Modern 2 meter EME and weak signal operation

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Agenda

► Not your average appliance operator on EME
  ► Why and who is on EME, VHF/UHF weak signal
  ► K1JT station pictures – EME Contest station
► Technical details of noise and signal processing
  ► Applicable to HF as well (WSPR)
  ► Path loss, KTB/noise, Averaging and estimation
► How do you get started
  ► NJ2R’s EME first stations
  ► Screen shots, and links – How to
  ► Pictures of EME stations
Background

  - Inexpensive and close – October 2-4, 2015
- My elmers – Worldwide Winners 2014 EME contest:
  - Dr Al Katz – [K2UYH@tcnj.edu](mailto:K2UYH@tcnj.edu)
  - Dr Joe Taylor – [K1JT@Princeton.edu](mailto:K1JT@Princeton.edu)
  - Roger Shultz – [NJ2R@Verizon.net](mailto:NJ2R@Verizon.net)
- Two contest weekends – November and December full moon
- EME is 12 hours/day x 365 days/yr passive reflector
- Worldwide/DXCC independent of solar cycle
- RF skills are invaluable when every db counts
Activity Trends – ARRL EME Contest de CT1DMK

- Top Score CW
- 10th Place CW
- Top Score JT


144, 1296
The log/antennas
EME specifics

- Doppler shift
- Faraday rotation
- Polarization
- Sequencing
- Schedules, activity night
- Q&A
Technical Details: Noise and signals

Thermal Noise floor (KTB)

\[ P_{\text{dBm}} = -174 + 10 \log_{10}(\Delta f) \]

Delta F is compared to 1 Hz

<table>
<thead>
<tr>
<th>Bandwidth</th>
<th>Thermal noise power</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Hz</td>
<td>-174 dBm</td>
</tr>
<tr>
<td>10 Hz</td>
<td>-164 dBm</td>
</tr>
<tr>
<td>100 Hz</td>
<td>-154 dBm</td>
</tr>
<tr>
<td>1 kHz</td>
<td>-144 dBm</td>
</tr>
<tr>
<td>10 kHz</td>
<td>-134 dBm</td>
</tr>
</tbody>
</table>

Plus other noise sources!

Signal Power after gain/loss:

<table>
<thead>
<tr>
<th>Component</th>
<th>dB/dBm</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>TX</td>
<td>60</td>
<td>dBm for KW</td>
</tr>
<tr>
<td>Ant</td>
<td>23</td>
<td>4 x yagis</td>
</tr>
<tr>
<td>Loss</td>
<td>-262</td>
<td>EME path loss</td>
</tr>
<tr>
<td>Ant</td>
<td>23</td>
<td>4 x yagis</td>
</tr>
<tr>
<td>RX</td>
<td>-156</td>
<td>dBm into pre-amp</td>
</tr>
</tbody>
</table>

CS/G ratio and sun noise for system test
JT65 uses single tones with averaging

- 64 tones in 400 hz passband
- < 3 hz/tone
  - 26 dB advantage over SSB
  - 20 dB advantage over CW
- Low bit rate = noise averaging
- Error recovery, redundancy, lookup
NJ2R’s Initial EME Station

9 element F9FT portable antenna

ARR pre-amp, Bypass relay
Roger’s EME Results – Past 5 Years

- Why EME?
- Results
  - 246 “Initials” An initial is a contact with a new station. 56 are within the US
  - 58 DXCC countries
  - All continents
  - 34 EME states
  - 195 Grid Squares
  - The majority of stations are in Europe
- Station
  - Kenwood TS-2000X and IQ+ SDR
  - SignaLink USB, W2DRZ sequencer
  - 2 2MXP20 cross pole antennas
  - Dual ARR 25 db gain preamps followed by DCI bandpass filters
  - Lots of relays for switching
  - Home brew 8877 amp from the ARRL Handbook in 1976 to 1990
What do you need?

- Antennas are the best investment!
- 2 meter all mode radio to drive amplifier
- Amplifier, the more power the better
- Sound card interface to computer
- WSJT software from K1JT and Time sync software for PC
- Sequencer to switch everything in the proper order
- Pre-amp at the antenna will be needed
- A few relays T/R, polarity, pre-amp protection
- Azimuth rotor, elevation rotor is also very helpful
- Attention to detail Where is the moon? Activity?
- Visual antenna alignment with moon to start
- Patience with single polarization antennas
Links to software, amps, presentations

- **WSJT, WSJT-X, MAP65, WSPR, SimJT, Open Source**
  - [http://physics.princeton.edu/pulsar/k1jt/](http://physics.princeton.edu/pulsar/k1jt/)
  - References: [http://physics.princeton.edu/pulsar/k1jt/refs.html](http://physics.princeton.edu/pulsar/k1jt/refs.html)
  - N0UK logger for scheds [http://www.chris.org/cgi-bin/jt65emeA](http://www.chris.org/cgi-bin/jt65emeA)
  - Moon tracking [http://www.f1ehn.org/](http://www.f1ehn.org/)
  - [http://members.shaw.ca/ve7sl/eme.html](http://members.shaw.ca/ve7sl/eme.html) for a good user example with a single yagi
- [http://wsprnet.org/drupal/wsprnet/map](http://wsprnet.org/drupal/wsprnet/map)
- **Solid State VHF Amplifiers (+ eBay)**
  - [http://www.w6pqj.com/1_kw_2m_ldmos_amplifier.htm](http://www.w6pqj.com/1_kw_2m_ldmos_amplifier.htm)
  - [http://www.beko-elektronik.de/index.php?do=03,01,01,02,05&lang=en](http://www.beko-elektronik.de/index.php?do=03,01,01,02,05&lang=en)
- **VHF conference proceedings CD available**
  - Starting out on EME-23cm K2UYH.ppt
  - W2PU Princeton Univ 432 EME station
  - K3RWR reducing noise sources
- **EME newsletter:** [http://www.nitehawk.com/rasmit/em70cm.html](http://www.nitehawk.com/rasmit/em70cm.html)
Or the very best! 24 Yagis

KB8RQ Gary
Many hams first EME QSO
KB5WIA just 2 X 7 Element yagi’s
MONACO 3A/DL3OCH
ONE OF MOST SUCCESSFUL
EME DXPEDITION OPS (1296)
USES SINGLE 59 EL (5 m) YAGI, NO PREAMP & 80 W!
DP1POL – Felix 67 EL 1296 YAGI WINTER AT SOUTH POLE!
Present Setup
4 × 15LFA-JT
G = 22.4 dBi
Princeton Univ.
W2PU