Report on Test Measurements

Measurements Report
The measurement report shows compliance information against the pertinent technical standards. Each section of the report contains either verbiage or graphs which show compliance to applicable standards as required. Each section also explains testing method 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

Report on Test Measurements

Measurements Report

SUBMITTED MEASURED DATA – INDEX (Continued)

Report on Test Measurements

RF Power Output Data

The RF power output was measured with the indicated voltage applied to and current into the final RF amplifying device. The DC current indicated is the total for the final RF amplifier stage, consisting of four parallel power transistors.

Linear Simulcast Modulation Mode:

Measured RF output	**110**	Watts, Average
DC Voltage	**27.6**	Volts
DC Current	**13.5**	Amperes
Input power for final RF amplifying device(s)	**373**	Watts
Primary Radio Input Supply Voltage	**120**	Volts AC
Minimum Measured RF output	**2**	Watts, Average
Normal DC Voltage	**21.0**	Volts
Normal DC Current	**3.9**	Amperes
Input power for final RF amplifying device(s)	**82**	Watts
Primary Radio Input Supply Voltage	**120**	Volts AC

Compatible 4-Level Frequency Modulation Mode:

Measured RF output	**110**	Watts
DC Voltage	**21.0**	Volts
DC Current	**15.0**	Amperes
Input power for final RF amplifying device(s)	**315**	Watts
Primary Radio Input Supply Voltage	**120**	Volts AC
Minimum Measured RF output	**2**	Watts
Normal DC Voltage	**21.0**	Volts
Normal DC Current	**3.9**	Amperes
Input power for final RF amplifying device(s)	**82**	Watts
Primary Radio Input Supply Voltage	**120**	Volts AC

Report on Test Measurements

Occupied Bandwidth – Linear Simulcast Modulation (LSM), 12.5 kHz Channel Spacing
There is one exhibit shown for Linear Simulcast Modulation. It can be used in a system configuration based upon channel usage as described in Exhibit B. The occupied bandwidth chart references the following setup and specification requirements.

Modulation Type:	Linear Simulcast Modulation, LSM
Emission Designator:	8K70D1W
Channelization:	12.5 kHz
Power Setting:	110 Watts, Average

Specification Requirement § 90.210(d) Emission Limits:
Emission *Mask D.* For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

(1) On any frequency from the center of the authorized bandwidth (f_0) to 5.625 kHz removed from f_0: *Zero dB*

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5.625 kHz but no more than 12.5 kHz: *At least 7.27 *(f_d –2.88 kHz) dB*

(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz: *At least 50 plus 10 log_{10}(P) dB or 70 dB, whichever is the lesser attenuation.*

(4) The reference level for showing compliance with the emission mask shall be established using a resolution bandwidth sufficiently wide to capture the true peak emission of the equipment under test. In order to show compliance with the emissions mask up to and including 50 kHz removed from the edge of the authorized bandwidth, adjust the resolution bandwidth to 100 Hz with the measuring instrument in a peak hold mode. A sufficient number of sweeps must be measured to ensure that the emission profile is developed.

Necessary Bandwidth Calculation: The necessary bandwidth of the modulation signal is not calculable per the formulas defined in 47 CFR 2.202 (b). Specifically, although the modulation for this emission is a composite modulation, the equations given in the composite tables in 2.202 are not applicable since none of them adequately approximate the form of digital modulation used. The necessary bandwidth of 8.70 kHz is based upon a 99% power measurement of the transmitter spectrum, per 2.202 (a).

Measurement Procedure and Instrument Settings:
Emission Measurement Analyzer Settings:

Horizontal:	12.5 kHz per Division	Resolution Bandwidth:	100 Hz
Vertical:	10 dB per Division	Video Bandwidth:	10 kHz
Sweep Time:	72 Seconds (<2000 Hz / Second)	Span:	125 kHz
Detector Mode:	Peak		

Test Procedure:
1) Adjust the spectrum analyzer per the values specified in the Emission Measurement Analyzer Settings.
2) Modulate the transmitter with the appropriate signaling pattern, (pseudorandom data) and key the transmitter at the full power rating. Use the analyzer controls to set this signal to the full-scale reference line. Allow the analyzer to sweep fully and store the sweep.
3) Use the band power marker function of the spectrum analyzer to measure the power of the carrier in a 12.5 kHz bandwidth.
4) Use the carrier power value from the previous step to generate the emission mask limit.
5) Plot the resulting analyzer trace and the emission mask limit, add text and labeling as appropriate.

EXHIBIT	DESCRIPTION
E1-2.1	Linear Simulcast Modulation (LSM), Low End of Band
E1-2.2	Linear Simulcast Modulation (LSM), Middle of Band
E1-2.3	Linear Simulcast Modulation (LSM), High End of Band

Report on Test Measurements

Occupied Bandwidth – Compatible 4-Level Frequency Modulation (C4FM), 12.5 kHz Channel Spacing
There is one exhibit shown for C4FM. It can be used in a system configuration based upon channel usage as described in Exhibit B. The occupied bandwidth chart references the following setup and specification requirements.

Modulation Type:	Compatible 4-Level Frequency Modulation, C4FM
Emission Designator:	8K10F1E
Channelization:	12.5 kHz
Power Setting:	110 Watts

Specification Requirement § 90.210(d) Emission Limits:
Emission *Mask D.* For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

(1) On any frequency from the center of the authorized bandwidth (f_0) to 5.625 kHz removed from f_0: *Zero dB*

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5.625 kHz but no more than 12.5 kHz: *At least 7.27 *(f_d –2.88 kHz) dB*

(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz: *At least 50 plus 10 log_{10}(P) dB or 70 dB, whichever is the lesser attenuation.*

(4) The reference level for showing compliance with the emission mask shall be established using a resolution bandwidth sufficiently wide to capture the true peak emission of the equipment under test. In order to show compliance with the emissions mask up to and including 50 kHz removed from the edge of the authorized bandwidth, adjust the resolution bandwidth to 100 Hz with the measuring instrument in a peak hold mode. A sufficient number of sweeps must be measured to ensure that the emission profile is developed.

Necessary Bandwidth Calculation: An occupied bandwidth of 8.10 kHz was measured for this emission, per 2.202 paragraph (a) of the Rules and Regulations, as that bandwidth which contains 99% of the power in the transmitted signal. For this system, the necessary bandwidth has been chosen to be the same as the occupied bandwidth, thereby per paragraph (b) (2), the necessary bandwidth is 8K10.

Measurement Procedure and Instrument Settings:
Emission Measurement Analyzer Settings:

Horizontal:	12.5 kHz per Division	Resolution Bandwidth:	100 Hz
Vertical:	10 dB per Division	Video Bandwidth:	10 kHz
Sweep Time:	72 Seconds (<2000 Hz / Second)	Span:	125 kHz
Detector Mode:	Peak		

Test Procedure:
1) Adjust the spectrum analyzer per the values specified in the Emission Measurement Analyzer Settings.
2) Modulate the transmitter with the appropriate signaling pattern, (pseudorandom data) and key the transmitter at the full power rating. Use the analyzer controls to set this signal to the full-scale reference line. Allow the analyzer to sweep fully and store the sweep.
3) Use the band power marker function of the spectrum analyzer to measure the power of the carrier in a 12.5 kHz bandwidth.
4) Use the carrier power value from the previous step to generate the emission mask limit.
5) Plot the resulting analyzer trace and the emission mask limit, add text and labeling as appropriate.

EXHIBIT	DESCRIPTION
E1-2.4	Compatible 4-Level Frequency Modulation (C4FM), Low End of Band
E1-2.5	Compatible 4-Level Frequency Modulation (C4FM), Middle of Band
E1-2.6	Compatible 4-Level Frequency Modulation (C4FM), High End of Band

APPLICANT: MOTOROLA **EQUIPMENT TYPE: ABZ89FC4821**

Report on Test Measurements

Occupied Bandwidth – Linear Simulcast Modulation (LSM) – Low End of Band

Occupied Bandwidth -- Linear Simulcast Modulation - 8K70D1W - 110 Watts

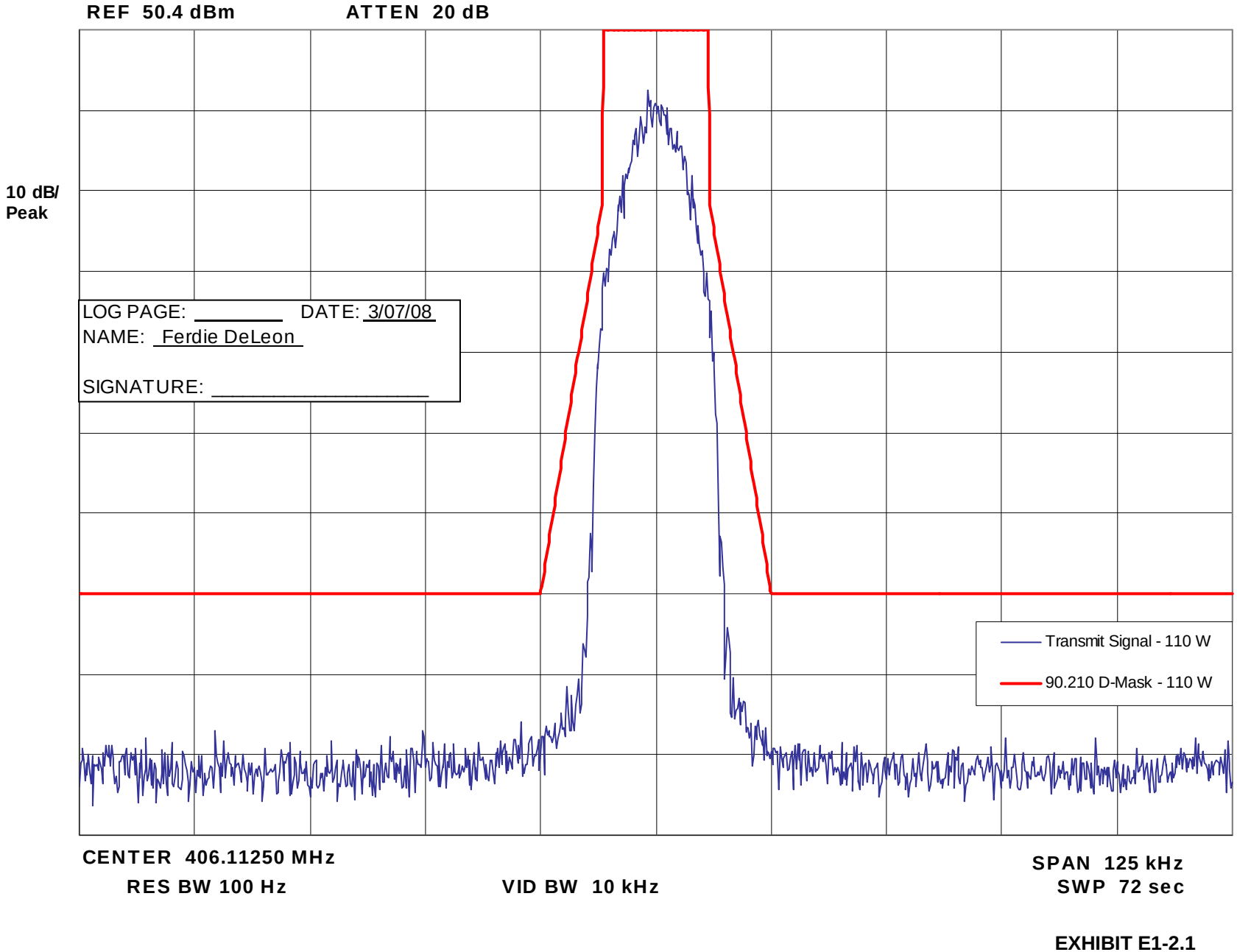


EXHIBIT E1-2.1

APPLICANT: MOTOROLA **EQUIPMENT TYPE: ABZ89FC4821**

Report on Test Measurements

Occupied Bandwidth – Linear Simulcast Modulation (LSM) – Middle of Band

Occupied Bandwidth -- Linear Simulcast Modulation - 8K70D1W - 110 Watts

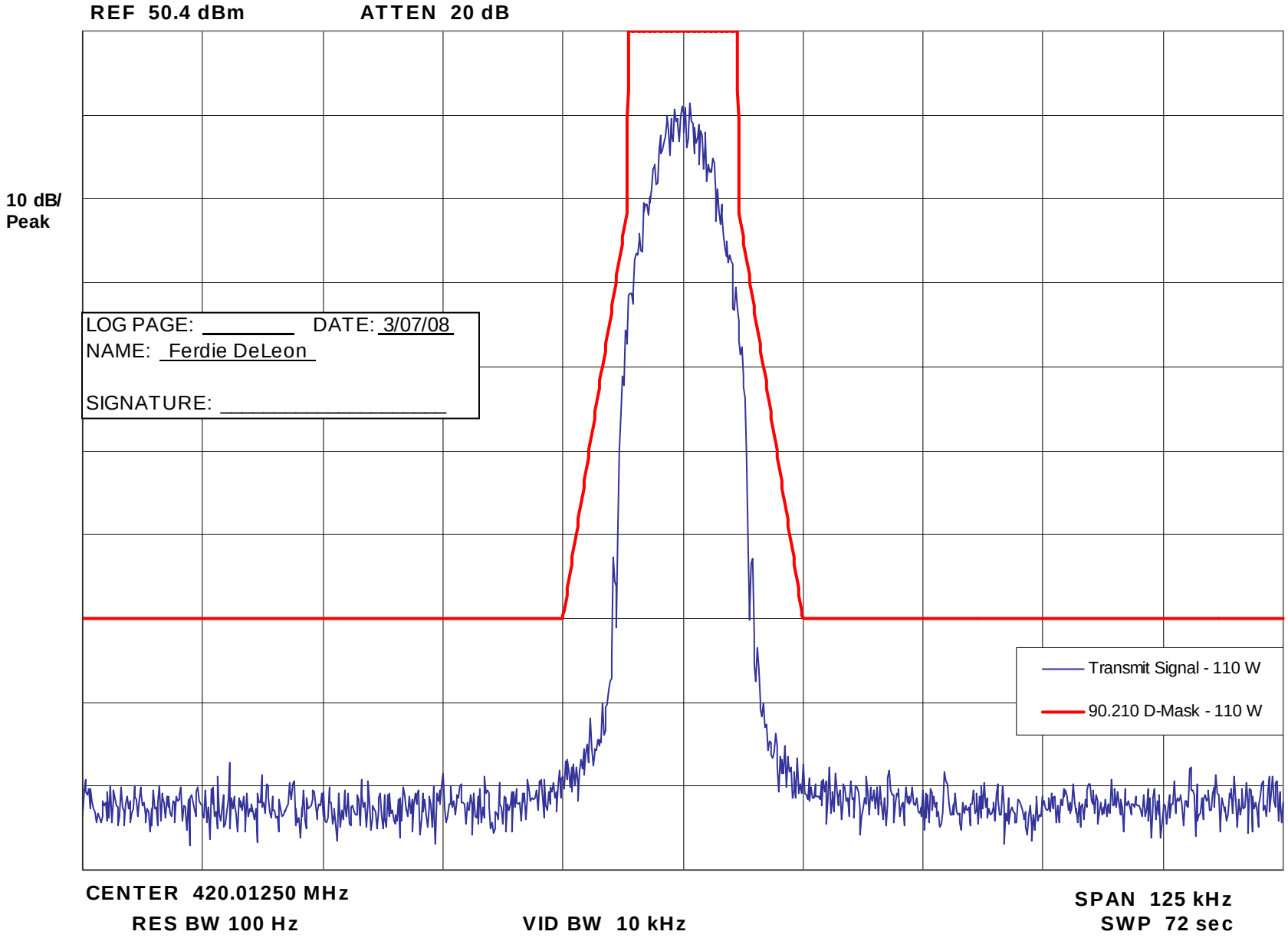


EXHIBIT E1-2.2

APPLICANT: MOTOROLA **EQUIPMENT TYPE: ABZ89FC4821**

Report on Test Measurements

Occupied Bandwidth – Linear Simulcast Modulation (LSM) – High End of Band

Occupied Bandwidth -- Linear Simulcast Modulation - 8K70D1W - 110 Watts

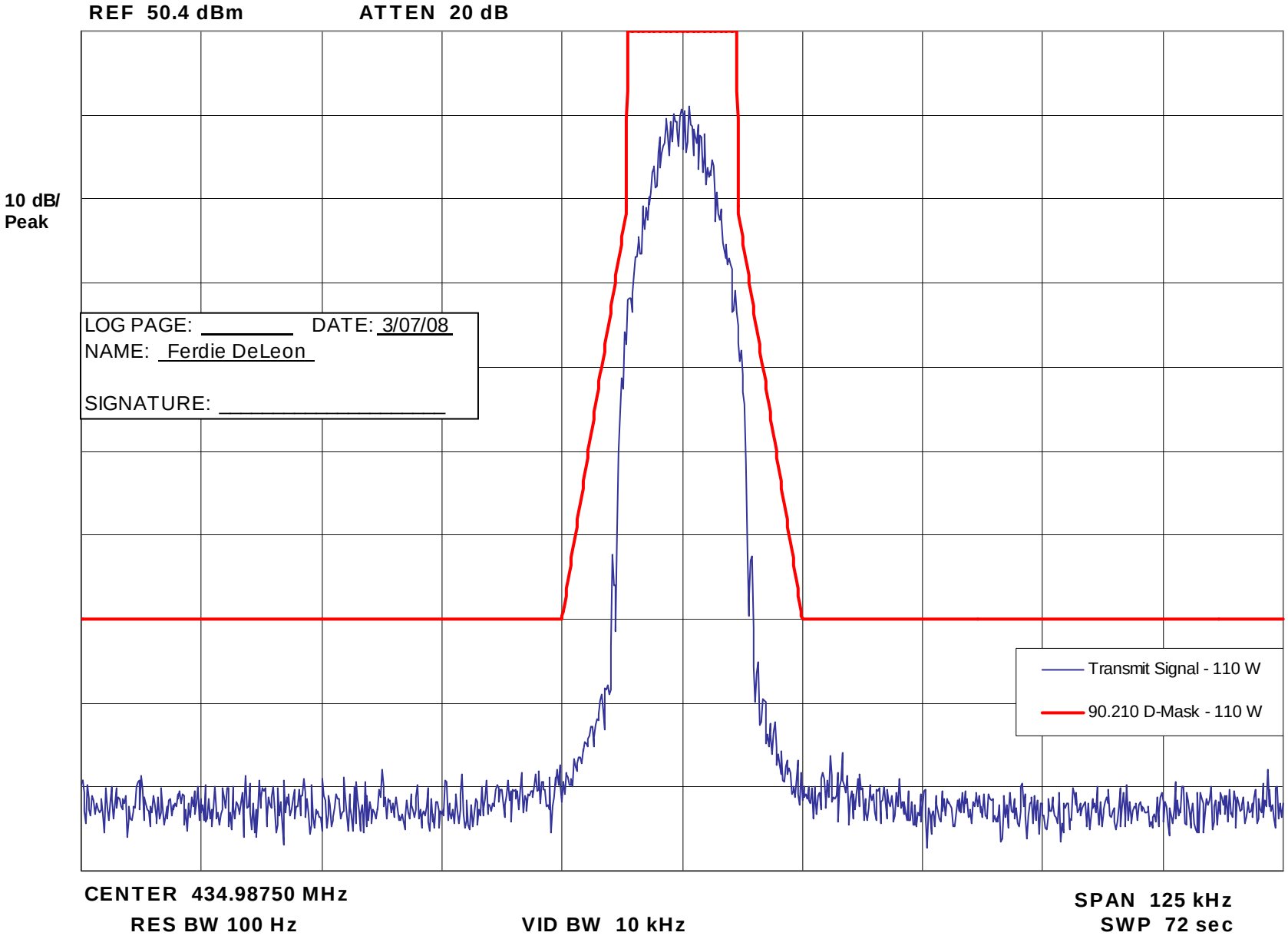


EXHIBIT E1-2.3

APPLICANT: MOTOROLA **EQUIPMENT TYPE: ABZ89FC4821**

Report on Test Measurements

Occupied Bandwidth – Compatible 4-Level Frequency Modulation (C4FM) – Low End of Band

Occupied Bandwidth -- Compatible 4-Level Frequency Modulation - 8K10F1E - 110 Watts

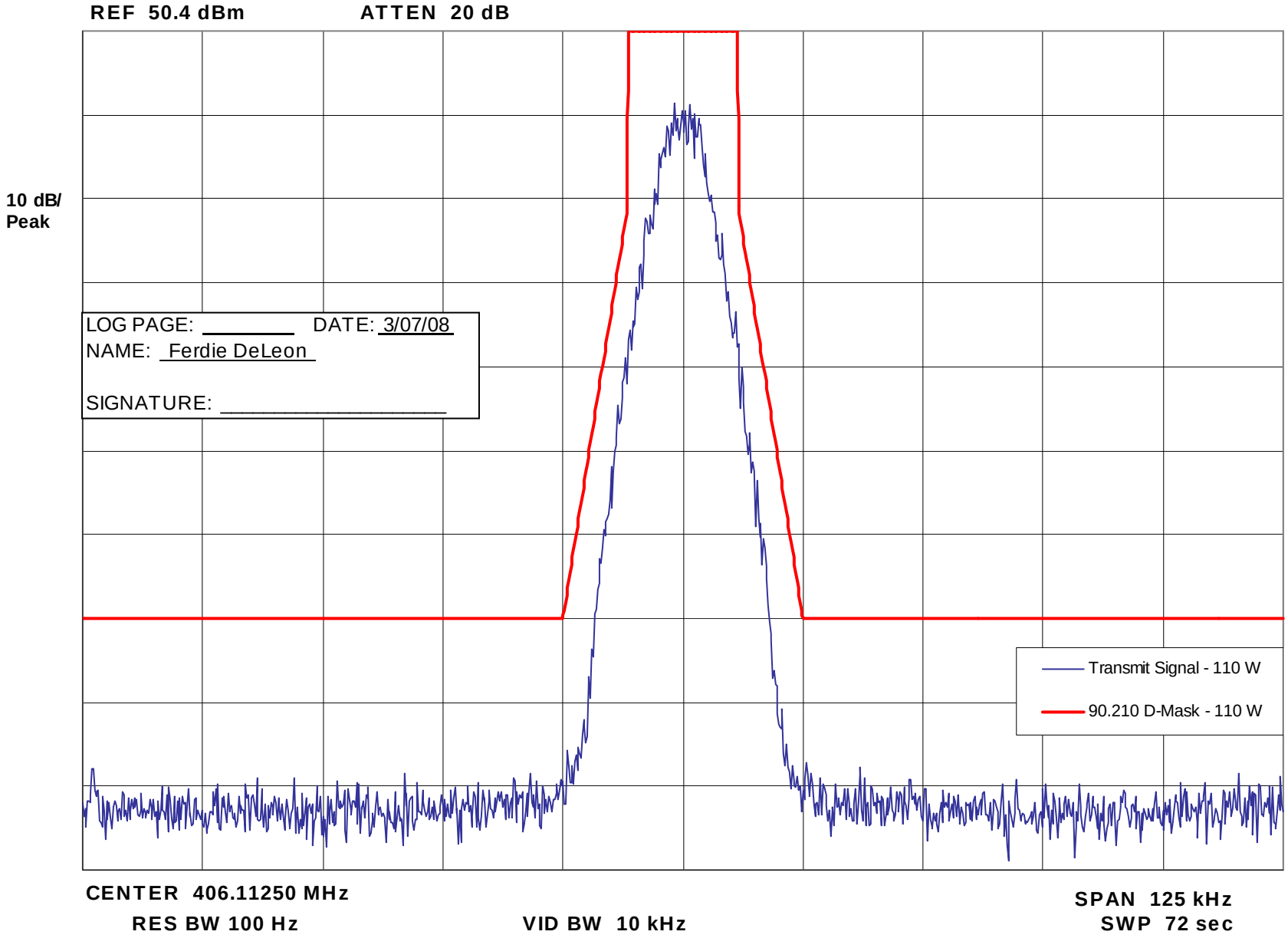


EXHIBIT E1-2.4

APPLICANT: MOTOROLA **EQUIPMENT TYPE: ABZ89FC4821**

Report on Test Measurements

Occupied Bandwidth – Compatible 4-Level Frequency Modulation (C4FM) – Middle of Band

Occupied Bandwidth -- Compatible 4-Level Frequency Modulation - 8K10F1E - 110 Watts

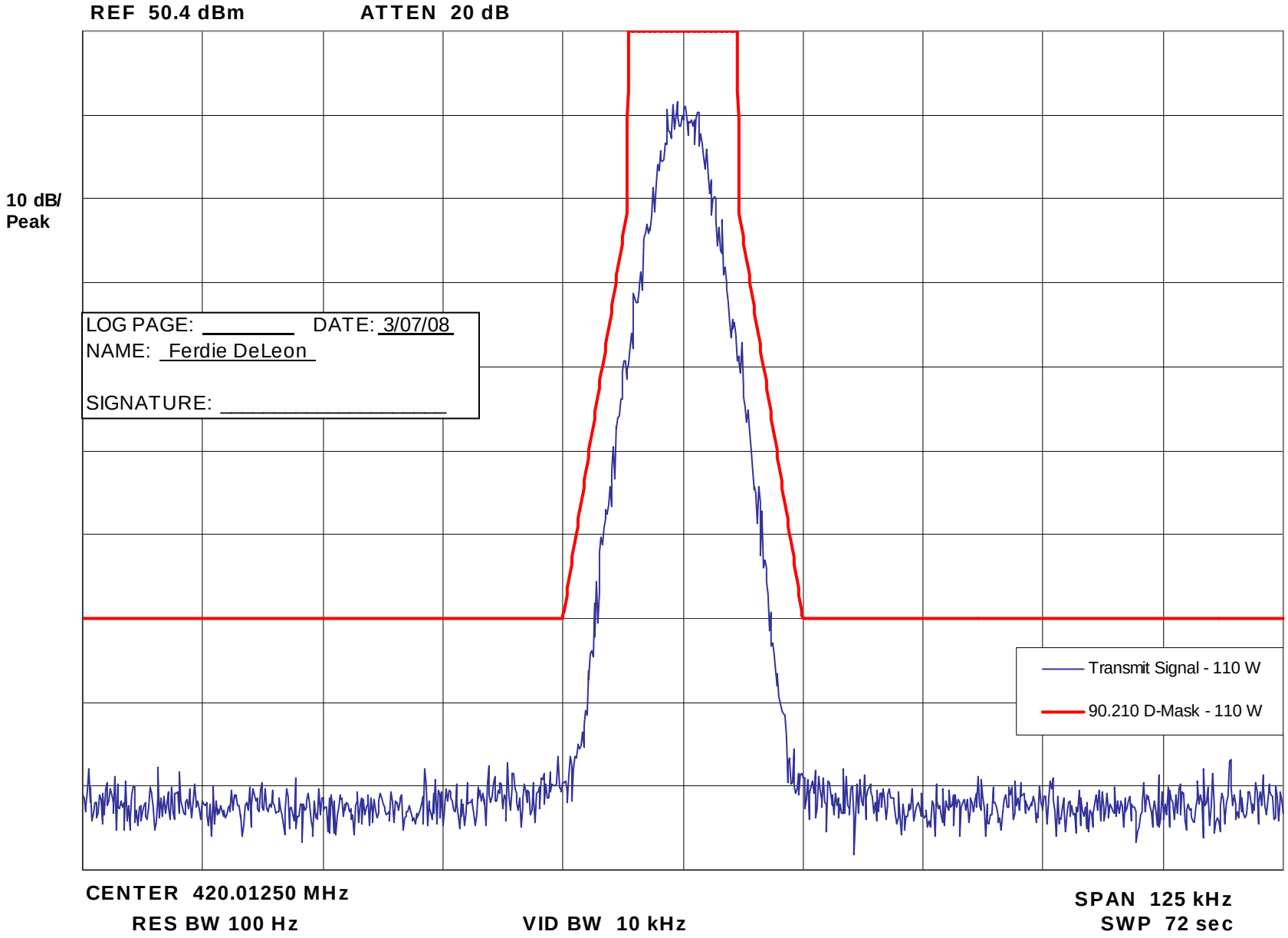


EXHIBIT E1-2.5

APPLICANT: MOTOROLA **EQUIPMENT TYPE: ABZ89FC4821**

Report on Test Measurements

Occupied Bandwidth – Compatible 4-Level Frequency Modulation (C4FM) – High End of Band

Occupied Bandwidth -- Compatible 4-Level Frequency Modulation - 8K10F1E - 110 Watts

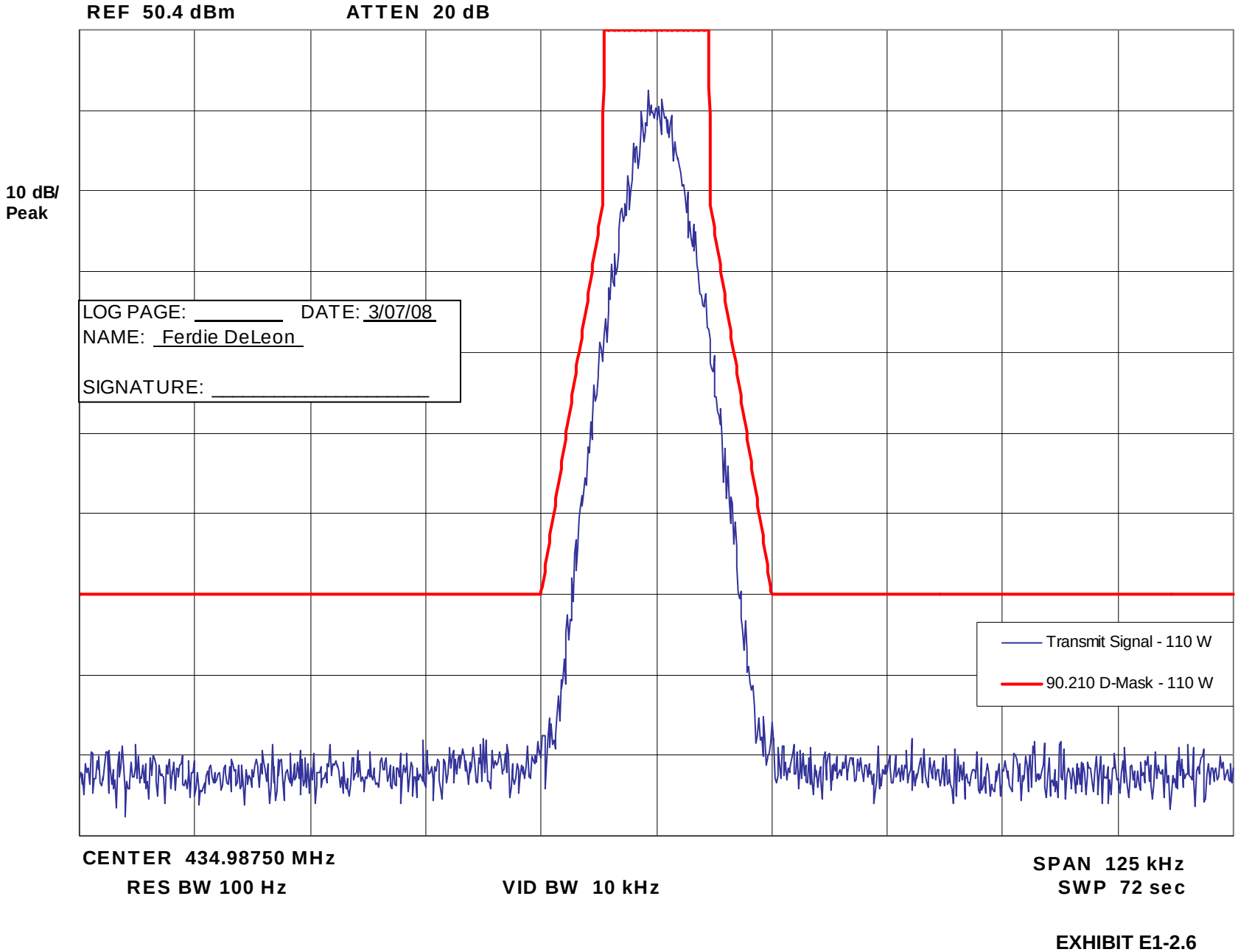


EXHIBIT E1-2.6

Report on Test Measurements

Conducted Spurious Emissions, Harmonics and Close-In

Specification Requirement § 90.210(d) Emission Limits:
Emission *Mask D:* For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:
(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz: *At least 50 plus 10 log_{10}(P) dB or 70 dB, whichever is the lesser attenuation.*

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

Carrier Frequencies: For harmonics, carrier frequencies of 380.0125, 406.1125, 420.0125, and 434.9875 MHz were measured. These frequencies represent the low end, center, and high end of the operating band. For Close-In, a carrier frequency in the middle of the FCC band 406.1-435 MHz was used

EXHIBIT	DESCRIPTION
E1-3.1	Conducted Spurious Emissions, Harmonics, Power Output 110 Watts, LSM The specification limit is -70.0 dBc
E1-3.2	Conducted Spurious Emissions, Harmonics, Power Output 2 Watts, LSM The specification limit is -53.0 dBc
E1-3.3	Conducted Spurious Emissions, Harmonics, Power Output 110 Watts, C4FM The specification limit is -70.0 dBc
E1-3.4	Conducted Spurious Emissions, Harmonics, Power Output 2 Watts, C4FM The specification limit is -53.0 dBc
E1-3.5	Conducted Spurious Emissions, Close-In, 200 MHz Span, Power Output at 110 Watts, LSM The specification limit is -70.0 dBc
E1-3.6	Conducted Spurious Emissions, Close-In, 200 MHz Span, Power Output at 110 Watts, C4FM The specification limit is -70.0 dBc

APPLICANT: MOTOROLA **EQUIPMENT TYPE: ABZ89FC4821**

Report on Test Measurements

Conducted Emission – Harmonics – 110 Watts LSM

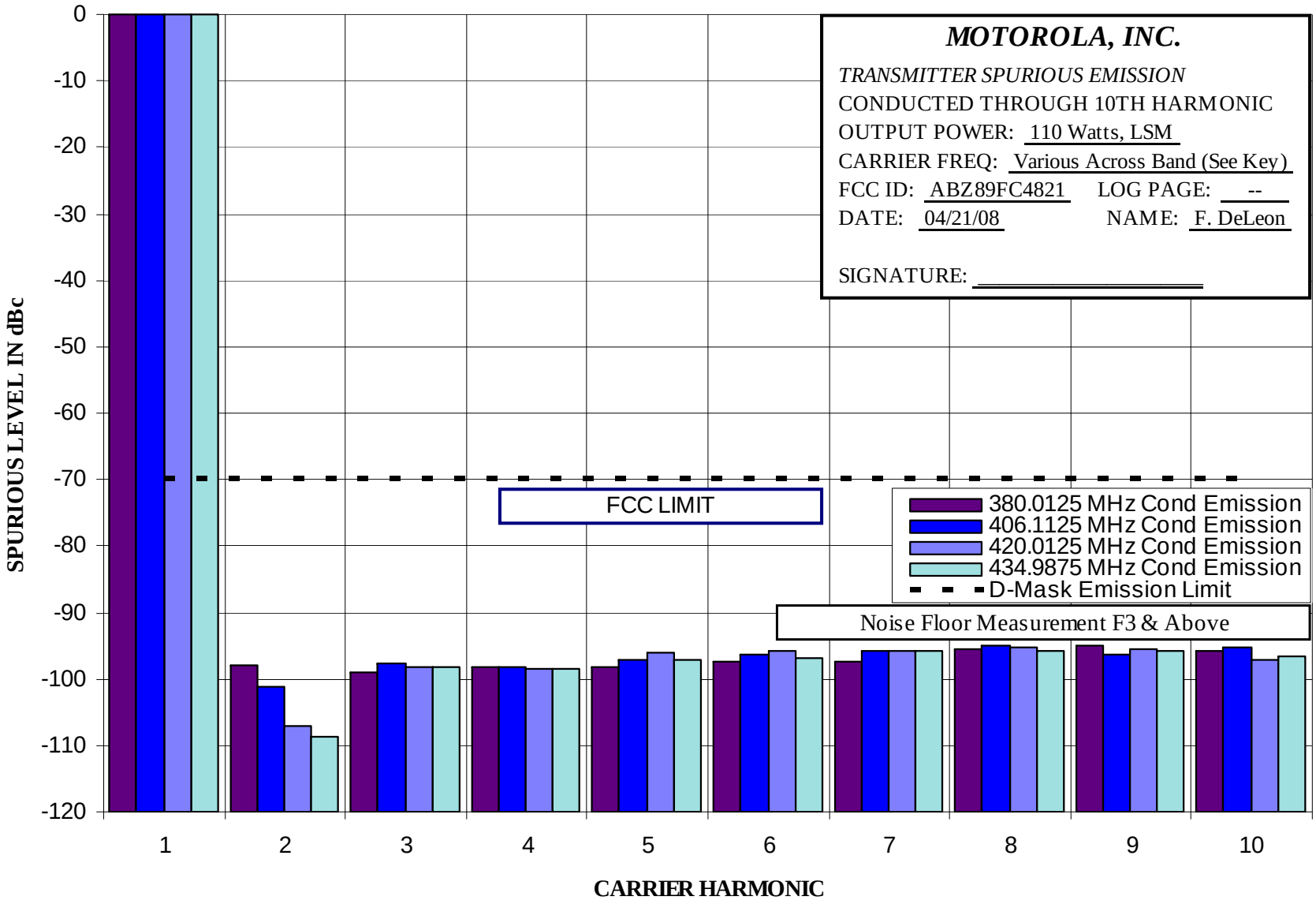


EXHIBIT E1-3.1

APPLICANT: MOTOROLA **EQUIPMENT TYPE: ABZ89FC4821**

Report on Test Measurements

Conducted Emission – Harmonics – 2 Watts LSM

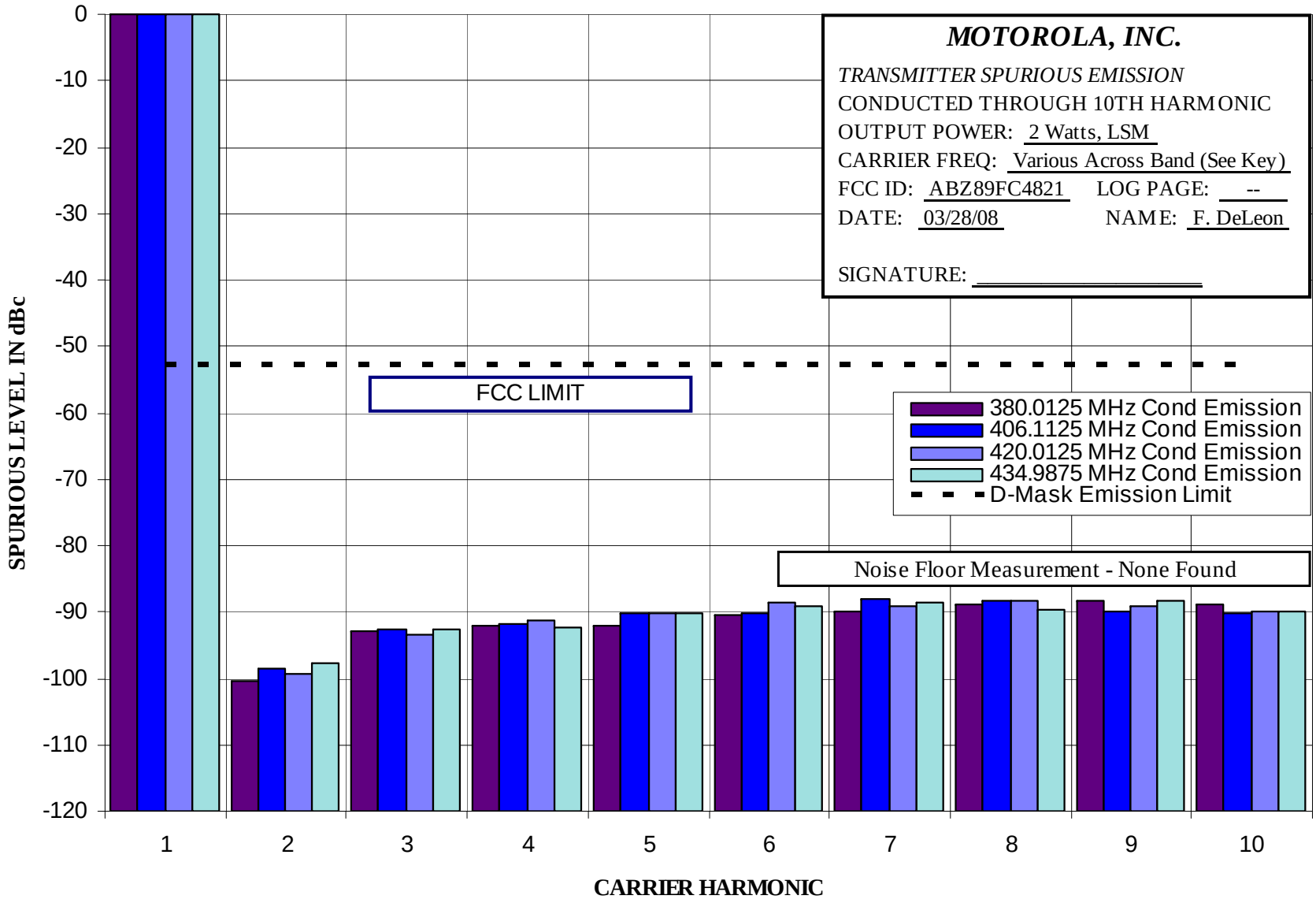


EXHIBIT E1-3.2

Report on Test Measurements

Conducted Emission – Harmonics – 110 Watts C4FM

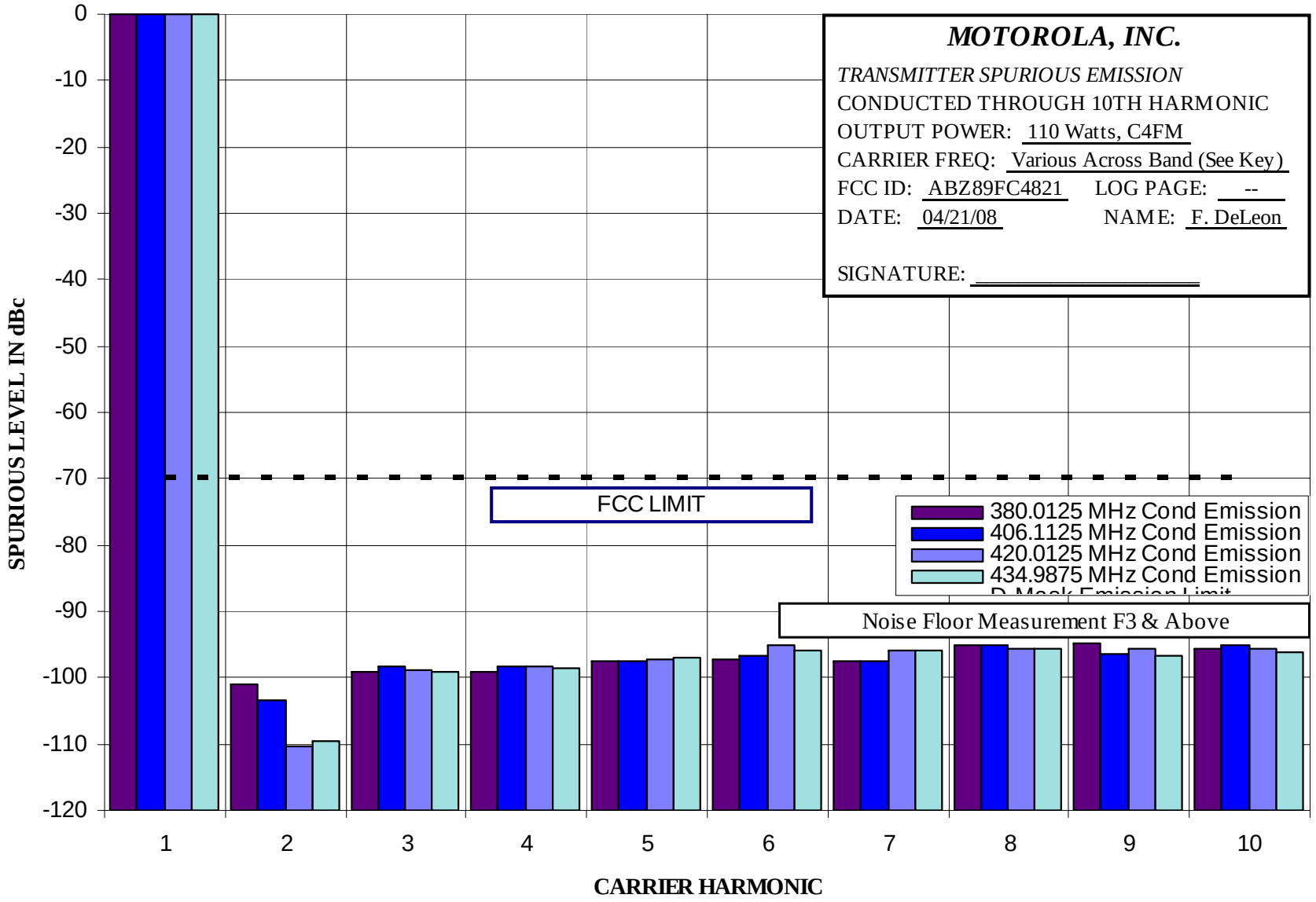


EXHIBIT E1-3.3

APPLICANT: MOTOROLA **EQUIPMENT TYPE: ABZ89FC4821**

Report on Test Measurements

Conducted Emission – Harmonics – 2 Watts C4FM

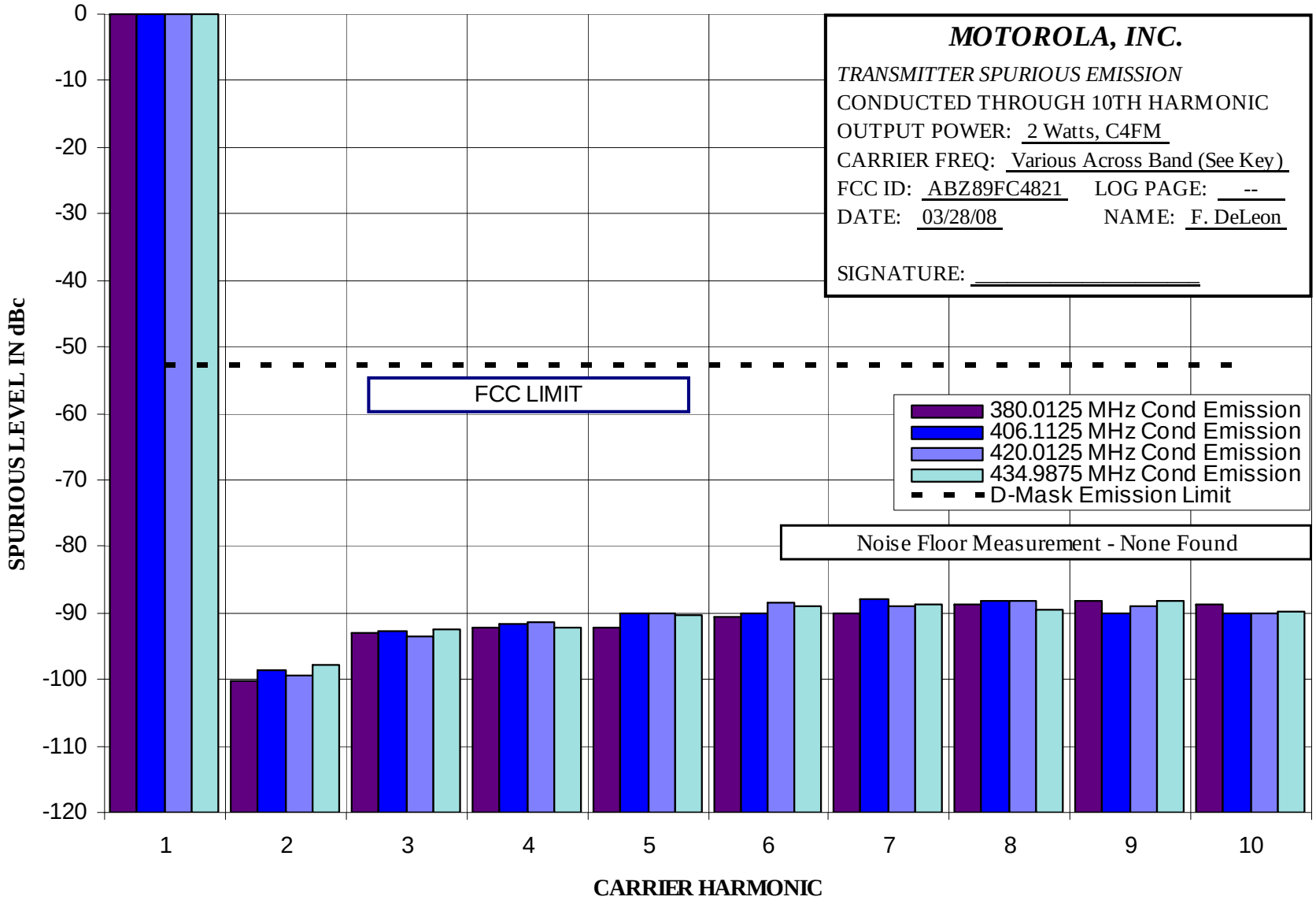


EXHIBIT E1-3.4

APPLICANT: MOTOROLA **EQUIPMENT TYPE: ABZ89FC4821**

Report on Test Measurements

Conducted Emission – Close-In – 110 Watts LSM – 200 MHz Span

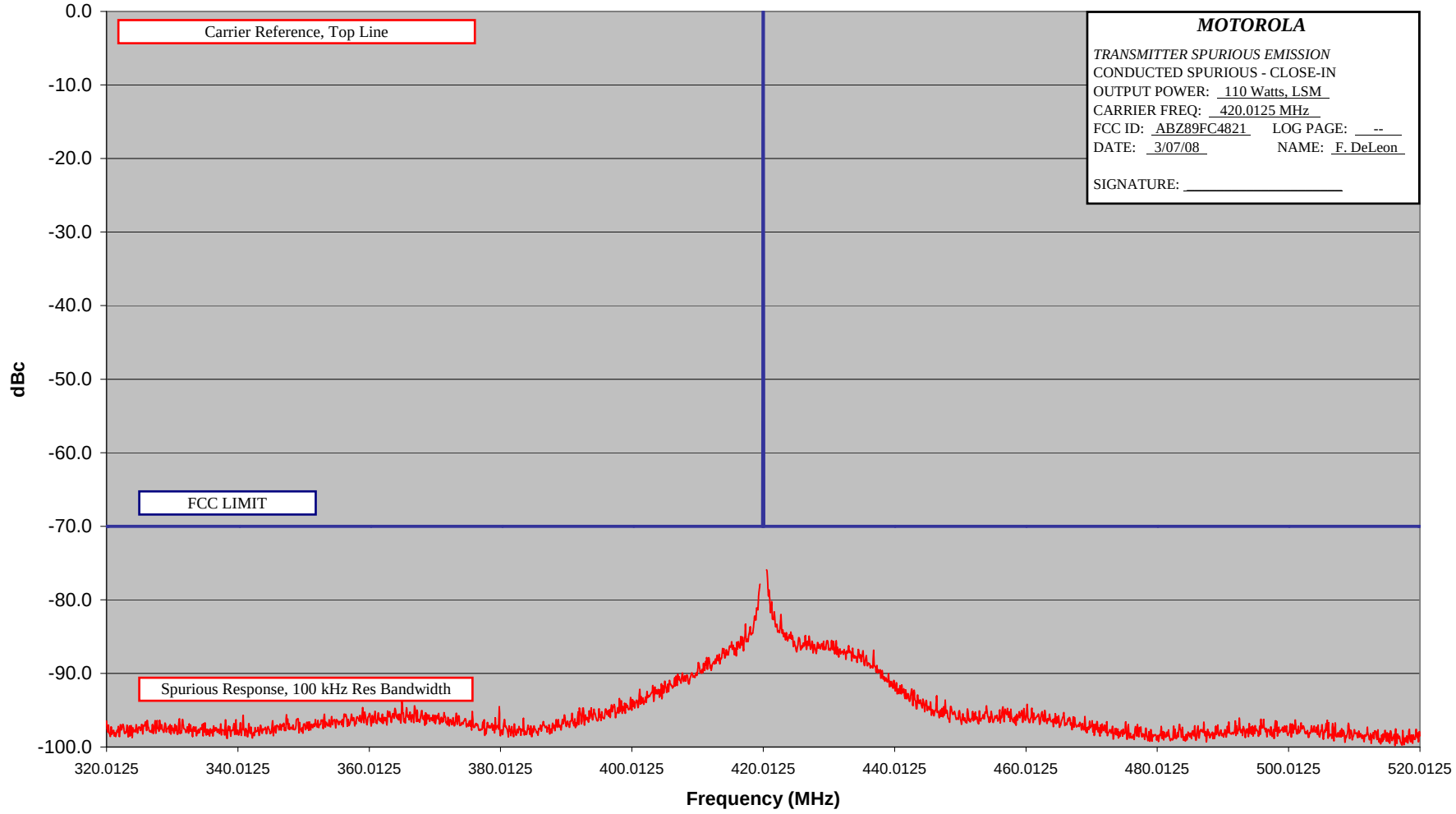


EXHIBIT E1-3.5

APPLICANT: MOTOROLA **EQUIPMENT TYPE: ABZ89FC4821**

Report on Test Measurements

Conducted Emission – Close-In – 110 Watts C4FM – 200 MHz Span

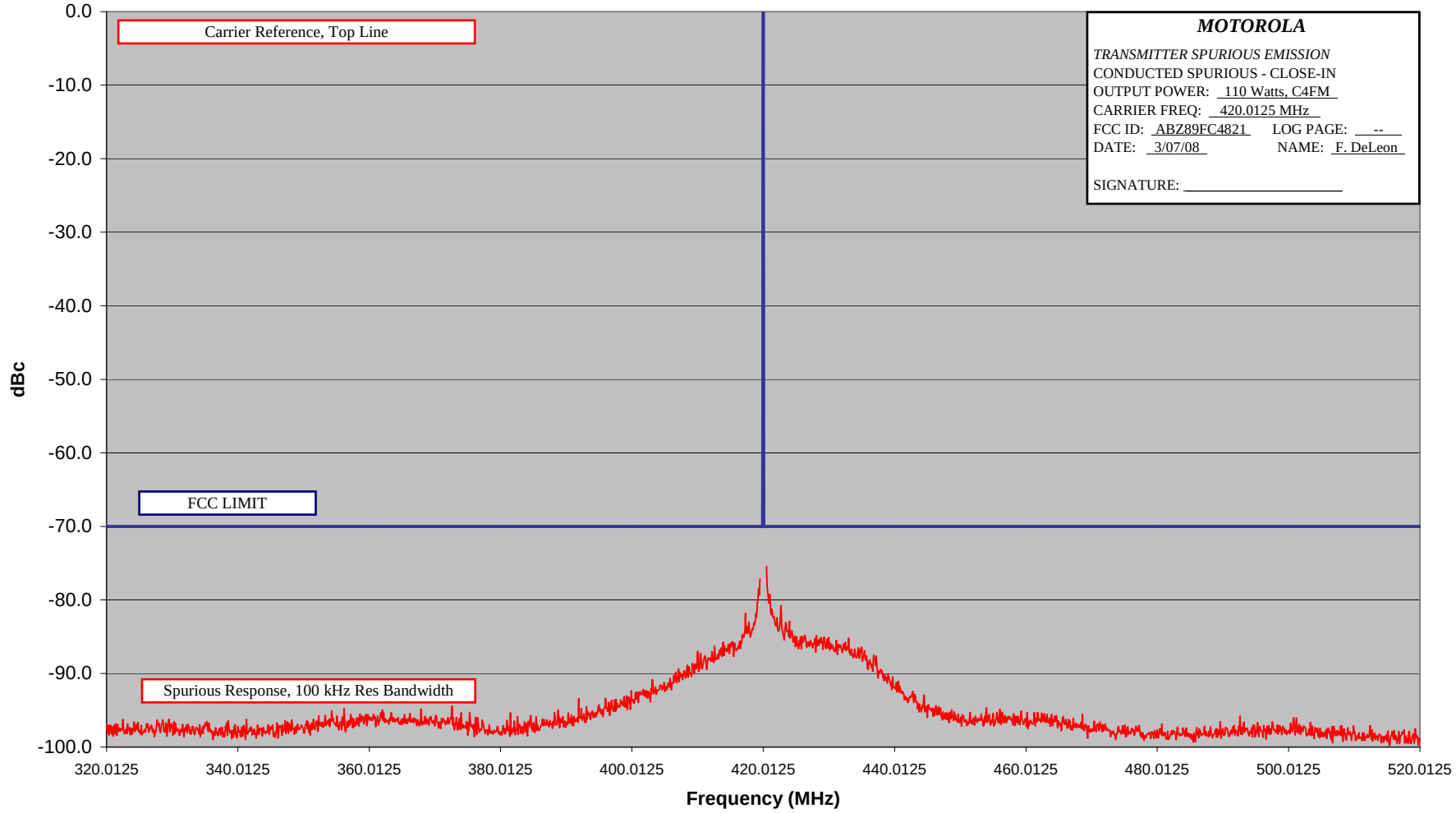


EXHIBIT E1-3.6

Report on Test Measurements

Radiated Spurious Emissions, Harmonics

Specification Requirement § 90.210(d) Emission Limits:
Emission *Mask D:* For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:
(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz: *At least 50 plus 10 log_{10}(P) dB or 70 dB, whichever is the lesser attenuation.*

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

Carrier Frequencies: A carrier frequency of 420.0125 MHz was measured. This frequency represents the center of the 406.1-435 MHz operating band

EXHIBIT	DESCRIPTION
E1-4.1	Radiated Spurious Emissions, Harmonics, Power Output 110 Watts, LSM The specification limit is -70.0 dBc
E1-4.2	Radiated Spurious Emissions, Harmonics, Power Output 2 Watts, LSM The specification limit is -53.0 dBc
E1-4.3	Radiated Spurious Emissions, Harmonics, Power Output 110 Watts, C4FM The specification limit is -70.0 dBc
E1-4.4	Radiated Spurious Emissions, Harmonics, Power Output 2 Watts, C4FM The specification limit is -53.0 dBc

Report on Test Measurements

Radiated Emission – Harmonics – 110 Watts – Linear Simulcast Modulation (LSM)

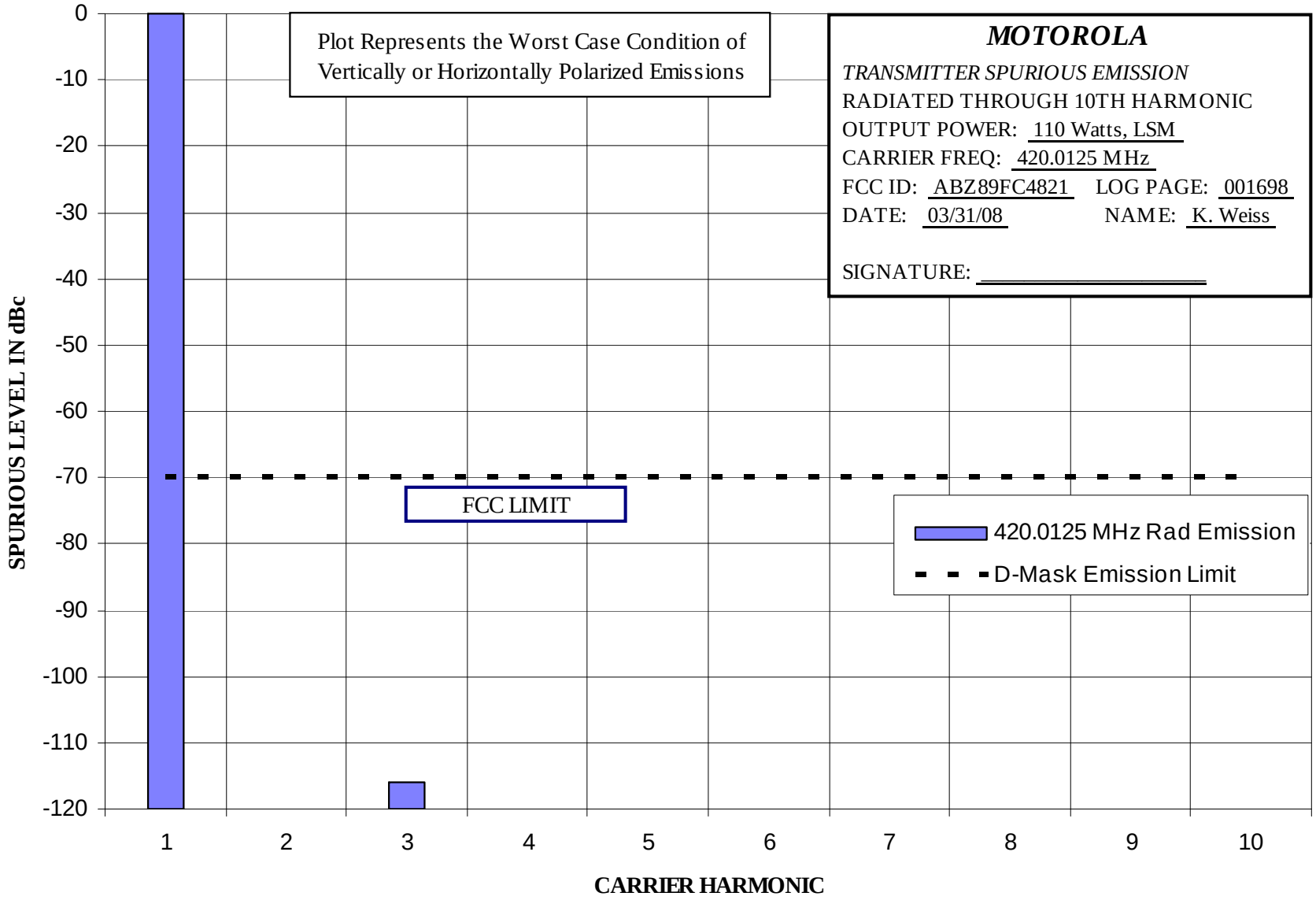
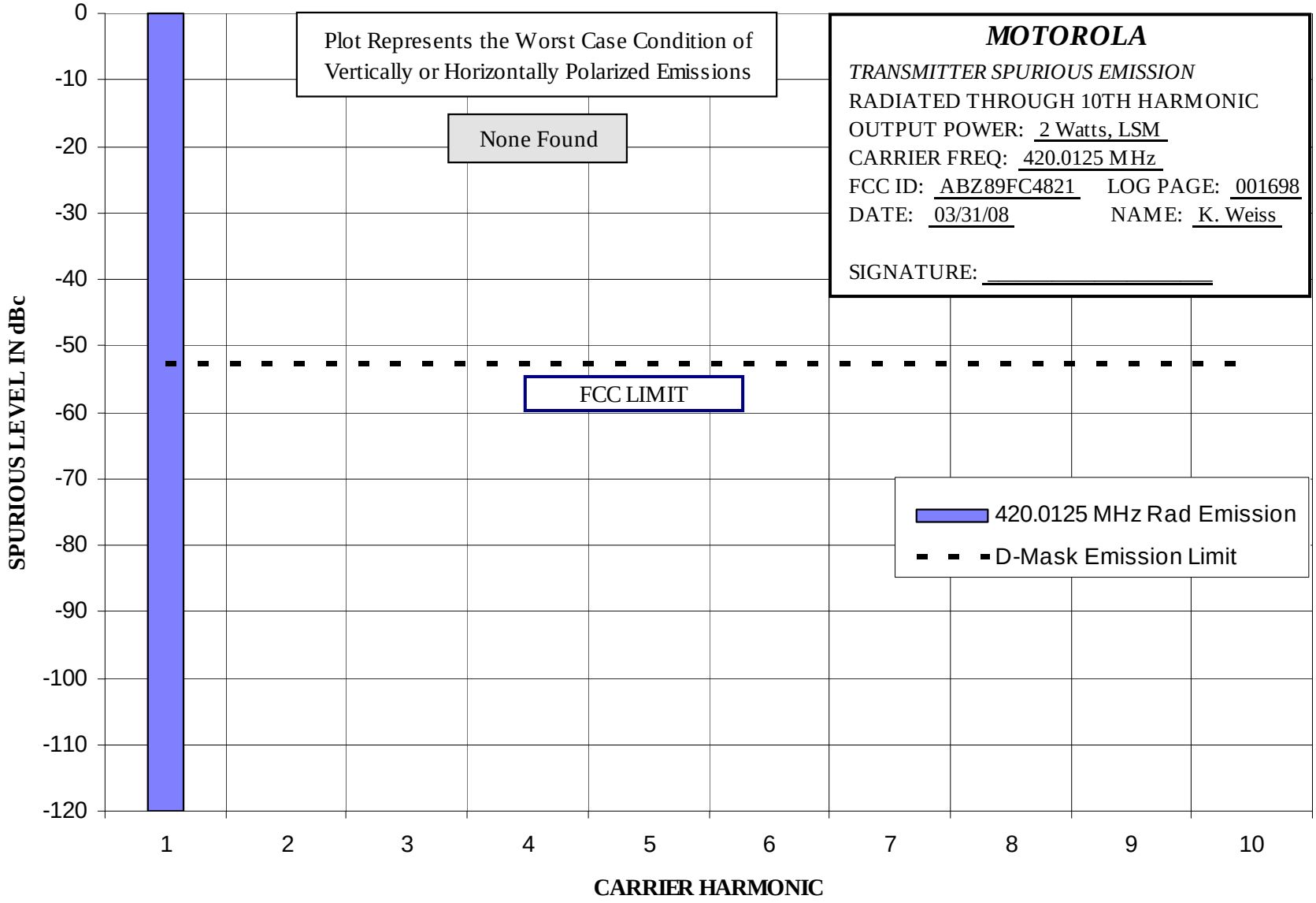


EXHIBIT E1-4.1

Report on Test Measurements

Radiated Emission – Harmonics – 2 Watts – Linear Simulcast Modulation (LSM)



Report on Test Measurements

Radiated Emission – Harmonics – 110 Watts – Compatible 4-Level Frequency Modulation (C4FM)

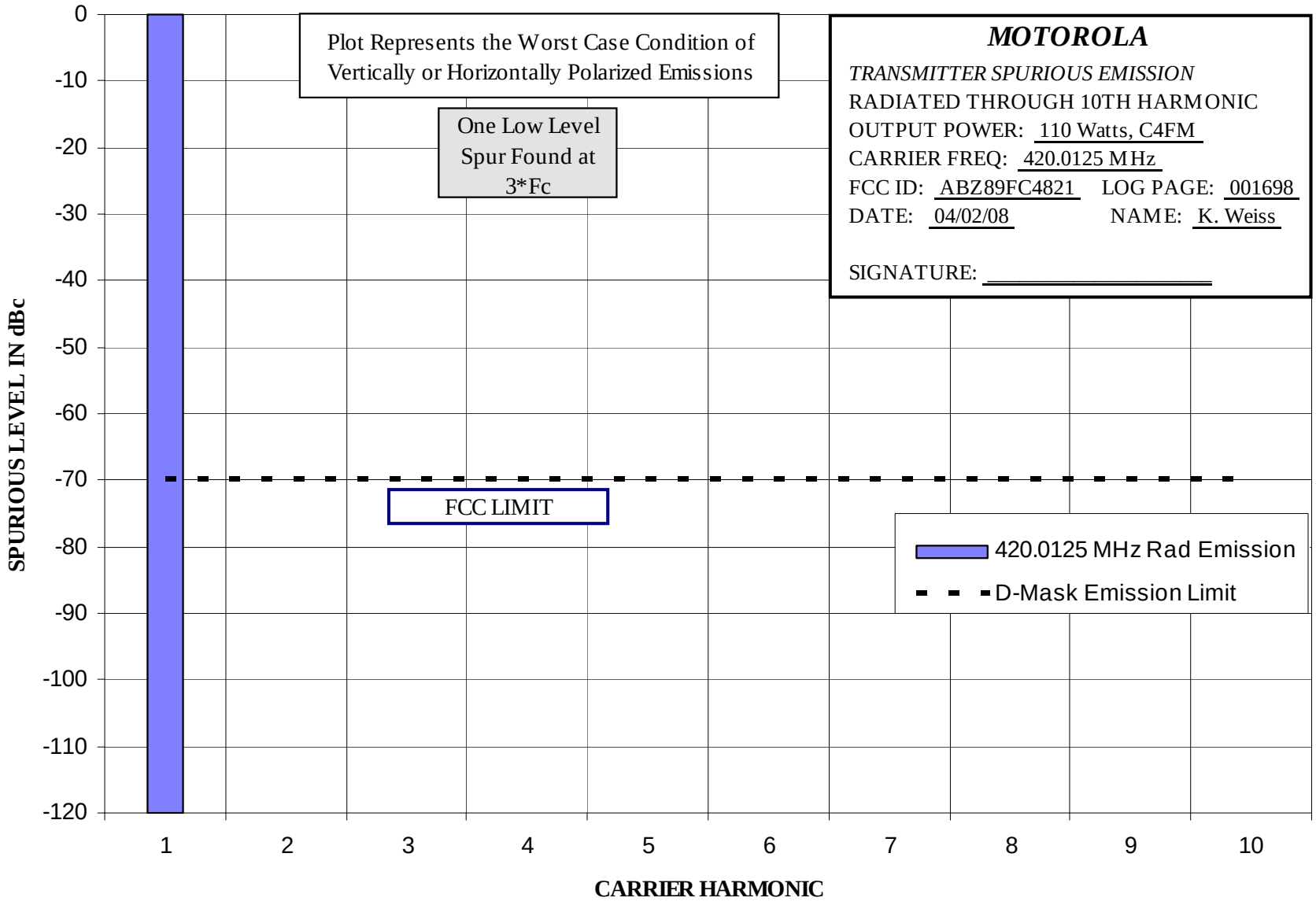


EXHIBIT E1-4.3

Report on Test Measurements

Radiated Emission – Harmonics – 2 Watts – Compatible 4-Level Frequency Modulation (C4FM)

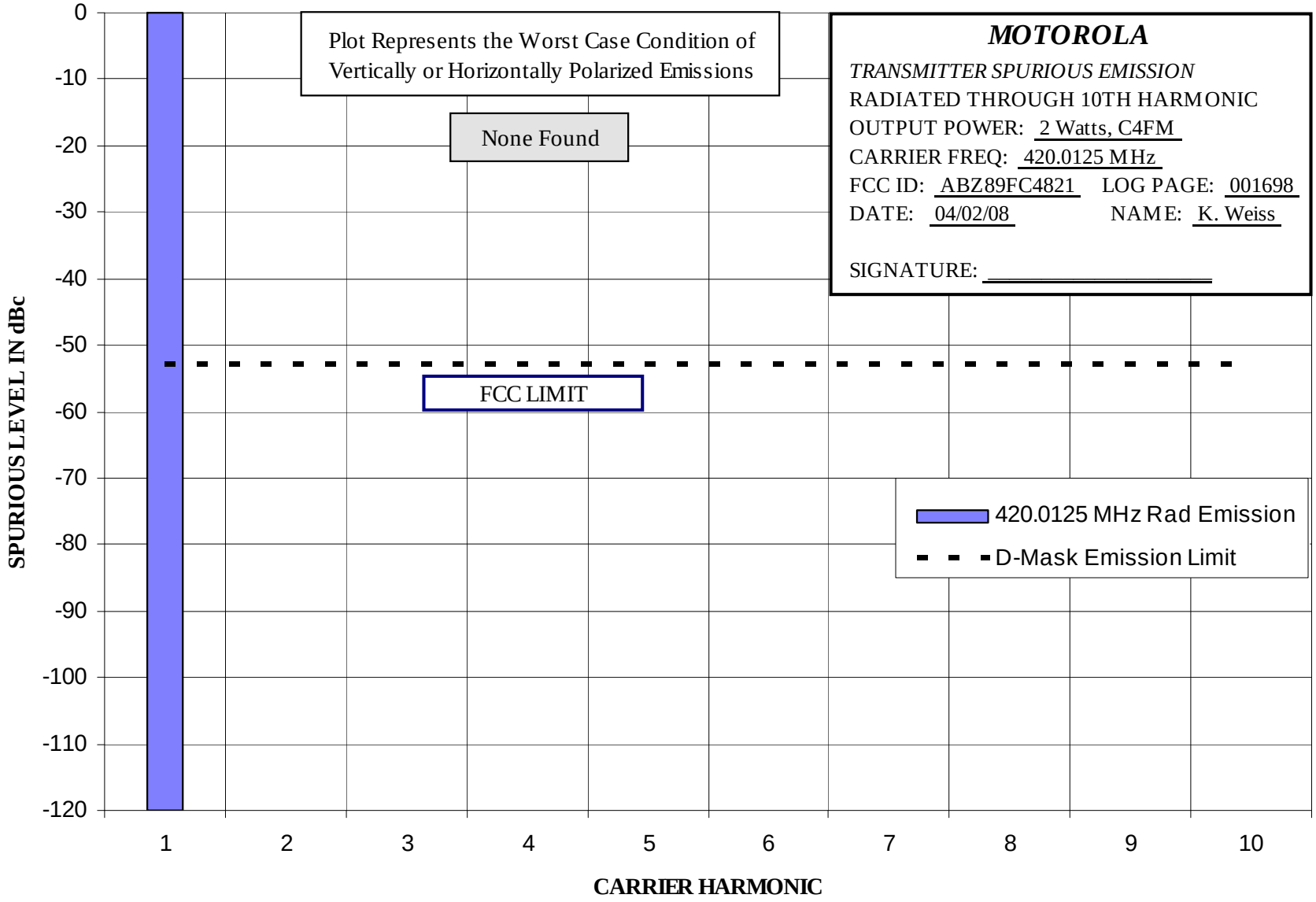


EXHIBIT E1-4.4

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 Part 90.213

Fixed and Base stations operating at 421-512 MHz and 12.5 kHz channel bandwidth must have a frequency stability of better than +/- 1.5 PPM.

EXHIBIT	DESCRIPTION
E1-5.1	Frequency Stability Vs Temperature
E1-5.2	Frequency Stability Vs Voltage

APPLICANT: MOTOROLA **EQUIPMENT TYPE: ABZ89FC4821**

Report on Test Measurements

Frequency Stability Vs Temperature

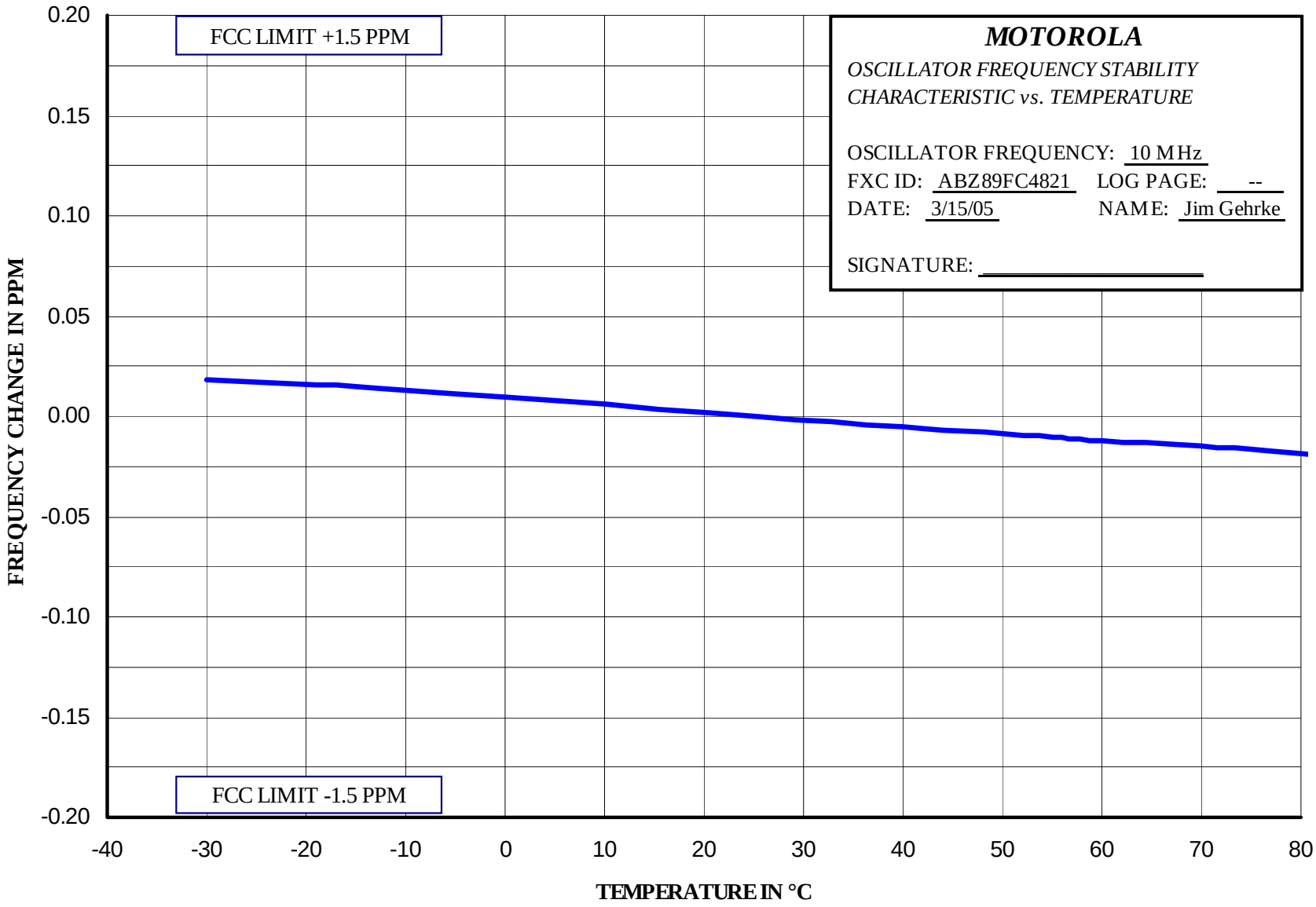


EXHIBIT E1-5.1

APPLICANT: MOTOROLA **EQUIPMENT TYPE: ABZ89FC4821**

Report on Test Measurements

Frequency Stability Vs Voltage

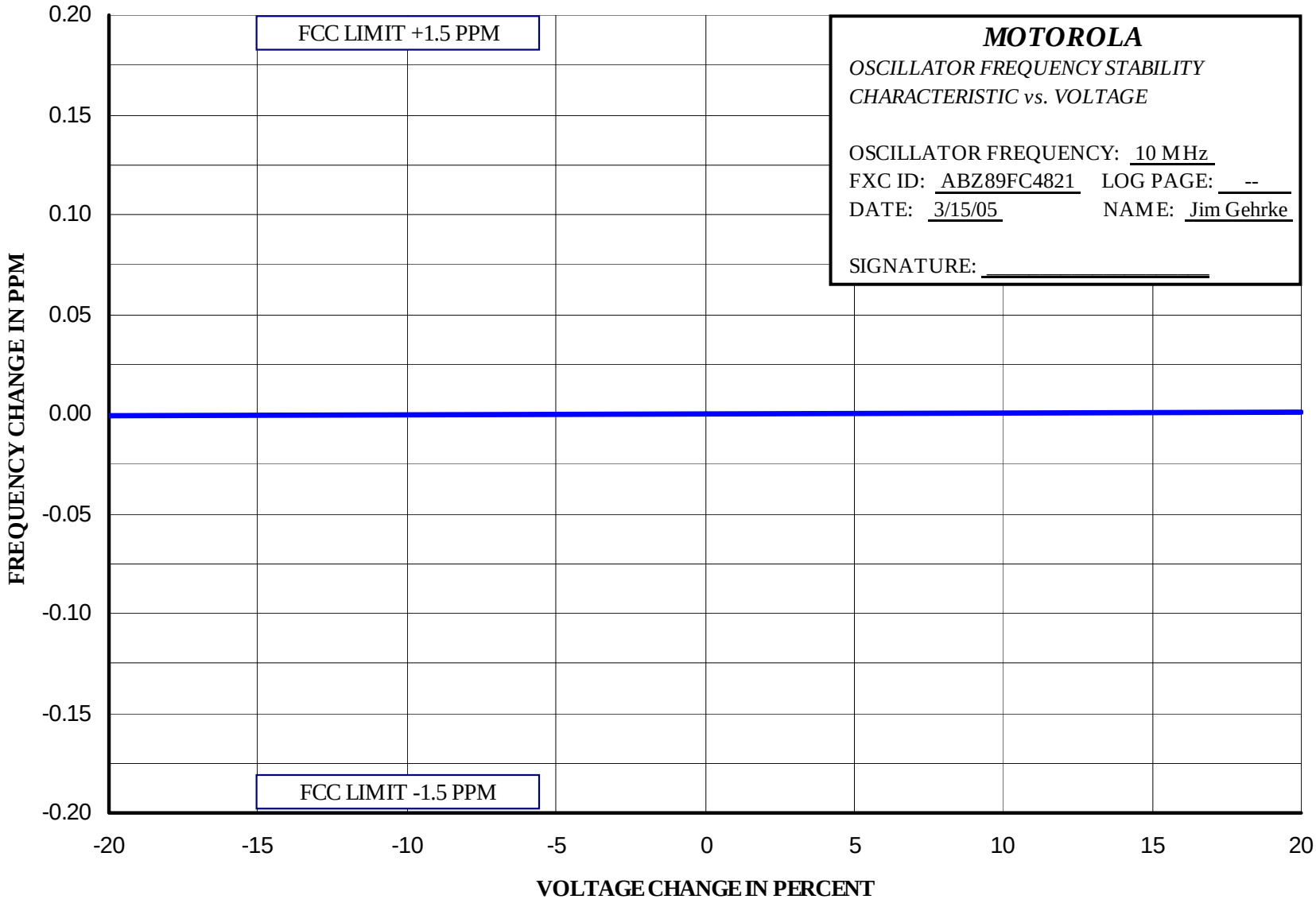


EXHIBIT E1-5.2

Report on Test Measurements

Frequency Transient Behavior

Specification Requirement: Reference Part 90.214

Transmitters designed to operate in the 421-512 MHz frequency band with 12.5 kHz channel operation must maintain transient frequencies within the maximum frequency difference limits during the time intervals indicated below:

Transient Frequency Behavior 12.5 kHz Channels

For time intervals:

a. t1 =10 ms Maximum Frequency Difference ±12.5 kHz

b. t2 = 25 ms Maximum Frequency Difference ±6.25 kHz

c. t3 = 10 ms Maximum Frequency Difference ±12.5 kHz

Where t1 and t2 are times immediately following when the transmitter is turned on, and t3 is the time from when the transmitter is turned off.

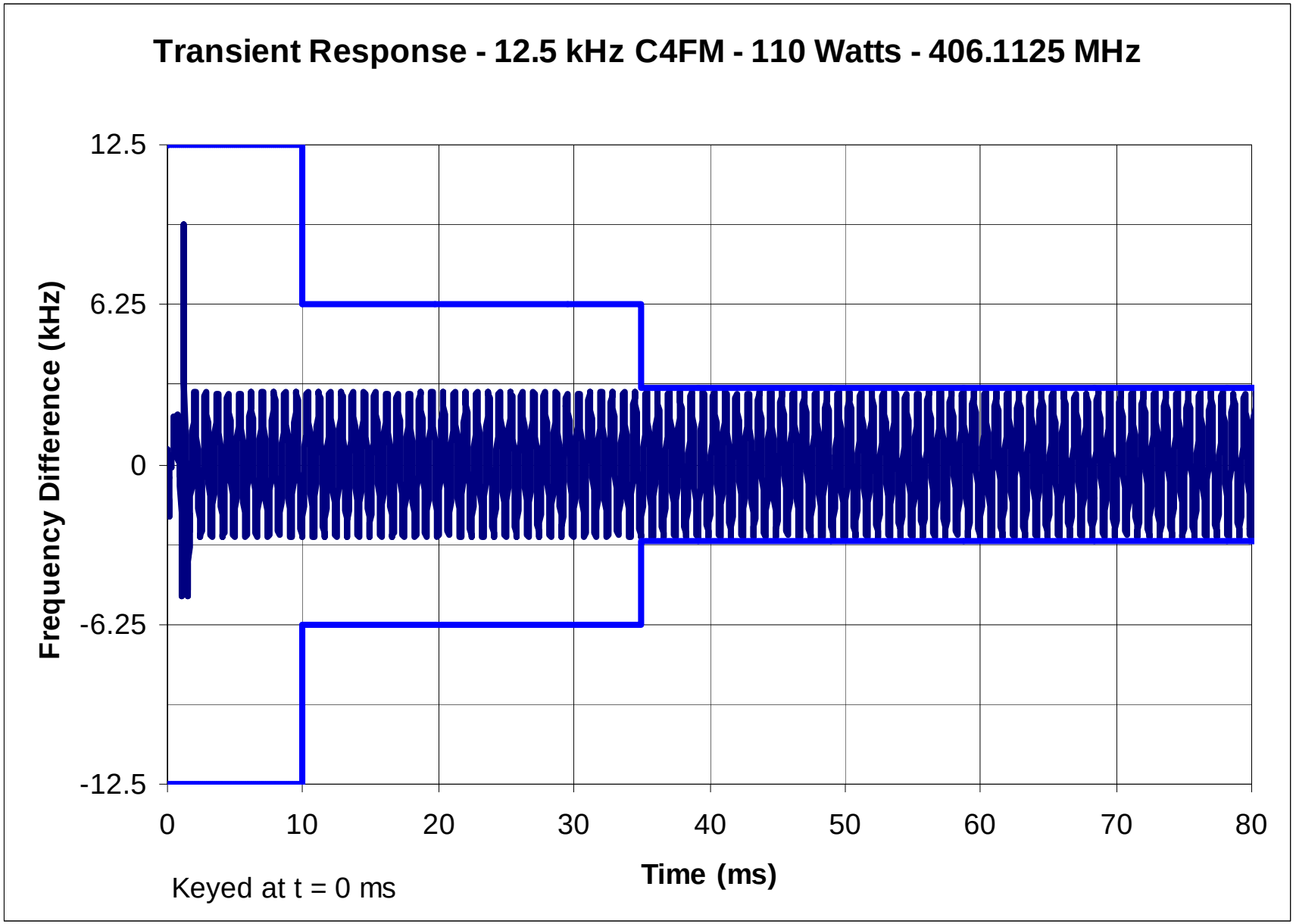
Modulation: Compatible 4-Level Frequency Modulation (C4FM) – Pseudorandom data

Carrier Frequencies: Carrier frequencies of 406.1125, 420.0125, and 434.9875 MHz were measured. These frequencies represent the low end, center, and high end of the 406.1-435 MHz operating band

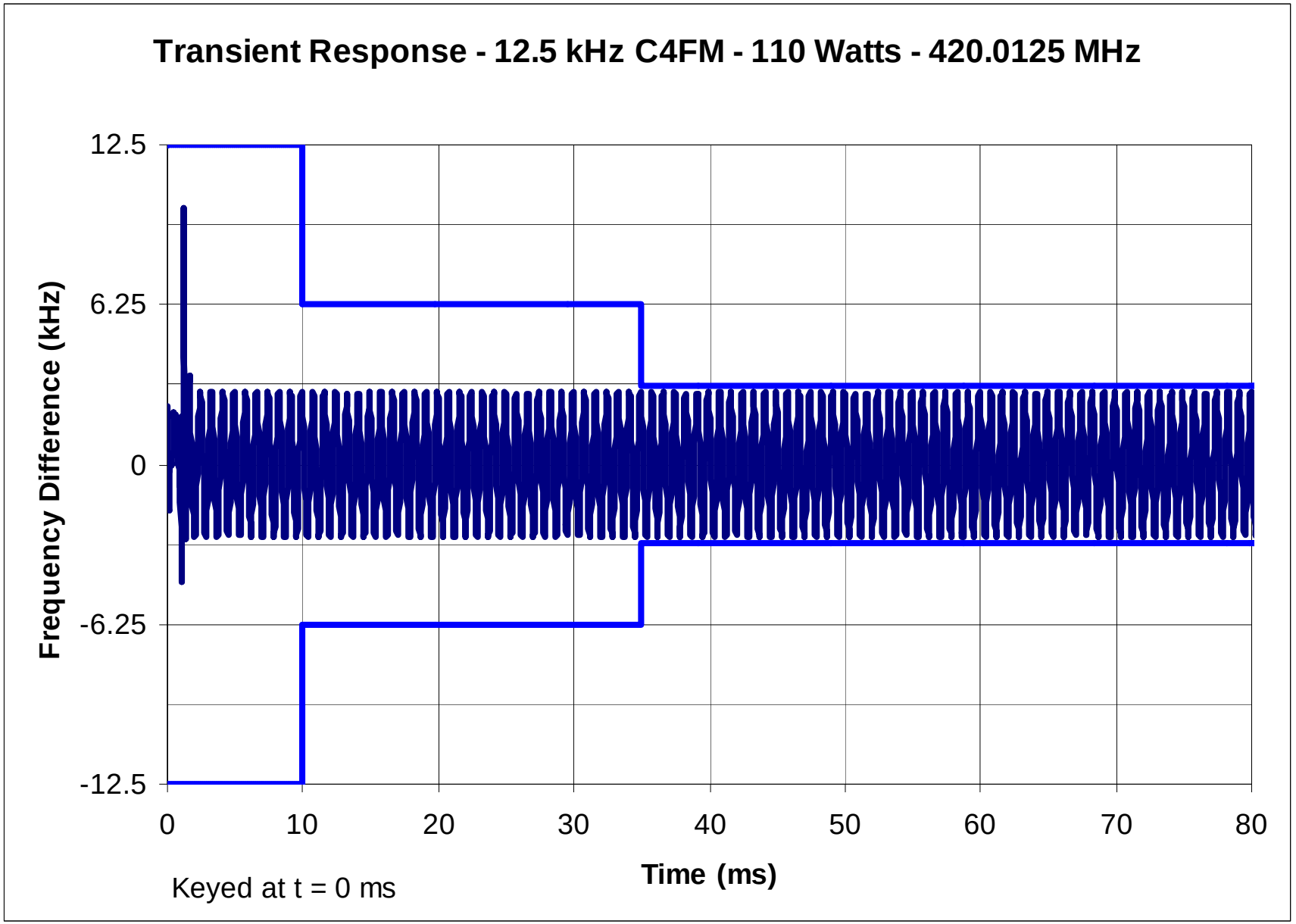
EXHIBIT	DESCRIPTION
E1-6.1	Frequency Transient Behavior, 12.5 kHz Channel Key-Up, Low End of Band
E1-6.2	Frequency Transient Behavior, 12.5 kHz Channel Key-Up, Middle of Band
E1-6.3	Frequency Transient Behavior, 12.5 kHz Channel Key-Up, High End of Band
E1-6.4	Frequency Transient Behavior, 12.5 kHz Channel De-key, Low End of Band
E1-6.5	Frequency Transient Behavior, 12.5 kHz Channel De-key, Middle of Band
E1-6.6	Frequency Transient Behavior, 12.5 kHz Channel De-key, High End of Band

The unit was tested at various power levels across the operating range. Power level was found to be irrelevant to performance according to this standard.

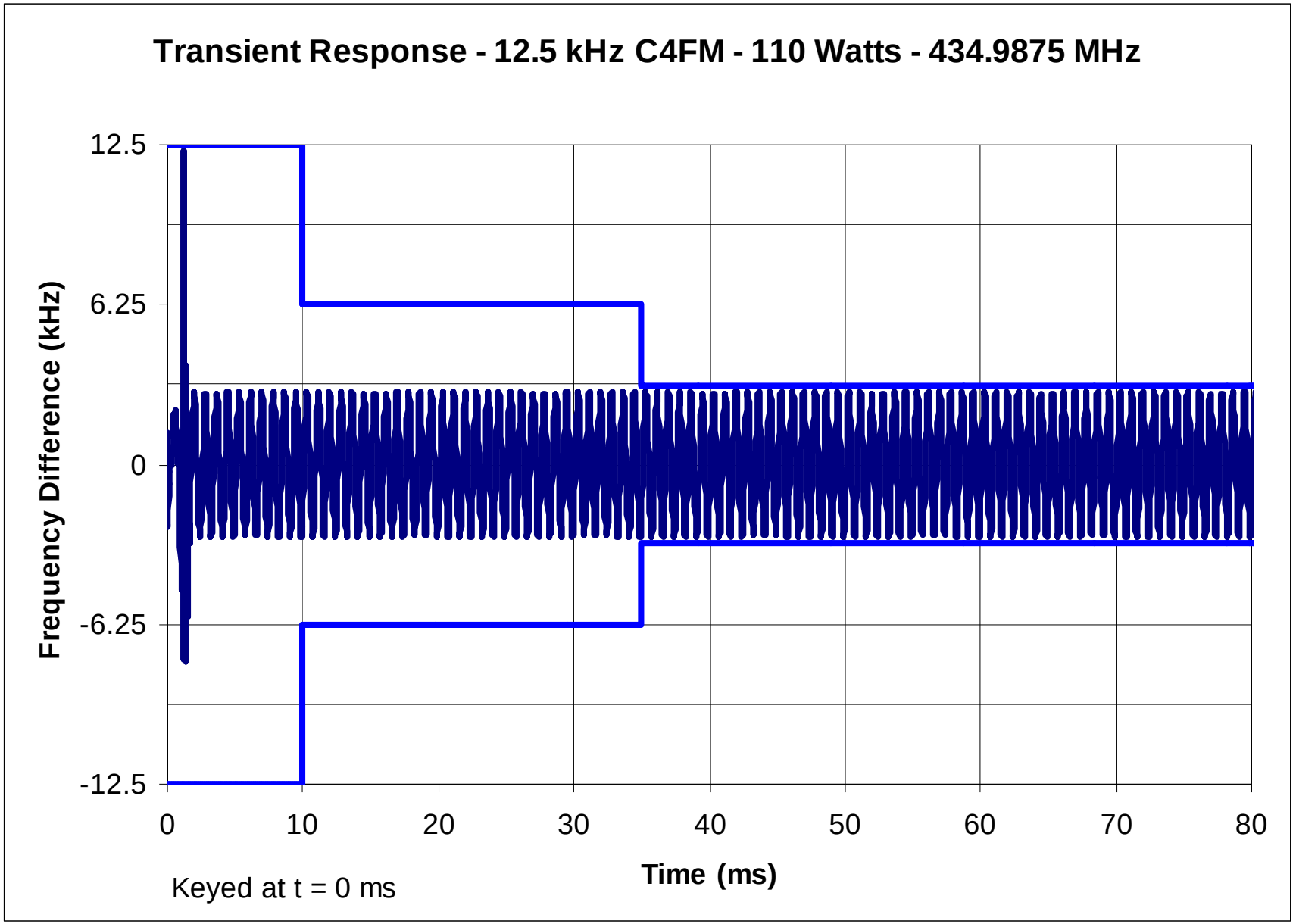
Frequency Transient – Key-up – Low End of Band



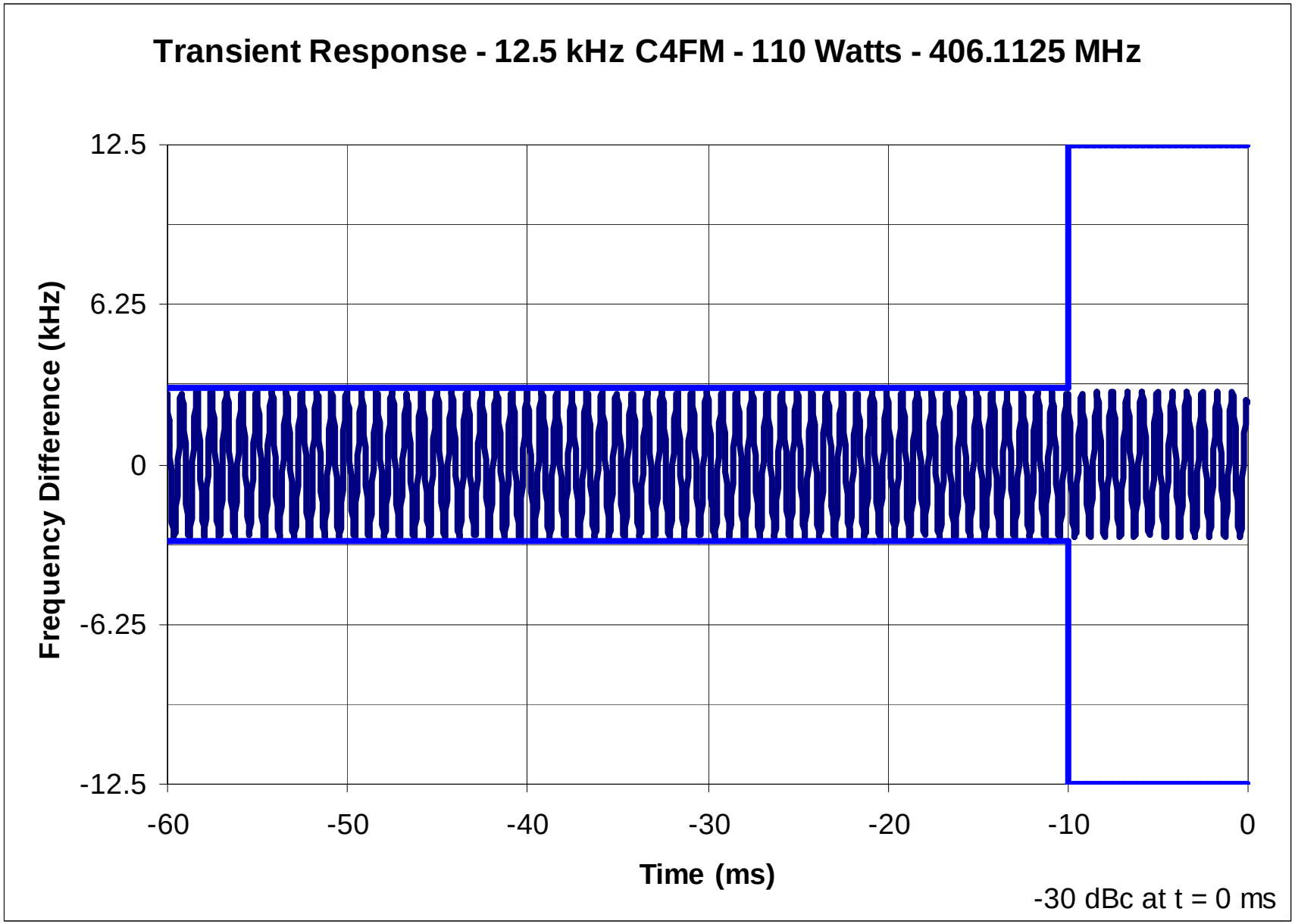
Frequency Transient – Key-up – Middle of Band



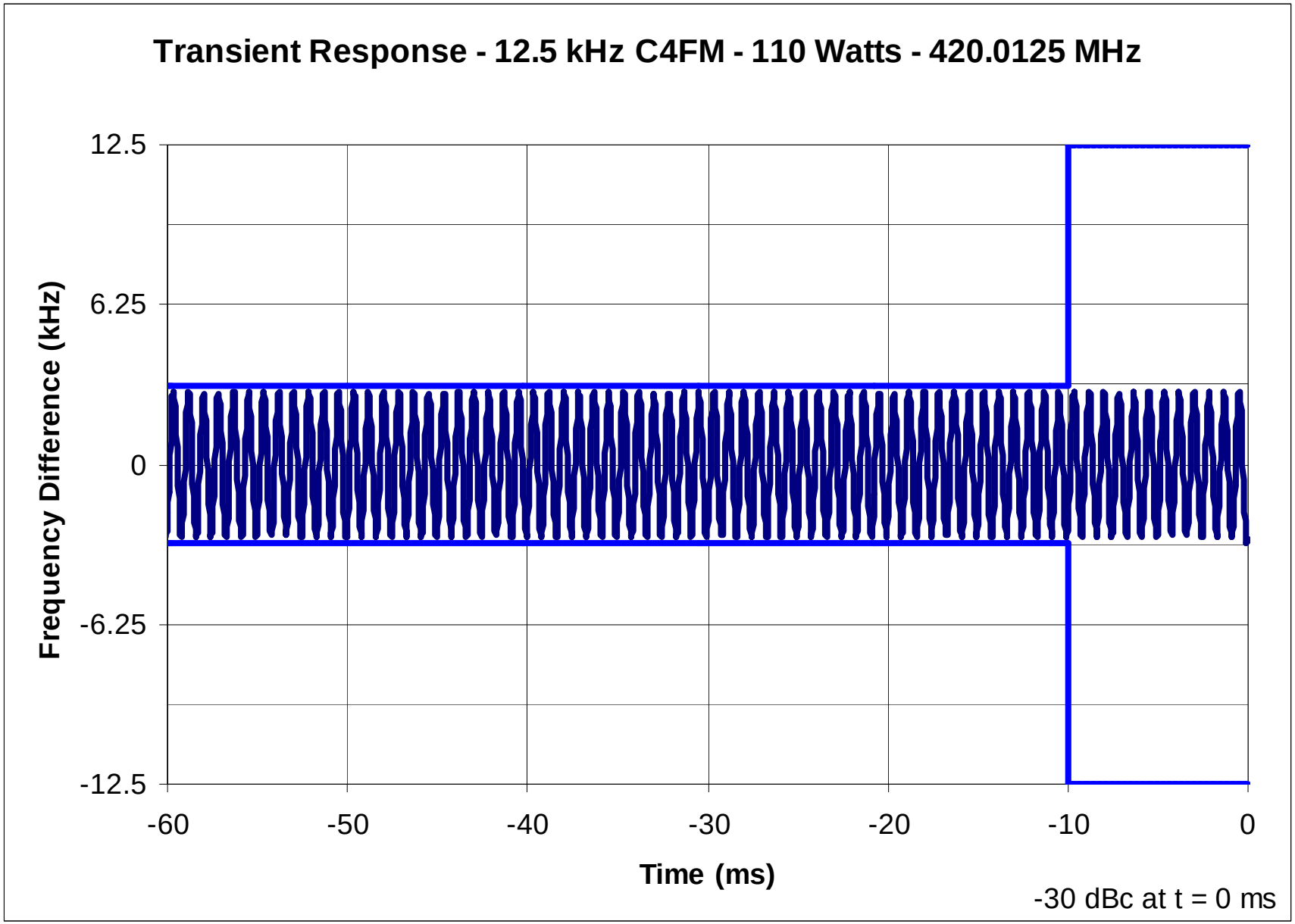
Frequency Transient – Key-up – High End of Band



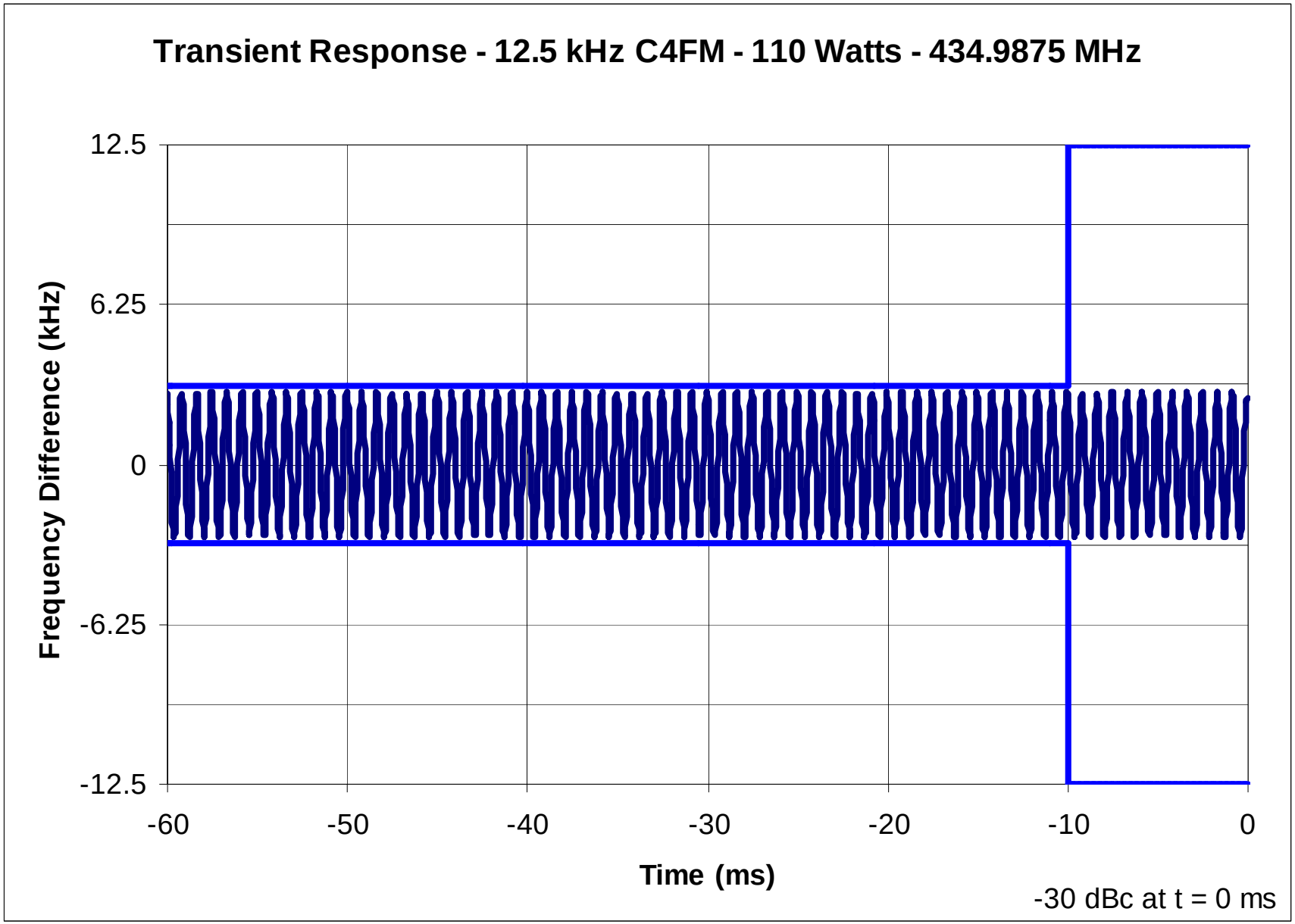
Frequency Transient – De-key – Low End of Band



Frequency Transient – De-key – Middle of Band



Frequency Transient – De-key – High End of Band



Report on Test Measurements

Test Equipment List

MODEL	MANUFACTURER	DESCRIPTION	Serial No.	Last Cal	Next Cal
437B	Hewlett Packard	RF Power Meter	2912A01517	05/10/05	05/10/08
8481A	Hewlett Packard	RF Power Sensor	2702A76706	05/09/07	05/09/10
E4443A	Agilent	Spectrum Analyzer	MY43360090	10/16/07	10/16/08
83712A	Hewlett Packard	Signal Generator	3429A00455	no calibration required	
8671B	Hewlett Packard	Signal Generator	2611A00159	10/24/07	10/24/10
85460A	Hewlett Packard	EMI Analyzer, Filter	3704A00467	07/21/07	07/21/10
85462A	Hewlett Packard	EMI Analyzer, RF/Display	3906A00500	07/21/07	07/21/10
8593E	Hewlett Packard	EMI Analyzer	3513A01649	06/08/07	06/08/10
89441A	Hewlett Packard	Vector Signal Analyzer	3416A00835	08/10/06	08/10/09
(Various)	Weinschel, Kathrein, Bird	RF Loads	Various	no calibration required	
TWPC-4510-1	Telewave	Cavity	5244	no calibration required	
3020A, etc.	Narda	Directional Coupler	Various	no calibration required	

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, Valparaiso University, Valparaiso, Indiana, USA**
MSEE, Illinois Institute of Technology, Chicago, Illinois, USA

__26___ years of Design and Development experience in the field of two-way radio communication.

NAME: **Ken Weiss**

SIGNATURE: 

DATE: **April 16, 2008**

POSITION: **Senior Staff Engineer**

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: **Ali Sajanlal**

SIGNATURE: 

DATE: **April 16, 2008**

POSITION: **Engineering Section Manager**