ELCOM

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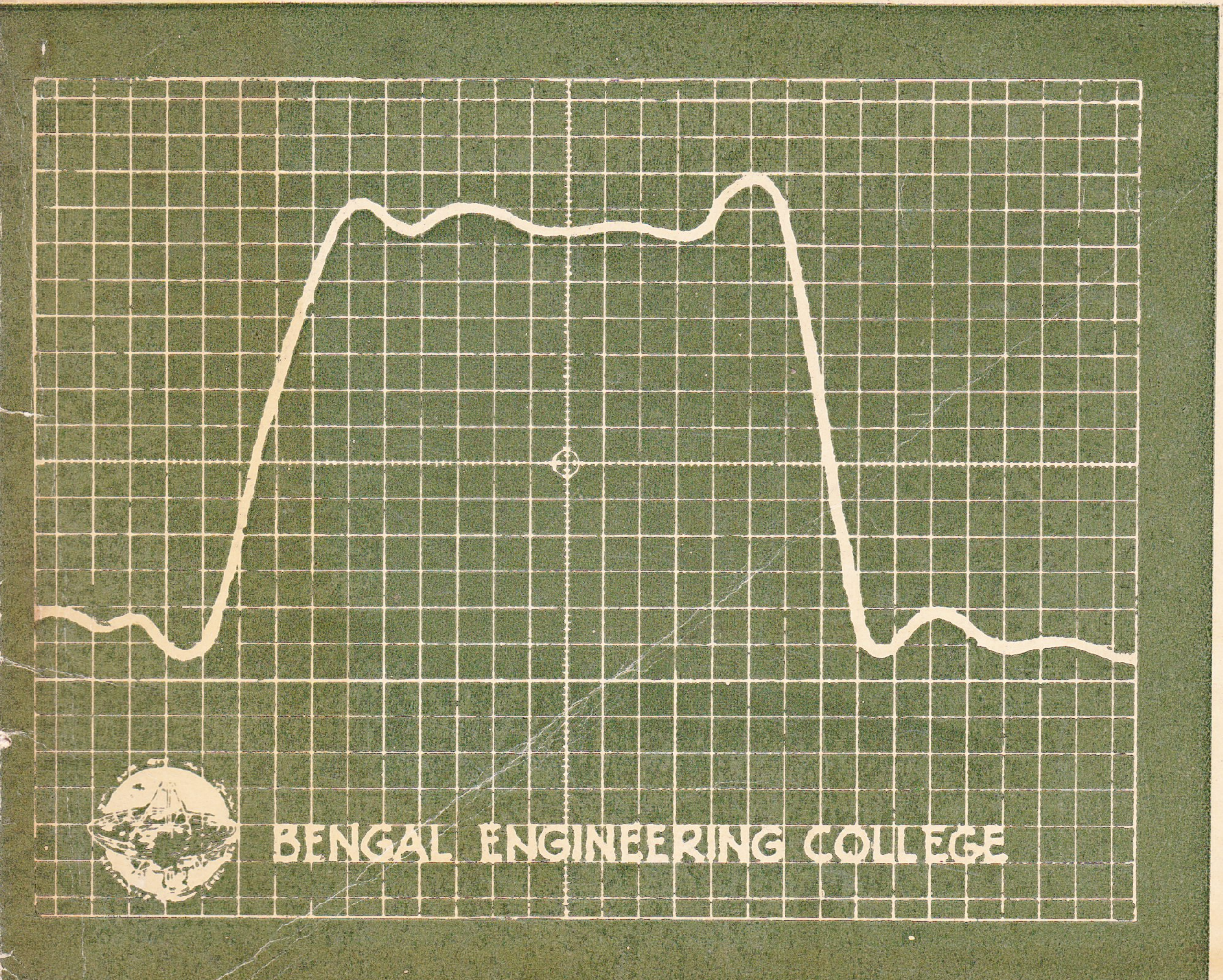

ELCOM

Electronics And Tele-Communication Engineers' Society

EDITED BY

ASHITABHA PAL

ELCOM

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"ELCOM"

THE ANNUAL TECHNICAL PUBLICATION OF
ELECTRONICS AND TELE-COMMUNICATION ENGINEERS' SOCIETY

BENGAL ENGINEERING COLLEGE
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Dr. S. M. Mukherjee
M. Sc., Ph. D., F. T. I. (U. K.)
Director of Industries (Retired)
West Bengal.

27th February, 1981.

To
The Editor,
ELCOM, B. E. College.

I congratulate the Students Society of Electronics and Tele-communication Engineers B. E. College for publishing another issue of their Magazine ELCOM. Electronics has now assumed a vital role in determining a country's advancement in science and technology. Those who belong to the Society of Electronic Engineers have the important responsibility of providing the know-how for the development of electronic industries in our country. I hope that through magazine ELCOM, the Electronic Engineers of B. E. College will execute their share of responsibility for uplifting the state of electronic industries in West Bengal.

S/d-
S. M. Mukherjee

Dr. S. S. Baral
PRS, D. Sc(Cal), FIETE, FIE CEng (India), MSRE (France)
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The 20th February 1981

Message

To
The Editor,
ELCOM, B. E. College

I am happy to send my greetings of goodwill and affectionate remembrance to those who have strived hard to bring out another issue of the magazine ELCOM. I still remember many of your faces. Your faces have merged into the very fabric of my mind. The colour of that fabric is still warm and glowing. May ELCOM put a distinguishing stamp on your studentship. May you achieve such excellence that all who came after you remember you with pride and admiration.

Big powers of the world have big achivements in electronics. Electronics has now become a measure of national growth. Shake off inertia, reduce your time-constant. Improve continuously upon traditional methods of working. Call the past "worthless" by all means, but show that the present is not "more worthless". Those who belong to professional societies should work individually and collectively to face the challenge of change that lies ahead. Build up courage, character, conscience. Remember that members of professional societies know no boss except their own conscience. Play major role in bringing about transformation and development in the teaching of Electronics and Telecommunication in Bengal Engineering College.

S/d-
S. S. BARAL

Gram : TECHNICS

Prof. A. K. Seal
B Sc (Hons.), B E. (Met.), Ph. D. (Sheffield), C. Eng. MIIF (Ind.), FIM (Lond.), FIE (Ind.),
National Metallurgist, 1965
Principal

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BENGAL ENGINEERING COLLEGE
P. O Botanic Garden.
Howrah-711103

21st February, 1981

MESSAGE

I am glad to learn that the Student's Society of Electronics & Tele-Communication Engineers is bringing out its Annual Number "ELCOM".

I must congratulate the Society for venturing to pull all its resources for publishing the issue in these hard days of soaring prices of printing and stationery and the paucity of advertisements ELCOM is just one of a number of Society magazines of the College I trust the present journal will not only live up to the reputation of its sister journals but also improve upon them both in content and depth of its reading materials and in format.

Electronics & Tele-Communication Engineering have opened up new vistas in the applied sciences of engineering and technology and holds promises of further opportunities and challenges to newer generations of scientists and engineers for discovering "brave new worlds". I have no doubt that our undergraduates in the Department will equip themselves suitably to accept these challenges

I conclude by conveying my greetings and good whishes to the Society and also the Staff and Students of the Department of Electronics & Tele-Communication Engineering through the medium of this Annual Number.

S/d-
(A. K. Seal)
Principal
Bengal Engineering College

Bengal Engineering College
Howrah-711103

P. K. Sinha Roy,
Professor & Head of the Department,
Electronics and Telecommunication Engg.

Dated 28th January 28, 1981

MESSAGE

I am pleased to learn that ELCOM is being published this year like the previous year with all its regular features. The enormous task of bringing out a journal in these hard days is really praiseworthy. After its reappearance following a long dormant period it is now expected that ELCOM has come to stay. I offer the editors, and others who assisted them my heartiest congratulations and wish this achievement inspire other students who should come forward and participate in such activities in future.

Let ELCOM remain and grow highlighting the achievements and difficulties of the E & TC Society.

S/d-
(P. K. Sinha Roy)

LETTER FROM THE EDITOR

An advertisement released by the International Telephone and Telegraph Industries in 1979 disclosed a very interesting 20th century statistics. A country's gross national product, it said, was in direct proportion proportion with the number of telephones it had.

The index of technological progress of any country in the time-domain of twentieth century is the status of Electronics & Telecommunication Engineering. This is not only a symbol of technological growth but also through intensive interaction has become the very life-blood of engineering activities. Our ELCOM is a forum for the dissemination of thought, action and creative ability of the budding engineers in this particular discipline.

The successful publication of this journal is the result of sincere efforts and untiring zeal of the student members of society. Besides the contribution from the student members, this journal contains articles from eminent professors and professional engineers. They purport in their smallness to present but a fringe view of the pattern of Electronics and Telecommunication Engineering teaching and practise in a rapidly developing country like ours.

It is of course, realized that the journal ELCOM by itself is too inadequate a vehicle to transmit effectively its readers all the progress in the different areas of Electronics Engineering taking place in the world. Nevertheless. I am sure that it will help the readers in appreciating the importance, development and potential payoff of Electronics in a country's march to the year 2000.

I want to express my deep gratitudes to all the professors of our department, advertiser and all the student members of the society of Electronics & Telecommunication Engineers who have lent their helping hands in publishing this journal.

ASHITABHA PAL
5th Yr. E. & T. C. Engg.

CONTENTS

Progress in Optical Communication Systems

Dr. S. S. Baral, D.Sc., F.I.E.
Retired Prof. B.E. College and
Member WBPSC

Progress in optical communication has been rapid during the period 1970-1980. The rate of progress has been determined by the developments of components such as infrared emitting devices, low-loss optical fibres and photoelectric detectors. Systems, which a few years ago existed only as paper designs, are now being installed as working links. Transmission distances of tens of kilometers have been covered with optical fibres, with the help of regenerative repeaters. The problems encountered in the use of repeaters are largely economic, involving initial cost, maintenance cost, cost of providing housings and also supplying period along the transmission path, if this is not locally available If junction networks can be provided within 10-15 kms distances, optical links wiil be feasible without any intermediate equipment. Optical systems have the advantage that in digital hierarchy, multiplexing upto 1920 channels will be possible. The limitation is imposed by attenuation rather than bandwidth. Optical fibre obviates the necessity of laying costly cables which may be prone to theft. Moreover, since the transmission path is purely of dielectric rather than conductor, induced electrical interference is avoided.

This is important near railway tracks or other electrically noisy area. Optical cable may run near electrical couductors. In hazardous environment such as in a coal mine where break in wire cable may lead to sparking, optical cable are safe to handle. In military applications the light and compact optical cable is certainly more desirable. It also offers higher security, as it is difficult to tape in the path of the optical fibre.

The optical source, the detector and the transmission medium offer flexibility of operation. In optical fibres the most important effects ars attenuation, bandwith and numerical aperture. A core of refractive inpex r_1 surrounded with lower refractive index r_2 has a critical angle θ_c and numerical aperture is $r_1 \sin \theta_c$ Which is equal to $\sqrt{2r \triangle r}$ where $r = \frac{r_1 + r_2}{2}$ and $\triangle r$ is $(r_1 - r_2)$. It is independent of firbre dimensions and is of great importance in determining the power that can be thrown into the fibre from a source. The higher the value of the numerical aperture, the greater the coupled power but the bandwidth is restricted.

Attenuation is caused by scattering absorption and mode mixing. Water free materials are of high quality, since absorption peak of the hydroxyl (OH) group is near the wavelength of interest. Mode mixing is caused by microbending of the fibre. Dispersion can be reduced by grading the index of refraction across the core. Bandwidths of 110 MHZ Km with an LED source, or 350 MHZ Km with a laser diode source, are easily realisable.

Most optical communicotion systems use semiconductor sources : either LED's or laser diodes emitting infra-red. Both semiconductor laser and gas laser are used depending on size, modulation method and carrier frequency. The advantages of LED are high radiance at low cost, high life and reliability, easy modulation and easy to couple to fibre. But they have non-linear transfer characteristics, low power output and restricted banwidth. The advantages of LASER are high output power, large bandwidth, high modulation rate (GHZ) and linear transfer characteristics. But LASER is expensive, not so reliable and difficult to couple to fibre efficiently. A long-distance high capacity trunk system would require a laser transmitter.

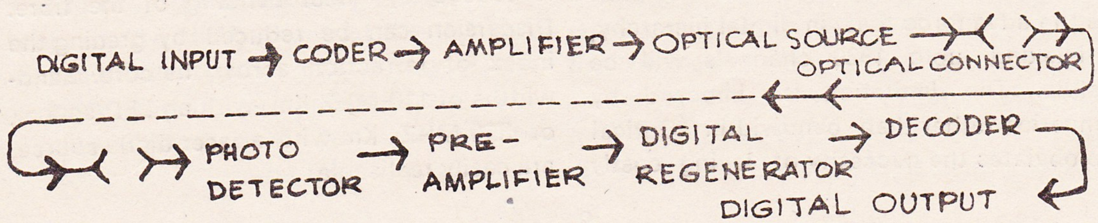
Most opitical detecting systems use Avalanche Photo Diode (APD) and PIN diodes. Phototransistors can also be used in low-capacity systems. An APD is more costly and its circuit is complex. A PIN diode is cheaper and is used for short range data links.

As in all communication systems, the major sections are : Source, detector, transmission media (fibre) and connectors (optical) in optical communication systems. The connectors must be easy to handle with minimum transmission loss and should be mechanically strong. Sockets of yielding plastic material are preferred. Losses of plastic connectors range from 1 to 2 dB.

Optical systems are well-suited to handle digital transmission. Future optical telecommunication networks are therefore, planned for digital exchange linked by digital transmissions : The system is designed as shown below :

A major break through in optical fibre technology occurred early in the seventies when fibres with attenuation less than 15 dB/km were produced. This achievement alone made optical communication an economic proposition. In 1980, optical fibres with less than 2 dB/Km attenuation have been realized. Data transmission, colour television signals, high capacity digital signals can all be accommodated in the fibre. Fibre communication has rendered possible excellent colour TV pictures—conveyed over tens of kilometers. TV signals, encoded into digital form travelled through a transmission link at 160 megabit per second and were received immune to interference, An LED source is preferred to a LASER in this application on grou ds of safety, longer life, simplicity and overall reliability. In a typical system, 7 microwatt peak optical power was launched into the fibre and transmitted over a few kilometers. At the receiving end an APD ensured adequate S/N ratio. Optical data link admit of very compact constructional forms—as a hybrid thick film compact circuit. One obvious application in public service is application of optical fibre communication in railway environment which is prone to high electrical interference.

Opticai fibre cables are light and easy to handle unlike metallic cable of same traffic



capacity: 120 channel systems, and information rates upto 140 megabits per second have been realized. Transmission lengtths upto 20 Kms. have been realised. Receivers using APD have high sensitivity and require only 20 nanowatt of optical power to achieve error rate better than one in a thousand million.

Improved transmission of digitai signals can be realized by a data scrambler inserted in the signal path prior to transmission. This tends to randomize the data and thus reduce dominant spectral components. Degradation of signal result from drift, ageing of electro-optical devices and pulse distortion.

Optical fibre technology will make telecommunication cheap without loss of quality.

It may open up new fields of application. This technology is now passing through a second generation of development since its inception early in 1970. It provides an all dielectric transmission medium. It operates in high interference environments. It has added to overall system economics. Silica fibres with as low an attenuation as 0·2 dB/Km have been realised in 1980. Fibre signal bandwidth can rise to many thousands of megahertz. However, reliable connectors for fibres ($\frac{1}{100}$ mm. dia) pose severe engineering problems, as pose optical splitters and combiners for the data bus and ring systems.

The next generation of optical fibre communication is full of challenging and exciting problems for research engineers engaged in telecommunications research.

Teletext

Dr. Pabitra Kumar Ray

Lecturer, E & T C Dept., B. E. College

A data broadcast system in Television known generally as Teletext is an exciting development in the field of TV technology. As a result of this system the viewer can watch the normal television programs and also the informations and news in the written form on the television screen. Written material has the advantage that it can be read at any pace, the reader can stop to think and re-read the text a number of times. Here the information is transmitted along side the television picture and a teletext decoder extracts and displays it in the form of characters and symbols on the television screen. Viewer can select any of data pages according to his own choice by means of set of control at the receiver. The pages may contain interesting news items, sports results, financial reports, shopping news, weather information and radio and television programs. Teletext is known in different countries by different names. It is Ceefax of the BBC, Oracle of the IBA and Antilope of the French. This facility in the television program is extended through the use of a memory unit. The stored data in the memory unit can be read over and over again to provide a static picture. The data collected from the many input signals can be assembled together to give fuller account of information to the viewer.

Transmission of data signal :

Of the $312\frac{1}{2}$ lines of each field of tv picture transmission about 25 lines per field are used for sending vertical synchronising and test signals. Not all these 25 lines are utilised for these purposes and a number of blank lines are still available for sending teletext signals. The 17th and 18th lines of each field carrry the signal for teletext information in the form of binary pulses. Each line of pulses contains coded data for one row of standard size text or graphics. The rows for a given page are transmitted one after another until the whole page is covered. The tv channel has got wide bandwidth and hence it can accomodate a large number of informations during each active line internal. It is observed that some 720 bits of information can be transmitted for scanning lines. Usually each datapage consists of 24 rows, each row containing 40 characters. If every line of a page has a text or graphics on it, the page takes 0·24 secs, to transmit. Binary pulses on the data lines are grouped into two sections. First section identifies the row of the text and the second constitutes the contents of the row. Each letter, number or graphic symbol is represented by an eight digit binary number and tne bit rate is 6·9375 M bits/sec.

Reception of data signal :

Normal television receiver capable of receiving television picture will be able to receive teletext. But in this case additional circuits are added to decode a teletext message. First, data extraction and recognition circuits examine the incoming teletext data and extract those signals which constitutes the page which is selected. The data from these lines is tnen stored in Random Access Memories and the page is displayed at the same rate as the normal picture. The binary number codes are then translated to to their corresponding character or graphic pattern by a character generator. These are finally displayed over the television screen. The page header that contains information on time, date, title, page number and some control information enables other rows to consist almost of data necessary for the characters to be displayed.

Futuristics :

There is a possibility of reducing the demand on telephone network for such matter as weather information, time, sports results and so on, as all such information would be readily available at the touch of a switch of a receiver. Further a concept of total integrated subscriber service can be introduced using the data receiver. In this case the data terminal provided in the subscriber's house when linked to the telephone network will give scope to new services of individual charecter. One can get local shopping information, travel information, entertainments, one's own bank statement and so on. Thus the subscriber will enjoy broadcast program via aerial connection and individual matter via telephone connection.

Aspiring further it is visualised that a receiver incorporating a memory unit of enhanced capacity will increase the scope of broadcast data enormously and if the transmitter is used for data after the close down of television programs, all lines can be used for data with an enormous increase of magazine material, if this is readily stored, with the result that one will read it out next day as one reads a newspaper.

Software Development Of Microcomputer Systems

Siddhartha Basu, Ex-Student (1978)
Tata Cosultancy Service, Bombay

The great advantages of microcomputer development system are the simplicity of hardware design, availability of low-cost hardware chips—thus a tremendous reduction in the hardware development time. Hence software is becoming of major importance in systems based on microprocessors.

But what is development software ? Hardware gives you a bare machine. Now comes the question of software. Basically, software serves two things—first, effectively utilizes the components of the system and its activities and second, improves communication gap between man and the machine. Software can be of two types—they are called development software (or system softwa e) and application software respectively. For a computer, the presence of the system software is a must. Application software is needed if the system is meant to be used in commercial and business purposes only. This article will briefly explain the necessity and function of system software of a computer system, with special emphasis on microprocessor-based system.

The biggest software for a system is called the operating system. Actually, it is master (brain) of the system. This brain has got different names—the operating system (made popular by IBM), the executive (made popular by UNIVAC systems), the Master Control Program or MCP (by Burroughs Corporation), etc. Briefly, an operating system keeps track of all system activities, talks to the user, controls internal activities in a very efficient manner. For small systems based on microprocessors, a term called 'Monitor' also means a mini-operating system. This monitor/operating-system operates with the the help of other development software programs. Every manufacturer of a computer system provides this software (OS or MCP or EXEC) alongwith the system.

Also, almost all manufacturers offer a complete package of development software programs. Normally, they are available in two forms—in the manufacturer's development hardware : on magnetic tape for entry into a user-owned larger computer (so called cross-computer programs). These development programs are supported by some independent software houses. But, what are these software programs ?

Basically, there are five categories of software programming tools for microcomputers. These are listed below. There functions are also explained,

a) Text Editors
b) Translators (assemblers, compilers or interpreters)
c) Loaders
d) Sinulators and/or cross-simulators
e) Debuggers

a) Text Editors—Editor program takes the source program, written in higher level or assembly level language and entered thru 'a keyboard or paper tape and transfers it into a file in backup memory (such as a tape or disk). The editor also acts on special commands from the user to add, delete, search, display or replace portions of the source program in the auxilliary memory. There may be varieties of editors. Sophisticated editors have large and complex user commands set. However, the less sophisticated text editors are easy to learn (to use).

b) Translators—Translator program translates the whole source text to the object program according to the machine's object code. Normally, translators can be of two types—higher, level translator and assembly level translator. Assembler or assembly level translator translates from assembly level language. There may be cross—assemblers which takes the assembly language program of one microprocessor and produces object program of another microprocessor. Depending on the need and requirements, user chooses assembler or cross-assembler. Say, you have got a full 8080-based microcomputer system. But, previously you have developed many programs using 6800 microprocessor assembly language Then, you need a cross-assembler which runs on new 8080 based system to convert 6800-based programs to 8080 microprocessor machine code. Of course, you also need an 8080 assembler because you may not be developing any programs with 6800 microprocessor in future. Higher level translators are mainly compilers and interpreters. These software tools are more costly than assembly level translators. There are many high level languages available on microprocessor (versions of BASIC-Beginner's All Purpose Symbolic Instruct on Code, PL/1-Programming language one, PASCAL, FORTRAN-Formula Translation, etc.). Programming with higher level languages have got many advantages-Programs are designed quite fast, they can be debugged easily, etc. If a high level language is chosen for the microcomputer system, a translator is needed to produce object code. Compilers are those which translate the whole source program into objeot code program in memory. Later on, the object program may be executed by the system. Interpreters are different. They translate each line of the source program into an intermediate language and executes it immediately before translation of the next line. There are many varieties of interpreters. For their immediate excution facility, interpreters are slower than compilers. But they are very useful as debugging tools. It is the customer's choice that he would prefer which translator and the important points of consideration are cost factor, programmer skills, available memory size, etc.

c) Loaders—Normally, translators produce object code program and keep it into a backup memory (such as disk or tape). A loader is a program which transfers the object program from the external medium (such as backup memory or paper tape) to the microcomputer main memory. There are varieties of loader available today. The simplest form is absolute loader which takes the information from the assembled object program about the starting location in main memory and loads it accordingly. Some loaders also convert a relocatable version of the object program to a loadable version. A program might originally be assembled to reside in the main memory starting from zero address. If the compiler or assembler has allowed the original program to be relocatable, the user can specify to the loader the program's new base address and then the loader will modify the addresses in the object program. This is referred to as relocatable loader.

Another feature that is sometimes available in linkage editing, which establishes the linkage between two object programs that make reference to one another. Linkage editing requires both a compiler or assembler and a loader program that can communicate the necessary informaion to each other.

d) Simulator—These are basically cross-computer programs that allows the user to test the object program by simulating the action of microcomputer when the actual circuitry is unavailable. Simulators also provide certain kinds of diagnostic information unavailble with a debugger program running on the actual microprocessor system like stack overflow, .addition/multiplication overflows etc. They usually allow manipulation and display of the simulated microcomputer memory and CPU registers ; setting of breakpoints and program flow-tracing. Often, they provide timing information, such as the number of instructions or machine cycles executed from program start to stop.

Note that the simulator cannot completely replace program testing on the micro-computer itself, because the specific timing and external environment conditions of the actual micro-computer hardware can never be completly simulated.

e) Debuggers—These programs facilitate the testing of the object program on the micro-computer and its input/output (IO) devices. They usually accept commands from the user to perform such functions as displaying or printing out the contents of the microcomputer memory (called as snapshots), or the contents of CPU registers, modifying the RAM, executing of object program from a specific program location, setting intermediate breakpoints or stop execution when a specific instruction or location or condition is reached.

Note that the above five necessary software can be developed by the user itself. Once ·the user has a system with a small monitor, he can extend the system capabilities by providing these software programs. But, at this point, question may arise, can hardware/software development go parallel ? or, when software development is necessary ?

A microprocessor manufacturer tends to provide support with a standard sequence. After announcing his microprocessor chip, he announces some support chips, those are necessary to develop a complete hardware system. Next, he mounts the microprocessor chip or a printed circuit board with many supporting components, thus producing a standard board layout. Till now, all development was full hardware-based. And the whole computer system is meant to be used by engineers only ; that means, who is ready with hardware equipments and test the system by running programs of absolute machine code form. A primitive software capability is provided at this time, through a small resident monitor. Now the manufacturer turns to develop software tools to make his system useful to all (and not only for engineers and scientists). There starts the development software system. Of course, with the technology development, the system is updated in hardwarc—but this effect is very little like addition/replacement of a chip, alteration of printed board, etc. Accordingly, software may be changed to facilitate more complex operations.

Still one idea, which was pointed out in the description of translators, need more clarification. With the advent of micro-computer systems, the differences between assembly language and high level language have become the subject of continuing controversy. Which type is best for use ? Truely, the answer is not straight way objective Language choice may be influenced by the storage capacity, register available, translator type, system

Interpreter can be ruled out. However, if a popular high level language is available, some of the time-dependent code can be written in assembly language while the remaining code can be written in more powerful form.

A designer should also consider program productivity It the software implementors are all relatively new to the field, the use of a h gher level language will probably the best. At a given programmer's productivity rate, high level language contribute the maximum amount of finished code in shortest pos‹ible time A typical BASIC program might consist of a few hundred lines ; an equivalent assembly language program typically takes up between 10)% to 10)0% more lines than a high-level language program. Thus the programmer saves program coding, debugging and testing cost. He can finish the program sonner. On the other hand, in some typical coses, by finding some novel ways to describe or process data, an efficient and smart assembly language proggrammer can turn a large, complex modale of program into a simple, small and fast equivalent. A complier, on the reverse, works on a rule basis, may generate code of very limited flexibility. So, consider those cases where price paid for using a higher ~~level~~ language (may be less efficient in object program execution) may turn up useless Different microcomputer languages available today one PL/M (by Intel corporation), MPL (by Motorola), PL/Z (by Zilog corporation), micro-forth (by Forth Inc.)—these are medium level languages. Besides, today PASCAL, BASIC, FORTRANS (Some simplified versions) are being supported by manufacturers.

Solid-State Oscilloscope*

Dhiraj Bhowmick (5th Yr. E.T.C.)
and
Bani Prasad Guha Thakurta
(5th Yr. E.T.C.)

In conventional oscilloscopes, we need a bulk cathode-ray tube (C. R. T.) which is also a space consuming device. Now-a-days most of C. R. O. circuitry is implemented by Linear ICs (such as Op-amp.). But it is in the solid-state oscilloscope, as the name suggests, C.R.T. is replaced by a dot matrix derived from L.E.D./L.C.D. and linear ICs are replaced by digital ICs and hence a step towards the minimisation of cost and space as well. Since the output is digitized in nature, curves would not be displayed well. However, every natural process is itself a digital process, as in case of C.R.O., where electron beam reaches the screen as a bunch(discrete process).

The basic concept behind any digital process is that, the analog signal is quantized first. It is then encoded and decoder gives the original information in digital manner from the encoded signal.

So, the basic block diagram, from the above discussion, for solid state oscilloscope may be given as follows : (Fig. 1)

1. Vertical gain amplifier is needed when input voltage level is low for proper amplification. A pot at the feedback path for 741C serves to calibrate the Input wave form (Fig 2)

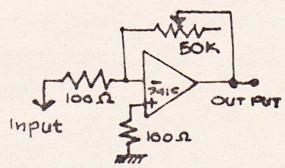


Fig. 2 : Vertical Gain Amplifier (VGA)

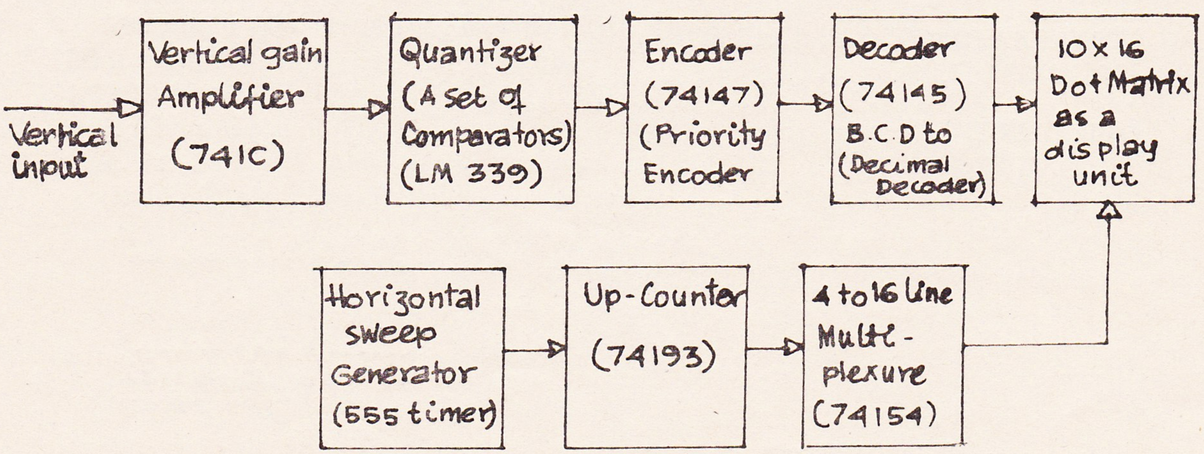


Fig. 1 Block Diagram for Solid State oscilloscope

* This circuit has been actually fabricated and displayed as a model in the students' exhibition stall in the 47th Reunion Meet (13—15 Feb '81)

2. Quantizer : The most important part for which care should be taken, is the QUANTIZER It consists of some comparators in which quantum (reference) levels are maintained at different values by using a chain of resistors, connecting them at the non inverting (N. I) terminals. All the inverting inputs of different quantum levels on the N. I. side are shorted and connected to the output terminal of 741c (V. G. A.).

If 11 Nos. 1K resistors are connected to a +5V supply, in series, the quantum states would be $\frac{1}{11}$ x 5 or 0 46 volt apart. These levels provide the ref. levels for the comparators. Thus uniform quantization is obtained.

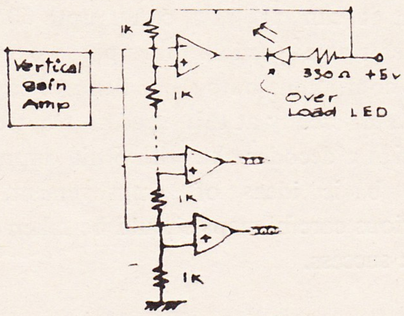


Fig. 3 : Quantizer

However, there exists leakage current (Ico) path as shown through the input diode of the comparator. So, lower quantum levels are no longer uniformly spaced, since Ico added up and affect mostly in lower quantum levels. So, to minimise Ico large resistor (in comparison with that of the series resistor chain) is to be connected at the two terminals of the comparator (Fig. 4). Here this resistor can be chosen as 10K. Quad LM 339 comparators are used here.

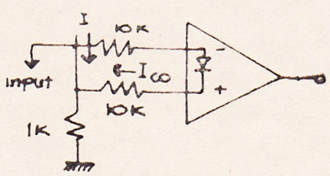


Fig. 4 : Effect of Leakage Current

3. Priority Encoder : The quantized output is then encoded by priority encoder (74147) to obtain the corresponding B. C. D. output.

3. Decoder Driver : Encoded signal is fed to the Decoder driver (74145), which makes any one out of 10 horizontal lines of the matrix high at a time. However, the input logical levels of 74145 is just an inverted version of 74147 output levels, and inverters (Hex inverter 7404) are used for interfacing. For this, output levels also should be inverted before driving a particular line as far as the truth table is concerned.

5. Display Board. It is a 10 x 16 dot matrix i. e., consists of 160 L. E. D.s. To form the L E D array all the anode legs are fed from the output of the horizontal lines, Similarly, Cathodes are connected vertically to form 16 vertical lines. Ten horizontal lines are driven by 74145, while 16 vertical lines are driven by a 4 to 16 line Multiplexer, 74154. To make display better, dots should be closely spaced. So, we choose miniature L E D. (dia $\simeq$ 3 mm) in spite of its low output (visual) efficiency.

Green L. E. D. is favoured than Red L. E. D. in spite of cost (cost of realisation of GaP as substrate and GaP : N junction materials) as green light has peak response nearer to eye and also to avoid visual discomfort.

L. E. D. other ihan L. C. D., Nixie tube, is chosen because it can be driven by standard gate without any interfacing ckt. Though power requirement is greater than that of the L. C. D, L. E. D. is easy to mount and also are faster (Switching time 1 μS.)- They also have greater life (100,000 hrs.).

6. Horizontal sweep generator : This is different from the conventional C. R. O.. In this case, vertical lines are made low one by

one in cyclic order having scanning rate 30 per sec. (minimum).

Timer ckt. produces the clock which is counted in t he up-counter 74193, its output being a 8421 B. C. D. i. e, there are 16 possible combinations. For each combination the 4 to 16 line multiplexer 74154 selects one vertical line out of sixteen, to be made low and rest are maintained high to back-bias the diodes. This is shown in the time diagram (Fig. 5).

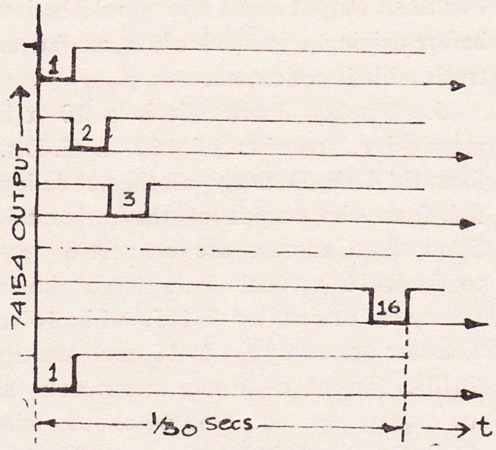
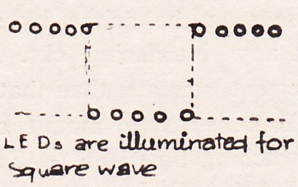


Fig. 5 : Horizontal Drive for Display

The pot. in the timer ckt. can be calibrated for freq. measurement. Suppose, timer freq. is 1/2 of the input signal frequency, then a full cycle will be displayed (Fig. 6).

Fig. 6 : Full cycle display of a square wave

In 10 x 16 matrix we can not accommodate



greater details of a waveform. If ref. levels are chosen very close then the improvement can be made from the idea shown (Fig 7).

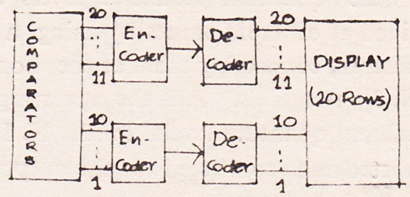


Fig. 7 : Better Vertical resolution with 20 horizontal lines

Again if we want to make resolution good enough, we are to design an up counter such that it can at least count upto 50 and then repeats at a speed 30 times per second to get the continuous output because eye cannot perceive discretely at this speed. So, we are to design a decoder ckt. with 6 bit input. These are basic ideas of improvement, though various careful steps should be taken to make it a success.

REFERENCE : 1 : POPULAR ELECTRONICS, APRIL, 1979

2 : LIGHT EMITTING DIODES By A. A. BERGH & P. J. DEAN

Black Holes : A New Answer ?

Niladri M. Roy (2nd Yr. E. & T. C.)

Man has long been aware of the limited nature of his energy reserves, and research has long been carried out to develop viable alternatives to replace the dwindling resources of petroleum, coal, and natural gas.

Solar cells etc. have been tried with limited success, but as the trend has shifted towards less conventional and more exotic types, an extra-terrestrial source of energy, namely the relatively new astronomical phenomenon of 'black holes' has begun to suggest interesting possibilities.

What is a black hole ?

The key to the understanding of the formation of a black hole lies in Newton's Law of Universal Gravitation which states that the force of attraction between two bodies varies directly as the product of their masses and inversely as the square of their distance apart.

When a star is 'born ; the tremendous force released by the thermonuclear reactions inside it is balanced by its inward gravitational force. As the star ages through millenia, the thermonuclear fire slowly dies down with the result that the star begins to be crushed by its graviiy. The entire mass of the star, therefore, tumbles inward, decreasing the radius of the star. As the radius decreases, by Newton's inverse-square law, the gravity increases, crushing the star still further. The effect is cumulative, and the star soon 'vanishes', shrinking, at the speed of light, to a point of infinite density, leaving a void.

So great is the gravitational attraction of this void, however, that nothing—not even light—can escape it : hence the name.

Detection of black holes.

Owing to their invisibility, black holes may be suppossed to be difficult to detect. The case is, actually quite the opposite. The tremendous gravity of black holes offer two tell-tale clues that lead to their detection.

Firstly, they cause any nearby star to wobble in its orbit, secondly, owing to the tremendous heating (500 million degrees) of matter from solar winds smashing into them, they emit bursts of energy in the form of X-rays.

Such X-rays are relatively easy to detect

Power from black holes.

According to astrophysicists Lowell Wood, Thomas Weaver and John Nuckolls of the U. S. Atomic Energy Commission's Lawrence Livermore Laboratory, there is a possibility that man may be able to tap a black hole as the ultimate, and only pollutionfree source of energy.

The average black hole is less than 5 kilometres in diameter and, owing to its tremendous gravity which pulls everything into it, is inaccessible to man. In 1971, a young British theorist, Stephen Hawking, speculated that during the Big Bang, the great primordal explosion that created our Universe, chunks of matter may have been forced to contract. forming 'mini black holes' each smaller than a virus. The smaller gravitational pull of these holes could permit a spacecraft to approach within 100 metres of them without being sucked in.

In order to tap such a hole, tiny pellets of matter would be fired into it from this distance. As the matter tunelled into the black hole, it would be compressed and heated to a temperature high enough to cause a nuclear explosion, with the result that most of it would be blown away as intensely hot, electrically charged gases. These gases, passing through a magnetic field set up by a generator aboard the spacecraft, would induce an electric current which could be transmitted to earth in the form of microwaves.

This, of course, is only theory, but in view of the potential payoff, astrophysists feel that it is worth the attempt.

The only disadvantage seems to be that microwave radiation has been known to affect humans. (see 'Power Syndrome' by Niladri M. Roy ; The Statesman, June 11, 1979.)

References.

Printed matter :

Can Black Holes Help Man ?'
by Niladri M. Roy ;
The Statesman May 10, 1979.

'A Devouring Hole in our Galaxy.'
by the Science Correspondent ;
The Statesman April 29, 1979.

Black Holes—the Darkest Riddle of the universe'—
by John Wilhelm, Readers Digest, January 1978.

Audiovisual :,
The Universe. (Videotape)
The American Center Library, Calcutta.

Colour TV In India—An Utility Item Or A Luxury Item

Arup Ratan Ray (5th Yr. E.T.C.)

One of the burning questions in the field of electronics and telecommunication in India is "Should India go in for colour TV ? There are a lot of people who are eagerly waiting for the switchover from the black-and-white system to the colour TV system. But there are still a lot more who are against the idea of colour TV system in India. Let us first discuss about the essential principles of colour TV.

The basic principles of colour television are, more or less, the same as for black and white. But the actual circuits are much more complicated. At the TV transmitter, the illuminated scene is televised with three camera tubes, each provided with an optical filter to transmit a particular colour. As all colours can be reproduced by the proper combination of Red, Green and Blue, these three colours are used. The colour outputs of each camera tube are then combined into two basic signals for transmission. One of these signals is called the luminance signal and it only contains the brightness variations of the picture, just as the ordinary video signal. The other signal, called the chrominance signal, contains the essential colour information for reproducing a coloured image. Actually this signal is a modulated subcarrier of 3. 58 MHz. Monochrome receivers use only the luminance signal to reproduce the picture in black-and-white. Color receivers use both the chrominance and luminance signals. It should be noted that the color receiver can also reproduce the picture in monochrome by turning down the colour control or if the 3. 58 MHz. Chrominance signal is missing. A colour picture tube has red, green and blue phosphors on the viewing screen to reproduce the picture in colour. A typical colour picture tube has three electron guns for the tricolour screen. The phosphors can be dottrio of red, green and blue, or vertical Stripes of colour. Then each gun produces an electron beam to illuminate the red, green or blue phosphor dots on the fluorescent screen.

Now with the above pretext let us try to visualise the pros and cons of colour TV in India.

For colour TV transmission, the studio set-up, the camera tubes, the VTRS and other equipments have to be either modified or changed. This will involve a huge cost. The people, who oppose colour TV, argue that India, being a poor country, can not afford such a luxury item, specially when India can not provide all its citizens with drinking water facilities, food, clothing and shelter. But those, who favour the introduction of colour TV, say that India should shift to colour TV for upholding the country's prestige. They also point out that if other poor nations can switchover to colour TV, then it will be harmful to India's prestige if she cotinues with black-and-white TV system.

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This, of course, is only theory, but in view of the potential payoff, astrophysists feel that it is worth the attempt.

The only disadvantage seems to be that microwave radiation has been known to affect humans. (see 'Power Syndrome' by Niladri M. Roy ; The Statesman, June 11, 1979.)

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Bio-Medical Effects Of Microwave On Human Body

Nirmal Das (5rh Yr. E. & T. C.)

The human organs and organic systems are affected by microwave or r f. fields. These effects are reported in terms of functional disturbance and structural alterations. Most Biological effects are explained by thermal energy conversion. The non-uniform distribution of energy absorption in different parts of the body may give rise to temperature increases and rates of heating which results in unique biological effects. The induced temperature gradients may act as a stimulant to alter normal function both in heated organs and other organs. The unequal temperature rise may induce chromosonal alterations, mutegenesis, virus activation and inactivation and some behavioral and immunological reactions. Researches on biological effects of microwave have been done with small animal. But their co-efficient of heat absorption, field concentration effects, body surface areas and thermal regulatory mechanism are different from those in human body. According to Durney, the specified absorption rate is a function of frequency for different sizes of animals and man But for the spherical models, the bodies have had uniform properties. Then the larger animals should be subjected to lower frequencies if the total absorption is to be the same as that obtained at higher frequency for smaller animals.

Microwave energy when exposed on a body leads to temperature rise if the energy absorption exceeds the energy dissipation. This temperature rise in a specified part of the anatomy depends on :

a) The characteristics and distribution of electromagnetic field within the body.

b) The passive and active thermoregulatory mechanisim in a biological entity.

The passive thermoregulatory mechanism consists of heat radiation, conduction, convection, evaporation and cooling. The heat convection between a body and its immediate influences depends on the environmental conditions Active thermoregulatory mechanism potentiate the passive heat transfer process by employing circulating fluids (such as blood) to transfer heat from internal regions to external regions where passive heat radiation and convection are more effective. The cutaneous mechanism of man transfer the internal heat to the skin from where it can be radiated into the surroundings. Sweating from the skin is a means of heat transfer.

It is known that chromosome changes in various plant and animal cells and tissue cultures. Microwave energy causes biological change especially, when such cellular response or mutagenesis is involved. Here thc temperature control is an important thing. The microwave induced biological changes in tissue culture give the total response of the specific tissue and not the genetic injury. The cellular response brought about by other means such as virus, heat, chemicals etc. produced chromosome anomaties. Present day experiments show that microwave exposure of power density below $10mw/cm^2$ are not mutagenic.

The non ionising microwave radiation having particular combination of frequency, duration and power density gives rise to some effects on embryological development and portuatal growth. The microwave induces some developmental abnormalities in the fetus by rise in temperature. Baranski and Czerski shows that no serious effects are to be expected at power densities below $10mw/cm^2$.

High power density microwave energy affect the testis because it is very sensitive to heat. The microwave can also affect the ovary. The responses is similar to the heating of the organs.

The endocrine changes due to stemulation of hypothalimic-hypophysical system, thermal interactions at the hypothalamic or adjacent levels of organization, the hyphysis itself (Pituitary), the particular endocrine gland and end-organ. The direct exposure to the microwave of low power level sometimes has effects on the central nervous system because homeo stasis hormone levels will fluctualet to maintain the organismic stability. The microwave exposure produces alteration in the electroencephalogram (EEG). Microwave causes the transient alteration in the permeability of small inert polar molecules across the blood brain barrier. This permeability changes in cerebral blood vessels under different conditions i. e. temperature, pressure, ionizing radiation, drugs, osmotic imbalance, edema and anoxia.

Microwave energy has effects on the behaviour also. The exposure to the radiation of microwave may suppress the performance of the trained task So a power density/does rate and a duration for achieving the suppression exists. Depending on duration and other parameters of the microwave, the power of density for affecting the trained behaviour range from 5 to $50mw/cm^2$.

Microwaves have direct and indirect effects on the cardiovascular system, but not serious ones. The microwaves produce appreciable hyperthermal effects. Such effects are indicated by hypotonus, bradycardia, delayed auricular and neutricular condition, decreased blood pressure and EKG alternations in persons working in microwave fields. But these changes do not diminish their work capacity.

The hematopotetic effect of microwave is inconsistent although the blood forming system are not affected by acute microwave exposure. The degree of hemotologic changes are must be cognizant of relative distributions of blood cells in the population of humans and the thermal influences in this alterations.

There is a relationship between microwave exposure and immune response. Due to hymphoblastoid and the thermal influences of microwave, therapy of infections diseases or cancer. Lymphoblastoid transformation occurs after free field exposure of human lymphocytes to 3000 MHz pulsed microwave. The changes in the mitotic index is dependent on the exposure time. The exposure initially causes the stimulation of the leucocytes, but if the exposure continues, the stimulatory effect disappears and the significant changes occurs on the basis of hyperthermia.

Short rectangular pulses of microwave of low power densities, when impinged on the head of a man produce a hearing sense. The acoustic response of pulsed microwave is due to direct cortical or neurel stimulation. This is a non thermal effect of microwave on the brain.

Microwave energy gives the ocular effects. Over 50 cases of human cataract induction has been attributed to microwave exposures, encountered in occupational situations involving acute and high intensity microwave energy. These cataracts in human resulting from acute high intensity exposure is on the basis of thermal injury.

Absorption of microwave energy results cutaneous thermal sensation or pain. The explanation of thermal sensation and pain is that the temparature of the warmth receptors in the skin is increased by a certain amount.

There are other various effects of microwave energy on human body. But here it is not possible to mention them all. Moreover, it calls for a scientific competence and integrity. It is important to maintain a proper perspective and asses realistically the biomedical effects of microwave, so that the workers or the general public are not unduly exposed to it and at the same time the research, development and beneficial utilization of this energy is encouraged.

References :

1) 'Influence of Microwave Radiation on the organism of Man and 'Animals'—I. R. Petrov.

2) 'Elecromagnetic fields and life'— A. S. Presman.

3) Microwave mesurement and engineering handbook—Harvey.

4) Proceedings of the IEEE— Journal of 1961 and 1965

A Brief Review Of The Esaki Diode

Subhasis Saha (5th Yr. E.T.C.)

Many a number of devices, conveniently characterized by —ve resistance property, have been developed so far which finds extensive applications in pulse and switching circuitry. The simplest of all is the Esaki Diode or more commonly known as the Tunnel Diode—a simple single P-N junction. Let us have a look at it which once caused a great interest amongst scientists, but became obsolete in due course because of its limitations discussed later.

The impurity concentration of an ordinary silicon or germanium diode (which is about 1 part in 10^8) when increased considerably (say to 1 part in 10^3), the width of the depletion layer is reduced from 5 microns to 100 Å, which is one-fifth of the wavelength of visible light and the device characteristics is completely changed. A minor alteration that has major repercussion. However, for barrier as indicated above Schrodinger Eqn. indicates that there is a larger probability that an electron will penetrate through the barrier. The effect discovered and explained by Dr. Leo Esaki in Japan in early 1958, is referred to as quantum mechanical tunneling and the diode as Tunnel or Esaki Diode. The symbol and the I-V characteristics of the diode are shown in Fig. A. Instead of going into the principle of operation which can be found in any standard book on Electronics, let us make a quantitative analysis and estimate of the current that flows and have a brief discussion of its implications, advantages and disadvantages.

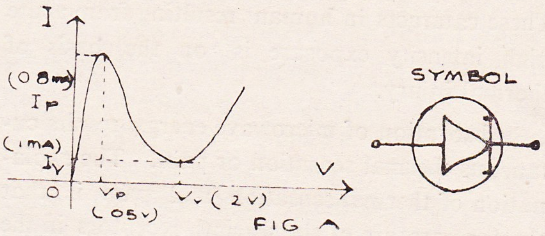


Fig. A

Esaki explained this behaviour of the diode by utiizing Zener's model for the dielectric breakdown of insulators. Zener suggested that very high electric fields can distort or tilt the energy bands of a solid so that the conduction band is in some parts of the crystal actually below the valence band (VB). In such circumstances an electron at a certain energy state in the V. B. can pass to a state at the same energy in the conduction band by a process of tunneling through the forbidden region rather than by going over it. This is similar to the tunneling of an α or β particle from the nucleus of an atom during radioactive decay. According to classical mechanics a particle caught in a deep energy well cannot of itself escape. There is zero probability of finding the particle outside the well, and the particle cannot leak through the wall. An electron on the other hand, according to quantum mechanics has a finite probability of being found outside the well. Thus if two allowed energy wells are separated by a narrow barrier, the probability of an electron passing from one well to the other is finite and increases as the barrier thickness and well depth decreases. This treatment may be applied to the problem of iso-energetic electron tunneling from one allowed band to another. The tuneling frequency T i. e. the no. of transitions per second is then the product of the probability of leakage through the barrier into the adjacent allowed band by an electron which strikes the barrier wall, and the frequency with which an electron actually strikes the wall. It is given by,

$$T = \frac{aeF}{h} \exp \left[-\left(\frac{\pi}{4}\right) \frac{\sqrt{2meff}}{h'F} \left(Eg\right)^{\frac{3}{2}} \right]$$

where, a = latticeconst. F = field(V/cm) 1 = electron charge, m_{eff} = effective•electron mass h = plank's constant. Eg = Gap width $h = h/2\pi$. So the tunneling frequencies for given values of field can be calculated easily.

As the field exceeds 10^5 V/cm, the tunneling frequencies increase at an extremely rapid rate, thereby illustrating the breakdown process.

Let us consider next the field emission current for the tunnel diode at both 0^0K and room temperature. For electrons tunneling from the conduction to the valence band, the current $I_{c \to v}$ is proportional to the product of the three quantities :

i) The number of electrons in conduction band states within the band overlap.

ii) The number of unoccupied states in the same energy intervael

iii) The tunneling frequency (T)

Consider, the energy-band scheme for this diode at thermal equillibrium (Fig. B). Following the development proposed by Esaki, let the current caused by electrons tunneling from V. B. to C. B. in an energy state interval dE of the over lapregion be labelled $-dI_{V \to C}$ ('—'sign referring to the fact that this is —x directed conventional current). Let ρ_c ρ_v (E) and (E) represents the energy-state densities in C. B and V. B is respectively ; f_c (E) and f_v (E) the corresponding Fermi distribution functions denoting the probability that a given energy state is occupied, and $T_{C \to V}$ & $T_{V \to C}$ represent the tunneling frequency of electrons from C. B. to V. B. and vice-versa respectively. So,

f_V (E) ρ_v (E) = density of valence band electron states occupied in dE and

$[1 - f_C (E)]\rho_C (E)$ = density of C. B. electeons states unoccupied in dE. The valence to conduction band tunneling current is

$$I_{V \to C} = K \int_{Ecn}^{Evp} T_{V \to C} \; \rho_V (E) \rho_c (E) f_V (E) [1 - f_c (E)] dE$$

where K is a constant. The interval of integration is from the conduction band edge of the n-side Ecn to the valence band edge of the p-side Evp, that is through the overlap. Likewise,

$$I_{C \to V} = K \int_{Ecn}^{Evp} T_{C \to V} \; \rho_V (E) \rho_C (E) f_C (E) [1 - f_v (E)] \, dE$$

Whereas in the normal diode the opposed directions of electron and hole flow produce an identical direction of current flow so that the total current is the sum of the component parts, in the tunnel diode, the tunneling current can be completely described as a gain or loss of majority carriers on either side, e. g. electrons on the n-side. Therefore, the total tunneling current is the net number of electrons transferred per second, and is given by the diference of the two component tunnel currents. Assuming $T_{C \to V} = T_{V \to C} = T$

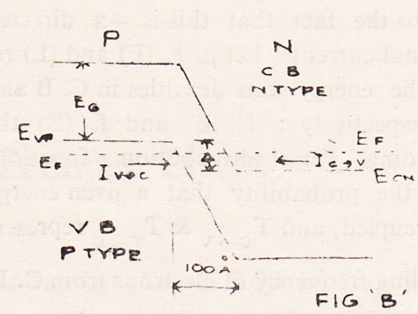


FIG. B

$$I = I_{c\to v} - I_{v\to c} = K\int_{Ecn}^{EvP} T[f_c(E) - f_v(E)]\rho_c(E)\rho_v\, d(E)$$

At thermal equilibrium $f_c(E) = f_v(E)$. Hence $I=0$. Also at zero bias and at O°K, $I=0$. However at higher temperature, at zero bias the component tunneling current can flow, but no net current will flow as these two are equal.

Based on the above considerations, it is reasonable to assume the simplest equivalent circuit of the diode in its active negative resistance mode, is as shown in Eig. C (i). Here R_b is the ohmic resistance, L is the lead inductance which depends on length and diode package, C is the junction capacitance which depends on the bias. Typical numerical values of R_b ,L, C and—R are as indicated in the diagram. The tunneling mechanism is essentially not subject to any frequency limitation but the equivalent circuit shows that the terminal impedance is frequency sensitive. This impedance is $Ze = Re + jXe$ where,

$$Re \simeq R_b - \frac{R}{1+(\omega CR)^2},\quad Xe = wL - \frac{\omega R^2 C}{1+(\omega CR)^2}$$

It can be sccn that a frequency exists where the effective negative resistance vanishes. Actually, 3 critical freqeuncies can be defined namely :

a) The resistive cut-off frequency, where $Re = O$

$$fc = \frac{1}{2\pi RC}\sqrt{(R/R_b - 1)}$$

b) The self-resonant frequency, where $Xe = O$

$$fo = \frac{1}{2\pi\sqrt{LC}}\sqrt{1 - L/R^2C)}$$

c) The oscillation frequency, where $fc = fo$

$$f_{ose} = \frac{1}{2\pi\sqrt{LC}}\sqrt{1 - Rb/R}$$

The diode is capable of operating at the microwave frequency also. The frequency response is limited only by the junction capacity. Now as $R >> Rb$ for a well made diode,

$$f_c = \frac{1}{2\pi C\sqrt{RR_b}} = \frac{1}{2\pi C}\sqrt{\frac{G}{R_b}}$$

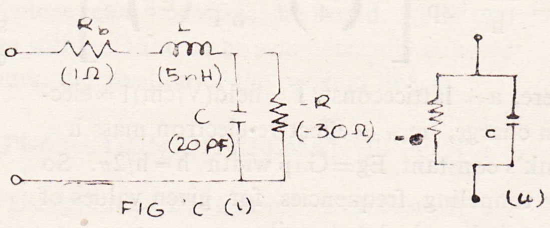


Fig. C (i) & (ii)

If we neglect 'L', it is easily verified that the diode presents at its terminals an admittance consisting of an equivalent pararllel capacity Ceq, and—ve conductance of magnitude Geq. $Y = -Geq + jwCeq$ where,

$$G_{eq} = \frac{1}{(R - R_b)}\,\frac{1 - (f/fc)^2}{1 + (f/fc)^2[Rb/(R - R_b)]}\quad \text{and}$$

$$C_{eq} = C\,\frac{[R/(R - Rb)]^2}{1 + (f/f_c)^2[R_b/(R - R_b)]}$$

For a good diode $R >> R_b$ and so

$$G_{eq} \simeq \frac{1}{(R - R_b)}\,[1 - (f/f_c)^2] \simeq G[1 - (f/f_c)^2]$$

and $C_{eq} \simeq C$.

The equivalent circuit of Fig. C (i) can therefore be simplified to one with —Geq and 'C' in parallel as shown in Fig. C (ii).

Main application of the Esaki diode is as a high speed-switch. Switching speed of the order of 50 pico sec. have been obtained. As they are highly non-linear it can also be used as amplifying, switching and frequeucy conversion devices. A single tunnel diode can be used to perform the functions of r. f. amplifier, local oscillator, mixer and first IF amplifier simultaneously of a receiver by proper circuit configuration. They can be used to perform information storage and logic functions in computers due to its bistable characteristics. They also make excellent harmonic generators. It can be used as a multifunctional element, an example of which was given by KO, who employed a tunnel diode to give audio gain and r. f. power for an f. m. wireless microphone. It is also employed as low power microwave oscillators.

The tunnel diode has a number of advantages like low-cost, low-noise, simplicity, high speed, low-power devices etc. On the otherhand the maximum power that can be handled or obtained from a single tunnel diode is rather limited since the maximum voltage swing cannot exceed the energy gap of the semiconductor and is approximately 1 watt. Also they are two terminal devices and, therefore, completely bilateral ; no isolation between input and output which leads to serious circuit design difficulties. Thus the low cross-over voltage render them suitable as r. f. detectors, voltmeter rectifiers, limiters and meter protectors.

So finally it can be concluded that inspite of a large number of advantages, the tunnel diode is by no means to be regarded as a universal replacement for transistor and vacunm tubes.

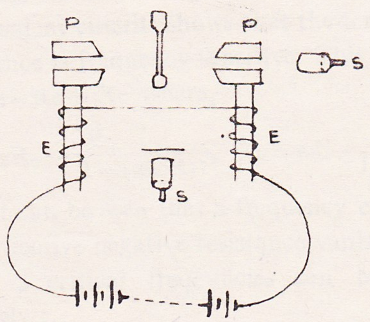
References :

1) Proceedings of the I. R. E. 1959
2) Solid-State Electronics—1960, Volume I
3) Electronic Engineering—1959, Vol. 34
4) IRE Transactions—1960 volume—7.

The Zeeman Effect

Amit Konar (2nd Year E.T.C.E.)

In 1896 Zeeman first observed that spectral lines are spilt up into components when the emitting atoms are placed in a strong magnetic field. This phenomenon, often the name of the discoverer, is known and Zeeman effect. Of course, Zeeman could not given suitable explanation of this experiment until Lorentz revealed his Classical Theory of Radiation from a moving electron. The Zeeman effect which could be explained using Loruetz's theory is known as normal Zeeman effeet. Moreover, there is another type of Zeeman effect which demands explanation by the quantum theory, involving the magnetic as well as the spin quantum members. The second type of Zeeman effect is called the anomalous Zeeman effect.

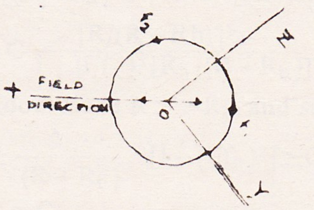


The apparatus to exibit Zeeman effect is as given in Fig. 1. E, E. are electromagnets capable of producing a strong magnetic field. P, P are two polepieces through which holes have already been made lengthwise.

Suppose L to be the source emitting radiations (e. g. sodium vapour lamp). The emitting spectral lines are generally observed with the aid of high resolving power spectroscope S. When the spectral lines are viewed parallel to the magnetic field through the holes of the poleepces it would be seen that the spectral lines are split up into two components one having a higher and the other having a lower frequency than that of the original spectral line, which, of course can no longer be found. The two lines will be found to be symmetrically situated around the position of the original line.

EXPLANATION OF ZEEMAN EFFECT :

Using Lorentz's theory satisfactory interpretations can be made as follows. Let us first resolve the motion of the electron into a linear oscillation of unchanged frequency f in the line of action of the field lines, a clockwise and another anticlockwise components of frequency f_1 and f_2 respectively, these two circular components lying on the plane perpendicular to the magnetic field.



The line of action of the alternating electric vector components are along the direction of motion of the electrons at instantaneous moments. The light wave entering the spectroscope, according to the electromagnetic theory, must have its electric vector, alternating in any direction, perpendicular to the direction of propagation. In the normal transverse Zeeman effect the radiated light energy from the atoms is viewed in the direction perpendicular to the magnetic field lines i. e. along 0Z. Therefore, the line of the previous frequency will be seen. By means of a spectroscope pointing along Z0 an observer may perceive the other circular frequency components as they are linear variations, both acting along OY.

In the longitudinal Zeeman effect two circular frequency components f_1 and f_2 which are circularly polarised in the clockwise and anticlockwise directions would be seen whereas the spectrum line component of unchanged frequency f will not be seen because the spectroscope is directed along 0X which makes the magnetic field direction and the fluctuating (alternating) eletric vector in the same direction.

The explanation of Zeeman effect with the help of the quantum theory can be given as follows. The motion of an electron in an orbit is equivalent to a current in a loop or mesh of a conductor. When a current carrying conductor is placed in a strong magnetic field, it experiences a torque and the energy of the system depends on the orientation of the mesh with respect to the magnetic field. Moreover, we know that the moment of an electron $= \frac{mh}{2\pi}$ where his Plank's constant and m=O, ±1, ±2............so on. Corresponding to different values of m, the emitting atom splits into several component lines. Hence, there will be different possible frequeney of the radiation emitted by the atom in the presence of magnatic field.

Solar Cells for Solar Energy Conversion

Alok Raychaudhury & Jagadish Maity
Fifth Year E & T.C. Engineering.

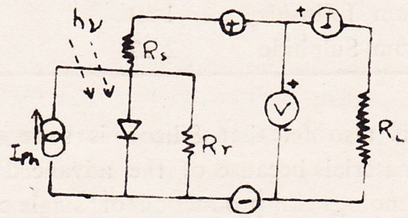
In recent years the crying need of the world is the solution of severe power crisis problem. The conventional power sources fail to meet the requirement. Present shortage of power can be easily solved by proper utilisation of solar energy. Several approaches to the large-scale terrestrial Solar energy programmes are (a) Solar thermal (b) Thermo-mechanical (c) Thermo electric and (d) Photovoltaic. Among them the photo voltaic devices are of

1) Conversion of Solar energy directly to electrical power without any moving part or intermediate heat cycle.
2) High power to weight ratio.
3) Simplicity, reliability and longibity.
4) As area devices, high temperature is not required for higher conversion efficiencies.
5) Higher conversion efficiency upto 15% with suitable semiconducting material (Silicon).

Solar cells are mostly used as photo-voltaic devices in this purpose.

A Solar cell is a p−n junction diode in which the upper layer is very thin and the cell has very low internal series resistance. When a photon of energy greater than the band gap of the semiconductor is incident upon it, a charged pair of carriers is liberated and then they are seperated by the junction barrier when an external load is connected across the cell, these separated carriers flow through it to complete the circuit giving out a useful power under illumination.

The equivalent circuit of a solar cell forming a parallel combination of a p−n junction diode and a photo-current generator is shown in the figure.



According to this ideal model, current voltage relation in a Solar cell is given by

$$I = -I_{sc} + I_0 \; [\; \text{EXP}\,(qv/kT) - 1 \;]$$

where I_{sc} is the photo-generated short-circuit current, I_0 is the dark saturation current. q is the charge of an electron, k is Boltzmann constant and T, the absolute temperature of the solar cell. Since the voltage produced by a single Solar cell is low, several cells must be connected in series to obtain the desired voltage. Such connection, called a 'Sting', is connected in parallel with several others to obtain the required power.

It is well known that the radiant energy of the Sun is a maximum in the green portion of the spectrum at wave lengths corresponding to about 2·5 eV. Therefore, satisfactory solar cells must be made of semiconductors having forbidden energy gap in the range of 1.0 to 1·5 eV so that the majority of the Sun's energy is effective in creating electrons and holes. With this fact in view several semiconducting materials e. g., germanium, Silicon, indium phosphide, gallium arsenide, cadmium telluside, cadmium sulphide and aluminium antimonide have been investigated and the best results obtained only with Silicon. This may be clarified from the table given below :

Material	Forbidden gap energy Eg (eV)	Highest reported efficiency n max (%)
Silicon	1·10	15·00
Gallium Arsenide	1·38	13·00
Cadmium Telluside	1·50	6·00
Cadmium Sulphide	2·20	6·00

It is also felt that Silicon is superior to other materials because of the advanced state of technology in production of single crystal material, formation of p-n junction and high quality electrical contacts there in. For this reason Silicon is best suitable material to be used as Solar cell in every space satellite. The high quality junction of Silicon gives rise to maximum efficiency of converting Solar energy into electrical power.

There are two important considerations for evaluating the economics of the solar cell power systems. Firstone is the cost of production per unit power. Second one is the energy budget of the power system. The latter is particularly important in the case of solar cell power systems, where the energy input is quite large. For an insolation of 800 mw/cm2/day with solar cells of 10% efficiency it takes at least six years to achieve a break even point in the energy budget. The immediate objective of the investigation all over the world is to bring down the cost of photo voltaic Solar energy conversion technology to a level of Rs. 5,000/- per KW to make it competitive with conventional power sources and use it in large-scale terrestrial energy programmes. The long-term objective is to further bring down the costs to as low as Rs. 1.000/- per KW.

The higher economy in the construction of single crystal Silicon solar cells leads to pay attention towards other thin film semiconductor devices. Cadmium sulphide is best suited for its low resistivity (10π-cm), high mobility (10 cm^2 per v per sec.) and sharp optical absorption edge. Heterojunction cu_2s-cds solar cells with efficiency of 2.3% have been fabricated by the conventional technique. However, there are a number of factors, including environmental ones, that can cause damage to these cells. If the cds solar cells are based on Mo and Kerpton Substrates, these difficulties may be removed. A thin film of cds can show photo voltage even in the absence of any barrier which depends on the gradient of trapped carrier concentration. Larger the gradient, larger will be the open circuit voltage. This may be facilitated by fabricating cds solar cells on cold glass substrate and sandwitching between gold and indium.

Excluding the economic problem, Si solar cells are best suited for high efficiency in solar to electrical power conversion. So due attention should be paid in reducing the cost of production of Si solar cells. Schottkey barrier (SB) solar cells are of late gaining importance because of their potential low cost of fabrication, lower series resistance, greater blue response and higher radiation resistance. However, possible performances of Si, GaAs, CdTe and Cd_2S_3 Schottkay barrier solar cells are examined by studying the variation of maximum conversion efficiency compared to the thickness of the semiconductor layer.

Power dissipation in solar cell increases with the increase in temperature. Using higher intensity of light by concentrators, if the solar cell temperature is kept small with the help of suitable heat sink, the loss and out put power can be minimised.

Electrophoretic Image Display

Arindam Chaudhuri
5th Year Electronics and
Tele-Communication Engineering,
Bengal Engineering College.

Display devices provide visual display in response in electrical input and hence serve as the constituents of electronic display systems. In the early days CRT was the only major display device in electronics. But many new technologies have entered the display field in recent years. Light emitting diodes, liquid-crystal displays, and gas discharge plasma displays are some of the important display devices available today for the system designer. Together with the recent developments in semiconductor electronics and ICs, this has greatly advanced digital instrumentation.

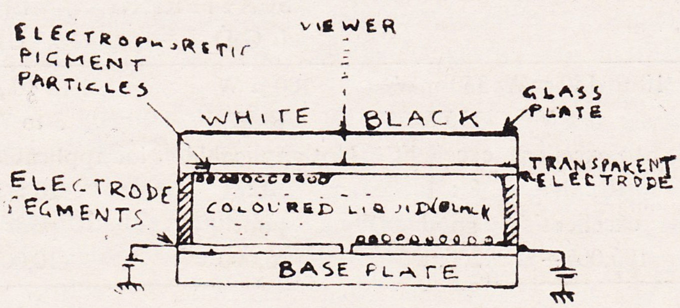
Electrophoretic Image Display :

Electrophoresis is the movement of charged pigment particles suspended in a liquid under the influence of an electric field. Although this phenomenon has been known and widely used in science and industry for several decades, its use in display technology is very recent. The display devices based on this approach are indeed passive displays. Basic principles, fabrication, and operating characteristics of a reflective type electrophoretic image display (EPID) panel which is based on electrophoresis are described below. These displays are characterized by large character size, low power dissipation and international memory, and are now gaining acceptance in electronic instrumentation and other applications.

The EPID panel makes use of the electrophoretic migration of charged pigment particles in a suspension. The suspension 25-100 thick, which largely contains the pigment particles and a suspending liquid, is sandwiched between a pair of electrodes, one of which is transparent. Fig. gives the structure of an EPID.

The application of a d.c. electric field across the electrodes moves the particles electrophoretically towards one or the other electrode, the movement depending mainly on the polarity of charge on the particles. The reflective colour of the suspension layer changes on account of this migration of particles.

The EPID panels generally follow segmented character format, typically 7



segment for numeric characters. It is usual practice to have the transparent electrode as a common electrode covering the entire devide area closest to the viewer. The back electrodes are generally segmented. Two such segments are shown in Fig. as an example. In the normal-operation of the display the transparent electrode is maintained at ground potential, and the segment electrodes at the back are given different potentials.

If the pigment particles are white and positively charged in the black suspending liquid, the application of positive voltage to the chosen segment moves the pigment particles away from it, and towards the transparent electrode. This is shown on the left side of Fig. ; it appears which in reflective colour as viewed through the transparent electrode. On the other hand, when a segment has negative voltage with reference to the transparent electrode, the white pigment particles will now go towards this and get immersed in the black suspension. In this case, the viewer will see the reflection from the black liquid itself.

Colour combinations of both the pigment particles and the suspending liquid can be used to achieve a desired colour display. Moreover, a reversal between the colours of the displayed pattern and its background can be obtained by changing the polarities of segment voltages in Fig. In addition, the EPID panel has a memory because the pigment particles deposited on an electrode surface remain there even after the applied voltage is removed. This is mainly due to Vender Wall's attractive force between the pigment particles and the electrode. This memory function is an advantage in the use of EPID panels because it simplifies the driving circuit for the panel.

Many different suspensions and pigment particles have been used in practical EPID panels. For good results, it is necessary that the pigment particles and the suspending liquid should have the same density. In a typical EPID panel the suspending liquid is composed of a mixture of solvents, mainly ($CBrF_2$ $CBrF_2$), dyes, and charge control agents. It has a black colour and the same density as that of the white encapsulated TiO_2 particles (average dia 3) which serve as the pigment particles. The charge polarity of these particles is positive. Seven segement display devices based on these materials carry a steady state current of 0·3 A/cm² at 100 V applied across the electrodes. The contrast ratio realiazable using these devices is typically 40 : 1. Although these factors are favourable to the side spread use of this approach to display devices, the relatively slow speed of these displays is a major limitation particularly, in multiplexing of displays. Moreover, life spans of present-day EPID are still in the range of a few thousand hours only.

	LED	NIXIE	DYNAMIC SCATTERING L C D	FIELD EFFECT L C D	EPID
Power / Digit	10 to 140 mW	350 mW	100 μ W	1 to 10 μ W	30 μ W
Voltage	5 V	175 V	18 V	3 to 7 V	100 V
Brightness	good to excellent	excellent	Not applicable	Not applicable	Not applicable
Contrast Ratio	10 : 1	8 : 1	,0 : 1	20 : 1	40 : 1
Ease of mounting	excellent	good	poor	poor	poor
Life in hours	100,000+	200,000	10,000	10,000	1,000

GENERAL SECRETARY'S REPORT

It is with the pleasure and deep sense of satisfaction that I present this report. Although ours is a small society having limited financial resources its achievements are neverthless praiseworthy. The activities of the ETES in the last session have surpassed all previous records. All the sections of the society had been beaming with activities.

The new society took office on the 4th Sept. '80 with a meagre fund at its disposal. On the 9th Sept '80 we accorded a welcome to the freshers. The freshers' welcome has always proved an occasion for a get-together of all the members and this year was no exception.

First I record my appreciation to our dynamic Seminar Secretary for his commendable achivements. This section worked hard to arrange the series of lectures. These lectures were delivered by among others, Sri Tapan Kr. Roy, Managing Director, Imsicon (Eastern) Pvt. Ltd. on Digital Storage Oscilloscope & Histogram Techniques, Sri A. C. Palit, Electronics Consultant on Microprocessors and its applications, Dr. S. Roy, Professor, Institute of Radio Physics on Microwave Semiconductors, prof. M. K. Das Gupta, Institute of Radio Physics, on Space Communications, Dr. A. Sen, Reader, Institute of Radio Physics on Satellite Communications. We have initiated student participation in the seminars. "Round the Year Seminar Lecture Series" opened on 19. 9. '80 was a great success. We had most of the final year students addressing the seminar on variety of topics.

Number of educational tours were organised by the Society. Notable among them were to Calcutta T. V. Studio & Transmission centre, Calcutta Air Port, Dum Dum, All India Radio, Calcutta. A very enjoyable picnic was also arranged at Kolaghat. Efficient Tour Secretaries deserve praise.

The hardwork put in by the innovative Model Secretary made it possible for us to present an excellent working model on Solid State Oscilloscope on the occasion of the 47th Annual Reunion Meet of the College The model was adjudged the 2nd best.

The enthusiastic Cultural Secretaries were not lagging behind. A cultural evening ' SURA SANDHYA" was arranged on the 20th Sept. '80. The programme was a grand success. On the 15th Jan '81 our Society screened "INTERVIEW", a film by Mrinal Sen.

Lastly, I congratulate the indefatigable Magazine Secretaries for the successful publication of ELCOM. This was possible due to resoluteness, perseverance and unflinching zeal of theirs.

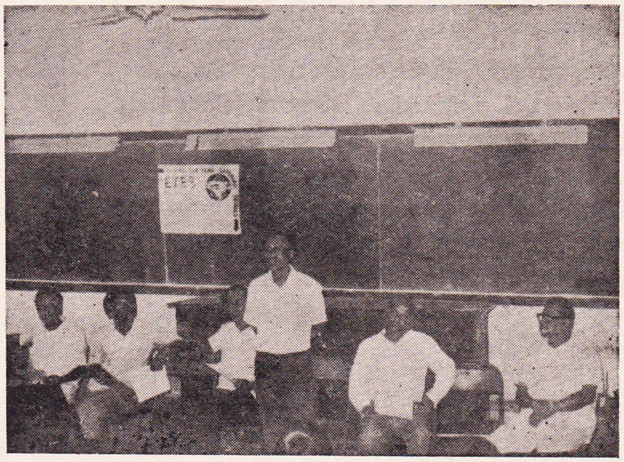
On behalf of the society, I would like to express deep gratitude to the ex-President Dr. S. S. Baral, President Dr P. K. Sinha Roy and the other respected members of the advisory board for their able guidance and unrestrained co-operation.

This in short is a resume of the activities and accomplishments of our society. We worked as a cohesive team. This performance may be remembered as an example of perfect co-ordination between the different sections of the society between the teachers and the taught.

I wish all the best to the society in the years ahead.

HEMENDRA TALESARA

General Secretary, ETES.



SEMINAR SECRETARY'S REPORT

Like every previous year, this year also the new society was elected to office after the admission of the first Year Students and it really started functioning from the begining of September, 1980. The seminar section also swing into action from the first week of September, 1980. But it was the 19th of September, 1980 when the formal inaguration ceremony of "The Round The Year Seminar Lecture Series" took place. It was decided to hold the lecture series every Friday with the participation of 5th Year Electronics & Tele-communication Engineering students where two student speakers would deliver lectures on any relevant topic, chosen by the speaker himself, for about 25 minutes each. This was a new idea and it was for the first time a round-the-year-lecture-series by the students was organised by the society.

The inauguration ceremony was indeed a grand success. The Principal of the college, the Heads of the Departments of Metallurgy, Electrical, Physics and our own department graced the occasion by their presence. Among others were present all the teachers of our department and Dr. T. Maulik of the department of Mathematics. Dr. S. S. Baral, our Ex-Head of the department sent a message as he could not be present because of preoccupation.

So far thirteen lectures could be held on seven Fridays and it is expected that about 20 students in all would be able to participate in the current lecture series. This covers about two third of the student enrolment of the 5th Year Electronics and Tele-communication Engineering. Intervened by the Puja and X-mas holidays, the half yearly evaminations, the annual sports and the Re-Union, the number of effective Fridays available for holding the seminar lectures in the current session were drastically reduced.

A wide range of subjects were covered in the seminar, like Avionics, Microprocessors, Medical Electronics, Doordarshan Kendra (Calcutta), Cassette Production, LED Technology, Negative Resistanee Devices, All India Radio (Calcutta), Feedback Amplifiers, Electrophoresis, Design of 2-stage R. C. coupled Amplifiers, Impatt Diode etc. It is our fervent hope that this seminar lecture series will end on a happy note with the prize distribution and closing ceremony at the end of this session, 1980-81.

Up till now two visiting lecturers have come to deliver a set of seminar lectures. This was made possible mainly by the ceaseless efforts of Dr. P. K. Sinha Roy, Head of our department and President of our Society. The first set of our lectures where delivered by Mr. Tapan Kumar Roy, Managing Director, IMSICON (Eastern) Pvt. Ltd., on "Digital Storage Oscilloscope and Histogram Techniques" The next set of six lectures were delivered by Mr. A. C. Palit, Electronics consultant, on "Microprocessors". Both sets of lectures were very much interesting and informative.

Much water will flow down the River of Hooghly till the next Seminar Secretary assumes his duty. I wish him and the future Society all success.

ARUP RATAN RAY

23. 02. 81

Seminar Secrtary

ETES, 1980-81

EXECUTIVE OF THE SOCIETY

President	:	Dr. P. K. Sinha Roy
Chairman	:	Dr S. Basumallick
General Secretary	:	Sri Hemendra Talesara (5th yr)
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		Sri Jayanta Majumdar (3rd yr)
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Cultural	—	Sri. S. K. Ghosh

The solar cells have vltal applications in power communication systems, recharging conventional chemical batteries during periods of Sunlight, the batteries supplying current during periods of darkness, in spaces satellites and unmanned relay stations where solar cells have been used as the primary sources of electrical power.

Several researches are going on for the development in utilisation of solar energy in various laboratories in the world. In India under the influence of Solar Energy Society of India (SESI) several projects have been initiated in C.S.M.C.R.I. Bhavnagar, C E L Delhi, C E E R I and E C I L and recent report shows their advancement in various aspects. By proper improvement and utilisation of Solar cells we will sure be able to overcome the recent power crisis in near future.

Reference :

1. Proceedings of National Solar Energy Convention, 1976.

2. E. S. Rittner, Phys. Rev. 96, 1708 (1954).

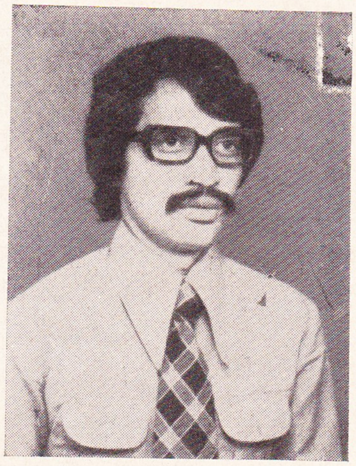
3. Report, SSPL (1967)

4. C.A. Lewis and J.P. Kirkpatrick, 8th IEEE Photovoltaic Specialists Conference, Seattle, Washington, Aug 4-6 (1970).

5. A.M. Zarem and D.D. Erway, Introduction to the Utilisation of Solar Energy, pp 153-189, McGraw Hill Book Co., New York (1963).

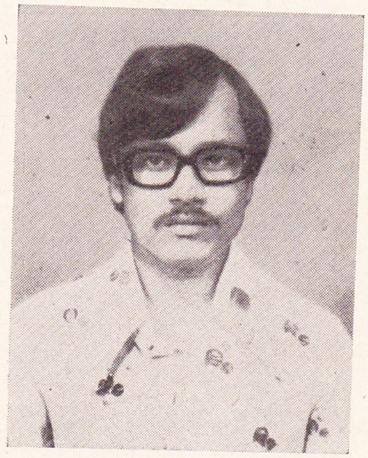
THE BUDDING ELECTRONICS ENGINEERS

1980-'81



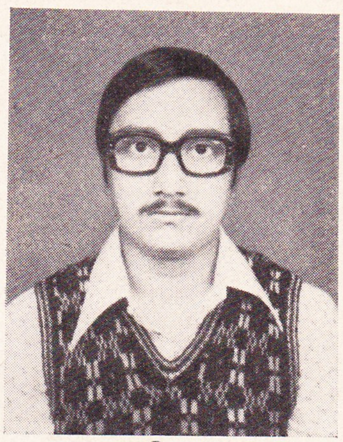
Saibal Pal
101/1, Bhairab Ghatak Lane, Salkia
Howrah-711106

Sorry, it is beyond our reach
to define him.



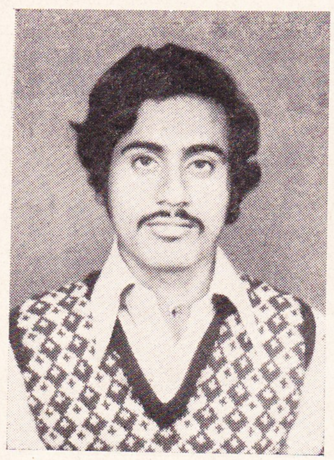
Bansi Badan Maji
Vill : Lakshmikundu
P. O. : Kashinathpur
Dt. : Midnapore

A specimen from Pluto



Partha Pratim Daw
11, Dacres Lane
Calcutta-700 069

Our Bardi prefers to stay
at "Baper Bari"

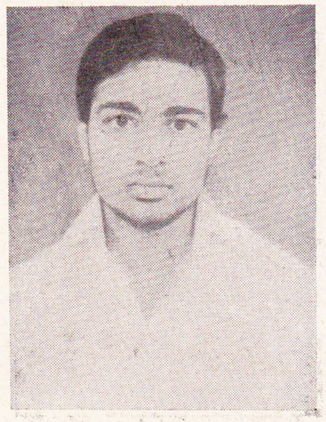


Bani Prasad Guhathakurta
Vill. : Bishnupur
P. O. : Rasulpur
Dt. : Burdwan, 713151
Phone : 52-3228

In Canteen, Bani with money is funny

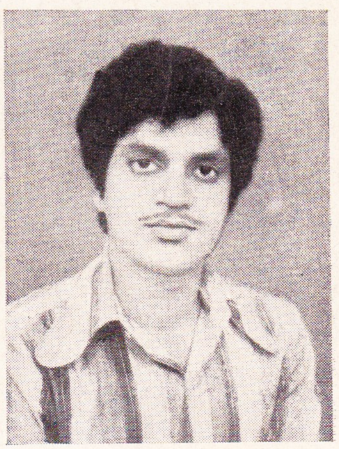
Miss Hena Mitra
Purbapara, Andul-Mourl,
Howrah.

Knows Metallurgy better than Electronics



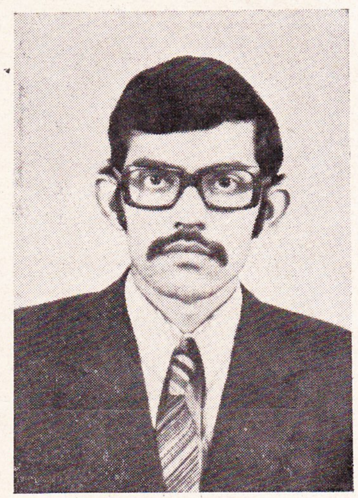
Arindom Chowdhury
C/o. Abinash Chowdhury
C. R. I.
P. O. : R. I. Kasouli
Himachal Pradesh
Pin 173205

I am the miracle of miracles, the great
miscrutable mystery of God.



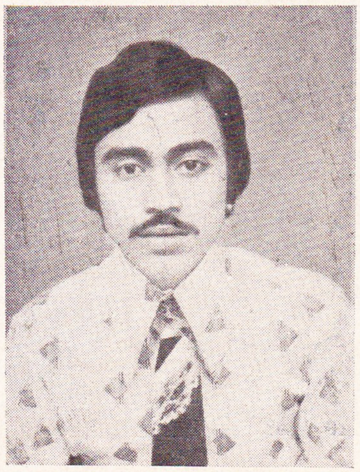
Alkoe Ranjan Bhunia
Jhakra at P. O.
Midnapore
Pin 721245

Our "Lords" teritory terminates
at Esplanade



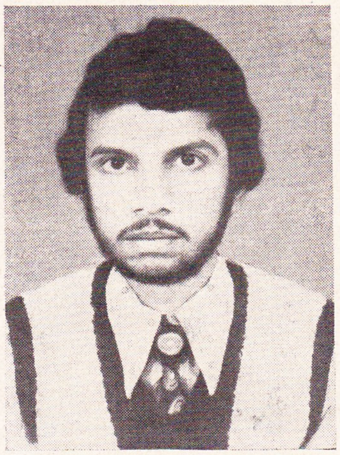
Debasis Banerjee
4, Gopi Mohan Datta Lane
Calcutta-700 003

Most of the time he teases the teachers
asking about the reference books,
though he never buys them.



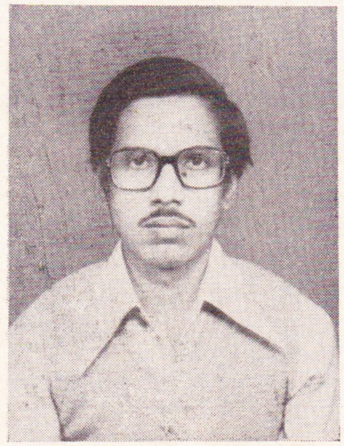
Aloke Roy Chowdhury
Prafulla Roy Road
P. O. : Agarpara
Dt. : 24 Parganas
Pin-743147

He is always thoughtful,
guess about what.



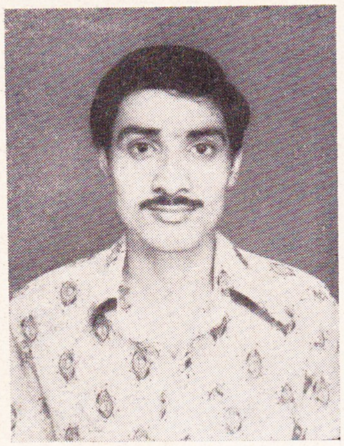
Prabal Kanti Bhattacharya
6/6/1D, Padma Pukur Road
Calcutta-700 040
Phone : 72-5369

He never has to Jostle in a crowded bus 'cause still now he finds himself quite at home in Ladies' & childrens —Seats (No one objects)



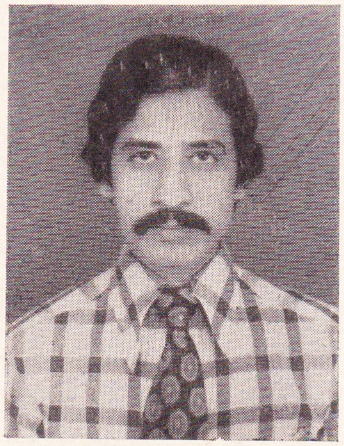
Ashok Kumar Chaturbedi
97, C. G. R. Road,
Kidderpore
Calcutta-23

His grave looks are 180° out of Phase
with his actual nature.



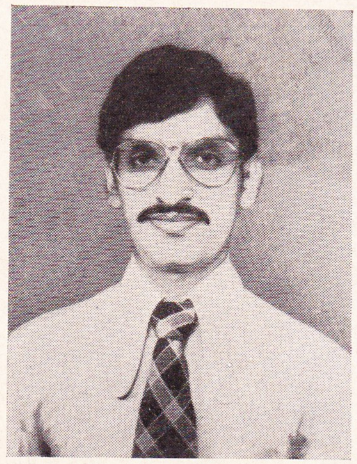
Partha Sarathi Dey
C/o. H. S. Dey
K: G. E. I.
P. O. : Bishnupur
Pin-722122
Dt. Bankura

The hostel dose is maturing our
infant rapidly.



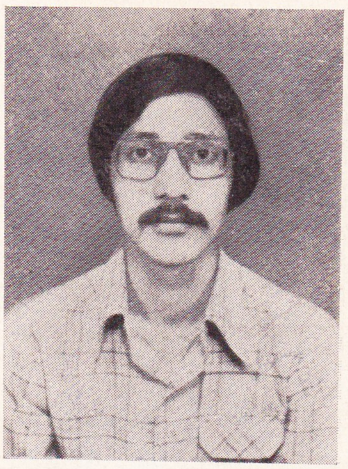
Ajit Ch. Bardoloi
C/o. G. P. Neog
Near Spun Silk Mill Ltd.
P. O. : Jagi Road
Dt. : Nowgong
Assam

The most dreadful sight to anyone preparing for exams.



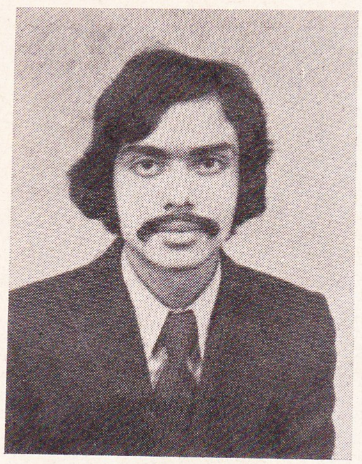
Hemendra Talesara
12, Chhabila Bheru-Marg
Udaipur-313001
Rajasthan

Misses almost all the classes to keep his extracurricular activities going.



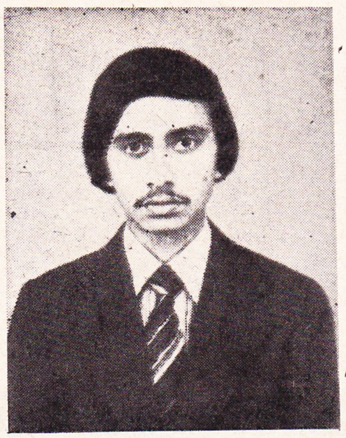
Partha Pratim Ghosh
6B, Dover Lane Extn.
Calcutta-700 029.

Rocky—his name suggests, he feels quite 'fish out of water' in a poor country like ours.



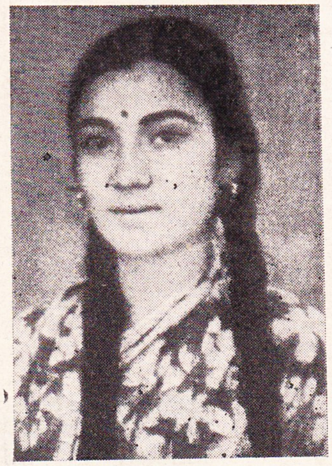
Ashitabha Pal
Kathuria Para
P. O. : Krishnagar
Dt. : Nadia
Pin-741101

Oh ! Handsome' often he says it about him-self before a mirror.



Arup Ratan Ray
"ASHOKA" Flat No.—8D
111, Southern Avenue,
Calcutta-700 029

GO TO 29
STOP
END



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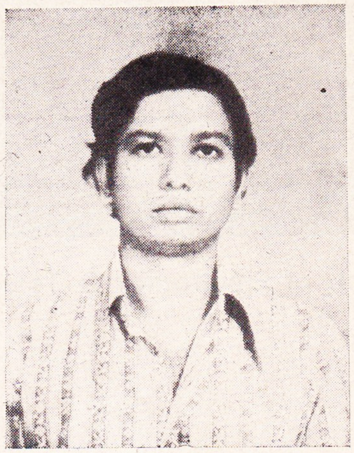

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Don't bite, it's not an apple.

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