



Earth Moon Earth Communications

The Ultimate Amateur Radio Challenge

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Presented to Motley Picnic 2026

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 - Design
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 - Electrical/Electronic
- You can do EME

Bio

- Grew up in SoDak, Ham in 1965
- EE SDSU – US Army
- FAA Chicago 1974
- Indiana, Michigan, Minneapolis, OKC, DC,
– Alaska 1992, on 3-5 year assignment
- Acquired my EME obsession, 1999
- Wife Lana is very tolerant of my obsession

MOTIVATION

- I acquired an unusual relationship with the Moon
- Typically about 0.5 degree of arc
- The thought of reflecting a signal off the moon is seemingly absurd considering:
 - Average 238,000 miles from Earth +/- 14,000 miles
 - Only 7% reflective
 - Huge path loss; hundreds of dB

How I got Hooked



- Amateur Satellites in 1992 until about 1998
- 1997 EME contest, heard my 1st moon signal
- The Ultimate ham radio challenge – EME

Hooked

- Technology “Sport”
 - Civil, Mechanical, Electrical, Electronic Engineering
 - Astrophysics – Moon dynamics are complicated
 - Control systems
 - High Power Amplifiers
 - Low noise, high sensitivity receivers
- EME Attracts all kinds of people from carpenters to Nobel Prize winners (~3000 world-wide?)

WSJT Inventor and EME'er and Nobel Prize Winner



History

- The first EME projects started just after the conclusion of WWII.
- Project Diana, 1946 - Radar echoes
- US Navy's Moon Relay project in 1951
- 1960: The first amateur two-way EME contact
- By 2000 estimated 1000 amateurs worldwide had successfully completed at least one EME QSO.
- Estimated ~3000 EME capable stations today.

Thanks to W5UN



The Steps

(to building an EME superstation)

- Acquire the Dish
- Design
- Procure parts, materials, services
- The mounting structure (Tower)
- The Mechanics
- The Electronics
- OPERATE !

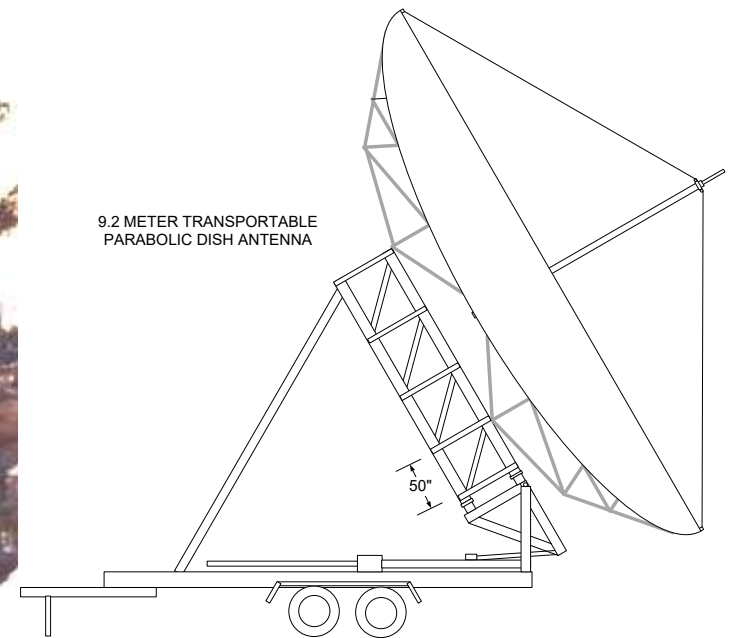
Structural Design

- Tower Requirements
 - Strength (wind and weight)
 - Height
 - Cheap ?
- Mechanical concepts
- Make Drawings
- Ask everyone!

Acquire a Dish (1999)



Original Transportable Dish



Modifications



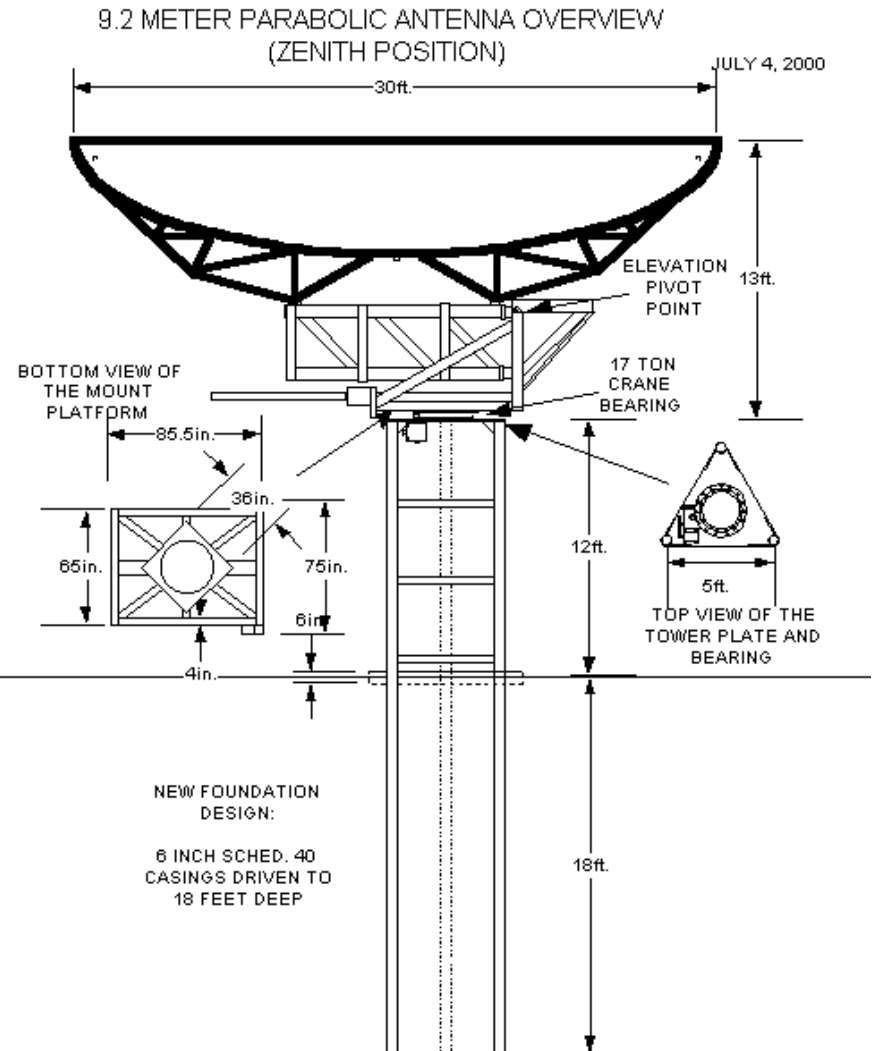
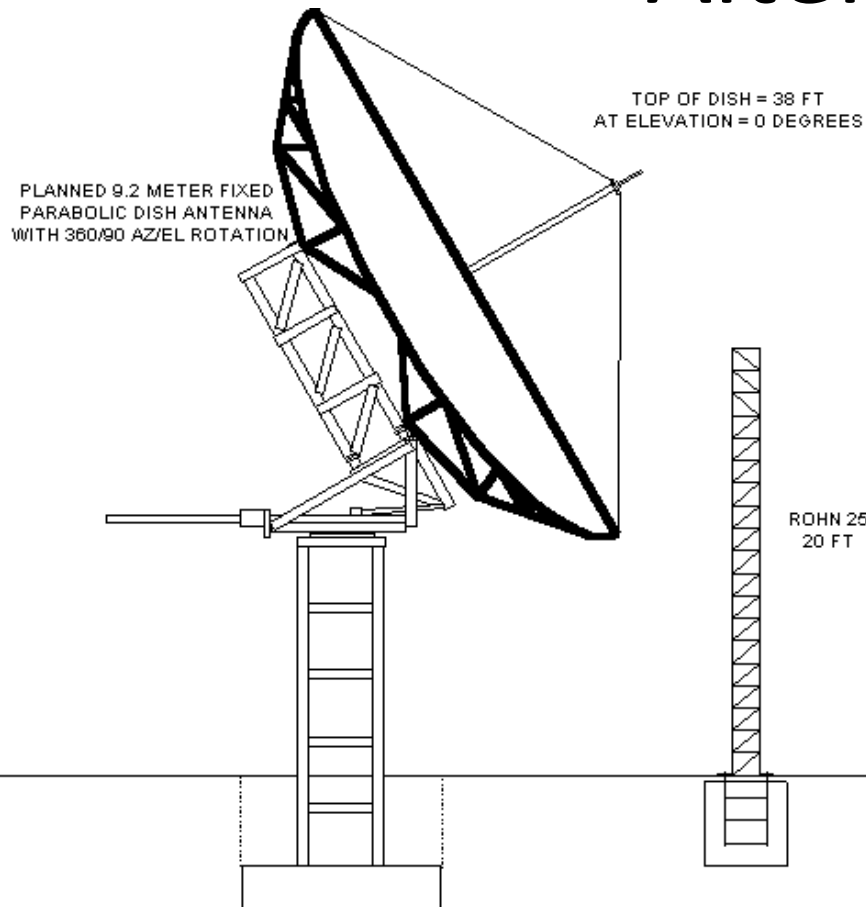
Design

WINDLOADING AND FOUNDATION CALCULATIONS

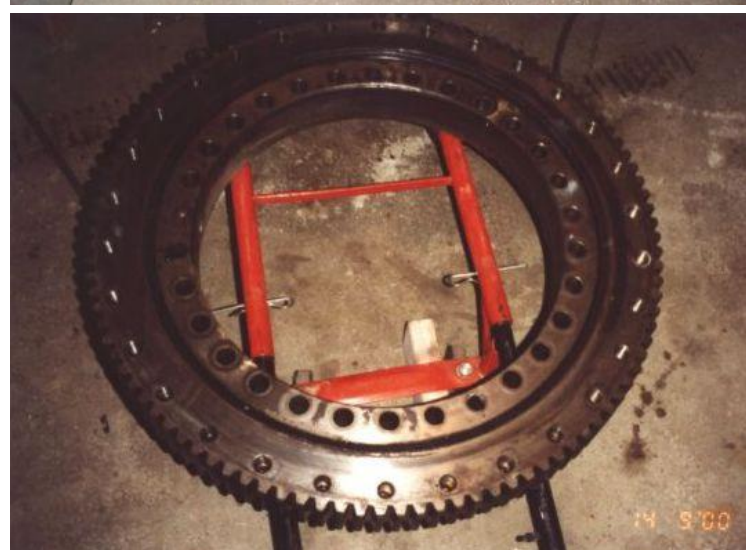
The following assumptions were used in the calculations:

1. Design windspeed ? 50 lbs/sq.ft. (approx. 120 mph)
2. Dish area = 700 sq. ft.
3. Maximum operating wind = 35 mph
4. Total weight of movable antenna = 6,000 pounds
5. Decision: Design for worst case in parked position
6. Design is with antenna parked (EL = 90; AZ = 150 +/-10)
(Historically most winds in excess of 30 mph are from this direction)
7. Locked with grade 8 x 1" bolt above 35mph

Alternatives



Beg, Borrow, Barter



Tower (Pilings)

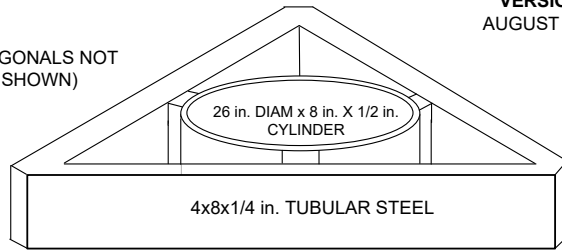


Tower Top

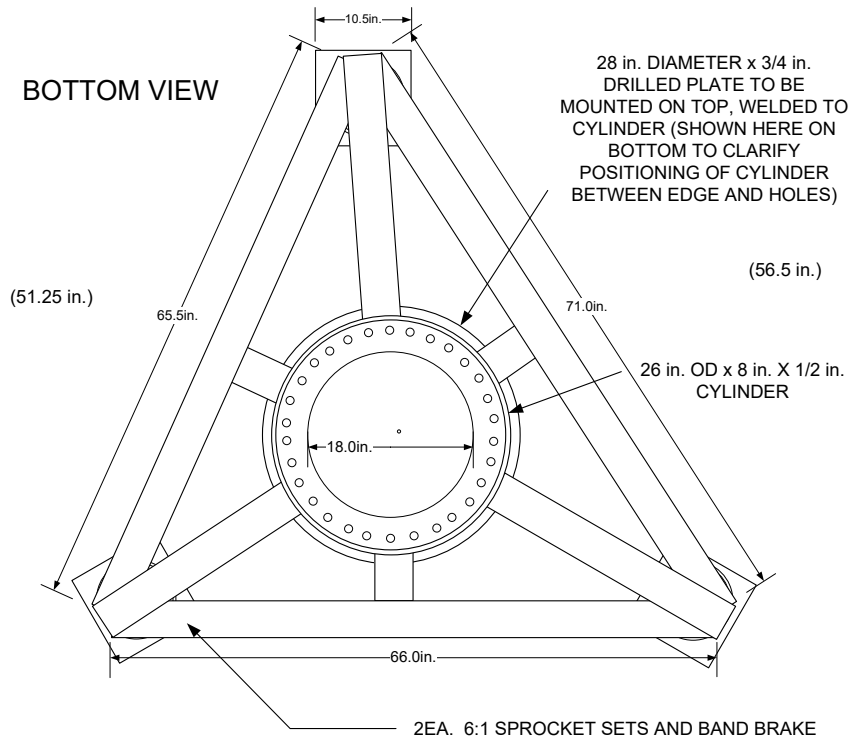
TOWER TOP FABRICATION

VERSION 4
AUGUST 31, 2000

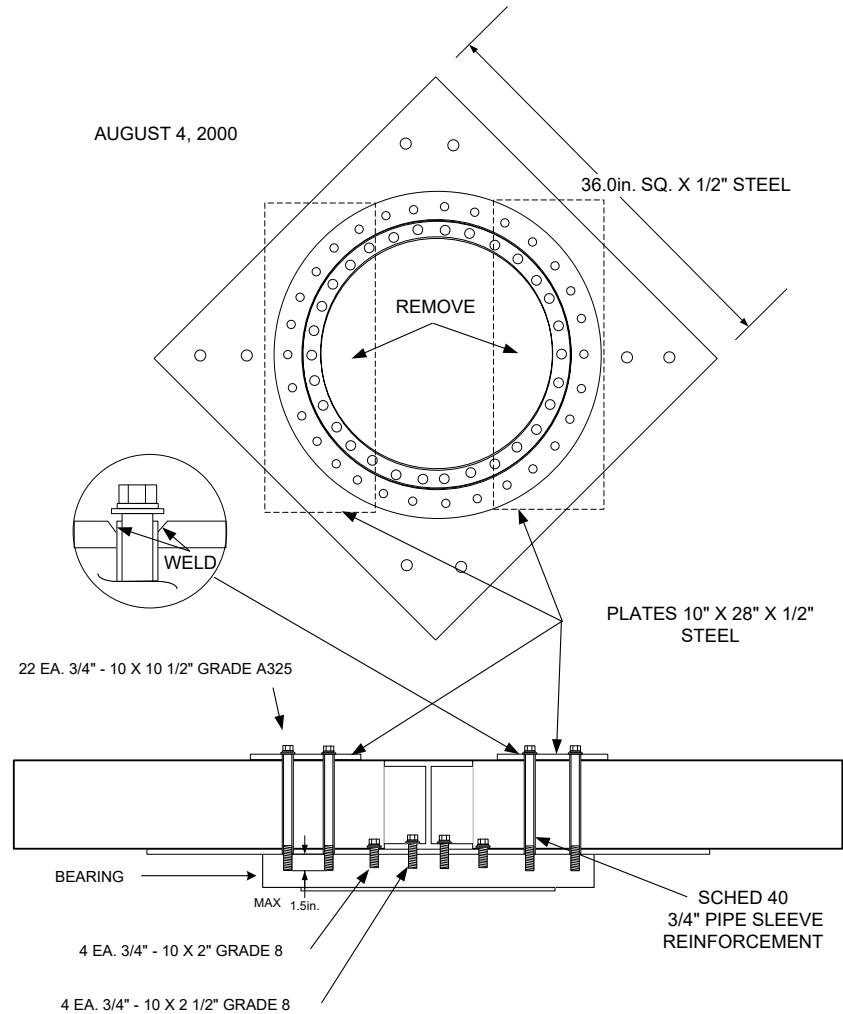
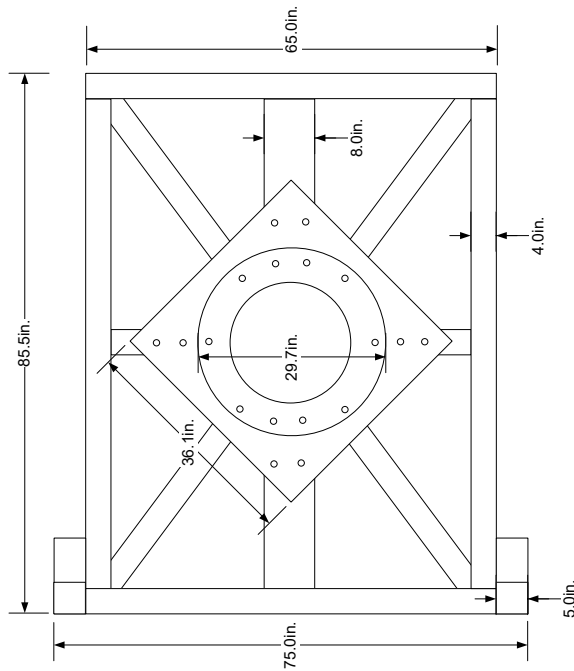
(DIAGONALS NOT
SHOWN)



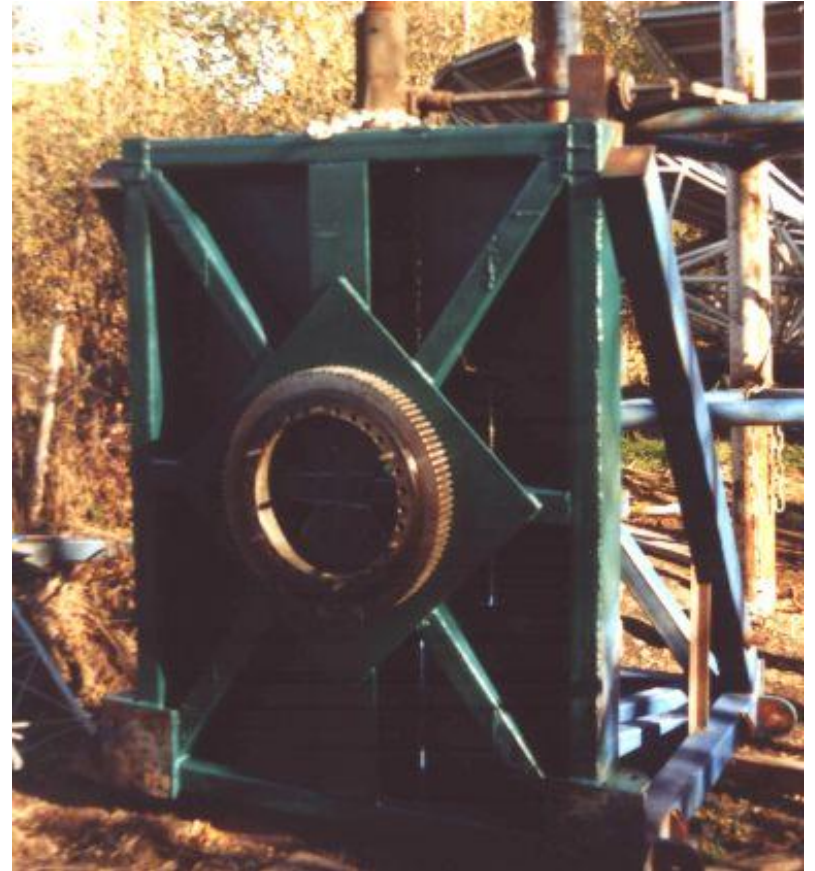
BOTTOM VIEW



Rotating Platform



Rotating Platform (Part 2)



Dish Assembly



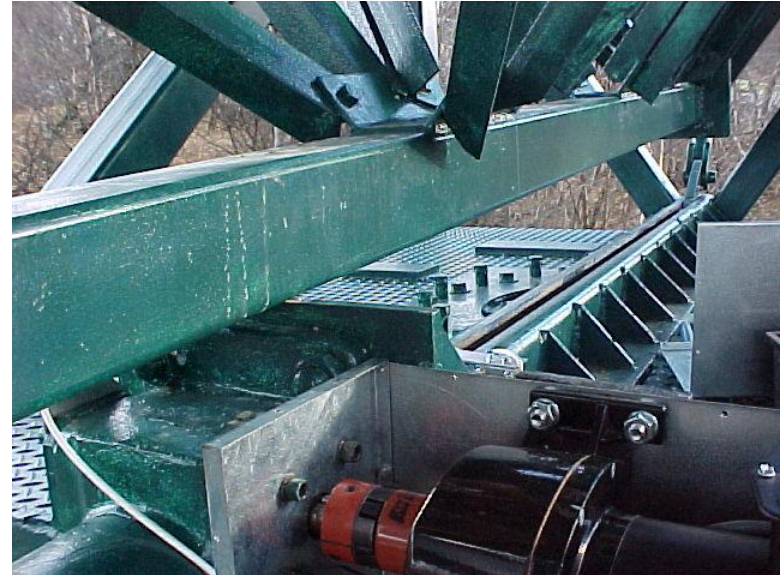
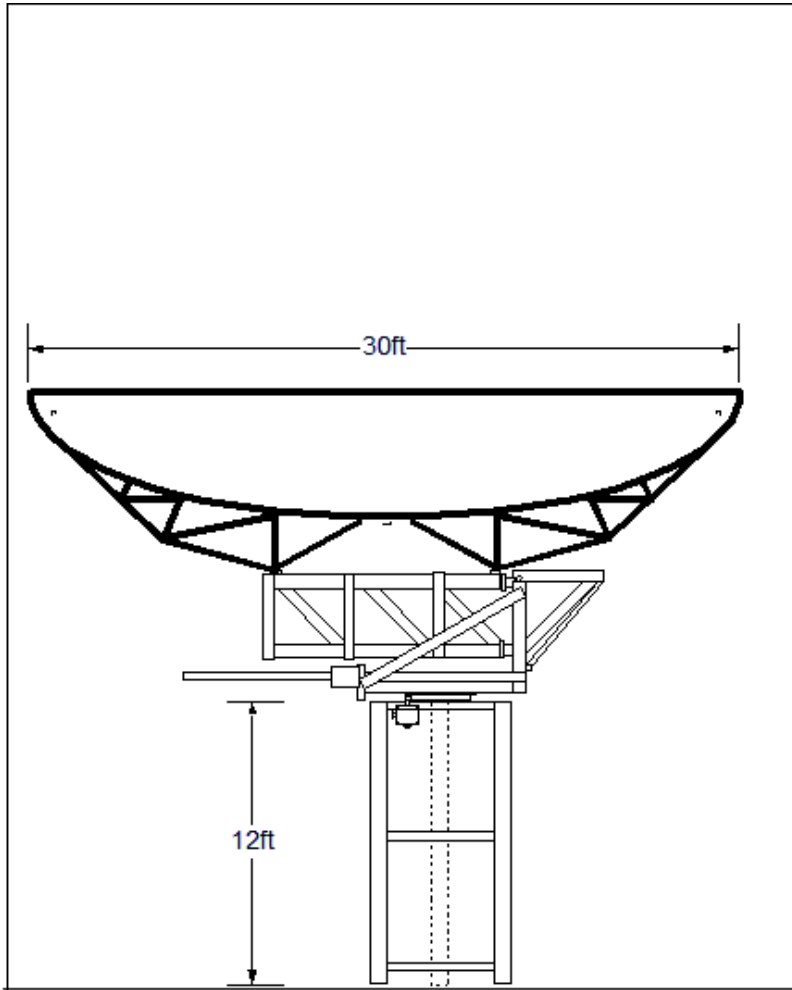
Lift Frame



Crane



Elevation Actuator

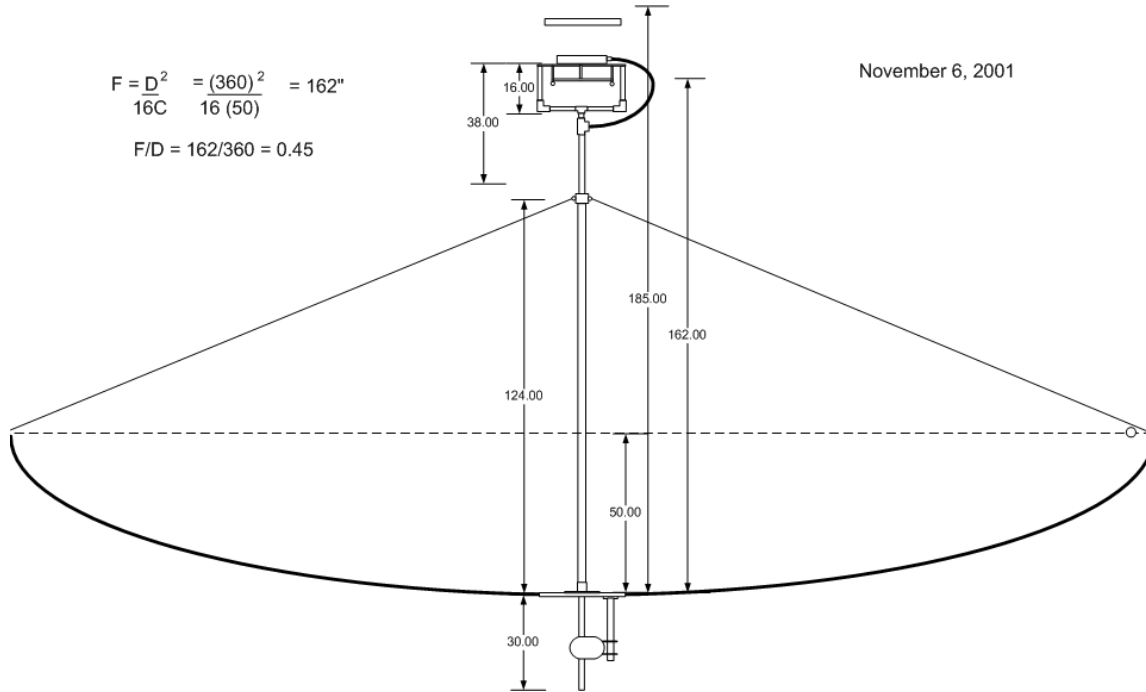


Mounting the Feed Phase 1

$$F = \frac{D^2}{16C} = \frac{(360)^2}{16(50)} = 162"$$

$$F/D = 162/360 = 0.45$$

November 6, 2001



Then my wife caught me changing feeds

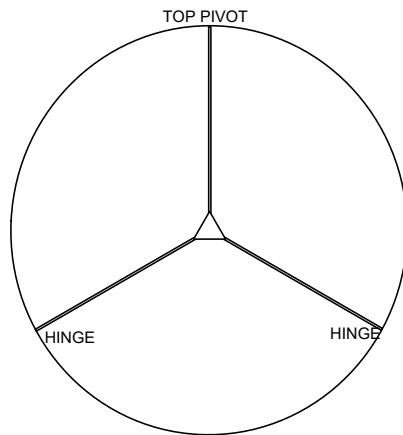
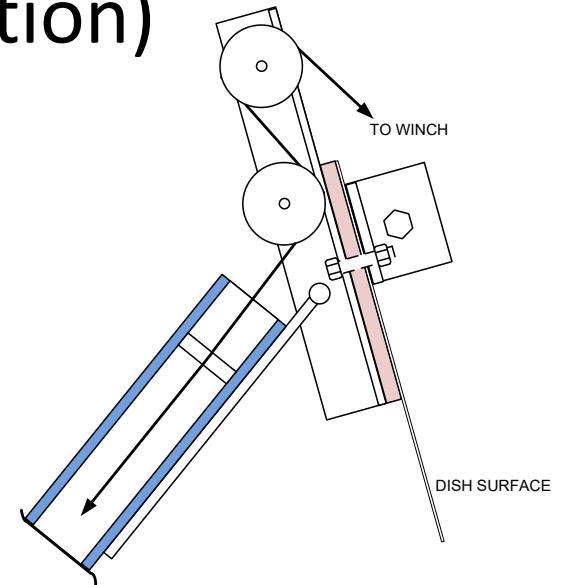
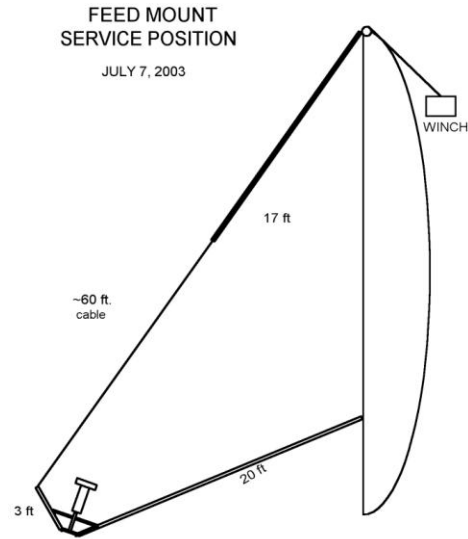
Mounting the Feed

Phase 2 (First Attempt)

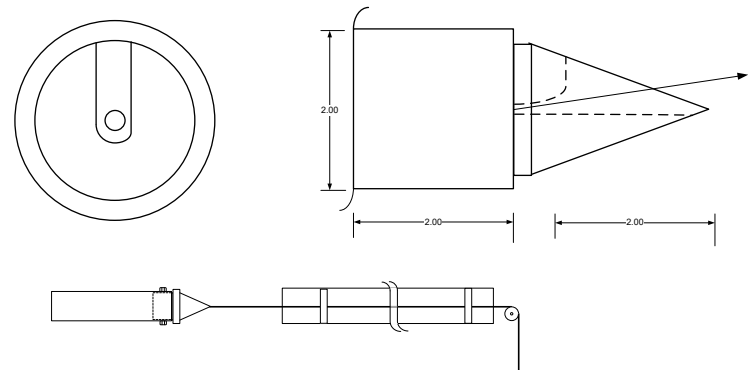


Mounting the Feed

Phase 2 (Final Solution)



FEEDCONE
MAY 22, 2003



Mounting the Feed

Phase 2 (First Attempt) (Continued)

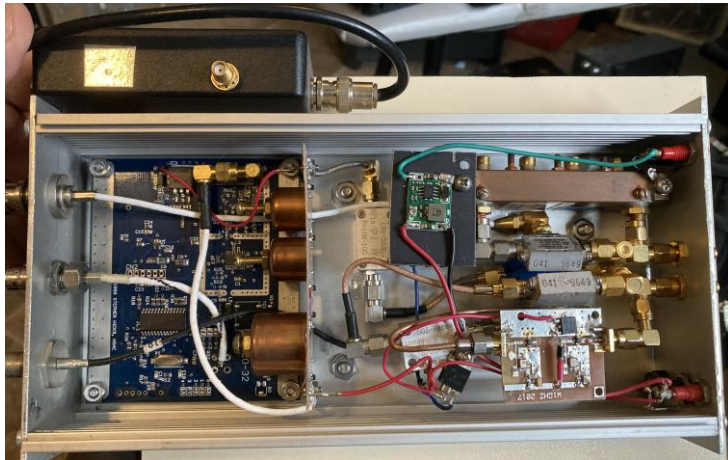
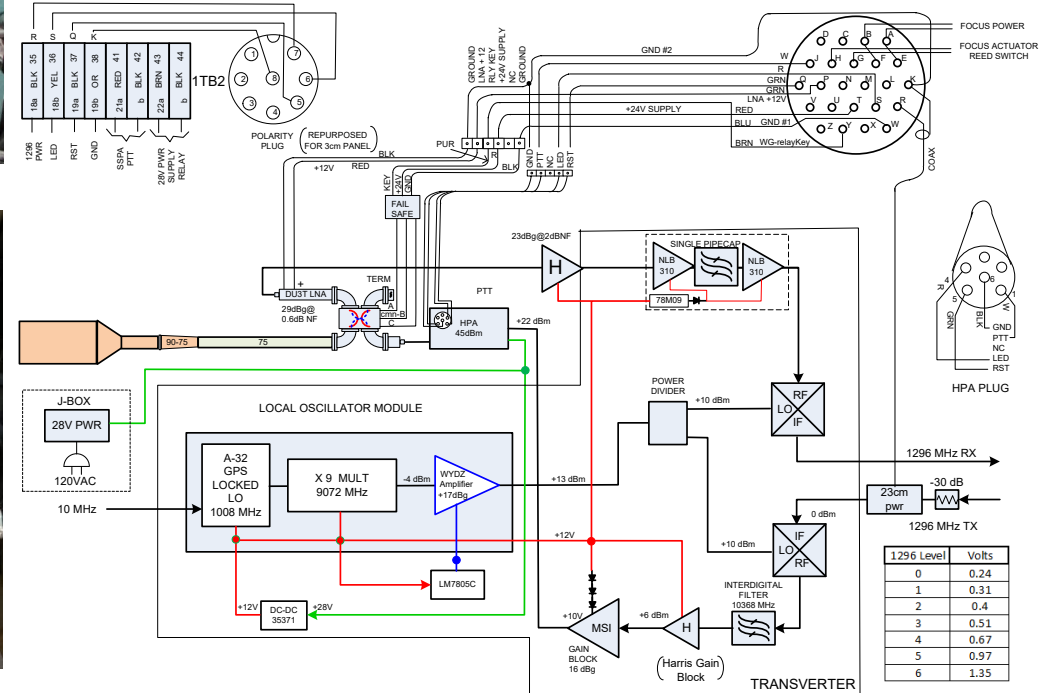


FEED WINCH OPERATION

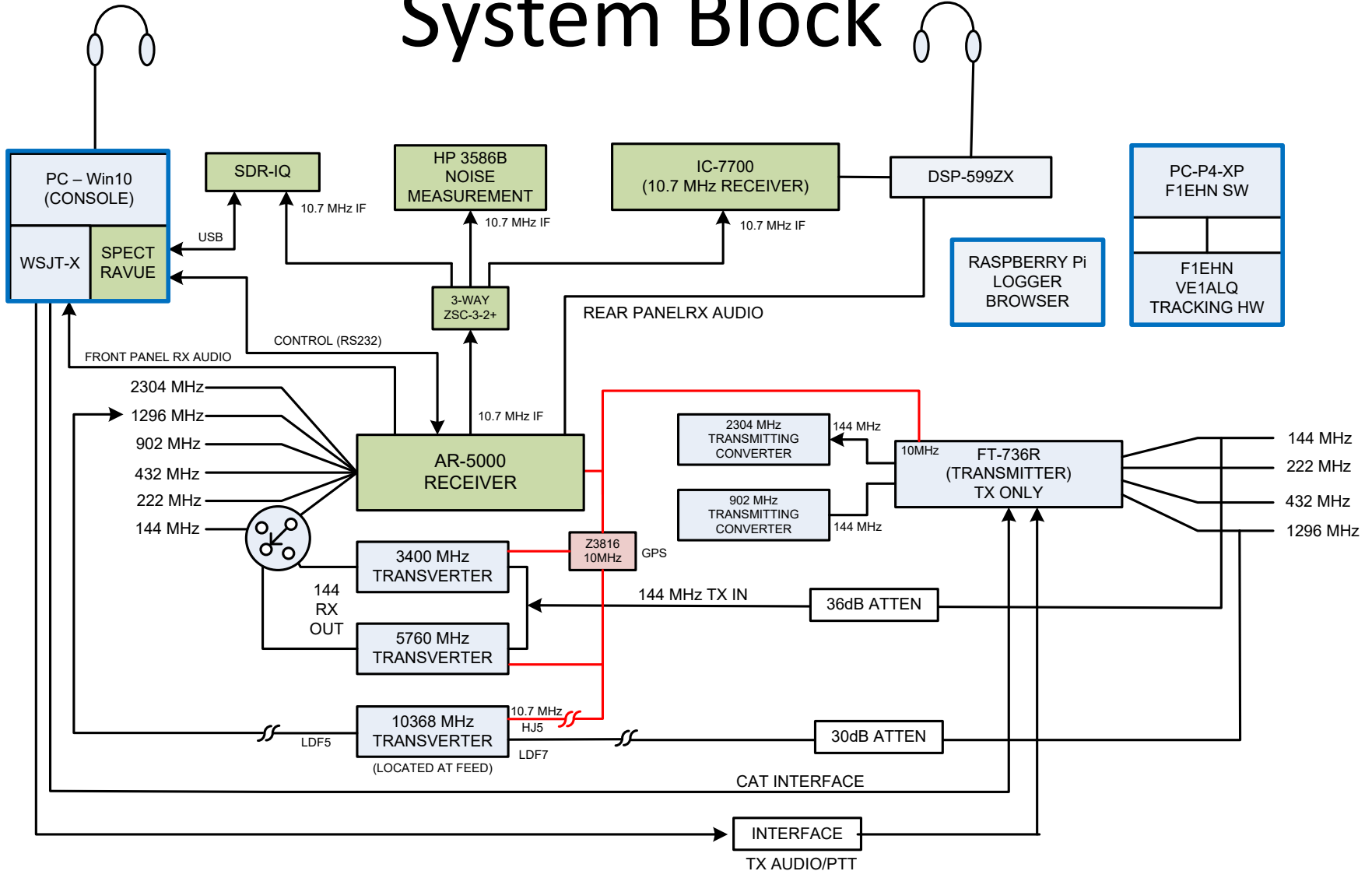


DIY

ANTENNA POSITION AND TRANSMIT CONTROL PANEL



System Block



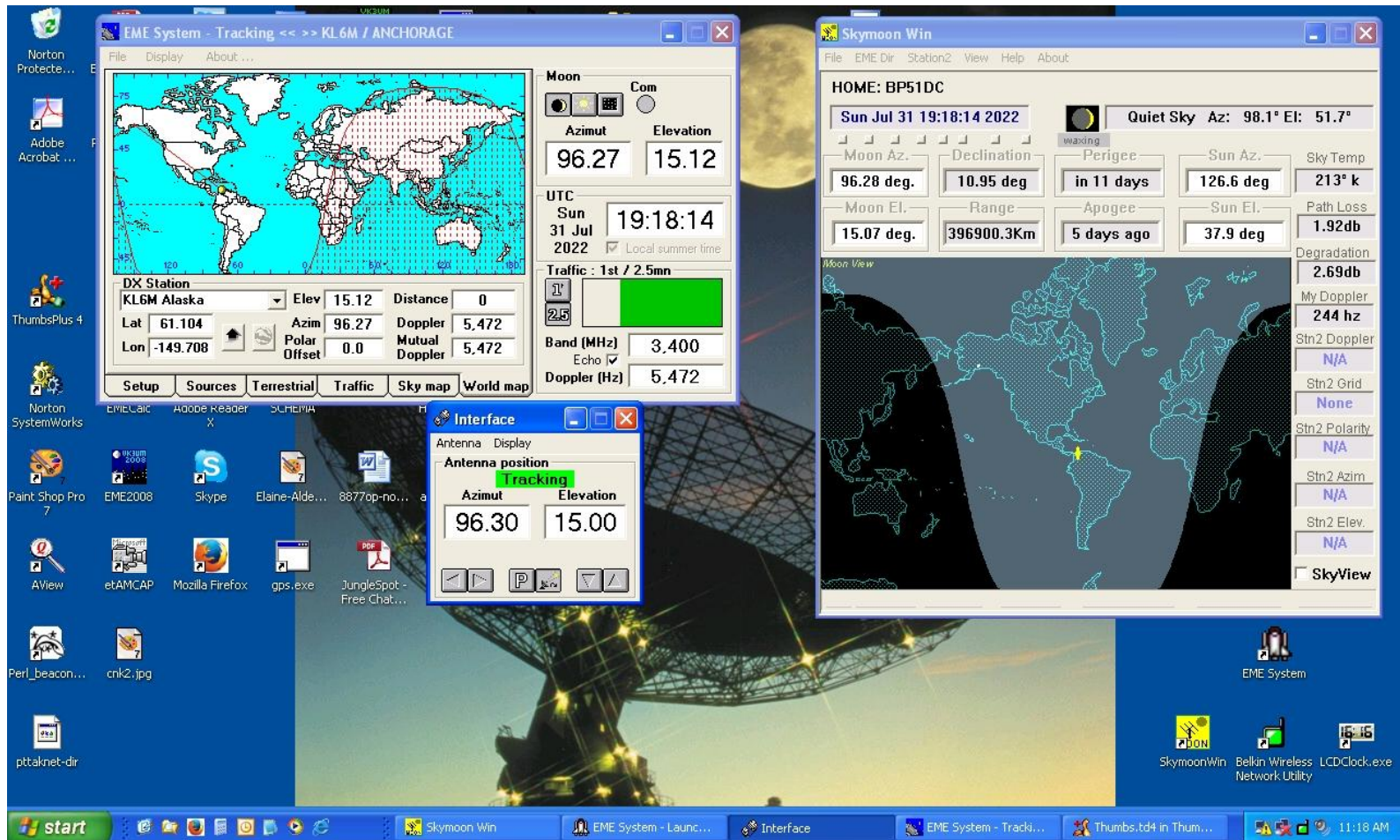
Fabrication Bench



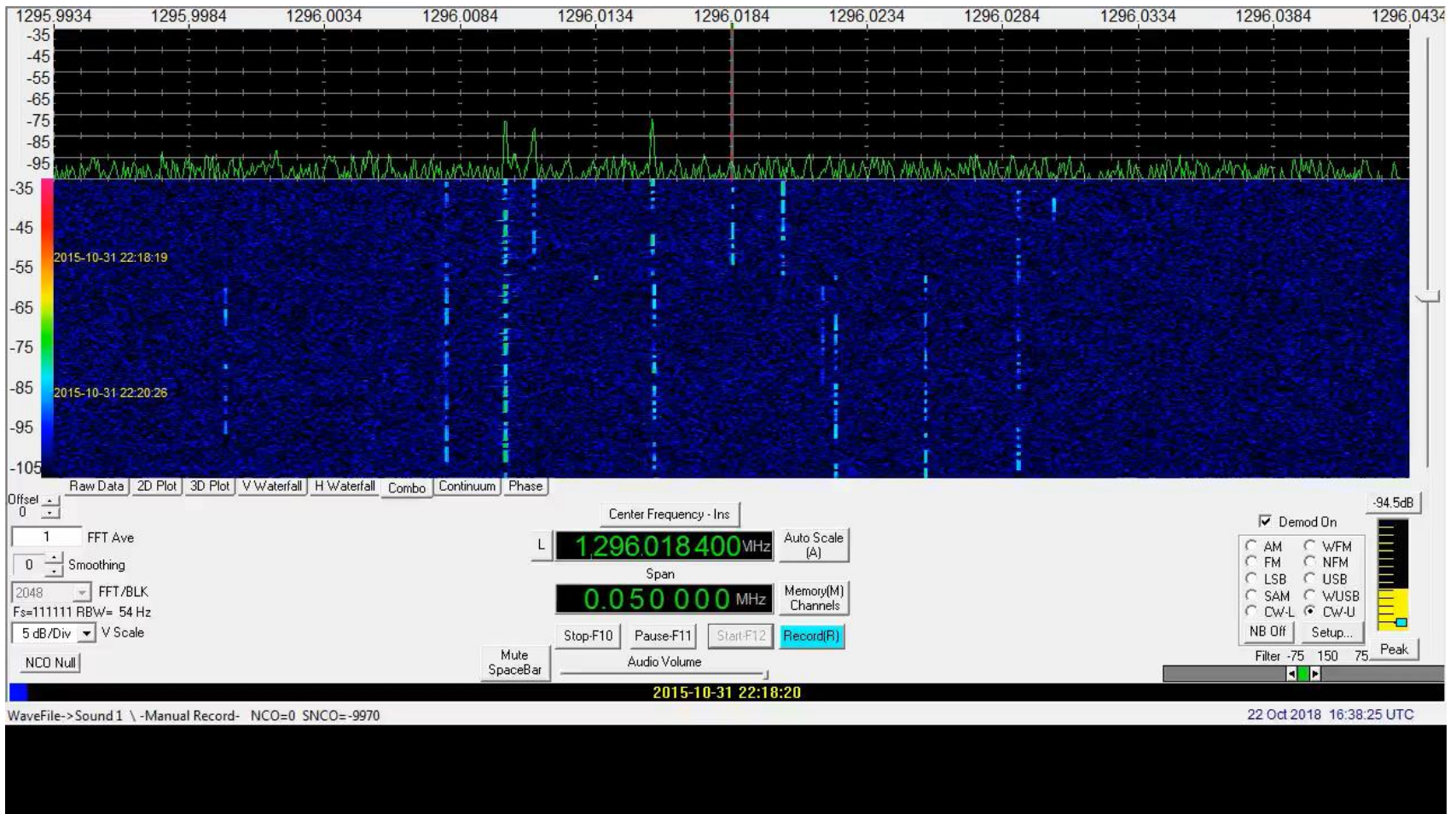
Operating Console



Antenna Control



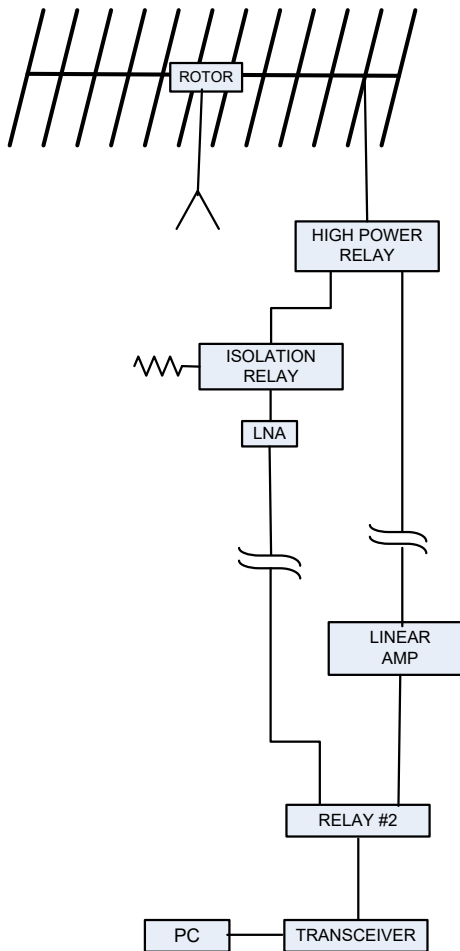
TYPICAL MOON EVENT



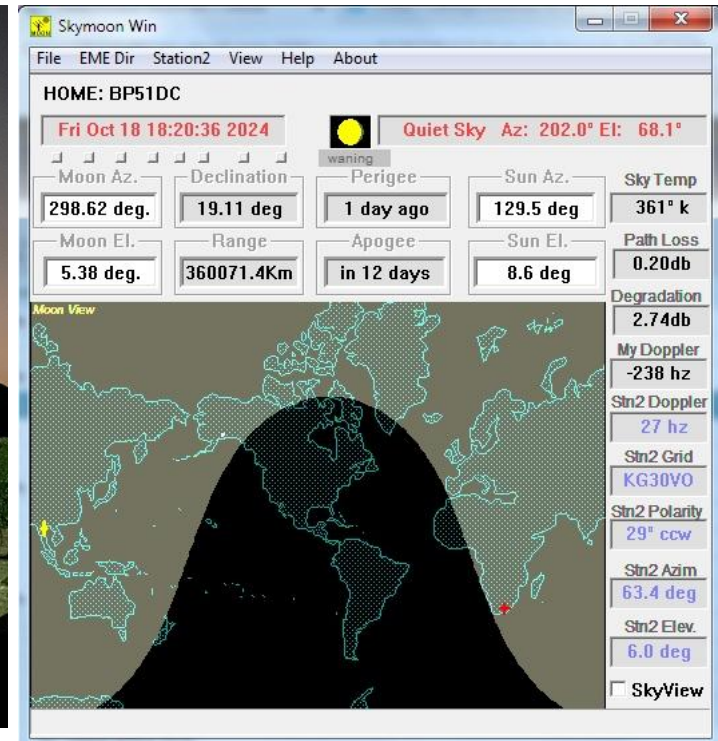
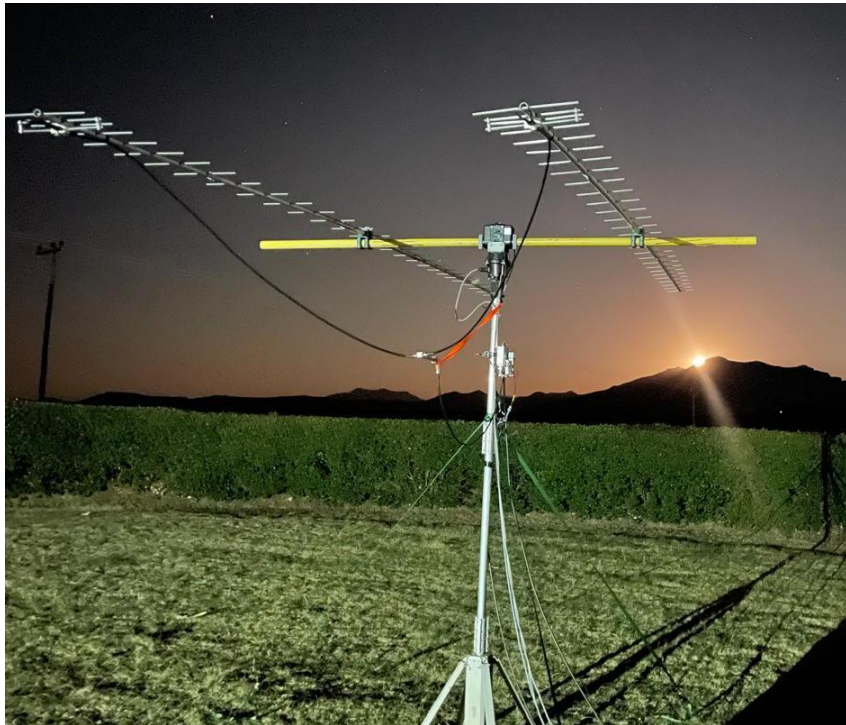
QRV EME on 9 Bands

<u>Band</u>	<u>Feed</u>	<u>Gain (dB)</u>	<u>Power Output</u>	<u>ERP</u>
144 MHz	1 wavelegth loop / Reflector	21	1500	125,000
222 MHz	1 wavelegth loop / Reflector	24	1500	250,000
432 MHz	1 wavelegth loop / Reflector	30	1500	1,200,000
902 MHz	1 wavelegth loop / Reflector	36	250	995,000
1296 MHz	CP Septum	40	500	5,000,000
2.3 GHz	CP Septum	43	200	3,990,000
3.4 GHz	CP Septum	47	100	5,000,000
5.7 GHz	CP Septum	52	40	6,340,000
10 GHz	Dual Mode Waveguide	49	30	2,300,000

Your Future EME System



Lesotho



MOON TRACKING PROGRAM