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COUNSELORS AT LAW

April 13, 2015

Via ECFS

Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

Re: *Ex Parte* Comments: Amendment of Part 15 of the Commission's Rules for Unlicensed Operations in the Television Bands, Repurposed 600 MHz Band, 600 MHz Guard Bands, and Duplex Gap, and Channel 37, ET Docket No. 14-165; Promoting Spectrum Access for Wireless Microphone Operations, GN Docket No. 14-166; Expanding the Economic and Innovation Opportunities of Spectrum through Incentive Auctions, GN Docket No. 12-268

Dear Ms. Dortch:

On April 9, 2015, Mark Brunner, Senior Director, Global Brand Management, Ahren J. Hartman, Senior Director, Wireless Engineering, and Edgar C. Reihl, P.E., Director, Spectrum Strategy with Shure Incorporated ("Shure") and Catherine Wang and Timothy L. Bransford of Morgan, Lewis & Bockius LLP met with the individuals identified in the attached list from the Office of Engineering and Technology, Wireless Telecommunications Bureau and Incentive Auctions Task Force.

During this meeting Shure reaffirmed its strong support for the Federal Communications Commission's ("Commission's" or "FCC's") proposal to authorize wireless microphone operations in the 600 MHz Band duplex gap between proposed cellular uplink and downlink transmissions and 600 MHz Band guard band spectrum.[1] Shure reemphasized that the duplex gap and guard bands would provide urgently needed spectrum for wireless microphone users given the looming repurposing of the broader 600 MHz Band.

Shure presented the attached slide deck during the meeting demonstrating that wireless microphone operations in the duplex gap as proposed by the Commission are compatible with

[1] *See* Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, GN Docket No. 12-268, Report and Order, 29 FCC Rcd 6567 at 6703-6704, para. 314 (2014) ("*Incentive Auction R&O*"), proposing exclusive use of 4 megahertz of the proposed duplex gap for licensed wireless microphone use and 6 megahertz for unlicensed use.

cellular operations and will fully protect new cellular entrants in adjacent frequencies from blocking and out-of-band emissions ("OOBE"). During its presentation Shure rebutted assertions made by CTIA - The Wireless Association ("CTIA") based on analysis undertaken by V-COMM Telecommunications Engineering ("CTIA Study") that relied upon fundamentally unsound and inaccurate assumptions about wireless microphone signal propagation in real-world environments.[2] Specifically, Shure made the following points with respect to the CTIA Study.

- CTIA analysis on LTE receiver sensitivity measurements and in-band blocking does not adhere to the 3rd Generation Partnership Project ("3GPP") 36.101 standard,[3] and overestimates the LTE receiver performance by a minimum of 10dB, thereby establishing a false and overly sensitive baseline for wireless microphone OOBE levels necessary to protect adjacent receivers.

- 700MHz LTE devices have successfully coexisted for years with hundreds of millions of consumer devices that emit undesired emissions in the 700MHz band up to the Part 15.109 Class A and B levels that the FCC established decades ago.

- Typical wireless microphone out-of-band emissions are 10 dB to 20 dB lower than the limits for general consumer devices (FCC Part 15.109 Class A and B levels), and therefore do not present a threat of interference to LTE devices.[4]

- CTIA analysis on the signal received by an LTE receiver from a wireless microphone is not based on measured data, but rather loose approximations, thereby establishing a false and overly aggressive baseline for the 600MHz duplex gap and guard band buffer spacing required for wireless microphones.

- Measured data on wireless microphone signals received by LTE receivers indicates CTIA underestimates the path loss between a wireless microphone and an LTE device by 10 dB to -20dB.

- When path loss between wireless microphones and LTE devices used in the CTIA analysis is measured using appropriate assumptions, the potential for interference to LTE devices

[2] *See* Comments of CTIA – The Wireless Association, ET Docket No. 14-165, GN Docket Nos. 14-166, 12-268, at Appendix B, Wireless Microphone and TVWS in 600MHz Duplex Gap and Guard Band Test Results with LTE Devices (filed Feb. 4, 2015).

[3] The 36.101 standard provides internationally recognized and adopted RF characteristics and minimum performance requirements for LTE equipment, including equipment under test conditions.

[4] CTIA actually argues for an OOBE limit for wireless microphones 40 dB lower (*i.e.*, 10,000 times lower) than the longstanding limit applicable to unlicensed devices under Section 15.109.

vanishes, indicating the 600MHz duplex gap and guard band buffer spacing of 1MHz is more than sufficient to protect LTE devices from wireless microphones.

- Shure's analysis has been confirmed during real-world operations. For example, during the 2014 Academy Awards in Los Angeles wireless microphones (authorized under FCC STA) were operated at 1 MHz of spectral separation from Verizon 700 MHz LTE downlink spectrum in Band 13, causing no interference or interruption in service to the several thousand LTE devices in use within the Kodak Theater.

If you have any questions regarding this ex parte notice, please do not hesitate to contact the undersigned. A copy of the above-referenced slide deck is attached for inclusion in the Commission record.

Very truly yours,

/s/

Catherine Wang
Timothy Bransford

Counsel for Shure Incorporated

cc:

Julius Knapp
Ira Keltz
Geraldine Matisse
Bruce Romano
Paul Murray
Martin Doczkat
Hugh Van Tuyl
Rodney Small
Donald Campbell
Chad Breckenridge
A.J. Glusman

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FCC Meeting Attendees

Julius Knapp	OET
Ira Keltz	OET
Geraldine Matisse	OET
Bruce Romano	OET
Paul Murray	OET
Martin Doczkat	OET
Hugh Van Tuyl	OET
Rodney Small	OET
Donald Campbell	OET
Chad Breckenridge	WTB
A.J. Glusman	Incentive Auction Taskforce

Wireless Microphones in the 600MHz Duplex Gap and Guard Bands

ET 14-165

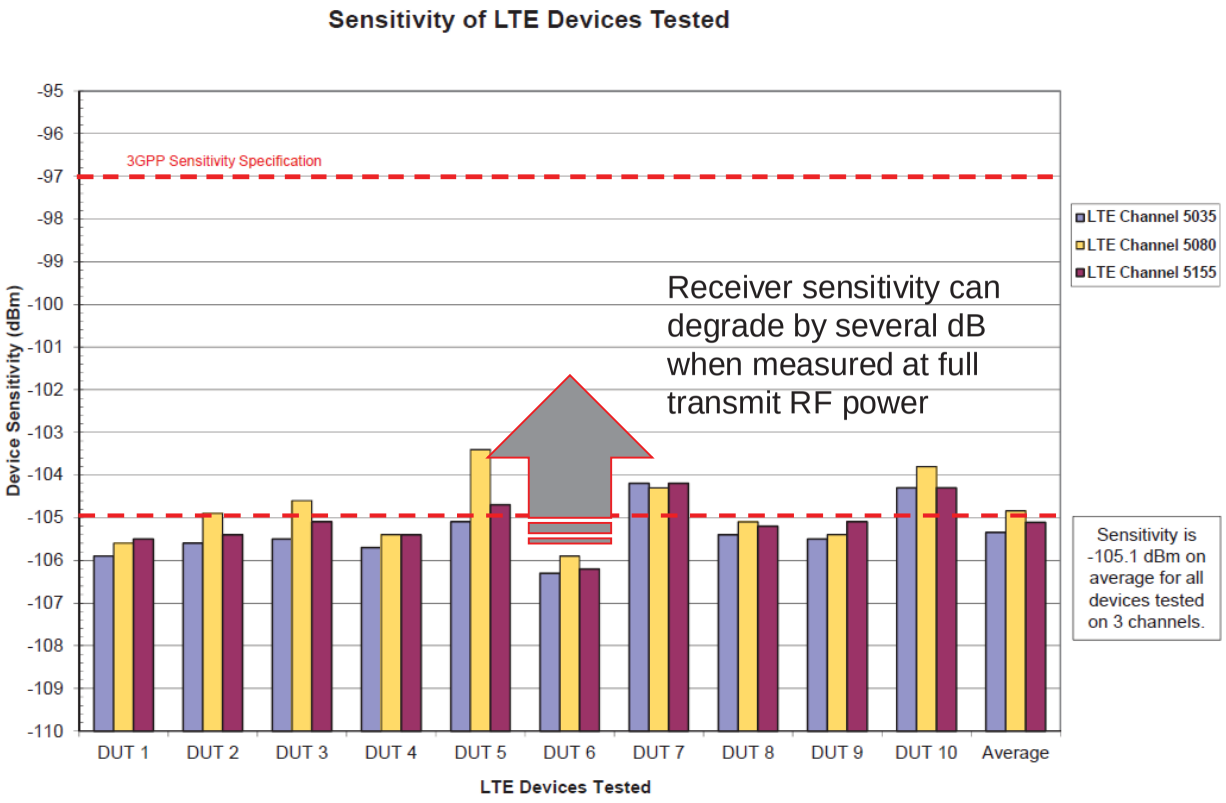
9 April 2015

Topics

- CTIA/VCOMM LTE receiver measurements
- Out of band emissions analysis
- LTE receiver blocking analysis
- Conclusions

CTIA/VCOMM 700MHz LTE Receiver Measurements

- 3GPP 36.101 (Section 7.3.1): Procedure for measuring receiver **sensitivity**



CTIA/VCOMM measured LTE receiver sensitivity at 0dBm transmit power, not P_{UMAX} as specified in 3GPP 36.101

CTIA LTE receiver sensitivity measurement is invalid – should use the -97dBm 3GPP sensitivity specification for interference analysis

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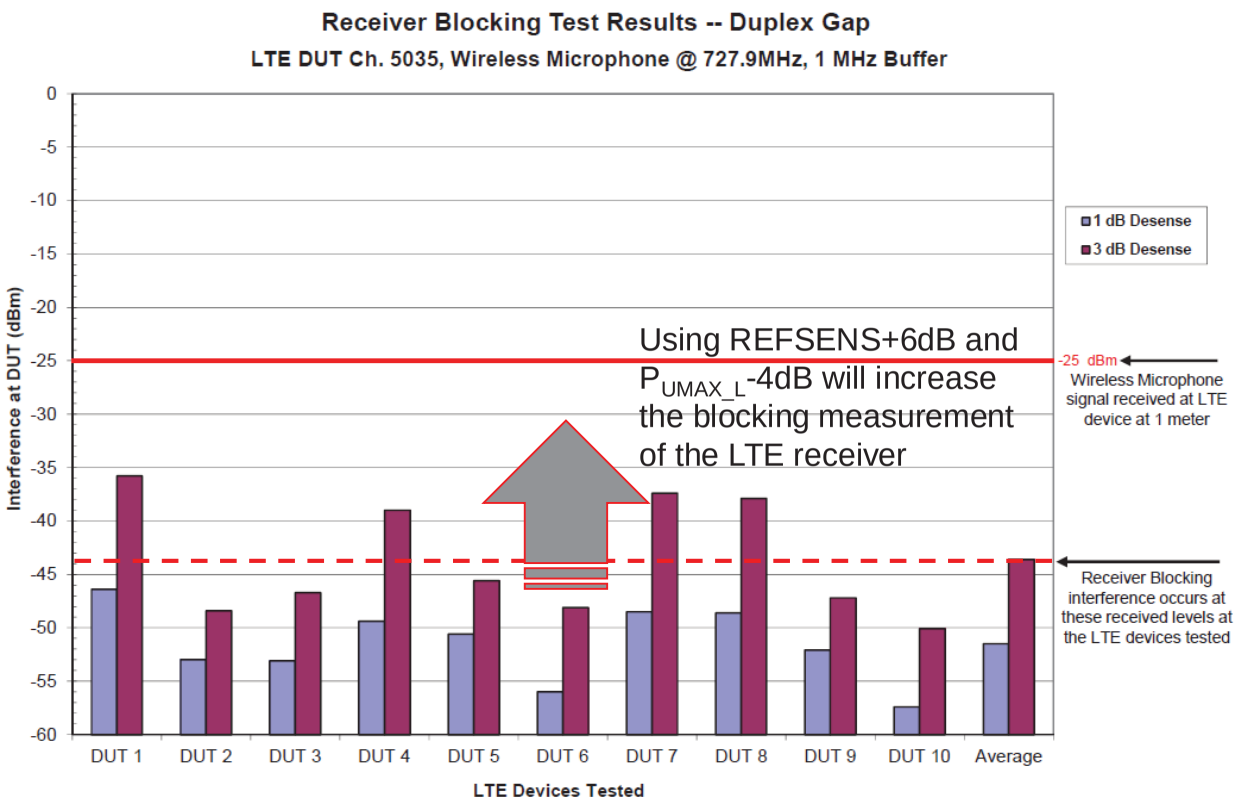
CTIA/VCOMM 700MHz LTE Receiver Measurements

- 3GPP 36.101 (Section 7.6.1): Procedure for measuring receiver **in-band blocking**



CTIA/VCOMM measures receiver blocking levels at REFSENS+1dB, not REFSENS+6dB as specified in 3GPP 36.101

CTIA/VCOMM measures receiver blocking levels at 0dBm transmit power, not the P_{UMAX_L}-4dB as specified in 36.101

CTIA LTE receiver blocking measurement is invalid – should use the REFSENS+6dB blocking level for interference analysis

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CTIA/V-COMM claims

CTIA
The Wireless Association™

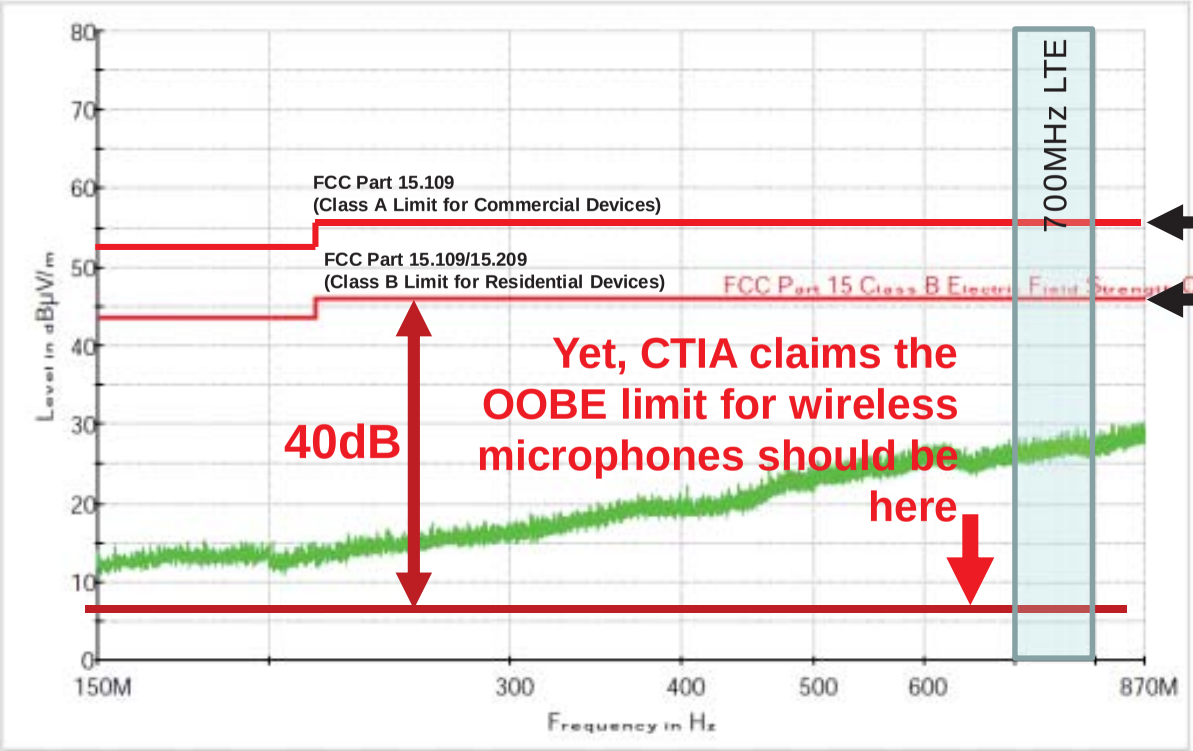
Recommendations Based Upon V-COMM Test Findings

- More Stringent OOBE Requirements Are Needed To Protect Licensed Services
  - OOBE was found to be the predominant interference effect once appropriate buffers between wireless microphone/white space device operations and licensed LTE services were utilized
  - The Commission's proposed -56.8 dBm/100 kHz OOBE attenuation requirement must be increased to -89 dBm/100 kHz at band edge to fully protect licensed downlink services in the 600 MHz band
  - Should the FCC adopt its -56.8 dBm/100 kHz OOBE limit, LTE devices will suffer harmful interference as much as 20 meters away
- Duplex Gap Requirements Must Be Modified To Protect Licensed Services
  - The OOBE limit must be -89 dBm/100 kHz at the downlink band edge
  - White Space Devices must have a five megahertz buffer from licensed downlink spectrum to operate at 40 milliwatts (16 dBm)
  - Wireless microphones must have a five megahertz buffer from licensed downlink spectrum to operate at 20 milliwatts (13 dBm)

CTIA claims the predominant source of interference to LTE devices will be wireless microphone out-of-band emissions (OOBE) – why?

SHURE

700MHz Emissions Analysis



LTE devices have operated in 700MHz since 2013 coexisting with …

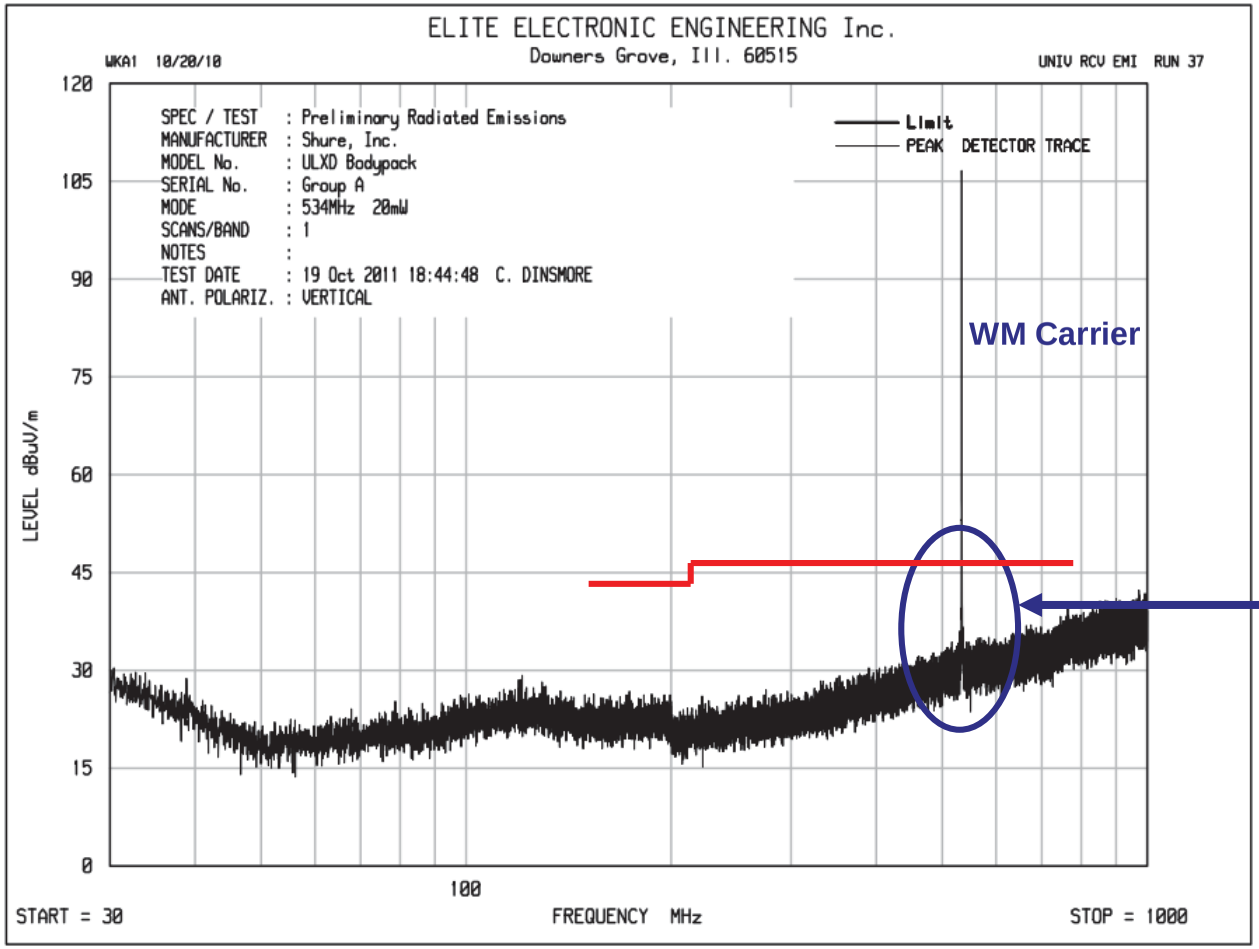
Hundreds of millions of devices radiating emissions up to the 15.109/15.209 limits

Green trace = analyzer noise floor with empty anechoic chamber

SHURE

FCC Emissions Examples

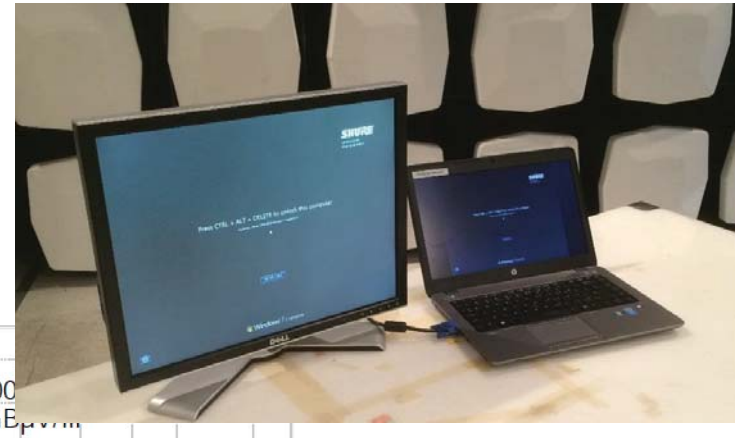
Shure ULXD1 Wireless Microphone Transmitter

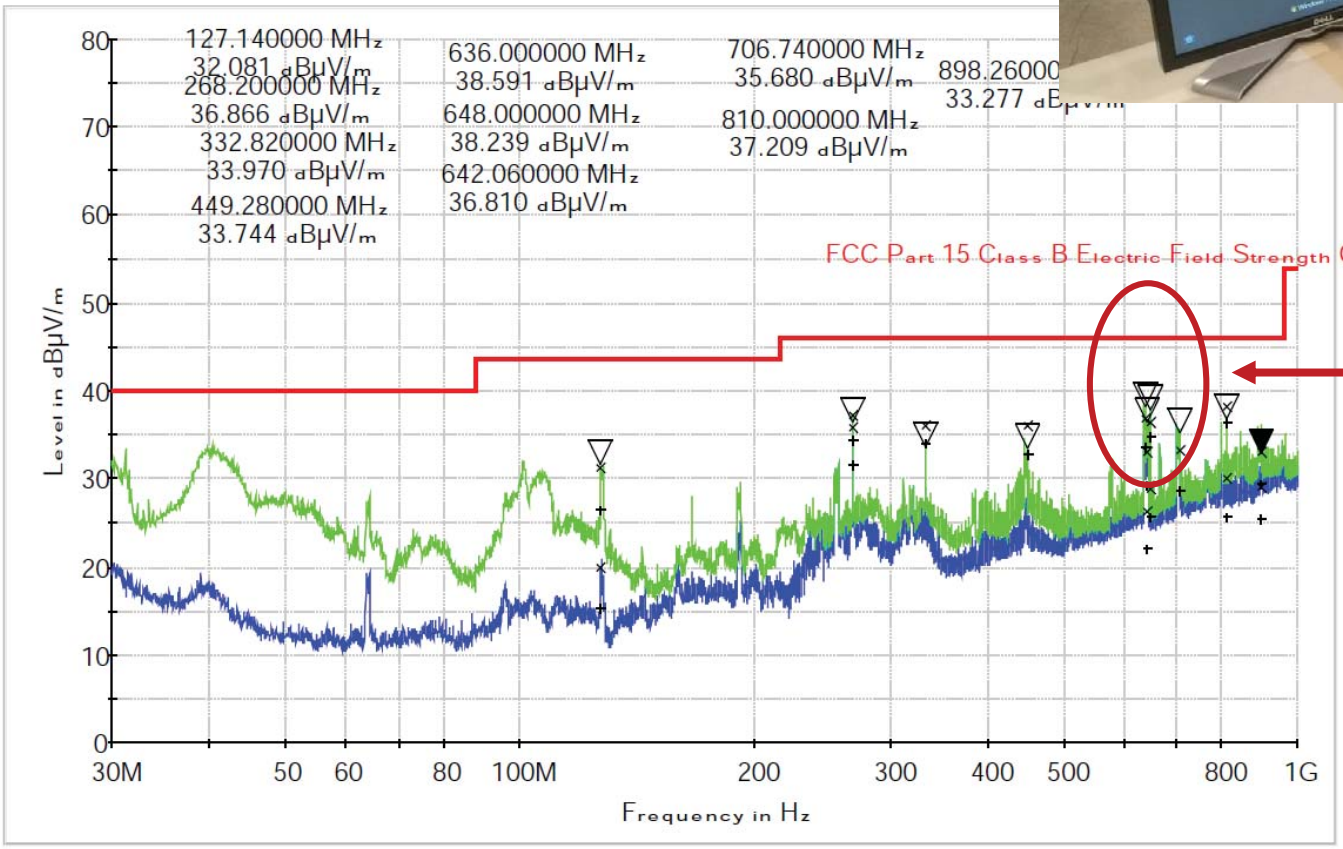


15-20 dB below 15.209 limit (measurement limited by EMC receiver noise floor)

FCC Emissions Examples

Laptop computer and display*





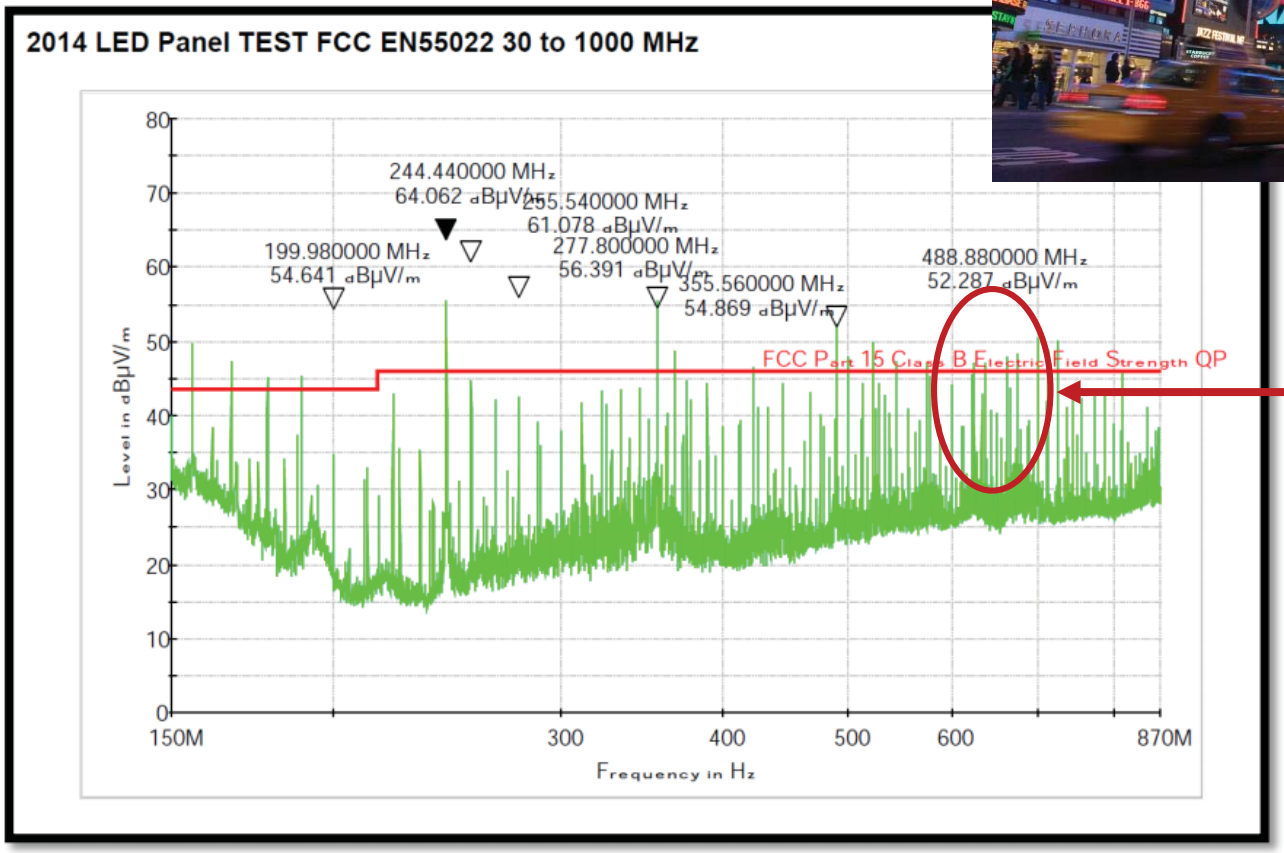
Within 7dB of limit;

Higher than wireless microphone OOBE

* FCC 15.109 Measurements taken in Shure EMC chamber

FCC Emissions Examples

LED Video Panel*



At 15.109 (Class B) limit – Approved to 15.109 (Class A);

Higher than wireless microphone OOBE

* FCC 15.109 Measurements taken in Shure EMC chamber

Emissions Analysis - CONCLUSIONS

Wireless Microphones meet the emissions limits set in 15.209 and the *Unlicensed NPRM* by a wide margin, therefore it's logical to conclude that wireless microphones won't interfere with LTE mobile devices, just as general consumer devices don't

Out-of-Band Emissions Example

Basketball court example – revisited

- CTIA/VCOMM claims WM OOBE will interfere with a mobile device across a basketball court using the REFSENS+1dB level criteria
- If this were true, the 700MHz LTE mobile devices would already be experiencing interference from the thousands of LED lights, computers, TV/LCD monitors in the arena that emit up to 40-50dB <u>above</u> the REFSENS+1dB level
- An arena of 20,000 mobile users will typically have LTE installed via distributed antenna systems for adequate signal coverage, and therefore, the mobile devices will operate far above the REFSENS+1dB level without interference[1]

1. http://www.chicagobusiness.com/article/20130110/BLOGS04/130119985/united-center-gets-cellular-network-tuneup

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CTIA/V-COMM claims

CTIA
The Wireless Association™

Recommendations Based Upon V-COMM Test Findings

- More Stringent OOBE Requirements Are Needed To Protect Licensed Services
  - OOBE was found to be the predominant interference effect once appropriate buffers between wireless microphone/white space device operations and licensed LTE services were utilized
  - The Commission's proposed -56.8 dBm/100 kHz OOBE attenuation requirement must be increased to -89 dBm/100 kHz at band edge to fully protect licensed downlink services in the 600 MHz band
  - Should the FCC adopt its -56.8 dBm/100 kHz OOBE limit, LTE devices will suffer harmful interference as much as 20 meters away
- Duplex Gap Requirements Must Be Modified To Protect Licensed Services
  - The OOBE limit must be -89 dBm/100 kHz at the downlink band edge
  - White Space Devices must have a five megahertz buffer from licensed downlink spectrum to operate at 40 milliwatts (16 dBm)
  - Wireless microphones must have a five megahertz buffer from licensed downlink spectrum to operate at 20 milliwatts (13 dBm)

CTIA claims the Duplex Gap should be modified – why?

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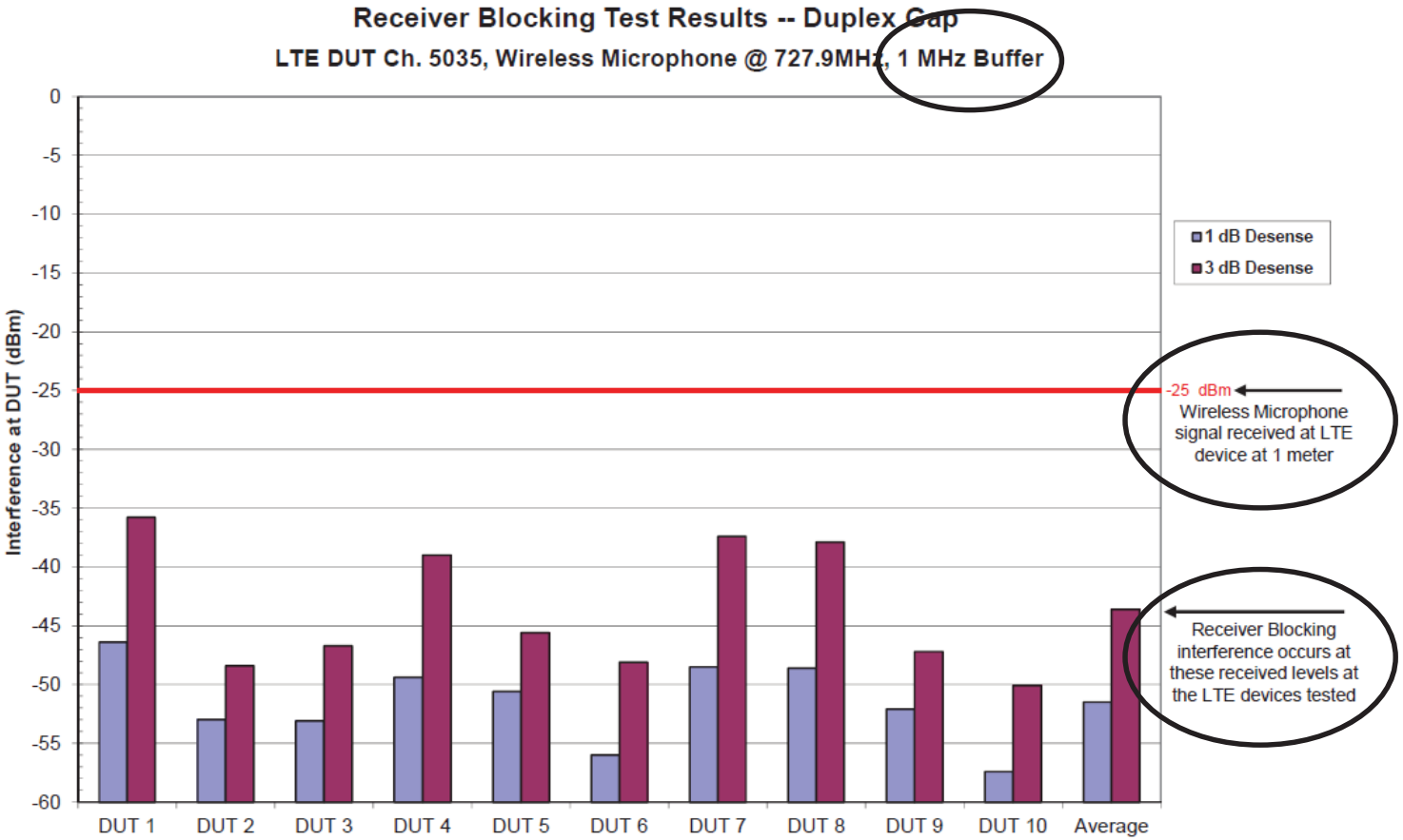
LTE Receiver Blocking Analysis

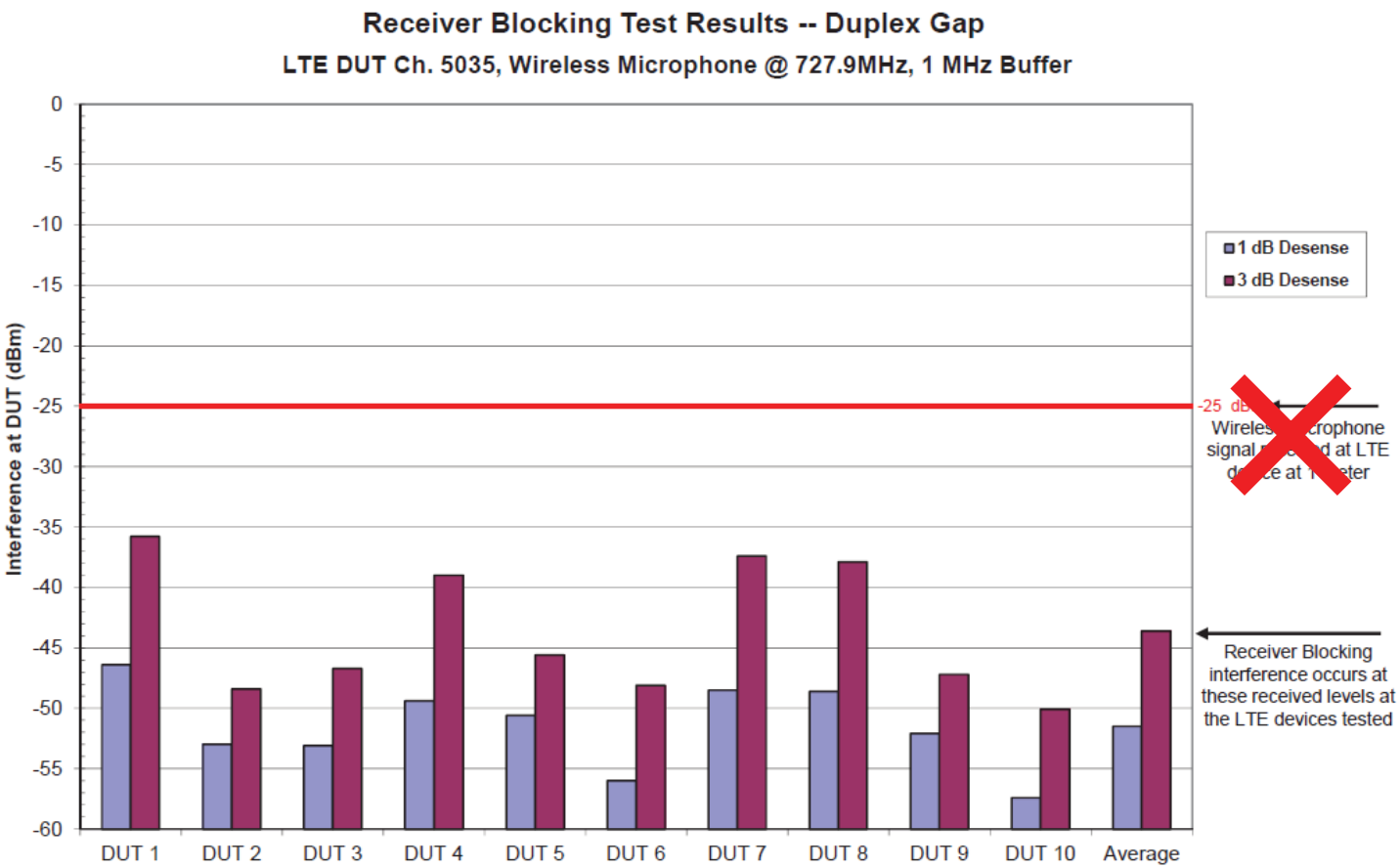


CTIA/VCOMM conducted LTE receiver blocking tests at a 1MHz buffer…

Then compared those results to the signal from a wireless microphone at 1 meter…

And concluded that a 1MHz buffer wasn't sufficient to protect LTE devices.

LTE Receiver Blocking Analysis



The LTE receiver blocking data was based on (flawed) measurements…

But the signal received from a microphone at 1 meter was not…

Instead, it was based on loose assumptions with no real data and it calculates the microphone signal level incorrectly.

LTE Receiver Blocking Analysis

Wireless Microphone Signal at 1 meter from LTE device (as calculated by CTIA/VCOMM)

- Wireless Microphone Output Power = 13dBm (20mw)
- Path loss at 1 meter seen by LTE receiver = 38dB
- Wireless Microphone signal at 1 meter = 13dBm – 38dB = -25dBm

A path loss of 38dB is not realistic and is incorrectly used in the LTE blocking analysis.

LTE Receiver Blocking Analysis

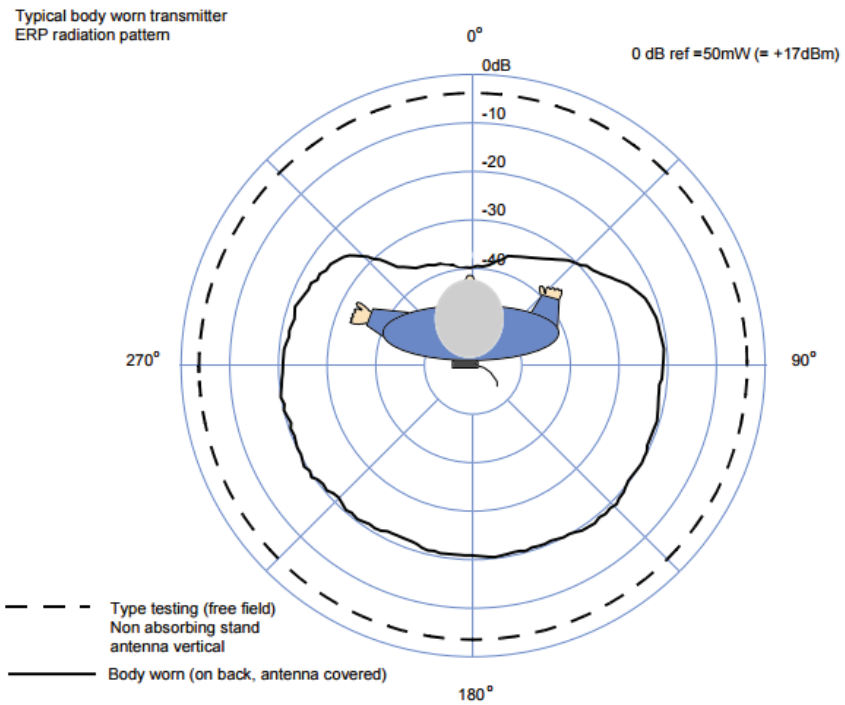
CTIA/VCOMM underestimates the real microphone path loss

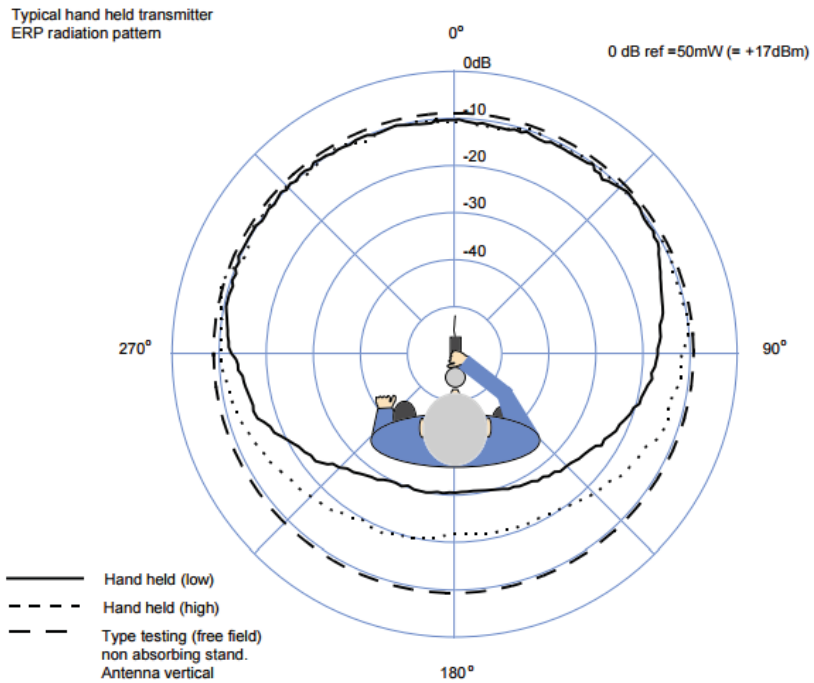
Wireless microphone and LTE device antenna gain	0dB
Wireless microphone antenna loss (held in hand)	3dB
LTE device antenna loss (held in hand)	3dB
Antenna polarization mismatch and other losses	3dB
1 meter free space loss at 665MHz	29dB
TOTAL PATH LOSS @ 1 Meter	**38dB**

Assumptions – not based on real data

LTE Receiver Blocking Analysis

Body loss data for handheld and body-pack wireless microphones[1,2,3]





650MHz Testing:

WM BP Body Loss = 18dB

WM HH Body Loss = 8dB

1. http://www.erodocdb.dk/Docs/doc98/official/Pdf/CEPTRep030.pdf
2. http://www.erodocdb.dk/Docs/doc98/official/pdf/REP042.pdf
3. Body loss is defined as the combined antenna efficiency plus the loss associated with the human body

LTE Receiver Blocking Analysis

LTE Device Antenna Gain

- iPhone 6+ antenna gain @ 704-716MHz = -4.7dB (primary), -4.9dB (secondary)[1]
- Estimated LTE antenna gain @ 655MHz = -5dB

REPORT NO: 14U17676-E17F
MODEL: A1524

DATE: AUGUST 27, 2014
FCC ID: BCG-E2817A

5.3. SOFTWARE AND FIRMWARE

The firmware installed in the EUT during testing was 12A310 Baseband 0.26.01.

The EUT is linked with Agilent 8960, Anritsu MT8820C, and CMW500 Communication Test Sets.

5.4. MAXIMUM ANTENNA GAIN

Please see table below:

LTE BANDS	Antenna Gain (dBi)
LTE Band 2, 1850 – 1910 MHz	2.9
LTE Band 4, 1710 – 1755 MHz	2.7
LTE Band 5, 824 – 849 MHz	-2.3
LTE Band 13, 777 – 787 MHz	-1.8
LTE Band 17, 704 – 716 MHz	-4.7
LTE Band 25, 1850 – 1915 MHz	2.9
LTE Band 26, 814 – 824 MHz	-2.3
LTE Band 41, 2496 – 2690 MHz	3.6

Primary

LTE BANDS	Antenna Gain (dBi)
LTE Band 2, 1850 – 1910 MHz	2.2
LTE Band 4, 1710 – 1755 MHz	1.6
LTE Band 5, 824 – 849 MHz	-3.8
LTE Band 13, 777 – 787 MHz	-3.8
LTE Band 17, 704 – 716 MHz	-4.9
LTE Band 25, 1850 – 1915 MHz	2.2
LTE Band 26, 814 – 824 MHz	-4.2
LTE Band 41, 2496 – 2690 MHz	1.6

Secondary

1. FCC iPhone approval – BCG-E2817A

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LTE Receiver Blocking Analysis

Path loss with measured data

	Wireless Microphone Type	
	BP	**HH**
Wireless microphone antenna + body loss	18dB	8dB
LTE device antenna loss	5dB	5dB
LTE device antenna loss (held in hand)	3dB	3dB
Antenna polarization mismatch and other losses	3dB	3dB
1 meter free space loss at 665MHz	29dB	29dB
TOTAL PATH LOSS @ 1 Meter	**58dB**	**48dB**

LTE Receiver Blocking Analysis

Wireless Microphone Signal at 1 meter from LTE device using measured data

	Wireless Microphone Type	
	BP	**HH**
Wireless Microphone transmit power	13dBm	13dBm
Path loss @ 1 meter	58dB	48dB
Wireless Microphone Signal @ 1 Meter	**-45dBm**	**-35dBm**

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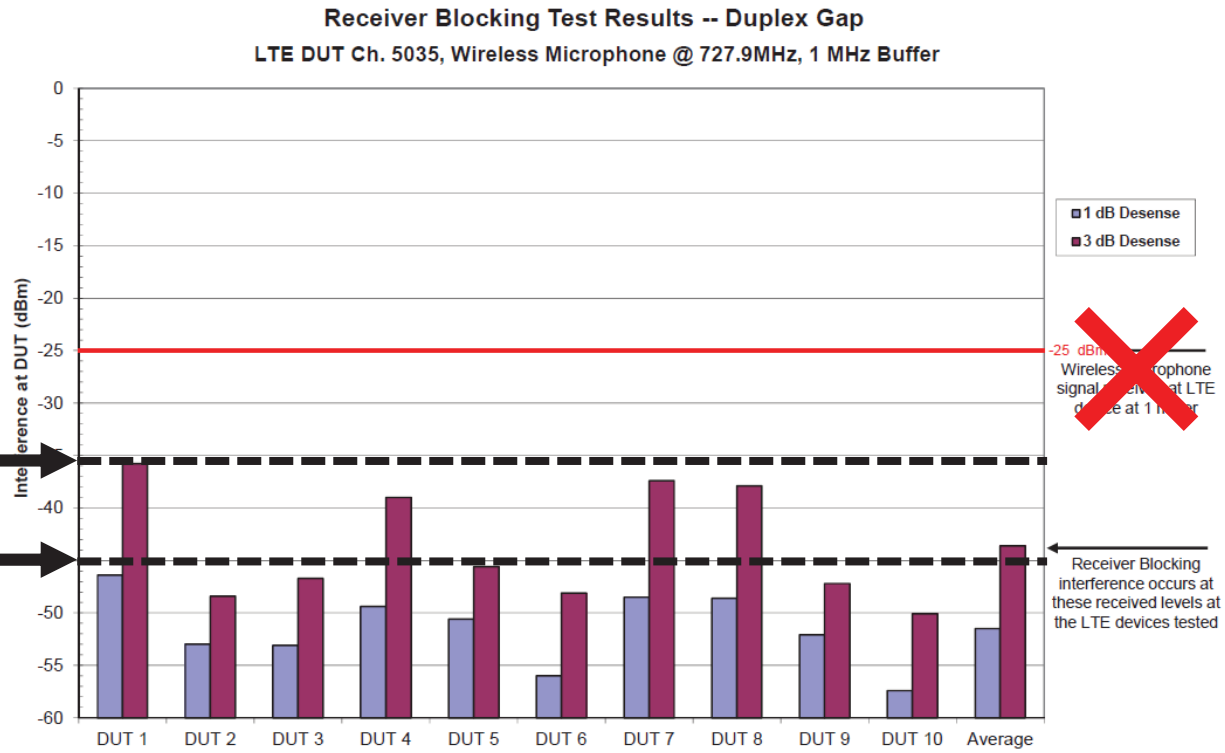
LTE Receiver Blocking Analysis

LTE Blocking analysis with measured loss model – 1 meter

Wireless Microphone HH signal received at LTE device at 1 meter with measured path loss model = -35dBm

Wireless Microphone BP signal received at LTE device at 1 meter with measured path loss model = -45dBm

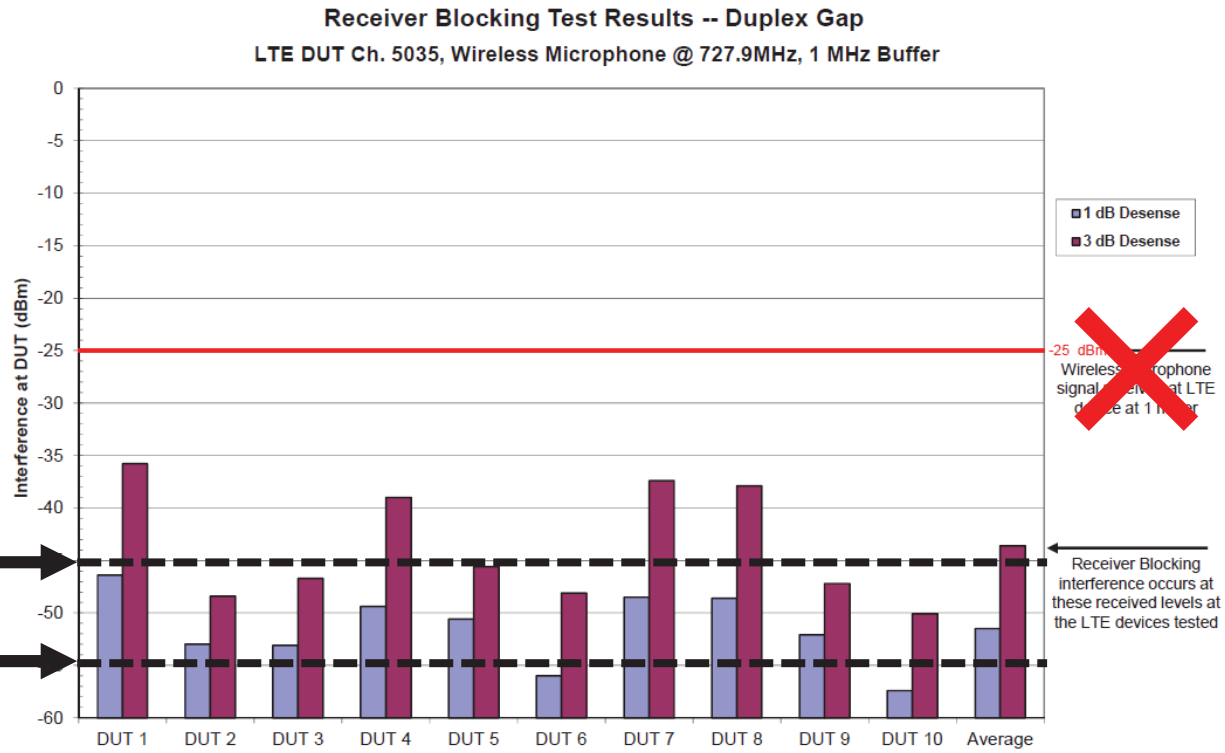


LTE Receiver Blocking Analysis

LTE Blocking analysis with measured loss model – 3 meters

Wireless Microphone HH signal received at LTE device at 3 meter with measured path loss model = -45dBm

Wireless Microphone BP signal received at LTE device at 3 meter with measured path loss model = -55dBm



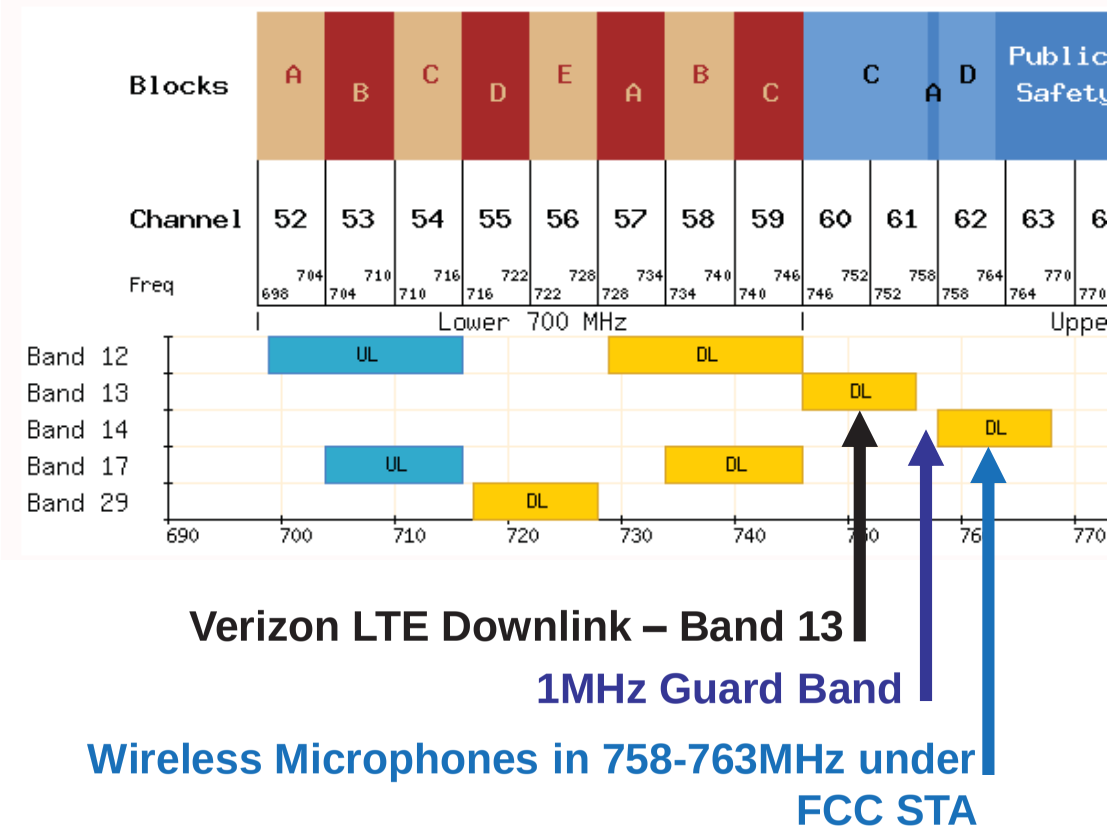
LTE Receiver Blocking Analysis - CONCLUSIONS

Based on measured microphone path loss data at 1 and 3 meters, the Duplex Gap/Guard Band proposed buffer of 1MHz is sufficient to protect LTE mobile devices from Wireless Microphones

LTE Receiver Blocking Example

2014 Academy Awards – Los Angeles

- In 2014, wireless microphones were used at the Academy Awards at the Dolby Theater in Los Angeles
- These microphones were operated in the open 700MHz 'D' block under STA by the FCC[1]
- 15 microphones were successfully operated in 758-763MHz, 1MHz away from the Verizon LTE down-link band 13 spectrum launched in June 2013[2]



1. http://wireless2.fcc.gov/UlsApp/ApplicationSearch/applMain.jsp?applID=8087842
2. http://www.verizonwireless.com/news/2013/06/verizon-wireless-500-4G-LTE-markets.html

LTE Receiver Blocking Examples

2014 **Academy Awards**
– 700MHz ‘D’ Block STA

LTE Receiver Blocking Examples

2014 **Grammy Awards**
– 700MHz ‘D’ Block STA

CONCLUSIONS

FCC-proposed Out-of-Band Emissions levels and Duplex Gap / Guard Band 1MHz buffers are sufficient to protect 600MHz LTE devices from Wireless Microphones and do not need to be modified

Thank You