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The LongPath

A North Alabama DX Club Publication

Contents

From the President

Here we are at the beginning of a new year, hoping that things will somehow return to normal. The new vaccinations are here. But the virus is careening out of control. Hamfests are being cancelled, DXpeditions are still on hold, and who can predict when we will have another in-person DX Club meeting. On the brighter side, HF contesting is going strong and so many of our members are stepping forward each month to write articles for this newsletter. So hold on, folks. We just might have a Huntsville Hamfest this year.

Time goes on, and we have lost another long-time club member, Jerry Cross, N4NO, Dr No. Jerry's expertise was in propagation prediction, and this guy always had a written plan for each minute of every contest he ever entered. He showed me his plans several times, and I was more than impressed. He could score higher than anybody doing S&P only. Jerry was also an incoming QSL manager for the ARRL for very many years. I'll miss him.

We had the pseudo-contest Straight Key Night last weekend, as well as the ARRL RTTY Round-up. I listened to one and worked the other. Just listening to SKN brings back so many memories. How things have changed. Since RU is mostly American stations, you have all these very strong signals to work. Shooting-fish-in-the-barrel is pretty easy, so everyone gets to have huge scores. I also placed my Alpha 9500 back on-line so I could run at 1200 watts constantly. Wow, was that fun, especially when the afterburner fan would light up!

We made some changes to the Long Path last year, in order to make articles easier to write. I'm looking for articles on station configuration (why you set up your QTH the way you did), and product reviews. We're also accepting commercial, as well as private, ads for sale. I'd sure like to see more of these. This is a free hamfest for those interested.

Dues are now "due" for 2021. I think we now have the membership roster up to date online at our website. We'll try to keep it spiffy.

I've been practicing up on the antenna simulation program EZNEC. I'm not an antenna expert, but I'm hoping to pass for one at the program for our next meeting on January 12. I'll do an intro for this very useful utility and model antennas we often use. The demo version is a free online download, and can demonstrate many of the difficult concepts found in the ARRL Antenna Book.

So come join us for another covid-free virtual meeting of the NADXC on Tuesday, January 12. We'll use Zoom again. I'll send you another invitation, but the sign-on will be exactly the same. I'll open Zoom for informal discussion at 6:30, and start the meeting at 7pm.

How to Join

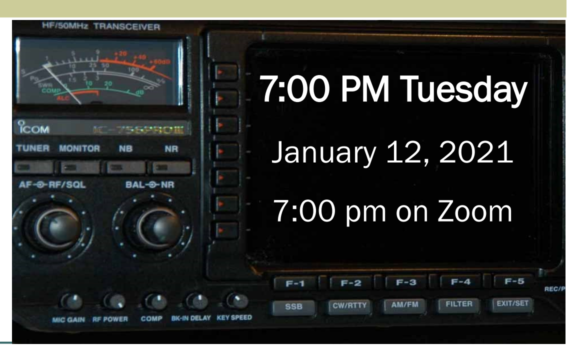
** Come to a club meeting;*

** or send in an application by mail (form on www.NADXC.org)*

EZNEC Basics

January Program by Bob DePierre, K8KI

Roy Lewallen's EZNEC has become the standard modeling program used by hams for antennas. Bob K8KI will show us the basics. For those who have an interest but haven't used EZNEC, you might want to download the free version (limited to 20 segments) - just google EZNEC and you'll find it. Zoom in at 7:00 Tuesday!



History and Revival of a KLM KT34A Triband Yagi

By Art Davis, N4UC

Several months ago I began having some SWR issues with my 40+ year-old KLM KT-34A yagi. This is the story of my efforts, driven mostly by frugality (i.e. cheap), to keep an old piece of equipment on the air.

For those not familiar with the KT-34 and it's big brother the KT-36, otherwise known back in the day as the "California Tribanders", they became available in the 1970's and represented a new approach to multiband yagi element design. Up until that time the standard of the industry for multiband yagi design involved the use of a parallel tuned circuit (i.e. a trap) in each element for all but the lowest frequency bands covered by the antenna. However, the mechanical design of traps was problematic due to the fact that they were lossy, heavy, inefficient , and too easily affected by moisture intrusion. KLM was formed by three hams who took the approach of using linear-loading in place of the traps. They also introduced the dual-driven elements to increase the VSWR bandwidth of the antenna. The dual-driven elements form a log cell and may have been the first production antenna for amateur radio to use this arrangement, but I stand to be corrected about that. It wasn't long until Hy-Gain responded by adding a second driven element to the ever popular TH6DXX tribander resulting in what we now know as the TH7. The electrical and mechanical details of each element half of the KT34 are shown in figure 1 below.

Looks like a bunch of banjo-work, and it is. But it works, and works well, <u>when</u> it works, as they say!. However, as you can imagine, the weakness of the design was in the methods used to make the mechanical connections of all the straps to the aluminum tubing. As it aged a KT34 would begin to be a very finicky antenna requiring more than average maintenance

Here is what a typical strap connection looked like after a few years.

Not very conducive (or conductive) to maintaining low impedance connections at all the joints. And there are a ton of joints, 36 <u>per element</u> in fact. Lots of room for corrosion to creep in and ruin your day.

Fast forward a few years when KLM closed and re-emerged as M-Squared Antennas. If you are interested, the history of the KLM company and particularly the KT-series of yagis can be found on the qrz.com page of Mike K6MYC. Mike is one of the three founders of KLM (he's the "M") and also the designer of the KT-34 and KT-36.

Upon the formation of M2 antenna company, the company continued to produce the KT-34 and KT-36. The mechanical designs were upgraded to replace the strap arrangement with precision machined aluminum clamping jumpers. This alone resulted in a much more robust antenna both mechanically as well as electrically. The yagis were also subjected to new antenna range testing to update the element dimensions to improve the gain and f/b performance.

In addition to continuing the KT34 and KT36 product lines with their new model numbers, KT-34M2 and KT-36M2, they offered upgrade kits which could be installed on the original KLM KT-34 and KT-36 antennas. Installation of the upgrade kits tremendously improved the mechanical integrity of the joints making the antenna much more rigid and less susceptible to the effects of weather over time.

Newly-designed straps provided by the upgrade kit.

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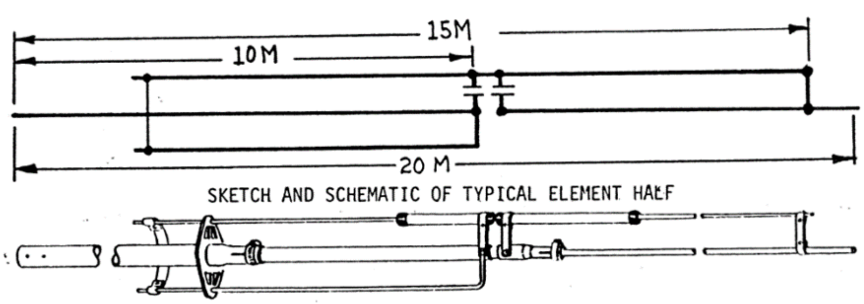

Figure 1—Electrical and Mechanical Details

When my KT-34 started exhibiting intermittent SWR issues I decided that it might be time to retire it along with the TH-7 I had bought new in 1989. Since the TH-7 is so heavy and I am 30 years older than when I put it up the first time, I decided to research the market for a new lighter-weight yagi that would approximate the performance of the TH7 and KT34. What I learned was that things have really changed since 1989, not the least of which is the cost. Considering propagation these days I couldn't get excited over the idea of putting $2000-3,000 into a new antenna.

All things considered the old KT-34 didn't look so bad. After all it was 4 active elements on a 16 ft boom and weighed just 47 pounds versus 85 lb for the TH-7. Maybe I'd just buy a new one. Whoa! $2000 for a new version of what I already had? Even I failed to see the logic in that. So I decided that my best option was to purchase an upgrade kit from M2 for $350 and have ended up with, for all practical purposes , a new antenna.

I bought the upgrade kit and proceeded to take down the KT-34 (thanks to Glen Martin for inventing the Hazer!). The only part that the upgrade kit did not include was a new 4:1 current balun. The fellow at M2 assured me that if the case of the old balun was not damaged it would not need to be replaced. But when I took down the antenna and removed the balun, I found that it rattled. Being fairly sure that this was not acceptable behavior for a 3KW (or any) balun, I proceeded to open up the cylindrical housing to inspect the cause of this odd behavior. Noting that the housing was still intact with no cracks, holes or other evidence of damage, what I found inside surprised me. Two handfuls of shattered ferrite material mixed in with about a quarter-cup of water poured out onto the benchtop. I was starting to have my doubts about re-using this 50 year-old balun.

The balun consisted of four (now two) 3-inch long ferrite cylinders with wire routed through them. I'll refer you to the excellent program on balun design given by our illustrious president for the technical explanation of how baluns work. (I could explain it myself here but I don't want to steal his thunder, you understand).

After trying to determine what could have caused the shattering of the two ferrite rods, only one scenario seems likely...heat. After all it's only rated for 3KW but we'll leave it at that. The source of the water, I don't know. That was an awful lot of water to be simply condensation, but the housing was still sealed tightly. Or maybe water cooled to handle 3KW? Yeah, right!

Needless to say I was in need of a replacement balun. So I put out the call for anyone having a 4:1 current balun laying around that they could part with. Many thanks to those who responded. Bob K8KI tried his best to re-educate me on magnetics theory and balun construction, and Tom KG4CUY graciously contributed a couple of store-bought ones to use till I decided on a permanent option. Based on the recommendation of several trusted experienced contesters (i.e. old guys) I ended up buying one from balundesigns.com. I wholeheartedly recommend the products and the service I received from Bob at balundesigns. He knew exactly which of their baluns was appropriate for an old KT34 and the price was much lower than other sources.

With the balun issue resolved, I proceeded to completely disassemble the KT-34 element by element so that all the surfaces requiring good electrical contact could be scrubbed with steel wool and treated with anti-oxidant paste. There are how many pieces and parts there are to this antenna. It's not just a handful of hose clamps and tubing like the TH-7. It took about a week working every day to disassemble and clean the elements. After receiving the new balun from Bob at balundesigns, I had to redeign the balun mounting configuration. I thought I did a fantastic job of making a very neat professional-looking installation. Except for the fact that the SWR was now worse than when I started all this, everything was fine. As it turns out, I got reminded about the effects of inductance. Those two straps, as pretty as they look, exhibit more inductance than the system design can handle. Even though they are wide and flat (good), they have a 90 degree bend and are too long (bad).

Balun now in place.

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KT34A

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After replacing them with the original straps made from flattened coax braid and routing them point to point, everything settled down and now the antenna exhibits under 1.5:1 across 20 and 15M, as well as from 28.0-29.3 portion of 10M. Perfect! Now I just need to design a cradle of some fashion to hard-mount the balun to the three inch boom.

I'm happy to report that the antenna now performs better, both mechanically and electrically, than it did when I first got it. Hopefully the time and effort spent on reviving the "bunch of banjo-work" will be rewarded by many more years of service.

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Log-Periodic Dipole Arrays

By Tom Duncan, KG4CUY

Introduction

Transducers having wide bandwidth, holding other characteristics constant over that bandwidth, have been and remain a goal of many disciplines. Broadening the use of "transducers" to a very general sense, engines of all sorts should nominally operate at a constant efficiency over a wide range of loads. Ideally an internal combustion engine moving an automobile at 10 miles per hour would perform the same as at 100 miles per hour. A jack-hammer would break up concrete just as well at one impulse per second as at ten impulses per second. A loudspeaker would deliver the same perceived loudness at 100 Hz and 1000 Hz for a given input power.

Limiting our concerns to the "radio domain", an antenna excited by a constant power at a constant source impedance would radiate identical far-field patterns from say 1 MHz to 1 GHz, with corresponding receive performance for reciprocal antennas. Here are a few cases where this might be useful:

- Ignoring legacy channels 1-13, the North American TV spectrum covers 470 MHz through 990 MHz, a little over a one octave range.
- Short-wave broadcast stations (back when such things existed) need to cover frequencies between 2.3 MHz and 22 MHz to accommodate propagation changes and dodge QRM, about 3 octaves.
- MIL STD 461-based EMI/RFI susceptibility testing typically covers 10 kHz to 30 MHz or 1 GHz.
- Ham antennas, particular on frequencies covered by a single radio.

Beginning in the mid 1950s, work on wide bandwidth, constant feedpoint impedance, constant pattern antennas was undertaken, originally at the University of Illinois. There was no preconceived notion about the radiation patterns or the physical shapes of antennas with the desired characteristics, so omnidirectional, bidirectional, and unidirectional antennas with both planar and non-planar shapes were developed and characterized. This work identified a class of antennas called logarithmically periodic, because variations in feedpoint impedance and radiation pattern repeat periodically with the logarithm of frequency. If the variation over one period is kept small, the variation over multiple contiguous periods will also be small, resulting in constant characteristics over a wide bandwidth[1].

The log periodic antenna is not the only class of wide bandwidth antennas. The "angular" class[2,3] including discones and biconics has bandwidths of between 1 and 2 octaves, but not over 3 octaves as with the log periodic. The W8NWF discone covering 14 MHz through 30 MHz has appeared in the Antenna Book[3] for years.

Hams will be most familiar with the log periodic dipole array (LPDA), which is planar in structure like a yagi. Be aware, though, that there are many other log periodic designs with widely varying appearances, and certain spiral log periodics are used in the UHF bands. The remainder of this article will concentrate on the LPDA, and in particular HF LPDAs.

Physical Characteristics

In gross terms, the LPDA looks like a yagi with evenly-spaced elements, all driven in a crisscrossed fashion. Shown in fig. 1 at the top of the next page are two methods for feeding the elements[4]. Mechanical considerations limit (a) to higher frequencies.

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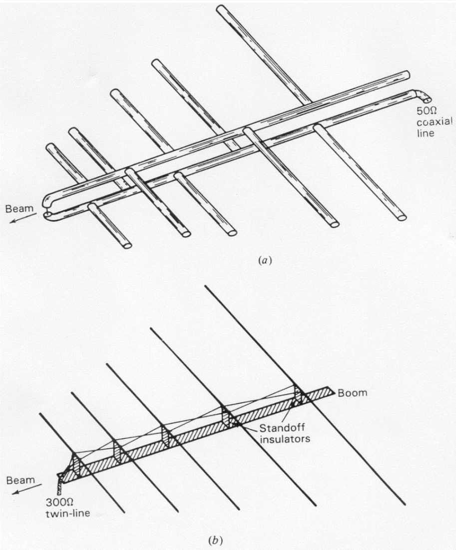

Figure 1—Typical LPDA Configurations

Important measurements and their relationships[5] are shown in fig 2. below. τ, α (or the lengths of the shortest and longest elements), and the number of elements n are sufficient to characterize the antenna. Some[6] use

$$\sigma = \frac{R_{n+1} - R_n}{l_n}$$

instead of α as a relationship between boom length and the number of elements.

Ideally, there is strict scaling between dipoles, but mechanical considerations will probably dictate not-so-strictly-scaled values for d and s. Generally the longest element is very slightly longer than a dipole cut for the lowest frequency, and the shortest element about the length of a dipole cut for the highest frequency. Reasonable values for τ are in the range of 0.85 to 0.96[6].

Performance

As is the case with yagis, various combinations of number of elements and element spacing yield different gains, patterns, and impedances. The goal is to keep variations as small as possible over the entire antenna bandwidth. Just how this may be done and the nature of tradeoffs is the subject of various references[1, 6, 7, 8, 9]. The W4RNL references use various implementations of a 7 MHz to 15 MHz antenna as a consistent test case, comparing apples to apples. K8CU covers the details of a 10 MHz to 30 MHz design, with many designs he rejected and the reasons. Updates made since the original publication in QST are important.

The simplistic upshot of both W4RNL and K8CU is that a long boom with many elements is best in terms of gain and F/B, not surprising since that also applies to yagis. This also flattens the overall SWR curve and maintains radiation pattern consistency, two goals more important to the log periodic than to the yagi. But continuous wide-bandwidth response comes at a cost: more elements, and often a longer boom. This means more weight, more wind load, and heftier rotor and tower requirements.

Variants

There is middle ground between LPDAs and yagis – LPDAs modified to include parasitic elements. UA9BA explains this in a current article[10] with his own real-life examples. W4RNL also suggests tweaking of strictly orthodox LPDA designs[8]. Compare the Tennadyne T8 with the M2 10-30LP8 and you will find a difference in a parasitic element. The Cushcraft X7 uses a 4-element log periodic "cell" as the driven element, with trapped parasitics. In all these cases traps are avoided in driven elements, and the LPDA's bandwidth helps to flatten the SWR within wide bands like 10m.

Design rules don't restrict the LPDA to aluminum tubing at right angles to a boom. Wire elements configured as vees will also work, allowing operation at lower frequencies and with much lower construction cost, given a fixed orientation[11]. The Antenna Book has several other log periodic construction projects well worth investigation.

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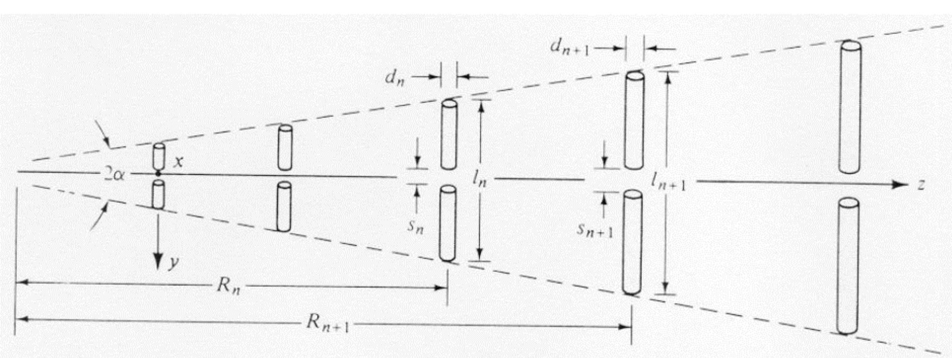

Figure 2—Key LPDA Measurement Relationships

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LPDAs
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Conclusion

The log periodic dipole array is another weapon in the HF operator's arsenal, sharing many of the yagi's characteristics, since both descend from the humble dipole.

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Busting the Pileup the Panadapter Way

By Rob Suggs, NN4NT

For those of you who have panadapter technology in your shacks you probably know all this so jump on to the next article. But for those of you who are not using a software defined radio (SDR) or a transceiver with a panadapter display in your DXing here is a glimpse of what it can do for you in a DX pileup. As AC4G and KF3FRK have discussed on these pages and at a recent club meeting, you don't have to have an SDR-based transceiver to use this technology. You can attach an SDR receiver to your analog radio's IF output or receiver output to get the same advantage. I used an LP-Pan2 attached to the IF out of my Yaesu FTDX-3000 for years and have also used an SDR Play receiver attached to the receive output. I recently upgraded to an FTDX-101D which is based on an SDR architecture and has a second receiver. There are several ways to skin the proverbial CAT.

But how can this technology help you in a DX pileup? Let's say you've just seen 7Q7RU spotted on the DXcluster at 7015 "listening up". How can you know where they are listening so you can be transmitting at the right frequency and time? Here's where a panadapter comes in very handy.

Picture 1 below is a snapshot of 7Q7RU DXpedition active from Malawi in mid-November. I've labeled the DX signal, the pileup, receiver 1 and 2 filter width graphics and my transmit frequency which is also the receive frequency of the 2nd receiver .

Just set your primary receiver on the DX station with all the filtering necessary to isolate his signal and set your transmit frequency where he is listening. The latter is easier said than done. All major DXpeditions operate split and are typically listening "up" 1 - 2 kHz on CW or RTTY or 5 – 10 kHz on SSB. With the spectrum display you can see the pileup which helps you pick a frequency in the pile but not too close to others. You can do this purely visually but it is even more powerful when you use the 2nd receiver to listen to the pileup. Don't use a narrow filter for that so you can hear more stations. Using headphones with the DX station in one ear and the pileup in the other uses your noggin filtering to keep the 2 separated. You sure don't want to miss that DX station when she comes back to you

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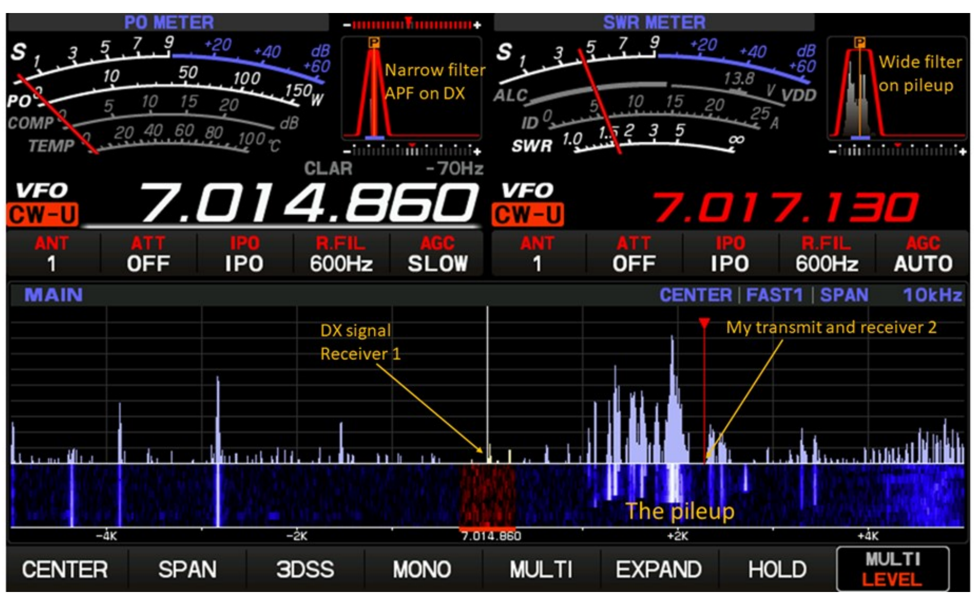

Picture 1—7Q7RU Pileup Spectrum

Busting the Pileup the Panadapter Way

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because your hearing was overloaded with the pileup. The beauty of listening to the pileup is that you can hear who the DX is working, if you are tuned relatively close, so they are somewhere in your passband. As soon as you hear the TU 599 in the pileup you should set your transmit frequency close to, but not on top of, that station, preferably in a clear spot (a valley in the spectrum display). Sometimes you'll notice a pattern that the DX is tuning up or down the pileup. Anticipating this and calling at the just the right spot is great fun. This takes some fiddling and a bit of luck, but even with 100W and a dipole I have been successful in making the contact in a large pileup. Of course, you can't always hear what the DX is hearing so there could be big signals on exactly your frequency, but you have to start somewhere.

Note that you can listen to the pileup even if your radio doesn't have a 2nd receiver by using the audio output of your SDR program. NaP3 works great with the LP-Pan2 and SDR Console works well with the SDR Play. You will notice a sizeable fraction of a second delay due to the processing time of your PC, but it is still very usable depending on how fast your PC is and how much other software is running.

So if you haven't taken the plunge into the world of panadapters and you like the thrill of the DX hunt, give it a try. Even the relatively inexpensive Icom IC-7300 can do the job, although you won't have that second receiver to hear the pileup so you'll be using only the visual aspects of this technique. An SDR receiver and proper software configuration to track your transceiver's frequency and display your split transmit frequency makes the contact a lot easier. It is also fun to see as well as hear what is going on in the pileup. Here's hoping that beating COVID and increasing solar activity will combine to give us some good DXpeditions in the new year. There will be a lot of pent-up demand so having that competitive advantage of a panadapter will help you navigate those big pileups.

Gud DX

Rob NN4NT

VP Corner

By Steve Molo, KI4KWR

Welcome to 2021…hope this is better than 2020 for sure. Only a few days into the year and ARRL RTTY Roundup was not too bad. Some reporting conditions were bad but then many had a good time too. I am using 2021 to get my shack for both Jessica and I for contesting and chasing DX more. With the CL-33 and the add-ons we should get the rare DX we both need. See ya in the pileups…

Pitching and Catching Radio Waves – The Last Bounce

In the previous *Ionospherica* (Spring 2013) we learned that the Earth-Sun system is the source of our DXing delight – the ionosphere. The last 300 kilometers of the Earth-Sun distance governs all the magic we call ionospheric propagation. We can exhibit some control over ionospheric radio wave propagation in just the last few tens of meters by choosing how we orient our antennas. In this episode we consider the last bounce of the path between the ionosphere and our station antenna.

Radio wave photons "pitched" from the ionosphere are "caught" at our station antenna, see Figure 1. Those packets of HF energy arrive by two paths. One path is direct, but the second path involves a bounce from earth. This earth-reflected wave fights and interferes with the direct wave at the our receiving antenna. We observe a vertical standing wave pattern over home plate right where we place our antenna to snag the RF energy! The story is all about geometry, and the detailed spherical Earth geometry equations are in [1]. Our pitcher's mound is the typical 100 km height of the ionosphere, and our catcher represents the height of our station antenna.

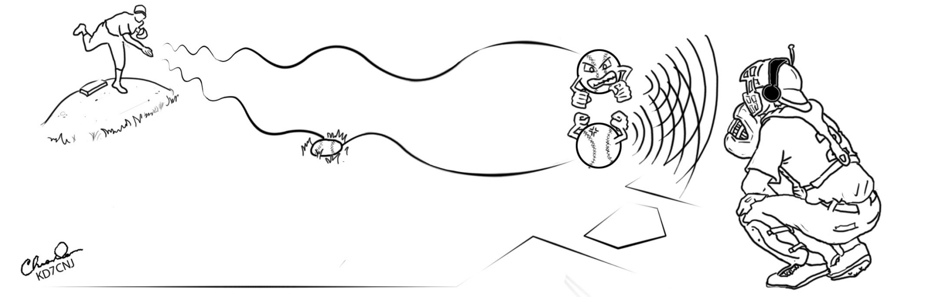

Figure 1 – The ionospheric pitcher hurls radio wave photons that take both direct and earth-reflected paths to the catcher's receiving antenna. *Source:* Copyright 2013 Chris Dean, KD7CNJ, used with permission.

Arrival Angle and Takeoff Angle

An "aluminum cloud" of antennas placed on a high tower can snag a lot of DX. So, questions arise. Why does height matter? Is there an optimum height? What exactly is "takeoff angle", and how does it relate to a good DX antenna system? We gain a lot of insight by turning the problem around from transmitting to receiving. "Arrival angle" is the receiving analog to the transmitting "takeoff angle", and is a *DX parameter* rather than an *antenna characteristic*, see [2]. The *Theorem of Reciprocity* guarantees that transmit and receive antenna system performance is identical so we are justified in looking at the antenna receiving performance.

The field-strength of a radio wave arriving from the ionosphere at our receiving location varies with height. So the proper height for an antenna must be where the field strength is at a maximum, or at the very least, is not in a null. Proper antenna height matters! Figure 2 shows the field strength variation (dB relative to a free space path) versus height for signals pitched from a 100 km height along a 10 degree arrival angle. The three curves illustrate reflection from a medium earth (e =12) ground (solid), from fresh water (dashed), and from sea water (dotted). See [3] for details concerning reflection coefficient. Figure 2 shows the vertical polarization and horizontal polarization field strength versus height. In general, both polarizations are present no matter what was transmitted by the DX station, but that is a tale for a future episode. We pick off the polarization we want by choosing a suitable antenna.

Expected DX Station Arrival Angles

The arrival angle (or takeoff angle) is a characteristic of the geometry between the ionospheric height and the distance separating our location from the DX station. Since we don't know the angle of arrival, we will want to find the best height solution over a *range* of arrival angles. Dean Straw, N6BV, has provided updated statistical elevation-angle files for use with the HFTA application contained on the ARRL Antenna Book CD in [4]. Using the combined arrival angle statistics between several USA regions and all other regions of the world, we can show that 90% of the arrival angles are smaller than 16 degrees. So we will confine our interest to arrival angles between 3 and 16 degrees. This is the *range* of "takeoff angles" that the antenna must accommodate. As seen in Dean Straw's arrival angle files, the lower arrival angles become much less important as frequency is decreased.

Height Gain

The field strength variation depends on wavelength as well as on the wave polarization. When the direct and earth reflected waves meet, their constructive and destructive interference form a vertical standing wave. The curves in Figure 2 were calculated for a 10 degree arrival angle.

For horizontal polarization the gain initially increases with height to the first peak near 1.5 wavelengths. The vertical standing wave scales with the arrival angle. A 16 degree arrival angle

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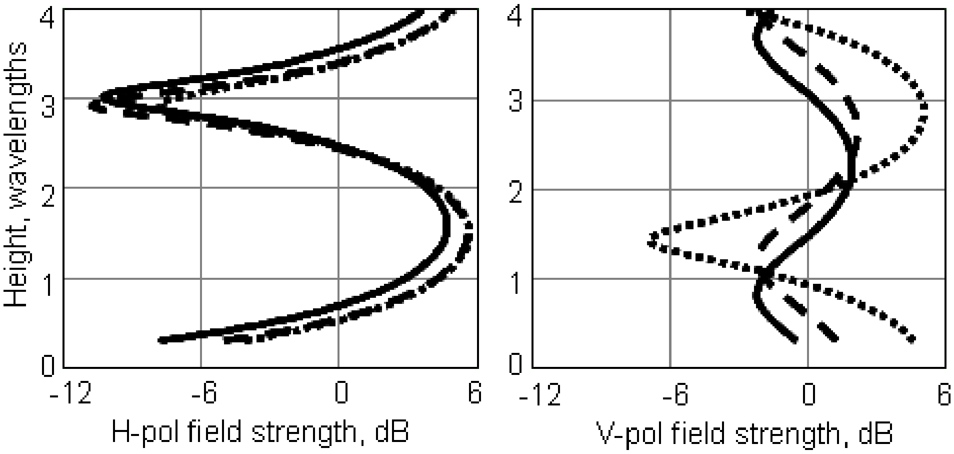

Figure 2 – The vertically polarized (V-pol) and horizontally polarized (H-pol) field strengths vary differently and depend on whether the reflection is from medium earth ground (solid), fresh water (dashed) or sea water (dotted).

compresses the curves so that the first peak appears near one wavelength height. A 5 degree arrival angle expands the curve so that the peak appears three wavelengths high. For horizontal polarization, the curves have a very similar behavior over the range of reflection parameters from medium ground to sea water. Placing horizontally polarized antennas between 1 and 1.5 wavelengths above ground, emerges as one definition of the optimum antenna height. We are not taking into account terrain variations here. That detail is handled by Dean Straw's HFTA terrain analysis application.

For vertical polarization, one optimum height is at ground or sea level, as depicted in Figure 2. Although you should elevate vertical antennas above local obstructions and local roof lines, increasing height any further may initially reduce the received field strength. The sea-reflected vertically polarized wave has an optimum at sea level that can add as much as 5 dB height gain to the actual antenna gain. This is why vertically polarized antennas on the beach are so effective. Ground mounted vertical antennas over earth ground exhibit negative height gains of –1 to –5 dB depending on the signal arrival angle. The gains shown in Figure 2 are in addition to any directive gain provided by the antenna system.

Where's the Reflection Point?

The reflection from earth that causes the vertical standing wave does not occur under the elevated antenna. Let's rephrase that. The ground directly under the antenna (catcher) has no effect on the constructive and destructive wave behavior that results in height gain. There may be mutual coupling to the ground which may affect the antenna impedance, but that is a completely different matter. The location of the reflection point is shown in Figure 3. For arrival angle T in degrees and antenna height H in meters, the distance D_G in meters along the ground

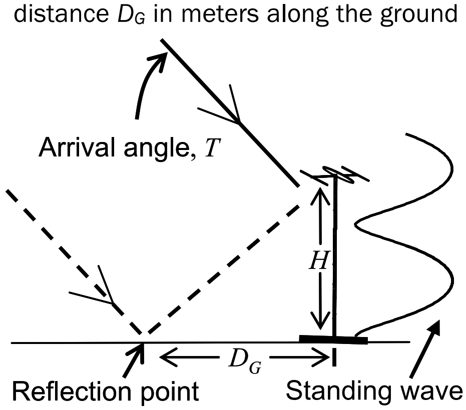

Figure 3 – The reflection point is distant from the antenna tower

to the reflection point is $D_G=55H/T$. Thus an antenna on a 30 m tall tower receiving a wave from 3 degree arrival angle observes a reflection from earth that is 550 m (1,800 ft) from the base of the tower. Ground parameters that are 550 m from the antenna determine which of the curves in Figure 2 are relevant. What's directly under the antenna doesn't matter!

Finding an Optimum Antenna Height

Some multiband Yagi beams can cover the 40 m to 10 m bands in a single structure. Raising and lowering such an antenna to the optimum height per wavelength is not desirable, so knowing an overall optimum height could be very useful. We can calculate a family of curves, like in Figure 2, for any band or any combination of frequency bands. One effective strategy is to choose the best height for the highest frequency band of interest. That sacrifices some of the performance for the lowest arrival angles at the lower frequency bands, but does so more gently than the destructive interference loss for higher arrival angles if a higher antenna were chosen. For frequency bands between 7 and 30 MHz, 1.5 wavelengths at 30 MHz is reasonable if higher frequencies are deemed more important, and 1.5 wavelengths at 14 MHz may be used if the lower frequencies are more important.

Summary and Conclusions

You can increase your low power fun by understanding how radio waves reach your antenna. By adopting a "receive mode" view we see that wave interference from a direct path and an earth reflected path causes a vertical standing wave at the antenna location. The details depend on the radio wave angle of arrival, the polarization, on

Cont'd on p. 10

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(cont'd from p. 9)

whether the reflection point is ground or sea water, as well as on terrain (not considered here). Optimum antenna heights are largely governed by the highest frequency deemed important and by the range of expected arrival angles. Antennas that are placed too high can suffer from significant wave destructive interference at the higher arrival angles. Optimum height for horizontally polarized antennas is 1.5–1.6 wavelengths for any one band, or a compromised height can be found for a multiband antenna operating over several bands by using the optimum height for the highest frequency. Keeping in mind that this analysis was limited to rough but not locally mountainous earth and not a dense urban region, HF antenna heights in the range of 15 to 30 m (50 to 100 ft) emerge as reasonable compromise choices for horizontally polarized multiband antennas operating from a fixed height. Vertically polarized antennas are best kept near ground or sea level, but above local obstructions.

References:

1. K. Siwiak, KE4PT, "An Optimum Height for an Elevated HF Antenna", May 2011, ***QEX***, p 32-38.

2. K. Siwiak, KE4PT, "Is There an Optimum Height for an HF Antenna?", ***QST***, Jun 2011, pp 33-36.

3. K. Siwiak and Y. Bahreini, **Radiowave Propagation and Antennas for Personal Communications, Third Edition**, Artech House, Norwood MA: 2007, Chapter 6.

4. *ARRL Antenna Book* tab at **www.arrl.org/product-notes**, "updated statistical elevation-angle files"..

Kazimierz (Kai) Siwiak, KE4PT, is an avid DXer who packs a DX-go-bag station on his travels. His technical writings appear in many publications. You can reach Kai at **k.siwiak@ieee.org**.

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Experiences from Straight Key Night

By Bob DePierre, K8KI

Few experiences bring back memories like Straight Key Night. The sounds you hear are from days long gone now, but you get to relive the memories one night each year.

I now have a "computer-rig" that incorporates all of the latest technology. Yet tonight it delivered sounds that I remember from 60 years ago:

- A rig using cathode keying. When your rig keys this way, you have about 500 volts right at your fingertips. 500V will arc from some distance, so when you key the rig, you hear arcing at the front and back of each dit. Kinda exciting. I did hear one guy say his rig was 70 years old. Heck, that's younger than me.
- We take sidetones for granted now, but my first two transmitters had transformers that hummed loudly when keyed. So my sidetone was a 60Hz hum.
- Bug skills were prominently on display. Here's where you find fists with a swing. How long has it been since I last heard CQ sounding like dahdidahdit didaaaaaaahdidah. Sorta like a Tennessee drawl. Other bugs had the dots set to 50wpm and the dashes at 5wpm. You just can't miss a sound like that. More like a Chicago machine gun.
- I heard QSO participants 2 kHz apart. When your rig reads frequency to the nearest 10kHz, that's pretty close. I don't have to zero-beat with my rig these days – I just line up the spikes.
- I heard RST reports of 339 and many QSOs ending with KN.
- There were a few ops that could copy at 20+ wpm, but had 5wpm fist skills. Of course, they were running at 20wpm. But they were trying and having a good time at it. I didn't hear anyone give a QLF report, but folks tonight didn't care if you were sending with your left foot.

And I heard more than a few club members on the air tonight. It sounded like they were reliving memories just like mine. My vote for best fist is John Stensby, N5DF.

DX Contests for January

By Chuck Lewis, N4NM

YB DX Contest, (SSB), 80-10 meters

Jan 9, 0000Z to 2359Z

Exchange: RS plus serial number

See page 75, Jan QST and www.ybdxcontest.com

DARC 10 Meter Contest, (CW/SSB), 10 meters

Jan 10, 0900Z to 1059Z

Exchange: RS(T) plus serial No., DOK code

See page 75, Jan QST and www.darc.de

HA DX Contest, (CW/SSB), 160-10 meters

Jan 16, 1200Z to Jan 17, 1159Z

Exchange: RST + S.N.; HA sends County

See page 75, Jan QST and www.ha-dx.com/en

BARTG RTTY Sprint, (DIG), 80 -10 meters

Jan 23, 1200Z to Jan 24, 1200Z

Exchange: Serial no.

See: page 75 Jan. QST & www.bartg.org.uk

UK/EI DX Contest CW, (CW), 80 – 10 meters

Jan 23, 1200Z to Jan 24, 1200Z

Exchange: RST + Serial#; UK/EI add district code

See page 75, Jan. QST and www.ukeicc.com

CQWW 160 Meter Contest, (CW), 160 meters

Jan 29, 2200Z to Jan 31, 2200Z

Exchange: RST + State/province; DX send RST + CQ zone

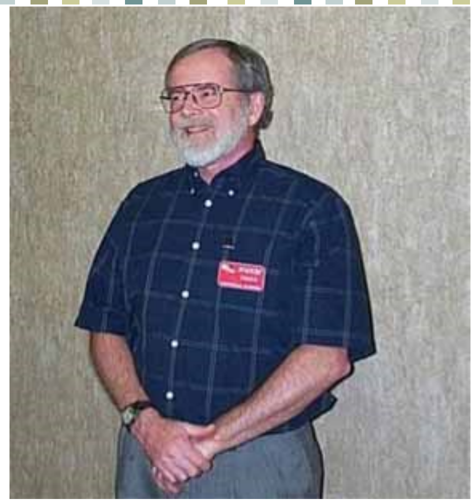
See page 75, Jan. QST and www.cq160.com

REF French Contest, (CW), 80-10 meters

Jan 30, 0600Z to Jan 31, 1800Z

Exchange: RST plus serial no. (F stns. give Dept. ID)

See page 75, Jan. QST and http://concours.r-e-f.org



UBA (Belgium) Contest (SSB), 80-10 meters

Jan 30, 1300Z to Jan 31, 1300Z

Exchange: RS(T) plus serial no.; ON sends province

See page 75, Jan. QST and www.uba.be/en

Dates & times often change or are misprinted in the journals; beware.

Chuck, N4NM

Yaesu FTDX10 HF/50MHz Transceiver

By Steve Molo, KI4KWR

Back in October there were whispers of a new HF rig coming from Yaesu. For me...that is a new product to learn and promote to the amateur radio community. Finally after some delivery constraints I was able to get my hands on one for the weekend. First impression once I powered it up was a mini DX101D and well not off by much. With my current antenna situation being a Hustler 6BTV 80-10m vertical during the 2021 shack rebuild and all bands sounded amazing. Then I did a comparison between the IC-7300 and DX10 and many know I have a full ICOM equipment shack and this could become a Station #2. Thought the DX10 is slightly bass"y" in audio that can be adjusted thru Settings for those concerned. What really stood out was 20m on Saturday evening where I was hearing a IK station calling out CQ and dead ears on the 7300. Thought maybe this was a fluke I switched over to my GAP 20 monoband vertical and same results as I saw on DX80 too.

DX10 Overview

- Hybrid SDR Configuration

Like the FTDX101 series, the new FTDX10 utilizes the Yaesu Hybrid SDR configuration - Narrow Band SDR and Direct Sampling SDR. The Narrow band SDR receiver emphasizes excellent receiver performance, while the Direct Sampling SDR provides a Digital Processing Real-Time Spectrum Scope.

- Narrow Band SDR with 3 types of Roofing Filters and Phenomenal Multi-signal receiving Characteristics

Like the FTDX101 series, the Down Conversion type receiver configuration with the first IF at 9MHz has been adopted. It makes it possible to incorporate excellent narrow bandwidth crystal roofing filters that have the desired sharp "cliff edge" shape factor.

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Yaesu FTDX10 HF/50MHz Transceiver

(cont'd from p. 11)

Thanks to the Narrow Band SDR with the latest circuit configuration including 500Hz, 3kHz and 12kHz roofing filters and low-noise oscillator, the RMDR (Reciprocal Mixing Dynamic Range) reaches 116dB or more, the close-in BDR (Blocking Dynamic Range) reaches 141dB or more and 3rd IMDR (third-order Intermodulation Dynamic Range) reaches 109dB or more in the 14MHz band at 2kHz separation.

- 250MHz HRDDS (High Resolution Direct Digital Synthesizer) affords Quiet and Clear Reception

The local circuit of the new FTDX10 uses 250MHz HRDDS method same as the FTDX101 series. Thanks to its characteristics that improve the C/N (carrier to noise) ratio and the careful selection of components in the design, the phase noise characteristic of the local signal achieves an excellent value of -145dB or less in 14MHz at 2kHz separation.

- 3DSS (3-Dimensional Spectrum Stream) on the 5-inch Full-Color TFT Display with Touch-Panel Functionality

The 5-inch Full-Color panel shows the 3DSS display. By touching the frequency display, the numeric keypad is displayed and the active band and frequency adjustment can be set by direct input. Frequency setting and adjustment can also be performed by turning the MAIN dial or touching the scope display. Similar to the FTDX101 series, the MULTI display, RX operation status display, Center, FIX and Cursor modes are available.

- Front Panel Designed for Superior Operating Efficiency

MPVD (Multi-Purpose VFO Outer Dial), is a large multi-purpose ring around the outside of the VFO dial that enables control of Clarifier, C/S (custom selection function) and recall of memory channels.

- Remote Operation with optional LAN unit (SCU-LAN10)

Remote operation of the transceiver is possible with the optional SCU-LAN10 and SCU-LAN10 Network Remote Control Software. In addition to controlling the transceiver basic operations, the versatile scope displays enable sophisticated operations such as monitoring the band conditions on a large display at a location away from the ham shack by connection to a home LAN network.

The features of the new FTDX10 include:

- 15 separate band pass filters
- Effective QRM rejection with the IF DSP (IF SHIFT/WIDTH, IF NOTCH DNF, DNR, COUNTOUR)
- High-quality and super stable final amplifier utilizing the new push-pull MOSFET RD70HUP2
- Aluminum Heat Sink with 80mm low-noise axial flow cooling fan
- High Speed Automatic Antenna Tuner with a large capacity 100-channel memory
- RF & AF Transmit Monitor
- Microphone Amplifier with Three-stage parametric Equalizer (SSB/AM mode)
- QMB (Quick Memory Bank)
- Band Stack Function
- Optional speaker – SP-30 designed for the new FTDX10
- Optional roofing filter (300Hz) – XF-130CN available

Sherwood Engineering rates the FTDX10 #3 as shown in the table below, reprinted with permission. For more details see www.sherweng.com.

Device Under Test	Noise Floor (dBm)	AGC Thrshld (uV)	dB	100kHz Blocking (dB)	Sensitivity (uV)	LO Noise (dBc/Hz)	Spacing kHz	Front End Selectivity	Filter Ultimate (dB)	Dynamic Range Wide Spaced (dB)	kHz	Dynamic Range Narrow Spaced (dB)	kHz
LO Noise Corrected 05/10/19 Yaesu FTdx-101D	-127 -136^{b} -141^{6}	4.5 1.6^{b} 0.58^{b1}	3	>147	0.60 0.20^{b} 0.12^{b1}	154 155	10 50	A Trk Presel	>115	110	20	110	2
Added 9/29/14 FlexRadio Systems 6700 Hardware Updated	-118 -135^{b2}	3.0 1.0^{b2}	Var	130 preamp Off	2.0 0.25^{b2}	145 155	10 50	B Band Pass	115	99	20&2	108^{y}	20&2
Added 12/30/20 Yaesu FTdx10	-126 -135^{b} -140^{6}	4.2 1.46^{b} 0.54^{b1}	3	141	0.63 0.21^{b} 0.15^{b1}	152 153	10 50	B Half Octave	105	107	20	107	2

NOTE y: Tests in 2017 of a second 6700, and by the ARRL of a 6500, no longer measured a dynamic-range increase with the preamp ON. The 108 dB value is no longer valid. 2 kHz dynamic range is 99 dB, same as 6600M. As with any radio, only use a preamp if it improves copy, and usually only on 15m and up. A second sample of a Flex 6700 that was tested along with an Elecraft K3S on 3/17/17 on 10 meters. That data should also be valid for Flex 2.x and 3.x software/firmware.

Elecraft KPA-500 and Other Solid-State Amplifiers

By Jim Spikes, N4KH

Recently, I've been making some changes to my shack and equipment line up. One such change was downsizing from a larger tube linear amplifier to a Elecraft KPA-500, no tune, solid-state amplifier. This 500-watt amplifier was certainly more affordable than a legal limit/near legal limit solid-state amp. After looking at the capabilities of the matching KAT-500 automatic antenna tuner (ATU), I opted to get that as well. This seemed like a good combination for operating convenience and my current needs and setup. I purchased the kit versions at a slightly lower cost and assembled them myself. Assembly was a little tedious but not difficult. The circuit boards and modules come pre-assembled, and the Elecraft assembly instructions are excellent.

My previous amplifier, an Acom 1000, served me well for several years. Making the switch to the KPA-500 was not a decision I made quickly. The Acom can deliver 1000 watts with 50 to 60 watts of drive (although I typically ran it at 800-900 watts). It's an awesome amplifier and built like a tank but must be manually tuned whenever changing bands or moving far in frequency, and requires 2.5 minutes to warm-up upon every power-up. That can be really annoying for "search and pounce" (S&P) style operation in a contest, or when a needed DX station unexpectedly pops up on the cluster. So, an instant on, solid-state, no tune HF amplifier was appealing, even if it meant somewhat lower power output. Part of my thought process was that there's always the option to add a gently used legal limit tube amp later, if desired. Finding a local buyer for the Acom wasn't difficult and covered the cost of the new Elecraft amplifier.

To put things in proper perspective, 6 dB is equal to about 1 S-unit. In terms of signal strength, I traded off 2 to 3 dB (500 versus 1000 watts), or about half of 1 S-unit. That might make a difference in very marginal conditions, but not too bad all things considered. A 500 watt amplifier provides about 7 dB of signal improvement (a little over 1 S-unit) compared to 100 watts. If running at less than 100 watts on high duty cycle modes, e.g., RTTY, FT-8, PSK, MSK144, an amplifier provides an even bigger advantage. For example, if 40 watts drive gets provides 500 watts output, that equates to a gain of 11 dB (almost 2 S-units). A legal limit amplifier can provide 16 or 17 dB gain, depending on the input drive required.

P_{out}	Gain over 100 watts
200	3 dB
400	6 dB
500	7 dB
800	9 dB
1000	10 dB
1200	11 dB
1500	11.75 dB
$Gain_{DB} = 10log_{10}[P_{out}/100]$	

On the air, I haven't noticed any difference so far in QSO success rate between the Acom and Elecraft amps. With the optional control cable connected between my FTdx101d or K3 transceiver and the KPA-500/KAT-500, the amp and tuner automatically follow the radio around on the various bands and frequencies quite nicely without having to key the radio or make other adjustments, to include 160 and 6 meters. The amplifier uses a pair of VRF2933 FETs, and is rated for 10 minutes keydown/5 minutes standby. The fan will automatically come on and adjust its speed as needed, or can be manually set to always on. 30 to 40 watts of drive will provide 500 watts output. I ran stations at full output for about 2 hours during the recent ARRL RTTY Roundup and the heatsink temperature in the amp settled in at 60 to 65 deg C the entire time, although the fan got a little loud a few times. Maximum heatsink temperature is rated at 90 degrees C. One of the features I really like is the silent PIN-diode T/R switching, which will support high speed QSK if desired. The size is very compact; it weighs 26 lbs (can be carried around pretty easily) as compared to my Acom which was much larger and weighed in at almost 50 lbs. The main issue I've had with the amplifier so far is a noticeable hum from the power transformer on CW and digital modes. I'm still in the process of working with Elecraft tech support to hopefully solve that problem.

In the table on the next page, I compiled information on some popular solid-state amplifiers currently on the market. All the amplifiers listed cover 160 through 6 meters unless otherwise noted. The features, output, and degree of operation varies of course, but all provide for no-tune operation. The rated power output tends to fall into one of 3 basic classes: 500W, 1KW, and 1.5KW. Some come fitted with an internal ATU, or one is available as an option. If not, a high power ATU is needed unless all your antennas are resonate with a good match since solid-state amplifiers can be more fussy about load than tube amps. Information and prices are from internet sales sites as of December, 2020.

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Elecraft KPA-500 and Other Solid-State Amplifiers

(cont'd from p. 13)

Model	P Out W	ATU	T/R Switch	PA Device (Qty)	Approx Price$	Remarks
Acom A700s	700	N	Relay	MRFE6VP61K25N LDMOS (1)	3250	Auto operation with ACOM 04AT ATU
Acom 1200S	1000	N	Relay	BLF188 MOSFET	3750	Auto operation with ACOM 04AT ATU
Ameritron ALS-600	600	N	Relay	FET (4)	1900	500w CW, no 6m coverage, 10/12m with optional kit $1800 w/switching PS
Ameritron ALS-606	600	N	Relay	MRF-150 FET (4)	2200	$1800 w/switching PS
Ameritron ALS-1300	1200	N	Relays	MRF-150 FET (8)	2600	No 6m coverage 10/12m with optional kit 100w drive for full output
Ameritron ALS-1306	1200	N	Relays	MRF-150 FET (8)	2850	100w drive for full output
Elecraft KPA-500	500	N	Pin-diodes	VRF2933 FET (2)	2400	1.5:1 or less SWR, Auto operation w/KAT-500 ATU
Elecraft KPA-1500	1500	Y	Pin-diodes	LDMOSFET (2)	6000	Full output to 3:1 SWR, up to 10:1 at reduced output
Expert 1.3K-FA	1300	Opt	Relays	LDMOSFET (1)	4000	Price with ATU: $5000 1.5:1 or less SWR without ATU, 3:1 with ATU
Expert 1.5K-FA	1500	Y	Relays	LDMOSFET (1)	5400	Full output to 3:1 SWR, 2.5:1 on 6 meters
Expert 2K-FA	1500 +	Y	Relays	MRF151G MOSFETs (6)	7000	Full output to 3:1 SWR, 2.5:1 on 6 meters
Flex PowerGenius XL	1500	N		MRF-1K50H (2)	7000	Full output to 2:1 SWR, no output above 3:1
Palstar LA-1K	1000	N	Vacuum Relay	MRFE6VP5600H LDMOS (2)	3500	1000w SSB, 850w CW, 500 FM/RTTY, bypasses @ 2.5:1 SWR

Retirement and COVID Project Update 9

By Steve Werner, AG4W

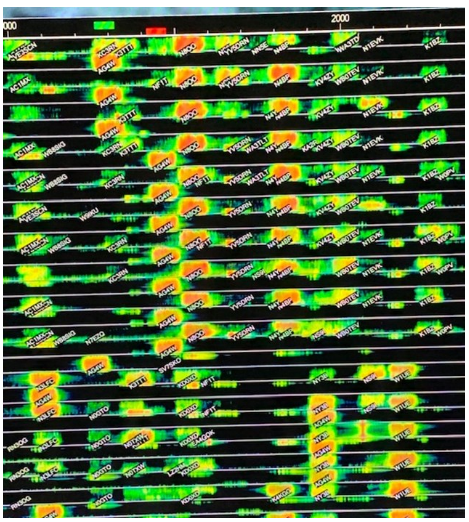
Last month I encouraged you all to set some goals for 2021. If you set some goals for DXCC or VUCC you can start by mining your current logs for those DXCC countries or VUCC grids that have not been confirmed on Log book of the World (LOTW) and send out QSLs. If you do not have an LOTW account I recommend you set one up. Getting Started — Logbook of the World (LoTW) Help Pages (arrl.org).

If you don't have envelopes at the ARRL Incoming QSL bureau I encourage you to send some. Instructions are at Incoming QSL Service (arrl.org). For grid squares I recommend sending foreign grid square QSLs via the ARRL Outgoing QSL service. I was able to find about 50 foreign grid squares that I needed between 2 and 6 meters that I sent out QSLs to in December. I understand the ARRL forwarded 1500 pounds of QSLs in December. I also sent out 10 QSLs direct for US grid square contacts I needed confirmed.

The 10 meter contest had more action than last year. I had more than two times as many QSOs. After reading some of the station summary reports I missed the big E skip opening Friday night. I have had those openings before on 10 meters after dark. They can be amazing. This time of year family obligations and football games can get in the way of evening operating. Saturday morning felt more like a Florida QSO party. E skip openings can sure cover a limited footprint. The contest was also good to improve my CW speed. I plan to continue to improve my CW skills before the Swains DXpedition. It is amazing the rates a good CW operator can make.

Cont'd on p. 15

The RTTY Roundup was frustrating for me. I have a rule to never upload new software before a contest. I uploaded the new DigiRite for FT4 this week because the version I used last year had some problems. This also forced me to load the newest version of WriteLog. I tested both before the contest and it all worked fine on FT4 and RTTY. When the contest started only FT4 worked. After numerous workarounds I had MMTTY working on RTTY again only to have it not work again Sunday morning for four hours.



I enjoyed the new DigiRite software which even shows the calls now, but I sure have some work to do before the next RTTY contest. I am guessing that all this new software does not like my Windows 7 computer. I hate changing out computers. It takes a long time to get things working again, but I see a new one will be needed in the next few months. My current computer is 8 years old which makes it a dinosaur. I still did slightly better than last year.

I love all the different contest reports that WriteLog provides. It is amazing what you can learn from these reports. This RTTY Roundup report clearly shows 40 meters was not only the best band for QSOs, but was also the best band to work DX around the world.

	80M	40M	20M	15M	10M	Total	%
NA	149	475	256	38	0	918	90.4
AF	0	0	1	0	0	1	0.1
AS	0	3	1	0	0	4	0.4
EU	1	42	37	0	0	80	7.9
OC	0	3	1	0	0	4	0.4
SA	0	4	1	3	0	8	0.8

RTTY Roundup QSO Summary Produced by WriteLog

A review of the rate chart below shows my problem at the beginning of the contest for 3 hours and Sunday morning for 4 hours with RTTY not working and trying to resolve the problem . My best rate hour was 0100 UTC at 89 per hour on RTTY on 40M. I also had 2 hours with rates at 74 and 75 per hour on RTTY. Those are not bad rates for RTTY. My best rate on FT4 was 59 per hour on FT4 at 0300 UTC on 80M. I am still learning how to get my rate up on FT4.

I tried Straight Key Night this year on January first. It gave me a chance to use my new Vibroplex key my wife gave me last year.

I made 4 QSOs on 40 meters and 4 QSOs on 20 meters. This is the first time I have ragchewed with a straight key in 55 years. Talk about being rusty with a straight key. Back then I used a

Cont'd on p. 16

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QSO/Sta+Prov+Dx by hour and band

Hour	80M	40M	20M	15M	10M	Total	Cumm	OffTime
D1-1800Z	-	-	24/15	-	-	24/15	24/15	
D1-1900Z	-	-	18/3	6/1	-	24/4	48/19	
D1-2000Z	-	-	9/3	-	-	9/3	57/22	57
D1-2100Z	-	-	34/9	-	-	34/9	91/31	
D1-2200Z	-	46/21	12/1	-	-	58/22	149/53	
D1-2300Z	-	47/8	-	-	-	47/8	196/61	
D2-0000Z	--+--	61/10	--+--	--+--	--+--	61/10	257/71	
D2-0100Z	-	89/9	-	-	-	89/9	346/80	
D2-0200Z	59/1	16/0	-	-	-	75/1	421/81	
D2-0300Z	57/0	2/1	-	-	-	59/1	480/82	
D2-0400Z	-	51/1	-	-	-	51/1	531/83	
D2-0500Z	17/0	47/0	-	-	-	64/0	595/83	
D2-0600Z	6/0	-	-	-	-	6/0	601/83	54
D2-0700Z	-	-	-	-	-	0/0	601/83	60
D2-0800Z	--+--	--+--	--+--	--+--	--+--	0/0	601/83	60
D2-0900Z	-	-	-	-	-	0/0	601/83	60
D2-1000Z	-	-	-	-	-	0/0	601/83	60
D2-1100Z	-	-	-	-	-	0/0	601/83	60
D2-1200Z	11/0	19/0	-	-	-	30/0	631/83	12
D2-1300Z	-	23/0	16/4	-	-	39/4	670/87	
D2-1400Z	-	-	19/1	-	-	19/1	689/88	
D2-1500Z	-	-	30/3	1/0	-	31/3	720/91	
D2-1600Z	--+--	--+--	58/2	5/1	--+--	63/3	783/94	
D2-1700Z	-	-	34/0	7/0	-	41/0	824/94	
D2-1800Z	-	-	15/0	-	-	15/0	839/94	38
D2-1900Z	-	-	-	-	-	0/0	839/94	60
D2-2000Z	-	-	10/1	14/0	-	24/1	863/95	23
D2-2100Z	-	3/0	18/4	8/0	-	29/4	892/99	
D2-2200Z	-	74/0	-	-	-	74/0	966/99	
D2-2300Z	-	49/1	-	-	-	49/1	1015/100	
Total:	150/1	527/51	297/46	41/2	0/0			

RTTY Roundup Rates

(cont'd from p. 15)

Vibroplex Straight Key used for SKN

Heathkit DX-20 and an HR-10. Most of my QSOs in Straight Key Night were over 20 minutes.. K6DF used a key his father used in WW2 in the Navy. W0NTA was still pounding the brass at age 80. I hope my fist lasts that long.

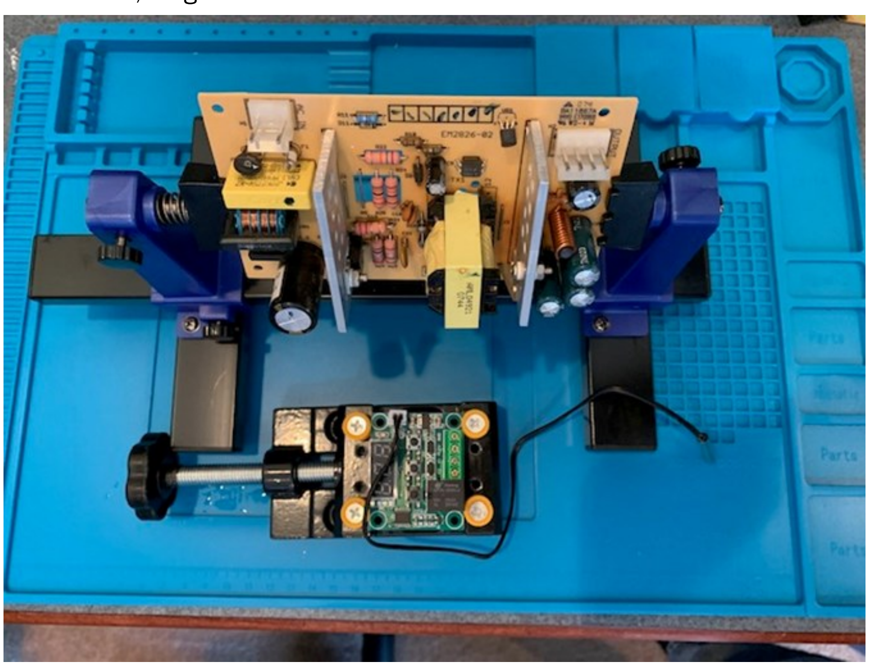
I had no calls on the equipment I showed for sale last month. You might be surprised how low the price is. I want the equipment to get used.

My favorite QSOs last month on 2 meter EME were China BA4SI and Trinidad 9Y4D, Ogasawara JD1BMH and China BG2AUE on 30M, and Svalbard JW7QIA on 160M. We have a short period of common moon with China and the Trinidad station only runs 150 watts. Both stations took a lot of patience to work on EME. I am always amazed at how courteous and helpful EME stations are. I have now worked low power and single yagi stations with my EME station. Even without DXpeditions and few sunspots there is some good DX to be worked.

Besides getting my new Coaxial Dynamics wattmeter for Christmas I also got some nice tools for my projects. It included a high temperature work surface with lots of compartments for small parts and 2 circuit board holding fixtures.

I also got an Arduino kit for Christmas with 37 sensor modules. One of the sensors is a digital temperature sensor that claims to have great anti interference capability and high precision. That could find its way into my 2 meter amplifier soon. There is also a relay module that could be used to control fan speed. I had already built a voltage monitoring circuit before. Now you can see how the circuit board holders will be put to good use this year.

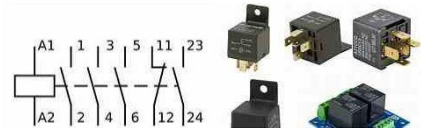
73 Steve AG4W



Circuit Board Holders for Christmas

Relays Used in Amateur Radio Equipment

By Bruce Smith, AC4G



I recently had some issues with my HF amplifier. With the help of Bob (K8KI), we managed to find some schematics. We are currently troubleshooting attempting to figure out what the issue is that prevents my amplifier from powering-up. The amplifier is microprocessor controlled and full of logic chips commonly known as integrated circuits (IC's) making finding the problem somewhat more difficult due to not fully knowing what the firmware is doing. But as I studied the twenty-six page schematic, I noticed many components, especially many relays in the design having differing electrical and physical configurations. Therefore, this gave me an idea on a topic to write about this month in the North Alabama DX Club (NADXC) newsletter, the "Longpath". Let's dive in and discuss a basic electrical component, the RELAY, an electronic component normally taken for granted.

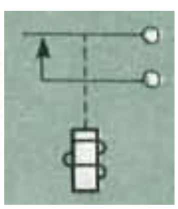



Fig 1 - Solid-state Relays and Basic Relay Schematic

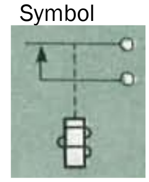
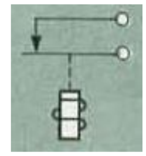
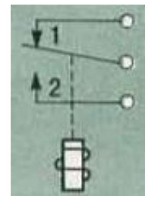
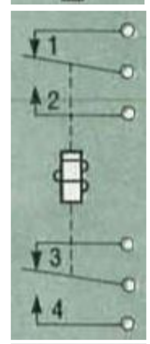
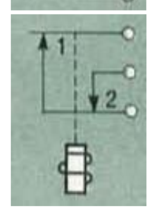
Figure	Design	Sequence	Symbol	Form
2-a	SPST-NO	Make		1A
2-b	SPST-NC	Break		1B
2-c	SPDT	Break(1) Make(2)		1C
2-d	DPDT	Break (1,3) Make (2,4)		2C
2-d	SPDT	Make (1) before break (2)		1D

Fig. 2—Four Basic Relay Configurations

A relay is basically a switch activated by a voltage or signal applied to the relay activation lines; therefore, a relay is an electromagnetic switch allowing one circuit to open or close another circuit or control another component or device. Normally, a relay depends on a magnetic field from a coil to open or close one or more sets of contacts. Figure 1 shows a solid state reed relay commonly soldered in place on a circuit board. Relays are often taken for granted. When you need one, you need it to function properly. If you need to order a relay, you must contend with size, type of case, contacts, power ratings and other features. No single relay can be used for all applications and the wrong one can cause poor performance for any circuit design. We will be taking a closer look only at how they work.

Relay contacts are available in many different configurations. The configuration of a switch is denoted by the number of poles and throws. These are designated by either a number or letter such as "S" for Single or "D" for Double. These configurations can be SPST (single pole, single throw), SPDT (single pole, double throw), DPDT (double pole, double throw), etc. The relay's coil can drive a few contacts or multiple contacts at the same time.

Figure 2 shows the four basic relay configurations. Figure 2-a shows the Normally Open (NO) relay where the contacts are normally open until the coil is activated by voltage and the contacts close (Make). Figure 2-b shows the Normally Closed (NC) relay where the contacts are normally closed until a voltage is applied to open (Break) the contacts of the relay. Figures 2c and

Cont'd on p. 18

(cont'd from p. 17)

2e are double throw contacts configured as a break-before-make and make-before-break; respectively. These types of relays are referred to Forms A-D. The number of poles is placed in front of the form letter showing relays 1A, 1B, 1C, 2C, and 1D. Relays can also be multiple contact types like 1A1B, 2A2C, etc. There are other variations, but are based on these types. Form C momentarily opens both sets of contacts as the center moves from side to side preventing both sides of the switch from being shorted. Sometimes a circuit design requires the relay contact not be unconnected which required Form D. Form D include noise-free switching of current limited switching of current limited audio or control system signals or avoiding voltage spikes when switching inductive loads. Form D contacts cannot switch between two sources when shorting could cause major damage.

Relays switch signals ranging from microwatts of RF to megawatts of power depending on design. The most popular relays are general-purpose relays and reed relays. Figure 3 shows a typical general-purpose relay with socket. This type of relay switches power of 10-30 amps at 120/240 VAC. Miniature general-purpose relays are epoxied into rectangular plastic shells and have printed circuit board pins. Typical dimensions are about 1 inch and their controls can typically switch 1-5 amps.

Fig. 3—Potter-Brumfield General-purpose Relay

Reed relays (previously shown in Figure 1) can be either open or encapsulated and are mounted on printed circuit board-mounted dual inline packages (DIPs). A magnetic field brings the reeds together. The reeds are sealed in a glass envelope to protect them from contamination. Reed relays switch very fast such as 500 usec compared to 5-30 msec for the general purpose relays. Reed relays are intended for dry contact and low-power switching. Typical contact ratings are 200-250 volts, 10-30 watts of switch power with low voltage current ratings of 0.5 to 2 amps. High =-voltage models can switch up to 1 kilowatt, while mercury reed relays can switch up to 100 watts. Coil voltages from 1-24 volts are available with operating powers at a fraction of a watt.

Perhaps the smallest relays are encapsulated in T005 cans looking like small transistors. Some are round, while others are square. The overall dimension is about 0.3 inch with wire leads coming out of the bottom of the 0.2 inch can. The contacts can handle 28 Volts DC or 120 VAC at 1 amp. Coil power is at a fraction of a watt to 32 Volts DC. These are hermetically sealed and some are available with a drive transistor or diode surge suppressor.

Power switching relays are larger in size and are used to switch all power levels. Figure 4 shows a relay used in a high power application such as an HF amplifier. Overall dimensions are 2-4 inches and can switch up to 30 amps. The coil power is 2 watts DC or 5-10 Volt-amperes AC. The contactors on a switch such as this provide the same function as heavy duty relays. The contacts are moved by a solenoid that exerts high forces to open & close the contacts. Arcing needs to be minimized. Electrical and thermal resistance must below in order to minimize heating.

Fig. 4– Power Switching Relay

Latching relays are mechanical flip-flops changing state when their coils are activated by a momentary pulse. These are useful in battery and low-power applications because they use power only when toggled and remember their state during power loss. In a mechanically latched relay, a small permanent magnet goes inside the coil. The magnet is strong enough to hold the reeds together once in contact, but not strong enough to pull them together initially. Energizing the coil with one polarity adds to the field and closes the reeds. The reeds remain closed until energized with the opposite polarity.

I am glad I studied the schematic of my HF amplifier so that I could write this article. I trust this refresher has helped to trigger your memory regarding relays function and their significance in amateur radio equipment. When troubleshooting amateur radio equipment, you should not assume that these components always function. Relays may be taken for granted, but their function is significant when switching power and RF. No, I have not figured out my problem yet, but am getting more familiar with the function of my amplifier. I am hoping to have my amplifier operating soon. I trust my problem is not relating to a relay, its function, or a control line switched by a relay. I hope the issue is simple such as a cheap, simple component, but I will make sure to not take any relay or control line for granted during this troubleshooting stage.