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component news

Are plasma displays for you?

Why consider plasma displays? High reliability, long life and favorable environmental characteristics are three good reasons. Plasma displays are available in a variety of numeric and alphanumeric configurations. Currently, we have part numbered 1½-, 2-, 2½-, and 3-digit plasma displays, and there may be other applications out there where plasma displays would be appropriate, especially where long life is critical.

How PDPs work

Plasma display panels (PDPs) are so named because the gas (usually neon) in its ionized form is referred to as a plasma. They are often called gas discharge displays, too.

There are two basic types of plasma displays — AC and DC excitation. The difference between AC and DC displays is the manner in which the gas discharge is initiated and maintained. Although the physical structures and modes of operation are different, the basic physical mechanism which produces the light is the same — an electric field ionizes the gas (as current results through the gas, outer shell electrons of the gas atoms are excited by electron bombardment and driven to higher energy states). Then, the spontaneous recombination of ions and electrons results in the emission of photons.

Various gases are used for plasma devices, such as mercury, helium and cadmium, but by far the most popular is neon. These different gases each have their own characteristic color and their own particular ionization potential (the energy required to separate electrons from the field of the ion).

This gas is placed between two electrodes, and when sufficient voltage is applied the gas will ionize (break down) and glow. The breakdown voltage of a plasma display depends on the gas pressure, distance between the anode and cathode, and the type of gas used. Also, small amounts of other gases are often added to the primary gas to alter its breakdown voltage (see Figure 1).

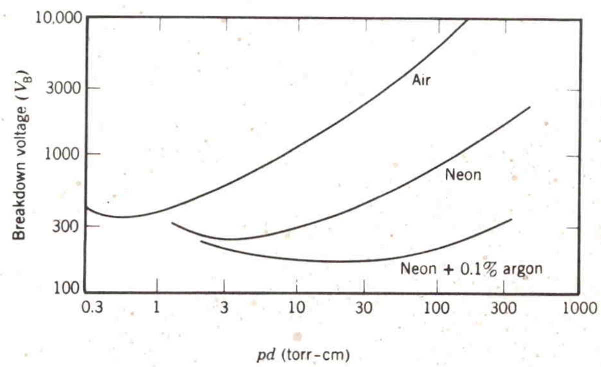

Figure 1

Figure 2 (page 2) shows a representation of a DC gas discharge tube (a) and the distribution of intensity from cathode to anode (b) and voltage from cathode to anode (c).

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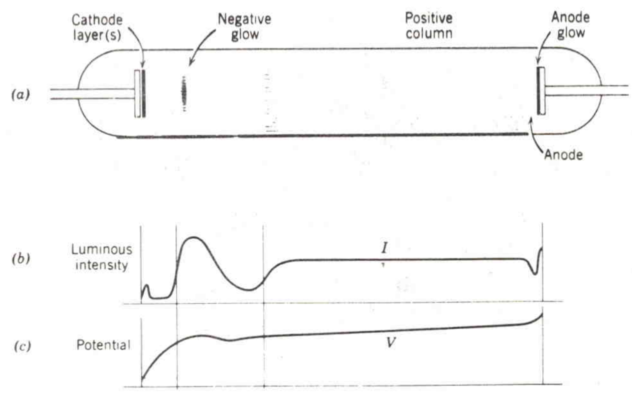


Figure 2

As shown, the brightest portion is the negative glow (the region close to the cathode). The majority of gas discharge displays (AC and DC) use the negative glow as the light source.

Obviously some type of current-limiting is required because once the gas becomes ionized, excessive amounts of current could result.

The basic two-terminal AC plasma display device is shown schematically in Figure 3 (Figure 4 shows a physical representation). The capacitor dielectric shown in Figure 4 is the glass envelope that contains the gas. Notice that the electrodes are on the outside, not inside like the DC tube. The electrodes being on the outside form a capacitor, so this device is AC driven because the anode and cathode are effectively capacitively-coupled. I think the original reason for placing the electrodes on the outside of the glass tube was to protect them from a type of degradation called sputtering, which is caused from ion bombardment.

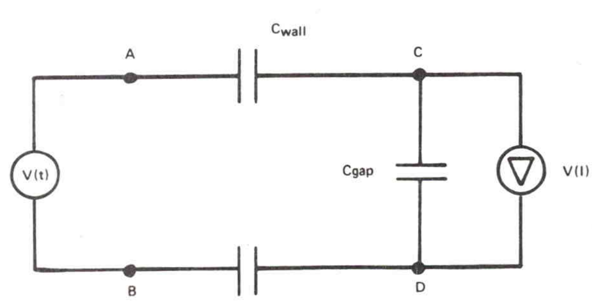


Figure 3

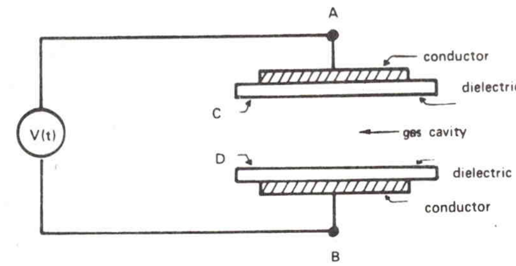


Figure 4

Figure 5 shows a wave form to drive a cell. Note that it requires less voltage for a cell to sustain its glow than is required to initially fire the cell. This lower sustaining voltage is sometimes referred to as "memory" and is a result of the inherent capacitance of the AC plasma cell. When the voltage potential across the cell terminals exceeds the firing voltage (V_f) of the gas, as shown between T_0 and T_1, the gas breaks down and produces a short burst of light. When this happens current begins and builds up a voltage charge on the cell capacitors that oppose the applied voltage, thus extinguishing the discharge.

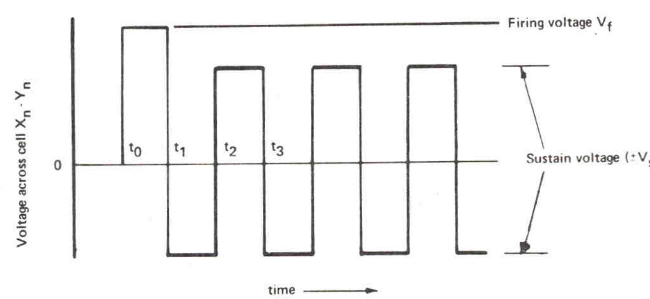


Figure 5 — Drive waveform and corresponding wall charges

These built-in capacitors retain much of their charge; therefore at time T_1, when the driving voltage is applied with reverse polarity, its amplitude can be reduced below V_f and still cause the cell to fire, because of the additive voltage created within the cell by the deposited charge on the walls from the previous cell firing.

This memory can be erased by reducing the sustaining voltage until the cell fires weakly. The cell will soon cease firing even with subsequent application of the sustaining voltage amplitude.

continued on page 3

The AC configuration does not require current-limiting like the DC type because of its capacitive coupling. The current depends on the X_C, which is a function of driving frequency and various characteristics of the cell.

Characteristics of the PDP

The light output of a cell is typically 30 to 75fL. This measurement is usually obtained with a light-measuring device that has an aperture equal to the cell area and averages light output over a period of time. The luminous efficiency of a cell is from 0.1 to 0.5L/W. The luminous efficiency is affected by the gas mixture (usually manufacturers will put about 0.2% to 0.3% xenon with the neon gas to obtain a lower operating voltage), which unfortunately reduces the efficiency a little. As mentioned earlier, the color is dependent on the type of gas used, see Table 1.

Gas or vapor	Ionizing potential (eV)	Discharge color
A (Argon)	15.7	Blue
Cd (Cadmium)	8.96	Red
He (Helium)	24.5	Yellow
Hg (Mercury)	10.4	Purple
Na (Sodium)	5.12	Yellow
Ne (Neon)	21.5	Orange

Table 1

The common neon/0.2% xenon mixture emits at about 590nm (orange). This is the wavelength of emission in the negative glow region (the brightest area in the cell). Other colors are possible with a neon display by using the larger, positive column emission area to excite a phosphor deposited on the cell walls.

Life expectancy is typically 30,000 to 50,000 hours. This is the time it takes the display to reach 50% of its initial brightness. The brightness gradually decreases because of metal vapor deposition on the inside glass surface. This is vaporization of the metal electrodes. The vaporization occurs even though the display is a cold cathode device, but can be reduced by adding a small amount of mercury to the display chamber.

This electrode vaporization gradually deteriorates the cathode which also shortens the life of the display. If the cathode becomes severely damaged from this the cell will not fire. Displays with "screened on" cathodes (thin layer of metallization) will of course wear out sooner than the so-called "raised cathode" type where the cathode is made of strips of metal shaped into segments and welded onto pins for support and continuity to the outside world.

"On" time is usually around 80μS. The basic neon cell could take up to 14 seconds to reach full brightness, so to shorten this time the ionization is influenced by electrons or ions artificially introduced from the adjacent cell. This is called priming. Sometimes a second set of electrodes located beneath the display plane send priming ions forward through small ports to aid in firing; this will also reduce the firing voltage.

Power requirements are in the range of 250 to 350mW per digit (or character); current requirements are about 200 to 300μA per segment.

Displays from most manufacturers will withstand fairly severe environmental conditions — storage from -55 to +85°C (some have storage temperature up to +125°C); operation from 0 to +70°C; humidity MIL-STD 202E, method 106D.

Products available

There are six major manufacturers of plasma displays. IBM has one of the largest R&D facilities that I know of; they have made tremendous progress in manufacturing large panel displays such as 5 X 7 dot matrices with 1024 characters and 512 X 512 matrices with a resolution of 60Lpi. They are, of course, pursuing large flat panel displays for use in IBM terminals and unfortunately are not interested in selling to OEMs.

IEE makes similar large panels commercially available. Their displays are from 32-character (10.67" X 1.06") to 960-character (8.88" X 10.33"). These all have the driving circuitry, latches and power supplies included in one package, and they are TTL compatible. Other characteristics and pricing are available on request.

continued on page 4

Burroughs offers a fairly broad line of PDPs, their smallest being a 16-character dot matrix. They also have 20-, 32-, 40-, 96-, 240-, 256- and 480-character displays. These are all dot matrix displays.

Dale manufactures several smaller displays, mostly 16-segment alphanumeric types (16- to 36-character), and they have some 7-segment numeric displays as well.

Beckman provides 7-segment displays from ½- to 16-digits, and 14-segment alphanumeric displays from 2- to 16-characters. All are available in several character heights. They also have a dot matrix (40-character) with power supply and driving circuitry included.

Cherry has a line of 7-segment numeric displays including 4-, 5-, 6-, 12-, 14- and 16-digit models. They also have 16- and 20-character dot matrix types. Many of their displays are for clock applications.

Beckman and Burroughs also offer special displays like bar graphs (linear and circular) and large clock displays.

Description	Character height (inch)	Price ($) approx.
2 digit, 7 segment	0.33	6.00
6 digit, 7 segment	0.7	20.00
16 digit, 7 segment	0.4	50.00 — 80.00
16 character dot matrix 16 seg. (with drive circuitry)	0.5	170.00 — 200.00
40 character dot matrix (with drive circuitry)	0.25	230.00 — 250.00
480 character dot matrix (with drive circuitry)	0.27	1,000.00 +

Table 2

Most PDP manufacturers will consider custom displays — one that is designed for a particular application with special front and nomenclature, but the price for tooling is usually expensive (at least compared to custom LCD displays).

The largest digit size I have seen from any company is a 2-inch high, 4-digit clock display from Beckman. In fact, it is the largest character height that I know of in any display technology except for the large incandescent matrix type used for outdoor viewing.

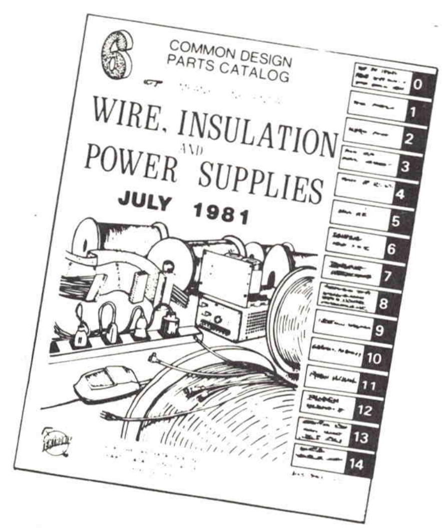
For those interested in pricing PDPs, Table 2 shows some approximate costs for several display types.

If you need more information or for a copy of the *Designer's Guide to Flat Panel Displays*, please contact me at 78-552, ext. BDR-2317.

Al LaValle
Optoelectronic & Passive Comp. Eng.

Coming soon... New wire, insulation and power supply catalog

The Parts Catalogs group will be distributing a new Common Design Parts Catalog very soon. If you'd like to receive this new catalog, plus have your name added to the distribution list to receive other catalog announcements, call ext. BDR-2591.



Chassis Trak rack mount slides modified

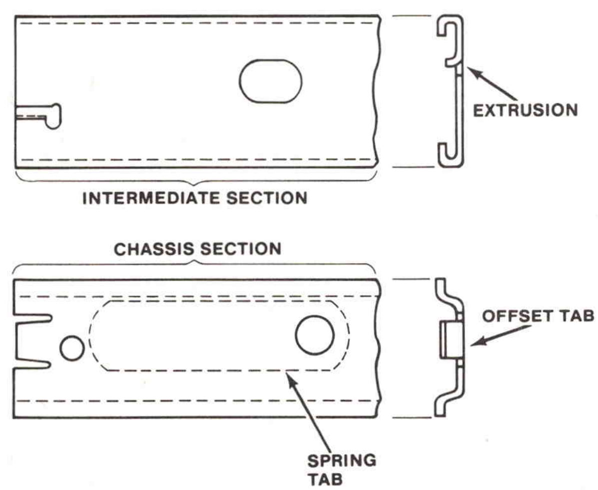
A safety problem has surfaced concerning the 85lb/pair capacity rack mount slides purchased from Chassis Trak. A full set of slides consists of six individual pieces: two stationary sections which are attached directly to the rack; two intermediate sections which slide into the stationary sections and lock into place when extended; and two chassis sections which bolt directly to the instrument and slide into the intermediate section.

The chassis sections have been designed so that when they are fully extended, they will lock into the intermediate sections and prevent the instrument from being pulled out of the rack. The slides, however, are not reversible. If either of the two chassis sections are switched, or the stationary and intermediate sections are switched so that the left hand sections are mounted on the right side and vice versa, this locking feature fails to operate.

This situation exists because the spring tabs located on the chassis sections and the corresponding holes in the intermediate sections into which the spring tabs lock have been slightly offset from the center line (due to the narrowness of the slide). When you attempt to reverse the chassis sections with respect to the intermediate sections, these spring tabs will no longer be aligned with their corresponding holes. In this case, the spring tabs and the holes would be offset to opposite sides of the center line. As a result, the tab misses the hole completely, the locking mechanism fails to lock, and the instrument can be pulled directly out of the rack! The 175lb/pair capacity slides, however, do not have the same problem because of their symmetric design.

A solution to this problem has been proposed (and is currently being implemented) which not only solves the safety problem, but is 100% compatible with the rack mount slides being used now. The modification of the slides will not affect their form, fit or function. They will operate exactly the same except that it will be impossible to insert the right hand chassis section into the left hand intermediate section, and vice versa.

The actual modification consists of an extrusion being punched and bent 90° to the slide at the front end of the intermediate section (see illustration). The extrusion is positioned so that when the correct chassis section is inserted in the intermediate section, the end of the spring tab (located at the rear of the chassis section) nearest the center (the top of the tab) passes just under the extrusion. This allows the chassis section to slide into the other sections as usual. However, when you attempt to insert the wrong chassis section, the spring tab at the rear of the chassis section will come into contact with the extrusion and prevent the chassis section from sliding into place.



The Tek part numbers affected are:

351-0040-03	351-0241-01	351-0314-01
351-0100-01	351-0241-02	351-0331-03
351-0100-02	351-0266-00	351-0375-01
351-0104-00	351-0285-00	351-0376-00
351-0104-03	351-0301-02	351-0394-01
351-0104-04	351-0301-03	351-0487-01
351-0195-01	351-0313-00	351-0487-02
351-0214-00		

Part numbers 351-0104-00 through 351-0104-04 are the chassis sections and will remain unchanged. All of the other part numbers are combinations of stationary and intermediate sections and will have an extrusion punched on the intermediate sections.

If you have any questions, please contact **Halsey Royden, ext. BDR-2314.**

64K DRAM selection process defined

The table below is a list of timing parameters (t_{acc} = 200nS category) and operating currents for nine dynamic RAM vendors who have sampled Tektronix. Of the nine, three have some form of auto/self refresh, and one (TI) has a 4mS, 256-cycle refresh. Information currently available indicates the 2mS, 128-cycle will dominate, and the number of auto/self refresh designs will be limited. Also, because of smaller cell capacitance and lower supply voltage, soft error rates will be higher than with the three power supply 16K DRAMs.

Memory and I/O Component Engineering will use this information, plus data based on testing analysis, circuit design, process analysis and Tek user inputs, to compile a "preferred list" of 64K dynamic RAM vendors. If you have any comments, please contact **Brad Benson (ext. BDR-2557)** or **John Carlson (ext. BDR-2541).**

	Parameter (nS)	Hitachi HM 4864-3		OKI MSM3764-20AS		Mostek MK4564-20		Fujitsu MB8264-20		Intel 12164-20		NEC µPD 4164-2		Mitsub. M5K4164S-20		TI TMS4164-20		Motorola (2) MCM6664L20	
		min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max
1	trac		200		200		200		200		200		200		200		200		200
2	trc	335		330		350		330		350		335		330		350		350	
3	trwc	335		330				375		360		335		385		350		350	
4	tpc	225		225		215		225		170		225		200		225		200	
5	tcac		135		135		115		135				135		100				110
6	toff	0	50	0	50	0	40	0	50	0	50	0	50	0	50			0	40
7	tT	3	50	3	50	3	50	3	50	3	50	3	50	3	50	3	50	3	50
8	trp	120		120		140 (1)		120				120		120		120		140	
9	tras	200	10K	200	10K	200	10K	200	32K	200	10K	200	10K	200	10K	220	10K	200	10K
10	trsh	135		135		115		135		120		135		100		135		110	
11	tcas	135		135	10K	115	$2x10^6$	135	10K	120	10K	135	10K	100	∞	135	10K	110	10K
12	tcsh	200		200		200		200		200		200		200		200		200	
13	trcd	25	65	25	65	30	85	35	65	40		30	65	30	100	25	65	35	90
14	tcrp	-20		0				0		-20		0				0		-10	
15	tasr	0		0		0		0		0		0		0		0		0	
16	trah	25		25		25		20		30		20		25		25		30	
17	tasc	-10		0		0		0		0		0		-5		-5		0	
18	tcah	55		55		30		55		50		55		35		55		55	
19	tar	120		120		115		120		130		120		135		140		155	
20	trcs	0		0		0		0		0		0		0		0		0	
21	trch	0		0		0		0		0		0		0		0		10	
22	twch	55		55		55		55		50		55		55		80		55	
23	twcr	120		120		140		120		130		120		155		180		155	
24	twp	55		55		55		55		40		55		55		55		55	
25	trwl	55		55		60		80		50		55		70		80		55	
26	tcwl	55		55		60		80		50		55		70		80		55	
27	tds	0		0		0		0		0		0		0		0		0	
28	tdh	55		55		50		55		50		55		55		55		55	
29	tdhr	120		120		145		120		130		120		155		180		155	
30	tcp	80		80		90		80		40		80				80		80	
31	tref		2mS		2mS		2mS		2mS		2mS		2mS		2mS		4mS		2mS
32	twcs	-20		-10		0		-10		0		-20		-10		-5		-10	
33	tcwd	80		80		95		95		95		80		80		50		55	
34	trwd	145		145		180		160		175		145		180		130		160	
35	trpc	0										0							
36	trrh					35		25				25						35	
37	tcpn					50				35		30		40					
38	tcpg													200					
39	trmw					415													
40	tpcm									200									
														Auto/Self Refresh				Auto/Self Refresh	
	Operating current (I_{DD}max) mA	60		45		54		45		55		50		45		37		50	

(1) Avail with t_{rp}=120nS

(2) 2nd Generation due in 4Q81

Tantalum cap "hit list" compiled

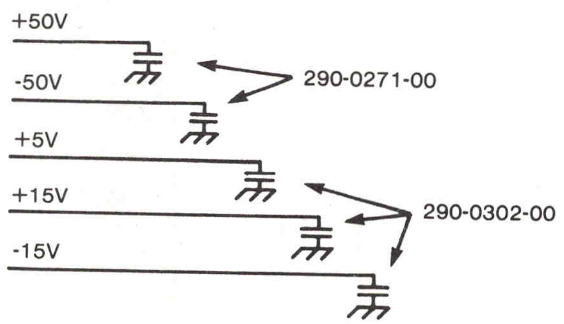
The high price of tantalum capacitors has drawn alot of attention in recent months. This has prompted a new project in Component Engineering to select certain high usage, high price, tantalum caps for replacement with miniature aluminum electrolytic capacitors.

CE first compiled a "hit list" of tantalum caps ranging in price from $1.25 to $4.25 each (see Table 1). These were selected on the basis of annual cost to Tektronix for each part number. Aluminum electrolytic replacements were chosen based on size, CV product and availability.

Tek P/N	Value	Cost	Replacement cost
290-0529-00	47µF at 20V	$2.00	5-10¢
290-0531-00	100µF at 10V	$2.00	5-10¢
290-0316-00	47µF at 35V	$3.75	5-10¢
290-0519-00	100µF at 20V	$2.50	5-10¢
290-0719-00	47µF at 25V	$3.00	5-10¢
290-0722-00	100µF at 10V	$2.00	5-10¢
290-0272-00	47µF at 50V	$4.25	5-10¢
290-0271-00	9µF at 125V	$4.25	5-10¢
290-0302-00	100µF at 20V	$3.00	5-10¢
290-0721-00	100µF at 20V	$3.00	5-10¢
290-0559-00	22µF at 35V	$2.00	5-10¢
290-0574-00	47µF at 20V	$2.00	5-10¢
290-0270-00	8.2µF at 60V	$1.25	5-10¢

Table 1

The first attempt at this replacement process involved five tantalums on the main interface board of the 7600 Series oscilloscopes. Three 290-0302-00s and two 290-0271-00s were being used to bypass the supplies:



Reviewing available aluminum electrolytics eventually led to a 22µF at 100V part for the 50V lines, and a 220µF at 25V for the other three lines. All these parts are axial lead.

Parameters of interest when selecting the aluminum replacements were ESR, ripple current rating, CV product for proper derating, and size. Real world performance was tested with the power supply checker normally used. Recovery time from a 35mA step must be within 2.4cm at 10µS/div, or 24µS. Results are shown in the graphs on the following page.

As you can see, ripple current and overshoot are comparable or better using aluminum electrolytics.

At this time, Del Weaver (7000 Series Mainframe Staff Engineering) is working on replacing 11 caps in the 7704A oscilloscope. Replacing these 11 caps would save $16.25 per instrument; plus, seven other caps are being considered for replacement, bringing the total savings to $23.25 per instrument. Del reports that similar savings are also possible on the 7904 oscilloscope.

The bottom line in this situation is that aluminum electrolytics are suitable replacements for tantalum caps in many of our applications. The eye opener comes when the bill for the five caps previously mentioned is 50¢ as compared to $17 per instrument! This modification alone will save $100K per year for the 7600 Series mainframes.

Please contact **Dave Hayes (ext. BDR-2538)** to review current tantalum cap applications and determine the feasibility of replacement with aluminum electrolytics.

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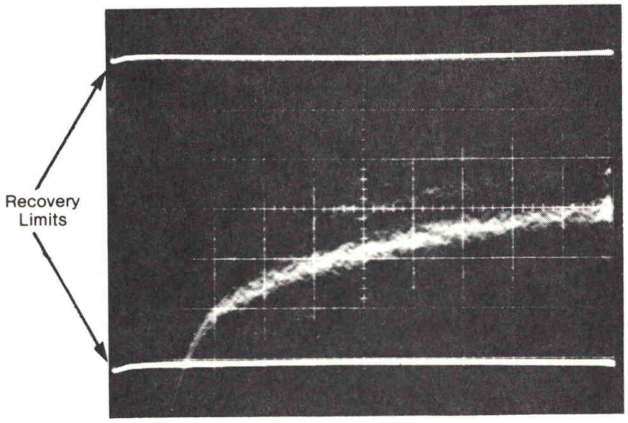
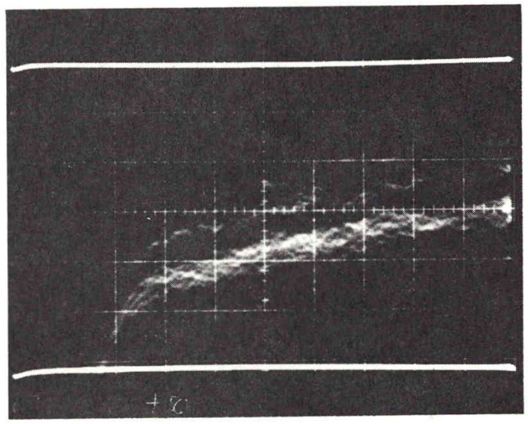
+50V line

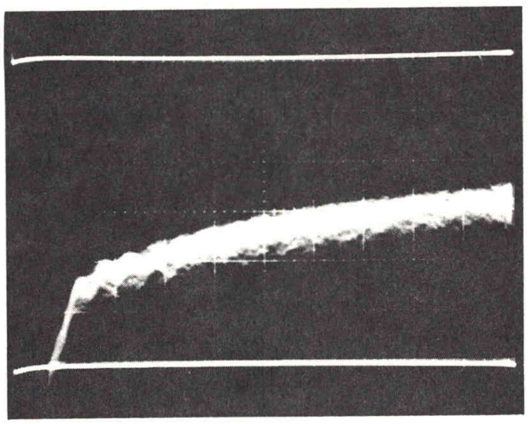


9μF Tantalum

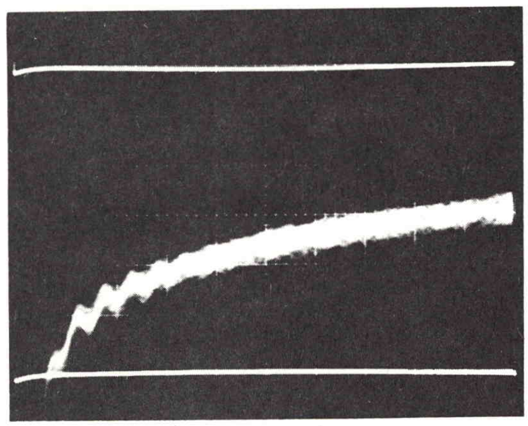


22μF Aluminum

+15V line

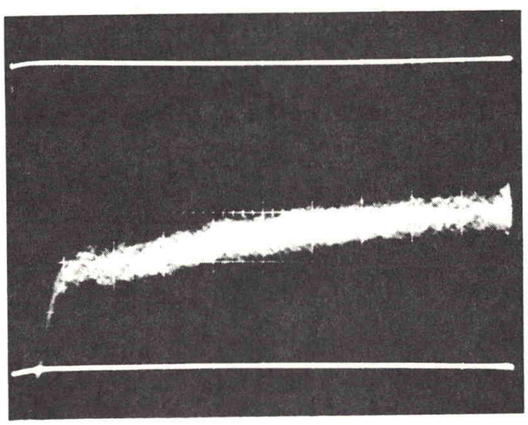


100μF Tantalum

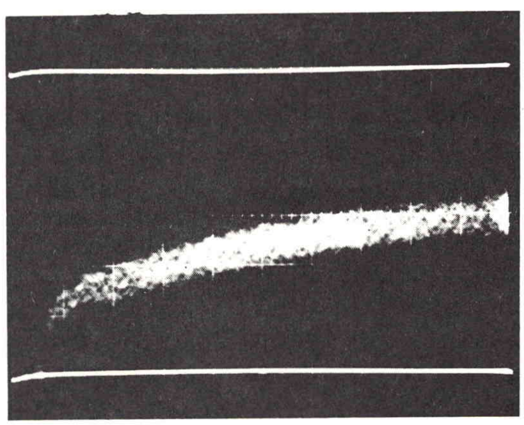


220μF Aluminum

+5V line



100μF Tantalum



220μF Aluminum

Clarostat pots not washable

Recently completed evaluations show that Clarostat ½-inch diameter PC pin panel potentiometers (Model 382) are **not** washable in the in-line boardwash machines used at Tek. This is the case in spite of O-ring shaft seals, varnish body seals and the widely-held notion of being washable.

Clarostat states that while some customers do successfully wash these pots, they (Clarostat) make no such formal claim. Their reason is that while most parts will pass the boardwash test, some lots will have excessive numbers of leaky pots. Our evaluations show from 20% to 50% defectives after boardwash.

The Tek part numbers affected are:

311-0881-00	311-1496-00	311-1884-00	311-2110-00
1043-	1498-	1885-	2111-
1044-	1499-	1886-	2132-
1068-	1500-	1887-	2135-
1155-	1583-	1958-	2147-
1298-	1584-	1959-	2148-
1301-	1753-	1967-	2149-
1480-	1845-	1996-	2165-
1495-	1846-	2109-	2167-

Clarostat has developed an improved sealing method which our tests show is effective. Costing about 15¢ extra, it consists of a heat-shrunk sleeve over the body, with epoxy fill at the terminal end. Using areas will be notified when this part becomes available. They are also designing a new, ½-inch diameter pot with washability being one of the design criteria. This product is about one year away.

Until further notice, do not wash Clarostat Model 382 PC pin pots in the in-line boardwash machines. Allen-Bradley ½-inch diameter PC pin pots, on the other hand, are fully washable.

For more information, please contact **Gene Single (78-552), ext. BDR-2544.**

PROM/EPROM programming service

About a year ago, the PROM/EPROM area of Memory and I/O Component Engineering (MICE) began offering PROM/EPROM programming. Prior to this time, Tek experienced manufacturing failure rates of more than 30% in the programming of raw PROM/EPROM components. As of May 5, 1981, 10,238 PROMs/EPROMs have been programmed, with a 2.9% failure rate.

A DATA I/O System 19 machine does the programming. It is equipped with modules which permit programming of all Tek part numbered PROMs and EPROMs. Scheduled maintenance and calibration assures high programming yields. Benefits derived from using this service include reduced failures and a cost reduction for those areas that can't justify buying a programmer for their own areas.

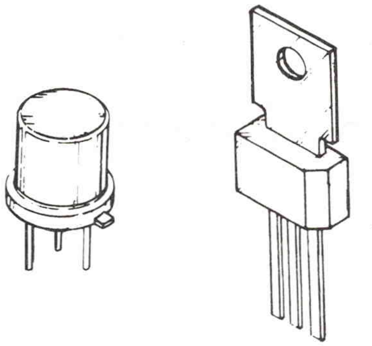
Users of this service, including design groups and production lines, usually send master devices along with the raw parts to be programmed. The master is downloaded into the DATA I/O, supplying the code required to program the parts. It is also possible to download parts from CYBER A or B machines into the DATA I/O. In addition, downloading from 5¼– or 8–inch floppy disks from systems using Southwest Technical Products' FLEX operating system can be accomplished.

To pay for this service, time is exceptioned to the customer's cost center. The amount exceptioned is determined by the time required to program the parts. For product lines, a written agreement is negotiated between the product line manager and the manager of the MICE group. This agreement includes the number of parts to be programmed each fiscal year, plus a 30-day warning period if MICE can no longer support this service. For design engineers, the service is available on a need basis.

Questions about this service? Contact **Gary Johnson or Pat Emmons, ext. BDR-2009.**

Replace hot TO-39s with cool TO-202s

Due to the shortage of TO-39 transistor metal can packages, vendors have been emphasizing TO-92+ (now called TO-237) and TO-202 plastic packages. This situation is not as bad as it seems — rather than a small signal package, the plastic TO-202 device is a power transistor with a much higher free-air power capability. The TO-39 was **not** intended for, and is **not** suited for, applications requiring any amount of dissipation capability.



TO-39 **TO-202**

To illustrate the difference in free-air power capability between these three package types with the same basic die type installed, the table below shows the maximum power at rated maximum junction temperature and $R\theta_{JA}$ (thermal resistance from junction to ambient air). P_D is measured with the device soldered into an ECB.

Device	Case	P_D at T_J	$R\theta_{JA}$
151-0279-00	TO-39	1.0W at 200°C	175°C/W
National 92PU10/ 2N6719	TO-237	1.2W at 150°C	104°C/W
151-0615-00	TO-202	2.0W at 150°C	62.5°C/W

$R\theta_{JA}$ is computed from $\frac{T_J - T_A}{P_D}$

To the circuit designer, TO-202 devices have several advantages over TO-39 packaged units:

1. Lower per-piece cost due to automated assembly and because there is no precious metal used in the package.
2. Lower installed total cost because a TO-202 may not require a heat sink for a particular application, whereas a TO-39 certainly would.
3. Because they are easy to heat sink, TO-202s can be used comfortably at power levels far above what would be safe for TO-39s. Possible circuit simplification may result from running at a higher power level, reducing the number of devices needed.
4. At the same power level as a free-air TO-39, lower junction temperatures ensure higher reliability for TO-202s, even though the TO-202 is a non-hermetic package.

Below is a cross-reference between commonly used TO-39 devices and their TO-202 counterparts.

TO-39	TO-202	Description
151-0150-00, 151-0169-00, 151-0279-00	151-0615-00	300V NPN amplifier
151-0290-00, 151-0285-00	151-0612-00	300V PNP amplifier
151-0124-00, 151-0200-00	151-0728-00	120V NPN amplifier

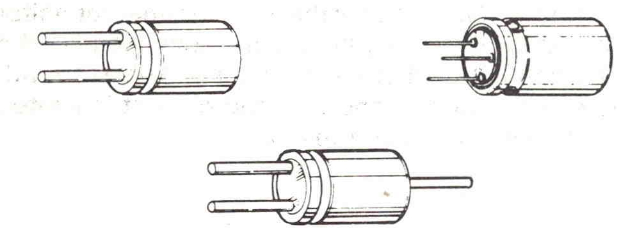
There are many other TO-202 (and TO-220) devices that do not have exact TO-39 equivalents but could be used in place of TO-39 units for new design. For more information, please contact **Jim Williamson, ext. BDR-2552.**

Low ESR radial lead caps

Several years ago a new line of very low ESR, low ESL and high-ripple current aluminum electrolytics was introduced. These single-ended caps with non-aqueous electrolyte were optimized for use as filters in switching power supplies. They were also unusual in that their parameters were specified at 10KHz and 100KHz in addition to the industry standard of 120Hz.

These caps have a single tab construction with a premium grade section in which the foil, etching, paper spacer and non-aqueous electrolyte were all optimized for low ESR. The single-ended design and the short wide tabs and leads give low ESL (series inductance). The non-aqueous electrolyte allows a 105°C ambient temperature and this, along with the very low ESR, gives high ripple current capability in a small package.

The premium package, section and electrolyte offer a very long life, with a quality acceptance life test of 2000 hours at 105°C and full voltage. Units with a 0.4" or 0.5" diameter have a solid rubber header with two leads (example: Sprague 672D), and the 3/4, 7/8 and 1" diameter units have a molded header with rubber O-ring seal and either a two- or three-lead base (example: Sprague 673D and 674D, Sangamo 300, Cornell-Dubilier UPC, or Mallory VPR). All parts have a groove in the can wall of carefully controlled depth which acts as an effective safety vent. At the present time there are at least five manufacturers that make similar lines of parts.



Package styles for radial lead capacitors

The VPR-type capacitor is produced in diameters of 4/10", 1/2", 3/4", 7/8" and 1", and lengths range from 1" to 3⅝" in 1/2" increments. Maximum ESR is usually under 1Ω, and will approach 0.015Ω for the large units. The maximum ripple current obtainable in this series is 12A RMS at 85°C or 15A RMS at 65°C. For voltages up to 50V, almost all of the ESR is in the foil, electrolyte and leads, with very little in the aluminum oxide dielectric, therefore ESR is directly proportional to the area of foil and thus to the case size. Maximum ripple current capabilities are determined by the ESR and the area of the case. The result is that for voltages between 6.3 and about 50 volts, the ESR and ripple are determined by the case size, and not by the capacitance or voltage ratings.

Capacitors are available in voltages between 6.3V and 250V. Figure 1 is a listing of the maximum values available at four different voltages.

18,000μF	6.3V
8,000μF	20V
2,500μF	50V
220μF	200V

Figure 1

Figure 2 is a typical frequency response plot of a large capacitor which is similar to our 290-0925-00. See *Component News 287*, page 17, for the plot of a small can size part. Figure 3 (next page) is a listing of all VPR-type parts that are part numbered at Tektronix as of April, 1981.

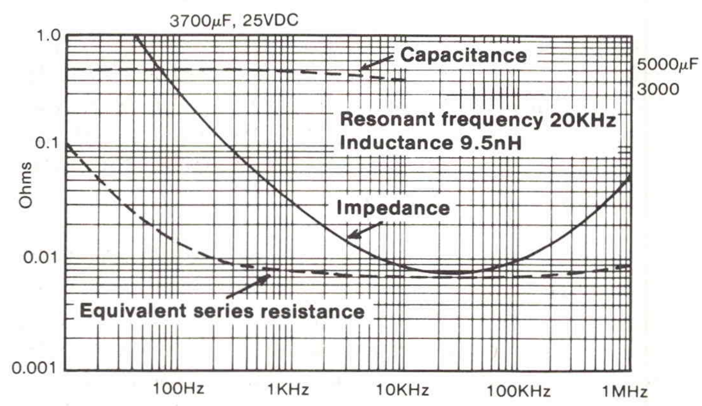


Figure 2 — Typical frequency response of a Mallory VPR (similar to 290-0925-00)

Other low ESR designs

The stacked foil capacitor has the lowest ESR and ESL of any aluminum capacitor. In this capacitor the anode and cathode foils are stacked up with the paper spacers. Then each plate is heli-arc welded to a low inductance thick aluminum

continued on page 12

		Max ESR, +25°C			Ripple 10-100KHz 85°C	Max Dia (inches)	Max Height (inches)		
C	V	120Hz	10KHz	100KHz				Base	Part #
10μF	100V	12.0Ω	2.0Ω	1.7Ω	0.3A	0.434	0.88	2 lead	290-0939-00
27μF	150V	3.2Ω	0.85Ω	0.8Ω	0.7A	0.780	1.20	2 lead	290-0962-00
100μF	25V	1.3Ω	0.45Ω	0.35Ω	0.7A	0.443	0.87	2 lead	290-0942-00
180μF	40V	0.52Ω	0.30Ω	0.18Ω	1.0A	0.515	1.10	2 lead	290-0798-00
250μF	20V	0.40Ω	0.18Ω	0.14Ω	1.3A	0.515	1.10	2 lead	290-0800-00
270μF	40V	0.32Ω	0.12Ω	0.12Ω	1.5A	0.530	1.39	2 lead	290-0946-00
300μF	50V	0.22Ω	0.098Ω	0.095Ω	2.3A	0.905	1.25	3 lead	290-0912-00
390μF	15V	0.44Ω	0.18Ω	0.12Ω	1.3A	0.530	1.10	2+1 lead	290-0932-00
390μF	40V	0.26Ω	0.15Ω	0.12Ω	1.7A	0.530	1.82	2 lead	290-0818-00
390μF	40V	0.20Ω	0.085Ω	0.079Ω	2.1A	0.530	1.82	2 lead	290-0818-01
390μF	40V	0.20Ω	0.085Ω	0.080Ω	2.1A	0.530	1.72	2+1 lead	290-0818-02
540μF	25V	0.17Ω	0.10Ω	0.077Ω	2.3A	0.780	1.20	2+1 lead	290-0931-00
800μF	50V	0.086Ω	0.036Ω	0.035Ω	4.75A	1.03	1.75	3 lead	290-0901-00
840μF	12V	0.18Ω	0.11Ω	0.075Ω	1.8A	0.530	1.39	2 lead	290-0945-00
1200μF	6.3V	0.11Ω	0.070Ω	0.060Ω	2.6A	0.530	1.72	2 lead	290-0877-00
1200μF	12V	0.125Ω	0.075Ω	0.060Ω	2.5A	0.530	1.72	2+1 lead	290-0964-00
1200μF	20V	0.095Ω	0.045Ω	0.049Ω	3.5A	0.780	1.72	2+1 lead	290-0965-00
1600μF	50V	0.047Ω	0.018Ω	0.018Ω	8.3A	1.030	2.75	3 lead	290-0900-00
2100μF	40V	0.044Ω	0.018Ω	0.018Ω	7.5A	1.030	2.25	3 lead	290-0925-00
5600μF	6.3V	0.049Ω	0.023Ω	0.029Ω	4.8A	1.060	1.76	3 lead	290-0853-00
6600μF	12V	0.030Ω	0.017Ω	0.020Ω	7.2A	1.030	2.25	3 lead	290-0929-00
11000μF	12V	0.021Ω	0.017Ω	0.017Ω	9.8A	1.030	3.25	3 lead	290-0930-00

Figure 3 — Low ESR single-ended aluminum electrolytic capacitors

bussbar or transmission line structure that forms the leads and terminations. These caps have 10KHz ESRs under 1mΩ, ESLs that are 1nH or less and ripple currents as high as 50A RMS. The high ratings come from the very low ESRs and the heat sinking provided by the bussbar termination.

Some disadvantages are large size because there's a square section in a round can, plus high cost due to the hand labor involved. In addition, the 1⅜" units are single sourced (the 3" units are not), they are not available in ratings over 50VDC, and they have poor low temperature operation.

Two examples of this part are the 290-0754-00 (2200μF, 10V, 40mΩ at 10KHz) and the 290-0630-00 (300μF, 12V).

Another type with low impedance is the four-terminal cap. This is an axial lead unit with the anode and cathode foils connected to two closely spaced #18 wires that pass through the capacitor and are brought out at each end. This provides very low ESL (less than 2nH), and some of this helps in filtering because it appears between the capacitor and rectifiers. The construction and low ESL give a low impedance up to 1MHz.

The disadvantages of the four-terminal capacitor are that the ESR may not be very low because the foil is contacted at one end only, it is axial lead with restricted C and V, and the load current is limited because it is through the cap.

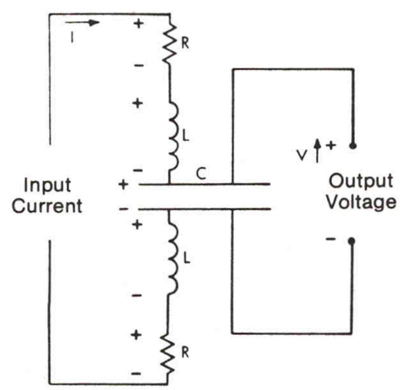


Figure 4 — Equivalent circuit of the 4-terminal capacitor

continued on page 13

Most capacitor manufacturers have a low ESR computer grade capacitor line. They use etched foil and paper optimized for low ESR, and may also have non-aqueous electrolyte and multiple tabbing. These have very high ripple current ratings (up to 35 ARMS at 120Hz, 85°C), and usually they are a long life capacitor. The trade-off to get the low ESR is that the CV product is lower than in a regular computer grade cap. The 290-0898-00 is a non-aqueous cap (2600μF, 35V) that was set up as a replacement for the 2200μF, 10V stacked foil cap. The -0898- has ESR almost as good, twice the ripple current rating, and half the cost of the stacked foil.

Recently, Sangamo announced the type 350 capacitor which is similar to the Sangamo 300, Sprague 674D or Mallory VPR. The big difference is new internal construction that lowers the ESL from 12 to 15nH (typical for the 300), to about 5 to 6nH for the 350. This decreases the high frequency impedance and will be useful for switchers operating at 100KHz to 200KHz. This capacitor line specifies impedance at 200KHz in contrast to 100KHz for the regular low ESR capacitor.

When a low ESR and low ESL capacitor is needed, and the ripple current requirement is under 10A RMS, the best bet is to use a Sprague 672D-673D (or equivalent) single-ended capacitor. We now have 22 of these part numbered and we highly recommend them. With this type capacitor, as with **ANY** aluminum electrolytic, you must use adequate derating to achieve good life.

If you have any questions about these parts, please contact me at 78-552, ext. BDR-2545.

Don Anderson
Optoelectronic & Passive Comp. Eng.

Heat sinks for 68-pin leadless chip carriers

Thermalloy, in cooperation with device and packaging suppliers, is developing heat sinks for the upcoming 68-pin leadless chip carrier (LCC) VLSI microcircuits. These heat sinks are epoxied to the die-attach surface of the package, as shown in Figure 1. Thus far, three types of heat sinks have been developed, with many more on the way.

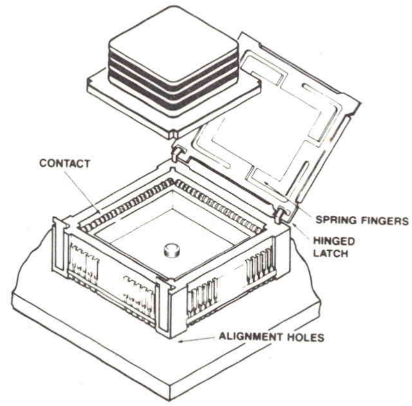


Figure 1 — Leadless package with connector

As an outgrowth of this program, a proposal for a heat sink (see Figure 2) tailored specifically for the Fairchild F100K super high speed ECL Flatpak® package was presented to Thermalloy by Component Engineering. Thermalloy's reply was that if sufficient interest was generated for this item, they would fabricate these heat sinks.

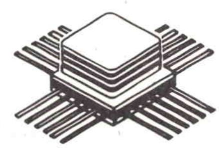


Figure 2 — F100K package with bonded heat sink

If your project uses these F100K microcircuits and you feel that a heat sink would be desirable, please contact **Jim Williamson, ext. BDR-2552.**

HEXFET data books available

I have a limited supply of International Rectifier's new HEXFET data book available. This data book has complete specifications on all of IR's power MOSFET products plus important application information and circuit suggestions.

We already have four HEXFETs part numbered at Tek and applications in our instruments are growing. This data book will be especially helpful to anyone designing with these parts.

If you'd like a copy, call me on ext. BDR-2539.

Jerry Willard
Analog Component Engineering

to theater tonight

ComponentNews NewComponents

Vendor	Number	Description	When Available	Tek P/N	Engineer to contact, ext.
		analog devices			
TRW	LT4700	NPN transistor, low noise amplifier, 1.6dB @ 1.0GHz typ; 1.2dB @ 0.5GHz typ; BV_{CEO} = 12V; H_{FE} >70 @ 5V, 25mA; C_{cb} <1.5pF @ 5V	samples available	No P/N	Matt Porter, BDR-2311
Amperex Motorola	BFR-96	NPN transistor, MACO-T pkg., BV_{CEO} = 15V; H_{FE} >30 @ 10V, 50mA; f_T = 4.5 GHz typ @ 10V, 50mA; C_{cb} <1.5pF @ 10V	now	151-0752-00	Matt Porter, BDR-2311
Motorola National	2N4401	NPN transistor, TO-92 version of 2N2222A (151-0302-00), higher power dissipation, better availability in future	now	151-0736-00	Matt Porter, BDR-2311
Plessey	SL360	NPN-dual transistor, TO-99; high frequency amplifier monolithic dual; BV_{CEO} = 8V, f_T = 2.5GHz @ 2.5V, 5mA typ, f_T = 3.2GHz @ 5V, 25mA typ; H_{FE} = 30 @ 2V, 5mA; Cob ≈ 1.5pF @ 0V	now	151-0725-00	Matt Porter, BDR-2311
NEC Motorola	NE73433 MMBR2060	NPN transistor, TO-236 SOT device; f_T = 2GHz typ 10V, 10mA, C_{cb} <1pF 10V, H_{FE} >45 1V, 10mA, BV_{CEO} >14V, NF 3dB typ, 30mA, 10V	——	151-0754-00	Matt Porter, BDR-2311
H-P	HXTR-3102	NPN transistor, μ-x pkg general purpose amplifier; high gain 11.5dB @ 1GHz; f_T = 6GHz typ 15V, 30mA; $\lvert S_{21}\rvert^2$ = 12.5dB @ 15V, 30mA; H_{FE} = 15 min	samples available	——	Matt Porter, BDR-2311
H-P	HXTR-3101	NPN transistor, μ-X pkg; low noise amplifier; NF = 1.8dB typ @ 1GHz, 10V, 10mA; H_{FE} = 50 typ; f_T =6GHz typ 10V, 15mA	samples available	——	Matt Porter, BDR-2311
		digital devices			
TI	9914A	GPIB Adapter, "A" version	now	156-1444-01	Ken Smith, BDR-2319
		memory and I/O devices			
XICOR	X2201A	Nonvolatile static RAM, 1024 × 1, T_{ACC} = 300nS, 5.0V programming. The X2201A is a redesign of the XICOR X2201, which will be discontinued.	Aug. '81	——	Jim McKay, BDR-2557
XICOR	X2210	Nonvolatile static RAM, 64 × 4, T_{ACC} = 300nS, 5.0V programming	samples now	——	Jim McKay, BDR-2557
XICOR	X2212	Nonvolatile static RAM, 256 × 4, T_{ACC} = 300nS, 5.0V programming	samples July, '81	——	Jim McKay, BDR-2557
Mostek	MK37000-4	MROM; 64K, 28-pin, dynamic MROM preliminary evaluation completed; results are favorable	now	——	Jim McKay, BDR-2557
		optoelectronic and passive devices			
Electro-cube	230D	Capacitor, 0.022μF ±20%, 400V metallized mylar, machine-insertable	now	285-1236-00	D. Anderson, BDR-2545
Electro-cube	A910D	Capacitor, 0.01μF ±20%, 200V metallized polypropylene, 0.23" × 0.48"	now	285-1237-00	D. Anderson, BDR-2545
TRW	TEK-242	Capacitor, 0.22μF ±20%, 100V metallized polypropylene, 0.33" × 0.65"	now	285-1238-00	D. Anderson, BDR-2545
Panasonic	L5	Capacitor, 220μF, 25V single-ended aluminum electrolytic, 0.41" × 0.67"	now	290-0963-00	D. Anderson, BDR-2545
Mallory	VPR	Capacitor, 1200μF, 12V, low ESR single-ended aluminum electrolytic, 0.53" × 1.72", 2.5A RMS ripple current	now	290-0964-00	D. Anderson, BDR-2545

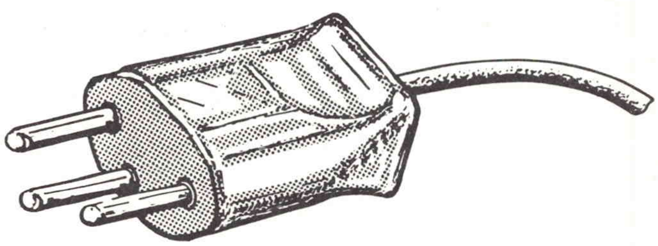
continued on page 15

Vendor	Number	Description	When Available	Tek P/N	Engineer to contact, ext.
Mallory	VPR	Capacitor, 1200µF, 20V, low ESR single-ended aluminum electrolytic, 0.78" × 1.72", 3.5A RMS ripple current	—	290-0965-00	D. Anderson, BDR-2545
Panasonic	L5	Capacitor, 220µF, 25V, axial lead aluminum electrolytic, 0.34" × 0.87"	—	290-0966-00	D. Anderson, BDR-2545
Panasonic	L5	Capacitor, 22µF, 25V, axial lead aluminum electrolytic, 0.27" × 0.53"	—	290-0967-00	D. Anderson, BDR-2545
Mallory	PFP	Capacitor, 14,000µF, 30V, PC mount aluminum electrolytic, 1.45" × 3.7"	—	290-0968-00	D. Anderson, BDR-2545
Panasonic	L5	Capacitor, 22µF, 100V, axial lead aluminum electrolytic, 0.34" × 0.87"	—	290-0969-00	D. Anderson, BDR-2545
Panduit	FCM2-A-14	Flat cable mount with adhesive back	now	343-1048-00	E. Doolittle, BDR-2309
Cooner	—	Flat insulated braid, size 10 AWG, UL style number 1680	now	176-0371-00	E. Doolittle, BDR-2309
Berg	—	Cable assembly, 6 signal and 72 ground conductors, 72.0 length, socket/socket	now	175-4066-00	E. Doolittle, BDR-2309
Berg	—	Cable assembly, 22 signal and 44 ground conductors, 19.6 length, 1 socket connector	now	175-4081-00	E. Doolittle, BDR-2309
Berg	—	Cable assembly, 36 signal and 72 ground conductors, 19.6 length, 1 socket connector	now	175-4092-00	E. Doolittle, BDR-2309
3M	—	Cable assembly, 20 conductors, 30.0 length, cord edge/cut & strip	now	175-4100-00	E. Doolittle, BDR-2309
3M	—	Cable assembly, 34 conductors, 25.5 length, socket/socket, with ground plane	now	175-4120-00	E. Doolittle, BDR-2309
3M	—	Cable assembly, 34 conductors, 24.0 length, socket/socket, with ground plane	now	175-4121-00	E. Doolittle, BDR-2309
3M	—	Cable assembly, 40 conductors, 2.4 length, socket/socket	now	175-4157-00	E. Doolittle, BDR-2309
3M	—	Cable assembly, 34 conductors, 25.25 length, socket/socket, sockets oppose	now	175-4158-00	E. Doolittle, BDR-2309
3M	—	Cable assembly, 34 conductors, 33.0 length, socket/socket, sockets oppose	now	175-4159-00	E. Doolittle, BDR-2309
3M	—	Cable assembly, 34 conductors, 21.25 length	now	175-4160-00	E. Doolittle, BDR-2309
3M	—	Cable assembly, 50 conductors, 17.5 length, socket/cord-edge/D-subminiature	now	175-4161-00	E. Doolittle, BDR-2309
3M	—	Cable assembly, 20 conductors, 23.0 length, socket/socket, with strain relief	now	175-4162-00	E. Doolittle, BDR-2309
3M	—	Cable assembly, 50 conductors, 24.0 length, socket/cord-edge	now	175-4168-00	E. Doolittle, BDR-2309

New international power option

An additional International Power Option has been established for Switzerland. Option A5 is now available for the Swiss power cord (220V, 50Hz operation). The following two part numbers have been set up for the power cord and extension:

161-0154-00	Power cord; 2.5 meter length, black; 250V, 6A; Swiss plug and IEC connector (CEE-22)
131-2763-00	Cord mountable 3-conductor, female receptacle; 250V, 10A



If you have any questions, please contact Bob Randall (58-305), ext. BDR-1810. For a complete listing of the International Power Options, refer to **Component News 286,** page 10.

Gary Hamrick
63-406, ext. W1-3317

The harmonica saga continues...

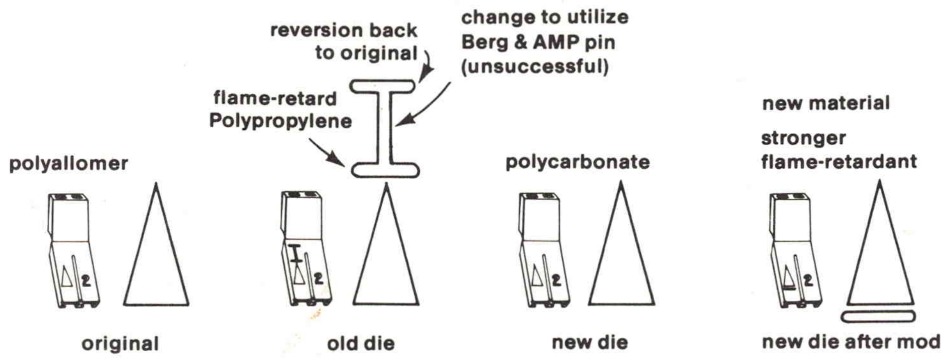
Some confusion has arisen regarding the two-pin terminal holders, Tek P/N 352-0169-00 through -09 (harmonicas or mini-housings). Parts are appearing in manufacturing areas which do not have the array of bars above the arrow at Pin #1 (see illustrations below). These parts have been molded in a new die and, at the time the new die was designed, it was decided that the bars above the arrow would be deleted.

What was overlooked was the fact that these parts could be easily mistaken for the original parts made of non-UL flame rated polyallomer — and they were! A mod (GMP 1948) is in progress to add a bar **below** the arrow to denote that these parts are molded in the new die (with an improved hinge area) and the new UL-rated material.

All parts in the system which have a plain arrow are good, usable parts and should not be discarded. However, as we replace old worn dies, these bars will be added to show that the parts are molded in new improved dies.

Another new die has just arrived, for 8-pin terminal holders (P/Ns 352-0166-00 through -09). Specifications and materials are the same as for the new two-pin holder.

If you have any questions, please contact **Bert Hippe (08-538), ext. V1-7296.**



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COMPONENT NEWS

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