UNISYS

PCTC
Product Compliance Test Center
2476 Swedesford Road, Malvern, PA 19355

ELECTROMAGNETIC INTERFERENCE TEST REPORT

Doc. 20061106R / Project No. 1386

TEST STANDARD: USA 47 CFR PART 15

NOM-110 React
FCC ID: TSDNMD-AM07

NOMADIO, INC.
PHILADELPHIA, PA

TEST DATE: October 24 – November 29, 2006
ISSUE: December 8, 2006

Prepared by:

Dipak Patel
Technical Staff Engineer

The results described in this report relate only to the item(s) tested.
This document shall not be reproduced except in full without written permission of Unisys - PCTC.

ACCREDITED
AMERICAN ASSOCIATION FOR LABORATORY ACCREDITATION
Certificate No: 1028.01

PREFACE

This report documents product testing conducted to verify compliance of the specified EUT with applicable standards and requirements as identified herein. EUT, test instrument configurations, test procedures and recorded data are generally described in this report. The reader is referred to the applicable test standards for detailed procedures. The following table summarizes the test results obtained during this evaluation.

SUMMARY

The Nomadio, model NOM-110 React (FCC ID: TSDNMD-AM07) was tested to the standards listed below, and found to have the following characteristics:

TEST	STANDARD	REQUIREMENT	RESULT
Radiated Emissions - Intentional Radiation	FCC Part 15C, Section 15.247 and Section 15.205	Emissions up to 10 Harmonics in the Restricted Bands	Below Max. Permissible limit
Radiated Emissions - Spurious and Unintentional Radiation	FCC Part 15C, Section 15.209 FCC Part 15B, Class B	30 MHz – 25 GHz	Below Max. Permissible limit
Conducted Emissions - AC Power lines	FCC Part 15C, Section 15.207 FCC Part 15B, Class B	150 KHz - 30 MHz	Below Max. Permissible limit
Antenna Port	FCC Part 15C, Section 15.247	Operating Band 2.4000 MHz – 2.4835 MHz	Below Max. Permissible limit

EUT Modifications

The following modifications were made on the NOM-110 React during the EMI testing:

1. Installed RF shield onto board (Nomadio P/N RF00-004) using existing shield mount points. This modification is documented in Nomadio ECN document "N-Link-ECN-1"

2. Attached clamp-on ferrite ring, Nomadio P/N RF00-007 (Steward HFA100049-0A2) onto connector cable (Nomadio P/N J01-026). This modification is documented in Nomadio ECN document "N-Link-ECN-1"

3. Rerouted the RF PCB ground connection to minimize return current path length. This modification is documented in Nomadio ECN document "N-Link-ECN-1"

4. Replaced components at locations R13, R14, and R15 on N-Link PCB as below. This modification is documented in Nomadio ECN document "N-Link-ECN-2".

Component Location	Original	Modification
R13	37.4 ohms	2.2 nH
R14	150 ohms	2.0 pF
R15	150 ohms	2.0 pF

MEASUREMENT UNCERTAINTY				
Measurement Type	Measurement Dist	Frequency Range	Measurement Limit	Expanded Combined Uncertainty
Radio Disturbance	10 meters	30 MHz to 1 GHz	Class A	4.3 dB
Radio Disturbance	10 meters	30 MHz to 1 GHz	Class B	5.0 dB
Radio Disturbance	3 meters	30 MHz to 1 GHz	Class B	4.3 dB
Conducted Disturbance	N/A	150 kHz to 30 MHz	Class A or B	3.6 dB

As all values of uncertainty are less than the CISPR 16-4:2002 recommendations, no adjustments to measured data presented in this report are required.

LAB CERTIFICATIONS/ACCREDITATIONS

The testing presented in this report is covered under one or a combination of all of the following Certifications or Accreditations.

AGENCY	CERT/REG. NUMBER
American Association of Laboratory Accreditation	1028.01
FCC	91047
Canada	IC3442
Taiwan - BSMI	SL2-IN-E-1037
Japan – VCCI (OATS Site – Radiated Emissions)	R-1191
Japan – VCCI (OATS Site – Conducted Emissions)	C-1241
Japan – VCCI (Shielded Enclosure Site – Conducted Emissions)	C-1242

TABLE OF CONTENTS

1.0 Description of the Equipment Under Test (EUT) 6
1.1 General Description 6
1.2 Test Configurations 9
1.3 Rationale for the Chosen Configuration 12
1.4 EUT Modifications 13
2.0 Operation of the EUT During Testing 14
2.1 General 14
2.2 Operating Mode 14
2.3 Rationale for the Chosen Mode of Operation 15
3.0 Applicable Requirements, Methods and Procedures 16
3.1 Applicable Requirements 16
3.2 Basic Test Methods and Procedures 16
3.3 Deviations Or Exclusions From The Requirements And Standards 16
4.0 Test Results 17
4.1 Radiated Emissions 17
4.1.1 Radiated Emissions Test Procedure 17
4.1.2 Radiated Emissions Test Results (11/6/06 – 11/29/06) 19
4.2 AC Power Lines Conducted Emissions 33
4.2.1 Conducted Emission Test Procedure 33
4.2.2 Conducted Emissions Test Results (11/15/06) 34
4.3 Antenna Port (10/24/06 – 11/28/06) 42
4.3.1 Antenna Requirements 42
4.3.2 Numbers of Hopping Channel 42
4.3.3 Maximum Peak Output Power 48
4.3.4 Frequency Separation 52
4.3.5 Time of Occupancy on Channel 56
4.3.6 Antenna Port Conducted Emissions Requirements 60
4.3.7 RF Safety - Maximum Permitted Exposure 79
4.3.8 Bandedge Requirements 80
4.3.9 20 dB Bandwidth Measurements 85
Appendix A – Test Equipment 89

1.0 Description of the Equipment Under Test (EUT)

Equipment Identification	React (Remote Control)
Model Number	NOM-110
ID Number	The required testing was accomplished by using the following two preproduction units: Unit 1: TP1 Unit 2: TP2
Manufacturer	Nomadio, Inc. 2400 Market St Ste 13 Philadelphia, PA 19103
Technical Contact	Alex Gizis Joseph Kopanic
Condition Received	Acceptable for Test
Date Received	October 24, 2006
Sample Type	Preproduction Unit
Equipment Classification	Intentional Radiator, Unlicensed Low power Transmitter
Unisys Test Personnel	Charles Cunningham Dipak Patel

Unless otherwise noted in the individual test results sections, testing was performed on the EUT configured as follows.

1.1 General Description

The model NOM-110 React is a wireless USB 2.4GHz DSSS / FHSS remote telemetry and control system, intended for use for control with remotely-controlled military scale-model unmanned ground vehicles. Trigger and steering pots are provided for user vehicle control. LCD, vibe motor and buzzer are present for user feedback. USB-based PC connectivity is available for controller software and settings updates.

The React operates with a rechargeable battery pack containing four (4) of 1.2 VDC Nickel Metal Hydride (NiMH) batteries. The React incorporates voltage regulators.

The NOM-110 React has 78 hopping channels with operating frequency range of 2.402 GHz - 2.479 GHz.

Photo 1: NOM-110 React –View 1

Photo 2: NOM-110 React –View 2

1.2 Test Configurations

The following three EUT configurations were evaluated:

(1) Standalone for Transmit and Receive modes of operation
(2) USB interface operation
(3) Battery charging with Battery Charger (AC Adaptor)

The EUT was placed on a wooden table of 80 cm height. Since the EUT is a handheld device, where applicable, it was tested with placing it in each of the three orthogonal axes for radiated emission evaluation.

Block Diagram and Cable listing

A block diagram of the EUT configuration showing interconnection cables is shown on the next page for reference. The drawings show the physical hardware layout used for the tests along with I/O cables connection and AC power distribution. A description of any external interface cable present during the test is attached to this drawing for reference.

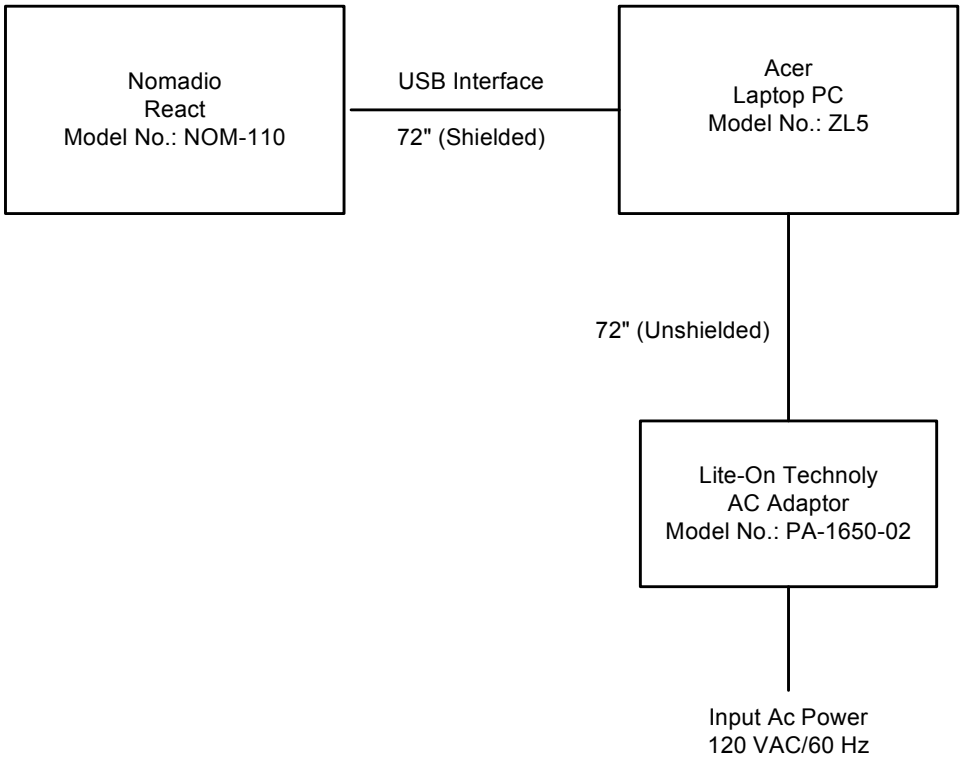


Figure 1 – Test Setup Block Diagram – USB Interface

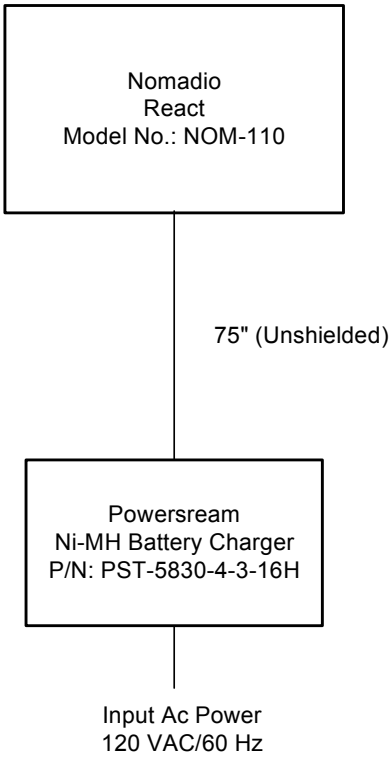


Figure 2 – Test Setup Block Diagram – Battery Charging

Detailed EUT Hardware Listing

The NOM-110 React has an internally attached antenna. The detail of hardware tested is listed below:

Description	Manufacturer	Manufacturer Part Number
React Main Board	Nomadio	BA05-003
React N-Link Module Board	Nomadio	BA50-002
2.4 GHz Radio Transceiver	Cypress	CYWUSB6934
Processor	Philips	LPC2142FBD64-S
Processor	Philips	LPC2146FBD64-S
Voltage Regulator on Main Board	Nomadio	U00-748
Voltage Regulator on N-Link	Nomadio	U00-755

Test Support Items

The following device was used to support the EUT operation during the testing.

Description	Manufacturer	Model Number
Laptop PC	Acer	ZL5
AC Adaptor	Lite-On Technology	PA-1650-02
Ni-NH Battery Pack (Battery Charger)	Powerstream	PST-5380-4-3-16H

1.3 Rationale for the Chosen Configuration

The tested configuration of the NOM-110 React represents actual deliverable hardware. During the testing, the EUT was configured for all possible customer application configurations.

1.4 EUT Modifications

The following modifications were made on the NOM-110 React during the EMI testing:

1. Installed RF shield onto board (Nomadio P/N RF00-004) using existing shield mount points. This modification is documented in Nomadio ECN document "N-Link-ECN-1"

2. Attached clamp-on ferrite ring, Nomadio P/N RF00-007 (Steward HFA100049-0A2) onto connector cable (Nomadio P/N J01-026). This modification is documented in Nomadio ECN document "N-Link-ECN-1"

3. Rerouted the RF PCB ground connection to minimize return current path length. This modification is documented in Nomadio ECN document "N-Link-ECN-1"

4. Replaced components at locations R13, R14, and R15 on N-Link PCB as below. This modification is documented in Nomadio ECN document "N-Link-ECN-2".

Component Location	Original	Modification
R13	37.4 ohms	2.2 nH
R14	150 ohms	2.0 pF
R15	150 ohms	2.0 pF

2.0 Operation of the EUT During Testing

Unless otherwise noted in the individual test results sections, testing was performed on the EUT as follows.

2.1 General

Climatic Environment

The following were the ambient conditions in the laboratory during testing:
Temperature: 22° C ± 5° C
Relative Humidity 50% ± 10% RH

Input Power

The NOM-110 React was powered from its integral battery pack.

2.2 Operating Mode

During the emissions testing, the NOM-110 React was operated for various modes of operation

Mode 1: Fixed channel transmission. As per the FCC rules, the intentional radiation/conduction testing was performed with operating the NOM-110 React at the three selected transmission frequencies (Low, Medium and High) as identified below:

Low TX: 2.402 GHz
Medium TX: 2.440 GHz
High TX: 2.479 GHz

Mode 2: Frequency Hopping

Mode 3: Receive

Mode 4: USB interfacing operation with a Laptop. During this mode of operation the RF module is not operating.

Mode 5: Battery charging mode using an AC Adaptor. During the charging mode, the EUT ON/OFF switch remains off.

2.3 Rationale for the Chosen Mode of Operation

The EUT was evaluated for operating modes that simulate the EUT normal applications. Further, as per the FCC rules, intentional radiated testing was performed at the selected three frequencies, therefore it was considered as appropriate operating modes for the EMI evaluation.

3.0 Applicable Requirements, Methods and Procedures

3.1 Applicable Requirements

The results of the measurement of the radio disturbance characteristics of the EUT described herein may be applied and, where appropriate, provide a presumption of compliance to one or more of the following requirements or to other requirement at the discretion of the client, regulatory agencies, or other entities.

USA

47 CFR, Part 15, Radio Frequency Devices,
- Subpart B, "Unintentional Radiators".
- Subpart C, "Intentional Radiators".

Canada

Industry Canada (IC) Spectrum Management and Telecommunication, Radio Standards Specifications:
- RSS-Gen, "General Requirements and Information for the Certification of Radiocommunication Equipment". Issue 1, September 2005.
- RSS-210, "Low Power License – Exempt Radiocommunication Devices (All Frequency Bands): Category I equipment", Issue 6, September 2005.

3.2 Basic Test Methods and Procedures

The applicable regulatory product family or generic standards require that radio disturbance/interference tests be performed in accordance with the following:

- C63.4, 2003 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in The Range of 9 kHz to 40 GHz".
- FCC DA 00-705, March 2000, FCC filing and measurement guidelines for Frequency Hopping Spread Spectrum Systems

3.3 Deviations Or Exclusions From The Requirements And Standards

There were no deviations or exclusions from the requirements and standards.

4.0 Test Results

4.1 Radiated Emissions

4.1.1 Radiated Emissions Test Procedure

Radiated Emissions 30 MHz – 1000 MHz

Initial measurements, for the purpose of identifying suspect emissions from the equipment under test, were performed by dividing the test frequency range into the following twenty bands:

Band	Frequency Range	Band	Frequency Range	Band	Frequency Range
1)	30 - 40 MHz	8)	108 - 148 MHz	15)	570 - 670 MHz
2)	40 - 50 MHz	9)	148 - 165 MHz	16)	670 - 770 MHz
3)	50 - 88 MHz	10)	165 - 200 MHz	17)	770 - 855 MHz
4)	88 - 93 MHz	11)	200 - 300 MHz	18)	855 - 875 MHz
5)	93 - 98 MHz	12)	300 - 450 MHz	19)	875 - 892 MHz
6)	98 - 103 MHz	13)	450 - 470 MHz	20)	892 - 1000 MHz
7)	103 - 108 MHz	14)	470 - 570 MHz		

Each of these bands was monitored on a spectrum analyzer display while the turntable was initially positioned at the reference 0 degree point. A mast mounted broadband antenna was located at a distance of 3 meters (as applicable) from the periphery of the EUT(s). The antenna was set to a height of 1 meter, for the vertical polarity and a height of 2.5 meters, for horizontal polarity for these suspect emission scans. All emissions with amplitudes 8 dB or less below the appropriate regulatory limit were identified and saved for later source identification and investigation. This initial suspect identification procedure was repeated for turntable positions of 90, 180 and 270 degrees. The resolution bandwidth was set to 120 KHz.

The source of questionable emissions was verified by powering off the EUT(s). Those emissions remaining were removed from the suspect list. Valid suspect emissions were then maximized through cable manipulation. The highest six signals or all within 4 dB of the limit, identified during this initial investigation, were then maximized by rotating the turntable through a complete 360 degrees of azimuth and then raising the antenna from 1 to 4 meters of elevation with the turntable positioned at the angle of maximum signal level. When the EUT(s) azimuth, antenna height and polarization that produced the maximum indication were found, the emission amplitude and frequency were remeasured to obtain maximum peak and quasi-peak field strength. The frequencies and amplitudes of RFI emissions are recorded in this report in units derived as follows:

Field Strength (dBuV/m) = meter reading (dBuV) + antenna factor (dB/m)+ Cable Loss (dB)

Radiated Emissions above 1 GHz

The required test frequency range above 1 GHz, was scanned manually by placing a Double Ridged Guide antenna at a distance of 3 meters from the perimeter of the equipment under test. Emissions were monitored using EMI Test Receiver ESIB 40 set for a 1 MHz resolution bandwidth with rotating the turntable through a complete 360 degrees of azimuth. Both horizontal and vertical antenna polarities were investigated for suspect emissions. The support equipment and test item(s) were powered off in turn to determine the source of the emissions. The test procedure described above for 30 –1000 MHz was observed to maximize the emissions. The measurements were made with both peak and average detectors. The field strengths were recorded as follows:

Field Strength (dBuV/m) = Meter reading (dBuV) + Correction Factor*

* Correction Factor includes Antenna Factor (dB/m) + Cable Loss (dB) – Amplifier Gain (dB)

4.1.2 Radiated Emissions Test Results (11/6/06 – 11/29/06)

Restricted Bands Radiated Emissions Test - FCC Part 15.205

Radiated emission scan for the harmonics and spurs emissions in the restricted bands (FCC 15.205) up to the 10th Harmonics of the fundamental transmission frequency were made. Testing was performed at a test distance of 3 meters with the NOM-110 React operating at the following transmission frequencies:

(1) Low TX: 2.402 GHz
(2) Medium TX: 2.440 GHz, and
(3) High TX: 2.479 GHz

For each of the fundamental transmitting frequency, testing was carried out with EUT mounting in three orthogonal axes. Out of all three orthogonal axes, the EUT in UP (vertical) orientation was determined to be worst case emission orientation. The results of the measurements with EUT in UP orientation are presented on the next page.

Fixed Frequency Transmission

Freq [GHz]	PK Level dBuV/m	AV Level dBuV/m	Ant Pol	Angle [deg]	Ht [cm]	CF [dB]	PK Limit (dBuV/m)	PK Delta [dB]	AV Limit [dBuV/m]	AV Delta [dB]	Note
1.721	65.70	33.80	V	137	154	-6.70	74	-8.30	54	-20.20	3
2.206	66.67	33.87	V	181	144	-3.75	74	-7.33	54	-20.13	2
2.220	63.86	31.76	V	173	110	-3.70	74	-10.14	54	-22.24	1
2.695	67.03	33.83	V	117	139	-2.30	74	-6.97	54	-20.17	1
2.702	66.73	33.73	V	122	125	-2.30	74	-7.27	54	-20.27	2
2.731	67.09	33.99	V	120	142	-2.28	74	-6.91	54	-20.01	3
3.261	62.08	28.98	V	239	118	-0.89	74	-11.92	54	-25.02	2
3.261	54.78	20.92	H	91	149	-0.89	74	-19.22	54	-33.08	2
3.263	60.61	28.33	V	228	126	-0.88	74	-13.39	54	-25.67	3
3.775	49.03	15.73	V	227	101	0.00	74	-24.97	54	-38.27	2
4.507	62.08	28.98	V	157	114	0.31	74	-11.92	54	-25.02	1
4.804	51.29	21.89	H	55	150	1.34	74	-22.71	54	-32.11	1
4.804	57.20	29.73	V	322	148	1.34	74	-16.80	54	-24.27	1
4.880	56.39	28.13	V	219	105	1.60	74	-17.61	54	-25.87	2
4.880	51.56	22.01	H	278	102	1.60	74	-22.44	54	-31.99	2
4.958	61.91	33.32	V	200	105	1.85	74	-12.09	54	-20.68	3
4.958	56.36	27.35	H	240	101	1.85	74	-17.64	54	-26.65	3
7.320	59.14	29.41	H	225	135	5.30	74	-14.86	54	-24.59	2
7.320	61.14	31.41	V	112	131	5.30	74	-12.86	54	-22.59	2
7.437	53.03	22.22	H	85	100	5.59	74	-20.97	54	-31.78	3
7.437	53.43	23.32	V	4	156	5.59	74	-20.57	54	-30.68	3
12.011	58.49	28.04	V	254	120	9.99	74	-15.51	54	-25.96	1
12.011	55.8	24.05	H	173	127	9.99	74	-18.20	54	-29.95	1
12.201	61.41	31.62	V	114	114	10.09	74	-12.59	54	-22.38	2
12.201	58.55	28.25	H	158	101	10.09	74	-15.45	54	-25.75	2
12.396	57.56	26.96	V	110	121	10.20	74	-16.44	54	-27.04	3
12.396	56.22	24.59	H	239	107	10.20	74	-17.78	54	-29.41	3
14.640	53.38	19.91	V	264	134	11.44	74	-20.62	54	-34.09	2
14.640	53.77	19.85	H	257	107	11.44	74	-20.23	54	-34.15	2

Note legends for EUT operation:

1: Low TX - 2.402 GHz
2: Medium TX - 2.440 GHz
3: High TX: - 2.479 GHz

All the detected radiated emissions were found below the limit specified in FCC Part 15.209

Radiated Emissions Test - FCC Part 15.109 and 15.209

Emission scan for detection of spurious and unintentional radiation was performed. The recorded levels are compared with the applicable limit specified in FCC Part 15, Section 15.209 which is the same limit as FCC Part 15 specified for Class B digital devices for the test measurement frequency spectrum. Measurement scan was performed for the frequency range of 30 MHz to 25 GHz, at the test distance of 3 meters. Emission scan was carried out with EUT mounting in all three orthogonal axes. Out of all three orthogonal axes, the EUT in UP (vertical) orientation was determined to be worst case emission orientation. The results of the measurements with EUT in UP orientation are presented below. Further it may be noted that the emissions in the Receive and Battery Charging operating modes were low with respect to the Frequency Hopping mode and USB interface mode and considerably below the applicable FCC Part 15 Class B limit. Therefore the emission characteristic data for the Frequency Hopping and USB Interface modes are presented below:

Frequency Hopping Operation

Freq	Q-Pk	Ant	Angle	Ht	CF	Limit	Delta
[MHz]	[dBuV/m]	Pol	[deg]	[cm]	[dB]	[dBuV/m]	[dB]
180.00	15.85	V	307	399	11.45	43.5	-27.65
240.00	32.83	V	308	184	14.47	46	-13.17
240.00	37.53	H	15	107	14.47	46	-8.47
360.00	34.43	V	162	128	17.79	46	-11.57
360.00	33.10	H	248	195	17.79	46	-12.90
444.53	41.66	V	190	111	19.6	46	-4.34
444.53	31.56	H	95	149	19.6	46	-14.44
452.823	41.23	V	120	100	19.7	46	-4.77
452.823	31.8	H	80	171	19.7	46	-14.20
459.904	42.62	V	161	103	19.93	46	-3.38
459.904	30.55	H	304	197	19.93	46	-15.45
465.482	41.36	V	195	102	20.11	46	-4.64
478.771	41.41	V	277	100	20.44	46	-4.59
478.771	32.75	H	319	148	20.44	46	-13.25
488.034	38.66	V	176	116	20.51	46	-7.34
488.034	37.97	H	99	146	20.51	46	-8.03
996.869	35.64	H	85	221	27.88	54	-18.36
996.869	39.84	V	114	100	27.88	54	-14.16

(Cont.)

USB Interface Operation

Freq	Q-Pk	Ant	Angle	Ht	CF	Limit	Delta
[MHz]	[dBuV/m]	Pol	[deg]	[cm]	[dB]	[dBuV/m]	[dB]
72.067	27.84	V	44	400	8.64	40	-12.16
72.067	25.97	H	334	398	8.64	40	-14.03
163.618	34.88	V	159	103	11.82	43.5	-8.62
163.618	32.01	H	93	136	11.82	43.5	-11.49
179.982	23.39	V	181	107	11.45	43.5	-20.11
179.982	20.59	H	42	170	11.45	43.5	-22.91
240.005	37.63	H	207	113	14.47	46	-8.37
240.005	34.55	V	153	179	14.47	46	-11.45
360.002	38.60	V	128	146	17.79	46	-7.40
360.002	34.45	H	87	101	17.79	46	-11.55
488.030	32.62	V	170	116	20.51	46	-13.38

Overall Results: All the detected EUT signals are under the FCC Part 15, Section 15.209 limit at 3 meters and FCC Part 15, Section 15.109, Class B digital devices limit.

Test Setups

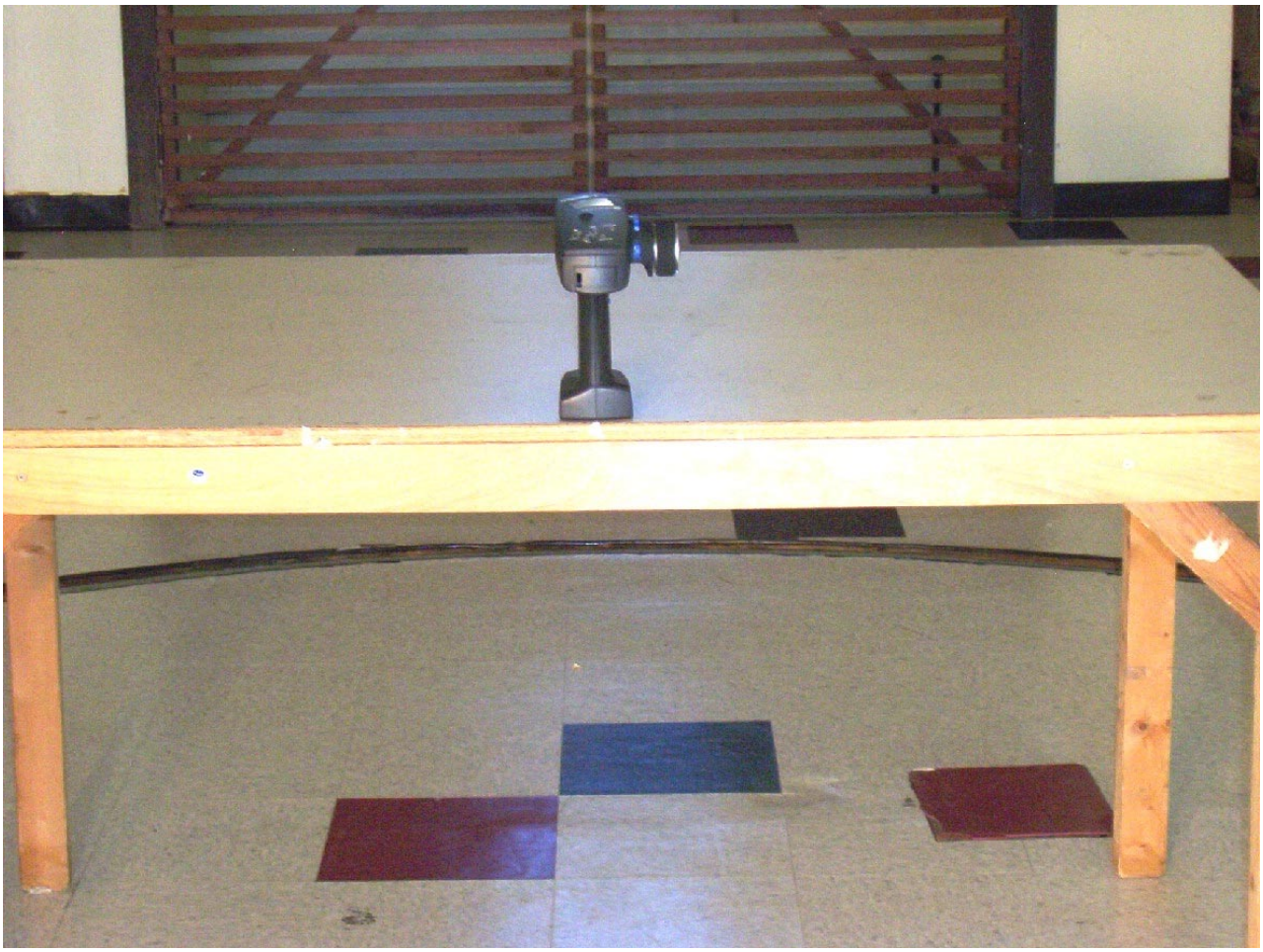


Photo 3: Radiated Emission Test Setup – EUT Standalone, Up Position View 1

Photo 4: Radiated Emission Test Setup – EUT Standalone, Up Position View 2

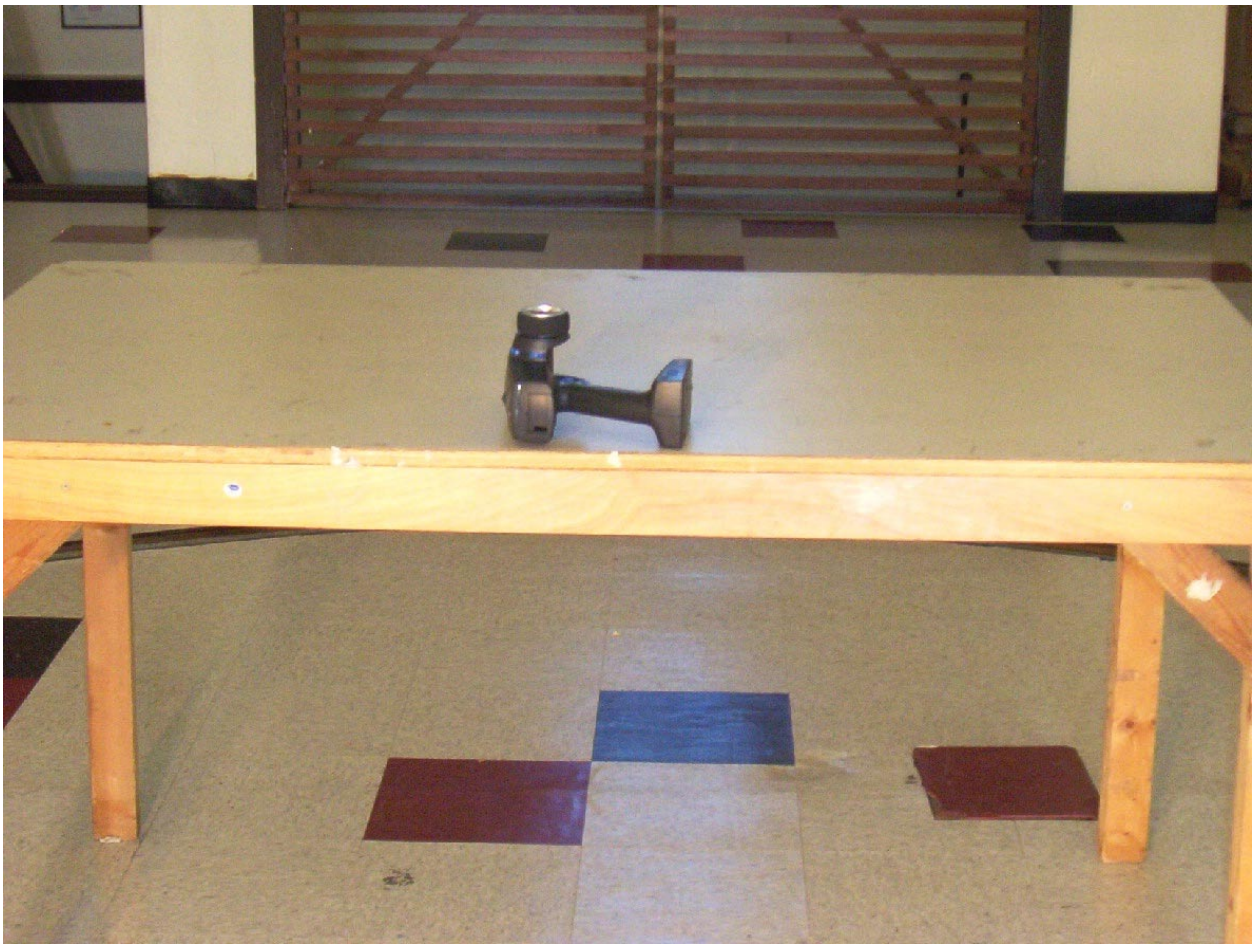


Photo 5: Radiated Emission Test Setup – EUT Standalone, Side Position View 1

Photo 6: Radiated Emission Test Setup – EUT Standalone, Side Position View 2

Photo 7: Radiated Emission Test Setup – EUT Standalone, Down Position View 1

Photo 8: Radiated Emission Test Setup – EUT Standalone, Down Position View 2

Photo 9: Radiated Emission Test Setup – EUT in USB Interface mode, Up Position View 1

Photo 10: Radiated Emission Test Setup – EUT in USB Interface mode, Up Position View 2

Photo 11: Radiated Emission Test Setup – EUT in Battery charging mode, Up Position View 1

Photo 12: Radiated Emission Test Setup – EUT in Battery charging mode, Up Position View 2

4.2 AC Power Lines Conducted Emissions

4.2.1 Conducted Emission Test Procedure

Peak amplitude terminal voltage emissions at the AC power input port of the USB interfacing Laptop PC and Battery Charger (AC Adaptor), were measured with a receiver, using a peak detector and the appropriate CISPR bandwidth, connected to the RF output of a 50 Ohm, 50 microhenry Line Impedance Stabilization Network (LISN) installed in each power line. Peak detector emission data measurements were made over the frequency range from 150 kHz to 30 MHz while the EUT(s) was operating as described in paragraph 2.2.

Note: For speed and convenience, a receiver employing a peak detector was used to sweep through and record the spectrum. As a tool to judge compliance of the emissions, the peak detector sweep is displayed and graphed against the appropriate average limit. This type of measurement is valid given that the peak reading will always be greater than or equal to the average or quasi-peak reading. From the Peak detector emission data plot, the top six (6) emissions or any other peak emissions that exceed the average limit, or are found to be within 1 dB of the average limit, are re-measured using receiver with the detector function first set to quasi-peak and then to average. These measurements are recorded and presented in the table format below the peak emission graph.

The amplitudes of emissions measured on the AC power lines of the EUT(s) are recorded in this report in units derived as follows:

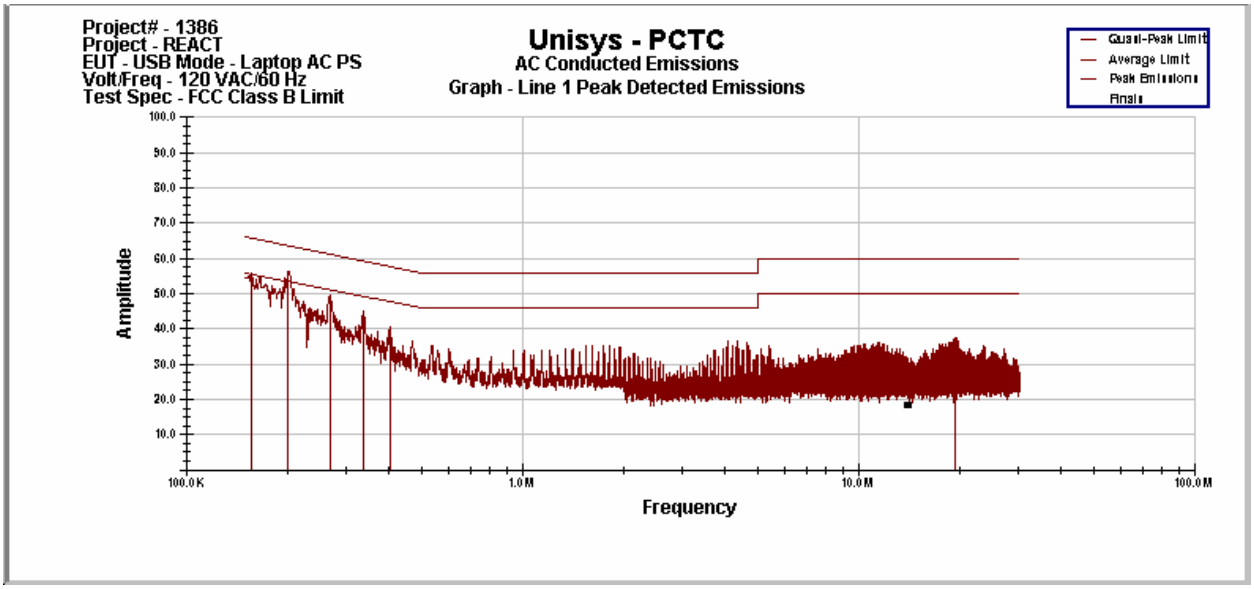
Conducted Emission (dBuV) = Meter reading (dBuV)+ Correction Factor*

* Correction Factor = Cable Loss (dB) + LISN factor (dB) + Limiter Loss (dB).
.

4.2.2 Conducted Emissions Test Results (11/15/06)

The conducted emissions recorded at the AC power input port of the Laptop PC during USB Interface mode and the Battery Charger during Battery Charging mode operation; displayed against the limits for FCC Part 15.207 (same as FCC Part 15.107 Class B Conducted Emission limit) are presented below:

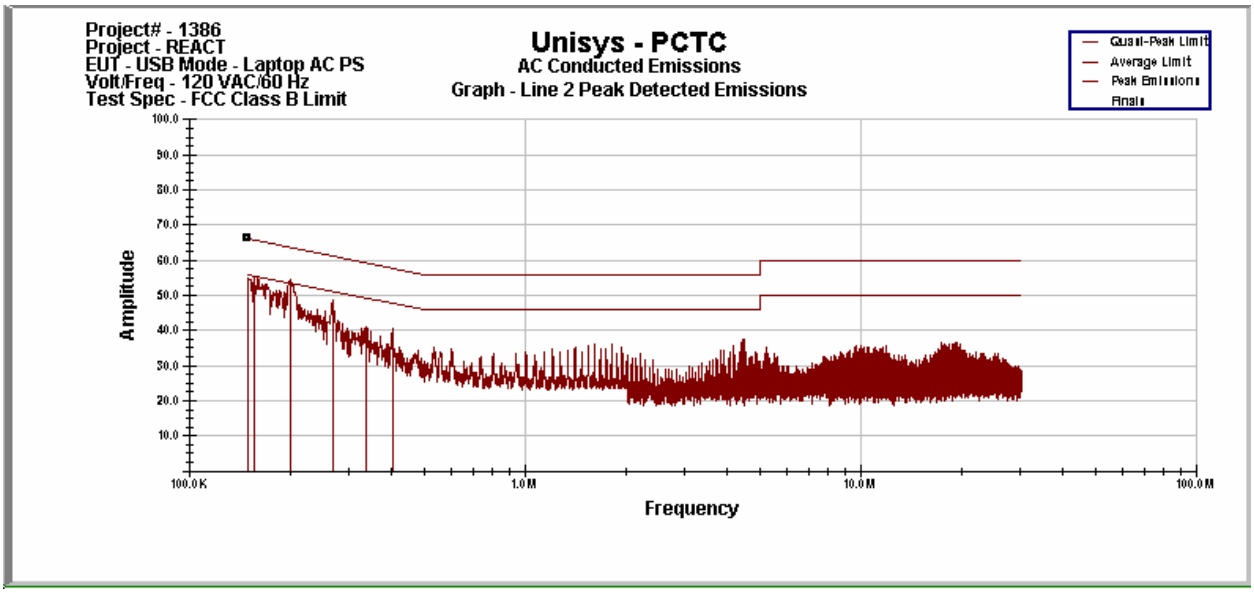
USB Interface Mode Operation, Laptop PC – Line 1



Unisys - PCTC
Line 1 Conducted Emissions
09:12:55 AM, Wednesday, November 15, 2006

	1	2	3	4	5	6	7
Frequency	AVG	AVG	AVG	QP	QP	QP	Corr
MHz	dBuV	Limit	Margin	dBuV	Limit	Margin	Factor
156.000 KHz	34.39	55.83	-21.44	46.55	65.83	-19.28	13.298
201.000 KHz	40.83	54.54	-13.72	53.67	64.54	-10.88	11.582
268.000 KHz	36.64	52.63	-15.98	45.68	62.63	-16.95	10.662
337.000 KHz	30.11	50.66	-20.55	39.79	60.66	-20.87	10.545
404.000 KHz	28.36	48.74	-20.38	35.94	58.74	-22.81	10.516
19.248 MHz	24.36	50.00	-25.64	33.13	60.00	-26.87	10.530
Project# - 1386							
Project - REACT							
EUT - USB Mode - Laptop AC PS							
Volt/Freq - 120 VAC/60 Hz							
Test Spec - FCC Class B Limit							

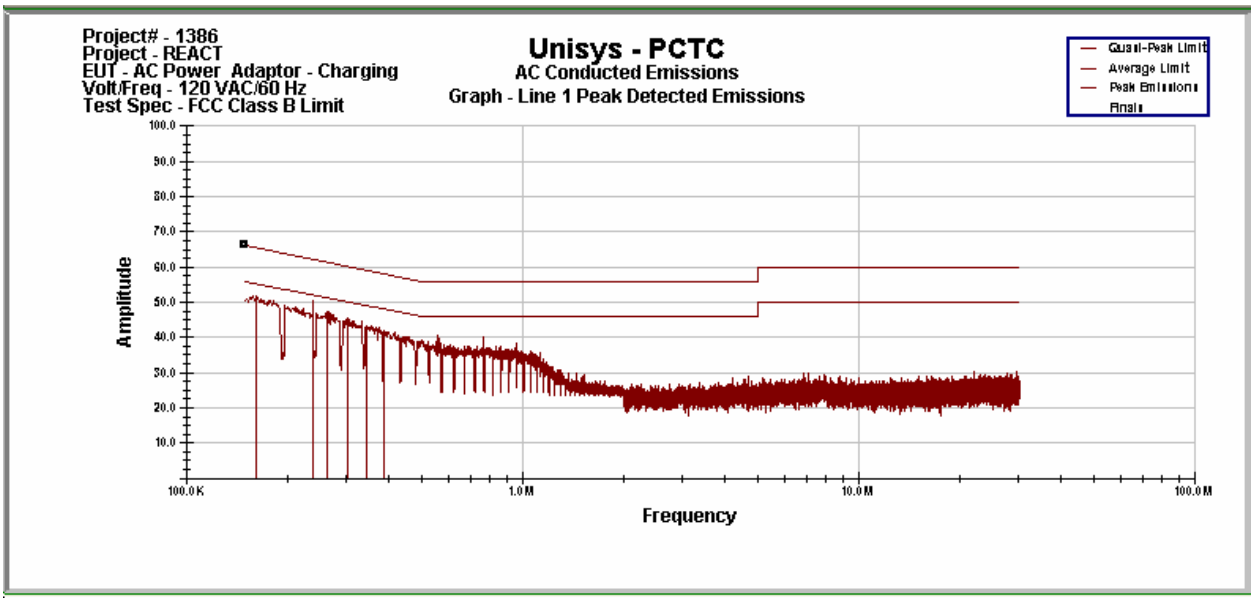
USB Interface Mode Operation, Laptop PC – Line 2



Unisys - PCTC
Line 2 Conducted Emissions
09:18:36 AM, Wednesday, November 15, 2006

	1	2	3	4	5	6	7
Frequency	AVG	AVG	AVG	QP	QP	QP	Corr
MHz	dBuV	Limit	Margin	dBuV	Limit	Margin	Factor
150.000 KHz	28.328	56.000	-27.672	45.712	66.000	-20.288	13.530
156.000 KHz	34.439	55.829	-21.390	45.191	65.829	-20.637	13.298
201.000 KHz	39.742	54.543	-14.801	51.752	64.543	-12.791	11.582
267.000 KHz	36.277	52.657	-16.380	43.499	62.657	-19.158	10.666
335.000 KHz	31.677	50.714	-19.037	37.965	60.714	-22.749	10.546
403.000 KHz	27.877	48.771	-20.894	35.700	58.771	-23.071	10.517
Project# - 1386							
Project - REACT							
EUT - USB Mode - Laptop AC PS							
Volt/Freq - 120 VAC/60 Hz							
Test Spec - FCC Class B Limit							

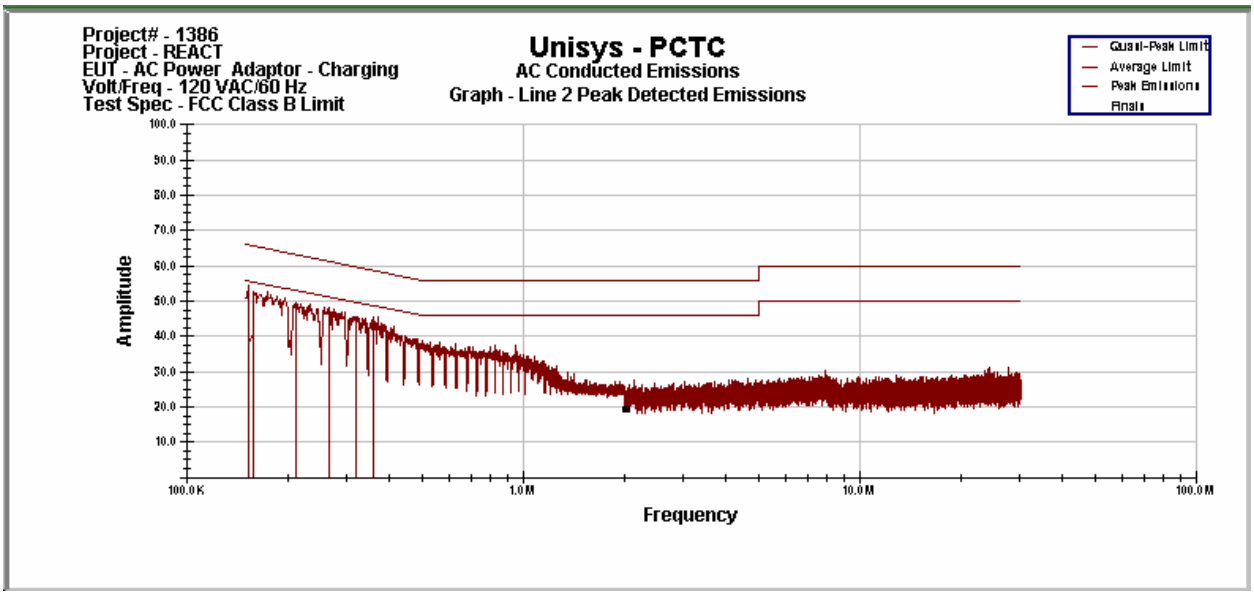
Battery Charging Mode Operation, AC Power Adaptor – Line 1



Unisys - PCTC
Line 1 Conducted Emissions
10:01:47 AM, Wednesday, November 15, 2006

	1	2	3	4	5	6	7
Frequency	AVG	AVG	AVG	QP	QP	QP	Corr
MHz	dBuV	Limit	Margin	dBuV	Limit	Margin	Factor
161.000 KHz	34.40	55.69	-21.28	43.73	65.69	-21.95	13.105
238.000 KHz	27.98	53.49	-25.51	39.28	63.49	-24.20	10.931
263.000 KHz	33.91	52.77	-18.86	39.67	62.77	-23.10	10.678
300.000 KHz	25.97	51.71	-25.75	37.27	61.71	-24.44	10.560
345.000 KHz	21.81	50.43	-28.62	35.73	60.43	-24.70	10.542
388.000 KHz	20.46	49.20	-28.74	33.85	59.20	-25.35	10.525
Project# - 1386							
Project - REACT							
EUT - AC Power Adaptor - Charging							
Volt/Freq - 120 VAC/60 Hz							
Test Spec - FCC Class B Limit							

Battery Charging Mode Operation, AC Power Adaptor – Line 2



Unisys - PCTC
Line 2 Conducted Emissions
10:06:51 AM, Wednesday, November 15, 2006

	1	2	3	4	5	6	7
Frequency	AVG	AVG	AVG	QP	QP	QP	Corr
MHz	dBuV	Limit	Margin	dBuV	Limit	Margin	Factor
152.000 KHz	29.049	55.943	-26.894	43.463	65.943	-22.480	13.453
158.000 KHz	36.180	55.771	-19.591	44.700	65.771	-21.072	13.221
211.000 KHz	29.052	54.257	-25.205	40.849	64.257	-23.408	11.406
264.000 KHz	35.160	52.743	-17.582	40.406	62.743	-22.337	10.675
320.000 KHz	30.117	51.143	-21.026	36.855	61.143	-24.288	10.552
357.000 KHz	22.656	50.086	-27.430	35.229	60.086	-24.857	10.537
Project# - 1386							
Project - REACT							
EUT - AC Power Adaptor - Charging							
Volt/Freq - 120 VAC/60 Hz							
Test Spec - FCC Class B Limit							

Overall Results: All conducted emissions measured at the AC power input port of the Laptop PC during USB Interface mode and the Battery Charger during Battery Charging mode operation, are below the FCC 15.207 limit.

Test Setup

Photo 13: Conducted Emission Test Setup, USB Interface Mode – Front View

Photo 14: Conducted Emission Test Setup, USB Interface Mode – Side View

Photo 15: Conducted Emission Test Setup, Battery Charging Mode – Front View

Photo 16: Conducted Emission Test Setup, Battery Charging Mode – Side View

4.3 Antenna Port (10/24/06 – 11/28/06)

4.3.1 Antenna Requirements

The antenna used for transmitting is an integral part of the NOM-110 React. Connector used for connecting the antenna is a U.FL type connector. The antenna is considered as consumer non-replacement part. The antenna has directional gain of 1.9 dBi.

Overall Results: The NOM-110 React met the antenna requirements of FCC Part 15, Section 15.203.

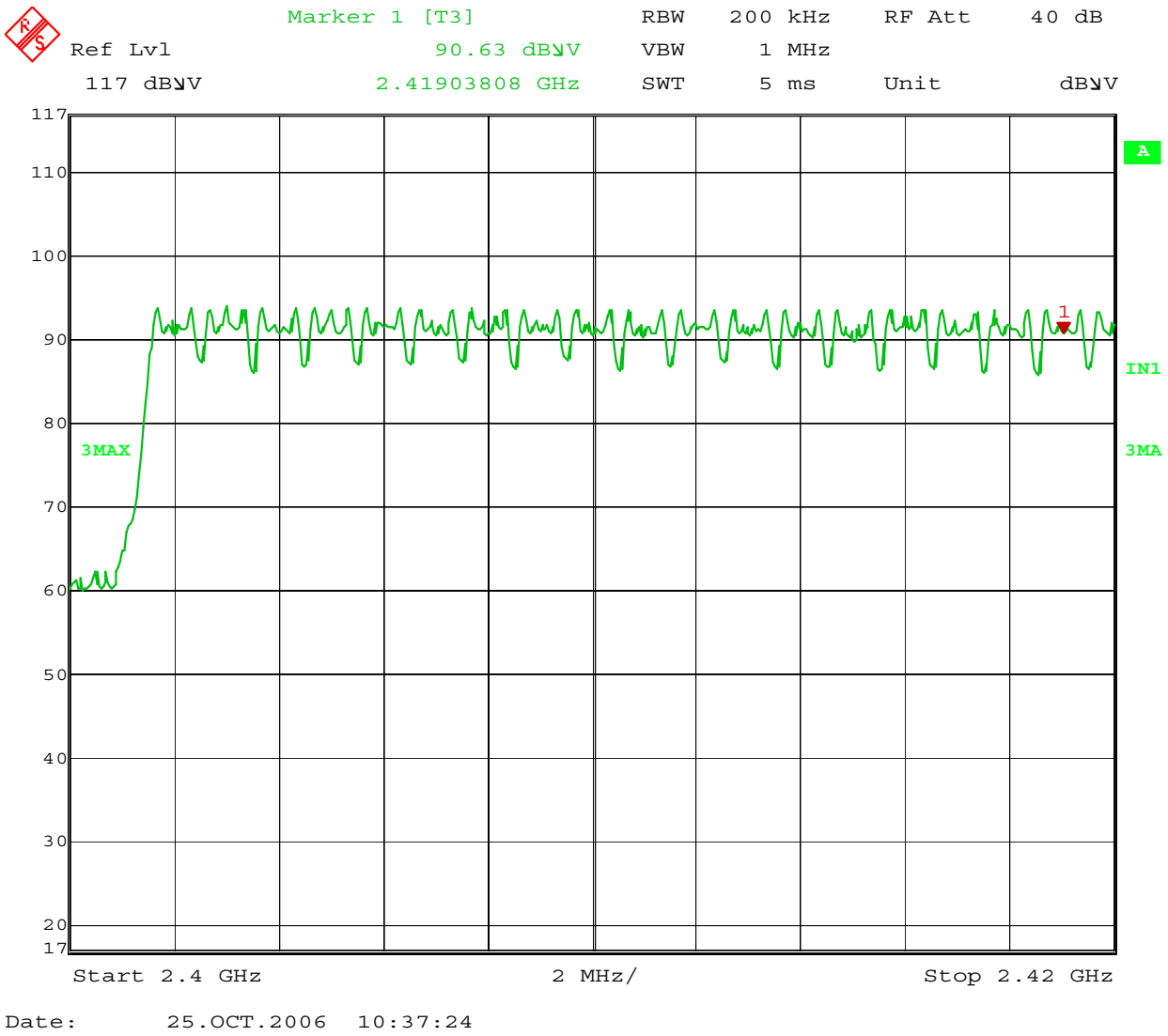
4.3.2 Numbers of Hopping Channel

The NOM-110 React transmits in the frequency band of 2400 MHz – 2483.5 MHz, with a total of 78 frequency hopping channels. According to the FCC Section 15.247 (a) (1) (iii), for the frequency band of 2400 MHz – 2483.5 MHz, the requirements, it shall have at least 15 channels.

The graphical plots showing each individual channels are presented on the next pages.

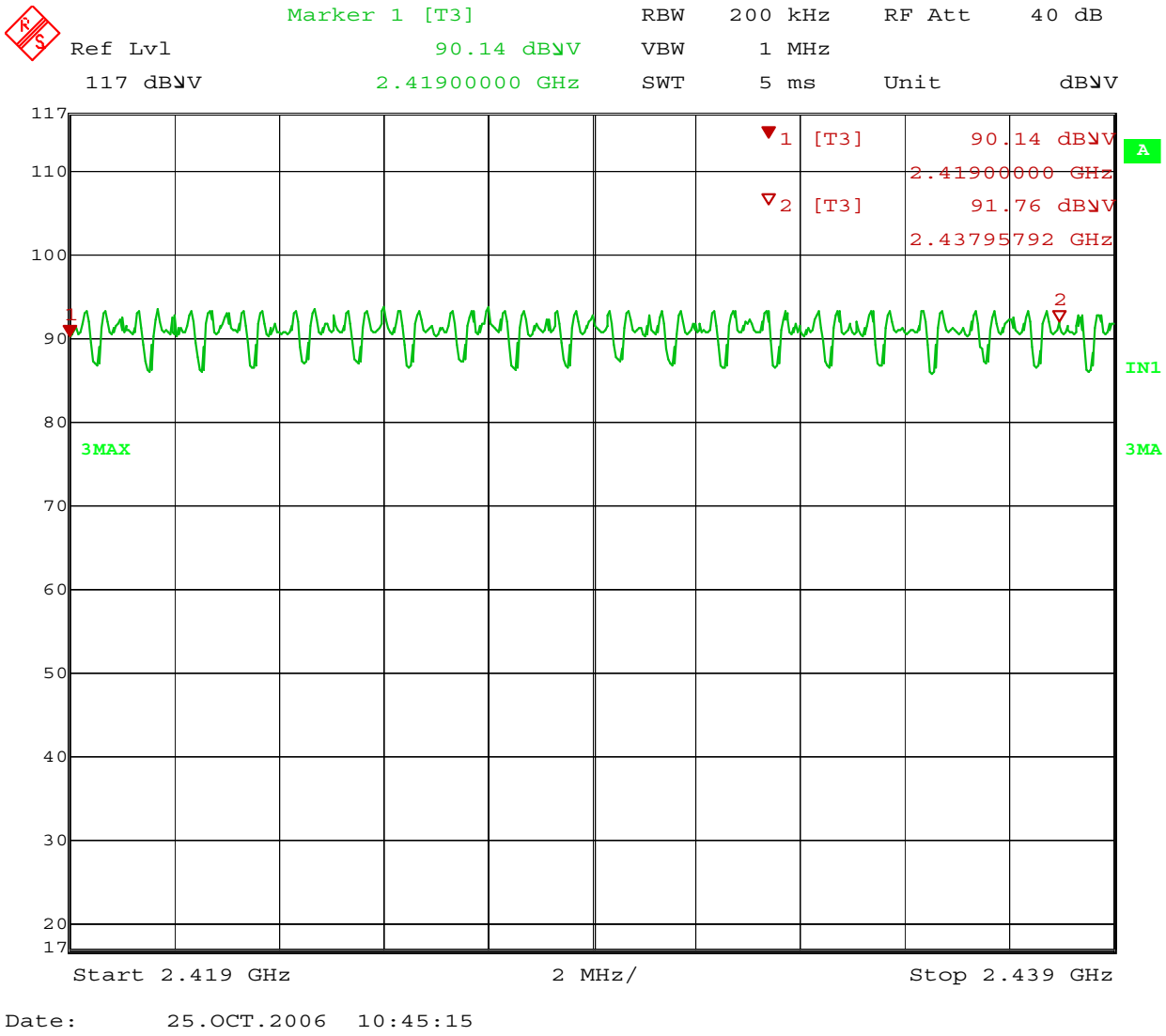
Overall Results: The NOM-110 React met the minimum numbers hopping channel requirements of FCC Part 15, Section 15.247.

Graphical Plots for Nos. of Channels

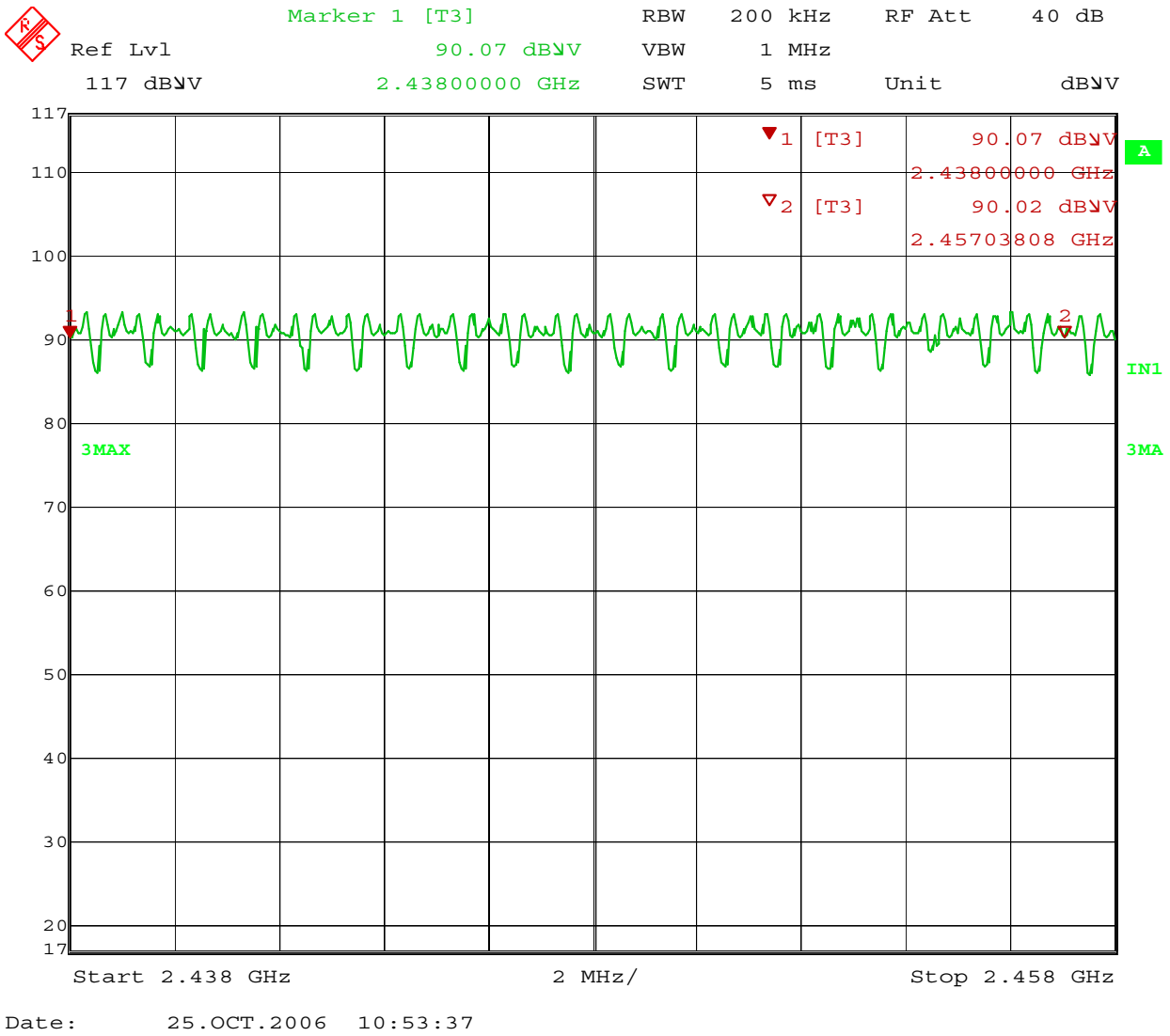


Date: 25.OCT.2006 10:37:24

Plot 1: Channels 0 - 17

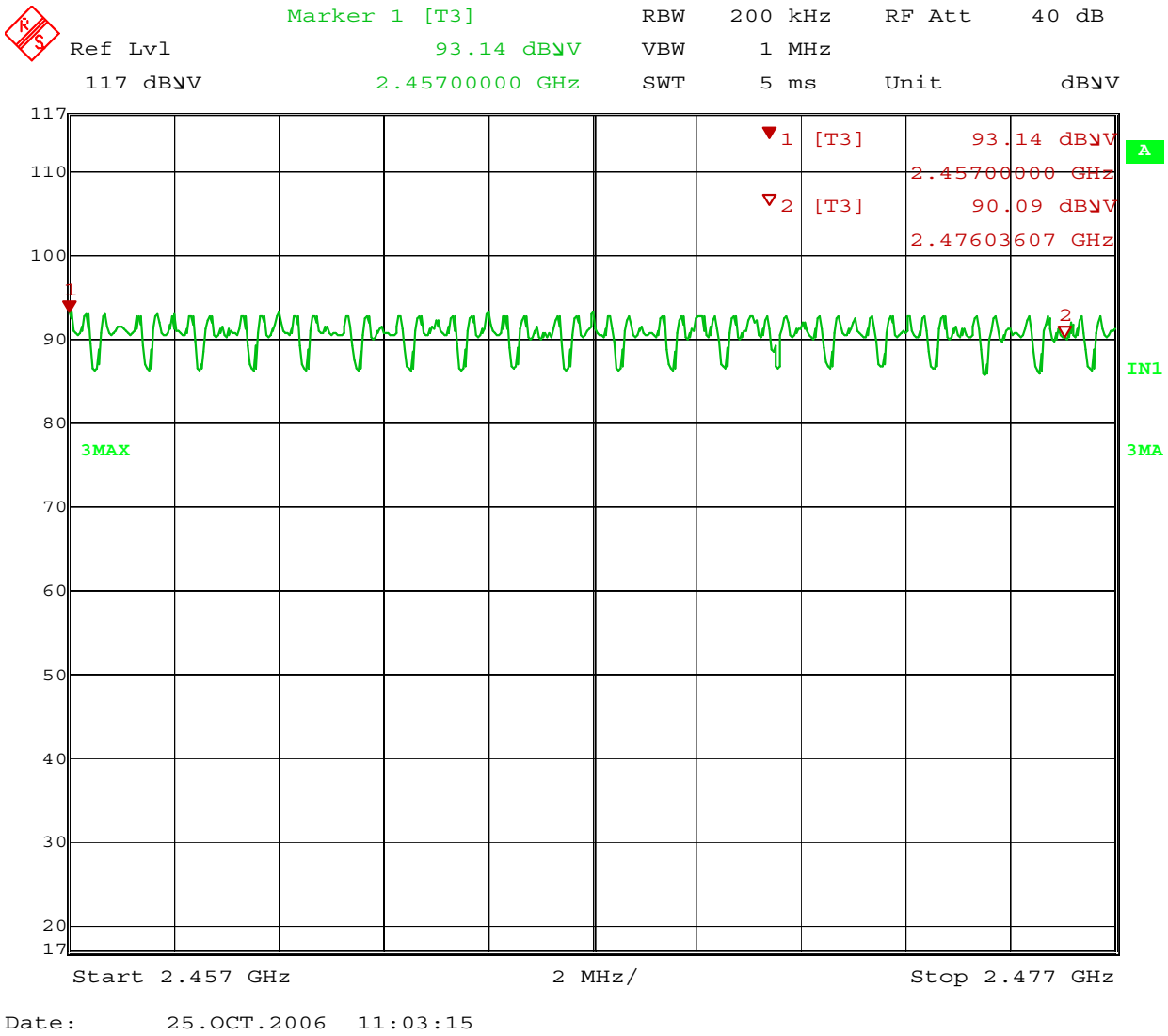


Plot 2: Channels 18 - 36



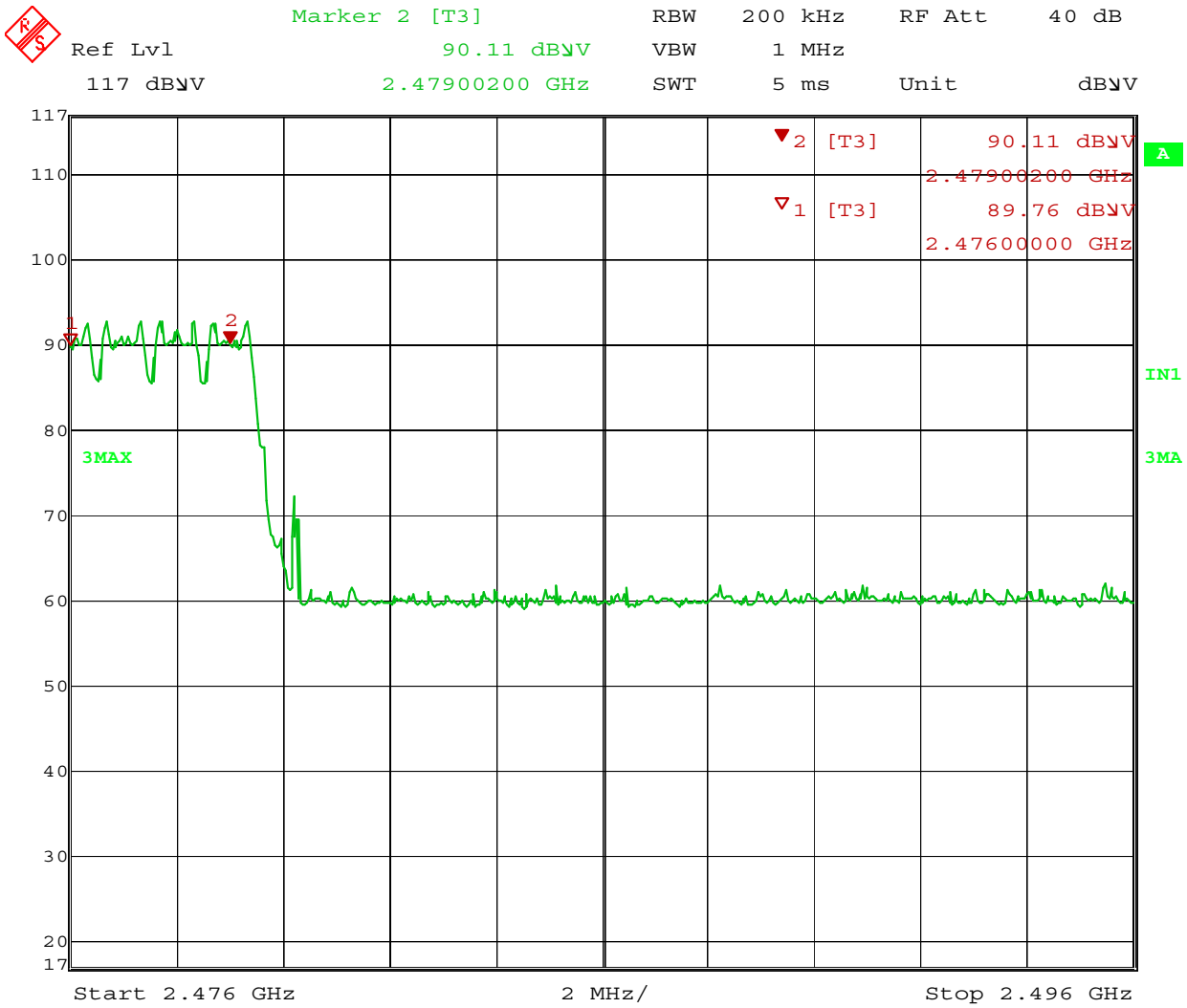
Date: 25.OCT.2006 10:53:37

Plot 3: Channels 37 - 55



Date: 25.OCT.2006 11:03:15

Plot 4: Channels 56-74



Date: 25.OCT.2006 11:09:46

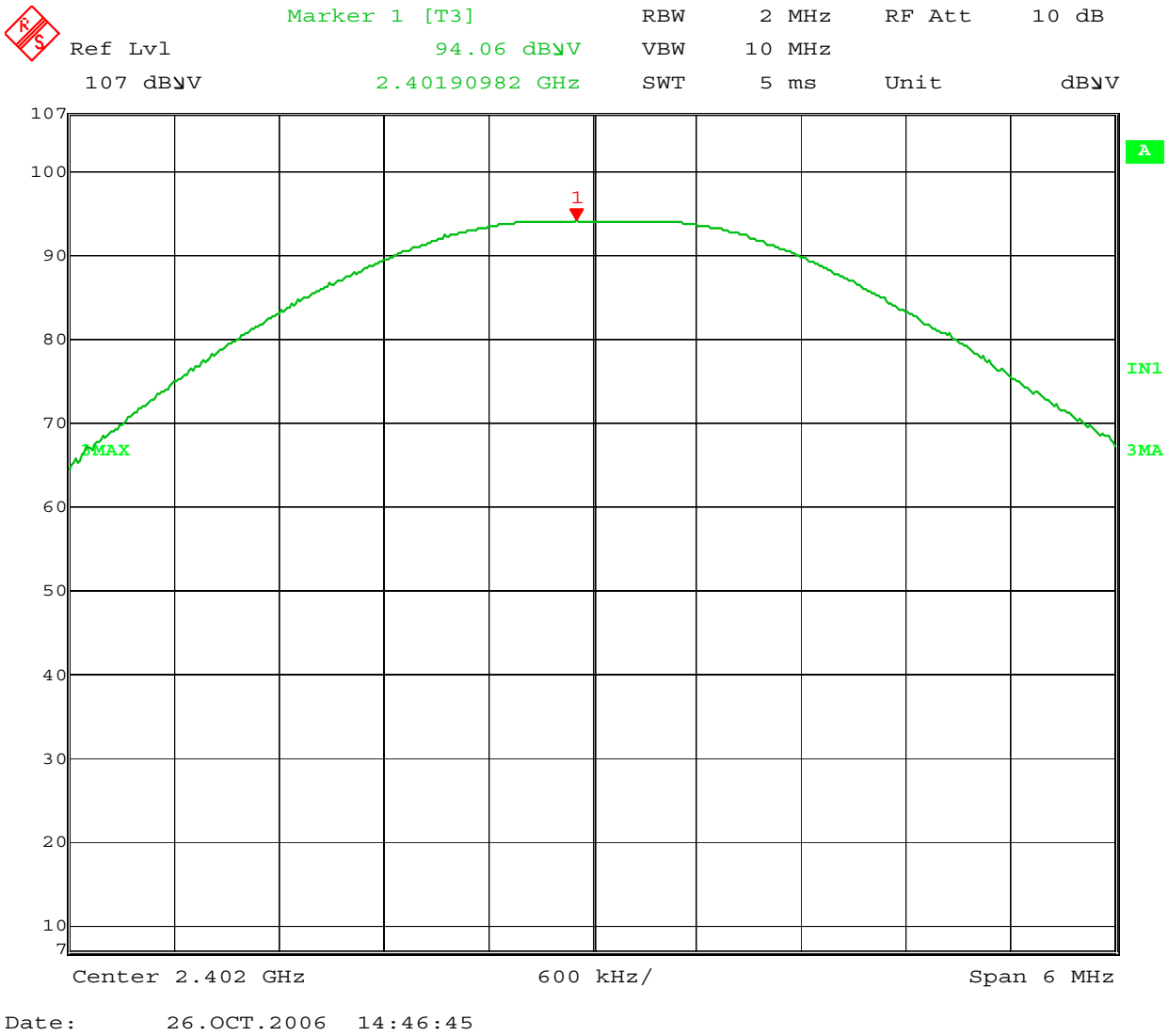
Plot 5: Channels 75-77

4.3.3 Maximum Peak Output Power

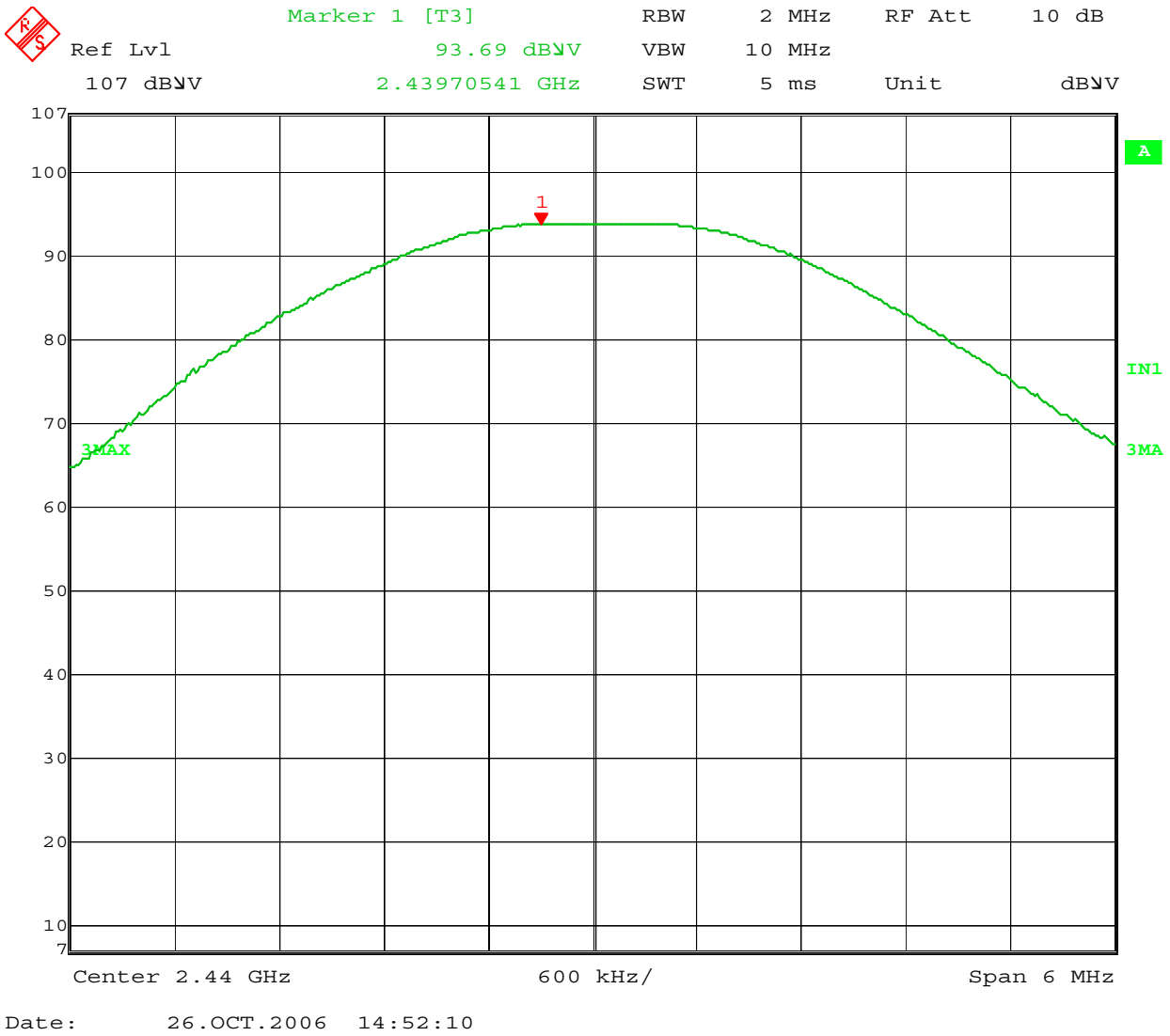
According to FCC Part 15, Section 15.247 (b) (1) for the frequency hopping systems operating in the 2400 MHz – 2483.5 MHz band and employing at least 75 hopping channels, the peak output power limit is 1 Watt (30 dBm). The NOM-110 React antenna port was connected directly to the spectrum analyzer through a suitable attenuator. The following table shows the results of peak power measurements at the selected fundamental transmit frequencies:

Transmit Frequency	Receiver Measured Voltage Level	Correction Factor	Corrected Voltage Level	Corrected Power Output	FCC Power Output Limit
	(dBuV)	(dB)	(dBuV)	(dBm)	(dBm)
2.402 GHz (Low TX)	94.06	30.7	124.76	17.76	30
2.440GHz (Medium TX)	93.69	30.7	124.39	17.39	30
2.479 GHz (High TX)	93.93	30.7	124.63	17.63	30

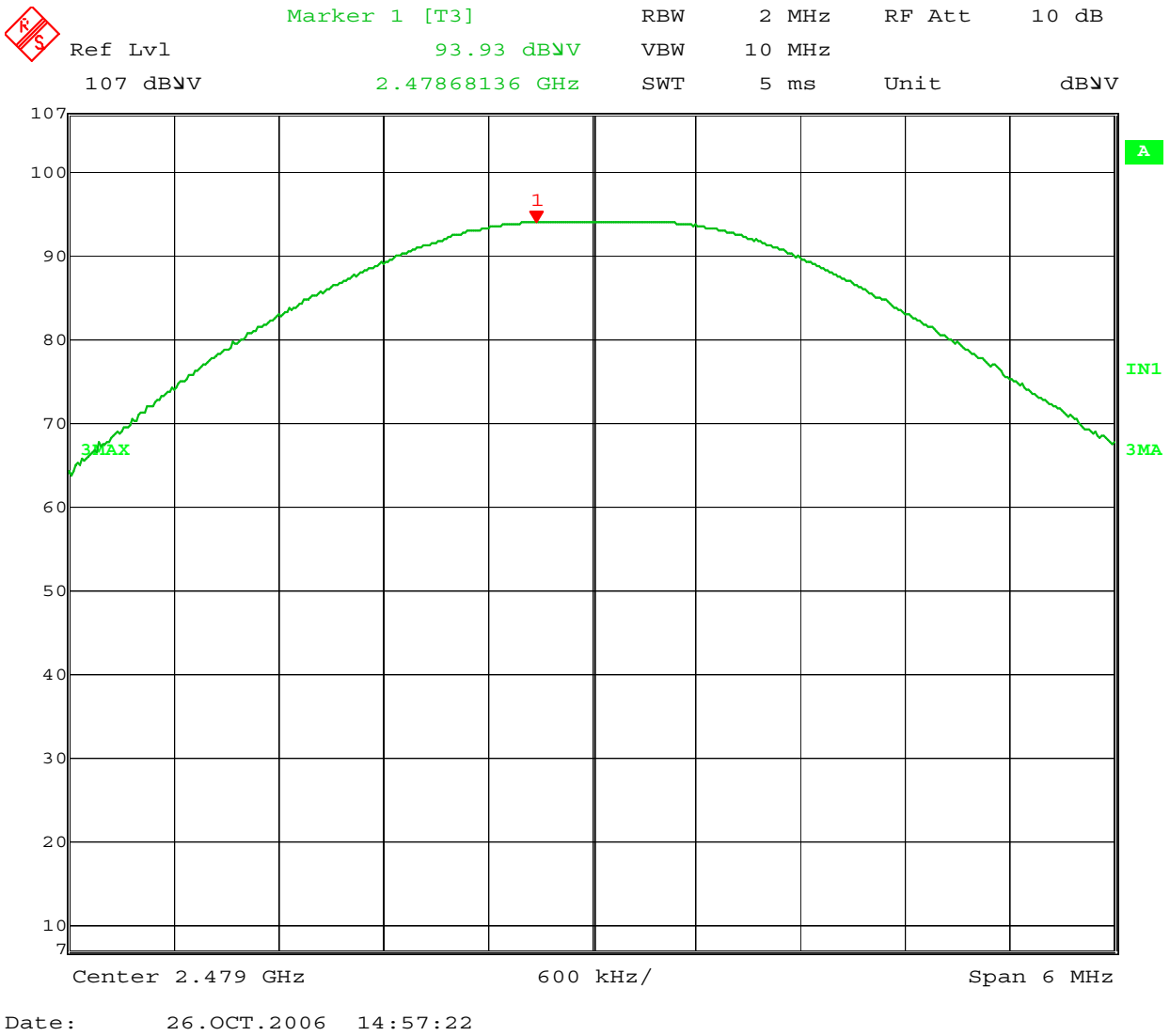
Overall Results: The NOM-110 React conducted peak power output was below the limit specified in FCC Part 15, Section 15.247 (b) (1).



Plot 6: Peak Power at Low TX



Plot 7: Peak Power at Medium TX



Plot 8: Peak Power at High TX

4.3.4 Frequency Separation

The NOM-110 React operates with an output power no greater then 125 mw. Therefore according to the FCC Part 15, Section 15.247, the applicable hopping channel minimum separation requirement is 25 KHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater. 20 dB bandwidth measurements were performed at the Low TX, Medium TX and High TX channel frequencies. The two-thirds of measured 20 dB bandwidth (average) was 0.813 MHz (Section 4.3.9).

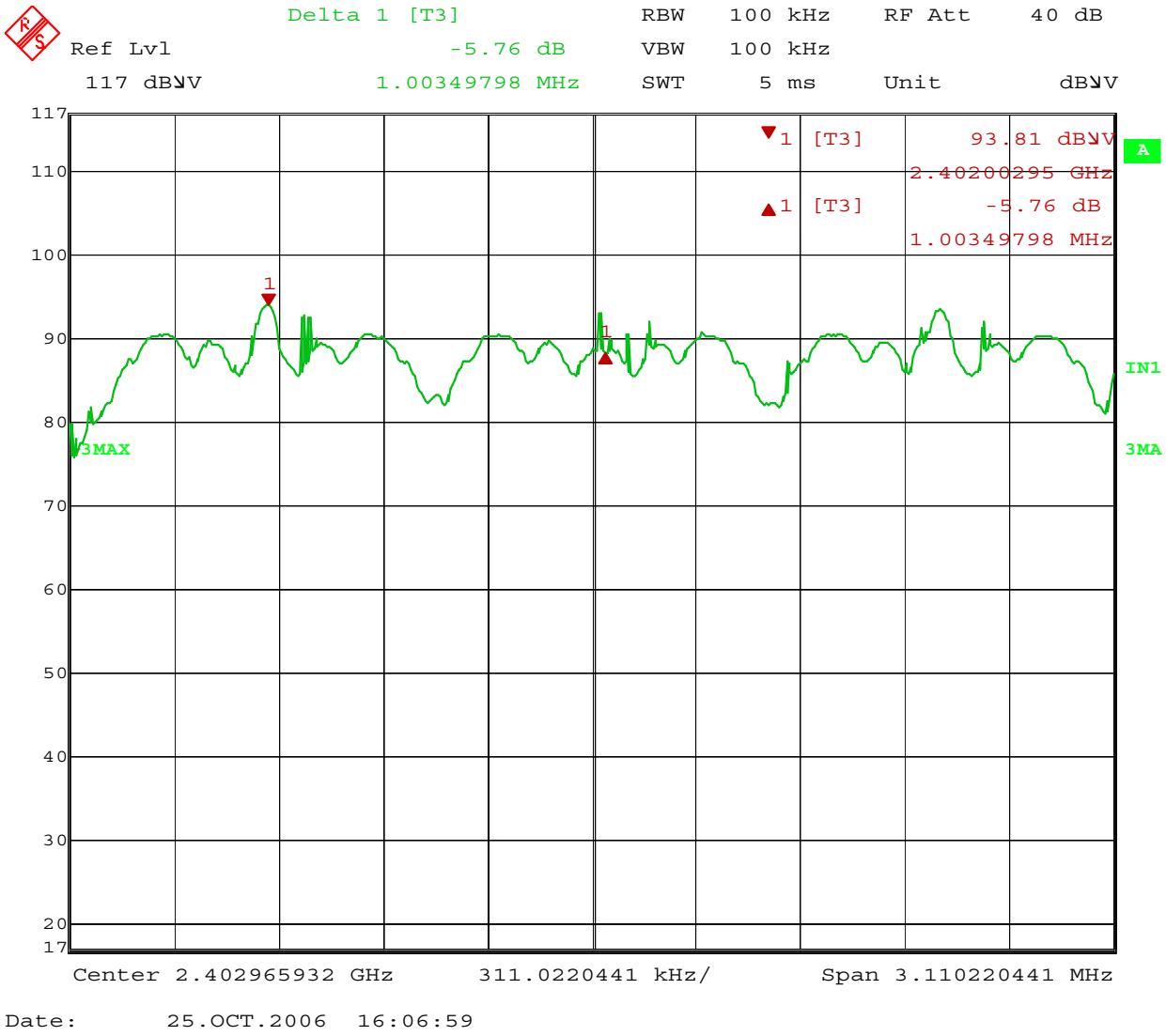
Channel	TX Frequency (GHz)	Channel Separation (MHz)	Average of 20 dB BW (MHz)	Result
Low Tx	2.402	1.003	0.813	Compliant
Medium Tx	2.440	1.003		Compliant
High Tx	2.479	1.003		Compliant

The frequency separation of hopping channel was measured as 1.003 MHz.

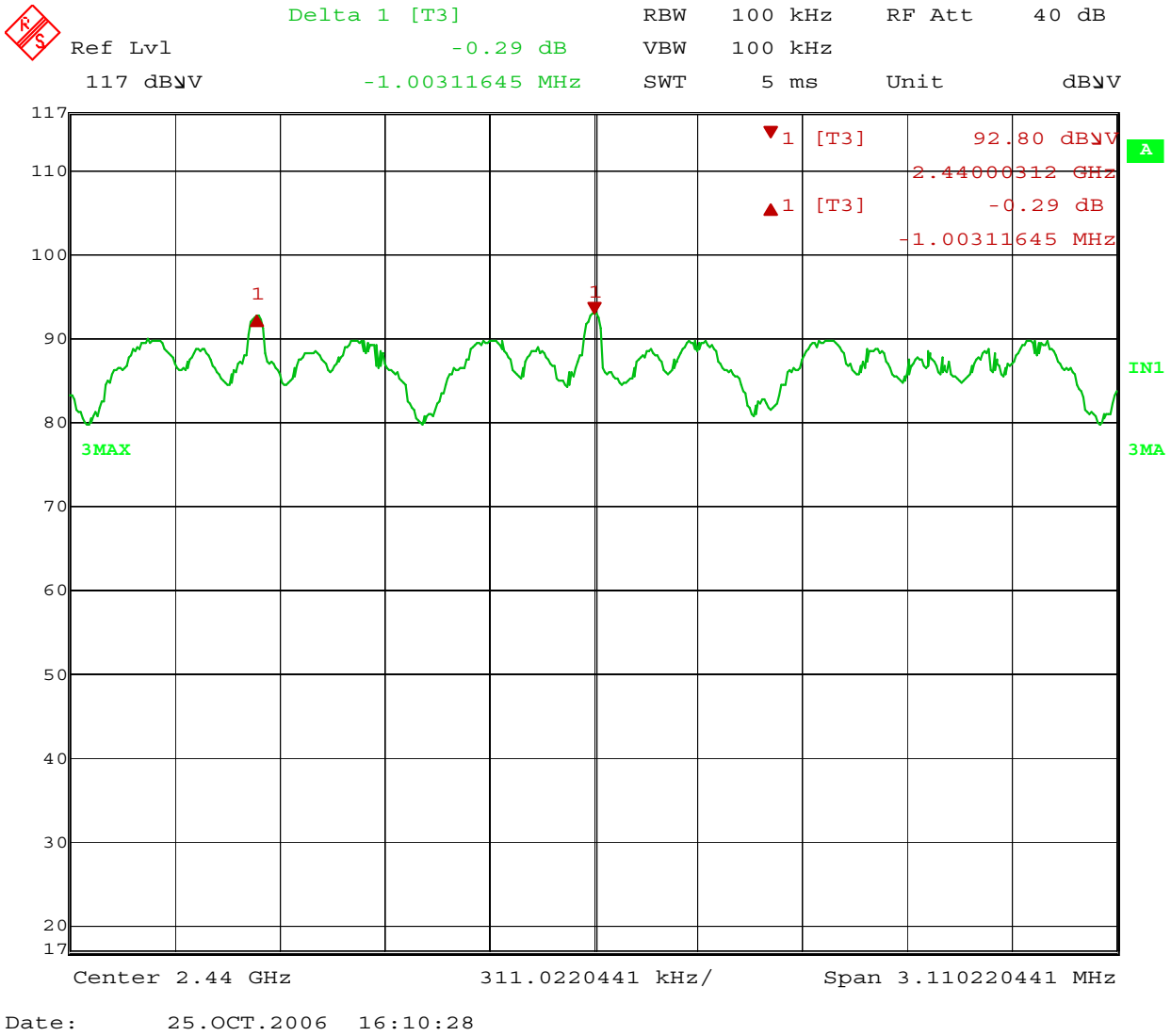
The graphical plots showing channel separation at the Low TX, Medium TX and High TX channel frequencies. are presented on the next pages.

Overall Results: The NOM-110 React met the minimum hopping channel frequency separation requirements of the FCC Part 15, Section 15.247 (a) (1).

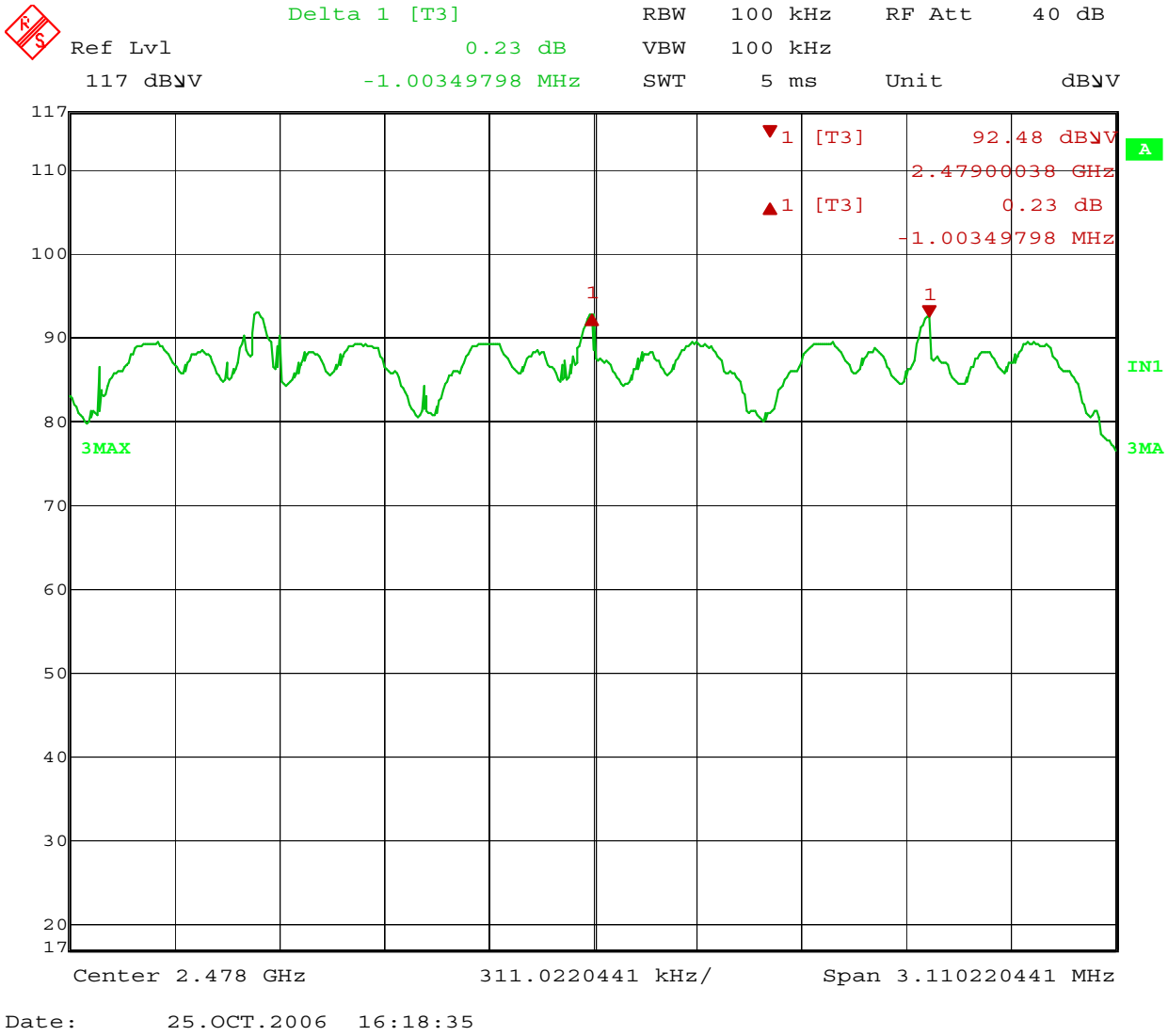
Frequency Separation Plots



Plot 9 – Low Frequency Separation



Plot 10 - Mid Frequency Separation



Date: 25.OCT.2006 16:18:35

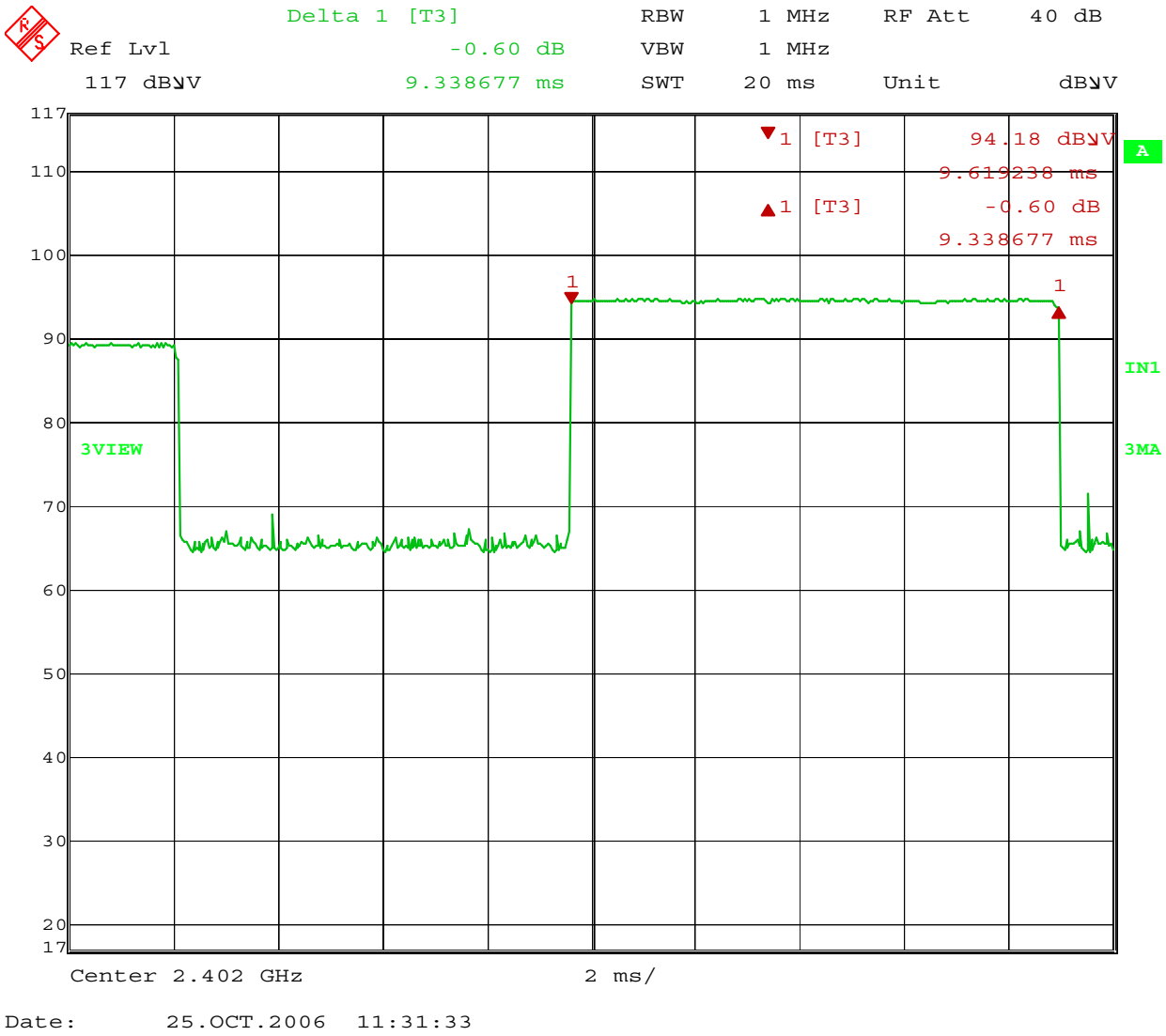
Plot 11 - High Frequency Separation

4.3.5 Time of Occupancy on Channel

Following table shows results of time of occupancy measurements at the selected fundamental transmit frequencies:

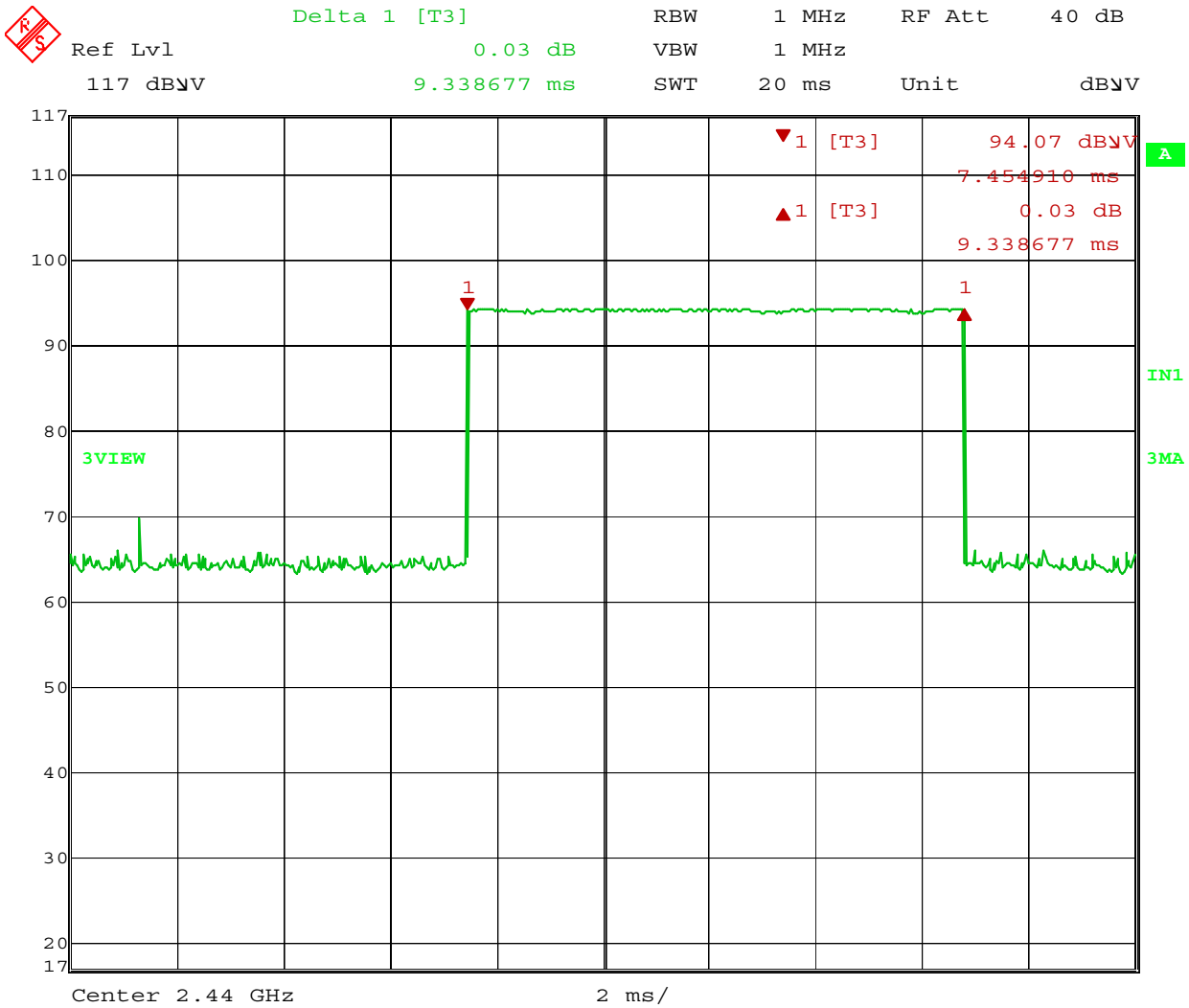
Transmit Frequency	Measured Time of Single Pulse	Nos. of Hops in Specified Test Duration of 31.6 Seconds	Total Time of Occupancy	FCC Limit for Time of Occupancy FCC 15.247 (a) (iii)
	(ms)	(Nos. Hops)	Seconds	Seconds
2.402 GHz (Low TX)	9.338677	24	0. 2241	0.4
2.440GHz (Medium TX)	9.338677	23	0.2148	0.4
2.479 GHz (High TX)	9.338677	22	0.2086	0.4

Overall Results: The NOM-110 REACT met the time of occupancy limit specified in FCC Part 15, Section 15.247 (a) (1) (iii).



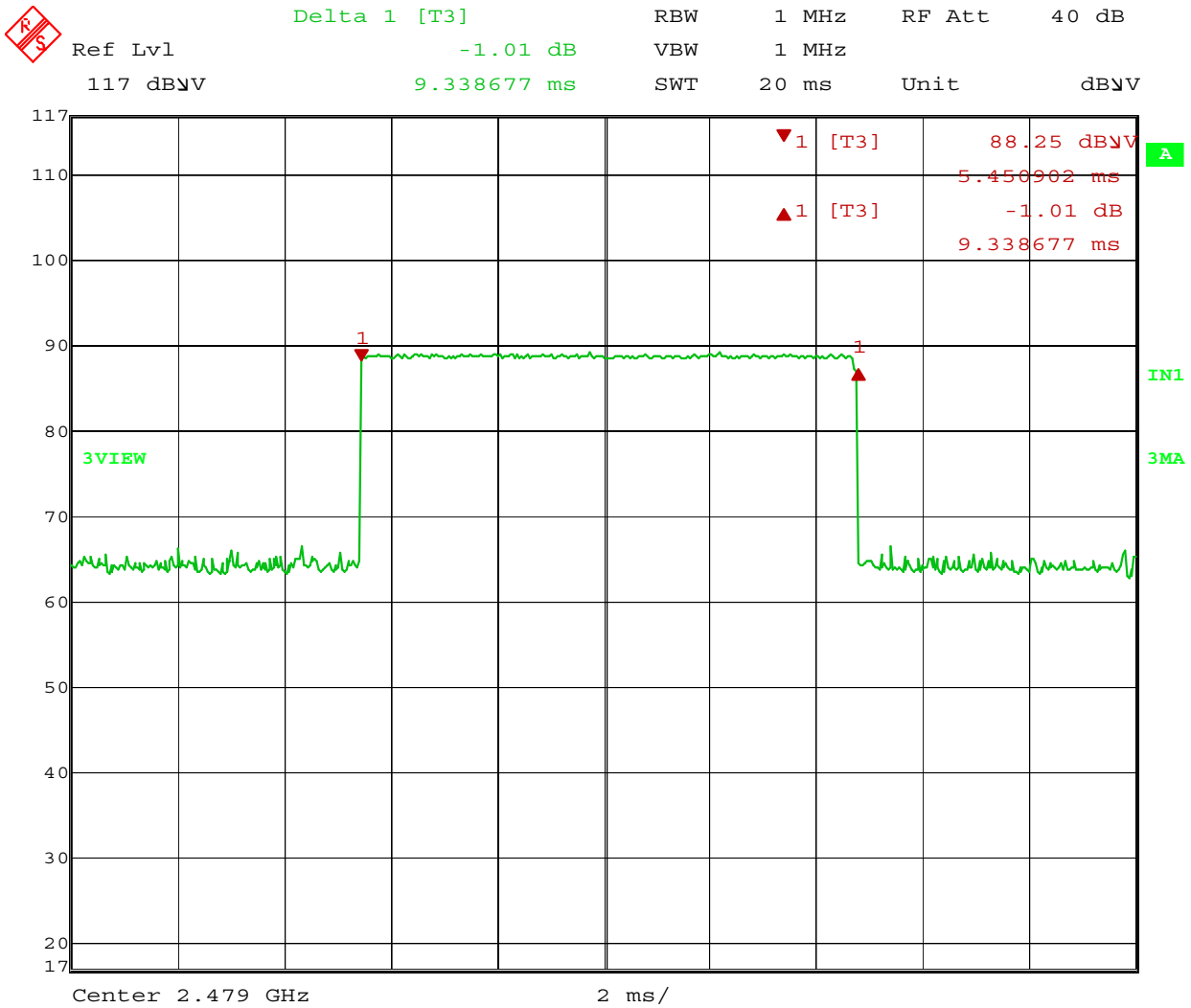
Date: 25.OCT.2006 11:31:33

Plot 12 – Low TX Frequency Dwell Time Measurements



Date: 25.OCT.2006 11:33:43

Plot 13 – Medium TX Frequency Dwell Time Measurements



Date: 25.OCT.2006 11:34:36

Plot 14 – High TX Frequency Dwell Time Measurements

4.3.6 Antenna Port Conducted Emissions Requirements

This test was performed with the NOM-110 React antenna port connected directly to the spectrum analyzer through a suitable attenuator (30 db). Measurements made with a peak detector and a 100 kHz RBW. Measurement scan was performed for the frequency range of 30 MHz to 25 GHz. The purpose of this test is to demonstrate that all harmonics of the fundamental frequency and spurious Emissions from the EUT are 20 dB below from the highest emission level within the authorized band.

Measurements were performed with operating the NOM-110 React at three selected transmission frequencies (Low, Medium and High) as identified below:

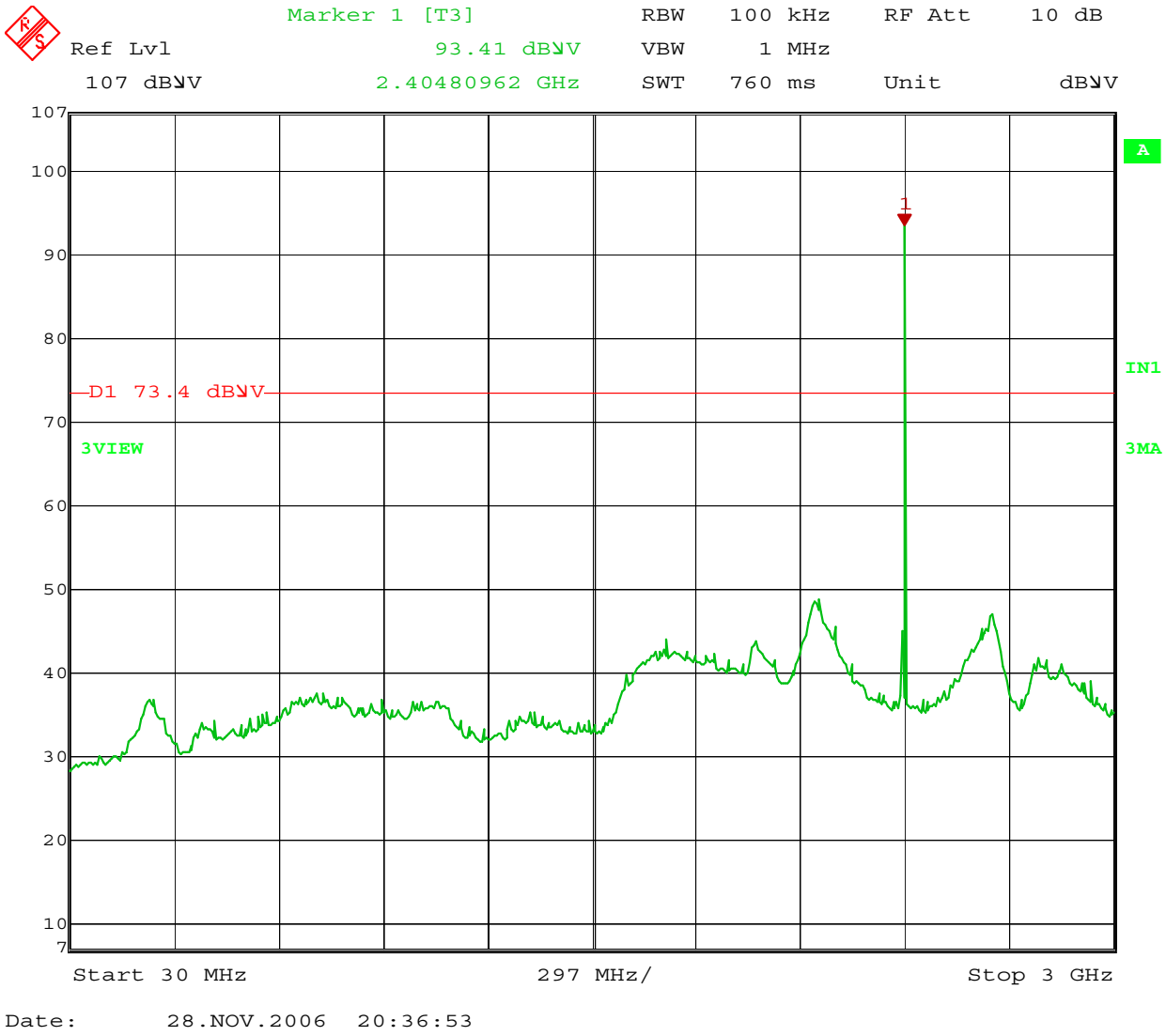
Low TX: 2.402 GHz
Medium TX: 2.440 GHz
High TX: 2.479 GHz

Emission scan did not find any significant level with respect to the applicable limit, all the levels were considerably below the applicable limit per FCC Part 15.247 (d).

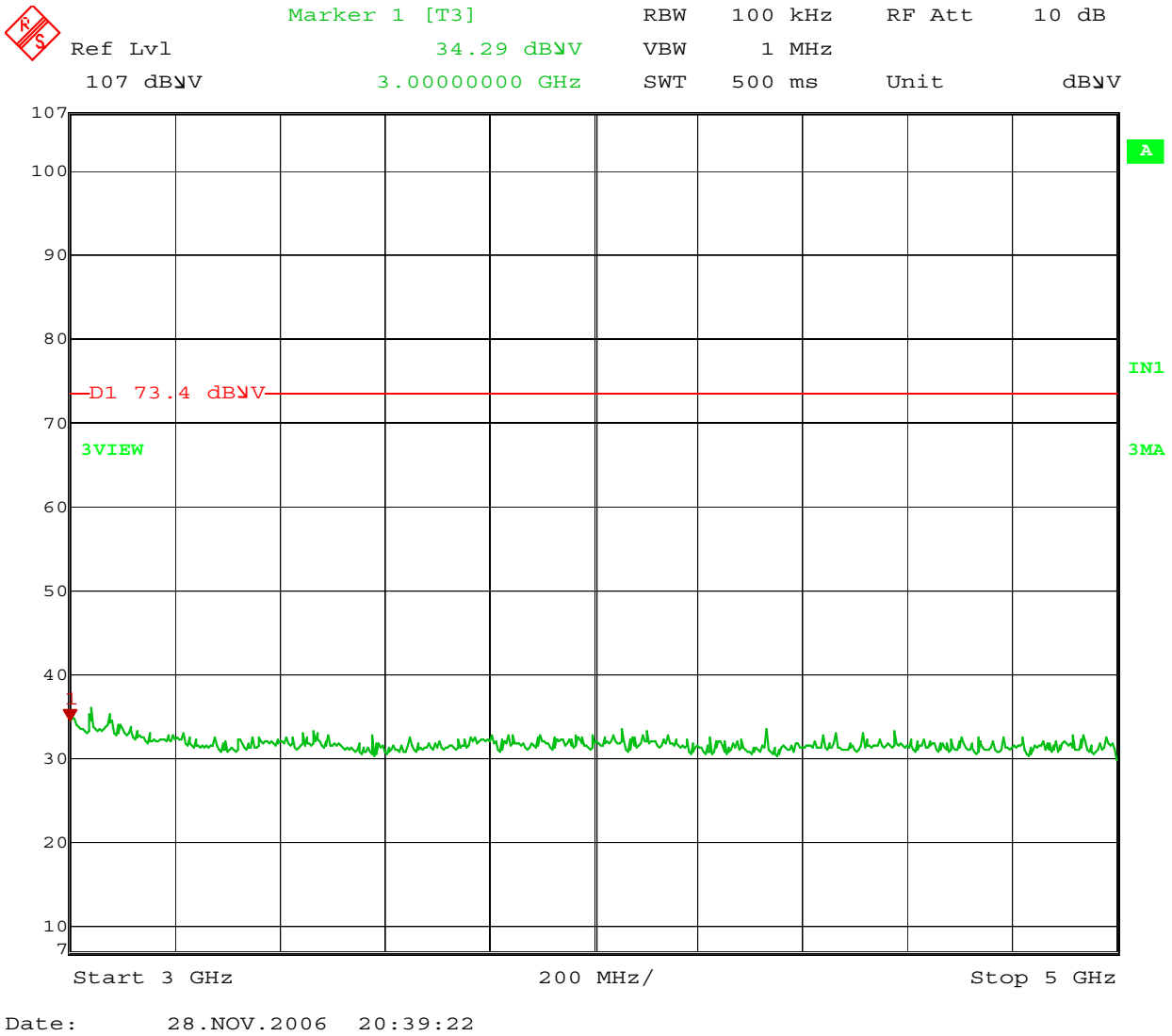
The graphical plots showing conducted emissions measurements are presented on the next pages.

Overall Results: All harmonics and spurious emissions are more than 20 dB down from the highest emissions level the authorized band.

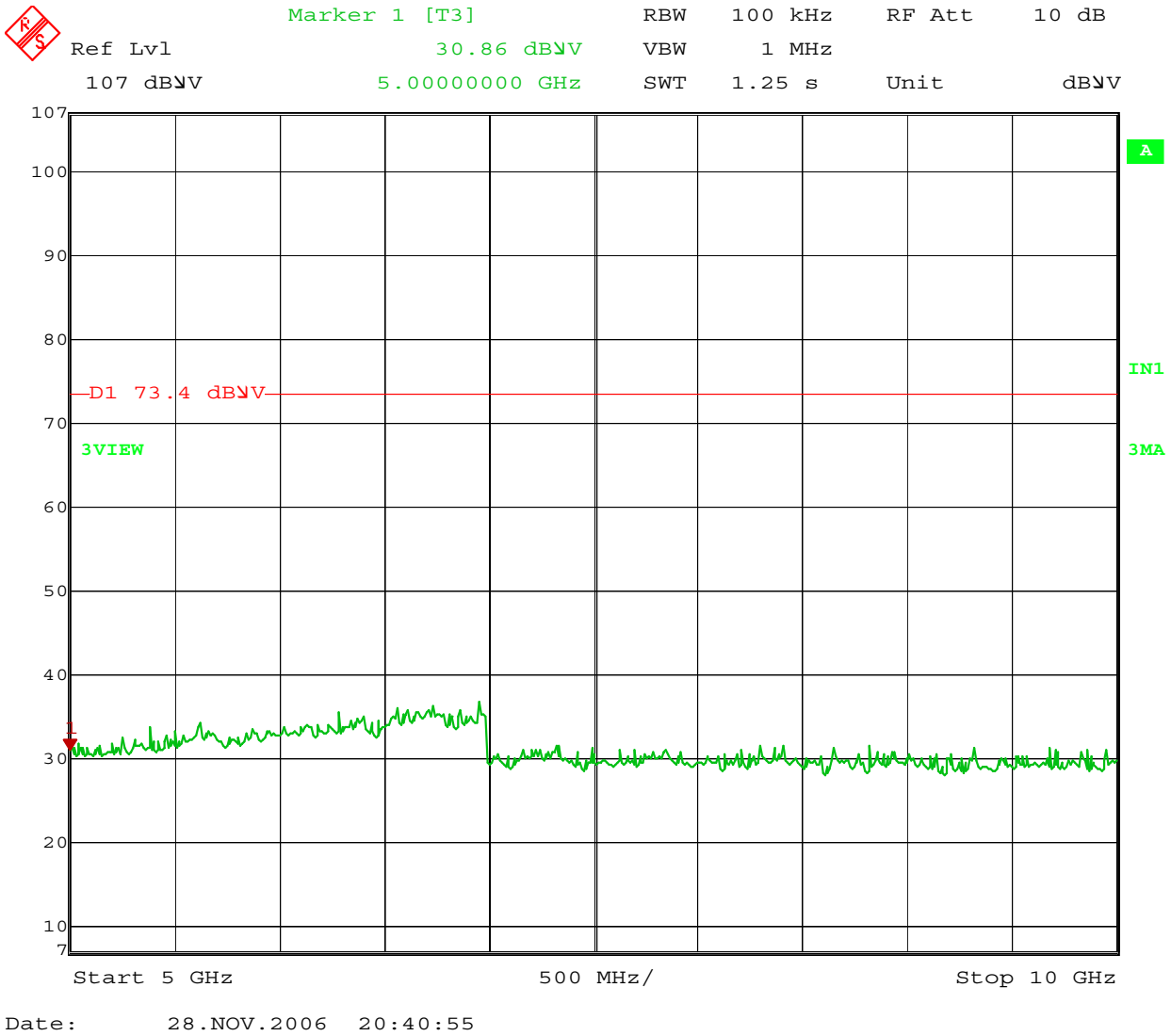
Antenna Port Conducted Emission Plots



Plot 15 – Low Tx Channel Antenna Conducted Emissions, 30 MHz - 3 GHz

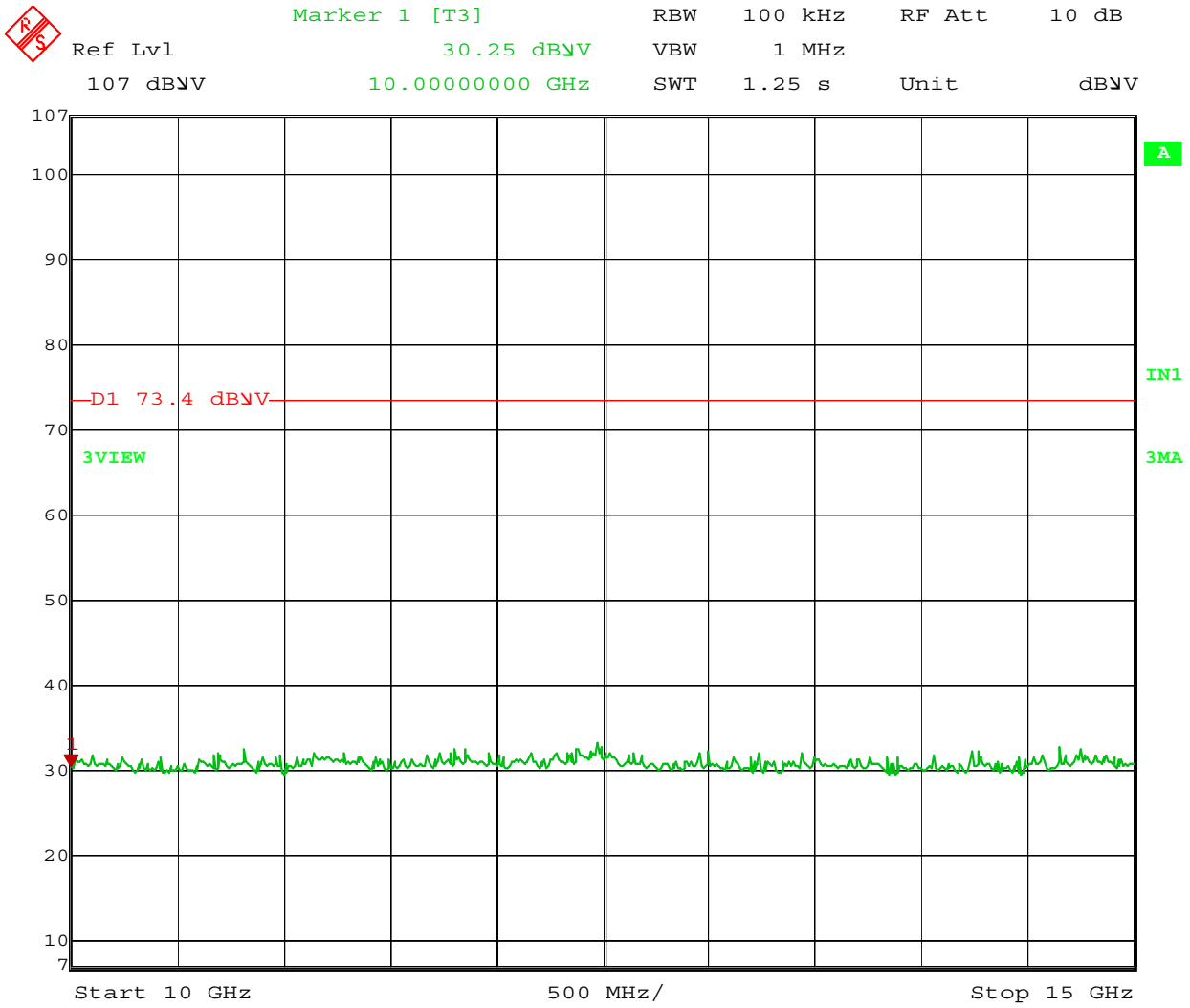


Plot 16 - Low Tx Channel Antenna Conducted Emissions, 3 GHz - 5 GHz



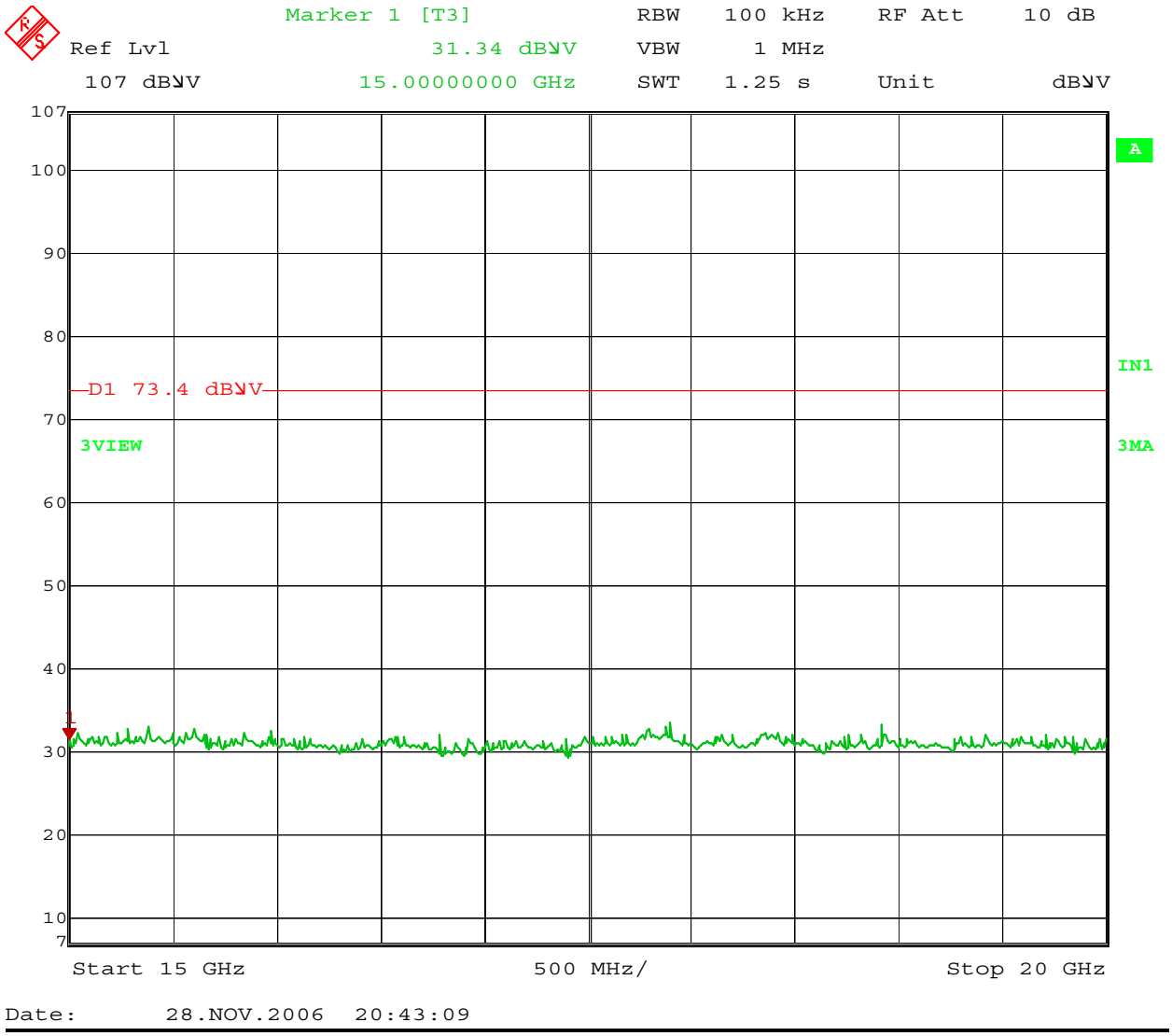
Date: 28.NOV.2006 20:40:55

Plot 17 - Low Tx Channel Antenna Conducted Emissions, 5 GHz - 10 GHz

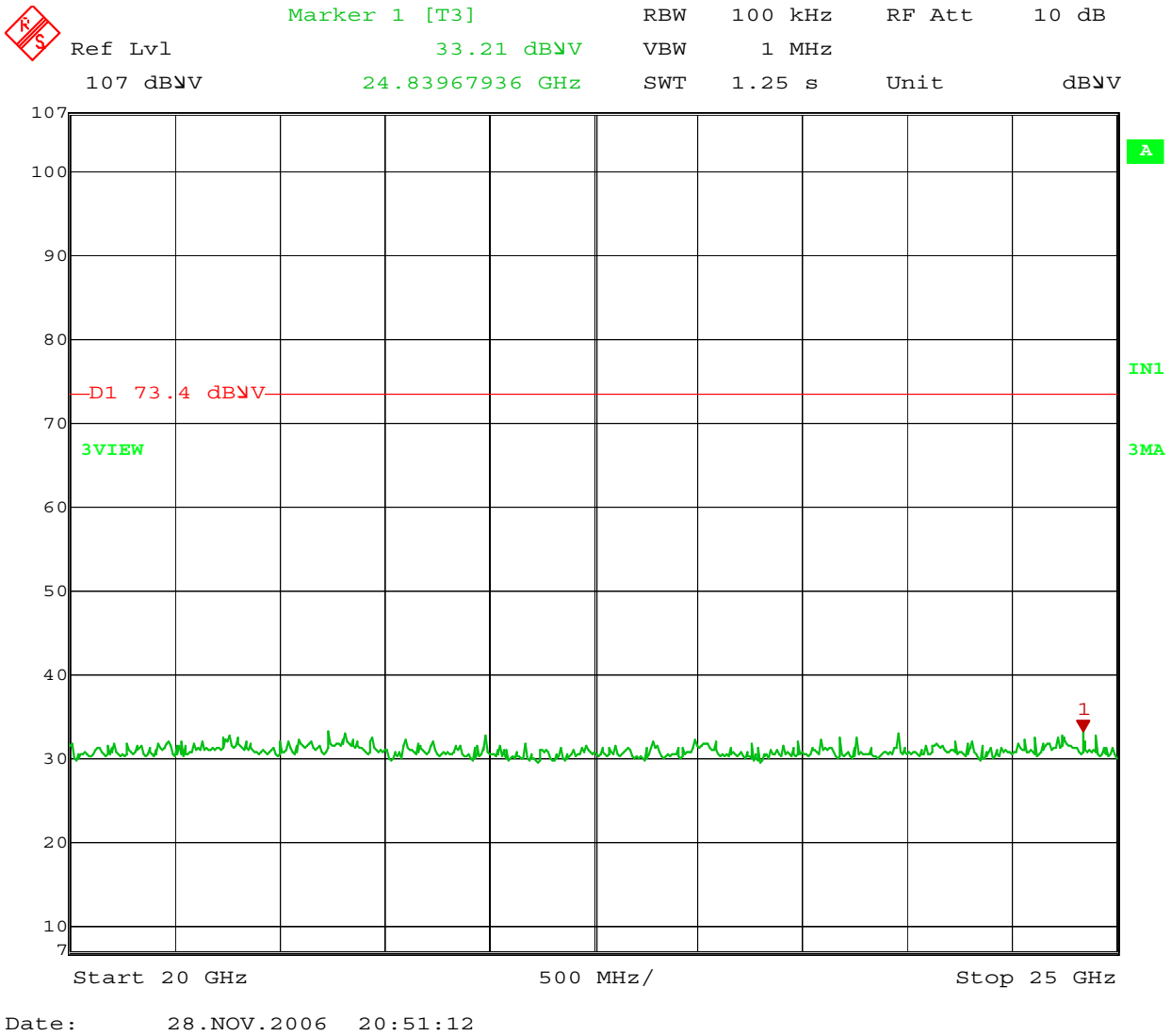


Date: 28.NOV.2006 20:42:03

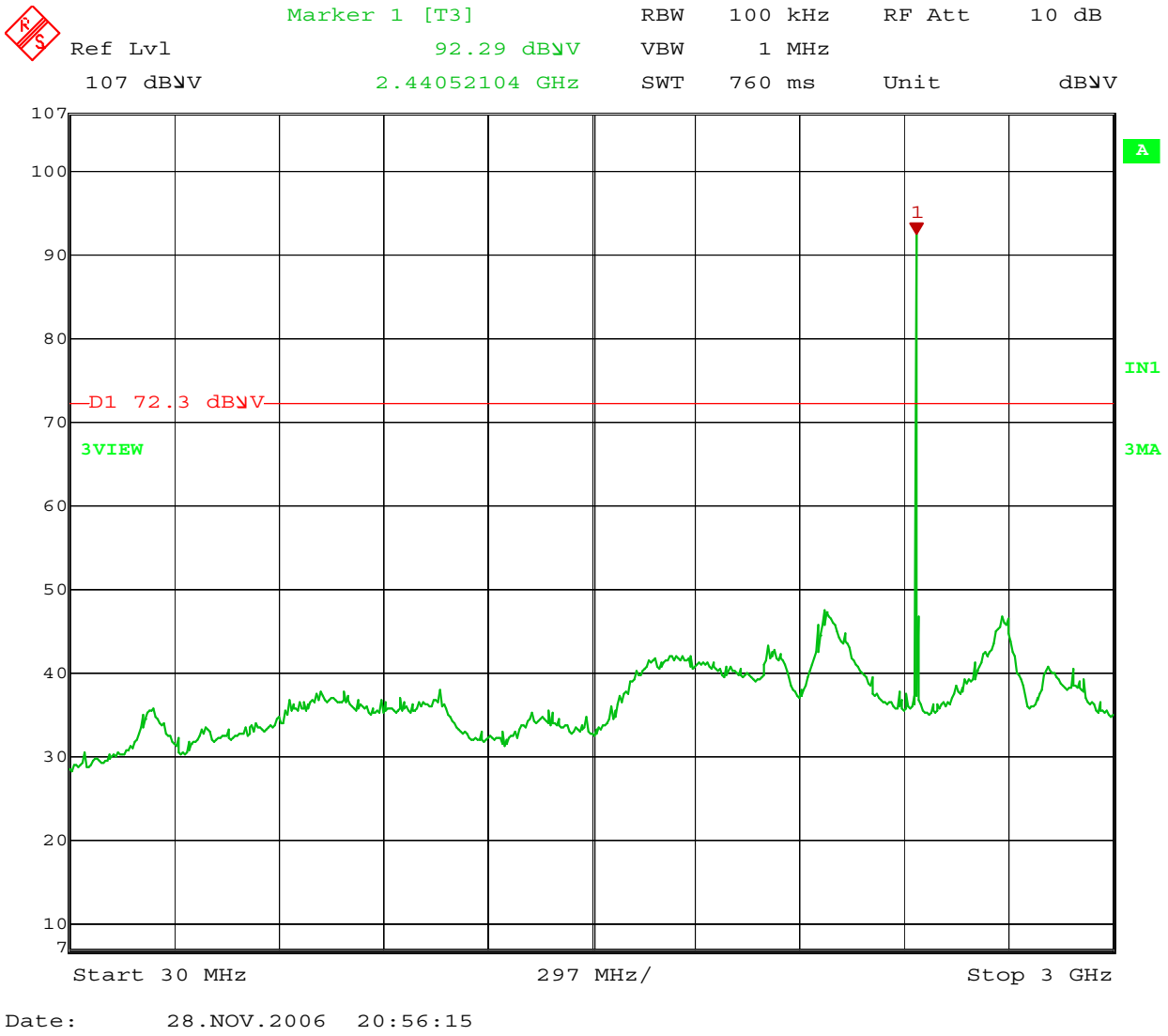
Plot 18 - Low Tx Channel Antenna Conducted Emissions, 10 GHz – 15 GHz



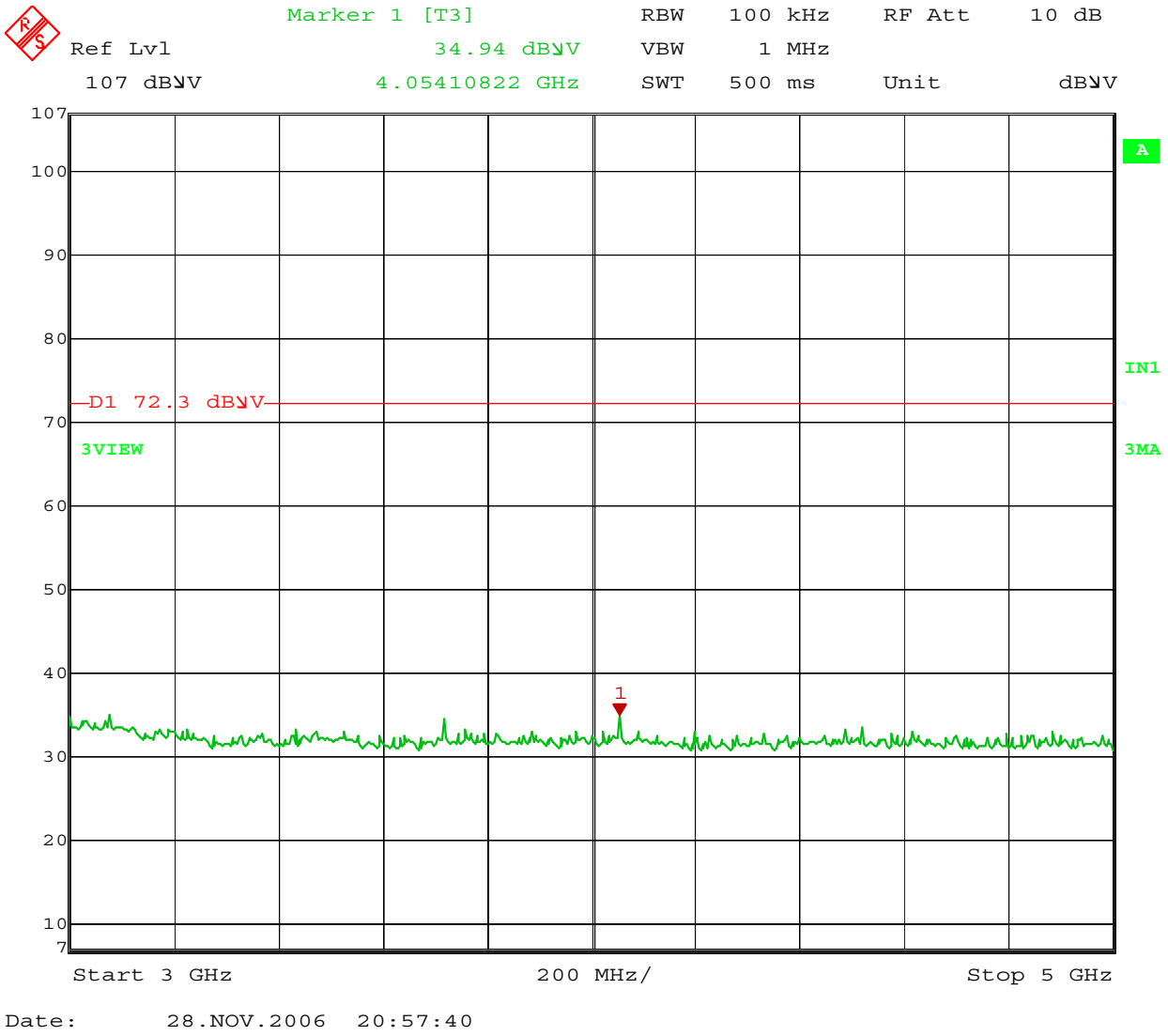
Plot 19 - Low Tx Channel Antenna Conducted Emissions, 15 MHz - 20 GHz



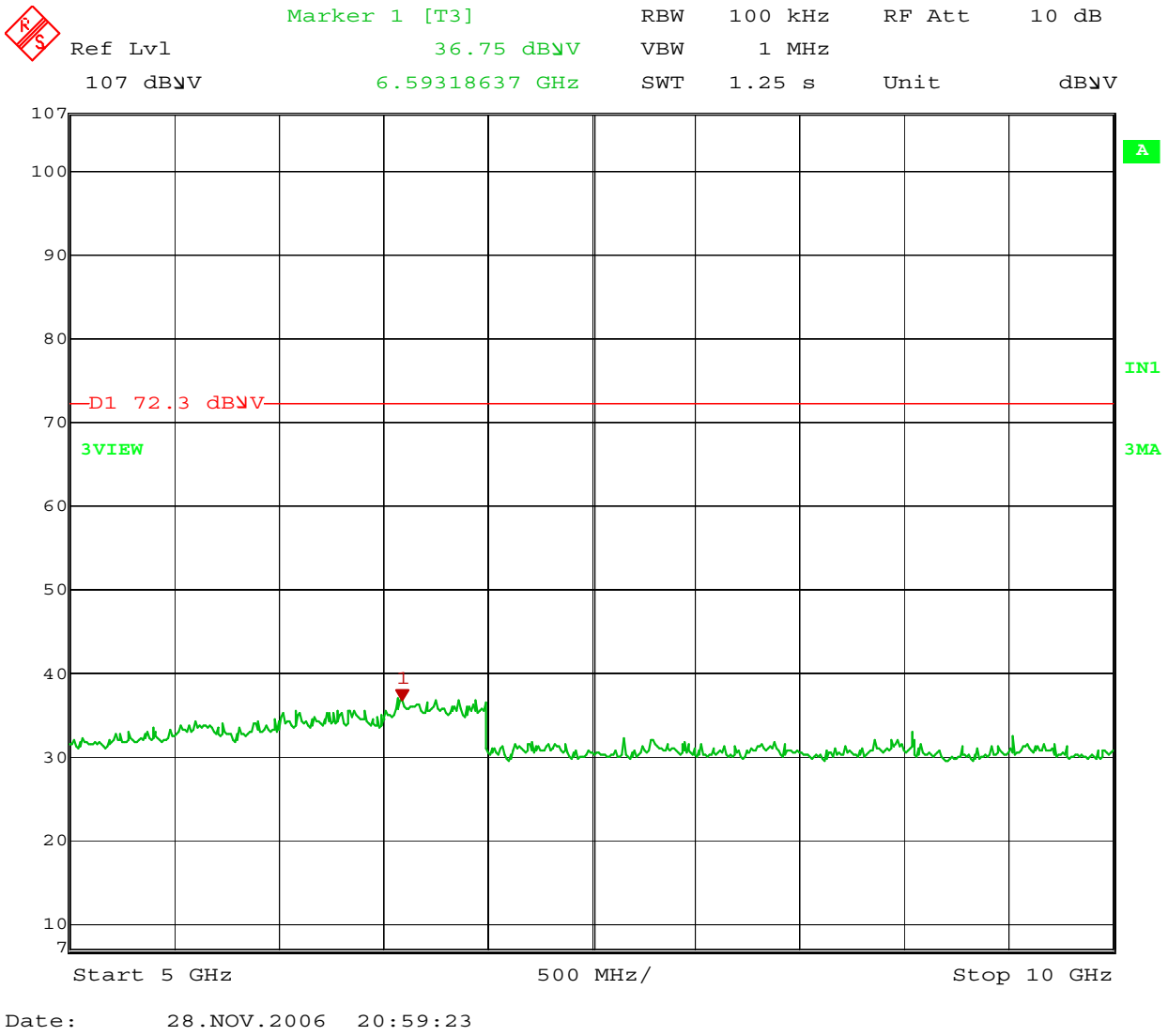
Plot 20 - Low Tx Channel Antenna Conducted Emissions, 20 GHz -25 GHz



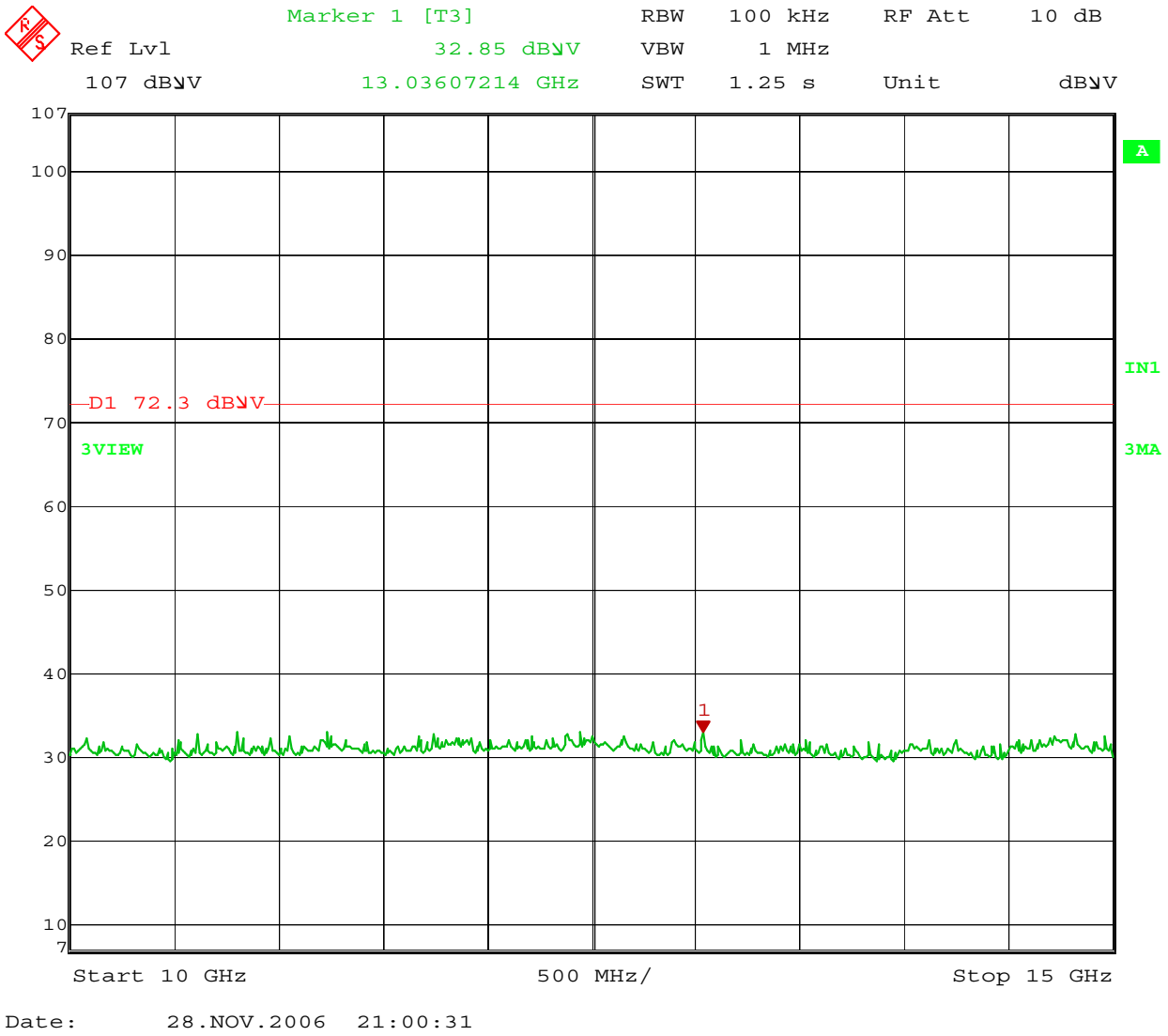
Plot 21 – Medium Tx Channel Antenna Conducted Emissions, 30 MHz - 3 GHz



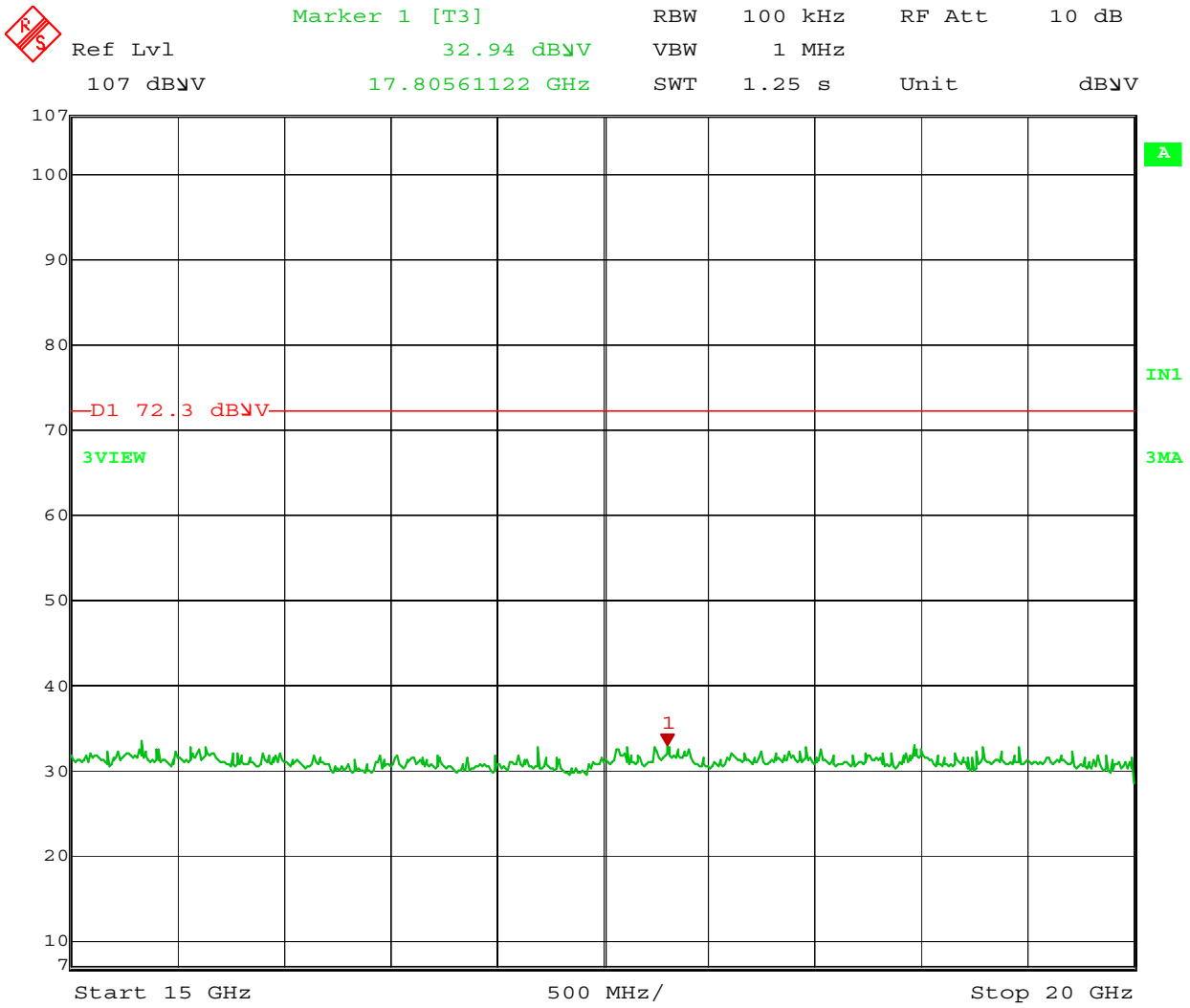
Plot 22 - Medium Tx Channel Antenna Conducted Emissions, 3 GHz - 5 GHz



Plot 23 - Medium Tx Channel Antenna Conducted Emissions, 5 GHz - 10 GHz

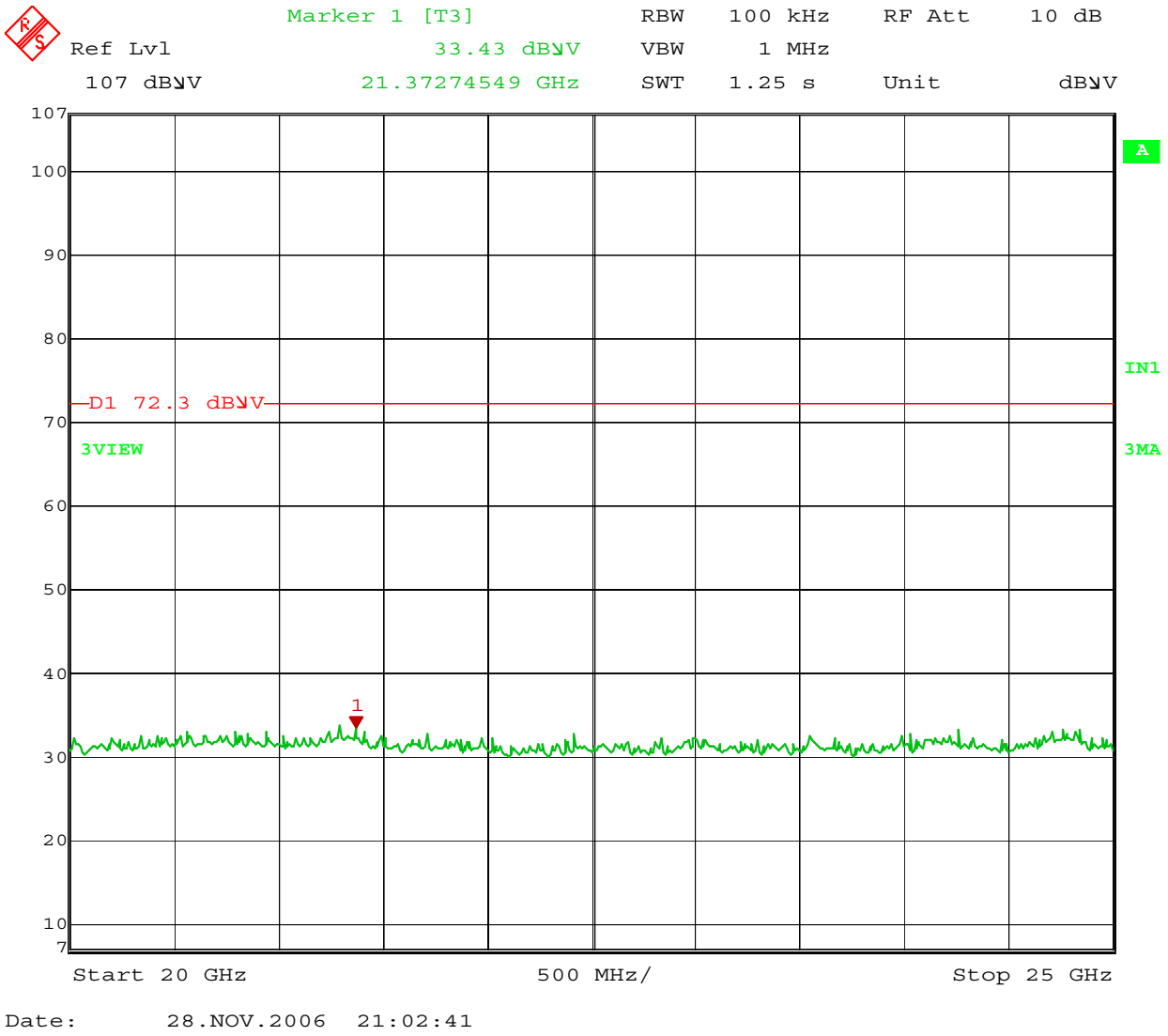


Plot 24 - Medium Tx Channel Antenna Conducted Emissions, 10 GHz – 15 GHz

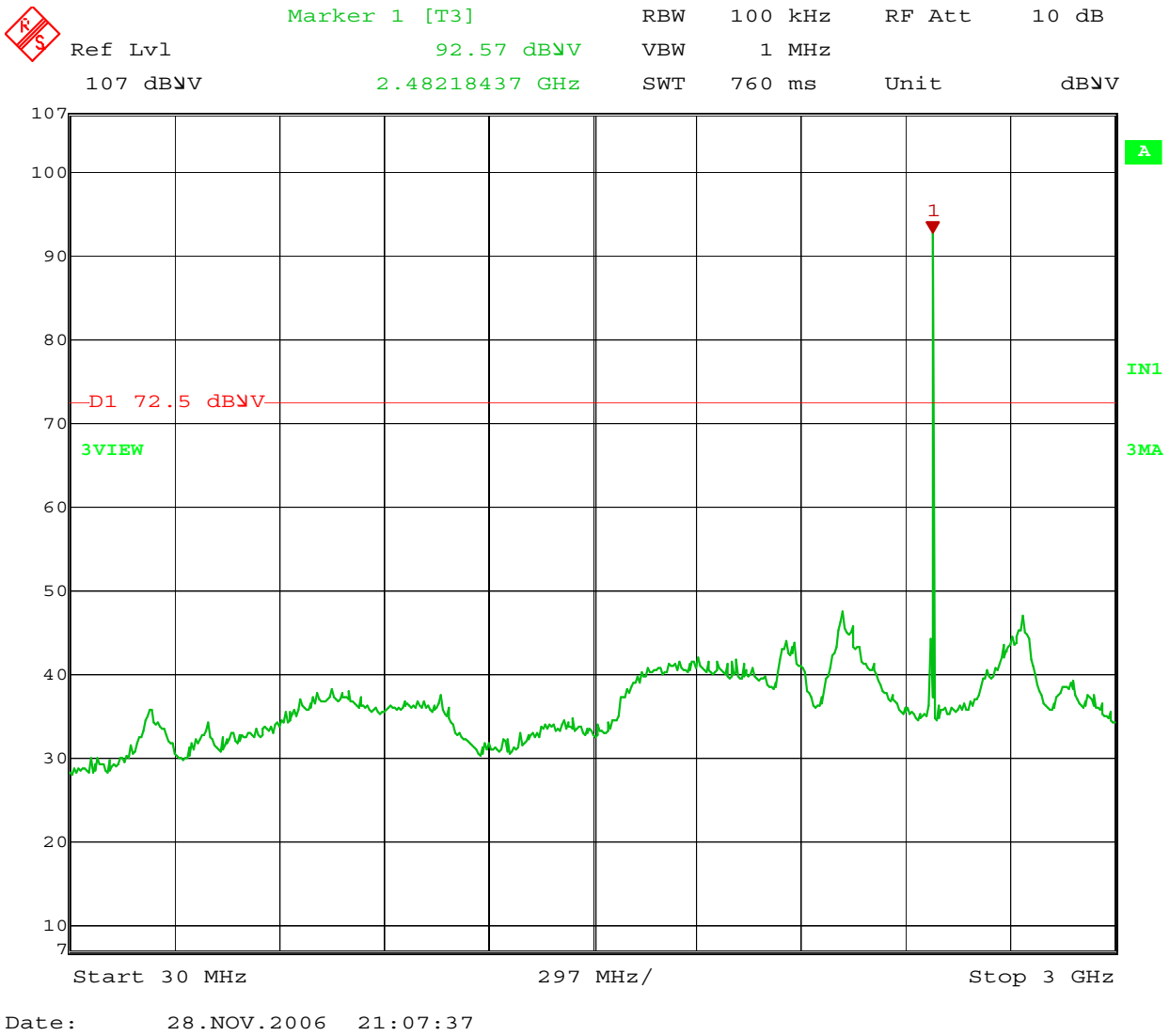


Date: 28.NOV.2006 21:01:43

Plot 25 - Medium Tx Channel Antenna Conducted Emissions, 15 MHz - 20 GHz

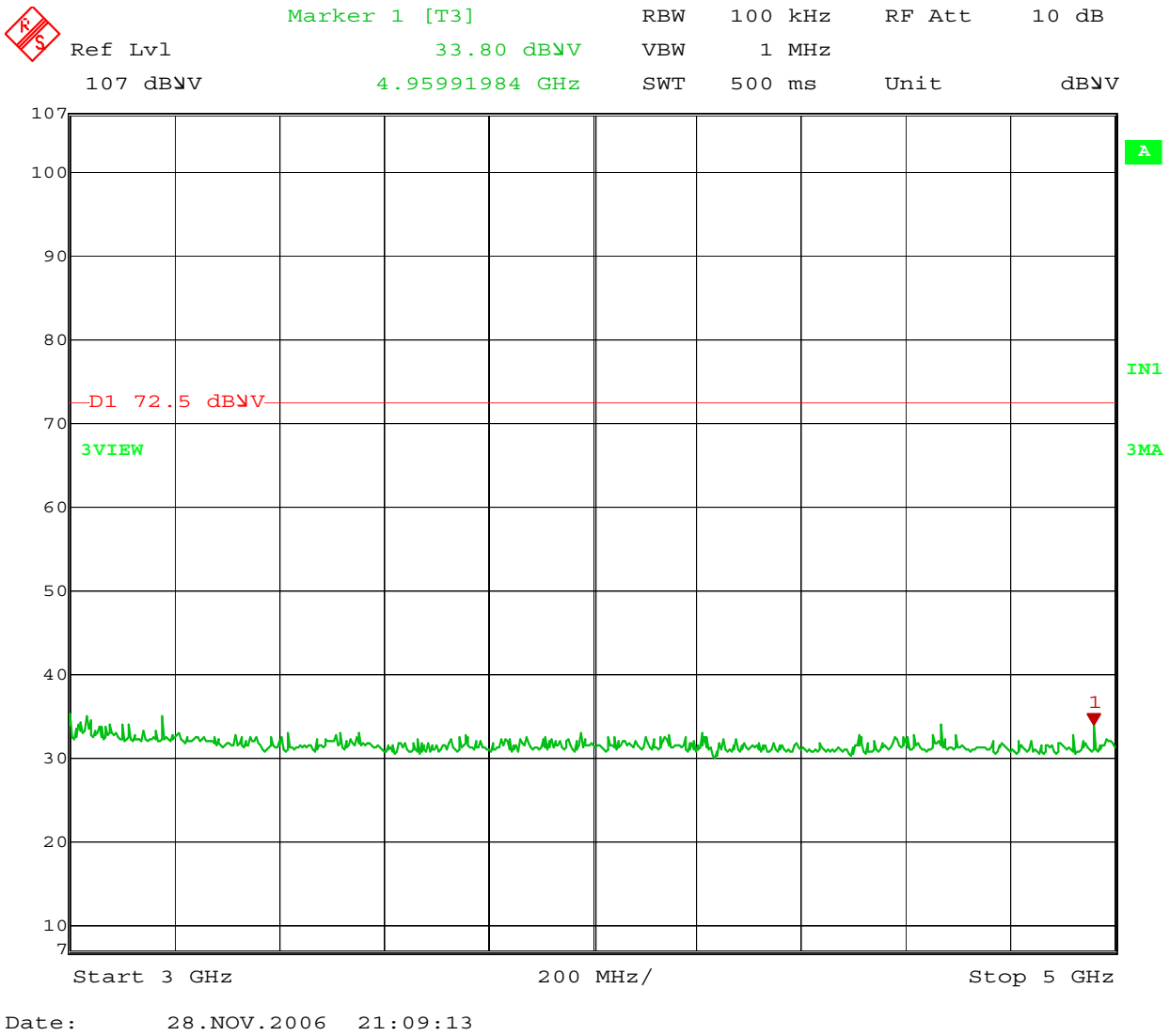


Plot 26 - Medium Tx Channel Antenna Conducted Emissions, 20 GHz -25 GHz



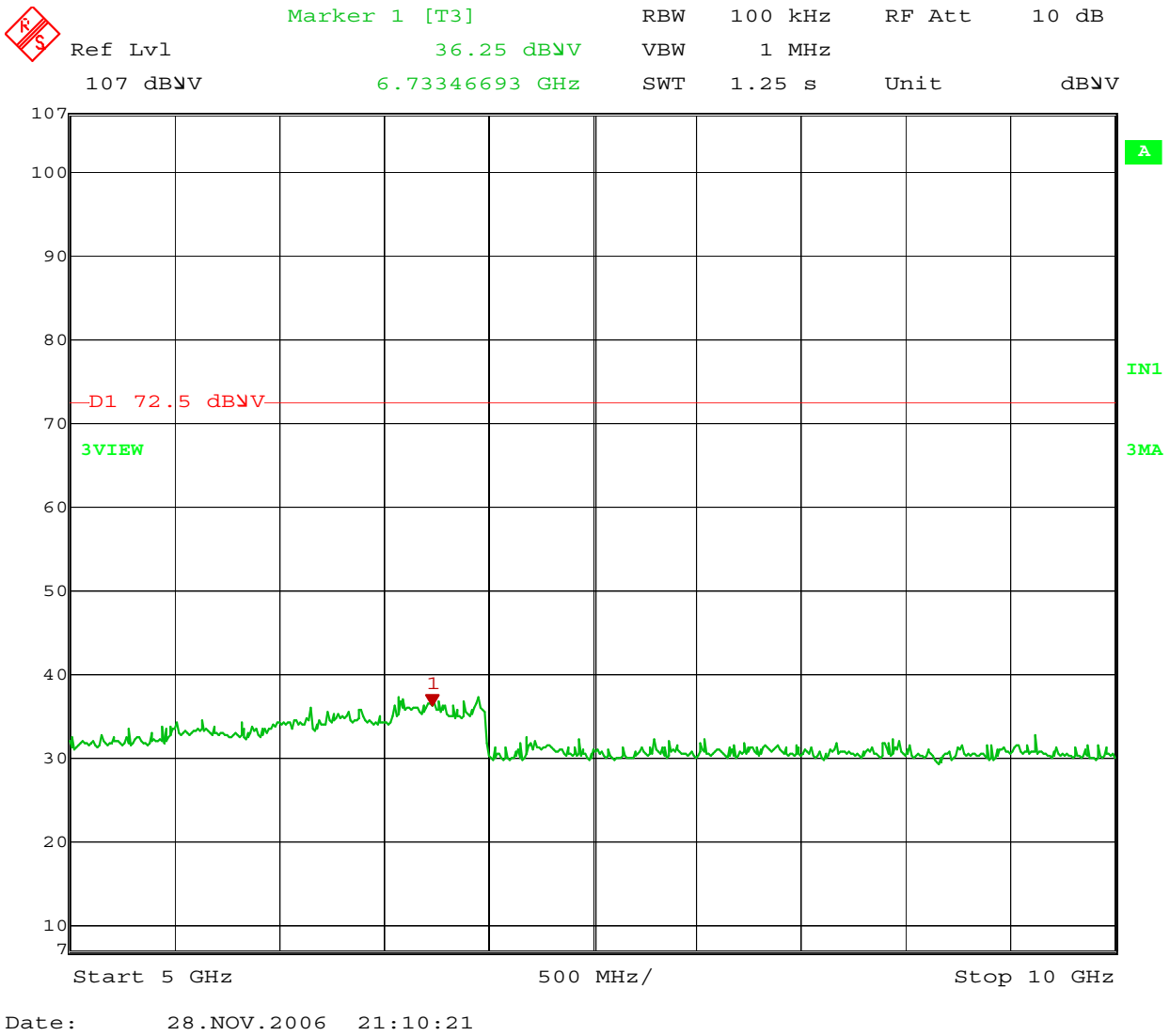
Date: 28.NOV.2006 21:07:37

Plot 27 – High Tx Channel Antenna Conducted Emissions, 30 MHz - 3 GHz



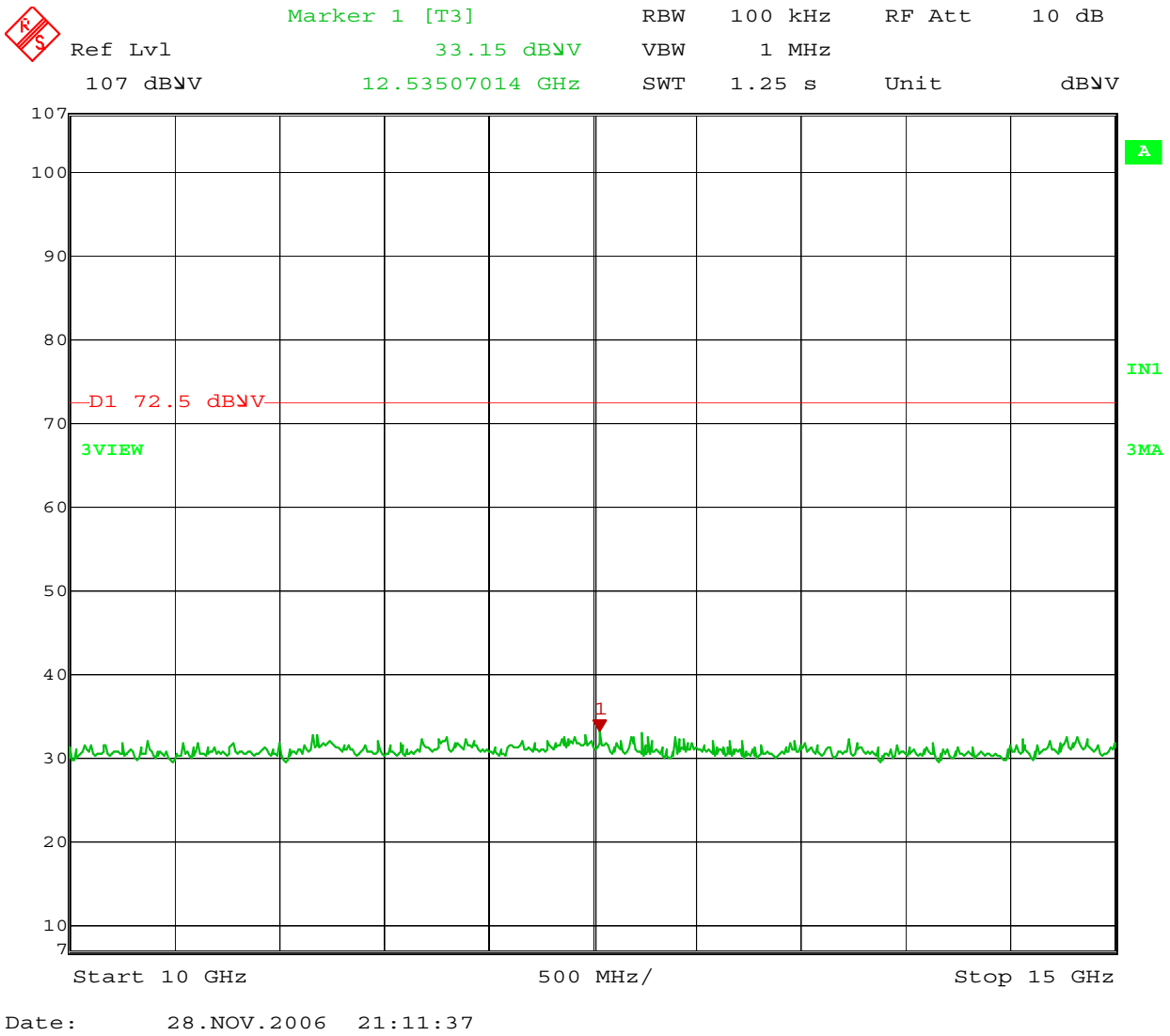
Date: 28.NOV.2006 21:09:13

Plot 28 - High Tx Channel Antenna Conducted Emissions, 3 GHz - 5 GHz



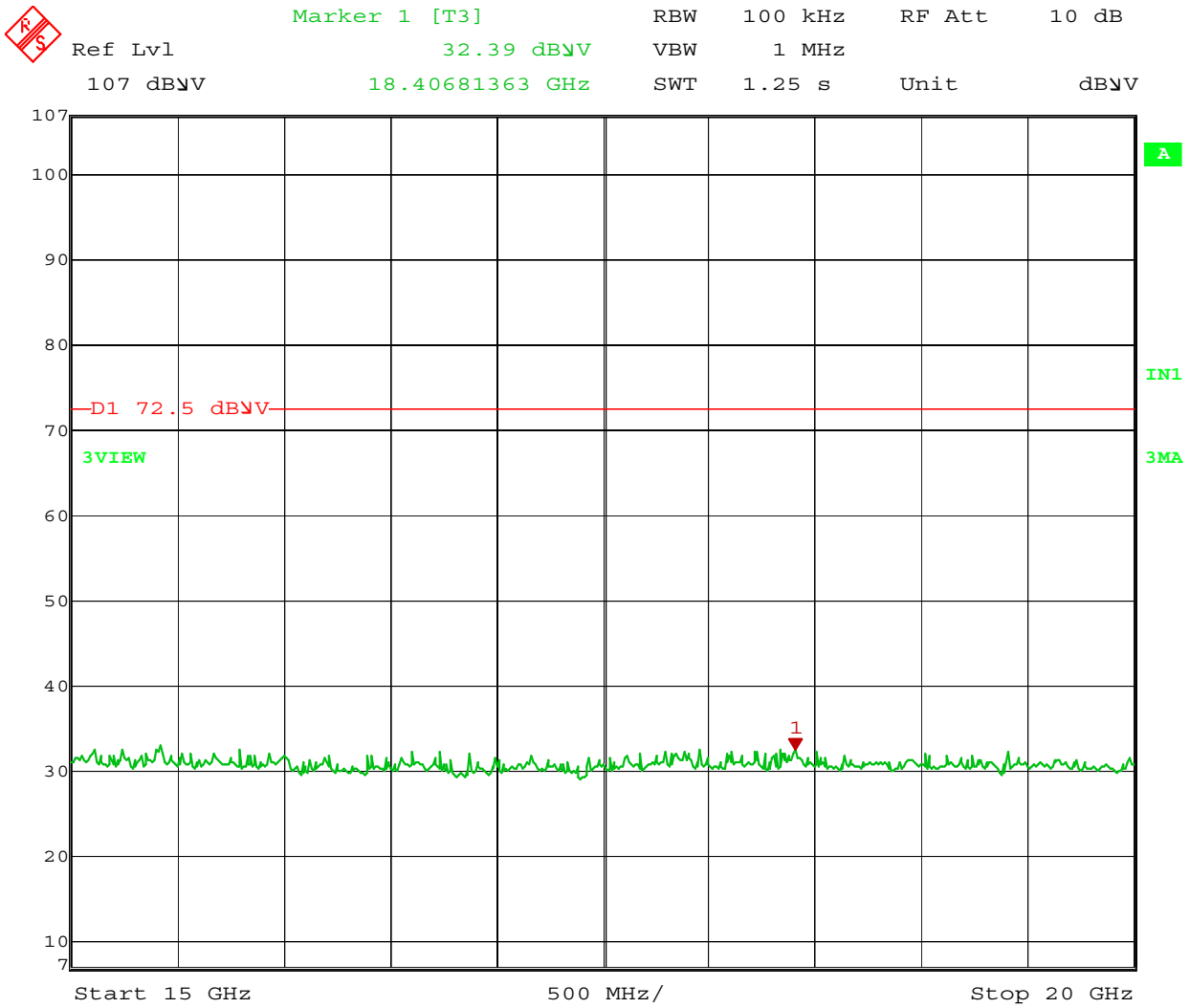
Date: 28.NOV.2006 21:10:21

Plot 29 - High Tx Channel Antenna Conducted Emissions, 5 GHz - 10 GHz



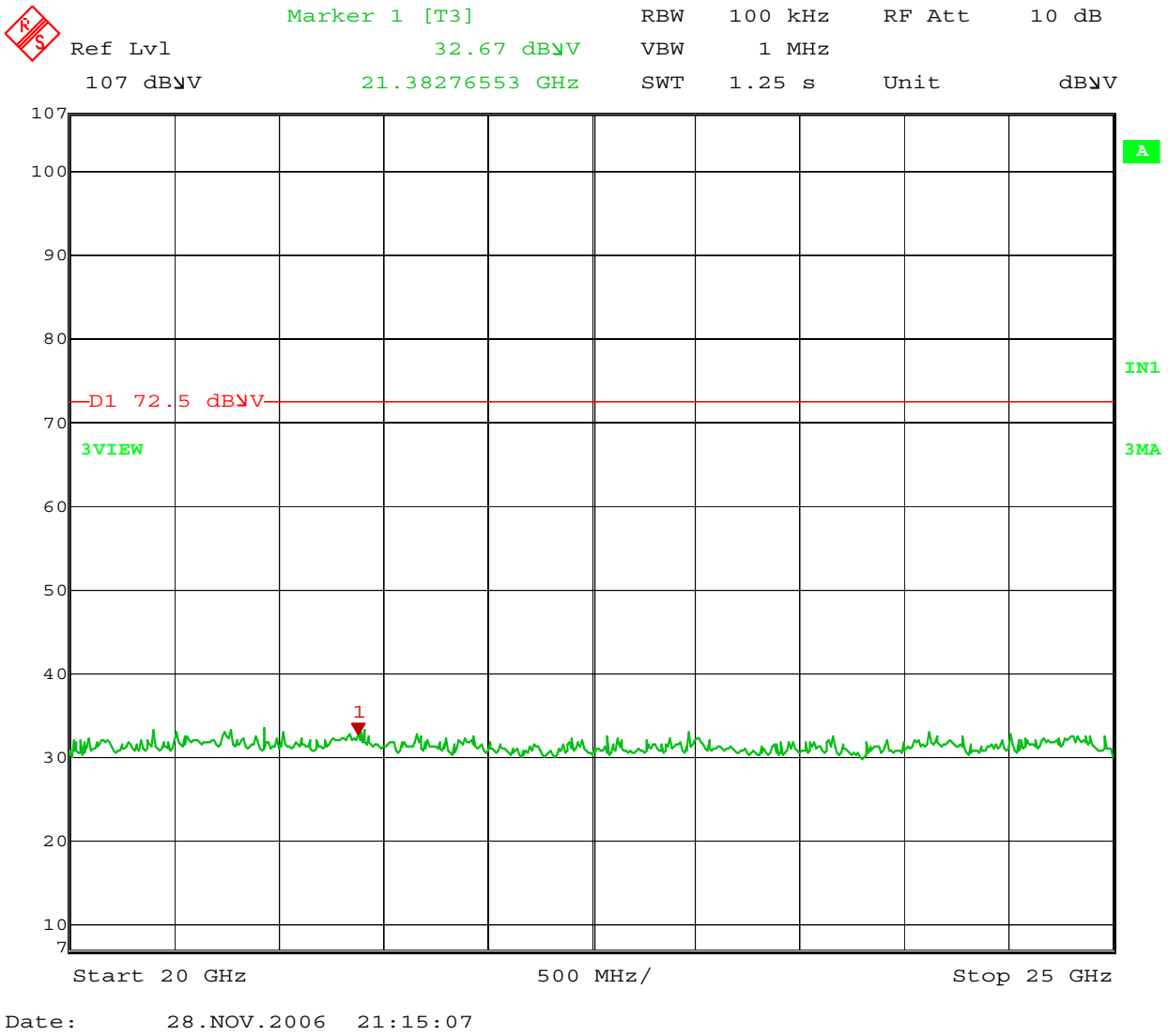
Date: 28.NOV.2006 21:11:37

Plot 30 - High Tx Channel Antenna Conducted Emissions, 10 GHz – 15 GHz



Date: 28.NOV.2006 21:14:05

Plot 31 - High Tx Channel Antenna Conducted Emissions, 15 MHz - 20 GHz



Plot 32 - High Tx Channel Antenna Conducted Emissions, 20 GHz -25 GHz

4.3.7 RF Safety - Maximum Permitted Exposure

The NOM-110 React has the antenna with 1.9 dBi nominal Antenna Gain. Therefore the numeric antenna gain is 1.549 (1.9 dBi=10 log (numeric gain))

Based on the FCC OET Bulletin 65, Edition 97-01, power density at a distance of 20 cm was calculated as below:

S=PG/4PiR^2

Where:
S=Power Density (mW/cm^2)
P=Power input to Antenna (mW)
G=Antenna Numeric Gain
R=Distance from center of Radiation Antenna (cm)

Tx Freq	Ant Gain (dBi)	Antenna Gain (Numeric)	Peak Output Power (dBm)	Peak Output Power (mW)	Power Density (mW/cm^2)	*Limit of Power Density (mW/cm^2)
2.402 GHz (Low TX)	1.9	1.549	17.76	59.70	0.0184	1
2.440GHz (Medium TX)	1.9	1.549	17.39	54.83	0.0169	1
2.479 GHz (High TX)	1.9	1.549	17.63	57.94	0.0178	1

*Limit for General Population/Uncontrolled Exposure is applied as per FCC Part 15, Section 1.1310.

Overall Results: The NOM-110 React met the Maximum Permitted Exposure (MPE) requirements specified in FCC Part 15, Section 15.247 (i).

4.3.8 Bandedge Requirements

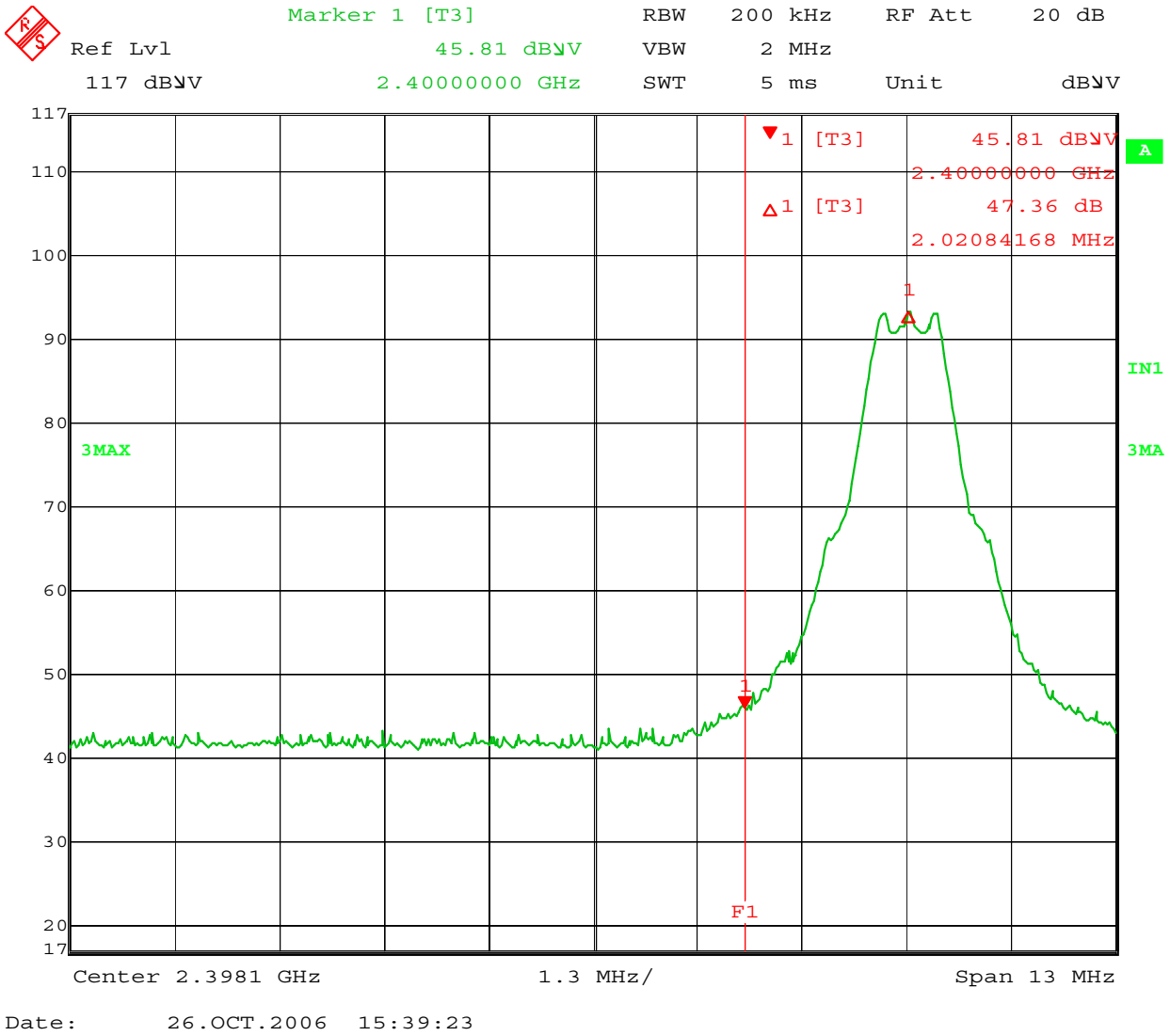
Measurements were made at the edge of the lowest and highest test frequencies.

The requirement is that the transmission signal frequency measured at 20 dB down from its peak amplitude at the lowest and highest channels shall remain within the permissible band.

The graphical plots showing bandedge measurements made at the lowest and highest channels are presented on the next pages.

Overall Results: The NOM-110 React met the bandedge requirements specified by the FCC Part 15.

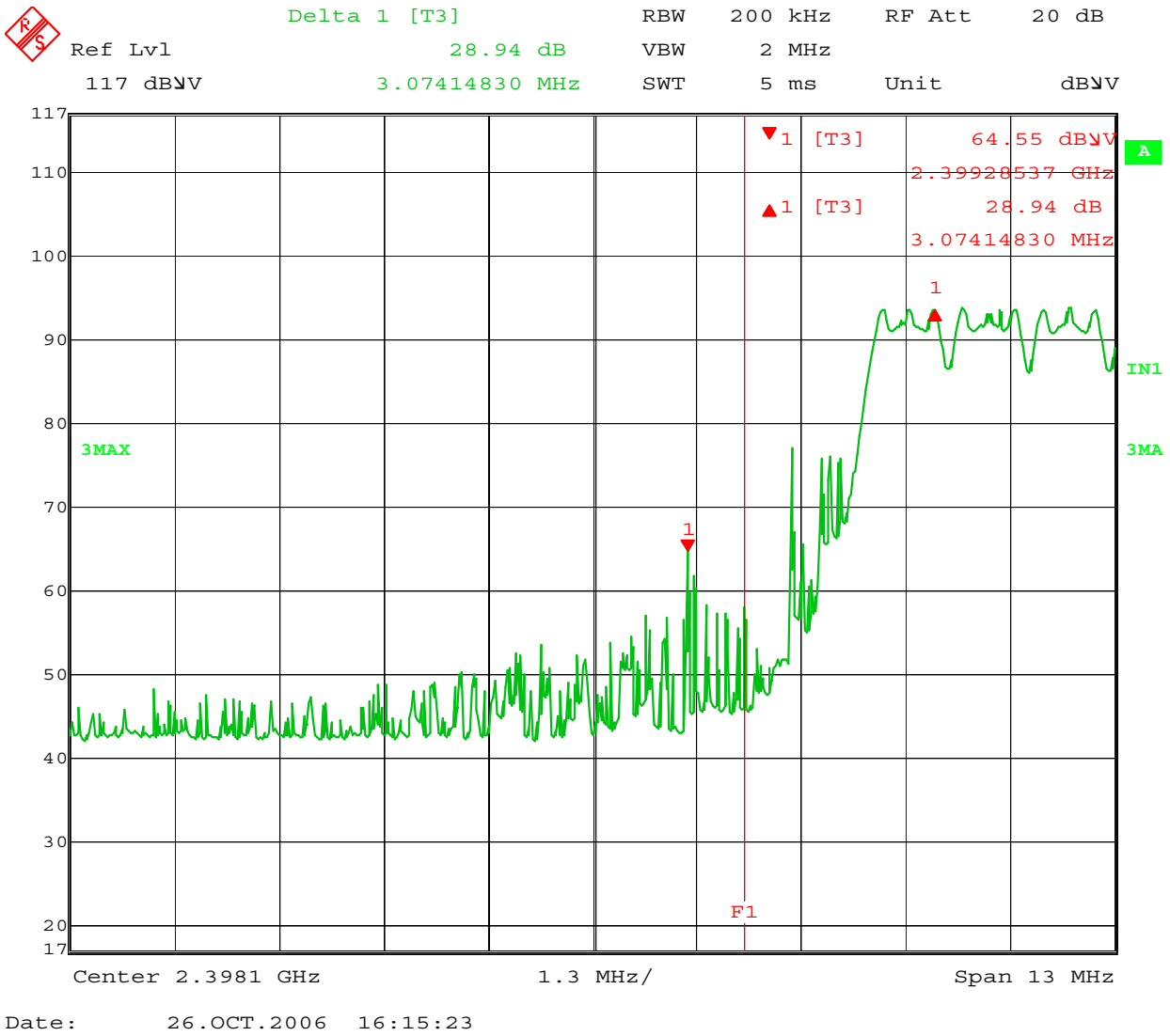
Bandedge Measurements Plots



Date: 26.OCT.2006 15:39:23

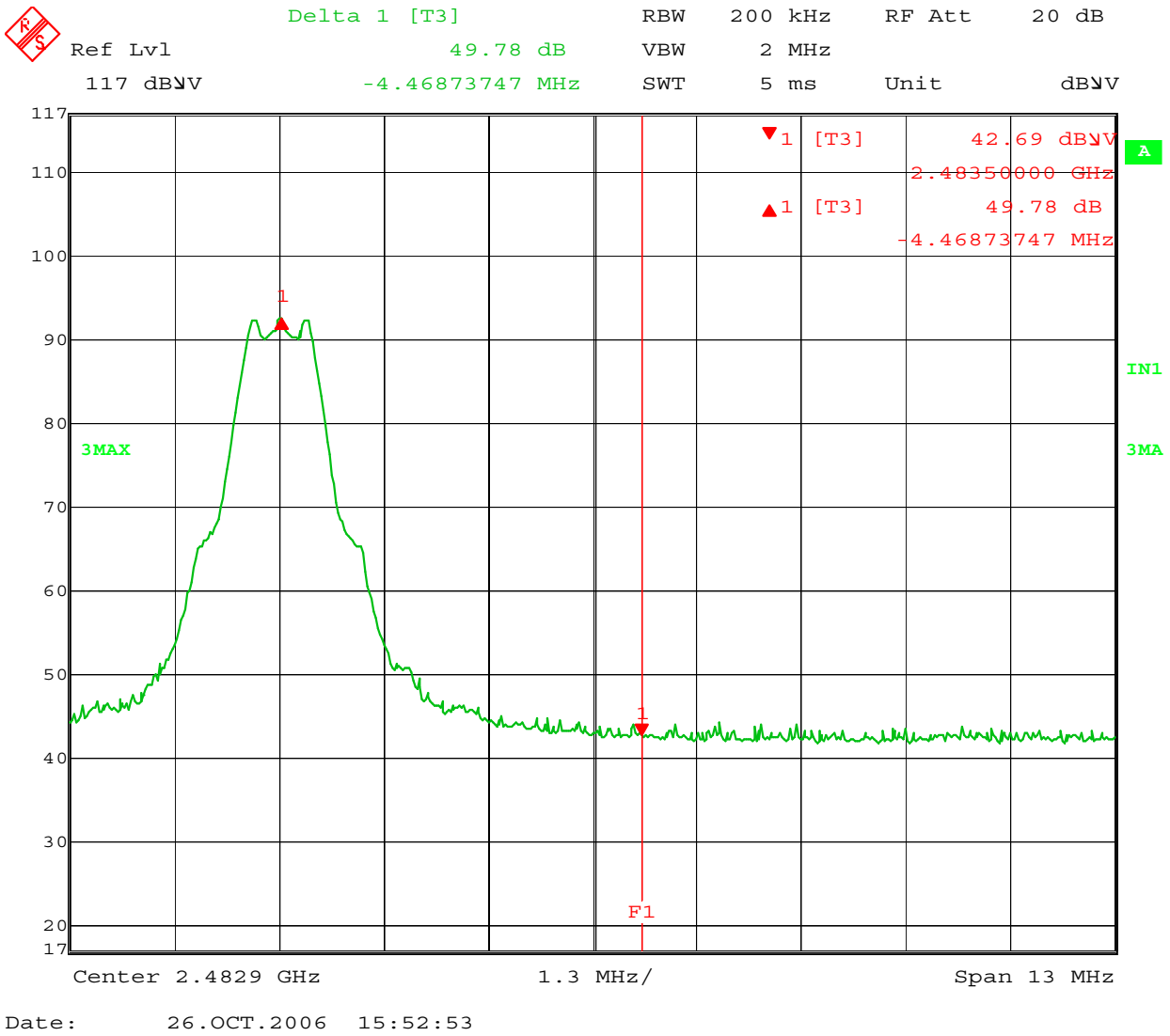
Note: Frequency Line F1 is at 2.4835GHz

Plot 33 - Bandedge at the Low Tx Frequency



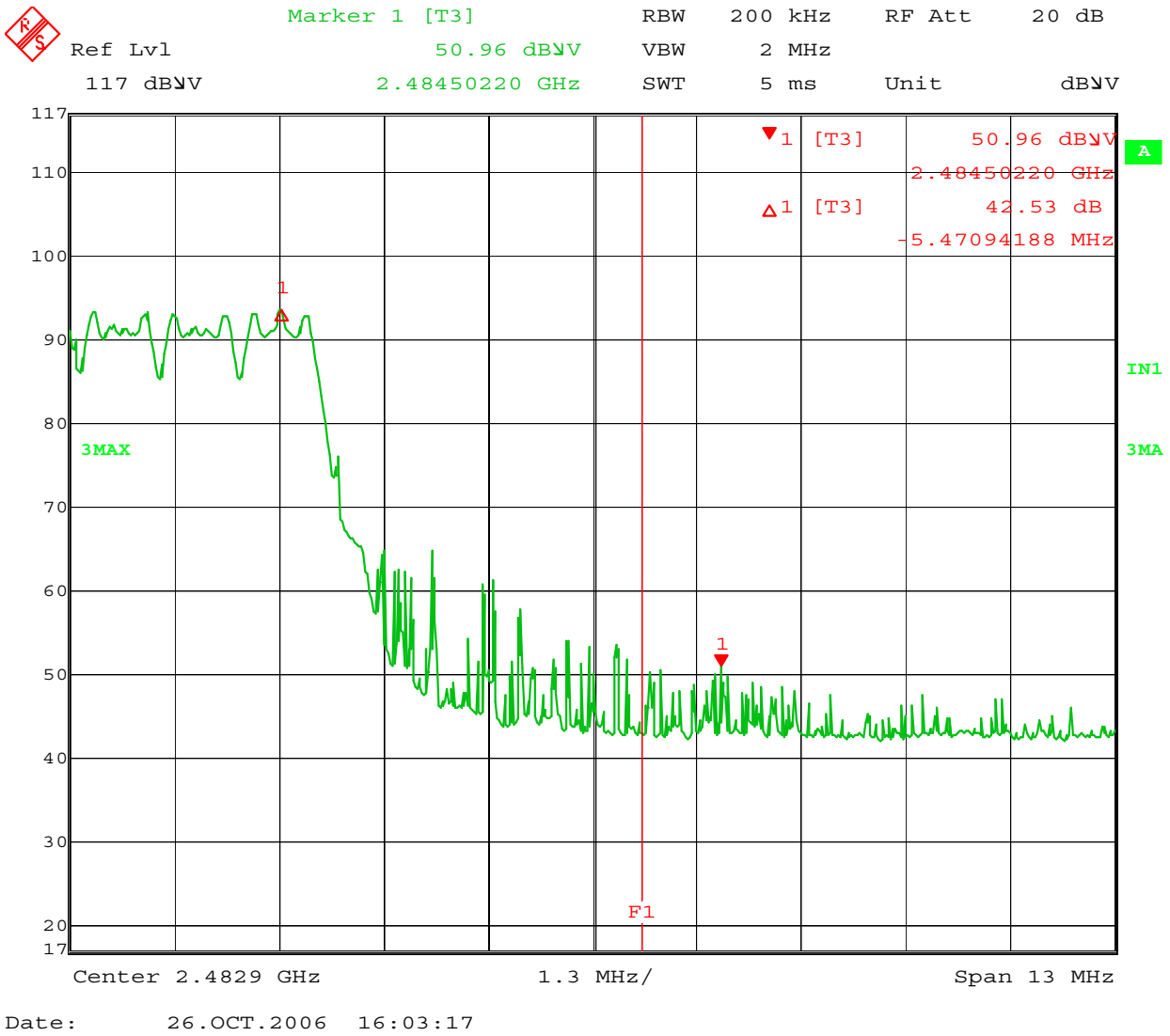
Note: Frequency Line F1 is at 2.4 GHz

Plot 34 - Bandedge at the Low Tx Frequency (Hopping Mode)



Note: Frequency Line F1 is at 2.4835 GHz

Plot 35 - Bandedge at the High Tx Frequency



Note: Frequency Line F1 is at 2.4835 GHz

Plot 36 - Bandedge at the High Tx Frequency (Hopping Mode)

4.3.9 20 dB Bandwidth Measurements

Measurements were made for all the three selected operating test frequencies – Low TX, Mid TX and High TX.

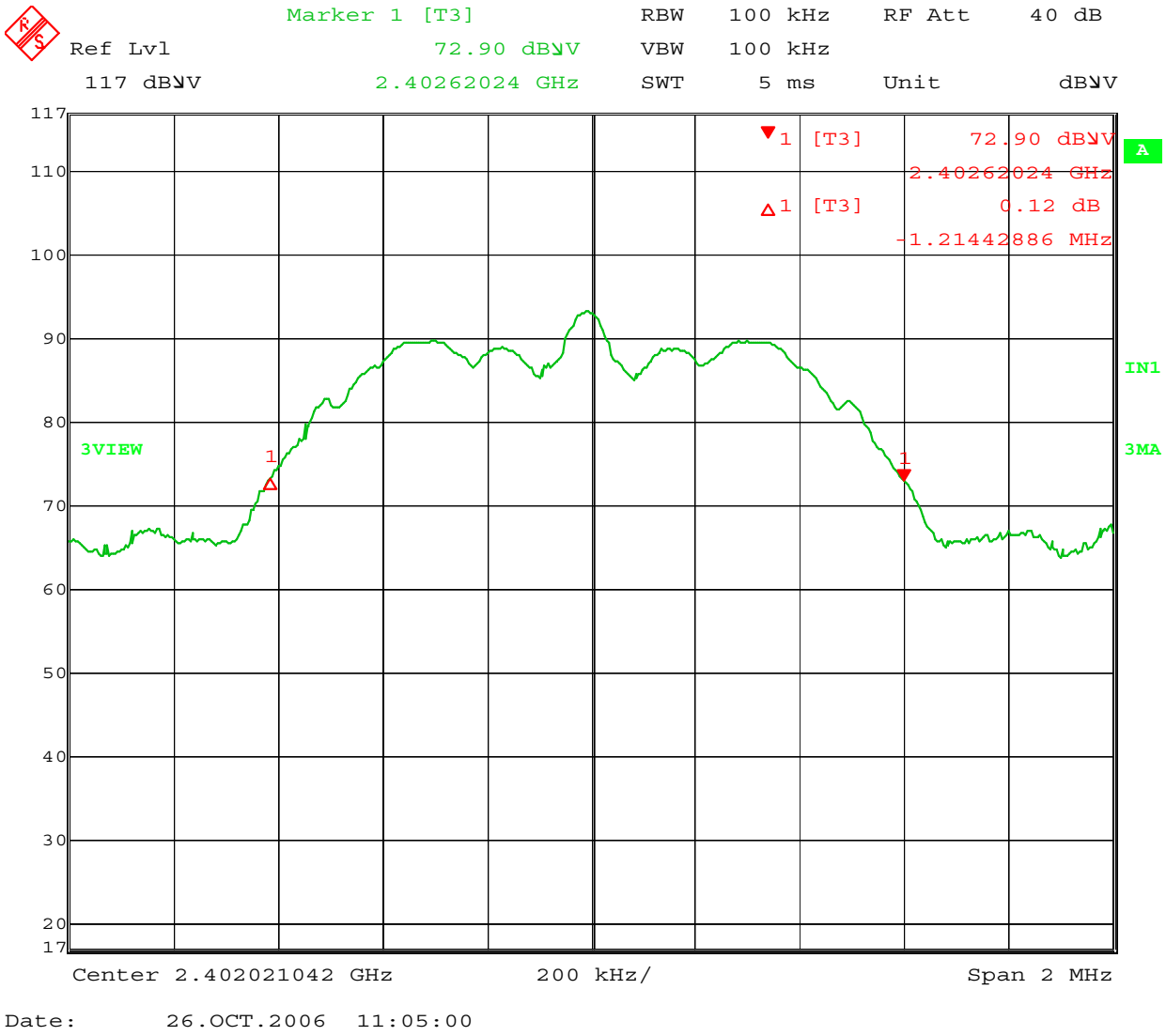
The test results are presented below:

Transmit Frequency	20 dB Bandwidth	Average of 20 dB Bandwidth	2/3 Average 20 dB Bandwidth
	(MHz)	(MHz)	(MHz)
2.402 GHz (Low TX)	1.214	1.219	0.813
2.440GHz (Medium TX)	1.218		
2.479 GHz (High TX)	1.226		

The graphical plots showing occupied bandwidth measurements are presented on the next pages.

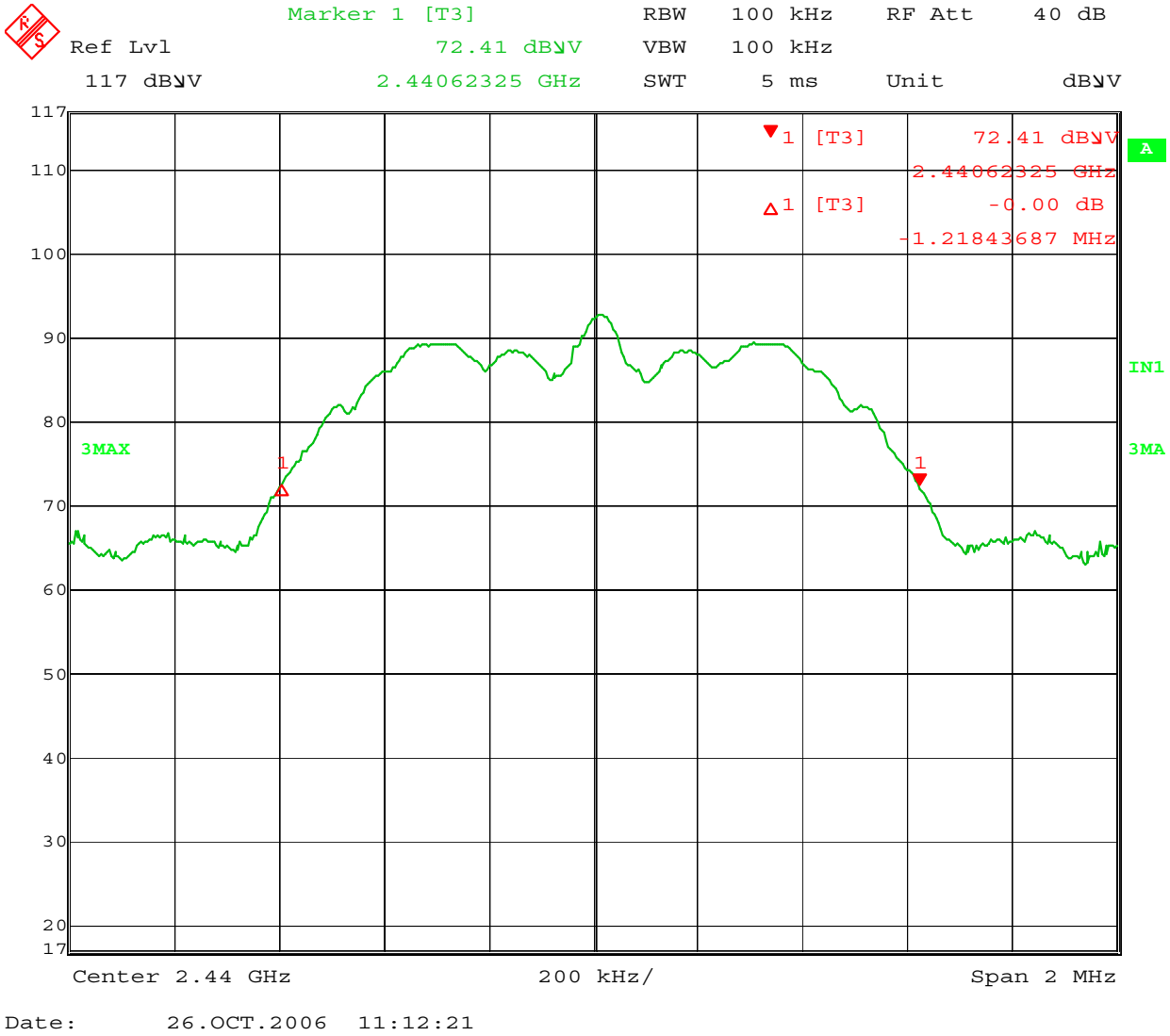
Overall Results: The two –thirds of the average 20 dB bandwidth of the NOM-110 React was determined as 0.813 MHz.

20 dB Bandwidth Measurement Plots

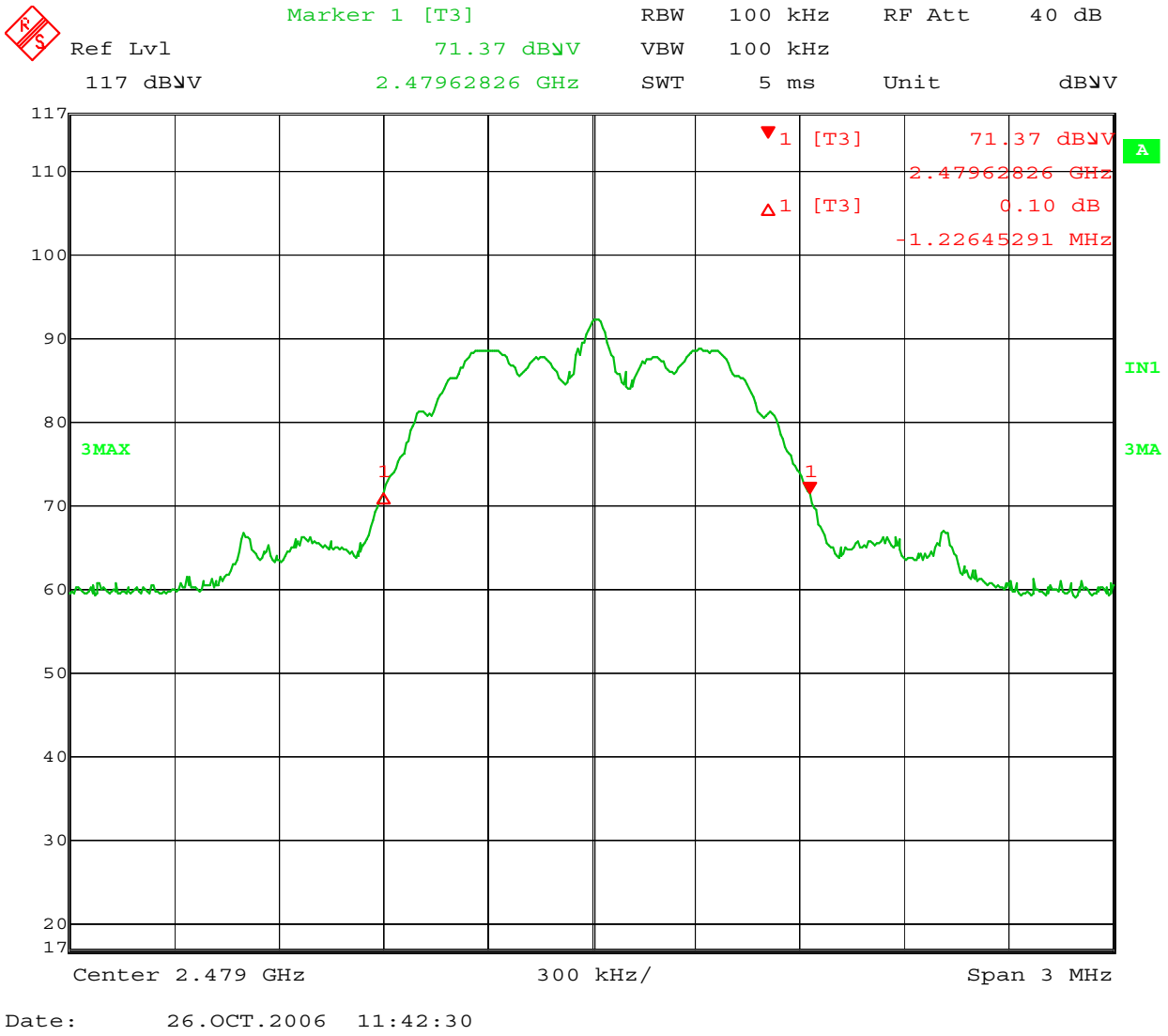


Date: 26.OCT.2006 11:05:00

Plot 37- 20 dB Bandwidth at Low Tx Frequency



Plot 38 - 20 dB Bandwidth at Medium Tx Frequency



Date: 26.OCT.2006 11:42:30

Plot 39 - 20 dB Bandwidth at High Tx Frequency

Appendix A – Test Equipment

Description	Freq Range (Hz)	Model Number	Manufacturer	ID / SN	Last Cal Date
EMI Test Receiver/Analyzer	20 Hz – 40 GHz	ESIB 40	Rohde & Schwarz	C-062	12/19/2005
Antenna	25M - 2G	LPB-2520/A	ARA	B965	9/26/2005
Antenna	1G – 18G	96001	EATON	U926	5/12/2005
Antenna	18G – 26.5G	DBE-520	DEMORNAY	D485	9/9/2005
Controller, Tower and Turntable	NA	2090	EMCO	B812	NA
Amplifier	1G – 40G	NSP4000-44	Miteq	B827	9/14/2005
EMI Test Receiver/Analyzer	20 Hz – 26.5 GHz	ESIB 26	Rohde & Schwarz	C232	5/18/2006
Filter, Bandpass	0.15M - 30M	NA	Unisys	NA	NA
Limiter, Pulse	DC - 30M	ESH3-Z2	Polarad	NA	NA
LISN	9k - 30M	MN 2053	Chase	U776	10/19/2005