

## COMPLEMENTARY SILICON HIGH-POWER TRANSISTORS

General Purpose-Amplifier and Switching Application..

### FEATURES:

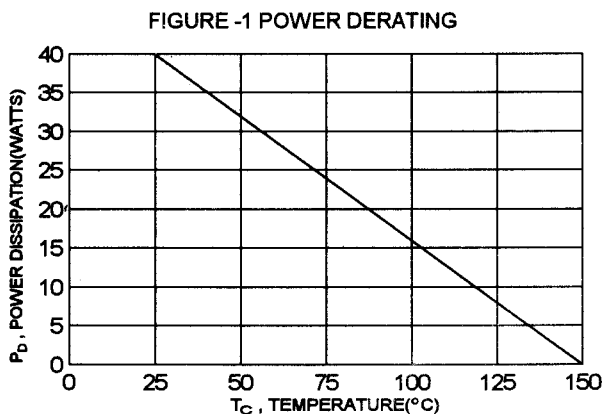
- \* Collector-Emitter Sustaining Voltage -  
 $V_{CEO(sus)} = 120V$  (Min)- TIP31D, TIP32D  
 $140V$  (Min)- TIP31E, TIP32E  
 $160V$  (Min)- TIP31F, TIP32F
- \* Current Gain-Bandwidth Product-  
 $f_T = 3.0MHz$ (Min)@ $I_C = 1.0 A$

### MAXIMUM RATINGS

Characteristic	Symbol	TIP31D TIP32D	TIP31E TIP32E	TIP31F TIP32F	Unit
Collector-Emitter Voltage	$V_{CEO}$	120	140	160	V
Collector-Base Voltage	$V_{CBO}$	160	180	200	V
Emitter-Base Voltage	$V_{EBO}$	5.0			V
Collector Current - Continuous - Peak	$I_C$	3.0 5.0			A
Base Current	$I_B$	1.0			A
Total Power Dissipation@ $T_C = 25^\circ C$ Derate above $25^\circ C$	$P_D$	40 0.32			W W/ $^\circ C$
Operating and Storage Junction Temperature Range	$T_J, T_{STG}$	-65 to +150			$^\circ C$

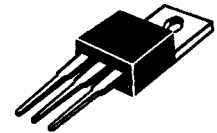
### THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance Junction to Case	$R_{\theta jc}$	3.125	$^\circ C/W$

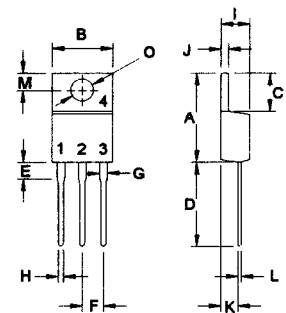


NPN	PNP
TIP31D	TIP32D
TIP31E	TIP32E
TIP31F	TIP32F

3.0 AMPERE  
COMPLEMENTARY SILICON  
POWER TRANSISTORS  
120-160 VOLTS  
40 WATTS



TO-220



PIN 1.BASE  
2.COLLECTOR  
3.EMITTER  
4.COLLECTOR(CASE)

DIM	MILLIMETERS	
	MIN	MAX
A	14.68	15.31
B	9.78	10.42
C	5.01	6.52
D	13.06	14.62
E	3.57	4.07
F	2.42	3.66
G	1.12	1.36
H	0.72	0.96
I	4.22	4.98
J	1.14	1.38
K	2.20	2.97
L	0.33	0.55
M	2.48	2.98
O	3.70	3.90

TIP31D, TIP31E, TIP31F NPN / TIP32D, TIP32E, TIP32F PNP

ELECTRICAL CHARACTERISTICS (  $T_c = 25^\circ\text{C}$  unless otherwise noted )

Characteristic	Symbol	Min	Max	Unit
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OFF CHARACTERISTICS

Collector -Emitter Breakdown Voltage (1) ( $I_C = 30\text{ mA}, I_B = 0$ )	TIP31D, TIP32D TIP31E, TIP32E TIP31F, TIP32F	$V_{(BR)CEO}$	120 140 160	V
Collector Cutoff Current ( $V_{CE} = 90\text{ V}, I_B = 0$ )		$I_{CEO}$	0.3	mA
Collector Cutoff Current ( $V_{CE} = 160\text{ V}, V_{BE} = 0$ ) ( $V_{CE} = 180\text{ V}, V_{BE} = 0$ ) ( $V_{CE} = 200\text{ V}, V_{BE} = 0$ )	TIP31D, TIP32D TIP31E, TIP32E TIP31F, TIP32F	$I_{CES}$	0.2 0.2 0.2	mA
Emitter-Base Cutoff Current ( $V_{EB} = 5.0\text{ V}, I_C = 0$ )		$I_{EBO}$	1.0	mA

ON CHARACTERISTICS (1)

DC Current Gain ( $I_C = 1.0\text{ A}, V_{CE} = 4.0\text{ V}$ ) ( $I_C = 3.0\text{ A}, V_{CE} = 4.0\text{ V}$ )		$h_{FE}$	25 5.0	
Collector-Emitter Saturation Voltage ( $I_C = 3.0\text{ A}, I_B = 750\text{ mA}$ )		$V_{CE(sat)}$	2.5	V
Base-Emitter On Voltage ( $I_C = 3.0\text{ A}, V_{CE} = 4.0\text{ V}$ )		$V_{BE(on)}$	1.8	V

DYNAMIC CHARACTERISTICS

Current-Gain-Bandwidth Product ( $I_C = 0.5\text{ A}, V_{CE} = 10\text{ V}, f = 1.0\text{ MHz}$ )		$f_T$	3.0	MHz
Small-Signal Current Gain ( $I_C = 0.5\text{ A}, V_{CE} = 10\text{ V}, f = 1.0\text{ KHz}$ )		$h_{fe}$	20	

SWITCHING CHARACTERISTICS

Turn On Time	$I_C = 1.0\text{ A}, I_{B1} = -I_{B2} = 0.1\text{ A}$ $V_{BE(off)} = -4.3\text{ V}, R_L = 30\Omega$	$t_{on}$	0.6	us
Off Time		$t_{off}$	2.8	us

(1) Pulse Test: Pulse width  $\leq 300\text{ us}$ , Duty Cycle  $\leq 2.0\%$

(2)  $f_T = |h_{fe}| \cdot f_{TEST}$

FIGURE 2 - SWITCHING TIME EQUIVALENT CIRCUIT

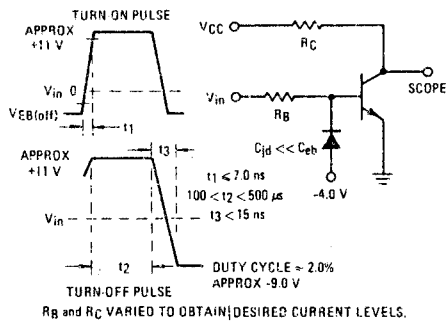


FIG-4 DC CURRENT GAIN

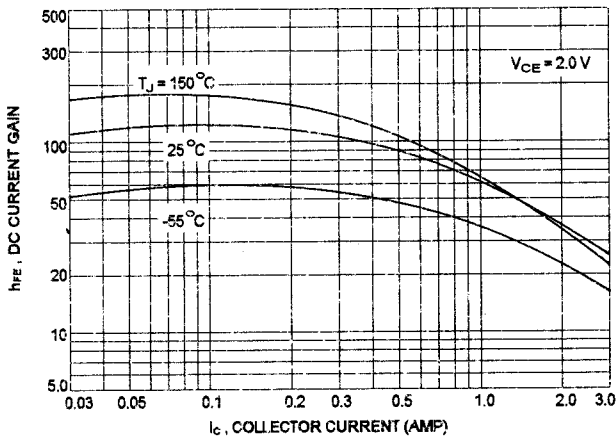


FIG-6 ACTIVE REGION SAFE OPERATING AREA

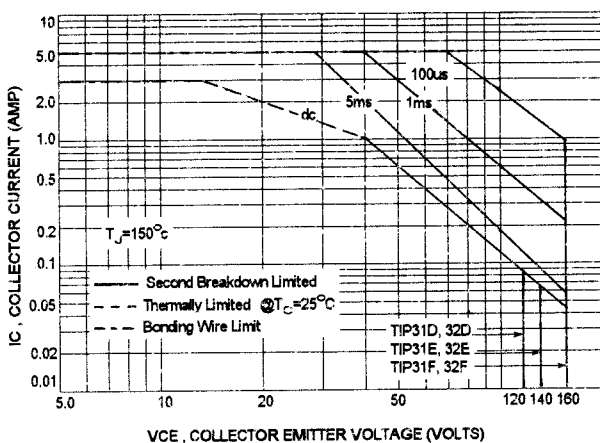


FIG-3 TURN-ON TIME

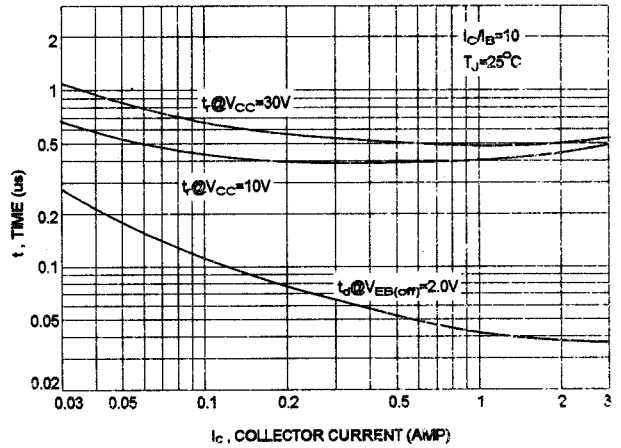
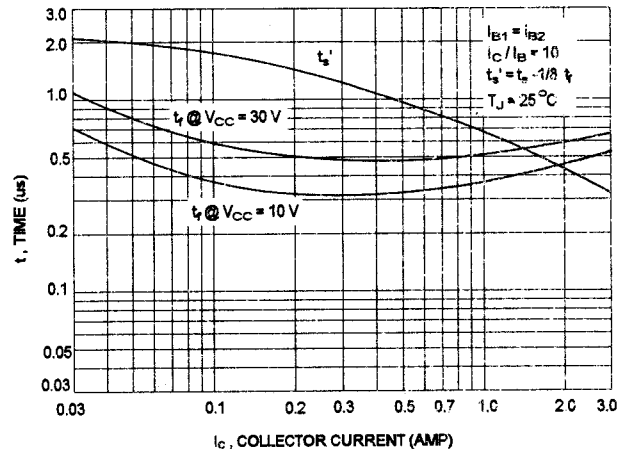


FIG-5 TURN-OFF TIME



There are two limitation on the power handling ability of a transistor: average junction temperature and second breakdown safe operating area curves indicate  $I_C$ - $V_{CE}$  limits of the transistor that must be observed for reliable operation i.e., the transistor must not be subjected to greater dissipation than curves indicate.

The data of FIG-6 curve is base on  $T_{J(PK)} = 150^\circ\text{C}$ ;  $T_C$  is variable depending on power level. second breakdown pulse limits are valid for duty cycles to 10% provided  $T_{J(PK)} \leq 150^\circ\text{C}$ . At high case temperatures, thermal limitation will reduce the power that can be handled to values less than the limitations imposed by second breakdown.

FIG-7 COLLECTOR SATURATION REGION

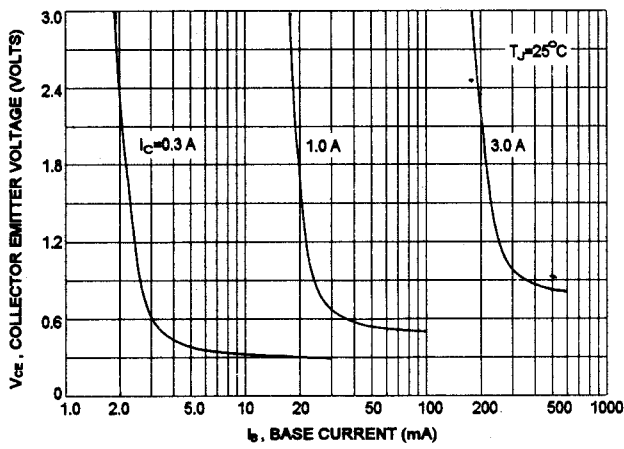


FIG-8 CAPACITANCES

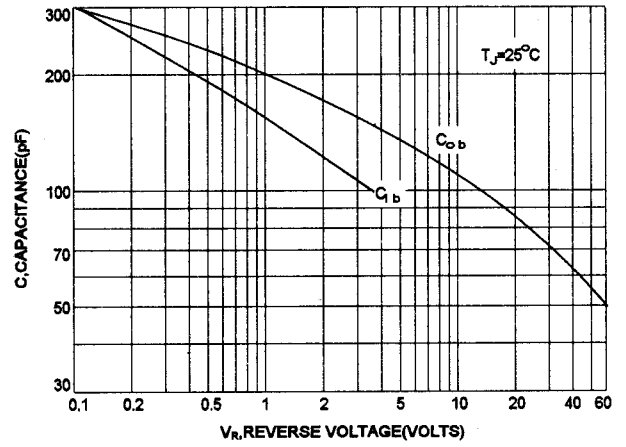


FIG-9 "ON" VOLTAGE

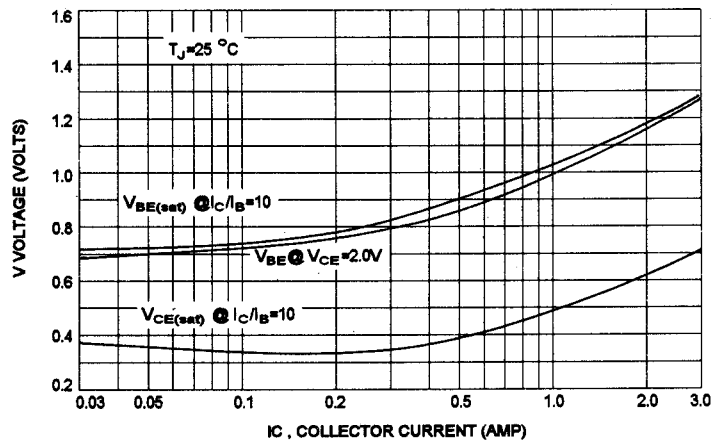


FIG-10 COLLECTOR CUT-OFF REGION

