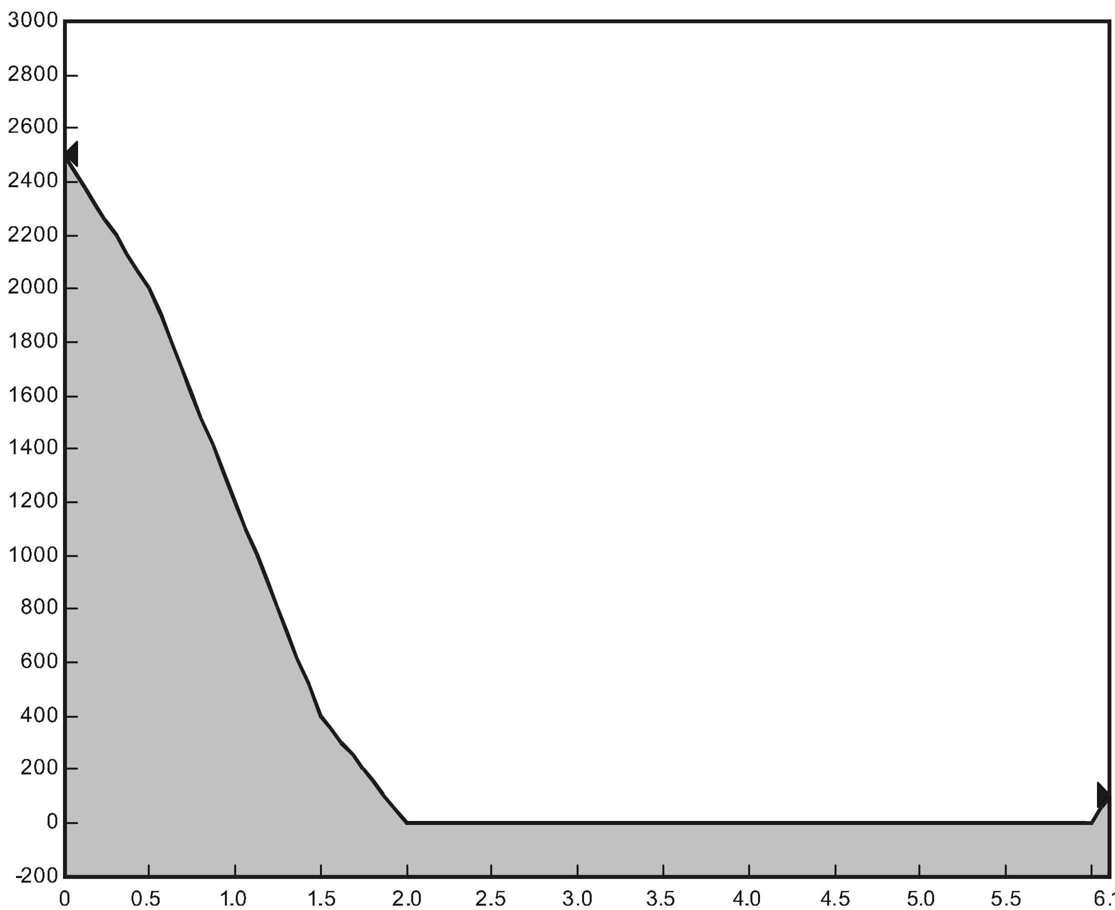
VERTICAL ANTENNA ORIENTATION IN THE MICROWAVE AND VHF-UHF WORKSHEETS

This example illustrates the different concepts used for antenna orientation in the microwave and VHF-UHF worksheets. The example is valid for program builds later than December 09, 2000. In previous builds, microwave applications did not consider the antenna pattern in the elevation plane. The data was taken from the azimuth pattern for both azimuth and elevation angles. The reason for this is that most microwave antenna patterns do not include elevation data. If available, the data only covers five degrees above and below the horizontal.

The data files for this example are located on the program CD-ROM in the folder Examples\Orient. To view this It will be necessary to set both the directories for the microwave antenna codes and the VHF-UHF antenna codes to this folder. (Select Configure - Directories)

Example Path Profile Data

The file orient.pl4 used in this example is shown below.



The path has the following characteristics:

Path length	6.1 km
Site 1 elevation	2500 meters
Site 1 antenna height	30 meters

Site 2 elevation	100 meters
Site 2 antenna height	30 meters
Vertical angle at Site 1	-21.49 degrees
Vertical angle at Site 2	21.46 degrees

Antenna

A Til-Tek TA-1406 antenna will be used in both a VHF-UHF and a microwave application. The NSMA ASCII data file for this antenna is located on the program CD-ROM in the file folder:

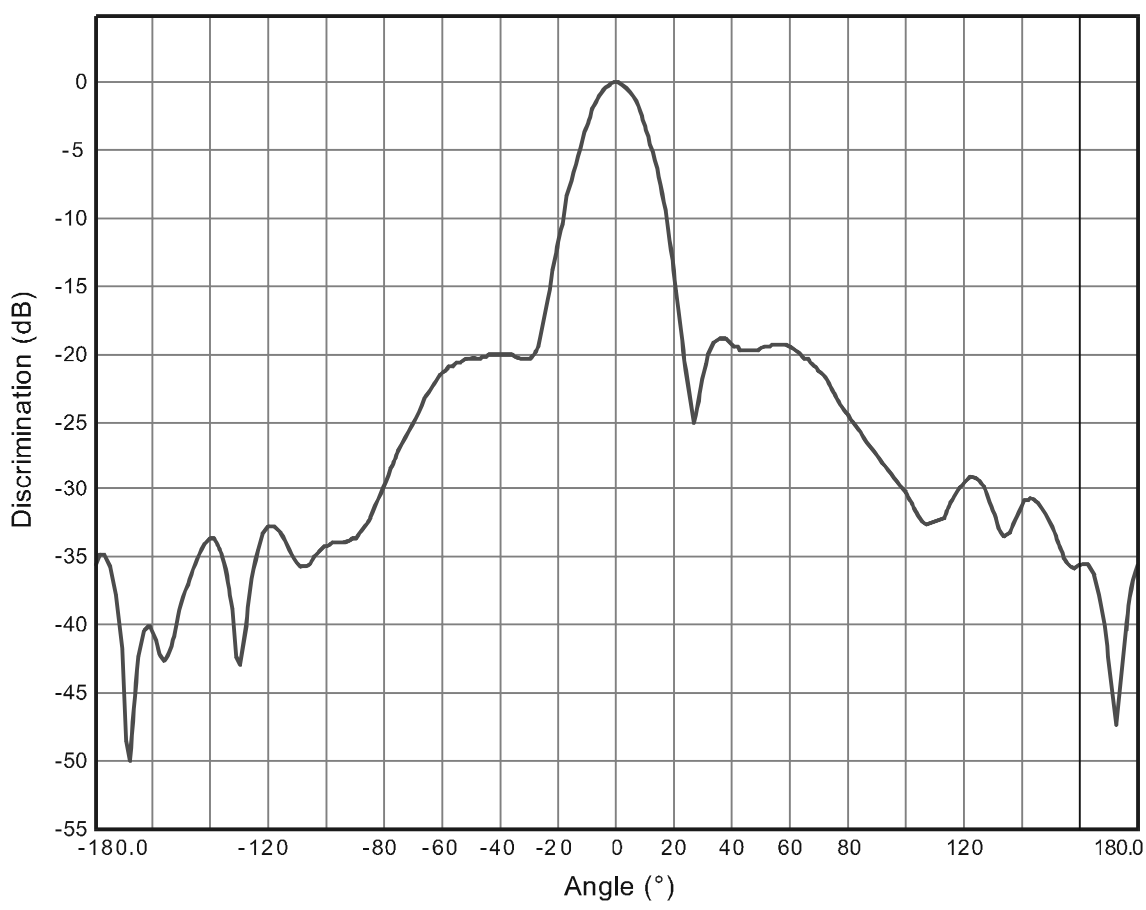
Equipmnt\VAS\til-tek\1425_1535\TA-1406.vaf.

This antenna is supplied for VHF-UHF applications and the compiled binary file TA-1406.vas is available in the same folder.

To use this antenna in a microwave application, the file must be converted to the binary microwave format. This was done by seelecting Configure - Convert - Microwave Antenna ASCII Files and converting the file TA-1406.vaf to TA-1406.mas. The file contains only a single copolar polarization combination. As such the file can be used for orientation loss but not for a microwave interference calculation.

Copies of the mas and vas files are included in the folder Examples\Orient

The vertical antenna pattern is shown below



Horizontal and Vertical Angles

Horizontal angles are referenced to the true azimuth between sites. These are determined from the site latitudes and longitudes.

The vertical angle requires a path profile and non zero antenna heights at each end.

In VHF-UHF applications, the vertical angle is the angle to the horizon if the path is obstructed.

The sign convention for vertical angles is positive above the horizontal and negative below the horizontal.

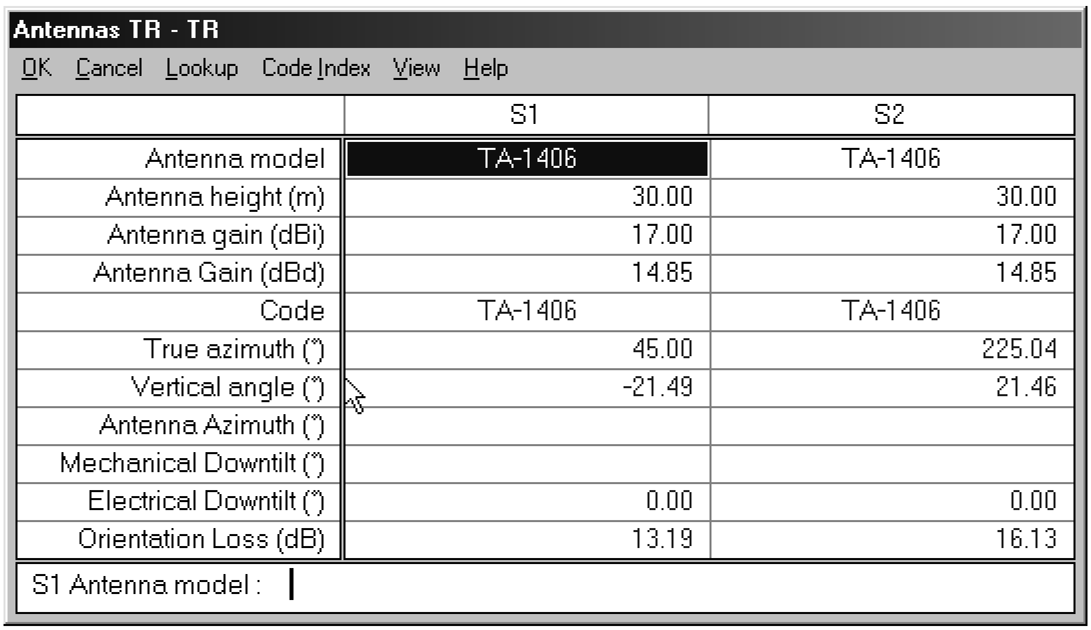
VHF-UHF Application

Load the file orient.pl4. This file includes TA-1406 antenna data for both VHF-UHF and microwave applications.

In the summary module, select Application and set the application to VHF-UHF.

Select Module - Worksheet.

Click the antenna icon to bring up the antenna data entry form.


Antennas TR - TR

OK Cancel Lookup Code Index View Help

	S1	S2
Antenna model	TA-1406	TA-1406
Antenna height (m)	30.00	30.00
Antenna gain (dBi)	17.00	17.00
Antenna Gain (dBd)	14.85	14.85
Code	TA-1406	TA-1406
True azimuth (°)	45.00	225.04
Vertical angle (°)	-21.49	21.46
Antenna Azimuth (°)		
Mechanical Downtilt (°)		
Electrical Downtilt (°)	0.00	0.00
Orientation Loss (dB)	13.19	16.13

S1 Antenna model :

In VHF-UFH applications the antenna boresight is assumed to be horizontal. The elevation angles are -21.49 and 21.46 at S1 and S2 respectively. This results in orientation losses of 13.19 and 16.13 dB at S1 and S2. This is read directly from the vertical pattern assuming that the antennas are oriented on boresight in the horizontal plane.

To correct this, it would be necessary to downtilt the S1 antenna by 21.49 degrees and uptilt the S2 antenna by 21.46 degrees. The antennas are now on boresight in both the horizontal and vertical planes and the orientation loss is zero as shown below.

Code	TA-1406	TA-1406
True azimuth (°)	45.00	225.04
Vertical angle (°)	-21.49	21.46
Antenna Azimuth (°)		
Mechanical Downtilt (°)	21.49	-21.46
Electrical Downtilt (°)	0.00	0.00
Orientation Loss (dB)	0.00	0.00

S2 Mechanical Downtilt (°) :

Microwave Application

Switch to the Summary module and set the application type to microwave. In the worksheet click the antenna icon.

Antennas TR - TR

OK Cancel Lookup Code Index View Help

	S1	S2
Antenna model	TA-1406	TA-1406
Antenna diameter (m)	428.55	428.55
Antenna height (m)	30.00	30.00
Antenna gain (dBi)	17.00	17.00
Radome loss (dB)		
Code	TA-1406	TA-1406
Antenna 3 dB beamwidth (°)	30.00	30.00
True azimuth (°)	45.00	225.04
Vertical angle (°)	-21.49	21.46
Antenna Azimuth (°)		
Antenna Downtilt (±°)		
Orientation Loss (dB)		

S1 Antenna model :

In microwave applications, it is assumed the antenna boresight is always perfectly oriented in the horizontal and vertical planes. Therefore there will be no orientation loss. This means that the antenna at S1 is tilted down 21.49 degrees and the antenna at S2 is tilted up 21.46 degrees.

If the vertical antenna boresight was installed in the horizontal plane, then it would be necessary to uptilt the S1antenna by 21.49 degrees and downtilt the S2 antenna by 21.46 degrees as shown below

Code	TA-1406	TA-1406
Antenna 3 dB beamwidth (°)	30.00	30.00
True azimuth (°)	45.00	225.04
Vertical angle (°)	-21.49	21.46
Antenna Azimuth (°)		
Antenna Downtilt (±°)	-21.49	21.46
Orientation Loss (dB)	13.19	16.13

S2 Antenna Downtilt (±°) :

The above is only valid when the antenna boresights are perfectly aligned in the horizontal (azimuth) plane.

ANTENNA MISALIGNMENT IN BOTH THE HORIZONTAL AND ELEVATION PLANES

Mechanical Downtilt

An antenna with a positive down tilt means that the antenna has been tilted towards the ground. This will affect the vertical angle and will depend on the horizontal orientation of the antenna. Downtilt at the front produces uptilt at the rear and no effect at 90 degrees off boresight. The vertical angle θ_V is modified as follows

$$\Delta\theta = \frac{\theta_{MD}}{90} \cdot (90 - \theta_H) \text{ for } 0 \le \theta_H \le 180$$
$$\Delta\theta = \frac{\theta_{MD}}{90} \cdot (-270 + \theta_H) \text{ for } 180 \le \theta_H \le 360 \qquad (1)$$
$$\theta_{Vmod} = \theta_V + \Delta\theta$$

where:

θ_{Vmod}	is the modified vertical angle
$\Delta\theta$	is the correction to the vertical angle
θ_{MD}	is the mechanical downtilt angle (positive down)
θ_H	is the azimuth angle relative to the antenna boresight

Omnidirectional Antennas

It is assumed that the vertical pattern of an omnidirectional is rotationally symmetric. The response, R_{dB} is given by:

$$R_{dB} = G_H(\theta_H) + G_V(\theta_V) \qquad (2)$$
$$G_H(\theta_H) = 0 \text{ for an omnidirectional antenna}$$

Directional Antennas

The situation in a directional antenna is more complex and assumes that the field distributions are separable into two orthogonal components. The response, R_{dB} is given by Equation (3) below

$$\begin{aligned} \Omega &= \sin^{-1}(\cos(\theta_H) \cdot \sin(\theta_V)) \\ R_{dB} &= G_H(\theta_H) + G_V(\Omega) \end{aligned} \quad \textbf{(3)}$$

In Equation (3), an effective vertical angle, Ω is first determined. The vertical response is read from the antenna data file E plane data at the angle Ω.