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INTRODUCTION TO WIRELESS MICROPHONE SYSTEMS



A Shure Educational Publication

INTRODUCTION TO WIRELESS MICROPHONE SYSTEMS

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NO CABLES. NO WORRIES.

Conventional wired microphones convert sound into an electrical audio signal that is sent to the sound system through a cable. Live music stages that are crowded with cables from microphones for vocals, guitars, drums and other instruments can become a snake pit of overlapping wires.

Wireless microphones convert audio signals created by microphones into radio signals, which are sent by a transmitter through the air to a receiver. The receiver converts the radio signals back into audio signals which are then sent through the sound system. They eliminate the need for cables, so you're no longer tethered to a sound system or tripping through messy performing environments.

With continuous technological advances and improvements in sound quality and reliability, wireless microphones are more affordable and popular than ever.

Their potential uses go far beyond the stage. You can find wireless microphones in exercise studios, schools, houses of worship, presentation halls – anywhere a performer or presenter wants true freedom of movement.

SIMPLICITY

Set up and go for it. Your stage is cleaner and your mics are less intrusive, so you can concentrate on your performance.

MOBILITY

Be even more expressive. Wireless microphones cut you loose wherever you perform.

VERSATILITY

Multiple microphone choices, system configurations and features mean wireless systems can adapt to nearly anything you do and any place you go.

PRODUCT GLOSSARY

Wireless Microphone Systems range from simple to sophisticated. But they all include various combinations of these key components:

- **Transmitters:** Convert the audio signal from the microphone to a radio signal. There are two types:
 - Handheld Microphone Transmitter – Combines handheld microphone element and transmitter in one unit.
 - Bodypack Transmitter – Wearable unit with a connector that accepts microphones or guitar cables.
- **Microphones (for Bodypack Transmitters):** Headworn, lavalier and instrument microphones ideal for a variety of vocal and instrument applications
- **Receivers:** Modules that receive radio signals sent from transmitters and convert them back to audio.

1 TRANSMITTING

Two types of transmitters—handheld or bodypack – convert audio signals to radio signals so they can be sent, without a cable, to a wireless receiver at the mixing console.



Handheld Microphone Transmitter

This microphone/transmitter integrates the transmitter into the microphone handle, so both functions are contained in one unit.

Like conventional wired microphones, wireless handheld vocal microphones are tailored to meet diverse performance vocal requirements and musician preferences. Many different choices are available.



Bodypack Transmitter

Lavalier, Headworn and Instrument Microphones, as well as guitar cables, must plug into a Bodypack Transmitter to send their audio signals. Sleek, lightweight bodypacks can be easily clipped to clothing or a guitar strap.



Headworn Vocal Mic

Rugged, comfortable, easy-to-position headsets provide superior voice pickup in any active user setting.



Lavalier Vocal Mic

A range of sizes combine low visibility with high-quality professional audio. They provide full, clear sound for speech applications.



Clip-On Instrument Mic

A versatile solution for high volume wind, brass and percussion players. Gooseneck and clamp ensure secure fit and positioning.



Guitar/Bass Cable

Connects any guitar to a Bodypack for wireless performance.

2 RECEIVING

Wireless receivers convert RF signals sent from a Handheld Microphone Transmitter or a Bodypack Transmitter back to an audio signal. They come in these receiver configurations:



Single Channel Receivers

This is the most common type of receiver. Receivers usually have XLR and 1/4" audio outputs for connection to a variety of devices. Units may be free standing or rack-mountable and are typically AC-powered. Indicators for power and signal levels may be present. Diversity receivers utilize two antennas, which may be removable or permanently attached.



Portable Receivers

These resemble portable transmitters externally; they are characterized by small size; one or two outputs; minimal controls and indicators, and are typically battery powered. Portable receivers are great for mounting directly to a camcorder or DSLR camera.



Multi-Channel Receivers

This type provides two or more channels of wireless, allowing multiple users to be wireless. These systems generally come with various transmitter combinations. Common options are dual or quad receivers.



Guitar Pedal Receiver

This receiver type is designed with the guitarist or bass player in mind. It mounts on a pedal board, and can be powered by the pedal board itself.

SETUP: VOCALS

This wireless system setup example follows the wireless signal path for common vocal system configurations using a handheld microphone.

Application:
Profile I Handheld
A handheld wireless setup is great for performers who want a handheld vocal microphone that's not connected to a bodypack transmitter.

Ideal for:
Vocalists
Speakers / Presenters
DJs

Singer

Handheld Transmitter

Signal transmitted to Receiver

Signal sent to house sound or monitors

Your input to the house board

Diversity Receiver

CONCEPT GUIDE

These technical and operating concepts help define how a wireless microphone system functions and which is best suited to a specific application.

Analog or Digital

Analog systems utilize proven radio technology that offers quality audio performance and high channel count, even with entry-level systems. Digital systems feature exceptionally clear audio, but potentially fewer on-air channels. High-end digital systems, however, offer the best of both worlds, combining superb audio with the ability to use many wireless systems in crowded RF environments.

Frequency Ranges

Every wireless microphone system transmits and receives audio on a specific radio frequency, known as the operating frequency. These frequencies are typically divided into these bands, or ranges.

The UHF-TV Band – Unused television channels in this range are available for wireless microphones and other wireless audio devices. Most cities have a significant number of television stations and the largest cities may also have public safety operations, but there are sufficient unused television channels available for most wireless users to find a clear channel. However, this spectrum is becoming increasingly crowded. Users may be licensed or unlicensed in the UHF Band.

Multiple frequency range options are available throughout the UHF band, and the best one to use will vary from city to city. In order to determine the best range for your area, you may want to consult with the manufacturer.

The 900 MHz Range – This band (specifically, 902 – 928 MHz) offers additional channels outside of the TV channel range. Users are allowed to operate without a license in this range. There are several high quality wireless microphone systems that operate in this range, most of them fully digital. While 900 MHz wireless microphone systems are legal to use in the United States (and most of the Americas), they are not necessarily legal to use in all parts of the world. Check with your local regulatory agency if you are unsure.

The 2.4 GHz Band has attracted some interest for wireless microphone use. Advantages of this band are: worldwide, license-free operation, and very short antennas, but there is some potential from interference from Wi-Fi devices. This band is great for users who only need a few channels of wireless, but for applications with many channels of wireless, the UHF-TV band may be preferred.

Frequency Selection

Fixed Frequency – Fixed-frequency systems are pre-set to their operating frequency and cannot be changed by the user. They are suitable for use in one particular area or installation, but due to their limited capabilities are not commonly available anymore.

Frequency Agile – Frequency-agile (tunable) systems allow users to quickly change frequencies to avoid local TV channels, other wireless users, or other interference sources. Most modern wireless microphone systems offer some degree of frequency agility.

Tips! Many newer wireless systems include easy to use features, such as *Scan and Sync* which quickly and easily sets up the system with a clear channel. Some wireless manufacturers have online tools and resources such as *wireless frequency finders* to help users find the best frequency for their location.

Using Multiple Wireless Microphones

Each microphone needs its own frequency to operate and transmit properly. So it is not possible to use two wireless systems on the same frequency in the same venue or to use two wireless microphones with just one receiver (unless you are using a dual-channel receiver).

The individual frequency used by each microphone requires a certain amount of space within a particular frequency band. When two wireless systems are used together, the frequencies must be separated by some minimum amount that depends on the design of the system. If frequencies are set too close, microphones will compete with each other, and each system will experience noisy interference and/or sound dropouts.

As more transmitters and receivers are added to a particular setup, interaction between frequencies increases. This interaction produces more interfering frequencies that need to be avoided. More advanced wireless systems offer greater frequency selection, flexibility and the ability to combine more receivers and transmitters to serve more users. Many of these systems offer pre-configured groups of compatible frequencies to accommodate multiple users, as well as software that can scan for the clearest frequencies in any one particular location.

Visit the Shure Wireless Frequency Finder for the most up to date frequencies for Shure Wireless System use in the United States.

<http://www.shure.com/americas/support/tools/wireless-frequency-finder>

SETUP: PRESENTER

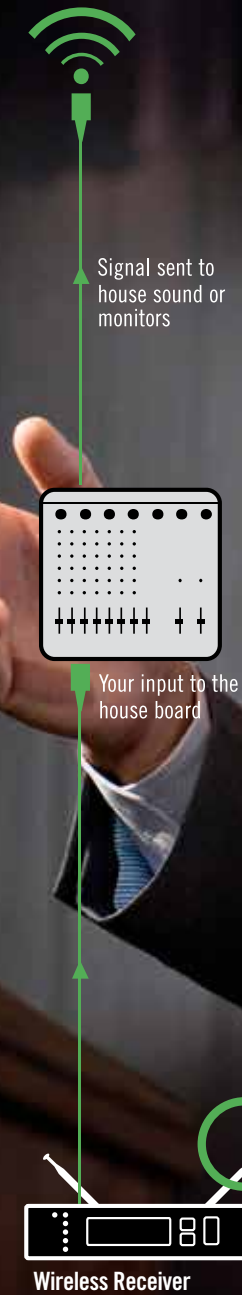
This wireless system setup example follows the wireless signal path for common vocal system configurations using a lavalier microphone.

**Application:
Profile | Lavalier**
A lavalier microphone and bodypack transmitter setup can work for any presenter or performer.

**Application:
Profile | Headworn**
For situations where performers or presenters work with louder sound systems or use stage monitor speakers, a headworn microphone is a more effective choice.

Ideal for:
Speakers / Presenters
Worship Leaders
Theater Stage Actors

Presenter



Signal sent to house sound or monitors

Your input to the house board

Signal transmitted to Receiver

Bodypack Transmitter

CONCEPT GUIDE

Microphone Basics

There's more to a microphone than its shape. While invisible from the outside of a microphone, these two fundamental operating principles can help fine tune the selection of the right microphone for your wireless system application.

Operating Principles

How a microphone changes sound into an electrical signal. This is determined by the type of Transducer inside the microphone. The two most common types are:



DYNAMIC

These are workhorse microphone elements with great sound that stand up to rugged regular use. They are also generally more affordable options.



CONDENSER

These produce a crisper, more defined sound and are better at capturing subtle details of delicate voices and instruments. They also require power to operate, which is supplied by the battery in a handheld wireless transmitter.

Polar Pattern

A polar pattern is the graphic representation of a microphone's directional sensitivity, which is how a microphone picks up sound from different directions. These are the three most common polar patterns:



CARDIOID

These patterns pick up the most sound from in front of the microphone and some from the sides. They are less susceptible to feedback in loud environments.



SUPERCARDIOID

These are tighter patterns that help screen unwanted sound sources. They are perfect for individual instruments in a multi-instrument setting or single sources in noisy environments. They also provide the best rejection of feedback when used with floor wedge monitor speakers.



OMNIDIRECTIONAL

Omnidirectional polar patterns are equally sensitive to sound from all directions. These are most often found in lavalier microphones.

SETUP: GUITAR

This wireless system setup example follows the wireless signal path for common instrument system configurations.

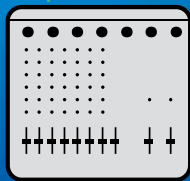
Application:
Profile | Guitar
 A wireless guitar setup helps guitarists move freely anywhere onstage.

Ideal for:
 Electric Guitarists
 Acoustic Guitarists
 Bass Guitarists

Guitarist



Signal sent to house sound or monitors



Your input to the house board

Bodypack Transmitter



Signal transmitted to Receiver

Guitar Cable links to Bodypack




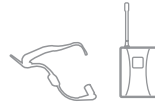

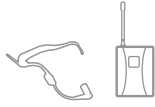


Guitar Pedal Receiver

NEEDS ANALYSIS

Microphone Configurations

Wireless system microphone and transmitter choices afford presenters and performers great flexibility in matching an application to a wireless configuration.

1 What type of microphone / transmitter configuration best fits your performance needs?

Application	Configuration
Vocalist	 Handheld Microphone / Transmitter
Singing Dancer Singing Keyboardist Singing Drummer Fitness Instructor Dance Instructor	 Headworn Mic + Bodypack Transmitter
Presenter Worship Leader Stage Actors	 Lavalier Mic + Bodypack Transmitter OR  Headworn Mic + Bodypack Transmitter
Horn Percussion	 Clip-On Mic + Bodypack Transmitter
Guitar Bass	 Instrument Cable + Bodypack Transmitter

2 Would your performance benefit from a particular microphone design profile?

Your usage application is only one key factor in choosing a wireless microphone. Also consider the microphone transducer design and polar pattern. These greatly impact how any wireless microphone reproduces your live sound.

For example, if you are a vocalist who performs on-stage with loud monitors, you might want a handheld transmitter with a tight supercardioid polar pattern to minimize feedback.

If you tend to sing softly, a condenser microphone will more smoothly capture the subtleties and details of your voice.

SETUP: INSTRUMENT

This wireless system setup example follows the wireless signal path for common instrument system configurations.

Application:
Profile I Clip-On
 A small, clip-on instrument microphone and Bodypack Transmitter is a great wireless solution for many acoustic instruments.

Ideal for:
 Brass
 Woodwind
 Percussion

Saxophone



NEEDS ANALYSIS

System Configurations

Different transmitter and receiver options in every wireless system are also designed to respond to the special needs of different user applications.

3 Where do you intend to use your wireless system? One location? Many locations?



ONE LOCATION

If you intend to use the wireless system in one location, you simply need to make sure that you select a system that operates on frequencies compatible with your location's available UHF broadcast TV channels, or operate on unlicensed frequencies.



MULTIPLE LOCATIONS

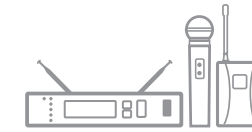
If you intend to use the wireless system in different cities, you will probably encounter different active TV channels. A frequency-agile wireless system lets you change frequencies to adapt to changing situations as you travel. Choose a system with Scan and Sync features, which will quickly and easily set up the system on a clear channel.



INTERNATIONAL LOCATIONS

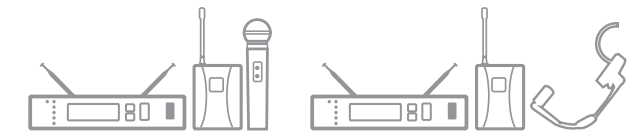
The 2.4 GHz Band can be used internationally with no license requirement.

4 How many wireless systems will be in use at the time and location?



ONE SYSTEM

If you are operating a single wireless system in a location where there are no other wireless systems in use, you will not have any special multisystem needs to manage.



MULTIPLE SYSTEMS

If you operate more than one wireless system and move from venue to venue, it is usually more convenient to mount receivers in a small rack case. Some wireless systems allow two receivers to mount together in one rack space. These can be used with an antenna splitter that feeds one "master" pair of antennas to serve all receivers.

There is a limit to the number of wireless systems that can be used in one location. Each system must transmit on its own frequency. And those frequencies must be selected carefully to prevent interference. Better wireless systems allow for more units to be operated at the same time without interference. Consult with the manufacturer for advice on ensuring multisystem operation.

SETUP: HEADWORN

This wireless system setup example follows the wireless signal path for common vocal system configurations using a headworn microphone.

Application:

Profile | Headworn

For situations where performers or presenters work with louder sound systems or use stage monitor speakers, a headworn microphone is a more effective choice.

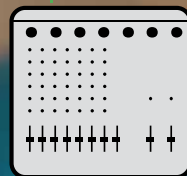
Ideal for:

Fitness / Dance
Instructors
Singing Dancers or
Instrumentalists (such
as drummers and
keyboardists)

Instructor



Signal sent to
house sound or
monitors



Your input to the
house board



Wireless Receiver

Signal
transmitted
to Receiver



Bodypack
Transmitter

Headworn
Mic

CONSIDERATIONS

RF SIGNALS



Signal path from transmitter to receiver

The signal path and signal strength between transmitter and receiver is affected not only by distance, but also by obstructions. Each installation location presents its own challenges.

Maintain line-of-sight between the transmitter and receiver antennas as much as possible. Avoid metal objects, walls, and large numbers of people between the receiving antenna and its associated transmitter. Ideally, this means that receiving antennas should be in the same room as the transmitters and elevated above the audience or other obstructions.



Receiver and antenna placement

PLACE THE RECEIVER PROPERLY

Receivers are subject to interference from external sources that emit radio frequencies. Where possible, keep receivers a few feet (or rack spaces) away from CD players, cell phones, digital special-effects units, and lighting boards, and other such devices.

POSITION ANTENNAS PROPERLY

Ideally, antennas should be positioned above an audience or other obstructions so that the transmitter and receiver can "see" one another. When receivers are mounted in a rack, antennas must be located on the front panel or allowed to project through the top of the rack. Antennas should be oriented vertically or angled apart to maximize the distance between antenna tips.

POWER



Batteries

Unlike most wired microphones, all wireless mic transmitters require batteries. As a result, batteries are an important and constant replacement part. If you are using non-rechargeable batteries, alkaline batteries offer the longest life for wireless applications. Off the shelf rechargeable batteries, such as nickel-cadmium or nickel-metal hydride, though an economical choice, typically last less than three hours before recharging is necessary. This short runtime makes them undesirable for most performers.

Some manufacturers offer proprietary rechargeable batteries that utilize more advanced technology, such as lithium-ion, that will provide continuous usage that often surpasses that of alkaline batteries.

LEARN MORE

Wireless Microphone Systems: Selection & Operation Guide

This booklet provides greater technical detail about specific wireless microphone systems, components, frequency selection, usage applications, setup suggestions and system expansion.

You can download a PDF of this guide at:

<http://www.shure.com/americas/support/downloads/publications>

Additional Shure educational publications available:

Audio Systems Guide for Houses of Worship
Audio Systems Guide for Video Production
Personal Monitor Systems I Introduction Guide
Mic Techniques for Music-Sound Reinforcement
Mic Techniques for Music-Recording
Introduction: Home Recording and Podcasting



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