



## General Description

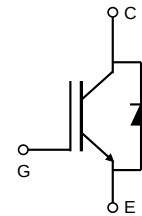
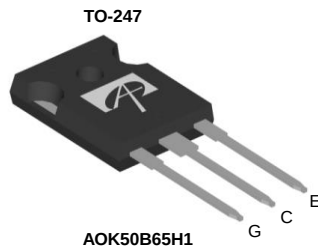
- Latest Alpha IGBT ( $\alpha$  IGBT) technology
- 650V breakdown voltage
- Very fast and soft recovery freewheeling diode
- High efficient turn-on di/dt controllability
- Very high switching speed
- Low turn-off switching loss and softness
- Very good EMI behavior
- Short-circuit ruggedness

## Applications

- Welding Machines
- Motor Drives
- UPS & Solar Inverters
- Very High Switching Frequency Applications

## Product Summary

|                                          |      |
|------------------------------------------|------|
| $V_{CE}$                                 | 650V |
| $I_C$ ( $T_C=100^\circ\text{C}$ )        | 50A  |
| $V_{CE(sat)}$ ( $T_J=25^\circ\text{C}$ ) | 1.9V |



| Orderable Part Number                                                                                                   | Package Type            | Form       | Minimum Order Quantity |
|-------------------------------------------------------------------------------------------------------------------------|-------------------------|------------|------------------------|
| AOK50B65H1                                                                                                              | TO247                   | Tube       | 240                    |
| <b>Absolute Maximum Ratings <math>T_A=25^\circ\text{C}</math> unless otherwise noted</b>                                |                         |            |                        |
| Parameter                                                                                                               | Symbol                  | AOK50B65H1 | Units                  |
| Collector-Emitter Voltage                                                                                               | $V_{CE}$                | 650        | V                      |
| Gate-Emitter Voltage                                                                                                    | $V_{GE}$                | $\pm 30$   | V                      |
| Continuous Collector Current                                                                                            | $T_C=25^\circ\text{C}$  | 100        | A                      |
|                                                                                                                         | $T_C=100^\circ\text{C}$ | 50         |                        |
| Pulsed Collector Current, Limited by $T_{Jmax}$                                                                         | $I_{CM}$                | 150        | A                      |
| Turn off SOA, $V_{CE} \leq 650\text{V}$ , Limited by $T_{Jmax}$                                                         | $I_{LM}$                | 150        | A                      |
| Continuous Diode Forward Current                                                                                        | $T_C=25^\circ\text{C}$  | 38         | A                      |
|                                                                                                                         | $T_C=100^\circ\text{C}$ | 19         |                        |
| Diode Pulsed Current, Limited by $T_{Jmax}$                                                                             | $I_{FM}$                | 150        | A                      |
| Short circuit withstanding time $t_1$<br>$V_{GE}=15\text{V}$ , $V_{CC} \leq 300\text{V}$ , $T_J \leq 175^\circ\text{C}$ | $t_{SC}$                | 5          | $\mu\text{s}$          |
| Power Dissipation                                                                                                       | $T_C=25^\circ\text{C}$  | 375        | W                      |
|                                                                                                                         | $T_C=100^\circ\text{C}$ | 188        |                        |
| 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        | $^\circ\text{C}$       |
| <b>Thermal Characteristics</b>                                                                                          |                         |            |                        |
| Parameter                                                                                                               | Symbol                  | AOK50B65H1 | Units                  |
| Maximum Junction-to-Ambient                                                                                             | $R_{\theta JA}$         | 40         | $^\circ\text{C/W}$     |
| Maximum IGBT Junction-to-Case                                                                                           | $R_{\theta JC}$         | 0.4        | $^\circ\text{C/W}$     |
| Maximum Diode Junction-to-Case                                                                                          | $R_{\theta JC}$         | 1.4        | $^\circ\text{C/W}$     |

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

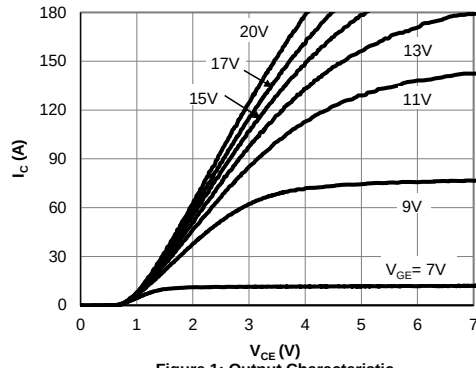
**Electrical Characteristics (T<sub>J</sub>=25°C unless otherwise noted)**

| 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 | $V_{GE}=15V, I_C=50A$                                              | $T_J=25^{\circ}C$  | -    | 1.9       | 2.4      | V       |
|                                                             |                                      |                                                                    | $T_J=125^{\circ}C$ | -    | 2.4       | -        |         |
|                                                             |                                      |                                                                    | $T_J=175^{\circ}C$ | -    | 2.67      | -        |         |
| $V_F$                                                       | Diode Forward Voltage                | $V_{GE}=0V, I_C=50A$                                               | $T_J=25^{\circ}C$  | -    | 2.25      | 2.85     | V       |
|                                                             |                                      |                                                                    | $T_J=125^{\circ}C$ | -    | 2.42      | -        |         |
|                                                             |                                      |                                                                    | $T_J=175^{\circ}C$ | -    | 2.3       | -        |         |
| $V_{GE(th)}$                                                | Gate-Emitter Threshold Voltage       | $V_{CE}=5V, I_C=1mA$                                               | -                  | 4.9  | -         | V        |         |
| $I_{CES}$                                                   | Zero Gate Voltage Collector Current  | $V_{CE}=650V, V_{GE}=0V$                                           | $T_J=25^{\circ}C$  | -    | -         | 10       | $\mu A$ |
|                                                             |                                      |                                                                    | $T_J=125^{\circ}C$ | -    | -         | 500      |         |
|                                                             |                                      |                                                                    | $T_J=175^{\circ}C$ | -    | -         | 10000    |         |
| $I_{GES}$                                                   | Gate-Emitter leakage current         | $V_{CE}=0V, V_{GE}=\pm 30V$                                        | -                  | -    | $\pm 100$ | nA       |         |
| $g_{FS}$                                                    | Forward Transconductance             | $V_{CE}=20V, I_C=50A$                                              | -                  | 38   | -         | S        |         |
| DYNAMIC PARAMETERS                                          |                                      |                                                                    |                    |      |           |          |         |
| $C_{ies}$                                                   | Input Capacitance                    | $V_{GE}=0V, V_{CC}=25V, f=1MHz$                                    | -                  | 2181 | -         | pF       |         |
| $C_{oes}$                                                   | Output Capacitance                   |                                                                    | -                  | 198  | -         | pF       |         |
| $C_{res}$                                                   | Reverse Transfer Capacitance         |                                                                    | -                  | 68   | -         | pF       |         |
| $Q_g$                                                       | Total Gate Charge                    | $V_{GE}=15V, V_{CC}=520V, I_C=50A$                                 | -                  | 76   | -         | nC       |         |
| $Q_{ge}$                                                    | Gate to Emitter Charge               |                                                                    | -                  | 20   | -         | nC       |         |
| $Q_{gc}$                                                    | Gate to Collector Charge             |                                                                    | -                  | 32   | -         | nC       |         |
| $I_{C(SC)}$                                                 | Short circuit collector current      | $V_{GE}=15V, V_{CC}=300V, t_{sc}\leq 5\mu s, T_J\leq 175^{\circ}C$ | -                  | 303  | -         | A        |         |
| $R_g$                                                       | Gate resistance                      | $V_{GE}=0V, V_{CC}=0V, f=1MHz$                                     | -                  | 13   | -         | $\Omega$ |         |
| SWITCHING PARAMETERS, (Load Inductive, $T_J=25^{\circ}C$ )  |                                      |                                                                    |                    |      |           |          |         |
| $t_{D(on)}$                                                 | Turn-On DelayTime                    | $T_J=25^{\circ}C, V_{GE}=15V, V_{CC}=400V, I_C=50A, R_G=6\Omega$   | -                  | 37   | -         | ns       |         |
| $t_r$                                                       | Turn-On Rise Time                    |                                                                    | -                  | 73   | -         | ns       |         |
| $t_{D(off)}$                                                | Turn-Off Delay Time                  |                                                                    | -                  | 141  | -         | ns       |         |
| $t_f$                                                       | Turn-Off Fall Time                   |                                                                    | -                  | 32   | -         | ns       |         |
| $E_{on}$                                                    | Turn-On Energy                       |                                                                    | -                  | 1.92 | -         | mJ       |         |
| $E_{off}$                                                   | Turn-Off Energy                      |                                                                    | -                  | 0.85 | -         | mJ       |         |
| $E_{total}$                                                 | Total Switching Energy               |                                                                    | -                  | 2.77 | -         | mJ       |         |
| $t_{rr}$                                                    | Diode Reverse Recovery Time          | $T_J=25^{\circ}C, I_F=50A, dI/dt=200A/\mu s, V_{CC}=400V$          | -                  | 261  | -         | ns       |         |
| $Q_{rr}$                                                    | Diode Reverse Recovery Charge        |                                                                    | -                  | 0.9  | -         | $\mu C$  |         |
| $I_{rm}$                                                    | Diode Peak Reverse Recovery Current  |                                                                    | -                  | 6.3  | -         | A        |         |
| SWITCHING PARAMETERS, (Load Inductive, $T_J=175^{\circ}C$ ) |                                      |                                                                    |                    |      |           |          |         |
| $t_{D(on)}$                                                 | Turn-On DelayTime                    | $T_J=175^{\circ}C, V_{GE}=15V, V_{CC}=400V, I_C=50A, R_G=6\Omega$  | -                  | 36   | -         | ns       |         |
| $t_r$                                                       | Turn-On Rise Time                    |                                                                    | -                  | 75   | -         | ns       |         |
| $t_{D(off)}$                                                | Turn-Off Delay Time                  |                                                                    | -                  | 173  | -         | ns       |         |
| $t_f$                                                       | Turn-Off Fall Time                   |                                                                    | -                  | 33   | -         | ns       |         |
| $E_{on}$                                                    | Turn-On Energy                       |                                                                    | -                  | 2.18 | -         | mJ       |         |
| $E_{off}$                                                   | Turn-Off Energy                      |                                                                    | -                  | 1.34 | -         | mJ       |         |
| $E_{total}$                                                 | Total Switching Energy               |                                                                    | -                  | 3.52 | -         | mJ       |         |
| $t_{rr}$                                                    | Diode Reverse Recovery Time          | $T_J=175^{\circ}C, I_F=50A, dI/dt=200A/\mu s, V_{CC}=400V$         | -                  | 437  | -         | ns       |         |
| $Q_{rr}$                                                    | Diode Reverse Recovery Charge        |                                                                    | -                  | 2.1  | -         | $\mu C$  |         |
| $I_{rm}$                                                    | Diode Peak Reverse Recovery Current  |                                                                    | -                  | 9    | -         | A        |         |

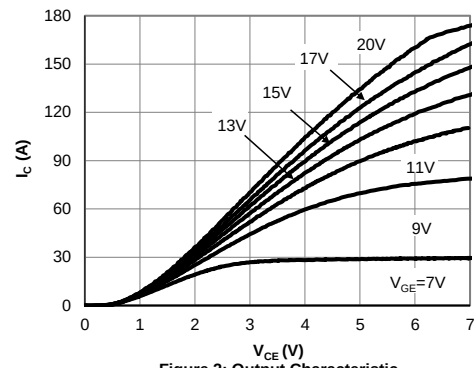
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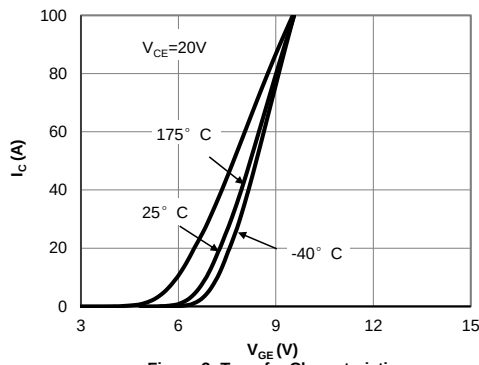
**TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS**



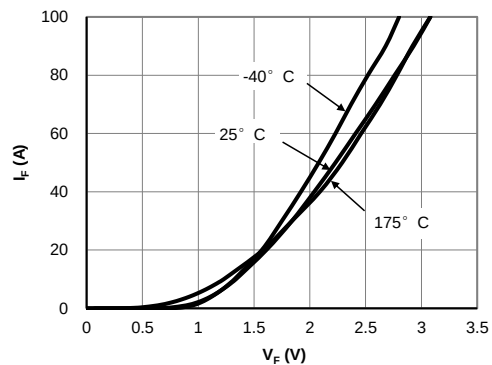
**Figure 1: Output Characteristic**  
( $T_j=25^\circ\text{C}$ )



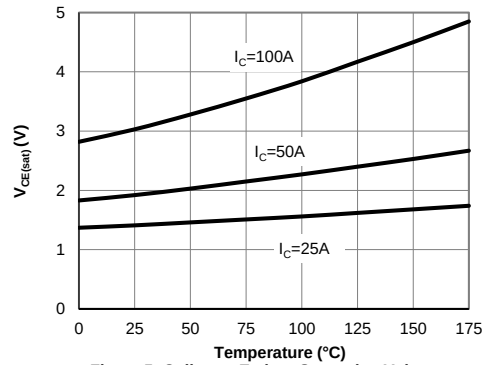
**Figure 2: Output Characteristic**  
( $T_j=175^\circ\text{C}$ )



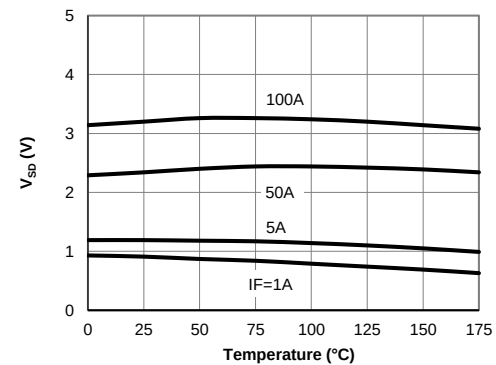
**Figure 3: Transfer Characteristic**



**Figure 4: Diode Characteristic**



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



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

**TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS**

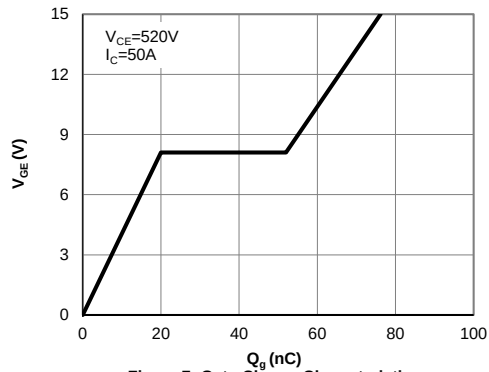


Figure 7: Gate-Charge Characteristics

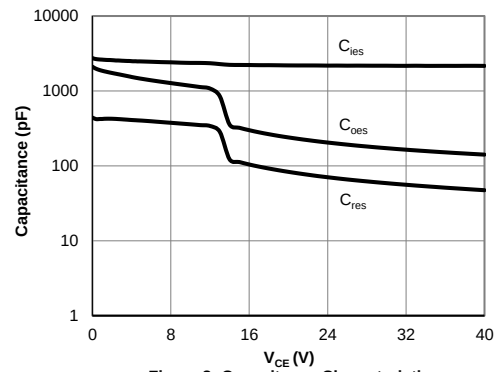


Figure 8: Capacitance Characteristic

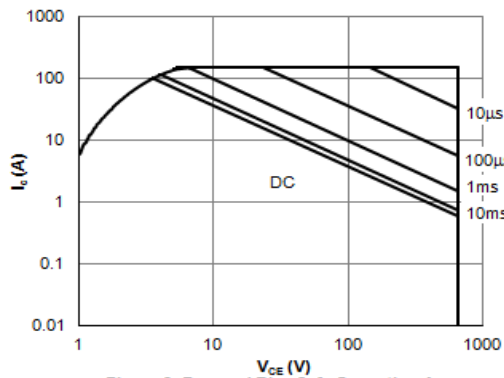


Figure 9: Forward Bias Safe Operating Area  
( $T_C=25^{\circ}\text{C}$ ,  $V_{GE}=15\text{V}$ )

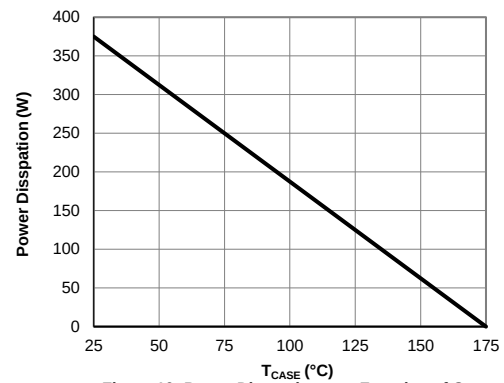


Figure 10: Power Dissipation as a Function of Case

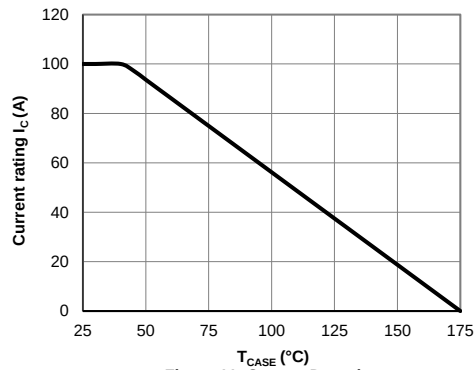


Figure 11: Current De-rating

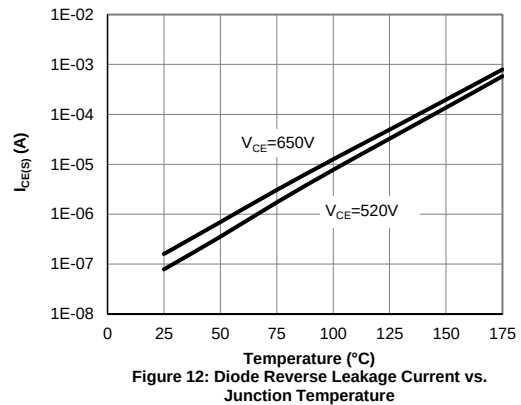
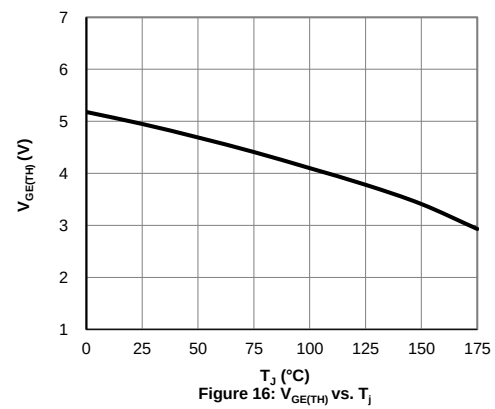
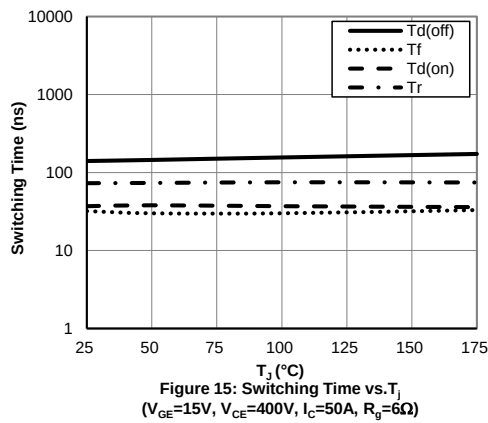
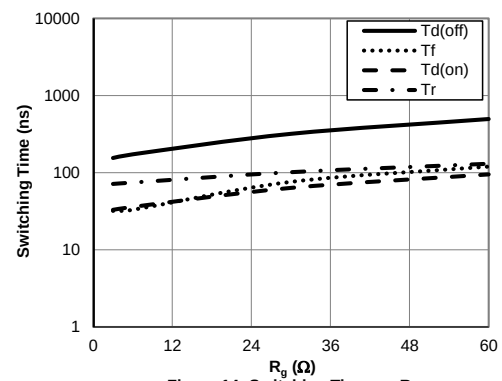
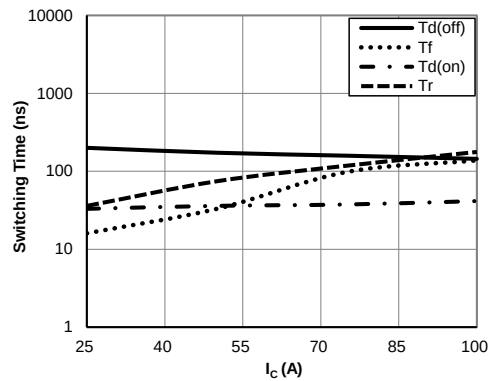
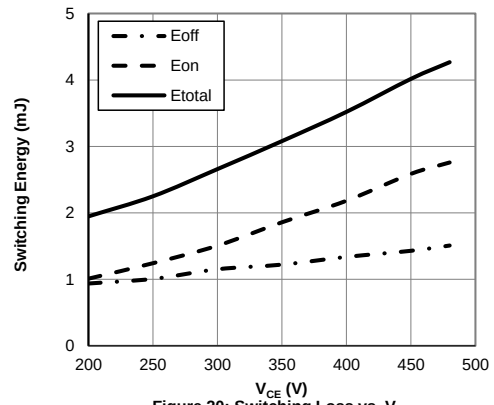
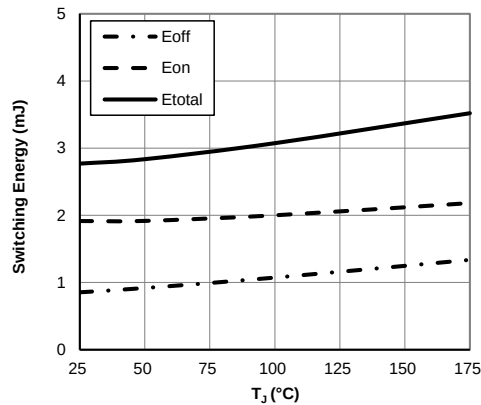
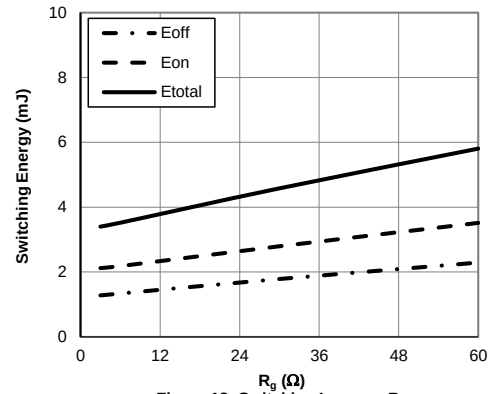
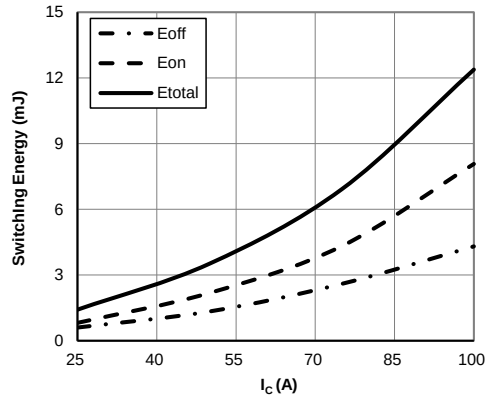


Figure 12: Diode Reverse Leakage Current vs. Junction Temperature

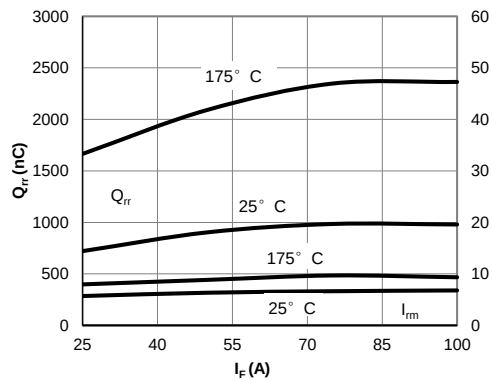
# TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS



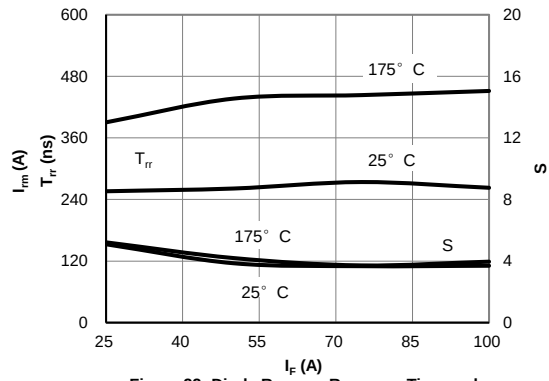
**TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS**



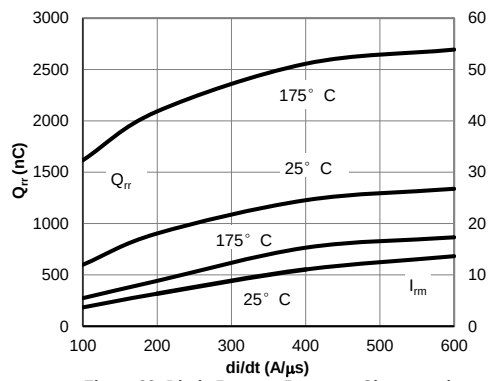
**TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS**



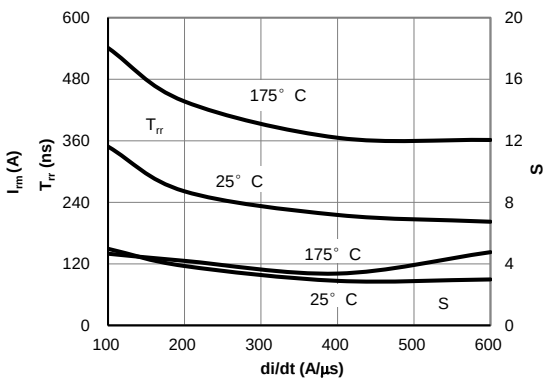
**Figure 21: Diode Reverse Recovery Charge and Peak Current vs. Conduction Current**  
( $V_{GE}=15V$ ,  $V_{CE}=400V$ ,  $di/dt=200A/\mu s$ )



**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.  $di/dt$**   
( $V_{GE}=15V$ ,  $V_{CE}=400V$ ,  $I_F=50A$ )



**Figure 24: Diode Reverse Recovery Time and Softness Factor vs.  $di/dt$**   
( $V_{GE}=15V$ ,  $V_{CE}=400V$ ,  $I_F=50A$ )

**TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS**

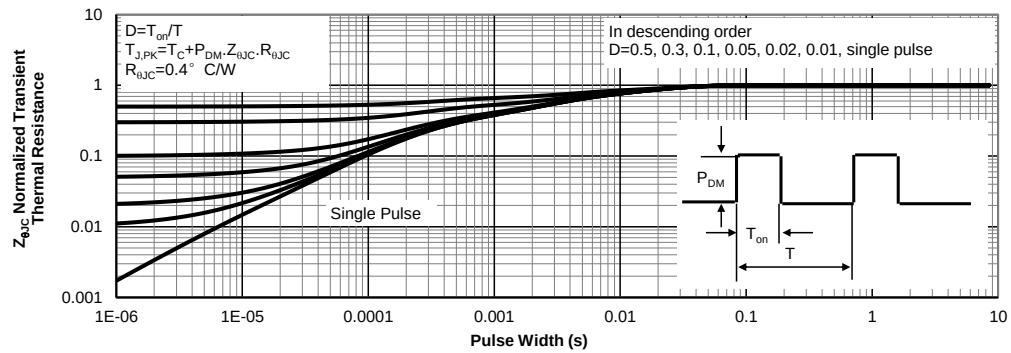


Figure 25: Normalized Maximum Transient Thermal Impedance for IGBT

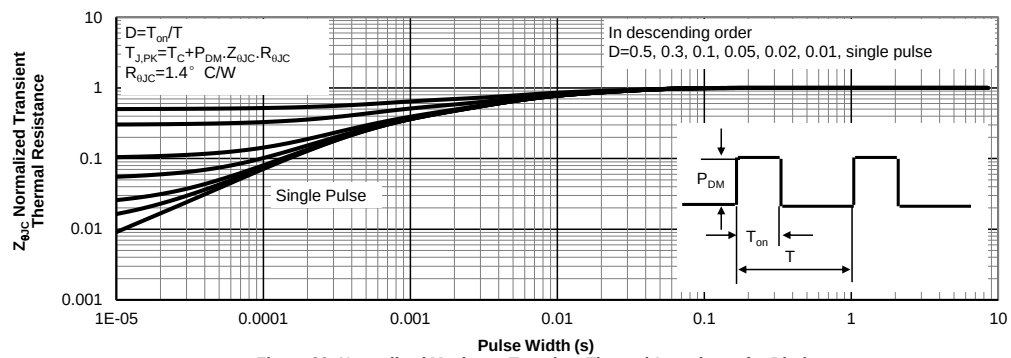


Figure 26: Normalized Maximum Transient Thermal Impedance for Diode



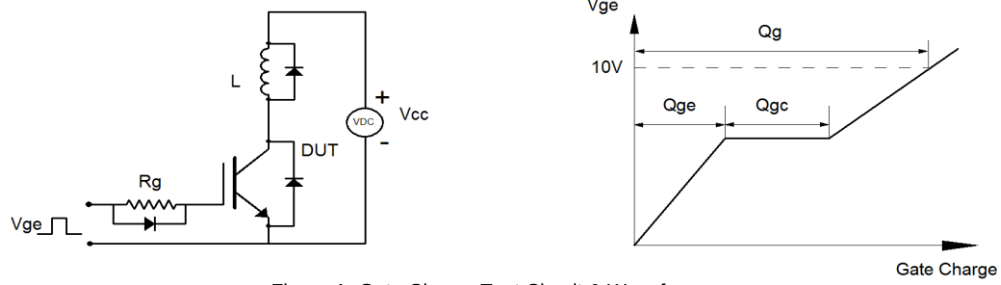


Figure A: Gate Charge Test Circuit & Waveforms

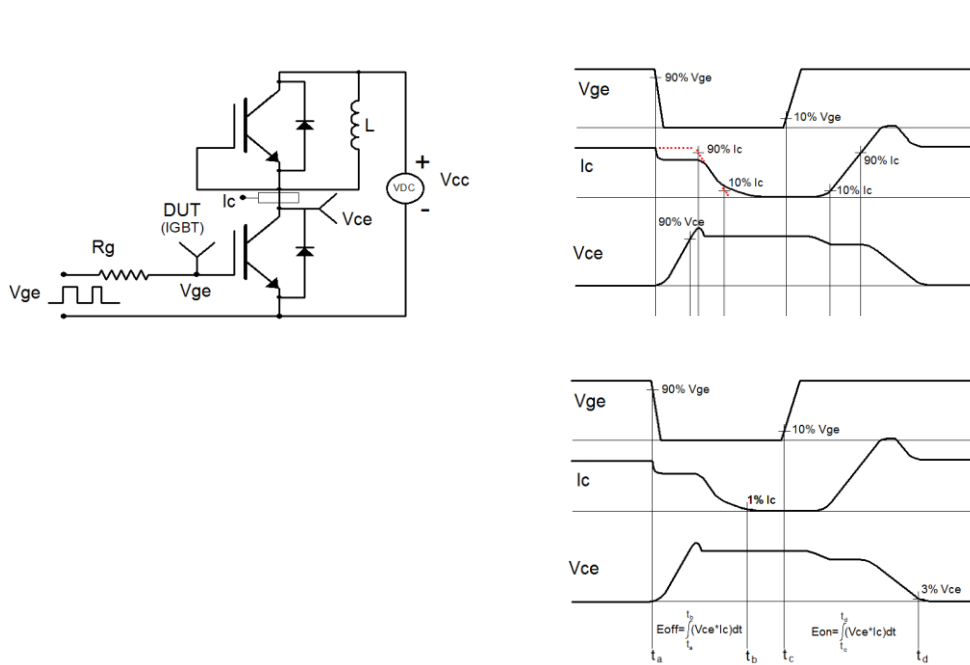


Figure B: Inductive Switching Test Circuit & Waveforms

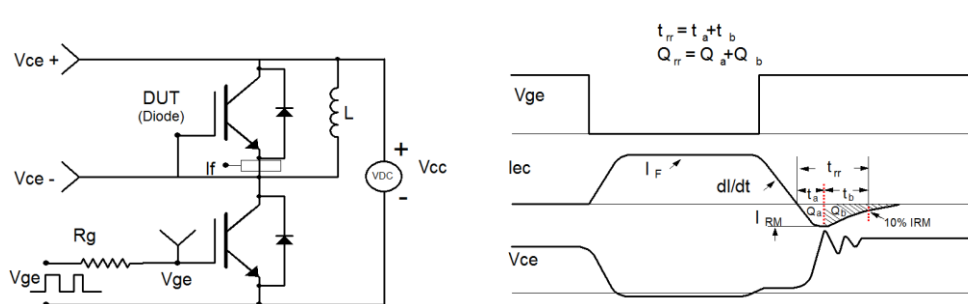


Figure C: Diode Recovery Test Circuit & Waveforms