Getting Started (and progressing) in EME Communications

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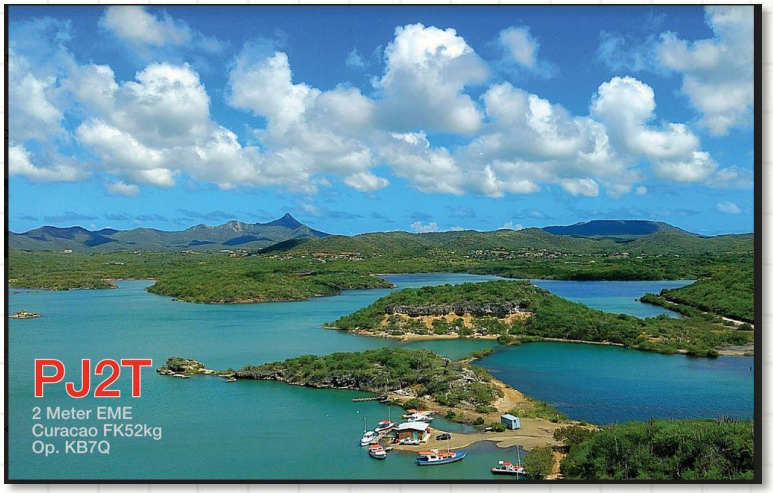
Topics

- What is EME? Why is it challenging?
- How do I get started?
- Finding contacts, assessing propagation and the necessary software…
- The EME Station at AB1OC-AB1QB

What is EME? How Does It Work?

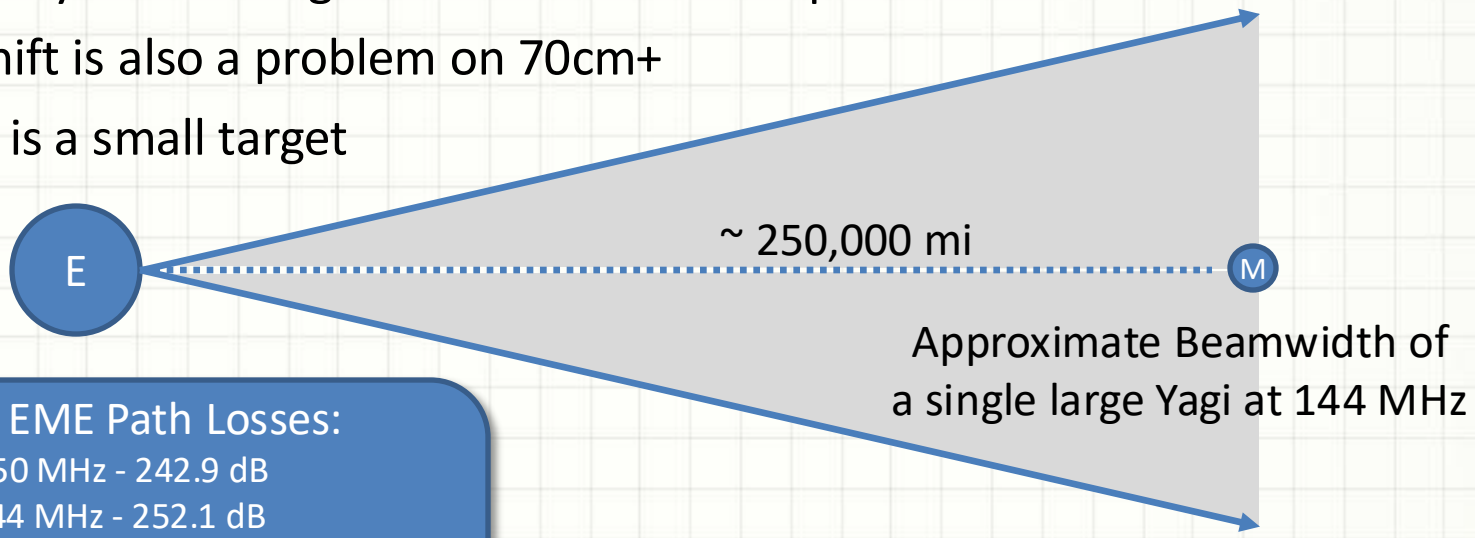
- EME or Moon Bounce Communications uses signals bounced off the Moon to make DX contacts on the VHF and higher bands
- About ½ of the globe can "see" the moon at any point in time making DX possible (and common)
- Bands from 6m through 10 GHz+ are used
  - 2m (144 MHz)
  - 6m (50 MHz)
  - 70cm (430 MHz)
  - 23 cm (1.2 GHz)



- EME is the ultimate weak signal VHF+ challenge
  - EME Operators often work to achieve DXCC on 2m, 6m, ….
- Most popular EME mode is JT65x Digital. CW is still used but requires BIG antennas and LOTS of power.
  - Its possible to make a 2m JT65x contact with 1 large or 2 medium Yagis and 200w - 500w of Tx power
  - Q65 mode is also beginning to be used
- EME contests are popular. Outside of contests, SKEDs are common.

What Makes EME So Challenging?

- The moon is far away – 357,200 km to 406,600 km (50,000 km equates to ~2 dB changes in path loss during each month)
  - Signals take between 2.4 and 2.7 seconds to make the trip
- The moon is not a very good reflector + **Libration Fading** (multipath effect)
- **Faraday Rotation** - ionosphere causes polarity changes which result in deep fading. Effect is **aggravated by spatial offset.**
- Space is noisy – sun and galactic noise are both problems
- Doppler shift is also a problem on 70cm+
- The moon is a small target

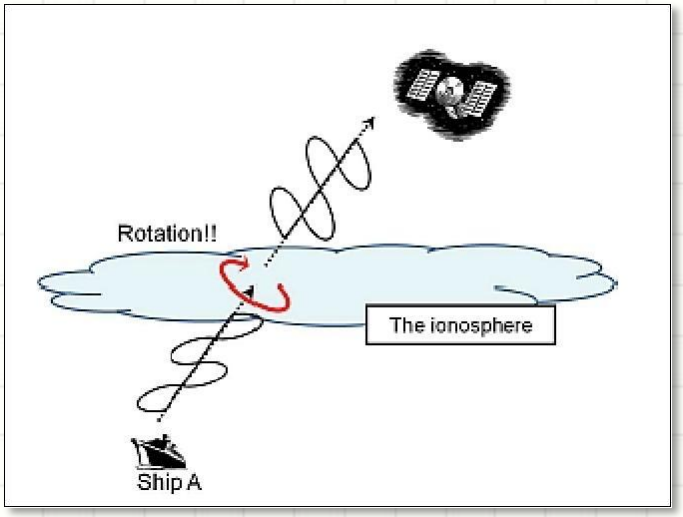


Typical EME Path Losses:

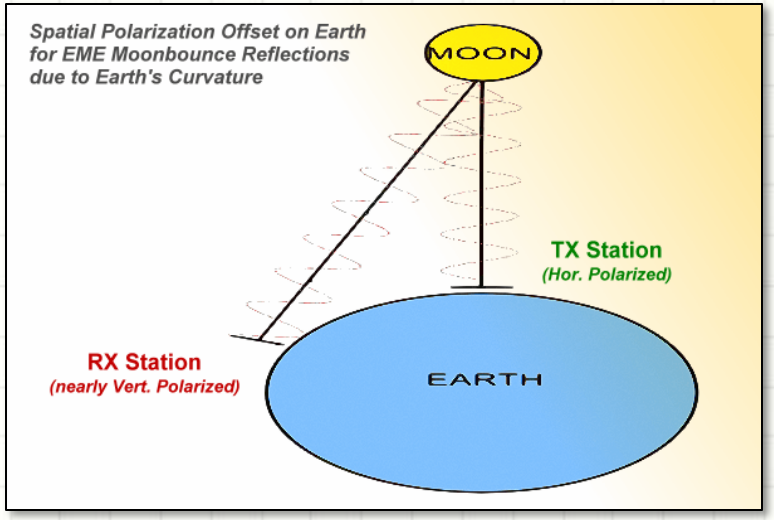
50 MHz - 242.9 dB
144 MHz - 252.1 dB
432 MHz - 261.6 dB
1296 MHz - 271.2 dB
10368 MHz - 289.2 dB
HF Skip on 20m - ~125 dB (5,570 km)

A Closer Look at Polarity Effects

- **Faraday Rotation** – Polarity changes caused by transiting the Ionosphere
- **Spatial Offset** – Polarity changes due to a station's location and the earth's curvature
- The two can destructively combine to create polarity lockout
  - ➢ This can sometimes last for hours
- Transmit and Receive path polarities may be different



Faraday Rotation



Spatial Offset

EME Band Choices – What's Best?

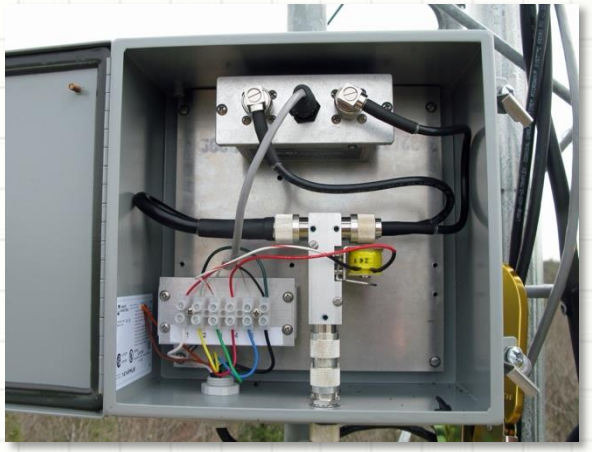
- Average path loss increases by approx. 6 dB each time the frequency is doubled
- Use of a Dish Antenna results in a 6 dB gain increase each time the frequency is doubled
  - Size of dish antennas become practical at 1296 MHz and above
- Yagi size, gain, and beamwidth decreases for a given boom length as frequency increases
  - Yagis are typically used for 6m, 2m, and 70cm
- Galactic noise is very significant on 6m and is a factor on 2m/70cm
- Doppler shift becomes a problem on the 70cm and higher bands

2m EME is the most popular band,
6m is next; many DXpeditions do EME there

4.5m Mesh Dish

What Do I Need To Get Started in 2m EME?

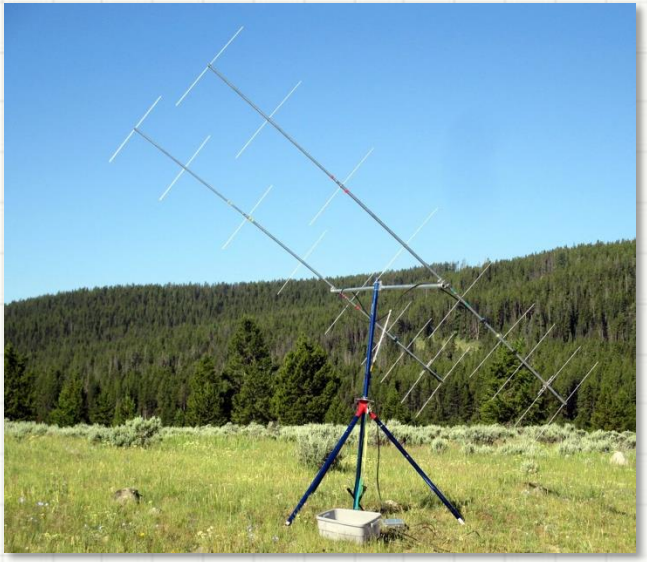
- One large or 2 medium yagis for the 2m weak-signal sub-band
  - Ground mounted cantilever with manual pointing
- An amplifier capable of 500w to 1 Kw
  - 100% duty cycle required
  - Beko, Gemini, W6PQL, M2 Antennas (used)
- A good, low-noise Rx Preamplifier
  - A high-power sequencing setup is required
  - Advanced Receiver Research is a good source for preamps, M2 Antennas for sequencing.
- A modern 2m weak signal transceiver
  - A 10m rig + a 2m transverter is also an option
- A computer running WSJT-X



2m EME Basic Antennas

One Large or Two Medium Yagis…

- For portable applications, two medium yagis will be the most manageable
  - Horizontal or vertical polarity will work (practical cross-boom length)
  - Power Divider and phasing lines are reqd.
- A large, single Yagi works well if you you have a tower
  - Horizontal polarity
  - You'll be taking advantage of ground gain which adds 3 – 5 dB
  - Will be able to work the moon up to 15^{o} – 20^{o} (30 - 40 minutes; moon rise/set)
- Preamp should be close to the antenna
- Pay attention to feedline loss and power handling capacity
- If you are using a rotator, be sure to calibrate it using the moon



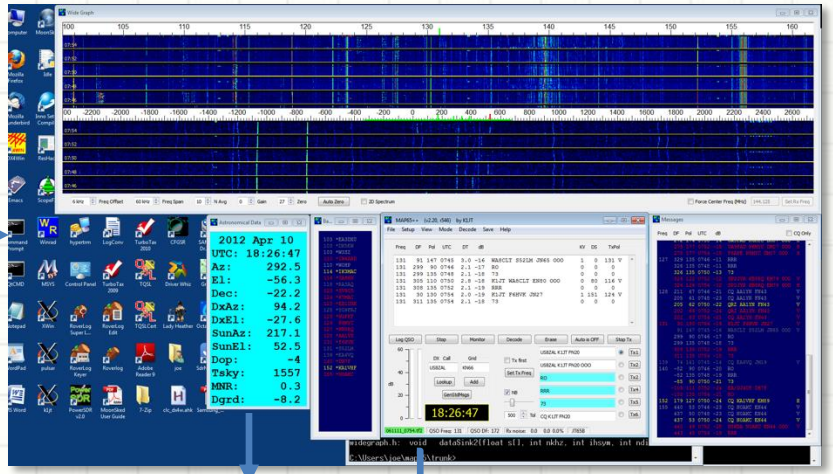
2 X 9 elements (14 ½' booms)
17 dBi Typical

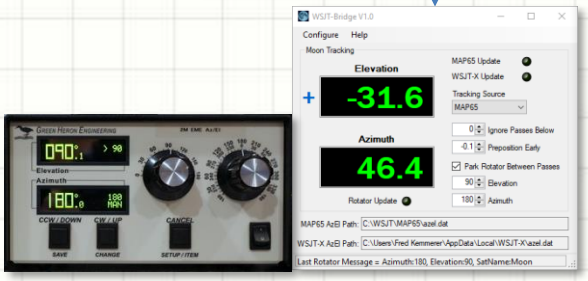
18 elements (36' boom)
17 dBi

2m EME Radio System

JT65B via MAP65 or WSJT-X

SDR Receiver





Custom App Enables MAP65 Rotator Control

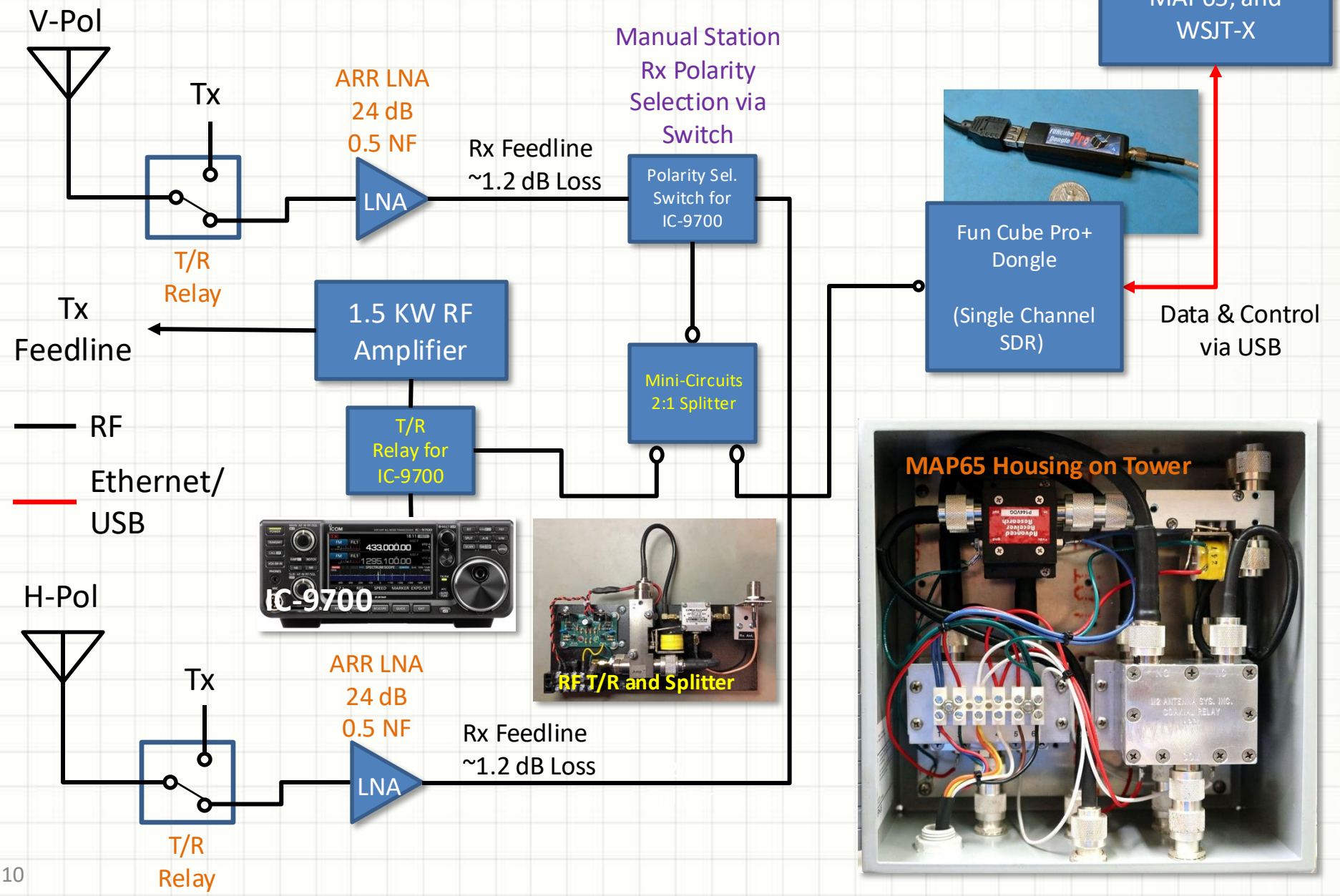
IC-9700 Transceiver

1.5 Kw Amplifier & Sequencer

- MAP65 Software - Adaptative Polarity Receive System
  - Requires separate Vertical and Horizonal SDR I/Q Receivers
- Moon Tracking via custom apps
- Transmit side uses IC-9700/1.5 Kw amplifier and sequencer to protect Preamps/Rx equipment

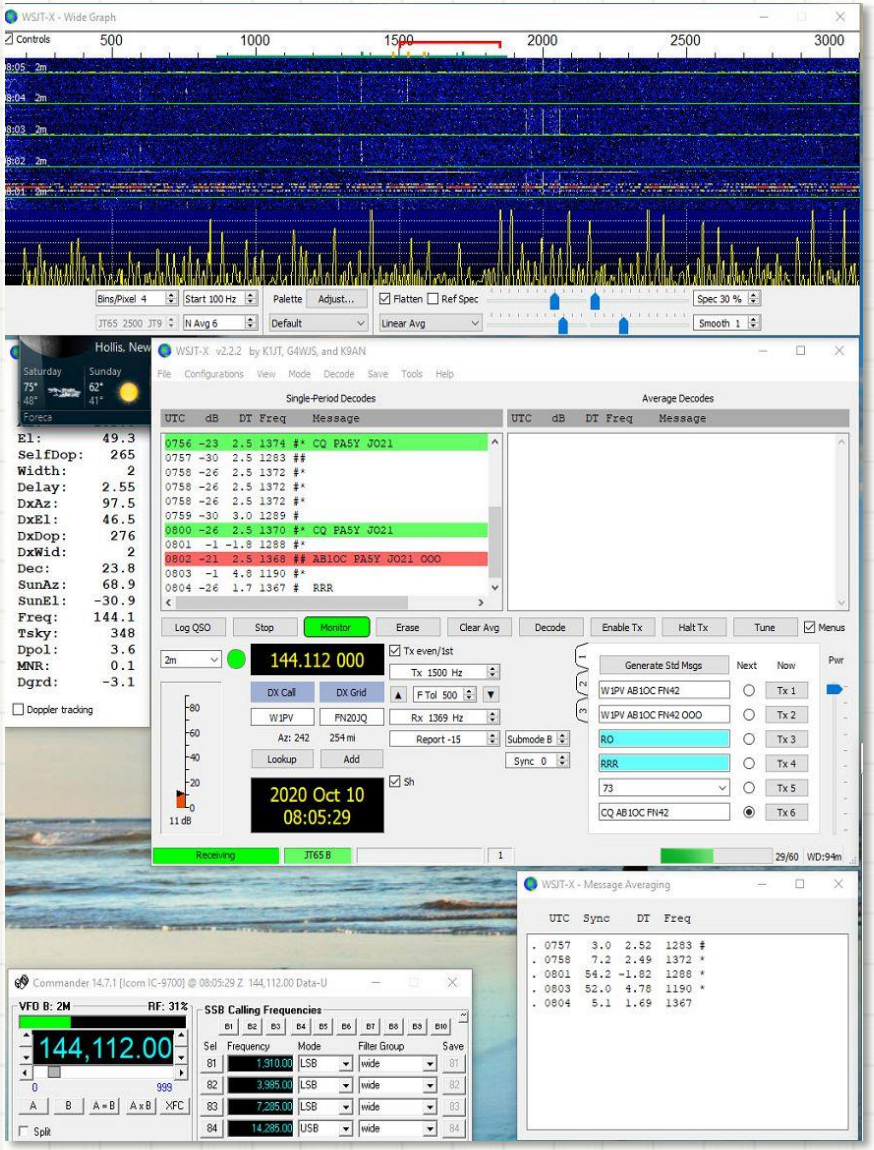
RF Receive Paths

Phase 1 Manual Polarity Selection Configuration



Software For Digital 2m EME Communications

- Use WSJT JT65B mode for 2m
  - JT65A for 6m EME
  - JT65C for 1296 EME and higher
  - WSJT Version 9 is best for EME
- Need to synchronize PC's clock
  - Dimension 4
- Software to run your rotator



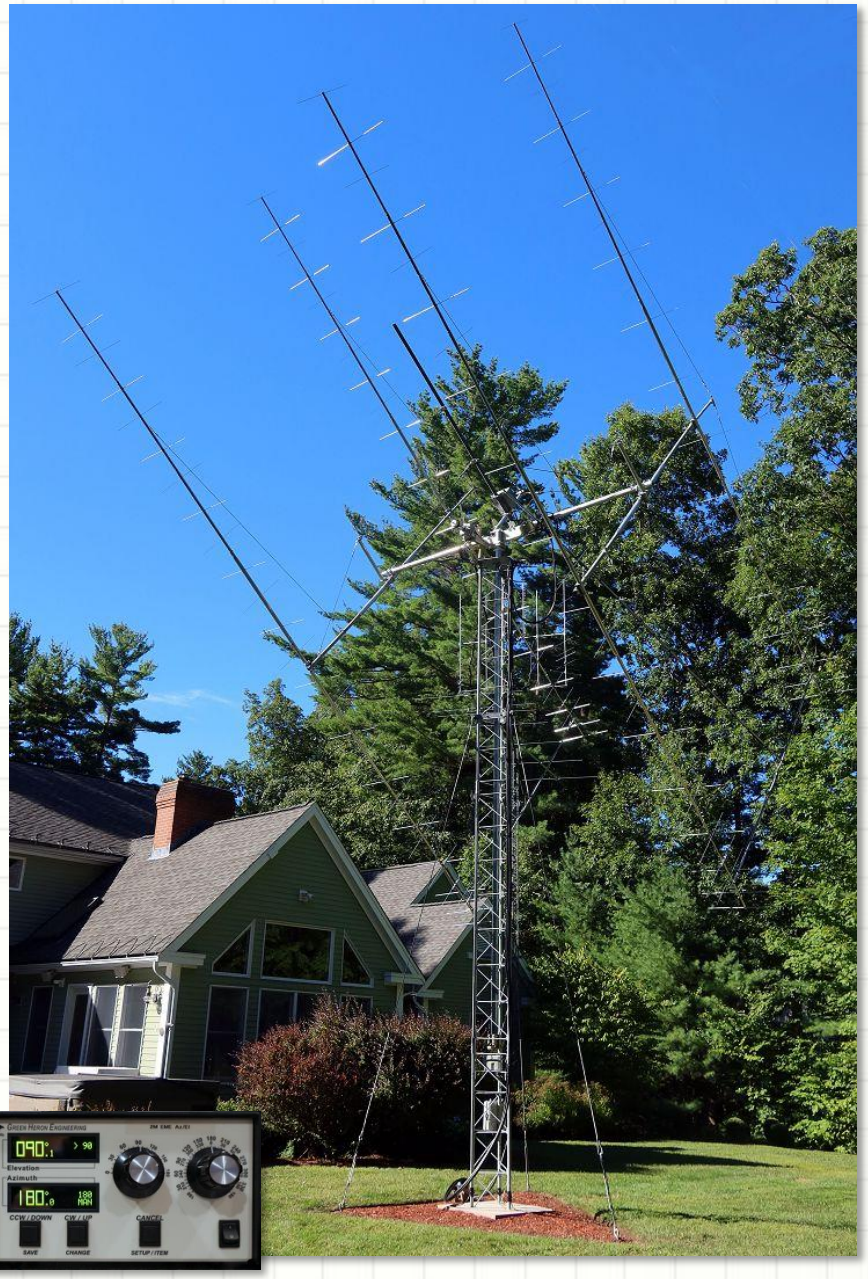
WSJT JT65B 2m EME QSO With PA5Y

2m EME Antenna System at AB1OC-AB1QB

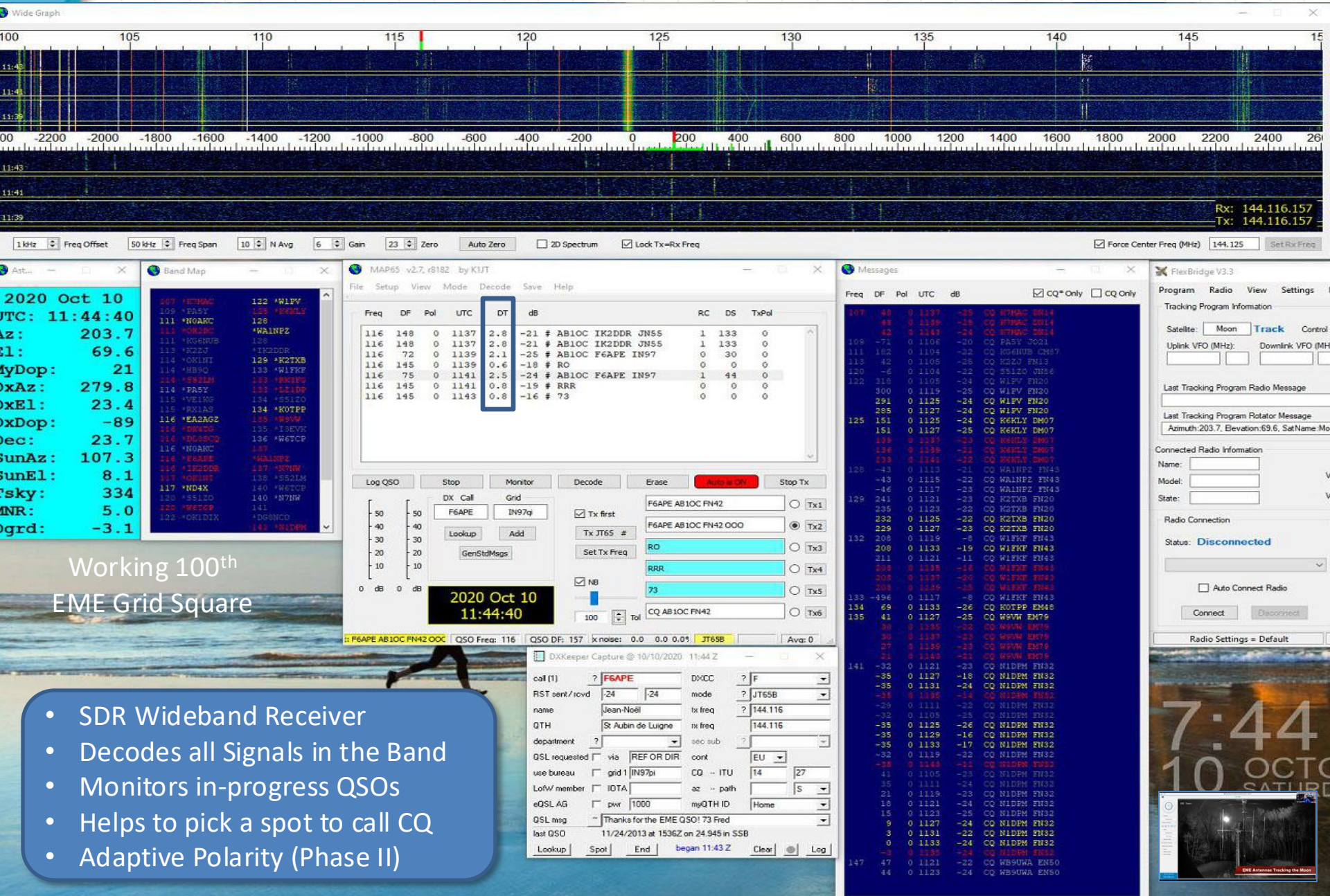
Antenna Array with X-Polarity

- 26’ Hybrid Free Standing/Guyed Rohn 45G Tower
- 4 X 28 Element X-Polarized Yagis (34 ½’ booms) in a 15’ by 15’ array
  - Total of 112 elements on 2m
- Heavy Duty Az/El Rotator System
  - Green Heron Az/El Controller
  - Computer control of antennas
- Dual-Receive, Tower Mounted Preamp System
  - High-power switching/sequencing
  - Dual Rx Preamps on Tower
- 7/8” Hardline for Transmit; 2 x LMR-600 Coaxes for Receive
  - Independent Rx for H-Pol & V-Pol

MPE evaluation is **essential.**
Online MPE Calculator



2m EME Operating – MAP65 Wideband Decoder



Working 100th
EME Grid Square

- SDR Wideband Receiver
- Decodes all Signals in the Band
- Monitors in-progress QSOs
- Helps to pick a spot to call CQ
- Adaptive Polarity (Phase II)

2m EME On The Air

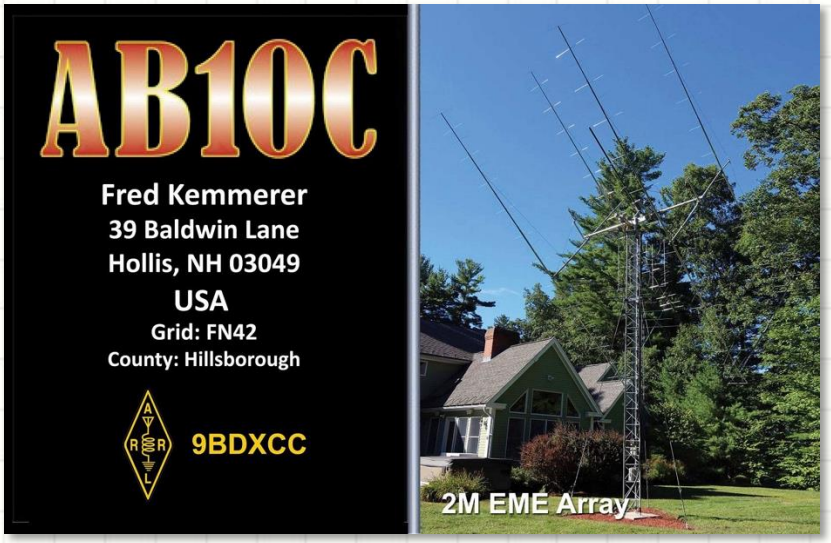
How Does It All Play?


EME/Satellite Station

EME Tower Camera

- Have made 200+ QSOs using 2m EME so far
  - Worked 129 Grids and confirmed a 2m VUCC in a ~1 month
  - Worked 34 of 50 States
  - Worked 34 DXCCs
- Made 70+ contacts during November ARRL EME Contest in 24 hours
- Rebuilt Home Network to lower noise levels at our QTH
  - Controlled shutdown of camera equipment
  - Replace long runs of unshielded CAT5/6 cable with Fiber Optics
  - 4 – 5 dB improvement in SNR
- Planned enhancements include Adaptive Rx Polarity

Thank You!



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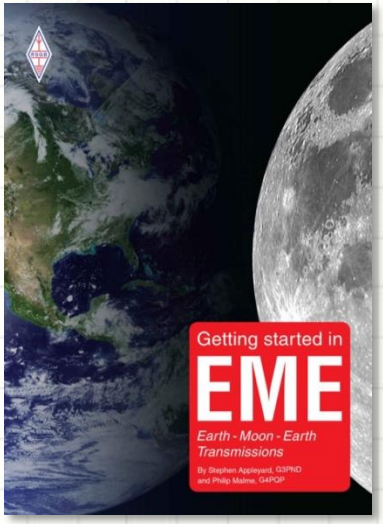
More information, pictures, and video is available on our Blog at:

stationproject.blog



Check out G4PQP's Getting Started in EME Book. Find it on Amazon here.