

# National Parks Via the Moon

**It only took 50 W and a single Yagi antenna for this team to make moonbounce contacts for National Parks on the Air. You can do it, too!**

## Dennis Schaefer, W5RZ

For decades, hams have been using the Moon as a giant radio reflector to make DX contacts. The practice is called *EME* (Earth-Moon-Earth), also known as *moonbounce*. I began my own EME journey a number of years ago by listening to CW EME signals on 2 meters. The signals I heard came from the big stations; the ones with massive antennas and high RF output power levels. That's what it seemed to take to make the half-million-mile trip between their stations and mine. As far as I was concerned, I'd forever be just a listener.

But thanks to Dr Joe Taylor, K1JT, and his *WSJT* software, it became possible for much smaller stations like mine to join in the fun. I downloaded and installed his free software package, and it wasn't long before I made several EME contacts on 2 meters using a digital mode known as *JT65B*.

In 2007, Dan Gautschi, operating as HB9Q, asked if I could try EME on 432 MHz, because he needed Arkansas on that band. I had an old quagi antenna and used it with my

Yaesu FT-897D transceiver on JT65B. Despite running only 15 W output, I completed the contact with Dan.

I put everything away until 2009 when Bernd Wilde, DL7APV, made the same request. By then I had two 24-element Cushcraft 424B Yagi antennas, both of which were obtained from the man who would later become the current ARRL President: Rick Roderick, K5UR. I worked Bernd, but he reported that my signals were weak. I checked the next day and discovered that, due to feed line losses, I had only 5 W at the antenna. Not bad for working Germany via the Moon!

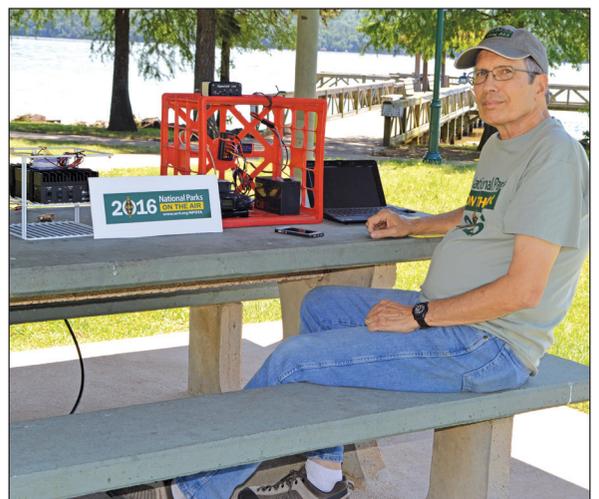
This was getting interesting, so I bought a used 100 W "brick" amplifier. It included a preamp, so it helped on both transmit and receive. With the two antennas and about 80 W, I worked several big stations, mostly in Europe. I would set the antenna up about once a year, work a few stations, and then take it all back down. I am involved in local club activities, DXCC, ARES/RACES, contests, and more, so EME is just an oc-



The W5RZ portable EME Yagi antenna, anchored to a barbecue grill at Lake Dardanelle State Park.



The EME station on a picnic table.



The author at the portable EME operating position.

## Low-Power EME Tips

Is an EME contact on your “bucket list?” There is a lot of EME information out there, but it can be daunting to put it all together. The operation described in this article took place on 432 MHz, but much of the advice that follows is applicable to 2-meter EME as well.

### Digital EME Frequency Ranges (MHz)

50.185 – 50.195  
144.115 – 144.135  
432.060 – 432.070

### Transceivers

You'll need a transceiver that will generate SSB on 432 MHz, preferably with at least 20 W output. I have used a Yaesu FT-857D (20 W), an Icom IC-7000 (35 W) and a Yaesu FT-991 (50 W), as well as the Yaesu FT-817 and amplifier described in the article. Frequency stability can be an issue at 432 MHz, but I have found these rigs to be sufficiently stable; you can add a temperature compensated crystal oscillator (TCXO) later if needed. The frequency stability of my FT-817 is not bad, but I added an inexpensive Chinese TCXO anyway.

### Antennas

My K1FO 22-element Yagi antenna has about 15.7 dBd gain and is 14 feet long. I have made contacts with this antenna with as little as 20 W. If your antenna is smaller, you will need more than 20 W, but you can take 15.7 dBd (17.8 dBi) gain and 20 W as a starting point. If you want to build your own antenna, you have many options, including excellent designs on DG7YBN's website ([www.dg7ybn.de](http://www.dg7ybn.de)). The long boom Yagis that appear in ARRL books are also excellent.

As mentioned in the article, you can receive DL7APV, HB9Q and some of the other big stations on an even smaller antenna than mine, but you probably won't complete the contact with just 20 W output. A small “brick” amplifier with a built-in receive preamp helps considerably; the more power the better!

Single Yagis are easier to mount horizontally and two Yagis are easier to mount vertically. Keeping the mast out of the plane of the elements seems more important than which polarity is used. Remember that you'll be working stations with sophisticated antenna systems. Many of them can change their antenna polarities to adapt to conditions.

When setting up your antenna, don't worry about keeping it high off the ground. The antenna only needs to be high enough to keep the reflector off the ground at maximum elevation. And, of course, refrain from transmitting while handling the antenna!

### Software

Your primary program is *WSJT*, which you'll find online at [physics.princeton.edu/pulsar/k1jt/](http://physics.princeton.edu/pulsar/k1jt/). This is the application you'll use to generate JT65B signals to apply to your transceiver, and decode the JT65B signals you receive. Learning to use *WSJT* isn't difficult, but a tutorial is beyond the scope

of this article. Read the user manual and follow the instructions carefully. If you already operate JT65 on the HF bands, you'll find much that is familiar.

As with other digital modes, you will need an interface between your computer and your transceiver. I'd suggest an interface with a built-in sound device. Some transceivers, such as the Yaesu FT-991, have built-in sound devices of their own, so all you will need is a USB cable between the radio and the computer.

JT65 requires accurate timing, but computer clocks tend to drift. I go into the *Windows* time setting function in Control Panel and update from the Internet before an EME session. Some people use software like *Dimension4* ([www.thinkman.com/dimension4/](http://www.thinkman.com/dimension4/)), which runs in the background and keeps your computer clock set accurately. If you're out in the field, you can also listen to WWV and set the time manually.

You need to determine when a path to the Moon will be available at your location. W7GJ makes an excellent planning program called *GJTracker*, available as a free download from [www.bigskyspaces.com/w7gj/](http://www.bigskyspaces.com/w7gj/). It shows the Moon position for any date or range of dates you specify, and shows the signal degradation for those dates. Degradation is mainly dependent on noise from other celestial objects and the distance of the Moon from Earth. For QRP EME, pick days with low degradation figures; 1.5 db or less. EME contests are often scheduled on weekends with good conditions.

When you are finally ready, you need to aim your antenna at the Moon. This is easy if you can see the Moon, but don't let the lack of visibility deter you! As stated in the article, I use an app for iPhone called *Lunatic*. The phone shows you exactly where to point your antenna. You can also use a compass and protractor along with the printout from *GJTracker*. Check the antenna about every 15 to 20 minutes to keep it on target.

### HB9Q Chat

To set up a contact attempt, log onto the HB9Q chat site at [www.hb9q.ch](http://www.hb9q.ch). Click on **432 MHz** at the top and you will see people exchanging information about their activities. Don't be afraid to post something like, “Any big stations want to try with a QRP station?”

QSO information is not exchanged via the chat room until the contact is complete, but when someone is new, there is plenty of coaching available.

### Doppler Details

Doppler shift can be a factor on 432 MHz. It's not unusual for signal frequencies to be as much as 1 kHz different from what might be posted on HB9Q chat. Some stations try to anticipate Doppler (which is different on each end) and put their signals on the sked frequency for the other station. Most people just set their VFO to the sked frequency and let the other station find them. If DL7APV says, “Let's try 432.063,” I set my VFO to 432.063, but I understand that I may sometimes need to use RIT or split operation to find his signal.

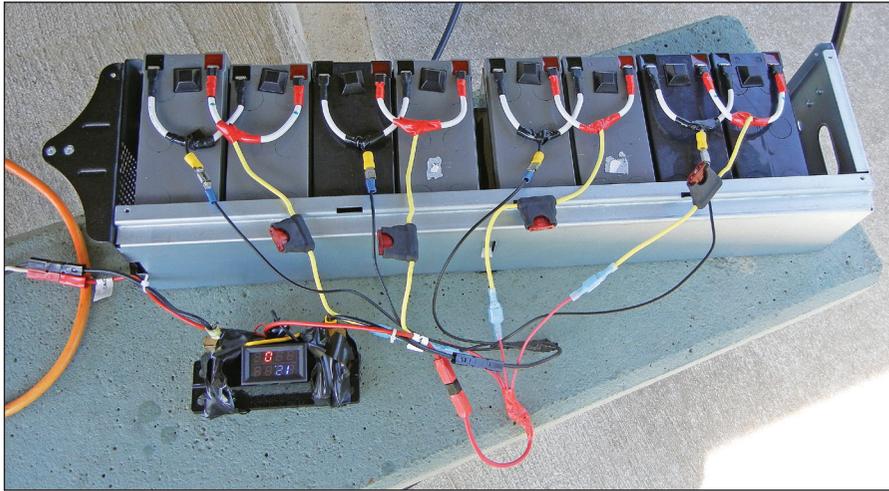
casual activity for me.

### The Facebook Push

The Essex DX Group, MX0CNS, contacted me about their QRP (low power) EME efforts, and I joined their Facebook group.

They were doing great things on 432 MHz with small antennas and low power, and they inspired me to drag out my gear and try again. Tom Hackett, M0ABA, is the prime mover in the group, and we have corresponded via e-mail and Facebook for

several years. When the ARRL National Parks on the Air (NPOTA) event organizers encouraged hams to make EME contacts from National Parks earlier this year, I knew I had to do it. ARRL Field Day is my favorite activity, and I have always wanted



The portable EME station was powered by a bank of 7.2 A/h sealed lead-acid batteries.

to make an EME contact outdoors at Field Day, but why wait for June?

### Preparations

For my NPOTA EME attempt, I chose a K1FO 22-element Yagi, about 14 feet long. The antenna was light enough to balance on a small tripod, which was a major asset. A satellite TV mount was used to change the antenna azimuth and elevation.

Rather than ask for permission to plug into the park's ac power, or drag a generator to the site, I decided to use battery power. Luke Williams, AE5AU, offered some 7.2 A/h sealed lead-acid batteries that had been taken out of commercial service. I wanted 2 hours of operation, and 8 batteries in parallel gave over 3 hours of operation in tests. The batteries were charged using a 15 W solar panel.

I selected April 9, the Associazione Radioamatori Italiani (ARI) EME contest weekend, and picked Dwight Mission, which is on the National Park Service's Trail of Tears National Historic Trail, as the primary location. My alternate was Lake Dardanelle State Park, also part of the Trail of Tears system.

The equipment lineup included a Yaesu FT-817 transceiver and an RF Concepts RFC 4-110 amplifier. The amplifier could be driven to about 70 W with the rig, but in testing at home I was able to work DL7APV with only 20 W. I chose to run 50 W at the park to make solid contacts while still conserving battery life. The feed line was a 35-foot run of LMR-400 coaxial cable. Since every fraction of a decibel counts, hardline would have been better, but I used what I had.

I asked George Cotton, WB5JJJ, if he would take some video to document the activity. As it turned out, George did a lot more, assisting with setup and tear-down, helping with operating, making antenna adjustments, etc.

### On The Air

Our operation was supposed to start at 1 PM local time, and we arrived at Dwight Mission at about 12:15 to find the park full of boat trailers. There was obviously a big bass tournament going on, even though there was nothing on the park calendar. We diverted to our alternate location, Lake Dardanelle State Park, checked in at the visitor's center, and were still on the air by 1 PM.

The winds were gusty, so we tied the antenna tripod to a handy barbecue grill. An iPhone app called *Lunatic* told us where to point the antenna, because we couldn't see the Moon in daylight. We moved the antenna about every 20 minutes as the Moon crept across the sky.

Using a netbook computer with a cellular Internet connection, I logged on to the HB9Q EME chat page to see who was active. The HB9Q chat pages are good sources of information, and most of the hams on it are glad to answer questions and help with problems.

After we described our unique setup on the chat page, Jurg Fielder, DK3WG, asked us give him a try. The sunshine was so bright, it was difficult to see the *WSJT JT65B* display on our screen, even in the shade with a box over the computer. However, we were able to complete a contact with DK3WG a few minutes later.

Then things started happening fast! HB9Q and OK1DFC wanted to work us. The contact with OK1DFC was completed quickly, but we didn't hear HB9Q. Doppler shift over the Earth-Moon-Earth path can exceed 1 kHz on 432 MHz, so we had to tune a bit to compensate, but we finally manage to lock onto HB9Q.

We finished the day by working Bernd, DL7APV. We had been on the air less than an hour and a half, although it certainly didn't seem that long. On the same day, MX0CNS worked PI9CAM via EME using 60 W and a three-element Yagi!

Of course, the credit for our success goes to the stations at the other ends of the trans-lunar paths. DL7APV and DK3WG both have arrays of 16 Yagis. OK1DFC has a 30-foot dish, and HB9Q has a 45-foot dish.

There are still many months left in the National Parks on the Air event, and many more opportunities to make moonbounce contacts in the great outdoors. There are plenty of large EME stations that are more than willing to help, and at 432 MHz, even multi-element Yagi antennas are easy to transport and set up.

All photos by the author.

Dennis Schaefer was first licensed in 1963 as WN5IIS. He held WA5IIS until the 1970s when he received his present call sign: W5RZ. While in the Air Force, Dennis operated as KA2DX from Japan and KA1DX from Minami Torishima. His main interest is chasing DX on CW and he achieved #1 DXCC Honor Roll (mixed). Dennis has been involved in ARRL activities since he was young, holding appointments as Emergency Coordinator, District Emergency Coordinator, Section Emergency Coordinator, Net Manager, Section Emergency Coordinator, Section Manager, and Assistant Director. He enjoys local club activities, QRP CW, casual contesting, building antennas, and his favorite ham radio event is ARRL Field Day. You can contact Dennis at [dennisw5rz@gmail.com](mailto:dennisw5rz@gmail.com).

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