



# **GETTING STARTED (AND PROGRESSING) IN EME COMMUNICATIONS**

**OCTOBER 2024  
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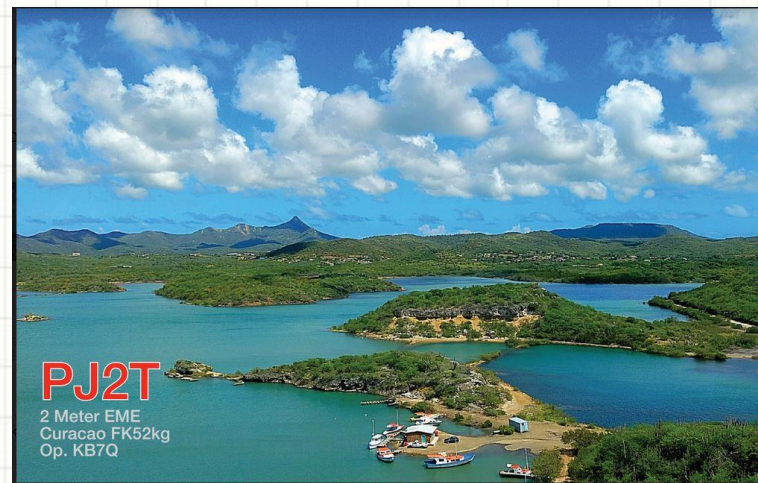
# Topics



- 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

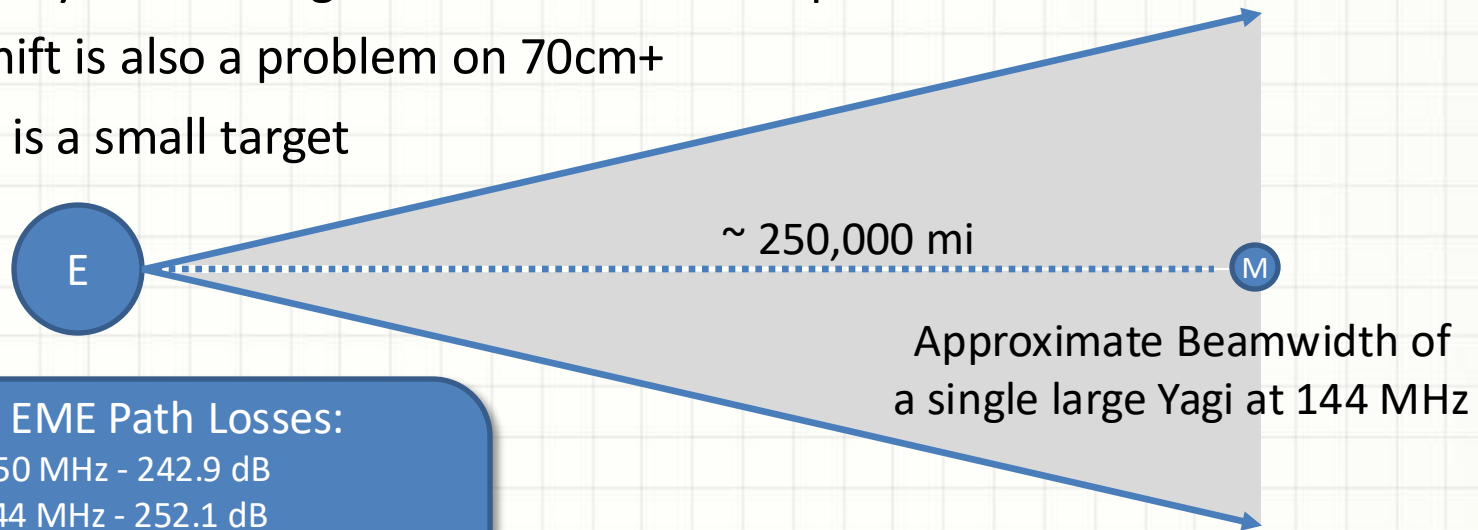
# What is EME? How Does It Work?

- 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

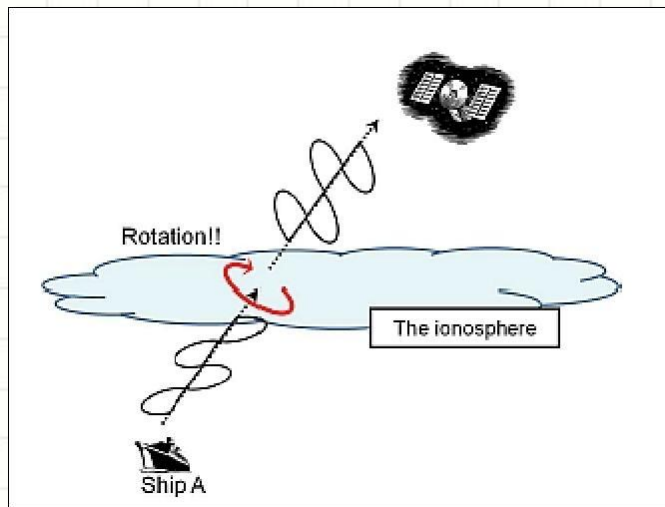


## Typical EME Path Losses:

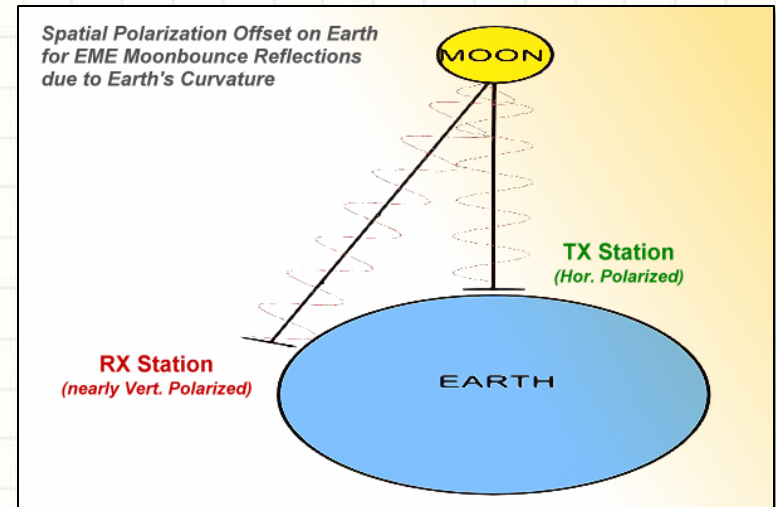
50 MHz - 242.9 dB  
144 MHz - 252.1 dB  
432 MHz - 261.6 dB  
1296 MHz - 271.2 dB  
10368 MHz - 289.2 dB  
HF Skip on 20m - ~125 dB (5,570 km)

# 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

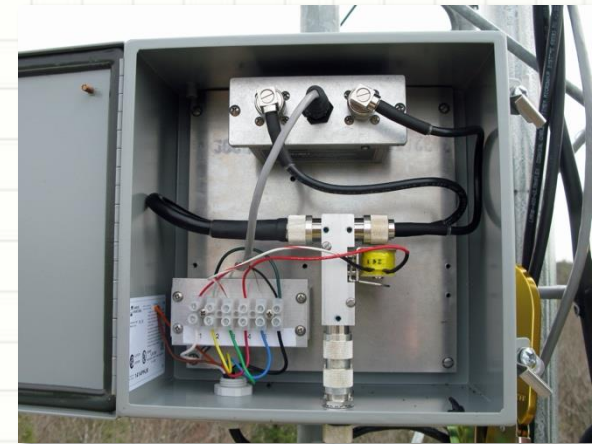
2m EME is the most popular band,  
6m is next; many DXpeditions do EME there



4.5m Mesh Dish

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

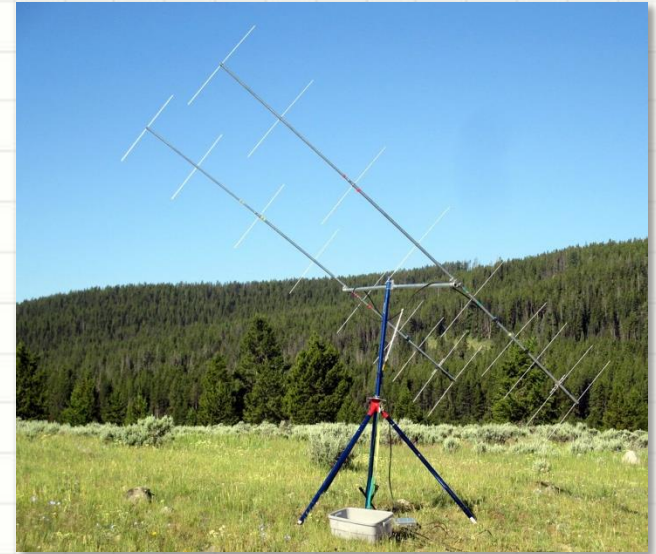
- One large or 2 medium yagis for the 2m weak-signal sub-band
  - Ground mounted cantilever with manual pointing
- An amplifier capable of 500w to 1 Kw
  - 100% duty cycle required
  - Beko, Gemini, W6PQL, M2 Antennas (used)
- A good, low-noise Rx Preamplifier
  - A high-power sequencing setup is required
  - 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 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° – 20° (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



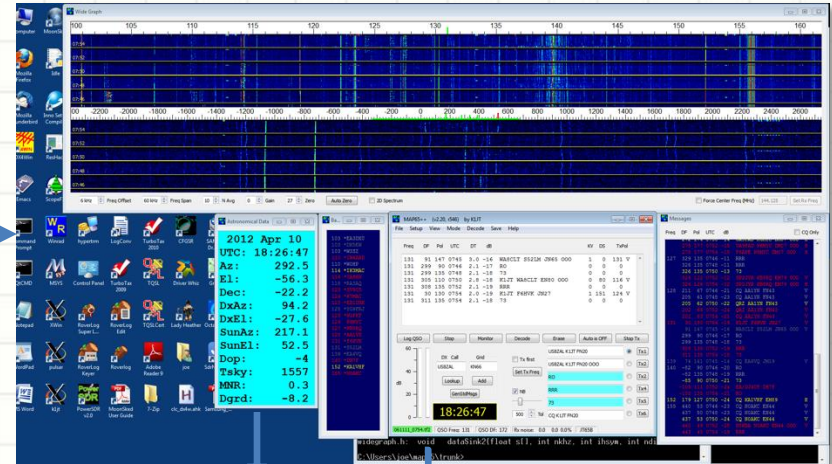
18 elements (36' boom)  
17 dBi

# 2m EME Radio System

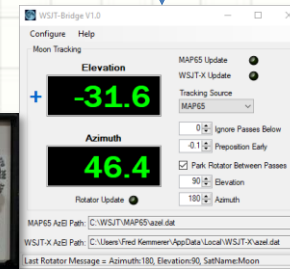
JT65B via MAP65 or WSJT-X



SDR Receiver



IC-9700  
Transceiver



Custom App  
Enables MAP65  
Rotator Control

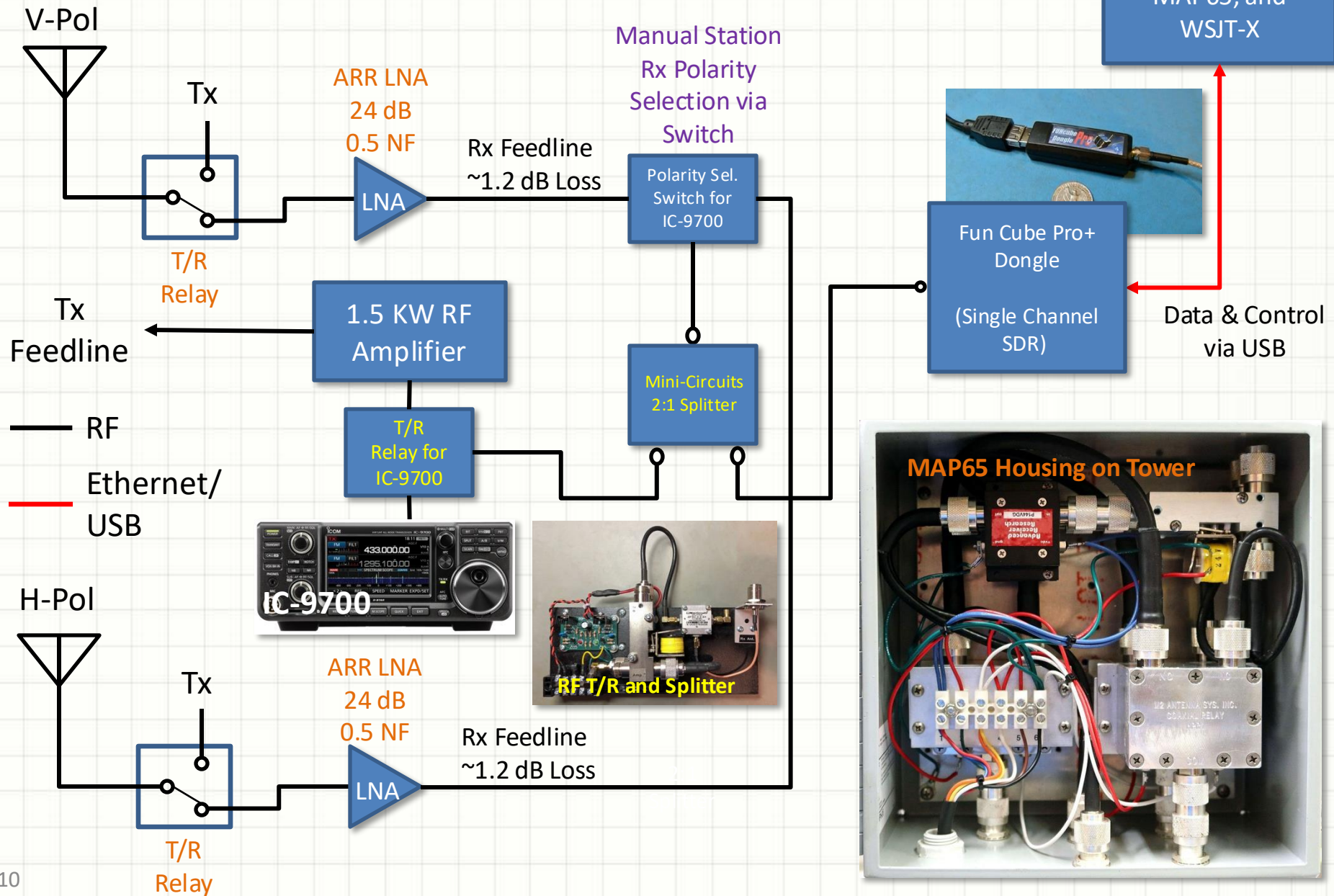
1.5 Kw  
Amplifier &  
Sequencer



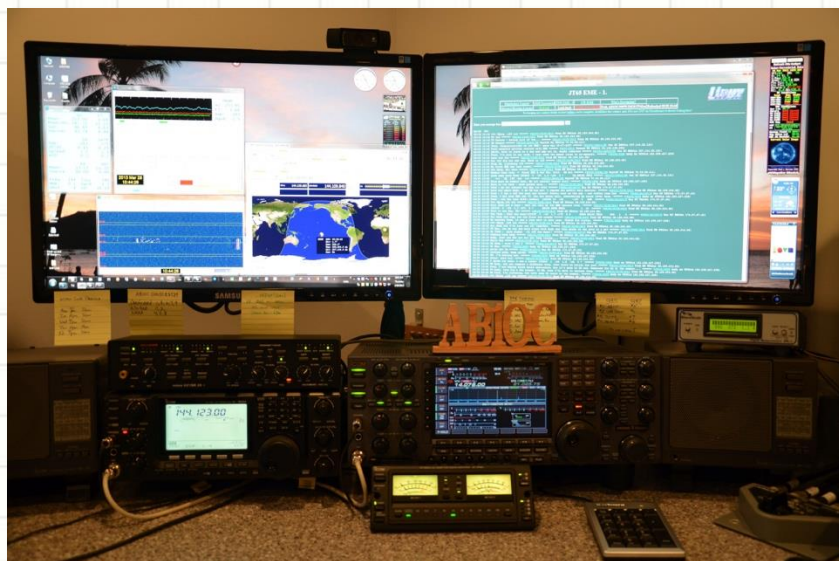
- MAP65 Software - Adaptive Polarity Receive System
  - Requires separate Vertical and Horizontal SDR I/Q Receivers
- Moon Tracking via custom apps
- Transmit side uses IC-9700/1.5 Kw amplifier and sequencer to protect Preamps/Rx equipment

# RF Receive Paths

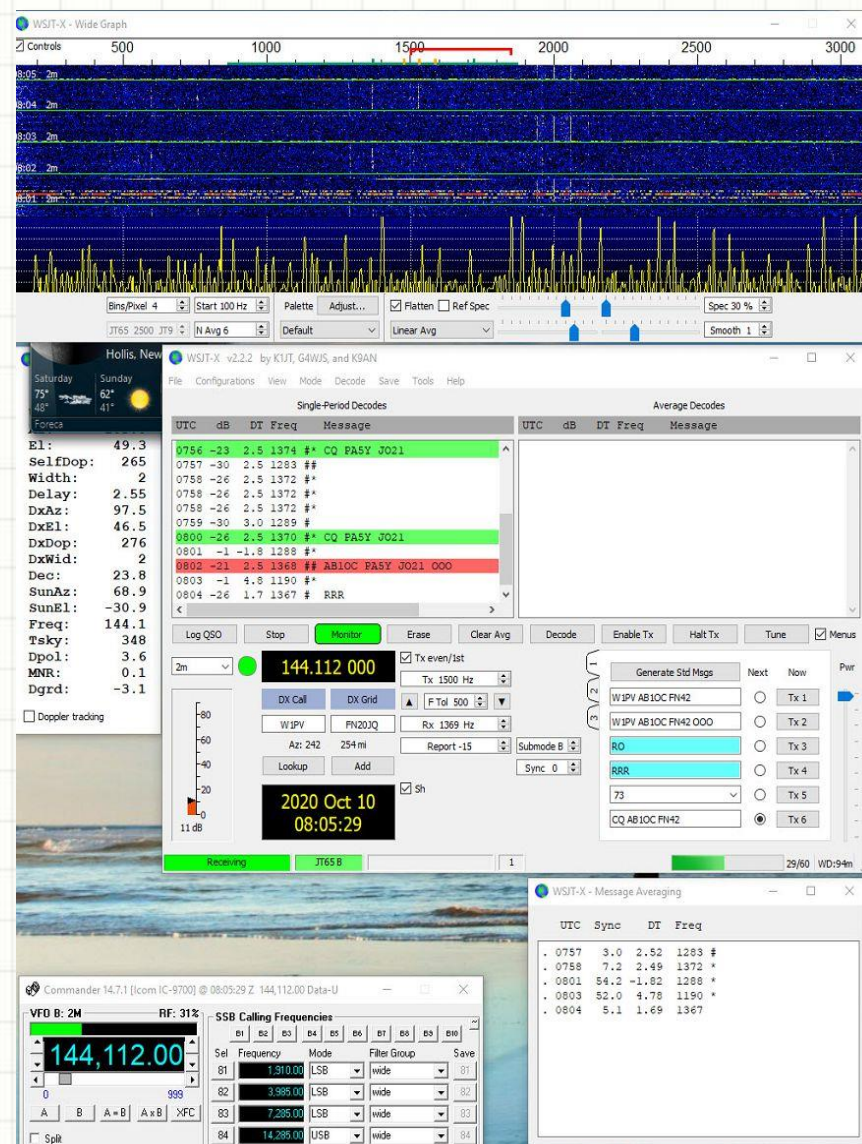
## Phase 1 Manual Polarity Selection Configuration



# 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

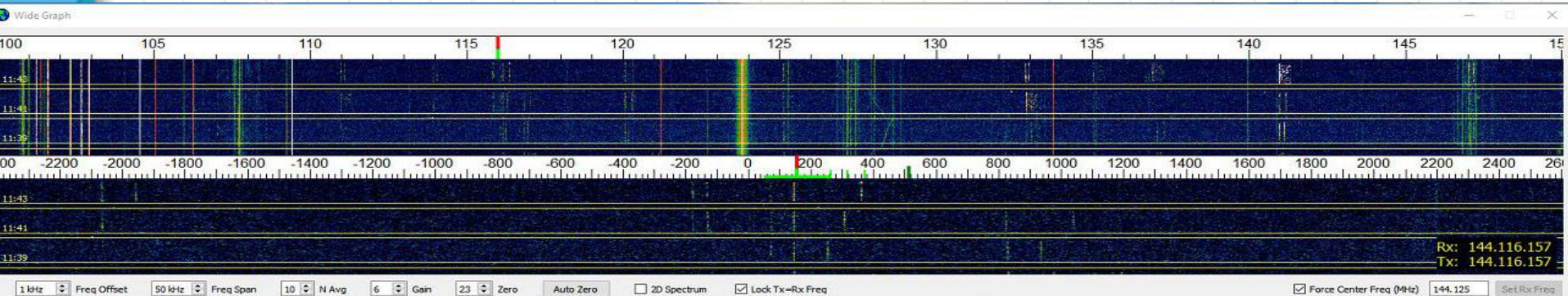
- 26' Hybrid Free Standing/Guyed Rohn 45G Tower
- 4 X 28 Element X-Polarized Yagis (34 ½' booms) in a 15' by 15' array
  - Total of 112 elements on 2m
- Heavy Duty Az/El Rotator System
  - Green Heron Az/El Controller
  - Computer control of antennas
- Dual-Receive, Tower Mounted Preamp System
  - High-power 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



2020 Oct 10 UTC: 11:44:40 Az: 203.7 El: 69.6 Dop: 21 xAz: 279.8 xEl: 23.4 xDop: -89 Dec: 23.7 SunAz: 107.3 SunEl: 8.1 Sky: 334 MNR: 5.0 grd: -3.1

MAP65 v2.7, r8182 by K1JT

| Freq | DF  | Pol | UTC  | DT  | dB                      | RC | DS  | TxPol |
|------|-----|-----|------|-----|-------------------------|----|-----|-------|
| 116  | 148 | 0   | 1137 | 2.8 | -21 # AB1OC IK2DDR JN55 | 1  | 133 | 0     |
| 116  | 148 | 0   | 1137 | 2.8 | -21 # AB1OC IK2DDR JN55 | 1  | 133 | 0     |
| 116  | 72  | 0   | 1139 | 2.1 | -25 # AB1OC F6APE IN97  | 0  | 30  | 0     |
| 116  | 145 | 0   | 1139 | 0.6 | -18 # RO                | 0  | 0   | 0     |
| 116  | 75  | 0   | 1141 | 2.5 | -24 # AB1OC F6APE IN97  | 1  | 44  | 0     |
| 116  | 145 | 0   | 1141 | 0.8 | -19 # RRR               | 0  | 0   | 0     |
| 116  | 145 | 0   | 1143 | 0.8 | -16 # 73                | 0  | 0   | 0     |

Log QSO Stop Monitor Decode Erase Auto is ON Stop Tx

DX Call Grid F6APE IN97q Lookup Add GenStdMags

2020 Oct 10 11:44:40

F6APE AB1OC FN42 OOO QSO Freq: 116 QSO DF: 157 xnoise: 0.0 0.0 0.0 JT65B Avg: 0

Working 100<sup>th</sup>  
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)

Messages

| Freq | DF   | Pol  | UTC  | dB             | CQ* Only       | CQ Only |
|------|------|------|------|----------------|----------------|---------|
| 147  | 48   | 0    | 1137 | -25            | CQ RTMAC EN14  |         |
| 48   | 0    | 1139 | -25  | CQ RTMAC EN14  |                |         |
| 42   | 0    | 1147 | -24  | CQ RTMAC EN14  |                |         |
| 199  | -71  | 0    | 1106 | -20            | CQ FASV EN21   |         |
| 111  | 182  | 0    | 1104 | -32            | CQ HGHUB EN87  |         |
| 113  | 42   | 0    | 1105 | -26            | CQ K223 EN13   |         |
| 120  | -6   | 0    | 1104 | -22            | CQ S5120 EN56  |         |
| 122  | 318  | 0    | 1105 | -24            | CQ WLPV EN20   |         |
| 300  | 0    | 1119 | -25  | CQ WLPV EN20   |                |         |
| 291  | 0    | 1125 | -24  | CQ WLPV EN20   |                |         |
| 285  | 0    | 1127 | -24  | CQ WLPV EN20   |                |         |
| 151  | 0    | 1125 | -24  | CQ KKKLY EN67  |                |         |
| 151  | 0    | 1127 | -25  | CQ KKKLY EN67  |                |         |
| 189  | 0    | 1137 | -23  | CQ KKKLY EN67  |                |         |
| 139  | 0    | 1139 | -21  | CQ KKKLY EN67  |                |         |
| 133  | 0    | 1141 | -22  | CQ KKKLY EN67  |                |         |
| 128  | -43  | 0    | 1113 | -21            | CQ WAIHP2 EN43 |         |
| -43  | 0    | 1115 | -22  | CQ WAIHP2 EN43 |                |         |
| -46  | 0    | 1117 | -23  | CQ WAIHP2 EN43 |                |         |
| 129  | 241  | 0    | 1121 | -23            | CQ K2TXB EN20  |         |
| 235  | 0    | 1123 | -22  | CQ K2TXB EN20  |                |         |
| 232  | 0    | 1125 | -22  | CQ K2TXB EN20  |                |         |
| 229  | 0    | 1127 | -23  | CQ K2TXB EN20  |                |         |
| 132  | 208  | 0    | 1119 | -8             | CQ WLPV EN20   |         |
| 208  | 0    | 1133 | -19  | CQ WLPV EN20   |                |         |
| 211  | 0    | 1121 | -11  | CQ WLPV EN20   |                |         |
| 298  | 0    | 1135 | -16  | CQ WLPV EN20   |                |         |
| -208 | 0    | 1137 | -20  | CQ WLPV EN20   |                |         |
| 208  | 0    | 1139 | -23  | CQ WLPV EN20   |                |         |
| 133  | -496 | 0    | 1117 | -8             | CQ K2TXB EN20  |         |
| 134  | 69   | 0    | 1133 | -26            | CQ KOTPP EN48  |         |
| 135  | 41   | 0    | 1127 | -25            | CQ W9VM EN76   |         |
| 30   | 0    | 1135 | -23  | CQ W9VM EN76   |                |         |
| 30   | 0    | 1137 | -23  | CQ W9VM EN76   |                |         |
| 27   | 0    | 1139 | -23  | CQ W9VM EN76   |                |         |
| 24   | 0    | 1143 | -21  | CQ W9VM EN76   |                |         |
| 141  | -32  | 0    | 1121 | -23            | CQ NIDPM EN32  |         |
| -35  | 0    | 1127 | -18  | CQ NIDPM EN32  |                |         |
| -35  | 0    | 1131 | -24  | CQ NIDPM EN32  |                |         |
| -39  | 0    | 1135 | -14  | CQ NIDPM EN32  |                |         |
| -29  | 0    | 1111 | -22  | CQ NIDPM EN32  |                |         |
| -32  | 0    | 1105 | -25  | CQ NIDPM EN32  |                |         |
| -35  | 0    | 1125 | -26  | CQ NIDPM EN32  |                |         |
| -35  | 0    | 1129 | -16  | CQ NIDPM EN32  |                |         |
| -35  | 0    | 1133 | -17  | CQ NIDPM EN32  |                |         |
| -32  | 0    | 1119 | -22  | CQ NIDPM EN32  |                |         |
| -35  | 0    | 1143 | -24  | CQ NIDPM EN32  |                |         |
| 41   | 0    | 1105 | -23  | CQ NIDPM EN32  |                |         |
| 35   | 0    | 1111 | -24  | CQ NIDPM EN32  |                |         |
| 21   | 0    | 1119 | -23  | CQ NIDPM EN32  |                |         |
| 10   | 0    | 1121 | -24  | CQ NIDPM EN32  |                |         |
| 15   | 0    | 1123 | -25  | CQ NIDPM EN32  |                |         |
| 9    | 0    | 1127 | -24  | CQ NIDPM EN32  |                |         |
| 3    | 0    | 1131 | -22  | CQ NIDPM EN32  |                |         |
| 0    | 0    | 1133 | -24  | CQ NIDPM EN32  |                |         |
| -1   | 0    | 1135 | -24  | CQ NIDPM EN32  |                |         |
| 147  | 47   | 0    | 1121 | -22            | CQ W9UWA EN50  |         |
| 44   | 0    | 1123 | -24  | CQ W9UWA EN50  |                |         |

FlexBridge V3.3

Tracking Program Information

Satellite: Moon Track Control

Uplink VFO (MHz): Downlink VFO (MHz):

Last Tracking Program Radio Message

Last Tracking Program Rotator Message

Azimuth: 203.7, Elevation: 69.6, SatName: Mo

Connected Radio Information

Name: Model: State:

Radio Connection

Status: Disconnected

Auto Connect Radio

Connect Disconnect

Radio Settings = Default

7:44 10 OCTOBER SATURDAY

EME Antennas Tracking the Moon

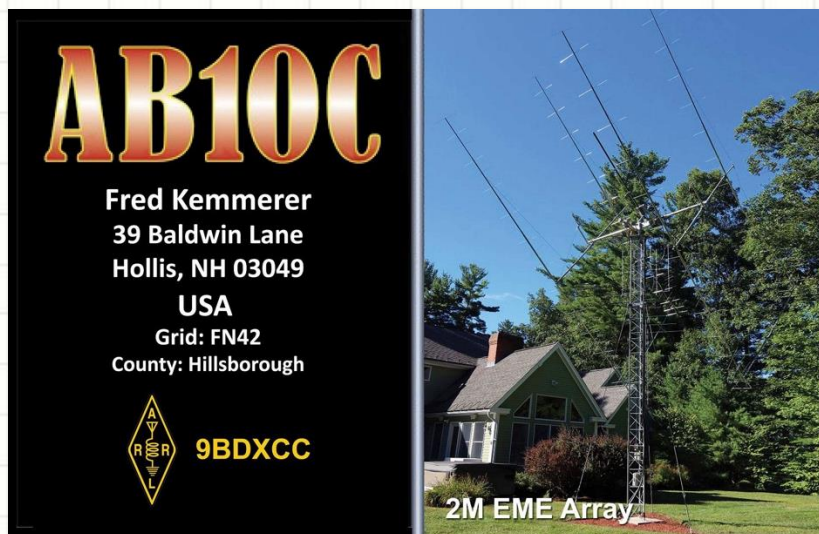
# 2m EME On The Air

## How Does It All Play?



- 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!



Fred Kemmerer, AB10C  
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More information, pictures, and  
video is available on our Blog at:

[stationproject.blog](http://stationproject.blog)

Check out G4PQP's Getting Started in  
EME Book. Find it on Amazon [here](#).

