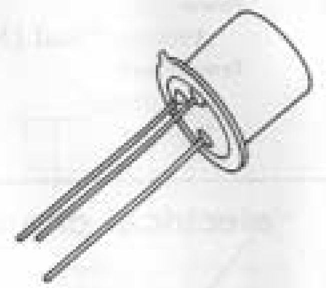
Silicon Complementary Unijunction Transistor

D5K1

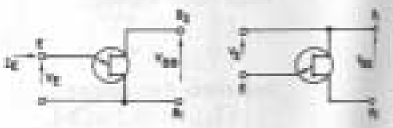
COMPLEMENTARY UNIJUNCTION



The General Electric D5K1 Complementary Unijunction Transistor is a silicon planar, monolithic integrated circuit. It has unijunction characteristics with superior stability, a much tighter intrinsic-standoff ratio distribution and lower saturation voltage.

FEATURES

- Guaranteed stability of better than .6% from −15°C to +65°C and better than 1.0% from −55°C to +150°C
- Low leakage current: less than 10nA
- Ability to temperature compensate and calibrate at room temperature
- Up to 100 kHz operation



Standard Unijunction　　Complementary Unijunction

WHAT IS A COMPLEMENTARY UNIJUNCTION TRANSISTOR?

The General Electric D5K is a silicon planar passivated semiconductor device with characteristics like those of a standard unijunction transistor except that the currents and voltages applied to it are of opposite polarity.

We have chosen to use this polarity so that standard NPN planar passivated transistor processing techniques can be used. This results in a unijunction having superior stability and better uniformity than any unijunction previously available. The much tighter spread of intrinsic-standoff ratio now available is a significant advantage. For most applications, the polarity is not important.

WHAT CAN THE D5K DO?

The General Electric D5K can be used in most applications now using standard type unijunctions. Its unique stability and uniform properties make it ideal for stable oscillators, timers, and frequency dividers.

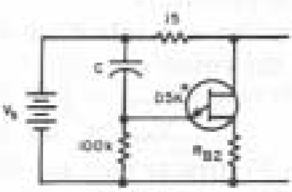
The key advantage of the D5K over conventional UJT's is its predictability over the specified temperature range. This allows an engineer to use design curves to select the correct R_{B2} compensating resistor instead of having to perform expensive temperature testing on individual devices.

The D5K1 has been characterized especially for applications requiring the best possible stability over the extreme temperature range specified. For most applications, because of the tight R_{BBO} and η spread, the D5K1 can be compensated in a given circuit with one resistor value by selecting the proper R_{B2} from Figure 2. For even better stability, a designer only has to measure the R_{BBO} of a device at room temperature, determine the proper R_{BBO}/R_{B2} ratio from Figure 3, and insert the correct R_{B2}. Using this method, oscillators and timers can be built offering 0.5% stability over most temperature ranges used.

Frequency dividers can be built with larger countdown ratios and drastically lower capacitor sizes due to the stability and low charge to trigger value (Q_T). Another product advantage, low base 1 to emitter voltage drop at high current, allows generation of high outputpulses with *low* base to base voltages.

For further application information, refer to Application Note 90.72.

FIGURE 1



TEST CIRCUIT
*CUJT ONLY SUBJECTED TO TEMPERATURE CHANGE
ALL RESISTORS 1%

FIGURE 2

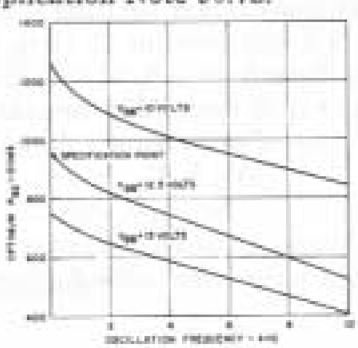
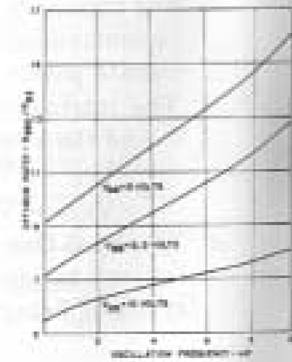
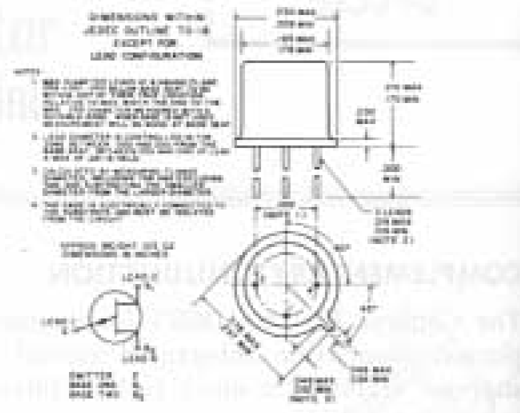


FIGURE 3



D5K1

absolute maximum ratings: (25° C free air)



	D5K1	
Voltage		
Interbase Voltage	30	V
Current (Note 2)		
Average Emitter (Forward)	150	mA
Peak Emitter (Forward) (Note 1)	2	A
Peak Reverse Emitter	15	mA
Power		
Average Total (Note 2)	300	mW
Temperature		
Operating	−55 to +150	°C
Storage	−55 to +200	°C

electrical characteristics: (25° C free air)

		Min.	Typ.	Max.	
Intrinsic Standoff Ratio (Note 3)	η	0.58	0.60	0.62	
Peak Point Voltage					
(V_{BB} = 5V)	V_P	3.2	3.45	3.7	Volts
(V_{BB} = 10V)	V_P	6.1	6.45	6.8	Volts
Interbase Resistance					
(I_{BB} = 0.1mA)	R_{BBO}	5.5	6.8	8.2	kohms
Emitter Breakdown Voltage					
(I_{EB1} = 10μA)	V_{EB1O}	8.0	9.5		Volts
Peak Point Current					
(V_{BB} = 10V)	I_P			5	μA
Valley Point Current					
(V_{BB} = 10V)	I_V	1	2		mA
Emitter Reverse Current					
(V_{EB1} = 5V)	I_{EB1O}		0.1	10	nA
Emitter Saturation Voltage					
(I_E = 50mA, V_{BB} = 10V)	$V_{E(sat)}$		1.1	1.5	Volts
Modulated Interbase Current					
(I_E = 50mA, V_{BB} = 10V)	$I_{B2(mod)}$		4	10	mA
Peak Pulse Voltage					
(Note 4)	V_{OUT}	3.5	4.5		Volts
Diode Voltage Drop					
(Note 3)	V_D	.30	.45	.60	Volts
Minimum Charge to Trigger					
(V_{BB} = 10V)	Q_t		50		pC
Turn-on Time (See Figure 7)	t_{on}			1	μsec.
Recovery Time (See Figure 7)	t_{rec}			10	μsec.
Relaxation Oscillator Frequency Shift from 25°C Value (See Figure 1, C = 0.1μF, R_{B2} = 950Ω, V_s = 12.5V)					
−15°C to +65°C			0.2	0.6	%
−55°C to +150°C			0.4	1.0	%

Notes:

1. For capacitor discharge, resistor current limiting is required for capacitors greater than 5 μF and recommended for all cases. (A minimum of 15 ohms is required for good temperature stability.)
2. Derate power and currents linearly to zero at maximum operating temperature.
3. The intrinsic-standoff ratio (η) is essentially constant with temperature and interbase voltage. It and the associated diode drop of peak point voltage are defined by the equations:

$$\eta = \frac{V_{P1} - V_{P2}}{V_{BB1} - V_{BB2}} \qquad V_D = V_{P2} - \eta V_{BB2}$$

Where: V_{BB1} = 10V ± .001V, V_{BB2} = 5V ± .001V

4. The Base-One Peak Pulse Voltage is measured in the circuit shown in Figure 4. This specification is used to insure a minimum pulse amplitude for applications in SCR firing circuits and other types of firing circuits.

FIGURE 4

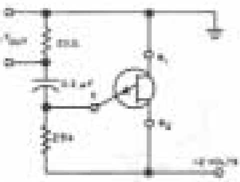
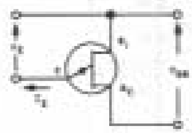


FIGURE 5



Complementary Unijunction Transistor symbol with nomenclature used for voltage and currents.

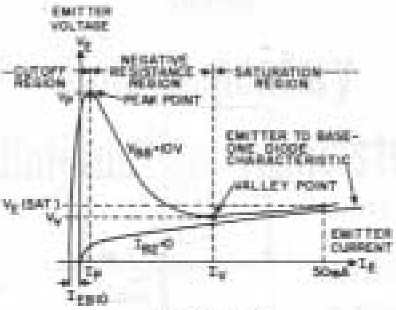


FIGURE 6

Static Emitter Characteristics curves showing important parameters and measurement points (exaggerated to show details).

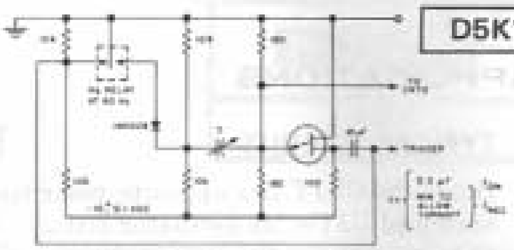
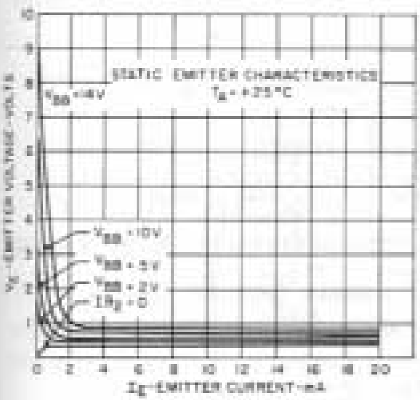
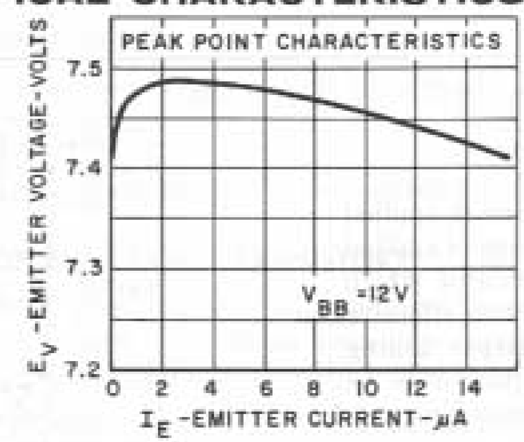
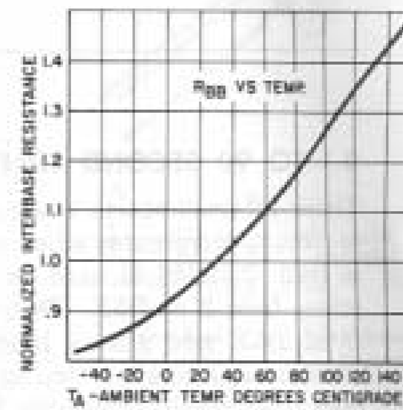


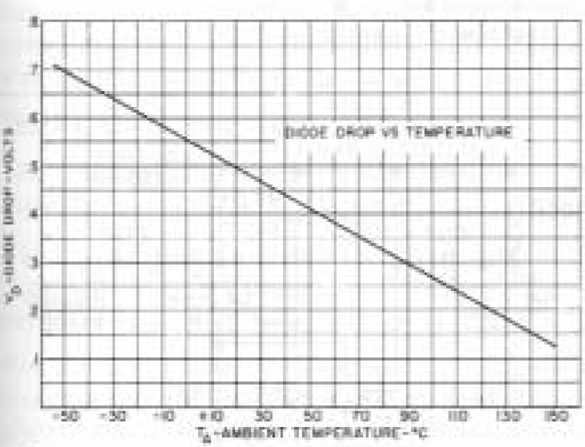
FIGURE 7

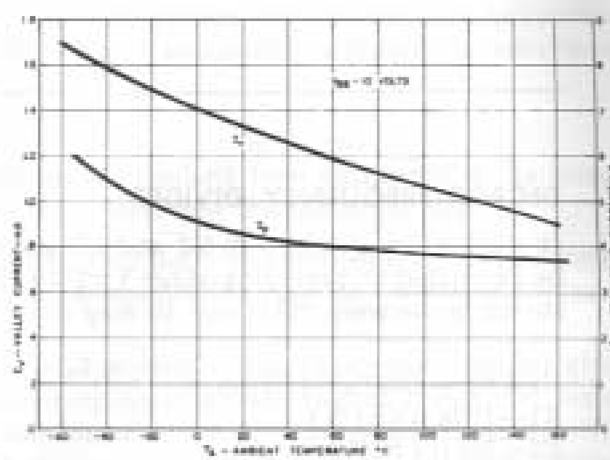
TYPICAL CHARACTERISTICS

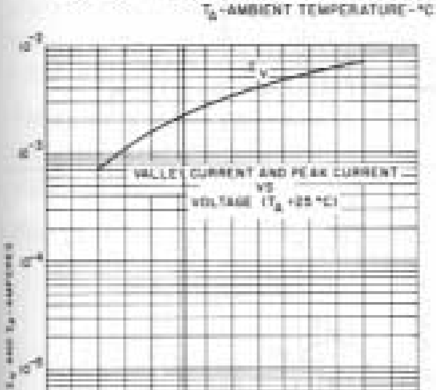


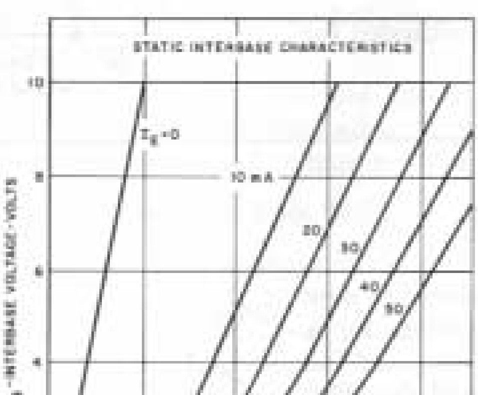


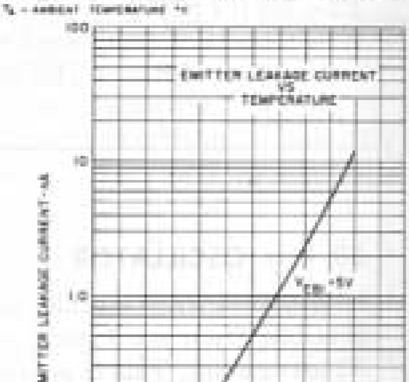








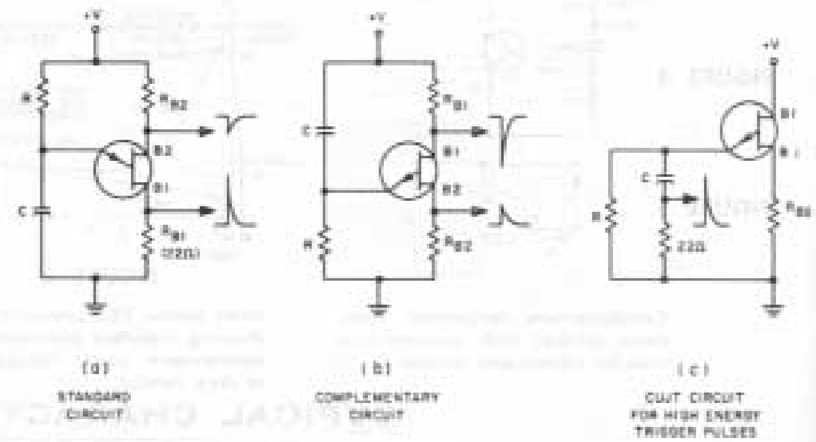




APPLICATIONS

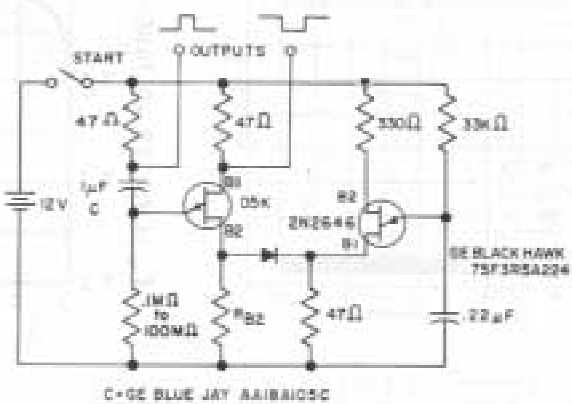
TYPICAL CIRCUITS

Since the CUJT has opposite polarities from standard UJT's, its oscillator circuit Figure (b) is "inverted." Figure (a) shows a positive, high energy pulse, while Figure (b) shows a negative. Circuit in Figure (c) results in positive pulses for SCR triggering.



0.1 TO 90 SECOND TIMER

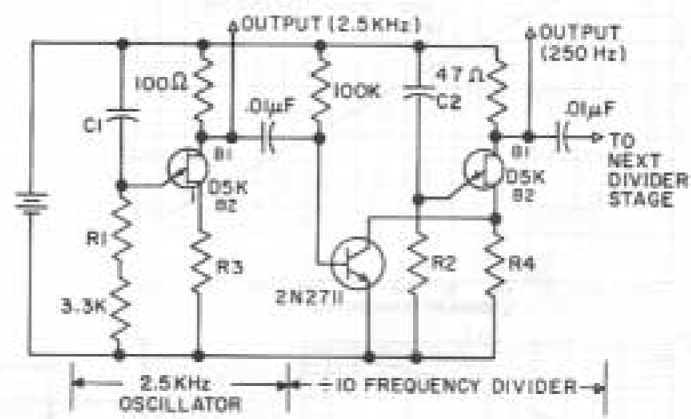
Timer interval starts when power is applied to circuit, terminates when voltage is applied to load. 2N2646 is used in oscillator which pulses base 2 of D5K. This reduces effective I_P of D5K and allows much larger timing resistor and smaller timing capacitor to be used than would otherwise be possible.



DECADE FREQUENCY DIVIDER

In next stage, product of R2 and C2 should be 10 × that of preceding stage (±2%). R2 should be between 27kΩ and 10 meg Ω.

C1 & C2—.0047 μF (±1%)
R1—100k Ω (±1%)
R2—1M Ω (±1%)
R3—R4—1k Ω (may need to be adjusted for variation of R_{BB} of CUJT)



50 kHz OSCILLATOR

Higher frequency (stable) oscillators are now possible. Here are typical components for a 50 kHz circuit. This is possible because of the more nearly ideal characteristics of the D5K (over conventional UJT's). One application for higher frequency is TV horizontal oscillators. Note the low R_{B2}.