Wireless Microphones

Bane, or Boon?

Presenter: Joel Lord
CDTS

Full Disclosure

CDTS is a Shure dealer and a Countryman dealer

All of the pictures used here are marketing materials that I have access to as a dealer.

Philosophically speaking...

Wireless Microphones, Bane or Boon?

Philosophically speaking...

Wireless Microphones, Bane or Boon?

Of course, the answer is: “Yes”

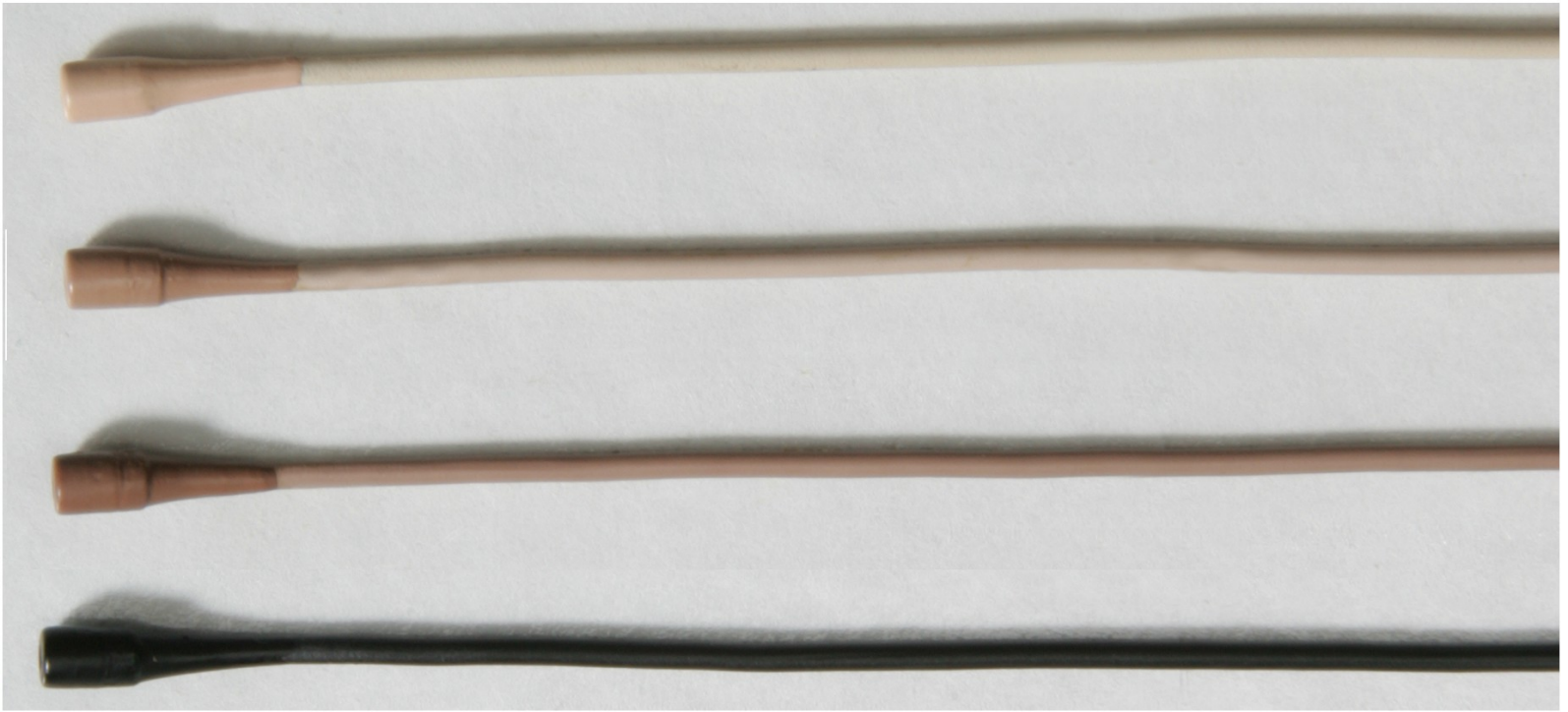
Transmitter

Receiver Front

Receiver Front Close-up

Receiver Rear

Capsules



Radio Basics

Wireless means radio.

Radio Basics

Wireless means radio.

Radio means many things:

- FCC regulation

Radio Basics

Wireless means radio.

Radio means many things:

- FCC regulation
- Interference

Radio Basics

Wireless means radio.

Radio means many things:

- FCC regulation
- Interference
- Something we can not see, which makes this hard

Radio Basics

Wireless means radio.

Radio means many things:

- FCC regulation
- Interference
- Something we can not see, which makes this hard
- Something that conforms to rules that involve differential equations, which makes this harder

Radio Basics

Wireless means radio.

Radio means many things:

- FCC regulation
- Interference
- Something we can not see, which makes this hard
- Something that conforms to rules that involve differential equations, which makes this harder
  - No, we won't try and cover the DiffEq

Spectrum and Bandwidth

The “spectrum” is the range of radio frequencies we can use.

Spectrum and Bandwidth

The “spectrum” is the range of radio frequencies we can use.

“Bandwidth” is how much information we need to stuff through in a given amount of time

Spectrum and Bandwidth

The “spectrum” is the range of radio frequencies we can use.

“Bandwidth” is how much information we need to stuff through in a given amount of time

“Bandwidth” is also how much information a particular channel can carry in a given amount of time

The FCC

- Wireless microphones are unlicensed users of radio spectrum
- That means as long as we play by the rules, we're legal
- That also means they don't know we really exist

FCC Regulations, Act I

- 700MHz Band Auction
  - Old news, but we can't use 698-806MHz any more
  - Fines can be $10,000 per instance, but public safety interference is a felony

FCC Regulations, Act I

- 700MHz Band Auction
  - Old news, but we can't use 698-806MHz any more
  - Fines can be $10,000 per instance, but public safety interference is a felony
- 600 MHz Band Auction
  - Wait... what?
  - Scheduled for mid-2015

FCC Regulations, Act II

- White space devices
  - New devices that are required to check if the spectrum is available before use, and change channel if necessary
  - Only check when they start up
  - Allowed to be far more powerful than wireless microphones
  - Might be in a patron's pocket.

FCC Regulations, Act III

- “Safe Haven” channels
  - 2 TV channels (6 MHz each) in each market that are reserved for wireless microphone use
  - Defined as the first unoccupied channels above and below channel 37. Obviously, this depends a lot on where you are.
- Below channel 21
  - Whitespace devices are not allowed
  - No solid guarantee, but it looks good

FCC Regulations, Act IV

- What if that isn't enough?
  - Register an additional TV channel
    - Both “Safe Havens” must be fully used already
    - The channel being requested must contain at least 12 wireless channels
      - As far as I know, Shure ULX-D is the only current product to meet this requirement, can get to 14.
      - Most other manufacturers can get to 10/channel

Adding it up

- At 12 microphones/TV channel, less bandwidth available per microphone
- Bandwidth of the human voice isn't going down
- Less spectrum available every time we turn around, either sold off or used up by our patrons' gadgets

What can we do?

- 2.4 GHz band
  - Only 14 channels
  - Smart phones
  - Very range limited and easily blocked by obstacles

What can we do?

- 2.4 GHz band
  - Only 14 channels
  - Smart phones
  - Very range limited and easily blocked by obstacles
- Budget to replace
  - We just replaced it all a couple years ago, but we have to do it again.

What can we do?

- 2.4 GHz band
  - Only 14 channels
  - Smart phones
  - Very range limited and easily blocked by obstacles
- Budget to replace
  - We just replaced it all a couple years ago, but we have to do it again.
- Lobby Congress

Price

- 1980s: $4000/ch
- 1990s: $1500/ch
- Today: $450/ch

Price

- 1980s: $4000/ch
- 1990s: $1500/ch
- Today: $450/ch

  EXCEPT, those don't meet the new FCC rules.
- ULX-D: $1600-2000/ch

Troubleshooting

- Gain structure
- Capsules
- Antennas
- Spectrum
- Hardware

Gain Structure

- Gain early
  - Gain your signal, not the noise you pick up along the way

Gain Structure

- Gain early
  - Gain your signal, not the noise you pick up along the way
- If it sounds awful, you're probably overdriving the compander in the transmitter

Gain Structure

- Gain early
  - Gain your signal, not the noise you pick up along the way
- If it sounds awful, you're probably overdriving the compander in the transmitter
- Use the pack trim

Gain Structure

- Gain early
  - Gain your signal, not the noise you pick up along the way
- If it sounds awful, you're probably overdriving the compander in the transmitter
- Use the pack trim
- It is NOT overloading the capsule
  - The least-capable capsules I've seen will start clipping at 120dB SPL. If it is that loud on your stage, something is wrong. Your actors can not produce that themselves.

Capsules

- 2 major categories of capsule problems
  - Makeup and sweat
    - If you are using a capsule with a protective cap, this may sound like the performer is merely muffled. The holes in the cap are getting clogged.
      - Take the cap off and drop it in an ultrasonic jewelry cleaner

Capsules

- 2 major categories of capsule problems
  - Makeup and sweat
    - If you are using a capsule with a protective cap, this may sound like the performer is merely muffled. The holes in the cap are getting clogged.
      - Take the cap off and drop it in an ultrasonic jewelry cleaner
    - Capsules without caps are more likely to go directly from fine to extremely muffled with no in-between
      - Sorry, these can't really be cleaned

Capsules

- 3 major categories of capsule problems
  - Makeup and sweat
  - Wire or connector
    - These take the form of pops and crackles, particularly when the actor is moving.
    - Try to reproduce the failure by wiggling connectors and wires
    - Swap capsules and keep trying: is it the capsule of the connector on the pack?
    - Connectors can probably be replaced, but if the wire is bad, throw it out.

Antennas

- Diversity
  - Radio waves are polarized, much like light reflecting off water
  - Think of it as a doughnut with the transmitter antenna straight through the hole

Antennas

- Diversity
  - Radio waves are polarized, much like light reflecting off water
  - Think of it as a doughnut with the transmitter antenna straight through the hole
  - When the receiver swaps from one antenna to the other, that's a “diversity switch”
    - On good receivers this is silent.
  - When neither antenna gets good signal, inexpensive receivers will often give loud bursts of noise

Antennas

- Diversity
  - Radio waves are polarized, much like light reflecting off water
  - Think of it as a doughnut with the transmitter antenna straight through the hole
  - When the receiver swaps from one antenna to the other, that's a “diversity switch”
    - On good receivers this is silent.

Antennas

- Transmitter
  - Breakage
    - Symptom: bad reception
    - Replace it

Antennas

- Transmitter
  - Breakage
    - Symptom: bad reception
    - Replace it
  - Stowing the length
    - Symptom: bad reception
    - Actors don't seem to like having a tail on the pack to deal with, so they coil it up
    - Antennas rely on their length, a coil counts only as the circumference of the coil

Antennas

- Receiver
  - Cheap
    - Standard ¼ wave antennas with have 3db less output than ½ wave
    - Active antennas have an amplifier built-in and are directional to help reject outside interference
  - Touching
  - Diversity orientation
  - Overload

Antennas

- Receiver
  - Cheap
  - Touching
    - Adjacent antennas touching changes the tuning away from the frequency you want
  - Diversity orientation
  - Overload

Antennas

- Receiver
  - Cheap
  - Touching
  - Diversity orientation
    - The point of diversity is to pick up signals that are traveling in different directions
    - Point the antennas 90 degrees apart from each other
  - Overload

Antennas

- Receiver
  - Cheap
  - Touching
  - Diversity orientation
  - Overload
    - In very high RF environments, it is possible to saturate the “RF front-end” (a.k.a. the receiver's radio) and possibly even the antenna itself
    - Lucky? Everything just stops working
    - Directional antennas might help, or need to change to a different band. (Not channel, BAND)

Spectrum

- Interference
  - Might be so blatant as picking up another mic
  - New digital whitespace products are unlikely to make recognizable noise

Spectrum

- Interference
- Intermodulation
  - Really is a special form of interference
  - Math: for mics A and B, 2A+B, 2A-B, 2B+A, 2B-A
  - I won't even show you 3 mics, let alone more, I promised we wouldn't get into the advanced math
  - Takes the form of the effected mics disappearing, generally with a pop.

Spectrum

- Interference
- Intermodulation
- Use vendor tools for frequency coordination
  - For example, Wireless Workbench from Shure
  - The vendors know their own products, what bands and channels they use, and how much spectrum each one needs
  - The tools also use the FCC database to know about TV stations and transmitters in your area

Spectrum

- Interference
- Intermodulation
- Use vendor tools for frequency coordination
- Even better, use a wide-band radio in conjunction with the vendor tools
  - The FCC database that the tools use only includes transmitters of above a certain power level
  - A radio will “see” other, unexpected transmitters such as whitespace devices
  - Modern wireless receivers can act as radios for this purpose

Hardware

- Keep gear clean and dry
- Don't store batteries in the packs
- Have a maintenance and repair budget

Hardware

- Keep gear clean and dry
- Don't store batteries in the packs
- Have a maintenance and repair budget
  - It's going to cost between $75 and $150 to get a transmitter serviced
  - If one transmitter keeps giving the same problems, with different batteries, different capsule, and on a different frequency...

Feedback

- The absolute classic “there's a microphone” problem
- Occurs when an audio loop is formed of microphone → speaker → microphone
- More technically, when a microphone picks up more reinforced sound than direct sound
- The limit is often referred to as “gain before feedback”

Feedback

- The solution is to reduce gain
  - But we still can't hear that singer, we need to turn it up!

Feedback

- The solution is to reduce gain
  - But we still can't hear that singer, we need to turn it up!
    - Is the capsule gunked up?

Feedback

- The solution is to reduce gain
  - But we still can't hear that singer, we need to turn it up!
    - Is the capsule gunked up?
    - Move the capsule closer to the mouth

Feedback

- The solution is to reduce gain
  - But we still can't hear that singer, we need to turn it up!
    - Is the capsule gunked up?
    - Move the capsule closer to the mouth
    - Replace with a better capsule

Feedback

- The solution is to reduce gain
  - But we still can't hear that singer, we need to turn it up!
    - Is the capsule gunked up?
    - Move the capsule closer to the mouth
    - Replace with a better capsule
    - “Feedback exterminator” will get as much as an additional 6db, but more likely 3

Feedback

- The solution is to reduce gain
  - But we still can't hear that singer, we need to turn it up!
    - Is the capsule gunked up?
    - Move the capsule closer to the mouth
    - Replace with a better capsule
    - “Feedback exterminator” will get as much as an additional 6db, but more likely 3
    - Turn down everything else

Feedback

- The solution is to reduce gain
  - But we still can't hear that singer, we need to turn it up!
    - Is the capsule gunked up?
    - Move the capsule closer to the mouth
    - Replace with a better capsule
    - “Feedback exterminator” will get as much as an additional 6db, but more likely 3
    - Turn down everything else
    - **Project!**

Wireless Microphones

Bane, or Boon?

Presenter: Joel Lord
CDTS
jpl@cdtsound.com