A Beginner's QRP Moonbounce Adventure

It only takes a small station to work the biggest DX.

Clair Cessna, K6LG

Until recently, moonbounce communications have been the domain of high power stations using large antenna arrays. In the last few years, weak signal digital mode innovations, especially JT65B (**physics.princeton.edu/pulsar/K1JT**), have made it possible for modestly equipped stations to make EME contacts.

Like many hams, I was largely unaware of these developments — and that I had gear that, with some additions, could be cobbled into a low power (QRP) moonbounce station. It was April 18, 2010 and I was on hand at a friend's station to hear KP4AO, the Arecibo Observatory ARC, on 432 MHz CW, SSB and JT65B — the first ham signals I had ever heard from the Moon.[1] John Oppen, KJ6HZ, was using a four Yagi array, but we could also hear the signals on a small handheld Yagi. John would become my mentor as I embarked on a project to try EME.

Setting Up the Hardware

Having been active on the high orbiter ham satellites some years ago, I already a Yaesu FT-847 transceiver, an old Tokyo Hy-Power HL-120U amplifier (rated 40-60 W continuous duty) with internal preamp and a Yaesu G-5400 azimuth-elevation rotator, but not the Yagi.

I was lucky to have a friend who loaned me an M² 432-9WL beam, which uses 28 elements for a 9 wavelength Yagi (17 dBd). He also made up two lengths of new LMR-400 coax with N connectors — 8 feet from amplifier to Yagi and 40 feet from amplifier to shack. Later an autoswitching ARR preamp (17.7 dB gain, 0.6 dB noise figure) was added just before the power amplifier to replace the noisier internal preamp.

A steel fence pole elevated the rotator to 10 feet off the ground. The boom mount clamp was rigged to facilitate polarization adjustment (see Figure 1). The 21 foot long Yagi was trussed with a PVC support and cotton clothesline rope to counter sag and misalignment of the elements (see Figure 2).

The amplifier, preamp and power supplies were put on a small wagon, which is wheeled outside under the Yagi when operating making possible the short coax run from amplifier to antenna, keeping losses at a minimum (see Figure 3).

An outdoor wired remote switchbox was rigged and connected to the rotator control in the shack. This makes it possible to visually aim at the Moon and also to adjust polarization at the rear end of the Yagi. A step ladder is used to do this if the boom is nearly horizontal. Fortunately, since the pattern of the Yagi is relatively broad, alignment needs to be done only every 5-10 minutes.

With regard to polarization, one big advantage of using a single Yagi is that polarization can be easily changed by twisting the boom. The Moon data in the JT65 program indicates the spatial polarization angle necessary for aligning with a given DX station. For example, generally from Southern California polarization should be near vertical for a horizontally polarized European. This is a starting point, since Faraday rotation of the signal as it passes through the ionosphere (daytime) on either end of the path may make the angle quite different. Also, at times, best results will be obtained while transmitting vertical and receiving horizontal or vice versa.

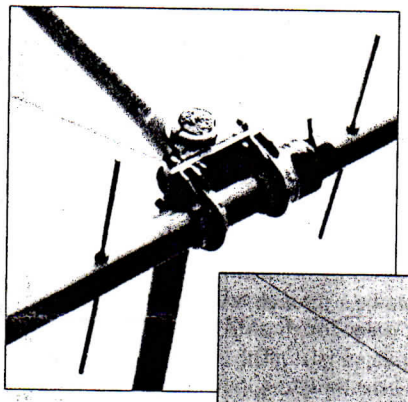

Figure 1 — The PVC bushings allow the boom to be twisted in its mount to adjust the polarization for receiving and transmitting.

Next the Software

The JT65B digital mode, created a few years ago by Joe Taylor, K1JT, with his subsequent improvements and those of collaborators, is the secret of QRP EME success.[2] JT65 is a soundcard mode. If you are set up for PSK or other digital modes just download the free program from Joe's website. You need to be proficient in using this mode before you try to use it on EME. You can usually find JT65A stations on 7.076 or 14.076 MHz, where the signals are generally strong and steady. (JT65A is used on HF; JT65B is optimized for EME but there is no difference in operation.) Read the documentation and practice until you're comfortable with it.

The JT65 mode compresses and encodes standardized text blocks, sends them via FSK composed of a sync tone and 64 data tones. Then, at the receiving end, data is uncompressed and decoded back into text. The

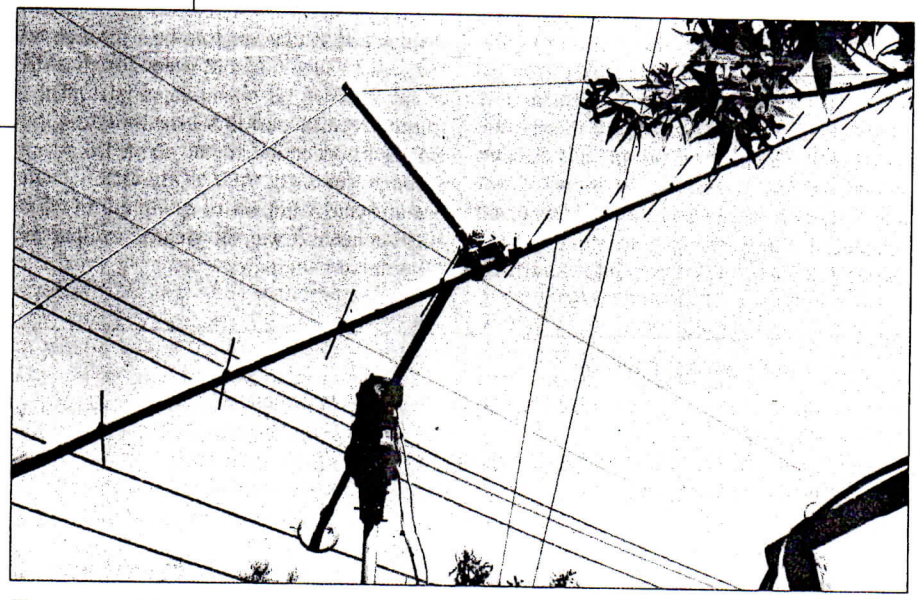

Figure 2 — This is the 28 element Yagi mounted on the directional and azimuth/elevation rotators.

[1]Notes appear on page 74.

blocks are sent in automated 1 minute transmissions. Decoding takes place only after the entire transmission is complete. One station transmits on the odd numbered (first) minute and the other on the even numbered (second) minute UTC. Since time accuracy to the second is essential, I set my computer clock via the Internet each time I operate.

Although 13 random characters can be put into text blocks, the standard message format is much more robust. The two-tone short-hand messages RO, RRR and 73 are readable at 5 dB less than even the standard messages (see Table 1).

Tools of the Trade

There are some valuable operating aids available to EME operators. The EME loggers are a great assist especially for beginners. One can get a quick view of who is operating on a particular band and coordinate schedules. The *VK3UM EME Planner* (**www.vk3um.com**) gives all the astronomical data for your station and a particular DX station. Moon windows are shown for both stations, including UTC and local times, azimuth and elevation of the Moon, Doppler shift, spatial polarization, path degradation, sky temperature and more. This makes schedule planning easy.

The JT65 program itself will display astronomical data for the Moon and path conditions in real time. Yes, moonbounce conditions vary from excellent to poor over time. Weekends that are predicted to have excellent conditions bring more action. Programs such as *Nova* or data from **www.vhfdx.info/w5luu.html** and **www.vhfdx.info/emecalendar.html** are great prediction resources.

Operating EME with minimal QRP gear is a challenge and much different from QRP HF operating. This is particularly true on 432 MHz where there are only a fraction of the EME stations operating on 2 meters, the most popular EME band. On 432 it is difficult to find stations by "tuning the band." All of my contacts have been made by prearranged schedules with *very big* guns running high power and using very large antenna arrays.

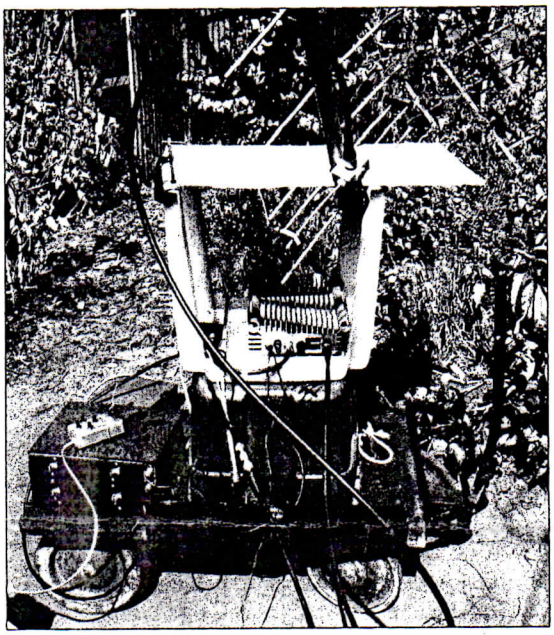

Figure 3 — The wagon holds the power amplifier, preamp and power supplies. The elevated platform raises the amplifier when the Yagi is horizontal and provides shade. The wired remote rotator switch box is shown on the left resting on the power supply.

Their stations make my contacts possible. Many of the operators of these stations are eager to assist and kindly accommodate us "little fish."

A couple of these have worked stations running 30 W, with Yagis half the length of mine. I e-mailed these operators to arrange schedules, then tried to contact them on the *HB9Q logger/chat* page (**hb9q.ch**) around the appointed time. Even then, my initial attempts at contacts failed.

The Longest DX

Then it happened. Bernd, DL7APV, was calling CQ at the scheduled time and frequency. He was visible on my waterfall display and loud enough to hear through my speaker. I called him and waited on the edge of my chair as his signal came back. The 1 minute receive period seemed endless, but finally the decoded signal popped onto my screen: K6LG DL7APV JO62 OOO. I was ecstatic and went on to complete my first EME contact. It was the greatest thrill of my 60 years of ham radio.

I was fortunate to have been assisted by Al Katz, K2UYH, well known for his encouragement and guidance of EME newbies and editor of the *432 and Up* EME newsletter. After many helpful e-mails and a couple of failed tries, we connected for my second EME contact.

Jan, operating at the Dwingeloo Radio Telescope, PI9CAM, was my third contact, followed by Zdenek, OK1DFC, and Nando, I1NDP. Five countries via the Moon and I still have several more big guns on my schedule request list.

I would still like to make a CW contact via EME but that will require substantial upgrading of my EME station. Of course, the numbers of stations you potentially can work is directly proportional to your power and the gain of your antenna system. You also may wish to consider starting on 2 meters, where the greatest number of EME stations operate.

I'm indebted to my friends John, KJ6HZ, for his guidance and support; Dave, W6DL, for the Yagi and custom made coax; Dave, WB6OVZ, for setting up the wired remote and his valuable suggestions, and Rein, W6SZ, for his help. Thanks to all the big gun operators who accommodated and assisted me, exemplifying the best spirit of ham radio and especially, to Joe, K1JT, whose contributions made it all possible.

I have sent signals from my backyard to travel 240,000 miles to the Moon with a tiny portion reflected to travel 240,000 miles back to Earth to be detected by another ham on the other side of the globe — the *ultimate* DX. Imagine that!

Table 1
A Typical EME JT65B Contact

First Minute	*Second Minute*	*Information*
CQ K2UYH FN20		CQ call, grid
	K2UYH K6LG DM13	K6LG reply, grid
K6LG K2UYH FN 20 OOO		K6LG copied solid by K2UYH
	RO	K6LG received report, solid copy of K2UYH
RRR		K2UYH received report and confirmation
73		73

Notes

[1]J. Taylor, K1JT, A. Vazquez, WP3R, J. Breakall, WA3FET, "Moonbounce from Arecibo Observatory," *QST*, Aug 2010, pp 62-65.
[2]S. Ford, WB8IMY, "JT65 — The 'Musical' Mode," *QST*, Apr 2011, pp 45-46. Feedback, *QST*, Jun 2011, p 64.

All photos by Clair Cessna, K6LG.

Clair Cessna, K6LG, an ARRL member and Amateur Extra Class operator, was first licensed in 1949 at age 15 as W6GZP. He is a retired high school science teacher and was radio club advisor in schools where he taught. Clair operates on 160 meters through UHF, using most modes. His favorite is still casual DX contesting on CW. He currently serves as secretary of the Riverside County Amateur Radio Association. He can be contacted at 3975 Madrona Rd, Riverside, CA 92504. **k6lg@arrl.net**.