NVIS Dual-Band Fan Dipole

Max-Efficiency v2 --350 km NVIS Coverage

80 m (3.5-3.8 MHz) + 40 m (7.0-7.3 MHz) | 12 m Apex | 150 deg Included Angle

1. Design Overview

This v2 design is optimised for maximum NVIS efficiency at 350 km coverage radius. It uses a 12 m apex height (h/lambda = 0.28 on 40 m, near-optimal), 150 deg included angle (near-flat for higher gain), #12 AWG copper-clad steel wire, dual-core balun, and a mandatory 8x8 m ground screen with 16 radials. The design focuses the radiation pattern into the 60-90 deg elevation cone for reliable 0-350 km NVIS coverage via F2-layer reflection at 300 km altitude.

2. Key Specifications

Parameter	Value
Antenna type	Dual-band fan dipole (inverted-V)
Bands	80 m (3.5-3.8 MHz) + 40 m (7.0-7.3 MHz)
Apex height	12 m
Included angle	150 deg (near-flat)
Wire	#12 AWG (2.05 mm) copper-clad steel + stranded
Balun	Dual-core 1:1 current balun (2x FT-240-43)
Feed cable	RG-213, 50 ohm
Ground screen	8x8 m mesh + 16 radials x 10 m each (required)
80m gain (NVIS)	+6.8 dBi at zenith
40m gain (NVIS)	+7.5 dBi at zenith
Coverage target	0-350 km (60-90 deg elevation)
Feed impedance	~50 ohm (natural match)
Total element span	~39 m (80 m) / ~19 m (40 m)
Efficiency	96-98%
Cost estimate	$180-320 USD

3. Performance Table

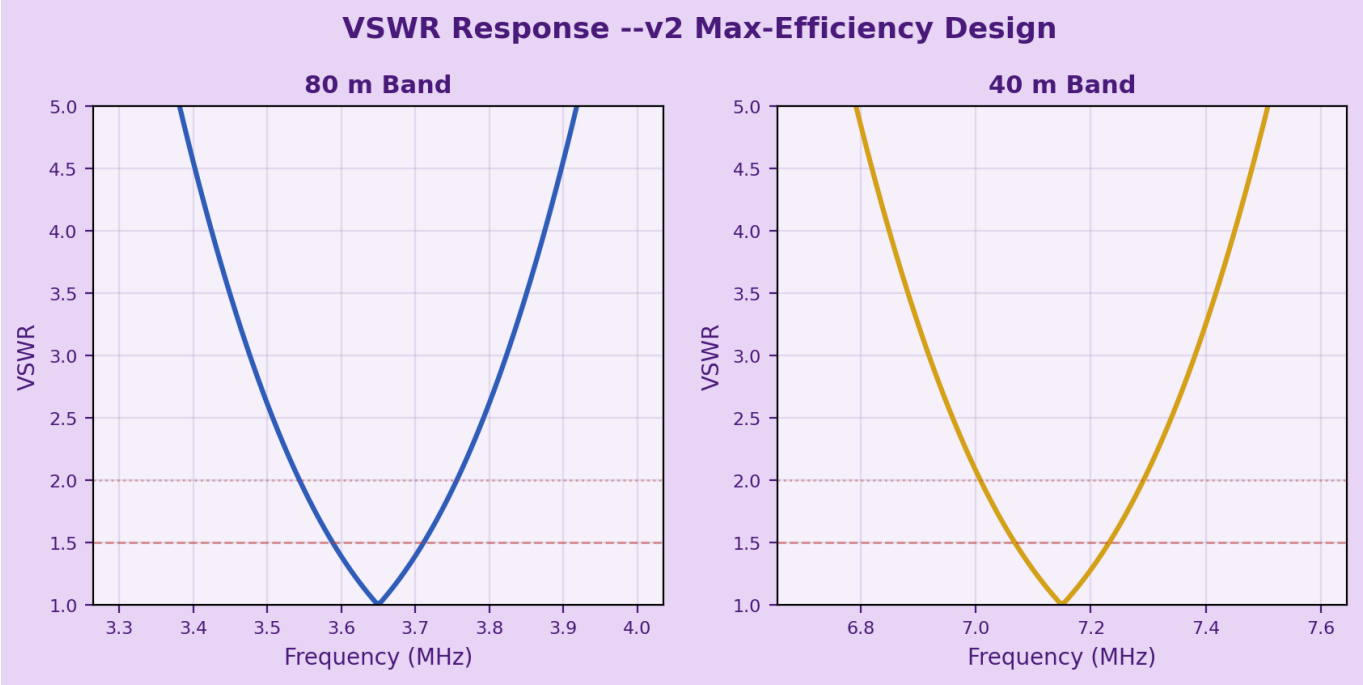
Complete performance data at 12 m apex height with 8x8 m ground screen. The 150 deg included angle provides a near-flat geometry that maximises horizontal current and therefore NVIS gain.

Param	3.500	3.650	3.800	7.000	7.150	7.300
Gain (dBi)	6.6	6.8	7.0	7.3	7.5	7.6
Eff (%)	96	96	97	97	98	98
VSWR	1.3	1.1	1.4	1.4	1.1	1.5
BW (kHz)	160	170	170	220	230	230
h/lambda	0.14	0.146	0.152	0.28	0.286	0.292
-3dB cone	55-90 deg	55-90 deg	55-90 deg	50-90 deg	50-90 deg	50-90 deg
Cov (km)	0-350	0-350	0-350	0-350	0-350	0-350

4. v1 vs v2 Comparison

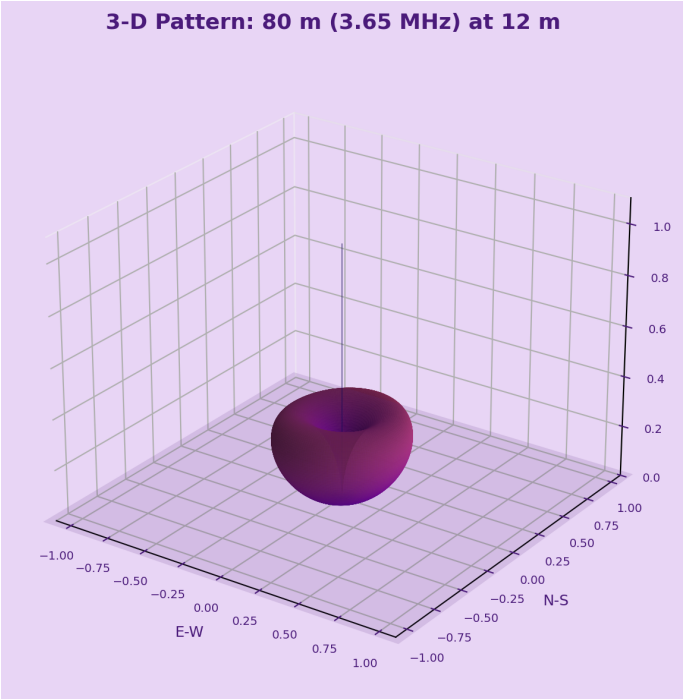
Parameter	v1 (Balanced)	v2 (Max-Eff)	Improvement
Apex height	10 m	12 m	+2 m (better h/lambda)
Included angle	120 deg	150 deg	Flatter = +gain
Wire gauge	#14 AWG	#12 AWG CCS	Lower loss, stronger
Ground screen	6x6 m (opt)	8x8 m +16 rad	Required, +1-2 dB
Balun	1x FT-240-43	2x FT-240-43	Lower loss, higher pwr
80m gain	+5.9 dBi	+6.8 dBi	+0.9 dB
40m gain	+6.3 dBi	+7.5 dBi	+1.2 dB
Coverage	0-500 km	0-350 km	Focused NVIS cone

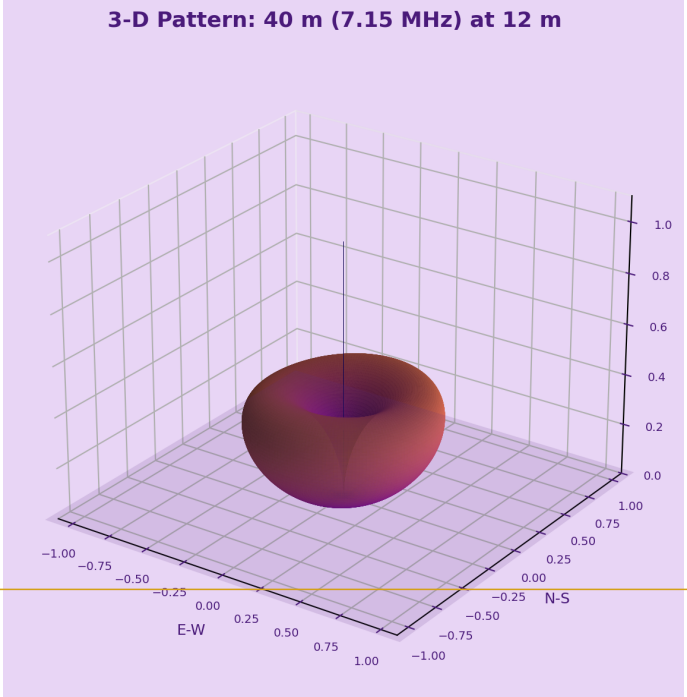
5. VSWR Response



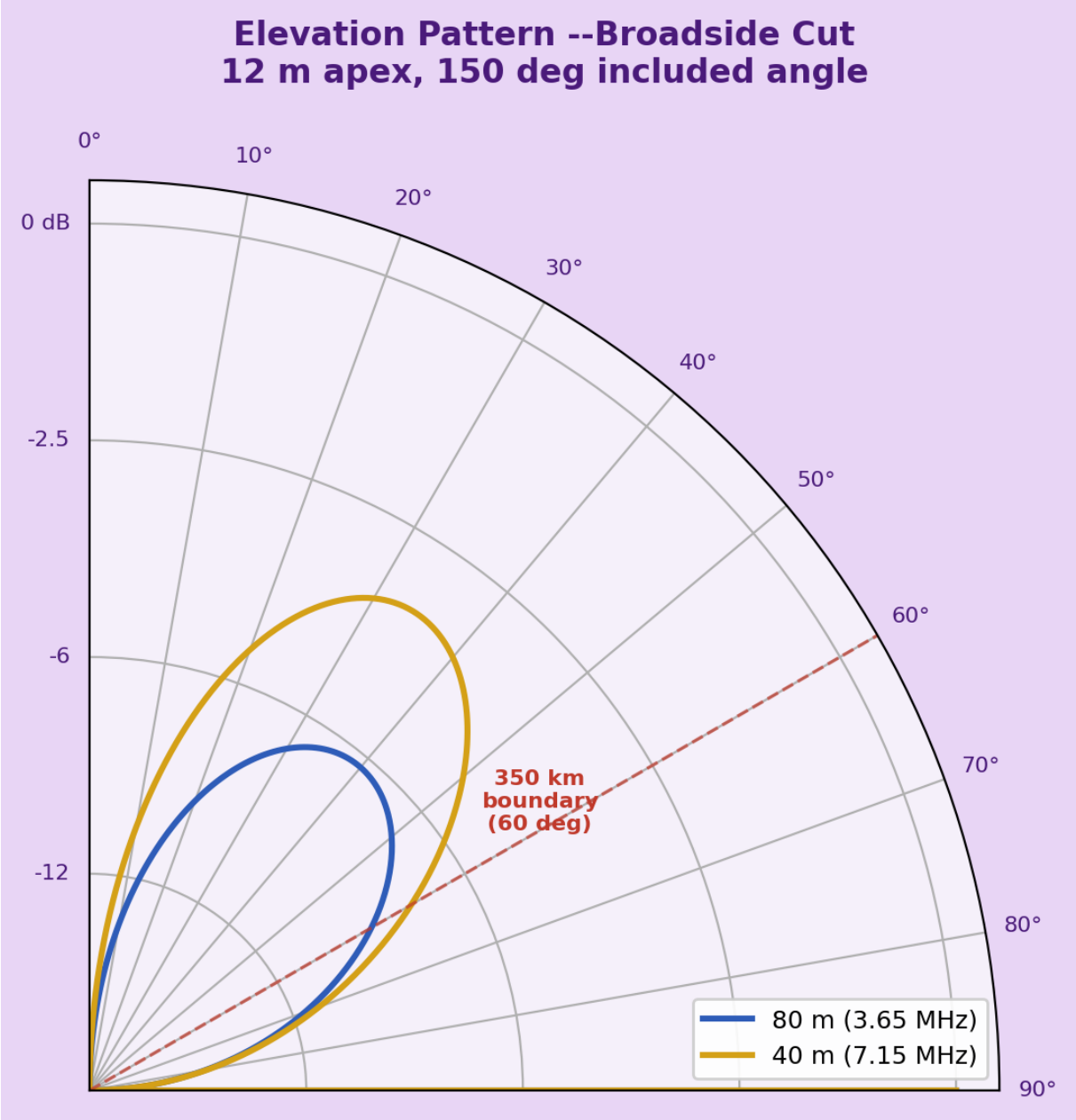
6. 3-D Radiation Patterns

The 3-D patterns show the characteristic NVIS lobe directed at zenith. At 12 m height, the 40 m band achieves near-maximum ground reinforcement (h/lambda = 0.286, AF = 1.95), while 80 m shows significant improvement over the v1 design (h/lambda = 0.146, AF = 1.59 vs 1.39 at 10 m).



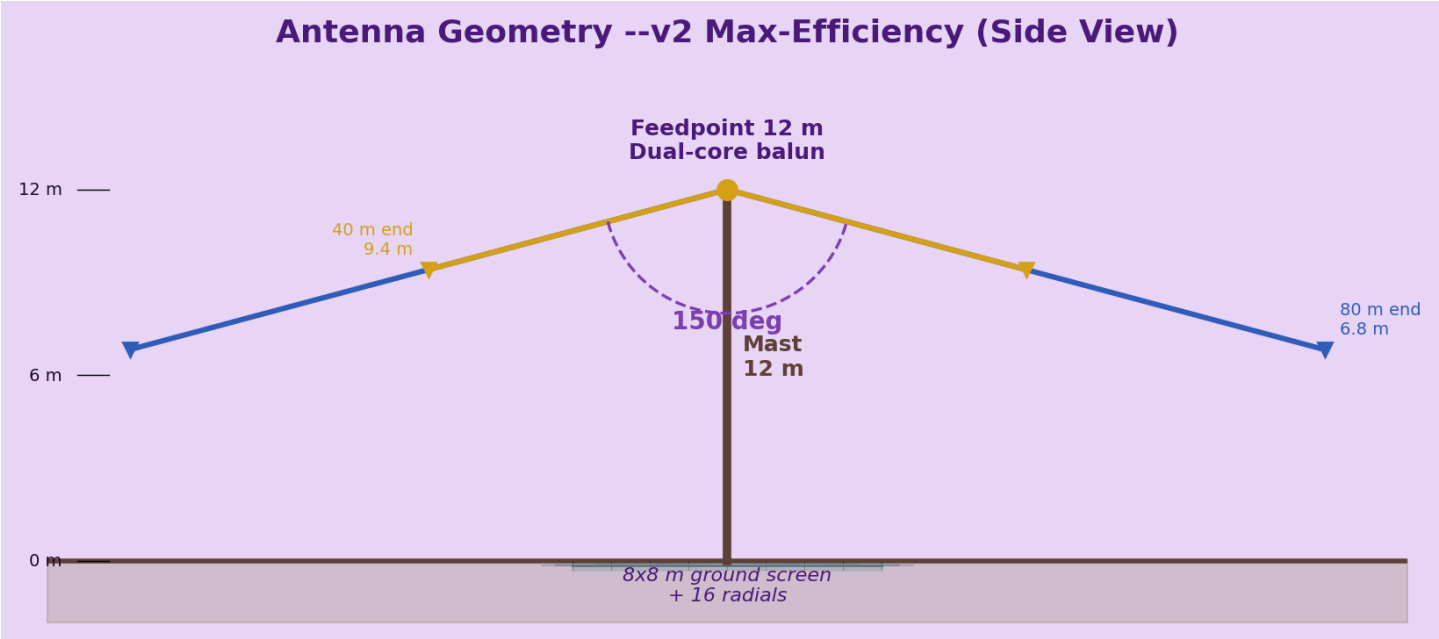


7. Elevation Pattern

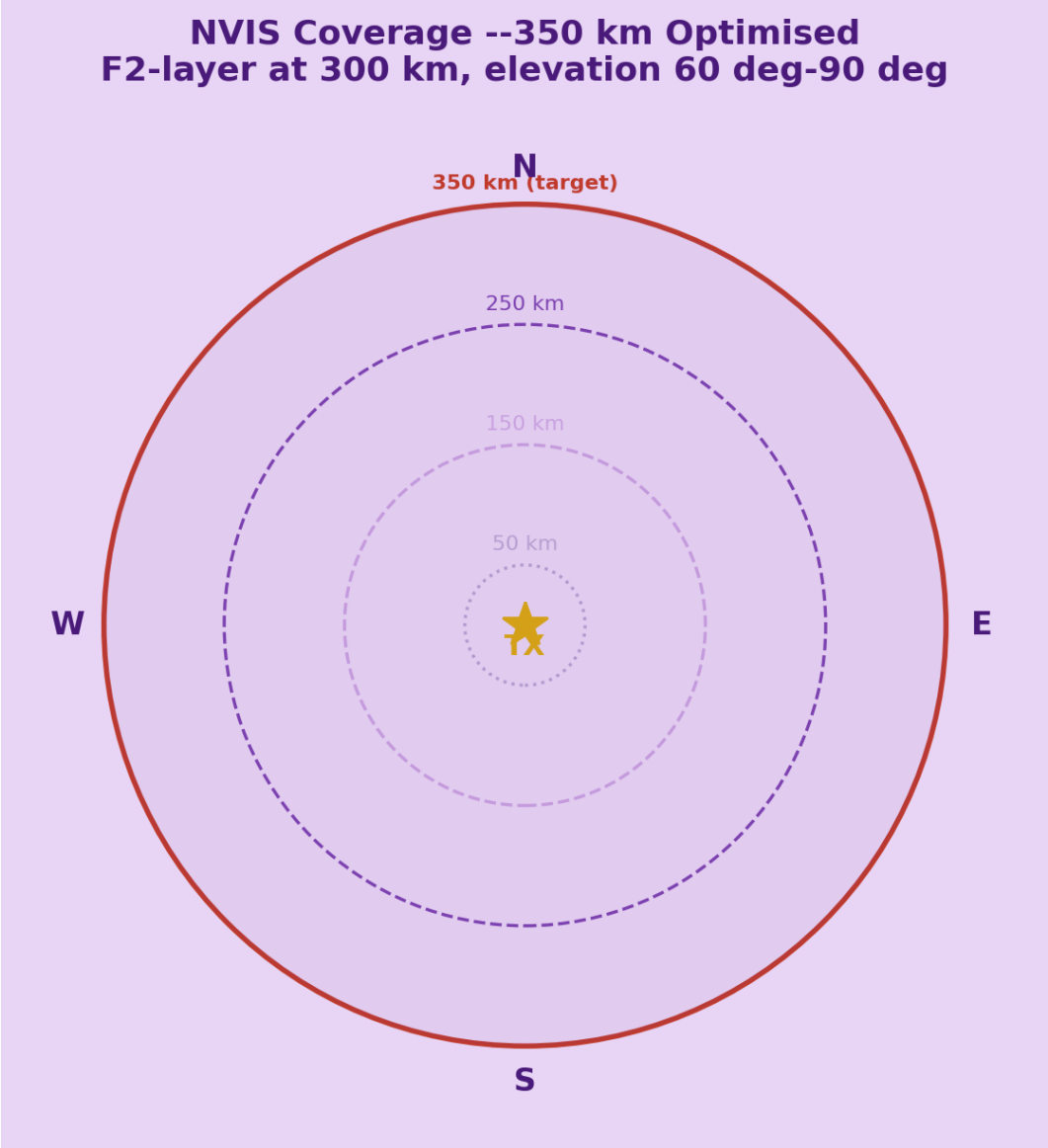

Elevation Pattern --Broadside Cut
12 m apex, 150 deg included angle
0°
10°
20°
30°
40°
50°
60°
70°
80°
90°
0 dB
-2.5
-6
-12
350 km
boundary
(60 deg)
80 m (3.65 MHz)
40 m (7.15 MHz)

8. Antenna Geometry

The v2 design uses a 12 m mast with near-flat 150 deg included angle. 80 m wire ends are at ~6.8 m height, 40 m ends at ~9.4 m. The 8x8 m ground screen with 16 radials is mandatory for the specified gain figures.



9. Coverage Map


NVIS Coverage --350 km Optimised
F2-layer at 300 km, elevation 60 deg-90 deg
N
350 km (target)
250 km
150 km
50 km
W
E
S

10. Bill of Materials

#	Item	Specification	Cost (USD)
1	Antenna wire	#12 AWG CCS + stranded Cu, 70 m	$20-35
2	Balun cores	FT-240-43 ferrite toroid x2	$16-30
3	Balun wire	#14 AWG PTFE, 4 m	$6-10
4	Coaxial cable	RG-213, 50 ohm, 20 m	$30-50
5	Connectors	PL-259, SO-239, barrel	$8-15
6	Mast	Fibreglass telescoping, 12 m	$60-100
7	Insulators	Egg or dog-bone, 6 pcs	$5-10
8	Support rope	Dacron UV-resistant, 60 m	$12-25
9	Wire spreaders	Plastic rod, 30-50 cm, 4 pcs	$5-10
10	Junction box	IP65 weatherproof	$5-10
11	Lightning arr.	Gas-discharge coaxial	$15-25
12	Ground screen	8x8 m mesh + 16 radials	$25-40
	TOTAL		$207-360

11. Construction Notes

1. Wire preparation: Cut #12 AWG CCS for 80 m elements (20.5 m each side) and stranded copper for 40 m elements (10.3 m each side) with trim allowance.

2. Dual-core balun: Wind 10 bifilar turns of #14 PTFE wire on TWO stacked FT-240-43 cores. This provides lower loss and handles higher power (1 kW+).

3. Ground screen: Lay 8x8 m chicken wire mesh centred below feedpoint. Add 16 radial wires (10 m each) at 22.5 deg spacing. Bond to station ground.

4. Mast: Use 12 m fibreglass telescoping mast. Guy with Dacron rope.

5. Wire geometry: 150 deg included angle means wires droop only 15 deg below horizontal. 80 m wire ends at ~6.8 m, 40 m ends at ~9.4 m above ground.

6. Tuning: Trim 40 m wires first. Target VSWR < 1.5:1 at band centres. The 150 deg angle naturally matches ~50 ohm.

7. CCS wire: Use copper-clad steel for 80 m elements (span/weight) and stranded copper for 40 m elements (flexibility).

12. NVIS Coverage Geometry (350 km)

Elevation	Ground Radius (km)	Application
90 deg (zenith)	0	Directly overhead
80 deg	53	City-wide
70 deg	109	Regional
60 deg	173	Inter-city (350 km boundary)
55 deg	210	Provincial
50 deg	247	Extended coverage edge