

### Features

- 6A, 400V and 500V
- $V_{CE(ON)}$ : 2.5V Max.
- $T_{FALL}$ : 1.0 $\mu$ s
- Low On-State Voltage
- Fast Switching Speeds
- High Input Impedance

### Applications

- Power Supplies
- Motor Drives
- Protective Circuits

### Description

The HGTD6N40E1, HGTD6N40E1S, HGTD6N50E1, and HGTD6N50E1S are n-channel enhancement-mode insulated gate bipolar transistors (IGBTs) designed for high voltage, low on-dissipation applications such as switching regulators and motor drivers. These types can be operated directly from low power integrated circuits.

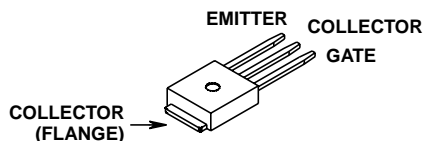
#### PACKAGING AVAILABILITY

| PART NUMBER | PACKAGE  | BRAND  |
|-------------|----------|--------|
| HGTD6N40E1  | TO-251AA | G6N40E |
| HGTD6N50E1  | TO-251AA | G6N50E |
| HGTD6N40E1S | TO-252AA | G6N40E |
| HGTD6N50E1S | TO-252AA | G6N50E |

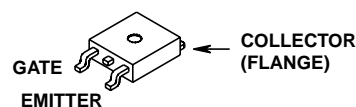
NOTE: When ordering, use the entire part number.

### Packages

HGTD6N40E1, HGTD6N50E1  
JEDEC TO-251AA

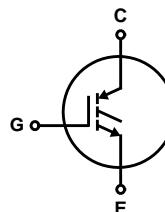


HGTD6N40E1S, HGTD6N50E1S  
JEDEC TO-252AA



### Terminal Diagram

N-CHANNEL ENHANCEMENT MODE



### Absolute Maximum Ratings $T_C = +25^\circ\text{C}$ , Unless Otherwise Specified

|   | HGTD6N40E1<br>HGTD6N40E1S | HGTD6N50E1<br>HGTD6N50E1S | UNITS               |
|---|---------------------------|---------------------------|---------------------|
| Collector-Emitter Voltage . . . . .                                 | 400                       | 500                       | V                   |
| Collector-Gate Voltage $R_{GE} = 1\text{M}\Omega$ . . . . .         | 400                       | 500                       | V                   |
| Gate-Emitter Voltage . . . . .                                      | $\pm 20$                  | $\pm 20$                  | V                   |
| Collector Current Continuous at $T_C = +25^\circ\text{C}$ . . . . . | 7.5                       | 7.5                       | A                   |
| at $T_C = +90^\circ\text{C}$ . . . . .                              | 6.0                       | 6.0                       | A                   |
| Power Dissipation Total at $T_C = +25^\circ\text{C}$ . . . . .      | 60                        | 60                        | W                   |
| Power Dissipation Derating $T_C > +25^\circ\text{C}$ . . . . .      | 0.48                      | 0.48                      | W/ $^\circ\text{C}$ |
| Operating and Storage Junction Temperature Range . . . . .          | -55 to +150               | -55 to +150               | $^\circ\text{C}$    |

#### INTERSIL CORPORATION'S PRODUCT IS COVERED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS:

|           |           |           |           |           |           |           |           |
|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| 4,364,073 | 4,417,385 | 4,430,792 | 4,443,931 | 4,466,176 | 4,516,143 | 4,532,534 | 4,567,641 |
| 4,587,713 | 4,598,461 | 4,605,948 | 4,618,872 | 4,620,211 | 4,631,564 | 4,639,754 | 4,639,762 |
| 4,641,162 | 4,644,637 | 4,682,195 | 4,684,413 | 4,694,313 | 4,717,679 | 4,743,952 | 4,783,690 |
| 4,794,432 | 4,801,986 | 4,803,533 | 4,809,045 | 4,809,047 | 4,810,665 | 4,823,176 | 4,837,606 |
| 4,860,080 | 4,883,767 | 4,888,627 | 4,890,143 | 4,901,127 | 4,904,609 | 4,933,740 | 4,963,951 |
| 4,969,027 |           |           |           |           |           |           |           |

# Specifications HGTD6N40E1, HGTD6N40E1S, HGTD6N50E1, HGTD6N50E1S

## Electrical Specifications $T_C = +25^\circ\text{C}$ , Unless Otherwise Specified

| PARAMETERS  | SYMBOL          | TEST CONDITIONS   | LIMITS  |      |                           |      | UNITS              |               |
|---|-----------------|---|---|------|---------------------------|------|--------------------|---------------|
|   |                 |   | HGTD6N40E1<br>HGTD6N40E1S   |      | HGTD6N50E1<br>HGTD6N50E1S |      |                    |               |
|   |                 |   | MIN   | MAX  | MIN                       | MAX  |                    |               |
| Collector-Emitter Breakdown Voltage   | $BV_{CES}$      | $I_C = 250\mu\text{A}$ , $V_{GE} = 0\text{V}$   | 400   | -    | 500                       | -    | V                  |               |
| Gate Threshold Voltage  | $V_{GE(TH)}$    | $V_{GE} = V_{CE}$ , $I_C = 1\text{mA}$  | 2.0   | 4.5  | 2.0                       | 4.5  | V                  |               |
| Zero Gate Voltage Collector Current   | $I_{CES}$       | $T_J = +150^\circ\text{C}$ , $V_{CE} = 400\text{V}$   | -   | 250  | -                         | -    | $\mu\text{A}$      |               |
|   |                 | $T_J = +150^\circ\text{C}$ , $V_{CE} = 500\text{V}$   | -   | -    | -                         | 250  | $\mu\text{A}$      |               |
| Gate-Emitter Leakage Current  | $I_{GES}$       | $V_{GE} = \pm 20\text{V}$ , $V_{CE} = 0\text{V}$  | -   | 100  | -                         | 100  | nA                 |               |
| Collector-Emitter On-Voltage  | $V_{CE(ON)}$    | $T_J = +150^\circ\text{C}$ , $I_C = 3\text{A}$ , $V_{GE} = 10\text{V}$  | -   | 2.9  | -                         | 2.9  | V                  |               |
|   |                 | $T_J = +150^\circ\text{C}$ , $I_C = 3\text{A}$ , $V_{GE} = 15\text{V}$  | -   | 2.5  | -                         | 2.5  | V                  |               |
|   |                 | $T_J = +25^\circ\text{C}$ , $I_C = 3\text{A}$ , $V_{GE} = 10\text{V}$   | -   | 2.5  | -                         | 2.5  | V                  |               |
|   |                 | $T_J = +25^\circ\text{C}$ , $I_C = 3\text{A}$ , $V_{GE} = 15\text{V}$   | -   | 2.4  | -                         | 2.4  | V                  |               |
| Gate-Emitter Plateau Voltage  | $V_{GEP}$       | $I_C = 3\text{A}$ , $V_{CE} = 10\text{V}$   | 6.5 (Typ)   |      |                           |      | V                  |               |
| On-State Gate Charge  | $Q_{G(ON)}$     | $I_C = 3\text{A}$ , $V_{CE} = 10\text{V}$   | 6.9 (Typ)   |      |                           |      | nC                 |               |
| Turn-On Delay Time  | $t_{D(ON)}$     | Resistive Load, $I_C = 3\text{A}$ ,<br>$V_{CE} = 400\text{V}$ , $R_L = 133\Omega$ ,<br>$T_J = +150^\circ\text{C}$ , $V_{GE} = 10\text{V}$ ,<br>$R_G = 25\Omega$ | 90 (Typ)  |      |                           |      | ns                 |               |
| Rise Time   | $t_R$           |   | 32 (Typ)  |      |                           |      | ns                 |               |
| Turn-Off Delay Time   | $t_{D(OFF)}$    |   | 24 (Typ)  |      |                           |      | ns                 |               |
| Fall Time   | $t_F$           |   | 1100 (Typ)  |      |                           |      | ns                 |               |
| Turn-Off Energy Loss Per Cycle<br>(Off Switching Dissipation =<br>$W_{OFF} \times \text{Frequency}$ ) | $W_{OFF}$       |   | 0.29 (Typ)  |      |                           |      | mJ                 |               |
| Turn-Off Delay Time   | $t_{D(OFF)I}$   |   | Inductive Load (See Figure 11),<br>$I_C = 3\text{A}$ , $V_{CE(CL P)} = 400\text{V}$ ,<br>$R_L = 133\Omega$ , $L = 50\mu\text{H}$ , $T_J = +150^\circ\text{C}$ ,<br>$V_{GE} = 10\text{V}$ , $R_G = 25\Omega$ | -    | 190                       | -    | 190                | ns            |
| Fall Time   | $t_{FI}$        |   |   | -    | 1                         | -    | 1                  | $\mu\text{s}$ |
| Turn-Off Energy Loss Per Cycle<br>(Off Switching Dissipation =<br>$W_{OFF} \times \text{Frequency}$ ) | $W_{OFF}$       | -   |   | 0.43 | -                         | 0.43 | mJ                 |               |
| Thermal Resistance Junction-to-Case (IGBT)  | $R_{\theta JC}$ |   | -   | 2.08 | -                         | 2.08 | $^\circ\text{C/W}$ |               |

## Typical Performance Curves

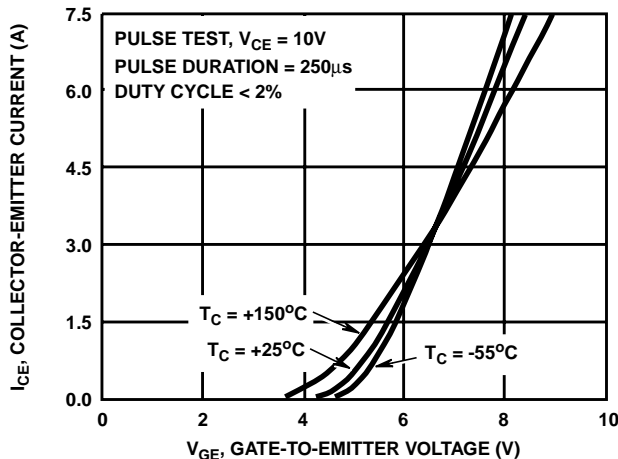


FIGURE 1. TYPICAL TRANSFER CHARACTERISTICS

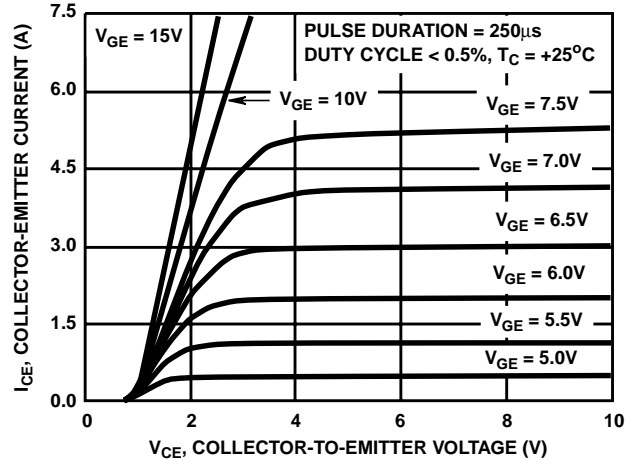


FIGURE 2. TYPICAL SATURATION CHARACTERISTICS

Typical Performance Curves (Continued)

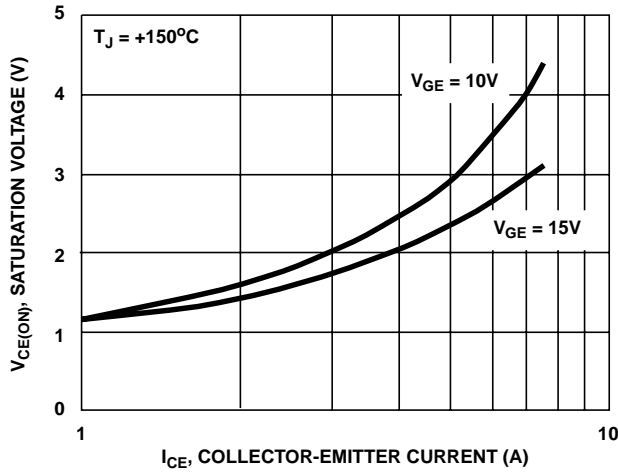


FIGURE 3. SATURATION VOLTAGE vs COLLECTOR-EMITTER CURRENT (TYPICAL)

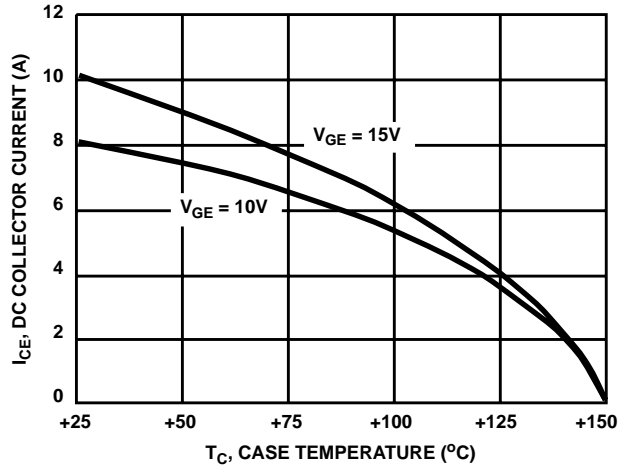


FIGURE 4. DC COLLECTOR CURRENT vs CASE TEMPERATURE

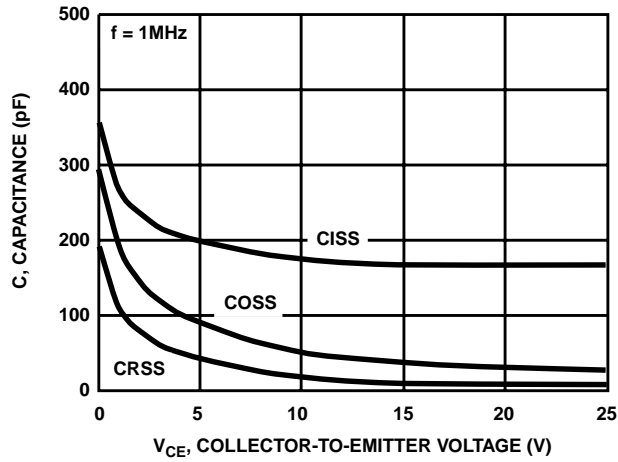


FIGURE 5. CAPACITANCE vs COLLECTOR-TO-EMITTER VOLTAGE (TYPICAL)

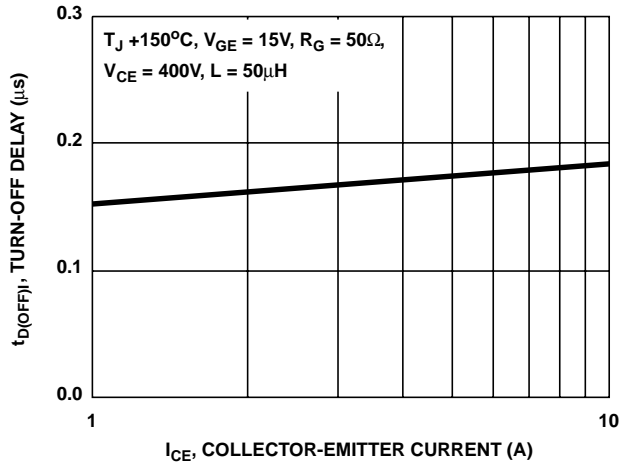


FIGURE 6. TURN-OFF DELAY vs COLLECTOR-TO-EMITTER CURRENT (TYPICAL)

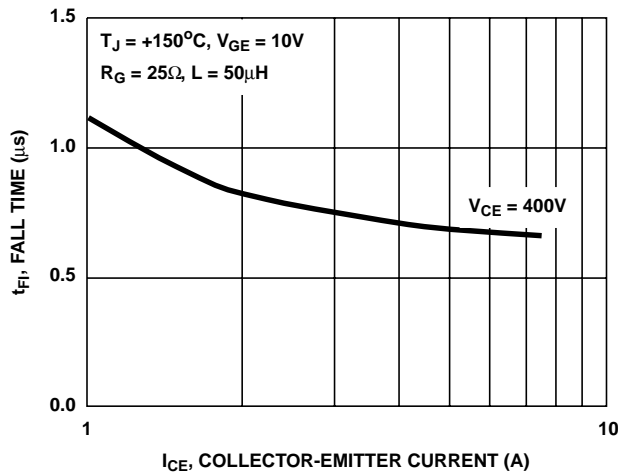


FIGURE 7. FALL TIME vs COLLECTOR-TO-EMITTER CURRENT (TYPICAL)

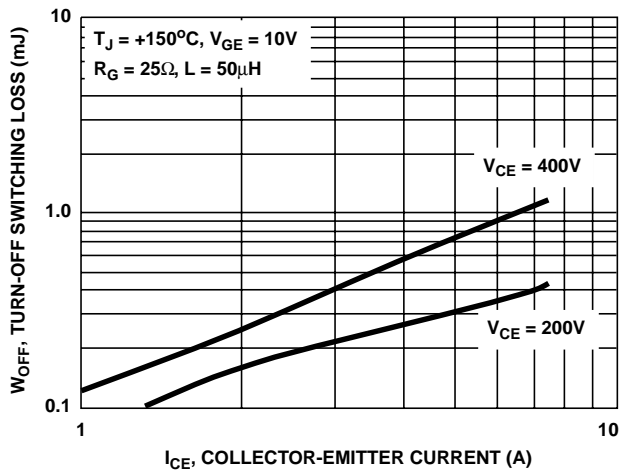


FIGURE 8. TURN-OFF SWITCHING LOSS vs COLLECTOR-EMITTER CURRENT (TYPICAL)

Typical Performance Curves (Continued)

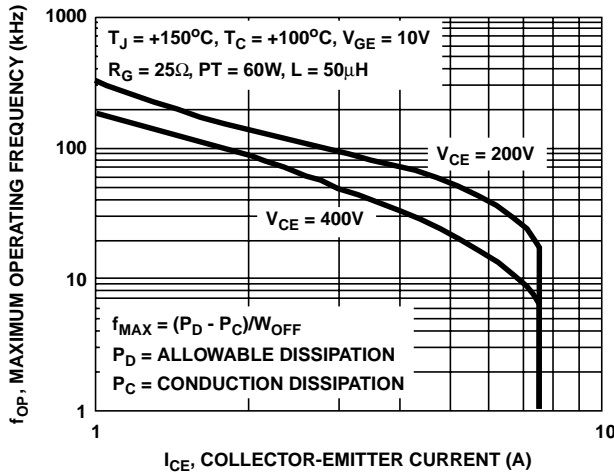


FIGURE 9. MAXIMUM OPERATING FREQUENCY vs COLLECTOR CURRENT AND VOLTAGE (TYPICAL)

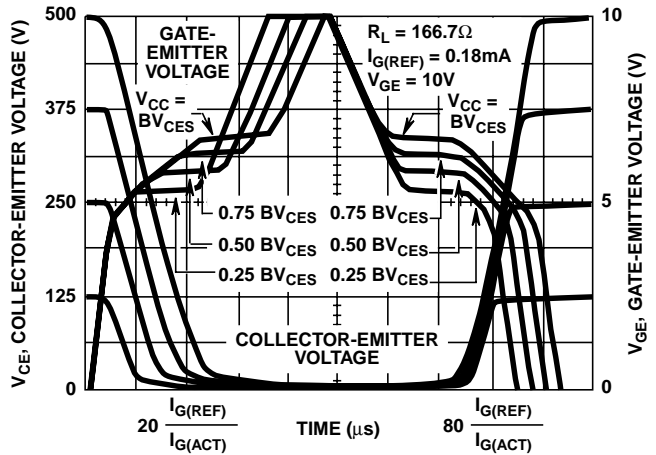


FIGURE 10. NORMALIZED SWITCHING WAVEFORMS AT CONSTANT GATE CURRENT

Test Circuit

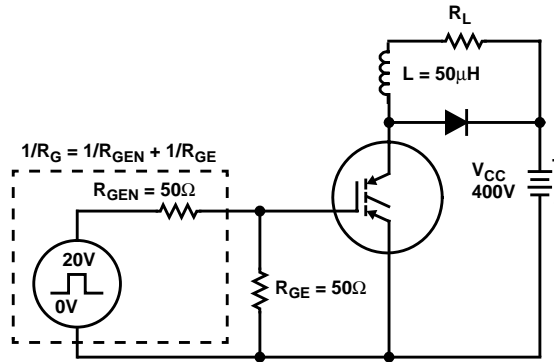


FIGURE 11. INDUCTIVE SWITCHING TEST CIRCUIT

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