Sound Systems 101

HOW ALL THE PIECES AND PARTS GO TOGETHER TO MAKE A QUALITY SOUND SYSTEM WORK

What is Sound?

- In physics, sound is a vibration that propagates as an acoustic wave through a transmission medium such as a gas, liquid or solid. In human physiology and psychology, sound is the reception of such waves and their perception by the brain.

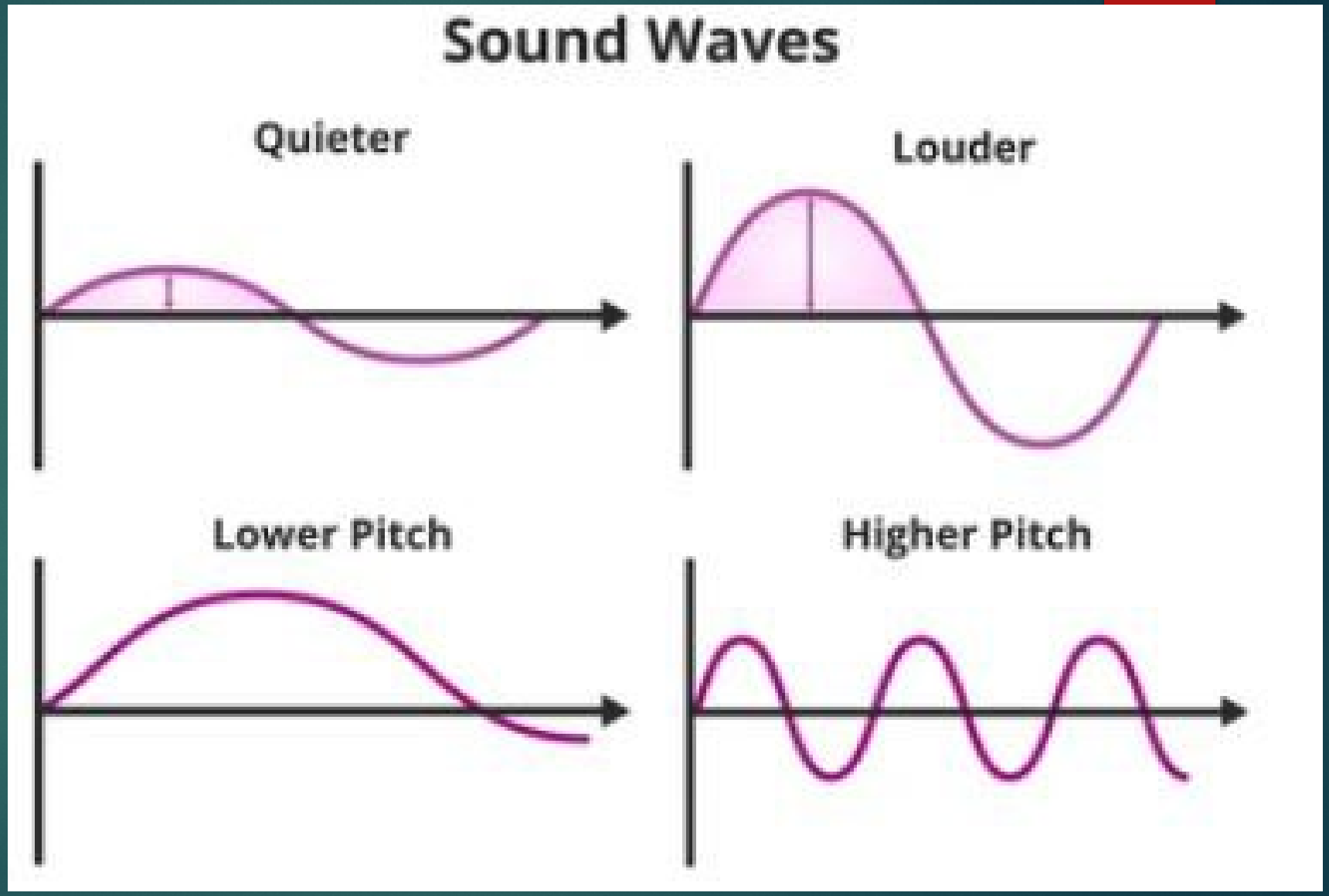
Human Hearing

- The human range is commonly given as 20 to 20,000 Hz, although there is considerable variation between individuals, especially at high frequencies, and a gradual loss of sensitivity to higher frequencies with age is considered normal.

- What is Hz?
  - How many cycles per second
  - 20 Hz is 20 cycles per second and results in long waves.
  - 20,000 Hz is 20,000 cycles per second and results in very short waves

Amplitude

Frequency



But First……Cables & Plugs

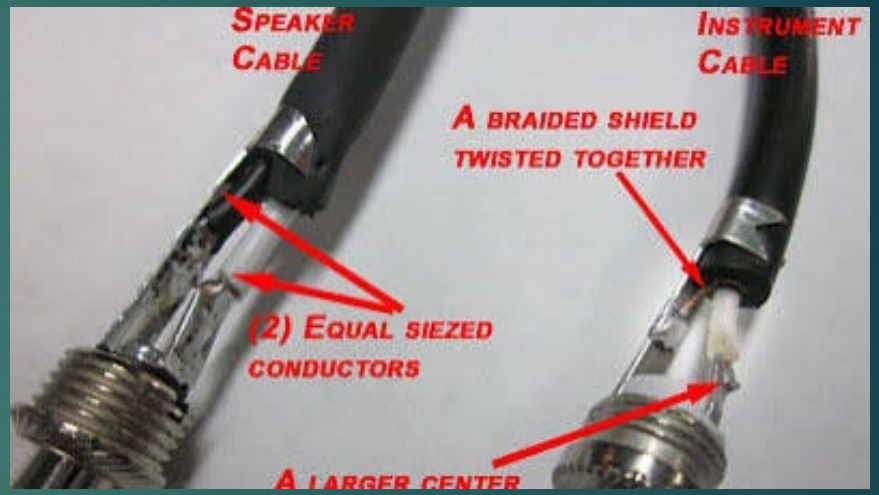
XLR – Microphone Cables

1. Balanced - 3-Conductors – Plus, Minus, and Ground
2. Can be run long Distances
3. Used to connect Microphones and to interconnect devices

¼" Cables

1. Mono – Unbalanced – Plus (Tip) and Ground (Sleeve)
    1. Shielded - Cables for Guitars, Keyboards
        1. Short Cable Runs – Longer runs pick up radio stations
    2. Unshielded – Speaker Cables – From the amplifier to the speakers

2. Stereo (TRS)– Balanced – Plus (Tip), Minus (Ring), Ground (Sleeve)
    1. Used as interconnect cables. Keeps the signal flow between devices balanced for less chance of noise.



Speakon Cables – Speaker Cables

1. Twist lock Plug
2. Can have 2, 4 or 8 conductors

RCA – For devices like CD Players

IMPORTANT SAFETY NOTICE

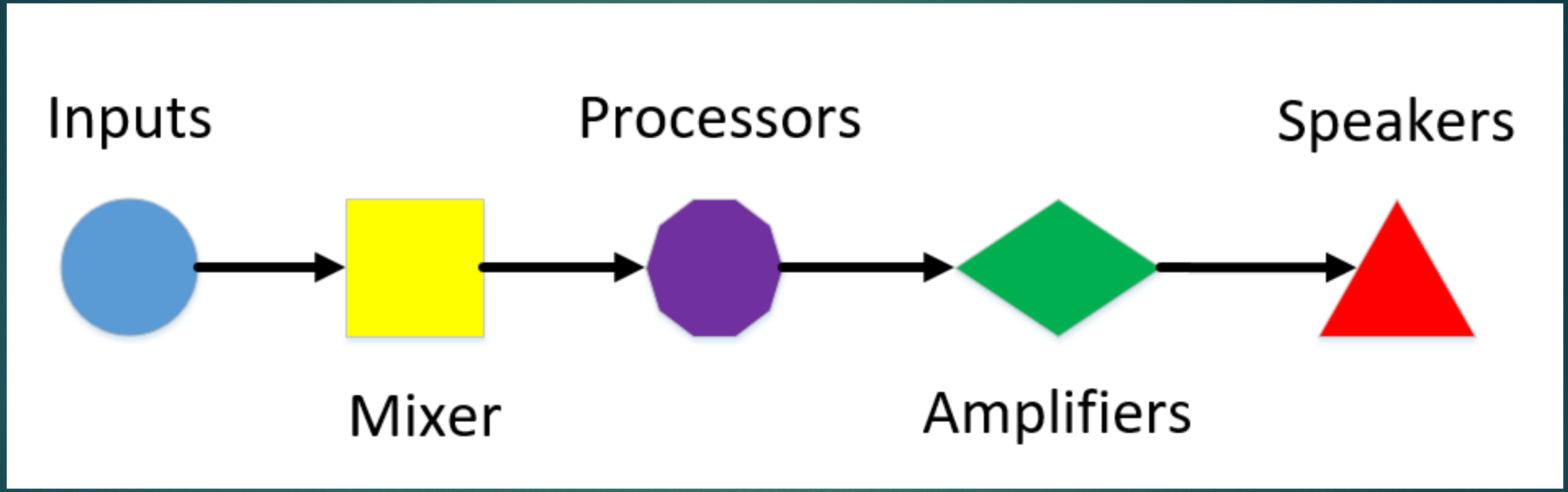
- **DO NOT USE**

3.5mm to XLR Cable when plugging in a Phone, Tablet or Computer.

If the “Phantom Power” (48v) is turned activated on the mixer, it will destroy your device.

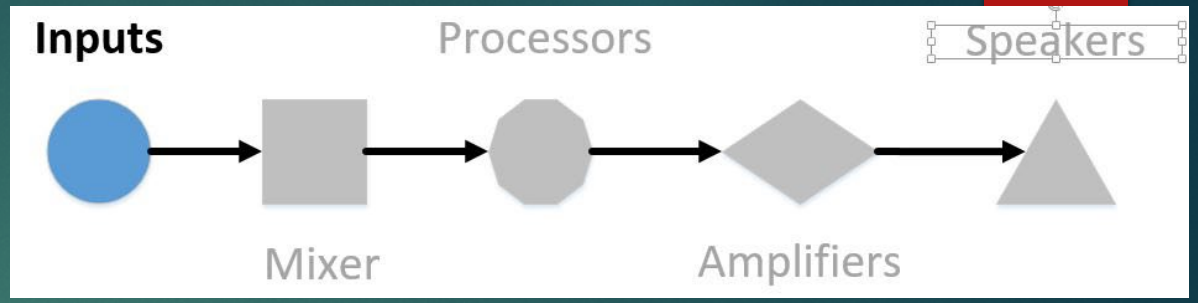
48-volts is sent down the cable and straight into your device, releasing the “magic Smoke”

The 5 Parts to a Sound System



5-Parts of the Sound System

Part 1 - Inputs



- Anything going into the mixer

1. Microphones
2. Instruments – Guitars, Keyboards
    1. Either direct to the mixer or through a DI Box
        1. What's a DI Box? Direct Injection Box – Converts an unbalanced ¼" cable to a balanced XLR Cable for long distance runs.
3. Bluetooth, iPods, Phones, etc.
4. Computers
    1. Best to use a computer interface – similar to a DI Box, but with a 3.5 plug and specifically designed to interface with a laptop.

What are the inputs plugged into?

Wall Plates

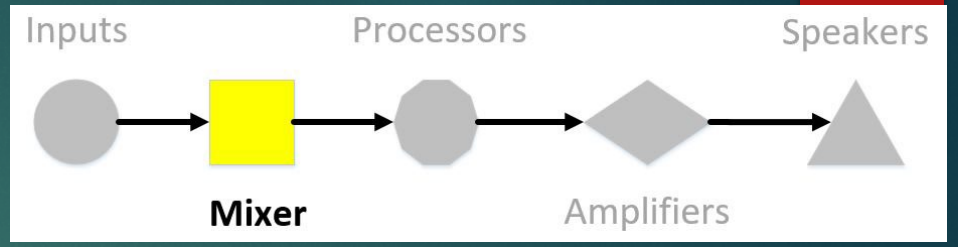
Audio Snake

Stage Box

Dante

5-Parts of the Sound System

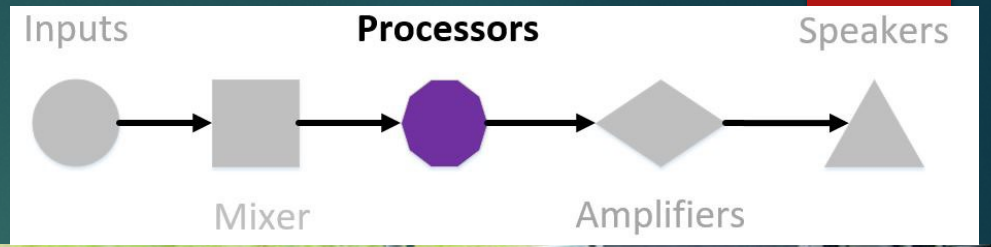
Part 2 - Mixers



- The mixer is the central hub of a sound system, where audio signals are combined and controlled.
- Each input source has a dedicated channel for adjustment.
- Mixers come in all different sizes from small 2-channel mixers to large 56+ channel mixers.
- Today's Mixer are either Analog or Digital.

5-Parts of the Sound System

Part 3 - Processors



- Signal Processors enhance and modify audio signals.
- Equalizers, Compressors, Effects Processors, Crossovers
- Can be external processors, like overall DSP system processors, or built into the mixer.


DigiTech
EQ
GATE
COMP
FX SENDS
AUX SENDS
PATCHING
dbx
PRESETS
FREQ
365hz
22kHz
Q
1.00
15
GAIN
-5.4dB
+20dB
+20
+10
0
-10
-20
HPF
1
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Ø
EASY EQ
RTA
HOLD RTA
RESET


DigiTech
EQ
GATE
COMP
FX SENDS
AUX SENDS
PATCHING
dbx
PRESETS
RATIO
2.3
ATTACK
30ms
RELEASE
500ms
GAIN
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T
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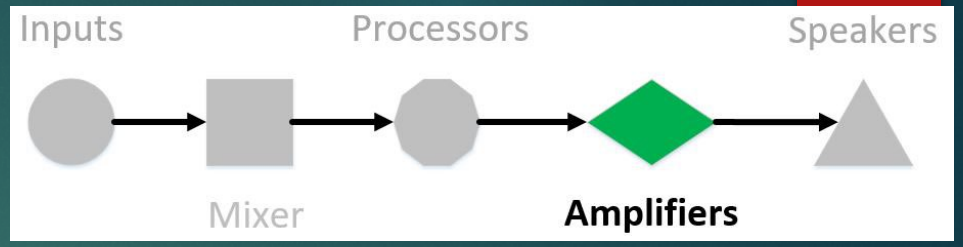
IN
OUT
COMP
THRESHOLD
-27.8dB
HARD KNEE
RESET
BYPASS

5-Parts of the Sound System

Part 4 - Amplifiers



- Amplifiers increase the power of audio signals to drive the speakers.
- Come in different channel configurations
  - Single Channel, 2-Channel (most common), 4-Channel and 8-Channel
- Are available in different wattage amounts, the amount of watts it can produce.
  - Match the amps power to the speaker requirements
  - Having an amp with more available power then the speaker requires (within reason) is better then having an amp that is under powered. This can result in damage to the speakers and amplifier.

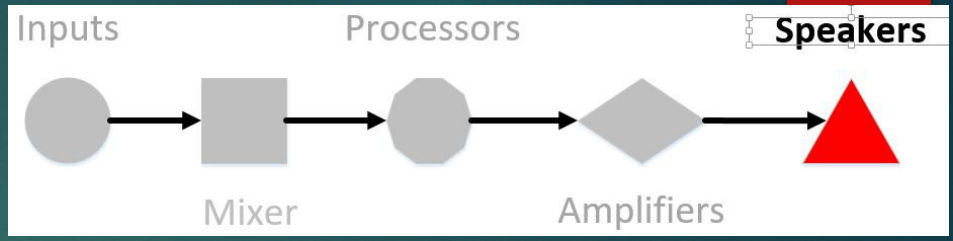
- Amplifier modes:
  1. Stereo – Each channel of the amplifier acts independently of the other channel. (ex. Left and Right are separate)
  2. Mono – The two channel's inputs are combined. This combined signal is sent to both power amps.
  3. Bridge – This mode is to provide the most power the amplifier can deliver, to ONE channel. It combines the output of both channels into a single output. To use this feature, it usually requires special wiring on the output side of the amplifier.
     - Example, if the amplifier will produce1000 watts per channel (stereo) at 4 ohms, it will probably produce 2000 watts into 8 ohms (mono). This is useful for powering large subwoofers that require a lot of power.

- The lower the speaker's ohms, the more power the amplifier will try to produce.
- Amplifiers have a minimum ohms rating. 2 or 4 ohm minimum are standard now with most amps.

- <u>Warning: Do not take the output of one amplifier into the input of another power amplifier.</u>

5-Parts of the Sound System

Part 5 - Speakers



- The final stage of a sound system, speakers convert amplified signals into audible sound.
- Speaker Types:
  - Passive – Require external amplifiers
    - Have a nominal impedance – example 8 ohms
    - You have to be careful when combining speakers (going from one speaker to another). This will produce a lower impedance (ohms). Amplifiers have a minimum ohm rating. If you go below the minimum ohm rating of an amplifier, you can damage the amplifier.
    - 2ea. 8-ohm speakers, when combined, will produce a 4 ohm load.
    - 4ea. 8-ohm speakers, when combined on one channel, will produce a 2 ohm load.
    - Easiest way to calculate the load for 2 speakers is: Product of the ohms divided by the sum of the ohms.
      - 2ea. 8-ohm speakers = 8x8=64/ 8+8=16, so 64/16=4
  - Active – Have built-in power amplifiers. No limit on how many active speakers can be combined, due to each speaker having it's own amplifier.

- Speaker Modes:
  - Full Range – A full range signal is sent to the speaker, where the speaker internally splits the signal into lows and highs, and then sends the split signal to the horn and woofer.
  - Bi-Amped – An external processor divides the signal into lows and highs, which are then sent to separate power amps and subsequently directed to the individual components of the speakers.,

Subwoofers

- Subwoofers are speakers designed to handle the very low frequencies of the audio signal.

- They can be fed from the main output signal from the mixer, going through a crossover to allow only the low frequencies to go to the subwoofer.
- They can also be fed from a separate channel of the mixer, to provide independent control for the subwoofer.

Components can be combined

- All 5 parts of the sound system can be separate, or different parts can be combined into one:
  - The mixer could have the processing built-in, or have the processing and amplifier built in.
  - The amplifier can have the processing built-in.
  - The speaker can have the amplifier built-in.

Microphones

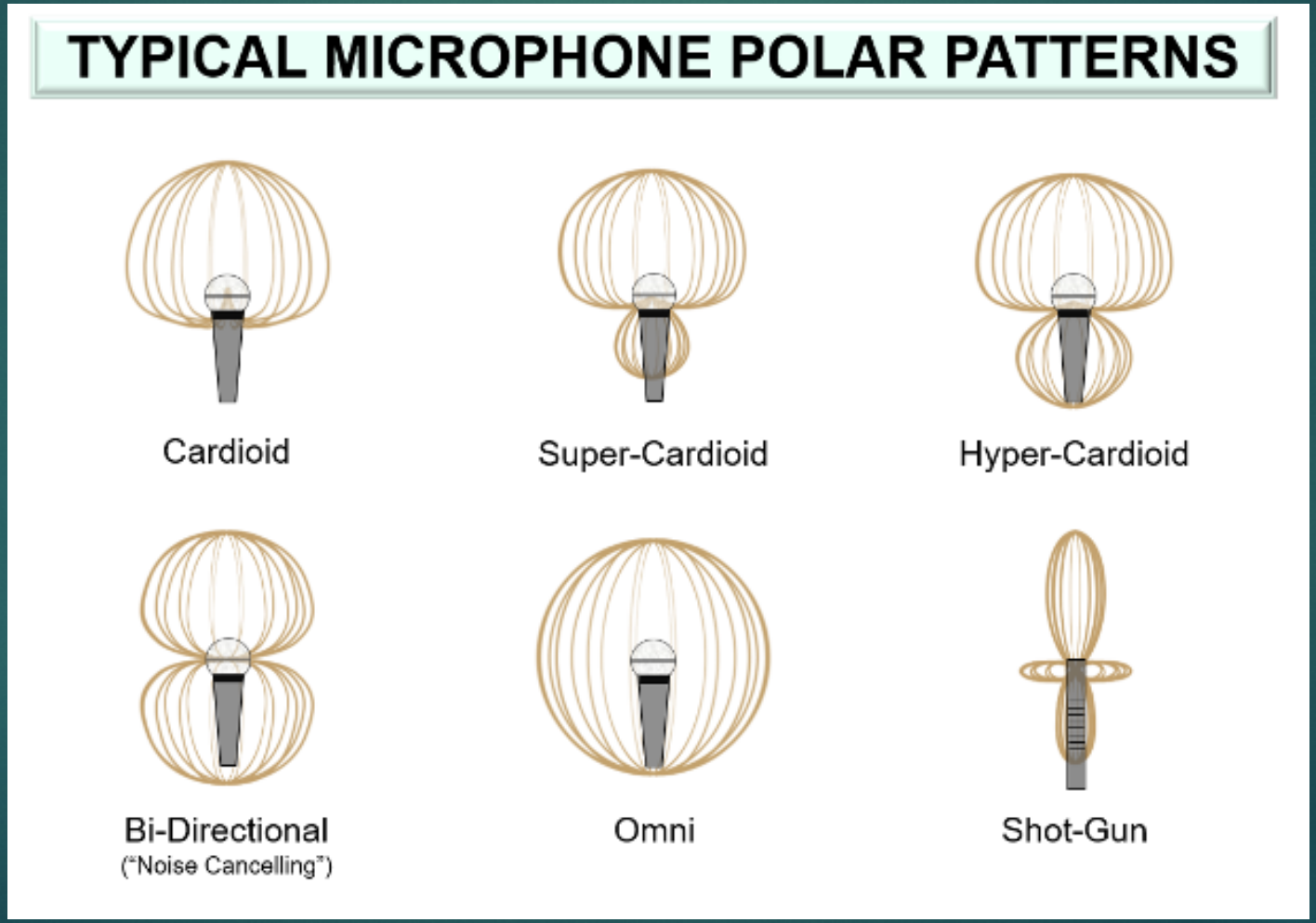
- Microphones come in 3 basic types:
  - Dynamic –
    - Uses electromagnetism tor create the sound. Works like a speaker in reverse. Use sound waves that vibrate the diaphragm and create electricity. This electricity is then increased with the use of a transformer, and sent to the microphone's output, creating sound.
    - Standard mic, does not require power.
    - Great at rejecting sound from the sides of the microphone
    - Suffers from proximity effect – Closer you get to the mic, the better the bass response is.
    - Typical handheld microphone and used for vocals and instruments.

- Condenser –
  - Condenser microphones work on the principle of variable capacitance. Sound waves vibrate the diaphragm with a magnetic plate that's behind it. When this happens, it creates a boost of voltage which is sent through a phantom power supply (+48V) to increase it then sent to the output of your microphone.
  - Requires a power source. Usually the 48-volt Phantom Power from the mixer powers these mics.
  - They are more sensitive then dynamic mics, but have lower "Gain-Before-Feedback.
  - Do not suffer from proximity effects
  - Usually used as hanging choir microphones, podium microphones and overhead drum microphones.

- Ribbon – Very fragile and mostly found in recording studios.

Microphone Polar Patterns

- The area around a microphone that the microphone will pick up audio.



Wireless Microphones

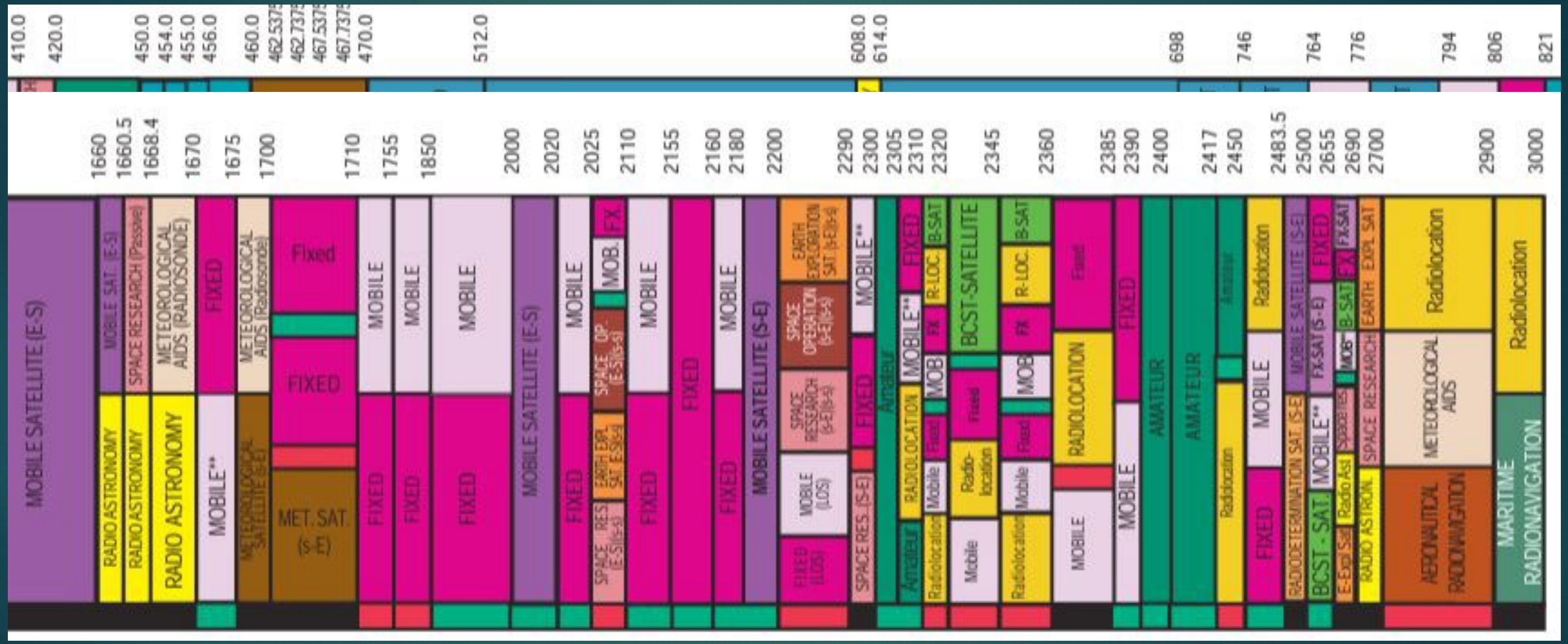
- Wireless system come with either:
  - Hand Held Transmitter
  - Body Pack Transmitter with different microphone options
    - Lavalier
    - Earset – Over the ear with a mic capsule on the end of a miniature boom
    - Headset

- Every microphone / transmitter must have it's own receiver, set to a different channel.
- Two transmitters set on the same channel with interfere with each other.

Wireless Frequencies

- Wireless microphones operate in the open frequency bandwidth between TV station.
- This space is getting smaller and smaller.
- If you are planning on using more then 4 wireless system together, your really need good quality, mid range or above systems, to allow all the systems to operate together.
- Inexpensive systems do not offer tight enough frequency control.
- Proper frequency set-up is very important and gets more complicated with the more systems you add, due to Intermodulation
- The good news is that most mid-level systems have auto-scan features to help with or completely do the set.
- Great free tool: Shure Wireless Workbench

Radio Space


410.0
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806
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3000
MOBILE SATELLITE (E-S)
RADIO ASTRONOMY
RADIO ASTRONOMY
MOBILE SAT. (E-S)
SPACE RESEARCH (Passive)
METEOROLOGICAL AIDS (RADIOSONDE)
FIXED
MOBILE**
METEOROLOGICAL SATELLITE (s-E)
MET. SAT. (s-E)
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MOBILE
MOBILE SATELLITE (E-S)
MOBILE
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SPACE RES. (s-E)
EARTH EXPL. SAT. (s-E)
SPACE RESEARCH (s-E)
SPACE OPERATION (s-E)
MOBILE (LOS)
FIXED (LOS)
SPACE RES. (E-S)
EARTH EXPL. SAT. (E-S)
SPACE OP. (E-S)
MOB.
FX
MOBILE
FIXED
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MOBILE
FIXED
MOBILE**
Amateur
Amateur
RADIOLOCATION
Radiolocation
Mobile
Fixed
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FIXED
FX
R-LOC.
B-SAT
Mobile
Radio-location
Fixed
BCST-SATELLITE
Radiolocation
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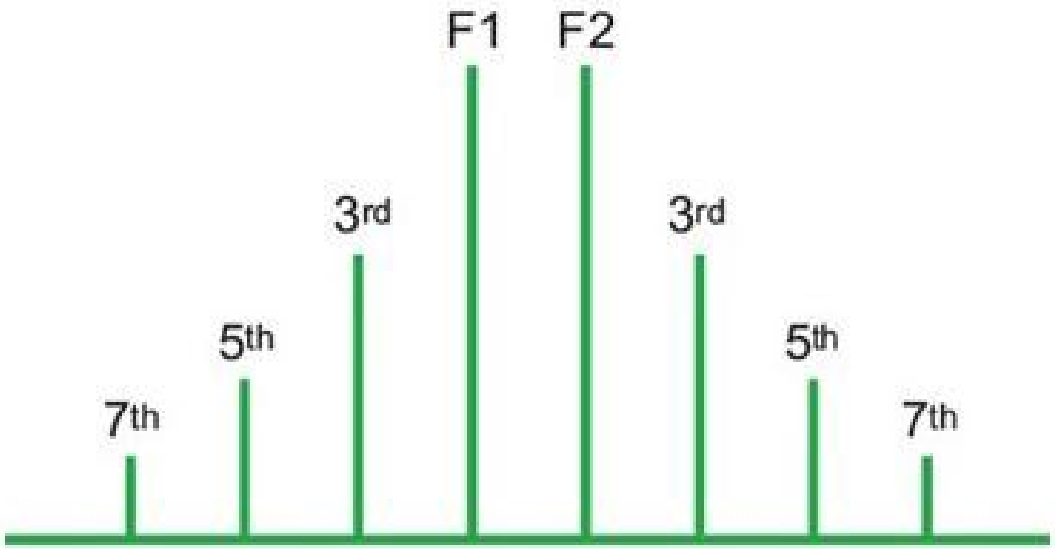
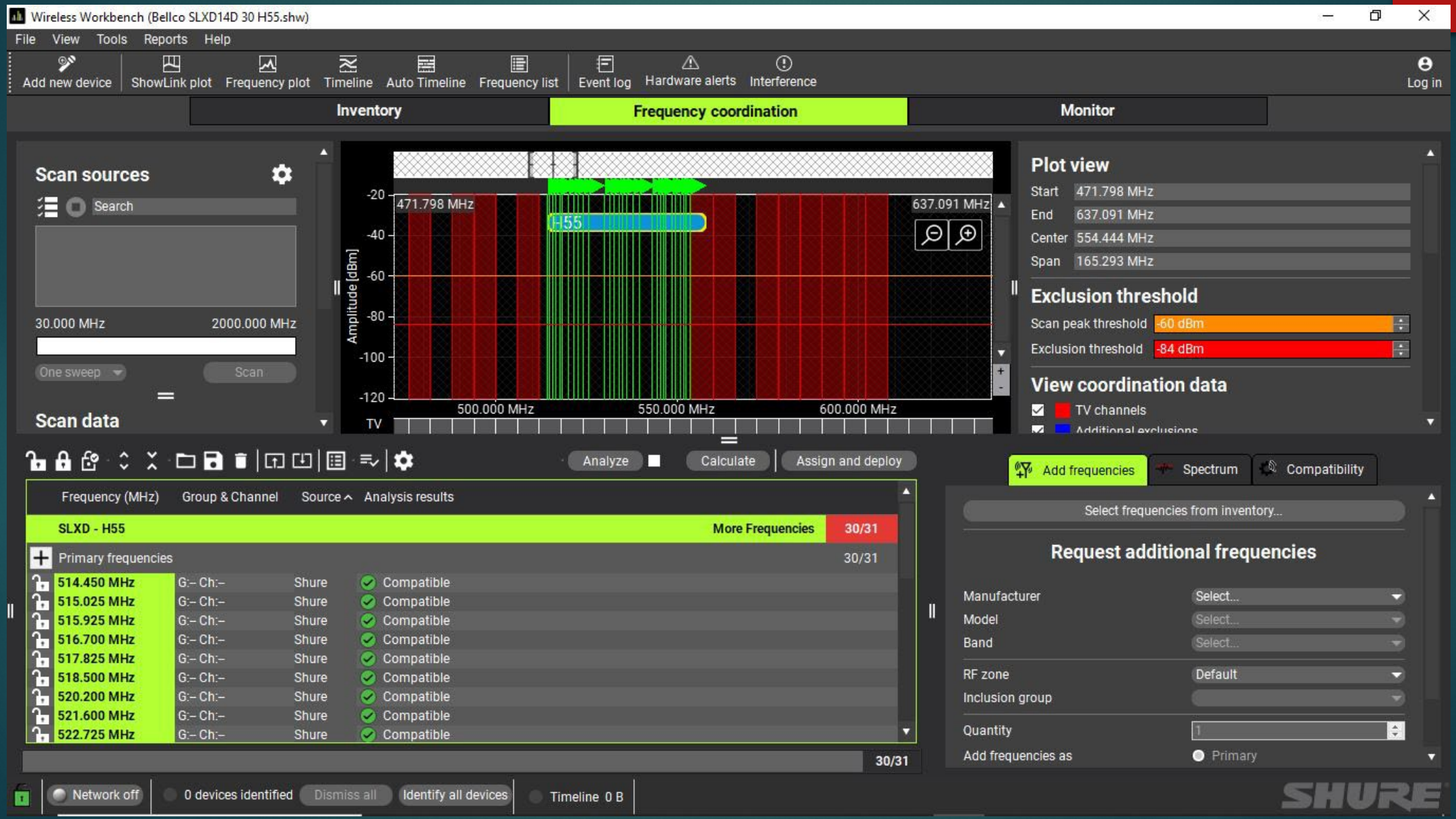
FX
FX-SAT
RADIO ASTRON.
SPACE RESEARCH
EARTH - EXPL SAT
AERONAUTICAL RADIONAVIGATION
METEOROLOGICAL AIDS
Radiolocation
MARITIME RADIONAVIGATION
Radiolocation

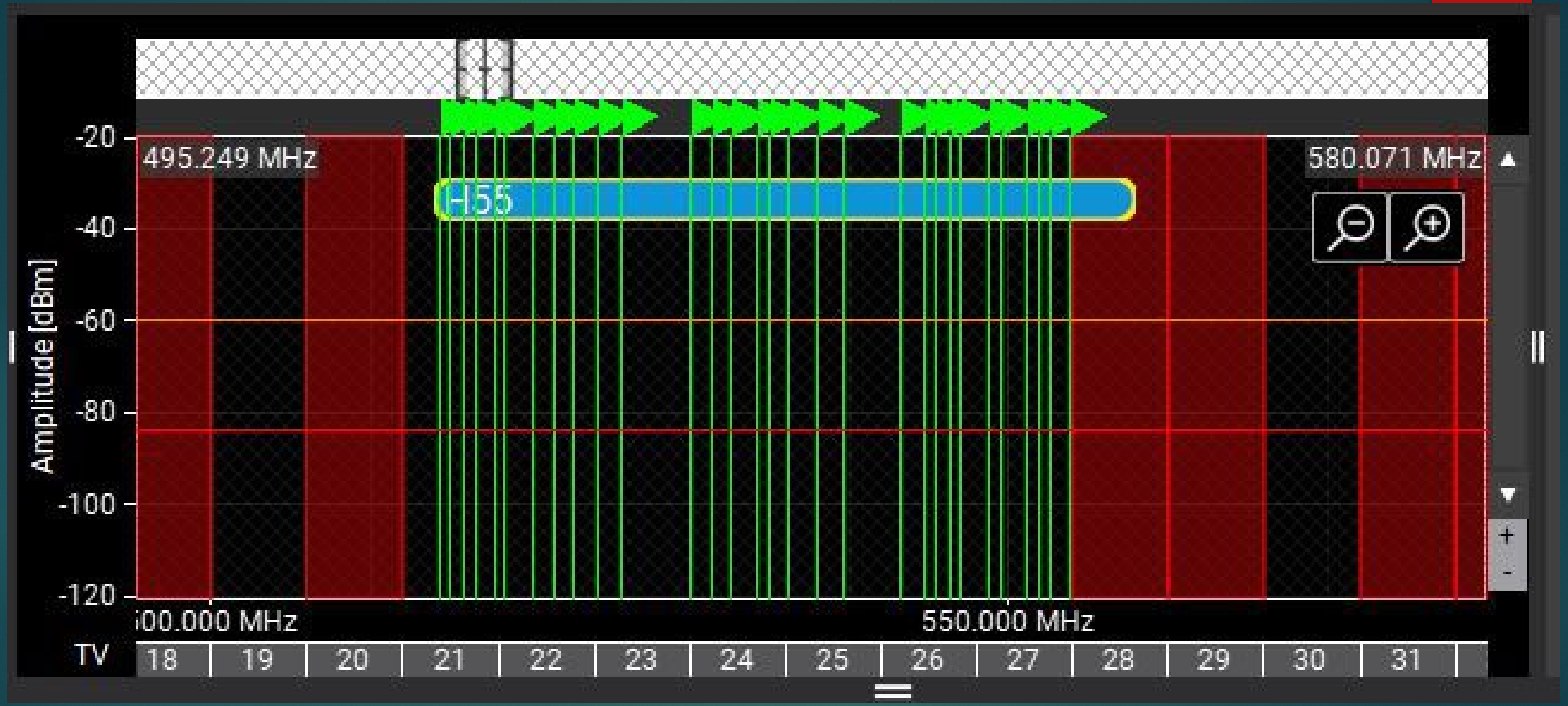
Wireless Intermodulation



Two or more signals can mix together to create harmonics or 'Intermodulation Products'

Shure Wireless Workbench




-20
-40
-60
-80
-100
-120
Amplitude [dBm]
495.249 MHz
580.071 MHz
H55
550.000 MHz
TV
18
19
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31

Antennas

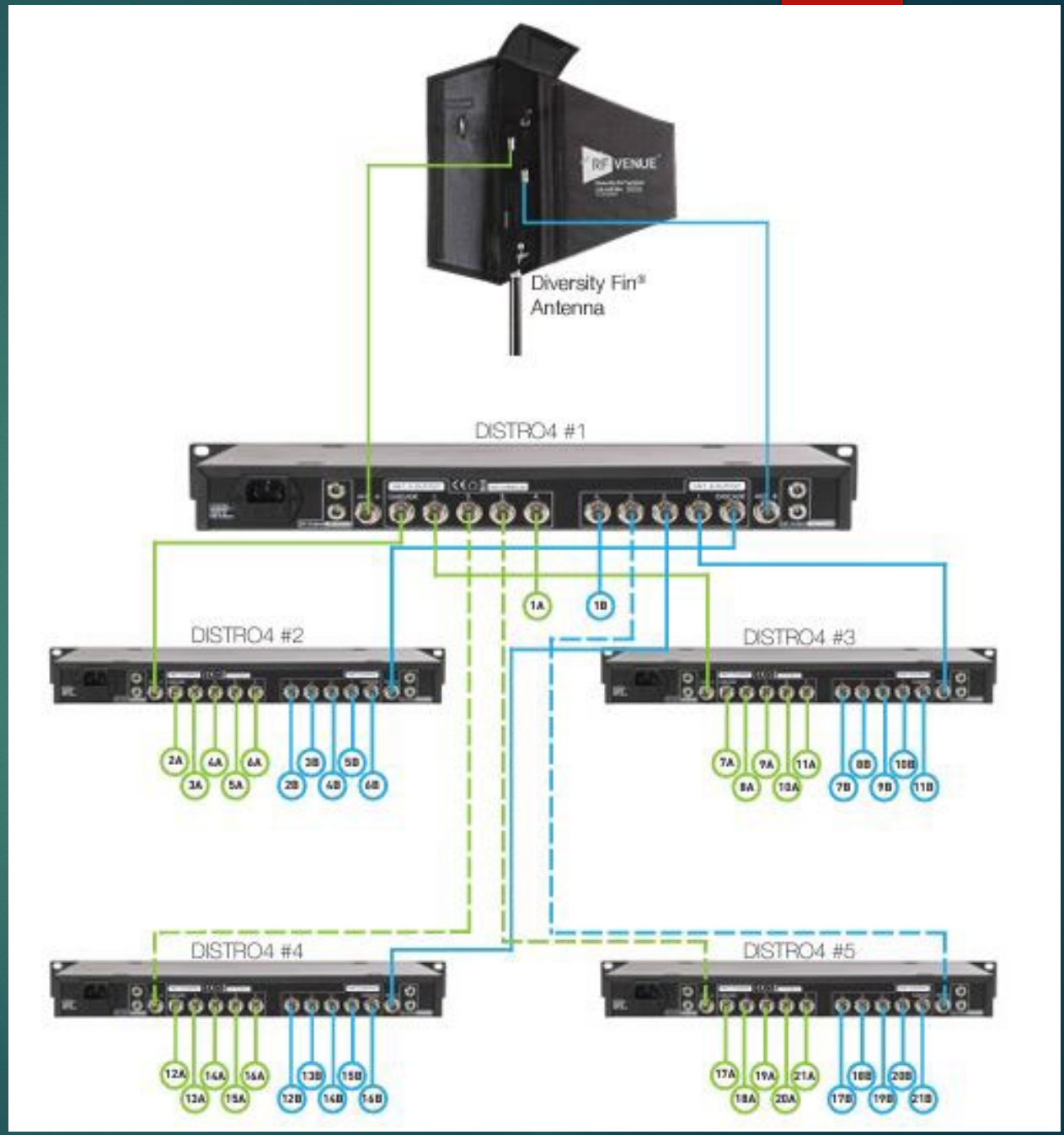
¼ Wave

½ Wave

Directional

Antenna Distribution

Example of a 21 Wireless Microphone System



Mixer – What are all those knobs?

- All mixers have some variation of the same inputs and controls.
  - Inputs – XLR and ¼" inputs
    - Digital mixers now use stage boxes along with "local" inputs
  - Some Mixers have "Insert" ¼" jacks – This is an In and Out for effects and other processors. Uses a special Y cable that has a TRS plug on one end and splits out to two mono ¼" plugs. It is not an input.
  - Gain – Incoming volume for that input.
  - 48v – Phantom Power
  - Phase – Not commonly used
  - EQ – Shelving, semi-parametric, and parametric (on digital mixers)

- Aux Sends – Monitor mixes and FX sends
- Pan Control – Left / Right control
- Mute
- Signal routing – Main or sub-groups
- PFL – Pre Fader Listen for use with headphones
- Fader – Final volume control for the house mix of that channel

Troubleshooting

- Know your system.
- Is all the power buttons turned on for all of your equipment.
  - It is common for an amplifier to get turned off
- Start from the input and work your way through the system.
  - Are you seeing signal on that channel
  - Are you seeing activity on the main meters
  - Are you seeing signal lights on the processors
  - Are you seeing signal lights on the amplifiers
  - Are the speakers plugged in.

Resources

- Yorkville has 2 very good, easy to follow Sound System guides:
- Basic PA
- Professional Audio Guides –
  Comprehensive Text