Electromagnetic Compatibility Test Report

Prepared in accordance with

Product Standard:

FCC Part 15

on

Lighting Control System

Transceiver

Prepared for:

Sensor Switch, Inc.

900 Northrop Road

Wallingford, CT 06492

Prepared by:

TUV Rheinland of North America, Inc.

Auftraggeber: *Client:*	Sensor Switch, Inc. 900 Northrop Road Wallingford, CT 06492		
Bezeichnung: *Identification:*	Lighting Control System	**Serien-Nr.:** *Serial No.*	TS 1
Gegenstand der Prüfung: *Test item:*	Transceiver	**Prüfdatum:** *Date tested:*	November 17 - 19, 2008
Prüfort: *Testing location:*	TUV Rheinland of North America 12 Commerce Road Newtown, CT 06470-1607 NVLAP # 200111-0		
Prüfgrundlage: *Test specification:*	FCC Part 15: FCC Part 15C Section 15.247 FCC Part 15.247 (a)(2), FCC Par 15.247 (b)(3), FCC Part 15.247 (b)(5) and 1.1310, FCC Part 15.247 (c), 15.205, 15.209, FCC Part 15, FCC Part 15.247 (e), FCC Part 15.215 (b)		
Prüfergebnis: *Test Result*	**Der vorstehend beschriebene Prüfgegenstand wurde geprüft und entspricht oben genannter Prüfgrundlage. The above product was found to be Compliant to the above test standard(s)**		
geprüft / *tested by:* **Randall E Masline**			
Randall E Masline 19 March 2009 **Datum** *Date* / **Name** *Name* / **Unterschrift** *Signature*			
Sonstiges : *Other Aspects:*	**None**		
Abkürzungen: OK, Pass, Compliant, Complies = entspricht Prüfgrundlage Fail, Not Compliant, Does not Comply = entspricht nicht Prüfgrundlage N/A = nicht anwendbar		Abbreviations: OK, Pass, Compliant, Complies = passed Fail, Not Compliant, Does Not Comply = failed N/A = not applicable	

FC	NVLAP	**Industry Canada**	**BSMI**
US90575	**200313-0**	**3466C-1**	**SL2-IN-E-050R**

TABLE OF CONTENTS

1 General Information

1.1 Scope

This report is intended to document the status of conformance with the requirements of the FCC Part 15C, based on the results of testing performed on November 17 - 19, 2008 on the Lighting Control System, Model No. Transceiver, manufactured by Sensor Switch, Inc.. This report only applies to the specific samples tested under the stated test conditions. It is the responsibility of the manufacturer to assure that additional production units of this model are manufactured with identical or EMI equivalent electrical and mechanical components. This report is further intended to document changes and modifications to the EUT throughout its life cycle. All documentation will be included as a supplement.

1.2 Purpose

Testing was performed to evaluate the EMC performance of the EUT (Equipment Under Test) in accordance with the applicable requirements, procedures, and criteria defined in the application of regulations and application of standards listed in this report.

1.3 *Summary of Test Results*

Applicant	Sensor Switch, Inc. 900 Northrop Road Wallingford, CT 06492	**Tel**	(203) 265-2842	**Contact**	William J Fassbender
		Fax	(203) 265-1565	**email**	fozzy@sensorswitch.com
Type of Equipment	Lighting Control System	**Model Number**	Transceiver		

Standards	Description	Severity Level or Limit	Criteria	Test Result
FCC Part 15	Radio Frequency Devices -Part C	See called out basic standards below	See Below	**Complies**
FCC Part 15.247 (a) (2)	Spectrum Bandwith of a Direct Sequence Spread Spectrum System	500kHz on a 6dB Bandwith, 2.405 GHz - 2.480 GHz	Limit	**Complies**
FCC Part 15.247 (b) (3)	Maximum Output Power	1 Watt (30dBm)	Limit	**Complies**
FCC Part 15.247 (b)(5) and 1.1310	RF Human Exposure Limit	1.0 (mW/cm2)	Limit	**Complies**
FCC Part 15.247 (c), 15.205, 15.209	Radiated Spurious Emissions	-20dBc, 15.205 (a), 15.209 (a)	Limit	**Complies**
FCC Part 15.247 (e)	Transmitter Power Density	8 dBm/3kHz	Limit	**Complies**
FCC Part 15.207	Conducted Emissions	15.207 (a)	Limit	**Complies**
FCC Part 15.215 (b)	Frequency Stability	Containment of 20dB,	Limit	**Complies**

2 Laboratory Information

2.1 Accreditations & Endorsements

2.1.1 US Federal Communications Commission

TUV Rheinland of North America located at 336 Initiative Dr, Rochester NY is accredited by the commission for performing testing services for the general public on a fee basis. This laboratory test facilities have been fully described in reports submitted to and accepted by the FCC (Registration No US90575). The laboratory scope of accreditation includes: Title 47 CFR Part 15, and 18. The accreditation is updated every 3 years.

2.1.2 NIST / NVLAP

Program, which is administered under the auspices of the National Institute of Standards and Technology. The laboratory has been assessed and accredited in accordance with ISO Standard 17025:2005 (Lab code: 200111-0). The scope of laboratory accreditation includes emission and immunity testing. The accreditation is updated annually.

2.1.3 VCCI

VCCI Accredited test lab. Registration numbers R-1065, C-1120, C-1121

2.1.4 Industry Canada

Registration No.: 3466C-1. The OATS has been accepted by Industry Canada to perform testing to 3 and to 10m, based on the test procedures described in ANSI C63.4-2003.

2.1.5 BSMI

Registration No.: SL2-IN-E-050R. The BSMI accreditation was obtained by NIST MRA with the BSMI.

2.2 Measurement Uncertainty

General

☒	The estimated combined standard uncertainty for ESD immunity measurements is ± 0.43%.
☒	The estimated combined standard uncertainty for radiated immunity measurements is ± 2.0dB.
☐	The estimated combined standard uncertainty for EFT fast transient immunity measurements is ± 6.0%.
☐	The estimated combined standard uncertainty for surge immunity measurements is ± 5.0%.
☐	The estimated combined standard uncertainty for conducted immunity measurements is ± 2.0 dB.
☐	The estimated combined standard uncertainty for power frequency magnetic field immunity measurements is ± 2.57%.
☐	The estimated combined standard uncertainty for voltage variation and interruption measurements is ± 4.89%.
☒	The estimated combined standard uncertainty for radiated emissions measurements is ± 4.6 dB.
☐	The estimated combined standard uncertainty for conducted emissions measurements is ± 2.6 dB.
☐	The estimated combined standard uncertainty for harmonic current ± 7.27% and flicker measurements is ± 3.87%.

2.3 Calibration Traceability

All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Measurement method complies with ANSI/NCSL Z540-1-1994 and ISO Standard 17025:2005. Equipment calibration records are kept on file at the test facility.

2.4 Measurement Equipment Used

Equipment	Manufacturer	Model #	Ref./Serial #		Last Cal dd/mm/yy	Next Cal dd/mm/yy	Test
BiLog	Chase	CBL6112A		2125	N/A	N/A	RI
BiLog	Chase	CBL6111		1169	29-June-07	29-June-09	RE
BiLog	Chase	CBL6111		1170	29-June-07	29-June-09	RE
Horn	EMCO	3115	C025	9512-4630	14-Jun-07	14-Jun-09	RE
Horn	EMCO	3115	C031	9812-5635	7-Feb-08	7-Feb-10	RE
LISN	Schwarzbeck	8121-200	C102	200	15-Jan-08	15-Jan-10	CE
LISN	Schwarzbeck	8121-131	C111	131	20-Dec-07	20-Dec-09	CE
LISN	Schwarzbeck	8121-128	C114	128	24-Jul-08	24-Jul-10	CE
ESD Gun	Schaffner	NSG 435	C200	1495	22-Jul-08	22-Jul-09	ESD
Precision Power Source	California Instruments	MDL 225500L/5	C210		N/A	N/A	HAR, FLI, VDSI
Power Analyzer	Voltech	PM3000A	C211	8992	6-May-08	6-May-09	FLI
Wideband (.01-230)	IFI	M75	C212	A295-0497	N/A	N/A	CI
Signal Generator	Marconi	2024	C213	112223122	19-Dec-07	19-Dec-08	RI
Signal Generator	HP	8657A	C214	312A04354	19-Dec-07	19-Dec-08	CI
Power Meter	HP	437B	C215	3125010240	19-Dec-07	19-Dec-08	CI
Power Supply & Control Module	IFI	PS 5000/28/40	C219	049-4146	N/A	N/A	RI
Wideband Amp (.01-1000)	IFI	M5580	C220	0492-4146	N/A	N/A	RI
Coupling Decoupling 1 PH	FCC	FCC-801-M3-32	C221	106	07-Jan-08	07-Jan-09	CI
Attenuator 6dB (0-1000MHz) 100W	JFW		C223		N/A	N/A	CI
Directional Coupler		62630	C224	5326	N/A	N/A	CI
CDN Adapter Kit	FCC	801-150-50 CDN	C225	752/753	04-Jan-08	04-Jan-09	CI
Calibration Fixture	FCC	801-2031-CF	C226	135	03-Jan-08	03-Jan-09	CI
EM Injection Clamp	FCC	F-2031	C227	259	03-Jan-08	03-Jan-09	CI
PS/Control Module	IFI	5000/28/40	C228	2245-1296	N/A	N/A	RI
Wideband Amp	IFI	CMX5001	C229	2244-1296	N/A	N/A	RI
Leveling PreAmplifier	IFI	LPA-5B	C230	2265-1296	N/A	N/A	RI
Field Monitor	Amplifier Research	FM5004		308114	N/A	N/A	RI

RF 900MHz Pulse Modulator	Schaffner	CPM9830	C240	1026	N/A	N/A	RI
Induction Coil (2.0m x 2.6m)	Haefely		C241		N/A	N/A	MF
Magnetic Field Test System	Haefely	MAG 100.1	C243	080-136-03	N/A	N/A	MF
Triaxial Field Meter	F.W.BELL	4080	C244		25-Apr-07	25-Apr-09	MF
Directional Coupler 0.8-4.2GHz	Amplifier Research	DC7144A	C251	307343	N/A	N/A	RI
Digitizing Oscilloscope 1GHz	Tektronix	TDS 784C	C254	B010847	17 Dec-07	17 Dec-08	SI, EFT VDSI
Field sensor	Amplifier Research	FP6001	C255	305319	6 Jun 08	6 Jun 09	RI
Power Sensor (100KHz-4.2GHz)	Agilent	8482A	C256	MY41093835	18 Dec-07	18 Dec-08	CI
Power Meter	Gigatronics	8541B	C257	1828546	28-May-08	28-May-09	RI
Peak Power Sensor	Gigatronics	80350A	C258	1829770	16-May-08	16-May-09	RI
Coupling Decoupling 2 PH	FCC	FCC-801-M4 -32A	C260	07005	10-Jun-08	10-Jun-09	CI
Coupling Decoupling 1 PH	FCC	FCC-801-M3 -16A	C261	07021	10-Jun-08	10-Jun-09	CI
EMI Receiver	Rohde & Schwarz	ESVS 30	C310	826006/015	19-Dec-07	19-Dec-08	RE
Analyzer w RF Filter Section 85460A	HP	8546A	C311	3325A00127	23-Jul-08	23-Jul-09	RE, CE
Receiver (20Hz-40GHz)	Rohde & Schwarz	ESI 40	C320	839283/005	22-Jul-08	22-Jul-09	RE,CE
Receiver (20Hz-40GHz)	Rohde & Schwarz	ESIB 40	C321	100180	20-Jan-08	20-Jan-09	RE,CE
EMI Receiver	Rohde & Schwarz	ESHS 30	C323	831954/012	19-Dec-07	19-Dec-08	CE
Multimeter	Fluke	87	C405	49050672	5-May-08	5-May-09	All Tests
Clamp On Meter	Amprobe	RS-3	C410		17-Dec-07	17-Dec-08	MF
Absorbing Clamp	Rohde & Schwarz	MDS-21	C413	76549	10-Sep-07	10-Sep-08	RE
Temp./Humidity Chart Recorder	Honeywell		C418	637592	9-Jan-08	9-Jan-09	RE
Temp./Humidity Chart Recorder	Honeywell		C419	639971	8-Jan-08	8-Jan-09	Re
Passive HV Probe 100X	Fluke	80K-40	C434		24-Jul-08	24-Jul-09	ESD
Oscilloscope	Tektronics	2430	C435	8010532	23-Jul-08	23-Jul-09	EFT
Multimeter	Fluke	83	C437	48162892	24-Jul-08	24-Jul-09	RE
Amplifier (1-26.5 GHz.)	Agilent	8449B	C438	3008A01842	18-Dec-07	18-Dec-08	RE
Amplifier 1 - 18GHz	Rohde & Schwarz	TS-PR18	C439	122002/001	18-Jan-08	18-Jan-10	RE
Signal Generator (10M-40GHz)	Rohde & Schwarz	SMR40	C440	100195	19-Dec-07	19-Dec-08	RI

Amplifier (18-26.5GHz)	Rohde & Schwarz	TS-PR18	C443	100005	22-Jul-08	22-Jul-08	RE
Digital Pressure/Temp/RH	Davis	Perception II	C444	40917	08-Jan-08	08-Jan-09	All tests
Multimeter	Fluke	87	C445	59890224	18-Dec-07	18-Dec-08	All tests
Power Analyzer	Voltech	PM6000	C446	100006700195	13-Dec-07	13-Dec-08	HAR, FLI, VDSI
Analyzer w RF Filter Section 85460A	HP	8546A	D004	3625A00356	23-Jul-08	23-Jul-08	RE, CE
ESD Gun	Schaffner	NSG 435	D005	1891	12 Dec-07	12 Dec-08	ESD
Fast Transient / Burst Generator	Schaffner	NSG2025	D007	109	18-Sep-07	18-Sep-08	EFT
Surge Immunity Test System	Schaffner	NSG2050	D008	199930-007SC	18-Sep-07	18-Sep-08	SI
Pulse Coupling Network	Schaffner	CDN 133	D009	102	24-Sep-07	24-Sep-08	SI

Note: CE = Conducted Emissions, CI= Conducted Immunity, DP=Disturbance Power, EFT=Electrical Fast Transients, ESD = Electrostatic Discharge, FLI=Flicker, HAR=Harmonics, MF=Magnetic Field Immunity, RE=Radiated Emissions, RI=Radiated Immunity, SI=Surge Immunity, VDSI=Voltage Dips and Short Interruptions

3 Product Information

3.1 Product Description

The Transceiver is only one component that is part of a new lighting control system being designed by Sensor Switch, Inc. The name for the newly designed system is called 'nLight'. nLight will typically consist of the following components: SensorView software, at least one gateway, at least one bridge (or two trancsceivers), radio bridges for switching lighting loads (nPP-16, nWSD, nCMR, …), devices for detecting occupancy, light levels (nCM, nWV, nCM-ADC, …) and devices for user control (nPOD, nPOD-D, …). SensorView software is a browser based application which will allow clients to customize their buildings lighting needs. The software will have the ability to change device parameters, load profiles, update device firmware, respond to load shedding, and many more selectable options. The gateway provides a method of translating Ethernet packets from SensorView to RS-485 where all nLight devices can communicate. The transceiver(s) contains two RS-485 ports. Each port typically represents a lighting zone to which devices can be connected. For example, a private office will typically require one nCMR and one nPOD. An open office area could potentially use five nPP-16 and seven nCM-PDT depending on the overall size and lighting load.

3.2 Equipment Modifications

No modifications were needed to bring product into compliance.

3.3 Test Plan

The EUT product information, test configuration, mode of operation, test types, test procedures, test levels, pass/failure criteria, in this report were carried out per the product test plan located in appendix A of this report

Figure 1 – Photo of EUT (Transmitter)

Figure 2 – Photo of EUT (side view)

4 Emissions

4.1 Spectrum Bandwidth

This test measures the spectrum bandwidth of the intentional radiator signal generated by the EUT.

4.1.1 Over View of Test

Results	**Complies** (as tested per this report)				**Date**	11/16/2008	
Standard	FCC Part 15.247 (a) (2)						
Product Model	Transceiver			**Serial#**	Ts 1		
Configuration	See test plan for details						
Test Set-up	Tested conductively on test bench, see test plans for details						
EUT Powered By	120VAC/60Hz	**Temp**	22ºC	**Humidity**	45%	**Pressure**	998mbar
Frequency Range	2.405 GHz - 2.480 GHz						
Perf. Criteria	500kHz. (Below Limit)		**Perf. Verification**		Readings Under Limit		
Mod. to EUT	None		**Test Performed By**		Randy Masline		

4.1.2 Test Procedure

In accordance with Measurements of Digital Transmission Systems Operating under Section 15.274

Power Output Option 1 and PSD Option 1 were used as measurement guidelines.

Radiated and FCC emissions tests were performed using the procedures of ANSI C63.4 including methods for signal maximizations and EUT configuration. The photos included with the report show the EUT in its maximized configuration.

The frequency range from 2.405-2.480 GHz was investigated for radiated emissions, testing the lowest middle and highest channels.

Radiated emission testing was first performed at a distance of 3 meters in the semi-anechoic chamber in order to identify the specific frequencies for which these measurements will be made on the 3m OATS.

4.1.3 Deviations

There were no deviations from the test methodology listed in the test plan.

4.1.4 Final Test

All final Bandwidth measurements were within (in compliance) the limits.

4.1.5 Summary of Final Data

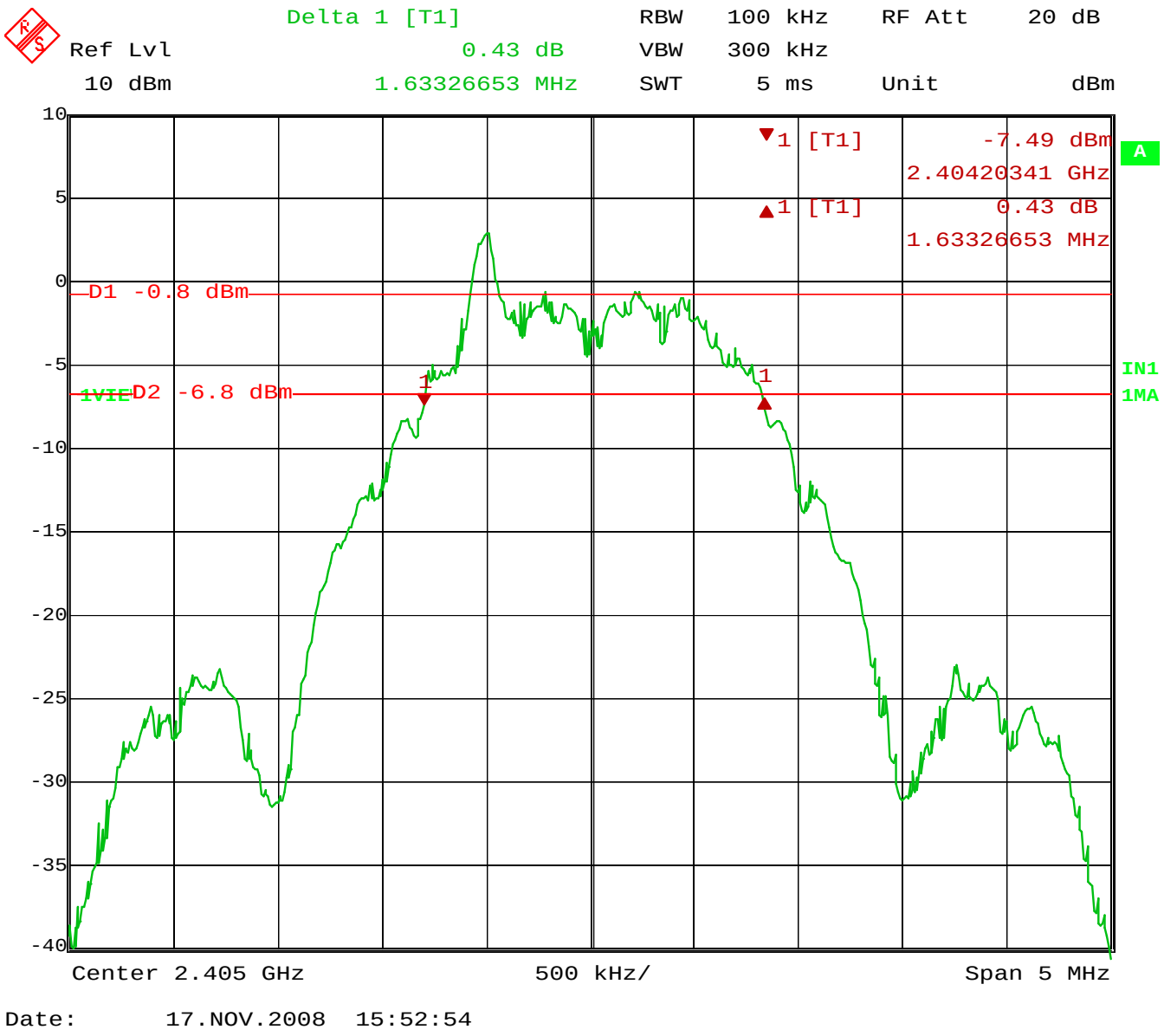

Figure 3 – Channel 11, -6dB Bandwidth

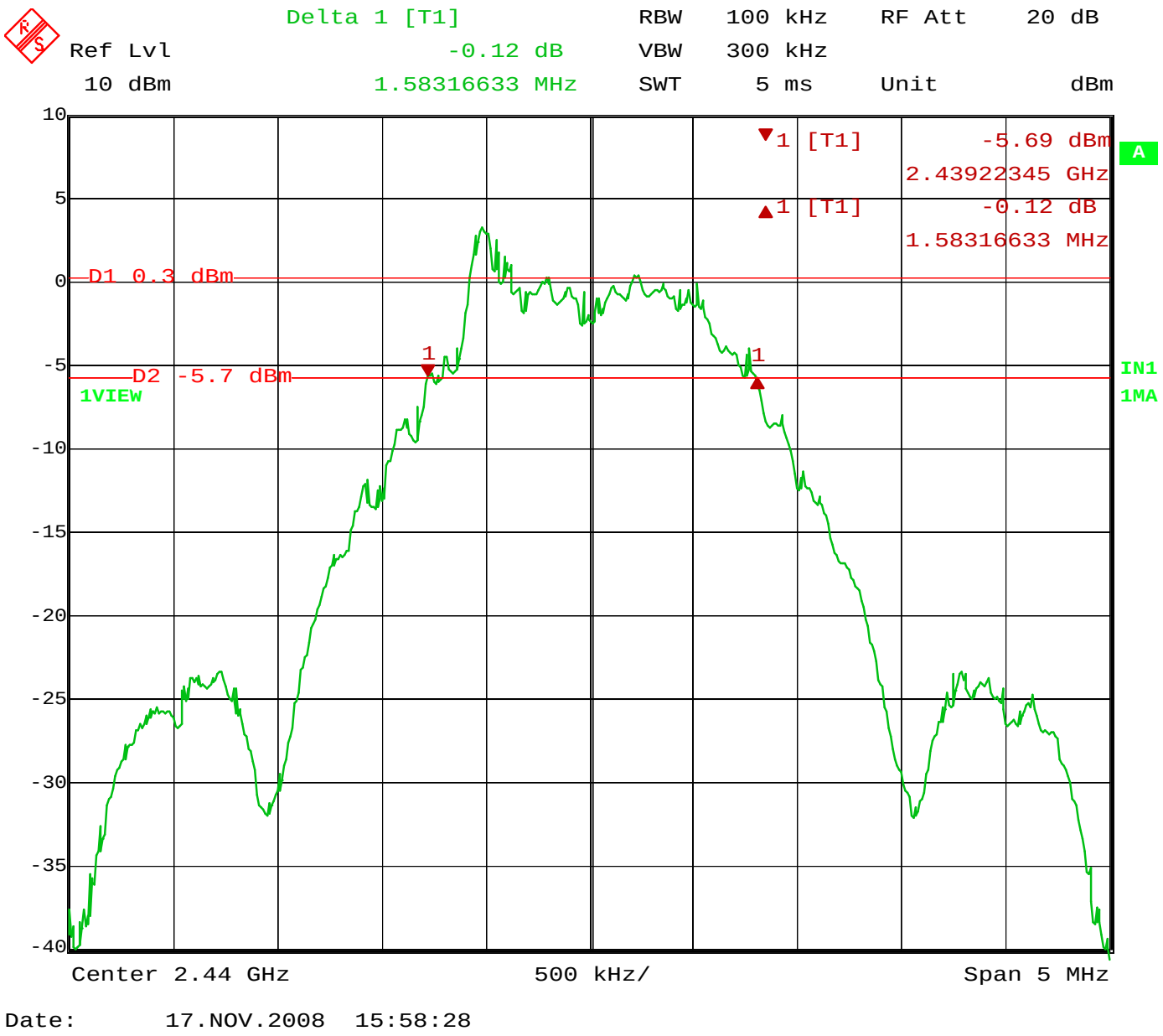

Figure 4 – Channel 18, -6dB Bandwidth

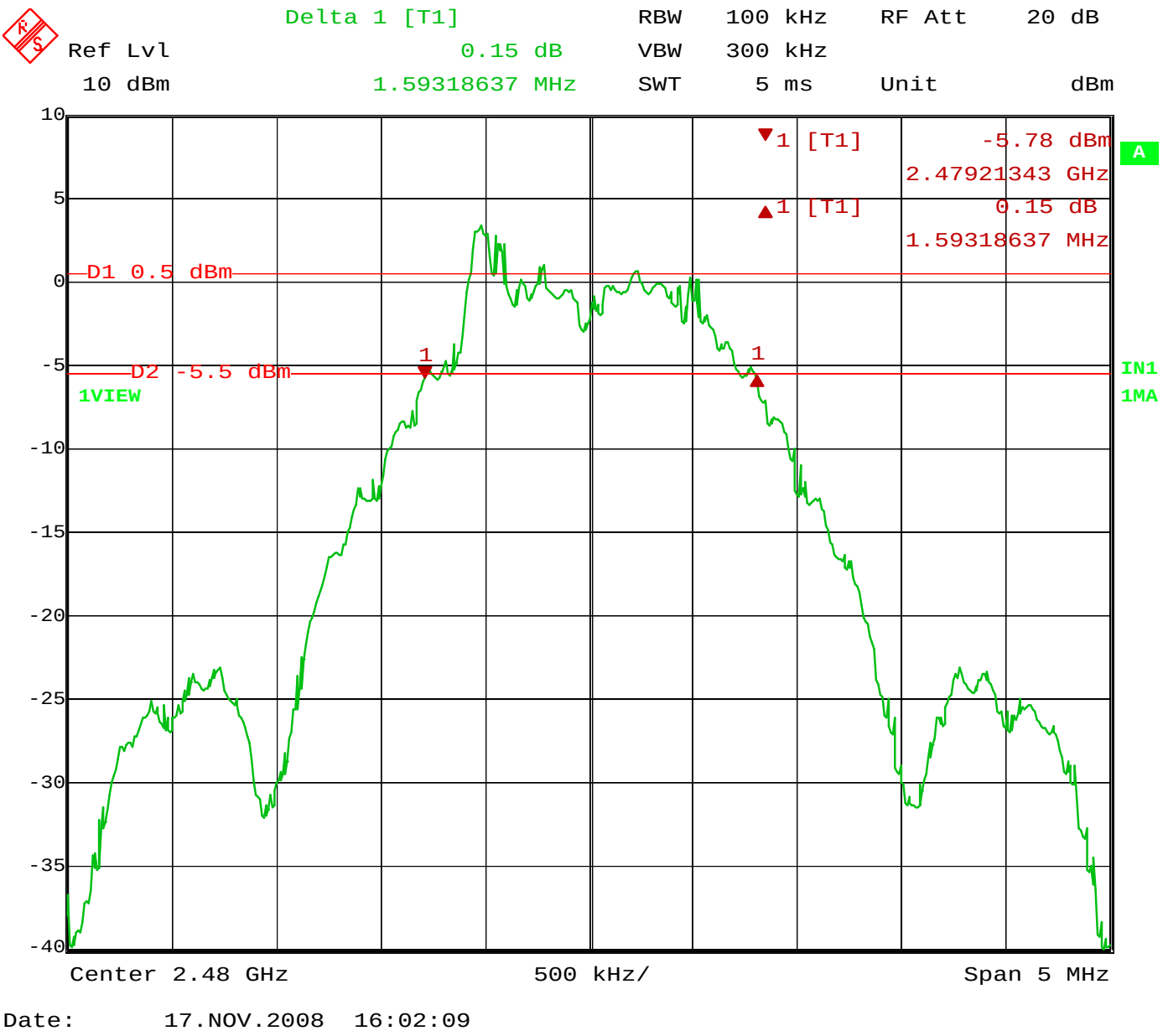

Figure 5 – Channel 26, -6dB Bandwidth

4.1.6 Tabulated Test Data

Channel	Frequency (MHz)	-6dB Bandwidth (MHz)	Minimum Limit (MHz)	Result
Ch 11	2405	**1.633**	0.500	**Complies**
Ch 18	2440	**1.583**	0.500	**Complies**
CH 26	2480	**1.593**	0.500	**Complies**

Table 1 – Bandwidth Measurements – 6dB

4.2 Band Edge Measurements:

Radiated Data taken at 3 meters at OATS

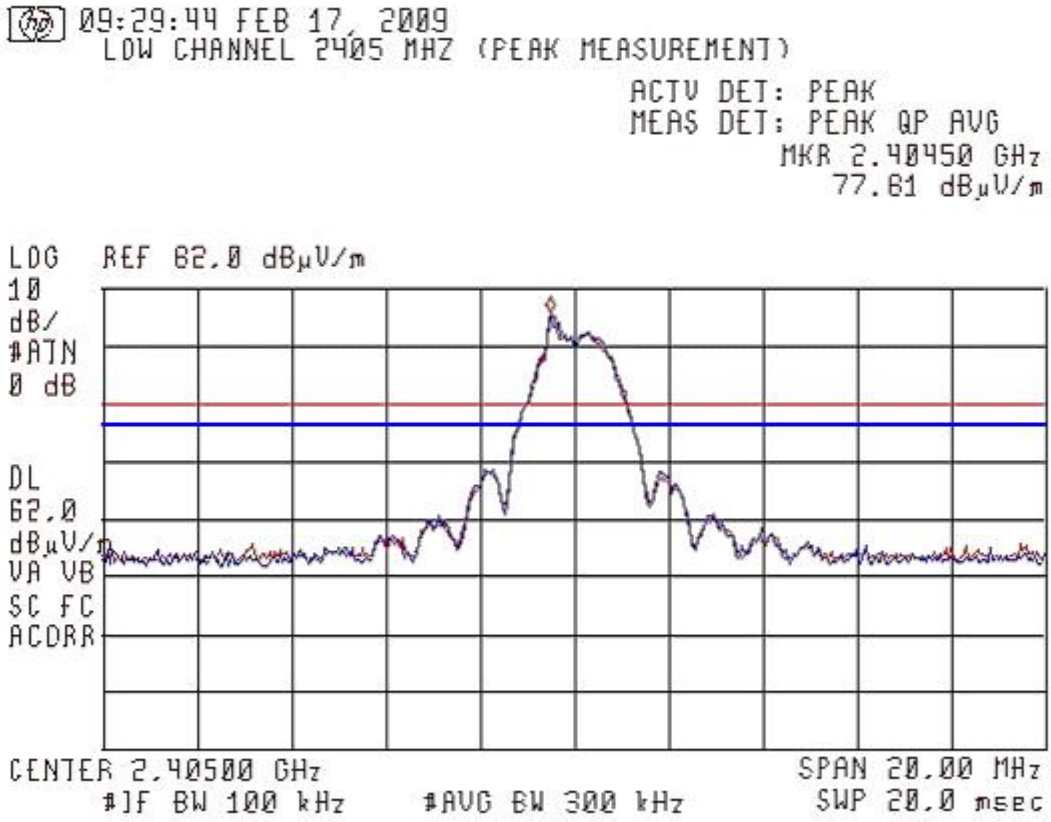

Figure 6 – Low Channel, Dark display line is -20dB from Peak measurement

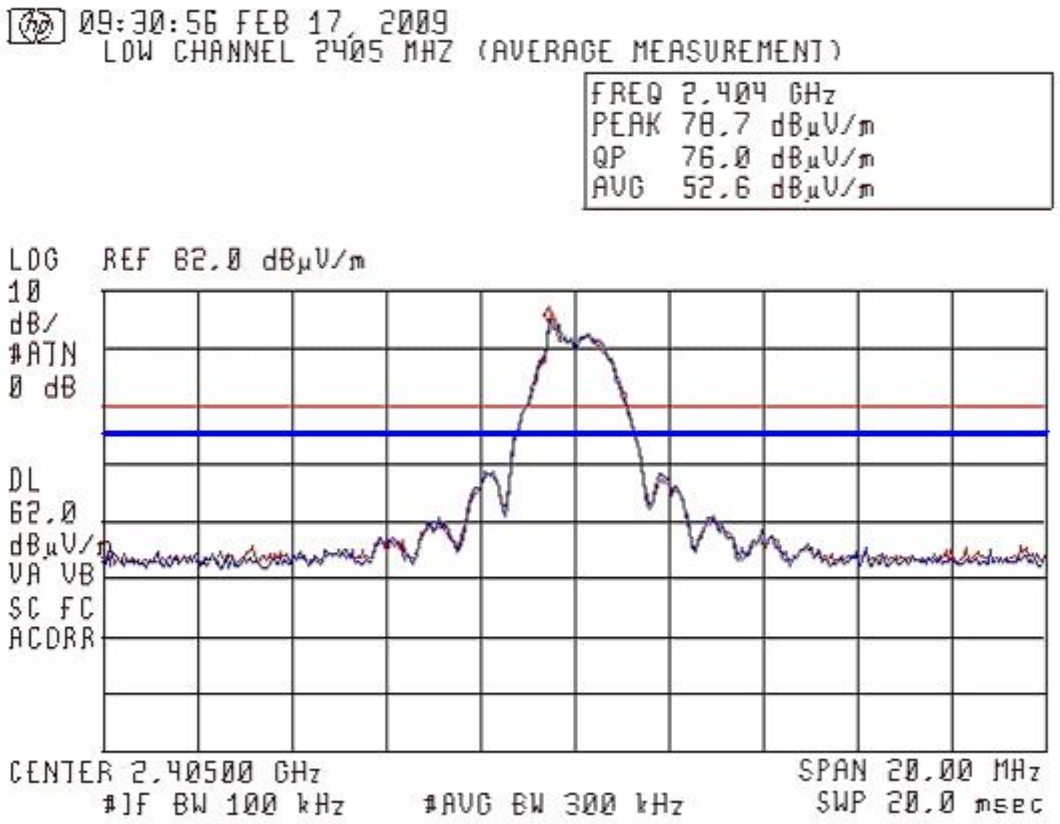

Figure 7 – Low Channel, Dark display line is -20dB from Average measurement

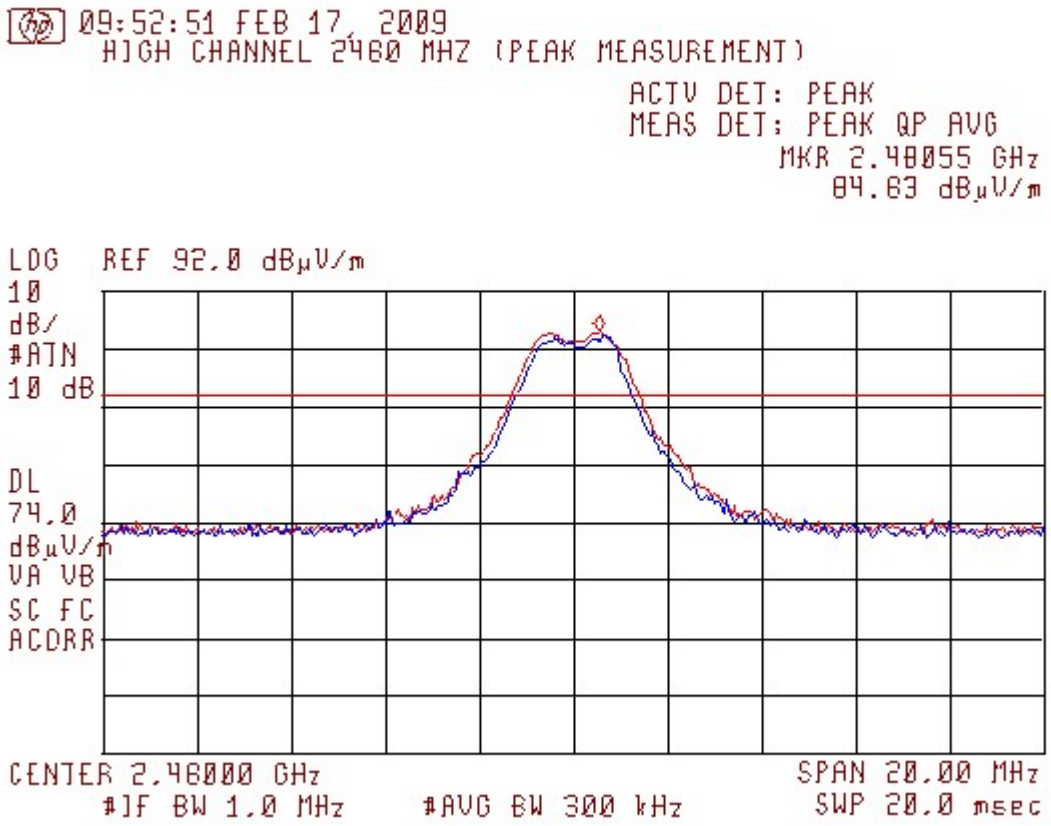

Figure 8 – High Channel Peak measurement, display line at 75dBuV

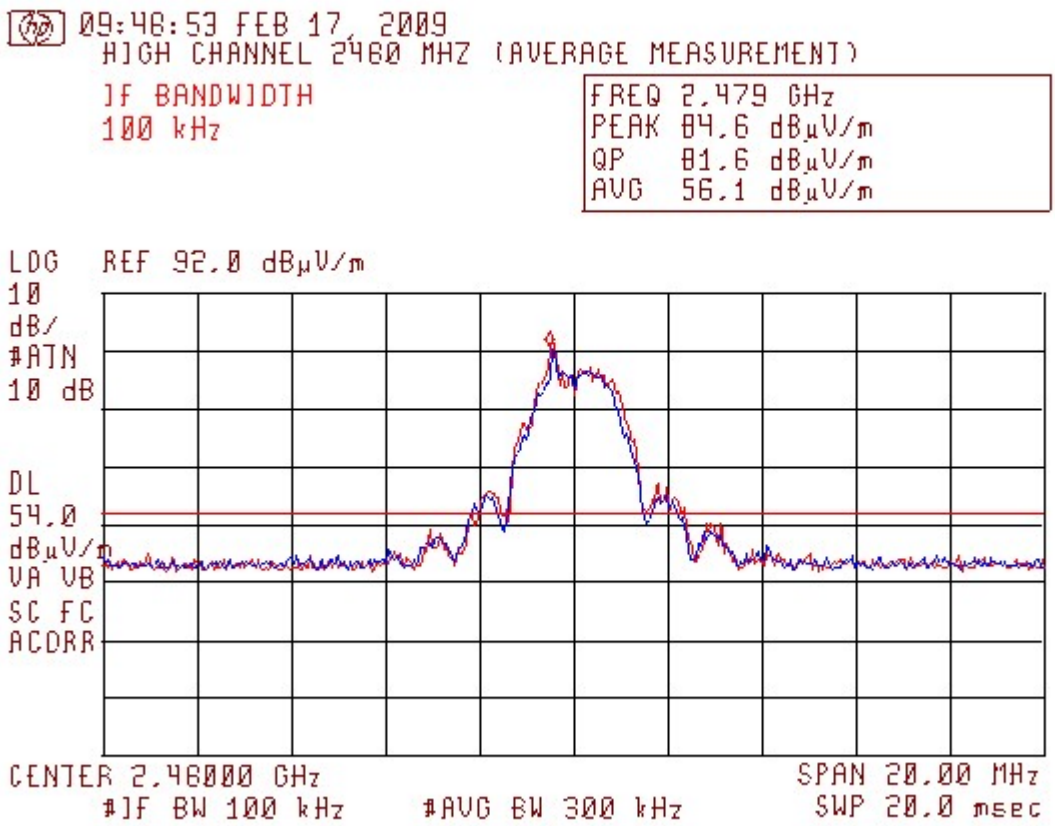

Figure 9 – High Channel Average measurement, display line is at 54dBuV

4.3 99% Spectrum Bandwidth

In accordance with RSS-210 Issue 7 §5.9.1

This test measures the spectrum bandwidth of the intentional radiator signal generated by the EUT.

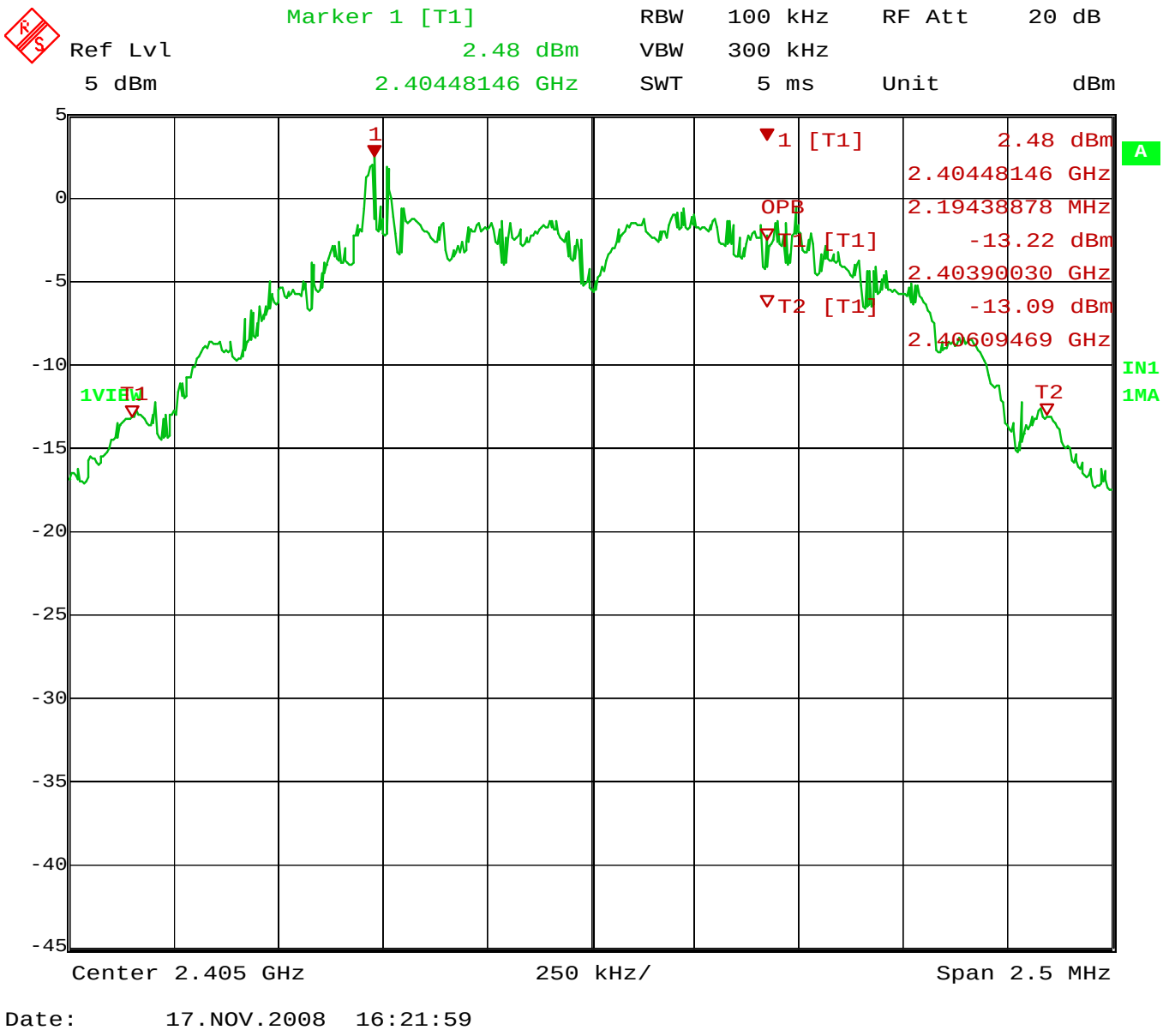

Figure 10 – Channel 11, 99% Bandwidth

Figure 11 – Channel 18, 99% Bandwidth

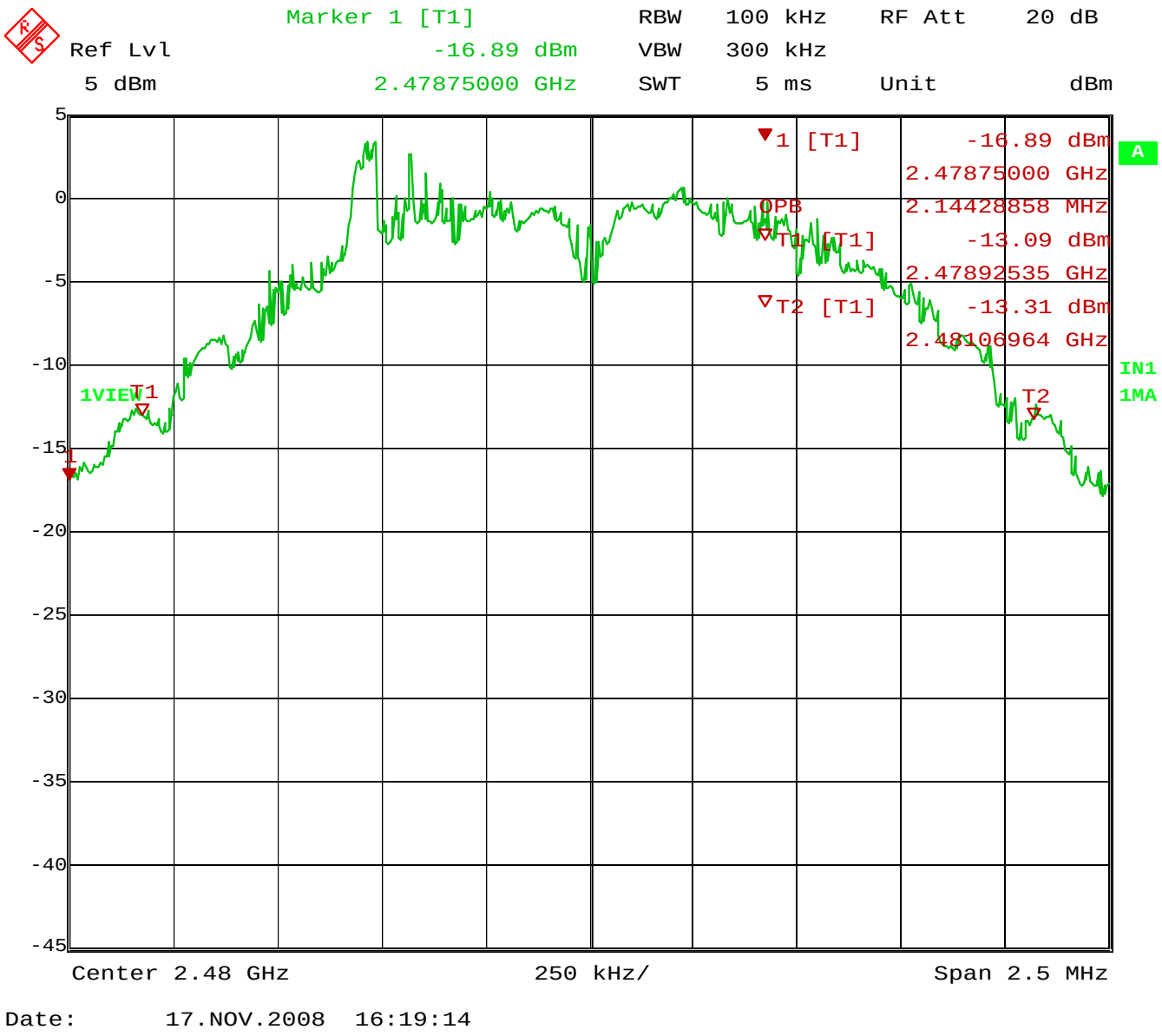

Figure 12 – Channel 26, 99% Bandwidth

4.3.1 Photos

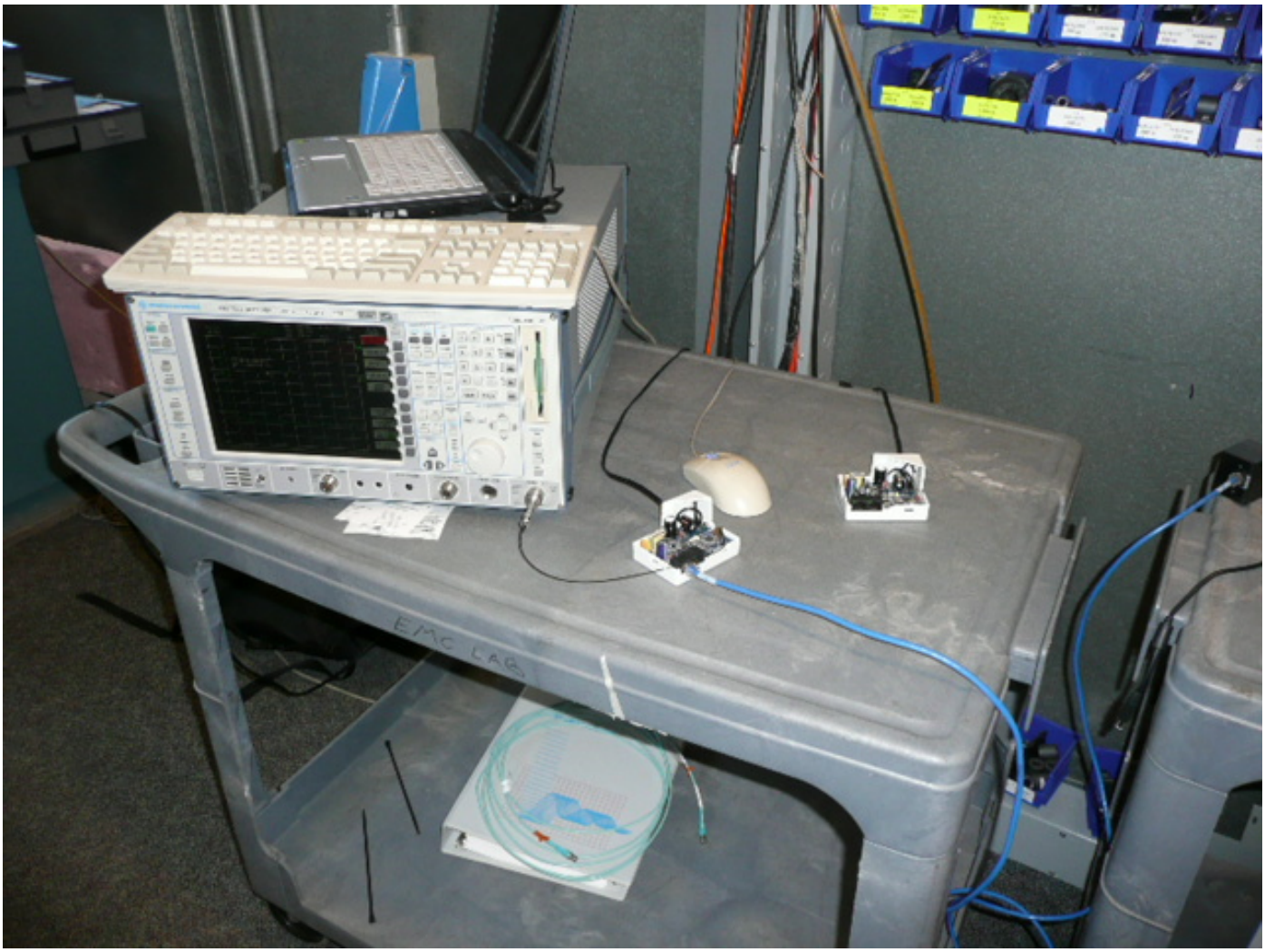

Figure 13 - Emissions Test Setup

4.4 Maximum Output Power

This test measures the radiated electromagnetic levels of the intentional radiator generated by the EUT through the antenna port.

4.4.1 Over View of Test

Results	**Complies** (as tested per this report)				**Date**	02/08/2008	
Standard	FCC Part 15.247 (a) (2)						
Product Model	Transceiver			**Serial#**	Ts **1**		
Configuration	See test plan for details						
Test Set-up	Tested in shielded room EUT placed on table see test plans for details						
EUT Powered By	AC/DC Adapter & Batteries	**Temp**	22ºC	**Humidity**	45%	**Pressure**	998mbar
Frequency Range	2.405GHz - 2.480GHz @ 3m						
Perf. Criteria	1 Watt (30dBm) (Below Limit)	**Perf. Verification**	Readings Under Limit for L1 and L2				
Mod. to EUT	None	**Test Performed By**	Randall E Masline				

4.4.2 Test Procedure

In accordance with Measurements of Digital Transmission Systems Operating under Section 15.274

Power Output Option 1 and PSD Option 1 were used as measurement guidelines.

Radiated emissions tests were performed using the procedures of ANSI C63.4 including methods for signal maximizations and EUT configuration. The photos included with the report show the EUT in its maximized configuration.

The frequency range from 2.405-2.480 GHz was investigated for radiated emissions, testing the lowest middle and highest channels.

Radiated emission testing was first performed at a distance of 3 meters in the semi-anechoic chamber in order to identify the specific frequencies for which these measurements will be made on the 3m OATS.

All other testing was performed conductively at the antenna output connector.

4.4.3 Deviations

There were no deviations from the test methodology listed in the test plan.

4.4.4 Final Test

All final radiated emissions measurements were below (in compliance) the limits.

4.4.5 Summary of Final Data

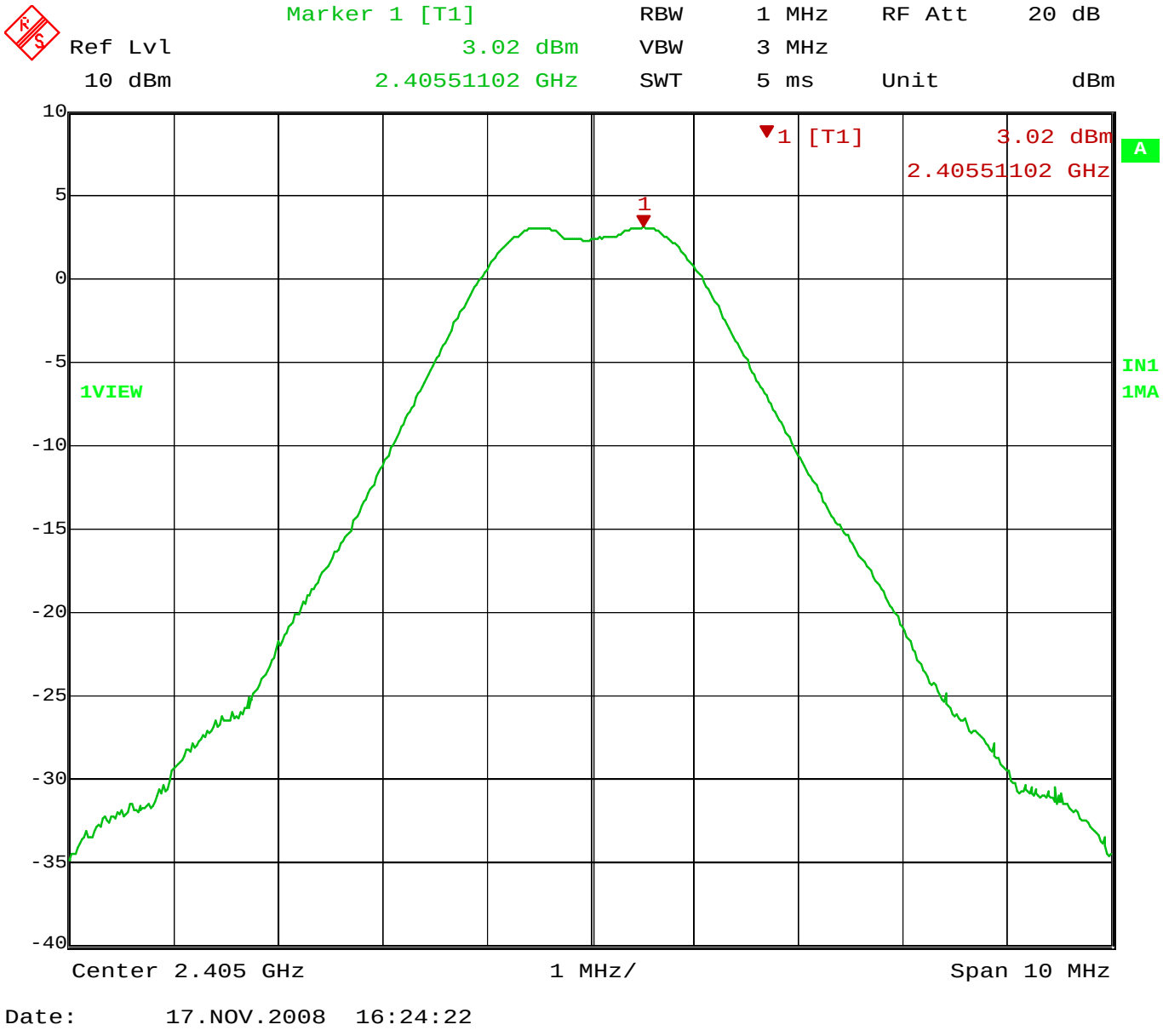

Figure 14 – Channel 11 (lowest) Maximum Power Output

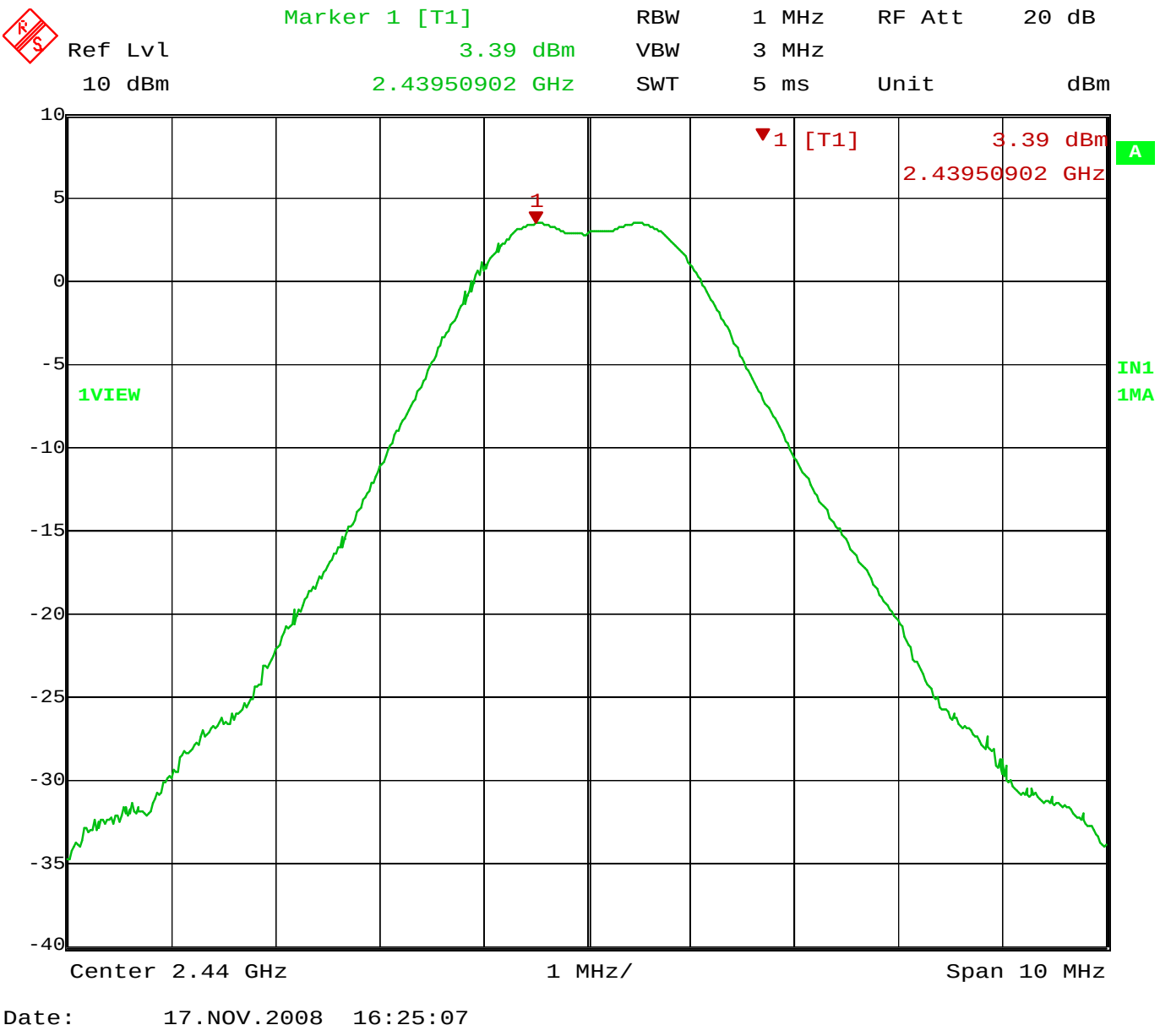

Figure 15 - Channel 18 (mid) Maximum Power Output

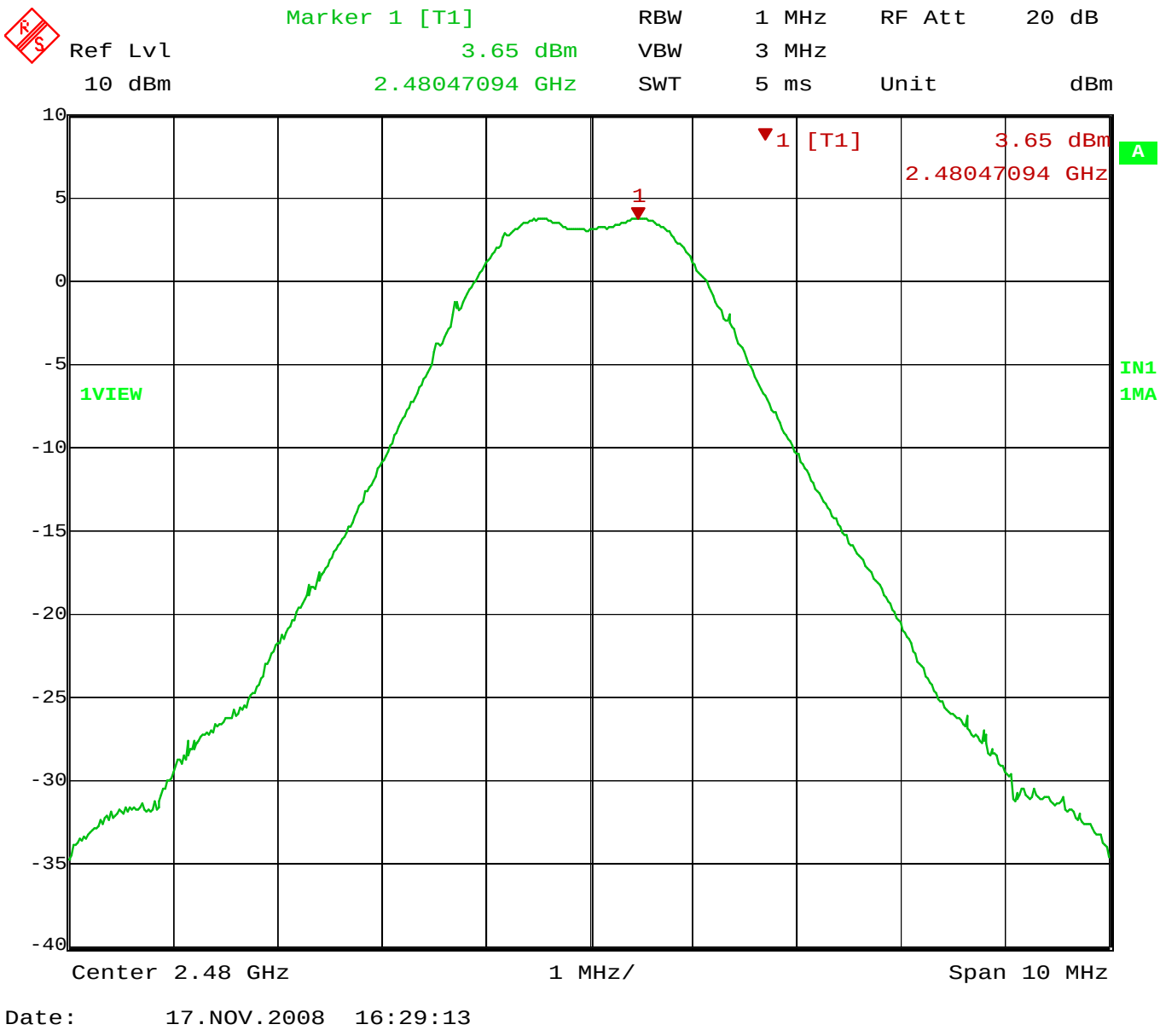

Figure 16 - Channel 26 (highest) Maximum Power Output

4.4.6 Tabulated Test Data

Channel	Freq (MHz)	Measured Peak (dBm)	Duty Cycle Correction	Antenna Gain	Corrected Measurement Average (dBm)	Peak Limit 1 Watt (30 dBm)	Delta Peak (dB)	Result
11	2405	3.02	-11.36	2.14	-6.2	30	-36.2	**Complies**
18	2440	3.39	-11.36	2.14	-5.83	30	-35.83	**Complies**
26	2480	3.65	-11.36	2.14	-5.57	30	-35.57	**Complies**

Table 2 – Power Output Measurements

Average values were calculated based on the duty cycle of the transmission frequency

Measured duty cycle is 1.462ms on time per pulse, there are 5 pulses in 100 ms

Therefore the total on time is 7.31 ms over 100 ms.

Duty Cycle = Tx On/ (Tx on + Tx Off)

Duty Cycle = 7.31ms/100ms = 7.31%

In dB = 10log (0.0731) = -11.36

Corrected measured peak (dBm) = Measured Peak + Correction Factor + Duty Cycle + Antenna Gain

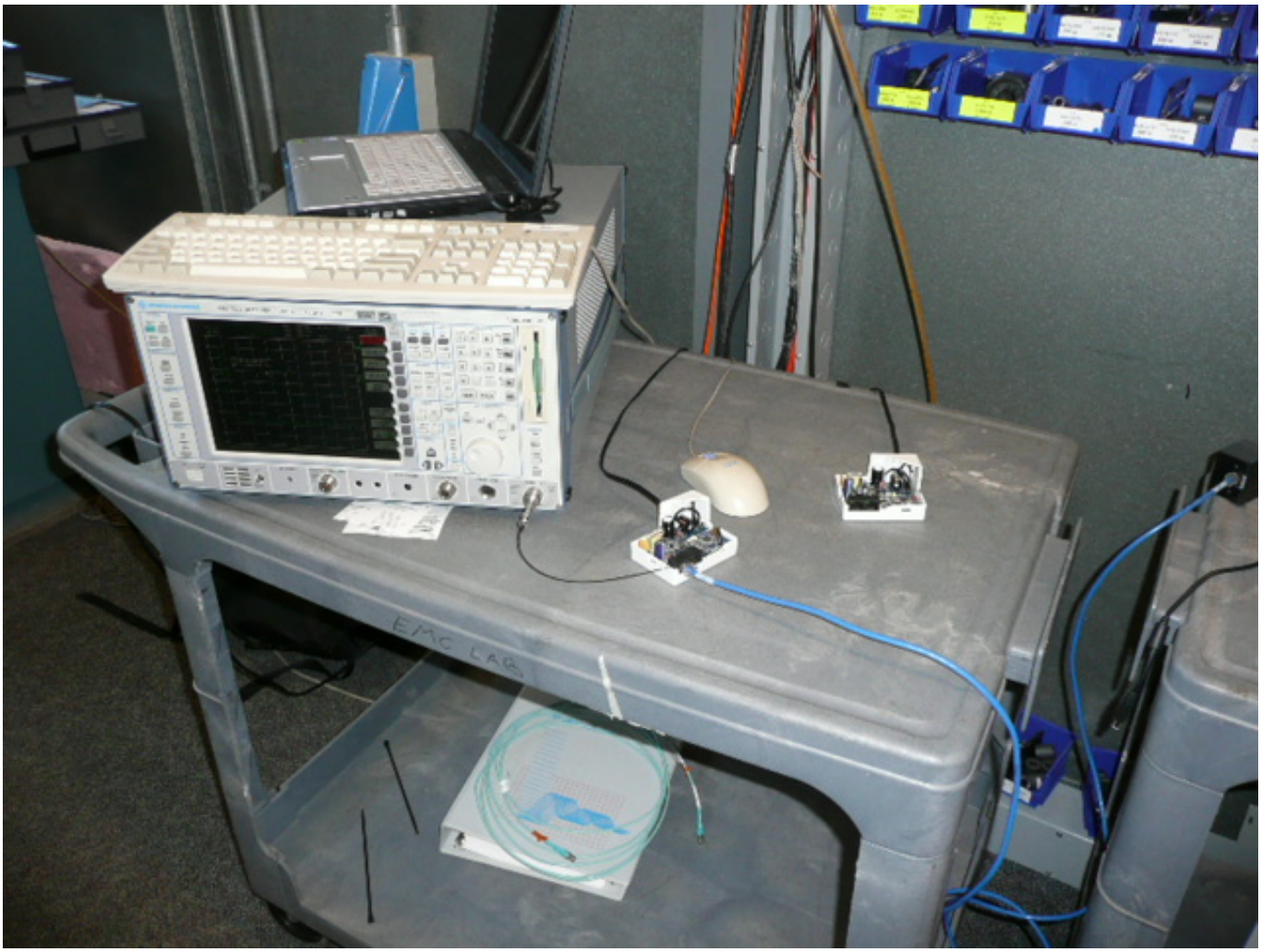

Figure 17 – Maximum Output Power

4.5 RF Human Exposure Limits

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4.5.1 Test Over View

Results	**Complies** (as tested per this report)				**Date**	11/18/208	
Standard	FCC Part 15.247 (b)(5) and 1.1310						
Product Model	Transceiver			**Serial#**	Ts **1**		
Configuration	See test plan for details						
Test Set-up	Tested in shielded room EUT placed on table						
EUT Powered By	AC/DC Adapter & Batteries	**Temp**	22ºC	**Humidity**	45%	**Pressure**	998mbar
Frequency Range	2.405GHz - 2.480GHz @ 3m						
Perf. Criteria	1.0 (mW/cm2) (Below Limit)		**Perf. Verification**		Readings under Limit		
Mod to EUT	None		**Test Performed By**		Randy Masline		

4.5.2 Test Procedure

The maximum input power was measured. Then the minimum distance to the radiator was calculated based on the following formula:

$S=PG/4\Pi r^2 = EIRP/4\Pi r^2$ where:

P: Power Input to the antenna in mW
EIRP: Equivalent (effective) isotropic radiated power.
S: power density mW/cm^2 (1.0 according to the maximum permissible exposure limits (MPE) stated in the FCC standard.
G: Numeric Gain of antenna relative to isotropic radiator
r: Distance to centre of radiation in cm $r = \sqrt{PG/4\Pi S}$

4.5.3 Deviations

There were no deviations from the test methodology listed in the test plan.

4.5.4 Final Test

The distance of the antenna is greater than the calculated in r. Therefore the FCC radio frequency exposure limits are not exceeded.

4.5.5 Tabulated Test Data

Channel	Freq (MHz)	Measured Peak (dBm)	Duty Cycle Correction	Total Average EIRP (dBm)	Total Average EIRP (mW)	S Max Exposure Limit (mW2/cm)	Under limit	Result
11	2405	3.02	-11.36	-8.34	0.146	1.0	-0.854	**Complies**
18	2440	3.39	-11.36	-7.97	0.179	1.0	**-0.821**	**Complies**
26	2480	3.65	-11.36	-7.71	0.169	1.0	-0.831	**Complies**

Table 3 – Maximum Permissible Exposure Calculations

Average values were calculated based on the duty cycle of the transmission frequency

Measured duty cycle is 1.462ms on time per pulse, there are 5 pulses in 100 ms

Therefore the total on time is 7.31 ms over 100 ms.

Duty Cycle = Tx On/ (Tx on + Tx Off)

Duty Cycle = 7.31ms/100ms = 7.31%

In dB = 10log (0.0731) = -11.36

4.6 Radiated Spurious Emissions

This test measures the radiated electromagnetic levels of the intentional and unintentional radiator generated by the EUT.

4.6.1 Test Over View

Results	**Complies** (as tested per this report)				**Date**	11/17/2008	
Standard	FCC Part 15.247 (c), 15.205, 15.209						
Product Model	Transceiver			**Serial#**	Ts **1**		
Configuration	See test plan for details						
Test Set-up	Tested in shielded room EUT placed on table						
EUT Powered By	AC/DC Adapter & Batteries	**Temp**	22ºC	**Humidity**	45%	**Pressure**	998mbar
Frequency Range	2.405GHz - 2.480GHz @ 3m						
Perf. Criteria	-20dBc, 15.205 (a), 15.209 (a)			**Perf. Verification**	Readings under Limit		
Mod to EUT	None			**Test Performed By**	Randy Masline		

4.6.2 Test Procedure

Radiated and FCC emissions tests were performed using the procedures of ANSI C63.4 including methods for signal maximizations and EUT configuration. The photos included with the report show the EUT in its maximized configuration.

The frequency range from 2.405-2.480 GHz was investigated for radiated emissions, testing the lowest middle and highest channels.

In accordance with FCC 15.33 if the intentional radiator operates below 10 GHz, radiated emissions shall be measured to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower. The EUT operates in the 2.4 GHz region and therefore was investigated up to 26 GHz.

Any harmonic emission that was indistinguishable from the noise floor was not recorded in this test report.

4.6.3 Deviations

There were no deviations from the test methodology listed in the test plan.

4.6.4 Final Test

The radiated and spurious emissions of the EUT were below the limits specified in the standard.

4.6.5 Tabulated Test Data – Radiated

Radiated Emissions Measurements										
Standard:	FCC Part 15.209(a)					Finals	Date:	11/18/2008		
Device Tested:	Sensor Switch Transceiver					3m	File .xls:	30860229.00		
		Measured Level								
Meas #	Freq (MHz)	Peak	Quasi-Peak	Quasi-Peak Limit	Quasi-Peak Δ	Result	Antenna Polarization	Angle (degrees)	Antenna Height (meters)	Comment
1	250.0000	27.20	14.60	37.00	-22.40	Complied	Horizontal	0	1.00	
2	300.0000	23.00	12.70	37.00	-24.30	Complied	Horizontal	0	1.00	
3	400.0000	21.40	17.30	37.00	-19.70	Complied	Horizontal	0	1.00	
4	450.0000	23.10	17.60	37.00	-19.40	Complied	Horizontal	0	1.00	
5	450.0000	22.60	17.70	37.00	-19.30	Complied	Vertical	0	1.00	
6	**748.0000**	**26.40**	**21.50**	**37.00**	**-15.50**	**Complied**	**Horizontal**	**0**	**1.00**	**Maximum Emissions**

4.6.6 Summary of Final Data – Spurious Harmonics Graphs

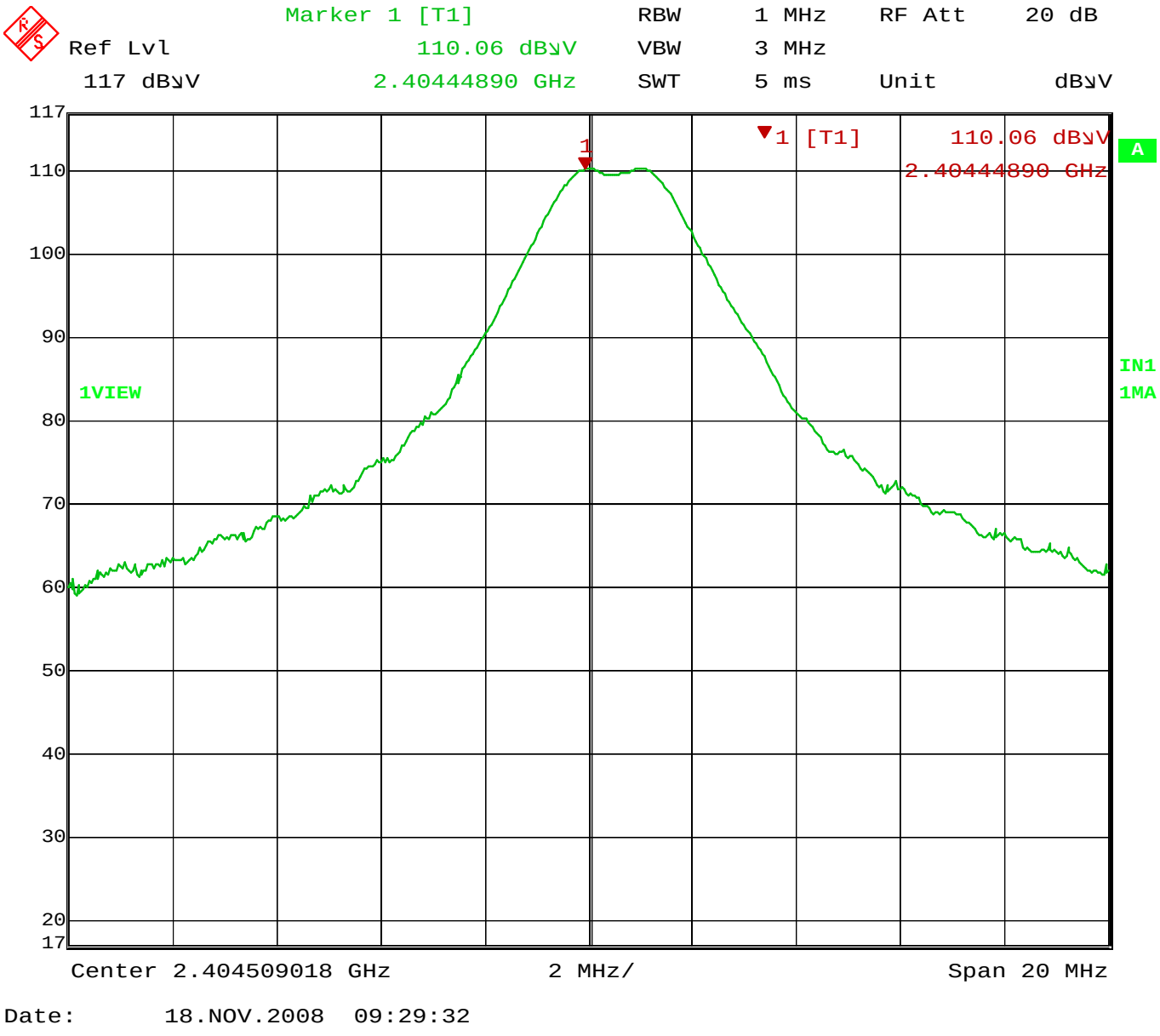


Figure 18 – Channel 11 Fundamental

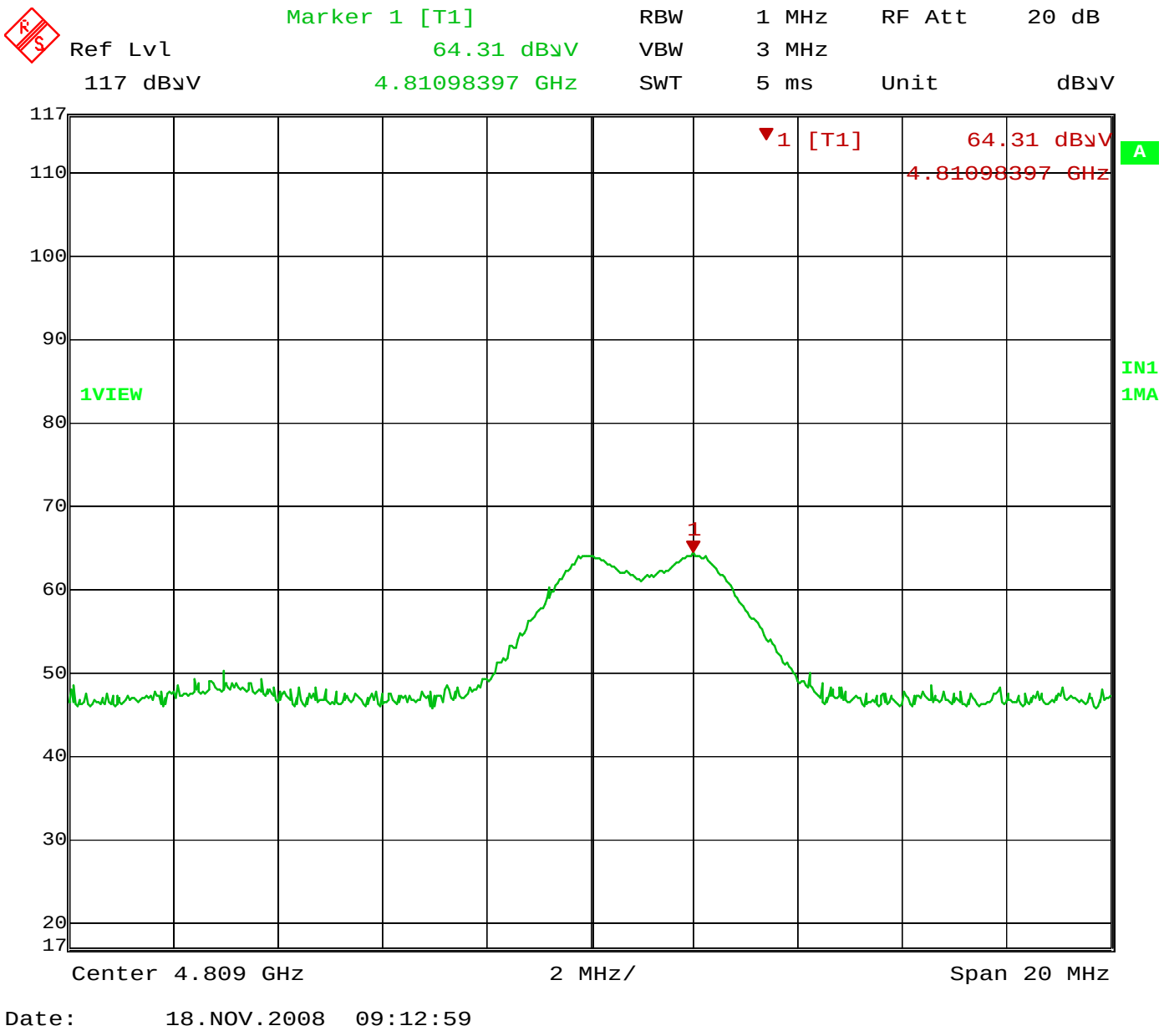


Figure 19 – Channel 11 Harmonic

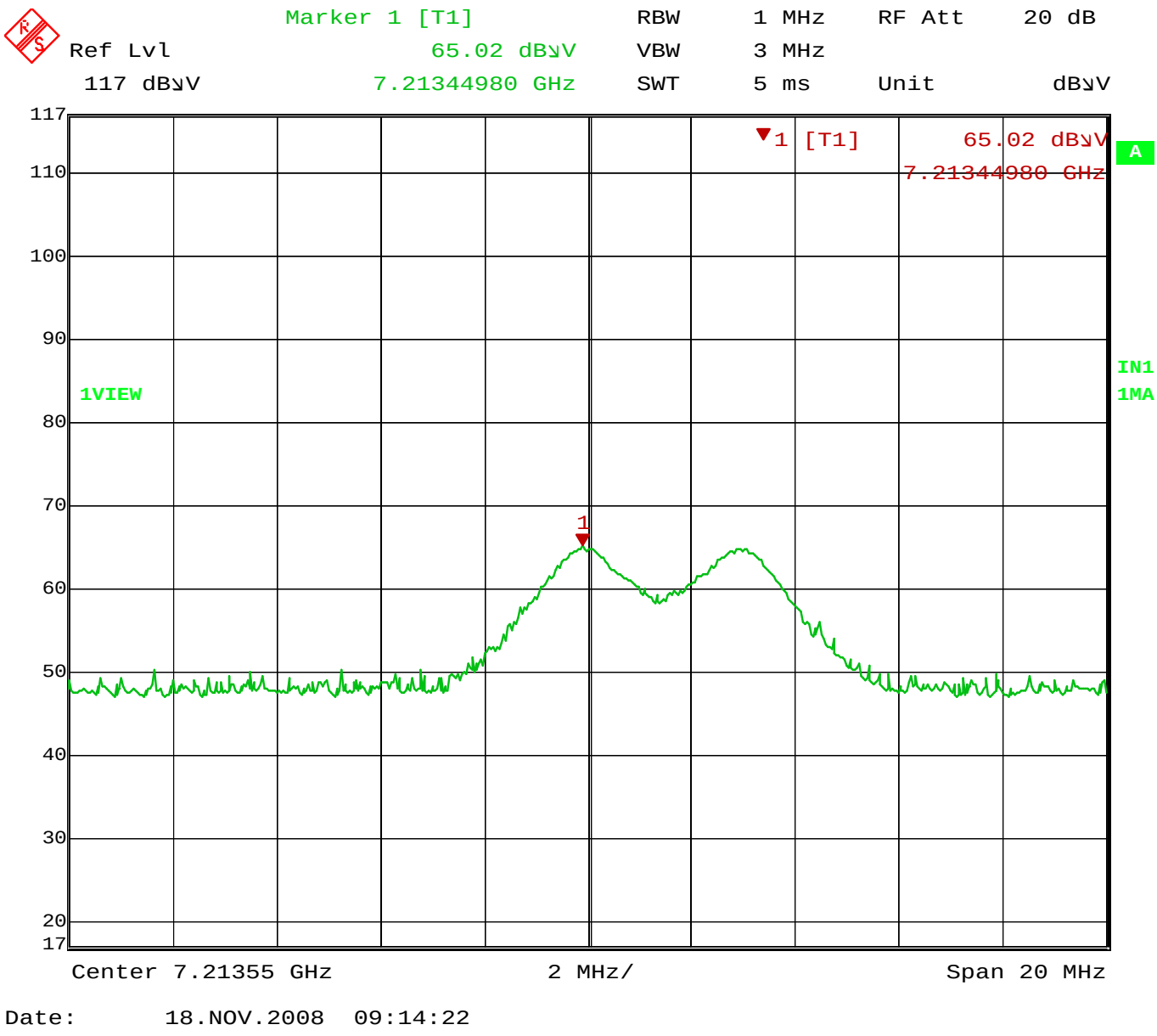


Figure 20 – Channel 11 Harmonic

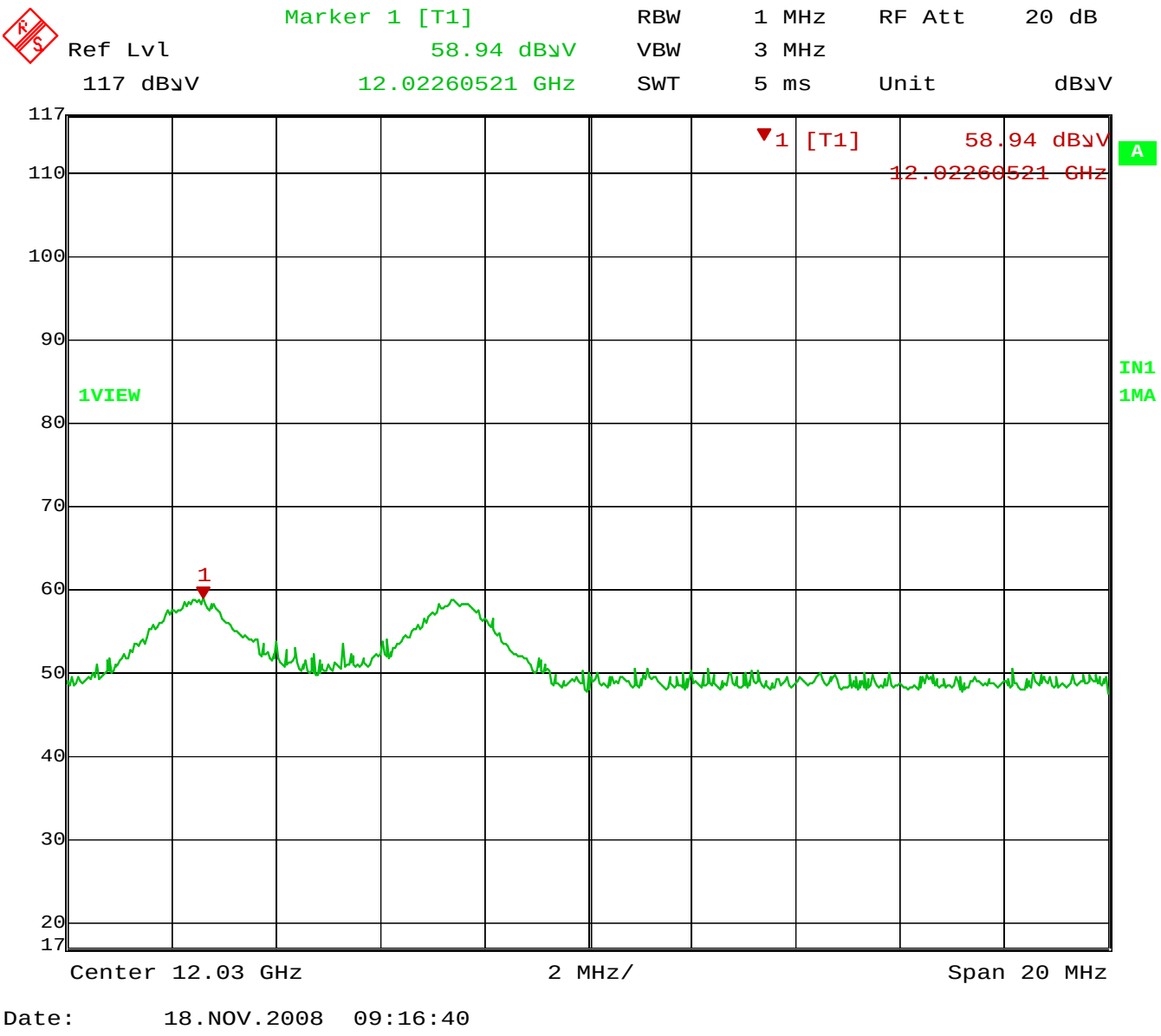


Figure 21 – Channel 11 Harmonic

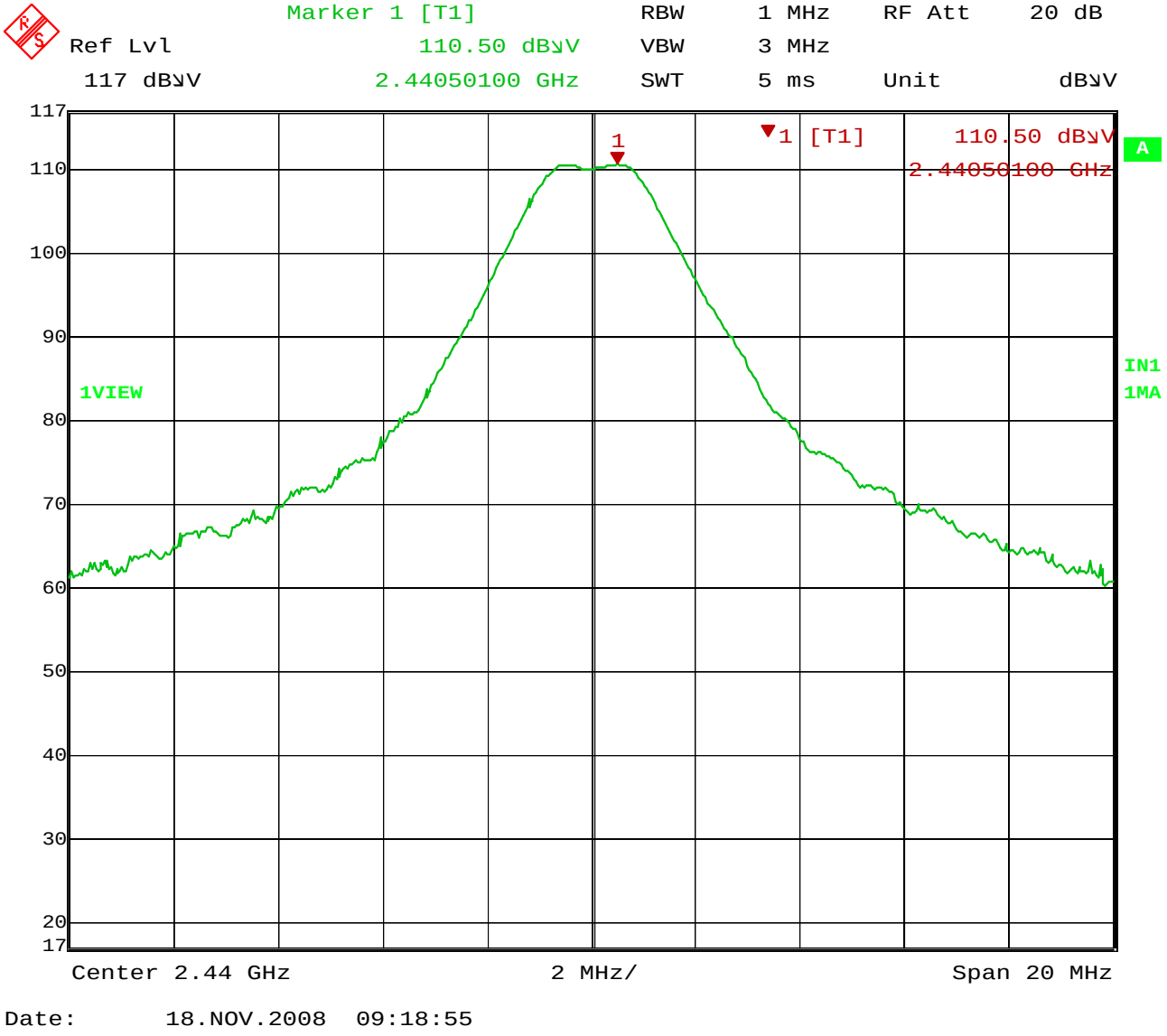


Figure 22 – Channel 18 Fundamental

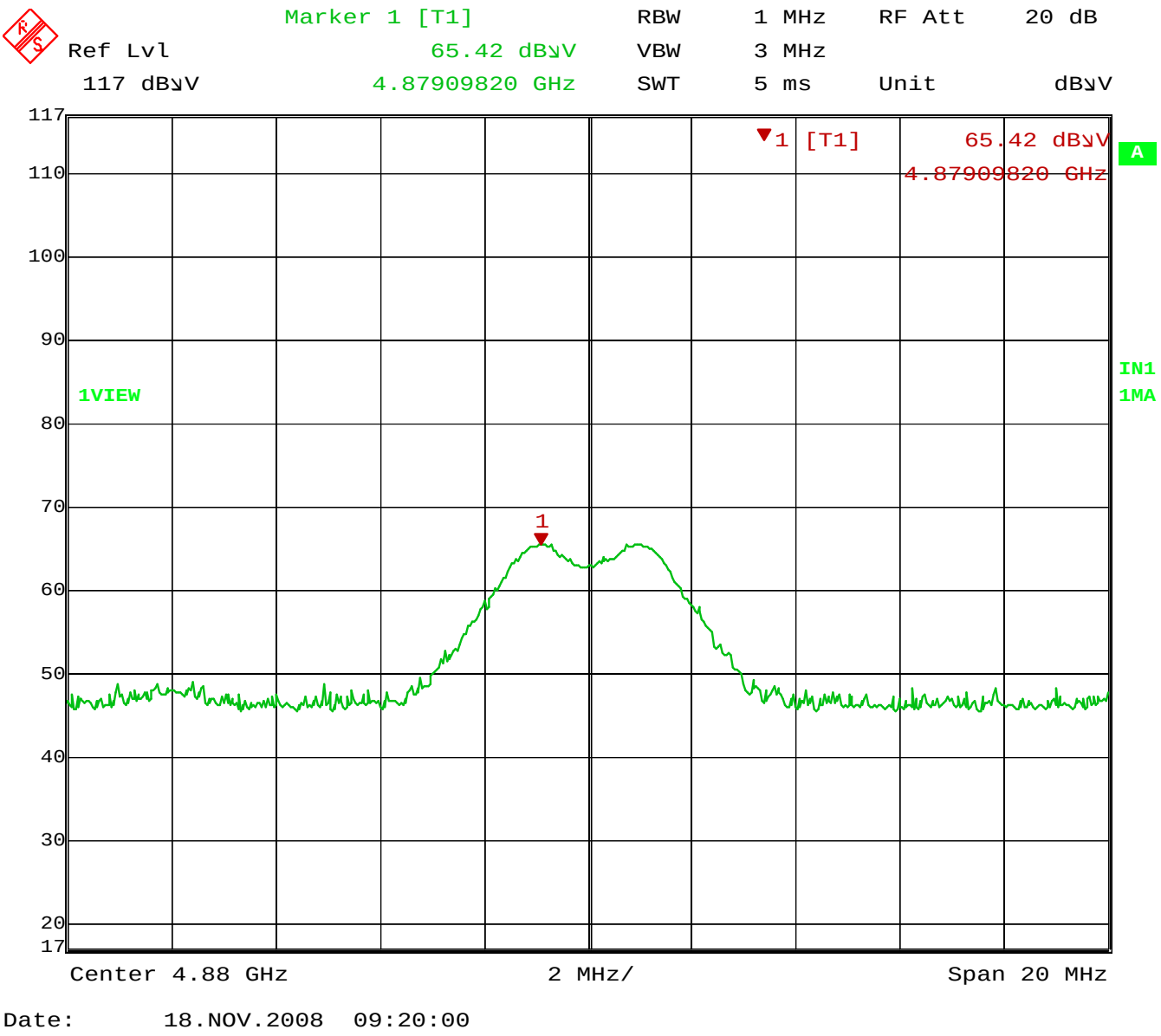


Figure 23 – Channel 18 Harmonic

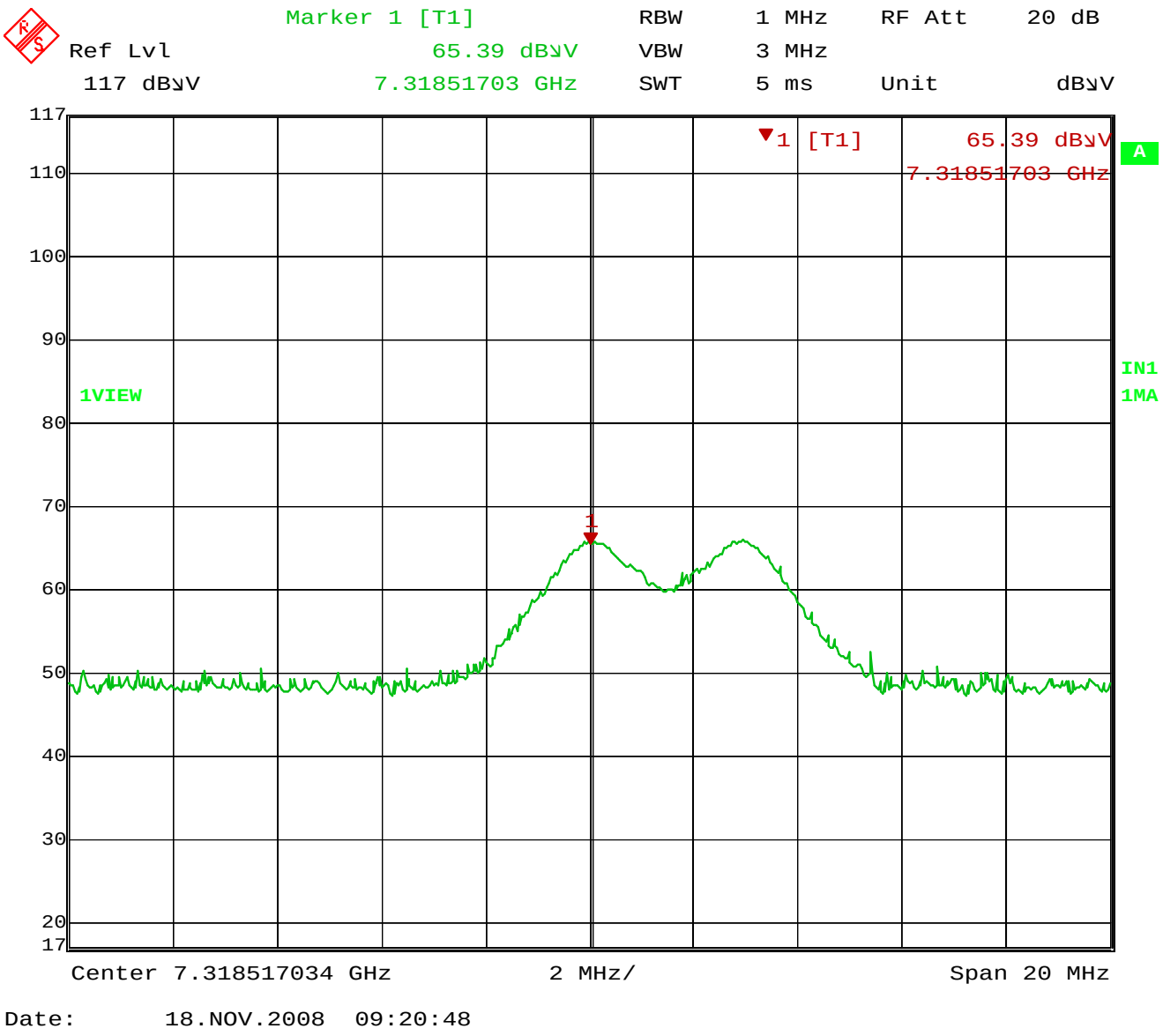


Figure 24 – Channel 18 Harmonic

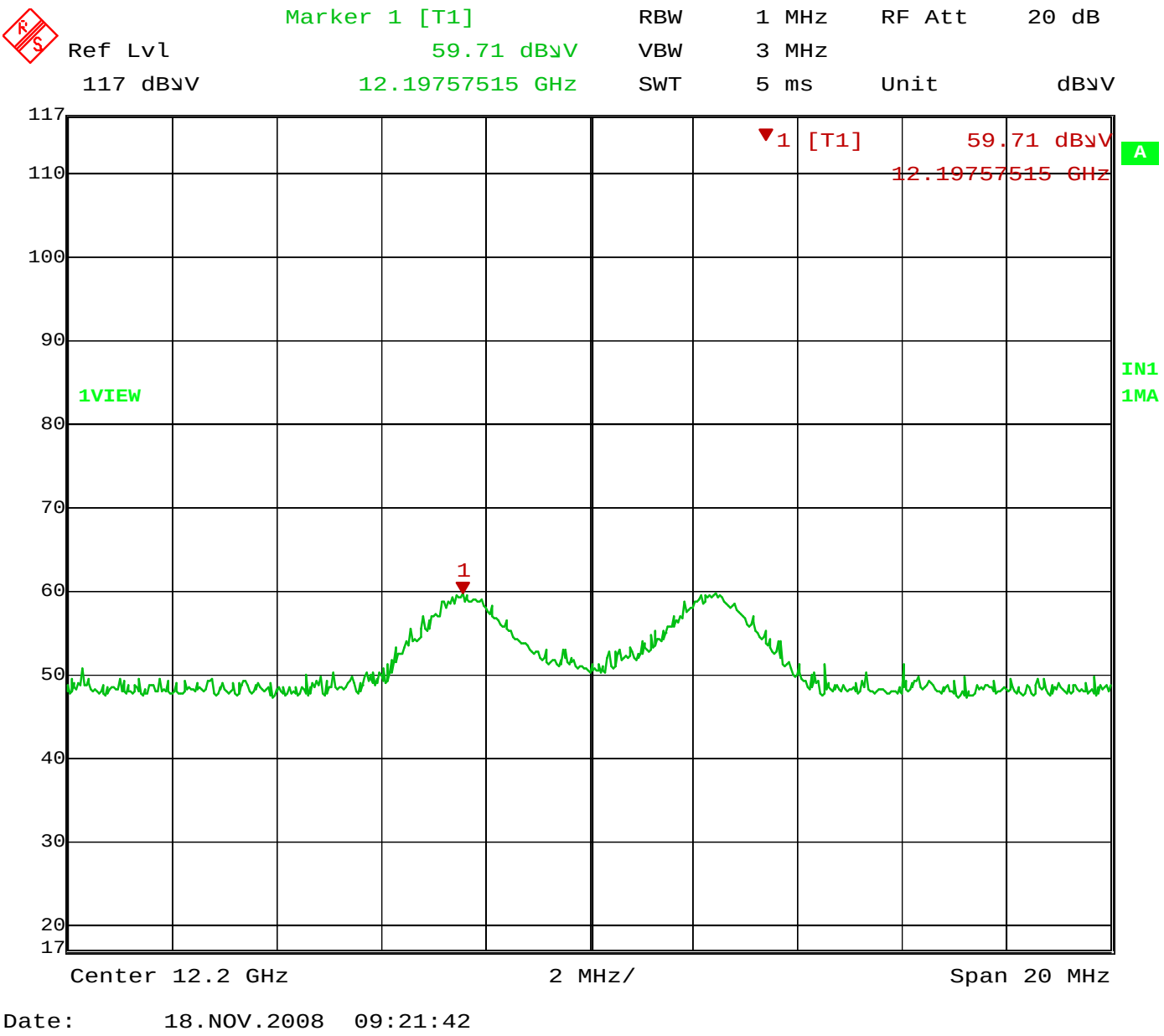


Figure 25 – Channel 18 Harmonic

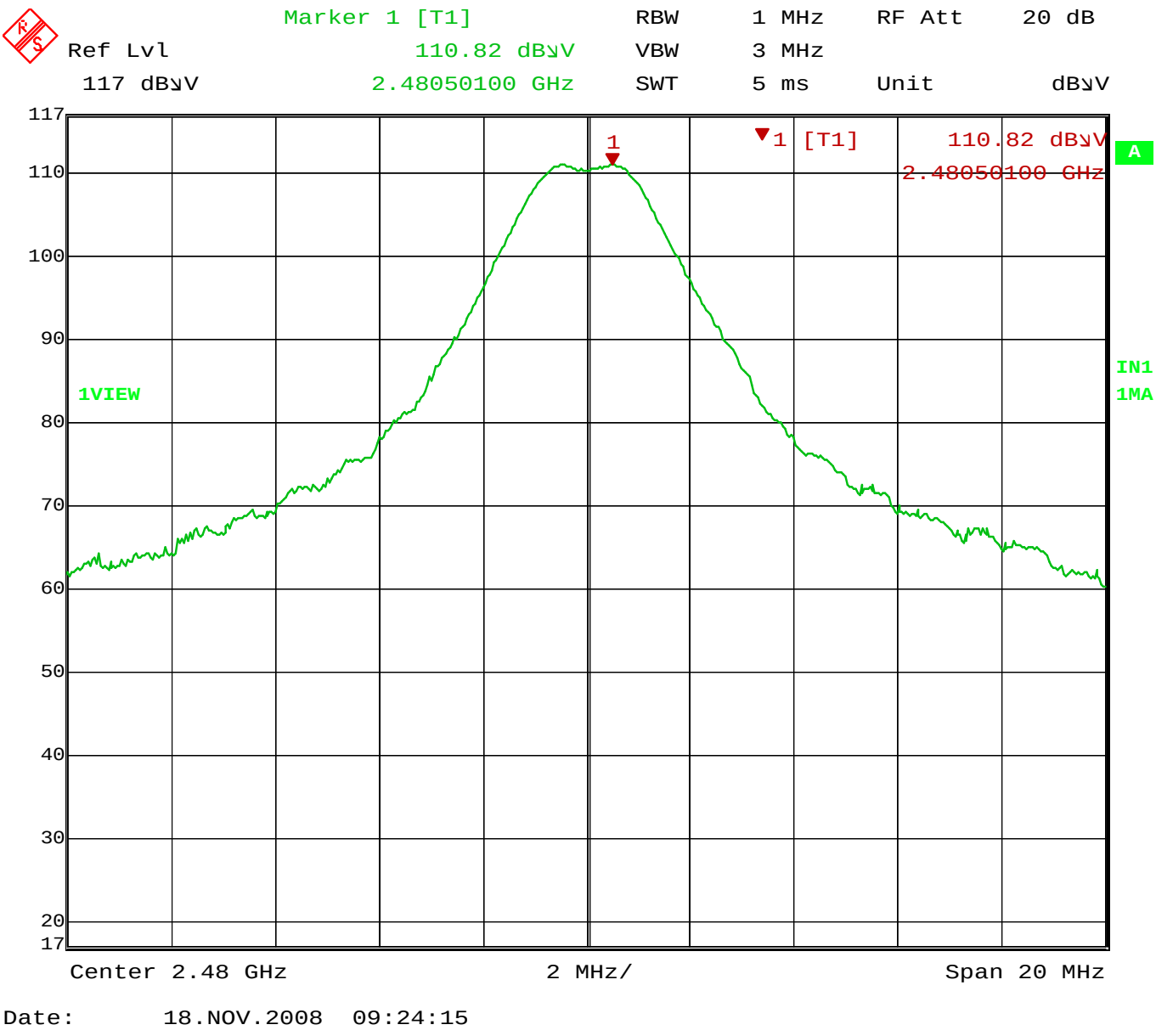


Figure 26 – Channel 26 Fundamental

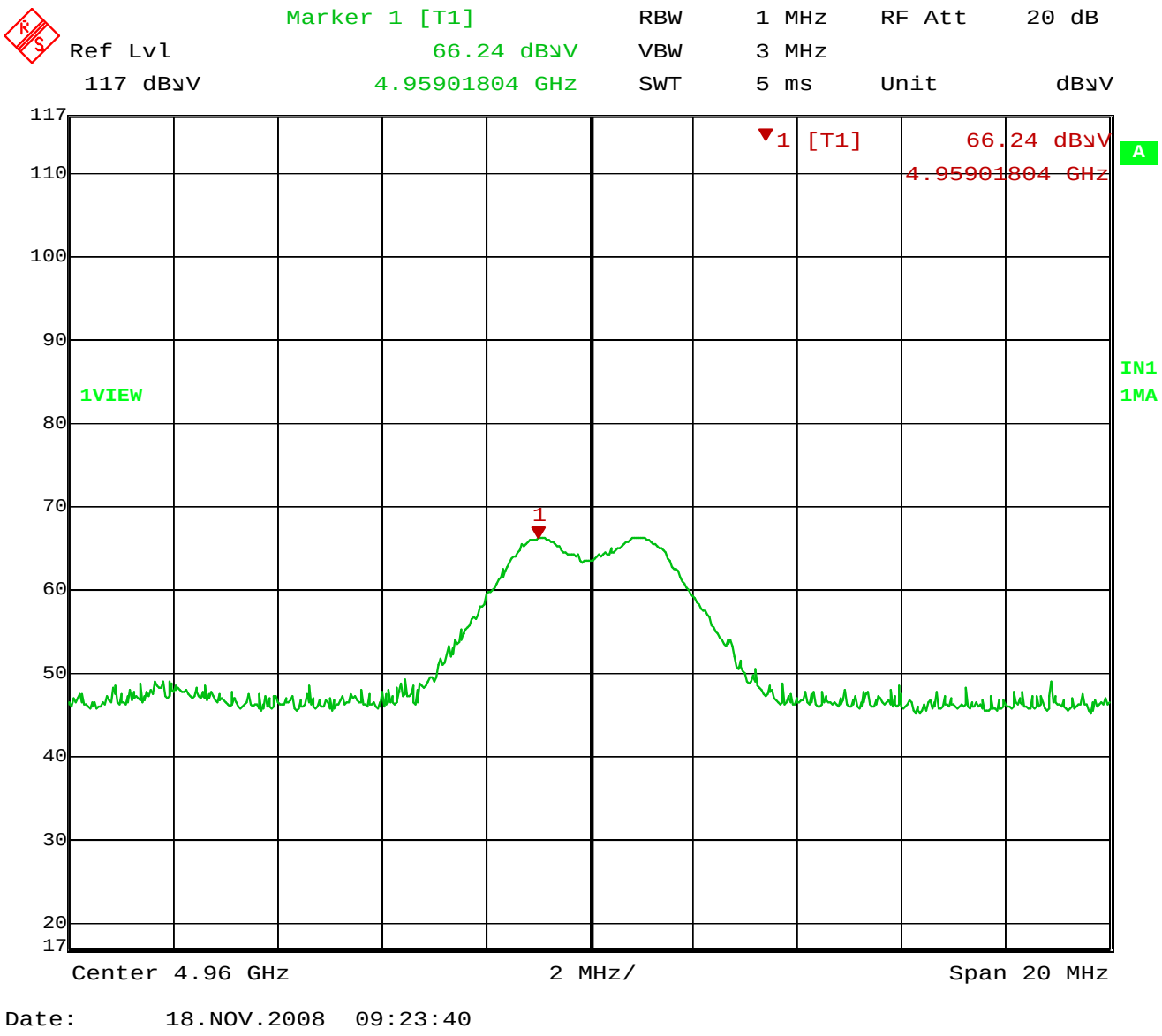


Figure 27 – Channel 26 Harmonic

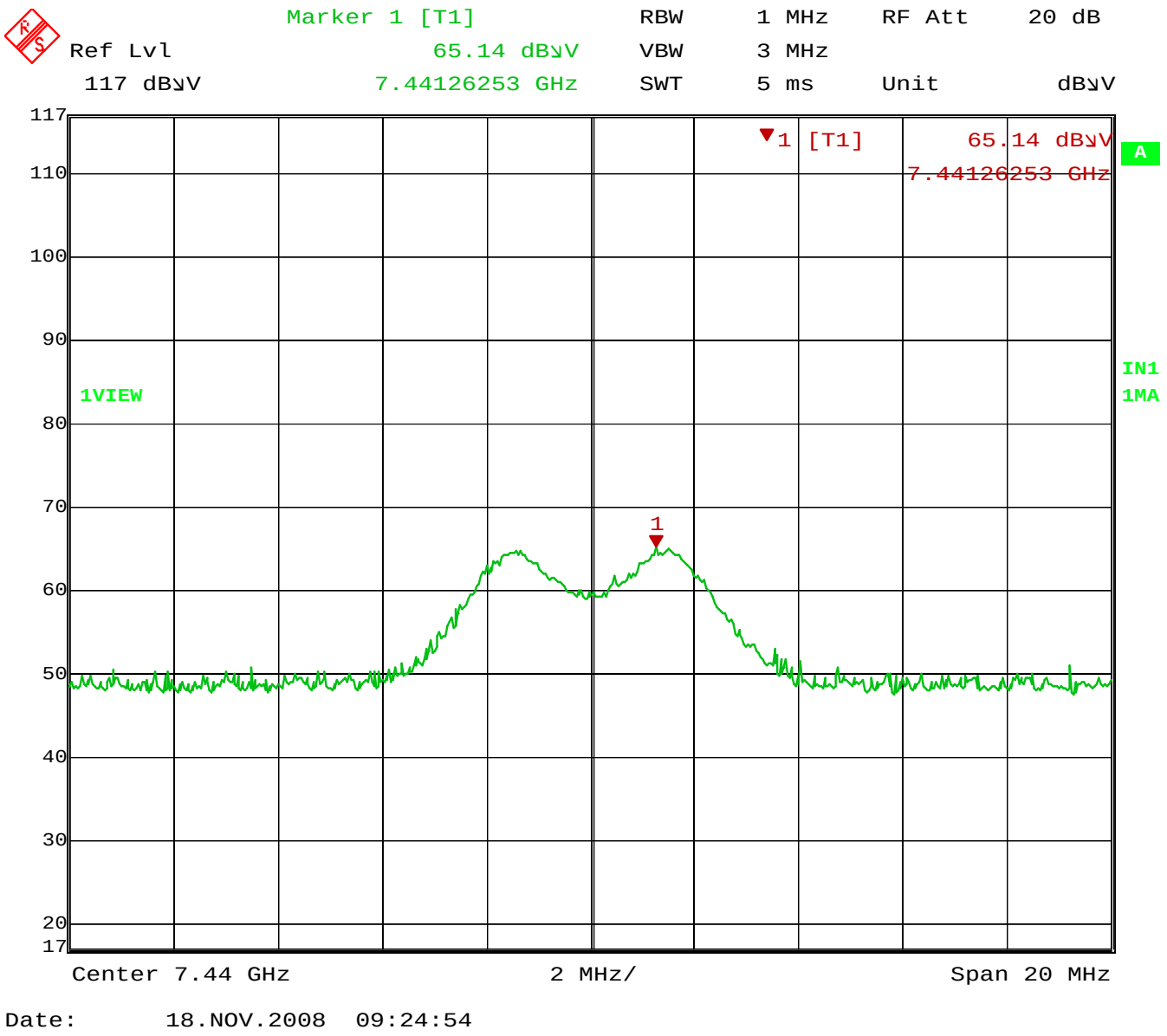


Figure 28 – Channel 26 Harmonic

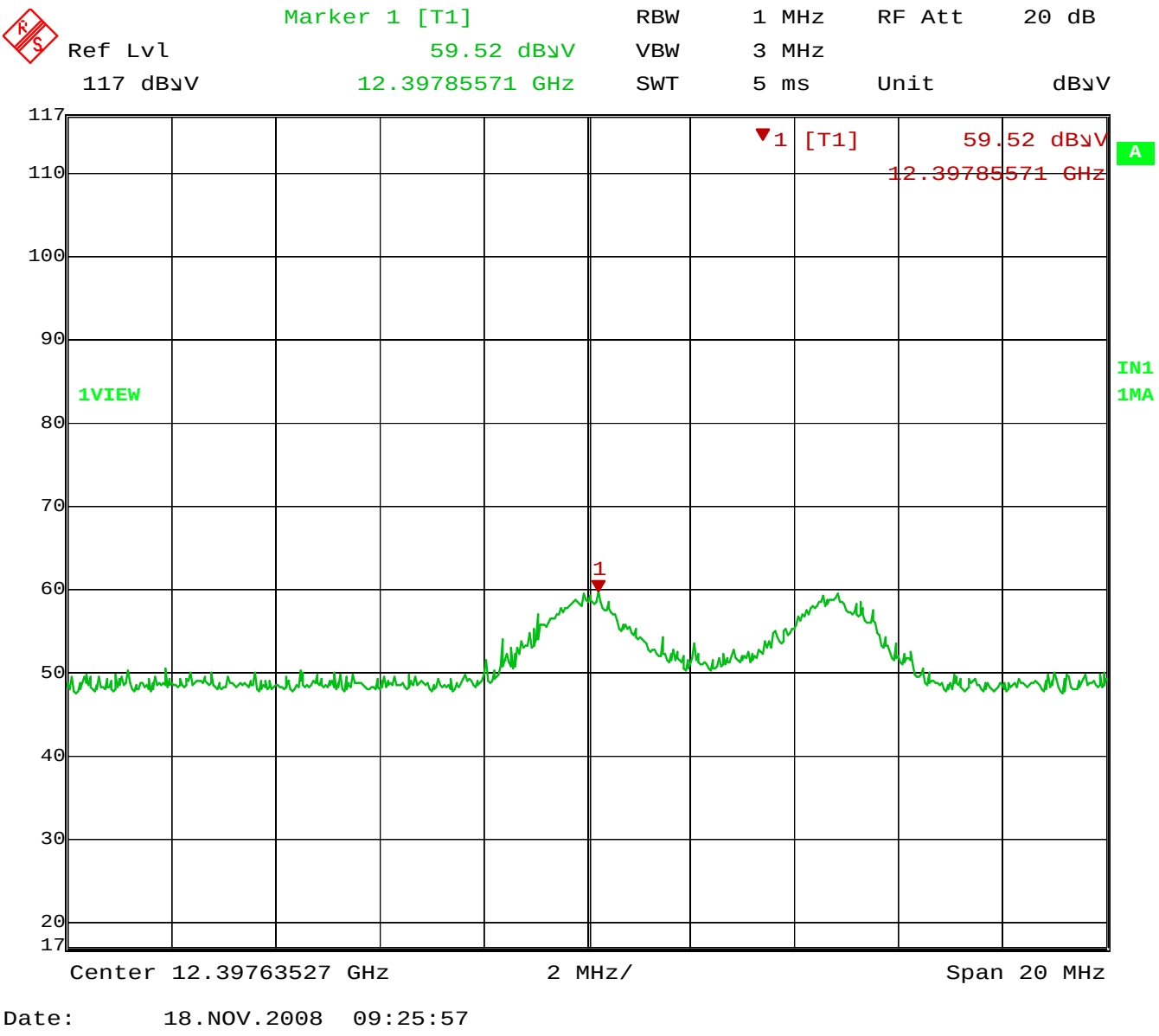


Figure 29 – Channel 26 Harmonic

4.6.7 Tabulated Test Data

In accordance with FCC 15.33 if the intentional radiator operates below 10 GHz, radiated emissions shall be measured to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower. The EUT operates in the 2.4 GHz region and therefore was investigated up to 26 GHz.

Any harmonic emission that was indistinguishable from the noise floor was not recorded in this test report.

Radiated Emissions Measurements												
Standard:	47 CFR 15.209(a)							Final			***Date:***	3/17/2009
Device Tested:	SensorSwitch							3.0m			***File:***	30860229
	Measured Level											
Meas #	Freq (MHz)	Peak	Average	Peak Limit	Peak Δ	Avg Limit	Avg Δ	Result	Polarization	Angle (degrees)	Antenna Height (meters)	Comment
1	2405.0000	110.06		74.00	36.06	54.00	-54.00	**Fundamental**	Vertical	0	1.00	
2	4810.0000	64.31	50.12	74.00	-9.69	54.00	-3.88	**Complied**	Vertical	0	1.00	
3	7215.0000	65.02	51.59	74.00	-8.98	54.00	-2.41	**Complied**	Vertical	0	1.00	
4	9620.0000	39.60	39.06	74.00	-34.40	54.00	-14.94	**Complied**	Vertical	0	1.00	Noise Floor
5	12022.0000	58.94	44.85	74.00	-15.06	54.00	-9.15	**Complied**	Vertical	0	1.00	
6	2440.0000	110.50		74.00	36.50	54.00	-54.00	**Fundamental**	Vertical	0	1.00	
7	4879.0000	65.42	51.27	74.00	-8.58	54.00	-2.73	**Complied**	Vertical	0	1.00	
8	7318.0000	65.39	51.18	74.00	-8.61	54.00	-2.82	**Complied**	Vertical	0	1.00	
9	9758.0000	40.12	40.12	74.00	-33.88	54.00	-13.88	**Complied**	Vertical	0	1.00	Noise Floor
10	12197.0000	59.71	46.57	74.00	-14.29	54.00	-7.43	**Complied**	Vertical	0	1.00	
11	2480.0000	110.82		74.00	36.82	54.00	-54.00	**Fundamental**	Vertical	0	1.00	
12	4959.0000	66.24	52.62	74.00	-7.76	54.00	-1.38	**Complied**	Vertical	0	1.00	
13	7441.0000	65.14	51.59	74.00	-8.86	54.00	-2.41	**Complied**	Vertical	0	1.00	
14	9921.0000	39.89	39.89	74.00	-34.11	54.00	-14.11	**Complied**	Vertical	0	1.00	Noise Floor
15	12397.0000	59.52	46.25	74.00	-14.48	54.00	-7.75	**Complied**	Vertical	0	1.00	

Table 4 – Spurious Emissions

4.6.8 Photos

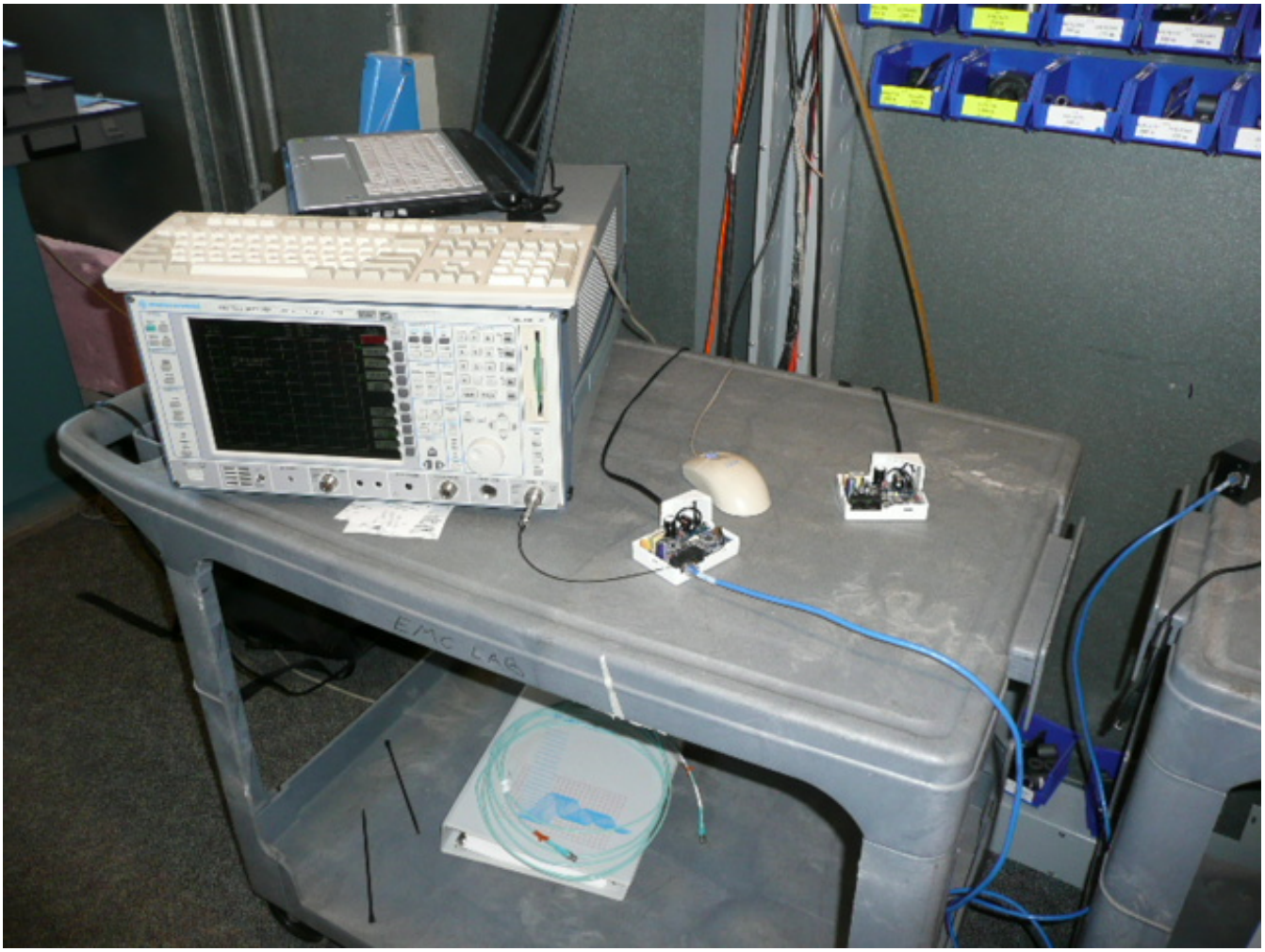


Figure 30 – Conducted Spurious Emissions Test Setup

Figure 31 - Radiated Spurious Emissions Test Setup (Radiated Prescan- Semi Anechoic Chamber)

Figure 32 - Radiated Spurious Emissions Test Setup (Radiated Final Test - OATS)

4.7 Transmitter Power Density Spectrum

4.7.1 Test Over View

Results	**Complies** (as tested per this report)				**Date**	11/17/2008	
Standard	FCC Part 15.215 (b)						
Product Model	Transceiver			**Serial#**	Ts **1**		
Configuration	See test plan for details						
Test Set-up	EUT placed on table See test plan for details						
EUT Powered By	AC/DC Adapter & Batteries	**Temp**	22ºC	**Humidity**	45%	**Pressure**	998mbar
Frequency Range	2.405GHz - 2.480GHz @ 3m						
Perf. Criteria	8dBm in a 3kHz BW			**Perf. Verification**	Readings under Limit		
Mod to EUT	None			**Test Performed By**	Randy Masline		

4.7.2 Test Procedure

In accordance with Measurements of Digital Transmission Systems Operating under Section 15.274

Power Output Option 1 and PSD Option 1 were used as measurement guidelines.

The Radiated Power Density was performed using a 1 second interval over a 3kHz bandwidth within each band.

The frequency range from 2.405-2.480 GHz was investigated for radiated emissions, testing the lowest middle and highest channels

4.7.3 Deviations

There were no deviations from the test methodology listed in the test plan for the Transmitter Power Density Spectrum test.

4.7.4 Final Test

The EUT met the performance criteria requirement as specified in the test plan of this report and in the standards.

4.7.5 Test Results

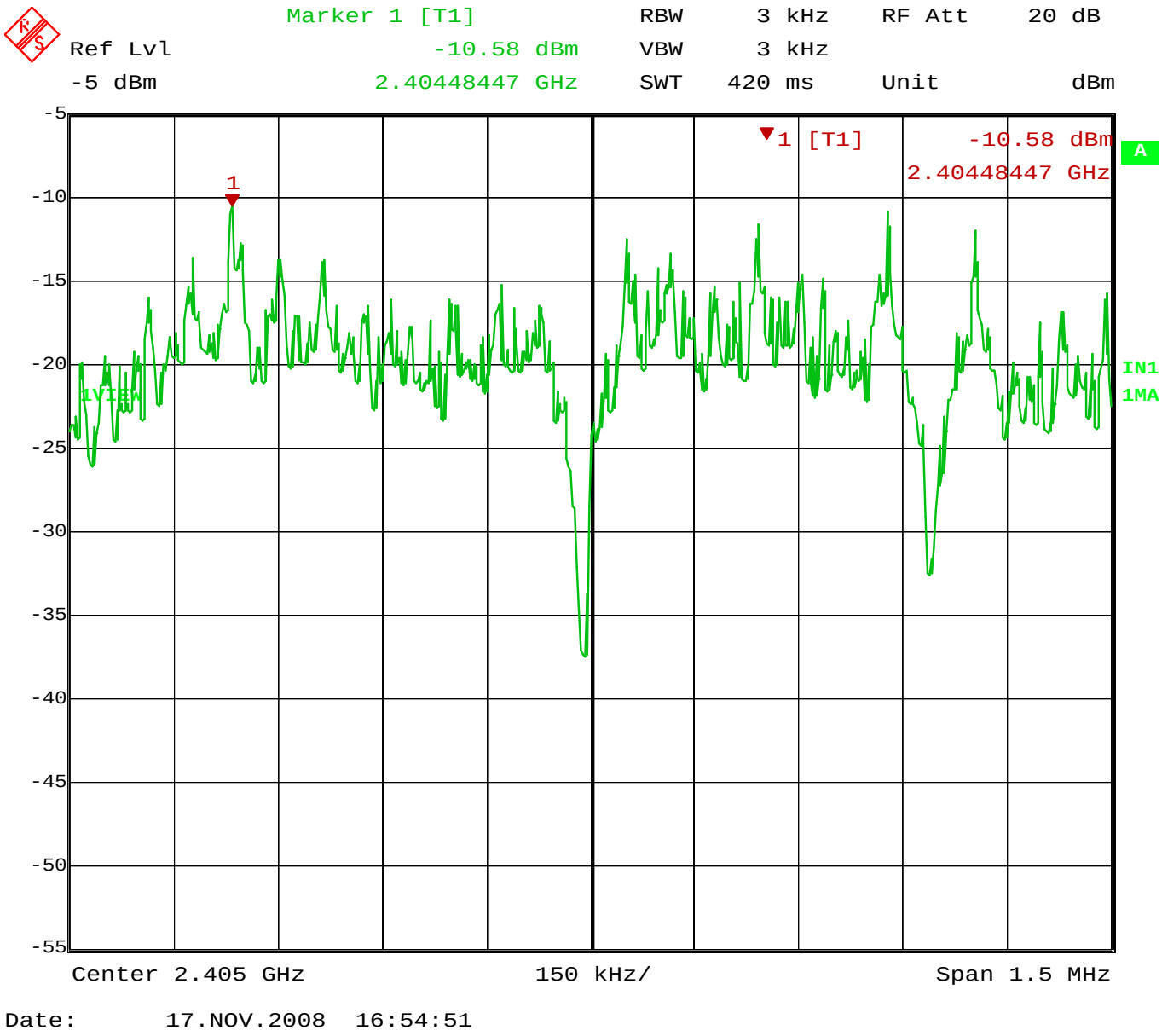


Figure 33 – Channel 11 (lowest)

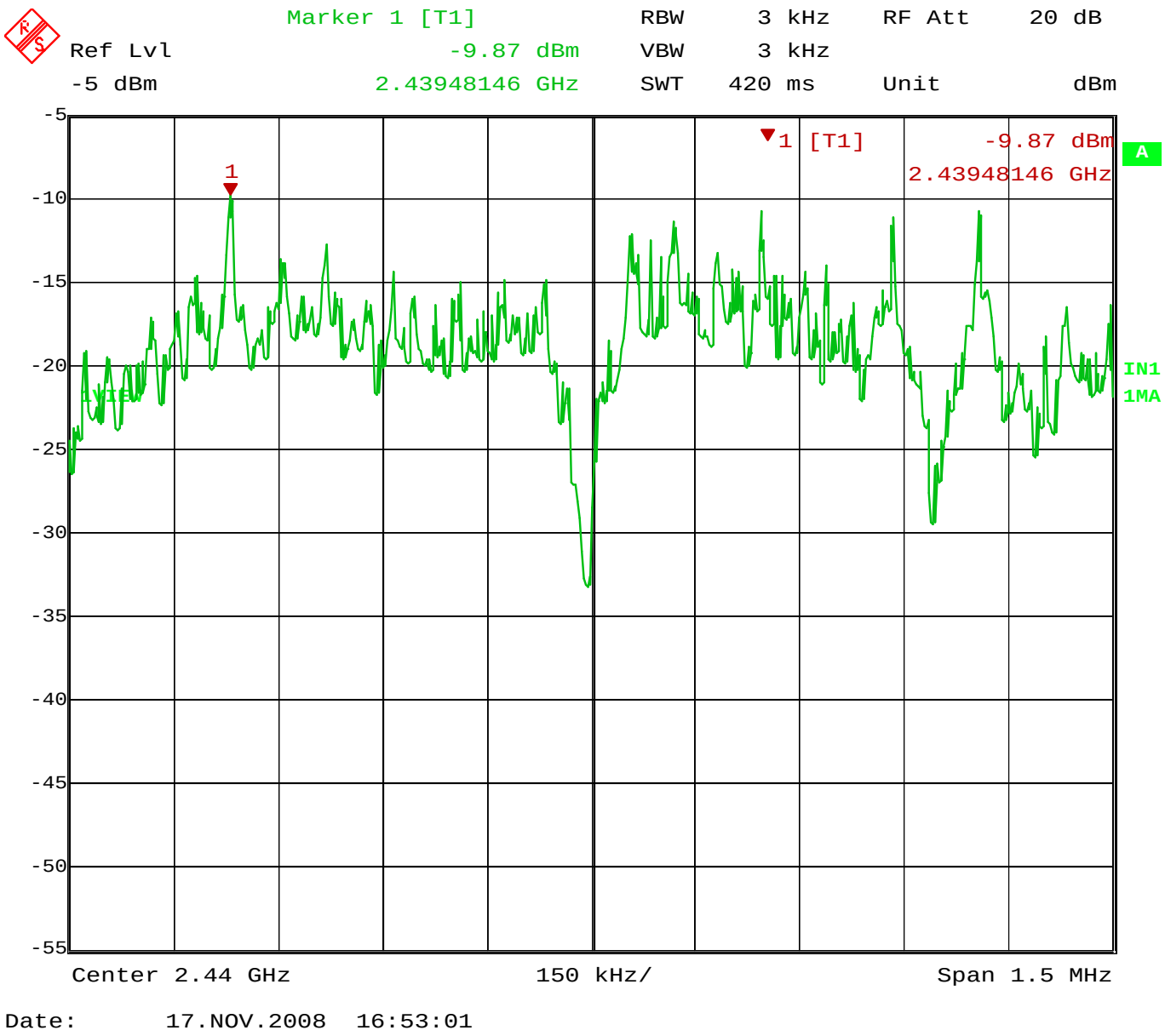


Figure 34 – Channel 18 (mid)

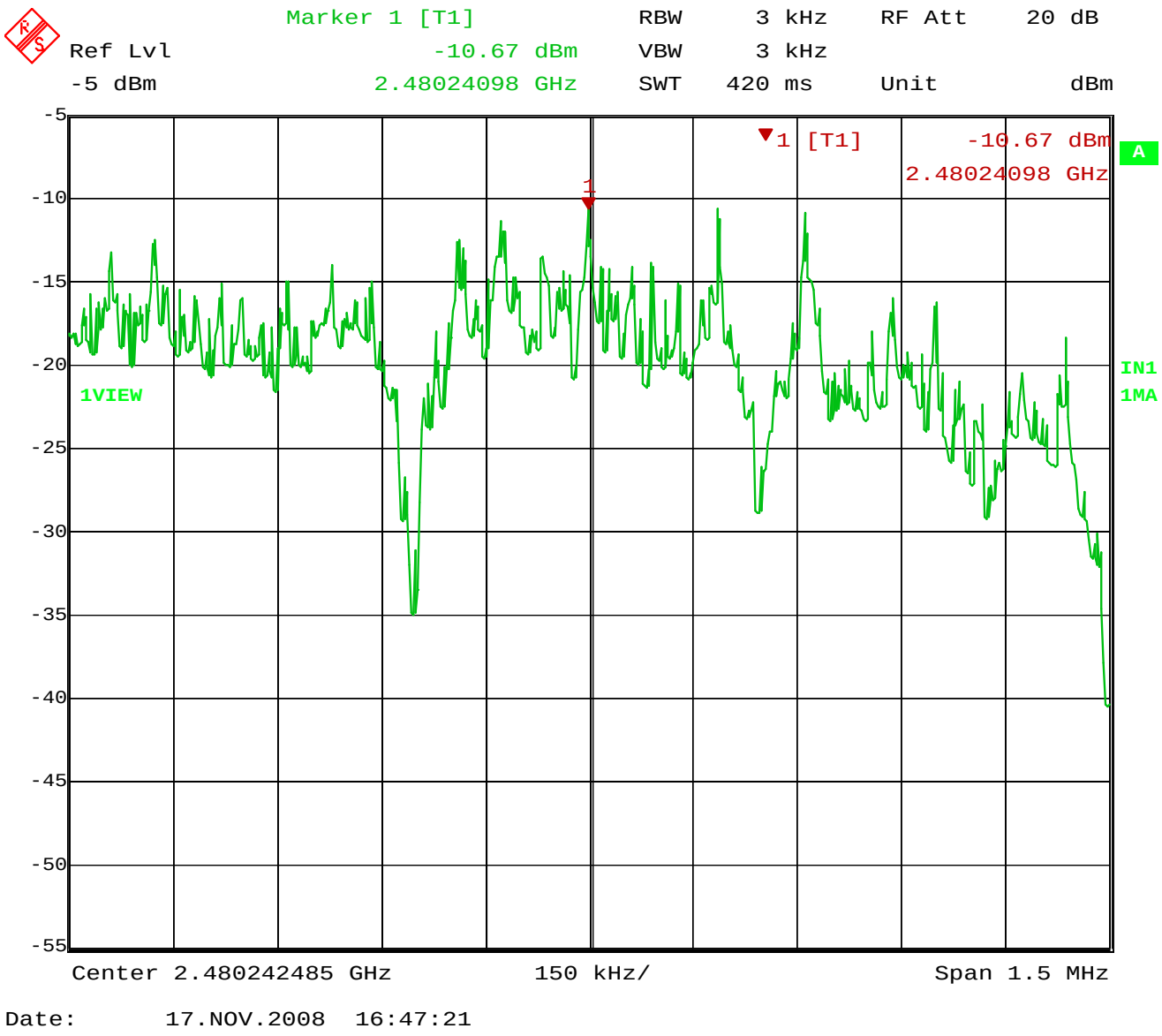


Figure 35 – Channel 26 (highest)

4.7.6 Tabulated Test Data

Channel	Frequency (MHz)	RF Power Level In 3 kHz (dBm)	Limit (dBm)	Result
11	2405	**- 10.58**	8.0	**Complies**
18	2440	**-9.87**	8.0	**Complies**
26	2480	**-10.67**	8.0	**Complies**

Table 5 – Power Spectral Density

4.7.7 Photos

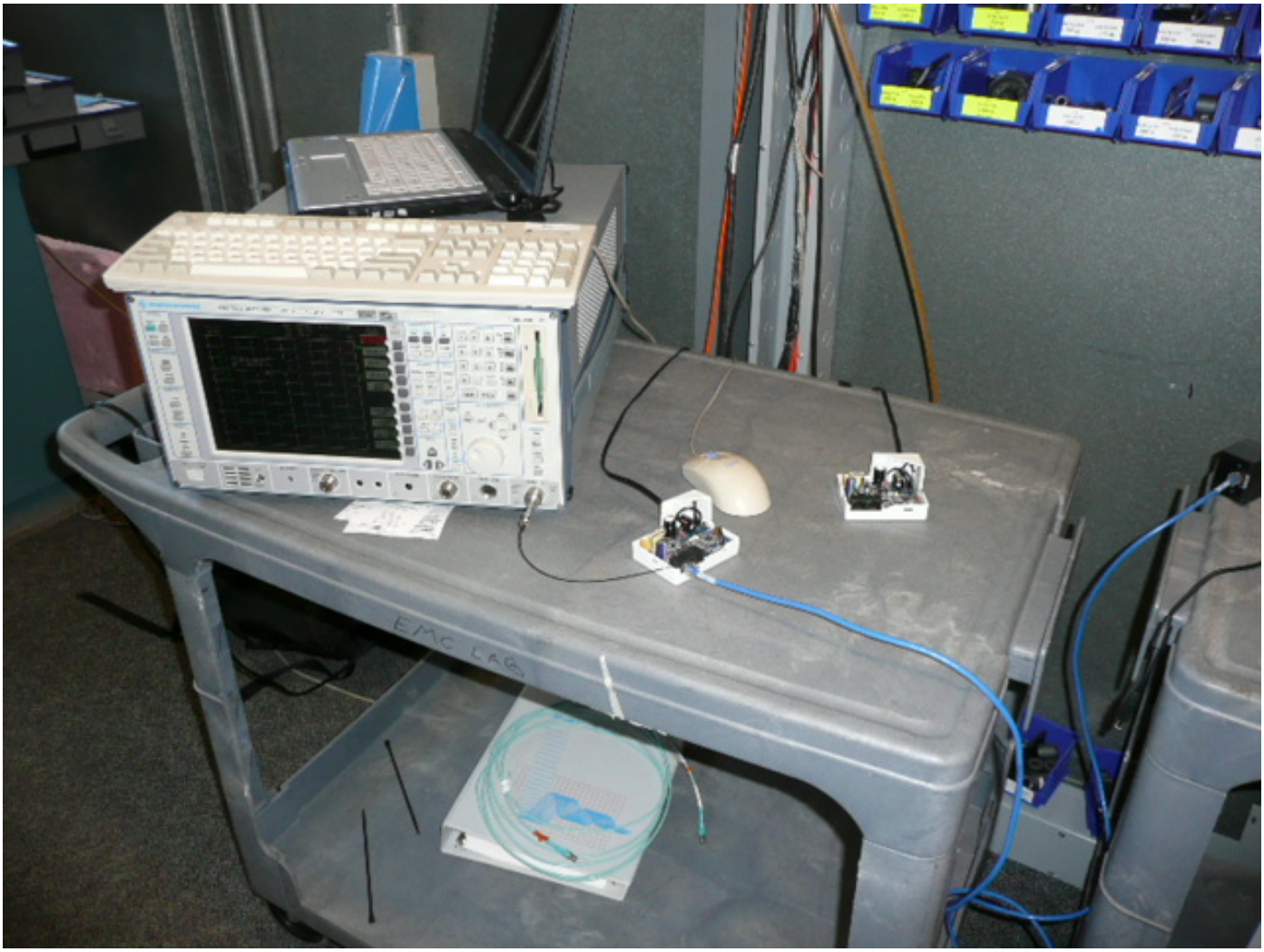


Figure 36 – Transmitter Power Density Spectrum

4.8 Conducted Emissions

This test measures the electromagnet levels of spurious signals generated by the EUT on the AC power line that may affect the performance of other near by electronic equipment.

4.8.1 Test Over View

Results	**Complies** (as tested per this report)				**Date**	11/18/2008	
Standard	FCC Part 15.207						
Product Model	Transceiver			**Serial#**	Ts **1**		
Configuration	See test plan for details						
Test Set-up	Tested in shielded room EUT placed on table						
EUT Powered By	AC/DC Adapter & Batteries	**Temp**	22ºC	**Humidity**	45%	**Pressure**	998mbar
Frequency Range	120V/60Hz, 0150-30MHz						
Perf. Criteria	FCC Part 15.207 (a)	**Perf. Verification**	Readings Under Limit for L1 and L2				
Mod. to EUT	None	**Test Performed By**	Randy Masline				

4.8.2 Test Procedure

Conducted and FCC emissions tests were performed using the procedures of ANSI C63.4 including methods for signal maximizations and EUT configuration. The photos included with the report show the EUT in its maximized configuration.

The frequency range from 0.15 to 30 MHz was investigated for conducted emissions.

Conducted Emissions measurements were performed in the shielded room using procedures specified in the test plan and standard.

4.8.3 Deviations

There were no deviations from the test methodology listed in the test plan for the conducted emission test.

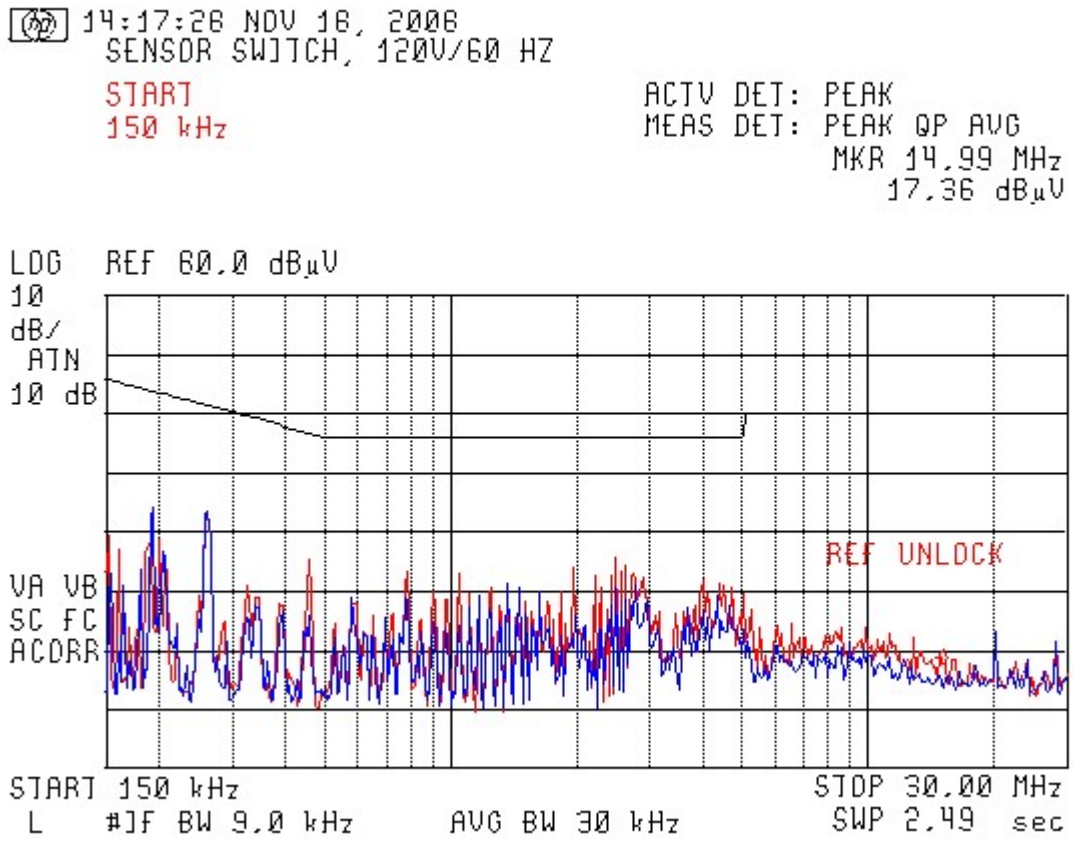
4.8.4 Final Test

All final conducted emissions measurements were below (in compliance) the limits.

4.8.5 Final Graph

NOTES:

Conducted Emissions @ 120V/60Hz



ANTENNA/COUPLER:

☐ 9124 Bicon	☐ 3109 Bicon	☐ CBL6140 X-Wing	☐ NNB-4/63TL LISN
☐ 3146 Log Per	☐ 3115 Horn	☐ JB3 Bilog	☐ NNB-4/200X LISN
☐ 3106 Horn	☐ CBL6112B Bilog	☐ NSLK 8126 LISN	☐ MDS–21 Clamp

MEAS TYPE:	POLARIZATION:	DISTANCE:	LOCATION:
☐ Radiated Prescan	☐ Vertical	☐ 3 Meter	☐ OATS
☐ Radiated Final	☐ Horizontal	☐ 10 Meter	☐ Semi-Anechoic
☒ Conducted	☒ Line	☐ ____Meter	☒ Shielded Room
☐ Disturbance Power	☒ Neutral	☒ NA	☐ Factory Floor
☐ Other_____	☐ NA		☐ Other_____

4.8.6 Final Tabulated Data at 120V/60Hz

Conducted Emissions Measurements											
Standard:	EN55022:1998, Class B/FCC Part 15.207 (a)								***Date:***	11/18/2008	
Device Tested:	Sensor Switch Transceiver								***File: .xls***	30860299	
Signal Num	Freq	QP Amp	Avg Amp	QP Limit	Avg Limit	Conductor	QP Δ	QP Result	Avg Δ	Average Result	Mode
	MHz	dBuV	dBuV	dBuV	dBuV		dB		dB		
1	0.2640	40.70	33.50	61.30	51.30	Neutral	-20.60	Complied	-17.80	Complied	
2	0.1970	44.00	32.60	63.74	53.74	Neutral	-19.74	Complied	-21.14	Complied	
3	0.3300	34.10	25.90	59.45	49.45	Neutral	-25.35	Complied	-23.55	Complied	
4	0.4600	33.30	26.20	56.69	46.69	Neutral	-23.39	Complied	-20.49	Complied	
5	2.5700	3.70	27.00	56.00	46.00	Neutral	-52.30	Complied	-19.00	Complied	
6	1.1200	35.10	27.70	56.00	46.00	Line	-20.90	Complied	-18.30	Complied	
7	0.1980	43.30	32.60	63.69	53.69	Line	-20.39	Complied	-21.09	Complied	
8	0.2630	39.50	34.50	61.34	51.34	Line	-21.84	Complied	-16.84	Complied	
9	**0.5930**	**34.10**	**30.00**	**56.00**	**46.00**	**Line**	**-21.90**	**Complied**	**-16.00**	**Complied**	**Maximum Emissions**
10	2.4360	37.50	29.70	56.00	46.00	Line	-18.50	Complied	-16.30	Complied	

4.8.7 Photos

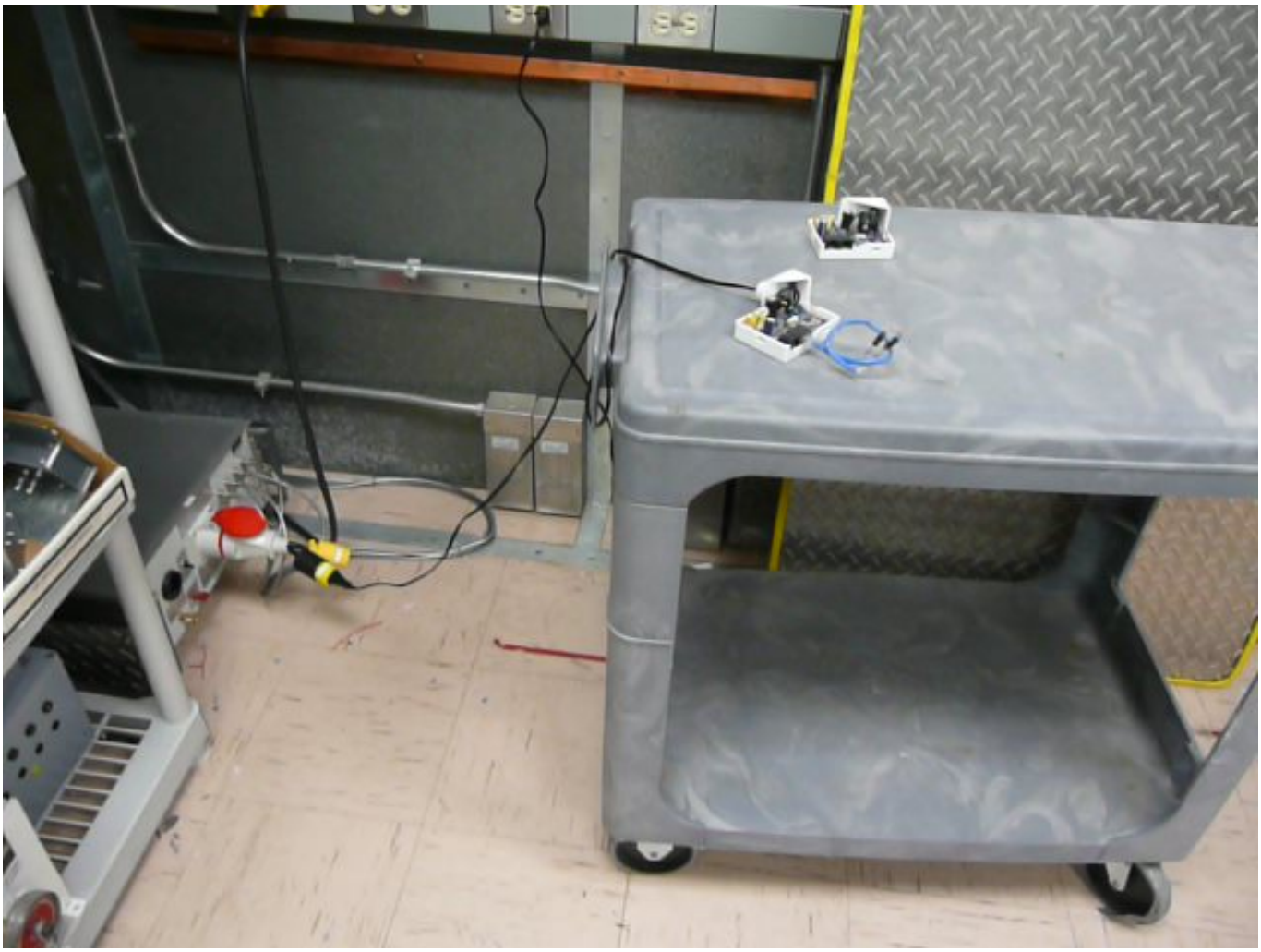


Figure 37 –Conducted Emissions Test Setup

4.9 Frequency Stability

This test is to evaluate the performance of the EUT when subjected to temperature and voltage changes

4.9.1 Test Over View

Results	**Complies** (as tested per this report)				**Date**	11/19/2008	
Standard	FCC Part 15.215						
Product Model	Transceiver			**Serial#**	Ts **1**		
Configuration	See test plan for details						
Test Set-up	Tested in shielded room. See test plans for details						
EUT Powered By	120VAC/60Hz	**Temp**	22ºC	**Humidity**	45%	**Pressure**	998mbar
Frequency Range	2.405 GHZ – 2.480GHz		**Temperature Range**		0°C – 70°C		
Perf. Criteria	Containment of 20dB of frequency range		**Perf. Verification**		Readings under Limit		
Mod to EUT	See section 5.5		**Test Performed By**		Randy Masline		

4.9.2 Test Procedure

EUT was place in a temperature chamber. Frequency and output power level were measured at room temperature. Temperature in the chamber was increased to 70°C and maintained till the EUT reached that temperature. Frequency and level was measured again. EUT was placed into a temperature chamber and temperature was set to 0 °C. Temperature was maintained till the EUT reached that temperature. Frequency and level were measured again.

4.9.3 Deviations

There were no deviations from the test methodology listed in the test plan for the frequency stability test.

4.9.4 Final Test

The EUT met the performance criteria requirement as specified in the test plan of this report and in the standards.

4.9.5 Summary of Final Test Results

Radiated Emissions Measurements - Frequency Stability Test					
Standard:	47 CFR 15.247 (d)			***Date:***	11/19/2008
Device Tested:	Sensor Switch - Transceiver			***File:***	Freq. Stability.xls
Test Variation:	Temperature Variation				
Meas #	- 20dB Freq (MHz)	Limit Freq (MHz)	Frequency Δ (MHz)	Result	Comment
Low Bandedge					
22°	2403.70	2400.00	3.70	**Complied**	
0 °		2400.00	-2400.00	**Complied**	
70°		2400.00	-2400.00	**Complied**	
High Bandedge					
22°	2481.30	2483.50	-2.20	**Complied**	
0 °		2483.50	-2483.50	**Complied**	
70°		2483.50	-2483.50	**Complied**	
Tested by:	Randy Masline				
TUV Rheinland of North America, Inc.	12 Commerce Road		Newtown, CT 06470	Tel:(203) 426-0888	Fax: (203) 426-4009

Radiated Emissions Measurements - Frequency Stability Test					
Standard:	47 CFR 15.247 (d)			***File:***	Freq. Stability.xls
Device Tested:	Sensor Switch - Transceiver				
Test Variation:	Voltage				
				Result	Comment
Meas #	- 20dB Freq (MHz)	Limit Freq (MHz)	Frequency Δ (MHz)	Result	
Low Bandedge					
120VAC	2403.70	2400.00	3.70	**Complied**	
102VAC (-15%)		2400.00	-2400.00	**Complied**	
138VAC (+15%)		2400.00	-2400.00	**Complied**	
High Bandedge					
120VAC	2481.30	2483.50	-2.20	**Complied**	
102VAC (-15%)		2483.50	-2483.50	**Complied**	
138VAC (+15%)		2483.50	-2483.50	**Complied**	
Tested by:	Randy Masline				
TUV Rheinland of North America, Inc.	12 Commerce Road		Newtown, CT 06470	Tel:(203) 426-0888	Fax: (203) 426-4009

4.9.6 Photos

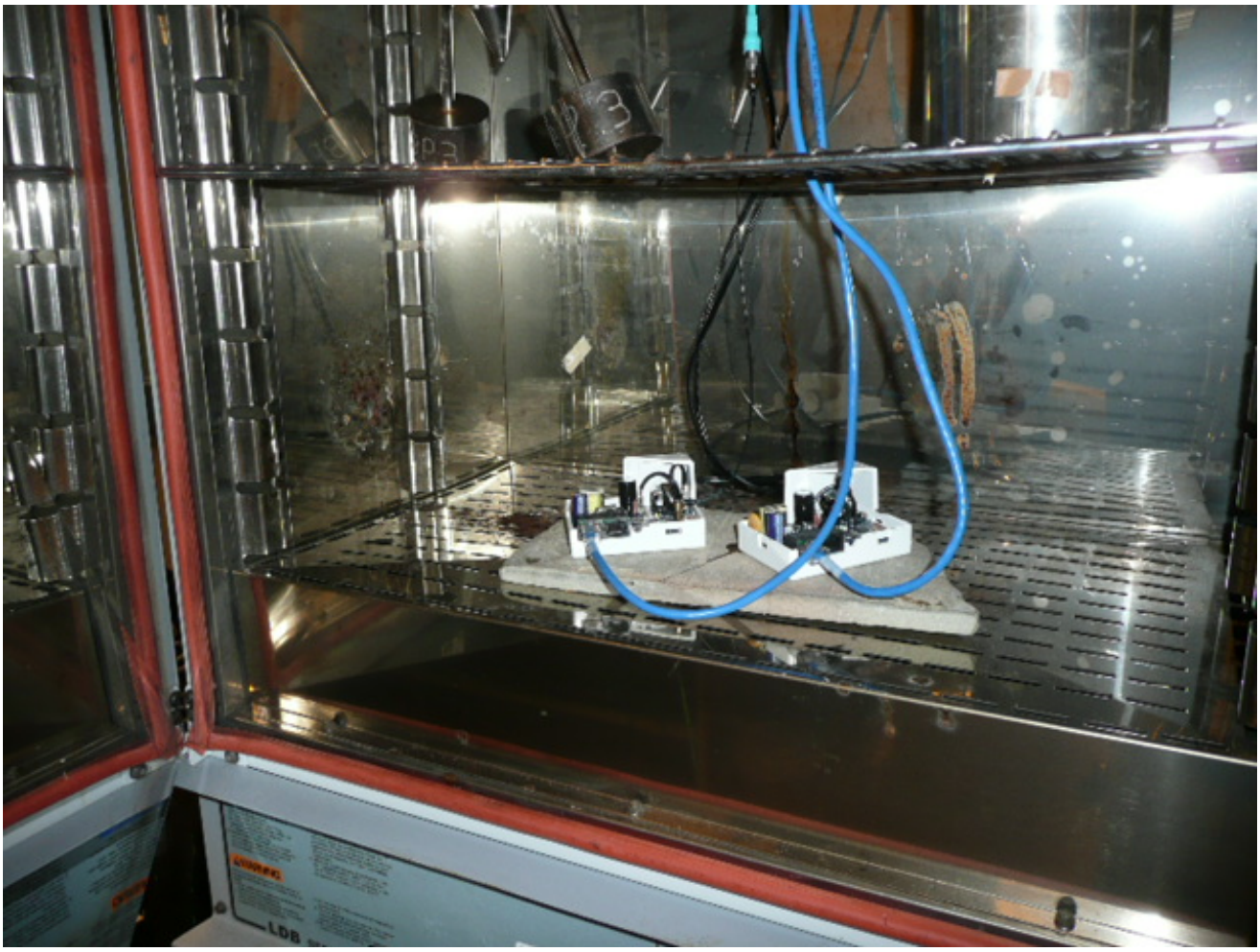


Figure 38 –Frequency Stability Test Setup – Temperature Chamber

Appendix A

5 Test Plan

This test report is intended to follow this test plan outlined here in unless other wise stated in this here report. The following test plan will give details on product information, standards to be used, test set ups and refer to TUV test procedures. The test procedures will give the steps to be taken when performing the stated test. The product information below came via client, product manual, product itself and or the internet.

5.1 General Information

Client	Sensor Switch, Inc.
Address	900 Northrop Road
Address	Wallingford, CT 06492
Contact Person	William J Fassbender
Telephone	(203) 265-2842
Fax	(203) 265-1565
email	fozzy@sensorswitch.com

5.2 Model(s) Name

Transceiver

5.3 Type of Product

Lighting Control System

5.4 Equipment Under Test (EUT) Description

The EUT is a wireless foot pedal used for various applications in the industrial environment. The wireless system eliminates the nuisance of wires under foot while invisible waves fill a room with 360° of signal. The EUT consist of a wireless foot pedal transmitter and a receiver; one (the transmitter) used with batteries and one (the receiver) used with an AC/DC adapter. The receiver also sends a signal every second to control de antenna output power of the transmitter.

5.5 Modifications

Software Change to comply with the frequency stability test.

5.6 Product Environment

☐	**Residential**	☐	**Hospital**
☒	**Light Industrial**	☐	**Small Clinic**
☐	**Industrial**	☐	**Doctor's office**
☐	**Other**		

*Check all that apply

5.7 Countries

☒	**USA**
☐	**Taiwan**
☐	**Japan**
☐	**Europe**

*Check all that apply

5.8 Applicable Documents

Standard	Description
FCC Part 15	Rado Frquency Devices -Part C
FCC Part 15.247 (a) (2)	Spectrum Bandwith of a Direct Sequence Spread Spectrum System
FCC Part 15.247 (b)	Maximum Output Power
FCC Part 1.1310	RF Human Exposure Limit
FCC Part 15.247 (c), 15.205, 15.209	Radiated Spurious Emissions
FCC Part 15.247 (d)	Transmitter Power Density of a Direct Sequence Spread Spectrum System
FCC Part 15.207	Conducted Emissions
FCC Part 15.215 (b)	Frequency Stability

5.9 General Product Information

Size (Transmitter)	**H**	5cm	**W**	15cm	**L**	15cm
Weight (Transmitter)	0.5		**Fork-Lift Needed**		No	
Notes	None					

5.10 EUT Powered Information

5.10.1 Power Type

☒	**AC**	☐	**DC**	☐	**Batteries**	☐	**Host -**

5.10.2 Power Information

Name	**Type**	**Voltage**		**Frequency**	**Current**	**Notes**
		min	**max**			
	Class 1	110	277	50/60Hz	500mA	
Notes						

5.11 EUT Modes Of operation

The receiver was constantly on, receiving signals from the transmitter.

5.12 EUT Configurations

Configuration	Description
Configuration 1	Transmitter was on all the time
Note: all configurations are the same except as noted above	

5.13 EUT Clock/Oscillator Frequencies

☐	**Less than 108MHz**	**FCC – scan up to 1GHz**
☐	**Less than 500MHz**	**FCC – scan up to 2GHz**
☐	**Less than 1000MHz**	**FCC – scan up to 5GHz**
☒	**Greater then 1000MHz**	**FCC – scan up to 5th Harmonic or 40GHz (2.4GHz)**

5.14 Electrical Support Equipment

Type	Manufacture	Model	Connected To
NA	NA	NA	NA

Non - Electrical Support Equipment

Item	Notes
NA	NA

5.15 EUT Equipment/Cabling Information

EUT Port	Connected To	Location	Cable Type		
			Length	Shielded	Bead
AC	AC Mains	Tx/ Rx	1.5m	No	No

5.16 EUT Grounding

☒	**None**
☐	**AC line cord – third wire**
☐	**Via host I/O cable**
☐	**Other**

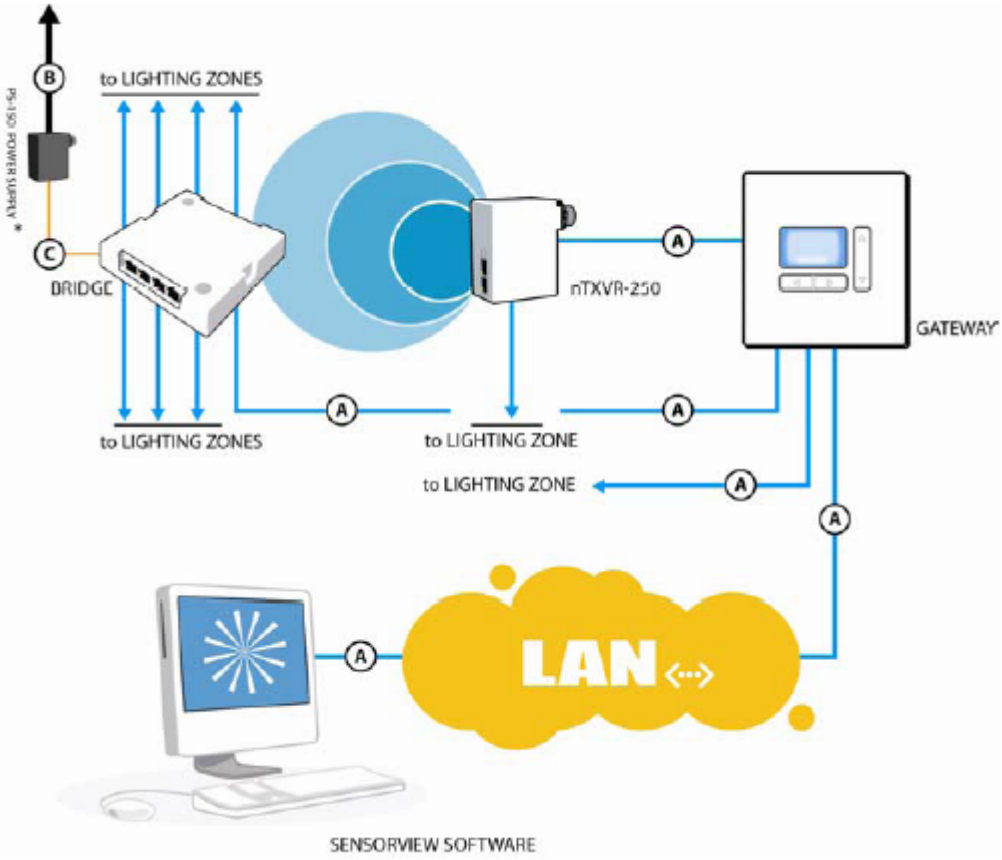
5.17 EUT Test Program

None

5.18 Monitoring of EUT during Testing

During the test the EUT was monitored by a spectrum analyzer connected to the antenna output, ensuring transmitting operation.

5.19 EUT Configuration Block Diagram



5.20 Constructional Data Form

TUV Rheinland D-51101 Köln 91 Am Grauen Stein/ Konstantin-Wille-Str. 1	Please submit in duplicate		
	Gen-Ausw-Nr.	Aktenzeichen: 30860299.001 Sensor Switch - Transceiver	Anlage-Nr. 1 of 1

EMC/EMV
Constructional Data Form

Item Listing No. & Location in EUT	Component / Sub-Assembly	Part No. & Description	Freq.; Rated ERP/Atten.
1.0	Enclosure	Plastic	NA
2.0	Antenna	AN -A2	1.443dBi

TUV Rheinland Prüfstelle für Gerätesicherheit	Applicant	
Köln, den:	Ort/place:	Datum/date:
(report copy not signed)	(report copy not signed)	
TUV Rheinland Prüfstelle für Gerätesicherheit	(Stempel und Unterschrift des Antragstellers/ stamp and signature of applicant)	