# IGT™ TRANSISTORS

## Insulated Gate Bipolar Transistor

**IGT6D11,E11**

**10 AMPERES**
**400, 500 VOLTS**
**EQUIV. $R_{DS(ON)}$ = 0.27 Ω**

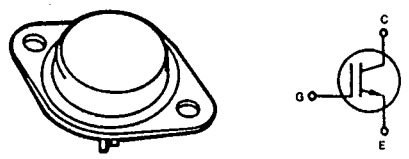
This IGT™ Transistor (Insulated Gate Bipolar Transistor) is a new type of MOS-gate turn on/off power switching device combining the best advantages of power MOSFETS and bipolar transistors. The result is a device that has the high input impedance of MOSFETS and the low on-state conduction losses similar to bipolar transistors. The device design and gate characteristics of the IGT™ Transistor are also similar to power MOSFETS. An important difference is the equivalent $R_{DS(ON)}$ drain resistance which is modulated to a low value (10 times lower) when the gate is turned on. The much lower on-state voltage drop also varies only moderately between 25° C and 150° C offering extended power handling capability.

The IGT™ Transistor is ideal for many high voltage switching applications operating at low frequencies and where low conduction losses are essential, such as; AC and DC motor controls, power supplies and drivers for solenoids, relays and contactors.

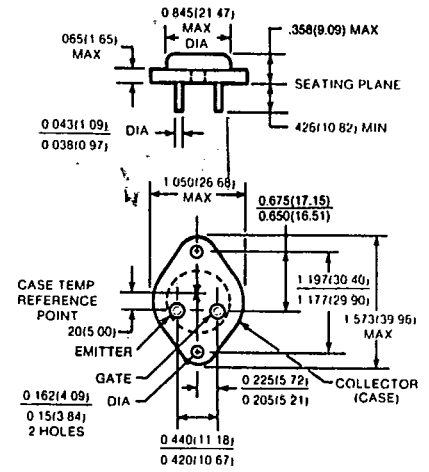
**Features:**

- Low $V_{CE(SAT)}$ — 2.5V typ @ 10A
- Ultra-fast turn-on — 100 ns typical
- Polysilicon MOS gate — Voltage controlled turn on/off
- High current handling — 10 amps @ 100° C

**N-CHANNEL**




**CASE STYLE TO-204AA (TO-3)**
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)




## maximum ratings ($T_C$ = 25° C) (unless otherwise specified)

| RATING | SYMBOL | IGT6D11 | IGT6E11 | UNITS |
|---|---|---|---|---|
| Collector-Emitter Voltage, $V_{GE}$ = 0V | $V_{CES}$ | 400 | 500 | Volts |
| Collector-Gate Voltage, $R_{GE}$ = 1MΩ | $V_{CGR}$ | 400 | 500 | Volts |
| Continuous Drain Current @ $T_C$ = 100° C<br>@ $T_C$ = 25° C | $I_C$ | 10<br>18 | 10<br>18 | A<br>A |
| Pulsed Collector Current(1) | $I_{CM}$ | 40 | 40 | A |
| Gate-Emitter Voltage | $V_{GE}$ | ±25 | ±25 | Volts |
| Total Power Dissipation @ $T_C$ = 25° C<br>Derate Above 25° C | $P_D$ | 75<br>0.6 | 75<br>0.6 | Watts<br>W/° C |
| Operating and Storage Junction Temperature Range | $T_J$, $T_{STG}$ | -55 to 150 | -55 to 150 | ° C |

## thermal characteristics

| | | | | |
|---|---|---|---|---|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 1.67 | 1.67 | ° C/W |
| Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds | $T_L$ | 260 | 260 | ° C |

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

## electrical characteristics ($T_C$ = 25°C) (unless otherwise specified)

| CHARACTERISTIC | | SYMBOL | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **off characteristics** | | | | | | |
| Collector-Emitter Breakdown Voltage ($V_{GE}$ = 0V, $I_C$ = 250μA) | IGT6D11 | $BV_{CES}$ | 400 | — | — | Volts |
| | IGT6E11 | | 500 | — | — | |
| Collector Cut-off Current | | $I_{CES}$ | | | | |
| ($V_{CE}$ = Max Rating, $V_{GE}$ = 0V, $T_C$ = 25°C) | | | — | — | 250 | μA |
| ($V_{CE}$ = Max Rating, × 0.8, $V_{GE}$ = 0V, $T_C$ = 150°C)(2) | | | — | — | 4.0 | mA |
| Gate-Emitter Leakage Current ($V_{GE}$ = ±20V) | | $I_{GES}$ | — | — | ±500 | nA |
| **on characteristics(3)** | | | | | | |
| Gate Threshold Voltage ($V_{CE}$ = $V_{GE}$, $I_C$ = 250μA) | $T_C$ = 25°C | $V_{GE(TH)}$ | 2 | 4.0 | 5 | Volts |
| | $T_C$ = 150°C | | — | 2.5 | — | |
| Collector-Emitter Saturation Voltage | | $V_{CE(SAT)}$ | | | | |
| $I_C$ = 10 A, $T_C$ = 25°C, $V_{GE}$ = 15V | | | — | 2.5 | 2.7 | Volts |
| $I_C$ = 10 A, $T_C$ = 150°C, $V_{GE}$ = 15V | | | — | 2.8 | — | |
| $I_C$ = 10 A, $T_C$ = 25°C, $V_{GE}$ = 10V | | | — | 2.9 | — | |
| **dynamic characteristics** | | | | | | |
| Input Capacitance | $V_{GE}$ = 0V | $C_{ies}$ | — | 1050 | — | pF |
| Output Capacitance | $V_{CE}$ = 25V | $C_{oes}$ | — | 340 | — | pF |
| Reverse Transfer Capacitance | f = 1 MHz | $C_{res}$ | — | 10 | — | pF |
| **switching characteristics(3)** (see figures 8 & 9) | | | | | | |
| Turn-on Delay Time | Resistive Load, $T_C$ = 125°C | $t_{d(on)}$ | — | 100 | — | ns |
| Rise Time | $I_C$ = 10A, $V_{CE}$ = Rated $V_{CES}$ | $t_r$ | — | 100 | — | ns |
| Turn-off Delay Time | $V_{GE}$ = 15V | $t_{d(off)}$ | — | 0.4 | — | μs |
| Fall Time | $R_{G(on)}$ = 50Ω, $R_{GE}$ = 100Ω | $t_f$ | — | 2.5 | — | μs |
| Turn-off Delay Time | Inductive Load, $T_C$ = 125°C, L = 550μH, $I_C$ = 10A, | $t_{d(off)}$ | — | 0.8 | 1.2 | μs |
| Fall Time | $V_{CE(CLAMP)}$ = Rated $V_{CES}$ | $t_f$ | — | 0.8 | 1.0 | μs |
| Equivalent Fall Time | $V_{GE}$ = 15V | $t_{f(eq)}$ | — | 0.6 | 0.8 | μs |
| Turn-off Switching Losses | $R_{G(on)}$ = 50Ω, $R_{GE}$ = 100Ω IGT6D11 | $E_f$ | — | 1.3 | 1.6 | mJ |
| | IGT6E11 | | — | 1.6 | 2.0 | |

(2) Applies for 3.3°C per watt maximum thermal resistance, case to ambient.

(3) Pulse test: Pulse widths ≤ 300 μsec, duty cycle ≤ 2%.

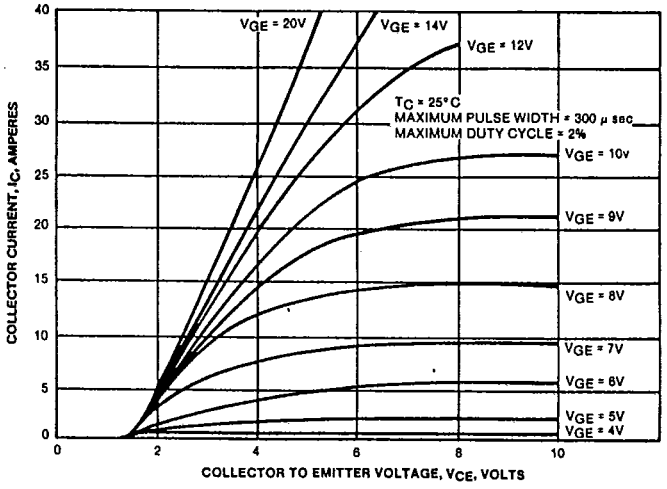



FIGURE 1. TYPICAL OUTPUT CHARACTERISTICS

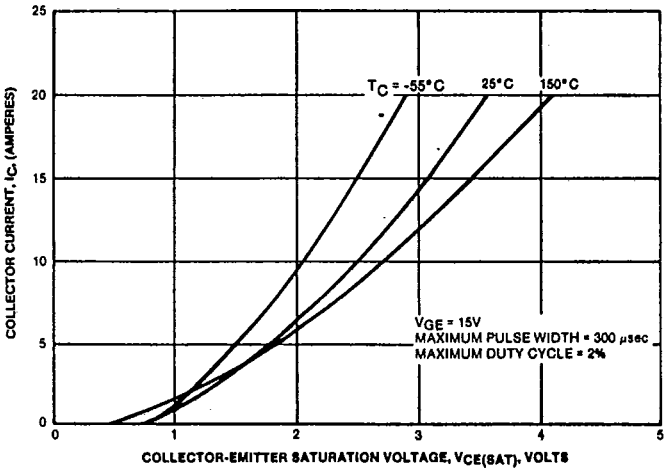



FIGURE 2. TYPICAL COLLECTOR-EMITTER SATURATION VOLTAGE

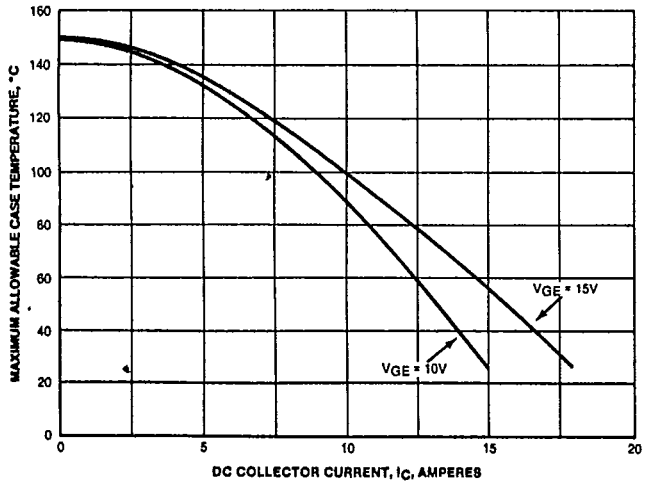



FIGURE 3. MAXIMUM ALLOWABLE CASE TEMPERATURE VS. DC COLLECTOR CURRENT

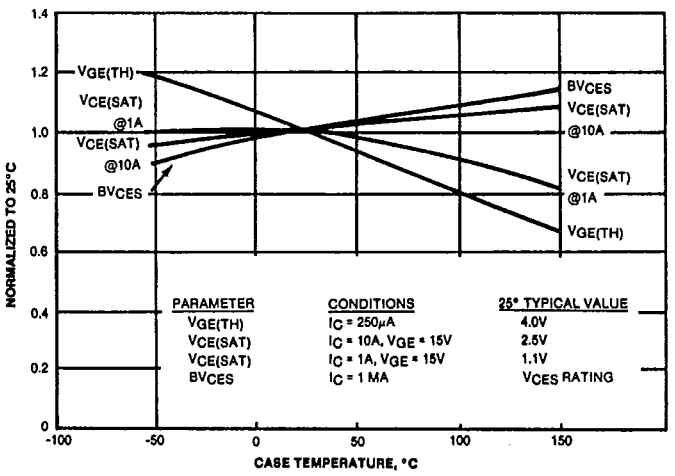



FIGURE 4. TYPICAL TEMPERATURE DEPENDENCE OF PARAMETERS

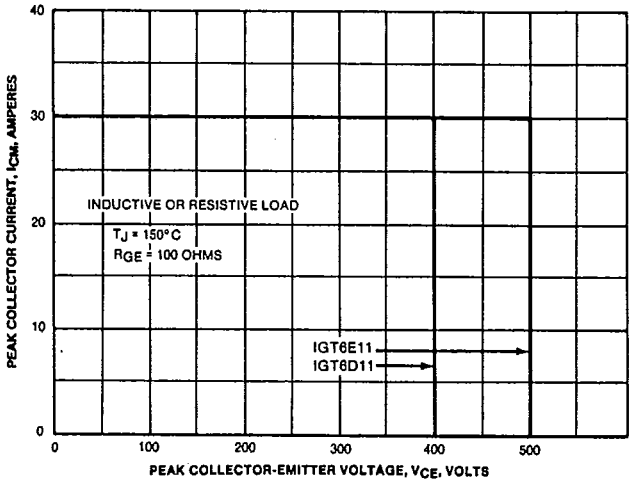



FIGURE 5. TURN-OFF SAFE OPERATING AREA

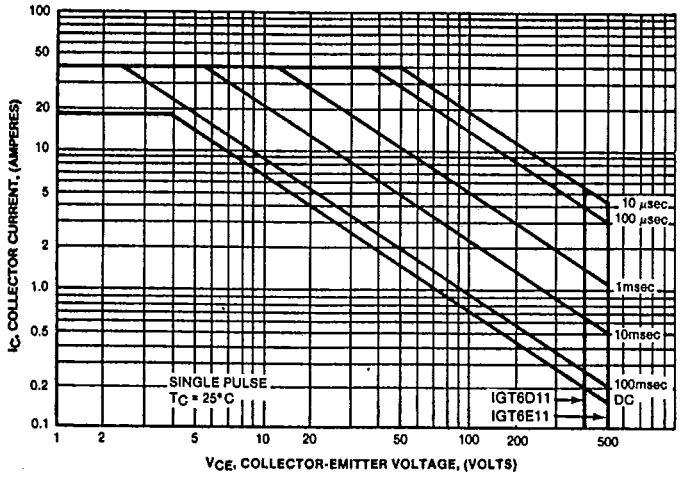



FIGURE 6. TURN-ON SAFE OPERATING AREA

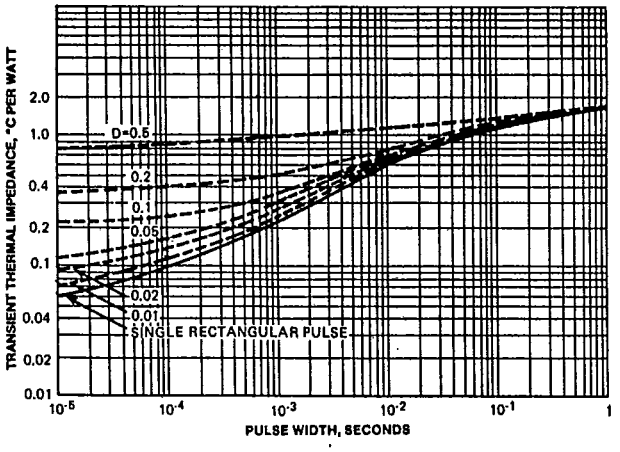
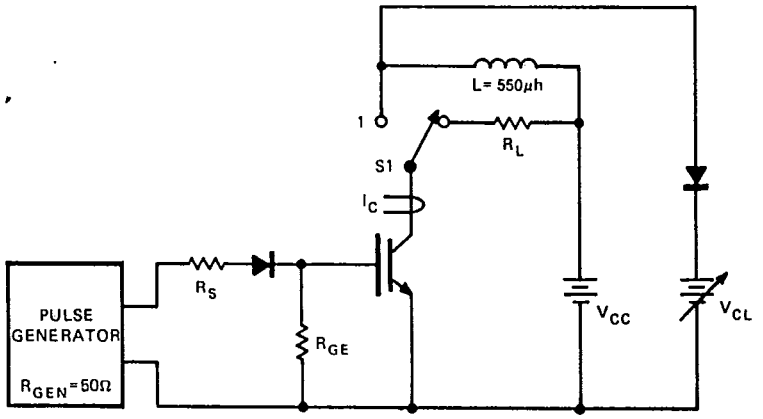


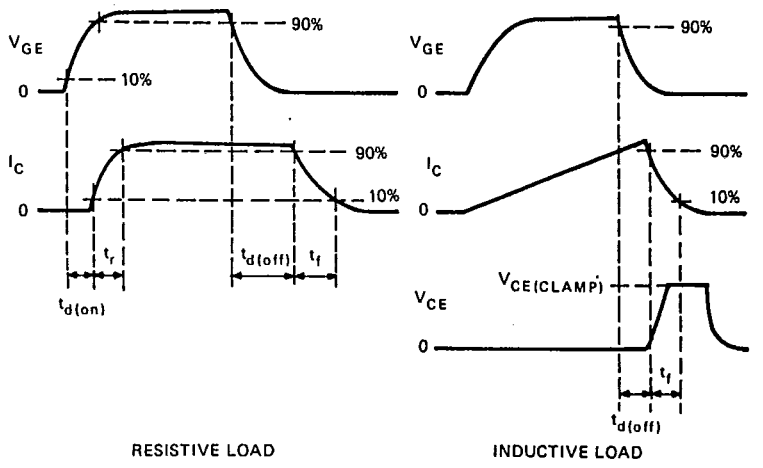

FIGURE 7. MAXIMUM TRANSIENT THERMAL IMPEDANCE




S1 (SWITCH POSITION) –1 CLAMPED INDUCTIVE LOAD
–2 RESISTIVE LOAD

$$R_{G(ON)} = \frac{(R_{GEN}+R_S)(R_{GE})}{R_{GEN}+R_S+R_{GE}}, \text{ PULSE WIDTH} \geq 60\mu\text{sec}, V_{CC} = \frac{L \cdot I_{C\,(MAXIMUM)}}{\text{PULSE WIDTH}}$$

**FIGURE 8. BASIC SWITCHING TEST CIRCUIT**




RESISTIVE LOAD INDUCTIVE LOAD

(WAVEFORMS NOT TO SCALE)

**FIGURE 9. SWITCHING WAVEFORMS**