TOPNET 2.2 - CAD PROGRAM FOR CATV NETWORK DESIGN

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A. Introduction

Construction of CATV networks seems to be lately one of the most dynamically developing fields of a telecommunication technique. These networks are able to bring to our households even tens of TV and radio channels in the highest possible quality. Beside that, modern fibre-optic networks (or hybrid fibre-optic & co-axial networks) can be employed for many other telecommunication services (e.g. for a transmission of tens of thousands of telephone calls or for nearly unlimited data transfer).

Modern CATV networks are generally complex broadband communication systems, using top equipment and technologies. Construction of such as network is a rather expensive business and requires high and long term investments. Optimum network design is in such a case absolutely essential matter, ensuring not only a perfect TV picture quality but also the most simple and consequently also the most economical structure. A CAD process, that means computer modelling, simulation and optimization seems to be the best solution of these requirements.

B. Program structure

The structure of described program TOPNET corresponds to above stated CAD strategy. The program enables computer modelling of CATV distribution networks with a general structure and dimension and optimization of its technical and economic parameters and settings. Whole system can be in a detailed way examined, parameters decisive for picture quality can be checked, all that also under extreme conditions (e.g. under extreme temperature changes). Complete network behavior can be known before installing the first meter of a co-axial cable. The design is terminated by printing of tested project documentation. This all can be done within a short time, with minimum charges and with guaranteed results.

C. Network components

The program TOPNET enables modelling of CATV networks, employing all common distribution elements:

- co-axial cables
- splitters (2 - 16 way)
- taps (1 - 16 way)
- attenuators (fixed, variable)
- equalizers (fixed , variable)
- amplifiers
- ALC & ASC amplifiers (1 and 2 pilots)
- wall outlets

Parameters of all components, including also amplitude - frequency characteristics, can be predefined in corresponding data files. These files can be created on basis of manufacturers supplied data or simple measurements. Large components data files directories are already available. More complex elements can be defined by sub-networks.

D. Distribution network

Distribution networks are composed from predefined distribution elements; the main network may contain up to 350 components. Larger networks can be structured with a help of sub-networks or by means of a network division. Definite parts of any network, especially those often employed (e.g. house distributions) or some more complex components (e.g. bridger amplifiers), can be defined as sub-networks (each may contain up to 100 elements). Defined sub-networks can be then used in any other network. In case of a network division, results at the end of one network can be connected to an input of another network.

E. The source

Source represents a frequency multiplex of a definite number of TV, FM radio and other special channels, distributed from a CATV head-end to users. The program enables definition of two basic source types:

The source with discrete channels can be composed from a definite number of channels with defined frequencies and bandwidths. Intermodulation products are in this case evaluated on basis of amplifiers parameters defined by DIN 45004B standard, as frequency combinations (2a, 2a+-b, a+-b+-c, 3a etc.); cross-modulation products are evaluated by exact formulas. This source type is applicable approximately up to 17 TV channels and enables optimization of the network right for a given number of channels. In case of any change of a channel structure, the network must be re-counted and re-adjusted.

The source with composite channels is generally considered as a frequency band, loaded with a maximum number of channels (e.g. 77 channels B = 6 MHz in a frequency band 50 - 550 MHz). The calculations are based on amplifiers parameters, measured by manufacturers right for a given number of channels. This source type enables an optimum network design and setting for a full employment of the bandwidth.

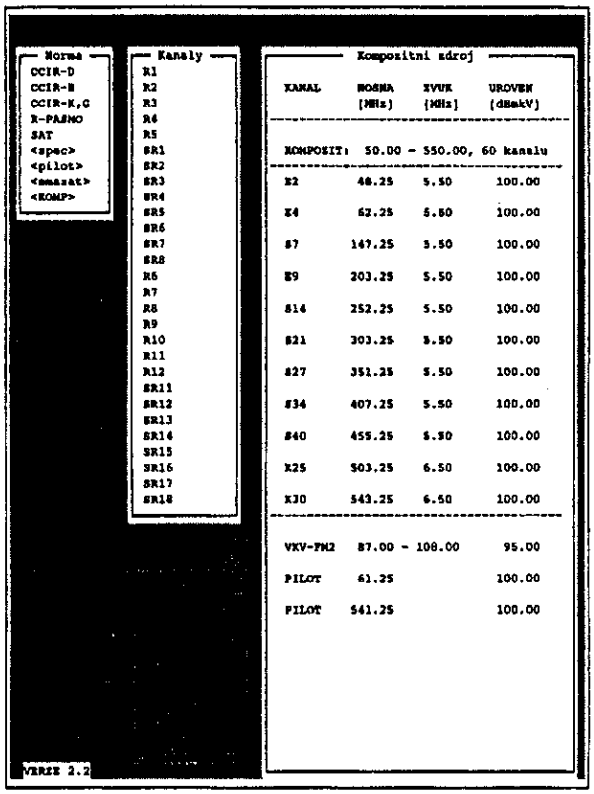

Fig. 1
Example of the souce with composite channels definition.

F. Analysis

The program evaluates at any network node and channel frequency all signal parameters, decisive for a perfect TV picture quality:

- signal level
- signal to noise ratio
- carrier to intermodulation products ratios (including second order beat, third order beat and cross-modulation).

The evaluation of the signal to noise ratio is based on initial head-end signal to noise ratios, attenuations of passive components and amplifier noise figures. The program is able to distinguish attenuation caused by thermal losses from attenuation caused by lossless transformation. The evaluation of carriers to intermodulations products ratios are based on initial source ratios, amplifiers intermodulation parameters, amplifiers output signal levels and on their positions in a distribution cascade.

G. Optimization

During optimization process the program scans automatically whole distribution network and optimizes settings of decisive network components:

During **optimization of equalizers** the procedure evaluates a difference between signal levels at the lowest end and the highest end of given frequency band and with help of fixed and variable equalizers compensates frequency dependent attenuation of used co-axial cables. Computed equalizers values are printed into a setting record.

The **optimization of amplifiers output levels** is performed in an interactive mode. Optimizing procedure stops at every network amplifier and according to its parameters, stated in a corresponding data file, offers boundary possibilities of amplifier setting. After selection of a required amplifier's output level value or of a maximum carrier to intermodulation ratio, the procedure adjusts the amplifier in a corresponding way and steps to a following amplifier.

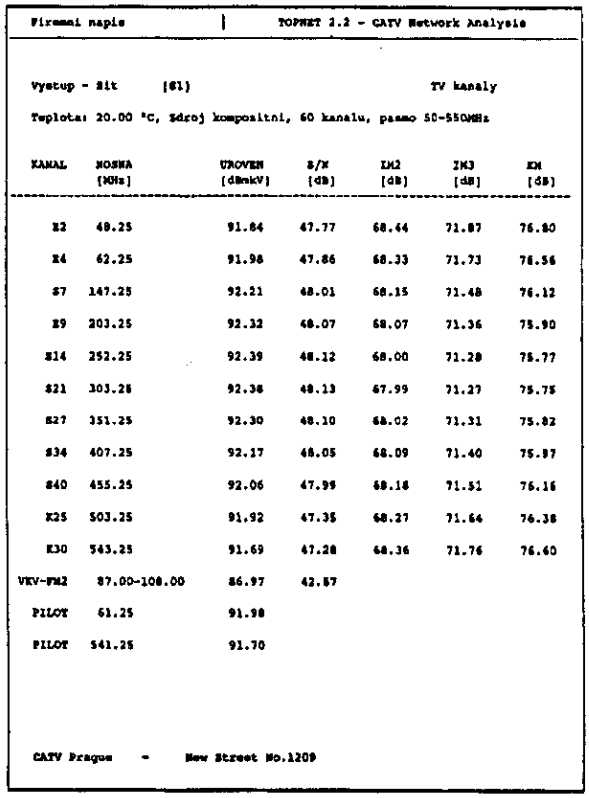

Fig. 2
Example of resulting output data table.

H. Other auxiliary functions

The TOPNET program includes a number of auxiliary procedures and functions, ensuring an optimal program environment and operating comfort.

Saving on disc - all networks, sources, analysis results and setting records can be saved on disc and loaded again. The project documentation can be in a simple way recorded, designed network can be at any time easily modified or extended.

Printing output records - program enables printing of all project and setting records (e.g. as a part of a project documentation).

Editor - program includes Turbo Pascal 6.0 editor for editing components data files and other necessary files.

Budget - program enables loading of a price list of all used network components, including connectors, and calculates a basic budget of a given CATV installation. The budget includes a list of all used components including their ordering numbers, numbers of given components and their total prices, the final price of components and the final price of installation works. Besides technical parameters it is possible to consider also economic parameters of a given network variant.

I. Conclusions

The TOPNET program includes all functions and procedures necessary for an optimal design and setting of any CATV network, at the same time it brings automation, accuracy and rapidity of a project documentation elaboration. The program has been already used by several CATV companies.

Further development of the program is focused into two main directions:

Analysis and optimization of a return path, operated in 5 - 25 (30, 50) frequency band. This signal path is employed for a return signal transmission from users to the main station, (e.g. for data transfer, security signals etc.).

Analysis and optimization of fibre-optic distribution networks

The final objective can be seen in a connection of the TOPNET program with some of the newest AutoCAD versions and creation of a complex design environment, combining signal and economic design with plotting of a complete installation documentation.

About author

Přemysl Hudec graduated from the Technical University in Prague in 1982. In the same year he joined its Department of Electromagnetic Field, where he has worked as an assistant professor of general electromagnetic field theory and microwave circuit theory and design. Recently his works are focused on CAD modelling and design of both active and passive RF and CATV components and on CAD software for CATV purposes.