The building-up of new EME QTH

and

Questions about designing and installing of new parabolic dish.

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ARP 11
Usti nad Labem
1.12 2018

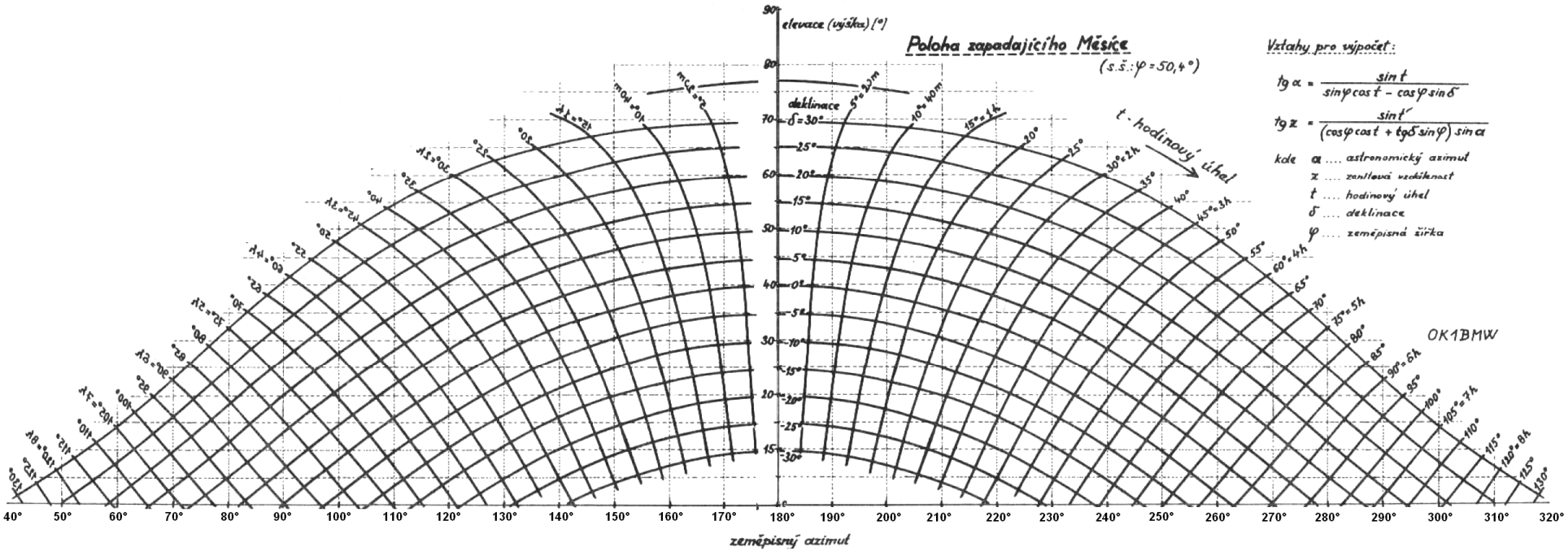
www.ok2kkw.com

Location of antenna versus Moon motion

Considering the location of dish at new EME QTH (elimination of natural obstacles such as trees, bush?) for usage of free path at Moonrise and Moonset in time of high declination for possibility of QSOs >10 000km (like KH6, ZL, VK, FK8, …). The possibility of ground-gain effect on VHF.

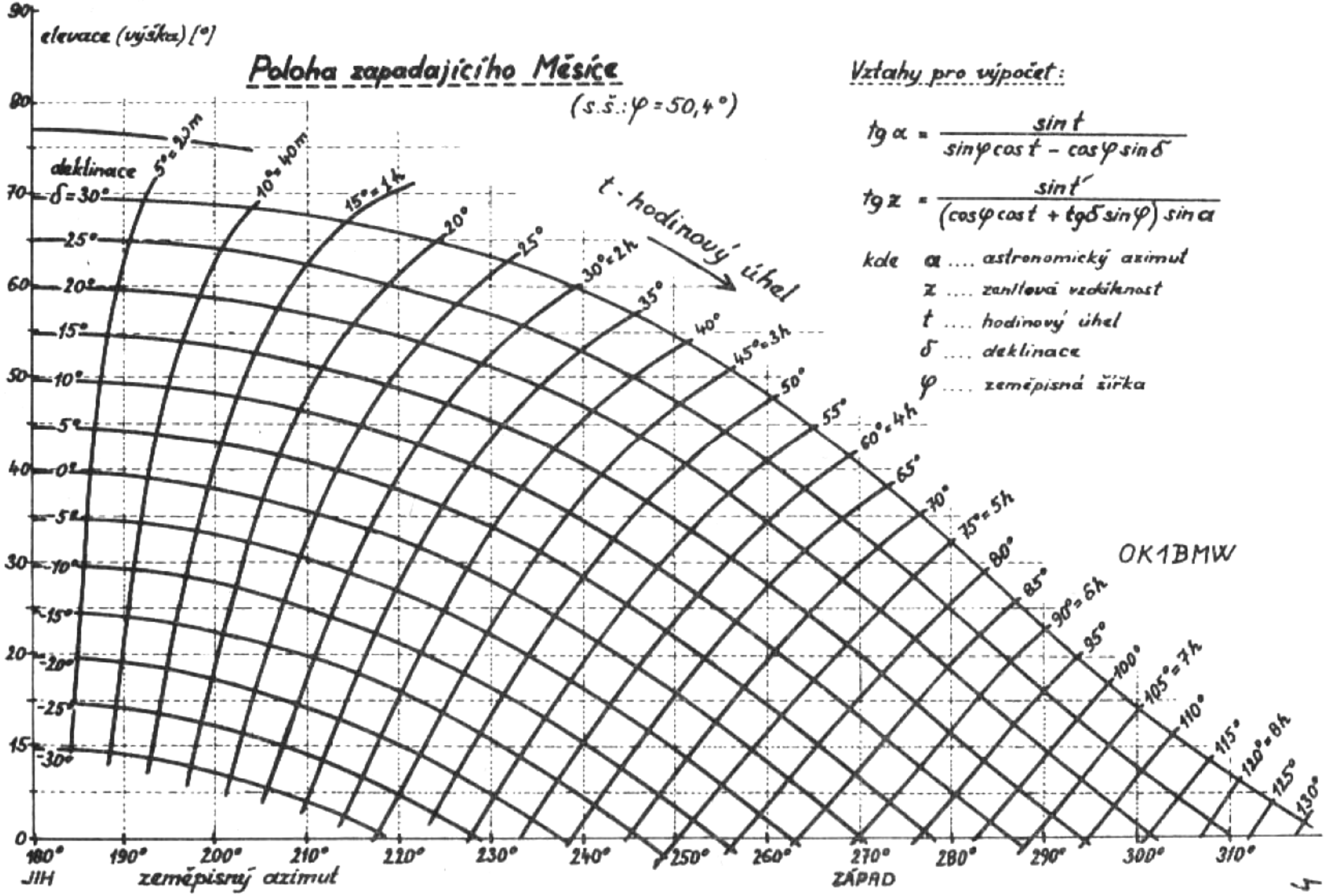
-**The Declination** (abbreviated dec; symbol δ) is one of the two angles that locate a point on the celestial sphere in the equatorial coordinate system, the other being hour angle.

-**The sidereal month** is defined as the Moon's orbital period in a non-rotating frame of reference (which on average is equal to its rotation period in the same frame). It is about 27.32166 days (27 days, 7 hours, 43 minutes, 11.6 seconds). It is closely equal to the time it takes the Moon to pass twice a "fixed" star.



In OK the Moon can't get over 67° of elevation, min. Moonrise AZ ± 40°, max. Moonset ± 320°

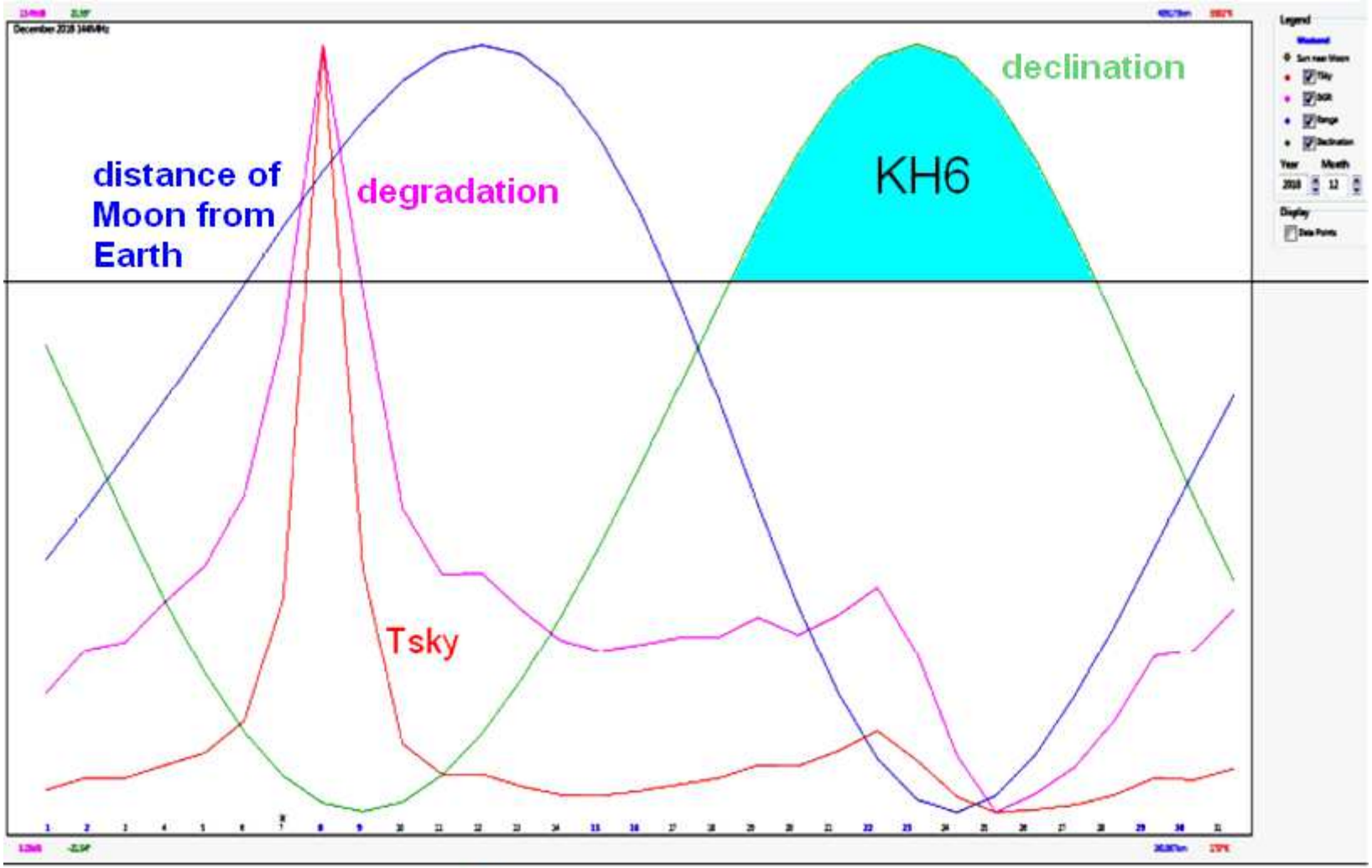
Location of antenna versus Moon motion



Source: UHF meeting 1972 OK1BMW

Location of antenna versus Moon motion

An example of the effect of declination to length of common window with KH6.



Moon Graph December 2018

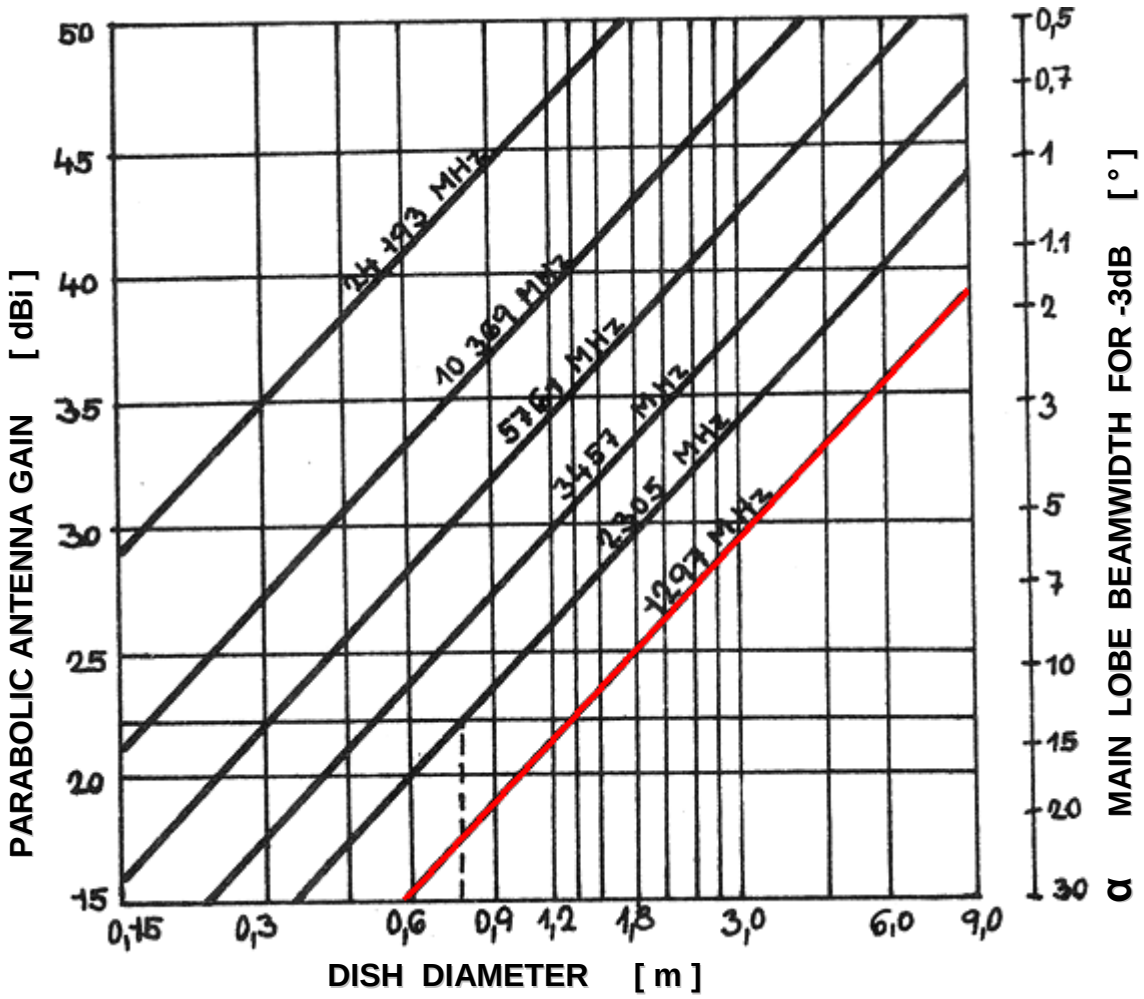
(Courtesy of David GM4JJJ (www.gm4jjj.co.uk/MoonSked/moonsked.htm)

Why use the parabolic antenna for EME at all?

Attenuation at EME path:

b = 207 + 20,5 log f [dB, MHz]

- **50 MHz -242 dB**
- **144 MHz -251 dB**
- **432 MHz -261 dB**
- **1296 MHz -271 dB**
- **2320 MHz -276 dB**
- **3400 MHz -279 dB**
- **5760 MHz -284 dB**
- **10 GHz -289 dB**
- **24 GHz -297 dB**
- **47 GHz -303 dB**



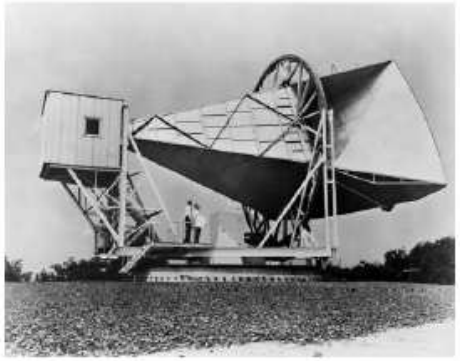
Dashes marks example for parabolic dish with ø 0,75 at 13cm band

What are the possible types of EME antennas?

Horn antennas
- Advantage: broad bandwidth, low noise
- Disadvantage: large apertures not practical (too long, problem with mount)

Purcell horn: HI (1951)

Crawford Hill horn reflector: CMB (1965)



Reflector dish antennas
- Advantage: high gain, possibility to use more feeds for more bands, large apertures are practical

Yagi antenna
- Advantage: small wind resistance, smaller but enough gain
- Disadvantage: impractical use for band above 70cm due to noise from cables, problematic polarization switching, single band ability

VLA

GBT feeds

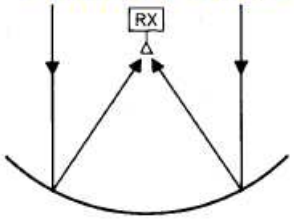
YAGI

Source of pictures:
http://ok2kkw.com/next/horn_23cm.pdf
https://science.nrao.edu/science/meetings/2014/14th-synthesis-imaging-workshop/archive/copy_of_AntennasReceivers.pdf
http://ok1teh.nagano.cz/eme_gal432.htm

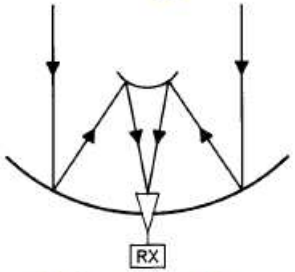
Types of reflectors

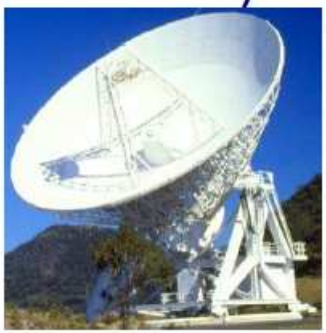
GMRT

Prime Focus



On-axis Cassegrain (best for array receivers)

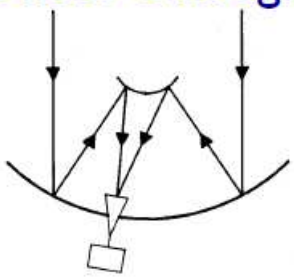




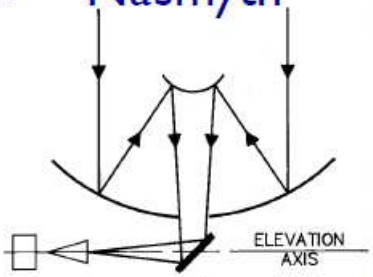
ATCA, Mopra

VLA, ALMA

Offset Cassegrain



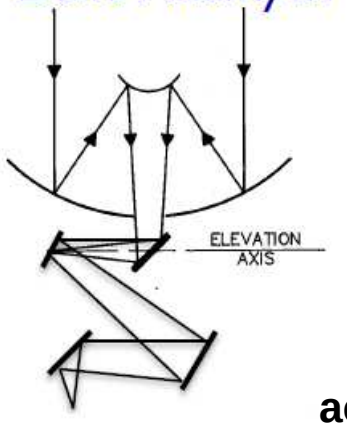
Nasmyth



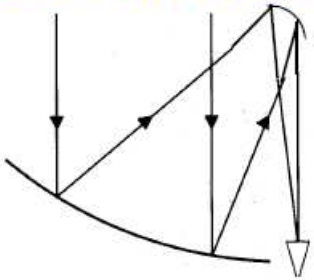
CARMA, CSO

SMA

Bent Nasmyth



Dual offset Gregorian



GBT

Cleanest beam, minimizes standing waves, access to feed, problem with ribs constructions

Source of pictures:
https://science.nrao.edu/science/meetings/2014/14th-synthesis-imaging-workshop/archive/copy_of_AntennasReceivers.pdf

offset dish – SKA project

Source of picture:
https://www.icrar.org/west-australian-innovation-could-save-ska-millions

offset dish – SKA project

Source of picture:
https://newsletter.skatelescope.org/enews-august2018-dish-report

offset dish – SETI project - ATA

Source of picture:
https://commons.wikimedia.org/wiki/File:Allen_Telescope_Array_-_Flickr_-_brewbooks_(5).jpg

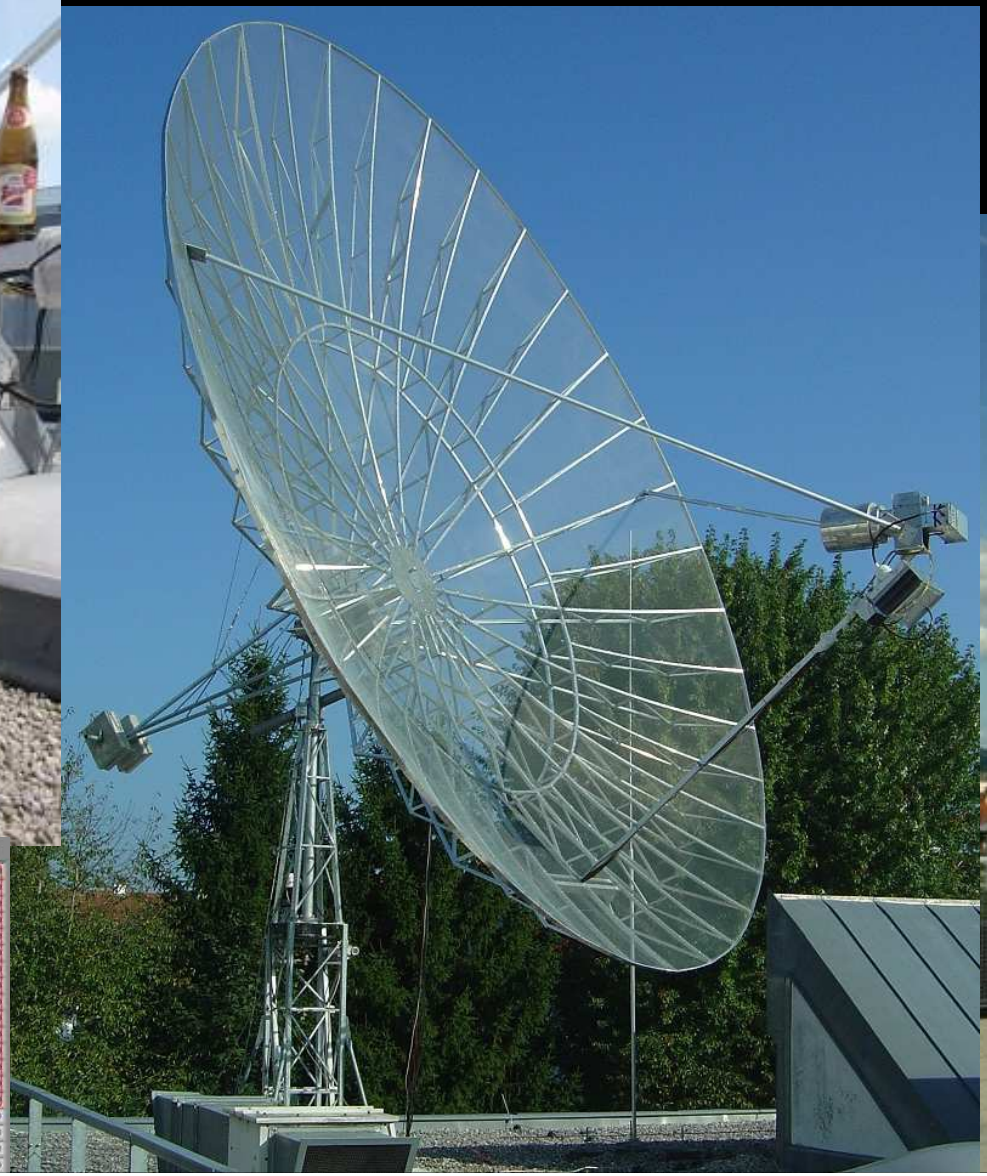
offset dish – SETI project - ATA

Source of picture:
http://inspirehep.net/record/879598/plots

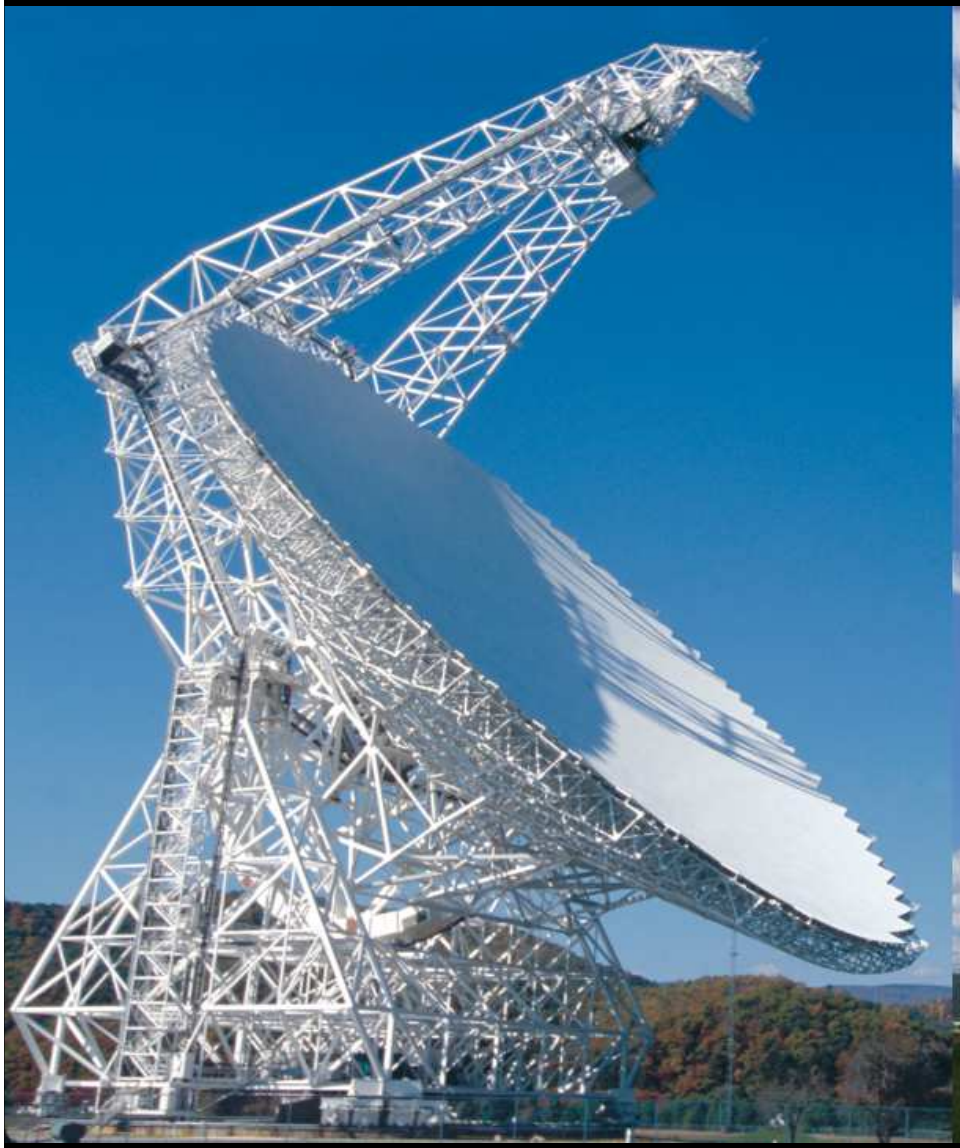
offset dish – 7,3m OE5JFL

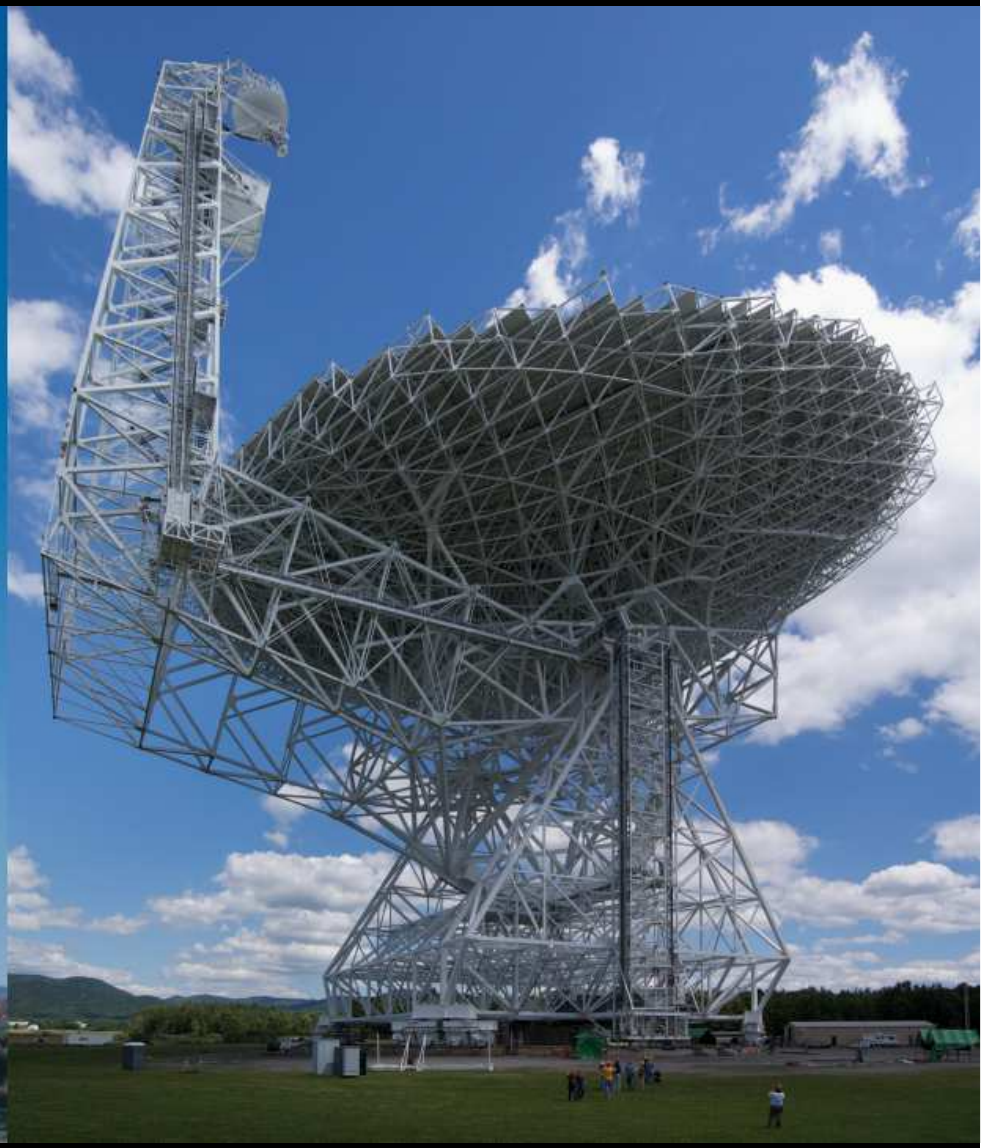
https://www.qsl.net/oe5jfl/hb_offset_jfl.pdf

0	15	30	45	60	75	90	105	120	135	150	165	180	0		
4	4	4	4	4	4	4	4	4	4	4	4	4	200		
14	14	14	15	15	16	16	16	16	15	15	15	15	400		
31	31	32	33	34	35	36	36	35	35	34	33	33	600		
54	55	56	58	60	62	63	64	63	62	61	60	60	800		
84	85	87	90	94	97	99	100	99	98	97	95	95	1000		
120	121	124	129	134	139	143	144	144	143	141	139	138	1200		
161	163	167	174	182	189	194	197	197	196	193	191	190	1400		
208	211	217	226	236	246	254	258	260	258	256	253	252	1600		
261	264	272	284	297	310	321	328	331	330	327	325	324	1800		
319	322	333	348	365	382	397	407	411	412	409	407	405	2000		
382	386	399	418	440	462	481	494	502	503	502	499	498	2200		
450	456	471	493	521	548	572	591	601	605	605	603	601	2400		
523	530	548	575	608	642	673	696	711	718	719	718	717	2600		
601	609	630	663	702	743	781	1411	1409	1415	1423	1430	1433	2800		
683	692	717	756	1471	1442	1422	2782	2750	2735	2731	2732	2733	3000		
770	780	1535	1504	2996	2907	2834	0	0	0	0	0	0	3200		
1567	1558	3180	3092	0	0	0	0	0	0	0	0	0	3400		
3266	3243	0	0	0	0	0	0	0	0	0	0	0	0		



offset dish – Green Bank (100m)





2004 of active panels – minimal preciosity **50 μm**, operating frequency **0,1 – 110 GHz**

Source of pictures:
https://commons.wikimedia.org/wiki/Category:Green_Bank_Telescope

Dual feeds at EME stations

Static feeds

VK3UM, PI9CAM (70/23cm)

Shifting feeds

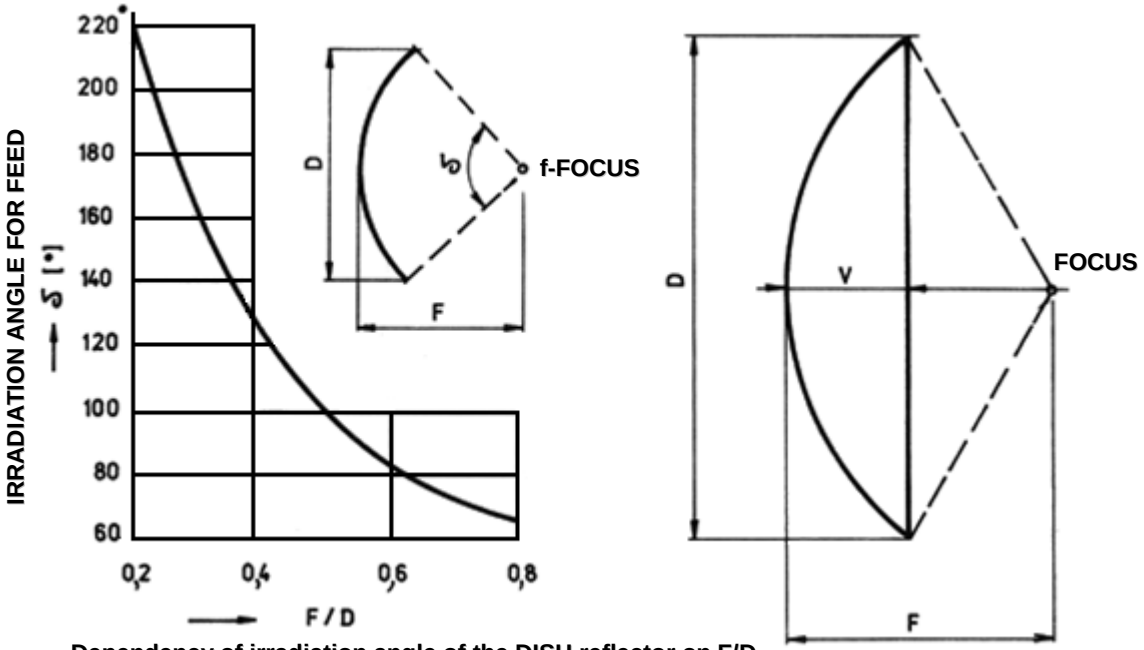
G4HUP (23/13cm)

Rotary feeds

HB0/DF1SR
(23/13cm)

Source of pictures:
http://www.vk3um.com/VK3UM%20Dual%20Feed.html
https://www.qsl.net/dl4mup/eme/emehistory.html
http://moonbouncers.org/Orebro2017/DL6SH%20EME-activity%20Liechtenstein.pdf

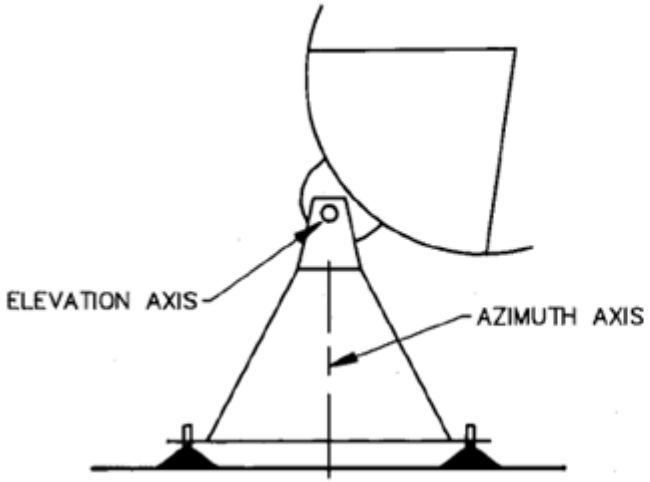
Calculations for center dish antenna



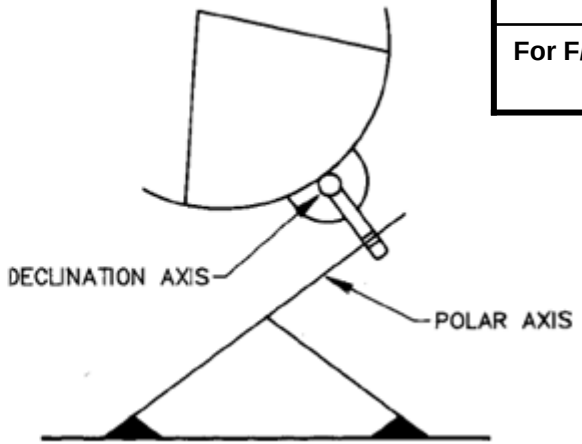
Dependency of irradiation angle of the DISH reflector on F/D

Distance of focus	$F = D^2 / 16\,v$
Main lobe bandwidth angle (-3dB)	$\alpha = 70\,(\lambda / D)$
Irradiation angle for feed	$\varphi = 2\ arctg\ (1/(4F/D))$
Dish gain [dB] G_{dBd} = Gi - 2,15	$Gi = 10 \log [\,0{,}59\,(\pi D / \lambda)2\,]$ *or* $Gi = 17{,}82 + 20\ \log\ D + 20\ \log\ f$
Surface of parabolic dish [m^2]	$S = \int_0^{2\pi} \int_0^{v} dS =$ $S = \frac{\pi r}{6v^2}\left[\left(r^2 + 4v^2\right)^{3/2} - r^3\right]$
Surface of disk	$S_O = \pi D^2 / 4$
For F/D = 0,5	$S_O \approx \pm S_{paraboloid}$

Azimuthal mount

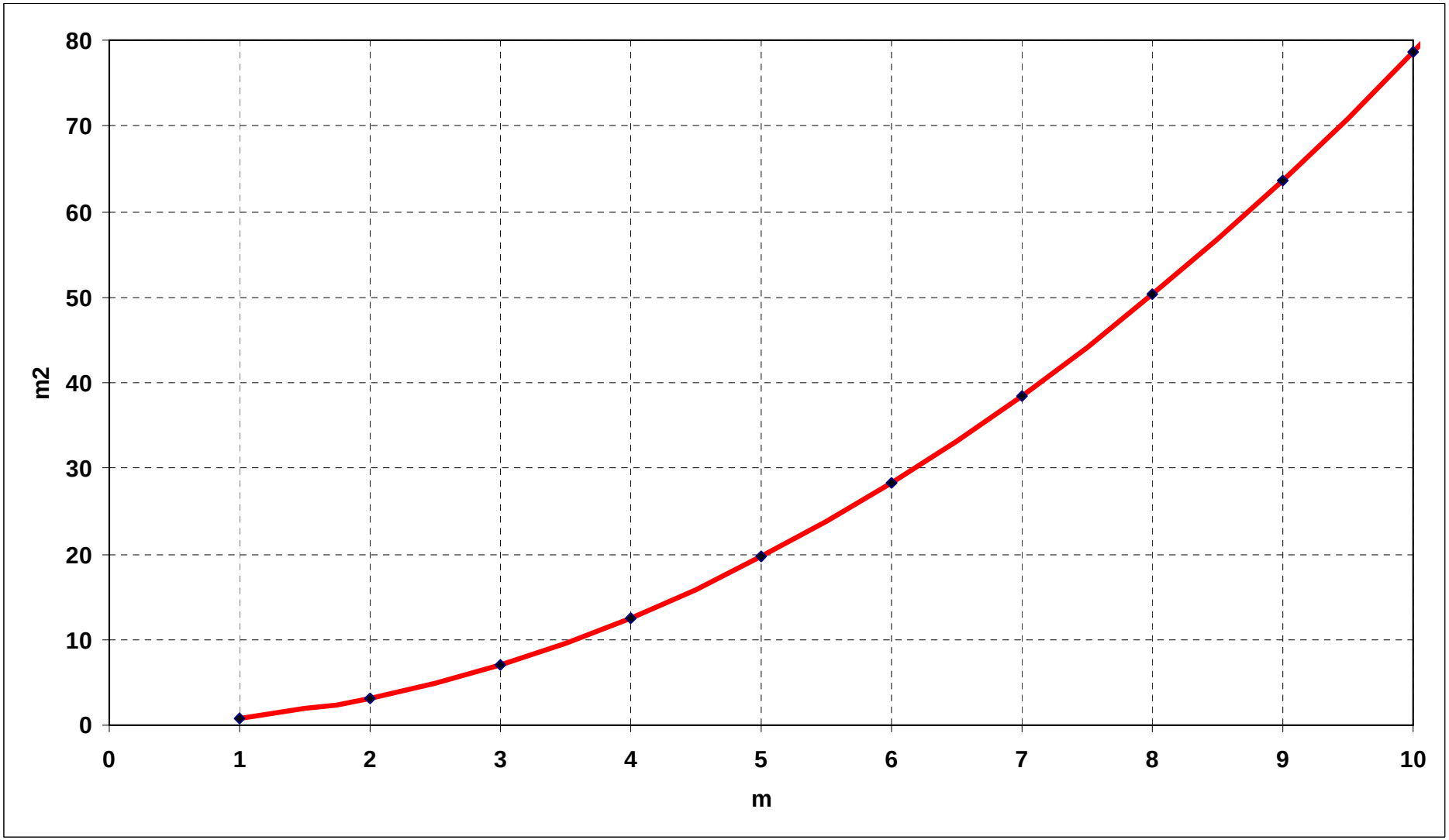


Equatorial mount

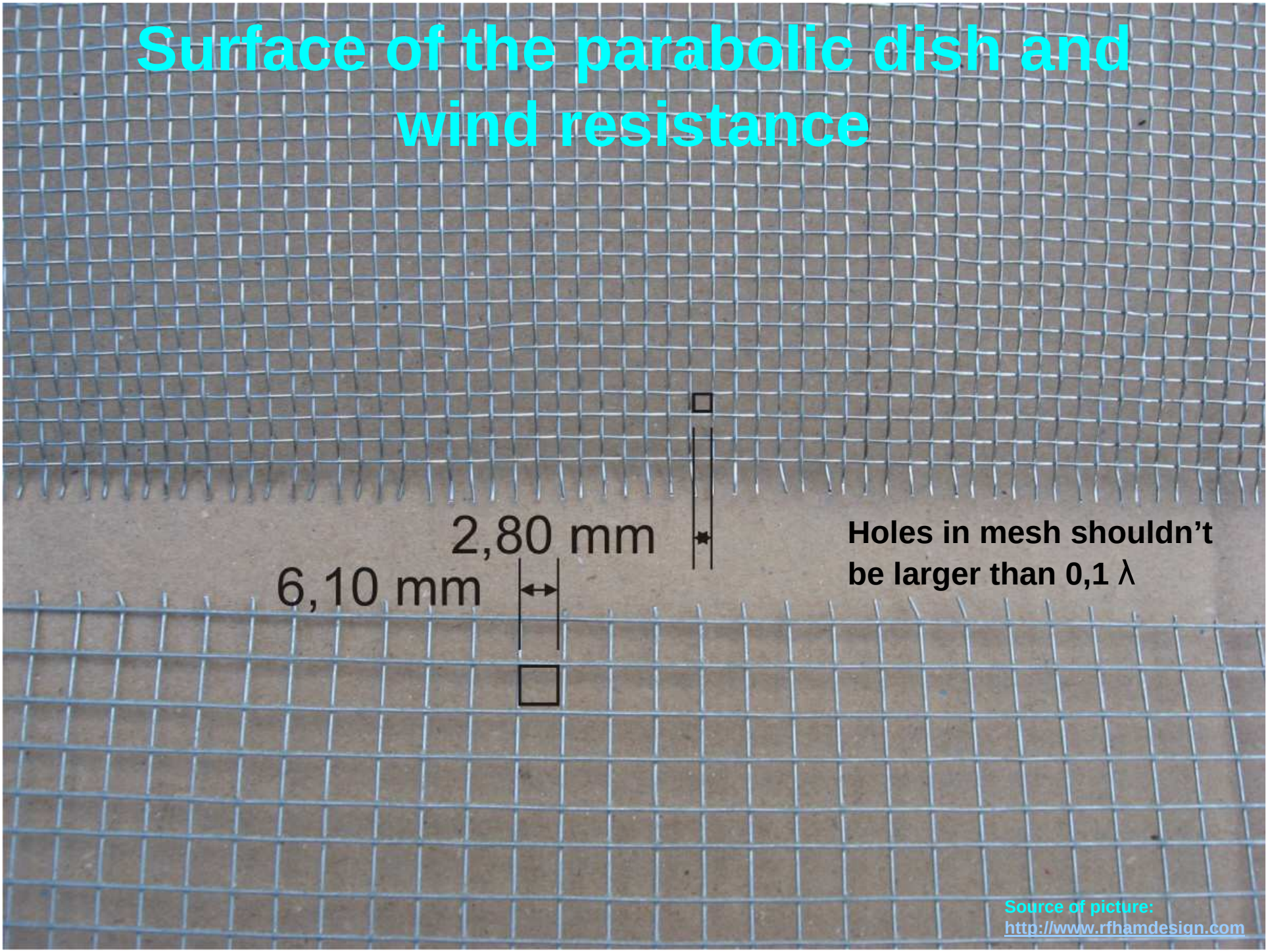


More at:
http://www.w1ghz.org/antbook/contents.htm

Surface of the parabolic dish and wind resistance



Surface of the parabolic dish and wind resistance



Holes in mesh shouldn't be larger than 0,1 λ

Source of picture:
http://www.rfhamdesign.com

Surface of the parabolic dish and wind resistance

Calculation of Wind-load

Wind force = parabolic dish surface x drag index x stagnation pressure

3m SOLID DISH

Diameter	3	m
Surface	7	m2
Surface resist the Wind 2/3	4,71238898	
Wind speed	150	km/h
Wind speed	41,67	m/s
Air density -25C at 101,325kPa	1,2922	kg/m3
The stagnation pressure	1121,70	N/m2
Drag contant	2	
Windload for solid surface	**10,6**	**kN**

$$P_{\text{stagnation}} = \frac{1}{2}\rho v^2$$

$P_{stagnation}$ = 0,5* 1,2992 * (41,67)² = **1121,7**

Total wind-load of the EME dish:

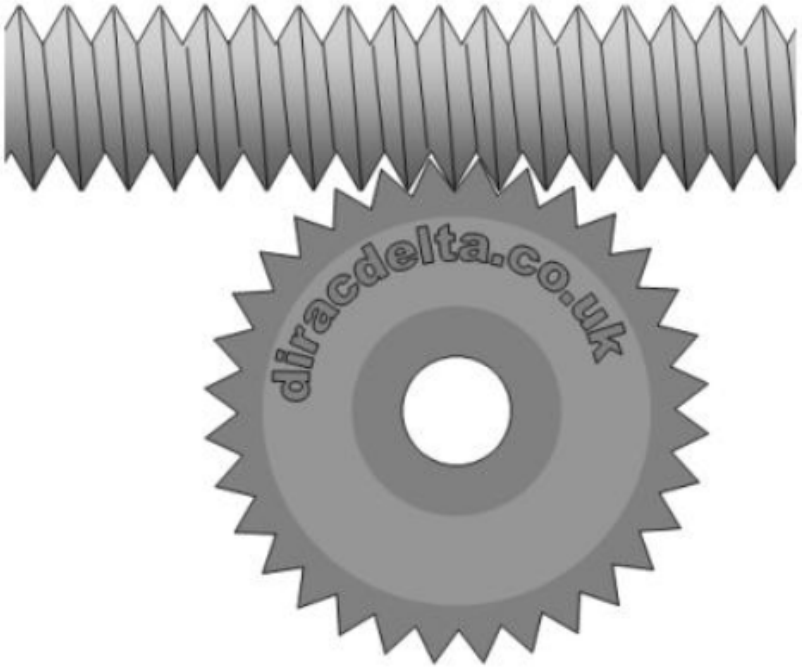
(4,71238898 * 2 * 1121,7) /1000 = **10,57 kN**

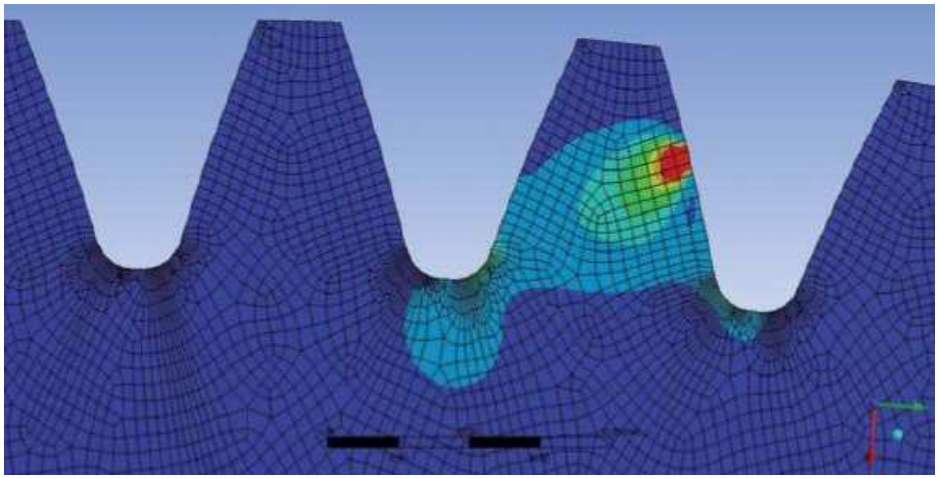
Temperature T (°C)	Density of air ρ (kg/m³)
35	1.1455
30	1.1644
25	1.1839
20	1.2041
15	1.2250
10	1.2466
5	1.2690
0	1.2922
−5	1.3163
−10	1.3413
−15	1.3673
−20	1.3943
−25	1.4224

Source:
https://en.wikipedia.org

150 km/h [D]	s m2	force [kN]
1	1	1,2
2	3	4,7
3	7	10,6
4	13	18,8
5	20	29,3
6	28	28,1
7	38	57,4
8	50	75,0
9	64	95,0
10	79	117,2
11	95	141,9
12	113	168,8
13	133	198,1
14	154	229,8
15	177	263,8
16	201	300,1
17	227	299,0
18	254	379,9
19	284	423,2
20	314	469,0
21	346	517,0
22	380	567,5
23	415	620,2
24	452	675,3
25	491	732,8
100	7853,98	11724,3

EME Gearbox – common solution



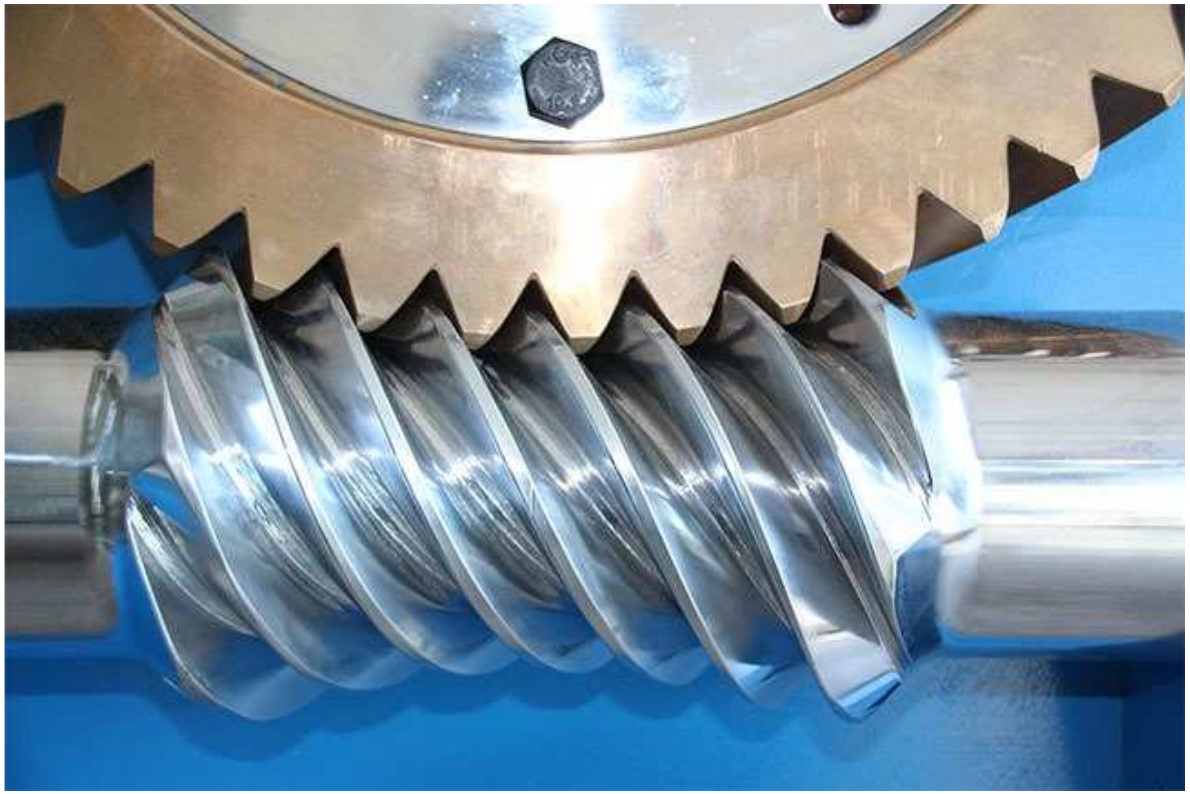


Source of pictures - DL1YMK's presentation:
http://moonbouncers.org/A%20semi%20professional.pdf

Gearbox clearance versus dish beamwidth ***α (°) = 70 (λ / D)***

dish main lobe for -3dB	432	1296	2320	3400	8400	10368	24048	47048	76000	MHz
10	**4,86**	**1,62**	**0,91**	**0,62**	**0,25**	**0,20**	**0,09**	**0,04**	**0,03**	deg
3	16,20	5,40	3,02	2,06	0,83	0,68	0,29	0,15	0,09	
2,4	**20,25**	**6,75**	**3,77**	**2,57**	**1,04**	**0,84**	**0,36**	**0,19**	**0,12**	
1,8	27,01	9,00	5,03	3,43	1,39	1,13	0,49	0,25	0,15	

EME Gearbox – Hourglass 0 backslash



Some manufacturers:

Sunslew https://www.sunslew.com

H-fang https://en.h-fang.com.cn

Source of pictures:
http://ntc8191.co.kr/products/plana-worm-reducer/
http://moonbouncers.org/onewebmedia/DL1YMK%20EME2017.ppt

DL1YMK 3m EME DISH
12” for AZ, 9” for EL

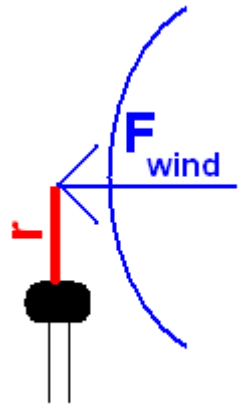
Gearbox selection – consideration of the specific Hourglass gearbox

FOR AZ	ZE12"	DL1YMK	ON7UN			
	TYPE	ZE12	WEA12-79-25H-R	PE12A	PE14A	PE17A
	WEB/COMPANY	US	DRE Engineering	HFANG	HFANG	HFANG
sila zateze	Axial load - Static:	475 kN	725 kN	475 kN	555 kN	970 kN
	Axial load - Dynamic:			114 kN	133 kN	235 kN
bocni sila	Radial load - Static:	222 kN	270 kN	190 kN	222 kN	390 kN
	Radial load - Dynamic:			100 kN	117 kN	205 kN
(moment=rameno x F)	Tilting moment torque:	55 kNm	54,3 kNm	54,3 kNm	67,8 kNm	135,6 kN,m
	Holding torque	43 kNm	43 kNm	43 kNm	48 kNm	72,3 kNm
	Output torque:	6240 Nm	9500 Nm	7500 Nm	8000 Nm	10 000 Nm
	Ration of Worm gear		79/1	78/1	85/1	102/1
	Weight:	61 kg		61	64	105
	Claimed backlash deg		0,15	0,05 - 0,07	0,05 - 0,09	0,05 - 0,09
	Real backslash					
	Motor	24VDC/150				
	Motor /	422/1				

FOR EL	ZVE9"	ZE9/ZVE9	ZE9"	PE9	PE12
	TYPE		SDLC9C-61B	PE9A	PE12A
	WEB		sunslew.com	h-fang.com.cn	h-fang.com.cn
sila zateze	Axial load - Static:		338kN	338 kN	475 kN
	Axial load - Dynamic:			81 kN	114 kN
bocni sila	Radial load - Static:		135kN	135 kN	190 kN
	Radial load - Dynamic:			71 kN	100 kN
(moment=rameno x F)	Tilting moment torque:		33,9 kNm	33,9 kNm	54,3 kNm
	Holding torque		38,7 kNm	38,7 kNm	43,0 kNm
	Output torque:	4880 Nm	6500 Nm	6500 Nm	7500 Nm
	Ration of Worm gear	78/1	61/1	61/1	78/1
	Weight:		48,7	48	61
	Claimed backlash		0,09deg	0,07 - 0,09	0,05 - 0,07
	Real backslash		0,3deg		
	Motor		24H500200		
	WEB		sunslew.com		
	Motor /				

Wind-load for 3m DISH = ~**10,6 kN**

Wind-load for 10m DISH = ~ **117,2 kN**



Torque moment = r x F

73

TNX for your attention