SABOR: A Fast Analysis Tool for Horn and Reflector Antennas.

Miguel A. Campo, Francisco J. del Rey, Jose. L. Besada and Leandro de Haro.

Dpto. Señales, Sistemas y Radiocomunicaciones.
Universidad Politécnica de Madrid.

E.T.S.I. de Telecomunicación.
Ciudad Universitaria s/n. E-28040 Madrid (Spain)
e-mail : leandro@gr.ssr.upm.es

Keywords: horn antennas, reflector antennas, educational software, radiation pattern, gain and efficiencies.

SABOR (Software de Análisis de Bocinas y Reflectores) is an antenna analysis software which provides an integrated approach for the computation of horn and reflector antenna performances. The software was firstly conceived as an educational tool to reinforce the student acknowledges about horns and reflectors for an antenna course for telecomunication engineers. However, the program is not only useful for undergraduate and graduated students, but also antenna engineers will probably find very interesting the number of options and possibilities of analysis that the program includes.

The program covers and widens topics already developed with other software as the software included by Sletten in [1] or the RASCAL [2], but improving the user interface and the graphic displays by means of windows facilities.

The program can analyse almost any kind of usual horn (E and H pyramidal horns, circular horns, corrugated horns). As far as the reflector part is concerned, the configurations that SABOR can analyse are simple (centred and offset) parabolic reflectors, dual offset Cassegrain and Gregorian reflectors, and centred Cassegrain systems. As feeders for the reflectors, the program allows the usage of a classical cos-q and any of the horns above mentioned. The usage of “real” horns improves the accuracy of computed efficiencies and the simulation of the cross-polar radiation. Moreover, the feeders may be displaced laterally and axially in order to study alignment errors or the scanning capabilities of the reflectors. Some topics that can be displayed using the program are the aperture field distribution (amplitude and phase), the blockage effects, the squint related with circular polarisation on offset reflectors, etc. SABOR also displays patterns, both for horns and reflectors, in copolar and crosspolar components according with third Ludwig’s definition, instead of the classical theta-phi components in order to compare the polarisation performances better.

Although SABOR does not cover all the topics of the professional programs for reflector analysis, because it may not analyse a full generic geometry (only it works with focussed conical surfaces) nor the far radiation related with the diffraction, it is an excellent analysis tool to realise predesign tasks due to its easily usage and its high level of accuracy and speed of computation. In fact, it needs less than 10 seconds (on a PENTIUM-100) to compute a radiation pattern.

The radiated fields are computed from the fields on the aperture antenna (horn or reflector) using a common engine which it applies a Gauss-Legendre’s quadrature to the
radiation integrals. Horn aperture fields are the usual dominant modes in the waveguide with a quadratic phase correction [3] while reflector aperture fields are computed by GO ray tracing from the feed. Equivalent reflector concept is applied to dual reflector antennas [4]. In the following AP-magazines a paper describing the integration techniques and the theoretical foundations of SABOR will be published. There is available an English version of the program which it can be downloaded in Internet (http://www.gr.ssr.upm.es/sabor.htm) sending a donation of $25 in order to improve the software (to correct mistakes, to add new capabilities, etc.)
Some Features of SABOR Program

As a summary of the program features, the following is the list of menus.

Menu for Horn calculations
Menu:
  Reflector
  Print
  Quit

Horn:
  Rectangular:
    H-plane sectoral horn
    E-plane sectoral
    Pyramidal
  Conical
  Corrugated:
    Rectangular
    Conical

Options:
  Frequency
  Theta range
  Phi cut
  Field Scale
  Automatic Field Scale
  Beam-width
  XY plot
  Polar plot
  Number of field points

Model:
  Chu Model
  E-field Model

Dimensions: (in cm)
Pattern: (Computation of the pattern at selected phi cut, directivity, beam-width, etc.)
Compare: (Superimpose a new computation over the previous one)
Help:
Some values about the maximum gain directivity, beam width at a certain level (fixed by beamwidth menu), phase center, and spillover losses are computed at same time the radiation pattern is required.

Menu for Reflector calculations
Menu:
  Horn
  Cos-q
  Print
  Quit

Reflector:
  Cassegrain
  Parabolic
  Single Offset
  Double Offset:
    Cassegrain
Gregorian

Options:
- Frequency
- Theta
- Phi cut
- Field Scale
- Automatic Field Scale
- Beam-width
- XY plot
- Polar plot
- Polarization:
  - Circular
  - Right hand
  - Left hand
- Linear
- Edge illumination Level
- Blockage:
  - None
  - Feeder
  - Another
  - Feeder displacement ($\Delta x_f$, $\Delta y_f$, $\Delta z_f$)
  - Feeder pointing
  - Number of field points

Dimensions: (in cm)
- Pattern: (Computation of the secondary pattern at selected phi cut, directivity, efficiencies, etc.)
- Compare: (Superimpose a new computation over the previous one)
- Aperture: (It displays the amplitude and the phase of the co-polar aperture field)
- Geometry: (An scheme at real scale of reflectors and feeder is plotted)
- Help:

The values of maximum gain, beam width at a certain level, blockage losses, spillover losses, aperture distribution losses, and the reflection at the feeder are computed when the radiation pattern menu is selected.

When the option compare is taken, the new pattern cut is superimposed and the upper mentioned values correspond to the last case considered in the comparison.

To show SABOR performance, some very simple examples of horn and reflector pattern calculations are show in figures 1 to 3.
References


Figure 1

d = 3.75
D = 3.75
R = 0
L = 0
s = 0

f = 10 GHz

Figure 2

d = 2.03
D = 8
R = 8.89
L = 6.63
s = 0.3

f = 10 GHz
Gain = 33.41 dB  Spillover efc. = -0.39 dB
Beamwidth -3 dB = 3.988°  Aperture efc. = -0.579 dB
Block. efc. = 0 dB

\( D = 50 \quad \Psi_{\phi} = 38.1 \)
\( C = 5 \quad \Psi_{\theta} = 38.9 \)
\( F/D = 0.9 \quad \phi = 30.9 \)
\( f = 10 \quad \text{GHz} \)

Feed: \( \cos-q \)

Figure 3
**Figure Captions**

**Figure 1.** It shows a comparison between the radiation pattern of a open TE_{11} cylindrical wave-guide horn with a diameter of 1.25λ, calculated using Chu model and the E field model. The results are well compared with those ones in figure 4.47 of [5].

**Figure 2.** A comparison between smooth and corrugated conical horn for the same diameter and quadratic phase distribution constant S can be seen. Both plots have been represented simultaneously using the “compare” menu and allow to remark the low crosspolar level corresponding to the corrugated horn. The data shown for directivity corresponds to the corrugated (the last one computed).

**Figure 3.** Cross-polar and squint effects on a single offset can also be studied. It corresponds to radiation pattern obtained at the anti-symmetrical plane for linear polarization (copolar pattern with a maximum to θ=0° and the inherent cross-polar peaks) and for a right hand circular polarization of the feeder (Copolar pattern suffers an squint of 0.2° and there is no circular cross-polar radiation).