Test of: Radwin Ltd RADWIN 2000 JET, RADWIN 5000 JET

To: FCC 47 CFR Part 90, Subpart Y; IC RSS-111

Test Report Serial No.: RDWN47-U1 Rev A

TEST REPORT

FROM

Test of Radwin Ltd RADWIN 2000 JET, RADWIN 5000 JET

To FCC 47 CFR Part 90, Subpart Y; IC RSS-111

Test Report Serial No.: RDWN47-U1 Rev A

This report supersedes NONE

Manufacturer: RADWIN Ltd
27 Habarzel Street
Tel Aviv, 69710
Israel

Product Function: 5 GHz Beamforming Outdoor Radio Device

Copy No: pdf **Issue Date:** 26th November 2017

This Test Report is Issued Under the Authority of;

MiCOM Labs, Inc.
575 Boulder Court
Pleasanton, CA 94566 USA
Phone: +1 (925) 462-0304
Fax: +1 (925) 462-0306
www.micomlabs.com

ACCREDITED
TESTING CERT #2381.01

MiCOM Labs is an ISO 17025 Accredited Testing Laboratory

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ACCREDITATION, LISTINGS & RECOGNITION

1.1. Testing Accreditation

MiCOM Labs, Inc. is an accredited Electrical testing laboratory per the international standard ISO/IEC 17025:2005. The company is accredited by the American Association for Laboratory Accreditation (A2LA) www.a2la.org test laboratory number 2381.01. MiCOM Labs test schedule is available at the following URL; http://www.a2la.org/scopepdf/2381-01.pdf

ilac-MRA A2LA

Accredited Laboratory

A2LA has accredited

MICOM LABS

Pleasanton, CA

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 *General requirements for the competence of testing and calibration laboratories*. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009*).

Presented this 4th day of February 2016.

Senior Director of Quality & Communications
For the Accreditation Council
Certificate Number 2381.01
Valid to November 30, 2017

For the tests or types of tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.

1.2. Recognition

MiCOM Labs, Inc has widely recognized wireless testing capabilities. Our international recognition includes Conformity Assessment Body designation by APEC MRA countries. MiCOM Labs test reports are accepted globally.

Country	Recognition Body	Status	Phase	Identification No.
USA	Federal Communications Commission (FCC)	TCB	-	US0159 Listing #: 102167
Canada	Industry Canada (IC)	FCB	APEC MRA 2	US0159 Listing #: 4143A-2 4143A-3
Japan	MIC (Ministry of Internal Affairs and Communication)	CAB	APEC MRA 2	RCB 210
	VCCI	--	--	A-0012
Europe	European Commission	NB	EU MRA	NB 2280
Australia	Australian Communications and Media Authority (ACMA)	CAB	APEC MRA 1	US0159
Hong Kong	Office of the Telecommunication Authority (OFTA)	CAB	APEC MRA 1	
Korea	Ministry of Information and Communication Radio Research Laboratory (RRL)	CAB	APEC MRA 1	
Singapore	Infocomm Development Authority (IDA)	CAB	APEC MRA 1	
Taiwan	National Communications Commission (NCC) Bureau of Standards, Metrology and Inspection (BSMI)	CAB	APEC MRA 1	
Vietnam	Ministry of Communication (MIC)	CAB	APEC MRA 1	

EU MRA – European Union Mutual Recognition Agreement.
NB – Notified Body
APEC MRA – Asia Pacific Economic Community Mutual Recognition Agreement.
Recognition agreement under which test lab is accredited to regulatory standards of the APEC member countries.

Phase I - recognition for product testing
Phase II – recognition for both product testing and certification

1.3. Product Certification

MiCOM Labs, Inc. is an accredited Product Certification Body per the international standard ISO/IEC 17065:2012. The company is accredited by the American Association for Laboratory Accreditation (A2LA) www.a2la.org test laboratory number 2381.02. MiCOM Labs test schedule is available at the following URL; http://www.a2la.org/scopepdf/2381-02.pdf

Accredited Product Certification Body

A2LA has accredited

MICOM LABS

Pleasanton, CA

This product certification body is accredited in accordance with the recognized International Standard ISO/IEC 17065:2012 *Requirements for bodies certifying products, processes and services*. This accreditation demonstrates technical competence for a defined scope and the operation of a management system.

Presented this 4th day of February 2016.

Senior Director of Quality & Communications
For the Accreditation Council
Certificate Number 2381.02
Valid to November 30, 2017

For the product certification schemes to which this accreditation applies, please refer to the organization's Product Certification Scope of Accreditation.

United States of America – Telecommunication Certification Body (TCB)
Industry Canada – Certification Body, CAB Identifier – US0159
Europe – Notified Body (NB), NB Identifier - 2280
Japan – Recognized Certification Body (RCB), RCB Identifier - 210

DOCUMENT HISTORY

Document History		
Revision	Date	Comments
Draft	10th October 2017	New product details and revised antenna list. No testing was performed
Draft #2	17th November 2017	
Rev A	26th November 2017	Initial Release
Report released as RDWN39-U10		
Rev A	8th December 2015	Second Document Release
Report originally released as RDWN34-U9 21st September 2015		
Rev A	21st September 2015	Initial Release

1. TEST RESULT CERTIFICATE

Manufacturer:	RADWIN Ltd 27 Habarzel Street Tel Aviv, 69710 Israel	Tested By:	MiCOM Labs, Inc. 575 Boulder Court Pleasanton California, 94566, USA
EUT:	5 GHz Beamforming Outdoor Radio Device	Telephone:	+1 925 462 0304
Model:	RADWIN 2000 JET RADWIN 5000 JET	Fax:	+1 925 462 0306
S/N's:	Prototype		
Test Date(s):	27th to 31st July 2015	Website:	www.micomlabs.com

STANDARD(S)	TEST RESULTS
FCC 47 CFR Part 90, Subpart Y; IC RSS-111	EQUIPMENT COMPLIES

MiCOM Labs, Inc. tested the equipment mentioned in accordance with the requirements set forth in the above standards. Test results indicate that the equipment tested is capable of demonstrating compliance with the requirements as documented within this report.

Notes:

1. This document reports conditions under which testing was conducted and the results of testing performed.
2. Details of test methods used have been recorded and kept on file by the laboratory.
3. Test results apply only to the item(s) tested.

Approved & Released for MiCOM Labs, Inc. by:

ACCREDITED
TESTING CERT #2381.01

Graeme Grieve
Quality Manager MiCOM Labs,

Gordon Hurst
President & CEO MiCOM Labs, Inc.

2. REFERENCES AND MEASUREMENT UNCERTAINTY

2.1. Normative References

REF.	PUBLICATION	YEAR	TITLE
(i)	FCC 47 CFR Part 90	2015	Code of Federal Regulations
(ii)	RSS-111 Issue 5	Sept 2014	Broadband Public Safety Equipment Operating in the Band 4940-4990 MHz
(iii)	ANSI C63.4	2014	American National Standards for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
(iv)	EN 55032	2012 + AC:2013	Information Technology Equipment – Radio Disturbance Characteristics, Limits and Methods of Measurement
(v)	M 3003	Nov. 2012 Edition 3	Expression of Uncertainty and Confidence in Measurements
(vi)	LAB34	Edition 1 Aug 2002	The expression of uncertainty in EMC Testing
(vii)	ETSI TR 100 028	2001-12	Parts 1 and 2 Electromagnetic compatibility and Radio Spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics
(viii)	A2LA	June 2015	Reference to A2LA Accreditation Status – A2LA Advertising Policy

2.2. Test and Uncertainty Procedures

Conducted and radiated emission measurements were conducted in accordance with American National Standards Institute ANSI C63.4, listed in the Normative References section of this report.

Measurement uncertainties stated are based on a standard uncertainty multiplied by a coverage factor k = 2, providing a level of confidence of approximately 95 % in accordance with UKAS document M 3003 listed in the Normative References section of this report.

3. PRODUCT DETAILS AND TEST CONFIGURATIONS

3.1. Technical Details

Details	Description
Purpose:	Test of RADWIN Ltd RADWIN 2000 JET, RADWIN 5000 JET to FCC Part 90 SubPart Y and IC RSSS-111 regulations
Applicant:	RADWIN Ltd 27 Habarzel Street Tel Aviv, 69710, Israel
Manufacturer:	As applicant
Laboratory performing the tests:	MiCOM Labs, Inc. 575 Boulder Court Pleasanton, California 94566 USA
Test report reference number:	RDWN47-U1 Rev A
Date EUT received:	14th July 2015
Standard(s) applied:	FCC 47 CFR Part 90 Subpart Y and IC RSS-111
Dates of test (from - to):	27th to 31st July 2015
No of Units Tested:	One
Type of Equipment:	2x2 Spatial Multiplexing MIMO configuration
Manufacturers Trade Name:	RADWIN JET
Model(s):	RADWIN 2000 JET, RADWIN 5000 JET
Location for use:	Outdoor
Declared Frequency Range(s):	4,940 – 4,990 MHz
Hardware Rev	Prototype
Software Rev	Prototype
EUT Modes of Operation:	802.11n: 5, 10, 20 MHz 802.11ac: 5, 10, 20 MHz
Type of Modulation:	Per 802.11n/ac BPSK, QPSK, 16QAM, 64QAM, 256 QAM, OFDM
Declared Nominal Average Output Power:	5 MHz: +27.0 dBm 10 MHz: +30.0 dBm 20 MHz: +33.0 dBm
Transmit/Receive Operation:	Time Division Duplex
System Beam Forming:	Yes
Rated Input Voltage and Current:	POE 55 Vdc 1 A
Operating Temperature Range:	Declared range -35° to +60ºC
ITU Emission Designator:	5 MHz 5M00W7W 10 MHz 10M0W7W 20 MHz 20M0W7W
Equipment Dimensions:	1.9” X 2.0” x 0.3”
Weight:	0.042 lb. (19g)
Primary function of equipment:	Beamforming Antenna Outdoor Radio Device

3.2. Scope of Test Program

RADWIN 2000 JET, RADWIN 5000 JET RF Testing

The scope of the test program was to test the RADWIN 2000 JET, RADWIN 5000 JET configurations in the frequency range 4,940 to 4,990 MHz for compliance against FCC 47 CFR Part 90 Subpart Y and Industry Canada RSS-111 specifications.

3.3. Equipment Model(s) and Serial Number(s)

Type (EUT/ Support)	Equipment Description (Including Brand Name)	Manufacturer	Model No.	Serial No.
EUT	Beamforming Antenna Outdoor Radio Device	RADWIN Ltd	RADWIN 2000 JET, RADWIN 5000 JET	Prototype
Support	POE 55 Vdc	RADWIN Ltd	CPU55A-270-1	--
Support	Laptop PC	IBM	Thinkpad	None

3.4. Antenna Details

Radiated emissions testing were performed in the mode with the highest spectral density to verify compliance. Radiated emissions were performed on the highest gain of each type of antenna as identified in the table below:

Type	Manufacturer	Model	Gain (dBi)	BF Gain	Dir BW	X-Pol
Integrated Beamforming	RADWIN Ltd.	SA0183620	8.00	9.0	9.4º	Yes
Integrated Beamforming	RADWIN Ltd.	SA0183620	8.00	0	60.0º	Yes

3.5. Cabling and I/O Ports

Number and type of I/O ports

1. 1 x 10/100/1000 Ethernet (includes POE +55 Vdc)

3.6. Test Configurations

Matrix of test configurations

Parameter	Operational Mode	Test Conditions	Bandwidths (MHz)
Occupied BW & Emission Mask	Modulated	Ambient	5, 10, 20
Peak Output power	Modulated	Ambient	5, 10, 20
Peak Power Spectral Density	Modulated	Ambient	5, 10, 20
Frequency Stability	Modulated	Temperature Variations and Voltage Variations	20
Conducted Emissions	Modulated	Ambient	5, 10, 20
Radiated Emissions	Modulated	Ambient	5, 10, 20

Only worst case plots are provided for each test parameter are identified within this report. Plots not included are held on file by the test laboratory and available upon request with client permission.

3.7. Equipment Modifications

The following modifications were required to bring the equipment into compliance:

1. NONE

3.8. Deviations from the Test Standard

The following deviations from the test standard were required in order to complete the test program:

1. NONE

3.9. Subcontracted Testing or Third Party Data

1. NONE

4. TEST SUMMARY

List of Measurements

The following table represents the list of measurements required under the **FCC CFR47 Part 90**, **Subpart Y (except Section 5.1.4)** and **Industry Canada RSS-111**; **Industry Canada RSS-Gen**.

Section(s)	Test Items	Description	Condition	Result	Test Report Section
2.1049; 90.210(m) **5.3** **4.6**	26 dB Occupied BW & Emission Mask	Emission mask and bandwidth measurement(s)	Conducted	Complies	6.1.1
2.1046; 90.1215 (a) **5.3 4.8**	Peak Output Power	Modulated Output Power	Conducted	Complies	6.1.2
2.1046; 90.1215 (a) **4.2**	Peak Power Spectral Density	Maximum Spectral Density	Conducted	Complies	6.1.3
Subpart C 90.1217 **5.6**	Maximum Permissible Exposure	Exposure to radio frequency energy levels	Radiated	Complies	6.1.4
2.1055(a)(1); 90.213 **5.2 4.7**	Frequency Stability	Includes temperature and voltage variations	Conducted	Complies	6.1.5
2.1051; 90.210(m) **5.4 4.9**	Conducted Spurious Emissions at Antenna Port	Emissions from the antenna port 30 MHz – 40 GHz	Conducted	Complies	6.1.6
2.1053; 90.210(m) **5.3 4.9**	Radiated Spurious Emissions	Spurious emissions 30 MHz – 40 GHz	Radiated	Complies	6.1.7
4.10 **6**	Radiated Receiver Emissions			Complies	6.1.8

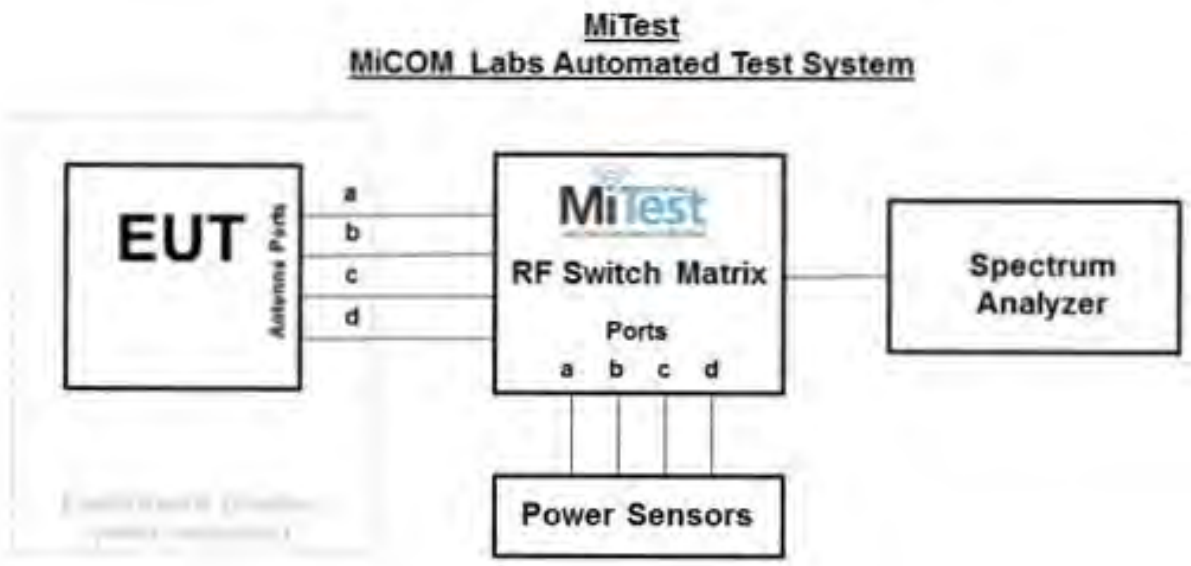
Note 1: *Test results reported in this document relate only to the items tested*
Note 2: *The required tests demonstrated compliance as per client declaration of test configuration, monitoring methodology and associated pass/fail criteria*
Note 3: *Section 3.7 Equipment Modifications highlights the equipment modifications that were required to bring the product into compliance with the above test matrix*

5. TEST EQUIPMENT CONFIGURATION(S)

5.1. Conducted Test Set-Up

Conducted RF Emission Test Set-up(s).

The following tests were performed using the conducted test set-up shown in the diagram below.
1. Occupied Bandwidth and Emission Mask
2. Peak Output Power
3. Peak Power Spectral Density
4. Frequency Stability
5. Spurious Emissions at Antenna Terminals - Transmitter



Conducted Test Measurement Setup

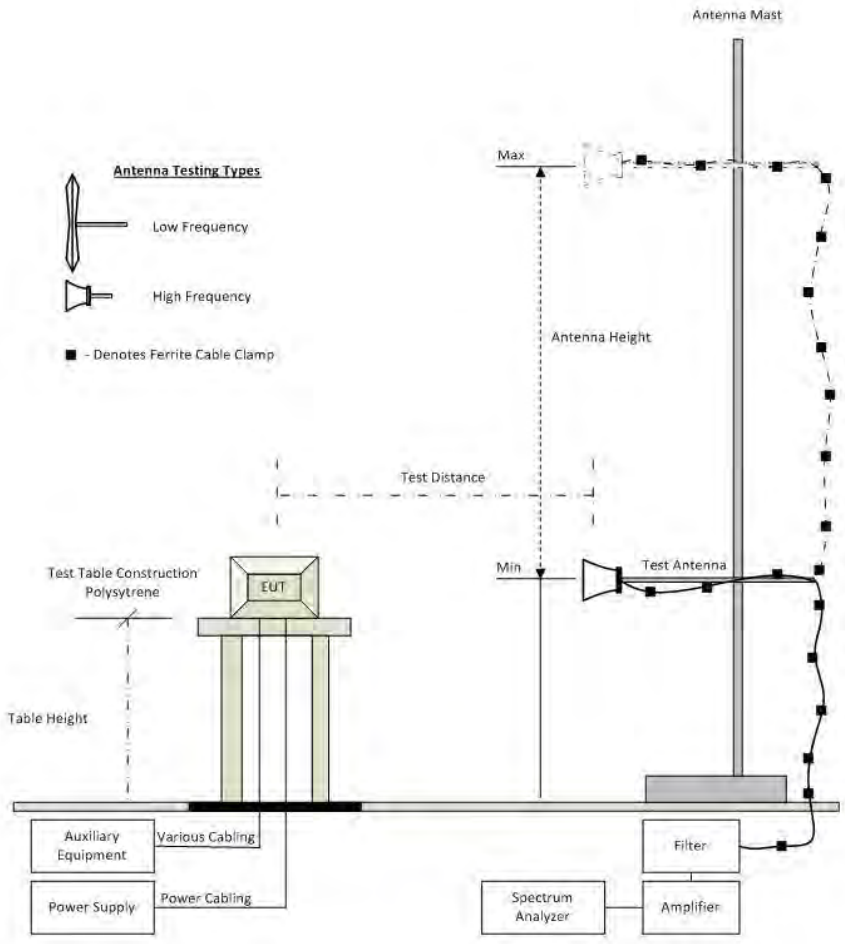
A full system calibration was performed on the test station and any resulting system losses (or gains) were taken into account in the production of all final measurement data.

Asset#	Description	Manufacturer	Model#	Serial#	Calibration Due Date
158	Barometer/Thermometer	Control Company	4196	E2846	01 Dec 2016
193	Receiver 20 Hz to 7 GHz	Rhode & Schwarz	ESI 7	838496/007	14 Jan 2016
249	Resistance Thermometer	Thermotronics	GR2105-02	9340 #2	23 Oct 2016
287	Rohde & Schwarz 40 GHz Receiver	Rhode & Schwarz	ESIB40	100201	27 Aug 2016
361	Desktop for RF#1, Labview Software installed	Dell	Vostro 220	WS RF#1	Not Required
378	Rohde & Schwarz 40 GHz Receiver with Generator	Rhode & Schwarz	ESIB40	100107/040	04 Aug 2016
380	4x4 RF Switch Box	MiCOM Labs	MiTest RF Switch Box	MIC001	20 Dec 2015
390	USB Power Head 50MHz - 24GHz -60 to +20dBm	Agilent	U2002A	MY50000103	17 Oct 2016
398	Test Software	MiCOM	MiTest ATS	Version 3.0.0.16	Not Required
405	DC Power Supply 0-60V	Agilent	6654A	MY4001826	Cal when used
408	USB to GPIB interface	National Instruments	GPIB-USB HS	14C0DE9	Not Required
436	USB Wideband Power Sensor	Boonton	55006	8731	31 Jul 2016
437	USB Wideband Power Sensor	Boonton	55006	8759	31 Jul 2016
445	PoE Injector	D-Link	DPE-101GL	QTAH1E2000625	Not Required
75	Environmental Chamber	Thermatron	SE-300-2-2	27946	24 Nov 2016
RF#1 GPIB#1	GPIB cable to Power Supply	HP	GPIB	None	Not Required
RF#1 SMA SA #452	Precision SMA Male RG-402 Spectrun Analyzer	Fairview Microwave	Precision SMA Male RG 402 coax	None	20 Dec 2015
RF#1 SMA#1	EUT to Mitest box port 1	Flexco	SMA Cable port1	None	20 Dec 2015
RF#1 SMA#2	EUT to Mitest box port 2	Flexco	SMA Cable port2	None	20 Dec 2015
RF#1 SMA#3	EUT to Mitest box port 3	Flexco	SMA Cable port3	None	20 Dec 2015
RF#1 SMA#4	EUT to Mitest box port 4	Flexco	SMA Cable port4	None	20 Dec 2015
RF#1 USB#1	USB Cable to Mitest Box	Dynex	USB Cable	None	Not Required

5.2. Radiated Emission Test Set-Up

The following tests were performed using the conducted test set-up shown in the diagram below.

1. Radiated Spurious Emissions
2. Radiated Digital Emissions (0.03 – 1 GHz)
3. Receiver Spurious Emissions



Radiated Emission Test Setup

A full system calibration was performed on the test station and any resulting system losses (or gains) were taken into account in the production of all final measurement data.

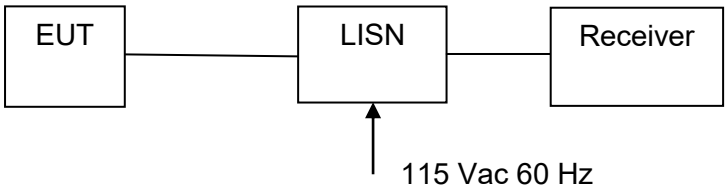
Asset#	Description	Manufacturer	Model#	Serial#	Calibration Due Date
158	Barometer/Thermometer	Control Company	4196	E2846	01 Dec 2016
170	Video System Controller for Semi Anechoic Chamber	Panasonic	WV-CY101	04R08507	Not Required
338	Sunol 30 to 3000 MHz Antenna	Sunol	JB3	A052907	15 Aug 2016
377	Band Rejection Filter 5150 to 5880MHz	Microtronics	BRM50716	034	18 Aug 2016
378	Rohde & Schwarz 40 GHz Receiver with Generator	Rhode & Schwarz	ESIB40	100107/040	04 Aug 2016
393	DC - 1050 MHz Low Pass Filter	Microcircuits	VLFX-1050	N/A	08 Oct 2016
397	Amp 10 - 2500MHz	MiCOM Labs	Amp 10 - 2500 MHz	NA	24 Feb 2016
399	ETS 1-18 GHz Horn Antenna	ETS	3117	00154575	10 Dec 2015
406	Amplifier for Radiated Emissions	MiCOM Labs	40dB 1 to 18GHz Amp	0406	28 May 2016
410	Desktop Computer	Dell	Inspiron 620	WS38	Not Required
411	Mast/Turntable Controller	Sunol Sciences	SC98V	060199-1D	Not Required
412	USB to GPIB Interface	National Instruments	GPIB-USB HS	11B8DC2	Not Required
413	Mast Controller	Sunol Science	TWR95-4	030801-3	Not Required
415	Turntable Controller	Sunol Sciences	Turntable Controller	None	Not Required
416	Gigabit ethernet filter	ETS-Lingren	Gigafoil 260366	None	Not Required
447	Rad Emissions Test Software	MiCOM	Version 1.0.73	447	Not Required
462	Schwarzbeck cable from Antenna to Amplifier.	Schwarzbeck	AK 9513	462	25 Feb 2016
463	Schwarzbeck cable from Amplifier to Bulkhead.	Schwarzbeck	AK 9513	463	25 Feb 2016
464	Schwarzbeck cable from Bulkhead to Receiver	Schwarzbeck	AK 9513	464	25 Feb 2016
480	Cable - Bulkhead to Amp	SRC Haverhill	157-157-3050360	480	11 Aug 2016
481	Cable - Bulkhead to Receiver	SRC Haverhill	151-151-3050787	481	11 Aug 2016
482	Cable - Amp to Antenna	SRC Haverhill	157-157-3051574	482	11 Aug 2016
502	Test Software for Radiated Emissions	EMISoft	Vasona	Version 5 Build 59	Not Required

5.3. ac Wireline Emission Test Set-up

The following tests were performed using the conducted test set-up shown in the diagram below.

1. ac Wireline Conducted Emissions

Test Measurement Set up



Measurement set up for AC Wireline Conducted Emissions Test

A full system calibration was performed on the test station and any resulting system losses (or gains) were taken into account in the production of all final measurement data.

Traceability of Test Equipment Utilized for ac Wireline Emission Testing

Asset#	Description	Manufacturer	Model#	Serial#	Calibration Due Date
158	Barometer/Thermometer	Control Company	4196	E2846	04 Dec 2015
184	Pulse Limiter	Rhode & Schwarz	ESH3Z2	357.8810.52	Cal when used
190	LISN (two-line V-network)	Rhode & Schwarz	ESH3Z5	836679/006	29 Oct 2016
287	Rohde & Schwarz 40 GHz Receiver	Rhode & Schwarz	ESIB40	100201	27 Aug 2016
316	Dell desktop computer workstation with Vasona	Dell	Desktop	WS04	Not Required

6. TEST RESULTS

6.1. Device Characteristics

6.1.1. Occupied Bandwidth and Emission Mask

FCC 47 CFR Part 90, Subpart Y; 2.1049; §90.210(m)

Test Procedure

The transmitter terminal of EUT was connected to the input of the spectrum analyzer set to measure the 26 dB occupied bandwidth and emission mask for the radio. The system highest power setting was selected with modulation ON and duty cycle set for 100% i.e. continuous operation at all times.

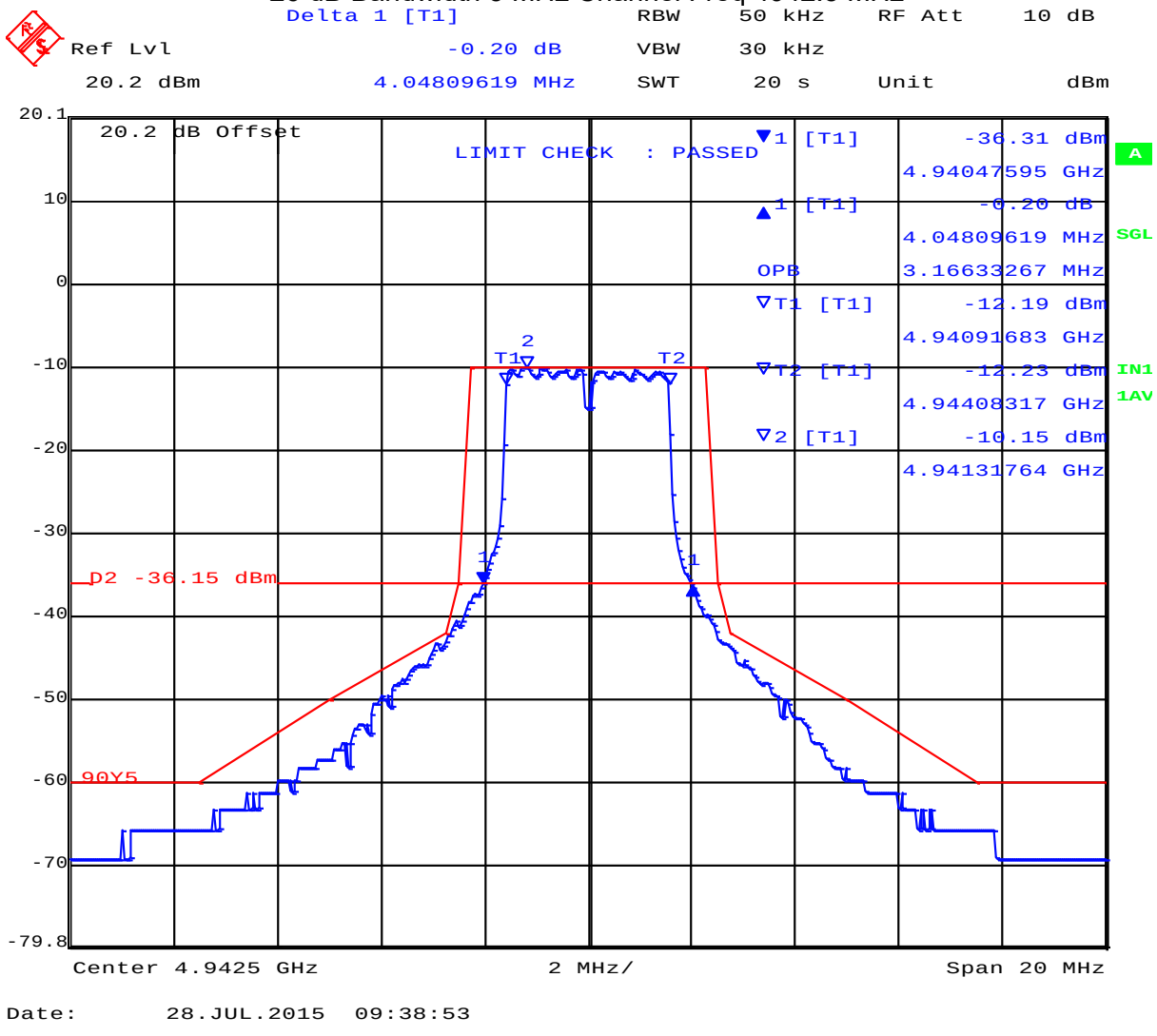
For emission masks the zero dB reference is measured relative to the highest average power of the fundamental emission measured across the designated channel bandwidth using a resolution bandwidth of at least one percent of the occupied bandwidth of the fundamental emission and a video bandwidth of 30 kHz.

Ambient conditions.
Temperature: 19 to 26 °C Relative humidity: 31 to 57 % Pressure: 999 to 1009 mbar

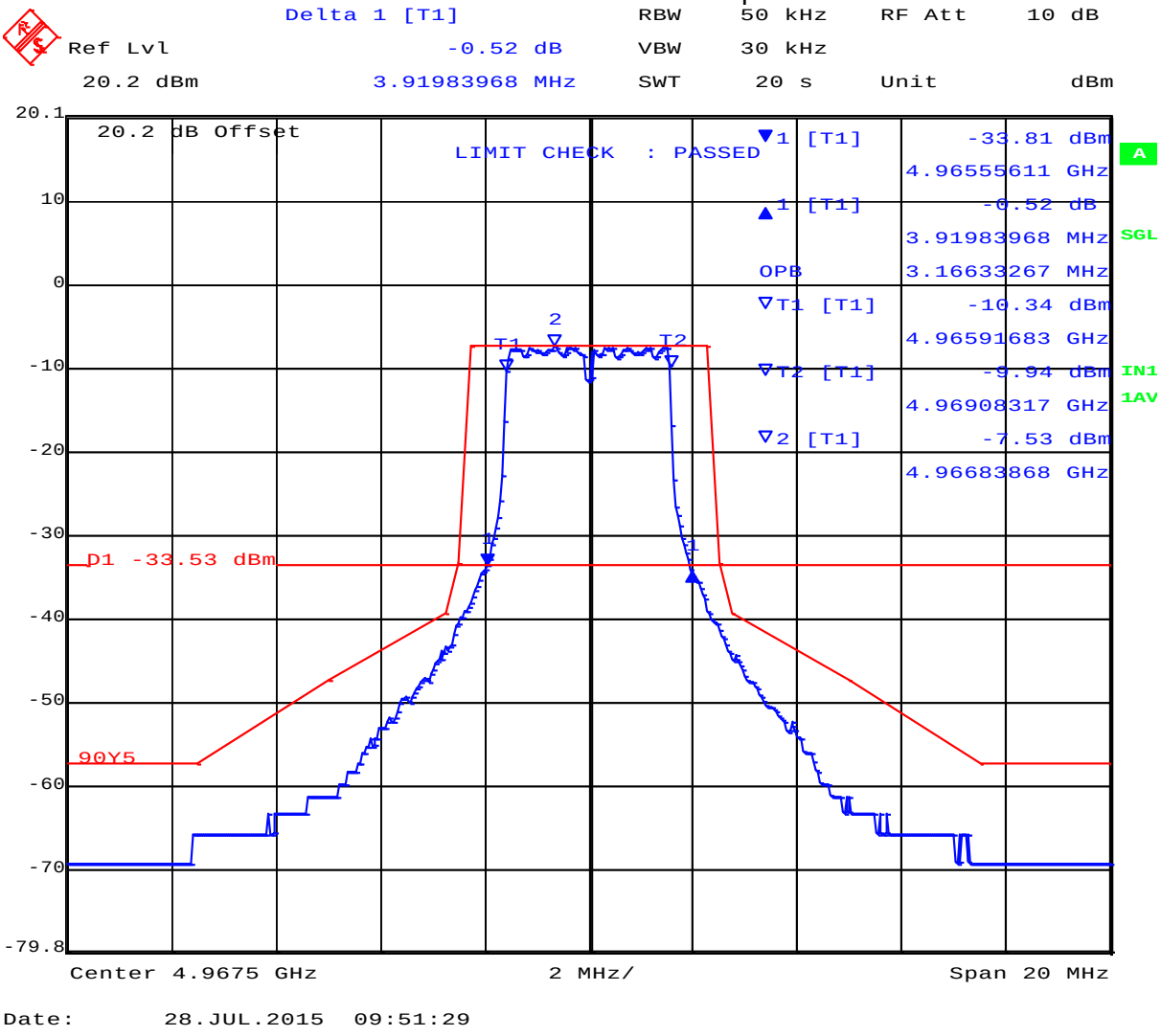
TABLE OF RESULTS – 5 MHz 26 dB Bandwidth(s)

Center Frequency (MHz)	26 dB Bandwidth (MHz)	
	Port A	Port B
4942.5	4.04	3.88
4967.5	3.91	3.87
4987.5	3.91	3.87

Port A
26 dB Bandwidth 5 MHz Channel Freq 4942.5 MHz

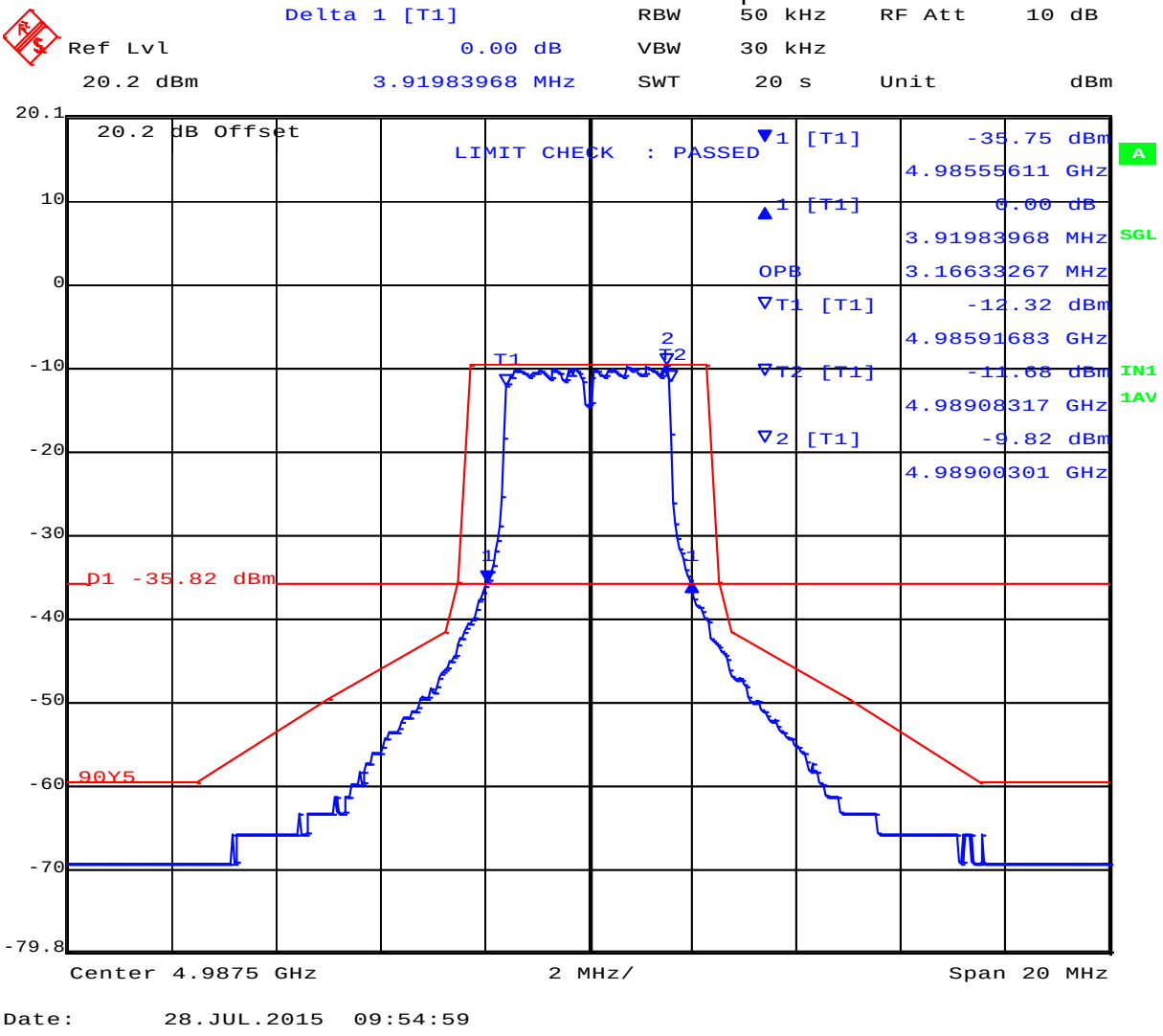


Port A
26 dB Bandwidth 5 MHz Channel Freq 4967.5 MHz



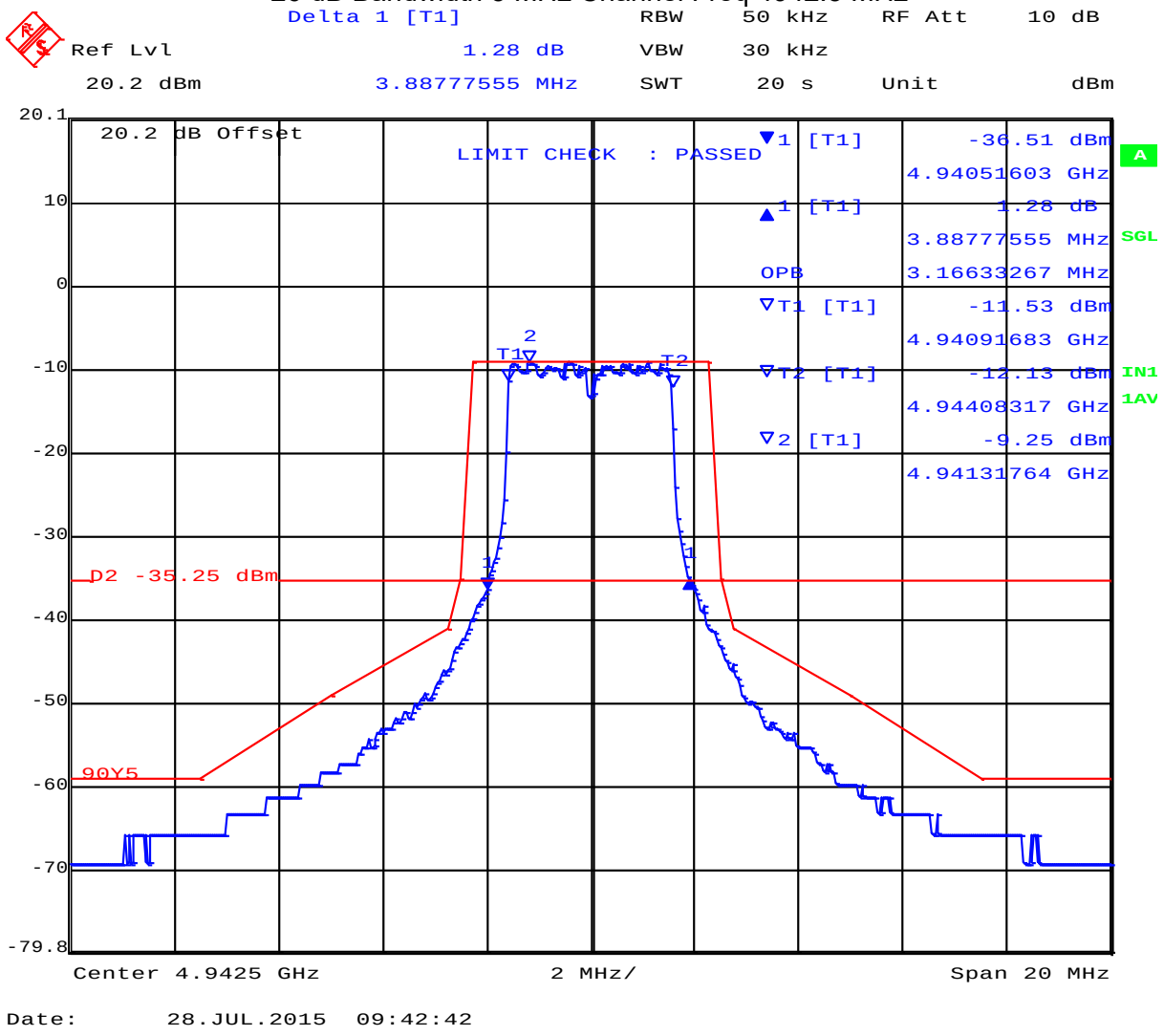
Port A

26 dB Bandwidth 5 MHz Channel Freq 4987.5 MHz



Port B

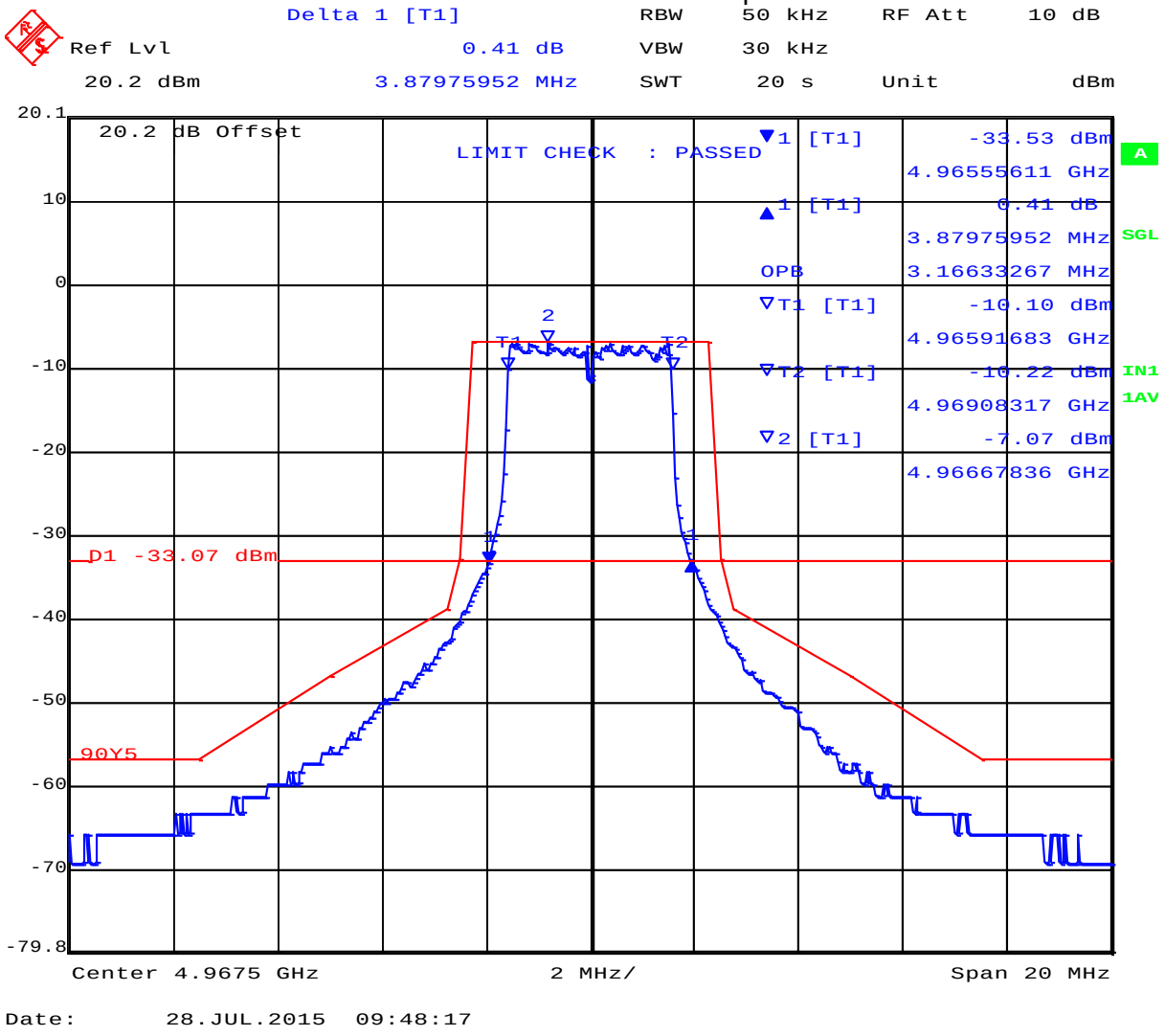
26 dB Bandwidth 5 MHz Channel Freq 4942.5 MHz



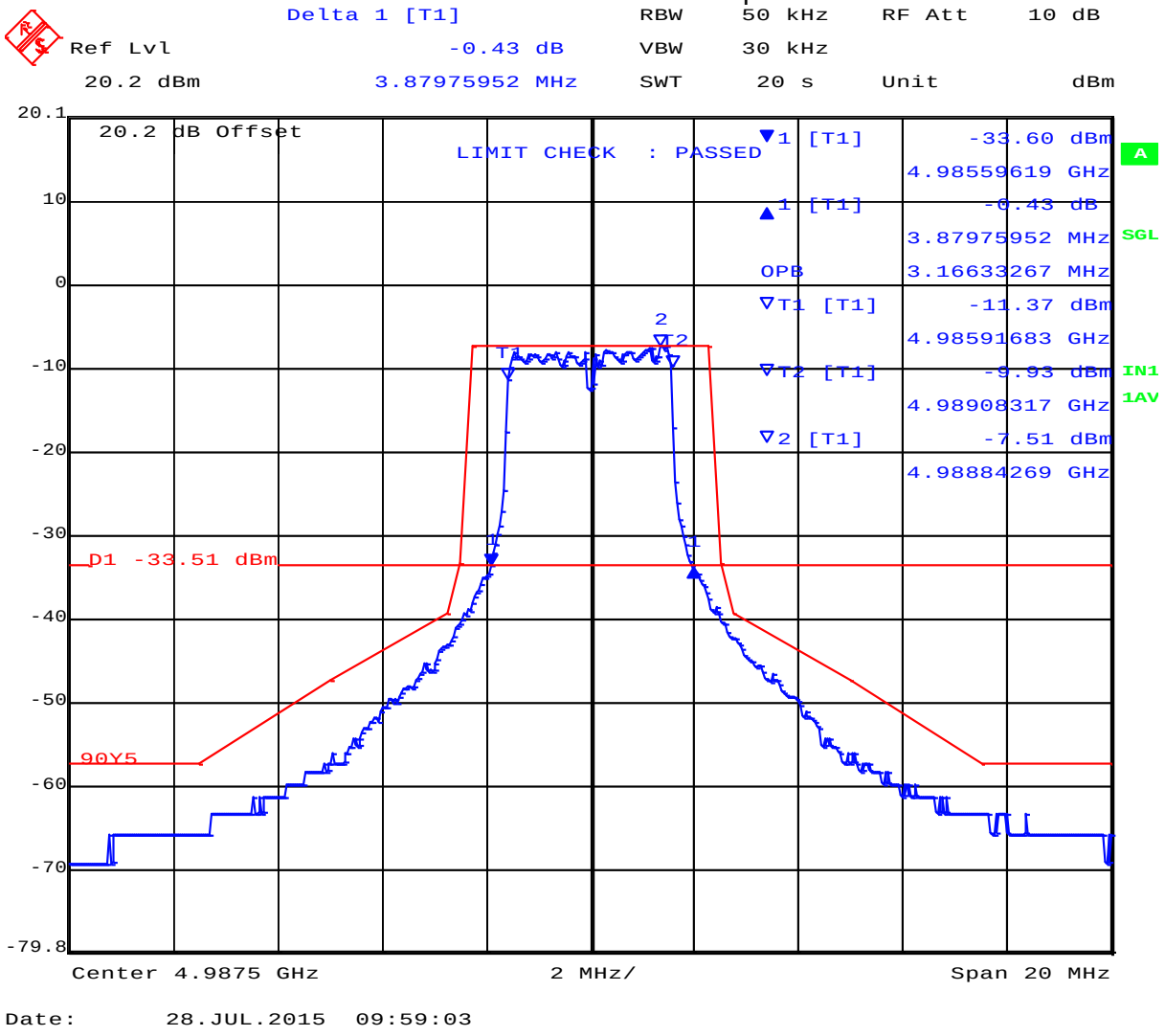
Date: 28.JUL.2015 09:42:42

Port B

26 dB Bandwidth 5 MHz Channel Freq 4967.5 MHz



Port B
26 dB Bandwidth 5 MHz Channel Freq 4987.5 MHz

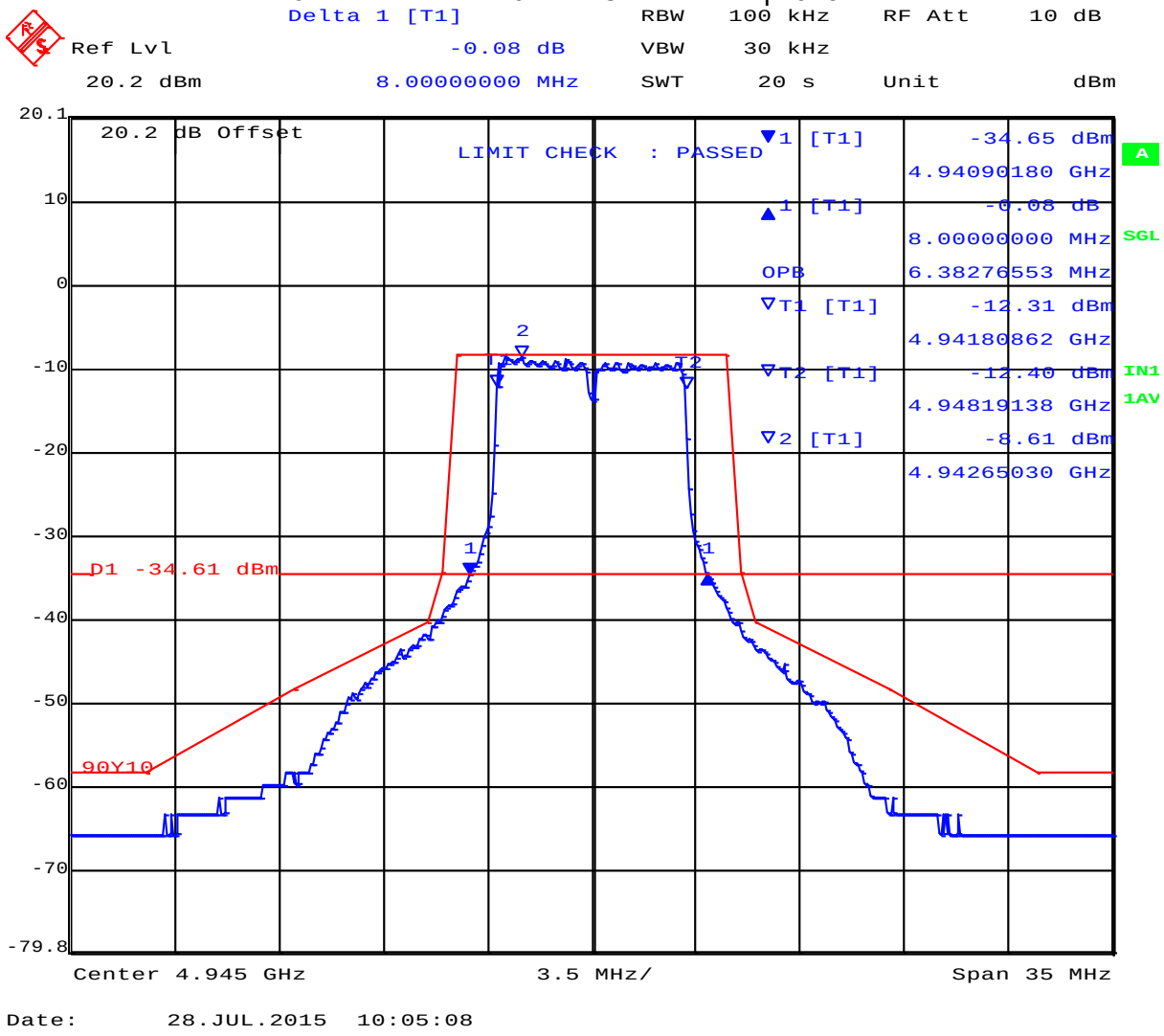


Date: 28.JUL.2015 09:59:03

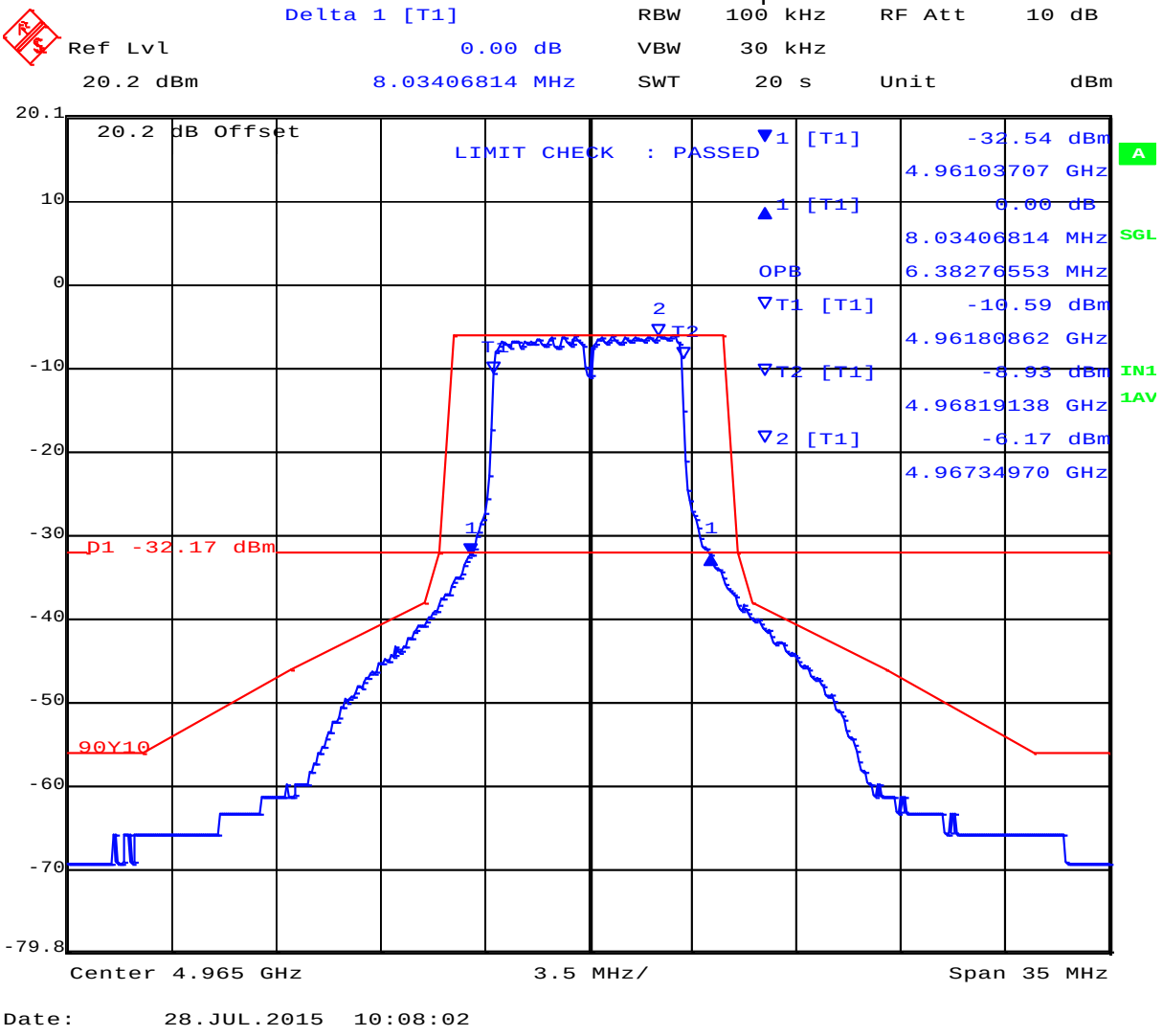
TABLE OF RESULTS – 10 MHz 26 dB Bandwidth(s)

Center Frequency (MHz)	26 dB Bandwidth (MHz)	
	Port A	Port B
4945	8.00	7.29
4965	8.03	8.03
4985	7.57	8.00

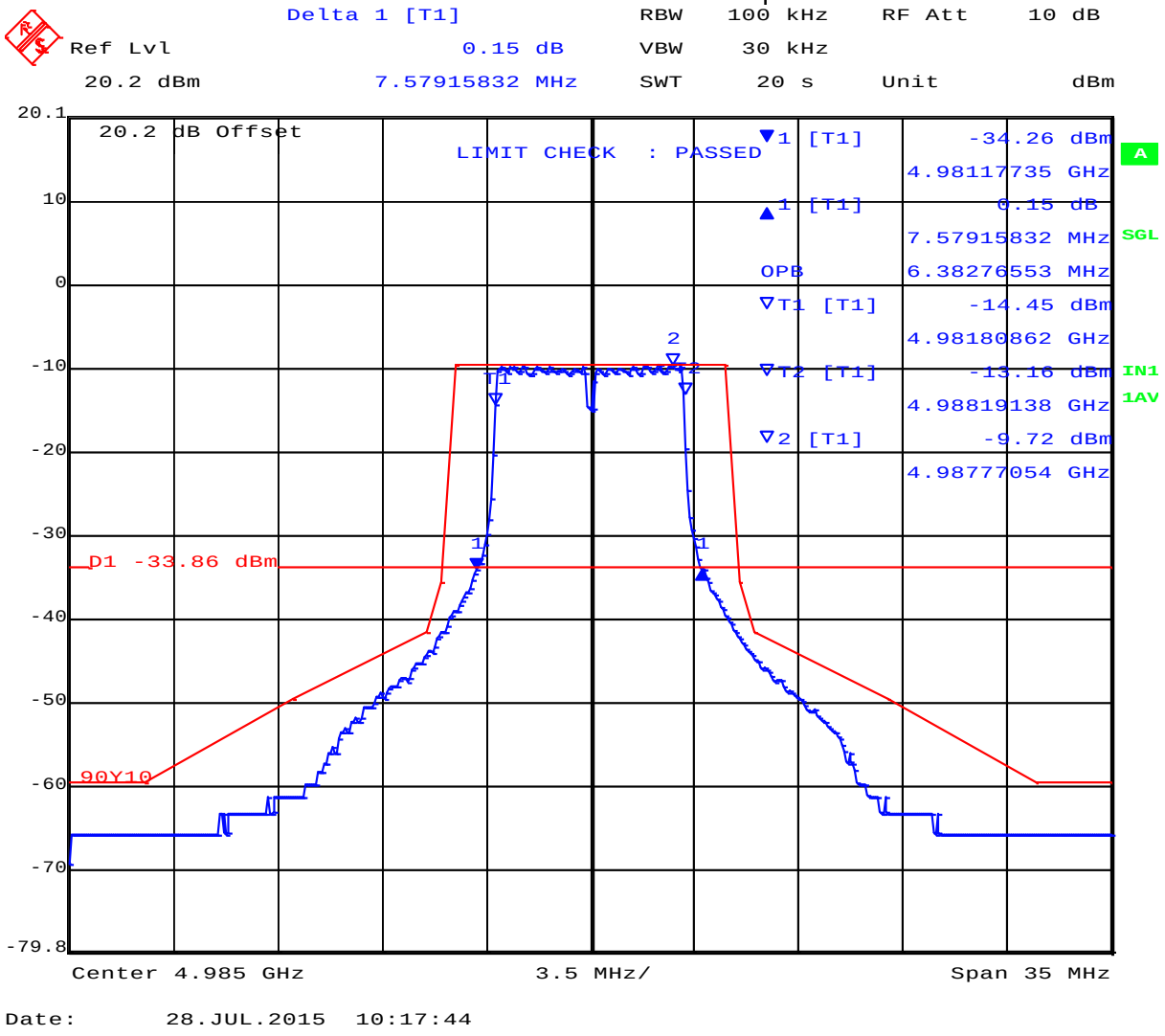
Port A
26 dB Bandwidth 10 MHz Channel Freq 4945 MHz



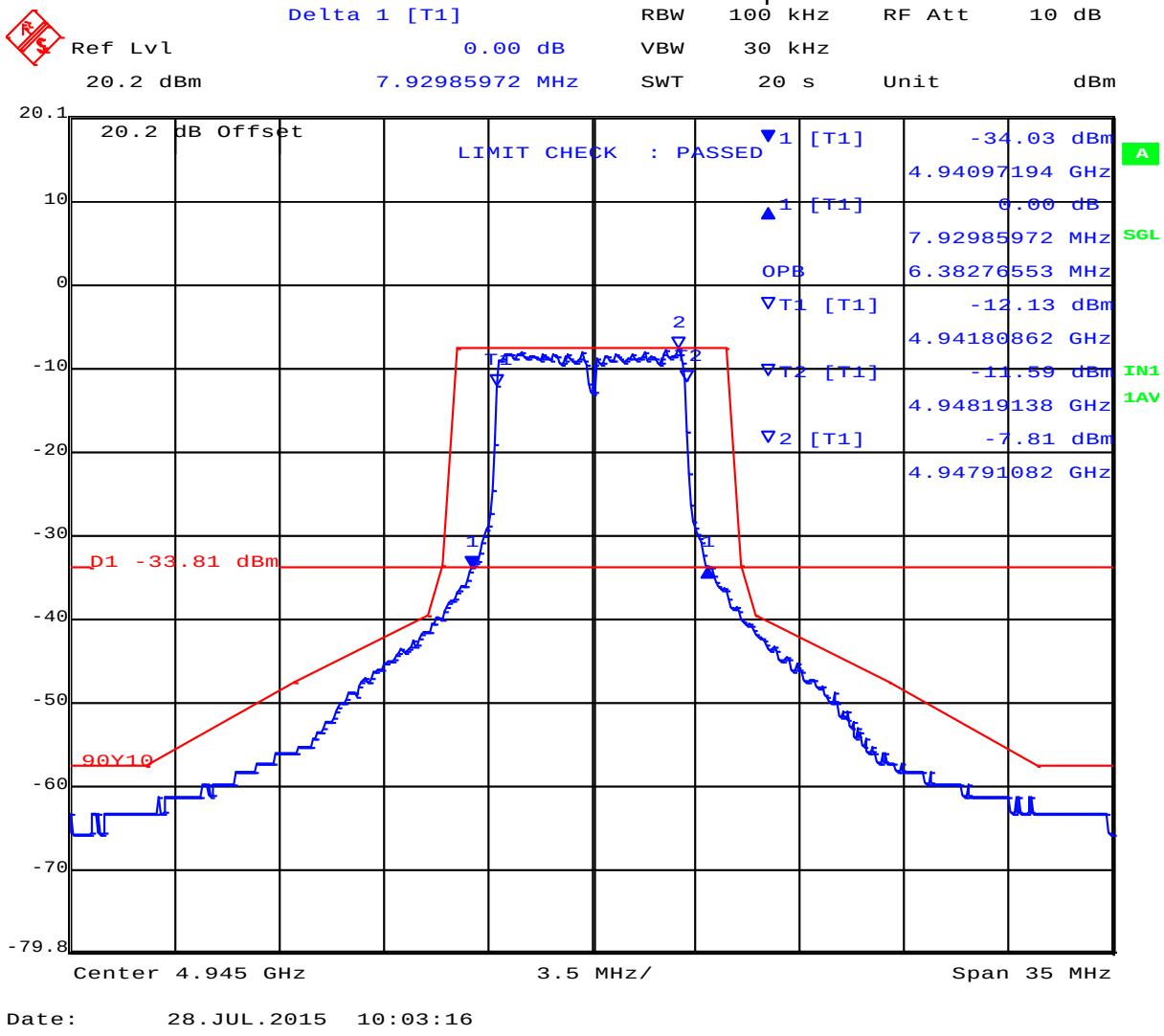
Port A
26 dB Bandwidth 10 MHz Channel Freq 4965 MHz



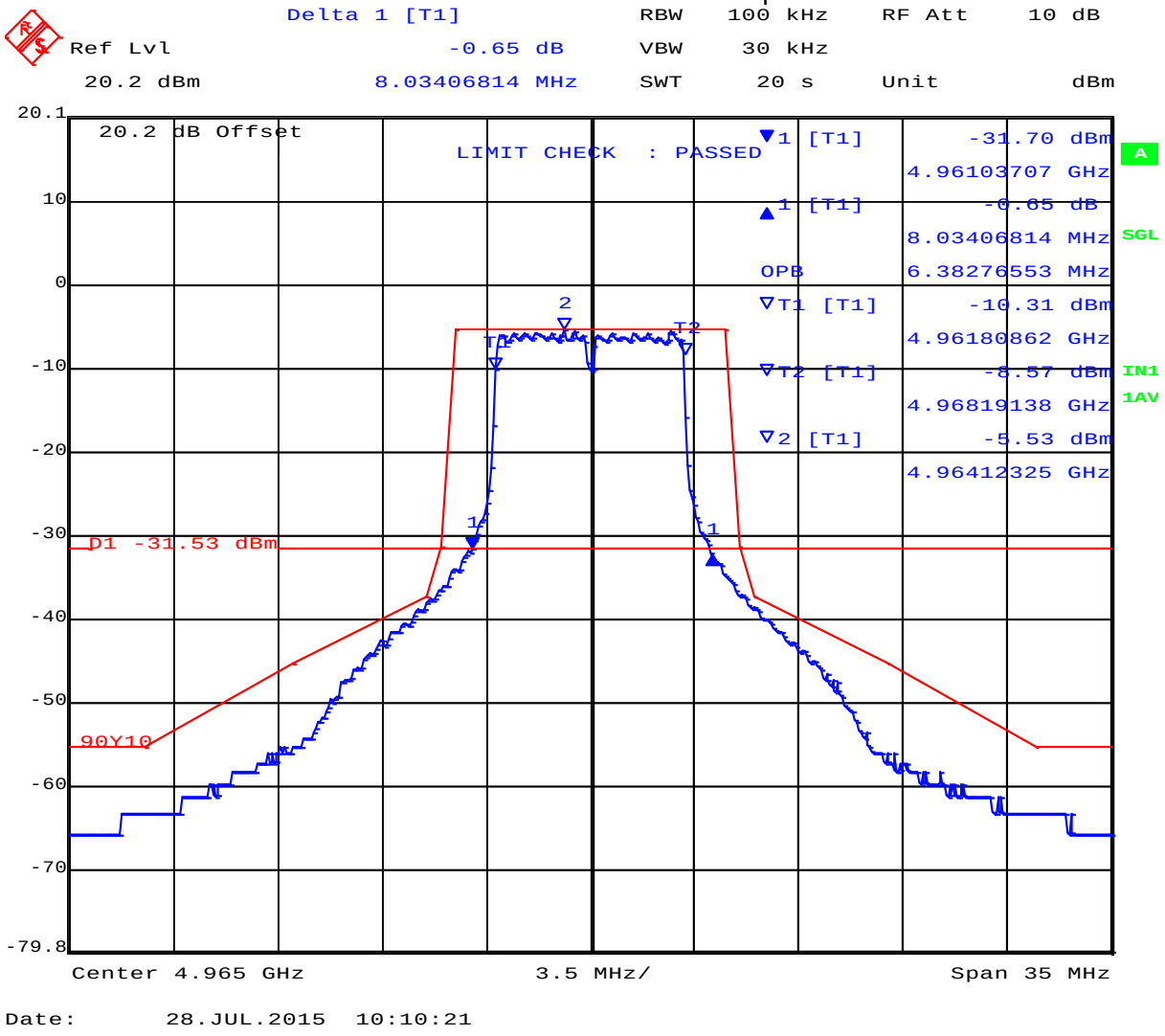
Port A
26 dB Bandwidth 10 MHz Channel Freq 4985 MHz



Port B
26 dB Bandwidth 10 MHz Channel Freq 4945 MHz



Port B
26 dB Bandwidth 10 MHz Channel Freq 4965 MHz



Port B
26 dB Bandwidth 10 MHz Channel Freq 4985 MHz

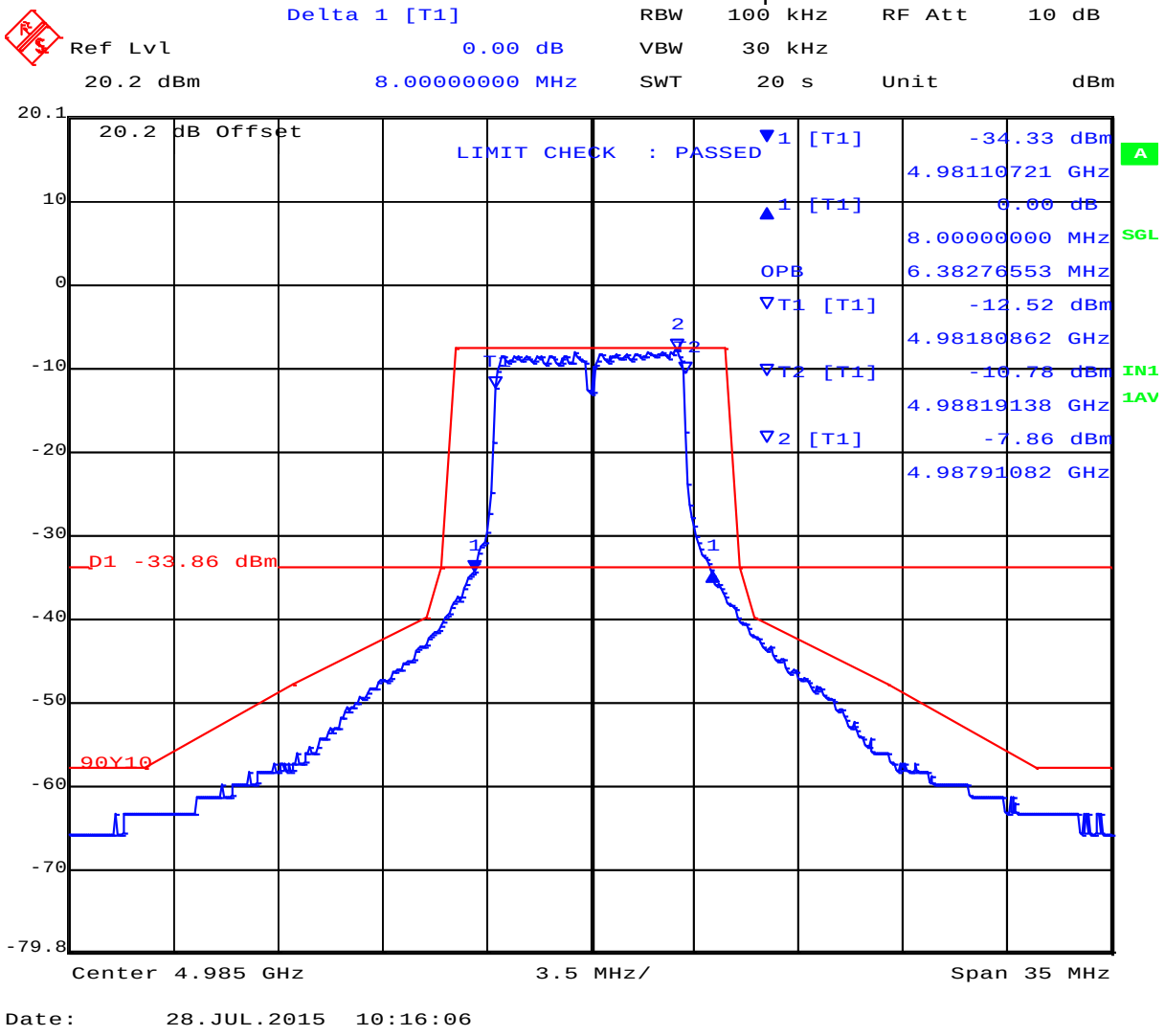
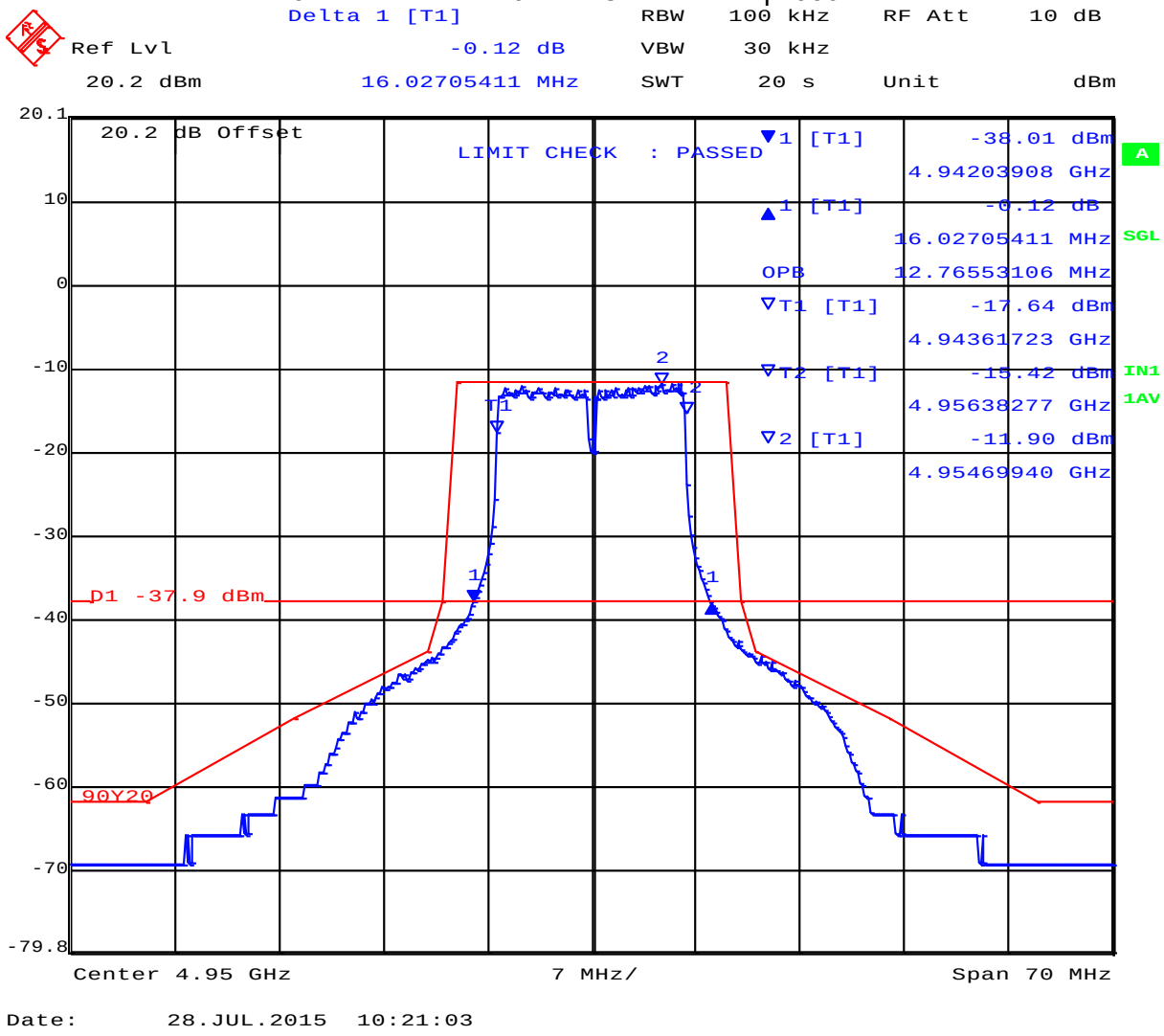


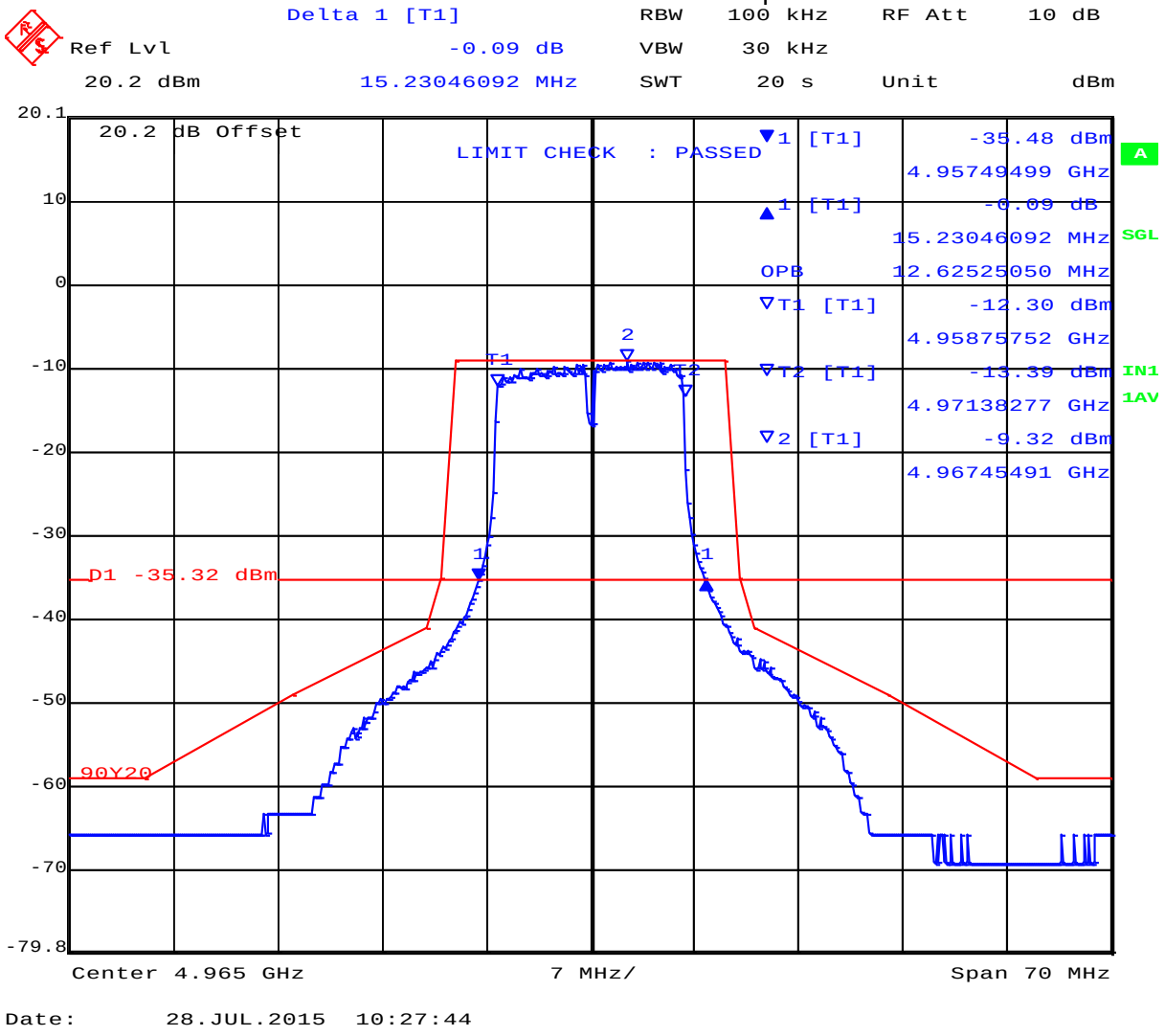
TABLE OF RESULTS – 20 MHz 26 dB Bandwidth(s)

Center Frequency (MHz)	26 dB Bandwidth (MHz)	
	Port A	Port B
4950	16.02	15.60
4965	15.23	15.51
4980	15.52	15.80

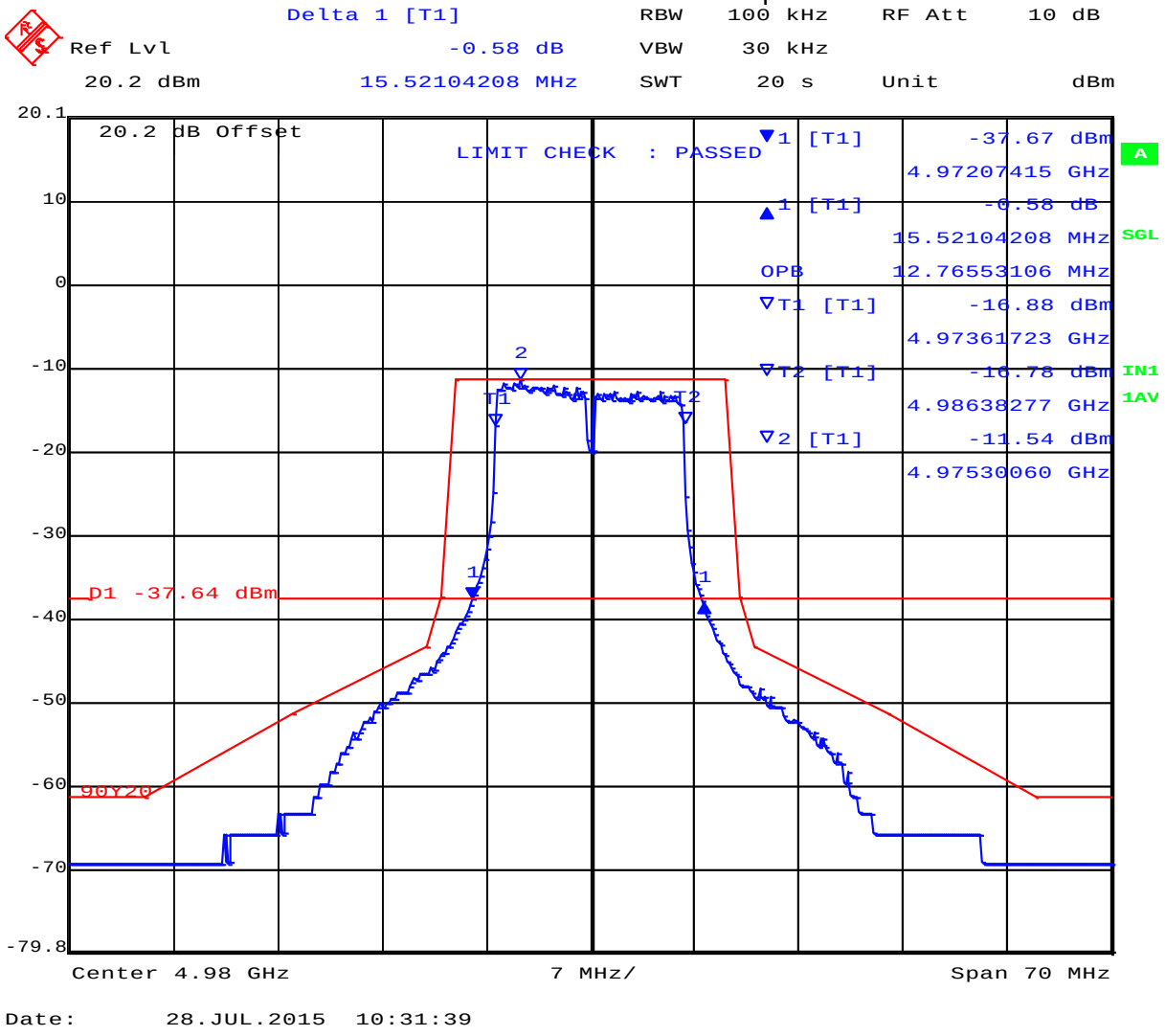
Port A
26 dB Bandwidth 20 MHz Channel Freq 4950 MHz



Port A
26 dB Bandwidth 20 MHz Channel Freq 4965 MHz

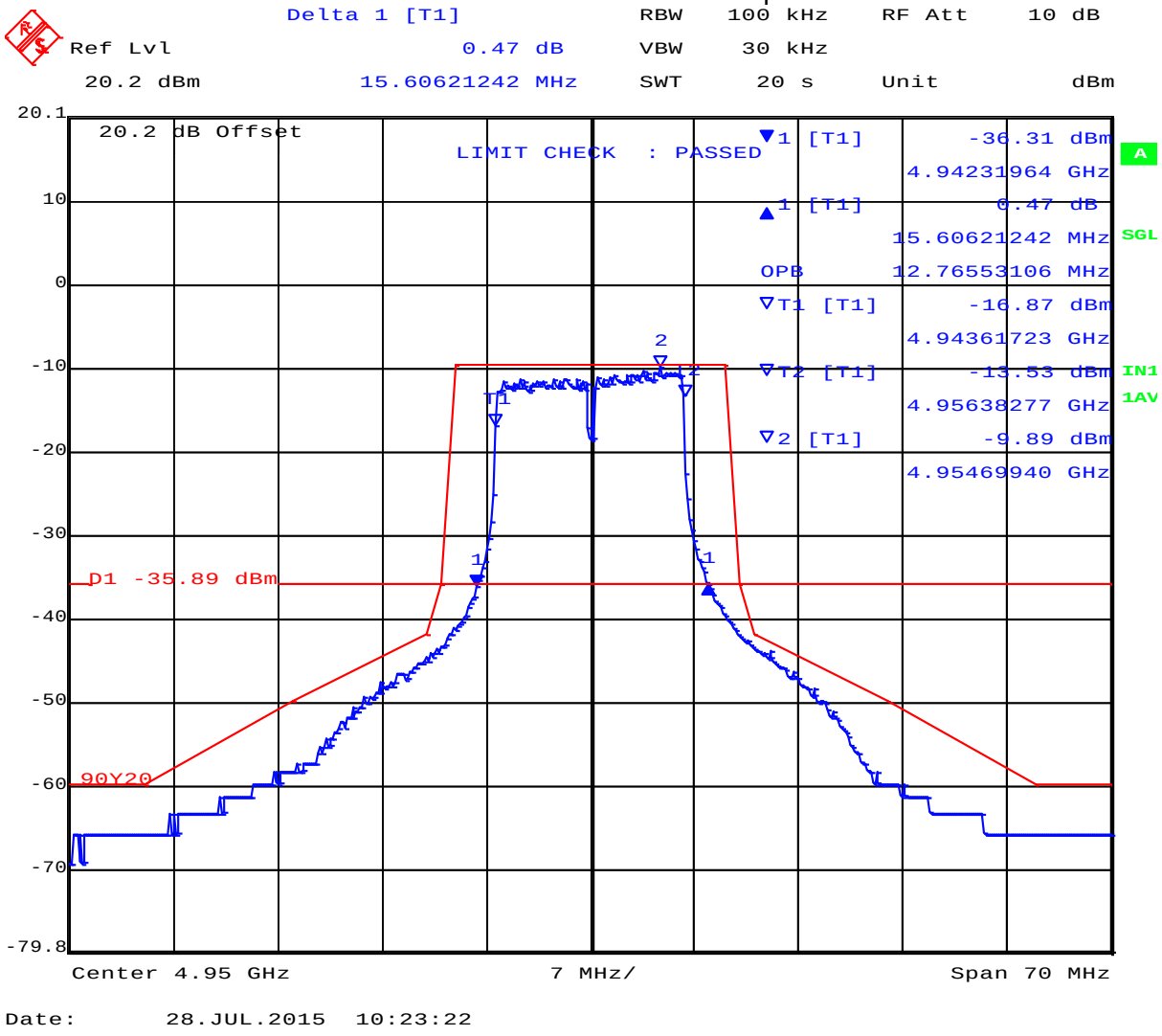


Port A
26 dB Bandwidth 20 MHz Channel Freq 4980 MHz

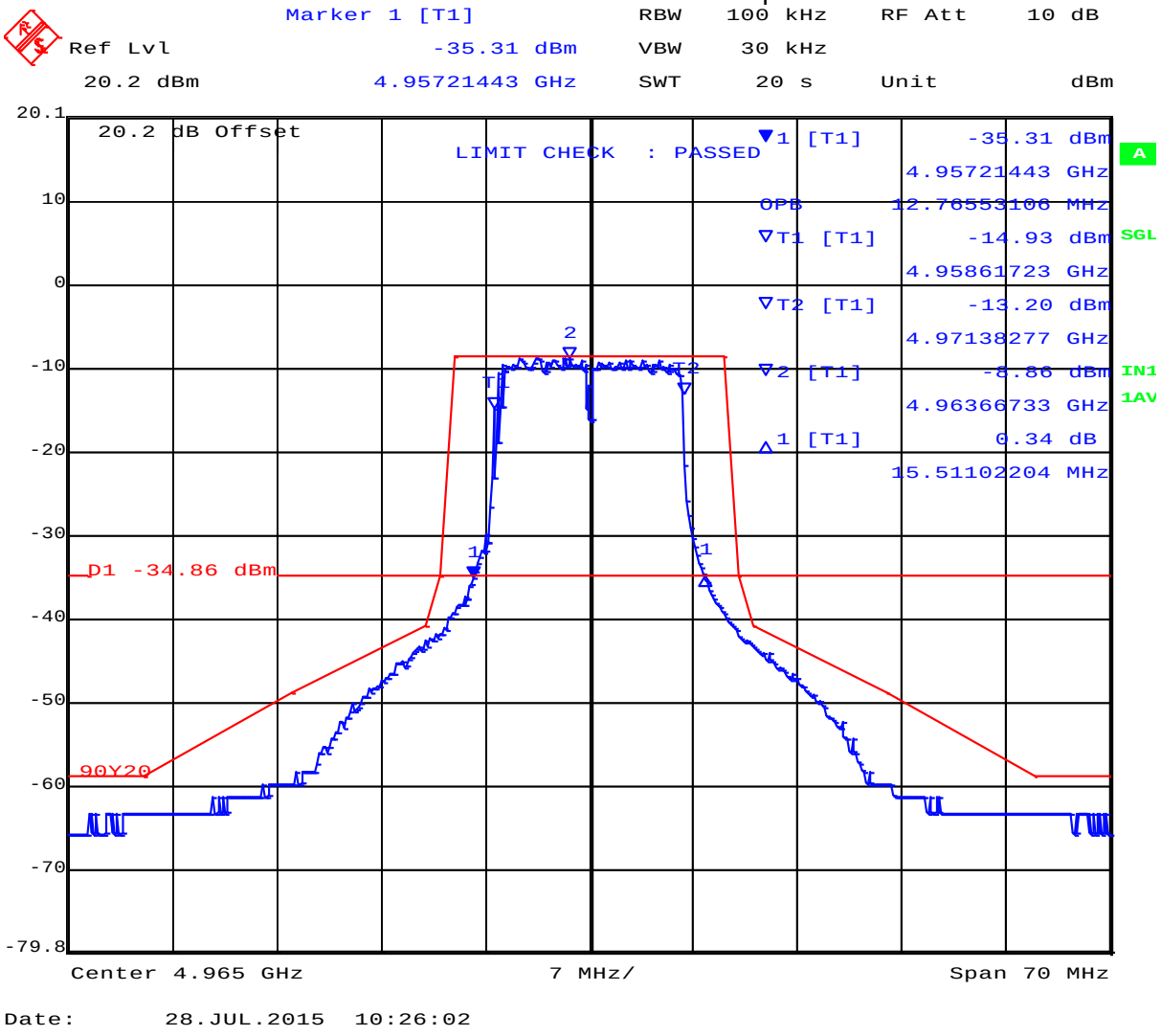


Port B

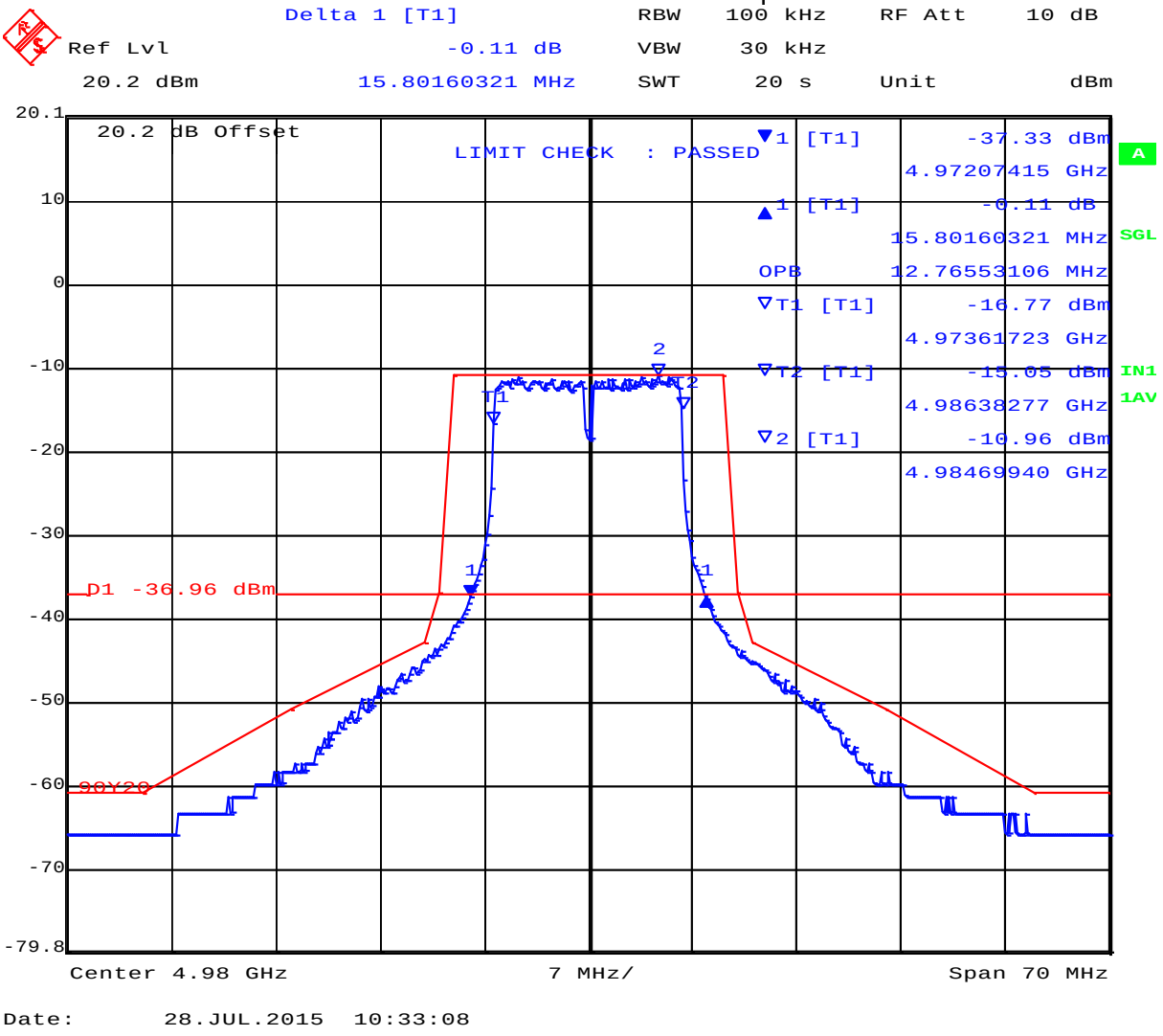
26 dB Bandwidth 20 MHz Channel Freq 4950 MHz



Port B
26 dB Bandwidth 20 MHz Channel Freq 4965 MHz



Port B
26 dB Bandwidth 20 MHz Channel Freq 4980 MHz



Specification Limits
FCC Part §90.210

Limits for Authorized Bandwidth

Frequency Band (MHz) and Related Documents	Spectrum Masks with Audio Filter	Without Audio Filter
4950 – 4990 MHz	L or M	L or M

Reference to the emission masks are provided below

Limits Emission Masks
90.210(L)

Emission Mask L. For low power transmitters (20 dBm or less) operating in the 4940-4990 MHz frequency band, the power spectral density of the emissions must be attenuated below the output power of the transmitter as follows:

(1) On any frequency removed from the assigned frequency between 0-45% of the authorized bandwidth (BW): 0 dB.

(2) On any frequency removed from the assigned frequency between 45-50% of the authorized bandwidth: 219 log (% of (BW)/45) dB.

(3) On any frequency removed from the assigned frequency between 50-55% of the authorized bandwidth: 10 + 242 log (% of (BW)/50) dB.

(4) On any frequency removed from the assigned frequency between 55-100% of the authorized bandwidth: 20 + 31 log (% of (BW)/55) dB attenuation.

(5) On any frequency removed from the assigned frequency between 100-150% of the authorized bandwidth: 28 + 68 log (% of (BW)/100) dB attenuation.

(6) On any frequency removed from the assigned frequency above 150% of the authorized bandwidth: 40 dB.

(7) The zero dB reference is measured relative to the highest average power of the fundamental emission measured across the designated channel bandwidth using a resolution bandwidth of at least one percent of the occupied bandwidth of the fundamental emission and a video bandwidth of 30 kHz. The power spectral density is the power measured within the resolution bandwidth of the measurement device divided by the resolution bandwidth of the measurement device. Emission levels are also based on the use of measurement instrumentation employing a resolution bandwidth of at least one percent of the occupied bandwidth.

Limits Emission Masks (continued)
90.210(M),

(m) *Emission Mask M.* For high power transmitters (greater than 20 dBm) operating in the 4940-4990 MHz frequency band, the power spectral density of the emissions must be attenuated below the output power of the transmitter as follows:

(1) On any frequency removed from the assigned frequency between 0-45% of the authorized bandwidth (BW): 0 dB.

(2) On any frequency removed from the assigned frequency between 45-50% of the authorized bandwidth: 568 log (% of (BW)/45) dB.

(3) On any frequency removed from the assigned frequency between 50-55% of the authorized bandwidth: 26 + 145 log (% of BW/50) dB.

(4) On any frequency removed from the assigned frequency between 55-100% of the authorized bandwidth: 32 + 31 log (% of (BW)/55) dB.

(5) On any frequency removed from the assigned frequency between 100-150% of the authorized bandwidth: 40 + 57 log (% of (BW)/100) dB.

(6) On any frequency removed from the assigned frequency between above 150% of the authorized bandwidth: 50 dB or 55 + 10 log (P) dB, whichever is the lesser attenuation.

(7) The zero dB reference is measured relative to the highest average power of the fundamental emission measured across the designated channel bandwidth using a resolution bandwidth of at least one percent of the occupied bandwidth of the fundamental emission and a video bandwidth of 30 kHz. The power spectral density is the power measured within the resolution bandwidth of the measurement device divided by the resolution bandwidth of the measurement device. Emission levels are also based on the use of measurement instrumentation employing a resolution bandwidth of at least one percent of the occupied bandwidth.

NOTE TO PARAGRAPH (m): Low power devices may as an option, comply with paragraph (m).

Laboratory Measurement Uncertainty for Power Measurements

Measurement uncertainty	±1.33 dB

Traceability

Method
Measurements were made per work instruction WI-03 ‘Measurement of RF Spectrum Mask’

6.1.2. Output Power

FCC 47 CFR Part 90, Subpart Y; §90.1215

Test Procedure

Average power measurements were measured with the use of an average power head. Peak power measurements were recorded via the spectrum analyzer. The system highest power setting was selected with modulation ON. Should the device implement a duty cycle then this is added to the measured power as a Duty Cycle Correction Factor (DCCF).

TABLE OF RESULTS – 5 MHZ BANDWIDTH MODULATED CARRIER

5 MHz Duty Cycle Correction factor 62.0%

Center Frequency (MHz)	Peak Transmitter Power (+dBm)		Total Power + DCCF (dBm)
	Port A	Port B	Calculated
4942.5	21.71	21.67	26.78
4967.5	21.91	20.87	26.69
4987.5	21.62	21.79	26.97

TABLE OF RESULTS – 10 MHz Bandwidth Modulated Carrier

10 MHz Duty Cycle Correction factor 60.2%

Center Frequency (MHz)	Peak Transmitter Power (+dBm)		Total Power + DCCF (dBm)
	Port A	Port B	Calculated
4945	21.29	22.10	26.93
4965	22.33	20.47	26.71
4985	21.33	22.78	27.41

TABLE OF RESULTS – 20 MHz Bandwidth Modulated Carrier

20 MHz Duty Cycle Correction factor 60.2%

Center Frequency (MHz)	Peak Transmitter Power (+dBm)		Total Power + DCCF (dBm)
	Port A	Port B	Calculated
4950	20.62	20.17	25.86
4965	22.57	23.08	28.24
4980	21.86	22.92	27.84

DCCF – Duty Cycle Correction Factor

Specification Limits

FCC Part §90.1215

Power limits.

The transmitting power of stations operating in the 4940-4990 MHz band must not exceed the maximum limits in this section.

(a)(1) The maximum conducted output power should not exceed:

Channel Bandwidth (MHz)	Low Transmitter Power (dBm)	High Transmitter Power (dBm)
1	7	20
5	14	27
10	17	30
15	18.8	31.8
20	20	33

(2) High power devices are also limited to a peak power spectral density of 21 dBm per one MHz. High power devices using channel bandwidths other than those listed above are permitted; however, they are limited to peak power spectral density of 21 dBm/MHz. If transmitting antennas of directional gain greater than 9 dBi are used, both the maximum conducted output power and the peak power spectral density should be reduced by the amount in decibels that the directional gain of the antenna exceeds 9 dBi. However, high power point-to-point and point-to-multipoint operations (both fixed and temporary-fixed rapid deployment) may employ transmitting antennas with directional gain up to 26 dBi without any corresponding reduction in the maximum conducted output power or spectral density. Corresponding reduction in the maximum conducted output power and peak power spectral density should be the amount in decibels that the directional gain of the antenna exceeds 26 dBi.

(b) Low power devices are also limited to a peak power spectral density of 8 dBm per one MHz. Low power devices using channel bandwidths other than those listed above are permitted; however, they are limited to a peak power spectral density of 8 dBm/MHz. If transmitting antennas of directional gain greater than 9 dBi are used, both the maximum conducted output power and the peak power spectral density should be reduced by the amount in decibels that the directional gain of the antenna exceeds 9 dBi.

(c) The maximum conducted output power is measured as a conducted emission over any interval of continuous transmission using instrumentation calibrated in terms of an RMS-equivalent voltage. If the device cannot be connected directly, alternative techniques acceptable to the Commission may be used. The measurement results shall be properly adjusted for any instrument limitations, such as detector response times, limited resolution bandwidth capability when compared to the emission bandwidth, sensitivity, etc., so as to obtain a true maximum conducted output power measurement conforming to the definitions in this paragraph for the emission in question.

(d) The peak power spectral density is measured as conducted emission by direct connection of a calibrated test instrument to the equipment under test. If the device cannot be connected directly, alternative techniques acceptable to the Commission may be used. Measurements are made over a bandwidth of one MHz or the 26 dB emission bandwidth of the device, whichever is less. A resolution bandwidth less than the measurement bandwidth can be used, provided that the measured power is integrated to show total power over the measurement bandwidth. If the resolution bandwidth is approximately equal to the measurement bandwidth, and much less than the emission bandwidth of the equipment under test, the measured results shall be corrected to account for any difference between the resolution bandwidth of the test instrument and its actual noise bandwidth.

(e) The ratio of the peak excursion of the modulation envelope (measured using a peak hold function) to the maximum conducted output power shall not exceed 13 dB across any 1 MHz bandwidth or the emission bandwidth whichever is less.

Laboratory Measurement Uncertainty for Power Measurement

Measurement uncertainty	±1.33 dB

Traceability

Method
Measurements were made per work instruction WI-03 'Measurement of RF Output Power'

6.1.3. Peak Power Spectral Density (PPSD)

FCC 47 CFR Part 90, Subpart Y; §**90.1215**

Test Procedure

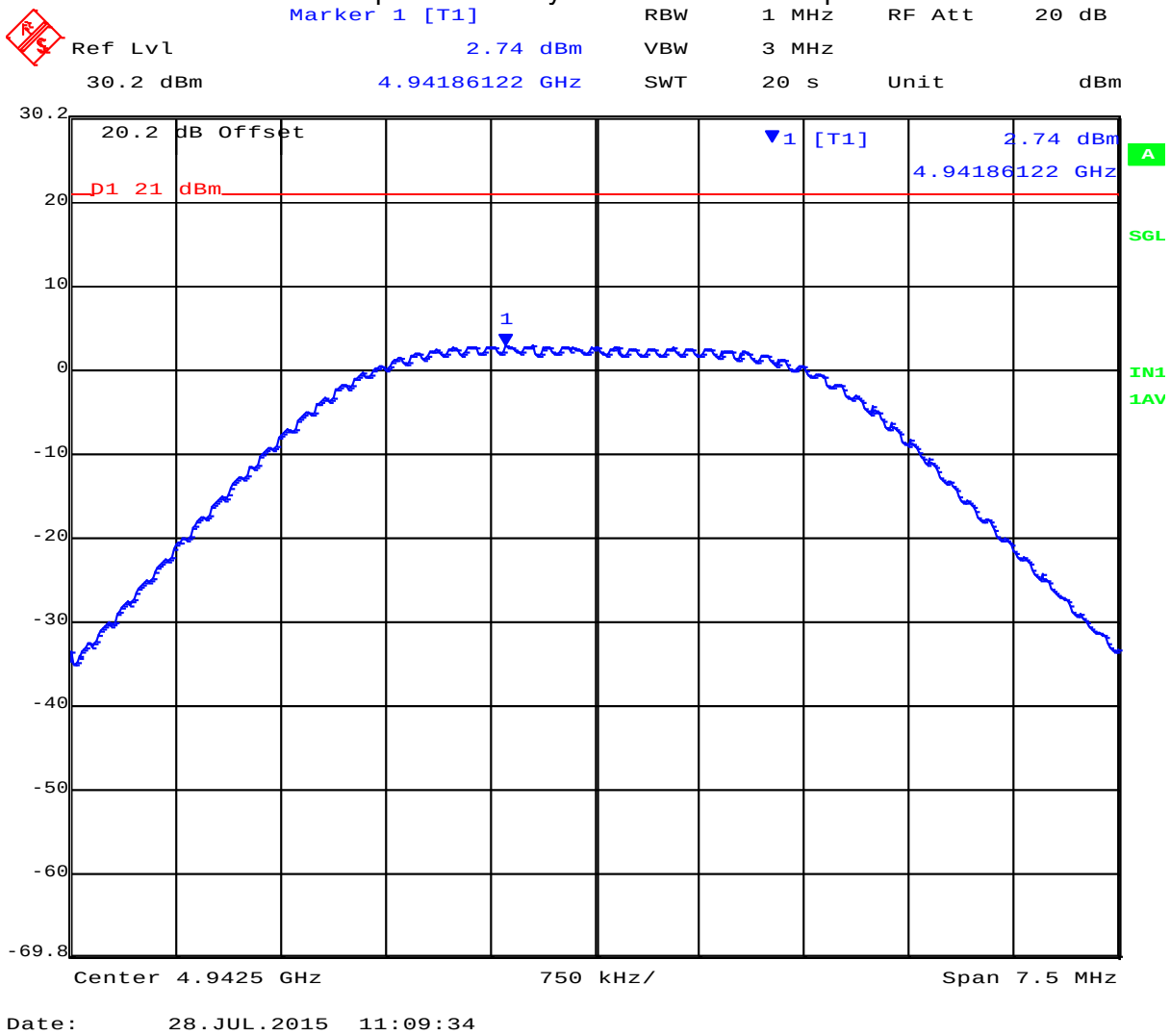
The test methodology used for this measurement was determined to provide the highest possible PPSD readings.

Peak power spectral density measurements were performed via the spectrum analyzer and plots were recorded. Modulation was ON and the system duty cycle was set for 100% i.e. continuous operation at all times. The system highest power setting was selected with modulation ON and duty cycle set for 100% i.e. continuous operation at all times.

TABLE OF RESULTS – 5 MHz Peak Power Spectral Density

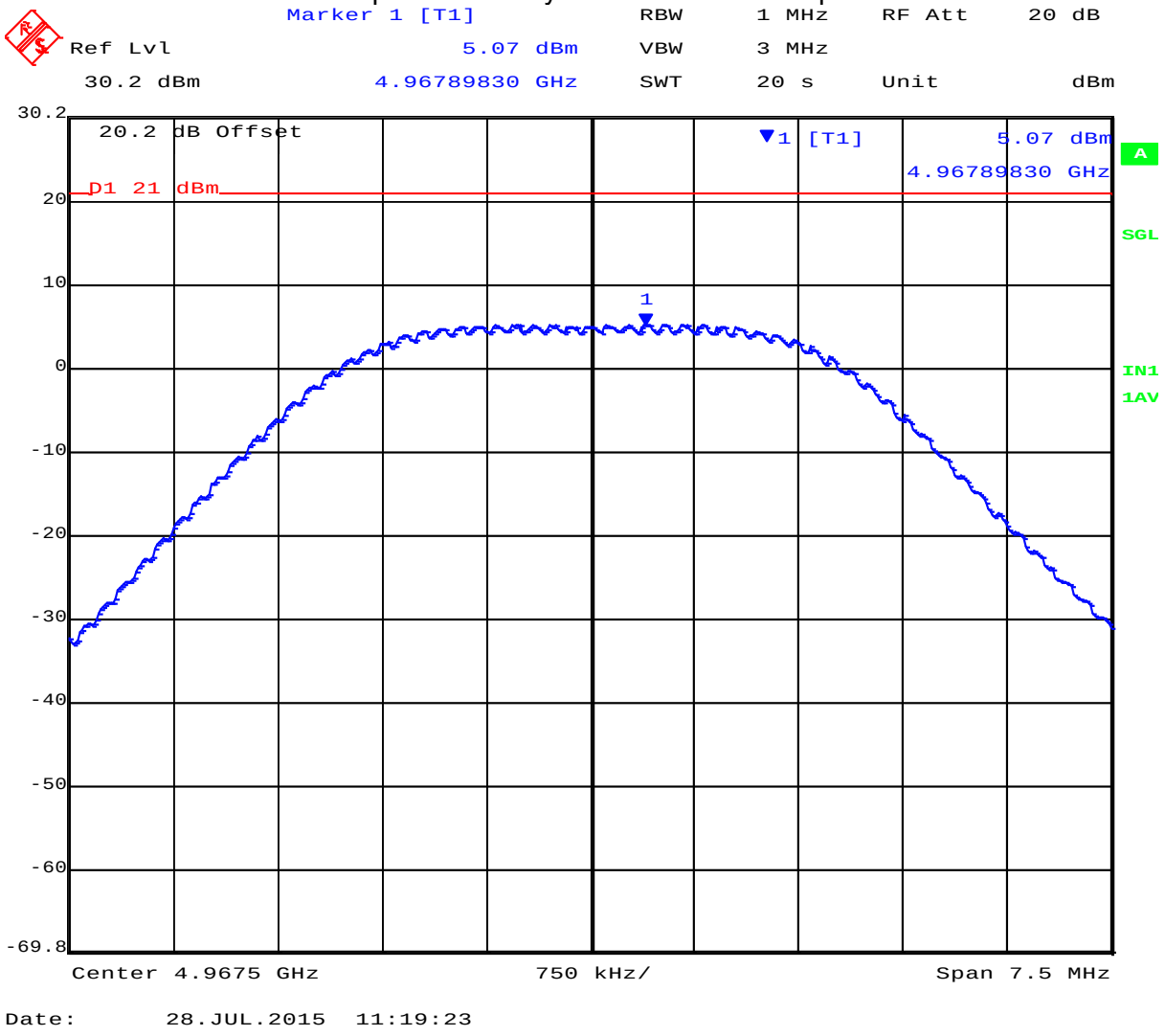
Center Frequency (MHz)	Peak Power Spectral Density (dBm/MHz)		
	Port A	Port B	Total
4942.5	2.74	3.46	8.34
4967.5	5.07	5.67	10.61
4987.5	2.69	4.81	9.11

Port A
Peak Power Spectral Density 5 MHz Channel Freq 4942.5 MHz



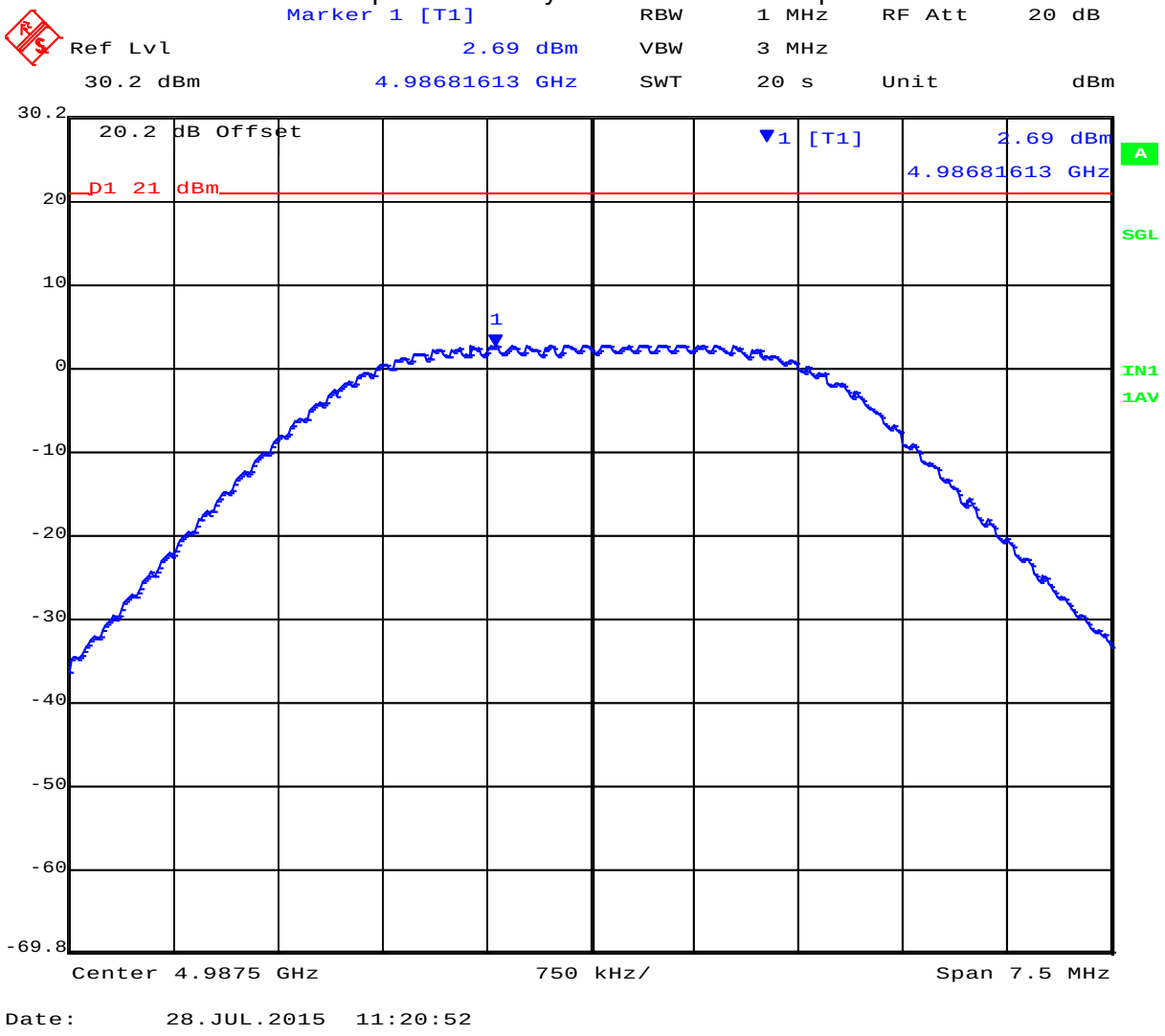
Port A

Peak Power Spectral Density 5 MHz Channel Freq 4967.5 MHz



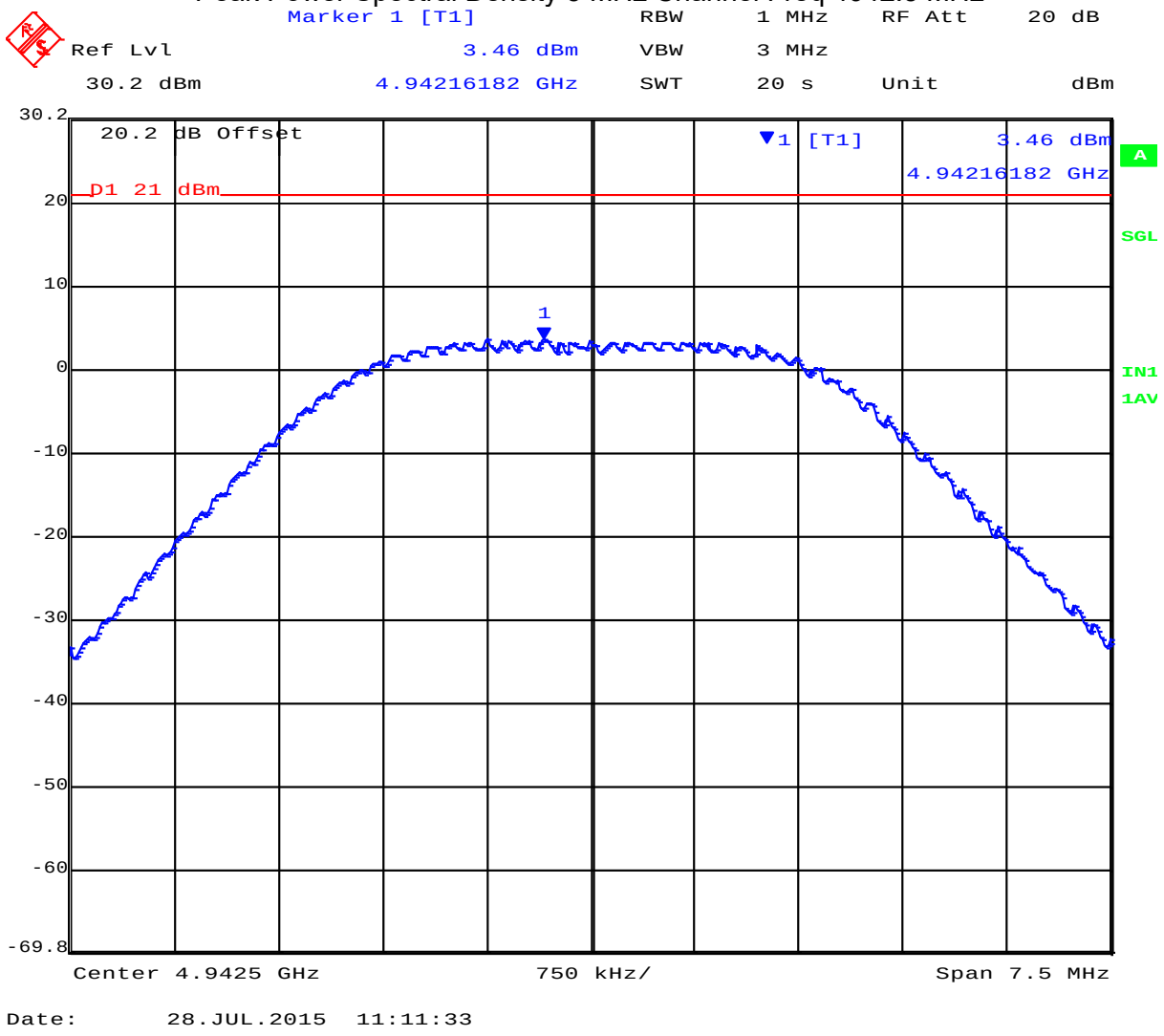
Port A

Peak Power Spectral Density 5 MHz Channel Freq 4987.5 MHz



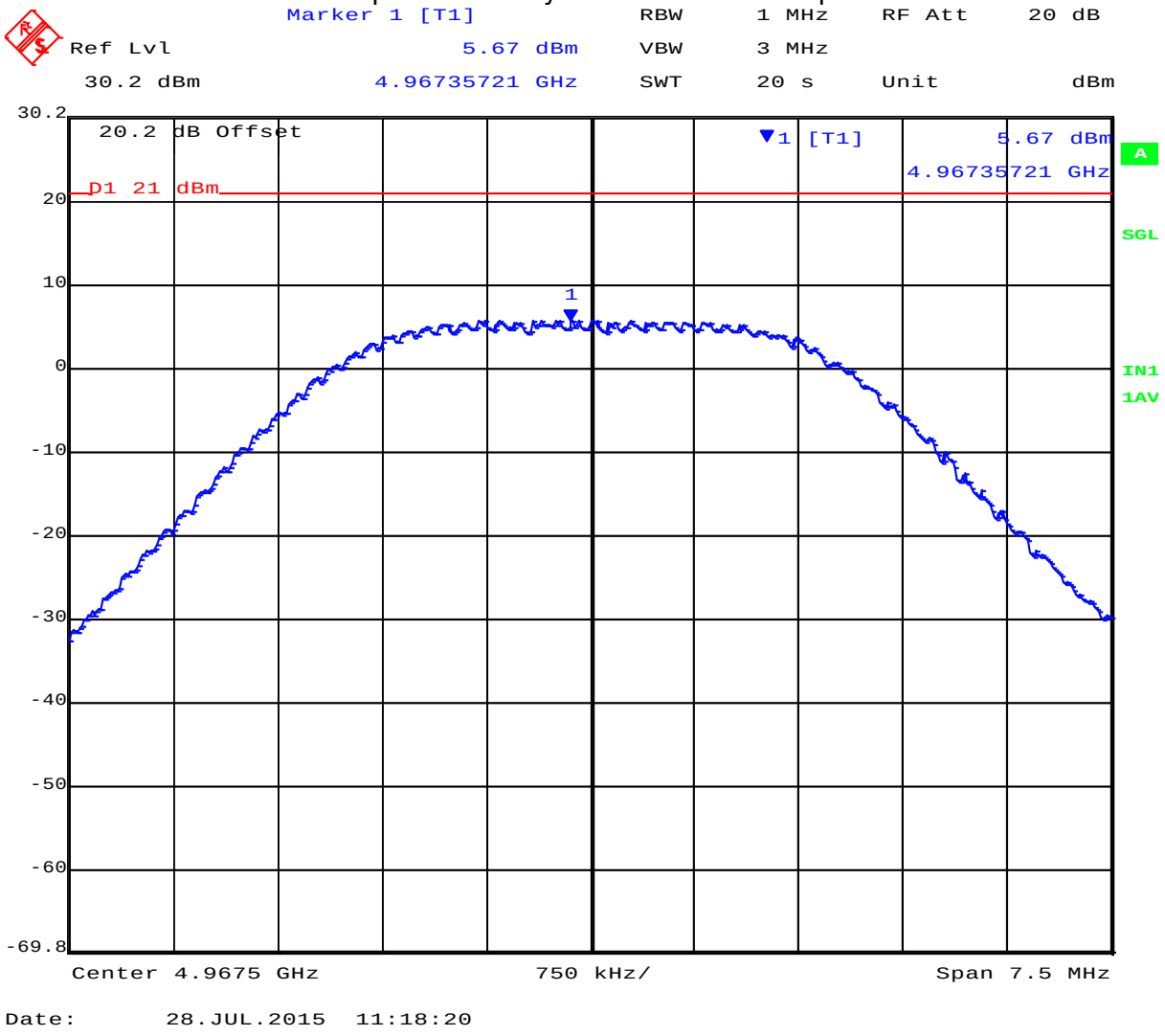
Port B

Peak Power Spectral Density 5 MHz Channel Freq 4942.5 MHz



Port B

Peak Power Spectral Density 5 MHz Channel Freq 4967.5 MHz



Port B

Peak Power Spectral Density 5 MHz Channel Freq 4987.5 MHz

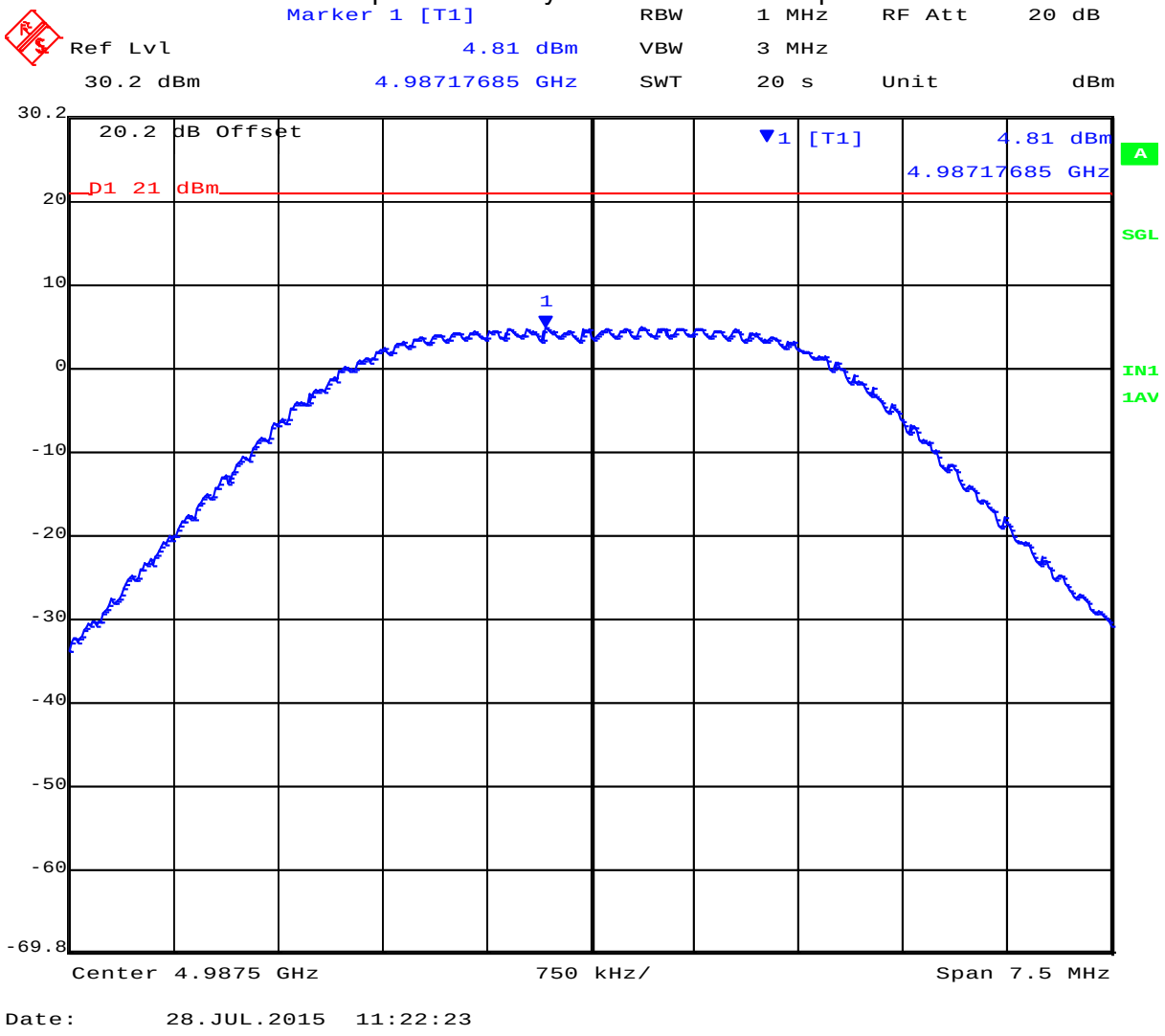
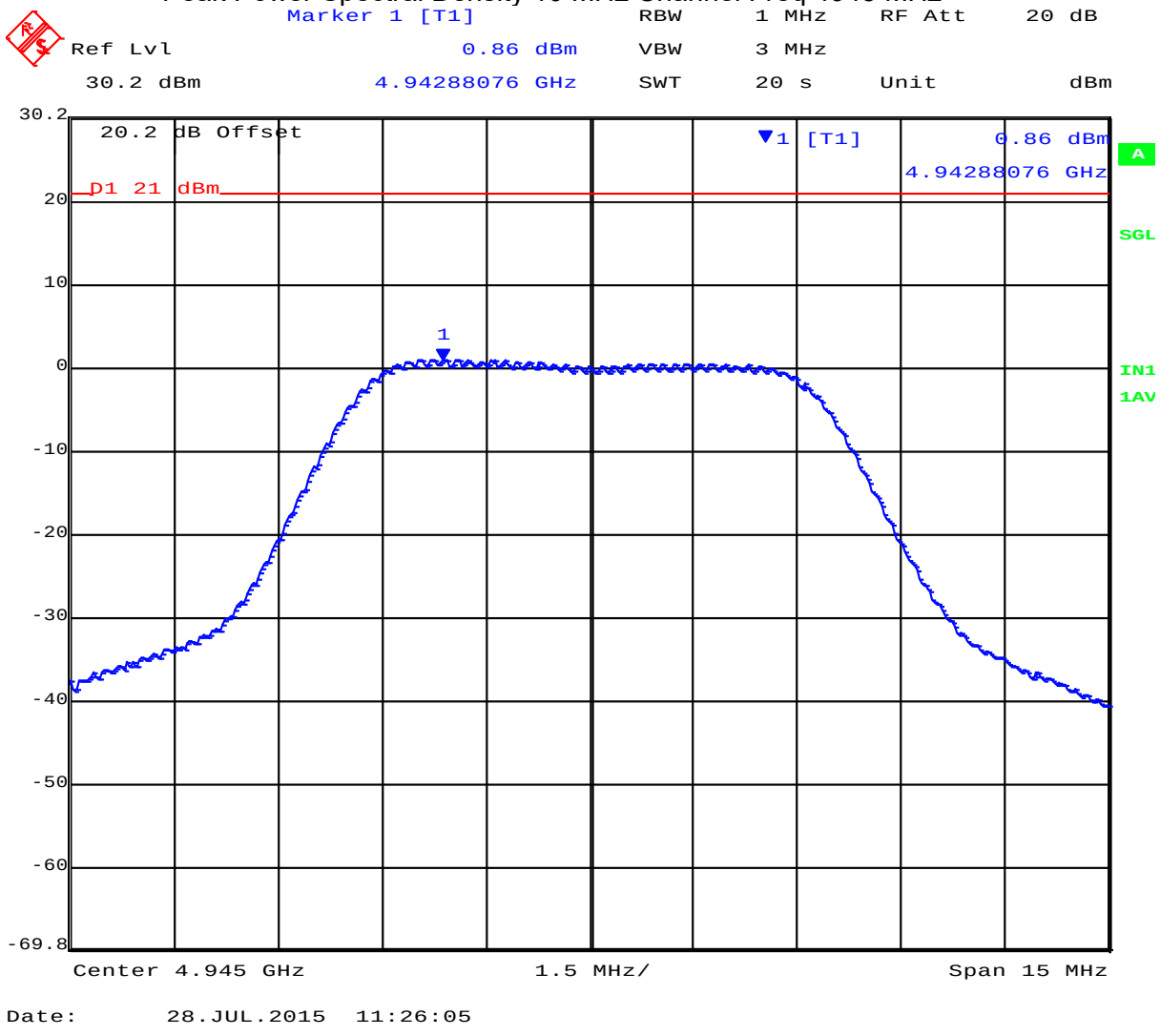


TABLE OF RESULTS – 10 MHz Peak Power Spectral Density(s)

Center Frequency (MHz)	Peak Power Spectral Density (dBm/MHz)		
	Port A	Port B	Total
4945	0.86	1.67	6.51
4965	3.52	4.06	9.03
4985	-0.03	2.01	6.34

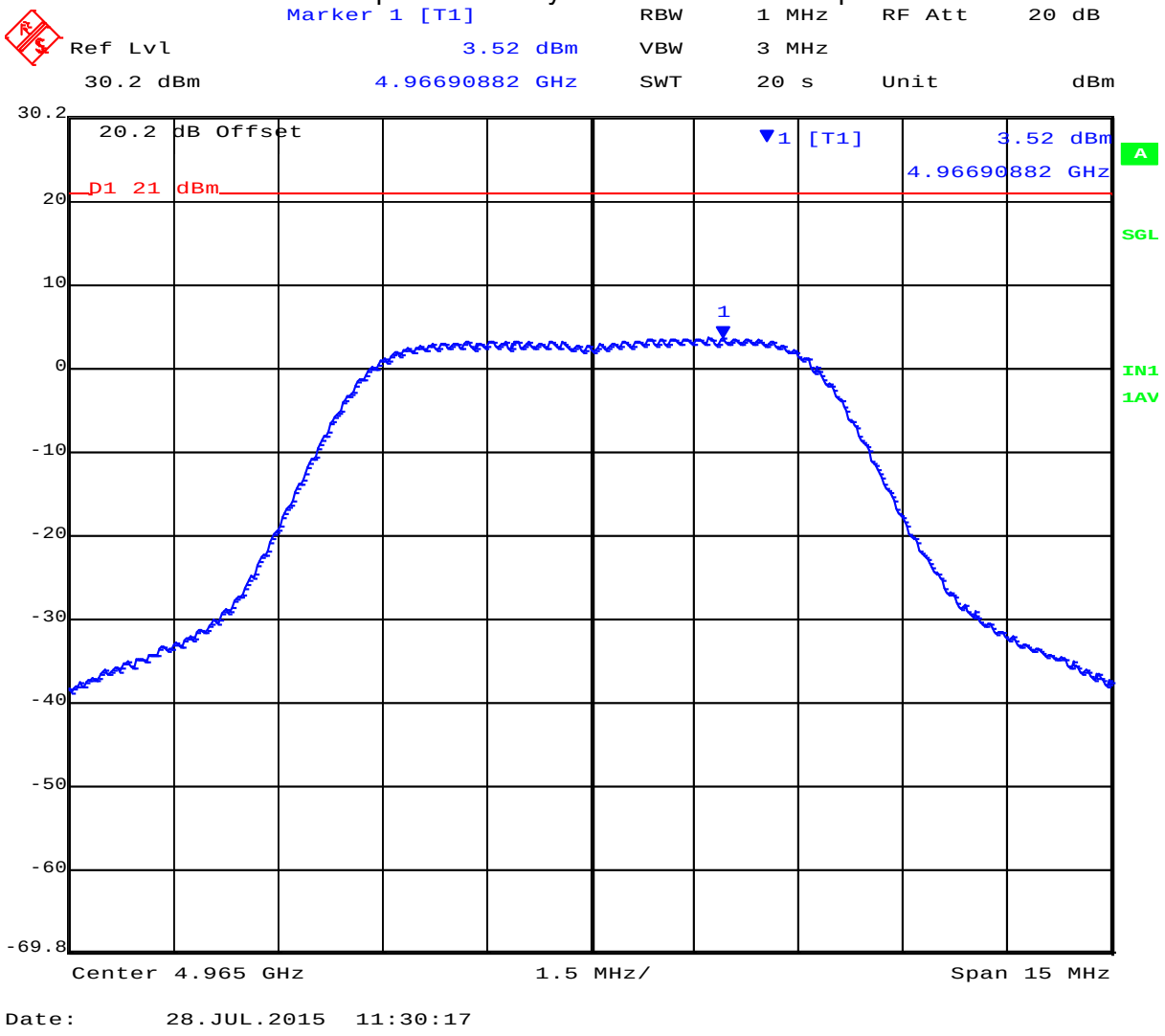
Port A

Peak Power Spectral Density 10 MHz Channel Freq 4945 MHz



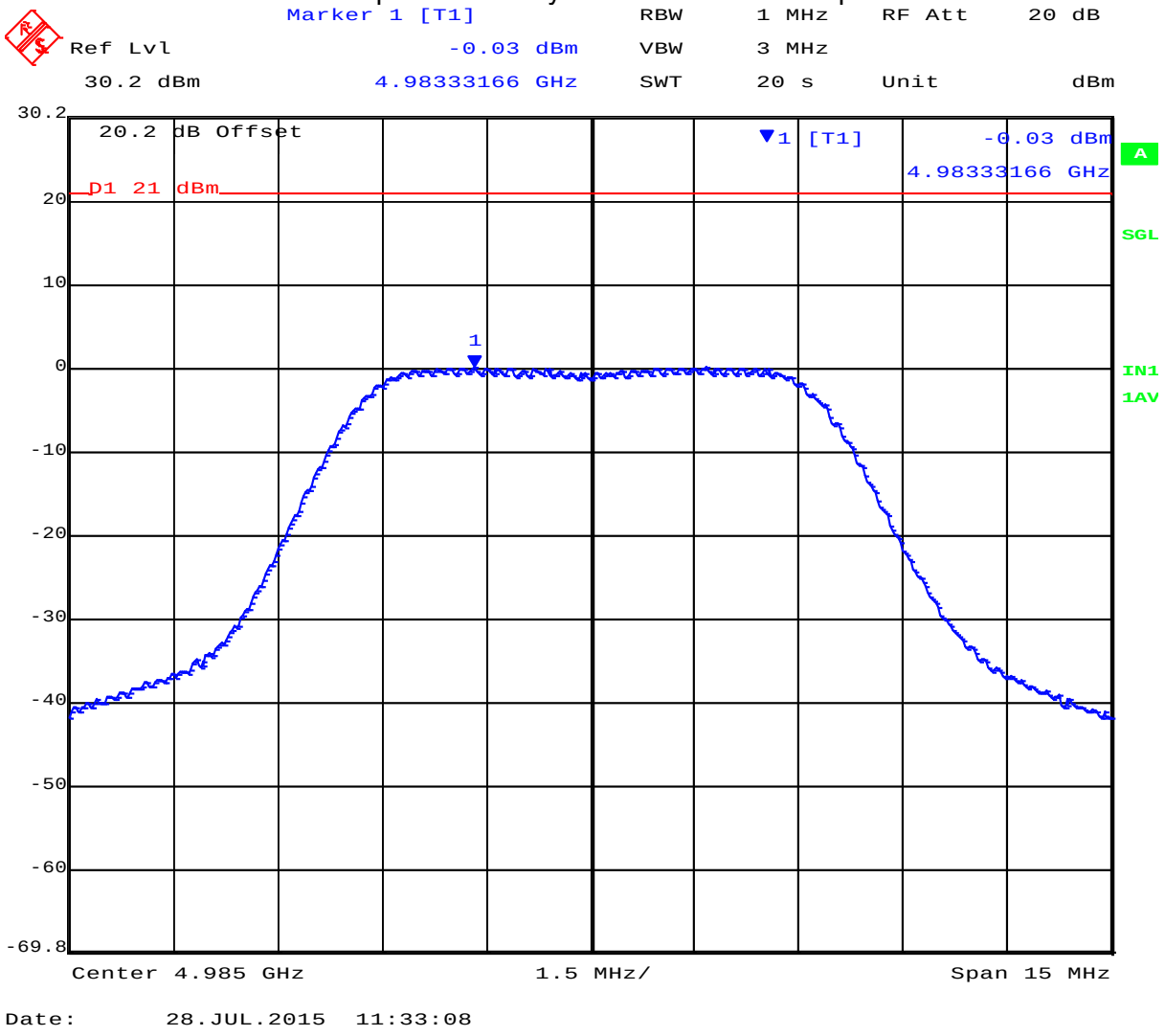
Port A

Peak Power Spectral Density 10 MHz Channel Freq 4965 MHz



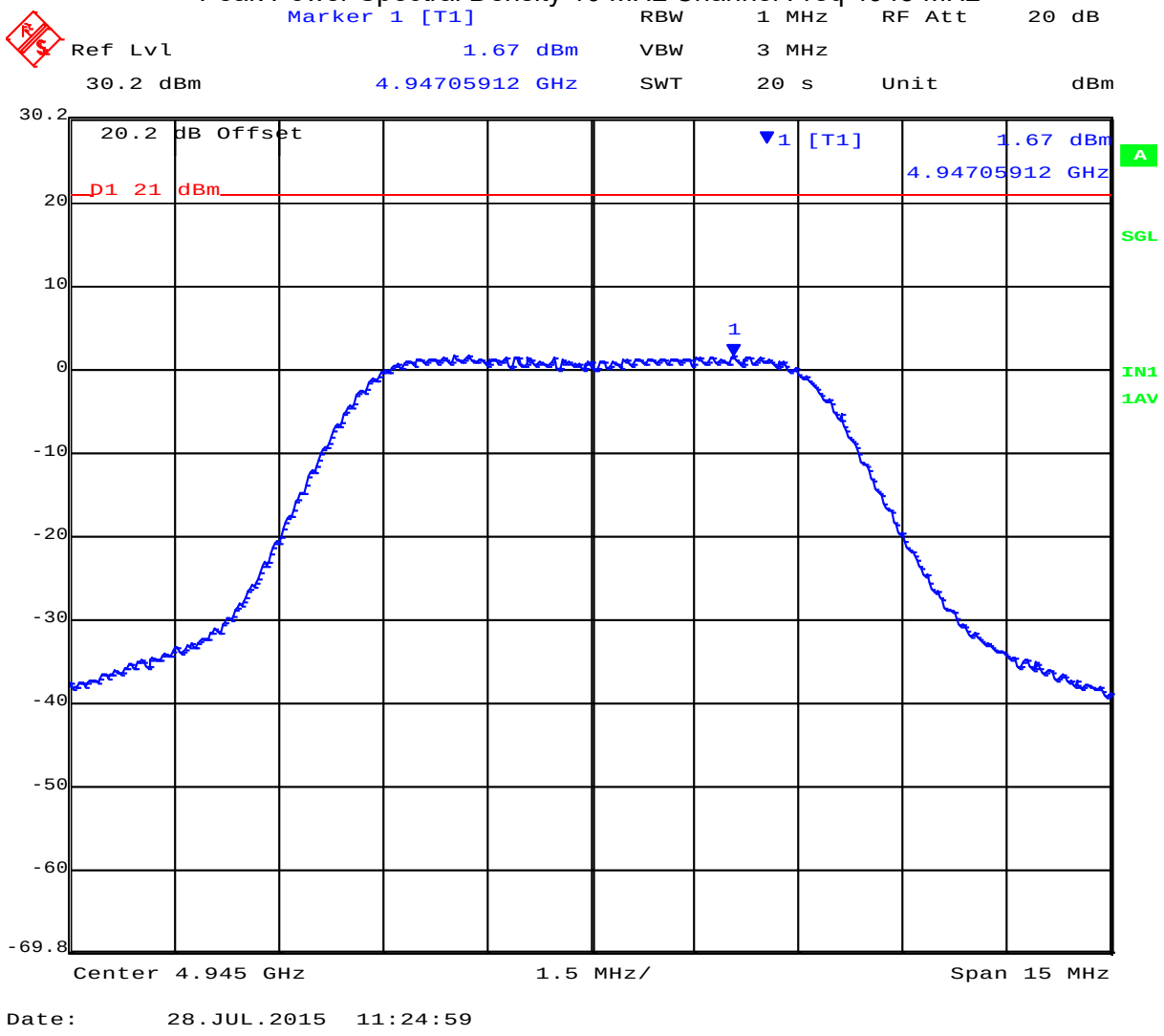
Port A

Peak Power Spectral Density 10 MHz Channel Freq 4985 MHz



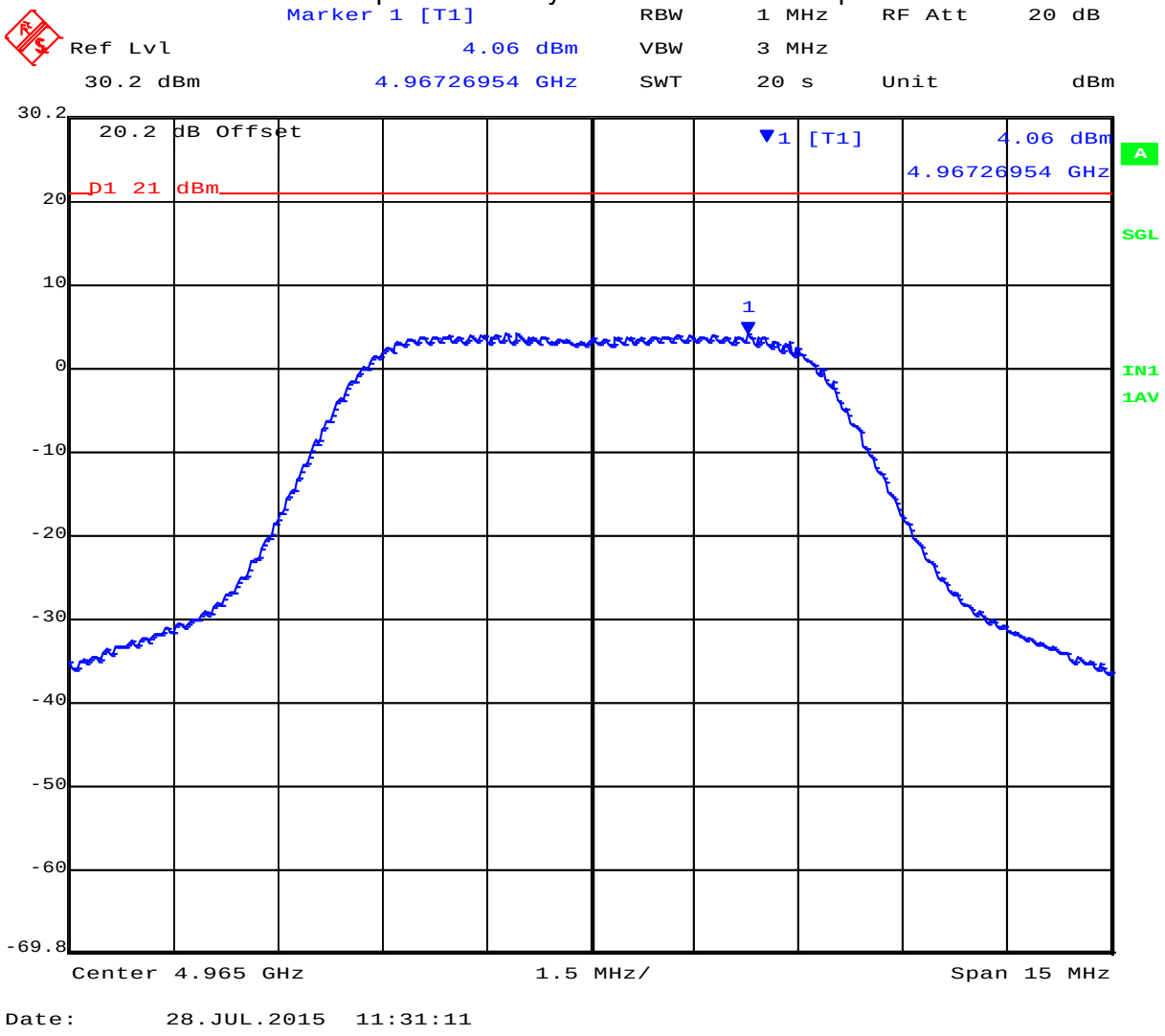
Port B

Peak Power Spectral Density 10 MHz Channel Freq 4945 MHz



Port B

Peak Power Spectral Density 10 MHz Channel Freq 4965 MHz



Port B

Peak Power Spectral Density 10 MHz Channel Freq 4985 MHz

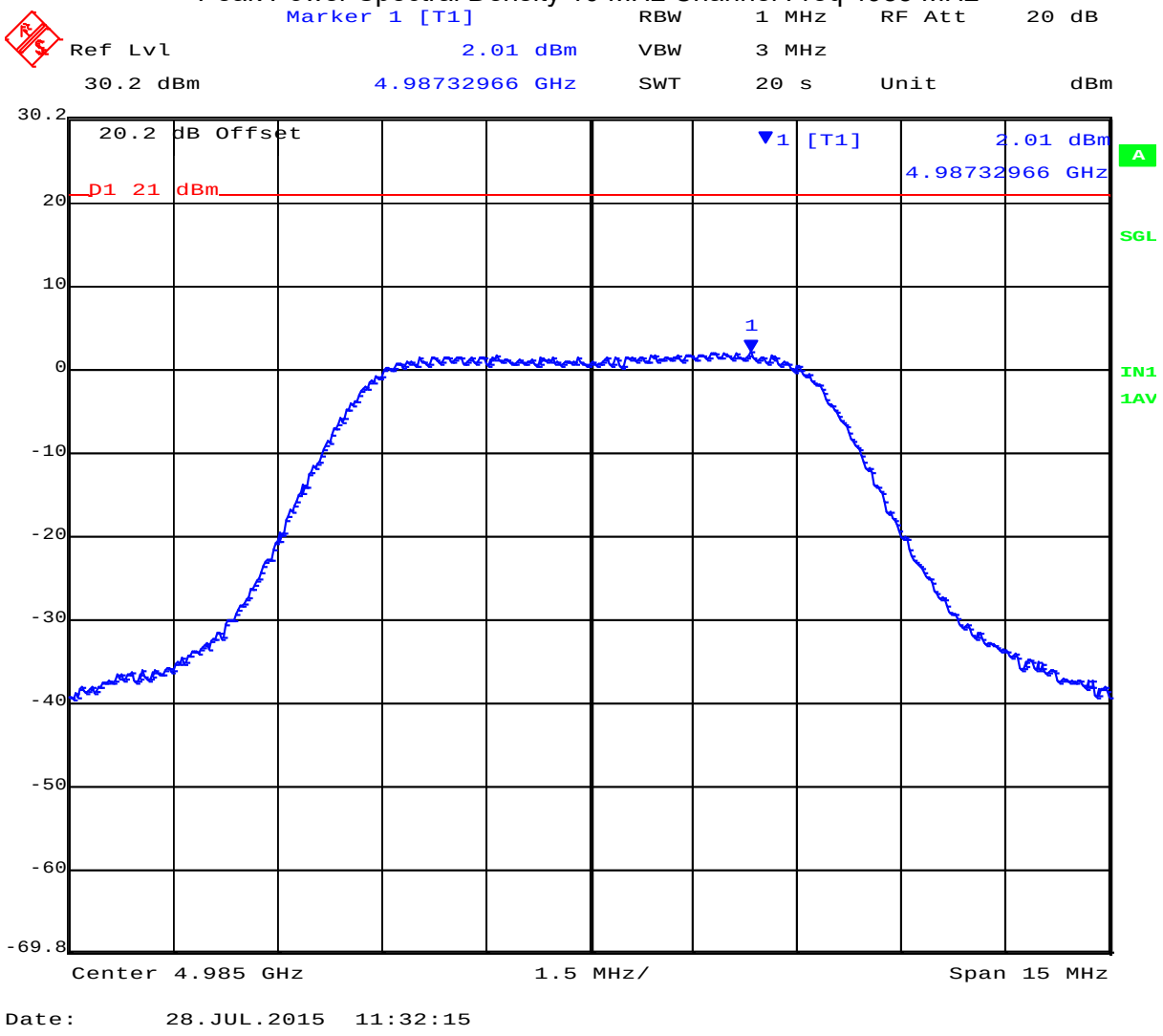
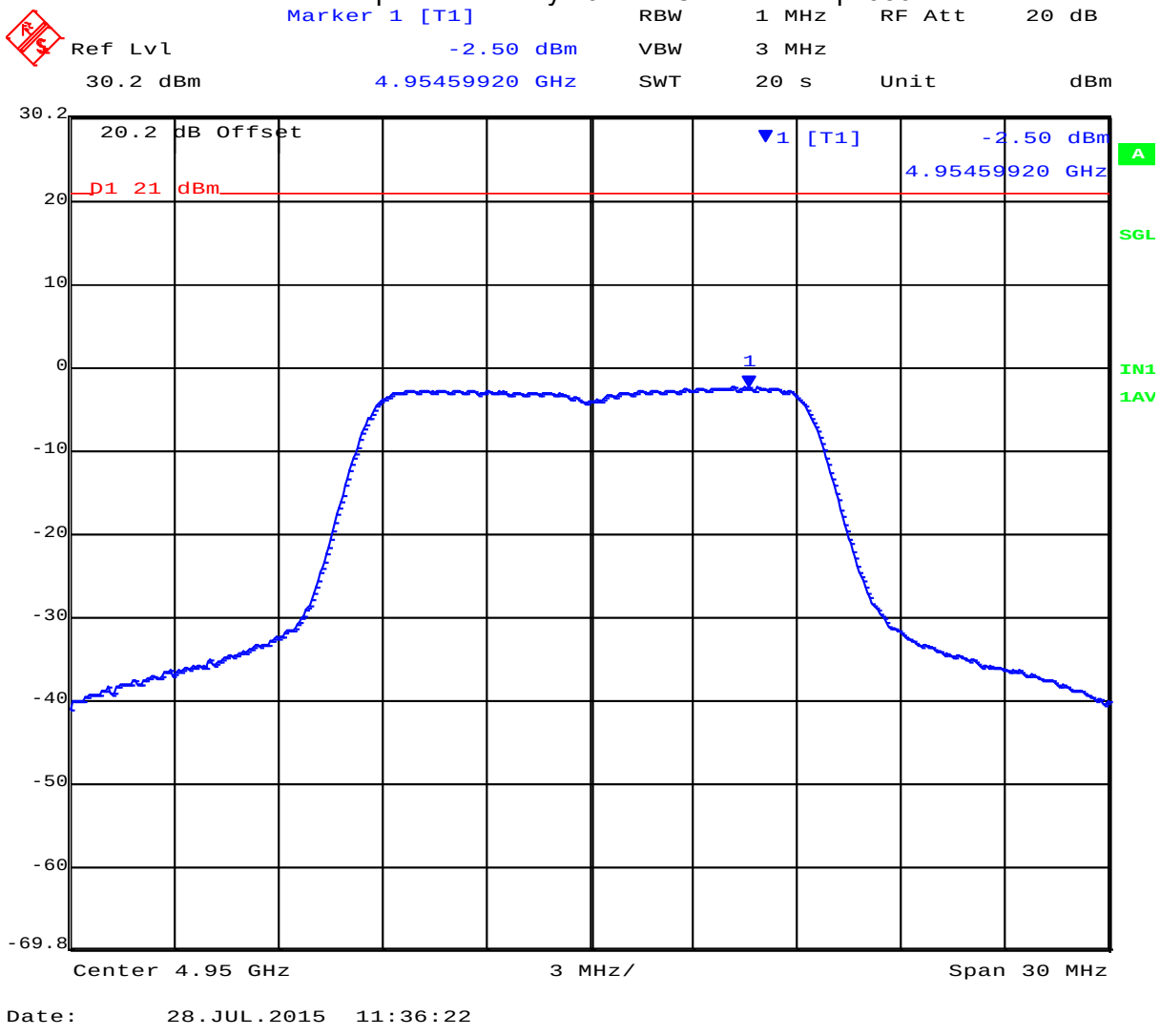


TABLE OF RESULTS – 20 MHz Peak Power Spectral Density(s)

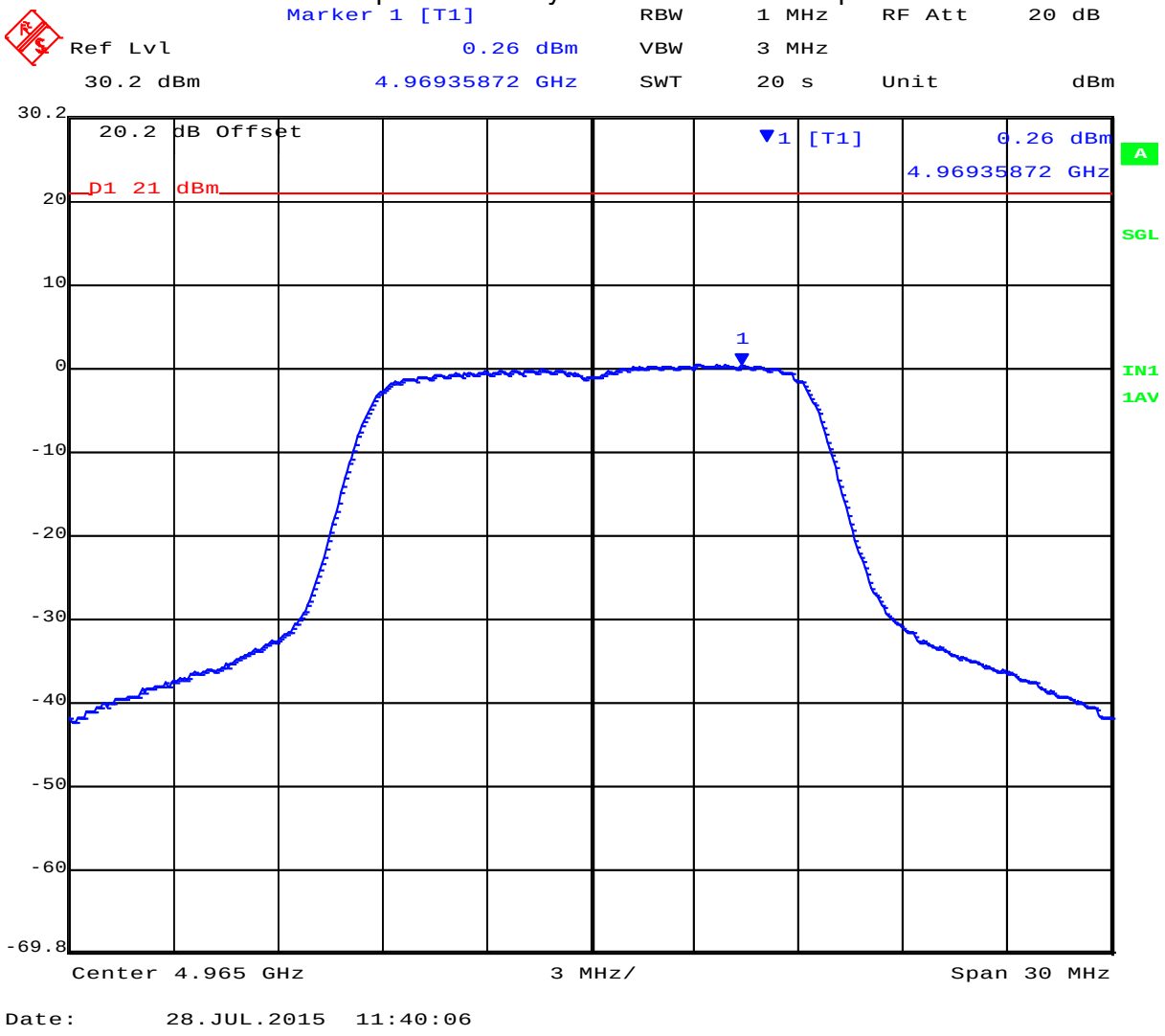
Center Frequency (MHz)	Peak Power Spectral Density (dBm/MHz)		
	Port A	Port B	Total
4950	-2.50	-0.75	3.69
4965	0.26	0.77	5.75
4980	-2.12	-1.54	3.41

Port A
Peak Power Spectral Density 20 MHz Channel Freq 4950 MHz



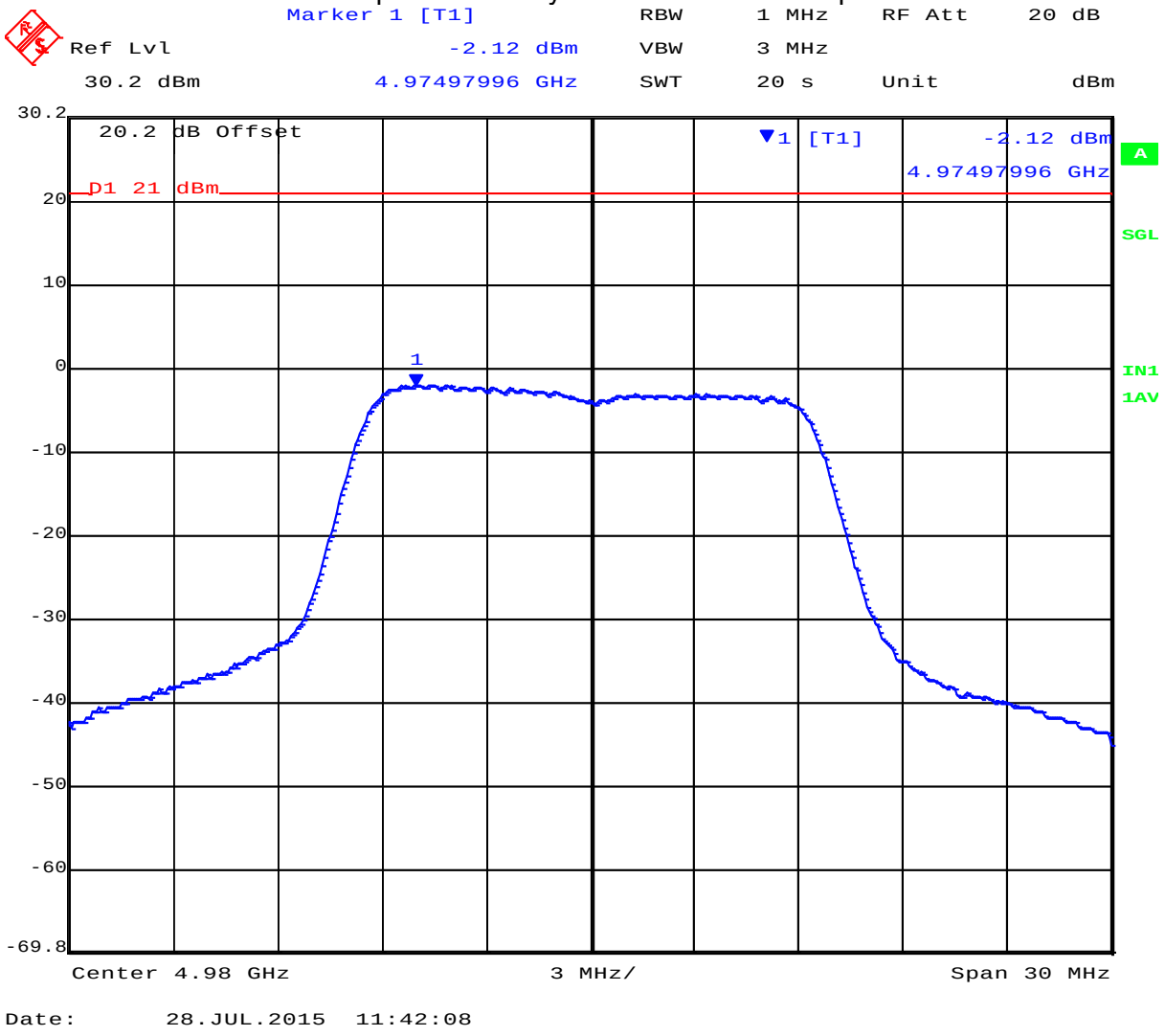
Port A

Peak Power Spectral Density 20 MHz Channel Freq 4965 MHz



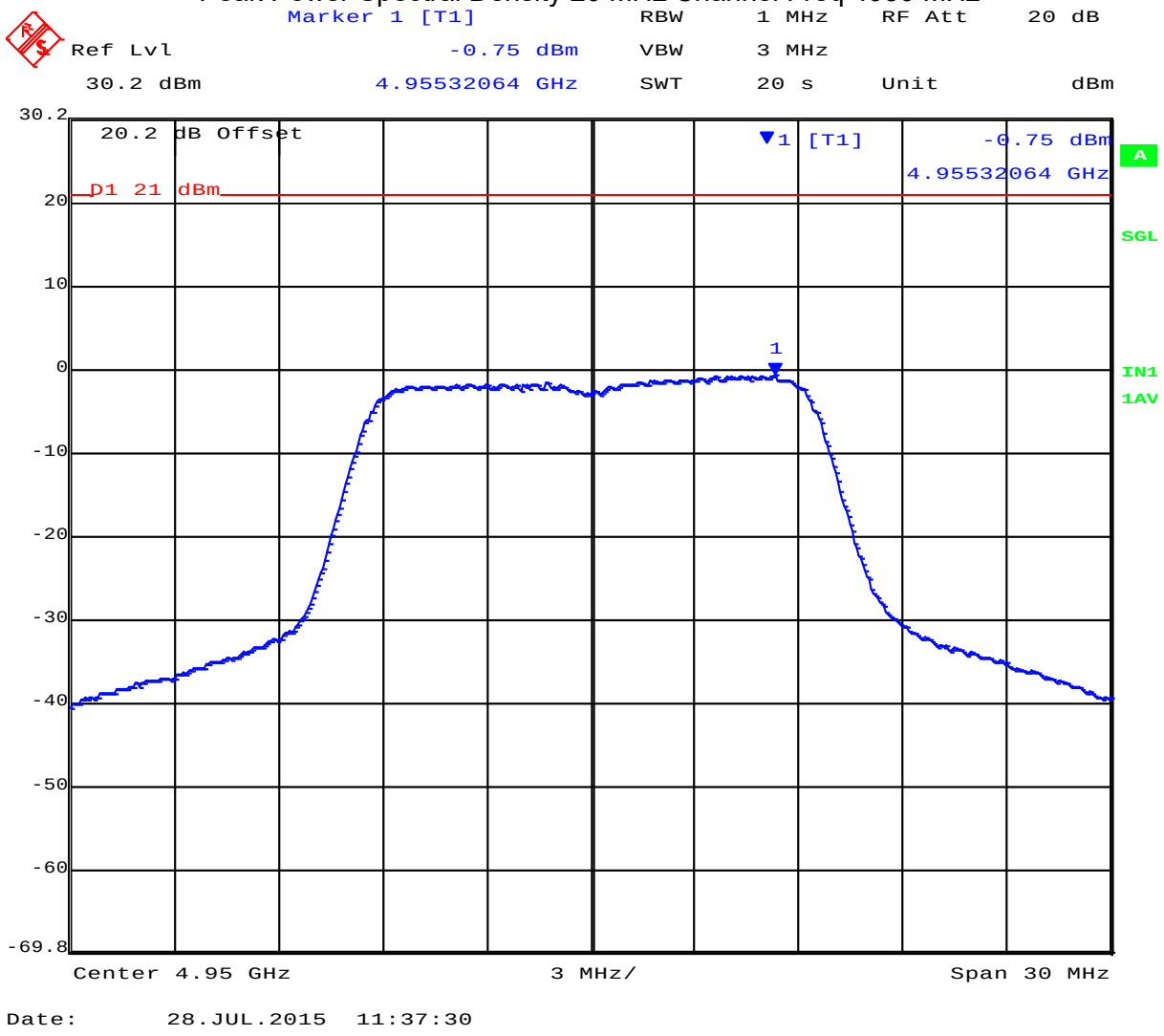
Port A

Peak Power Spectral Density 20 MHz Channel Freq 4980 MHz



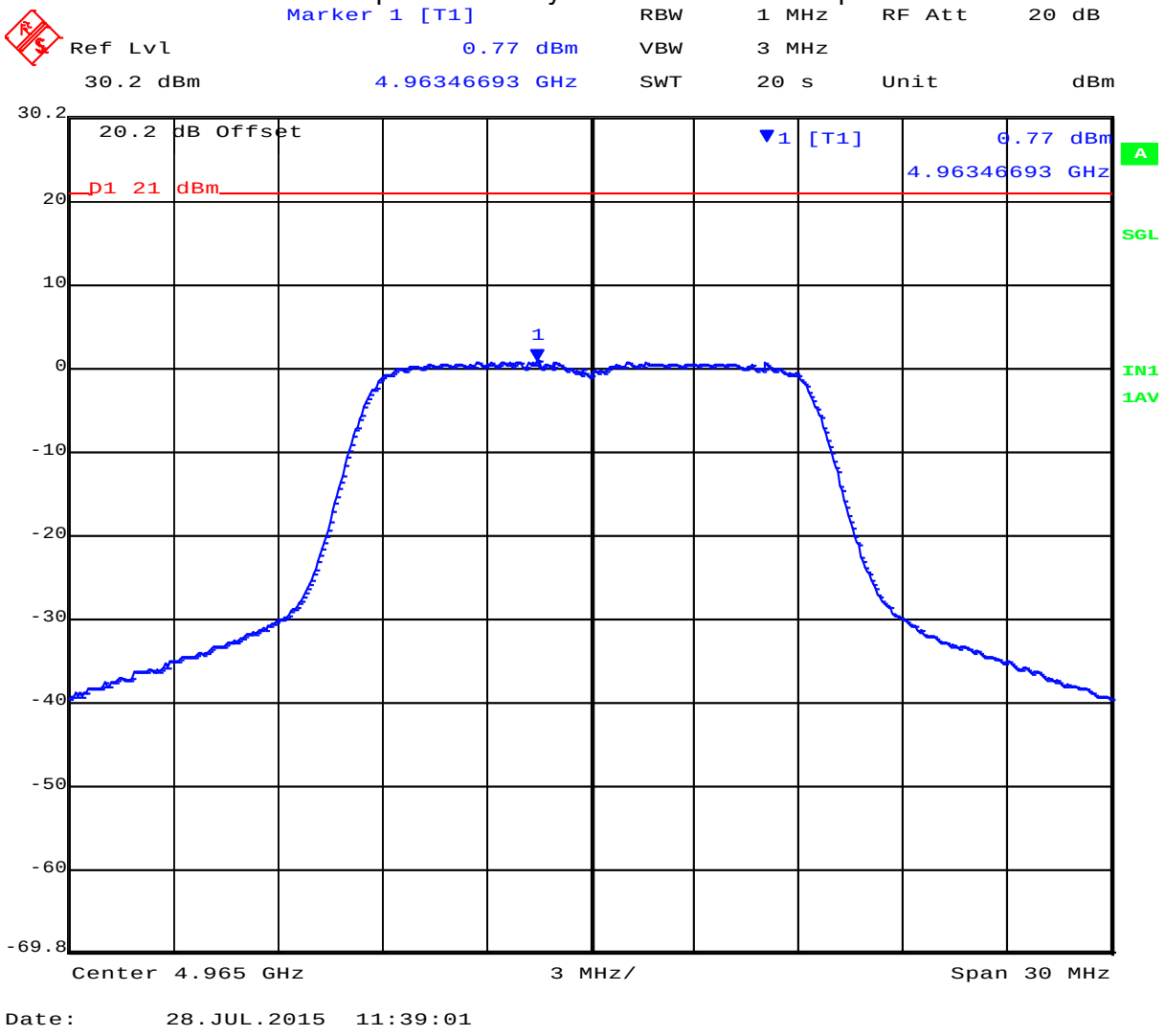
Port B

Peak Power Spectral Density 20 MHz Channel Freq 4950 MHz



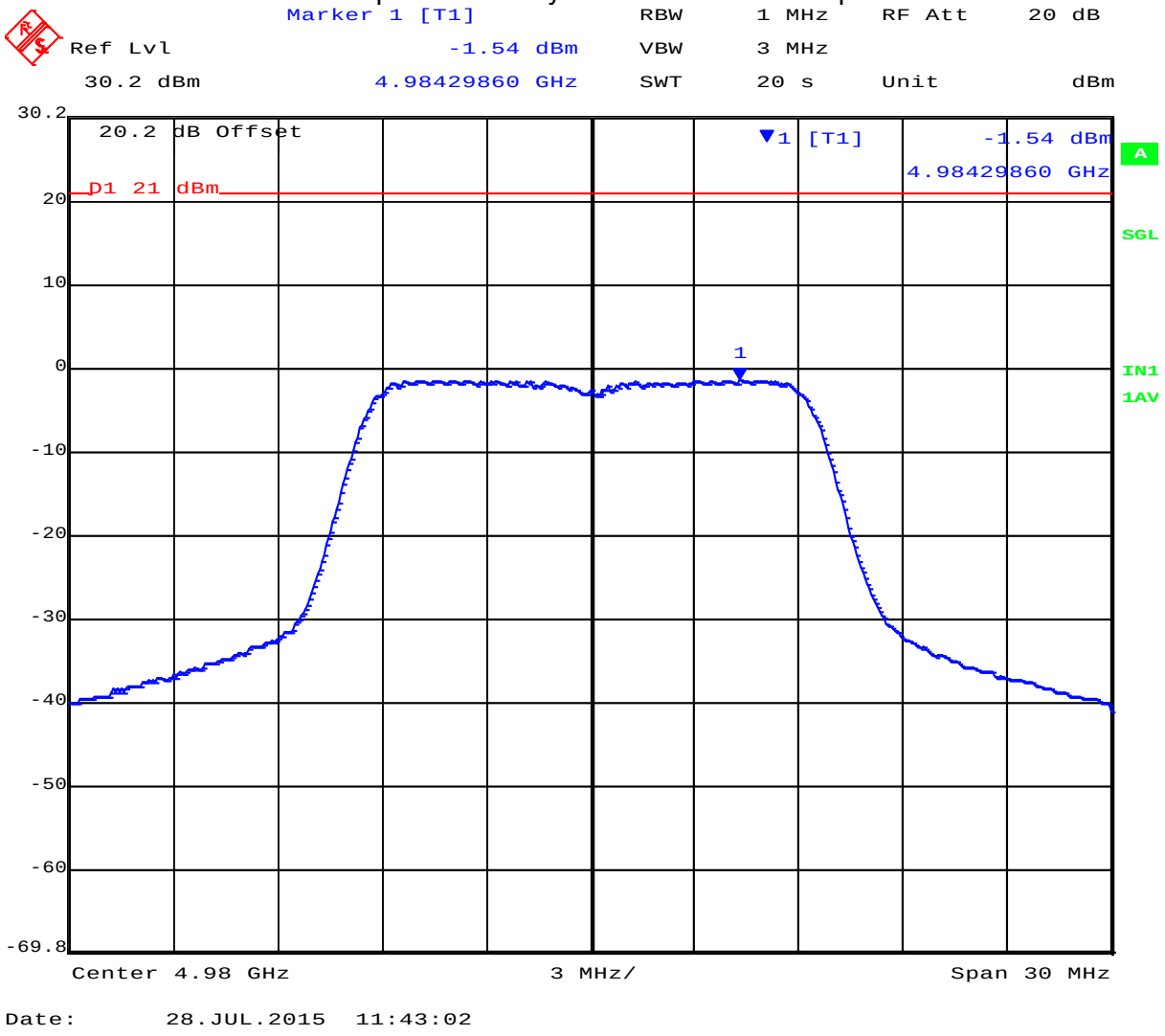
Port B

Peak Power Spectral Density 20 MHz Channel Freq 4965 MHz



Port B

Peak Power Spectral Density 20 MHz Channel Freq 4980 MHz



Specification Limits
FCC Part §90.1215

Refer to the Power Limits Specification in Section 6.1.2 of this report.

Laboratory Measurement Uncertainty for Power Measurement

Measurement uncertainty	±1.33 dB

Traceability

Method
Measurements were made per work instruction WI-03 'Measurement of RF Output Power'

6.1.4. Maximum Permissible Exposure

FCC, Part 90 Subpart C §90.1217
Industry Canada RSS-Gen §5.6

Calculations for Maximum Permissible Exposure Levels

Power Density = Pd (mW/cm^2) = EIRP/(4πd^2)
EIRP = P * G
P = Peak output power (mW)
G = Antenna numeric gain (numeric)
d = Separation distance (cm)
Numeric Gain = 10 ^ (G (dBi)/10)

Because the EUT belongs to the General Population/Uncontrolled Exposure the limit of power density is 1.0 mW/cm^2

Note: for mobile or fixed location transmitters the minimum separation distance is 20cm, even if calculations indicate the MPE distance to be less.

Specification
Maximum Permissible Exposure Limits

§90.1217
Licensees and manufacturers are subject to the radiofrequency radiation exposure requirements specified in §§ 1.1307(b), 2.1091 and 2.1093 of this chapter, as appropriate. Applications for equipment authorization of mobile or portable devices operating under this section must contain a statement confirming compliance with these requirements for both fundamental emissions and unwanted emissions. Technical information showing the basis for this statement must be submitted to the Commission upon request.

FCC §1.1310 Limit = 1mW / cm^2 from 1.310 Table 1

RSS-Gen §5.6 Category I and Category II equipment shall comply with the applicable requirements of RSS-102.

Laboratory Measurement Uncertainty for Power Measurements

Measurement uncertainty	±1.33dB

4940 – 4990 MHz

Type	Model	Family	Dir BW	Gain (dBi)	Numeric Gain	Peak Output Power (dBm)	Peak Output Power (mW)	Calculated Safe Distance @ 1mW/cm^2 Limit (cm)	Power Density @ 20cm (mW/cm^2)
Integrated Beamforming	SA0183620	Sector	120	17.0	50.1	23.08	203.2	28.5	2.03
Integrated Beamforming	SA0183620	Sector	120	8.0	6.3	23.08	203.2	10.1	0.26

6.1.5. Frequency Stability; Temperature Variations, and Voltage Variations

FCC 47 CFR Part 90, Subpart Y; §90.213

Test Procedure

The transmitter output was connected to a spectrum analyzer and the frequency stability was measured in either modulated or unmodulated state. Frequency stability was measured through the extremes of temperature on the selected channel only. Prior to a taking a frequency / temperature measurement the device is powered off and the temperature changed. The device is left to stabilize at the new temperature for 15 mins then switched on before any measurement is taken.

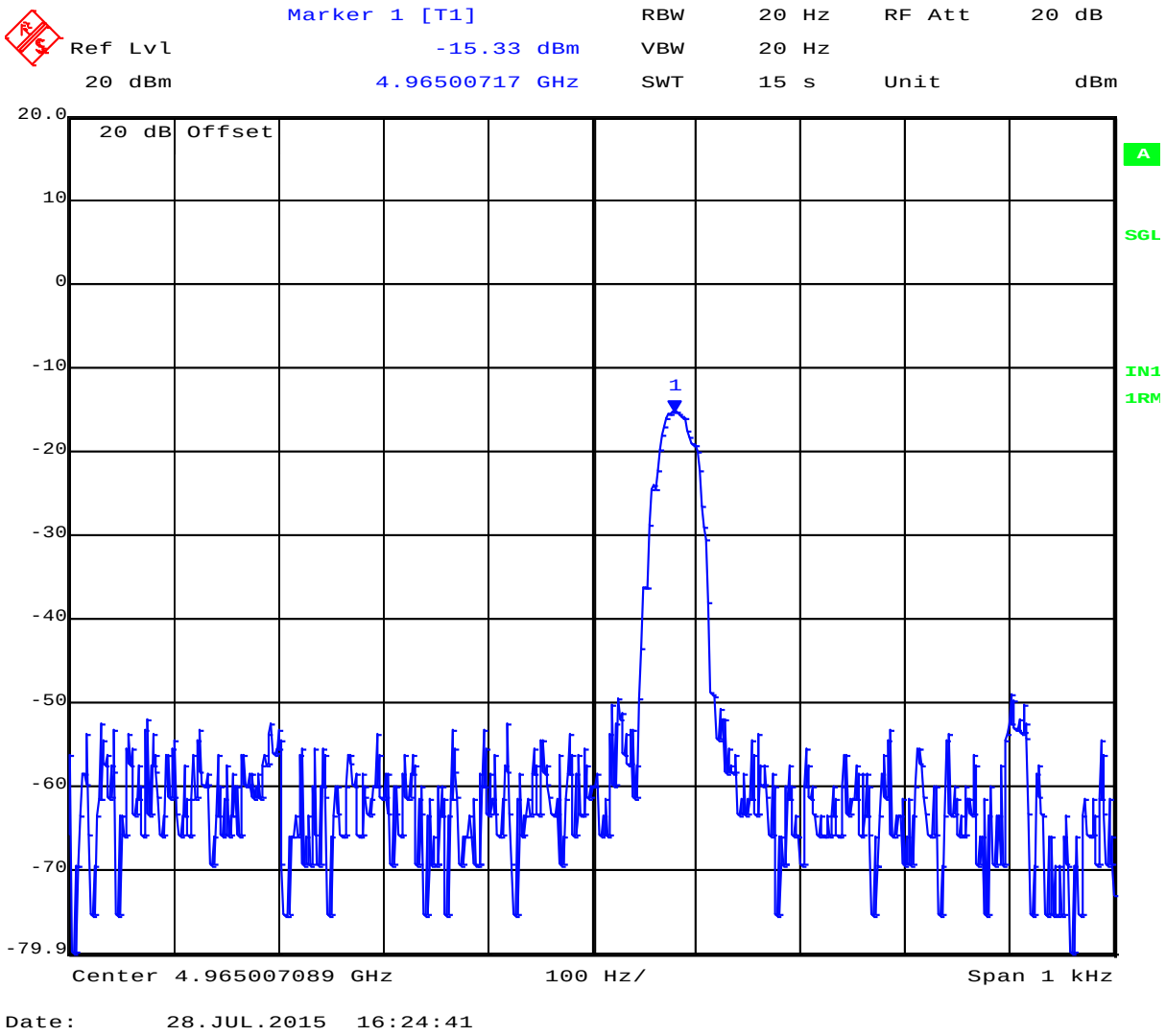
Ambient conditions.
Temperature: 19 to 26 °C Relative humidity: 31 to 57 % Pressure: 999 to 1009 mbar

TABLE OF RESULTS Frequency Stability;-

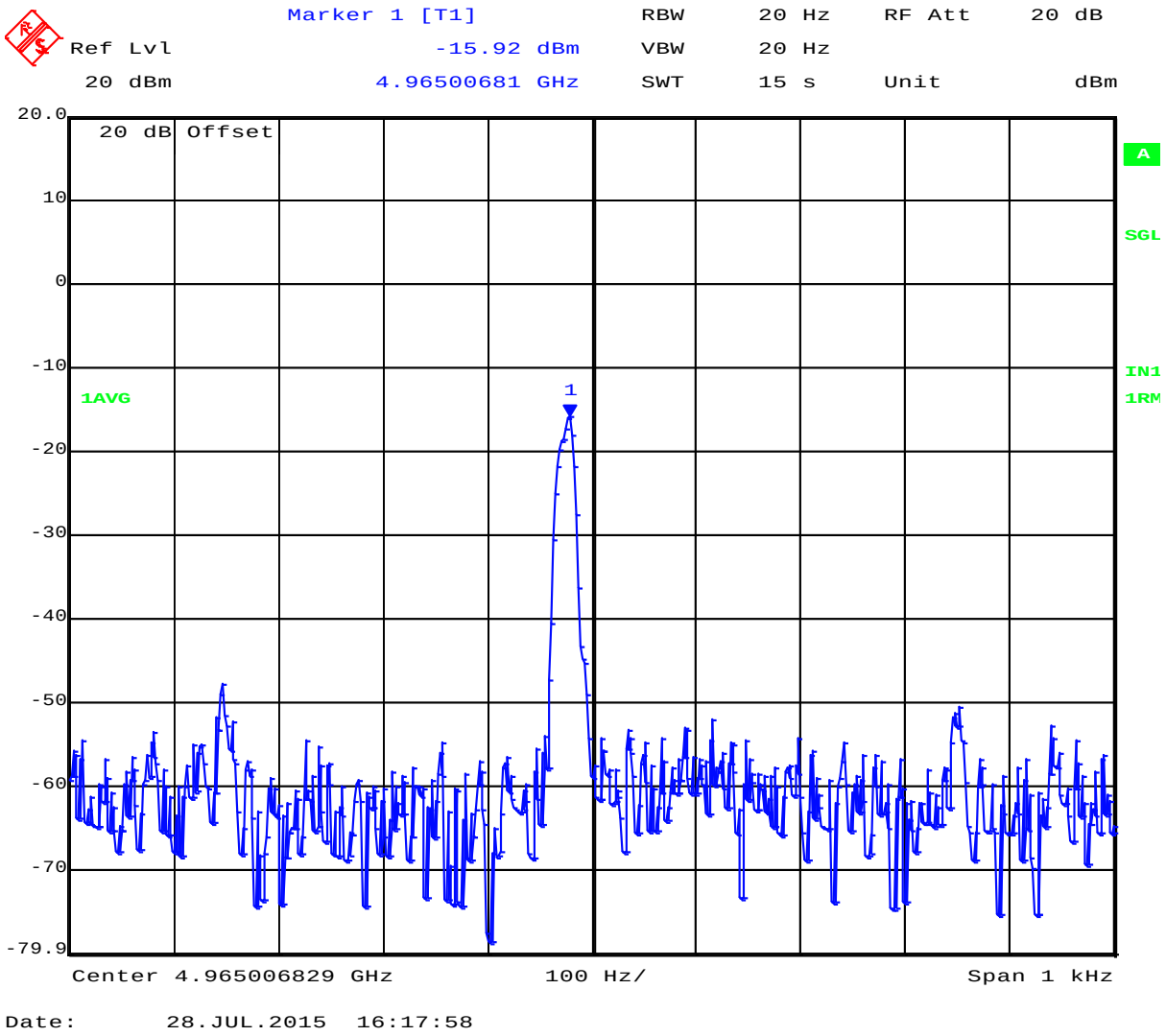
Voltage (dc)	Temperature	Measured Frequency (Hz) Channel 4965 MHz	Delta (kHz)	Drift (ppm)
55	60	4965007170.00	7.17	0.144
	55	4965006810.00	6.81	0.137
	45	4965004770.00	4.77	0.096
	35	4965003750.00	3.75	0.076
	25	4965003530.00	3.53	0.071
	15	4965002920.00	2.92	0.059
	5	4965001540.00	1.54	0.031
	-5	4965000180.00	0.18	0.004
	-15	4964999980.00	-0.02	0.000
	-25	4965000220.00	0.22	0.004
	-35	4965000960.00	0.96	0.019

Modulated carrier breakthrough was used to measure frequency stability.

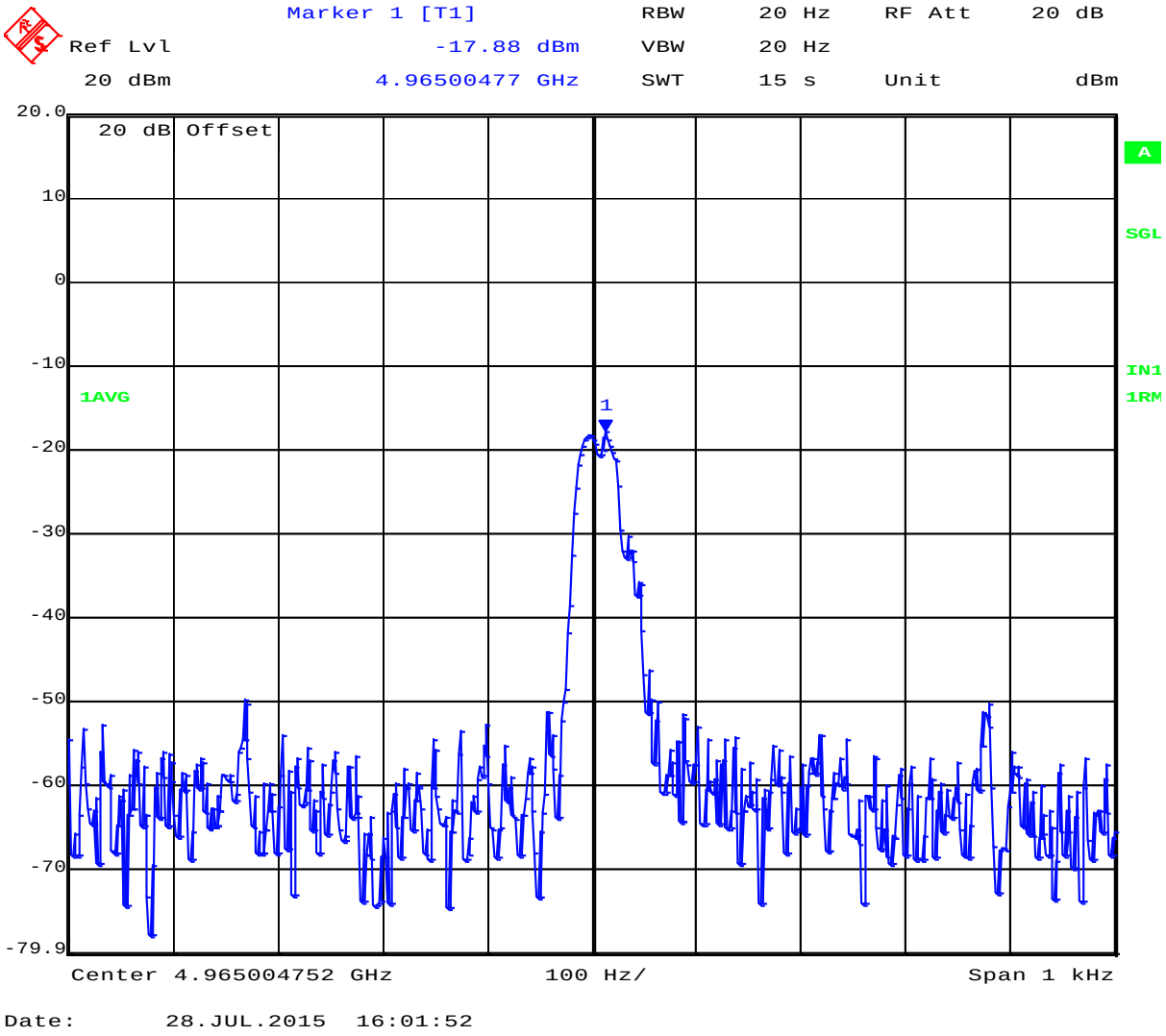
Frequency Stability 4965 MHz 55 Vdc +60°C



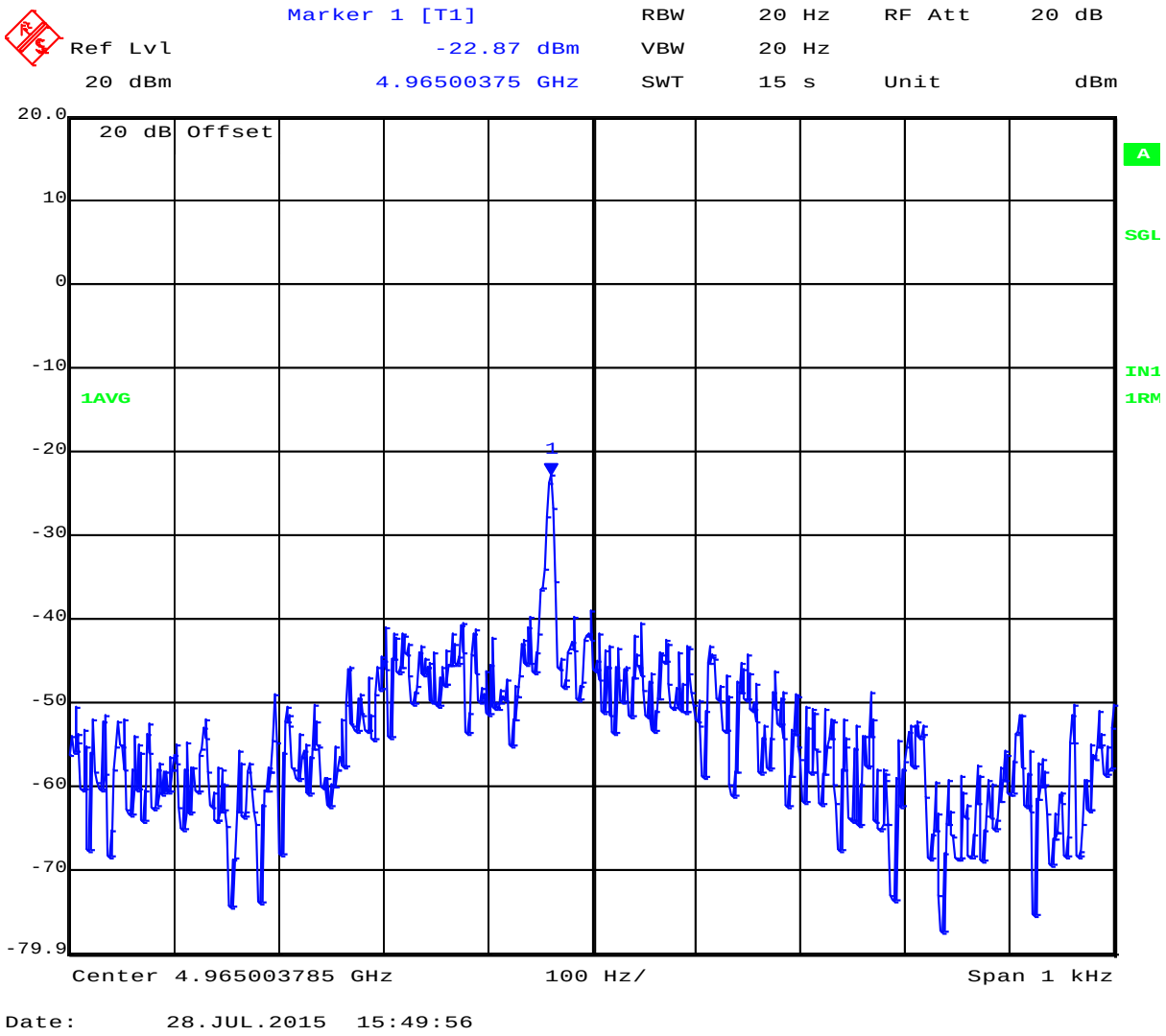
Frequency Stability 4965 MHz 55 Vdc +55°C



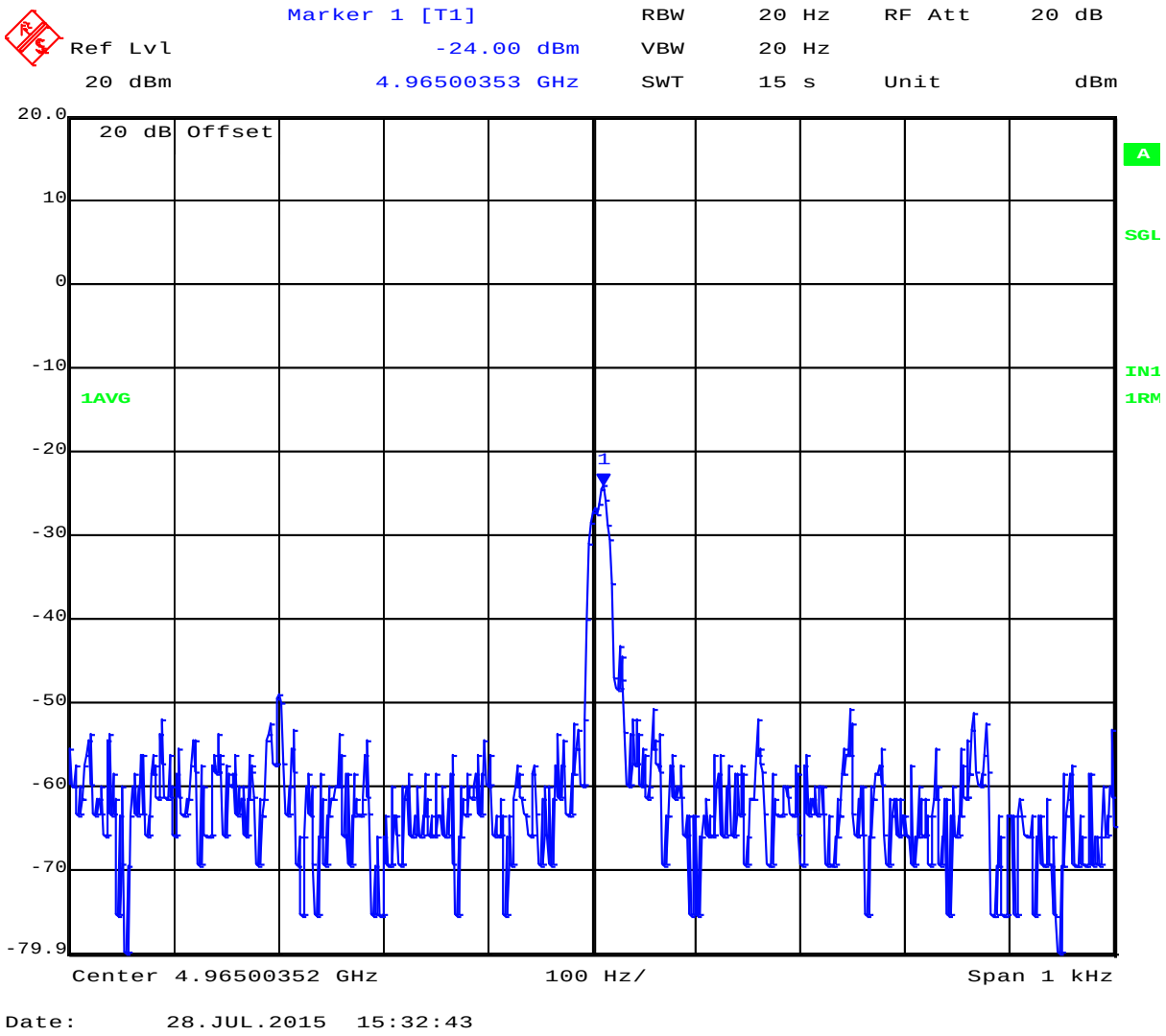
Frequency Stability 4965 MHz 55 Vdc +45ºC



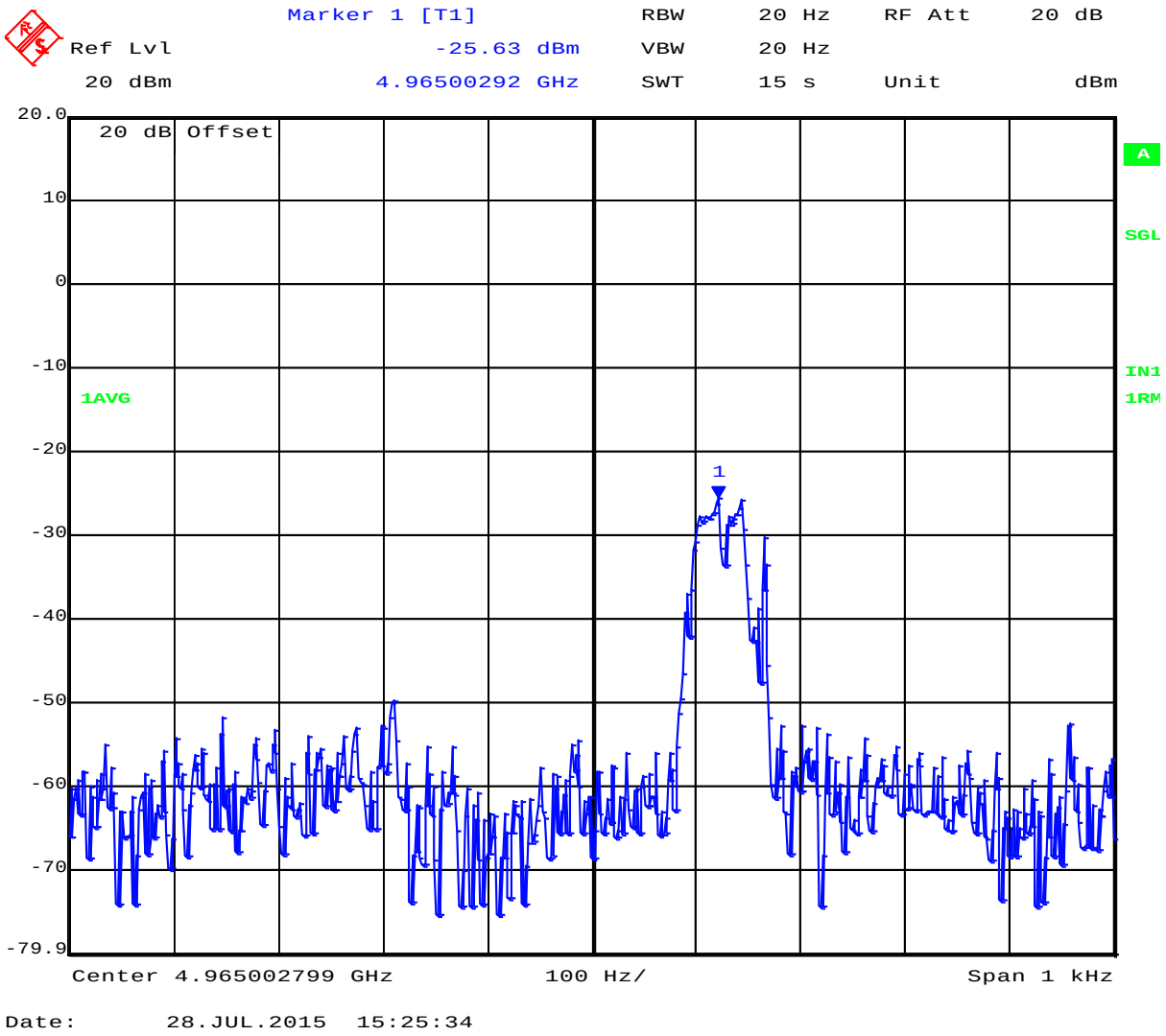
Frequency Stability 4965 MHz 55 Vdc +35°C



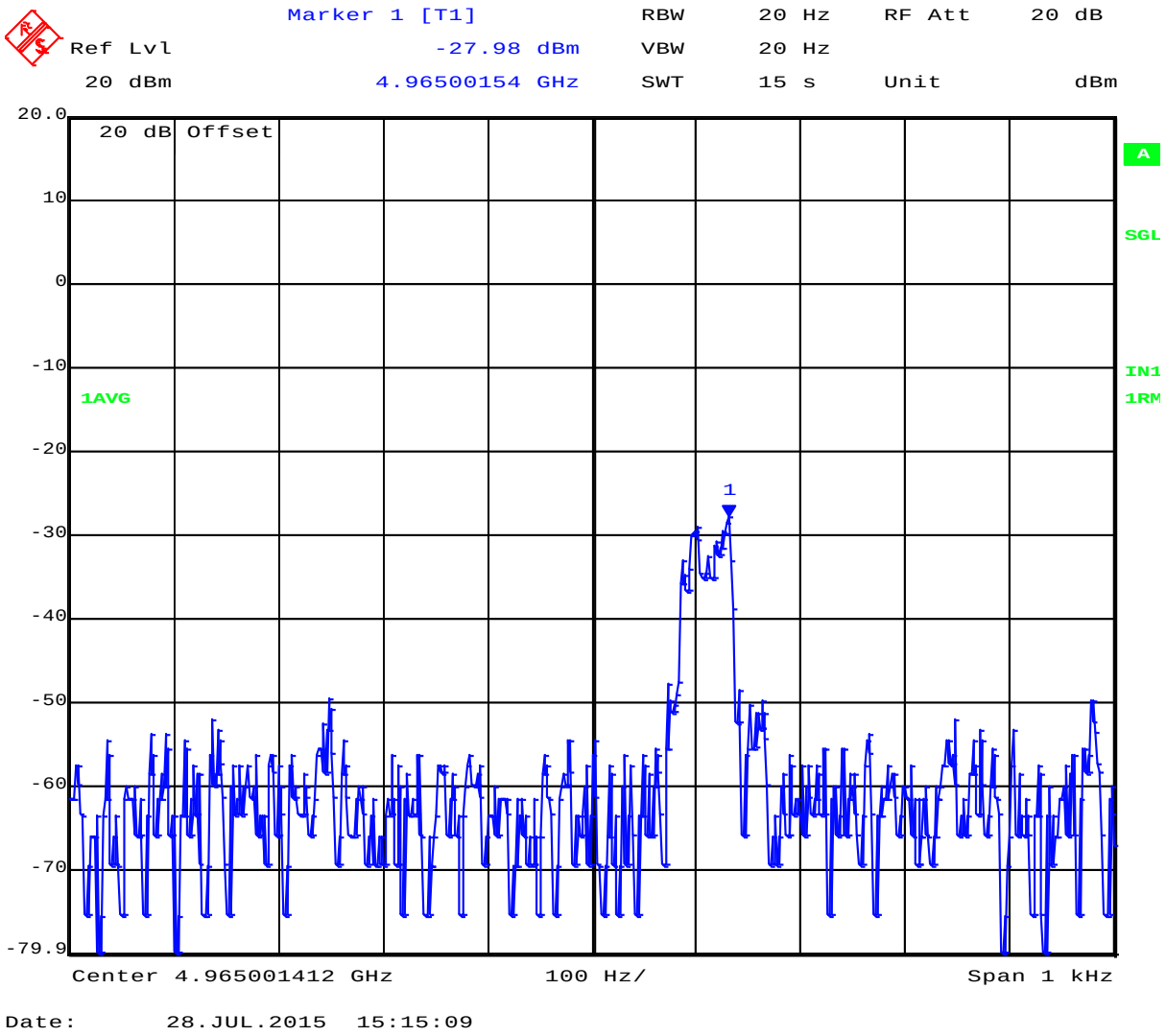
Frequency Stability 4965 MHz 55 Vdc +25°C



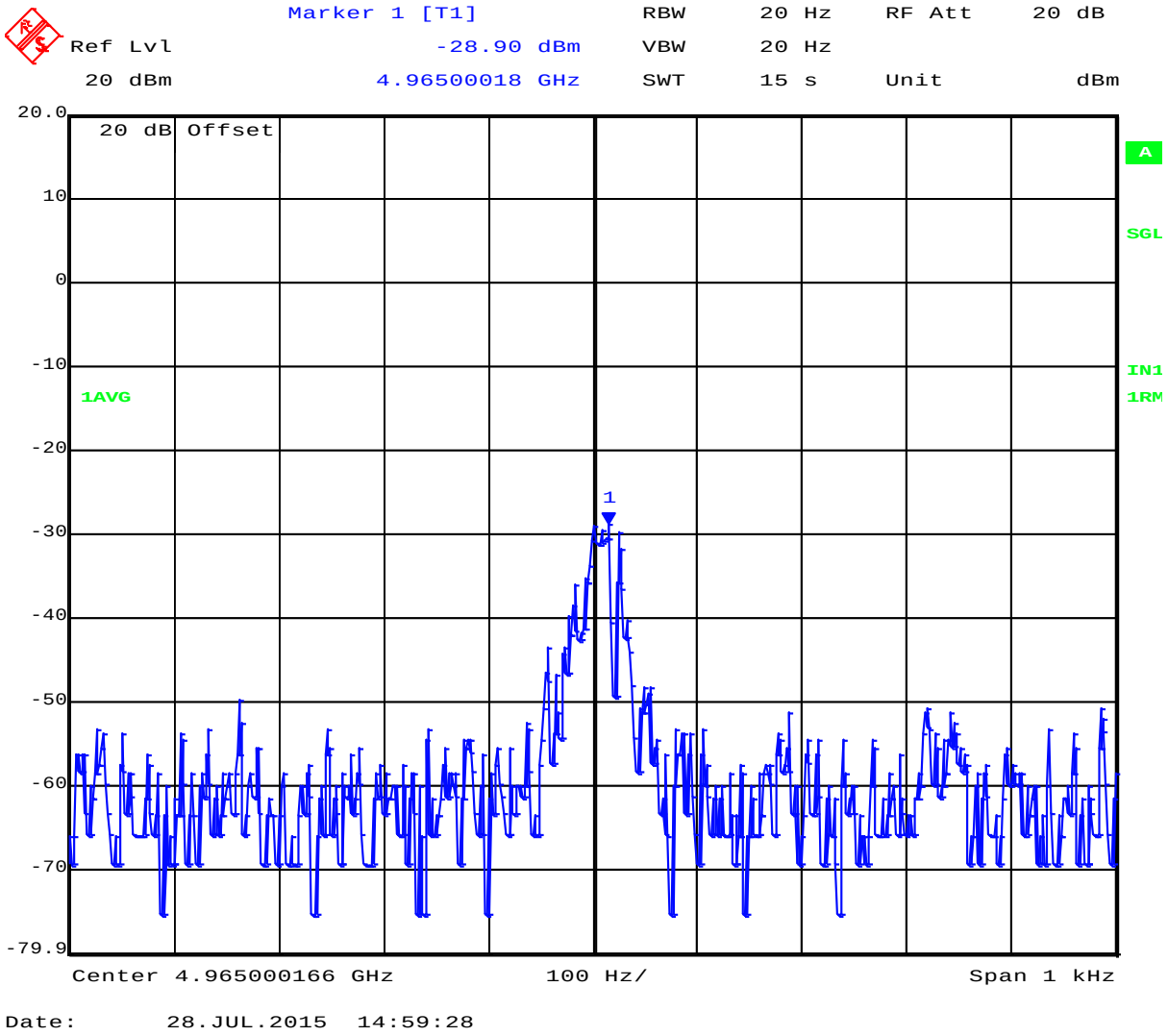
Frequency Stability 4965 MHz 55 Vdc +15°C



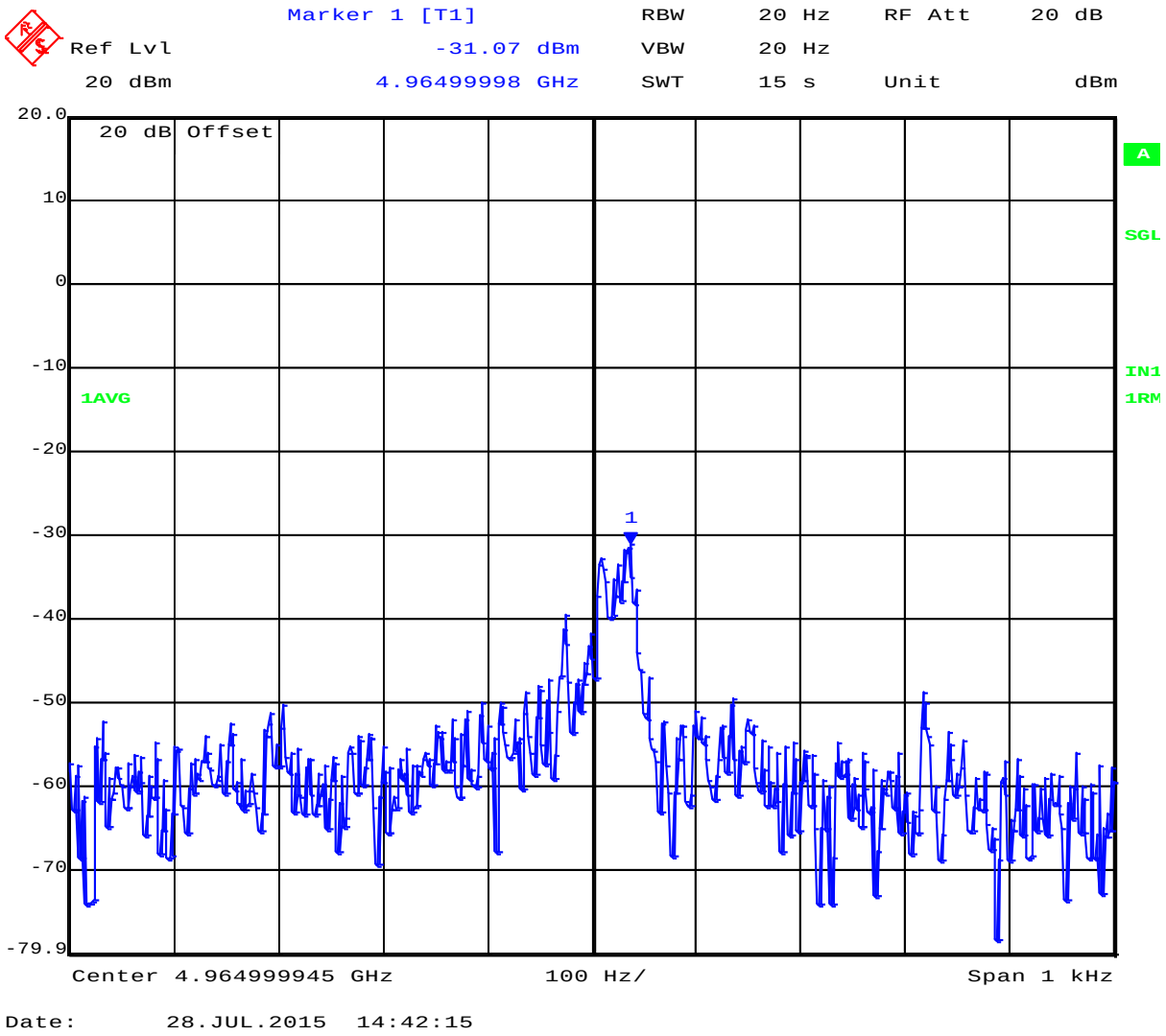
Frequency Stability 4965 MHz 55 Vdc +5ºC



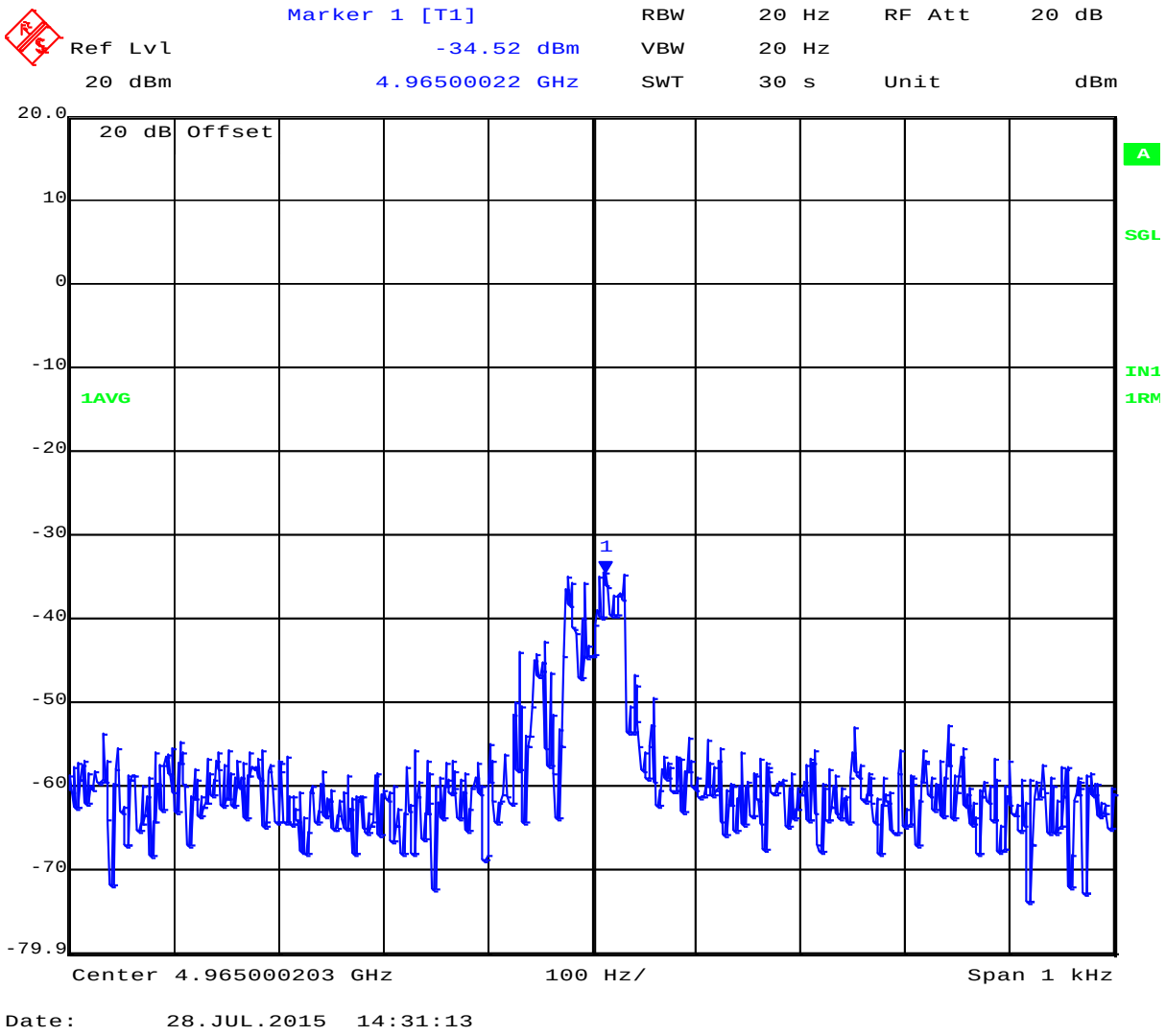
Frequency Stability 4965 MHz 55 Vdc -5°C



Frequency Stability 4965 MHz 55 Vdc -15ºC



Frequency Stability 4965 MHz 55 Vdc -25ºC



Frequency Stability 4965 MHz 55 Vdc -35ºC

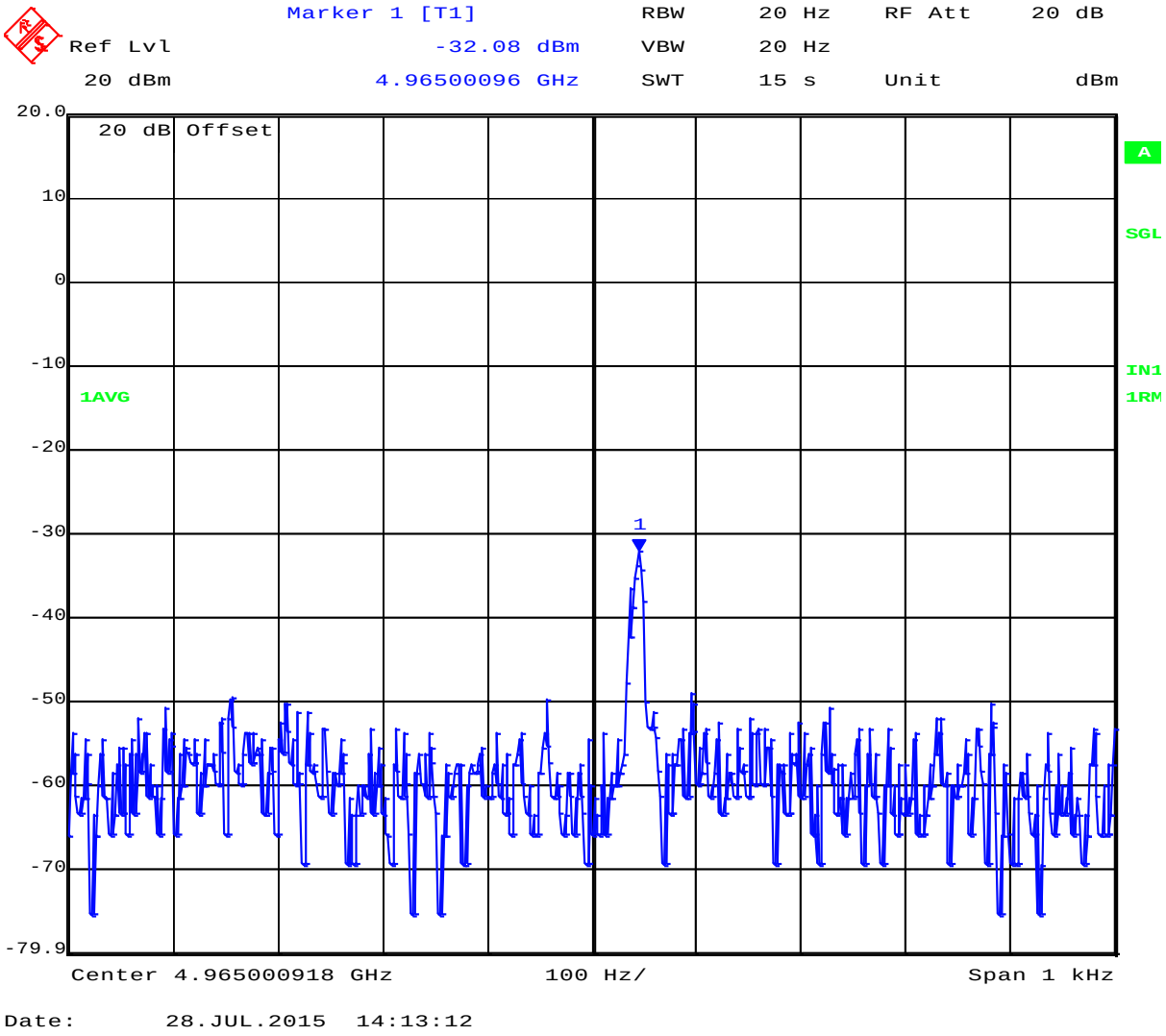
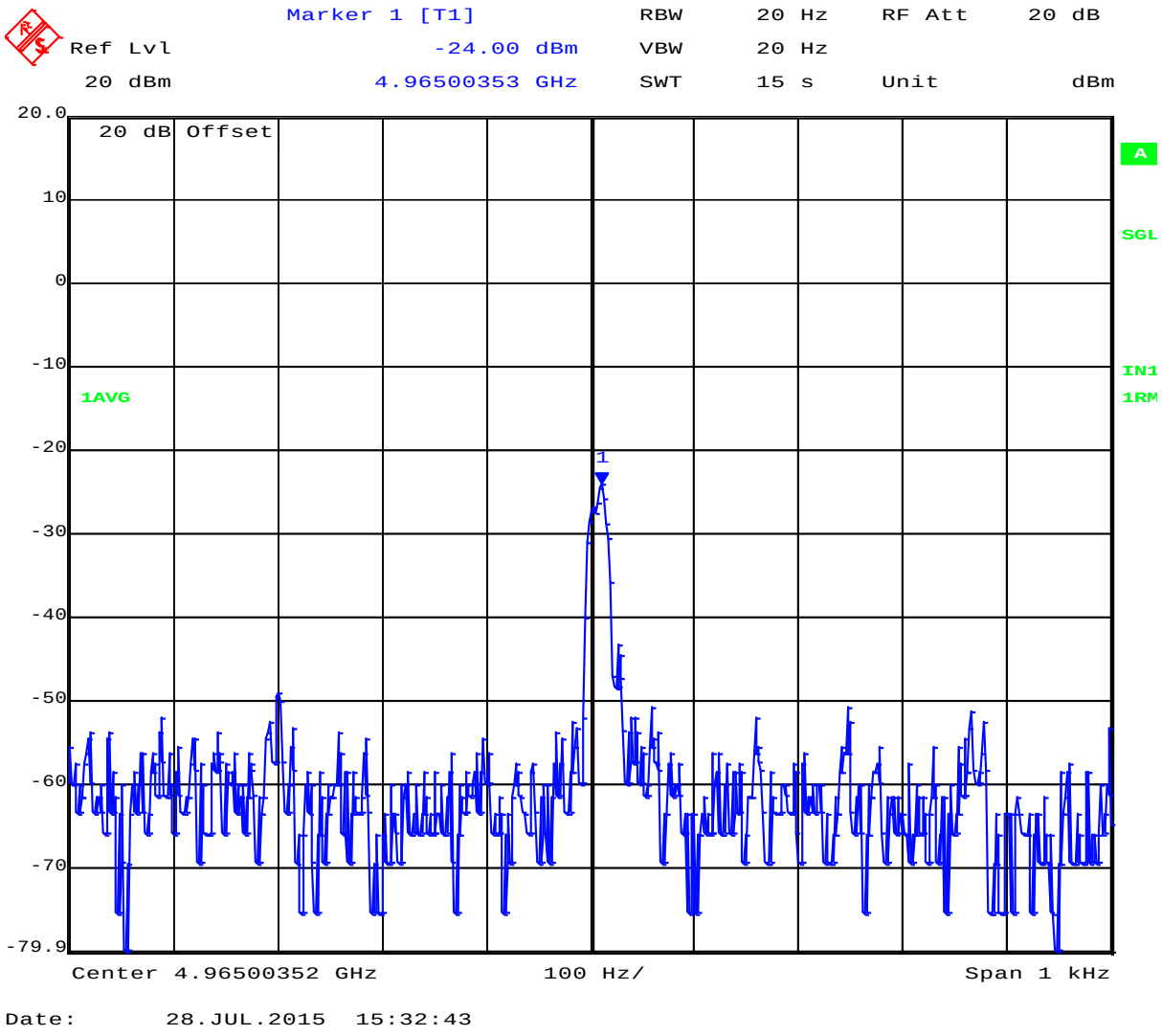


TABLE OF RESULTS Frequency Stability;-

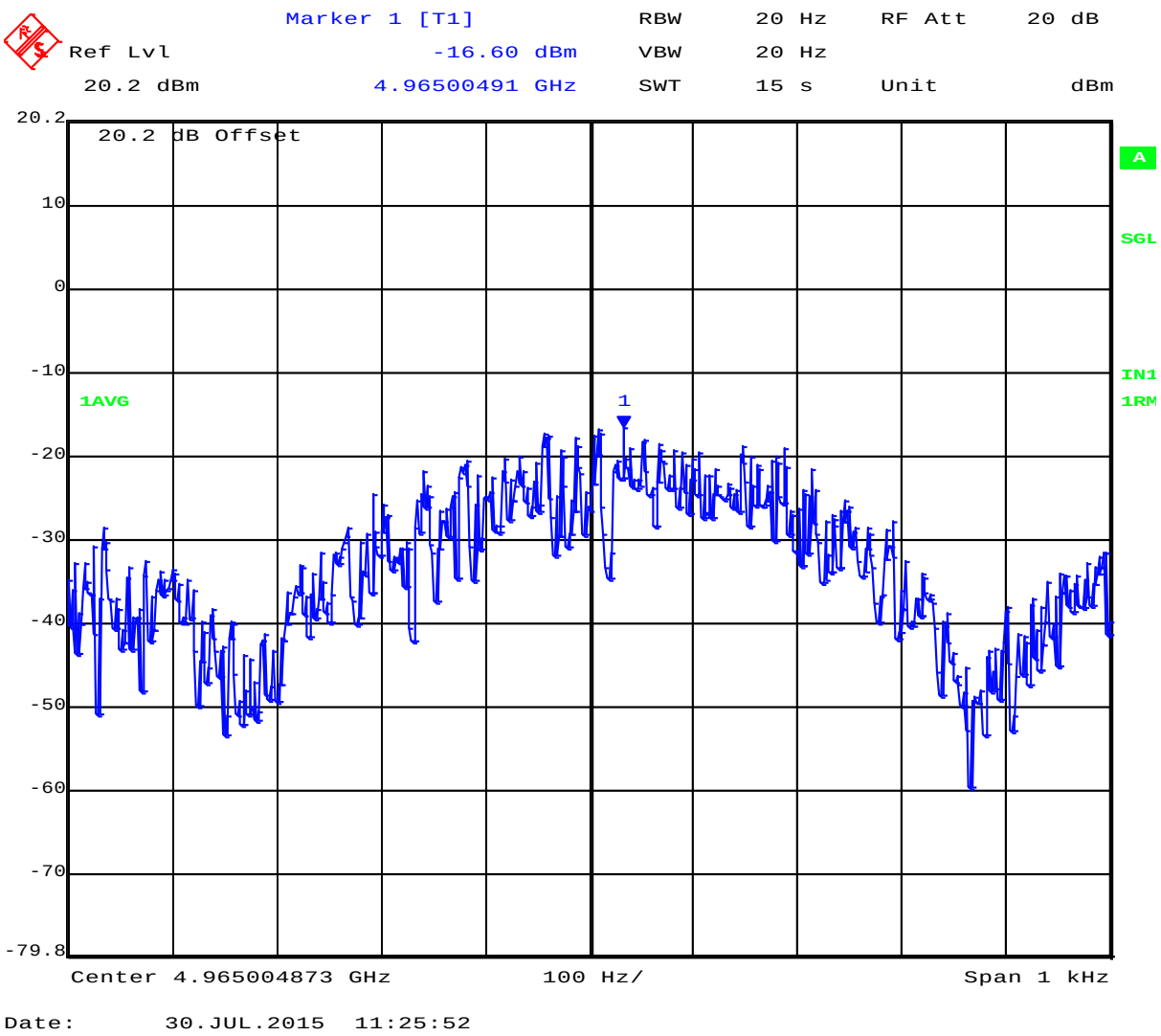
Voltage Variations at Ambient

Temperature	Voltage (Vac, 60 Hz)	FREQUENCY Delta (kHz)	Drift
		Channel 4965 MHz	ppm
Ambient	+43.2	4.91	0.099
	+55.0	3.53	0.071
	+59.0	5.08	0.102

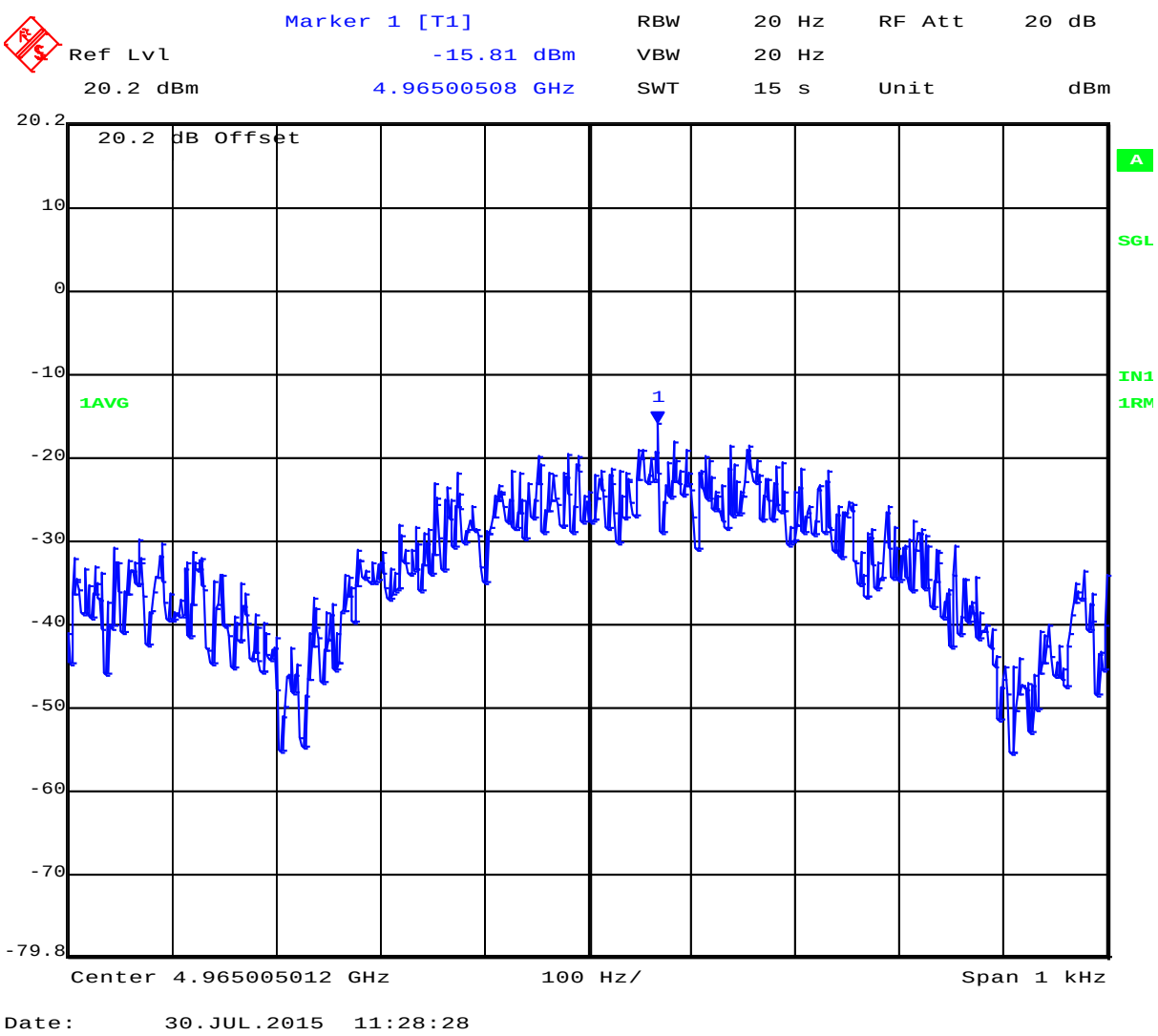
Frequency Stability 4965 MHz 55.0 Vdc +23°C



Frequency Stability 4965 MHz 43.2 Vdc +23°C



Frequency Stability 4965 MHz 60.0 Vdc +23°C



Specification Limits – Frequency stability

FCC Part §90.213

(a) Unless noted elsewhere, transmitters used in the services governed by this part must have a minimum frequency stability as specified in the following table.

Minimum Frequency Stability

[Parts per million (ppm)]

Frequency range (MHz)	Fixed and base stations	Mobile stations	
		Over 2 watts output power	2 watts or less output power
Below 25	[1,2,3] 100	100	200
25-50	20	20	50
72-76	5		50
150-174	[5,11] 5	[6] 5	[4,6] 50
216-220	1.0		1.0
220-222 [12]	0.1	1.5	1.5
421-512	[7,11,14] 2.5	[8] 5	[8] 5
806-809	[14] 1.0	1.5	1.5
809-824	[14] 1.5	2.5	2.5
851-854	1.0	1.5	1.5
854-869	1.5	2.5	2.5
896-901	[14] 0.1	1.5	1.5
902-928	2.5	2.5	2.5
902-928 [13]	2.5	2.5	2.5
929-930	1.5		
935-940	0.1	1.5	1.5
1427-1435	[9] 300	300	300
Above 2450 [10]			

[10] Except for DSRCS equipment in the 5850-5925 MHz band, frequency stability is to be specified in the station authorization. Frequency stability for DSRCS equipment in the 5850-5925 MHz band is specified in subpart M of this part.

Manufacturers Specification for Frequency Stability

As no apparent frequency stability limits were provided the manufacturer's specification was used ±20 ppm.

Laboratory Measurement Uncertainty for Frequency Stability

Measurement uncertainty	±0.866 ppm

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-02 'Frequency Measurement'	0070, 0116, 0158, 0193, 0252, 0313, 0314.

6.1.6. Spurious Emissions at Antenna Terminals - Transmitter

FCC 47 CFR Part 90, Subpart Y; §90.210(m)

Test Procedure
Transmitter conducted spurious emissions were measured for each bandwidth. Measurement were made while EUT was operating in a modulated transmit mode of operation, at the appropriate center frequency, 100% duty cycle and maximum power at all times. Conducted spurious emissions were measured to 40 GHz.

Conducted spurious emissions' testing was performed only in the configuration with the highest spectral density.

From FCC Part 90.210 (m)
On any frequency removed from the assigned frequency between above 150 % of the authorized bandwidth: 50 dB or 55 + 10 log (P) dB, (P in Watts) whichever is the lesser attenuation.

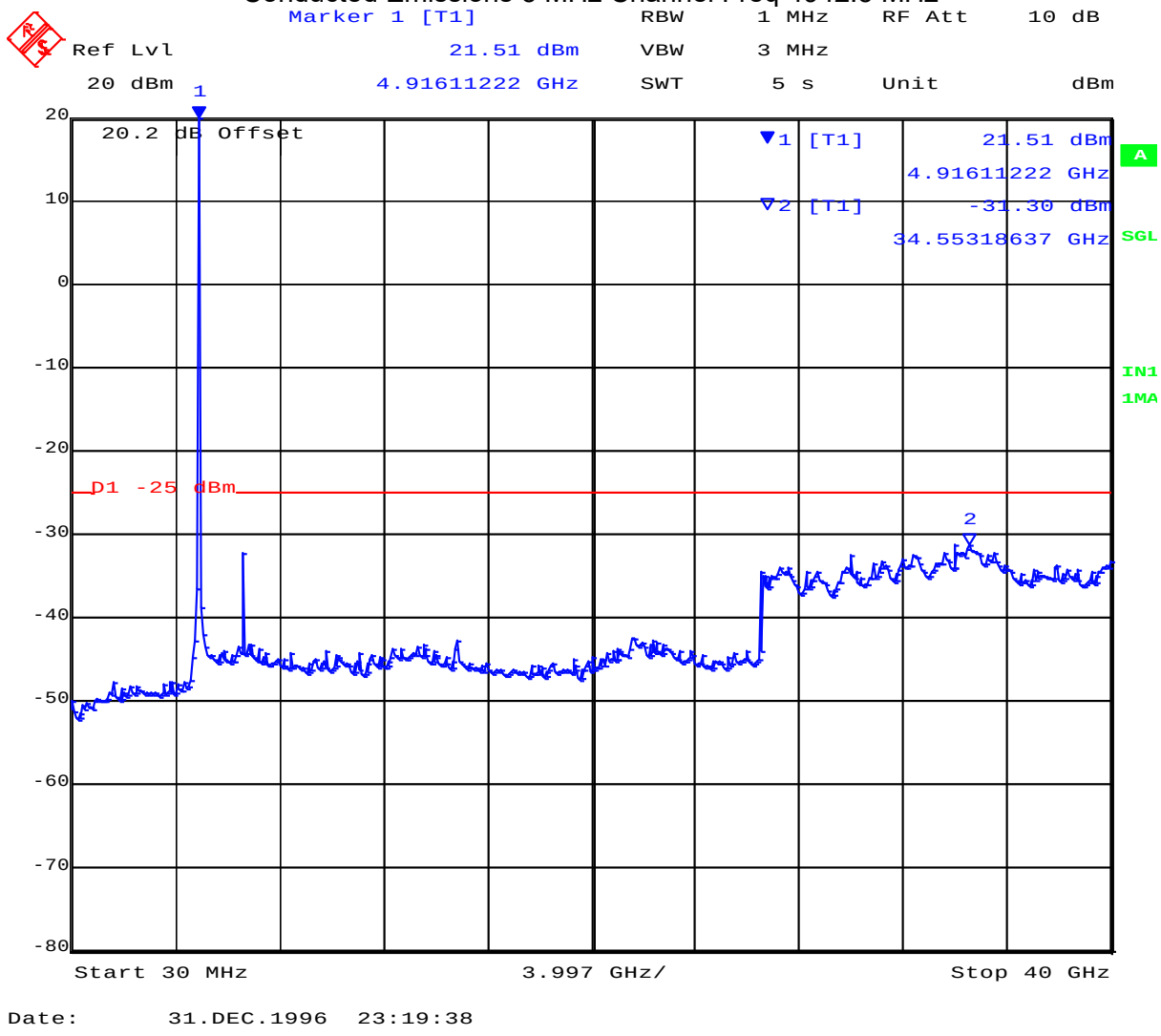
TABLE OF RESULTS – 5 MHz Bandwidth

PORT A Limit: -25 dBm

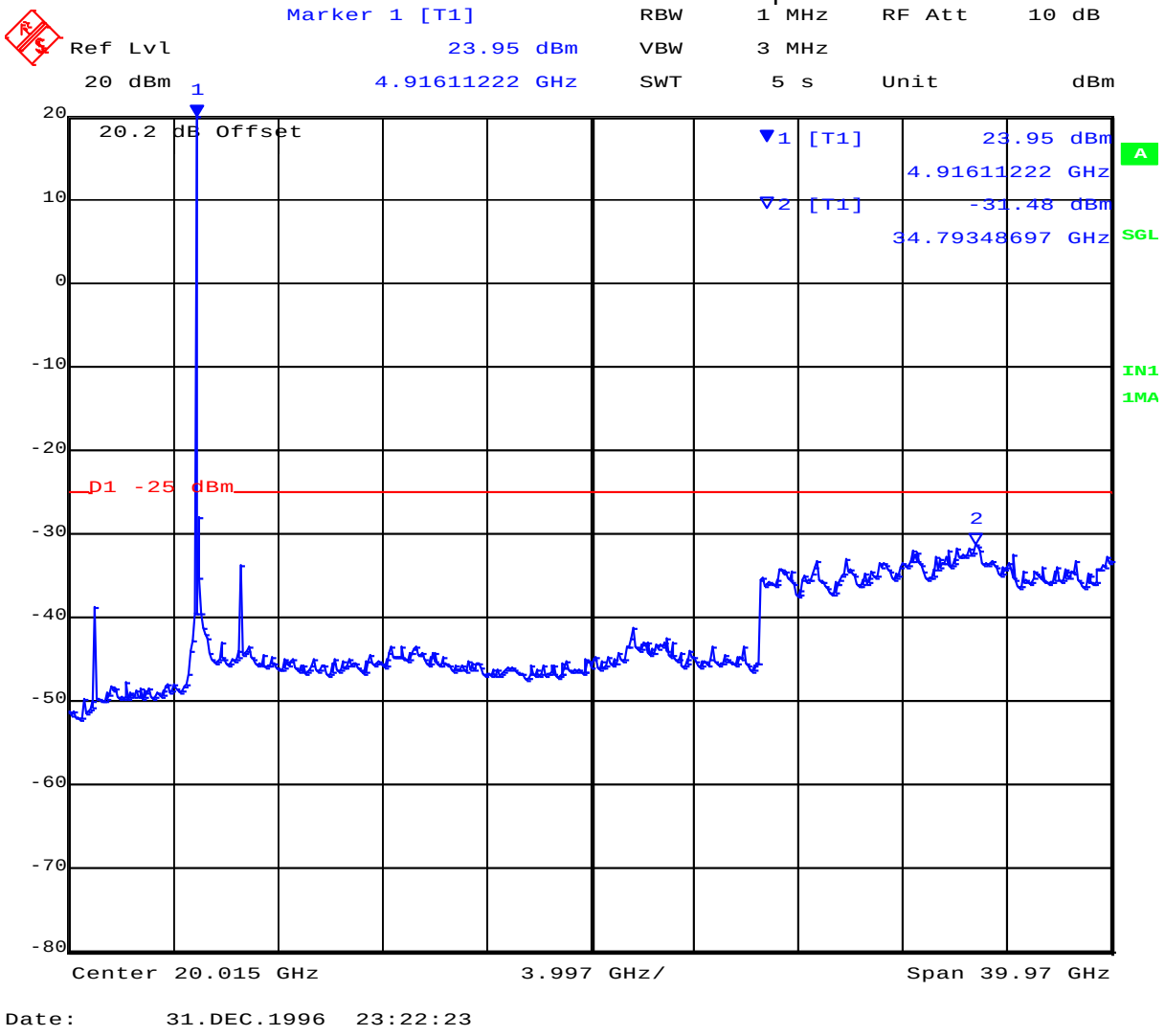
	Frequency (MHz)				
Channel (MHz)	**Start (MHz)**	**Stop (MHz)**	**Freq of Maximum Emission (MHz)**	**Emission Amplitude (dBm)**	**Margin (dB)**
4942.5	30	40.000	3455.31	-31.30	-6.30
4967.5	30	40.000	3479.34	-31.48	-6.48
4987.5	30	40.000	3495.36	-31.07	-6.07

Port A

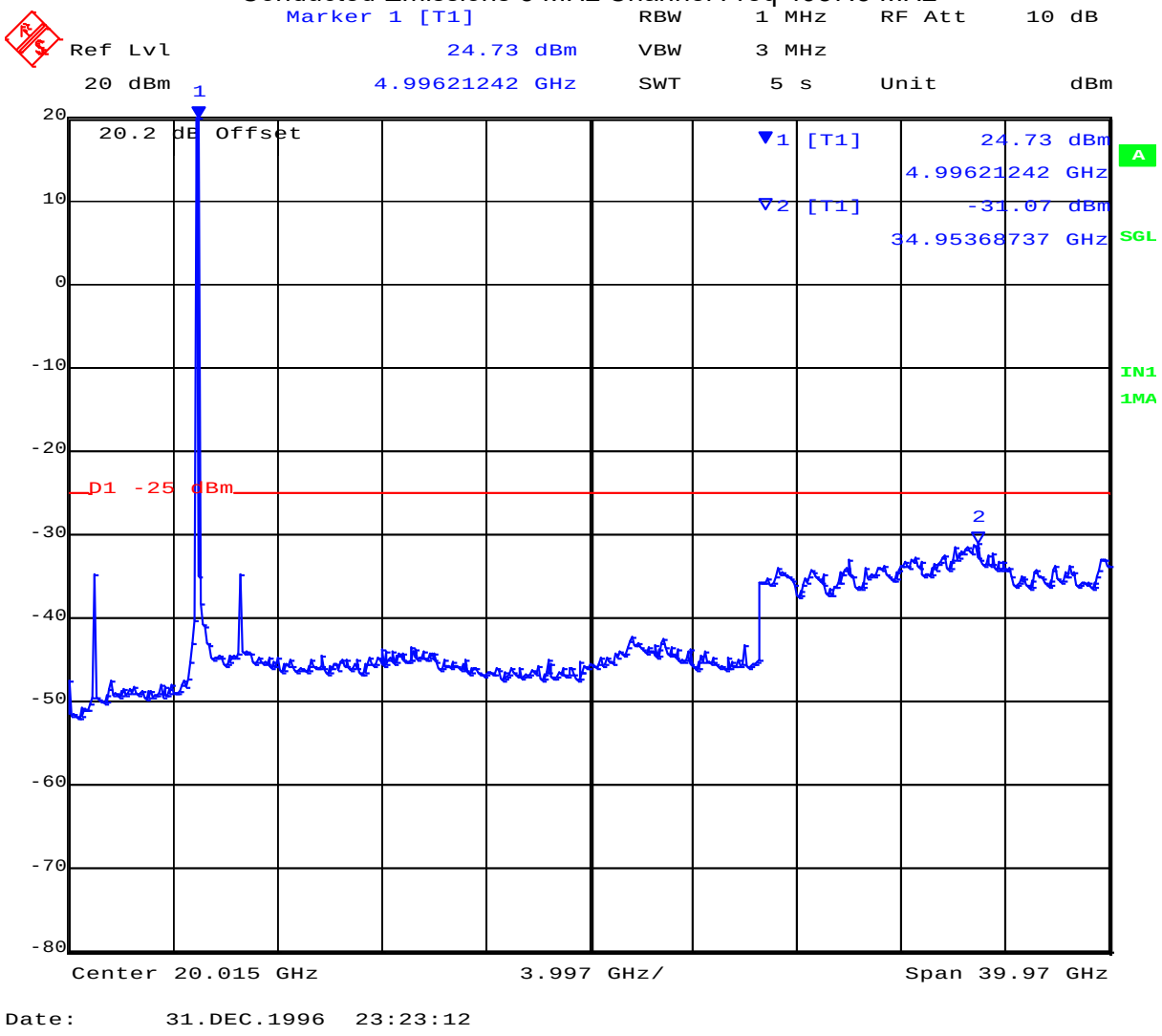
Conducted Emissions 5 MHz Channel Freq 4942.5 MHz



Port A
Conducted Emissions 5 MHz Channel Freq 4967.5 MHz



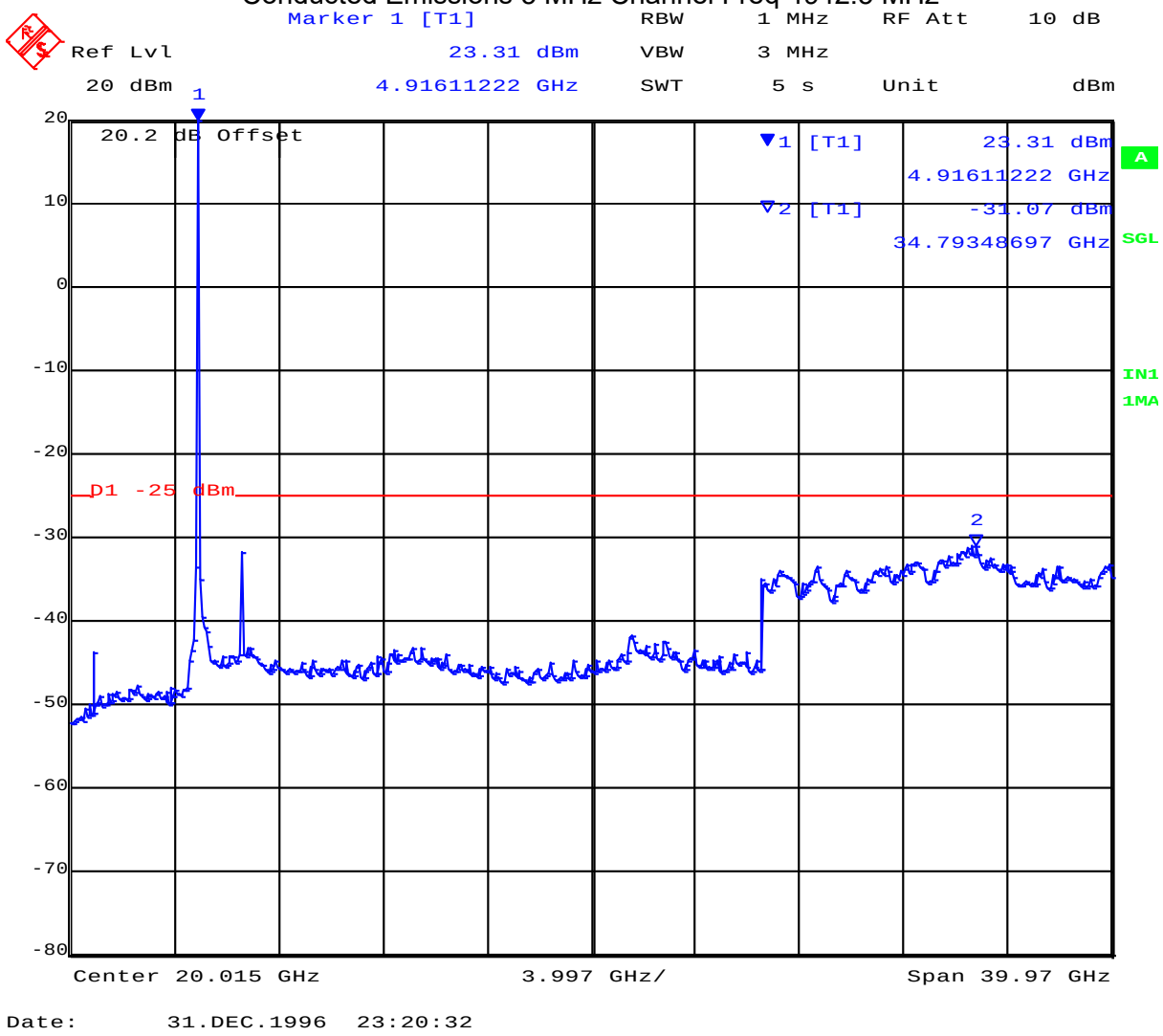
Port A
Conducted Emissions 5 MHz Channel Freq 4987.5 MHz



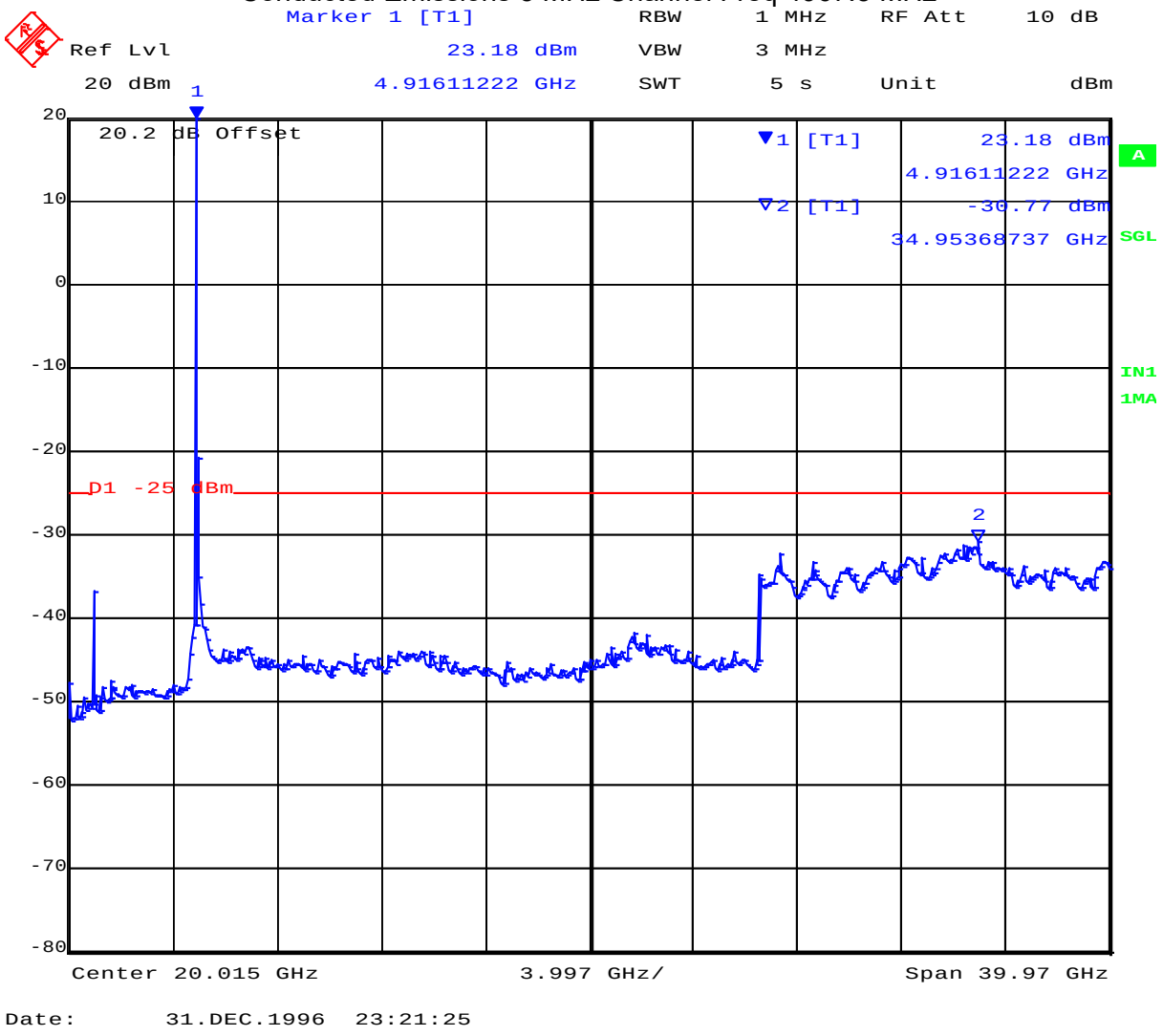
PORT B Limit: -25 dBm

	Frequency (MHz)				
Channel (MHz)	**Start (MHz)**	**Stop (MHz)**	**Freq of Maximum Emission (MHz)**	**Emission Amplitude (dBm)**	**Margin (dB)**
4942.5	30	40,000	3479.34	-31.07	-6.07
4967.5	30	40,000	3495.36	-30.77	-5.77
4987.5	30	40,000	3495.36	-30.64	5.64

Port B
Conducted Emissions 5 MHz Channel Freq 4942.5 MHz

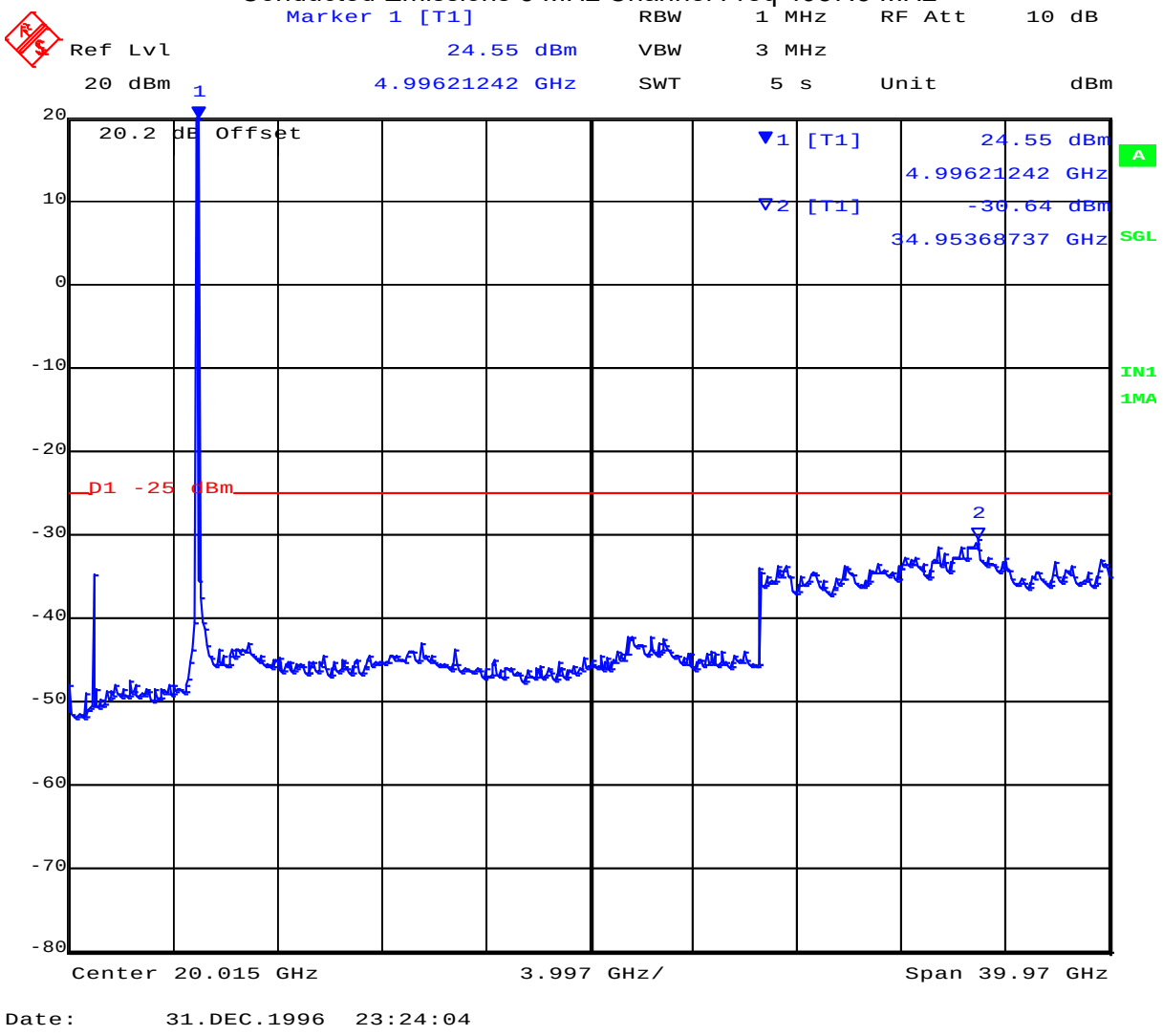


Port B
Conducted Emissions 5 MHz Channel Freq 4967.5 MHz



Port B

Conducted Emissions 5 MHz Channel Freq 4987.5 MHz



Specification Limits

Conducted Spurious Emission at Antenna Terminals – Transmitter Limits FCC Part §90.210

Emission Mask (m)
(6) On any frequency removed from the assigned frequency above 150% of the authorized bandwidth: 50 dB or 55 + 10*Log (P) dB, whichever is the lesser attenuation.

Laboratory Measurement Uncertainty for Conducted Spurious Emissions

Measurement uncertainty	±2.37 dB

Traceability

Method
Measurements were made per work instruction WI-05 'Measurement of Spurious Emissions'

6.1.7. Radiated Spurious Emissions

FCC 47 CFR Part 90, §90.210(m)

Test Procedure
Measurements were made while EUT was operating in a modulated transmit mode of operation, at the appropriate center frequency, 100% duty cycle and maximum power at all times. Radiated spurious emissions were measured to 40 GHz. Substitution was performed on any emissions observed. The antenna port was attenuated with 50 dB attenuation plus a 50 Ω terminator.

The measurement equipment was set to measure in peak hold mode. The emissions were measured in the anechoic chamber at a 3-meter distance on every azimuth in both horizontal and vertical polarities. The emissions are recorded and maximized as a function of azimuth by rotation through 360° with a spectrum analyzer in peak hold mode.

The highest emissions relative to the limit are listed for each frequency spanned.

Measurements below 1 GHz utilized 100 KHz RBW, measurements above 1 GHz were performed using a minimum RBW of 1 MHz.

From FCC Part 90.210 (m)
On any frequency removed from the assigned frequency between above 150 % of the authorized bandwidth: 50 dB or 55 + 10 log (P) dB, whichever is the lesser attenuation.

Radiated emissions' testing was performed only in the configuration with the highest spectral density.

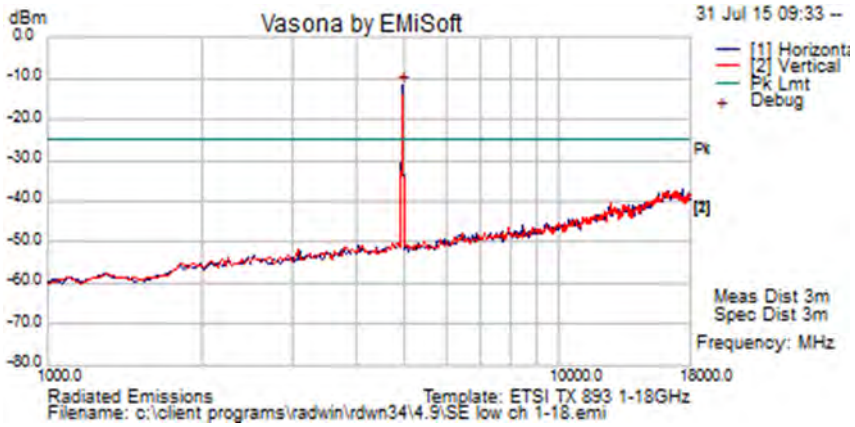
Attenuation
55 + 10 log (P) dB for 5 MHz bandwidth = 49.1 dB attenuation (P is in Watts)

Therefore maximum attenuation for any channel spacing is = 49.1 dB

5 MHz bandwidth limit: +24.1 – 49.1 = -25 dBm (82 dBuV)

Emission measurements were performed to the 10th harmonic of the transmitter. No emissions were found.

Test Freq.	4942.5 MHz	**Engineer**	SB
Variant	5 MHz	**Temp (ºC)**	18
Freq. Range	1 - 18 GHz	**Rel. Hum.(%)**	42
Power Setting	Maximum (+27 dBm)	**Press. (mBars)**	1003
Antenna	50 ohm load	**Duty Cycle (%)**	100%
Test Notes 1			
Test Notes 2			



Formally measured emission peaks

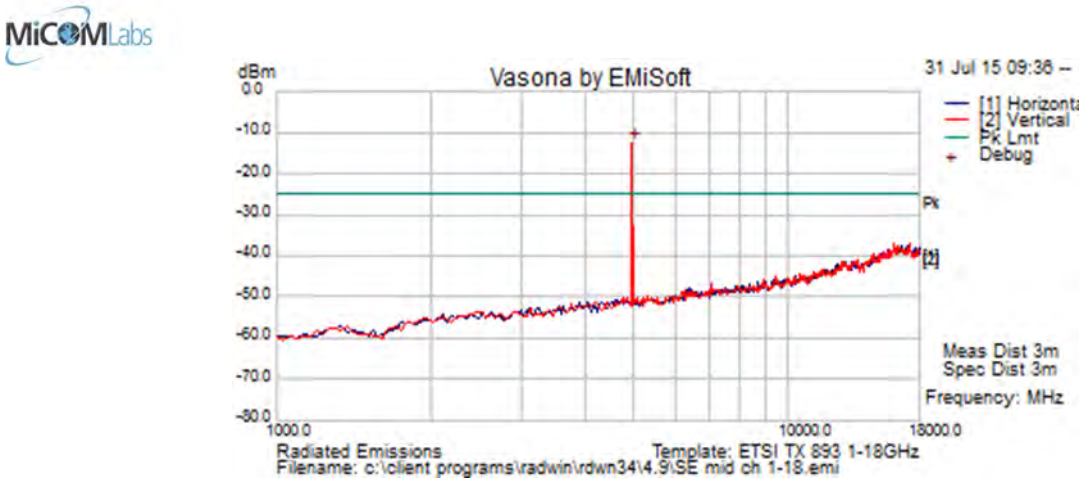
Frequency MHz	Raw dBm	Cable Loss	AF dB	Level dBm	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBm	Margin dB	Pass /Fail	Comments
4917.836	-19.1	5.7	1.6	-11.7	Peak [Scan]	H	100	0				FUND

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	NRB = Non-Restricted Band. Limit = 68.23 dBuV/m; RB = Restricted Band. Limits per 15.205

The emission breaking the limit line is the transmitter fundamental.

dBm to dBuV Conversion: dBuV = dBm + 107.

Test Freq.	4967.5 MHz	**Engineer**	SB
Variant	5 MHz	**Temp (ºC)**	18
Freq. Range	1 - 18 GHz	**Rel. Hum.(%)**	42
Power Setting	Maximum (+27 dBm)	**Press. (mBars)**	1003
Antenna	50 ohm load	**Duty Cycle (%)**	100%
Test Notes 1			
Test Notes 2			



Formally measured emission peaks

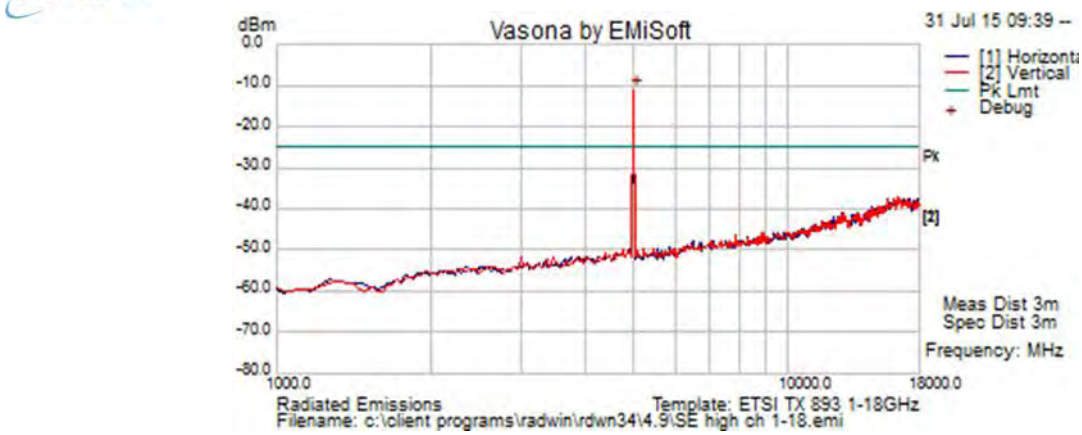
Frequency MHz	Raw dBm	Cable Loss	AF dB	Level dBm	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBm	Margin dB	Pass /Fail	Comments
4951.904	-19.7	5.7	1.5	-12.4	Peak [Scan]	V	100	0				FUND

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	NRB = Non-Restricted Band. Limit = 68.23 dBuV/m; RB = Restricted Band. Limits per 15.205

The emission breaking the limit line is the transmitter fundamental.

dBm to dBuV Conversion: dBuV = dBm + 107.

Test Freq.	4987.5 MHz	**Engineer**	SB
Variant	5 MHz	**Temp (ºC)**	18
Freq. Range	1 - 18 GHz	**Rel. Hum.(%)**	42
Power Setting	Maximum (+27 dBm)	**Press. (mBars)**	1003
Antenna	50 ohm load	**Duty Cycle (%)**	100%
Test Notes 1			
Test Notes 2			



Formally measured emission peaks

Frequency MHz	Raw dBm	Cable Loss	AF dB	Level dBm	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBm	Margin dB	Pass /Fail	Comments
4985.972	-18.2	5.8	1.5	-11.0	Peak [Scan]	V	100	0				FUND

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	NRB = Non-Restricted Band. Limit = 68.23 dBuV/m; RB = Restricted Band. Limits per 15.205

The emission breaking the limit line is the transmitter fundamental.

dBm to dBuV Conversion: dBuV = dBm + 107.

Radiated Spurious Emission Limits;

Transmitter Limits FCC Part §90.210 (m)

Emission Mask M
(6) On any frequency removed from the assigned frequency above 150% of the authorized bandwidth: 50 dB or 55 + 10 log(P) dB, whichever is the lesser attenuation.

Laboratory Measurement Uncertainty for Radiated Emissions

Measurement uncertainty	+5.6/ -4.5 dB

Traceability

Method
Measurements were made per work instruction WI-03 'Measurement of Radiated Emissions'

6.1.8. Digital Emissions (0.03 – 1 GHz)

FCC, Part 15 Subpart C §15.205/ §15.209

Test Procedure

Testing 30M-1 GHz was performed in a 3-meter anechoic chamber using a CISPR compliant receiver. Preliminary radiated emissions were measured on every azimuth and with the receiving antenna in both horizontal and vertical polarizations. To further maximize emissions the receive antenna was varied between 1 and 4 meters. The emissions are recorded with receiver in peak hold mode. Emissions closest to the limits are measured in the quasi-peak mode with the tuned receiver using a bandwidth of 120 kHz. Only the highest emissions relative to the limit are listed. The anechoic chamber test set-up is identified in Section 6 Test Set-Up Photographs.

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. In this test facility, the Antenna Factor, Cable Loss, and Amplifier Gains are loaded into the Rohde & Schwarz Receiver and the corrected field strength can be read directly on the receiver.

$$FS = R + AF + CORR$$

where:

FS = Field Strength
R = Measured Receiver Input Amplitude
AF = Antenna Factor
CORR = Correction Factor = CL – AG + NFL
CL = Cable Loss
AG = Amplifier Gain

For example:
Given a Receiver input reading of 51.5dBμV; Antenna Factor of 8.5dB; Cable Loss of 1.3dB; Falloff Factor of 0dB, an Amplifier Gain of 26dB and Notch Filter Loss of 1dB. The Field Strength of the measured emission is:

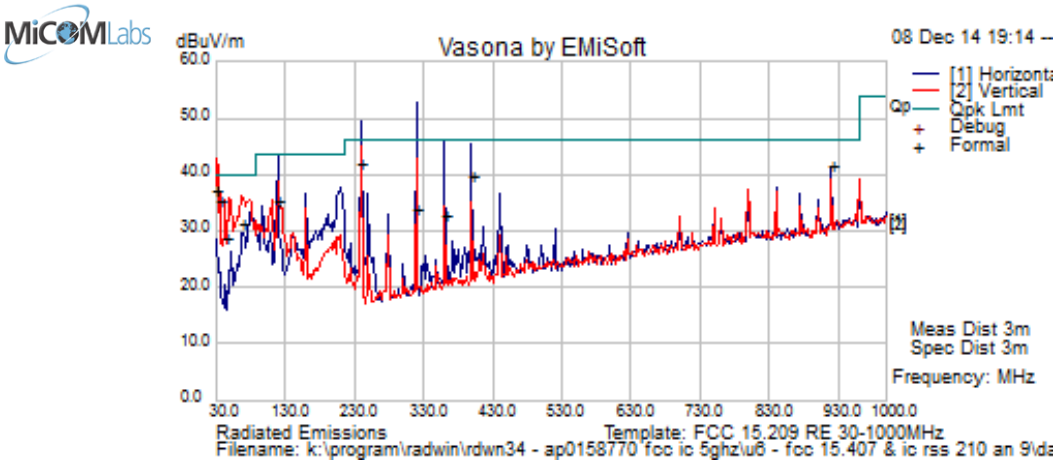
$$FS = 51.5 + 8.5 + 1.3 - 26.0 + 1 = 36.3 dB\mu V/m$$

Conversion between dBμV/m (or dBμV) and μV/m (or μV) are done as:

$$Level\ (dB\mu V/m) = 20 * Log\ (level\ (\mu V/m))$$

40 dBμV/m = 100μV/m

Test Freq.	NA	**Engineer**	JMH
Variant	Digital Emissions	**Temp (ºC)**	20
Freq. Range	30-1000 MHz	**Rel. Hum.(%)**	56
Power Setting	NA	**Press. (mBars)**	848
Antenna	32 dBi		
Test Notes 1	SN# No Serial number on unit		
Test Notes 2			



Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
319.999487	45.4	5.2	-16.7	33.9	Quasi Max	H	99	179	46.0	-12.1	Pass	
240.015	56.0	4.8	-19.0	41.9	Quasi Max	H	100	157	46	-4.2	Pass	
30.251	43.5	3.5	-9.9	37.1	Quasi Max	V	224	18	40	-2.9	Pass	
34.975	45.3	3.6	-13.6	35.3	Quasi Max	V	142	12	40	-4.7	Pass	
120.005	48.6	4.2	-17.5	35.3	Quasi Max	H	209	204	43.5	-8.2	Pass	
360.008	42.9	5.3	-15.4	32.8	Quasi Max	H	217	152	46	-13.2	Pass	
399.995	49.0	5.5	-14.8	39.7	Quasi Max	H	160	202	46	-6.3	Pass	

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental Frequency
	ETSI Vid Avg Type = 100 kHz RBW, 100 kHz VBW, Peak Detector, Video Average, 100 Sweeps

6.1.9. Receiver Radiated Spurious Emissions (above 1 GHz)

Industry Canada RSS-Gen §4.10, §6

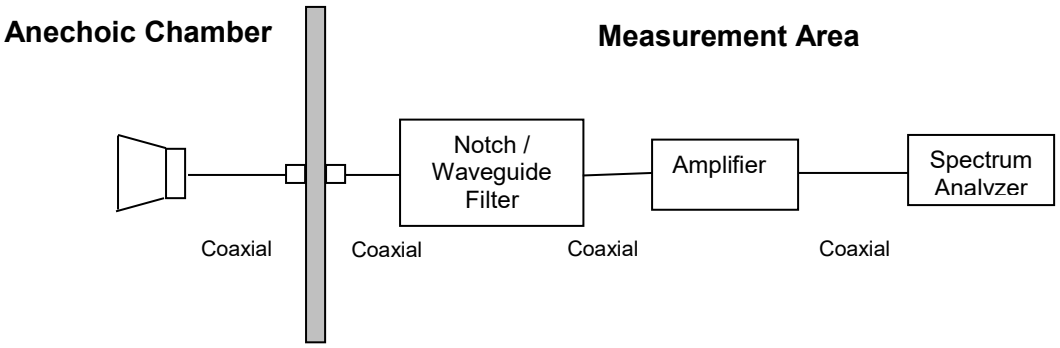
Test Procedure

Radiated emissions above 1 GHz are measured in the anechoic chamber at a 3-meter distance on every azimuth in both horizontal and vertical polarities. The emissions are recorded and maximized as a function of azimuth by rotation through 360° with a spectrum analyzer in peak hold mode. Depending on the frequency band spanned a notch filter and waveguide filter was used to remove the fundamental frequency. The highest emissions relative to the limit are listed for each frequency spanned.

All measurements on any frequency or frequencies over 1 MHz are based on the use of measurement instrumentation employing an average detector function. All measurements above 1 GHz were performed using a minimum resolution bandwidth of 1 MHz.

All Sectors of the EUT were tested simultaneously

Test Measurement Set up



Measurement set up for Radiated Emission Test

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. All factors are included in the reported data.

FS = R + AF + CORR - FO

where: FS = Field Strength
R = Measured Spectrum analyzer Input Amplitude
AF = Antenna Factor
CORR = Correction Factor = CL – AG + NFL
CL = Cable Loss
AG = Amplifier Gain
FO = Distance Falloff Factor
NFL = Notch Filter Loss or Waveguide Loss

For example:
Given receiver input reading of 51.5 dBμV; Antenna Factor of 8.5 dB; Cable Loss of 1.3 dB; Falloff Factor of 0 dB, an Amplifier Gain of 26 dB and Notch Filter Loss of 1 dB. The Field Strength of the measured emission is:

FS = 51.5 + 8.5 + 1.3 - 26.0 +1 = 36.3 dBμV/m

Conversion between dBμV/m (or dBμV) and μV/m (or μV) are done as:

Level (dBμV/m) = 20 * Log (level (μV/m))

40 dBμV/m = 100 μV/m
48 dBμV/m = 250 μV/m

Specification

Radiated Receiver Spurious Emissions

RSS-Gen §4.10 the search for spurious emissions shall be from the lowest frequency internally generated or used in the receiver (e.g.. local oscillator, intermediate or carrier frequency), or 30 MHz, whichever is higher, to at least 3 times the highest tunable or local oscillator frequency, whichever is higher, without exceeding 40 GHz.

For emissions below 1000 MHz, measurements shall be performed using a CISPR quasi-peak detector and the related measurement bandwidth. As an alternative to CISPR quasi-peak measurement, compliance with the emission limit can be demonstrated using measuring equipment employing a peak detector function properly adjusted for factors such as pulse desensitization as required, with an equal or greater measurement bandwidth relative to the applicable CISPR quasi-peak bandwidth.

Above 1000 MHz, measurements shall be performed using an average detector with a minimum resolution bandwidth of 1 MHz.

RSS-Gen §6 Receiver Spurious Radiated Limits
Spurious emissions from receivers shall not exceed the radiated limits shown in the table below:

RSS-Gen Spurious Emissions Limits

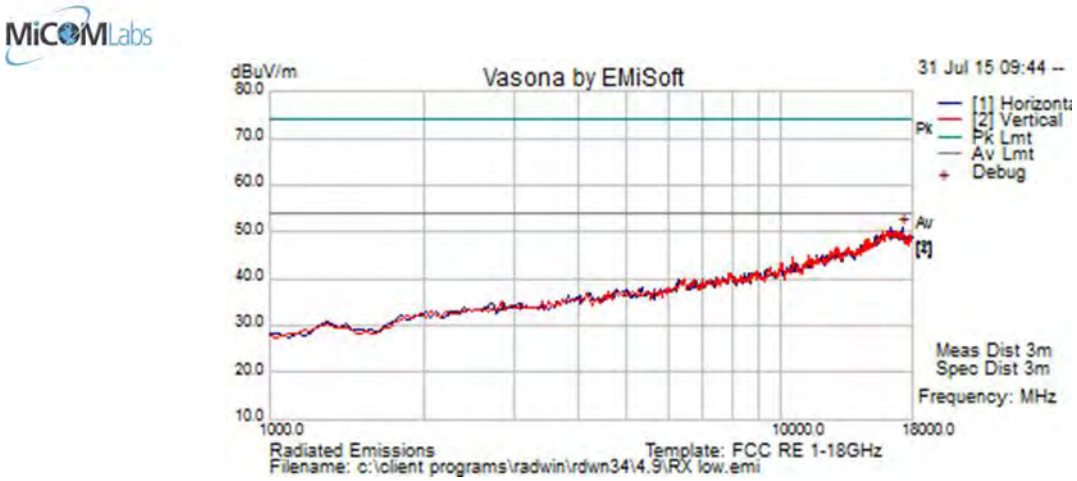
Frequency (MHz)	Field Strength (µV/m)	Field Strength (dBµV/m)	Measurement Distance (meters)
30-88	100	40.0	3
88-216	150	43.5	3
216-960	200	46.0	3
Above 960	500	54.0	3

Traceability:

Test Equipment Used
0088, 0158, 0134, 0304, 0311, 0315, 0310, 0312

Receiver Radiated Spurious Emissions above 1 GHz

Test Freq.	4967.5 MHz	**Engineer**	SB
Variant	5 MHz	**Temp (ºC)**	18
Freq. Range	1 - 18 GHz	**Rel. Hum.(%)**	42
Power Setting	Maximum (+27 dBm)	**Press. (mBars)**	1003
Antenna	50 ohm load	**Duty Cycle (%)**	100%
Test Notes 1			
Test Notes 2			



Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
17182.365	38.0	12.4	0.4	50.8	Peak [Scan]	H	100					Noise

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	NRB = Non-Restricted Band. Limit = 68.23 dBuV/m; RB = Restricted Band. Limits per 15.205

6.1.10. ac Wireline Emissions

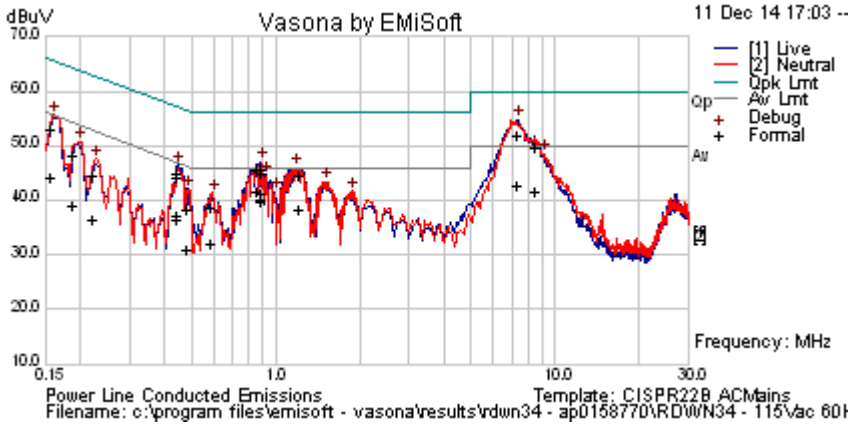
FCC, Part 15 Subpart C §15.207

Test Procedure

The EUT is configured in accordance with ANSI C63.4. The conducted emissions are measured in a shielded room with a spectrum analyzer in peak hold in the first instance. Emissions closest to the limit are measured in the quasi-peak mode (QP) with the tuned receiver using a bandwidth of 9 kHz. The emissions are maximized further by cable manipulation. The highest emissions relative to the limit are listed.

Measurement Results for ac Wireline Conducted Emissions (150 kHz – 30 MHz)

Test Freq.	N/A	**Engineer**	GMH
Variant	DC Line Emissions	**Temp (ºC)**	20
Freq. Range	0.150 MHz - 30 MHz	**Rel. Hum.(%)**	75
Power Setting	NA	**Press. (mBars)**	999
Antenna	N/A		
Test Notes 1	POE: Sinpro 115Vac 60 Hz: 55 Vdc		
Test Notes 2	POE Model #: CPU55A-270-1		



Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	Factors dB	Level dBuV	Measurement Type	Line	Limit dBuV	Margin dB	Pass /Fail	Comments
0.155	34.1	9.9	0.1	44.1	Average	Neutral	55.75	-11.7	Pass	
0.155	43.1	9.9	0.1	53.1	Quasi Peak	Neutral	65.75	-12.6	Pass	
0.187	38.1	9.9	0.1	48.1	Quasi Peak	Neutral	64.19	-16.1	Pass	
0.187	29.2	9.9	0.1	39.1	Average	Neutral	54.19	-15.1	Pass	
0.217	34.7	9.9	0.1	44.7	Quasi Peak	Neutral	62.92	-18.2	Pass	
0.217	26.4	9.9	0.1	36.3	Average	Neutral	52.92	-16.6	Pass	
0.440	34.8	9.9	0.1	44.8	Quasi Peak	Live	57.06	-12.3	Pass	
0.440	27.2	9.9	0.1	37.2	Average	Live	47.06	-9.8	Pass	
0.440	26.4	9.9	0.1	36.4	Average	Live	47.06	-10.7	Pass	
0.440	34.3	9.9	0.1	44.3	Quasi Peak	Live	57.06	-12.8	Pass	
0.472	28.4	9.9	0.1	38.4	Quasi Peak	Live	56.47	-18.1	Pass	
0.472	21.0	9.9	0.1	31.0	Average	Live	46.47	-15.5	Pass	
0.578	28.8	9.9	0.1	38.9	Quasi Peak	Neutral	56	-17.2	Pass	
0.578	21.9	9.9	0.1	31.9	Average	Neutral	46	-14.1	Pass	
0.843	31.6	9.9	0.1	41.6	Average	Live	46	-4.4	Pass	
0.843	35.8	9.9	0.1	45.9	Quasi Peak	Live	56	-10.2	Pass	
0.873	29.9	9.9	0.1	39.9	Average	Neutral	46	-6.1	Pass	

0.873	35.0	9.9	0.1	45.1	Quasi Peak	Neutral	56	-10.9	Pass	
0.876	30.1	9.9	0.1	40.2	Average	Live	46	-5.9	Pass	
0.876	35.5	9.9	0.1	45.5	Quasi Peak	Live	56	-10.5	Pass	
0.877	35.8	9.9	0.1	45.8	Quasi Peak	Live	56	-10.2	Pass	
0.877	31.2	9.9	0.1	41.2	Average	Live	46	-4.8	Pass	
1.189	28.2	9.9	0.1	38.2	Average	Neutral	46	-7.8	Pass	
1.189	34.6	9.9	0.1	44.6	Quasi Peak	Neutral	56	-11.4	Pass	
7.294	41.2	10.3	0.3	51.8	Quasi Peak	Live	60	-8.2	Pass	
7.294	32.0	10.3	0.3	42.6	Average	Live	50	-7.4	Pass	
8.379	39.2	10.3	0.3	49.9	Quasi Peak	Neutral	60	-10.1	Pass	
8.379	30.9	10.3	0.3	41.5	Average	Neutral	50	-8.5	Pass	

Legend:	DIG = Digital Device Emission; TX = Transmitter Emission; FUND = Fundamental Frequency
	NRB = Non-Restricted Band, Limit is 20 dB below Fundamental; RB = Restricted Band

Specification

Limits

§15.207 (a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μΩ line impedance stabilization network (LISN), see §15.207 (a) matrix below. Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal.

§15.207 (a) Limit Matrix
The lower limit applies at the boundary between frequency ranges

Frequency of Emission (MHz)	Conducted Limit (dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency

Laboratory Measurement Uncertainty for Conducted Emissions

Measurement uncertainty	±2.64 dB

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