

April 1995

### Features

- 15A and 20A, 400V and 500V
- $V_{CE(ON)}$  2.5V
- $T_{FI}$  1 $\mu$ s, 0.5 $\mu$ s
- Low On-State Voltage
- Fast Switching Speeds
- High Input Impedance
- No Anti-Parallel Diode

### Applications

- Power Supplies
- Motor Drives
- Protection Circuits

### Description

The HGTH20N40C1, HGTH20N40E1, HGTH20N50C1, HGTH20N50E1, HGTP15N40C1, HGTP15N40E1, HGTP15N50C1 and HGTP15N50E1 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.

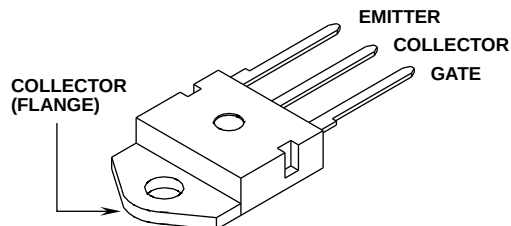
#### PACKAGING AVAILABILITY

| PART NUMBER | PACKAGE  | BRAND    |
|-------------|----------|----------|
| HGTH20N40C1 | TO-218AC | G20N40C1 |
| HGTH20N40E1 | TO-218AC | G20N40E1 |
| HGTH20N50C1 | TO-218AC | G20N50C1 |
| HGTH20N50E1 | TO-218AC | G20N50E1 |
| HGTP15N40C1 | TO-220AB | G15N40C1 |
| HGTP15N40E1 | TO-220AB | G15N40E1 |
| HGTP15N50C1 | TO-220AB | G15N50C1 |
| HGTP15N50E1 | TO-220AB | G15N50E1 |

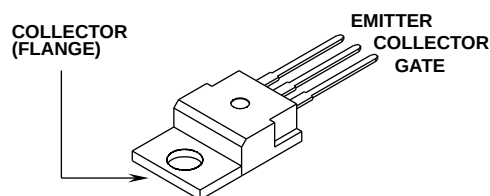
NOTE: When ordering, use the entire part number.

### Packages

#### HGTH-TYPES JEDEC TO-218AC

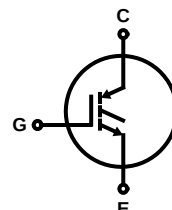


#### HGTP-TYPES JEDEC TO-220AB



### Terminal Diagram

#### N-CHANNEL ENHANCEMENT MODE



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

|                                                                    | HGTH20N40C1<br>HGTH20N40E1 | HGTH20N50C1<br>HGTH20N50E1 | HGTP15N40C1<br>HGTP15N40E1 | HGTP15N50C1<br>HGTP15N50E1 | UNITS               |
|--------------------------------------------------------------------|----------------------------|----------------------------|----------------------------|----------------------------|---------------------|
| Collector-Emitter Voltage..... $V_{CES}$                           | 400                        | 500                        | 400                        | 500                        | V                   |
| Collector-Gate Voltage $R_{GE} = 1\text{M}\Omega$ ..... $V_{CGR}$  | 400                        | 500                        | 400                        | 500                        | V                   |
| Reverse Collector-Emitter Voltage..... $V_{CES}(\text{rev.})$      | -5                         | -5                         | -5                         | -5                         | V                   |
| Gate-Emitter Voltage..... $V_{GE}$                                 | $\pm 20$                   | $\pm 20$                   | $\pm 20$                   | $\pm 20$                   | V                   |
| Collector Current Continuous..... $I_C$                            | 20                         | 20                         | 15                         | 15                         | A                   |
| Collector Current Pulsed..... $I_{CM}$                             | 35                         | 35                         | 35                         | 35                         | A                   |
| Power Dissipation at $T_C = +25^\circ\text{C}$ ..... $P_D$         | 100                        | 100                        | 75                         | 75                         | W                   |
| Power Dissipation Derating $T_C > +25^\circ\text{C}$ .....         | 0.8                        | 0.8                        | 0.6                        | 0.6                        | W/ $^\circ\text{C}$ |
| Operating and Storage Junction Temperature Range... $T_J, T_{STG}$ | -55 to +150                | -55 to +150                | -55 to +150                | -55 to +150                | $^\circ\text{C}$    |

# Specifications HGTP15N40C1, 40E1, 50C1, 50E1, HGTH20N40C1, 40E1, 50C1, 50E1

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

| PARAMETERS                                                                                      | SYMBOL               | TEST CONDITIONS                                                                                                                                       | LIMITS                              |          |                                     |          | UNITS |
|-------------------------------------------------------------------------------------------------|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|----------|-------------------------------------|----------|-------|
|                                                                                                 |                      |                                                                                                                                                       | HGTH20N40C1, E1,<br>HGTP15N40C1, E1 |          | HGTH20N50C1, E1,<br>HGTP15N50C1, E1 |          |       |
|                                                                                                 |                      |                                                                                                                                                       | MIN                                 | MAX      | MIN                                 | MAX      |       |
| Collector-Emitter Breakdown Voltage                                                             | BV <sub>CES</sub>    | I <sub>C</sub> = 1mA, V <sub>GE</sub> = 0                                                                                                             | 400                                 | -        | 500                                 | -        | V     |
| Gate Threshold Voltage                                                                          | V <sub>GE(TH)</sub>  | V <sub>GE</sub> = V <sub>CE</sub> , I <sub>C</sub> = 1mA                                                                                              | 2.0                                 | 4.5      | 2.0                                 | 4.5      | V     |
| Zero-Gate Voltage Collector Current                                                             | I <sub>CES</sub>     | V <sub>CE</sub> = 400V, T <sub>C</sub> = +25 <sup>o</sup> C                                                                                           | -                                   | 250      | -                                   | -        | μA    |
|                                                                                                 |                      | V <sub>CE</sub> = 500V, T <sub>C</sub> = +25 <sup>o</sup> C                                                                                           | -                                   | -        | -                                   | 250      | μA    |
|                                                                                                 |                      | V <sub>CE</sub> = 400V, T <sub>C</sub> = +125 <sup>o</sup> C                                                                                          | -                                   | 1000     | -                                   | -        | μA    |
|                                                                                                 |                      | V <sub>CE</sub> = 500V, T <sub>C</sub> = +125 <sup>o</sup> C                                                                                          | -                                   | -        | -                                   | 1000     | μA    |
| Gate-Emitter Leakage Current                                                                    | I <sub>GES</sub>     | V <sub>GE</sub> = ±20V, V <sub>CE</sub> = 0                                                                                                           | -                                   | 100      | -                                   | 100      | nA    |
| Reverse Collector-Emitter Leakage Current                                                       | I <sub>CE</sub>      | R <sub>GE</sub> = 0Ω, V <sub>EC</sub> = 5V                                                                                                            | -                                   | -5       | -                                   | -5       | mA    |
| Collector-Emitter on Voltage                                                                    | V <sub>CE(ON)</sub>  | I <sub>C</sub> = 20A, V <sub>GE</sub> = 10V                                                                                                           | -                                   | 2.5      | -                                   | 2.5      | V     |
|                                                                                                 |                      | I <sub>C</sub> = 35A, V <sub>GE</sub> = 20V                                                                                                           | -                                   | 3.2      | -                                   | 3.2      | V     |
| Gate-Emitter Plateau Voltage                                                                    | V <sub>GEP</sub>     | I <sub>C</sub> = 10A, V <sub>CE</sub> = 10V                                                                                                           | -                                   | 6 (Typ)  | -                                   | 6 (Typ)  | V     |
| On-State Gate Charge                                                                            | Q <sub>G(ON)</sub>   | I <sub>C</sub> = 10A, V <sub>CE</sub> = 10V                                                                                                           | -                                   | 33 (Typ) | -                                   | 33 (Typ) | nC    |
| Turn-On Delay Time                                                                              | t <sub>D(ON)I</sub>  | I <sub>C</sub> = 20A, V <sub>CE(CL P)</sub> = 300V,<br>L = 25μH, T <sub>J</sub> = +100 <sup>o</sup> C,<br>V <sub>GE</sub> = 10V, R <sub>G</sub> = 25Ω | -                                   | 50       | -                                   | 50       | ns    |
| Rise Time                                                                                       | t <sub>RI</sub>      |                                                                                                                                                       | -                                   | 50       | -                                   | 50       | ns    |
| Turn-Off Delay Time                                                                             | t <sub>D(OFF)I</sub> |                                                                                                                                                       | -                                   | 400      | -                                   | 400      | ns    |
| Fall Time                                                                                       | t <sub>FI</sub>      |                                                                                                                                                       | 680 (Typ)                           | 1000     | 680 (Typ)                           | 1000     | ns    |
|                                                                                                 |                      |                                                                                                                                                       | 400                                 | 500      | 400                                 | 500      | ns    |
| Turn-Off Energy Loss per Cycle<br>(Off Switching Dissipation =<br>W <sub>OFF</sub> × Frequency) | W <sub>OFF</sub>     | I <sub>C</sub> = 10A, V <sub>CE(CL P)</sub> = 300V,<br>L = 25μH, T <sub>J</sub> = +100 <sup>o</sup> C,<br>V <sub>GE</sub> = 10V, R <sub>G</sub> = 25Ω | 1810 (Typ)                          |          |                                     |          | μJ    |
|                                                                                                 |                      |                                                                                                                                                       | 1070 (Typ)                          |          |                                     |          | μJ    |
| Thermal Resistance<br>Junction-to-Case                                                          | R <sub>θJC</sub>     | HGTH, HGTM                                                                                                                                            | -                                   | 1.25     | -                                   | 1.25     | °C/W  |
|                                                                                                 |                      | HGTP                                                                                                                                                  | -                                   | 1.67     | -                                   | 1.67     | °C/W  |

### 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 |           |           |           |           |           |           |           |

## Typical Performance Curves

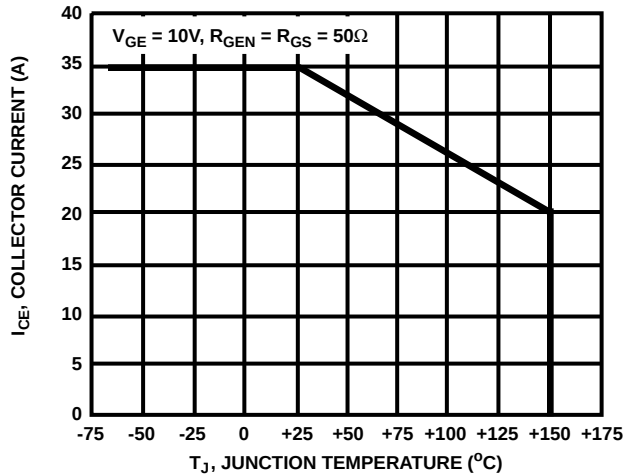


FIGURE 1. MAX. SWITCHING CURRENT LEVEL.  $R_G = 25\Omega$ ,  $V_{GE} = 0\text{V}$  ARE THE MIN. ALLOWABLE VALUES

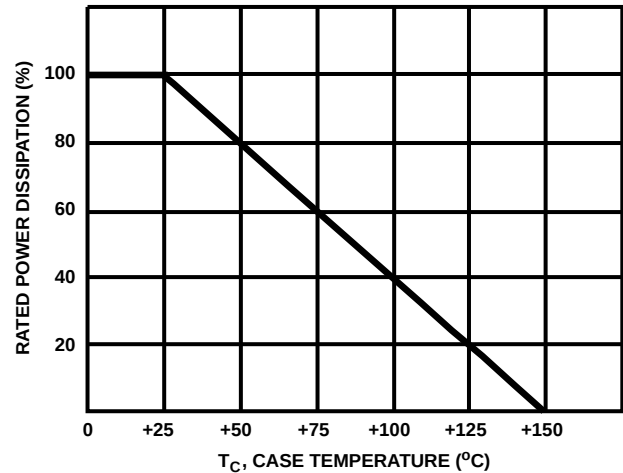


FIGURE 2. POWER DISSIPATION vs TEMPERATURE DERATING CURVE

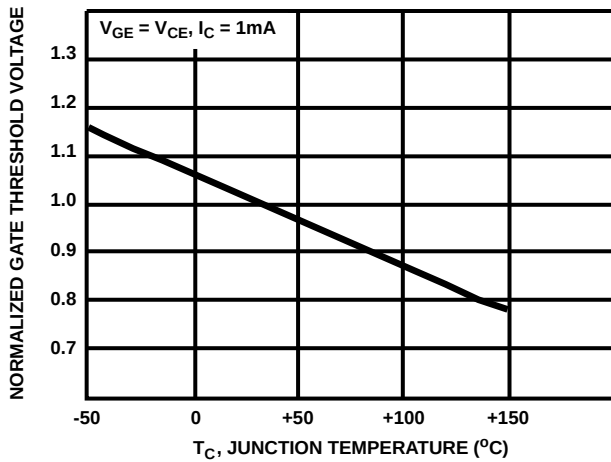


FIGURE 3. TYPICAL NORMALIZED GATE THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE

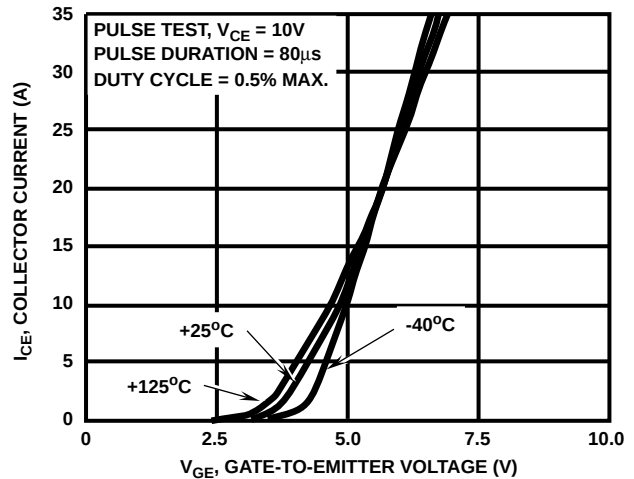


FIGURE 4. TYPICAL TRANSFER CHARACTERISTICS

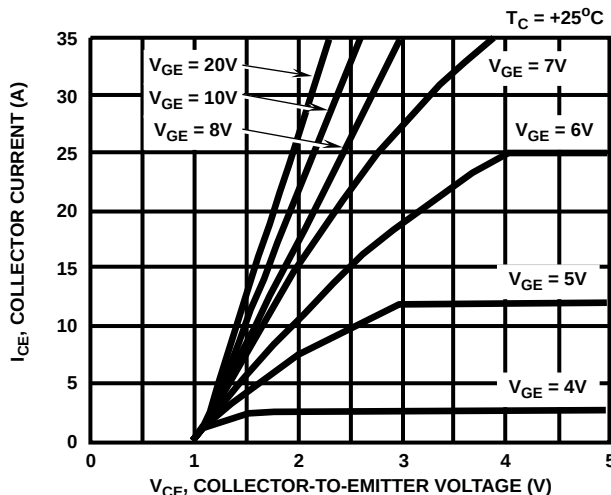


FIGURE 5. TYPICAL SATURATION CHARACTERISTICS

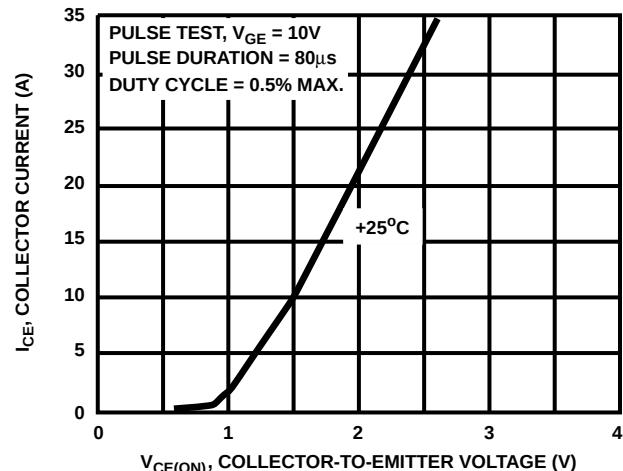


FIGURE 6. TYPICAL COLLECTOR-TO-EMITTER ON-VOLTAGE vs COLLECTOR CURRENT

# Typical Performance Curves (Continued)

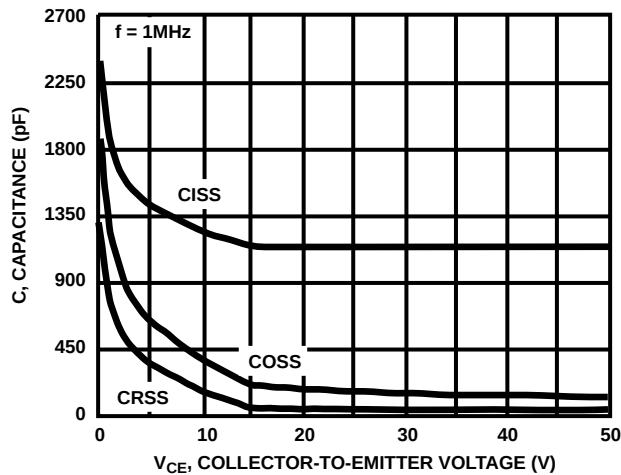


FIGURE 7. CAPACITANCE vs COLLECTOR-TO-EMITTER VOLTAGE

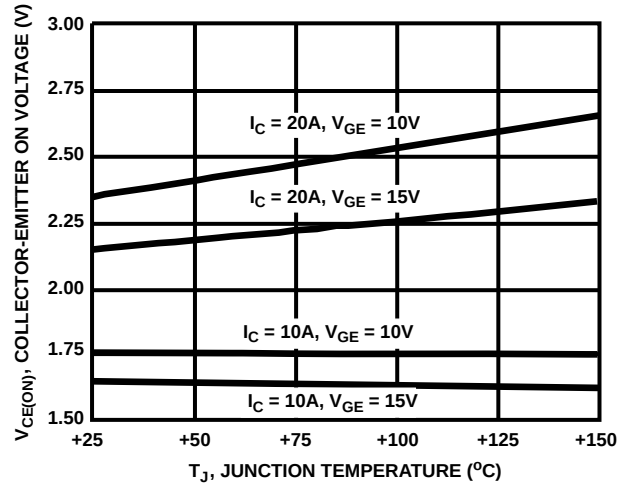


FIGURE 8. TYPICAL  $V_{CE(ON)}$  vs TEMPERATURE

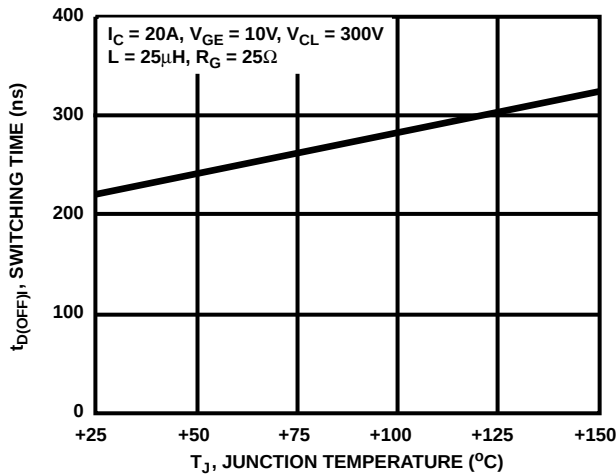


FIGURE 9. TYPICAL TURN-OFF DELAY TIME

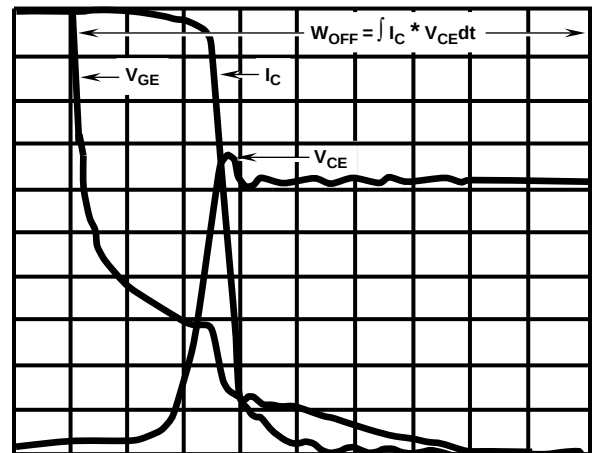


FIGURE 10. TYPICAL INDUCTIVE SWITCHING WAVEFORMS

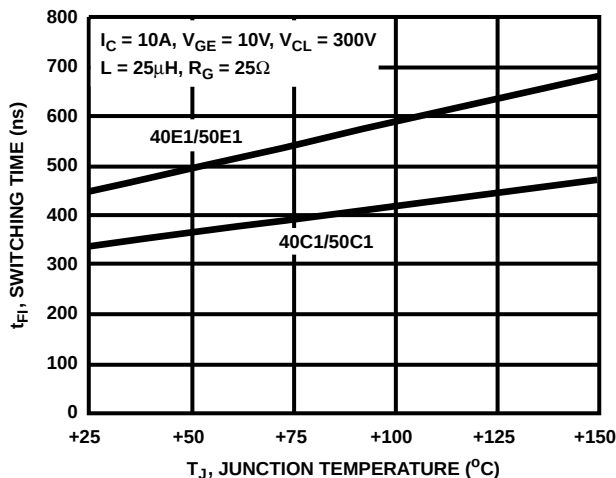


FIGURE 11. TYPICAL FALL TIME ( $I_C = 10A$ )

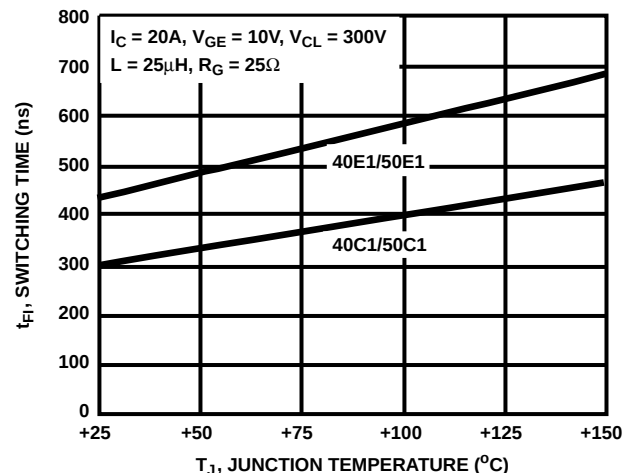


FIGURE 12. TYPICAL FALL TIME ( $I_C = 20A$ )

## Typical Performance Curves (Continued)

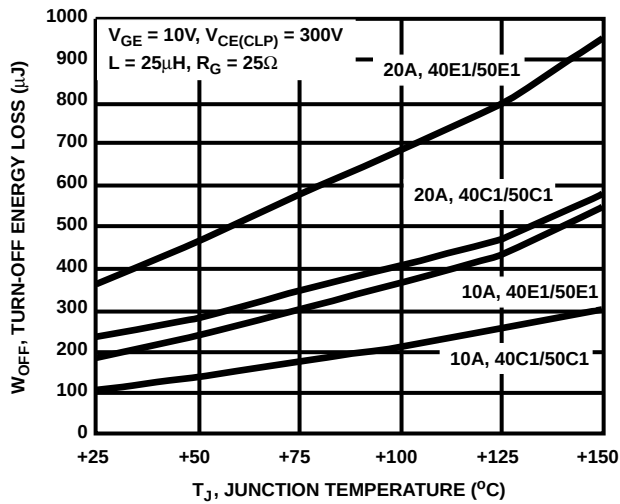


FIGURE 13. TYPICAL CLAMPED INDUCTIVE TURN-OFF SWITCHING LOSS/CYCLE

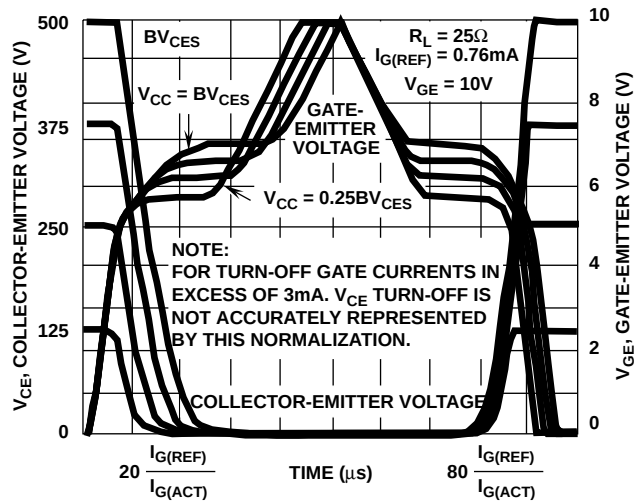


FIGURE 14. NORMALIZED SWITCHING WAVEFORMS AT CONSTANT GATE CURRENT. (REFER TO APPLICATION NOTES AN7254 AND AN7260 ON THE USE OF NORMALIZED SWITCHING WAVEFORMS)

## Test Circuit

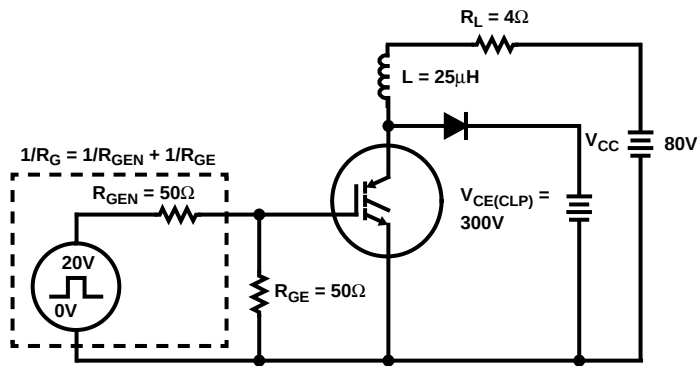


FIGURE 15. INDUCTIVE SWITCHING TEST CIRCUIT