component news

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Voltage-step depression in NiCd cells

by Dave Wilkinson
Portable Patient Monitors

When a nickel-cadmium cell is allowed to overcharge* for more than a few days at elevated temperature, the terminal voltage will exhibit a depression throughout all or part of the subsequent discharge. There are two components of this depression: positive plate voltage depression (PPD), and voltage-step depression (VSD).

Because PPD is frequently masked by normal variations in cell voltage, it is seldom a problem in day-to-day applications, and is not discussed in this article. VSD, on the other hand, introduces a 10% variation in cell voltage, presenting a new problem to the designer relying on the NiCd's familiar constant-voltage discharge characteristic.

Voltage-step depression, as observed in General Electric and Saft cells, is a 150-millivolt step reduction in terminal voltage occurring at some point in time during discharge, that point being a function of the duration of previous overcharge and the temperature of the cell during overcharge. Figure 1 illustrates this phenomenon.

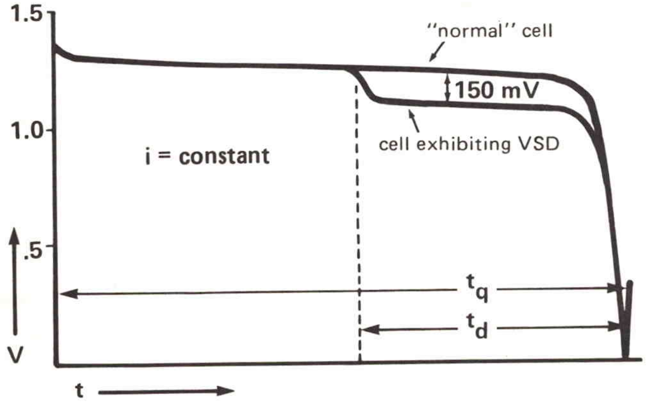

Figure 1 — Discharge curves for a "normal" NiCd cell and a cell exhibiting voltage-step depression.

Although the exact cause of VSD is not well documented, it is thought to occur as a result of chemical and/or metallurgical changes in the negative plate.

One manufacturer, Gould, says that VSD occurs (in GE cells) because the construction of the negative plate encourages alloying of nickel and cadmium during overcharge. (Gould cells have a considerably different negative plate structure, and the manufacturer maintains that their cells do not exhibit VSD. This claim is presently being looked into, but complete data is not yet available.)

Investigation and experiments done at Tek with GE and Saft cells indicate the following general characteristics of voltage-step depression:

1. Except at very low currents, the step height is a constant 150 millivolts independent of the discharge current. As such, depression is measured in terms of the percentage of the constant current discharge curve affected. Referring to Figure 1, this can be expressed as D = % Depression.

$$D(t_o, T) = \frac{t_d}{t_q} \times 100\%$$

where t_o = duration of overcharge
and T = cell temperature during overcharge

continued on page 2

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*Overcharge is that portion of the charge cycle occurring after the cell has ceased to accept charge. It is accompanied by a rise in cell temperature and pressure.

2. Depression increases (i.e., the voltage step in Figure 1 moves to the left) with time and temperature, as illustrated in Figure 2.

3. Internal cell resistance is not measurably affected during or after the step transition.

4. A cell exhibiting voltage-step depression can be returned to its normal (non-depressed) condition with a single deep discharge to less than 0.8 volts. The exact end-point potential is, to some extent, a function of the discharge rate, and 0.8 volts may not be low enough if the cell is being discharged at a rate much exceeding C/3.

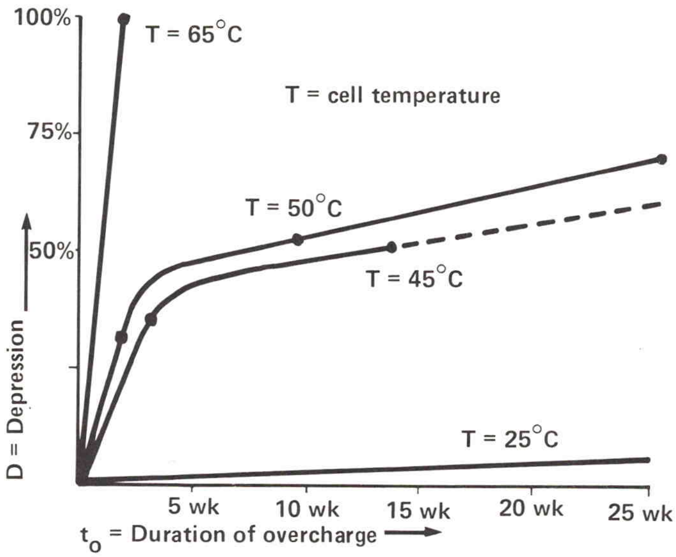

Figure 2 — Voltage-step depression as a function of overcharge time and cell temperature, T.

These points suggest four alternate means of dealing with this pesky phenomenon:

1. **Ignore it.** If your application requires very low current drain, you may never see VSD.

2. **Live with it.** If you can tolerate an extra 150-millivolt variation in cell voltage, VSD may not cause any problems, since the step magnitude is not a function of load current.

3. **Prevent it.** By avoiding extended periods of overcharge. Particularly when the ambient temperature is above 25°C, the likelihood of VSD appearing is greatly lessened by avoiding overcharge.

4. **Erase it.** If you cannot avoid VSD, you can periodically cleanse your batteries by discharging each cell to below 0.8 volt. This is easy enough to do with short (less than five cells) stacks, but can become a real headache if you are trying to deal with a 24-volt (20 cell) pack. This is because, due to normal variation in capacity from cell to cell, one or more cells will likely go to zero volts and then reverse polarity before the largest capacity cell has reached the required cutoff voltage. The discharge current from the higher capacity cells will then reverse charge the reversed cells — a situation in which nickel cadmium cells have been known to react violently, spewing out potassium hydroxide.

   To avoid reverse charging when discharging to 0.8 volts, no more than two cells can be connected in series through a common load. This approach is being implemented in Tektronix Portable Patient Monitors, which are often operated in environments conducive to VSD.

There are two other alternatives which come to mind, although neither represents a totally known quantity.

5. **Gates Sealed Lead Acid Cells (SLA).** The Gates SLA system performs much like a car battery, but you don't have to add water. In fact, you can't.

   The whole system is sealed up like a NiCd cell. Energy density (in terms of watt-hours per cubic inch or watt-hours per pound) and internal resistance (when expressed in terms of milliohms/volt) are comparable to NiCd's, while the lower cost per watt substantially offsets their shorter life-span. Of course, because the chemistry is different, SLA cells are not plagued with voltage-step depression.

   The state of charge can also be determined from a measurement of the terminal voltage. However, the Gates system is relatively new on the market and, although many characteristics are attractive, there is little field data available.

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6. **Gould Nickel-Cadmium Cells.** Up until about two years ago, Tek bought NiCd cells from Gould. A lot of them shorted due to separator failure and, when GE high-temperature cells eliminated that failure mode, Gould was out the window. Tek wasn't the only customer to give them the heave-ho. So Gould, fresh with the proceeds from their successful J C Penney car battery, went to work on a high-temperature cell of their own which, because of the construction of the negative plate, is said not to exhibit VSD. But, of course, once bitten, twice shy, and although Gould is trying hard to get back in at Tek, it will take a lot of testing to prove their product.

If you'd like to discuss NiCd's (and the ever-present problems they create) contact me at 58-098, ext. 5191.

Dave Wilkinson

Memory devices

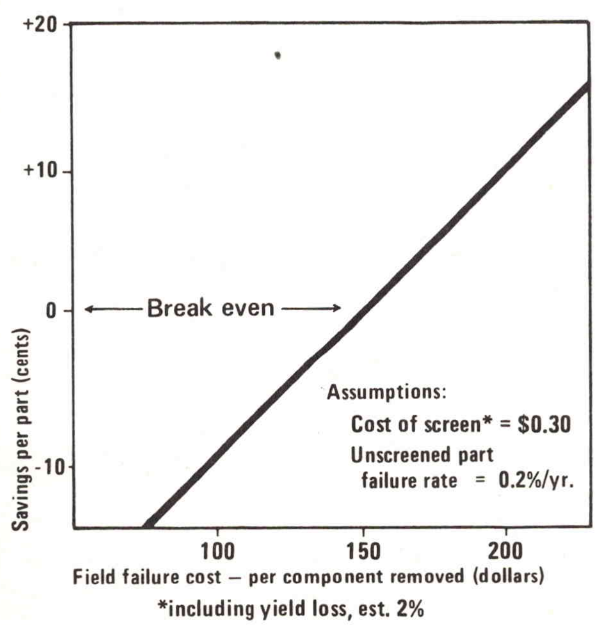
Is screening economical?

Life tests and field failure data have shown that unscreened RAMs and ROMs (4K or greater) have failure rates of about 0.2% per 1000 hours. Screened memory devices are much more reliable (0.01%/1000 hr. failure rate), but added cost is then a factor. Where is the break-even point?

Typically, memory device screening consists of a dynamic burn-in (voltage and signals applied) for 96 hours at 125°C ambient. Using the Micro-Test Burn-In System in the Component Test department, the overall screening cost is estimated to be 30¢ per part. Yield loss cost is estimated at 10¢.

Based on the above failure rates and screening cost, Figure 1 shows per part savings or cost as a function of field failure cost.

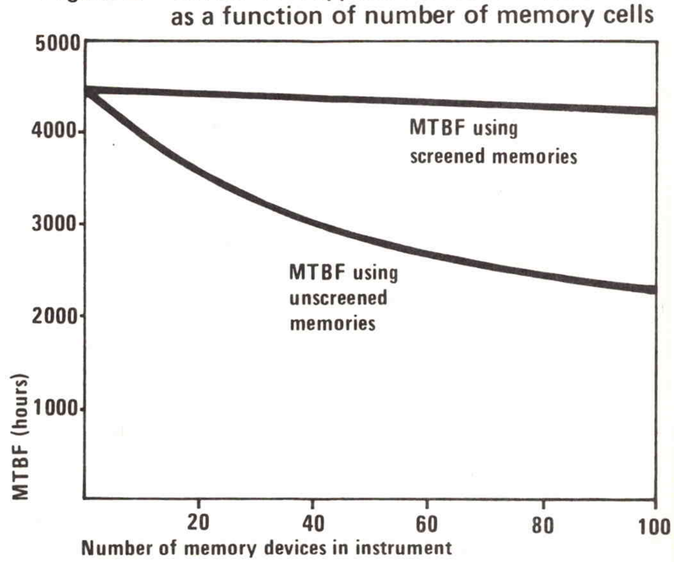
Figure 1 – Per part savings or cost as a function of field failure cost



To assess the impact of screening on the overall instrument MTBF, consider this example of an instrument with the following parts complement:

Linear IC	13	Capacitors, Other	88
Digital IC	105	Transf/Inductors	13
Bipolar Transistors	61	Connectors/Sockets	4
JFET	4	Switches	57
Diodes	117	CRT	1
Boards	12	Miscellaneous Parts	21
Variable Resistors	23	Memory ICs. Variable –	see graph below
Fixed Resistors	440		
Capacitors, Electrolytic	47		

Figure 2 – MTBF of a typical instrument (at 30°C) as a function of number of memory cells



Our recommendation is: 100% burn-in and test all ROMs and RAMs of 4K or greater density. This can be accomplished by setting up a dash number for the screened part via the PPIF process.

If you'd like to discuss memory device screening guidelines, please contact **Ron Schwartz (58-176), ext. 6511.**

Documentation control improved

Every time we need a new or modified purchased component, a document must be sent to Documentation Coordination. This group, managed by Dorothy Peterson, controls tracking and flow of these documents through Component Engineering, Base Data Management, Component Test Engineering, Purchasing, Mechanical Engineering and Reprographics.

Dorothy's group handles over 800 new documents per period — double the number initiated a year ago. Over half of these are the complex Purchased Parts Initiation Forms (PPIFs); the remaining documents are an assortment of Documentation Request Forms (DRFs), Component Qualifying Requests (CQRs), Sample Evaluation Requests (SERs), Vendor Response Letters (VRLs) and Mod Proposals. Dorothy and her staff must also respond to countless requests for information about the progress or contents of documents in process.

Given an average of one new document every 11 or 12 minutes, and no additional staff, some streamlining in the documentation control process was necessary. To accomplish this, Kris Leite of the Component Information Group wrote programs to enter all documentation records into a computer data base. A computer search may now be made by parts coordinator number, part number, name of originator, accounting period or project number. This gives Dorothy and her staff immediate access via terminal to all information concerning any document in process, and eliminates the costly, time-consuming hand-search methods formerly necessary to track documentation.

Originators of PPIFs and other documents benefit directly in several ways. The new system ensures against loss of any information. Questions are answered faster. In addition, it is now possible for the document's originator to have direct terminal access to this information, which is stored in the CYBER 73 computer.

To find out how to access this information, call **Dorothy Peterson, ext. 6336.**

Touch panel switch arrays

If you'd like to see how one of the new "touch panel" switch arrays would look on your design, we have the Centralab C-Panel for prototyping.

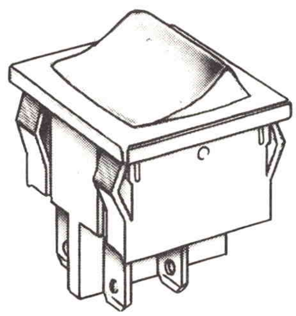
It is a flat circuit board panel covered with touch-switches on 0.75-inch spacing. The board can be trimmed to any front panel configuration, and you furnish the panel graphics.

The applicability of this type switch to Tek products is not clear at the present time. Advantages cited for these switches are long life and flexibility in terms of graphic design. Resistance to environmental stress and potentially lower cost are added benefits.

These touch panels are suitable for switching logic circuits, and are rated for 10 million operations at 30 VDC, 50 mA. Travel of the touch panel switching element is typically 0.007 inch.

For more details contact **Jim Deer (58-299), ext. 7711.**

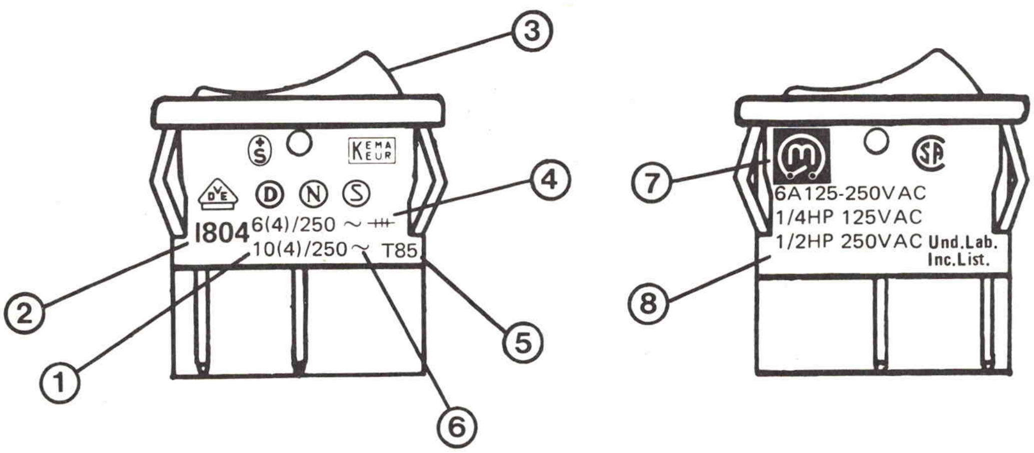
Switch safety markings



With proliferating international and domestic safety requirements, an engineer can easily get caught in the "safety squeeze." Before you know it, you're designing an instrument around safety-rated components, instead of choosing the most appropriate part for your design.

There's a way to relieve this squeeze, though. Use the markings on safety-rated components as a guide for choosing and applying these parts.

As an example, we recently part-numbered a rocker switch (P/N 260-1961-00) which holds a variety of safety approvals (see illustration below). The various safety symbols make it immediately apparent which countries accept the part, and which don't.



1. Rated current, motor load and voltage
2. Manufacturer's number
3. "Off" indicator marking
4. Symbol for frequent operation
5. Tempreature limit (if exceeding 55°C)
6. Symbol for nature of supply
7. Manufacturer's trademark
8. Rated current, motor load and voltage

international markings

Symbol (1) denotes the current and voltage ratings for the device. In this case, 6(4)/250 means a 6-amp resistive load and a 4-amp motor load, at 250 volts. When our applications are either inductive or capacitive, we can use the device at only one-half the rated amperage (3A @ 250V). We are also limited to 3 amps at 125 volts because there is no rating at that voltage. The same considerations apply to the second current and voltage rating (10(4)/250).

The symbol ~ following the current and voltage ratings denotes alternating current (---- denotes DC, ≃ denotes AC/DC).

If the device is approved for frequent operation, this symbol ⧻ will appear. In this case, frequent operation is permissible only when operating at the rated resistive load.

Temperature limits are usually specified on a device package when the part can tolerate ambient temperatures above 55°C. Here, the marking T85 means the maximum operating temperature is 85°C.

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Another very important international marking does not appear on this device. The micro-gap construction symbol (μ) means the switch has a contact opening which is less than 3mm. This type of switch is not recommended as the only means of disconnecting an appliance from the supply.

A final marking appears on the rocker of the switch. When visible, the marking "O" indicates the switch is off. This symbol is fast becoming a standard in Europe.

domestic markings

The opposite side of this switch holds domestic safety markings. Here, 6A125-250 VAC describes the resistive rating. Application considerations are the same as for international current and voltage ratings (3 Amps at 125V/250V maximum). The motor ratings (¼HP 125 VAC, ½HP 250 VAC) generally do not relate to our applications.

The other markings include UL and CSA symbols and the manufacturer's (Marquardt) trademark.

Following is a list of the major international and domestic test authorities and their respective insignias:

- **UL** — Underwriters Laboratories
- **CSA** — Canadian Standards Association
- **DEMKO** — Denmark
- **KEMA KEUR** — Holland
- **NEMCO** — Norway
- **OVE** — Austria
- **SEMKO** — Sweden
- **SEV** — Switzerland
- **VDE** — Germany
- **BSI** — British Standards Institution
- **CSE** — Denmark
- **JETL** — Japanese Electrical Test Lab

For more information on safety-rated components and safety markings, contact **Don Hanson (58-123), ext. 7728.** For more details on this rocker switch, contact me at 58-199, ext. 6365.

Joe Joncas

Air driver torque calibration

Air drivers are widely used to install threaded fasteners. It's important that the tightening torque these drivers develop be controlled to prevent fastener failures (such as stripped threads or burned recesses), and to eliminate loose fasteners.

Physical Standards recently purchased the equipment to torque-calibrate air drivers which have torque ranges between 2 and 150 pounds. If you need this service, call extension 7622, or send your driver to 19-275 with instructions as to torque you require.

Frank Javorsky

Static-Protected Tools & Materials

The following materials and tools are currently available for use with static-sensitive parts:

Conductive Foam (Velostat)	12"x24"x¼"	Tek P/N 006-2356-00
	5/8"x1½"x¼"	006-2357-00
	3/4"x2"x¼"	006-2358-00
Conductive Bench Top	3'x8'	006-2403-01
Static-Free Bubble Pack	6"x250'	006-1523-01
	12"x250'	006-1524-01
	24"x250'	006-1525-01
Static-Free Plastic Bags	2"x4" 2 mil	006-0763-02
	3"x4" 2 mil	006-1151-02
	3"x6.5" 2 mil	006-0769-02
	5"x5" 3 mil	006-0343-02
	5"x9¼" 3 mil	006-0764-02
	9"x12" 3 mil	006-0768-02
	12"x16" 3 mil	006-2395-02
	18"x29" 6 mil	006-0342-02
Anti-Static Wrist Strap	Conductive Fabric	006-2404-00
	Adjustable Bead w/270KΩ resistor	006-2404-01
Desoldering Tool	Silverstat Soldapullt	003-0795-00

submitted by Jim Rogers (ext. 2926)

Power supply reliability

Reliability Test Engineering has completed accelerated life tests on three types of purchased power supplies. These supplies are compact, high current switching types. The intended application was with STS.

Generally, it was found that reliability of some power supplies was much poorer than anticipated. It is our recommendation that any supplies in this category be evaluated for reliability before inclusion in products or systems marketed by Tektronix.

The Power Mate SWA-5-K (5V, 150A) and the Lambda LGS-EE-5-OV-R (5V, 100A) were *both found to be unacceptable.* Some failures were induced by vibration.

The Power Mate SU-UNI-30DV is *conditionally acceptable.* Failures were limited to the transformer, and some were vibration-induced. Service under lab conditions is probably acceptable. Some minor mechanical design changes could produce a highly reliable instrument.

The Lambda LJS-11-5-OV (5V, 20A) has been found highly acceptable.

For more information, contact **Jack Stoll, (50-132) ext. 5298.**

Warren Collier
Reliability Test Engineering

UL 1244 available

Underwriters Laboratories "Standard for Electrical and Electronic Measuring and Testing Equipment" (more commonly known as UL 1244) has been published, and is now available from UL.

Because this standard is now copyrighted, Product Safety Engineering can no longer provide copies, as was done with the various drafts. Copies of the standard can be obtained by completing a Library Requisition and sending it to 50-210. Price of the document is $4.50. Order from:

Underwriters Laboratories Inc.
Publications Stock
333 Pfingsten Road
Northbrook, Illinois 60062

Product Safety has purchased a limited number of copies of UL 1244. These are available to persons working on projects committed to UL 1244 listing.

Rich Nute
Product Safety Engineering

IBM diskette requirements

We have signed an annual agreement with IBM to purchase IBM diskettes, number 2305830. These diskettes are available from stock under Tek P/N 119-0967-00.

If you have unusual quantity requirements for these diskettes, please contact the buyer, Mildred MacDanold (94-323), ext. 1259.

Chuck Pearce
Mfg/Corp. Purchasing Services

second source DM71/81LS95,6,7,8

AMD plans to second source this National octal buffer/driver set because of demonstrated advantages over the 54LS/74LS240-244 series.

The 71/81LS95 and 71/81LS97 present true data at the outputs, while the 71/81LS96 and 71/81LS98 are inverting. The '95 and '96 versions have one common enable/disable function for all eight buffers. On the '97 and '98, four buffers are enabled from one common line, and the other four buffers are enabled from another common line.

For further information contact **Ernie Estrada, ext. 7148.**

New data books

The following new data books are in stock and available by ordering from Technical Communications, 58-299:

1978 National Semiconductor CMOS
1978 National Semiconductor MEMORY
1978 National Semiconductor DISCRETE

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Orders are now being accepted for Motorola's all new **POWER DEVICES** data book. You may see a copy at 58-299.

– – – –

INTEL will now fill Tek data book orders without the library requisition and dollar charges formerly necessary.

– – – –

We have a limited supply of Engineering Sourcebooks **(WHO, WHAT, WHERE, WHEN, HOW)** available. If you haven't received your copy or know of someone who needs one, let us know.

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For further information on data book availability, or to order books, drop by 58-299 or call **Lola Janes, ext. 6867.**

component news

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Jacquie Calame, editor
Birdie Dalrymple, illustrator
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To submit an article, call Jacquie on ext. 6867 or stop by 58-299.
For mailing list changes, contact Kelley Turner, (19-407), ext. 5835.

TECHNICAL STANDARDS

The function of Technical Standards is to identify, describe, and document standard processes, procedures, and practices within the Tektronix complex, and to insure these standards are consistent with established national and international standards. Technical Standards also provides a central repository for standards and specifications required at Tektronix. *Chuck Sullivan, manager (58-187)*

new and revised standards available from Technical Standards

ANSI/AAMI SCL 12/78 Safe Current Limits for Electromedical Apparatus

ANSI B71.1 (1972) and B71.1A & B (1974) Safety Specifications for Power Lawn Mowers, Lawn and Garden Tractors, and Lawn Tractors

ANSI C37.26 (1972) (IEEE 330-1972) IEEE Standard Guide for Methods of Power Factor Measurement for Low-Voltage Inductive Test Circuits

ANSI C37.93 (1976) Guide for Protective Relay Applications of Audio Tones Over Telephone Channels

ANSI/IEEE Std. 455 (1976) IEEE Std. Test Procedure for Measuring Longitudinal Balance of Telephone Equipment Operating in the Voice Band

ANSI PH3.12 (1975) Specifications for Lens Barrel Attachment Threads for Lens Accessories

ANSI S4.1 (1960) (IEEE 192) Methods of Calibration of Mechanically-Recorded Lateral Frequency Records

EIA JEDEC Pub. 94-1 (Supplement to JEDEC Pub. 94) Considerations Used in Establishing the X-Radiation Ratings of Monochrome and Color Picture Tubes

ISO 1090 Function Key Symbols on Typewriters

ISO 1091 Typewriters — Layout of Printing and Function Keys

ISO 3244 Office Machines and Data Processing Equipment — Principles Governing the Positioning of Control Keys on Keyboards

ISO 3781 Paper and Board — Determination of Tensile Strength After Immersion in Water for a Specified Period

MIL-C-10541C Cooling Unit, Stereoplotter Projection (9 Jan. 70)

MIL-C-55302/125 Connectors, Printed Circuit Subassembly and Accessories: for Printed Wiring Boards (.050 inch spacing)

MIL-C-55302/126 Connectors, Printed Circuit Subassembly and Accessories: Receptacle, 80 Contact Positions, for Printed Wiring Boards (.050 inch spacing)

MIL-M-28787/169A Modules, Standard Electronic, Memory, Read Only, Programmable, Digital, Key Code GYF (29 June 1978)

MIL-M-28787/239A Modules, Standard Electronic, Driver, NTDS Slow, Digital, Key Code QBQ

MIL-M-28787/272 Modules, Standard Electronic Converter, BCD/Binary, Digital, Key Code ZEZ (7 July 1978)

MIL-S-8805/4H Switches, Sensitive, SPDT, Unsealed (31 July 1978)

MIL-STD-1634-14 Module Descriptions for the Standard Electronic Modules Program (July 1978)

MIL-W-22759/36 Wire, Electric, Crosslinked Polyalkene Insulated, Crosslinked ECTFE Jacketed, Tin-Coated Copper, Light Weight, 600-volt, 150°C

NEMA L1 1-1971(R1976) NEMA Stds. Pub. for Industrial Laminated Thermosetting Products Revision No. 5

NEMA WC-30-1969, Revision No. 8 NEMA Standard for Rubber-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy, IPCEA - S-19-81 (5th Ed.) (31 Aug 78)

"062" part numbered standards

062-2476-00 Test Method Standard — Cables, Jacket Removal is not yet available.

062-2476-00 Drafting Standard: Symbols and Practices for Schematic Diagram Drafting of Electronic Circuits

for information on the above publications, please call Carol Whitmore, Technical Standards, ext. 7976.

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TECHNICAL STANDARDS

regarding procedures to obtain standards

The Directory of Standards is the primary source of information on standards issued by the Technical Standards group. It identifies each standard by part number and by category, and also provides a short summary of each standard. The Directory can be obtained from the Technical Standards group (58-187), ext. 7976.

External standards such as ANSI, ISO IEA, MIL and others can be ordered through the Technical Standards group.

Tektronix Technical Standards can be ordered singly (such as part number 062-1701-00) or by category (such as Circuit Board Standards) from Reprographics, ext. 5577.

Volume One, "Alpha" Standards can be obtained from Technical Standards.

Carol Jones
Technical Standards

ISO Directory of International Standardizing Bodies.

This publication provides names, addresses and functions of 68 committees on subjects of international interest. These include BIPM (International Bureau of Weights and Measures), CEE (International Commission on Rules for the Approval of Electrical Equipment), OIML (International Organization for Legal Metrology) and WMO (World Metrological Organization). Not available for loan — call 7976 or stop by 58-187 to see.

Plastics chart received

Technical Standards has received a limited quantity of Plastics World Guide to Plastics Properties wall chart.

for information on the above publications, please call Carol Whitmore, Technical Standards, ext. 7976.

Spinel structure clarified

During the recent ferrite seminar presented by Stackpole Carbon Company, a spinel structure slide depicting the ion distribution in the ferrite material was used. A participant in the seminar raised a question concerning the identity of the various ions.

The basic spinel structure of a ferrite consists of 64 tetrahedral (A) sites (red) and 32 octahedral (B) sites (blue), of which 8 and 16, respectively, are occupied. In a mixed ferrite (Mn-Zn or Ni-Zn) the metallic ions Fe^{3+} (iron) occupy some of both the A and B sites. The Zn^{2+} ions prefer to occupy some of the A sites. The Mn^{2+} ions can occupy some of both the A and B sites while the Ni^{2+} ions prefer the B sites. The amount each occupies depends on the specific composition of the material. The O_2 (oxygen) is represented by white.

To summarize: white is oxygen; red is iron, zinc or manganese; and blue is iron, manganese or nickel.

If there are further questions, please contact me on extension 5417.

Byron Witt

ComponentNewsNewComponents

This column is designed to provide timely information regarding new components, vendors, availability and price. "New Components" can also be used as an informal update to the Common Design Parts Catalogs. Samples may or may not be available in Engineering Stock.

Vendor	No.	Description	When available	Tek P/N	Approx. cost	Engineer to contact
		analog devices				
Motorola	MC3405	Op Amp/Comparator; dual op amp, dual comp.	now (samples)	156-1284-00	$ 1.00	John Hereford, 6700
National	LM392	Op Amp/Comparator; low power	now (samples)	no P/N	.50	John Hereford, 6700
National	LM13080	Op Amp; programmable 250 mA output current	now (samples)	no P/N	.60	John Hereford, 6700
T.I.	TL062	Op Amp; dual, low power BiFET, screened	now (samples)	156-1291-00	.80	John Hereford, 6700
		digital devices				
Fairchild	96L5488	GPIB Hybrid; talker-listener with xcurs; NOT μP compatible	1/79	no P/N	––	Jim Howe, 6303
Motorola	68B50	ACIA; 2 MHz	now	156-1206-00	9.50	Bill Pfeifer, 6303
Motorola	68B21	PIA; 2 MHz	now	156-1205-00	8.00	Bill Pfeifer, 6303
Fairchild	3871E	Peripheral I/O unit	now	156-1242-00	9.50	Bill Pfeifer, 6303
Fairchild	3853	Static Memory Interface	now	156-1241-00	12.00	Bill Pfeifer, 6303
		optoelectronic and passive devices				
H-P	5082-4160	LED; red, high-efficiency, subminiature	11/78	150-1068-00	––	Betty Lise Anderson, 6389
Monsanto	MAN73A	LED display; overflow and polarity indicator, 3-char., C.A.	soon	no P/N	1.30	Betty Lise Anderson, 6389
Monsanto	MAN4605	LED display; 0.4" char., digit w/polarity indicator, universal polarity	11/78	150-1066-00	1.45	Betty Lise Anderson, 6389
Mallory	PFP22JN2A3P	Capacitor; 200 μF, 200 V, printed circuit mount	now	290-0850-00	––	Don Anderson, 5415
Matsushita	ECE-A35V-47LU	Capacitor; 47 μF, 35 V, radial	now	290-0846-00	––	Don Anderson, 5415
Nichicon	16U47NPM	Capacitor; 47 μF, 16 V, radial, non polar	now	290-0848-00	––	Don Anderson, 5415
Nichicon	35ULA100	Capacitor; 100 μF, 35 V, radial lead	now	290-0844-00	––	Don Anderson, 5415
Plessey	160	Capacitor; 4.7 μF, 100 V, minibox	now	285-1186-00	––	Don Anderson, 5415
Plessey	160	Capacitor; .47 μF, 100 V, minibox	now	285-1187-00	––	Don Anderson, 5415
Plessey	160	Capacitor; .1 μF, 100 V, minibox	now	285-1189-00	––	Don Anderson, 5415
Plessey	160	Capacitor; .082 μF, 100 V, minibox	now	285-1188-00	––	Don Anderson, 5415
Plessey	160	Capacitor; .056 μF, 250 V, minibox	now	285-1185-00	––	Don Anderson, 5415
Plessey	160	Capacitor; .05 μF, 250 V, minibox	now	285-1190-00	––	Don Anderson, 5415
United Chemi-Con	5L25VB330	Capacitor; 330 μF, 25 V, radial	now	290-0845-00	––	Don Anderson, 5415

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Vendor	No.	Description	When available	Tek P/N	Approx. cost	Engineer to contact
		optoelectronic and passive devices, continued				
Several		Chip capacitor; 51 pF, 50 V,	16 wks.	no P/N	.20	Harry Ford, 6520
Caddock	1776-10	Resistor Network; fixed FI, 1 each 9M ohm, 900K ohm, 90K, 10K ohm	now	307-1134-00	4.18	Ray Powell, 6520
Caddock	1776-81	Resistor network; 10 meg total 9.9M, 90K, 10K, 0.25%	now	307-0644-00	3.52	Ray Powell, 6520
Epitek		Resistor network; 10 SIP 5-110 Ω ± 2%	now	307-0646-00	.30	Ray Powell, 6520
Dale	FP692003F	Film resistor; 200 Ω ± 1% 3 watt	now	307-0643-00	.13	Ray Powell, 6520
Kelvin	KMN500	Resistor; 0.03 Ω ± 0.25% 5W 4 term	now	308-0814-00	1.34	Ray Powell, 6520
Kelvin	KMN500	Resistor; 0.01 Ω ± 0.25% 5W 4 term	now	308-0815-00	1.83	Ray Powell, 6520
Dale	HL6022-8 48R00J	Resistor; 48 Ω ± 5% 5W tab	now	308-0816-00	.17	Ray Powell, 6520
Ametek/ Rodan	DB12503J	Thermistor; 10K ± 5% @ 25°C PTC	now	307-0642-00	.80	Ray Powell, 6520
M.C.I.	180Q50200	Thermistor; 5K ± 30% @ 80°C + 2° = 25 KΩ	now	307-0645-00	.85	Ray Powell, 6520
Dale	RS½x10000J	Thermistor; 1KΩ ± 5% 1/8W +3500 PPM/°C	––	308-0817-00	1.20	Ray Powell, 6520

COMPONENT CHECKLIST

The "Component Checklist" is intended to draw attention to problems or changes that affect circuit design. This listing includes: catalog and spec changes or discrepancies; availability and price changes; production problems; design recommendations; and notification of when and how problems were solved. For those problems of a continuing nature, periodic reminders with additional details will be included as needed.

Tek P/N	Vendor	Description of Part	Who to Contact
✓ **151-0472-00**	**Fairchild**	**Amplifier**	**Matt Porter, 7461**

This device was recently removed from the Common Design Parts Catalogs due to supply problems. However, NEC has just been approved as a second source for this high-frequency, high-speed amplifier. This should alleviate any supply probelms with the part, and it is again recommended for use in new designs.

Tek P/N	Vendor	Description of Part	Who to Contact
✓ **151-1108-00**	**Siliconix**	**VMOS FET**	**Jerry Willard, 7461**

By increasing the R_{ON} specification from 4.5 ohms to 5.0 ohms, the vendor has reduced the price of this part from $4.90 to $1.50. The spec change is insignificant; the price drop is great!

The Siliconix part number from which the -1108- is sourced is also changed. The old number — VMP22 — has been discontinued. Now their number VN99AK should be referenced.

Product Safety Note No. 35

18 SEPTEMBER 1978.

SUBJECT: Separation of primary circuits from secondary circuits.

I

Information in this Product Safety Note is beyond information in existing Product Safety Notes and in Tektronix Standards dated before this Product Safety Note. Do not try to find correlation between this Product Safety Note No. 35 and earlier Product Safety Notes or Tektronix Standards that have already been issued. Such correlation does not exist. This Product Safety Note No. 35 contains new information.

II

Information below reflects requirements in international safety standards (even tho' such requirements may not appear in North American Standards). These requirements have to do especially with connection to international telephone data-transmission systems.

III

We now have to devote new and serious attention to separation of primary and secondary circuits. Some of the reasons are:

a. In the past our products generally used 50-to-60-hertz power transformers, and it was generally discouraged to have supply (primary) circuits on circuit boards--in particular on boards that also carried secondary runs.

   Now, many products use (or will use) "converter-type" power supplies (some of them being of the switching variety, and others being of the resonant-circuit variety).

b. New products are also appearing using bobbin-wound transformers. In many such products the transformers are mounted directly on the circuit boards. In this construction both primary and secondary runs appear on the same circuit board.

c. Requirements are stringent since low-voltage secondary circuits are accessible from data-interface connectors, from input and output terminals, and from other sources--many of them connected to circuits directly mounted on circuit boards.

The matter of adequate separation is most urgent both from a safety viewpoint and to support international sales.

IV

To achieve adequate separation between primary and secondary circuits, consider what are the elements of a relevant circuit that would meet the international safety requirements mentioned above:

a. The primary circuit itself.

b. The functional insulation, necessary simply for the circuit to operate.

c. The protective system, or barrier, required by international safety standards (but which may not be required by North American standards).

d. The secondary circuit(s) in question, which in general become accessible (directly or indirectly through telephone circuits) from interface connections, from product input or output terminals, or possibly in other manners.

The third item (c above) is the protective system or barrier. This new requirement is not provided by North American standards. But it is required by international standards and is the subject of this Product Safety Note No. 35.

V

To provide the above-identified internationally required protective system, or barrier, we have certain options:

a. Independent primary and secondary systems--that is, systems with the primary runs entirely on one board, or more than one board; and with separate board(s) carrying any secondary run(s). Usually, this arrangement provides sufficient separation of the secondary circuits from the primary.

b. Interdependent systems--that is, systems with primary-circuit runs and secondary-circuit runs on the same board. In this arrangement, the international standards require (with the exception mentioned below) a spacing of not less than 8 millimeters between any primary circuit run and any secondary-circuit run.

In another arrangement, we may place a ground run between the primary and secondary runs. Spacing of the ground run from the primary run must be not less than 4 millimeters; the secondary run, depending upon the secondary voltage, may be closer to the ground run. The ground run must be able to handle a primary fault current or a secondary fault current--not necessarily both at the same time. Generally the ground run is all right if it can handle twice the primary fuse rating for one minute, thus assuring that the fuse will open before the ground run opens.

VI

We now consider a particular set of requirements--those of:

UK

POST OFFICE TELECOMMUNICATIONS SERVICES

REQUIREMENTS FOR PRIVATELY SUPPLIED AND MAINTAINED EQUIPMENT CONNECTED TO POST OFFICE MAINTAINED PLANT

TECHNICAL GUIDE NO. 26
PROTECTION DESIGN REQUIREMENTS FOR THE CONNECTION OF PRIVATELY MAINTAINED EQUIPMENT OR WIRES TO POST OFFICE MAINTAINED EQUIPMENT OR CIRCUITS

MARCH 1976
RE-ISSUED MARCH 1977

The above-mentioned UK Post Office publication is of course directly interesting since, as you know, in the UK the telephone system is operated by the Post Office. The information below is typical of safety requirements for telephone-connected data transmission equipment.

Consult with Product Safety Engineering concerning requirements of the above publication. The following passages of this Product Safety Note No. 35 present some of the most significant UK Post Office telephone-system requirements.

a. UK Post Office written consent is necessary before any Tek data terminal equipment is used in association, in any way, with a telephone installation. All Tek data terminal equipment must first be licensed. (Tek UK, on the basis of information from Tek Beaverton, applies for the license.)

b. In the license application, the required information includes details of the proposed barrier and the output signals.

c. Once evaluated, the Tek data terminal equipment (for telephone connection) may not be modified <u>in any manner</u> from the submitted model unless the Post Office (which operates the telephone system) agrees in writing to the modification.

d. The internal impedance must under normal conditions limit the current (through a 2,000-ohm resistive load) to 10 milliamperes rms ac, or 50 milliamperes dc.

e. Keep "dangerous voltages" (IEC definition: those exceeding 42.4 volts peak) <u>completely separated</u> from data-interface connectors (Sec. V above). (The UK "dangerous-voltage" definition happens to be a bit more lenient--but stay with 42.4 volts peak.)

f. A barrier is required to protect telephone equipment (UK Post Office equipment) from <u>each</u> dangerous voltage within the Tek equipment. Barriers must not be bypassed by component wiring unless the bypass path itself contains a suitable barrier.

g. If the Tek data-terminal equipment is to be connected to other equipment, then either each associated equipment must be separately evaluated by the Post Office (in its capacity of operating the UK telephone system), or the complete configuration must be separated by a barrier from the telephone equipment.

h. Wiring and terminals carrying dangerous voltages must be fully insulated to prevent connection to other circuitry by metallic objects dropped into the Tek data-terminal equipment.

When a board carries a separating barrier, the board must be fully enclosed on both sides by insulating material or grounded metal.

VII

Now for a different but related topic. This has to do with spacings in certain circuits as required by most standards, relating to circuit-board runs.

One is tempted to think that if we have adequate run spacings on circuit boards, all is well. But where spacings are required by standards, creepage distances (between two conductors, measured over the surface) on a circuit board do not guarantee adequate clearance distances (distances in air between two conductors) after the components are mounted on the board.

As an isolated example: Suppose that a safety standard requires 3 millimeters creepage distance (over the board surface between runs) for a certain circuit. And suppose the circuit-board arrangement allows this much over-the-surface spacing. The next thing to look for is this: What is the required spacing (through the air) between the circuits? For purposes of this example, suppose this required spacing is also 3 millimeters. This means that the through-the-air spacing between any uninsulated part of one component and any uninsulated part of any other component must be not less than 3 millimeters (unless, obviously, these two parts are connected together).

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