



**ALPHA & OMEGA**  
SEMICONDUCTOR

## AOD4S60/AOI4S60/AOU4S60 600V 4A $\alpha$ MOS™ Power Transistor

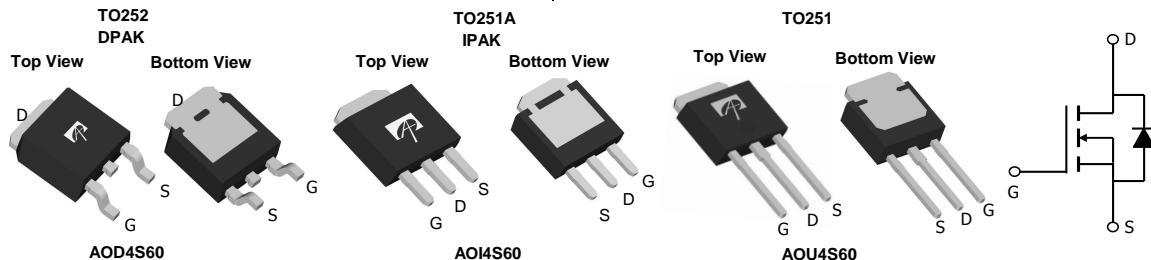
### General Description

The AOD4S60 & AOI4S60 & AOU4S60 have been fabricated using the advanced  $\alpha$ MOS™ high voltage process that is designed to deliver high levels of performance and robustness in switching applications. By providing low  $R_{DS(on)}$ ,  $Q_g$  and  $E_{OSS}$  along with guaranteed avalanche capability these parts can be adopted quickly into new and existing offline power supply designs.

### Product Summary

|                        |       |
|------------------------|-------|
| $V_{DS}$ @ $T_{j,max}$ | 700V  |
| $I_{DM}$               | 16A   |
| $R_{DS(ON),max}$       | 0.9Ω  |
| $Q_{g,typ}$            | 6nC   |
| $E_{OSS}$ @ 400V       | 1.5μJ |

100% UIS Tested  
100%  $R_g$  Tested



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

| Parameter   | Symbol         | Maximum    | Units               |
|---|----------------|------------|---------------------|
| Drain-Source Voltage  | $V_{DS}$       | 600        | V                   |
| Gate-Source Voltage   | $V_{GS}$       | $\pm 30$   | V                   |
| Continuous Drain Current  | $I_D$          | 4          | A                   |
| $T_C=100^\circ\text{C}$   |                | 3          |                     |
| Pulsed Drain Current <sup>C</sup>   | $I_{DM}$       | 16         | A                   |
| Avalanche Current <sup>C</sup>  | $I_{AR}$       | 1.6        | A                   |
| Repetitive avalanche energy <sup>C</sup>  | $E_{AR}$       | 38         | mJ                  |
| Single pulsed avalanche energy <sup>H</sup>   | $E_{AS}$       | 77         | mJ                  |
| Power Dissipation <sup>B</sup>  | $P_D$          | 56.8       | W                   |
| Derate above $25^\circ\text{C}$   |                | 0.45       | W/ $^\circ\text{C}$ |
| MOSFET dv/dt ruggedness   | dv/dt          | 100        | V/ns                |
| Peak diode recovery dv/dt   |                | 20         |                     |
| Junction and Storage Temperature Range  | $T_J, T_{STG}$ | -55 to 150 | $^\circ\text{C}$    |
| Maximum lead temperature for soldering purpose, 1/8" from case for 5 seconds <sup>K</sup> | $T_L$          | 300        | $^\circ\text{C}$    |

### Thermal Characteristics

| Parameter                                  | Symbol          | Typical | Maximum | Units                     |
|--|-----------------|---------|---------|---------------------------|
| Maximum Junction-to-Ambient <sup>A,D</sup> | $R_{\theta JA}$ | 45      | 55      | $^\circ\text{C}/\text{W}$ |
| Maximum Case-to-sink <sup>A</sup>          | $R_{\theta CS}$ | --      | 0.5     | $^\circ\text{C}/\text{W}$ |
| Maximum Junction-to-Case <sup>D,F</sup>    | $R_{\theta JC}$ | 1.8     | 2.2     | $^\circ\text{C}/\text{W}$ |

**Electrical Characteristics ( $T_J=25^\circ\text{C}$  unless otherwise noted)**

| Symbol                      | Parameter   | Conditions  | Min | Typ  | Max  | Units |
|-----------------------------|---|---|-----|------|------|-------|
| <b>STATIC PARAMETERS</b>    |   |   |     |      |      |       |
| BV <sub>DSS</sub>           | Drain-Source Breakdown Voltage                            | I <sub>D</sub> =250μA, V <sub>GS</sub> =0V, T <sub>J</sub> =25°C                        | 600 | -    | -    | V     |
|                             |   | I <sub>D</sub> =250μA, V <sub>GS</sub> =0V, T <sub>J</sub> =150°C                       | 650 | 700  | -    |       |
| I <sub>DSS</sub>            | Zero Gate Voltage Drain Current                           | V <sub>DS</sub> =600V, V <sub>GS</sub> =0V  | -   | -    | 1    | μA    |
|                             |   | V <sub>DS</sub> =480V, T <sub>J</sub> =150°C  | -   | 10   | -    |       |
| I <sub>GSS</sub>            | Gate-Body leakage current                                 | V <sub>DS</sub> =0V, V <sub>GS</sub> =±30V  | -   | -    | ±100 | nA    |
| V <sub>GS(th)</sub>         | Gate Threshold Voltage                                    | V <sub>DS</sub> =5V, I <sub>D</sub> =250μA  | 2.9 | 3.5  | 4.1  | V     |
| R <sub>DS(ON)</sub>         | Static Drain-Source On-Resistance                         | V <sub>GS</sub> =10V, I <sub>D</sub> =2A, T <sub>J</sub> =25°C                          | -   | 0.78 | 0.9  | Ω     |
|                             |   | V <sub>GS</sub> =10V, I <sub>D</sub> =2A, T <sub>J</sub> =150°C                         | -   | 2    | 2.4  | Ω     |
| V <sub>SD</sub>             | Diode Forward Voltage                                     | I <sub>S</sub> =2A, V <sub>GS</sub> =0V, T <sub>J</sub> =25°C                           | -   | 0.81 | -    | V     |
| I <sub>S</sub>              | Maximum Body-Diode Continuous Current                     |   | -   | -    | 4    | A     |
| I <sub>SM</sub>             | Maximum Body-Diode Pulsed Current <sup>C</sup>            |   | -   | -    | 16   | A     |
| <b>DYNAMIC PARAMETERS</b>   |   |   |     |      |      |       |
| C <sub>iss</sub>            | Input Capacitance   | V <sub>GS</sub> =0V, V <sub>DS</sub> =100V, f=1MHz                                      | -   | 263  | -    | pF    |
| C <sub>oss</sub>            | Output Capacitance  |   | -   | 21   | -    | pF    |
| C <sub>o(er)</sub>          | Effective output capacitance, energy related <sup>I</sup> | V <sub>GS</sub> =0V, V <sub>DS</sub> =0 to 480V, f=1MHz                                 | -   | 17.1 | -    | pF    |
| C <sub>o(tr)</sub>          | Effective output capacitance, time related <sup>J</sup>   |   | -   | 47.7 | -    | pF    |
| C <sub>rss</sub>            | Reverse Transfer Capacitance                              | V <sub>GS</sub> =0V, V <sub>DS</sub> =100V, f=1MHz                                      | -   | 0.75 | -    | pF    |
| R <sub>g</sub>              | Gate resistance   | V <sub>GS</sub> =0V, V <sub>DS</sub> =0V, f=1MHz  | -   | 18   | -    | Ω     |
| <b>SWITCHING PARAMETERS</b> |   |   |     |      |      |       |
| Q <sub>g</sub>              | Total Gate Charge   | V <sub>GS</sub> =10V, V <sub>DS</sub> =480V, I <sub>D</sub> =2A                         | -   | 6    | -    | nC    |
| Q <sub>gs</sub>             | Gate Source Charge  |   | -   | 1.6  | -    | nC    |
| Q <sub>gd</sub>             | Gate Drain Charge   |   | -   | 1.8  | -    | nC    |
| t <sub>D(on)</sub>          | Turn-On DelayTime   | V <sub>GS</sub> =10V, V <sub>DS</sub> =400V, I <sub>D</sub> =2A,<br>R <sub>G</sub> =25Ω | -   | 18   | -    | ns    |
| t <sub>r</sub>              | Turn-On Rise Time   |   | -   | 8    | -    | ns    |
| t <sub>D(off)</sub>         | Turn-Off DelayTime  |   | -   | 40   | -    | ns    |
| t <sub>f</sub>              | Turn-Off Fall Time  |   | -   | 12   | -    | ns    |
| t <sub>rr</sub>             | Body Diode Reverse Recovery Time                          | I <sub>F</sub> =2A, dI/dt=100A/μs, V <sub>DS</sub> =400V                                | -   | 177  | -    | ns    |
| I <sub>rm</sub>             | Peak Reverse Recovery Current                             | I <sub>F</sub> =2A, dI/dt=100A/μs, V <sub>DS</sub> =400V                                | -   | 12   | -    | A     |
| Q <sub>rr</sub>             | Body Diode Reverse Recovery Charge                        | I <sub>F</sub> =2A, dI/dt=100A/μs, V <sub>DS</sub> =400V                                | -   | 1.5  | -    | μC    |

A. The value of R<sub>θJA</sub> is measured with the device in a still air environment with T<sub>A</sub>=25°C.

B. The power dissipation P<sub>D</sub> is based on T<sub>J(MAX)=150°C</sub>, using junction-to-case thermal resistance, and is more useful in setting the upper dissipation limit for cases where additional heatsinking is used.

C. Repetitive rating, pulse width limited by junction temperature T<sub>J(MAX)=150°C</sub>, Ratings are based on low frequency and duty cycles to keep initial T<sub>J</sub>=25°C.

D. The R<sub>θJA</sub> is the sum of the thermal impedance from junction to case R<sub>θJC</sub> and case to ambient.

E. The static characteristics in Figures 1 to 6 are obtained using <300 μs pulses, duty cycle 0.5% max.

F. These curves are based on the junction-to-case thermal impedance which is measured with the device mounted to a large heatsink, assuming a maximum junction temperature of T<sub>J(MAX)=150°C</sub>. The SOA curve provides a single pulse rating.

G. These tests are performed with the device mounted on 1 in<sup>2</sup> FR-4 board with 2oz. Copper, in a still air environment with T<sub>A</sub>=25°C.

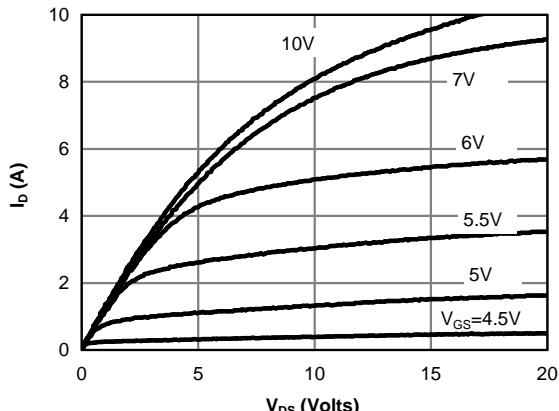
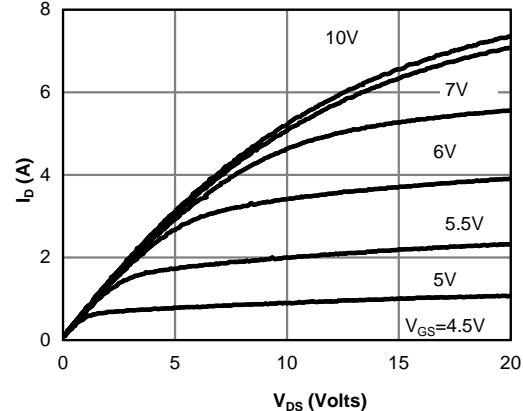
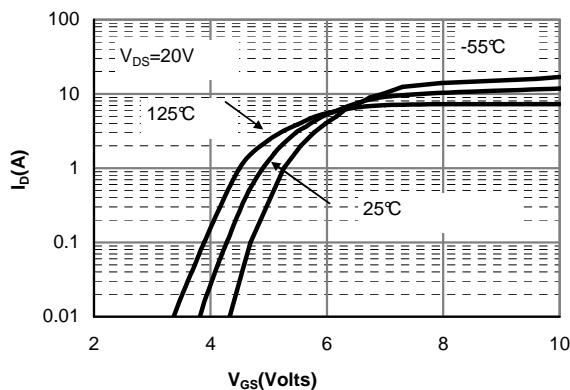
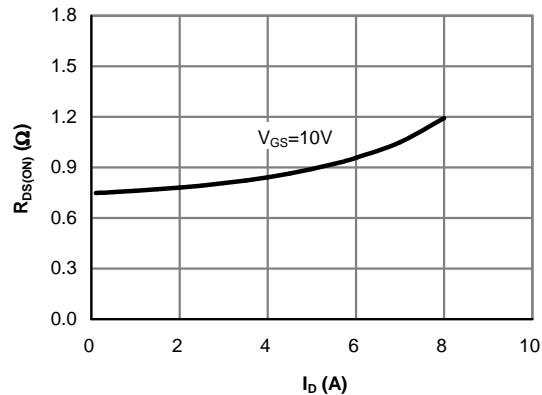
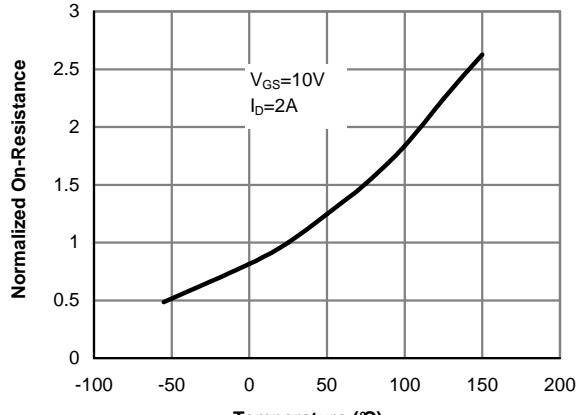
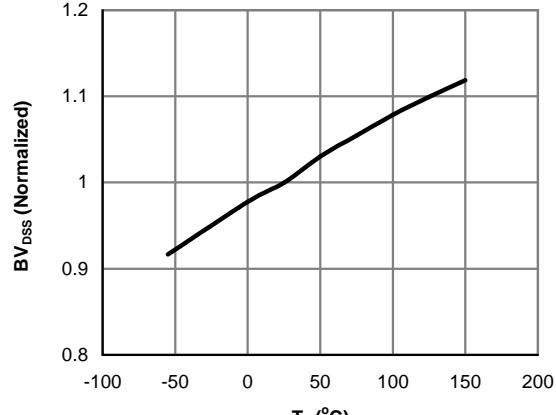
H. L=60mH, I<sub>AS</sub>=1.6A, V<sub>DD</sub>=150V, Starting T<sub>J</sub>=25°C

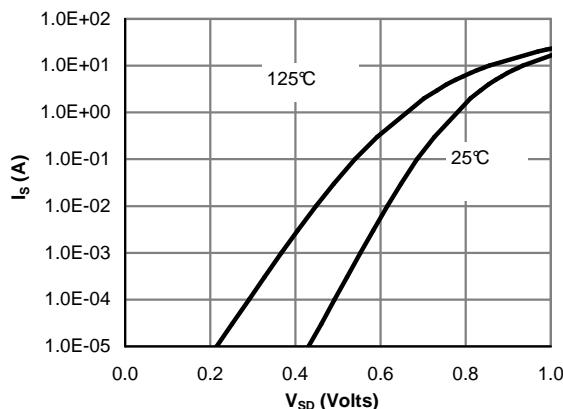
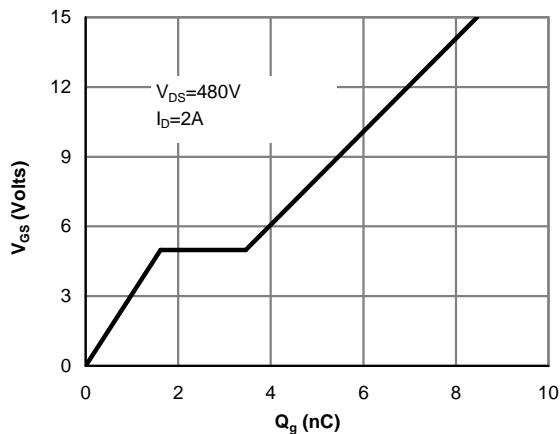
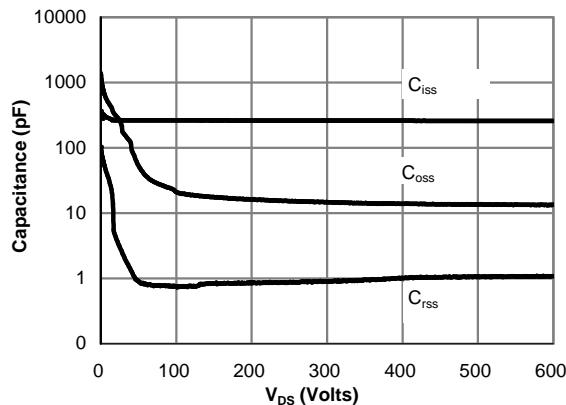
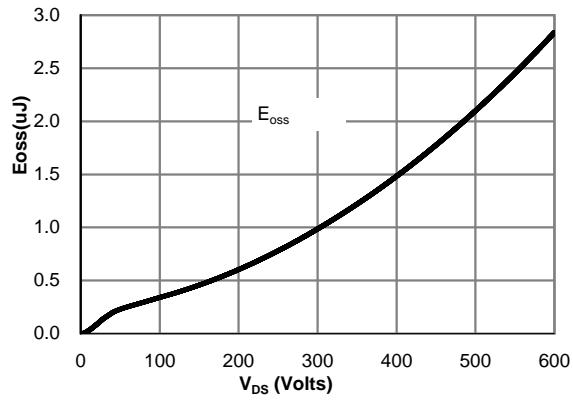
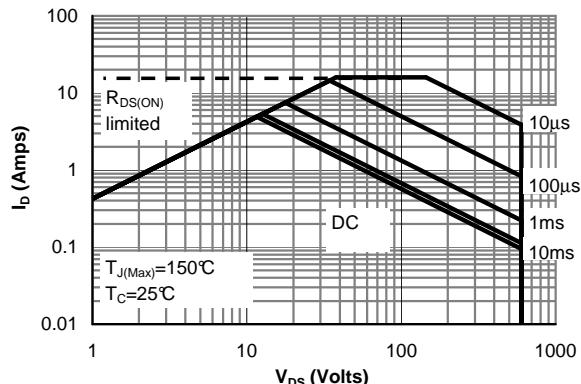
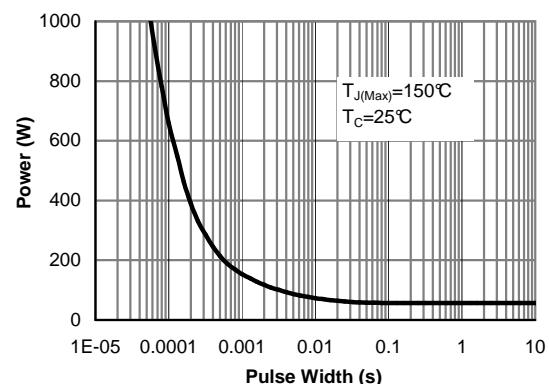
I. C<sub>o(er)</sub> is a fixed capacitance that gives the same stored energy as C<sub>oss</sub> while V<sub>DS</sub> is rising from 0 to 80% V<sub>(BR)DSS</sub>.

J. C<sub>o(tr)</sub> is a fixed capacitance that gives the same charging time as C<sub>oss</sub> while V<sub>DS</sub> is rising from 0 to 80% V<sub>(BR)DSS</sub>.

K. Wave soldering only allowed at leads.

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**TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS**

**Figure 1: On-Region Characteristics@25°C**

**Figure 2: On-Region Characteristics@125°C**

**Figure 3: Transfer Characteristics**

**Figure 4: On-Resistance vs. Drain Current and Gate Voltage**

**Figure 5: On-Resistance vs. Junction Temperature**

**Figure 6: Break Down vs. Junction Temperature**

**TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS**

**Figure 7: Body-Diode Characteristics (Note E)**

**Figure 8: Gate-Charge Characteristics**

**Figure 9: Capacitance Characteristics**

**Figure 10: Coss stored Energy**

**Figure 11: Maximum Forward Biased Safe Operating Area (Note F)**

**Figure 12: Single Pulse Power Rating Junction-to-Case (Note F)**

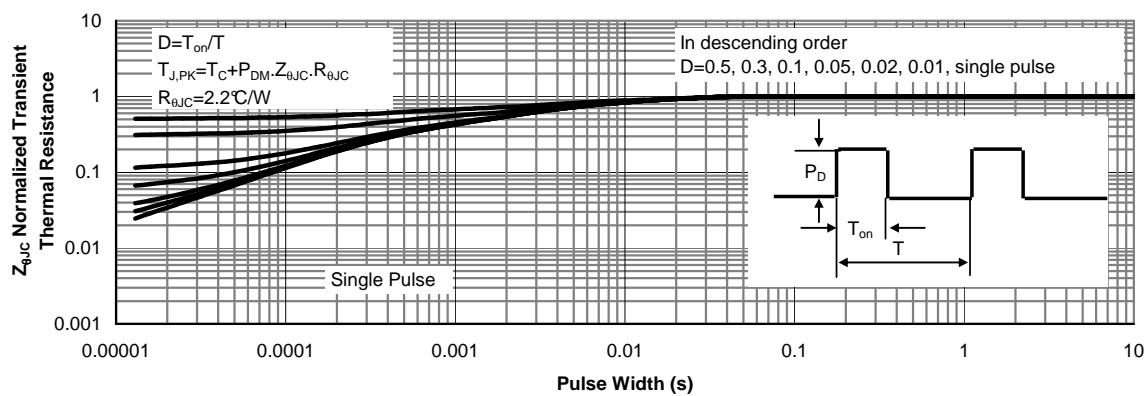
**TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS**


Figure 13: Normalized Maximum Transient Thermal Impedance (Note F)

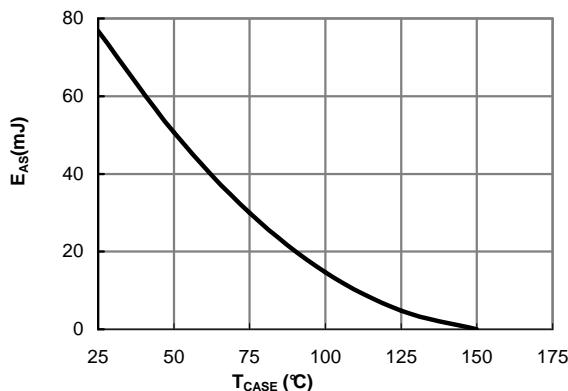


Figure 14: Avalanche energy

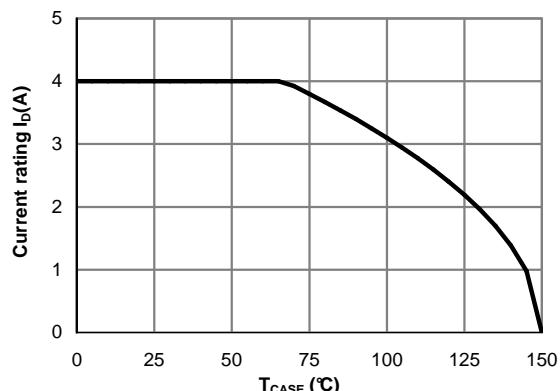


Figure 15: Current De-rating (Note B)

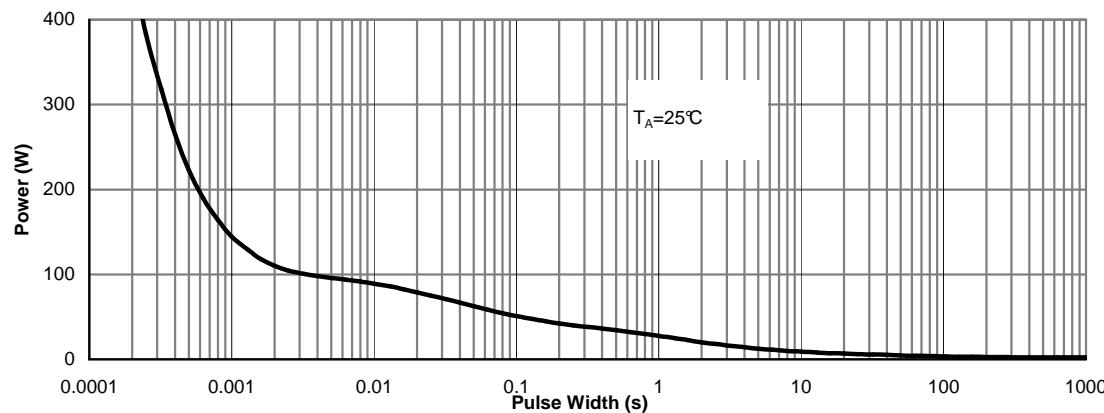
**TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS**


Figure 16: Single Pulse Power Rating Junction-to-Ambient (Note G)

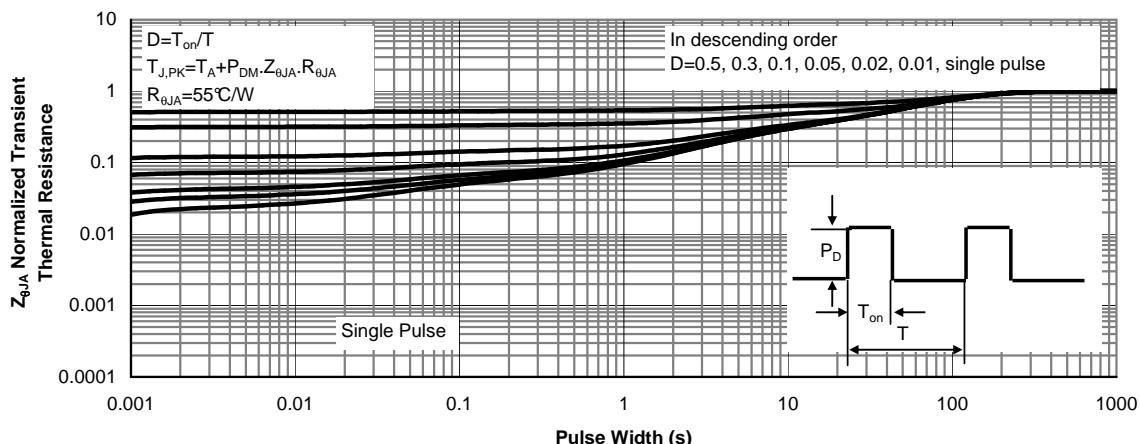
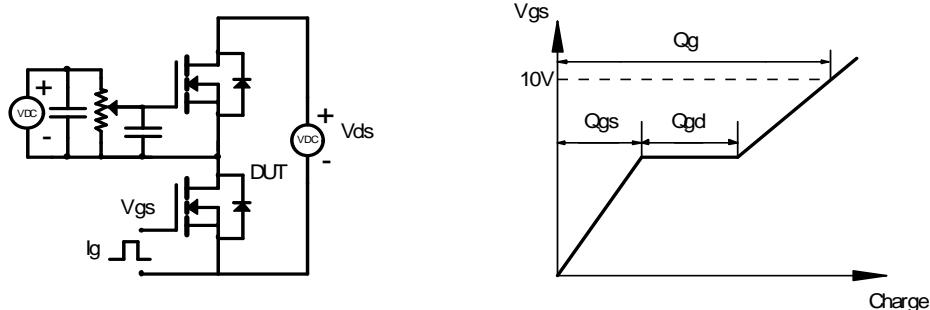
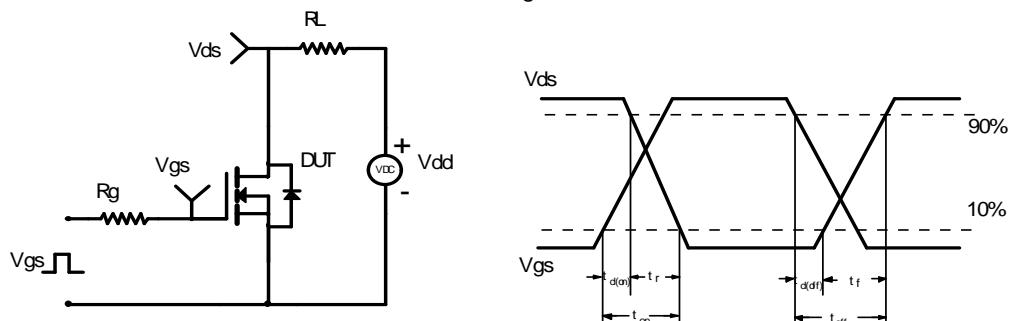
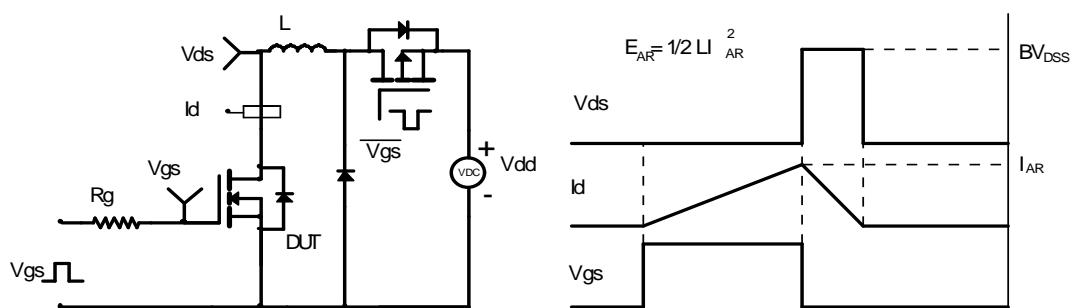


Figure 17: Normalized Maximum Transient Thermal Impedance (Note G)

**Gate Charge Test Circuit & Waveform**

**Resistive Switching Test Circuit & Waveforms**

**Unclamped Inductive Switching (UIS) Test Circuit & Waveforms**

**Diode Recovery Test Circuit & Waveforms**
