K2 comparison

# Idea

The extended source size correction factor can be calculated using the vendor-provided polynomial factor formula, using the approximation formula for uniform illumination, or using the direct integration of the radiation pattern.

## Polynomial factors

Polynomial factors are taken from Viasat K2 polynomial approximation formula for X-band antennas.

The polynomial formula is following:

$$K\_{2}=a\_{0}θ\_{d}f\_{GHz}^{2}+a\_{1}f\_{GHz}+a\_{2}f\_{GHz}^{2}+a\_{3}f\_{GHz}+a\_{4}θ\_{d}f\_{GHz}+a\_{5}θ\_{d}^{2}f\_{GHz}+a\_{6}+a\_{7}θ\_{d}+a\_{8}θ\_{d}^{2}+a\_{9}θ\_{d}^{3}$$

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Coefficients | 5.4m | 7.3m | 9.1m | 10.26m | 11.28m |
| a0 | 0.22124 | -3.22454 | 0.4137 | 0.5541 | 0.7434 |
| a1 | -0.00975 | 0.13412 | -1.2490 | -2.9581 | -0.3145 |
| a2 | 0.16554 | -2.12968 | 31.6666 | 75.1404 | 7.6079 |
| a3 | -0.57331 | 8.21186 | -269.3682 | -637.2681 | -60.4003 |
| a4 | -4.52011 | 50.88899 | 1.0325 | -0.6066 | -12.6905 |
| a5 | 1.64387 | 4.04585 | -5.8184 | -7.3650 | 0.9865 |
| a6 | -0.21724 | 3.08215 | 776.2878 | 1808.7976 | 153.4486 |
| a7 | 23.47034 | -201.17202 | -80.5964 | -65.4370 | 66.2610 |
| a8 | -15.20528 | -30.70381 | 142.7291 | 156.7675 | 12.4544 |
| a9 | 4.70339 | 4.38388 | -50.1728 | -60.9194 | -17.1503 |

Table 2: Typical parabolic antenna K2 coefficients

## Uniform-illumination approximation

The estimate of extended source size correction factor can be obtained also using the uniform-illumination formulas. In following, two different approximation formulas will be taken into the consideration (i.e. Gaussian far-field antenna pattern).

 (1) (2)

## Radiation pattern integration

To integrate radiation pattern, firstly it is important to normalize the pattern in a way that the maximum radiation value is unity (1).

The radiation pattern is presented in the UV grid for easier integration and not neglecting the maximum radiation peak.

Integration has been performed in MATLAB.

For each pattern, the UV grid boundaries were set to [-sin(1°) sin(1°)] inside the 401x401 matrix. Also, in all antennas, the blockage was included and the edge taper was set to -10dB.

# Results

Test 1:

* Frequency: 8.25 GHz
* Edge taper: -10 dB
* Blockage: ON
* Antenna design: Cassegrain (reflector f/D = 0.3)

|  |  |
| --- | --- |
|  | K2: Polynomial |
|  | 0.45° | 0.49° | 0.5° | 0.53° | 0.56° |
| D=5.4m | 1.4980 | 1.6105 | 1.6411 | 1.7398 | 1.8489 |
| D=7.3m | 1.7665 | 1.9511 | 2.0017 | 2.1674 | 2.3452 |
| D=9.1m | 2.8210 | 3.2951 | 3.4249 | 3.8364 | 4.2748 |
| D=10.26m | 3.7223 | 4.4071 | 4.5825 | 5.1127 | 5.6413 |
| D=11.28m | 4.4423 | 5.2482 | 5.4476 | 6.0393 | 6.6190 |

|  |  |
| --- | --- |
|  | K2: Approximation 1 (k = 70) |
|  | 0.45° | 0.49° | 0.5° | 0.53° | 0.56° |
| D=5.4m | 1.349410 | 1.421457 | 1.440790 | 1.502093 | 1.568533 |
| D=7.3m | 1.686973 | 1.837205 | 1.877837 | 2.007431 | 2.148962 |
| D=9.1m | 2.153688 | 2.417226 | 2.488674 | 2.716714 | 2.965601 |
| D=10.26m | 2.542729 | 2.901084 | 2.998071 | 3.306911 | 3.642501 |
| D=11.28m | 2.946654 | 3.401636 | 3.524367 | 3.913896 | 4.334882 |

|  |  |
| --- | --- |
|  | K2: Approximation 1 (k = 66.33) |
|  | 0.45° | 0.49° | 0.5° | 0.53° | 0.56° |
| D=5.4m | 1.393275 | 1.475140 | 1.497140 | 1.566979 | 1.642795 |
| D=7.3m | 1.778207 | 1.950321 | 1.996921 | 2.145641 | 2.308156 |
| D=9.1m | 2.313583 | 2.616210 | 2.698219 | 2.959767 | 3.244768 |
| D=10.26m | 2.760247 | 3.170941 | 3.281908 | 3.634653 | 4.016837 |
| D=11.28m | 3.223090 | 3.742648 | 3.882435 | 4.325064 | 4.801753 |

|  |  |
| --- | --- |
|  | K2: Approximation 1 (k = 65.269) |
|  | 0.45° | 0.49° | 0.5° | 0.53° | 0.56° |
| D=5.4m | 1.407534 | 1.492617 | 1.515492 | 1.588134 | 1.667030 |
| D=7.3m | 1.808022 | 1.987331 | 2.035891 | 2.190891 | 2.360285 |
| D=9.1m | 2.365942 | 2.681342 | 2.766793 | 3.039231 | 3.335920 |
| D=10.26m | 2.831416 | 3.259085 | 3.374568 | 3.741450 | 4.138570 |
| D=11.28m | 3.313361 | 3.853706 | 3.998961 | 4.458563 | 4.952997 |

|  |  |
| --- | --- |
|  | K2: Approximation 2  |
|  | 0.45° | 0.49° | 0.5° | 0.53° | 0.56° |
| D=5.4m | 1.339390 | 1.412012 | 1.431654 | 1.494373 | 1.563088 |
| D=7.3m | 1.687469 | 1.848620 | 1.892834 | 2.035567 | 2.194282 |
| D=9.1m | 2.199630 | 2.502381 | 2.585853 | 2.855563 | 3.154412 |
| D=10.26m | 2.649355 | 3.076590 | 3.193654 | 3.568609 | 3.976719 |
| D=11.28m | 3.13153 | 3.683904 | 3.833227 | 4.304583 | 4.804786 |

|  |  |
| --- | --- |
|  | K2: Integration |
|  | 0.45° | 0.49° | 0.5° | 0.53° | 0.56° |
| D=5.4m | 1.373663 | 1.452669 | 1.474982 | 1.543749 | 1.620254 |
| D=7.3m | 1.763730 | 1.940136 | 1.990593 | 2.147564 | 2.324326 |
| D=9.1m | 2.339701 | 2.670141 | 2.764844 | 3.059009 | 3.387935 |
| D=10.26m | 2.828110 | 3.285913 | 3.416085 | 3.816690 | 4.257118 |
| D=11.28m | 3.351820 | 3.937277 | 4.101727 | 4.601901 | 5.141817 |

|  |  |
| --- | --- |
|  | HPBW |
|  | simulation | k = 70 | k = 58.96·(1+0.0125·Te) | k = 58.96·(1+0.0107·Te) |
| D = 5.4m | 0.451° | 0.471° | 0.446° | 0.439° |
| D = 7.3m | 0.332° | 0.348° | 0.331° | 0.325° |
| D = 9.1m | 0.266° | 0.279° | 0.265° | 0.261° |
| D = 10.26m | 0.235° | 0.248° | 0.235° | 0.231° |
| D = 11.28m | 0.215° | 0.226° | 0.214° | 0.210° |















Test 2:

* Frequency: 8.25 GHz
* Edge taper: -15 dB
* Blockage: ON
* Antenna design: Cassegrain (reflector f/D = 0.3)

|  |  |
| --- | --- |
|  | K2: d=0.5° |
|  | Polynom. | Approx.1 k=70 | Approx.1 k=58.96·(1+0.0125·Te) | Approx.1 k=58.96·(1+0.0107·Te) | Approx.2 | Integration |
| D=5.4m | 1.6411 | 1.440790 | 1.440580 | 1.463744 | 1.431654 | 1.423525 |
| D=7.3m | 2.0017 | 1.877837 | 1.877396 | 1.926235 | 1.892834 | 1.865033 |
| D=9.1m | 3.4249 | 2.488674 | 2.487897 | 2.573823 | 2.585853 | 2.519243 |
| D=10.26m | 4.5825 | 2.998071 | 2.997016 | 3.113526 | 3.193654 | 3.071917 |
| D=11.28m | 5.4476 | 3.524367 | 3.523033 | 3.670220 | 3.833227 | 3.660750 |



Test 3:

* Frequency: 8.25 GHz
* Edge taper: -10 dB
* Blockage: OFF
* Antenna design: Front Feed (reflector f/D = 1.5)

|  |  |
| --- | --- |
|  | K2: d=0.5° |
|  | Polynom. | Approx.1 k=70 | Approx.1 k=58.96·(1+0.0125·Te) | Approx.1 k=58.96·(1+0.0107·Te) | Approx.2 | Integration |
| D=5.4m | 1.6411 | 1.440790 | 1.497140 | 1.515492 | 1.431654 | 1.495669 |
| D=7.3m | 2.0017 | 1.877837 | 1.996921 | 2.035891 | 1.892834 | 2.027442 |
| D=9.1m | 3.4249 | 2.488674 | 2.698219 | 2.766793 | 2.585853 | 2.817384 |
| D=10.26m | 4.5825 | 2.998071 | 3.281908 | 3.374568 | 3.193654 | 3.497375 |
| D=11.28m | 5.4476 | 3.524367 | 3.882435 | 3.998961 | 3.833227 | 4.202437 |



Test 4:

* Frequency: 8.25 GHz
* Edge taper: -15 dB
* Blockage: OFF
* Antenna design: Front Feed (reflector f/D = 1.5)

|  |  |
| --- | --- |
|  | K2: d=0.5° |
|  | Polynom. | Approx.1 k=70 | Approx.1 k=58.96·(1+0.0125·Te) | Approx.1 k=58.96·(1+0.0107·Te) | Approx.2 | Integration |
| D=5.4m | 1.6411 | 1.440790 | 1.440580 | 1.463744 | 1.431654 | 1.432414 |
| D=7.3m | 2.0017 | 1.877837 | 1.877396 | 1.926235 | 1.892834 | 1.881754 |
| D=9.1m | 3.4249 | 2.488674 | 2.487897 | 2.573823 | 2.585853 | 2.537953 |
| D=10.26m | 4.5825 | 2.998071 | 2.997016 | 3.113526 | 3.193654 | 3.102206 |
| D=11.28m | 5.4476 | 3.524367 | 3.523033 | 3.670220 | 3.833227 | 3.693291 |

