# 650V 50A Insulated Gate Bipolar Transistor
# AKB65N050WH

## Description:

Gen 3 IGBT offering ultra-low conduction losses, is designed for applications such as UPS, inverters, etc.

## Features:

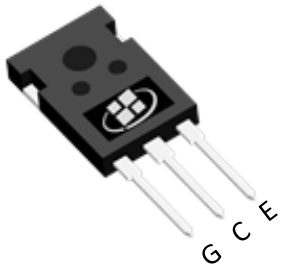
- Easy paralleling capability due to positive temperature coefficient in $V_{CESAT}$
- Low EMI
- Low Gate Charge
- Maximum junction temperature $T_{VJmax}$ = 175°C
- RoHS compliant
- Halogen-free

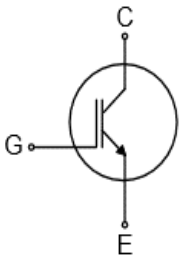
## Applications:

- Industrial UPS
- Charger
- Energy Storage
- Three-Phase Solar String Inverter

## Key Performance Parameters:

| Parameter | Value | Unit |
|---|---|---|
| $V_{CE}$ | 650 | V |
| $V_{CESAT}$, $T_{VJ}$ = 25°C | 1.6 | V |
| $I_C$ | 50 | A |




## Ordering Information:

| Ordering Code | Package Type | Marking Code | Form | Packing |
|---|---|---|---|---|
| AKB65N050WH | TO247-3L | B65N050WH | Tube | See the detail package information |

## Maximum Ratings ($T_{VJ}$ = 25°C unless otherwise noted)

| Symbol | Parameter | Value | Units |
|---|---|---|---|
| $V_{CE}$ | Collector - Emitter Voltage | 650 | V |
| $I_C$ | Collector Current - Continuous ($T_C$ = 25°C) (Note 1) | 80 | A |
| | Collector Current - Continuous ($T_C$ = 100°C) | 50 | A |
| $I_{CM}$ | Collector Current - Pulsed (Note 2) | 200 | A |
| $V_{GE}$ | Gate - Emitter Voltage | ±20 | V |
| | Transient Gate - Emitter Voltage (tp ⩽ 10μs, D < 0.010) | ±30 | |
| $P_D$ | Power Dissipation ($T_C$ = 25°C) | 258 | W |
| | Power Dissipation ($T_C$ = 100°C) | 129 | W |
| $T_{VJ}$ | Operating Junction Temperature Range | -40 to +175 | °C |
| $T_{STG}$ | Storage Temperature Range | -55 to +150 | °C |

## Thermal Characteristics

| Symbol | Parameter | Value | Units |
|---|---|---|---|
| $R_{\theta JC}$ | IGBT Thermal Resistance, Junction - to - Case, Steady - State | 0.58 | °C/W |
| $R_{\theta JA}$ | Thermal Resistance, Junction - to - Ambient Steady State | 40 | °C/W |

**Notes:**

1. The max collector current rating is package limited
2. Repetitive rating: pulse width limited by maximum junction temperature

| **Electrical Characteristics** ($T_{VJ}$ = 25°C unless otherwise noted) | | | | | | |
|---|---|---|---|---|---|---|
| **Symbol** | **Parameter** | **Test Conditions** | **Min** | **Typ** | **Max** | **Units** |
| **Static Characteristics** | | | | | | |
| $V_{(BR)CES}$ | Collector - Emitter Breakdown Voltage | $V_{GE}$ = 0 V, $I_C$ = 0.2 mA | 650 | | | V |
| $V_{CESAT}$ | Collector - Emitter Saturation Voltage | $V_{GE}$ = 15 V, $I_C$ = 50 A | | 1.60 | 2.10 | V |
| | | $V_{GE}$ = 15 V, $I_C$ = 50 A, $T_{VJ}$ = 125°C | | 1.93 | | |
| | | $V_{GE}$ = 15 V, $I_C$ = 50 A, $T_{VJ}$ = 175°C | | 2.00 | | |
| $V_{GE(th)}$ | Gate - Emitter Threshold Voltage | $V_{CE}$ = $V_{GE}$, $I_C$ = 0.5 mA | 3.2 | 4.0 | 4.8 | V |
| $I_{CES}$ | Zero Gate Voltage Collector Current | $V_{CE}$ = 650 V, $V_{GE}$ = 0 V | | | 50 | μA |
| | | $V_{CE}$ = 650 V, $V_{GE}$ = 0 V, $T_{VJ}$ = 175°C | | 2000 | | |
| $I_{GES}$ | Gate - Emitter Leakage Current | $V_{GE}$ = ± 20 V, $V_{CE}$ = 0 V | | | ±100 | nA |
| $g_{fs}$ | Transconductance | $V_{CE}$ = 20 V, $I_C$ = 50 A | | 65 | | S |
| **Dynamic Characteristics** | | | | | | |
| $C_{ies}$ | Input Capacitance | $V_{CE}$ = 25 V, $V_{GE}$ = 0 V, F = 1 MHz | | 1850 | | pF |
| $C_{oes}$ | Output Capacitance | | | 76 | | pF |
| $C_{res}$ | Reverse Transfer Capacitance | | | 16 | | pF |
| $Q_G$ | Total Gate Charge | $V_{CC}$ = 520 V , $I_C$ = 50 A, $V_{GE}$ = 15 V | | 67 | | nC |
| $Q_{GE}$ | Gate - Emitter Charge | | | 10 | | nC |
| $Q_{GC}$ | Gate - Collector Charge | | | 22 | | nC |
| $L_E$ | Internal Emitter Inductance | | | 8 | | nH |
| **Switching Characteristics, Inductive Load** ( $T_{VJ}$ = 25°C ) | | | | | | |
| $t_{d(on)}$ | Turn On Delay Time | $V_{CC}$ = 400 V<br>$I_C$ = 50 A<br>$V_{GE}$ = 15 V<br>$R_{G(on)}$ = 12 Ω<br>$R_{G(off)}$ = 12 Ω<br>( Diode from AKB65A050WHH ) | | 17 | | ns |
| $t_r$ | Rise Time | | | 29 | | ns |
| $t_{d(off)}$ | Turn Off Delay Time | | | 111 | | ns |
| $t_f$ | Fall Time | | | 34 | | ns |
| $E_{on}$ | Turn On Energy | | | 1.35 | | mJ |
| $E_{off}$ | Turn Off Energy | | | 0.51 | | mJ |
| $E_{ts}$ | Total Switching Energy | | | 1.86 | | mJ |

| | | | | | | |
|---|---|---|---|---|---|---|
| $t_{d(on)}$ | Turn On Delay Time | $V_{CC}$ = 400 V<br>$I_C$ = 25 A<br>$V_{GE}$ = 15 V<br>$R_{G(on)}$ = 12 Ω<br>$R_{G(off)}$ = 12 Ω<br>( Diode from AKB65A050WHH ) | | 18 | | ns |
| $t_r$ | Rise Time | | | 12 | | ns |
| $t_{d(off)}$ | Turn Off Delay Time | | | 120 | | ns |
| $t_f$ | Fall Time | | | 20 | | ns |
| $E_{on}$ | Turn On Energy | | | 0.49 | | mJ |
| $E_{off}$ | Turn Off Energy | | | 0.21 | | mJ |
| $E_{ts}$ | Total Switching Energy | | | 0.70 | | mJ |
| **Switching Characteristics, Inductive Load** ( $T_{VJ}$ = 150°C ) | | | | | | |
| $t_{d(on)}$ | Turn On Delay Time | $V_{CC}$ = 400 V<br>$I_C$ = 50 A<br>$V_{GE}$ = 15 V<br>$R_{G(on)}$ = 12 Ω<br>$R_{G(off)}$ = 12 Ω<br>( Diode from AKB65A050WHH ) | | 17 | | ns |
| $t_r$ | Rise Time | | | 27 | | ns |
| $t_{d(off)}$ | Turn Off Delay Time | | | 126 | | ns |
| $t_f$ | Fall Time | | | 33 | | ns |
| $E_{on}$ | Turn On Energy | | | 1.71 | | mJ |
| $E_{off}$ | Turn Off Energy | | | 0.82 | | mJ |
| $E_{ts}$ | Total Switching Energy | | | 2.53 | | mJ |
| | | | | | | |
| $t_{d(on)}$ | Turn On Delay Time | $V_{CC}$ = 400 V<br>$I_C$ = 25 A<br>$V_{GE}$ = 15 V<br>$R_{G(on)}$ = 12 Ω<br>$R_{G(off)}$ = 12 Ω<br>( Diode from AKB65A050WHH ) | | 17 | | ns |
| $t_r$ | Rise Time | | | 13 | | ns |
| $t_{d(off)}$ | Turn Off Delay Time | | | 148 | | ns |
| $t_f$ | Fall Time | | | 41 | | ns |
| $E_{on}$ | Turn On Energy | | | 0.67 | | mJ |
| $E_{off}$ | Turn Off Energy | | | 0.37 | | mJ |
| $E_{ts}$ | Total Switching Energy | | | 1.04 | | mJ |

## Electrical Characteristics Diagrams

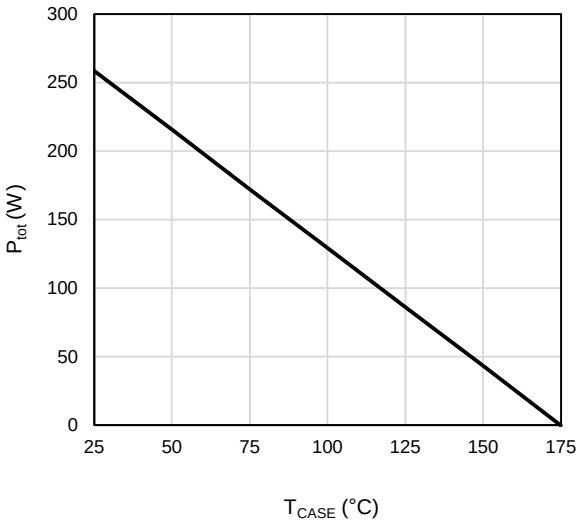



Figure 1: Power De-rating

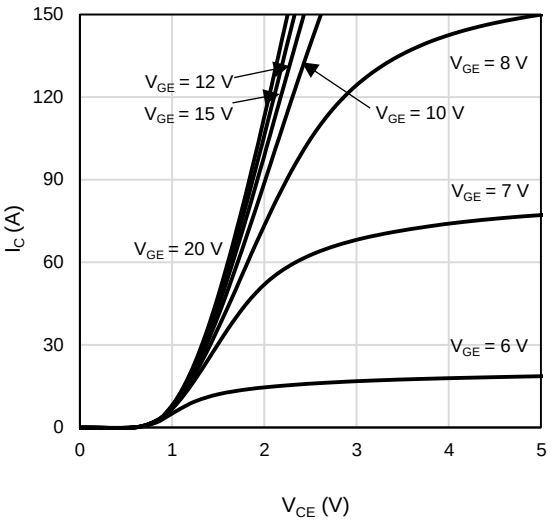



Figure 2: Typical Output Characteristics
($T_{VJ}$ = 25°C）

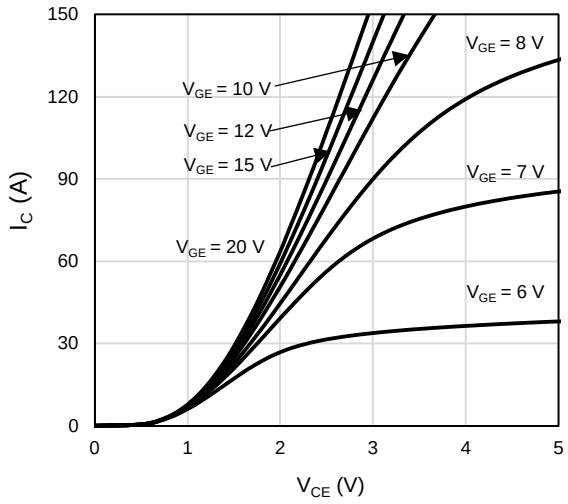



Figure 3: Typical Output Characteristics
($T_{VJ}$ =150°C）

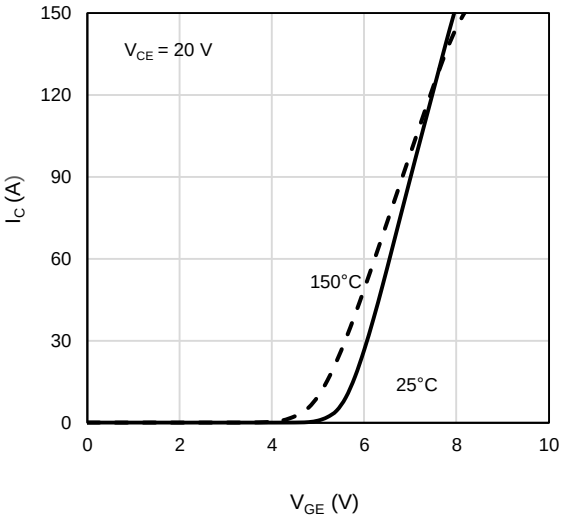



Figure 4: Transfer Characteristics

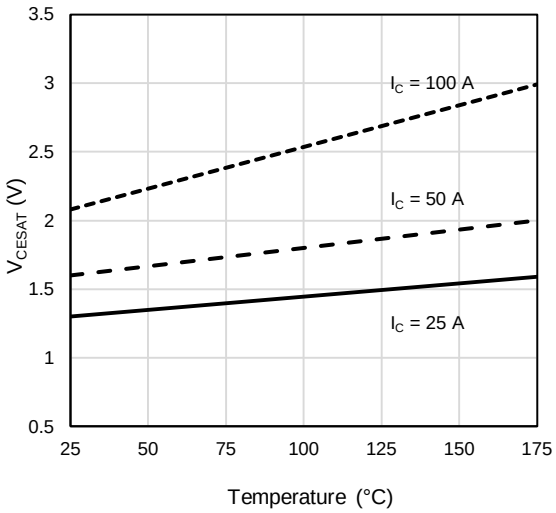



Figure 5: Collect-emitter saturation voltage vs. Junction Temperature

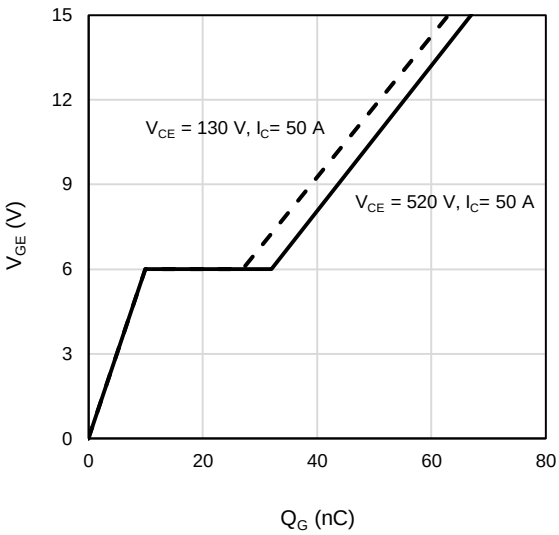



Figure 6: Gate-Charge Characteristics

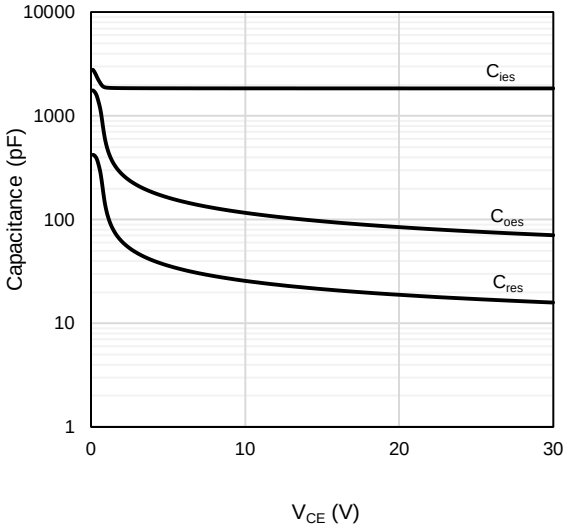



Figure 7: Capacitance Characteristics

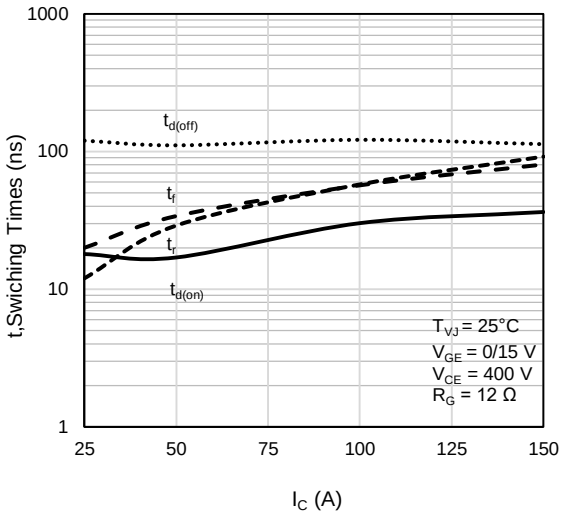



Figure 8: Swiching Times vs. Collector Current

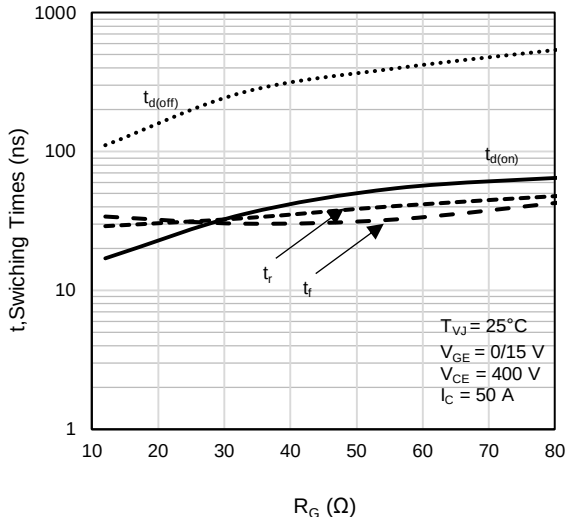



Figure 9: Swiching Times vs. Gate Resistor

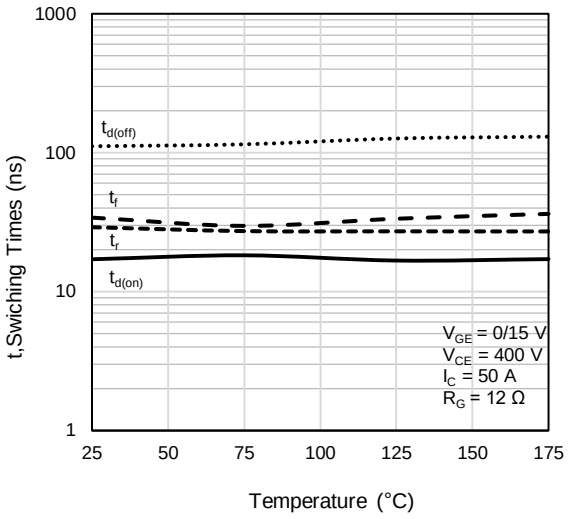



Figure 10: Swiching Times vs. Junction Temperature

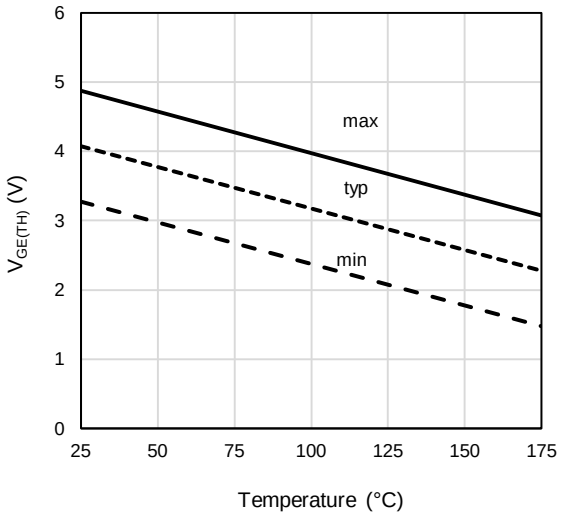



Figure 11: Threshold voltage vs. Junction Temperature

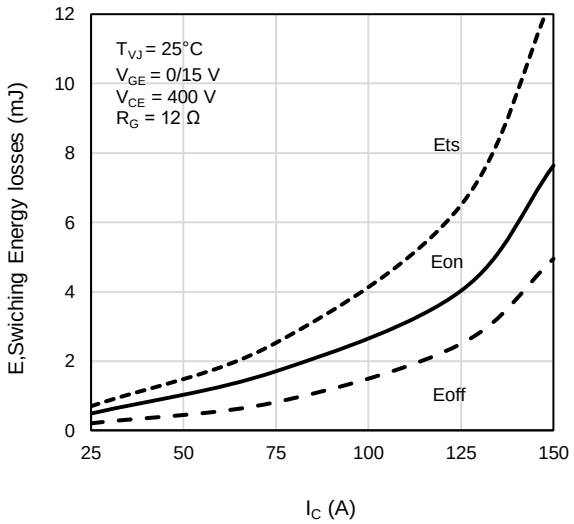



Figure 12: Swiching Energy losses vs. Collector Current

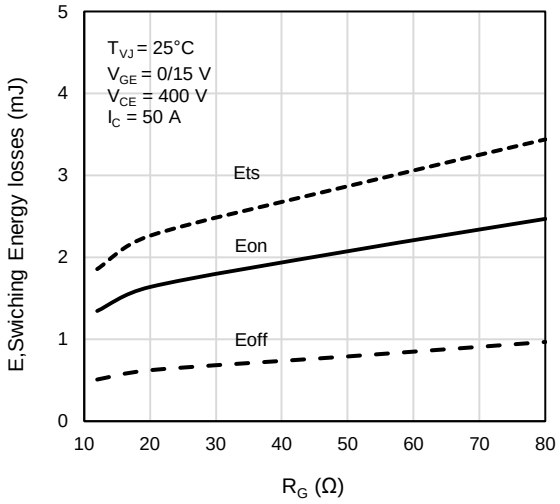



Figure 13: Swiching Energy losses vs. Gate Resistor

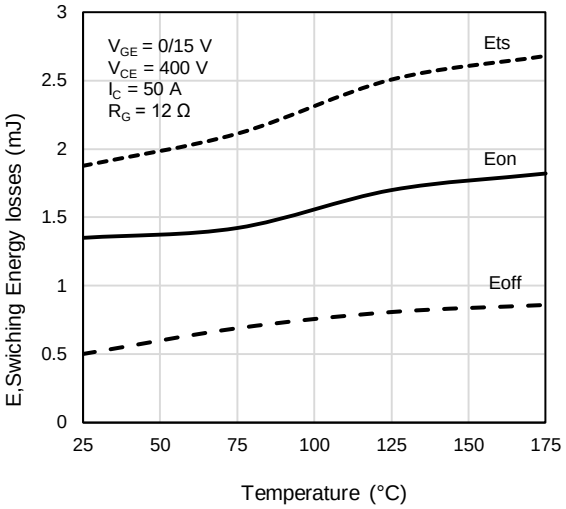



Figure 14: Swiching Energy losses vs. Junction Temperature

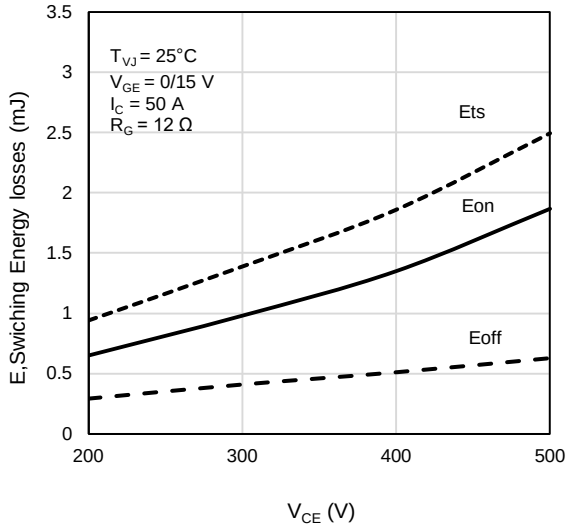



Figure 15: Swiching Energy losses vs. Collector Emitter Voltage

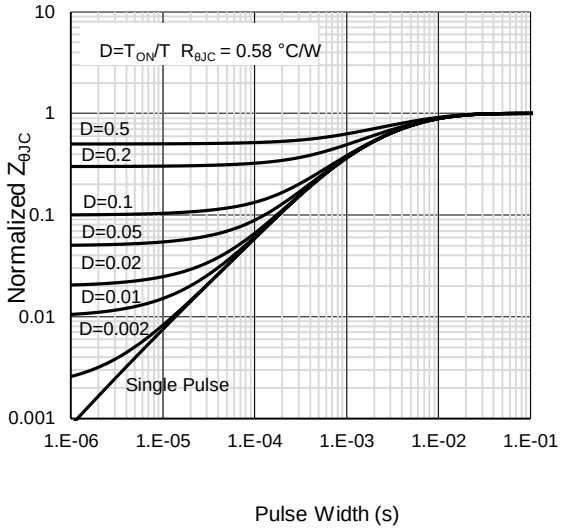
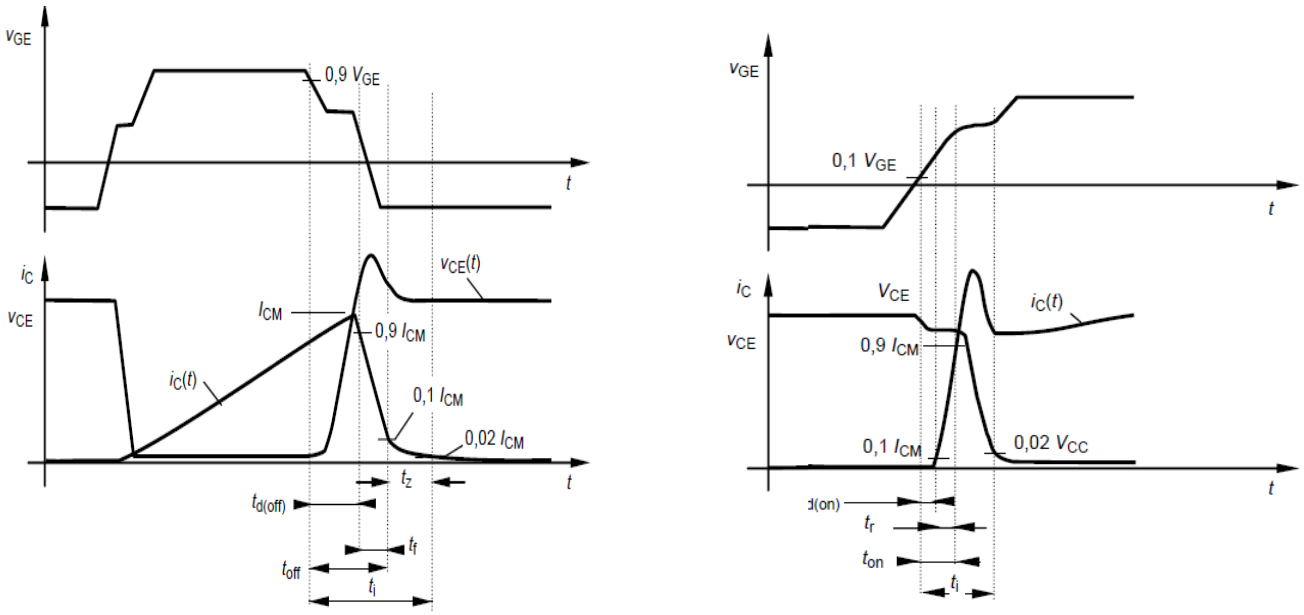


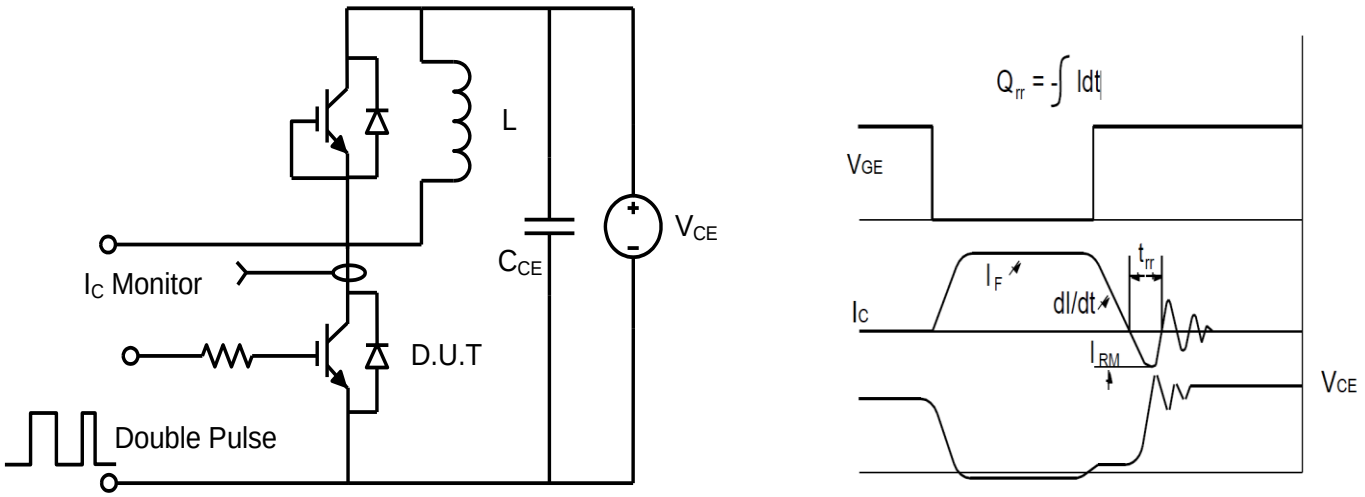

Figure 16: Normalized Maximum IGBT Transient Thermal Impedance

# Test Circuit and Waveform

Switching Test Circuit & Waveforms




Diode Recovery Test Circuit & Waveforms



## Revision History

| Revision | Released | Remark |
|---|---|---|
| Rev.1.0 | 2024 | Initial Release |

## Disclaimer

The information given in this document describes the independent performance of the product, but similar performance is not guaranteed under other working conditions, and cannot be guaranteed when installed with other products or equipment. To achieve the required performance of the product in actual scenarios, the customer should conduct a complete application test to assess the functionality of the product.

Alkaidsemi assumes no responsibility for equipment failures result from using products at values that exceed the ratings, operating conditions, or other parameters listed in the product specifications.

The product described in this specification is not applicable for aerospace or other applications which requires high reliability. Customers using or selling these products for use in medical, life-saving, or life-sustaining applications do so at their own risk and agree to fully indemnify.

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