

General Description

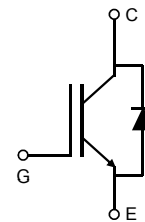
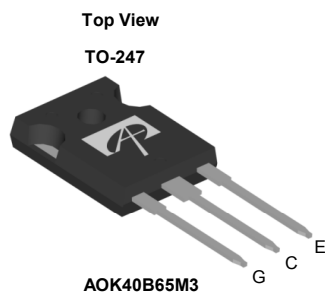
- Latest AlphaIGBT (α IGBT) technology
- 650V breakdown voltage
- Very fast and soft recovery freewheeling diode
- High efficient turn-on di/dt controllability
- Low VCE(SAT) enables high efficiencies
- Low turn-off switching loss and softness
- Very good EMI behavior
- High short-circuit ruggedness

Applications

- Motor Drives
- Welding Machines
- UPS and Solar Inverters
- Other hard switching applications

Product Summary

| | |
|--|-------|
| V_{CE} | 650V |
| I_C ($T_C=100^\circ\text{C}$) | 40A |
| $V_{CE(sat)}$ ($T_J=25^\circ\text{C}$) | 1.95V |



| Orderable Part Number | Package Type | Form | Minimum Order Quantity |
|-----------------------|--------------|------|------------------------|
| AOK40B65M3 | TO247 | Tube | 240 |

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

| Parameter | Symbol | AOK40B65M3 | Units |
|---|----------------|-------------------------|------------------|
| Collector-Emitter Voltage | V_{CE} | 650 | V |
| Gate-Emitter Voltage | V_{GE} | ± 30 | V |
| Continuous Collector Current | I_C | $T_C=25^\circ\text{C}$ | 80 |
| | | $T_C=100^\circ\text{C}$ | 40 |
| Pulsed Collector Current, Limited by T_{Jmax} | I_{CM} | 120 | A |
| Turn off SOA, $V_{CE} \leq 650\text{V}$, Limited by T_{Jmax} | I_{LM} | 120 | A |
| Continuous Diode Forward Current | I_F | $T_C=25^\circ\text{C}$ | 34 |
| | | $T_C=100^\circ\text{C}$ | 17 |
| Diode Pulsed Current, Limited by T_{Jmax} | I_{FM} | 120 | 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 | $T_C=25^\circ\text{C}$ | 300 |
| | | $T_C=100^\circ\text{C}$ | 150 |
| 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 | AOK40B65M3 | Units |
|--------------------------------|-----------------|------------|---------------------------|
| Maximum Junction-to-Ambient | $R_{\theta JA}$ | 40 | $^\circ\text{C}/\text{W}$ |
| Maximum IGBT Junction-to-Case | $R_{\theta JC}$ | 0.5 | $^\circ\text{C}/\text{W}$ |
| Maximum Diode Junction-to-Case | $R_{\theta JC}$ | 1.5 | $^\circ\text{C}/\text{W}$ |

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 | $V_{GE}=15V, I_C=40A$ | $T_J=25^\circ C$ | - | 1.95 | 2.45 | V |
| | | | $T_J=125^\circ C$ | - | 2.55 | - | |
| | | | $T_J=175^\circ C$ | - | 2.8 | - | |
| V_F | Diode Forward Voltage | $V_{GE}=0V, I_C=40A$ | $T_J=25^\circ C$ | - | 2.22 | 2.8 | V |
| | | | $T_J=125^\circ C$ | - | 2.45 | - | |
| | | | $T_J=175^\circ C$ | - | 2.35 | - | |
| $V_{GE(th)}$ | Gate-Emitter Threshold Voltage | $V_{CE}=5V, I_C=1mA$ | - | 5 | - | 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 | |
| | | | $T_J=175^\circ C$ | - | - | 10000 | |
| I_{GES} | Gate-Emitter leakage current | $V_{CE}=0V, V_{GE}=\pm 30V$ | - | - | ±100 | nA | |
| g_{FS} | Forward Transconductance | $V_{CE}=20V, I_C=40A$ | - | 25 | - | S | |
| DYNAMIC PARAMETERS | | | | | | | |
| C_{ies} | Input Capacitance | $V_{GE}=0V, V_{CC}=25V, f=1MHz$ | - | 1748 | - | pF | |
| C_{oes} | Output Capacitance | | - | 166 | - | pF | |
| C_{res} | Reverse Transfer Capacitance | | - | 62 | - | pF | |
| Q_g | Total Gate Charge | $V_{GE}=15V, V_{CC}=520V, I_C=40A$ | - | 59 | - | nC | |
| Q_{ge} | Gate to Emitter Charge | | - | 15 | - | nC | |
| Q_{gc} | Gate to Collector Charge | | - | 26 | - | nC | |
| $I_{C(SC)}$ | Short circuit collector current | $V_{GE}=15V, V_{CC}=400V,$ $t_{sc} \leq 5\mu s, T_J \leq 175^\circ C$ | - | 188 | - | 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 | $T_J=25^\circ C$ $V_{GE}=15V, V_{CC}=400V, I_C=40A,$ $R_G=7.5\Omega$ | - | 40 | - | ns | |
| t_r | Turn-On Rise Time | | - | 33 | - | ns | |
| $t_{D(off)}$ | Turn-Off Delay Time | | - | 125 | - | ns | |
| t_f | Turn-Off Fall Time | | - | 14 | - | ns | |
| E_{on} | Turn-On Energy | | - | 1.3 | - | mJ | |
| E_{off} | Turn-Off Energy | | - | 0.5 | - | mJ | |
| E_{total} | Total Switching Energy | | - | 1.8 | - | mJ | |
| t_{rr} | Diode Reverse Recovery Time | | $T_J=25^\circ C$ | - | 365 | - | ns |
| Q_{rr} | Diode Reverse Recovery Charge | | $I_F=40A, di/dt=200A/\mu s, V_{CC}=400V$ | - | 1 | - | μC |
| I_{rm} | Diode Peak Reverse Recovery Current | | | - | 6 | - | A |
| SWITCHING PARAMETERS, (Load Inductive, T_J=175°C) | | | | | | | |
| $t_{D(on)}$ | Turn-On Delay Time | $T_J=175^\circ C$ $V_{GE}=15V, V_{CC}=400V, I_C=40A,$ $R_G=7.5\Omega$ | - | 39 | - | ns | |
| t_r | Turn-On Rise Time | | - | 41 | - | ns | |
| $t_{D(off)}$ | Turn-Off Delay Time | | - | 149 | - | ns | |
| t_f | Turn-Off Fall Time | | - | 26 | - | ns | |
| E_{on} | Turn-On Energy | | - | 1.4 | - | mJ | |
| E_{off} | Turn-Off Energy | | - | 1.0 | - | mJ | |
| E_{total} | Total Switching Energy | | - | 2.4 | - | mJ | |
| t_{rr} | Diode Reverse Recovery Time | | $T_J=175^\circ C$ | - | 488 | - | ns |
| Q_{rr} | Diode Reverse Recovery Charge | | $I_F=40A, di/dt=200A/\mu s, V_{CC}=400V$ | - | 1.7 | - | μC |
| I_{rm} | Diode Peak Reverse Recovery Current | | | - | 7.4 | - | A |

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TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

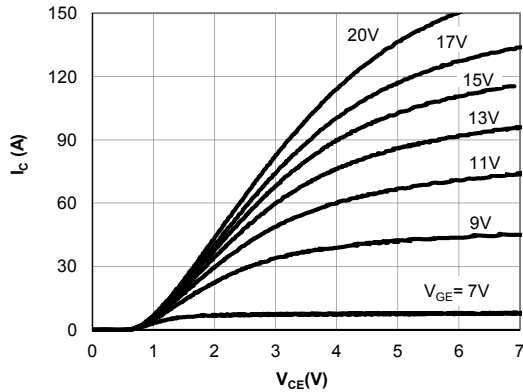


Fig 1: Output Characteristic
($T_j=25^\circ\text{C}$)

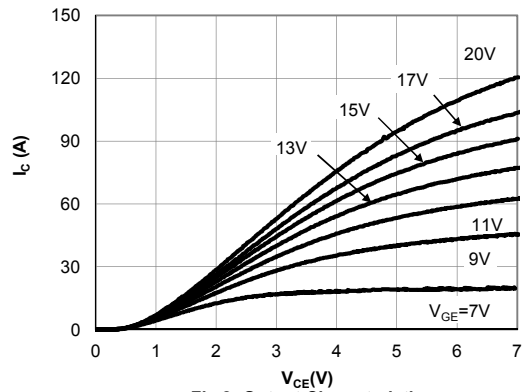


Fig 2: Output Characteristic
($T_j=175^\circ\text{C}$)

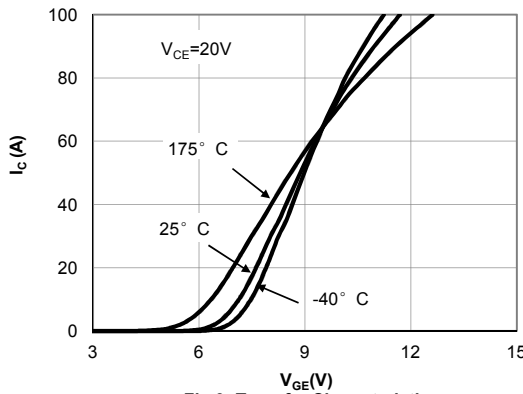


Fig 3: Transfer Characteristic

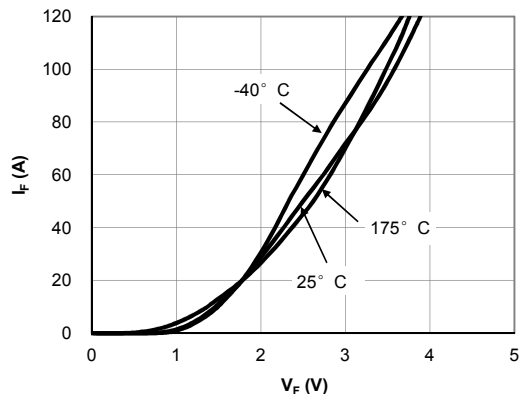


Fig 4: Diode Characteristic

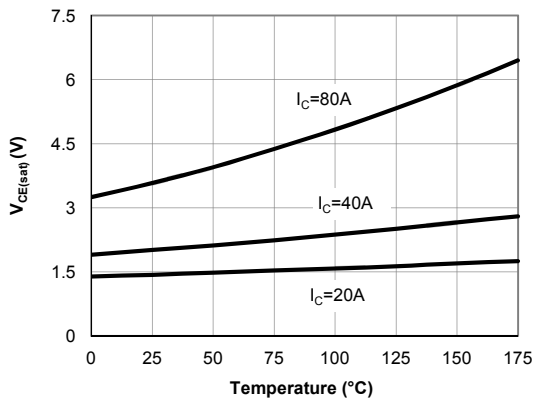


Fig 5: Collector-Emitter Saturation Voltage vs. Junction Temperature

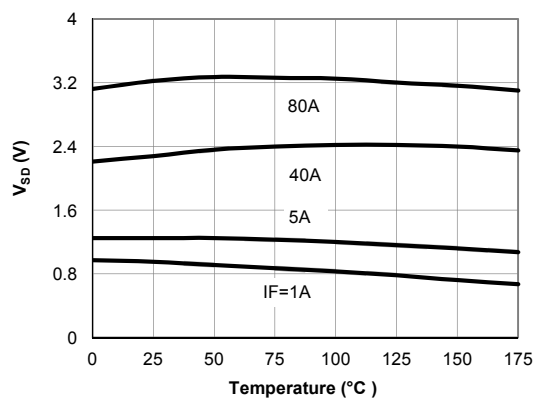


Fig 6: Diode Forward voltage vs. Junction Temperature

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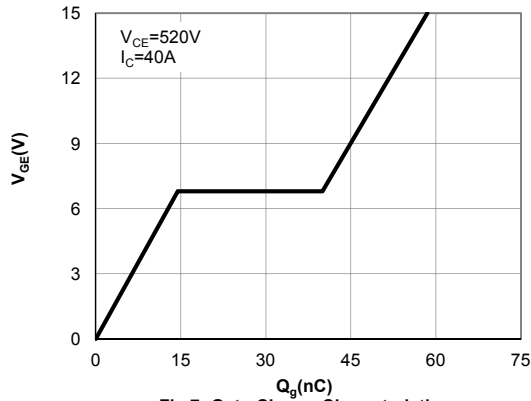


Fig 7: Gate-Charge Characteristics

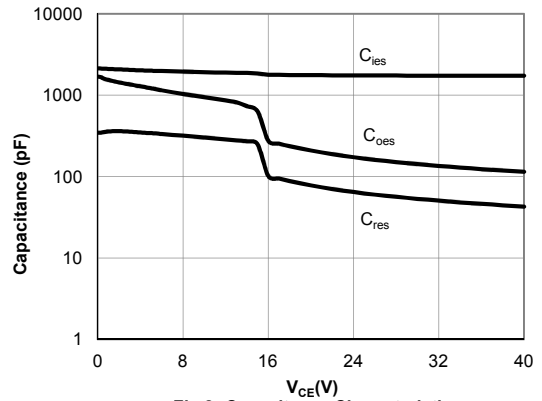


Fig 8: Capacitance Characteristic

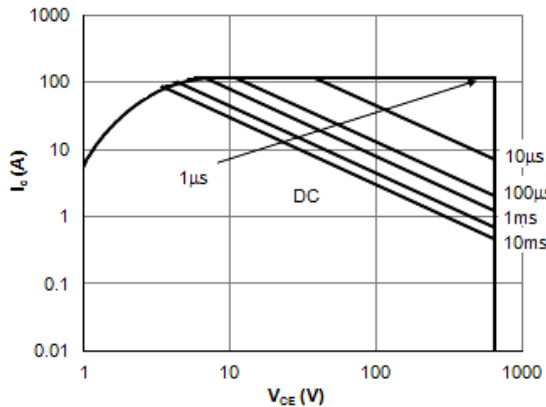


Fig 9: Forward Bias Safe Operating Area
($T_C=25^\circ\text{C}, V_{GE}=15\text{V}$)

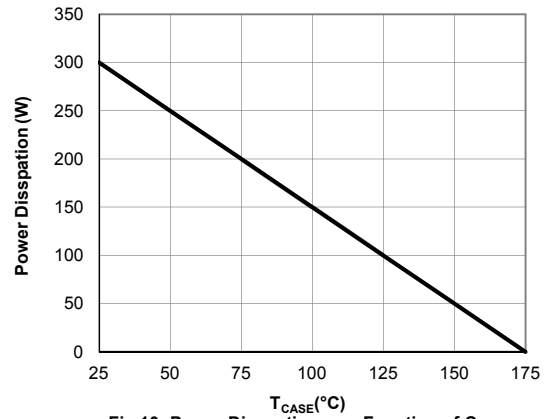


Fig 10: Power Dissipation as a Function of Case

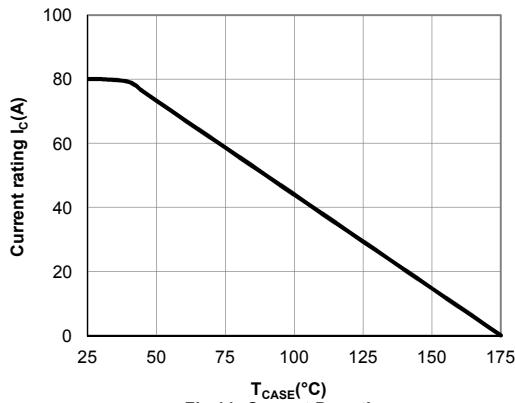


Fig 11: Current De-rating

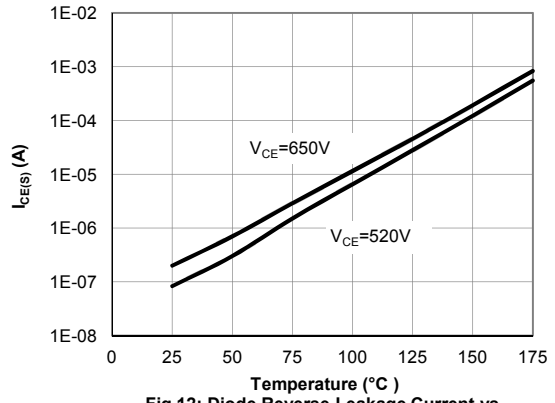


Fig 12: Diode Reverse Leakage Current vs. Junction Temperature

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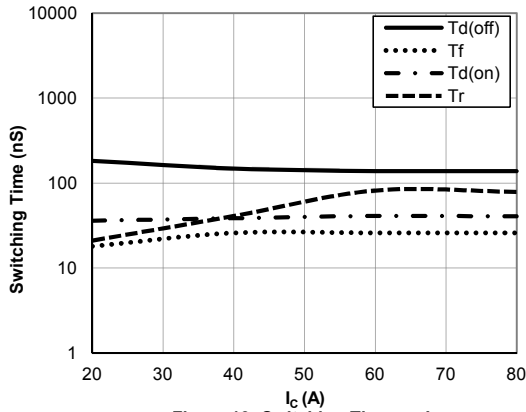


Figure 13: Switching Time vs. I_c
($T_j=175^\circ\text{C}, V_{GE}=15\text{V}, V_{CE}=400\text{V}, R_g=7.5\Omega$)

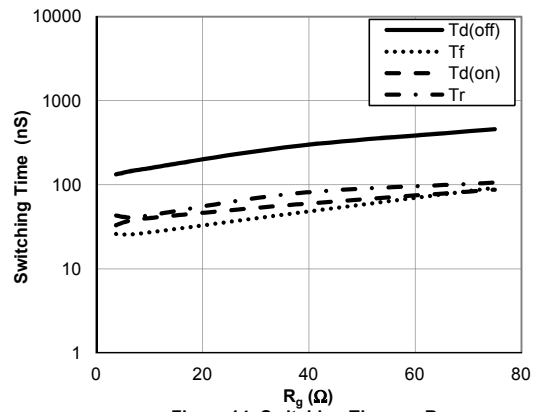


Figure 14: Switching Time vs. R_g
($T_j=175^\circ\text{C}, V_{GE}=15\text{V}, V_{CE}=400\text{V}, I_c=40\text{A}$)

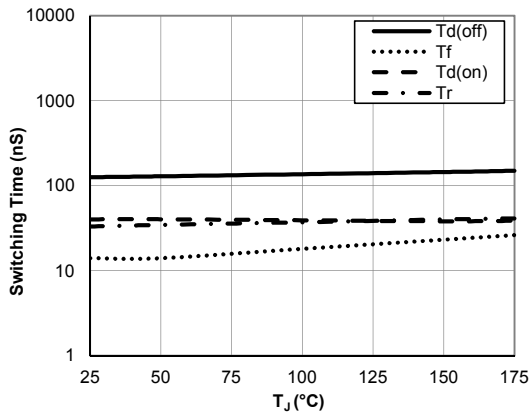


Figure 15: Switching Time vs. T_j
($V_{GE}=15\text{V}, V_{CE}=400\text{V}, I_c=40\text{A}, R_g=7.5\Omega$)

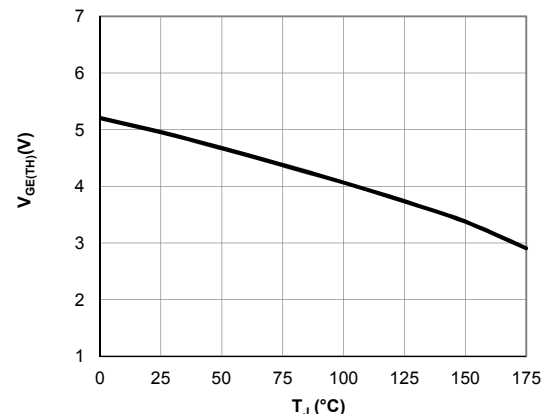


Figure 16: $V_{GE(TH)}$ vs. T_j

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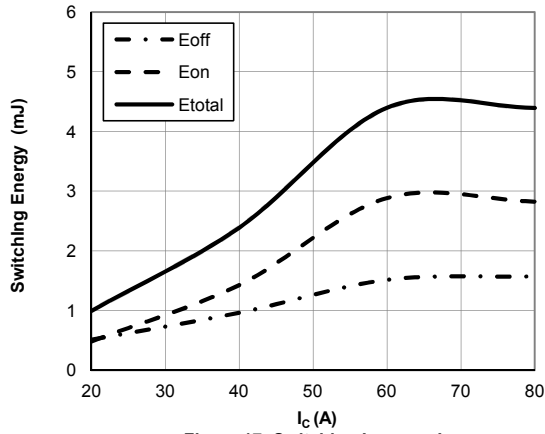


Figure 17: Switching Loss vs. I_c
($T_J=175^\circ\text{C}, V_{GE}=15\text{V}, V_{CE}=400\text{V}, R_g=7.5\Omega$)

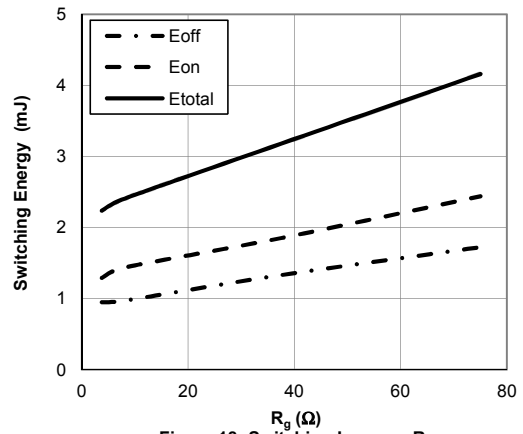


Figure 18: Switching Loss vs. R_g
($T_J=175^\circ\text{C}, V_{GE}=15\text{V}, V_{CE}=400\text{V}, I_c=40\text{A}$)

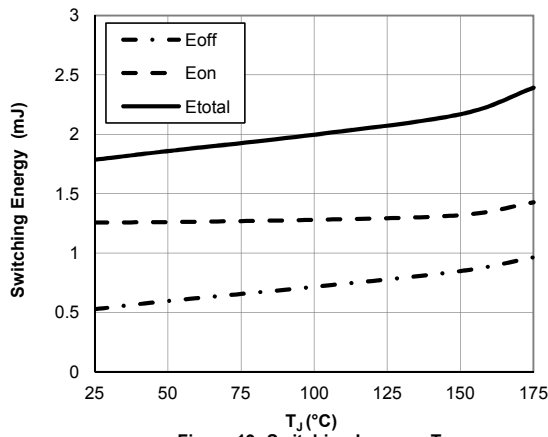


Figure 19: Switching Loss vs. T_J
($V_{GE}=15\text{V}, V_{CE}=400\text{V}, I_c=40\text{A}, R_g=7.5\Omega$)

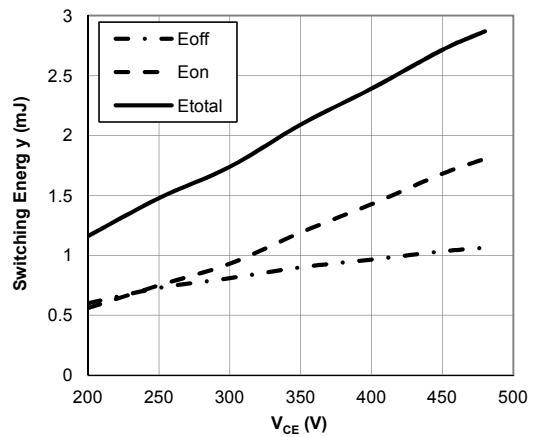


Figure 20: Switching Loss vs. V_{CE}
($T_J=175^\circ\text{C}, V_{GE}=15\text{V}, I_c=40\text{A}, R_g=7.5\Omega$)

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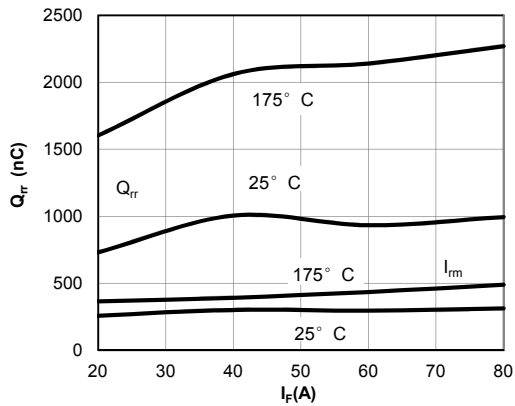


Fig 21: Diode Reverse Recovery Charge and Peak Current vs. Conduction Current
($V_{GE}=15V, V_{CE}=400V, di/dt=200A/\mu s$)

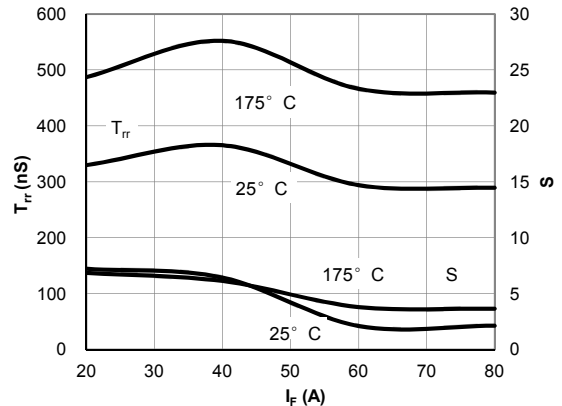


Fig 22: Diode Reverse Recovery Time and Softness Factor vs. Conduction Current
($V_{GE}=15V, V_{CE}=400V, di/dt=200A/\mu s$)

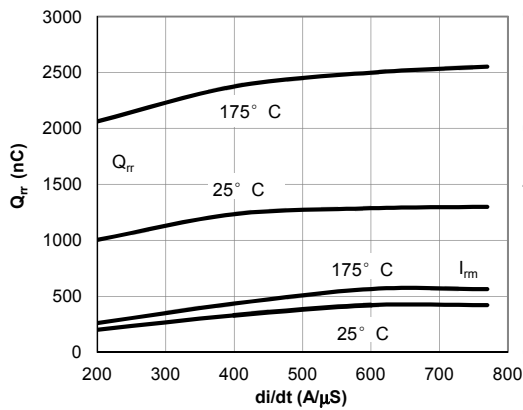


Fig 23: Diode Reverse Recovery Charge and Peak Current vs. di/dt
($V_{GE}=15V, V_{CE}=400V, I_F=40A$)

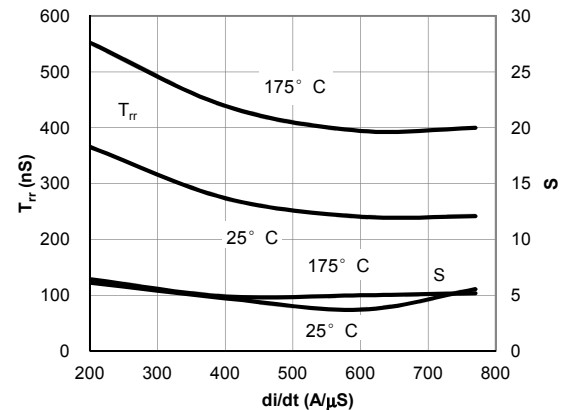


Fig 24: Diode Reverse Recovery Time and Softness Factor vs. di/dt
($V_{GE}=15V, V_{CE}=400V, I_F=40A$)

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

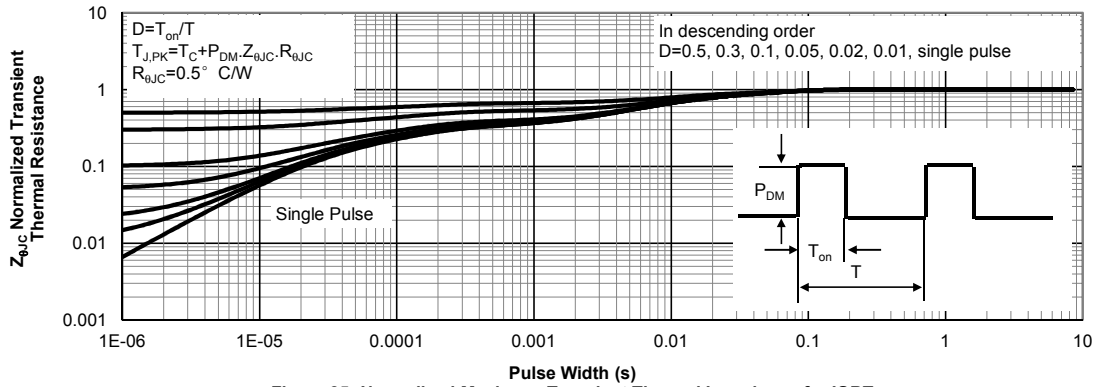


Figure 25: Normalized Maximum Transient Thermal Impedance for IGBT

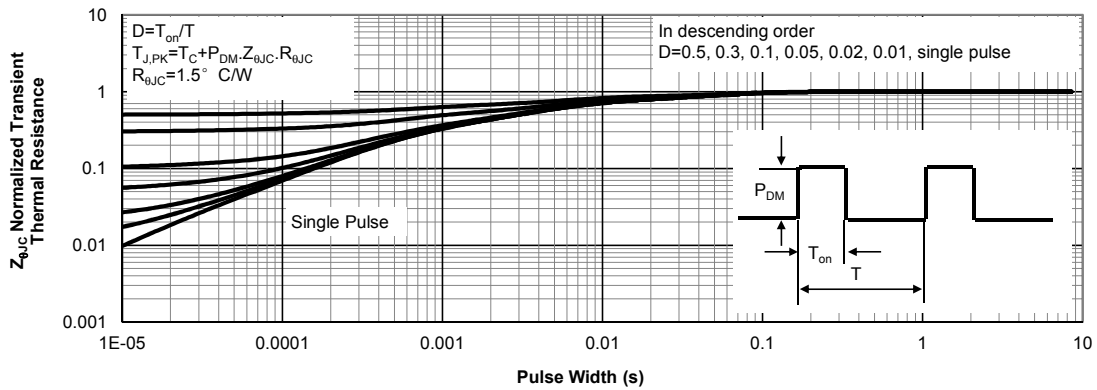
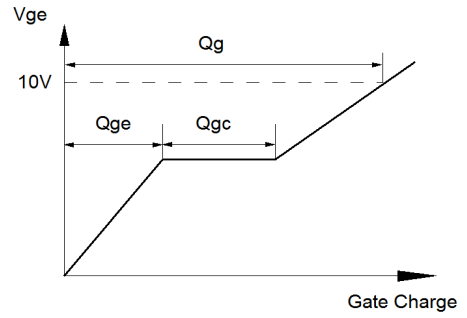
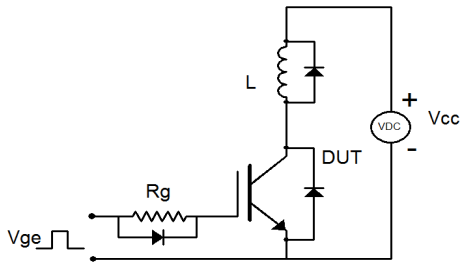
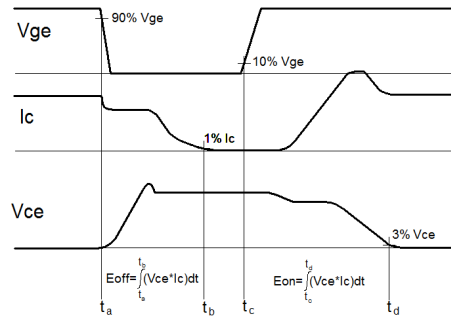
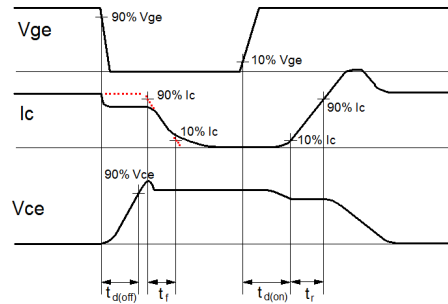
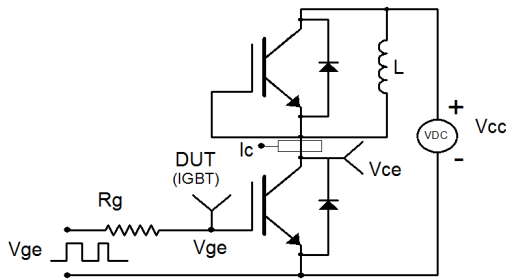


Figure 26: Normalized Maximum Transient Thermal Impedance for Diode

Gate Charge Test Circuit & Waveform



Inductive Switching Test Circuit & Waveforms



Diode Recovery Test Circuit & Waveforms

