The Technology Manager's

Guide to Wireless Microphones

Inside:

- Understanding Wireless Microphone Technologies
- The Emerging White Spaces Landscape
- Selecting the Right Wireless Microphone for Your Application
- Powering Wireless Microphones

Sponsored by

AKG

DA-CAPPO MICRO MICROPHONES

revolabs

EDITOR'S NOTE

Like most fundamental technologies that we rely on today, the promise of wireless dates back to the mid 19th century. Wireless microphones, however, didn't appear on the scene until the middle of the 20th century. Like radio, wireless microphones operate by modulating an audio signal over a carrier frequency. While they all use this transmission concept, there is a wide range of different types of wireless microphones, and no one type is best for all applications. Even for technical users, the topic can be dauntingly complex. Recently, it's become even more complicated by the Federal Communications Commission's Digital TV broadcasting mandate and decisions relating to radio frequency spectrum usage.

Most users would agree that the convenience of "going wireless" far outweighs the complexity. And for some users, wireless microphones are more than a convenience. In some applications, cable runs are not feasible, and wireless is the only practical way to transmit voice for sound reinforcement. But like everything else, there are trade-offs, and using wireless microphones introduces a whole host of new issues with which the user must contend.

Despite these trade-offs, the demand for reliable, high-quality wireless microphone systems continues to increase. In broadcast applications, wireless microphones have become a standard practice. It's not unusual for a major televised sporting event to use hundreds of channels of wireless microphone signals. For classroom and business presentations, the freedom to move about the room unencumbered can have a dramatic effect of the delivery of the message. And for entertainment applications — like theater — wireless microphones have dramatically improved the sound quality of productions large and small.

The key to using wireless microphones successfully in any application depends on understanding and managing the issues and trade-offs. The best approach is always to consult an audio professional before buying. But by reading this "Technology Manager's Guide to Wireless Microphones," you'll be informed on the major areas of concern so that you can ask the right questions before investing in these technologies.

— Mark Mayfield, Editor, *AV Technology* magazine

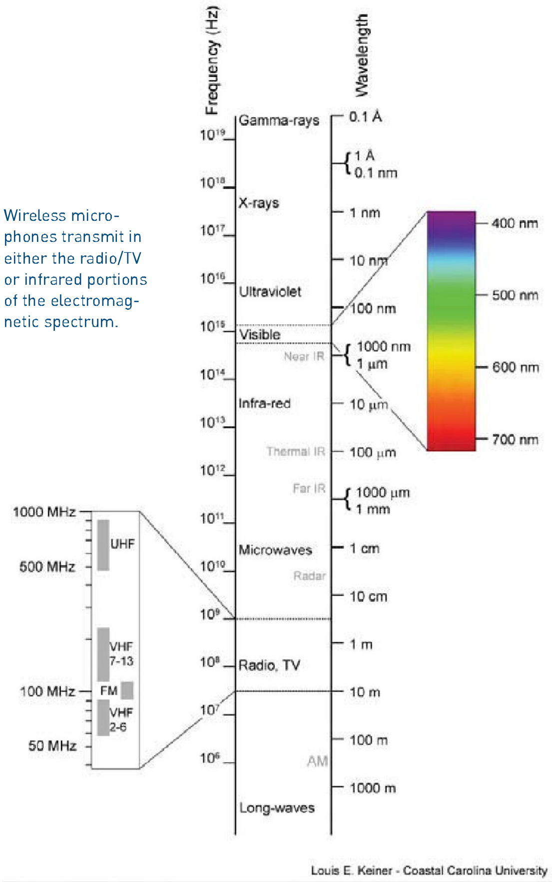
GET FULL ACCESS TO ALL OF AV TECHNOLOGY'S TECHNOLOGY MANAGER GUIDES

Visit AVTechnologyOnline.com to read digital editions of all of our Technology Manager Guides, including:

- Working with AV Integrators
- Videoconference Spaces
- Digital Signage in Enterprises
- Guide to Streaming Media
- Guide to Projection Technologies

TABLE OF CONTENTS

UNDERSTANDING WIRELESS MICROPHONE TECHNOLOGIES



Wireless microphones transmit in either the radio/TV or infrared portions of the electromagnetic spectrum.

Wireless microphones systems use a combination of conventional microphones with transmitters and receivers to replace the cable normally used to connect a microphone to a PA system. Most high-quality wireless microphone systems transmit on either infrared (IR) or radio frequency (RF) portions of the electromagnetic frequency spectrum.

Since they use radio waves, RF wireless microphones (VHF or UHF) can transmit over relatively long distances and even through walls, making it the optimum technology for use in churches, concert halls, and outdoor events. Most RF systems use Frequency Modulation (FM). In FM systems, the radio signal (the carrier) is frequency modulated (the frequency is increased and decreased) by the audio coming from the microphone.

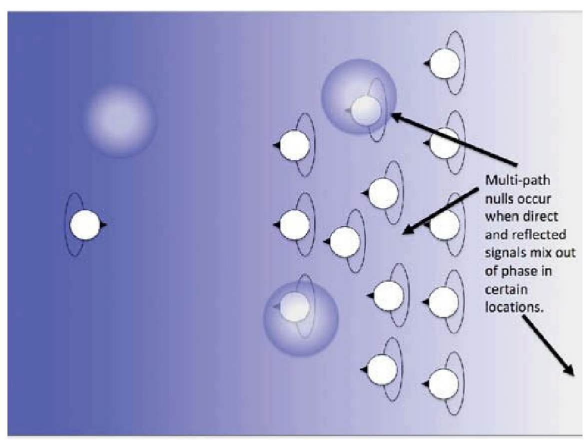
Amplitude Modulation (AM) is another method commonly used for communications and voice-band applications. In general, FM produces better audio than AM, so the FM principle is used almost exclusively for RF-based wireless microphones.

In the U.S., wireless microphones operate in frequency bands specified by the FCC (Federal Communications Commission). Bands have been allocated for RF wireless microphones in the VHF spectrum from 150 to 216 MHz, and (until recently) in the UHF spectrum from 470 to 806 MHz. These bands are used almost exclusively for television broadcast, except for a small portion of the VHF band between 169 and 172 MHz. DTV (digital television) broadcasts are being allocated in the UHF spectrum in what were formerly empty channels. The upper and lower parts of the UHF spectrum are also being broken up and re-allocated to make room for additional services. As the available spectrum space for wireless microphones continues to shrink, the need for higher quality wireless microphone systems increases dramatically.

VHF OR UHF?

There are pros and cons to both VHF and UHF:

- UHF has less chance of interference because of more available frequency spectrum.
- UHF wireless systems cost more than similar VHF wireless systems.
- Battery life for VHF wireless transmitters is almost always better than for similar UHF units.
- Diversity is especially valuable for UHF systems because



RF signals radiate in all directions from the transmitter to flood the room with RF energy.

dropouts due to multipath are more troublesome at UHF frequencies.

- Fixed-frequency (single channel) VHF and UHF systems in the TV bands may not be good choices for traveling use. This is because all VHF and most UHF TV channels are used in one location or another, and frequency conflicts will eventually occur. Frequency-agile UHF systems will be a better choice.
- UHF systems are good choices in situations where the smaller and less-visible antennas are highly important, such as when the transmitters must be concealed on the body.
- UHF may be preferable if high-performance antennas must be used to extend range.

Whether the choice is UHF or VHF, diversity systems are highly recommended.

DIVERSITY RECEPTION

The term "diversity" is one of the most widely misunderstood concepts of wireless systems. As it applies to wireless microphone receivers, the term simply refers to the use of two antennas to eliminate "dropouts" caused by multi-path phase cancellations (multi-path nulls).

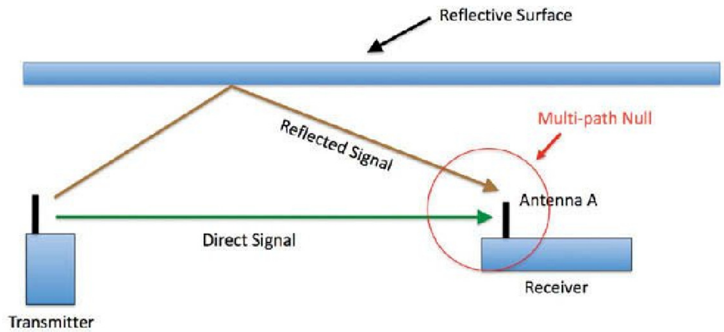
The most common type of dropout might more appropriately be called a "noise up," where the receiver audio output remains open during a multi-path null, and brief hiss, clicks, pops, or other noise can be heard momentarily along with the audio. A complete loss of the audio can also occur if the multi-path null is deep enough to cause the receiver to squelch. VHF dropouts usually sound more like a momentary swishing or hissing sound, sometimes along with a buzzing sound. UHF dropouts are shorter in duration than VHF due to the higher frequency and shorter wavelength, sometimes sounding more like a pop or click.

Multi-path conditions that cause dropouts are very common indoors, since the output of a wireless transmitter radiates in all directions and bounces off of many types of surfaces in the room. In reality, a wireless system operating in a room will be generating perhaps hundreds of reflections around the room, but the system continues to operate since the direct signal is normally stronger. Metal is an especially good reflector, so multi-path conditions also occur outdoors, since the transmitter signal can be efficiently reflected from cars, trucks, trailers, metal building surfaces, etc.

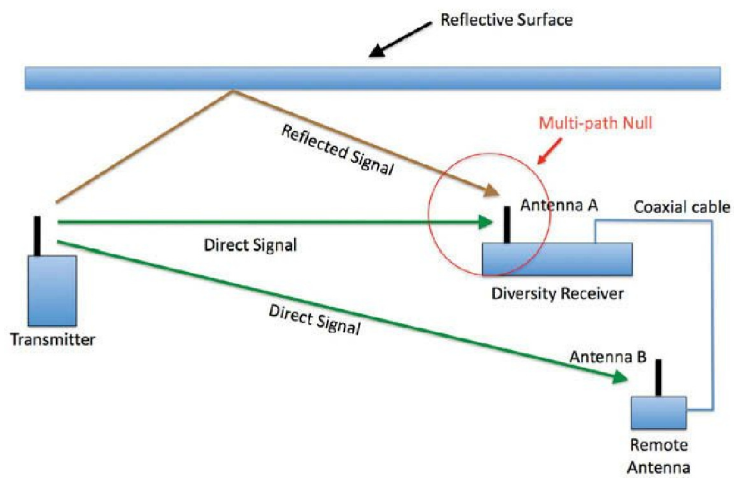
Dropouts occur when the transmitter and receiver antennas are in a particular location relative to each other. Moving the transmitter or receiver to a different location can oftentimes reduce or eliminate the dropouts. Other objects that move around the room, like people's bodies, also alter the reflected and direct signals and can make dropouts either more or less prevalent.

The wavelength of radio signal carriers at VHF frequencies ranges from about 5 to 6.5 feet long. At UHF frequencies, the wavelength ranges from about 12 to 20 inches. The point is that the "dropout zone" (the location where a dropout occurs) will be larger at VHF frequencies than at UHF frequencies, so antennas have to be moved farther with a VHF system than with a UHF system to alleviate dropouts. This also means that locating and being able to identify a dropout zone during a walk test is a bit easier with a VHF system than with a UHF system.

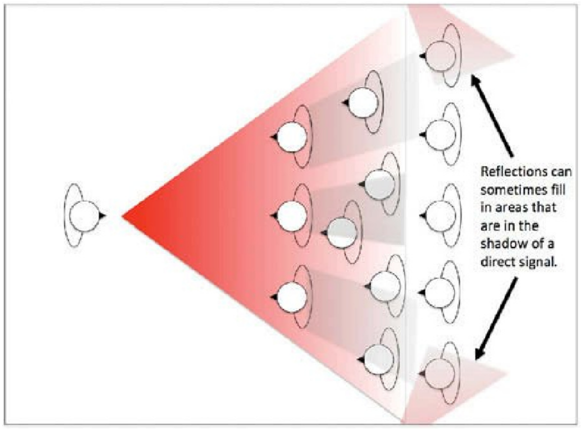
Imagine what would happen if antenna B was also



The signal from the transmitter reaches the receiver antenna via a direct path and a reflected path. The reflected signal path is a bit longer than the direct path, causing the two signals to be out of phase when they mix together at the receiver antenna, creating a multi-path null. The resulting weak signal causes what is known as a "dropout."



The signal arriving at antenna A is largely cancelled by a multi-path null, leaving little signal left for the receiver. The signal at antenna B remains strong and provides adequate signal for the receiver to produce a usable audio signal to noise ratio. Note that the illustration shows antenna B as a "remote" antenna connected with coaxial cable. The spacing between the antennas must be at least 1/2 wavelength of the operating frequency to ensure that the antennas are receiving uncorrelated ("diverse") signals to gain the full benefit of diversity reception.



line-of-sight is generally needed for reliable reception of IR signals.

mounted on the receiver. If the system were a VHF design, there would be a strong chance that the multi-path null would occur simultaneously at both antennas. What would be the benefit of trying to switch back and forth between two antennas that are picking up the same signal? The difference between the two signals would be either nonexistent or so minimal that it would not have any effect on the reception. At UHF frequencies with the shorter wavelengths, there might be enough space between the antennas to achieve some benefit of diversity reception when two antennas are mounted on the receiver.

Diversity circuitry implemented in a high-quality receiver with excellent sensitivity will reduce or eliminate multi-path dropouts, and, in some cases, increase operating range. The improvement in reception will vary depending upon the diversity methodology chosen by the designer.

The type of diversity reception circuitry chosen in the receiver design includes a number of considerations, including cost, size and weight, performance, and the practicality of each circuit type for a given application.

INFRARED

While infrared light is the portion of the electromagnetic spectrum just below visible light (wavelengths between 1 mm and 1,000 nanometers, at frequencies above 100 GHz), IR microphone systems operate by modulating an IR light source on carrier frequencies far below RF carrier frequencies — between 2 MHz and 3.7 MHz. IR microphones offer some very distinct advantages for certain applications — like training rooms and classrooms.

A classroom environment presents a whole different set of issues than a typical wireless microphone application. Rooms are small and don't require long-range transmission. Systems are being placed in every classroom in a building; and in many cases each classroom has two active microphones. Systems are sometimes moved to different classrooms from year to year.

With all of these unique challenges, infrared (IR) transmission has become the standard in the classroom amplification market for the following reasons:

- Immunity to outside interference from TV and radio stations
- Elimination of frequency management issues
- Ability to use microphones interchangeably throughout a building

IMMUNITY TO OUTSIDE RF INTERFERENCE

With the ever-growing number of television stations and digital TV broadcasting, the radio frequency environment is getting increasingly crowded. VHF- and UHF-based wireless microphones share the same RF spectrum as the television channels. More and more major metropolitan areas have little or no "free" airspace for wireless microphones to operate without interference.

Congestion in the airwaves makes finding one clear frequency a challenge, let alone 30 or more as are needed in most schools or training facilities. A clear frequency can immediately become unusable if a new TV station comes on the air. Conversely, IR transmission relies on infrared light, rather than radio waves, to transmit the signal. When designed and implemented properly, an infrared-based wireless microphone is completely immune to any interference from television stations or other RF transmission.

ELIMINATION OF FREQUENCY MANAGEMENT ISSUES

Another major difficulty in using RF-based classroom amplification is the proper coordination of frequencies. To operate without interference, multiple transmitters must be tuned to a different frequency. RF-based classroom amplification becomes highly problematic when you consider the following:

1. RF transmission travels through walls.
2. Low-power RF transmission, typical in classroom amplification systems, has an effective range of 300 feet or more.
3. Classrooms throughout a school are located in very close proximity to one another.
4. There is a very limited amount of "free" airspace for these systems to share.

When applied to the classroom environment, RF-based wireless microphones aren't only sharing space with existing TV stations, but also with each other. Even with precise coordination of frequencies and location of systems, an entire school of RF classroom systems operating together without interference is very unlikely.

When a second pass-around microphone for audience or class members is added, it becomes virtually impossible. If a system is ever moved or its transmission frequency is inadvertently changed, it can cause interference or crosstalk across multiple systems. Infrared technology avoids these issues by eliminating FM signal interference and crosstalk between systems.

[*Source: Lectrosonics, Lightspeed Technologies, Shure.*]

THE EMERGING WHITE SPACES LANDSCAPE

BY STEVE HARVEY

The November 2008 decision by the Federal Communications Commission to allow "white space" or television band devices (TVBDs) to operate below 698 MHz took the next step towards implementation on February 17 when it was published in the Federal Register. The years-long lead up to the decision, which also required wireless microphone, in-ear, and communications systems to cease operating in the so-called 700 MHz band by that date, has seen a public war of words waged between professional audio equipment manufacturers and prospective TVBD-makers.

With the publication of the decision, the fight has now moved to the courts. The February 17 publication automatically triggered a 30-day window for the filing of any Petition for Reconsideration and set a 60-day clock running for the Federal Court of Appeals process. The final results of this process are unknown — many comments have been filed, but the FCC has waited until after the DTV transition is complete to completely clarify the details of the new guidelines for TVBD operation and wireless microphone usage of the space.

Photo courtesy of Sabine

The pro audio industry knew about the switchover from NTSC to ATSC operation and the auctioning off of the spectrum vacated by analog television and has been preparing for some time, of course. Indeed, all of the mic makers have discontinued production of products for the domestic market that operate in the 700 MHz band. Most of the manufacturers have instituted various initiatives to educate customers, including a variety of web and telephone support programs, as well as rebate, trade-in, and retuning schemes to help customers relocate out of the affected spectrum.

But with so many legacy FM systems already in the field, it's no surprise that manufacturers and advocacy groups are now seeking legal recourse against the FCC's decision to allow TVBDs to share the increasingly limited RF spectrum available to pro audio users. In general, pro audio manufacturers believe that the FCC decision accepted that their products should take priority over TVBDs, which will be required to incorporate technology to prevent interference with wireless audio systems.

Most professionals initially believed that the overall outcome offered at least the semblance of adequate protection for wireless microphones, but there are concerns about the details of implementation of such safeguards. Chief among them is the spectrum-sensing technology — as yet largely unproven — that TVBDs must include. A number of the TVBD makers are now downplaying the role of spectrum sensing and support an expansion of the FCC's recommendation that two channels be set aside for RF audio gear use in the 13 major markets.

Another issue is the database of users that the devices must lookup. In live events, last-minute schedule adjustments are common. News crews may be called out to special or unforeseen events. This makes it difficult to maintain an up-to-date database to spot used or vacant frequencies. The prospective TVBD manufacturers, who include Motorola, Microsoft, and Dell, want currently unlicensed RF equipment users excluded from the database. There are also questions regarding the sensitivity threshold for spectrum-sensing devices.

Whatever safeguards are eventually put into place, James Stoffo, a wireless frequency coordinator for such high-profile events as the NBA Finals and Super Bowl, predicts there will be interference from TVBDs. The devices will not be able to sense a push-to-talk intercom if it's not in currently use, for example, he says. Noting also that audio professionals use big, helical, directional antennas to maximize signal pickup, he continues, "With a TVBD, the antenna is a little teeny portion of a quarter-wave whip that's right next to someone's body, which is absorbing RF. The chances that a TV band device would even 'see' a microphone are really slim to none. I'm skeptical that these will work."

Looking ahead, Stoffo believes RF professionals will have a tough row to hoe. "When I got into this business, we had everything from 470 MHz to 806 MHz. Now we have digital and analog TV, and we're about to lose 108 MHz of spectrum. It'll become extremely congested, and I think that, over the next two or three years, people are going to have to take wireless operation a little more seriously to get things to work."

SELECTING THE RIGHT WIRELESS MICROPHONE FOR YOUR APPLICATION

WHETHER YOU'RE WORKING WITH AN AUDIO PROFESSIONAL OR MAKING AUDIO DECISIONS ON YOUR OWN, HERE'S WHAT YOU'LL NEED TO CONSIDER TO MAKE THE BEST DECISION ABOUT WHICH WIRELESS MICROPHONE SYSTEM SUITS YOUR NEEDS.


Photo courtesy of Shure Incoporated

KNOW YOUR APPLICATION. Like any good decision strategy, it all starts with defining your situation. What is your sound source — voice, a musical instrument, etc. — and how many? You should also know the destination of that sound source, whether it's a sound system or some sort of recording or broadcast application. Perhaps most important is to have a clear understanding of the space in which you'll use your wireless microphone. Make note of any special requirements or limitations: visual aesthetics, range, maintenance, other possible sources of RF interference, etc. And finally, have an idea of the desired performance level you require: radio quality, audio quality, and overall reliability.

CHOOSE THE MICROPHONE TYPE. A clear understanding of your application will usually lead to which microphone physical design is best: if hands-free use is desired, you'll want a lavalier or clip-on type attached to clothing, or a head-worn type. Or if it's for a vocal performance — or if a mic must be passed around to different users — a handheld type is best.

CHOOSE THE TRANSMITTER TYPE. The microphone choice will also usually determine the required transmitter type (handheld, bodypack, or plug-on), again based on the application. General features of the transmitter include: antenna style (internal or external), control functions and location (power, muting, gain, tuning), indicators (power, battery condition), batteries (operating life, type, accessibility), and physical description (size, shape, weight, finish, material). For handheld and plug-on types, interchangeability of microphone elements may be an option. For bodypack transmitters, inputs may be hardwired or detachable. Multi-use inputs are often desirable and may be characterized by connector type, wiring scheme, and electrical capability (impedance, level, bias voltage, etc.).

CHOOSE THE RECEIVER TYPE. The main decision is whether to choose a diversity or non-diversity antenna system. Generally, diversity receivers are always preferred for all but the most budget-conscious applications. Though non-diversity types will work well in many situations, a diversity receiver will minimize multipath problems, so it's usually well worth the somewhat higher cost. Other receiver features that should be considered are: controls (power, output level, squelch, tuning), indicators (power, RF level, audio level, frequency), antennas (type, connectors), and electrical outputs (connectors, impedance, line/microphone/headphone level, balanced/unbalanced). In some applications battery power may be required.

HOW MANY SYSTEMS WILL BE USED? Determine the total number of systems to be used simultaneously. This should take into account future additions to the system; choosing a system type that can only accommodate a few frequencies may prove to be an eventual limitation. Of course, the total number should include any existing wireless microphone systems with which the new equipment must work.

WHERE WILL THE SYSTEM BE USED? The geographic location in which the system will be used will help to coordinate frequencies among wireless systems and other RF equipment that may be operating in the same area (like television stations).

FREQUENCY COORDINATION. Frequency coordination includes the choice of operating band (VHF/UHF or IR) and choice of the individual operating frequencies (for compatibility and avoidance of other transmissions).

ACCESSORY EQUIPMENT. This may include remote antennas (1/2 wave, 5/8 wave, directional), mounting hardware (brackets, ground-planes), antenna splitters (passive, active), and antenna cables (portable, fixed).

MICRO MICROPHONES

da-cappo

Model DA12AE Shown

Many Options
One Solution

Big-microphone sound is small solution if the microphone fits poorly. Designed around unique capsules that deliver full-range performance and superb EMI rejection, Da-Cappo Micro Microphones are your high-end solution—regardless of the wireless system. Dark or light skin tone, short or long boom, earset or lavaliere, we have a model to satisfy your most demanding client. Contact your Da-Cappo Micro Microphone dealer and arrange an audition today.

Visit us online at www.hosatech.com or call 714.522.8878

TROUBLESHOOTING WIRELESS MICROPHONE SYSTEMS

AF=audio frequency, RF=radio frequency, RFI=RF interference, TX=transmitter, RCV=receiver
Conditions assume a single system with both transmitter and receiver 'on'.

SYMPTOM	TX - RCV DISTANCE	POSSIBLE CAUSE	ACTION
No AF signal and no RF signal	any	low TX battery voltage	replace battery
No AF signal and no RF signal	any	TX and RCV tuned to different frequencies	retune one or both units
No AF signal and no RF signal	average	multipath dropout	use diversity RCV or reposition TX and/or RCV
No AF signal and no RF signal	long	out of range	move TX closer to RCV
No AF signal but normal RF signal	any	TX muted	un-mute TX
No AF signal but normal RF signal	any	microphone or other input source	check input source
Distortion with no AF peak indication	any	low TX battery voltage	replace battery
Distortion with AF peak indication	any	excessive TX input level	decrease source level or TX input level
Distortion with AF peak indication in subsequent equipment	any	excessive RCV output level	decrease RCV output level
Noise with low AF signal and normal RF signal	any	insufficient TX input level	increase source level or TX input level
Noise with low AF signal and normal RF signal	any	strong RFI	identify source and eliminate, or change frequency
Noise with normal AF signal and low RF signal	average	moderate RFI	increase squelch setting until RCV mutes
Noise with normal AF and RF signals	any	very strong RFI	increase squelch setting until RCV mutes
Intermittent AF signal and low RF signal	long	out of range	move TX closer to RCV
Intermittent AF signal and low RF signal	long	insufficient antenna gain	use higher gain antenna
Intermittent AF signal and low RF signal	long	excessive antenna cable loss	use low loss cable and/or less cable
Intermittent AF and RF signals	average	multipath interference	use diversity RCV or reposition TX and/or RCV
Intermittent AF and RF signals	average	obstructions in signal path	remove obstructions or reposition TX and/or RCV
Intermittent AF and RF signals	average	squelch set too high	decrease squelch setting
Intermittent AF and RF signals	average	very strong RFI	identify source and eliminate, or change frequency

Source: Shure Incorporated

POWERING WIRELESS MICROPHONES

Photo courtesy of Sennheiser

Where you're using an infrared or RF wireless microphone, there's a price to pay for the freedom and convenience — and that price is batteries. Most transmitters use either 9-volt or AA-type batteries, which is easily found in any type of retail store. But there are differences and tradeoffs.

DISPOSABLE BATTERIES

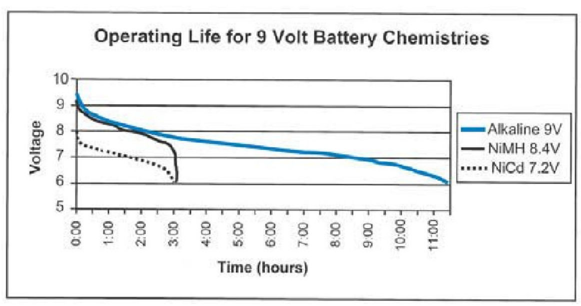
Regardless of which brand or type you use, always use fresh batteries of the correct type in the transmitter and/or receiver. Most manufacturers recommend only alkaline-type batteries for proper operation. Alkaline batteries have a much higher power capacity, more favorable discharge rate, and longer storage life than other types of single-use batteries such as carbon zinc. Alkaline types will operate up to 10 times longer than so-called "heavy duty" non-alkaline cells. They are also far less likely to cause corrosion problems if left in the unit. Consider bulk purchase of alkaline batteries to get the greatest economy: they have a shelf life of at least one year.

The battery condition should be determined before system use and checked periodically during use, if possible. Most transmitters are equipped with a battery status indicator of some kind that will at least indicate a go/no-go or some minimum operating time. Some units have a "fuel gauge" that can allow more precise indication of remaining battery life. A few models even have the capability of transmitting battery condition information to the receiver for remote monitoring.

RECHARGEABLE BATTERIES

Rechargeable batteries are also common in both RF and IR systems. The conventional rechargeable battery uses a Ni-Cad (nickel-cadmium) cell or Ni-Mh (nickel-metal-hydride) cell. The voltage of an individual Ni-Cad or Ni-Mh cell is 1.2 volts rather than the 1.5 volts of an alkaline cell. This is a 20 percent lower starting voltage per cell. For systems using AA or AAA size batteries, this lower starting voltage may not be an issue because most transmitters using these battery sizes have internal voltage regulators that can compensate. High-capacity Ni-Mh single cell (AA or AAA) batteries are available with operating times that are comparable to single-cell alkaline types.

However, the standard alkaline 9-volt battery is made up of six cells in series, which yields an initial voltage of at least 9 volts. Typical continuous operating time for a 9-volt alkaline battery in a wireless microphone is about eight hours. The least expensive "9-volt size" rechargeable also has six cells, giving it an initial voltage of only 7.2 volts. When combined with its lower power capacity, the operating time may be less



than 1/20 of an alkaline, only about 15 minutes in some units. The "better" 9-volt size rechargeable has seven cells (8.4 volts initial), but still has significantly less power capacity than an alkaline. Operating time for these types may be as little as two hours compared to eight hours for an alkaline 9-volt battery.

It is possible to obtain high performance 9-volt size Ni-Mh batteries that approach the power capacity of an alkaline. These may offer up to six hours of operation. A battery chemistry that shows potential for exceeding alkaline capacity is lithium-ion (Li-on) or lithium-polymer (Li-polymer). However, this chemistry is presently only found in custom battery designs such as those used in digital cameras, laptop computers, and other high discharge rate devices. When standard size (AA, AAA, 9-volt) versions become available, rechargeable types may finally replace single-use types.

If it is decided to use rechargeable batteries, battery management is very important. For systems in daily service a minimum of two batteries per unit is recommended due to the charging time: one charging and one in use. In addition, Ni-Cad batteries must periodically be completely cycled to get maximum service life and avoid developing a short discharge "memory effect." Generally, Ni-Mh and Li-on types do not exhibit memory effect. However, for maximum performance from any rechargeable battery it is necessary to use a high-quality charger that is designed for the specific battery type. Improper charging can impair or even damage rechargeable batteries prematurely.

Ultimately, the long-term potential savings in battery cost must be weighed against the expected operating time, initial investment, and ongoing maintenance requirements for rechargeable batteries.

[*Source: Shure*]

RECHARGABLE BATTERY TIPS

Nickel-cadmium (NiCd)	Nickel-metal-hydride (NiMH)	Lithium-ion (Li-ion)
CHARGING		
Do run the battery fully down once per month; try to use up all energy before charging.	Do run the battery fully down once every 3 months. Over-cycling is not advised.	Do charge the battery often. The battery lasts longer with partial rather than full discharges.
Do not leave battery in charger for more than 2 days because of memory.	Do not leave battery in charger for more than 2 days because of memory.	Do not use if pack gets hot during charge. Check also charger.
Avoid getting battery too hot during charge.	Avoid getting battery too hot during charge.	
Charge methods: Constant current, followed by trickle charge when full. Fast-charge preferred over slow charge. Slow charge = 16h, Rapid charge = 3h, Fast charge = 1h+	Charge methods: Constant current, followed by trickle charge when full. Slow charge not recommended. Battery will get warm towards full charge. Rapid charge = 3h, Fast charge = 1h+	Charge methods: Constant voltage to 4.20V/cell (typical). No trickle-charge when full. Li-ion may remain in the charger (no memory). Battery must remain cool. No fast-charge possible. Rapid charge = 3h
DISCHARGING		
Full cycle does not harm NiCd. NiCd is one of the most hardy and durable chemistries.	Avoid too many full cycles because of wear. Use 80% depth-of-discharge. NiMH has higher energy density than NiCd at the expense of shorter cycle life.	Avoid full cycle because of wear. 80% depth-of-discharge recommended. Re- charge more often. Avoid full discharge. Low voltage may cut off safety circuit.
SERVICE NEEDS		
Discharge to 1V/cell every 1 to 2 months to prevent memory. Do not discharge before each charge.	Discharge to 1V/cell every 3 months to prevent memory. Do not discharge before each charge.	No maintenance needed. Loses capacity due to aging whether used or not.
STORAGE		
Best to store at 40% charge in a cool place. Open terminal voltage cannot determine state-of-charge. 5 years and longer storage possible. Prime battery if stored longer than 6 months.	Store at 40% charge in a cool place. Open terminal voltage cannot determine state-of-charge. Prime battery if stored longer than 6 months.	Store at 40% charge in a cool place (40% state-of-charge reads 3.75-3.80V/cell at open terminal. Do not store at full charge and at warm temperatures because of accelerated aging.
DISPOSAL		
Do not dispose; contains toxic metals; must be recycled.	Should be recycled. Low volume household NiMH may be disposed.	Should be recycled. Low volume household Li-ion may be disposed

Sourcing: Cadex Electronics

WHO MAKES THEM?

		RADIO FREQUENCY	INFRARED
AKG Acoustics	www.akg.com	x	
Anchor Audio	www.anchoraudio.com	x	
Astatic	www.astaticinstalled.com	x	
Audio-Technica	www.audio-technica.com	x	x
Audix	www.audixusa.com	x	
Avlex	www.avlex.com	x	
Azden	www.azdencorp.com	x	x
beyerdynamic	www.beyerdynamic-usa.com	x	x
Bogen	www.bogen.com	x	
Califone	www.califone.com	x	x
Electro-Voice	www.electrovoice.com	x	
Front Row	www.gofrontrow.com	x	x
Hosa (Da-Cappo)	www.hosatech.com	x	
Lectrosonics	www.lectrosonics.com	x	
Lightspeed	www.lightspeed-tek.com		x
Panasonic	www.panasonic.net		x
Paso	www.pasosound.com	x	x
Peavey	www.peavey.com	x	
Polycom	www.polycom.com	x	
Revolabs	www.revolabs.com	x	
Sabine	www.sabine.com	x	
Sennheiser	www.sennheiserusa.com	x	x
Shure	www.shure.com	x	
TeachLogic	www.teachlogic.com	x	x
TOA	www.toaelectronics.com	x	

AVOIDING INTERFERENCE

Interference is generally defined as an undesired RF signal that causes noise or distortion. It can also cause limited operating range and dropouts. Interference can result from external RF signal sources such as television station broadcasts, or it can be generated within a wireless system itself. Interference is also generated by operating multiple systems in the same location. To further complicate matters, interference can also result from some combination of all of these sources.

The most obvious way to avoid interference is to find frequencies that aren't already in use wherever you're operating your wireless mic system. The best tool to help you do this is an RF scanner.

A typical RF scanner can cost between $50 and $400.

USING AN RF SCANNER

An RF scanner is electronic device that is designed to pick up radio activity over a certain range of frequencies. When scanning for potential sources of interference, it is only necessary to search the frequency ranges where wireless microphone systems are assigned. The most common (and most crowded) frequency range for wireless microphone use is high-band VHF, which extends from 174 to 216 MHz. The "traveling" frequency range is 169 to 172 MHz. The spread of UHF frequencies is much wider, from 470 to 806 MHz, and can take a long time to scan. If you are considering a UHF system, first determine the operating range of the wireless system in question and scan only those frequencies. The UHF band is much less congested than VHF, making it easier to locate unused frequencies. Frequencies outside of those used by wireless microphones do not normally cause problems.

1. Check a specific frequency. Dial in the frequency of the wireless microphone system in question and check for any audible signals. If you hear anything through the scanner when the wireless transmitter is off, it could be a potential source of interference for the wireless system when you're actually using it.

2. Scan or search function. This feature automatically scans through a preset or programmed range, stopping wherever there's significant RF activity. Avoid these frequencies. Some scanners offer the ability to search repeatedly over a certain range, allowing the scanner to catch intermittent transmissions missed on initial scans.

3. Listen. Paging systems produce a series of beeps and crackling noises. The video signal carrier of a television station is identified by a steady buzz, and the color signal is usually heard as a high-frequency whine. Audio information is, of course, easily recognizable. Be sure to check adjacent frequencies, as they can also cause interference even though they're not on the exact frequency of the wireless system.

4. Use squelch. The squelch control eliminates unwanted background noise on normally inactive frequencies. But be careful. If squelch is set too high, significant RF interference may be overlooked. If squelch is set too low, the scanner will frequently stop on background noise when using scan or search modes. To set the squelch control, select a known clear frequency (e.g., an unused local TV channel), rotate the squelch control until the background noise disappears, and add a bit more squelch for extra insurance.

IS IT REALLY THE WIRELESS?

Not all noise in audio systems using wireless mics is due to interference, or even to the wireless equipment itself. Because interference is a known problem with wireless, it is common to blame it for unwanted audio noise. Sometimes, however, the real problem is elsewhere. For example, AM radio stations can introduce noise into an audio system through the input circuits of the mixer or amplifiers. Because the interference is plainly a radio station, it is easy to jump to the conclusion that it comes from the wireless. Recognizing the actual source of the problem can help avoid fruitless efforts to correct a nonexistent wireless system problem.

- Try momentarily turning off the wireless receivers and disconnecting the audio cables. If the problem is still present with the receivers off or with the cables disconnected, the trouble is almost certainly elsewhere in the audio system, not in the wireless.
- Turn off all wireless transmitters and make certain that all receiver "signal" indicators go out. Listen to the audio system to see if the problem is still present. If it is, the trouble is probably not radio interference, but some type of non-wireless interference. If the "signal" indicators do not go out, there may be squelch problems.

SIMPLE TIPS

- Make certain than no radio transmitters, including the system transmitter or those for other wireless systems, are allowed to come closer than approximately 10 to 15 feet (3 to 4.5 m) to the wireless receiving antennas. This can overload the receivers and increase the chances of interference.

- Make certain not to allow receiver antennas to touch each other when arranging receivers. Make especially certain that the antennas from one receiver do not touch, or come too close to, those of another receiver. Try to provide at least 10 inches (25 cm) of separation between the antennas of any two receivers.
- Make certain that all transmitters have good batteries. The low output voltage of weak batteries can cause some transmitters to generate harmful interference. If there is any doubt, install a new, fresh alkaline battery in all wireless transmitters.
- If you have a "combination" system (handheld + body-pack) with two transmitters on the same frequency, or two wireless systems on the same frequency, make absolutely certain that both transmitters cannot be turned on at the same time.
- Check the squelch control setting on the receiver. A higher squelch setting provides better protection against interference. However, since a high setting also can cause a reduction in operating range, set the control to the lowest position that reliably mutes the interference.

[*Sources: Audio-Technica, Lectrosonics, Shure.*]

CHANNEL ASSIGNMENTS

In the U.S., the FCC is responsible for allocating spectrum to broadcasters and other users. These are the channel assignments from the FCC; of course, not all channels are occupied in all regions of the U.S., so it's best to check which channels could be available for wireless microphone use in the specific area you're in.

BAND DESCRIPTION	FREQUENCY RANGE
AM Radio Broadcast	540 kHz to 1630 kHz
TV Channels 2-6 (VHF)	54 MHz to 88 MHz
FM Radio Broadcast	88 MHz to 174 MHz
TV Channels 7-13 (VHF)	174 MHz to 216 MHz
Super Band (mobile/fixed radio & TV)	216 MHz to 600 MHz
Ultra-High Frequency (UHF)	300 MHz to 3000 MHz
TV Channels 14-70	470 MHz to 806 MHz
Personal Communications Services (PCS)	1850 MHz to 1990 MHz
Unlicensed PCS Devices	1910 MHz to 1930 MHz
Infrared	300 GHz to 430 THz
Visible Light	430 THz to 750 THz
Ultraviolet	1.62 PHz to 30 PHz
X-Rays	30 PHz to 30 EHz
Gamma Rays	30 EHz to 3000 EHz

<table>
<tr><th colspan="3">NEW FCC ALLOCATIONS</th></tr>
<tr><td rowspan="4">Fixed TV Band Devices
(wireless broadband to homes/businesses)
(Wireless Mics may continue to operate in unoccupied channels in this band)</td><td>Channel 2</td><td>54 MHz to 60 MHz</td></tr>
<tr><td>Channels 5 to 13</td><td>76 MHz to 216 MHz</td></tr>
<tr><td>Channels 14 to 36</td><td>470 MHz to 602 MHz</td></tr>
<tr><td>Channels 38 to 51</td><td>614 MHz to 698 MHz</td></tr>
<tr><td rowspan="2">Portable TV Band Devices
(mobile phones, wireless PCs)</td><td>Channels 21 to 36</td><td>512 MHz to 608 MHz</td></tr>
<tr><td>Channels 38 to 51</td><td>614 MHz to 698 MHz</td></tr>
<tr><td>Wireless Mics may no longer operate in this band</td><td>Channels 52 to 69</td><td>698 MHz to 806 MHz</td></tr>
</table>

AKG DMS 700
Professional Digital Wireless System

LEGENDARY AKG SOUND
Wireless Transmission that Sounds Like a Wire
Pristine Digital Audio – No Compander circuit needed

150 MHz Tunable Range Transmitters and Receiver
Will work anywhere you need wireless

DSP with Memory Locations for Instant Recall
3 band EQ / dbx 5 parameter Compressor
Adjustable Brick Wall Limiter

Signal Encryption for Secure Transmission
Protect Your Sensitive Information
Corporate / Government / Military

Auto Setup Single or Multi-Channel Systems
Auto Frequency Coordination
IR Sync for Transmitters
Make No Mistake During Setup of Your System

- Up to 155 MHz Tuning Range
- Signal Encryption for Secure Sensitive Audio Information
- 2-Channel Digital True-Diversity Receiver
- Quick Setup via Infrared Data Link to the Transmitter
- Spectrum Analyzer for Experts
- Designed for Quick and Easy Operation

ADV 690/1/E

www.akg.com
A Harman International Company

AKG SOUNDS BETTER