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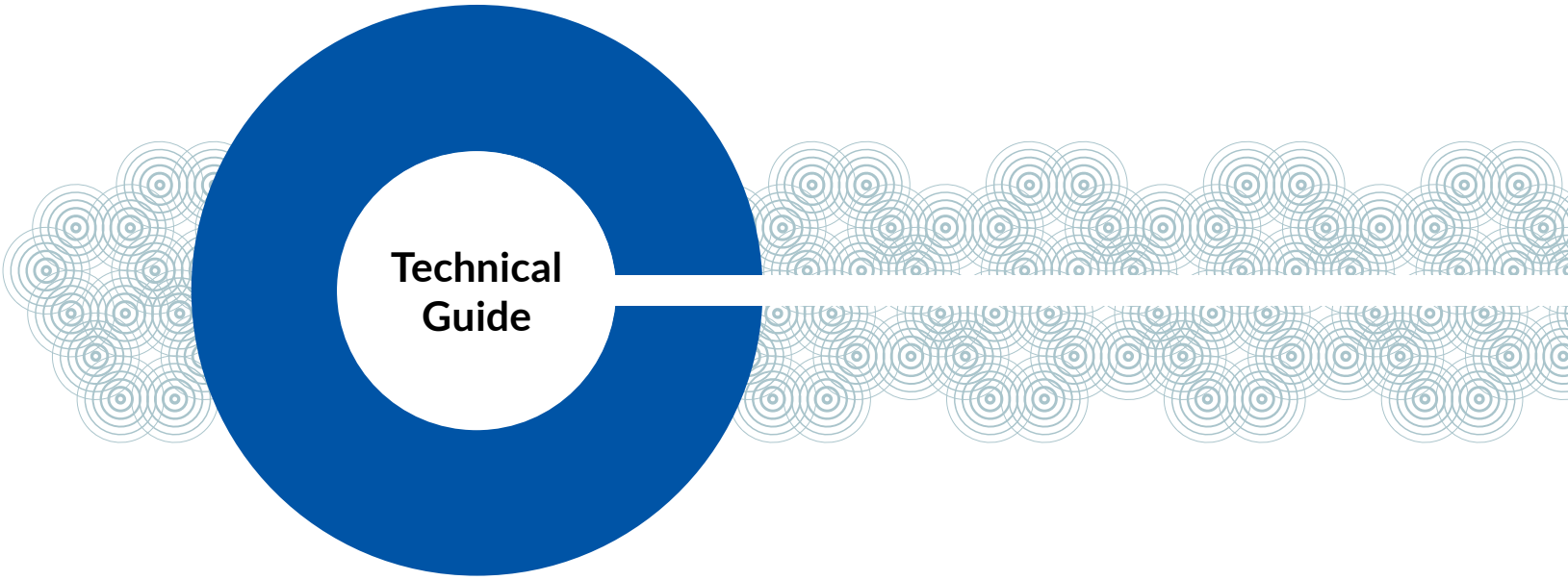

FreeSpeak Edge™
Digital Wireless RF Configuration Guide

June 8, 2020

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I. Introduction

FreeSpeak Edge is a new, best-in-class multi-channel duplex digital wireless intercom system, extending the capabilities of the FreeSpeak™ Product Family with the addition of a new 5 GHz option. As a product intended for the most complex and sophisticated deployments, FreeSpeak Edge offers more flexibility in deployment, with dedicated coordinated RF channels, remote transceivers with external antennas, and a nine-button programmable beltpack.

FreeSpeak Edge uses two radios in the beltpack and transceiver for redundancy, providing the most flexible and reliable wireless intercom available, with the lowest latency (< 50 ms) and best-in-class 12 kHz audio bandwidth.

When deployed with an Eclipse® HX Digital Matrix frame and E-IPA-HX IP audio cards, customers can leverage an extremely high-density wireless solution scaling to over 100[1] beltpacks and 64 transceivers. The FreeSpeak Edge system provides:

- Up to 27 RF Channels
- High quality 12 kHz audio bandwidth
- Lowest latency in the wireless duplex market
- Larger data bandwidth/throughput
- Robust performance, with dual radios and redundant audio packets
- AES256 Encryption

II. The 5 GHz Band

FreeSpeak Edge operates in the 5 GHz band and uses OFDM technology to resolve the issues of multipath interference and degradation due to reflection. There are several characteristics of the 5 GHz band which make it ideal for intercom. Compared to traditional 1.9 GHz DECT and the 2.4 GHz ISM band, the 5 GHz band offers four-to-five times more non-overlapping channels. For intercom systems, this means an increase in audio quality and number of beltpacks, while at the same time decreasing audio latency. In addition, the 5 GHz band actually uses multipath reflections to improve signal strength, turning what has traditionally been a weakness into an advantage.

5 GHz signals have different electrical properties, and do not propagate as freely through walls in a building. However, the 5 GHz signal utilizes reflection and multipath to propagate signal making it well suited for indoor use, or outside with reflective surfaces. This characteristic also means that different zones can be more easily contained, allowing for re-use of channels in relatively close proximity.

[1] Initial releases may have up to 64 beltpacks, but the FreeSpeak Edge system has capability for almost double this capacity.

The 5 GHz radio band offers the widest range of RF channels available (15-27) depending on region, and removes common problems found in traditional 1.9 GHz DECT and 2.4 GHz band, such as multipath interference and degradation due to reflection.

	2.4 GHz	1.9 GHz	5 GHz
Available Channels	11	5-10	5-27
Total Available Spectrum	50 MHz	10-20 MHz	420- 600 MHz
Maximum Outdoor Range	1200 ft	1200 ft	1000 ft
Indoor Range	300-600 ft	300-600 ft	200-500 ft
Multipath and Reflection	Harms propagation	Harms propagation	Helps propagation
Interference by Other Devices	Severe	None	None if frequency coordinated

FreeSpeak Edge uses two high-throughput, low-latency 5 GHz radios in each device to provide for redundancy. FreeSpeak Edge uses 20 MHz channels with a custom Orthogonal Frequency Division Modulation (OFDM)[2] transport layer developed specifically for wireless intercom, which provides a robust and reliable connection between the beltpack and transceiver.

- Over-the-air data rate is five times that of previous-generation systems, allowing higher user density and 12 kHz audio with high dynamic range.
- Frequency propagation ability of 5 GHz allows for better channel reuse. This, combined with a larger channel allocation, allows for deployment of larger systems.
- Built-in Wi-Fi system awareness allows co-existence with deployed infrastructure wireless networks.
- RF power attenuation on the beltpack and transceiver allows for deployment of large roaming systems with custom cell sizes.

Since the 5 GHz band offers many channels, it allows co-existence with other system like Wi-Fi, DMX, and wireless cameras, by allowing each to have its own set of dedicated channels when properly allocated by an IT department and/or event frequency coordination.

In worst-case situations where channels must be shared with other devices, FreeSpeak Edge's dual-radio design with OFDM and channel coordination should allow FreeSpeak Edge to operate normally.

[2] Orthogonal Frequency Division Modulation (OFDM) is a form of multicarrier modulation that provides a robust transport layer that is immune to most forms of interference.

III. Regulations

In most countries there are restrictions on how each channel may be used, and the rules vary from region to region. The FreeSpeak Edge system operates in a way that follows the regulations of the country the system is certified in. None of the parameters required by the regulation can be modified by the user.

The FreeSpeak Edge initial release will be approved for use in USA, Canada, EU countries, Australia, New Zealand, South Korea and Japan. Each country has a FreeSpeak Edge transceiver approved and configured to the appropriate frequencies and power levels. FreeSpeak Edge beltpacks are universal and receive their country configuration from the FreeSpeak Edge transceiver.

Part Number	Description
FS-EDGE-TVCR-AZ	FREESPEAK EDGE 5GHZ IP TRANSCEIVER - AUSTRALIA AND NEW ZEALAND VERSION
FS-EDGE-TVCR-CA	FREESPEAK EDGE 5GHZ IP TRANSCEIVER - CANADIAN VERSION
FS-EDGE-TVCR-EU	FREESPEAK EDGE 5GHZ IP TRANSCEIVER - EUROPEAN VERSION
FS-EDGE-TVCR-J	FREESPEAK EDGE 5GHZ IP TRANSCEIVER - JAPANESE VERSION
FS-EDGE-TVCR-KR	FREESPEAK EDGE 5GHZ IP TRANSCEIVER - SOUTH KOREAN VERSION
FS-EDGE-TVCR-US	FREESPEAK EDGE 5GHZ IP TRANSCEIVER - UNITED STATES VERSION

IV. Type of Channels

In most countries, 5 GHz channels fall into the following categories:

- **U-NII 1 & 3 Channels -** These are the channels with the least restrictions and highest allowance for transmission power. However, they may be crowded with interference since these channels are often the first choice for other wireless equipment. Note that generic U-NII 3 channels don't exist in some countries (e.g. Japan).
- **Indoor Channels -** If these channels are used, the equipment may only operate in an indoor setting, with lower power output. Different countries have different definitions and requirements for indoor settings.
- **DFS (Dynamic Frequency Selection) Channels -** Devices operating in this channel are required to implement a radar detection mechanism and move to a different channel when radar pulses are detected.
- **Weather Radar -** Channels 120, 124 and 128 are used for weather radar.

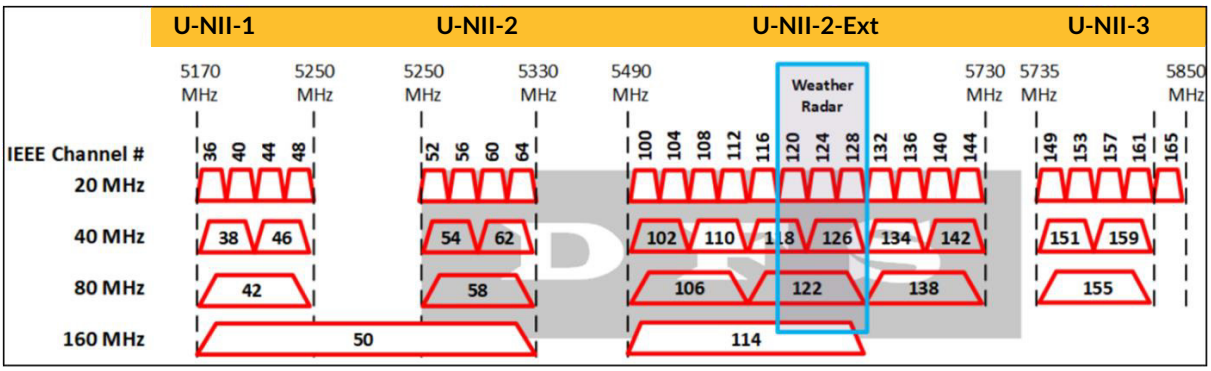


Figure 1

A. Use of DFS Channels

FreeSpeak Edge factory default channels are DFS channels, as they are less crowded. However, operating in these bands does present performance challenges due to Transmit Power Control (TPC) and DFS requirements. Interruption on DFS channels would only be experienced in the presence of an actual critical radar signal. In this case, the FreeSpeak Edge transceiver will seamlessly change channels without interruption. TPC is a requirement for transmitter output power to be controlled/reduced by 6 dB, resulting in reduced interference with other systems.

B. DFS In-Service Monitoring

In-service monitoring of DFS channels is continuous. FreeSpeak Edge transceivers have a dedicated set of radios for DFS monitoring to assure system performance.

C. DFS Channel Availability Check (CAC)

Upon restart or power cycle of the FreeSpeak Edge transceiver, the device must automatically begin a channel availability check (CAC). The time required for this is a minimum of 60 seconds. CAC is to be performed at each power cycle or device restart. Any occupied channels will be "blacklisted," so that they cannot be used for a period of 30 minutes from detection.

D. When Radar is Detected

If radar is detected in one of the channels, the transceiver seamlessly switches to an assigned back up channel.

V. Channel Scan Selection Options

The 5 GHz band is much larger than we are used to with the FreeSpeak II. There are many channels we may use, and several ways to use them, depending on the setup and the environment. FreeSpeak Edge transceivers default to DFS channels. In order to deploy multiple transceivers, a group of channels will have to be used. In order to pick which channels to use, you must determine what other equipment might be causing interference. It is recommended to use either the built-in scanner mode within the FreeSpeak Edge beltpack or a third-party RF scanner to help determine channel selection (see Appendix A).

In some venues it may be necessary to scan each coverage area to get an accurate view of channel usage.

VI. FreeSpeak Edge Beltpack Channel Scanner

The FreeSpeak Edge beltpack has a built-in channel scan mode that provides details of all devices using 20 MHz 5 GHz channels, including FreeSpeak Edge devices. This is a standalone mode and does not require a FreeSpeak Edge transceiver.

To enter channel scan mode on the FreeSpeak Edge Beltpack:

- Enter "Menu" mode
- Scroll down and select "Diagnostics"
- In "Diagnostics," scroll down and select "Channel Scan"
- Select "Yes" to reboot command to enter channel scanner

Scanner Diagram View

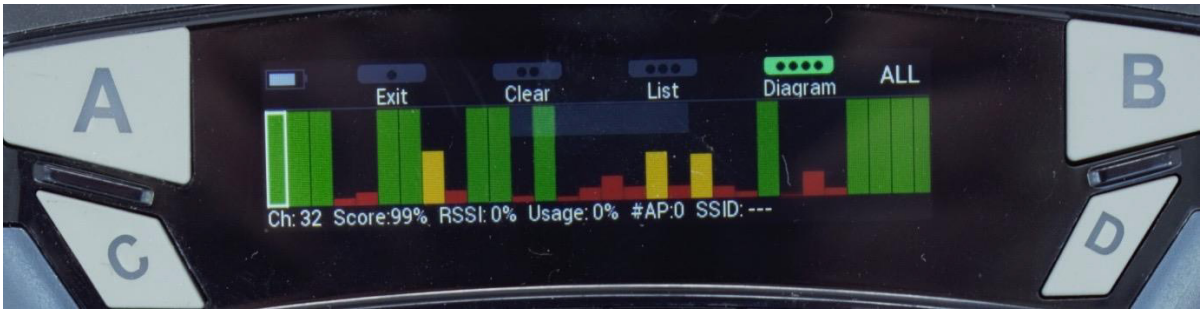


Figure 2: Green channels are recommended channels to use, followed by yellow. Avoid red channels.

Scanner List Mode

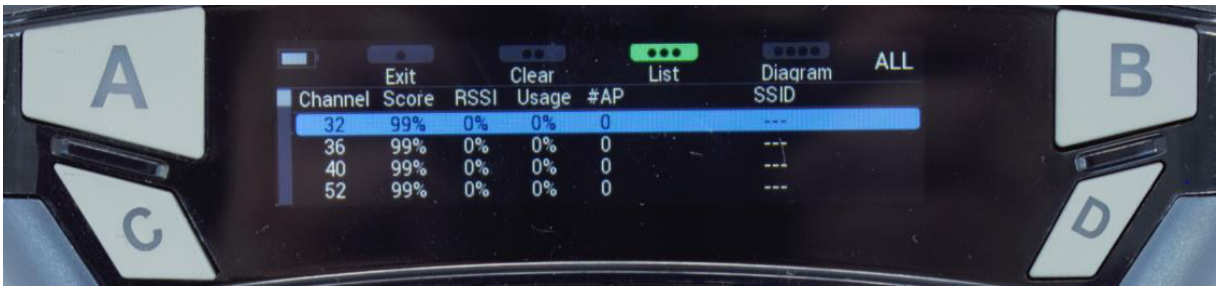


Figure 3: When sharing Wi-Fi channels, select channels in area of transceiver placement that have RSSI below 55%, with usage rate below 20%.

When evaluating the channel scan, look for channels that are not in use by other devices. Make a note of these channels, along with the channels which show the lowest usage rate.

Each FreeSpeak Edge transceiver requires two channels, with minimum of eight channels of separation (default channels in the U.S. are 52 and 60). A roaming system using more than four transceivers requires six to eight channels.

When using DFS channels, try to use one U-NII channel and one DFS channel in each FreeSpeak Edge transceiver.

VII. Operating Environment

Venue size, ceiling height, walls and types of material will affect RF coverage. High ceilings and metal will reflect RF. Lower ceilings, glass and concrete tend to absorb RF and provide less coverage.

RF Absorption Rates by Common Material

Material	Absorption Value
Plasterboard/drywall	3-5 dB
Glass wall and metal frame	6 dB
Metal door	6-10 dB
Window	3 dB
Concrete wall	6-15 dB
Block wall	4-6 dB

VIII. Channel Reuse and Overlapping

To achieve desired reliability and signal diversity, each FreeSpeak Edge transceiver requires two channels to operate. For example, a system with four transceivers would need eight channels to operate. In a smaller system with four transceivers or less, there are generally enough available channels in the spectrum such that there is no need to worry about channel overlapping. However, in a large system, several transceivers may be needed in the same area to cover many beltpacks. If there are five transceivers or more in the same area, it is possible to run out of usable channels, creating need to reuse them.

It's possible to re-use the channel of the transceiver, given that the devices are far apart enough so one does not interfere with the other's RF space. It is important to assure that a beltpack sees **no more than one transceiver with the same pair of channels** in any coverage area location.

A. Coverage Zone

Transceivers in the FreeSpeak Edge system will have a coverage zone based on the environment. This coverage zone represents the coverage area that one transceiver covers. Indoors it will typically average around 250 feet (80 meters), outdoor range will be 750 feet (230 meters) line-of-sight. Reflective surfaces can increase distance with proper transceiver placement. (These ranges are based on 22 dBm output)

Figure 4

B. Indoor Coverage by Output Power

FreeSpeak Edge transceivers offer multiple steps of power attenuation to customize zone sizes and accommodate regulatory requirements in specific countries.

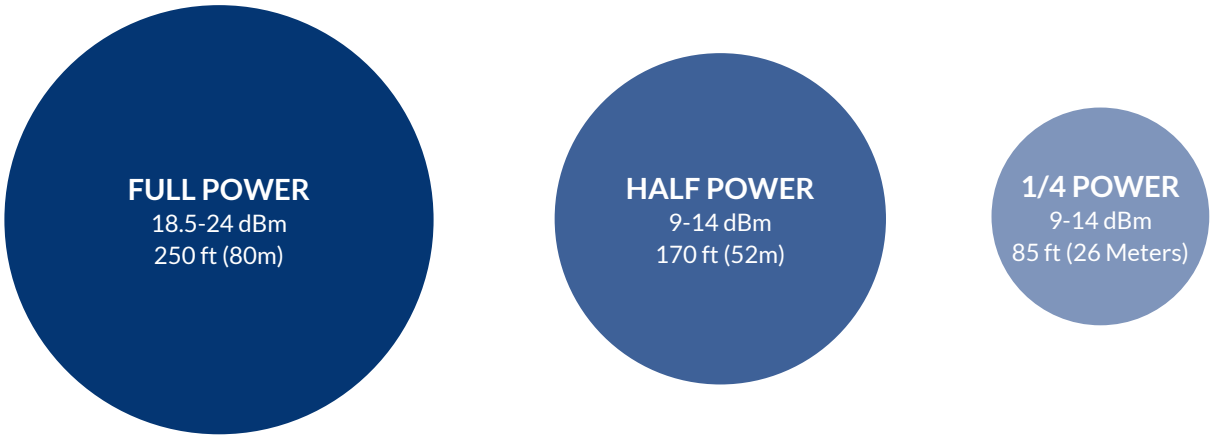


Figure 5: Distance are averages, actual coverage area will vary depending on venue.

C. Overlapping Zones

In order to create a roaming system that covers an entire venue without beltpacks disconnecting, overlapping coverage zones must be created. Do not overlap with the same channel and allow at least 20 percent overlap with adjacent channels.

Two Zone Overlapping TCVRs

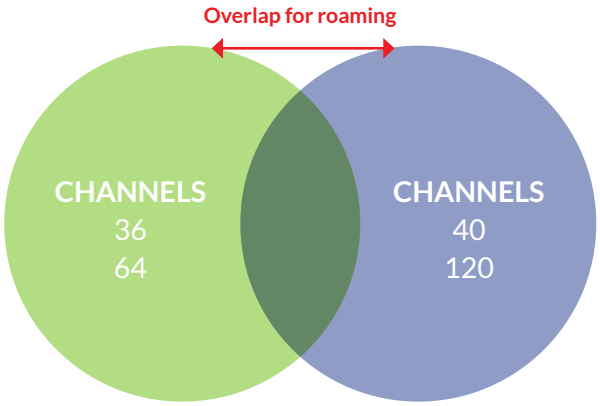


Figure 6: When selecting RF Channels try to use one UNII & one DFS Channel in each Transceiver.

D. Channel Reuse

When setting up a roaming system for full-venue coverage that requires more than four coverage zones, channels will need to be reused. Channel reuse allows the use of a smaller set of channels in a system to cover the entire space.

Use of 3 Zones for Overlapping Coverage

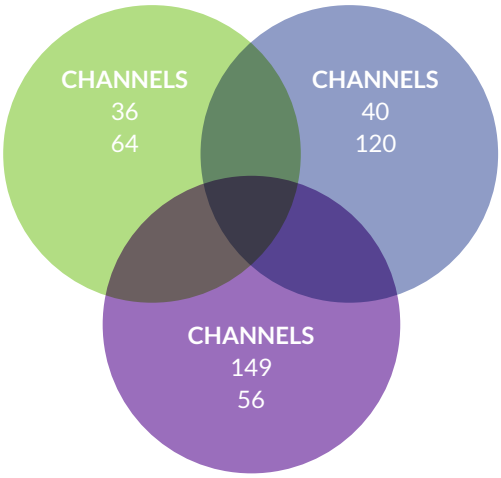


Figure 7

Use of 4 Zones for Overlapping Coverage

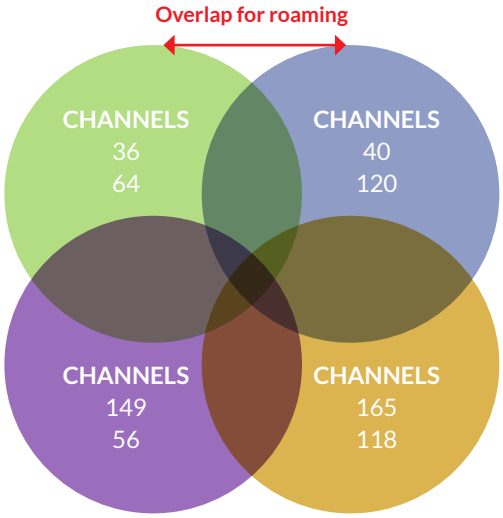


Figure 8

E. Density

FreeSpeak Edge transceivers support 10 full-duplex beltpacks. Depending upon the size of the area and the number of beltpacks needed in any given area, multiple transceivers will need to be co-located in order to provide the necessary capacity for the number of beltpacks desired for use in any given area.

Since each transceiver requires two channels, the simplest method to provide density is to use multiple channels. Ten beltpacks require two channels, 20 beltpacks require four channels, 30 beltpacks require six channels, 40 beltpacks require eight channels, 50 beltpacks require 10 channels, 60 beltpacks require 12 channels, etc. If there are 20 5 GHz channels available, it would be possible to have 100 beltpacks in one RF zone.

A more efficient way to provide density is to use six to eight channels across multiple transceivers, using the lowest power settings to make very small coverage zones for each transceiver, and laying these out to provide the density of beltpacks required.

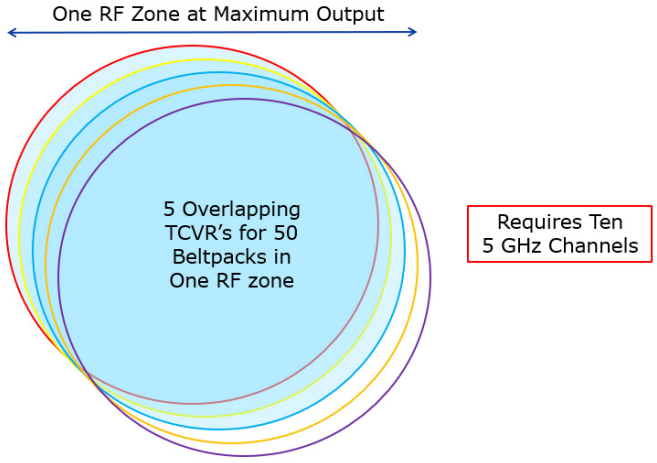


Figure 9

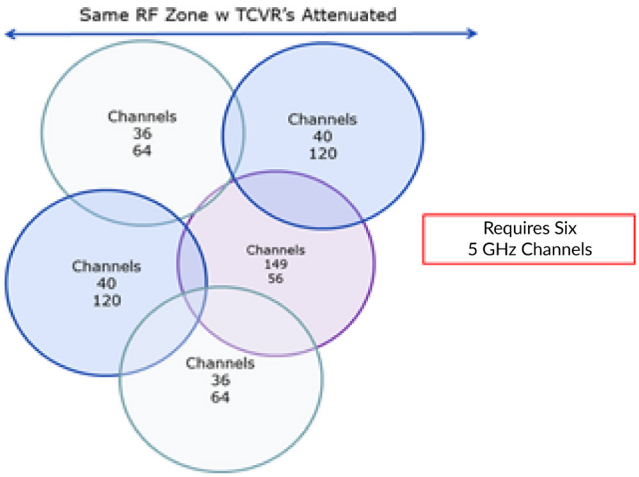


Figure 10

IX. Co-Channel Interference

Deploying a FreeSpeak Edge system with more than two transceivers requires the reuse of channels. In order to avoid interference between transceivers with the same channels and causing a decrease in bandwidth, careful placement and use of power transmit settings is required. FreeSpeak Edge transceivers with the same channels should never be deployed where they overlap.

If sharing a channel with Wi-Fi, place the FreeSpeak Edge transceiver as far away as possible.

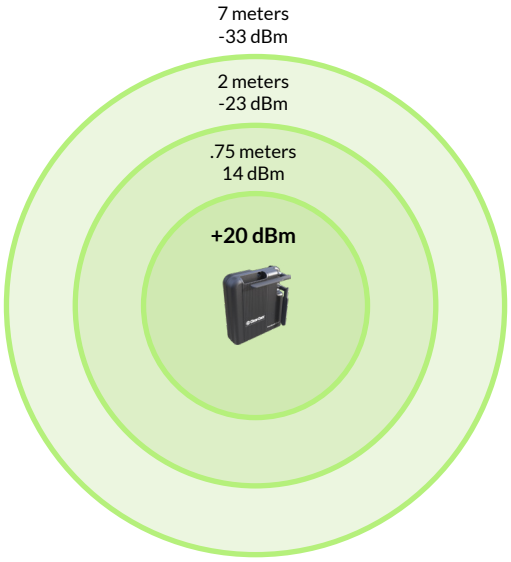


Figure 11

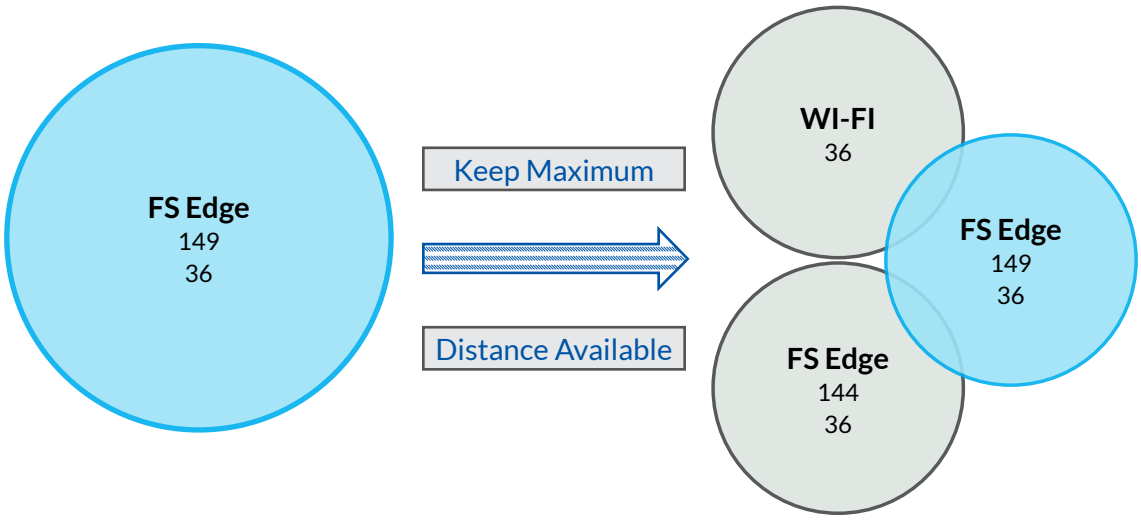


Figure 12

X. Channel Reuse

If a FreeSpeak Edge system requires more than two transceivers, reusing channels is necessary.

Channel Reuse 3 Zones

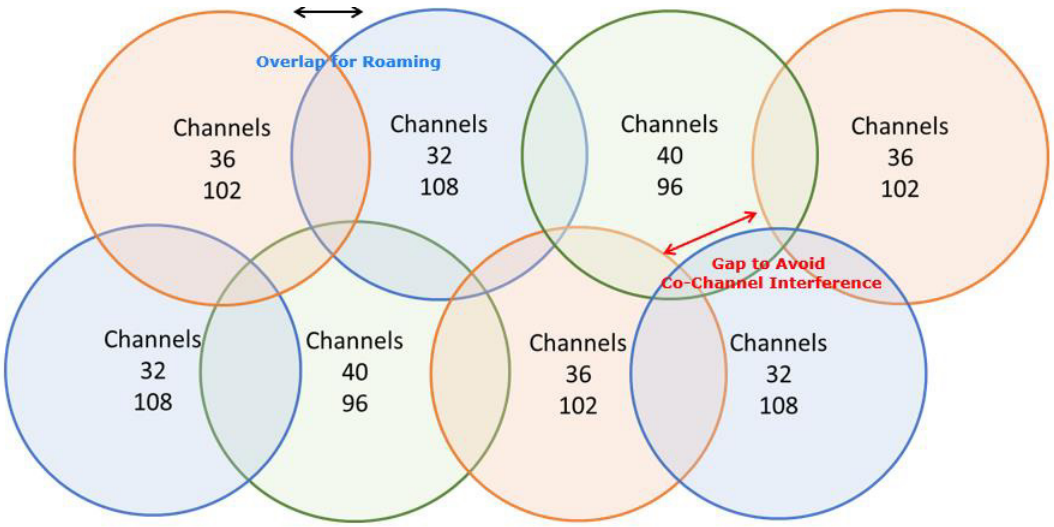


Figure 13

Channel Reuse 4 Zones

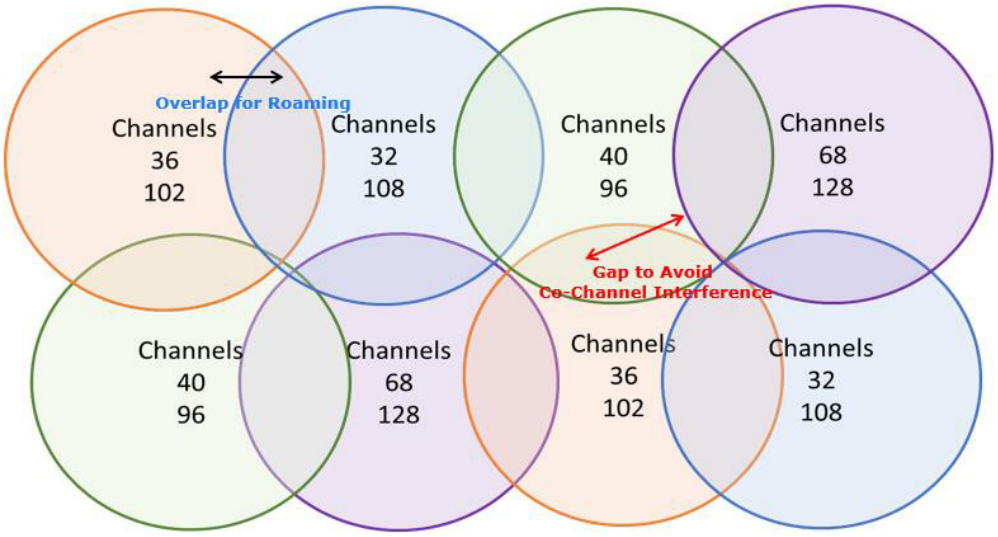


Figure 14

Once the usable channels are known, they need to be shared among the equipment in this band. Ideally, each transceiver has two channels, all different from each other to avoid channel overlapping. Otherwise, if it's not possible, the channels may be reused by two non-adjacent transceivers that are never seen by the same beltpack.

XI. FreeSpeak Edge Transceiver Placement

FreeSpeak Edge transceivers must be mount vertically to assure IP rating and proper heat distribution.

Orientation of TCVR	Environmental performance
Upright 	• Up to 50°c (with 4 inch clearance above and below plus no heat sources below) • IP rating 53
Upside down 	• Up to 50°c (with 4 inch clearance above and below plus no heat sources below) • IP rating not guaranteed
On it's side 	• Up to 32°c • No IP rating

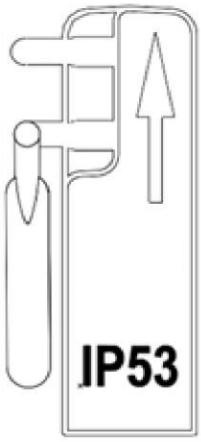


Figure 15

Transceiver Placement

- Height 8-40 feet (2.4–12 meters)
- Position (Vertical)
- Angle 15% down when mounting > 15 feet (4.5 meters)

Antenna Position

FreeSpeak Edge transceivers use Omni 3 dB gain external antennas with RP-TNC female connectors. For optimum performance, one antenna needs to be in the vertical position and the other in the horizontal position, to assure diversity and reduce interference between radios.

Figure 16: Proper positions for maximum performance.

XII. Appendix A

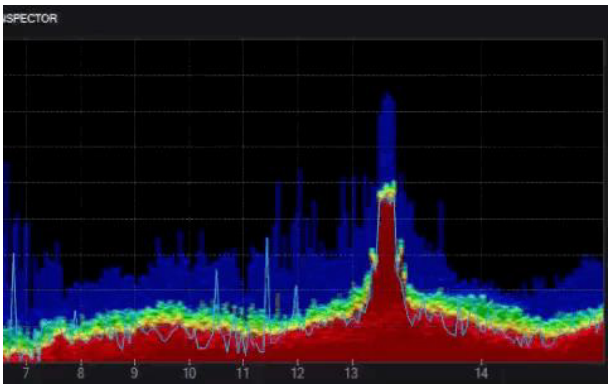
5GHz Scanning Tools

Metageek Chanalyzer Essential

Metageek provides an extremely easy to use combination of products, which includes the Chanalyzer software, the Wi-Spy DBx dual band spectrum analyzer, and a report builder to document your findings. The dual-band analyzer has a USB adapter and a clip to attach the device to your monitor. The device then measures Wi-Fi and non-Wi-Fi activity in both 2.4 GHz and 5 GHz bands to provide a real-time visual report of a wireless network in the Chanalyzer. Once the equipment that's causing the interference has been identified, use the directional antenna to locate and eliminate it.

More importantly, the reports provided in Chanalyzer allow users to monitor and manage channels to avoid interference and saturation. It's also possible to identify dead spots where additional transceivers may be needed.

In final, Chanalyzer can output reports as a pdf so users can provide details to clients or team members for use in the future.



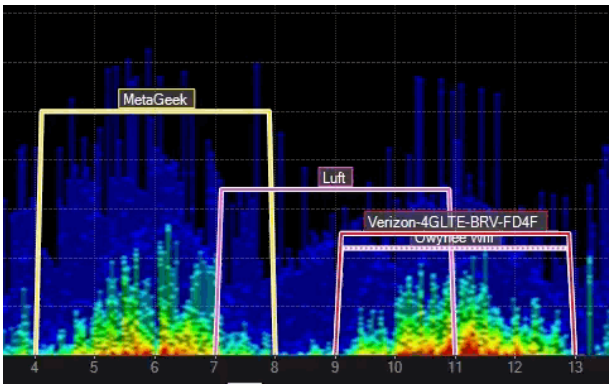


Figure 17: Images Sourced from Metageek Chanalyzer.

RF Explorer

RF Explorer is a handheld spectrum analyzer that provides the user access to:

- A spectrum analyzer screen, which spans frequency ranges as follows: 15-2700 MHz and 4850-6100 MHz
- Wi-Fi analyzer, which shows the Wi-Fi channels in use, along with their power
- A set of antennas that can be used according to the frequencies that are targeted for scanning. For FreeSpeak Edge, which operates under the 5 GHz band, it is recommended to use the Rubber Duck 5.8 GHz articulated antenna, as it offers a good coverage area in the range of 5.4-5.9 GHz and reasonable coverage in the 2.4 GHz band as well. It can be used as dual-band antenna for Wi-Fi.

Figure 18: Images Sourced from RF Explorer.

RF Explorer provides free software for PC, which allows real-time data exchange between the handheld spectrum analyzer and the client on a PC via USB. The software allows users to save the raw signal data over CSV or RFE format. This data can be reloaded into the program for later comparison to current analysis.

For a lighter-weight solution, a third-party developer has created the Touchstone Mobile application that allows users to run RF Explorer on a mobile device. However, the mobile device must be Android running 8.x. This will require a USB cable with a male micro type B on one side and a male mini-USB port on RF Explorer side for data exchange.

Android and Apple Smartphone 5 GHz Scanning Tools

To get a quick view of a venue's 5 GHz channels, users can download a third-party app from the Google Play or Apple Store, which will provide an idea of which 5 GHz channels are in use. This is a good starting point to see which channels could be available for FreeSpeak Edge.

Android Apps

- NetSpot for Android
- Wi-Fi Analyzer
- OpenSignal
- Network Signal Info
- Wi-Fi Monitor
- Scan-Fi

iPhone Apps

- Network Analyzer Pro
- IP Network Scanner
- Fing-Network Scanner
- Wi-Fi Sweets
- Speedtest by Ookla
- Scany-Network

XIII. Appendix B – Frequently Asked Questions (FAQ)

What is FreeSpeak Edge?

FreeSpeak Edge is an advanced wireless intercom that uses the 5 GHz frequency band. Wireless beltpacks roam between IP transceivers, which connect to the E-IPA card in an Eclipse HX Digital Matrix frame via AES67 IP network infrastructure.

How many buttons and volume controls are on the FreeSpeak Edge beltpack?

The FreeSpeak Edge beltpack comes with an OLED color display and four main buttons, plus five secondary buttons, making a total of nine keys.

The beltpack also provides four individual volume control pots and one master volume. Via the menu, users may access volume control for all eight talk/listens. There is also a toggle to swap level controls when using eight talk/listens.

Does the FreeSpeak Edge beltpack support loudspeaker mode?

Yes, the FreeSpeak Edge beltpack comes with a built-in speaker and microphone, allowing the user to take their headset off and still listen to comms. The beltpack acts as a wireless desktop unit.

How many hours is the battery life?

FreeSpeak Edge BAT80 battery provides up to 12 hours of continuous use. The battery can be charged using the four-bay dual drop-in battery charger (AC80) or local USB.

What is the maximum number of IP transceivers and beltpacks that can be deployed on one E-IPA card?

64 beltpacks and 64 transceivers.

Can you run FreeSpeak II 2.4, 1.9 and FreeSpeak Edge systems in the same frame?

Yes, using multiple E-QUE-HX and E-IPA-HX cards, a system can be designed to support and share audio between all three systems.

Can I run FreeSpeak Edge and FreeSpeak II on one IPA card?

Yes, you can run both systems on the same card with a limit of 64 total beltpacks and 64 transceivers split between the two systems.

Can the display and the keys be dimmed to 0% on the beltpack?

Yes, we now have a blackout mode that can be set per beltpack, and users can reduce the display to zero.

What type of USB charger is required?

USB 3.0 adapters and cables with a minimum 2.1 Amp rating.

Can you daisy-chain FreeSpeak Edge transceivers?

Yes. You can loop through up to three, but this can be dependent on cable lengths. You must also use local power on the second and third transceiver.

Can you remotely power transceivers?

Yes, using standard networking Power-over-Ethernet (POE).

How many beltpack connections per transceiver?

Ten full-duplex beltpacks with 12 kHz audio.

Can the FreeSpeak Edge beltpack be used for on-air broadcast?

Yes, FreeSpeak Edge offers 12 kHz audio, and supports dynamic and electret microphones.

What is the latency of FreeSpeak Edge?

60 milliseconds beltpack to beltpack.

What are IP ratings for FreeSpeak Edge beltpack and transceivers?

IP53. Water falling as a spray at any angle up to 60 degrees from the vertical shall have no harmful effect.

Can you use FreeSpeak Edge with the FreeSpeak II BASE-II?

No. FreeSpeak Edge initial release only works with an E-IPA-HX card in an Eclipse-HX Digital Matrix frame. The Eclipse HX frame must be running EHX V12 or later.

What is the polar pattern on the FreeSpeak Edge transceiver external antennas?

Omni.

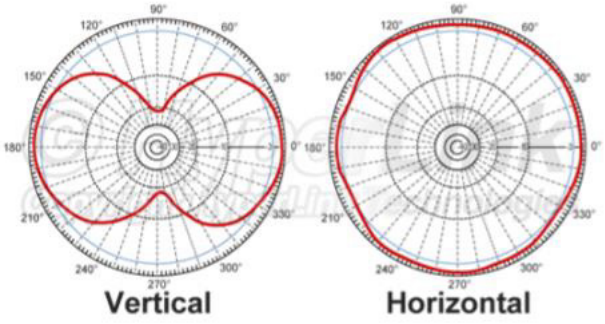


Figure 19

What other types of devices use the 5 GHz spectrum?

The most common use of 5 GHz is for Wi-Fi networks, which typically use two to four channels. Wireless DMX and wireless cameras also use this frequency band.

Is FreeSpeak Edge a Wi-Fi System?

No, FreeSpeak Edge uses the same frequency band used by some Wi-Fi systems, but will not run on a Wi-Fi system. To avoid interference from Wi-Fi and other devices using this spectrum, unique channels should be selected that can be dedicated to the FreeSpeak Edge system in order to provide a secure and reliable system. Collaboration with a frequency coordinator or IT department that manages the 5 GHz frequency is highly recommend in order to avoid co-channel interference with other systems. Unlike the FreeSpeak II 1.9 and 2.4 GHz systems, the FreeSpeak Edge frequencies are manually controlled by the user.

What effect will cell phones have on FreeSpeak Edge?

Cell phones are clients and get their channels from network access points, so it should only affect channels that are used by the in-house Wi-Fi. Some large venues also use 5 GHz Wi-Fi for phone access.

What is the coverage distance of a FreeSpeak Edge transceiver?

Line of sight outdoors 500-1000 feet (160-300 meters), indoors 300-500 feet (92-154 meters).

What types of customers should consider FreeSpeak Edge?

Venues with overhangs and domed ceilings that need an advanced wireless system and are familiar with frequency coordination and deploying IP audio networks, and which require the features and customization provided with FreeSpeak Edge.

What is required to implement a FreeSpeak Edge system?

First thing you need to do is determine if the venue has 5 GHz channels available, and what other systems and devices are using this frequency. Once channels are determined, a site survey should be done with empty and full venues to determine transceiver density and placement.

Which 5 GHz Channels does FreeSpeak Edge utilize?

FreeSpeak Edge uses 20 MHz channels within the 5 GHz frequency band, from 5180-5825, channels 36, 40, 41, 44, 48, 52, 56, 60, 64, 100, 104, 108, 112, 116, 120, 124, 128, 136, 140, 149, 153, 157, 161, 165, 169, 173. Depending on region.

What 5 GHz Channels are available in each country?

20 MHz	5150-5250 MHz (Ch 32-48)	5250-5350 MHz (Ch 52-64)	5470-5725 MHz (Ch 100-144)	5725-5850 MHz (Ch 149-173)	Total UNI	Total DFS	Total
USA	4–U-NII (22 dBm) (36, 40, 44, 48)	4–DFS (22 dBm) (52, 56, 60, 64)	12–DFS (22 dBm) (104, 108, 112, 116, 120, 124, 128, 132, 136, 140, 144)	5-U-NII (22 dBm) (149, 153, 157, 161, 165)	9	16	25
Canada	4–U-NII (18.5 dBm)(36, 40, 44, 48)	4–DFS (22 dBm) (52, 56, 60, 64)	9–DFS (22 dBm) (100, 104, 108, 112, 116, 132, 136, 140, 144)	5–U-NII (22 dBm) (149, 153, 157, 161, 165)	9	13	22
Europe - EU	4 U-NII (20 dBm) (36, 40, 44, 48)	4–DFS (21.5 dBm) (52, 56, 60, 64)	11–DFS (21.5 dBm) (100, 104, 108, 11, 116, 120, 124, 128, 132, 136, 140)	7–U-NII (13 dBm) (149, 153, 157, 161, 165, `69, 173)	11	15	26
Japan	4–U-NII (14 dBm) (36, 40, 44, 48)	4–DFS (9 dBm) (52, 56, 60, 64)	12–DFS (18.5 dBm) (100, 104, 108, 112, 116, 120, 124, 128, 132, 136, 140, 144)	NA	4	16	20
KR, AUS, NZ	4–U-NII (14 dBm) (36, 40, 44, 48)	4–DFS (9 dBm) (52, 56, 60, 64)	9–DFS (14 dBm) (100, 104, 108, 11, 116, 132, 136, 140, 144)	5–U-NII (14 dBm) (149, 153, 157, 161, 165)	9	13	22

Who uses DFS channels for Radar?

Weather services, airports, military and marine radar.

What are the Weather Radar Locations in the United States?

STATE	CITY	LONGITUDE	LATITUDE	FREQUENCY	TERRAIN ELEVATION (MSL) [ft]	ANTENNA HEIGHT ABOVE TERRAIN [ft]
AZ	PHOENIX	W 112 09 46	N 33 25 14	5610 MHz	1024	64
CO	DENVER	W 104 31 35	N 39 43 39	5615 MHz	5643	64
FL	FT LAUDERDALE	W 080 20 39	N 26 08 36	5645 MHz	7	113
FL	MIAMI	W 080 29 28	N 25 45 27	5605 MHz	10	113
FL	ORLANDO	W 081 19 33	N 28 20 37	5640 MHz	72	97
FL	TAMPA	W 082 31 04	N 27 51 35	5620 MHz	14	80
FL	WEST PALM BEACH	W 080 16 23	N 26 41 17	5615 MHz	20	113
GA	ATLANTA	W 084 15 44	N 33 38 48	5615 MHz	962	113
IL	MCCOOK	W 087 51 31	N 41 47 50	5615 MHz	646	97
IL	CRESTWOOD	W 087 43 47	N 41 39 05	5645 MHz	663	113
IN	INDIANAPOLIS	W 086 26 08	N 39 38 14	5605 MHz	751	97
KS	WICHITA	W 097 26 13	N 37 30 26	5603 MHz	1270	80
KY	COVINGTON CINCINNATI	W 084 34 48	N 38 53 53	5610 MHz	942	97
KY	LOUISVILLE	W 085 36 38	N 38 02 45	5646 MHz	617	113
LA	NEW ORLEANS	W 090 24 11	N 30 01 18	5645 MHz	2	97
MA	BOSTON	W 070 56 01	N 42 09 30	5610 MHz	151	113
MD	BRANDYWINE	W 076 50 42	N 38 41 43	5635 MHz	233	113
MD	BENFIELD	W 076 37 48	N 39 05 23	5645 MHz	184	113
MD	CLINTON	W 076 57 43	N 38 45 32	5615 MHz	249	97
MI	DETROIT	W 083 30 54	N 42 06 40	5615 MHz	656	113
MN	MINNEAPOLIS	W 092 55 58	N 44 52 17	5610 MHz	1040	80
MO	KANSAS CITY	W 094 44 31	N 39 29 55	5605 MHz	1040	64
MO	SAINT LOUIS	W 090 29 21	N 38 48 20	5610 MHz	551	97
MS	DESOTO COUNTY	W 089 59 33	N 34 53 45	5610 MHz	371	113
NC	CHARLOTTE	W 080 53 06	N 35 21 39	5608 MHz	807	113
NC	RALEIGH DURHAM	W 078 41 50	N 36 00 07	5647 MHz	400	113
NJ	WOODBRIDGE	W 074 16 13	N 40 35 37	5620 MHz	19	113
NJ	PENNSAUKEN	W 075 04 12	N 39 56 57	5610 MHz	39	113
NV	LAS VEGAS	W 115 00 26	N 36 08 37	5645 MHz	1995	64
NY	FLOYD BENNETT FIELD	W 073 52 49	N 40 35 20	5647 MHz	8	97
OH	DAYTON	W 084 07 23	N 40 01 19	5640 MHz	922	97
OH	CLEVELAND	W 082 00 28	N 41 17 23	5645 MHz	817	113
H	COLUMBUS	W 082 42 55	N 40 00 20	5605 MHz	1037	113
OK	AERO. CTR TDWR #1	W 097 37 31	N 35 24 19	5610 MHz	1285	80
OK	AERO. CTR TDWR #2	W 097 37 43	N 35 23 34	5620 MHz	1293	97
OK	TULSA	W 095 49 34	N 36 04 14	5605 MHz	712	113
OK	OKLAHOMA CITY	W 097 30 36	N 35 16 34	5603 MHz	1195	64
PA	HANOVER	W 080 29 10	N 40 30 05	5615 MHz	1266	113
PR	SAN JUAN	W 066 10 46	N 18 28 26	5610 MHz	59	113
TN	NASHVILLE	W 086 39 42	N 35 58 47	5605 MHz	722	97
TX	HOUSTON INTERCONTL	W 095 34 01	N 30 03 54	5605 MHz	154	97
TX	PEARLAND	W 095 14 30	N 29 30 59	5645 MHz	36	80
TX	DALLAS LOVE FIELD	W 096 58 06	N 32 55 33	5608 MHz	541	80
TX	LEWISVILLE DFW	W 096 55 05	N 33 03 53	5640 MHz	554	31
UT	SALT LAKE CITY	W 111 55 47	N 40 58 02	5610 MHz	4219	80
VA	LEESBURG	W 077 31 46	N 39 05 02	5605 MHz	361	113
WI	MILWAUKEE	W 088 02 47	N 42 49 10	5603 MHz	820	113

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