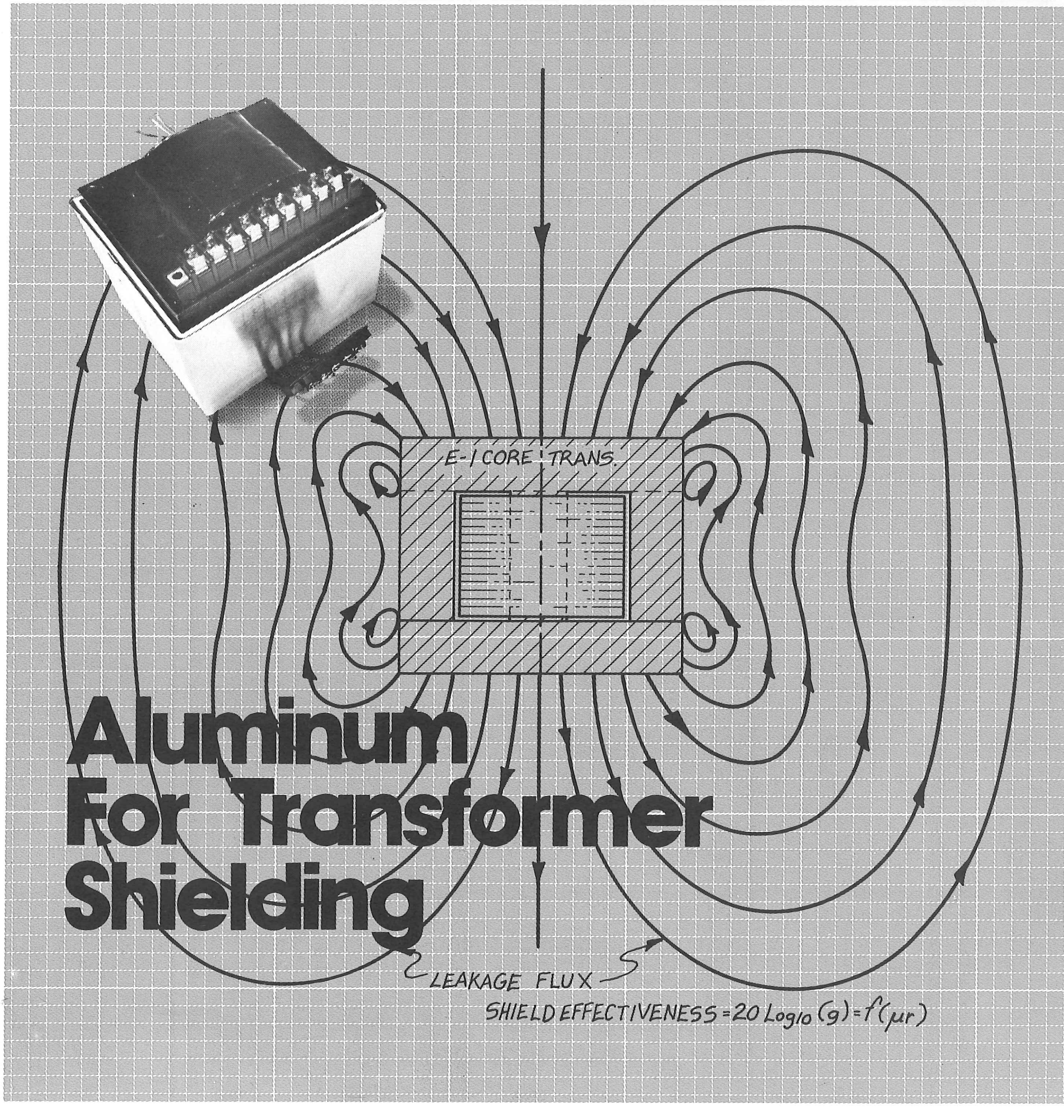
Engineering News

March 1978

Aluminum For Transformer Shielding



Aluminum For Transformer Shielding

Al Schamel,
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BACKGROUND

There are two sources of leakage flux in transformers. The primary winding produces flux not totally coupled to the secondary winding and the secondary winding likewise produces flux not totally coupled to the primary winding. The coupled portion (mutual flux) exists mostly within the iron core. However, the geometry of the core and the higher reluctance caused by the E-I lamination junctions allows a small portion of the core flux to escape into the environment. A higher mutual flux density in the core results in a correspondingly higher core-leakage flux.

TRANSFORMER INTERFERENCE

Line-frequency power transformers used in equipment containing cathode ray tubes produce leakage flux that interferes with the crt's electron beam.

This interference appears as a line-frequency modulation of the display and is referred to as "swim" on refreshed computer terminals. On storage displays, it affects beam registration and hard copy.

In oscilloscopes, the problem shows up more when the sweep repetition rate approaches, but does not quite equal, the line frequency. This is the problem we encountered on the GMA102A 19-inch Storage Display Monitor. In attempting to shield the transformer with various types of material, we found that aluminum greatly enhances the shielding effect of Mumetal. This effect made it possible to reduce the thickness of the Mumetal shield and thereby reduce the overall shield costs. *Figure 1* shows the construction of an aluminum-Mumetal shield.

SOLUTIONS

One or a combination of the following methods may be used to reduce the core flux interference problem:

- position the transformer to reduce I x B beam deflection (where I is beam current and B is leakage flux).
- increase the effective core area of the transformer and thereby reduce core flux density.
- add shielding to reduce the magnitude of the core-leakage flux.

The first two methods are usually preferred, but once package design and transformer size limitations have been reached, further reduction of

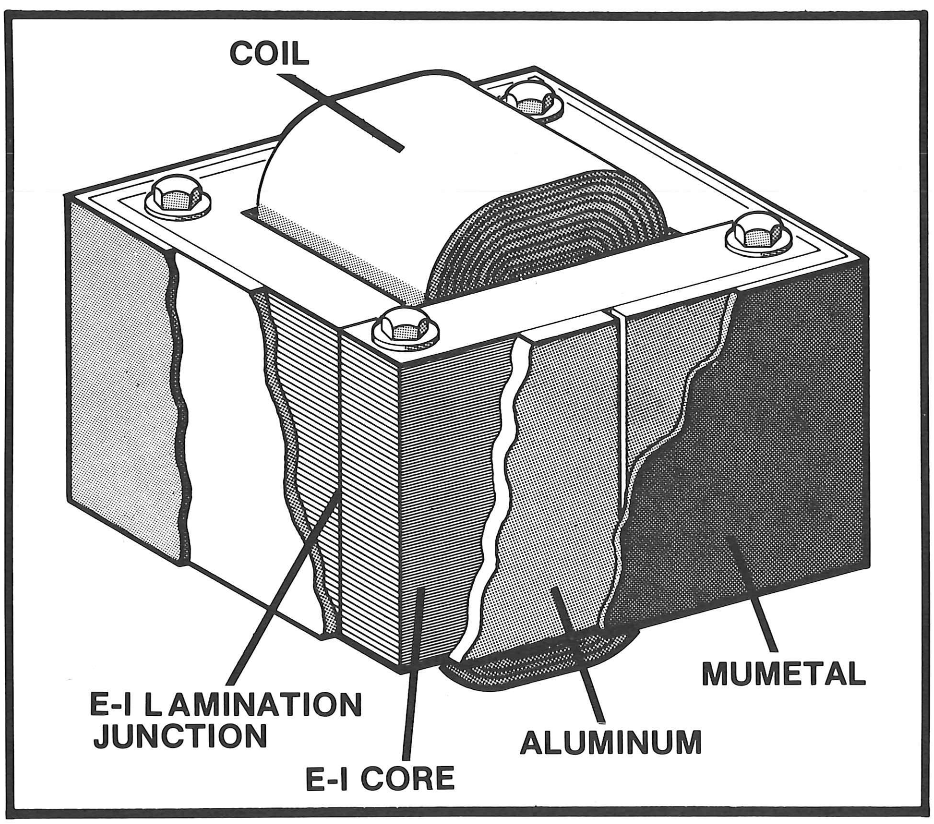


Figure 1. The aluminum and Mumetal shields on the power transformer.

GLOSSARY

Mumetal - a very high permeability alloy of nickel, iron, copper and chromium.

Reluctance - the impediment to the flow of magnetic flux. Inversely proportional to permeability.

E-I Lamination Junction - point where the E and I laminations of the transformer core meet. See figure 1.

Permeability - a material property that relates flux density to magnetic field intensity. The higher the permeability, the denser the flux field. The relative permeability of a material is its permeability divided by the permeability of free space.

the interference must employ the shielding technique. Magnetic shielding is usually achieved with a ferromagnetic shield that surrounds the transformer core. The attentuation (g) provided by the shield is a ratio of the field intensity outside the shield to the field intensity inside the shield. Shield Effectiveness (SE) defines the efficiency of the shield in decibels:

$$SE = 20 \log_{10} g = f(\mu)$$

Since SE is directly related to the relative permeability (μ) of the shielding material, it seems that a material with a very high μ would be the best choice for a magnetic shield. Thus, Mumetal would seem a likely choice to be used as shielding material. However, as *figure 2* shows, the relative permeability of Mumetal decreases rapidly when subjected to high field intensities. *Figure 2* also shows a large reduction in μ as the frequency of the field increases.

Figures 3 and *4* show the core-leakage flux near the core of a transformer that has a relatively high core flux density. As can be seen in *figure 4*, the field is not only 60Hz but also contains many higher odd harmonics.

Figure 5 shows the same field attentuated by a .025 inch thick Mumetal sheet spaced approximately .125 inch away from the transformer core. Closer spacing resulted in saturation of the sheet in this field.

As *figure 6* shows, the higher frequency harmonics are not shielded very effectively by the Mumetal. However, these higher frequency components can be attenuated by using a conductive shielding material. In a conductive shield, the incident magnetic field causes a current to flow in the conductor. This current, in turn, produces a magnetic field which opposes the incident field and therefore results in an attenuated field.

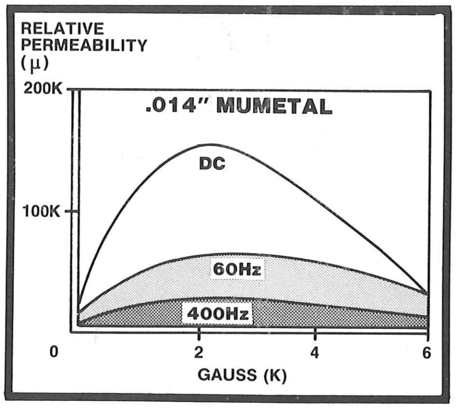


Figure 2. The relative permeability of Mumetal decreases rapidly when subjected to high field intensities. Also, as the frequency of the field increases, the permeability decreases.

CONDUCTIVE SHIELDS

The SE of the conductive shield is a function of the conductivity of the material, the thickness of the material and the frequency of the incident field. Unlike the Mumetal shield, the conductive shield's SE increases with frequency.

Figures 7 and *8* show the effect on the field of the transformer core when a .125 inch sheet of aluminum is placed in the field. While figure 7 shows that there is very little attenuation of the 60Hz component, figure 8 reveals that the higher frequency harmonics are better attenuated. *Figures 9* and *10* show the result of combining the aluminum shield and the Mumetal shield (the aluminum was placed between the transformer core and the Mumetal).

COMBINATION

Figure 11 shows the attenuation of each shield and the combination shield. The shielding effectiveness of the combination shield is much greater than the sum of the Mumetal and aluminum shields used separately. This can be explained in part by the nonlinearity of the Mumetal's permeability with respect to frequency and field intensity. The higher frequency harmonics not only reduce the Mumetal's relative permeability, but also cause a peaking effect which increases the peak intensity present. For this reason, it is important to locate the aluminum between the field and the Mumetal.

For shielding transformer cores, an aluminum shield used with a Mumetal shield can greatly enhance the effectiveness of the Mumetal. In most equipment that includes a cathode ray tube, a Mumetal shield is used to protect the electron beam from the earth's magnetic field and other fields such as those produced by a transformer.

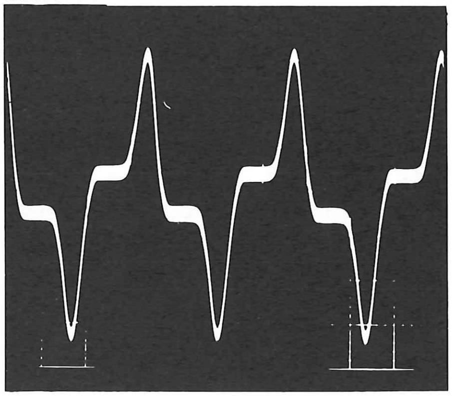
The effectiveness of this shield can be increased by banding the transformer core with aluminum. Also an aluminum chassis will be of some help, as it will act as a conductive type shield in addition to being a mechanical structure.

COPPER

Copper, having about 40% higher conductivity than aluminum, yields about that same percentage better shielding effectiveness for the same thickness material. But the increased weight and cost of the copper should also be considered when it is compared to aluminum for this application.

Figure 3. Left, an unshielded field, showing flux density versus time.

Figure 4. Right, the frequency spectrum of the unshielded field shown in figure 3 reveals high odd-harmonic content. (Log scale.)



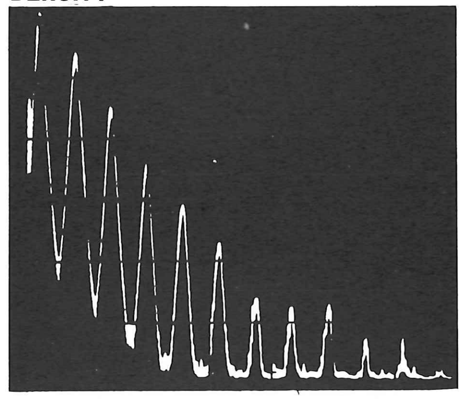
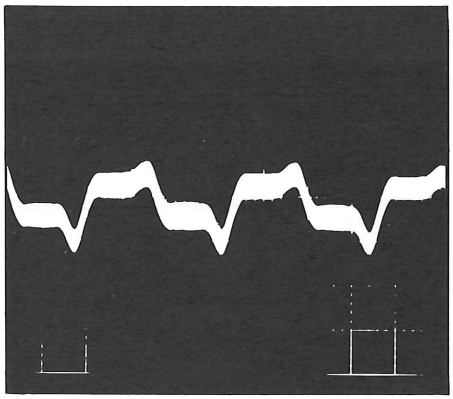


Figure 5. Left, the field shown in figure 3 is here attenuated by a .025 inch Mumetal shield.

Figure 6. Right, this frequency spectrum shows that higher frequency harmonics are still present in the attenuated field shown in figure 5.



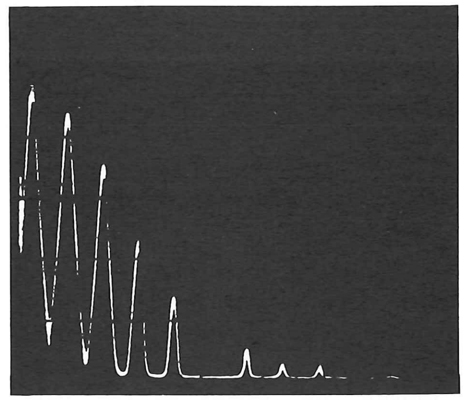
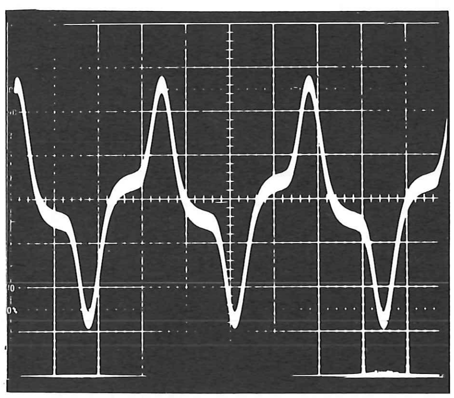


Figure 7. Left, here the field is attenuated by a .125 inch aluminum shield.

Figure 8. Right, with the .125 inch aluminum shield, there is very little attenuation of the 60Hz component but higher frequency harmonics are highly attenuated.



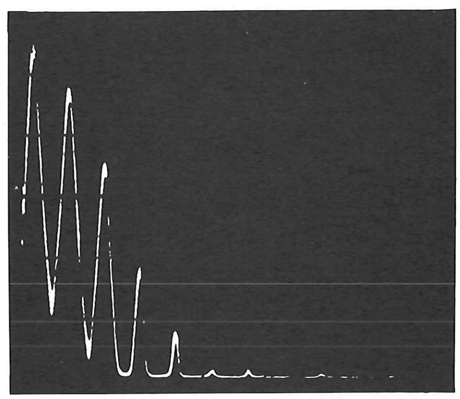
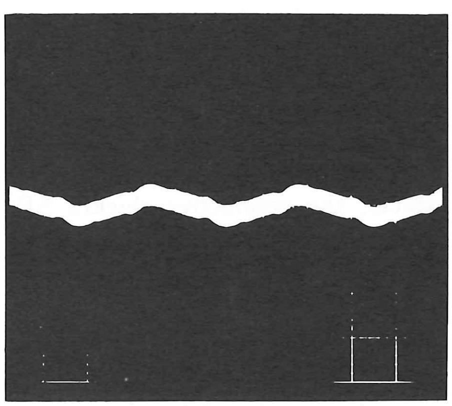
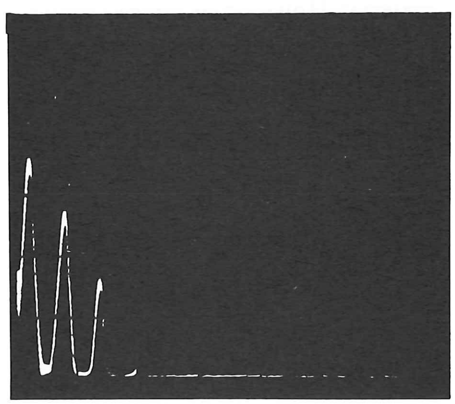


Figure 9. Left, a combination of .025 inch Mumetal and .125 inch aluminum shields greatly attenuates the field's 60Hz component.

Figure 10. Right, the Mumetal-aluminum combination shield dramatically attenuates higher frequency harmonics.





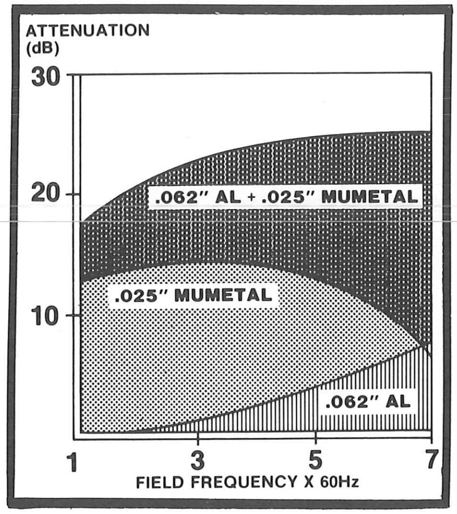


Figure 11. Measured Shield Effectiveness of .025 inch Mumetal, .062 inch aluminum and a combination of both.

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NEW EE DICTIONARY

The IEEE has published a new **IEEE Standard Dictionary of Electrical and Electronics Terms.**

The 20,254 definitions in this 896 page second edition include more than 7,000 terms that are new or have been revised since the 1972 edition. The book also contains the largest single list of acronyms--over 10,000--currently used in areas of EE science and engineering, business, government and the military.

There are special introductory prices of $22.45 for IEEE members and $24.95 for non-members. These prices remain effective through June 30, 1978.

The book can be ordered postpaid from the IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854. A payment of $2 for shipping and handling should be added to the price.

IN PRINT

Dennis Feucht (Portable Oscilloscopes) is the author of an article entitled "Pattern Recognition: Basic Concepts and Implementations." in the December 1977 issue of **Computer Design** (pp. 57-68). The article first defines the problems in pattern recognition, and then surveys the current approaches to decision-making and classification. Two techniques in particular--clustering and learning--are examined in detail.

If you would like a copy of the article, call the library on ext. 5388.

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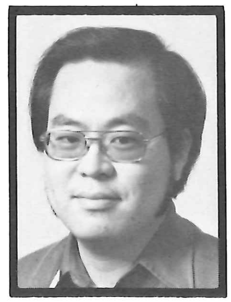
ERROR-CORRECTING CODES AND THEIR CONTROL FEATURES

This article is an excerpt from Chong's Tek Labs Report of the same name. The full report discusses the mathematical basis for the codes and control features; linear-block, binary-cyclic and convolutional codes; and error detection. In addition, the report includes an extensive bibliography and appendices (detection probability calculation and encoder/decoder design; error statistics; and measure of protection). For a copy of the full report, call Chong on ext. 6556.

The purpose of this report is to provide Tektronix engineers with an introduction to coding theory and error control features so that they can more easily overcome data communication problems.



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INTRODUCTION

Errors in data transmitted over a noisy channel are a serious problem in data communication systems and are therefore a major concern of communication engineers.

In recent years, the demand for efficient and reliable digital data transmission systems has been accelerated by the increasing use of automatic data processors and by the growing need for long-range communication.

Error control, however, is a problem for many digital systems engineers as well as communications engineers.

Reliability is important in programmable instrumentation where communication lines interconnect instruments. The General Purpose Interface Bus (IEEE 488) is widely accepted for interconnecting programmable instruments. Now there is also a trend toward connecting such systems with serial communication media when the instruments are geographically separated.

Instrument systems for process control, manufacturing and for laboratory automation also call for reliable communication. Multi-user interactive graphic systems for computer aided design applications are another important area.

Various kinds of communication protocols (BSC, SDLC and ADCCP are examples) are used in data terminals, computer networks, communication controllers and message switching systems. Data communication options that handle these protocols are becoming more important for Tektronix terminals because the terminals have greater communication needs and greater intelligence.

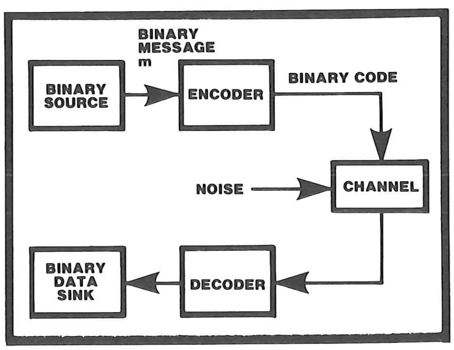


Figure 1. A block diagram of a digital data communications system. A major problem is designing a system that will encode the message, transmit the binary data over a noisy channel as fast as possible and then accurately decode the message.

STANDARDS

In the future, communication standards will be developed which might affect such possible Tektronix areas of interest as process control systems, manufacturing control and automation, laboratory automation and other systems that share these characteristics: transmission speeds up to several megabists/sec., high reliability and local communication (units will be no more than a few miles apart).

When data communication standards are developed, Tektronix engineers should be knowledgeable enough to help define them.

COMMUNICATION SYSTEMS

A block diagram of a typical digital data communication system is shown in *figure 1.*

A **channel** is a medium through which signals containing useful information are transmitted. Examples of transmission channels are telephone lines, radio links, and space communication links.

Of course, in digital computers and digital data communication systems, information is in binary form. A major problem is designing the channel encoder-decoder pair so that the binary data can be transmitted over a noisy channel as fast as possible, while accurately reproducing the information sequence at the output of the channel decoder. The design of the channel encoder-decoder pair is determined

continued on page 7

primarily by the system reliability requirements and by channel characteristics such as speed, error rate and modulation technique.

When each transmitted symbol is affected independently by noise, the errors are called **random errors.** Codes designed to combat independent errors are called **random-error-correcting codes.**

There are also channels (telephone lines and magnetic tape storage systems, for example) on which disturbances introduce errors of varying time duration so that errors tend to cluster together in bursts. Codes designed to correct this kind of error are called **burst-error-correcting codes.**

BASICS

The message from the binary source is first segmented into message blocks. Each message block m consists of k information digits, so there are 2^k possible messages. The encoder transforms each message block into a longer binary sequence of n digits.

The digits, (n)-(k), added to each message block by the encoder are called **redundant digits.** They carry no new information. Instead, their function is to provide the code with the capability of correcting errors made in transmission. Forming these

TERMINOLOGY

A **message block** with k digits of information:

here, k=11

1	0	1	1	1	0	0	0	1	1	0

here, n=14 (n is the total number of digits in a message block)

1	0	1	1	1	0	0	0	1	1	0	0	0	1

(n)-(k) digits added by the encoder; these are the redundant digits for error correction and/or deletion.

Code rate = k/n or 11/14, here.

Distance between code words is the number of digits in which they differ. For example, if:

n_1 = 1 1 1 n_2 = 1 1 0

The distance between n_1 and n_2 is 1. But if:

n_1 = 1 1 1 n_2 = 0 0 0

The distance between n_1 and n_3 is 3.

If a code set consists of:

C_1 = (0000), C_2 = (1100), C_3 = (0011),

then the distance between any two code words are as follows.

- distance between C_1 and C_2 is 2
- distance between C_2 and C_3 is 4
- distance between C_3 and C_1 is 2./us

By definition, the **minimum distance** of this code set is 2.

This is **not** a single-error **correcting** code but a single-error **detection** code.

GLOSSARY

ADCCP (Advanced Data Communication Control Procedure) is the ANSI standard bit-oriented synchronous line discipline.

BSC (Binary Synchronous Communication) is IBM's byte-oriented line discipline.

Communication Protocol is a set of procedures for management of information transferred over data communication channels.

CRC (Cyclic Redundancy Check)—often called polynomial error check. A redundancy element is transmitted along with the message. At the receiver, the whole message (including the redundancy) is examined to detect errors that may have occurred during transmission. If there is an error, the message is transmitted again.

Error-correcting Code—a code in which each acceptable expression conforms to specific rules of construction that also define one or more equivalent nonacceptable expressions. If certain errors occur, in an acceptable expression the result will be one of its equivalents and thus the error can be corrected.

Error-detecting Code—in a digital computer, a system of coding characters such that any single error produces a forbidden or impossible code combination.

SDLC (Synchronous Data Link Control) is IBM's bit-oriented line discipline.

redundant digits so that the code has good error-correcting capability is a major part of designing the encoder.

The ratio R=k/n is the **code rate** (the number of information digits entering the encoder per transmitted channel digit).

The **distance** (d) between two n-symbol code words is the number of digits in which they differ. The **minimum distance** for a code is the least number of digits in which any two code words in a code set can differ. (See TERMINOLOGY for an example.)

To correct all combinations of t or fewer random errors (that is, to be a t-error-correcting code), the minimum distance must be at least 2t+1. This assures that if t errors do occur, the received sequence will still be closer to the transmitted code word than to any other possible code word. Thus, to correct single errors, the minimum distance must be at least 3.

As an example, consider the code set 110, 001 (see *figure 2).* Single-bit error correcting is possible because the distance is 3, which satisfies our requirement:

$$d_{min} \geq 2t+1.$$

DESIGN PARAMETERS

The merit of any error correcting scheme is a function of three properties: control capability (What is the efficiency in detecting errors? How many incorrect messages does it let through?), line efficiency (How much does it reduce the line throughput?) and cost.

We can vary the design between these parameters by choosing one coding method or another. In some systems, high accuracy is all-important and a high price will be paid for it if necessary. However, the codes that give the highest measure of protection are rarely used. Designers usually settle for a reasonably high measure of protection at a cost that is not too high.

COST

There is a trend towards using more complex codes because large scale integration has lowered circuit costs.

Even though the circuit cost of CRC may be higher than the cost of horizontal and vertical parity checking (sometimes called "row and column parity check"), the extra expense is small compared to the much greater performance obtained. The cost difference in circuits is becoming much less significant with the cost of LSI circuits declining.

For data communication systems which require high-speed and high-reliability transmission, fixed-length messages are desirable for predictable error control. Normally in communications of megabits per second or higher, message length is limited by buffer size at the receiver.

Where frequent retransmission of messages to avoid errors is undesirable, correcting features can be added by using higher redundancy (that is, by reducing the code rate) and a more expensive encoder and decoder.

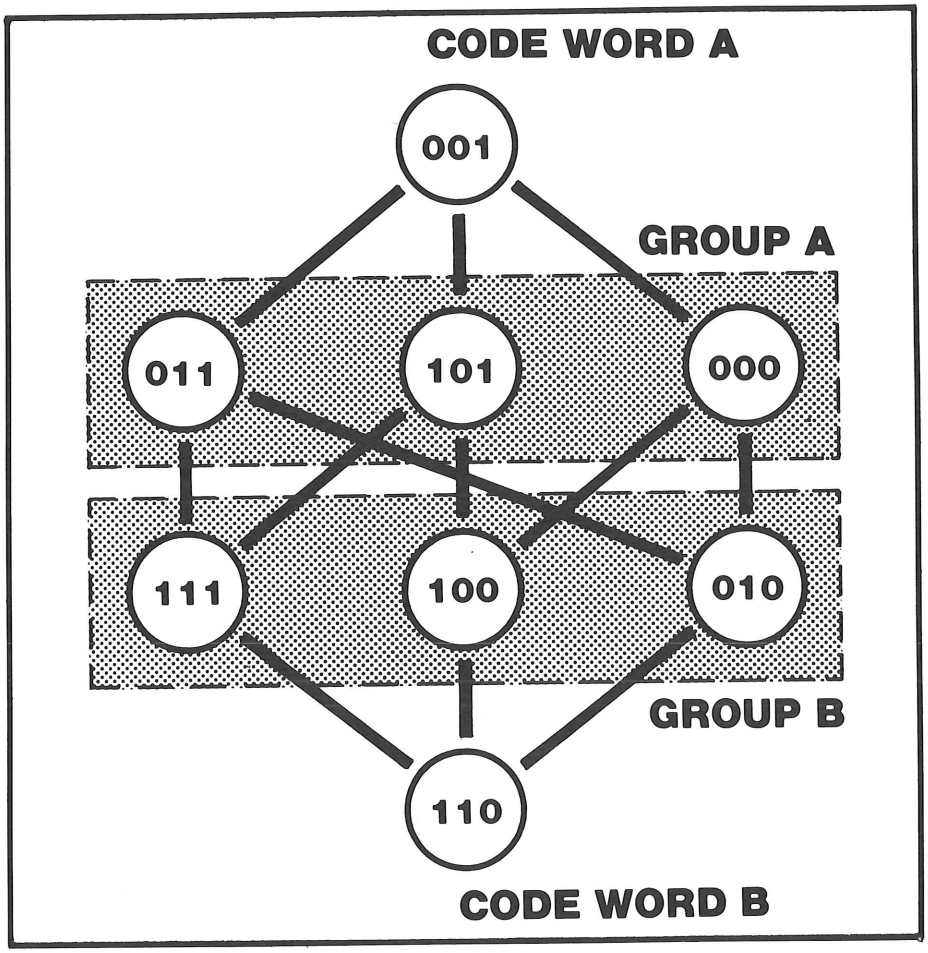


Figure 2. In this distance diagram showing the connectivity of the code words A and B, each straight line indicates a unit distance.

The distance between code words A and B is three which is also the minimum distance of the code set because these are the only two codes in the set.

If a single bit error occurs on code word A or B, it will become one of the three erroneous codes in group A or B respectively, and there exists at least a unit distance between any member of group A and any member of group B (i.e., group A and group B are non-overlapping). This ensures that a single bit error on code words A and B are distinguishable. Therefore the code set of (001) and (110) is a single error correcting code.

ERROR-DETECTING CODES

However, with error-detecting codes it is not necessary to have much redundancy to achieve a high level of protection.

If we transmit a long block of data, we can protect it very well with relatively few bits. The error-detecting power depends primarily on the number of checking bits in a group rather than on the percentage of redundancy. If long blocks are protected by a single group of bits, the high ratio of data bits to check bits provides more efficient coding. Error-detecting power, however, is highly dependent on the nature of the code.

An advantage of using CRC is that the length of the message can vary greatly. However, with a given probability of error for each digit, the longer the message the higher the undetectable error rate becomes.

CHECK SUM

A check sum technique has been widely used for error detection in storage elements. In check sum, a check pattern is first created by summing (or by summing combined with shifting) the multiple of fixed-length data, and then storing the pattern for later pattern match.

The summation is performed by modulo-2 addition (the equivalent of an exclusive-OR operation in Boolean algebra). This stored check pattern is used to assure the correct retrieval of the information by matching it to the recalculated check pattern. This is a very simple and workable method for smaller, and less sophisticated applications that don't require high reliability. For example, this technique has been used widely for checking the information stored in ROMs when system power is initialized.

However, considering the trend toward more storage, lower memory and processing element costs, and the need for higher reliability, a more powerful technique is needed to replace the conventional check sum technique.

STEERING MEETINGS

Deane Kidd, New Product Introduction ext. 7965.

HISTORY

It was in August 1949 that I first talked with Jack Murdock about working for Tektronix. He advised me that this was a small company but that it might double in a few years. There were about 60 employees then. Today we have over 15,000 employees world-wide.

In the early 1950's, Tektronix sent to the IEEE show in New York the first three-inch laboratory-grade oscilloscope. Howard Vollum visited the various booth displays and found a better three-inch tube for the scope. In August we again showed the instrument, but with the flat-faced 3WP2 crt. The instrument engineers from Dumont Company were very impressed with this scope and inquired about the source for the crt...Howard told them that we were buying the crt from the CRT Division of Dumont!

At an employee meeting after this showing, Howard expressed his concern that we never get so big that we do not know what all divisions of our corporation are doing. Today we have at least 10 major divisions in Beaverton, Wilsonville, Grass Valley, and several overseas locations.

In the early 1960's, Tektronix introduced several new products at a WESCON show in August with the promise of deliveries to start in January of the following year. Manufacturing saw the instruments for the first time at the show and were not prepared to support the engineering effort with product deliveries in January. It was at this time that the steering meetings were introduced to provide better communication between Engineering and Manufacturing. The steering meetings were originally chaired by Manufacturing with representatives of all groups in attendance.

TODAY

Today we still have the steering meetings and representatives of the various business units are invited to participate. There is always representation from the new product introduction people (building 55) and the liaison people from buildings 16 and 38, but we have only occasional representation of Central Planning and Scheduling, the Business Unit Marketing staff and, to a lesser degree, the Business Unit Manufacturing and Engineering staffs. Steering of the new product schedules requires that all parties be aware of the schedule and of the problems of engineering, tooling, fabrication, component development, assembly manufacturing and marketing.

Phase charts, which are part of the weekly minutes, and the comments that are attached to them are only valuable if the participants can use and rely on them. Recently, there has been more frustration expressed by many parties over their inability to meet the schedules because of the rules by which our computer netting system operates. This system provides the netted demand at points in time for all parts required to make the products we sell. This system must operate by rather rigid rules, but some leeway is possible in processing parts for products just entering the netting system.

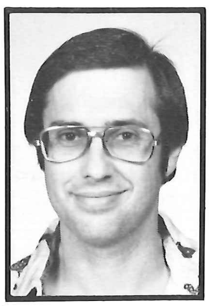
Steering meeting participants must give special attention to details if they are to make the scheduled-parts warehouse dates. If even one part is missing, we cannot assemble, test and ship the product on time.

ARE YOU REPRESENTED?

I urge everyone to look at their operation and see if it is represented at the steering meeting. Some groups need only a few minutes at these meetings each week, but some groups need a representative there every week for the full four hours. After almost 18 years as a member of the New Products Introduction system, I still feel that the steering meetings are necessary.

I believe that the steering meetings provide a window through which we can keep in touch with all of our expanding component and product developments from the time they emerge from the designer's bench until they are fully merged into the manufacturing process.

ALPHANUMERICS AND GRAPHICS INTEGRATED BY VIRTUAL BIT-MAPPING



Stanford M. Davis, IDP Engineering, ext. 2517.

Stan presented this paper at the Mini-Micro Exposition in Anaheim in December 1977.

Now in the marketplace are computer terminals that use bit-map memory to display graphs, mechanical diagrams, maps and process-monitoring schematics along with alphanumerics.

This paper compares the bit-map memory technique with an important new technique, virtual memory bit map. This new technique integrates graphic capability with form-fillout, scrolling and text editing in an alphanumeric terminal. With this technique it is possible to scroll several pages of graphs and text together and to provide output for hard copy. The capacity of the copy device, rather than screen size, limits the size of the hard copy.

SCROLLING

Scrolling alphanumeric data is running through page after page of information as if it were on a scroll or roller. Some alphanumeric terminals that offer graphics can scroll alphanumerics but not graphics. Graphics information displayed on such a system is on the screen in its set area all the time. If alphanumeric information is scrolled while graphic information is on the screen, the characters are written over the graph.

Using the virtual bit-map technique for graphics, the graphic data is stored in memory along with the alphanumeric data. So, when the alphanumeric data is scrolled, the graphic data is automatically scrolled with it. An example of the convenience of scrolling both alphanumerics and graphics is the display of financial data. The graph of a particular function can be continually updated, and scrolled off screen, while the user is filling out forms on the top part of the screen. When the user wishes to look at the graph, he merely scrolls it onto the screen.

This feature is also ideal for working with large bodies of text and graphics together. In this case, the user can define an alphanumeric and graphic area for each page, fill in the words and graphs, then scroll through the various pages of data. This is a simple technique that yields very attractive pages for reports.

HARD COPY

Another unique feature of virtual memory bit-mapping is the ability to record copies directly from display memory with a raster-scan hard-copy unit. The 8 1/2- by 11-inch copies are ideal for reports or desk work. The ability to mix alphanumerics and graphics also makes for a more viewable hard-copy page. The hard-copy unit delivers these copies in a matter of seconds.

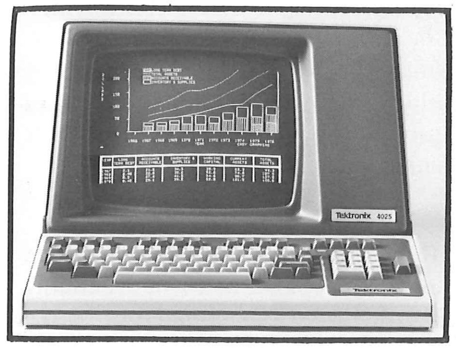
ADVANTAGES

This virtual bit-mapping technique provides three fundamental advantages. One, the alphanumeric and graphic data are essentially integrated into one list. When the alphanumeric data is scrolled, the graphic data is thus automatically scrolled along with it. This makes an attractive page and there is no chance of having alphanumeric characters overlayed on a graph. Graphic regions can be set up anywhere on screen and off screen, which allows the page format to be changed from page to page.

A second advantage is that now more than one graph can be stored in the graphics memory. The only limitation on how many graphs can be stored is the memory size.

The third advantage is more efficient use of memory. Using virtual bit-mapping, memory is assigned only to areas of the screen that are going to actually have a graph. If only one-fourth of the screen is designated for graphs, only one-fourth as much memory is required compared to tranditional bit-map storage.

Also, the screen boundaries are no longer a limitation. For example, graph width may be limited to 640 dots, but the length of the graph can stretch beyond the length of one page. The whole graph is then read by scrolling through it. Hard copies can be produced with normal 8 1/2- by 11-inch typed page capacity and orientation.



The 4025 Computer Display Terminal uses virtual bit-mapping to simultaneously scroll alphanumerics and graphics. Virtual bit-mapping also allows more than one graph to be stored in memory while using memory more efficiently.

HOW IT WORKS

To understand how the virtual memory bit-map technique integrates alphanumerics and graphics, it would help to first understand how alphanumeric data is stored in a raster-scan terminal and how the traditional bit-map technique works.

Alphanumeric-only terminals store their characters in memory in an ASCII display list. The terminal scans this list and uses each ASCII code to fetch a dot pattern from a character generator ROM.

For bit-map storage of graphic data, however, one memory bit is specifically assigned to each addressable point on the display screen.

The terminal then uses a straight scanning method to output the data. Bit-map storage is a straight-forward method of producing graphics on a raster-scan display. It does, however, require a lot of RAM memory. The simplest graph requires 38K bytes of RAM as does the most complex graph.

To make a combination alphanumeric and graphic terminal using the bit-map technique, the alphanumeric and graphic information are sent through a video mixer before being displayed. However, this is not a truly integrated system; the graphics are an add-on or overlay. So the most significant drawback of bit-map graphics, from the user's point of view, is the inability to scroll the graphics. Alphanumeric data can be scrolled by simply changing the starting point in the display list, but the characters are written over the graph. A hard copy of this would be confusing, and would be in screen format rather than typed page format.

With the **virtual** bit-map technique, however, the display cells in memory are related to positions in the display list rather than to specific dots on the crt screen. When the code for the letter A is read, for example, it points to the ROM for the dot pattern to be displayed. Pointing is also used with graphics; however, the list does not point to a ROM but to a RAM containing a dot configuration for part of the graph. When we get to a part of the alphanumeric display list that has been designated as graphics we go to the graphics memory RAM for the next character rather than to the alphanumeric ROM. The graphics memory is RAM which is grouped into by 8-by-14 dot map pieces or programmable characters.

SIMULATING FLAT PANEL DISPLAYS

Steve Heitmann, Computer Research (Tektronix Laboratories), ext. 5225.

Flat panel display technology is evolving rapidly, and will eventually become a serious competitor to the crt*.

The cost of manufacturing high-resolution displays (even those based on inexpensive light-emitting diodes or liquid crystal displays) is currently very high. However, low-resolution flat panels utilizing these devices can already be made quite inexpensively, since the square of the resolution dictates the cost. And fabrication advances are certain to reduce manufacturing costs and improve the resolution of such displays.

Thus it is becoming increasingly important that Tektronix consider flat panel displays for use in new instruments. In particular, exploring the low resolution displays already available is an immediate concern.

Determining the viability of low-resolution displays could require building many flat panel prototypes. A variety of flat panels are required to investigate variable qualities such as the minimum acceptable resolution, the most desirable spacing between pixels, and the most effective pixel geometry (a **pixel** is a display element; for example, a single LED). Since these feasibility studies can be quite expensive, both in time and money, it is very convenient to be able to simulate a flat panel design before actually building it.

FLAPS

To address this need, a flat panel simulation (FLAPS) program was written and is now available on the Cyber LIBRARY.

*See the October, 1977 issue of **Computer Design,** p. 101, "Flat Panel Displays Offer Graphics Alternatives."

Flaps is used on a Tektronix 4014 Computer Display Terminal. With FLAPS, one can interactively portray the various physical qualities of flat panels, the effects of several different modes of digitization, and a variety of mathematically-generated waveforms. The waveforms may be varied by using simulated oscilloscope parameters to investigate visual effects caused by the discrete display elements. See *figure 1.*

The simulated flat panel can be either rectangular or square with the dimensions specified by the user. Pixels can be represented as circular, square or diamond shapes as small as 10 mils wide.

The pixel array dimensions that determine the display resolution can be defined by the user within the constraints of the specified display area and pixel size. Any dimension incompatible with these constraints is rejected by the program.

The simulated flat panel can display mathematically-generated wave-

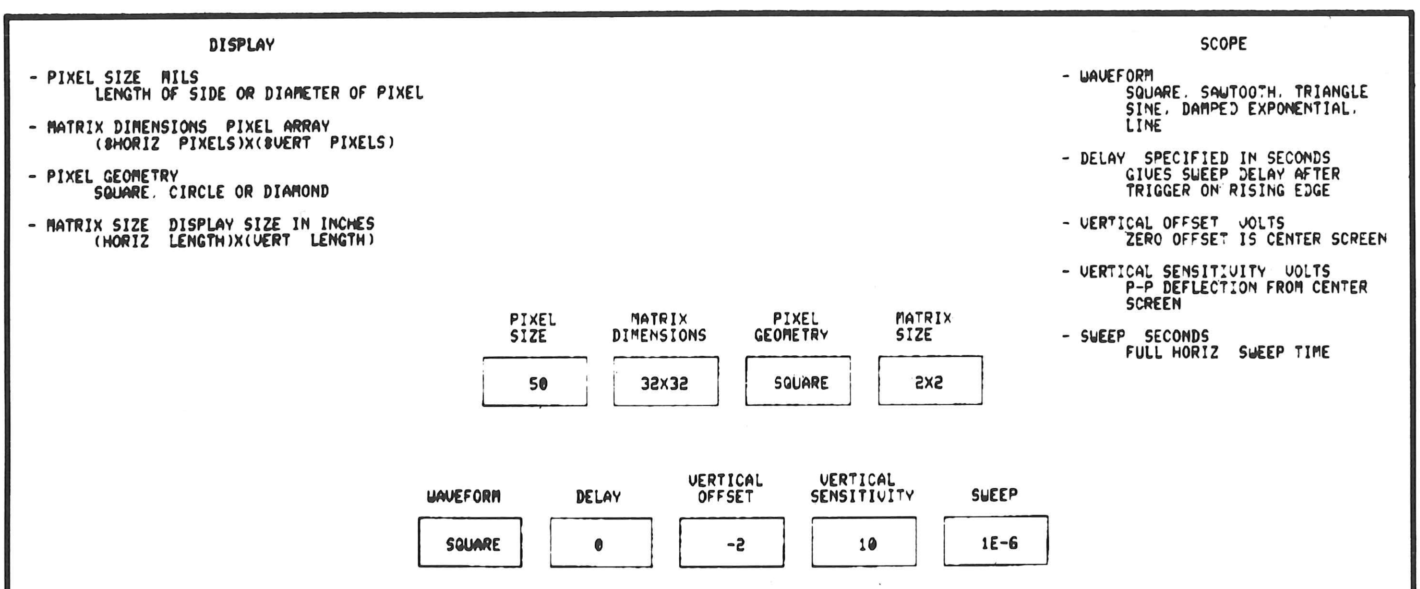


Figure 1. The flat panel simulation program (FLAPS) portrays various physical qualities of flat panels: pixel size, the matrix dimensions of the pixel array, the pixel geometry and the matrix size. The user can manipulate a selected waveform by varying simulated scope parameters and then observing the result on the simulated flat panel display. In this example, the user specified square pixels. The user also asked that a square wave be displayed on the simulated panel.

forms such as sine, square and damped-exponential. While adjusting typical scope parameters such as sweep delay and vertical offset, the user can observe changes in the quality of the displayed waveform that result from the geometric configurations of the specified flat panel. See *figures 1* and *2*.

MODES

The FLAPS program provides for three simulated digitization modes. One mode simulates ordinary data acquisition by digitizing only one point per time sample (*figure 3*). Another mode, which simulates Bruce Campbell's (LDP Engineering) oscilloprobe technique,** will digitize as many points as can be acquired during a given time sample (figure 4). The third mode is a mathematical idealization of data acquisition which eliminates space-time quantization distortions in the oscilloprobe approach.

FLAPS also has several options available to the user which make interaction easier and allow the user to document the simulations. For instance, the program can compensate automatically for size reductions of the displayed image caused by the Tektronix hardcopy unit.

FOR MORE INFORMATION

A users manual is available from the Scientific Computer Center (D.S. 50-454), but FLAPS provides enough on-line explanation and error checking to allow a new user to explore its capabilities directly.

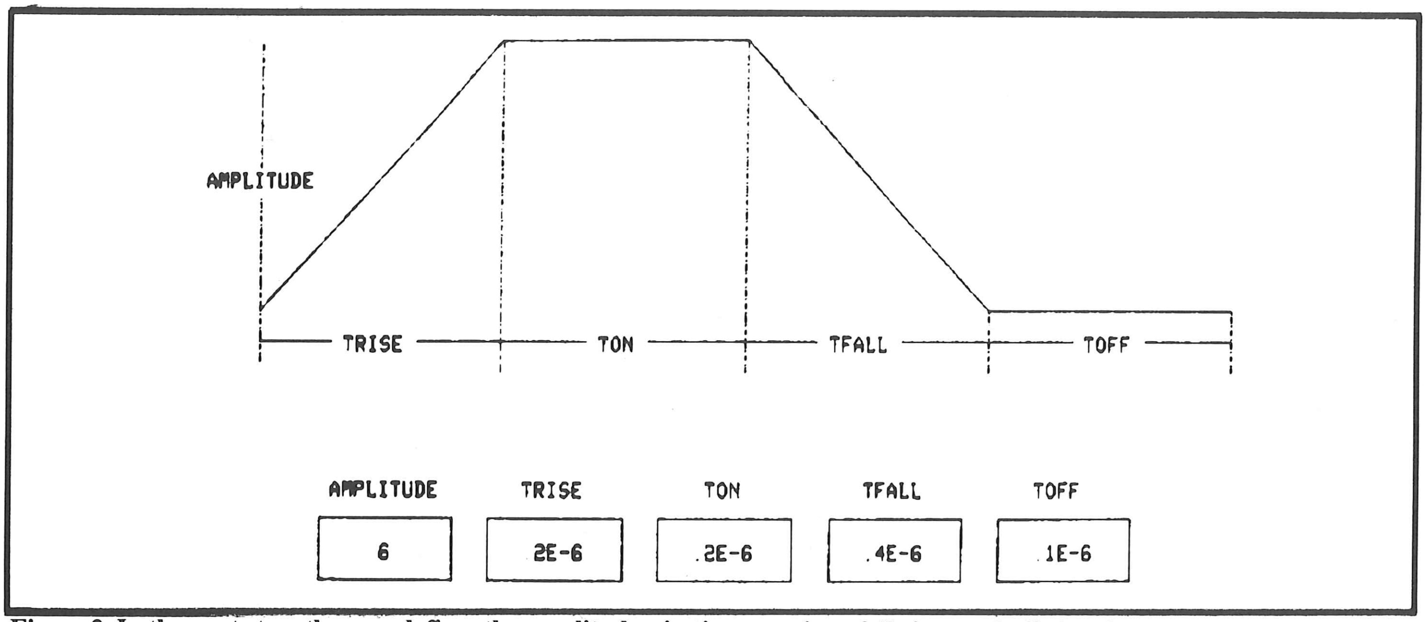


Figure 2. In the next step, the user defines the amplitude, risetime, on-time, fall-time and off-time for the waveform that will be displayed.

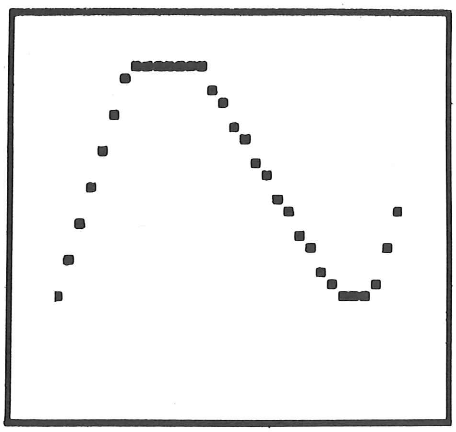


Figure 3. Shown here is the waveform specified by the user in figures 1 and 2.

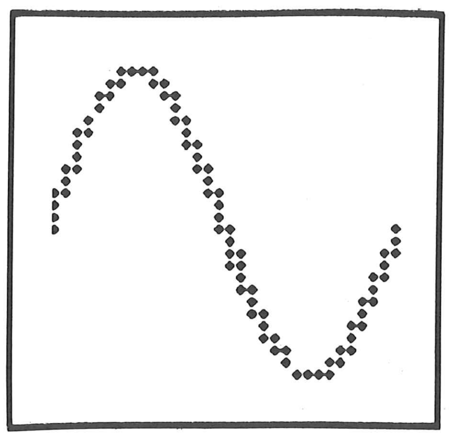
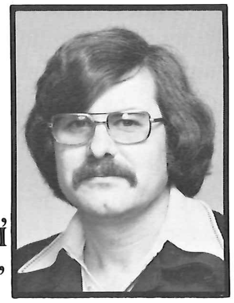


Figure 4. FLAPS, in one mode, simulates the oscilloprobe techniques and digitizes as many points as can be acquired during a given time sample.

**A real-time digitization method, in which the waveform is continuously digitized and displayed without regard to the number of points that turn out to occupy a single column. Like the vertical amplifier of a normal oscilloscope, the digitizer simply follows the waveform independent of the horizontal mechanics.

IMPROVEMENT THROUGH INVOLVEMENT



Jerry Sherrill, formerly with ITI but now with IDP, ext. 2716.

INTRODUCTION

In the summer of 1975, Tektronix started a work measurement program which began with analysts observing production methods and applying work standards. Method improvements resulted from the study.

The work measurement program was well on its way to its goals but it was resisted by production operators. A thorough examination identified a flaw in the program--there was no "operator involvement." The individual responsible for job performance was not involved in establishing the job methods and standards. This lack of involvement lead to resistance to the program. Also, we found that there was no formal way to tap the vast resource of employees' ideas.

There was a third problem. Once work problems were identified, what system would involve the operator (who usually is the expert on the job) with the work-measurement analyst to establish the best method of getting the job done?

STRATEGY

We wanted to develop a formal improvement system which would involve production operators and first-line managers. We selected the **work-simplification** concept because it parallels Tektronix' personnel philosophy. (An assumption underlying the work-simplification concept is that employees are creative and will use their creativity to improve their jobs when given an opportunity.) Our plan called for a full-time coordinator responsible for developing an "improvement through involvement" (ITI) program.

To avoid re-inventing the wheel, we tried to discover why some ITI programs failed while others succeeded. In paticular, we communicated with Texas Instruments, whose policies and philosophies are similar to Tektronix and who have a successful work-simplifiction program. Texas Instruments let our coordinator observe their system in operation. We developed our own system in August 1975 and put it into effect in October.

ITI OBJECTIVES

Before starting the program, we estblished our objectives, most of which were non-financial. Tektronix believes that its skilled and creative work force is the only resource that neither diminishes with time nor erodes with use. Furthermore, proper involvement expands its capacity. Therefore, our objectives were to involve all employees in the improvement process and to share ideas that improve employee and company performance. As these goals are achieved, a higher return on investment is received.

TEKTRONIX PHILOSOPHY

A part of the Tektronix philosophy that made it easier to start the ITI program is that "People want to do a good job and to realize as much of their potential as possible." To the extent that a company enables and encourages personal excellence, it strengthens its bond with its employees.

Another part of Tektronix philosophy is that the basic goals of the individual are the same as those of the company. We have thrived because that belief has proved itself time and again. Tektronix has been privileged over the years to have a very large number of people who take pride in their work. From our experience, pride in a job is enhanced when an employee knows

- that a goal is a worthy goal.
- that the organization is successfully achieving that goal.
- that the job is worth doing.
- that the job is being done well.
- that excellence is rewarded accordingly.
- and that opportunity exists for personal growth and for realizing more of one's potential.

INTRODUCTION TO MANAGERS

The system was introduced to first-, second-, and third-level managers. Participation was on a voluntary basis: managers requested training for themselves and then trained their own groups. Enthusiasm was high at the beginning, but dissipated after several months. From talks with managers, we identified three problems:

- Some managers felt that they lacked the expertise to instruct in a classroom situation.
- Managers didn't have time to teach.
- There was no formalized follow-up.

Once the problems were identified, the solution was simple: develop a structured follow-up with a full-time coordinator to train and work with the production operators and their managers. We called that coordinator the "ITI Implementation Specialist."

DUTIES OF THE ITI SPECIALIST

At the request of a first-line manager to have his people involved, the specialist works with the manager to establish a training schedule. The manager's group receives six hours of classroom training in ITI concepts.

After completion of classroom instruction, the specialist and the manager call together problem-solving teams. The manager then sets a schedule for each team to meet on a regular basis. The specialist provides assistance and leadership for each team's problem-solving conferences until a group leader is developed. At the start of each session, the specialist asks the team to list major problems that prevent them from achieving their job goals.

The team assigns priorities to the problems and then identifies those problems in which the group can effect a change. This is accomplished by using a seven-point test that asks questions that can be answered "yes" or "no", such as "Can you do something about it?", "Can the group handle it, or is it too big for the resources available?"

The problems that receive a "yes" to all seven questions are the ones in which the group can probably effect improvement. This yes-or-no technique keeps the team from spending time on problems whose solutions are out of reach.

FORMS

Once a solution is found, it may be presented to management in one of two forms. The first is the Improvement Through Involvement Report used when materials, time or dollar savings can be quantified.

The second is the Thought For Improvement form. This form is used for ideas relating to items such as quality, safety and morale...benefits that are without readily quantifiable dollar savings, but which can improve an operation or the attitude of an individual or group. The completed form is submitted to the first-level manager for review.

ITI FOR YOUR GROUP?

ITI is not designed exclusively for production operators. It has also been used as a tool for managers and staff personnel to improve their own jobs.

If you need more information on how ITI can help you improve your job, call Jim Lushina on ext. 5658.

TEAM APPROACH TO PROBLEM SOLVING

ITI at Tektronix stresses the team approach to problem solving because the best results come through teamwork. People like to work in groups because there is usually a greater feeling of accomplishment and satisfaction, and because it gives everyone an opportunity to get into the act by contributing their ideas. A person who wouldn't otherwise be heard from will frequently speak up when given the opportunity.

Another reason to emphasize teamwork is that individuals are more receptive to a solution reached by their team than one reached by an individual who is not responsible for the performance of the job.

The team approach to problem solving also creates a cooperative atmosphere where each member gains confidence in and from the ideas of the other team members. Overall, communication is improved and there is little resistance to change.

As an approach to the team concept, using our ITI specialists to coordinate activities has been very successful. About 80% of the ideas submitted for improvement have come from problem solving teams. Training 1500 employees and managers resulted in over 500 improvements with savings of over $500,000. The majority of the ideas were method changes which resulted in better use of equipment.

RECOGNITION

Employees whose ideas are approved receive recognition in two ways:

- an article in **Tekweek** describes the idea and the savings, along with the individual's name (if a team, all names).
- a certificate, signed by the division manager, recognizes the contribution.

Individuals and teams also receive recognition from their immediate manager in group meetings.

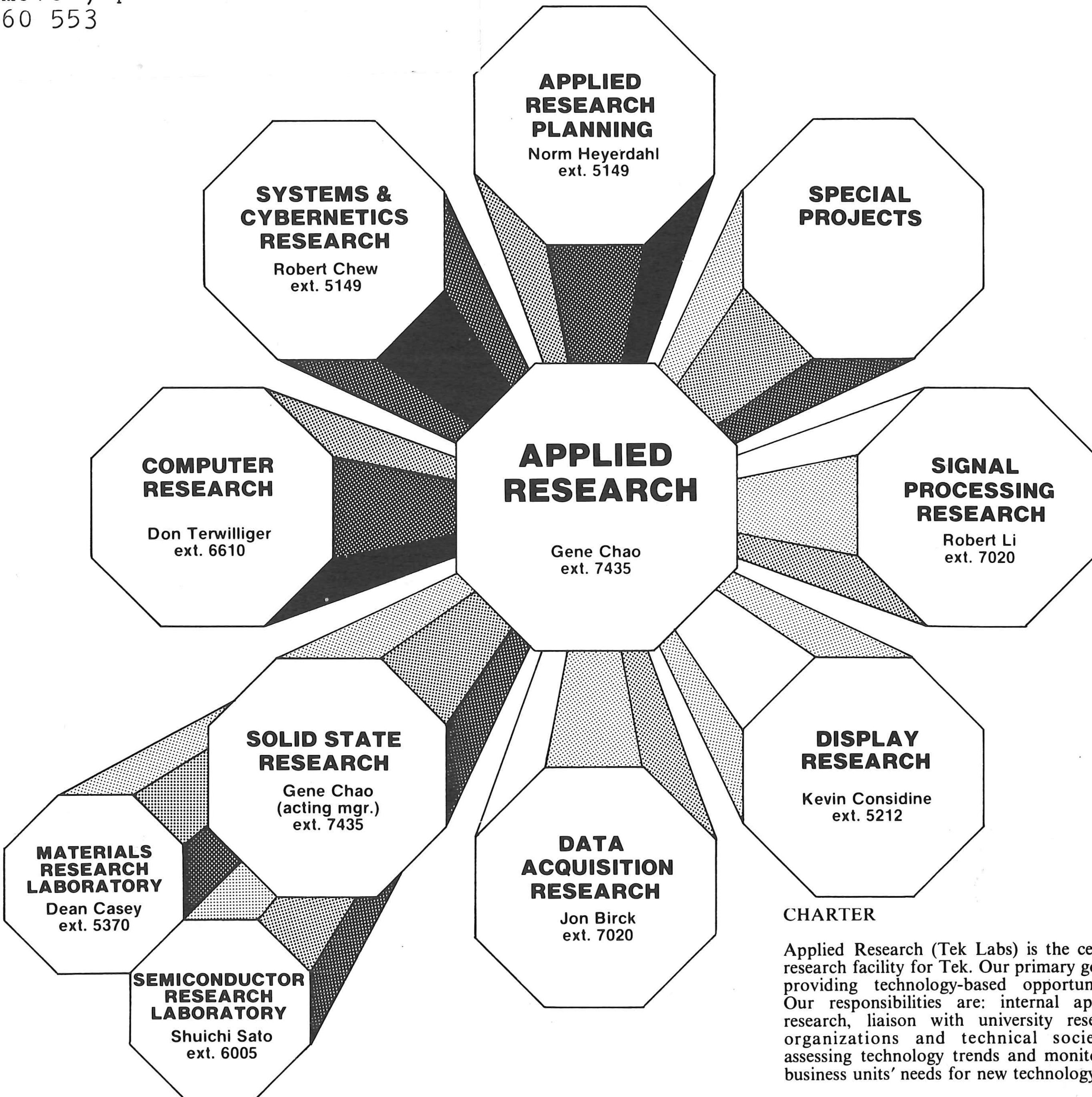
CONCLUSION

Our program has been in effect for over two years. The first year, when we worked without ITI Specialists, was fairly lean. In the second year we received the desired results.

We attribute the success of the ITI activity to four factors:

- the Tektronix philosophy and the practice of participative management.
- the ITI specialist who trains each group to coordinate their activities.
- a formalized follow-up that keeps enthusiasm high and provides a means of tapping the talents and creativeness of each employee.
- recognition of employee's involvement in the improvement process.

Maureen Key If you have moved, please call Ext. 5407
60 553



CHARTER

Applied Research (Tek Labs) is the central research facility for Tek. Our primary goal is providing technology-based opportunities. Our responsibilities are: internal applied research, liaison with university research organizations and technical societies, assessing technology trends and monitoring business units' needs for new technology.

—Gene Chao, Applied Research Manager

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Engineering News serves two purposes. Long-range, it promotes the flow of technical information among the diverse segments of the Tektronix engineering and scientific community. Short-range, it publicizes current events (seminars, new services available, and notice of achievements by members of the technical community).

Contributing to EN

Do you have an article or paper to contribute or an announcement to make? Contact the editor on ext. 5468.

How long does it take to see an article in print? That is a function of many things (the completeness of the input, the review cycle and the timeliness of the content). But the **minimum** is three weeks for simple announcements and about five weeks for articles.

The most important step for you, the contributor, is to put your message on paper so that the editor will have something to work with. Don't worry about problems with organization, spelling or grammar. The editor will take care of those when he puts the article into shape for you.