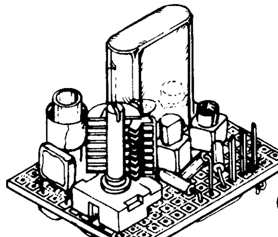
component news

March 19, 1979 COMPANY CONFIDENTIAL Issue 269

Oscillator *n* (L. *oscillatus*): one that oscillates, as in



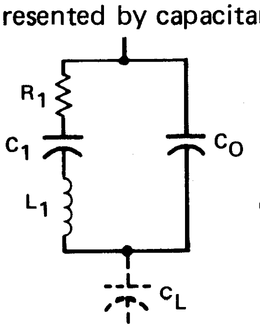
by Byron Witt
Electromechanical
Component Engineering

A crystal oscillator has three basic components: an amplifier, a feedback network and a crystal, all in a loop. At turn-on, oscillations build up to the point where non-linearities decrease the loop gain to unity. The frequency adjusts itself until the total phase shift is 0° or 360°.

The crystal has a large reactance-frequency slope and is located in the feedback loop so that it has the maximum influence on the frequency of oscillation. Because the impedance of the crystal changes so rapidly with frequency, all other components can be considered to be of constant reactance at the nominal frequency of the crystal. If, after the crystal has adjusted its frequency to satisfy the phase shift requirement, the loop gain is not greater than unity, oscillation will cease.

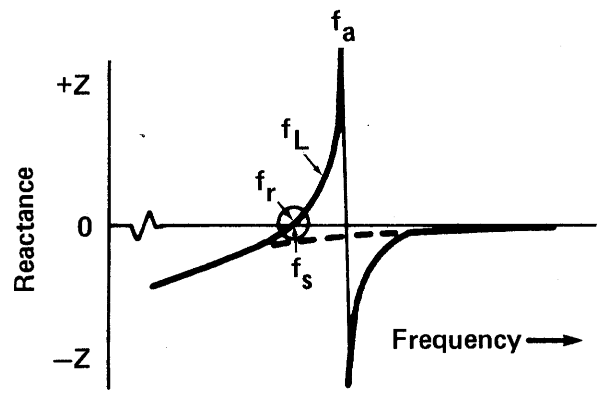
crystal characteristics

Before proceeding with basic oscillator design considerations, a discussion of crystal characteristics is in order. The quartz resonator is an extremely high Q device with excellent temperature stability. The equivalent circuit of a crystal is represented by capacitance, inductance and resistance.



where R_1 represents the losses in the crystal and mounting
C_1 represents the elasticity of the crystal
L_1 represents the mass of the crystal
C_O represents the electrode and holder capacitance
and C_L represents the load capacitance

The reactance-frequency plot of a quartz crystal looks like this:



where $f_s = \dfrac{1}{2\pi\sqrt{L_1 C_1}}$ the series resonant frequency

f_r = the frequency where $x_e = 0$ and, for practical purposes is equal to f_s

$f_L = \dfrac{1}{2\pi\sqrt{L_1 C_L}}$ where C_L is the circuit load capacitance

f_a = the maximum positive antiresonant reactance of the fundamental mode

$$= f_s\left(1 + \frac{C_1}{2C_O}\right)$$

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Normally the crystal is operated somewhere between f_s and f_a, the closer to f_a the worse the stability. The point we are more interested in is f_L. This is quite incorrectly called the parallel resonant point. Where f_L is situated on the frequency-reactance curve is determined entirely by the oscillator design. The slope of the curve at f_L is determined by basic crystal design. How far along the curve we can move the crystal in frequency is given by

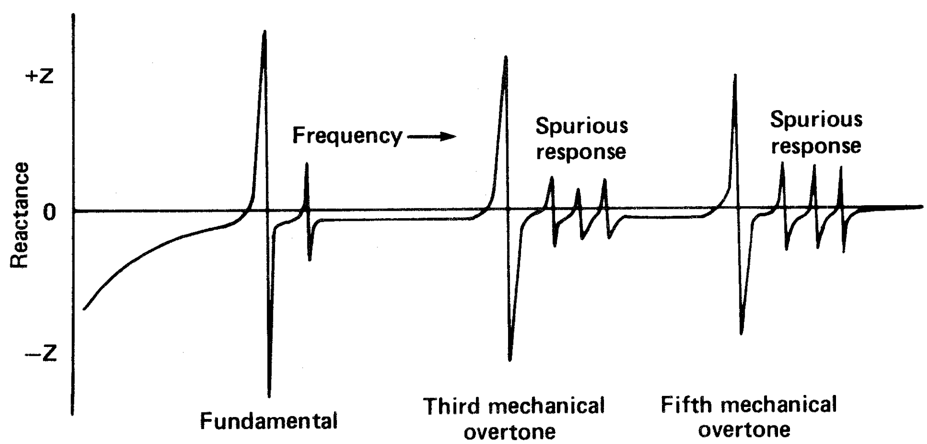
$$\Delta f = \frac{f_s C_1}{2(C_O + C_L)}$$

So, we must give the crystal manufacturers several pieces of information so that they can make a crystal that will work on frequency in the intended circuit. A method quite often used is to ship the manufacturer a mock-up of the circuit with the frequency and tolerance required over a given temperature range. Then, they can design a crystal to meet those requirements.

A more sophisticated approach is to furnish the manufacturer with the following:

1. The frequency and tolerance at room temperature.
2. The holder style.
3. The temperature range over which the unit must stay within tolerance.
4. The mode in which the oscillator works (series or antiresonant).
5. The value of C_1 or the Δf over which we want to move the frequency.
6. The load capacitance (antiresonant mode).
7. The series resistance (R_c) series mode.
8. Sometimes the Q required.
9. Sometimes spurious frequency information.

If the crystal must be for an overtone oscillator, we must also state *which* overtone (only odd overtones allowed!). The reactance-frequency plot extended to include the overtone frequencies looks like this:



The oscillator circuit must be designed to favor the frequency that we want. Otherwise, the oscillator will take off on the first frequency at which the non-linearities in the circuit reduce the gain to unity. Incidentally, the overtones are not exact multiples of the crystal fundamental frequency.

methods of oscillator design

There are three methods of oscillator design. The first and simplest is the experimental method where a known design is adapted to the particular requirement. In using this method keep in mind that mechanical arrangement usually affects performance, so the circuit must be thoroughly tested. The selection of active devices must also be done with care to ensure proper performance, lack of free running, and lack of spurious responses.

The second method is the Y-parameter method. The equations are:

$$Y_f Z_f + Y_i Z_O + Y_O Z_i + Y_r Z_r + \Delta Y \Delta Z + 1 = 0$$

where

$$\Delta Y = Y_O Y_i - Y_f Y_r, \quad \Delta Z = Z_O Z_i + Z_f Z_r$$

The equations for specific oscillator types are derived by determining the Z-parameters of the feedback network and substituting them into the equations above. Because they generally do not give accurate results, it is best to use them in conjunction with the experimental method.

The third approach is basically a power gain analysis and is usually limited to series mode oscillators. Phase shift considerations are taken care of by the experimental method, by getting the crystal to operate on frequency. The power gain required from the transistor must be sufficient to supply the output power and all the power losses in the circuit.

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The equation that must be satisfied is:

$$(P_{in}G_P) = P_L + P_{in} + P_d$$

where P_{in} = power to the transistor
G_P = the power gain of the transistor
P_L = output power to load
P_d = all other losses within the oscillator circuit

The steps are:

1. Determine transistor power gain.
2. Calculate the feedback network.
3. Calculate the ratio of output power to feedback power.
4. Determine the required impedance transformation ratio of the feedback network.

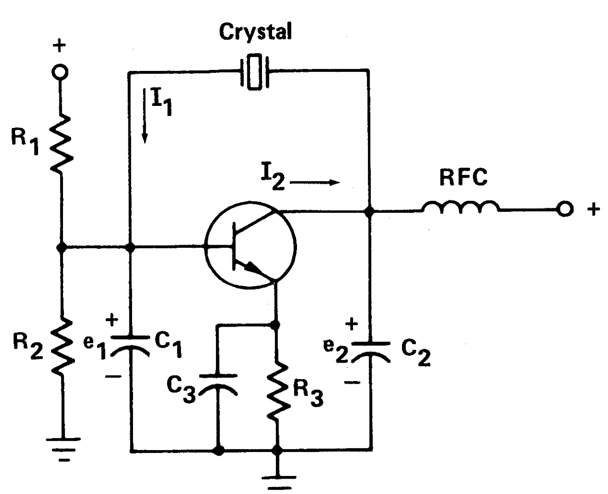
The equations required to accomplish the calculations are fairly straightforward, so they will not be listed here.

The power gain approach is one of the few approaches simple enough to be of practical value. Combined with the experimental approach, it will yield excellent oscillator designs.

oscillator circuits

The discussion of crystal oscillators will include four types. Three of these – the Pierce, Colpitts and Clapp – are actually the same circuit but with the ground point at a different location in the loop. The fourth is the gate oscillator which is most widely used in computer and microprocessor work.

the Pierce oscillator



In this oscillator the basic phase shift network is composed of C_1, C_2, and the crystal, which looks inductive. Referring to the impedance-frequency curves of the crystal presented earlier, the crystal operates in an antiresonant mode (commonly called parallel mode) at some point to the right of the series resonant point. The resonant circuit consists of the crystal, C_1, and C_2. The phase shift requirements are met by the frequency adjusting itself so that the crystal and C_1, considered alone, have a net reactance that is inductive and is resonated by C_2. Under these conditions the voltage at the base lags the collector voltage by 180°. The shift through the transistor is 180°, and the collector looks into a resistive load. The other requirement for oscillation is that the loop gain must be greater than one. After rigorous derivation the two equations boil down to:

$$gfeX_1X_2 \geq Re + K_1 \text{ (gain equation)}$$

$$X_1 + X_2 + X_e = 0 + K_2 \text{ (phase equation)}$$

where

gfe = real part of the forward transfer admittance
X_1 = $-1/\omega C_1$
X_2 = $-1/\omega C_2$
Re = effective crystal resistance
X_e = crystal reactance

K_1 and K_2 are corrective terms to make up for the difference between the theoretical and real-life situations. They are generally negligible.

In general, C_1 and C_2 should be made as large as possible but still allow the circuit to oscillate with two to three times the maximum permissible crystal resistance (Re). At higher frequencies C_1 and C_2 in series may become less than the desired load capacitance for minimum gain requirements. A good place to start is to let $C_1 = C_2 = 2C_L$. C_L is the load capacitance of the entire circuit presented to the crystal. If this does not allow sufficient gain, a small inductor must be placed in series with the crystal.

In some applications, it is desirable to introduce some emitter degeneration to reduce 1/F noise. In other circuits a tank circuit may be placed in the collector circuit to produce a frequency multiplier. In these circuits the crystal operates in

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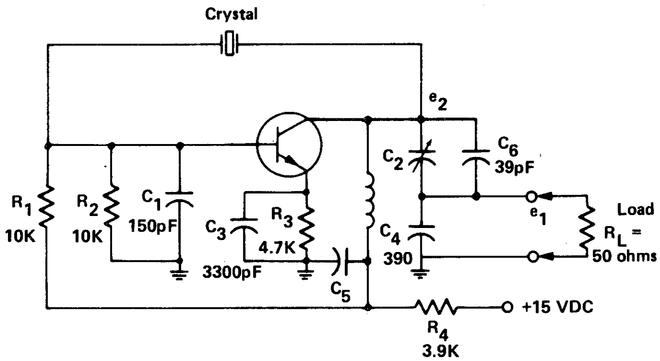
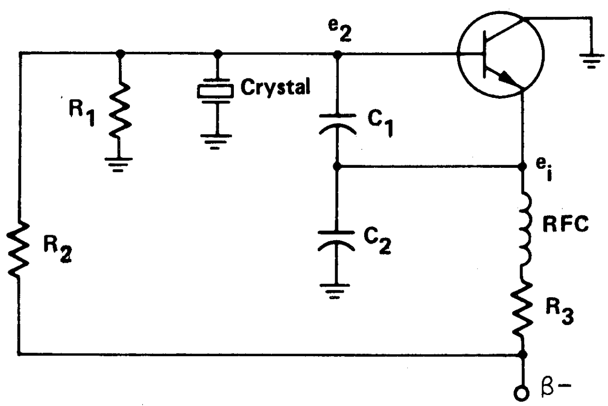
the fundamental mode. For frequencies above that obtainable with fundamental mode crystals, the overtone Pierce oscillator, containing a parallel resonant circuit in the collector circuit, is used.



This tank circuit must be tuned below the overtone frequency to present a positive reactance to unwanted frequencies. However, oscillations will occur at the desired frequency because the reactance is capacitive, and the phase requirement is met.

the Colpitts oscillator

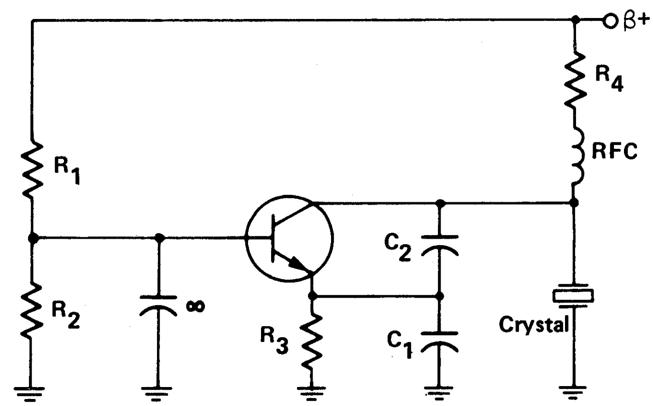


The Colpitts oscillator is actually a Pierce with the collector instead of the emitter grounded. The same two capacitors are resonant with the crystal in the same manner. In this case, the emitter load is:

$$Z_2 = \frac{(X_2)^2}{Re}$$

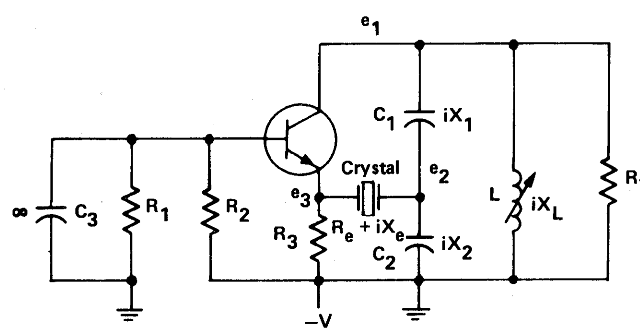
and is purely resistive. By the time we have boiled the equations down, we derive the same ones that were derived for the Pierce, except the K_1 and K_2 are indeed missing because they are truly negligible. Operation is generally limited to fundamental mode crystals.

the Clapp oscillator



The Clapp oscillator is actually a Pierce with the base grounded instead of the collector or emitter. If appropriate allowances for circuit strays are made, the same equations apply. The applications for this oscillator are also similar to the Pierce.

the grounded base oscillator



A variation on the Clapp is the grounded base oscillator. By the addition of an inductor from collector to ground and by moving the crystal to the junction of C_1 and C_2, and by connecting the other end to the emitter, a good, very high frequency (overtone) oscillator may be made. Frequency is limited to about 75 MHz.

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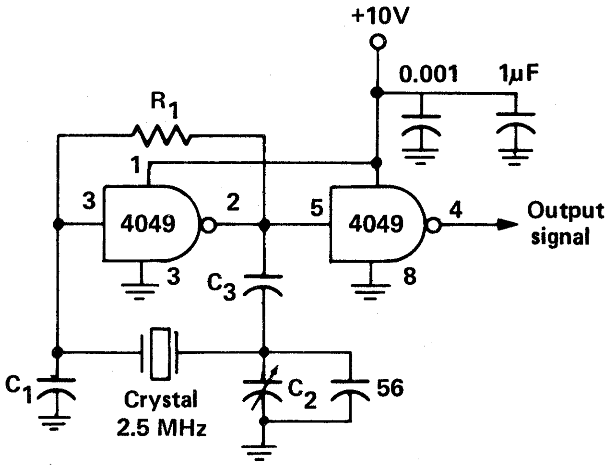
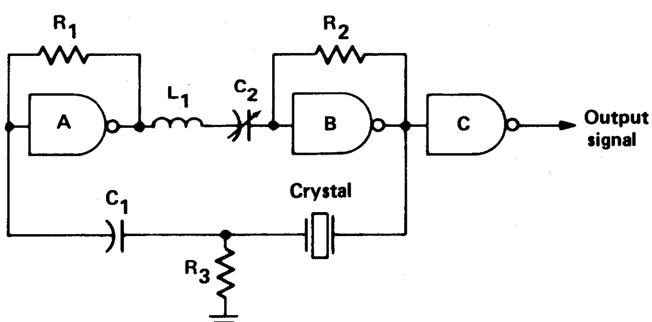
the gate oscillator



The use of logic gates is common where the oscillator output must drive digital hardware. These oscillators are less stable than those discussed previously, and are all prone to spurious oscillations and free running.

Lower frequency gate oscillators are usually CMOS. The frequency stability is not as good as transistor oscillators, but most of the applications do not require it. All of the requirements for oscillation exist and are satisfied in the same manner as previously discussed. The best approach is the experimental (cut and try) method, starting with the necessary components for the feedback network, the crystal, and the gate. It may not be possible to eliminate all of the free running or spurious modes of oscillation. If start-up conditions are met for more than one frequency, the one that reaches saturation first causes the others to die out. Layout changes and power supply bypassing may have to be tried, as well as paying attention to the effects produced by the second gate used as a buffer.

the dual gate oscillator

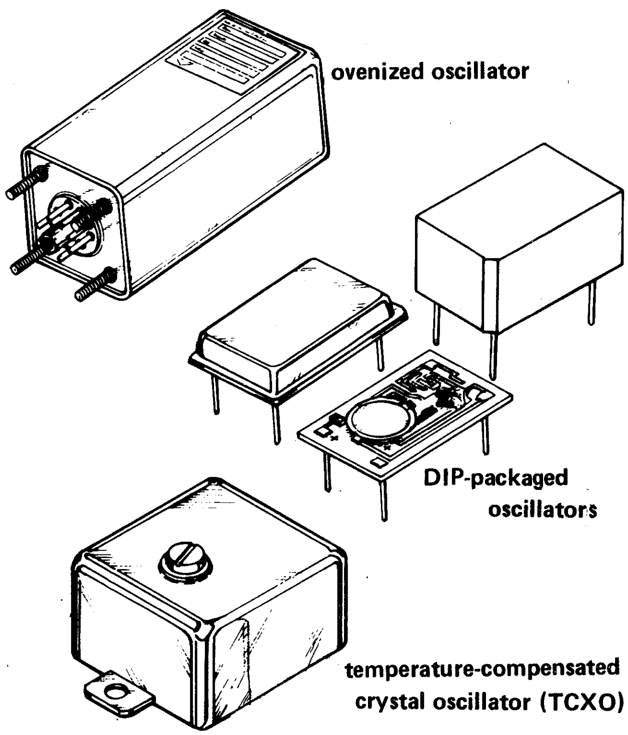


For frequencies higher than an few megahertz, it is necessary to use TTL. This oscillator may be either a single or multiple gate circuit. The latter usually is more prone to oscillate at the wrong frequency than the single gate.

Most integrated circuit oscillators use a CMOS gate or some variation of it with two pins to connect to the crystal and feedback network. They are quite numerous and will not be covered here. Follow the data sheet recommendations.

In conclusion, **all** oscillator circuits should be thoroughly tested for free running, spurious oscillations, and start-up characteristics. A good rule of thumb is to replace the crystal with a "pure" resistor of two to three times the largest equivalent resistance of the crystal you will experience. The circuit should oscillate near the desired frequency.

examples of oscillator packages



oscillator reference chart

On page 6 you'll find a chart that compares the oscillator types just discussed. If you have any questions about this article, or oscillators in general, feel free to contact me at 58-299, ext. 5417.

Byron Witt

Comparison of Crystal Oscillator Types

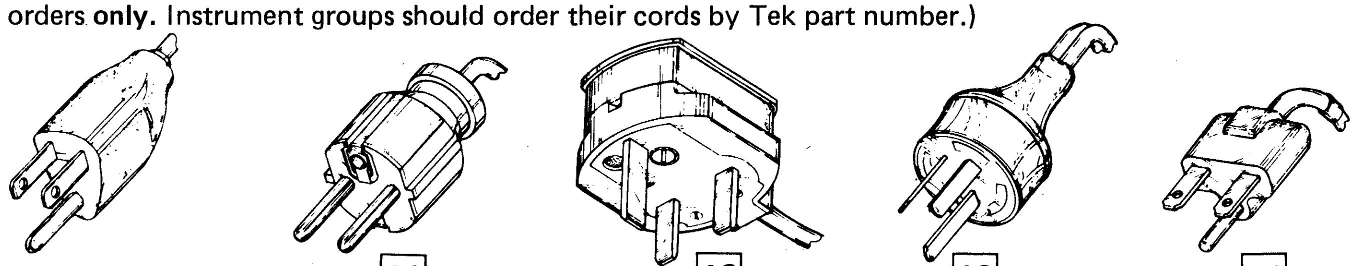
Oscillator Type	Recommended Frequency Range	Relative Frequency Stability	Power Output	Waveform	Ability to Operate Properly When Circuit Stray Capacitance and Inductance Are Large	Ability to Operate Over a Band of Frequencies Without Retuning	Ease of Design	Remarks
Gate	16 KHz to 20 MHz	Low	Moderate	Square wave	Good	High	Moderate	Recommended for logic level output in low-stability applications.
Pierce	100 KHz to 20 MHz	High	Moderate	Poor at low freq. fair to good above 3 MHz	Very good	High	Simple	Recommended unless one side of crystal must be grounded.
Colpitts	1 to 20 MHz	Moderate	Moderate	Fair to good	Good	High	Moderate	Generally inferior to Pierce and Clapp. Recommended if Pierce and Clapp cannot be used.
Clapp	2 to 20 MHz	Moderate to high	Moderate	Fair to good	Good	High	Moderate	Generally inferior to Pierce. Recommended if one side of crystal must be grounded. Should not be used with low supply voltages.
Impedance inverting Pierce	20 to 75 MHz	High	Low	Good	Fair	Low	Difficult	Recommended if large stray inductances cannot be eliminated from crystal switch.
Grounded base	20 to 150 MHz	Moderate	High	Good	Poor	Low	Moderate	Recommended if stray inductance and capacitance can be kept low.

Power cords P/N'd for international orders

To better accommodate our international customers and to comply with local regulations, Tek is implementing a new instrument option. This option will provide our customers with any one of several internationally approved power cord and plug configurations.

As this is implemented, incoming instrument orders from our international market groups will call out an "option number" (A1, A2, A3 or A4) which denotes the required power cord/plug to be used. In the past, international orders were shipped to their foreign destinations with the standard, North American power cord and plug, then modified for each customer's need. Modifying the power cord and plug consists of removing the complete power cord and plug unit, then installing a new one. This is done so the power cord and plug will comply with safety standards in the country where the equipment will be used. Modifying power cords at the destination has become very expensive and wasteful, as well as time-consuming.

To facilitate this change-over, we have modded-in part numbers for our high-usage power cords so that each instrument group can order the appropriate power cord and plug configuration. The following power cords have been Tek part-numbered. (The option numbers will be used by order processing on incoming orders **only.** Instrument groups should order their cords by Tek part number.)



Power Cord Option Number →	A1	A2	A3	A4
North American 120V/15A	**Universal Euro 220V/16A**	**UK 240V/15A**	**Australian 240V/10A**	**North American 240V/15A**
161-0017-00 →	161-0017-13	161-0017-14	161-0017-15	161-0017-16
161-0033-03	161-0033-27	161-0033-28	161-0033-29	161-0033-30
161-0033-04	161-0033-31	161-0033-32	161-0033-33	161-0033-34
161-0033-07	161-0033-35	161-0033-36	161-0033-37	161-0033-38
161-0033-09	161-0033-39	161-0033-40	161-0033-41	161-0033-42
161-0049-00	161-0049-06	161-0049-07	161-0049-08	161-0049-09
161-0066-00	161-0066-09	161-0066-10	161-0066-11	161-0066-12
161-0107-00	161-0107-03	161-0107-04	161-0107-05	161-0107-06

The use of option A3 (Australia) may require a different strain relief. A strain relief that we've found acceptable in most cases (when replacing SVT cordage with the Australian equivalent) has been part-numbered (358-0624-00). In all cases, an example of each power cord/strain relief should be pull-tested to ensure compliance with safety standards.

In addition to supplying the proper power cord and plug, other changes are required on equipment being shipped internationally.

- The equipment must be set for the appropriate line voltage.
- The proper fuse must be installed.
- The fuseholder must be one of the touchproof types.

See **Component News 262,** page 7, for information on a safety-rated fuseholder that may meet your needs.

We realize that this new system may take some getting used to. Also, there will be a need for new mods on power cords not already Tek part-numbered. If you have any questions regarding existing part-numbered cords and plugs, or safety testing, contact **Wally House, (ext. 7192).** If you have questions or problems relating to this system in general, or need help setting up a new part number, contact **Joe Joncas (ext. 6365).**

Fusible resistors offer many advantages

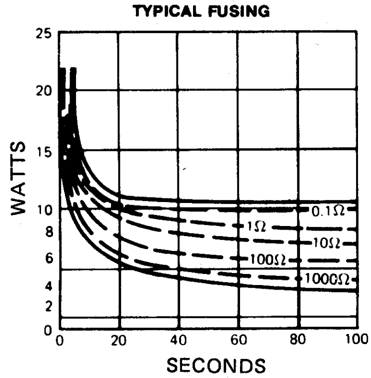
Do you need a resistor that's flameproof, meets UL-494-2, has a better resistance-temperature characteristic and voltage coefficient, plus improved load stability? A new, fusible resistor we've evaluated has these advantages over standard carbon composition resistors.

The resistors are manufactured by IRC-TRW, and are available in 2-watt (BWF) and 1-watt (BW-20F) versions. The power ratings are double that of the same size hot-molded carbon composition or carbon film resistor. The instantaneous overload can be 4 to 1000 times the rated power, not to exceed 1000 volts.

After performing a dynamic overload test (after one minute of rated wattage the power is increased by 100% every two seconds) we found no flaming, and at power levels of 25 times and greater the current surges weren't more than double the normal power current. Also, a paper tissue (Kimwipes type 9004 or equivalent) did not ignite when resting across or beneath the resistor. These parts are self-extinguishing within ten seconds after exposure to external flames.

BW-20F

TYPICAL FUSING



The following resistors have been Tek part-numbered:

308-0764-00	2.7Ω ±5%, 2W	(1W AB size)
308-0822-00	1.3Ω ±5%, 1W	(½W AB size)
308-0788-00	20Ω ±5%, 1W	(½W AB size)

Range: 0.1Ω to 1000Ω, 5% and 10% tolerances.

In addition, Corning Glass Works has released a ¼-watt carbon size fusible resistor that performs like the 1% T-O metal film type. The resistor (FZ4) has a ±150 PPM/°C temperature coefficient and is rated ¼-watt at 70°C.

We performed the following flammability test on these parts: one minute of rated power, then 120% for an additional 30 seconds. The wattage was increased to 200%, then 100% per step for a duration of one to five seconds. There should be no flaming, and under constant current conditions the resistors must open (resistance in excess of 1000 times the initial value) at the overload in less than the times specified below.

20 X rated wattage	<10 seconds
32 X rated wattage	<5 seconds
40 X rated wattage	<4 seconds
64 X rated wattage	<2 seconds
80 X rated wattage	<1 second
100 X rated wattage	<1 second

Range: 1Ω to 100Ω, 1% to 10% tolerances.

There are no assigned part numbers for these resistors. If you have questions about any of the fusible resistors discussed here, please contact me on ext. 6520.

Ray Powell

Handling CRT shields

CRT shields are very important because they reduce the effect that energy fields have on the CRT trace. For the shield to perform properly it is best treated (annealed) as the last step in the fabrication process. Annealing removes stresses in the metal induced during fabrication. An unstressed shield is required to produce the needed energy field attenuation.

Although shields typically aren't a problem component, certain precautions should be observed so that stresses aren't reintroduced during assembly.

When fitting a shield into an instrument do not hammer, pry, bend or deform it from its original configuration. Shields that are bent during shipment, or dropped during assembly, should not be used until they are checked for proper signal attenuation.

For more information, please call **Frank Javorsky, ext. 6391.**

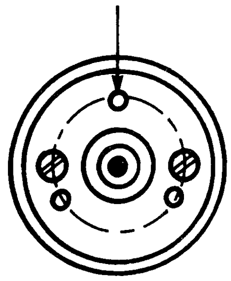
New gear motor meets specifications

Life testing has just been completed on a new gear motor assembly from Escap. The motor is approximately 1 inch in diameter, 2.6 inches long and operates on 15 volts DC or less. It produces 14 oz-in. operating torque in either rotational direction at 87 RPM. The maximum repetitive stall torque is 20 oz-in. The motor is an ironless rotor (very low rotational mass) type with exceptionally low power consumption (100 mA at full recommended operating load).

Initial testing showed the gear box not capable of meeting the minimum operating requirement (500 hours) under worst-case loading conditions. Escap then redesigned the gear box, and further testing showed the assembly operating within specification limits after 1400 hours of operation.

Our test results showed the gear box failing long before the motor. No signs of motor wear were observed after 1400 hours of operation. Note that the gear box should be oriented in the proper direction with respect to the side load (see illustration) in order to get maximum life from the gear box.

Escap seems to be the only vendor at present who can produce an assembly that meets our electrical and mechanical requirements. A detailed specification is available at Reprographics.



Fixtures have been set up in Component Engineering to life test DC gear motors, simulating worst-case torque, mass and speed requirements. At present, work is underway on a mass test DC motor station to life test high speed DC motors.

If you would like more details, please contact **Bill Stadelman, ext. 7711.**

Semiconductor market share estimates

Preliminary estimates of semiconductor shipments by the leading US suppliers show a 24.2% growth for 1978. The table below ranks the major manufacturers by annual sales in millions of dollars. This is a preliminary estimate provided by DATAQUEST, Inc.

1978 Worldwide Shipments by U. S. Semiconductor Suppliers
(dollars in millions)

	ICs	Discretes[1]	Other[2]	Total
Texas Instruments	$666	$254	––	$920
Motorola	318	351	$11	680
National	325	45	51	421
Fairchild	275	105	––	380
Intel	300	0	––	300
RCA	127	113	––	240
Signetics	205	0	––	205
ITT	70	100	––	170
General Instrument	80	55	––	135
AMD	132	0	––	132
Mostek	120	0	––	120
General Electric	2	111	––	113
Harris	85	0	––	85
Hewlett-Packard	0	81	––	81
Rockwell	80	0	––	80
International Rectifier	0	70	––	70
Intersil	60	9	––	69
AMI	67	0	––	67

1 Includes optoelectronic devices

2 Consists primarily of hybrids and modules

Transistor life testing continues

For the past two years, Component Reliability Engineering has been conducting 96-hour accelerated life tests on purchased transistors to measure the percentage of early life failures (freaks). A summary of the latest results follows this article.

This failure information is useful in selecting second sources and in calculating transistor failure rates (see Figure 1). This graph shows the average failure rate versus junction temperature for plastic and metal can transistors, assuming that 10% of the transistor population is composed of freaks. All new second sources now must contain ⩽10% freaks. Because the failure rate is directly proportional to the percent of freaks, calculations can easily be made for populations containing freaks of other than 10%.

Example: Plastic transistor;
junction temperature (T_J) = 70°C;
2% freaks.

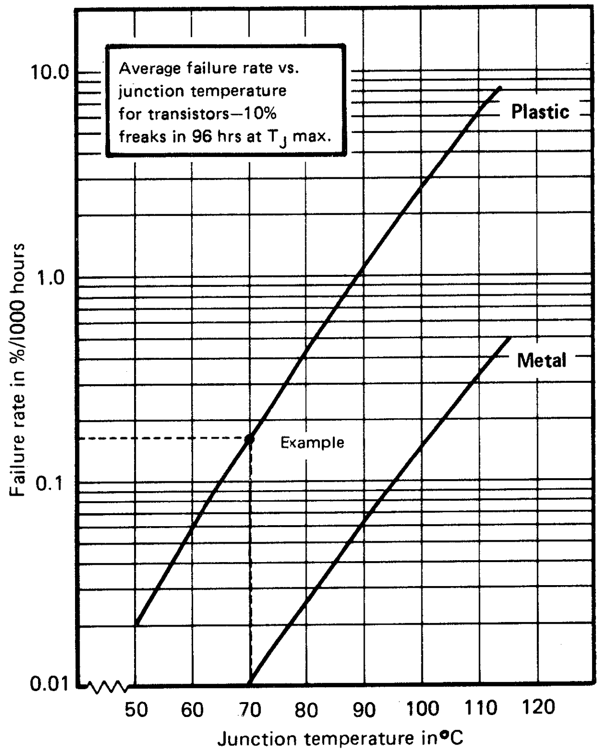
$$\text{Failure rate} = \frac{2\%}{10\%} \times \frac{0.17\%}{1000\text{ hrs.}} = \frac{.034\%}{1000\text{ hrs.}}$$

Note that this failure rate is an average value and is valid only until all the freaks have failed (~1000 hrs at T_J = 100°C).

In CRE's life tests a failure is classed as the failure of any transistor to meet a DC specification. This implies that the actual circuit failure rate may be considerably less than that calculated by using the above formula, depending on the circuit tolerance to specific parameter shifts.

We recommend that transistors be operated at junction temperatures of less than 70°C. If a specific application requires a low failure rate at junction temperatures much greater than 70°C, 100% screening may be advisable.

Contact **Art Fraser (ext. 6511)** for information on the failure mode, extended life test results and other information needed to calculate actual circuit failure rates.



Transistor Life Test Results

Part Number	Vendor	Qualified?	Freak %
151-0103-00	Motorola	yes	8
	Fairchild	yes	20
	T. I.		12
151-0126-00	Motorola	yes	4
	National	yes	4
	Fairchild	Q	4
151-0127-00	Motorola	Q	6
	Fairchild	yes	2
151-0136-00	N.S.	VS	2
151-0150-00	Motorola	yes	10
	Fairchild	yes	10
	RCA	yes	40
151-0188-00	NEC	0	2
	Motorola*	VS	2
	T. I.	yes	8
151-0190-00	T. I.	yes	10
	NEC	yes	2

continued on page 11

Transistor Life Test Results (continued)

Part Number	Vendor	Qualified?	Freak %
151-0190-06	Motorola	yes	4
(151-0460-00)	T. I.	yes	2
151-0192-00	Motorola*	VS	2
151-0195-00	Motorola	yes	4
151-0199-00	Motorola	yes-P	15
	Motorola*	VS	2
151-0207-00	G. E.	yes	16
	T. I.	Q	22
151-0216-00	Motorola	yes	2
	T. I.	yes	2
151-0219-00	Fairchild	yes	6
	T. I.	yes	2
151-0220-00	Motorola	yes	2
	T. I.	yes	2
151-0221-00	Motorola	yes	38
	Motorola*	VS	2
151-0224-00	NEC	Q	2
151-0225-00	Motorola	yes	2
	National	yes	2
	Fairchild	yes	2
151-0228-00	Fairchild	yes	8
151-0250-00	Fairchild	yes	12
151-0254-00	T. I.	yes	4
	G. E.	yes	89
	National	yes	4
151-0259-00	Fairchild	yes	4
151-0260-00	Motorola	yes	2
	T. I.	yes	4
151-0269-00	Fairchild	yes	2
151-0270-00	Fairchild	yes	6
	T. I.	yes	10
151-0271-00	T. I.	yes	2
151-0273-00	Motorola	yes	6
	T. I.	VS	2
151-0276-00	Motorola	yes	2
151-0279-00/01	Fairchild	yes	25
	Motorola	yes	25
	National	yes	12
	T. I.	yes	25

Part Number	Vendor	Qualified?	Freak %
151-0180-00	T. I.	yes	2
	Motorola	yes	2
151-0289-00	Motorola	yes	25
151-0291-00	RCA	yes	2
151-0309-00	Motorola	yes	2
151-0311-01	Motorola	yes	2
151-0323-00	Motorola	yes	2
151-0324-00	Motorola	yes	2
151-0331-00	Motorola	VS	2
151-0333-00	Motorola	yes	4
	Sprague	yes	2
151-0334-00	Motorola	yes	2
151-0335-00	Motorola	yes	2
151-0341-00	National	yes	4
151-0342-00	National	yes	4
	Fairchild	yes	4
151-0347-00	Motorola	yes-P	6
	Fairchild	E	54
	National	yes	50
	NPC	yes	3
	Motorola*	VS	18
151-0350-00	T. I.	yes	62
	Fairchild	yes	10
151-0358-00	G. E.	yes	5
151-0390-00	Motorola	yes	2
151-0391-00	Motorola	yes	4
151-0405-00	SGS	VS	4
151-0423-00	Fairchild	yes	2
	Unitrode	VS	65
	NEC	yes	5
151-0424-00	NPC	VS	46
	Motorola	VS	2
	Fairchild	yes	2
151-0425-00	Motorola	yes	8
151-0426-00	G. E.	yes	2
151-0427-00	National	yes	11

continued on page 12

Transistor Life Test Results (continued)

Part Number	Vendor	Qualified?	Freak %
151-0429-00	SGS	VS	4
151-0435-00	Motorola	yes	15
151-0439-00	Motorola	VS	4
151-0440-00	Motorola	VS	2
151-0443-00	Motorola	yes	15
151-0444-00	Motorola	yes	2
151-0444-02	Motorola	VS	2
151-0450-00	Motorola	yes	2
151-0451-00	RCA	yes	10
	SSS	no	15
	Motorola	yes	10
151-0458-00	Fairchild	yes	2
	Motorola	Q	2
151-0462-00	RCA	yes	20
	Motorola	yes	5
	Fairchild	yes	5
151-0463-00	Motorola	VS	2
151-0464-00	RCA	yes	4
151-0472-00	Fairchild	yes	2
	NEC	yes	2
151-0478-00	T. I.	no	15
	RCA	yes	5
	Motorola		5
151-0482-00	T. I.	VS	50
151-0496-00	Motorola	VS	2
151-0497-00	MATS	VS	2
151-0632-00	Motorola	yes	100†
151-0656-00	SGS	VS	4
151-0657-00	SGS	VS	17

Notes: VS – Vendor Sample

Q – In qualification processes

* – New silicon nitride passivation and epoxy package

E – Emergency source

P – Phenolic package

† – Under investigation

"Downy" cleans static-free surfaces

We've found that the best cleaner for static-free benchtops is **Downy Fabric Softener.**

In the past we recommended using freon, but even this compound has contaminants which dissolve the anti-static agent in the benchtops. This reduces the effectiveness of the benchtops in spite of removing the dirt.

The fabric softener not only cleans the benchtop but leaves a detergent residue which reinforces the static-dissipating properties of the bench. This cleaning method should be effective with any pink polyethylene items.

There is a possibility of sodium contamination from the Downy. The Environmental Lab is checking this condition out at the present time. If you have any questions, contact **Paul Phelps (58-287), ext. 7615.**

Sorry...Wrong number

In the last issue of **Component News** (Issue 268) we gate you Central Stores' number for ordering NiCd calculator batteries. Unfortunately, the number we listed was for gauze bandages, not batteries! The correct number is **14106.**

Component applications review defined

What happens during a review?

Initially, I go through the diagrams and parts lists to match potential problems and to determine which component engineers need to review these diagrams.

While we frequently spot potential application problems this way, we don't do a thorough circuit analysis except for those circuits that seem questionable upon superficial examination. (Product Evaluation managers have accepted the responsibility for circuit analyses within their groups.) We do look for potential application problems that are not readily anticipated from a review of the component specifications, but that have been observed during component characterization and/or evaluation.

Predominantly, I receive comments about *which* component is being used, rather than *how* the part is used. These comments are often as important as defining application problems, because they're based on quality, reliability or availability criteria.

After the component engineers complete their reviews, I prepare a report for the requestor (usually the project leader). I also attend the release meeting and report our findings.

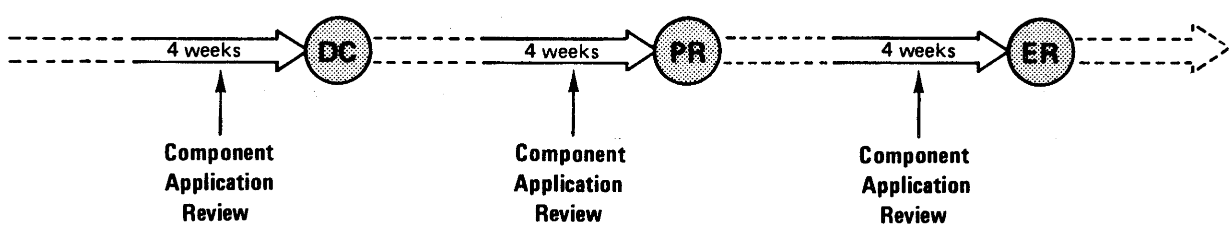
What we need to perform a review

At minimum, we need a set of diagrams and parts lists, both listing circuit symbols. An EIS (Engineering Instrument Specification) helps us understand the instrument's function and environmental specifications.

Having the instrument "in hand" for a day, or even a few hours, is particularly helpful in determining the application of electromechanical components. For example, the mechanical smoothness of a potentiometer connected to the front panel knob through a long, small diameter extension shaft is much more critical than that of one mounted directly on the panel.

When should a review be scheduled?

We should be notified at least four weeks before the scheduled release meeting. While change negotiations can and do occur after this meeting, the component applications review should be completed beforehand.



The review is most beneficial prior to DC when changes are less disruptive (see illustration). The New Product Introduction Guidebook asks the review question at DC, PR and ER phases. If component applications changes subsequent to the last review are not extensive, a good approach is to circle the changed or added circuits or components on the diagrams, then submit the new diagrams and parts lists for another review four weeks prior to the release date. In this case, only the changed applications will be reviewed, but the entire parts list will be scanned.

For more information

If you have any questions about the component applications review, or if you need more information, please contact me at 58-299, ext. 5698.

Virg Tomlin
Component Engineering

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)*

cable tracer colors reviewed

Paragraph 7.3, Tek Standard 062-2877-00, states: "Identical tracer colors will not be used consecutively." However, there are some cables that do have these tracers. Because of possible misinterpretation, efforts should be made to adhere to this standard. The present non-conforming cables will be reviewed for possible withdrawl from use.

Carol Jones (ext. 6224), Technical Standards
Larry Berry (ext. 6887), SPECS Engineering
Loren Spohn (ext. 38-7346), Wire Prep Prod. Eng.

new drafting standard

Drafting Standard 062-3761-00 "Unspecified Conditions on Drawings" is now available from Reprographics (ext. 5577). The standard identifies some normal Tek practices which are not usually shown on the drawing. The conditions are not all-inclusive, but are those that have been agreed upon by the consensus of people involved in developing the standard. If you have any additional items you would like to add, please let me know by memo or phone. You can also obtain a "Request for Revision of Standard" form by calling ext. 7976.

Roy Eckelman (ext. 7451), Technical Standards

indexes to reference documents

Computer indexes to reference standards and other documents contained in the Technical Standards files are being placed in the library areas of Beaverton and Wilsonville. Indexes will also be available in new library sections at Walker Road (index is currently in Tom Boggs' area) and at Vancouver (currently in Carol Schober's area) when these branches are established. Suggestions for further distribution of the Indexes are welcome....call ext. 7976.

new standards available at Reprographics

Test Method Standard 062-3535-00 and Finish Standard 062-2868-01 are available from Reprographics (ext. 5577).

Standard 062-3535-00, Bondability of Ribbon Cables, describes the test procedures necessary for measuring the force required to separate an individual wire from a bonded ribbon cable. This standard is to be used whenever it is necessary to establish or confirm a ribbon cable specification.

Standard 062-2868-01, Chromate Conversion Coating for Aluminum Die Casting Alloy 343.1, identifies the electro-chemical process, the tests used to confirm acceptability of the process and the drawing all-out for this alloy. Although this standard was developed for the Modular Packaging System castings, it should be considered where other applications of the 343.1 alloy are required.

notice to all holders of the Directory of Standards

A revision of the Directory of Standards is now being distributed. If you aren't sure whether you're listed with Technical Standards to receive updates to the Directory, please complete the coupon below and send to 58-187. Thank you.

Name ______________________ Delivery Station ______________

Ext. ______________________ Department ______________

IC socket selection criteria

Even though no sockets have been found that are entirely satisfactory and fulfill our requirements, Component Engineering is still looking for new sockets to evaluate. Some of the important criteria for choosing a socket are discussed here, along with some of the quality requirements that we have established.

Due to the fact that IC leads have been optimized for soldering-in, the lead dimensional variability we encounter, and the unspecified platings on leads, direct soldering is still considered the most reliable method for inserting pre-tested ICs.

selecting the optimum socket

The primary consideration in choosing an IC socket has been reliability, or minimum ohmic change in resistance after severe environmental stress. This has led to high insertion force requirements for tin-plated leads. Tek has not been able to control whether an IC package will have gold, silver or tin plating.

If gold-plated IC leads with sufficient plating and a diffusion barrier were available, then lower insertion force sockets could be utilized. A plating of 30 microinches of gold over 50 microinches of nickel is the minimum plating considered for reliable use. Our testing in this area includes humidity and sulfide tests to monitor environmental susceptibility.

lead tolerances important

Acceptability to a wide range of lead widths and thicknesses, as well as row and centerline spacings, are major considerations in the selection of IC sockets. A large target area is beneficial so that bent leads or non-standard spacings have a maximum chance of being led into the contact area without buckling. A cycle life of about ten cycles is considered to be the maximum a socket would see for all applications through manufacturing and field servicing.

Redundant contacts are desirable but not considered a necessity. Some manufacturers are using the socket body to back up the IC lead in the socket. This plastic back-up must not deform or creep. Environmental tests (including high temperature tests) have been used as the criteria for contact reliability in this area.

washability should be considered

An open socket design minimizes flux and solvent contamination while enhancing manufacturability. Solder barrier strips (plastic or paper) are considered a disadvantage to good washability. Even though open bottom designs may leave the contact open to solder wicking, we have had bad experiences with flux entrapment on designs with so-called anti-wicking wafers.

However, an anti-overstress barrier is an advantageous feature, because it prevents deformation of the contacts by scope probes and oversized adapters. If possible, these barriers should also be "unbreakable."

Open socket sides are desirable so that the IC leads may be accessible for clip-on probes. High barriers on the sides of the socket body are not preferred.

Field serviceability is enhanced with a removable socket body. This allows the contacts to be removed individually, and minimizes the possibility of damage to multi-layer boards. The availability of new de-soldering tools may lessen this requirement.

size and cost requirements

Size requirements always present a problem in socket selection. A 0.250-inch body height has been considered a maximum. There have been many constraints to require denser boards, such as smaller packaging and higher speed circuitry (the need for shorter board runs). Always consider that dense socketing is much more difficult to clean than densely soldered-in ICs.

Cost has been the last priority in our evaluations. The IC socket industry is becoming more competitive, and up to four cents per terminated lead is considered an acceptable cost for socketing ICs.

users survey

The following questionnaire (page 16) should help us determine your present and future needs for IC sockets. Please complete this survey if you utilize IC sockets in your area. Because we plan to follow up on this information, we're asking that you include your name and delivery station. If you have any questions about the survey, or IC sockets in general, contact me at 58-299, ext. 5417.

Peter Butler

IC socket application survey

Answer the following questions with regard to your IC socket use. Return the completed questionnaire to **Peter Butler, 58-299.**

1. Are redundant contacts required? yes ☐ no ☐
2. What orientation of socket spring to IC lead do you prefer? face grip ☐ edge grip ☐
3. Is an anti-overstress barrier necessary? yes ☐ no ☐
4. Is a removable socket body necessary? yes ☐ no ☐
5. What is the number of insertion/withdrawal cycles required? ____________
6. What are the maximum socket dimensions? ____________ body height
   ____________ body width
   ____________ body length
7. Are there any cost constraints? yes ☐ no ☐ If yes, please elaborate.
   ____
8. What is your estimated annual usage of IC sockets? ____________
9. What is the worst-case failure due to ohmic resistance increase you've seen? (maximum resistance allowable) ____________
   ____

These questions are optional:

What division do you work for? ____________

Your name ____________ Delivery station ________ Ext. ______

Return to Peter Butler, 58-299

Surplus power supplies for sale

MSD/STS Engineering has the following surplus power supplies for sale. Contact **Barb Mobley, (ext. 1434)** if you have any questions.

Vendor	Part Number	Description	Quantity	Unit Cost
Power Mate	SWA-5-K	5V, 150A, 47/63 Hz	10	$575
Power Mate	PXS-B-48	48V, 1.1A, 47/63 Hz	5	100
Power Mate	PXS-CC-120	120V, 1.5A, 47/63 Hz	4	200
Lambda	LGS-5-28-OV	30V, 9.6A	1	275
Lambda	LMD120	120V, 1.5A	1	225
Lambda	LGS-EE-5-OV	5V, 110A	1	400
Power Mate	UNI-30-DV	0-30V, 18A, 47/63 Hz	2	250
Lambda	LGS-5-24-OV	24V, 11.5A	1	250

Save this page

Engineering Services
COMPONENT ENGINEERS

Call the appropriate engineer listed below or stop by 58-299 for information on purchased components. (Note: The Digital Group is located at 58-125.)

ATTENUATORS	Byron Witt 5417
BATTERIES	Byron Witt 5417
BULBS	Peter Butler 5417
CABLES & HARNESS ASSEMBLIES	Rod Christiansen 5953
CAPACITORS	
ceramic	Harry Ford 6520
electrolytic, film	Don Anderson 5415
variable, mica	Alan LaValle 5415
COILS	Harry Ford 6520
CONNECTORS	Peter Butler 5417
CORES, ferrite	Byron Witt 5417
CRYSTALS & SAW	Byron Witt 5417
DELAY LINES	Byron Witt 5417
DIODES	
visible LEDs	Betty Anderson 6389
IR emitter, laser diode	Louis Mahn 6389
all others	Gary Sargeant 5345
DISPLAYS	Betty Anderson 6389
ELECTROMECHANICAL PRINTERS	Jim Deer 7711
FANS	Bill Stadelman 7711
FETs	Jerry Willard 7461
FIBER OPTICS, cables, emitters, decoders	Louis Mahn 6389
FILTERS	
air	Bill Stadelman 7711
crystal	Byron Witt 5417
light	Jim Deer 7711
line	Joe Joncas 6365/Herb Zajac 7887
FUSES, FUSEHOLDERS	Joe Joncas 6365
GASKETS	Rod Christiansen 5953
GENERATORS	Bill Stadelman 7711
HARDWARE	Rod Christiansen 5953
HEAT SINKS	Jim Williamson 5345
INDUCTORS	Harry Ford 6520
INTEGRATED CIRCUITS	see microcircuits
JOYSTICKS	Jim Deer 7711
KEYBOARDS	Jim Deer 7711
KNOBS	Rod Christiansen 5953
LAMPS, LAMP SOCKETS	Peter Butler 5417
LIGHT-EMITTING DIODES	Betty Anderson 6389
MAGNETIC TAPE HEADS	Bill Stadelman 7711
METERS	
digital panels	Chris Martinez 7709
general	Joe Joncas 6365
MICROCIRCUITS	
A/D converters	Chris Martinez 7709
analog switches	Jerry Willard 7461
bubble memory devices	Brad Benson 6302
CCD/analog	John Hereford 6700
CCD/digital	Bob Goetz 6302
CMOS devices	Wilton Hart 7607
communications	Matt Porter 7461
comparitors	John Hereford 6700
D/A converters	Don Gladden 6700
EAPROMs	Bob Goetz 6302
EPROMs, PROMs	Gene Stout 6003
ECL devices	Don VanBeek 5414
FPLAs, PALs	Carl Teale 7148
MICROCIRCUITS, continued	
high speed logic	Don VanBeek 5414
linear devices	Don Gladden 6700
low-power Schottky TTL	Ernie Estrada 7148
MOS (general)	Bill Pfeifer 6303
operational amplifiers	John Hereford 6700
regulators, linear	Chris Martinez 7709
regulators, switching	Jim Williamson 5345
RAMs, dynamic	Bob Goetz 6302
RAMs, static	John Carlson 6003
ROMs	Gene Stout 6003
Schottky TTL	Don VanBeek 5414
TTL devices	Ernie Estrada 7148
MICROPROCESSORS	Carl Teale 7148
bit-slice microprocessors	Carl Teale 7148
peripherals and interface	Jim Howe/Bill Pfeifer 6303
Z80, 8080, 8085	Wilton Hart 7607
MICROWAVE components	Byron Witt 5417
MONITORS	Harry Ford 6520
MOTORS	Bill Stadelman 7711
MULTIPLIERS, high-voltage	Gary Sargeant 5345
OEM	Jim Deer 7711
OSCILLATORS	Byron Witt 5417
PHOTOCOUPLERS	Louis Mahn 6389
POTENTIOMETERS	Gene Single 5302
POWER CORDS/receptacles/plugs	Joe Joncas 6365
RAW MATERIALS, metals, plastics	Rod Christiansen 5953
READOUT DEVICES	Louis Mahn 6389
RELAYS, mechanical & solid state	Paul Johnson 6365
RESISTORS	
fixed	Ray Powell 6520
variable	Gene Single 5302
SCRs, SCSs	Paul Johnson 6365
SHIELDS	Harry Ford 6520
SPARK GAPS	Peter Butler 5417
SLEEVES, insulating	Rod Christiansen 5953
SPEECH, input/output	Jim Deer 7711
SOCKETS	
crystal	Byron Witt 5417
all others	Peter Butler 5417
SWITCHES	
general, solid state	Joe Joncas 6365
reed	Paul Johnson 6365
TERMINAL PINS	Peter Butler 5417
TERMINATIONS	Byron Witt 5417
THERMISTORS	Ray Powell 6520
TRANSDUCERS	Byron Witt 5417
TRANSFORMERS	Byron Witt 5417
power	Bill Stadelman 7711
TRANSISTORS	
field-effect	Jerry Willard 7461
phototransistors	Louis Mahn 6389
power	Jim Williamson 5345
small signal, arrays	Matt Porter 7461
triacs, unijunctions	Paul Johnson 6365
TUBING, metal	Rod Christiansen 5953
WIRE	Rod Christiansen 5953

Revised 3/1/79

MRO, Production & Engineering
PURCHASING BUYERS

Buyer Name	Ext./Del. Sta.	Buyer No.
Glenn Johnson	7128/58-274	01, 1H
Gordon Stewart	7120/19-677	02
Harriet Frank	7929/58-274	03, 1D
Don Adams	6695/76-337	04, 4A
Karel Strand	7919/58-274	05, 1P
Cal Bjerke	6603/16-815	06
Mel Swire	7571/48-320	07
Bill Wendt	7844/58-274	08, 1V, 44
George Roussos	7927/58-274	09
Clyde Deardorff (Vancouver)	7370/08-439	1W
Dick Tollisen	7911/58-274	10, 1Z
Ron Wetzler	7172/58-274	12, 1C, 1G
Art Peterson	7913/50-283	13
Jack Connor	5277/19-677	14
———	———	15
Ed Zilk	5449/58-274	16
Frances Lockhart	6430/15-000	17
———	———	18
Lloyd Davidson	6195/58-274	19
Bill Hart	5376/13-856	20
Harold Fritzler	6425/58-274	21
Bill Isaacson	7694/22-780	22
Paul Tripp	5575/48-217	23
Russ McKichan	7922/58-274	24, 1F
Jim Seed (Walker Road)	1161/94-323	25
Ron Kennedy	7573/48-320	26
Larry Fisher	6854/19-677	27
Dave Elliott	7916/58-274	28, 1E
Bill Hart	5376/13-856	29
Rex Gedney	7125/16-815	30
Glenn E. Ross	7915/58-274	31, 1B
Art Merrill	5472/22-780	32
Sharon Webb (Library)	7912/58-274	33
Ron Brown (Wilsonville)	2257/60-757	34, 2W
Ed Holzschuh (Wilsonville)	2258/60-757	35, 1A
Ed Kolb	7814/38-216	36
———	———	37
Ken Stucki, Kathie McDaniel	7923/58-274	38, 1T
Mildred MacDanold (Walker Road)	1259/94-323	39
Larry Dougherty	7302/19-677	40
Debbie Walbert	5576/48-217	41
Dave Lemas	7931/58-274	42
Andy Forbes	5583/22-780	43
Bill Wendt	7844/58-274	44, 1V, 08
———	———	45
Dave Elle	6059/58-274	46
Harry Wilson	7779/58-274	47, 2V
Christy Lynch	6854/19-677	48
Judy Paxson	7126/16-815	49

SUBCONTRACT BUYERS

Buyer Name	Ext./Del. Sta.	Buyer No.
Jim Benson	7835/19-364	2B
Anita Wright	7588/38-301	2E
Jim Morrow	5578/16-805	2M
Bob Jennings	5895/16-805	2N
Billie Branson (Vancouver)	7273/08-202	2P

Manufacturing Engineering
COMPONENT QUALITY CONTROL

This group is responsible for maintaining the quality level of the components used in our manufacturing areas (both purchased and Tek-made). The engineers listed below can be contacted at 19-194.

Engineer, ext.	Responsibility
Vince Bail, 6938	Bulbs, relays, motors, crystals, cords, miscellaneous electrical
Emerson Beer, 5034	Sockets, connectors, wire
Myron Bidiman, 7783	Contact for all purchased component problems
Lee Crocker, 7383	Contact for all Tek-made component problems
Dennis Crop, 6402	Transistors, diodes
Delano Dalesky, 5037	CRTs, quality control statistics, special projects
Frank Javorsky, 6391	Mechanical components, hardware
Paul Lamer, 5276	Integrated circuits
Neill Martin, 7642	Switches, circuit boards
Ken Nordling, 6938	Potentiometers, resistors
Harry Tanielian, 6405	Capacitors
Horst Zittlau, 6404	Mechanical components, hardware

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
✓ 290-0584-00 290-0586-00 290-0638-00	Mallory	PC-mount aluminum electrolytic capacitor	Larry Meneghin, ext. 7268

Mallory capacitors with lot dates 7839 through 7847 have severe end-seal problems which allow electrolyte leakage. All of these parts currently in stock should have been run through the 85 C screening process (see **Component News 208**, page 8), denoted by a red dot on the top of the can. These parts are all in the one inch diameter can.

✓ 156-0958-00	Burr-Brown	D/A converter (DAC 801)	Don Gladden, ext. 6700

Tektronix is single-sourced to Burr-Brown for this device. We expect the usage of this part to increase greatly in the future, and finding a second source is very important. I have evaluated the DAC 801 from Analog Devices and it meets or exceeds the Burr-Brown part in all areas *except* the following:

	Burr-Brown	Analog Devices
Output Impedance	15KΩ	6.6KΩ
Output Voltage Compliance	±2.5V	+10V, −1.5V

If these parameters would adversely affect anyone, please call Don Gladden.

ComponentNewsNewComponents

Vendor	No.	Description	When available	Tek P/N	Approx. cost	Engineer to contact
		analog devices				
Intersil	ICL7109	Converter, A/D, 12-bit, 33mS	now	--------	$7 (1K qnty)	Chris Martinez, 7709
Signetics	NE5034	Converter, A/D, 8-bit, 17μS	now	--------	$15 (100s)	Chris Martinez, 7709
Analog Devices	AD 574	Converter, A/D, 12-bit, 25μS	now	--------	$36 (100s)	Chris Martinez, 7709
Analog Devices	AD 570	Converter, A/D, 8-bit, 25μS	now	--------	$13.50 (1K)	Chris Martinez, 7709
Analog Devices	AD 571	Converter, A/D, 10-bit, 25μS	now	--------	$21.50 (1K)	Chris Martinez, 7709
National	LM338K	Voltage Regulator, adjustable, 5A, 3 term. TO-3 package	samples	--------	$3.65	Chris Martinez, 7709
National	LM10	Op amp, 1.1V operation, LM308 specs, with reference	samples	--------	$2	John Hereford, 6700
Signetics	NES534N	Op amp, low noise, drive 600Ω, 12V/mS slew rate	now	156-1338-00	$0.75	John Hereford, 6700
TI	TL287	Op amp, dual, biFET, low offset voltage (0.5mV)	4/79	--------	$5	John Hereford, 6700
Plessey	SP9687	Comparator, dual, ECL, 4nS max. delay	samples	--------	$12	John Hereford, 6700
		optoelectronic & passive devices				
Dale	MSP08CO1-224G	Resistor, fixed, 8-pin SIP, 2%, 7–220KΩ	4/79	307-0668-00	$0.25	Ray Powell, 6520
Caddock	MG716	Resistor, fixed, film, 9MΩ 1% axial lead	4/79	325-0332-00	$2	Ray Powell, 6520
Corning	FP31003J	Resistor, axial lead, power film,3W	4/79	--------	$0.13	Ray Powell, 6520
		digital devices				
Nat./Fairchild	40098B	Hex Tri-state inverter	now	--------	$0.60	Wilton Hart, 7607
AMD	74S161	STTL, 4-bit SYNC CNTR, w/clear	now	--------	---------	Don Van Beek,5414

announcements

Hobby Fair III scheduled

The Engineering Activities Council recently announced that it will sponsor Hobby Fair III in July, 1979. Hobby Fairs are exhibits of engineering hobby and "G-job" projects. Hobby Fair I (1977) and Hobby Fair II (1978) included only microprocessor projects, but this year's fair is open to engineering projects in all disciplines.

Because space is limited, the Engineering Activities Council will select participants from among applicants.

If you would like to exhibit a project at Hobby Fair III, call Dave Armstrong (Digital Accessories Design) on ext. 5244 or write to 19-092. Applications must be in by *June 1, 1979.*

GPIB consulting service

Do you:

- Need help on a GPIB problem?
- Have trouble getting your GPIB system up?
- Have a good GPIB idea?
- Have the solution to a GPIB problem others might be facing?

The Digital Products Coordination Group has a GPIB consulting service to assist you. For details contact **Steve Joy (58-526), ext. 5285.**

Motorola databook availability

Following is the most recent listing of databooks available from Motorola:

Databook	**Availability**
Volumes 1, 2, 3 (Discrete)	Out of print
Replacement Volumes:	
Power Data Book	Now
RF Data Manual	3/79
Rectifier Data Manual	5/79
Zener Diode Data Manual	5/79
Small Signal Data Book	9/79
FET Data Book	9/79
Optoelectronics Data Book	9/79
Tuning Diodes (w/revised RF manual)	1/80
Volume 6 (Linear ICs)	Out of print
Replacement Volumes:	
Interface Circuits Data Book	5/79
Industrial Linear Circuits Data Book	5/79
MECL Data Book	3/79
CMOS Data Book	Now
Low-power Schottky Data Book	Now
Microcomputer Data Library	Now
Handbooks	
MECL System Design Handbook	Now
Voltage Regulator Handbook	Now
Basic Integrated Circuit Engineering	Now

MPU Literature (Currently Available)

Basic Microprocessors and the 6800

Introduction to Data Communication (MC6854)

M6800 Applications Manual

M6800 Programming Reference Manual

If you have any questions about this literature, please contact Lola Janes (ext. 6867).

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