NVLAP Lab Code 200087-0

Application Submittal Report

For

FCC And Industry Canada Grant Of Certification

FOR

Model: LigoPTP 5-N MiMo PRO
5745-5825 MHz, 5755-5815 (40 MHz Mode)
MIMO Broadband Digital Transmission System
FCC ID: V2V-PTP5NMP
IC: 7607A-PTP5NMP

FOR

Ligowave LLC

138 Mountain Brook Dr
Canton, GA 30115

Test Report Number: 120222

Authorized Signatory: Scot D Rogers
Scot D. Rogers

NVLAP Lab Code 200087-0

ROGERS LABS, INC.

4405 West 259th Terrace
Louisburg, KS 66053
Phone / Fax (913) 837-3214

Engineering Test Report For Grant of Certification Application

FOR

CFR 47, PART 15C - Intentional Radiators
CFR 47 Paragraph 15.247 and Industry Canada RSS-210
License Exempt Intentional Radiator

For

Ligowave LLC

138 Mountain Brook Dr
Canton, GA 30115

Model: LigoPTP 5-N MiMo PRO

MiMo Broadband Digital Transmission System

Frequency Range 5745-5825 MHz, 5755-5815 (40 MHz Mode)
FCC ID#: V2V-PTP5NMP
IC: 7607A-PTP5NMP

Test Date: February 22, 2012

Certifying Engineer: Scot D Rogers

Scot D. Rogers
Rogers Labs, Inc.
4405 West 259th Terrace
Louisburg, KS 66053
Telephone/Facsimile: (913) 837-3214

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The following information is submitted for consideration in obtaining Grant of Certification for License Exempt Digital Transmission System Intentional Radiator operating under CFR 47 Paragraph 15.247, KDB 662911, and Industry Canada RSS-210.

Name of Applicant: Ligowave LLC
138 Mountain Brook Dr
Canton, GA 30115

Model: LigoPTP 5-N MiMo PRO

FCC I.D.: V2V-PTP5NMP FRN: 0016 81 8056 IC: 7607A-PTP5NMP
Frequency Range: 5745-5825 (802.11n), 5755-5815 MHz (802.11n, 40 MHz Channel)
Operating Power: 27.8 dBm, 0.5 Watts (single channel), 1.00 Watt MiMo, Occupied Bandwidth of 18,141 kHz (802.11n) or 37,179 kHz (40 MHz channel)

Applicable Standards & Test Procedures

In accordance with the Federal Communications Code of Federal Regulations, dated October 1, 2011, Part 2, Subpart J, Paragraphs 2.907, 2.911, 2.913, 2.925, 2.926, 2.1031 through 2.1057, and applicable parts of paragraph 15, Part 15C Paragraph 15.247, KDB 662911 MIMO and Industry Canada standard RSS-210 the following information is submitted.

Test procedures used are the established Methods of Measurement of Radio-Noise Emissions as described in the ANSI C63.4-2009 Document, FCC KDB 662911 MIMO, KDB 558074 DTS Measurement Guide, and/or RSS-210. Testing for the AC line-conducted emissions were performed as defined in sections 7 and 13.1.3, testing of the radiated emissions was performed as defined in sections 8 and 13.1.4 of ANSI C63.4-2009. Testing of the intentional radiated emissions was performed as defined in section 13 of ANSI C63.4-2009.

Environmental Conditions

Ambient Temperature	21.2° C
Relative Humidity	27%
Atmospheric Pressure	1002.7 mb

Opinion / Interpretation of Results

Tests Performed	Margin (dB)	Results
Emissions as per CFR 47, 15.205, RSS-210 (Restricted)	-1.5	Complies
Emissions as per CFR 47, 15.207, RSS-210 (AC Line)	-12.5	Complies
Emissions as per CFR 47, 15.209, RS-210 (Gen, Radiated)	-1.5	Complies
Emissions as per CFR 47, 15.247, RSS210 (Tx Harmonic)	-5.1	Complies

Test Site Locations

Conducted EMI — The AC power line conducted emissions testing performed in a shielded screen room located at Rogers Labs, Inc., 4405 W. 259th Terrace, Louisburg, KS

Radiated EMI — The radiated emissions tests were performed at the 3 meters, Open Area Test Site (OATS) located at Rogers Labs, Inc., 4405 W. 259th Terrace, Louisburg, KS

Site Registration — Refer to Annex for Site Registration Letters

NVLAP Accreditation — Lab code 200087-0

Units of Measurements

Conducted EMI — Data is in dBµV; dB referenced to one microvolt

Radiated EMI — Data is in dBµV/m; dB/m referenced to one microvolt per meter

Sample Calculation:

RFS = Radiated Field Strength, FSM = Field Strength Measured
A.F. = Receive antenna factor, Gain = amplification gains and/or cable losses
RFS (dBµV/m @ 3m) = FSM (dBµV) + A.F. (dB) - Gain (dB)

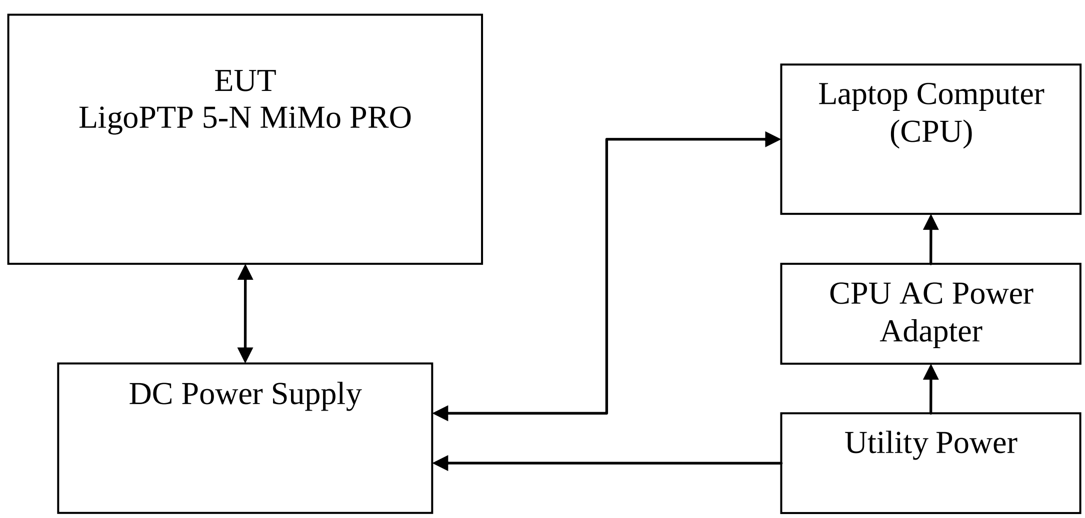
Equipment Tested

Equipment	Model	FCC I.D.
EUT	LigoPTP 5-N MiMo PRO	V2V-PTP5NMP
POE	FN-GPOE-C55	N/A
Dell Latitude Laptop	E6520	N/A

Equipment Function and Configuration

The EUT is a 5745-5825 MHz, 2x2 Multiple Input Multiple Output (MiMo), Digital Transmission System used to transmit data in applications offering broadband wireless connectivity. The equipment is marketed for use to incorporate a wireless link to exchange data information from one point to another. For testing purposes, the LigoPTP 5-N MiMo PRO transceiver was connected to the manufacturer supplied Power-Over-Ethernet (POE) interface and laptop computer allowing for power and operational control of the transmitter. The LigoPTP 5-N MiMo PRO receives power from authorized POE adapter only and offers no other provisions for interfacing. For testing purposes, the LigoPTP 5-N MiMo PRO was powered from the POE adapter and interfaced with the laptop computer for control. Testing was performed with the EUT set to transmit in available data modes. The design is marketed for professional installation and offers no provision for connection to alternate antenna systems. The design complies with the unique antenna connection requirements.

Equipment Configuration



Application for Certification

(1) Manufacturer: Ligowave LLC
138 Mountain Brook Dr
Canton, GA 30115

(2) Identification: Model: LigoPTP 5-N MiMo PRO

FCC I.D.: V2V-PTP5NMP IC: 7607A-PTP5NMP

(3) Instruction Book:

Refer to Exhibit for Instruction Manual.

(4) Description of Circuit Functions:

Refer to Exhibit of Operational Description.

(5) Block Diagram with Frequencies:

Refer to Exhibit of Operational Description.

(6) Report of Measurements:

Report of measurements follows in this Report.

(7) Photographs: Construction, Component Placement, etc.:

Refer to Exhibit for photographs of equipment.

(8) List of Peripheral Equipment Necessary for operation: Optional equipment available for the EUT includes Power Over Ethernet (POE) power adapter. The available configuration options were investigated for this and other reports in compliance to required standards with worst-case data presented.

(9) Transition Provisions of CFR47 15.37 are not requested.

(10) Not Applicable: The unit is not a scanning receiver.

(11) Not Applicable: The EUT does not operate in the 59 – 64 GHz frequency band.

(12) The equipment is not software defined and this section is not applicable.

Test Procedures

AC Line Conducted Emission Test Procedure

Testing for the AC line-conducted emissions was performed as defined in sections 7.2.4 and 13 of ANSI C63.4-2009. The test setup, including the EUT, was arranged in the test configurations as shown above and placed on a 1 x 1.5-meter wooden bench, 0.8 meters high located in a screen room. The power lines of the system were isolated from the power source using a standard LISN with a 50-µHy choke. EMI was coupled to the spectrum analyzer through a 0.1 µF capacitor internal to the LISN. The LISN was positioned on the floor beneath the wooden bench supporting the EUT. The power lines and cables were draped over the back edge of the table. Refer to photographs in exhibits for EUT placement used during testing.

Radiated Emission Test Procedure

The EUT was placed on a rotating 1 x 1.5-meter wooden platform, 0.8 meters above the ground plane at a distance of 3 meters from the FSM antenna. Testing for the radiated emissions was performed as defined in sections 8 and 13.1.4 of ANSI C63.4-2009. EMI energy was maximized by equipment placement, raising and lowering the FSM antenna, changing the antenna polarization, and by rotating the turntable. Each emission was maximized before data was taken using a spectrum analyzer. Refer to photographs in the test setup exhibits for EUT placement during testing.

List of Test Equipment

A Rohde and Schwarz ESU40 and/or Hewlett Packard 8591EM was used as the measuring device for the emissions testing of frequencies below 1 GHz. A Rohde and Schwarz ESU40 and/or Hewlett Packard 8562A Spectrum Analyzer was used as the measuring device for testing the emissions at frequencies above 1 GHz. The analyzer settings used are described in the following table. Refer to the appendix for a complete list of test equipment.

AC Line Conducted Emissions (0.150 -30 MHz)		
RBW	AVG. BW	Detector Function
9 kHz	30 kHz	Peak / Quasi Peak
Emissions (30-1000 MHz)		
RBW	AVG. BW	Detector Function
120 kHz	300 kHz	Peak / Quasi Peak
Emissions (Above 1000 MHz)		
RBW	Video BW	Detector Function
100 kHz	100 kHz	Peak
1 MHz	1 MHz	Peak / Average

Equipment	Manufacturer	Model	Calibration Date	Due
LISN	Comp. Design	FCC-LISN-2-MOD.CD	10/11	10/12
Antenna	ARA	BCD-235-B	10/11	10/12
Antenna	EMCO	3147	10/11	10/12
Antenna	EMCO	3143	5/11	5/12
Analyzer	HP	8591EM	5/11	5/12
Analyzer	HP	8562A	5/11	5/12
Analyzer	Rohde & Schwarz	ESU40	5/11	5/12

Intentional Radiators

As per CFR47, Subpart C, paragraph 15.247, KDB 662911 MIMO, and RSS-210 Issue 8 the following information is submitted.

Antenna Requirements

The EUT utilizes type N antenna connector port for use with authorized antenna systems. The design is marketed for professional installation and use in point-to-point applications as described in accompanying documentation. The antenna connection point complies with the unique antenna connection requirements. The requirements of 15.203 are fulfilled; there are no deviations or exceptions to the specification.

Restricted Bands of Operation

Spurious emissions falling in the restricted frequency bands of operation were measured at a distance of three meters on the OATS. The EUT utilizes frequency, determining circuitry, which generates harmonics falling in the restricted bands. Emissions were measured at the OATS, using appropriate antennas or pyramidal horns, amplification stages, and a spectrum analyzer. No other significant emission was observed which fell into the restricted bands of operation.

Radiated Emissions in Restricted Bands Data

Frequency in MHz	Horizontal Peak (dBµV/m)	Horizontal Quasi-Peak (dBµV/m)	Horizontal Average (dBµV/m)	Vertical Peak (dBµV/m)	Vertical Quasi-Peak (dBµV/m)	Vertical Average (dBµV/m)	Limit @ 3m (dBµV/m)
135.9	41.7	34.5	N/A	32.8	27.0	N/A	43.5
137.0	41.0	34.9	N/A	33.6	27.7	N/A	43.5
160.9	35.2	28.1	N/A	34.1	29.2	N/A	43.5
250.0	47.6	42.9	N/A	47.8	44.5	N/A	46.0
11490.0	56.7	N/A	44.2	55.9	N/A	43.9	54.0
11570.0	57.5	N/A	44.8	58.5	N/A	45.1	54.0
11650.0	58.1	N/A	45.4	59.8	N/A	44.9	54.0
22980.0	37.9	N/A	33.4	35.8	N/A	33.5	54.0

Other emissions present had amplitudes at least 20 dB below the limit.
Quasi-Peak amplitude emissions are recorded above for frequency range of 30-1000 MHz.
Average amplitude emissions are recorded above for frequency range above 1000 MHz.

Summary of Results for Radiated Emissions in Restricted Bands

The EUT demonstrated compliance with the radiated emissions requirements of CFR 47 Part 15C Intentional Radiators. The EUT demonstrated a minimum margin of -1.5 dB below the radiated emissions requirements in restricted frequency bands. Peak, Quasi-peak, and average amplitudes were checked for compliance with the regulations. Worst-case emissions are reported with other emissions found in the restricted frequency bands at least 20 dB below the requirements.

AC Line Conducted Emissions Procedure

The EUT was arranged in the testing configuration, emulating a typical configuration, and placed on a 1 x 1.5-meter wooden bench 80 cm above the conducting ground plane, floor of a screen room. The bench was positioned 40 cm away from the wall of the screen room. The Power Over Ethernet for the EUT was connected to the LISN for AC line conducted emissions testing. A second LISN was positioned on the floor of the screen room 80-cm from the rear of the supporting equipment of the EUT. All power cords except the EUT were then powered from the second LISN. EMI was coupled to the spectrum analyzer through a 0.1 μF capacitor, internal to the LISN. Power line conducted emissions testing were carried out individually for each current carrying conductor of the EUT. The excess length of lead between the system and the LISN receptacle was folded back and forth to form a bundle not exceeding 40 cm in length. The screen room, conducting ground plane, analyzer, and LISN were bonded together to the protective earth ground. Preliminary testing was performed to identify the frequency of each radio frequency emission displaying the highest amplitude. The cables were repositioned to obtain maximum amplitude of measured EMI level. Once the worst-case configuration was identified, plots were made of the EMI from 0.15 MHz to 30 MHz then the data was recorded with maximum conducted emissions levels. Refer to figures one and two for plots of the EUT powered by POE, AC Power Line conducted emissions.

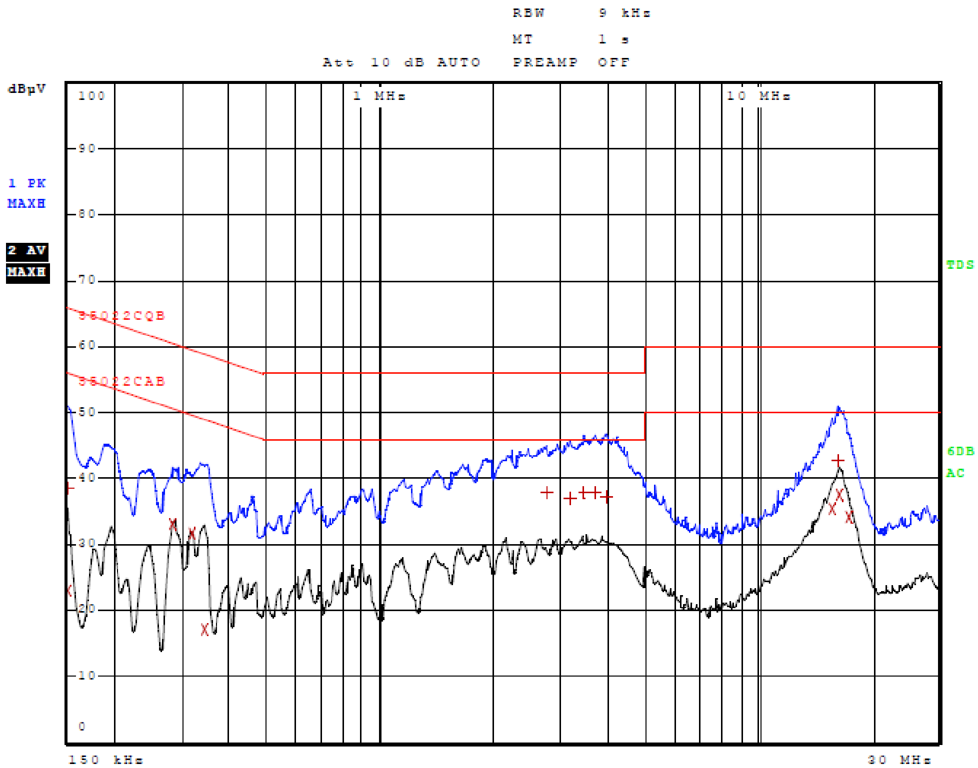


Figure 1 AC Line Conducted Emissions Line 1

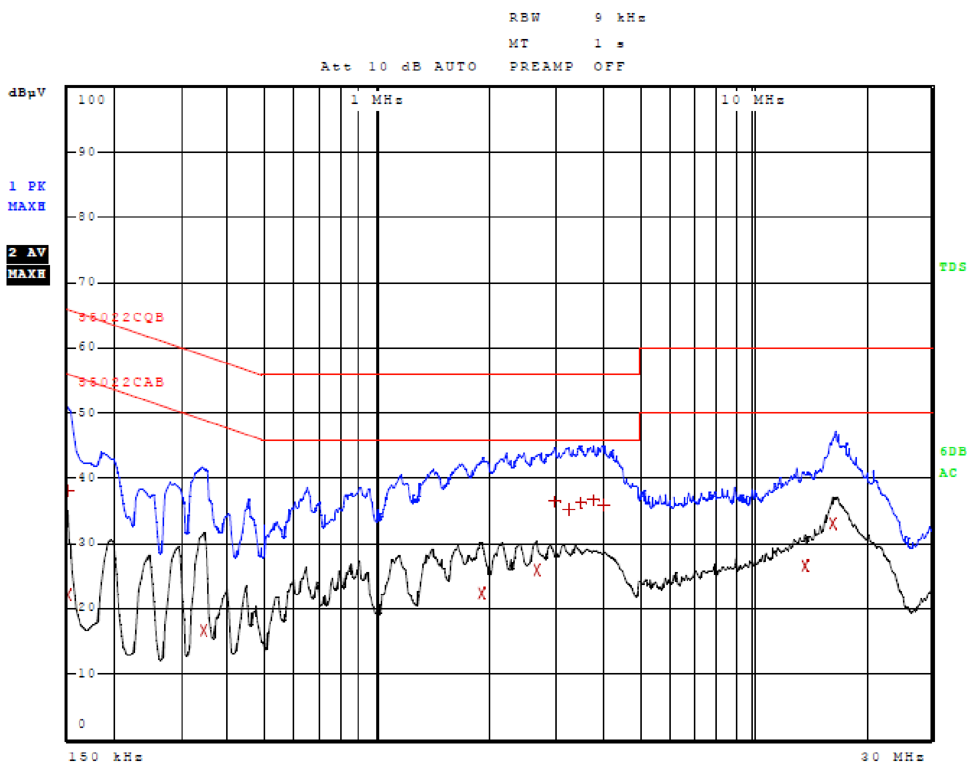


Figure 2 AC Line Conducted Emissions Line 2

AC Line Conducted Emissions Data (Highest Emissions)

Line 1

Trace	Frequency	Level (dBµV)	Detector	Delta Limit/dB
1	150.000000000 kHz	38.52	Quasi Peak	-27.48
2	150.000000000 kHz	23.02	Average	-32.98
2	286.000000000 kHz	33.18	Average	-17.46
2	318.000000000 kHz	31.69	Average	-18.07
2	342.000000000 kHz	17.06	Average	-32.09
1	2.746000000 MHz	37.88	Quasi Peak	-18.12
1	3.194000000 MHz	37.07	Quasi Peak	-18.93
1	3.478000000 MHz	37.91	Quasi Peak	-18.09
1	3.702000000 MHz	37.82	Quasi Peak	-18.18
1	3.970000000 MHz	37.32	Quasi Peak	-18.68
2	15.780000000 MHz	35.40	Average	-14.60
1	16.216000000 MHz	42.85	Quasi Peak	-17.15
2	16.352000000 MHz	37.42	Average	-12.58
2	17.408000000 MHz	34.21	Average	-15.79

Line 2

Trace	Frequency	Level (dBµV)	Detector	Delta Limit/dB
1	150.000000000 kHz	38.18	Quasi Peak	-27.82
2	150.000000000 kHz	22.12	Average	-33.88
2	342.000000000 kHz	16.61	Average	-32.55
2	1.890000000 MHz	22.29	Average	-23.71
2	2.658000000 MHz	25.96	Average	-20.04
1	2.974000000 MHz	36.37	Quasi Peak	-19.63
1	3.234000000 MHz	35.13	Quasi Peak	-20.87
1	3.502000000 MHz	36.27	Quasi Peak	-19.73
1	3.762000000 MHz	36.65	Quasi Peak	-19.35
1	4.006000000 MHz	35.86	Quasi Peak	-20.14
2	13.900000000 MHz	26.55	Average	-23.45
2	16.388000000 MHz	33.09	Average	-16.91

Other emissions present had amplitudes at least 20 dB below the limit.

Summary of Results for AC Line Conducted Emissions

The EUT demonstrated compliance to the conducted emissions requirements of CFR47 Part 15C and RSS-GEN. The EUT demonstrated minimum margin of -12.5 dB below the limit. Measurements were taken using the peak, quasi peak, and average, measurement function for each emissions amplitude and were below the limits stated in the specification. Other emissions were present with recorded data representing worst-case amplitudes.

General Radiated Emissions Procedure

The EUT was arranged in the testing configuration emulating typical equipment configuration and operated through available modes with worst-case data recorded. Preliminary testing was performed in a screen room with the EUT positioned 1 meter from the FSM. Radiated emissions investigation measurements were performed to identify frequencies, which produced the highest emissions. The frequency spectrum from 9 kHz to 60,000 MHz was searched for general radiated emissions during investigation. Final radiated emissions data was taken with the EUT located at the OATS at a distance of 3 meters between the EUT and the receiving antenna. Each radiated emission was then maximized at the OATS location before final radiated emissions measurements were performed. Measured emission levels were maximized by EUT placement on the table, rotating the turntable through 360 degrees, varying the antenna height between 1 and 4 meters above the ground plane and changing antenna position between horizontal and vertical polarization. Antennas used were Broadband Biconical from 30 to 200 MHz, Biconilog from 30 to 1000 MHz, Log Periodic from 200 MHz to 1 GHz and or Double Ridge Horn or Pyramidal Horns and mixers from 1 GHz to 60 GHz, notch filters, and appropriate amplifiers and external mixers were utilized.

General Radiated Emissions from EUT Data (Worst-case General Emissions)

Frequency in MHz	Horizontal Peak (dBµV/m)	Horizontal Quasi-Peak (dBµV/m)	Horizontal Average (dBµV/m)	Vertical Peak (dBµV/m)	Vertical Quasi-Peak (dBµV/m)	Vertical Average (dBµV/m)	Limit @ 3m (dBµV/m)
135.9	41.7	34.5	N/A	32.8	27.0	N/A	43.5
137.0	41.0	34.9	N/A	33.6	27.7	N/A	43.5
144.4	41.1	35.7	N/A	30.8	24.0	N/A	43.5
160.9	35.2	28.1	N/A	34.1	29.2	N/A	43.5
174.2	39.2	32.5	N/A	36.4	31.5	N/A	43.5
175.0	38.7	32.6	N/A	37.3	31.3	N/A	43.5
178.6	36.0	30.0	N/A	35.5	29.4	N/A	43.5
181.0	35.9	29.7	N/A	33.0	27.9	N/A	43.5
181.4	34.9	29.7	N/A	33.4	27.8	N/A	43.5
182.0	35.6	29.9	N/A	34.5	27.6	N/A	43.5
205.2	39.8	33.8	N/A	36.1	31.2	N/A	43.5
210.6	41.0	35.9	N/A	35.4	30.5	N/A	43.5
219.1	42.1	36.8	N/A	34.7	29.9	N/A	43.5
250.0	47.6	42.9	N/A	47.8	44.5	N/A	46.0
265.9	43.4	27.6	N/A	32.6	24.2	N/A	46.0

Other emissions present had amplitudes at least 20 dB below the limit.
Quasi-Peak amplitude emissions are recorded above for frequency range of 30-1000 MHz.
Average amplitude emissions are recorded above for frequency range above 1000 MHz.

Summary of Results for General Radiated Emissions

The EUT demonstrated compliance with the radiated emissions requirements of CFR47 Part 15C paragraph 15.209 Intentional Radiators. The EUT demonstrated a minimum margin of -1.5 dB below the requirements. Other emissions were present with amplitudes at least 20 dB below the Limits.

Operation in the Frequency Band of 5725 – 5850 MHz

The power output and emissions were measured at the antenna port in compliance with regulation. EUT radiated emissions were also measured on the open area test site at a three-meter distance. The EUT and test configurations were placed on a wooden turntable 0.8 meters above the ground plane at a distance of 3 meters from the FSM antenna. The peak and quasi-peak amplitude of the frequencies below 1000 MHz were measured using a spectrum analyzer. The peak and average amplitude of emissions above 1000 MHz including were measured using a spectrum analyzer. Data was recorded from the analyzer measurement result. Plots were made of transmitter antenna port conducted performance taken in a screen room. Refer to figures three through sixty-two showing plots of the EUT emissions performance displaying compliance with the specifications. Emissions testing was performed on each chain of the EUT at the antenna ports.

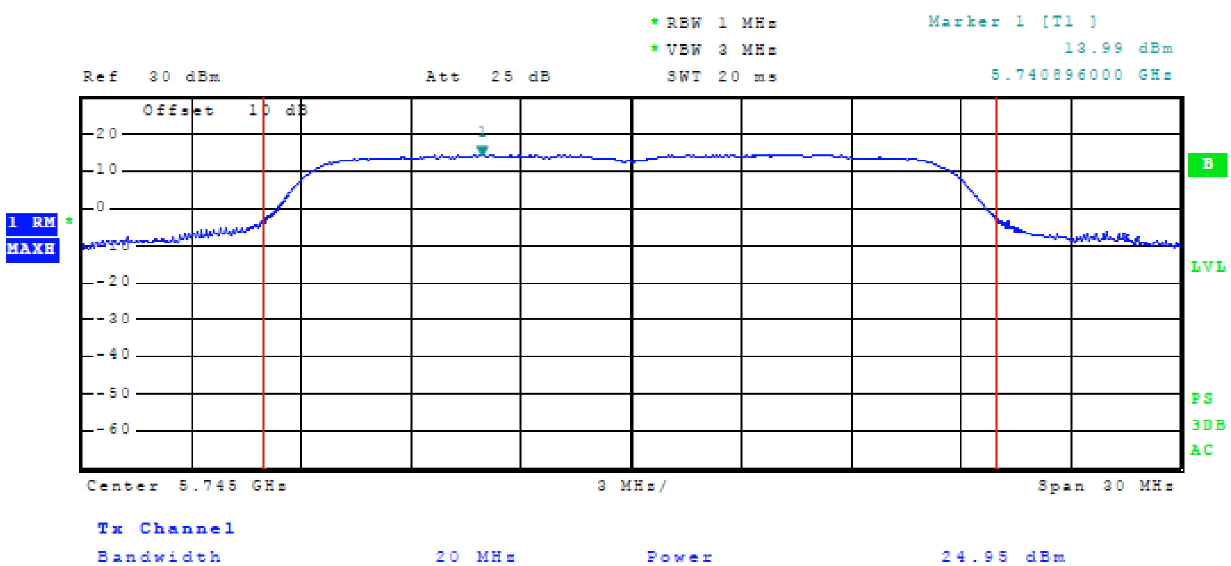


Figure 3 Plot of Antenna Port Conducted (Power, 5745 MHz, Chain 0, 20 MHz Mode)

NVLAP Lab Code 200087-0

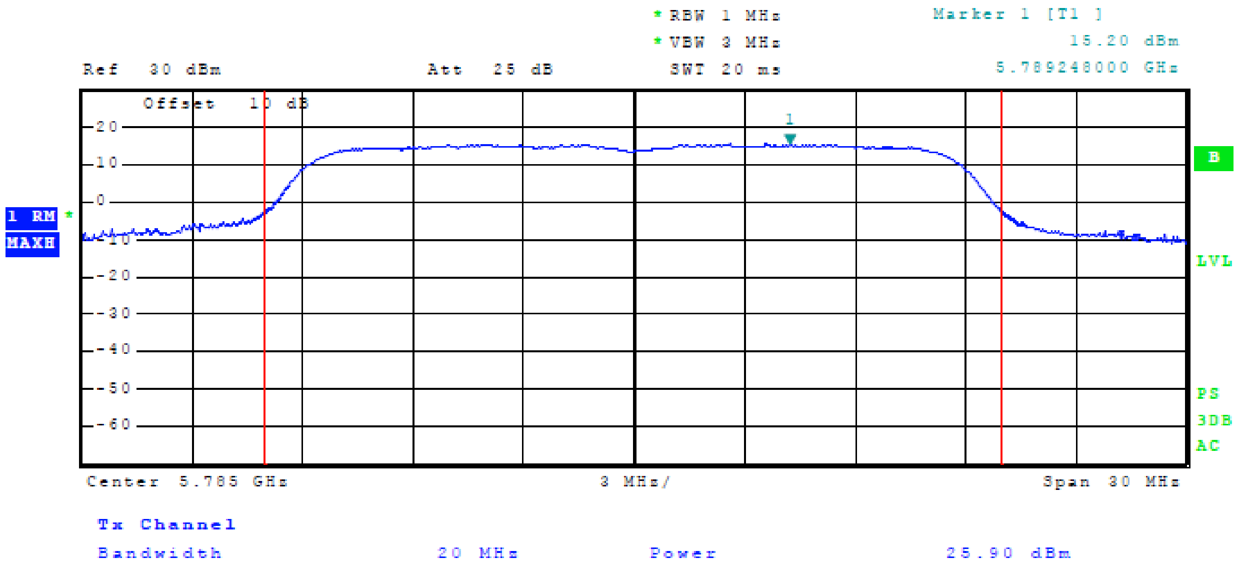


Figure 4 Plot of Antenna Port Conducted (Power, 5785 MHz, Chain 0, 20 MHz Mode)

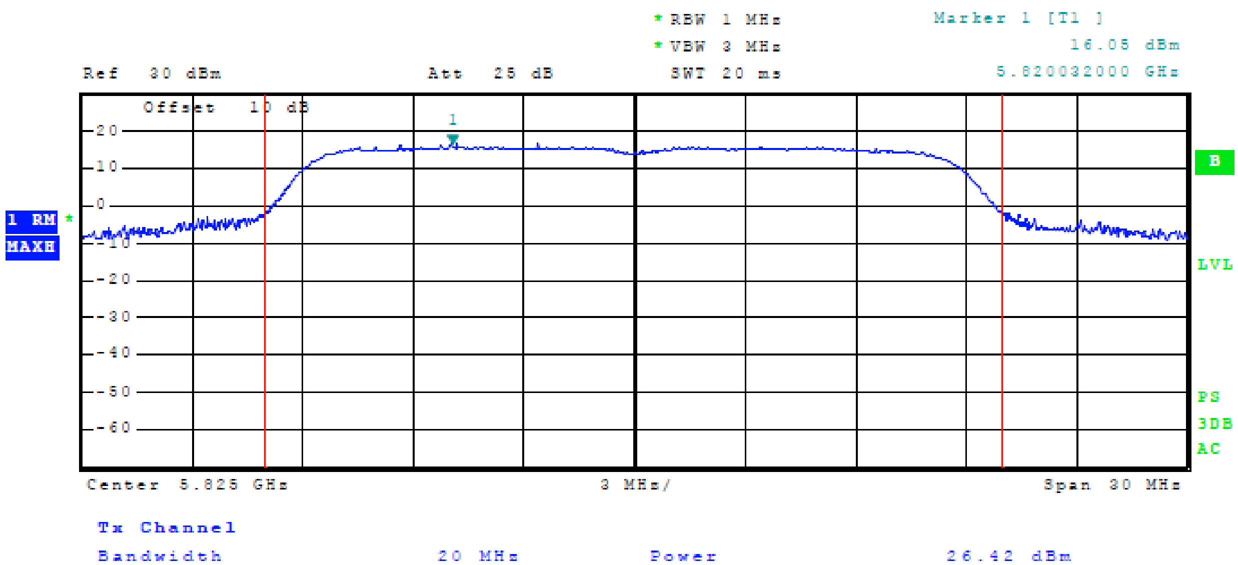


Figure 5 Plot of Antenna Port Conducted (Power, 5825 MHz, Chain 0, 20 MHz Mode)

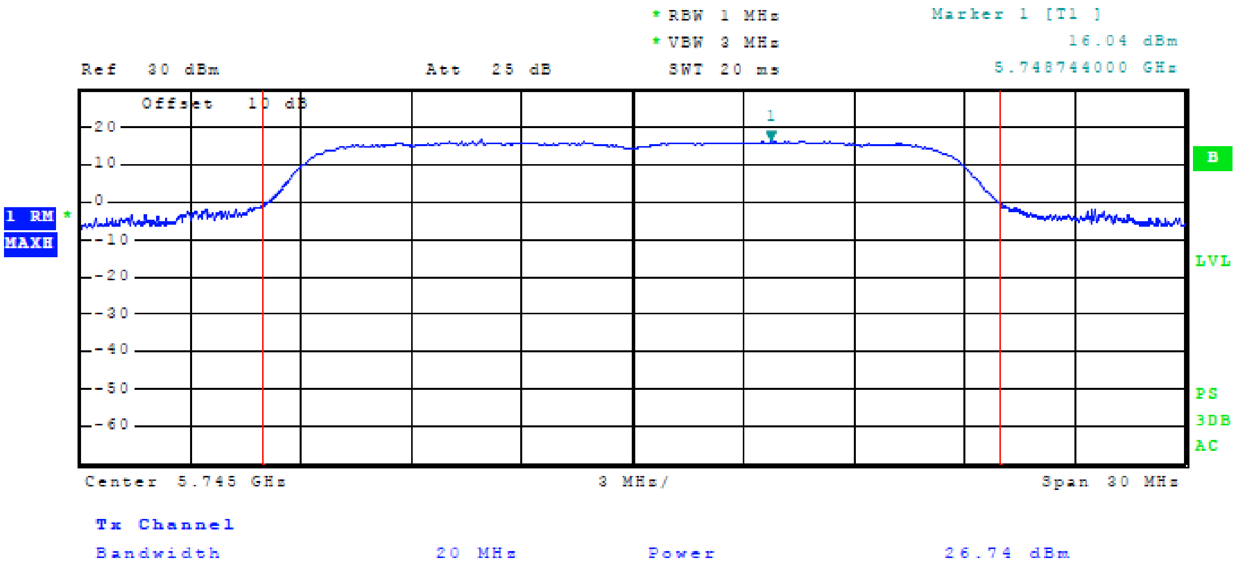


Figure 6 Plot of Antenna Port Conducted (Power, 5745 MHz, Chain 1, 20 MHz Mode)

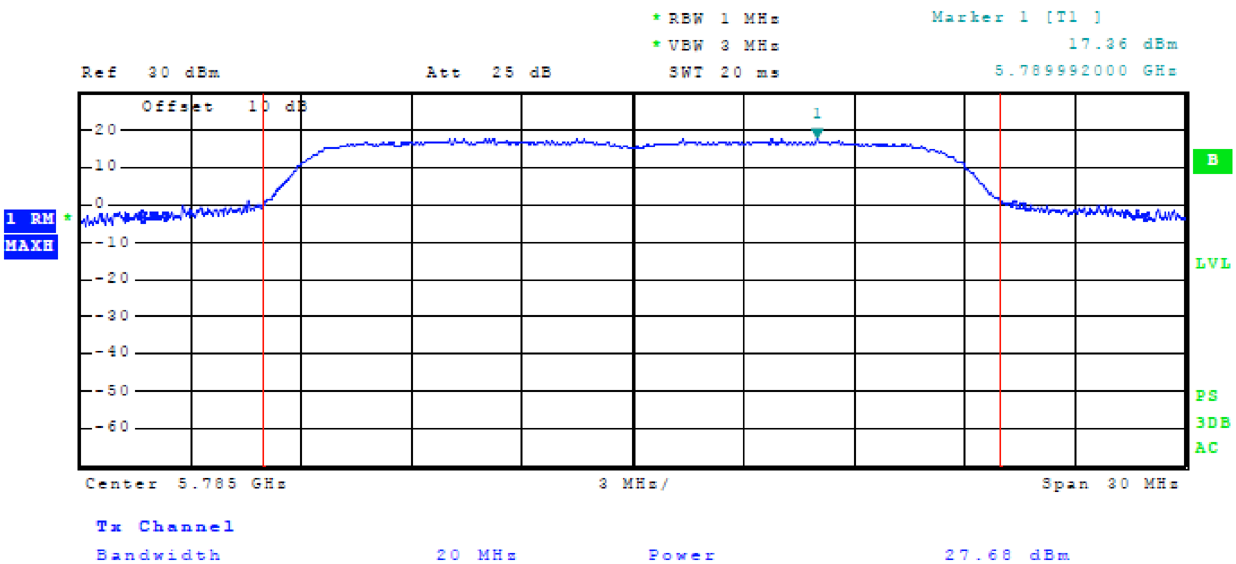


Figure 7 Plot of Antenna Port Conducted (Power, 5785 MHz, Chain 1, 20 MHz Mode)

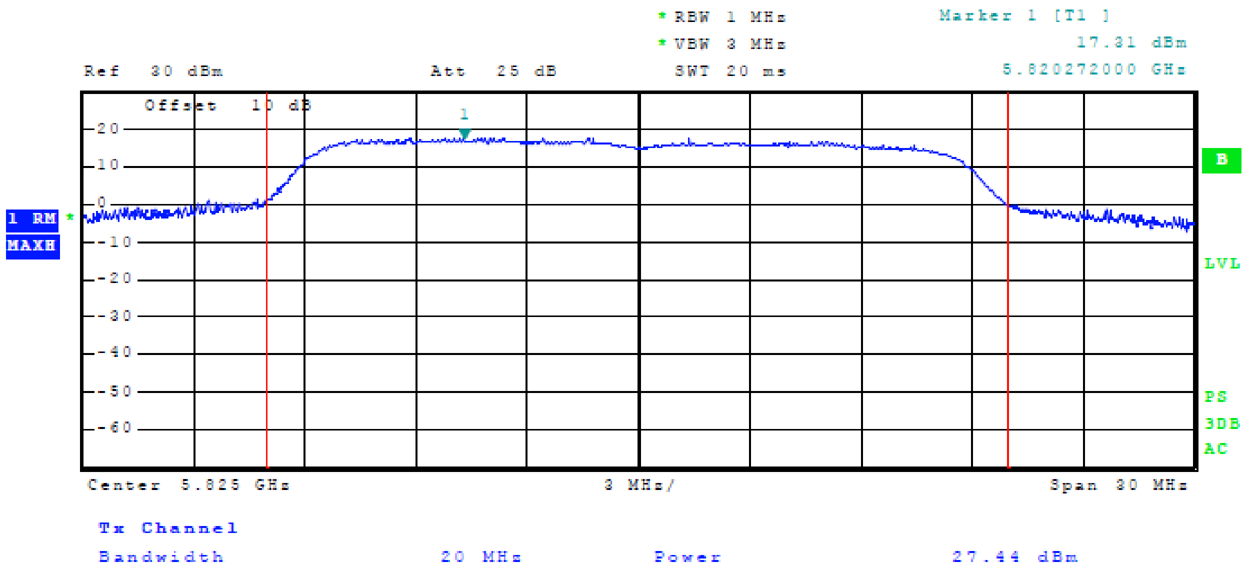


Figure 8 Plot of Antenna Port Conducted (Power, 5825 MHz, Chain 1, 20 MHz Mode)

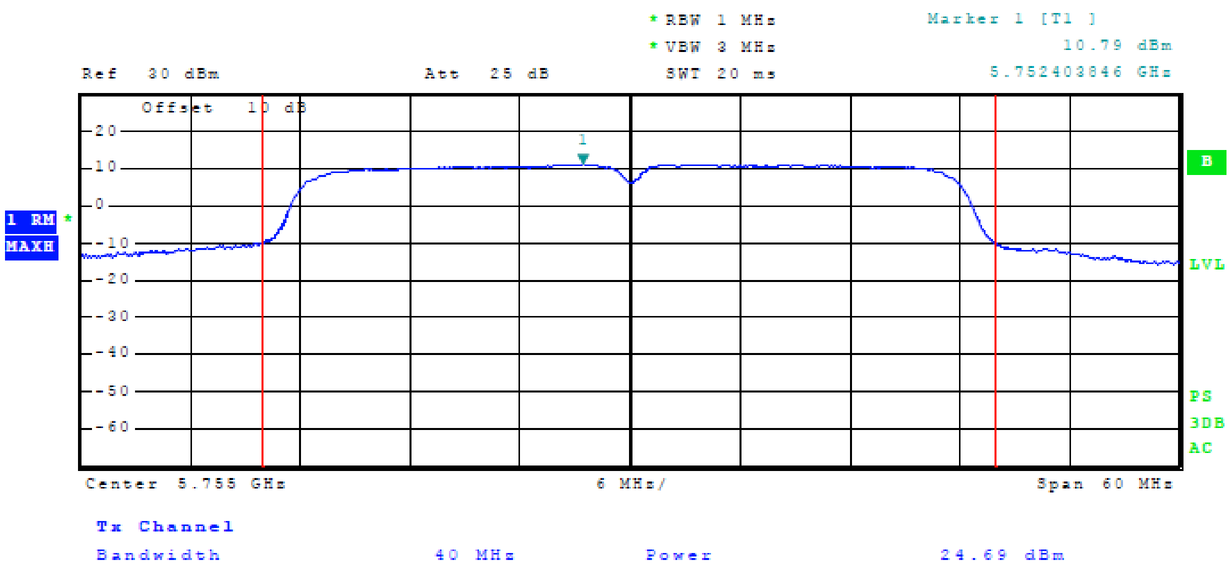


Figure 9 Plot of Antenna Port Conducted (Power, 5755 MHz, Chain 0, 40 MHz Mode)

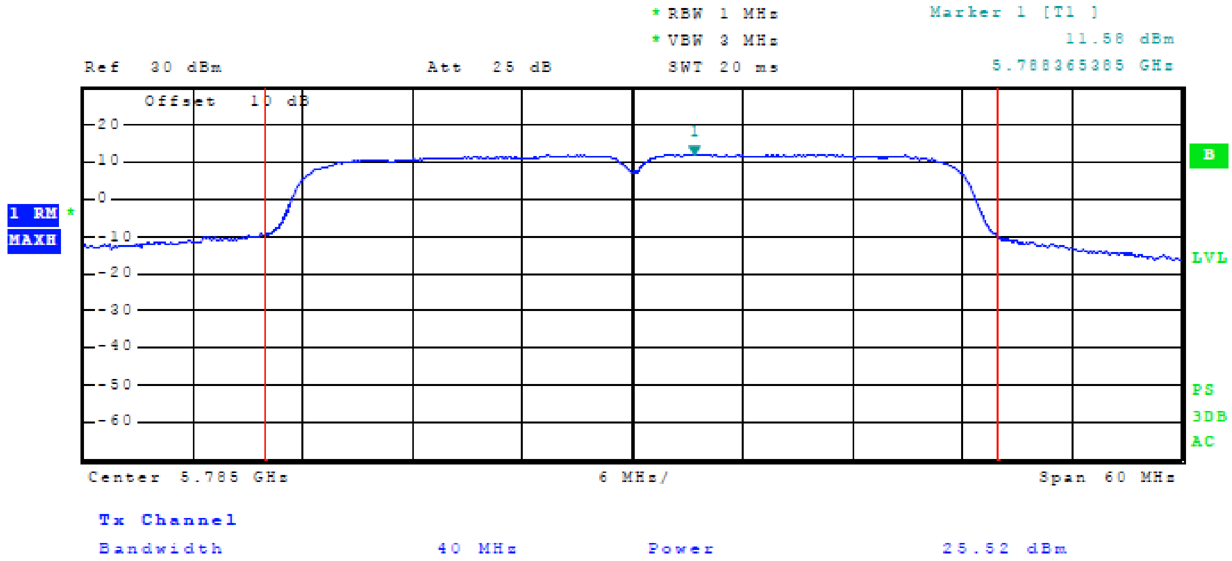


Figure 10 Plot of Antenna Port Conducted (Power, 5785 MHz, Chain 0, 40 MHz Mode)

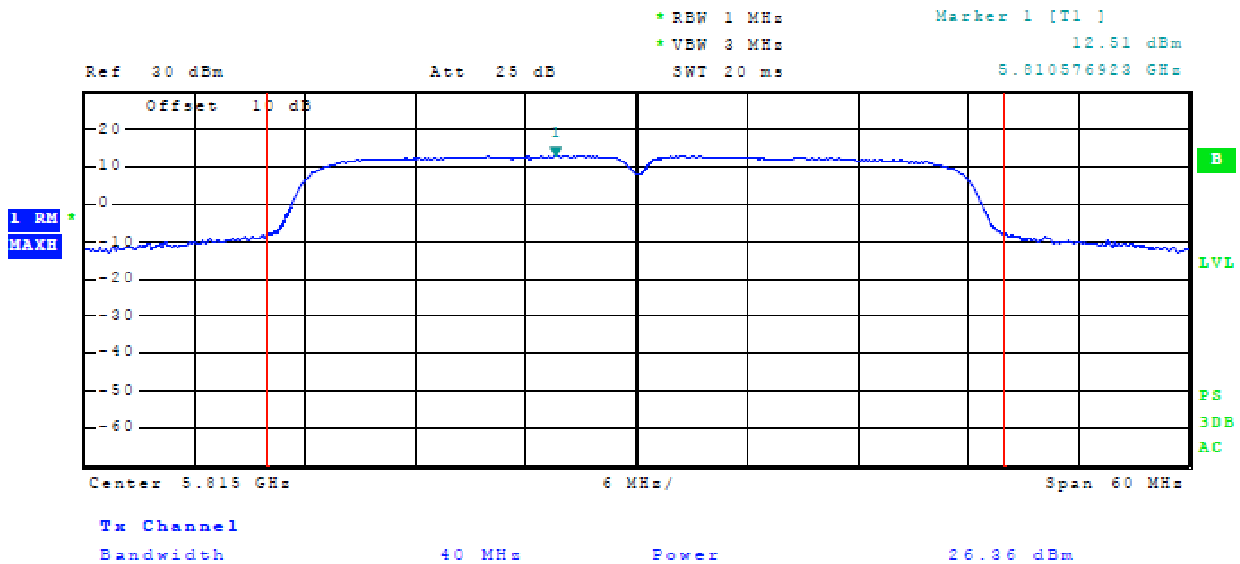


Figure 11 Plot of Antenna Port Conducted (Power, 5815 MHz, Chain 0, 40 MHz Mode)

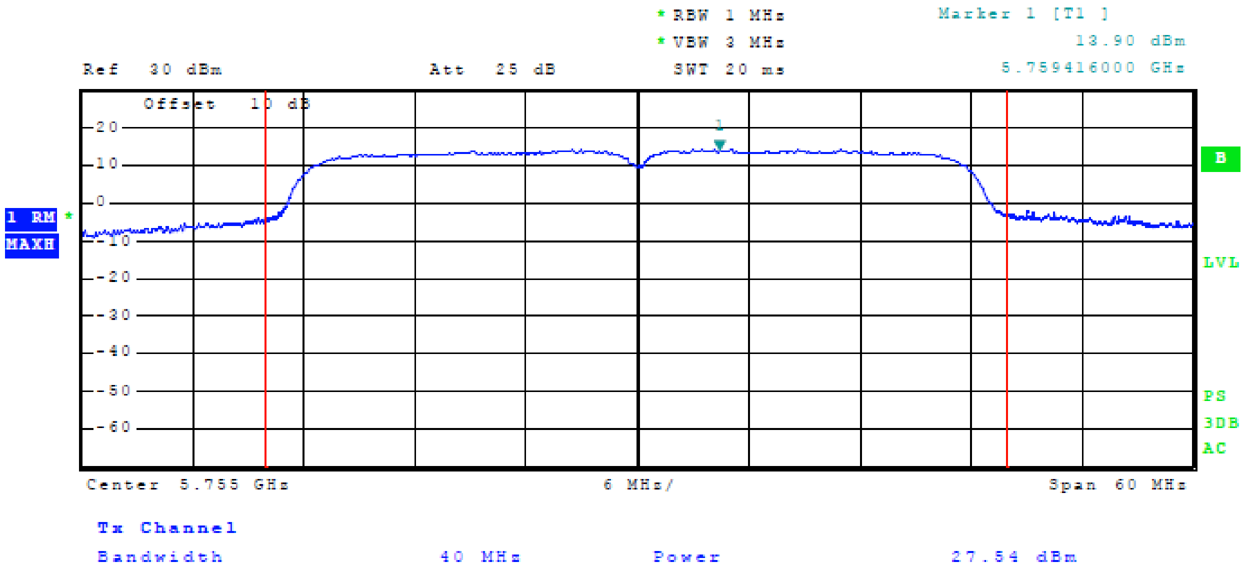


Figure 12 Plot of Antenna Port Conducted (Power, 5755 MHz, Chain 1, 40 MHz Mode)

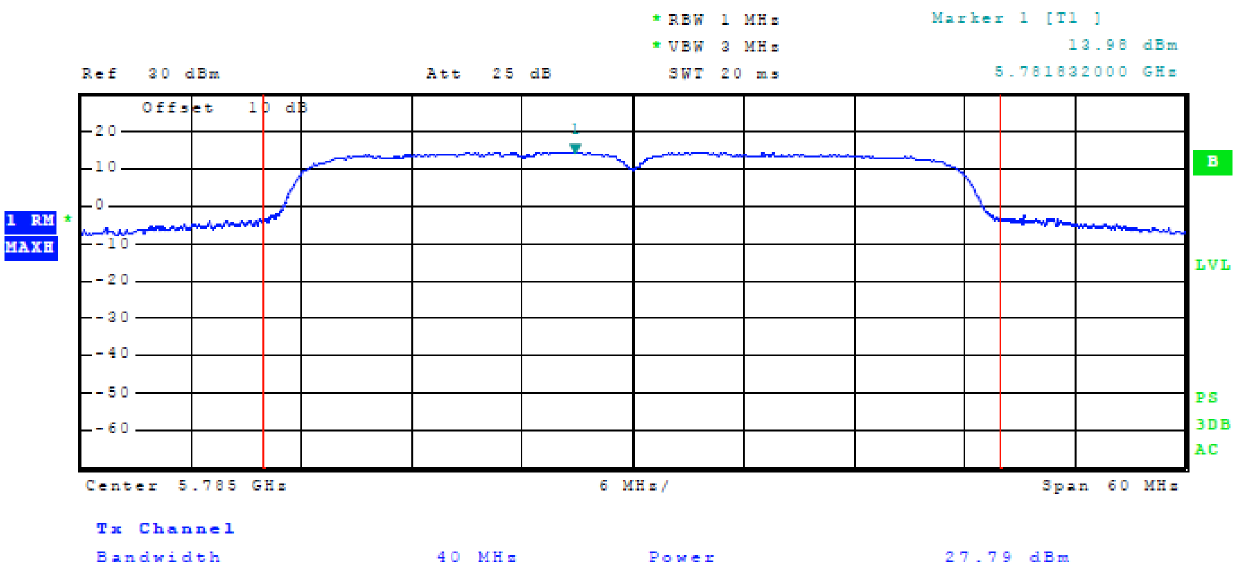


Figure 13 Plot of Antenna Port Conducted (Power, 5785 MHz, Chain 1, 40 MHz Mode)

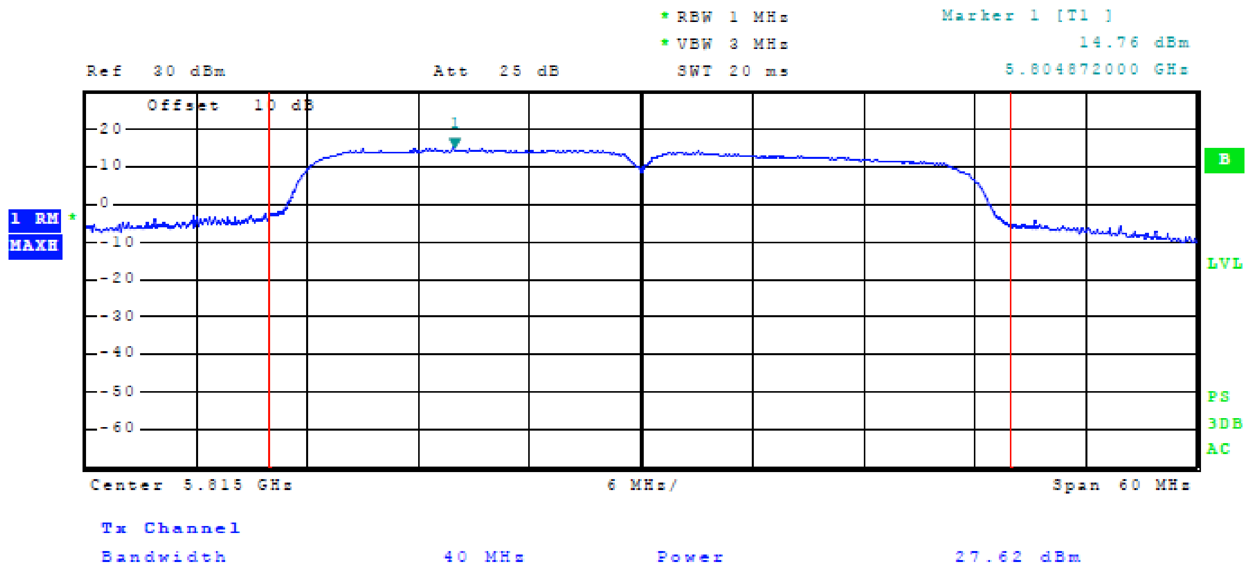


Figure 14 Plot of Antenna Port Conducted (Power, 5815 MHz, Chain 1, 40 MHz Mode)

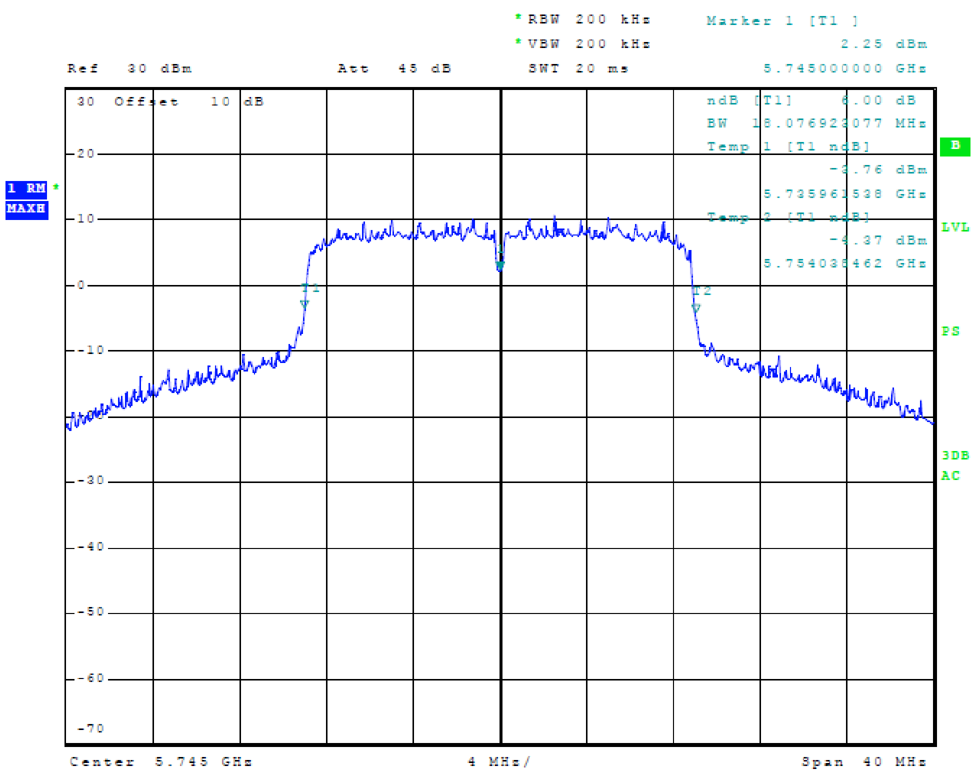


Figure 15 Plot of Antenna Port Conducted 6dB Band width (5745 MHz, Chain 0, 20 MHz Mode)

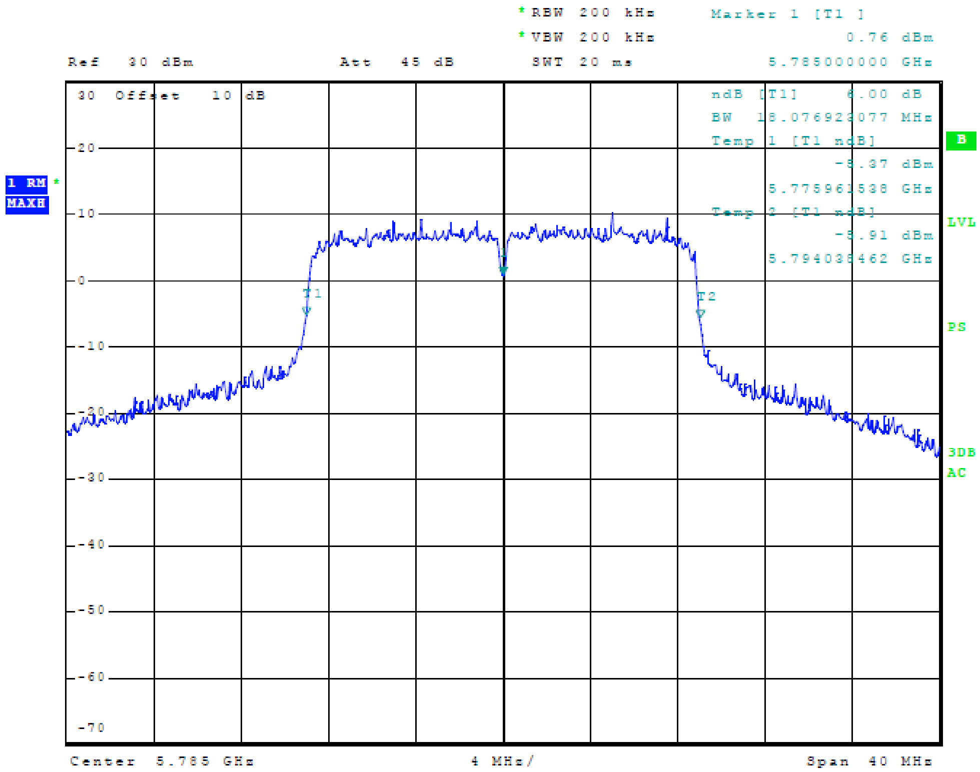


Figure 16 Plot of Antenna Port Conducted 6dB Band width (5785 MHz, Chain 0, 20 MHz Mode)

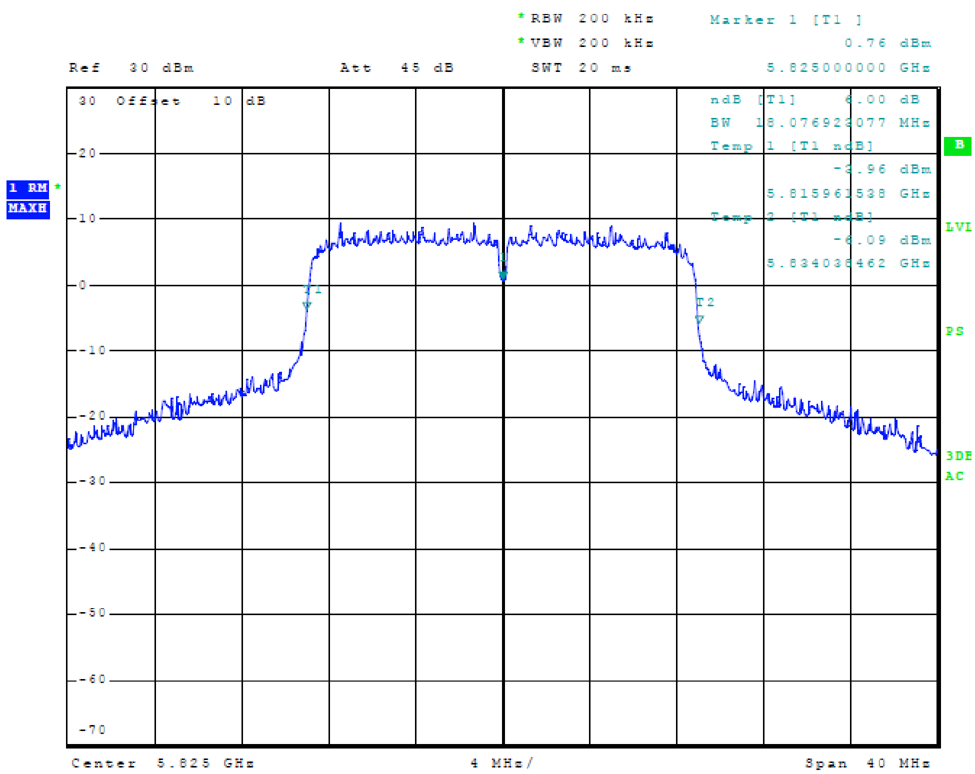


Figure 17 Plot of Antenna Port Conducted 6dB Band width (5825 MHz, Chain 0, 20 MHz Mode)

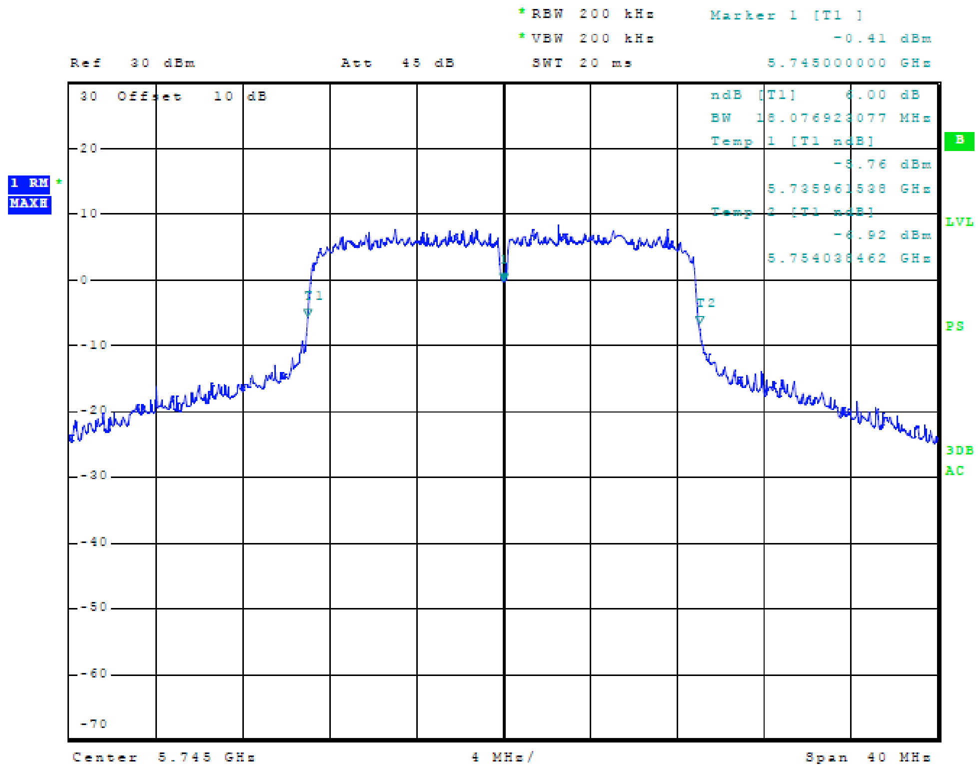


Figure 18 Plot of Antenna Port Conducted 6dB Band width (5745 MHz, Chain 1, 20 MHz Mode)

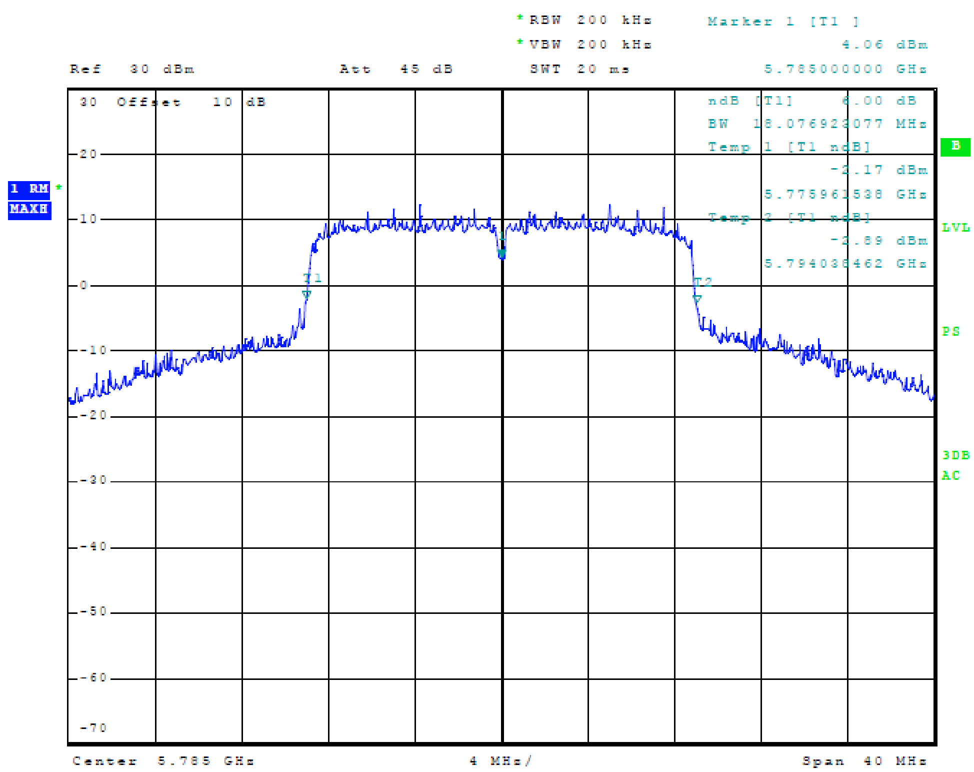


Figure 19 Plot of Antenna Port Conducted 6dB Band width (5785 MHz, Chain 1, 20 MHz Mode)

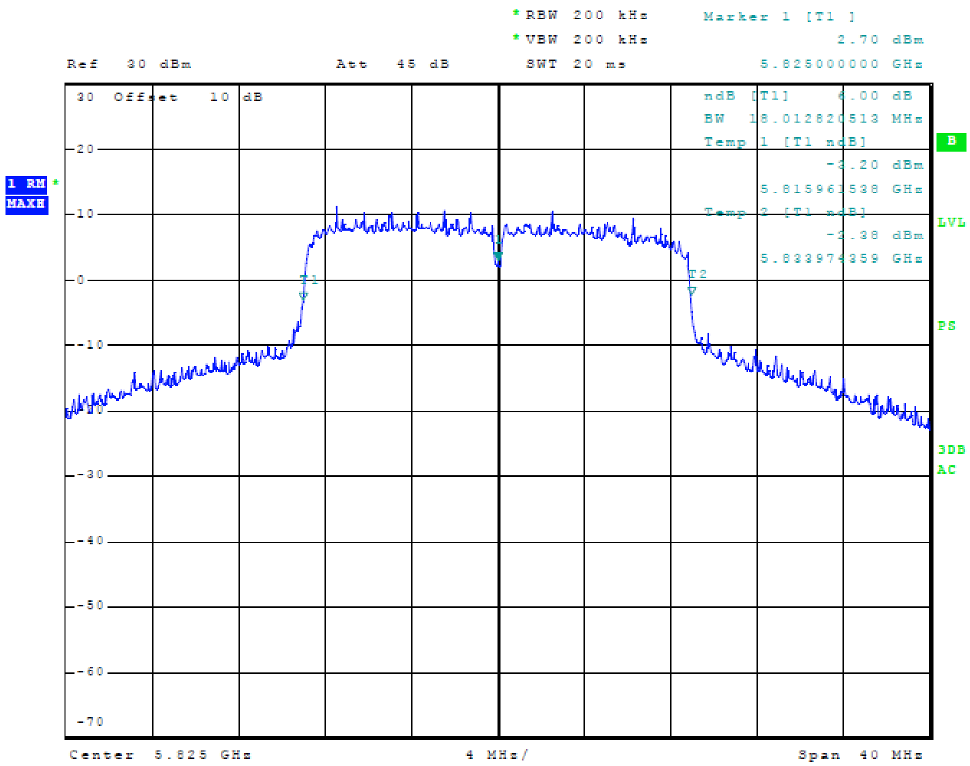


Figure 20 Plot of Antenna Port Conducted 6dB Band width (5825 MHz, Chain 1, 20 MHz Mode)

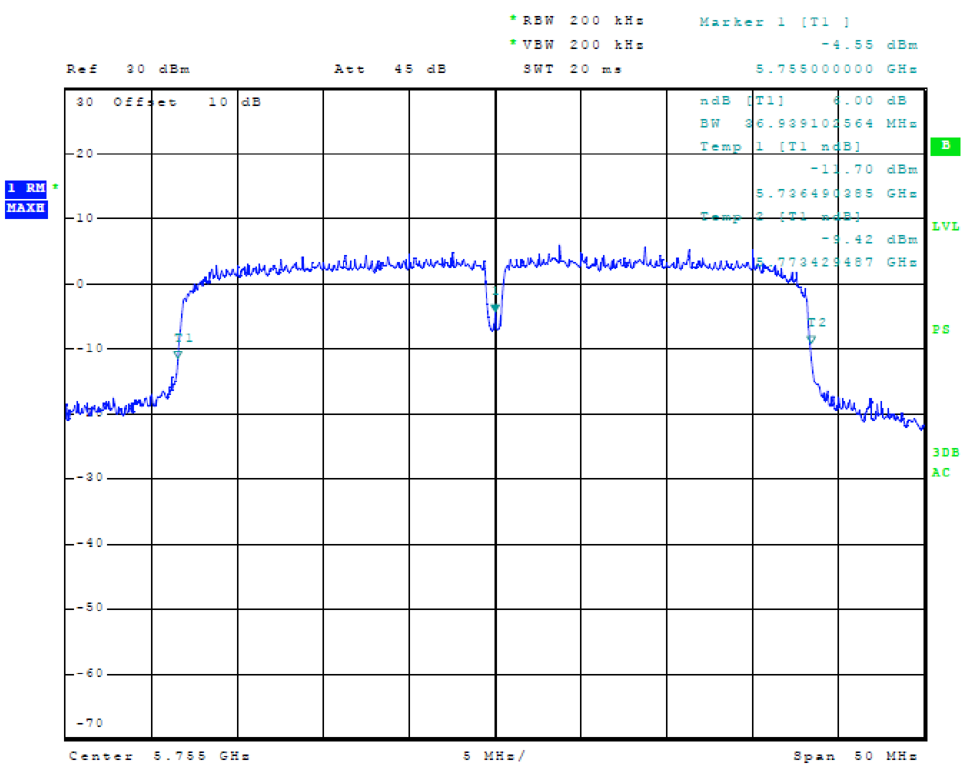


Figure 21 Plot of Antenna Port Conducted 6dB Band width (5755 MHz, Chain 0, 40 MHz Mode)

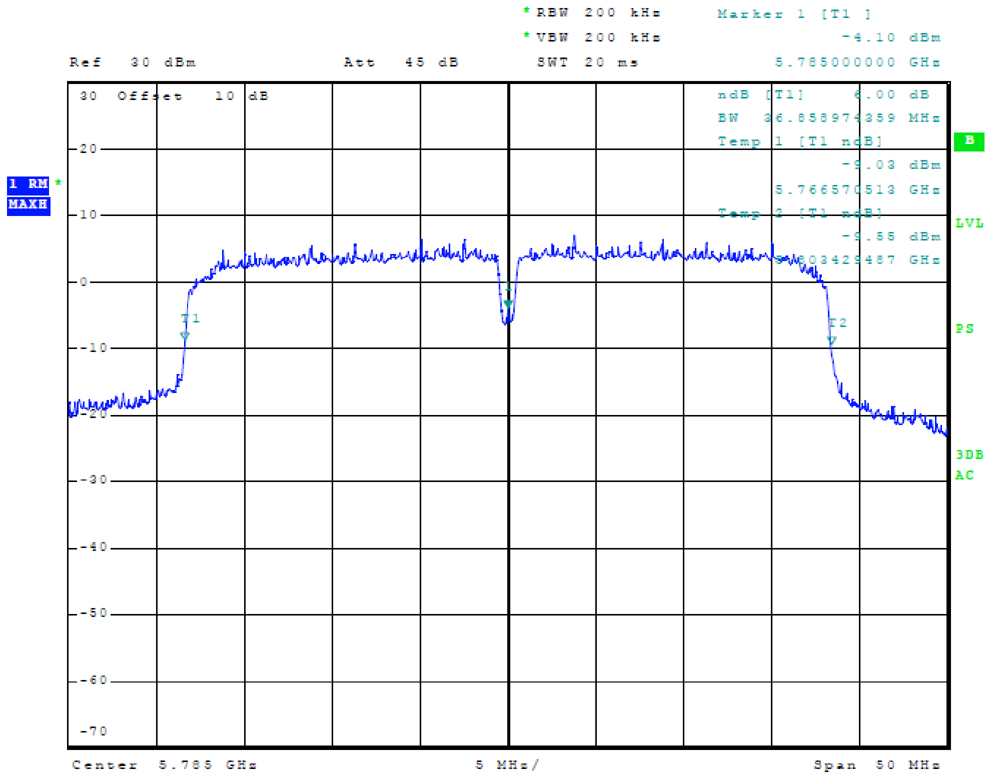


Figure 22 Plot of Antenna Port Conducted 6dB Band width (5785 MHz, Chain 0, 40 MHz Mode)

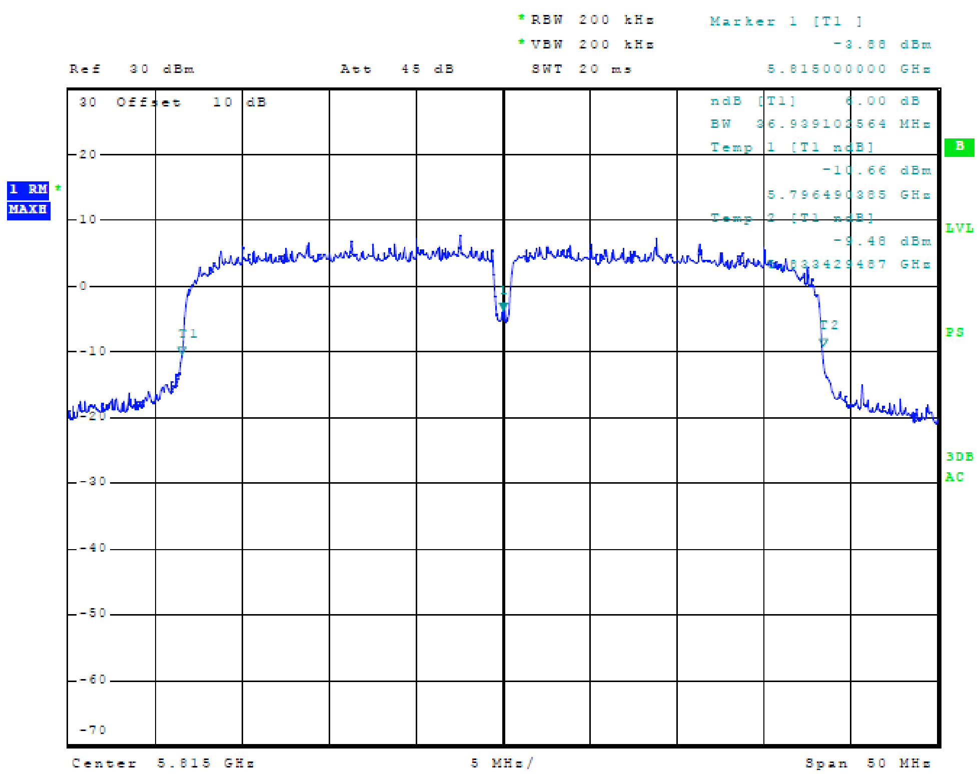


Figure 23 Plot of Antenna Port Conducted 6dB Band width (5815 MHz, Chain 0, 40 MHz Mode)

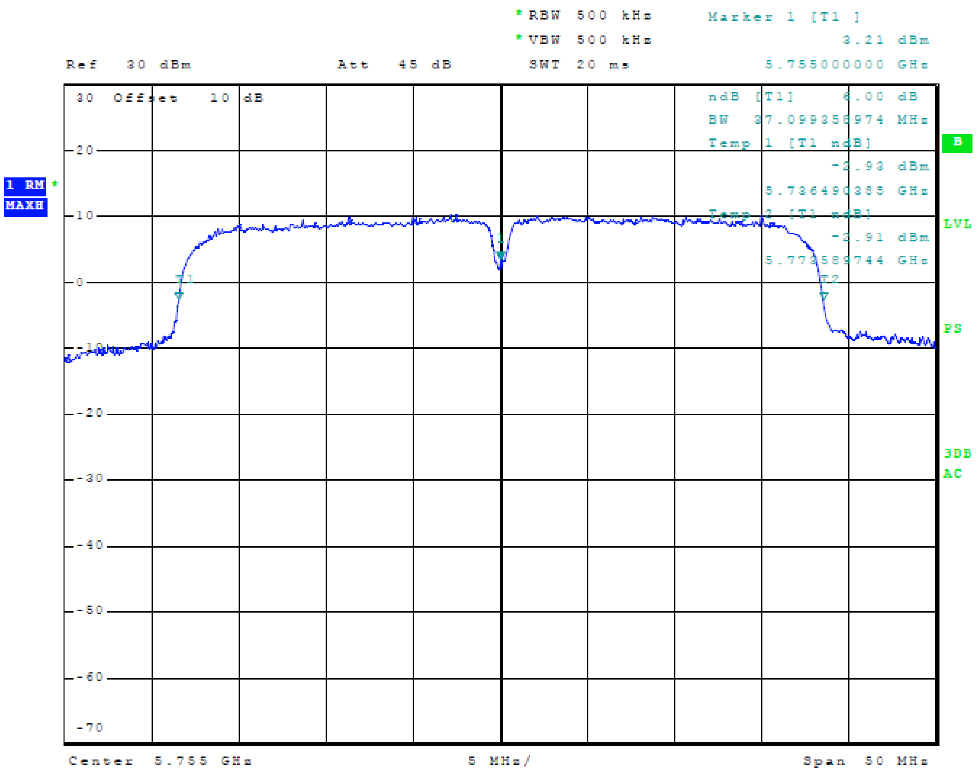


Figure 24 Plot of Antenna Port Conducted 6dB Band width (5755 MHz, Chain 1, 40 MHz Mode)

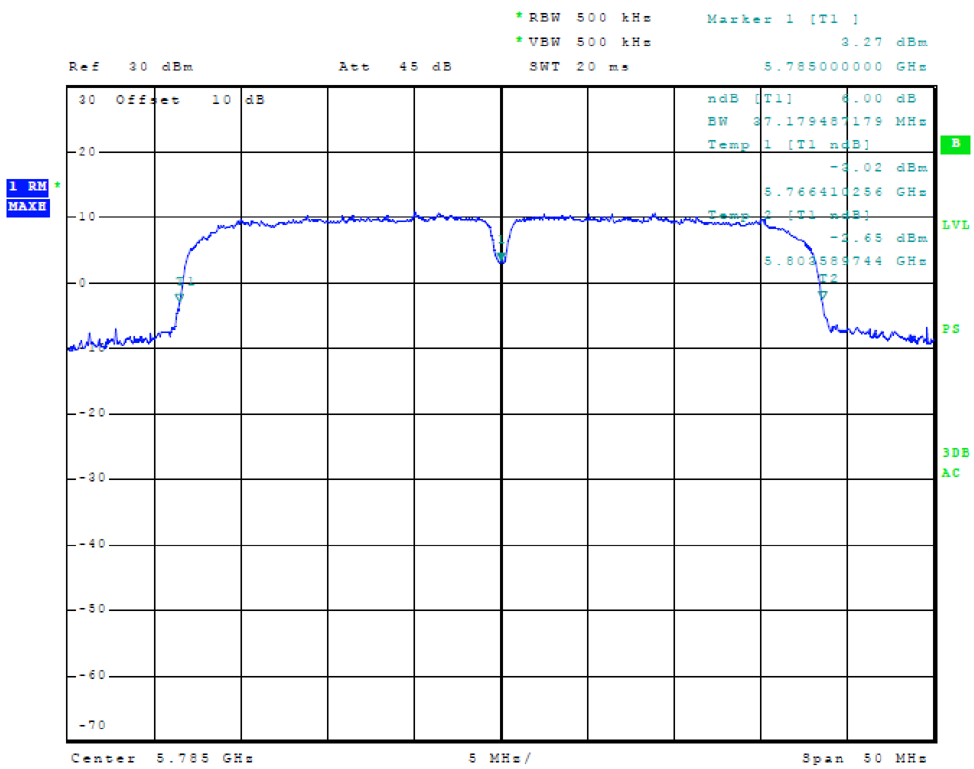


Figure 25 Plot of Antenna Port Conducted 6dB Band width (5785 MHz, Chain 1, 40 MHz Mode)

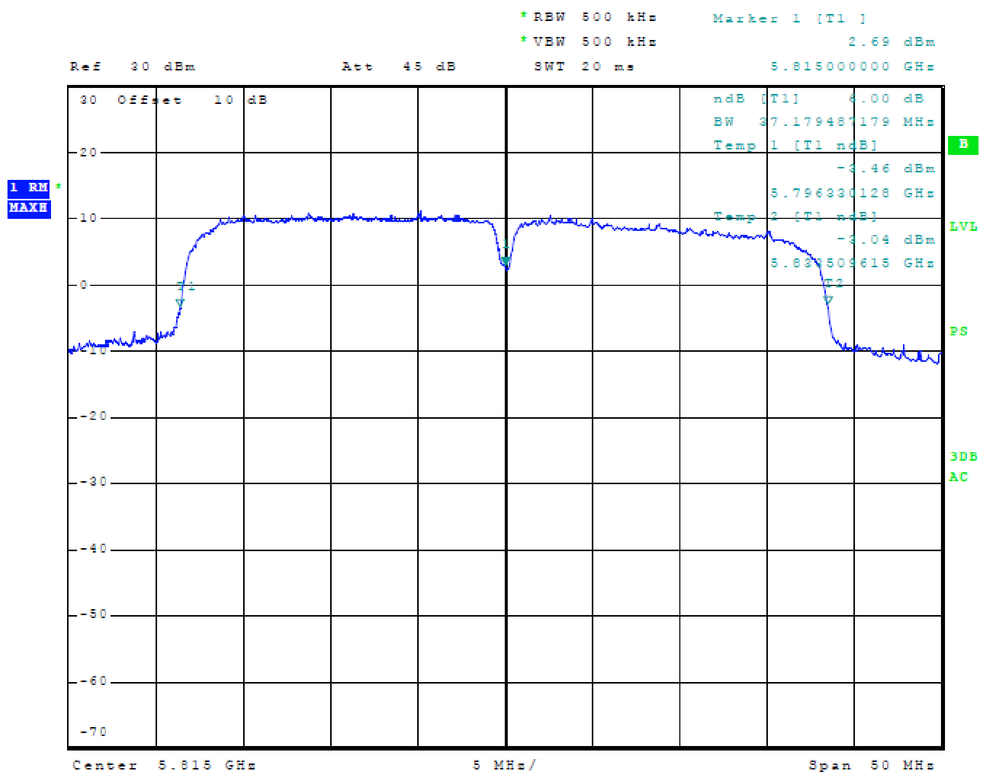


Figure 26 Plot of Antenna Port Conducted 6dB Band width (5815 MHz, Chain 1, 40 MHz Mode)

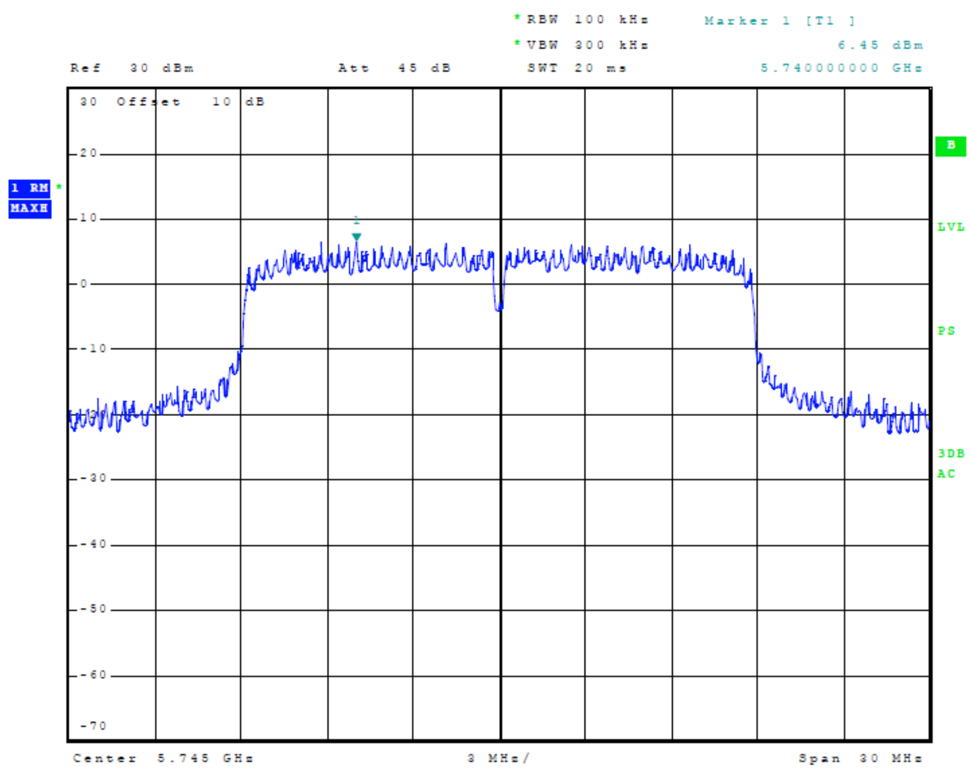


Figure 27 Plot of Power Spectral Density (5745 MHz, Chain 0, 20 MHz Mode)

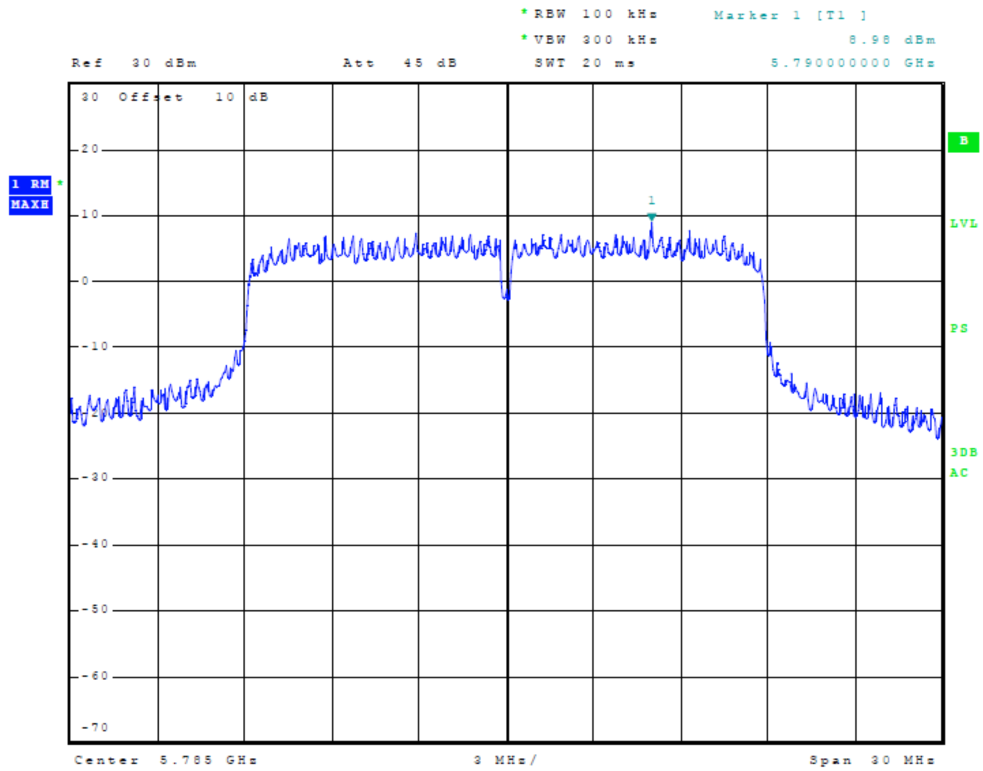


Figure 28 Plot of Power Spectral Density (5785 MHz, Chain 0, 20 MHz Mode)

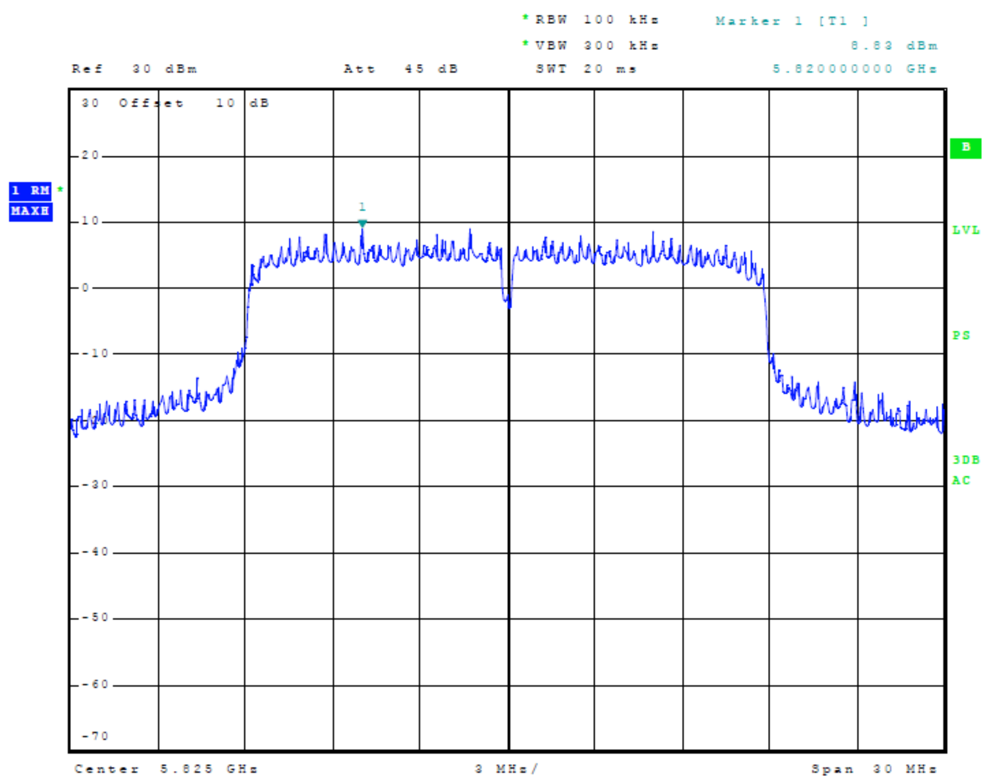


Figure 29 Plot of Power Spectral Density (5825 MHz, Chain 0, 20 MHz Mode)

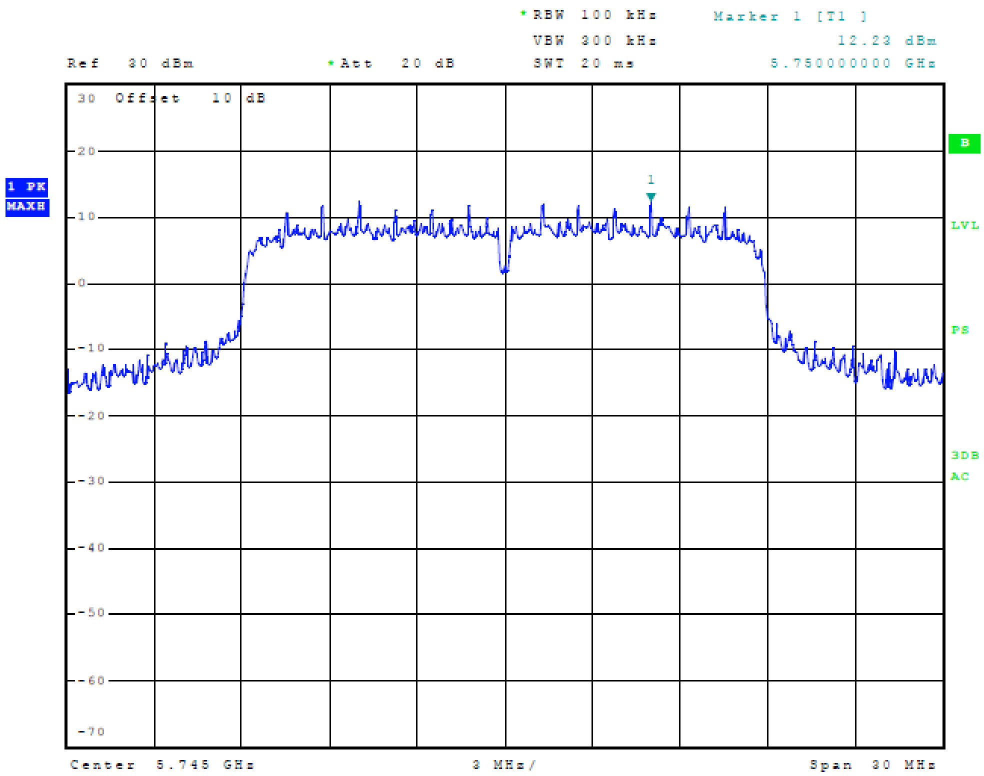


Figure 30 Plot of Power Spectral Density (5745 MHz, Chain 1, 20 MHz Mode)

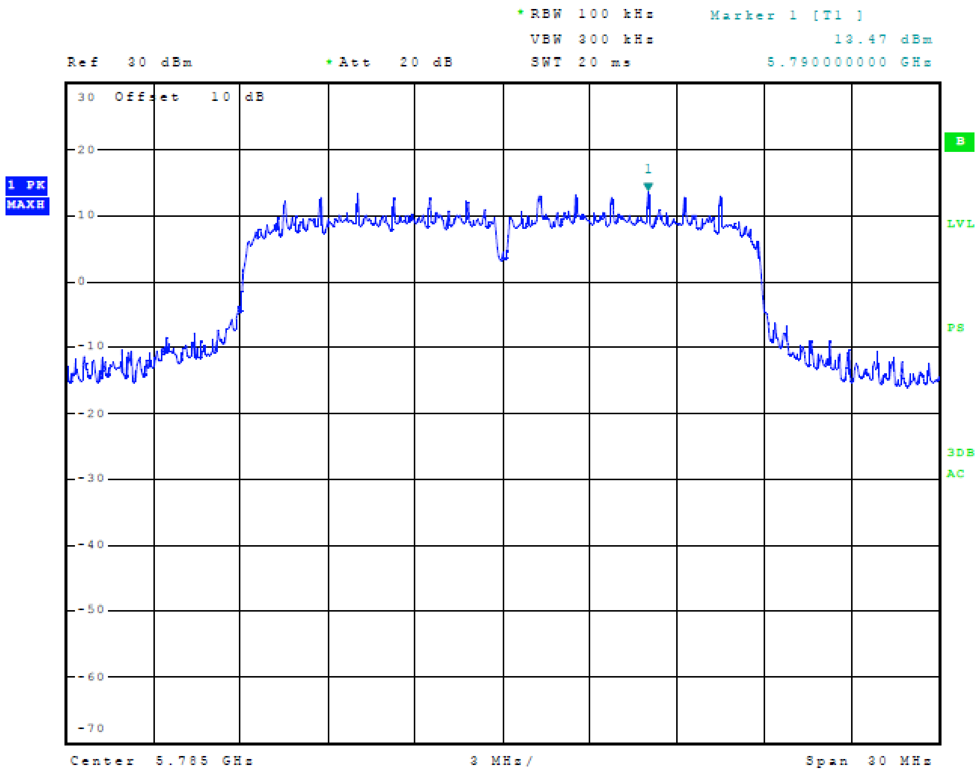


Figure 31 Plot of Power Spectral Density (5785 MHz, Chain 1, 20 MHz Mode)

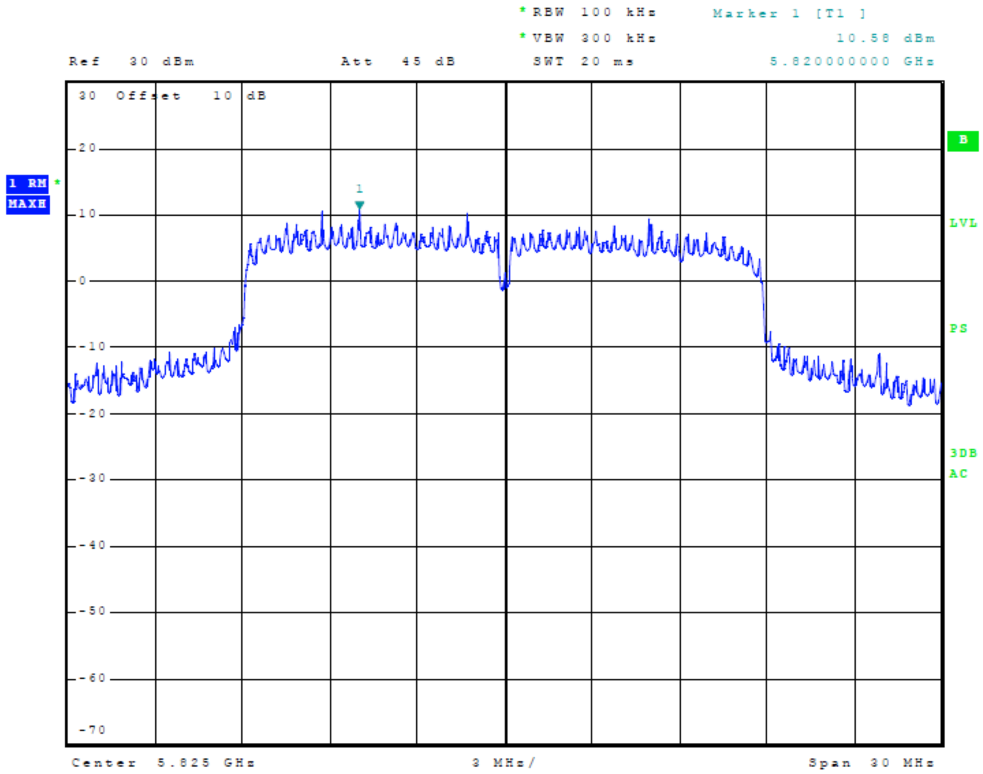


Figure 32 Plot of Power Spectral Density (5825 MHz, Chain 1, 20 MHz Mode)

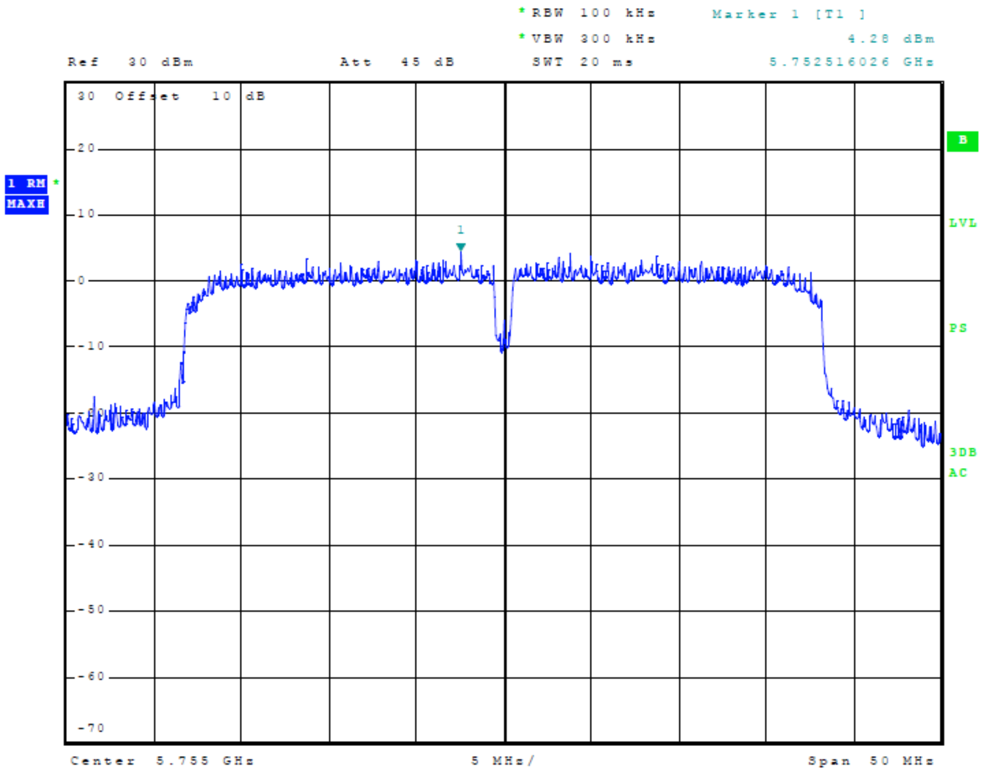


Figure 33 Plot of Power Spectral Density (5755 MHz, Chain 0, 40 MHz Mode)

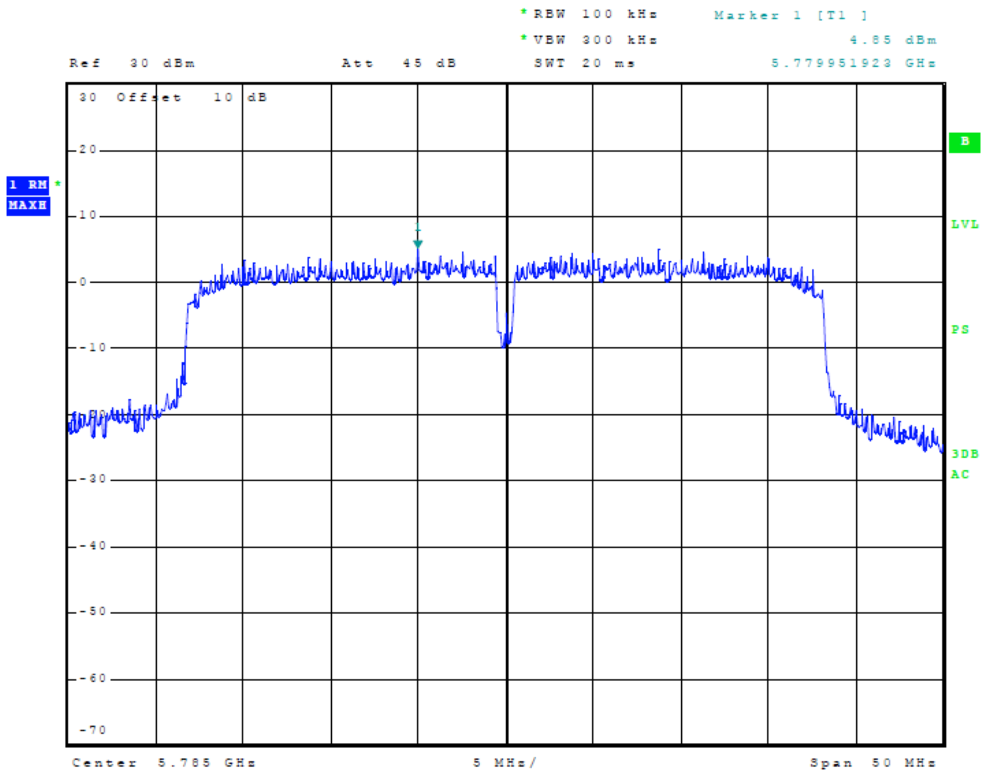


Figure 34 Plot of Power Spectral Density (5785 MHz, Chain 0, 40 MHz Mode)

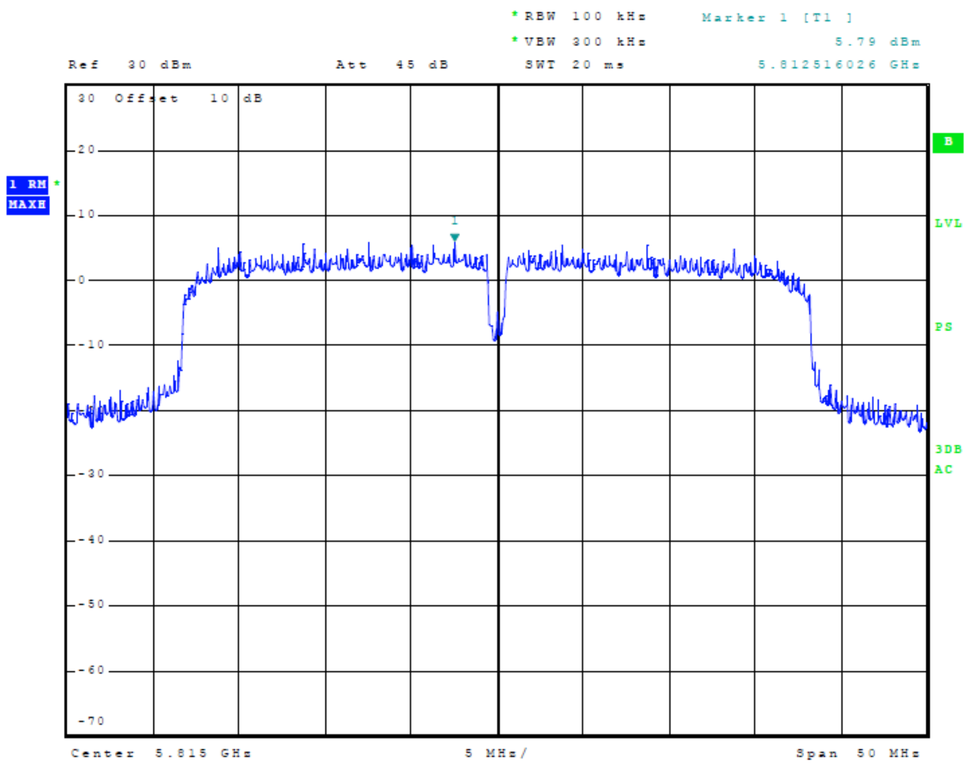


Figure 35 Plot of Power Spectral Density (5815 MHz, Chain 0, 40 MHz Mode)

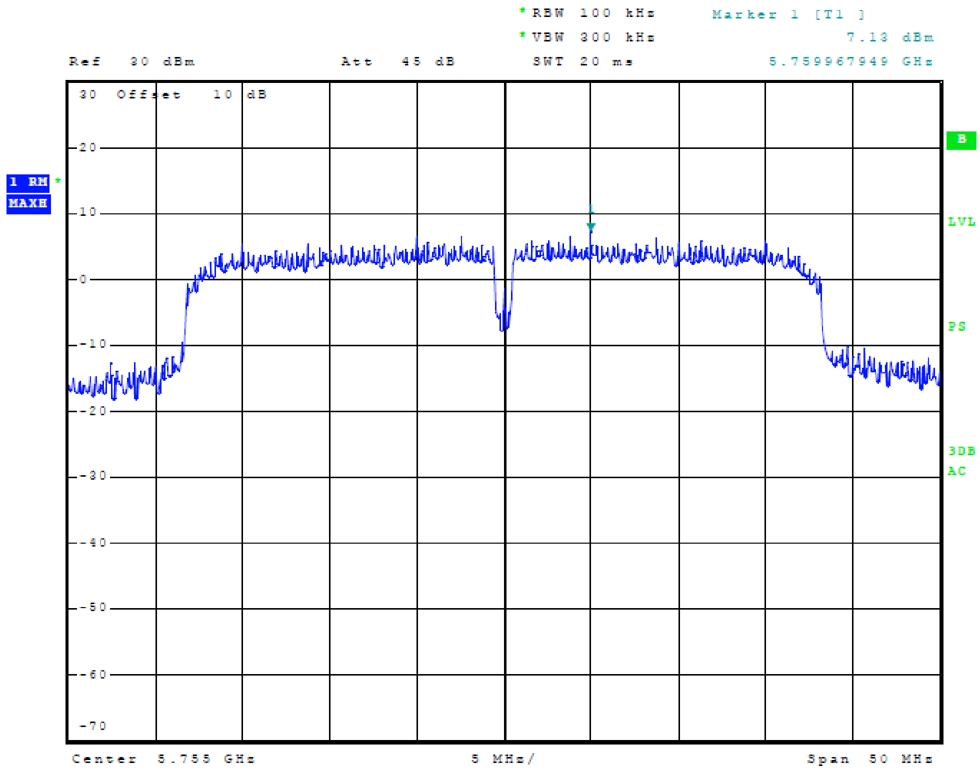


Figure 36 Plot of Power Spectral Density (5755 MHz, Chain 1, 40 MHz Mode)

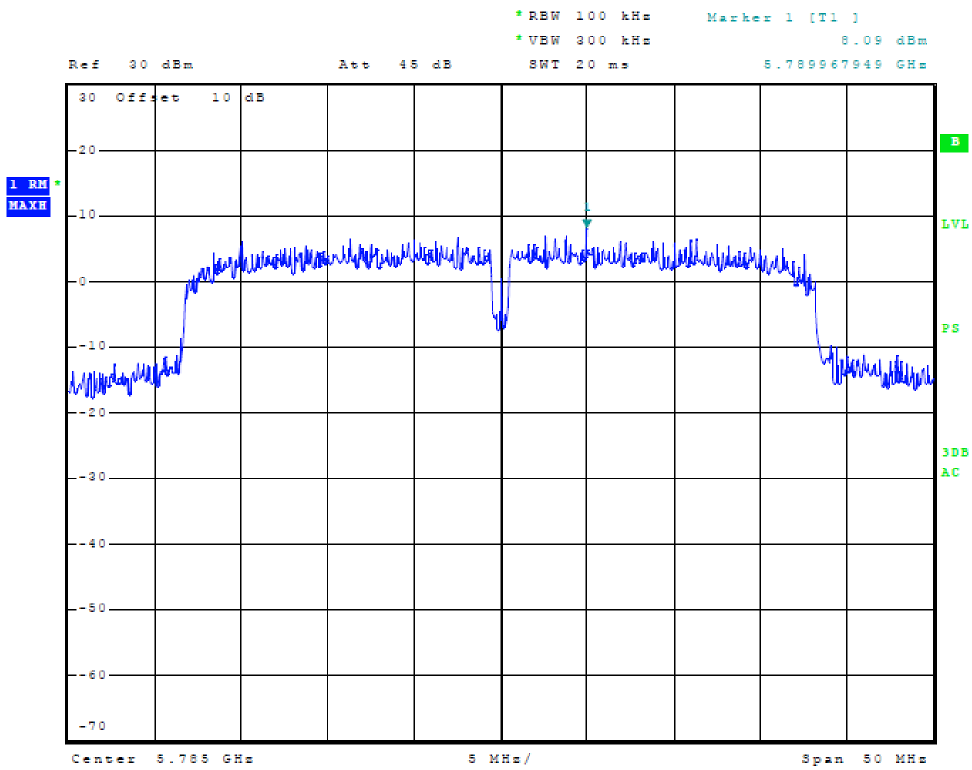


Figure 37 Plot of Power Spectral Density (5785 MHz, Chain 1, 40 MHz Mode)

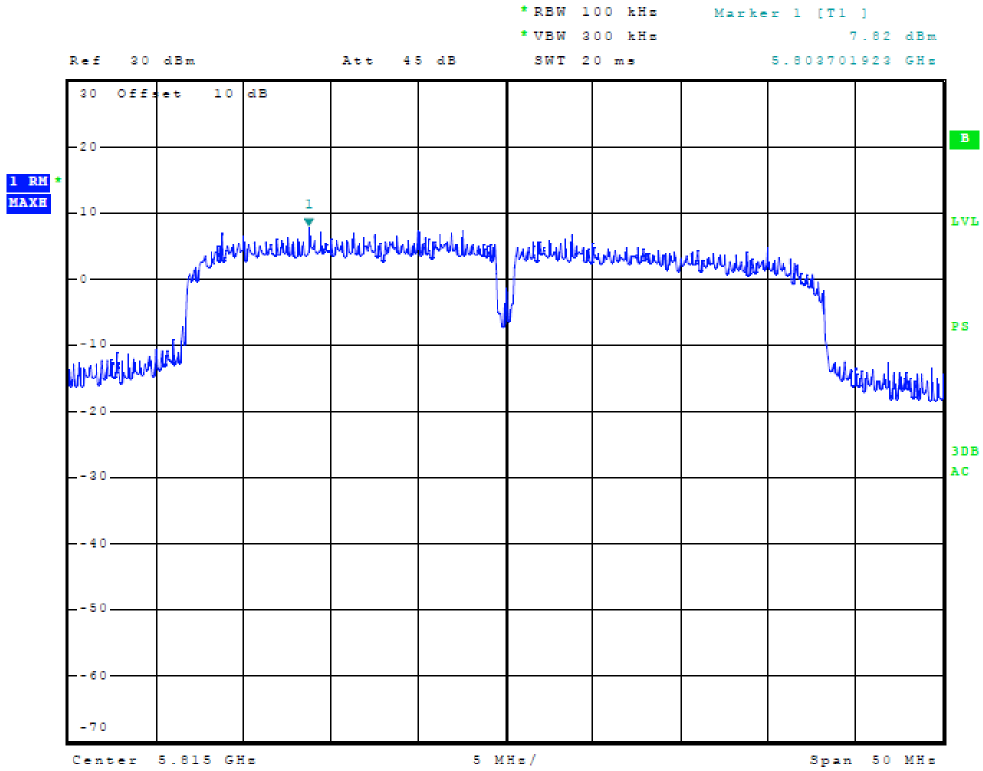


Figure 38 Plot of Power Spectral Density (5815 MHz, Chain 1, 40 MHz Mode)

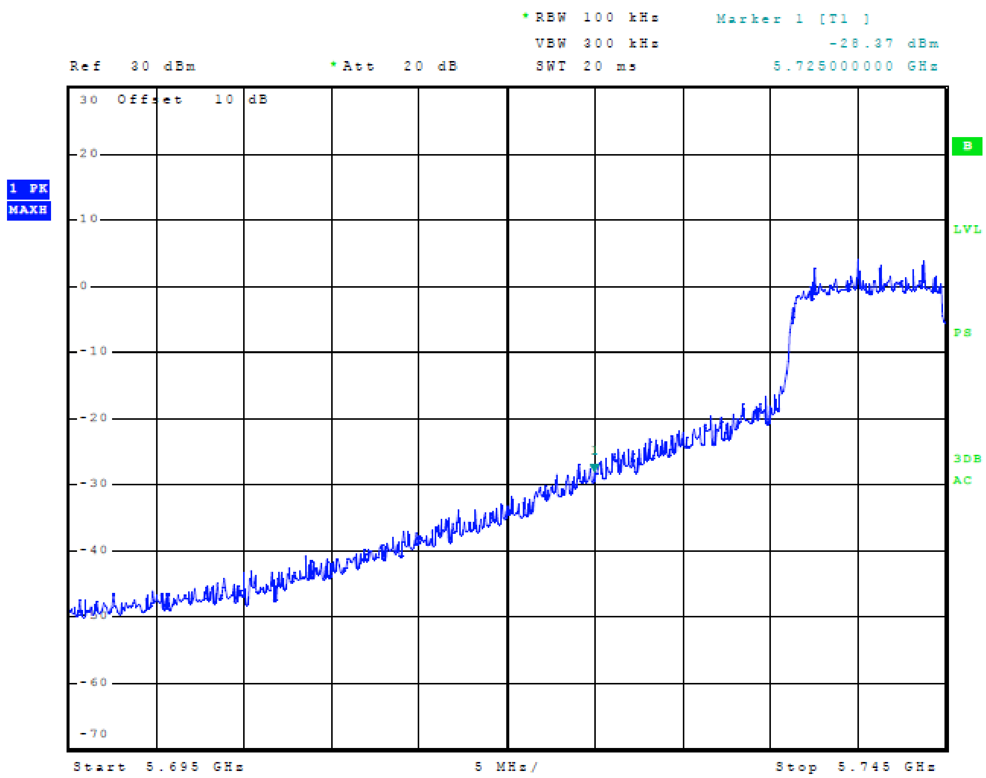


Figure 39 Plot of Low Band Edge Compliance (5745 MHz, Chain 0, 20 MHz Mode)

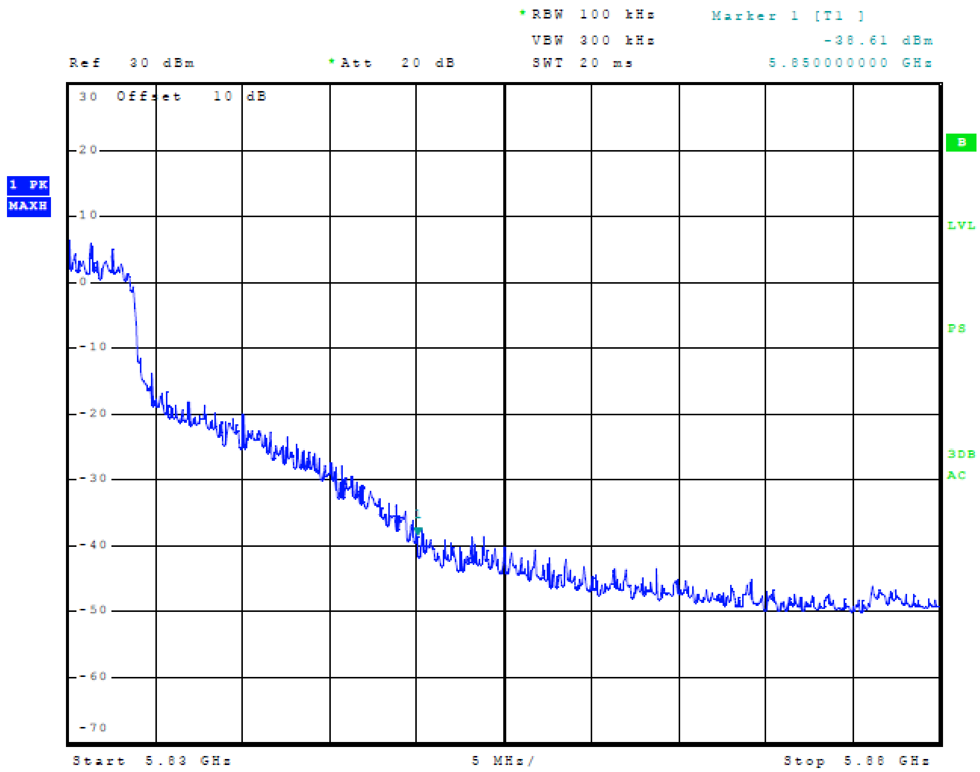


Figure 40 Plot of High Band Edge Compliance (5825 MHz, Chain 0, 20 MHz Mode)

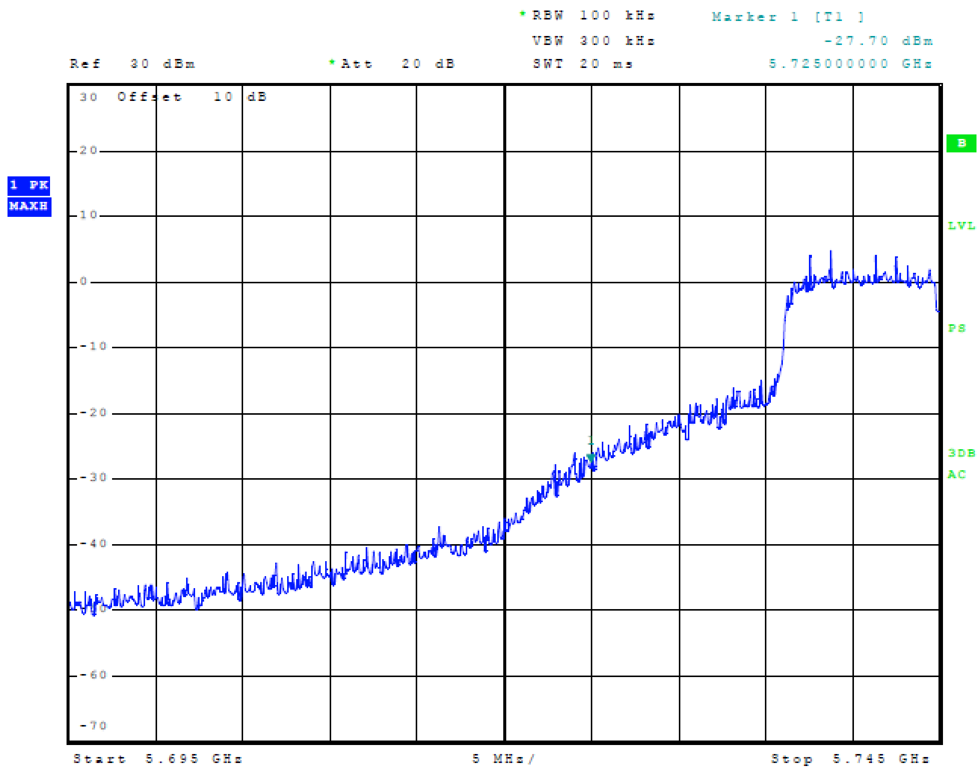


Figure 41 Plot of Low Band Edge Compliance (5745 MHz, Chain 1, 20 MHz Mode)

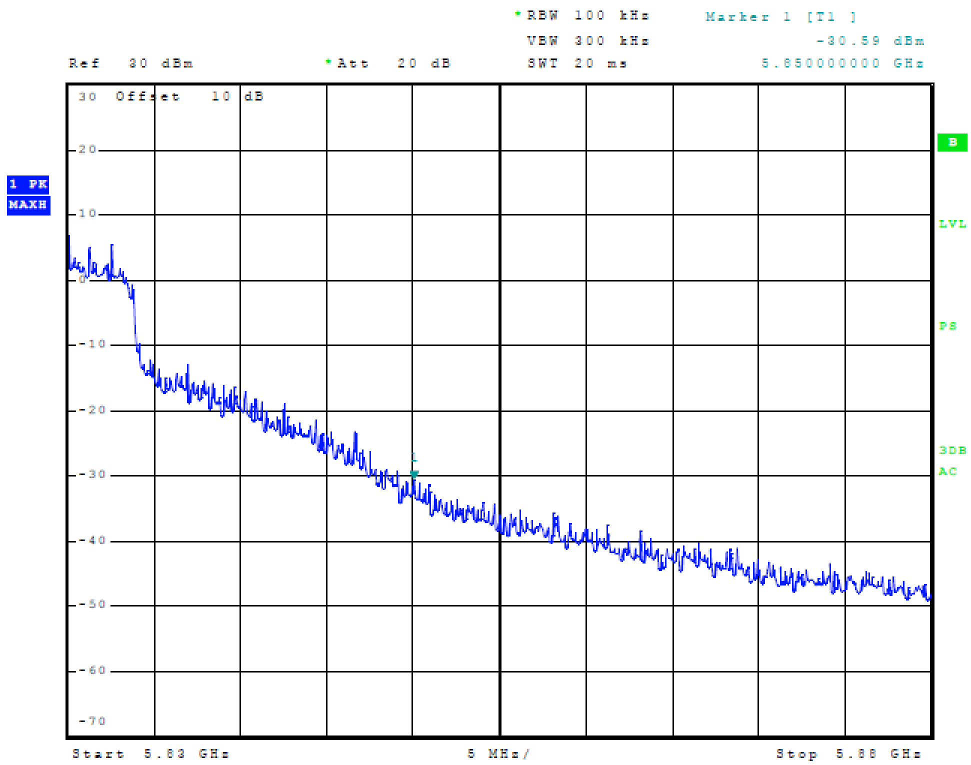


Figure 42 Plot of High Band Edge Compliance (5825 MHz, Chain 1, 20 MHz Mode)

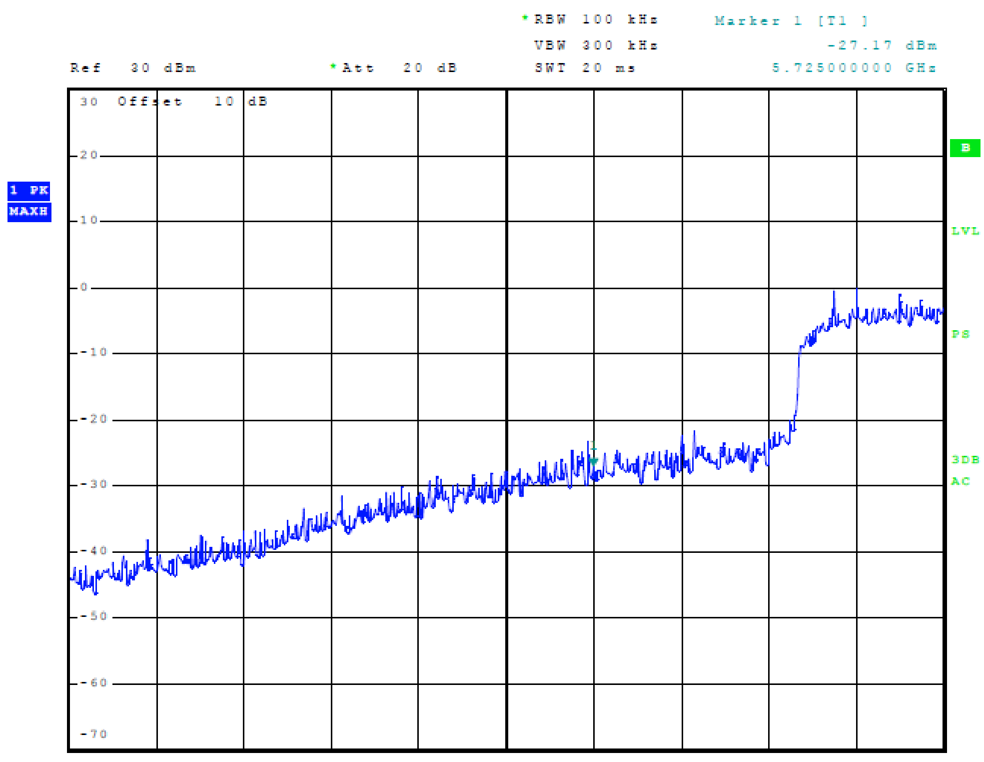


Figure 43 Plot of Low Band Edge Compliance (5755 MHz, Chain 0, 40 MHz Mode)

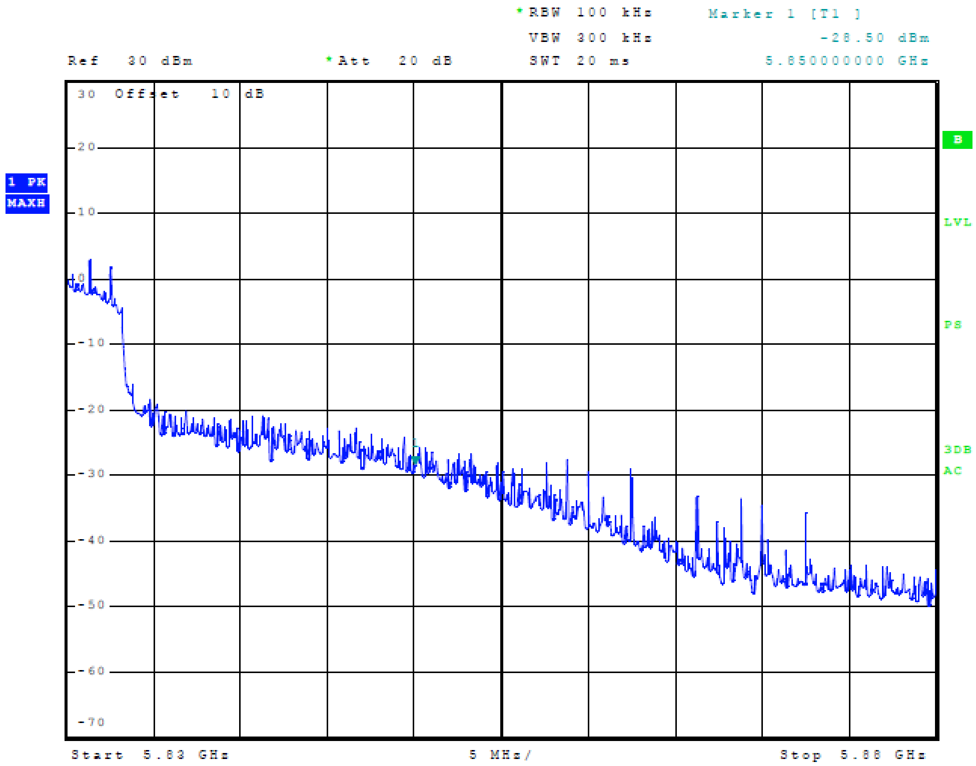


Figure 44 Plot of High Band Edge Compliance (5815 MHz, Chain 0, 40 MHz Mode)

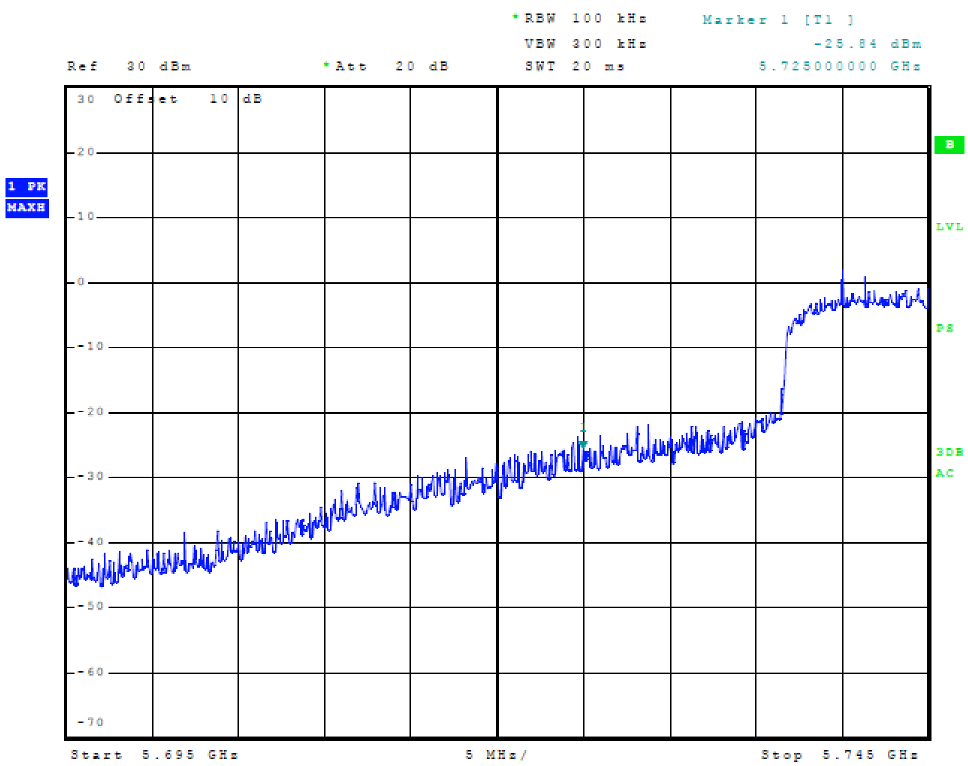


Figure 45 Plot of Low Band Edge Compliance (5755 MHz, Chain 1, 40 MHz Mode)

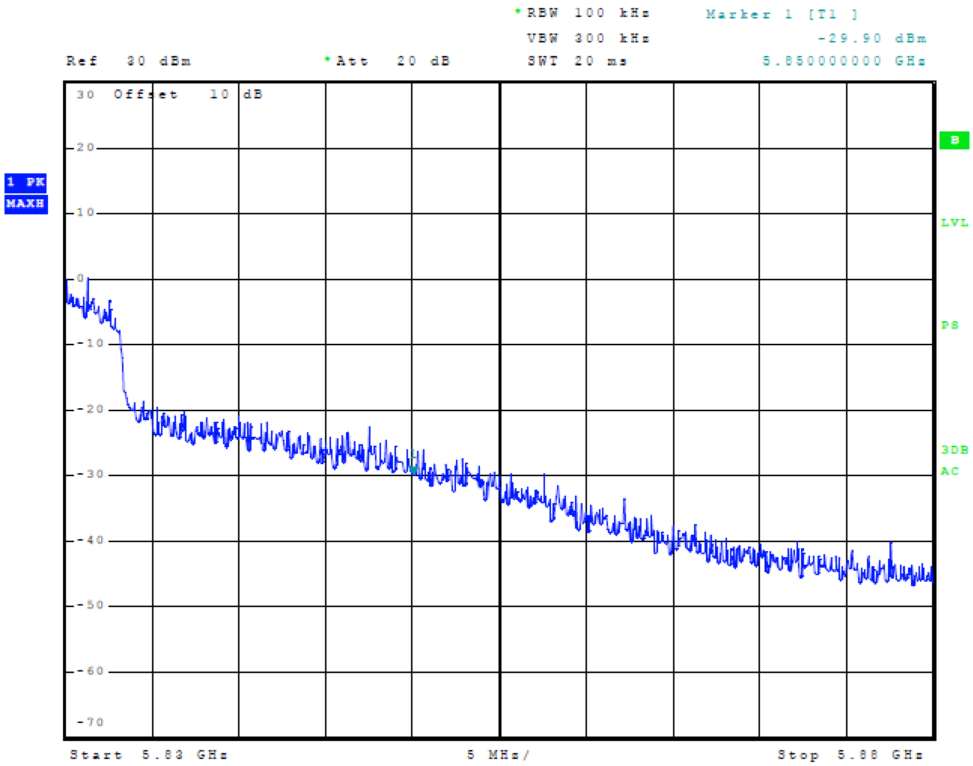


Figure 46 Plot of High Band Edge Compliance (5815 MHz, Chain 1, 40 MHz Mode)

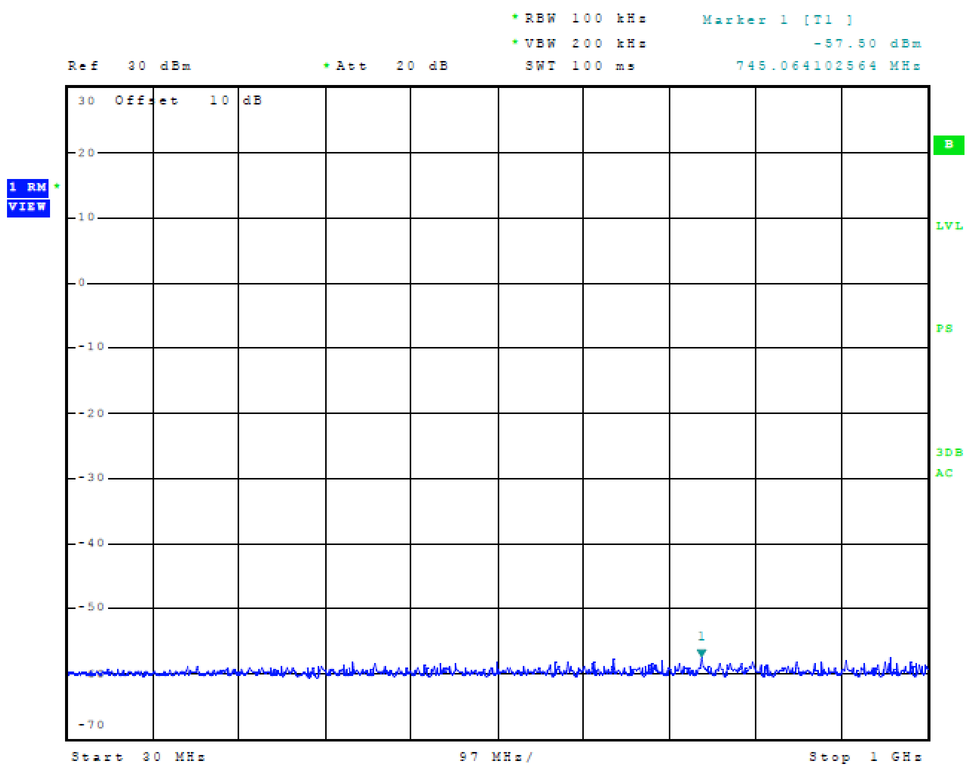


Figure 47 Plot of Antenna Port Conducted Emissions (Chain 0)

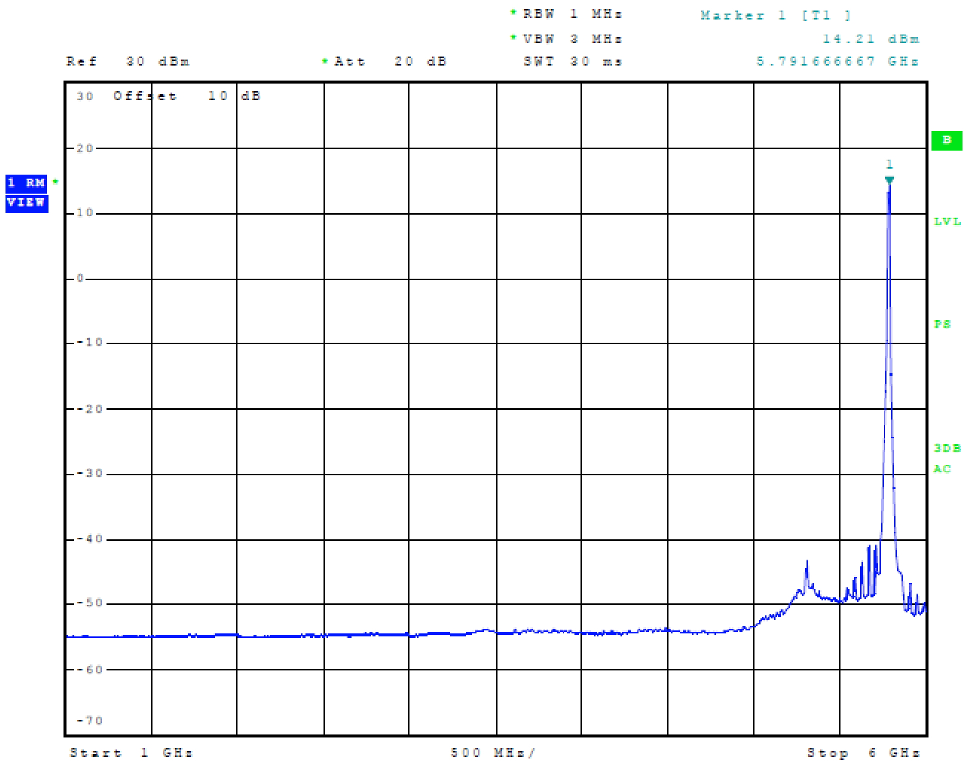


Figure 48 Plot of Antenna Port Conducted Emissions (Chain 0)

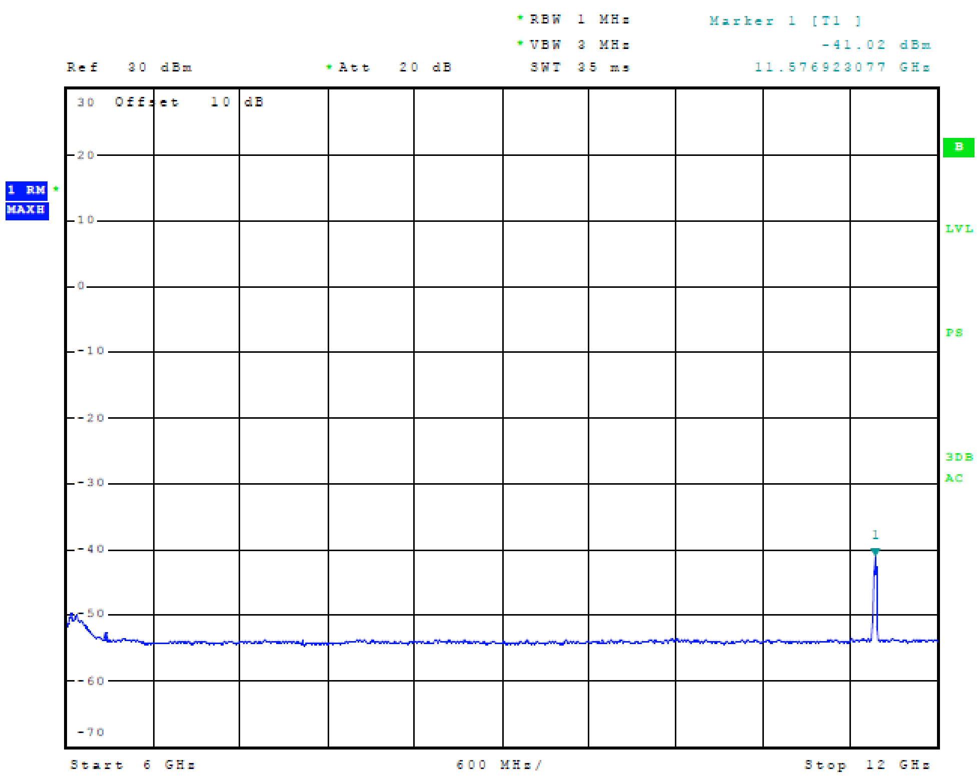


Figure 49 Plot of Antenna Port Conducted Emissions (Chain 0)

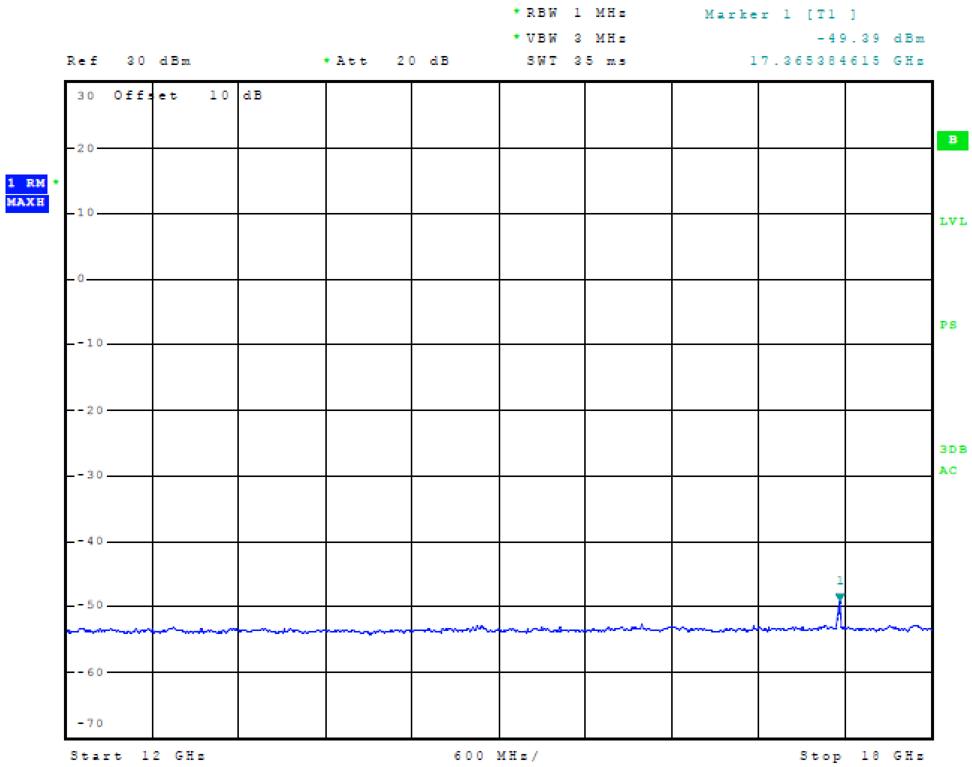


Figure 50 Plot of Antenna Port Conducted Emissions (Chain 0)

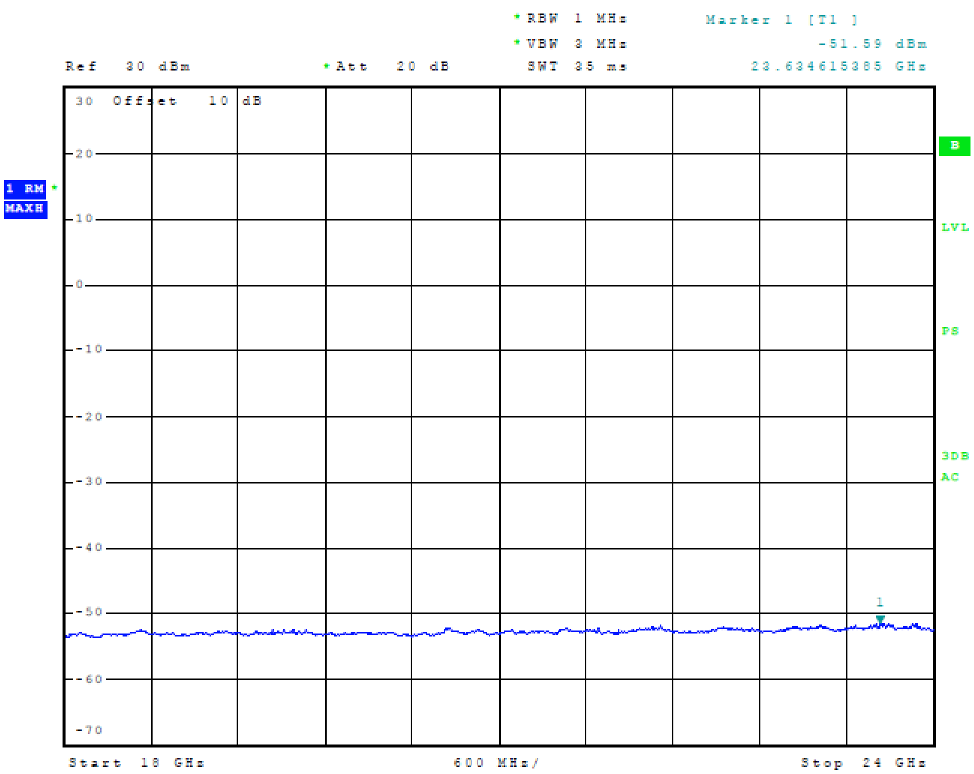


Figure 51 Plot of Antenna Port Conducted Emissions (Chain 0)

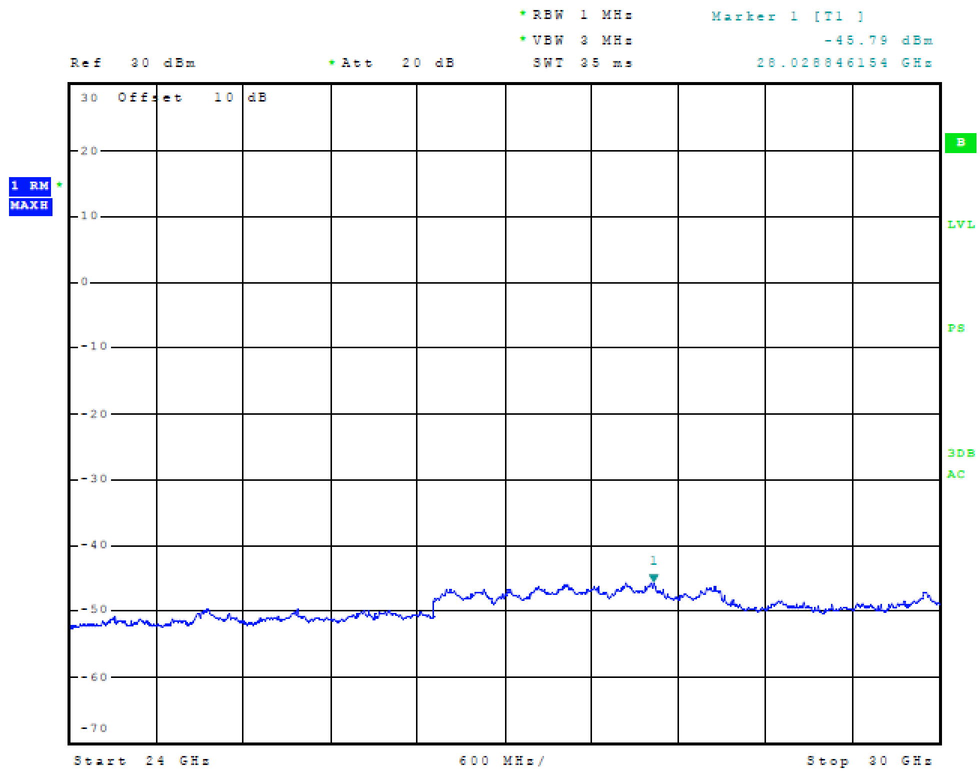


Figure 52 Plot of Antenna Port Conducted Emissions (Chain 0)

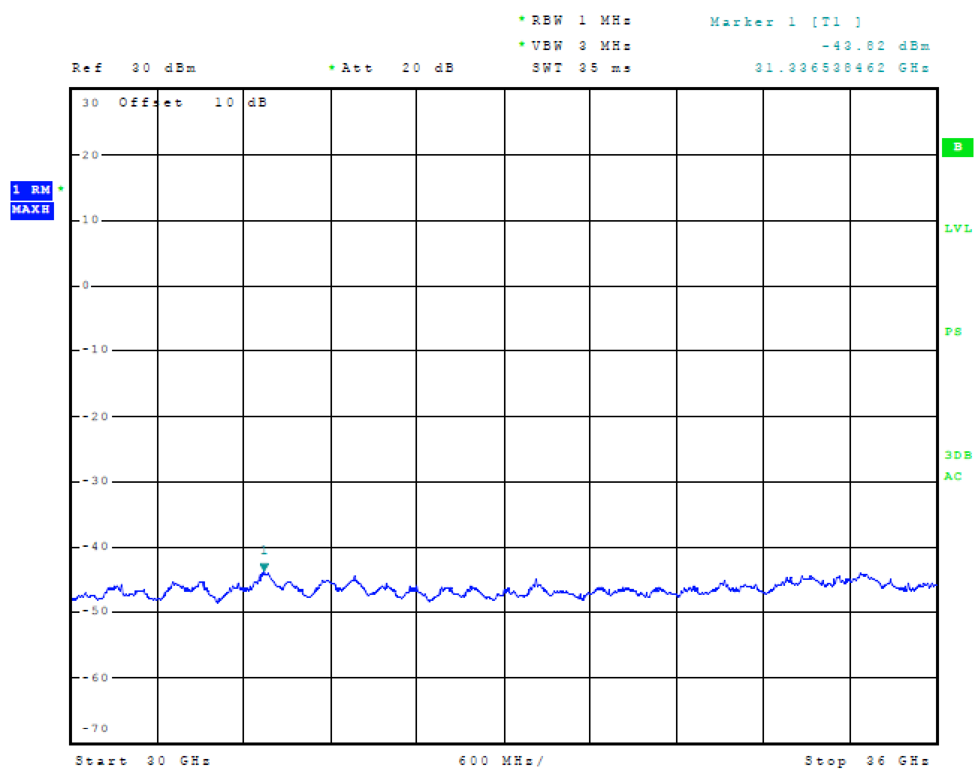


Figure 53 Plot of Antenna Port Conducted Emissions (Chain 0)

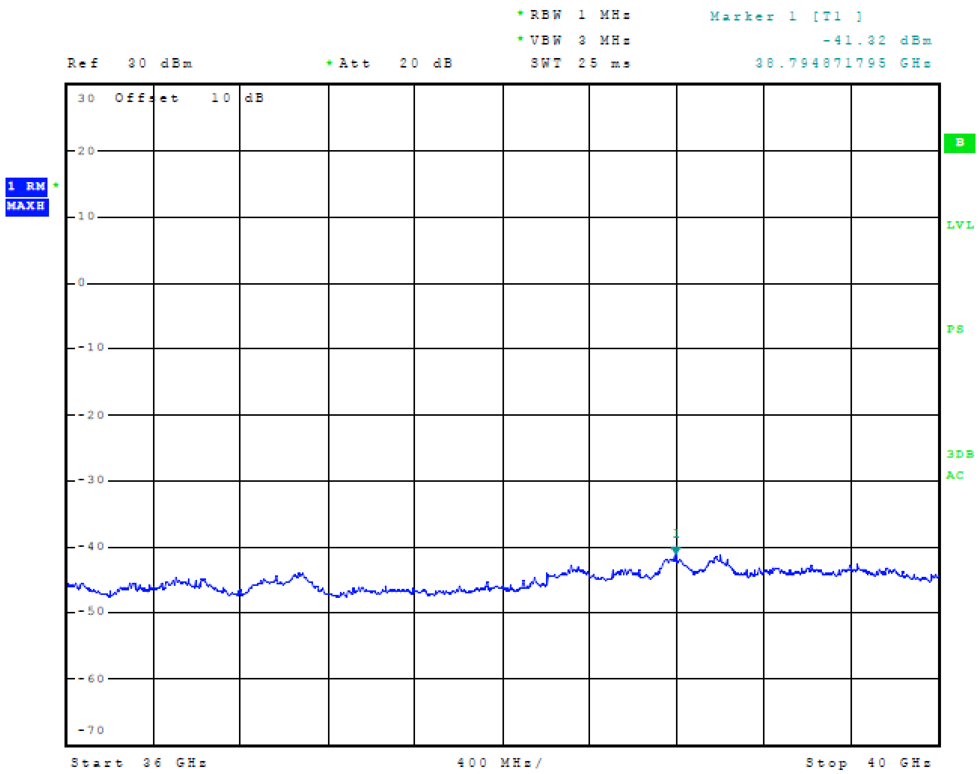


Figure 54 Plot of Antenna Port Conducted Emissions (Chain 0)

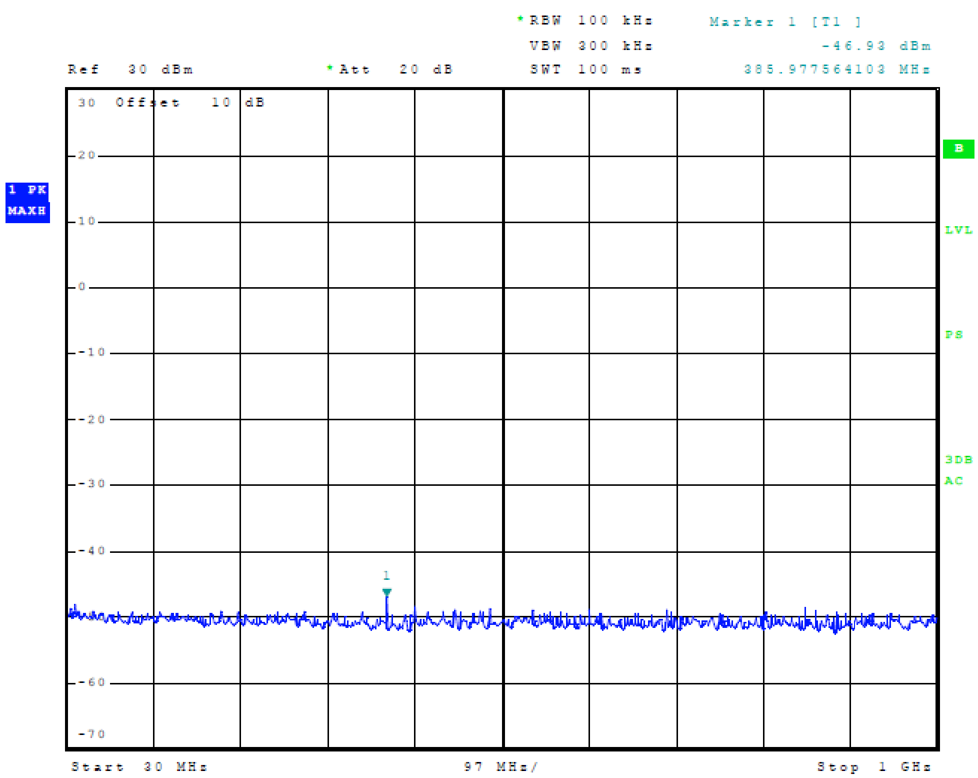


Figure 55 Plot of Antenna Port Conducted Emissions (Chain 1)

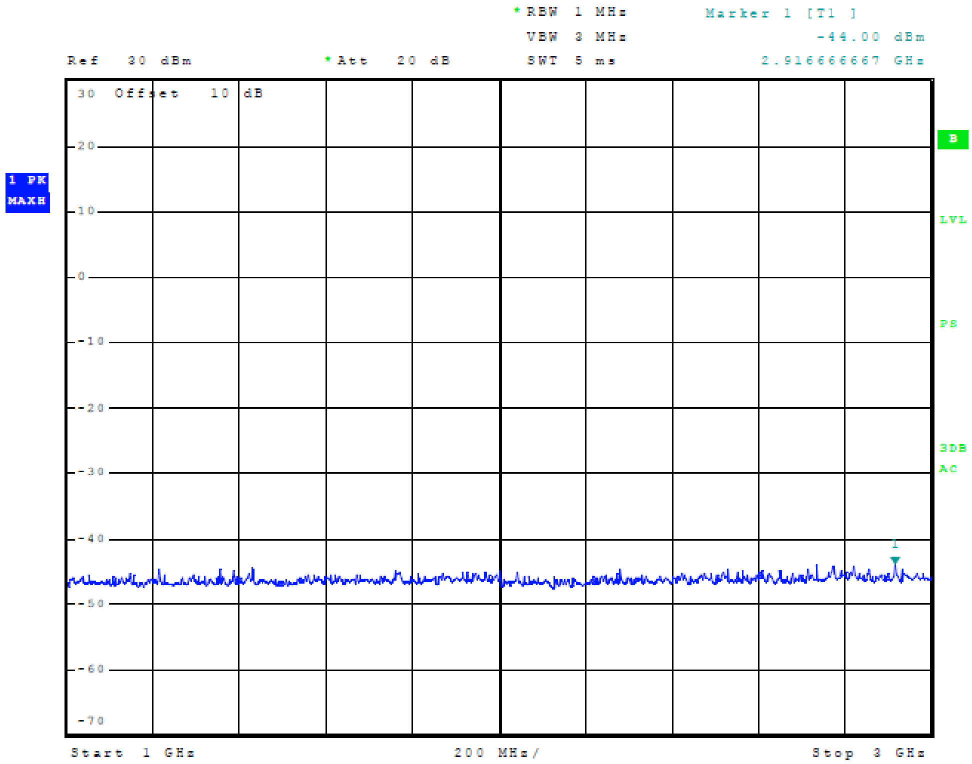


Figure 56 Plot of Antenna Port Conducted Emissions (Chain 1)

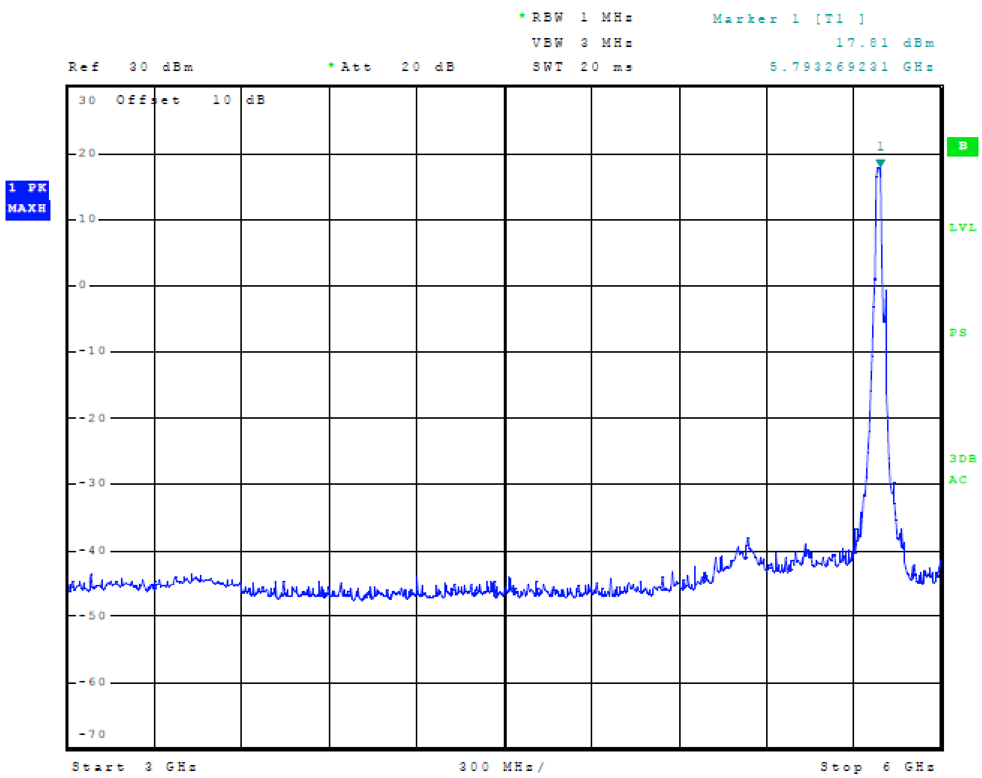


Figure 57 Plot of Antenna Port Conducted Emissions (Chain 1)

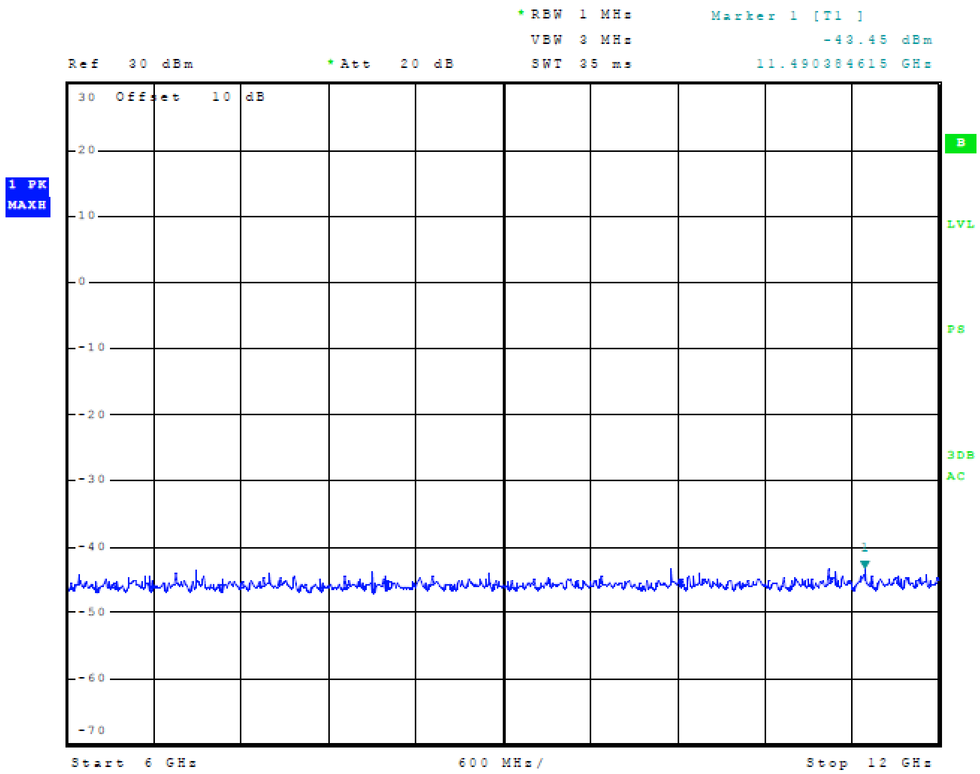


Figure 58 Plot of Antenna Port Conducted Emissions (Chain 1)

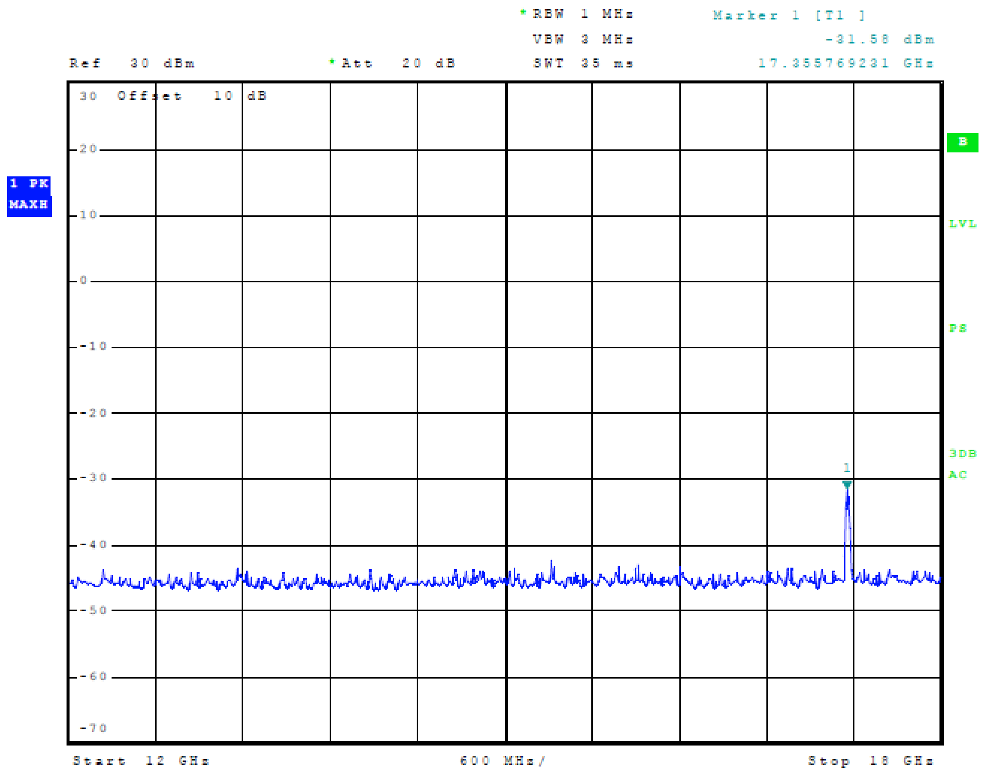


Figure 59 Plot of Antenna Port Conducted Emissions (Chain 1)

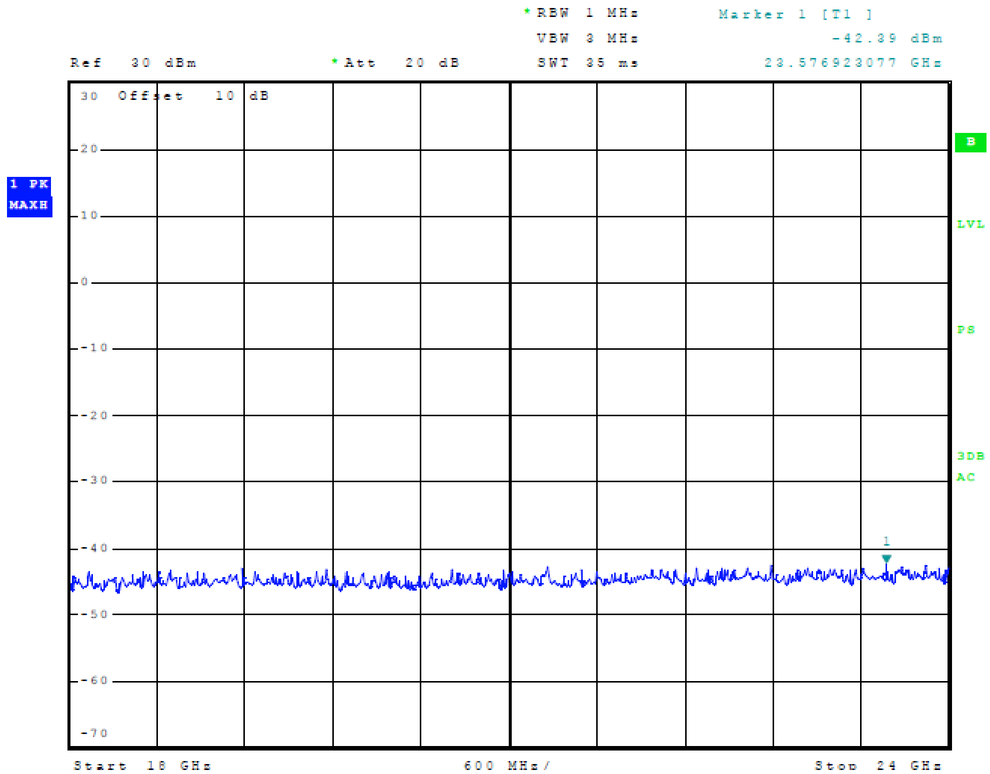


Figure 60 Plot of Antenna Port Conducted Emissions (Chain 1)

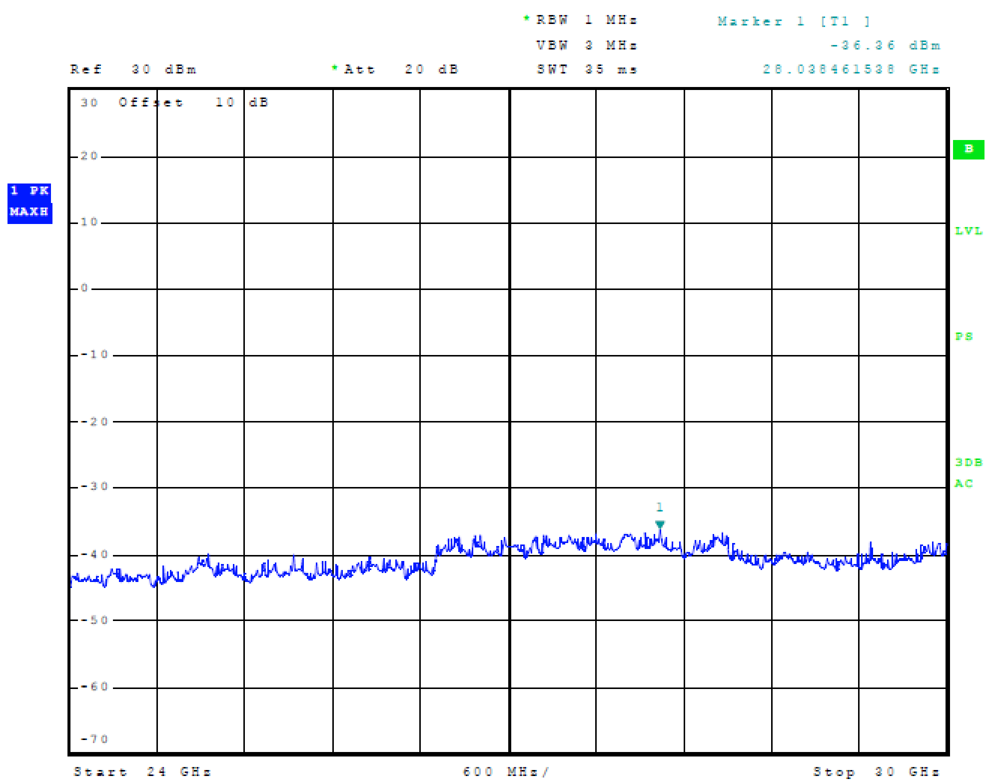


Figure 61 Plot of Antenna Port Conducted Emissions (Chain 1)

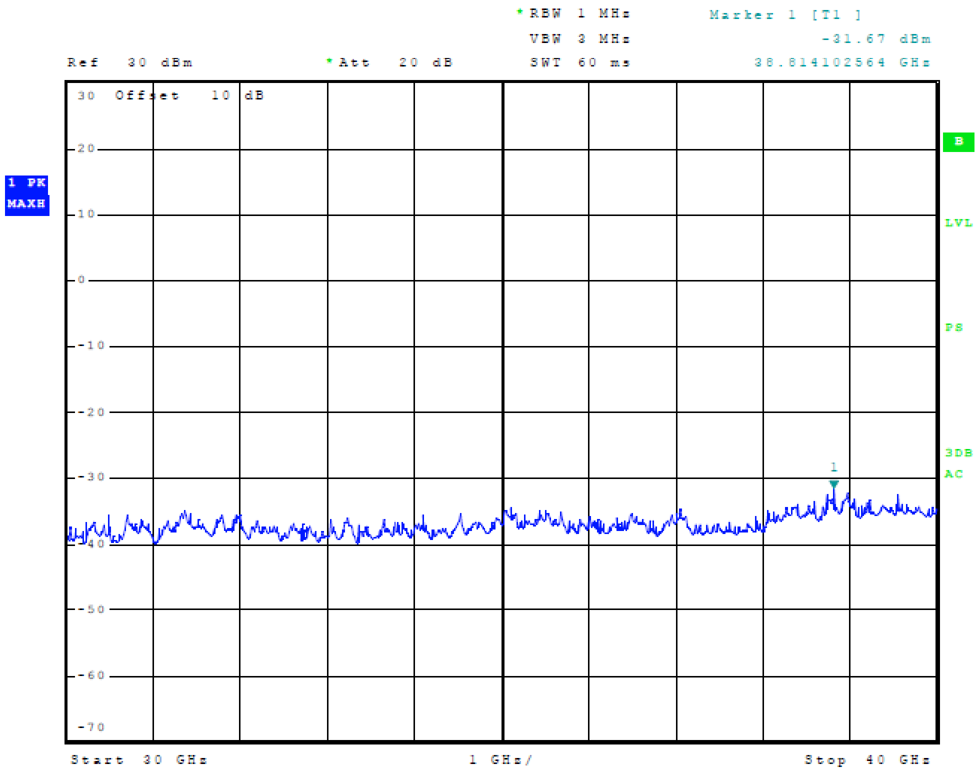


Figure 62 Plot of Antenna Port Conducted Emissions (Chain 1)

Transmitter Emissions Data

Transmitter Antenna Port Conducted Emissions Data (Total for Both Chains)

Channel Mode	Frequency MHz	Total Output Power Watts	Total Power Spectral Density (dBm)
20 MHz	5745	0.784	-1.95
20 MHz	5785	0.975	-0.41
20 MHz	5825	0.993	-2.40
40 MHz	5755	0.862	-6.25
40 MHz	5785	0.957	-5.42
40 MHz	5815	1.00	-527

Transmitter Antenna Port Conducted Emissions Data

Frequency MHz	Antenna Conducted Output Power dBm	Occupied Bandwidth MHz	Power Spectral Density dBm
20MHz Mode Chain 0			
5745	24.95	18,076.9	-8.75
5785	25.90	18,076.9	-6.22
5825	26.42	18,076.9	-6.37
20MHz Mode Chain 1			
5745	26.74	18,141.0	-2.97
5785	27.68	18,076.9	-1.73
5825	27.44	18,012.8	-4.62
40MHz Mode Chain 0			
5755	24.69	36,939.1	-10.92
5785	25.52	36,859.0	-10.35
5815	26.36	36,939.1	-9.41
40MHz Mode Chain 1			
5755	27.54	37,099.4	-8.07
5785	27.79	37,179.5	-7.11
5815	27.62	37,179.5	-7.38

Transmitter Antenna Port Conducted Spurious Emissions Data (Chain 0, 20 MHz Channel)

Channel MHz	Spurious Freq (MHz)	Measured Level (dBm)	Level Below Carrier (dBc)
5745.0	11490.0	-35.44	-60.1
	17235.0	-34.79	-59.5
	22980.0	-34.22	-58.9
	28725.0	-31.42	-56.1
	34470.0	-27.48	-52.2
5785.0	11570.0	-35.98	-61.5
	17355.0	-35.60	-61.1
	23140.0	-34.93	-60.5
	28925.0	-30.07	-55.6
	34710.0	-27.76	-53.3
5825.0	11650.0	-36.03	-62.4
	17475.0	-35.28	-61.6
	23300.0	-34.22	-60.6
	29125.0	-31.21	-57.6
	34950.0	-27.19	-53.6

Transmitter Antenna Port Conducted Spurious Emissions Data (Chain 1, 20 MHz Channel)

Channel MHz	Spurious Freq (MHz)	Measured Level (dBm)	Level Below Carrier (dBc)
5745.0	11490.0	-36.09	-60.8
	17235.0	-35.42	-60.1
	22980.0	-33.75	-58.4
	28725.0	-30.95	-55.6
	34470.0	-27.72	-52.4
5785.0	11570.0	-36.48	-62.0
	17355.0	-35.51	-61.0
	23140.0	-34.03	-59.6
	28925.0	-30.32	-55.8
	34710.0	-27.08	-52.6
5825.0	11650.0	-36.08	-62.4
	17475.0	-35.86	-62.2
	23300.0	-34.41	-60.8
	29125.0	-30.94	-57.3
	34950.0	-26.78	-53.1

Transmitter Antenna Port Conducted Spurious Emissions Data (Chain 0, 40 MHz Channel)

Channel MHz	Spurious Freq (MHz)	Measured Level (dBm)	Level Below Carrier (dBc)
5755.0	11510.0	-36.35	-61.0
	17265.0	-35.26	-60.0
	23020.0	-33.76	-58.5
	28775.0	-30.84	-55.5
	34530.0	-27.04	-51.7
5785.0	11570.0	-35.72	-61.2
	17355.0	-36.29	-61.8
	23140.0	-33.71	-59.2
	28925.0	-30.05	-55.6
	34710.0	-27.50	-53.0
5815.0	11630.0	-36.14	-62.5
	17445.0	-35.11	-61.5
	23260.0	-34.45	-60.8
	29075.0	-30.38	-56.7
	34890.0	-27.28	-53.6

Transmitter Antenna Port Conducted Spurious Emissions Data (Chain 1, 40 MHz Channel)

Channel MHz	Spurious Freq (MHz)	Measured Level (dBm)	Level Below Carrier (dBc)
5755.0	11510.0	-34.56	-59.3
	17265.0	-34.74	-59.4
	23020.0	-34.15	-58.8
	28775.0	-31.10	-55.8
	34530.0	-26.69	-51.4
5785.0	11570.0	-36.14	-61.7
	17355.0	-35.98	-61.5
	23140.0	-34.23	-59.8
	28925.0	-29.45	-55.0
	34710.0	-27.01	-52.5
5815.0	11630.0	-35.73	-62.1
	17445.0	-35.27	-61.6
	23260.0	-34.20	-60.6
	29075.0	-30.81	-57.2
	34890.0	-27.77	-54.1

Transmitter Radiated Emission (33 dBi Dish, Worst-case)

Frequency in MHz	Horizontal Peak (dBµV/m)	Horizontal Average (dBµV/m)	Vertical Peak (dBµV/m)	Vertical Average (dBµV/m)	Limit @ 3m (dBµV/m)
5745.0	118.6	107.5	118.6	107.5	--
11490.0	56.7	44.2	55.9	43.9	54.0
17235.0	59.0	45.9	61.3	45.1	54.0
22980.0	37.9	33.4	35.8	33.5	54.0
28725.0	38.4	24.9	37.6	24.9	54.0
5785.0	123.2	111.6	123.2	111.6	--
11570.0	57.5	44.8	58.5	45.1	54.0
17355.0	60.7	46.4	61.4	45.4	54.0
23140.0	38.0	35.1	37.7	35.0	54.0
28925.0	38.8	26.3	39.3	26.3	54.0
5825.0	122.0	109.6	125.3	113.7	--
11650.0	58.1	45.4	59.8	44.9	54.0
17475.0	66.0	48.9	64.3	48.0	54.0
23300.0	36.5	34.8	37.0	34.3	54.0
29125.0	37.7	24.9	37.5	25.1	54.0

Other emissions present had amplitudes at least 20 dB below the limit.
Quasi-Peak amplitude emissions are recorded above for frequency range of 30-1000 MHz.
Average amplitude emissions are recorded above for frequency range above 1000 MHz.

Summary of Results for Transmitter Radiated Emissions of Intentional Radiator

The EUT demonstrated compliance with the conducted and radiated emissions requirements of CFR47 Part 15.247. Conducted antenna port power of 26.42 dBm, 0.5 Watts (chain 0), 27.79 dBm, 0.5 Watts (chain 1) was measured. The EUT demonstrated a minimum radiated emission margin of -5.1 dB below the harmonic emission requirements. There were no other significantly measurable emissions in the restricted bands other than those recorded in this report. Other emissions were present with amplitudes at least 20 dB below the requirements. The specifications of CFR47 paragraph 15.247 and RSS-210 were met; there are no deviations or exceptions to the requirements.

Statement of Modifications and Deviations

No modifications to the EUT were required for the unit to demonstrate compliance with the CFR47 Part 15C or RSS-210 emissions requirements. There were no deviations to the specifications.

Annex

- Annex A Measurement Uncertainty Calculations
- Annex B Rogers Labs Test Equipment List
- Annex C Rogers Qualifications
- Annex D FCC Site Registration Letter
- Annex E Industry Canada Site Registration Letter

Annex A Measurement Uncertainty Calculations

Radiated Emissions Measurement Uncertainty Calculation

Measurement of vertically polarized radiated field strength over the frequency range 30 MHz to 1 GHz on an open area test site at 3m and 10m includes following uncertainty:

Contribution	Probability Distribution	Uncertainty (dB)
Antenna factor calibration	normal (k = 2)	±0.58
Cable loss calibration	normal (k = 2)	±0.2
Receiver specification	rectangular	±1.0
Antenna directivity	rectangular	±0.1
Antenna factor variation with height	rectangular	±2.0
Antenna factor frequency interpolation	rectangular	±0.1
Measurement distance variation	rectangular	±0.2
Site Imperfections	rectangular	±1.5

Combined standard uncertainty $u_c(y)$ is

$$U_c(y) = \pm \sqrt{\left[\frac{1.0}{2}\right]^2 + \left[\frac{0.2}{2}\right]^2 + \left[\frac{1.0^2 + 0.1^2 + 2.0^2 + 0.1^2 + 0.2^2 + 1.5^2}{3}\right]}$$

$U_c(y) = \pm 1.6$ dB

It is probable that $u_c(y) / s(q_k) > 3$, where $s(q_k)$ is estimated standard deviation from a sample of n readings unless the repeatability of the EUT is particularly poor, and a coverage factor of k = 2 will ensure that the level of confidence will be approximately 95%, therefore:

$$s(q_k) = \sqrt{\frac{1}{(n-1)} \sum_{k-1}^{n} (q_k - \bar{q})^2}$$

$U = 2\,U_c(y) = 2 \times \pm 1.6$ dB $= \pm 3.2$ dB

Notes:

1.1 Uncertainties for the antenna and cable were estimated, based on a normal probability distribution with k = 2.

1.2 The receiver uncertainty was obtained from the manufacturer's specification for which a rectangular distribution was assumed.

1.3 The antenna factor uncertainty does not take account of antenna directivity.

1.4 The antenna factor varies with height and since the height was not always the same in use as when the antenna was calibrated an additional uncertainty is added.

1.5 The uncertainty in the measurement distance is relatively small but has some effect on the received signal strength. The increase in measurement distance as the antenna height is increased is an inevitable consequence of the test method and is therefore not considered a contribution to uncertainty.

1.6 Site imperfections are difficult to quantify but may include the following contributions:
-Unwanted reflections from adjacent objects.
-Ground plane imperfections: reflection coefficient, flatness, and edge effects.
-Losses or reflections from "transparent" cabins for the EUT or site coverings.
-Earth currents in antenna cable (mainly effect Biconical antennas).

The specified limits for the difference between measured site attenuation and the theoretical value (± 4 dB) were not included in total since the measurement of site attenuation includes uncertainty contributions already allowed for in this budget, such as antenna factor.

Conducted Measurements Uncertainty Calculation

Measurement of conducted emissions over the frequency range 9 kHz to 30 MHz includes following uncertainty:

Contribution	Probability Distribution	Uncertainty (dB)
Receiver specification	rectangular	±1.5
LISN coupling specification	rectangular	±1.5
Cable and input attenuator calibration	normal (k=2)	±0.5

Combined standard uncertainty $u_c(y)$ is

$$U_c(y) = \pm \sqrt{\left[\frac{0.5}{2}\right]^2 + \frac{1.5^2 + 1.5^2}{3}}$$

$U_c(y) = \pm 1.2$ dB

As with radiated field strength uncertainty, it is probable that $u_c(y) / s(q_k) > 3$ and a coverage factor of k = 2 will suffice, therefore:

$U = 2\ U_c(y) = 2 \times \pm 1.2$ dB $= \pm 2.4$ dB

Annex B Rogers Labs Test Equipment List

List of Test Equipment	Calibration Date
Spectrum Analyzer: Rohde & Schwarz ESU40	5/11
Spectrum Analyzer: HP 8562A, HP Adapters: 11518, 11519, and 11520 Mixers: 11517A, 11970A, 11970K, 11970U, 11970V, 11970W	5/11
Spectrum Analyzer: HP 8591EM	5/11
Antenna: EMCO Biconilog Model: 3143	5/11
Antenna: Sunol Biconilog Model: JB6	10/12
Antenna: EMCO Log Periodic Model: 3147	10/12
Antenna: Com Power Model: AH-118	10/12
Antenna: Antenna Research Biconical Model: BCD 235	10/12
LISN: Compliance Design Model: FCC-LISN-2.Mod.cd, 50 μHy/50 ohm/0.1 μf	10/12
R.F. Preamp CPPA-102	10/12
Attenuator: HP Model: HP11509A	10/12
Attenuator: Mini Circuits Model: CAT-3	10/12
Attenuator: Mini Circuits Model: CAT-3	10/12
Cable: Belden RG-58 (L1)	10/12
Cable: Belden RG-58 (L2)	10/12
Cable: Belden 8268 (L3)	10/12
Cable: Time Microwave: 4M-750HF290-750	10/12
Cable: Time Microwave: 10M-750HF290-750	10/12
Frequency Counter: Leader LDC825	2/11
Oscilloscope Scope: Tektronix 2230	2/11
Wattmeter: Bird 43 with Load Bird 8085	2/11
Power Supplies: Sorensen SRL 20-25, SRL 40-25, DCR 150, DCR 140	2/11
R.F. Generators: HP 606A, HP 8614A, HP 8640B	2/11
R.F. Power Amp 65W Model: 470-A-1010	2/11
R.F. Power Amp 50W M185- 10-501	2/11
R.F. Power Amp A.R. Model: 10W 1010M7	2/11
R.F. Power Amp EIN Model: A301	2/11
LISN: Compliance Eng. Model 240/20	2/11
LISN: Fischer Custom Communications Model: FCC-LISN-50-16-2-08	2/11
Antenna: EMCO Dipole Set 3121C	2/11
Antenna: C.D. B-101	2/11
Antenna: Solar 9229-1 & 9230-1	2/11
Antenna: EMCO 6509	2/11
Audio Oscillator: H.P. 201CD	2/11
ELGAR Model: 1751	2/11
ELGAR Model: TG 704A-3D	2/11
ESD Test Set 2010i	2/11
Fast Transient Burst Generator Model: EFT/B-101	2/11
Field Intensity Meter: EFM-018	2/11
KEYTEK Ecat Surge Generator	2/11
Shielded Room 5 M x 3 M x 3.0 M	

Annex C Rogers Qualifications

Scot D. Rogers, Engineer

Rogers Labs, Inc.

Mr. Rogers has approximately 17 years experience in the field of electronics. Engineering experience includes six years in the automated controls industry and remaining years working with the design, development and testing of radio communications and electronic equipment.

Positions Held

Systems Engineer: A/C Controls Mfg. Co., Inc. 6 Years

Electrical Engineer: Rogers Consulting Labs, Inc. 5 Years

Electrical Engineer: Rogers Labs, Inc. Current

Educational Background

1) Bachelor of Science Degree in Electrical Engineering from Kansas State University.

2) Bachelor of Science Degree in Business Administration Kansas State University.

3) Several Specialized Training courses and seminars pertaining to Microprocessors and Software programming.

Scot D Rogers

Scot D. Rogers

Annex D FCC Site Registration Letter

FEDERAL COMMUNICATIONS COMMISSION

Laboratory Division
7435 Oakland Mills Road
Columbia, MD 21046

November 01, 2011

Registration Number: 90910

Rogers Labs, Inc.
4405 West 259th Terrace,
Louisburg, KS 66053

Attention: Scot Rogers,

Re: Measurement facility located at Louisburg
3 & 10 meter site
Date of Renewal: November 01, 2011

Dear Sir or Madam:

Your request for renewal of the registration of the subject measurement facility has been received. The information submitted has been placed in your file and the registration has been renewed. The name of your organization will remain on the list of facilities whose measurement data will be accepted in conjunction with applications for Certification under Parts 15 or 18 of the Commission's Rules. Please note that the file must be updated for any changes made to the facility and the registration must be renewed at least every three years.

Measurement facilities that have indicated that they are available to the public to perform measurement services on a fee basis may be found on the FCC website www.fcc.gov under E-Filing, OET Equipment Authorization Electronic Filing, Test Firms.

Sincerely,

Phyllis Parrish
Industry Analyst

Annex E Industry Canada Site Registration Letter

Industry Canada Industrie Canada

December 28, 2011

OUR FILE: 46405-3041
Submission No: 152685

Rogers Labs Inc.
4405 West 259th Terrance
Louisburg, KS, 66053
USA

Attention: Mr. Scot D. Rogers

Dear Sir/Madame:

The Bureau has received your application for the renewal of 3/10m OATS. Be advised that the information received was satisfactory to Industry Canada. The following number(s) is now associated to the site(s) for which registration / renewal was sought (**Site# 3041A-1**). Please reference the appropriate site number in the body of test reports containing measurements performed on the site. In addition, please keep for your records the following information;

- The company address code associated to the site(s) located at the above address is: **3041A**

Furthermore, to obtain or renew a unique site number, the applicant shall demonstrate that the site has been accredited to ANSI C63.4-2003 or later. A scope of accreditation indicating the accreditation by a recognized accreditation body to ANSI C63.4-2003 or later shall be accepted. Please indicate in a letter the previous assigned site number if applicable and the type of site (example: 3 metre OATS or 3 metre chamber). If the test facility is not accredited to ANSI C63.4-2003 or later, the test facility shall submit test data demonstrating full compliance with the ANSI standard. The Bureau will evaluate the filing to determine if recognition shall be granted.

The frequency for re-validation of the test site and the information that is required to be filed or retained by the testing party shall comply with the requirements established by the accrediting organization. However, in all cases, test site re-validation shall occur on an interval not to **exceed three years**. There is no fee or form associated with an OATS filing. OATS submissions are encouraged to be submitted electronically to the Bureau using the following URL;
http://strategis.ic.gc.ca/epic/internet/inceb-bhst.nsf/en/h_tt00052e.html.

If you have any questions, you may contact the Bureau by e-mail at certification.bureau@ic.gc.ca Please reference our file and submission number above for all correspondence.

Yours sincerely,

Dalwinder Gill

Dalwinder Gill
For: Wireless Laboratory Manager
Certification and Engineering Bureau
3701 Carling Ave., Building 94
P.O. Box 11490, Station "H"
Ottawa, Ontario K2H 8S2
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