

# Basic Microwave Antennas - Utility-Driven Tradeoff Analysis



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# So, You Want to Get On the Microwave Bands?

- What Antenna?
- How do I Decide?
- Build or Buy?
- Cost?
- How Hard to Install?
- How Good?
- How Reliable?

# Assumptions

- Basic Fixed Tropo Station
- Up to 10 GHz
- Not Considered:
  - Preamps, RF Switching
  - Feedlines
  - Mounting, Rotating
  - Omnis

# Decide on a Band

- This Determines Many Tradeoff Choices
- Start Low (say 2304)
- Start Simple
- Principles:
  - KISS (simple), KICK, KIDD (doable)
  - Low Cost
  - Easy

# Basic Microwave Antenna Types

- Yagis
  - Standard Linear
  - Loop/Quad
- Parabolic Reflectors (Dishes)
- Phased Arrays
- Horns

# Basic Tradeoffs

- Antenna Type
- Gain, Beamwidth, Size
- Cost, Complexity
- Buy or Build

# Implementation Trades

- Dish Feeds (Many Choices)
- Single vs Multiple Bands
- Height vs Wind Load
- Personal Confidence

# 902, 1296 Bands

- Dominated by Loop Yagis
- Some Dishes (but need to be large)
- Similar to Other UHF Systems



# 2304, 3456 Bands

- Both Dishes and Yagis
- Directive System Kits
- WiFi Dishes can be cheaper
- Coax Feedlines

# 5, 10 GHz Bands

- Mostly Dishes
- Horns for Portability (and Feeds)
- Some WiFi Antennas on 5 GHz (not 10)
- More Antenna Gain Mitigates Low Power
- Smaller Beamwidths Require Good Pointing Accuracy
- Potential dB Losses Increased (Gotchas)

# Loop Yagis

- Originally the Loop-Quad Design
- By G3VJL in 1974
- Now Optimized Designs
- Low Wind Loading
- Easy Mounting, Feeding
- Higher Cost
- Kits Avail from Directive Systems

# 21 Element Loop Yagi Example



Frequency range: 2.25 to 2.35 GHz

Gain: 17.5 dBi

Number of elements: 21

3 dB Beamwidth: 24°

Boom length: 36 inches

Boom diameter: 0.5 inches

F/B ratio: >20 dB

Maximum Power: 400 W average

Weight: (assembled) 2 pounds assembled

# Loop Yagi Cost/Perf Comparison (Directive Systems)

## 13cm (2300 – 2350 MHz)

Click on any **bold model number** below to view or download a PDF manual.

Search:

Model	Elements	Boom Length (IN)	GHz Range	Gain (dBI)	Mount Position	Polariz.	Description	Price
<b>DSE1321LYRMK</b>	21	36	2.25-2.35	17	Rear	Horizontal	Loop Yagi kit	93.95
<b>DSE1321LYRM</b>	21	36	2.25-2.35	17	Rear	Horizontal	Loop Yagi assembled	114.95
<b>DSE1327LYRMK</b>	27	48	2.3-2.4	18	Rear	Horizontal	Loop Yagi kit	98.95
<b>DSE1327LYRM</b>	27	48	2.3-2.4	18	Rear	Horizontal	Loop Yagi assembled	123.95
<b>DSE1345LYK</b>	45	80	2.25-2.35	20	Center	Horizontal	Loop Yagi kit	111.95
<b>DSE1345LY</b>	45	80	2.25-2.35	20	Center	Horizontal	Loop Yagi assembled	136.95
<b>DSE1376LYK</b>	76	144	2.28-2.36	23.4	Center	Horizontal	BLOWTORCH KIT	175.95
<b>DSE1376LY</b>	76	144	2.28-2.35	23.4	Center	Horizontal	BLOWTORCH	224.95
<b>DSE13MOD</b>	9						1345/1352LY Mod kit for pre 1995 versions - Improved performance	7.50

# Parabolic Dish Reflectors

- Types:
  - Prime Focus ( $0.3 - 0.5 f/D$ )
  - Offset Fed (TV Dish) ( $0.5 - 0.8+ f/D$ )
  - Wire Grid
  - Mesh
- Design Geometry
  - Graphic
  - F/D IMPORTANT!
  - Gain vs Diameter
  - Gain vs Frequency

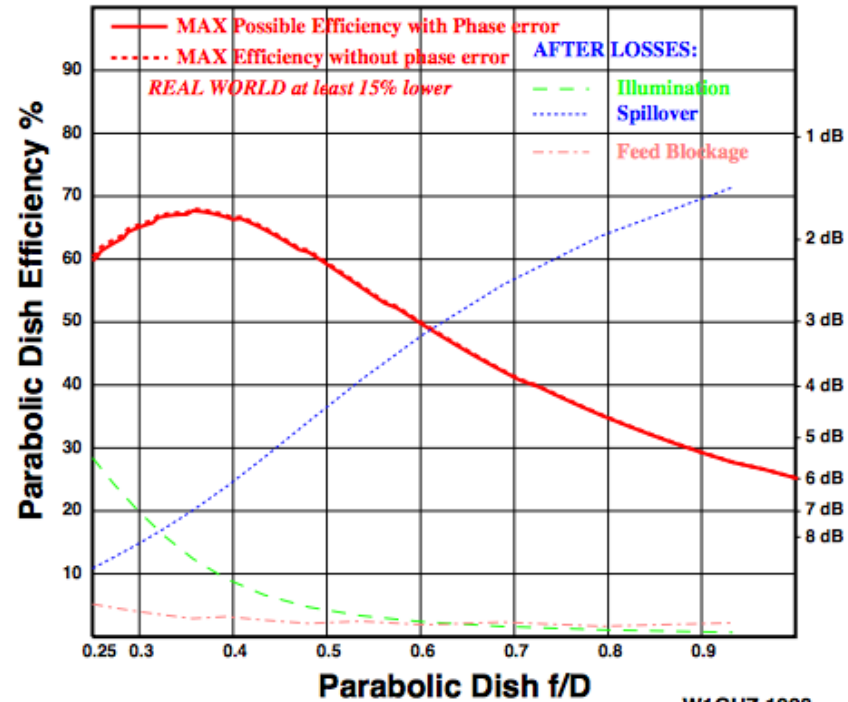
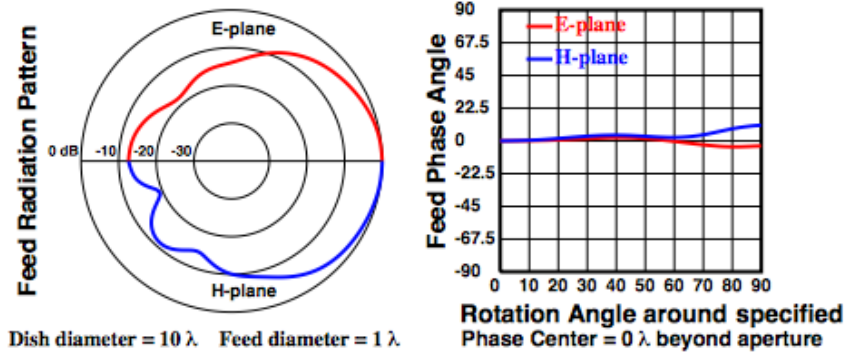
# Dish Efficiency Factors

- Illumination Loss
- Surface Error
- Phase Errors
- Spillover
- Feed Mismatch/VSWR
- Feed Blockage
- Pointing Error
- Feed Mechanical

# W1GHz Example Analysis

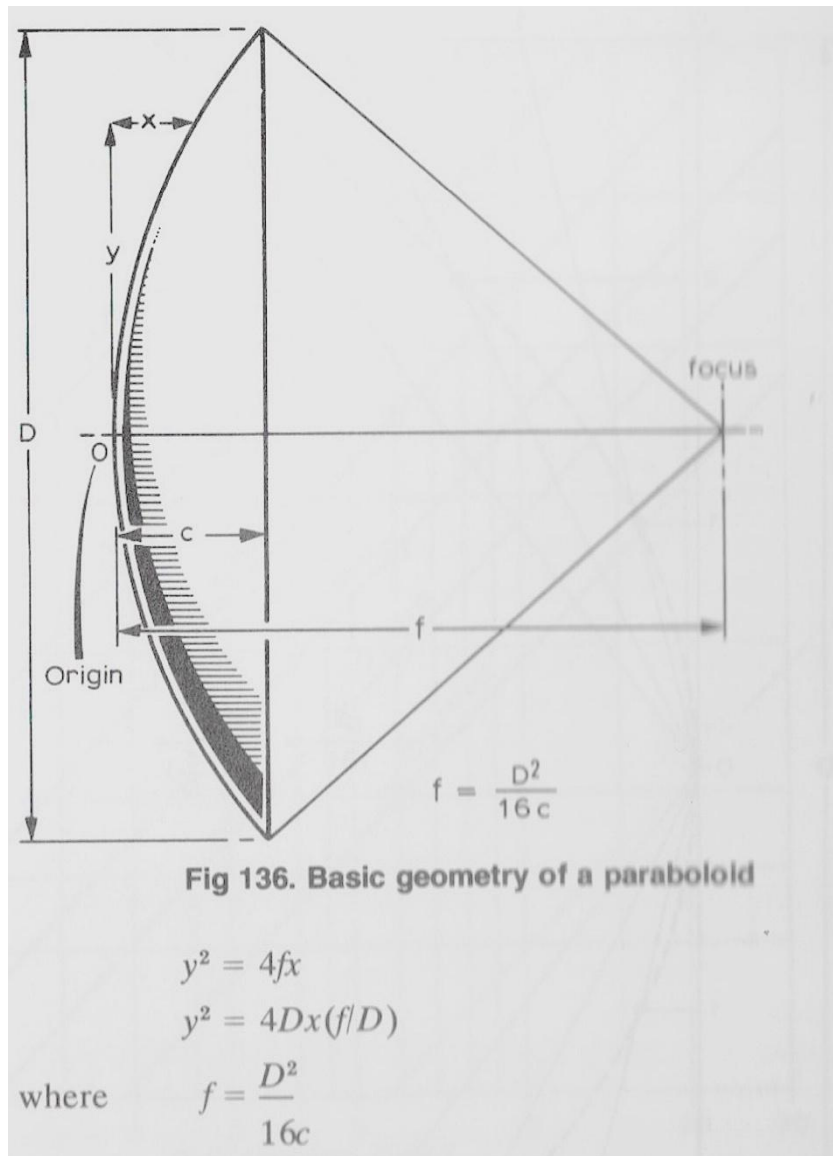
Coffee can feed,  $0.76\lambda$  diameter, by NEC2

Figure 6.3-1





# Dish Geometry



# Dish Illumination Issues

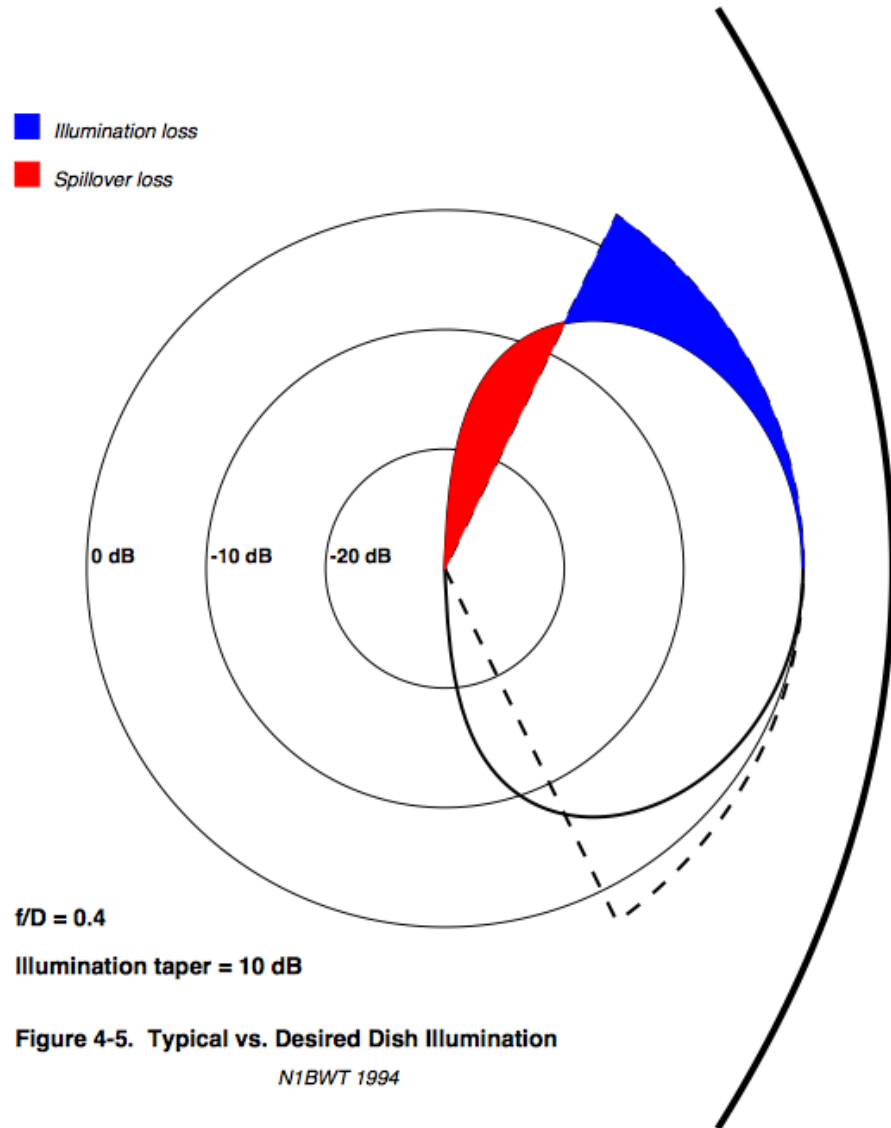


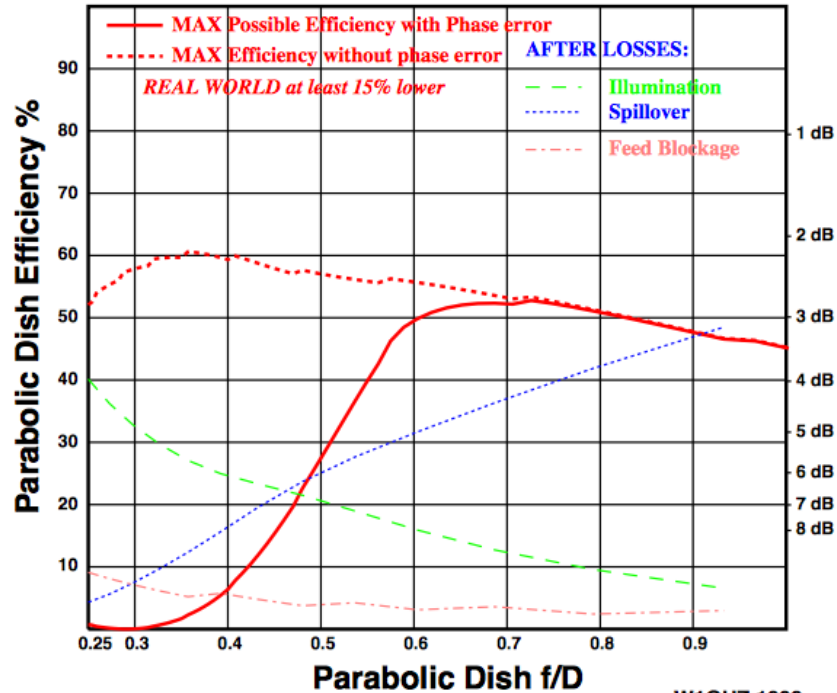
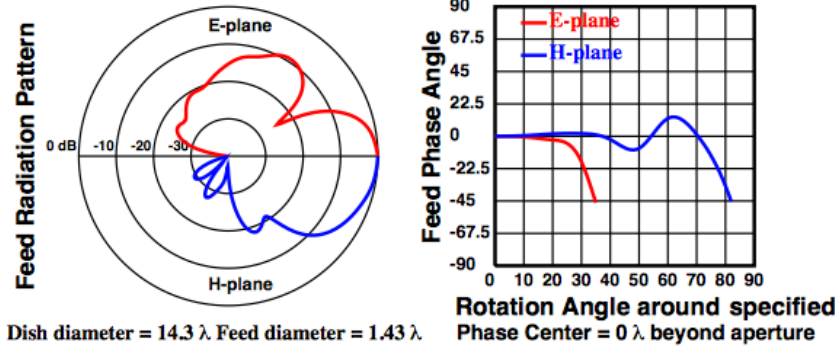
Figure 4-5. Typical vs. Desired Dish Illumination

N1BWT 1994

# Not So Good Example

W2IMU feed - bad imitation, by NEC2

Figure 6.1-5

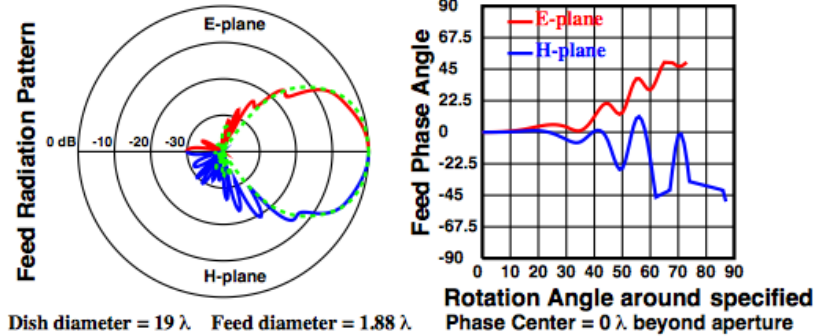


W1GHZ 1998

# Great Feed Example

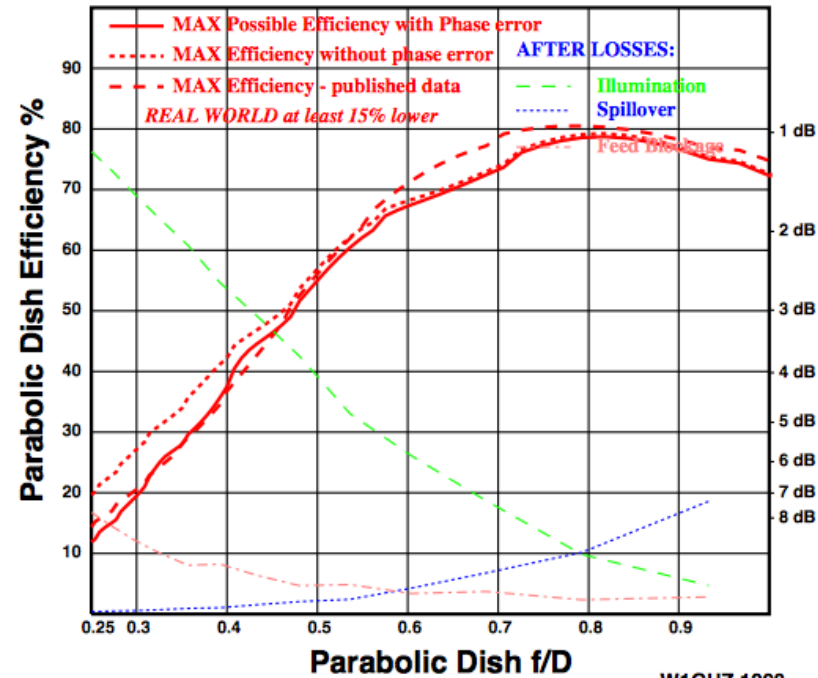
Large W2IMU dual-mode feed,  $1.88\lambda$  diameter, by NEC2

Figure 6.5-2

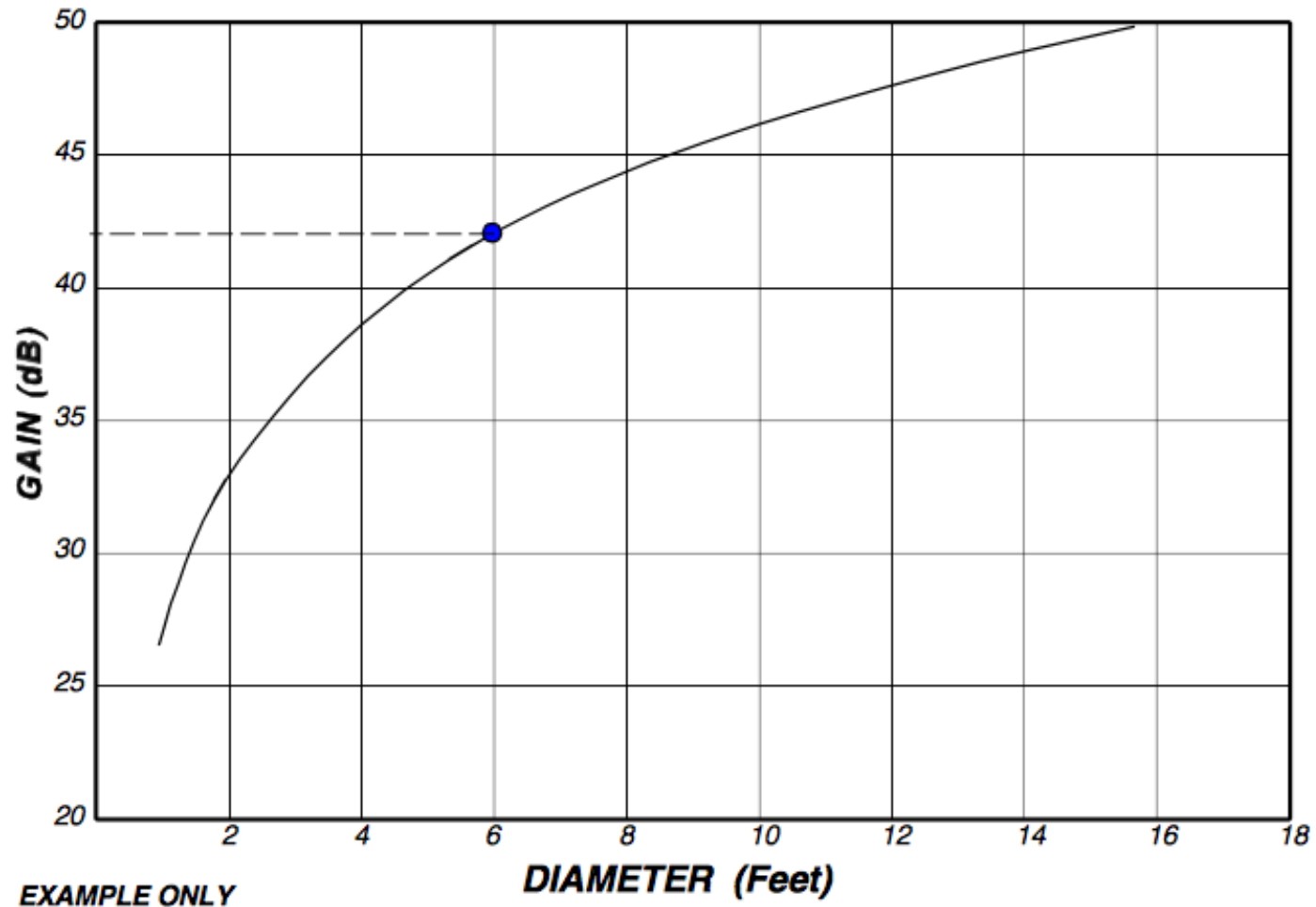


Dish diameter =  $19\lambda$  Feed diameter =  $1.88\lambda$

Rotation Angle around specified Phase Center =  $0\lambda$  beyond aperture

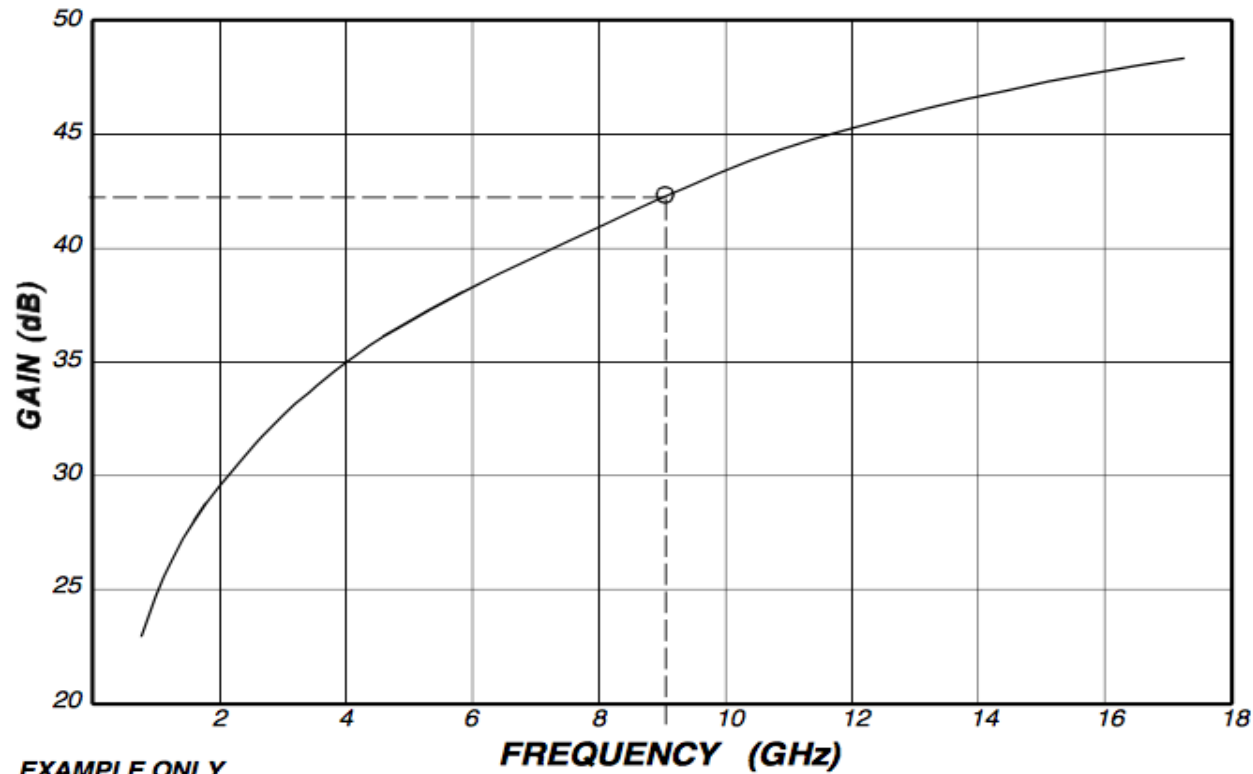


# Gain vs Diameter



**Figure 8.** Gain of a Typical Dish at 9 GHz (With Losses)

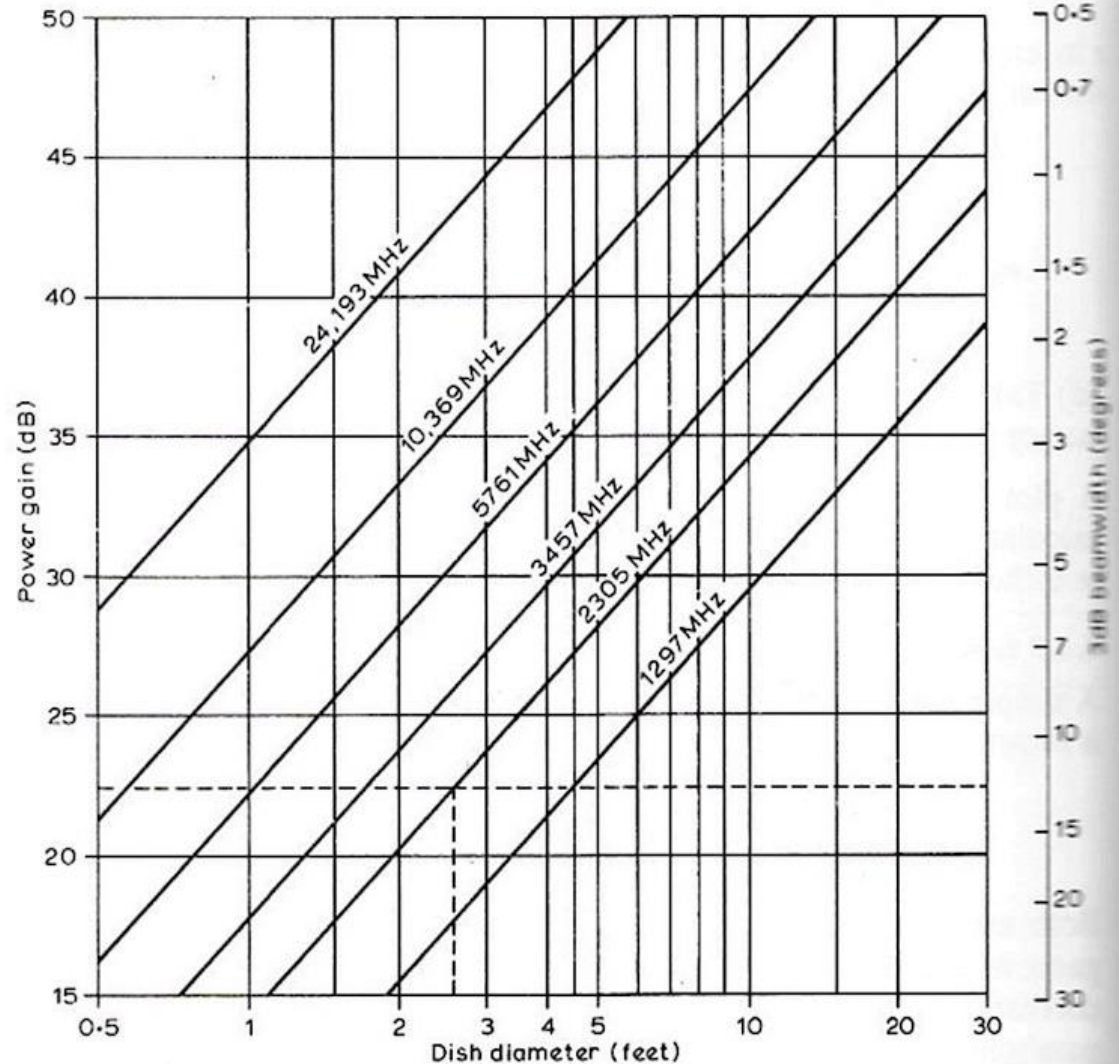
# Dish Gain vs Frequency



**Figure 7.** Gain of a Typical 6 Foot Dish Antenna (With Losses)

# Dish Design Combined

**Fig 4.24. Relationship between the size of a dish, its gain and bandwidth as a function of frequency. An overall efficiency of 50 per cent is assumed. As an example, a dish 2.5ft in diameter at 2,305MHz will have a gain of 22dB and a beamwidth of about 22°**



# Dish Recommendations, Common Usage

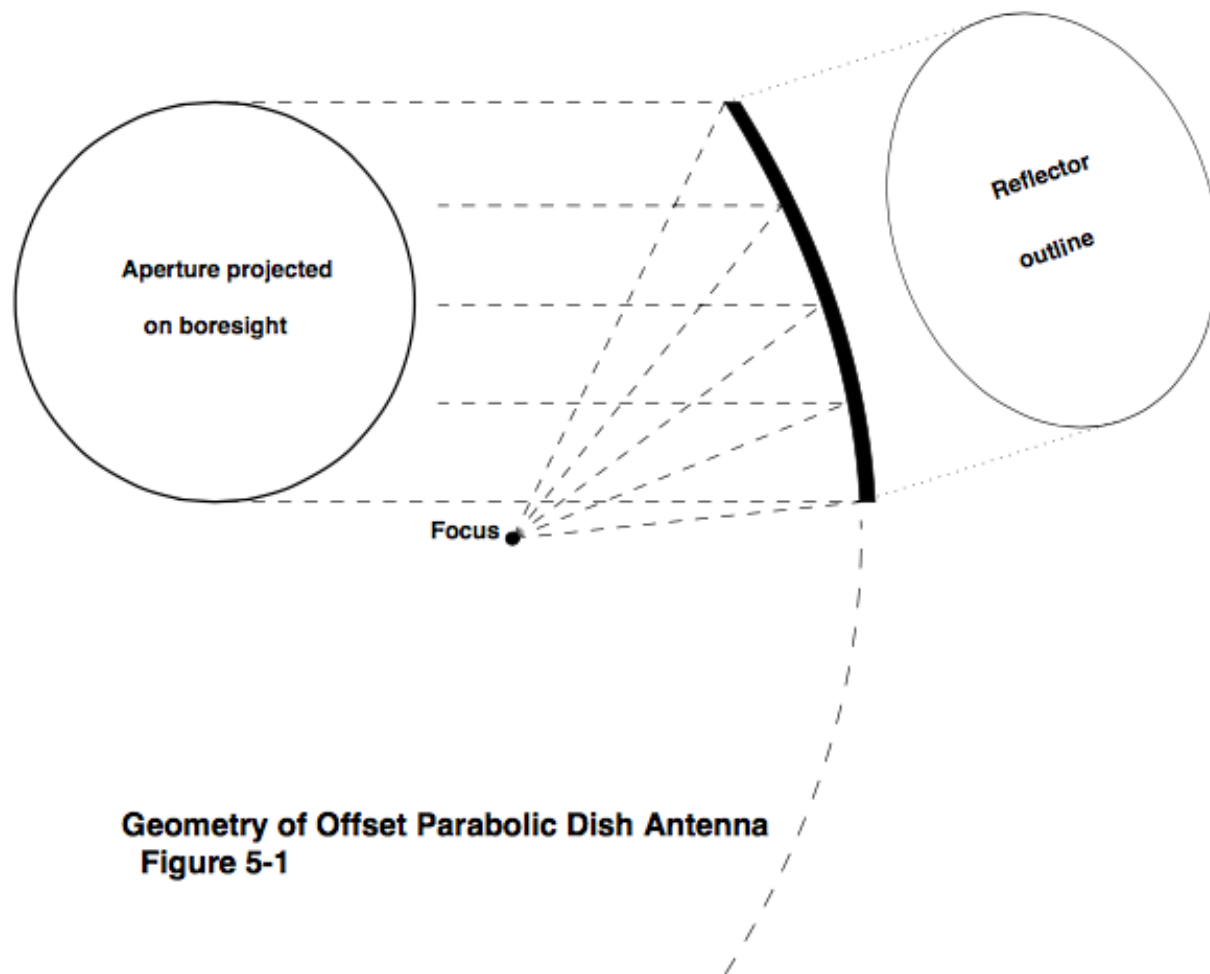
- Long Loopers for 902, 1296
  - Big Dishes have BIG Wind Loads
- Loop Yagi or 2 – 4 ft Dishes for 2304, 3456
  - Big Dish Wind Loading
  - Pointing Becoming Difficult
- 18 in to 36 in Dishes for 5.7, 10 GHz
  - Wind Loading
  - Big Dish Pointing Muy Difficile!



# Offset Fed (TV) Dishes

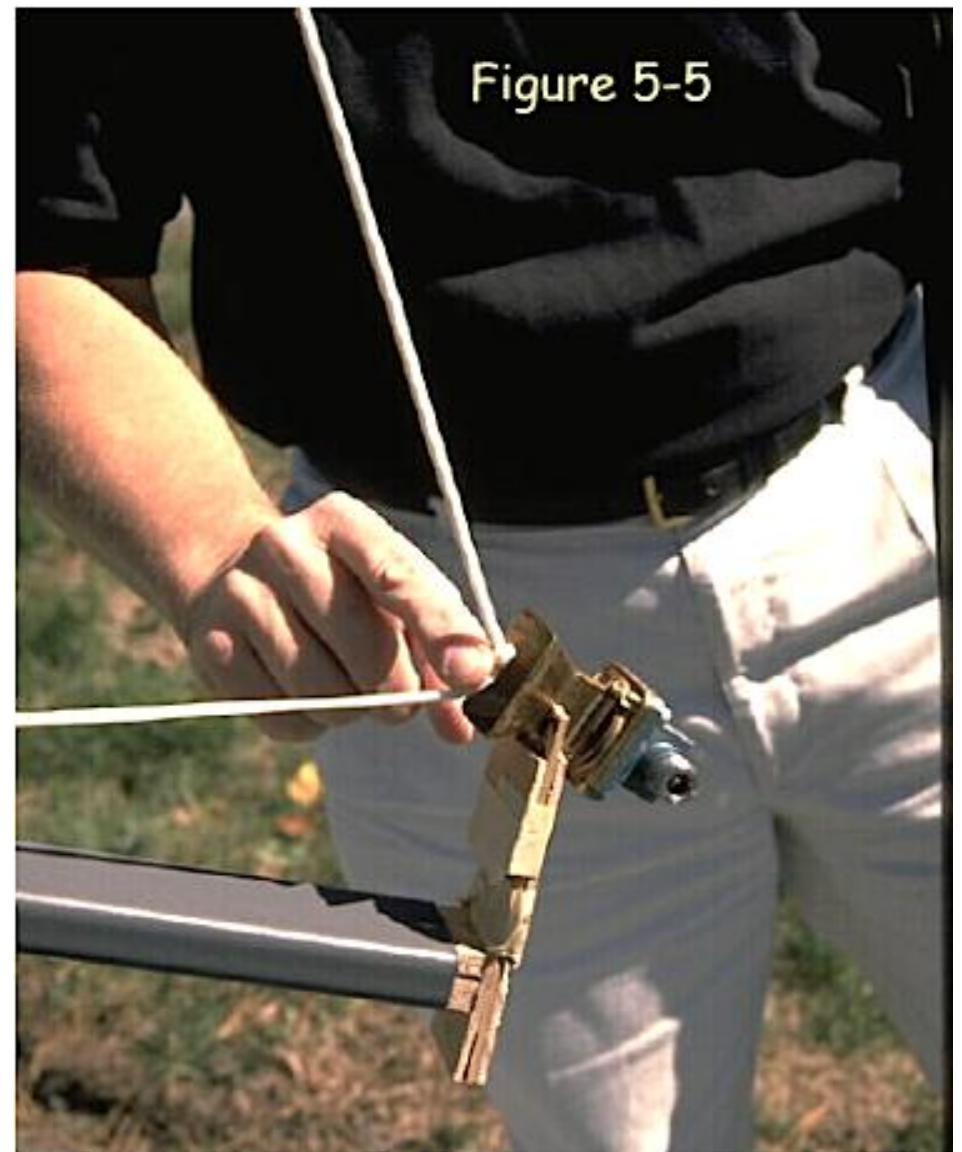
- Better Efficiency for Small Dish –
- No Feed Blockage
- Higher G/T due to Feed Position
- Typical Subtended  $f/D$  approx 0.7
- Free

# Offset Dish Geometry



Geometry of Offset Parabolic Dish Antenna  
Figure 5-1

# Find the Focal Point



# Horn Feed Template for TV Dish

Template for 11.49 dBi horn for 10368 MHz

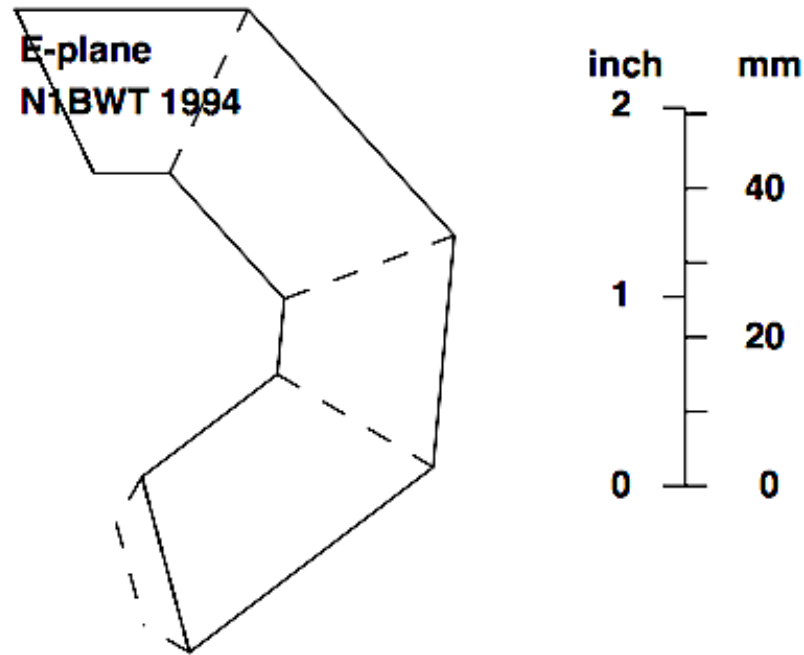


Figure 5-6. Feedhorn Template for RCA DSS Offset Dish  
(WR-90 Waveguide)

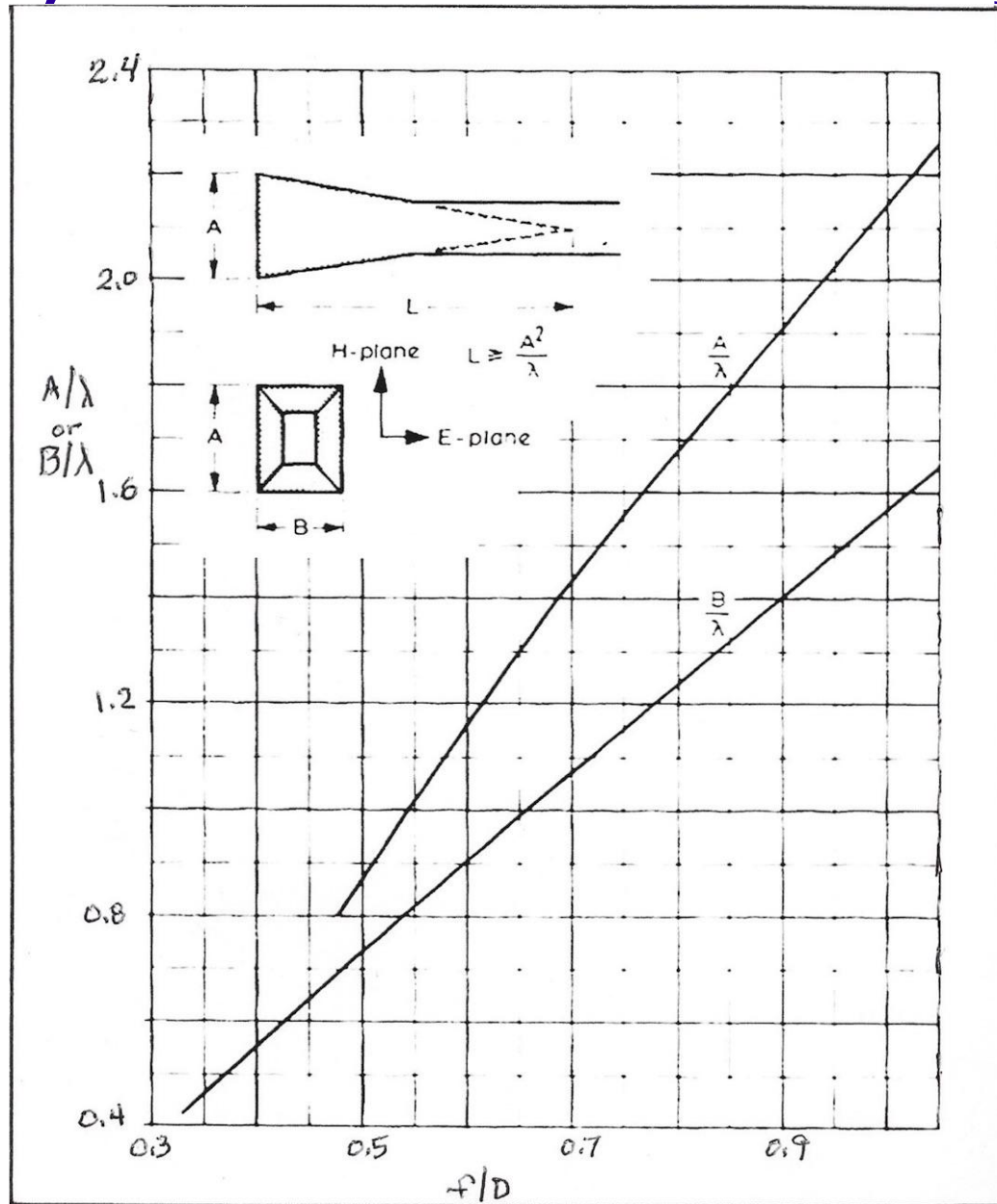
# .Dish Feeds

- Basic Types:
  - Horn
  - Dipole with Splash Reflector
  - Loop plus Splash
  - Reverse Feed (Shepherd's Crook)

# .Horn Antennas

- Often Used as Feeds (5+ GHz)
- Simple Design
- Can Be Fabricated
- Precision Gain, Pattern
- Efficient
- See W1GHz Dish Feed Pages

# Pyramidal Horn Design





# Circular Horns

- Similar Design Approaches
- Simple Horn 5 GHz
- W5LUA Dual Band 5G, 10G Feed
- Coffee Can Feeds for Lower Bands
- More Exotic Feeds for EME (CP)



# Wire Feeds



**23 & 13cm Dish feed**

# Phased Arrays

- Types
  - Log Periodic
  - Stacked Yagis
  - Slot Arrays
  - Others
- Beginners: Purchase LP from WA5VJB
- Don't Stack; Use Longer Yagi
- Slots often for Omnis

# Book References

- RSGB Microwave Handbook (Loop Yagi, Dish, Horn Design)
- ARRL Antenna Manual Ch. 18 (1296 LY)
- W1GHz Online Microwave Antenna Book  
([w1ghz.org](http://w1ghz.org))
- Antennas, J. D. Kraus
- Conference Proceedings

# Vendors

- Directive Systems
- RF Hamdesign (Holland)
- ProCom (SSB Electronic 10 GHz)
- Ebay (who knows)
- Kent Britain WA5VJB
- Various WiFi Antenna Vendors, ex:
  - L-com
  - Rowe Wireless

# Summary

- Many Antenna Choices ( What Fun! )
- Mainly Dishes vs Loop Yagis for Basic Station
- Can Be Cheap and Can Be Easy
- Fun to Tinker, Experiment –
  - Still Room for Creativity !
  - Or Climb the Highest Mountain

# Recommendations

- Try Not to Do Too Much
- Add a Band at a Time
- Then Increase Antenna Size, Complexity
- There is NO PERFECT ANTENNA !!

# More Examples

Septum Dish Feed 2304 MHz

**DUAL MODE CIRCULAR DISH FEED 1296 MHz (Septum Dish Feed)**



**Dual Mode Circular Dish Feed 2320MHz**

# Example: Wire Grid, 3456 MHz

3.5 GHz 27 dBi Lightweight Die-cast Grid Antenna - N-Female Connector



L-com Item # HG3527EG

List Price	\$103.95
<b>Your Price 1-9</b>	<b>\$103.95</b>
10-24	\$99.79
25-99	\$95.63
100 +	Call Us

Availability: **In Stock**

[Available for Same Day Shipping](#)

Quantity

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# Example: 36 inch Dish Radome

900mm Diameter Radome Cover for Parabolic Dish Antennas



Roll over image to zoom in

L-com Item # HGR-09

List Price	\$74.95
<b>Your Price 1-9</b>	<b>\$74.95</b>
10-24	\$73.45
25-99	\$71.95
100 +	Call Us

Availability: **In Stock**

[Available for Same Day Shipping](#)

Quantity

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