

Getting The Most Out Of Your Wireless Mics

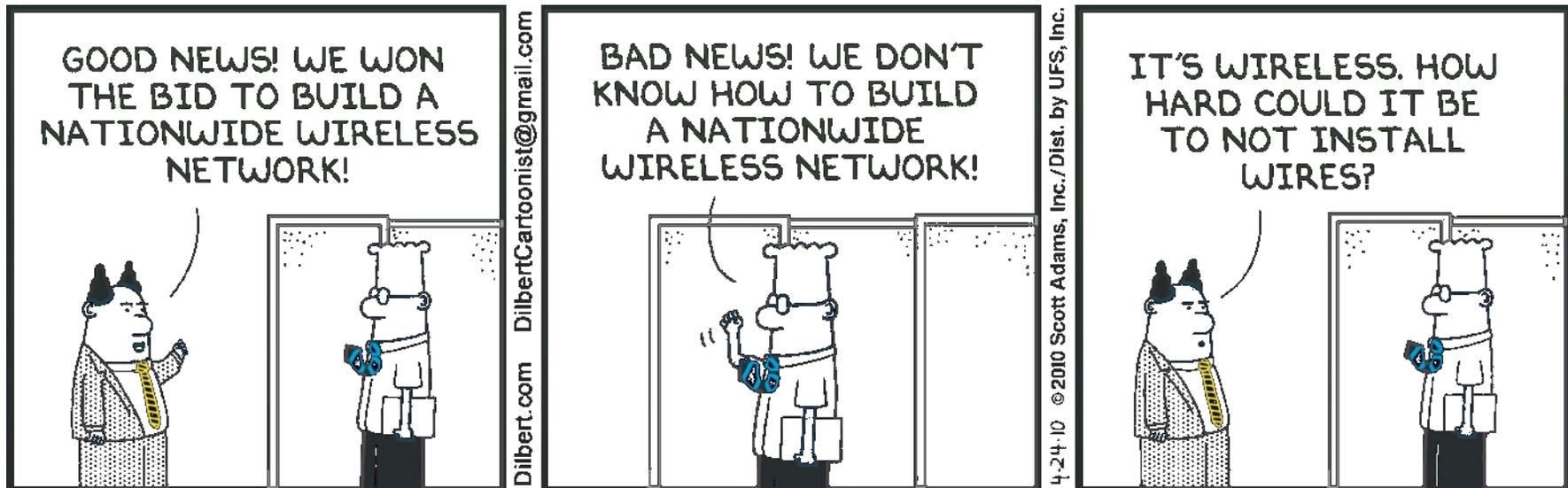
Best Practices: Antennas, RF Coordination & Hardware



Dave Mendez –Senior Market Development Specialist

SHURE[®]
LEGENDARY
PERFORMANCE™

The Wisdom of Dilbert...



SHURE

LEGENDARY
PERFORMANCE™

Antennas: Getting the range you need

SHURE[®]
LEGENDARY
PERFORMANCE™

Shure UHF Wireless

What Is The Range?

- **Let's define "Range"**
 - Distance between the receiver and where the first drop-out occurs

The range of most PRO UHF systems is approx. 500 ft. under ideal conditions

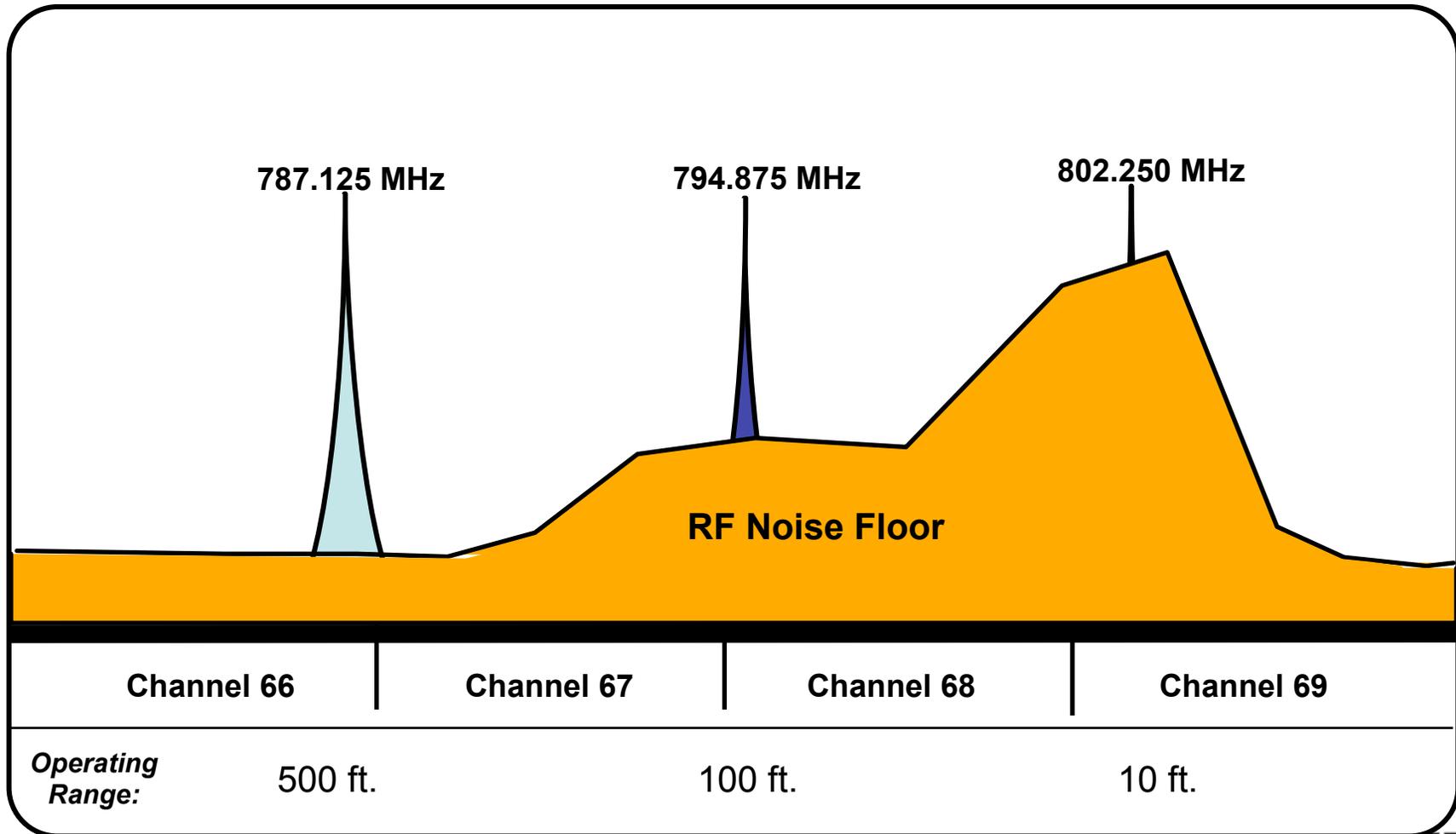
- Minus:
 - 95% (outdoor) if the selected frequency overlaps with a TV channel
 - 65% (indoor) if the selected frequency overlaps with a TV channel
 - 50% if the frequencies are not compatible (multiple systems)
 - 50% if the antennas are not properly setup
 - 50% if used inside of a building
 - 40% if the receive antennas are very close to other electronic equipment

SHURE®

LEGENDARY
PERFORMANCE™

UHF Wireless Systems

What Is The Range?

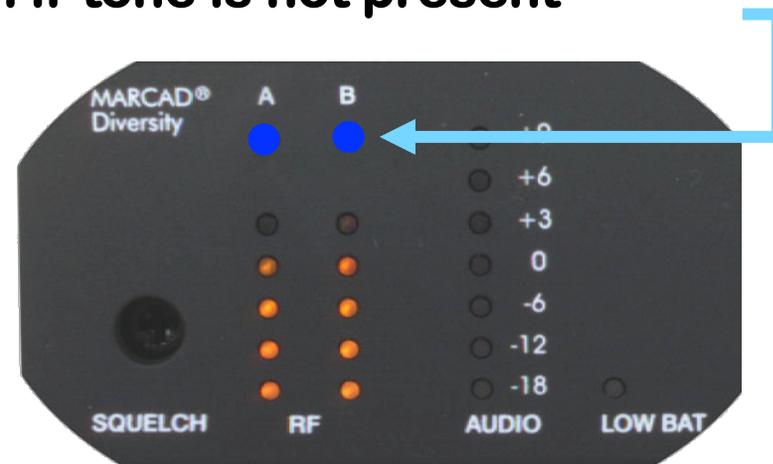


SHURE

LEGENDARY
PERFORMANCE™

Squelch Circuits

- **AMPLITUDE SQUELCH**
 - based on RF signal strength
- **NOISE SENSITIVE SQUELCH**
 - based on audio signal quality, looks for high frequency noise characteristic of RF signal
- **TONE KEY SQUELCH**
 - a super-audible tone is sent with carrier, receiver gate will not open if tone is not present
- **INCREASE SQUELCH**
 - May improve system stability and quality of sound
 - Decreases range
- **DECREASE SQUELCH**
 - May improve range & reduce dropouts
 - Increases noise in system



SHURE

LEGENDARY
PERFORMANCE™

Antenna Types

- Omnidirectional

- $\frac{1}{2}$ wave or $\frac{1}{4}$ wave dipole type
- Vertical polarization
- Uniform sensitivity in plane perpendicular to axis
- 2.14dBi gain (relative to theoretical isotropic antenna)



- Directional

- Log periodic or helical type
- Vertical or circular polarization
- Increased sensitivity on-axis
- Decreased sensitivity off-axis
- Up to 13dBi gain (up to 11dB relative to $\frac{1}{2}$ wave)

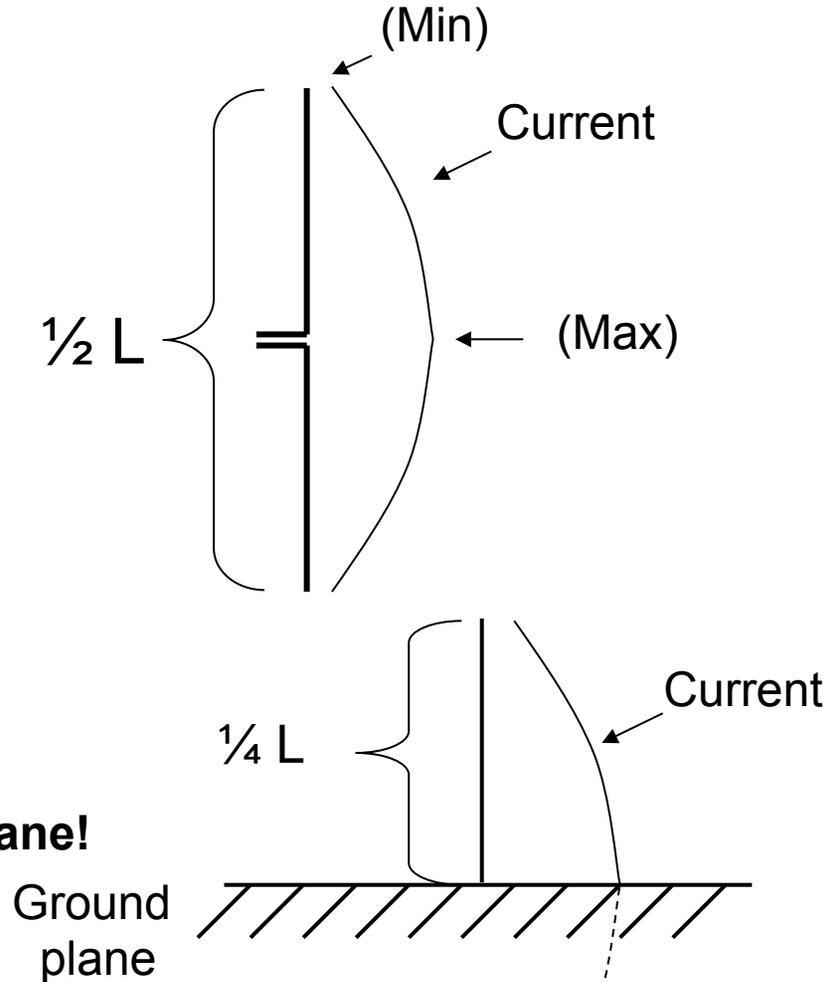


SHURE[®]

LEGENDARY
PERFORMANCE™

Omnidirectional Antennas

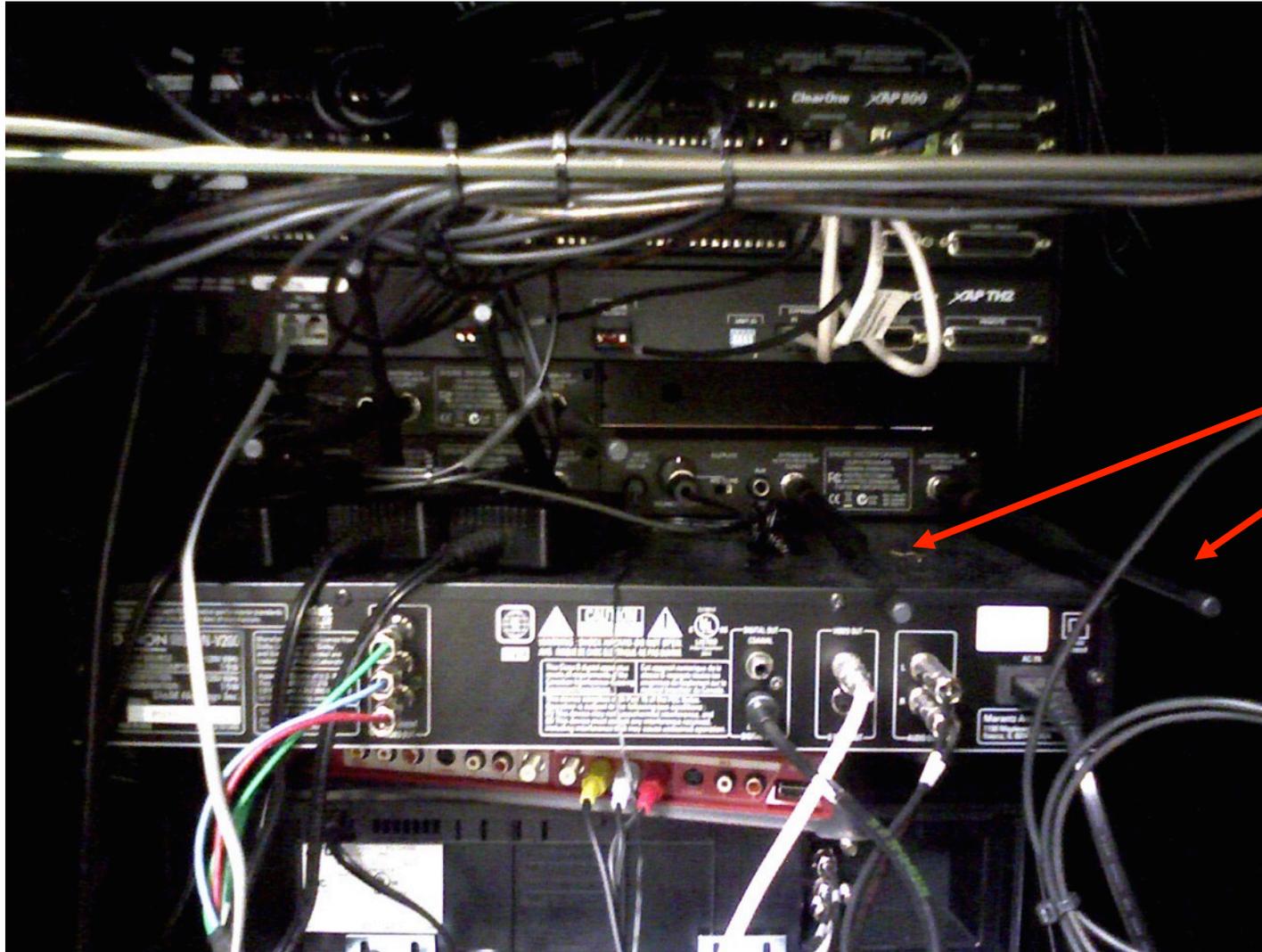
- Omnidirectional
 - 1/2 Wave (Dipole)
 - Whip, telescoping, or cable types
 - Wideband types available
 - **Independent of ground plane**
 - 1/4 Wave
 - Whip type
 - Narrow band
 - **Must be attached to a ground plane!**



SHURE[®]

LEGENDARY
PERFORMANCE™

Antenna Placement ?

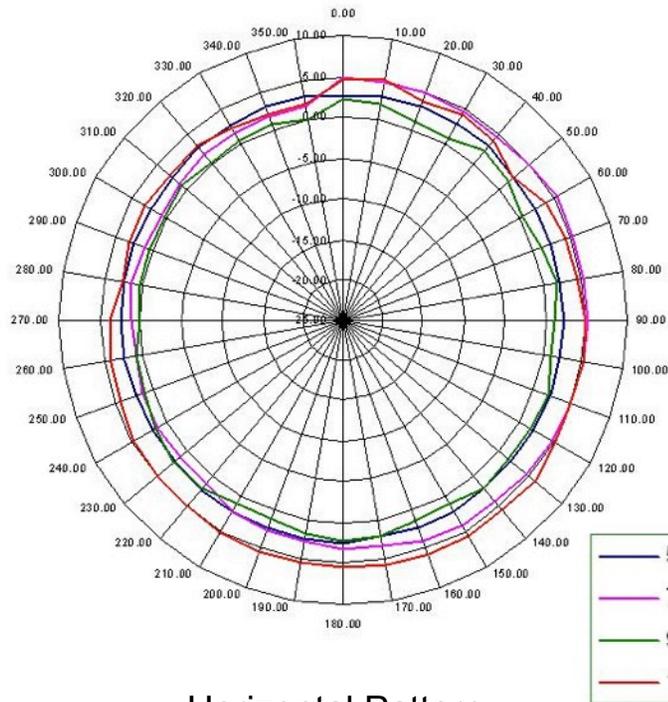
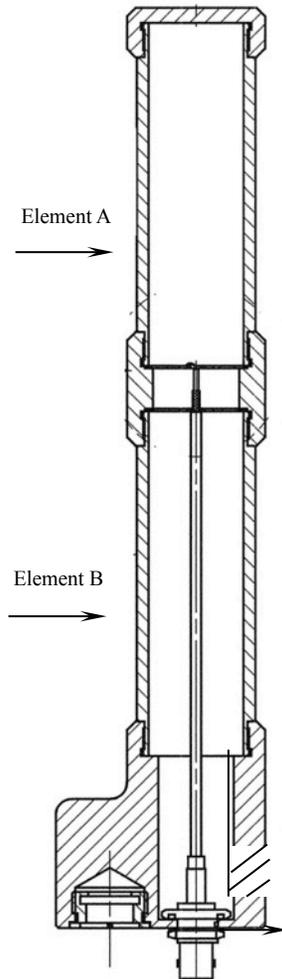


Antennas inside
steel enclosure

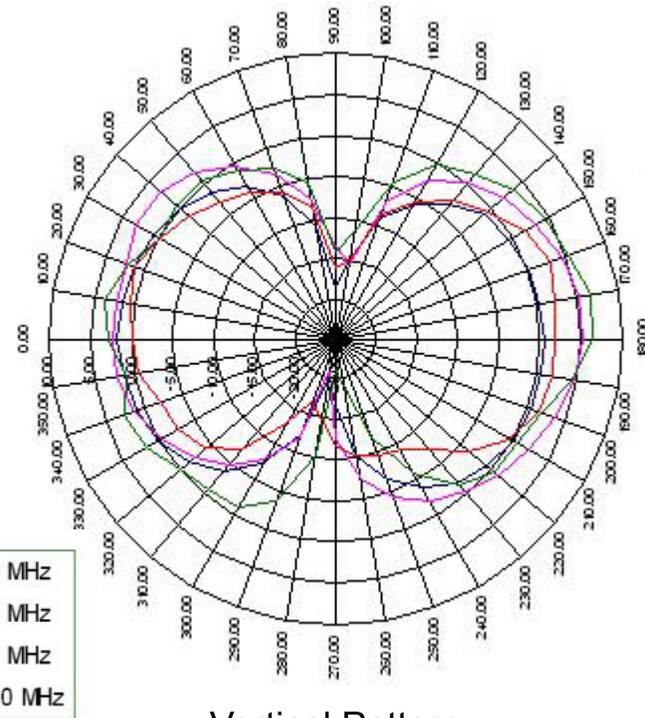
SHURE[®]

LEGENDARY
PERFORMANCE™

Wideband Omnidirectional Antenna



Horizontal Pattern
(viewed from above)



Vertical Pattern
(viewed from side)

SHURE[®]

LEGENDARY
PERFORMANCE™

Directional Antennas

- Directional
 - Log periodic (wide band)
 - Helical (wide band)
 - Good for increased range or pattern control



Log periodic (with amplifier)



Helical

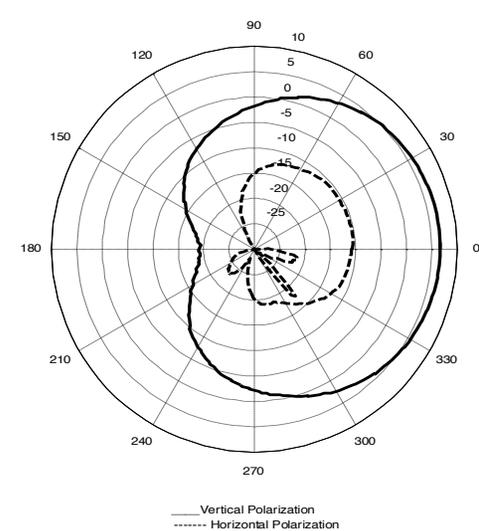
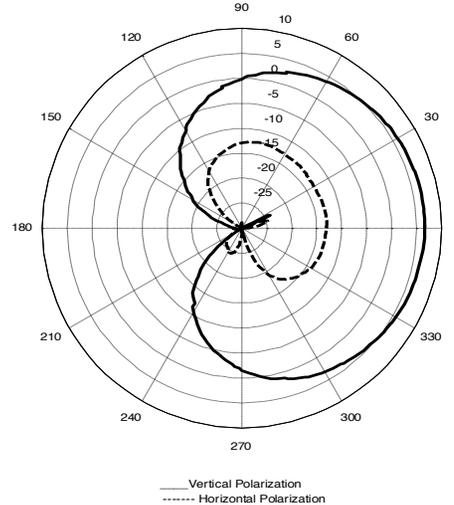
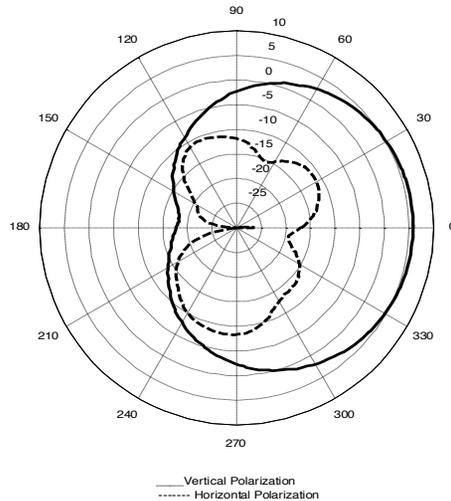
(courtesy of Professional Wireless Systems)

SHURE[®]

LEGENDARY
PERFORMANCE™

Log Periodic Antenna

- Near cardioid pattern
 - 470-870 MHz band
 - 120 deg. beamwidth
 - 5-7dBi forward gain
 - Vertical polarization



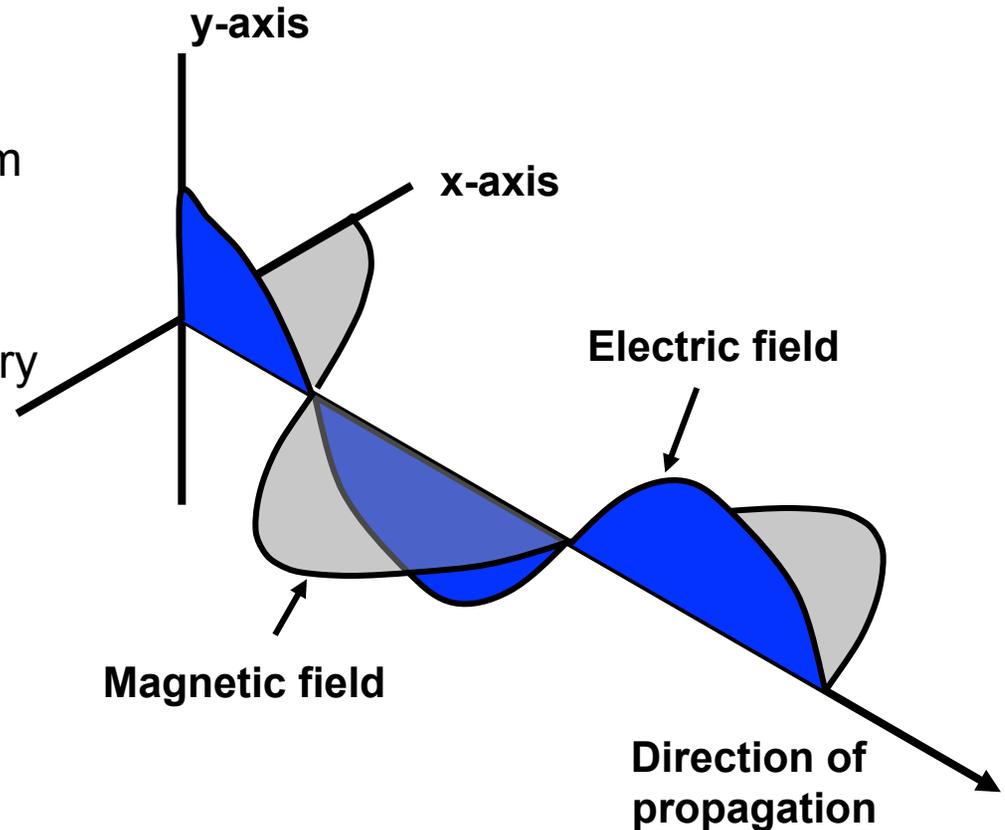
Log periodic pattern from above (antenna pointing right)

SHURE

LEGENDARY
PERFORMANCE™

Radio Frequency Transmission

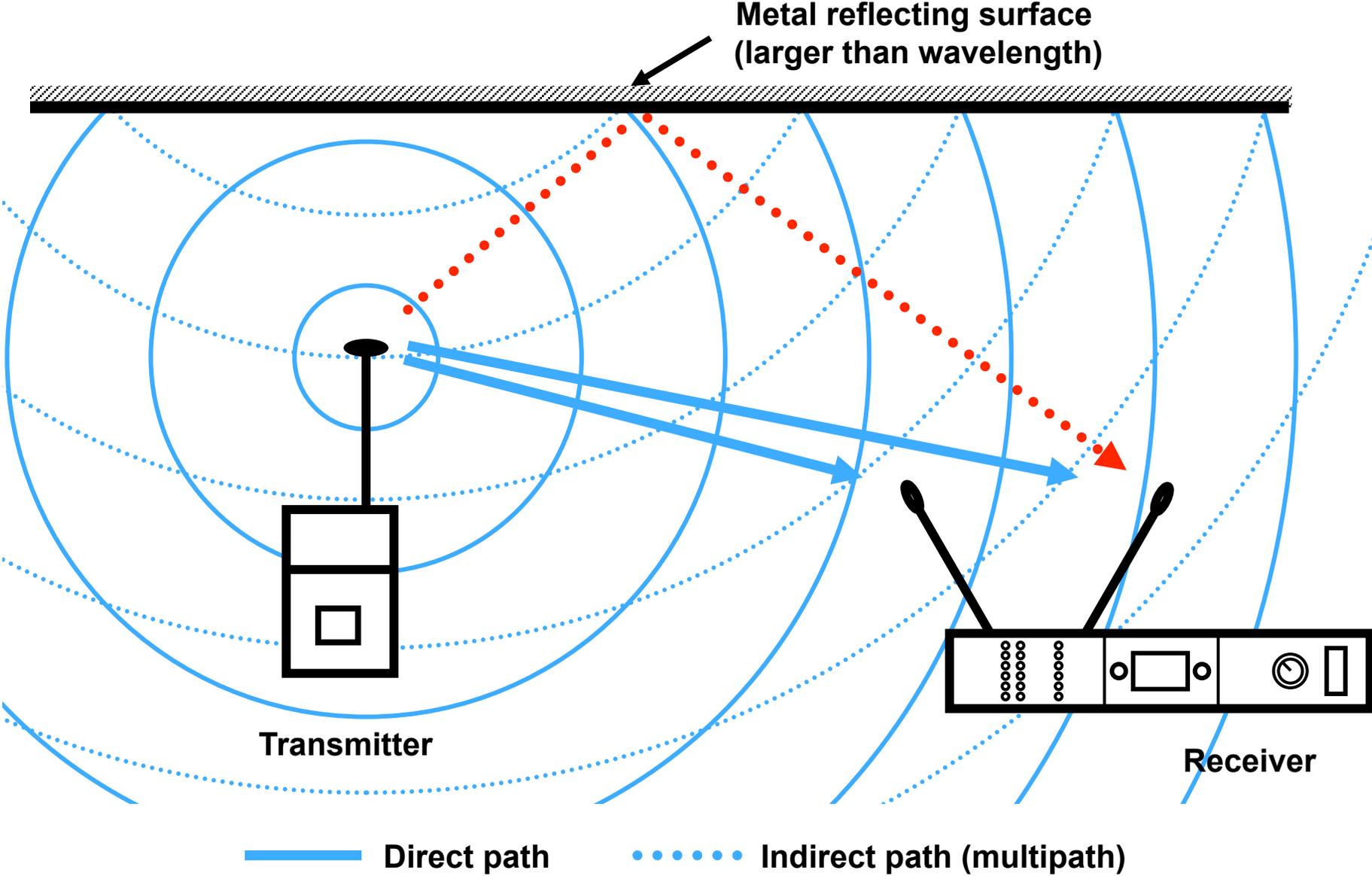
- Radio Waves:
 - Series of electro-magnetic field variations in space.
 - Travel a significant distance from their source.
- Radio Signals:
 - Radio waves “modulated” to carry information.
 - May be modulated in amplitude, frequency, and/or phase



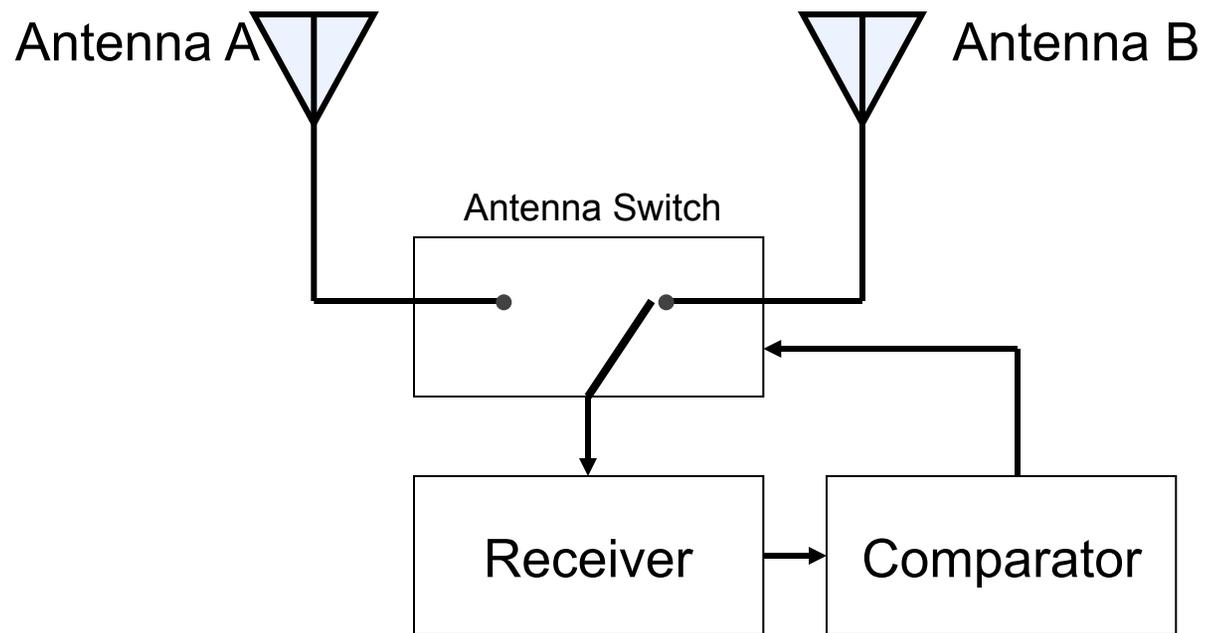
SHURE®

LEGENDARY
PERFORMANCE™

Multipath Interference



Diversity Systems 3

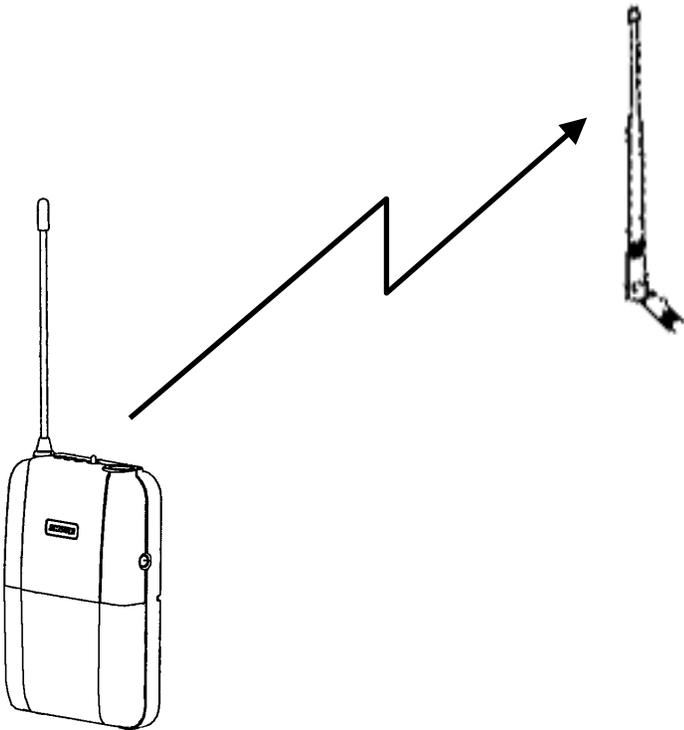


Antenna switching diversity

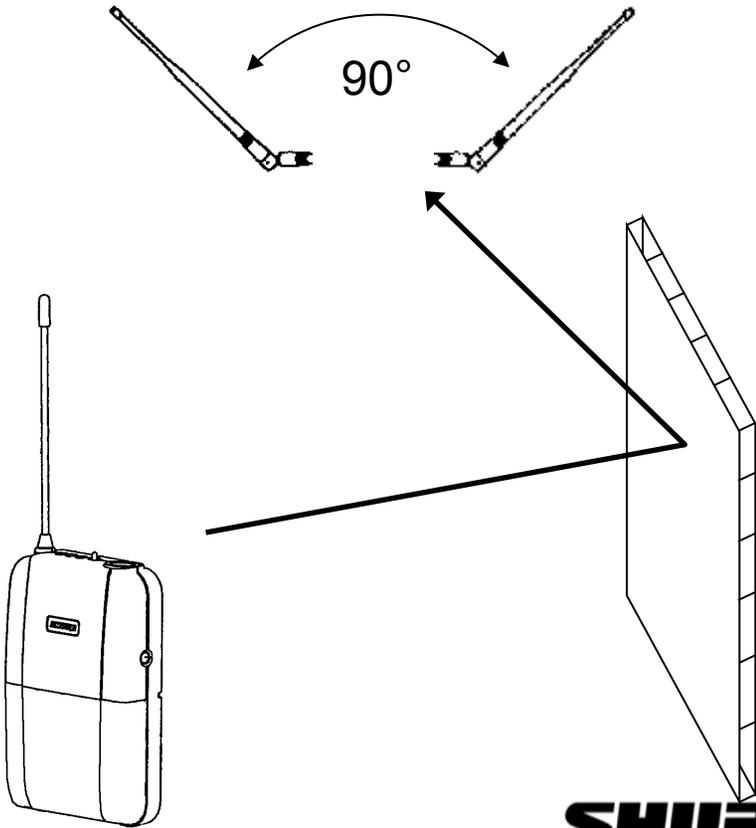
Antenna Placement

- Proper orientation

Non-diversity receiver: vertical



Diversity receiver: 90° apart

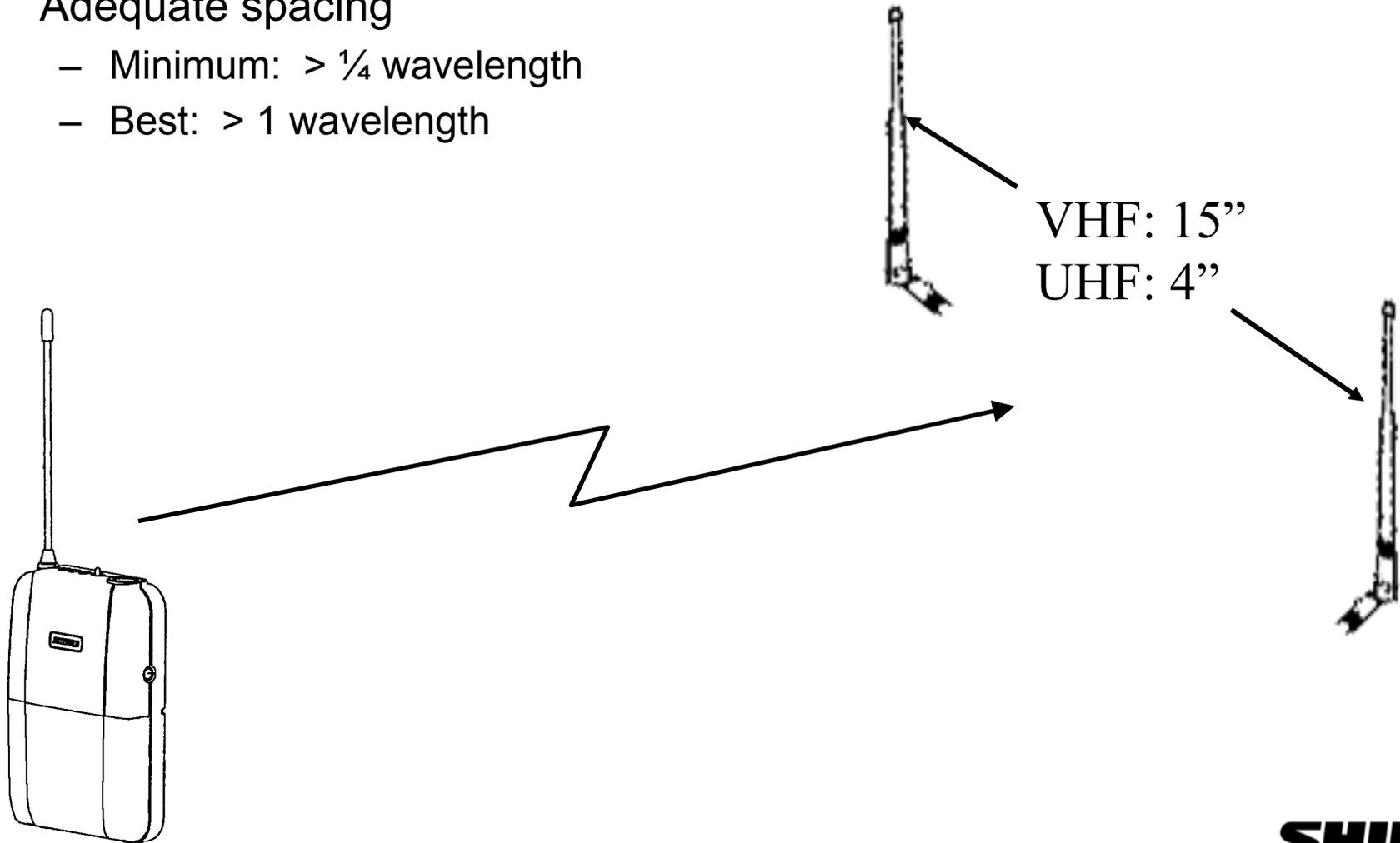


SHURE[®]

LEGENDARY PERFORMANCE™

Antenna Placement

- Adequate spacing
 - Minimum: $> \frac{1}{4}$ wavelength
 - Best: > 1 wavelength

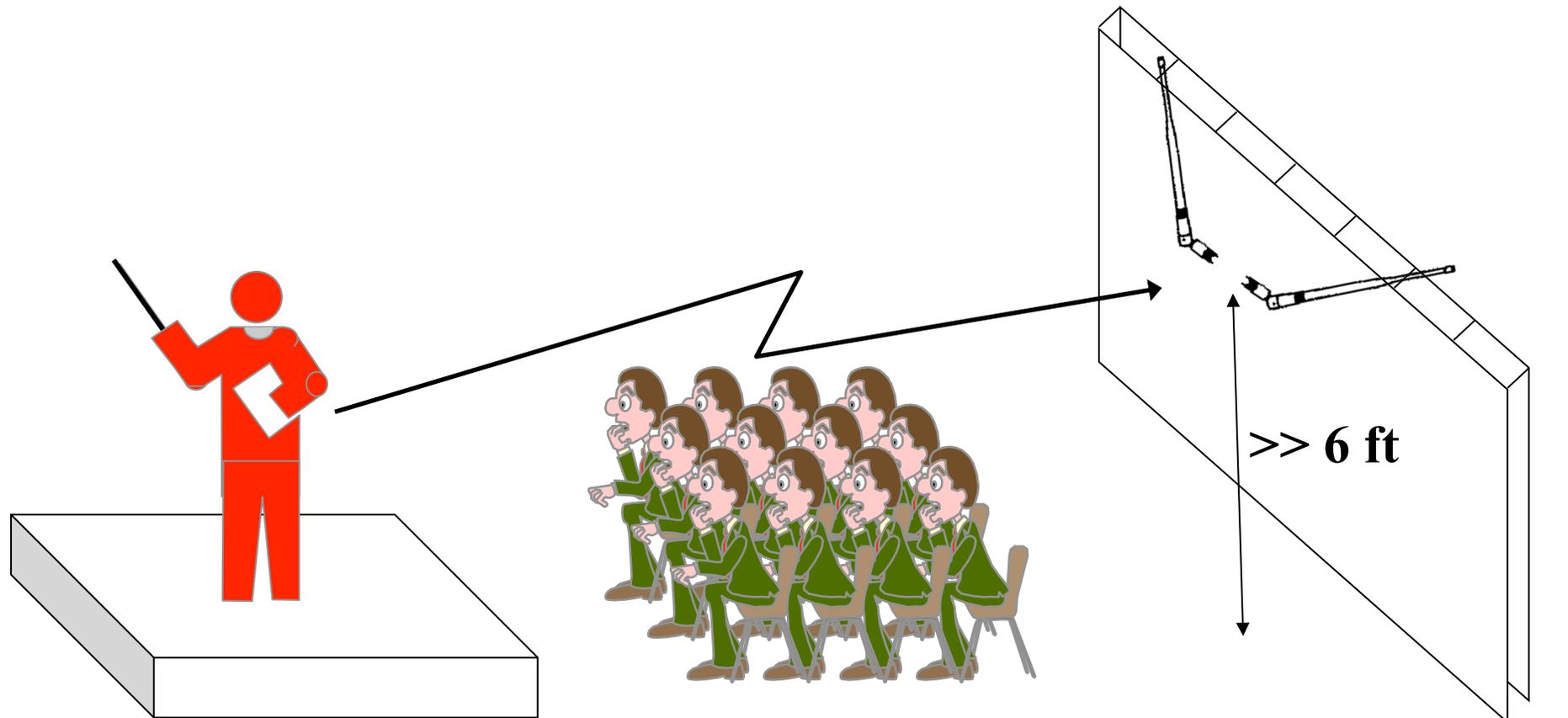


SHURE[®]

LEGENDARY
PERFORMANCE™

Antenna Placement

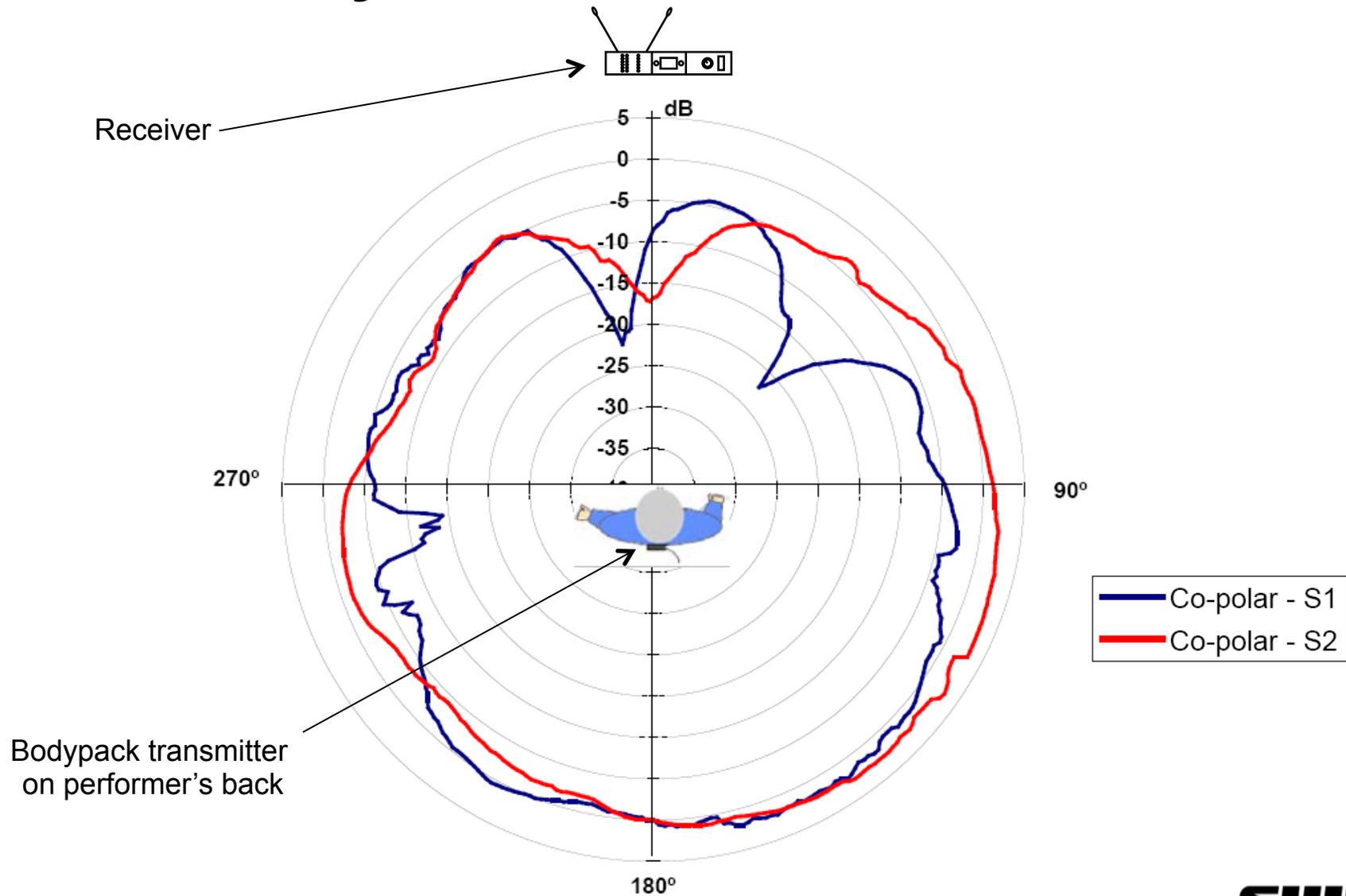
- Antenna height should be above audience or other obstructions
- Altitude is your friend!



SHURE[®]

LEGENDARY
PERFORMANCE™

Body Attenuation vs. Direction

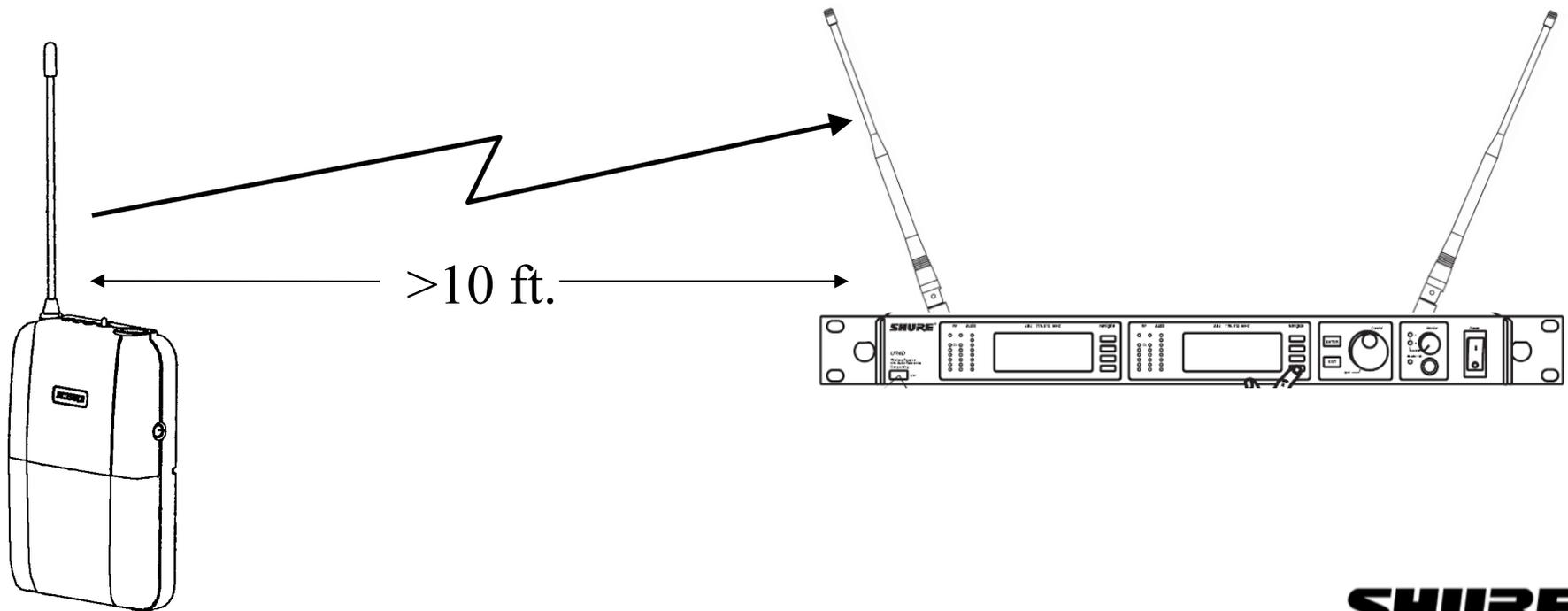


SHURE

LEGENDARY
PERFORMANCE™

Antenna Placement: Wireless Mic Transmit > Wireless Mic receive

- Minimum distance from transmit antenna to receive antenna should be at least 10 ft.

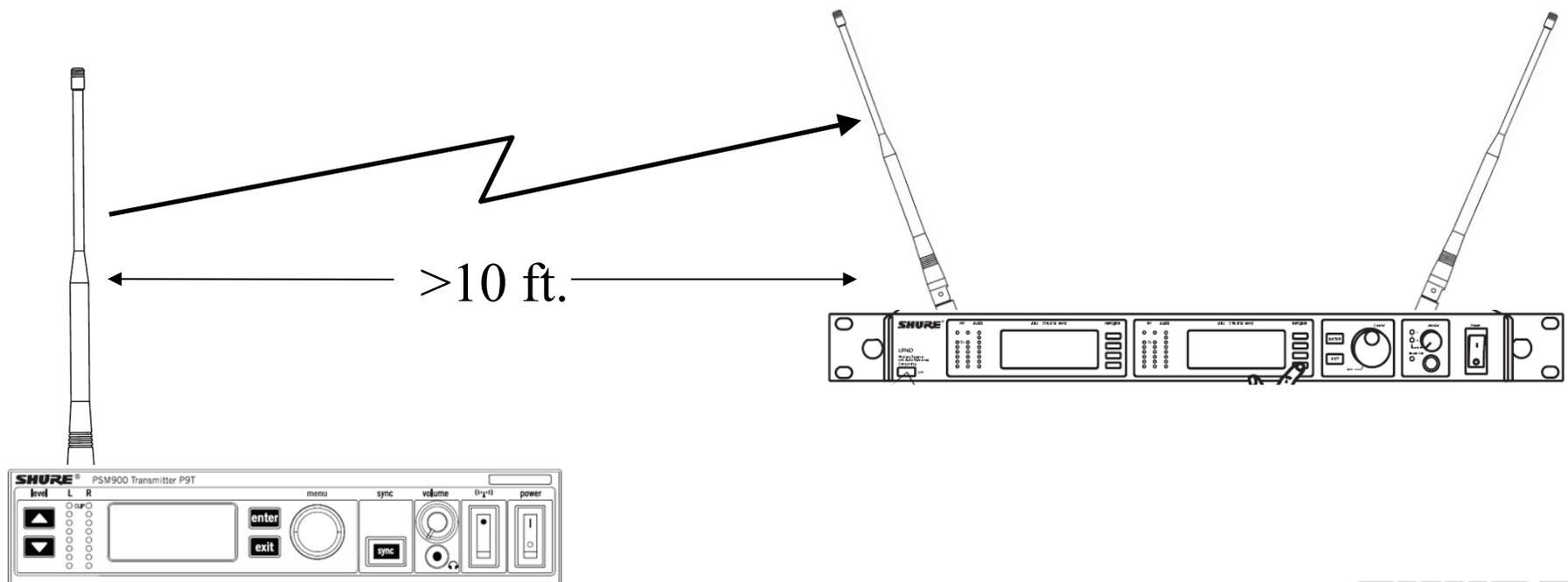


SHURE

LEGENDARY
PERFORMANCE™

Antenna Placement: In-ear Transmit > Wireless Mic Receive

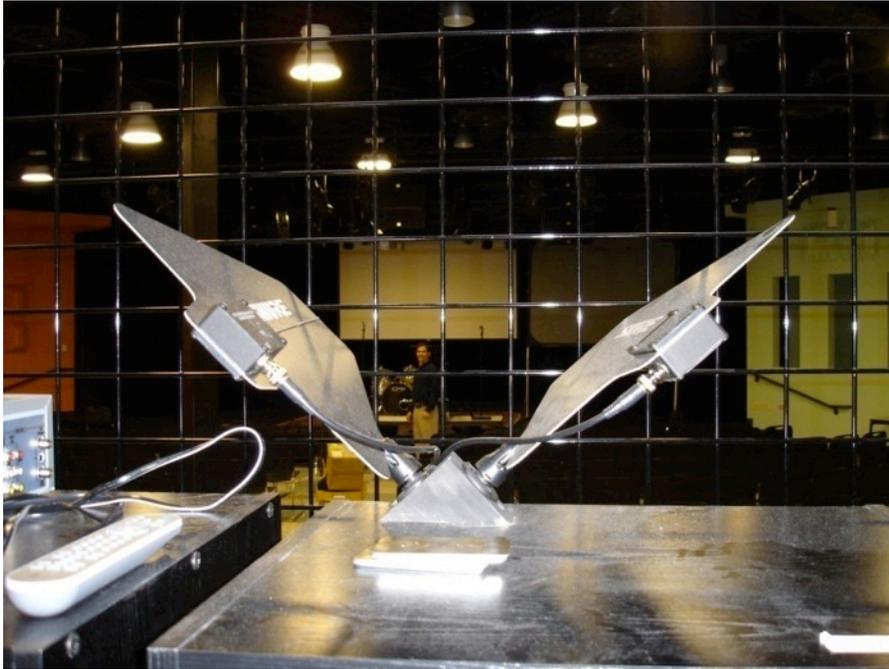
- Minimum distance: In-ear transmit > Wireless mic receive
 - At least 10 ft. with low-power, omni antennas
 - Farther with high-power and/or high-gain antennas
 - May be closer with parallel directional antennas



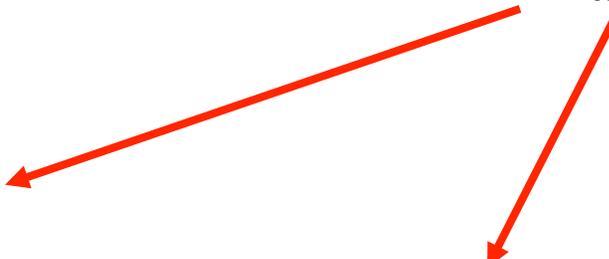
SHURE

LEGENDARY
PERFORMANCE™

Antenna Placement ?



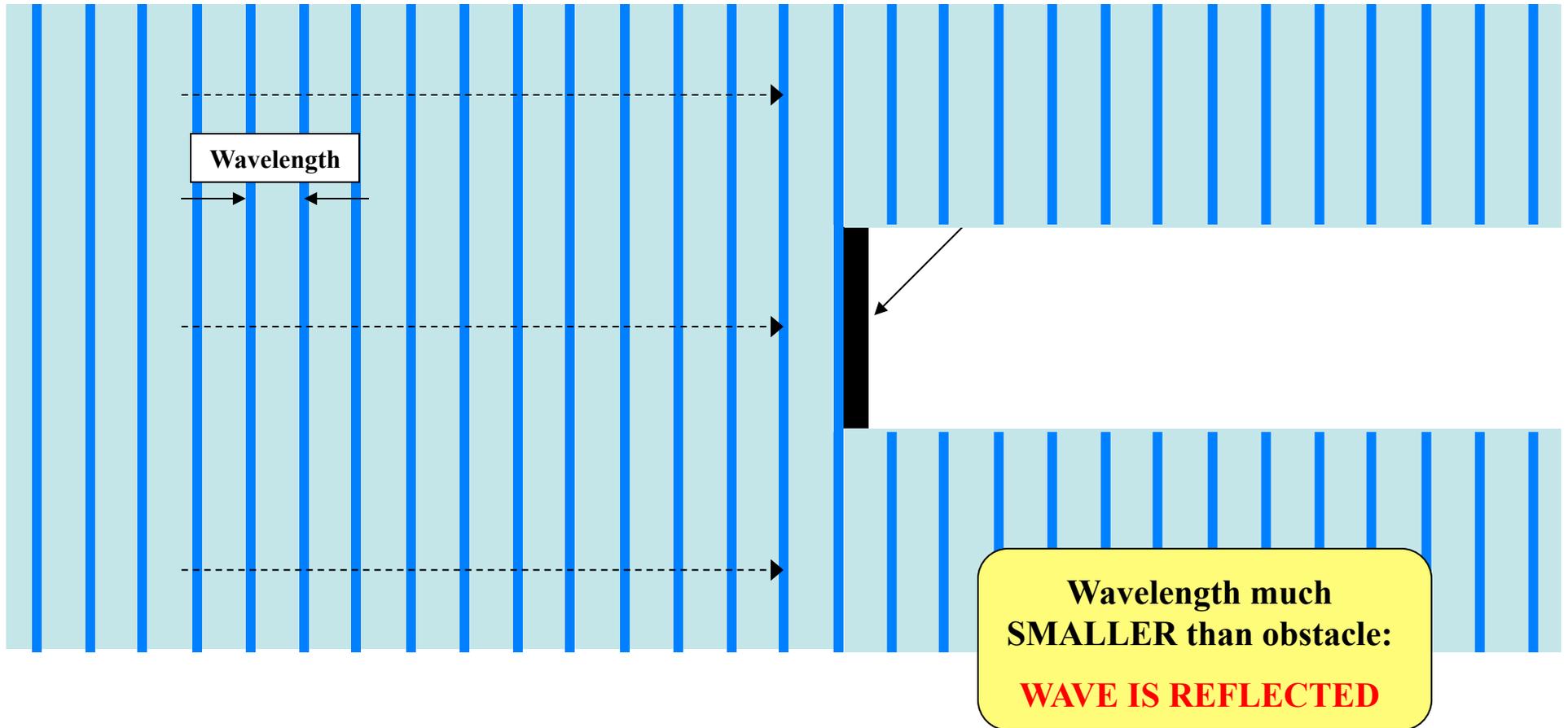
Antennas in metal cage



SHURE[®]

LEGENDARY
PERFORMANCE™

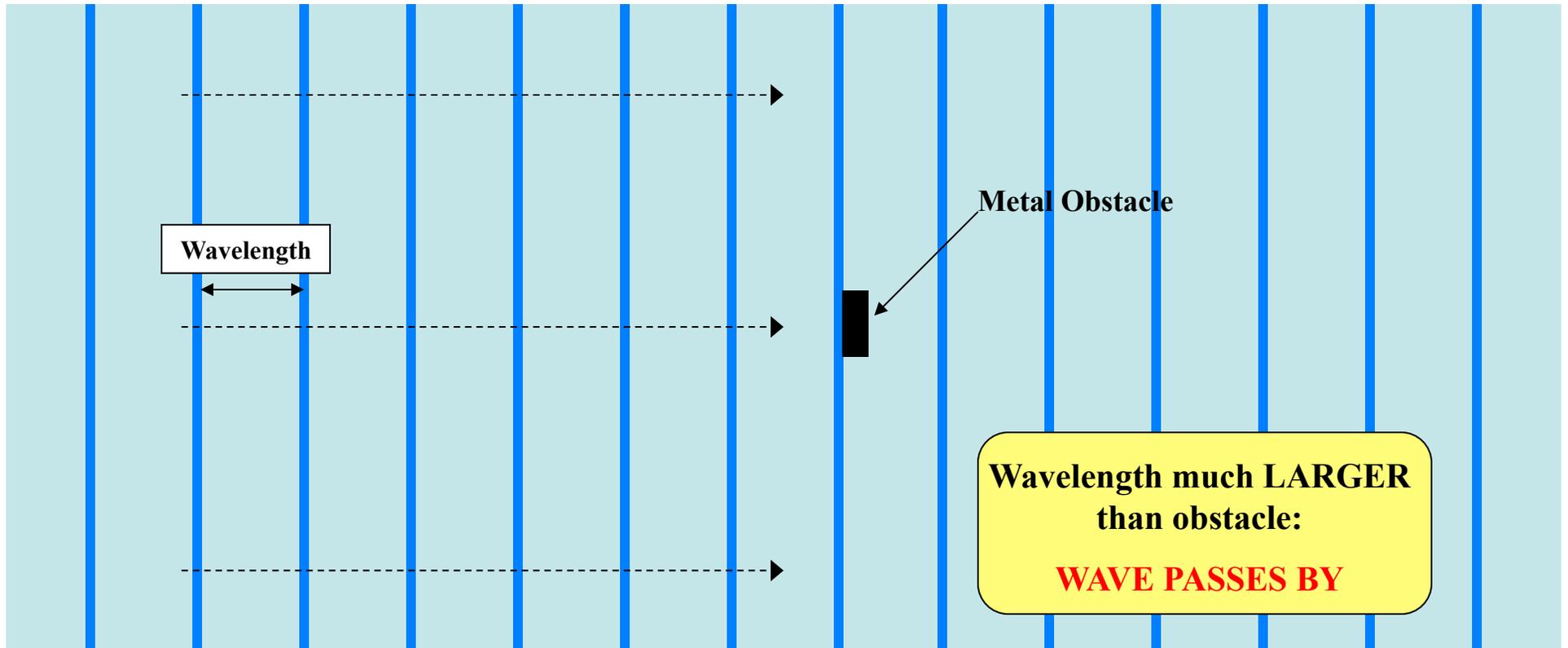
Propagation: Wavelength vs. Obstacle



SHURE®

LEGENDARY
PERFORMANCE™

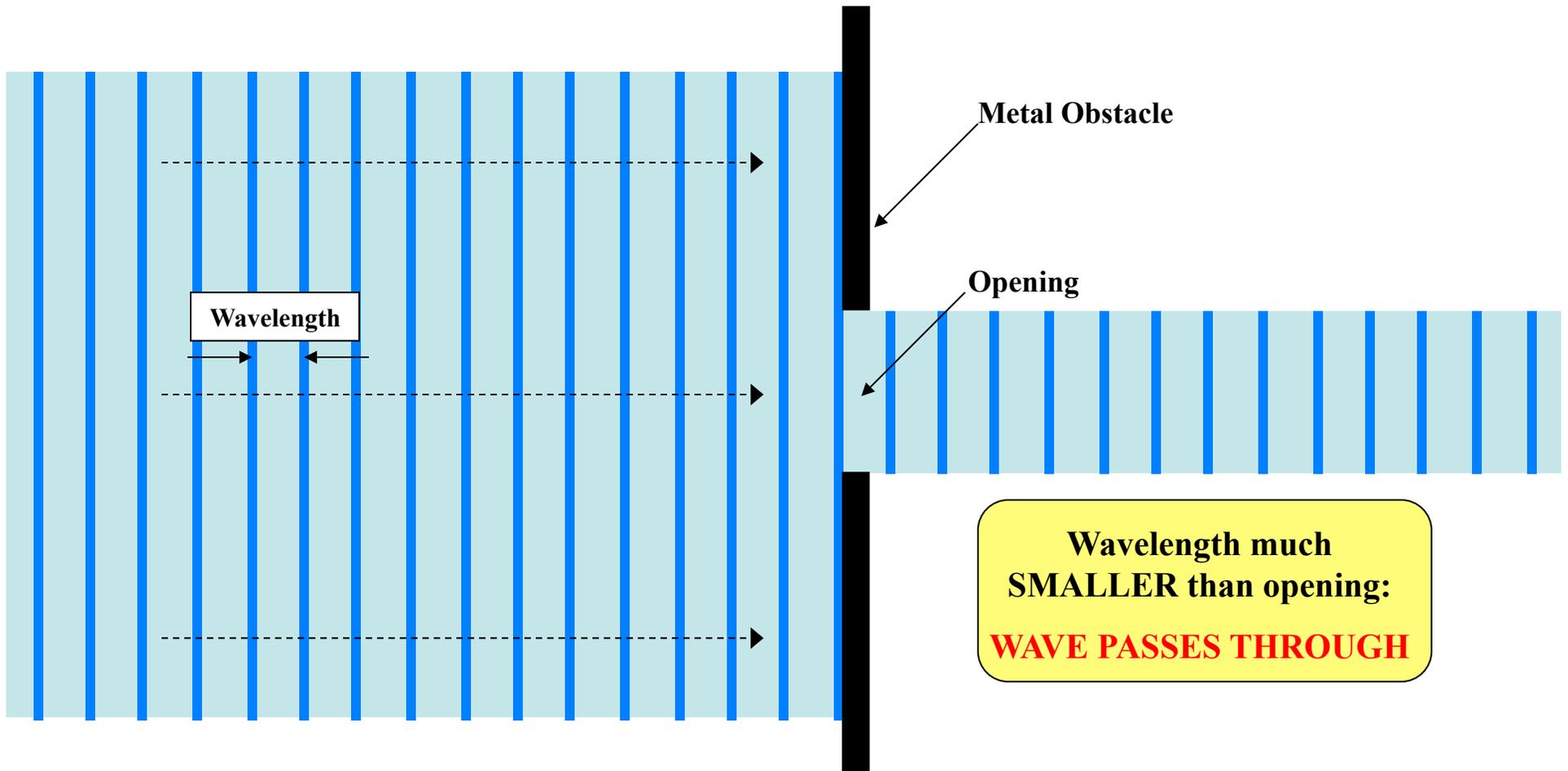
Propagation: Wavelength vs. Obstacle



SHURE®

LEGENDARY
PERFORMANCE™

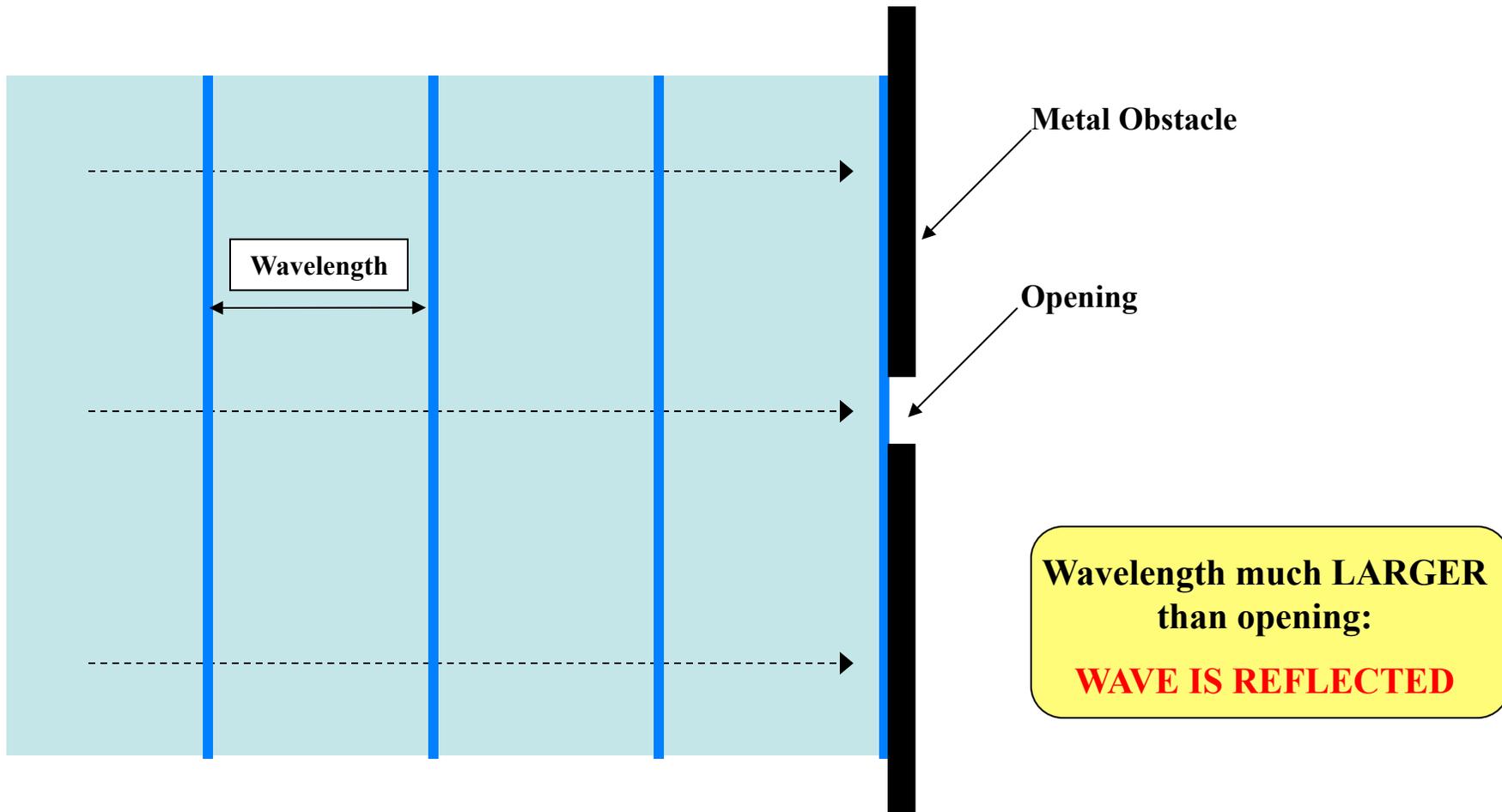
Propagation: Wavelength vs. Opening



SHURE®

LEGENDARY
PERFORMANCE™

Propagation: Wavelength vs. Opening

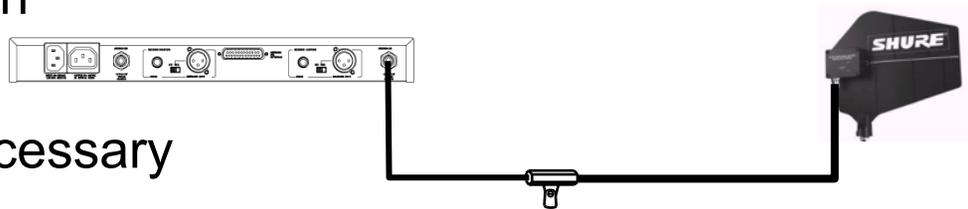


SHURE[®]

LEGENDARY
PERFORMANCE™

Remote Antenna Best Practices

- Use ½ wave omni or wideband directional antennas
- Position for best line-of-sight
- Maintain adequate diversity separation
- Net loss < 5dB
 - Use minimum cable length
 - Use lowest loss cable
 - Use amplifier(s) when necessary
- Net gain < 5dB
 - Use minimum gain
- **Separate wireless mic receive antennas from in-ear monitor and intercom transmit antennas!**



SHURE

LEGENDARY
PERFORMANCE™

Coaxial Cable Losses

- 50 Ω coaxial cable should be used (robust, consistent)
- Less recommended: RG59, RG6, RG11 (75 Ω)

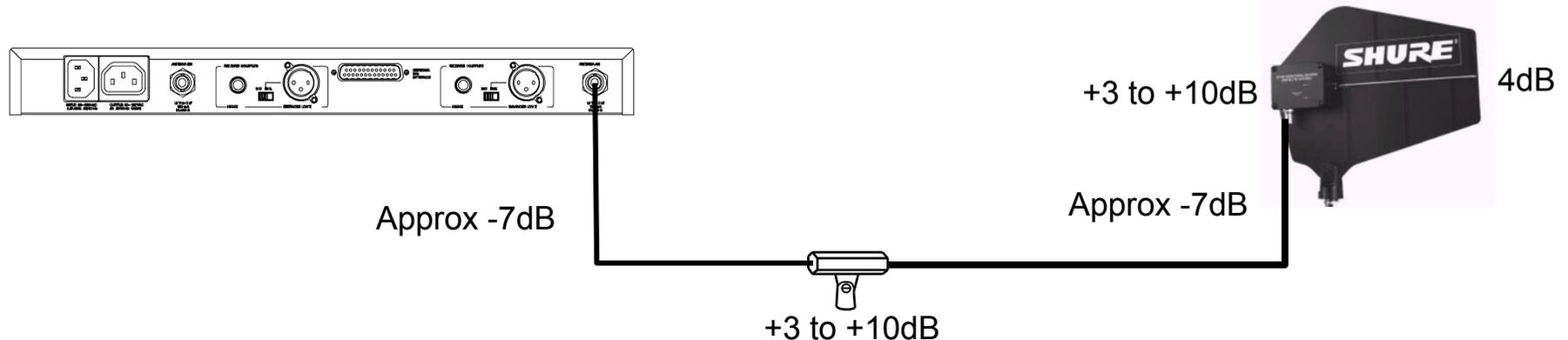
Typical Cable Loss for 50 Ohm Cable

Type Of Cable	Loss @ 200MHz (100 ft)	Loss @ 650MHz (100 ft)
RG58C/U SHURE PA725	9dB	19 dB
RG8X/U SHURE UA850	4.5dB	10.3 dB
RG213/U SHURE UA8100	2.7 dB	6.03 dB
RG8/U Belden 9913	1.8 dB	3.1 dB

SHURE[®]

LEGENDARY
PERFORMANCE™

Antenna System Configuration



- Antenna System Gain:

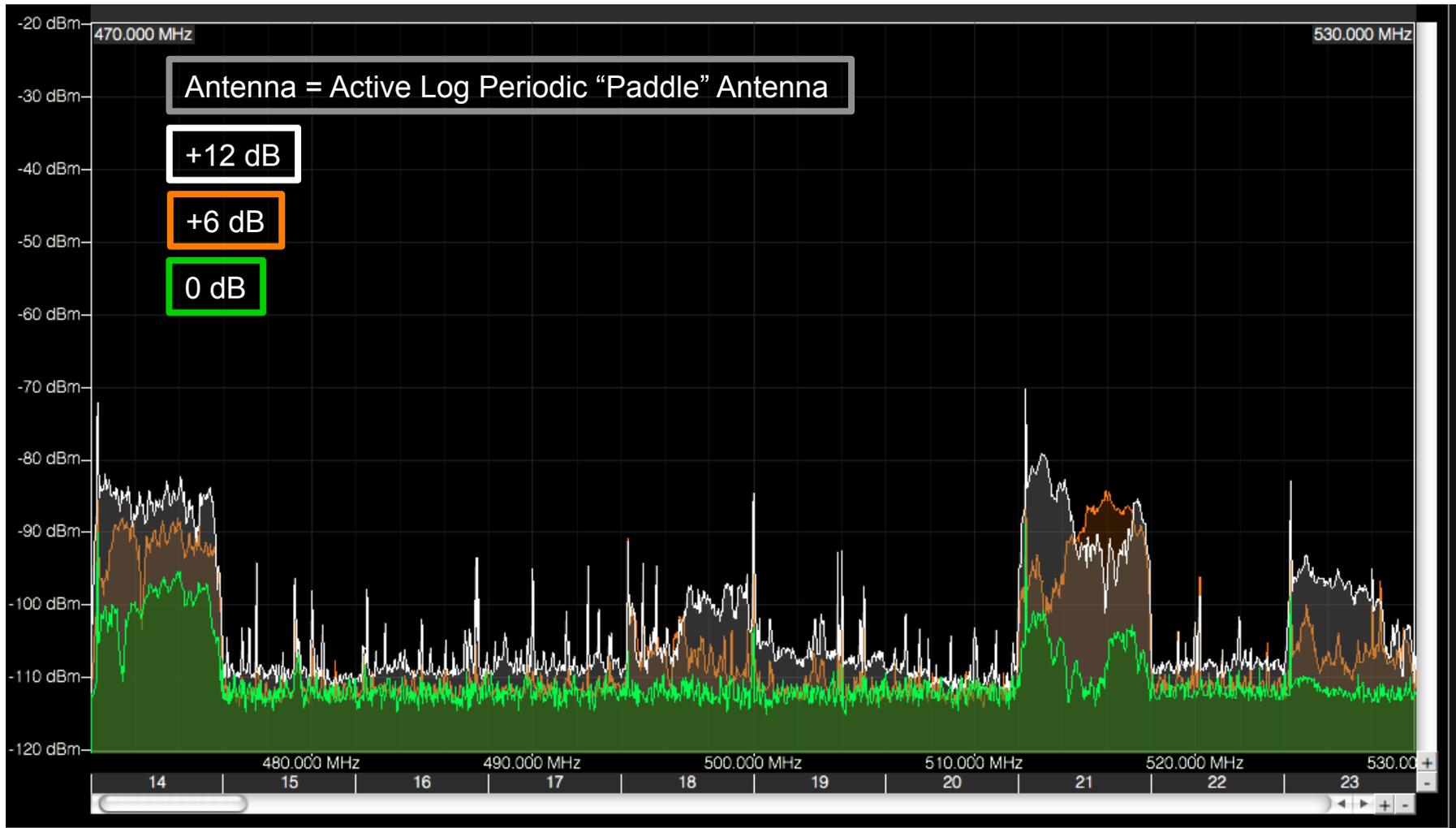
$$(\text{Ant Gain}) + (\text{total booster/amp gain}) - (\text{cable loss}) - (\text{split loss})$$

- Total gain for 500 ft range = -3 to +6 dB (fewer compatible systems)
- Total gain for 20 to 200 ft range = -12 to -3dB (more compatible systems)
- Total acceptable gain varies with system and manufacturer

SHURE[®]

LEGENDARY
PERFORMANCE™

Antenna Gain Settings



SHURE

LEGENDARY
PERFORMANCE™

Antenna System Configuration

- NO requirement for symmetry in antenna configuration:
 - Antennas do NOT have to be the same type:
 - Omni with uni OK!
 - Different types of omni OK!
 - Different types of uni OK!
 - Antenna cables do NOT have to be the same length:
 - Short cables with long cables OK!
 - Cable with direct connection on receiver or distribution amp OK!



SHURE

LEGENDARY
PERFORMANCE™

Antenna System Configuration



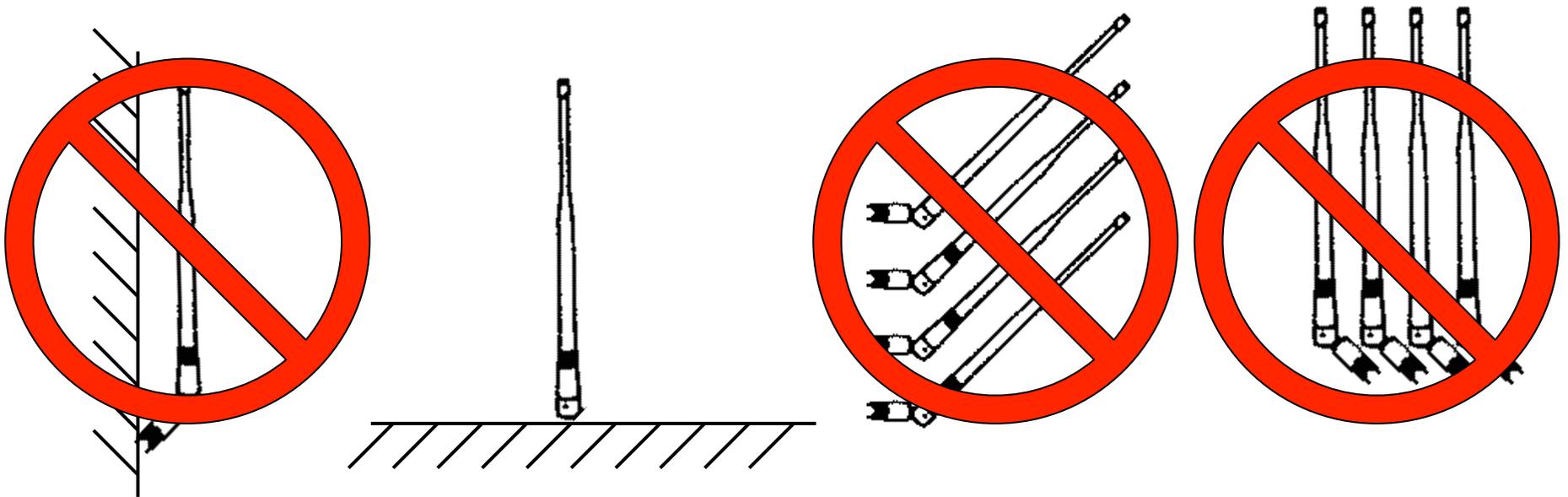
- More than 3 systems? Antenna distribution
- Hidden receivers? Remote antennas
- Long range operation? Directional antennas

SHURE

LEGENDARY
PERFORMANCE™

Antenna Placement

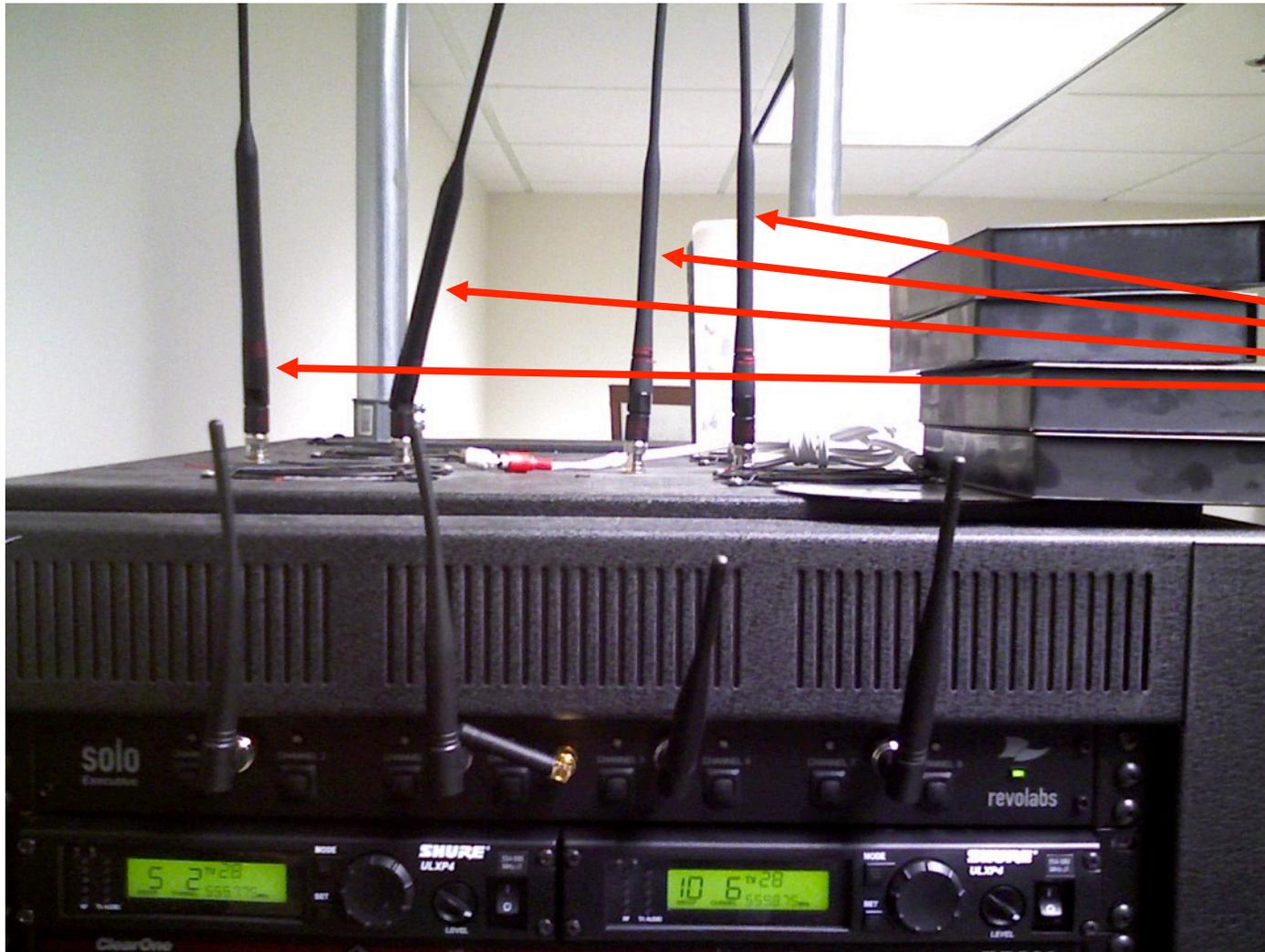
- Minimum distance from transmit or receive antenna to any parallel metal structure should be at least $\frac{1}{4}$ -wavelength (4-5 in. in the UHF range).



SHURE[®]

LEGENDARY
PERFORMANCE™

Antenna Placement ?



Antennas too close together

SHURE

LEGENDARY
PERFORMANCE™

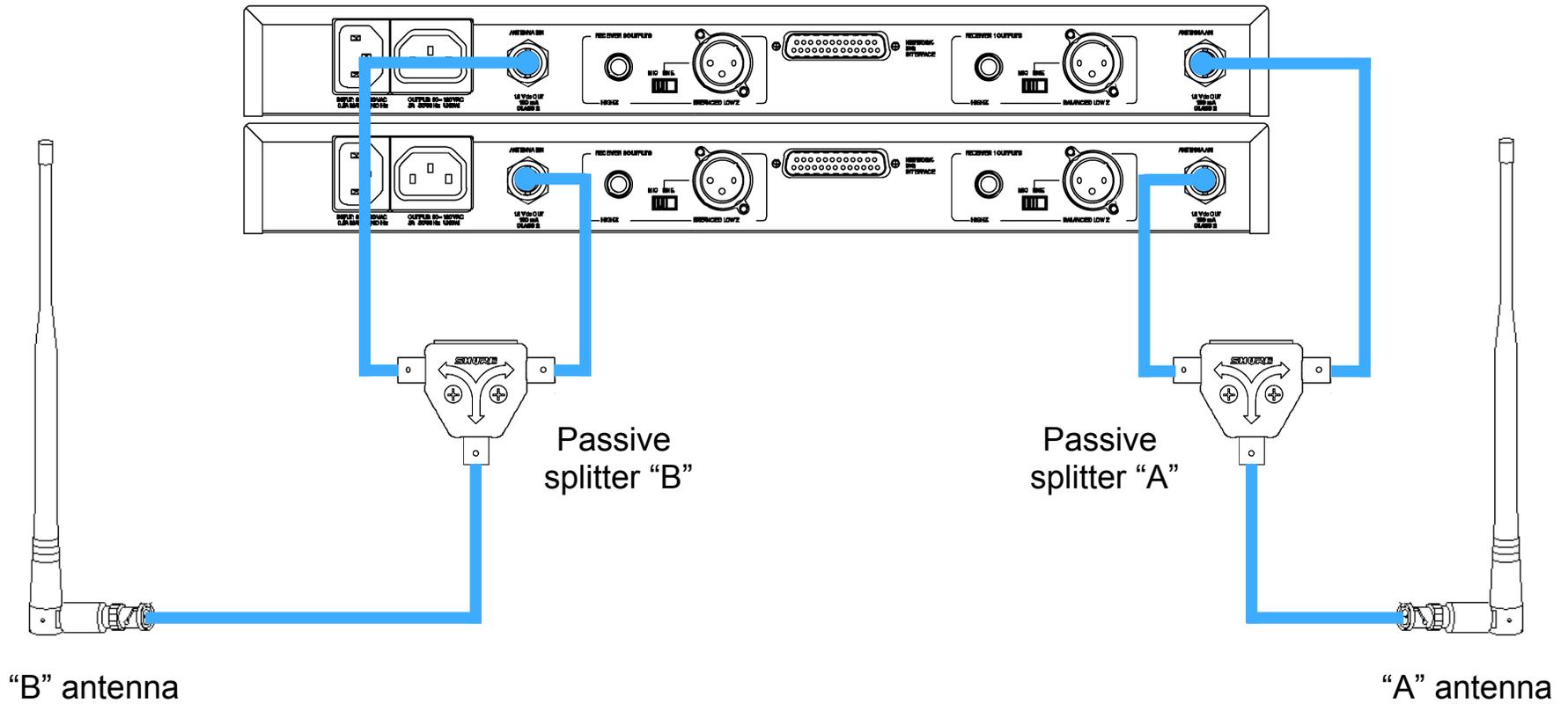
Antenna Distribution

- Prevents closely-spaced receiver antennas from interfering with each other
 - Passive splitter
 - feeds one pair of antennas to 2 diversity receivers
 - ~3dB loss per split
 - Active splitter
 - feeds one pair of antennas to 4-5 diversity receivers
 - no loss!
 - Multiple active splitters can be linked to feed a large number of receivers
 - RF Cascade
 - Only available on some receivers
 - Eliminates need for external splitter
 - No loss, but limited cascade depth

SHURE[®]

LEGENDARY
PERFORMANCE™

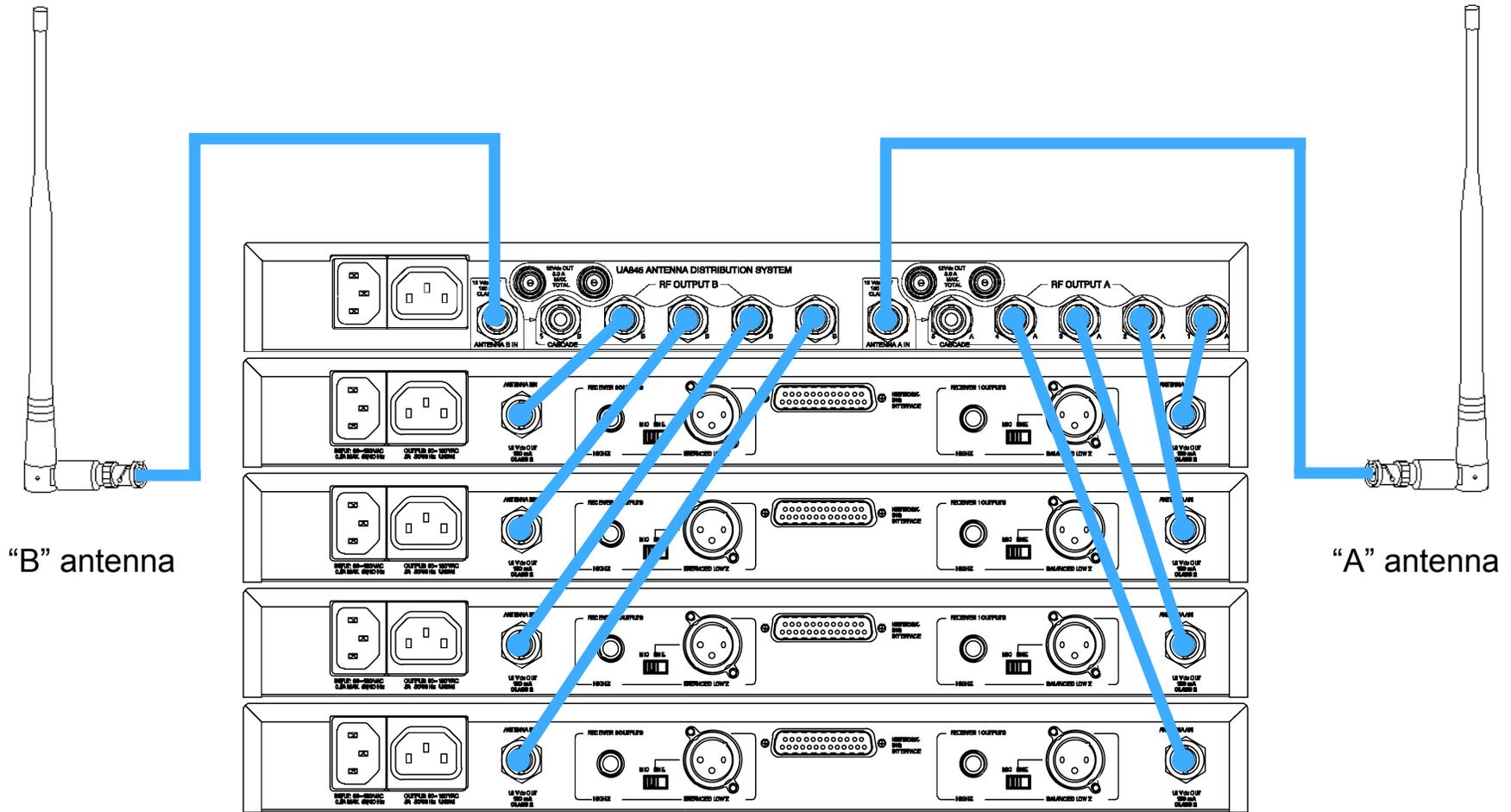
Passive Antenna Distribution



SHURE

LEGENDARY
PERFORMANCE™

Active Antenna Distribution (one level)



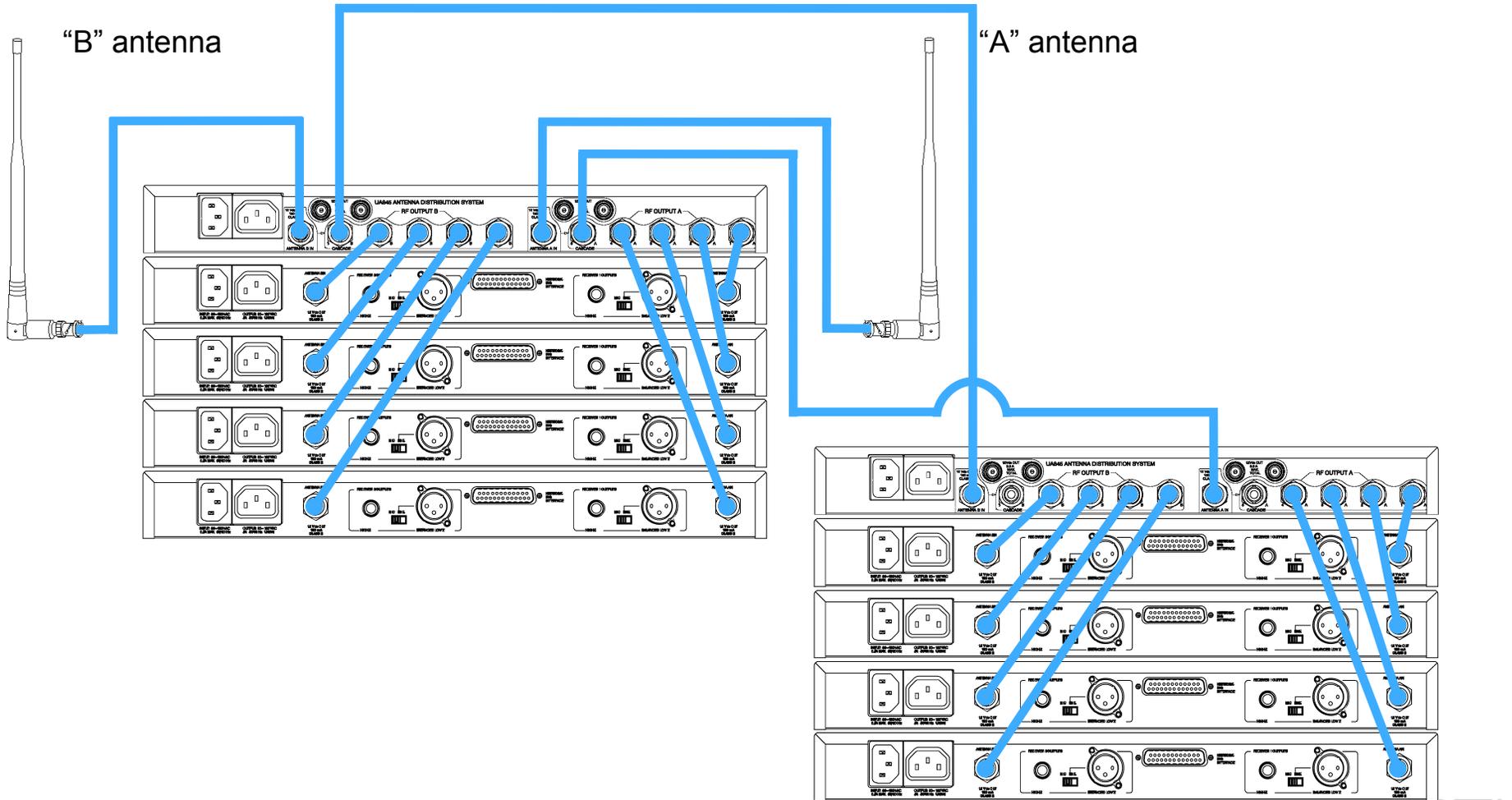
"B" antenna

"A" antenna

SHURE

LEGENDARY
PERFORMANCE™

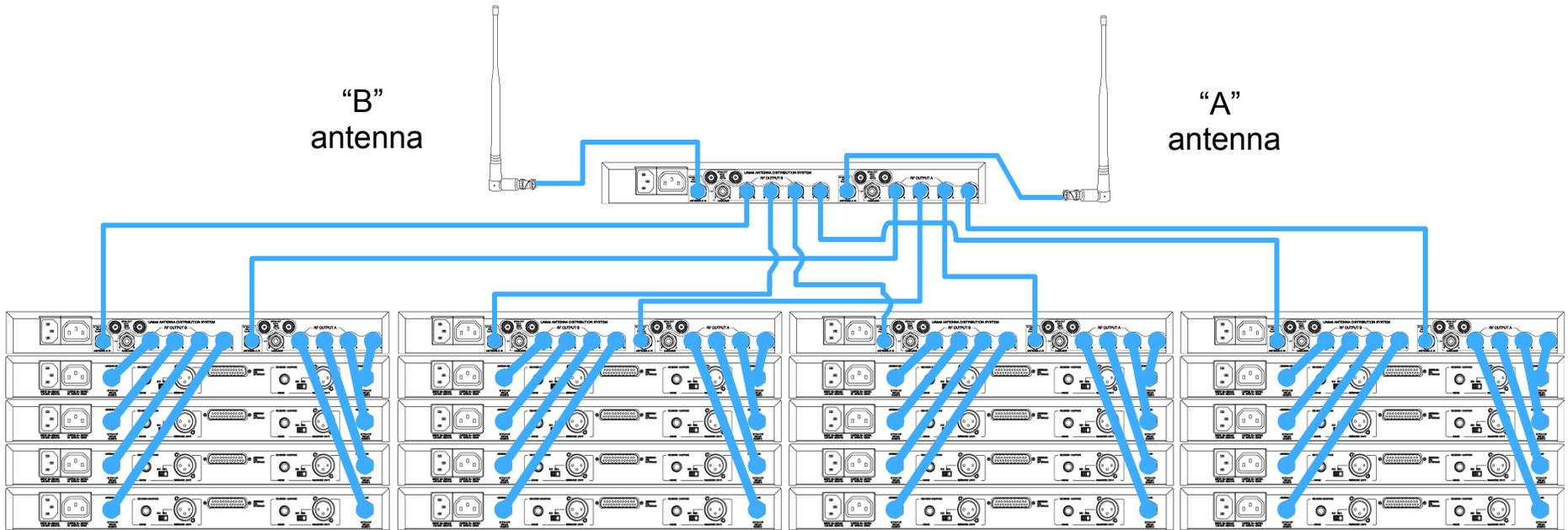
Active Antenna Distribution (two level)



SHURE

LEGENDARY
PERFORMANCE™

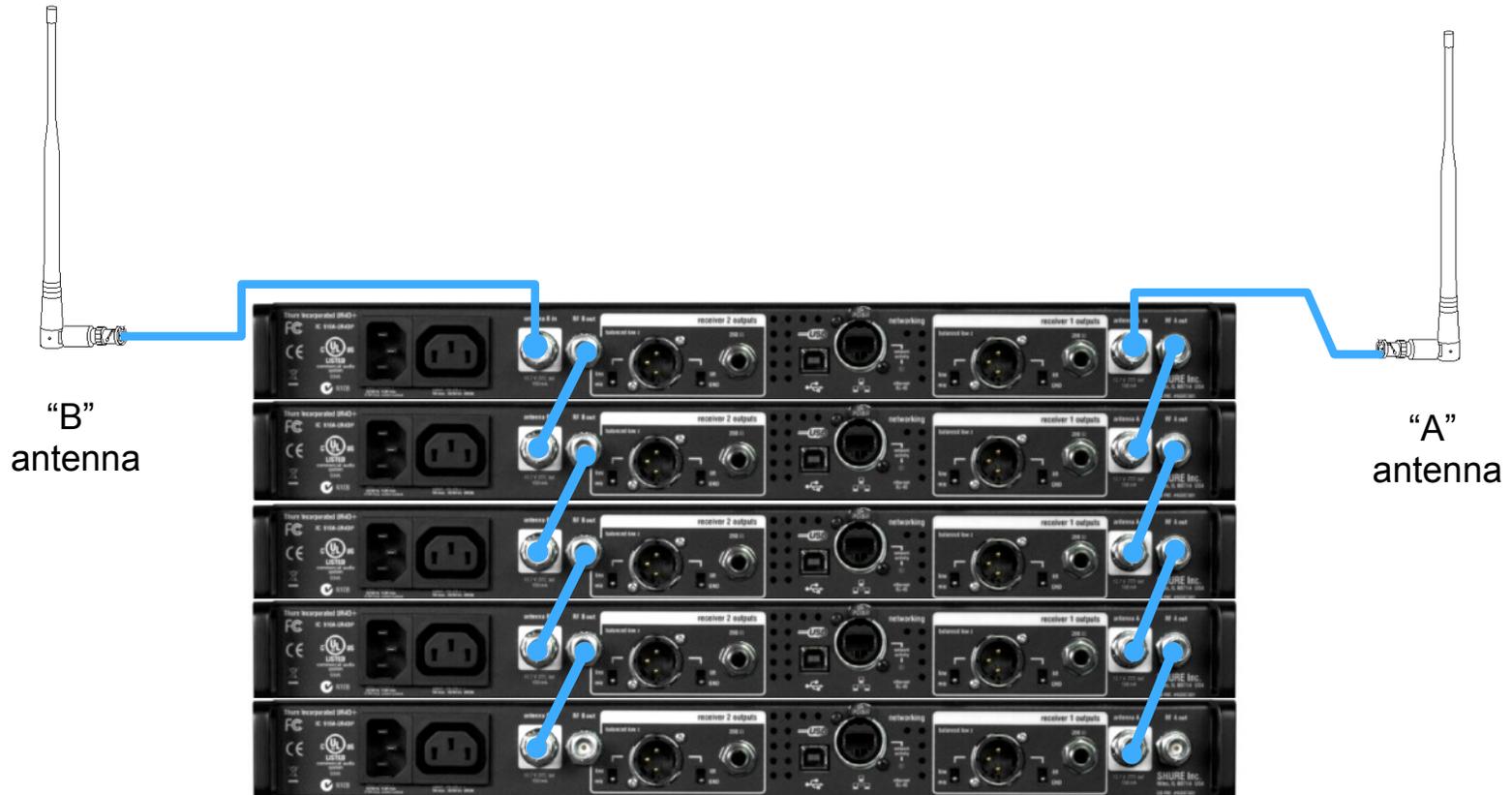
Active Distribution (>2 distros)



SHURE[®]

LEGENDARY
PERFORMANCE™

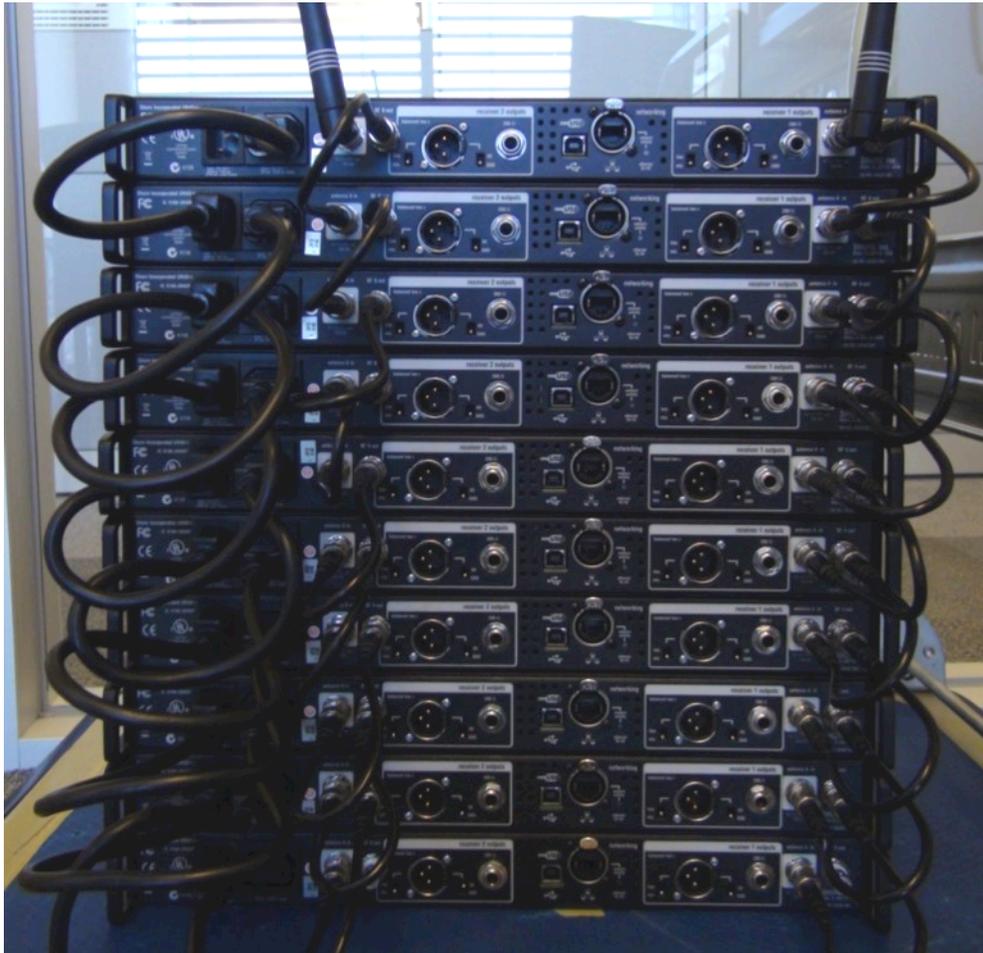
RF Cascade Distribution



SHURE®

LEGENDARY
PERFORMANCE™

RF Cascade Distribution – UR4+

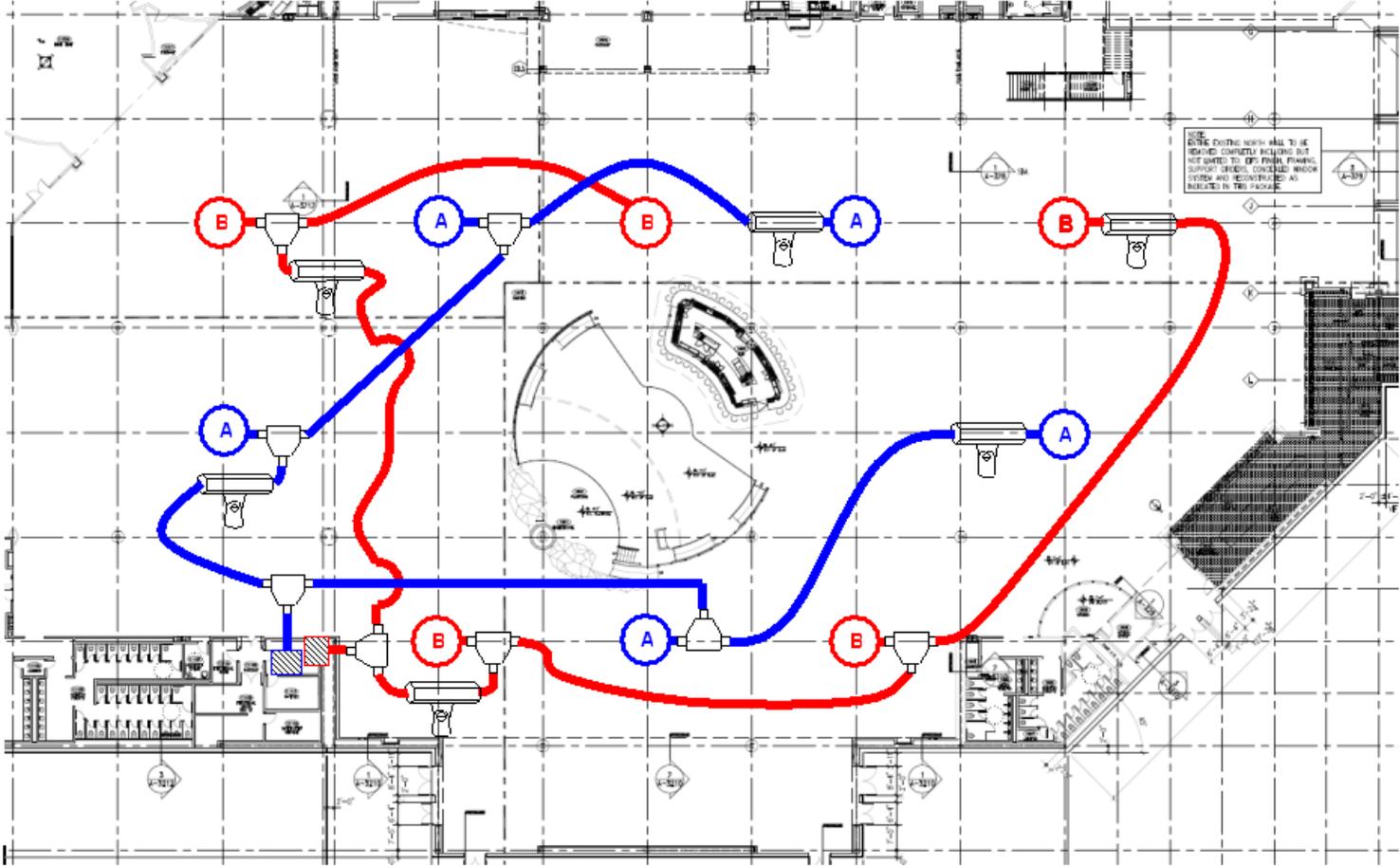


- Maximum 10 units
 - 20 dual channel RX
- All RX must be in same band!
- All RX must be powered on!

SHURE[®]

LEGENDARY
PERFORMANCE™

Large area antenna coverage



Proposed antenna locations for "Lincoln Park"

(A) "A" antenna

(B) "B" antenna

 UA221

 UA830WB

 Bias "T"



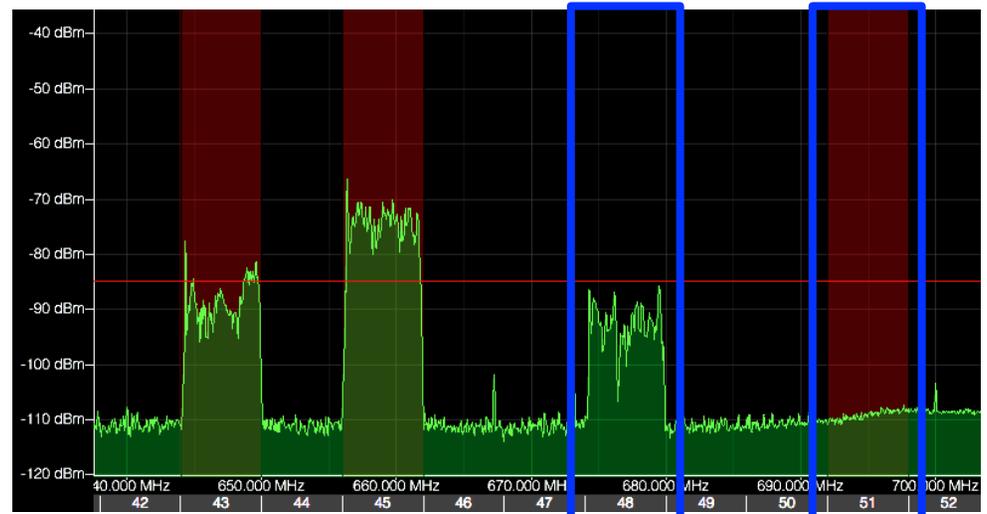
LEGENDARY PERFORMANCE™

Frequency Coordination

SHURE[®]
LEGENDARY
PERFORMANCE™

Main UHF Interference Sources

- OTA Television Signals
 - Digital TV
 - Occupy all 6MHz allocation
 - Watch for Lower Power stations!
 - Public Safety Channels
 - 13 Major Markets in US
 - Analog TV still around!
- Other wireless mic users
 - ENG/Studio Broadcast
 - Theatres
 - HOW
 - Concert Venues
 - The list goes on....



SHURE

LEGENDARY
PERFORMANCE™

Other Interference Sources

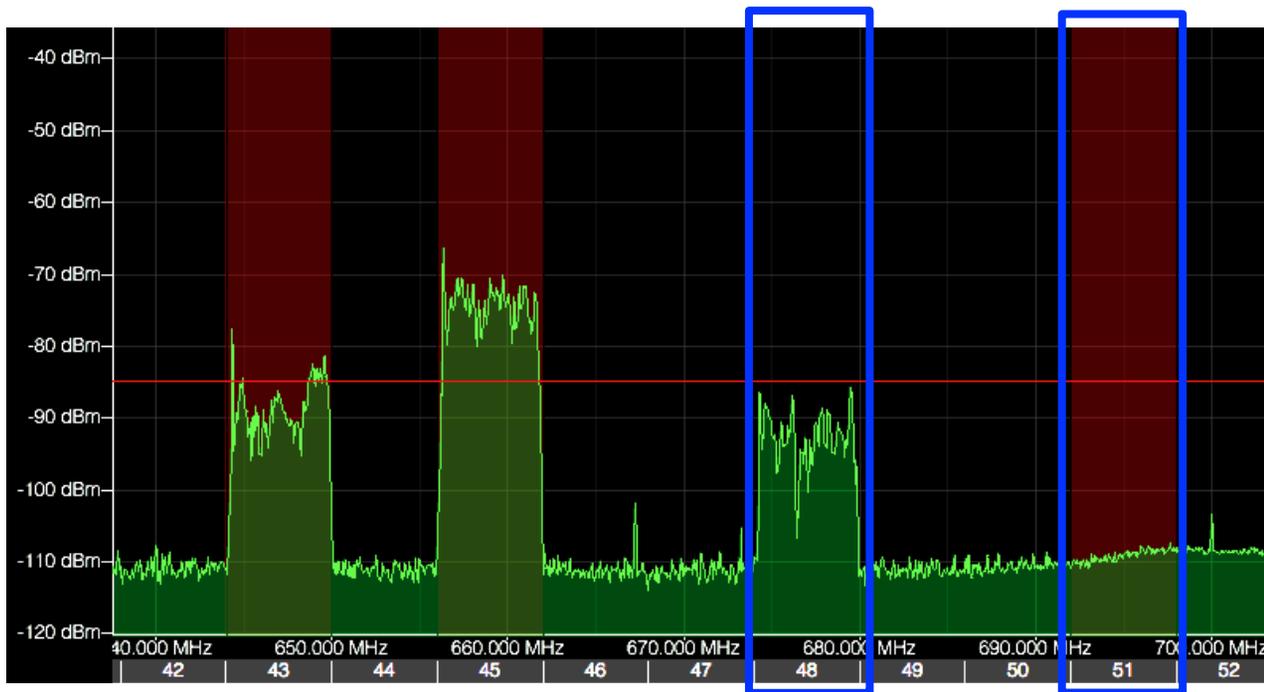
- Unknown radio transmitters
 - Wireless in-ear monitor systems
 - Wireless intercom systems
 - Portable Studio Transmitter Links (STL)
 - Out-of-band transmitters (CB, Business, Public Safety)
 - GSM devices: mobile phones, pda's
- Nearby digital equipment
 - Audio DSP (CD players, DAT, FX)
 - Computers, computer-controlled devices (Lighting, etc)
- Hi-capacity power equipment
 - Motors, HVAC, Lighting

SHURE[®]

LEGENDARY
PERFORMANCE™

Scanning and RF Meters

- Especially important for remote work
 - Scanning can capture TV or public safety unknown to software/hardware
 - Receiver RF Meters can help

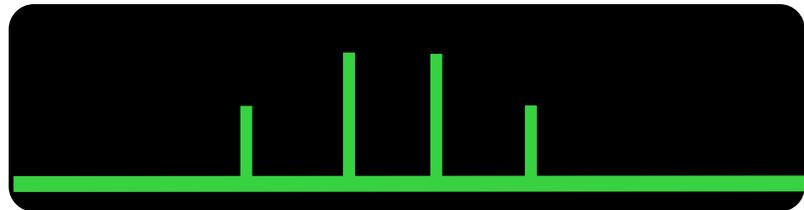
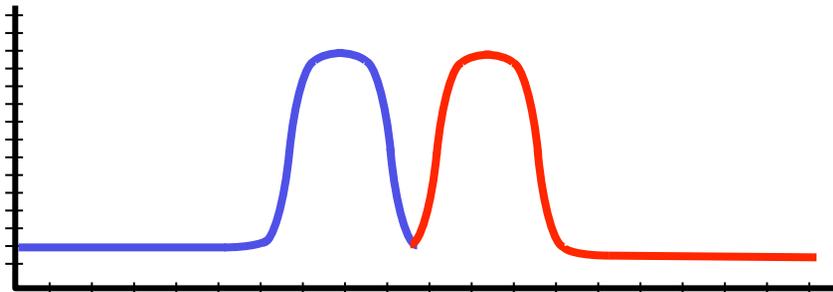


SHURE

LEGENDARY
PERFORMANCE™

System-to-System Interference

- Primary Compatibility issues:
 - Minimum frequency separation (selectivity)
 - Transmitter IMD products (intermodulation)

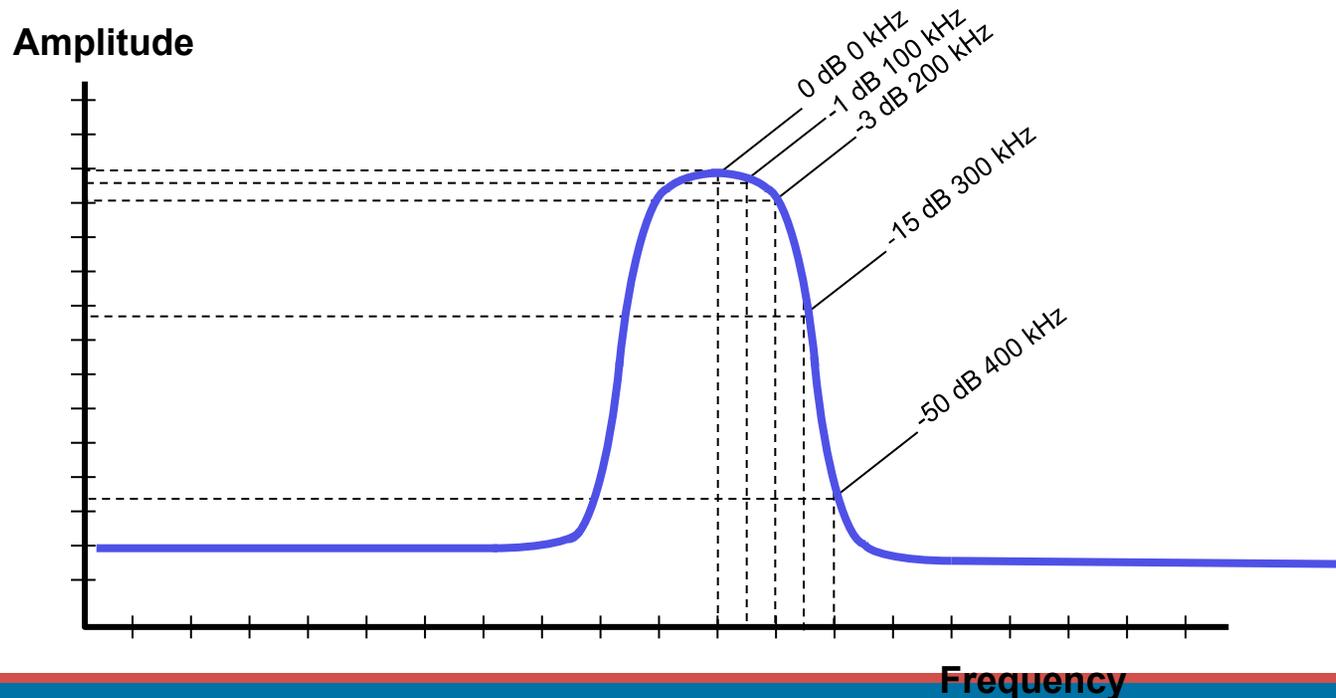


SHURE[®]

LEGENDARY
PERFORMANCE™

Frequency Compatibility: Minimum frequency separation

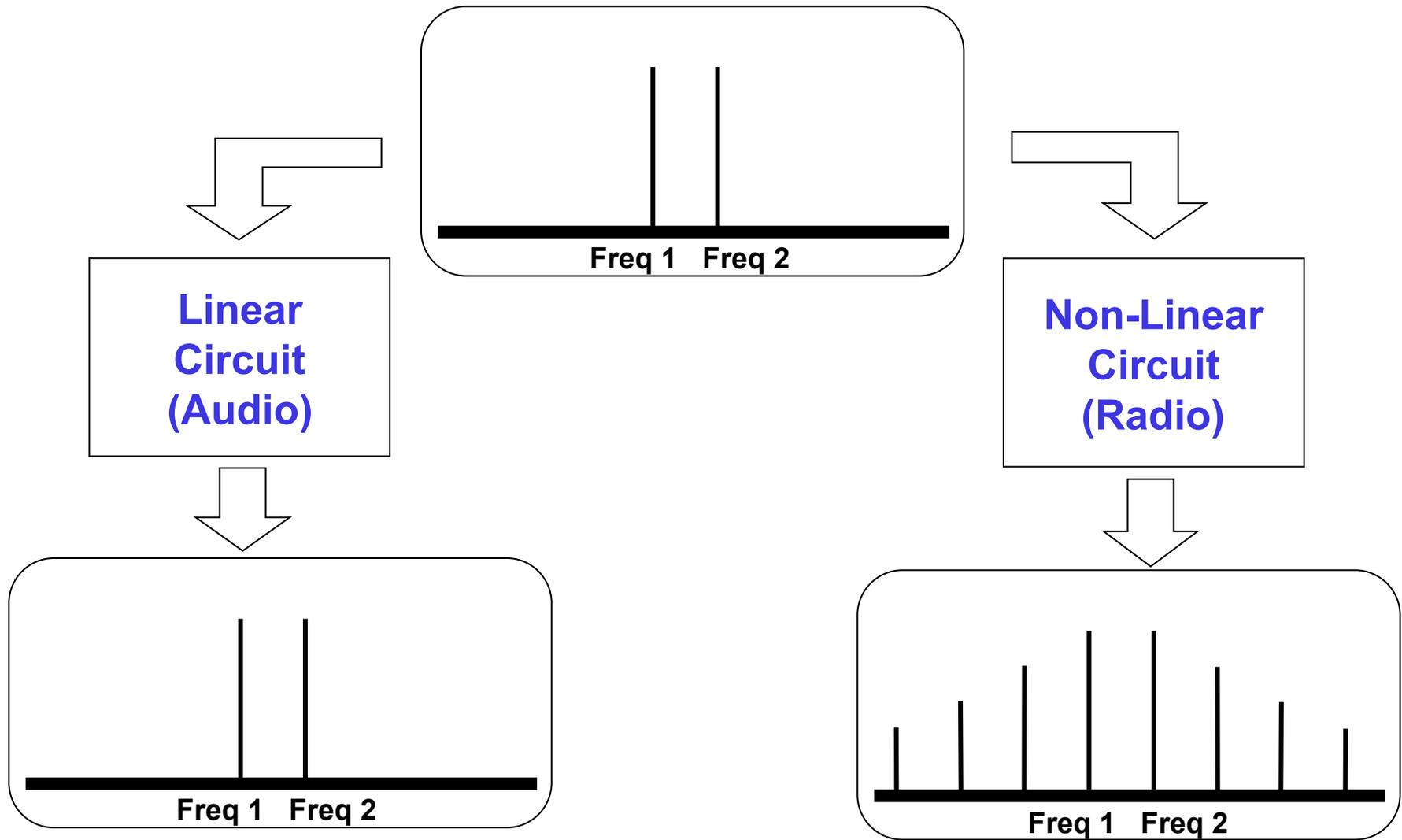
- Each system must operate on a unique frequency
- Frequencies must be at least 0.4 - 1.5 MHz apart
- Minimum spacing a function of receiver selectivity
- **BE CAREFUL WITH COMBO SYSTEMS!**



SHURE[®]

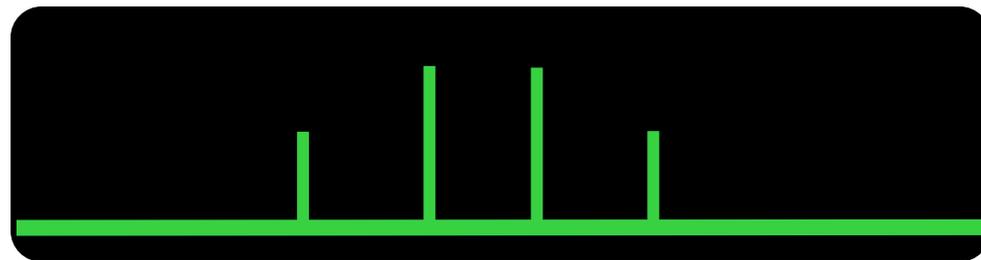
LEGENDARY
PERFORMANCE™

Linear vs. Non-linear Circuits



Frequency Compatibility: Intermodulation (IMD)

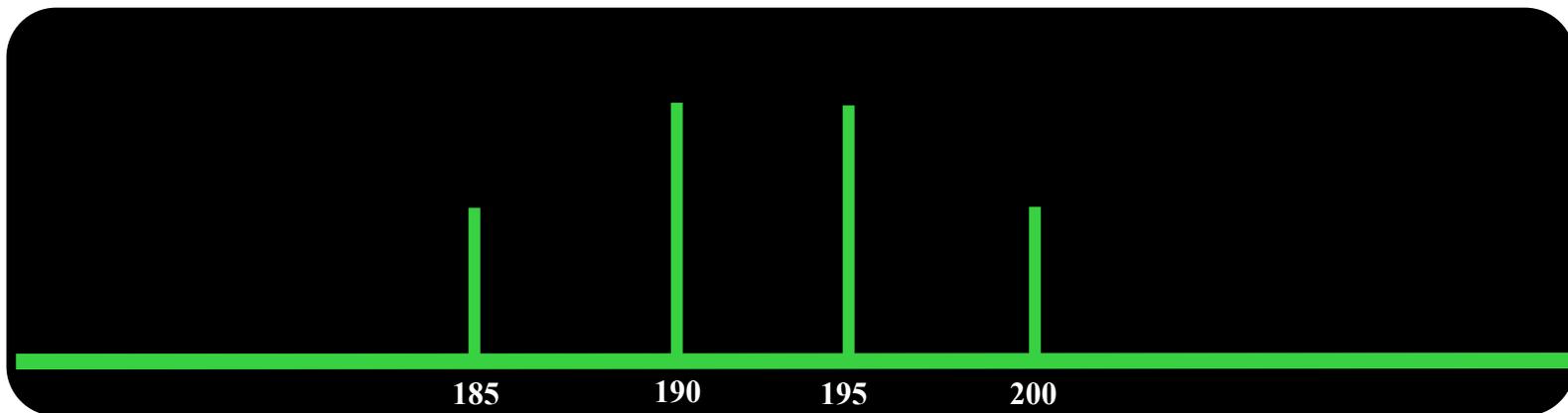
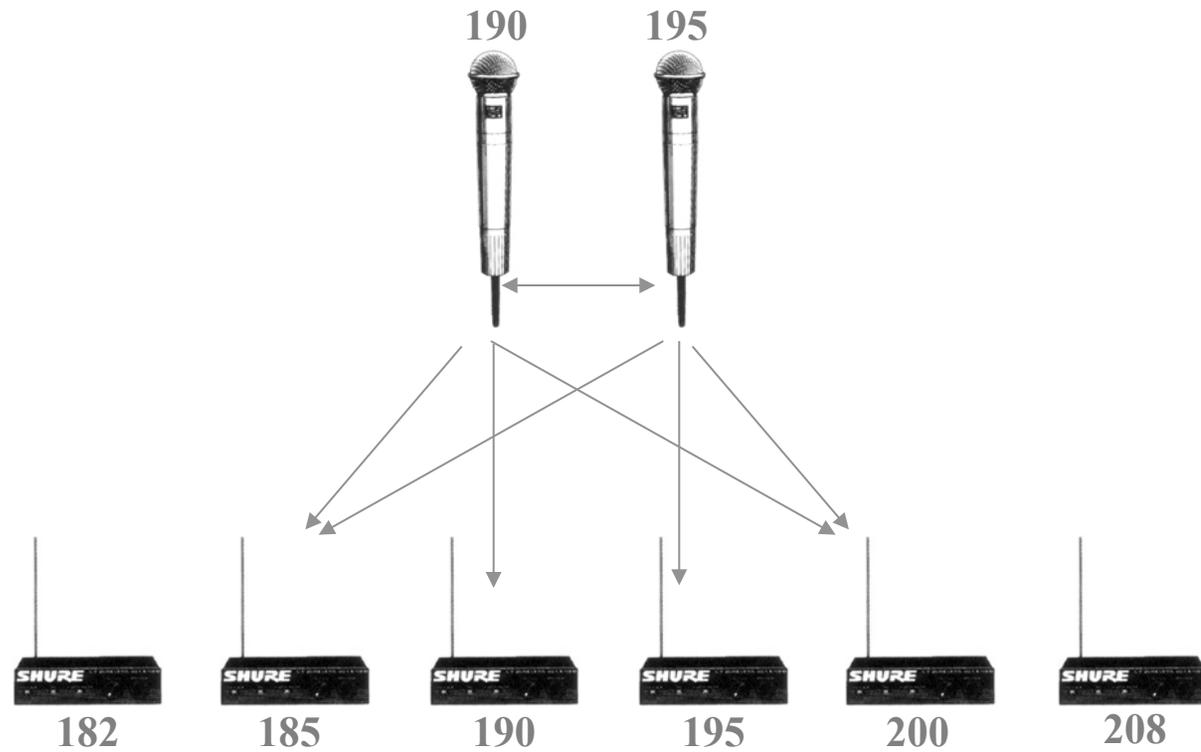
- Inherent non-linearities of wireless circuitry
- Occurs with 2 or more transmitters
- Generated in transmitters and/or receivers
- IMD product strength
 - Proportional to square of transmitter power
 - Inversely proportional to square of transmitter separation



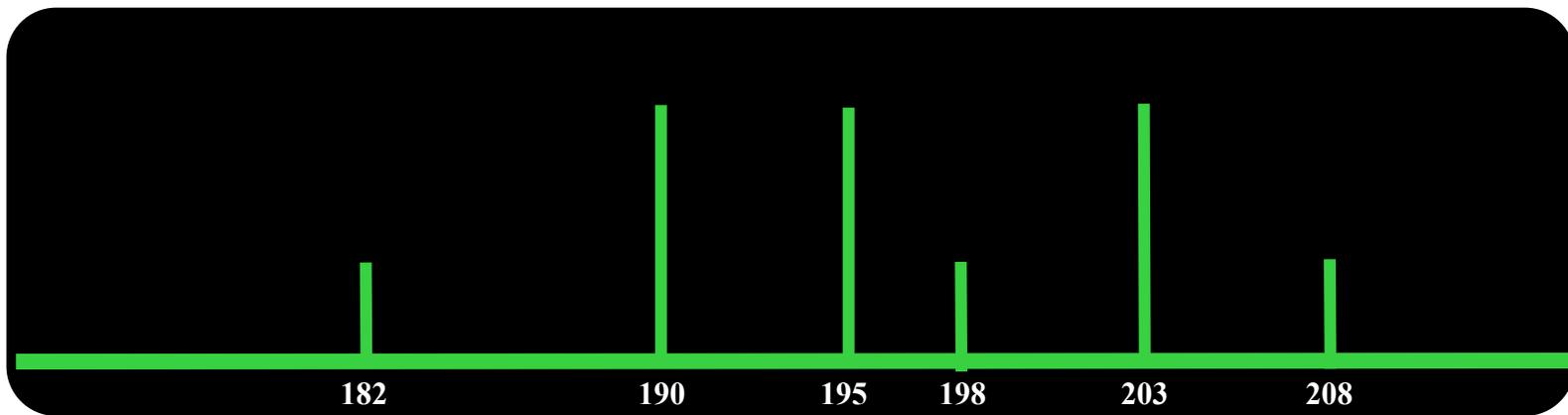
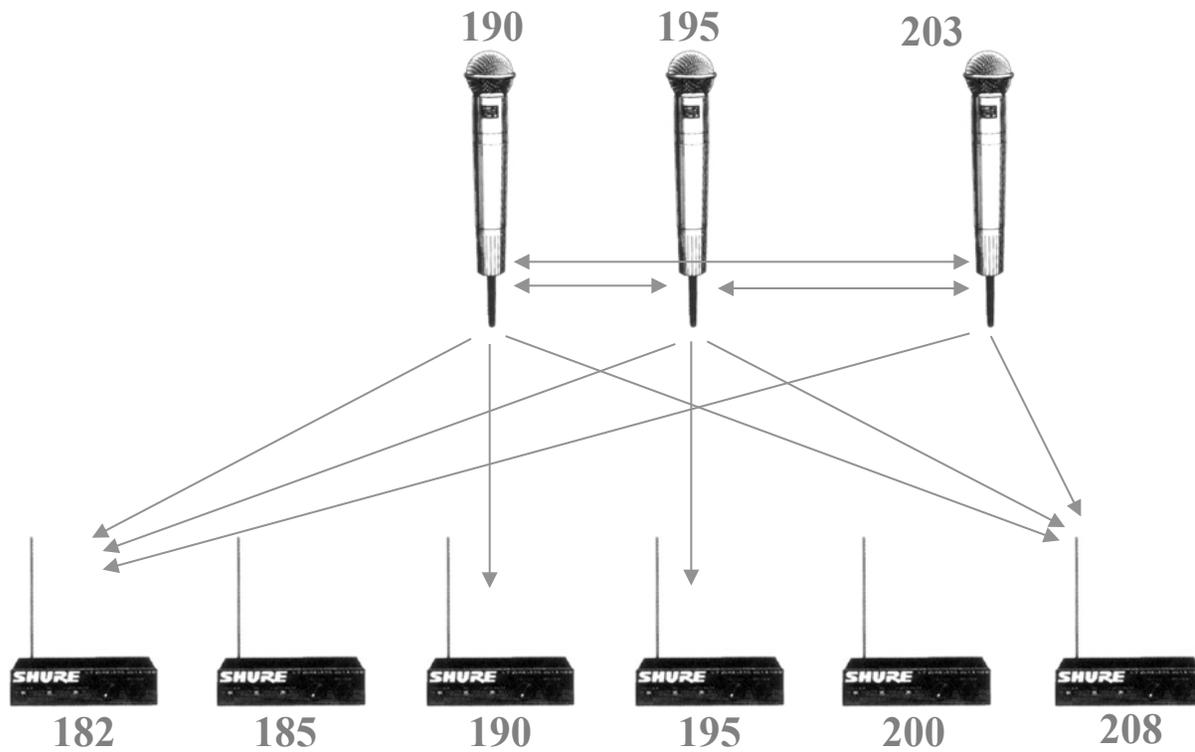
SHURE[®]

LEGENDARY
PERFORMANCE™

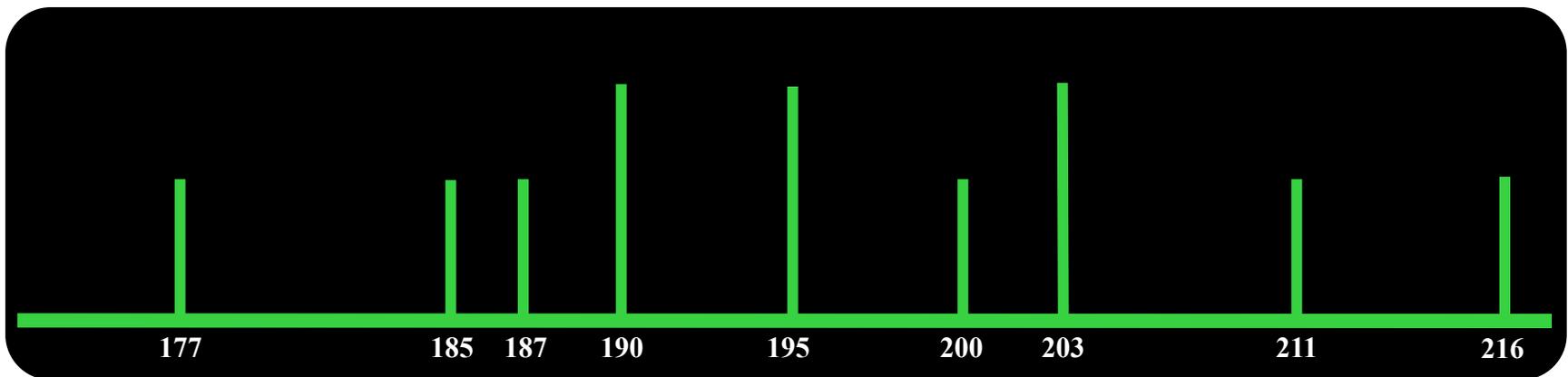
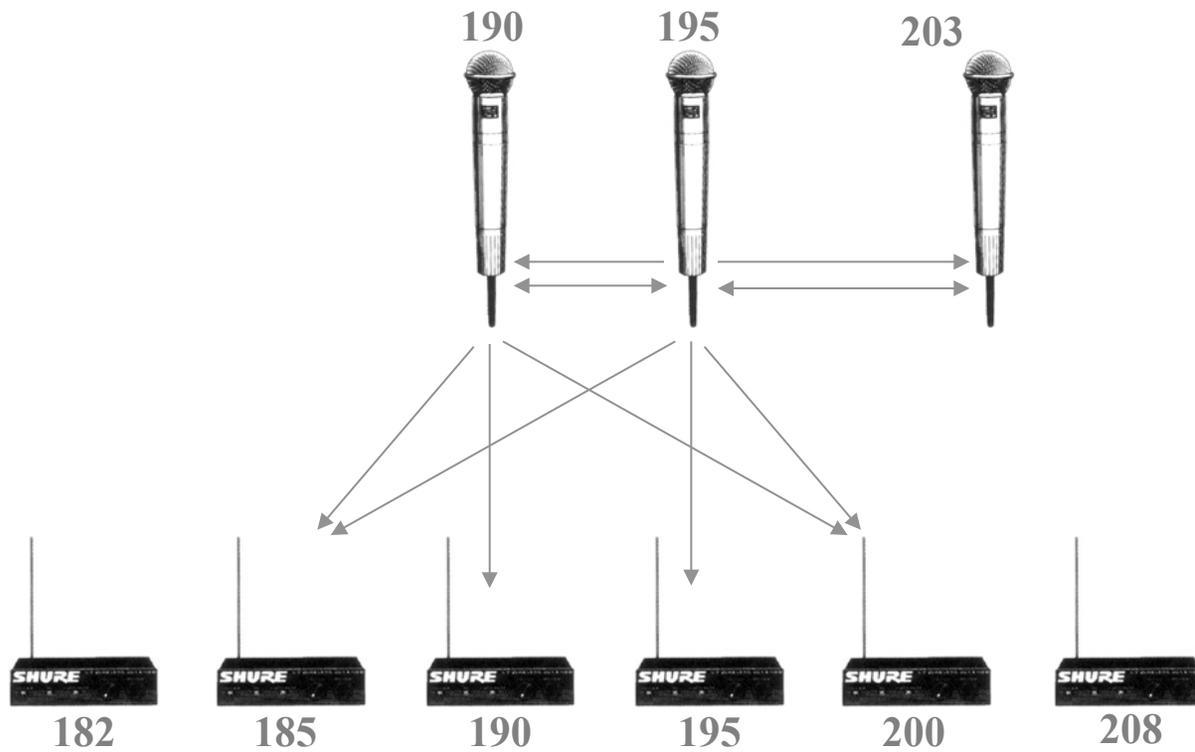
2 Transmitter IMD



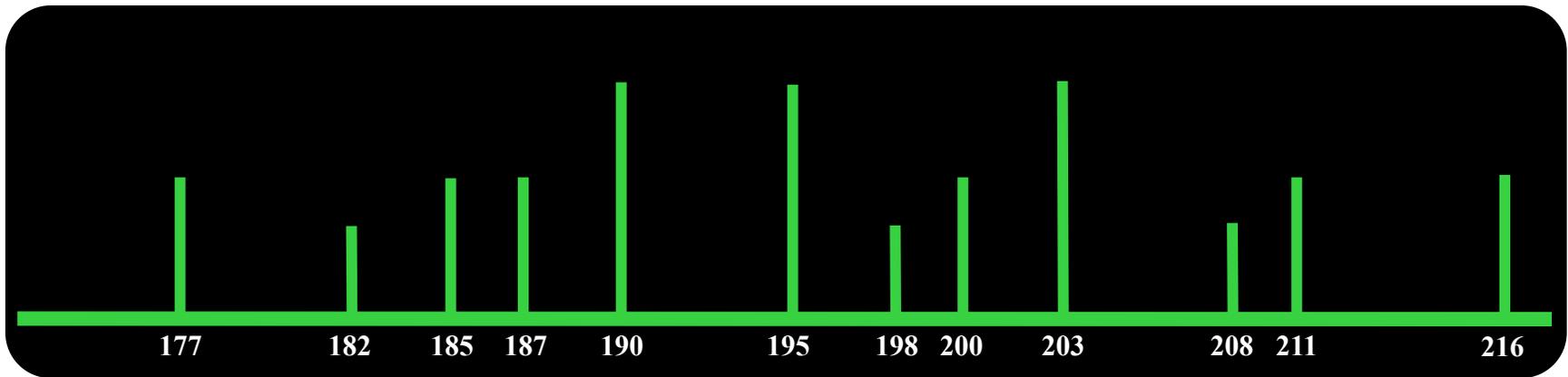
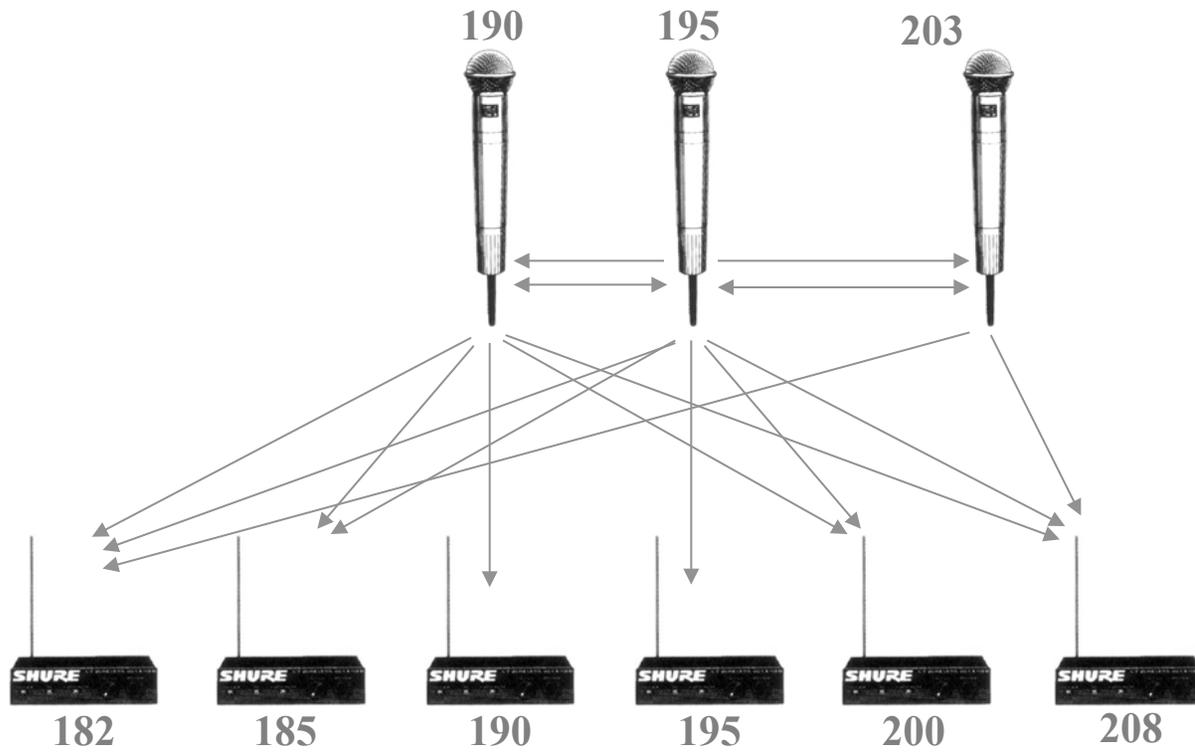
3 Transmitter IMD



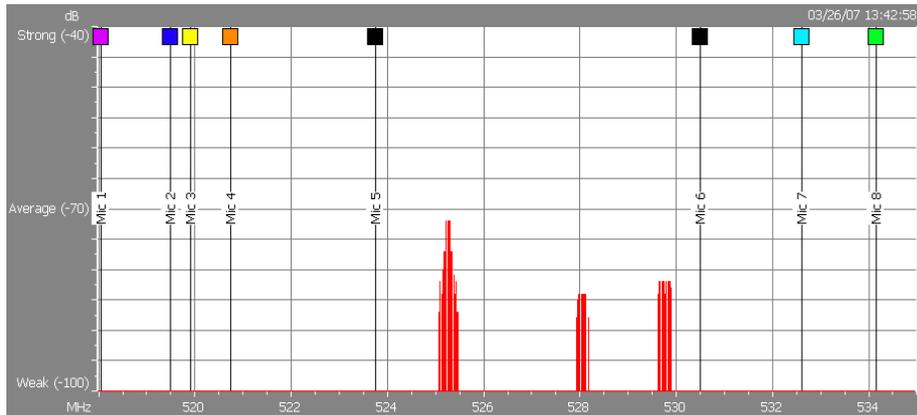
2 Transmitter IMD



2 & 3 Transmitter IMD

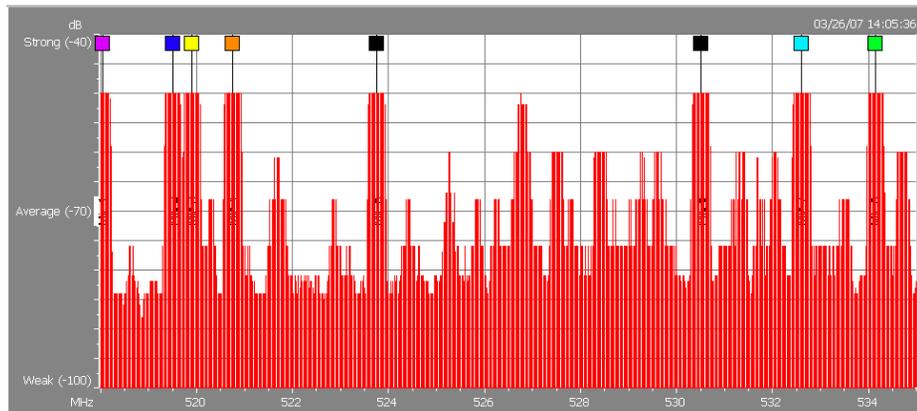


Multiple Transmitters On



Scan with
Transmitters Off

- Peaks are Transmitters
- Lower carriers are IMD Products
- This a fully COMPATIBLE frequency set!



Scan with UHF-R
Receiver and 8
Transmitters ON

SHURE[®]

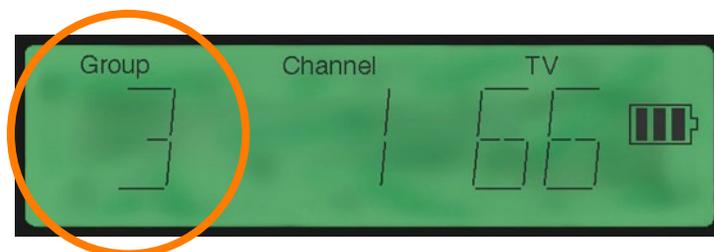
LEGENDARY
PERFORMANCE™

Insuring System-to-System Compatibility

- Choose pre-selected compatible frequency set:
 - A “Group” is a programmed set of freqs
 - A “Channel” is one frequency in a group
 - All “Channels” in a “Group” are compatible

-or-

- Calculate a “custom” compatible frequency set:
 - Observe minimum ch-to-ch spacing
 - Observe minimum ch-to-IMD spacing
 - Must be done with a software(i.e. WWB)



Worst possible set is equally spaced frequencies!

SHURE®

LEGENDARY
PERFORMANCE™

Compatibility Tools

- *Shure Wireless Work Bench 5.0.5*
 - *UHF-R receivers*
 - *Compatible with certain WinRadio models*
 - *WR-G305e or WR-G33WSM*
- *Shure Wireless Workbench 6.4*
 - *UHF-R*
 - *ULX-D*
 - *PSM1000*
 - *Axient Receivers or Spectrum Manager*
- *PWS Intermod Analysis Software*



- TECH SUPPORT
 - Find An Answer
 - Wireless Frequency Finder
 - Educational Articles
 - Magazines And Newsletters
 - Cable Selector
 - Wireless Mic Remote Antennas Tool

Pro Audio Home > Tech Support > Wireless Mic Remote Antennas Tool

Wireless Microphone Remote Antennas Tool

Use this tool to find the cable type and antenna amplifiers needed by distance.

Enter distance between antenna and receiver:

Feet Meters

Use UA820 half wave antennas Use UA870 directional antenna

SHURE PRO AUDIO

ABOUT SHURE ARTIST ENDORSERS PRESS EVENTS DEALER LOGIN CONTACT PRO AUDIO

Search GO

HOME PRODUCTS TECH SUPPORT DOWNLOADS SERVICE & WARRANTY WHERE TO BUY

- TECH SUPPORT
 - Find An Answer
 - Wireless Frequency Finder
 - Educational Articles
 - Magazines And Newsletters
 - Cable Selector
 - Wireless Mic Remote Antennas Tool

Pro Audio Home > Tech Support > Wireless Mic Remote Antennas Tool

Wireless Microphone Remote Antennas Tool

Use this tool to find the cable type and antenna amplifiers needed by distance.

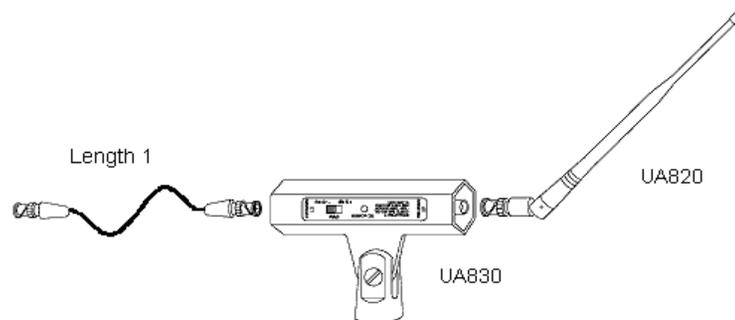
Wireless system with 100 Feet of cable and UA820 antenna. Use one of the following choices:

Search Again

Option #1

Cable Type: RG213/U (Belden 8267)
Length#1: 100 Feet, UA830 #1 Setting: +10 dB

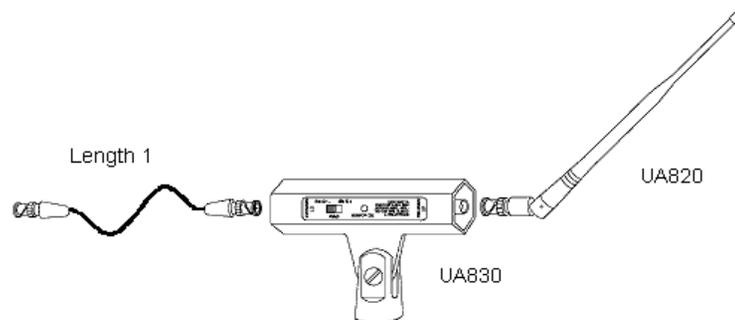
* The UA830 can not be connected directly to an SLX4 or UC4 receiver.



Option #2

Cable Type: RG-8/U (Belden 9913)
Length#1: 100 Feet, UA830 #1 Setting: +3 dB

* The UA830 can not be connected directly to an SLX4 or UC4 receiver.



Option #3

Cable Type: RG-8X/U (Belden 9258)
Length#1: 100 Feet, UA830 #1 Setting: +3 dB

- TECH SUPPORT
 - Find An Answer
 - Wireless Frequency Finder
 - ▼ Educational Articles
 - Magazines And Newsletters
 - Cable Selector
 - Wireless Mic Remote Antennas Tool

Pro Audio Home -> Tech Support -> **Educational Articles**

Educational Articles
Explore these articles and expand your knowledge on how to get the most out of your equipment.

PDF ARTICLES

Antenna Set-up for Wireless Systems
These recommendations are useful guidelines to help achieve satisfactory performance from wireless audio systems. [En Espanol.](#)

Audio Systems Guide for Houses of Worship
Comprehensive review of microphones, wireless microphone systems and mixers for church sound applications. Specific sections covering miking techniques for altar, lectern and choir. [En Espanol.](#)

Audio Systems Guide to Meeting Facilities
Covers the selection and application of wired microphones, wireless microphones and microphone mixers for meeting facility sound systems.

Audio Systems Guide for Music Educators
This guide covers everything from recording to live sound reinforcement and will help you choose equipment for a variety of applications.

Audio Systems Guide for Theater Performances
The purpose of this booklet is to provide useful tips, practical advice and a general knowledge of microphones and other audio tools – all with the clear intent of making theater productions as understandable, clear and impressive as possible.

Audio Systems Guide for Video Production
This booklet is intended to help anyone involved with video projects improve the audio quality of their productions. It is not intended as a comprehensive study of the subject of audio. Its goal is to provide helpful tips, practical advice and a general knowledge of audio tools – all with the express purpose of making video productions as clear, understandable and impressive as possible.

Connecting Your Devices to a Shure Mixer
The variety of connectors on audio equipment sometimes leads to confusion in wiring. The diagrams in this booklet provide wiring recommendations for most common cables.

Introduction to Recording and Sound Reinforcement
Written for the beginner, this guide will help you choose and set up equipment for a variety of typical applications.

Microphone Techniques for Drums
Some suggestions to follow when miking musical instruments and drums for sound reinforcement.

Microphone Techniques for Music - Sound Reinforcement
Recommended microphone type and placement for a large variety of vocal and instrument situations.

Microphone Techniques for Music - Studio Recording
In this guide, Shure application engineers describe particular microphone techniques and placement: techniques to pick up a natural tonal balance, techniques to help reject unwanted sounds, and even techniques to create special effects.

Microphones and Multitracks
Essential steps to quality recording using a microphone and multitrack recorder.

Request Literature
Select literature is available. [Request Literature](#) at no cost in individual printed versions.

Featured Articles
[CommShield™ Technology Improves RF Resistance](#)
[Shure Position on White Spaces](#)

QUESTIONS?

- Presenter
 - Dave Mendez: mendez_dave@shure.com
- Shure Technical Support
 - Ph: 847-600-8440
 - email: support@shure.com
 - Knowledge base: www.shure.com/faq
- Shure Service Department (Repair and Parts)
 - Ph: 800-516-2525
 - email: service@shure.com