Automated Measurement System for Characterization of CATV Components and Devices

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***Abstract* – This paper presents the automated measurement system for characterization of CATV components and devices. The automatisation of measurement system enables the control of the instruments using the computer. This kind of measuring makes controlling measurement devices easier and more efficient, as collecting, analysis and presentation of the results.**

***Keywords:* CATV measuring, CATV amplifiers, HP VEE.**

I. INTRODUCTION

What is considered under cable distribution system is antenna system for reception and distribution of radio diffusive programme via cable distribution net to the blocks of buildings, towns and cities.
The primary task of cable distribution system is to enable the signal of continual and permanent quality for all the customers, where servicing means the distribution of radio and TV programme as well as the joint data services. Cable TV presents the most significant system for the TV programme distribution and different largescale services accomplishment. More than 70% of the population in the USA has access to cable TV, whereas in some European countries the number is even higher (Belgium, the Netherlands about 98%). In our country cable TV has been expanding in recent years, so that there are over 300.000 on-line customers, and the number of users is increasing for about 10.000 each month.

II. THE PURPOSE OF AMPLIFIER MEASURING

With the large expansion of new technologies and services in the sphere of cable distribution systems, there is an increasing demand for the improvement of the performance of some components in CATV which would further provide a better quality of video as well as audio signal for each subscriber. CATV amplifier as an active device is a key element of the CATV system structure, therefore it is necessary to get to know it and if possible improve its performances. CATV amplifier has a role to:

- make the signal stronger in the largescale range for multichannel signal distribution
- enable minimum distortion and fluctuations of frequency characteristics
- have an input and output impedance of 75 Ω
- enable signal distribution in both directions (bidirectional component)
- have changeable amplification which can be altered in accordance with the changes of environmental conditions.

The basic role of the amplifier is to compensate for the losses of the strength of a signal while it is being disturbed and in that way to improve the quality of the signal before sending it eventually to the subscriber (Fig.1). The losses added because of the cable distribution, given in the relation to the frequency are:

$$Losses(f) = a * f + b * \sqrt{f} + c \qquad (1)$$

, where the *losses(f)* are, in fact, the cable losses over the length measuring unit (dB/km), *f* is the frequency in MHz, while *a*, *b* and *c* are the constants which correspond the cable characteristics.

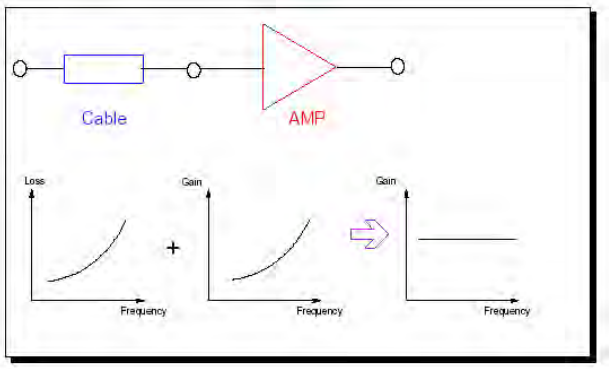

Fig. 1. Amplitude vs. frequency characteristics of cable and amplifier

Electrical characteristics [1-2] of the amplifier is because of that really essential, and it is gained by vectoral and spectral measurements. In order to do measurings effectively, it is necessary to have the measuring equipment which will enable:

- precise amplitude and phase measuring
- a low level noise and distortion when measuring the level
- fast measuring with a high resolution

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III. GRAPHIC PROGRAMMING AND HP VEE

Necessary measuring with CATV components and devices can be carried out directly (by hand) but higher accuracy and validity is achieved by fully automated measuring. Automate measuring with CATV amplifiers is carried out by using HP VEE developing environment which is made on the principle of graphic programming.

Graphic programming [4] differs in many ways from a traditional programming because it is graphically carried out while the programme and data processing go on. HP VEE programme is made by connecting icons together using a mouse; whereas with textual languages we use a keyboard applying syntax rules. The outcome with HP VEE resembles a diagram of data processing which is easier to use and understand than traditional coded lines and there is no tiresome process of edit-compile-link-done. The programme is created by using objects and lines. The lines represent data, while the objects create, analyze and display data. The objects have different functions like I/O operation, analysation and display. All the objects have input and output pins which are located in this way: the data input pin on the left; the data output pin on the right; the sequence input pin is on the top and the sequence output pin is at the bottom of the object. Each object can be shown as an icon or in its open view. The open view is larger and more elaborate.

HP VEE provides three easy ways to control instruments: panel drivers, "Direct I/O" object, and PC I/O libraries. There are panel drivers that offer a simple user interface for the instrument control from computer screen. These are provided by HP with VEE and cover over 450 instruments from different vendors, or you can use VXI plug&play drivers to call C functions to control instruments. These are provided by HP and other vendors with their instruments for support. Panel drivers have two purposes with HP VEE :

- they allow defining of measure state that describes all the performing functions of instruments. When the panel driver is in operation, the adequate instrument is automatically programmed to be set with the state defined by the panel driver.
- operate as control panels for interactive control of instruments. This is useful during the programme development and debugging and when the instrument has no physical front panel.

The open view of a panel driver contains graphical control panel for connecting the instruments. If the instrument is connected with a computer in a specified way, the instrument can be controlled by pressing some area on the graphic control panel. In addition to that, some measurements can be shown on numerical or XY display. Direct I/O objects allow the distribution of commands and the reception of data via one of the supported interfaces.

It can be concluded that the process of creating a programme by using a graphic programming is quite simple [6-7]. Graphic programming can be easily understood and maintained by the author himself as well as any other user. Due to the characteristics that the objects can be selected from the falling menus, it is possible to make a valid and usable code. Most objects used so far would require hundreds or even thousands of lines of traditional code. The processing of the performing programme and processing data can be easily seen from a diagram which represents a programme itself. There are fewer possibilities for human factor erring, and it is easier to detect a problem.

IV. MEASURING SYSTEM AND THE MEASUREMENT RESULTS

For the realization of the measuring system for measuring with CATV components and devices the following equipment, which is available at the Faculty of Electronic Engineering, Laboratory for Microwave technique and satellite television, is used:

- HP8970B Noise Figure Meter,
- HP8757A Scalar Network Analyzer,
- HP8753C Vector Network Analyzer,
- HP8350B Sweep Oscilator,
- HP437B Power Meter,
- HP5350B Microwave Frequency Counter,
- Power supply and switch matrica
- Signal generators
- HP 82341 HP-IB card for PC (system controler),
- HP VEE enviroment, software for developing applications for measurement automatisation.

For the sake of automising the realized measuring system, the adequate software is created for control and measuring equipment handling by using HP VEE developing environment. The created software is primarily intended for characterization of CATV amplifiers and it can support the following types of measuring with amplifiers:

Vectoral measurements:

- Amplitude characteristics (amplification)
- Phase characteristics (group delay)
- The standing wave ratio and return losses
- The noise factor

Spectral measurements:

- The distortion of the secondary order
- The distortion of the third order
- Cross modulation distortion
- Intermodulation distortion
- Hum modulation distortion

By means of the available measuring equipment the measuring of the amplitude frequency characteristics, return losses, and the standing wave ratio, noise factor and power level are measured. A part of the programme for the automation of the realized measuring system is shown in the Fig. 2. This diagram would be analogue to the original code of the main procedure in some of the textual languages. From this part of the programme the calling of subprogrammes needed for the correct performance of corresponding types of measuring is done.

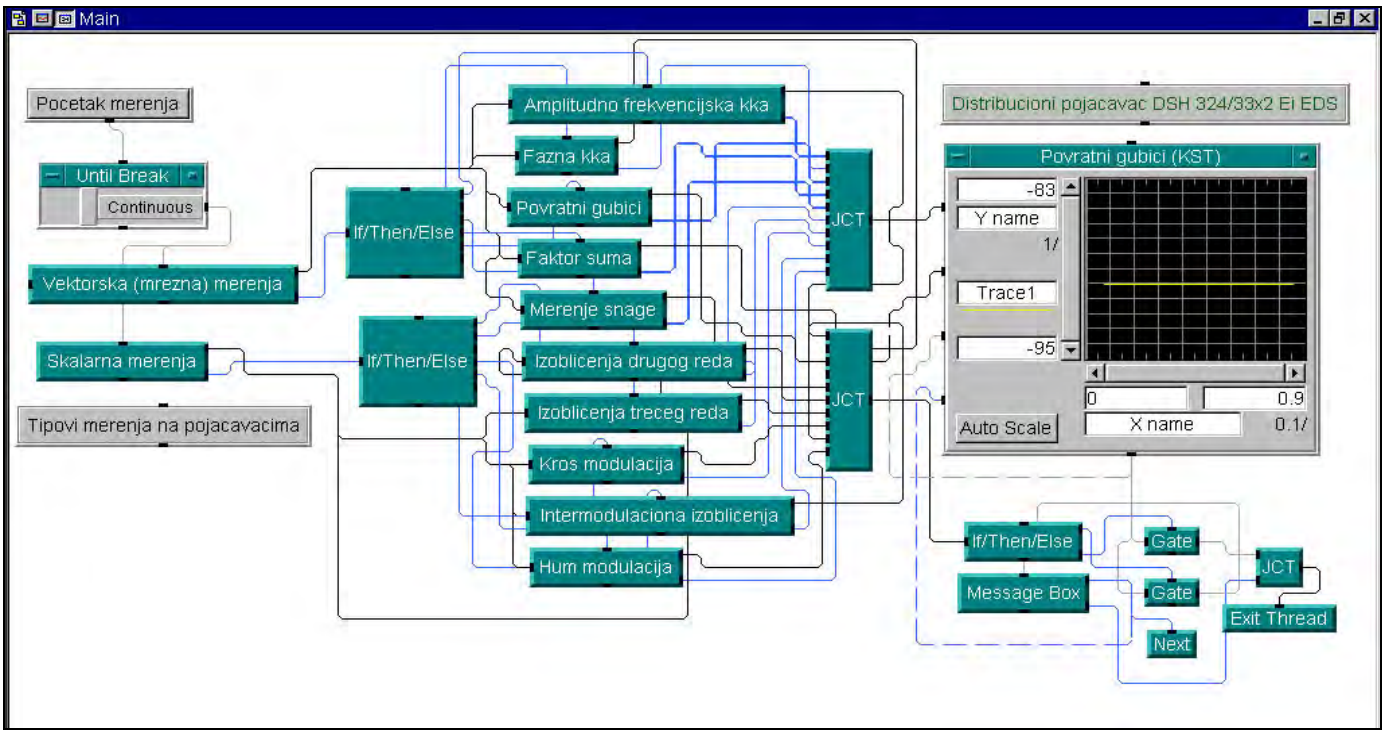

Fig. 2. Part of the designed programme for automatisation of the measurement system

The basic screen (Fig. 3) contains two measuring groups: vectoral (net) and scalar (spectral). From the measuring group a particular measuring is selected from the falling menus. On the right, there is a screen showing the data. There is a possibility of changing the name of asis as desired. There is also a possibility of changing unit range on both sides, which enables zooming of particular characteristics of interest (the size of peaks at particular frequencies as well as frequencies can be determined with higher accuracy). The option of *Auto Scale* enables adjustment of the size of the graphic on a display. The option *Start Measure* signifies that the choice of measuring is completed and that a corresponding procedure can start. In order to verify software, some measuring procedures have been performed at corresponding amplifiers and the gathered results have been compared with factory specifications. The results of measuring for the distribution amplifiers DSH 324/33x2 made by Electronics Industry Co. in Nish are shown in Figs. 3, 4 and 5.

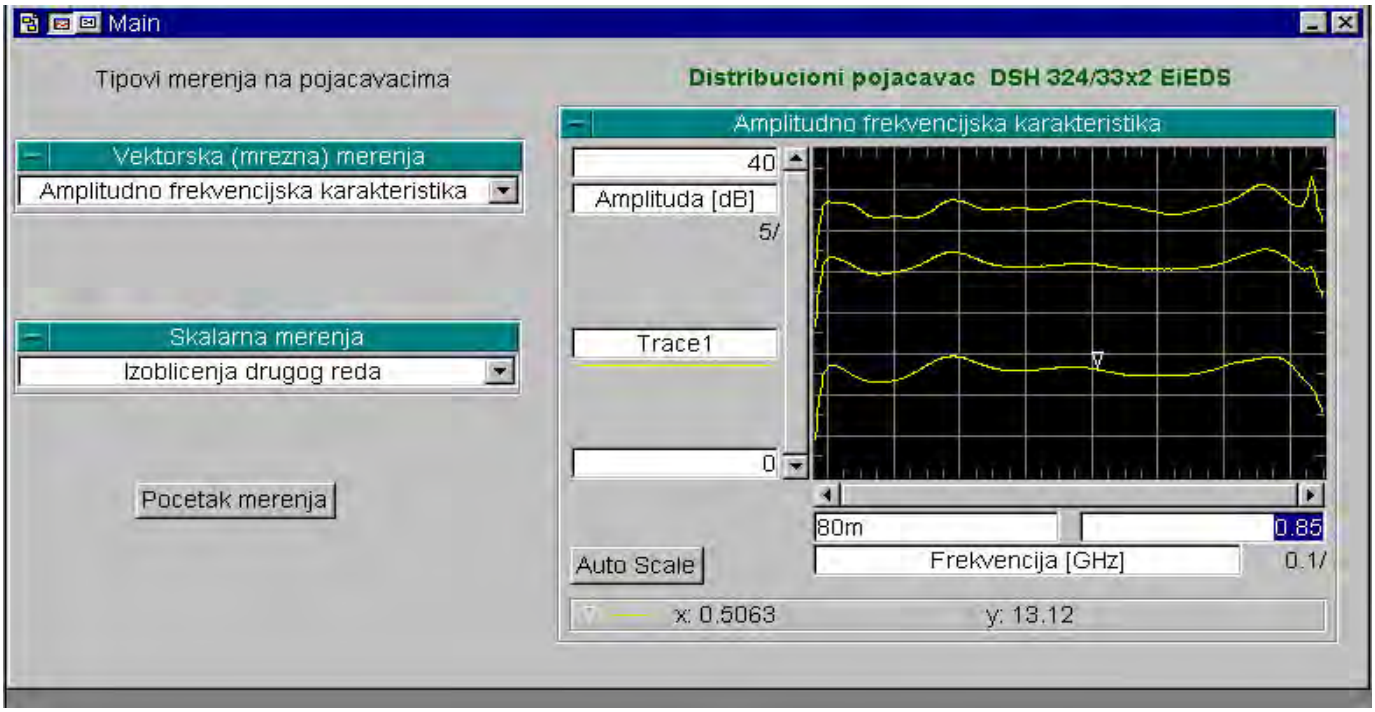

Fig. 3. Display of the measument results of amplitude-frequency characteristics

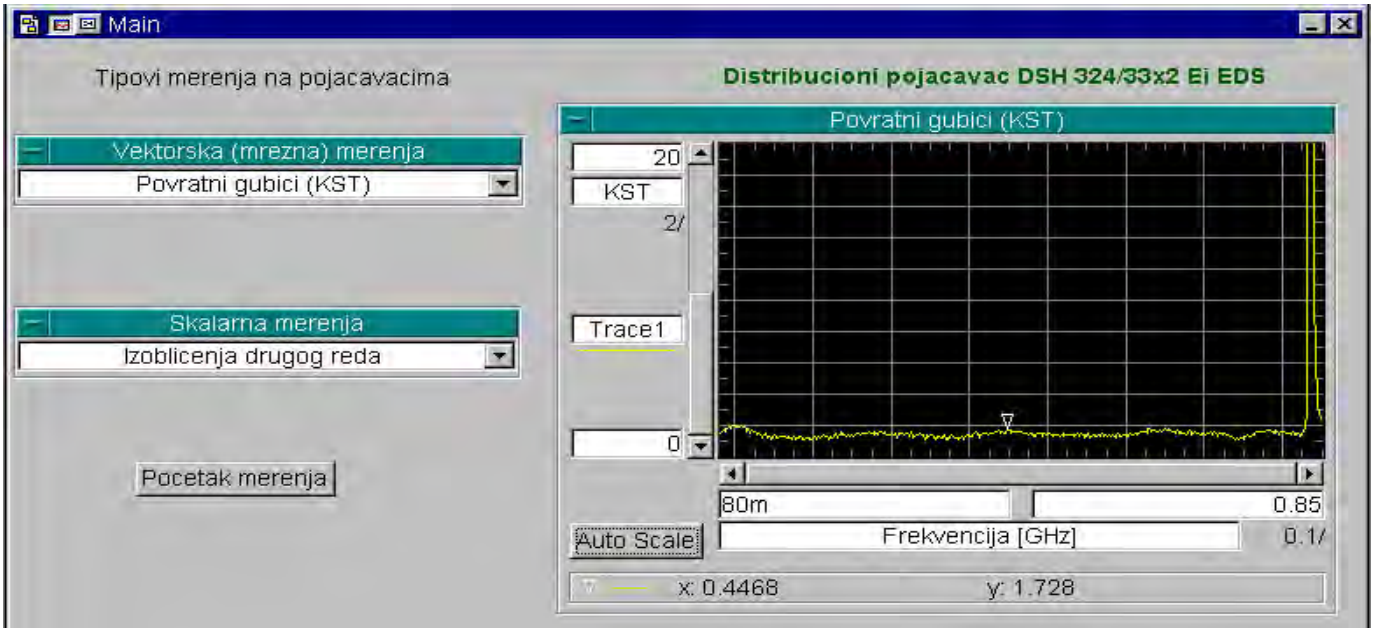

Fig. 4. Display of the measurement results of standing wave ratio

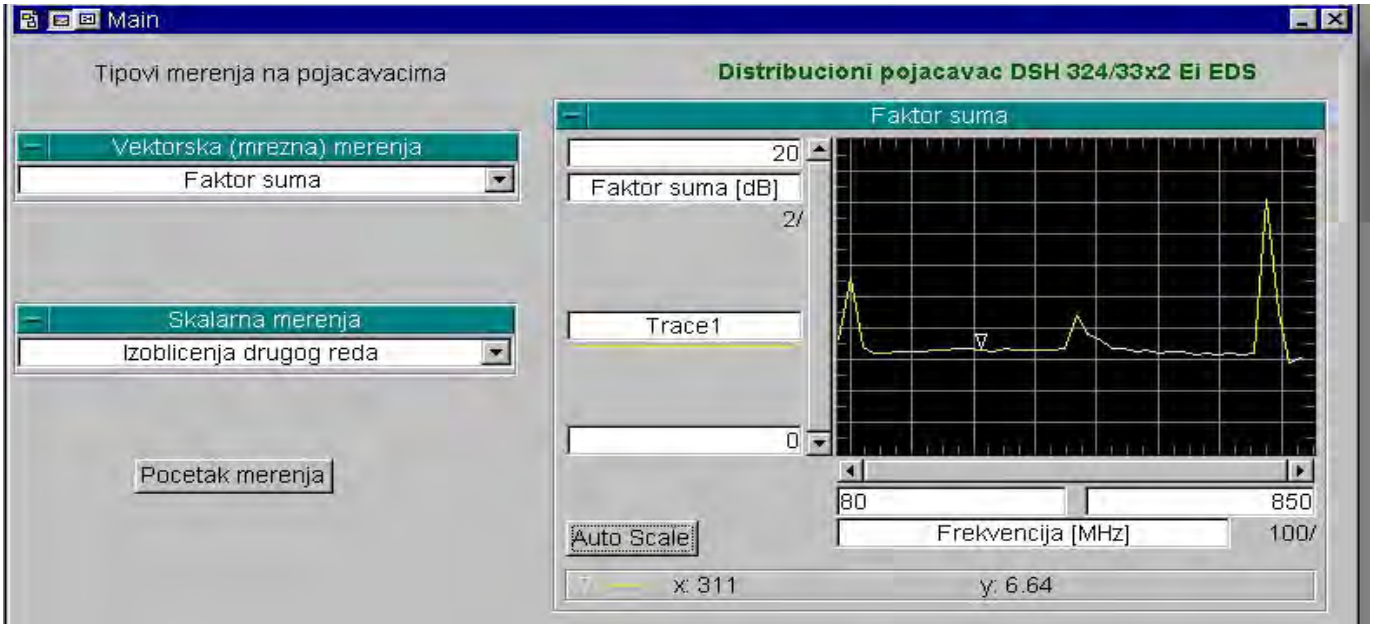

Fig. 5. Display of the maesurement results of the noise factor

V. Conclusion

Characteristics measurement of CATV amplifiers can be often large, difficult to check up and control and poor as far as the outcome results are concerned. For the sake of overcoming shortcomings we have turned to automated measuring by creating a corresponding software in HP VEE environment. This particular software enables not only an easier equipment handling (only by a computer which is the sole comanding component), but its advantages take place both in the measuring process and the process of gathering results (the characteristics drawing, table generating and so on).

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