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April 6, 2015

Via Electronic Filing

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

Re: GN Docket Nos. 12-268 and 14-166 and ET Docket No. 14-165
***Ex Parte* Filing of Sennheiser Electronic Corporation**

Dear Ms. Dortch:

On April 2, 2015, Joe Ciaudelli, Director, Spectrum Affairs, Sennheiser Electronic Corporation ("Sennheiser"), and the undersigned, counsel for Sennheiser, met with the following Federal Communications Commission ("FCC" or "Commission") staff: Julius Knapp, Paul Murray, Ira Keltz, Hugh Van Tuyl, Chad Breckinridge, Gary Epstein, John Schauble, Stephanie Minnock, AJ Glusman, Stephen Buenzow (via telephone), Chris Helzer (via telephone) and Simon Banyai.

The participants discussed the points Sennheiser has made in the above-captioned dockets with regard to the future of wireless microphone use in the U.S., as detailed in the attached presentations. Additionally:

- Sennheiser showcased its top-of-the-line Digital 9000 wireless microphone system, demonstrating the technological innovations of the industry and showing how professional wireless microphone operators scan the UHF frequency range and take other steps to find clear spectrum for wireless microphone use;

- Sennheiser suggested that "Class B" wireless microphone users be defined as entities that must comply with the Americans with Disabilities Act assisted listening requirements;

- Sennheiser explained that wireless microphones and white space devices ("WSD") use different technology and serve different purposes. They should not be regulated identically. Unlike WSD, wireless microphones are point-to-point links that do not require internet connectivity for their fundamental purpose and they cannot tolerate the interruptions sometimes required by the WSD database system; and

- Sennheiser noted that WSD pose a more difficult challenge than sharing with television stations because the location of television stations is predictable and the location of portable WSD will not be predictable.

In addition, with regard to Class B users, in Sennheiser's experience those which do not have sound operators on staff, such as some schools, rely on sound contractors to set up wireless microphone systems tuned to specific frequency ranges. In Sennheiser's experience, these Class B users employing sound contractors do not retune their equipment once it is set-up, except with the assistance of the sound contractor.

Please direct any questions to the undersigned.

Respectfully submitted,

Laura A. Stefani
Counsel for Sennheiser Electronic Corp.

Attachments

cc: Renee Gregory
Louis Peraertz
Priscilla Delgado Argeris
Brendan Carr
Erin McGrath
Gary Epstein
Howard Symons
David Goldman
Julius Knapp
Paul Murray
Ira Keltz
Hugh Van Tuyl
Chad Breckinridge
John Schauble
Stephanie Minnock
AJ Glusman
Stephen Buenzow
Chris Helzer
Simon Banyai

Proposal for Future Wireless Microphone Operation in The United States – A Balanced Approach

April 2, 2015 11:00am

SENNHEISER

Sennheiser at a Glance

The leading manufacturer in high-end professional wireless microphones (more than 90% of Broadway)

- Founded in 1945
- More than 2300 employees worldwide, annual sales ˜$800M
- Three U.S. facilities:
  - Old Lyme, CT
    - Sales & Marketing
  - Albuquerque, NM
    - Factory (140 employees, $60M annual sales)
  - San Francisco, CA
    - Advanced R&D

First wireless microphone introduced in 1957

Today's technology

SENNHEISER

Cutting Edge Technology

Sennheiser has a long history of innovation

- **Latest professional microphones introduced have high spectral efficiency:**
  - Digital 9000 – allows equally spaced carriers
  - SK 5212 / SKM 5000 analog – low IM mode feature
- **New semi-pro products operate outside of UHF:**
  - Digital-1 musician system, 2.4 GHz
  - 1.9 GHz digital system for presentation and video applications
- **Digital is not inherently more spectrally efficient than analog:**
  - Digital does allow for compression and can increase spectral efficiency, assuming clean spectrum (low noise floor), but at the cost of latency, audio quality, or both
  - Market forces, not mandatory technical requirements, should be the driving force in the technology applied

SENNHEISER

Three Classes of Microphone Operators

Class A: Power users (licensed professionals)

- Need priority over WSD devices
- Need up to 350 MHz spectrum total to stage mega-events
- Sometimes need power up to 250 mW (though generally 50 mW)

Class B: Civic and commercial productions

- Often professional level events (Baltimore Symphony, Steppenwolf)
- Needs cannot be completely served with unlicensed bands
- Many do not qualify for licensing under current Part 74 eligibility requirements
- There should remain a path for them to register their events for interference protection

Class C: Hobbyists

- Many have been already transitioned out of UHF
- Use unlicensed bands such as 2.4 MHz

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Economics of Content Creation

- 600 MHz proceeding focuses on content distribution via broadband
- Spectrum is also essential for content creation
- U.S. produced news and entertainment is the best in the world and vital to our economy:
  - Nearly $1 Trillion to the economy = ~ 6.5% of the national GDP
  - 3-to-1 export to import ratio - the highest, by far, of any American made product or service
- Demand for content and wireless microphones is growing

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Wireless Microphones are Different from WSD

- **Fault intolerant**
  - Must be completely free from drop-outs or other interruptions
    - Prime motivator for operators to seek clear frequencies, which makes wireless microphones good spectrum neighbors
- **Real time devices**
  - Must have negligible latency (sound delay)
    - <4 ms for microphones (<10 ms through the whole sound system) vs. a cell phone typically has >100 ms latency (>200 ms between two mobile devices)
- **Extremely low out-of-band (emissions) in professional microphones**
- **Long history of peaceful co-existence**

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Millions Watching – No Second Chance

- Some hyper-critical applications require UHF that does not rely on the proper operation of the database system and not in the guard bands

Time Square On News Year's Eve

Taylor Swift Performance

The Today Show

> Six Million Viewers Daily

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Two Blocks of Clean UHF for Critical Applications

- Many wireless microphone applications can operate in, and are being moved to, other frequency bands
- Hyper-critical wireless microphone applications require UHF due to wave propagation. It also must be “clean” (low noise)
- News events are spontaneous and the location can change quickly. The white space database system cannot properly address such situations, regardless of its response time
- Sharing with WSD is dependent on the complete proper operation of the database system and *all* the WSD it governs. There is no real world experience gauging the reliability of the database system with portable WSD
- The guard bands and duplex gap will have limited reliability for wireless microphone operation because of high noise due to out-of-band emissions from the uplink and downlink blocks

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Proposal – Spectrum for Wireless Microphones

Television Bands

- **Two blocks for hyper-critical use (not available to WSD)**
  - Channel 37 (WMTS Coalition has indicated support)
  - “Naturally occurring” UHF white space channel
- **Remaining unlicensed channels shared with WSD**
  - Guard bands (microphone power limit at 50 mW)
  - Duplex gap (upper 6 MHz per current FCC proposal, microphone power limit at 50 mW)
  - Other white space TV channels (no portable WSD in Channels 14-20)
- **VHF useful for less critical links, such as intercoms, due to noise**

Additional Bands

- Current STL band widened from 944-952 MHz to 941-960 MHz, opened to all Part 74 licensees
- 1435-1525 MHz, for Part 74 licensed operation
- Other bands to accommodate less critical links, such as 2020-2025 MHz

SENNHEISER

White Spaces Databases

- **Manual database checks by wireless microphone operators fulfill the Spectrum Act**
  - Users also routinely use additional methods to avoid experiencing and causing interference:
    - Scan functions incorporated in the microphone system
    - Spectrum analysis software provided by the manufacturers
    - Licensed professionals routinely use outboard spectrum analyzers
- **Wireless microphones cannot tolerate WSD database interruptions**
- **Wireless microphones generally operate indoors where geolocation is a challenge**
- **WSD recheck times should be increased and geographic protection zone expanded if location accuracy decreased**
- **Class B users must be able to register for protection**

SENNHEISER

Smooth 600 MHz Transition

Virtually all existing professional wireless microphones operate in UHF

- It takes years *after* a technical specifications are *fully defined* to enter the market
- The usefulness of the 39 month transition period is uncertain
- The Commission should allow access to new wireless microphone allocations, and set technical and operational rules, before conducting the Incentive Auction
- Existing wireless microphones should be allowed to continue to operate on lawful UHF frequencies after the repacking and transition, and should not be required to be junked
- Wireless microphone owners should be compensated for any equipment purchased during the 700 MHz reallocation that will be rendered obsolete by this reallocation
  - During the 700 MHz proceeding, the Commission's press release directed wireless operators to use UHF below 700 MHz
  - Much 600 MHz equipment was purchased prior to notice of the Incentive Auction
  - Replacing equipment a second time is a financial hardship and simply unfair
  - The Commission has the authority to mandate compensation from auction winners

SENNHEISER

Thank you!

Joe Ciaudelli | 860-848-0411 | spectrum@sennheiserusa.com

Laura Stefani | 703-812-0450 | stefani@fhhlaw.com

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Proposal for Future Wireless Microphone Operation in The United States – A Balanced Approach

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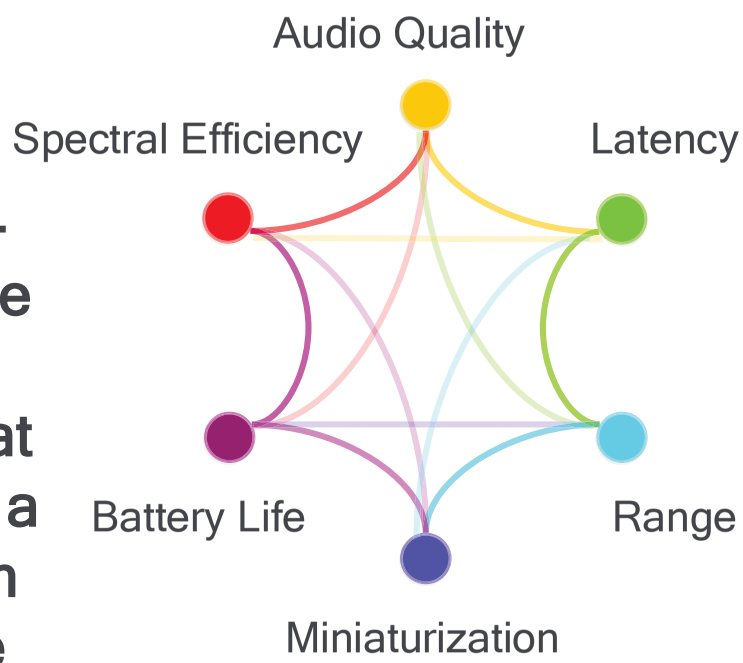
Wireless Microphone Technology Demands

- Wireless microphones must be drop-out free, have CD quality sound, have negligible latency (audio delay), be compact, operate continuously with at least 5 hours of battery life, and fit in a tight spectrum mask. Any feature can be optimized but only at the expense of one or many of the others
- Some applications can tolerate compromise, but critical wireless microphone applications cannot



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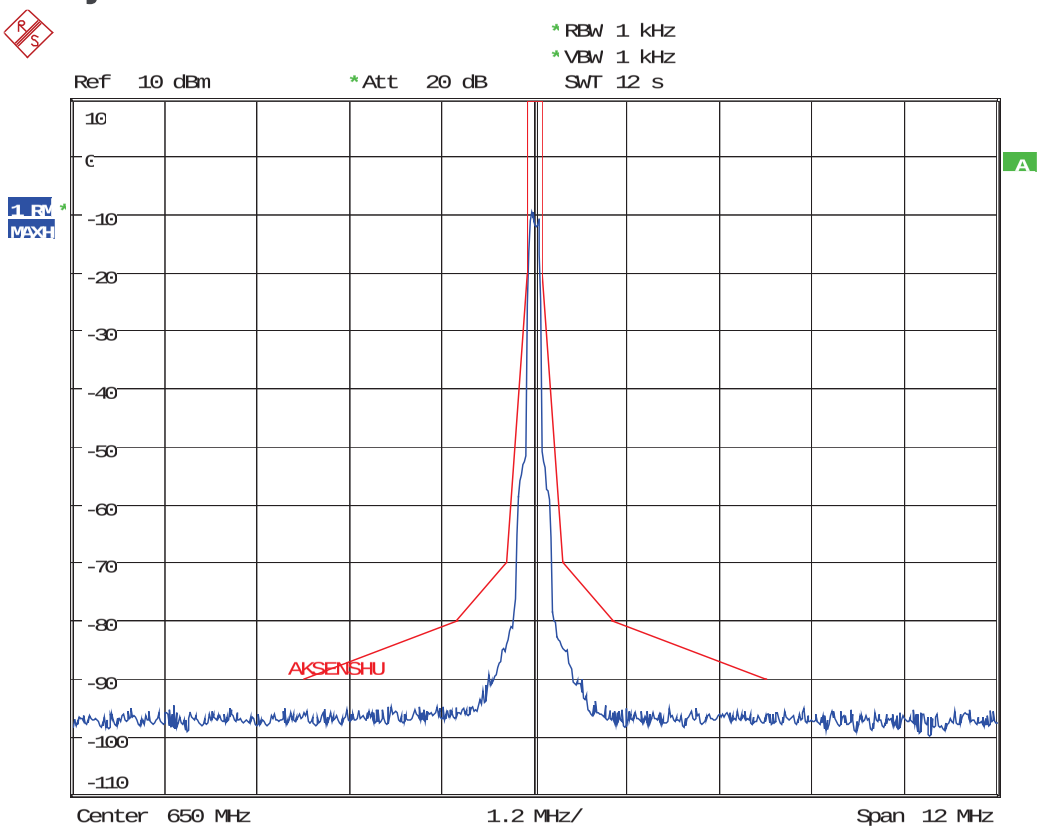
Wireless Microphones Make Good Spectrum Neighbors

Long history of peaceful coexistence with other services sharing the same spectrum

- Professional equipment has extremely low out-of-band (spurious) emissions; exceeds ETSI mask standards
- Necessary for multiple microphones operation; prevents interference to services in adjacent channels



Emission of Digital SK 9000 transmitter overlaid in the ETSI mask

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Negligible Likelihood of Interference to 600 MHz Licensees

- Millions of wireless microphones operate each day without incident on channels immediately adjacent (no buffer) to TV, land mobile, and other services
- It is redundant to require a both an out-of-band emissions mask and a buffer greater than 100 kHz
- Wireless microphones can operate in the guard bands at 50 mW
- The sensitivity of a microphone receiver prevents it from mistaking a down link signal detectable by a handset for a clear channel
- The assumed 4W aggregate power of multiple microphones is severely overestimated; even in the highly unlikely occurrence that sixteen 250 mW microphones are used in the same channel, they will be physically separated

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Microphones in The Guard Bands Will Not Cause Interference

The conclusions drawn by CTIA, Qualcomm and CEA are based on unrealistic assumptions and are wrong

- 1 dB de-sense LTE handsets is over protective
  - Equates barely detectible threshold standards with device failure
- They interchange Effective Isotropic Radiating Power ("EIRP") with conducted power at the antenna terminal, overstating the impact
- -15 C temperature results were used for tests simulating indoor operation, resulting in a 2.5 – 2.8 dB overstatement
- Continuous tone was used in simulated tests rather than typical audio input signal
- Handheld microphone transmitters were assumed; body pack microphones are much more popular and experience a higher degree of body absorption
- Conclusions are not supported by practical real world experiences with wireless microphones

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The “Unused” TV Channels are Well-Used by Wireless Microphones

- **Standard productions use dozens of wireless microphones**
  - Networks and content creators routinely use 10 or more UHF channels for each of their daily productions
  - More than 1600 coordinated frequencies (lapel mics, intercoms, etc.) are used on Broadway each night
  - More than 1000 frequencies are coordinated and used for the Super Bowl
- **Hyper-critical situations require clean UHF**

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Clean, Suitable Spectrum

- Professional RF audio engineers require access to two blocks of highly reliable UHF for their mission critical wireless microphones - for spontaneous breaking news and live events viewed by millions
- Best practices: ear monitors and vocal wireless microphones should be in separate, non-adjacent channels (just like a duplex system)
- They also need priority access to spectrum <1 GHz in channels shared with unlicensed devices
- The 600 MHz duplex gap and guard bands are not suitable: high noise floor and/or spurious emissions from adjacent services and limited power (20 mW proposed)

SENNHEISER

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Co-Channel Operation

- The 4 km co-channel operation separation distance was determined using overly conservative assumptions: equated wireless microphone operation to a 4 W WSD with a three foot antenna height
- A field strength threshold, such as -80 dBm, would be more practical and unambiguous with regard to indoor vs. outdoor operation

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Key Technical Needs

- Technical and operational requirements for newly allocated spectrum should be finalized as soon as possible so advanced development of future products can move forward
- Regulations in all bands should be flexible to accommodate new developments

SENNHEISER

Thank you!

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