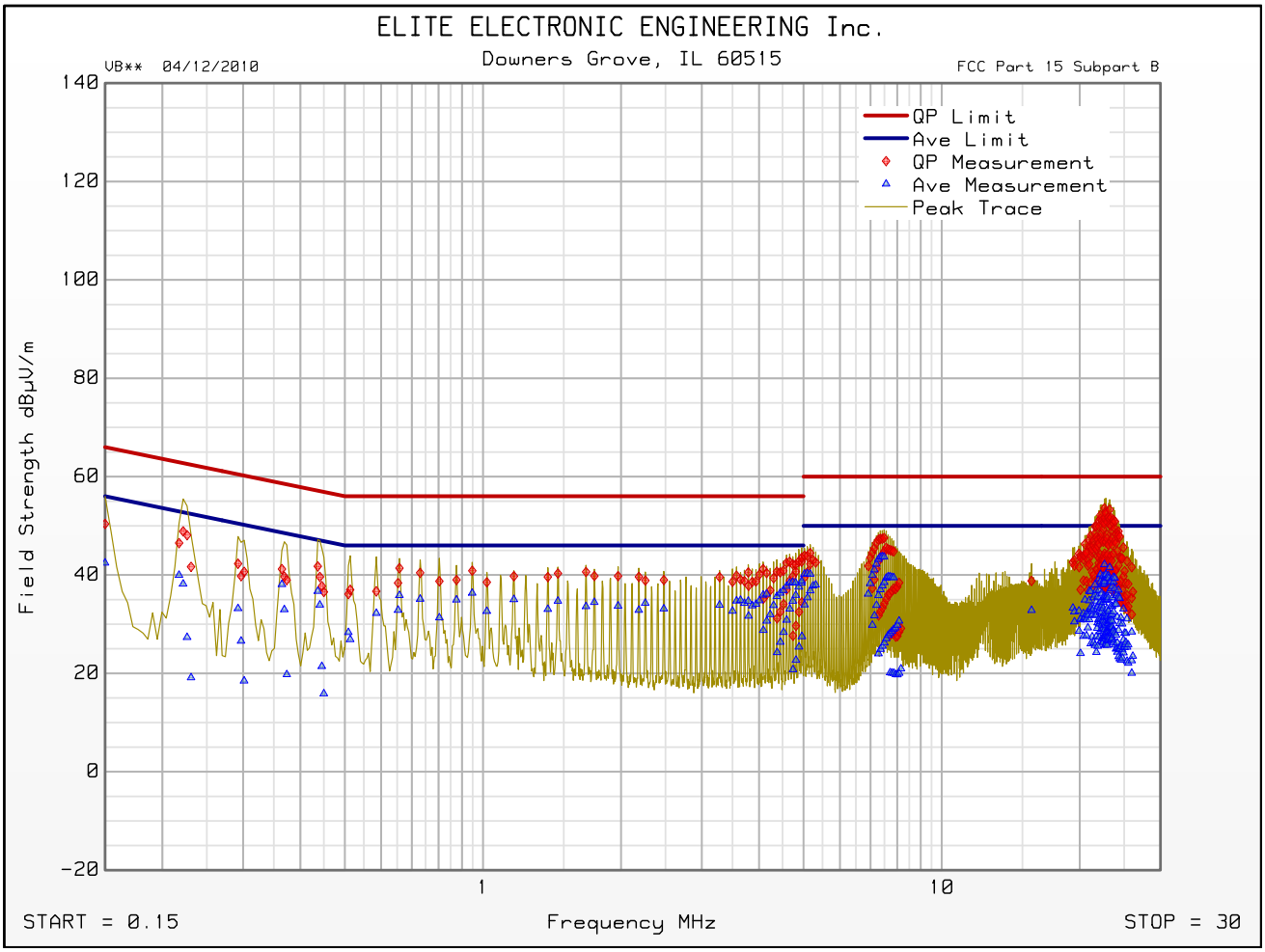
Freq MHz	Quasi-peak Level dBµV/m	Quasi-peak Limit dBµV/m	Excessive Quasi-peak Emissions	Average Level dBµV/m	Average Limit dBµV/m	Excessive Average Emissions
0.218	46.5	62.9		40.0	52.9	
0.437	41.8	57.1		36.7	47.1	
0.658	41.4	56.0		35.9	46.0	
0.948	40.9	56.0		36.3	46.0	
1.457	40.3	56.0		34.7	46.0	
2.259	38.9	56.0		34.3	46.0	
4.954	43.5	56.0		38.8	46.0	
7.421	47.4	60.0		43.7	50.0	
15.701	38.8	60.0		32.8	50.0	
22.640	53.6	60.0		42.1	50.0	

FCC Part 15 Subpart B Conducted Emissions Test

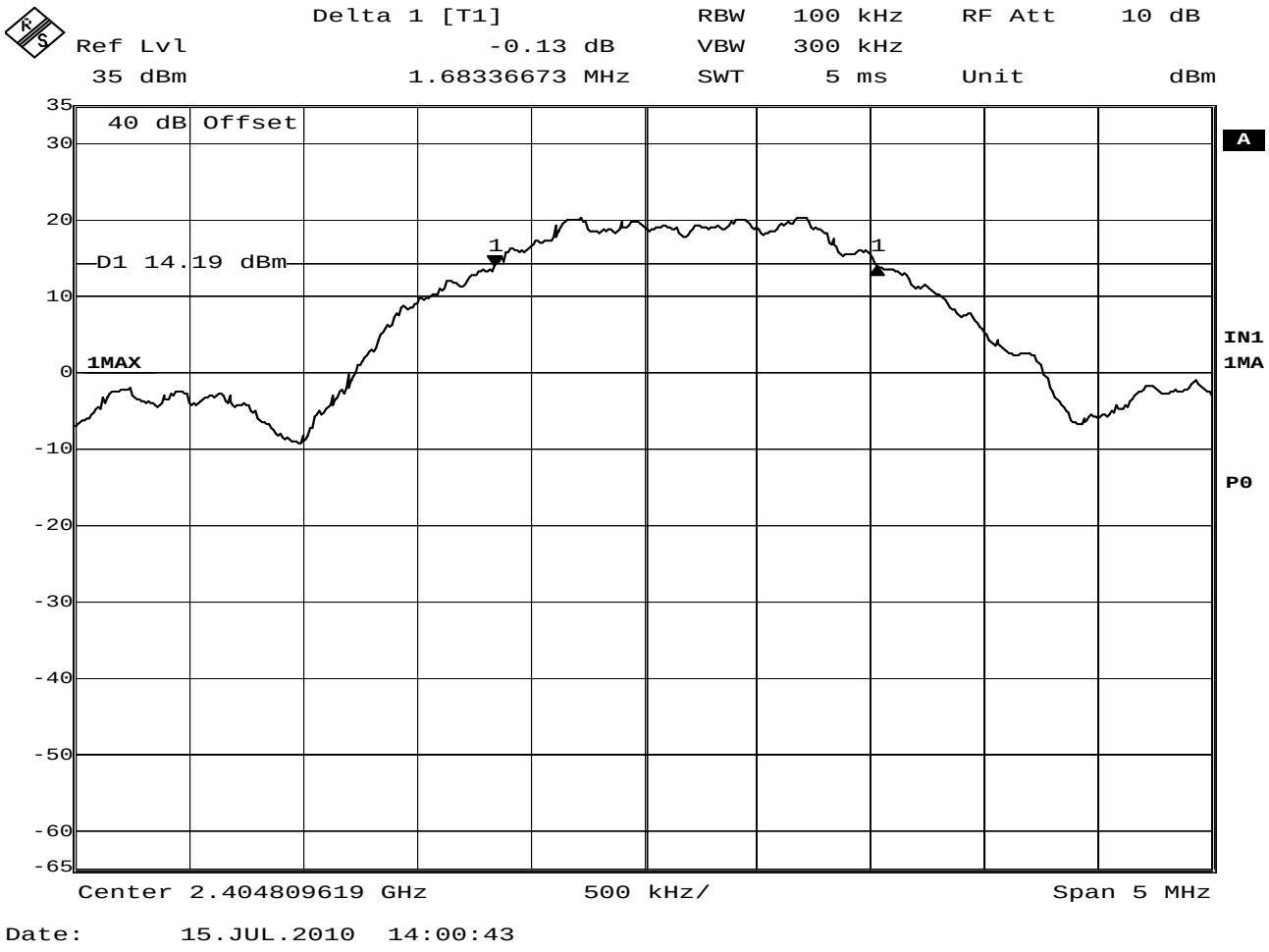
Cumulative Data

VB** 04/12/2010

Manufacturer	:	TWISTHINK
Model	:	MASTER STATION 803 FILTER
DUT Revision	:	
Serial Number	:	1085
DUT Mode	:	Tx @ 2425MHz (CH. 15)
Line Tested	:	115V, 60Hz RETURN
Scan Step Time [ms]	:	30
Meas. Threshold [dB]	:	-6
Notes	:	
Test Engineer	:	M. Longinotti
Limit	:	Class B
Test Date	:	Jul 08, 2010 01:04:30 PM

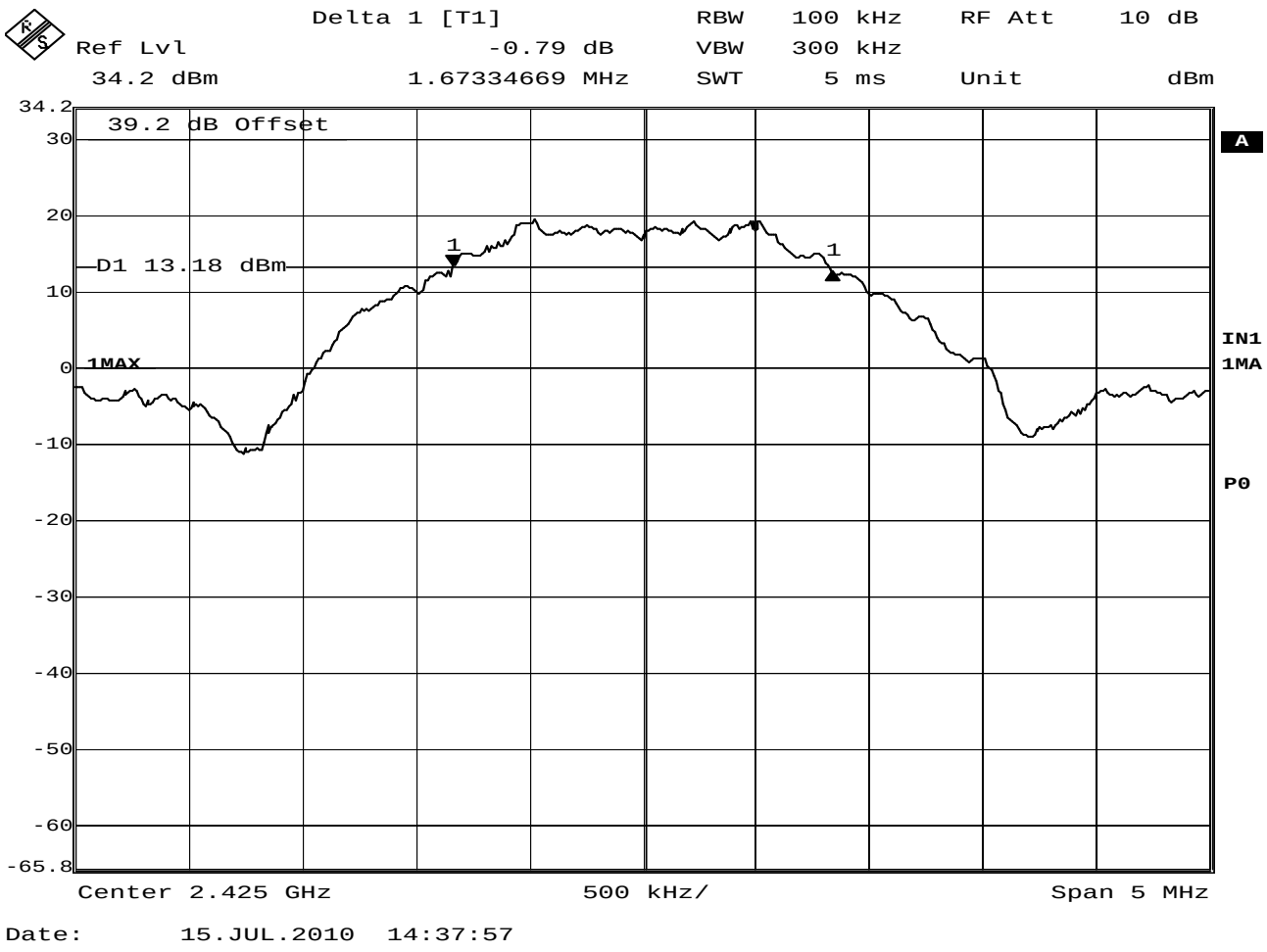


Emissions Meet QP Limit
Emissions Meet Ave Limit



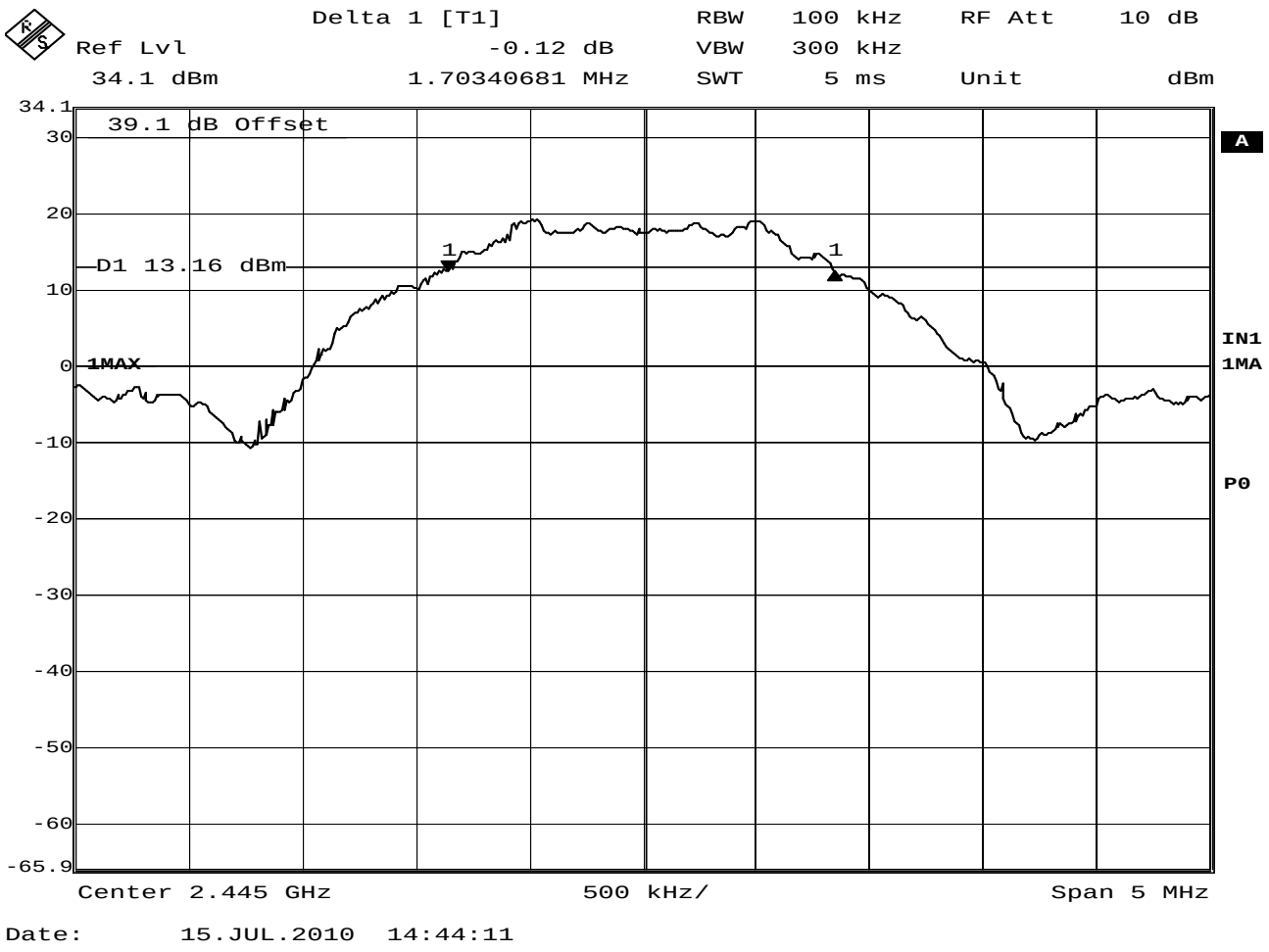
FCC 15.247(a) 6dB Band Width

MANUFACTURER	:	Twisthink
MODEL NUMBER	:	Master Station 801 Filter
SERIAL NUMBER	:	1082
TEST MODE	:	Tx @ 2.405GHz (Ch. 11)
TEST DATE	:	July 15, 2010
TEST PARAMETERS	:	6dB band width
NOTES	:	Display line D1 represents the 6dB down point.
	:	6dB bandwidht = 1.68MHz
EQUIPMENT USED	:	RBB0, T2S7, T2S8



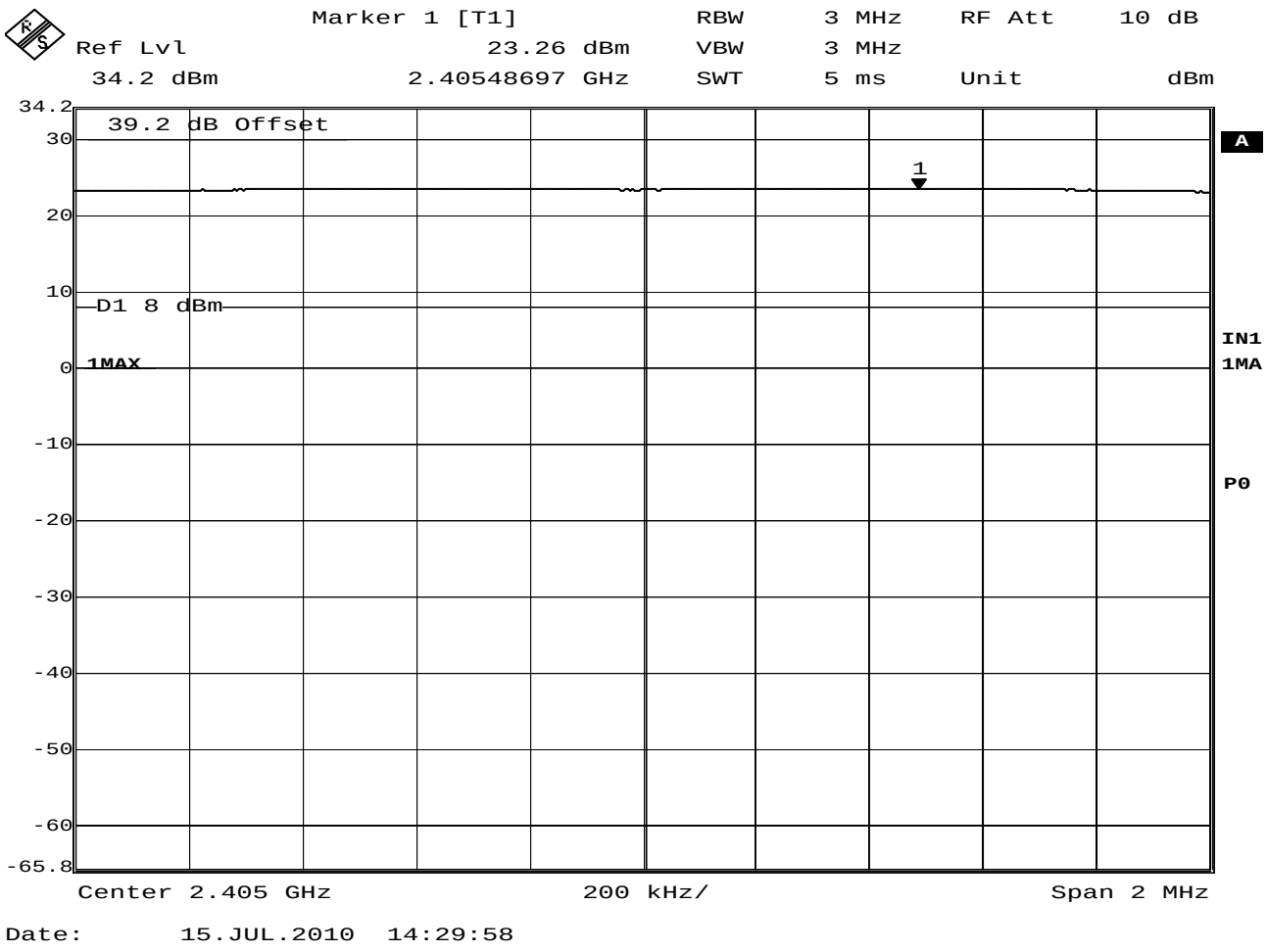
FCC 15.247(a) 6dB Band Width

MANUFACTURER	:	Twisthink
MODEL NUMBER	:	Master Station 803 Filter
SERIAL NUMBER	:	1085
TEST MODE	:	Tx @ 2.425GHz (Ch. 15)
TEST DATE	:	July 15, 2010
TEST PARAMETERS	:	6dB band width
NOTES	:	Display line D1 represents the 6dB down point.
	:	6dB bandwidht = 1.67MHz
EQUIPMENT USED	:	RBB0, T2S7, T2S8



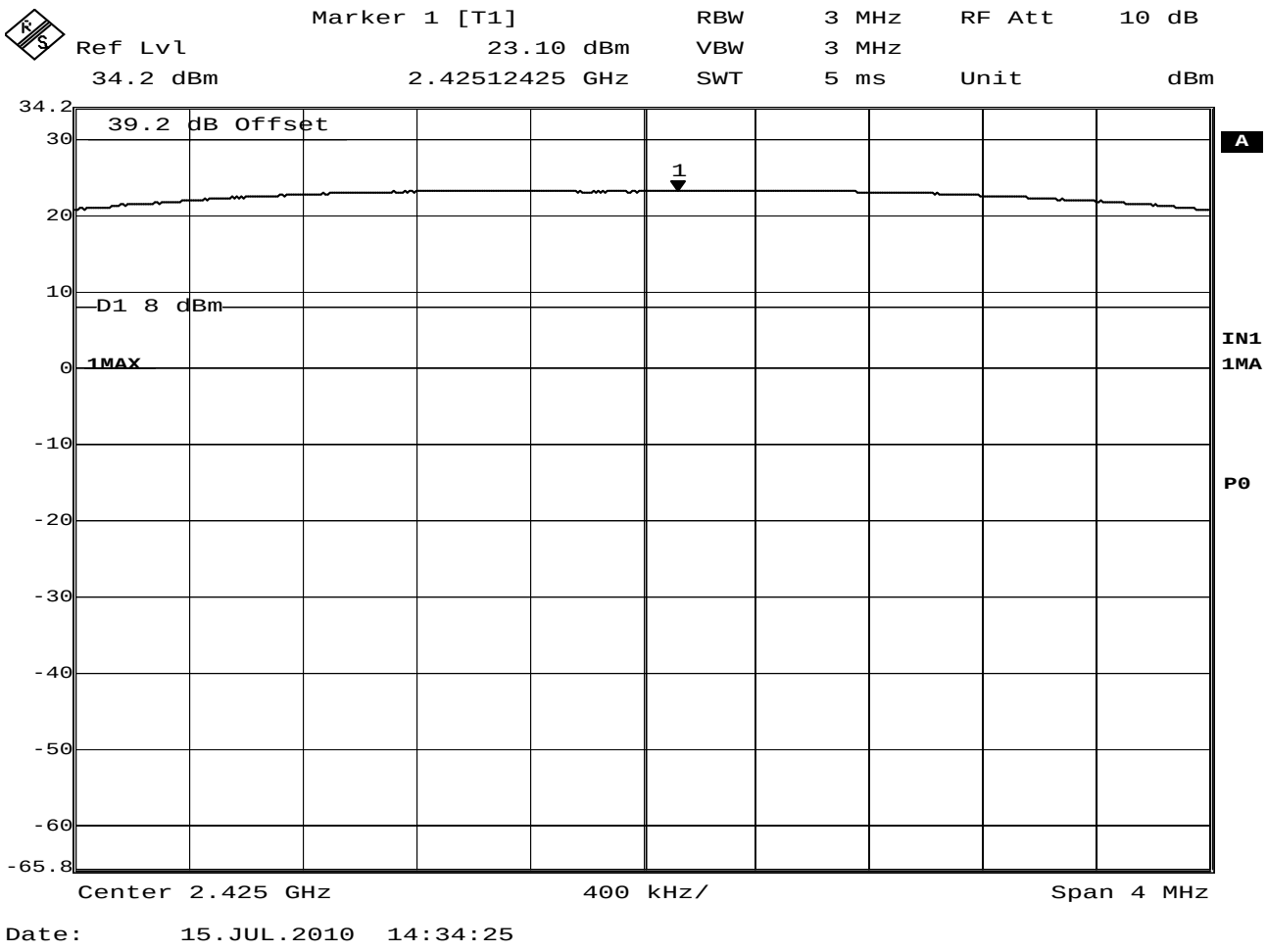
FCC 15.247(a) 6dB Band Width

MANUFACTURER	:	Twisthink
MODEL NUMBER	:	Master Station 806 Filter
SERIAL NUMBER	:	1087
TEST MODE	:	Tx @ 2.445GHz (Ch. 19)
TEST DATE	:	July 15, 2010
TEST PARAMETERS	:	6dB band width
NOTES	:	Display line D1 represents the 6dB down point.
	:	6dB bandwidht = 1.67MHz
EQUIPMENT USED	:	RBB0, T2S7, T2S8



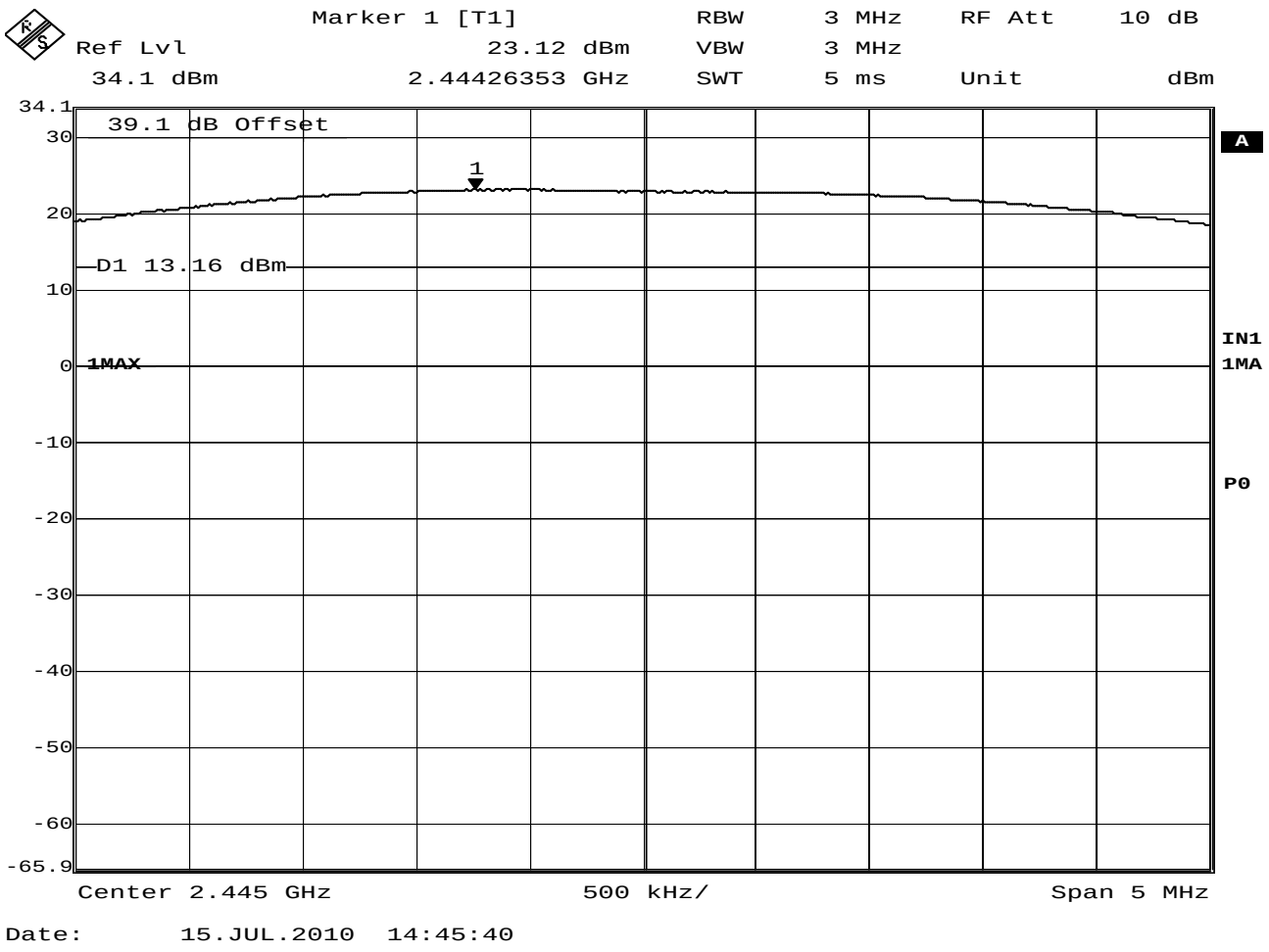
15.247(b)(3) Antenna Conducted Output Power

MANUFACTURER	:	Twisthink
MODEL NUMBER	:	Master Station 801 Filter
SERIAL NUMBER	:	1082
TEST MODE	:	Tx @ 2405MHz (ch. 11)
TEST DATE	:	July 15, 2010
TEST PARAMETERS	:	Antenna Conducted Output Power
NOTES	:	Output Power = 23.3dBm = 209mW
EQUIPMENT USED	:	RBB0, T2S8, T2S7



15.247(b)(3) Antenna Conducted Output Power

MANUFACTURER	:	Twisthink
MODEL NUMBER	:	Master Station 803 Filter
SERIAL NUMBER	:	1085
TEST MODE	:	Tx @ 2425MHz (ch. 15)
TEST DATE	:	July 15, 2010
TEST PARAMETERS	:	Antenna Conducted Output Power
NOTES	:	Output Power = 23.1dBm = 204mW
EQUIPMENT USED	:	RBB0, T2S8, T2S7



15.247(b)(3) Antenna Conducted Output Power

MANUFACTURER	:	Twisthink
MODEL NUMBER	:	Master Station 806 Filter
SERIAL NUMBER	:	1087
TEST MODE	:	Tx @ 2445MHz (ch. 19)
TEST DATE	:	July 15, 2010
TEST PARAMETERS	:	Antenna Conducted Output Power
NOTES	:	Output Power = 23.1dBm = 204mW
EQUIPMENT USED	:	RBB0, T2S8, T2S7