



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

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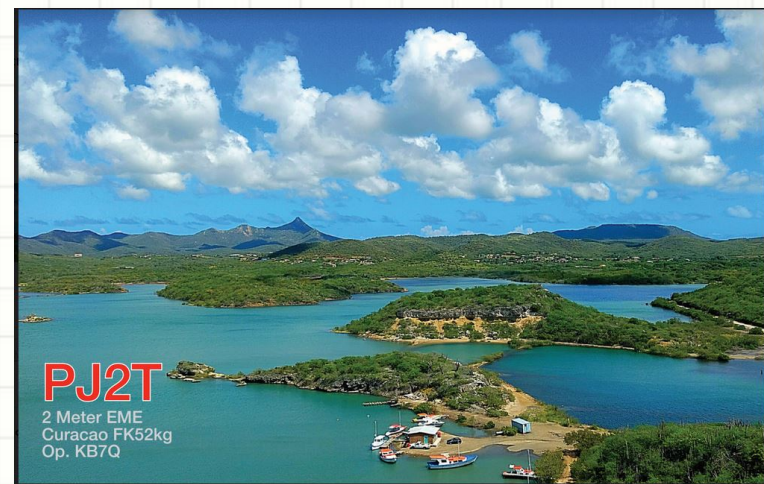
# Topics

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



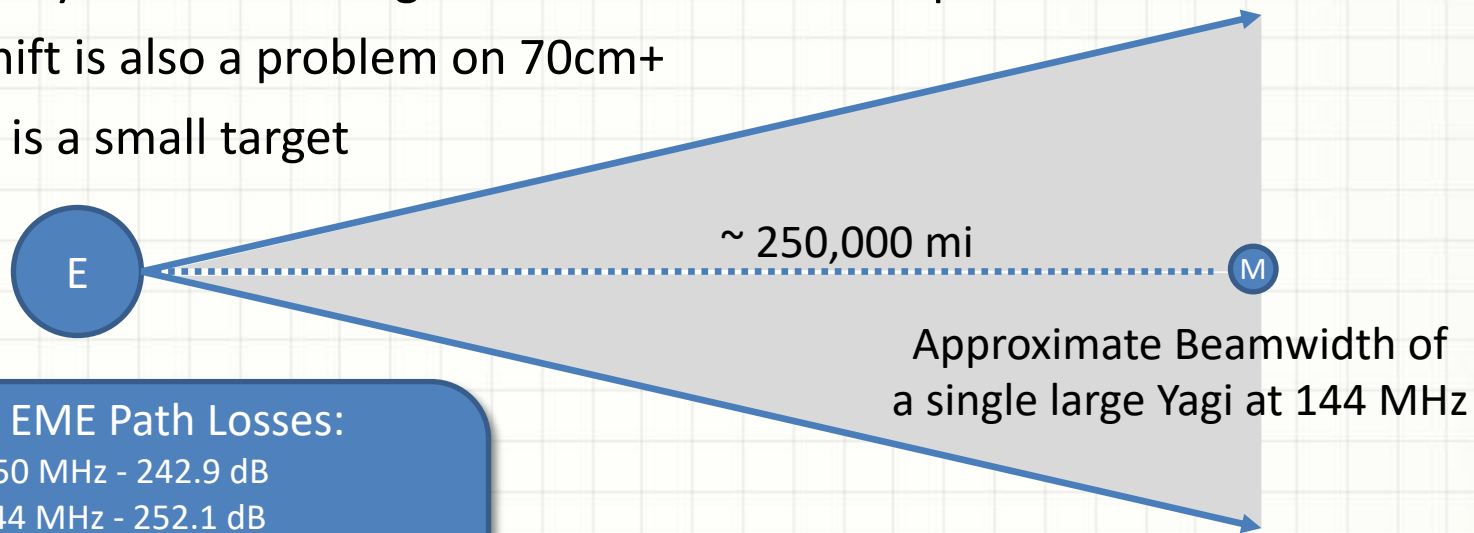
# What is EME? How Does It Work?

- EME or Moon Bounce Communications uses signals bounced off the Moon to make DX contacts on 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
- Bands, in order of activity:
  - 2m (144 MHz)
  - 6m (50 MHz)
  - 23 cm (1.2 GHz)
  - 70cm (430 MHz)
- 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
- 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 2 dB change 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 – the sun and galactic noise are both a problem
- Doppler shift is also a problem on 70cm+
- The moon is a small target

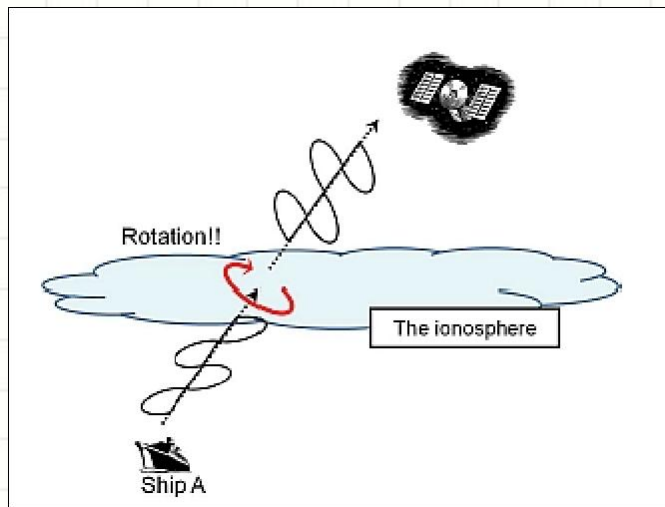


## Typical EME Path Losses:

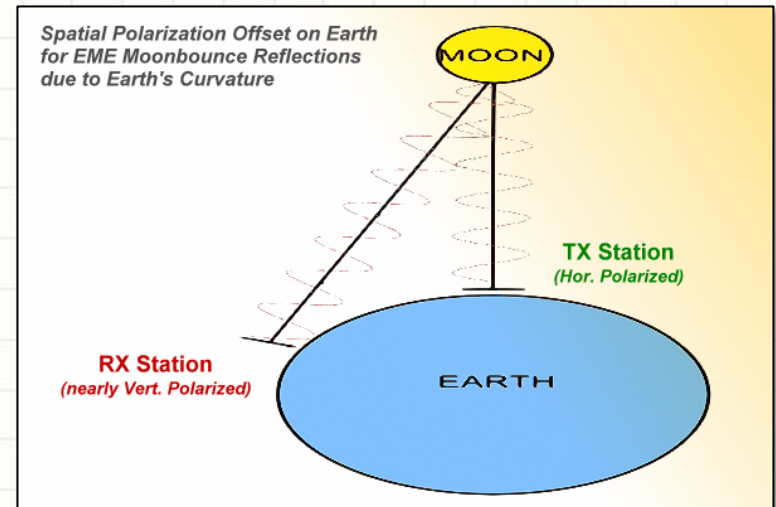
50 MHz - 242.9 dB
144 MHz - 252.1 dB
432 MHz - 261.6 dB
1296 MHz - 271.2 dB
10368 MHz - 289.2 dB
HF Skip on 20m - ~125 dB (5,570 km)

# 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

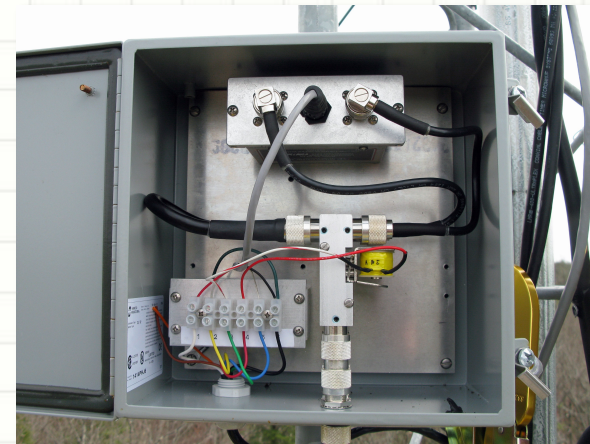
Net is that 2m EME is the most popular band, 6m is next as many DXpeditions do EME there



4.5m Mesh Dish

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

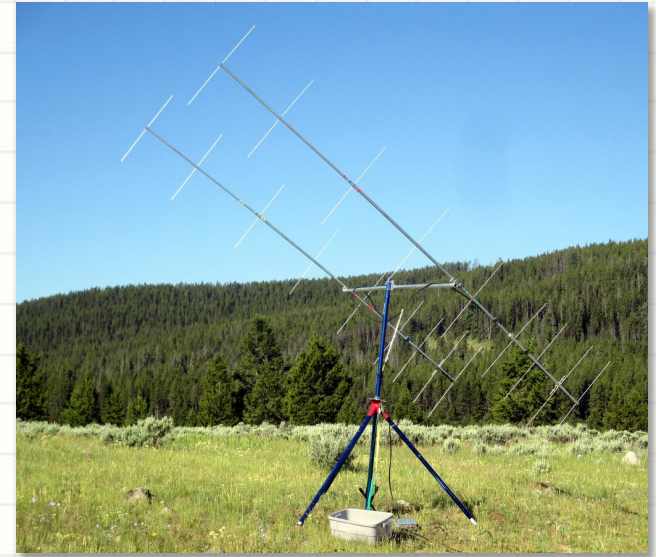
- One large or 2 medium yagis for 2m weak-signal sub-band
  - Ground mount cantilever with manual pointing
- An amplifier capable of 500w to 1 Kw
  - 100% duty cycle required
  - OM Power, Beko, Gemini, W6PQL (build your own), M2 Antennas (used)
- A good, low-noise preamplifier
  - A high-power sequencing setup will be needed
  - 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 X-boom length)
  - A Power Divider and phasing lines 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 – 6 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

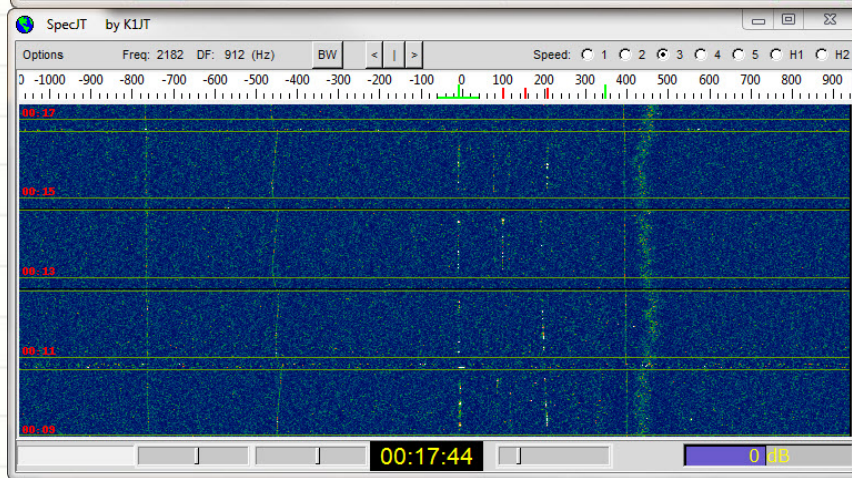


18 elements (36' boom)  
17 dBi

# 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 (if needed)
  - PstRotator, AB1OC (future), ...



WSJT JT65B 2m EME QSO With S52LM

# Finding Contacts, Prop & Signal Assessment

## WSJT EME - 1.

Due to recent abuse of this system, you will be unable to post any messages until you complete the User Details page  
Exchanging any contact details on here before you're complete, invalidates the contact, and, if it's not WSJT via Moonbounce it doesn't belong here!

Enter your message here

DDMM UTC

09Apr 00:16 sky your trace is back again! ===== (UTSBL/A Jury xx K031lg 194.44.182.161)

09Apr 00:16 sky I have ops. 4 x 16 and RW ===== (UTSBL/A Jury xx K031lg 194.44.182.161)

09Apr 00:14 ----- CQ CQ 118 1st ----- ===== (B3PA/2X14/1K Victor xx K093jv 92.61.34.77)

09Apr 00:14 VE1SKY SP3RSD J090 ===== (VE1SKY/1X12/400 Sky NS FN74iu 104.129.18.208)

09Apr 00:12 #111 calling Jury ----- (VE1SKY/1X12/400 Sky NS FN74iu 104.129.18.208)

09Apr 00:12 VE1SKY SP3PCH J090 ===== (VE1SKY/1X12/400 Sky NS FN74iu 104.129.18.208)

09Apr 00:19 aka - good idea ===== (VE1SKY/1X12/400 Jay ny PR30rx 74.90.21.1)

09Apr 00:20 Jay I am using WJRT-K and also have WJRT 9 open for RX ===== (VE1SKY/1X12/400 Sky NS FN74iu 104.129.18.208)

09Apr 00:27 Tr Jury ----- (VE1SKY/1X12/400 Sky NS FN74iu 104.129.18.208)

09Apr 00:26 VE1SKY Sky I continue, QSB now ===== (UTSBL/A Jury xx K031lg 194.44.182.161)

09Apr 00:24 VE1SKY - sky u using WJRT-K or WSJT 10 ===== (B3PA/2X14/1K Victor xx K093jv 92.61.34.77)

09Apr 00:22 UTSBL Jury calling u next, seq ===== (VE1SKY/1X12/400 Sky NS FN74iu 104.129.18.208)

09Apr 00:22 M2KCY CQ 117 2nd ===== (UTSBL/A Jury xx K031lg 194.44.182.161)

09Apr 00:17 UT55B 001600 7 -21 db 1.8 s -79 Hz 5 M Freq 1191 Hz VE1SKY UTSBL/A ===== (OK2AB/ZX8HLPA/1 Rosta xx JN89t1 89.203.220.250)

09Apr 00:16 wow there u go ! ===== (UTSBL/A Jury xx K031lg 194.44.182.161)

09Apr 00:16 CQ 2nd 115 ===== (VE1SKY/1X12/400 Sky NS FN74iu 104.129.18.208)

09Apr 00:16 001500 0 -27 2.4 24 2 \* CQ VE1SKY FN74 ===== (UTSBL/A Jury xx K031lg 194.44.182.161)

09Apr 00:16 2 kinds doubt u and i could work off the moon with slight delay ===== (B3PA/2X14/1K Victor xx K093jv 92.61.34.77)

09Apr 00:15 Yeah - everybody in EU want to bed already and everybody to the west of us have no moon yet ===== (B3PA/2X14/1K Victor xx K093jv 92.61.34.77)

09Apr 00:14 was spotted last night, but no ops around ===== (VE1SKY/1X12/400 Sky NS FN74iu 104.129.18.208)

09Apr 00:14 did work M2KCY though - he is 100% off the moon -25 to me ===== (B3PA/2X14/1K Victor xx K093jv 92.61.34.77)

09Apr 00:13 yes amazing..wasnt hearing anything but being heard in ok ! ===== (B3PA/2X14/1K Victor xx K093jv 92.61.34.77)

09Apr 00:12 Hi Jay saw ur spot on Live CQ 432 a couple night's ago ===== (VE1SKY/1X12/400 Sky NS FN74iu 104.129.18.208)

09Apr 00:10 VE1SKY - CQ sky...waiting on my MR... ===== (VE1SKY/1X12/400 Jay ny PR30rx 74.90.21.1)

09Apr 00:10 CQ 2nd 144-115 ===== (VE1SKY/1X12/400 Sky NS FN74iu 104.129.18.208)

09Apr 00:08 OK2AB should get better in the next 5-10 minutes ===== (VE1SKY/1X12/400 Sky NS FN74iu 104.129.18.208)

09Apr 00:08 skip CQ 118 ===== (B3PA/2X14/1K Victor xx K093jv 92.61.34.77)

09Apr 00:08 UT7QF Igor OK see you later ===== (B3PA/2X14/1K Victor xx K093jv 92.61.34.77)

09Apr 00:07 17 - toloko nastavine - = 15 el ===== (UT7QF Igor xx RN7mw 194.28.182.60)

09Apr 00:07 UT7QF Igor spb, poz dr ja nemoj malo, tako for sky 73 CQ ===== (B3PA/2X14/1K Victor xx K093jv 92.61.34.77)

09Apr 00:06 4 17H F3FT and ICOM IC-910 ===== (UT7QF Igor xx RN7mw 194.28.182.60)

09Apr 00:05 4 15H ===== (UT7QF Igor xx RN7mw 194.28.182.60)

09Apr 00:05 VE1SKY hello Roger looking for but no see ===== (OK2AB/ZX8HLPA/1 Rosta xx JN89t1 89.203.220.250)

09Apr 00:03 UT7QF Igor kakoj setup ? ===== (B3PA/2X14/1K Victor xx K093jv 92.61.34.77)

09Apr 00:02 UT7QF Igor OK ja ne vidim u H-TOG i V-TOG ===== (B3PA/2X14/1K Victor xx K093jv 92.61.34.77)

09Apr 00:02 Hello Rosta ----- sky 2nd CQ 115 ===== (VE1SKY/1X12/400 Sky NS FN74iu 104.129.18.208)

09Apr 00:01 ya viza -24 ===== (UT7QF Igor xx RN7mw 194.28.182.60)

09Apr 00:01 UT7QF Igor manja palinbaste ? ===== (B3PA/2X14/1K Victor xx K093jv 92.61.34.77)

09Apr 00:01 velsky ===== (B3PA/2X14/1K Victor xx K093jv 92.61.34.77)

09Apr 00:01 valko ===== (UT7QF Igor xx RN7mw 194.28.182.60)

09Apr 00:00 UT7QF Igor poka ne vidim ===== (B3PA/2X14/1K Victor xx K093jv 92.61.34.77)

09Apr 00:00 \*\* MR now CQ 2nd 144.115 ===== (VE1SKY/1X12/400 Sky NS FN74iu 104.129.18.208)

09Apr 23:55 UT7QF Igor privet ===== (B3PA/2X14/1K Victor xx K093jv 92.61.34.77)

09Apr 23:55 QZ/QM no here in 8 min ===== (VE1SKY/1X12/400 Sky NS FN74iu 104.129.18.208)

09Apr 23:54 Victor OM! Calling you! ===== (UT7QF Igor xx RN7mw 194.28.182.60)

09Apr 23:53 Rosp CQ 118 ===== (B3PA/2X14/1K Victor xx K093jv 92.61.34.77)

09Apr 23:52 HIGBL David calling you! ===== (UTSBL/A Jury xx K031lg 194.44.182.161)

09Apr 23:52 OK2AB Rosta thanks for report ===== (B3PA/2X14/1K Victor xx K093jv 92.61.34.77)

09Apr 23:49 UT55B 234500 9 -21 db 2.4 s -73 Hz 2 M Freq 1197 Hz CQ B3PA K093 ===== (OK2AB/ZX8HLPA/1 Rosta xx JN89t1 89.203.220.250)

09Apr 23:39 ----- CQ CQ 118 1st ----- ===== (B3PA/2X14/1K Victor xx K093jv 92.61.34.77)

<https://www.chris.org/cgi-bin/jt65emeA>

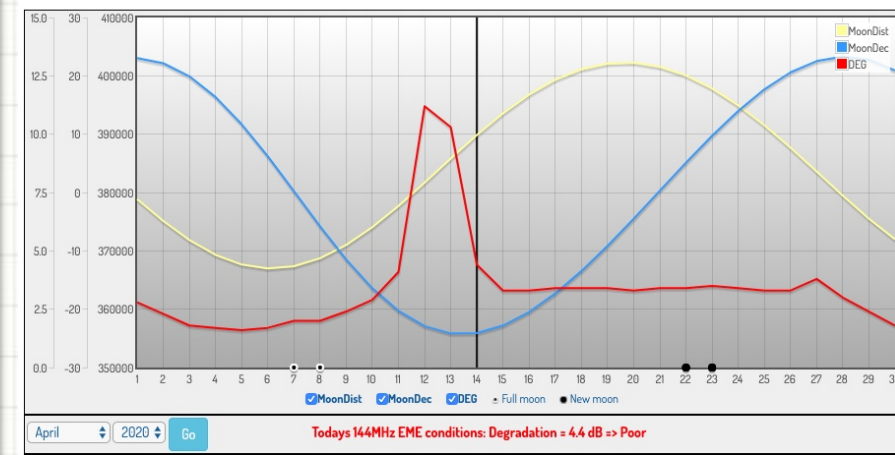
## WSJT Sked Page

Some useful tools for:

- Deciding when to operate
- Gauging conditions
- Arranging contacts

Next 30 days lowest degradation:  
 2020-04-30 (18) => Good  
 2020-05-01 (17) => Good  
 2020-05-02 (16) => Good  
 2020-05-03 (16) => Good  
 2020-05-04 (18) => Good

<http://mmonvhf.de/eme.php>



## EME Degradation (lower is better)

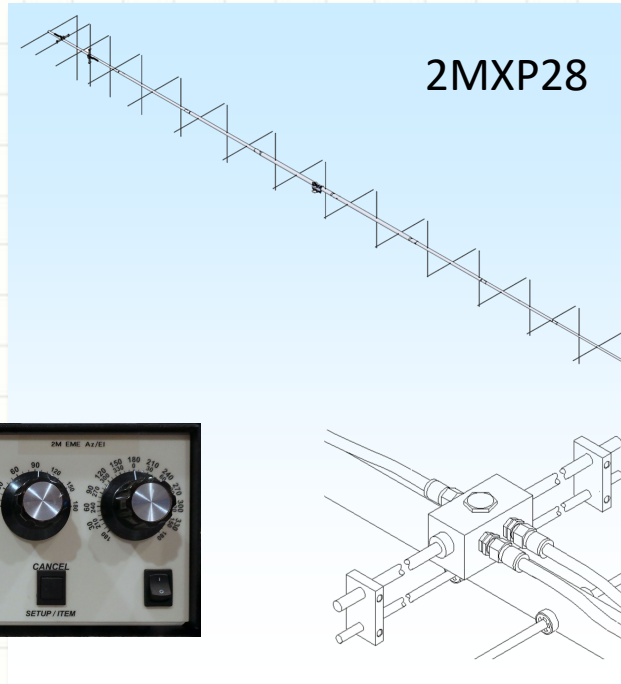
Freq	Date	Time	Signal	DF	DT	Call	Loc	Pol	Mode	Spotter	
144.125	10-Apr	2159	-22	+297	2.6	CQ	IK3VZO	JN55	68	JT65b	SS1ZO
144.122	10-Apr	2154	-20	-064	1.6	CQ	ZL3NW	RE66	0	JT65b	IK2DDR
144.122	10-Apr	2140	-25	+001	2.5	CQ	ZL3NW	RE66	40	JT65b	SS1ZO
144.134	10-Apr	2132	-20	-037	2.8	CQ	ZL2MQ	RF80	50	JT65b	SS1ZO
144.132	10-Apr	0535	-21	-078	2.5	CQ	AI1K	DM34	168	JT65b	PA9RX
144.114	10-Apr	0536	-24	-362	2.2	CQ	ON4GG	JO20	99	JT65b	PA9RX
144.118	10-Apr	0518	-20	+115	2.3	CQ	IV3RYX	JN65	77	JT65b	PA9RX
144.130	10-Apr	0446	-24	+490	2.4	CQ	HABCE	KN06	76	JT65b	PA9RX
144.126	10-Apr	0422	-24	-318	2.7	CQ	OH1HSC	KP10	91	JT65b	PA9RX
144.133	10-Apr	0421	-23	-067	2.6	CQ	K9MRI	EN70	156	JT65b	PA9RX
144.129	10-Apr	0416	-18	+467	2.7	QRZ	I3MEK	JN55	33	JT65b	PA9RX

LiveCQ EME RBN

<https://www.livecq.eu/latest.asp>

# Taking Your EME Station To The Next Stage

## Antenna Array with X-Polarity

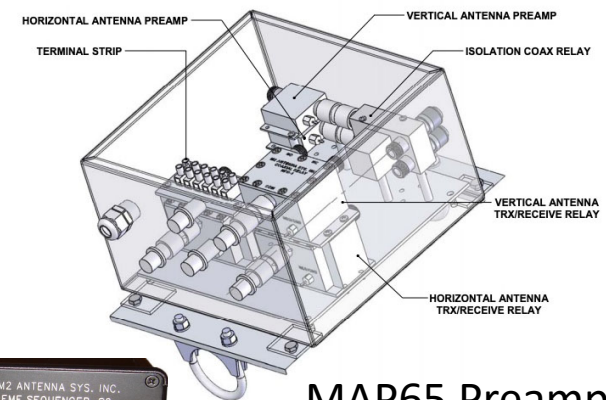


2MXP28



WA1NPZ  
Installation

- Dedicated tower and az/el rotator system
- Array of four X-polarity Yagis (28 elements on 24 1/2' booms, 112 elements total)
- H-Frame, Phasing Lines, and Power Dividers
- 7/8" Hardline for Tx, Two LMR-600 coax for Rx
- Dual receive preamp system with switchable Tx Polarity

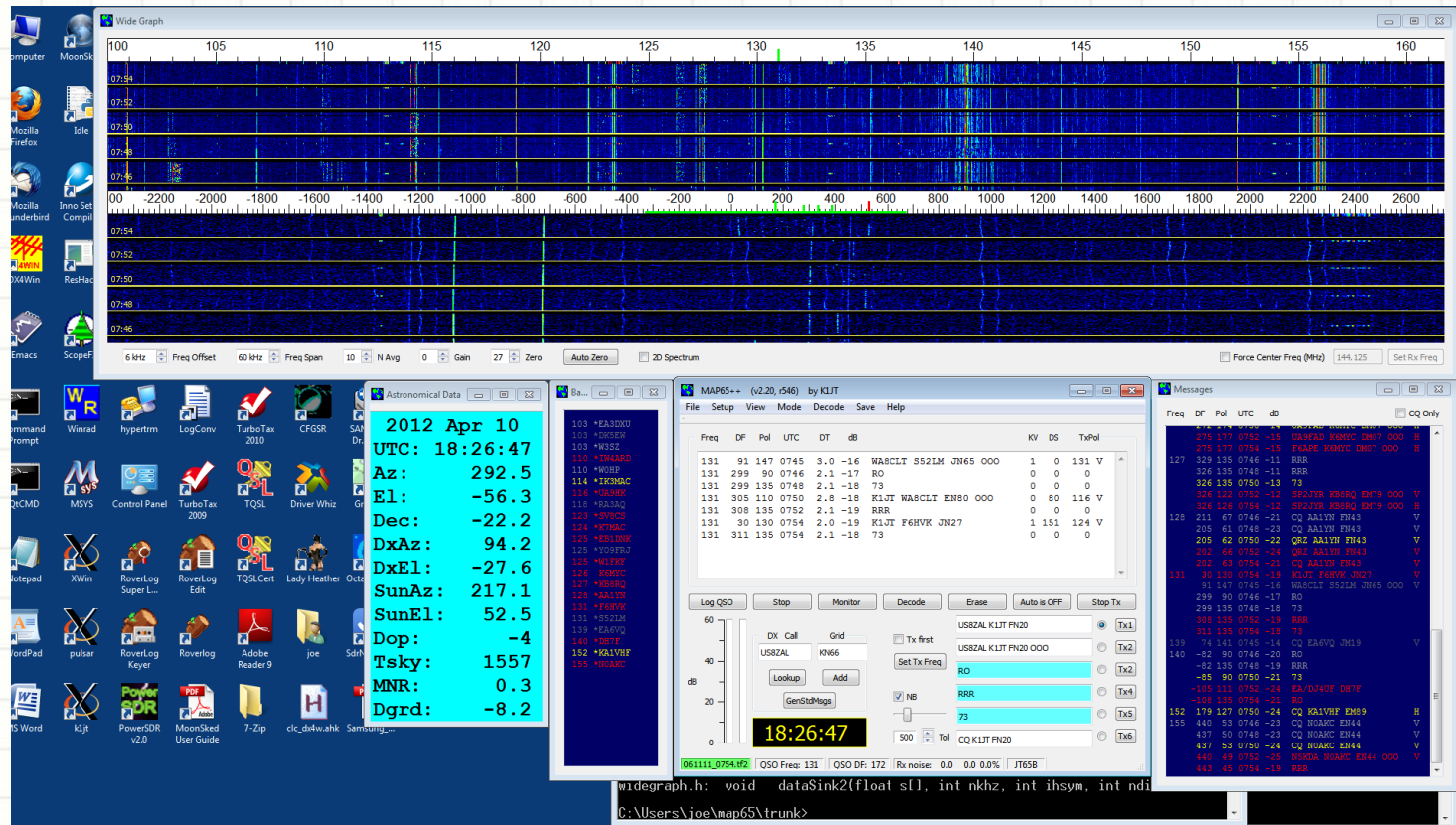


MAP65 Preamp  
System



# Taking Your EME Station To The Next Stage

## Adaptive Polarity Via MAP65



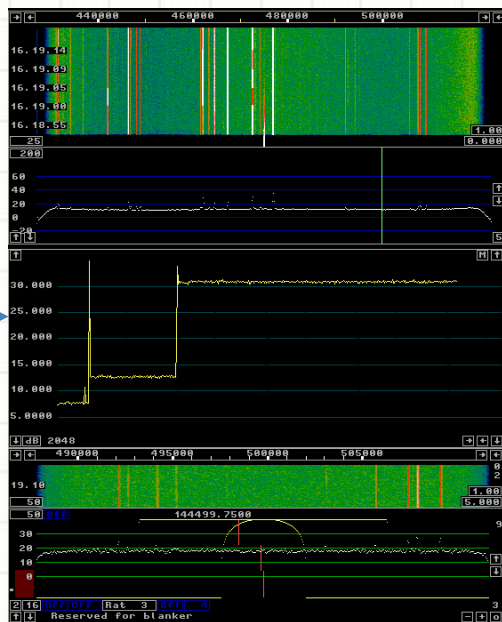
- Adaptive polarity on receive + polarity switching on Tx addresses polarity degradation problems
- MAP65 version of WSJT automatically determines and adapts receive polarity for all signals in the band
- Requires X-pol antennas and uses dual, phase-locked SDR I/Q receivers

# AB1OC-AB1QB 2m EME 2.0 Station

## SDR Receive System

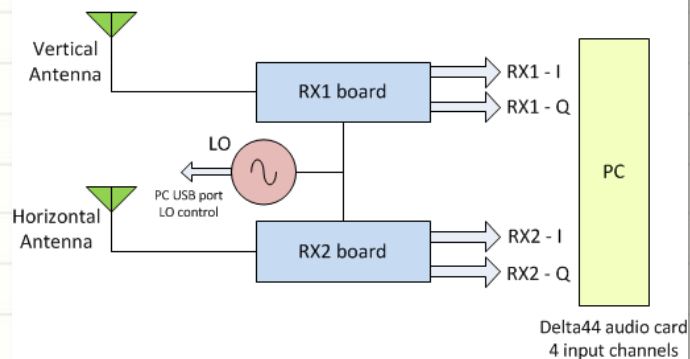


4-Channel  
SDR Receiver  
(H/V I and Q)

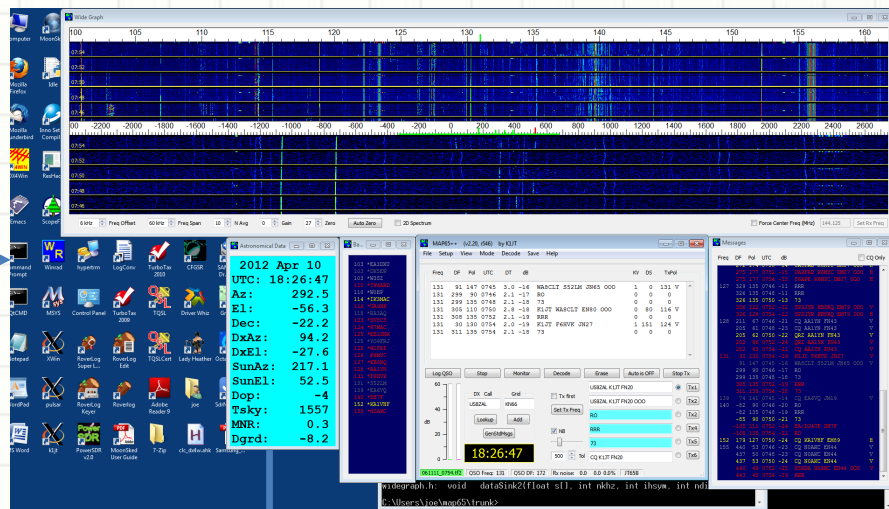


Linrad (for Noise Blanking and  
Fixed Receive Polarity)

IQ+ for Adaptive Polarization  
Block Diagram



WSJT MAP65 or WSJT-X for JT65



Custom App  
for Rotator  
Control

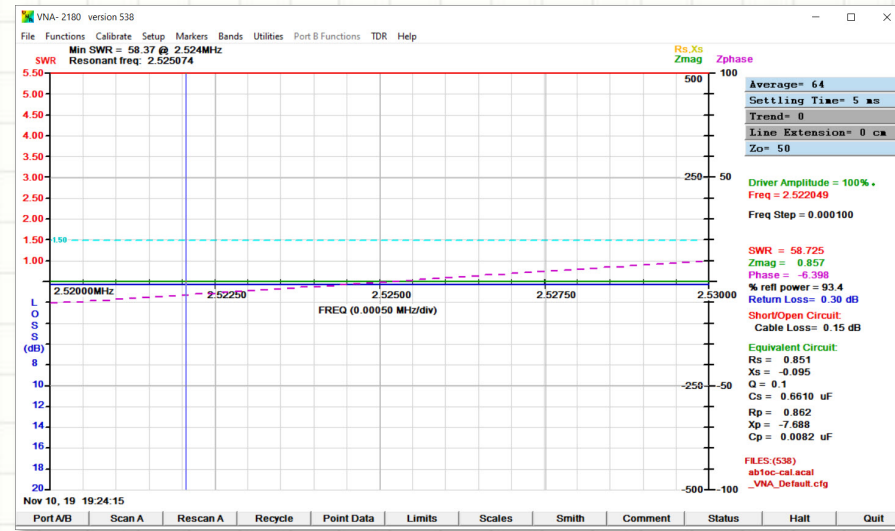
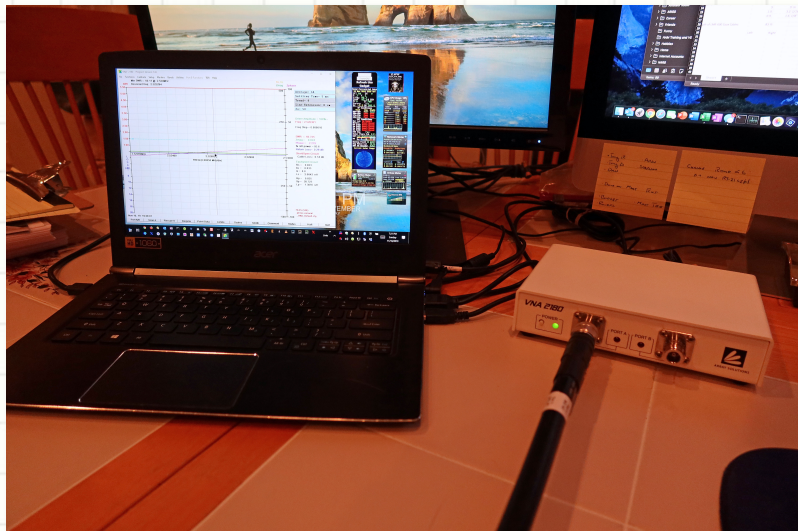
IC-9100  
Transceiver

- 4 Channel Sound Card + Dual SDR Receivers processes sperate I and Q phases for both V & H-polarities
- Linrad front-end for noise blanking
- WSJT MAP65 detects and adapts polarity for each signal in the band

# AB1OC-AB1QB 2m EME 2.0 Station

## Construction Status and Details

- Tower and feedlines are completed
  - Used a VNA to precisely cut and phase align LMR-600 receive coax cables
- Antennas and equipment have just arrived, expect to begin building antennas shortly
- Custom software to run rotators from WSJT under development
  - Implement safety lockouts to protect us and our neighbors
- Availability of Receive SDR Components from LinkRF



# The Big Stuff!

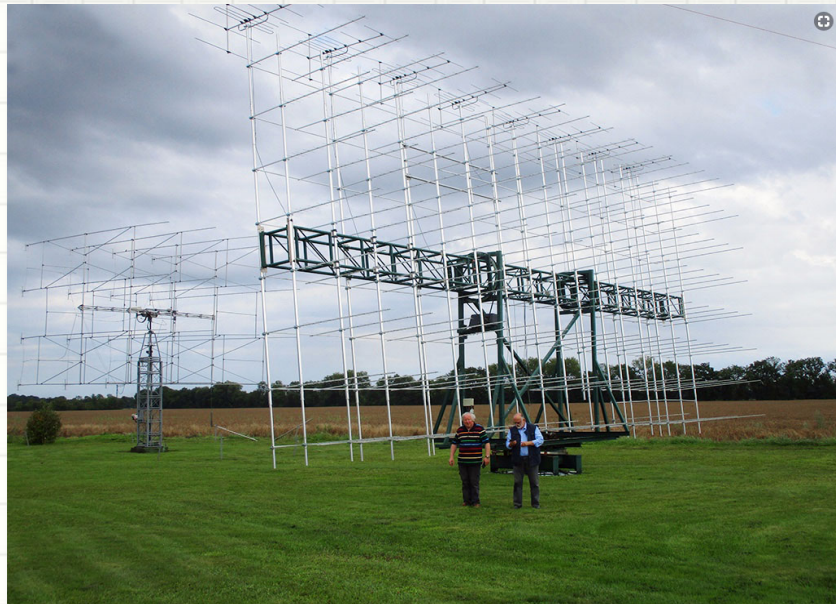
EME Arrays for CW, Dishes...



PEOSAT 16 x 8 el on 2m



DL6SH Dish on 144 MHz, 432 MHz, 1296 MHz



DL7APV 128 x 11 el on 70cm



AB1OC'S Next EME Antenna System...

# Thank You!

## Contact Information:

Fred Kemmerer, AB1OC  
[ab1oc@ar1.net](mailto:ab1oc@ar1.net)



Much more information, pictures and video are available on our Blog at:

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

You can find a good intro to EME Propagation and 1296 MHz operation [here](#).

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

