Moonbounce on a Budget

By Bob DeVarney W1ICW

Winter 2013
What is moonbounce?

- Contact made via signals bounced off the moon
- EME or Earth Moon Earth
- First done by US Army in Project Diana in 1946
- First successful amateur contact made in 1960
Project Diana

• Camp Evans, NJ near Fort Monmouth
• Used a highly modified SCR-271 radar set
• Same radar set in use at Pearl Harbor in 1941
• 3,000 watts at 111.5 MHz
• John H. DeWitt was also a ham operator
DIANA MOON RADAR

Acknowledging your reception of the U.S. Army Signal Corps - U.S. Naval Research Laboratory Minutack Calibration Signal for Satellite Tracking

DIANA MOON TRANSMITTER 1.2 MILLION WATTS ERP FREQUENCY 108 MHz RANGE TO MOON AND RETURN

THE UNITED STATES ARMY SIGNAL ENGINEERING LABORATORIES FORT MONMOUTH, NEW JERSEY U.S.A.
Amateur Work

• First echoes heard on 2 meters in 1953 by W4AO and W3GKP
• It was not until 1960 that two-way was possible W6AY and W1FZJ
• First two-way on 1296 MHz band
W4AO and W3GKP in 1953
The Eimac Gang July 1960
EME in Vermont

• Al Parrish K1KKP made two 60 foot helix antennas in 1965 and worked moonbounce from Peru, VT for Vermont’s first EME effort.
EME in Vermont

Warren, K1BKK was Vermont’s second EME op circa 1975 with a 160 element collinear array running 1 kw from a pair of 4CX250Bs in a K2RIW-design amplifier from his home in Barre, VT
Lance, WA1JXN, ( now W7GJ ) was third from Bridgewater VT
Now, from Montana, he is the undisputed 6 meter EME king.
Chip W1AIM
4x Cushcraft 3219 + Henry 2002 (1 kW)
Fast forward to 2013
Design Considerations:

• Antennas small enough to use standard rotors; large enough to get the job done
• Small (less than 500 watt) amplifier to start
• Build as much as possible to save $$$
• Zero dollar investment. Sell off surplus gear to fund the project
• First 10 QSOs made using existing gear to test the concept
First EME QSOs from W1ICW

• Used existing satellite antenna ( M2 2MCP14 ) and existing radio ( Kenwood TS-2000X ) running 100 watts/ SSB mast mount preamp
• First QSO on January 31 2010 with RK3FG (degrade 0.2 dB )
• Second QSO February 3 with Gary, KB8RQ (degrade 2.5 dB )
• Third QSO I2FAK Feb 21 ( degrade 3.7 dB )
What are the difficulties?

• 250 dB of path loss
• Amateur limit of 1.6 kW output
• Degrade
• Antenna polarity effects
• More/bigger antennas the answer
Path loss example

• average receiver will hear -120 dBm
• 250-120 still 130 dB off !
• 1.6 kW output is 62 dBm
• 130-62 still 68 db off !
• Antenna gain helps you twice !
• Preamp gain
• Software gain
Moonbounce antennas of the rich and famous:
W5UN, Dave, Texas

W5UN EME Array with 32 2M5WL horizontal antennas, and 32 front mounted ten element vertical antennas
KB8RQ, Gary, Ohio
RK3FG, Anatoli, Russia
RN6BJ, Russia
Polarity effects

• Antennas polarise your signal similar to polarized light
• Reflection off the moon often changes polarity
• Cross polarized means you can’t see the signal
• Switchable polarity antennas nice but expensive and difficult to maintain
So what is degrade?

- Combination of background cosmic radiation (sky noise) and extra loss from elliptical orbit of moon
- Predictable and repetitive
- Can be planned for
- Sun noise also affects propagation
So what has made low power EME possible?

• 2001 Joe Taylor releases WSJT which is a suite of soundblaster based digital modes for weak signal work.

• They rely on DSP post-processing for increasing the S/N

• Can decode as low as 30 dB BELOW the noise!

• Listen for 48 seconds, process, then tx for one minute in JT65B
What has WSJT done for us?

- First ever single yagi to single yagi EME
- First ever 6 meter EME
- Small stations can now work EME
- 10 elements and 100 watts all you need now
- (I’ve actually done it with 7 elements and 100 watts)
- Revolutionized moonbounce for good and brought it to the masses
What does it look like?
My Initial Budget

- Antennas 624
- Rotors 529
- Feedline 0
- Amp 540
- Preamp 125
- Misc 200
- Transverter/Rig 600
Amplifier Rev 1

- Vocomm Repeater Amp
- 7 watts in gave approx 300 out
Amplifier Rev 2

- Homebrew using 2x BLF-177 broadcast pallets
- 15 watts in gave 600 out
- Ran off 48 volts DC
- Used HP Blade Server supply (50 bucks!)
- Power supply capable of 50 VDC@ 55 AMPS!
Amplifier Rev 3

- Homebrew 1X BLF-578
- 2.5 watts in gives 1 kW out!
So how has it worked for me?

- 325 contacts since erecting new array May 15 2010
- 248 different stations worked
- 191 grid squares worked ( VUCC awarded )
- 50 countries worked
- 32 states worked
- WAC and VUCC awarded on 2 meters
- All worked with four 7-element yagis, 300-1000 watts, .3 dB NF preamp, and Elecraft K2/XV-144 transverter
MAP-65 adds a lot to the desktop:
New Waterfall screen
Main screen

<table>
<thead>
<tr>
<th>Freq</th>
<th>DF</th>
<th>Pol</th>
<th>UTC</th>
<th>DT</th>
<th>dB</th>
<th>KV</th>
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<td>74</td>
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<td>-16</td>
<td>RO</td>
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<td>0</td>
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<td>408</td>
<td>0</td>
<td>022900</td>
<td>3.0</td>
<td>-23</td>
<td>DK3WG W3SZ FN20</td>
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<td>0</td>
</tr>
</tbody>
</table>

- **DX Call**: FG4KH W1ICW FN34
- **Grid**: JO93ac
- **Time**: 12:11:22
- **Logs**: 121103_0229.iq
- **Rx noise**: 0.0 0.0 0.0%
### Messages

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<th>UTC</th>
<th>dB</th>
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<td>0</td>
<td>022900</td>
<td>-23</td>
<td>DK3WG W3SZ FN20</td>
</tr>
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</table>
Band Map

112  W&2FGK
115  VE1KG
118  KJJT
120  UA4PMW
131  G0GOK
132  RX1A5
132  W3SZ
**Astro Data**

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<th>Date</th>
<th>Time</th>
<th>Az</th>
<th>El</th>
<th>MyDop</th>
<th>DxAz</th>
<th>DxEl</th>
<th>DxDop</th>
<th>Dec</th>
<th>SunAz</th>
<th>SunEl</th>
<th>Tsky</th>
<th>MNR</th>
<th>Dgrd</th>
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<tr>
<td>2013 Feb 20</td>
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<td>349.3</td>
<td>-25.3</td>
<td>-36</td>
<td>70.5</td>
<td>9.8</td>
<td>110</td>
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<td>109.1</td>
<td>3.7</td>
<td>609</td>
<td>25.0</td>
<td>-6.1</td>
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</table>
Tracking now on separate computer
Things to consider:

• Choose best times to operate for optimal success
• Choose moonrise or moonset times to get ground gain
• 10 element yagi or better
• 100 watts or better
• Preamp as close to the antenna as possible
• EU vs NA vs AS “windows”
What is the EU window?
Example statistics:

```
WAC continents worked by W1ICW (FN34KP) on 2 m.
Mode: All mode

<table>
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<tr>
<th>CONTIN.</th>
<th>QSO</th>
<th>Conf.</th>
<th>CALLSIGN</th>
<th>DATE</th>
<th>TIME</th>
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<tbody>
<tr>
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<td>5</td>
<td>5</td>
<td>ZS2GK</td>
<td>18/05/2010</td>
<td>16:56</td>
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<tr>
<td>AS (Asia)</td>
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<td>5</td>
<td>JR3REX</td>
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<td>EU (Europe)</td>
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<td>122</td>
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<tr>
<td>NA (North America)</td>
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<td>49</td>
<td>KB8RQ</td>
<td>03/02/2010</td>
<td>04:05</td>
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<td>OC (Oceania)</td>
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<td>4</td>
<td>VK4CDI</td>
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<td>SA (South America)</td>
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<td>5</td>
<td>PY2SRB</td>
<td>20/05/2010</td>
<td>01:15</td>
</tr>
<tr>
<td>Total:</td>
<td>6</td>
<td>331</td>
<td>190</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```
EME on 15 meters!
ES5TV in Estonia
ES5TV details

• 8 x 5-elements on 15 meters
• Acom 2 kW amp
• Yaesu FTDX5000
• http://www.youtube.com/watch?v=Z9fDlbIFhMs
Links:

WSJT Home page for WSJT software: http://www.physics.princeton.edu/pulsar/K1JT/

Home page for the VK3UM EME calculator software: http://www.sm2cew.com/download.htm

GM4JJJ MoonSked moon tracking and prediction software: http://www.gm4jjj.co.uk/MoonSked/moonsked.htm

G8KBB Noise Meter software to measure sun noise: http://g8kbb.roberts-family-home.co.uk/NoiseMeter.zip

Project Diana history: http://www.k3pgp.org/1946eme.htm


W7GJ web page (lots of useful information): http://www.bigskyspaces.com/w7gj/


N0UK JT65B spotter page (online frequency spots plus chat): http://www.chris.org/cgi-bin/jt65emeA

LiveCQ on 144 (frequency spots from automated receivers): http://www.livecq144.com/