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The Official Journal of the Society For Information Display

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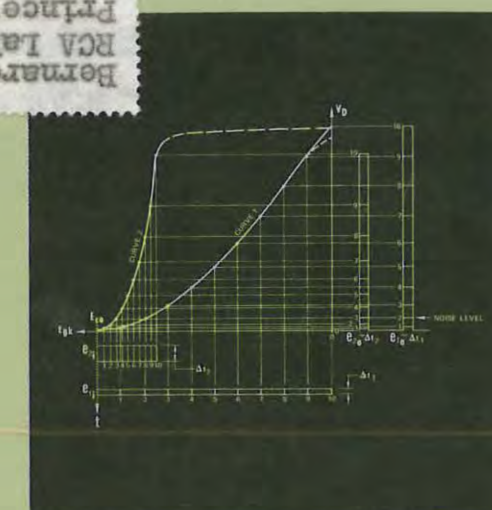
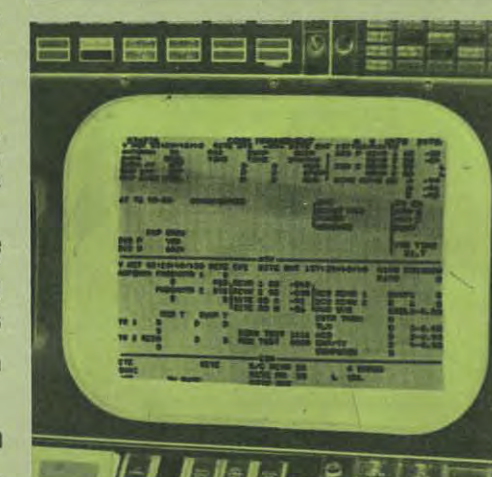
Bernard J. Lechner EX
RCA Laboratories
Princeton, N J 08540





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New special editorial replaces the usual "Presidents Message" which will reappear in our next issue.

Some Thoughts on the Future of Television

BY ROBERT ADLER
Zenith Radio Corporation

Television has been called a window to the world. The variety of images it carries is indeed great. But technically speaking, it is not a very large window; at typical viewing distances, the screen occupies only about 12° along the horizontal axis of our field of vision. Imaginative engineers have wondered whether television could not be altogether different — more like a picture window: you don't look *at* it, you look *through* it at the world, with a viewing angle close to 180°. Could this be a future form of television?

Holography seems the answer, but the difficulties are enormous. At the receiver, we would need an electrically controllable tri-color hologram with an area measured in square meters; at the transmitting end, we must have light that remains coherent over the entire scene, also in three colors, and cameras with unheard-of resolution. Outdoor scenes present a special problem. The transmission link requires enormous bandwidth, about a million megahertz. These difficulties are too great even for optimists.

A more modest goal is a large display in two dimensions. We will look *at* it, not through it. It could, for instance, hang on the wall like a large picture, several feet wide.

Such pictures can be made today by projection systems. Getting enough light for daylight viewing is a perennial difficulty; reducing complexity to the point where home use becomes practical would be a remarkable achievement. Laser projectors are impractical because of low laser efficiency. In addition, there is some doubt whether any projection system would find public acceptance.

The most popular approach to the large display is a flat-screen x-y matrix of active elements that light up when energized, or change their reflectivity or transparency. Many ideas for such displays have been published, and many more are probably under investigation by SID members at this moment. For example, a plasma display demonstrated in New York last year by some of my co-workers consisted of a 200 x 80 array of neon lamps. It showed only a portion of the full TV picture, in monochrome, and not very bright. The peripheral circuits took more space than the panel. However impractical it was, it showed live pictures; it made one think of what might follow.

When will the flat screen arrive? Call t_0 the time when the new device is working beautifully in the laboratory; add a few years to learn how to manufacture it, and a few more to make it competitive, but remember: no one has yet claimed to be at t_0.

The flat screen should be made wider than the picture tube. More information can be placed on it then, and a new, superior service established to transmit programs with higher resolution, on cable or on millimeter waves. There may also be much smaller flat screens, brief-case size.

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An experimental TV display using a gas-discharge flat panel

Discussion of making a gas-discharge TV receiver with a screen area greater than that of a conventional CRT. It should be more suitable than liquid crystal or electro-luminescent screens, say the authors.

An experimental set-up was constructed to display a portion of a monochrome picture, reproduced from NTSC TV signals, on a flat panel display device. The set-up uses a combination of a 77 by 222 dot gas-discharge display panel developed for graphic displays by Burroughs Corp. and a set of the analog memories and associated circuitries utilizing MOS-LSIs. The experimental set-up covers TV pictures occupying a range of about 24 and 90 percent of the horizontal and vertical deflections, respectively. A luminance of up to 15 ft-L, a contrast ratio of up to 25 to 1 and a variation in luminance of 2 percent were obtained in the experimental set-up.

By

HIROAKI IKEDA,
TETSUO SAKAI,
IWAO OHISHI
TERUO HIRASHIMA

■ A conventional TV display system or TV receiver using a CRT has limitations to increasing the screen-area. The more the screen-area increases, the greater the size and weight of the CRT. A TV receiver utilizing a flat panel display can reduce cabinet depth while keeping screen-area large. Since depth of a flat panel display usually lies on the order of magnitude of centimeters, it is feasible to construct a TV receiver with a screen-area greater than that of a conventional CRT. Examples demonstrating feasibility of TV receivers utilizing flat panel displays have been proposed by engineers at the Philips Corp.[1] and Mitsubishi Electric Corp.[2] In those TV receivers, the gas-discharge display panel is expected to be more suitable

By HIROAKI IKEDA, TETSUO SAKAI,
IWAO OHISHI & TERUO HIRASHIMA

than, for example, liquid crystal or electro-luminescent screens, since it can better provide large screen-area, high luminance and contrast.

Luminance modulation controlling the duration of time during which gas-discharge current flows through a gas discharge cell of the panel was carried out in a gas-discharge panel proposed by Th. J. de Boer of the Philips Corp.[1] However, the Burroughs' gas-discharge panel provides the scanning and display cells which are interconnected to each other through a hole bored through the cathode plate. Hence, luminance modulation in which the cell current is continuously controlled can be easily carried out if the Burroughs panel is used. An advantage of amplitude luminance modulation over pulse-width modulation lies in simplification of the arrangement of electronic circuits used in video-signal systems.

Although a TV receiver using the Burroughs panel does not seem to be reported, except for a still-picture display[3], a TV receiver utilizing the Burroughs panel is considered to be a useful concept in exploring future flat panel TV receivers. The purpose of this paper is to describe an experimental flat panel TV-receiver utilizing the Burroughs gas-discharge panel, shown at the exhibition of the Technical Research Laboratories of the Japan Broadcasting Corp., held on May 26-28, 1972, and also to provide a new type of an integrated TV-signal processor in which a sequential TV video signal is converted into corresponding parallel signals suitable for providing brightness on the panel.

Selecting a Display Panel

A display panel used in an experimental version was selected from among those available on the market. These included one made by an Illinois firm and by Burroughs. In the former, it is difficult to obtain an arbitrary half-tone over a wide range of luminance even though some experiments to obtain half-tones have been reported.[4-6] However, half-tones are easily obtained in the Burroughs panel if display anode current is controlled. Hence, in its present form the latter is suitable for use as a display device for reproducing TV pictures. Advantages of the Burroughs panel SSPD® include:

1. Pull-out of priming gas discharge from a scanning cell into a corresponding display cell is utilized in the Burroughs SSPD® as shown in Figure 1. Hence, priming gas discharge existing in a scanning cell behind a narrow aperture is stably pulled out from the scanning cell into the display cell through the aperture, if positive voltage large enough to pull out discharge from the scanning to display cells is applied to the display anode. This means that conditions for the scanning and luminance modulation of currents are selected independently from each other.
2. An arbitrary luminance is more easily obtained by changing currents flowing through each of the display anodes, although it is obtained by changing pulse-rate of currents flowing through the cells as well as in the Illinois panel.
3. Inter-cathode scanning, performed by shifting a cathode on which gas discharge is generated from one to an adjacent one, utilizes diffusion of priming gas-discharge from one cathode to an adjacent one. This scanning at a lower rate is used as the vertical deflection in a TV-picture display.

Some of the deficiencies in the Burroughs panel when used for TV display include:

1. Radiation wavelengths of light are determined by energy levels of Ne-gas molecule. Hence, pictures are characterized by the red-and-black tone determined by the radiation wavelengths.
2. Spans between dots spaces on the 1 mm centers. A dot diameter in the panel available for graphic displays measures about 0.6mm. Hence, the dotted structure of the panel is seen if the panel is observed at less than 2 m distance.

The Burroughs SSPD, containing a dot matrix of 77 by 222 points, was selected as a display device for use in reproducing TV pictures. Specifications of the panel selected for use as the TV picture display are listed in Table I.[7]

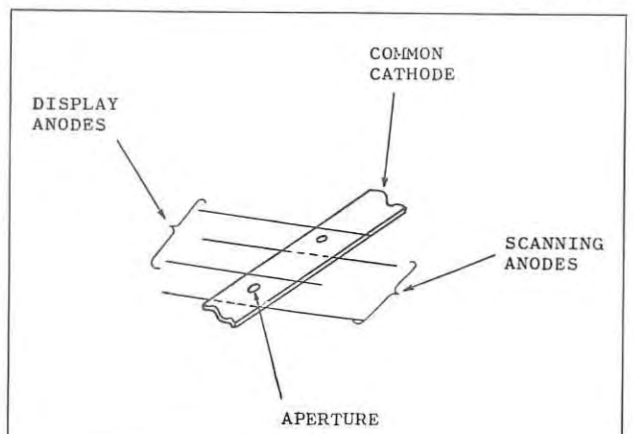
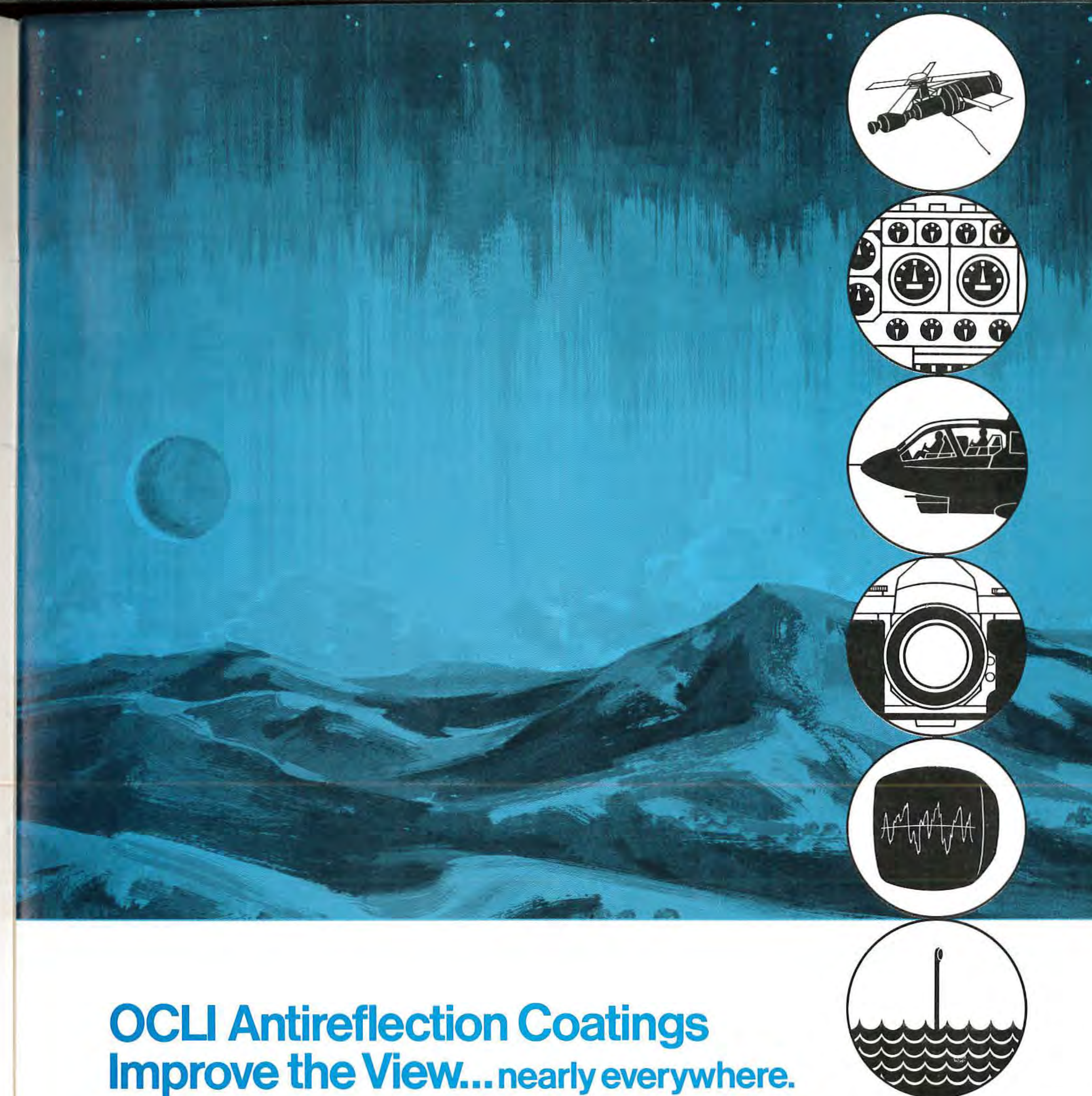


Figure 1. Display and scanning mechanisms.

(Reprinted from the product specification of C5004 manufactured by the Burroughs Corp.)

Number of Dots	77 by 222 (17,094) (77 anodes 222 cathodes)
Center to Center	
Dot Spacing	0.040 in.
Dot Diameter	0.024 in.
Light Output	red-orange
Phase Number of Pulses used for Cathode Scan	7ϕ

Table 1. Specifications for the 77 by 222 dot-panel. (Reprinted from the product specification of C5004, manufactured by the Burroughs Corp.)



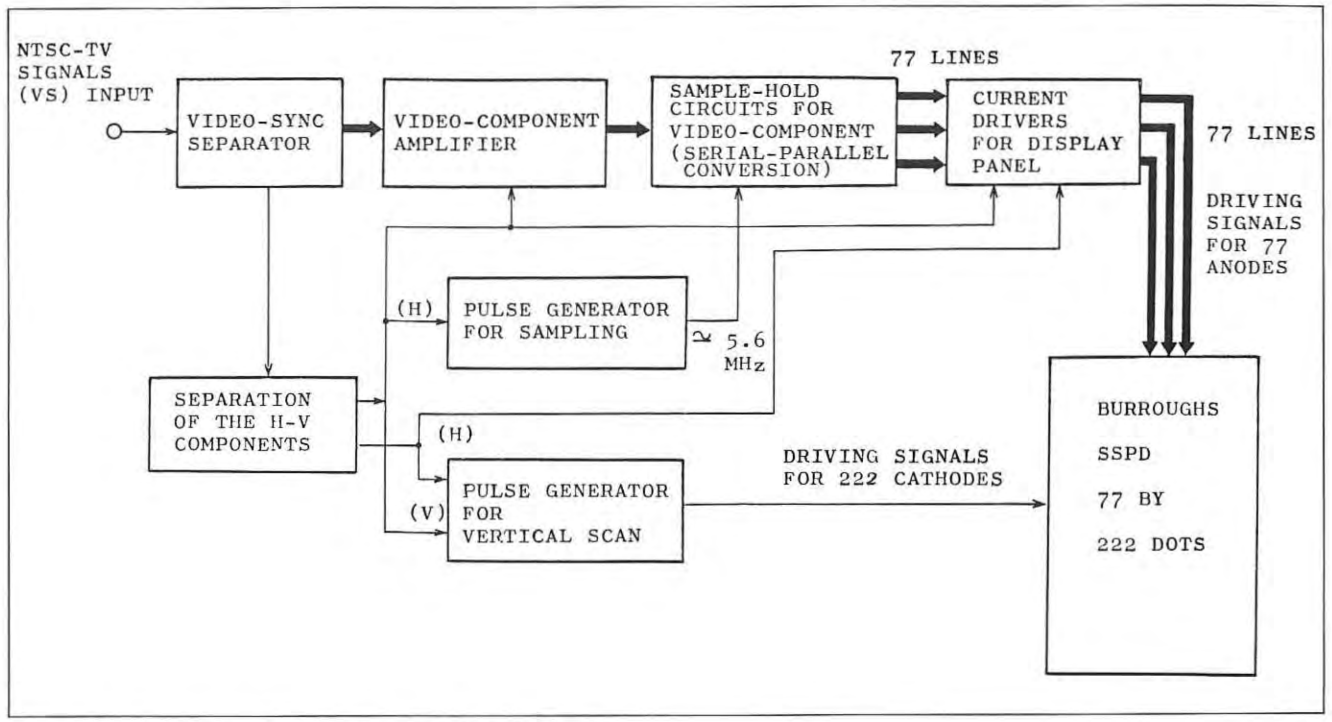


Figure 2. Arrangement of an experimental TV display system.

Organization of Display System

Specifications for the experimental TV display system through which TV pictures are reproduced from the NTSC-TV signals are given below.

1. Signals. NTSC-TV signals are applied to the video input terminals of this system.
2. Horizontal Deflection. Conventional circuits for horizontal deflection are eliminated due to utilization of the "one-line-at-a-time" address. Currents flowing through the display anodes constituted with 77 lines are, in the experimental display system, simultaneously supplied. Hence, horizontal deflection is practically carried out by use of sample-hold circuits constructed with MOS-LSIs.
3. Vertical Deflection. A lower rate scanning utilizing priming gas-discharge of the panel is used for vertical deflection.
4. Grayscale. Grayscale results from modulation of currents flowing through the display anodes of the panel.

The above requirements have been arranged in the experimental display system shown in Figure 2. Video signals (the NTSC-TV signals including synchronizing pulse components) are, in Figure 2, divided

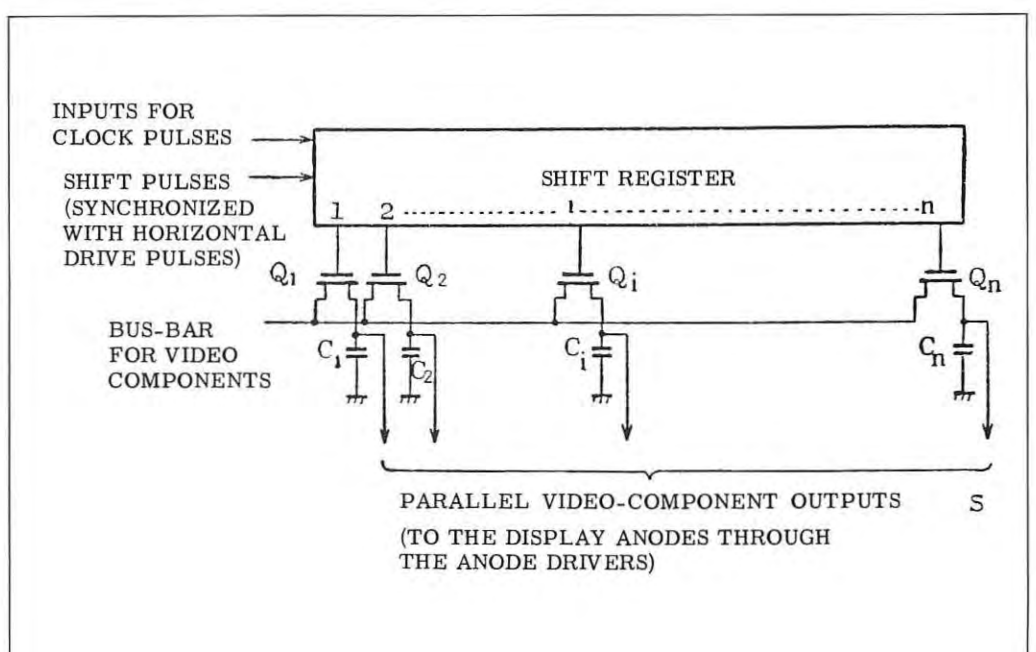


Figure 3. Arrangement of the sample-hold circuits for the horizontal "one-line-at-a-time" address.

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IWAO OHISHI & TERUO HIRASHIMA

into the video and synchronizing signal components. The video-signal component is applied through the buffer amplifier to the sample-hold circuits. The video-signal voltage is, in the sample-hold circuits, divided into segments corresponding to picture elements. A signal voltage constituting each of the picture elements is stored in a corresponding memory capacitor. Voltages across the memory capacitors are simultaneously applied to the display anodes of the panel through the corresponding anode line drivers through which currents supplied from the high-voltage source flow.

The sample-hold circuits are shown in Figure 3, in which one package of the sample-hold integrated circuits consists of 20 bits of an MOS shift-register and 20 sample-gates. Both of the electronic circuits are constructed with MOS-LSIs. The shift-register, to which the sample-hold circuits are connected, corresponds to a conventional horizontal scanner.

In Figure 3, if the i-th bit of the shift-register is addressed, the MOS transistor Q_i turns on and thus the capacitor C_i is charged to the bus voltage at a time of the address. The capacitors C_1, C_2, C_3 . . . . . . C_i . . . C_n are charged to the bus voltages at times of the addresses 1-st, 1-nd, 3-rd . . . i-th . . . n-th, respectively. The voltages stored in the capacitors are fed to the display anodes through FET buffers and bipolar line drivers.

Although 77 lines have been provided for the display anodes, variation inluminance, when a video signal having a constant amplitude throughout a frame of pictures is applied to the system inputs, was kept low without providing any manually adjustable means.

Address points on the Burroughs SSPD, by means of the "one-line-at-a-time" address, are, one by one, shifted from the upper to lower columns at a time of every horizontal synchronizing pulse. The vertical synchronizing pulses were used for drawing back the end of the vertical scanning points and for determining the starting phases of the vertical scanning points. Vertical scan of the panel was carried out by the use

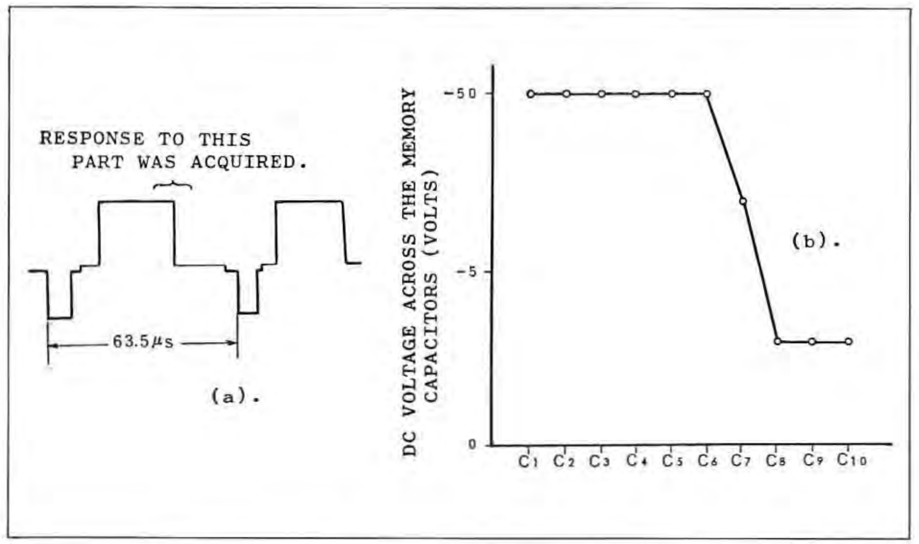


Figure 4. Rectangular waveform response to the horizontal-deflection axis. (a) Applied video-signal waveform. (b) Response.

Figure 6. Pictures reproduced on a flat-panel.

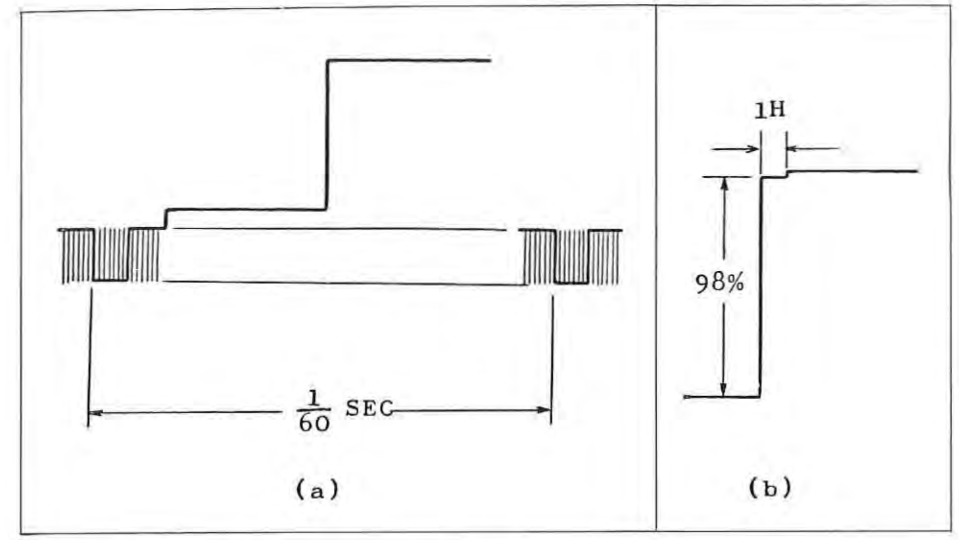


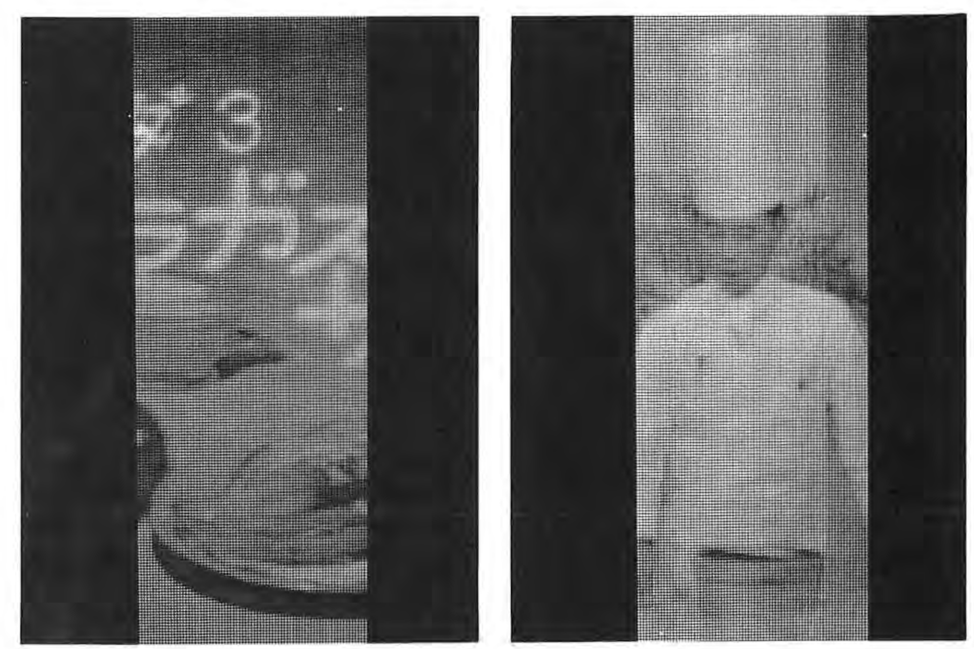
Figure 5. Rectangular waveform response to the vertical-deflection axis. (a) Applied video-signal waveform. (b) Response.

of this method. Multiple-phase pulses, by means of which a bright line on the display panel is shifted, are used for vertical scan. Hence, 241 to 242 cathodes are required to perform vertical scan of a picture frame. If an aspect ratio of 4:3 is assumed, 321 anode wires are required. Since the Burroughs SSPD designed for graphic display provides 77 anodes and 222 cathodes, pictures covering about one-fourth of the horizontal-deflection axis and about 90 percent of the vertical-deflection axis are displayed on the panel.

Experimental Set-Up

Performances obtained with the experimental set-up are summarized as follows.

1. Coverage of the reproduced pictures. In the direction of the horizontal-deflection axis: about 24 percent of the effective deflection width (about ¼ H). In the direction of the vertical-deflection axis: about 90 percent of the effective deflection width (about 0.9 V).
2. The maximum luminance — 15 ft-L.
3. Contrast ratio — 25:1 (max.)
4. Variation in luminance — 2 percent (for the maximum luminance).
5. Rectangular waveform response to the horizontal deflection axis. When a rectangular-waveform video-signal with a synchronizing component, shown in Figure 4(a), was applied to the system input, voltages shown in Figure 4(b) appeared at the outputs of the serial-parallel converter constructed with MOS-LSIs. Voltages of -10 and -3 V correspond to the higher and lower levels of the video signal, respectively. The time interval corresponding between C_6 and C_8, equal to 360 ns of the video signal, was determined by performances of the experimental set-up.
6. Rectangular waveform response to the vertical deflection axis. When a rectangular waveform video-signal with a synchronizing component, shown in Figure 5(a), was applied to the system input, a voltage response shown in Figure 5(b) appeared across a memory capacitor.
7. Dissipated power — 30 to 50 W (where 10 to 25 W were consumed in the panel).



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8. Pictures. Figures 6(a) through 6(d) show examples of pictures obtained from an experimental set-up. The pictures were reproduced from received signals using a conventional TV tuner.

Conclusion

The following conclusions can be drawn based upon the experiment described herein:

1. Utilization of priming gas discharge led to reproduction of pictures with half-tones.
2. Capacitor memories utilizing MOS-LSIs were effectively used for the conversion from sequential TV signals to the corresponding parallel signals.
3. Variations in sensitivity, between signal lines for driving the display anodes of the panel, qualitatively affect pictures reproduced from TV signals. Hence, variation in luminance should be kept low.

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About the Authors

Hiroaki Ikeda is with the Technical Research Laboratories of the Japan Broadcasting Corp., where he is engaged in circuit applications of semiconductor devices including integrated circuits and MOS transistors, and in the measurement of MOS parameters. He is also involved in the developmental design of MOS circuits in a flat-panel receiver.

Tetsuo Sakai works for the Technical Research Laboratories of the Japan Broadcasting Corp., where he has engaged in the development of color TV transmission equipment, and in conducting research on improving the signal-to-noise ratio of pre-amplifiers for the vidicon cameras. He is currently working on panel types of the image pick-up and display devices.

Iwao Ohishi, PhD, is a Senior Research Member of The Technical Research Laboratories of the Japan Broadcasting Corp. He has been engaged in research on cathode-ray tubes, pick-up-tubes and flat-panel display devices.

Teruo Hirashima is employed at the office of the R & D Committee of the Japan Broadcasting Corp. He has worked at the Technical Research Laboratories, where he was engaged in research on TV systems, imaging systems and flat-panel display systems.

Computer Users Loyal to Brands

Intensifying the pattern set last year, computer users will reach an all-time high degree of loyalty to their mainframe manufacturers, according to a forecasting technique used by *EDP Industry Report*.

In its sixth annual Customer Loyalty Study, *EDP/IR* concludes that although some users stretched their EDP dollars during the economic squeeze by looking to independent peripheral manufacturers or third-party leasing companies, they stuck by their mainframe manufacturer to a much higher degree in 1971 than in 1970. This trend is continuing, according to the report, and a proven accurate forecasting technique indicates that level or better loyalty is expected for all manufacturers except Univac in 1972.

Achieved Greatest Gains

IBM experienced the highest number of defections, according to *EDP/IR*, but also achieved the greatest gains from other vendors, for a second-place loyalty rating of 82%. Burroughs retained its usual first-place standing with 86%. As System/370 deliveries gather even greater momentum, however, IBM may well reach 94%, surpassing even Burroughs in 1972 loyalty.

Univac will probably decrease its rating from 61% to about 50% in 1972. The RCA rental base will be a major source of defections, and the current trend among Univac's Model 9200 users is to step up to some other manufacturer's system —most often one by IBM.

Honeywell and NCR also achieved high degrees of loyalty in 1971 — 79% and 76% respectively— having gained most of IBM's defected customers, and will probably maintain these approximate levels in 1972.

The Halftone Response of Electrical Recording Storage Tubes

BY R. A. DAVIDSON
Litton Industries/Data Systems Division

Storage tubes have a reputation for poor gray level rendition, states the author. At best, in the past, tubes have yielded four or five distinguishable gray levels. More recently dual-gun dielectric storage tubes have produced 10 halftone levels in the output display. Reasons for poor halftone response, and the new techniques, are discussed.

■Most electrical input and output storage tubes of the dielectric target type have a reputation for poor halftone or gray level rendition, especially when video is written at slow scan rates. In the past, such tubes could produce, at best, 4 or 5 distinguishable gray levels. Yet very little has appeared in the literature regarding this performance.

One major contributor to the poor dynamic range of storage tubes has been the non-linear transfer function of the dielectric type storage tube. Non-linearity in the writing electron gun, coupled with the storage target charging process, causes compression of signals. These signals are then masked by noise in the read-out process. Recently, dual-gun dielectric storage tubes have been designed into equipments to provide pre-emphasis of low level signals. This overcomes non-linearity in the low level or "black" regions of the transfer characteristics and produces 10 half-

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tone levels in the output display.

The underlying reasons for poor halftone response by storage tubes are discussed in detail and two equipment techniques are discussed to overcome the problem.

Exponent Exact Value Unimportant

Poor halftone response from single or dual gun dielectric recording storage tubes arises from the transfer curve of a writing electron gun coupled with the charging of a dielectric. Figure 1a qualitatively shows a typical transfer curve for an electron gun. Note that the beam current is a non-linear function of the grid-cathode voltage above cutoff, of the form:

$$i_b = K_e^{\gamma}$$

The exact value of the exponent is relatively unimportant. What should be noted is that the non-linearity in beam current is most apparent at low values of grid-cathode voltage above beam current cutoff.

Now consider that this beam current charges a dielectric "capacitor".* At some point, the dielectric saturates and will not accept any more charge. Then a transfer curve of charge (or potential) on the dielectric versus the input signals to the storage tube might appear as the idealized curves in Figure 1b. These curves are parametrically time-dependent since the vertical axis is now dielectric charge, dielectric or potential. Assume that the curves in Figure 1b were constructed by pulsing the electron gun for an interval Δt_1. Then note that the dielectric potential will follow the non-linearities of the electron gun transfer curve, assuming the dielectric is a passive linear element, until the saturation point is reached. Now let the electron beam pulse width be increased; the dielectric will still saturate at the same potential so that this must force the saturation to occur at a lower beam current and, therefore, a more negative electron gun grid-cathode voltage.

Dwell Period

The input signal modulates the write gun of the storage tube as the electron beam is deflected or scanned across the dielectric. Generally, the deflection will be at a constant rate; that is, a linear scan is produced, which essentially establishes the "dwell" period of the electron beam on the dielectric for each resolvable element. Thus, the slower the data rate of the incoming signal, the more compressed will be the dynamic range of the writing process since the "dwell" period for each element is longer. This is qualitatively shown in Figure 1c by drawing two different pulsewidths (for a given resolution element) on the grid-target transfer function to simulate two different data rates. The input signal pulse is broken up into 10 equal amplitude segments. The wider pulse occupies a smaller dynamic range, curve 2, since it charges the dielectric more rapidly at each voltage level. By the simple graphic construction shown in Figure 1c, the two "pulses" can be reproduced "through" the electron-gun/dielectric transfer functions as though they had been "scanned" by a perfectly linear reading process; these are shown at the right of the transfer curves. Note how much more non-linear the successive segments of the wider pulse are (proportional to Δt_2) compared to those of Δt_1. In addition, if it is hypothesized that the pre-amplifier following the storage tube readout produces an equivalent input noise level as shown, then this also determines the black tone. Thus, noise washes out the first *two* levels for e_1, but the first three levels for e_2. In addition, more adjacent levels are indistinguishable from each other in signal e_2 than in signal e_1.

In this discussion, and in the Figure 1c, the baseline of the signals is assumed to start from cutoff of the storage tube to preserve the equivalent of the "black reference" level from the sensor.

In addition to "black compression" the peaks or white levels are compressed since the dielectric saturation does not really take place as sharply as is shown in Figure 1b, but is more rounded as shown by the dotted lines at the top of the transfer curves in Figure 1c. Although not as serious as black compression, this effect can also "lose" one or more levels of the signal.

Human Factor

Signals processed by the non-linear transfer function of a storage tube appears much worse when displayed because of the human factor involved. To a human observer, equal incremental steps of light intensity appear compressed; it requires logarithmically increasing steps of light intensity to appear as equal steps. Consequently, logarithmically increasing steps of signal voltage are required to drive the output CRT display (assuming that the CRT is linear). If the input signal were divided up into 10 steps related by the ratio $\sqrt{2}$, they would appear as in Figure 2 before and after the writing process of the storage tube.

*For principles of operation, refer to: "Storage Tubes and their Basic Principles", Knoll and Kazan, John Wiley, 1952; "Recording Storage Tubes and their Applications", A.S. Luftman, Electronics World, May 1953; "A Display System Using the Alphecon Storage Tube", Marlowe, Wendt, and Wine, Proceedings of Society of Information Display, Vol. 12, No. 4, 1971.

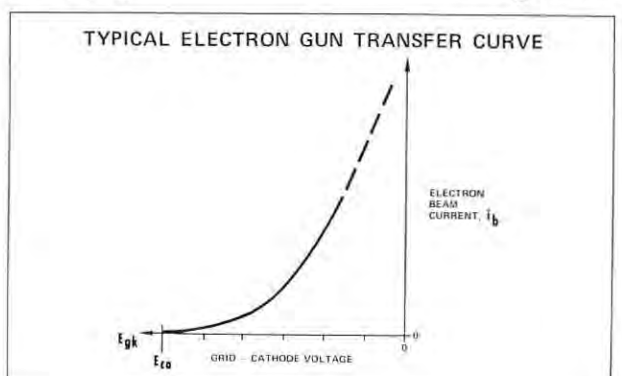

Figure 1a.

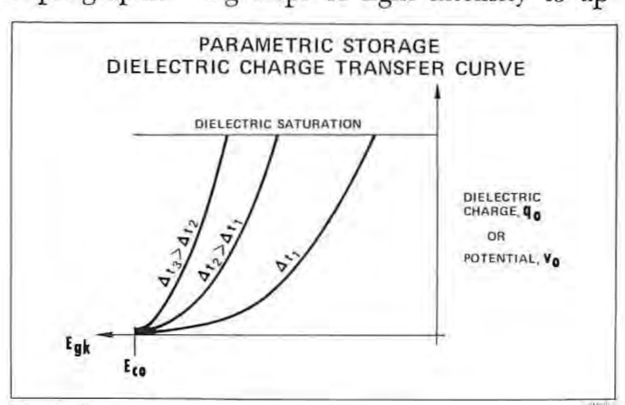

Figure 1b.

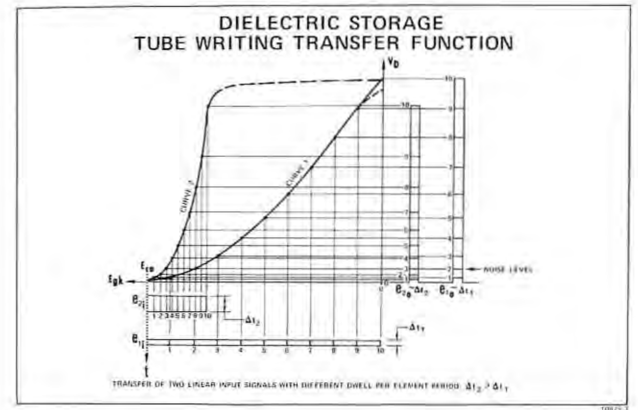

Figure 1c.

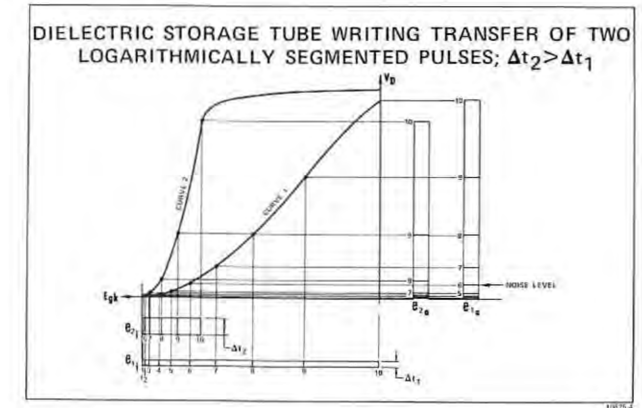

Figure 2.

Two Solutions

In the best case for the narrow pulse signal, $^{e}1_o$, only 5 "gray" levels or halftones (including black) will be discernible to an observer. The long pulse which compresses the dynamic range more severely would produce only 3 gray levels in $^{e}2_o$.

This effect has never been specifically discussed in the literature before, yet it is one of the most serious problems facing the storage tube user in slow scan conversion for display or in multi-sensor display where the data rates of the different sensors vary widely.

There are at least two solutions to this problem; one a simple but partial solution, the other requiring additional complexity. The partial solution is to sample sensor signals which have a very low data rate with narrow pulses and apply the sampled signal to the writing gun of the storage tube. This avoids the very serious black compression of slow signals, although some compression will still occur because of the basic non-linearity of the electron gun itself. Applications of dielectric storage tubes where the input signal is at, or near, real time television rates frequently do not encounter this problem.

A second solution to this problem was effectively tried on a developmental multi-mode radar display in 1968. Amplitude pre-emphasis of video signals near black level was applied to the very low data rate (slow scan) signals from a SAR sensor and ten (10) gray levels were achieved in this manner. What is required is a non-linear correction amplifier which automatically adjusts the amount and level of pre-emphasis as a function of the sweep speed on the writing side of the storage tube. The storage tube itself becomes the "de-emphasizer".

If the storage tube has been made "linear" by one or both of the above methods, then the dynamic range is limited simply by noise in the readout signal (assuming all electrical amplifiers are also linear).

The number of gray levels or halftones that can be reproduced is determined by the S/N ratio of the output video signal from the storage tube *and* pre-amplifier.

A commonly accepted standard is that two halftone or gray levels are related by $\sqrt{2}$*; that is

$$\frac{^{e}n+1}{^{e}n} = \sqrt{2}$$

where $^{e}n+1$ is a signal level representing a full halftone step above ^{e}n.

It follows that the power or light intensity ratio of two adjacent steps is 3 db. Thus the linear dynamic range, in decibels, must be

$$Spp/N_{rms} = 3n_H$$

where n_H represents the number of halftones.

Most storage tube pre-amplifiers are capable of S/N = 30 db and therefore, it would seem that they could also provide 10 halftones. As has become evident, however, the dynamic range must be linear to obtain good halftone rendition.

Of course, other factors may affect gray level response in a storage tube, such as the signal-to-disturbance ratio in some tubes. There may also be situations where the input signal-to-noise ratio is low and input noise predominates in limiting the dynamic range of the system, as for example, when the storage tube is being used to provide video integration. In this case, pre-emphasis may not be necessary or desirable. ■

*"Fundamentals of Television Engineering", G.M. Glasford, McGraw-Hill, 1955, p. 13.

about the author

Richard A. Davidson received his BS in Electrical Engineering from New York University in 1949 and an MSEE from Syracuse University in 1955. As a Group Leader at RCA, 1954-62, he worked on slow scan and solid state electro-optical imaging and signal processing devices and various types of displays. Subsequently he has served Electro-Optical Systems, Inc. as Manager of Electronic Imaging Systems; Hughes Aircraft as Head of the Advanced Display Development section; and Litton Technische Werke (West Germany). In 1970 he transferred to Litton's Data Systems Division where he is at present a Member of the Senior Technical Staff in the Display Systems Department of the Engineering Directorate. He is a member of SID and several other societies.

whither television

The following introductory remarks preceded a panel discussion of the future of television. Mr. Markin moderated the panel, which was a feature of the 1973 SID International Symposium.

BY JOSEPH MARKIN

Zenith Radio Corporation—Chicago

■ We shall discuss and debate some of the foreseeable technical developments in TV, such as the availability of inexpensive video playback devices and software; the impact of cable TV; and changes in receiver design and performance. Related subjects include the new services that may become available, how they will be financed and how they will affect people.

Two new developments of great potential importance are waiting in the wings. The first, low-cost video playback, is now preparing to offer video disc records and players whose prices could well approach those of audio components. How will the public react to this new gadget? Will it welcome an opportunity to buy or rent its video fare, so that people may better see *what* they want *when* they want it? Or will it ignore this new product and leave the video recording and playback business to schools, to industrial use and to other low-volume peripheral applications?

The second development is that of CATV, probably with pay TV. Here the difficulty is that of reaching critical mass, of getting enough subscribers. There probably aren't enough people in hard-to-reach outlying areas or in central-metropolitan poor-reception areas to get over the hump. How will CATV offer enough to tempt the typical viewer, who has reasonably good reception and three or four TV stations to choose from? Will it be by showing otherwise blacked-out athletic events, such as football, boxing and hockey, or by showing first-run movies?

One or more of these new approaches may give us a chance to approach a more pluralistic society, one in which the tyranny of numbers no longer forecloses our opportunity to enjoy a movie or a TV program just because it's not being shown in the movie houses nearby or because its measured popularity on the performance ratings does not put it among the top ten or twenty.

We have heard much about the new Wired City, about interactive displays with shopping, library research, educational facilities and other amenities offered via CATV. But who will pay for this and why? Not everything technically possible becomes economically viable.

Will CATV, with its large spectrum space and control of transmitted signals, encourage some variation in TV standards? Greater transmission bandwidth could be used to produce higher-resolution pictures, which could make for pictures with greater entertainment value as well as the ability to transmit information approaching that on the printed page. However, the generation, transmission and reproduction of these higher-quality pictures will need new equipment designs and improved display performance. Wider bandwidth could enhance the appeal of large-screen displays, perhaps using the often-heralded flat-screen TV picture.

One surprising thing about the TV industry is that its product continues to perform better, to be easier to use and, in a time of rampant inflation, to cost less than it did five or ten years ago. Compare this to the auto industry, with its relatively static technology and sharply higher costs. TV costs, including the color tube and its supporting circuitry, should continue to come down, both by design simplification and by production automation. The latter is particularly important in competing against low-cost off-shore labor in what is still a labor-intensive product, as witness a TV assembly line with its many workers sitting side-by-side.

Picture quality should improve; TV broadcast quality can and should approach European standards, perhaps with the help of the proposed Vertical Interval Reference added to the composite video signal. There is also room for improvement in TV receiver picture quality in resolution and stability.

Thin flat-panel displays, when and if available, should offer less weight, sharply reduced volume, a larger display area and freedom from convergence problems. They will be relatively expensive initially, so their first effect should be on the high-priced end of the TV product line. However, one vital condition will be the ability of solid state technology to provide cost-effective IC's in what amounts to large scale integration.

The TV industry is probably going to change radically in the years ahead. There is the potential of new products and new services; but its realization will take a combination of technological success, the large-scale acceptance which can lead to low-cost production (and without low-cost production there won't be large-scale consumption), and the necessary political decisions on such matters as who shall be permitted to offer what services in what areas at what prices. ■

about the author

Joseph Markin has his BS in mathematics and physics from the University of Chicago and an MSEE from Illinois Institute of Technology. He has been with Zenith Radio Corporation since 1960, and is now Manager of Display Systems in the Research Department. Much of his work is concerned with flat-panel matrix displays for consumer TV application. Before Zenith, he was Manager of the Microwave Department at Raytheon Corporation. He is an active member of SID.

NEW SKYLAB Display Consoles

Sky lab flight controller at one of new command/control consoles in Skylab Mission Control Center. Flight controller is using it to obtain data from Center's computer systems, which can store and deliver up to 40 times more information than was available for Apollo.

The huge data displays and busy consoles at NASA's Mission Control Center (MCC) here look much the same as during earlier days of space flight. Yet, vast differences rapidly became apparent as flight controllers worked feverishly to salvage the recently troubled Skylab program. Most striking is the amazing amount of information being transmitted or stored for later use—more than 40 times the amount needed for Apollo.

Unlike Apollo, which operated from a fixed flight plan, Skylab was designed for maximum flexibility. Many of the astronauts' specific assignments were to be determined on a day-to-day basis, with teams of biomedical, earth resources and other scientific experts submitting proposals for flight crew activities only 48 hours in advance. This approach was originally adopted to serve Skylab's goal of broad scientific experimentation.

Then, because of launch damage that threatened the spacecraft's survival, this ability to improvise quickly as the program progresses became a vital tool in saving the mission. It continues to be important as NASA restructures Skylab's third manned mission to make up for experimental time lost during the first and second flights and compensate for reduced spacecraft power supplies.

To evaluate "near-real-time" action plans rapidly and resolve conflicts between competing proposals from scientists, an immense amount of mission data has to be kept on hand and made instantly available to the decision makers.

The second floor of MCC has been converted for Skylab use. According to Robert C. Benware, four major computer and display systems and many more complex computer programs have been added to those used for Apollo (Benware is Houston director for Philco-Ford Corp., which designed and built MCC over 10 years ago).

Another big change has been complete redesign of the desk-like command and control consoles where flight controllers sit to get information and to direct the mission (see picture).

"The net result," said Benware, "is that a single flight controller now has more information available at his fingertips than all the controllers combined had during the moon missions."

The new systems include one for processing computer tapes of earth resources data carried back from the spacecraft by the astronauts; a digital television system that forms the nucleus of Skylab's display and control system at MCC; a Mass Data Storage Facility (MDSF), and new Mission Operations Planning System (MOPS) terminals.

At the heart of the MCC's increased data handling capability is the MDSF. To evaluate mission planning proposals thoroughly in

turn to page 29

Description of a target structure for a new input-output storage tube, citing choices of materials, and their advantages.

IMPROVED MEMORY TUBE for Alphanumeric, Graphics And Frame Freezer Applications

By K.R. HESSE
Hughes Aircraft Company
Industrial Products Division
Oceanside, California

■ A new target structure for a single ended electrical input-electrical output storage tube is described here, which features ruggedness, ruggedability, both mechanically and electrically, fast writing and erasing rates, and economical fabrication. The target can be made using either one of two basic materials, semiconductors or insulators. Both materials exhibit the same general enhanced characteristics over the more widely known mesh and silicon/silicon dioxide targets. In the case of insulating substrates, the target structure is metallic grid printed on glass, while in the case of semiconducting substrates, it consists of a metallic grid pattern on a silicon dioxide/silicon wafer. The fast response of both structures is due to the comparatively low capacitance of an elemental area compared to standard targets. Comparative values of capacitance for the targets are calculated and discussed in relation to the speed characteristics. A brief description is given of fabrication techniques for both types of targets. These techniques make use of the photolithographic processes commonly associated with LSI fabrication. Performance characteristics of tubes fabricated with the new targets are given. The tubes are used in various applications such as slow scan thermography, frame grabbing, and computer terminal buffer storage.

The Industrial Products Division of the Hughes Aircraft Company has developed an improved memory tube for alpha-numeric, graphics, and frame freezer applications. It is based upon a novel target structure patented by Hughes. Tubes utilizing this target are shown in Figure 1. They are a one-inch vidicon - type tube, the H1268, and a two-inch tube, the H1269. These tubes are subsequently used in scan conversion

Figure 1A.

Figure 1B.

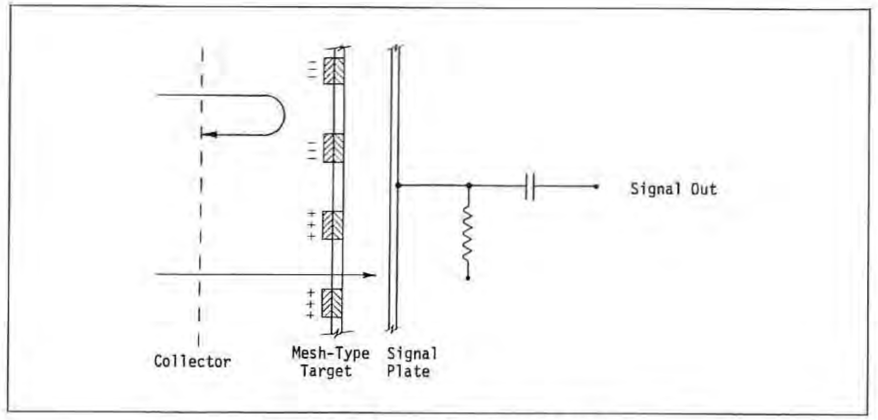

Figure 2A. Transmission Modulation

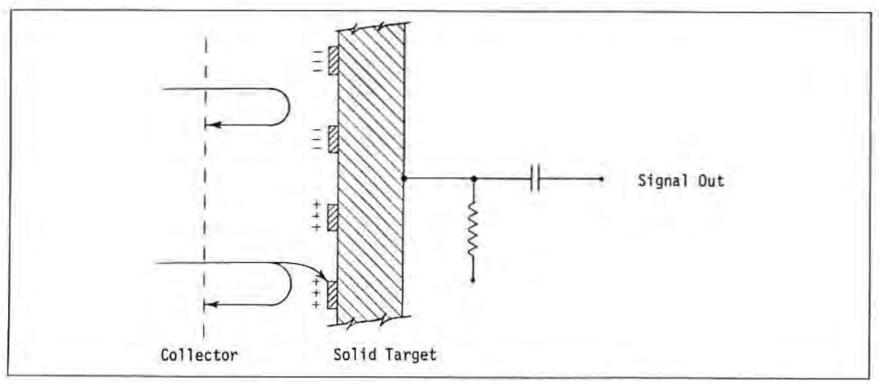

Figure 2B. Reflection Modulation

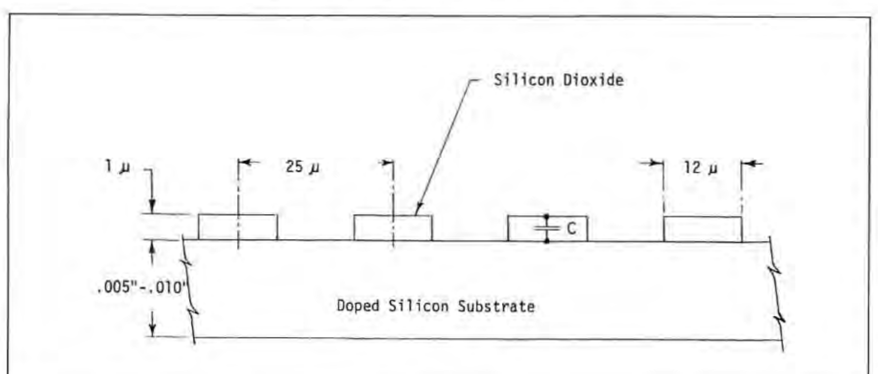

Figure 3. Solid Target Elemental Capacitance

memory units and shown in Figure 1, the MSC-1 and the 639. MSC-1 has standard 525-line TV type performance capability while the 639 unit features high performance, typically 1000-line TV with a bandwidth of 22 MHz.

Single ended scan converter tubes have employed two basic modes of operation: transmission modulation and reflection modulation. Information, stored in the form of electrical charges on the surface of an insulator, modulates a beam of electrons used to "read" that stored pattern. In the transmission modulation mode of operation, Figure 2A, the insulator is deposited as a thin film in a supporting mesh structure. The charges stored upon the insulator surface control the transmissability of electrons through the mesh. Sufficiently negatively charged areas will repel all the reading electrons, producing no signal output. Positively charged areas allow the read electrons to penetrate the mesh in greater or lesser numbers, depending upon the exact potential. These transmitted electrons constitute the video signal output from the tube.

In the reflection modulation mode of operation, Figure 2B, the target structure is placed upon a solid substrate. Read electrons do not penetrate past the storage plane. In this mode read electrons again are completely repelled by target areas having a sufficiently high negative potential, and are partially repelled by areas having more positive potential. The read signal is extracted from the conductive solid backplate.

The majority of single ended scan converter tubes today utilize the solid target, reflection modulation type of structure. The reasons for this are:

1) The solid target is inherently more rugged than the mesh structure. Meshes used for these tubes are generally between 750- and 1500-pitch and vary between 0.0003 inch to 0.0008 inch in thickness. This makes handling during processing rather hazardous. In addition, the mesh targets fabricated in the form of drumheads are susceptible to spurious signal output due to drumhead resonances during the various pulsing operations that must be done to operate single ended scan converter tubes.
2) The solid target is also capable of greater inherent resolution compared to mesh targets. Resolution is partially dependent upon the mesh pitch. The fabrication of 1500-line mesh is difficult; going higher in mesh count becomes excessively costly due both to mesh fabrication and target fabrication problems. However, solid targets are routinely made with a 1500-count grid printed on them, and higher counts are only slightly more difficult.
3) The solid targets are also capable of simpler fabrication methods. Standard LSI techniques can be used.
4) Lastly, the solid target is also capable of higher inherent speeds, both in erasure and in writing. This is particularly true of the Hughes targets, as shall be covered later.

Structure Compared

Figure 3 shows a solid target, exemplified by the silicon-silicon dioxide structure. Specifically consider a silicon target having an array of oxide islands spaced on 25 μm centers with a thickness of 1 μm, each island being 12 μm square. This structure will be compared with other targets later having the same dimensions. The elemental capacitance of this target can be approximated by the standard parallel plate formula, $C = \frac{EE_0A}{D}$ where E is the dielectric constant of the oxide, E_0 is the permittivity of free space, A is the surface area of the island, and D is the thickness of the oxide. Substituting the appropriate values into this formula, the elemental capacitance is about 6.4×10^{-15} farads.

The target in Figure 4 has two preferred structures. The solid substrate may be either a dielectric such as glass, quartz, or sapphire, or it may be a silicon wafer. If silicon is used, the wafer is first oxidized and then a metal matrix is printed on the surface of the oxide (Figure 4A). For purposes of comparison with the silicon target already considered, assume the same elemental storage area. The elemental capacitance in this case is composed of two components, C_1, the capacitance through the oxide similar to the previous case, and C_2, the capacitance to the surrounding metal grid.

C_1 is calculated the same as pre-

By K. R. HESSE

viously and is approximately 2.1×10^{-15} farads, while C_2 is calculated assuming it to be the equivalent of an elemental length of coaxial cable. C_2 is roughly approximated, therefore as 1.6×10^{-17} farads, two orders of magnitude less than C_1. The total capacitance of this structure then is about one-third that of the silicon-silicon oxide structure shown in Figure 3. Since the speed of a target is a direct function of the elemental capacitance, the Hughes structure has the advantage of faster speeds, other conditions being equal.

In the other structure, Figure 4B, a metallic grid is printed onto a dielectric substrate. The total elemental capacitance is again approximated by C_2 and the total elemental capacitance, therefore, is very much less than either of the two silicon structures, namely 1.6×10^{-17} farads. Considering the two silicon structures, the primary difference which produces the smaller

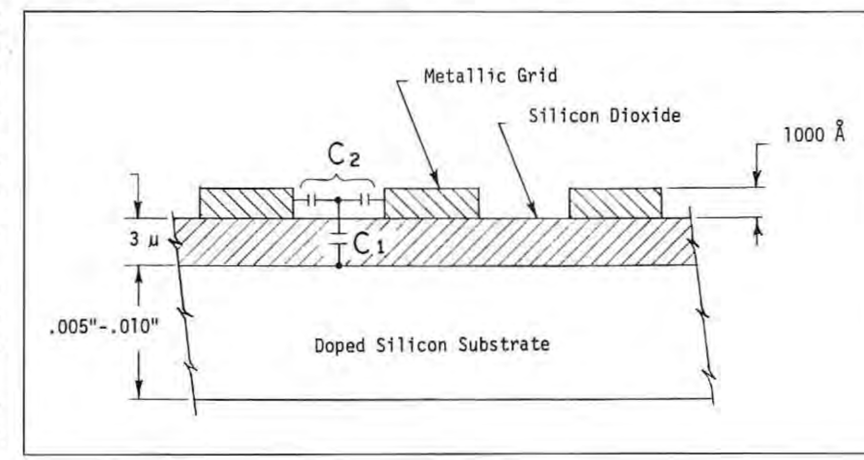

Figure 4A. Silicon Type

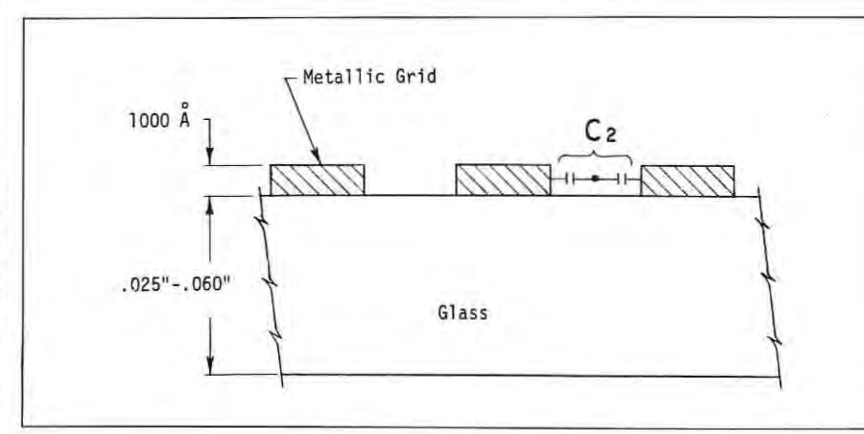

Figure 4B. Insulator Type

By K. R. HESSE

capacitance feature of the Hughes target is the thickness of the oxide film. While it may seem to be a simple matter to increase the thickness of this layer in the etched oxide target to the same as that used by Hughes, in practice it is all but impossible. The delineation of these very fine patterns in the oxide layer becomes impossible when the oxide layer thickness exceeds about 1 to 1.2 μm. In actuality, use of targets with even this thickness produces very objectionable background effects during tube operation, so that the usual oxide thickness is generally kept well below this value. In comparison, since no etching at all is done to the oxide film in the Hughes target, this effect is not encountered. The thickness of the oxide is controlled by the length of time necessary to form the layer rather than by its etching properties.

The processes used to form these targets are shown in Figure 5. Both forms of the target use very similar techniques for fabrication. The glass or other dielectric substrate structure obviously does not require the oxidation step shown.

1. CLEAN WAFER. Silicon wafers of suitable size and thickness, for example, 1.1" in diameter and 0.010" thick, are loaded into a teflon basket. The basket and wafers are immersed in a solution of nine volumes of sulfuric acid and one volume of nitric acid at 90°C for approximately ten minutes. At the end of this time the wafers are rinsed in circulating fresh deionized water and then transferred to 49% hydrofluoric acid solution. Another rinse in deionized water follows. The basket and wafers are then immersed in concentrated nitric acid for ten minutes, the acid being preheated to 90°C. After another deionized water rinse the wafers are spun dry.

The above processing steps serve to clean off by solution in the various acids any metallic or other inorganic contaminants present on the surface. The hydrofluoric acid dissolves any oxide that may be present on the surface. This treatment prepares the wafer for the next step, oxidation, by presenting a clean, nearly nascent surface to the oxidizing conditions in the furnace, thereby favoring a controlled, uniform growth of silicon dioxide on the wafer.

2. OXIDIZE WAFER. The cleaned wafers are then loaded into a quartz boat which is loaded into a quartz tube oxidation furnace. The exact conditions of oxidation have not been found to be critical. Temperatures may range from 920°C to 1200°C and the furnace atmosphere may be either dry oxygen or wet oxygen. The wet is preferred because of the faster oxide growth compared to dry. The handbook, "Silicon Semiconductor Data," by H. F. Wolf, Permagon Press, 1969, devotes pages 532 through 558 to data relating oxide growth rates to various parameters such as furnace temperature, crystal orientation, partial pressure of water, etc. The oxidation step is generally controlled so as to produce a three-micron thick layer of the oxide. When the wafers have been removed from the furnace, they are stored in a clean desiccator until the next step.

It is of utmost importance during all the wafer processing steps to make certain that they are handled carefully and cleanly. All operations are done in a dust-controlled environment, preferably under laminar flow hoods. The smallest speck of dirt can cause a blemish on the finished target.

Figure 5.

1. Clean Wafer.
2. Oxidize Wafer.
3. Chromium Layer Evaporated on Oxide Side.
4. Photoresist Applied over Chromium Layer.
5. Photoresist Exposed with Mesh Interstice Pattern.
6. Photoresist Developed.
7. Chromium Etched away in Exposed Areas.
8. Photoresist Removed, Target Cleaned, Dried.

Figure 6. Tube Characteristics

	H1268	H1269
Diameter, inches	1	2-1/4
Length, inches	6	10-1/4
Usable target diameter, inches	0.75	1.6
Resolution, TV 50% lines/diameter, measured by orthogonal write-read at 40 μsec/diameter to 80% saturation	1000	2000
Erase time, full target, to 5% residual, milliseconds	100	33
Writing speed, maximum, μsec/diameter	2	2
Storage time, continuous read, minutes	15	25
Output current, saturated, microamperes	0.5	0.5

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about the author

K.R. Hesse joined Hughes Aircraft Company in 1957 and worked on the design, development and production of direct view and electrical input/output storage tubes. Since 1967 his concern has been with the processes required to develop and fabricate various types of camera tubes based on the silicon diode array target. He has a B.S. Ch.E. from Cooper Union Institute of Technology, and A M.Ch.E. from Polytechnic Institute of Brooklyn He holds five patents in the field of electronic display devices.

PHOTO RESEARCH The Photometer Specialists

Photo Research was founded in 1942 by Karl Freund, ASC. The Spectra Exposure meter, using the Incident Light principle, was the basis for the success of the company in its early years.

The next product developed was the Spectra 3-Color Meter which, because of its design, reliability, usefulness and accuracy, has resulted in Photo Research receiving two Academy Award Citations from the Academy of Motion Picture Arts and Sciences. The first award was in 1953 and the second in 1971 for an updated model, currently called the Film Balanced 3-Color Meter.

In 1953 the Spectra Brightness Spotmeter was developed and introduced. Thousands of these meters have been manufactured and some of the first spotmeters built are still in active use. Developed to meet the needs and requirements of the aircraft instrument and panel lighting industry, the spotmeter was, and still is, used for standardization, meeting MIL/SPECS, and correlation of measurements between vendor, manufacturer and customer.

In 1960, with the assistance of the late Ben Pritchard, the Spectra Pritchard Photometer was developed and has become a standard in the industry over the past decade. Although it has many of the same applications as the Spectra Brightness Spotmeter, its extreme versatility and high sensitivity made possible a whole new world of applications.

In 1968, Photo Research was acquired by Kollmorgen Corporation and now operates as an independent division, with complete profit and loss responsibility. After being acquired by Kollmorgen, Photo Research undertook an extensive research and development program. The results: a completely new solid-state Spectra Brightness Spotmeter; a completely new and versatile Spectra Pritchard Photometer Model 1980; a Photometer/Radiometer PR-1000; and a Film Gate Photometer. These are now being rapidly accepted in the market place and are replacing the older models as the standards of the light measuring industry.

In this and future issues, SID Journal readers will meet some of the companies who actively support the Society for Information Display as sustaining members. These companies serve us in often-unseen ways, from supplying speakers for local meetings and national conventions to supporting their employees who volunteer for SID committees. They encourage employees to write for journals such as ours, besides supporting SID financially as Sustaining Members

—THE EDITOR

In 1972 Photo Research received its Third Academy Citation for the Film Gate Photometer, which is used by the film processing industry to normalize and control color printers.

The business of Photo Research is the development, manufacture and marketing of electro-optical instrumentation and services which

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provides quantitative data on the output of radiant-energy (light) sources in the visible, near-infrared and near--ultraviolet portions of the electromagnetic radiation spectrum, the development, manufacture and marketing of electro-optical test equipment which assists in the calibration, alignment and/or evaluation of certain other electro-optical systems, and the development, manufacture and marketing of new electro-optical instrumentation closely related in technology to these areas.

Photo Research products fall into two basic categories:

1. Scientific and industrial photometric instrumentation and test equipment for industrial applications related to production, product quality control, research activities — including universities and government agencies.
2. Professional photographic instrumentation used by the professional motion picture and television production markets.

There are more Photo Research precision photometers in use all over the world, in all fields, than any other photometers. This reputation for building accurate, reliable and dependable instruments has caused Photo Research to become known as the "Light Measurement People."

Key staff members include Nick Bensussen, Production and Standards Lab Management; Dick Walker, Director of Engineering; Fred Grover, Director of Marketing; and Jim Branch, President of Photo Research Division.

A typical application is shown in the photo.

The Naval Aircraft Lighting Group of the National Bureau of Standards, in solving the problem of precise measurement of luminance, contrast and edge definition of characters, lines, and symbols in aircraft panel displays, has developed a novel application for the "Spectra® Pritchard® Photometer."

Another group at the National Bureau of Standards, using the same physical setup, and with a special slit aperture in the Pritchard Photometer Model 1980 has measured a test pattern to a resolution of 203 line pairs/mm in an image intensifier tube evaluation program.

New Technologies Pace Expansion in Growing Display Market

According to a major article in McGraw-Hill's prestigious Business Week, consumer and industrial products application for electronic displays is increasing at an unprecedented rate and can be expected to increase by more than 1000% over the next decade.

Reason for this explosive jump is the introduction of two radically new technologies and the sudden sophistication of an older technology. The two newcomers, LED's (light emitting diodes) and liquid crystal technology (LCD) both have developed within the last four years. The LED is a semiconductor which glows brightly under the impact of an electrical current. Its small size and minimal current consumption make it ideal for such applications as hand-held calculators and similar instruments. The market for LED's jumped some 400% this past year to an estimated total of $25 million. Many market experts place the potential market by 1976 in the $100 million area.

The LCD, an even newer technology than LEDs, works in an exactly opposite manner to the LED. The liquid crystal turns opaque when the electrical current is applied, reflecting instead of emitting light. Many people predict a volume for LCDs that could equal or surpass the volume predicted for LEDs. Again the important factor is small size and low current consumption.

A sophistication in technology has suddenly brought new life to the older gas discharge display. Here the principle is passing a high voltage current through a helium gas mixture which causes the gas to glow brightly. Smaller and more efficient gas discharge displays now are moving strongly back into the market and are considered effective, particularly where high contrast is important.

The variety and flexibility of the new visual display techniques have caused designers of electronic instruments, both consumer and industrial, to take a new look at options they had not thought possible.

Liquid Crystals As Media For Aircraft Displays

Report is available on a study to determine the feasibility of utilizing nematic liquid crystals as media for aircraft displays from the point of view of their temperature range, response time, gray scale and color control. The experiments were conducted by U. Bonne and J. P. Cummings of the Honeywell Research Center (10701 Lyndale Ave. South, Bloomington, Minn. 55420). The following conclusions were reached:

1. The nematic temperature range can be made to fit any reasonable specification by forming multiple eutectic mixtures.
2. "Write" or "contact" times less than 2 μs have been realized (and less than .1 probably can be) with the help of "blocking" diodes. However, true rise times become generally longer than one second at temperatures below -20°C and $3x10^4$V/cm.
3. The optical properties of electrically induced (dynamic) scattering can be described by specifying the liquid-crystal birefringence ratio, n_o/n_e, the average refractive index, $\tilde{n}$, and the applied voltage. Light-scattering differences between white paper, paint, or oil-water emulsions, on one hand, and liquid crystals, on the other, will be discussed.
4. Of several possible color display approaches, electrically tunable birefringence was studied in some detail. The widest viewing angle ($|\alpha| \leq 30°$) is achieved with reflective displays and best color definition ($\Delta\lambda/\lambda \cong .2$) with retardations $\Gamma \cong 3/2$ in single-stage displays, as long as the overall cell thickness fluctuation $\Delta d < 0.1\lambda/(n_e - n_o)$.

Pass SID Journal along to a friend.

NEW PRODUCTS

SID SID SID SID

New Tiny Lamp

New light bulb quarter of an inch in diameter but said to be as bright as bulbs three times its size has been developed by General Electric Company. About the size of a pencil eraser, midget 13-watt tungsten-halogen lamp is for scientific equipment instruments, microscope illuminators and optical devices including fiber-optics.

New lamp (#3026) called smallest of its type, sets new industry standards for size, and light output of 15 candlepower. Diminuitive light source will allow miniaturization of equipment such as reflectors, housings and optical systems, with resulting cost savings, according to GE engineers.

In a microscope illuminator, for example, filament of the new lamp can be placed within two-tenths of an inch of the focussing lens. This compares with the half-inch required by larger lamps typically used in this application.

Circle #101 on Readers Service Card

Send for SID membership information.

Zenith Gas Discharge TV Display

Zenith Radio has been demonstrating a prototype thin-panel display based on gas discharge technology.

The thin-panel picture unit has 80 columns and 212 rows of gas cells resulting in a picture 2.4" x 6.3", while the panel is only 0.63-inch thick. The specifications, according to the company, are cell spacing, 0.030-inch; color, line at a time; gray scale, continuous; % of TV picture shown, vertical, 43%, horizontal, 12%; video band width, 3.3 MHz; horizontal resolution, 260 lines; peak luminance, 8 fls; and usable contrast ratios, 40:1.

Circle #102 on Readers Service Card

Hi-Resolution

Sample of photography from outer space produced by signals from Earth Resources Technology Satellite (ERTS) to Edson Ryder-Celco 5" CRT display (picture shows portion of Lake Tahoe and Sacramento (Cal.) area). Celco says sharp focus is made possible by use of its high-resolution system.

Circle #103 on Readers Service Card

new products

Data Entry Tool For CRT's

The CRT Cursor Control Trackball, manufactured by Librascope Division of The Singer Company, is used to write new data or figures on CRTs and also to drive a cursor spot for pointing out and entering data into computers. The Trackball is a direct digital device designed for orthogonal control applications. The ball is easily operated by the palm of the hand whereby movement positions two non-contact magnetic incremental encoders in proportion to the motion in the X axis and the Y axis. The output of each encoder is processed by internal electronics to sensed pulses for each axis. The electronics required for generating data is minimal compared to a light pen or joystick.

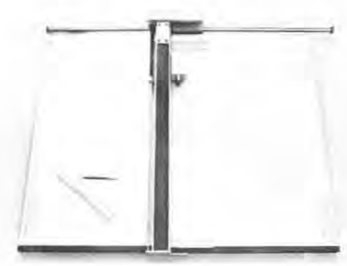
Circle #104 on Readers Service Card

Digital Clocks in Kits

MIT's clocks display four or six digits with reliable, easy-to-read light emitting diodes. The units operate on either a twelve or a twenty-four hour cycle and a one pulse per second colon may be utilized in the four digit clock. The clocks are light weight and styled to enhance any contemporary decor.

Circle #105 on Readers Service Card

New 31" x 42" Plotter



The new 732 Digital Flat Bed Plotter from Wang Laboratories, Inc. is said to be the lowest priced unit of its size and capacity (31" x 42"). Driven by the Model 700 Programmable Calculator, the 732 produces accurate continuous line or point plotting graphics of curves and data of problems solved on the calculator. Alphanumeric labeling of plots under program control of the calculator and the Model 708 Extended Memory Controller gives user complete flexibility for content, size, format and location of character setting, any sized character with any orientation. Finished plots are titled, scaled and labeled on any type of paper including linen, vellum and mylar.

Circle #106 on Readers Service Card

New Photometer

The new Spectra® Pritchard® Pulsed-Light Photometer, Model 1980-PL, by Photo Research, has been specially designed to measure the integrated (average) value of sources from 10^{-5} to 10^{7} footlambert-seconds. The instrument is also equipped with a high-speed (video) amplifier, which can be used—in conjunction with a high-speed oscilloscope—to study the shape and peak value of pulses as short as *1 micro-second.*

Circle #107 on Readers Service Card

Video Hard Copy Unit

The 4632 Video Hard Copy Unit can make paper copies of any video refreshed raster image at any selected line rate, whether input is standard video (TV type) or a digital video signal. Within seconds, clean, clear 8" x 11" copy of a display, gray scale or black/white characters or graphics can be produced. The 4632 is plug-compatible with virtually all of the many thousands of video alphanumeric and graphic terminals in use today.

The 4632's dry-process development system is geared to high image quality and ease of use, producing high image contrast required for high-resolution copies of complex graphics and alphanumerics. The unit is as stable as wet-process photo-sensitive papers, but offers the convenience of dry printout. Cost is low—5 to 7 cents per copy, depending on usage. Copies can be handled like conventional paper and may be erased or written on with pen or pencil.

Circle #108 on Readers Service Card

Fairchild "Light Pipe" Displays

A new family of "super-digits" came to the market this month, according to an announcement from the Microwave & Optoelectronics Division of Fairchild. Called the FND-70, the quarter-inch display uses the light pipe technique.

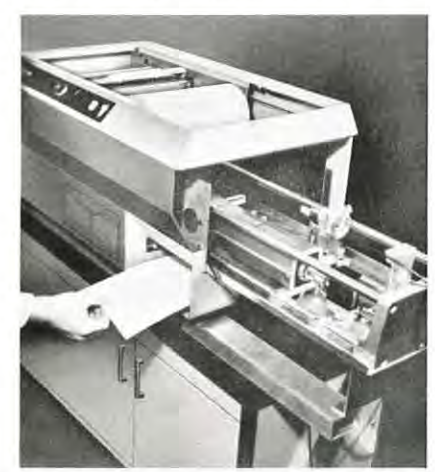
According to the manufacturer, a smaller amount of gallium arsenide phosphide is used because they employ only one LED for each display segment. A molded plastic light pipe spreads the light spot into a uniform bar segment. Fairchild says that the units display a digit which measures 0.27 x 0.16-inch.

Circle #109 on Readers Service Card

Metrology System

Circon MV 9631 MicroVideo Metrology System is called a sophisticated "yet easy-to-use" measuring instrument which meets the requirements of modern quality control and production processes. Offers features of an integrated closed circuit television-microscope system plus two measuring systems said to give "the highest degree of electronic and mechanical accuracy." System has following quality features for precision measurement of small parts under magnification by two techniques. These include: electronic measuring system, digital micrometer stage, high resolution camera, solid state monitor, turret microOptical system, and two illumination systems.

Circle #110 on Readers Service Card



Zenith D-150R high resolution 1000-spot acousto-optic laser deflector, in a non-impact printer which prints hard copy at rate of 5,000 lines per minute.

Circle #111 on Readers Service Card

Action Switch

To satisfy the strong demand for high reliability in a miniature, momentary action switch, Dialight Corporation introduces the series 913. This model has a light-emitting diode for its light source and operates from a 5-volt dc supply. If voltages other than 5 volts are desired, an external resistor is is needed.

The switch is ideal in applications where extra-long life or low power is required. It is available either in a normally open, normally closed or two-circuit version, and is supplied with a long cylindrical lens cap with an internal fresnel ring for uniform light distribution. Its overall dimension is 1.790 inches.

Circle #112 on Readers Service Card

Color Monitor

New from World Video is CR 6700 professional 17" one-gun color video monitor utilizing only 15¾" of vertical rack space and the unique lightweight inner frame design. The Trinitron tube is used in all models.

The CR6700 is a fully regulated, solid state monitor with plug-in circuit boards. The CR6700 features pulse cross, under-scan, A - B input, internal—external sync, keyed —back porch clamping and numerous other features desired by the video engineer.

Circle #113 on Readers Service Card

new products

Tektronix Terminal

Technological break-through enables Tektronix to provide users needing high density alphanumerics and full 19-inch diagonal screen storage graphics with new 4014 Computer Display Terminal and companion APL version, the 4015 Computer Display Terminal. As many as 8500 alphanumeric characters and more than one million graphic points can be displayed on direct-view storage CRT display portion of the 4014 Computer Display Terminal.

Fully supported by PLOT-10 software developed for Tektronix' extensive line of Computer Display Terminals known as the 4010-Family, the 4014/4015 is said to offer the user environments listed interactive keyboard control of high density alphanumeric or graphic computer output and hard copy capability. The 4015 APL version provides large, easy-to-view platform for the easy-to-learn-and-use problem-solving APL language. Both units offer 4-program selectable alphanumeric formats.

Circle #114 on Readers Service Card

Field & Data Formatting Terminal

Fast data entry and retrieval, on-screen editing, and full upper and lower case alphanumerics are features of the newly-announced Tektronix 4023 Computer Display Terminal.

The 4023, which represents Tektronix' first entry into the refreshed terminal field, provides complete versatility infield and data formatting. The "forms" capability arranges displayed data to resemble the source document. Forms information can then be rapidly retrieved, updated, edited, and entered. Forms can be "ruled" with an optional forms ruling package vertical lines. Visual field formats include: inverted field, blinking field, blanked field, reverse field, blinking reverse field, and dim field. Logical formats include: transmit, non-transmit, protected, non-protected, and numeric only. Each field and data format is designed for speed and control in sending and receiving data.

The 4023 has a capacity of 1920 characters (24 lines, 80 characters per line) on a 12" non-glare screen. Editing features include insert character and line, delete character and line, replace, erase to end, erase input, and erase page.

Some Thoughts on the Future of TV

continued from page 4

The first part of this discussion dealt with future television screens. In the second part, let us look at new sources of television signals.

Video recording is now an old art. Magnetic tape has been the standard medium. Video tape equipment is finding wider use; whether it will become a full-fledged consumer product seems uncertain. Another interesting candidate has appeared: the video disc.

Video discs look much like phonograph records, except for the number of grooves or tracks per inch — up to about 10,000 instead of 200. They spin much faster, but their playing time resembles that of phonograph records. Three systems of information retrieval have been demonstrated — mechanical, electrostatic and optical. In all cases, the discs are made of plastic, pressed like phonograph records. They should cost little to manufacture, and disc players should cost considerably less than tape players.

If the video disc becomes popular, it will probably develop its own style, like the movies years ago and television more recently. Imagine paper-thin, flexible discs enclosed in magazines, carrying a run-down of current events; in playing these, the user can skip portions that do not interest him, playing only those he wants and repeating them at will, instantly, without rewinding. The same feature would be valuable with discs containing do-it-yourself material, home-studies, travel, etc. It is too early to predict which of the systems will win, but it seems likely that video disc players will be in wide use a few years from now.

Cable systems with low-bit-rate return circuits have been widely discussed recently. The return circuit permits each subscriber, through a simple keyboard, to request services and to extract information stored at a central site. Such systems have been demonstrated; most of the required technology is available in practical form, with one possible exception: the frame grabber — a device which recognizes a single television frame by its code number and stores it for continuous playback until the user writes in a new frame. Several of these may be used with each keyboard; an inexpensive frame grabber might be the key to making such cable systems viable.

Summing up, there are interesting developments ahead in the technique of generating and displaying pictorial information. There should be plenty for us to do.

Call for Papers

11 January 1974. Conference on Computer Graphics and Interactive Techniques, University of Colorado, Boulder, Colorado, July 15-17, 1974. Sponsor: University of Colorado and ACM SIGGRAPH. Send three copies of 100 word abstract by Nov. 1, 1973, to Conference Chairman, R. L. Schiffman, Computing Center, University of Colorado, Boulder, Colorado 80302. Draft papers due by January 11, 1974. Authors notified by March 29, 1974. Final papers due May 20, 1974. Publication in Journal of Computers and Graphics or proceedings.

Franklin Medal Given To Howard Vollum

The Howard N. Potts Medal of The Franklin Institute has been awarded to Howard Vollum, board chairman of Tektronix, Inc. of Beaverton (Ore.) "for his personal contributions to the design and manufacture of the Tektronix Oscilloscope." Formal award ceremonies were to be held during October. The cathode ray oscilloscope is one of the most widely used laboratory instruments in physics, chemistry, biology, medicine, engineering and many industries.

about the author

Robert Adler, born in Vienna, received his PhD in physics from the University of Vienna, 1937. He worked in Vienna and London before joining the Research Group, Zenith Radio Corporation, Chicago, in 1941. He became Associate Director of Research in 1952 and Director in 1963. Dr. Adler has been active in two fields: electron beam tubes and ultrasonic devices. In recent years he has been active in the fields of acousto-optical interaction (light deflection and light moderation); and acoustic surface waves (filters and amplifiers). He is a fellow of IEEE and a member of the National Academy of Engineering.

Improved Memory Tube

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3. METAL EVAPORATION. When the wafers are removed from the oxidation boat they are loaded into the evaporator holders and placed into a vacuum bell jar. The vacuum deposition of metals is well known and will not be dealt with in depth here. Reference is made to "Vacuum Deposition of Thin Films," by Holland, published by Wiley in 1961.

Several different metals can be used; however chromium is favored because of its advantages, viz., it forms comparatively hard, durable coatings which are easily handled during subsequent photo lithographic steps. A suitable source of chromium is a tungsten filament that has been electroplated with chromium. This source has given very good results, since the chromium is in intimate thermal contact with the tungsten and hence evaporates easily when current is passed through the filament. Evaporation takes place at about 1×10^{-6} Torr pressure and is allowed to proceed until a film of chromium 800 to 1000 angstroms thick has been built up on one side of the oxide film.

4. PHOTORESIST APPLICATION, EXPOSURE, DEVELOPMENT. When the wafers are removed from the evaporator, they are next coated on the chromium side with photoresist. The wafer is placed on a spinner chuck, vacuum applied to hold the wafer onto the chuck, and a positive photoresist is flowed onto the wafer. The spinner is switched on and the photoresist spreads out, coating the chromium uniformly. When drying has stopped, the spinner, is turned off, the wafer removed from the vacuum chuck and placed in a drying oven. When removed from the oven it is inspected for visual, macroscopic defects and, if satisfactory, placed in position on a printer where the mesh pattern, of the order of 1000 lines-per-inch, is exposed on the photosensitive resist layer. Exposure to ultraviolet light such as that produced by high pressure mercury arc lamps causes a reaction in the photoresist so that upon subsequent development those areas of the photoresist that have been exposed are rendered soluble in developing solvents.

5. CHROME ETCH. After exposure, the pattern is developed, rinsed well in deionized water, and then the chromium is etched away from the developed areas in the photoresist with any of the standard chrome etches, e.g., 1:1 HCl. The length of etching is determined by the thickness of the chrome layer. After etching the wafer is thoroughly rinsed in deionized water and the photoresist pattern is dissolved off. After rinsing well in deionized water the wafers are spun dry. The wafers are now ready for inspection and final assembly into a tube.

Tube Performance

Figure 6 shows typical performance figures for tubes made with the Hughes targets. The primary advantage of the lower elemental capacitance is reflected in the writing and erasing speed capabilities of the tubes and, secondarily, in the resolution. ■

Skylab Consoles

continued from page 18

the brief time between their submission and implementation, flight controllers must have access to as much as 72 hours of information on the past and present status of experiments, astronaut health, guidance and navigation, and a variety of other variables.

To make this possible, the MDSF can store more than two billion bytes of data. That's roughly equivalent to the amount of news contained in a 10-year subscription to The Wall Street Journal.

Equally important is MOPS, which delivers the information from the MDSF to the people who need it. Seventy-two MOPS access terminals are now scattered throughout the MCC for use by flight controllers, biomedical personnel and scientific principal investigators.

The new Universal Command/Control Consoles have also been placed at strategic locations within the MCC.

During Apollo, consoles generally were limited to performing only one specialized function, with a different console required for each major task—such as spacecraft environment control, guidance and navigation, communications, recovery operations, or the monitoring and control of experiments.

Now, a Skylab flight controller can convert his new universal console in seconds from one specialized use to another by simply changing a film-strip overlay on the keyboard. He can also access and use nearly all computer systems within the MCC, while Apollo controllers were restricted to only two.

"This means several flight controllers, regardless of their assignments, can all get their work done at a single console," Mr. Benware noted. "More important, the wider range of available information lets them quickly adjust to fast changing events and requirements as the mission progresses.

"This universal console approach also saved the government about $1.5-million over the only alternative, which was to physically expand the MCC and build a great many more Apollo-type consoles to accommodate the additional data and controllers needed for Skylab," he said.

Besides the major additions to the Center, Benware's staff also reconfigured much of the existing equipment, including the video and other data displays and the big Command, Communications and Telemetry (CCATS) computer system to make it compatible with MOPS. The electrical work alone required nearly 300,000 wire connections and was comparable to rewiring three complexes the size of the one used to control Apollo.

Marketing Pact

Applied Digital Data Systems Inc. of Hauppauge, N.Y. announces it has reached a tentative agreement with The National Cash Register Company of Dayton, Ohio, under which NCR would market domestically and abroad a new line of video display (CRT) terminals manufactured by ADDS for use with various NCR computer systems.

Photophysics Pact

Photophysics, Inc., has reported the signing of an exclusive distributor agreement with Matsushita Electric Trading Co., Ltd. of Japan. Matsushita will provide complete marketing and equipment maintenance services in Japan for the full line of products manufactured by Photophysics, including microfilm and cathode ray tube copiers and data terminals. Matsushita has already processed a small evaluation order for Photophysics products from Fujii Film, the largest manufacturer of photographic film in Japan.

SID Journal Subscriptions

For information concerning subscriptions to the SID Journal, please contact Blackwent Publishing Co, directly, 1605 Cahuenga Blvd., Los Angeles, Calif. 90028.

If you heard 'em Lucky, if You Didn't, Too Bad.

LOS ANGELES
September 26

Demonstration: Feasibility model of "world's first multicolor graphic LED display, by Data Systems Division, Litton Industries.

SAN DIEGO
September 18

Speaker: Bernie Jackson, Computer Power Systems, Inc.

Subject: The CPS 4-Color Beam Penetration Display.

MINNEAPOLIS-ST. PAUL
September 25

Demonstration: Graphic digitizers for transmitting pictures, prints, X-Rays, etc., by Di Co Med.

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THOMSON-CSF
Paris, France

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WEAPONS RESEARCH ESTABLISHMENT
Salisbury, South Australia 5108

XEROX DATA SYSTEMS
El Segundo, California 90245

New Officers of Bay Area SID

New officers recently elected by the Bay Area Chapter of the Society for Information Display are:

President, Jim Thompson, CPS Corp.; Vice President, James Wurtz; Secretary-Treasurer, Alan de Scheinwitz.

Minnesota Area SID Elects

New officers recently elected by the Minneapolis-St. Paul Chapter of the Society for Information Display are:

President, Vernon A. Born, Control Data Corp.; Vice President, Thomas J. Werner, The 3M Company; Secretary, Andy Anderson; Treasurer, Robert Keagy. Chapter Member Marlin Noffke is a National Director of SID.

True Seaborn Editor

True Seaborn of Los Alamitos (Cal.) becomes editor of Computer Magazine, published by the Computer Society of IEEE. He succeeds John Kirkley, who joins the staff of Datamation magazine.

Graphics Workshop Planned with NBS

The Special Interest Group for Graphics (SIGGRAPH) of the Association for Computing Machinery (ACM), and the National Bureau of Standards, are cosponsoring a Workshop on Machine-Independent Graphics. It will be held at NBS headquarters in Gaithersburg, Md., just outside of Washington, D.C., on April 22 and 23, 1974.

Sessions are planned on the following topics: Interaction Device Independence, Picture Description Languages, Portability—How to Get It, Standards Proposals, Are We Ready for Standards? (Panel

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