

Report on Test Measurements

Measurements Report

The measurement report shows compliance information against the pertinent technical standards. Each parameter is measured generally at the low end, middle, and at the high end of the applicable frequency band. Each section of the report contains either verbiage or graphs which show compliance to applicable standards as required, explains testing method used, and indicates what the applicable specification is. A list of test equipment for all sections, and certification signoff page are included at the end of the measurement report.

SUBMITTED MEASURED DATA -- INDEX

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RF Power Output Data

The RF power output was measured with the indicated voltage applied to and current into the final RF amplifying device(s). The DC current indicated is the total for the final RF amplifier stage.

Linear Simulast Modulation Mode:

	<u>768 MHz</u>	<u>772 MHz</u>	<u>776 MHz</u>	
Measured RF output	<u>33</u>	<u>33</u>	<u>33</u>	Watts
DC Voltage, final RF amplifier stage/stages	<u>25.5</u>	<u>25.5</u>	<u>25.5</u>	Volts
DC Current, final RF amplifier stage/stages	<u>4.9</u>	<u>4.8</u>	<u>4.8</u>	Amperes
Input power for final RF amplifying device(s)	<u>124</u>	<u>123</u>	<u>122</u>	Watts
Primary Radio Input Supply Voltage	<u>120</u>	<u>120</u>	<u>120</u>	Volts AC
Minimum Measured RF output	<u>2</u>	<u>2</u>	<u>2</u>	Watts
DC Voltage, final RF amplifier stage/stages	<u>19.0</u>	<u>19.0</u>	<u>19.0</u>	Volts
Normal DC Current	<u>1.6</u>	<u>1.6</u>	<u>1.6</u>	Amperes
Input power for final RF amplifying device(s)	<u>30</u>	<u>30</u>	<u>30</u>	Watts
Primary Radio Input Supply Voltage	<u>120</u>	<u>120</u>	<u>120</u>	Volts AC

Compatible 4-Level Frequency Modulation Mode:

	<u>768 MHz</u>	<u>772 MHz</u>	<u>776 MHz</u>	
Measured RF output	<u>33</u>	<u>33</u>	<u>33</u>	Watts
DC Voltage, final RF amplifier stage/stages	<u>25.5</u>	<u>25.5</u>	<u>25.5</u>	Volts
DC Current, final RF amplifier stage/stages	<u>5.3</u>	<u>5.3</u>	<u>5.2</u>	Amperes
Input power for final RF amplifying device(s)	<u>135</u>	<u>134</u>	<u>133</u>	Watts
Primary Radio Input Supply Voltage	<u>120</u>	<u>120</u>	<u>120</u>	Volts AC
Minimum Measured RF output	<u>2</u>	<u>2</u>	<u>2</u>	Watts
DC Voltage, final RF amplifier stage/stages	<u>19.0</u>	<u>19.0</u>	<u>19.0</u>	Volts
Normal DC Current	<u>1.6</u>	<u>1.6</u>	<u>1.6</u>	Amperes
Input power for final RF amplifying device(s)	<u>31</u>	<u>31</u>	<u>31</u>	Watts
Primary Radio Input Supply Voltage	<u>120</u>	<u>120</u>	<u>120</u>	Volts AC

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Adjacent Channel Power (ACP) Requirements

The transmitter can utilize various modulation modes as determined by customer requirements, channel usage, and system configuration as described in Exhibit B. These modulations are: High Performance Data (HPD) which operates at 50 Watts (average) in 25 kHz channels; linear modulations which operate at 100 Watts (average) in 12.5 kHz channels, and Compatible 4-Level Frequency Modulation (C4FM) which is a non linear modulation and operates in 12.5 kHz channels at 100 Watts. The two types of linear modulations are similar, Linear Simulcast Modulation (LSM) is for FDMA applications, and H-DQPSK is for TDMA applications. For purposes of the ACP performance present in this exhibit, both of these linear modulations perform similarly and data from only one of them is presented. All of the following charts reference the following setup and specification requirements for the modes summarized as follows:

Modulation Type:	LSM / H-DQPSK	C4FM
Channelization:	12.5 kHz	12.5 kHz
Power Setting:	33Watts, Average	33 Watts

Specification Requirement Limits: FCC §90.543, §27.53 and IC RSS-119 section 5.8.9

§ 90.543	Emission limits: For operation in the 769-775 MHz Band
§ 27.53	Emission limits: For operation in the 775-776 MHz Band
119-5.8.9	Emission limits: For operation in the 768-776 MHz Band

ACCP Tables per 90.543(a), 27.53(e)(6), RSS-119 Sec 5.8.9 Table 13 & 14: For base transmitters designed to operate with a 12.5 kHz channel bandwidth, the ACCP shall be in accordance to the following table.

Offset from Center Frequency (kHz)	Measurement Bandwidth (kHz)	Maximum ACCP (dBc)
9.375	6.25	-40
15.625	6.25	-60
21.875	6.25	-60
37.50	25	-60
62.50	25	-65
87.50	25	-65
150.00	100	-65
250.00	100	-65
350.00	100	-65
≥ 400 kHz to 12 MHz	30 (swept)	-80
12 MHz to paired receive band	30 (swept)	-80
In the paired receive band	30 (swept)	-100

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Adjacent Channel Coupled Power (ACCP) Requirements

ACP measurement procedure: For all measurements modulate the transmitter as it would be modulated in normal operating conditions. The ACP measurements may be made with a spectrum analyzer capable of making direct ACP measurements. "Measurement bandwidth", as used for non-swept measurements, implies an instrument that measures the power in many narrow bandwidths equal to the nominal resolution bandwidth and integrates these powers to determine the total power in the specified measurement bandwidth.

(1) *Setting reference level.* Set transmitter to maximum output power. Using a spectrum analyzer capable of ACP measurements, set the measurement bandwidth to the channel size. Set the frequency offset of the measurement bandwidth to zero and adjust the center frequency of the instrument to the assigned center frequency to measure the average power level of the transmitter. Record this power level in dBm as the "reference power level".

(2) *Non-swept power measurement.* Using a spectrum analyzer capable of ACP measurements, set the measurement bandwidth and frequency offset from the assigned center frequency as shown in the tables above. Any value of resolution bandwidth may be used as long as it does not exceed 2 percent of the specified measurement bandwidth. Measure the power level in dBm. These measurements should be made at maximum power. Calculate ACP by subtracting the reference power level measured in (1) from the measurements made in this step. The absolute value of the calculated ACP must be greater than or equal to the absolute value of the ACP given in the table for each condition above.

(3) *Swept power measurement.* Set a spectrum analyzer to 30 kHz resolution bandwidth, 1 MHz video bandwidth and average, sample, or RMS detection. Set the reference level of the spectrum analyzer to the RMS value of the transmitter power. Sweep above and below the carrier frequency to the limits defined in the tables. Calculate ACP by subtracting the reference power level measured in (1) from the measurements made in this step. The absolute value of the calculated ACP must be greater than or equal to the absolute value of the ACP given in the table for each condition above.

Measurement results:
For measurements less than or equal to 400 kHz offset from the center frequency, the ACCP results are shown in Tabular format. For measurements great than 400 kHz offset from the center frequency, the ACCP results are shown in Graphical format. The results shown are from testing performed at the base radio level without the use of any external transmit filtering.

All results show sufficient margin to the specified requirements.

EXHIBIT	DESCRIPTION
E1-2.1	ACP Tabular Results – Offsets $\leq$ 400 kHz for HPD, H-DQPSK / LSM, and C4FM Modes
E1-2.2, 3, 4	ACP Results >400 kHz for H-DQPSK / LSM, Low End / Middle / High End of band
E1-2.5, 6, 7	ACP Results >400 kHz for C4FM, Low End / Middle / High End of band

Report on Test Measurements

Adjacent Channel Power (ACP) Requirements

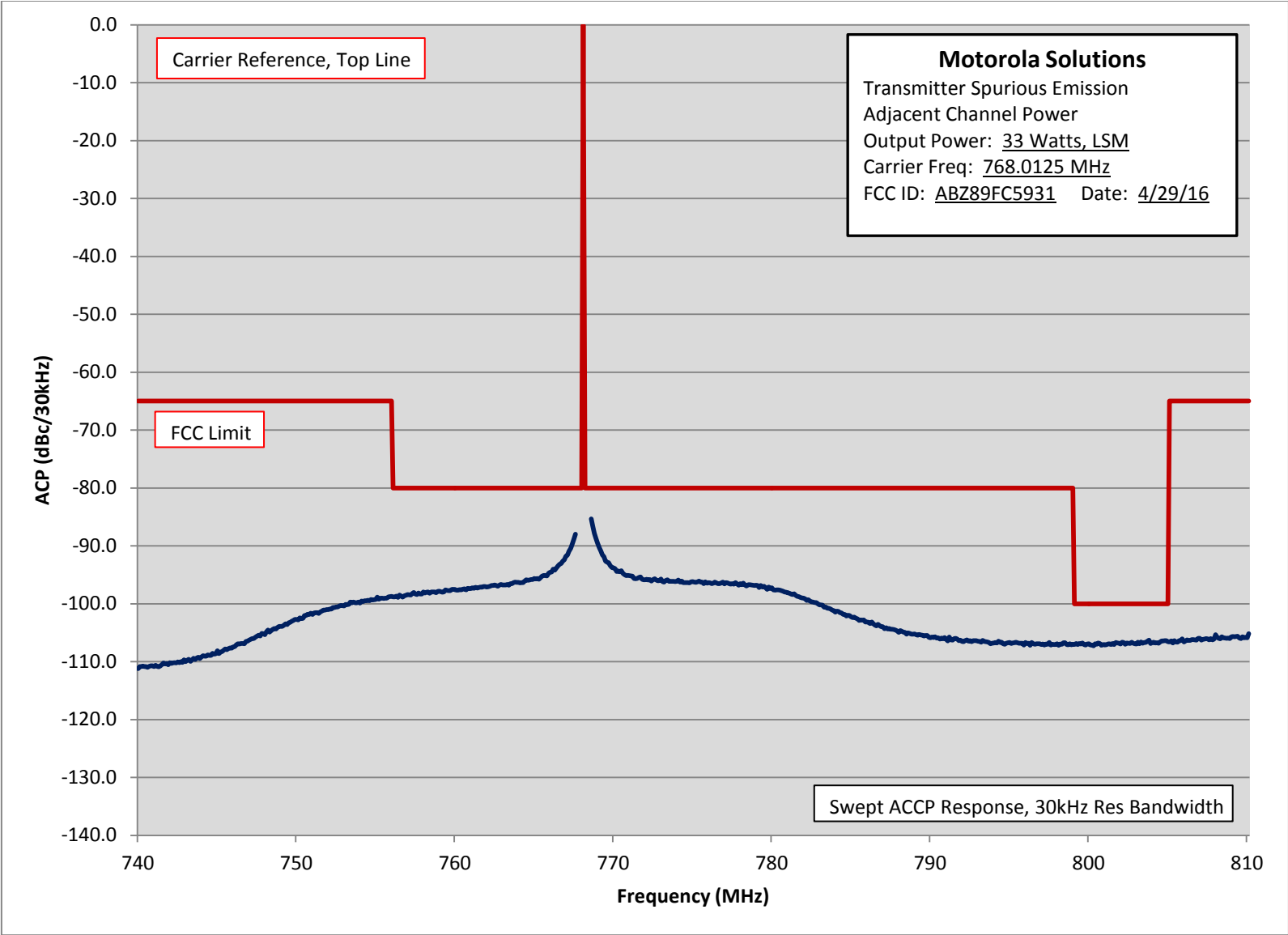
ACP Test Results for offset frequencies ≤ 400 kHz

ACP Test Results: Linear Modulation (H-DQPSK shown), Pout = 33 Watts (avg), Channel Spacing = 12.5 kHz								
FCC/IC Requirements			Measurement Results					
Offset from Center Freq (kHz)	Measurement BW (kHz)	Maximum ACP (dBc)	768.0125 MHz		772.0125 MHz		775.9875 MHz	
			Max ACP at low side offset freq (dBc)	Max ACP at high side offset freq (dBc)	Max ACP at low side offset freq (dBc)	Max ACP at high side offset freq (dBc)	Max ACP at low side offset freq (dBc)	Max ACP at high side offset freq (dBc)
+/- 9.375	6.25	-40	-42.1	-40.7	-43.0	-41.9	-44.2	-43.6
+/- 15.625	6.25	-60	-81.6	-81.5	-81.3	-81.5	-81.0	-80.9
+/- 21.875	6.25	-60	-83.2	-83.4	-83.8	-84.1	-83.4	-83.5
+/- 37.5	25	-60	-79.1	-79.1	-79.0	-79.1	-78.6	-78.7
+/- 62.5	25	-65	-80.3	-80.0	-80.3	-79.7	-80.2	-80.0
+/- 87.5	25	-65	-81.1	-80.6	-81.2	-80.5	-80.8	-80.0
+/- 150	100	-65	-75.6	-74.9	-75.6	-74.9	-75.5	-74.8
+/- 250	100	-65	-77.7	-76.5	-77.8	-76.4	-77.7	-76.4
+/- 350	100	-65	-79.7	-78.1	-79.5	-78.0	-79.5	-77.9
+/- 400	30 (swept)	-80	-86.5	-83.9	-86.5	-83.9	-86.8	-83.7

ACP Test Results: C4FM Modulation, Pout = 33 Watts, Channel Spacing = 12.5 kHz								
FCC/IC Requirements			Measurement Results					
Offset from Center Freq (kHz)	Measurement BW (kHz)	Maximum ACP (dBc)	768.0125 MHz		772.0125 MHz		775.9875 MHz	
			Max ACP at low side offset freq (dBc)	Max ACP at high side offset freq (dBc)	Max ACP at low side offset freq (dBc)	Max ACP at high side offset freq (dBc)	Max ACP at low side offset freq (dBc)	Max ACP at high side offset freq (dBc)
+/- 9.375	6.25	-40	-41.4	-40.7	-40.1	-40.6	-41.3	-42.8
+/- 15.625	6.25	-60	-81.3	-81.5	-81.4	-81.8	-81.5	-81.6
+/- 21.875	6.25	-60	-84.2	-83.4	-83.9	-83.7	-83.1	-82.9
+/- 37.5	25	-60	-79.2	-79.1	-78.9	-79.2	-78.9	-78.8
+/- 62.5	25	-65	-80.5	-80.0	-80.3	-79.8	-80.1	-79.7
+/- 87.5	25	-65	-81.2	-80.6	-81.2	-80.7	-80.7	-80.3
+/- 150	100	-65	-75.6	-74.9	-75.6	-74.7	-75.6	-74.9
+/- 250	100	-65	-77.9	-76.5	-77.8	-76.3	-77.7	-76.3
+/- 350	100	-65	-79.8	-78.1	-79.6	-78.0	-79.4	-77.7
+/- 400	30 (swept)	-80	-86.1	-83.8	-86.5	-83.9	-86.2	-83.5

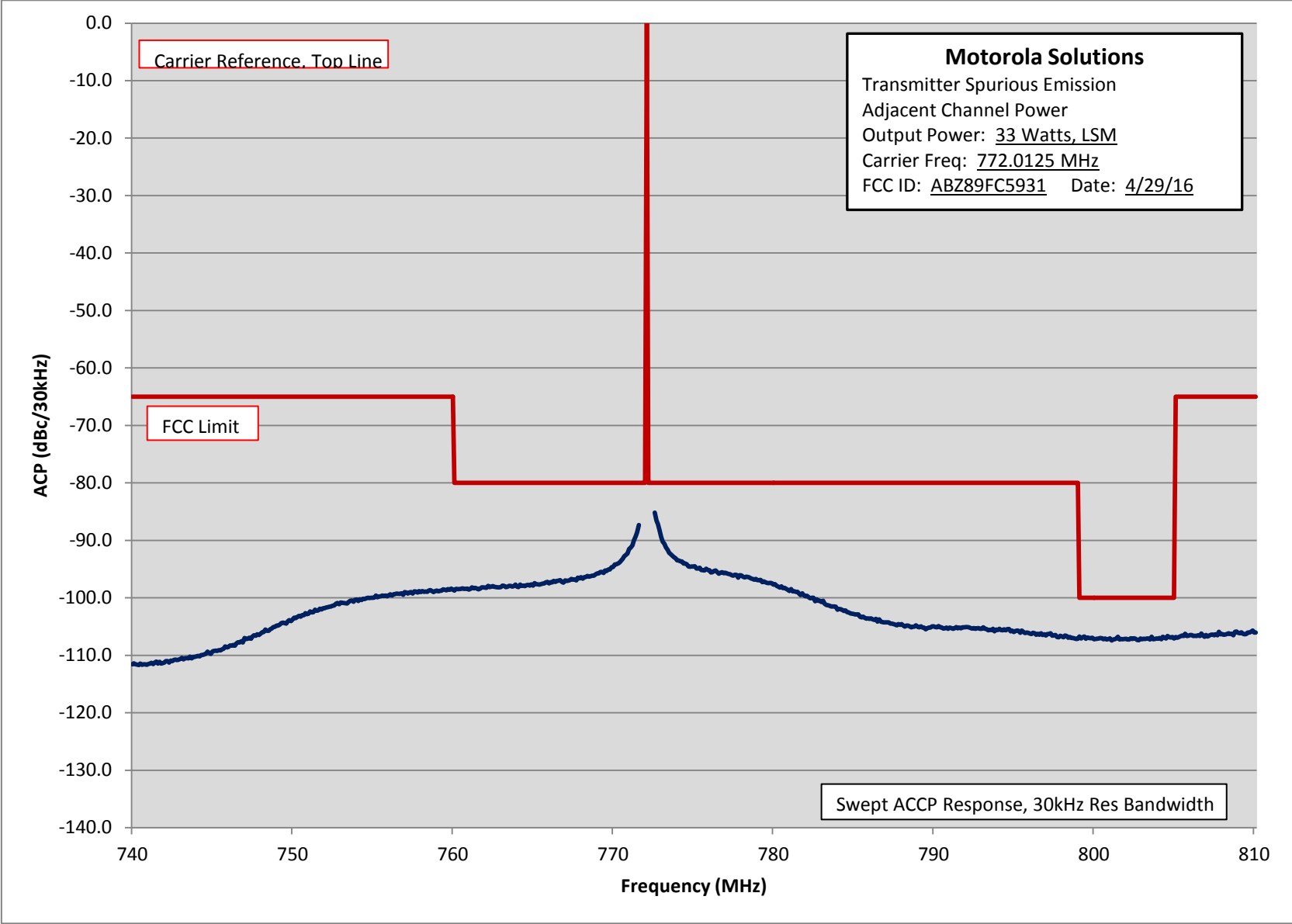
Report on Test Measurements

ACP – Linear Simulcast Modulation – offset > 400 kHz – Low End of Band



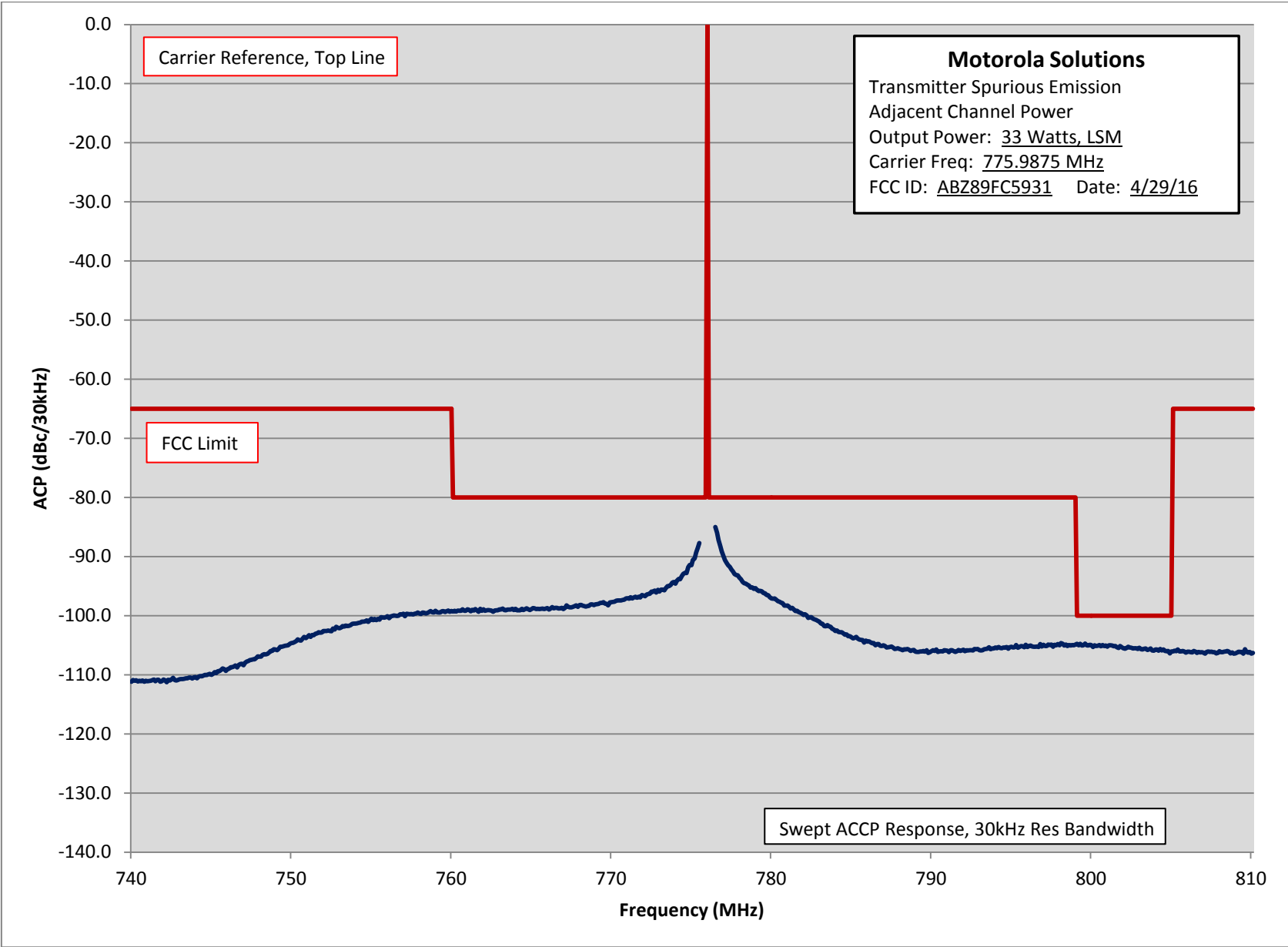
Report on Test Measurements

ACP – Linear Simulcast Modulation – offset > 400 kHz – Middle of Band



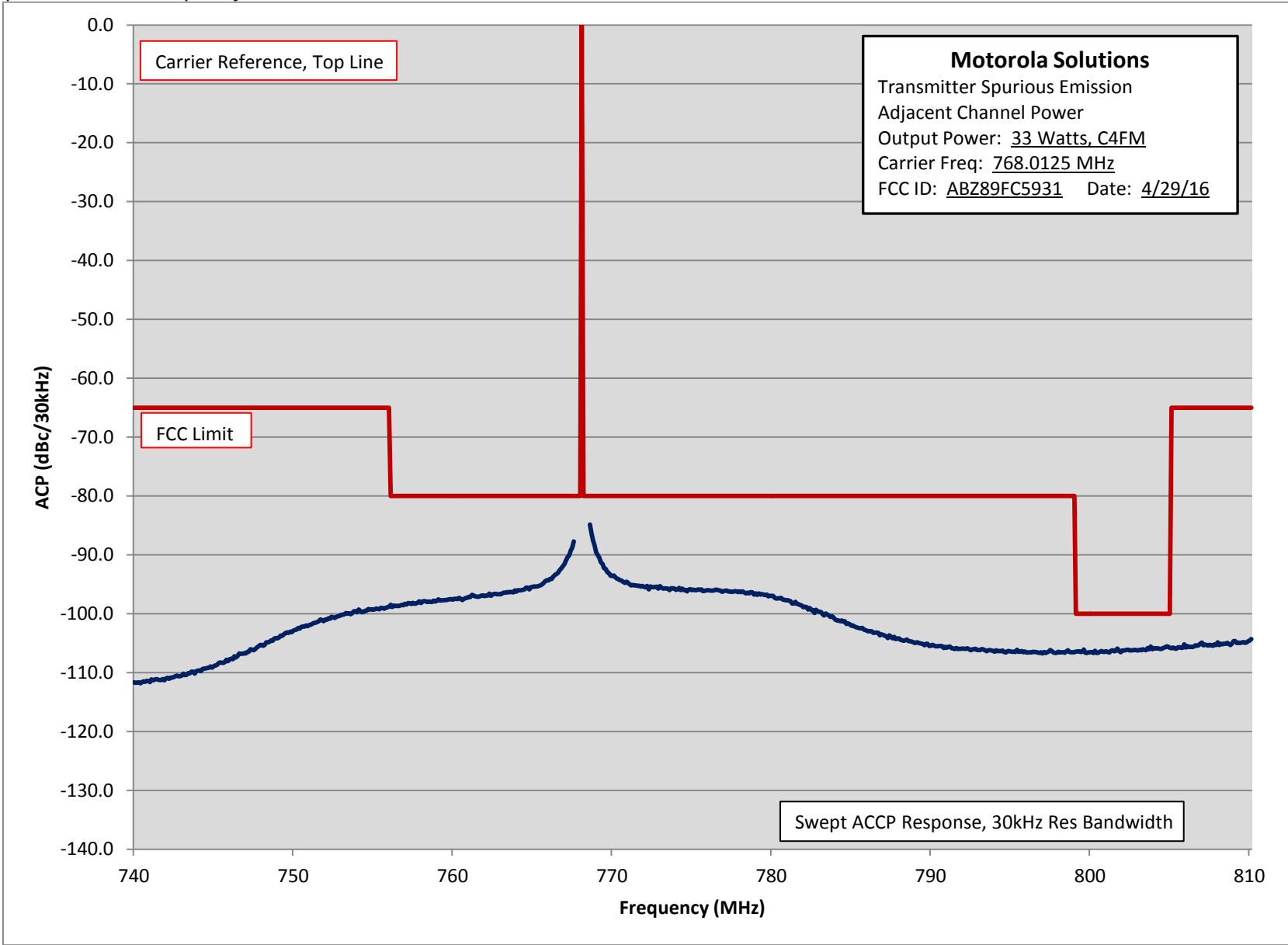
Report on Test Measurements

ACP – Linear Simulcast Modulation – offset > 400 kHz – High End of Band



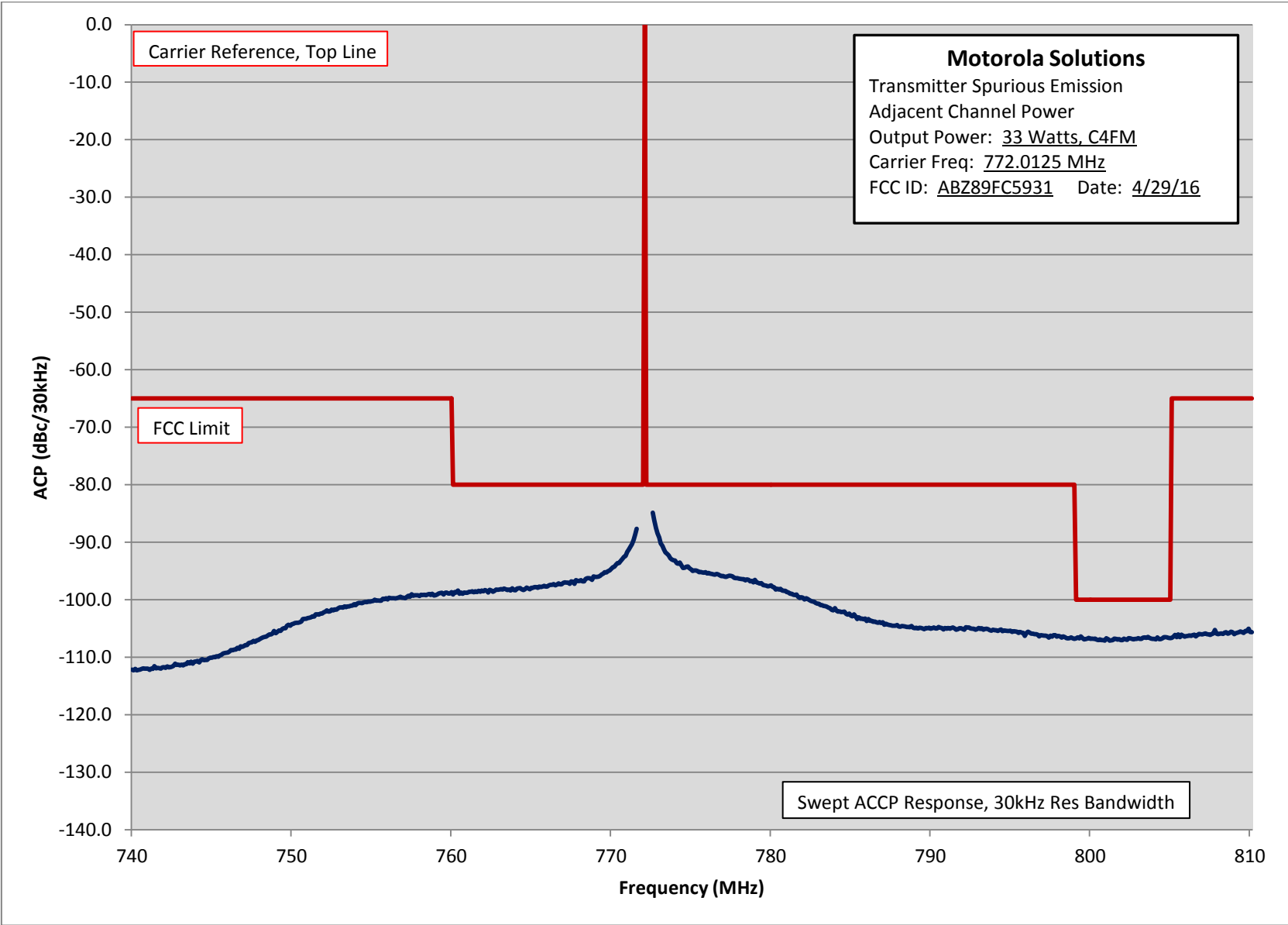
Report on Test Measurements

ACP – Compatible 4-Level Frequency Modulation – offset > 400 kHz – Low End of Band



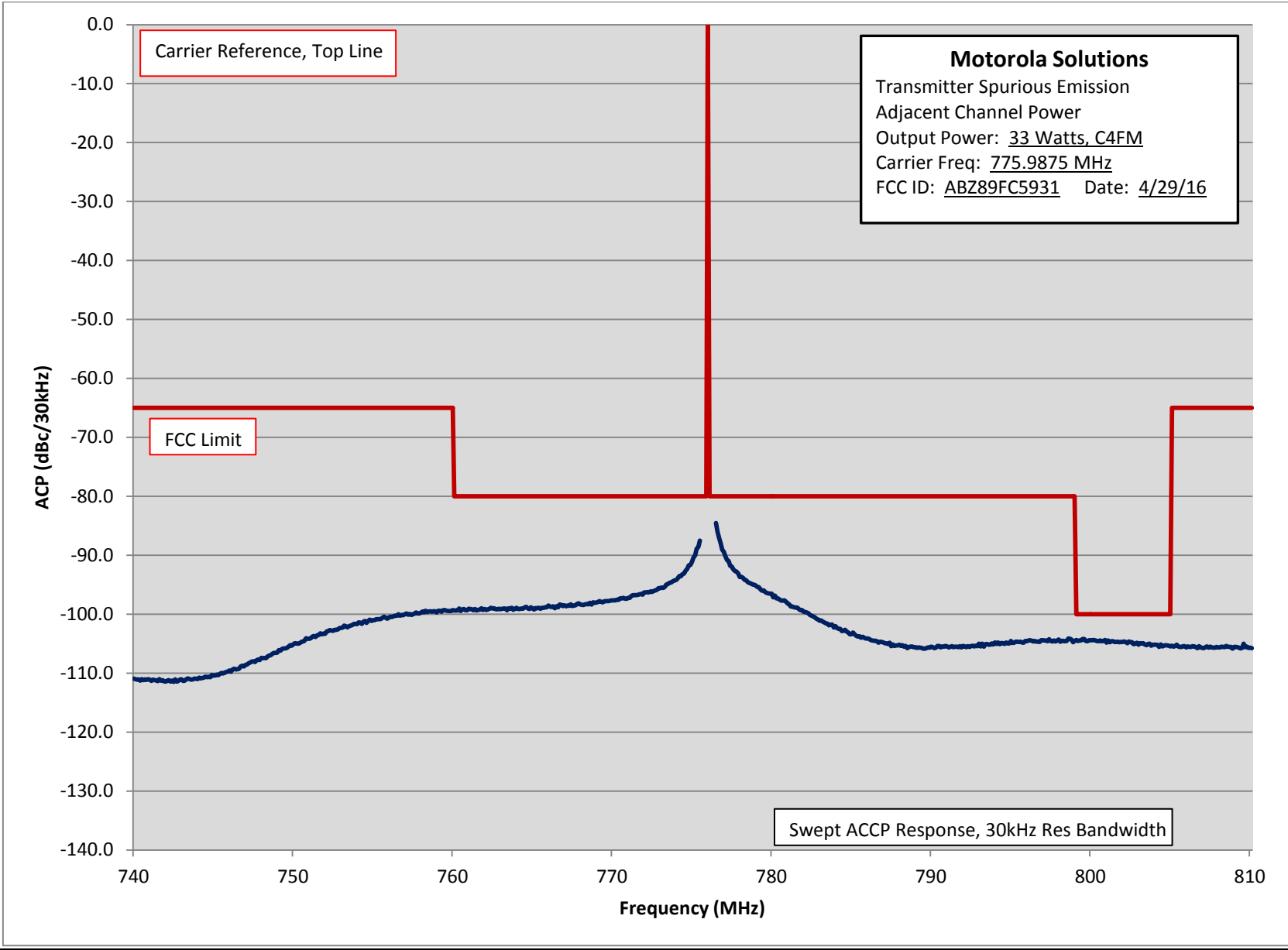
Report on Test Measurements

ACP – Compatible 4-Level Frequency Modulation – offset > 400 kHz – Middle of Band



Report on Test Measurements

ACP – Compatible 4-Level Frequency Modulation – offset > 400 kHz – High End of Band



Report on Test Measurements

Conducted Spurious Emissions – Harmonics and Emission Spectrum

Specification Requirement RSS-119 section 5.8.9.2, FCC § 90.543(c), and 27.53(d)(3) Emission Limits:

Out-of-band emission limit: On any frequency outside of the frequency ranges covered by the ACP tables in this section, the power of any emission must be reduced below the mean output power (P):

At least $43 + 10 \log (P)$ dB

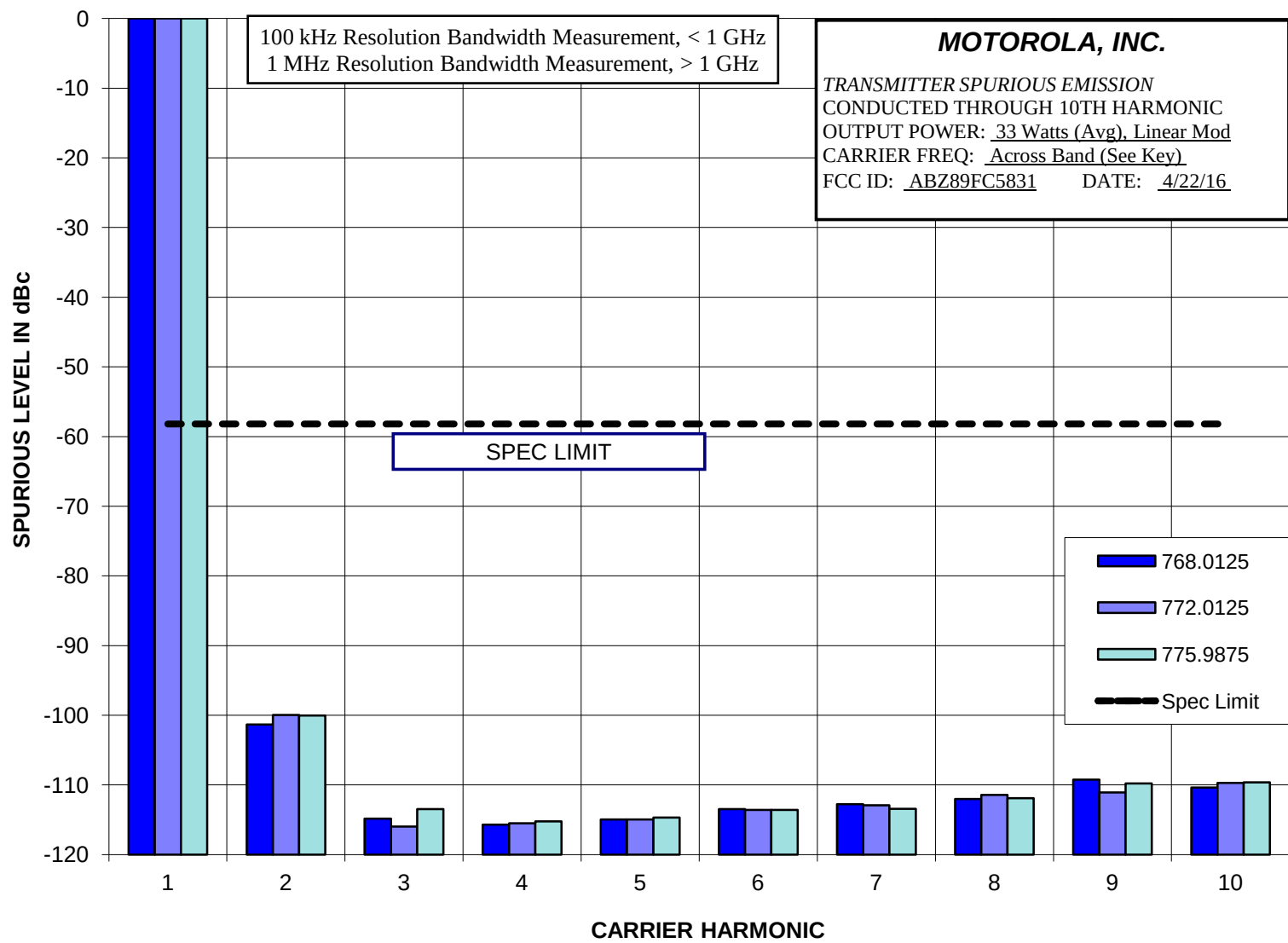
measured in a 100 kHz bandwidth for frequencies less than 1 GHz, and in a 1 MHz bandwidth for frequencies greater than 1 GHz.

Modulation: Linear Simulcast Modulation (LSM), or Compatible 4-Level Frequency Modulation (C4FM) as indicated

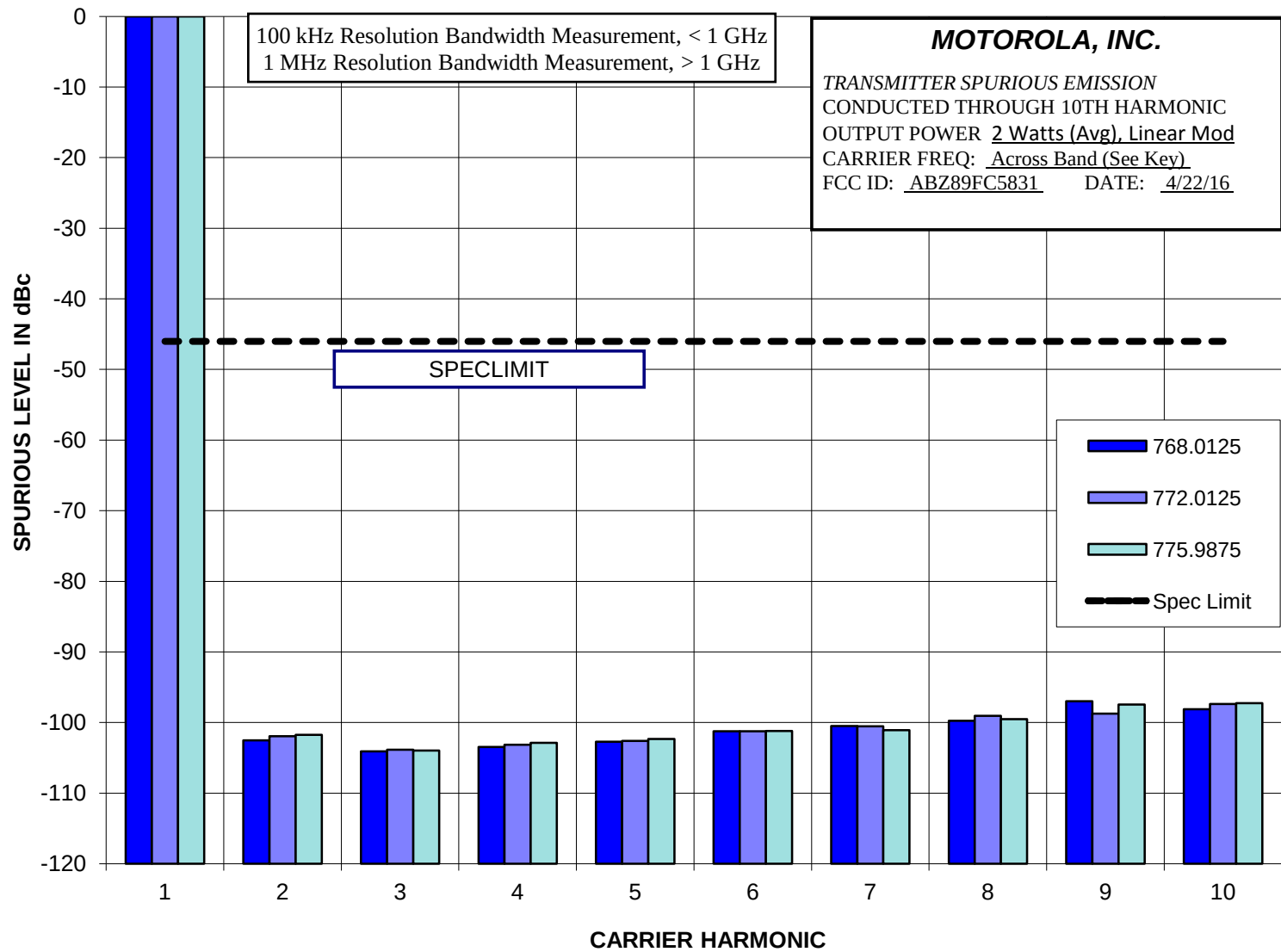
Carrier Frequencies: Carrier frequencies across the band were measured. For LSM and C4FM, carrier frequencies of 768.0125, , 772.0125, and 775.9875 MHz were measured for conducted carrier harmonics. These frequencies represent the low end, center, and high end of the 768-776 MHz operating band, and are representative of the full operating band

EXHIBIT	DESCRIPTION
E1-3.1	Conducted Spurious Harmonic Emissions, Power Output 33 Watts (Average), LSM The specification limit is -58.2 dBc
E1-3.2	Conducted Spurious Harmonic Emissions, Power Output 2 Watts (Average), LSM The specification limit is -46.0 dBc
E1-3.3	Conducted Spurious Harmonic Emissions, Power Output 33 Watts, C4FM The specification limit is -58.2 dBc
E1-3.4	Conducted Spurious Harmonic Emissions, Power Output 2 Watts, C4FM The specification limit is -46.0 dBc

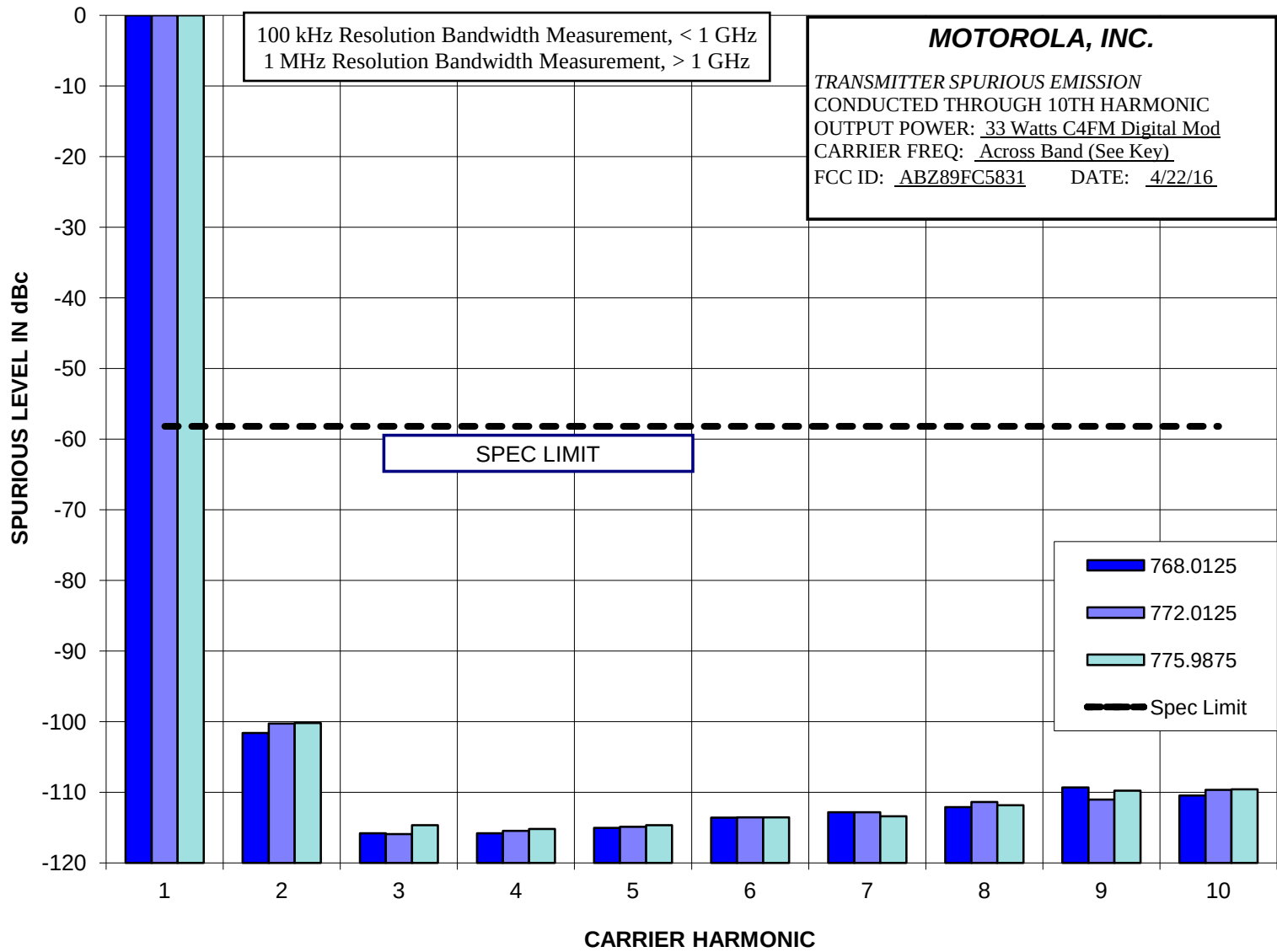
Report on Test Measurements
 Conducted Spurious Harmonic Emissions — 33 Watts (Average) – Linear Simulcast Modulation (LSM)



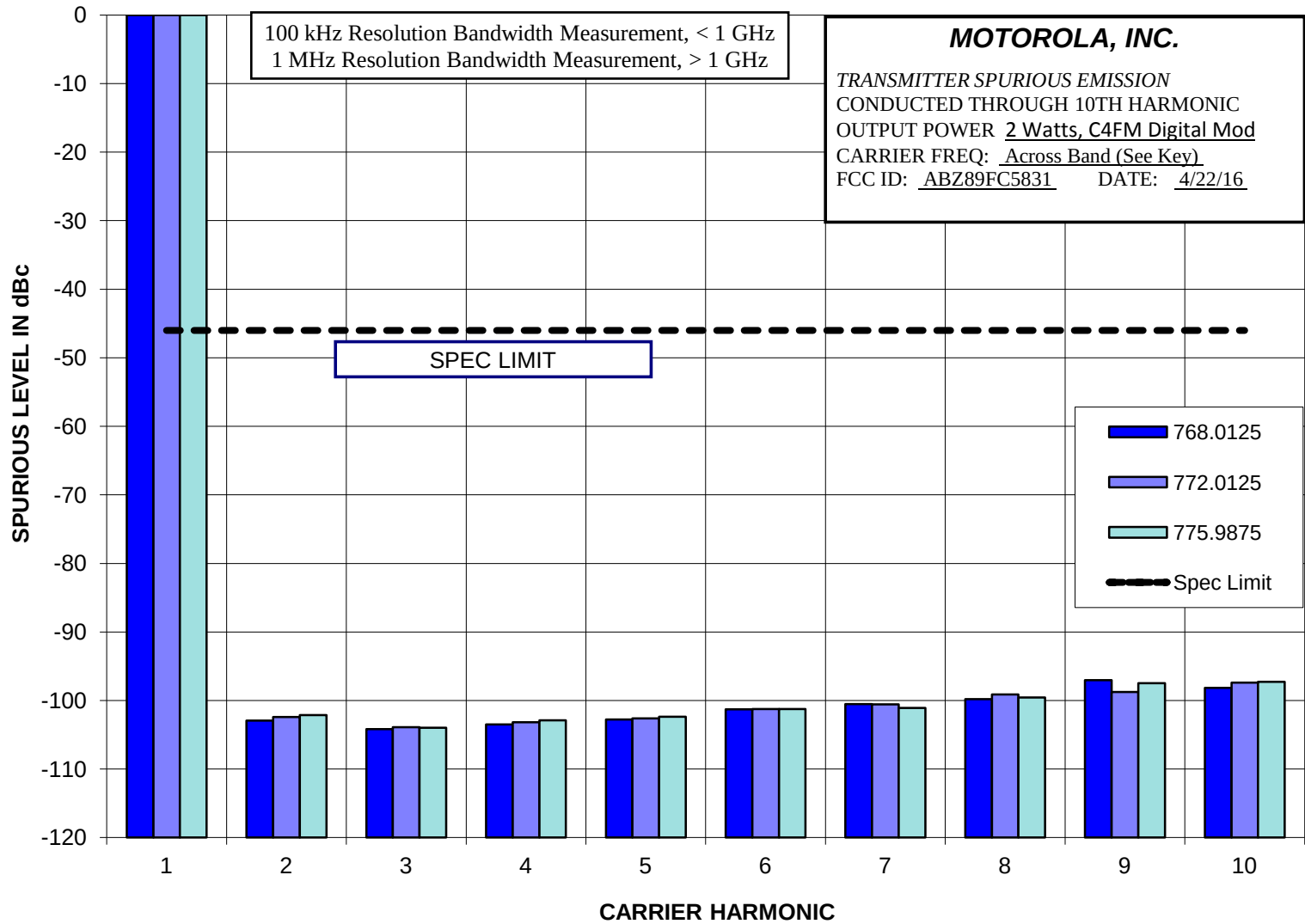
Report on Test Measurements
 Conducted Spurious Harmonic Emissions — 2 Watts (Average) – Linear Simulcast Modulation (LSM)



Report on Test Measurements
 Conducted Spurious Harmonic Emissions — 33 Watts – Compatible Four-Level Frequency Modulation (C4FM)



Report on Test Measurements
 Conducted Spurious Harmonic Emissions — 2 Watts – Compatible Four-Level Frequency Modulation (C4FM)



Report on Test Measurements

Radiated Spurious Emissions, Harmonics

Specification Requirement RSS-119 section 5.8.9.2, FCC § 90.543(c), and 27.53(d)(3) Emission Limits:
Out-of-band emission limit: On any frequency outside of the frequency ranges covered by the ACP tables in this section, the power of any emission must be reduced below the mean output power (P):

At least $43 + 10 \log (P)$ dB

measured in a 100 kHz bandwidth for frequencies less than 1 GHz, and in a 1 MHz bandwidth for frequencies greater than 1 GHz.

Modulation: Compatible 4-Level Frequency Modulation (C4FM),

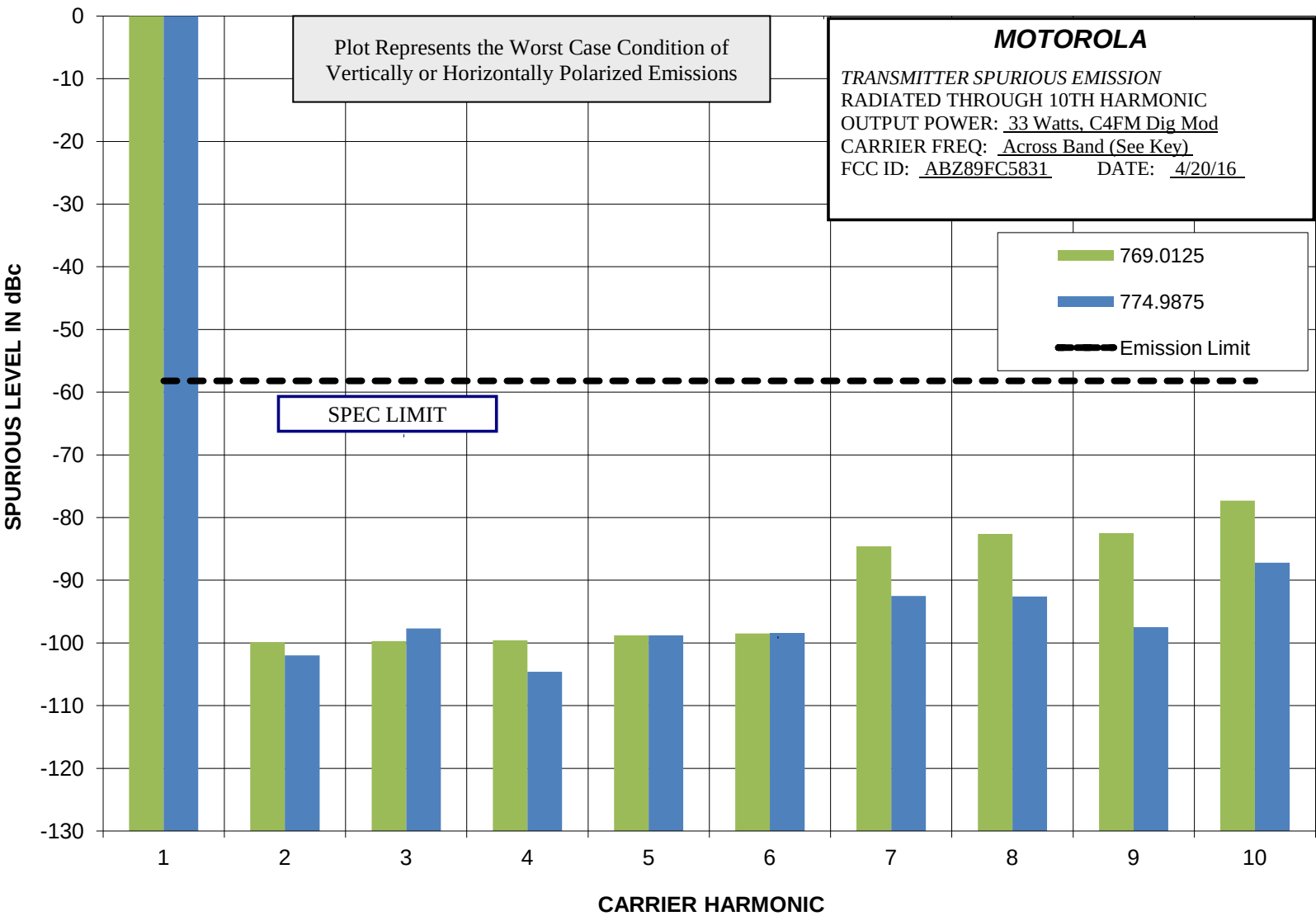
Carrier Frequencies: Carrier frequencies at the low end and high end of the band were measured. Carrier frequencies of 769.0125, and 774.9875 MHz were measured for radiated carrier harmonics. These frequencies represent the low end and high end of the 769-775 MHz operating band, and are representative of the full operating band.

EXHIBIT DESCRIPTION

- E1-4.1 Radiated Spurious Harmonic Emissions, Power Output 3 Watts (Average), C4FM
The specification limit is -58.2 dBc
- E1-4.2 Radiated Spurious Harmonic Emissions, Power Output 2 Watts (Average), C4FM
The specification limit is -46.0 dBc

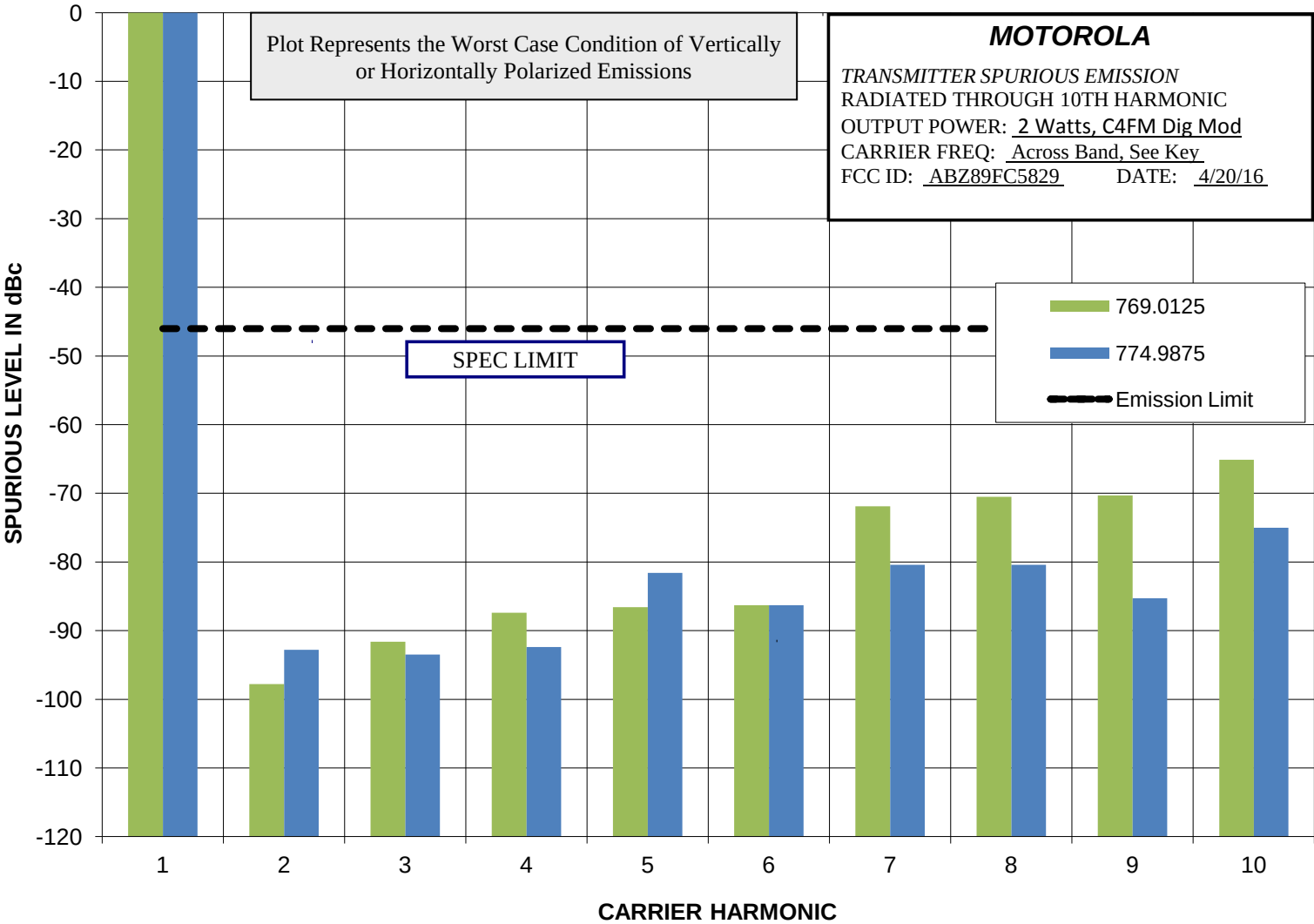
Report on Test Measurements

Radiated Spurious Harmonic Emissions — 33 Watts



Report on Test Measurements

Radiated Spurious Harmonic Emissions — 2 Watts



Report on Test Measurements*Oscillator Frequency Stability*

Manufacturer data for the system site frequency standard was used in generation of the following frequency stability exhibits.

Specification Requirement: Reference IC RSS-119 Section 5.3

Fixed and Base stations operating at 764-776 MHz and 794-806 MHz must have a frequency stability of better than +/- 0.1 PPM for 6.25 kHz, 12.5 kHz, and 25 kHz channel spacing and +/- 1 PPM for 50 kHz channel spacing.

Specification Requirement: Reference FCC Part 90.539(b)

Transmitters designed to operate in 769-775 MHz and 799-805 MHz frequency bands must meet the frequency stability requirements in this section: (b) The frequency stability of base transmitters operating in the narrowband segment must be 100 parts per billion or better.

Specification Requirement: Reference FCC Part 27.54

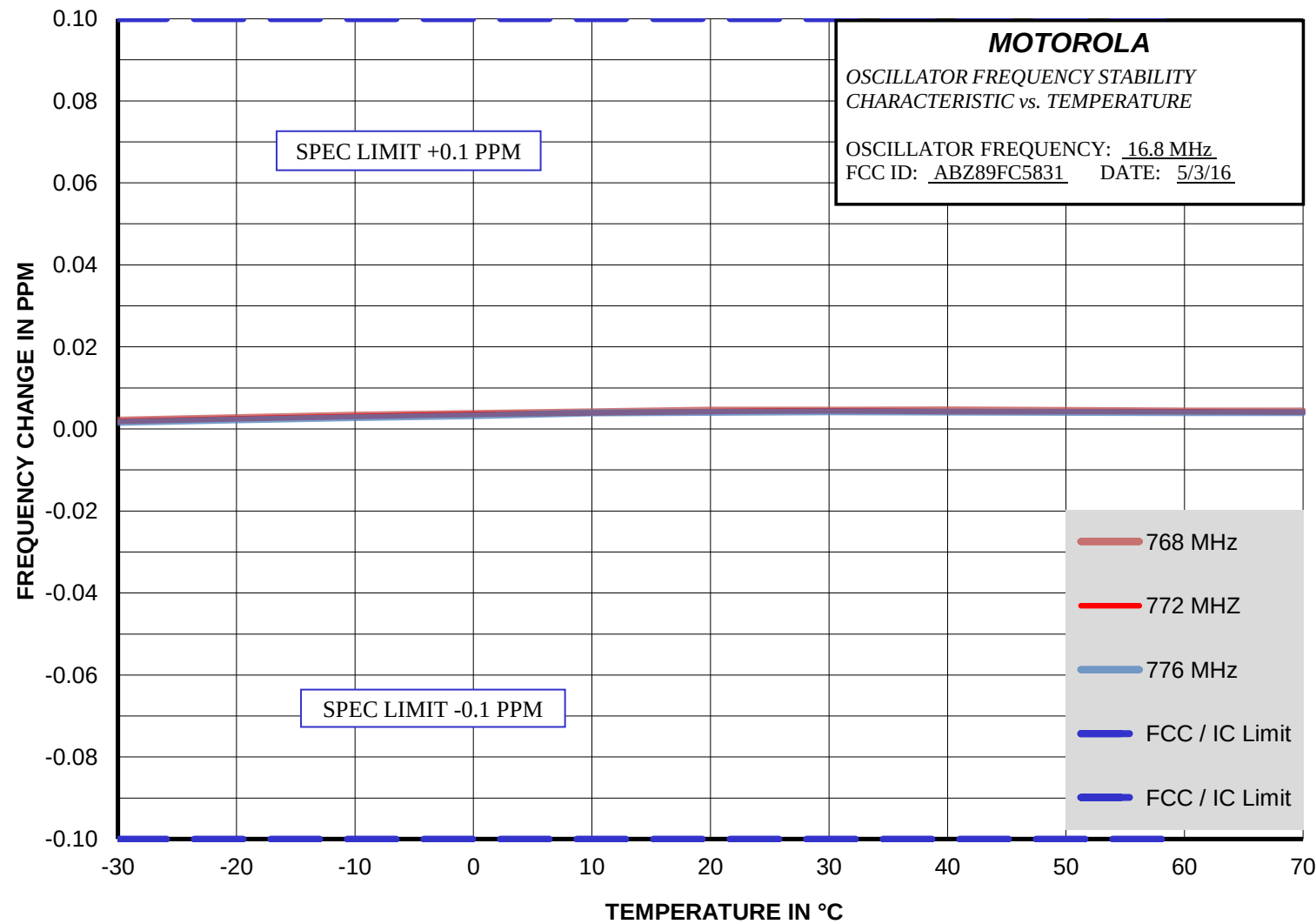
The frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorized bands of operation.

The specification limits for IC and FCC are identical, 0.1 part per million. This specification limit is shown on the following charts. Performance was measured at carrier frequencies at the low end, middle, and high end of the operating band.

<u>EXHIBIT</u>	<u>DESCRIPTION</u>
E1-5.1	Frequency Stability Vs Temperature
E1-5.2	Frequency Stability Vs Voltage

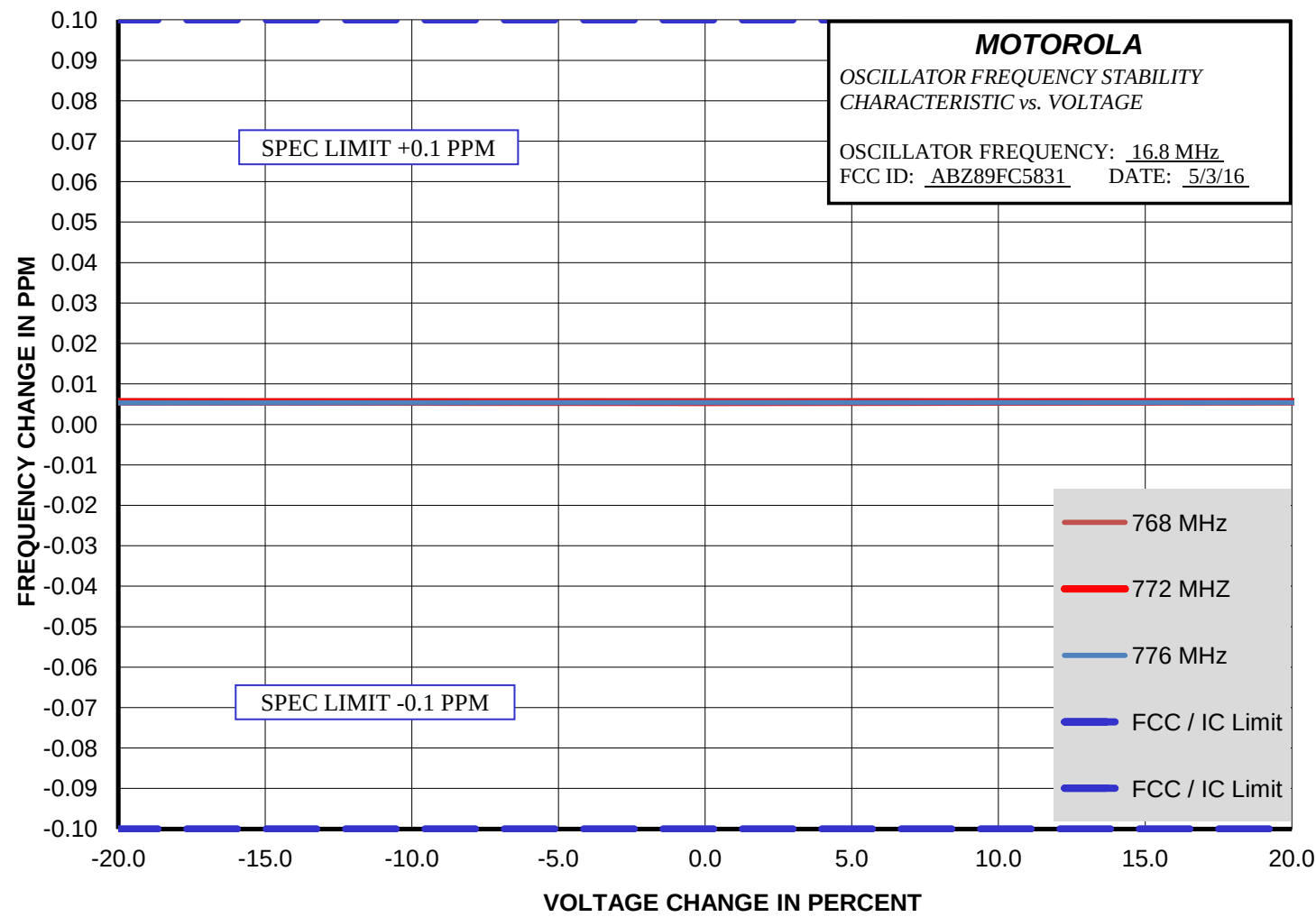
Report on Test Measurements

Frequency Stability Vs Temperature



Report on Test Measurements

Frequency Stability Vs Voltage



Report on Test Measurements

*Protection of the 1559 – 1610 MHz Band*Specification Requirement RSS-119 section 5.8.9.2 Emission Limits:

... for operations in the 764-776 MHz and 794-806 MHz, all emissions (including harmonics in the band 1559-1610 MHz), shall not exceed -70 dBW / MHz e.i.r.p. for wideband emissions, and -80 dBW / kHz e.i.r.p. for discrete emissions of less than 700 Hz bandwidth.

Specification Requirement FCC § 90.543(f) Emission Limits:

For operations in the 763-775 MHz and 793-805 MHz bands, all emissions including harmonics in the band 1559-1610 MHz shall be limited to -70 dBW / MHz equivalent isotropically radiated power (EIRP) for wideband signals, and -80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

Specification Requirement FCC § 27.53(f) Emission Limits:

For operations in the 746-763 MHz, 775-793 MHz, and 805-806 MHz bands, emissions in the band 1559-1610 MHz shall be limited to -70 dBW / MHz equivalent isotropically radiated power (EIRP) for wideband signals, and -80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation

Modulation: Pseudorandom data, Linear Simulcast Modulation (LSM) was used

Power Level: Maximum rated power, 100 Watts (average) was used as a worst case

Carrier Frequency: Performance was measured using a transmitter carrier frequency of 775 MHz. This frequency represents the band edge of the 769-775 MHz IC transmitter band, and also the band edge of the 775-776 MHz FCC part 27 band. The second harmonic for this upper limit frequency is closest to the 1559 – 1610 MHz band. The corresponding receiver channel was set to 805 MHz

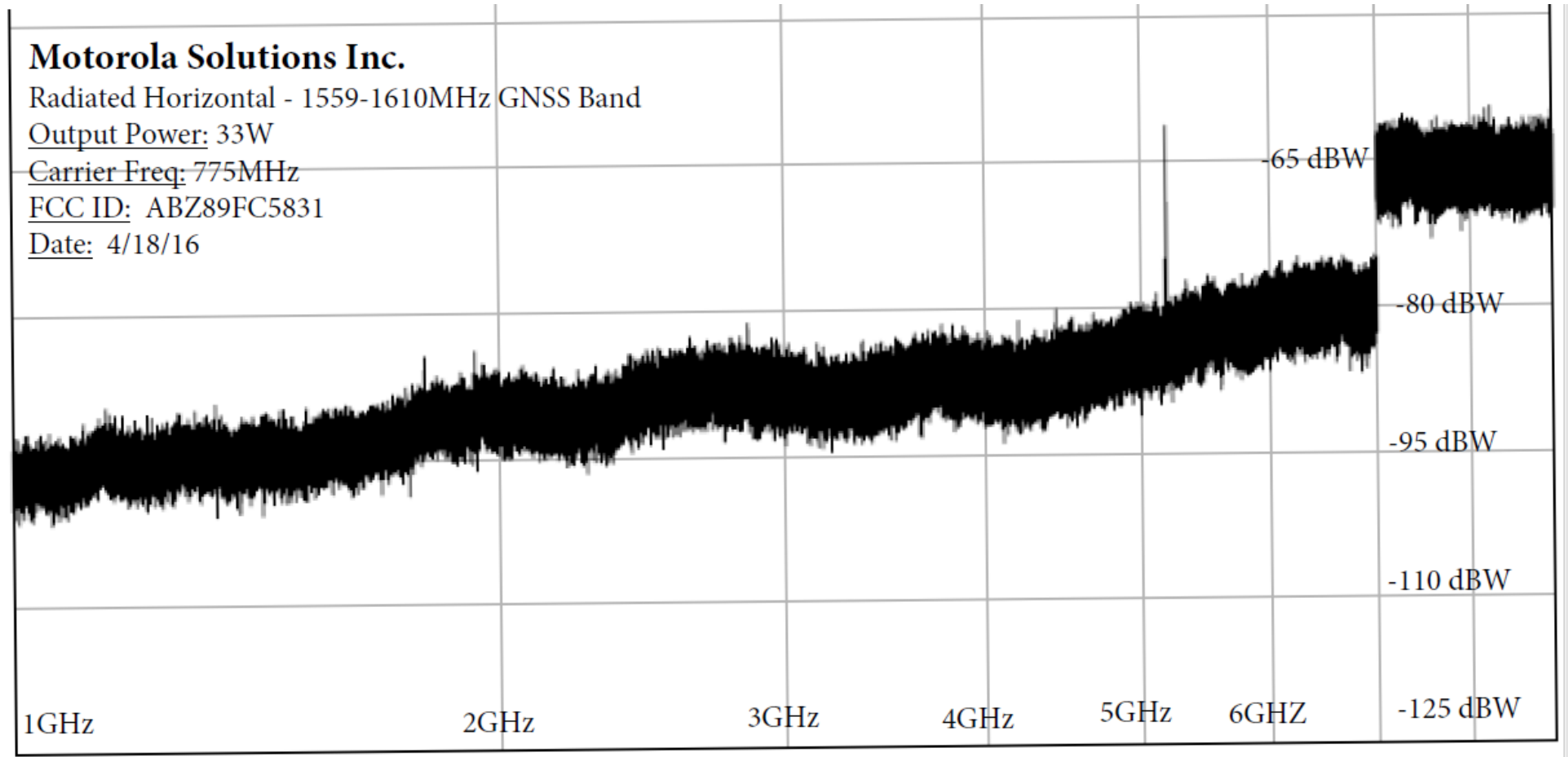
Setup: The data was measured using the base radio to drive a representative antenna. The radiated emissions in the 1559 – 1610 MHz band were recorded.

Results: Test results are shown of the following pages. The emissions were significantly below the specification limit of -70 dBW/MHz and no narrowband emissions were observed.

<u>EXHIBIT</u>	<u>DESCRIPTION</u>
E1-6.1,2	Protection of the 1559 – 1610 MHz Band The specification limit is -70dBW

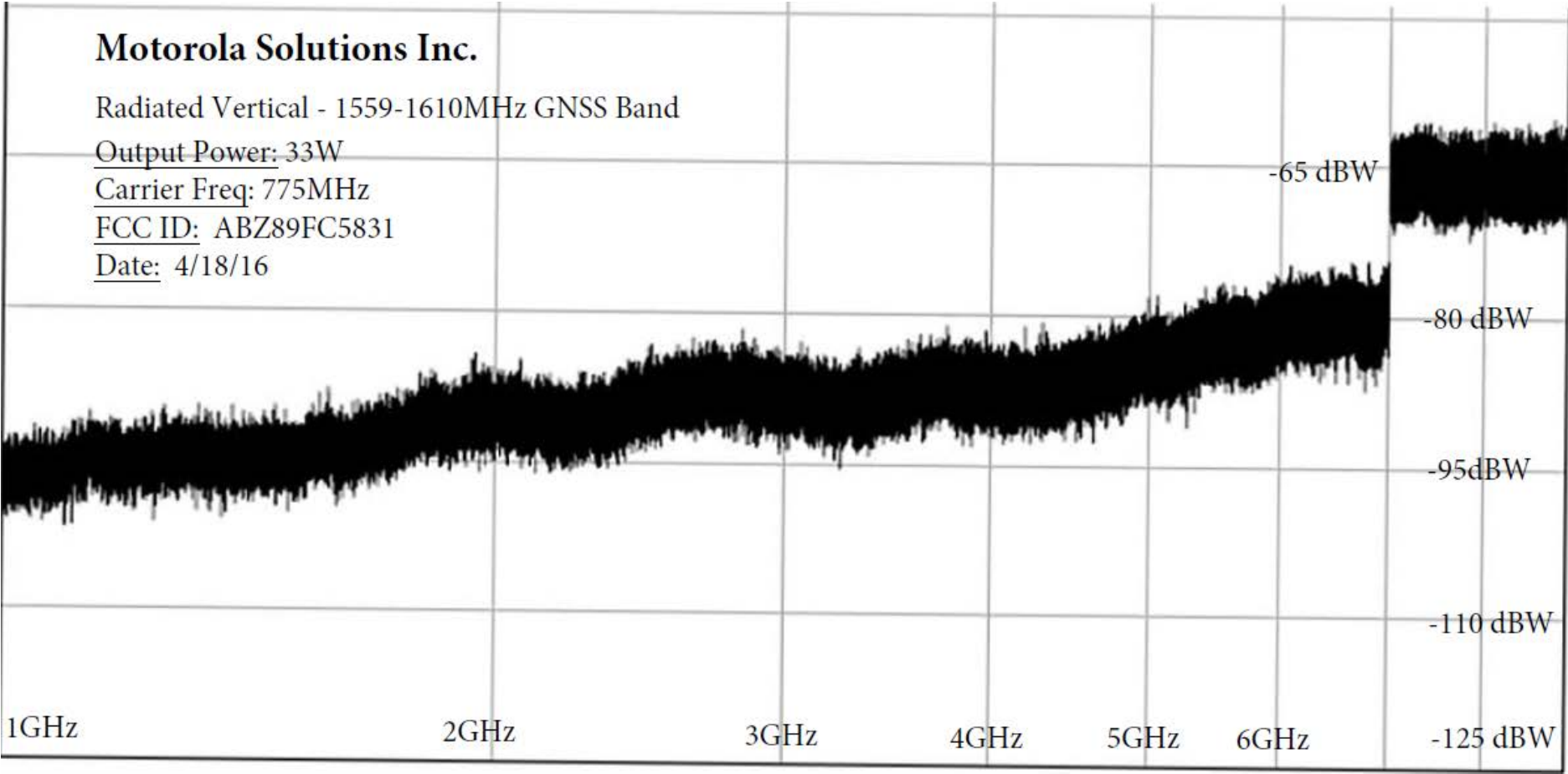
Report on Test Measurements

Protection of the 1559 – 1610 MHz Band



Report on Test Measurements

Protection of the 1559 – 1610 MHz Band



Report on Test Measurements

Test Equipment List

MODEL	MANUFACTURER	DESCRIPTION	Serial No.	Last Cal	Next Cal
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Conducted Harmonics / Conducted Spurious Emission Spectrum

E4440A	Agilent	Spectrum Analyzer	MY46185813	09/04/15	09/04/18
438A	Hewlett Packard	Power Meter	3048U02488	05/07/14	05/07/16
8482A	Hewlett Packard	Power Sensor	GG00004032	05/14/14	05/14/17

Frequency Stability

N9020A	Agilent	Spectrum Analyzer	MY51110030	09/01/15	09/01/18
6032A	Hewlett Packard	DC Power Supply	US38321104	Correlated to DMM (*)	
34401A	Hewlett Packard	Digital Multimeter (*)	US36056373	10/01/14	10/01/15
6813B	Hewlett Packard	AC Power Supply	MY41000529	Correlated to DMM (*)	

Occupied Bandwidth / Modulation Limiting / Audio Frequency Response / Frequency Transients

N9030A	Agilent	Spectrum Analyzer	MY49432180	10/01/14	10/01/17
U8903A	Agilent	Audio Analyzer	MY49420007	09/17/14	09/17/17

Radiated and Power Supply Conducted Emissions

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Due Date
GRB0	1MHZ, LISN SIGNAL CHECKER	ELITE	LISNCHKR1M	1	1MHZ	1/28/2016	1/28/2017
GRE0	SIGNAL GENERATOR	AGILENT TECHNOLOGIES	E4438C	MY42083127	250KHZ-6GHZ	2/25/2016	2/25/2017
GSG0	PSG ANALOG SIGNAL GENERATOR	AGILENT	E8257D	US46461202	250KHZ-50GHZ	7/29/2015	7/29/2016
NTA2	BILOG ANTENNA	TESEQ	6112D	28040	25-1000MHz	10/27/2015	10/27/2016
NWQ2	DOUBLE RIDGED WAVEGUIDE ANTENNA	ETS LINDGREN	3117	66659	1GHZ-18GHZ	3/2/2016	3/2/2018
PLF1	CISPR16 50UH LISN	ELITE	CISPR16/70A	001	.15-30MHz	5/20/2015	5/20/2016
PLF3	CISPR16 50UH LISN	ELITE	CISPR16/70A	003	.15-30MHz	5/20/2015	5/20/2016
RAKG	RF SECTION	HEWLETT PACKARD	85462A	3549A00284	0.009-6500MHZ	2/22/2016	2/22/2017
RAKH	RF FILTER SECTION	HEWLETT PACKARD	85460A	3448A00324	---	2/22/2016	2/22/2017
RAKI	RF SECTION	HEWLETT PACKARD	85462A	3411A00181	0.009-6500MHZ	3/4/2016	3/4/2017
RAKJ	RF FILTER SECTION	HEWLETT PACKARD	85460A	3330A00154	---	3/4/2016	3/4/2017
RBB0	EMI TEST RECEIVER 20HZ TO 40 GHZ	ROHDE & SCHWARZ	ESIB40	100250	20 HZ TO 40GHZ	2/16/2016	2/16/2017
WKA1	SOFTWARE, UNIVERSAL RCV EMI	ELITE	UNIV_RCV_EMI	1	---	I/O	
WQB0	RE_8546A						
WQC0	HF_8546A						

Report on Test Measurements

Statement of Certification

The technical data supplied with this application, having been taken under my supervision is hereby duly certified. The following is a statement of my qualifications:

College Degree: BSEE, University of Illinois, Urbana-Champaign, Illinois, USA

30 years of Design and Development experience in the field of two-way radio communication.

NAME: Robert Sarocka

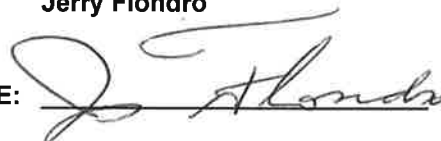
SIGNATURE: 

DATE: June 21, 2016

POSITION: Technical Manager

I hereby certify that the above application was prepared under my direction and that to the best of my knowledge and belief, the facts set forth in the application and accompanying technical data are true and correct:

NAME: Jerry Flondro

SIGNATURE: 

DATE: June 21, 2016

POSITION: Senior Resource Manager