

April 1995

### Features

- 12A, 400V and 500V
- $V_{CE(ON)}$ : 2.5V Max.
- $T_{FALL}$ : 1 $\mu$ s, 0.5 $\mu$ s
- Low On-State Voltage
- Fast Switching Speeds
- High Input Impedance
- Anti-Parallel Diode

### Applications

- Power Supplies
- Motor Drives
- Protective Circuits

### Description

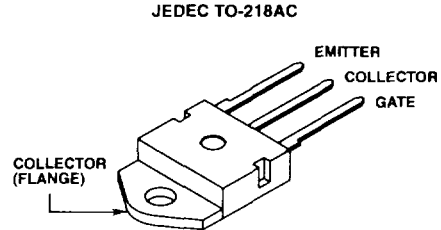
The HGTH12N40C1D, HGTH12N40E1D, HGTH12N50C1D, and HGTH12N50E1D are n-channel enhancement-mode insulated gate bipolar transistors (IGBTs) designed for high voltage, low on-dissipation applications such as switching regulators and motor drivers. They feature a discrete anti-parallel diode that shunts current around the IGBT in the reverse direction without introducing carriers into the depletion region. These types can be operated directly from low power integrated circuits.

#### PACKAGING AVAILABILITY

| PART NUMBER  | PACKAGE  | BRAND     |
|--------------|----------|-----------|
| HGTH12N40C1D | TO-218AC | G12N40C1D |
| HGTH12N40E1D | TO-218AC | G12N40E1D |
| HGTH12N50C1D | TO-218AC | G12N50C1D |
| HGTH12N50E1D | TO-218AC | G12N50E1D |

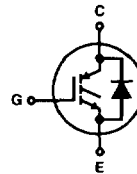
NOTE: When ordering, use the entire part number

### Package



### Terminal Diagram

N-CHANNEL ENHANCEMENT MODE



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

|                                                      | HGTH12N40C1D<br>HGTH12N40E1D | HGTH12N50C1D<br>HGTH12N50E1D | UNITS               |
|------------------------------------------------------|------------------------------|------------------------------|---------------------|
| Collector-Emitter Voltage                            | 400                          | 500                          | V                   |
| Collector-Gate Voltage $R_{GE} = 1M\Omega$           | 400                          | 500                          | V                   |
| Gate-Emitter Voltage                                 | $\pm 20$                     | $\pm 20$                     | V                   |
| Collector Current Continuous                         | 12                           | 12                           | A                   |
| Collector Current Pulsed                             | 17.5                         | 17.5                         | A                   |
| Power Dissipation Total at $T_C = +25^\circ\text{C}$ | 75                           | 75                           | W                   |
| Power Dissipation Derating $T_C > +25^\circ\text{C}$ | 0.6                          | 0.6                          | W/ $^\circ\text{C}$ |
| Operating and Storage Junction Temperature Range     | -55 to +150                  | -55 to +150                  | $^\circ\text{C}$    |

#### HARRIS SEMICONDUCTOR IGBT 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 |           |           |           |           |           |           |           |

CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper ESD Handling Procedures.  
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File Number **2273.3**

**Specifications HGTH12N40C1D, HGTH12N40E1D, HGTH12N50C1D, HGTH12N50E1D**

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

| PARAMETERS                                                                                    | SYMBOL          | TEST CONDITIONS                                                                                                                                        | LIMITS                        |           |                               |          | UNITS              |
|-----------------------------------------------------------------------------------------------|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|-----------|-------------------------------|----------|--------------------|
|                                                                                               |                 |                                                                                                                                                        | HGTH12N40C1D,<br>HGTH12N40E1D |           | HGTH12N50C1D,<br>HGTH12N50E1D |          |                    |
|                                                                                               |                 |                                                                                                                                                        | MIN                           | MAX       | MIN                           | MAX      |                    |
| Collector-Emitter Breakdown Voltage                                                           | $BV_{CES}$      | $I_C = 1\text{mA}, V_{GE} = 0$                                                                                                                         | 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                                                           | $I_{CES}$       | $V_{CE} = 400\text{V}, T_C = +25^\circ\text{C}$                                                                                                        | -                             | 250       | -                             | -        | $\mu\text{A}$      |
|                                                                                               |                 | $V_{CE} = 500\text{V}, T_C = +25^\circ\text{C}$                                                                                                        | -                             | -         | -                             | 250      | $\mu\text{A}$      |
|                                                                                               |                 | $V_{CE} = 400\text{V}, T_C = +125^\circ\text{C}$                                                                                                       | -                             | 1000      | -                             | -        | $\mu\text{A}$      |
|                                                                                               |                 | $V_{CE} = 500\text{V}, T_C = +125^\circ\text{C}$                                                                                                       | -                             | -         | -                             | 1000     | $\mu\text{A}$      |
| Gate-Emitter Leakage Current                                                                  | $I_{GES}$       | $V_{GE} = \pm 20\text{V}, V_{CE} = 0$                                                                                                                  | -                             | 100       | -                             | 100      | nA                 |
| Collector-Emitter On Voltage                                                                  | $V_{CE(ON)}$    | $I_C = 10\text{A}, V_{GE} = 10\text{V}$                                                                                                                | -                             | 2.5       | -                             | 2.5      | V                  |
|                                                                                               |                 | $I_C = 17.5\text{A}, V_{GE} = 20\text{V}$                                                                                                              | -                             | 3.2       | -                             | 3.2      | V                  |
| Gate-Emitter Plateau Voltage                                                                  | $V_{GEP}$       | $I_C = 5\text{A}, V_{CE} = 10\text{V}$                                                                                                                 | -                             | 6 (Typ)   | -                             | 6 (Typ)  | V                  |
| On-State Gate Charge                                                                          | $Q_{G(ON)}$     | $I_C = 5\text{A}, V_{CE} = 10\text{V}$                                                                                                                 | -                             | 19 (Typ)  | -                             | 19 (Typ) | nC                 |
| Turn-On Delay Time                                                                            | $t_{D(ON)}$     | $I_C = 10\text{A}, V_{CE(CLIP)} = 300\text{V},$<br>$L = 50\mu\text{H}, T_J = +100^\circ\text{C},$<br>$V_{GE} = 10\text{V}, R_G = 50\Omega$<br>(Note 9) | -                             | 50        | -                             | 50       | ns                 |
| Rise Time                                                                                     | $t_{RI}$        |                                                                                                                                                        | -                             | 50        | -                             | 50       | ns                 |
| Turn-Off Delay Time                                                                           | $t_{D(OFF)}$    |                                                                                                                                                        | -                             | 400       | -                             | 400      | ns                 |
| Fall Time                                                                                     | $t_{FI}$        |                                                                                                                                                        |                               |           |                               |          |                    |
| 40E1D, 50E1D                                                                                  |                 | 680 (Typ)                                                                                                                                              | 1000                          | 680 (Typ) | 1000                          | ns       |                    |
| 40C1D, 50C1D                                                                                  |                 | 400 (Typ)                                                                                                                                              | 500                           | 400 (Typ) | 500                           | ns       |                    |
| Turn-Off Energy Loss per Cycle<br>(Off Switching Dissipation = $W_{OFF} \times$<br>Frequency) | $W_{OFF}$       | $I_C = 10\text{A}, V_{CE(CLIP)} = 300\text{V},$<br>$L = 50\mu\text{H}, T_J = +100^\circ\text{C},$<br>$V_{GE} = 10\text{V}, R_G = 50\Omega$             | 1810 (Typ)                    |           |                               |          | $\mu\text{J}$      |
|                                                                                               |                 |                                                                                                                                                        | 1070 (Typ)                    |           |                               |          | $\mu\text{J}$      |
| Thermal Resistance Junction-to-Case                                                           | $R_{\theta JC}$ |                                                                                                                                                        | -                             | 1.67      | -                             | 1.67     | $^\circ\text{C/W}$ |
| Diode Forward Voltage                                                                         | $V_{EC}$        | $I_{EC} = 10\text{A}$                                                                                                                                  | -                             | 2         | -                             | 2        | V                  |
| Diode Reverse Recovery Time                                                                   | $t_{RR}$        | $I_{EC} = 10\text{A}, dI_{EC}/dt =$<br>$100\text{A}/\mu\text{s}$                                                                                       | -                             | 100       | -                             | 100      | ns                 |

Typical Performance Curves

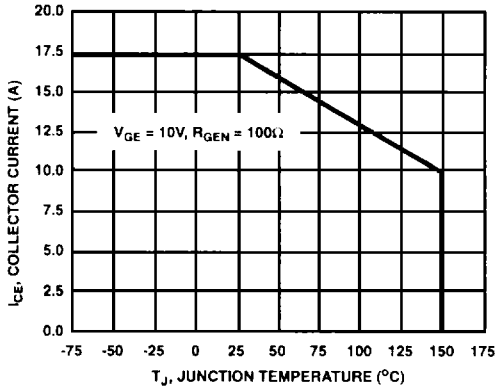


FIGURE 1. MAX. SWITCHING CURRENT LEVEL.  $R_G = 50\Omega$ ,  $V_{GE} = 0V$  ARE THE MIN. ALLOWABLE VALUES

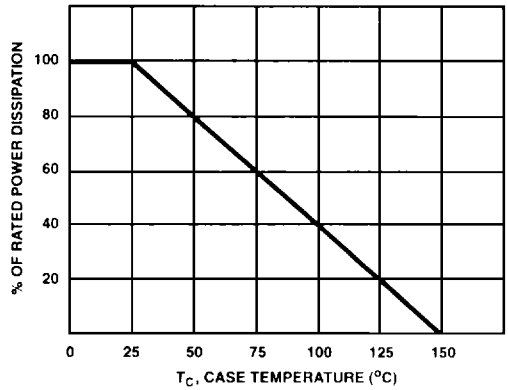


FIGURE 2. POWER DISSIPATION vs TEMPERATURE DERATING CURVE

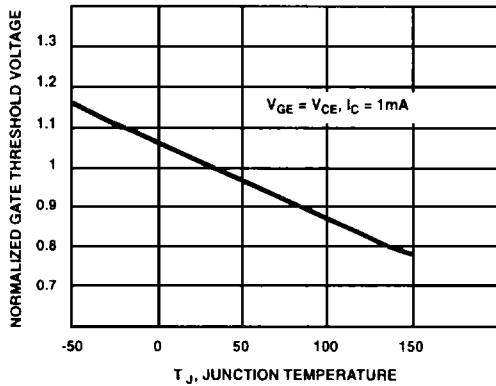


FIGURE 3. TYPICAL NORMALIZED GATE THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE

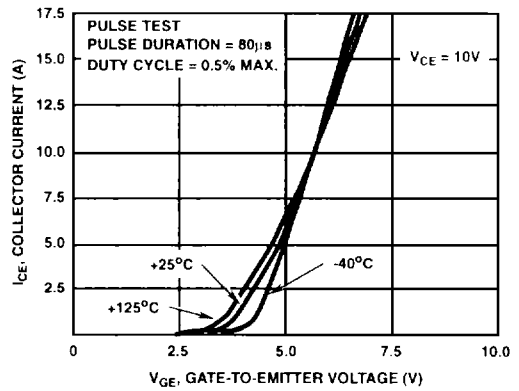


FIGURE 4. TYPICAL TRANSFER CHARACTERISTICS

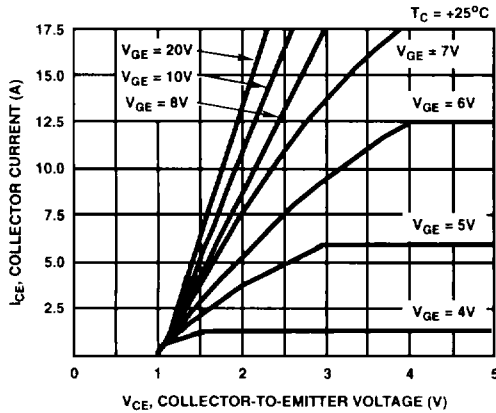


FIGURE 5. TYPICAL SATURATION CHARACTERISTICS

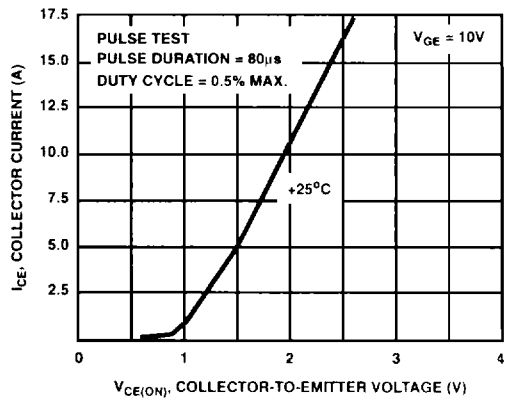


FIGURE 6. TYPICAL COLLECTOR-TO-EMITTER ON VOLTAGE vs COLLECTOR CURRENT

Typical Performance Curves (Continued)

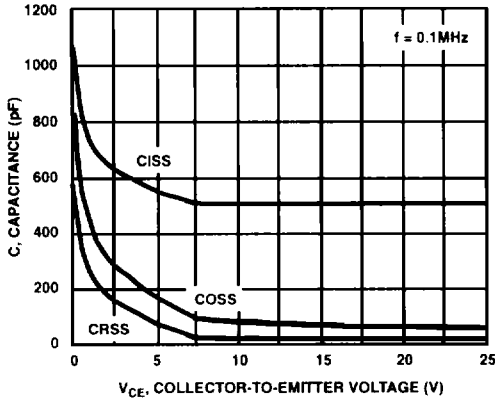


FIGURE 7. CAPACITANCE vs COLLECTOR-TO-EMITTER VOLTAGE

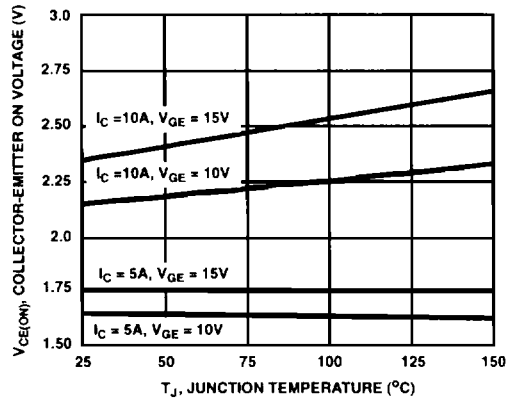


FIGURE 8. TYPICAL  $V_{CE(ON)}$  vs TEMPERATURE

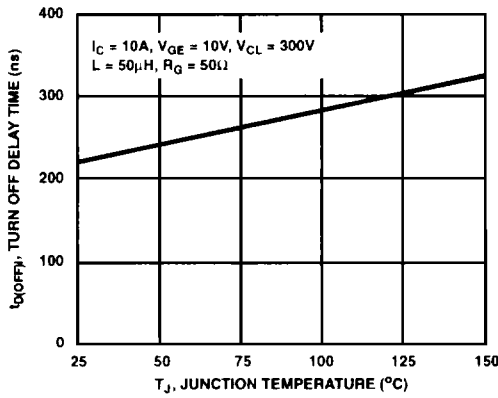


FIGURE 9. TYPICAL TURN-OFF DELAY TIME

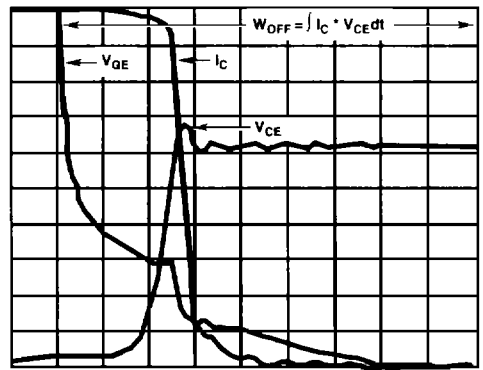


FIGURE 10. TYPICAL INDUCTIVE SWITCHING WAVEFORMS

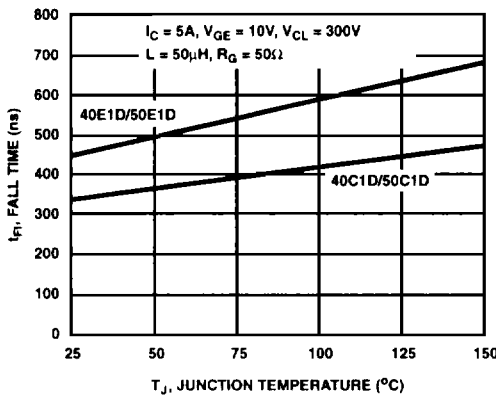


FIGURE 11. TYPICAL FALL TIME ( $I_C = 5A$ )

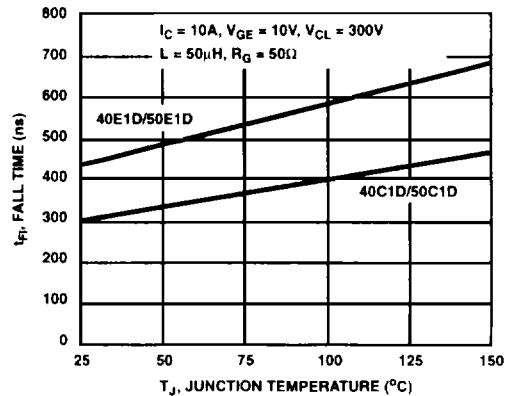


FIGURE 12. TYPICAL FALL TIME ( $I_C = 10A$ )

Typical Performance Curves (Continued)

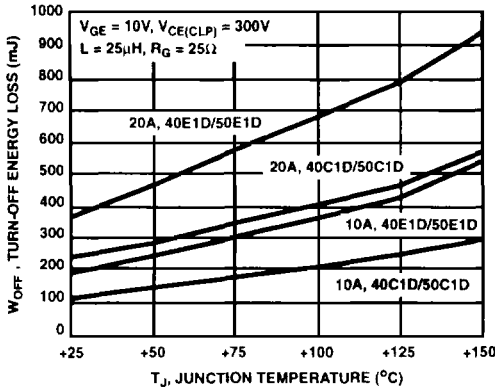


FIGURE 13. TYPICAL CLAMPED INDUCTIVE TURN-OFF SWITCHING LOSS/CYCLE

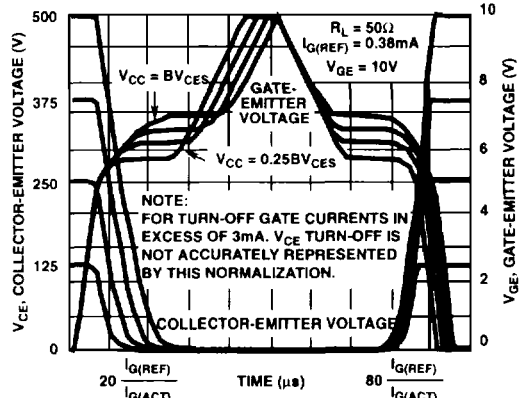


FIGURE 14. NORMALIZED SWITCHING WAVEFORMS AT CONSTANT GATE CURRENT (REFER TO APPLICATION NOTES AN7254 AND AN7260)

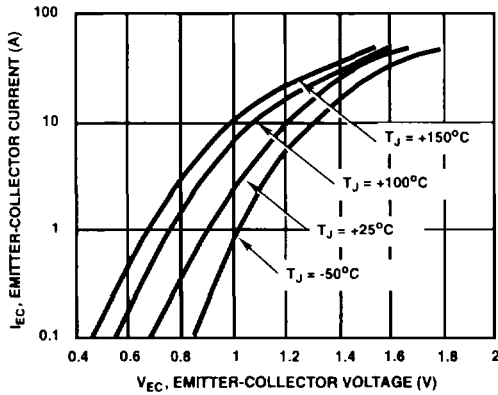


FIGURE 15. TYPICAL DIODE EMITTER-TO-COLLECTOR VOLTAGE vs CURRENT

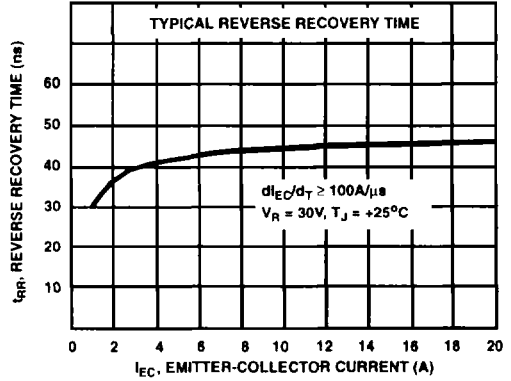


FIGURE 16. TYPICAL DIODE REVERSE RECOVERY TIME

Test Circuit

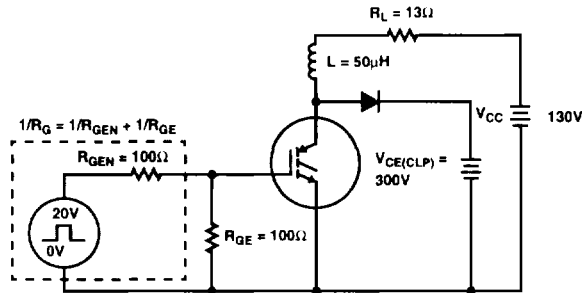


FIGURE 17. INDUCTIVE SWITCHING TEST CIRCUIT