other). I've been to two local emergency clubs and put word out to try and find an Elmer and equipment and haven't really had a lot of help in either area. Perhaps some of your club members are selling equipment or know of contest clubs in this area. I live in Westchester County, NY, just south of NY City. Many thanks.

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All About Stacking
Ken Wolff, K1EA

Why stack yagis? The most common reason is bragging rights. Sometimes it makes you louder, sometimes not, depending on your implementation. Because my station runs 4/4/4/4 on 10 and 15 meters and 4/4/4 on twenty, I get a few questions. Here are the answers.

What I Have
I have one 120 foot tall Rohn 45 tower and one 90 foot tall Rohn 45 tower. The 120 foot tower has three, 4-element Cushcraft 20 meter beams and four 4-element Cushcraft 15 meter beams. The booms are not particularly long on these antennas: 24 feet on 15 and 32 feet on 20. They have a horisontal beamwidth of 60 degrees, which is just what I want. They cover UA0 all the way down to EA6 without turning the beam. It is true that they give up gain over a very long boom, but they reach a larger target audience in Europe, are much easier to put up and maintain, and they are not rotor croakers. The 90 foot tower has four 4-element 10 meter beams and a 4-element KLM 40 meter beam. The KLM *is* a rotor croaker.

The bottom two 20 meter and bottom three 15 meter antennas are fixed at 35 degrees. The top antennas are rotatable. Switching is very simple: top only or all at once. I have heard that at NR5M some bands have 11 antenna combinations/choices! I don't think well enough to use that station. The bottom three 10 meter antennas are fixed at 45 degrees, while the top one rotates.

The 20 meter antennas are located at 40, 80, and 120 feet. The 15 meter antennas are at 32, 64, 96, and 128 feet. The 10 meter antennas are at 35, 55, 75, and 95 feet. The reason the bottom 10 meter antenna is a little high is that the 90 foot tower is located 10 feet down from the flat apple orchard to the northeast. Effectively, the tower is an 80 footer.

For the curious, on 80 I use four phased verticals with a raised ground screen. These are free standing aluminum elements mounted in two sections of Rohn 45. They weigh 135 pounds each. The first winter I used them I worked over 100 JAs longpath at sunset... On 160 meters I use an inverted vee off the 120 foot tower. The top set of guys on each tower are Phillystran and all others are steel broken up with insulators.

Stacking Gain
Depending on spacing, a pair of yagis can provide 2.5 to 3.0 dB of stacking gain, three antennas provide 4.0 to 5.0 dB and a set of four provide 5.0 to 6.0 dB.

Wave Angle Control
Notice that stacking provides at most one s-unit of additional gain. Why bother? How can this account for the results the guys with stacks get? The answer is that the stack provides a much broader lobe in the vertical plane, covering many more square miles at the DX end. Consider broadcast satellites. They have antennas designed to provide a *footprint* covering a specific region. From New England we have to cover a region from England (3,300 miles) to Kazakh (5,600 miles). DX signals almost always come in on multiple hops and at wave angles (vertical arrival angles) of 2 to 20 degrees.

An example demonstrates the problem. Suppose you have 15 meter yagis at 120 feet and 60 feet, but can only feed one at a time. A 15 meter beam at 120 feet has its first maxima at roughly 5 degrees and the first minima at 10 degrees. The yagi at 60 feet has a maxima at 10 degrees and a minima at 20 degrees. At daybreak the band is just opening, signals are arriving at 3 degrees or less and the high yagi outperforms the low one by 5 to 10 dB. Late in the morning, western Europeans are arriving at angles of 10 degrees or more while UA6 is still arriving at 4 or 5 degrees. Western Europe can be 20 or 30 dB louder on the low antenna than the high! I have heard this happen on my own antennas. it sounds like the top antenna is broken. Moscow is still 5 dB louder on the top antenna. What to do? Stack 'em!

The two stack results in a maxima at 8 degrees with a peak gain almost 3 dB above the peaks of each individual antenna (at 5 and 10 degrees). The really good news is that the stack is louder than *either* antenna from less than 3 degrees to almost 15 degrees!! That's coverage. That's 60/hour at midday versus 40/hour on a single antenna. Without stacking you could constantly switch from one antenna to the other to get coverage, but who says that UAs only tune by when you are on the top antenna and Gs tune by when you are on the bottom one?

Picking Antenna Spacing
In his book Antennas, Kraus (*the* W8JK of Ohio State) introduces the concept of aperture. Basically, an antenna has a physical capture area, related to its gain, called its effective aperture. If two antennas are stacked and their physical capture areas don't overlap, a gain of 3 dB results. As the antennas are moved closer together their apertures start to overlap and

gain decreases until the antennas are on top of each other and there is no stacking gain at all. Why not always stack far apart? At very wide separations extra lobes appear in the vertical pattern causing nulls in some of the arrival angles we are trying to cover. A typical (25' boom) 4 element 15 meter beam has a vertical aperture of about 35 feet. Below 30 foot separation you start to lose gain. Above about 60 feet you can profitably fit another antenna in between for some extra gain and a smoother vertical pattern. For example, that 120' tower with two yagis on 15 could profitably hold 2, 3, or 4 yagis spaced at 60, 40, or 30 feet. I happen to have used 4 antennas on 15 with 32 foot spacing. The fourth antenna probably doesn't buy me much, but it is psychologically helpful. I would prefer it have 38 foot spacing and a 150 foot tower, but that would put the top antenna just too high when fed alone.

The answer to the spacing question is basically: stack at 1.5 boomlengths. The longer boom antennas have greater gain and aperture, requiring greater spacing. This does not hold for very high gain antennas at VHF. For 3 to 6 element HF antennas it is OK. Closer spacing probably costs you aluminum without too much benefit, but I do it anyway. Spacing is not nearly as critical as many folks think. Variations of 20 or 30 percent in stacking distances are fine. The moonbounce guys worry much more because that last .2 dB of gain and sidelobe attenuation really matters.

How to Feed Them

Some guys have a 6-element KLM on the top of the tower, put the old homebrew 4-element from last year halfway up the tower, hook them to a Tee connector and call CQ. Sometimes this works, sometimes it doesn't. You *definitely* can't predict the vertical pattern this way. You can add relays or switches for upper/lower/both. Unfortunately, unless you are very lucky, the load seen by the final will be all over the place and you will need to retune every time you switch. In all probability you will need to switch constantly because without proper phasing, one of the single antennas will often be louder than the stack.

If, on the other hand, the antennas are identical and fed properly, you can count on the stack always being as loud or louder than any antenna separately. The name of the game is to get equal amplitude and phase out of each antenna.

Rule 1: Always use physically identical antennas.

Rule 2: Always use physically identical feedlines. This means take the coax off the same spool.

Rule 3: Make sure there is no RF on the outside of the feedline. Use a balun or RF choke.

Rule 4: All switching systems must preserve the electrical length of the feed system. In other words, don't switch in an extra 1/4 wave of feedline unless you are switching out another 1/4 wave someplace else. K2TR pointed this out over ten years ago in the Scuttlebutt. This preserves the feedpoint impedance so you don't have to retune the amplifier when switching.

Here is how I feed my antennas. I sent a box of ferrite SuperBeads (available from Radio Kit) to Nemal in Florida. For each antenna set I had them cut equal lengths of coax from the same spool and slip SuperBeads and heatshrink tubing over one end. Next, they heatshrunk over the beads and sealed with a sealant. Finally they put silver-teflon PL259s on both ends. They charged about a buck a connector and $1.50 for the heatshrink, over the cost of the cable and connectors. I them do 11 cables this way. it was worth it.

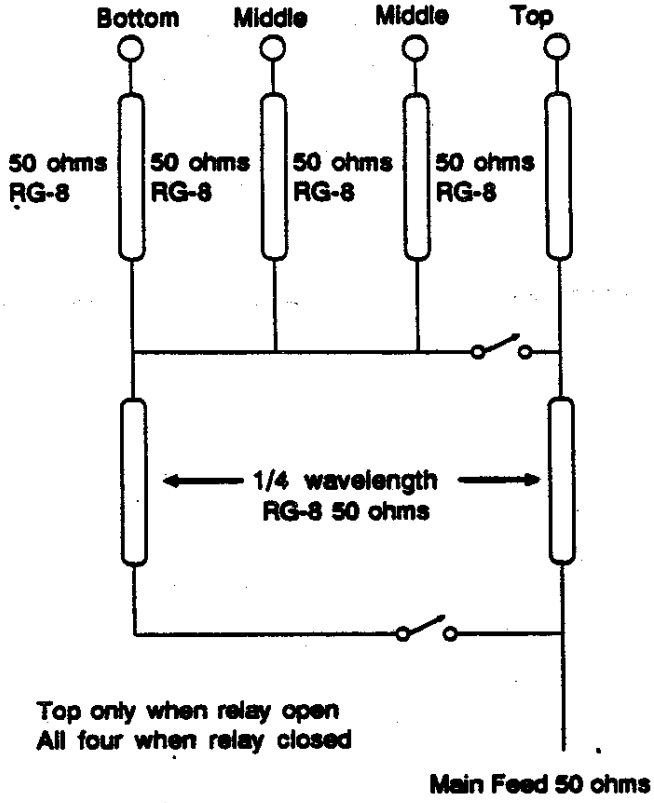
The 10 meter cables have 4 SuperBeads, the 15 meter cables have 5 SuperBeads, and the 20 meter cables have 6 SuperBeads. I borrowed an HP vector impedance meter and determined that rf chokes made this way have an impedance greater than 1000 ohms on each band.

I switch each stack in its own relay box mounted on the tower at the array center. I feel I can control the phasing better closer to the antennas, and I save on feedline. The drawbacks are obvious, the relays are out of doors and require an outdoor control cable. K1GQ thinks I'm crazy. Who knows? Each antenna feedline is an odd multiple of a quarter wavelength. This is an attempt to force the currents in each antenna to be the same despite the fact that they are in slightly different environments. The switching boxes are fairly large diecast boxes (read expensive) mounted upside down with SO-239s mounted in the cover. The relays are Original OW-SH-124DM with 20 amp contacts and a 24 volt coil. They are hermetically sealed and have extremely low inductance, which is important for preserving phase on 10 meters. The relays are small and are mounted on the inside of the box cover very close to the SO-239s. Internal RF wiring is done with 3/4 inch flat braid (like you ground your tower with) mounted 1/4 inch above the surface of the box. This creates an approximate 50 ohm transmission line, lessening the phase changes due to inductive wiring. Overall, these boxes are probably usable up to 2 meters.

The switching system I use is shown in the figures. Notice that the electrical length of the feedline does not change when switching from a single to multiple antennas.

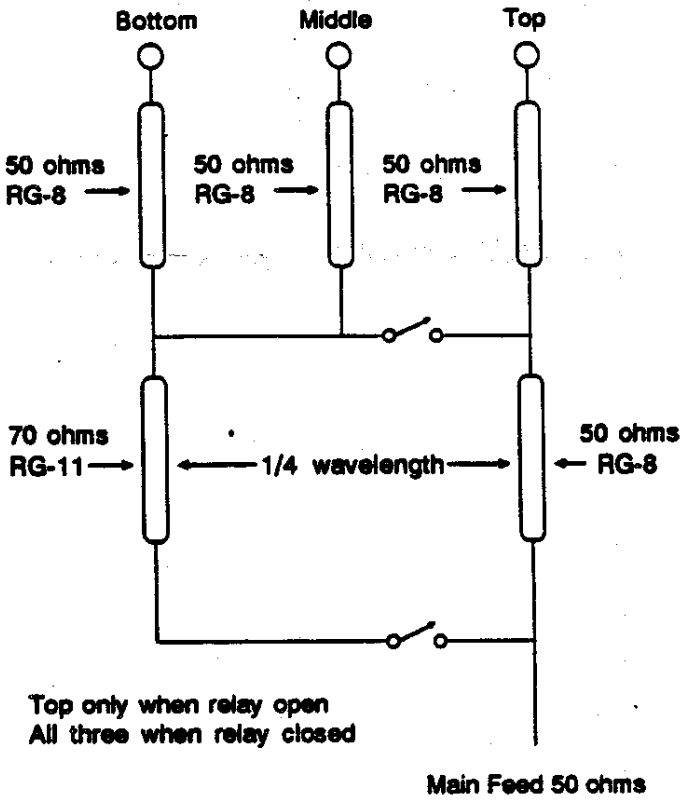
The basic impedance matching trick is to connect all the antennas in parallel, creating a lower impedance, then transform them up using a 1/4 wave coax cable transformer. The other trick many hams are not aware of is that coax cables of equal length parallel just like

K1EA Stacked Beam Switching System



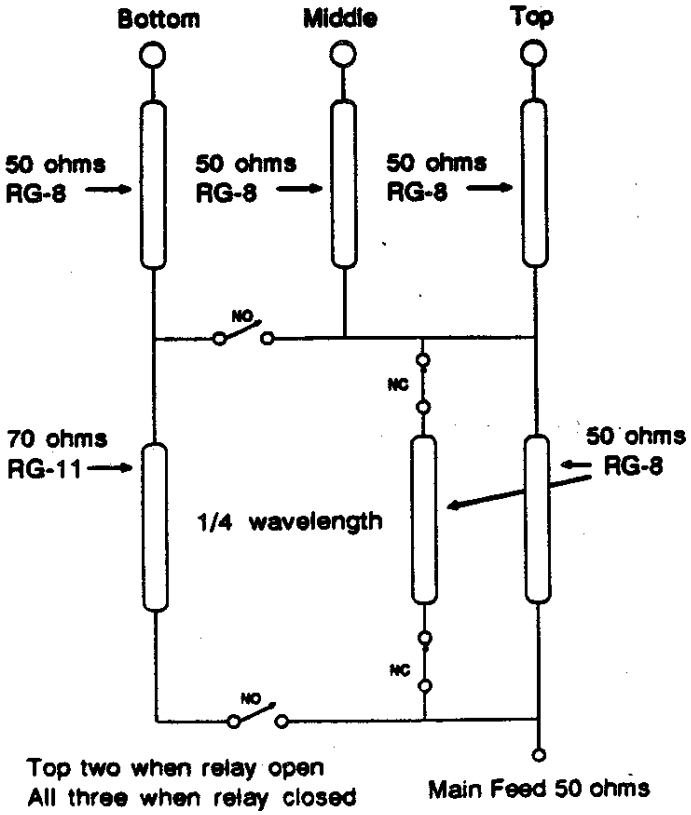
K1EA Stacked Beam Switching System

Top Only or All Three



K1EA Stacked Beam Switching System

Top Two or All Three



resistors do. For example, two 50 ohm lines in parallel act to all the world as a single 25 ohm line. A 50 ohm line in parallel with a 70 ohm line acts like a 29.3 ohm line.

The formula for a 1/4 coax transformer is:
Znew = (Zline * Zline) / Zold

My three stack on twenty works this way:

Three 50 ohm antennas in parallel are 50/3 = 16.7 ohms = Zold. A 70 ohm line in parallel with a 50 ohm line is 29.2 ohms = Zline.

Znew = (29.2 * 29.2)/16.7 = 51 ohms, a pretty good match.

The four stack is easy: four antennas in parallel, 50/4 = 12.5 ohms = Zold. Two 50 ohm lines in parallel = 25 ohms = Zline.

Znew = (25*25)/12.5 = 50 ohms, exactly.

How about six antennas? 50/6 = 8.33 ohms = Zold. Use two 70 and one 50 ohm lines in parallel = 1/(1/50+1/70+1/70) = 20.6 = Zold.

Znew = (20.6 * 20.6)/8.33 = 50.9, magic!!

Five antennas? 50/5 = 10 ohms = Zold. Three 70 ohm lines yields 23.3 ohms = Zline.

Znew = (23.3 * 23.3)/10 = 54.4, oh well, not perfect, just close.

Once you know these tricks, you can dream up any crazy combinations you want from one to six antennas. Just switch particular antennas you wish to drive in parallel, then switch in combinations of 50 and 70 ohm lines to suit the number of antennas in parallel.

Callsign Trivia

Fred Laun, K3ZO
(reprinted from the PVRC Bulletin, October, 1989)

As I've said in comments elsewhere, it helps me immensely in DX contests to know which callsign combinations are likely to be correct and which are not. Of course, at the rapid pace amateur radio is growing in some areas, those rules of thumb change constantly, and it helps to be active on the bands to become aware of changes. Here by first letter, are rules of thumb that I use when operating contests. I don't have a little sheet with these rules on it; they are just files "upstairs" for future reference. If I omit a first letter in my review, it's because the rules of thumb have occasion to be too seldom used (because of lack of activity in the affected areas) to be worth keeping in mind as an operating aid. Here, then are these rules of thumb. They apply to HF operations only, since we are not taking up VHF operations in this review. Some countries use special callsigns for their VHF licensees.

CALLS BEGINNING WITH "B": Only BT, BV, BY, and BZ prefixes are possible.

CALLS BEGINNING WITH "D": DA, DF, DJ, and DK will almost always have two letter suffixes. The main exceptions are DJ0 and DK0, which frequently have three letter suffixes. The exception that proves the rule is DF1IAF. Don't ask me how he got his call! DH calls will be found only on 28 MHz and 3.5 MHz CW.

CALLS BEGINNING WITH "F": Stations operating in France (F, FB, FD, FE, and FF) do not use the numbers 4 or 7 in their calls. Such stations with a 1 or a 6 in their calls will always have three letter suffixes. Such stations with a 2, 3, 5, 8, or 9 in their calls will almost always have two letter suffixes.

CALLS BEGINNING WITH "G": The numbers 1, 7, and 9 are not used on HF in prefixes beginning with G, GD, GI, GJ, GM, GU, and GW. Stations with a 0 in their calls will always have three letter suffixes, while those with a 5, 6, or 8 in their calls will almost always have two letter suffixes. Don't forget that in the CQ WW contests, GM-Shetlands counts as an additional multiplier.

CALLS BEGINNING WITH "H": The HJ (Colombia) prefix will be found only on CW and on 3.5 and 7 MHz SSB. Except on 28 MHz, almost all stations using the HG (Hungary) prefix will have a single letter suffix.

CALLS BEGINNING WITH "I": Almost all Italian stations are limited to the I, IK, or IO prefixes. The biggest are IN3 and IV3 prefixes, and of course we all know about IT9 and IS0, but the latter doesn't count for Italy anyway in the contests (IT9 counts as a separate multiplier in the CQ WW). Stations with the IK prefix have three letter suffixes only.

CALLS BEGINNING WITH "J": The prefixes JB and JC are not used. The Japanese began with the JA prefix, then jumped to JH, and then to JR, before coming back to JE and starting up the line alphabetically from there. Thus, in the less populated call areas, you will not find prefixes near the end of the Japanese allocation block (JA through JS) except for JR. JS6 is the exception, designating newer stations on Okinawa. At this time, I am not aware of any assignments of the following prefixes: JN-JS2, JQ3, JS3, JJ-JQ4, JF5, JG5, JI-JQ5, JS5, JK-JQ6, JJ-JQ7, JS7, JI-JQ8, JS8, JE-JI9, JJ-JQ9, JS9, JF0, JI-JQ0, and JS0. Incidentally, if you ever have a JA pile-up that is so bad that you just can't pull anybody through, the best thing is to say " The JA5, go ahead" or "The JA9, go ahead". These are the two least populated JA call areas, so chance are, given the JAs noted discipline,