

## THE FCC'S MEASURED & PRACTICAL APPROACH A REVIEW OF POLICY CHANGES THAT EFFECT WIRELESS MICS

*By Joe Ciaudelli*

*Sennheiser Electronic Corporation*

A few years ago some in the audio community were predicting doom for wireless mics due to the uncertain outcome of two major issues involving the TV spectrum: the digital dividend (due to the spectrum reallocation) and the white space debate. The former would reduce the amount of spectrum available for mics. The latter has the potential to increase interference in the remaining spectrum. The Federal Communications Commission (FCC) was faced with crafting a policy that fostered technological progress within the internet age, yet simultaneously protected incumbent TV services and wireless production tools, especially wireless mics (in-ear monitoring, intercom and cueing systems included in this definition). Many in the audio production community feared their needs would be ignored. Some in the telecom and computer industries, vying for access to this spectrum, even argued for the audio community to be ignored. They argued that their use of the spectrum would have a larger positive economic impact since telecom and computer companies dwarf the comparatively small audio industry. They also pointed out that many wireless mic operators using the UHF range (470-806 MHz corresponding to TV channel 14 to 69) were operating without proper licensing. However, the FCC clearly recognized that wireless mics had already become ubiquitous within our society for some time. In 2010 the FCC made two significant rulings. Both rulings demonstrated a practical approach to these complex issues by balancing the needs of those with a vested interest in this spectrum

### **700 MHZ DIGITAL DIVIDEND RULINGS AND UNLICENSED USE:**

In January 2010, the FCC official announced that wireless mics would be prohibited to operate in the range 698 – 806 MHz, generically called the 700 MHz band, as of June 12, 2010. This corresponded to the one year anniversary of analog to digital transition of the U.S. TV broadcast standard. With most full power analog TV off the air, the remaining digital TV broadcasts were consolidated below channel 52. This allowed the reallocation of TV channels 52 to 69 (698 MHz to 806 MHz). The 700 MHz range is now partially used for emergency communications. The rights to use two-thirds of the range were auctioned to telecom companies such as AT&T, Verizon, and Qualcomm to provide high-speed internet access. The proceeds from this auction raised billions of dollars for the federal government. Therefore this initiative was called the digital dividend.

The ban of wireless mics operating in the 700MHz range was anticipated by manufacturers, prompting them to launch educational outreach and trade-in programs even years before the announcement of the actual deadline. Unclear prior to 2010 was how the FCC would form policy on unlicensed operation of UHF wireless mics, consistent with the present day reality. In their January 2010 ruling the FCC defined certain restrictions for unlicensed use of a wireless mic system:

1. It may not cause harmful interference
2. It must operate at low power level (not in excess of 50 mW)
3. It has no protection from interference received from any other device

These restrictions are included as part of a required consumer alert at the point of sale, either by a sign or on the packaging, as well as all mail advertising, web pages, and catalogs. These limitations are inconsequential for the vast majority of mic users.

Licensed users are allowed to operate systems at higher power, up to 250mW in the UHF band, which is often useful for long-range requirements such as the broadcast of major sporting events. Licensed use also takes priority: any unlicensed device must terminate operation if it causes interference to a licensed operator. Licensed operators will also be allowed direct registration in the forthcoming spectrum database (discussed later). Broadcasters, cable operators, motion picture producers, and content for broadcast producers are eligible to obtain a license by submitting FCC Form 601. All other users fall into the unlicensed category. In early 2010 FCC did invite comments on expanding license eligibility. Although there was considerable response for support, the Commission has not yet addressed the issue and is unlikely to do so in the foreseeable future.

## TVBD (AKA WHITE SPACE) RULING

On September 23, 2010 the Federal Communications Commission (FCC) released a ruling on Television Band Devices (TVBD), previously known as White Space Devices (WSD). TVBD are a new class of unlicensed consumer devices that will be used primarily for broadband access. Like wireless mics, TVBD will also operate on locally unused TV channels. The audio community has been concerned about this issue because more devices using the same frequency ranges increases the potential for interference. This latest ruling updates the guidelines the FCC previously released in November 4, 2008. Major revisions in this ruling versus the original include:

1. TVBD can use either geo-location and database access or spectrum sensing to detect signals of TV stations and wireless mics. Originally, TVBD were required to do both. Also the sensing threshold for detecting mics was reduced from -114 dBm to -107 dBm.
2. Two vacant UHF TV channels will be reserved for wireless mics in all areas of the country. These will be the first open (non-TV) channels above and below channel 37. (Fig 1) Previously only 13 major cities were slated for reserved channels.
3. Wireless mic users will be able to reserve additional channels if they demonstrate need after planning to fill (with at least six mics) all other channels not available to TVBD.
4. The exclusion zones distancing a personal/portable TVBD from wireless mics operating in reserved TV channels has been reduced to 400 meters.

### Cleveland

TV Channel	Frequency (MHz)	Allocation
14	470-476	LM/Public Safety
15	476-482	LM/Public Safety
16	482-488	CHWI-TV
17	488-494	WKYC-TV
18	494-500	W63CH
19	500-506	WYFX-LP
20	506-512	WFMJ-TV
21	512-518	
22	518-524	CIII-TV
23	524-530	WVPX
24	530-536	WD10
25	536-542	
26	542-548	WVIZ
27	548-554	W69AD
28	554-560	WUAB
29	560-566	W29CO
30	566-572	WBNX-TV
31	572-578	WJW
32	578-584	W32AR
33	584-590	W33BW
34	590-596	WQHS-TV
35	596-602	W35AX
36	602-608	WYTV
37	608-614	Radio Astronomy
38	614-620	W63CT
39	620-626	WDLI-TV
40	626-632	
41	632-638	WKBN-TV
42	638-644	WGGN-TV
43	644-650	W47ABD
44	650-656	WXOX-LP
45	656-662	WNEO
46	662-668	WNEO
47	668-674	WOAC
48	674-680	
49	680-686	WDLI
50	686-692	WEAO
51	692-698	W51BI

Legend:

- Land Mobile/Public Safety
- Low Power
- Digital TV
- Open Channel

← Channel reserved for wireless mics\*

← Channel reserved for wireless mics\*

Source: FCC Database  
For zip code: 44104  
As of 11/12/2010

\*Allocations subject to change before final FCC determination of reserved channels

Fig. 1. Cleveland Frequency Chart

At first glance these changes may seem like a major setback to the audio industry, especially in light of the challenges posed by the loss of access to the 700 MHz range. However, in their ruling, the FCC reiterated their recognition of widespread use of wireless mics throughout our society and the need to protect them from interference. They are demonstrating this with its plans to reserve two UHF channels in every part of the country. This is a very positive development for the audio industry in that it will represent the first time spectrum will be exclusively reserved for wireless mics. Some cities will have additional channels closed to TVBD and available for mics. Licensed users, such as broadcasters and their content providers, will be able to reserve still more channels through direct registration in the forthcoming spectrum database. Unlicensed users operating in professional performances venues can also apply to protect additional channels during performance times by electronically filing a request with the FCC at least 30 days in advance.

## FUNDAMENTAL ELEMENTS TO UNDERSTAND

TVBD are categorized as:

### ■ Fixed

These are allowed to operate with effective radiating power up to 4W on channels 2 to 51, with the exceptions of channels 3, 4, and 37. They cannot operate on a channel adjacent to an active TV channel.

### ■ Personal/Portable

Due to their mobile nature, these devices are the most concerning for production professionals. However, portable TVBD are restricted to channels 21 to 51, and are also not allowed in channel 37 (reserved channel for radio astronomy and medical telemetry). Those are limited to 100mW operating power (50mW for sensing-only devices), or 40mW if operating in a channel adjacent to an active station. This moderate power will reduce their range and therefore the possibility to cause interference.

**Licensed operation of wireless mics takes precedence over TVBD. TVBD must coordinate around active licensed wireless mic systems as well as properly registered unlicensed mic systems.**

**THE GEOLOCATION/DATABASE SYSTEM**

TVBD can use location sensing in conjunction with a database of registered broadcast license assignments. The database will also include a list of channels reserved for wireless microphones to be used in registered events at protected areas, such as entertainment and sporting venues. TVBD must first access the spectrum database to obtain a list of permitted channels in the area before operating. A TVBD that lacks this capability can operate only under the direct control of a TVBD that has it.

**SPECTRUM SENSING**

As an alternative, TVBD can listen to the airwaves to sense wireless microphones (in addition to TV stations). Spectrum sensing-only devices will have to demonstrate through “proof of performance” that they can reliably sense wireless mics and avoid causing interference, before they will be approved by the FCC for sale.

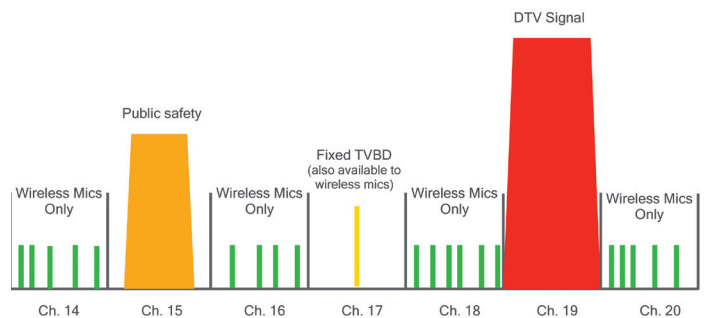
**RESERVED CHANNELS**

With at least two channels available exclusively reserved, at minimum, 16 wireless mic or monitoring systems (8 in each TV channel) can be used simultaneously in any venue. When using equipment with high linearity (extreme suppression of harmonic distortion known as intermodulation) the number increases to at least 20 systems (10 in each TV channel).

**CHANNEL 14 – 20**

Many cities will have additional channels not available to TVBD. TV channels 14 to 20 (470 – 512 MHz) are used in some areas for land mobile services (public safety) as well as TV broadcast. Portable TVBD are prohibited from operating in this range. Fixed TVBD cannot operate on a channel adjacent to an active TV broadcast or channel used for public safety. Therefore, there will be additional channels that can act as safe havens for wireless mics (Fig 2). It should be noted, however, that public safety interests have asked the FCC to ban unlicensed wireless mics from these channels. The FCC has not yet responded to this request.

**Fig 2. TV Channels 14-20 (470 – 512 MHz): Only fixed TVBD can operate on channels not adjacent to active TV and Land Mobile Public Safety channels.**



**SPECTRAL EFFICIENCY**

The September 2010 ruling included commentary in which the FCC stated that current wireless mic technology is spectrally inefficient. However, some microphone transmitters, recently introduced, feature a low intermodulation mode. These microphone transmitters operate with low RF output power and use highly linear amps for added headroom, allowing more mics to be packed in a smaller range. This type of performance will continue to be a major design criterion in future product development of manufacturers’ high-end systems. Nevertheless, there are steep technical hurdles to increasing efficiency without sacrificing performance. Wireless mics must be compact, operate without drop-outs, exhibit negligible latency, and have full audio frequency response. No other technology comes close to meeting these performance requirements. Eventually, some of these challenges will be overcome with improvements in chip speed and battery technology.

There are other ways users of wireless mics at multiple stage and studio properties can effectively increase the number of systems in use:

- **Regulating the physical distance between installations and transmitter output power management.**  
This can be augmented by a balance of other techniques such as shifted coordinated frequency sets (same frequency spacing but offset by 100 kHz or more), zone isolation (natural or enhanced shielding between rooms), directional antennas, and filtered distribution systems.
- **Time multiplexing:**  
Using systems in different rooms at different times

## RESERVING THE BEST CHANNEL

For very large productions that require reserving additional channels, a technique can be used to ensure maximum protection from portable TVBD. If a city, such as Wichita, KS for example, has three consecutive vacant channels (Fig. 3A), it would be most beneficial to reserve and operate your wireless mic in the middle channel. This will force the TVBD to operate on a channel adjacent to an active TV broadcast, which means it will have to operate at its lower 40mW output power which has less potential for interfering with wireless mics (Fig. 3B).

It is desirable that a portable sensing-only TVBD approaching your production area detect your wireless audio systems from as far away as possible. The effective radiating power of mobile wireless mic transmitters is often diminished by shadowing and body absorption, especially when using a body pack transmitter. Conversely, a monitoring system with a stationary transmitter using an antenna fixed in a high position provides a more stable signal. A portable TVBD should sense it from much farther away compared to mobile wireless mics. This is especially true for a licensed mic user operating at the maximum allowable power of 250 mW (Fig. 3C). Effectively, this technique allows a monitoring system to act as a beacon, adding a level of protection for wireless mics within the same channel. This approach is a bit different than what was often recommended in the past which involved segregating wireless mics and monitoring systems in different ranges.

## FUTURE POLICY

In March 2010, the FCC delivered its report to Congress, titled *Connecting America: The National Broadband Plan*. The report proposes the reallocation of another 120 MHz of spectrum from TV broadcast in five years. Some observers speculate that 600 MHz band will experience the same fate as the 700 MHz band. This is of course a concern for the audio industry. However, the report repeatedly calls for deeper, comprehensive studies on spectrum use. The report specifically states: "Changes to the TV broadcast spectrum need to be carefully considered to weigh the impact on consumers, the public interest, and the various services that share this spectrum, including...wireless microphones..." There are a number of steps that will take place, and each step will be met with much scrutiny and debate before any of the recommendations are enacted. If any changes are approved, spectrum industry and policy insiders predict it will be about ten years before any definitive reallocation deadlines and vacate dates go into effect.

## CONCLUSION

The reduction in available spectrum plus forthcoming TVBD poses new challenges for production professionals. Bottom line is that wireless microphones will remain vital tools in audio systems everywhere. Pre-planning will become increasingly more important as well as choosing an equipment provider that is able to offer a high level of technical support.

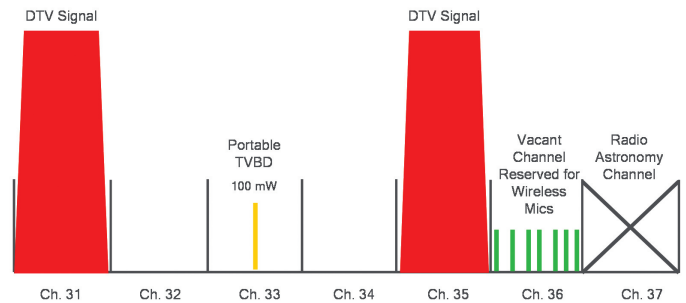


Fig 3A. Portable TVBD can operate at their maximum 100 mW output power in a vacant channel that is not adjacent to an active TV signal.

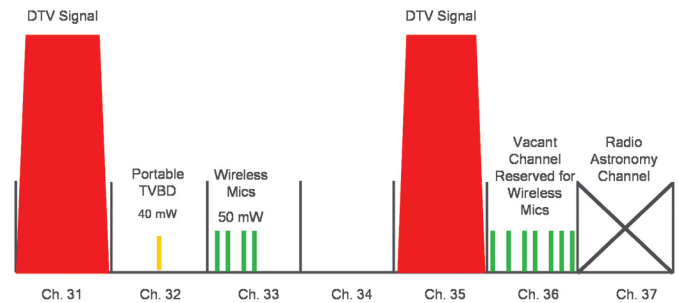


Fig 3B. Eligible users can reserve additional channels. In this case, reserving channel 33 will force the TVBD to operate at lower output power in a channel adjacent to an active TV signal.

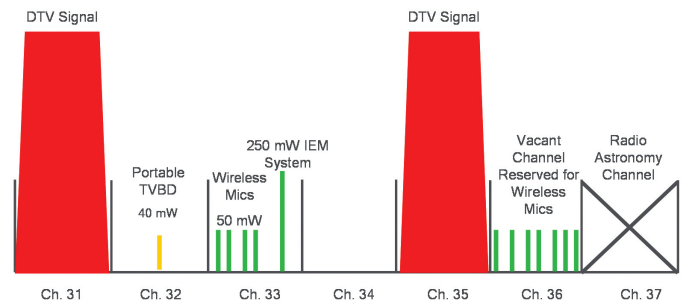


Fig 3C. An IEM monitoring system with a fixed antenna provides a stable signal that should be detected by sensing TVBD more easily. This is especially useful for a licensed mic user that operates it at the maximum allowable output power.



Joe Claudelli is Director of Market Development & Education. He joined Sennheiser in 1987 upon graduating from Columbia University with an electrical engineering degree. He provided frequency coordination for large multi-channel wireless microphone systems used by Broadway productions, major theme parks, and broadcast networks, including the frequency plan used for NFL football games. He wrote the Turbo-RF software which became the industry standard planning tool of the time. He also wrote the white paper "Large Multi-Channel Wireless Mic Systems", published by industry trade journals, the NAB and InfoComm proceedings, and the Audiocyclopedia. Joe is also the patent holder for the narrow angle hologram and is the founder of Rayvel Holographics.