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ABSTRACT

The advantages of the application of LSI elements in display terminals are discussed and the role of intelligence and the use of colours are emphasized. The architecture of an intelligent colour display terminal is treated in detail and some application examples in the field of process control and business are given.

АННОТАЦИЯ

Указываются преимущества, которые дает применение БИС в дисплейных терминалах. Рассматривается роль интеллектуальности и преимущества использования цветов. Подробно описывается построение интеллектуального цветного дисплейного терминала и дается несколько примеров применения в области управления процессами и автоматизации административных работ.

KIVONAT

Tárgyaljuk az LSI elemek alkalmazásából fakadó előnyöket a display terminálóknál. Vizsgáljuk az intelligencia szerepét és a szinek adta előnyöket. Részletesebben ismertetjük egy szines intelligens display terminál felépitését és néhány alkalmazási példát adunk a folyamat és ügyvitelgépesités köréből.

The advantages of the application of LSI elements in display terminals are discussed and the role of intelligence and the use of colours are emphasized. The architecture of an intelligent colour display terminal is treated in detail and some application examples in the field of process control and business are given.

I. What LSI technology has to offer

As a consequence of the recent development of semiconductor technology the prices of LSI components have significantly decreased thereby exerting a considerable influence on terminal systems. This effect has first of all made it profitable to use colours in terminals of medium and low price categories by the fast capacity increase of semiconductor memory elements in a single chip; the end result of this has been to cause a reduction in the price/bit ratio. A similar process can be observed in the LSI-microprocessor field which is why microprocessors are now utilized in nearly all categories of modern terminals. These sorts of terminals are quite often called "intelligent terminals".

Application-oriented consequences can be divided into three groups:

- The effect of market competition as a consequence of fashion. This factor affects manufacturers as well as users and nowadays it can be considered to be the main factor.
- Advantaged which can be seen or even utilized nowadays. Different ergonomical and human engineering factors are dominant in the case of "colour", whereas "intelligence" is mainly a benefit in flexibility and economy.
- The use of colours as well as the appearance of microprocessors as new terminal building blocks are brand new, essentially unused possibilities as yet. Colour gives rise to new application fields, and on the other hand leads to future changes in the structure and design of present-day systems.

This process - which is a general trend, and a part of the so called "intelligence decentralization" - brings more and more tasks to the terminal "level".

Intelligence

There is a tendency among manufacturers to claim that their products are "intelligent". Our view is that the application of microprocessors in control does not meet the demands of intelligence even if a "soft-centred" terminal controller has many advantages for the manufacturer /as a consequence of flexibility/ as well as the user /e.g. in periphery handling/. Though the direct outcome - programability - is the necessary basis of an intelligent terminal, it is not however, the only form of its appearance since it can, for exanple, be the tool of the emulation of an existing system, but we would not consider it as intelligence. Intelligent terminals having the features of the above mentioned two groups should in addition, be able to realize functions defined by an intelligent user /e.g. the modification of data or their form/ and in many cases they provide "off-line" type facilities.

Table 1 summarizes the advantages of intelligence from the manufacturer point of view and from that of different kinds of terminal users.

The role of Colours

Considerations

Prior to the design of a colour display terminal one should consider precisely what role colours have when displaying different problems. Here want to emphasize just some of the factors.

Good arrangement

The use of colour enhances the arrangement of the picture. Different colours distinguish different functions thereby facilitating orientation even at first glance. This is an important factor in complicated figures but its importance should not be neglected even when the figure itself is not complicated but the person is untrained /e.g. personnel working at aiports or in banking who may not be expected to have a background in using display terminals/. etc.

Highlighting

Often it is important to highlight parts relating to highly informative aspects or warnings. This can be achieved by using a colour /e.g. red/which greatly differs from the colour of the picture or, alternatively, a background colour can be used.

Feature	The role of intelligence at the level of			Comment
	manufacturing	general application	process control	
Programmability	Soft centred control. Family principles	Emulation Communication protocol realization	User-defined functions	General flexibility
Stand-alone working mode	Off-line test capability	Validity checking of data entry. Peripheral device driving /e.g. Floppy-disc/	Picture generation Validity checking of operator manipulations	Microcomputer
Distributed processing /task distribution/	Support Software. Complex text.	Data formatting. Editing. High-level language /e.g. BASIC/	Screen - split - rolling - enlargement Data processing /deviation, statistical/	Hierarchical structure

Table 1.

Concentration

Information can be concentrated by the adequate use of colours in such a way that a certain colour indicates not only a shape but a state too /e.g. on a traffic control screen the colour for a vehicle symbol varies according to its load./

3-D effect

By appropriate use of colour, excellent shading effects can be achieved; this is an important element for three-dimensional display.

Aesthetics

By no means least is the fact that colour display has a certain aesthetic effect which induces a pleasant emotional feeling in the operator and in the client too. It is very important in the field of business applications when the mass of displayed data may sometimes distressing. We consider this factor as having been important during the early spreading of colour displays.

II. Organization of the colour terminal

Picture generation

The quality of a coloured picture is defined by the colour and the linear resolution.

Our intent was to develop a terminal to process control and business applications we found that the quality requirements of both applications can be met by using a standard colour TV monitor. In order to decrease the size of the refresh memory, symbol-matrix type picture generation was employed. By selecting a 7x9 dot matrix as a basic symbol size, a maximum of 64x32 symbols can be placed on the screen. This corresponds to a 448x288 dot resolution.

Any kind of alphanumeric or graphic 7x9 dot symbol pattern can be realized, however, a maximum of 227 different patterns can be defined at the same time. This symbol set can be given and altered according to user needs. Although the number of colours which can be displayed is given by the eight combinations of the three basic colours of the TV monitor, the colour information can be further increased by using the combinations of the background colours and the inverse display mode.

The symbol-matrix picture generation technique results in a decreased degree of freedom as compared with the addressability of every dot on the screen, yet the process control schemes and business application tables can be generated quite easily this way. At the same time the refresh memory capacity required can be decreased by more than an order of magnitude.

Symbol definition

Two bytes of information are necessary to define a symbol-matrix:

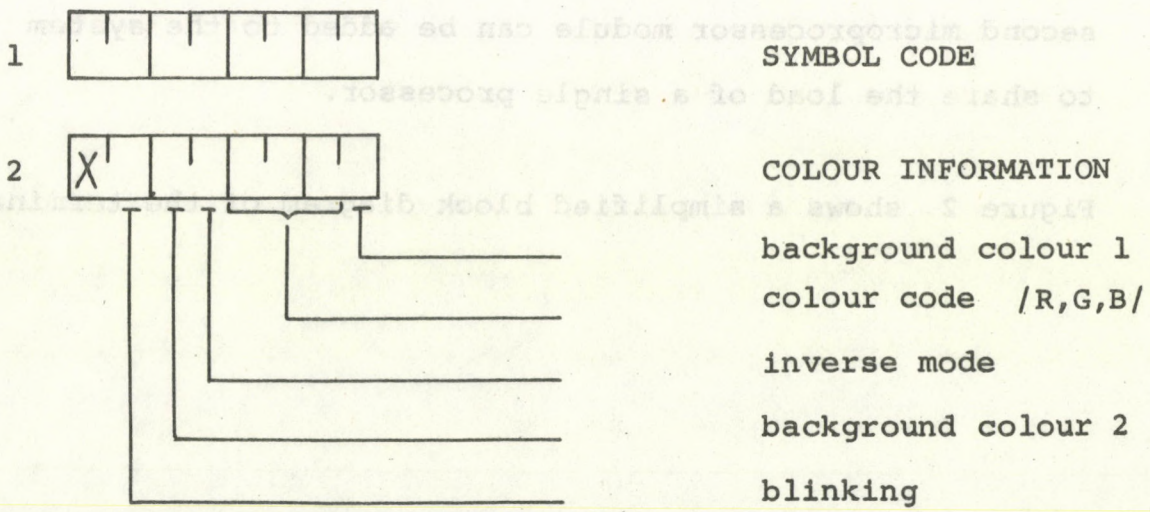

Fig. 1.
Symbol definition.

As can be seen in Fig.1, eight different colours for pattern drawing, and four colours for background can be selected; the pattern and background colours can be exchanged /inverse mode/ and the entire symbol can be blinked, as defines by the second byte.

Hardware

As mentioned earlier, today's LSI technology renders possible the up to date realization of an intelligent display terminal. In our design we used INTEL's 8080A microprocessor and its support circuits.

All functional modules are plugged into a time-shared Multi Microprocessor System Bus, enabling simple hardware reconfiguration and extension. If necessary, even a second microprocessor module can be added to the system to share the load of a single processor.

Figure 2 shows a simplified block diagram of the terminal.

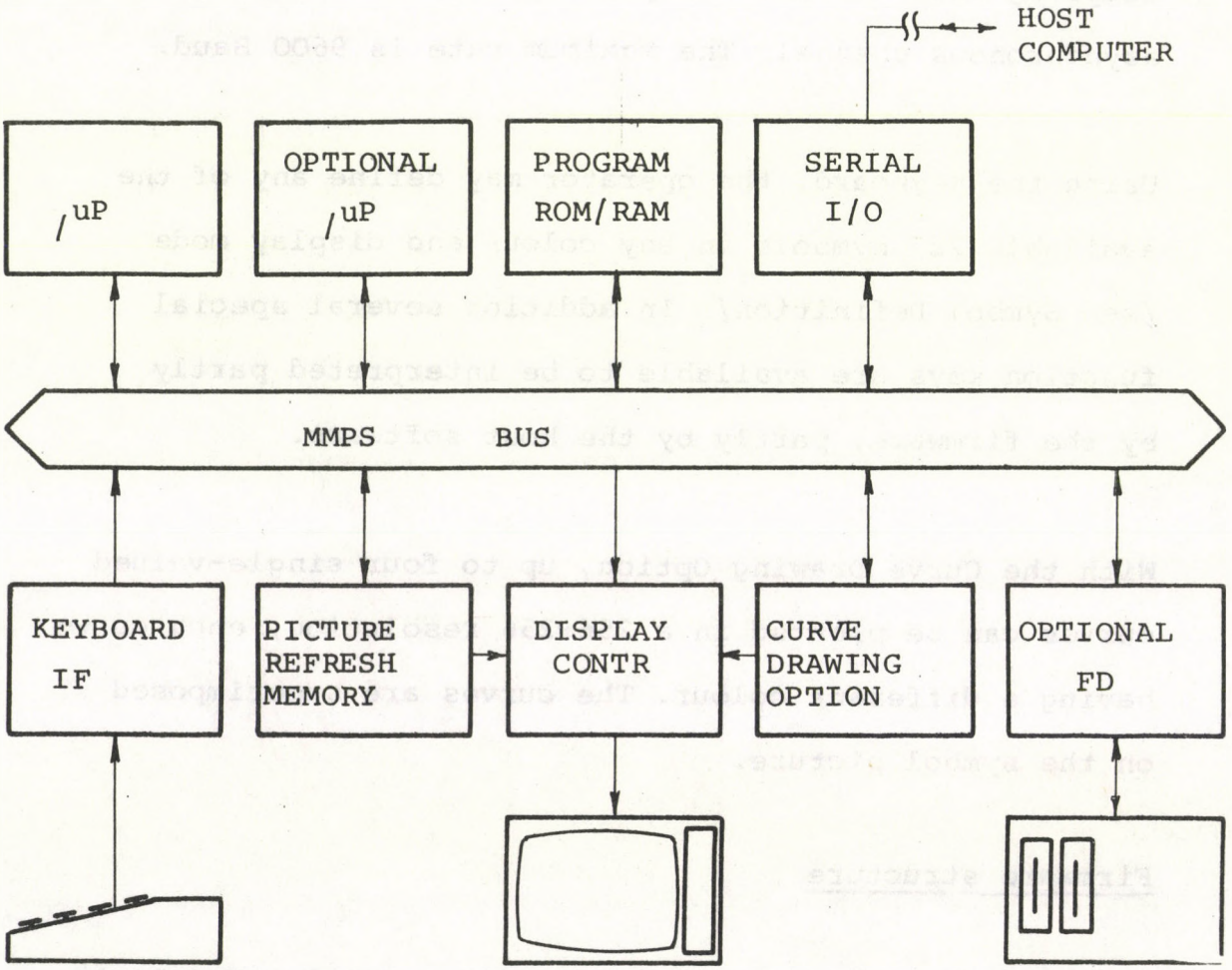

Fig. 2.

Structure of Hardware

The firmware is written into EPROM's, for program working registers and I/O buffer static RAM is employed. The picture refresh memory is made of 4K dynamic RAM elements. Coupling with the host computer is via full duplex serial asynchronous channel. The maximum rate is 9600 Baud.

Using the Keyboard, the operator may define any of the available 227 symbols in any colour and display mode /see Symbol Definition/. In addition several special function keys are available to be interpreted partly by the firmware, partly by the host software.

With the Curve Drawing Option, up to four single-valued curves can be plotted in a 256x256 resolution, each curve having a different colour. The curves are superimposed on the symbol picture.

Firmware structure

The Firmware of the Intelligent Colour Display Terminal consists of the four main parts shown in Fig. 3.

Firmware F1 handles information originating from the keyboard. On the keyboard the operator can select symbols, define the position and colour of symbols, send messages

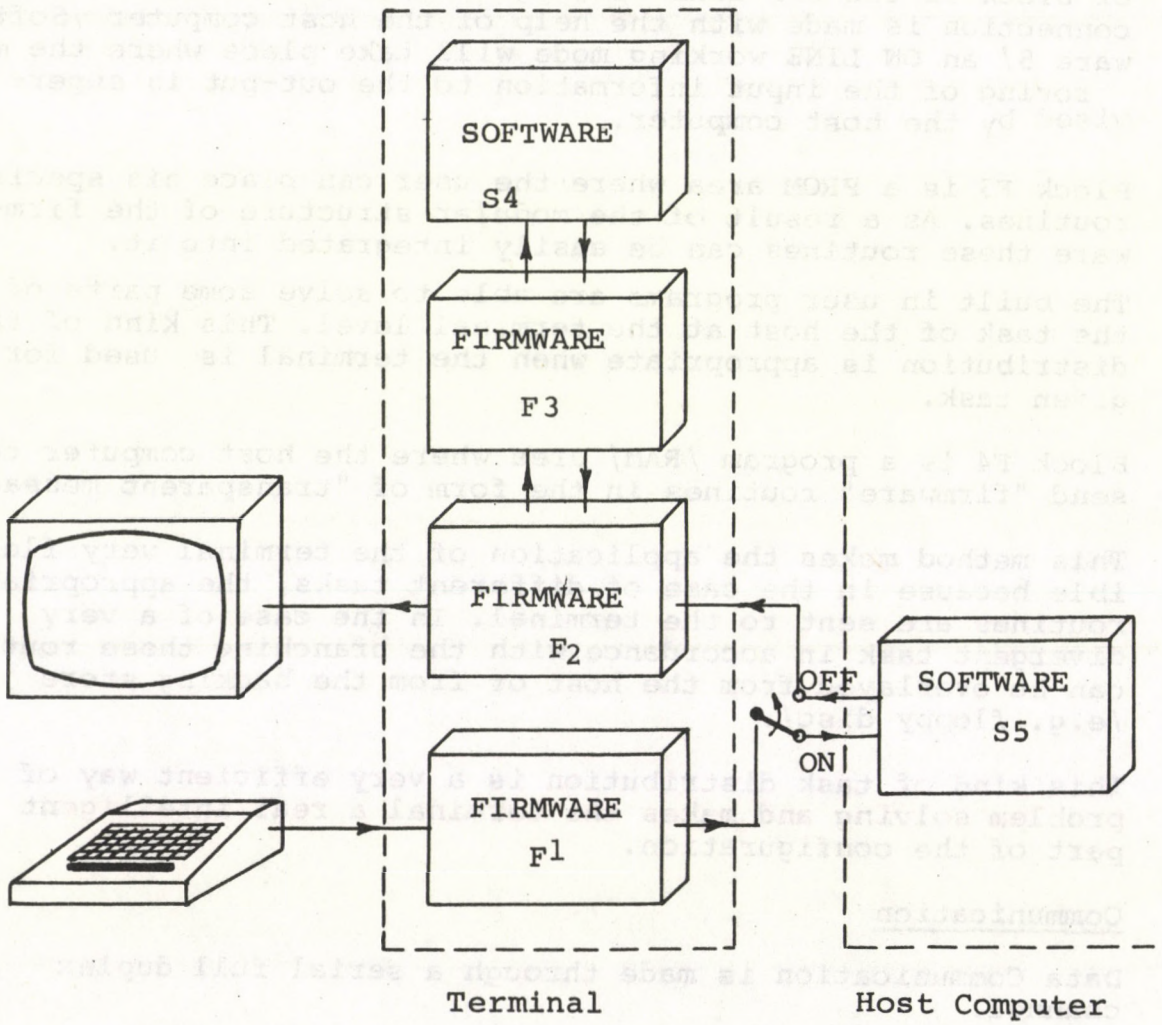

Fig.3.
Structure of Firmware.

or commands. The task of this firmware is to interpret the codes of the keys and prepare a format according to the communication procedure /line-format/.

Firmware F2 generates the picture from the incoming information. It handles the line-format of data and commands, selects the necessary routines to generate picture or to perform the required functions.

If the output of Block F1 is connected directly to the input of Block F2 the OFF LINE working mode is realized. If the connection is made with the help of the host computer /Software 5/ an ON LINE working mode will take place where the mirroring of the input information to the out-put is supervised by the host computer.

Block F3 is a PROM area where the user can place his special routines. As a result of the modular structure of the firmware these routines can be easily integrated into it.

The built in user programs are able to solve some parts of the task of the host at the terminal level. This kind of task distribution is appropriate when the terminal is used for a given task.

Block F4 is a program /RAM/ area where the host computer could send "firmware" routines in the form of "transparent message".

This method makes the application of the terminal very flexible because in the case of different tasks, the appropriate routines are sent to the terminal. In the case of a very divergent task in accordance with the branching these routines can be overlayed from the host or from the backing store /e.g. floppy disc/.

This kind of task distribution is a very efficient way of problem solving and makes the terminal a real intelligent part of the configuration.

Communication

Data Communication is made through a serial full duplex channel.

The applied "line-formats" are as follows:

a/ The codes of symbols are transmitted in the form of single bytes.

b/ Functions, definable by one character /e.g. cursor movement, clear/ are transferred in a two byte format where the command defining character is preceeded by an ESC character.

c/ Instruction needing more information /e.g. colour definition, cursor positioning are transmitted in a three or four byte format. Following the above mentioned two characters, additional /data/byte/s/ are transmitted.

d/ To send a larger amount of information /e.g. a program, or in the presence of the Curve Drawing Option the data of a complete curve/ the "transparent message" mode is used.

III. Applications

Applications will be discussed in the fields of process control, business and scientific research. The advantages of terminal intelligence and the use of colours are emphasized.

Process Control

In the field of process control one of the most characteristic applications of a display terminal is to display a schema of a part of the process and to indicate the actual parameters. To get an easy understandable picture, the different parts of the schema are displayed in different colours. The different types of data and the state of variable elements are also distinguished by colour.

In the given example /Fig.4/, the schema of an oil storage system is shown. The tanks are displayed in blue, the pipelines in white. The closed state of the valves is displayed in red, the open state in green.

The operator is able to arrange the transfer of oil from one tank to another by changing the state of the valves interactively. A built in user program can test the correctness of the selected path and warn the operator in case of error. This feature is in accordance with those mentioned in Table 1.

Business application

In the field of business application the task of the terminal is mainly to display data in an arrangement of tables and diagrams. Colour is a very helpful tool to separate different groups of data and to make any relationships clear.

An example of the type of application mentioned above is illustrated in Fig.5. Where an airport information service is displayed on the screen. Data of different flights are displayed in different colours so it is very easy to select the flight of interest. To highlight a warning or message the blinking facility is also available.

Scientific Research

The task of the colour display in the field of scientific research is mainly to display measured data. There are two possibilities to display curves in this terminal. The first one is to use the Curver Drawing Option, where up to four single-valued curves of 256x256 resolution in different colours can be displayed.

The other method is to assemble the appropriate symbol elements fitting to the measured spectrum by a special program.

An example of the second method is displayed in Fig.6.

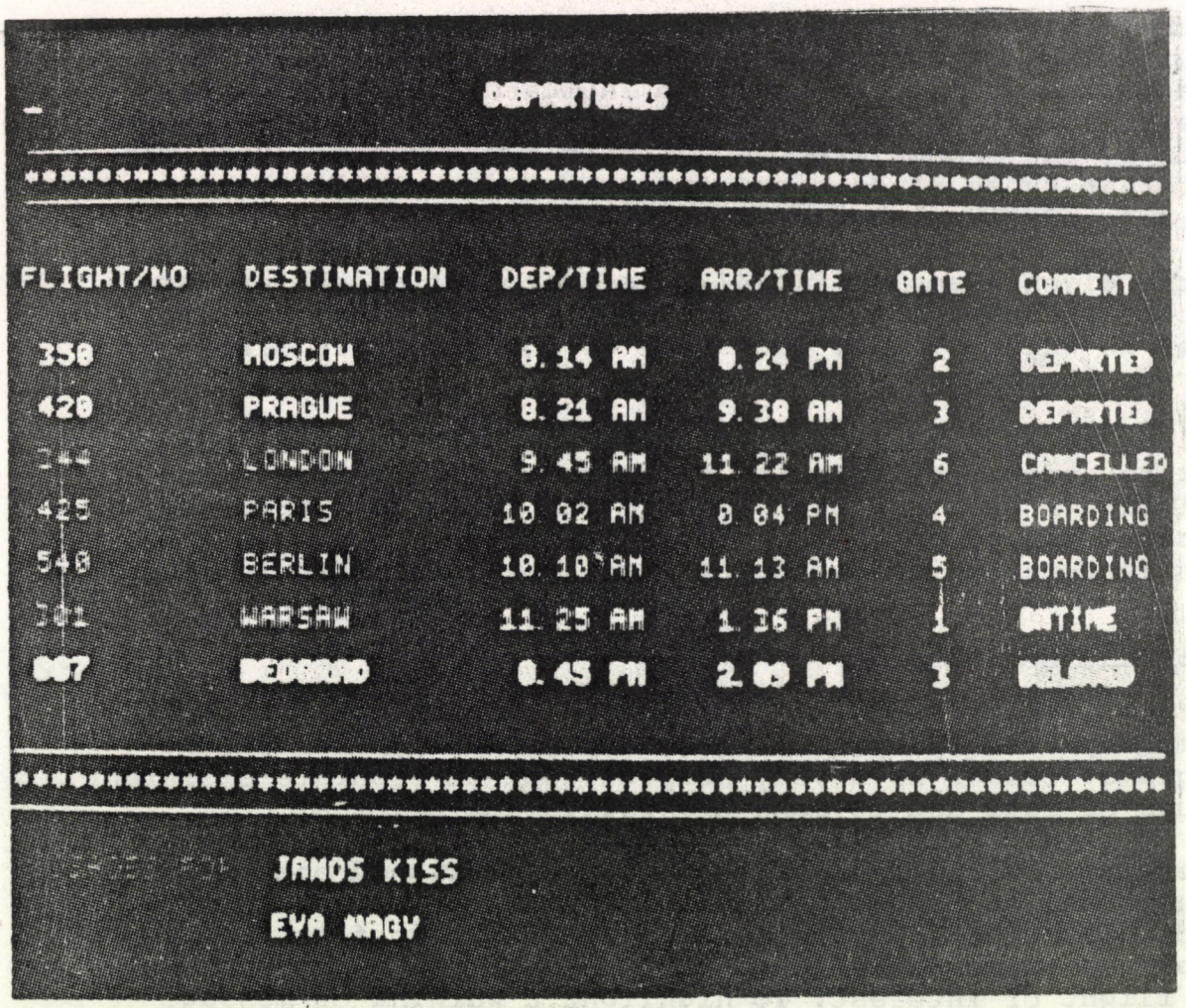

Fig.5.
Airport information.

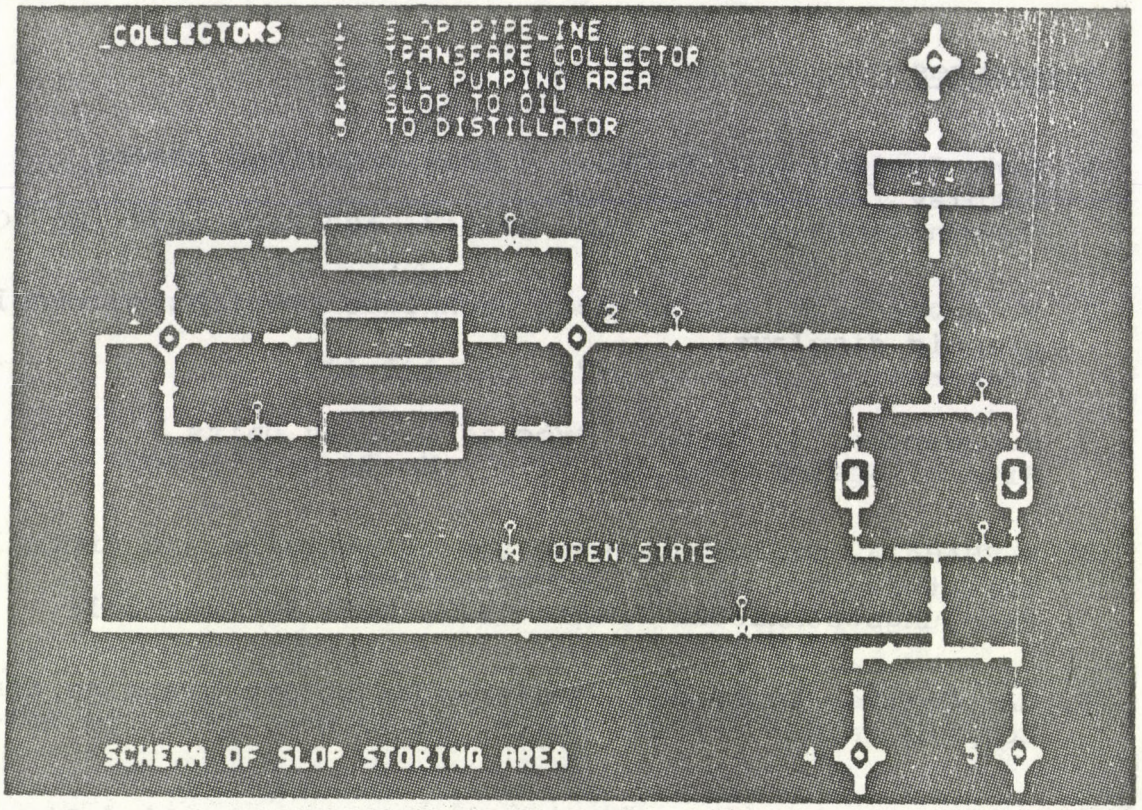
COLLECTORS
1 SLOP PIPE-LINE
2 TRANSFARE COLLECTOR
3 OIL PUMPING AREA
4 SLOP TO OIL
5 TO DISTILLATOR
OPEN STATE
SCHEMA OF SLOP STORING AREA

FIG.4.

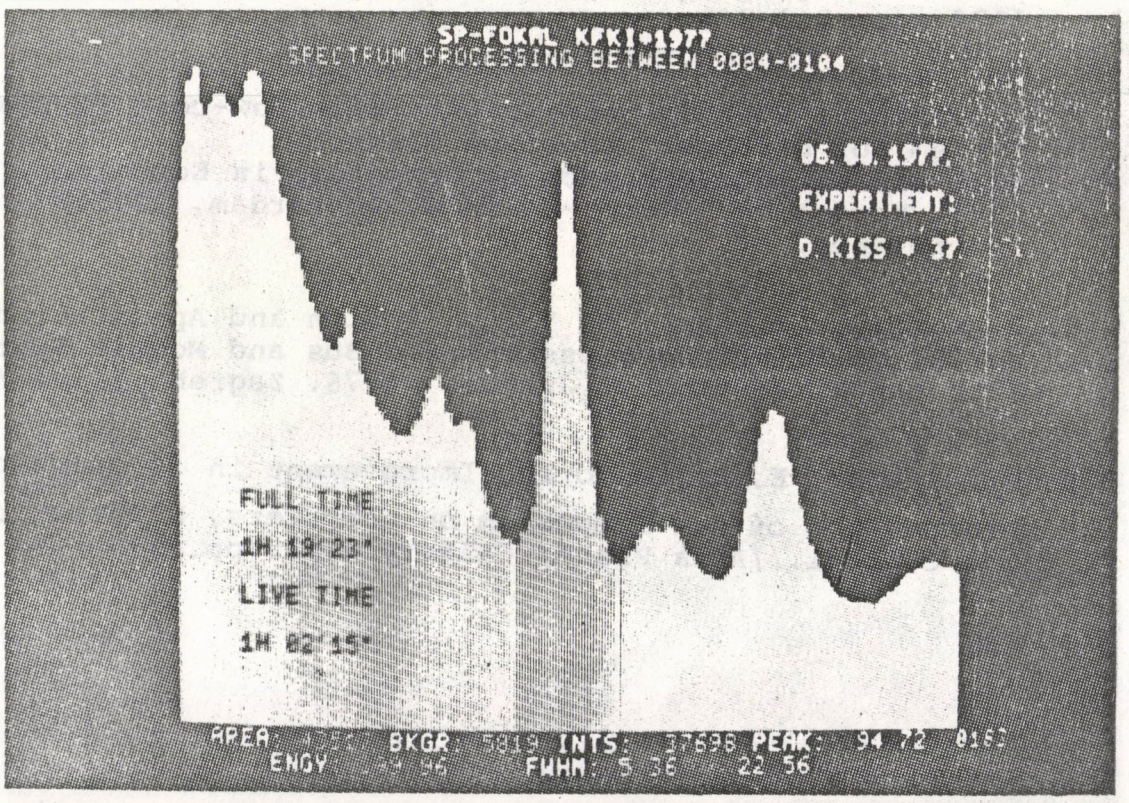
SP-FOKAL KFKI•1977
SPECTRUM PROCESSING BETWEEN 0004-0104
06.08.1977.
EXPERIMENT:
D.KISS • 37
FULL TIME
1H 19'23"
LIVE TIME
1H 02'15"

FIG.6.

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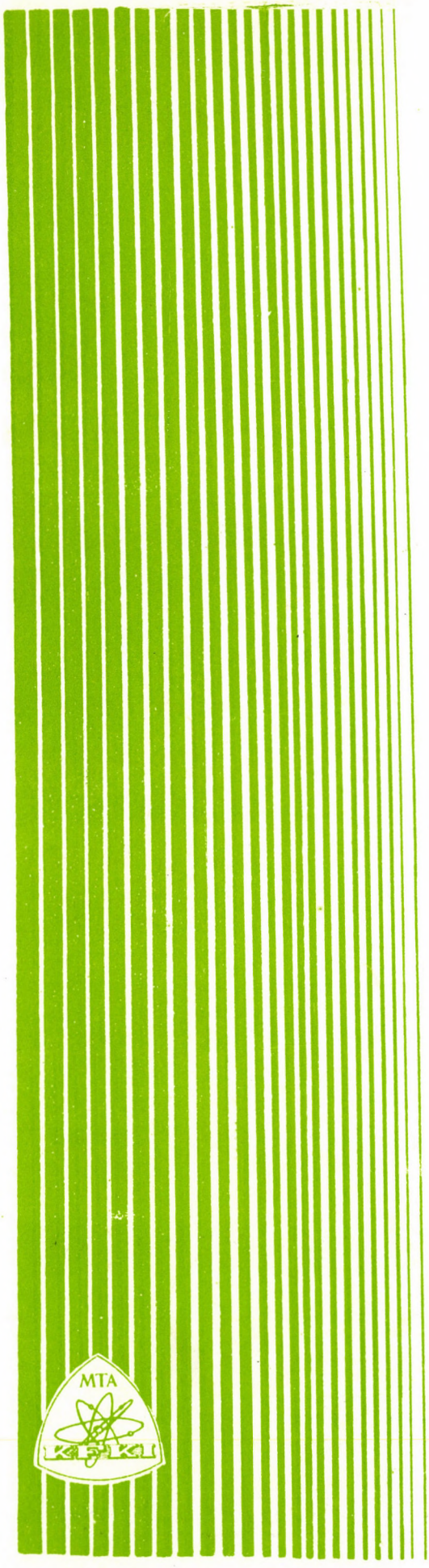

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