

# IGBT

## NGTB45N60SWG

This Insulated Gate Bipolar Transistor (IGBT) features a robust and cost effective Field Stop (FS) Trench construction, and provides superior performance in demanding switching applications, offering both low on state voltage and minimal switching loss. The IGBT is well suited for half bridge resonant applications. Incorporated into the device is a soft and fast co-packaged free wheeling diode with a low forward voltage.

### Features

- Low Saturation Voltage using Trench with Fieldstop Technology
- Low Switching Loss Reduces System Power Dissipation
- Low Gate Charge
- Soft, Fast Free Wheeling Diode
- These are Pb-Free Devices

### Typical Applications

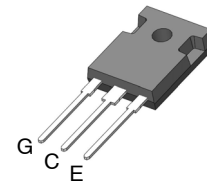
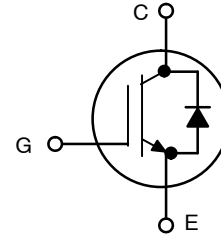
- Inductive Heating
- Soft Switching

### ABSOLUTE MAXIMUM RATINGS

| Rating                                                                             | Symbol           | Value           | Unit             |
|------------------------------------------------------------------------------------|------------------|-----------------|------------------|
| Collector-emitter Voltage                                                          | $V_{CES}$        | 600             | V                |
| Collector Current<br>@ $T_C = 25^\circ\text{C}$<br>@ $T_C = 100^\circ\text{C}$     | $I_C$            | 90<br>45        | A                |
| Pulsed Collector Current, $T_{\text{pulse}}$<br>Limited by $T_{J\text{max}}$       | $I_{CM}$         | 180             | A                |
| Diode Forward Current<br>@ $T_C = 25^\circ\text{C}$<br>@ $T_C = 100^\circ\text{C}$ | $I_F$            | 90<br>45        | A                |
| Diode Pulsed Current, $T_{\text{pulse}}$ Limited<br>by $T_{J\text{max}}$           | $I_{FM}$         | 180             | A                |
| Gate-emitter Voltage                                                               | $V_{GE}$         | $\pm 20$        | V                |
| Power Dissipation<br>@ $T_C = 25^\circ\text{C}$<br>@ $T_C = 100^\circ\text{C}$     | $P_D$            | 250<br>50       | W                |
| Operating Junction Temperature<br>Range                                            | $T_J$            | $-55$ to $+150$ | $^\circ\text{C}$ |
| Storage Temperature Range                                                          | $T_{\text{stg}}$ | $-55$ to $+150$ | $^\circ\text{C}$ |
| Lead temperature for soldering, 1/8"<br>from case for 5 seconds                    | $T_{\text{SLD}}$ | 260             | $^\circ\text{C}$ |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

**45 A, 600 V**  
 $V_{CE\text{sat}} = 2.2 \text{ V}$   
 $E_{\text{off}} = 0.55 \text{ mJ}$



TO-247  
CASE 340AM

### MARKING DIAGRAM



45N60S = Specific Device Code  
A = Assembly Location  
Y = Year  
WW = Work Week  
G = Pb-Free Package

### ORDERING INFORMATION

| Device       | Package             | Shipping        |
|--------------|---------------------|-----------------|
| NGTB45N60SWG | TO-247<br>(Pb-Free) | 30 Units / Rail |

# NGTB45N60SWG

## THERMAL CHARACTERISTICS

| Rating                                         | Symbol          | Value | Unit                 |
|------------------------------------------------|-----------------|-------|----------------------|
| Thermal resistance junction-to-case, for IGBT  | $R_{\theta JC}$ | 0.87  | $^{\circ}\text{C/W}$ |
| Thermal resistance junction-to-case, for Diode | $R_{\theta JC}$ | 1.47  | $^{\circ}\text{C/W}$ |
| Thermal resistance junction-to-ambient         | $R_{\theta JA}$ | 40    | $^{\circ}\text{C/W}$ |

## ELECTRICAL CHARACTERISTICS ( $T_J = 25^{\circ}\text{C}$ unless otherwise specified)

| Parameter | Test Conditions | Symbol | Min | Typ | Max | Unit |
|-----------|-----------------|--------|-----|-----|-----|------|
|-----------|-----------------|--------|-----|-----|-----|------|

### STATIC CHARACTERISTIC

|                                                                   |                                                                                                                         |               |        |            |          |    |
|-------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|---------------|--------|------------|----------|----|
| Collector-emitter breakdown voltage, gate-emitter short-circuited | $V_{GE} = 0\text{ V}, I_C = 500\text{ }\mu\text{A}$                                                                     | $V_{(BR)CES}$ | 600    | –          | –        | V  |
| Collector-emitter saturation voltage                              | $V_{GE} = 15\text{ V}, I_C = 45\text{ A}$<br>$V_{GE} = 15\text{ V}, I_C = 45\text{ A}, T_J = 150^{\circ}\text{C}$       | $V_{CEsat}$   | –<br>– | 2.2<br>2.6 | 2.4<br>– | V  |
| Gate-emitter threshold voltage                                    | $V_{GE} = V_{CE}, I_C = 150\text{ }\mu\text{A}$                                                                         | $V_{GE(th)}$  | 4.5    | 5.5        | 6.5      | V  |
| Collector-emitter cut-off current, gate-emitter short-circuited   | $V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}$<br>$V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}, T_J = 150^{\circ}\text{C}$ | $I_{CES}$     | –<br>– | –<br>–     | 0.2<br>2 | mA |
| Gate leakage current, collector-emitter short-circuited           | $V_{GE} = 20\text{ V}, V_{CE} = 0\text{ V}$                                                                             | $I_{GES}$     | –      | –          | 100      | nA |

### DYNAMIC CHARACTERISTIC

|                              |                                                                  |           |   |      |   |    |
|------------------------------|------------------------------------------------------------------|-----------|---|------|---|----|
| Input capacitance            | $V_{CE} = 20\text{ V}, V_{GE} = 0\text{ V}, f = 1\text{ MHz}$    | $C_{ies}$ | – | 3100 | – | pF |
| Output capacitance           |                                                                  | $C_{oes}$ | – | 120  | – |    |
| Reverse transfer capacitance |                                                                  | $C_{res}$ | – | 80   | – |    |
| Gate charge total            | $V_{CE} = 480\text{ V}, I_C = 45\text{ A}, V_{GE} = 15\text{ V}$ | $Q_g$     |   | 134  |   | nC |
| Gate to emitter charge       |                                                                  | $Q_{ge}$  |   | 27   |   |    |
| Gate to collector charge     |                                                                  | $Q_{gc}$  |   | 67   |   |    |

### SWITCHING CHARACTERISTIC, INDUCTIVE LOAD

|                         |                                                                                                                                            |              |  |      |  |    |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|--------------|--|------|--|----|
| Turn-on delay time      | $T_J = 25^{\circ}\text{C}$<br>$V_{CC} = 400\text{ V}, I_C = 45\text{ A}$<br>$R_g = 10\text{ }\Omega$<br>$V_{GE} = 0\text{ V}/15\text{ V}$  | $t_{d(on)}$  |  | 70   |  | ns |
| Rise time               |                                                                                                                                            | $t_r$        |  | 34   |  |    |
| Turn-off delay time     |                                                                                                                                            | $t_{d(off)}$ |  | 144  |  |    |
| Fall time               |                                                                                                                                            | $t_f$        |  | 68   |  |    |
| Turn-off switching loss |                                                                                                                                            | $E_{off}$    |  | 0.55 |  |    |
| Turn-on delay time      | $T_J = 150^{\circ}\text{C}$<br>$V_{CC} = 400\text{ V}, I_C = 45\text{ A}$<br>$R_g = 10\text{ }\Omega$<br>$V_{GE} = 0\text{ V}/15\text{ V}$ | $t_{d(on)}$  |  | 70   |  | ns |
| Rise time               |                                                                                                                                            | $t_r$        |  | 39   |  |    |
| Turn-off delay time     |                                                                                                                                            | $t_{d(off)}$ |  | 151  |  |    |
| Fall time               |                                                                                                                                            | $t_f$        |  | 88   |  |    |
| Turn-off switching loss |                                                                                                                                            | $E_{off}$    |  | 0.89 |  |    |

### DIODE CHARACTERISTIC

|                          |                                                                                                                 |           |  |             |     |    |
|--------------------------|-----------------------------------------------------------------------------------------------------------------|-----------|--|-------------|-----|----|
| Forward voltage          | $V_{GE} = 0\text{ V}, I_F = 20\text{ A}$<br>$V_{GE} = 0\text{ V}, I_F = 20\text{ A}, T_J = 150^{\circ}\text{C}$ | $V_F$     |  | 1.1<br>1.03 | 1.4 | V  |
| Reverse recovery time    | $T_J = 25^{\circ}\text{C}$<br>$I_F = 25\text{ A}, V_R = 200\text{ V}$<br>$di_F/dt = 200\text{ A}/\mu\text{s}$   | $t_{rr}$  |  | 376         |     | ns |
| Reverse recovery charge  |                                                                                                                 | $Q_{rr}$  |  | 4145        |     | nc |
| Reverse recovery current |                                                                                                                 | $I_{rrm}$ |  | 22          |     | A  |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

# NGTB45N60SWG

## TYPICAL CHARACTERISTICS

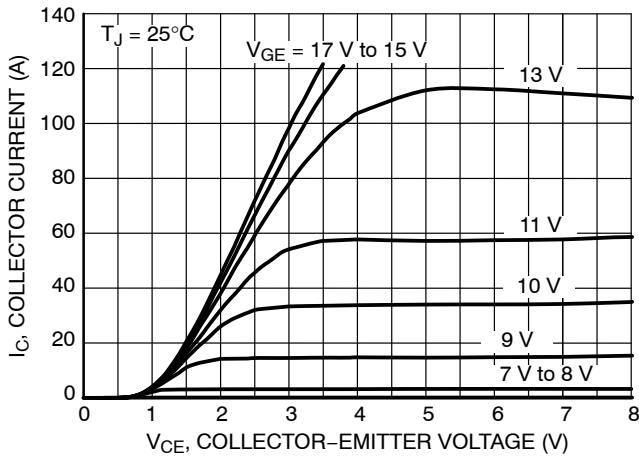


Figure 1. Output Characteristics

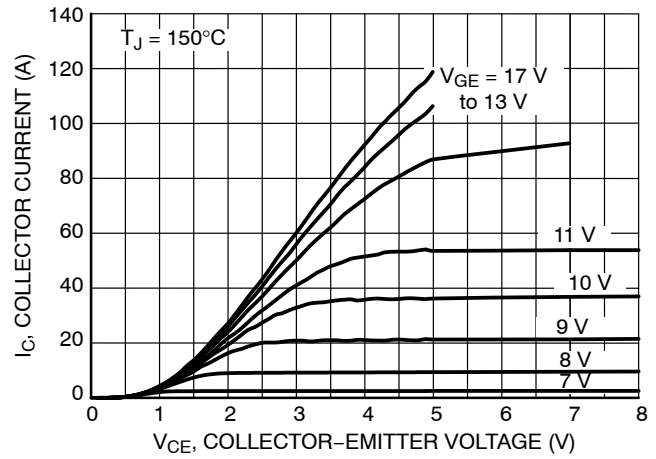


Figure 2. Output Characteristics

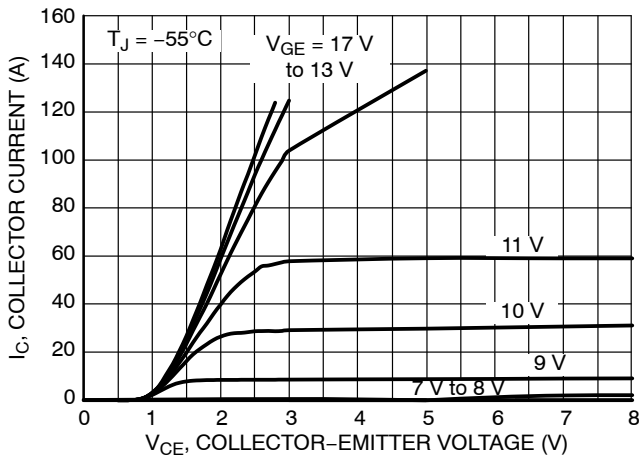


Figure 3. Output Characteristics

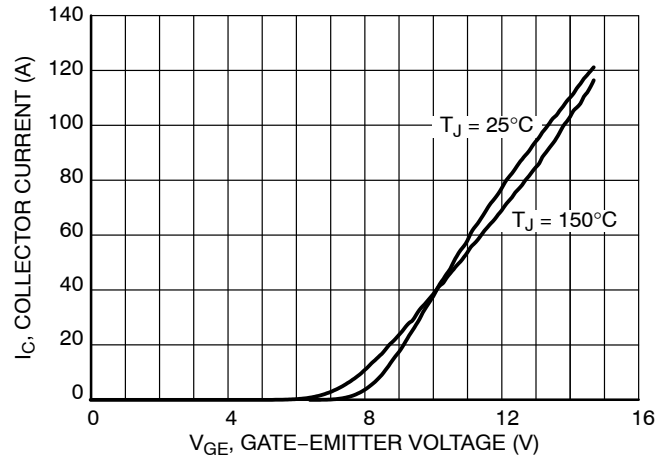


Figure 4. Typical Transfer Characteristics

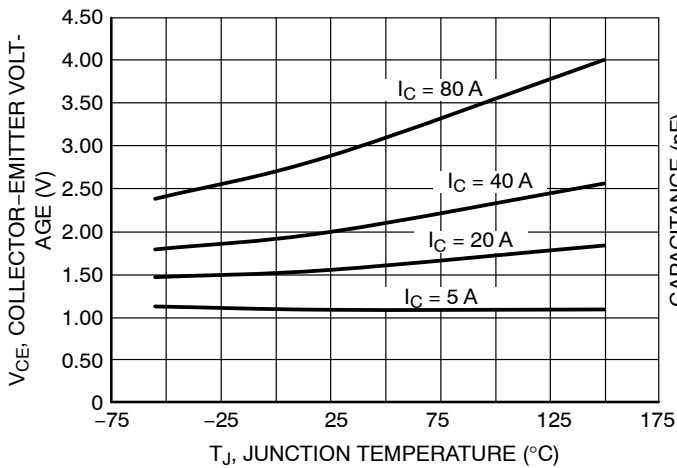


Figure 5.  $V_{CE(sat)}$  vs.  $T_J$

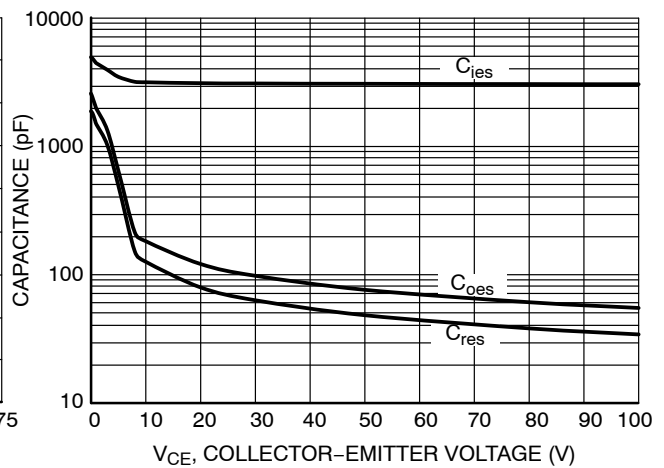


Figure 6. Typical Capacitance

# NGTB45N60SWG

## TYPICAL CHARACTERISTICS

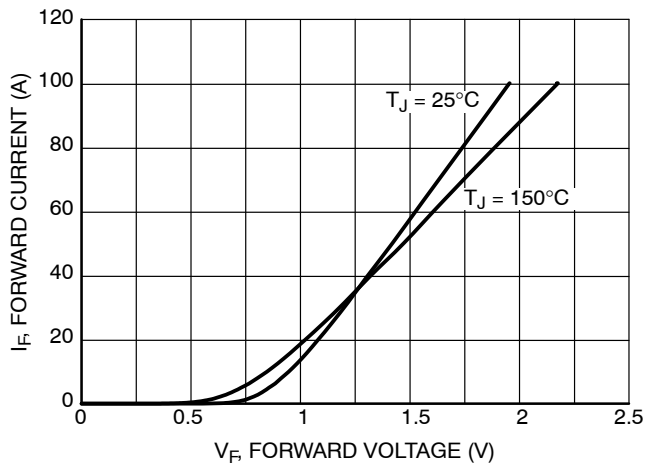


Figure 7. Diode Forward Characteristics

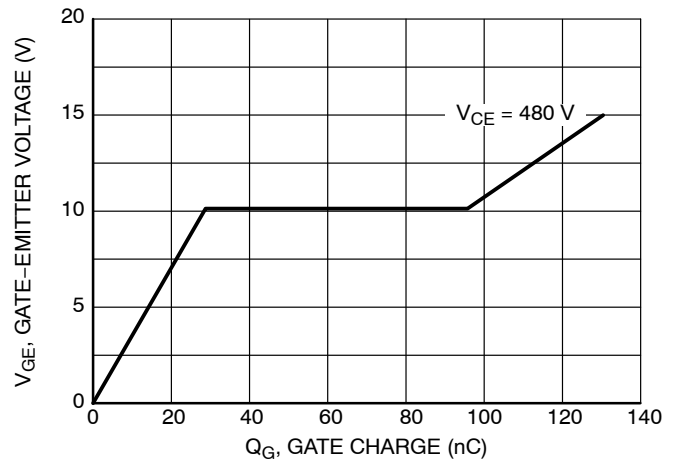


Figure 8. Typical Gate Charge

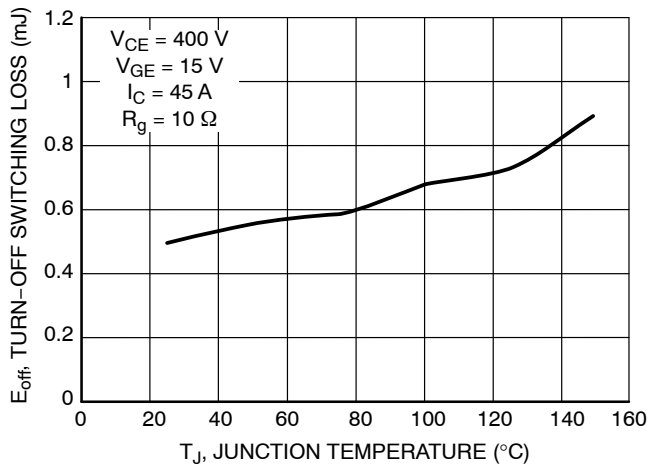


Figure 9. Switching Loss vs. Temperature

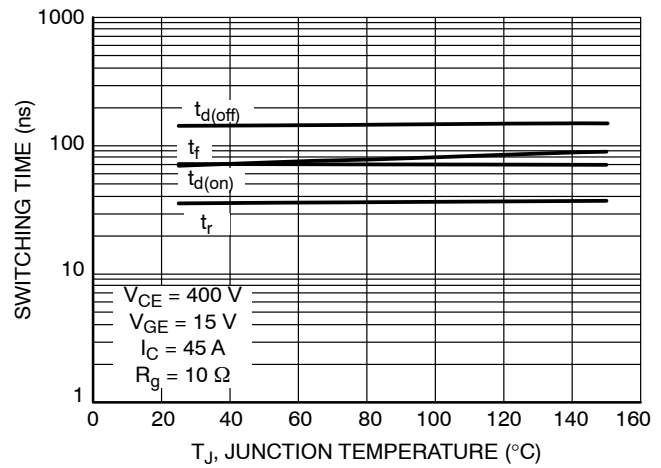


Figure 10. Switching Time vs. Temperature

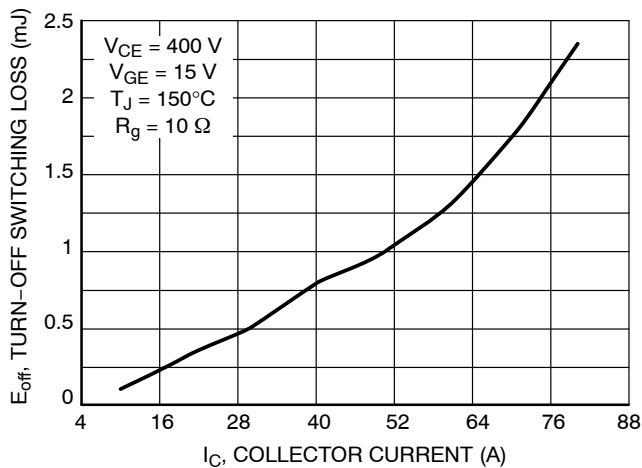


Figure 11. Switching Loss vs.  $I_C$

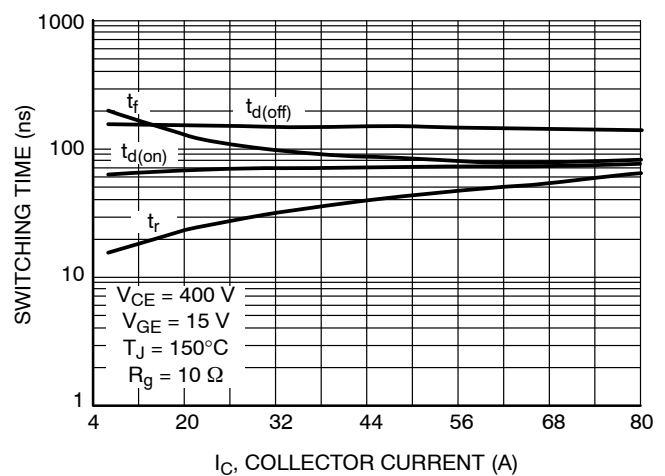


Figure 12. Switching Time vs. Current

# NGTB45N60SWG

## TYPICAL CHARACTERISTICS

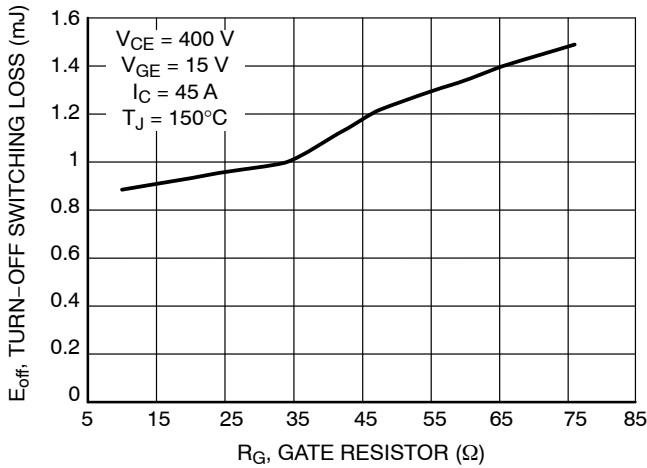


Figure 13. Switching Loss vs.  $R_G$

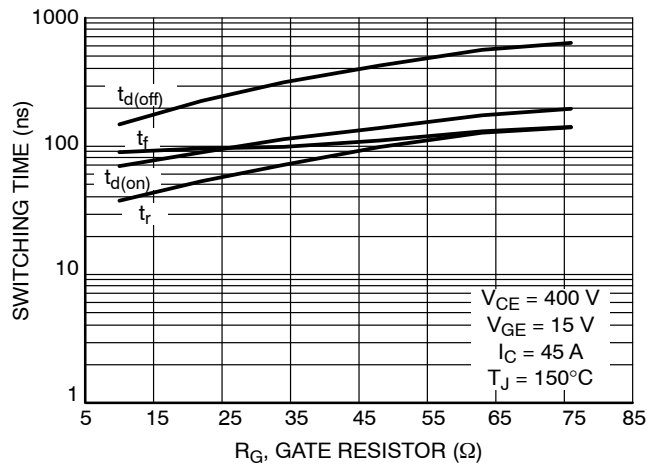


Figure 14. Switching Time vs.  $R_G$

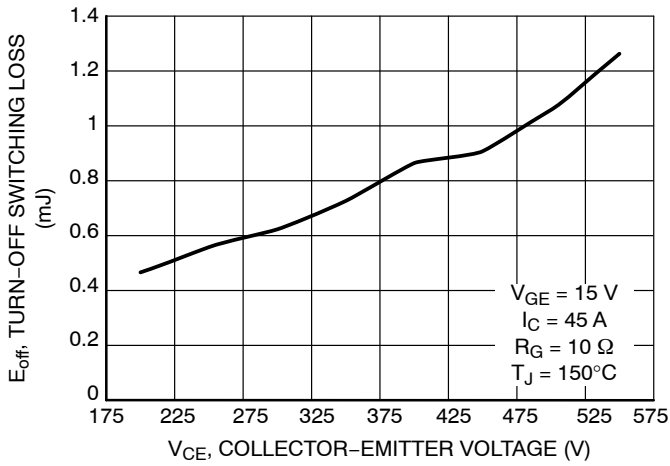


Figure 15. Switching Loss vs.  $V_{CE}$

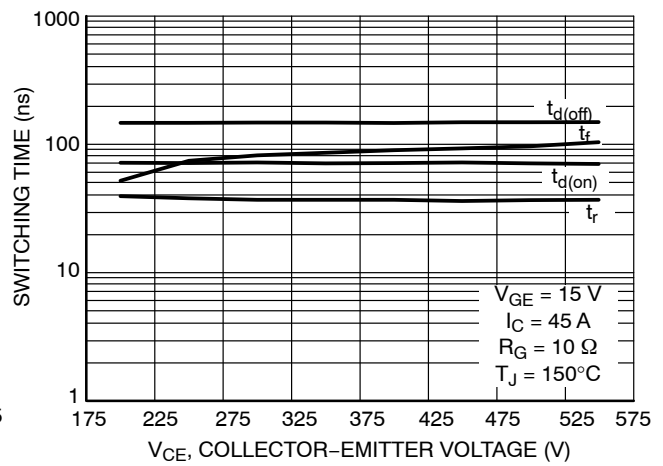


Figure 16. Switching Time vs.  $V_{CE}$

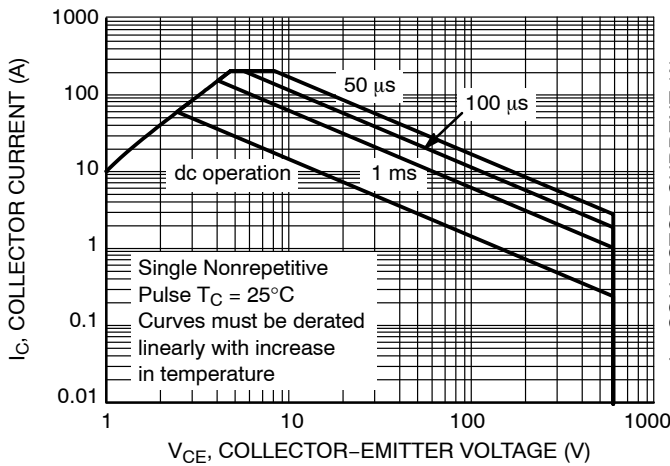


Figure 17. Safe Operating Area

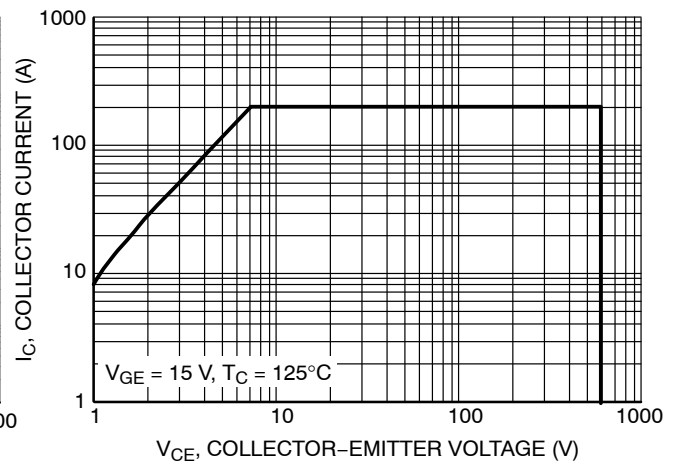


Figure 18. Reverse Bias Safe Operating Area

# NGTB45N60SWG

## TYPICAL CHARACTERISTICS

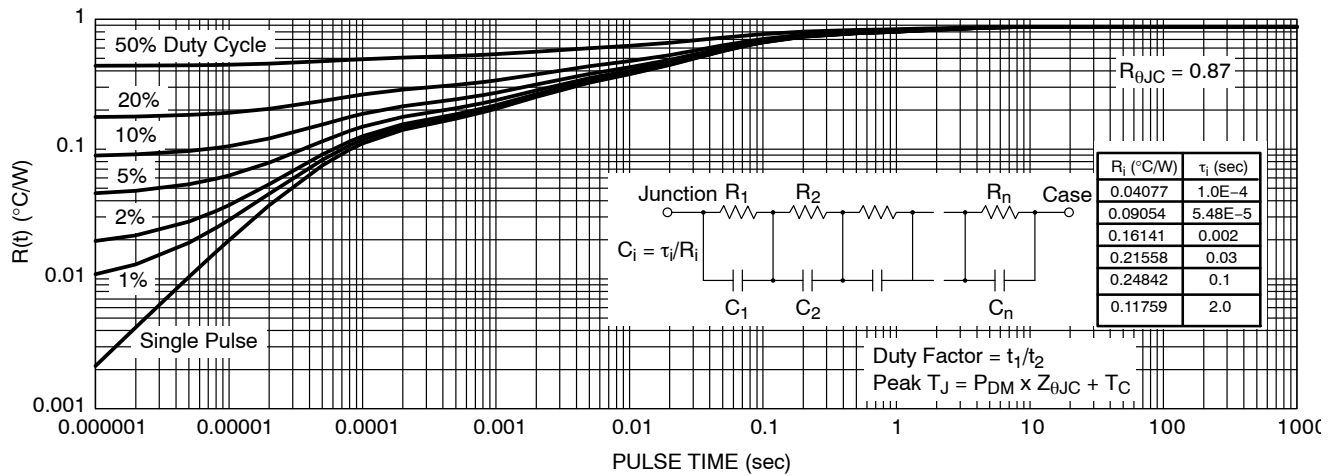


Figure 19. IGBT Transient Thermal Impedance

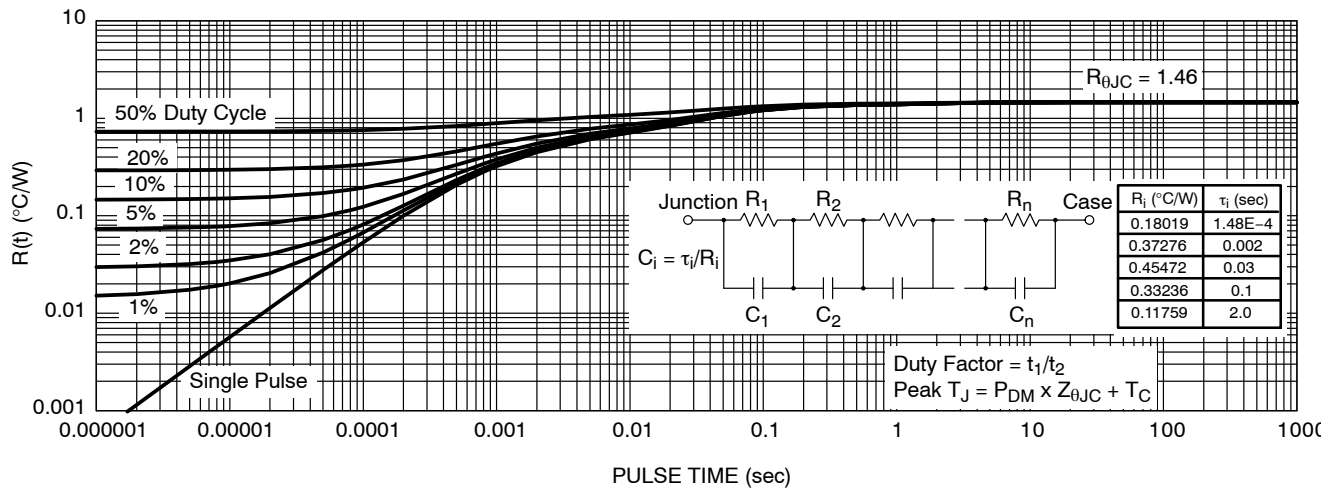


Figure 20. Diode Transient Thermal Impedance

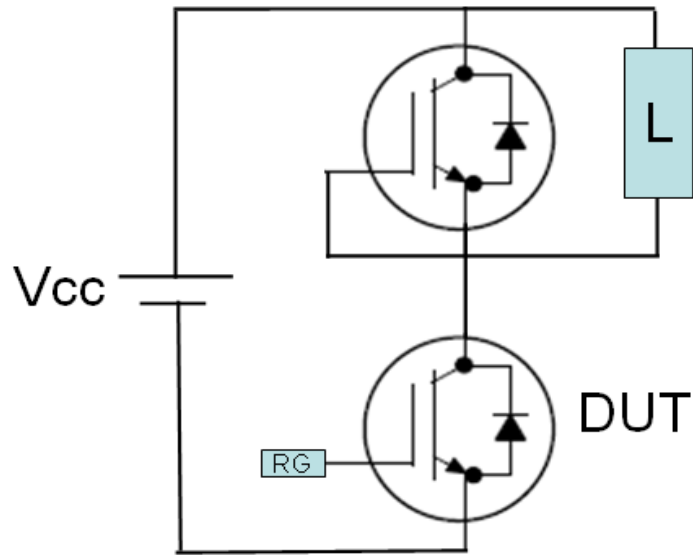


Figure 21. Test Circuit for Switching Characteristics

# NGTB45N60SWG

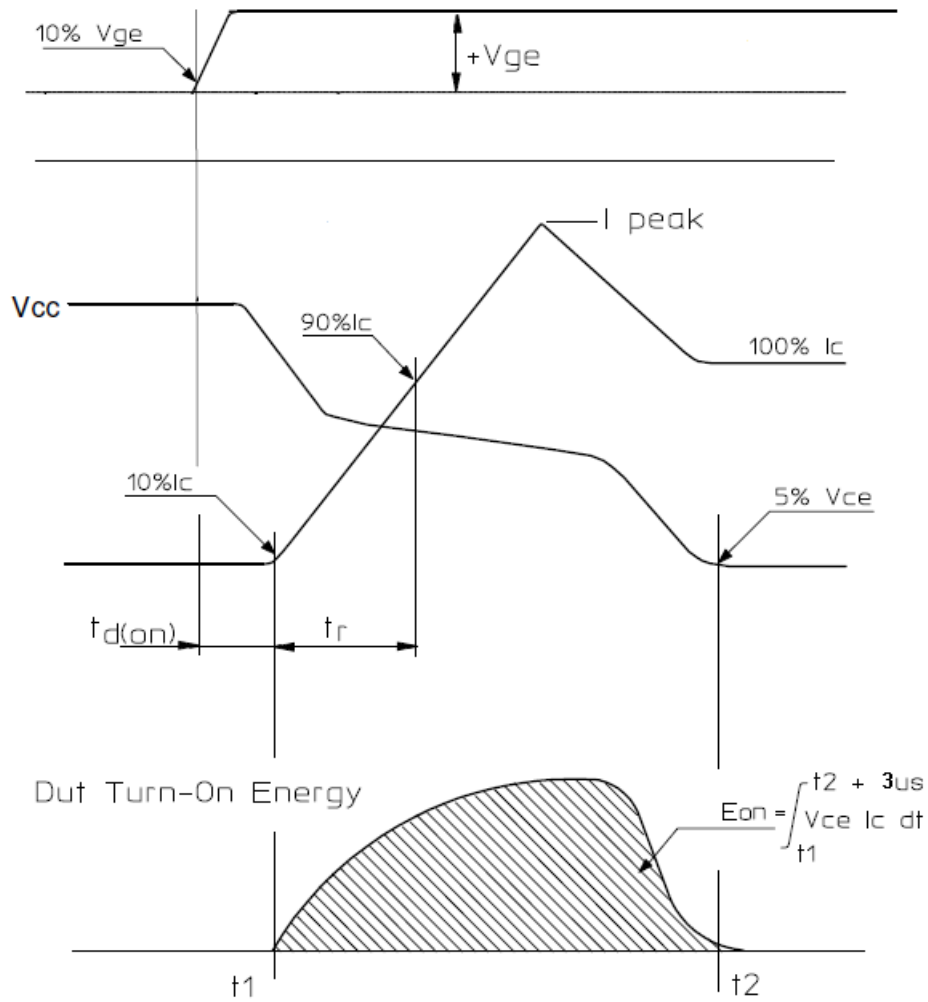


Figure 22. Definition of Turn On Waveform

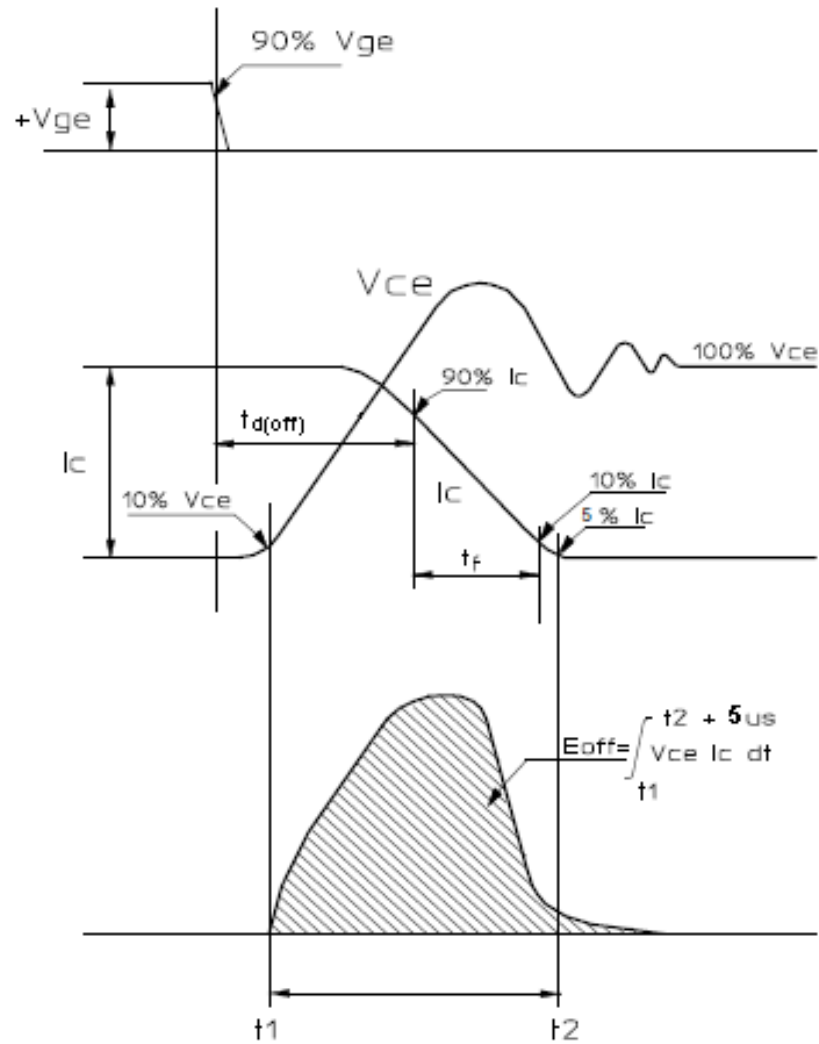
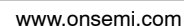


Figure 23. Definition of Turn Off Waveform

**ON**



**onsemi**, **Onsemi**, and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "**onsemi**" or its affiliates and/or subsidiaries in the United States and/or other countries. **onsemi** owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of **onsemi**'s product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). **onsemi** reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and **onsemi** makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does **onsemi** assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using **onsemi** products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by **onsemi**. "Typical" parameters which may be provided in **onsemi** data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. **onsemi** does not convey any license under any of its intellectual property rights nor the rights of others. **onsemi** products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use **onsemi** products for any such unintended or unauthorized application, Buyer shall indemnify and hold **onsemi** and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that **onsemi** was negligent regarding the design or manufacture of the part. **onsemi** is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

## PUBLICATION ORDERING INFORMATION

### LITERATURE FULFILLMENT:

Email Requests to: [orderlit@onsemi.com](mailto:orderlit@onsemi.com)

**onsemi Website:** [www.onsemi.com](http://www.onsemi.com)

### TECHNICAL SUPPORT

**North American Technical Support:**

Voice Mail: 1 800-282-9855 Toll Free USA/Canada

Phone: 011 421 33 790 2910

**Europe, Middle East and Africa Technical Support:**

Phone: 00421 33 790 2910

For additional information, please contact your local Sales Representative