component news

Sept. 13, 1979 COMPANY CONFIDENTIAL Issue 274

Voltage regulators — design considerations

Understanding the limitations of voltage regulators allows designers to select the most appropriate device and use it to its optimum performance and reliability.

The process for selecting a voltage regulator in order to avoid critical design "pitfalls" involves specifying:

1) desired output voltage and tolerance limits,
2) maximum input voltage,
3) maximum output current required,
4) line and load regulation required,
5) maximum ambient temperature (or heat sink temperature),
6) maximum allowable junction temperature.

All of these parameters should be specified to completely define the device. Table 1 (page 2) shows the regulators which are currently part numbered at Tektronix. This table can be used as an easy reference, showing output voltages and package styles available. Some relevent thermal information concerning package styles is also given. However, two parameters from Table 1 need further clarification.

First, the tolerance specification is an overall tolerance limit which includes a variance of several factors. These factors include line, load and temperature changes. Typically, the regulators Tektronix buys have a tolerance of ±5%. Tighter output voltage tolerances of ±2% along with tighter line and load regulation specifications can be purchased from several manufacturers for an added cost of approximately 20%.

Secondly, the amount of steady-state current which a regulator can source is dependent on the junction temperature of the chip. *All* three-terminal voltage regulators are thermal overload-protected to ensure that the junction temperature will not exceed a certain limit. Exceeding the thermal limit of 175° – 185°C will cause the device to curtail its regulation and reduce its output voltage.

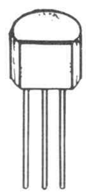
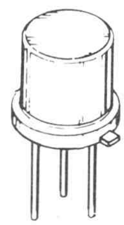
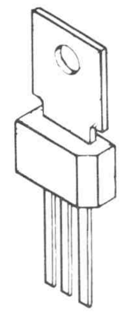
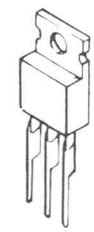
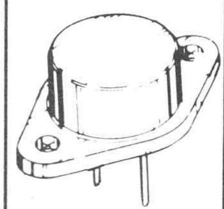
Junction temperature is an important parameter to consider. The regulator chip should be designed to operate below the maximum junction temperature if the device is to have maximum reliability. Operating life decreases at high junction temperatures. Although many regulators are rated at 150°C, it is not a good idea to operate continuously at that temperature. A reasonable maximum operating temperature would be 100°C for epoxy-packaged devices, and 125°C for hermetically-sealed devices. These temperatures provide a suitable compromise between reliability and realistic design practices.

Chip temperature can be calculated by multiplying the amount of power dissipated by the thermal resistance of the package (from chip to free air) plus the ambient temperature. Nominal thermal resistances are specified in data sheets.

continued on page 2

Also in this issue

Table 1 - Voltage Regulator Selection Guide

	 TO-92		 TO-39		 TO-202		 TO-220		 TO-3	
Max Current	100mA		100mA		500mA		1.5A		3.0A	
Max Power on a Heatsink	—		—		7.5W		15W		30W	
Max Power in Air $T_A = 70°C$	150mW for $T_J = 100°C$		370mW for $T_J = 125°C$		380mW for $T_J = 100°C$		460mW for $T_J = 100°C$		—	
$R_{\theta\ JA}$	200°C/W		150°C/W		79°C/W		65°C/W		—	
$R_{\theta JC}$	—		38°C/W		10°C/W		5°C/W		3°C/W	
Polarity / *Voltage	+	−	+	−	+	−	+	−	+	−
5V	156-0991-00	156-1150-00			156-1263-00		156-0277-00	156-0846-00	156-0684-00	
5.2V								156-0655-00		156-1348-00
8V			156-1244-00							
12V			156-1160-00	156-1207-00		156-1264-00	156-0285-00	156-0872-00		
15V	156-1261-00	156-1260-00			156-1262-00		156-0988-00 156-0312-00	156-0527-00 156-0930-00		
18V							156-0264-00			
20V										
24V							156-0926-00			

*Tolerance specifications are ±5%, except when otherwise noted on the spec.

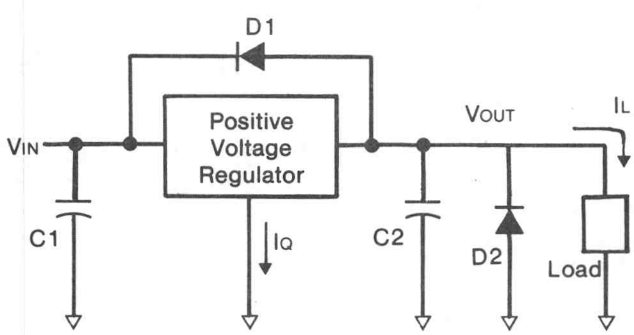
continued on page 3

continued from page 1

Manufacturers are reluctant to specify maximum thermal resistances in data sheets because of the difficulty in production testing. Therefore, a good rule of thumb for worst-case design calculations is to use a maximum thermal resistance which is 50% over the stated nominal thermal resistance of the package.

When calculating the amount of power dissipated, the quiescent current of the regulator should be considered. In some cases I_Q may account for as much as 50% of the power dissipated (see figure 1).

Figure 1



Power Dissipated = $(V_{IN} - V_{OUT})\ I_L + V_{IN}\ I_Q$

$T_{JUNCTION} = P\ \theta_{JA} + T_{AMBIENT}$

Thermal resistance of package

Design aids

When a positive regulator is loaded to a negative supply, a start-up problem can occur. If the output pin is driven more negative than the ground pin, the regulator will appear to latch up. This latch-up condition is attributed to a parasitic substrate diode which becomes forward biased. Under normal mode of operation, the parasitic substrate diode is reverse biased. A clamping diode (D2) shown in figure 1 should solve any start-up problems.

If the voltage on the output pin exceeds the voltage on the input pin, failure of the device can occur. Cause of failure is due to the base-emitter junction of the internal pass transistor breaking down. A diode (D1) connected between the input and output terminals of the regulator will prevent reverse biasing of the base-emitter junction.

New developments

The newest and hottest regulator to be introduced recently is the LM338, manufactured by National Semiconductor. The device is capable of supplying in excess of 5 amps over a 1.2 volt to 32 volt range. A unique feature of the LM338 is time-dependent current limiting. The current limit circuitry allows peak currents of up to 12 amps to be drawn from the regulator for short periods of time (~1.5mS). The LM338 is housed in a TO-3 package and is priced at about $3.65. Samples are available.

If you have any questions about voltage regulator design considerations, please contact me at 58-299, ext. 7709.

Chris Martinez
Analog Component Engineering

Coating found unacceptable

Lea Manufacturing Company has been advertising a protection coating for aluminum under the name Decoral. Recently, samples of different aluminum alloys were coated by Lea Manufacturing and then tested in the Tek Environmental Labs.

Humidity and salt spray test results show this coating to be *totally unacceptable* for our applications. If you have any questions about this coating material please contact Casey Veenendaal ext. 7045.

New LCDs show promise

The main reason Tektronix has not used many liquid crystal displays (LCDs) in the past is probably because the polarizers would bleach out, shrivel up and fall off in high temperature/high humidity environments (see *Component News 267,* pages 11-12).

Beckman, however, has come out with a display and polarizers that pass our standard, 10-day humidity test (MIL-STD-202E, method 106D), with no apparent degradation. This test cycles up to 65°C at 95% relative humidity (RH). Before this device was released, the best polarizer was generally agreed to be Polaroid's K-type (high-stability) polarizer. The K-type could withstand only 49°C at 95% RH.

Hitachi claims that their polarizer can meet 70°C at 95% RH for an unspecified length of time, as well. No parts have been tested in Component Engineering, though.

Note that Beckman's liquid crystal fluid is specified to operate from −10°C to +55°C. The clearing point (at which this display turns completely black) was measured at about +58°C. They spec the storage limits from −30°C to +70°C. This is interesting because, generally, storing an LCD much above its clearing point will degrade it in a matter of hours. Beckman, when asked about this apparent discrepancy, replied that they haven't had that problem.

They attribute this phenomenon to their use of biphenol-type liquids (as opposed to Schiff-base, which they claim is used by their competition), which Beckman purifies to a high degree. They plan to have a material with a broader temperature range available soon.

CE stored a Beckman LCD at +70°C for 26 days with no degradation. Another display was then stored at +85°C. After 14 days, the seal began to lighten slightly in color around the inside edges. Performance was not affected. This display was stored for another week at 85°C with no further change.

The moral of the story is: LCDs are becoming more useful for our applications. Tek's needs will probably involve mostly custom displays (tooling charge is about $1,000 – $3,000). It is therefore worth mentioning that Beckman, unlike many LCD manufacturers, likes to see fairly large quantities before tooling up. They assure me that they are happy to review *any* drawing. Hitachi's LCDs are all customs, and they have indicated that about $25,000/year in orders is optimum.

For more information about LCDs, contact **Betty Lise Anderson (58-299), ext. 6389.**

Memory CE group moves

Memory and I/O Component Engineering has moved to delivery station 58-121. The new phone extension for the group is 4663. The people involved in this move are:

Paul Gray, manager
Brad Benson
John Carlson
Caroline Driver
Bob Goetz
Dick Green
John Higley
Jim Lowry
Pete Reitmajer
Don VanBeek

Some precautions when using Freon 12

Component News 273 (page 8) reported on an electrostatic discharge mode which affects MOS LSI components in hermetically-sealed packages with nonconductive lids. Failure can be induced by spraying package lids with Freon 12 canned circuit coolant. Also, failures can occur by wiping the IC package lids with paper.

Frank Tucker, T&M Service Support, has some precautions to take if you must use Freon 12 on these hermetically-sealed MOS LSI devices:

- For UV EPROMs with metal tops, cover the top of the bullseye lid with metal tape. This will discharge the positive ions to ground.
- The use of freeze spray from cans that are less than 25% full will reduce the possibility of damage. The amount of charge flow depends upon the flow rate of Freon from the can.
- Do not wipe the tops of these devices with paper, plastic or other nonconductive material.

For more information about this ESD failure mode, reference *IEEE Transactions on Electron Devices, Vol. ED-26, No. 1, January 1979.*

ComponentNews NewComponents

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	P/N	Appr. Cost	Engineer to contact
Analog Devices	7523	D/A converter, CMOS 8-bit	now	156-1366-00	$ 1.90	Don Gladden, 6700
Analog Devices	7524	D/A converter, CMOS μP-compatible	now	156-1367-00	2.75	Don Gladden, 6700
Analog Devices	AD565	D/A converter, 12-bit DAC — Current Out 200nS	now	156-1329-00	14.00	Don Gladden, 6700
Intersil	7555	Timer, CMOS, low power, 555 equivalent	now	soon	.70	Don Gladden, 6700
National	398	Sample and Hold	now	156-1370-00	2.60	Don Gladden, 6700
Raytheon	4151	Voltage to frequency converter	now	156-1362-00	.65	Don Gladden, 6700
*Motorola	MPSH81type	Transistor, PNP high f_T, high Beta, 600MHz	now	151-0712-00	.13	Matt Porter, 7461
*Motorola	MPSH10type	Transistor, NPN, high f_T, high Beta, 600MHz	now	151-0711-00	.13	Matt Porter, 7461
*Complimentary parts; low capacitance (<1pF)						
Intel	8086	MPU, 16-bit microprocessor	now	NA	75.00	Wilton Hart, 7607
Mostek	MK4118-2	Static RAM, 1K x 8, 150nS T_{AA}	now	156-1383-00	17.20	Pete Reitmajer, 4663
Mostek	MK4118-4	Static RAM, 1K x 8, 250nS T_{AA}	now	156-1382-00	15.95	Pete Reitmajer, 4663
Hitachi	HM6147	Static RAM, 4K x 1, CMOS, 70nS T_{AA}	now	soon	—	Pete Reitmajer, 4663
Litronix	RBG1000	LED, 10-element bar graph display, .100" spacing	now	soon	1.95	Betty Anderson, 6389
H-P	HLMP1502	LED, green, bright, T1 size	now	150-1078-00	.55	Betty Anderson, 6389
Dialight	559-0201-001	LED, green, in black snap-in mounting	now	150-1055-00	.75	Betty Anderson, 6389
Itron	DC169A2	Fluorescent, 16 char, 5x7 dot matrix, 9mm char fluorescent display	now	soon	45.00	Betty Anderson, 6389

Ball terminal module evaluation

Component Engineering recently completed a characterization of a Ball Brothers terminal module. The results of this evaluation follow.

Brightness. The maximum intensity was 70 foot-lamberts. There was some blooming at 20 foot-lamberts. The intensity variation across the screen at 20 foot-lamberts was 1 foot-lambert. The linearity did not change with brightness.

Resolution. The monitor is not a high resolution display. The maximum number of lines is 200 before line pairing occurs. The dots are distorted on the left side of the screen.

Linearity. The vertical linearity can be adjusted for nearly zero error. There is no horizontal adjustment. The error in the horizontal is less than 5%.

Gray scale. The Z-axis required some gamma correction in order to obtain a $\sqrt{2}$ light intensity relationship between adjacent bars. Eight bars of light intensity ranging from full brightness to beam cutoff were displayed.

Z-axis bandwidth. The bandwidth was below the manufacturer's specification. The frequency response was measured at the CRT cathode.

Raster size. The vertical was set to 14.8 cm, and there was no adjustment on the horizontal. The width of the display unblanked was 23.0 cm.

Blanking times. The horizontal sweep required the maximum specified time for adequate blanking — 10μS. The vertical required 1500mS. For complete blanking, the spec allowed 900mS.

Sync rates. The maximum horizontal sweep rate is 20KHz; the maximum vertical rate is 83Hz.

Vertical linearity. The vertical linearity control was a little noisy. All of the other controls were good.

Workmanship. The workmanship on this monitor was acceptable.

If you have any questions about these evaluation results, please contact **Harry Ford (58-299) ext. 6520.**

New Component Engineer

Bella Geotina has joined the Electromechanical Component Engineering group, reporting to Peter Butler. Bella's primary duties will be to provide technical support for materials and chemicals. Before joining Electromechanical CE, Bella worked at American Cyanamid Company as quality control chemist. She has a BS in chemical engineering and an MA in education.

Bella can be reached at 58-299, ext. 5953.

Bob Aguirre, manager
Electromechanical Component Engineering

How pollution affects electrical contacts

Electronic equipment is known to fail or operate intermittently as a result of airborne contaminants. The concentration of these contaminants tends to be more severe in areas with high industrial activities; precisely where most sensitive electronic equipment is used.

Probably the largest source of air pollution is the combustion of fuels for heating, power generation, transportation and the incineration of refuse. Another source of man-made pollution is industrial. These pollutants include emissions from chemical processes, metallurgical operations, and construction activities.

There are basically two types of pollutants — particulate and gaseous. Airborne particles and aerosols are suspended mineral dusts: smokes, oil and other liquid mists, spores and pollens, soots, flyash,lint and paper fibers. This dust absorbs polluting gases and initiates corrosion or tarnish films on base metal.

Gaseous impurities in the air are often involved in tarnish film formation. Tarnish films are a result of chemical reactions between a metal surface and components of the environment to which it is exposed. The nature of the film depends on the type of metal and the chemical composition of the environment.

The adverse effects of atmospheric contaminants on electrical contacts include:

Hydrocarbons — The activation of precious metal contacts by hydrocarbon vapors has been recognized for a number of years. Motor vehicles constitute the biggest source of hydrocarbons.

Sulfur Dioxide (SO_2) — Generally recognized as the most corrosive contaminant gas. In combination with water, it forms sulfuric acid mist. The major source of sulfur dioxide is fuel combustion and industrial operations.

Oxides of Nitrogen (NO_2) — Causes nitrate stress cracking of electrical contacts, and absorbed gases will react to form nitric acid on component surfaces. These oxides are produced almost entirely in combustion processes.

Total Oxidants — The presence of oxidizing gases in the atmosphere, particularly ozone. These substances are known to be potentially harmful to any organic material.

Hydrogen Sulfide (H_2S) — A rapid corrosive agent, particularly to copper and silver. It also causes deterioration of microfilm. H_2S gas is a common atmospheric constituent near oil fields, sulfur springs and marshy areas. Occasionally emissions from industrial or sewage treatment activities can occur.

Ammonia — When present in sufficient concentrations ammonia has caused cracking of stressed brass, plus decreasing the insulation resistance and increasing the loss factor of certain insulators. Ammonia is believed to be produced naturally by the soil and released from industrial sources.

Chlorine and other free halogens (Cl_2) — These substances have shown detrimental effects on contact materials. Singular or cumulative mixtures of Cl_2, H_2S, SO_2, NH_3 should not be neglected and need to be investigated in a complex mixture and low concentration to simulate field conditions.

This information was abstracted from a paper presented by Bob Aguirre, manager of Electromechanical Component Engineering. Contact Bob (58-299), ext. 5228, if you have any questions or comments.

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, ext.
151-0438-00	Motorola	PNP small signal transistor	Matt Porter, 7461

Tek is experiencing a shortage on one of its popular PNP small signal transistors. We are unable to buy the 151-0438-00 to our full spec at this time. This is a high f_T, high Beta PNP transistor. Our only source is Motorola, and they have indicated their yields to our spec have gone down to around 2%. They need relaxations on f_T and HFE in order to supply any parts. We have given a temporary authorization to Motorola to ship Tek parts to a relaxed version of our spec (the relaxations are listed below).

It is not known at this time how many old or new applications can use these parts. If you have a new design using the part and would like to see a worst-case part please contact me at ext. 7461.

A new part number has been created which is from the same chip as the 151-0438-00. This part number has specs close to the relaxations sought by Motorola and is substantially lower in price. A spec comparison of this new part with the current part is shown below. This new part is cheaper and has better availability. If you can use it, I would suggest you change over, because the problems we are experiencing with the 151-0438-00 will not disappear in the future.

	(MPSH81) 151-0438-00	Motorola relaxed spec	(MPSH81) 151-0712-00
f_T			
at 4V, 5mA	1 GHz	800 MHz	600 MHz
at 4V, 20 mA	800 MHz	750 MHz	——
at 5V, 20 mA	1 GHz	800 MHz	——
at 10V, 20 mA	——	——	800 MHz
HFE			
at 1V, 2 mA	100	80	60
at 1V, 20 mA	80	60	——
BV_{CEO}			
at I_C = 1 mA	20	20	15

Responsibilities in Electromechanical CE

The following responsibility changes have been instituted in the Electromechanical Component Engineering group.

Peter Butler ext. 5417	Connectors, plug sockets, terminal pins, cable assemblies
Bella Geotina ext. 5953	Tapes, paints, adhesives, bulk materials (metals and plastics), metal tubing, insulating sleeves, gaskets, substrates, wires and cables
Jim Deer ext. 7711	OEM, printers, joysticks, acoustic I/O
Dennis Johnson ext. 5953	Panel switches, power switches, fuses, circuit breakers, line cords, line filters, receptacles, plugs, hardware, fasteners, knobs
Paul Johnson ext. 6365	Mechanical relays, solid state relays, reed switches, Triacs, SCRs, solenoids, spark gaps, Hall effect devices, unijunctions
Jim Deer (temporary) ext. 7711	Keyboards, keyswitch modules, keycaps, lamps and lampholders
Bill Stadelman ext. 7711	Fans, air filters, generators, magnetic tape heads, motors, power transformers
Byron Witt ext. 5417	Accelerometers, attenuators, batteries, ferrite cores, crystals and SAW, delay lines, oscillators, terminations, transducers, speakers, microwave components

Please direct your inquiries to the appropriate component engineer.

Bob Aguirre, manager
Electromechanical Component Engineering

Screening specs for switching components

Business units experiencing unacceptably high failure rates on electromechanical switching components might consider using screened versions of the parts. We currently have several of these screened parts, but this method is not being used as extensively as we believe it merits.

Techniques for weeding out components that are likely to fail are well-known. However, the implementation of these techniques is an economic question. If the cost of weeding out the weak component is greater than the cost of repair, screened parts should not be used. If, on the other hand, the weeding-out cost is less than the repair or replacement cost, then it makes good economic sense to do so.

There are three ways this "screening beyond normal specs" can be accomplished. Screening can be done by the vendor as an added step in the manufacturing process; it can be done by specialized testing companies; or it can be done at Tektronix.

For example, on the 148-0107-00, a TO-5 size relay, we require the supplier to do extensive miss-detection tests as part of the manufacturing process. On the 148-0086-02, the relays are given extensive screening tests by Relay Testing Service before we receive them. Devices which we are prepared to design a screening test in-house include: relays, switches, fuses, lamps and similar electromechanical parts.

If you are using one of these component types and think such screening might be beneficial, please contact us and we will make an analysis. We will estimate the factor by which failures can be reduced, in addition to estimating the cost of doing so. If you find the estimate favorable, we will establish a screening specification and support it.

If you would like more information about these screening procedures, please contact me on ext. 7711, or stop by 58-299.

Jim Deer
Electromechanical Component Engineering

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