ALPHA & OMEGA SEMICONDUCTOR

# AOTF20B65LN2

## 650V, 20A AlphaIGBT™

## With Soft and Fast Recovery Anti-Parallel Diode

### General Description

- Latest AlphaIGBT (αIGBT) technology
- 650V Breakdown voltage
- Very low VCE(sat)
- Very fast and soft recovery freewheeling diode
- High efficient turn-on di/dt controllability
- Low Turn-Off switching loss and softness
- Very good EMI behavior

### Applications

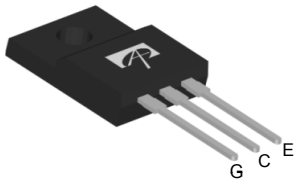
- Motor Drives
- Power Tools and Sewing Machines
- Mid to High Range Switching Frequency Converters
- Other Hard Switching Applications

### Product Summary

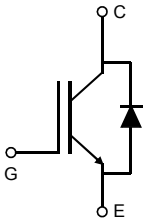
| | |
|---|---|
| $V_{CE}$ | 650V |
| $I_C$ ($T_C$=100°C) | 20A |
| $V_{CE(sat)}$ ($T_J$=25°C) | 1.54V |

RoHS Compliant

TO-220F




AOTF20B65LN2




| Orderable Part Number | Package Type | Form | Minimum Order Quantity |
|---|---|---|---|
| AOTF20B65LN2 | TO220F | Tube | 1000 |

**Absolute Maximum Ratings $T_A$=25°C unless otherwise noted**

| Parameter | | Symbol | AOTF20B65LN2 | Units |
|---|---|---|---|---|
| Collector-Emitter Voltage | | $V_{CE}$ | 650 | V |
| Gate-Emitter Voltage | | $V_{GE}$ | ±30 | V |
| Continuous Collector Current | $T_C$=25°C | $I_C$ | 40[2] | A |
| | $T_C$=100°C | | 20[2] | |
| Pulsed Collector Current, Limited by $T_{Jmax}$ | | $I_{CM}$ | 60 | A |
| Turn off SOA, $V_{CE}$≤650V, Limited by $T_{Jmax}$ | | $I_{LM}$ | 60 | A |
| Continuous Diode Forward Current | $T_C$=25°C | $I_F$ | 40[2] | A |
| | $T_C$=100°C | | 20[2] | |
| Diode Pulsed Current, Limited by $T_{Jmax}$ | | $I_{FM}$ | 60 | A |
| Power Dissipation | $T_C$=25°C | $P_D$ | 45 | W |
| | $T_C$=100°C | | 18 | |
| Junction and Storage Temperature Range | | $T_J$, $T_{STG}$ | -55 to 150 | °C |
| Maximum lead temperature for soldering purpose, 1/8" from case for 5 seconds | | $T_L$ | 300 | °C |

**Thermal Characteristics**

| Parameter | Symbol | AOTF20B65LN2 | Units |
|---|---|---|---|
| Maximum Junction-to-Ambient | $R_{\theta JA}$ | 65 | °C/W |
| Maximum IGBT Junction-to-Case | $R_{\theta JC}$ | 2.8 | °C/W |
| Maximum Diode Junction-to-Case | $R_{\theta JC}$ | 3.2 | °C/W |

1) TO220F $I_C$ follows TO220/TO263.

**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°C | | 650 | - | - | V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage | $V_{GE}$=15V, $I_C$=20A | $T_J$=25°C | - | 1.54 | 1.95 | V |
| | | | $T_J$=125°C | - | 1.83 | - | |
| | | | $T_J$=150°C | - | 1.91 | - | |
| $V_F$ | Diode Forward Voltage | $V_{GE}$=0V, $I_F$=20A | $T_J$=25°C | - | 1.6 | 2.1 | V |
| | | | $T_J$=125°C | - | 1.66 | - | |
| | | | $T_J$=150°C | - | 1.63 | - | |
| $V_{GE(th)}$ | Gate-Emitter Threshold Voltage | $V_{CE}$=5V, $I_C$=1mA | | - | 4.7 | - | V |
| $I_{CES}$ | Zero Gate Voltage Collector Current | $V_{CE}$=650V, $V_{GE}$=0V | $T_J$=25°C | - | - | 10 | µA |
| | | | $T_J$=125°C | - | - | 500 | |
| | | | $T_J$=150°C | - | - | 1000 | |
| $I_{GES}$ | Gate-Emitter leakage current | $V_{CE}$=0V, $V_{GE}$=±30V | | - | - | ±100 | nA |
| $g_{FS}$ | Forward Transconductance | $V_{CE}$=20V, $I_C$=20A | | - | 19 | - | S |
| **DYNAMIC PARAMETERS** | | | | | | | |
| $C_{ies}$ | Input Capacitance | $V_{GE}$=0V, $V_{CC}$=25V, f=1MHz | | - | 1237 | - | pF |
| $C_{oes}$ | Output Capacitance | | | - | 124 | - | pF |
| $C_{res}$ | Reverse Transfer Capacitance | | | - | 38 | - | pF |
| $Q_g$ | Total Gate Charge | $V_{GE}$=15V, $V_{CC}$=520V, $I_C$=20A | | - | 52 | - | nC |
| $Q_{ge}$ | Gate to Emitter Charge | | | - | 14 | - | nC |
| $Q_{gc}$ | Gate to Collector Charge | | | - | 22 | - | nC |
| $R_g$ | Gate resistance | $V_{GE}$=0V, $V_{CC}$=0V, f=1MHz | | - | 11 | - | Ω |
| **SWITCHING PARAMETERS, (Load Inductive, $T_J$=25°C)** | | | | | | | |
| $T_{d(on)}$ | Turn-On DelayTime | $T_J$=25°C<br>$V_{GE}$=15V, $V_{CC}$=400V, $I_C$=20A,<br>$R_G$=15Ω | | - | 23 | - | ns |
| $T_r$ | Turn-On Rise Time | | | - | 23 | - | ns |
| $T_{d(off)}$ | Turn-Off Delay Time | | | - | 135 | - | ns |
| $T_f$ | Turn-Off Fall Time | | | - | 12 | - | ns |
| $E_{on}$ | Turn-On Energy | | | - | 0.45 | - | mJ |
| $E_{off}$ | Turn-Off Energy | | | - | 0.26 | - | mJ |
| $E_{total}$ | Total Switching Energy | | | - | 0.71 | - | mJ |
| $T_{rr}$ | Diode Reverse Recovery Time | $T_J$=25°C<br>$I_F$=20A, dI/dt=200A/µs, $V_{CC}$=400V | | - | 266 | - | ns |
| $Q_{rr}$ | Diode Reverse Recovery Charge | | | - | 0.6 | - | µC |
| $I_{rm}$ | Diode Peak Reverse Recovery Current | | | - | 5.4 | - | A |
| **SWITCHING PARAMETERS, (Load Inductive, $T_J$=150°C)** | | | | | | | |
| $T_{d(on)}$ | Turn-On DelayTime | $T_J$=150°C<br>$V_{GE}$=15V, $V_{CC}$=400V, $I_C$=20A,<br>$R_G$=15Ω | | - | 22 | - | ns |
| $T_r$ | Turn-On Rise Time | | | - | 24 | - | ns |
| $T_{d(off)}$ | Turn-Off Delay Time | | | - | 160 | - | ns |
| $T_f$ | Turn-Off Fall Time | | | - | 20 | - | ns |
| $E_{on}$ | Turn-On Energy | | | - | 0.49 | - | mJ |
| $E_{off}$ | Turn-Off Energy | | | - | 0.44 | - | mJ |
| $E_{total}$ | Total Switching Energy | | | - | 0.93 | - | mJ |
| $T_{rr}$ | Diode Reverse Recovery Time | $T_J$=150°C<br>$I_F$=20A, dI/dt=200A/µs, $V_{CC}$=400V | | - | 363 | - | ns |
| $Q_{rr}$ | Diode Reverse Recovery Charge | | | - | 1.3 | - | µC |
| $I_{rm}$ | Diode Peak Reverse Recovery Current | | | - | 6.9 | - | A |

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

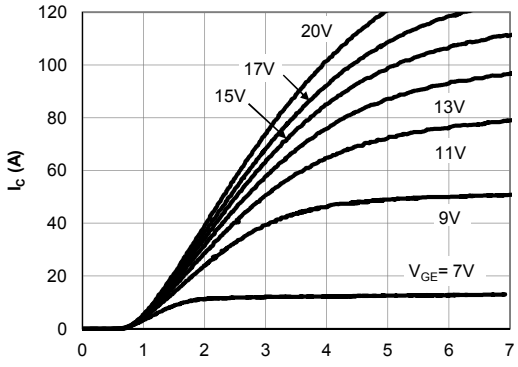



**Figure 1: Output Characteristic ($T_j$=25°C)**

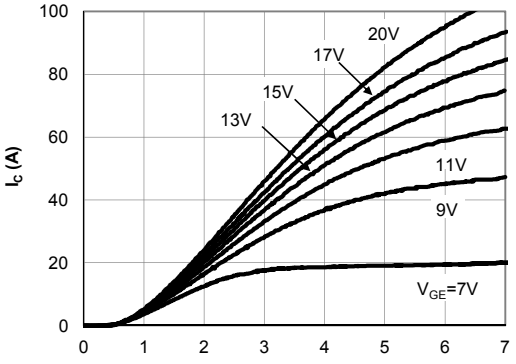



**Figure 2: Output Characteristic ($T_j$=150°C)**

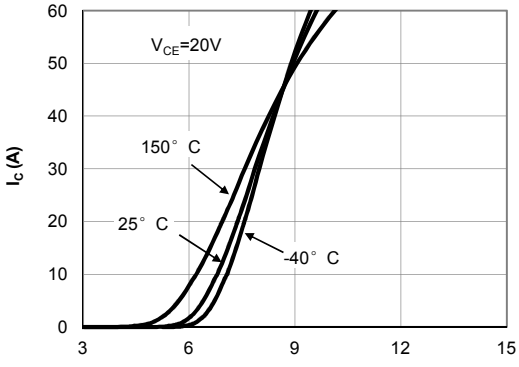



**Figure 3: Transfer Characteristic**

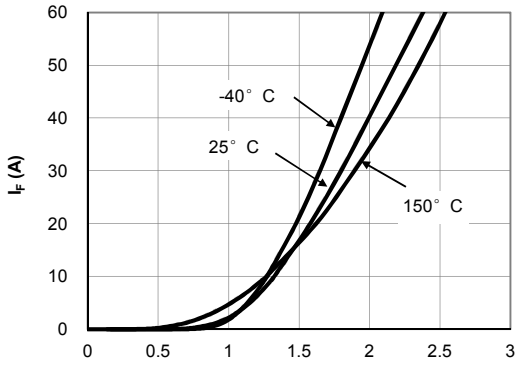



**Figure 4: Diode Characteristic**

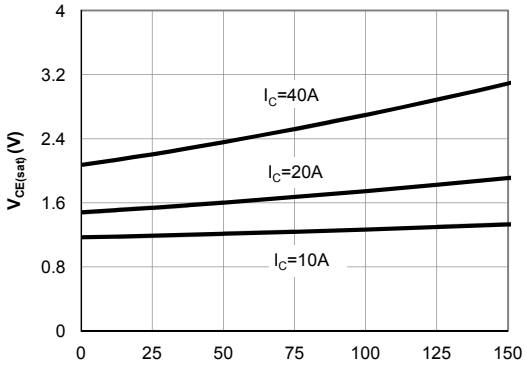



**Figure 5: Collector-Emitter Saturation Voltage vs. Junction Temperature**

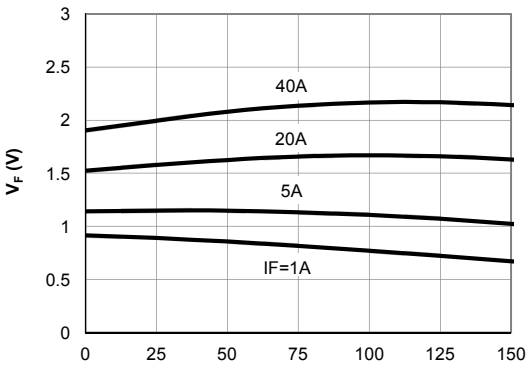



**Figure 6: Diode Forward voltage vs. Junction Temperature**

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

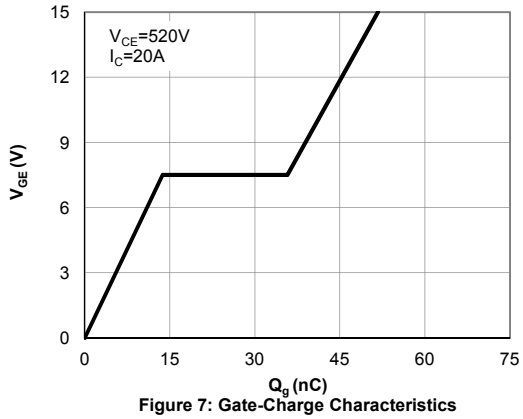


Figure 7: Gate-Charge Characteristics

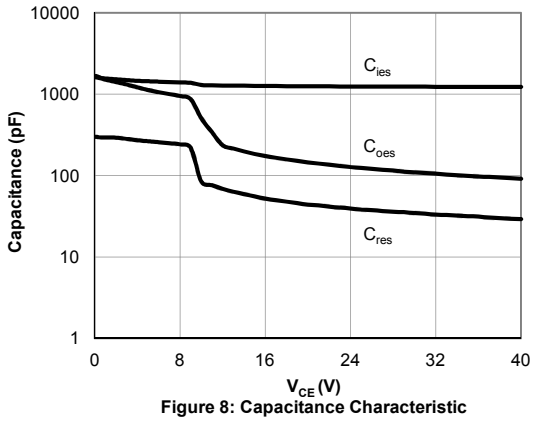


Figure 8: Capacitance Characteristic

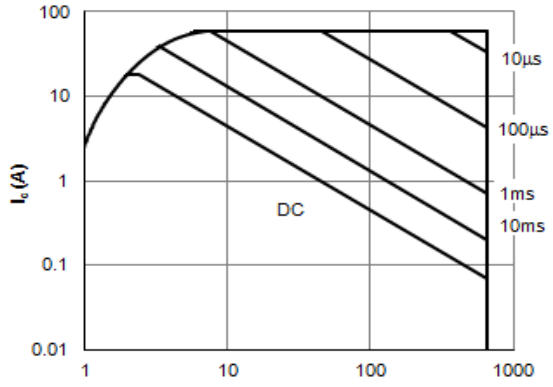


Figure 9: Forward Bias Safe Operating Area
($T_C$=25°C, $V_{GE}$=15V)

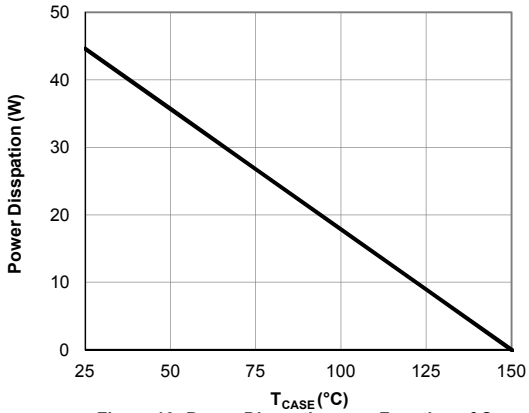


Figure 10: Power Disspation as a Function of Case

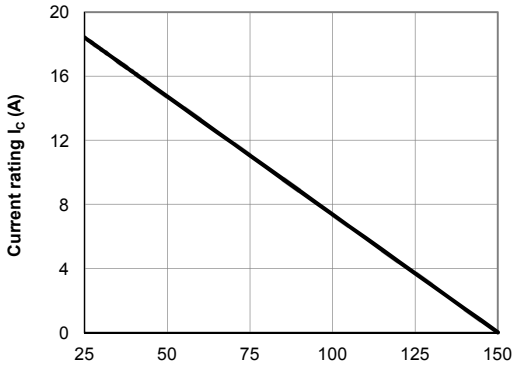


Figure 11: Current De-rating

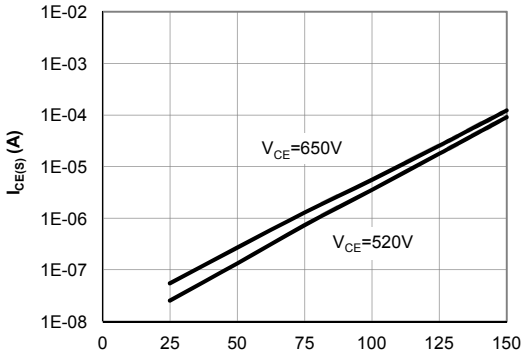


Figure 12: Diode Reverse Leakage Current vs. Junction Temperature

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

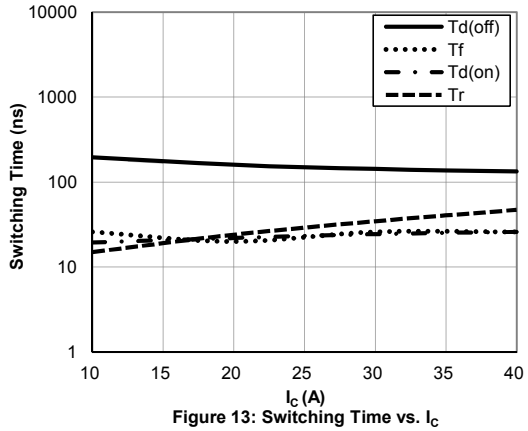



**Figure 13: Switching Time vs. $I_C$**
**($T_j$=150°C, $V_{GE}$=15V, $V_{CE}$=400V, $R_g$=15Ω)**

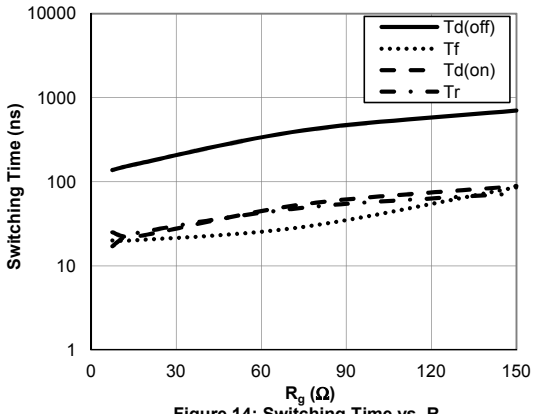



**Figure 14: Switching Time vs. $R_g$**
**($T_j$=150°C, $V_{GE}$=15V, $V_{CE}$=400V, $I_C$=20A)**

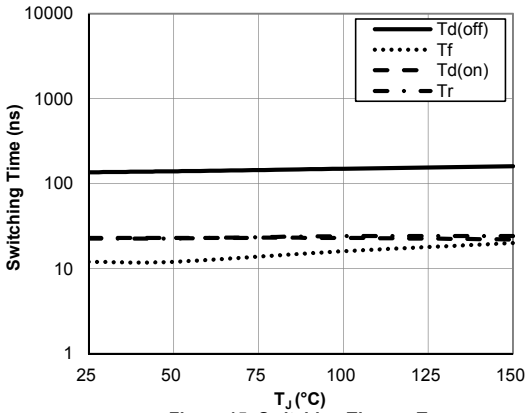



**Figure 15: Switching Time vs.$T_j$**
**($V_{GE}$=15V, $V_{CE}$=400V, $I_C$=20A, $R_g$=15Ω)**

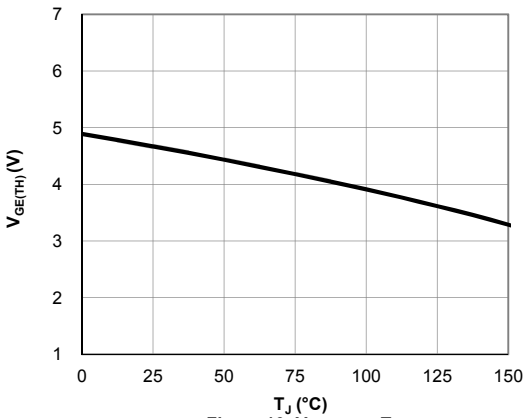



**Figure 16: $V_{GE(TH)}$ vs. $T_j$**

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

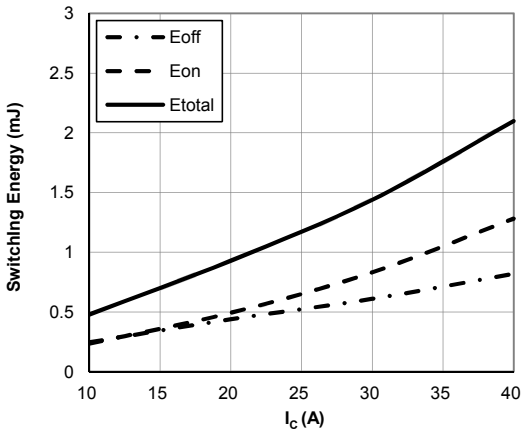



**Figure 17: Switching Loss vs. $I_C$**
**($T_j$=150°C, $V_{GE}$=15V, $V_{CE}$=400V, $R_g$=15Ω)**

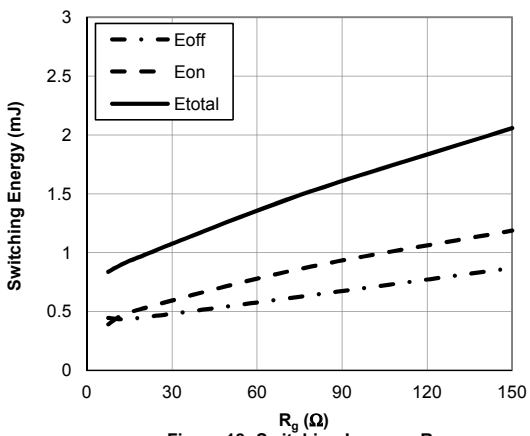



**Figure 18: Switching Loss vs. $R_g$**
**($T_j$=150°C, $V_{GE}$=15V, $V_{CE}$=400V, $I_C$=20A)**

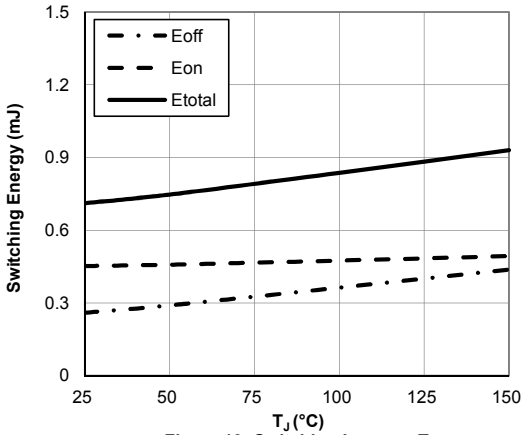



**Figure 19: Switching Loss vs. $T_j$**
**($V_{GE}$=15V, $V_{CE}$=400V, $I_C$=20A, $R_g$=15Ω)**

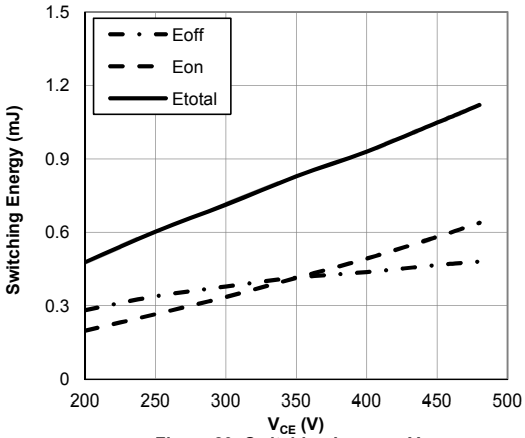



**Figure 20: Switching Loss vs. $V_{CE}$**
**($T_j$=150°C, $V_{GE}$=15V, $I_C$=20A, $R_g$=15Ω)**

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

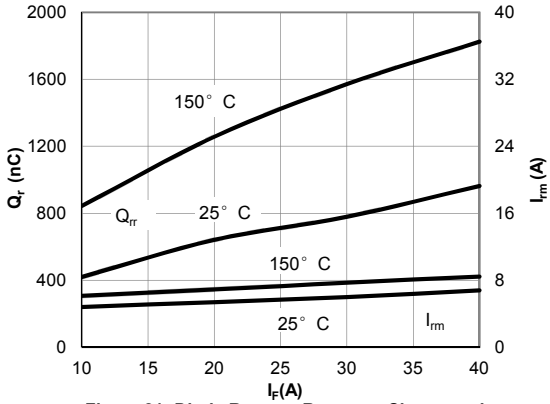



**Figure 21: Diode Reverse Recovery Charge and Peak Current vs. Conduction Current ($V_{GE}$=15V, $V_{CE}$=400V, di/dt=200A/µs)**

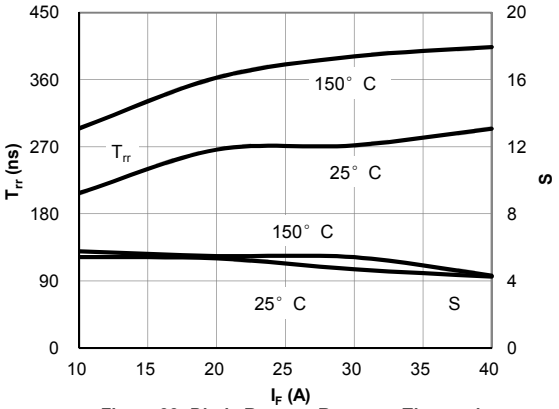



**Figure 22: Diode Reverse Recovery Time and Softness Factor vs. Conduction Current ($V_{GE}$=15V, $V_{CE}$=400V, di/dt=200A/µs)**

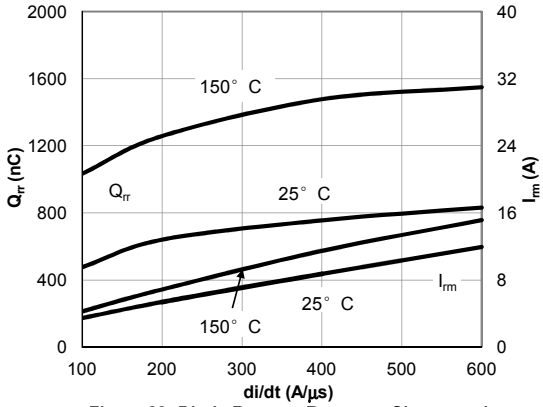



**Figure 23: Diode Reverse Recovery Charge and Peak Current vs. di/dt ($V_{GE}$=15V, $V_{CE}$=400V, $I_F$=20A)**

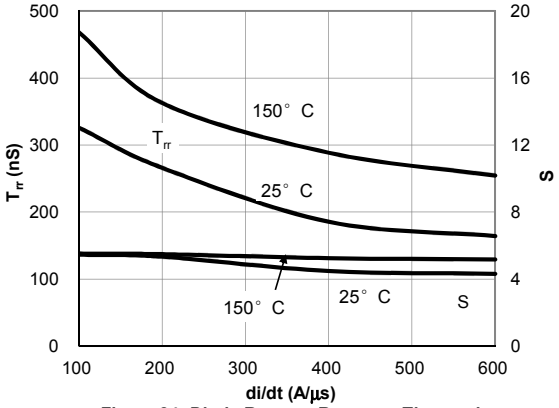



**Figure 24: Diode Reverse Recovery Time and Softness Factor vs. di/dt ($V_{GE}$=15V, $V_{CE}$=400V, $I_F$=20A)**

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

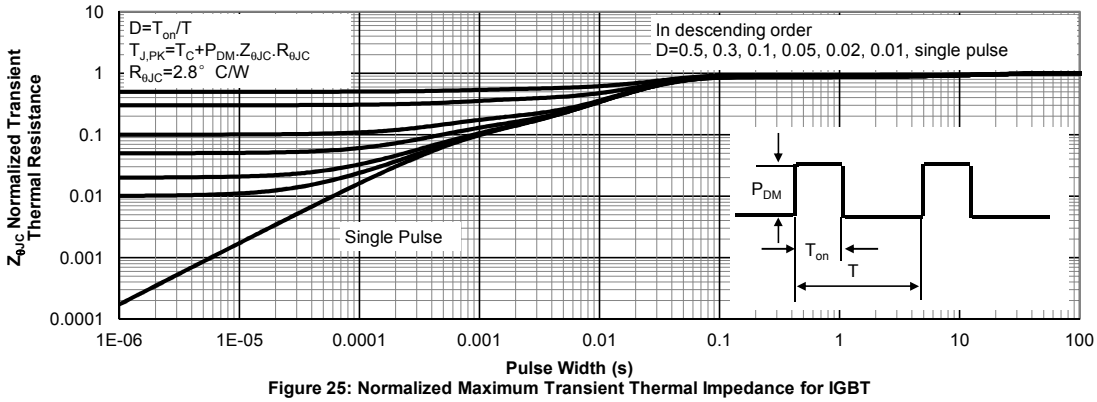



**Figure 25: Normalized Maximum Transient Thermal Impedance for IGBT**

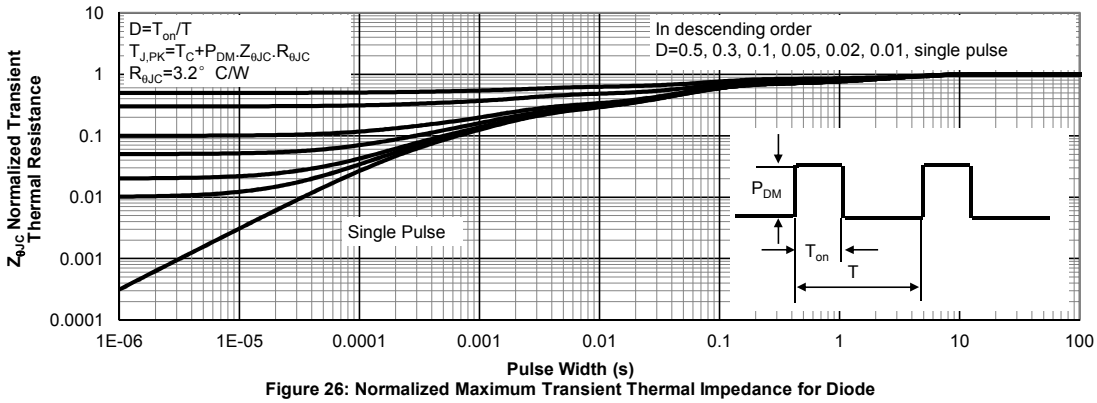



**Figure 26: Normalized Maximum Transient Thermal Impedance for Diode**

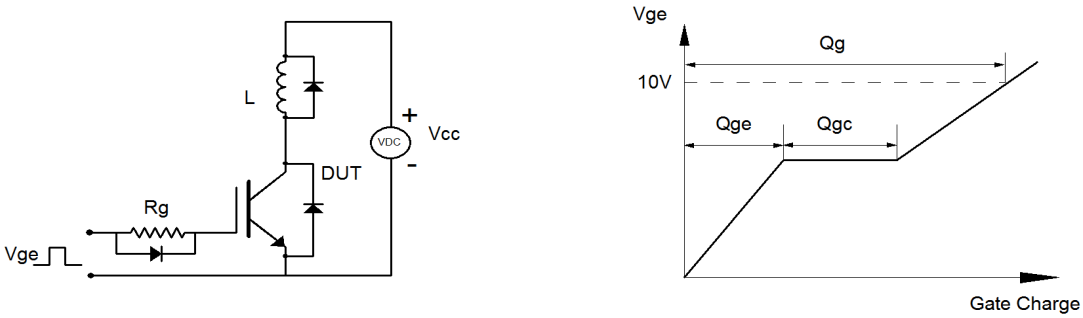



Figure A: Gate Charge Test Circuit & Waveforms

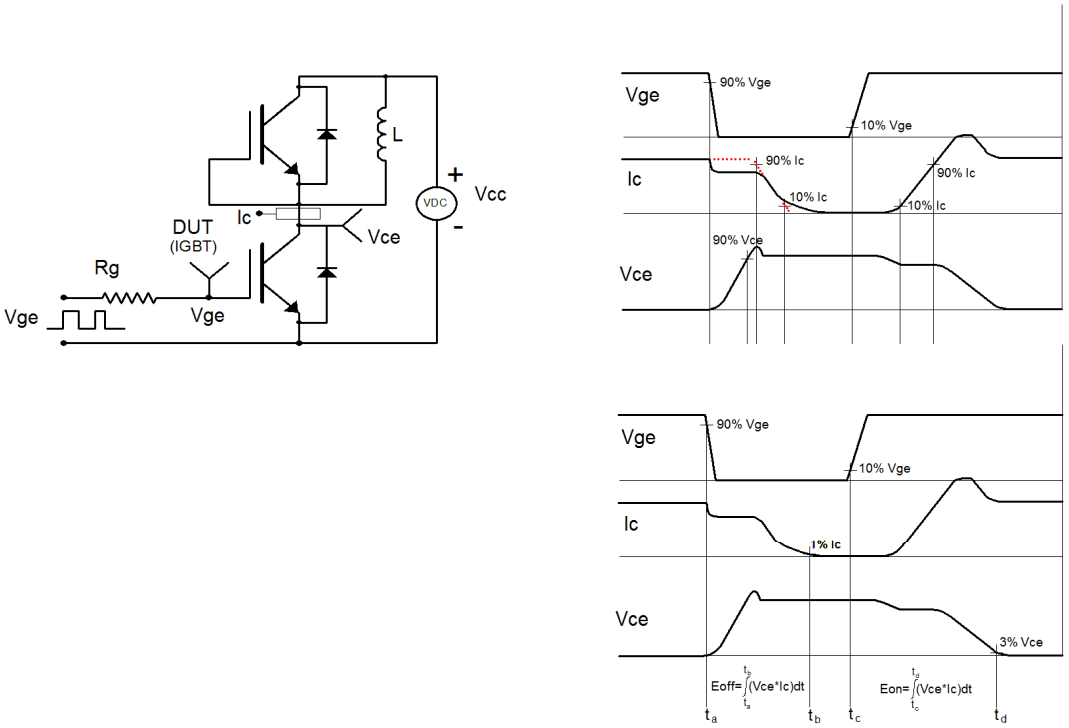



Figure B: Inductive Switching Test Circuit & Waveforms

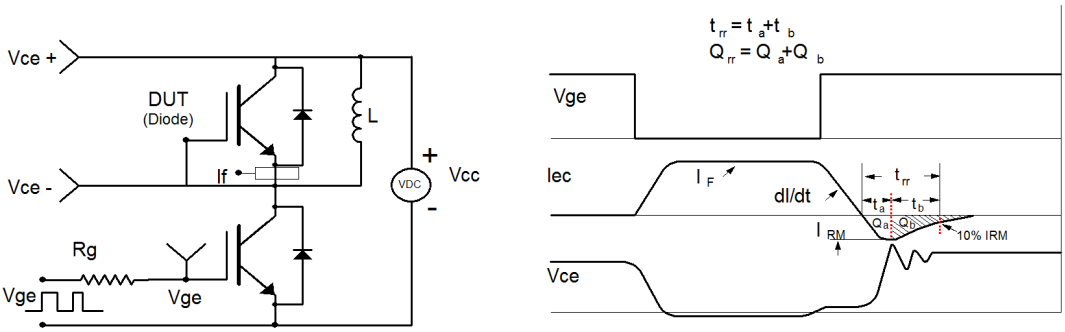



Figure C: Diode Recovery Test Circuit & Waveforms