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By R. A. Davidson

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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 18" 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 our co-workers consisted of a 104 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 it, the time when the new device is working beautifully in the laboratory; a few years to learn how to manufacture it, and a few more to make it competitive, but remember: none has yet claimed to be at it.

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.

Discussion of making a gas-discharge TV receiver with a screen area greater than that of a conventional CRT. It should be more compact 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 27 by 222 dot gas-discharge display panel developed for graphic displays by Burrus Corp., and a number of the analog memories and associated circuits utilizing MOS-LSI. 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
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 Roer of the Philips Corp. 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, 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 Co., held on May 26-28, 1972, and also to provide a new type of an integrated TV-signal process 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 since some experiments to obtain half-tones have been reported. However, half-tones are easily obtained in the Burroughs panel if display mode 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, and 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 current 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 space 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 1.

Table 1. Specifications for the 77 by 222 dot panel. (Reprinted from the product specification of CS04 manufactured by the Burroughs Corp.)

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Dots</td>
<td>77 by 222 (17,094)</td>
</tr>
<tr>
<td>Center to Center Dot Spacing</td>
<td>0.049 in.</td>
</tr>
<tr>
<td>Dot Diameter</td>
<td>0.024 in.</td>
</tr>
<tr>
<td>Light Output</td>
<td>red-orange</td>
</tr>
<tr>
<td>Phase Number of Pulses</td>
<td>76</td>
</tr>
</tbody>
</table>

Figure 1. Display and scanning mechanisms.
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-Ls.

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 3, divided into inputs for clock pulses, shift pulses (synchronized with horizontal drive pulses), bus-bar for video components, parallel video-component outputs (to the display anodes through the anode drives), and driving signals for 77 lines.

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

Here are just five of the leading families in RCA's complete line of "advanced design" display and storage tubes that can meet your most exciting and specialized electro optics requirements:

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4. Silicon-Target Storage Tubes: Available in 1" and 15" diameters for use in a variety of information-reading converters; in TV "Frame Freeze"; and narrow-band video communication.

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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 turns on and thus the capacitor C is charged to the bus voltage at a time of the address. The capacitors C, C, C, ..., C, C are charged to the bus voltages at times of the addresses 1-at, 1-sd, 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 in luminance, 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 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 34 percent of the effective deflection width (about ¾ 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 and C, equal to 300 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).
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 on the experiments 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.

References

3. Private information from the Burroughs Corp.
7. Instruction for operation for the 222 by 77 SSPD for graphic displays, Burroughs Corp.

Acknowledgment

The authors wish to thank Messrs. Iwamura and Ose of NHK, and Mr. Onosawa of Tokyo Electric Co., Ltd., for their contribution in constructing MOS-LSIs.

About the Authors

Hiromi 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 826. Burroughs retained its usual first-place standing with 981. As System/360 deliveries gather even greater momentum, however, IBM may well reach 945, surpassing even Burroughs in 1972 loyalty.

Univac will probably decrease its rating from 614 to about 620 in 1972. The RCA regional 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 —765 and 766 respectively—having gained most of IBM's defected customers, and will probably maintain these approximate levels in 1972.
Poor halftone response from single or dual gun dielectric recording storage tubes arises from the transfer curve of the 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:

\[ I_s = I_e^7 \]

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 accept any more charge. Then a transfer curve of change (or potential) on the dielectric versus the input signal 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 achieved by passing the electron gun for an interval \( \Delta t \). 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. However, this must force the saturation to occur at a lower beam current and, therefore, a more negative electron gun grid-cathode voltage.

**Swell 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 "swell" period of the electron beam on the dielectric for each removable element. Since the slower the data rate of the input signal, the more the correspondingly slower the dynamic range of the writing process since the "swell" period for each element is longer. This is qualitative as shown in Figure 1c by drawing two different pulsewidths (for a given resolution element) on the grid-cathode 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 function as though they had been produced 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 \( \Delta t \)) compared to those of \( \Delta t \). In addition, it is improbable that the pre-amplifier following the storage-tube readout produces an equivalent input pulse noise level as shown, then this also determines the black tone. Thus, noise washes out the first two levels for \( \varepsilon_1 \), but the first three levels for \( \varepsilon_2 \). In addition, more adjacent levels are indistinguishable from each other in signal \( \varepsilon_1 \) than in signal \( \varepsilon_2 \).

In this ratio to the baseline value of signal \( \varepsilon \), one might appear as in Figure 2 before and after the writing process of the storage tube.

**Two Solutions**

In the best case for the narrow pulse signal, only 5 gray levels or halftones (including black) will be discernible to an observer. The long pulse compresses the dynamic range severely. As a result, three adjacent levels of gray were achieved in this way. 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 equipment for display or in multi-signal display where the data rates of the different signals 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 accepted standard is that two half-tone or gray levels are related by \( \log_{10} \); that is

\[ n+1 = \varepsilon \]

where \( n+1 \) is a signal level representing a full half-tone step above \( n \).

It follows that the power or light intensity ratio of two adjacent steps is 3:1. Thus the current linear range, in decibels, must be

\[ 20 \log_{10} \frac{40}{3} = 20 \log_{10} 13.3 \]

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...
NEW SKYLAB Display Consoles

Skylab 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, became 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 the case of conducting 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 tubes 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 alphanumeric, 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 H1238, and a two-inch tube, the H1239. These tubes are subsequently used in scan conversion.
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 progressively more costly due 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 concentric islands spaced on 25 μm centers with a thickness of 1 μm, each island being 12 μm square, fabricated on top of a 10 μm thick silicon dioxide layer. This target is compared with other targets later having the same dimensions. The elemental capacitance of this target can be approximated by the standard parallel plate formula,

$$ C = \frac{\varepsilon_0 A}{d} $$

where $\varepsilon$ is the dielectric constant of the oxide, $A$ 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 $6 \times 10^{-14}$ 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, $C_0$, the capacitance through the oxide similar to the previous case, and $C_1$, the capacitance to the surrounding metal grid.

$C_1$ is calculated as the parallel

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Figure 4A. Silicon Type

Metallic Grid

Silicon Dioxide

10 μm

Doped Silicon Substrate

$C_2$

Figure 4B. Insulator Type

Metallic Grid

Glass

By K. R. Hesse

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Page 20 / SID Journal

$C_2$

Figure 4B. Insulator Type

Metallic Grid

Glass

By K. R. Hesse
The 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 amount 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 thickness exceeds about 1 to 2 μm. In actuality, use of targets with even this thickness precludes very objectionable background effects during tube operation, so that the usual oxide thickness is generally kept well below this value. In comparison, 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 targets with even this thickness prove impractical, since no acid or other 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.

Figure 5

1. Clean Wafer.
2. Oxidize Wafer.
3. Chromium Layer Evaporated on Oxide Side.
4. Chromium Etched Away in Exposure Area.
5. Photoreist Applied over Chromium Layer.
6. Photoreist Exposed with Mesh Interscopic Pattern.
7. Photoreist Developed.
8. Photoreist Removed, Target Cleaned, Dried.

Figure 6. Tube Characteristics

<table>
<thead>
<tr>
<th>Diameter, inches</th>
<th>1</th>
<th>2 1/4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height, inches</td>
<td>0</td>
<td>10 1/4</td>
</tr>
<tr>
<td>Usable target diameter, inches</td>
<td>0.975</td>
<td>0.725</td>
</tr>
<tr>
<td>Resolution, TV 50% lines diameter, measured by orthogonal write-read at 40 μs/diameter to 90% saturation</td>
<td>1000</td>
<td>2000</td>
</tr>
<tr>
<td>Erase time, full target, % residual, milliseconds</td>
<td>100</td>
<td>33</td>
</tr>
<tr>
<td>Writing speed, maximum, μs/diameter</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Storage time, continuous read, μs</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>Outpost current, saturated, microamperes</td>
<td>0.5</td>
<td>0.5</td>
</tr>
</tbody>
</table>

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-C 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-C 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 industry and panel lighting industry, the spotmeter was, and 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 1969, 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/Readout Meter PR-1000, and a Film Gate Photometer. These are now being rapidly accepted in the marketplace 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 unspoken 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 prints. The business of Photo Research is the development, manufacture and marketing of electro-optical instrumentation and services which turn to page 29
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 to technology in these areas. Photo Research products fall into two basic categories: 1. Scientific and industrial photometry, 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 in 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” Electronic Photometer. Another group at the National Bureau of Standards, using the same problem-solving approach, has developed special slit apparatus in the Pritchard Photometer Model 1980 which has measured a transition 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 4000% this past year to an estimated total of $35 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 LCD’s in future years equal to 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 displays. 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 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 dramatically increased the number 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. Bosse and J. P. Cummings at the Honeywell Research Center (1701 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 etch-mixture techniques. 2. “Write” or “contact” times less than 2 μsec have been realized (and less than 1 probably can be) with the help of “blocking” discl. However, true rise times can become generally longer than one second at temperatures below -20°C and 3x10⁻⁶ cm.

3. The optical properties of electrically induced (dynamic) scattering can be described by specifying the liquid-crystal birefringence ratio, n₁/n₂, the average refractive index, n, and the applied voltage. Liquid-crystal voltage differences between white paper, paper, or off-white emulsions, or 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 (±=30°) is achieved with reflective displays and best color definition (Δn/Δx=2) with retardations (Δn/Δx=2) in single-stage displays, as long as the overall cell thickness fluctuates less than 50 μm.

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### New Tiny Lamp

**Zenith Gas Discharge TV Display**

Zenith Radios has been demonstrating a prototype thin-panel display based on gas discharge technology. The thin-panel picture unit has 90 columns and 212 rows of gas cells, resulting in a picture 25.2" wide, 6.7", while the panel is only 0.63" thick. The specifications, according to the company, are cell spacing, 0.030-inch, color, line at a time, gray scale, continuous; 3% of TV picture shown, vertical, 48%; horizontal, 12%; video band width, 3.5 MHz; horizontal resolution, 500 lines; peak luminance, 85% and usable contrast ratio, 40:1.

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**Hi-Resolution**

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

Circle #103 on Readers Service Card
Data Entry Tool
For CRT's

The CRT Cursor Control Trackball, manufactured by Lorscope 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.

Digital Clocks in Kits

MIT's clock 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.

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 100 to 100 footlambert-seconds. The instrument is also equipped with a high-speed voltage 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.

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. The image input is standard video (TV type) or a digital video signal. Within seconds, clear, 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.

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 Programmer, 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 701 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 yellow.

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 unit displays a digit which measures 0.37 x 0.16 inch.

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 qualities 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 micro-Optical system, and two illumination systems.

Zenith D-150H 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.

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 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 on-off circuit version, and is supplied with a long cylindrical lens cap with an internal retaining ring for unit in light distribution. Its overall dimension is 1.750 inches.

Color Monitor

New from World Video is CRT 6700 professional 17” one-gun color video monitor utilizing only 139” 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 a pulse cross, under-sync, A - B input, internal—external sync, keyer, back porch clamping and numerous other features desired by the video engineer.

Tektronix Terminal

Technological break-through enables Tektronix to provide users needing high density alphanumeric 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 5000 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 environment lists 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.
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 versatility in field 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 field formats include, non-protected, non-protected, protected, and protected forms. Logical fields are space and character forms.

Some Thoughts on the Future of TV

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 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 discs. The video disc becomes popular, it will probably develop its own 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.

The cathode ray oscilloscope is one of the most widely used laboratory instruments in physics, chemistry, biology, medicine, and many industries.

Call for Papers


Franklin Medal Given to Howard Vollum

The Howard N. Potts Medal of The Franklin Institute has been awarded to Howard Vollum, chairman of Tektronix, Inc. of Beaverton (Ore.) "for his personal contributions to the development and manufacture of the Tektronix Oscilloscope." Formal award ceremonies were to be held during October 7, 1973. At which time he was placed on a spinner chuck, vacuum applied to hold the wafer onto the chuck, and a positive photolithography is floated onto the wafer. The spinner is switched on and the photolithography is floated uniformly. When drying has stopped, the spinner is turned off, the wafer is removed from the vacuum chuck and placed in a drying oven. When removed from the oven it is found to be free of macroscopic defects and, if satisfactory, placed in position on a printer where the pattern of the order of 1000 lines-per-inch, is exposed on the photoplastic resist layer. Exposure to ultraviolet light makes the photoresist chemically sensitive to ionizing radiation, which destroys the photoperforated areas of the photore sist that have been exposed. This is followed a mask and additional ionizing radiation is absorbed in developing the resist with an oxide film. After exposure, the photolithography is dissolved into the developing solution. After rinsing well in developing solution, the wafers are now ready for inspection and final assembly.

Improved Memory Tube

When the wafer is to be etched, an ozonization etch first etches away about 500 Å of the oxide film. After etching the wafer is immersed in a hydrofluoric acid solution to etch away about 250 Å of the oxide film. The wafer is then immersed in the developing solution, the developing solution is removed, and the wafer is spun dry. The wafers are now ready for inspection and final assembly.

3. METAL EVAPORATION: When the etched wafer has been exposed and developed, the wafer is placed into a plasma etcher with a vacuum chuck and placed in a drying oven. The evaporation of metal is well known and will not be dealt with in depth here. The etched wafer is placed into a vacuum Deposition of Thin Films," by Holland, published by Wiley in 1968.

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 evaporation is easily controlled. After evaporating to a point where the wafer is 100-200 Å thick, the wafer is rotated 90° and chemically etched.

4. PHOTORESIST APPLICATION: The second step is the deposition of a photoresist. This is done by spraying the wafer with a solution of a solubility. The next step is the development of the photoresist. This is done by spraying the wafer with a solution of a non-soluble in developing solvents. After rinsing well in developing solution, the wafers are now ready for inspection and final assembly.

NASA Skylab Consoles

Now, a Skylab flight controller can access any of the 112 computer consoles in seconds from one special- ized use to another simply by keying in a command: MCC. "This means several flight controllers, regardless of their assign- ments, can get their work done at a single console," Mr. Benware noted. "More important, the wider range of available information lets them analyze the changing events and requirements as the mission progresses."

"This also gives the new MCC a great advantage over existing consoles with limited displays and data controllers. Controllers not needed for Skylab," he said.

MDDP, the major additions to the Center, Benware's staff also re- configured much of the existing equipment 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. Benware also confirmed his vision: "We can store more than two billion bytes of data. That's really important, the wider range of available information lets them analyze the changing events and requirements as the mission progresses."

Marketing Pact

Applied Digital Display Systems Inc. of Hauppauge, N.Y. announces that it has reached a tentative agreement with The National Cash Reg- ister Company of Dayton, Ohio, under which NCR would market the company's terminal systems, which are 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 script to the contact Black went Publishing Japan. Photophysics, including microfilm and cathode ray tube copiers and data terminals. Matsushita has already processed a small evaluation script to the contact Black went Publishing Japan.

AEG Hochhaus
San Diego, California 92111

IBM

New Officers of Bay Area SID
New officers recently elected by the Bay Area Chapter of the Society for Information Display are: President, Jason Thompson, CPS Corp.; Vice President, James Wurtz; Secretary-Treasurer, Alan de Schetzwitz.

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 Kragy. Chapter Member Martin Nolte 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 stuff 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, 1976.

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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