Going Portable with the Amateur Radio Satellites

By Keith Baker, KB1SF/ VA3KSF

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It's springtime here in the Northern Hemisphere. And while the higher HF Bands are beginning to go all but silent for the next few years, many of us amateurs, being an experimental lot, are looking for some other way to get our signals out and be heard. One of those ways (that I have been writing about on these pages) is via our growing fleet of amateur radio satellites. And, yes, I've heard all the laments that getting on the satellite is "too hard" or "too expensive" for you or that you live in a deed-restricted area that prohibits outside antennas. Or, perhaps while not being strictly prohibited, you simply don't have the room (or the spouse approval?) at your home to put up an antenna array that might make your humble abode look like a NASA tracking station.

Well, my friends, there IS a way for you to get on the "birds" without breaking the bank or making your home look like something out of a Star Trek movie. And, very much like I wrote in a previous feature in TSM about putting your HF operations "on the road", satellite work can also be done portably with the right combination of antennas and radios.

Going Hand-Held

Probably the easiest (and cheapest) way to operate on our satellites is via a small, hand-held portable antenna array along with one or more FM Hand-held transceivers.

And, contrary to what you might believe, you don't need a super powerful FM transceiver with these antennas to work the birds. In fact, I (and many other amateur satellite operators) have sometimes met with success using just a simple dual-band hand-held radio and an antenna with just a bit more gain than the ordinary "rubber duck."

That is, over the years, I (and others) have had minimal success using an "extended rubber duck" on these transceiver(s) to make a few contacts on our FM satellites (such as SO-50 and AO-85) on near overhead passes.

However, because the downlink output power on most of our satellites is usually pretty weak (often less than 1 watt) and because of the "capture effect" of FM signals, you'll have far better success if you can create some signal gain on both the downlink (from the satellite) as well as on your uplink (to the satellite).

Several people have "rolled their own" Yagi satellite antennas using nothing more sophisticated than a series of trimmed coat hangers mounted on a block of wood. However, for many years (and for most of my own non-permanent, portable satellite contacts) I've been using a commercially made, hand-held antenna from Arrow Antenna of Cheyenne Wyoming.

The Arrow

The Arrow II Satellite Antenna Model 146/437 provides an impressive forward gain of approximately 10.3 dBd at 70cm and 4.6 dBd at 2 meters. Sturdily machined from aluminum arrow shafts (hence the name) this antenna actually consists of two antennas mounted at right angles to each other on the same boom…a three element Yagi for 2m and a seven element Yagi for 70cm. A removable foam handgrip plus threaded horizontal and vertical photo tripod mounting holes underneath the handgrip make this a totally collapsible antenna that

I often use a Kenwood TH-78A dual-band HT and a lightweight Arrow Antenna to make contacts through one of our FM amateur radio satellites from the shores of Lake Huron in Michigan. When used with a 5 watt, full-duplex handheld in an open location free of foliage (such as a beach or a field) the antenna provides enough uplink and downlink gain to successfully work the FM "birds", even on passes close to the horizon. (Courtesy: KB1OGF) Enterprises) antenna and about 5 watts of uplink power provides just enough gain on the uplink and downlink to briefly work these satellites on near overhead passes.

Your author's wife, Kate Baker (KB1OGF/VA3OGF), makes a contact through one of our FM amateur radio satellites from the shores of Lake Huron in Michigan with a Kenwood TH-78A dual band HT. The extended "rubber duck" (MFJ Model 1717 from MFJ Enterprises) antenna and about 5 watts of uplink power provides just enough gain on the uplink and downlink to briefly work these satellites on near overhead passes. [All photos by Keith Baker unless otherwise noted.]

During AMSAT's 2016 "Symposium at Sea", AMSAT's Secretary, Paul N8HM makes a nighttime QSO using a hand-held Alaskan Arrow antenna and a pair of Yaesu FT-817s from the deck of the cruise ship Carnival Liberty in the Gulf of Mexico.

Another popular commercially made hand-held satellite antenna is the Elk. Here, Craig Wolsey, AC8EJ/VA3ICW, uses his HT and an Elk Model 2M/440L5 antenna to make a contact through one of the AMSAT satellites from the shores of Lake Huron in Canada. The antenna's unique log periodic design allows for dual band VHF/UHF operation using just five elements connected to a single feed line, all without the need for a diplexer.

is also useful for terrestrial radio direction finding or portable emergency work.
With models starting at about US $75, the Arrow is very well constructed and can be easily taken apart (some models even have a split boom!) for extended portable use. A somewhat more expensive version also sports a 10-Watt duplexer (or more correctly, a "diplexer") in the handle, which, if your radio can operate in full duplex mode, requires only a single feed line.

I actually own four of these split-boom and duplexer-equipped Arrow antennas and I remain absolutely delighted with their performance. One of them, along with my Kenwood TH-78A handi-talkie (HT), goes with me in my vehicle or suitcase whenever I travel. Using my Arrow and my HT, I've been able to consistently work thorough AO-85 and SO-50 down to about 10 degrees elevation.

As of late, the Arrow is now being offered in an "Alaskan" version, which offers a bit higher gain, ostensibly for use in far northern latitudes (or if you are using really low power on the uplink). This model sports an extra element on 2m and three extra elements on 70cm.

AMSAT usually carries a supply of both the Alaskan and standard versions of these antennas available via their online "store" on the AMSAT Web site (store.amsat.org/catalog/). Several Amateur Radio dealers also offer various versions of the Arrow Satellite Antenna in their catalogs, or they can be ordered directly from the manufacturer at www.arrowantennas.com.

The Elk

Another variant of the hand-held satellite antenna genre is called an "Elk". This antenna sports a log-periodic design for 2m and 70cm that allows for a single feed line and is available directly from the manufacturer at https://elkantennas.com/product/dual-band-2m440l5-log-periodic-antenna/. As the boom material is manufactured from standard PVC pipe material, it is easily mounted on a photo tripod with just a few extra pieces of PVC piping from your local "big box" hardware store.

Arrow On a Tripod

Because the Arrow boasts threaded receptacles under the foam grip that make it suitable for mounting on a photo tripod, a while back a good friend of mine, Art VE3GNF was intrigued by an article in the March /April 2013 issue of *The AMSAT Journal* by Rick Tejera K7TEJ.

Rick wrote about an equatorial mount for satellite antennas using one designed for a small telescope and adapted for satellite tracking. Having the same interests as Rick, Art believed that he could produce a functioning system "really cheap". Thus, the birth of what he has come to call "The Gizmo".

A number of AMSAT's experimenters have adapted the Arrow Antenna design to a wide range of unique tracking mounts. Here, Art VE3GNF shows off his "Gizmo" mount. The design features a small counterweight and "plumber's tee" that allows for a single movement (similar to an equatorial telescope mount) to track satellites across the sky.

Much like an equatorial astronomical telescope mount (and with the addition of a small, 12 volt DC motor along with some fabricated parts) the Gizmo allows you to track the satellites across the sky from your operating position with just a single movement.

I've worked a number of satellites using one of Art's Gizmos and have found that, once you set the parameters for an upcoming satellite pass, positioning the antenna array with just a single movement really helps to simplify the inherent complexities of amateur satellite tracking and operation.

Old U-110 Rotators

Another approach to portable satellite antenna arrays I've used consists of two old Alliance (Genie) U-110 television antenna rotators. The U-110 is particularly useful because, unlike most of the more modern TV rotators, the U-110 allows for a TV-mast-sized "boom" to be mounted right through the rotator housing. This feature, in turn, greatly simplifies mounting and operating the elevation part of your portable satellite array using these rotators.

Unfortunately, U-110 rotators are becoming increasingly hard to find, even online or in the junk boxes of "flea markets" at hamfests. At one time, the (pre-MFJ) Cushcraft Corporation also made a customized, boom-to-mast kit for U-110s. But, these, too, are becoming increasingly hard to find. On the other hand, if you do happen to come across two of these rotators and also have access to a machine shop, fabricating a boom-to-mast plate for these rotators makes for an interesting project.

Personally, I've had good success working through the Low Earth Orbit (LEO) satellites using a pair of standard-sized (10 element VHF and 22 element, singularly polarized UHF) arrays mounted on a metal cross-boom with a Cushcraft boom-to-mast kit. The array is rotated with two U-110 rotators all mounted on TV antenna masts and a small TV-type roof tripod.

Now, satellite purists will tell you that mounting any UHF or VHF satellite antenna with a metal cross boom protruding through the middle of the antenna elements will destroy the radiation pattern. However, I've found that rotating the antenna array elements at least 45 degrees to the boom helps to very much minimize this effect.

A Pair of Arrows

Another approach to portable satellite operation is to mount two Arrow-style antennas on opposite ends of a cross-boom and feed the dual 2m and 70cm elements together with RG-59 (72 Ohm) phasing coax lines. If the two sets of antenna elements are also mounted 90 degrees from each other, this arrangement creates a "pseudo circular" radiation pattern that can help offset the sometimes deep fades one encounters in satellite uplinks and downlinks when your antennas are cross-polarized with those of the satellite. The only real downside to this arrangement is that it almost requires a more expensive rotator arrangement (such as a Yaesu G-5400 or 5500 Az/El combo) to rotate the array properly.

Mounting It All

Finding the right mounting tripod and mast material to mount your rotators and cross boom can also present somewhat of a challenge. However, I've since found that any number of DJ speaker stands (E-Bay is your friend here) or something similar to MFJ's Model 1918 tripod work just beautifully to support your portable array. For example, a few years back, our local radio club used this portable satellite antenna arrangement to good advantage during the ARRL Field Day, making several contacts on a number of both the FM and linear (analog) satellites.

The M2 "LEO Pack"

And then, like most other aspects of our wonderful amateur radio hobby, there will always be those who want to do it First Class. For those folks who want to take their satellite operating to the field in style, I highly recommend using M2 Antenna System's "LEO Pack" (http://www.m2inc.com/amateur/leo-pack/).

This antenna package consists of M2's Model 436CP16, circularly polarized Yagi for 70cm and their Model 2MCP8A, circularly polarized Yagi for 2m. Either antenna can be assembled using right-hand or left-hand circular polarization, although most veteran

ARRL's Field Day is a great opportunity to try out different portable satellite antenna designs. Here, a pair of Arrow-style antennas are used with 75 Ohm phasing lines to achieve a "circular-like" radiation pattern. The rotator is a Yaesu G-5400 Az/El combo and the tripod is a DJ speaker stand, both obtained from E-Bay.

In recent years, M2 Antenna Systems has marketed their "LEO Pack" consisting of their Model 436CP16, circularly polarized Yagi for 70cm and their Model 2MCP8A, circularly polarized Yagi for 2m. The array is shown here being used during a recent DXpedition to St. Paul Island, Canada. [CY9C, photo.]

satellite ops choose the right-hand circular option. The package also includes a three-piece boom and mounting plate that you may (or may not) need to use depending on your rotator and cross boom selection.

During January and February of 2017, I used one of these LEO packs at our family's rental cottage on Fripp Island in South Carolina. Using a TS-2000 in the satellite mode and a Mirage pre-amplifier (their Model KP2/2m) on the 2m downlink (along with two lengths of about 50 feet of Belden 9913 low-loss coaxial cable) I was able to work any other satellite station I could hear. As of this writing (late February) I've since confirmed well over 50 "grid squares" toward the ARRL's coveted VUCC award from that location via their Logbook of the World (LOTW) using this setup. In short, these antennas really work well!

And, what's even more exciting that AMSAT members can now order their very own M2 LEO pack from the AMSAT online "store" (http://store.amsat.org/catalog/product_info.php?cPath=1&products_id=123) at a somewhat reduced price from retail. If you order it that way, M2 will also graciously donate some of the proceeds from each sale to AMSAT for our satellite construction activities. Clearly, this is a "win-win" for both of our organizations.

Do I Need a Pre-Amp?

One of the questions I'm frequently asked by budding satellite operators is whether (or not) a receive pre-amplifier on the downlink side of a satellite antenna array is needed. The short (flip!) answer is, "It depends". That is, it depends on the gain in your downlink antenna, the length and type of feed line you use and whether (or not) there is a receive pre-amplifier already installed in your radio. Having used many different combinations of antennas, feed lines and satellite-capable radios over the years, I've found that, unless you using long lengths (greater than 50 feet) of higher loss coaxial cable (such as RG-58, RG-8, RG-8X or RG-213 that are better suited for HF operation) you can usually get by with using just the pre-amplifier in your radio…if it has one.

My suggestion is to simply try out the best combination of these elements that you can assemble and see if that arrangement gives you acceptable results. Most of the time, if you are using a hand-held antenna, external receive pre-amplifiers are not needed to bring your received satellite signals up to a readable level, even when using short lengths of RG-58 or RG-8X cable. But, mounting your antenna array on a rotator-equipped tripod with a longer length of higher-loss feed line may generate the need for some more receive gain on the downlink.

Bottom Line

Once again, it is important to remember that satellite work is weak signal work. You need to discard the "S9+" approach from your HF operations while working the birds. All that is required (if working full duplex) is that you be able to hear your own signals through the satellite with a "copyable" downlink signal, period! Anything beyond that is overkill and simply robs downlink power from others who are also just tying to be heard through the transponder.

But, just like as other aspects of our wonderful radio hobby, the bottom line here is to not be afraid to use what you may already have lying around (in your garage or junk box) to experiment with different approaches to mounting and turning your portable satellite array.

And, I very much look forward to "seeing you on the birds"…from my (and your) very own portable satellite setups in the weeks and months of beautiful Summer weather just ahead.

A portable satellite antenna array can also be used in a semi-permanent (or even permanent!) setup. My principle satellite antennas consist of an M2 Model 2MCP14 for 2m and a M2 436CP30 for 70cm. The array is mounted on a metal cross-boom with a Yaesu G-5400 rotator and an MFJ Model 1921 Heavy Duty tripod. Mounting the 2m antenna at a 45-degree angle on the cross boom helps to minimize interference to the circularly polarized pattern.

"Now THAT'S a strange pair or antlers!" A passing deer at our family's rental home on Fripp Island, South Carolina eyes my M2 "LEO Pack". Fripp Island is a nature preserve and the deer roam free.