# 24 GHz EME – Conquered 47 GHz EME – The Next Frontier

Al Ward W5LUA Barry Malowanchuk VE4MA

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### The First 24 GHz EME QSO

- Dishes Used
- Preamplifier Requirements
- TWTs & Power Supplies
- Feed Systems
- Operating Results

### The Moon at 24 GHz

- Rough surface of moon produces very rough sounding note – like aurora – worse when moon is at zenith
- Spreading can be several hundred Hz making the use of very narrow bandwidth IF filters impossible
- Doppler shift upwards of +60 kHz on rising moon and –60kHz on setting moon
- Antenna beamwidths less than half the 0.5° subtended angle of the moon

Atmospheric Effects at 24 GHz

 Warm & humid days worse for 24 GHz – increased path loss

- Thick cloud cover also effects 24 GHz – increased path loss due to absorption
- Working through rain is certainly a test of your equipment
- Best conditions occur on a cold crisp night in the middle of winter

## 2 Dishes at VE4MA



## 2.4m Dish at VE4MA



## 2.4m Dish at VE4MA



### 5 Meter Dish at W5LUA



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

W5LUA June 2001

## 3 Meter Dish at W5LUA



## 24 GHz Dish with Back Structure



## **Modified Azimuth Drive**

### 70:1 Gearbox



# 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

### Homebrew 24 GHz LNAs



## Homebrew 24 GHz LNAs



### **Retuning TWTs for 24 GHz**

- More conventional Helix TWTs have better chance of going up in frequency
- Normally a drop in helix voltage will improve performance at higher frequency
- Waveguide tuning can also enhance performance
- Magnets can provide surprising results!

## Retuning TWTs for 24 GHz

#### Coupled Cavity TWTs not very broadband



## VTU-6191 14 GHz TWT



### First 24 GHz Echoes at W5LUA

- Andrew 3 Meter Dish with Back Structure
- 2.25 dB Noise Figure at Feed Produced with Agilent PHEMT Devices
- 18 Watts at Feed Produced with Optimized VTU-6191 TWT
- Sun Noise 12.5 dB
- Moon Noise 1.3 dB
- March 7, 2001 Winter / Spring
- Only took 4 years of work!

### First 24 GHz Echoes at W5LUA



## **TH-3864C TWT**



### TH-3864C TWT on the inside



# Varian VPW-2931 TWT Power Supply



## High Voltage Test Bench



# TH-3864C TWT Mounted Behind 3 Meter Dish



## 80 Watt 32-38 GHz TWT



## 80 Watt TWT at 24 GHz





## Feed / Waveguide Switch / LNA



## VE4MA Offset Dish Feed System



# VE4MA Offset Dish Feed System



#### Present Station at VE4MA

- Prodelin 2.7 m Offset Dish
- 1.55 dB NF DB6NT Preamp at Feed
- 110 Watts (70 Watts at Feed) Produced with "Optimized" NEC LD-7235A TWT
- Sun Noise 15.0 dB
- Moon Noise 2.3 dB Winter/ 1.2-1.8 dB Summer

# **Operating Position at VE4MA**

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### The Station at W5LUA

3m Andrew Dish with Back Structure
1.75 dB NF HB Preamp
80 Watts at Feed with TH3864c TWT
Moon Noise 1.6 dB Winter / 0.8 to 1.2 dB Summer

## **Operating Position at W5LUA**



W5LUA March 2001

### The First 24 GHz EME QSO

- The first 24 GHz EME QSO took place on August 18, 2001 at 1415 GMT
- 10 years after the first 10 GHz EME QSO
- "M" Signal Reports were exchanged both ways
- This QSO was only the beginning!

### Since the First 24 GHz EME QSO

- VE4MA and W5LUA have had a total of 10 24 GHz EME QSOs since August 2001
- W5LUA worked RW3BP on April 18
- VE4MA worked RW3BP on April 20
- RW3BP worked AA6IW on April 21
- VE4MA worked AA6IW and VE7CLD on April 21

## 24 GHz EME SWL Reports





#### W5LUA-VE4MA Power Tests

- Tests ran in January 2002
- "O" copy with 60 to 70 Watts
- Still "O" copy with 30 Watts
- "M" copy with 15 watts
- 10 watts may be tough but do-able in winter

#### The Station at RW3BP

- Supral 2.4m Offset Dish
- 1.75 dB NF DB6NT Preamp at Feed
- 50 Watts at Feed Produced with Alelco TH 3602 / B TWT
- Sun Noise 15.0 dB
- Moon Noise 1.5 2 dB

# 2.4 Meter Offset Fed Dish at RW3BP



# RW3BP 24 GHz EME Transverter at Feedhorn



# Switched Feedhorn Arrangement at RW3BP



#### The Station at AA6IW

2.4 Meter Offset Fed Dish
DB6NT Preamp at Feed
100 Watts produced with Thompson TH-3864 C TWT

### The Dish at AA6IW



# Feed System at AA6IW



### The Station at VE7CLD

Andrews 4.5 Meter Prime Focus Dish
DB6NT Preamp at Feed
100 Watts produced with Alelco TH 3602 / B TWT

### The Dish at VE7CLD



# Feed System at VE7CLD



### 24 GHz EME Summary

- 24 GHz EME has produced 15 QSOs in the last 9 months with more very likely
- W5LUA, VE4MA, RW3BP, AA6IW, and VE7CLD all active with QSOs completed
- More stations are expected very soon -WA7CJO, CT1DMK, G3WDG, OH2AUE, LX1DB, OK1UWA, PA0EHG, DL?
- Requirements
  - a "good" 8 or 10 ft dish & 15 Watts at Feed
  - Lots of Work !

# 47 GHz EME – The Next Frontier

- We're not stopping at 24 GHz
- TWT Power is available at 45 GHz
- Preamplifiers will use chip and wire technology

 Small 4 to 6 ft offset fed dishes may be the best choice – surface accuracy very very important!

# W5LUA 47 GHz EME Converter and Feedhorn



# Hughes 32 Watt TWT for 45 GHz



### The First 47 GHz EME QSO ?

- Within a year???
- 30 Watts is realistic
- 4 dB noise figure is available
- Biggest concern is the dish
- Stations working toward EME AD6FP / W0EOM / AA6IW, & VE4MA & W5LUA

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• Any Questions?