

## Complementary Silicon Power Transistor

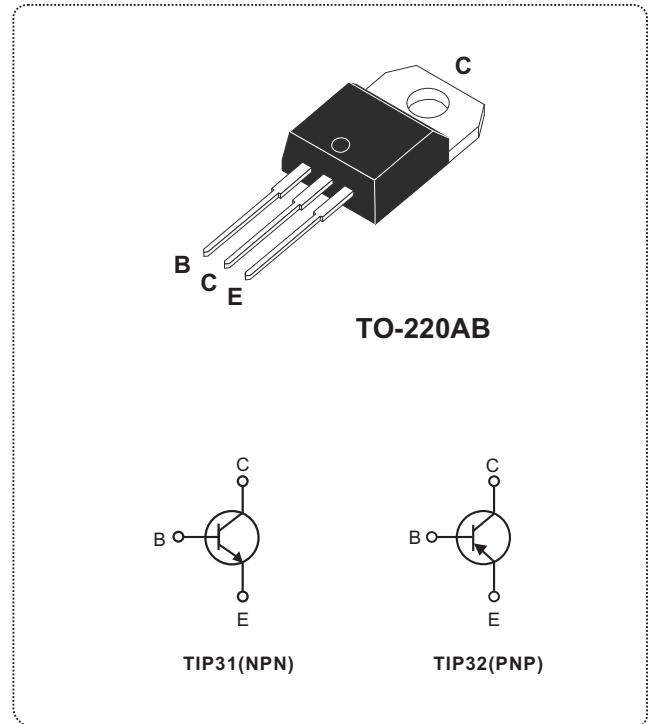
### 3A/40~100V/40W

#### FEATURES

- Complementary NPN-PNP transistors
- Low collector-emitter saturation voltage
- Satisfactory linearity of forward current transfer ratio  $h_{FE}$
- TO-220AB package which can be installed to the heat sink with one screw
- Collector - Emitter Saturation Voltage:  
 $V_{CE(sat)} = 1.2V_{dc}$  (MAX.) @  $I_C = 3A$
- Collector - Emitter Saturation Voltage:  
 $V_{CEO(sus)} = 40V_{dc}$  (Min.) - TIP31, TIP32  
=  $60V_{dc}$  (Min.) - TIP31A, TIP32A  
=  $80V_{dc}$  (Min.) - TIP31B, TIP32B  
=  $100V_{dc}$  (Min.) - TIP31C, TIP32C
- DC Current Gain  $h_{FE} = 25$  (Min.) @  $I_C = 1.0A$
- High Current Gain - Bandwidth product  
 $f_T = 3.0$  MHz (Min.) @  $I_C = 0.5A$

#### APPLICATIONS

- Audio amplifier
- General purpose switching and amplifier



| ABSOLUTE MAXIMUM RATINGS ( $T_C = 25^\circ C$ ) |   |                      |                  |                  |                  |         |
|---|---|----------------------|------------------|------------------|------------------|---------|
| SYMBOL  | PARAMETER   | VALUE                |                  |                  |                  | UNIT    |
|   |   | TIP31<br>TIP32       | TIP31A<br>TIP32A | TIP31B<br>TIP32B | TIP31C<br>TIP32C |         |
| $V_{CBO}$                                       | Collector to base voltage ( $I_E = 0$ )                     | 40                   | 60               | 80               | 100              | V       |
| $V_{CEO}$                                       | Collector to emitter voltage ( $I_B = 0$ )                  | 40                   | 60               | 80               | 100              |         |
| $V_{EBO}$                                       | Emitter to base voltage ( $I_C = 0$ )                       | 5                    |                  |                  |                  |         |
| $I_C$   | Collector current   | 3                    |                  |                  |                  | A       |
| $I_{CM}$  | Collector peak current ( $t_p < 5mS$ )                      | 5                    |                  |                  |                  |         |
| $I_B$   | Base current  | 1                    |                  |                  |                  |         |
| $P_C$   | Collector power dissipation<br>(Derate above $25^\circ C$ ) | @ $T_C = 25^\circ C$ | 40 (0.32)        |                  |                  | W(W/°C) |
|   |   | @ $T_A = 25^\circ C$ | 2.0 (0.016)      |                  |                  |         |
| $T_j$   | Junction temperature  | 150                  |                  |                  |                  | °C      |
| $T_{stg}$                                       | Storage temperature   | -65 to 150           |                  |                  |                  |         |
| E   | Unclamped inductive load energy (Note 1)                    | 32                   |                  |                  |                  | mJ      |

Note: 1. This rating is based on the capability of the transistor to operate safely in a circuit of:  
 $I_C = 1.8A$ ,  $L = 20mH$ ,  $R_{BE} = 100\Omega$ , P.R.F = 10Hz,  $V_{CC} = 20V$

| THERMAL CHARACTERISTICS ( $T_C = 25^\circ\text{C}$ ) |   |       |                           |
|--|---|-------|---------------------------|
| SYMBOL   | PARAMETER                                       | VALUE | UNIT                      |
| $R_{th(j-c)}$  | Maximum thermal resistance, junction to case    | 3.1   | $^\circ\text{C}/\text{W}$ |
| $R_{th(j-a)}$  | Maximum thermal resistance, junction to ambient | 62.5  | $^\circ\text{C}/\text{W}$ |

| ELECTRICAL CHARACTERISTICS ( $T_C = 25^\circ\text{C}$ unless otherwise specified) |  |  |                                  |     |               |
|---|--|--|----------------------------------|-----|---------------|
| SYMBOL  | PARAMETER  | CONDITIONS   | MIN                              | MAX | UNIT          |
| ⊙ Off Characteristics   |  |  |                                  |     |               |
| $V_{CEO(SUS)}$  | Collector to emitter sustaining voltage (Note 1) | $I_C = 30\text{mA}, I_B = 0$                                     | TIP31, TIP32                     | 40  | V             |
|   |  |  | TIP31A, TIP32A                   | 60  |               |
|   |  |  | TIP31B, TIP32B                   | 80  |               |
|   |  |  | TIP31C, TIP32C                   | 100 |               |
| $I_{CEO}$   | Collector cutoff current                         | $V_{CE} = 30\text{V}, I_B = 0$                                   | TIP31, TIP32<br>TIP31A, TIP32A   | 0.3 | mA            |
|   |  | $V_{CE} = 60\text{V}, I_B = 0$                                   | TIP31B, TIP32B<br>TIP31C, TIP32C |     |               |
| $I_{EBO}$   | Emitter cutoff current                           | $V_{EB} = 5\text{V}, I_C = 0$                                    |                                  | 1.0 |               |
| $I_{CES}$   | Collector cutoff current                         | $V_{CE} = 40\text{V}, V_{EB} = 0$                                | TIP31, TIP32                     | 200 | $\mu\text{A}$ |
|   |  | $V_{CE} = 60\text{V}, V_{EB} = 0$                                | TIP31A, TIP32A                   | 200 |               |
|   |  | $V_{CE} = 80\text{V}, V_{EB} = 0$                                | TIP31B, TIP32B                   | 200 |               |
|   |  | $V_{CE} = 100\text{V}, V_{EB} = 0$                               | TIP31C, TIP32C                   | 200 |               |
| ⊙ On Characteristics  |  |  |                                  |     |               |
| $h_{FE}$  | Forward current transfer ratio (DC current gain) | $V_{CE} = 4\text{V}, I_C = 1.0\text{A}$                          | 25                               |     |               |
|   |  | $V_{CE} = 4\text{V}, I_C = 3\text{A}$                            | 10                               | 75  |               |
| $V_{CE(sat)}$   | Collector to emitter saturation voltage (Note1)  | $I_C = 3\text{A}, I_B = 0.375\text{A}$                           |                                  | 1.2 | V             |
| $V_{BE(on)}$  | Base to emitter voltage (Note1)                  | $I_C = 3\text{A}, V_{CE} = 4\text{V}$                            |                                  | 1.8 |               |
| ⊙ Dynamic Characteristics   |  |  |                                  |     |               |
| $f_T$   | Current gain - Bandwidth product (note 2)        | $I_C = 0.5\text{A}, V_{CE} = 10\text{V}, f_{test} = 1\text{MHz}$ | 3.0                              |     | MHZ           |
| $h_{fe}$  | Small signal current gain                        | $I_C = 0.5\text{A}, V_{CE} = 10\text{V}, f = 1\text{KHz}$        | 20                               |     |               |

Note 1. Pulsed : Pulse duration  $\leq 300 \mu\text{s}$ , duty cycle  $\leq 2.0\%$ .

Note 2.  $f_T = |h_{fe}| \cdot f_{TEST}$

Note 3. For PNP type voltage and current are negative.

Fig.1 Power derating

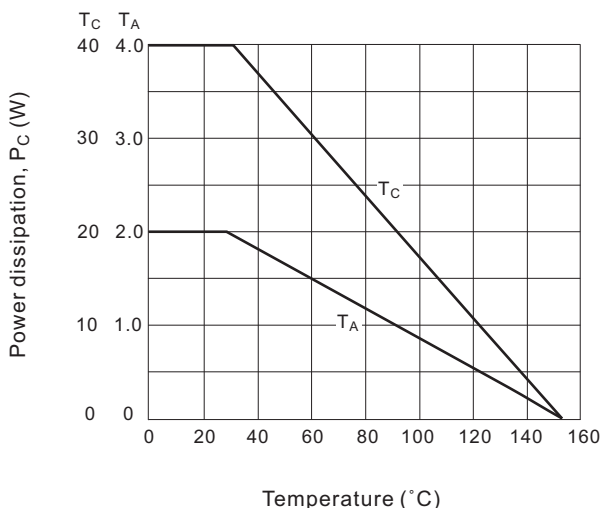
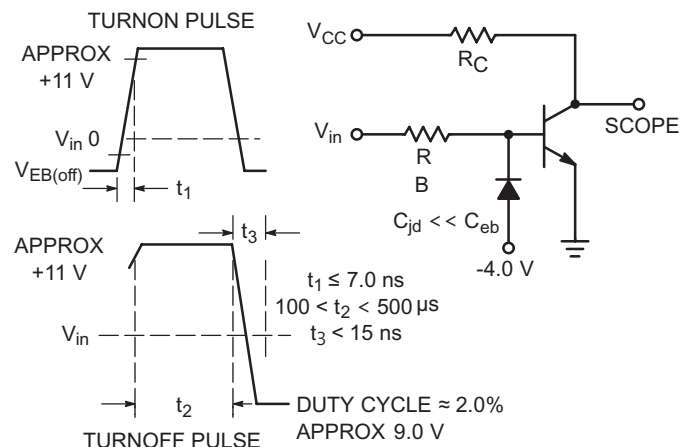
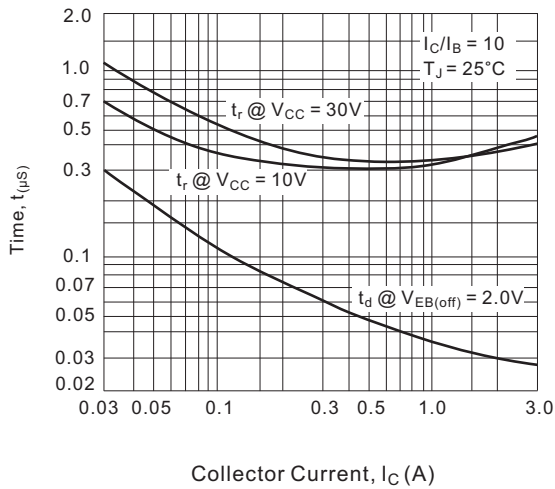


Fig.2. Switching Time Equivalent Circuit

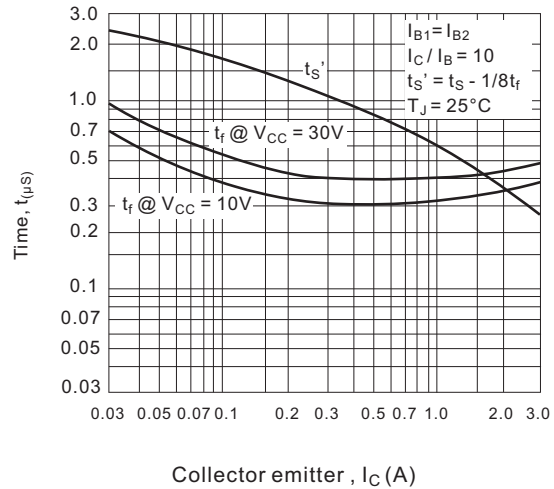


$R_B$  and  $R_C$  VARIED TO OBTAIN DESIRED CURRENT LEVELS.

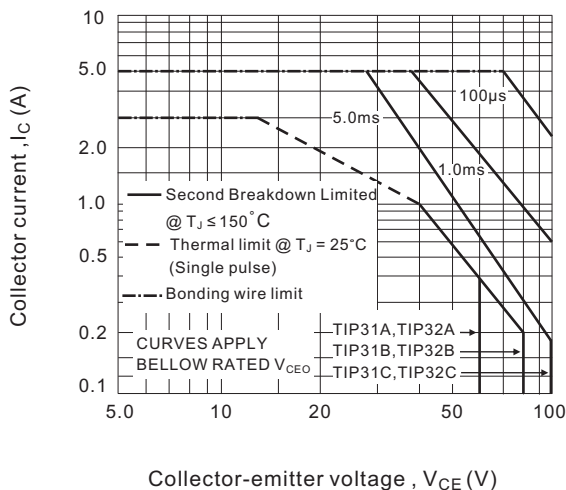
**Fig.3 Turn-on time**



**Fig.4 Turn-off time**



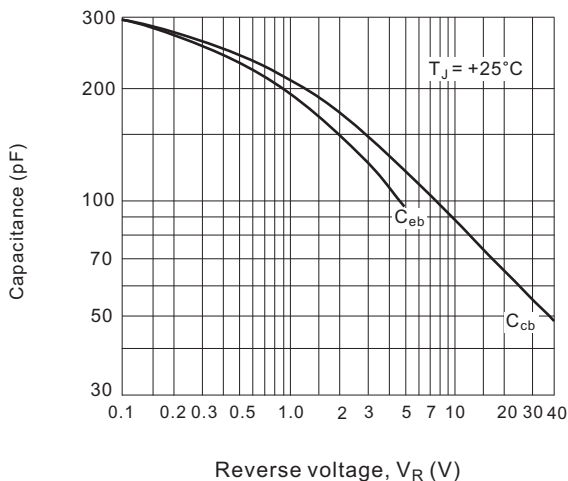
**Fig.5 Active region safe operating area**



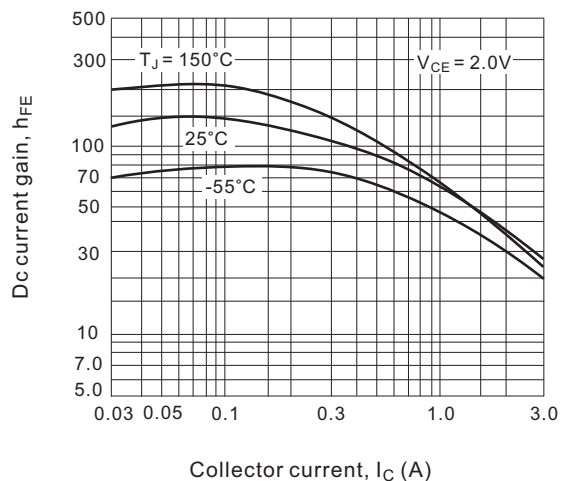
There are two limitations on the power handling ability of a transistor: average junction temperature and second breakdown. Safe operating area curves indicate  $I_C$ - $V_{CE}$  limits of the transistor that must be observed for reliable operation; i.e., the transistor must not be subjected to

The data of fig.5 is based on  $T_{J(pk)} = 150^\circ\text{C}$ ;  $T_C$  is variable depending on conditions. Second breakdown pulse limits are valid for duty cycles to 10% provided  $T_{J(pk)} \leq 150^\circ\text{C}$ .  $T_{J(pk)}$  may be calculated from the data in Figure 13. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations by second breakdown.

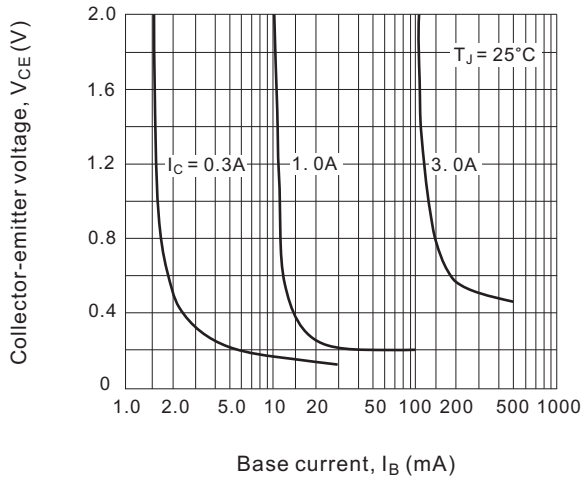
**Fig.6 Capacitance**



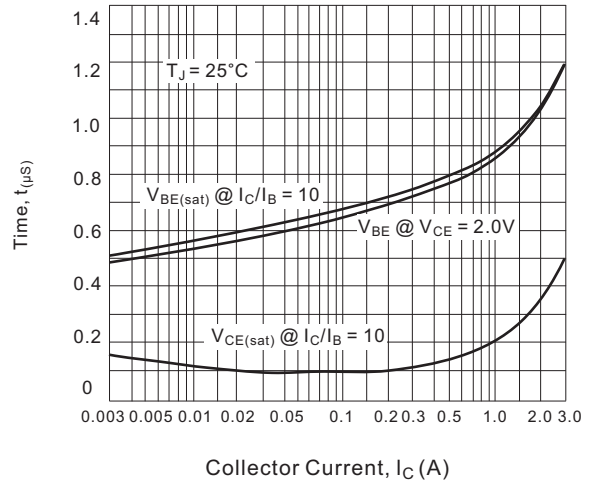
**Fig.7 Dc current gain**



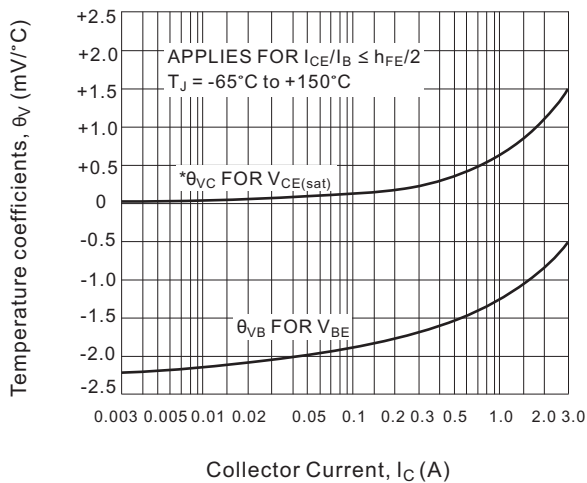
**Fig.8 Collector saturation region**



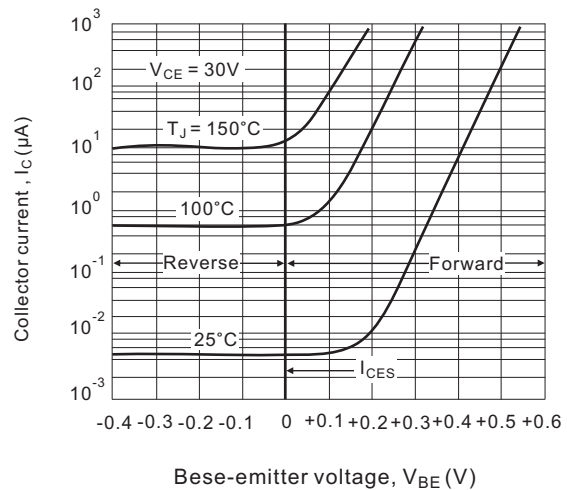
**Fig.9 "On" voltages**



**Fig.10 Temperature coefficients**



**Fig.11 Collector cut-off region**



**Fig.12 Effects of base-emitter resistance**

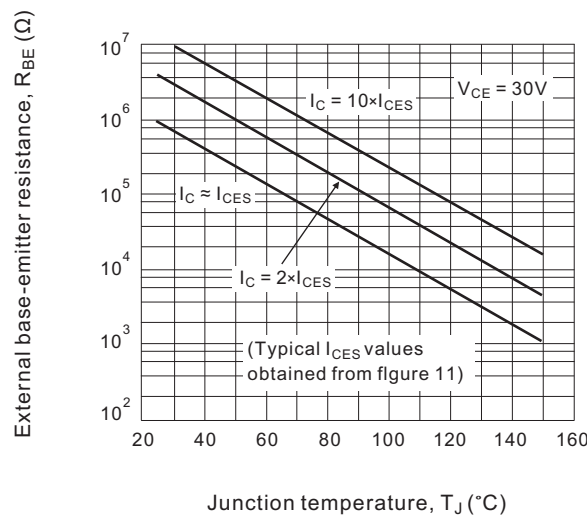
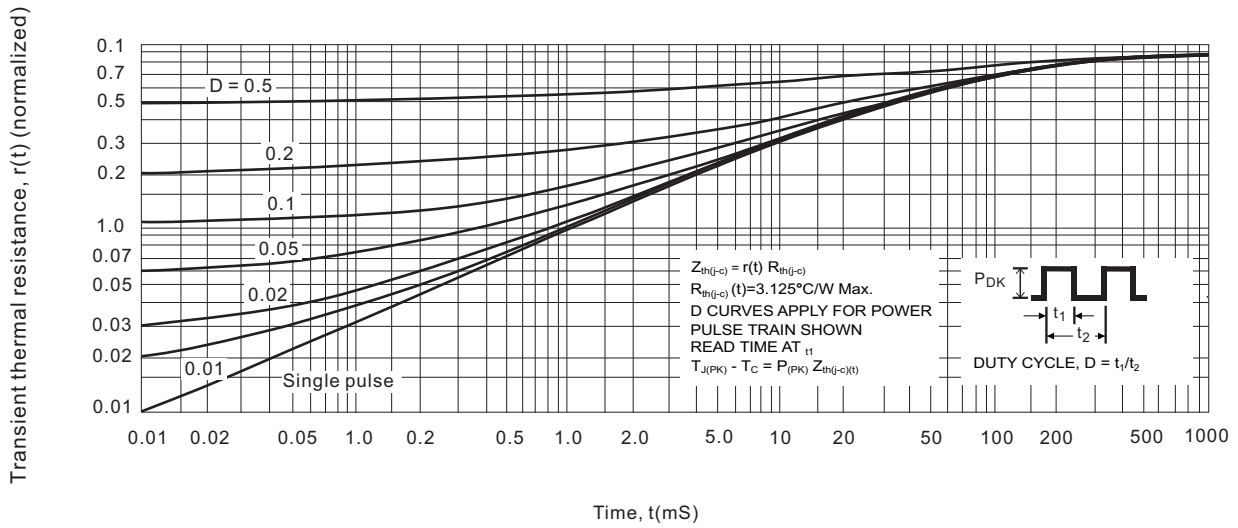


Fig.13 Thermal response



## Case Style

