

General Description

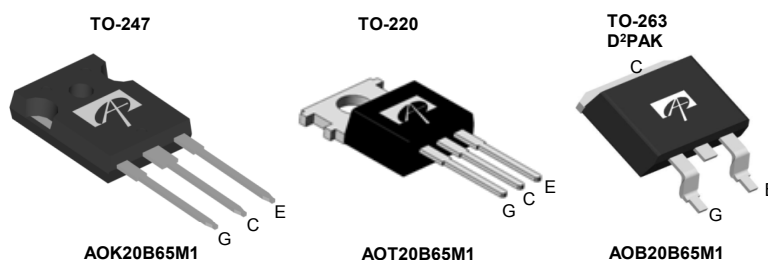
- Latest Alpha IGBT (α IGBT) technology
- 650V breakdown voltage
- Very fast and soft recovery freewheeling diode
- High efficient turn-on di/dt controllability
- Low $V_{CE(sat)}$ enables high efficiencies
- Low turn-off switching loss and softness
- Very good EMI behavior
- High short-circuit ruggedness

Applications

- Motor Drives
- Sewing Machines
- Home Appliances
- Fan, Pumps, Vacuum Cleaner
- Other Hard Switching Applications

Product Summary

| | |
|--|------|
| V_{CE} | 650V |
| I_C ($T_C=100^\circ\text{C}$) | 20A |
| $V_{CE(sat)}$ ($T_J=25^\circ\text{C}$) | 1.7V |



| Orderable Part Number | Package Type | Form | Minimum Order Quantity |
|-----------------------|--------------|-------------|------------------------|
| AOK20B65M1 | TO247 | Tube | 240 |
| AOT20B65M1 | TO220 | Tube | 1000 |
| AOB20B65M1 | TO263 | Tape & Reel | 800 |

Absolute Maximum Ratings $T_A=25^\circ\text{C}$ unless otherwise noted

| Parameter | Symbol | AOK20B65M1/AOT(B)20B65M1 | Units |
|---|----------------|--------------------------|------------------|
| Collector-Emitter Voltage | V_{CE} | 650 | V |
| Gate-Emitter Voltage | V_{GE} | ± 30 | V |
| Continuous Collector Current | I_C | $T_C=25^\circ\text{C}$ | 40 |
| | | $T_C=100^\circ\text{C}$ | 20 |
| Pulsed Collector Current, Limited by T_{Jmax} | I_{CM} | 60 | A |
| Turn off SOA, $V_{CE} \leq 650\text{V}$, Limited by T_{Jmax} | I_{LM} | 60 | A |
| Continuous Diode Forward Current | I_F | $T_C=25^\circ\text{C}$ | 40 |
| | | $T_C=100^\circ\text{C}$ | 20 |
| Diode Pulsed Current, Limited by T_{Jmax} | I_{FM} | 60 | A |
| Short circuit withstanding time ¹⁾ $V_{GE}=15\text{V}$, $V_{CC} \leq 400\text{V}$, $T_J \leq 175^\circ\text{C}$ | t_{SC} | 5 | μs |
| Power Dissipation | P_D | $T_C=25^\circ\text{C}$ | 227 |
| | | $T_C=100^\circ\text{C}$ | 114 |
| Junction and Storage Temperature Range | T_J, T_{STG} | -55 to 175 | $^\circ\text{C}$ |
| Maximum lead temperature for soldering purpose, 1/8" from case for 5 seconds | T_L | 300 | $^\circ\text{C}$ |

Thermal Characteristics

| Parameter | Symbol | AOK20B65M1 | AOT(B)20B65M1 | Units |
|--------------------------------|-----------------|------------|---------------|--------------------|
| Maximum Junction-to-Ambient | $R_{\theta JA}$ | 40 | 65 | $^\circ\text{C/W}$ |
| Maximum IGBT Junction-to-Case | $R_{\theta JC}$ | 0.66 | | $^\circ\text{C/W}$ |
| Maximum Diode Junction-to-Case | $R_{\theta JC}$ | 1.5 | | $^\circ\text{C/W}$ |

1) Allowed number of short circuits: <1000; time between short circuits: >1s.

Electrical Characteristics (T_J=25°C unless otherwise noted)

| Symbol | Parameter | Conditions | Min | Typ | Max | Units | |
|--|--------------------------------------|--|--|------|------|-------|----|
| STATIC PARAMETERS | | | | | | | |
| BV_{CES} | Collector-Emitter Breakdown Voltage | $I_C=1mA, V_{GE}=0V, T_J=25^\circ C$ | 650 | - | - | V | |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage | $V_{GE}=15V, I_C=20A$ | $T_J=25^\circ C$ | - | 1.7 | 2.15 | V |
| | | | $T_J=125^\circ C$ | - | 2.02 | - | |
| | | | $T_J=175^\circ C$ | - | 2.2 | - | |
| V_F | Diode Forward Voltage | $V_{GE}=0V, I_F=20A$ | $T_J=25^\circ C$ | - | 1.66 | 2.1 | V |
| | | | $T_J=125^\circ C$ | - | 1.67 | - | |
| | | | $T_J=175^\circ C$ | - | 1.62 | - | |
| $V_{GE(th)}$ | Gate-Emitter Threshold Voltage | $V_{CE}=5V, I_C=1mA$ | - | 5.1 | - | V | |
| I_{CES} | Zero Gate Voltage Collector Current | $V_{CE}=650V, V_{GE}=0V$ | $T_J=25^\circ C$ | - | - | 10 | μA |
| | | | $T_J=125^\circ C$ | - | - | 500 | |
| | | | $T_J=175^\circ C$ | - | - | 5000 | |
| I_{GES} | Gate-Emitter leakage current | $V_{CE}=0V, V_{GE}=\pm 30V$ | - | - | ±100 | nA | |
| g_{FS} | Forward Transconductance | $V_{CE}=20V, I_C=20A$ | - | 14 | - | S | |
| DYNAMIC PARAMETERS | | | | | | | |
| C_{ies} | Input Capacitance | $V_{GE}=0V, V_{CC}=25V, f=1MHz$ | - | 1212 | - | pF | |
| C_{oes} | Output Capacitance | | - | 141 | - | pF | |
| C_{res} | Reverse Transfer Capacitance | | - | 50 | - | pF | |
| Q_g | Total Gate Charge | $V_{GE}=15V, V_{CC}=520V, I_C=20A$ | - | 46 | - | nC | |
| Q_{ge} | Gate to Emitter Charge | | - | 12 | - | nC | |
| Q_{gc} | Gate to Collector Charge | | - | 21 | - | nC | |
| $I_{C(SC)}$ | Short circuit collector current | $V_{GE}=15V, V_{CC}=400V,$ $t_{sc} \leq 5\mu s, T_J \leq 175^\circ C$ | - | 115 | - | A | |
| R_g | Gate resistance | $V_{GE}=0V, V_{CC}=0V, f=1MHz$ | - | 13 | - | Ω | |
| SWITCHING PARAMETERS, (Load Inductive, T_J=25°C) | | | | | | | |
| $t_{D(on)}$ | Turn-On Delay Time | $T_J=25^\circ C$ $V_{GE}=15V, V_{CC}=400V, I_C=20A,$ $R_G=15\Omega$ | - | 26 | - | ns | |
| t_r | Turn-On Rise Time | | - | 25 | - | ns | |
| $t_{D(off)}$ | Turn-Off Delay Time | | - | 122 | - | ns | |
| t_f | Turn-Off Fall Time | | - | 13 | - | ns | |
| E_{on} | Turn-On Energy | | - | 0.47 | - | mJ | |
| E_{off} | Turn-Off Energy | | - | 0.27 | - | mJ | |
| E_{total} | Total Switching Energy | | - | 0.74 | - | mJ | |
| t_{rr} | Diode Reverse Recovery Time | | $T_J=25^\circ C$ | - | 322 | - | ns |
| Q_{rr} | Diode Reverse Recovery Charge | | $I_F=20A, di/dt=200A/\mu s, V_{CC}=400V$ | - | 0.8 | - | μC |
| I_{rm} | Diode Peak Reverse Recovery Current | | | - | 5.2 | - | A |
| SWITCHING PARAMETERS, (Load Inductive, T_J=175°C) | | | | | | | |
| $t_{D(on)}$ | Turn-On Delay Time | $T_J=175^\circ C$ $V_{GE}=15V, V_{CC}=400V, I_C=20A,$ $R_G=15\Omega$ | - | 27 | - | ns | |
| t_r | Turn-On Rise Time | | - | 24 | - | ns | |
| $t_{D(off)}$ | Turn-Off Delay Time | | - | 150 | - | ns | |
| t_f | Turn-Off Fall Time | | - | 28 | - | ns | |
| E_{on} | Turn-On Energy | | - | 0.52 | - | mJ | |
| E_{off} | Turn-Off Energy | | - | 0.49 | - | mJ | |
| E_{total} | Total Switching Energy | | - | 1.01 | - | mJ | |
| t_{rr} | Diode Reverse Recovery Time | | $T_J=175^\circ C$ | - | 494 | - | ns |
| Q_{rr} | Diode Reverse Recovery Charge | | $I_F=20A, di/dt=200A/\mu s, V_{CC}=400V$ | - | 1.6 | - | μC |
| I_{rm} | Diode Peak Reverse Recovery Current | | | - | 7.1 | - | A |

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TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

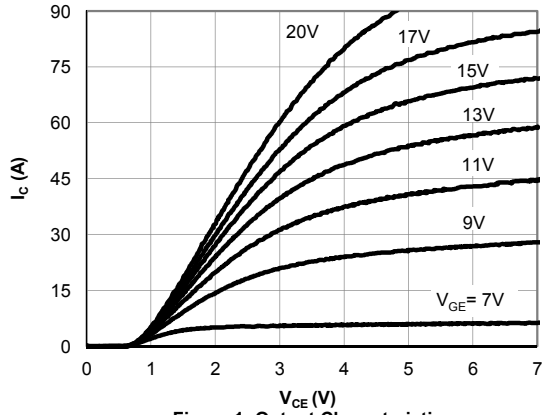


Figure 1: Output Characteristic
($T_j=25^\circ\text{C}$)

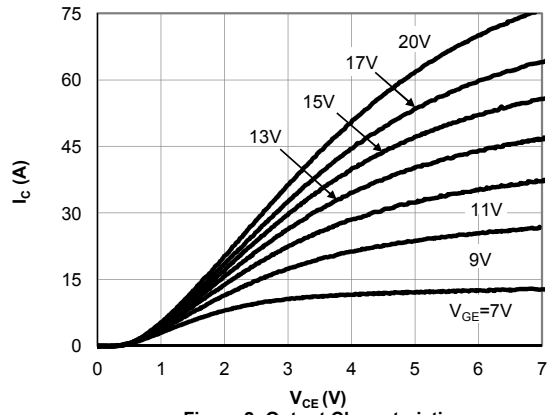


Figure 2: Output Characteristic
($T_j=175^\circ\text{C}$)

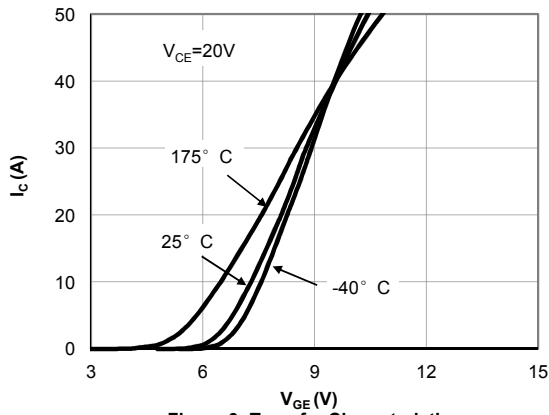


Figure 3: Transfer Characteristic

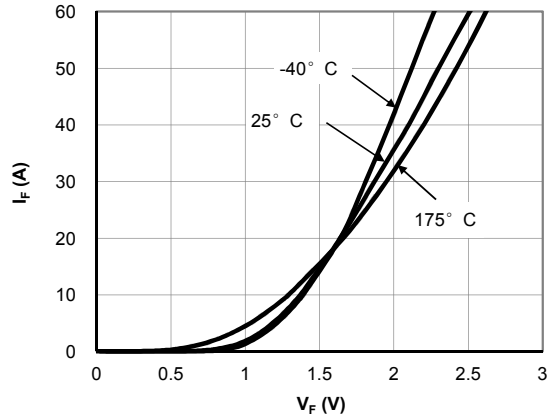


Figure 4: Diode Characteristic

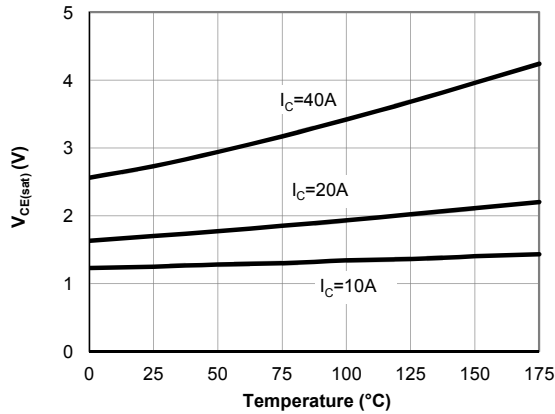


Figure 5: Collector-Emitter Saturation Voltage vs. Junction Temperature

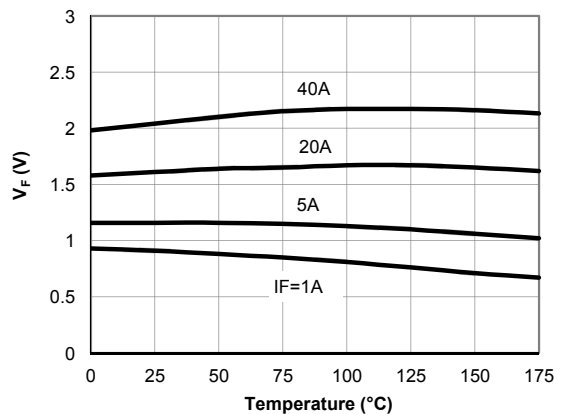


Figure 6: Diode Forward voltage vs. Junction Temperature

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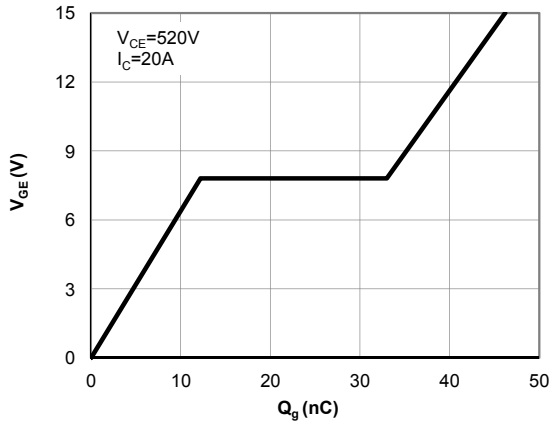


Figure 7: Gate-Charge Characteristics

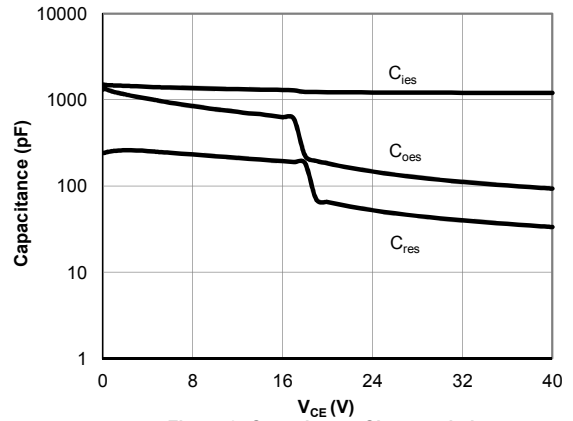


Figure 8: Capacitance Characteristic

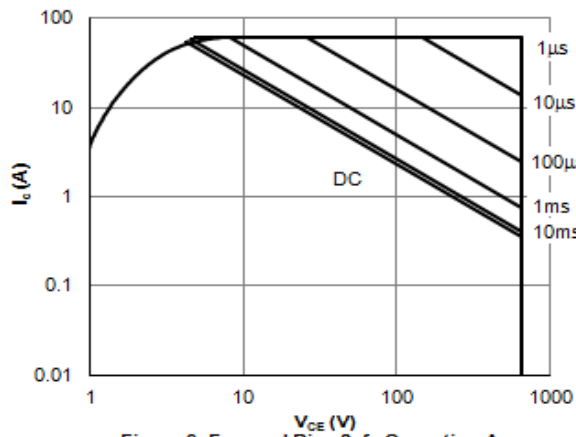


Figure 9: Forward Bias Safe Operating Area
($T_C=25^{\circ}\text{C}$, $V_{GE}=15\text{V}$)

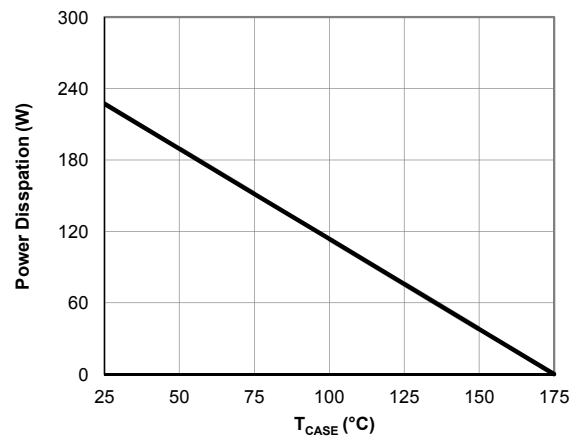


Figure 10: Power Dissipation as a Function of Case

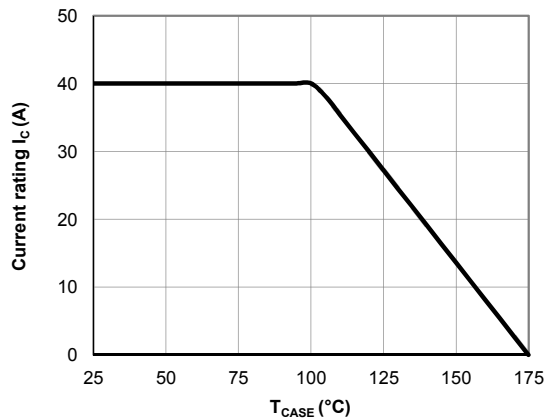


Figure 11: Current De-rating

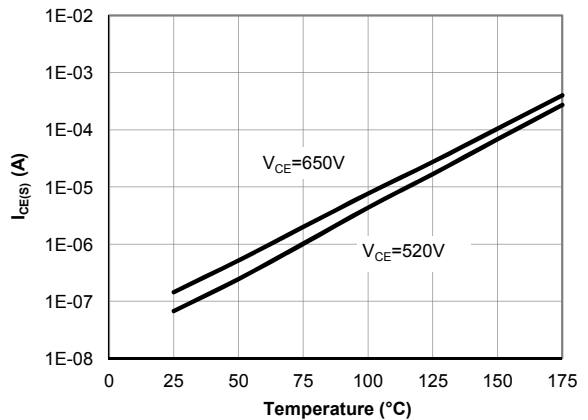
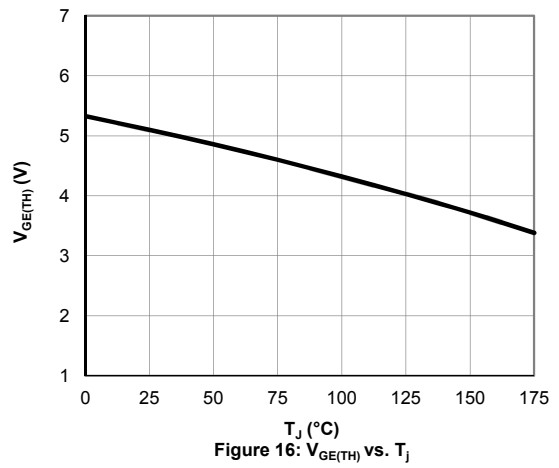
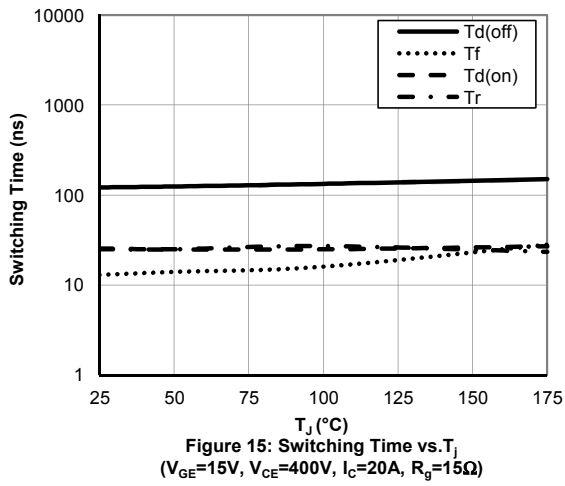
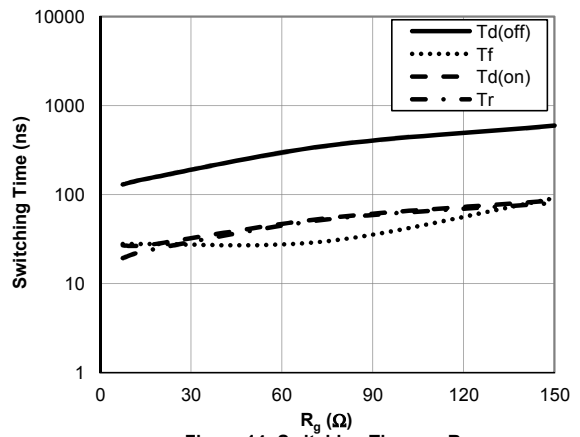
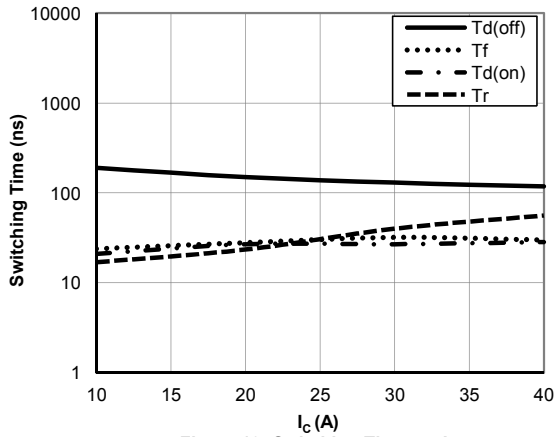


Figure 12: Diode Reverse Leakage Current vs. Junction Temperature

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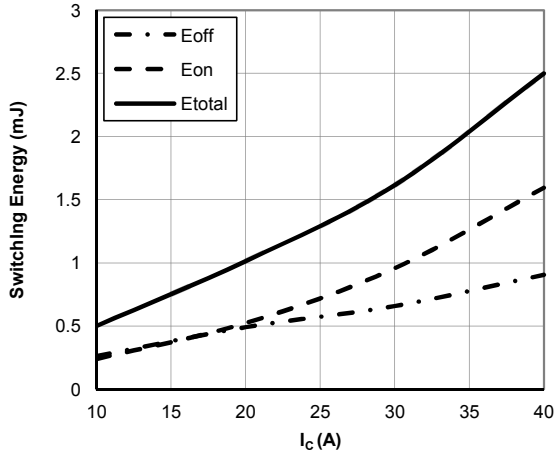


Figure 17: Switching Loss vs. I_C
($T_J=175^\circ\text{C}$, $V_{GE}=15\text{V}$, $V_{CE}=400\text{V}$, $R_g=15\Omega$)

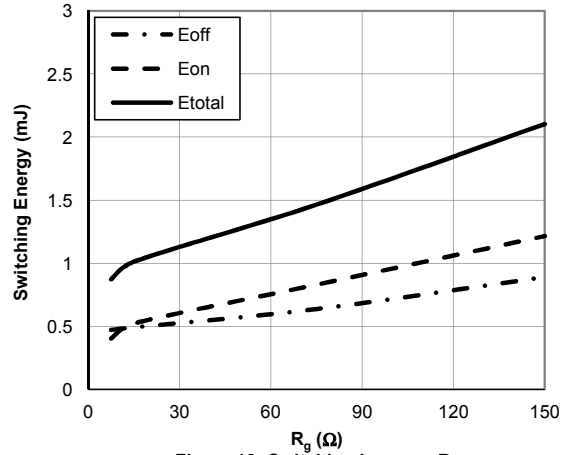


Figure 18: Switching Loss vs. R_g
($T_J=175^\circ\text{C}$, $V_{GE}=15\text{V}$, $V_{CE}=400\text{V}$, $I_C=20\text{A}$)

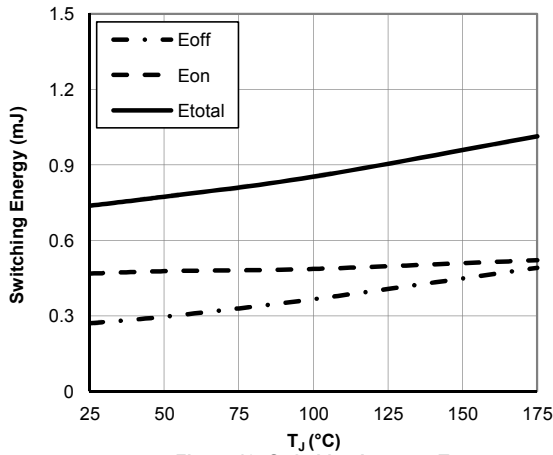


Figure 19: Switching Loss vs. T_J
($V_{GE}=15\text{V}$, $V_{CE}=400\text{V}$, $I_C=20\text{A}$, $R_g=15\Omega$)

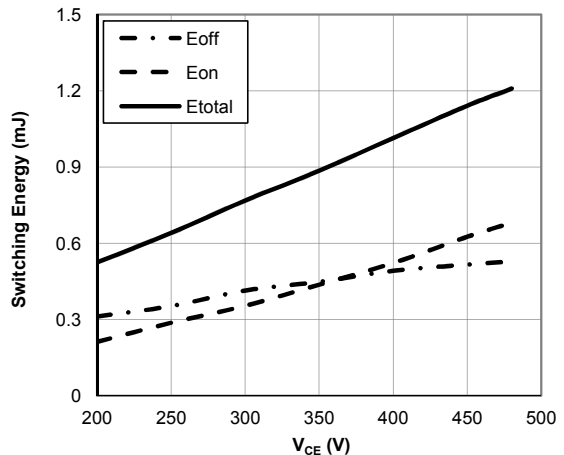


Figure 20: Switching Loss vs. V_{CE}
($T_J=175^\circ\text{C}$, $V_{GE}=15\text{V}$, $I_C=20\text{A}$, $R_g=15\Omega$)

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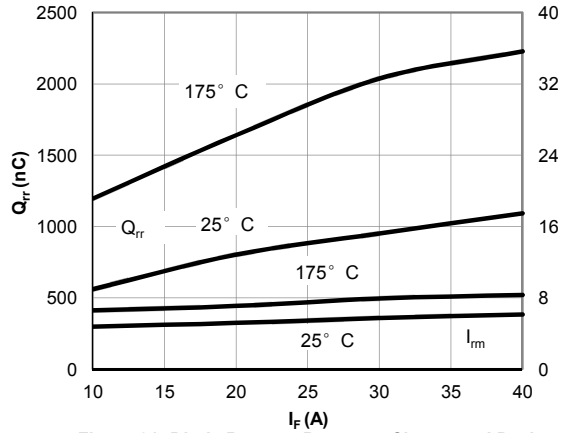


Figure 21: Diode Reverse Recovery Charge and Peak Current vs. Conduction Current
($V_{GE}=15V$, $V_{CE}=400V$, $di/dt=200A/\mu s$)

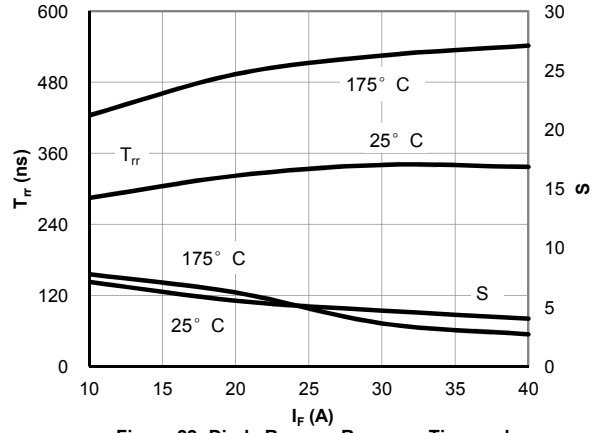


Figure 22: Diode Reverse Recovery Time and Softness Factor vs. Conduction Current
($V_{GE}=15V$, $V_{CE}=400V$, $di/dt=200A/\mu s$)

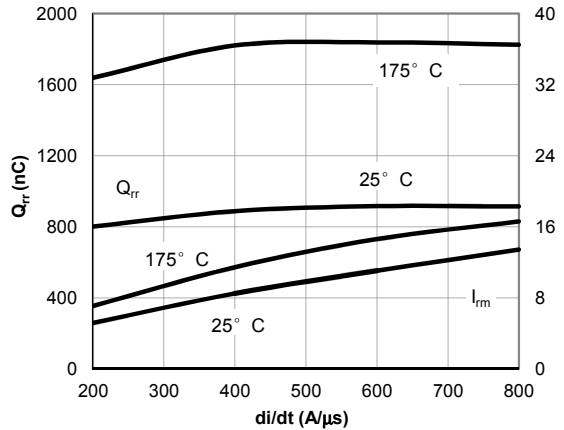


Figure 23: Diode Reverse Recovery Charge and Peak Current vs. di/dt
($V_{GE}=15V$, $V_{CE}=400V$, $I_F=20A$)

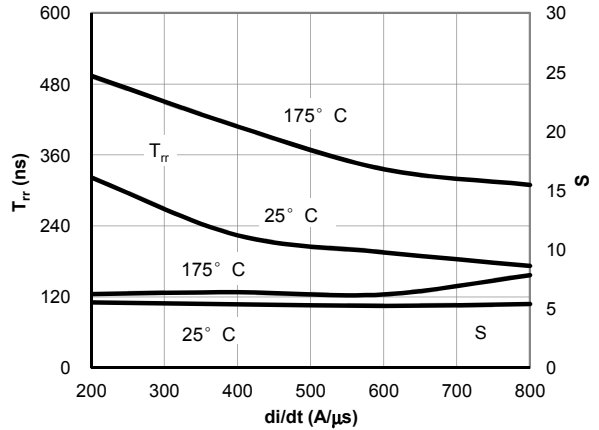


Figure 24: Diode Reverse Recovery Time and Softness Factor vs. di/dt
($V_{GE}=15V$, $V_{CE}=400V$, $I_F=20A$)

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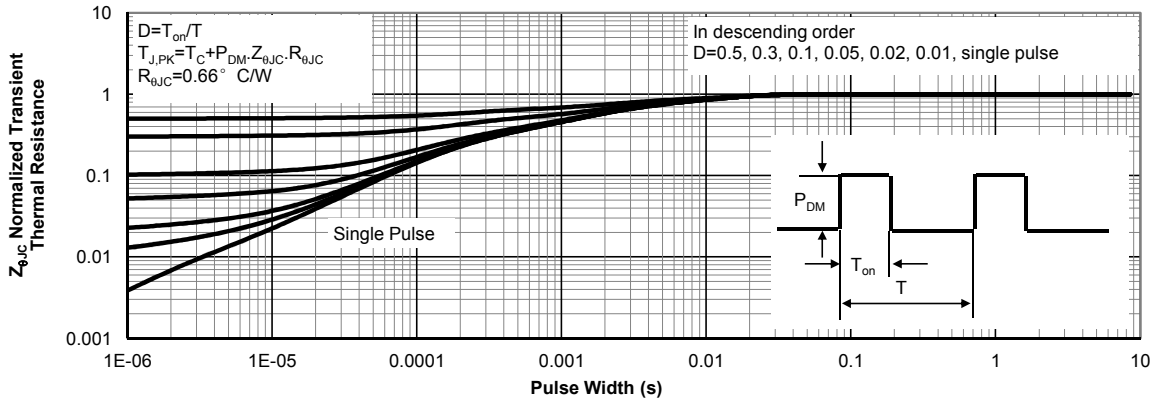


Figure 25: Normalized Maximum Transient Thermal Impedance for IGBT

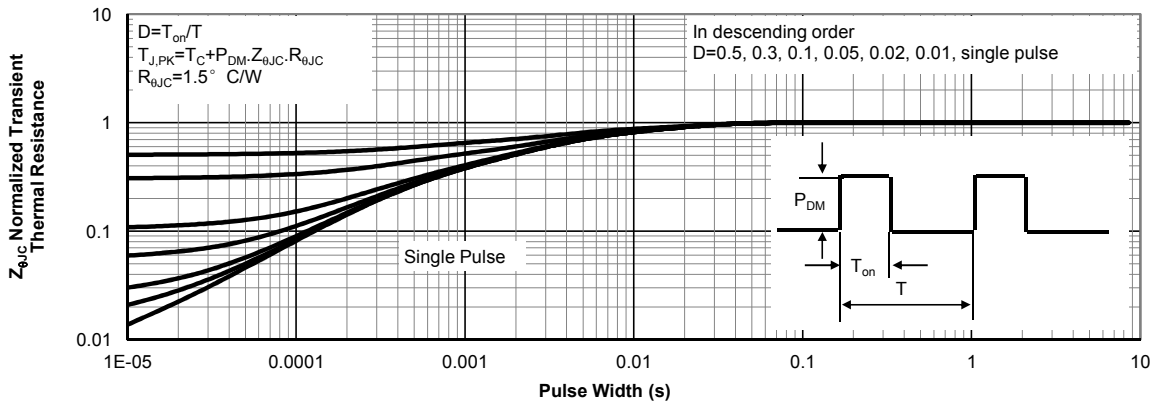


Figure 26: Normalized Maximum Transient Thermal Impedance for Diode

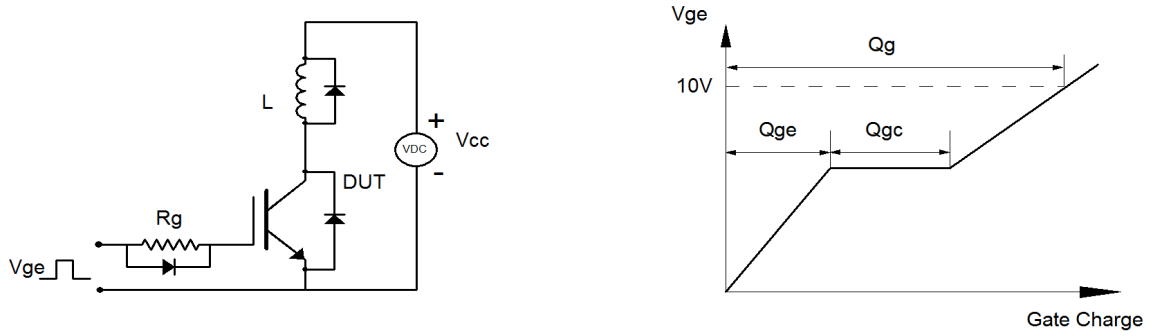


Figure A: Gate Charge Test Circuit & Waveforms

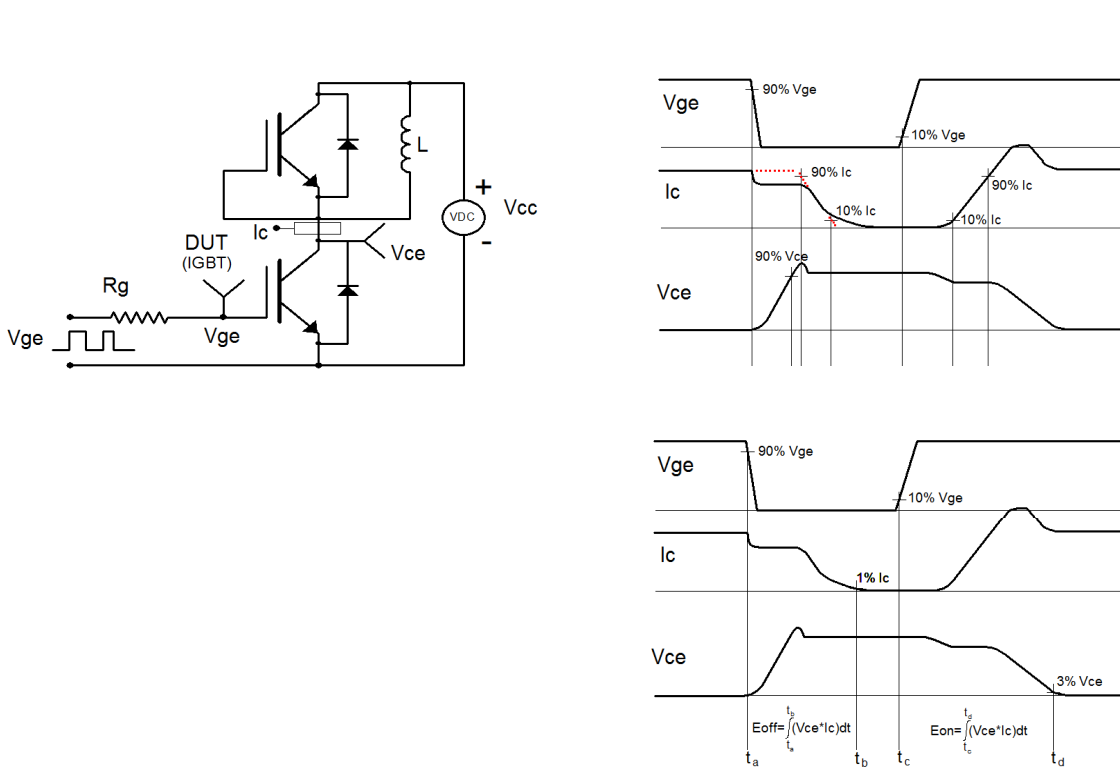


Figure B: Inductive Switching Test Circuit & Waveforms

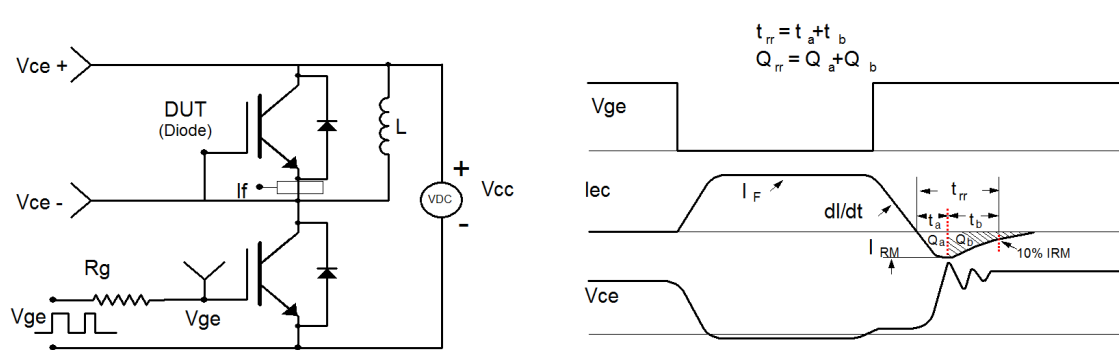


Figure C: Diode Recovery Test Circuit & Waveforms