Test of Digi International XBee Pro S3B

To: FCC 47 CFR Part15.247 & IC RSS-210

Test Report Serial No.: DIGI31-U1 Rev A

TEST REPORT

FROM

MiCOM Labs

Test of Digi International XBee Pro S3B

To FCC 47 CFR Part15.247 & IC RSS-210

Test Report Serial No.: DIGI31-U1 Rev A

This report supersedes: NONE

Manufacturer: Digi International
355 South 520 West, Suite 180
Lindon Utah 84042
USA

Product Function: General Data and Control Radio

Copy No: pdf **Issue Date:** 11th September 2012

This Test Report is Issued Under the Authority of;

MiCOM Labs, Inc.
440 Boulder Court, Suite 200
Pleasanton, CA 94566 USA
Phone: +1 (925) 462-0304
Fax: +1 (925) 462-0306
www.micomlabs.com

A2LA ACCREDITED

TESTING CERTIFICATE # 2381.01

MiCOM Labs is an ISO 17025 Accredited Testing Laboratory

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ACCREDITATION & LISTINGS

MiCOM Labs, Inc. an accredited laboratory complies with the international standard BS EN ISO/IEC 17025. 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

The American Association for Laboratory Accreditation

World Class Accreditation

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 27th day of March 2012.

President & CEO
For the Accreditation Council
Certificate Number 2381.01
Valid to November 30, 2013

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

RECOGNITION

MiCOM Labs, Inc has widely recognized Electrical testing capabilities. Our international recognition includes Conformity Assessment Body designation by APEC MRA** countries. Our test reports are widely accepted for global type approvals.

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
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	

**APEC MRA – Asia Pacific Economic Community Mutual Recognition Agreement.
Is a 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
N/A – Not Applicable

**EU MRA – European Union Mutual Recognition Agreement.
Is a recognition agreement under which test lab is accredited to regulatory standards of the EU member countries.

**NB – Notified Body

PRODUCT CERTIFICATION

MiCOM Labs, Inc. is an accredited Product Certification Body per the international standard EN ISO/IEC Guide 65. 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

United States of America – Telecommunication Certification Body (TCB)
TCB Identifier – US0159

Industry Canada – Certification Body
CAB Identifier – US0159

Europe – Notified Body
Notified Body Identifier - 2280

Japan – Recognized Certification Body (RCB)
RCB Identifier - 210

DOCUMENT HISTORY

Document History		
Revision	**Date**	**Comments**
Draft		
Rev A	11th September 2012	Initial Release

This report uses a combination of test data previously reported in MiCOM labs test reports DIGI22-U1 Rev B dated 3rd January 2012 where the EUT was tested at 20 kbps; and DIGI26-U1 Rev B dated 8th August 2012 where the EUT was tested at 10 kbps and 200 kbps.

This report was created to combine the results from these two test programs at the request of the customer.

1. TEST RESULT CERTIFICATE

Manufacturer:	Digi International 355 South 520 West, Suite 180 Lindon Utah 84042 USA	Tested By:	MiCOM Labs, Inc. 440 Boulder Court Suite 200 Pleasanton California, 94566, USA
EUT:	General Data and Control Radio	Telephone:	+1 925 462 0304
Model:	XBee Pro S3B	Fax:	+1 925 462 0306
S/N:	Not Available		
Test Date(s):	15 – 22nd September 2011 and 3rd - 12th July 2012	Website:	www.micomlabs.com

STANDARD(S)	TEST RESULTS
FCC 47 CFR Part15.247 & IC RSS-210	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.

ACCREDITED
TEST CERTIFICATE # 2381.01

Approved & Released for MiCOM Labs, Inc. by:

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 15, Subpart C	2012	Title 47: Telecommunication PART 15—RADIO FREQUENCY DEVICES Subpart C—Intentional Radiators
ii.	RSS-210 Annex 8	2010	Radio Standards Specification 210, Issue 8, Low-power Licence-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment
iii.	FCC OET KDB 662911	4th April 2011	Emissions Testing of Transmitters with Multiple Outputs in the Same Band
iv.	DA 00-705	2000	FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems" released March 30, 2000
v.	RSS-GEN	2010	Radio Standards Specification-Gen, Issue 3, General Requirements and Information for the Certification of Radiocommunication Equipment
vi.	FCC 47 CFR Part 15, Subpart B	2010	47 CFR Part 15, SubPart B; Unintentional Radiators
vii.	ICES-003	2004	Spectrum Management and Telecommunications Policy Interference-Causing Equipment Standard Digital Apparatus; Issue 4
viii.	ANSI C63.4	2009	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
ix.	CISPR 22/ EN 55022	2008 2006+A1: 2007	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
x.	M 3003	Edition 2 Jan. 2007	Expression of Uncertainty and Confidence in Measurements
xi.	LAB34	Edition 1 Aug 2002	The expression of uncertainty in EMC Testing
xii.	ETSI TR 100 028	2001	Parts 1 and 2 Electromagnetic compatibility and Radio Spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics
xiii.	A2LA	July 2012	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 uncertainty figures are calculated in accordance with ETSI TR 100 028 Parts 1 and 2.

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 the Digi International XBee Pro S3B to FCC Part 15.247 and Industry Canada RSS-210 regulations for Frequency Hopping operation.
Applicant:	Digi International 355 South 520 West, Suite 180 Lindon, Utah 84042 USA
Manufacturer:	Digi International 355 South 520 West, Suite 180 Lindon Utah 84042 USA
Laboratory performing the tests:	MiCOM Labs, Inc. 440 Boulder Court, Suite 200 Pleasanton, California 94566 USA
Test report reference number:	DIGI31-U1 Rev A
Standard(s) applied:	FCC 47 CFR Part15.247 & IC RSS-210
Date EUT received:	1st September 2011 and 26th June 2012
Dates of test (from - to):	15 – 22nd September 2011 and 3rd - 12th July 2012
No of Units Tested:	Three (10 kbps, 20 kbps & 200 kbps)
Type of Equipment:	915 MHz Frequency Hopping
Manufacturers Trade Name:	XBee 900 HP
Model:	XBee ProS3B
Location for use:	Indoor and Outdoor
Declared Frequency Range(s):	902 - 928 MHz
Type of Modulation:	FSK (10 kbps and 20 kbps), GMSK (200 kbps)
Declared Nominal Output Power:	Max: +24 dBm Min: -17 dBm
EUT Modes of Operation:	FHSS
Transmit/Receive Operation:	Transceiver Half Duplex
Manufacturers Declared Rated Input Voltage and Current:	Nom: 3.3 Vdc, Min: 2.4 Vdc Max: 3.6 Vdc
Operating Temperature Range:	-40ºC to +85ºC (client declared range)
ITU Emission Designator:	10 kbps 307KF7D 20 kbps 300KF7D 200 kbps 346KF7D
Long Term Frequency Stability:	±3ppm/year
EUT Dimensions (L x W x H):	33 x 22 x 4mm or with Reverse SMA 33 x 22 x 8mm
EUT Weight :	6 grams
Primary function of equipment:	General data and control radio

3.2. Scope of Test Program

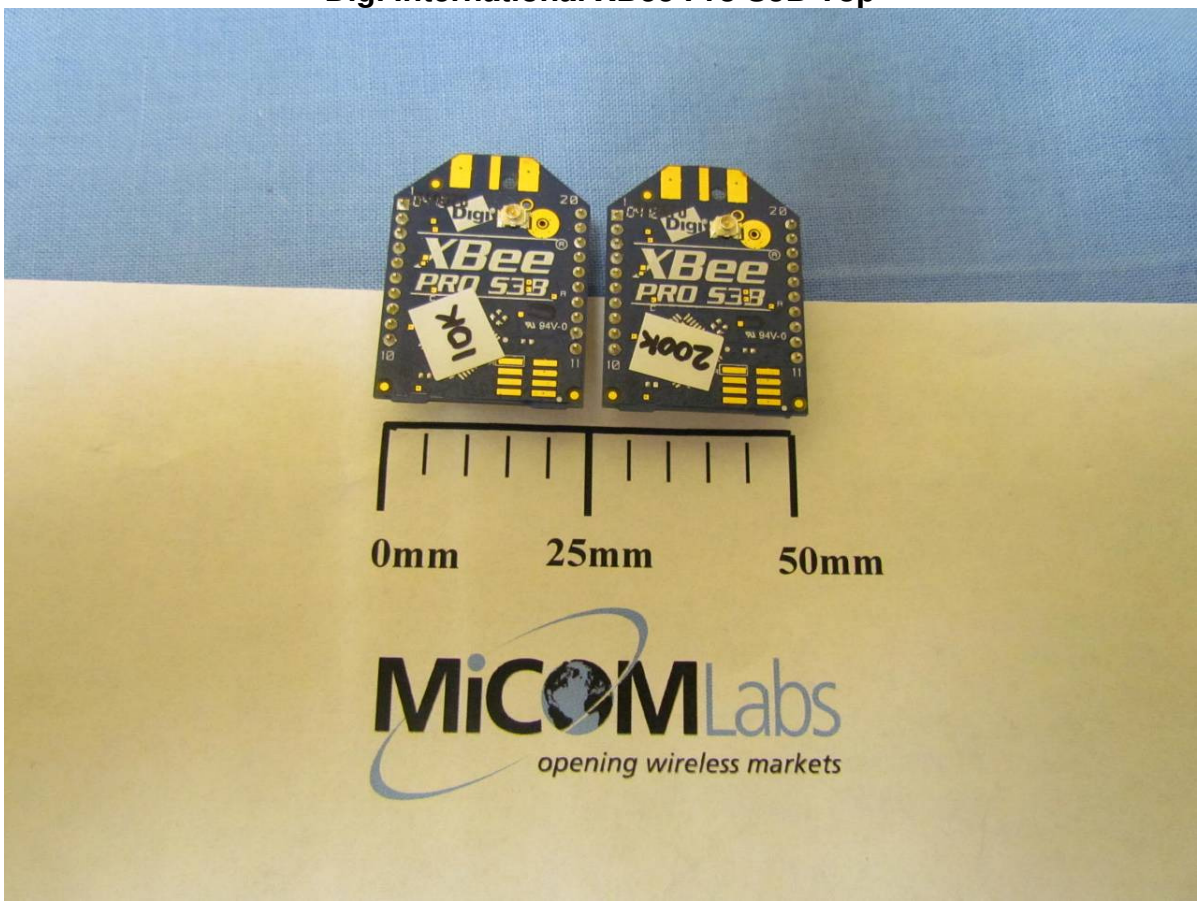
The scope of the test program was to testing on the Digi International XBee Pro S3B in the frequency ranges 902 - 928 MHz against FCC 47 CFR Part 15.247 and Industry Canada RSS-210 specifications for radiated and conducted emissions for intentional radiators. The intentional radiator was tested in a simulated typical installation to demonstrate compliance with the stated standards.

This report uses a combination of test data previously reported in MiCOM labs test reports DIGI22-U1 Rev B dated 3rd January 2012 where the EUT was tested at 20 kbps; and DIGI26-U1 Rev B dated 8th August 2012 where the EUT was tested at 10 kbps and 200 kbps.

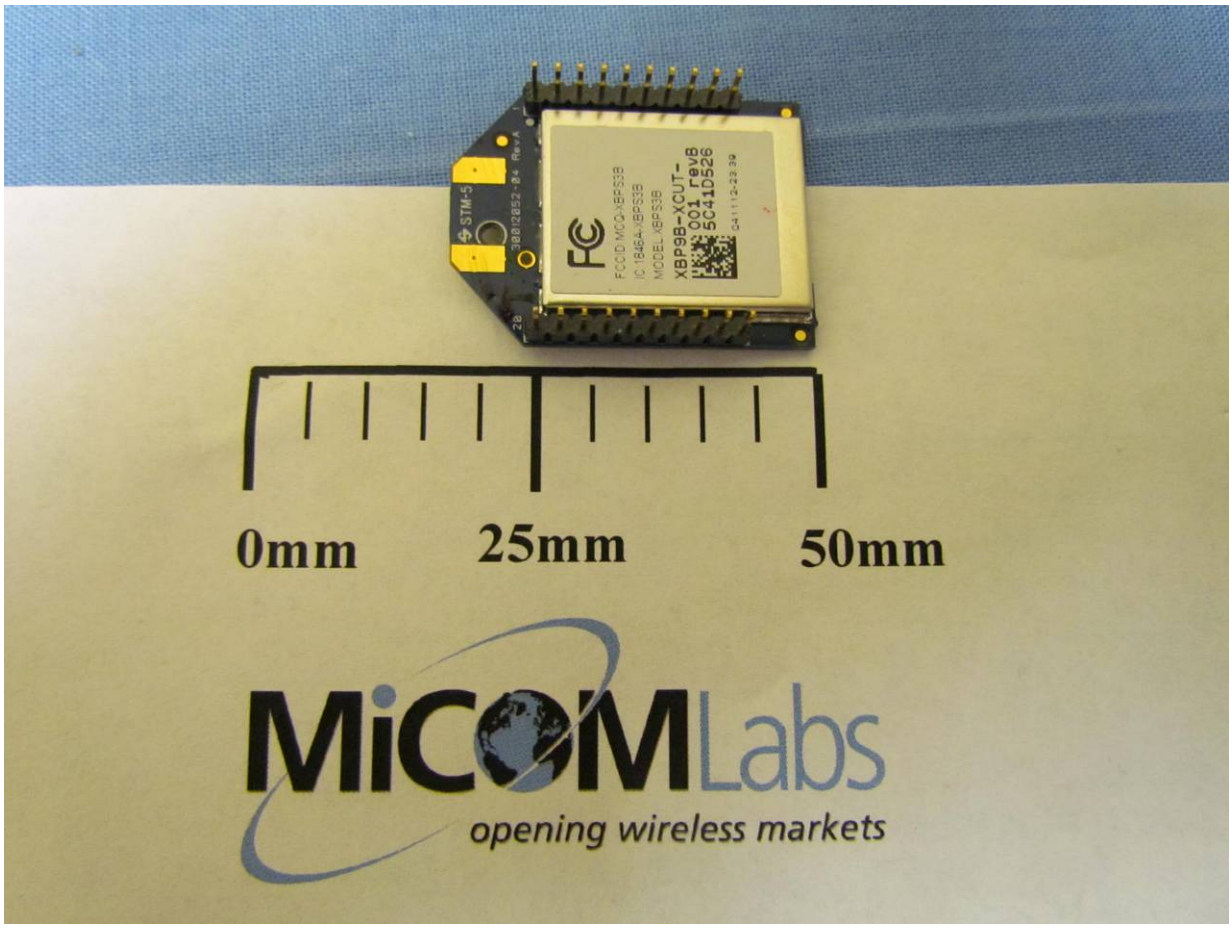
This report was created to combine the results from these two test programs at the request of the customer.

Device is a frequency hopper. There were three data rates tested during the programs 10 kbps, 20 kbps and 200 kbps.

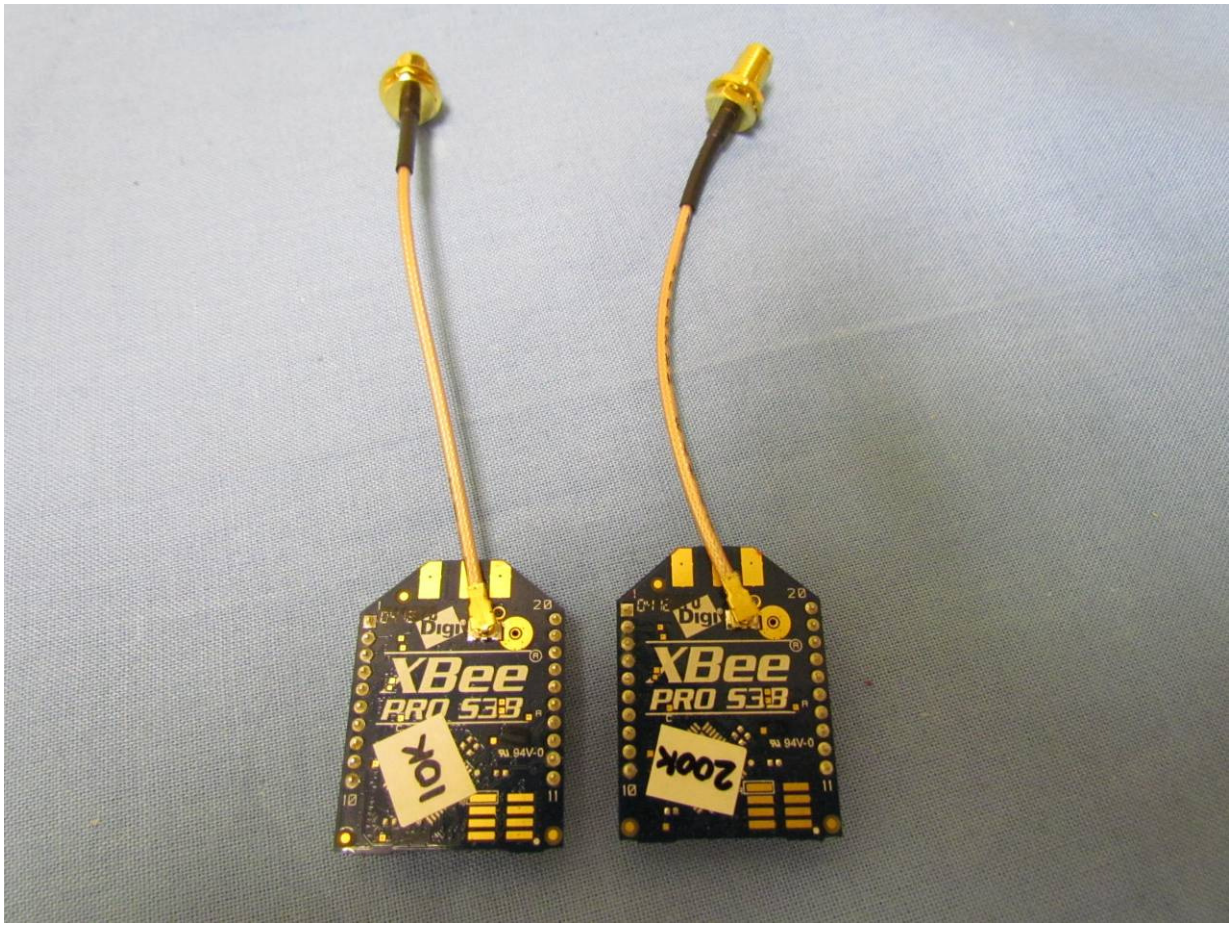
Digi International XBee Pro S3B Top



Digi International XBee Pro S3B Reverse



Digi International XBee Pro S3B with SMA Test Connectors



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

Type (EUT/ Support)	Equipment Description (Including Brand Name)	Mfr	Model No.	Serial No.
EUT	915 MHz	Digi International	XBPS3B (10 kbps)	None Available
EUT	915 MHz	Digi International	XBPS3B (200 kbps)	None Available
EUT	915 MHz	Digi International	XBPS3B (20 kbps)	None Available
Support	Cable Assembly + pcb + dc voltage supply	Digi International	N/A	N/A

3.4. Antenna Details

The following is a description of the EUT antennas.

Manufacturer	Model	Type	Gain (dBi)	Frequency Band (MHz)
Cushcraft Corporation	PC9013	Yagi Directional	15.1	900 - 950
Laird Technologies	FG9026	FiberGlass Omni	8.1	900 - 950

3.5. Cabling and I/O Ports

Number and type of I/O ports

1. RF Port (915 MHz) U.fl

3.6. Test Configurations

Test configurations

Operating Channel	Frequencies (MHz)
0	902.4
33	915.2
63	927.6

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

The following tests were performed by a MiCOM Labs approved test facility;-

1. NONE

4. TEST SUMMARY

List of Measurements

The following table represents the list of measurements required under the **FCC CFR47 Part 15.247**, **Industry Canada RSS-210** and **Industry Canada RSS-Gen.**

Section(s)	Test Items	Description	Condition	Result	Test Report Section
15.247(a)(1) A8.1	20 dB BW	20 dB BW	Conducted	Complies	5.1.1
15.247(a)(1) A8.1	Transmitter Channels	Channel Spacing	Conducted	Complies	5.1.2
15.247(a)(1) A8.1	Transmitter Channels	Number of Channels	Conducted	Complies	5.1.3.1
		Channel Occupancy	Conducted	Complies	5.1.3.2
15.247(b)(2) A8.4	Output Power	Transmit Power	Conducted	Complies	5.1.4
15.247(i) 5.5	Maximum Permissible Exposure	Exposure to radio frequency energy levels	Conducted	Complies	5.1.5
15.247(d) A8.5	Conducted Spurious Emissions	Band Edge	Conducted	Complies	5.1.6
		Spurious Emissions Transmitter (1 to 10 GHz)	Conducted	Complies	
§7.2.3		Standby	Conducted	Complies	5.1.7

List of Measurements

The following table represents the list of measurements required under the **FCC CFR47 Part 15.247**, **Industry Canada RSS-210** and **Industry Canada RSS-Gen.**

Section(s)	Test Items	Description	Condition	Result	Test Report Section
15.247(d) **15.205** **15.209** **A8.5** **2.2** **2.6** **4.9**	Radiated Emissions above 1 GHz & below 1 GHz	Transmitter	Radiated	Complies	*5.1.8.1*
4.10		Receiver	Radiated	Complies	*5.1.8.2*

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 RESULTS

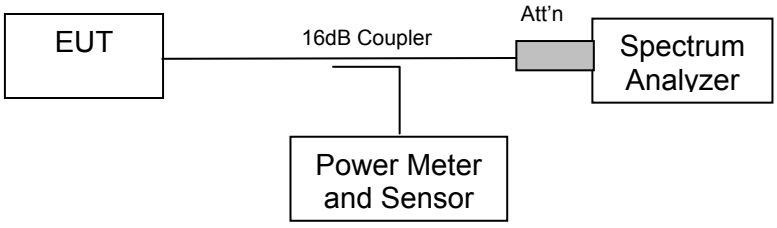
5.1. Device Characteristics

5.1.1. 20 dB Bandwidth

FCC, Part 15 Subpart C §15.247(a)(1)
Industry Canada RSS-210 §A8.1

Test Procedure
The 20 dB bandwidth is measured with a spectrum analyzer connected to the antenna terminal, while the EUT is operating in transmission mode at the appropriate center frequency and modulation.

Test Measurement Set up



Measurement set up for 20 dB bandwidth test

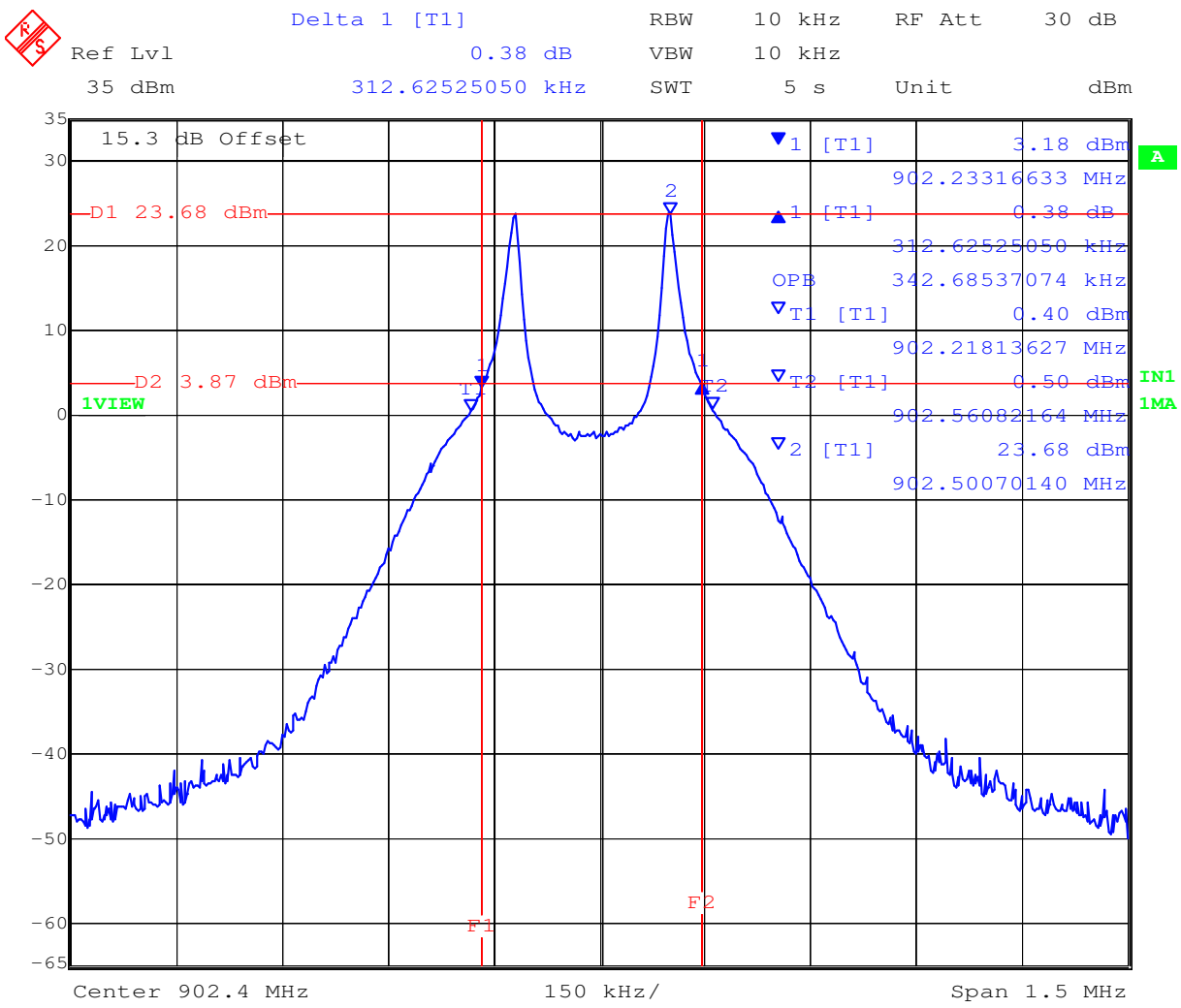
Test Results for 20 dB Bandwidth

Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

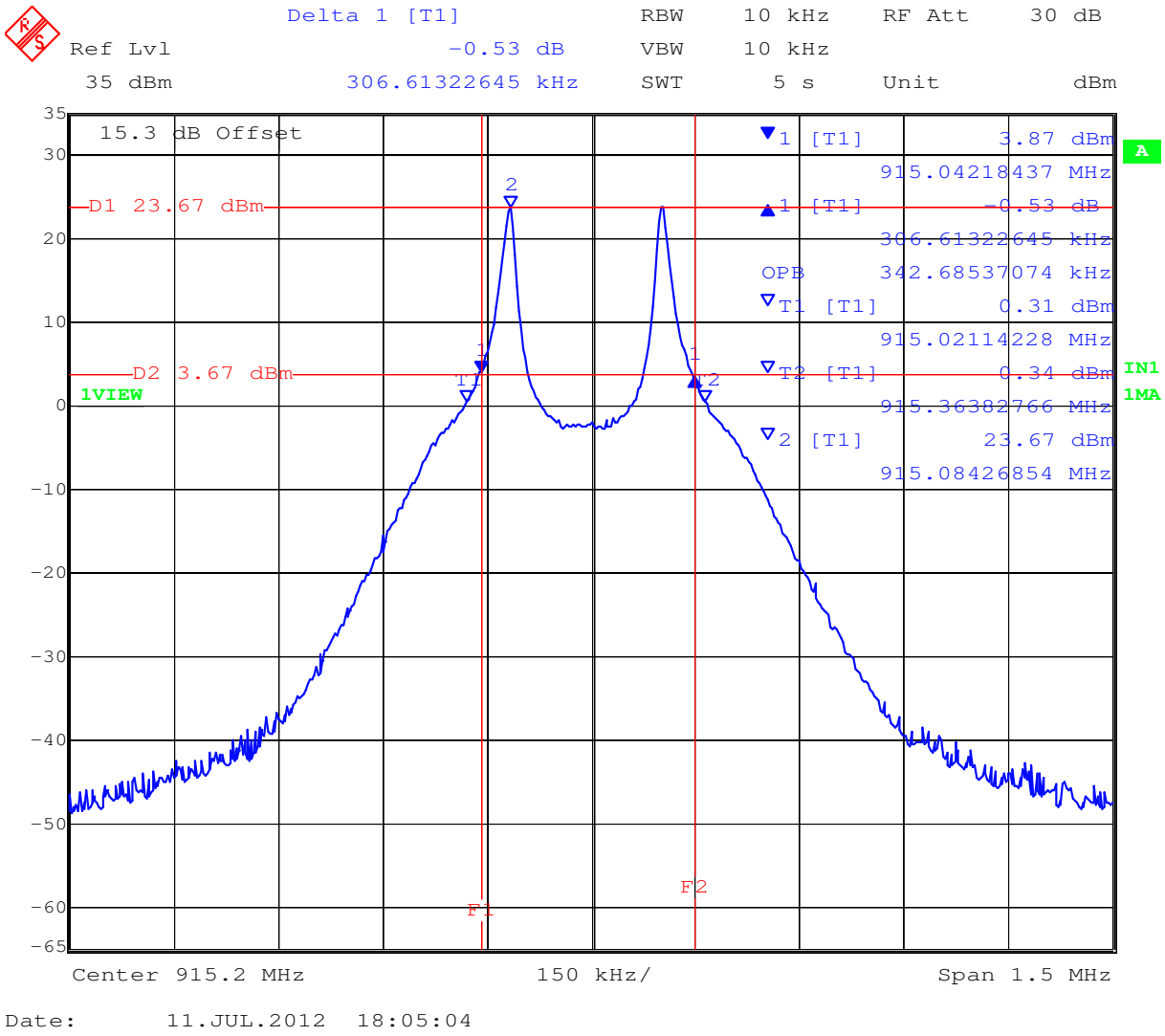
TABLE OF RESULTS – 10 kbps

Channel #	Center Frequency (MHz)	20 dB Bandwidth (kHz)	Specification (kHz)
0	902.4	312.625	<500
33	915.2	306.613	
63	927.6	309.118	

10 kbps CH 0 902.4 MHz 20 dB Bandwidth



10 kbps CH 33 915.2 MHz 20 dB Bandwidth



10 kbps CH 63 927.6 MHz 20 dB Bandwidth

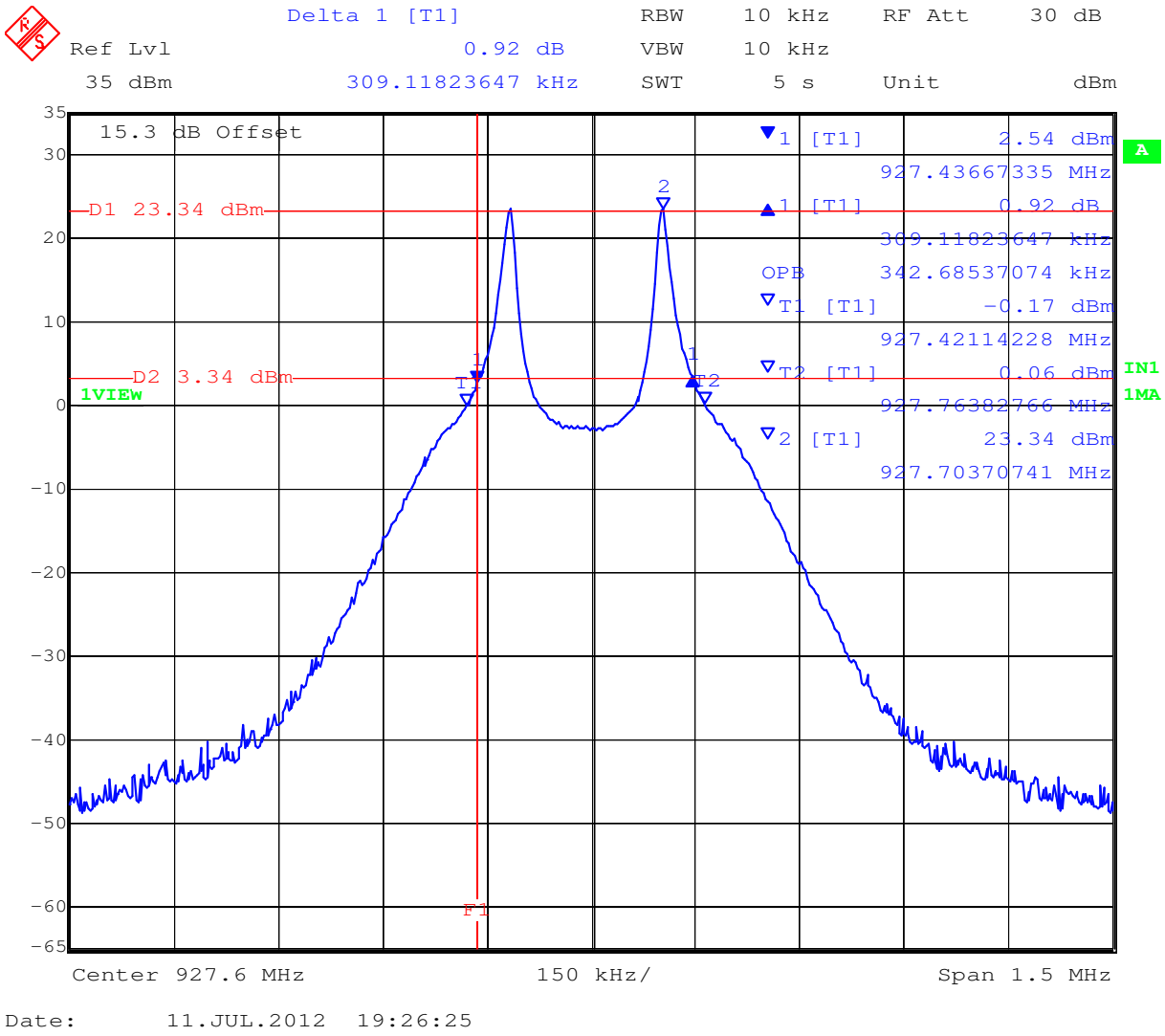
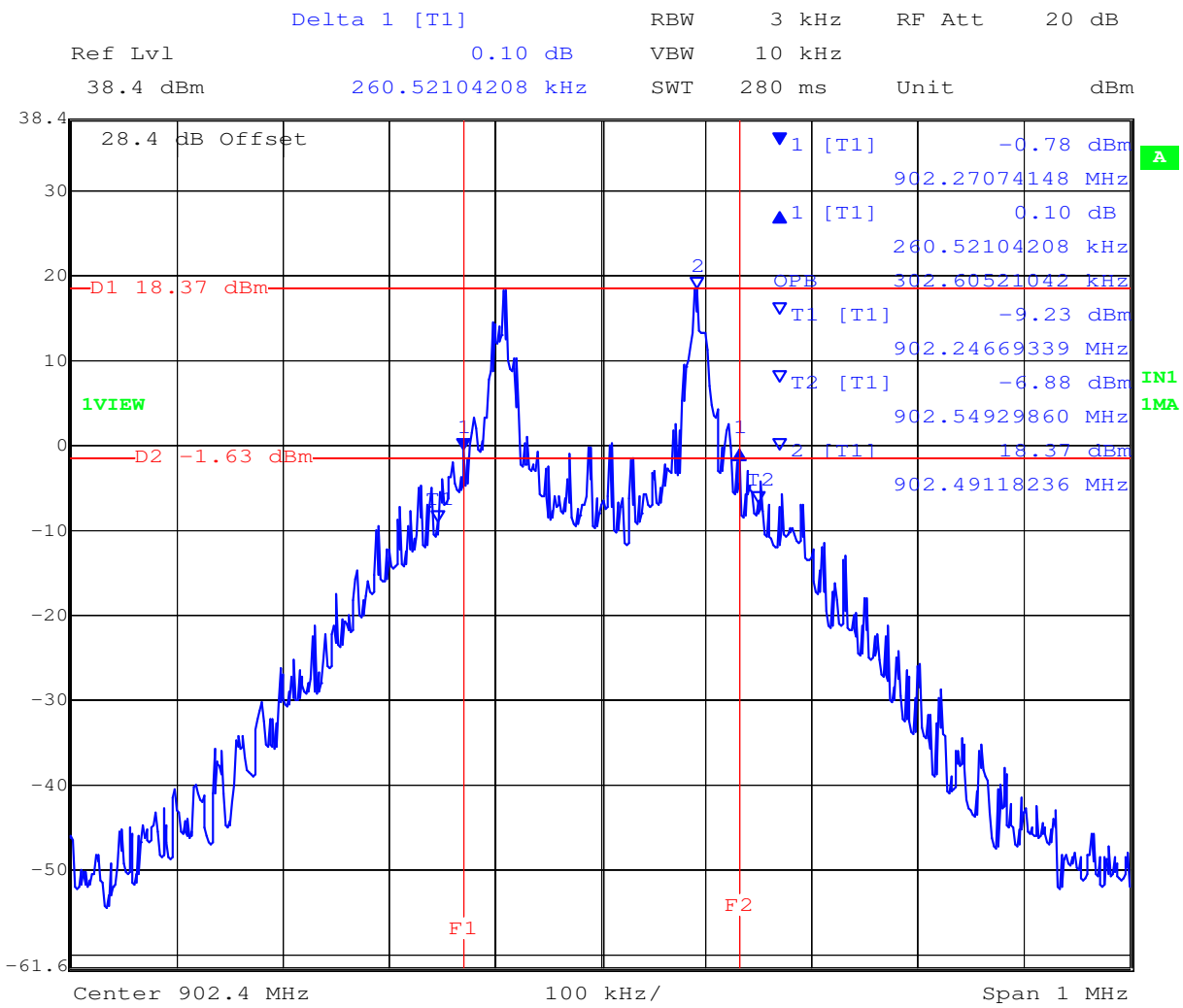


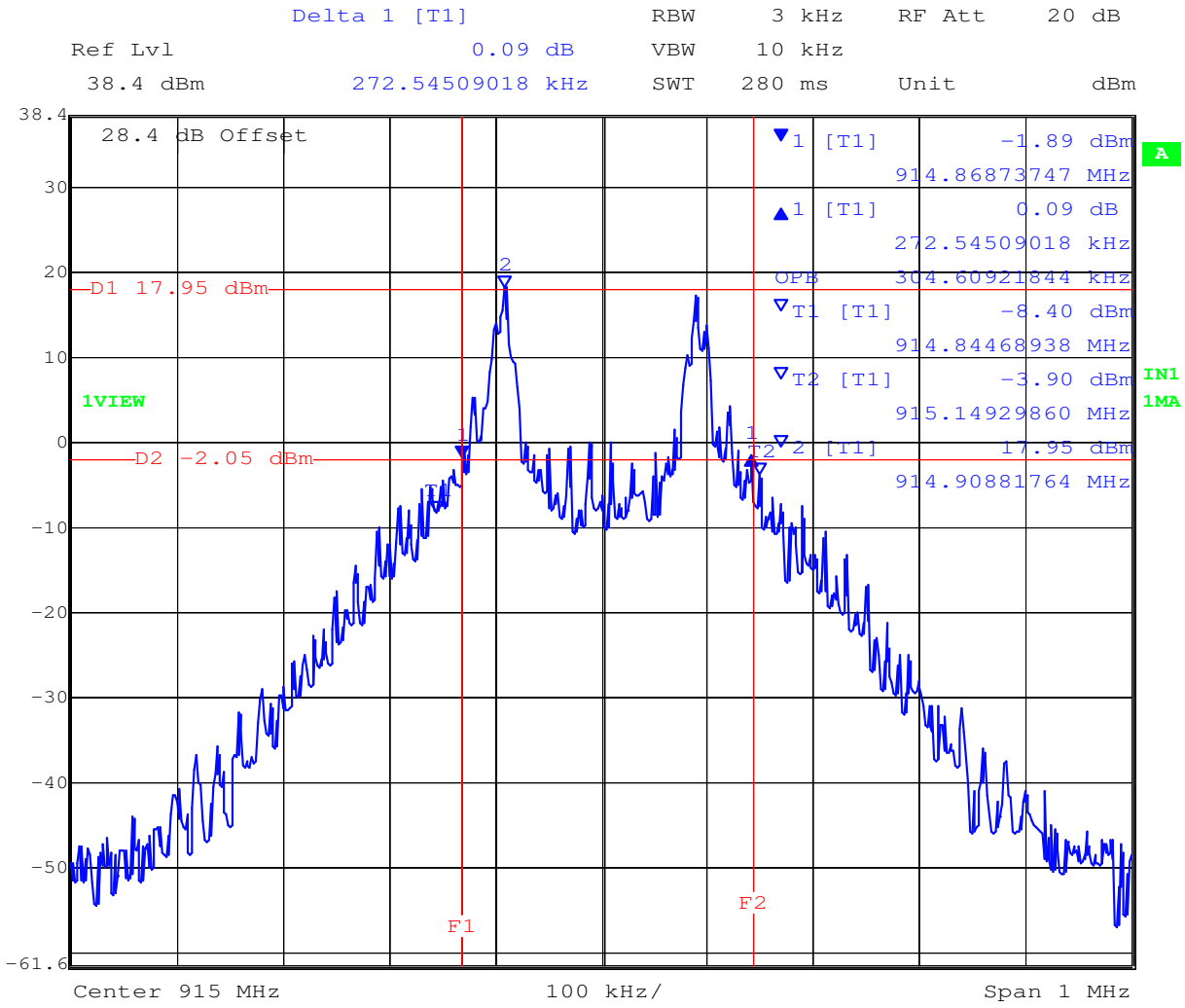
TABLE OF RESULTS – 20 kbps

Channel #	Center Frequency (MHz)	20 dB Bandwidth (kHz)	Specification (kHz)
0	902.4	260.521	<500
42	915.2	272.545	
83	927.6	282.565	

20 kbps CH 0 902.4 MHz 20 dB Bandwidth



20 kbps CH 42 915.2 MHz 20 dB Bandwidth



20 kbps CH 83 927.6 MHz 20 dB Bandwidth

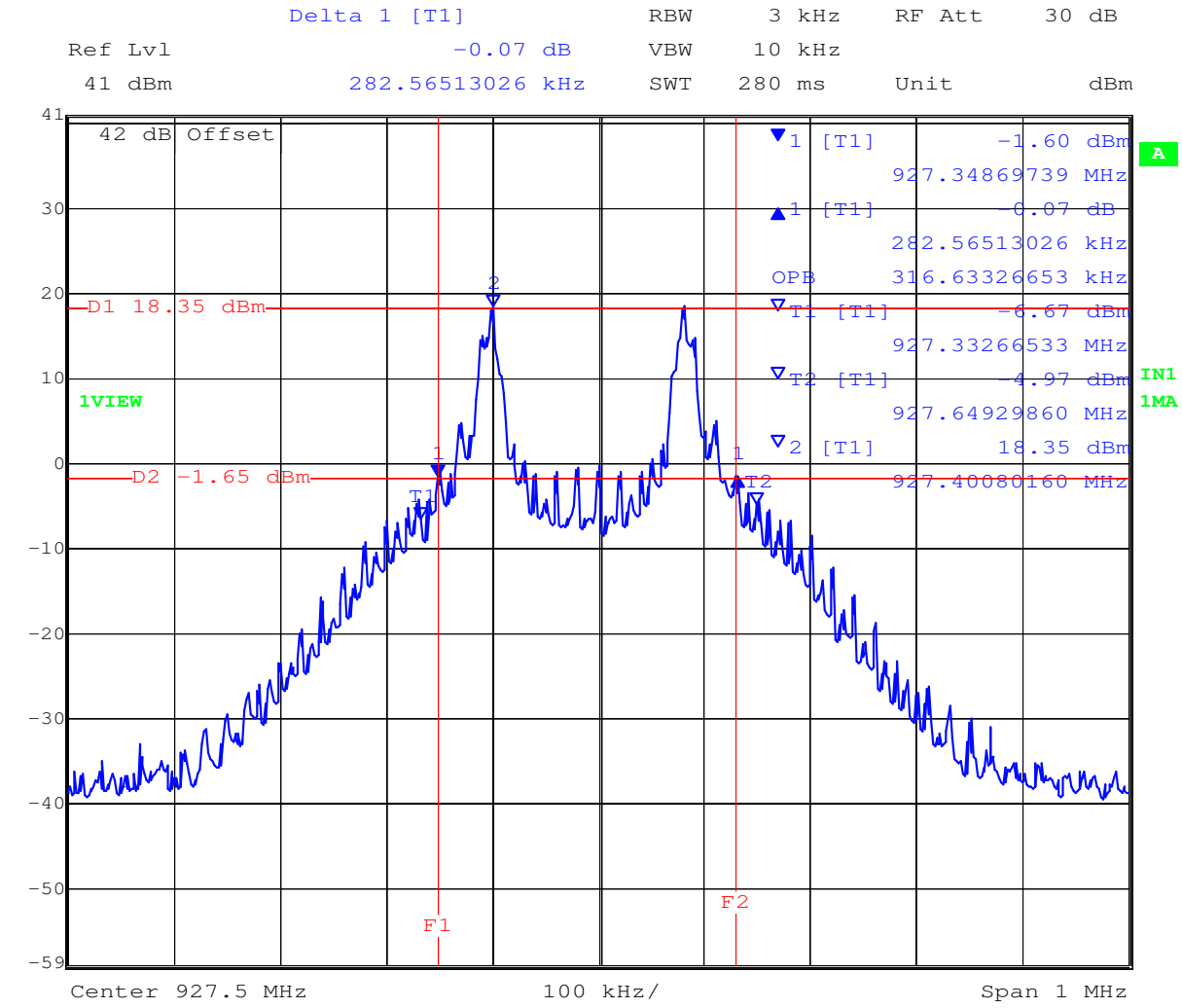
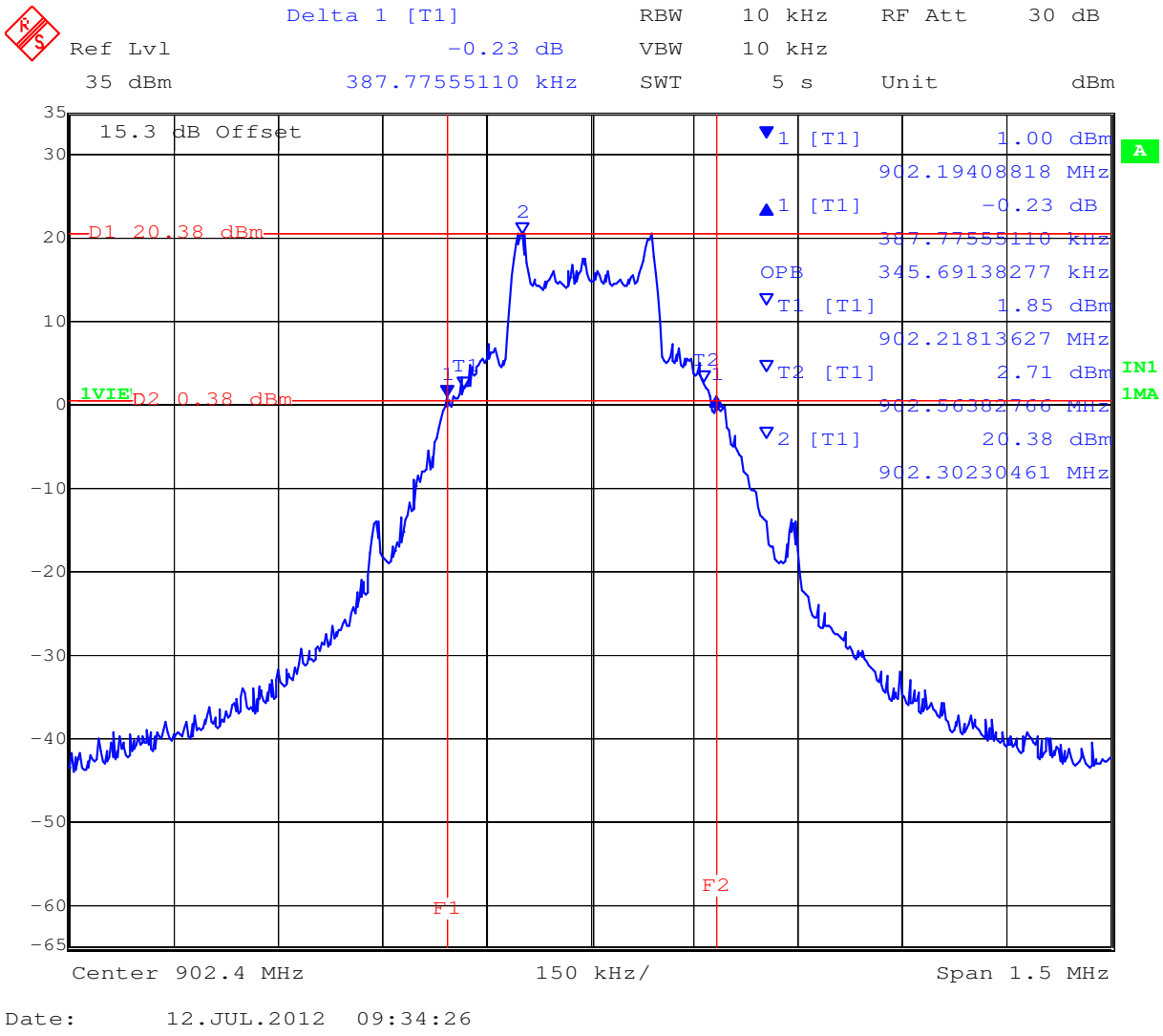


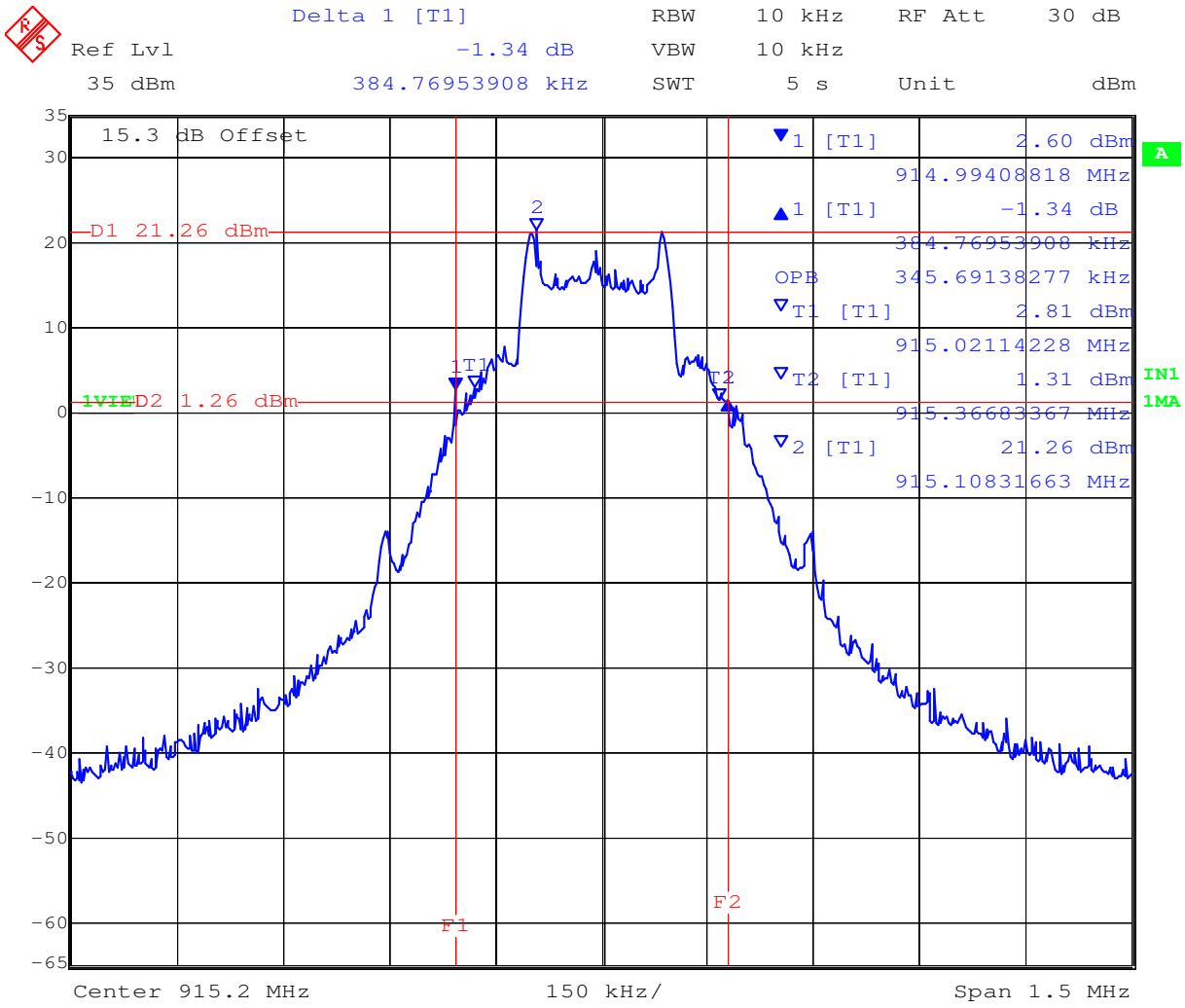
TABLE OF RESULTS – 200 kbps

Channel #	Center Frequency (MHz)	20 dB Bandwidth (kHz)	Specification (kHz)
0	902.4	345.691	<500
33	915.2	384.770	
63	927.6	357.715	

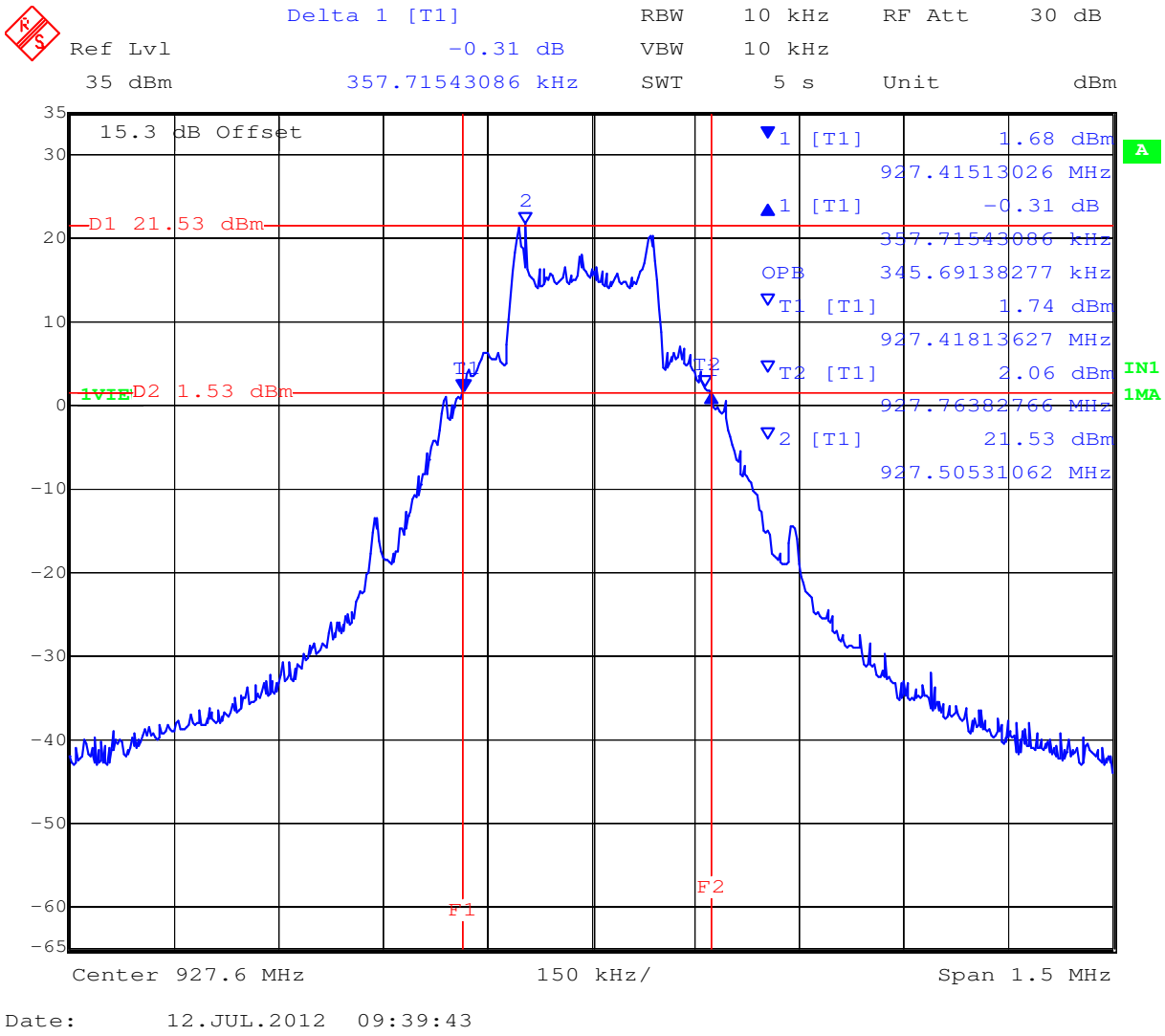
200 kbps CH 0 902.4 MHz 20 dB Bandwidth



200 kbps CH 33 915.2 MHz 20 dB Bandwidth



200 kbps CH 63 927.6 MHz 20 dB Bandwidth



Specification

Limits

FCC §15.247 (a)(1)
Industry Canada RSS-210 §8.1

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Laboratory Measurement Uncertainty for Spectrum Measurement

Measurement uncertainty	±2.81 dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of RF Spectrum Mask'	0158, 0193, 0252, 0313, 0314, 0070, 0116, 0117

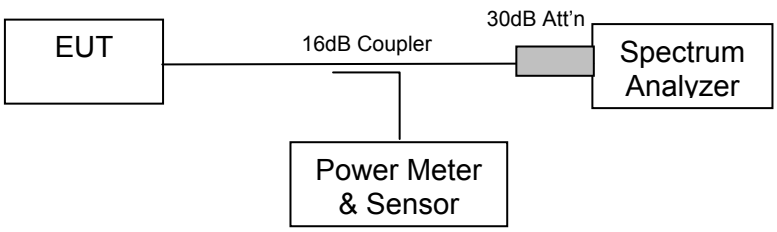
5.1.2. Transmitter Channels - Channel Spacing

FCC, Part 15 Subpart C §15.247(a)(1)
Industry Canada RSS-210 §8.1(2)

Test Procedure

The channel spacing is measured with a spectrum analyzer connected to the antenna terminal, while the EUT is operating in transmission mode at the appropriate center frequency and modulation.

Test Measurement Set up



Measurement set up for Channel Spacing Test

Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

TABLE OF RESULTS – 10 kbps

Channel(s)	Channel Spacing (KHz)	Maximum 20 dB Bandwidth (kHz)	Specification
First two channels	400.866	312.625	Greater than maximum 20 dB Bandwidth

Channel spacing for first two channels

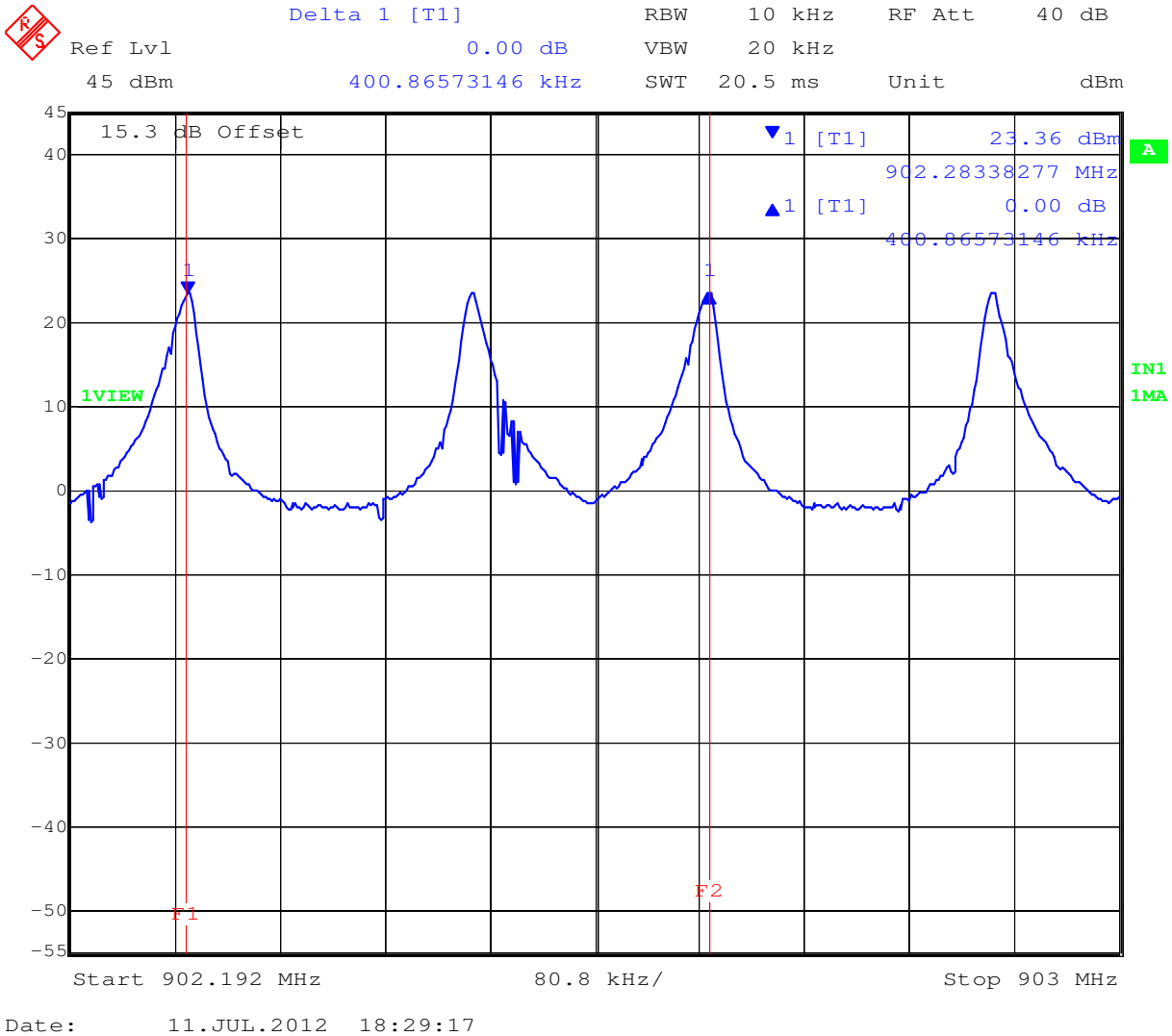


TABLE OF RESULTS - 20 kbps

Channel(s)	Channel Spacing (KHz)	Specification
25-26	300.902	Greater than maximum 20 dB Bandwidth

Maximum 20 dB bandwidth = 52.6052 kHz

Channel Spacing for CH 25 – CH 26

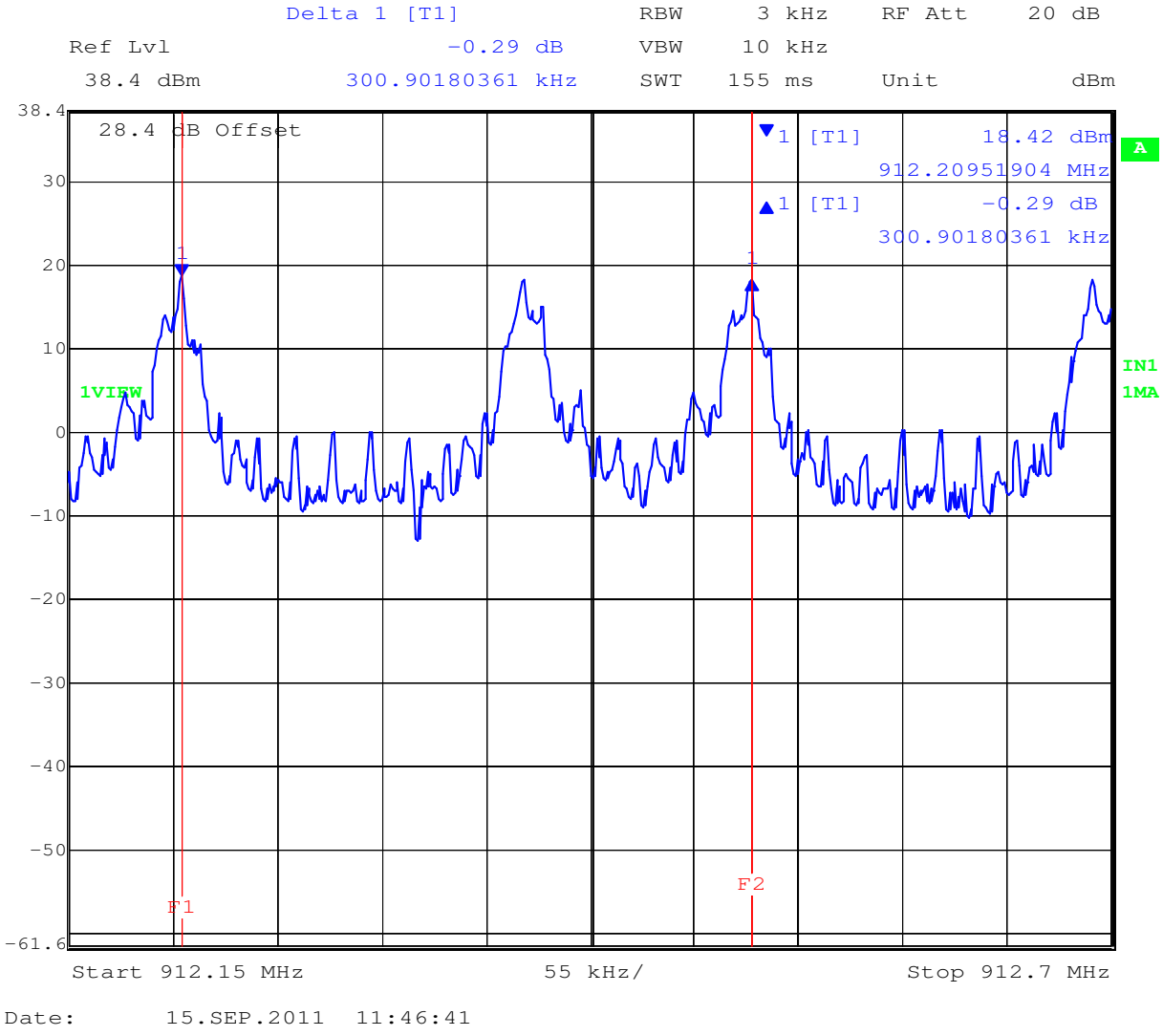
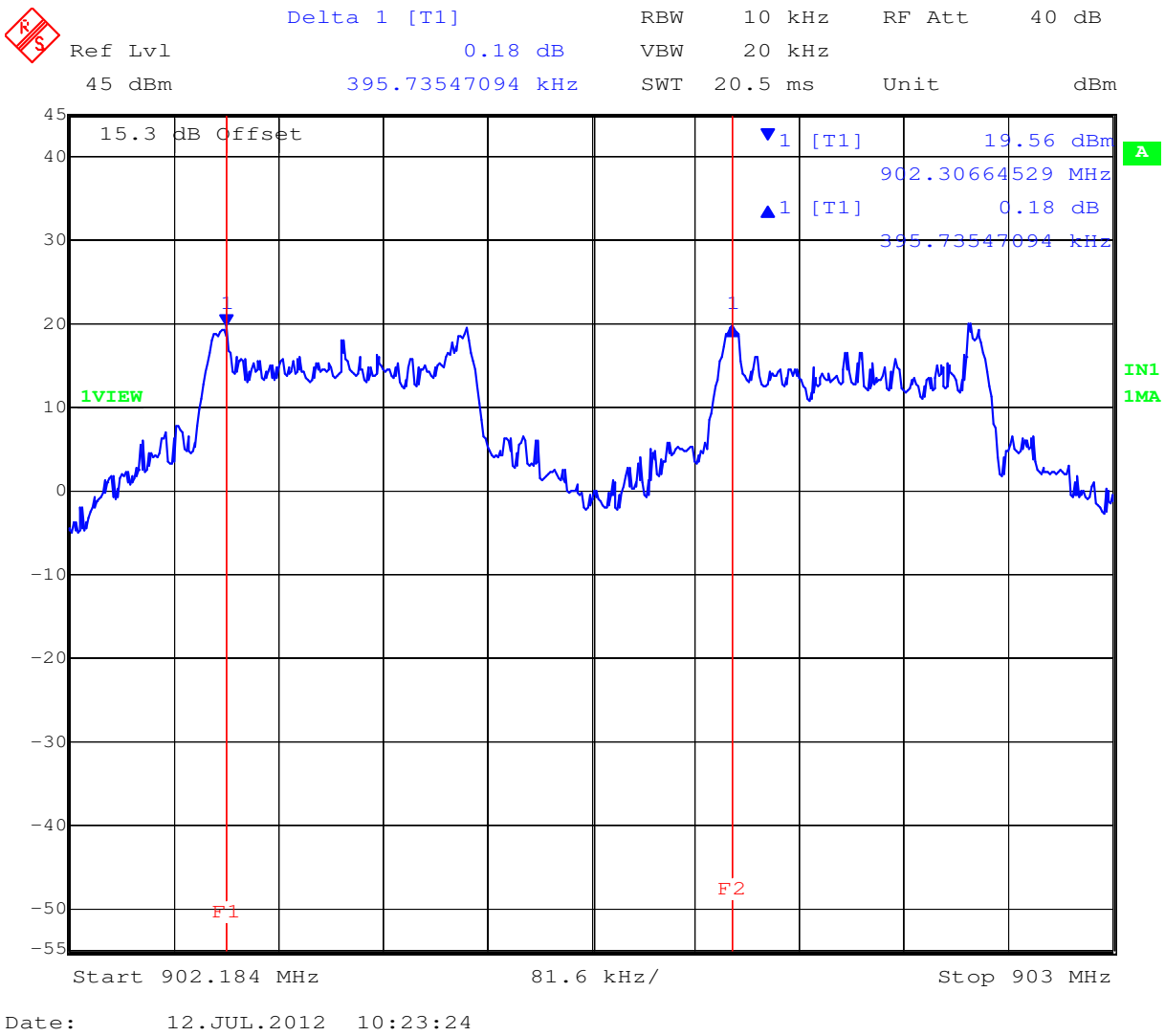


TABLE OF RESULTS – 200 kbps

Channel(s)	Channel Spacing (KHz)	Maximum 20 dB Bandwidth (kHz)	Specification
First two channels	395.735	384.770	Greater than maximum 20 dB Bandwidth

Channel spacing for first two channels



Specification for Channel Spacing

Limits

FCC §15.247 (a)(1)
Industry Canada RSS-210 §A8.1(2)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Laboratory Uncertainty for Frequency Measurements

Measurement uncertainty	±0.86ppm

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-02 'Frequency Measurement"	0078, 0134, 0158, 0184, 0193, 0250, 0252 0310, 0312.

5.1.3. Transmitter Channels

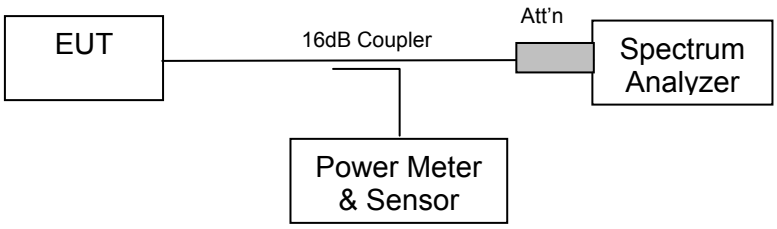
5.1.3.1. Number of Channels

FCC, Part 15 Subpart C §15.247(a)(1)
Industry Canada RSS-210 §A8.1

Test Procedure

The number of channels and channel occupancy is measured with a spectrum analyzer connected to the antenna terminal, while the EUT is operating in transmission mode at the appropriate center frequency and modulation.

Test Measurement Set up



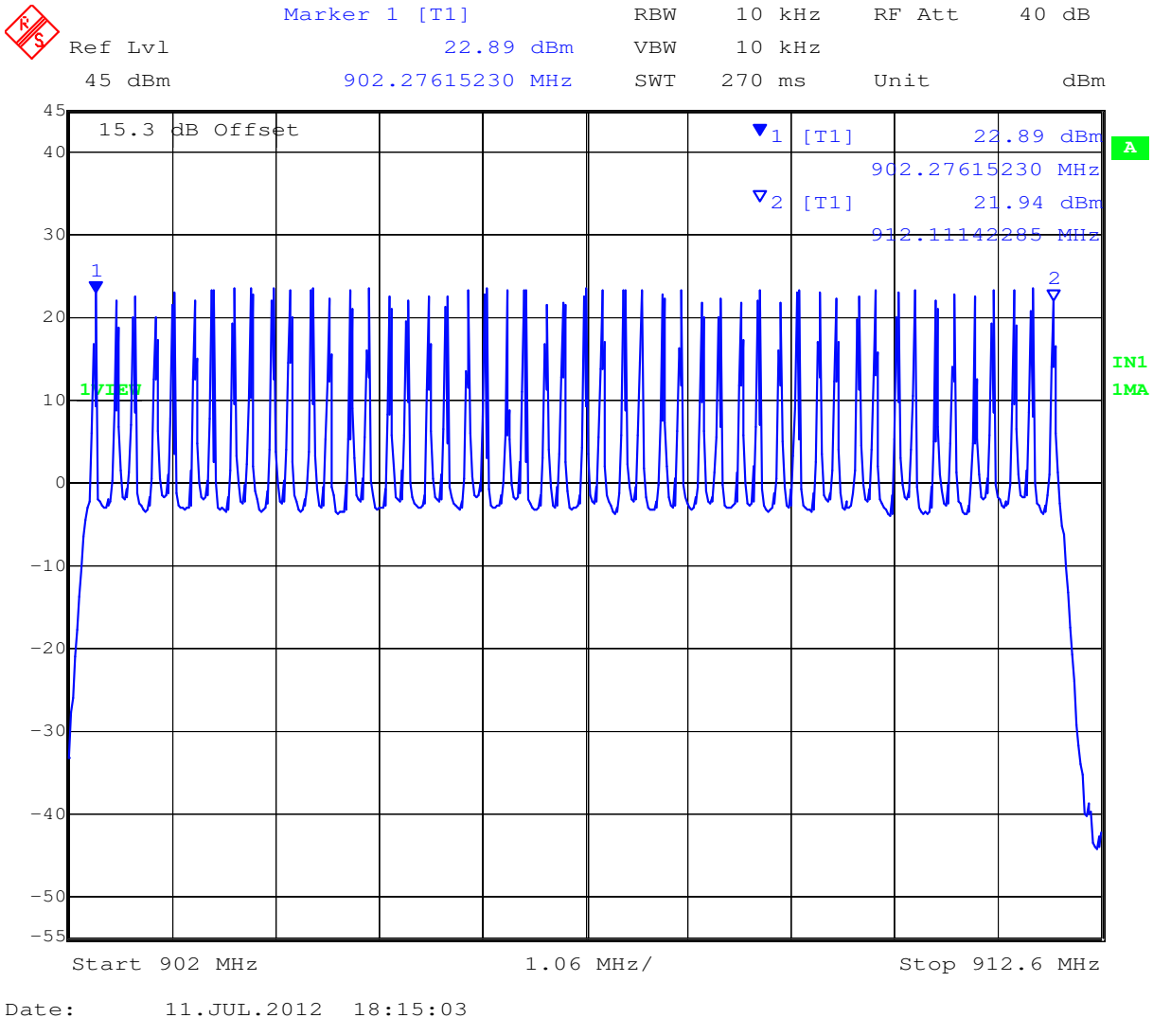
Test set up to measure the number of channels and channel occupancy

Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

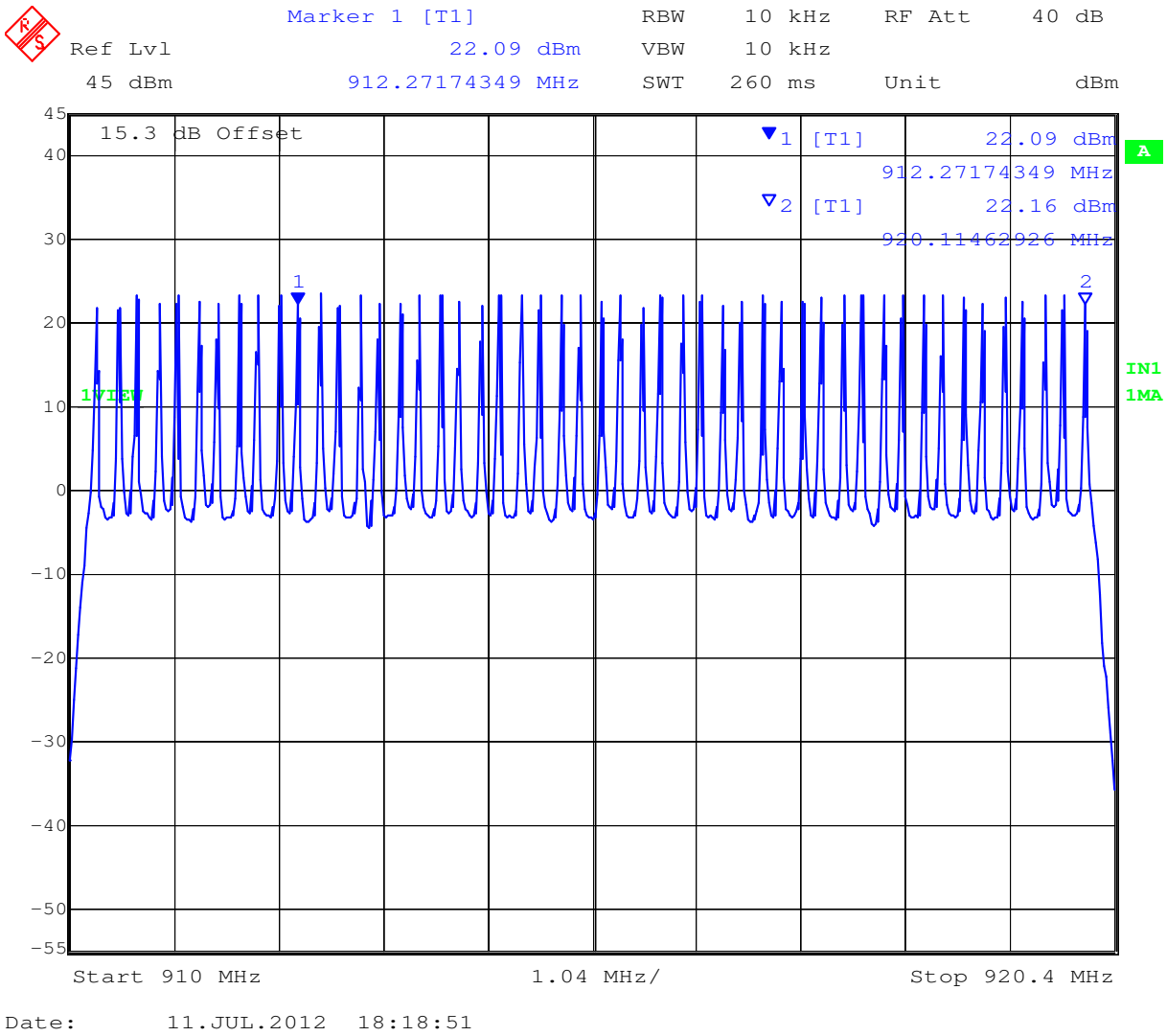
TABLE OF RESULTS – 10 kbps

Number of Channels	Specification
64	At least 25 hopping channels

10 kbps Number of Transmission Channels – Low Band



10 kbps Number of Transmission Channels – Mid Band



10 kbps Number of Transmission Channels – Upper Band

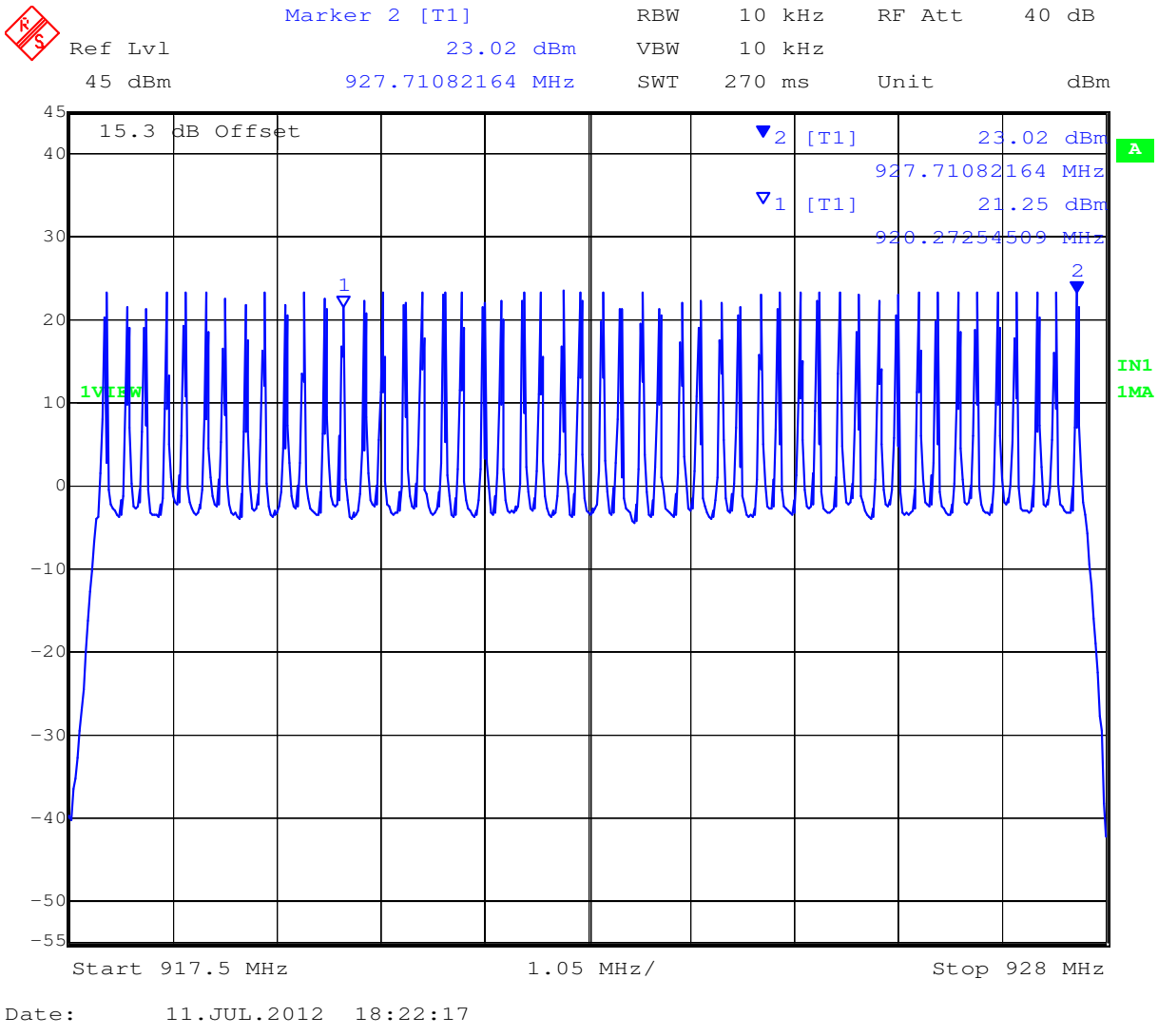
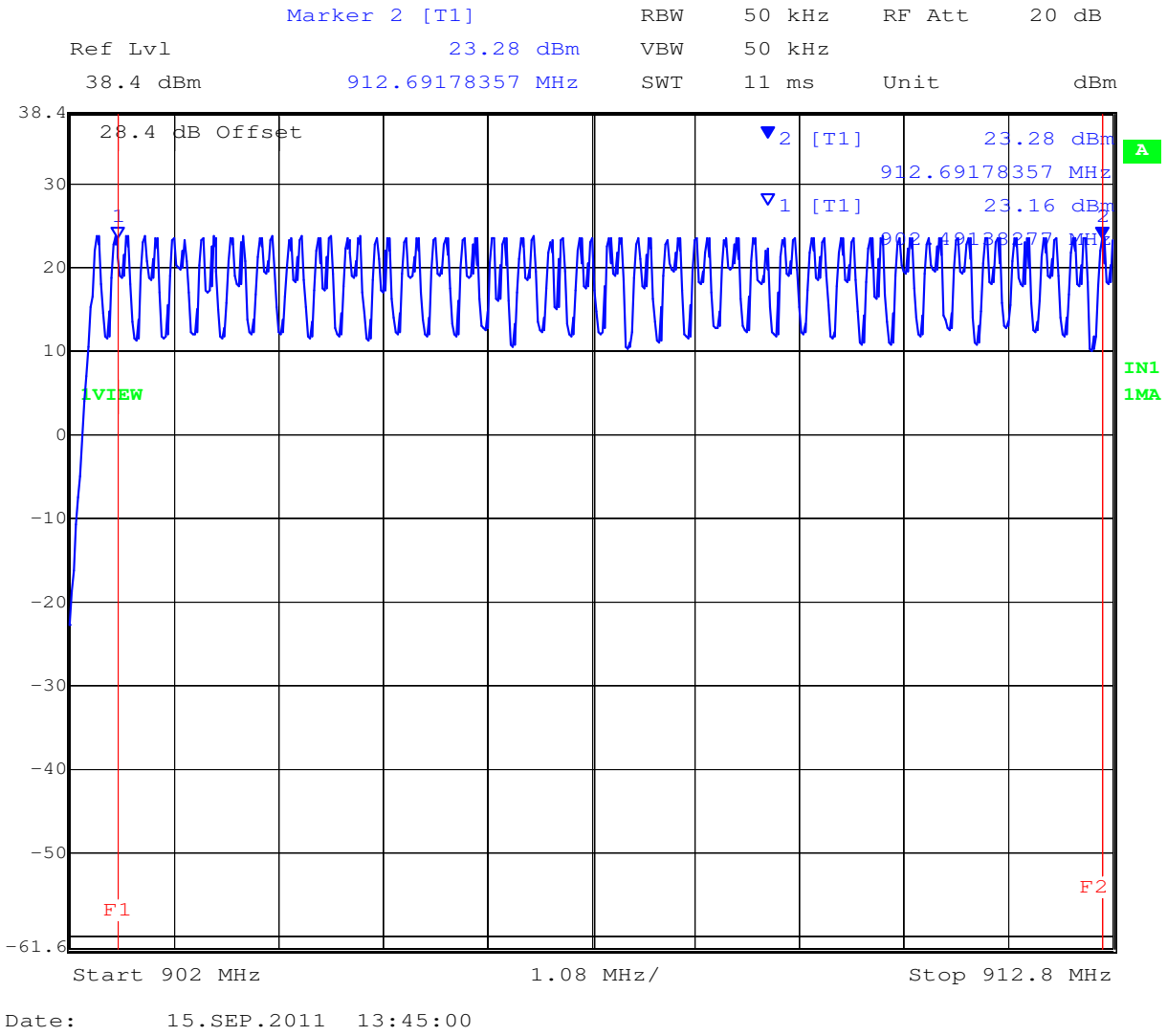


TABLE OF RESULTS – 20 kbps

Number of Channels	Specification
84	At least 25 hopping channels

20 kbps Number of Transmission Channels – Lower Band



20 kbps Number of Transmission Channels – Upper Band

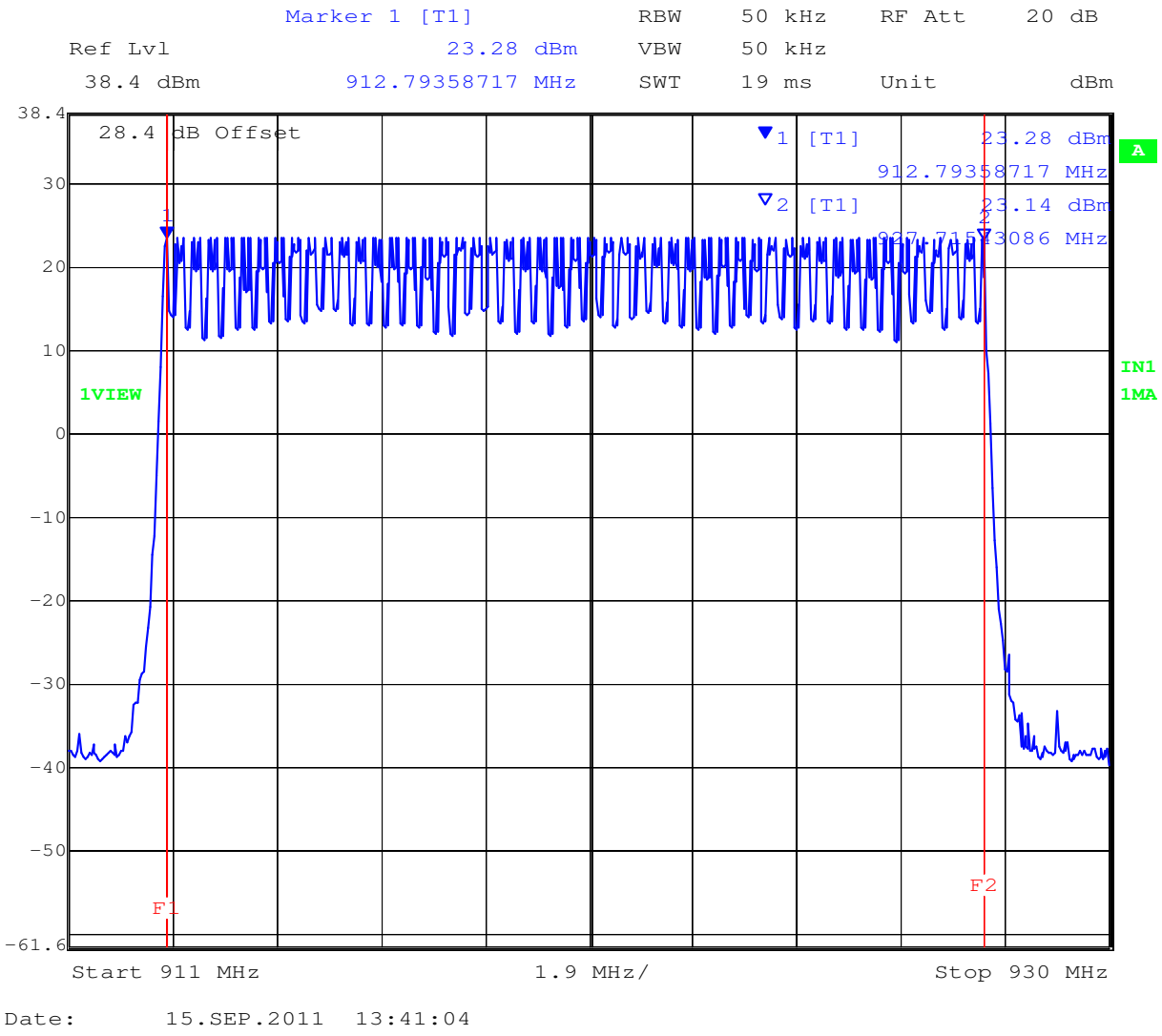
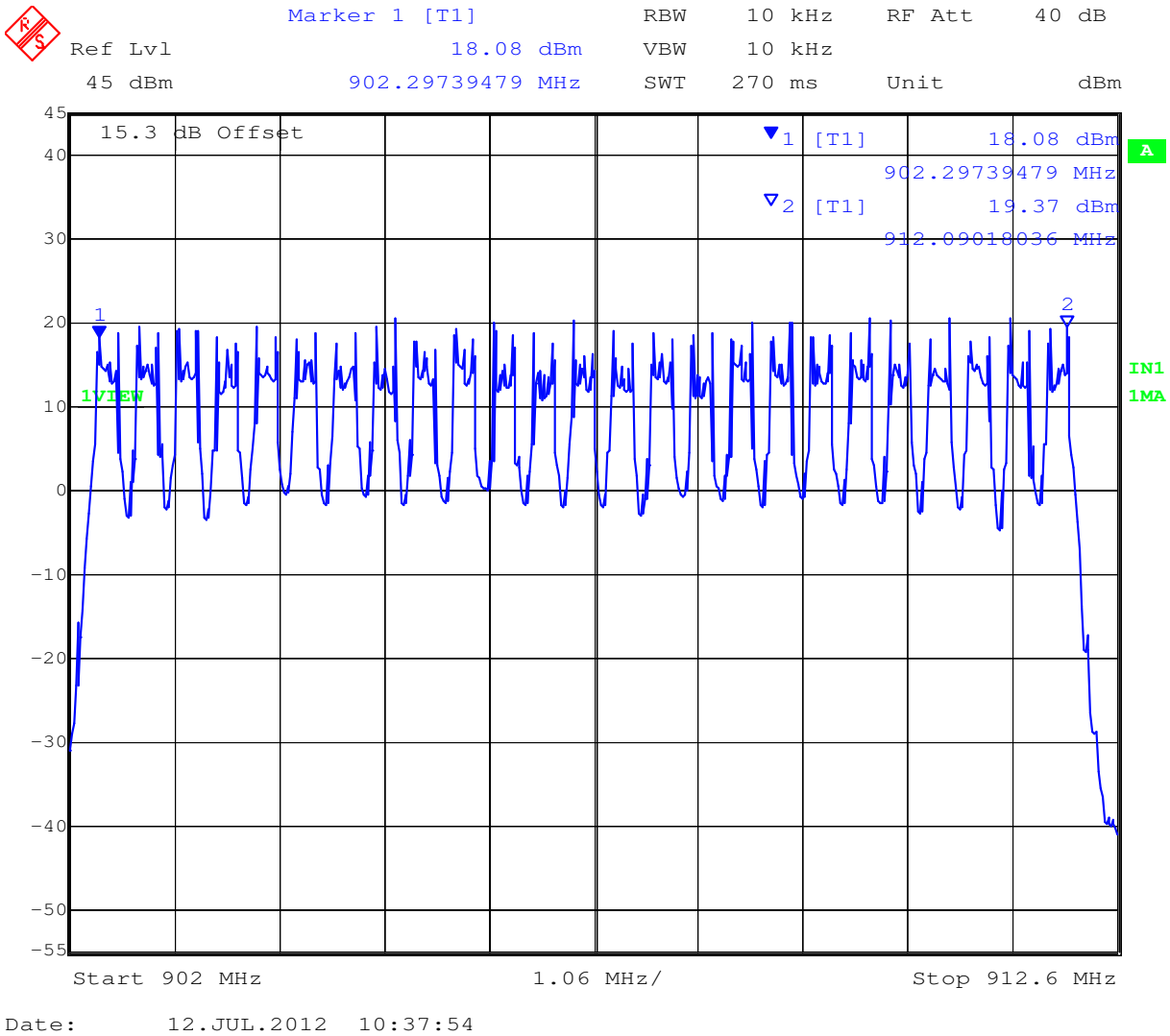


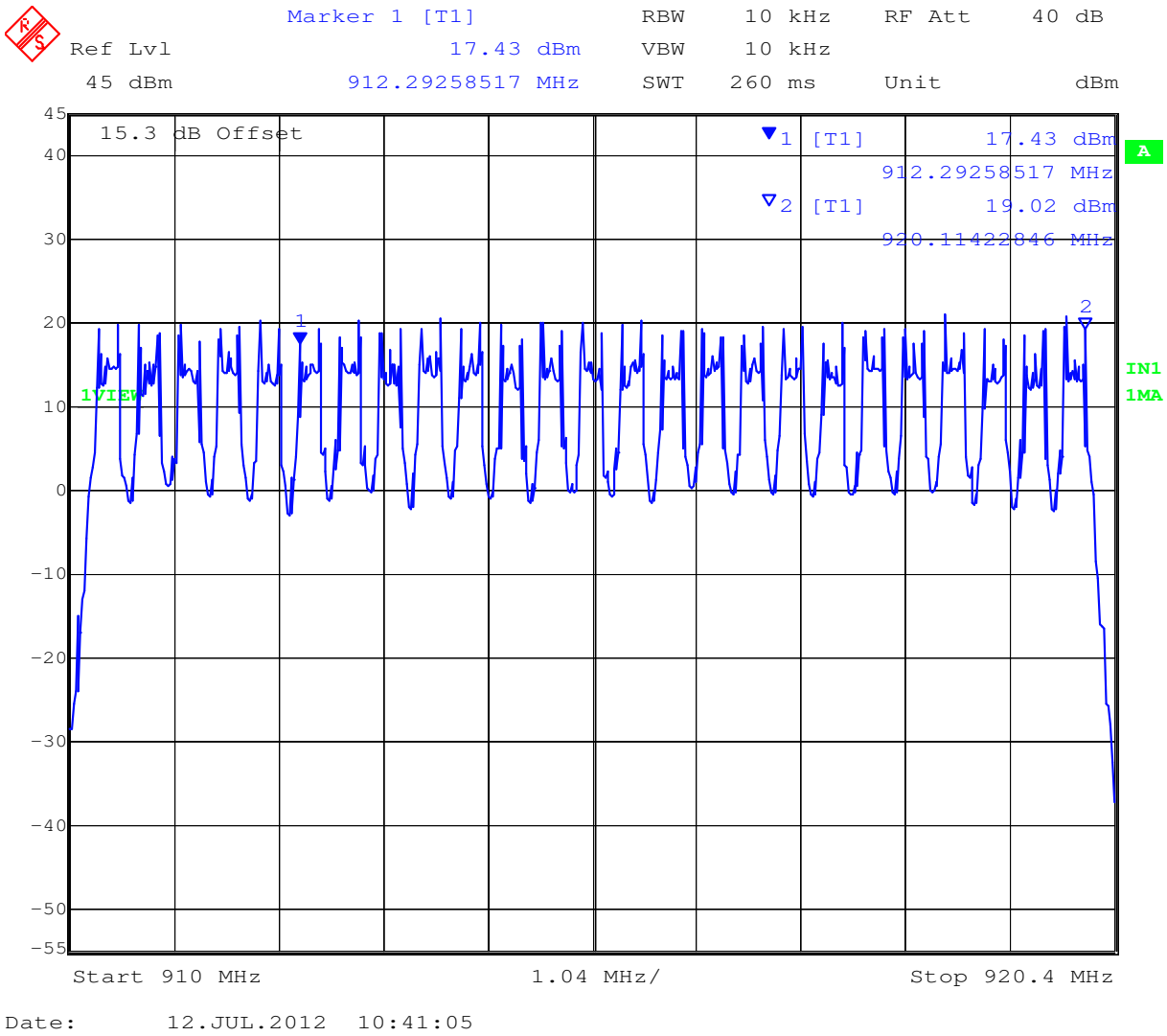
TABLE OF RESULTS – 200 kbps

Number of Channels	Specification
64	At least 25 hopping channels

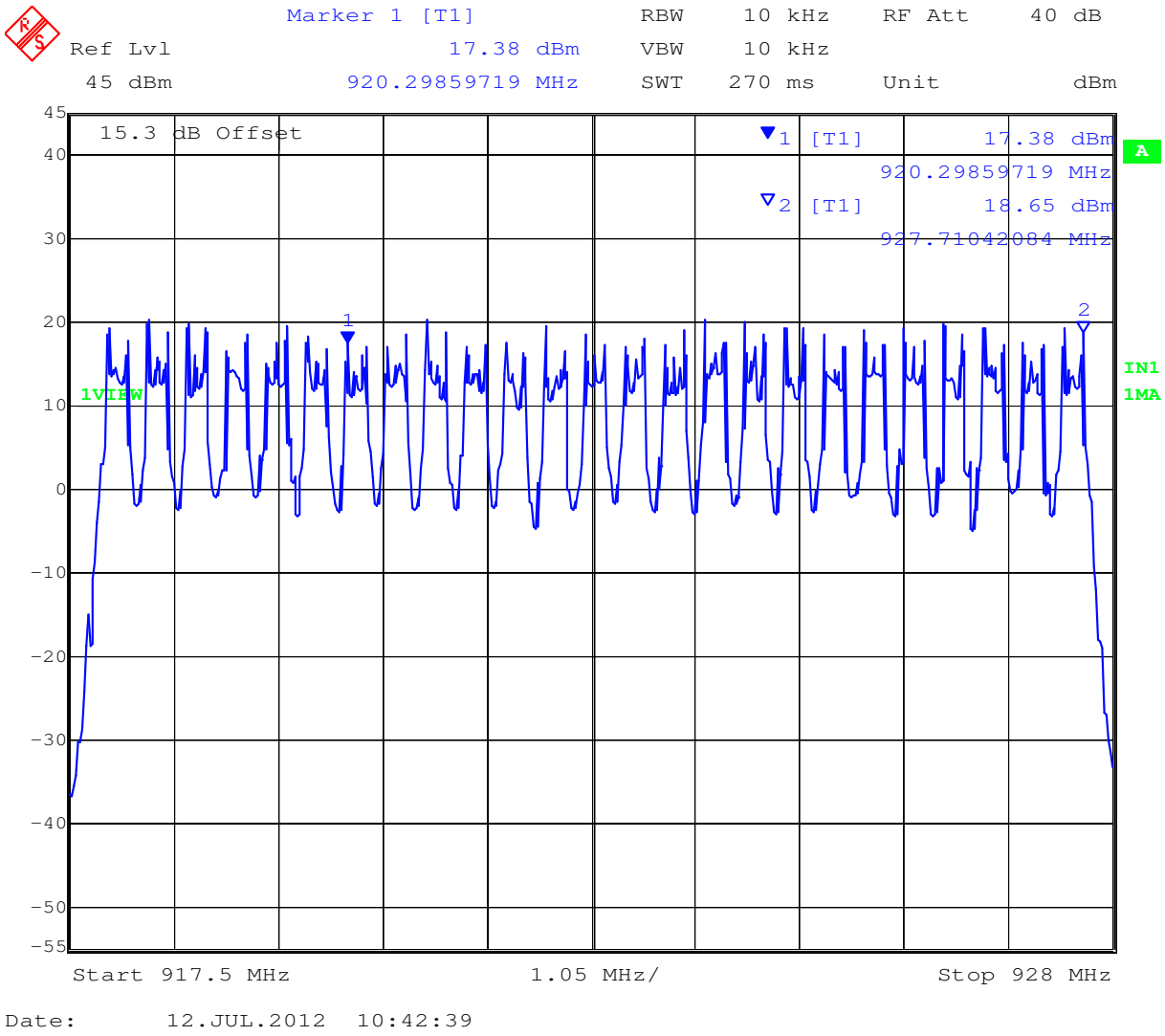
200 kbps Number of Transmission Channels – Low Band 902 – 912.6 MHz



200 kbps Number of Transmission Channels – Mid Band 910 – 920.4 MHz



200 kbps Number of Transmission Channels – Upper Band 917.5 – 928 MHz



5.1.3.2. Channel Occupancy

FCC, Part 15 Subpart C §15.247(a)(1)
Industry Canada RSS-210 §A8.1

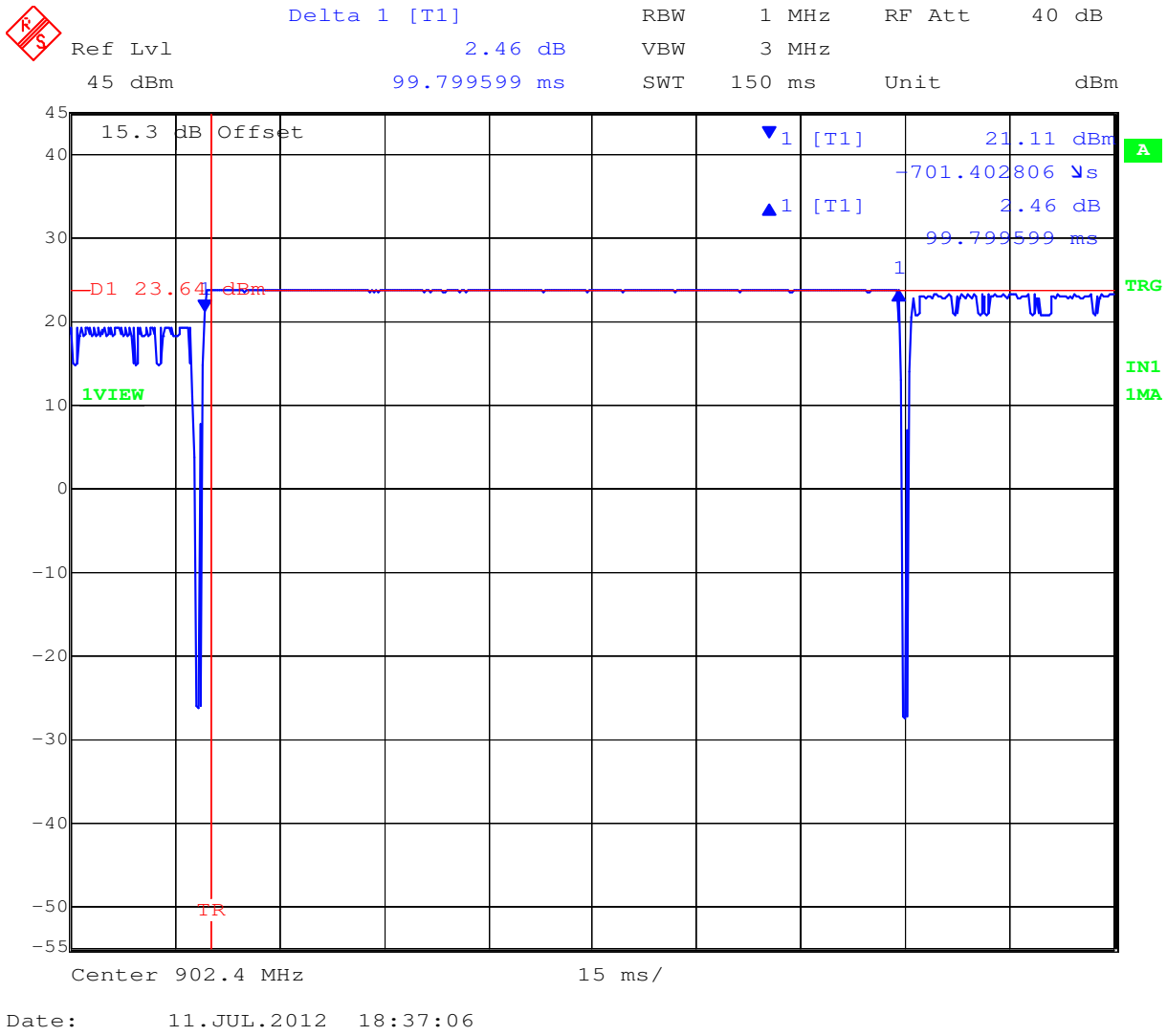
Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

Channel Dwell Time

TABLE OF RESULTS – 10 kbps

Channel #	Center Frequency (MHz)	Channel Dwell Time (single channel) (mSecs)
0	**902.4**	99.800

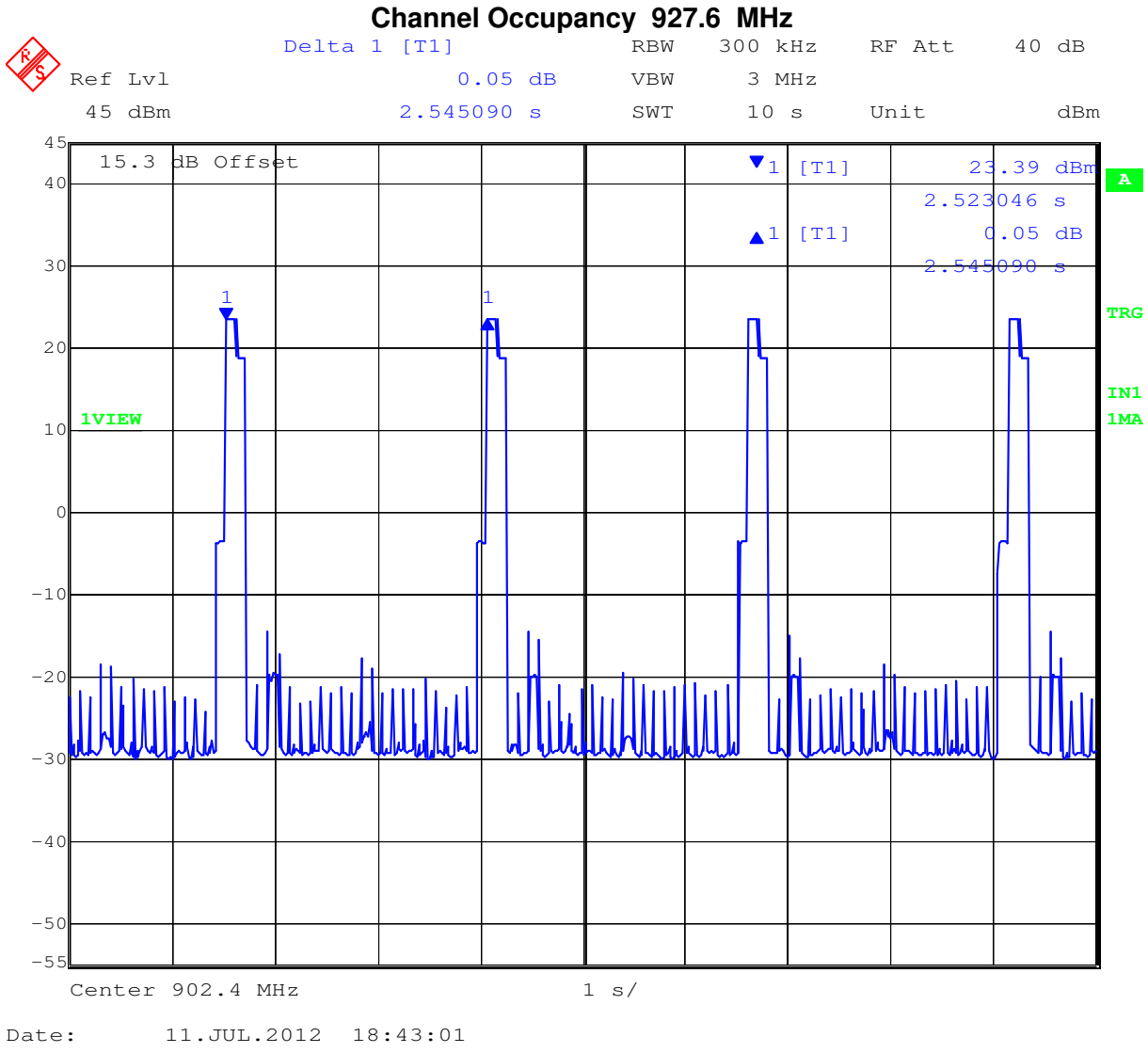
Channel dwell time Ch 0 902.4 MHz



Channel Occupancy

TABLE OF RESULTS – 10 kbps

Channel #	Center Frequency (MHz)	Channel Occupancy within 10 Second Period (Seconds)
0	902.4	4 * 0.998 = 3.992

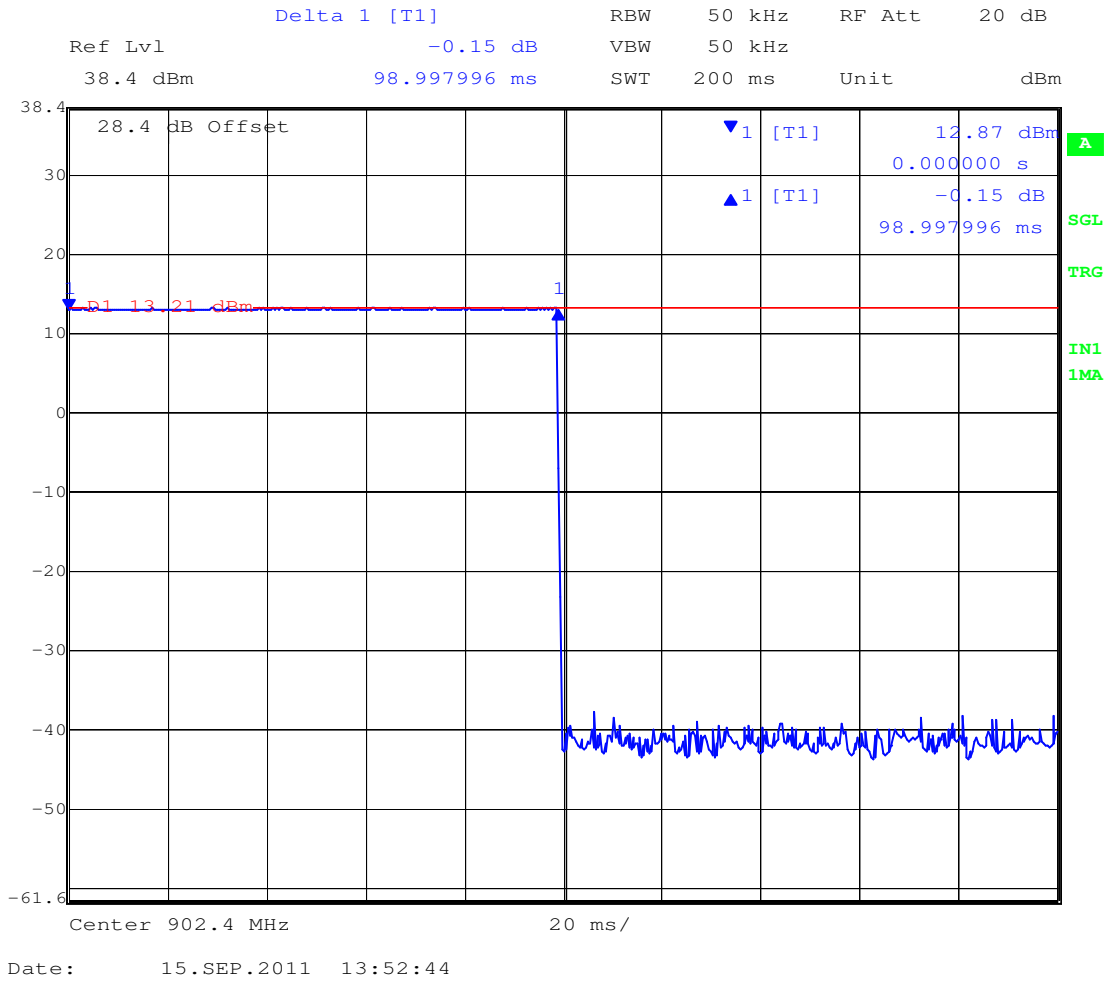


Channel Dwell Time

TABLE OF RESULTS – 20 kbps

Channel #	Center Frequency (MHz)	Channel Dwell Time (single channel) (mSecs)
0	**902.4**	98.997

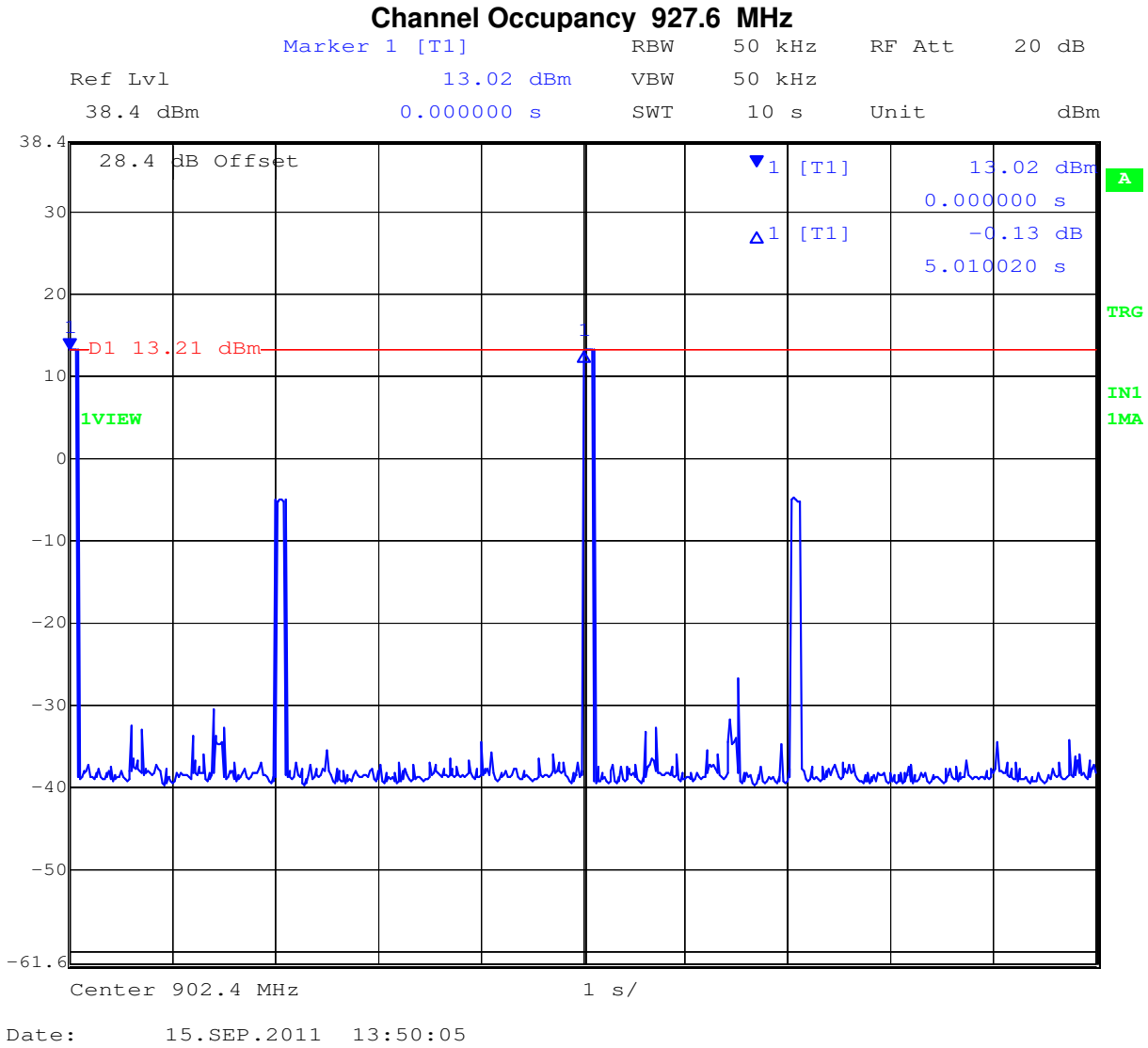
Channel dwell time Ch 0 902.4 MHz



Channel Occupancy

TABLE OF RESULTS– 20 kbps

Channel #	Center Frequency (MHz)	Channel Occupancy within 10 Second Period (Seconds)
0	902.4	5.01

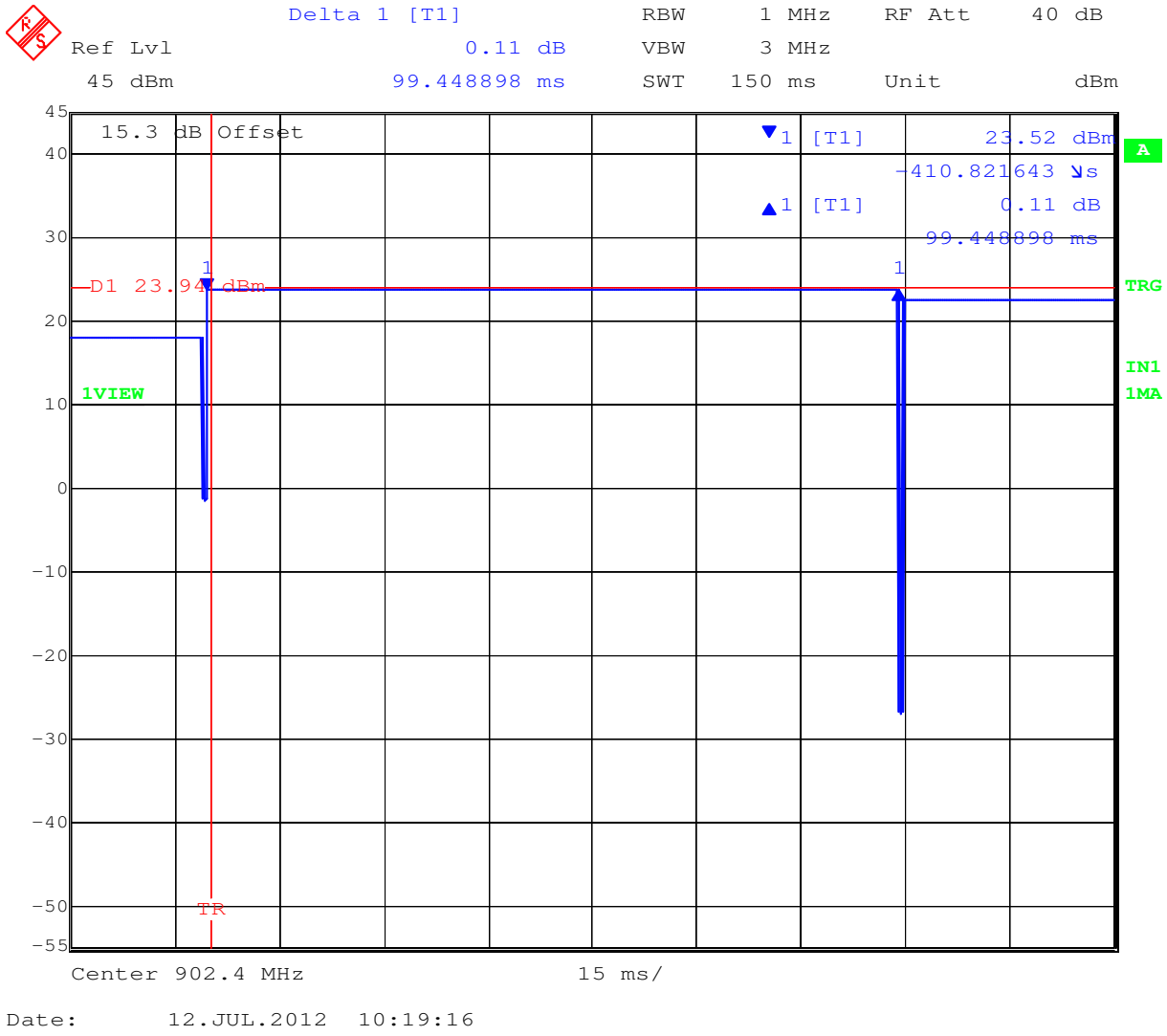


Channel Dwell Time

TABLE OF RESULTS – 200 kbps

Channel #	Center Frequency (MHz)	Channel Dwell Time (single channel) (mSecs)
0	**902.4**	99.44

Channel dwell time Ch 0 902.4 MHz

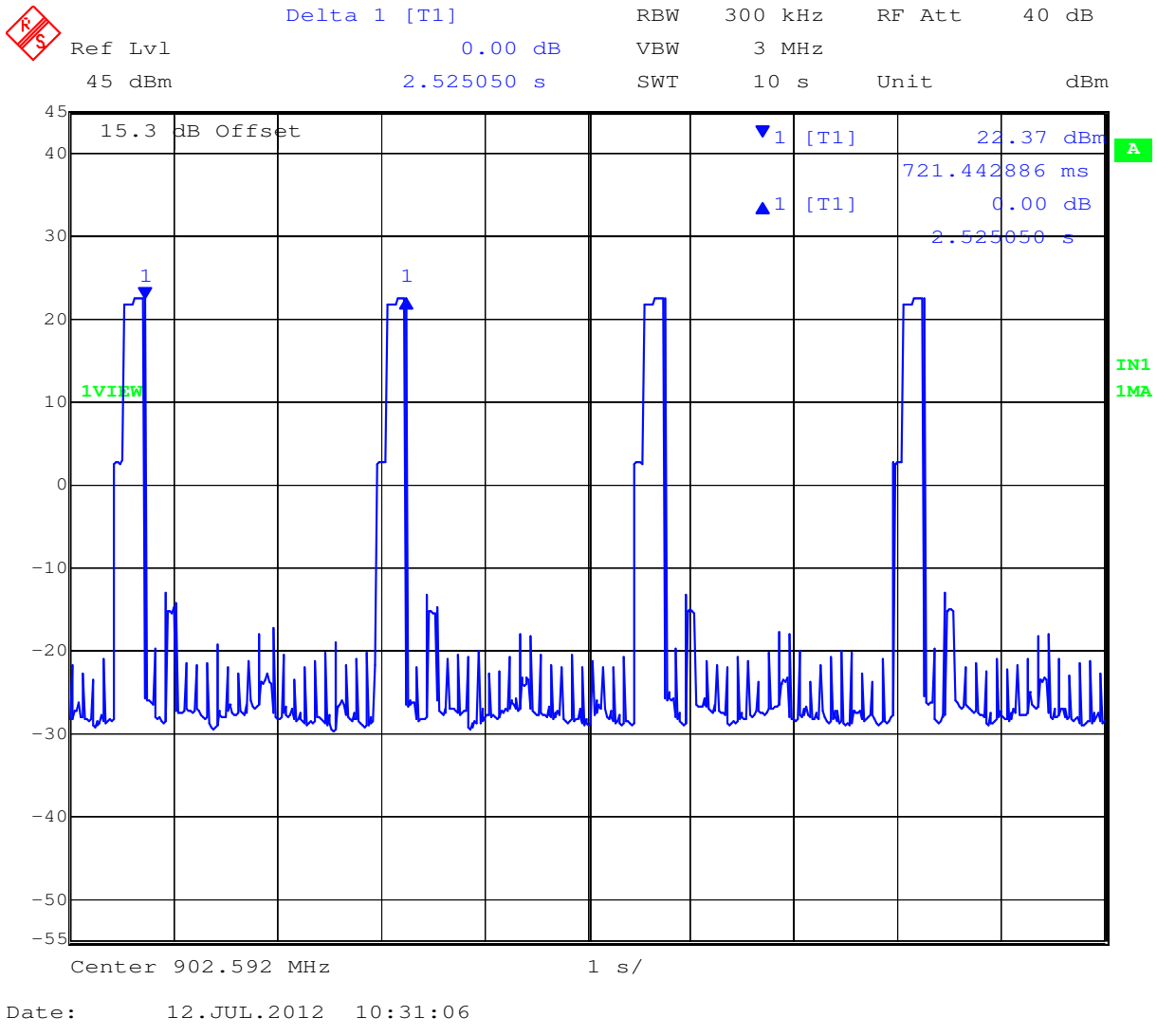


Channel Occupancy

TABLE OF RESULTS – 200 kbps

Channel #	Center Frequency (MHz)	Channel Occupancy within 10 Second Period (Seconds)
0	902.4	4 * 0.994 = 3.976

Channel Occupancy 927.6 MHz



Specification for Number of Channels and Channel Occupancy

Limits

FCC, Part 15 Subpart C §15.247(a)(1)
Industry Canada RSS-210 §A8.1

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Laboratory Uncertainty for Frequency Measurements

Measurement uncertainty	±0.86ppm

Traceability

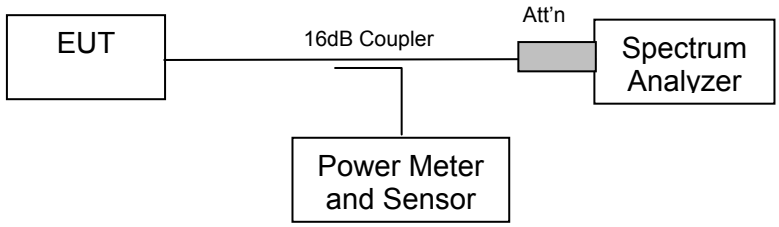
Method	Test Equipment Used
Measurements were made per work instruction WI-02 'Frequency Measurement"	0078, 0134, 0158, 0184, 0193, 0250, 0252 0310, 0312.

5.1.4. Output Power

FCC, Part 15 Subpart C §15.247(b)(2)
Industry Canada RSS-210 §A8.4

Test Procedure
The transmitter terminal of EUT was set for CW (continuous wave) operation and connected to the input of the power meter which was calibrated to measure power. The value of measured power including antenna cable loss was reported.

Test Measurement Set up



Measurement set up for Transmitter Output Power

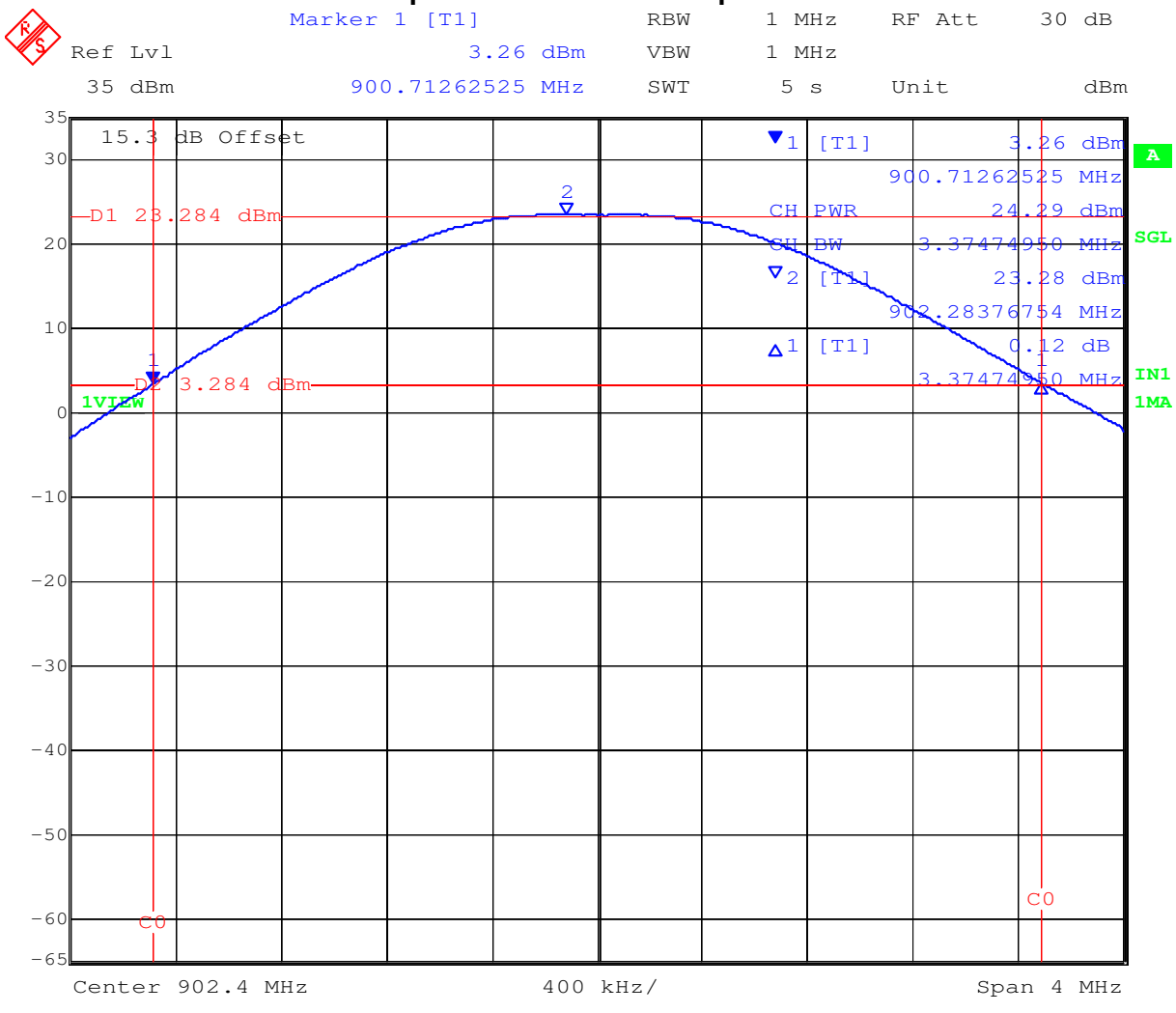
Measurement Results for Peak Output Power

Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

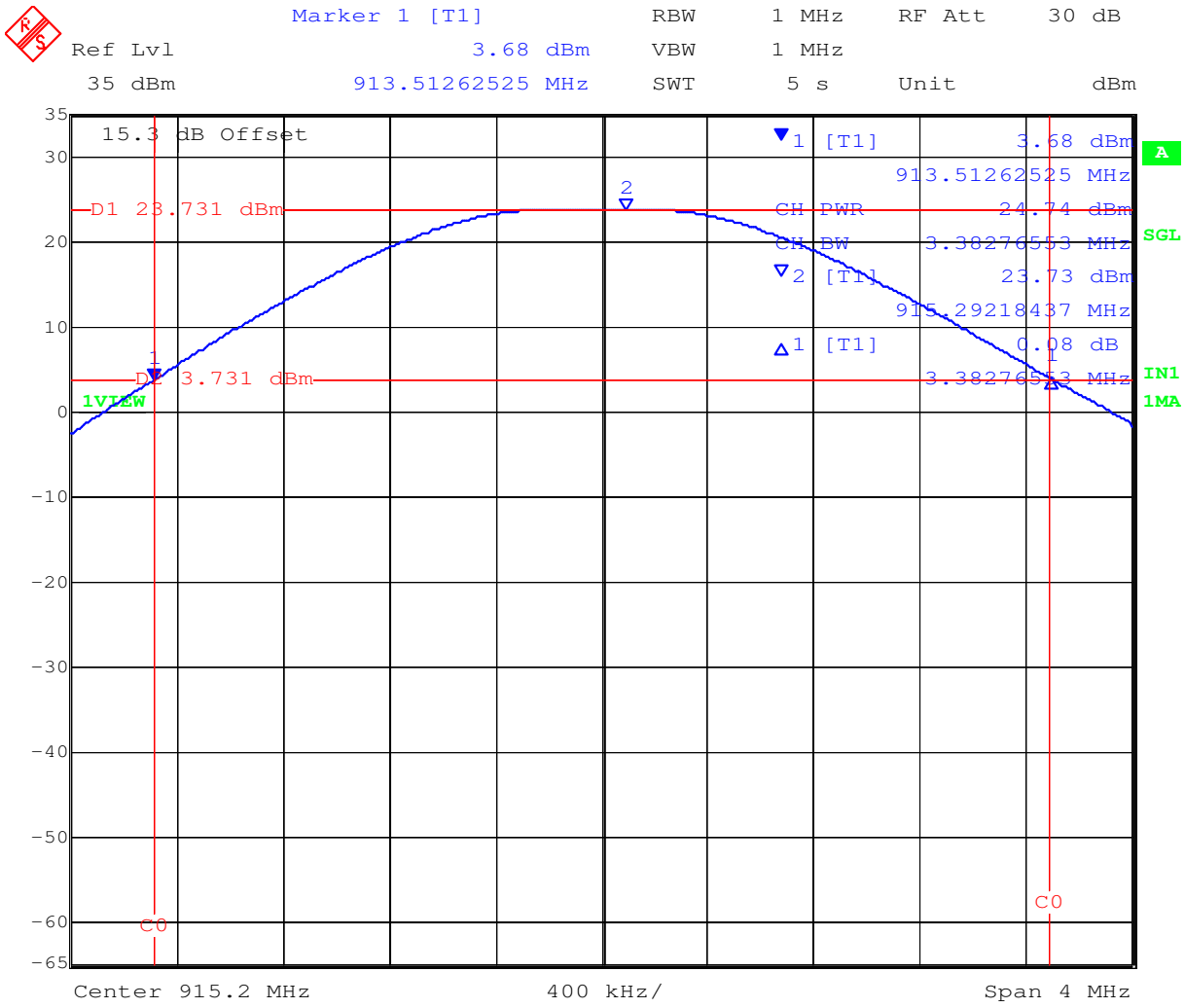
TABLE OF RESULTS– 10 kbps

Channel #	Center Frequency (MHz)	Power (dBm)
0	902.4	+24.29
33	915.2	+24.74
63	927.6	+24.54

10 kbps 902.4 MHz Peak Output Power



10 kbps 915.2 MHz Peak Output Power



10 kbps 927.6 MHz Peak Output Power

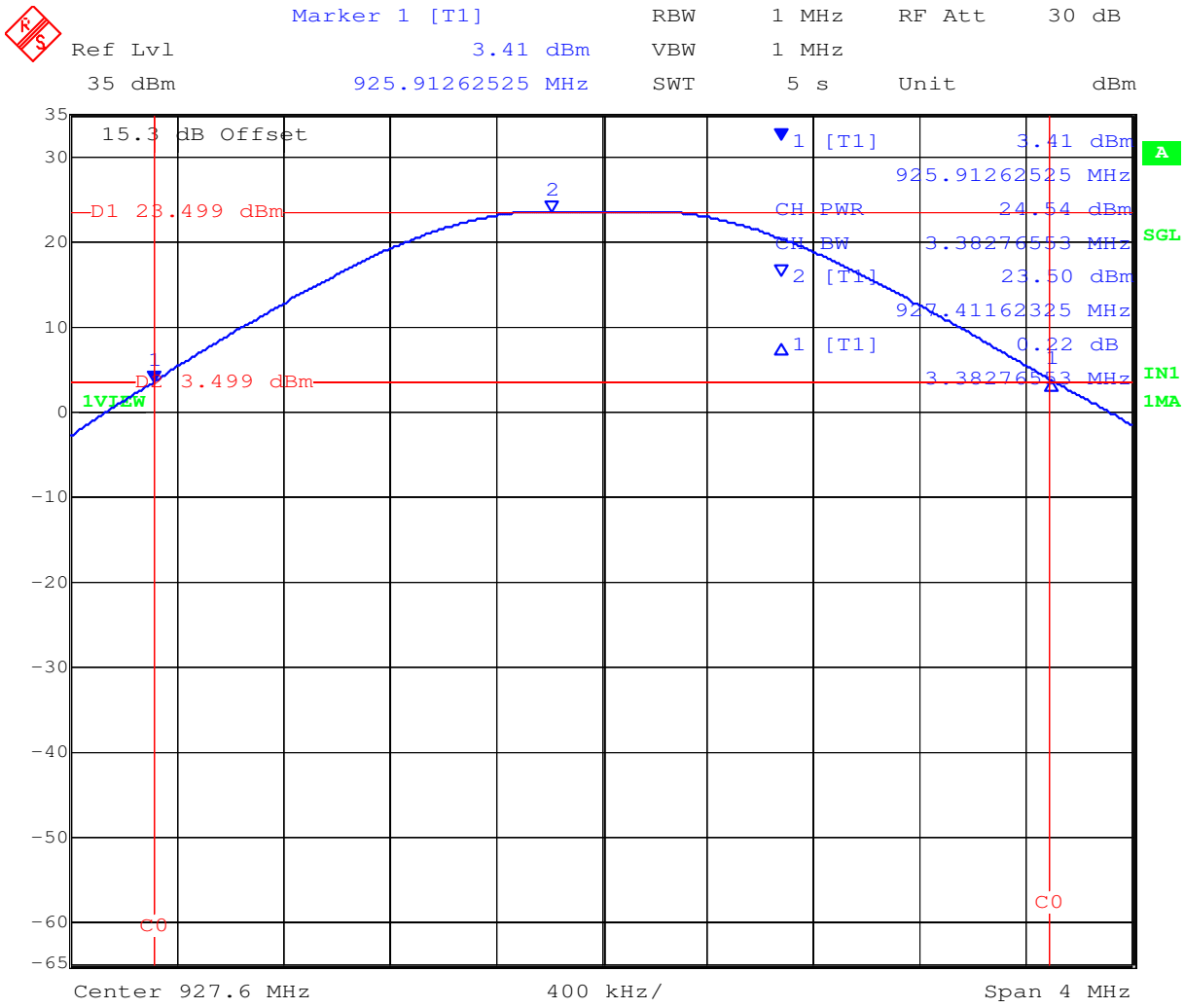


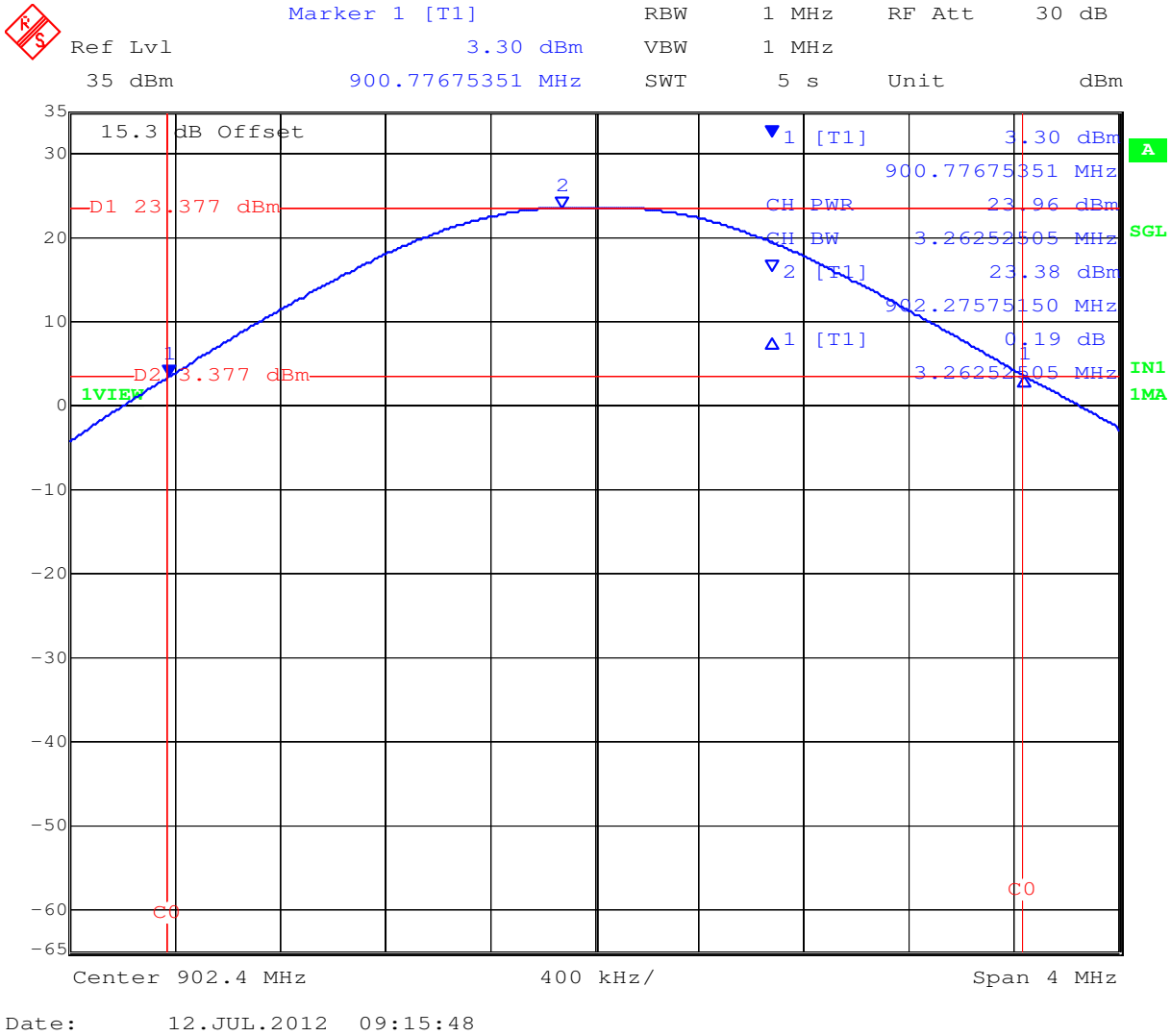
TABLE OF RESULTS– 20 kbps

Channel #	Center Frequency (MHz)	Power (dBm)
0	902.4	+23.63
42	915.2	+23.59
83	927.6	+23.69

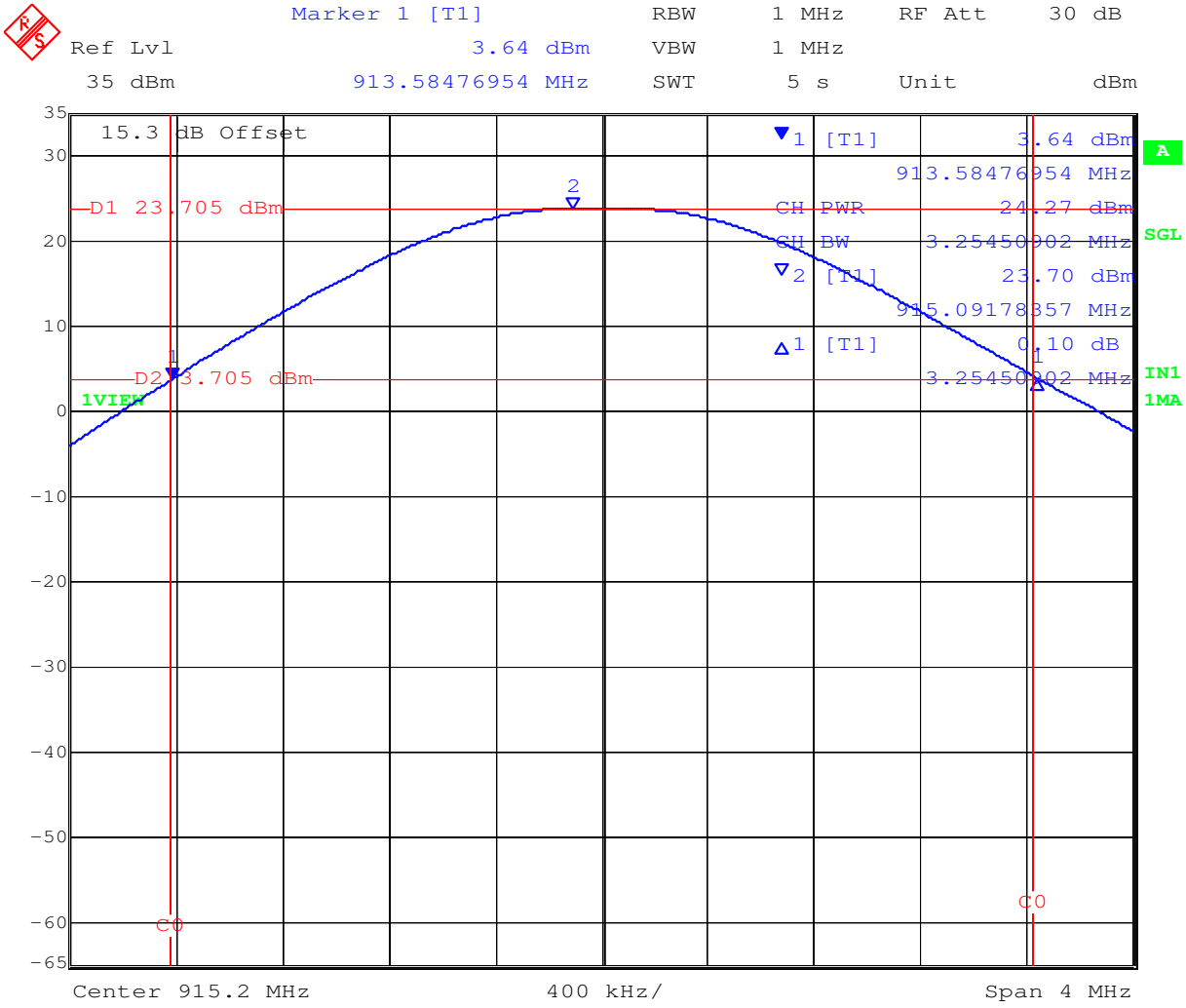
TABLE OF RESULTS– 200 kbps

Channel #	Center Frequency (MHz)	Power (dBm)
0	902.4	+23.96
33	915.2	+24.27
63	927.6	+24.09

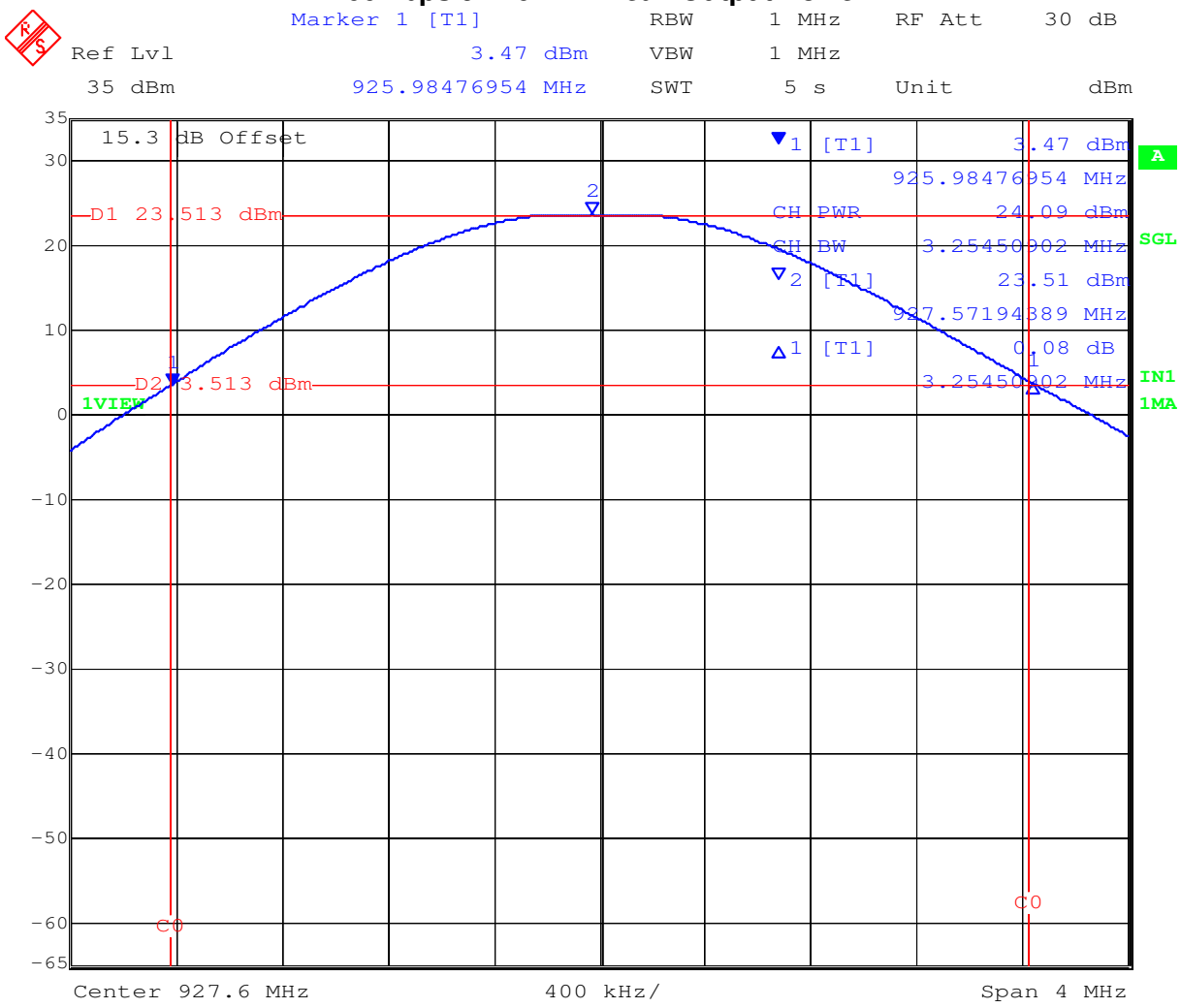
200 kbps 902.4 MHz Peak Output Power



200 kbps 915.2 MHz Peak Output Power



200 kbps 927.6 MHz Peak Output Power



Specification

Limits

FCC, Part 15 Subpart C §15.247 (b)(2) The maximum output power of the intentional radiator shall not exceed the following:
(2) For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

Industry Canada RSS-210 §A8.4
For frequency hopping systems operating in the 902 - 928 MHz band, the maximum peak conducted power output power is not to succeed 1.0 W if the hopset uses 50 or more hopping channels and 0.25 W if the hopset uses less than 50 hopping channels.

Laboratory Measurement Uncertainty for Power Measurements

Measurement uncertainty	±1.33 dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-01 'Measuring RF Output Power'	0158, 0193, 0252, 0313, 0314, 0070, 0116, 0117

5.1.5. Maximum Permissible Exposure

FCC, Part 15 Subpart C §15.247(i)
Industry Canada RSS-Gen §5.5

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

Antenna Gain (dBi)	Numeric Gain (numeric)	Peak Output Power (dBm)	Peak Output Power (mW)	Power Density @ 20 cm 1mW/cm^2 Limit(cm)	Minimum Separation Distance (cm)
8.1	6.46	+24.74	297.90	0.059	20*
15.1	32.36	+20.90	123.03	0.792	20*

***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

§15.247(i) Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency levels in excess of the Commission's guidelines.

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

RSS-Gen §5.5 Before equipment certification is granted, the applicable requirements of RSS-102 shall be met.

Laboratory Measurement Uncertainty for Power Measurements

Measurement uncertainty	±1.33 dB

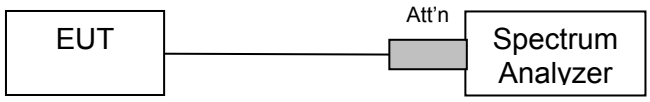
5.1.6. Conducted Spurious Emissions Transmitter

FCC, Part 15 Subpart C §15.247(d)
Industry Canada RSS-210 §A8.5

Test Procedure

Conducted emissions were measured at a limit of 20 dB below the highest in-band spectral density measured with a spectrum analyzer connected to the antenna terminal. Emissions at the band edge were measured and recorded. Measurements were made while EUT was operating in transmit mode of operation at the appropriate center frequency.

Test Measurement Set up



Band-edge measurement test configuration

Measurement Results of Conducted Spurious Emissions

Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

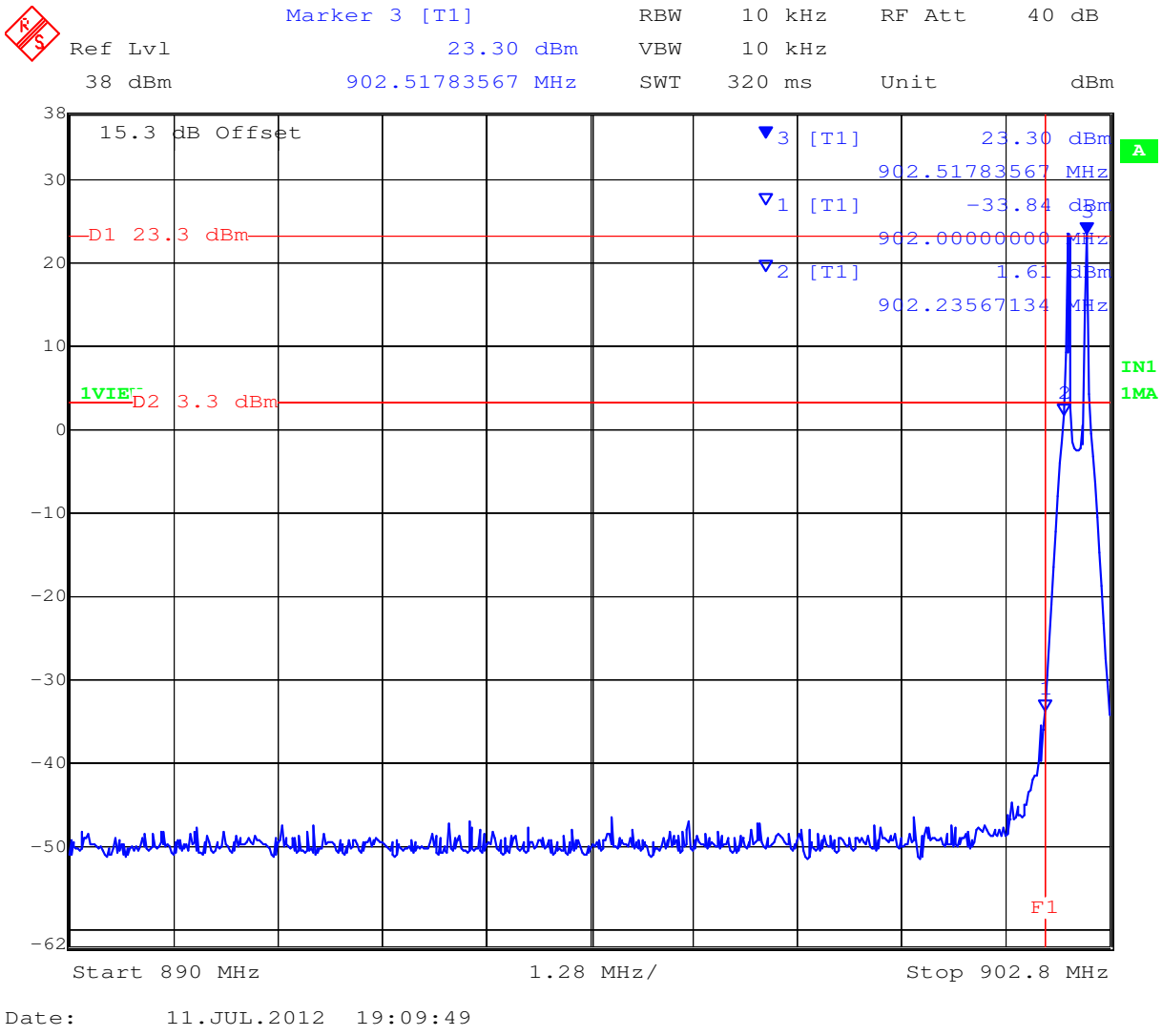
Conducted Band-Edge Results

TABLE OF RESULTS – 10 kbps Hopping OFF

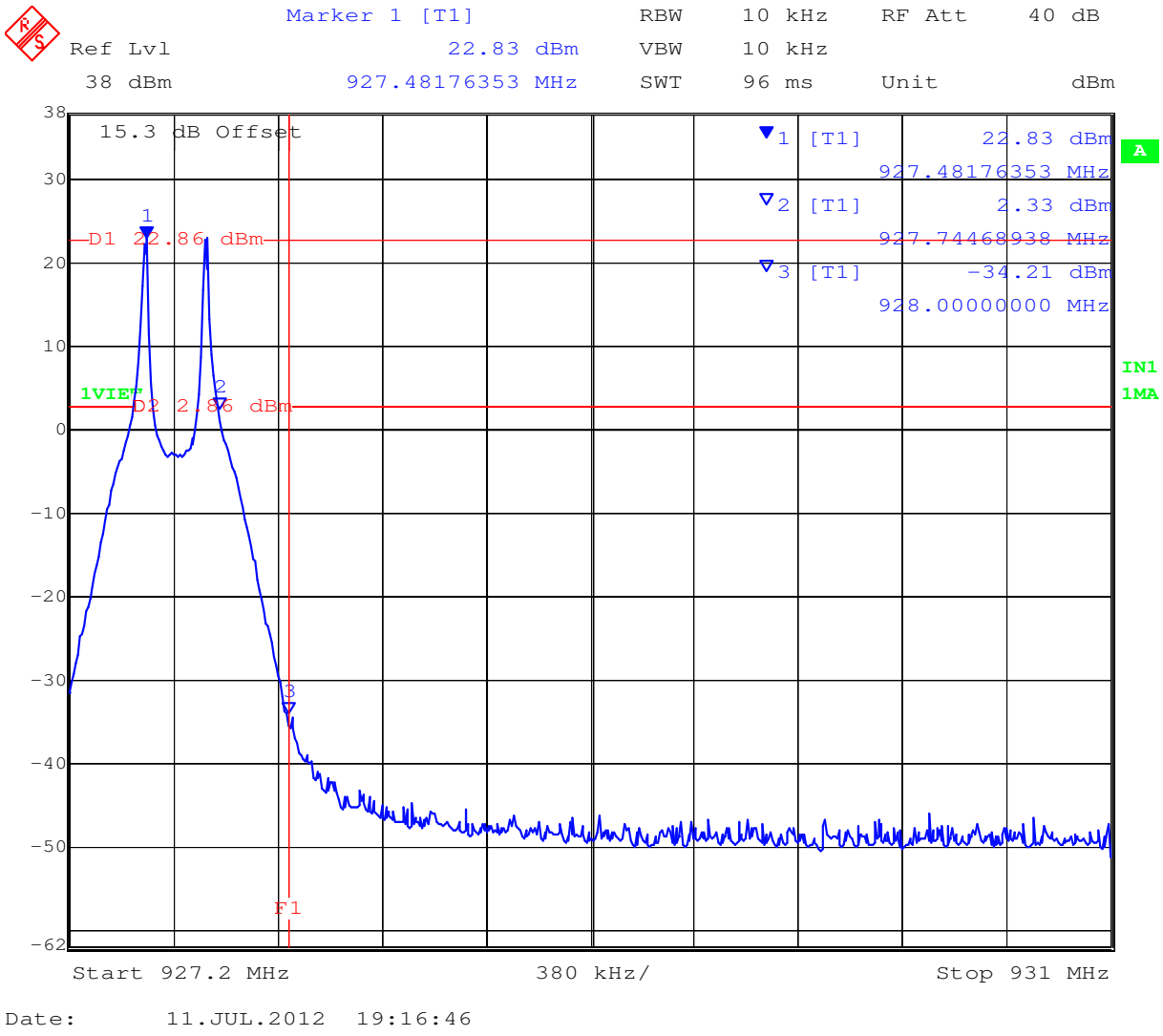
Channel #	Center Frequency (MHz)	Band-edge Frequency (MHz)	Limit (dBm)	Amplitude @ Band-edge (dBm)		Margin (dB)
				Hopping OFF	Hopping ON	
0	902.4	902.0	+3.30	-33.84	-35.42	-37.14
63	927.6	928.0	+2.86	-34.21	-37.23	-37.07

Margin calculated for worst case result

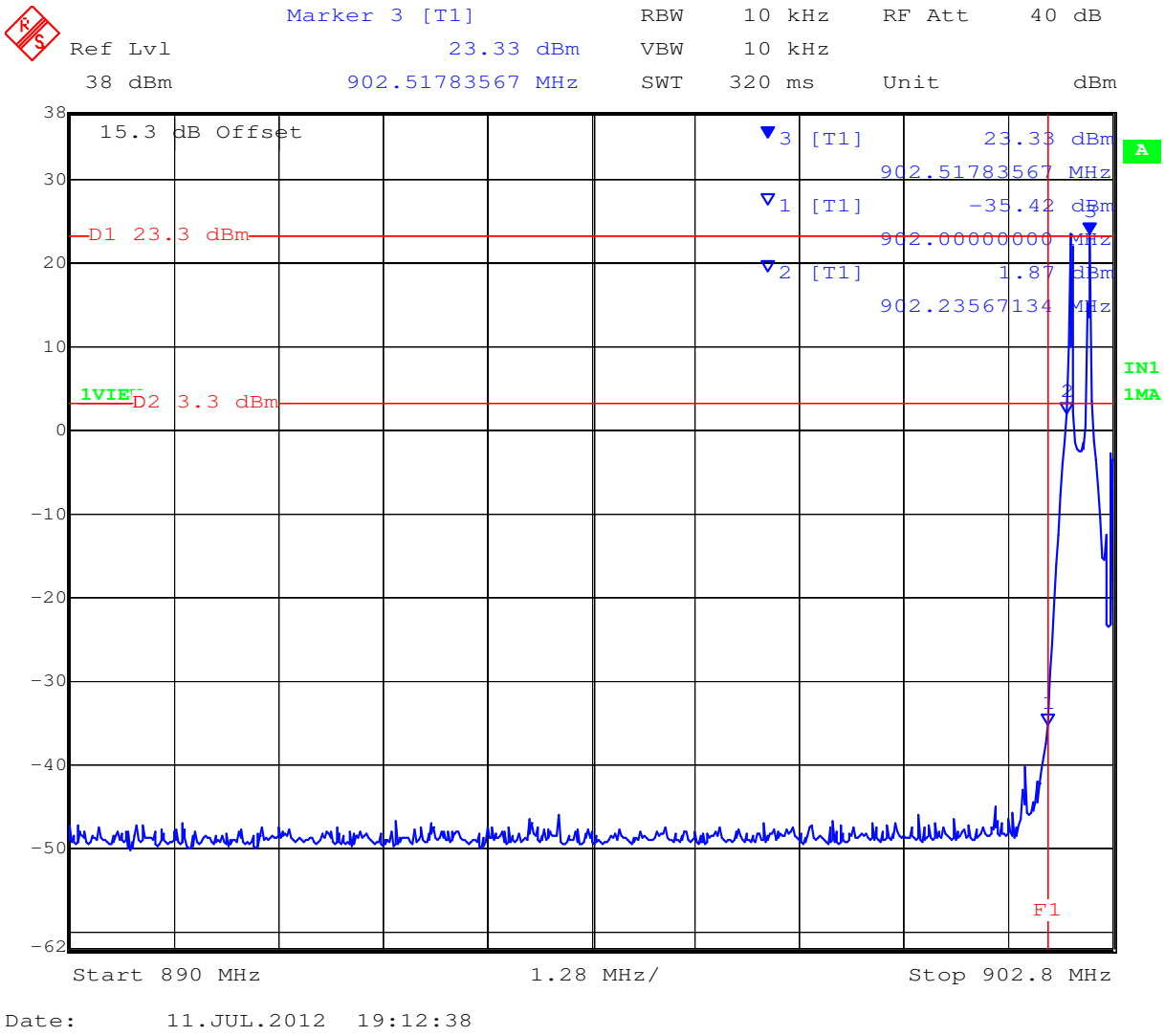
10 kbps - Conducted Spurious Emissions at the 902.4 MHz Lower Band Edge



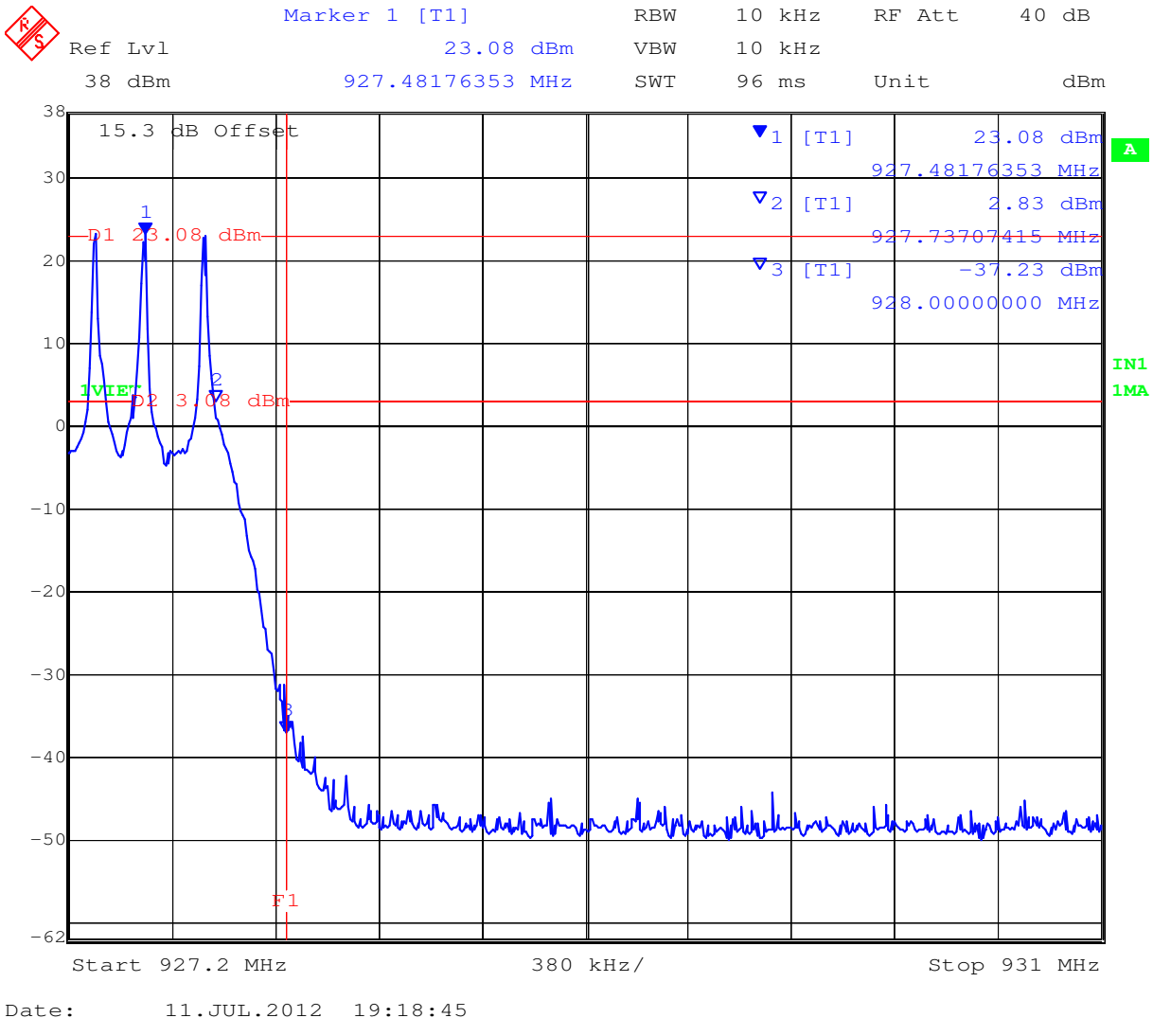
10 kbps - Conducted Spurious Emissions at the 928 MHz Upper Band Edge



Hopping ON 10 kbps - Conducted Spurious Emissions at the 902.4 MHz Lower Band Edge



Hopping ON 10 kbps - Conducted Spurious Emissions at the 928 MHz Upper Band Edge

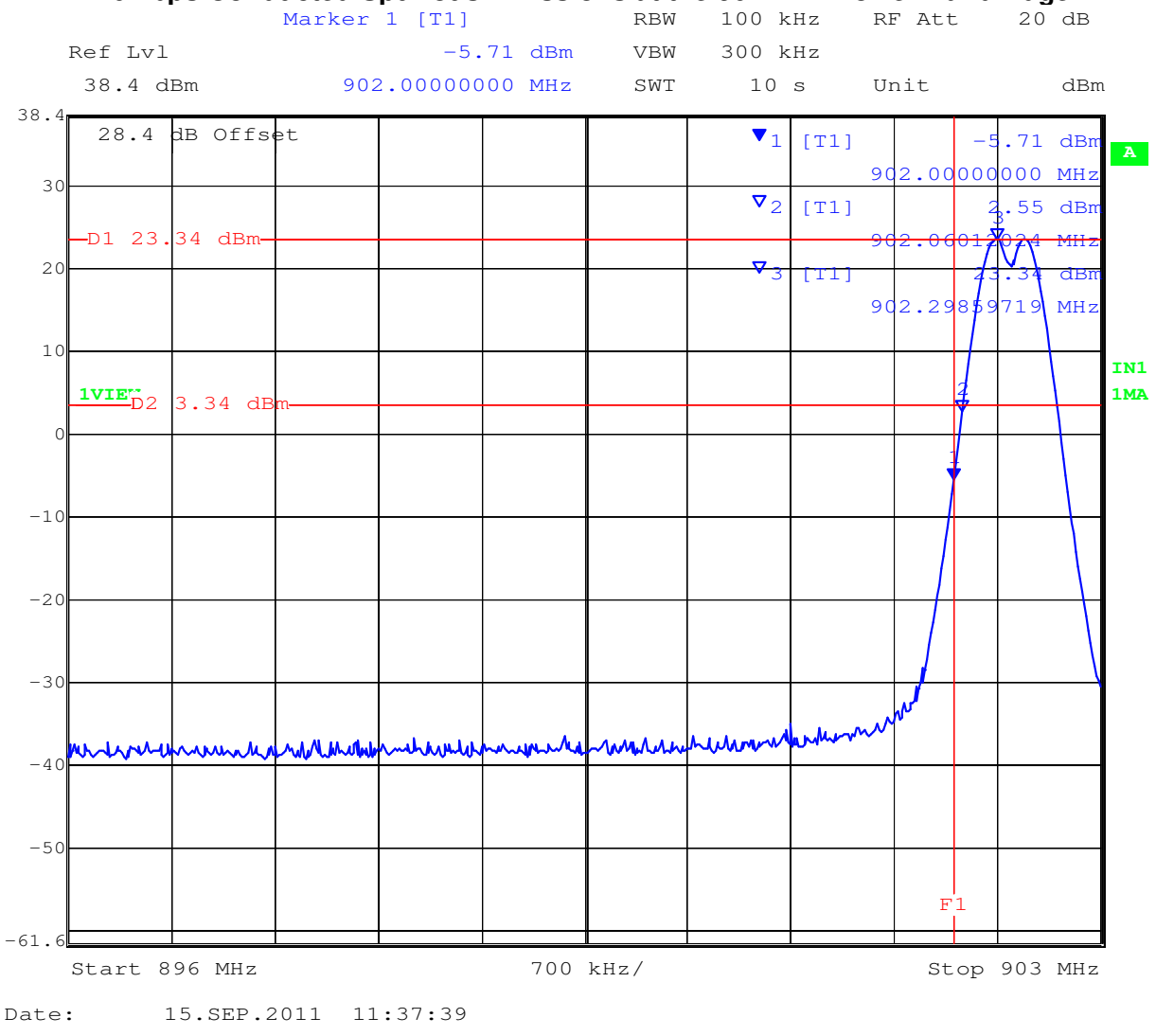


Conducted Band-Edge Results

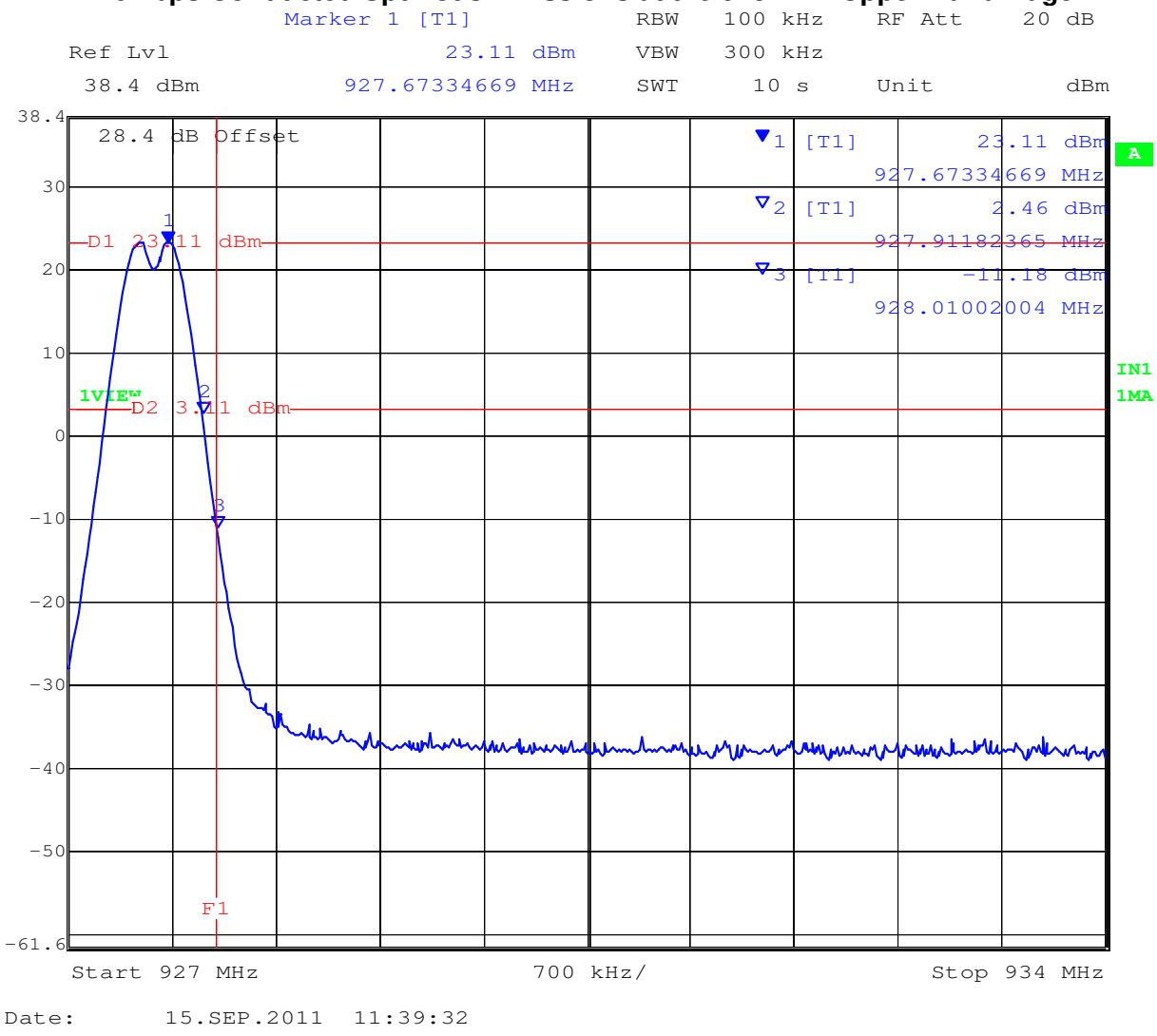
TABLE OF RESULTS 20 kbps

Channel #	Center Frequency (MHz)	Band-edge Frequency (MHz)	Limit (dBm)	Amplitude @ Band-edge (dBm)	Margin (dB)
0	902.4	902.0	+3.34	-5.71	-9.05
83	927.6	928.0	+3.11	-11.18	-14.29

20 kbps Conducted Spurious Emissions at the 902 MHz Lower Band Edge



20 kbps Conducted Spurious Emissions at the 928 MHz Upper Band Edge



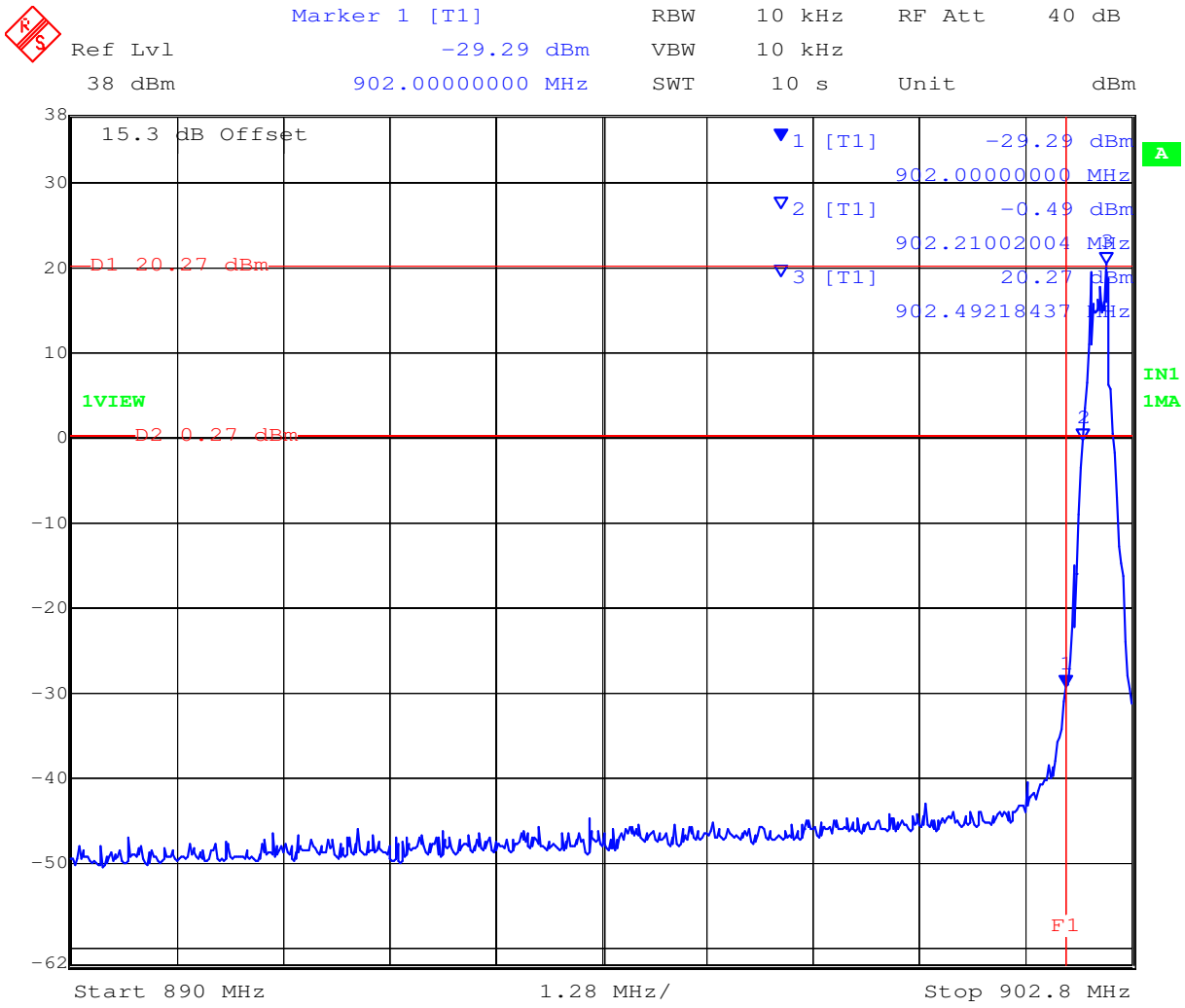
Conducted Band-Edge Results

TABLE OF RESULTS – 200 kbps Hopping OFF

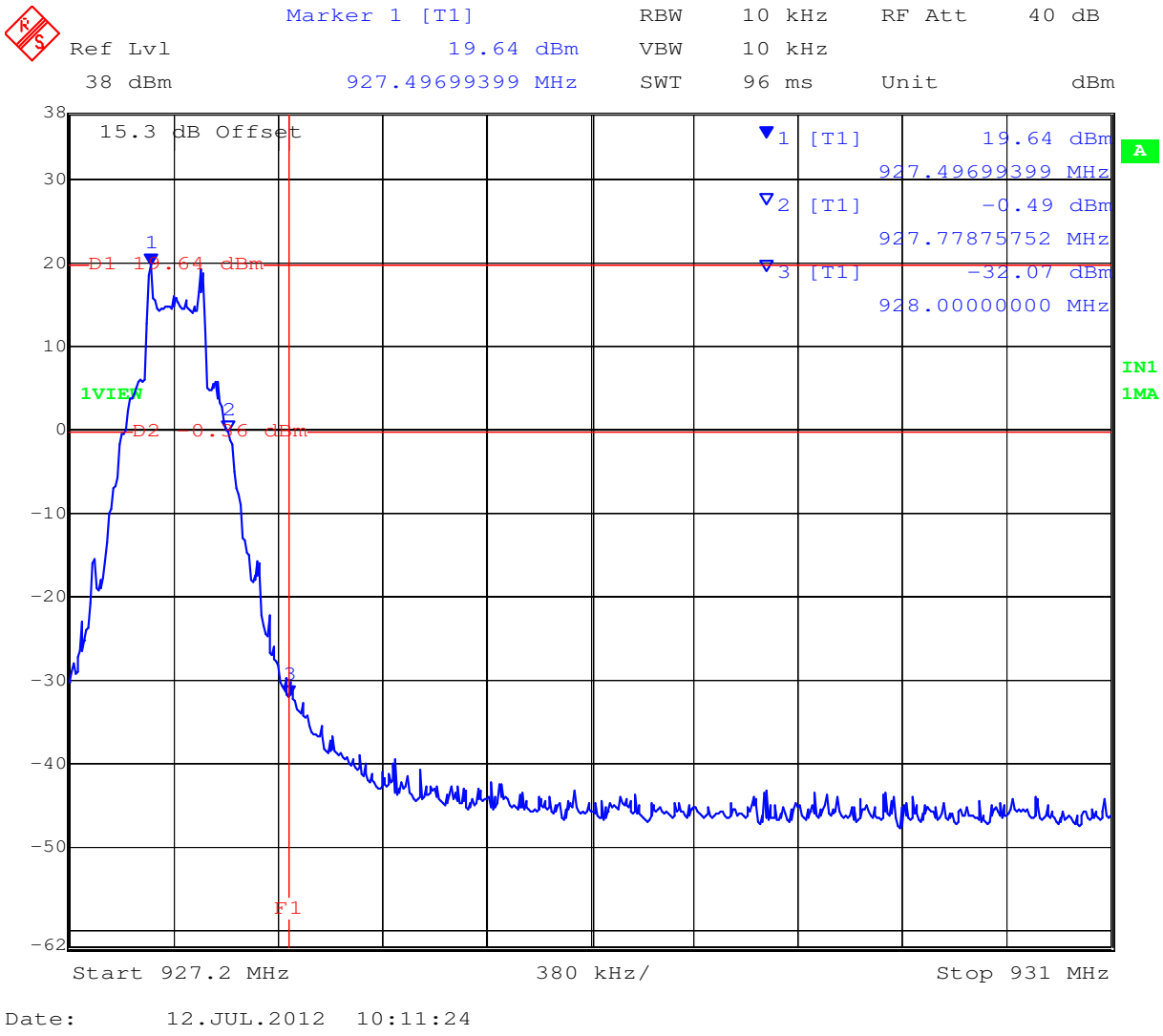
Channel #	Center Frequency (MHz)	Band-edge Frequency (MHz)	Limit (dBm)	Amplitude @ Band-edge (dBm)		Margin (dB)
				Hopping OFF	Hopping ON	
0	902.4	902.0	+0.27	-29.29	-31.35	-29.56
63	927.6	928.0	-0.36	-32.07	-30.56	-30.20

Margin calculated for worst case result

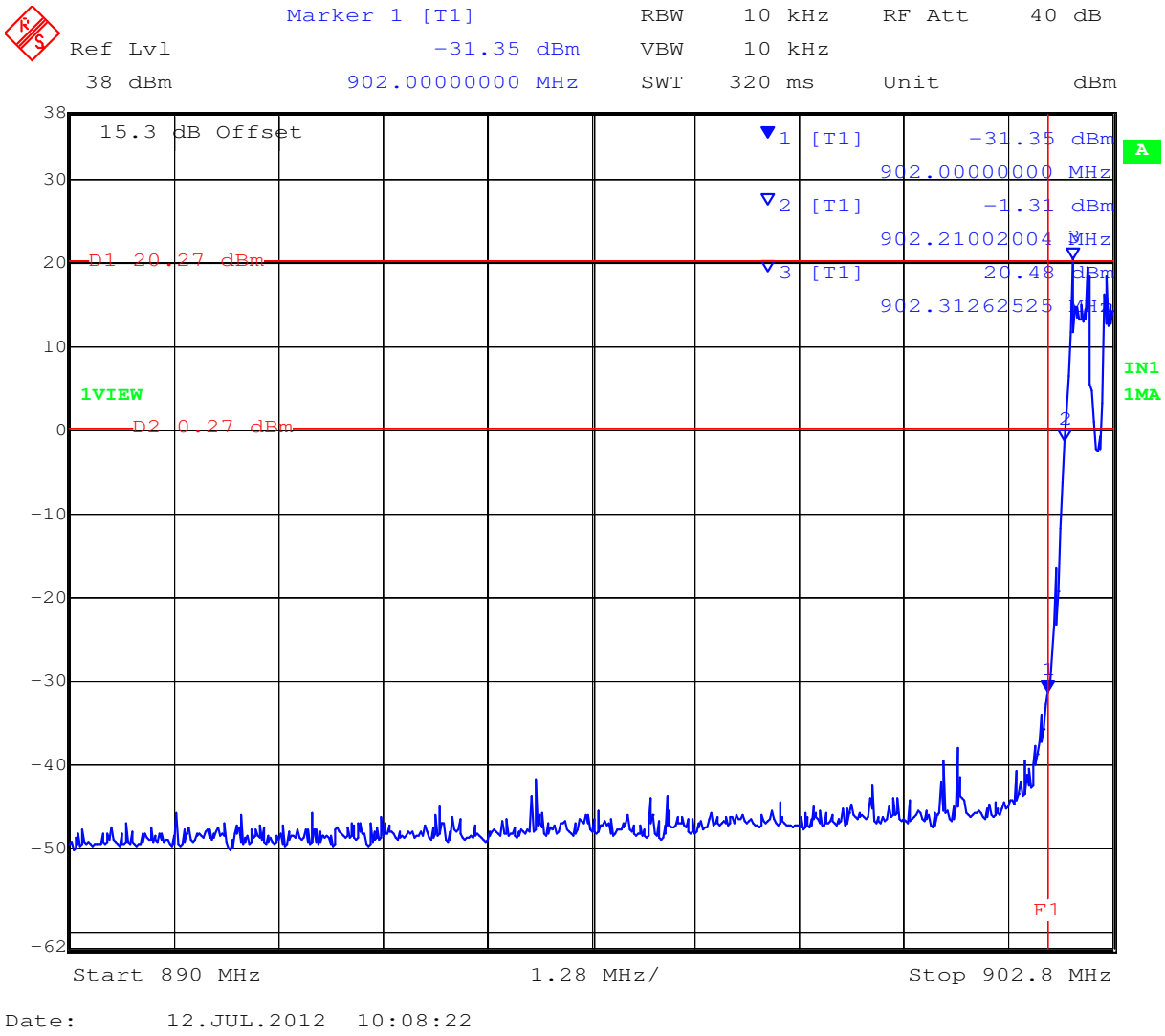
No Hopping 200 kbps - Conducted Spurious Emissions at the 902.4 MHz Lower Band Edge



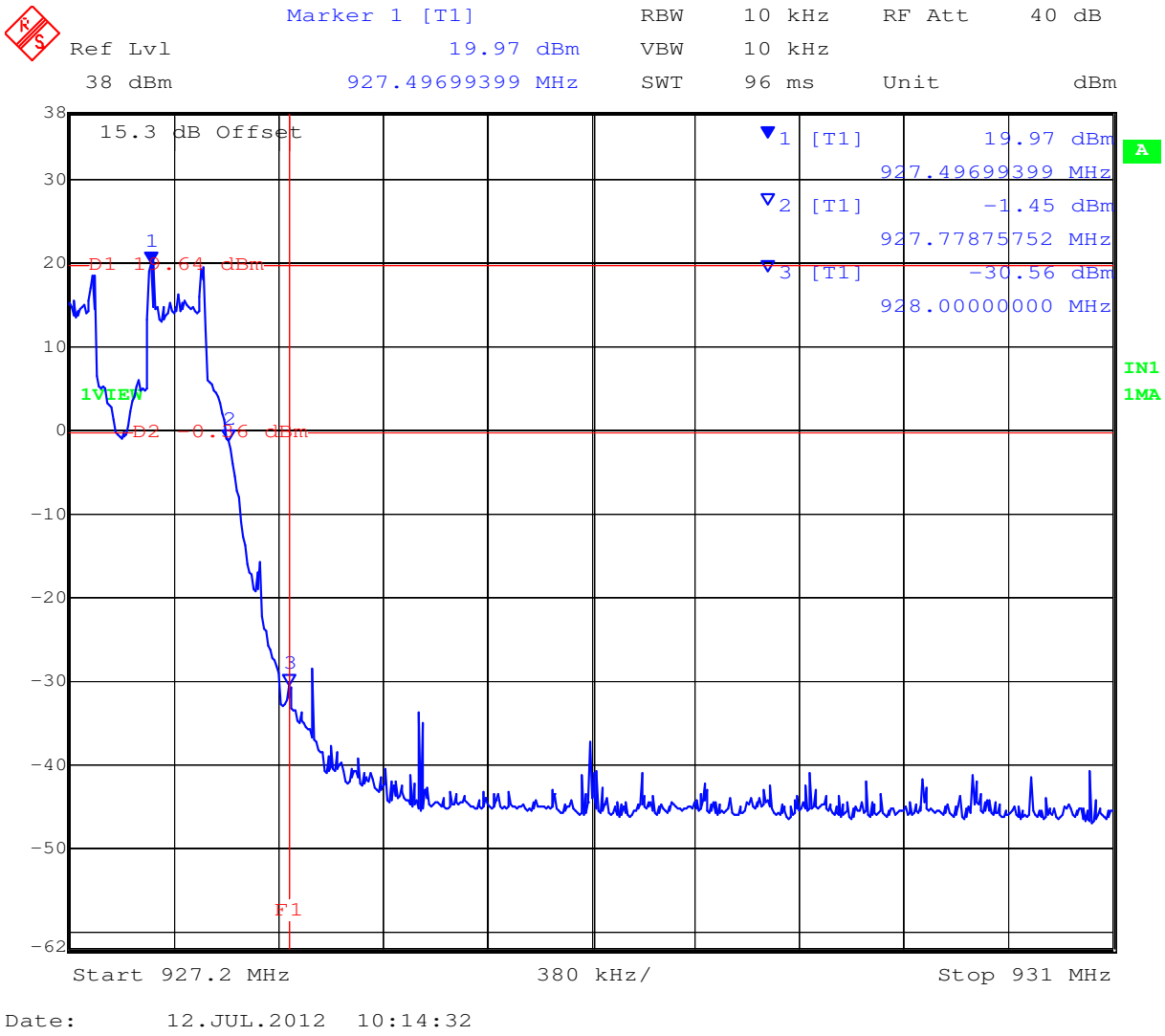
No Hopping 200 kbps - Conducted Spurious Emissions at the 928 MHz Upper Band Edge



Hopping ON 200 kbps - Conducted Spurious Emissions at the 902.4 MHz Lower Band Edge



Hopping ON 200 kbps - Conducted Spurious Emissions at the 928 MHz Upper Band Edge



Spurious Emissions (1-10 GHz)

Conducted spurious emissions (1-10 GHz) are provided indicated by the following matrix. Measurements were performed with the transmitter tuned to the channel closest to the band-edge being measured. All emissions were maximized during measurement. Limits which were derived from the band-edge measurements provided below are drawn on each plot.

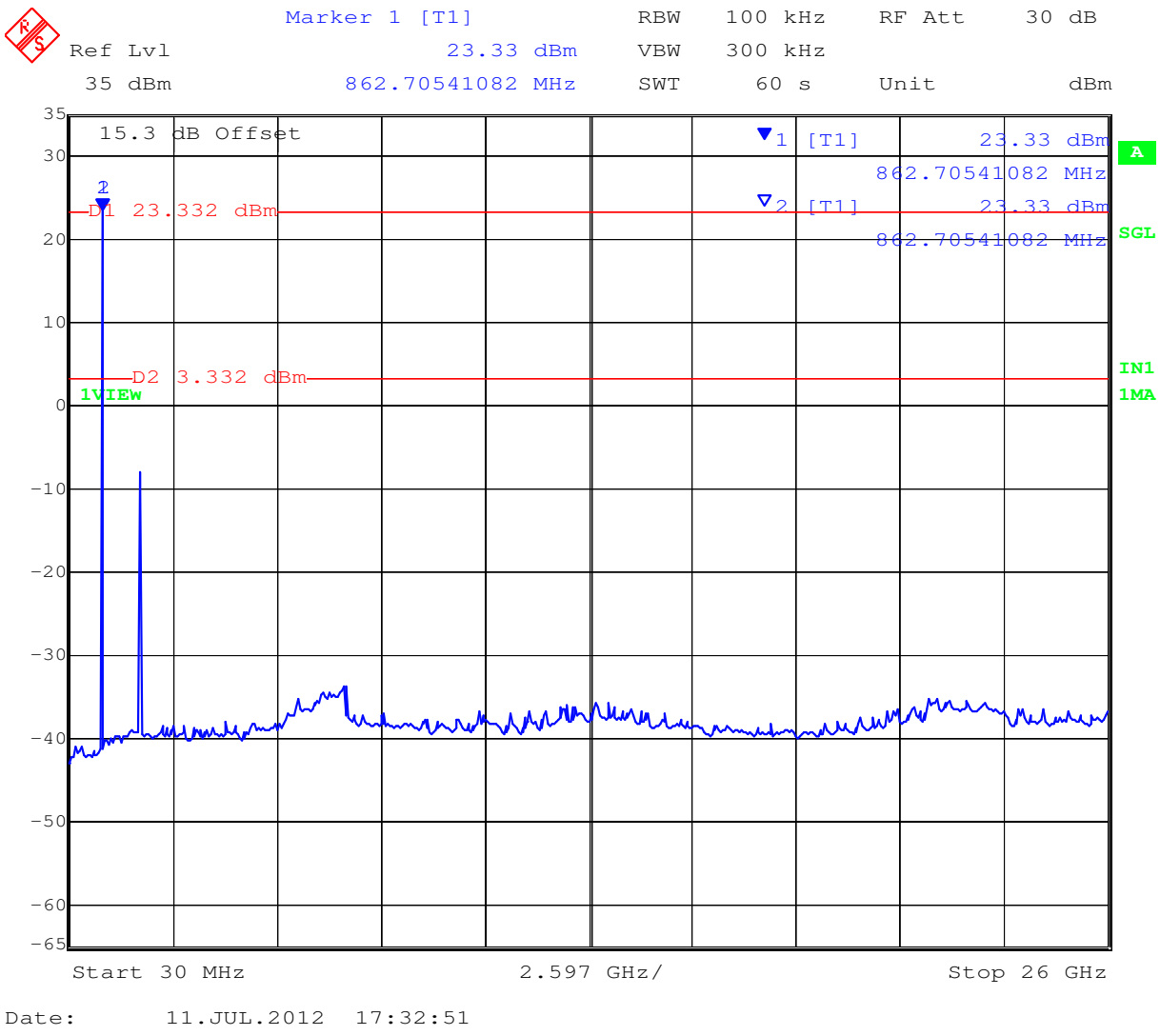
TABLE OF RESULTS – 10 kbps

Channel Centre Frequency (MHz)	Start Frequency (MHz)	Stop Frequency (MHz)	Maximum Emission Observed (dBm)	Limit (dBm)	Margin (dB)
902.4	30	10,000	-8.13	3.332	-11.46
915.2			-8.16	3.808	-11.97
927.6			-8.25	3.422	-11.67

The emission breaking the limit line in all cases is the carrier.

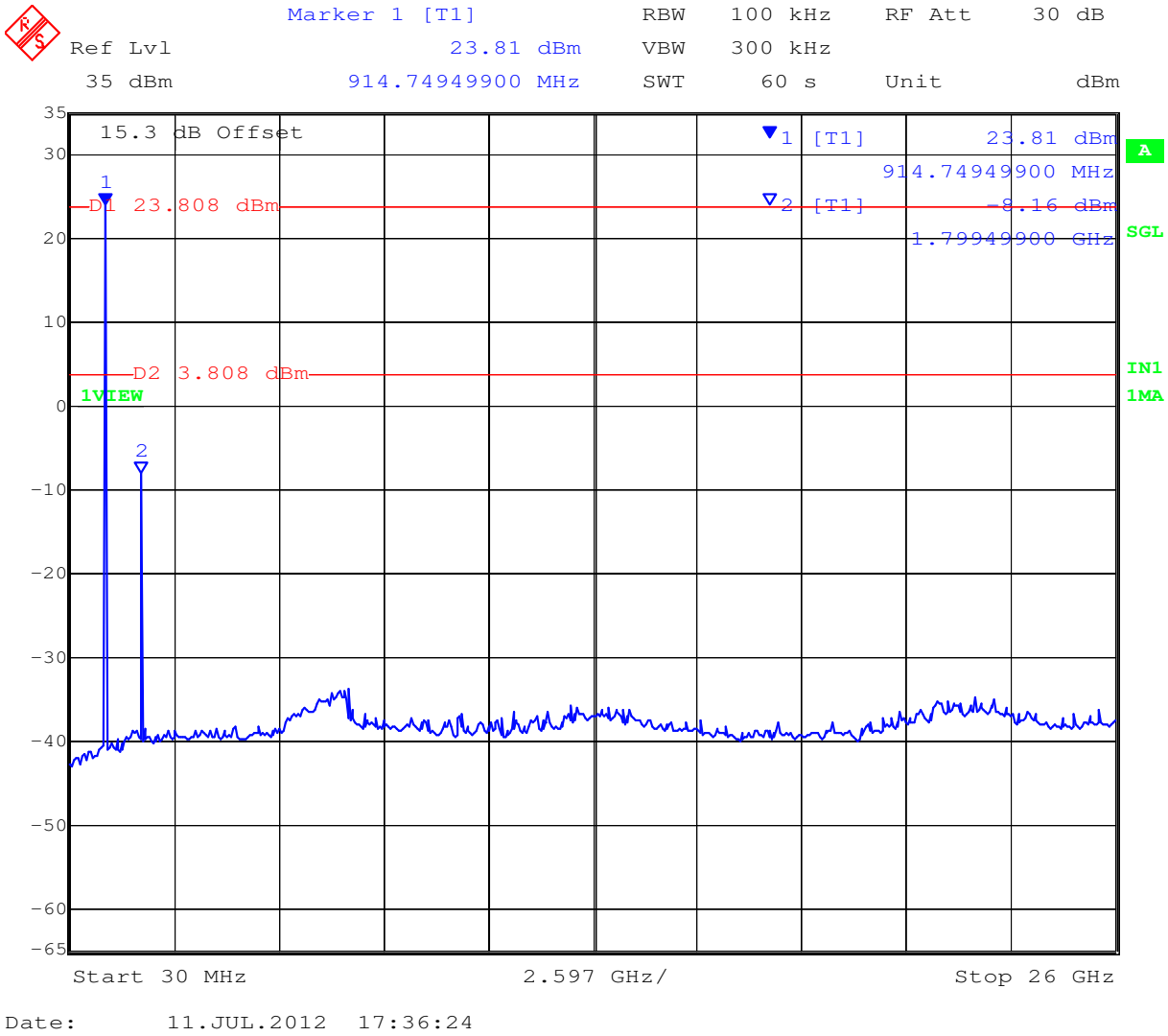
Conducted Transmitter Spurious Emissions

10 kbps Channel 902.4 MHz - 30 MHz to 10,000 MHz



Conducted Transmitter Spurious Emissions

10 kbps Channel 915.2 MHz - 30 MHz to 10,000 MHz



Conducted Transmitter Spurious Emissions

10 kbps Channel 927.6 MHz - 30 MHz to 10,000 MHz

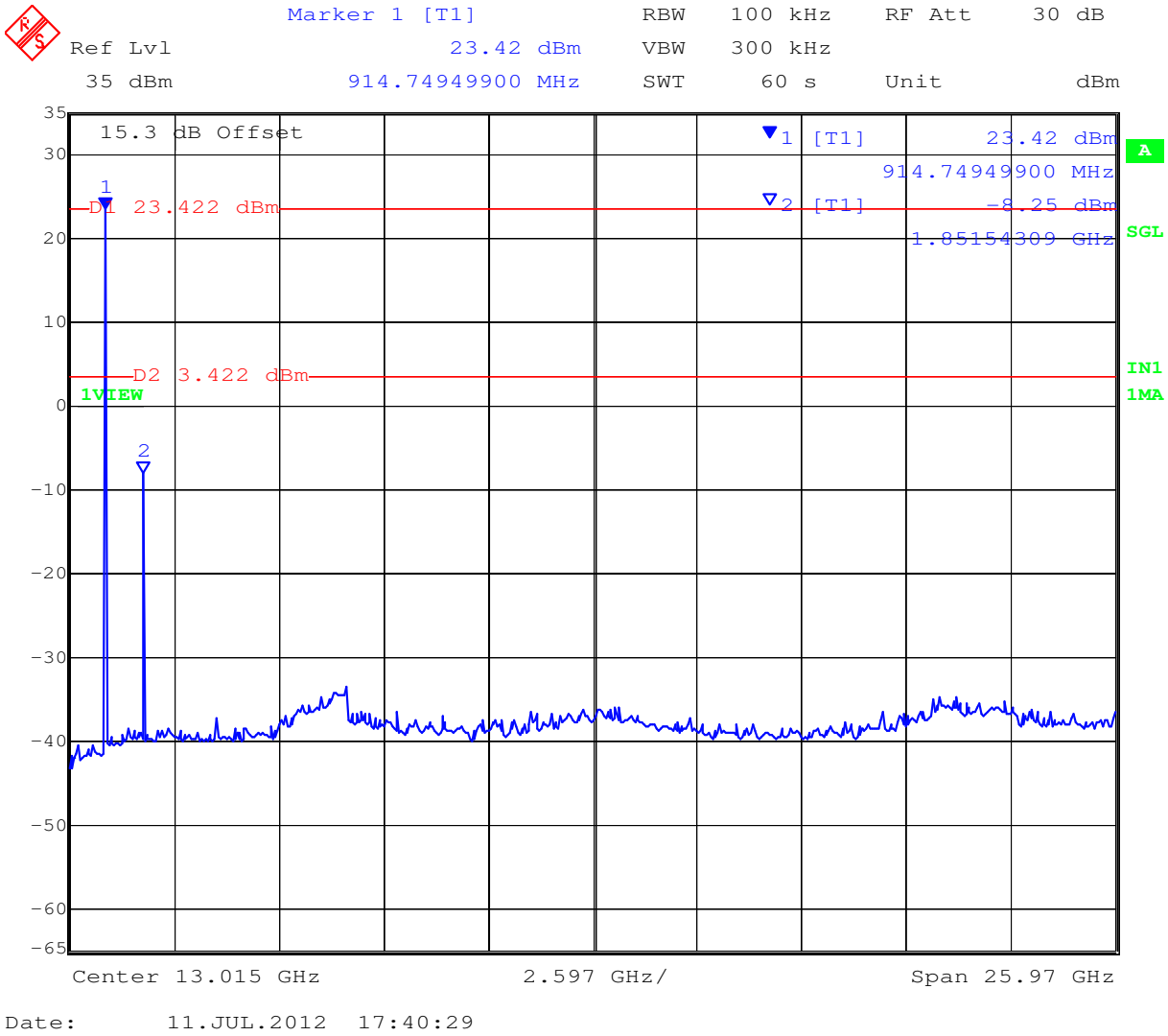


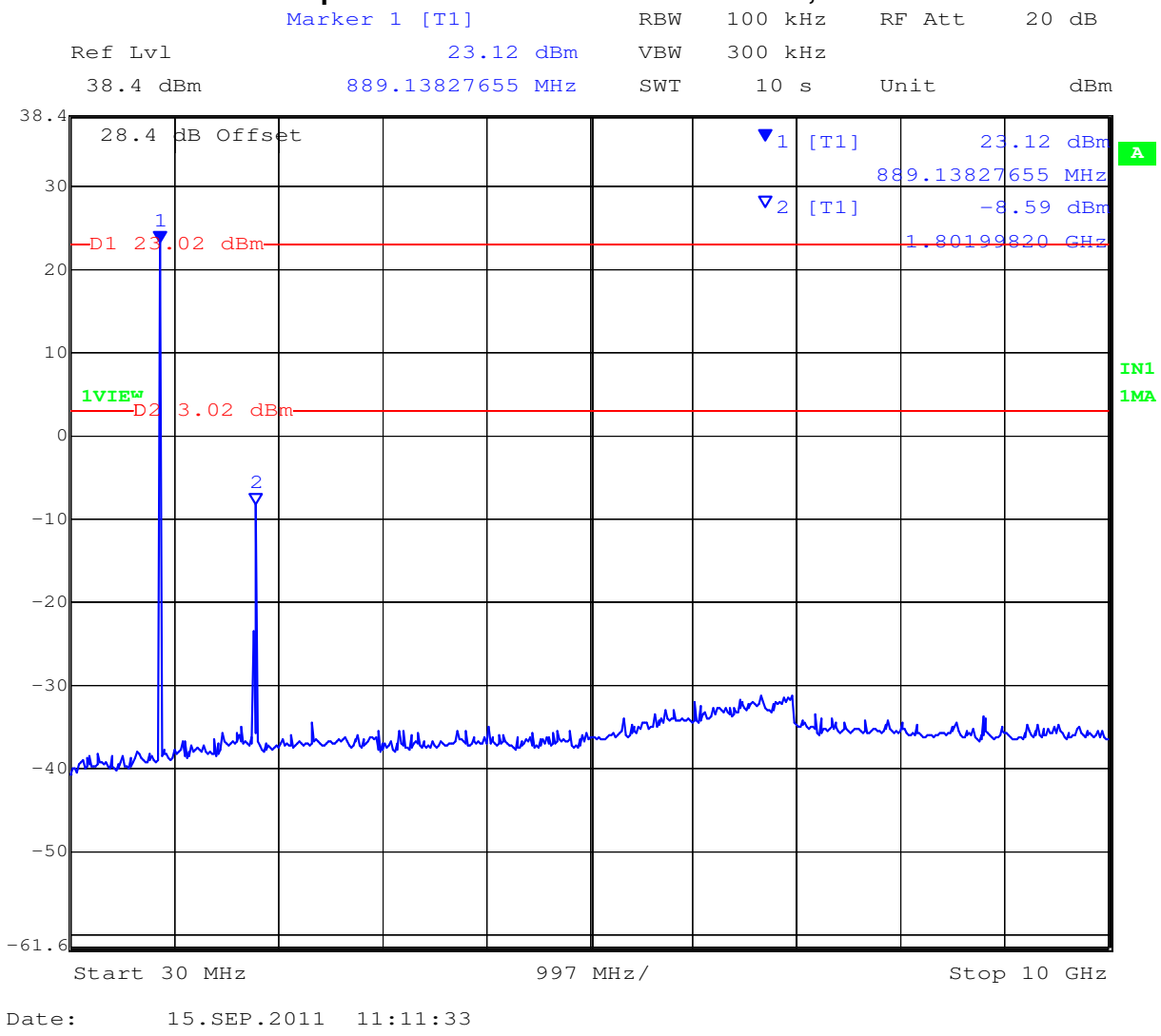
TABLE OF RESULTS – 20 kbps

Channel Centre Frequency (MHz)	Start Frequency (MHz)	Stop Frequency (MHz)	Maximum Emission Observed (dBm)	Limit (dBm)	Margin (dB)
902.4	30	10,000	-8.58	+3.02	-11.60
915.2			-8.95	+3.02	-11.97
927.6			-9.50	+3.02	-12.52

The emission breaking the limit line in all cases is the carrier.

Conducted Transmitter Spurious Emissions

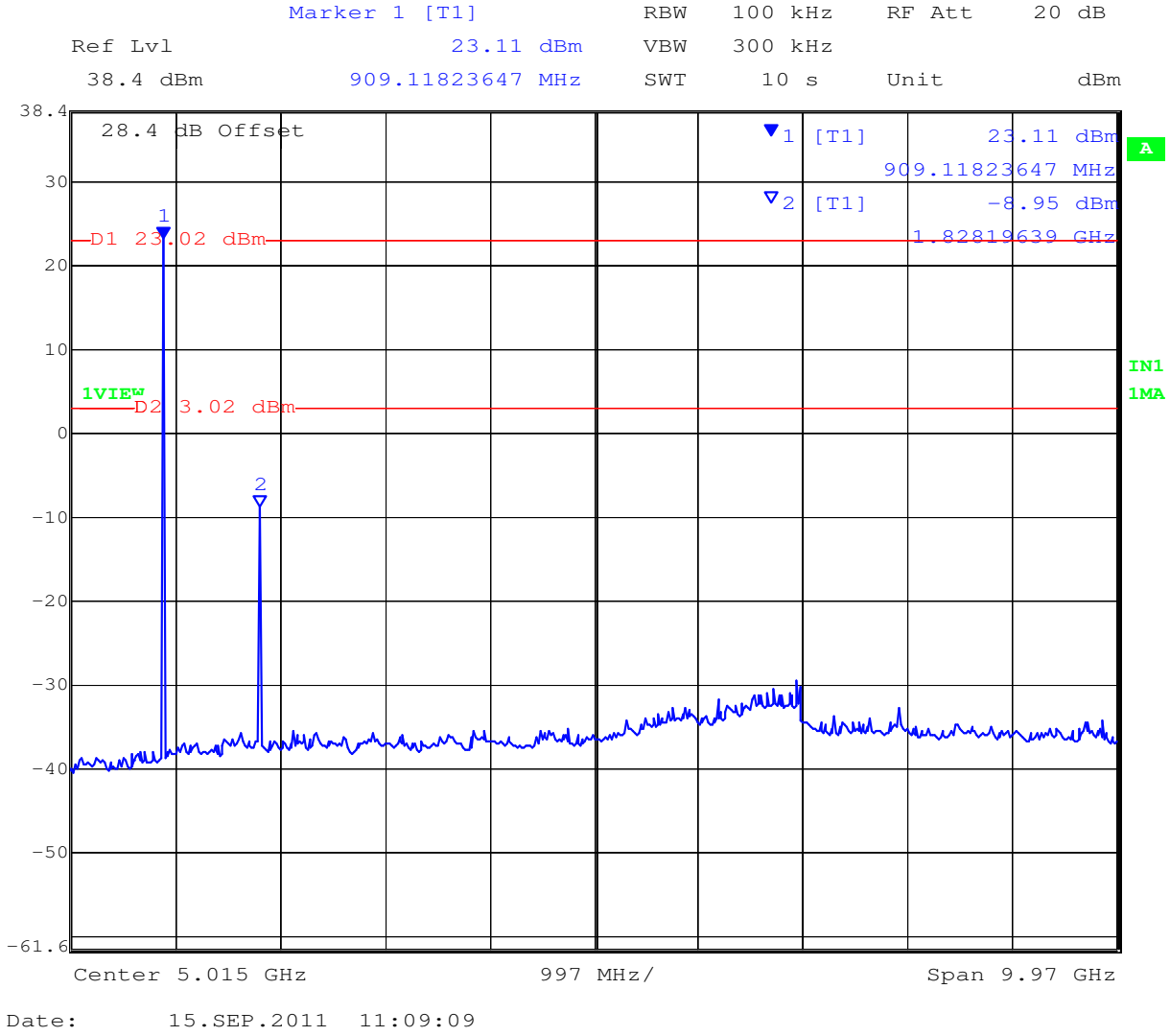
20 kbps Channel 902.4 MHz - 30 MHz to 10,000 MHz



The emission breaking the limit line is the carrier.

Conducted Transmitter Spurious Emissions

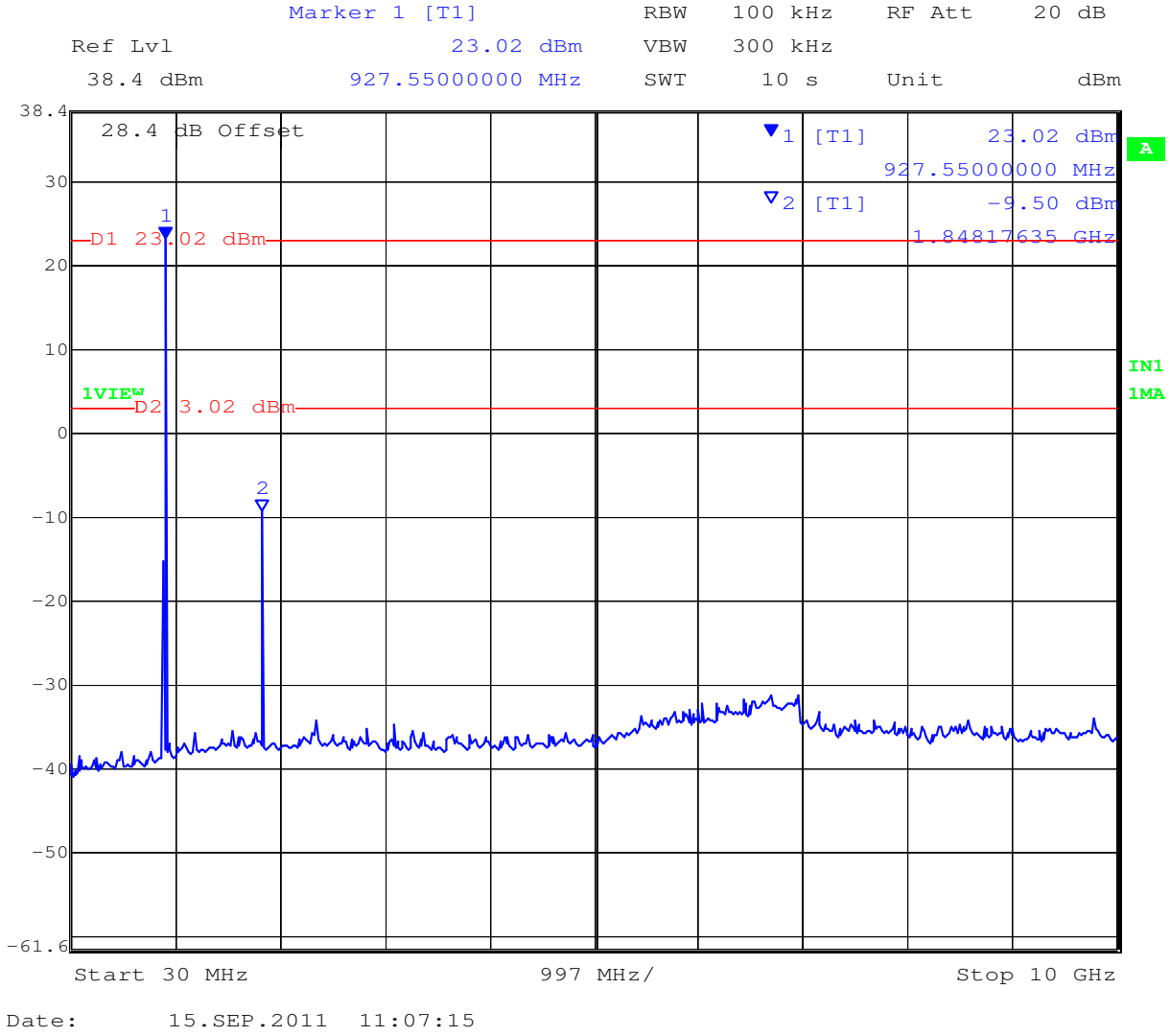
20 kbps Channel 915.2 MHz - 30 MHz to 10,000 MHz



The emission breaking the limit line is the carrier.

Conducted Transmitter Spurious Emissions

20 kbps Channel 927.6 MHz - 30 MHz to 10,000 MHz



The emission breaking the limit line is the carrier.

Specification

Limits Band-Edge

Lower Limit Band-edge	Upper Limit Band-edge	Limit below highest level of desired power
902 MHz	928 MHz	≥ 20 dB

FCC, Part 15 Subpart C §15.247(d)

Industry Canada RSS-210 §A.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

Laboratory Measurement Uncertainty for Conducted Spurious Emissions

Measurement uncertainty	±2.37 dB

Traceability

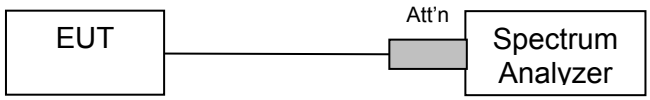
Method	Test Equipment Used
Measurements were made per work instruction WI-05 'Measurement of Spurious Emissions'	0287, 0158, 0193, 0252, 0313, 0314, 0070, 0116, 0117.

5.1.7. Conducted Receiver Spurious Emissions

Industry Canada RSS-Gen §7.2.3

Test Procedure
Conducted Stand-By emissions were measured on the device on the mid channel. The EUT was placed in Stand-By mode and emissions were measured 30 MHz – 7 GHz.

Test Measurement Set up



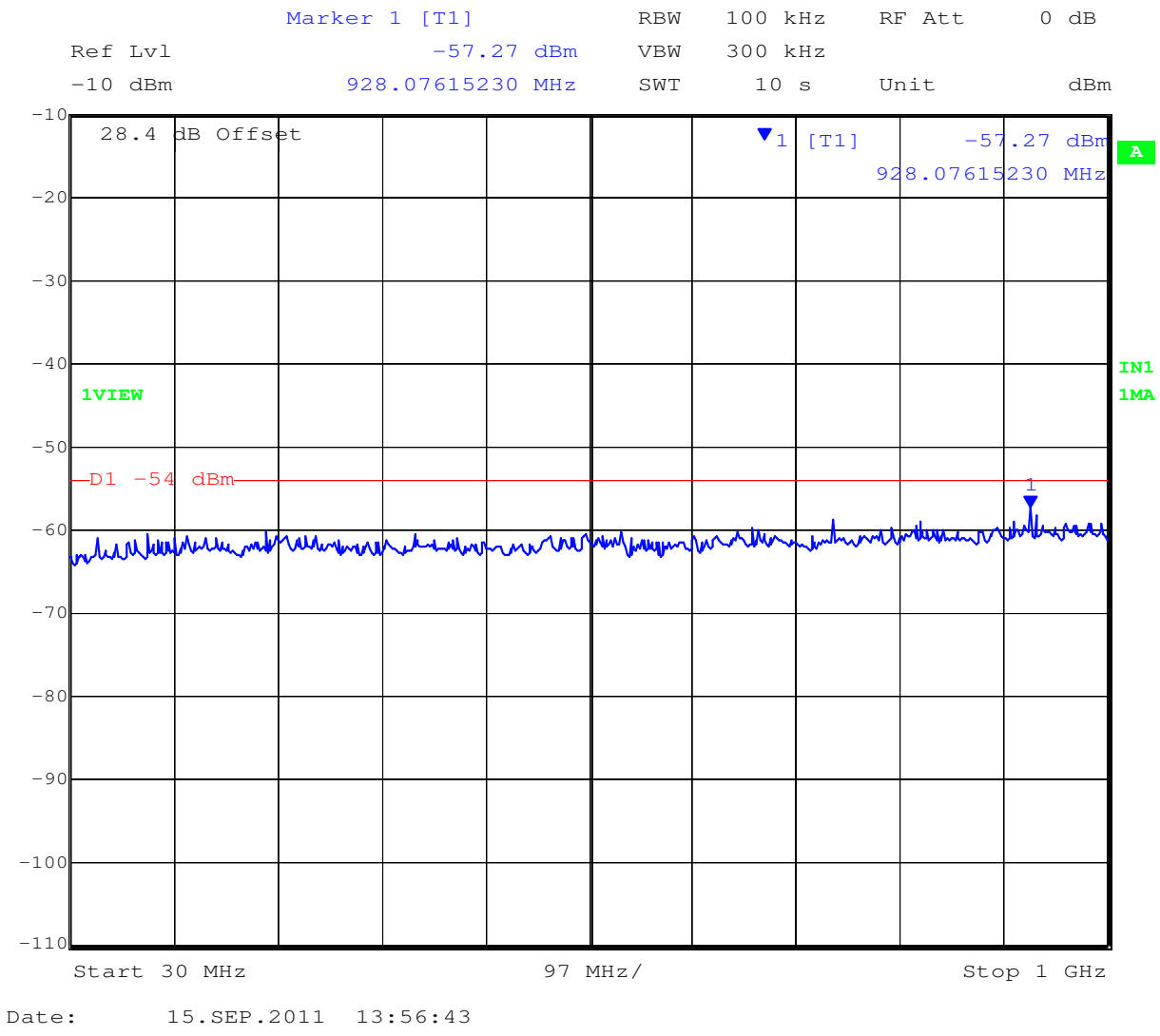
Stand-By spurious emissions test configuration

Measurement Results of Stand –By Spurious Emissions

Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

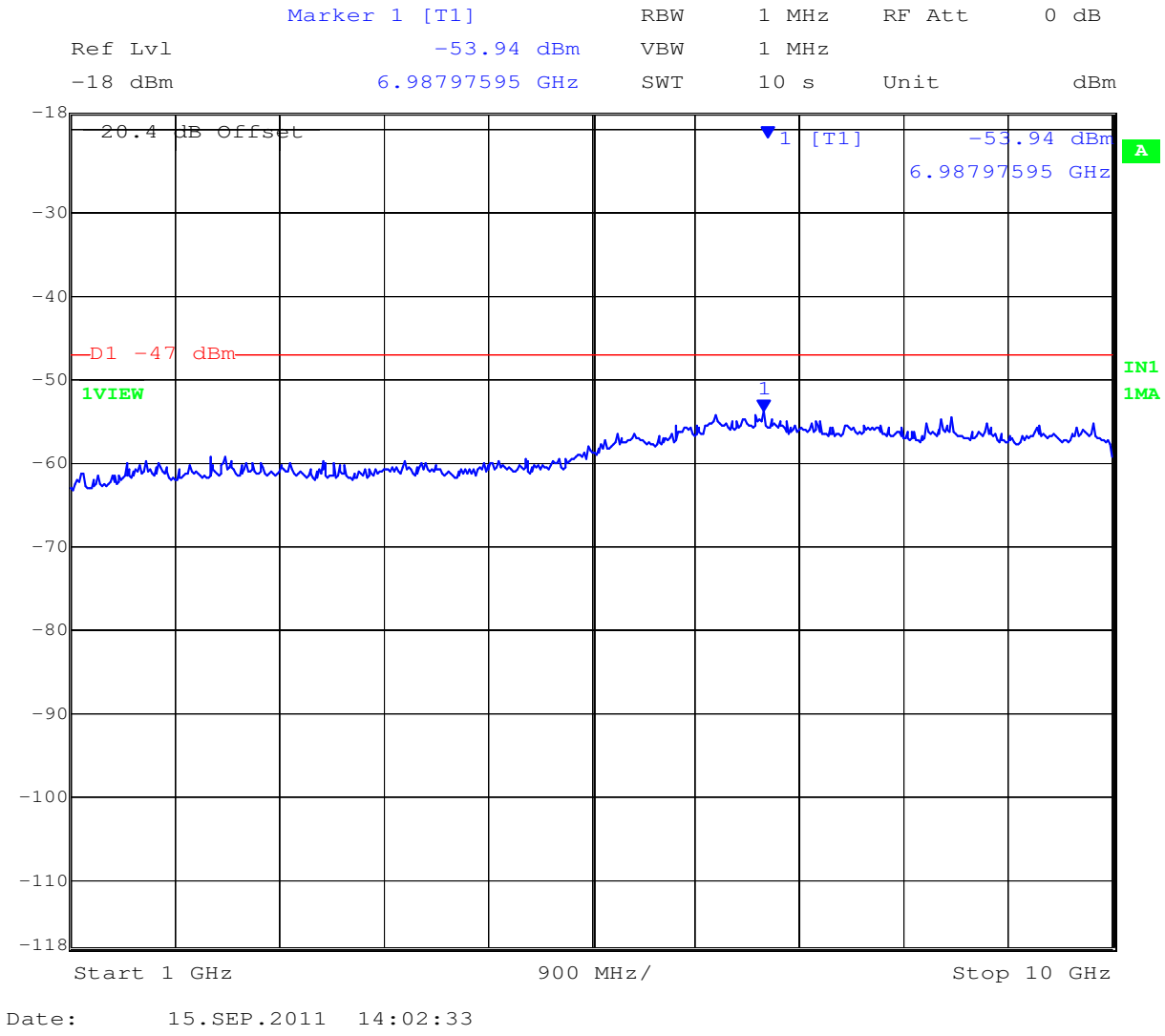
Receiver Conducted Spurious Emissions 0.03 – 10 GHz

20 kbps 902.4 MHz Receiver Conducted Emissions 30 MHz – 1 GHz



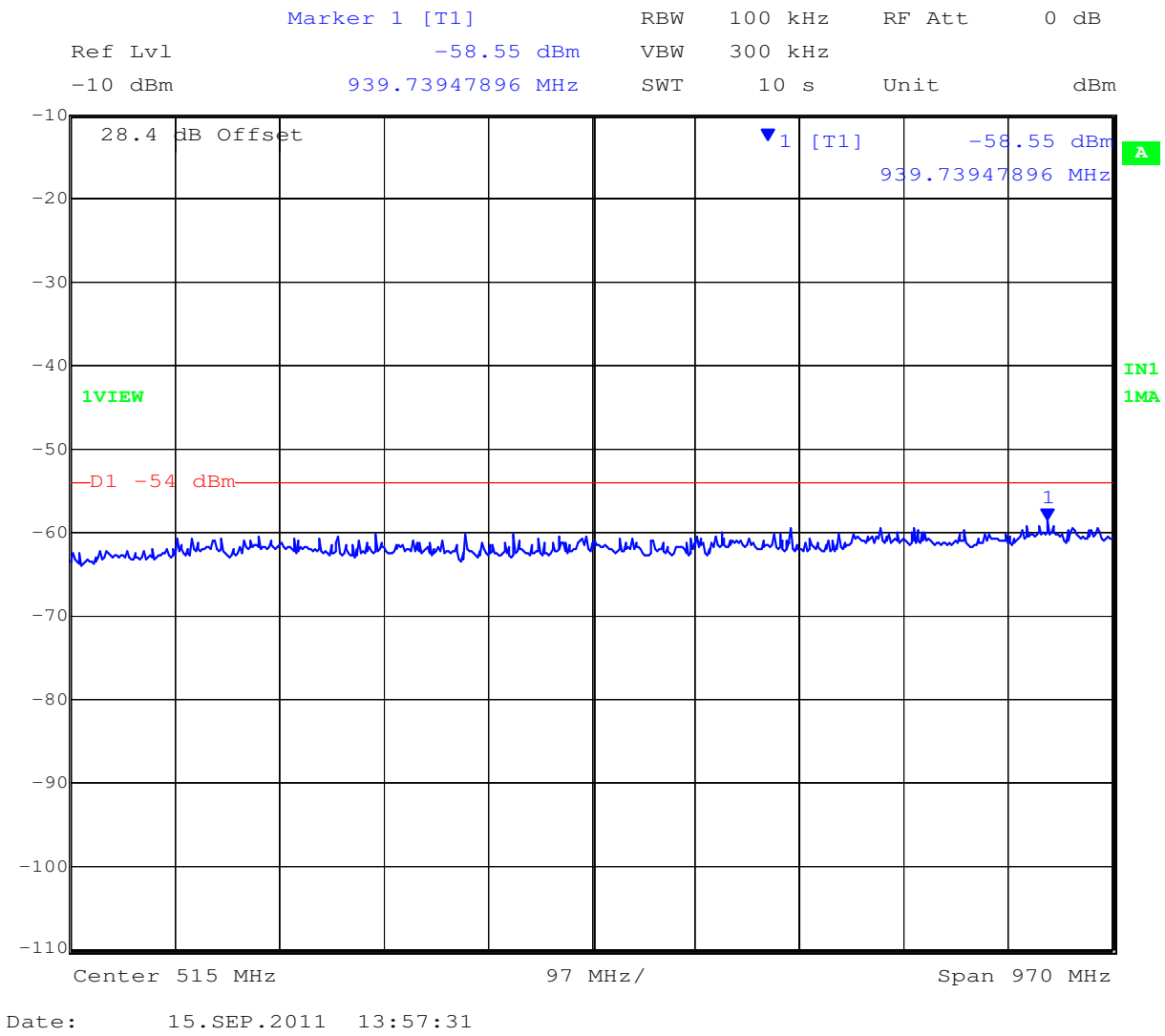
No emissions were observed breaking the limit.

902.4 MHz Receiver Conducted Emissions 1 – 10 GHz



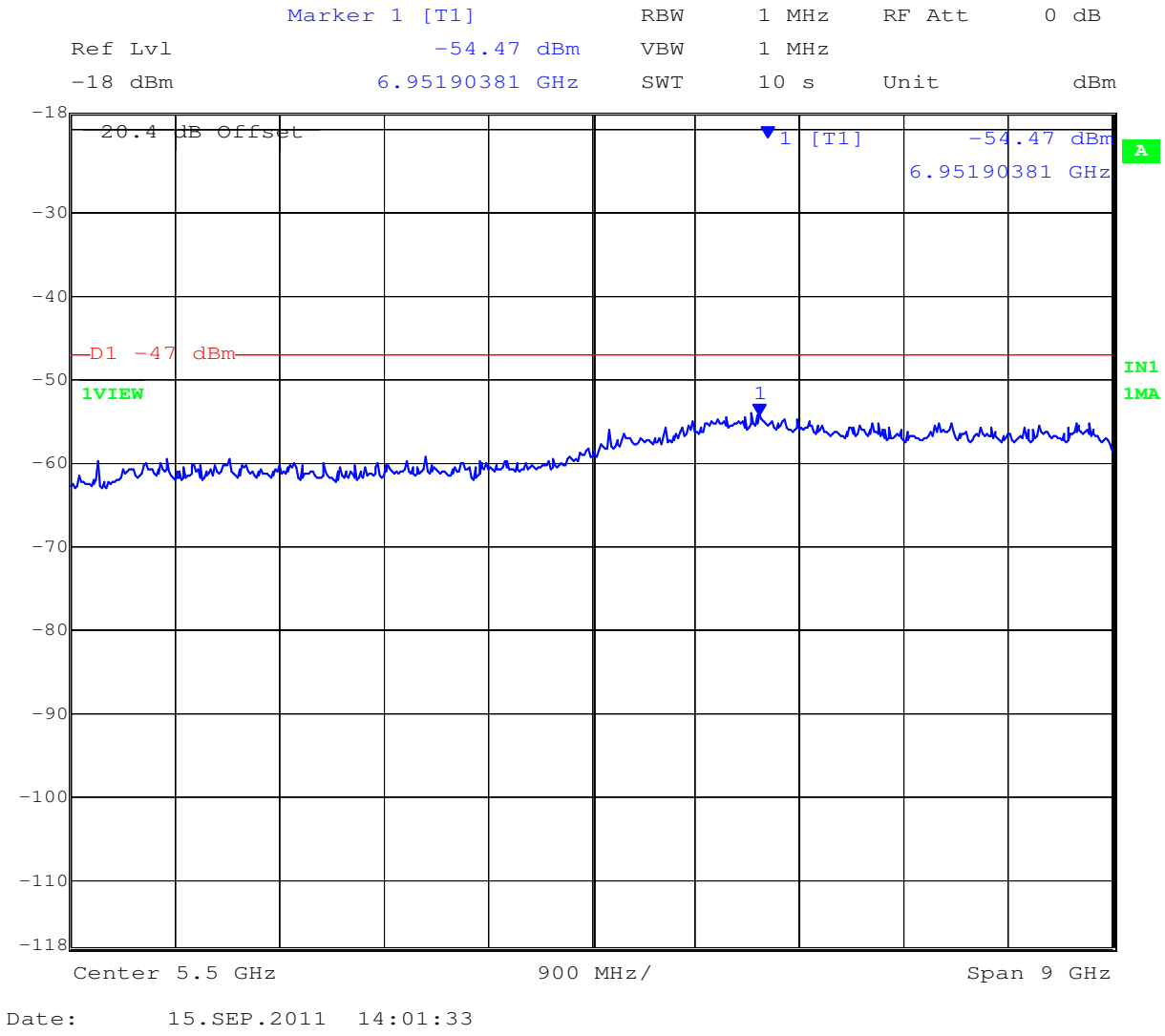
No emissions were observed breaking the limit.

915 MHz Receiver Conducted Emissions 30 MHz – 1 GHz



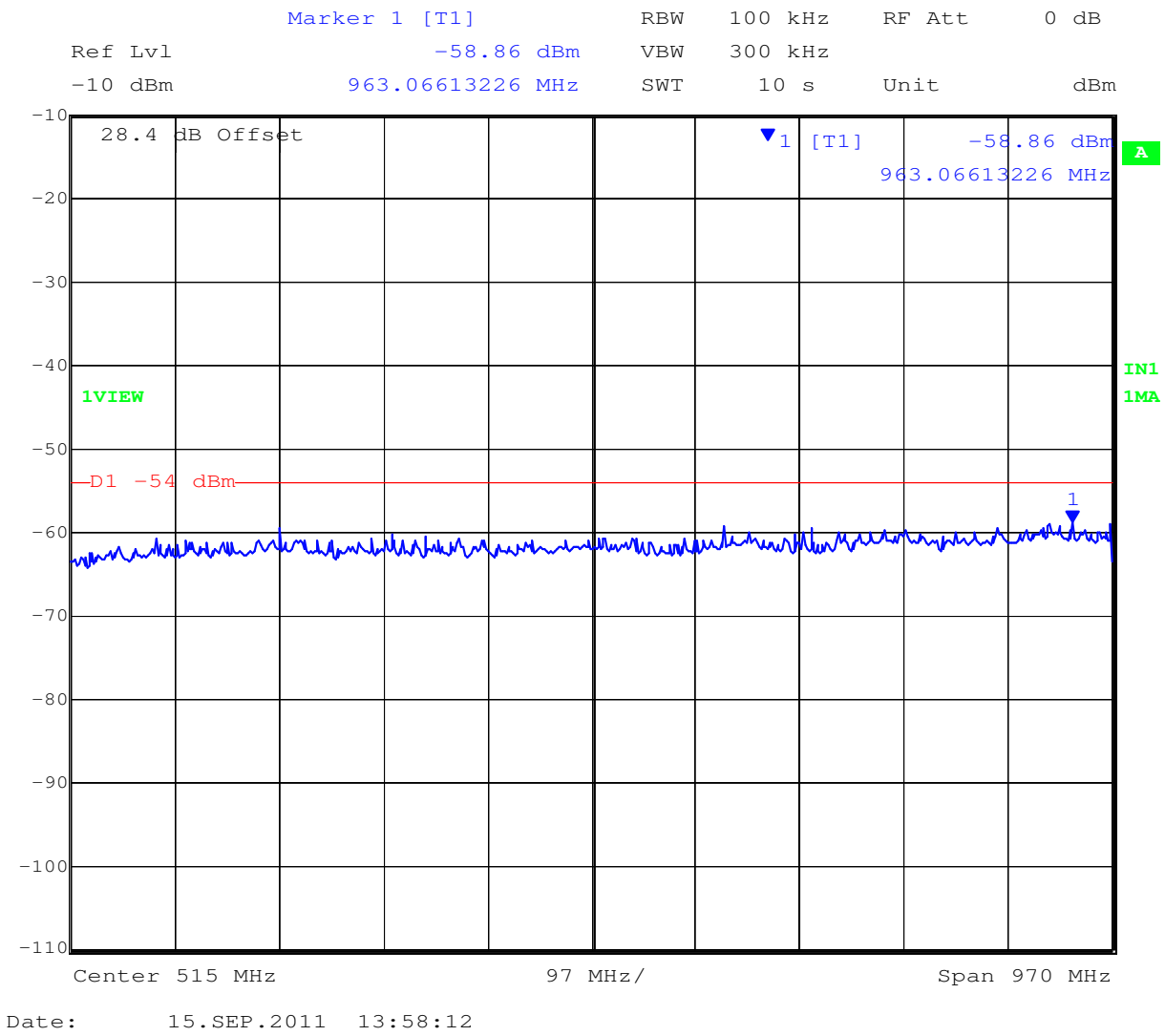
No emissions were observed breaking the limit.

915 MHz Receiver Conducted Emissions 1 – 10 GHz



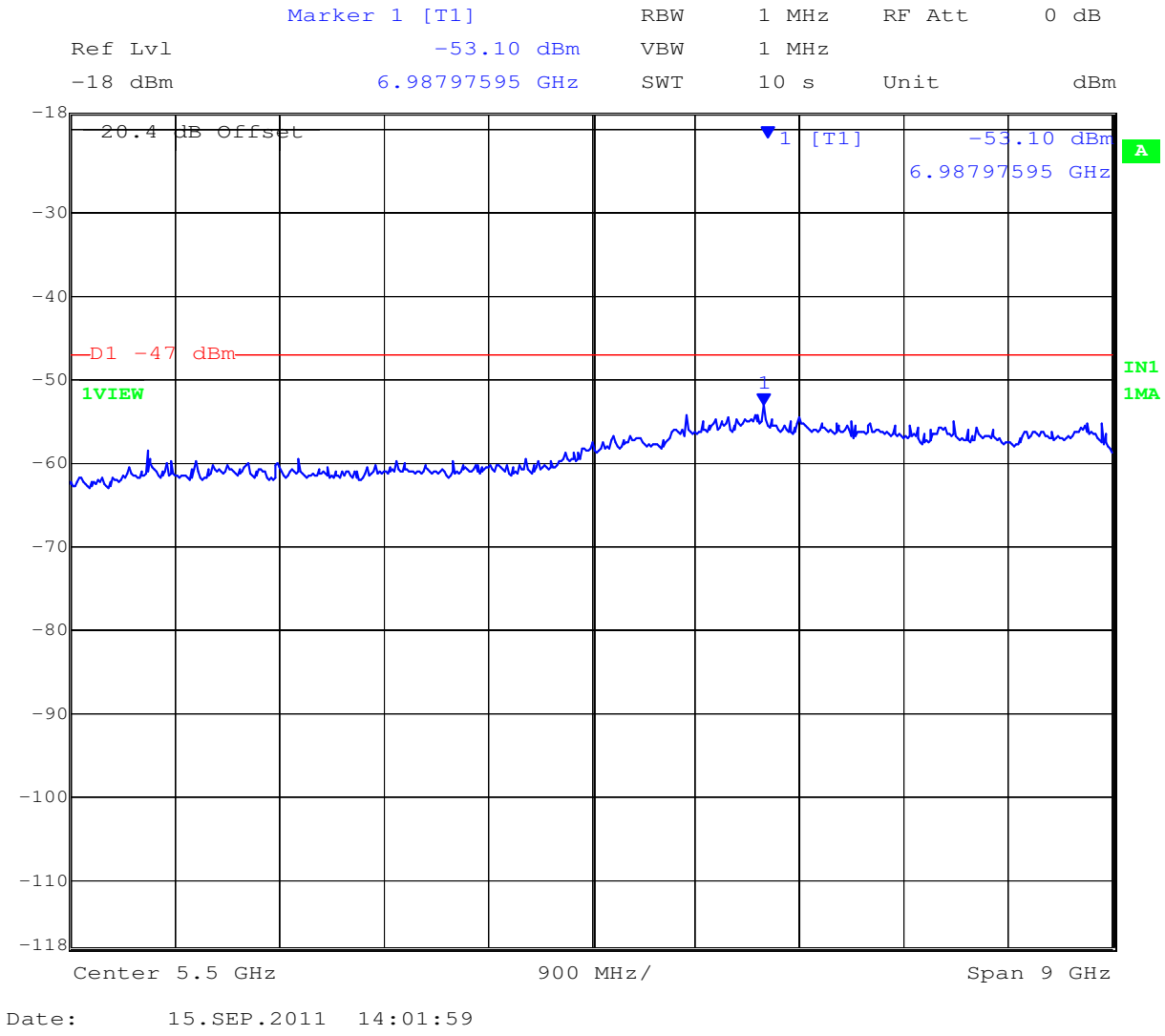
No emissions were observed breaking the limit.

927.5 MHz Receiver Conducted Emissions 30 MHz – 1 GHz



No emissions were observed breaking the limit.

927.5 MHz Receiver Conducted Emissions 1 – 10 GHz



No emissions were observed breaking the limit.

Specification
Antenna Conducted Measurement
Industry Canada RSS-Gen §7.2.3

If the device has a detachable antenna of known antenna impedance, then the antenna conducted method is permitted in lieu of a radiated measurement.
Receiver spurious emissions at any discrete frequency shall not exceed 2 nanowatts (-57 dBm) in the band 30-1000 MHz, or 5 nanowatts (-53 dBm) above 1 GHz.

Laboratory Measurement Uncertainty for Conducted Spurious Emissions

Measurement uncertainty	±2.37 dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-05 'Measurement of Spurious Emissions'	0287, 0158, 0193, 0252, 0313, 0314, 0070, 0116, 0117.

5.1.8. Radiated Emissions

FCC, Part 15 Subpart C §15.247(d) 15.205; 15.209
Industry Canada RSS-210 §A8.5, §2.2, §2.6
Industry Canada RSS-Gen §4.7

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.

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:

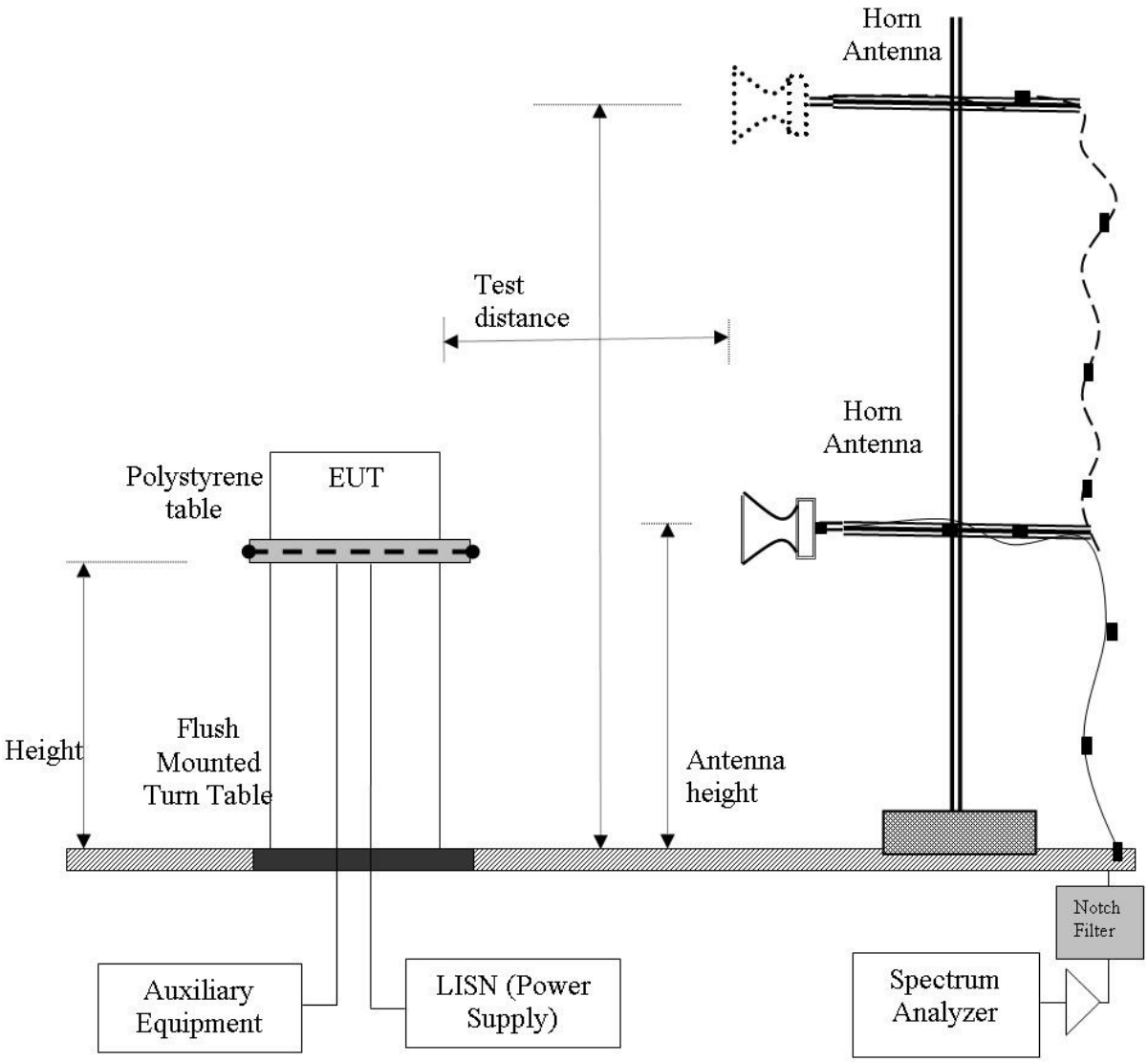
FS = 51.5 + 8.5 + 1.3 - 26.0 +1 = 36.3 dBμV/m

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

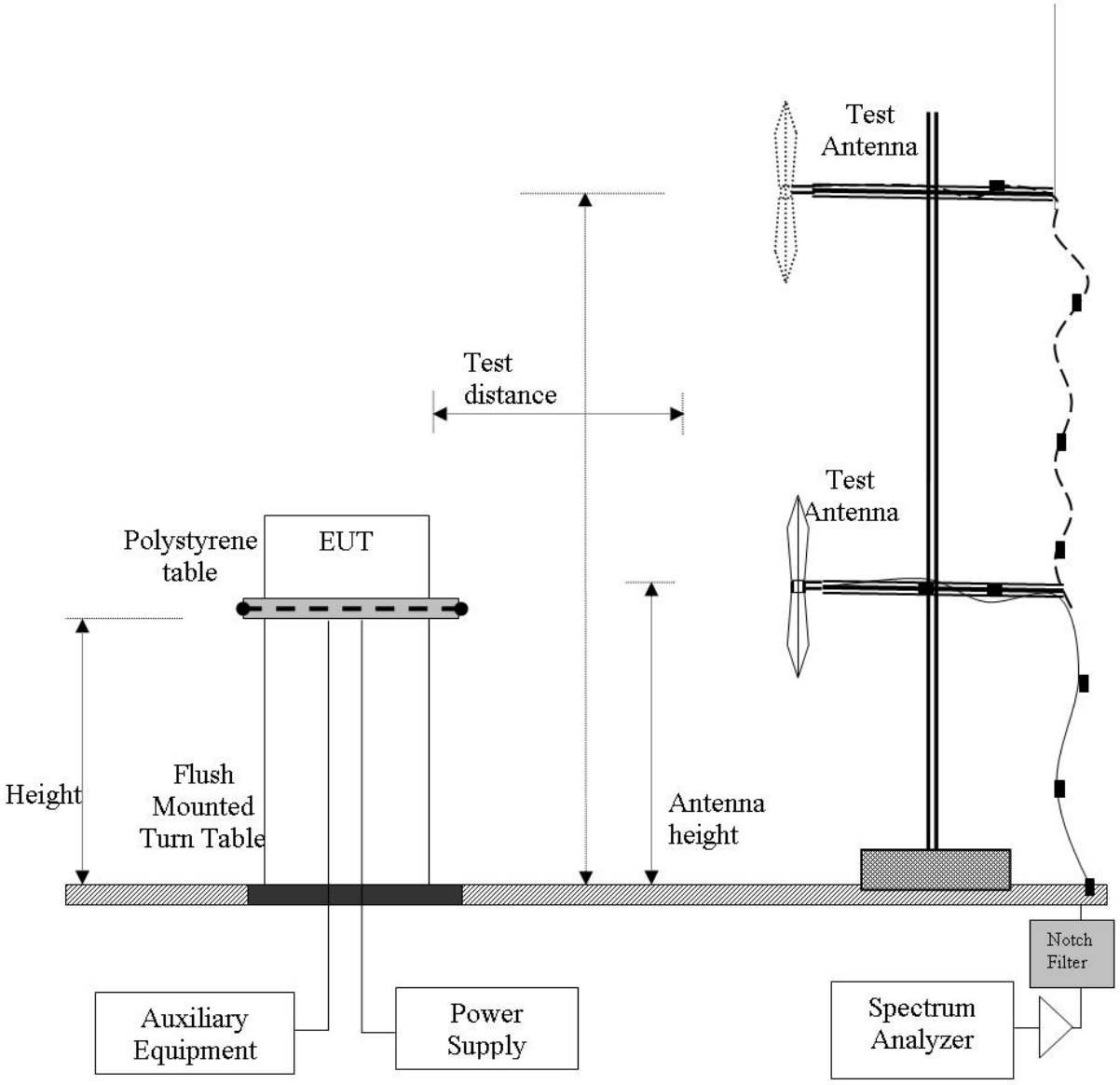
Level (dBμV/m) = 20 * Log (level (μV/m))

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

Radiated Emission Measurement Setup – Above 1 GHz



Radiated Emission Measurement Setup – Below 1 GHz



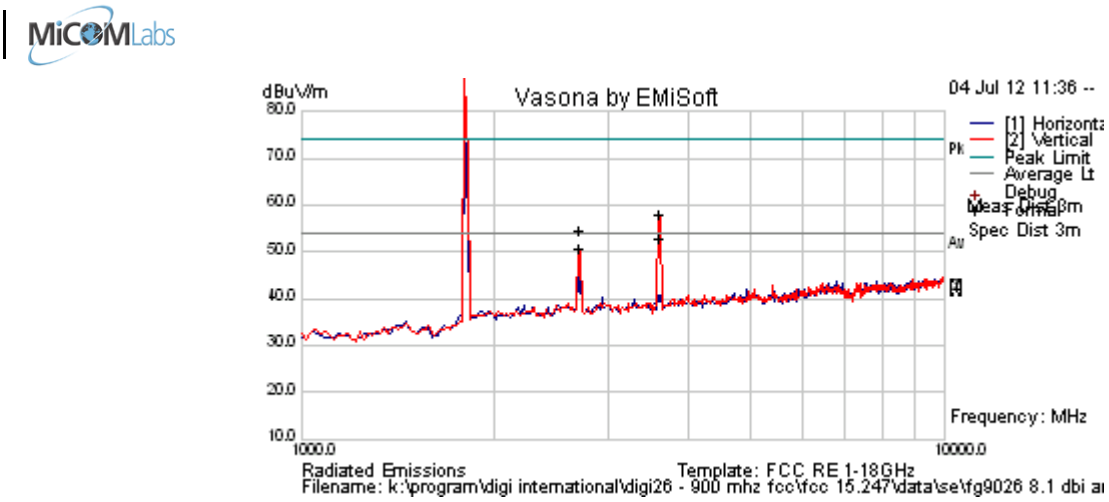
5.1.8.1. Antenna Omni Directional - Radiated Spurious Emissions

Radiated Peak Emissions

Initial evaluation performed for both antennas to determine the worst case for radiated emissions in terms of power level and data rate (10 kbps, 20 kbps or 200 kbps). The report shows worst case radiated emissions for each data rate. Other results are held on file.

Omni 8.1 dBi

Test Freq.	902.4 MHz	**Engineer**	JMH
Variant	10 kbps	**Temp (ºC)**	26
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	30
Power Setting	24 dBm	**Press. (mBars)**	1000
Antenna	Monopole A09-F8 8.1 dBi	**Duty Cycle (%)**	100
Test Notes 1			
Test Notes 2			

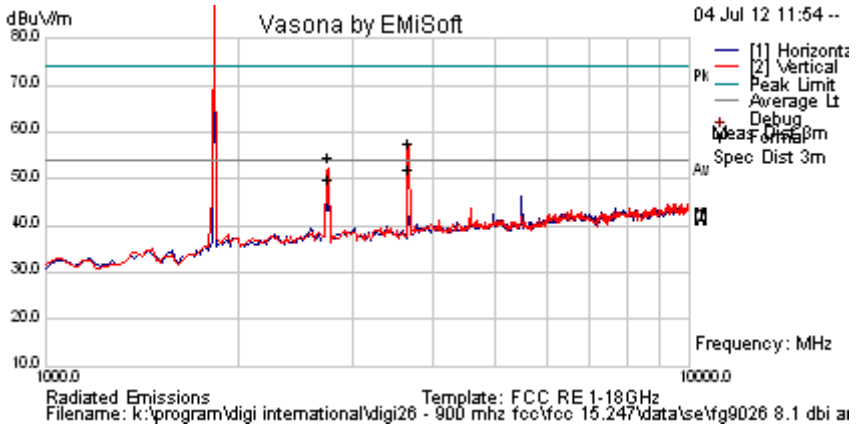


Formally measured emission peaks

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
1804.689	103.0	2.6	-12.6	93.0	Peak Max	V					Pass	NRB
3609.94	65.8	3.7	-11.5	58.0	Peak Max	V	203	83	74.0	-16.0	Pass	RB
2706.974	63.1	3.2	-11.7	54.6	Peak Max	V	189	159	74.0	-19.4	Pass	RB
3609.940	60.8	3.7	-11.5	53.0	Average Max	V	203	83	54	-1.1	Pass	RB
2706.974	59.3	3.2	-11.7	50.8	Average Max	V	189	159	54	-3.2	Pass	RB

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak

Test Freq.	915.2 MHz	**Engineer**	JMH
Variant	10 kbps	**Temp (ºC)**	26
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	30
Power Setting	24 dBm	**Press. (mBars)**	1000
Antenna	Monopole A09-F8 8.1 dBi	**Duty Cycle (%)**	100
Test Notes 1			
Test Notes 2			

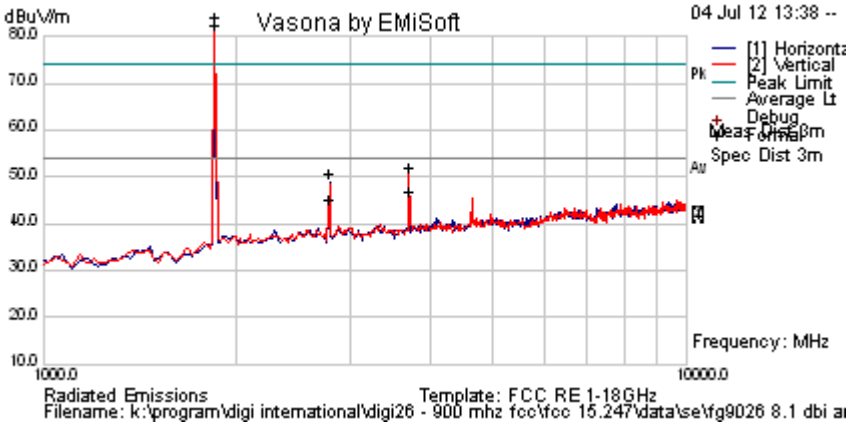


Formally measured emission peaks

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
1830.190	101.7	2.6	-12.5	91.8	Peak Max	V					Pass	NRB
3660.321	65.4	3.7	-11.3	57.8	Peak Max	V	197	81	74.0	-16.2	Pass	RB
2745.240	63.4	3.2	-11.7	54.8	Peak Max	V	104	139	74	-19.2	Pass	RB
3660.321	59.5	3.7	-11.3	51.9	Average Max	V	197	81	54	-2.1	Pass	RB
2745.240	58.5	3.2	-11.7	50.0	Average Max	V	104	139	54	-4.1	Pass	RB

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak

Test Freq.	927.6 MHz	**Engineer**	JMH
Variant	10 kbps	**Temp (ºC)**	26
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	30
Power Setting	24 dBm	**Press. (mBars)**	1000
Antenna	Monopole A09-F8 8.1 dBi	**Duty Cycle (%)**	100
Test Notes 1			
Test Notes 2			



Formally measured emission peaks

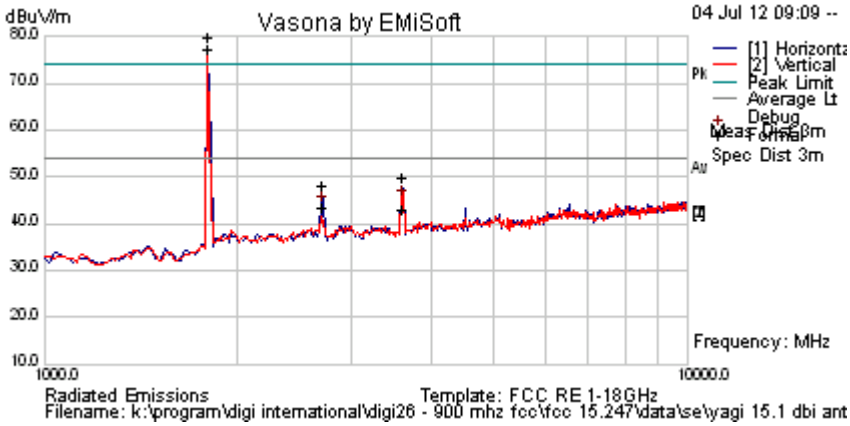
Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
1855.351	93.8	2.7	-12.4	84.1	Peak Max	V						NRB
3710.481	59.5	3.7	-11.1	52.1	Peak Max	V	98	160	74.0	-21.9	Pass	RB
2783.116	59.3	3.2	-11.8	50.8	Peak Max	H	124	180	74	-23.3	Pass	RB
3710.481	54.4	3.7	-11.1	47.0	Average Max	V	98	160	54	-7.0	Pass	RB
2783.116	53.6	3.2	-11.8	45.1	Average Max	H	124	180	54	-8.9	Pass	RB

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak

Antenna Yagi Directional - Radiated Spurious Emissions

Yagi 15.1 dBi

Test Freq.	902.4 MHz	**Engineer**	JMH
Variant	200 kbps	**Temp (ºC)**	26
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	31
Power Setting	+24 dBm	**Press. (mBars)**	1000
Antenna	13 Element Welded Yagi 15.1 dBi	**Duty Cycle (%)**	100
Test Notes 1			
Test Notes 2			

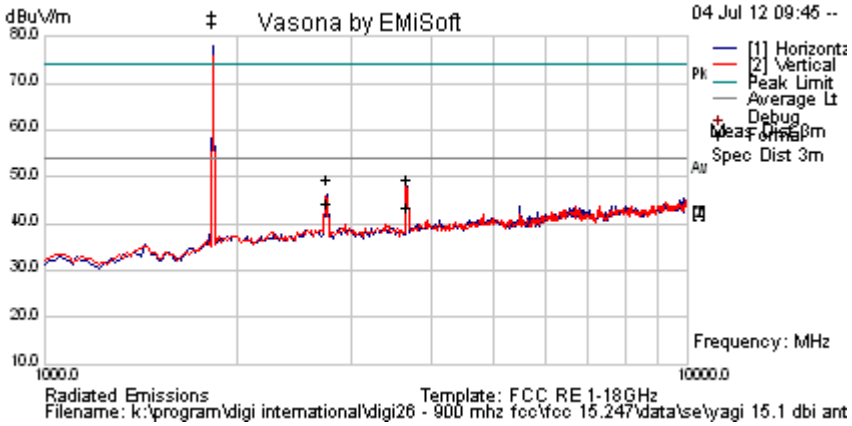


Formally measured emission peaks

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
1804.529	90.0	2.6	-12.6	80.0	Peak Max	H					Pass	NRB
3609.947	57.6	3.7	-11.5	49.8	Peak Max	H	114	230	74.0	-24.2	Pass	RB
2707.020	56.8	3.2	-11.7	48.3	Peak Max	H	98	10	74.0	-25.7	Pass	RB
1804.529	87.5	2.6	-12.6	77.5	Average Max	H					Pass	NRB
3609.947	50.7	3.7	-11.5	42.9	Average Max	H	114	230	54	-11.1	Pass	RB
2707.020	52.0	3.2	-11.7	43.5	Average Max	H	98	10	54	-10.5	Pass	RB

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak

Test Freq.	915.2 MHz	**Engineer**	JMH
Variant	200 kbps	**Temp (ºC)**	26
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	31
Power Setting	+24 dBm	**Press. (mBars)**	1000
Antenna	13 Element Welded Yagi 15.1 dBi	**Duty Cycle (%)**	100
Test Notes 1			
Test Notes 2			

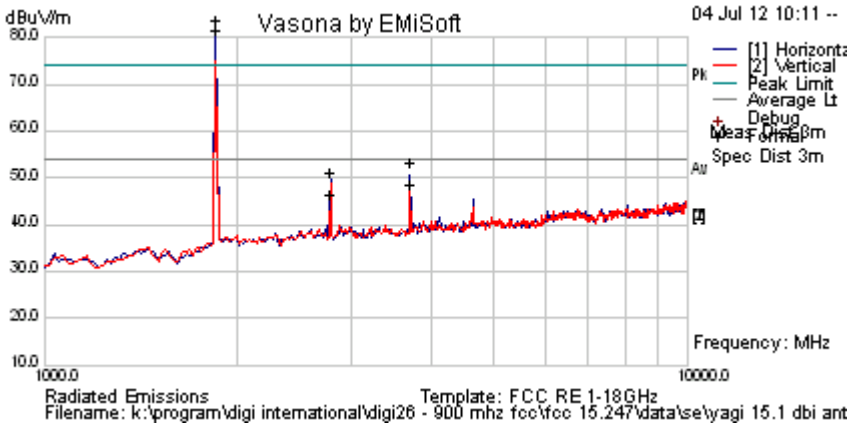


Formally measured emission peaks

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
1830.210	94.7	2.6	-12.5	84.8	Peak Max	H					Pass	NRB
3660.56497	57.2	3.7	-11.3	49.7	Peak Max	V	98	260	74.0	-24.4	Pass	RB
2745.405	57.9	3.2	-11.7	49.3	Peak Max	H	98	129	74	-24.7	Pass	RB
1830.210	92.9	2.6	-12.5	83.1	Average Max	H					Pass	NRB
3660.565	51.1	3.7	-11.3	43.5	Average Max	V	98	260	54	-10.5	Pass	RB
2745.405	53.0	3.2	-11.7	44.5	Average Max	H	98	129	54	-9.5	Pass	RB

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak

Test Freq.	928 MHz	**Engineer**	JMH
Variant	200 kbps	**Temp (ºC)**	26
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	31
Power Setting	+24 dBm	**Press. (mBars)**	1000
Antenna	13 Element Welded Yagi 15.1 dBi	**Duty Cycle (%)**	100
Test Notes 1			
Test Notes 2			



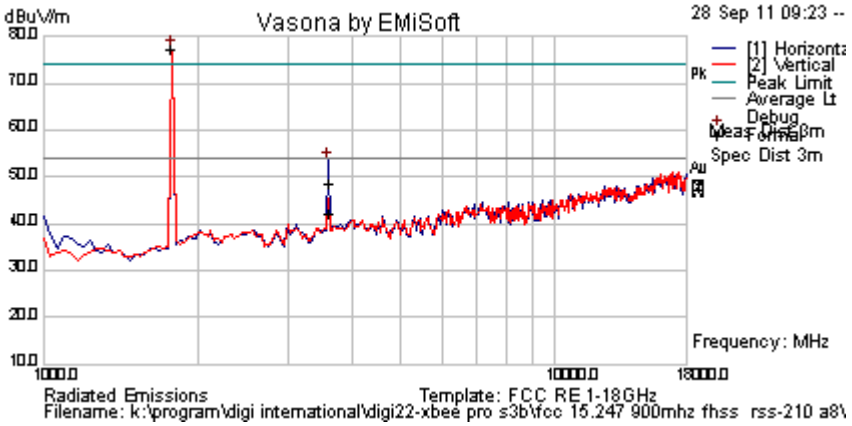
Formally measured emission peaks

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
1855.411	93.4	2.7	-12.4	83.7	Peak Max	H					Pass	NRB
3710.601	60.9	3.7	-11.1	53.5	Peak Max	H	148	211	74.0	-20.5	Pass	RB
2782.555	59.8	3.2	-11.8	51.2	Peak Max	H	98	128	74	-22.8	Pass	RB
1855.411	91.3	2.7	-12.4	81.6	Average Max	H					Pass	NRB
3710.601	55.9	3.7	-11.1	48.5	Average Max	H	148	211	54	-5.5	Pass	RB
2782.555	55.2	3.2	-11.8	46.7	Average Max	H	98	128	54	-7.3	Pass	RB

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak

Yagi 15.1 dBi

Test Freq.	902.4 MHz	**Engineer**	SB
Variant	20 kbps	**Temp (ºC)**	28.5
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	30
Power Setting	24 dBm	**Press. (mBars)**	1000
Antenna	13 Element Welded Yagi 15.1 dBi	**Duty Cycle (%)**	100
Test Notes 1			
Test Notes 2			



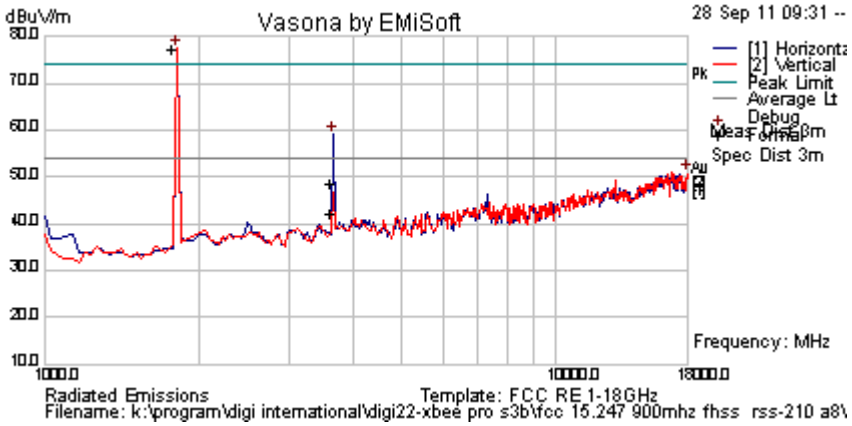
Formally measured emission peaks

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
3609.735	56.1	3.7	-11.3	48.5	Peak Max	H	138	183	74.0	-25.5	Pass	RB
3609.735	49.8	3.7	-11.3	42.2	Average Max	H	138	183	54.0	-11.9	Pass	RB
1783.567	88.0	2.6	-13.3	77.3	Peak [Scan]	H	100	0	109.8	-32.5	Pass	NRB

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak

NRB Limit = Pk Emission – 20 dB = 129.8 – 20 = 109.8 dBµV

Test Freq.	915 MHz	**Engineer**	SB
Variant	20 kbps	**Temp (ºC)**	28.5
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	30
Power Setting	24 dBm	**Press. (mBars)**	1000
Antenna	13 Element Welded Yagi 15.1 dBi	**Duty Cycle (%)**	100
Test Notes 1			
Test Notes 2			



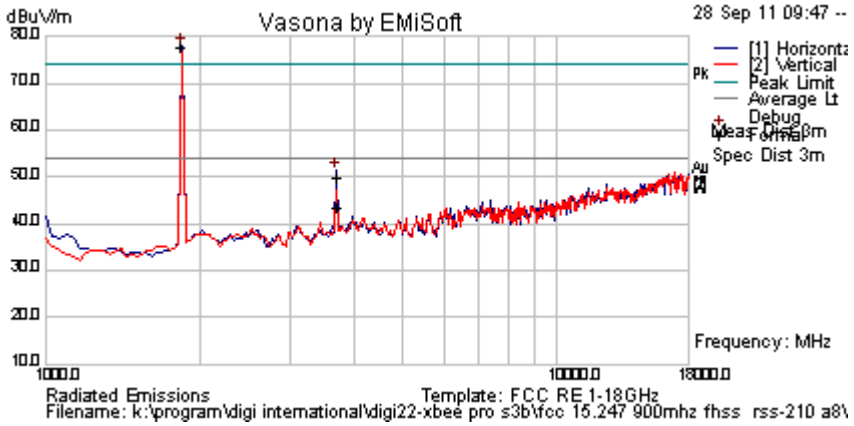
Formally measured emission peaks

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
3659.699	62.9	3.7	-11.3	55.3	Peak Max	H	200	169	74.0	-18.7	Pass	RB
3659.699	57.6	3.7	-11.3	50.0	Average Max	H	200	169	54.0	-4.0	Pass	RB
1817.635	88.0	2.6	-13.0	77.6	Peak [Scan]	H	150	0	110.8	-33.2	Pass	NRB

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak

NRB Limit = Pk Emission – 20 dB = 130.8 – 20 = 110.8 dBµV

Test Freq.	928 MHz	**Engineer**	SB
Variant	20 kbps	**Temp (ºC)**	28.5
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	30
Power Setting	24 dBm	**Press. (mBars)**	1000
Antenna	13 Element Welded Yagi 15.1 dBi	**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
3710.591	57.4	3.7	-11.1	50.1	Peak Max	H	149	172	74.0	-23.9	Pass	RB
3710.591	50.9	3.7	-11.1	43.5	Average Max	H	149	172	54.0	-10.5	Pass	RB
1851.703	88.0	2.7	-12.8	77.9	Peak [Scan]	H	200	0	110.6	-32.7	Pass	NRB

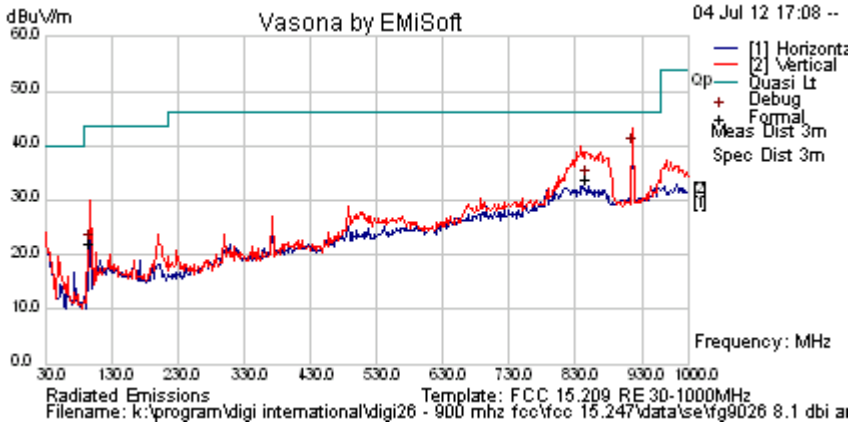
Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak

NRB Limit = Pk Emission – 20 dB = 130.6 – 20 = 110.6 dBµV

Transmitter Spurious Emissions < 1 GHz

Omni Antenna

Test Freq.	915.2 MHz	**Engineer**	JMH
Variant	Digital Emissions	**Temp (ºC)**	27
Freq. Range	30 MHz - 1000 MHz	**Rel. Hum.(%)**	30
Power Setting	24 dBm	**Press. (mBars)**	100
Antenna	Monopole 8.1 dBi		
Test Notes 1			
Test Notes 2			



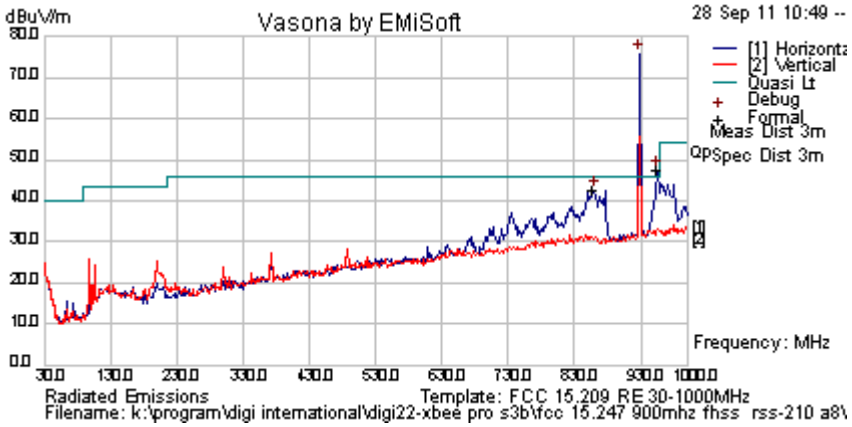
Formally measured emission peaks

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
915.093	40.5	7.2	-7.7	39.9	Peak [Scan]	V	98					Fund
846.740	35.4	6.9	-8.4	34.0	Quasi Max	V	98	232	46	-12.0	Pass	
97.220	40.0	4.1	-22.1	22.0	Quasi Max	V	98	205	43.5	-21.5	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

Yagi Antenna

Test Freq.	927.6 MHz	**Engineer**	SB
Variant	Digital Emissions	**Temp (ºC)**	28
Freq. Range	30 MHz - 1000 MHz	**Rel. Hum.(%)**	30
Power Setting	18 dBm	**Press. (mBars)**	100
Antenna	13 Element Welded Yagi 15 dBi		
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
953.511	46.5	7.5	-6.5	47.6	Quasi Max	H	98	15				NRB
857.090	39.6	7.2	-7.8	39.0	Quasi Max	H	107	19				NRB
928.076	75.3	7.4	-6.9	75.8	Peak [Scan]	H	100	0				FUND

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

§15.205 (a) Except as shown in paragraph (d) of 15.205 (a), only spurious emissions are permitted in any of the frequency bands listed.

§15.205 (a) Except as shown in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

§15.109 (b) The field strength of radiated emissions from a Class A digital device, as determined at a distance of 3 meters, shall not exceed the following:

§15.109 (b) Limit Matrix Class A digital device

Frequency(MHz)	Field Strength (μV/m)	Field Strength (dBμV/m)	Measurement Distance (meters)
30-88	100	49.5	3
88-216	150	54.0	3
216-960	200	57.0	3
Above 960	500	60.0	3

Laboratory Measurement Uncertainty for Radiated Emissions

Measurement uncertainty	+5.6/ -4.5 dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of Radiated Emissions'	0287, 0335, 0338, 0158, 0134, 0304, 0311, 0315, 0310, 0312, 0341

5.1.8.2. 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

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:

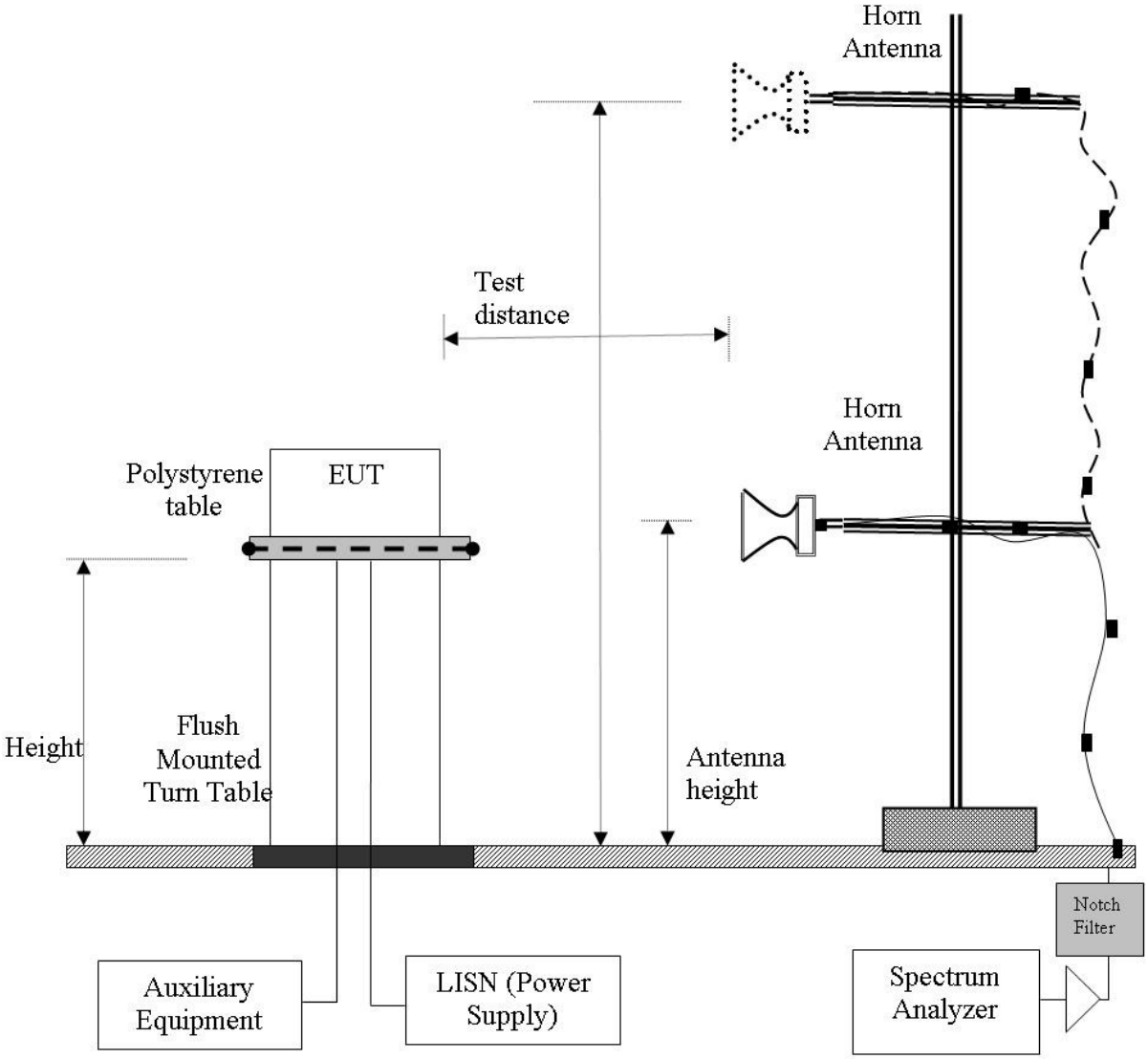
FS = 51.5 + 8.5 + 1.3 - 26.0 +1 = 36.3 dBμV/m

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

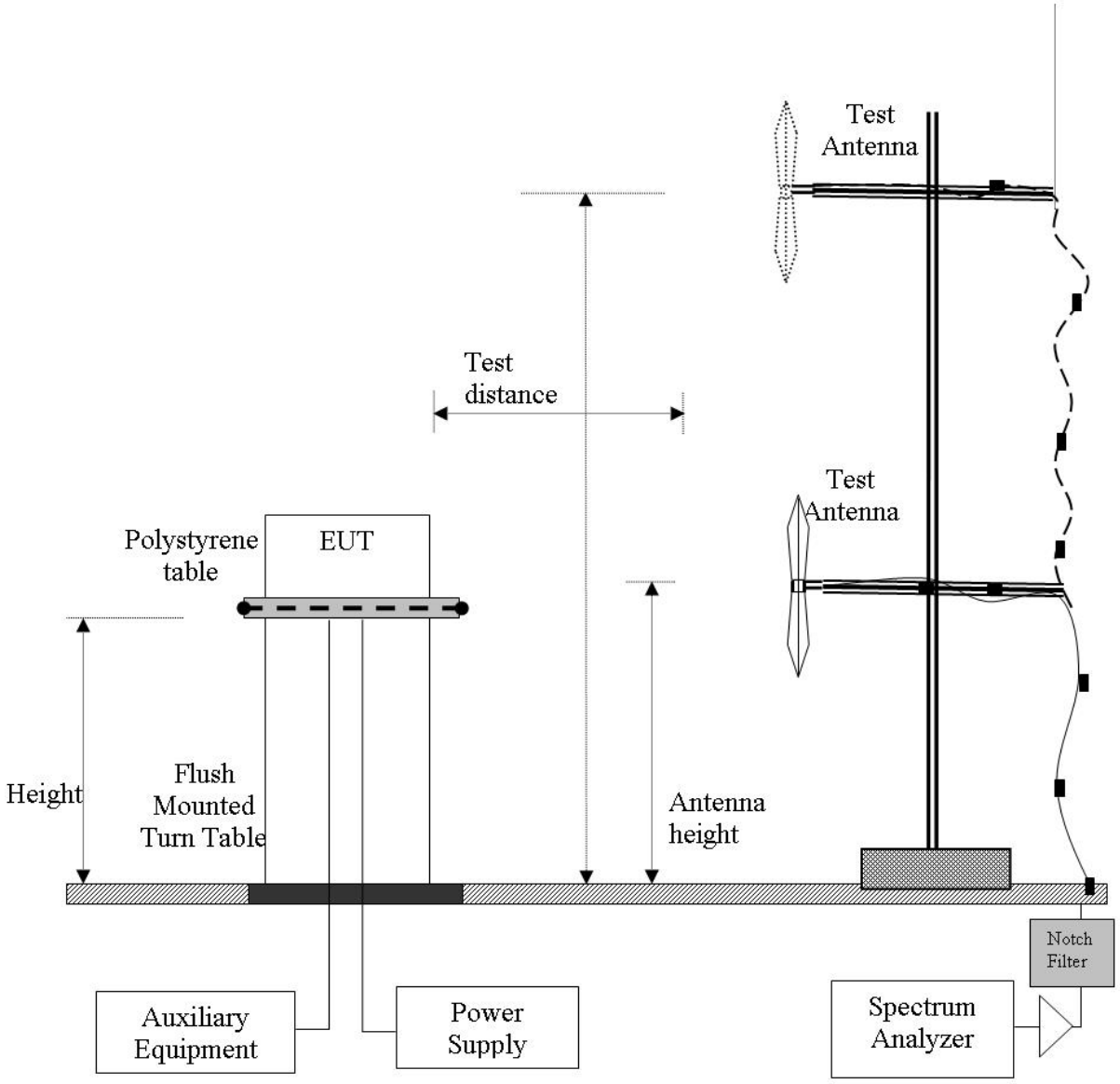
Level (dBμV/m) = 20 * Log (level (μV/m))

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

Radiated Emission Measurement Setup – Above 1 GHz

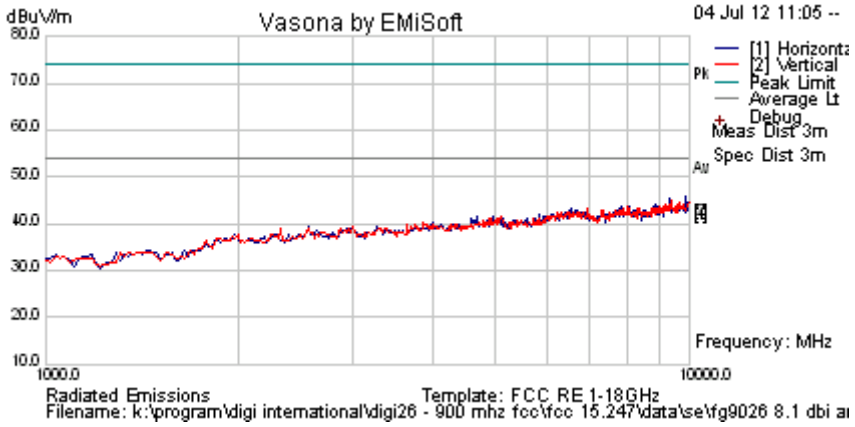


Radiated Emission Measurement Setup – Below 1 GHz



Omni Receiver Spurious Emissions

Test Freq.	915 MHz	**Engineer**	JMH
Variant	10 kbps	**Temp (ºC)**	26
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	30
Power Setting		**Press. (mBars)**	1000
Antenna	Monopole 8.1 dBi	**Duty Cycle (%)**	100
Test Notes 1			
Test Notes 2			



Formally measured emission peaks

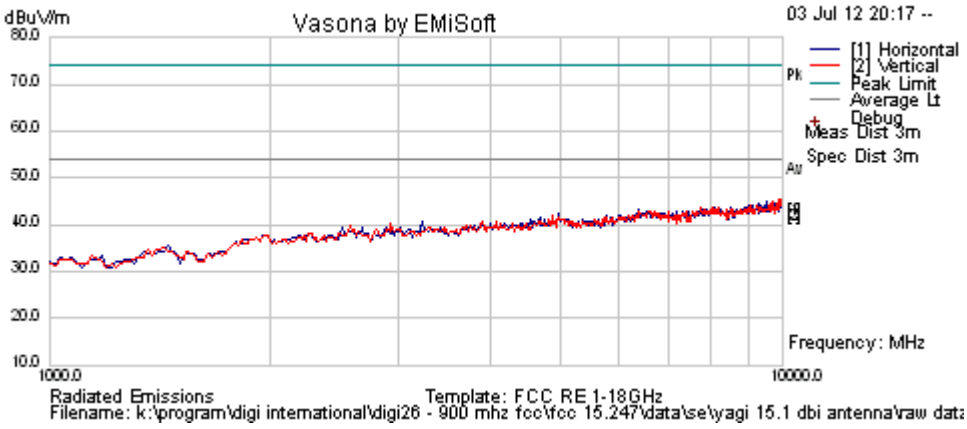
Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak

No emissions found within 6 dB of the limit

Yagi Receiver Spurious Emissions

Test Freq.	902 MHz	**Engineer**	JMH
Variant	10 kbps	**Temp (ºC)**	26
Freq. Range	1000 MHz - 10000 MHz	**Rel. Hum.(%)**	31
Power Setting	RX Mode	**Press. (mBars)**	1000
Antenna	13 Element Welded Yagi 15.1 dBi	**Duty Cycle (%)**	100
Test Notes 1			
Test Notes 2			



Formally measured emission peaks

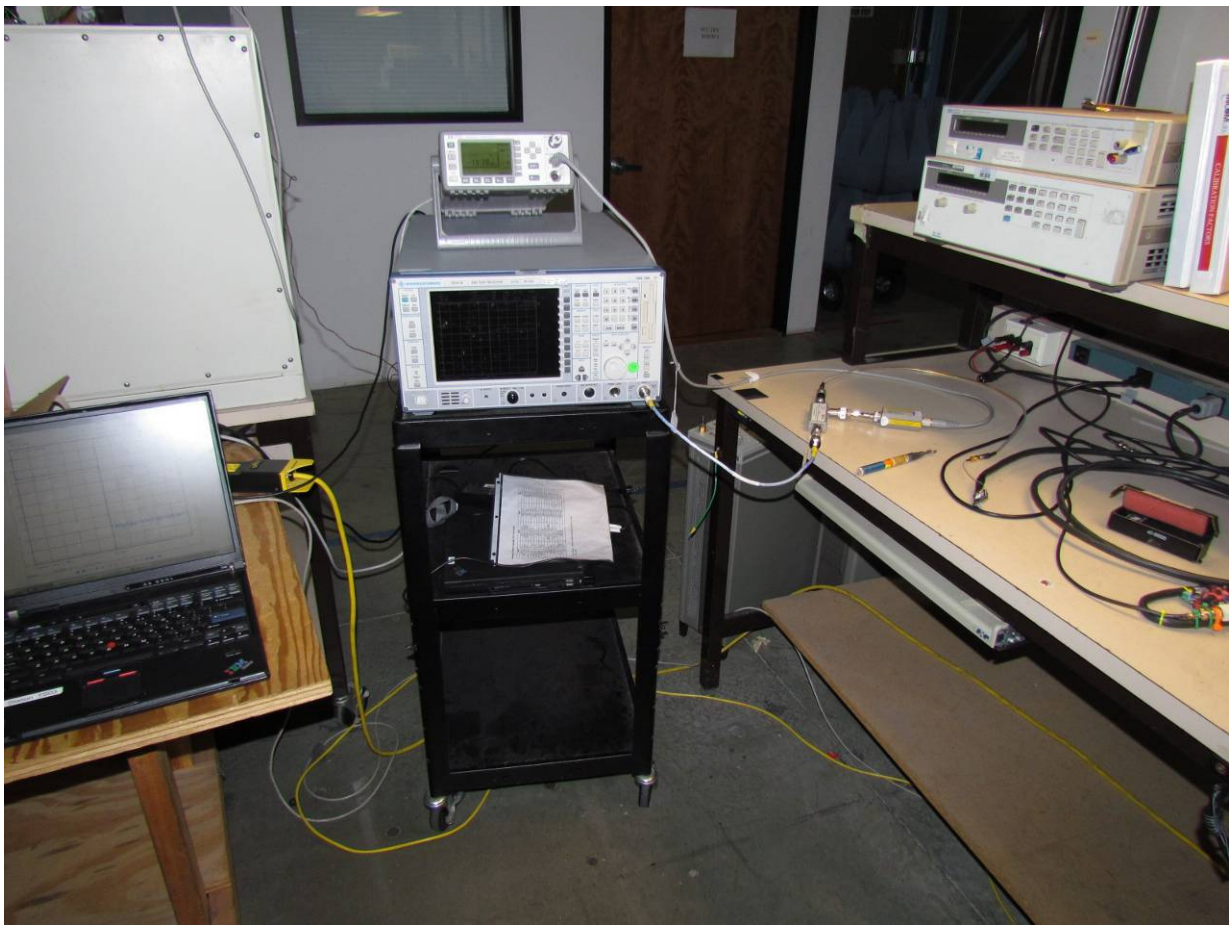
Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments

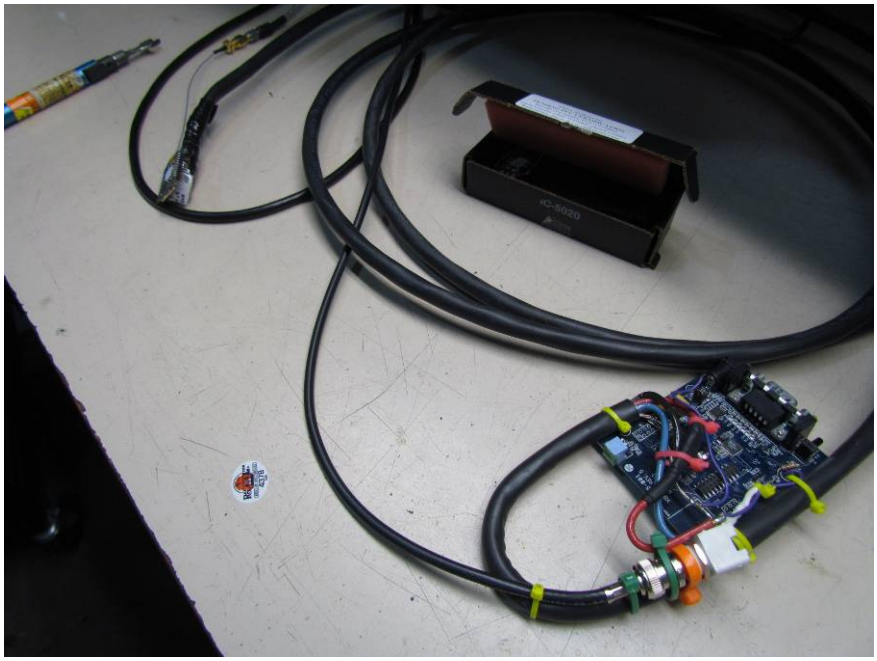
Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak

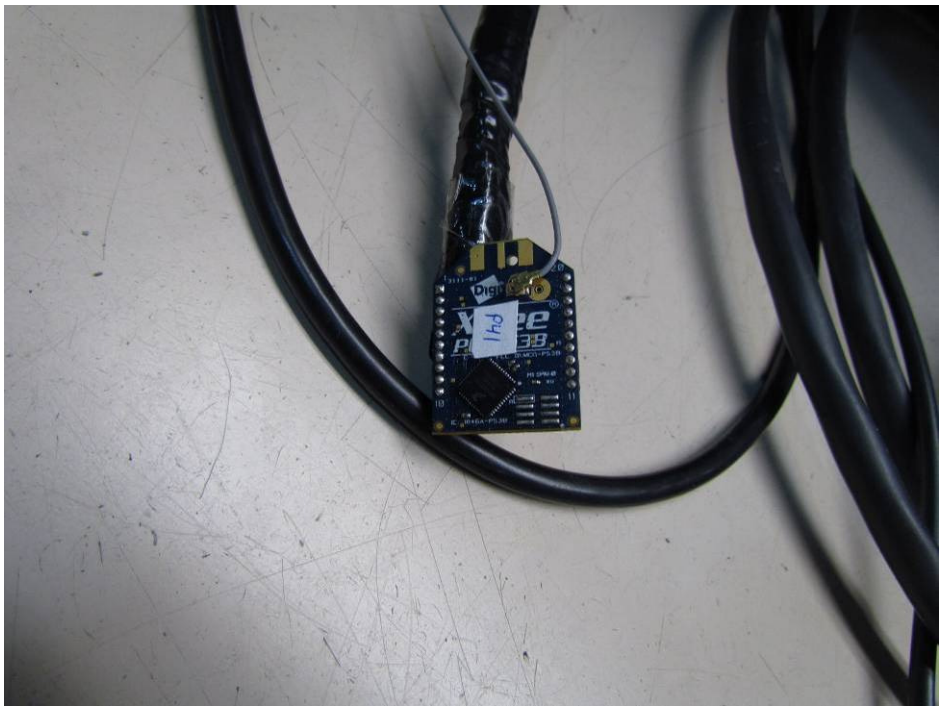
No emissions found within 6 dB of the limit

6. PHOTOGRAPHS

6.1. General Measurement Test Set-Up

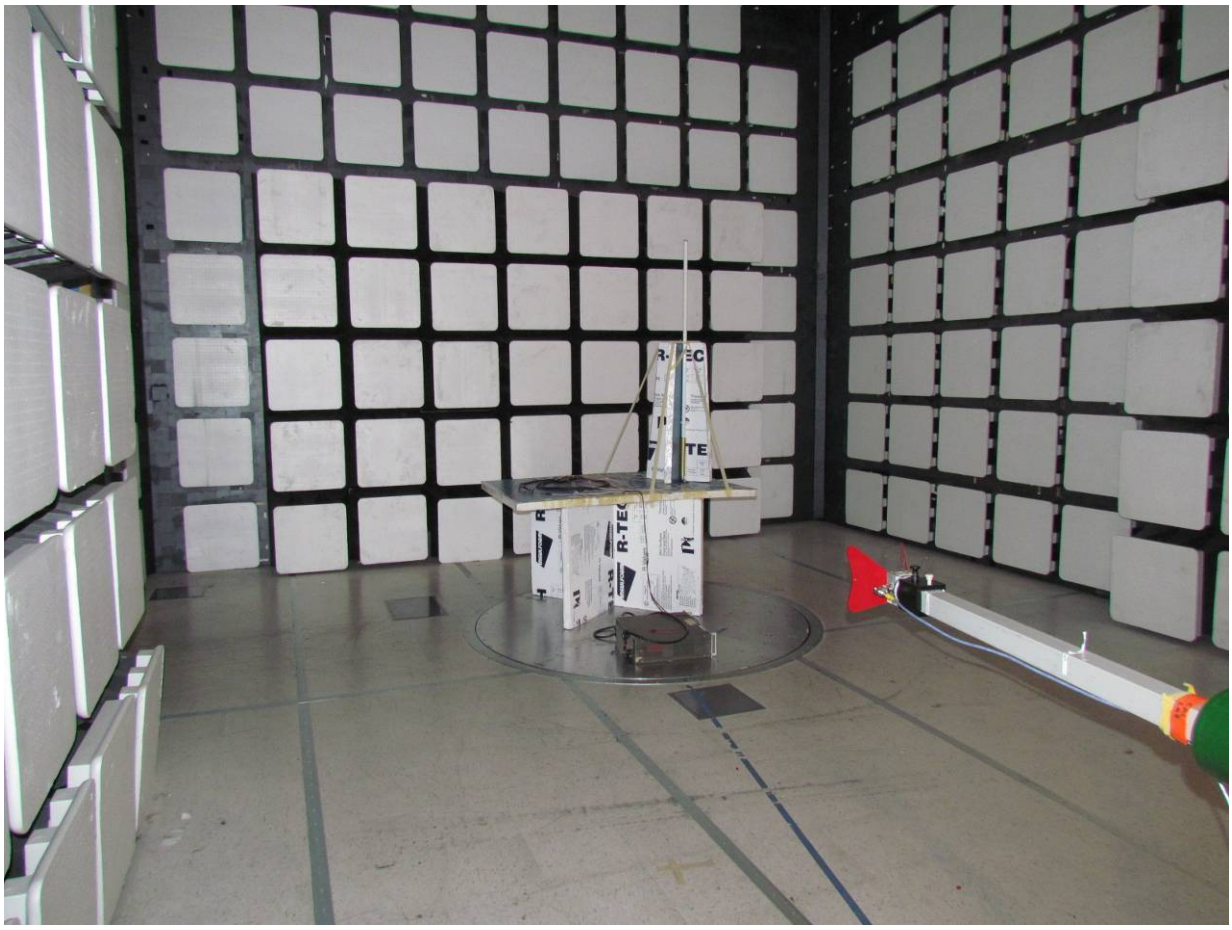






6.2. Radiated Emissions >1 GHz

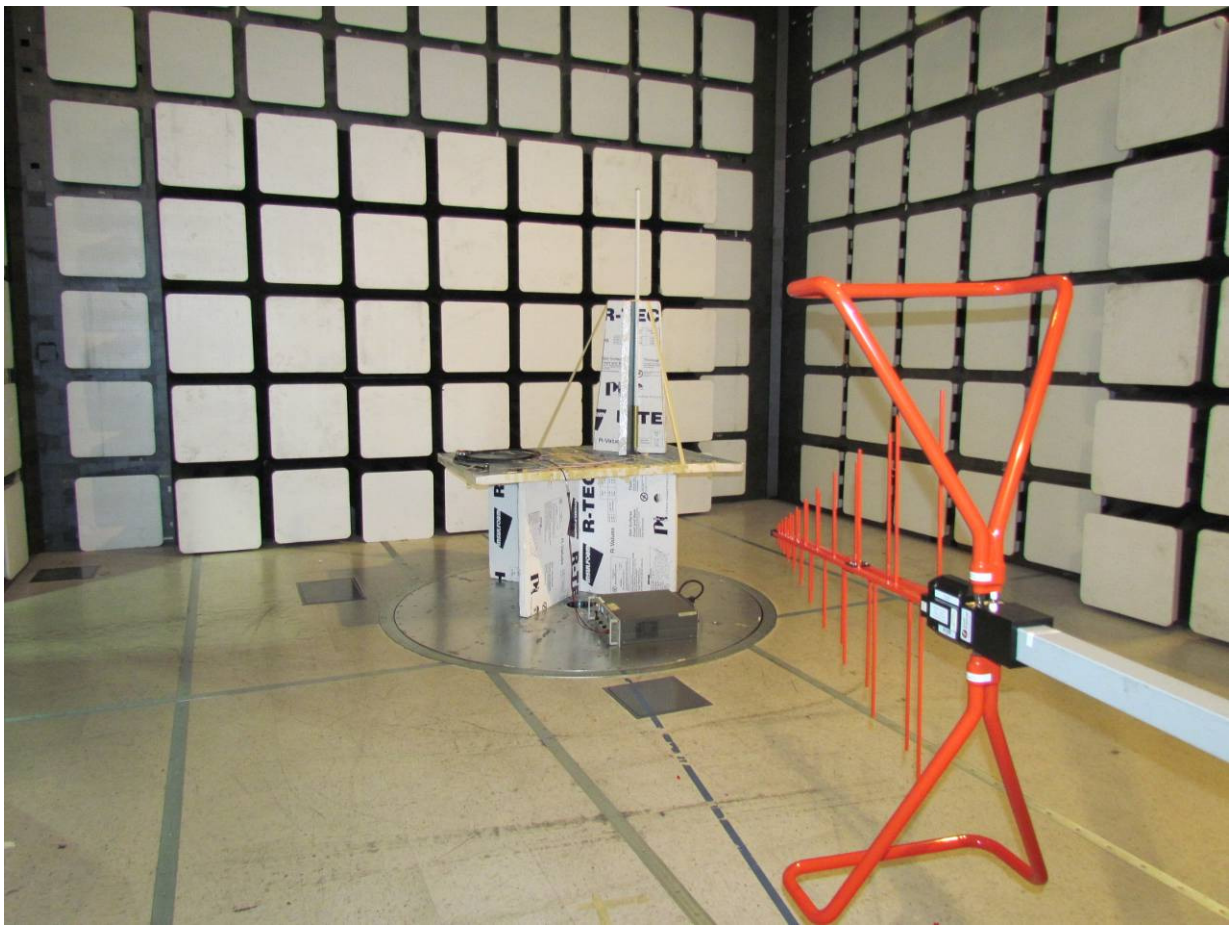
Omni Directional Antenna



Yagi Directional Antenna

6.3. Radiated Emissions <1 GHz

Omni Directional Antenna



Yagi Directional Antenna

7. TEST EQUIPMENT DETAILS

Asset #	Instrument	Manufacturer	Part #	Serial #	Calibration Due Date
0070	Power Meter	Hewlett Packard	437B	3125U11552	28th Nov 12
0117	Power Sensor	Hewlett Packard	8487D	3318A00371	15th Nov 12
0223	Power Meter	Hewlett Packard	EPM-442A	US37480256	15th Nov 12
0374	Power Sensor	Hewlett Packard	8485A	3318A19694	29th Nov 12
0158	Barometer /Thermometer	Control Co.	4196	E2846	8th Dec 12
0193	EMI Receiver	Rhode & Schwartz	ESI 7	838496/007	2nd Dec 12
0287	EMI Receiver	Rhode & Schwartz	ESIB40	100201	16th Nov 12
0338	30 - 3000 MHz Antenna	Sunol	JB3	A052907	8th Nov 12
0335	1-18 GHz Horn Antenna	EMCO	3117	00066580	7th Nov 12
0252	SMA Cable	Megaphase	Sucoflex 104	None	N/A
0293	BNC Cable	Megaphase	1689 1GVT4	15F50B001	N/A
0307	BNC Cable	Megaphase	1689 1GVT4	15F50B002	N/A
0310	2m SMA Cable	Micro-Coax	UFA210A-0-0787-3G03G0	209089-001	N/A
0312	3m SMA Cable	Micro-Coax	UFA210A-1-1181-3G0300	209092-001	N/A
0314	30dB N-Type Attenuator	ARRA	N9444-30	1623	N/A
	EMC Test Software	EMISoft	Vasona	5.0051	N/A

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