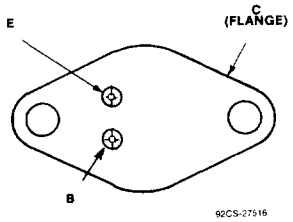
File Number 2374

Silicon N-P-N Darlington Power Transistors

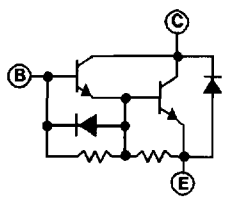
The GE10015, GE10016 and GE10020 thru GE10023 series of silicon n-p-n power Darlington transistors are designed for use in power switching applications requiring high-voltage capability and fast switching speeds. They are ideally suited for off-line switching power supplies, ac and dc motor controls, UPS systems, ultrasonic equipment, and other high-frequency power conversion equipment.

These devices are supplied in the JEDEC TO-204AE hermetic steel package.

TERMINAL DESIGNATIONS



JEDEC TO-204AE



DEVICE CIRCUIT

MAXIMUM RATINGS (25° C) (unless otherwise specified)

Voltages	Symbol	GE 10015	GE 10016	GE 10020	GE 10021	GE 10022	GE 10023	Units
Collector Emitter	$V_{CEO(SUS)}$	400	500	200	250	350	400	Volts
Collector Emitter	V_{CEV}	600	700	300	350	450	600	Volts
Emitter Base	V_{EBO}	8.0	8.0	8.0	8.0	8.0	8.0	Volts
Currents								
Collector Current (continuous)	I_C	50	50	60	60	40	40	Amps
Collector Current (peak)	I_{CM}	75	75	100	100	60	60	Amps
Base Current (continuous)	I_B	10	10	20	20	20	20	Amps
Base Current (peak)	I_{BM}	15	15	30	30	30	30	Amps
Power Dissipation								
Power Dissipation	$P_D(T_C = 25°C)$	250	250	250	250	250	250	Watts
Power Dissipation	$P_D(T_C = 100°C)$	143	143	143	143	143	143	Watts
	Derate above 25°C	1.43	1.43	1.43	1.43	1.43	1.43	W/°C
Temperatures								
Storage and Junction	T_{stg} and T_J	-65 to +200	-65 to +200	-65 to +200	-65 to +200	-65 to +200	-65 to +200	°C
Soldering[1]	T_L[1]	+275	+275	+275	+275	+275	+275	°C
Thermal Resistance	$R_{\theta JC}$	0.7	0.7	0.7	0.7	0.7	0.7	°C/Watt

1) Max. lead temperature for soldering purposes 1/8" from case for 5 seconds.

DEVICE ELECTRICAL CHARACTERISTICS
(Test conditions on next page ,T_C = 25°C except as noted)

STATIC		GE 10015	GE 10016	GE 10020	GE 10021	GE 10022	GE 10023	Units
(1) $V_{CEO(SUS)}$	Min.	400	500	200	250	350	400	Volts
(2) I_{CEV}	Max.	.25	.25	.25	.25	.25	.25	mA
I_{CEV} (T_C = 150°C)	Max.	5.00	5.00	5.00	5.00	5.00	5.00	mA
(3) I_{EBO}	Max.	350	350	175	175	175	175	mA
(4) $I_{s/b}$	See Figure	13	13	14	14	15	15	
(5) h_{FE}	Min.	25	25	75	75	50	50	
	Max.	—	—	1000	1000	600	600	
(6) h_{FE}	Min.	10	10	—	—	—	—	
	Max.	—	—	—	—	—	—	
(7) $V_{CE(SAT)}$	Max.	2.2	2.2	2.2	2.2	2.2	2.2	Volts
(8) $V_{CE(SAT)}$	Max.	5	5	4	4	5	5	Volts
(9) $V_{CE(SAT}$	Max.	2.5	2.5	2.4	2.4	2.5	2.5	Volts
(10) $V_{BE(SAT}$	Max.	2.75	2.75	3.00	3.00	2.5	2.5	Volts
(11) $V_{BE(SAT)}$, (T_C = 100°C)	Max.			3.5	3.5	2.5	2.5	Volts
(12) DIODE V_F	Typ.	1.9	1.9	2.1	2.1	1.9	1.9	Volts
	Max.	5.0	5.0	5.0	5.0	5.0	5.0	Volts
DYNAMIC								
OUTPUT CAPACITANCE	Typ.	580	580	580	580	580	580	pF
(V_{CB} = 10V, I_E = 0, f_{TEST} = 1MHz)	Max.	750	750	750	750	750	750	pF
SWITCHING								
(1) Resistive t_d	Typ.	.09	.09	.095	.095	.09	.09	μs
	Max.	.30	.30	.20	.20	.25	.25	μs
t_r	Typ.	.20	.20	.32	.32	.20	.20	μs
	Max.	1.00	1.00	1.00	1.00	1.00	1.00	μs
t_s	Typ.	1.45	1.45	1.50	1.50	1.45	1.45	μs
	Max.	2.5	2.5	3.5	3.5	2.5	2.5	μs
t_f	Typ.	.25	.25	.30	.30	.25	.25	μs
	Max.	1.0	1.0	.50	.50	.90	.90	μs
(2) Inductive t_s	Typ.	2.8	2.8	2.7	2.7	2.8	2.8	μs
(T_C = 100°C)	Max.	—	—	4.5	4.5	5.0	5.0	μs
t_f	Typ.	.21	.21	.30	.30	.21	.21	μs
	Max.	—	—	1.0	1.0	1.0	1.0	μs
t_c	Typ.	.68	.68	.85	.85	.68	.68	μs
	Max.	—	—	2.0	2.0	2.0	2.0	μs
(3) Inductive t_s	Typ.	1.6	1.6	1.8	1.8	1.6	1.6	μs
(T_C = 25°C)	Max.	3.0	3.0	—	—	—	—	μs
t_f	Typ.	.10	.10	.12	.12	.10	.10	μs
	Max.	.50	.50	—	—	—	—	μs
t_c	Typ.	.30	.30	.40	.40	.30	.30	μs
	Max.	1.0	1.0	—	—	—	—	μs

TEST CONDITIONS

STATIC

(1) $V_{CEO(SUS)}$ I_C = 100mA, V_{CLAMP} = V_{CEO} Rated	APPLIES TO All
(2) I_{CEV} V_{CEV} = Rated Valve, V_{BE} = -1.5V	APPLIES TO All
(3) I_{EBO} I_{EB} = 2.0 Volts	APPLIES TO All
(4) $I_{s/b}$ SEE APPROPRIATE FORWARD BIAS SECOND BREAKDOWN FIGURE	
(5) h_{FE} (a) I_C = 10A, V_{CE} = 5V (b) I_C = 15A, V_{CE} = 5V (c) I_C = 20A, V_{CE} = 5V	APPLIES TO GE10022, 23 GE10020, 21 GE10015, 16
(6) h_{FE} I_C = 40A, V_{CE} = 5V	APPLIES TO GE10015, 16
(7) $V_{CE(SAT)}$ a) I_C = 20A, I_B = 1A b) I_C = 30A, I_B = 1.2A	APPLIES TO GE10015, 16, 22, 23 GE10020, 21
(8) $V_{CE(SAT)}$ (a) I_C = 40A, V_{CE} = 5V (b) I_C = 50A, V_{CE} = 10V (c) I_C = 60A, V_{CE} = 5V	APPLIES TO GE10022, 23 GE10015, 16 GE10020, 21
(9) $V_{CE(SAT)}$ (a) I_C = 20A, I_B = 1A (b) I_C = 30A, I_B = 1.2A	APPLIES TO GE10015, 16, 22, 23 GE10020, 21
(10) $V_{BE(SAT)}$ (a) I_C = 20A, I_B = 1A (b) I_C = 30A, I_B = 1.2A	APPLIES TO GE10015, 16, 22, 23 GE10020, 21
(11) $V_{BE(SAT)}$ SAME AS (10) BUT T_C = 100°C	
(12) DIODE V_F a) I_F = 20A b) I_F = 30A	APPLIES TO GE10015, 16, 22, 23 GE10020, 21

SWITCHING

(1) RESISTIVE t_p = 50μs, Duty Cycle ≤ 2% a) V_{CC} = 250V, I_C = 20A, I_{B1} = 1A, I_{B2} = 4A b) V_{CC} = 175V, I_C = 30A, I_{B1} = 1A, I_{B2} = 4A	APPLIES TO GE10015, 16, 22, 23 GE10020, 21
(2) INDUCTIVE L = 100μh, I_{B1} = 1A, I_{B2} = 4A, T_C = 100°C a) I_C = 20A, V_{CLAMP} = 250V b) I_C = 30A, V_{CLAMP} = 175V	APPLIES TO GE10015, 16, 22, 23 GE10020, 21
(3) INDUCTIVE SAME AS (2), BUT T_C = 25°C	

NOTE: See FIGURE 22 for Switching Time Test Circuit.

TYPICAL CHARACTERISTICS

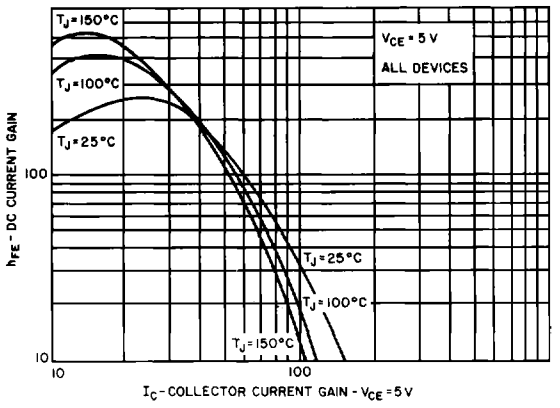


FIGURE 1. DC CURRENT GAIN (V_{CE} = 5V)

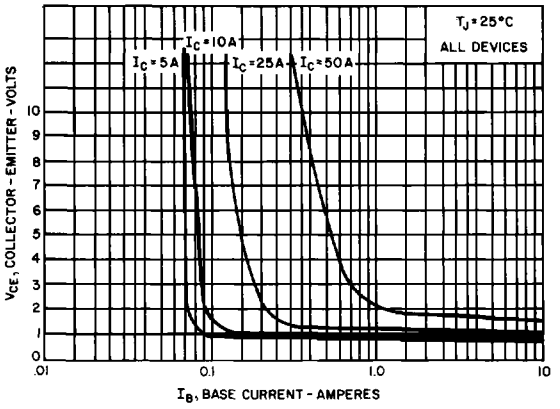


FIGURE 2. COLLECTOR SATURATION REGION

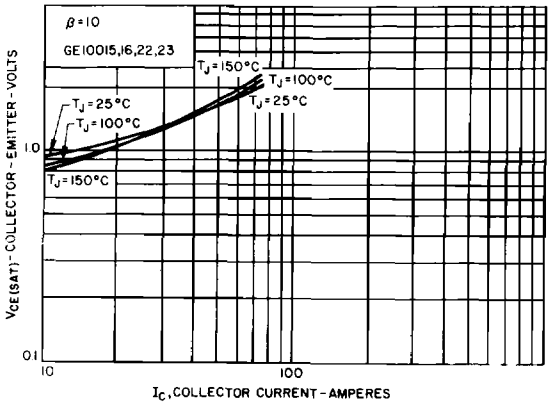


FIGURE 3. $V_{CE\ (SAT)}$ VS I_C

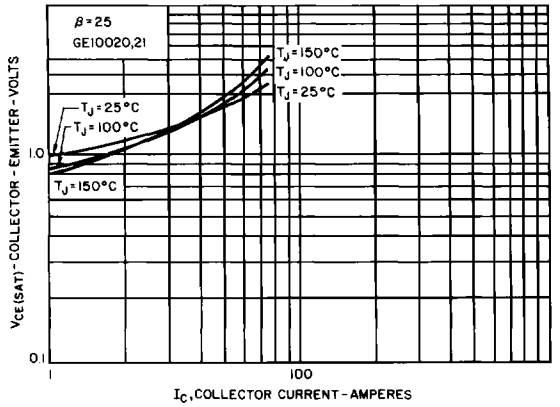


FIGURE 4. $V_{CE\ (SAT)}$ VS I_C

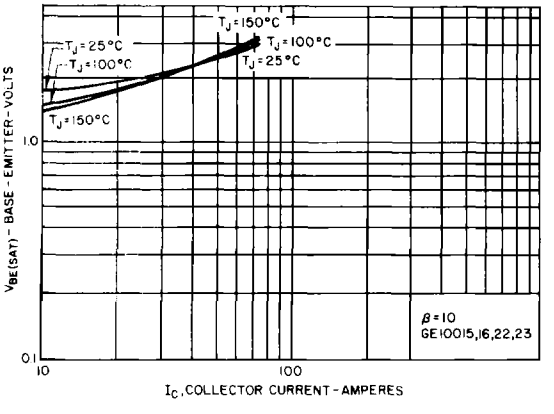


FIGURE 5. $V_{BE\ (SAT)}$ VS I_C

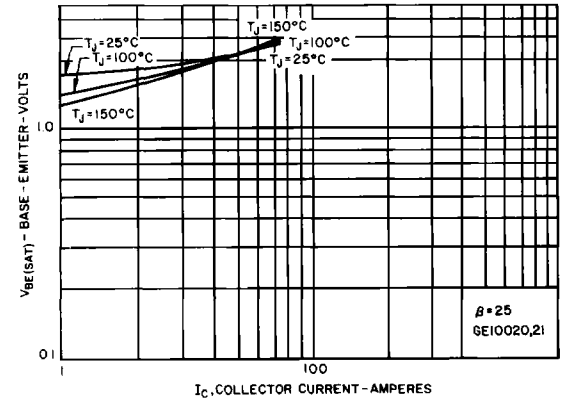


FIGURE 6. $V_{BE\ (SAT)}$ VS I_C

TYPICAL CHARACTERISTICS

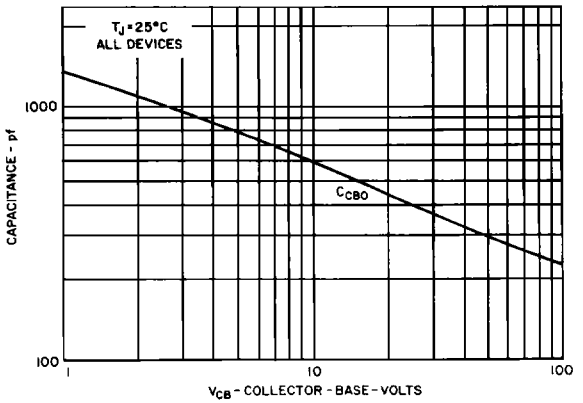


FIGURE 7. CAPACITANCE (C_{CBO})

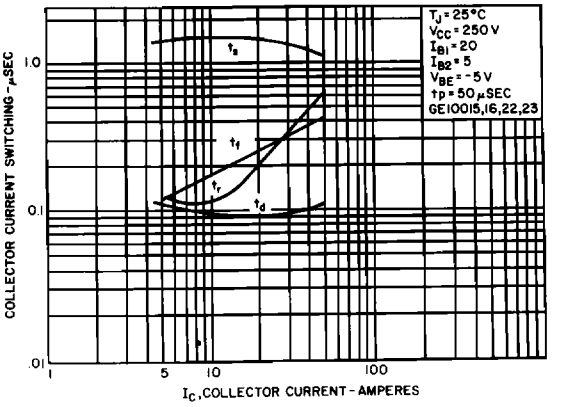


FIGURE 8. RESISTIVE SWITCHING PERFORMANCE

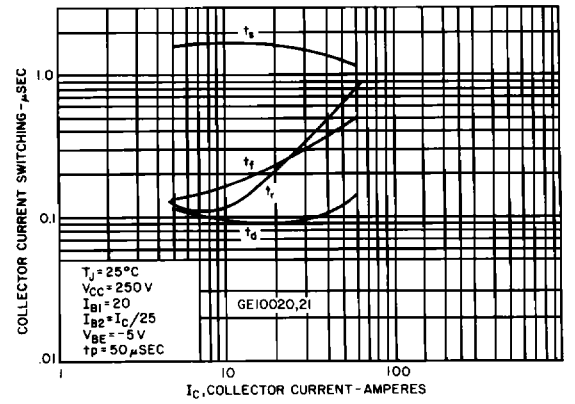


FIGURE 9. RESISTIVE SWITCHING PERFORMANCE

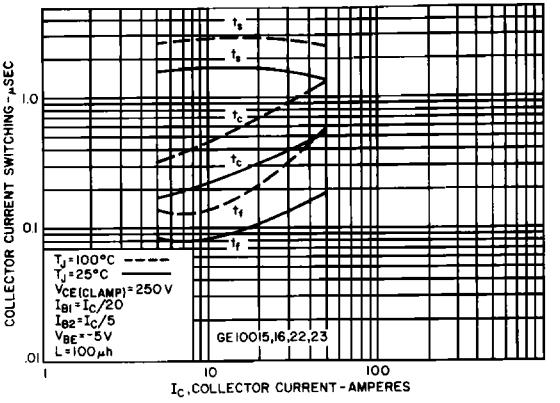


FIGURE 10. INDUCTIVE SWITCHING PERFORMANCE (CLAMPED)

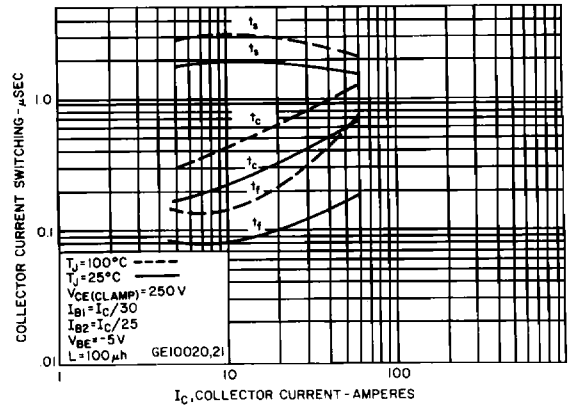


FIGURE 11. INDUCTIVE SWITCHING PERFORMANCE (CLAMPED)

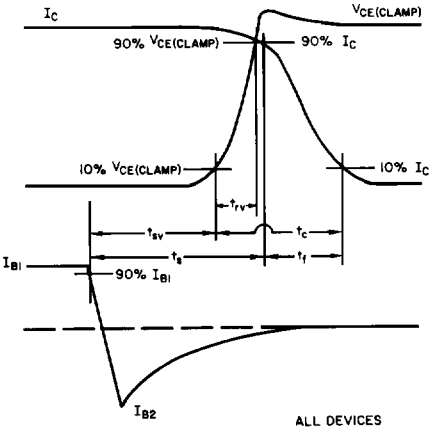


FIGURE 12. INDUCTIVE SWITCHING TURN-OFF WAVEFORMS

TYPICAL CHARACTERISTICS

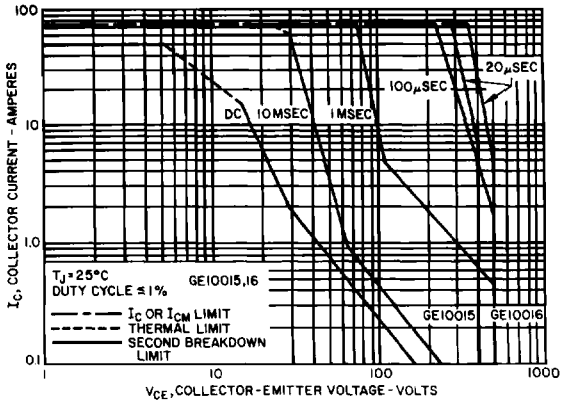


FIGURE 13. FORWARD BIAS SAFE OPERATING AREA

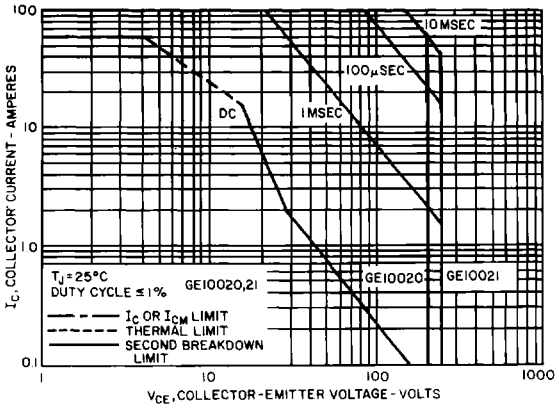


FIGURE 14. FORWARD BIAS SAFE OPERATING AREA

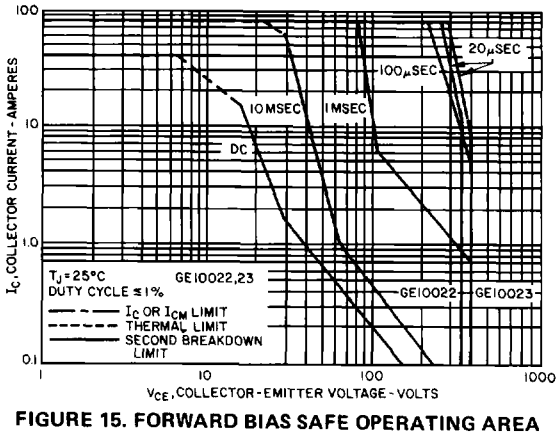


FIGURE 15. FORWARD BIAS SAFE OPERATING AREA

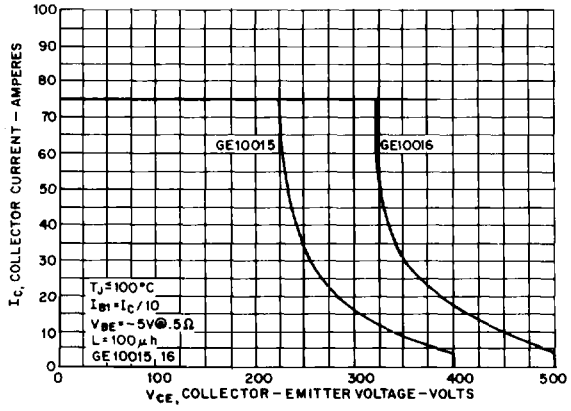


FIGURE 16. FORWARD BIAS SAFE OPERATING AREA (CLAMPED)

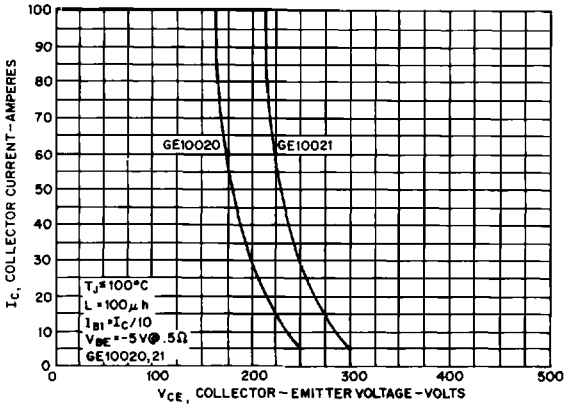


FIGURE 17. REVERSE BIAS SAFE OPERATING AREA

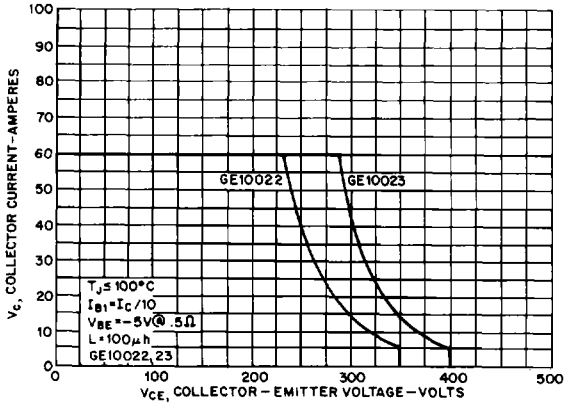


FIGURE 18. REVERSE BIAS SAFE OPERATING AREA

TYPICAL CHARACTERISTICS

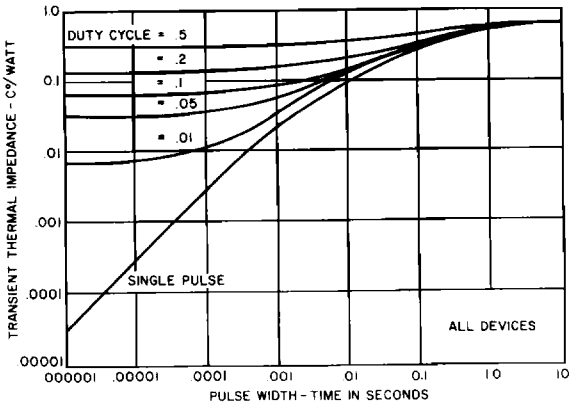


FIGURE 19. TRANSIENT THERMAL RESPONSE

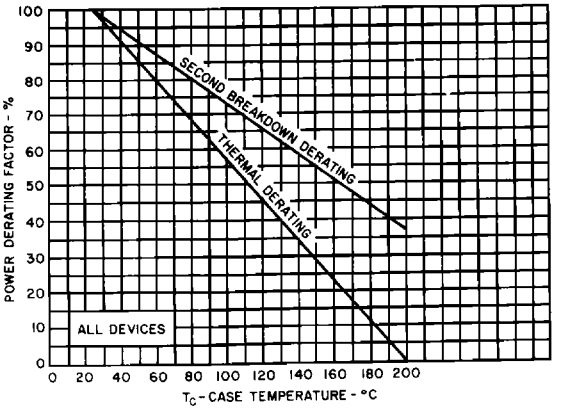


FIGURE 20. POWER DERATING

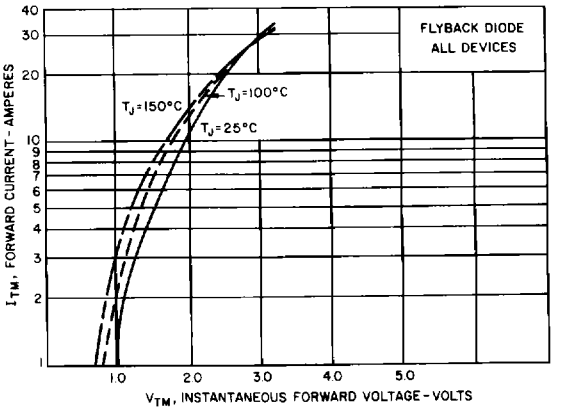


FIGURE 21. FORWARD CHARACTERISTICS

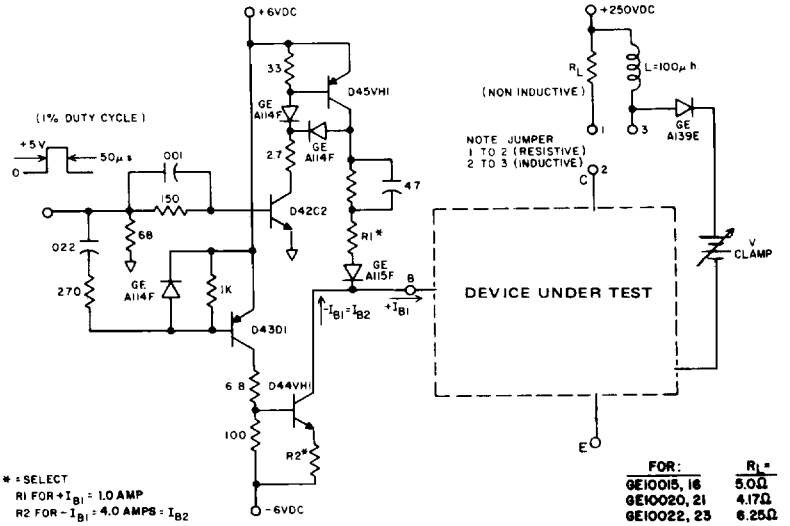


FIGURE 22. SWITCHING TIME TEST CIRCUIT