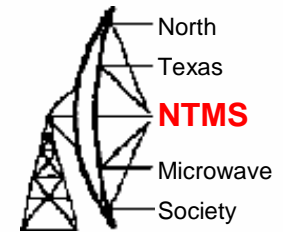


Microwave EME

by
Al Ward
W5LUA

Ham-Com
June 8, 2007

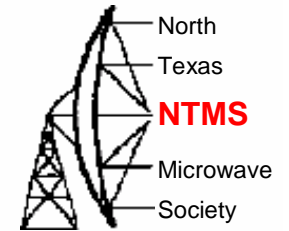
The Microwave Bands



Band	Frequency Range	Weak signal work in NA
33 cm	902 to 928 MHz	902 MHz
23 cm	1240 to 1300 MHz	1296 MHz
13 cm	2300 to 2310 MHz	2304 MHz
	2390 to 2450 MHz	
9 cm	3300 to 3500 MHz	3456 MHz
6 cm	5650 to 5925 MHz	5760 MHz
3 cm	10000 to 10500 MHz	10368 MHz
1.25cm	24000 to 24250 MHz	24192 MHz and 24048 MHz
.6 cm	47000 to 47200 MHz	47088 MHz
.35 cm	77000 to 81000 MHz	allocation changing

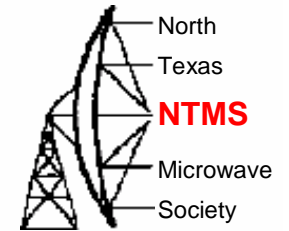
Not all countries have same allocation as us.....

902 to 928 MHz



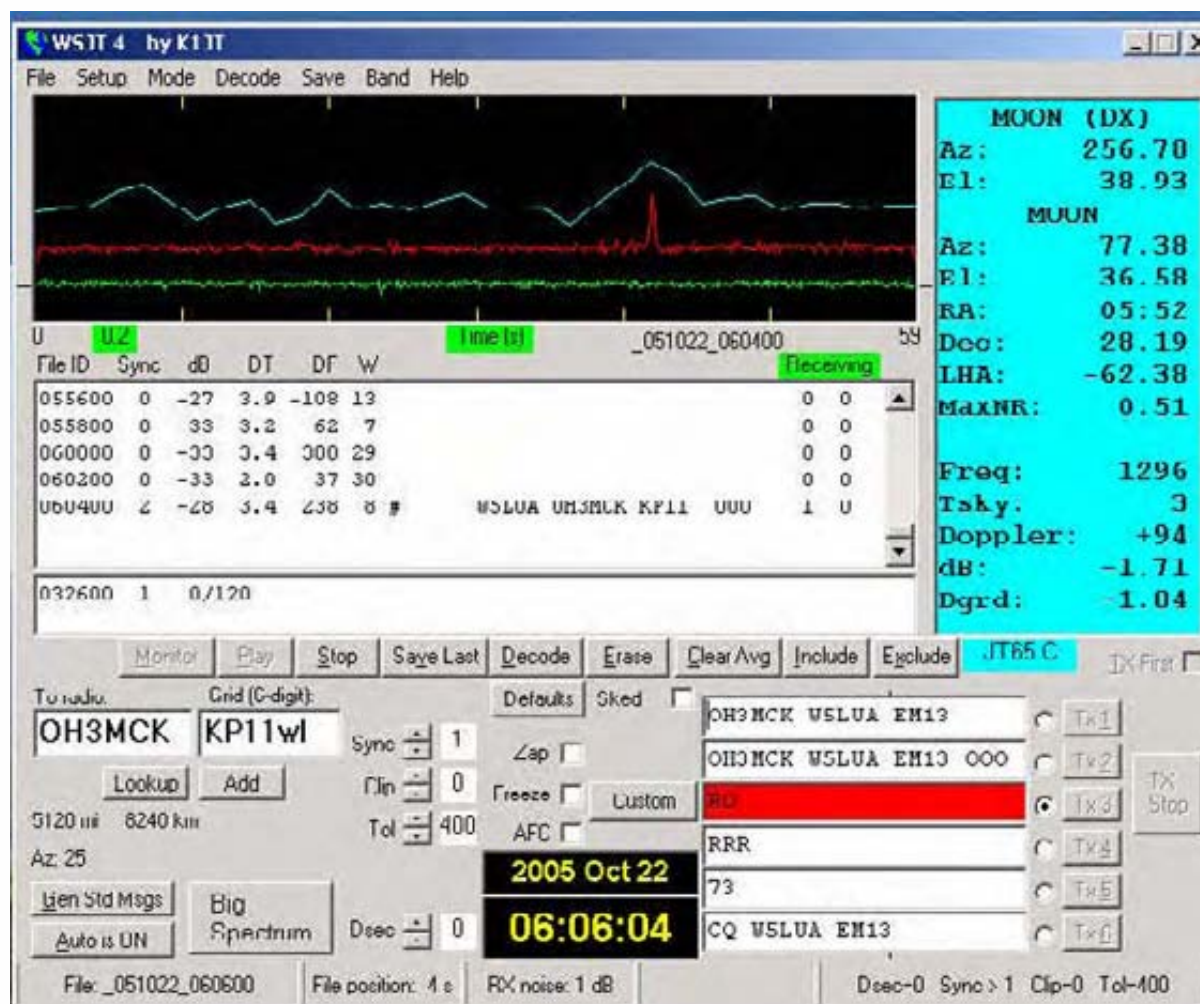
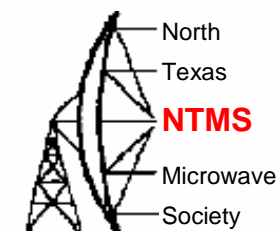
- Shared by Region 1 only
- Includes US and Canada
- 10 Stations operational over the years
- Station Requirements – 3m Dish with dual dipole feed, 150 watts from 2C39s, or 150/300/600 watt solid state amplifiers
- Active stations include K5JL, WA5ETV, W5LUA, K2DH, W0RAP, WB0TEM, VE4MA, NU7Z, WA8WZG, AND AF1T
- Interference from ISM and part 15 devices is a real problem on this band
- Operation by appointment only!

1240 to 1300 MHz



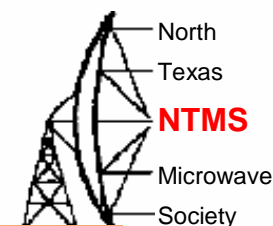
- World wide allocation
- Primary operation between 1296.0 and 1296.1 MHz
- CW and SSB
- 200+ stations operational
- Digital modes being explored – JT-44 initially, however JT-65C is used presently
- Minimum Station Requirements – 3m Dish with VE4MA or Septum type circular polarized feed and 150 watts from 2C39s or GS15b
- Big stations run 7 or 8 meter dishes and kw plus from TH-327/347 or YL-1050
- This is an excellent random CW band

OH3MCK on 1296 MHz JT-65C



4 Yagis 27 dBi
200 watts

www.emeham.com/1296/



JT65 - EME ACTIVITY REPORT LOGGER

1296 MHz - JT65C

by HB9DRI, Alex Artieda, Hosted by **AEMME.NET**

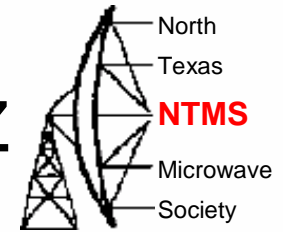
[50 MHz \(JT65A\)](#)
[144 Mhz \(JT65B\)](#)
[432 Mhz \(JT65B\)](#)
[13cm and UP \(JT65C\)](#)

This Logger is dedicated to promote QRP-EME with the JT65C mode on 1296 Mhz

Your Callsign: Your Report:

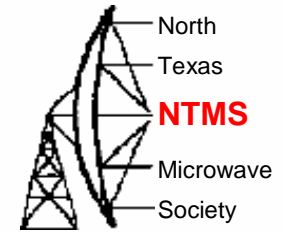
Date	UTC	Call Sign	Report
7.06.2007	08:37:25	g4ech	3SE Salvo I'm on 010 now, but echoes weak hr / 217.233.11.180
7.06.2007	08:24:12	DK3SE/SALVO	+++CQ 1296.010 CW/1st 2.5 min+++ / 217.233.11.180
7.06.2007	07:18:46	DK3SE/SALVO	++++ CQ 1296.070-JT65C-1st +++++ / 217.233.11.180
7.06.2007	04:21:08	DK3SE/SALVO	GM ALL! / 217.233.11.180
7.06.2007	04:19:06	DK3SE/SALVO	GE ALL! QRV 2.2m/150W@patch feed / 217.233.11.180
3.06.2007	00:21:51	ra3is	qrv / 217.118.88.21
2.06.2007	15:54:41	HB9DRI	Check http://www.emeham.com / 88.158.208.217
31.05.2007	21:35:43	py2mj	GN Salvo / 200.100.74.28
31.05.2007	21:07:40	dk3se	GN ALL 73! / 217.233.27.25
31.05.2007	20:54:03	dk3se	SV10E, Costa are you here? / 217.233.27.25
31.05.2007	20:32:20	DK3SE/SALVO	GE ALL! / 217.233.27.25
31.05.2007	10:11:16	DK3SE/SALVO	FOR SKEDES-> dk3se@gmx.de / 217.233.27.25
29.05.2007	22:18:54	py2mj	yes, I read / 200.100.74.28
29.05.2007	21:12:13	dk3se	LOCOUT-CN ALL! / 217.233.27.25
29.05.2007	19:35:15	dk3se	Hello Guilherme, have you read my last e-mail? / 217.233.27.25
29.05.2007	19:27:22	py2mj	CE Salvo, here is all OK, but sky closed / 200.100.74.28
29.05.2007	17:39:14	DK3SE/SALVO	PY2MJ, Guilherme, I'm here for info...! / 217.233.27.25
28.05.2007	20:23:40	GM3SBC	Now qsy to on4kat eme chat only / 193.113.228.171
28.05.2007	20:22:53	GM3SBC	CQ CQ CQ 1296.065 J65C 1st period / 193.113.228.171

2300 - 2310 and 2390 - 2450 MHz



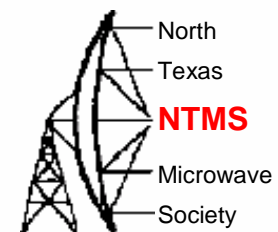
- Most operation between 2304.0 and 2304.150 MHz
- UK can only operate at 2320 MHz - no allocation at 2304 MHz
- Japanese operate at 2424 MHz - no allocation at 2304 MHz
- 2320 MHz is primary terrestrial frequency in Europe
- Crossband operation requires extra receive converters
- 50+ stations operational
- Station Requirements – 3m Dish, circular polarization, 100 watts

Path Loss

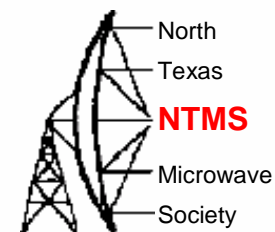


- According to the Radar equation, the path loss increases by 6 dB every time the frequency is doubled
- However dish gain also increases by 6 dB every time frequency is doubled
- Since we gain the same 6dB on both receive and transmit and assuming we use the same power and the same NF as we go up in frequency, our echoes will improve as frequency is increased – this is in fact what we see!

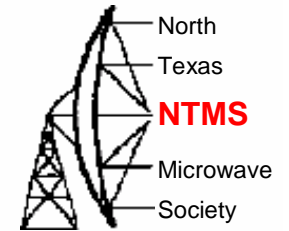
WD5AGO 8ft Dish for 2304 MHz



WA5WCP 10ft Dish for 2304 MHz

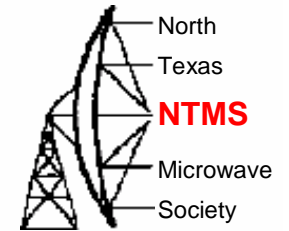


3300 to 3500 MHz



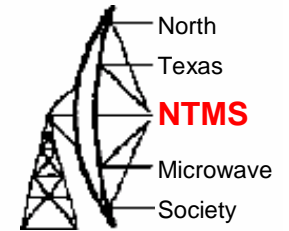
- Most operation between 3456.0 and 3456.1 MHz
- Not a world wide allocation
- Operation from Germany and Luxembourg on 3456 MHz, UK coming soon
- Finland operation on 3408 MHz
- W5LUA worked OH2AXH on 3408 MHz
- Stations that have been operational include K2DH, W7CNK, K0KE, W5LUA, DL9EBL, VE4MA, NU7Z, OH2AXH, LX1DB, OK1CA, WA9FWD, AND G4NNS
- G3LTF and WW2R working towards being operational
- Station Requirements – 3M Dish, 50 watts, linear polarity has been used – horizontal in NA and vertical in Europe – most active stations migrating to circular polarization to avoid spatial offset problem
- Activity must be coordinated as random activity is nil

5650 to 5925 MHz



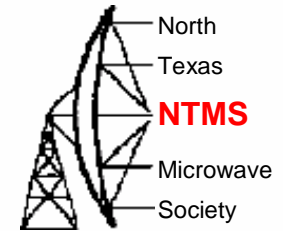
- Most operation between 5760.050 and 5760.150 MHz
- W, OE, VE, SM, OK, I, DJ, LX, JA, OH, RW, CT, ZS, F, G, VK Operation
- RW3BP operational on 5670 MHz
- W5LUA and OE stations worked RW3BP cross-band 5760/5670 MHz using 5616 MHz LO and 54 MHz IF
- 25+ stations operational
- Station Requirements – 3M Dish and 25 watts

5.7 GHz Activity List



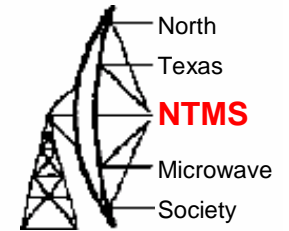
- WA5TNY, K2DH, W7CNK, K0KE, W5LUA, OE9PMJ, VE4MA, SM4DHN, OK1KIR, I6PNN, OE9ERC, DJ5FJ, LX1DB, NU7Z, JA7BMB, W5ZN, IK2RTI, OH2AXH, RW3BP, CT1DMK, VE1ALQ, ZS6AXT, WA5ICW, F2TU, F1ANH, WD5AGO, G4NNS, VK3NX
- Most use linear polarity but there is a strong migration towards CP mainly because of the spatial offset problem.
- CP has also been shown to reduce the spreading on 5.7 GHz signals

10000 to 10500 MHz



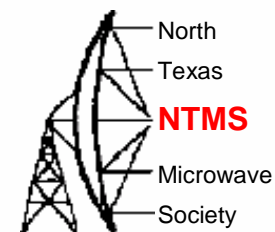
- Most operation between 10368.050 and 10368.150 MHz
- W, GW, OE, VE, SM, OK, I, DJ, LX, JA, OH, CT, ZS, F, G, PA, VK, RW, S57, HB, SP, RW Operation
- JAs operational on 10450 MHz - another cross-band challenge - JA7BMB has worked several stations
- 40+ stations operational
- Station Requirements – 3m Dish, 25 watts

10.3 GHz Activity List



- NA – WA7CJO, WA5VJB, W5LUA, VE3ONT, VE7CLD, WA6EXV, K9KFR, AA5C, WA6PY, N4MW, NU7Z, VE4MA, W6HD, W7SZ, K6RE, W4AD
- ROW – SM4DHN, G3WDG, OK1KIR, PA3CSG, F6KSX, DJ5FJ, CT1DMK, VK2ALU, RW3BP, DF0OVH, I4CHY, LX1DB, DL2LAC, IK5WJD, IW4BTG, S57UUU, HB9BHU, OK1UWA, DL0EF, OH2AXH, OK1CA, F2TU, PA0EHG, G4NNS, F3VS, F1BLL, I4TTZ, I5PPE, DJ5MN, DK7LJ, JA7BMB, GW3XYW, IQ4DF, DL0SHF, F5JWF, HB9SV, IK2RTI, SP7JSG, RW1AW, GW4DGU, DF9QX, F5JTA

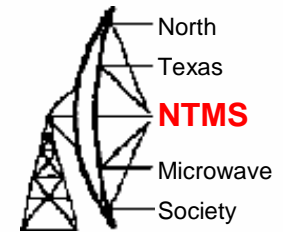
5 Meter Dish at W5LUA



**Used for
EME on
902 MHz
1296 MHz
2304 MHz
3456 MHz
5760 MHz
10368 MHz**

May use on 222
and 432 MHz
Also considered
use as a 2.5M
offset fed dish for
24 GHz

AZ EL Mount for 5 Meter Dish

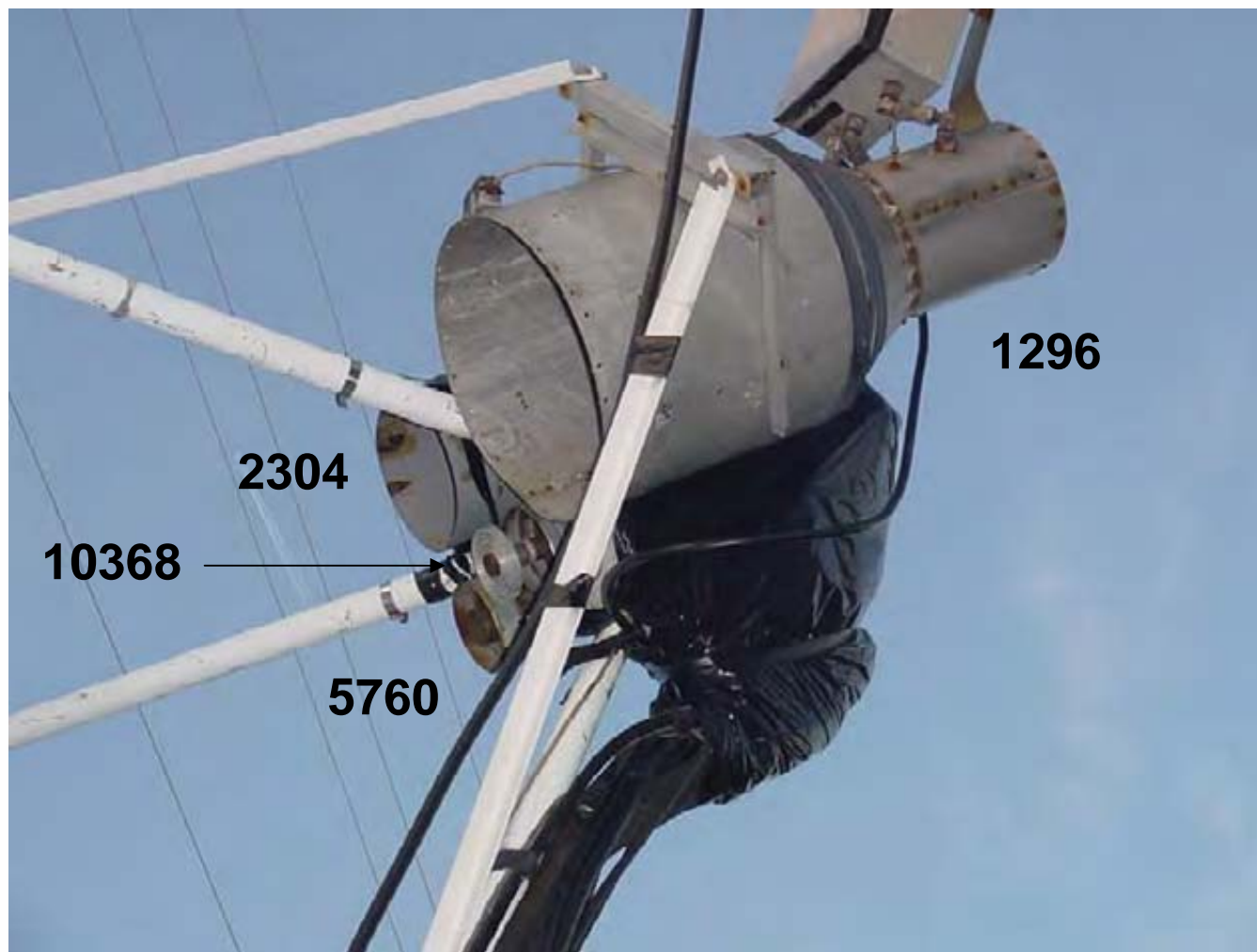
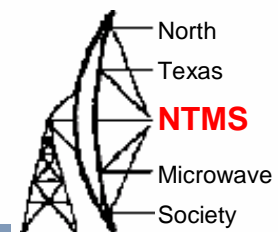


Hydraulics for elevation drive

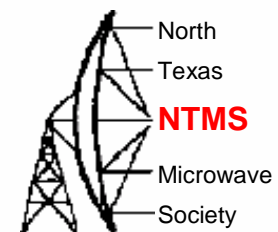
Prop pitch rotor for azimuth drive

US Digital Absolute Encoders for readout and K5GW tracking program

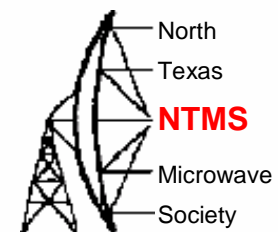
Multi-Band Feed System



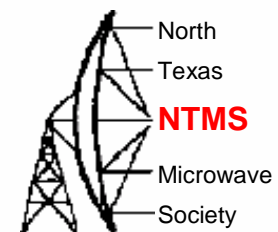
K0YW at KH7X on 23 & 13 cm



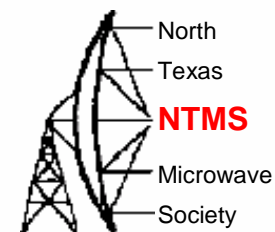
10 ft Dish at WW2R



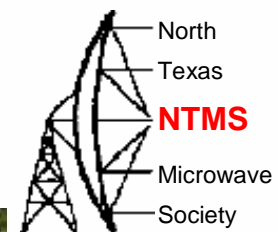
At Midlothian EME Contest 2005



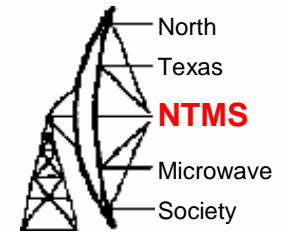
WA5WCP Mobile 5,4,3,2,1



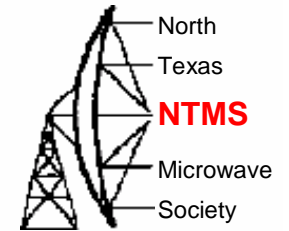
WA5WCP / 1 @ W1JJ RI



WA5WCP/1 Four States on 1296 EME in 16 Days Aug 2006

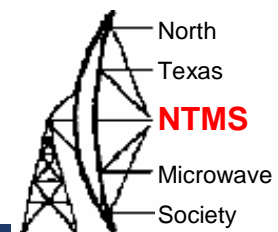


24000 MHz

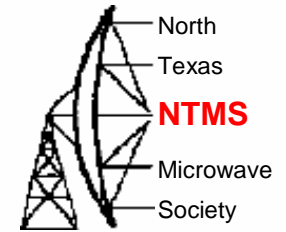


- Operation originally occurred at 24192.100 MHz – migrating to 24048.1 MHz because of primary int'l allocations
- W5LUA, VE4MA, RW3BP, AA6IW, VE7CLD became operational in 2001 and 2002
- More recently OK1UWA, G4NNS, DF1OI and LX1DB have become operational
- Minimum station Requirements – 3M prime focus or 2.4M offset fed dish and 20 watts

3 Meter Dish at W5LUA

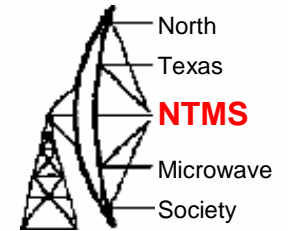


Tracking the Moon at 24 GHz at W5LUA



- Antenna beam width less than 0.3 degree
- Moon noise meter such as GR-1216 and GR-1236 allows tenths of dB to be measured
- Elevation - Multi-turn pot and direct drive gearing provides voltage to drive IBM A/D board and W9IP Realtrack software
- Azimuth – Precision transducer in Andrews positioner provides voltage to drive IBM A/D board 8V=360 Degrees
- 0.1 degree readout and accuracy
- Update antenna position every 30 to 45 seconds

47088 MHz



- Operation at 47088.100 MHz
- AD6FP, RW3BP, W5LUA, and VE4MA operational
- Station Requirements – 1.8 or 2.4 M offset fed dish and W2IMU type feed and 30 watts minimum
- Required use of RW3BP software for averaging of cw transmissions to enhance S/N ratio

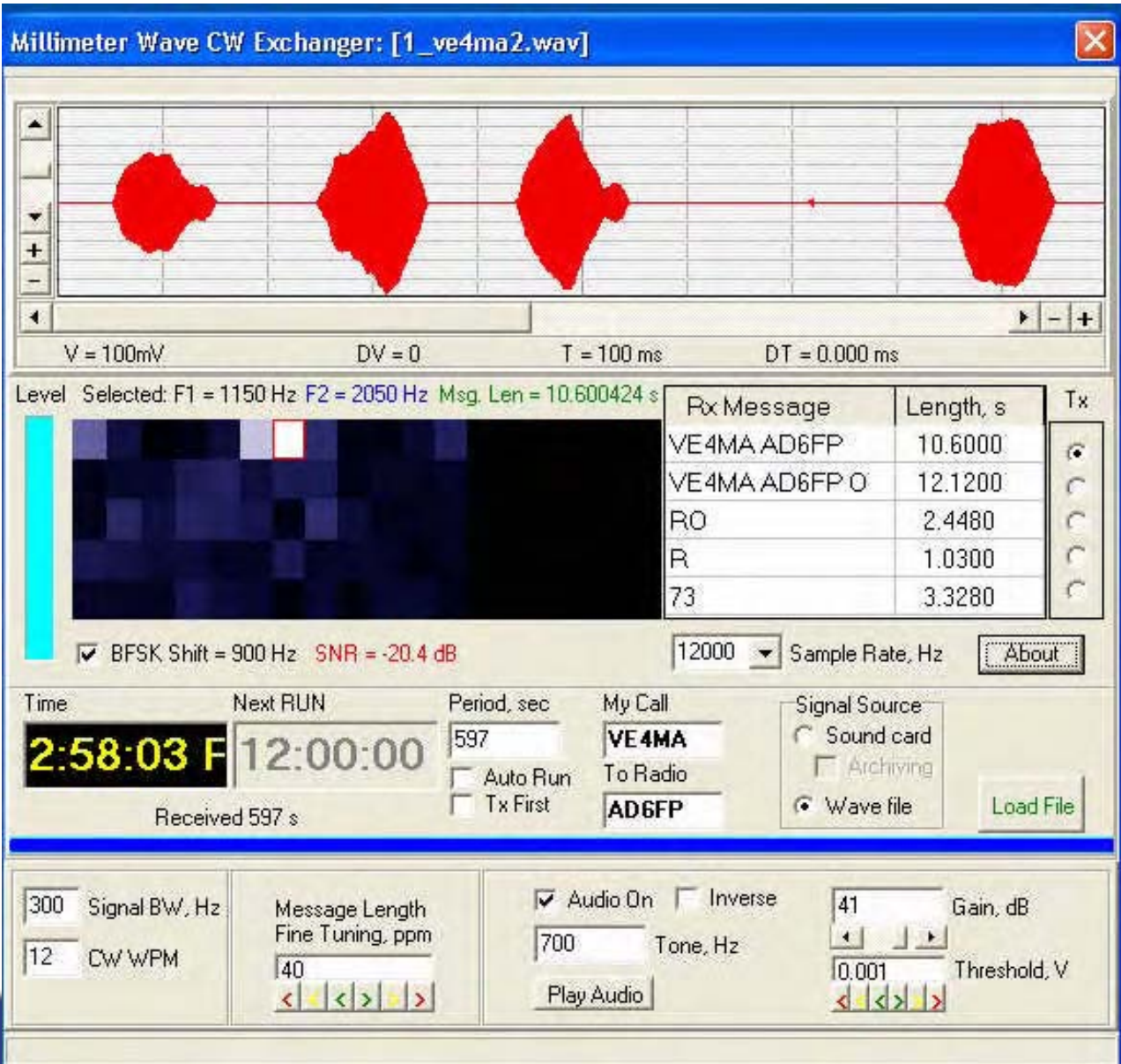
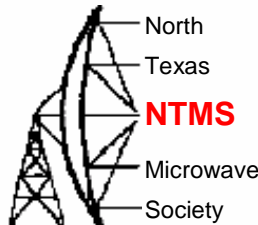


W5HN

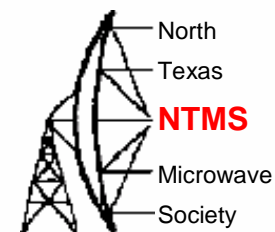
47

Millimeter Wave

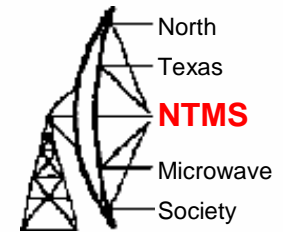
47 GHz EME Software



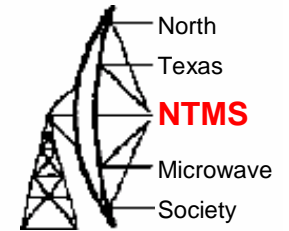
2.4m Offset Fed Dish at W5LUA



AZ-EL for W5LUA 2.4 Meter Dish

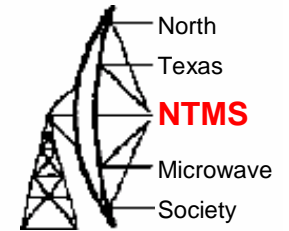


Atmospheric & Weather Effects



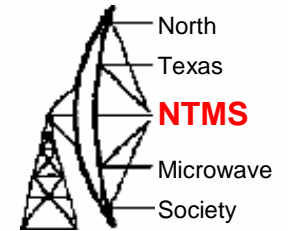
- Normally rain does not have a major impact on EME conditions through 5760 MHz – some effect on 10 GHz
- Humidity and heavy cloud cover cause increased absorption at 24 GHz – best conditions occur on a cold crisp night in the middle of winter
- At 47 GHz oxygen absorption is major contributor – there are no good times to operate!

Doppler



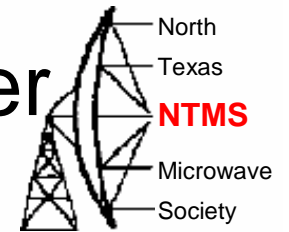
- The doppler shift is a change in frequency of the signal reflected off the moon and received back on earth.
- Doppler scales with frequency and is an indication of the relative motion of the moon with respect to the earth.
- When the moon is rising the doppler will be positive and when the moon is setting the doppler will be negative. The doppler is at a maximum when the moon is on the horizon and at a minimum at zenith.
- While doppler may be several hundred Hz at 2M, it is over 3 kHz at 1296 MHz and greater than 100 kHz at 47 GHz

Faraday Rotation

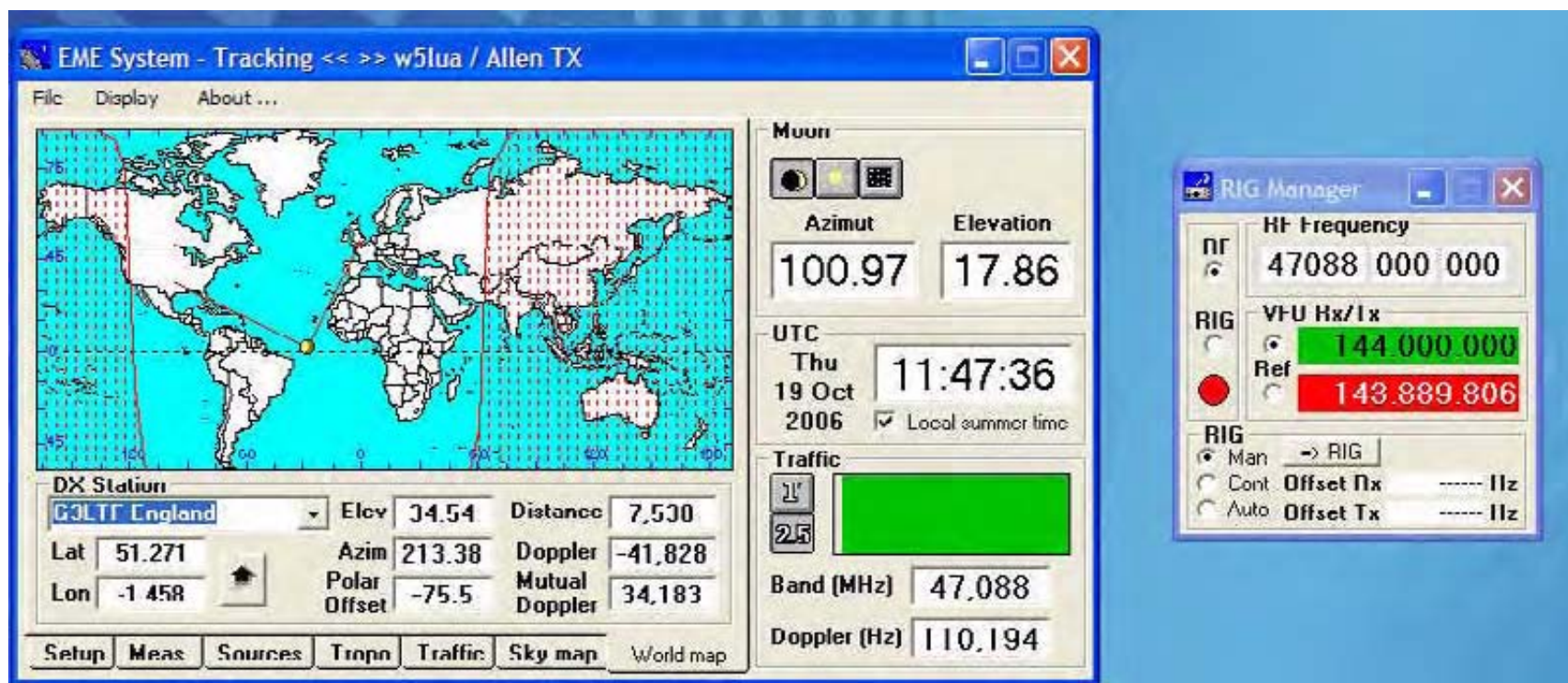
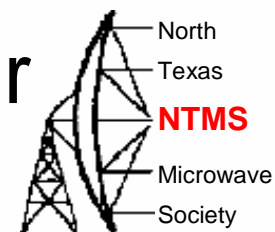


- According to Skolnik's Radar handbook.. "The Faraday rotation of the plane of polarization can be 2 to 5 revolutions in the UHF range, but since it scales as $1/f^2$, is negligible at and above L band" L band is defined in Skolnik as 1000 MHz to 2000 MHz and UHF is defined as 300 to 1000 MHz
- If we scale from 144 to 432 MHz the effect is 1/9
- If we scale from 432 to 1296 MHz it is another 1/9
- We know that time between signal peaks on 6M can be about 5 minutes, and 15 to 20 minutes on 2M and up to hours or days on 432 MHz so....
- In terms of what we hear, does this scale the time in between max and min signal strength or the level in dB between max and min or both?
- Most likely it is scaling the amount of rotation of a linear polarized signal and decreases significantly at 902 MHz and higher

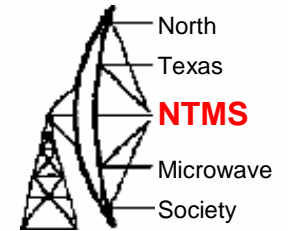
K5GW Tracking Software with Doppler Calculation & RX Tuning



F1EHN Tracking Software with Doppler Calculation & RX Tuning

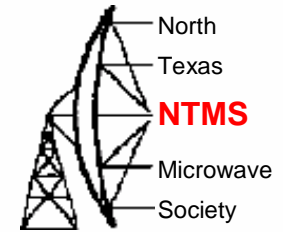


EME Net



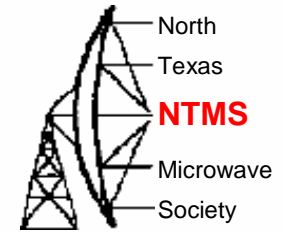
- Meets Saturday and Sunday Mornings at 9AM Central time on 14.345 MHz – NET Control is K1RQG
- Also available via the internet courtesy of K0TAR
- Weekly NET notes also available from K1RQG by emailing Joe at k1rqg@aol.com
- Also informal activity during the week on 14.345 MHz starting at 9AM Central

432 MHz and Above EME Newsletter



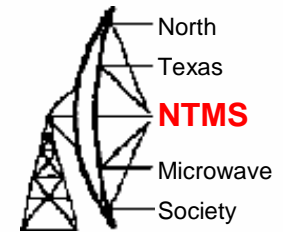
- Edited and distributed monthly by Al Katz, K2UYH since 1972 – send reports to a.katz@ieee.org
- Available from Rein W6/PA0ZN via the internet at <http://www.nitehawk.com/rasmit/em70cm.html>
- Available from Warren Butler wbutler@comcast.net in .pdf format

International EME Conference



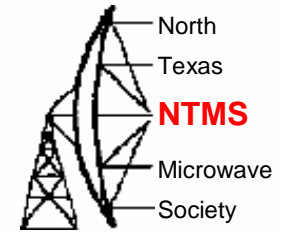
- DF6NA and his group sponsored the 2006 Int'l EME Conference in Wuerzburg, Germany in August. 140 amateurs from all over the world were in attendance
- The 2008 Int'l EME Conference will be held in Florence, Italy

Coordination of Activity



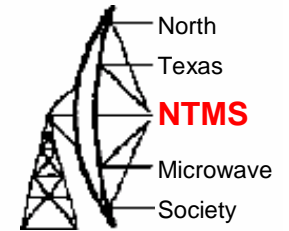
- Band by band activity weekends and many contests during the year – best to stay tuned in to the newsletter, net notes, reflectors and the 20M net.
- Bands like 1296 and 10368 MHz have considerable activity each month.
- Improved random activity on 2304.
- Best to coordinate other bands with individual operators known to be active

When is the Best MW EME Activity?



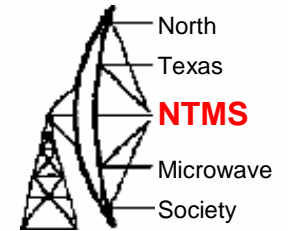
- Perigee when the moon is closest to the earth
- High declination best for northern hemisphere activity – most hours of moon
- Perigee and High declination not always occurring at the same time of the month – however as we approach 2007, the 2 conditions get pretty close
- Stay away from new moon
- Mainly weekend activity unless retired

Moonbounce Reflectors

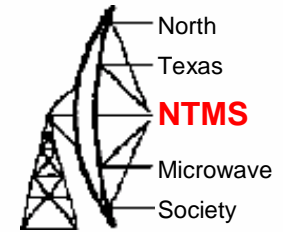


- Moon-Net -
<http://www.nlsa.com/nets/moon-net-help.html>
- EME-net -
<http://web.telia.com/~u37029479/>

Websites for more Information



- VE1ALQ - <http://www.ve1alq.com/>
- F1EHN - <http://www.f1ehn.org/>
- W2DRZ - <http://www.w2drz.ramcoinc.com/index.htm>
- K2AH – www.k2ah.com
- W1GHZ – www.w1ghz.org



Any Questions?

73

Al Ward W5LUA

al.ward@avagotech.com