Engineering News

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COMPONENT PRECONDITIONING FOR THE T900

In November of 1974, Service Instruments Engineering began power cycling transistors for use in the development of the T900 oscilloscope line. The original breadboard preconditioning equipment is long gone, but in its place are six racks of equipment and an oven in Building 70 serving the T900 production line. Three racks of equipment in Building 39 serve other experimental reliability programs in various divisions of the company.

All transistors and ICs used in the T900 production lines are preconditioned in some manner. While it is too early to accurately evaluate results in terms of field failures, a 700-hour reliability test of 25 instruments with preconditioned components and 25 instruments with standard components was favorable to the instruments with preconditioned components.

Reliability has been emphasized in the T900 program for many reasons. Because they are low cost instruments, we cannot afford to absorb much warranty cost. Some of the competition in the T900 market area is emphasizing reliability. By doing the same with the T900, we will maintain a competitive position. Finally, since the T900 has lower component count than most other portable scopes, it seemed a good vehicle for evaluating reliability techniques. These techniques may have applications in future products.

Besides component preconditioning, other reliability measures are employed in the T900 program. Conservative designs stress components well below their ratings, where possible. Each finished instrument is run for seven days in the cycle room to shake out early component failures.

What is Component Preconditioning?

Component preconditioning is subjecting components to a controlled amount of stress continuously over a period of time. Normally these stresses are greater than the stress that components would encounter after being installed in the instruments. Generally the stresses do not exceed specified component ratings. Some of these measures are: power cycling, burn-in, high temperature reverse bias (HTRB) bake, thermal shock, and thermal cycling. The component testing that follows preconditioning eliminates those components that failed, hopefully the same components that would normally fail in the instrument. Stabilization bake is also used, not as a stress, but rather as a "finishing touch" to the semiconductor manufacturing process.

COMPONENT TYPE	TREATMENT			
TRANSISTORS (AND TWO LINEAR IC's)	STABILIZATION BAKE 24 HOURS	POWER CYCLING BURN-IN 48 HOURS		TEST AND MARK WITH PAINT DOT
LINEAR IC's (OP AMPS)	THERMAL SHOCK	4 HOUR DRY AT 40° C	HTRB BAKE 4 DAYS	TEST AND MARK WITH PAINT DOT
DIGITAL IC's	THERMAL SHOCK	4 HOUR DRY AT 40° C	STABILIZATION BAKE 7 DAYS	TEST AND MARK WITH PAINT DOT

HI VOLTAGE MULTIPLIERS	2 DAYS OPERATIONAL BURN-IN	TEST

Figure 1. Outline of the T900 component preconditioning program.

Since components may be used in several applications, preconditioning methods are not consistent from company to company, or even for all applications within any one company. An even larger variable is in the differing opinions as to the effectiveness of the various preconditioning methods, and in the willingness of different companies to invest money in component reliability assurance.

Power Cycling

For the T900, transistors and certain ICs are subjected to a power cycling burn-in. The transistor is operated in common base mode with current controlled to the emitter. The collector-base voltage (50% to 80% of rated voltage) stays on all of the time. The emitter current is turned on so that the transistor dissipates rated power for five minutes. Then it is turned off so that the transistor cools for five minutes with the collector-base voltage still applied. This cycle repeats steadily for two days.

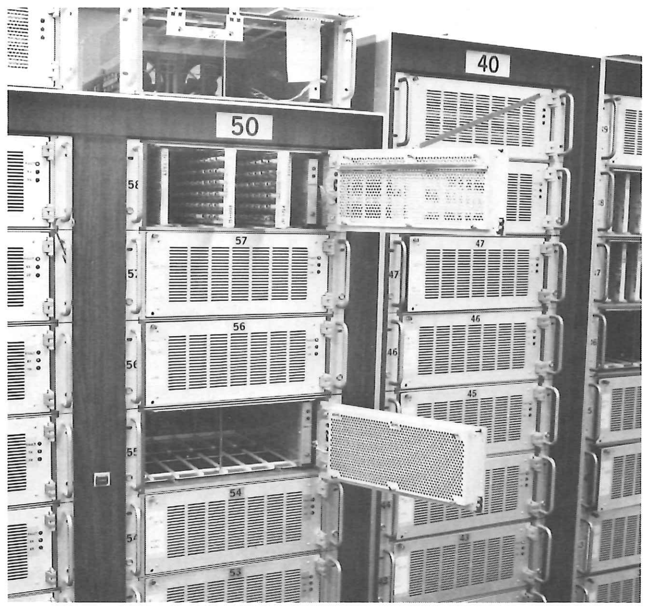


Figure 2. Transistor power cycling burn-in equipment showing some of the boards with components installed. These are only a few of the 36 drawers which receive boards for the two-day cycle. A six-foot rack of power supplies is outside the room to the right.

Normal Burn-In

This is similar to power cycling burn-in except that power is applied constantly. Because the parts do not need to cool down every ten minutes, the power can be reduced. In this case an oven is used to bring the junction temperature up to specified rating. The T900 program uses burn-in at room temperature for potted high voltage multipliers.

Thermal Shock

One tub of water is kept close to freezing temperature and another is close to boiling temperature. Deionized water is used. Baskets of parts are alternately suspended in the hot and cold for 30 cycles. Liquids other than water can be used for greater temperature extremes. The T900 program uses thermal shock for all integrated circuits except those receiving power cycling burn-in.

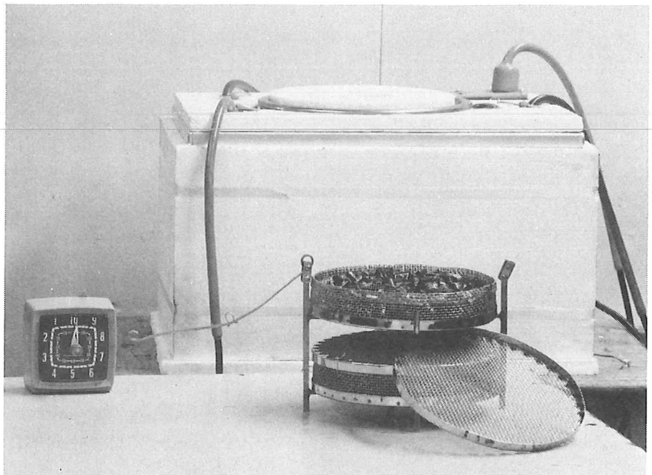


Figure 3. This is the hot chamber for thermal shock. In the foreground is the basket which holds components. The basket is lowered into a tub of nearly boiling deionized water which sits in large Styrofoam insulated container in background. Large container holds ordinary tap water which is heated by immersion heaters. Cold chamber is not shown.

Thermal Cycling

An alternative to thermal shock is thermal cycling. The medium is air, rather than liquid. The component does not change temperature as rapidly when transferred from hot to

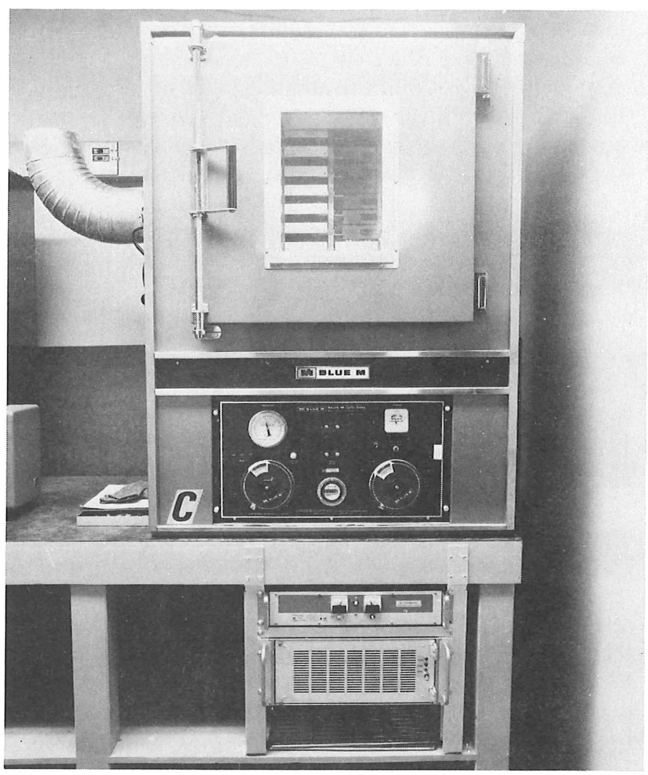


Figure 4. This oven is used for high temperature reverse bias (HTRB) bake of op-amp integrated circuits. Circuit board trays which hold ICs in sockets can be seen through the glass door. Bias power supplies are shown on the lower shelf.

cold. Wider extremes (-40 degrees C to +125 degrees C) are typical.

High Temperature Reverse Bias (HTRB) Bake

Parts are installed in sockets within an oven. The oven temperature is set so the junction temperature is at manufacturer's rating. Parts are baked with reverse bias voltage applied. The technical difference between HTRB and normal burn-in is that in HTRB, a transistor would have collector-base voltage applied but the emitter would be left open. HTRB is a voltage stress under high temperature, whereas burn-in is an "operating mode" power stress. The T900 program uses this treatment on op-amp type ICs, with power applied to the ICs and the inputs biased to the extremes.

Stabilization Bake

The ICs are baked at the rated storage temperature with no power applied. The T900 program includes stabilization bake for seven days on digital ICs, and 24 hours for transistors.

Capacity

At present all T900 component preconditioning is done in the Component Preconditioning and Test Group headed by Jim Brammer in Building 70 (formerly a part of Incoming Inspection and Component Selection). There is additional capacity to handle parts in the oven system for HTRB bake and stabilization bake. The thermal shock system, while primitive and inconvenient, can handle many more parts. Its primary limitation is container size and persons available to operate it.

The Power Cycling System for transistors will be filled to its capacity of 10,000 components for the T900 sometime in mid 1976. However, the Reliability Engineering Group headed by Clair Gruver in Building 39 also operates a transistor power cycling system with capacity for several thousand transistors. This group assisted in the power cycling of parts for the T900 program until the system in Building 70 was complete. They are presently power cycling transistors for a group of color TV monitors. They can gear up fairly quickly to power cycle transistors for a low volume instrument or for an experiment. They can also do thermal shock and are set up to experiment with power cycle burn-in parameters. Burn-in of capacitors is one of their current experiments.

Results

Parts that fail during T900 preconditioning are eliminated in the testing that follows. Typically, one-fourth percent to seven percent of the parts are rejected, with fallout of one-half percent to two percent occuring most often. The most common failure mode for transistors with fallout rates higher than two percent is a reduction in beta, particularly at low collector current. Failures for all transistors also include excessive leakage current and low breakdown voltage.

Among the digital and linear ICs being preconditioned, the highest fallout rates are for a 12 volt regulator and the 741 op amp (five percent to ten percent). Other ICs are rejected about one percent to two percent.

Fallout rates do not translate directly into savings in field failures. The main reason is that parts are preconditioned at or near maximum ratings to accelerate failures. Parts in the instruments are stressed well below maximum ratings in most cases. Another reason for the difference is that one large failure mode, beta degradation at low collector current, will not always cause the instrument to malfunction.

Preconditioning fallout information is sent to Clair Gruver for computer sorting. Clair can provide fallout rates for components that were preconditioned for the T900. The results are sorted by part number and vendor. This information will be used in the future to help determine whether 100% preconditioning is needed or whether a lot sampling system could be used for some vendors and part numbers.

Not the Whole Answer

Component preconditioning as outlined above is just one of the general methods that can be used to ensure that the production line receives reliable parts. Other methods for transistors are also employed. Incoming automatic testing with hot track can catch most of the thermal intermittent problems. The hot track process involves application of heat to components as they approach the test station. Accelerated life testing of a sample of each incoming lot can determine if the number of unreliable parts in the lot is within a specified acceptable percentage. An alternative to buying new equipment at Tektronix is to ask vendors to do some of these operations before shipping the parts, or to farm the job out to outside testing labs.

Various groups in the company are involved in deciding the best approach for Tektronix to take in improving the reliability of components. Bill Snell, ext. 7897 in Engineering Services, is the primary contact if you have questions or comments.

While Tektronix is gearing up to get more reliable components to the production line, it may be important to see where component reliability fits into the overall product reliability program. Using the 465 as an example, approximately 25% of the failures are caused by transistors. Of these transistor failures, approximately 40% to 60% appear to be caused by application problems. The remainder would be related to inherent component unreliability which could be reduced by component preconditioning. Even if all of the transistors were preconditioned, approximately 85% to 90% of the 465 failures would remain due to failures of other components and application and workmanship problems. These figures are typical for a number of oscilloscopes.

In addition to **component** reliability improvement, reliability efforts are also needed in instrument design and manufacturing. Good field service is still needed because we cannot economically eliminate **all** failures.

All of the results on the T900 reliability program are not in yet. T900 is a fairly new instrument and the number of instruments in the field is not sufficient yet to base conclusions on. The failure of a single preconditioned component at this point would indicate a higher failure rate for that part in the T900 than the average failure rate company wide. The results will become more meaningful as the quantity of instruments in the field increases.

Information supplied by John Eskeldson.

EXTRA!

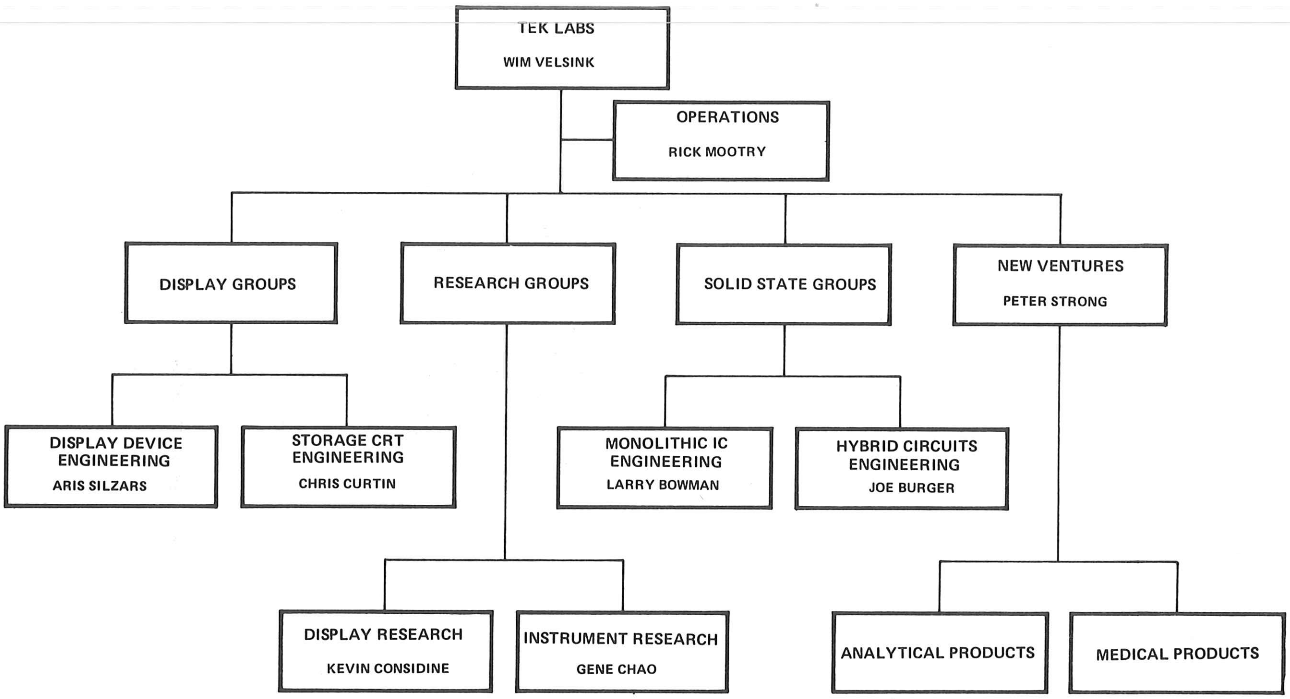
Because **Engineering News** comes out near the beginning of each month, we have found that it is not always possible to publish announcements for seminars and meetings before they happen. We would like to publish a one-page meeting, conference, and call for paper notice around the fifteenth of every month.

The one-pager would contain only such notices, while the regular **Engineering News** will contain articles as well as notices. In this way, we will provide bi-weekly announcements of important events.

We will publish the **Engineering News Extra** if the demand exists. Therefore, we would like to know if you find this service valuable. If you have avoided making announcements through **Engineering News** before because you thought it would not get printed in time, we'd like you to try us again. Send us any notices you would like publicized: meetings, conferences, seminars, visiting vendors who may be of general interest, classes and other information not otherwise easily available.

We hope this will make us more useful as a communication vehicle for the engineers at Tek. That's what we're here for.

A Look at Tek Labs



We are frequently asked, "What exactly is 'Tek Labs?' What do they do?" The following is the result of talking with managers of the various groups and some of the people who work with them. We would like to thank Rick Mootry, the managers of the groups and Ray Hayes, Binoy Rosario and Jon Fessler for their assistance in getting this information together.

—EN Staff

In an effort to keep pace with rapidly advancing technology, Tek Labs works in the design and development of unique processes, devices and product concepts for ICs, hybrids and CRTs. These developments have contributed greatly to the advanced characteristics of Tektronix instruments.

Tek Labs designs and builds only those components that contribute significantly to product performance and are not available outside on reasonable terms. Recent increases in short term projects at Tektronix has put pressure on long term development. Flat budgets make costly but necessary changes more difficult. The world wide electronic instrument market is demanding that instruments be smaller, cheaper, battery-operated and possess signal processing characteristics. Also, the processes which accompany new technologies are expensive and depend heavily on computer support. All of these factors must be considered in planning new products.

Monolithic ICs—Larry Bowman

When an IC is needed in an instrument design, all groups concerned must consider whether it is economically desirable to build in-house, or if a purchased item will serve the purpose. Considerations include design and performance compromises which are sometimes necessary when an instrument is to interface with a purchased IC. Performance characteristics can usually be controlled better when ICs are built in-house, and sometimes no existing ICs will do the job.

Among the functions of the monolithic IC group is fabrication of linear ICs for the oscilloscope groups, bipolar logic, high performance and discrete bipolar devices, and high speed logic. There is an ongoing process development effort to maintain state-of-the-art processing capabilities. This enables us to respond quickly to specific product requests, and provide yield and performance improvements in current products.

The complexity of component and IC designs is increasing all the time. With this increasing complexity, ICE designers participate in more of the actual circuit design for instruments. When designing a new device or circuit, Monolithic ICs will try to use an existing technology. They will develop new technologies if there is no alternative and it is economically practical.

ICs are made not only to miniaturize existing circuits, but also to improve performance. This was the case with the M:152 Correction Circuit for Geometry and Focus in Electromagnetic Display tubes. This circuit gave Tek a significant competitive advantage.

Put simply, the electron beam from the CRT gun is subject to distortion when it is aimed at the face of the tube. There are two reasons for this: (1) the sine of the deflection angle (not the angle itself) is proportional to the input signal, and (2) on a flat faced tube, different points on the face of the tube are different distances from the beam source.

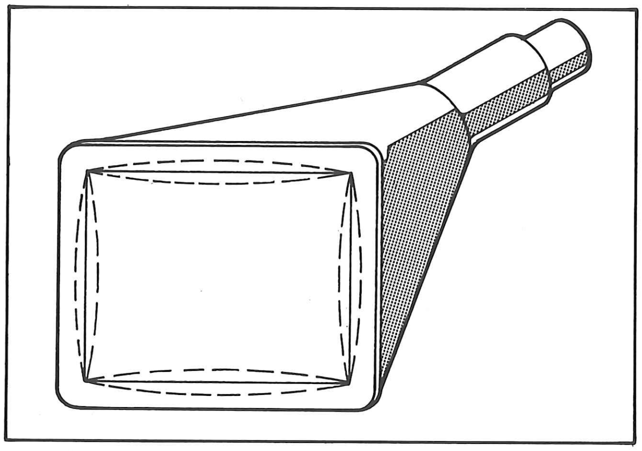


Figure 1. The dotted lines indicate potential distortion on a square picture. The M:152 corrects this problem.

Correction circuits for this distortion are built from discrete components, are expensive, and there are seven trimming steps required during calibration. The M:152 was designed by engineers from IDG and Monolithic ICE. It was built at Tek to replace the correction circuits for many reasons. The desired IC was not available outside Tektronix. The M:152 is a single IC, replacing a large circuit which had many components. It is applicable to different tube sizes by changing the value of two external resistors. This circuit now provides the required nonlinear corrective functions, with only two calibration adjustments. All the other parameters are built in.

Hybrid Circuit Engineering—Joe Burger

The activities of Hybrid Circuit Engineering encompass more than the name implies. Their main function is the design of Hybrid ICs. Hybrid technology offers distinct advantages for component design in the areas of size, cost and performance. And the unique technologies required for hybrids are readily adaptable to other applications such as metallization of prototype monolithic ICs and other components, packaging microcircuits, and microassembly.

Calibration time can be reduced by laser trimming resistors and capacitors on the substrates. This eliminates the need for manual potentiometer and capacitor adjustments, resulting in overall savings.

There are two major reasons for replacing standard circuitry with Hybrid devices. One is cost. In the 455, for example, a hybrid was used for the preamplifier. This let to cost savings in terms of assembly time and serviceability. The other is high performance. Metallization patterns can be very precisely deposited on a substrate. They provide highly accurate transmission lines which are vital to spectrum analyzer circuits and other high frequency devices.

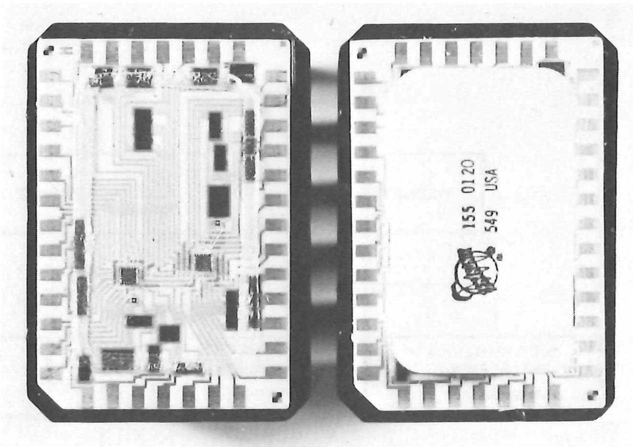


Figure 2. A hybrid device was used for the preamplifier in the 455.[1]

Display Devices—Aris Silzars

It is the responsibility of the Display Devices Group to support new product programs with appropriate display devices. When a new product requires a unique device that cannot be purchased, they must conceive, design and develop the new device. Production support is also provided.

Recent trends have been to higher performance (brightness, writing speed, spot size) and lower cost CRTs. Also some entirely new electron beam technologies are being developed that will add to our future capabilities. New beam forming technologies like meshless scan expansion and new display concepts such as micro channel plates will add significantly to future instrument performance capability.

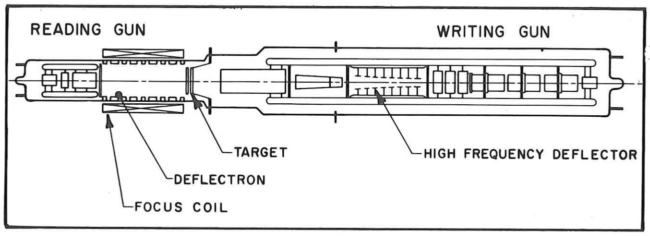


Figure 3. The target in the tube for the R7912 Transient Digitizer is a diode array.

New markets are also being opened by technologies that combine electron beams and semiconductors. An example of this is the R7912 Transient Digitizer. This unique product centers around a diode array which is able to capture and digitize a single 500 MHz transient. A tube containing the diode array is the key element in the instrument. The successful combination of electron beam and semiconductor technologies for this application was a notable achievement. Other signal acquisition and signal processing devices using this technology are currently under development.

Storage CRT Engineering—Chris Curtin

Storage CRT is primarily concerned with developing new Storage CRTs and engineering improvements on existing devices. The Tektronix invention of meshless bistable storage has provided unique solutions to the problem of low cost computer graphics. Information is stored directly on the CRT screen, eliminating the need for costly separate memory.

Some of the new technologies that are under investigation are: new phosphor combinations to increase CRT performance, improvements in writing gun design for lower power requirements, and new methods of depositing the storage target structure to increase viewability.

One example of a significant new product in the storage field was the 4014/4015 graphics terminal. The addition of large screen graphics to the Tektronix display terminal line greatly increased the number of customer graphics requirements that Tek could fulfill.

Figure 4. The face area of the 4014/4015 is three times that of our next largest CRT.

To produce the 19 inch storage CRT for the 4014/4015, CRT engineering and production processes were scaled up. Since the face area is three times that of our next sized tube, a new method of depositing the storage target structure was developed to meet the large area requirements.

Storage CRT is also developing mesh type storage target CRTs for oscilloscope application. Tremendous gains in single shot writing speeds have been made in the last three years through the use of mesh transfer storage techniques.

Instrument Research—Gene Chao

The primary objective of the Instrument Research Group is to gather, coordinate and develop new product concepts which will contribute significantly to future Tek products. The group monitors new technologies and assesses their impact on segments of the Tektronix market.

The group investigates long range product concepts by market research and by assessing technology trends and human factors. They focus on novel concepts and conduct feasibility studies.

Current projects include various miniature Surface Acoustic Wave Signal Processing Devices, trade-off studies in analog/digital conversion schemes and memories, and speech/digital conversion.

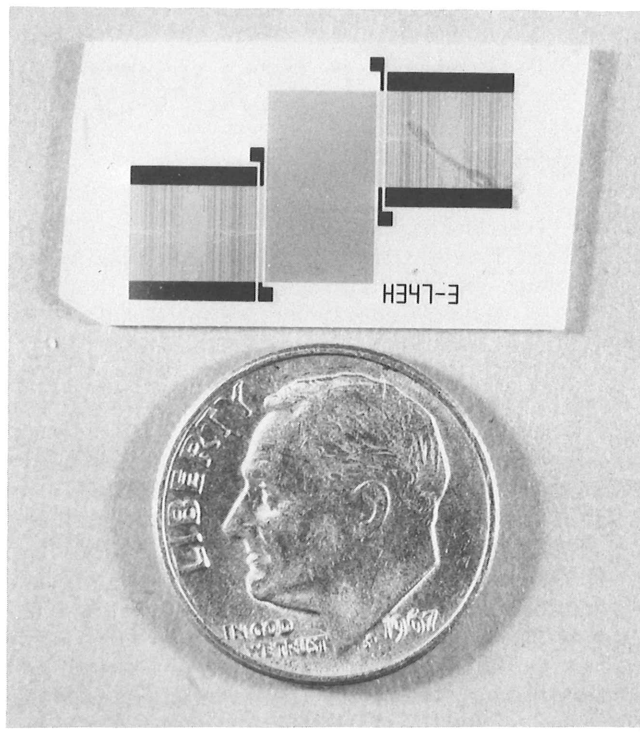


Figure 5. The surface acoustic wave bandpass filter consists of a thin film metal pattern on a single crystal (YZ) lithium niobate.

Display Research—Kevin Considine

Display technology plays a major role in Tek product lines. It is essential that our short and long term display needs be understood and planned for. For this reason, Tek Labs has a Display Program within the Display Research group. The group evaluates the various display technologies and assesses their potential application to our product lines.

For example, if Tektronix were to find it necessary to produce flat panel displays in future products, the Display Research group would be the place where the new technologies would be explored, assessed, and preliminary development work identified.

Not all of our future needs are presently known, so the evaluation is an on-going exercise. Specific requirements for the future cannot be fully determined. It is possible, however, to observe trends and general display requirements. Our Display Program is aimed at developing capacities that will have wide application throughout our market areas. (See "Flat Panel Display Technologies" in January 1976 Engineering News.)

New Ventures—Peter Strong

The New Ventures group is where new ideas and business opportunities which do not relate to any existing product area are gathered and evaluated. The ideas are received and researched by a logistics group and then evaluated by a planning group under Wim Velsink. The logistics group uses Tektronix resources, as well as outside consultants.

The New Ventures Planning Group determines which opportunities offer Tektronix the best potential for long term financial rewards. Once an opportunity is approved for development, a business unit is formed. Currently, two new venture business units exist; Medical Products and Analytical Products. Both units were actually conceived before the above structure was set up.

The Medical Products group is involved in the portable patient monitoring business. There are three primary products; the 408, 412, and 414 patient monitors.

Analytical Products is engaged in two principal businesses. We entered the field of optical spectroscopy with the 7J20 Rapid Scan Spectrometer (RSS). Electro-optical measurements can be made with instruments from the J16 family of products.

FAST FOURIER TRANSFORM (FFT)

The FTT: Fundamentals and Concepts

Have you been looking for a good book on Fourier analysis and the fast Fourier transform? Are you tired of being bogged down by textbook equations and derivations, confused by technical seminars that are too technical, left hanging by magazine articles that are too brief?

If you find yourself saying "yes" to any of the above, then **The FFT: Fundamentals and Concepts** is for you. It begins with the basics—the very basics of time and frequency measurements. Then you're introduced to classical Fourier analysis. You'll see the equations, the Fourier series and Fourier integral, but just for purposes of familiarity. You won't have to figure out the important concepts—they are all shown with photographs and illustrations and discussed in simple terms. And the same is done for the FFT (fast Fourier transform). All of the important concepts are illustrated through pictures and examples. There are more than 90 major illustrations sprinkled liberally through more than 140 pages of discussion. And it's all in a big, easy-to-read, easy-to-see, 8.5x11-inch format.

And that's not all: "A Guide to Fourier Analysis and the FFT" is also available. This large wall chart summarizes many of the important concepts detailed in **The FFT: Fundamentals and Concepts.** Put it up in your office or laboratory and you'll be able to refresh your memory at a glance.

The wall chart is free. **The FFT: Fundamentals and Concepts** is customer priced at $25.00 per copy, with quantity discounts available.

You can obtain a copy of **The FFT: Fundamentals and Concepts** by ordering part number 070-1754-00. The wall chart can be obtained by contacting Advertising. For customer ordering, we hope to have reviews and ordering information placed in the new literature sections of some major trade journals. Customers may also obtain copies through their local Tektronix Field Office.

—Bob Ramirez

We have looked through "The FFT: Fundamentals and Concepts" by Bob Ramirez. It seems to be all he claims. The information is clearly presented with plenty of photos, illustrations and well organized text. Some FFT applications are included in the back. —Ed.

SCHOOL/INDUSTRY DRAFTING INTERACTION

Chuck Sullivan, Technical Standards will speak to second term drafting students at the Sylvania campus of Portland Community College on the afternoon of Friday, February 6. In a recent article published in ENGINEERING GRAPHICS Chuck stressed the need for more interaction between industry and education in the drafting field. Chuck emphasizes that the increasing need for conformance with international standards will directly influence the construction of engineering drawings.

UL 1244: FINAL FORM IN 1976?

On October 16, 1972 Underwriter's Laboratories announced their intent to investigate and list electronic test and measurement equipment. A rough draft of the proposed standard UL 1244 has seen many revisions. It is expected that UL 1244 will be in final form by about June of 1976.

The UL 1244 was triggered largely by the Occupational Safety and Health Act (OSHA) of 1970. OSHA states that everything that an employee uses must have third party safety testing if an applicable standard exists. The oscilloscopes used at Tektronix in design and manufacturing areas came into question. Also customers began to ask Tek and other test and measurement manufacturers to supply them with UL listed equipment.

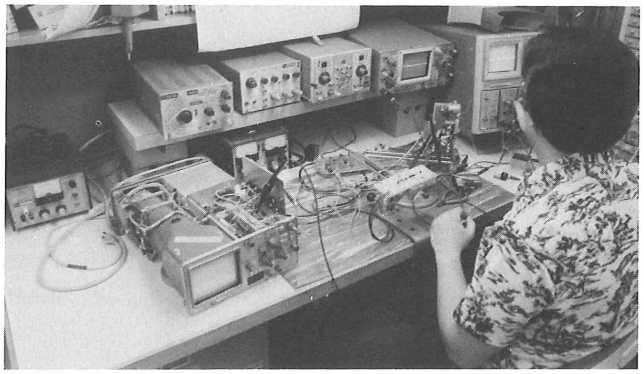


Figure 1. OSHA states that equipment used by an employee must be UL listed if an applicable standard exists. This photo shows Peter Zietzke at a workbench full of equipment.

We replied that no UL standard existed. This was slightly deceptive, because UL will actually accept oscilloscopes and other measurement equipment for testing, but under different standards. They will apply other standards where they fit, such as individual transformer or switch standards.

Besides complying with OSHA, UL listing is desirable for other reasons too. It implies that there is less chance of an item catching fire or presenting shock hazards. Instruments with UL listing can help lower insurance rates.

In January, 1974, UL held a meeting with representatives of industry to discuss the proposed standard. Tektronix was invited to the meeting, but as the letter was addressed to "Tektronix" only, the product safety group never knew about the meeting and Tek didn't participate.

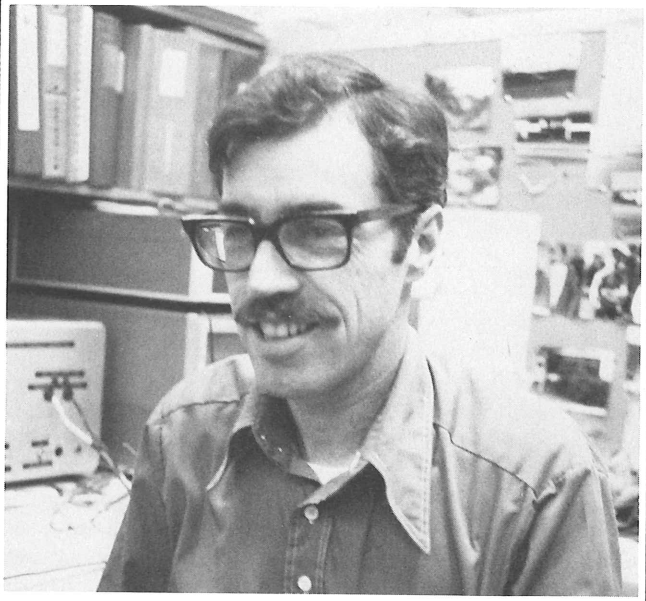
In August of 1974 Richard Nute, Product Safety, received the first draft of UL 1244. Rich passed it around to a number of people at Tek, asking for questions, comments, and criticism. The responses were combined into a 23-page letter, the most extensive reaction UL received about the 1244.

Rich's letter, combined with the reactions of the rest of industry convinced UL that 1244 needed a lot of work. One of the major problems is that many of the instruments which will be affected by the 1244 are unfamiliar to Underwriters Laboratories. Some of the proposed standards severely restricted the performance of high frequency instruments.

When UL tests a toaster, they know that it is unsafe to put a fork in it, but because they know that there is no other way to make a toaster, they allow that unsafe feature. Since UL is not familiar with the function of some of Tektronix' test equipment they don't make the same allowances. They

RICHARD NUTE TO HEAD W.E.M.A. COMMITTEE

On January 15, 1976, **Richard Nute**, Product Safety, attended a meeting of the Western Electronics Manufacturing Association (WEMA) in Palo Alto, California. Eben Tisdale, Vice President of WEMA, brought together representatives from Tektronix, Hewlett-Packard, Sierra Electronics, John Fluke, Beckman Instruments, Systron Donner, and the Velonics Division of Varian. The purposes of the meeting was to determine the position of industry with respect to UL 1244, to decide if WEMA should sponsor a group to represent industry with respect to UL 1244, and to discuss the direction in which such a group should go.



They established a WEMA-sanctioned group which will represent the electronics industry to UL and will critique standards, especially UL 1244. **Richard Nute** was elected chairman of the group. They are now beginning to formulate a consolidated industry response to the December, 1975 draft of UL 1244.

make the assumption that the standards for a scope should be basically that of a TV set because of similar circuits.

In October 1974, UL held a meeting in Chicago to discuss the revisions. UL assigned an Ad Hoc committee to rewrite 1244. The committee consisted of the writer from UL, Richard Nute, and people from Hewlett-Packard and Laboratory for Electronics (LFE). Tek sponsored a week-long meeting in Beaverton where the committee went over 1244 point by point. The result of that meeting was the April 1975 draft.

When UL 1244 is issued in final form, Underwriter's will set a date in the future when it will become effective, probably one to two years. Part one of their job is to come up with a standard. Part two is to give the manufacturers adequate time to comply with the standard.

UL 1244 will apply to all new equipment sold after that time. Equipment that a customer owns will not have to be replaced, but existing product lines will have to be modified if they are to meet UL 1244 requirements.

ABC'S OF ECB'S

When designing circuit boards, it is important to keep standard "flat" sizes in mind. By designing around standard sizes, material waste is kept to a minimum. The following charts will enable draftsmen and engineers to cut cost per board by utilizing maximum flat area. These sizes are not valid for Polysulfone. Larger sizes are possible subject to negotiation with Electrochem. Contact Jim Kerr, ext. 6502.

To use these tables, find one of the outside dimensions of a proposed board in the width and length columns. You will notice that each of these figures has a corresponding figure in the images columns. Multiply the corresponding figures in the images column to achieve your answer. The dimensions must always be the same or less than the ones listed on the tables.

Example: Proposed board is a standard 1 & 2 sided circuit board, 2.100 x 1.600. By reducing the length only .012, it becomes one of our standard sizes, 1.588.

2.100 in the width column denotes **five** images wide.
1.588 in the second column denotes **ten** images long.
5 x 10 or **50** images per flat.

Standard 1 & 2 sided circuit board flat:

Images	Width	Length
1	11.000	17.000
2	5.438	8.438
3	3.583	5.583
4	2.656	4.156
5	**2.100**	3.300
6	1.729	2.729
7	1.464	2.321
8	1.266	2.016
9	1.111	1.778
10	.988	**1.588**
11	.886	1.432
12	.802	1.302
13	.731	1.192
14	.670	1.098
15	.617	1.017
16	.570	.945
17	.529	.882

Multi-Layer Circuit Board Flat:

Images	Width	Length
1	11.000	18.100
2	5.438	8.988
3	3.583	5.950
4	2.656	4.431
5	2.100	3.520
6	1.729	2.913
7	1.464	2.479
8	1.266	2.153
9	1.111	1.900
10	.988	1.698
11	.886	1.532
12	.802	1.394
13	.731	1.277
14	.670	1.177
15	.617	1.090
16	.570	1.014
17	.529	.947

Protect Your Property Against Theft

Engineering News has asked Myron Warren to put together a few tips each month on how to protect equipment from being stolen. These are by no means meant as a total security system, but rather as simple precautions that will help protect against theft.

- Ed.

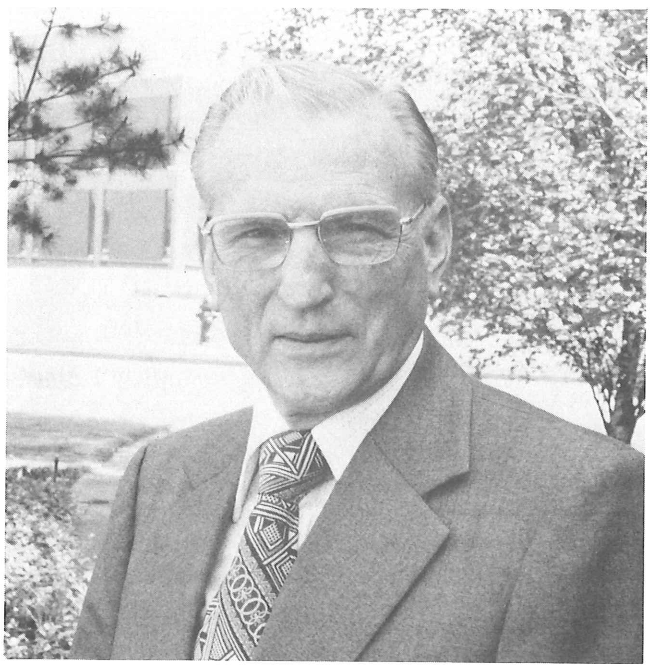
Protecting Property Against Theft

There is no way to ensure 100% protection against theft, but there are some simple things individuals can do to reduce the opportunities.

Exposure Time

The time it takes a thief to remove stolen property from the premises is called "exposure time." If property is located near an exit door rather than the center of a building, the "exposure time" is shorter. The shorter the "exposure time" the more vulnerable the equipment is to theft. That is why a loading dock is a "high risk" area and needs close supervision.

Recently two 465 scopes were taken from near the Laser Lab on the third floor of Bldg. 50. The Lab is in the corner of the building near the breezeway to Bldg. 47 and adjacent to the elevators. The location afforded the thief a short "exposure time."



Myron Warren, Corporate Security Consultant.

Pocket Calculators

Pocket calculators are high risk items because of their size and common usage. Again, there is no 100% protection from theft, but they should be locked in a desk when not in use and during non work hours. Another point to consider is that the recharge cord lying across the desk is an indicator of the location of a calculator. There have been a few desks pried open at Tektronix. It is a good idea to hide the recharge cord, as well as the calculator.

- Myron Warren

Stolen Equipment

Following is a list of instruments and calculators that have been reported missing from Tek in the past three months. If you know the whereabouts of any of these items, contact **Myron Warren**, ext. 5337. If you feel uncomfortable because of circumstances, anonymous letters will be accepted. His delivery station is 50-250. Include particulars (serial number, etc., if possible); the equipment may just be on loan.

ITEM	SERIAL NUMBER	BLDG.	VALUE
7L12 Spectrum Analyzer	B070117	58	$5,000.00
T1 Calculator T1 2550	2550-331-651	73	52.00
Power Supply (Power Design 4005)	Calibration No. 132	58	--
TM503	B076558	74	150.00
7A16A	B040953	74	525.00
7A18	B065070	74	615.00
7A18	B065074	74	615.00
7A18	B066476	74	615.00
7A26	B061683	74	1,150.00
7B53A	B093984	74	925.00
7B71	B020526	74	825.00
7B71	B205260	74	825.00
T1 2550 Calculator	036518	39	52.00
T1 4000 Calculator	158710S	50	60.00
1105 Memory Board for PP11	159	48	2,000.00
TM503	74103	50	175.00
FG501	92382	50	400.00
TG501	10455	50	745.00
DM501	72562	50	505.00
T1 2500 Calculator	531077	55	43.50
7A22	81773	50	610.00
7A22	81785	50	610.00
Pulse Generator	Cal. No. 18752 S/N 112	50	900.00

MATING CAPABILITIES OF THE ZEBRA

That's right. You as an Electrical Engineer should be interested in reading about a Zebra that mates indiscriminately with gold, tin or any other contact material. Not because it might be a delicate or weird story, but because it deals with a high density interconnection concept. If the train of your fantasy has not yet come to a screeching halt, look at the illustrations.

Zebra is the name used by Tecknit for a "layered Elastomer device which provides electrical contact between two or more circuit elements." In plain talk—slices of silver-filled silicone rubber are alternately layered with unfilled silicone rubber slices. The resulting product is called the Zebra. If the Zebra is compressed to the extent that the silver particles touch each other, a conductive path is formed. The conductive layer is colored light grey, the insulating layer looks dark. Switch and Relay Design put the Zebra into a rigid shell and made it into a board-to-board, high density connector.

Contact metal compatibility is not a problem with this type of connector. It can be used to connect gold to gold, tin to tin, gold to tin, etc. (Try finding combinations for yourself.) Furthermore, being imbedded in the silicone rubber, the silver particles appear to be well protected from adverse environments.

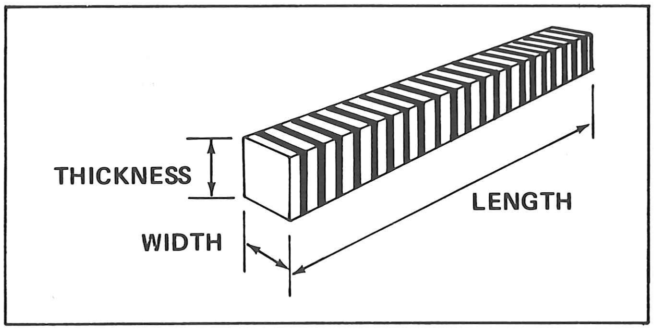


Figure 1. Zebra with dimensions indicated.

Standard conductor spacing on the EC board is no longer critical. So far, connectors have been designed for .025", .050", .075", .100", etc. spacing and accepted a certain number of conductors. There is also the .025" square pin system. The Zebra will not eliminate these systems completely, but may become a tough competitor. Maximum conductor width on the ECB is limited only by the length of the Zebra. Minimum conductor width on the ECB and space between conductors is .012". As long as the conductor is within these size limits, and the conductor patterns on the boards are aligned with respect to each other, the conductive layers of the Zebra strip will form a satisfactory electrical path between the EC boards.

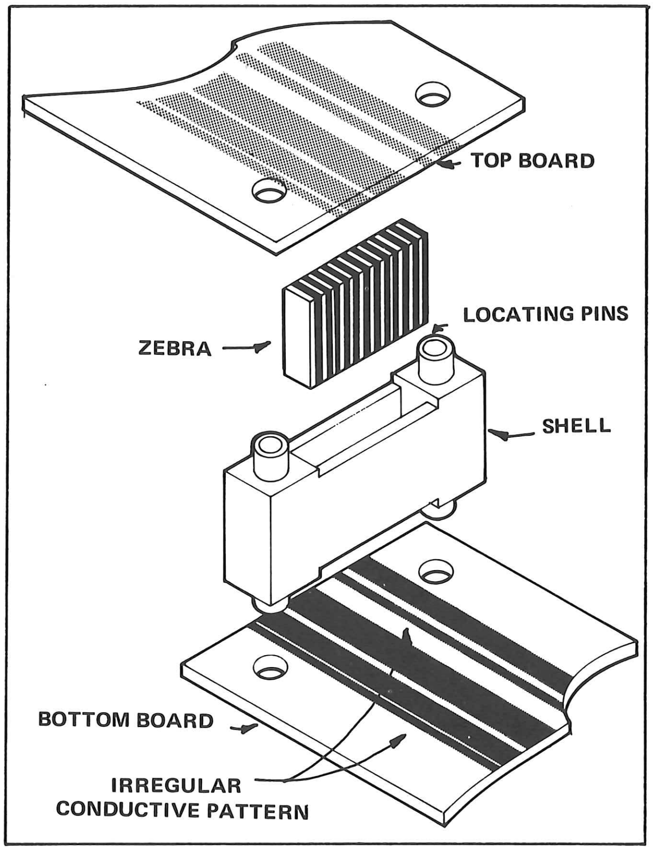


Figure 2. Conductive patterns on top and bottom boards must match and are aligned by locating pins on shell.

—The Zebra is aligned to the conductor pattern by registration holes in the EC board which also locate the shell.

—Conductor density at its best is 40 connections per inch.

—Contact resistance (board-connector-board) is .5 Ω for a .55" thick connector.

—Current carrying capability is approximately 1 Amp at 1 Volt.

—Where the Zebra is used, the rigid shell may replace some spacing posts.

So now you know something about the Zebra and its mating capabilities. For more information and some application ideas, call Elmar Wefers, ext. 5184 or Jay Magerl, ext. 7987, or better yet, come see us. We are located on the first floor in Building 58, del. sta. 58-021.

—Elmar Wefers

Probe Package Improved

Industrial Design has developed a new, more rugged packaging concept for probes. The package consists of a vinyl book type cover which encloses a vacuum formed tray. The tray is molded into compartments which securely hold and organize the probe and its accessories.

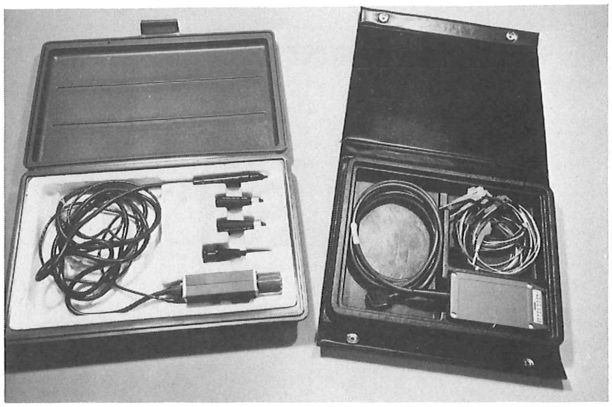


Figure 1. Old probe case (left), new probe case with vacuum formed tray (right).

Probes were previously packaged in a blow-molded case with a Styrofoam liner. The liner was formed to the shape of the probe, but the beaded Styrofoam deteriorates, looks shoddy, and produces static discharges which can kill the sensitive probes.

Because this packaging concept is fairly new to Tek, Industrial Design investigated it. They looked at the carrying case for the Tek 208 Storage Monitor. They took apart the display trays from various consumer products, similar to those used for razors and hairdryers.

The case was designed with manufacturing methods and functional performance in mind. The vinyl case will have "Tektronix" debossed on the cover and have a space for the probe name and number. Cases can be stacked or stored on a bookshelf like a set of books.

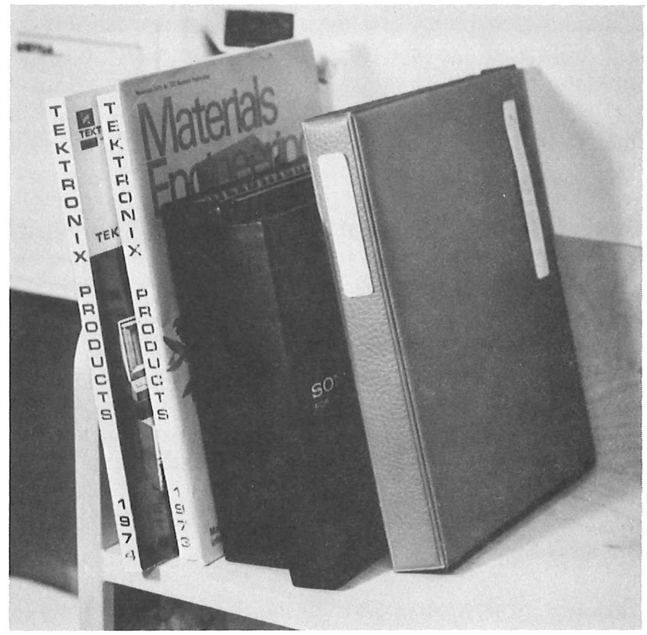


Figure 2. New probe case's attractive exterior blends harmoniously with handsomely bound volumes of Tolstoy, Chaucer, and Dickens.

The trays are interchangeable within the vinyl cases, and can be designed with extra notches and compartments for use with more than one probe. An additional advantage is that the cost of dies for vacuum forming is a fraction of that of dies to form Styrofoam. There is also the possibility of forming the trays in static proof "pink poly." (See January 1976 EN.)

With slight modifications the concept could be applied to other accessories and small products. For more information, contact Alan Wright, ext. 7706.

IN PRINT

Gene Cowan, S.P.S. Engineering, wrote an article which appeared in the December 1975 issue of **MICROWAVES** entitled, "Digital Processing Adds Accuracy to TDR." He describes the techniques used in making TDR difference measurements using the Digital Processing Oscilloscope. Methods of improving the Signal-to-Noise Ratio are discussed and examples of Precision and BNC connector measurements are shown.

Ron Roberts, Staff Engineering for 475, and Ken Arthur, Advertising, co-authored an article which appeared in the December 11, 1975 issue of **ELECTRONICS** entitled "Storing Fast Transients Calls for Transfer Scope." They describe the different types of CRT storage techniques (Bistable, variable persistence, and fast-transfer), theory of operation, advantages and disadvantages. They also give some examples of using a transfer storage scope for capturing noncyclical fast transients and slow rep-rate digital waveforms.

IN PRINT

Papers which appeared in the December 1975 issue of the **IEEE Journal of Solid State Circuits** described the work of three persons from Tektronix.

Elinar Traa authored a paper entitled "An Integrated Function Generator with Two-Dimensional Electronic Programming Capability." He describes the design, fabrication, and testing of an electronically programmable function generator. Output is a piecewise linear function of the input and both coordinates of the function breakpoints can be independently programmed.

Barrie Gilbert, formerly of Tek Labs, now with Analog Microsystems in England, authored "A New Technique For Analog Multiplication." The new techniques uses devices of special geometry, but which are capable of being fabricated with a standard bipolar process. A narrow region of current injection can be positioned on an emitter by one electrical input and controlled in magnitude by a second input. The resistive epi layer resolves the current into a differential output proportional to the product of the inputs.

Jim Smith, IC Engineering, authored "A Second Generation Carrier Domain Four Quadrant Multiplier.

The new design, an extension of Barrie Gilbert's earlier design, is based on the carrier domain principle. The base-collector transfer characteristic is predicted theoretically by analysis of the motion of the domain's centroid for quasi-static operation. The base-emitter planar geometry is designed to yield nearly ideal domain motion for an input modulation depth of 95 percent. Sources of nonideal operation are identified in experimental devices and means of eliminating these are presented.

Leon Orchard, Manager of Service Instruments Division and Bill Peek, Manager of Laboratory Instrument Division, were interviewed in the December 1 issue of **ELECTRONIC ENGINEERING TIMES.** The article is entitled "New ICs Promise More Cost-Effective Scopes." They discuss the advantages of digital waveform measurements and the effect that microprocessors will have on our future instruments in terms of cost and performance.

Note: All articles IN PRINT are available in the Tek Library, ext. 5388.

WRITE RIGHT

Technical magazines are always looking for articles written by people doing research or design work. Some pay for articles, and all bring their information to a large national or international audience.

Maybe you would like to write an article and just need some help getting started. We can help you organize your ideas and outline an article. We can also provide assistance in writing, graphics, communications with editors and even typing. All aspects of writing for publication are our concern.

Come to the Technical Information office on the fourth floor of Building 50 just across from the center elevator and let us help you to turn your ideas into the printed word.

Call Joyce Lekas, extension 6601.

papers. . .Call for papers. . .Call for papers

MEETING

The **Electronic Components Conference** will be held at the Jack Tar Hotel, San Francisco, California on April 26-28, 1976. The meeting is sponsored by the Electronic Industries Association and the Parts, Hybrids, and Packaging Group of IEEE. To occur in conjunction with the **ECC** is the **Design Engineer's Electronics Components Show.**

For further information contact:

Tyler Nourse
Electronic Industries Association
2001 Eye Street, N.W.
Washington, D.C. 20006

The **1976 International Microelectronics Symposium** will be held October 11, 12 and 13, 1976 at the Hotel Vancouver, Vancouver, British Columbia.

SPONSOR: International Society for Hybrid Microelectronics

TOPICS: Areas of interest include but are not limited to:

The International Microelectronics Market Place
Thin-Film Microelectronics
Thick-Film Materials
Thick-Film Processes

Call for Papers continued on page 16......

MICROPROCESSOR USERS GROUPS

The Microprocessor Users Group is composed of one engineer from each product or research group at Tek desiring representation. The purpose of MUG is threefold: (1) to provide user interaction with the Microprocessor Support Group, (2) to provide a forum for microprocessor users to communicate with their peers and share ideas and developments, and (3) to provide unified representation to hardware and software manufacturers.

The group held its first meeting on Wednesday, January 28. It was attended by about 35 persons.

Henceforth, MUG meetings will be held on the last Wednesday of every month, with the location to be announced. Managers of groups now using (or contemplating using) microprocessors, and whose groups are not represented in MUG can appoint a delegate. Call Bill Lowery at ext. 5865 and give him your delegate's name, delivery station, and phone number. That's all there is to it.

MICROPROCESSOR HIGH LEVEL LANGUAGE

The Scientific Computer Center is developing a higher level, block structured, system programming language. Ideas from many higher level languages and the few existing system programming languages were analyzed and organized into our language, TESLA. Our goal is a higher level language with the flexibility and power of an assembly language.

The language definition is close to completion. The control structures are nearly finished, but we are spending a great deal of time trying to organize data structures.

A document will be prepared by the end of February describing TESLA informally. It will include examples, in the formal BNF notation.

In the near future you will be able to write algorithms in TESLA (syntax checking only) to see how you like the language. We would like feedback from you before we've invested much time writing the code generators.

```
             TESLA
             # THIS IS A DO NOTHING CODE #
             DECLARE I,A,B
      F       FOR I = 1 TO 10 DO
      F       A=3+4  B=A+7
      FW       WHILE B<100 DO
      FW       B=B+1
      FWI       IF A=B THEN
      FWI        B = B*2
      FWI-       ELSE
      FWIC        CASE TRUE OF
      FWIC         [B<10] : A=A*2
      FWIC         [B<25] : A=A*3
      FWIC         [B<75] : A=A*4
      FWIC-        [ELSE] : A=A*5
      FWIC                  B=B+1
      FWIC        ENDCASE
      FWI        ENDIF
      FW       ENDWHILE
      F       ENDFOR
             FIN
```

Figure 1. The sample test program shows block structures of TESLA.

```
A        3     5     5     8    12    12    13    13    14    14
        15    15
B        3     5     6     7     7     8     9     9    12    13
        14    16    16
I        3     4

     3 IDENTIFIERS        27 OCCURRENCES
```

Figure 2. Cross reference table indicates use of variables in the program.

The above is a very limited example of the use of TESLA. The profile (the character string on the left-hand side next to the line number) was generated by TESLA. It outlines the block structure of the program. (The programmer may indent the source code, but indentation is not required.) The code does not show the "REPEAT UNTIL" structure, the "GOTO", or the "computed go to" that we've named "JUMP".

Please forward questions, comments, and suggestions to Lynn R. Carter, Scientific Computer Center, ext. 7668, Del. Sta. 50-454.

ATTENTION: SATURDAY USERS

Starting in period 609, The Scientific Computer Center will charge for printed paper and punch cards which are used on Saturday. All other uses of the machine on Saturdays will remain free. Bob Mainero, ext. 5104.

Semiconductors and Their Application to Hybrid Technology

Interconnections and Bonding Technology

Advanced Microelectronics Applications

Hybrid Microwave Technology

CAD Applications for the Hybrid Industry

Microelectronics Procurement Specifications and Problems

Ceramic Technology

Displays

Testing, Quality Assurance and Reliability

Non-Ceramic Hybrid Assembly

Integrated Optics

Hybrid Transducers (Analog and Digital)

Adhesives for Hybrid Application

Packaging Concepts

Design Considerations

Materials Science and Technology

ABSTRACTS: Six copies of a 250-word summary and biography of the author must be submitted by April 1, 1976. Paper selections will be announced by May 15, 1976. Send summaries and biographies to:

Jim Keski

Del. Sta. 13-850

Tektronix

TOPICS: Papers are invited on significant current advances and key contributions in all major sections of instrumentation and automatic control. Areas of interest include but are not limited to:

Aerospace
Analysis
Biomedicine
Cryogenics
Direct Digital Control
Electric Power Generation
Fluidics
Metals
Pollution Control
Process Control

Concurrent symposia are being programmed on:

Cryogenics
Process Measurement & Control
Aerospace & Test Technology
Environmental Instrumentation & Control

ABSTRACTS: The deadline for submission of abstracts is March 1, 1976. Abstracts to be considered must be submitted on special forms which may be obtained by writing to:

ISA/76 Conference
400 Stanwix Street
Pittsburgh, Penn. 15222

The **ISA-76 International Conference and Exhibit** will be held October 11-14, 1976 at the Astrohall in Houston, Texas. The theme of the conference is "Productivity through Instrumentation and Control."

SPONSOR: Instrument Society of America (ISA).

CALL FOR PAPERS

The complete notices for all Call for Papers are on file in the Technical Information Office. Editorial assistance with these papers is available from the Technical Information Services, ext. 6601, del. sta. 50-462. Ask for Joyce.