

AO4612

60V Complementary Enhancement Mode Field Effect Transistor

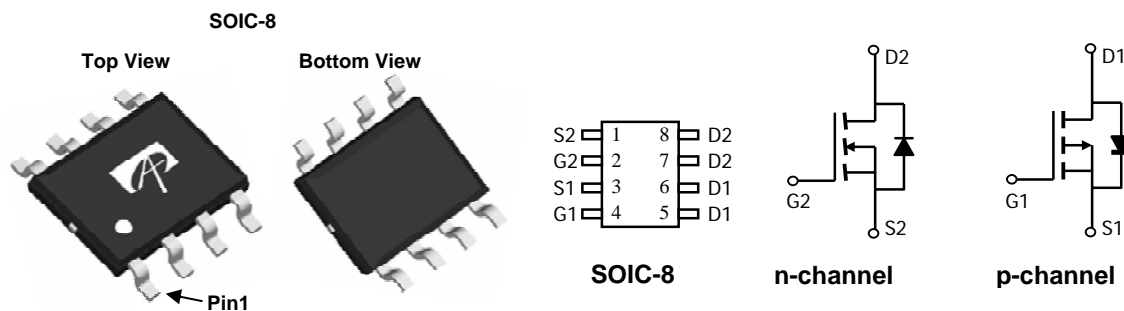
General Description

The AO4612 uses advanced trench technology MOSFETs to provide excellent $R_{DS(ON)}$ and low gate charge. The complementary MOSFETs may be used in H-bridge, Inverters and other applications.

Features

| | |
|----------------------------------|--------------------------------------|
| n-channel | p-channel |
| V_{DS} (V) = 60V | -60V |
| I_D = 4.5A ($V_{GS}=10V$) | -3.2A ($V_{GS} = -10V$) |
| $R_{DS(ON)}$ | $R_{DS(ON)}$ |
| < 56m Ω ($V_{GS}=10V$) | < 105m Ω ($V_{GS} = -10V$) |
| < 77m Ω ($V_{GS}=4.5V$) | < 135m Ω ($V_{GS} = -4.5V$) |

100% Rg tested



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

| Parameter | Symbol | Max n-channel | Max p-channel | Units |
|--|----------------|------------------------|---------------|------------------|
| Drain-Source Voltage | V_{DS} | 60 | -60 | V |
| Gate-Source Voltage | V_{GS} | ± 20 | ± 20 | V |
| Continuous Drain Current ^A | I_D | $T_A=25^\circ\text{C}$ | 4.5 | -3.2 |
| | | $T_A=70^\circ\text{C}$ | 3.6 | -2.6 |
| Pulsed Drain Current ^B | I_{DM} | 20 | -20 | A |
| Power Dissipation | P_D | $T_A=25^\circ\text{C}$ | 2 | 2 |
| | | $T_A=70^\circ\text{C}$ | 1.28 | 1.28 |
| Junction and Storage Temperature Range | T_J, T_{STG} | -55 to 150 | -55 to 150 | $^\circ\text{C}$ |

Thermal Characteristics: n-channel and p-channel

| Parameter | Symbol | Typ | Max | Units |
|--|-----------------|-----|------|--------------------|
| Maximum Junction-to-Ambient ^A $t \leq 10\text{s}$ | $R_{\theta JA}$ | 48 | 62.5 | $^\circ\text{C/W}$ |
| Maximum Junction-to-Ambient ^A Steady-State | | 74 | 90 | $^\circ\text{C/W}$ |
| Maximum Junction-to-Lead ^C Steady-State | $R_{\theta JL}$ | 35 | 40 | $^\circ\text{C/W}$ |

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

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|-----------------------------|---------------------------------------|---|-----|----------|--------|---------------|
| STATIC PARAMETERS | | | | | | |
| BV_{DSS} | Drain-Source Breakdown Voltage | $I_D=250\mu\text{A}, V_{GS}=0\text{V}$ | 60 | | | V |
| I_{DSS} | Zero Gate Voltage Drain Current | $V_{DS}=48\text{V}, V_{GS}=0\text{V}$ $T_J=55^\circ\text{C}$ | | | 1 5 | μA |
| I_{GSS} | Gate-Body leakage current | $V_{DS}=0\text{V}, V_{GS}=\pm 20\text{V}$ | | | 100 | nA |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{DS}=V_{GS}, I_D=250\mu\text{A}$ | 1 | 2.1 | 3 | V |
| $I_{D(ON)}$ | On state drain current | $V_{GS}=10\text{V}, V_{DS}=5\text{V}$ | 20 | | | A |
| $R_{DS(ON)}$ | Static Drain-Source On-Resistance | $V_{GS}=10\text{V}, I_D=4.5\text{A}$ $T_J=125^\circ\text{C}$ | | 46 79 | 56 | m Ω |
| | | $V_{GS}=4.5\text{V}, I_D=3\text{A}$ | | 64 | 77 | m Ω |
| g_{FS} | Forward Transconductance | $V_{DS}=5\text{V}, I_D=4.5\text{A}$ | | 11 | | S |
| V_{SD} | Diode Forward Voltage | $I_S=1\text{A}, V_{GS}=0\text{V}$ | | 0.74 | 1 | V |
| I_S | Maximum Body-Diode Continuous Current | | | | 3 | A |
| DYNAMIC PARAMETERS | | | | | | |
| C_{iss} | Input Capacitance | $V_{GS}=0\text{V}, V_{DS}=30\text{V}, f=1\text{MHz}$ | | 450 | 540 | pF |
| C_{oss} | Output Capacitance | | | 60 | | pF |
| C_{rss} | Reverse Transfer Capacitance | | | 25 | | pF |
| R_g | Gate resistance | $V_{GS}=0\text{V}, V_{DS}=0\text{V}, f=1\text{MHz}$ | | 1.65 | 2 | Ω |
| SWITCHING PARAMETERS | | | | | | |
| $Q_g(10\text{V})$ | Total Gate Charge | $V_{GS}=10\text{V}, V_{DS}=30\text{V}, I_D=4.5\text{A}$ | | 8.5 | 10.5 | nC |
| $Q_g(4.5\text{V})$ | Total Gate Charge | | | 4.3 | 5.5 | nC |
| Q_{gs} | Gate Source Charge | | | 1.6 | | nC |
| Q_{gd} | Gate Drain Charge | | | 2.2 | | nC |
| $t_{D(on)}$ | Turn-On Delay Time | $V_{GS}=10\text{V}, V_{DS}=30\text{V}, R_L=6.7\Omega,$ $R_{GEN}=3\Omega$ | | 4.7 | 7 | ns |
| t_r | Turn-On Rise Time | | | 2.3 | 4.5 | ns |
| $t_{D(off)}$ | Turn-Off Delay Time | | | 15.7 | 24 | ns |
| t_f | Turn-Off Fall Time | | | 1.9 | 4 | ns |
| t_{rr} | Body Diode Reverse Recovery Time | $I_F=4.5\text{A}, dl/dt=100\text{A}/\mu\text{s}$ | | 27.5 | 35 | ns |
| Q_{rr} | Body Diode Reverse Recovery Charge | $I_F=4.5\text{A}, dl/dt=100\text{A}/\mu\text{s}$ | | 32 | | nC |

A: The value of $R_{\theta JA}$ is measured with the device mounted on 1 in² FR-4 board with 2oz. Copper, in a still air environment with $T_A=25^\circ\text{C}$. The value in any a given application depends on the user's specific board design. The current rating is based on the $t \leq 10\text{s}$ thermal resistance rating.

B: Repetitive rating, pulse width limited by junction temperature.

C: The $R_{\theta JA}$ is the sum of the thermal impedance from junction to lead $R_{\theta JL}$ and lead to ambient.

D: The static characteristics in Figures 1 to 6 are obtained using 80 μs pulses, duty cycle 0.5% max.

E: These tests are performed with the device mounted on 1 in² FR-4 board with 2oz. Copper, in a still air environment with $T_A=25^\circ\text{C}$. The SOA curve provides a single pulse rating. Rev3: Oct 2010

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TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS: N-CHANNEL

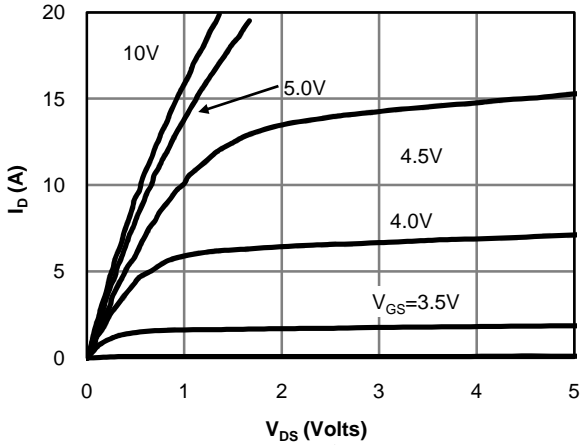


Fig 1: On-Region Characteristics

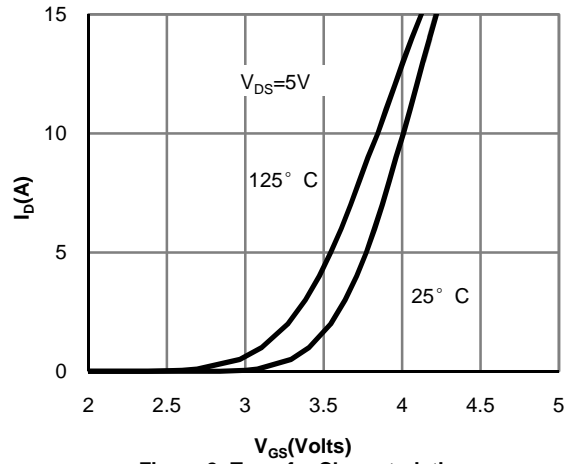


Figure 2: Transfer Characteristics

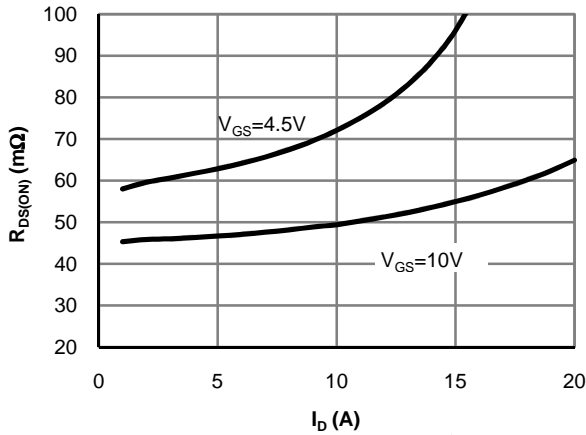


Figure 3: On-Resistance vs. Drain Current and Gate Voltage

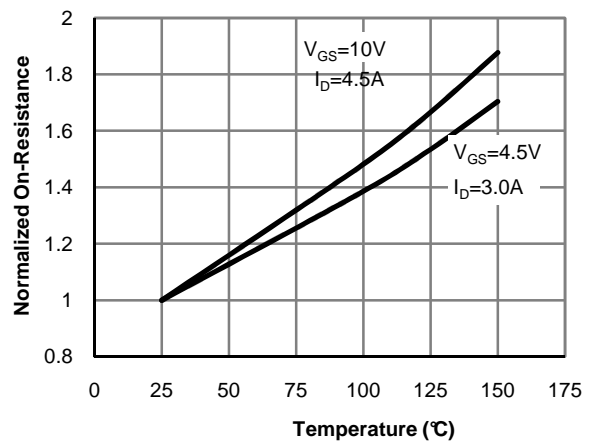


Figure 4: On-Resistance vs. Junction Temperature

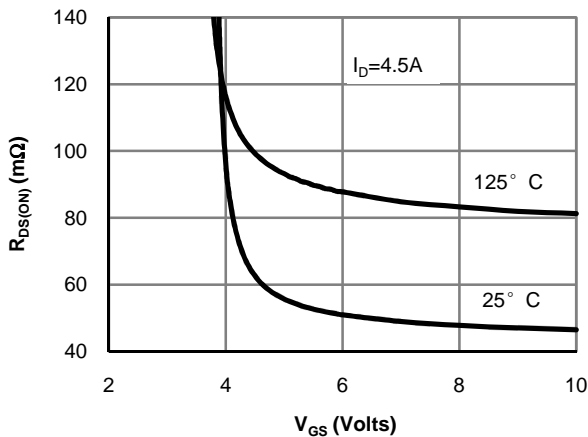


Figure 5: On-Resistance vs. Gate-Source Voltage

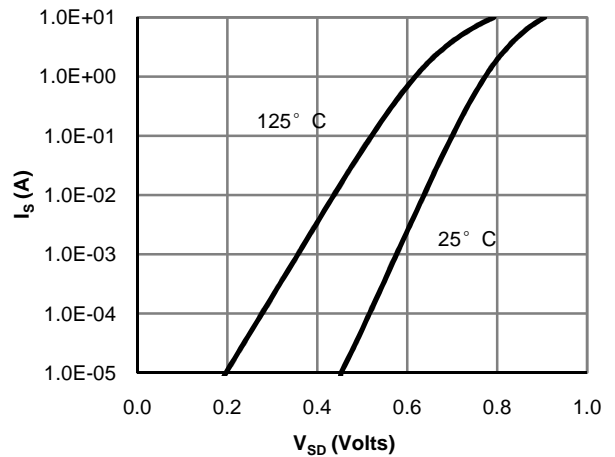


Figure 6: Body-Diode Characteristics

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS: N-CHANNEL

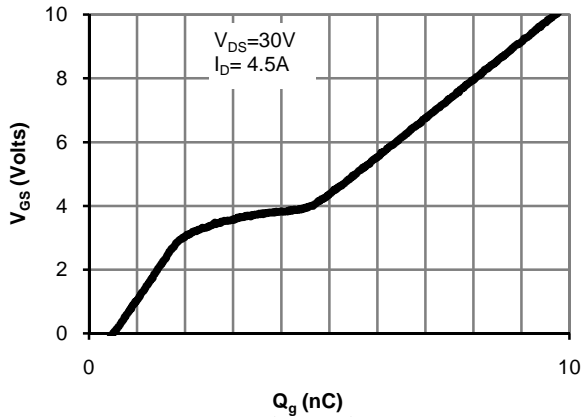


Figure 7: Gate-Charge Characteristics

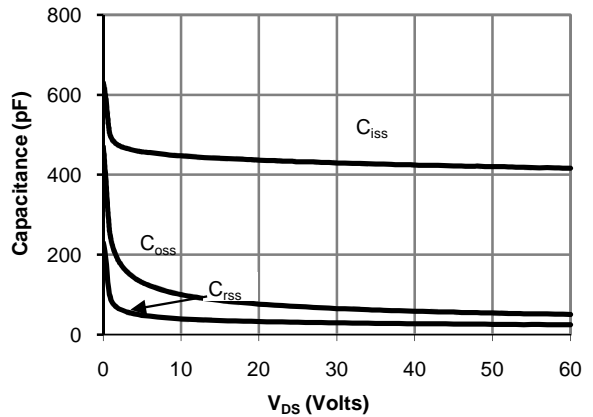


Figure 8: Capacitance Characteristics

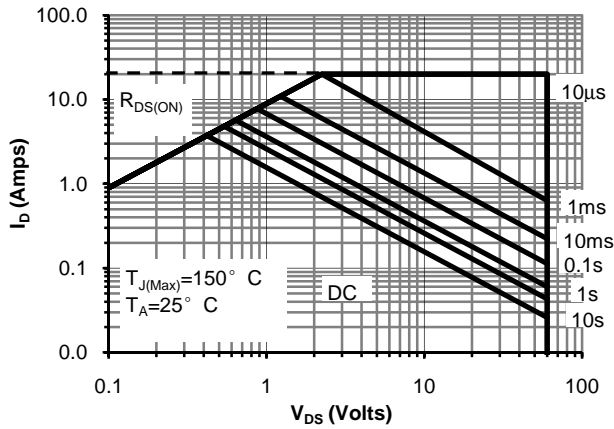


Figure 9: Maximum Forward Biased Safe Operating Area (Note E)

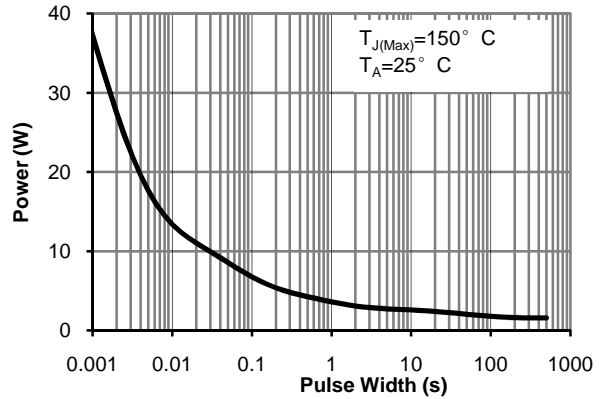


Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note E)

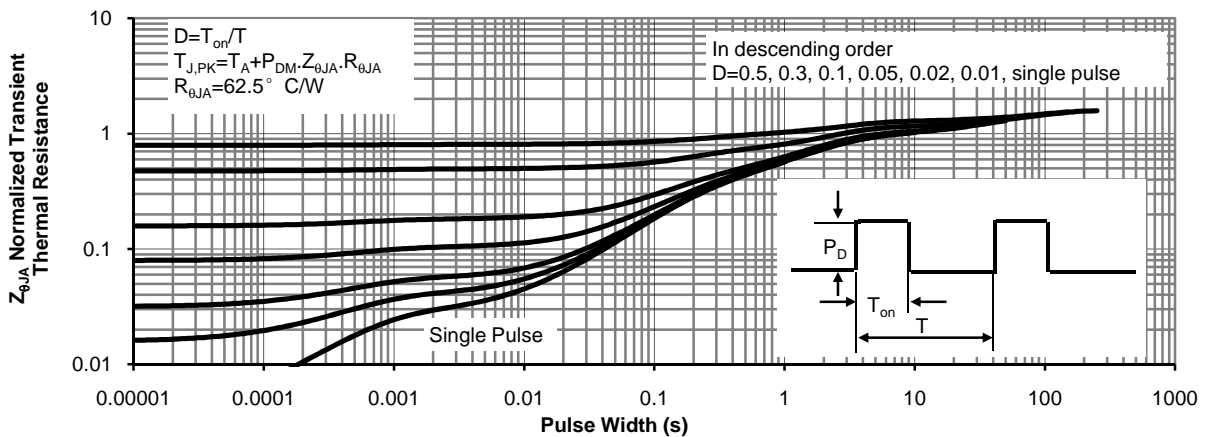
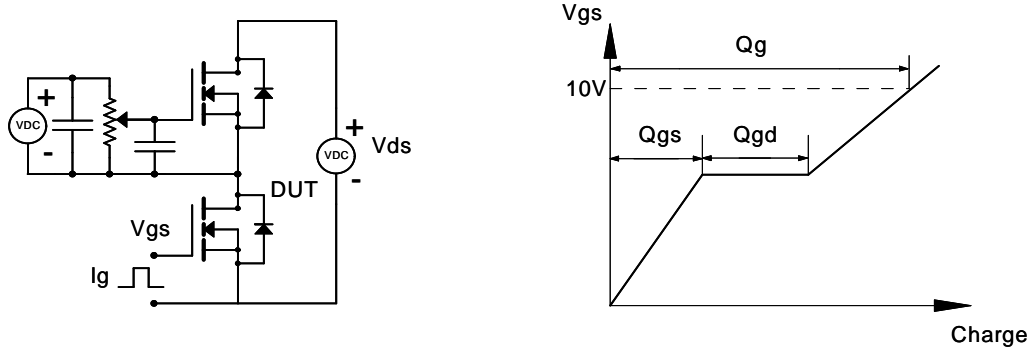
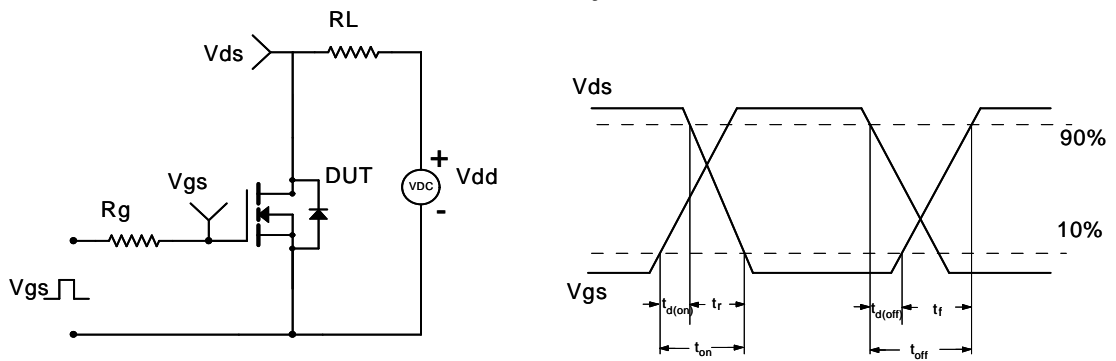


Figure 11: Normalized Maximum Transient Thermal Impedance

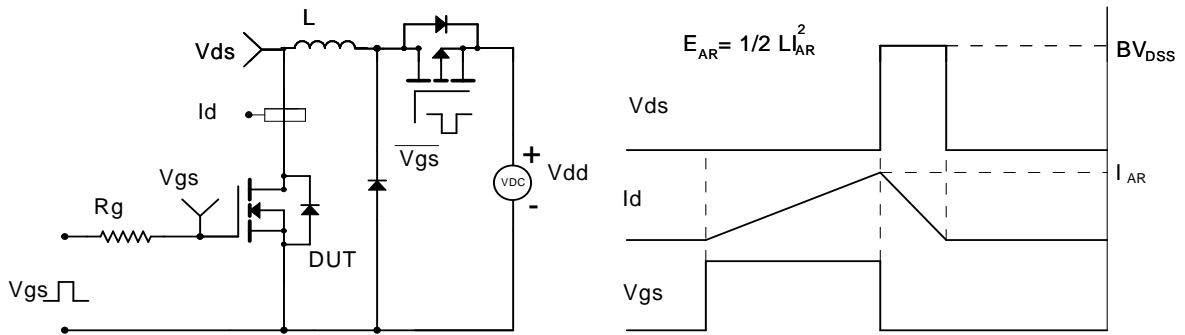
Gate Charge Test Circuit & Waveform



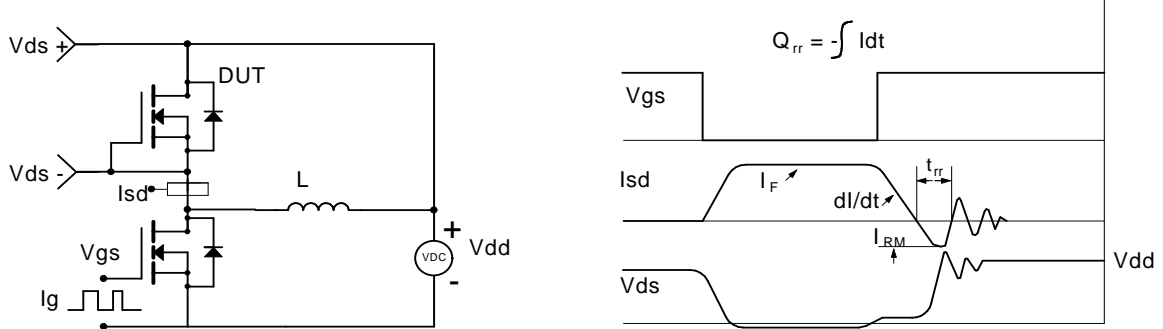
Resistive Switching Test Circuit & Waveforms



Unclamped Inductive Switching (UIS) Test Circuit & Waveforms



Diode Recovery Test Circuit & Waveforms



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

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|-----------------------------|---------------------------------------|--|--|-------|-----------|---------------|
| STATIC PARAMETERS | | | | | | |
| BV_{DSS} | Drain-Source Breakdown Voltage | $I_D=-250\mu\text{A}$, $V_{GS}=0\text{V}$ | -60 | | | V |
| I_{DSS} | Zero Gate Voltage Drain Current | $V_{DS}=-48\text{V}$, $V_{GS}=0\text{V}$ | | | -1 | μA |
| | | $T_J=55^\circ\text{C}$ | | | -5 | |
| I_{GSS} | Gate-Body leakage current | $V_{DS}=0\text{V}$, $V_{GS}=\pm 20\text{V}$ | | | ± 100 | nA |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{DS}=V_{GS}$, $I_D=-250\mu\text{A}$ | -1 | -2.1 | -3 | V |
| $I_{D(ON)}$ | On state drain current | $V_{GS}=-10\text{V}$, $V_{DS}=-5\text{V}$ | -20 | | | A |
| $R_{DS(ON)}$ | Static Drain-Source On-Resistance | $V_{GS}=-10\text{V}$, $I_D=-3.2\text{A}$ | | 84 | 105 | m Ω |
| | | $T_J=125^\circ\text{C}$ | | 145 | | |
| | | $V_{GS}=-4.5\text{V}$, $I_D=-2.8\text{A}$ | | 106 | 135 | m Ω |
| g_{FS} | Forward Transconductance | $V_{DS}=-5\text{V}$, $I_D=-3.2\text{A}$ | | 9 | | S |
| V_{SD} | Diode Forward Voltage | $I_S=-1\text{A}$, $V_{GS}=0\text{V}$ | | -0.73 | -1 | V |
| I_S | Maximum Body-Diode Continuous Current | | | | -3 | A |
| DYNAMIC PARAMETERS | | | | | | |
| C_{iss} | Input Capacitance | $V_{GS}=0\text{V}$, $V_{DS}=-30\text{V}$, $f=1\text{MHz}$ | | 930 | 1120 | pF |
| C_{oss} | Output Capacitance | | | 85 | | pF |
| C_{rss} | Reverse Transfer Capacitance | | | 35 | | pF |
| R_g | Gate resistance | $V_{GS}=0\text{V}$, $V_{DS}=0\text{V}$, $f=1\text{MHz}$ | | 7.2 | 9 | Ω |
| SWITCHING PARAMETERS | | | | | | |
| $Q_g(10\text{V})$ | Total Gate Charge (10V) | $V_{GS}=-10\text{V}$, $V_{DS}=-30\text{V}$, $I_D=-3.2\text{A}$ | | 16 | 20 | nC |
| $Q_g(4.5\text{V})$ | Total Gate Charge (4.5V) | | | 8 | 10 | nC |
| Q_{gs} | Gate Source Charge | | | 2.5 | | nC |
| Q_{gd} | Gate Drain Charge | | | 3.2 | | nC |
| $t_{D(on)}$ | Turn-On Delay Time | $V_{GS}=-10\text{V}$, $V_{DS}=-30\text{V}$, $R_L=9.4\Omega$, $R_{GEN}=3\Omega$ | | 8 | 12 | ns |
| t_r | Turn-On Rise Time | | | 3.8 | 7.5 | ns |
| $t_{D(off)}$ | Turn-Off Delay Time | | | 31.5 | 48 | ns |
| t_f | Turn-Off Fall Time | | | 7.5 | 15 | ns |
| t_{rr} | Body Diode Reverse Recovery Time | | $I_F=-3.2\text{A}$, $dI/dt=100\text{A}/\mu\text{s}$ | | 27 | 35 |
| Q_{rr} | Body Diode Reverse Recovery Charge | $I_F=-3.2\text{A}$, $dI/dt=100\text{A}/\mu\text{s}$ | | 32 | | nC |

A: The value of $R_{\theta JA}$ is measured with the device mounted on 1in² FR-4 board with 2oz. Copper, in a still air environment with $T_A=25^\circ\text{C}$. The value in any a given application depends on the user's specific board design. The current rating is based on the $t \leq 10\text{s}$ thermal resistance rating.

B: Repetitive rating, pulse width limited by junction temperature.

C: The $R_{\theta JA}$ is the sum of the thermal impedance from junction to lead $R_{\theta JL}$ and lead to ambient.

D: The static characteristics in Figures 1 to 6,12,14 are obtained using 80 μs pulses, duty cycle 0.5% max.

E: These tests are performed with the device mounted on 1 in² FR-4 board with 2oz. Copper, in a still air environment with $T_A=25^\circ\text{C}$. The SOA curve provides a single pulse rating.

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TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS: P-CHANNEL

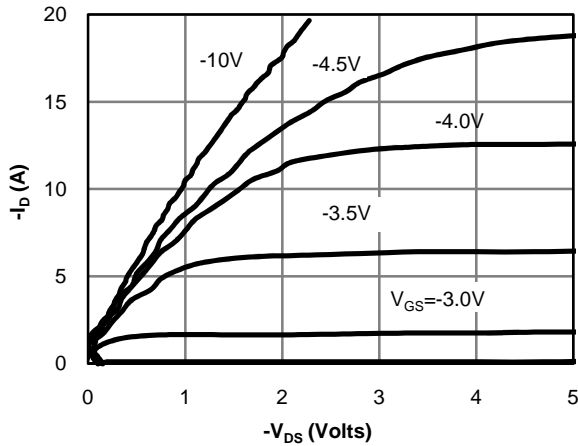


Fig 1: On-Region Characteristics

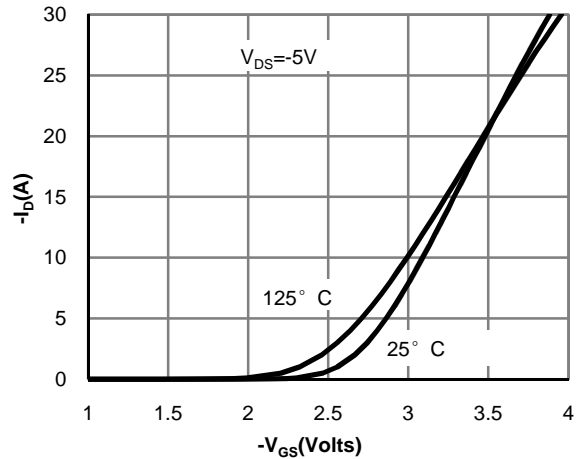


Figure 2: Transfer Characteristics

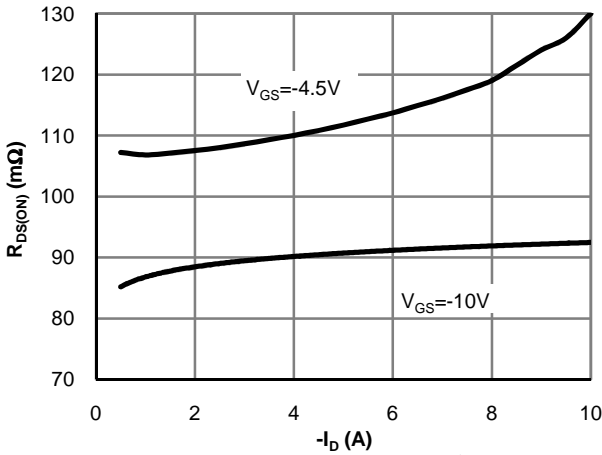


Figure 3: On-Resistance vs. Drain Current and Gate Voltage

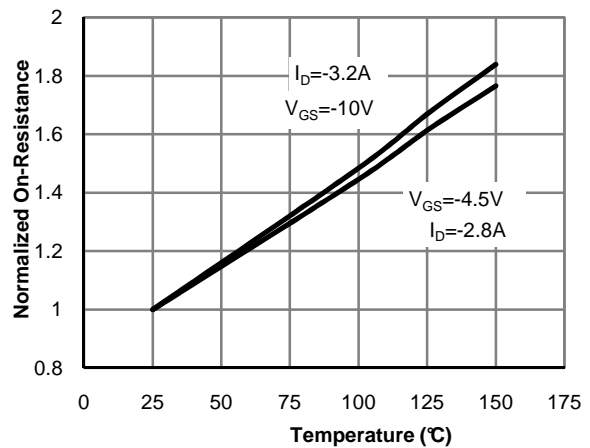


Figure 4: On-Resistance vs. Junction Temperature

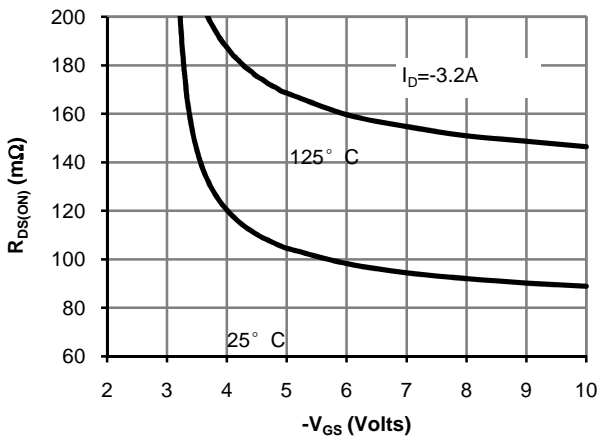


Figure 5: On-Resistance vs. Gate-Source Voltage

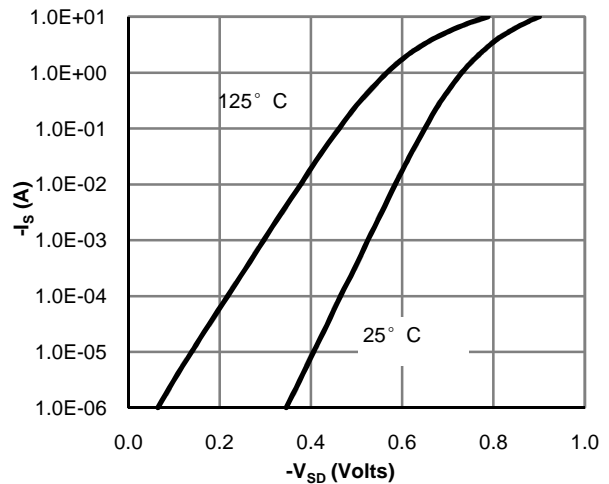


Figure 6: Body-Diode Characteristics

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS: P-CHANNEL

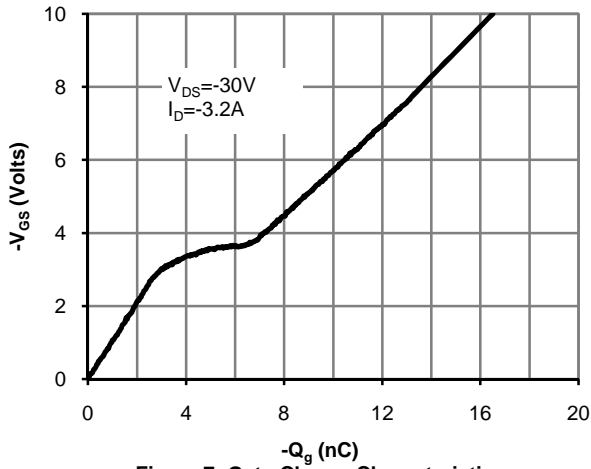


Figure 7: Gate-Charge Characteristics

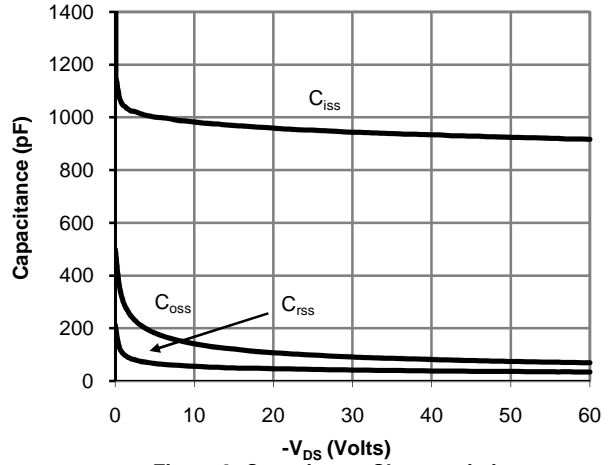


Figure 8: Capacitance Characteristics

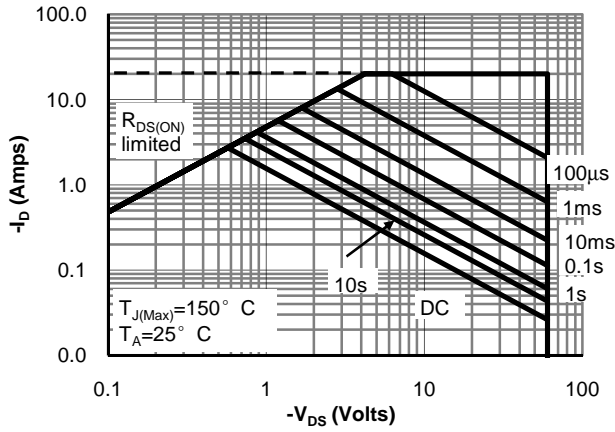


Figure 9: Maximum Forward Biased Safe Operating Area (Note E)

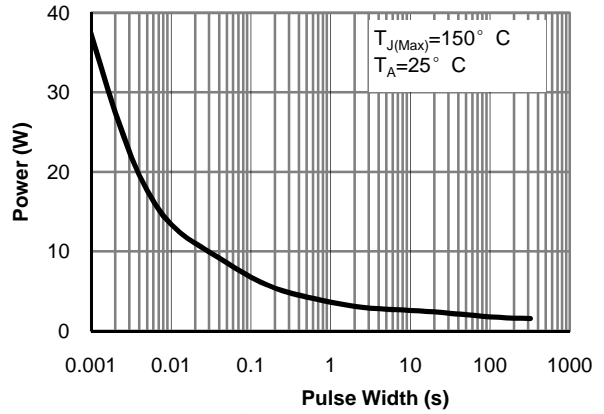


Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note E)

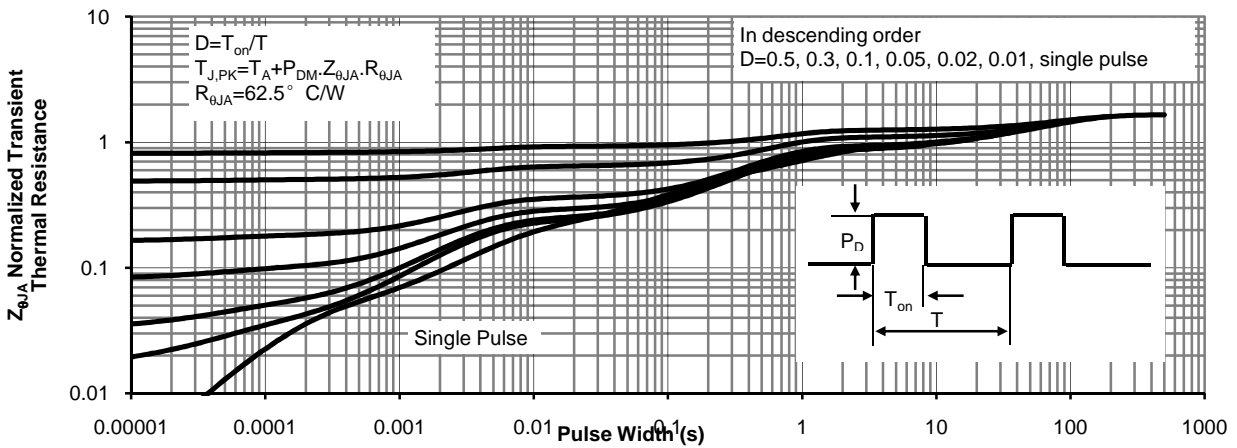
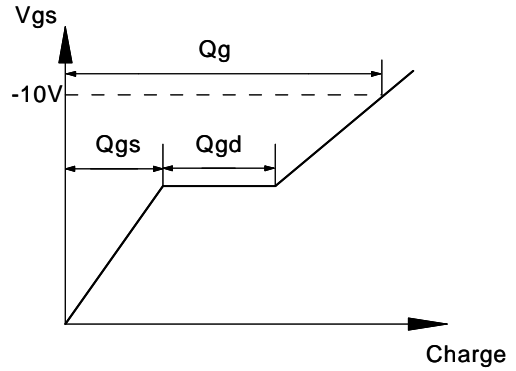
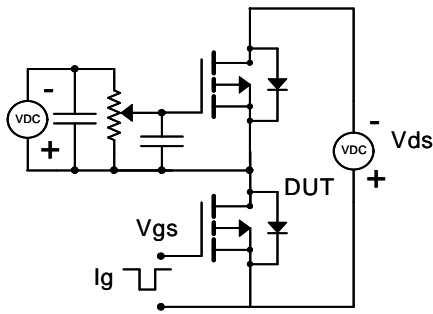
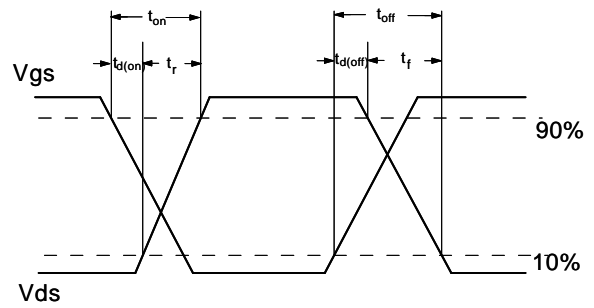
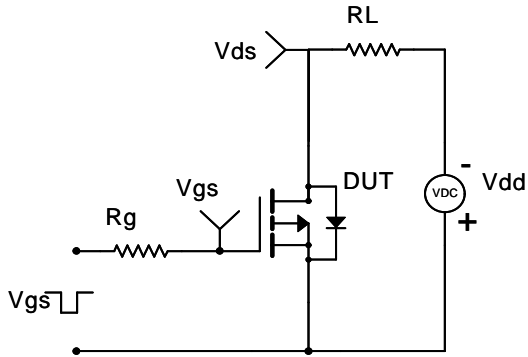


Figure 11: Normalized Maximum Transient Thermal Impedance

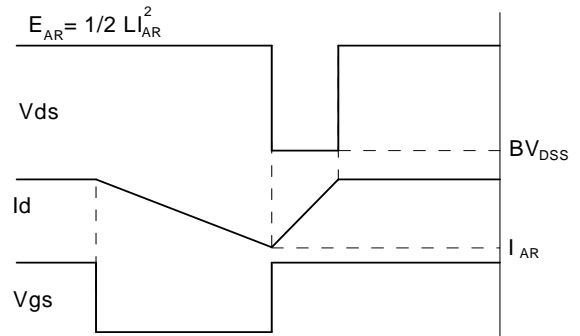
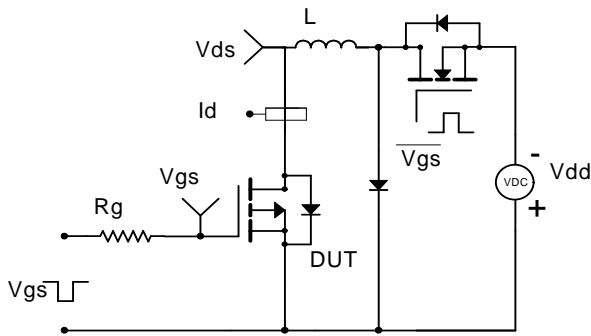
Gate Charge Test Circuit & Waveform



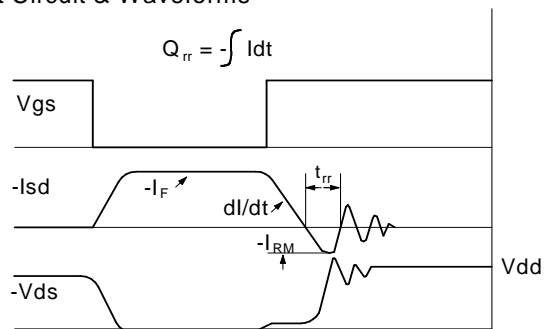
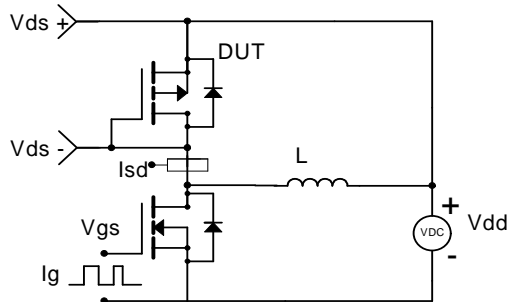
Resistive Switching Test Circuit & Waveforms



Unclamped Inductive Switching (UIS) Test Circuit & Waveforms



Diode Recovery Test Circuit & Waveforms



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