# Shop Prep for RF

By Ike Zimbel



# Shop prep: What's the goal?

- The goal: A complete, functional RF package that will deploy at the job site, with no surprises!
- Touchstones:
- Consistency: All systems that *are* the same *work* the same
- Accuracy: All I/O is patched correctly
- Documentation: What have you built?
- Repeatability: Could you build the same system again, if required?

# Shop prep for RF: Hardware:

- Check firmware in all devices and update all to the same version.*
- Reset all hardware's firmware (ie: Factory reset).
- Reset all hardware's hardware: Mic/Line and ground Lift switches, any other physical controls.
- Establish a system/table for IP addresses. Address in groups and leave gaps for changes / additions.
- Check all hardware for physical integrity: Loose screws (especially on rack ears), missing/broken jack hardware, display backlights etc.
- Above applies to IP switches as well. Check it all!.
- *subject to company guidelines on updates!

# Shop Prep for RF: Racks

- Plan it out!
- Talk to engineers to find out their preferred operating levels and IEM pack presets (Limiter settings etc.)
- Place units you need to see / touch near the top of the rack for easy viewing.
- My standard is antenna distros at the top, then receivers, then IEM transmitters.
- Power management: Manage the power!

# Shop Prep for RF: Rack planning

| | FRONT RACK 12-U | REAR |
|---|---|---|
| 1 | AC Power & Light | VENT |
| 2 | MAT288 | VENT |
| 3 | AXT630 | 20 PORT SWITCH |
| 4 | AD4Q-1 | |
| 5 | AD4Q-2 | 3-U DOOR PANEL |
| 6 | AD4Q-3 | |
| 7 | AD4Q-4 | ANTENNA I/O |
| 8 | EM6000-1 | |
| 9 | EM6000-2 | AUDIO I/O |
| 10 | EM6000-3 | |
| 11 | | AC I/O |
| 12 | 2-U DRAWER | |

**Number of connections per unit:**

| MAKE/MODEL: | | Shure AD4Q | Shure AD4Q | Shure AD4D | Shure AD4D | Senn EM6000 | Senn EM6000 |
|---|---|---|---|---|---|---|---|
| Connection: | Type: | Max Qty: | Min Qty: | Max Qty: | Min Qty: | Max Qty: | Min Qty: |
| AC | IEC-M | 1 | 1 | 1 | 1 | 1 | 1 |
| AC pass through | IEC-F | 1 | | 1 | | | |
| Antenna A | BNC | 1 | 1 | 1 | 1 | 1 | 1 |
| Antenna B | BNC | 1 | 1 | 1 | 1 | 1 | 1 |
| Ant-A pass thru | BNC | 1 | | 1 | | 1 | |
| Ant-B pass thru | BNC | 1 | | 1 | | 1 | |
| Network | RJ45 | 1 | 1 | 1 | 1 | 1 | 1 |
| Network thru | RJ45 | 1 | | 1 | | 1 | |
| Audio Ch-1 | XLR | 1 | 1 | 1 | 1 | 1 | 1 |
| Audio Ch-2 | XLR | 1 | 1 | 1 | 1 | 1 | 1 |
| Audio Ch-3 | XLR | 1 | 1 | | | | |
| Audio Ch-4 | XLR | 1 | 1 | | | | |
| AES 1-2 | XLR-110 | | | | | 1 | |
| AES 3-4 | XLR-110 | | | | | | |
| CLOCK | BNC-75 | | | | | 1 | |
| CLOCK Thru | BNC-75 | | | | | 1 | |
| Dante Primary | RJ45 | 1 | | 1 | | 1 | |
| Dante Secondary | RJ45 | 1 | | 1 | | 1 | |
| TRS Ch-1 | TRS | 1 | | 1 | | 1 | |
| TRS CH-2 | TRS | 1 | | 1 | | 1 | |
| TRS Ch-3 | TRS | 1 | | | | | |
| TRS CH-4 | TRS | 1 | | | | | |
| **Total:** | | **18** | **8** | **14** | **6** | **16** | **6** |

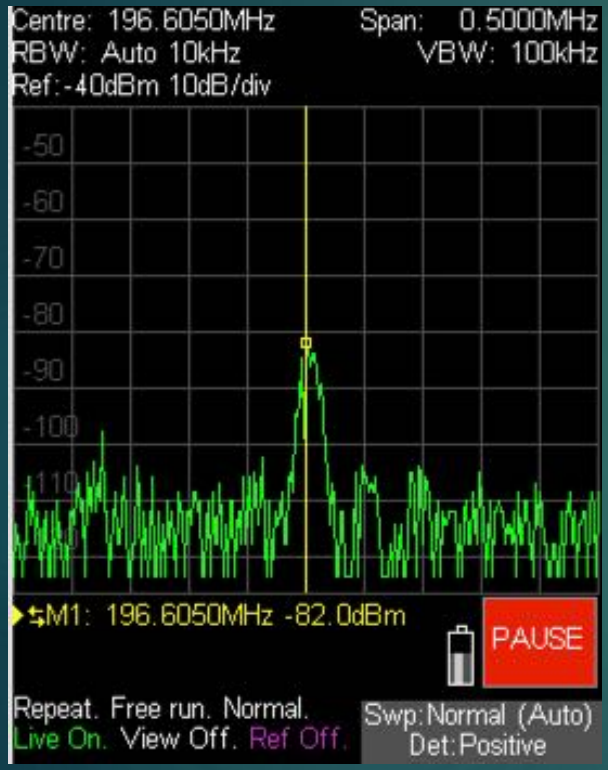
# Shop prep for RF: Racks-1:

- On large racks, install master antenna distro, even if RX's have loop-through BNC's.
- Feed groups of RX's from separate outputs of master distro.
- Do NOT bundle BNC cables with cable ties.
- Route audio connections on one side, AC and Ethernet on the other, BNC's up the middle.
- Check BNC's for defects; recessed pins etc. Check with TG if available.
- Use minimal pass throughs for antenna connections.

# Shop prep for RF: Racks-2:

- Rack hardware with lowest frequency range in top of rack. Next lowest in next group etc.
- Cable IEM antenna outputs vertically, so on a Shure PA821-B, for example, the first four inputs would be IEM 1-3-5-7 and the second four would be 2-4-6-8.
- Never, ever, daisy-chain IEM combiners! If they must be combined, use the passive combiners provided (Shure) or external passive combiners.

# Shop prep for RF: Rack cabling




RF emissions from a Stage Rack

While most of us use RG58 for interior rack wiring, that cable offers, at best, 95% shielding.

Consider upgrading rack wiring to double shielded (braid over foil) RG-8X or equivalent. Especially if using VHF systems like AD V-50, or RAD Intercom systems.

# Shop Prep for RF:

| Lowest frequency | | | | | |
|---|---|---|---|---|---|
| **IEM's G10** | | | | | |
| Shure PSM-1000 G10 | Seamus Local PFL | 471.600 | Shure PSM-1000 G10 | Didgi-L Nate | 475.150 |
| Shure PSM-1000 G10 | Didgi-2, Paul | 473.875 | Shure PSM-1000 G10 | | 474.300 |
| Shure PSM-1000 G10 | Hugh Mic-1 | 475.250 | Shure PSM-1000 G10 | Jenna | 482.950 |
| Shure PSM-1000 G10 | Kayleigh | 483.525 | Shure PSM-1000 G10 | Deacon | 484.375 |
| Shure PSM-1000 G10 | Guest-1, Clifton | 485.400 | Shure PSM-1000 G10 | Guest-2, Olive | 486.025 |
| Shure PSM-1000 G10 | | 487.125 | Highest frequency | | |

| JU IEM's JR | | | | | |
|---|---|---|---|---|---|
| Shure PSM-1000 JR | Kasia | 602.775 | Shure PSM-1000 JR | Tech | 603.200 |
| Shure PSM-1000 JR | Hugh Mic-2 | 604.400 | Shure PSM-1000 JR | MD Patrick | 605.350 |
| Shure PSM-1000 JR | Guest-0 | 606.450 | Shure PSM-1000 JR | GTR 12 | 607.875 |
| Shure PSM-1000 JR | Spare Mic | 614.175 | Shure PSM-1000 JR | PFL-Cue Shouts | 614.875 |
| Shure PSM-1000 JR | | 616.175 | | | |

| JU Mics and Instruments | | | | | |
|---|---|---|---|---|---|
| Sennheiser EM6000 AJ-4 | JUVPM-1 | 538.675 | Sennheiser EM6000 A1-4 | JU HH-1 | 543.575 |
| Sennheiser EM6000 AJ-4 | JU HH-2 | 544.375 | Sennheiser EM6000 A1-4 | Jenna | 545.450 |
| Sennheiser EM6000 AJ-4 | Kayleigh | 546.100 | Sennheiser EM6000 A1-4 | Brenta | 546.850 |
| Sennheiser EM6000 AJ-4 | Guest-0 | 547.450 | Sennheiser EM6000 A1-4 | AC GTR | 548.075 |
| Sennheiser EM6000 AJ-4 | JU HDST | 548.675 | Sennheiser EM6000 A1-4 | Kasia | 549.375 |
| Sennheiser EM6000 AJ-4 | Didgi-1 | 549.975 | Sennheiser EM6000 A1-4 | Didgi-2 | 550.600 |
| Sennheiser EM6000 AJ-4 | JU USPR | 551.200 | Sennheiser EM6000 A5-8 | Guest-1 | 551.850 |
| Sennheiser EM6000 A5-8 | Guest-2 | 552.475 | Sennheiser EM6000 A5-8 | VDG | 553.075 |
| Sennheiser EM6000 A5-8 | Ultimate Spare | 553.700 | Sennheiser EM6000 A5-8 | JUVPM-2 | 568.575 |

| PA Tuning Mic | | | | | |
|---|---|---|---|---|---|
| Lectrosonics 100 KHz Block 22 | | 470 570.400 | Lectrosonics 100 KHz Block 22 | | TA 575.400 |

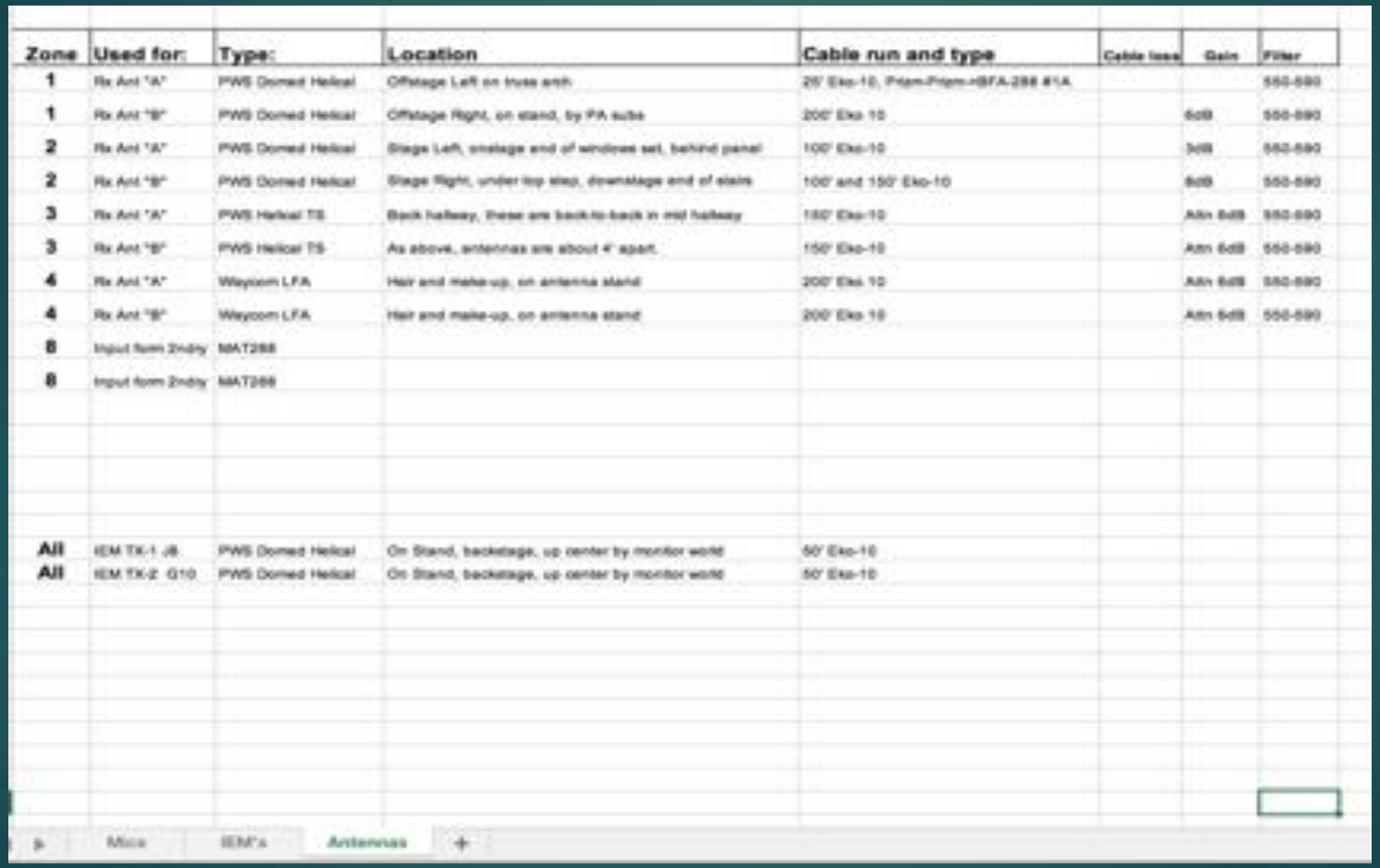
| RF Shouts | | | | | |
|---|---|---|---|---|---|
| Shure UHF-R G1 | David | 528.450 | Shure UHF-R G1 | Ilse | 529.000 |

Items printed in Red, Strike Through Text are NOT Coordinated. Items printed in Dark Yellow Italics have new frequencies. Items printed in Underlined with Orange Background do not match the freq range of the model. Items printed in Blue were manually accepted during IMD testing.

# RF Prep: Documentation

| | Show: | | Hugh Jackman 2019 Tour | | | | Date: 04-16-19 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Show batteries | Mic # | Artist | TYPE: | Firmware | Gain/Aden | RF power | Range | HPF | NOTES: MAT288, master antenna distro. | IP Address: 10.10.10.101 |
| Y | RF-1 | Hugh HH-1 | SKM6000 | 2.2.4.126 | 12dB | LR | A1-4 | 100 Hz | w/ MD9235 capsule. Change gain to +12dB, 07-13-19 | 10.10.10.11 |
| | RF-1-A | Hugh HH-1 | SKM6000 | 2.2.4.126 | 12dB | LR | A5-8 | 100 Hz | | |
| Y | RF-2 | Hugh HDST | SK6000 | 2.2.4.126 | 9dB | | A1-4 | 100 Hz | HSP-4 headset | 255.255.255.000 |
| Y | RF-3 | BV-1 Jenna | SK6000 | 2.2.4.126 | 9dB | | A1-4 | 100 Hz | HSP-4 headset | 10.10.10.12 |
| Y | RF-4 | BV-2 Kayleigh | SK6000 | 2.2.4.126 | 9dB | | A1-4 | 100 Hz | HSP-4 headset | |
| Y | RF-5 | BV-3 Bronté | SK6000 | 2.2.4.126 | 18dB | | A1-4 | 100 Hz | HSP-4 headset | 10.10.10.13 |
| | RF-6 | Guest-6 | SK6000 | 2.2.4.126 | 15dB | | A1-4 | 100 Hz | Special guests channel | |
| Y | RF-7 | Acc GTR | SK6000 | 2.2.4.126 | -6dB | | A1-4 | 100 Hz | 2 x ferrites on cable, doubled at each end | 10.10.10.14 |
| Y | RF-8 | Keala | SK6000 | 2.2.4.126 | 9dB | | A1-4 | 120 Hz | Keala will use when she's with us. | |
| Y | RF-9 | HJ HH-2 | SKM6000 | 2.2.4.126 | 12 | | A5-8-A1-4 | 100 Hz | W13448 was A5-8 stick, replaced 05-21-19, weak Tx. | 10.10.10.15 |
| Y | RF-10 | HJ Univ Spr | SKM6000 SK6000 | 2.2.4.126 | see note | | A1-4 | 100 Hz | HH (12dB) and Headset (9dB) | |
| | RF-11 | Didgi-1 | SK6000 | 2.2.4.126 | 12dB | | A1-4 | 100 Hz | DPA 4099 | 10.10.10.16 |
| | RF-12 | Didgi-2 | SK6000 | 2.2.4.126 | 12dB | | A1-4 | 100 Hz | DPA 4099 | |
| Y | RF-13 | Guest-1 | SKM6000 | 2.2.4.126 | 18dB | | A5-8 | 100 Hz | | 10.10.10.17 |
| Y | RF-14 | Guest-2 | SKM6000 | 2.2.4.126 | 9dB | | A5-8 | 100 Hz | Gain change to +9dB for Jenna | |
| Y | RF-15 | VOG | SKM6000 | 2.2.4.126 | 18dB | | A5-8 | 100 Hz | | 10.10.10.18 |
| Y | RF-16 | Ultimate Spare | SKM6000 | 2.2.4.126 | 9dB | | A5-8 | 100 Hz | Used for DJ, spare for all except HJ, change gain to 9dB to match Jenna and Keala | |
| | RF-17 | Patch Shout | UHF-R URM1 | 1.1T1 | 0dB | Normal | H4 | n/a | Sens at 0, Gain at "+6" | 10.10.10.009 |
| | RF-18 | Ike Shout | UHF-R URM1 | 1.1T1 | 0dB | Normal | H4 | n/a | Sens at 0, Gain at "+6", o/p -6, Mic | |
| | BVPIM-1 | Jenna Prop | | | | | A1-4 | | c/w dead battery | |
| | BVPIM-2 | Kayleigh Prop | | | | | A5-8 | | c/w dead battery | |

# RF Prep: Documentation-2



| Zone | Used for: | Type: | Location | Cable run and type | Cable loss | Gain | Filter |
|---|---|---|---|---|---|---|---|
| 1 | Rx Ant "A" | PWS Domed Helical | Offstage Left on truss arch | 25' Eko-10, Prism-Prism-nBFA-288 #1A | | | 550-590 |
| 1 | Rx Ant "B" | PWS Domed Helical | Offstage Right, on stand, by PA subs | 200' Eko 10 | | 6dB | 550-590 |
| 2 | Rx Ant "A" | PWS Domed Helical | Stage Left, onstage end of windows set, behind panel | 100' Eko-10 | | 3dB | 550-590 |
| 2 | Rx Ant "B" | PWS Domed Helical | Stage Right, under top step, downstage end of stairs | 100' and 150' Eko-10 | | 6dB | 550-590 |
| 3 | Rx Ant "A" | PWS Helical TS | Back hallway, these are back-to-back in mid hallway | 150' Eko-10 | | Attn 6dB | 550-590 |
| 3 | Rx Ant "B" | PWS Helical TS | As above, antennas are about 4' apart. | 150' Eko-10 | | Attn 6dB | 550-590 |
| 4 | Rx Ant "A" | Wayoom LFA | Hair and make-up, on antenna stand | 200' Eko 10 | | Attn 6dB | 550-590 |
| 4 | Rx Ant "B" | Wayoom LFA | Hair and make-up, on antenna stand | 200' Eko 10 | | Attn 6dB | 550-590 |
| 8 | Input from 2ndry | MAT288 | | | | | |
| 8 | Input from 2ndry | MAT288 | | | | | |
| All | IEM TX-1 J8 | PWS Domed Helical | On Stand, backstage, up center by monitor world | 50' Eko-10 | | | |
| All | IEM TX-2 G10 | PWS Domed Helical | On Stand, backstage, up center by monitor world | 50' Eko-10 | | | |

Mics | IEM's | Antennas | +

# Shop Prep for RF: Documentation

**Show files:**

IAS, WWB, WSM, WSD etc.

Any IP related files: Dante routing etc.

Save them all on a CLEAN USB stick.

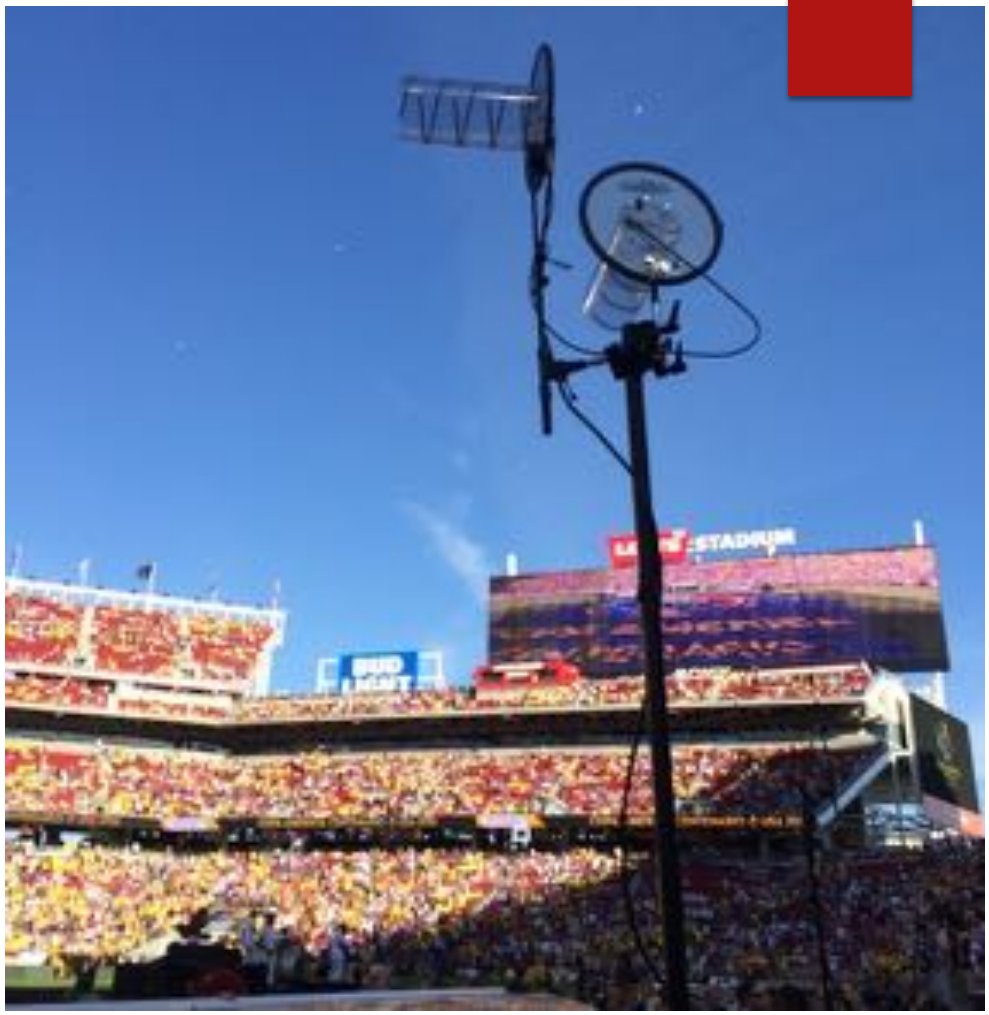
…and then upload them to cloud based storage like DropBox, OneDrive, iCloud etc.

# Shop prep for RF: Antennas:

- Check carefully for good physical condition, especially BNC (or N) connectors and mounting hardware.
- Check with antenna tester, if available and establish base VSWR readings.
- **VSWR** stands for **Voltage Standing Wave Ratio**, and is also referred to as **Standing Wave Ratio** (SWR). **VSWR** is a function of the reflection coefficient, which describes the power reflected from the antenna.
- The area of lowest reflection is the optimal tuning area for the antenna, typical the mid-point of the range they are meant to be used in.

# Shop prep for RF: Antenna Support

- Check all mic stands, tri-pod stands, Magic-Arms, clamps etc for missing and broken parts.
- Have multiple mounting options for each antenna as conditions can change, a lot, on site.



# Shop prep for RF: Common errors:

- Missed loop-through connections
- Reversed loop-through connections
- Cascaded IEM combiners
- Unsupported rack gear
- Inaccessible rear panels on equipment.

# Shop Prep for RF: Anatomy of an RF cable (coax)

# Shop prep for RF: Cables

- Inspect all for nicks, cuts, kinks, bends, crushing.
- Inspect connectors for bent or broken rings, bent-crushed-recessed pins, spread sockets (N connectors). Replace as required.
- Test with a spectrum analyzer with tracking generator. DC cable tests are almost useless for measuring RF performance.
- When looming cables, especially new ones, take the time to make sure they lay out ***absolutely flat,*** with no bends, loops, twists etc. This will ensure that the looms wrap properly, and have the longest possible life out on the road.
- **Cables are a consumable! They will and do wear out, and they will need to be replaced.**

# Shop prep for RF: Battery Chargers

- Inspect as with other hardware, screws, rack ears, doors, contacts etc.
- Hint, Shure SBC chargers will benefit from giving the door contacts a wipe from time-to-time.
- Networking optional (IMHO).
- Check diagnostics on every battery, where possible.

# Shop prep for RF: Testing Receivers

- Tune all RX's to one frequency*
- Sync and power up a TX and check that all units are getting both "A" and "B" antennas. Look for missing blue lights on Shure products.
- Disconnect one antenna at a time and make sure that the corresponding RF display goes out on each receiver (ie: look for swapped A and B inputs).
- Connect network and ensure that all units are present and respond to controls. Missing units may be duplicate IP addresses, or bad RJ45 cables (this is common…include spare network cables when bundling).
- Check WiFi connection to network, if applicable.

# Shop prep for RF: Testing IEM's

- Connect TX antenna.
- Turn on one TX. Sync all packs to that one frequency, feed program (or pink noise) into system and walk-test all packs.
- Repeat for each band if using multiple bands.
- This will verify that all RX's (packs) are performing as expected and/or weed out ones that aren't.
- Program ***coordinated*** frequencies into all TX's. Verify that all TX's are showing up on the correct combiner inputs.
- Switch on TX, one at a time and verify TX level with spectrum analyzer. If you don't have one, use WB, WSM, WSD etc.

# Shop prep for RF: Testing IEM's -2

- If you see levels that are lower than the rest:
- Double check that TX power is set the same.
- Try swapping the frequency with a TX that is showing the expected level. If problem clears, what you were seeing is most likely a frequency related issue (reflections and cancellations) *in the shop space*.
- If fault doesn't clear, try swapping combiner ports, and/or cabling (but not both at the same time!).
- Port failure is not unheard of in IEM combiners, especially older ones.

# Shop prep for RF: RF Spares Kit

- BNC and / or "N" barrels
- Spare panel pass-throughs, BNC or N
- Attenuators, preferably at least two of each value
- Filters, in pairs
- Passive splitter/combiners
- VNA Line amplifiers
- Short BNC cables
- Adapters, BNC-N, for example
- Mic stand / Magic Arm parts, thread adapters etc.
- Trompeter tool

# Shop Prep for RF: Deployment Kit

- Bread tins for transmitters
- Label maker with lots of spare tape
- PVC, Scotch, Gaff and other tape
- Assortment of medical tapes and band-aids for cable dressing
- Alcohol Prep-Pads and / or other disinfectant wipes
- Hand sanitizer dispenser
- Small waste basket

# Q & A:

THANKS FOR LISTENING,
AND STAY SAFE OUT THERE!

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