Station Setup Techniques to Prevent Field Day RFI

Advice from multi-station operators on how to minimize intermodulation and RFI.

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ARRL Field Day weekend is the one big event each year when clubs everywhere gather to try to make as many contacts as possible on the 160-, 80-, 40-, 20-, 15-, and 10-meter HF bands, as well as all bands 50 MHz and above. The event rules state that all stations must be within a circle with a 1,000-foot radius, which translates to being a multi-station operation in a confined area. Depending on the size of the club and the number of operators participating, ARRL sees submissions from participants using anywhere from one transmitter to 23, with the average being three.

It's likely that most Field Day participants have experienced *intermodulation* at some point. As defined in section 11.10.2 of the 101st edition of *The ARRL Handbook*, "Intermodulation distortion products can be produced when a nonlinear amplifier acts as a mixer, producing sum and difference frequencies of all pairs of frequencies and their harmonics." In simpler terms, someone's transmissions on 40 meters could be bleeding into a nearby receiver that's trying to listen on 20 meters. That can make operating simultaneously difficult, if not impossible. Sensitive receivers can also be subjected to fundamental overload from strong signals on any band nearby (see section 27.4.1 of the 101st edition of *The ARRL Handbook*).

To figure out how clubs can operate as many as 23 transceivers at once without creating intermodulation, I spoke to people with direct experience to find out what they all have in common. These amateurs have successfully designed contest stations, planned DXpeditions, and operated during Field Day.

W1AW

Let's begin with ARRL's own W1AW, one of the most famous multi-station operations in the world, located at ARRL Headquarters in Newington, Connecticut.

W1AW transmits code practice every weekday using high power on nine bands from 160 to 2 meters. W1AW Station Manager Joe Carcia, NJ1Q, explained

W1AW antennas at ARRL Headquarters.

K3LR multi-station operation. [Tim Duffy, K3LR, photo]

that it's possible to have transceivers transmitting simultaneously on that many bands without causing intermodulation problems because W1AW's transceivers and power amplifiers are connected directly to dedicated, resonant antennas for each band with sufficient horizontal separation between the antennas (for more information on W1AW's antennas, visit **www.arrl.org/w1aw-antenna-farm**). There are band-pass filters on 160, 6, and 2 meters to prevent intermodulation on those frequencies, while the rest operate fine without additional filtering.

Once code practice is over, licensed amateur guests visiting W1AW can operate from one of the three studios housing two stations each. To prevent intermodulation between stations, each studio has a Hamation Bandpasser II switchable band-pass filter rated at 100 W connected to the output of each transceiver and is set for the band being operated on. Each station is dedicated to a particular band.

Finally, for high-power contesting, W1AW uses band-pass filters from 403A, such as their Band Pass Filter Series XL rated at 4500 W, which offers more than enough power-handling capability for legal-limit power in the amateur radio bands.

Dedicated antennas and band-pass filters are key to the successful operation of multiple stations at once at W1AW.

K3LR

Another multi-station operation many amateurs are familiar with is Tim Duffy's, K3LR, contest station in West Middlesex, Pennsylvania. When I asked Tim what his secret to success was, his first piece of advice was that you need to begin with an RF-quiet environment. It may seem obvious, but trying to run any station, much less a multi-station operation, in a place with a high noise floor or interference from things, such as power-line noise or solar arrays, won't provide good results. Stay clear of LED lights, and don't use inexpensive wall-wart power supplies, as they can also cause noise that the receivers will pick up.

K3LR's contest station has standardized on Icom transceivers, and IC-7610s and IC-7851s are his top choice. Clean transmissions with digital pre-distortion technology help send out clean signals, and good built-in filtering rejects unwanted signals. Tim suggested the Yaesu FT-101 as another good choice.

For grounding and bonding, Tim suggests following the guidance provided in ARRL's *Grounding and Bonding for the Radio Amateur* by Ward Silver, NØAX (**https://home.arrl.org/action/Store/Product-Details/productId/133989**). He said that using quality connectors and making sure connections are tight can make a big difference in performance.

For band-pass filters, Tim uses three manufacturers: VA6AM, RA6LBS, and DX Engineering.

Keeping noise down on peripheral equipment such as computers is also important, and Tim uses EMI filters on ac power lines, mentioning Corcom and Delta filters as possible solutions.

DXpeditions

I also spoke with Glenn Johnson, WØGJ, who has been on multiple DXpeditions, about a less permanent setup, and he suggests beginning with site planning. All antennas should be in line (think dipoles end to end) with the signal broadside to the direction you want it to go. The main lobe should aim out toward where you know propagation will be open and carry the signal.

Glenn also suggests using radios with excellent filtering. Modern software-defined radios (SDRs) are a must; Glenn uses Elecraft or FlexRadio transceivers, because both have excellent adjacent channel signal rejection, and transceivers are so good now that it's

A diplexer, a triplexer, and band-pass filters in use at the CY9C St. Paul DXpedition. [Glenn Johnson, WØGJ, photo]

possible to run CW or digital on the same band as sideband at opposite ends of the band and not get interference.

Having full legal-limit power band-pass filters is a must to go with your radio. Glenn said Low Band Systems (RA6LBS) makes good filters, but they're hard to come by because the manufacturer is based in Russia. He noted that VA6AM also makes good high-power ones.

Glenn recommends using high-power filters, even if you're not running high power, just in case someone makes an error, such as transmitting on the wrong frequency.

When using a multiband antenna, Glenn uses diplexers and triplexers. He's heard of *pentaplexers* (used on hexbeams for operating five bands simultaneously) but hasn't used them before. For the CY9C DXpedition in St. Paul, operators used a tri-band antenna for 20, 15, and 10 meters and a dual-band antenna for 17 and 12 meters, keeping the antennas separated as far as possible to prevent signals from bleeding into each other. If you plan to use a multiband antenna, you should consider the antenna and balun component power ratings, and make sure they are rated for the total power of all transmitters you plan to have on the air simultaneously.

In the past, Glenn has used *cross polarization* (the strategy of transmitting on opposite antenna polarities), running stepped vertical dipole arrays (SVDAs) set up to beam into a particular direction on higher-frequency bands and horizontal dipoles on the lower-frequency bands. Cross polarization can offer 20 – 30 dB of isolation. How much isolation you can achieve depends on the antenna orientation and geography. For example, Glenn said the SVDAs work well on beaches but aren't very good inland.

Finally, because they're portable, generators are a must. Glenn finds Honda generators to be reliable and RF quiet. Be sure to keep your RF and power cabling as far apart as physically possible to avoid induction of the ac power into the RF lines. Heavy-duty shielded power cables will help prevent additional noise.

Glenn's last bit of advice is related to what he calls piloting skills — teaching people how to operate and creating checklists are very important to a successful operation.

ARRL Field Day in California

Now, let's apply these principles to your club's Field Day operations, or to any multi-station portable operation. Keith Elliott, W6KME, from the Conejo Valley Amateur Radio Club, AA6CV, in southern California has successfully run Field Day for his club for 3 years using 23 stations that are able to operate at the same time.

Antennas

Keith maximizes use of the space allowed in the Field Day rules and selects antennas that will provide maximum isolation between one another, providing good signals aiming north/northwest. By lining up the three identical HF antenna arrays end to end, the nulls at each end of the dipoles aim at each other, minimizing the amount of RF getting into the adjacent array. They use 36-foot military crank-up towers with a Hy-Gain tri-band antenna at the top of three towers for 20, 15, and 10 meters; an 80-meter homebrew dipole at 31 feet, and a 40-meter dipole at 27 feet. The dipoles are all horizontal and parallel to the ground, not inverted-**V** antennas. There is an RF choke — a 2½-inch mix-31 toroid — at the feed point of each antenna.

Transmission Line and Filters

Keith uses RG-214 shielded coaxial cable for all RF cable runs. The Conejo Valley Amateur Radio Club uses Dunestar triplexers connected to tri-band antennas so all three bands can be used simultaneously, while isolating each band and radio from the others. Another run of RG-214 coaxial cable goes from the triplexers to each of the radio positions, where a VA6AM band-pass filter is installed at each transmitter for the single band it will operate on. The transceivers cannot be tuned to other bands — they're dedicated to the band they're assigned to. Changing frequency is prohibited to protect the filters and the triplexers. Finally, another RF choke like the one at the antenna feed point is installed between the radio and the band-pass filter.

Conejo Valley Amateur Radio Club's, AA6CV, 2025 Field Day antenna. [Keith Elliott, W6KME, photo]

Transceivers

Good transceivers are key. Keith said he tends to put the worst performers on the low bands, like 160 or 80 meters, which, relatively speaking, don't get nearly as much use as the 40- and 20-meter bands. He reserves the better-quality transceivers for CW operators because they need the best filtering to operate. Keith avoids putting transceivers with poor automatic level control performance on digital modes.

Keith says that when Field Day kicks off in California at 11 AM local time, each one of their 23 stations is live and on the air. He's proud to say that everyone can operate, interference-free.

Good Operator Hygiene

The final message Keith wanted everyone to know is that training people on how to use the equipment ahead of time is a key factor in helping to keep their Field Day interference-free. Not overmodulating FT8, not switching bands and burning up a band-pass filter, and not removing the filters or chokes from the systems all contribute to a successful, RFI-free event. It's understood that filters and chokes can cause a bit of insertion loss, but that's a necessary compromise to have that many stations operating within the 1,000-foot radius. Spend time with your operators to train them on how to use the equipment properly.

Visit **https://youtu.be/bdfhGbszZNE** to watch ARRL Technical Editor Conrad Trautmann, N2YCH, and W1AW Station Manager Joe Carcia, NJ1Q, discuss preventing RFI at a multi-station operation. Joe gives a tour of W1AW's multi-station studios, transmission, and antenna systems.

In Conclusion

Wrapping up, the common messages and takeaways from successful multi-station operations include:

- Having an RF-quiet location
- Using dedicated bands, antennas, and radios
- Installing high-power band-pass filters for each band on the radio
- Having transceivers with good filtering and adjacent channel rejection
- Installing dipole antennas in-line to minimize pattern overlap
- Having a quiet power source and ac-line filtering
- Using quality, shielded-RF ac and computer cables
- Setting up good grounding and bonding
- Having 1:1 baluns at radio and antenna feed points
- Training operators

I look forward to seeing you all on the air during this year's ARRL Field Day on June 27 – 28!