



# THE DATASHEET OF AO6604





**General Description**

The AO6604 combines advanced trench MOSFET technology with a low resistance package to provide extremely low  $R_{DS(ON)}$ . This device is ideal for load switch and battery protection applications.

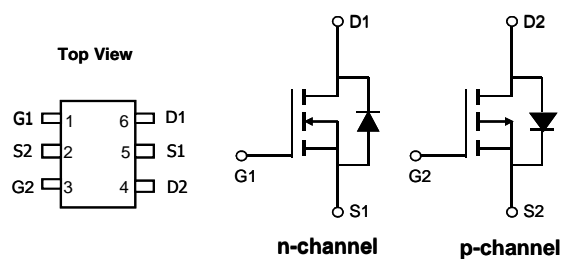
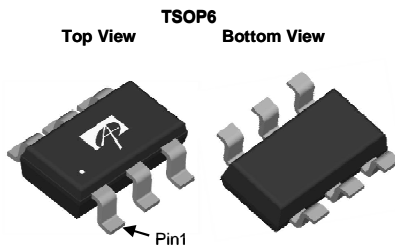
**Product Summary**

**N-Channel**

$V_{DS} = 20V$   
 $I_D = 3.4A$  ( $V_{GS} = 4.5V$ )  
 $R_{DS(ON)} < 65m\Omega$  ( $V_{GS} = 4.5V$ )  
 $< 75m\Omega$  ( $V_{GS} = 2.5V$ )  
 $< 100m\Omega$  ( $V_{GS} = 1.8V$ )

**P-Channel**

$-20V$   
 $-2.5A$  ( $V_{GS} = -4.5V$ )  
 $R_{DS(ON)} < 75m\Omega$  ( $V_{GS} = -4.5V$ )  
 $< 95m\Omega$  ( $V_{GS} = -2.5V$ )  
 $< 115m\Omega$  ( $V_{GS} = -1.8V$ )



**Absolute Maximum Ratings  $T_A = 25^\circ C$  unless otherwise noted**

Parameter	Symbol	Max n-channel	Max p-channel	Units
Drain-Source Voltage	$V_{DS}$	20	-20	V
Gate-Source Voltage	$V_{GS}$	$\pm 8$	$\pm 8$	V
Continuous Drain Current	$I_D$	$T_A = 25^\circ C$	3.4	-2.5
		$T_A = 70^\circ C$	2.5	-2
Pulsed Drain Current <sup>C</sup>	$I_{DM}$	13	-13	A
Power Dissipation <sup>B</sup>	$P_D$	$T_A = 25^\circ C$	1.1	1.1
		$T_A = 70^\circ C$	0.7	0.7
Junction and Storage Temperature Range	$T_J, T_{STG}$	-55 to 150		$^\circ C$

**Thermal Characteristics**

Parameter	Symbol	Typ	Max	Units
Maximum Junction-to-Ambient <sup>A</sup>	$R_{\theta JA}$	78	110	$^\circ C/W$
Maximum Junction-to-Ambient <sup>A,D</sup>		106	150	$^\circ C/W$
Maximum Junction-to-Lead	$R_{\theta JL}$	64	80	$^\circ C/W$

**N-Channel Electrical Characteristics (T<sub>J</sub>=25°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	20			V
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	V <sub>DS</sub> =20V, V <sub>GS</sub> =0V T <sub>J</sub> =55°C			1 5	μA
I <sub>GSS</sub>	Gate-Body leakage current	V <sub>DS</sub> =0V, V <sub>GS</sub> = ±8V			±100	nA
V <sub>GS(th)</sub>	Gate Threshold Voltage	V <sub>DS</sub> =V <sub>GS</sub> I <sub>D</sub> =250μA	0.4	0.7	1	V
I <sub>D(ON)</sub>	On state drain current	V <sub>GS</sub> =4.5V, V <sub>DS</sub> =5V	13			A
R <sub>DS(ON)</sub>	Static Drain-Source On-Resistance	V <sub>GS</sub> =4.5V, I <sub>D</sub> =3.4A T <sub>J</sub> =125°C		51 68	65 85	mΩ
		V <sub>GS</sub> =2.5V, I <sub>D</sub> =3A		58	75	mΩ
		V <sub>GS</sub> =1.8V, I <sub>D</sub> =2A		68	100	mΩ
g <sub>FS</sub>	Forward Transconductance	V <sub>DS</sub> =5V, I <sub>D</sub> =3.4A		16		S
V <sub>SD</sub>	Diode Forward Voltage	I <sub>S</sub> =1A, V <sub>GS</sub> =0V		0.7	1	V
I <sub>S</sub>	Maximum Body-Diode Continuous Current				1.5	A
<b>DYNAMIC PARAMETERS</b>						
C <sub>iss</sub>	Input Capacitance	V <sub>GS</sub> =0V, V <sub>DS</sub> =10V, f=1MHz	205	260	320	pF
C <sub>oss</sub>	Output Capacitance		33	48	63	pF
C <sub>riss</sub>	Reverse Transfer Capacitance		16	27	38	pF
R <sub>g</sub>	Gate resistance	V <sub>GS</sub> =0V, V <sub>DS</sub> =0V, f=1MHz	1.5	3	4.5	Ω
<b>SWITCHING PARAMETERS</b>						
Q <sub>g(4.5V)</sub>	Total Gate Charge	V <sub>GS</sub> =4.5V, V <sub>DS</sub> =10V, I <sub>D</sub> =3.4A		2.9	3.8	nC
Q <sub>gs</sub>	Gate Source Charge		0.4		nC	
Q <sub>gd</sub>	Gate Drain Charge		0.6		nC	
t <sub>D(on)</sub>	Turn-On DelayTime	V <sub>GS</sub> =5V, V <sub>DS</sub> =10V, R <sub>L</sub> =2.95Ω, R <sub>GEN</sub> =3Ω		2.5		ns
t <sub>r</sub>	Turn-On Rise Time		3.2		ns	
t <sub>D(off)</sub>	Turn-Off DelayTime		21		ns	
t <sub>f</sub>	Turn-Off Fall Time		3		ns	
t <sub>rr</sub>	Body Diode Reverse Recovery Time	I <sub>F</sub> =3.4A, dI/dt=100A/μs		14	19	ns
Q <sub>rr</sub>	Body Diode Reverse Recovery Charge	I <sub>F</sub> =3.4A, dI/dt=100A/μs		3.8		nC

A. The value of R<sub>θJA</sub> is measured with the device mounted on 1in<sup>2</sup> FR-4 board with 2oz. Copper, in a still air environment with T<sub>A</sub>=25° C. The value in any given application depends on the user's specific board design.

B. The power dissipation P<sub>D</sub> is based on T<sub>J(MAX)</sub>=150° C, using ≤ 10s junction-to-ambient thermal resistance.

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

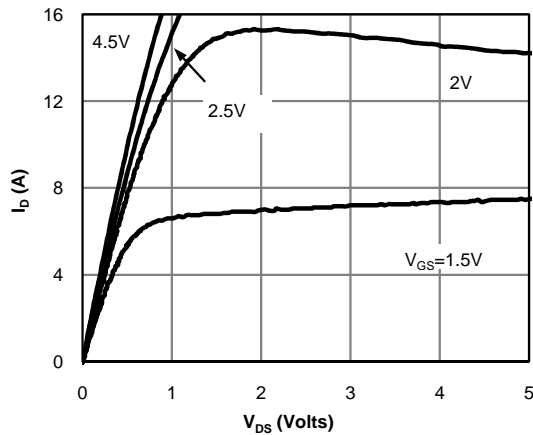
D. The R<sub>θJA</sub> is the sum of the thermal impedance from junction to lead R<sub>θJL</sub> and lead to ambient.

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

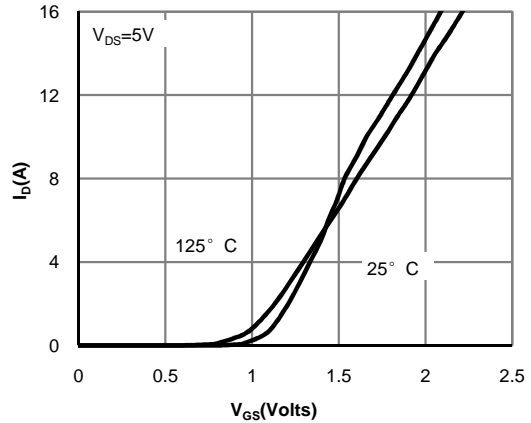
F. These curves are based on the junction-to-ambient thermal impedance which is measured with the device mounted on 1in<sup>2</sup> FR-4 board with 2oz. Copper, assuming a maximum junction temperature of T<sub>J(MAX)</sub>=150° C. The SOA curve provides a single pulse rating.

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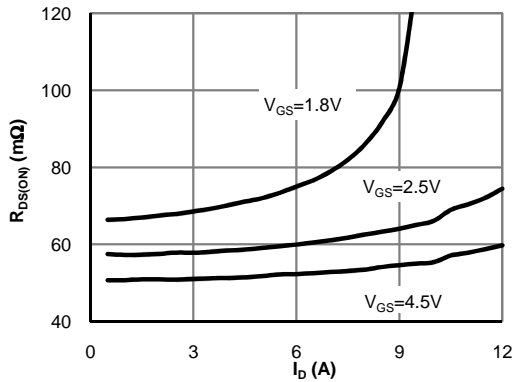
**N-Channel: TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS**



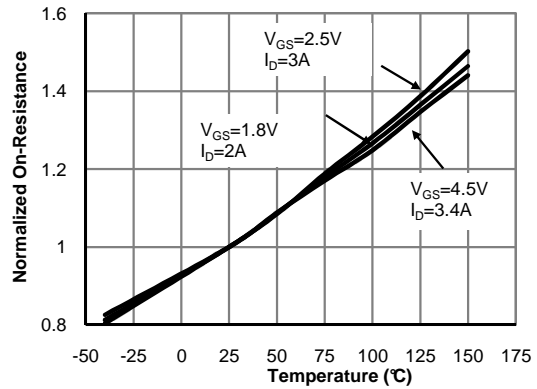
**Fig 1: On-Region Characteristics (Note E)**



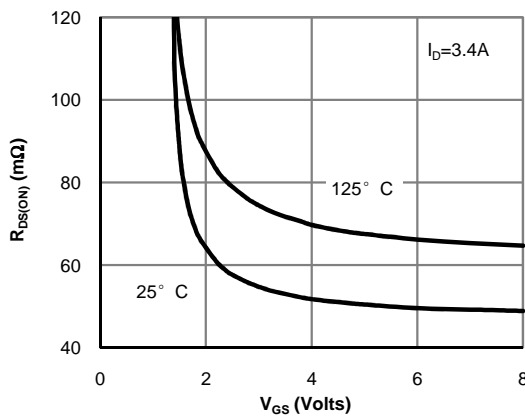
**Figure 2: Transfer Characteristics (Note E)**



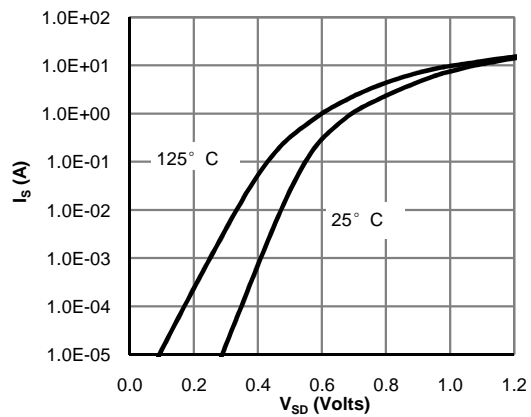
**Figure 3: On-Resistance vs. Drain Current and Gate Voltage (Note E)**



**Figure 4: On-Resistance vs. Junction Temperature (Note E)**

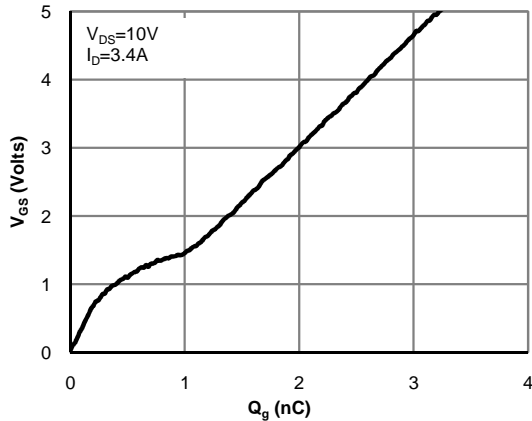


**Figure 5: On-Resistance vs. Gate-Source Voltage (Note E)**

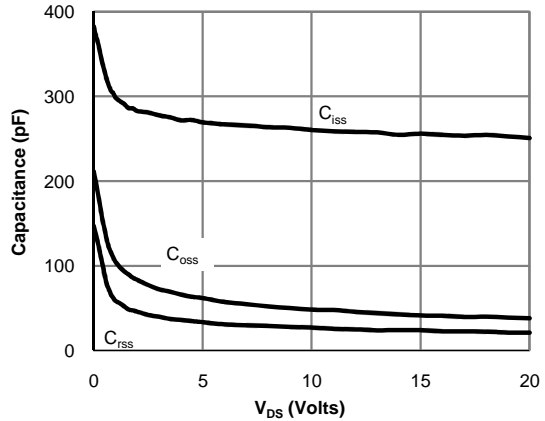


**Figure 6: Body-Diode Characteristics (Note E)**

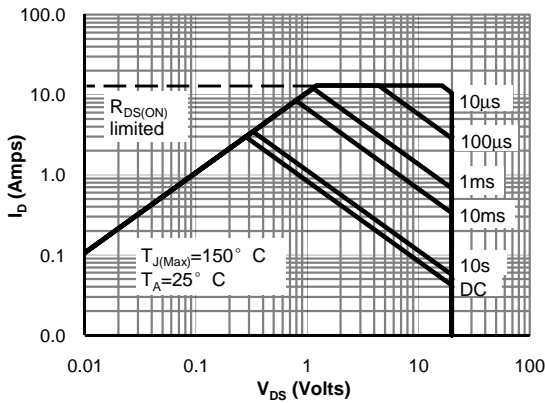
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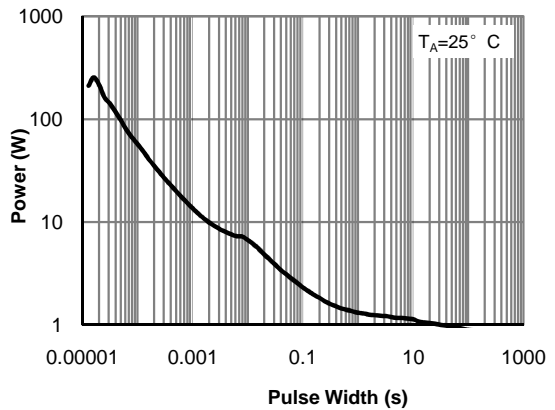
**Figure 7: Gate-Charge Characteristics**



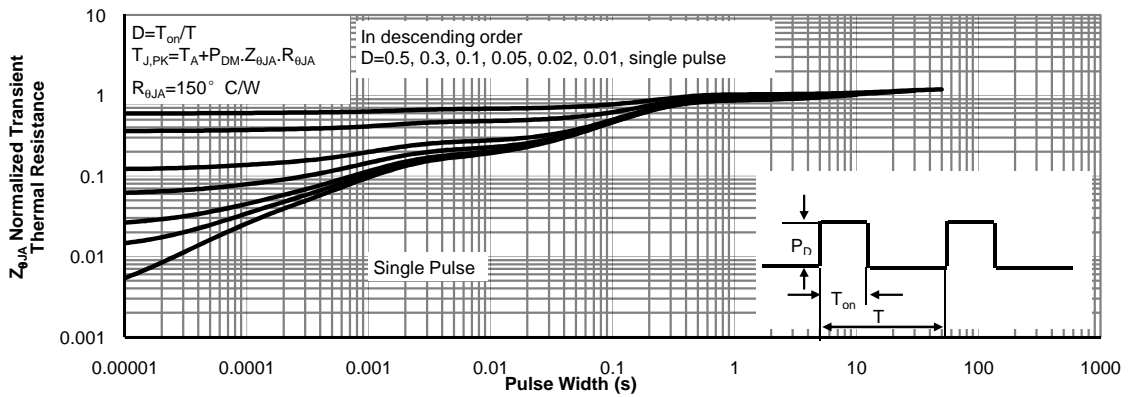
**Figure 8: Capacitance Characteristics**



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

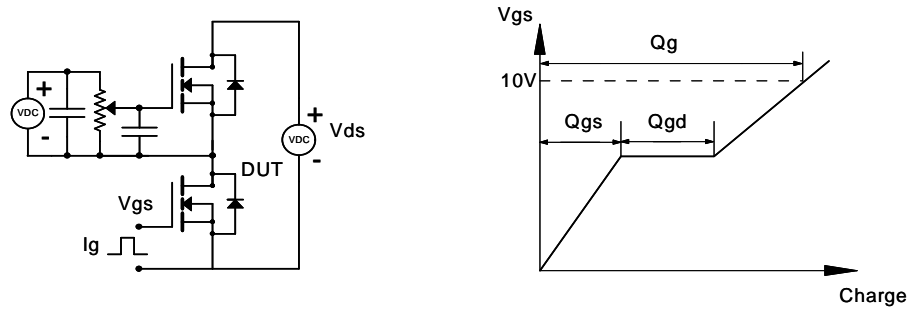


**Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note F)**

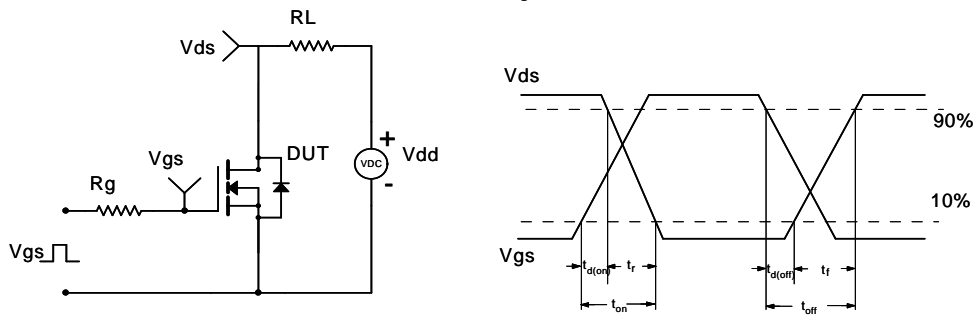


**Figure 11: Normalized Maximum Transient Thermal Impedance (Note F)**

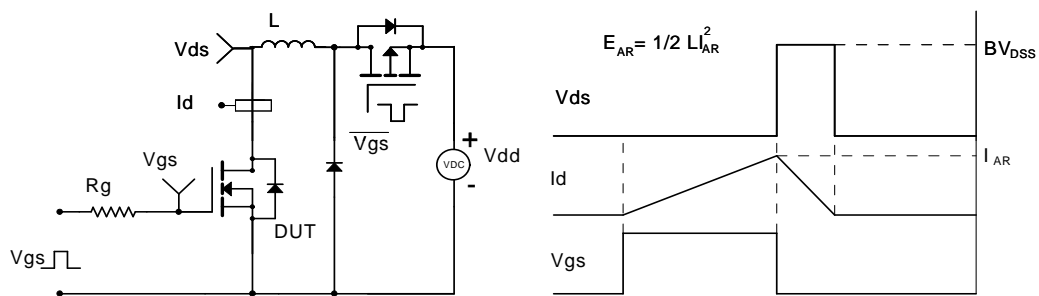
**Gate Charge Test Circuit & Waveform**



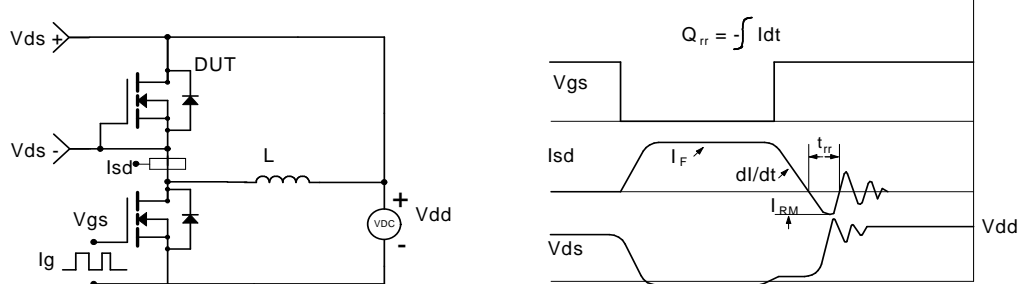
**Resistive Switching Test Circuit & Waveforms**



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



**Diode Recovery Test Circuit & Waveforms**



**P-Channel Electrical Characteristics (T<sub>J</sub>=25°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	-20			V
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	V <sub>DS</sub> =-20V, V <sub>GS</sub> =0V T <sub>J</sub> =55°C			-1 -5	μA
I <sub>GSS</sub>	Gate-Body leakage current	V <sub>DS</sub> =0V, V <sub>GS</sub> = ±8V			±100	nA
V <sub>GS(th)</sub>	Gate Threshold Voltage	V <sub>DS</sub> =V <sub>GS</sub> , I <sub>D</sub> =-250μA	-0.4	-0.65	-1	V
I <sub>D(ON)</sub>	On state drain current	V <sub>GS</sub> =-4.5V, V <sub>DS</sub> =-5V	-13			A
R <sub>DS(ON)</sub>	Static Drain-Source On-Resistance	V <sub>GS</sub> =-4.5V, I <sub>D</sub> =-2.5A T <sub>J</sub> =125°C		56 80	75 105	mΩ
		V <sub>GS</sub> =-2.5V, I <sub>D</sub> =-2A		70	95	mΩ
		V <sub>GS</sub> =-1.8V, I <sub>D</sub> =-1A		85	115	mΩ
g <sub>FS</sub>	Forward Transconductance	V <sub>DS</sub> =-5V, I <sub>D</sub> =-2.5A		13		S
V <sub>SD</sub>	Diode Forward Voltage	I <sub>S</sub> =-1A, V <sub>GS</sub> =0V		-0.7	-1	V
I <sub>S</sub>	Maximum Body-Diode Continuous Current				-1.5	A
<b>DYNAMIC PARAMETERS</b>						
C <sub>iss</sub>	Input Capacitance	V <sub>GS</sub> =0V, V <sub>DS</sub> =-10V, f=1MHz		560	745	pF
C <sub>oss</sub>	Output Capacitance			80		pF
C <sub>riss</sub>	Reverse Transfer Capacitance			70		pF
R <sub>g</sub>	Gate resistance	V <sub>GS</sub> =0V, V <sub>DS</sub> =0V, f=1MHz		15	23	Ω
<b>SWITCHING PARAMETERS</b>						
Q <sub>g(4.5V)</sub>	Total Gate Charge	V <sub>GS</sub> =-4.5V, V <sub>DS</sub> =-10V, I <sub>D</sub> =-2.5A		8.5	11	nC
Q <sub>gs</sub>	Gate Source Charge			1.2		nC
Q <sub>gd</sub>	Gate Drain Charge			2.1		nC
t <sub>D(on)</sub>	Turn-On DelayTime	V <sub>GS</sub> =-4.5V, V <sub>DS</sub> =-10V, R <sub>L</sub> =4Ω, R <sub>GEN</sub> =6Ω		7.2		ns
t <sub>r</sub>	Turn-On Rise Time			36		ns
t <sub>D(off)</sub>	Turn-Off DelayTime			53		ns
t <sub>f</sub>	Turn-Off Fall Time			56		ns
t <sub>rr</sub>	Body Diode Reverse Recovery Time	I <sub>F</sub> =-2.5A, dI/dt=100A/μs		37	49	ns
Q <sub>rr</sub>	Body Diode Reverse Recovery Charge	I <sub>F</sub> =-2.5A, dI/dt=100A/μs		27		nC

A. The value of R<sub>θJA</sub> is measured with the device mounted on 1in<sup>2</sup> FR-4 board with 2oz. Copper, in a still air environment with T<sub>A</sub> =25° C. The value in any given application depends on the user's specific board design.

B. The power dissipation P<sub>D</sub> is based on T<sub>J(MAX)</sub>=150° C, using ≤ 10s junction-to-ambient thermal resistance.

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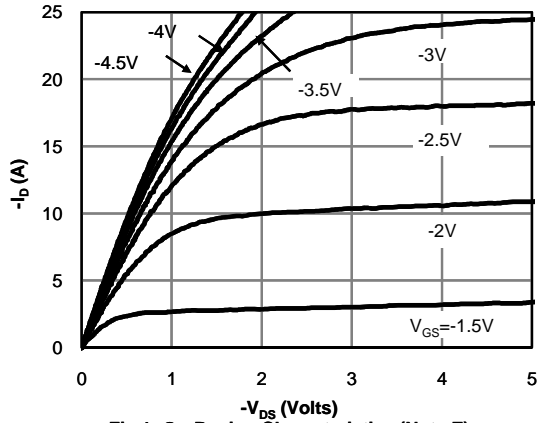
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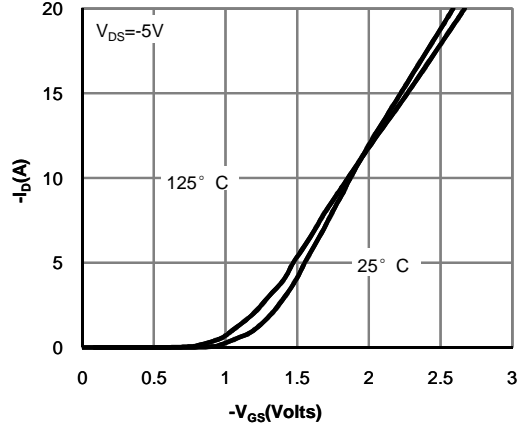
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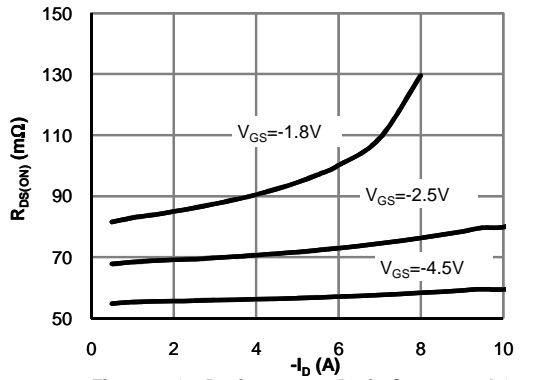
**P-Channel: TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS**



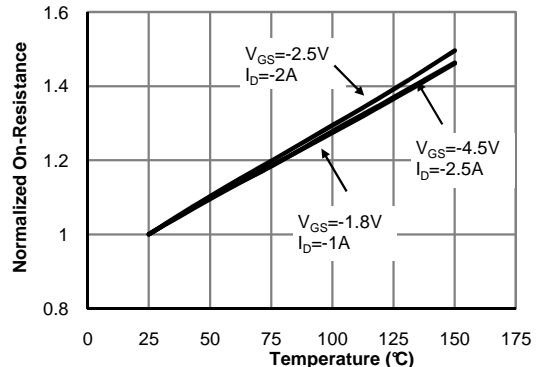
**Fig 1: On-Region Characteristics (Note E)**



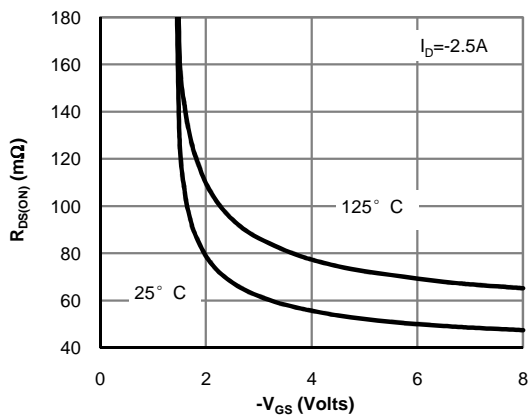
**Figure 2: Transfer Characteristics (Note E)**



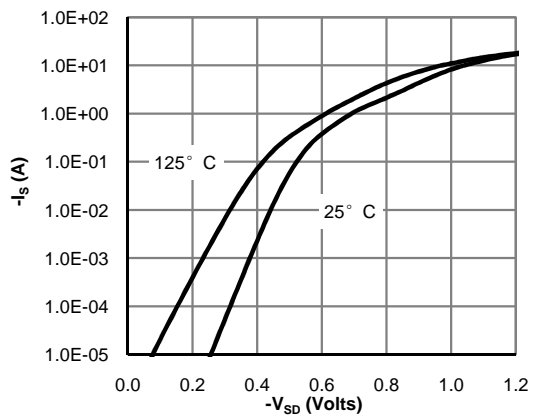
**Figure 3: On-Resistance vs. Drain Current and Gate Voltage (Note E)**



**Figure 4: On-Resistance vs. Junction Temperature (Note E)**



**Figure 5: On-Resistance vs. Gate-Source Voltage (Note E)**



**Figure 6: Body-Diode Characteristics (Note E)**

**P-Channel: TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS**

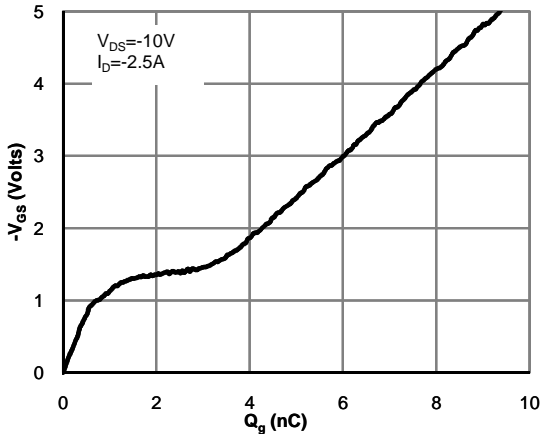


Figure 7: Gate-Charge Characteristics

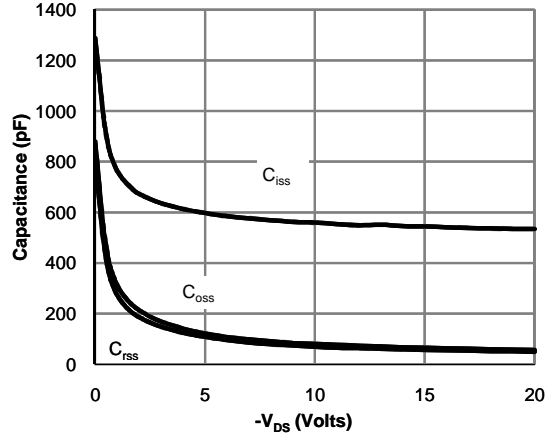


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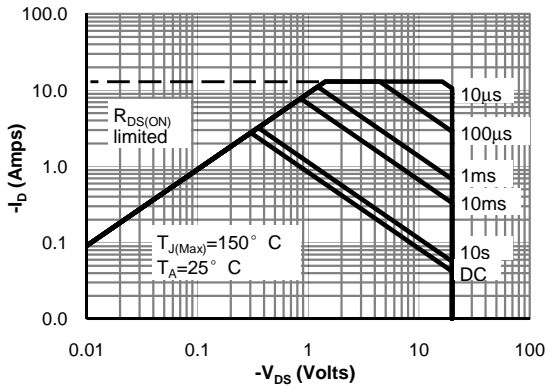


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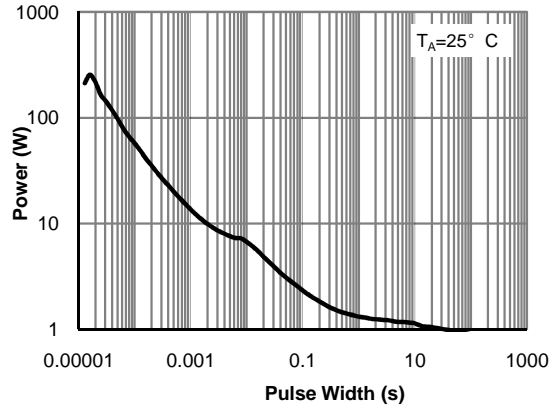


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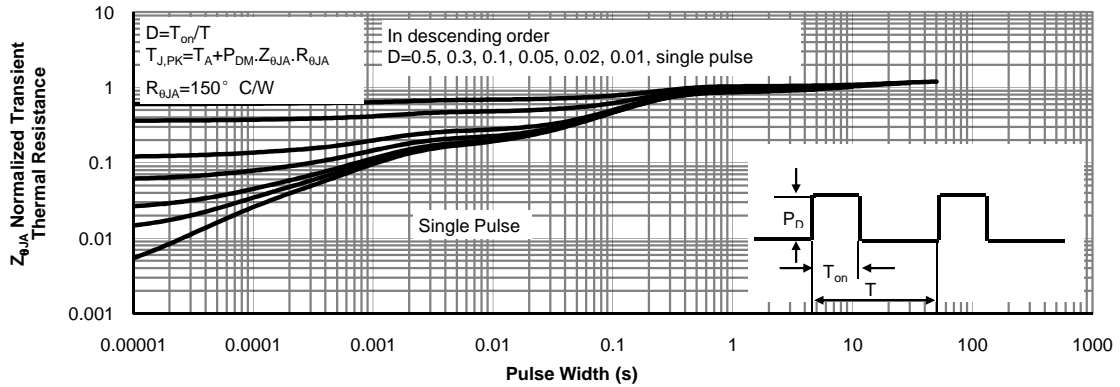
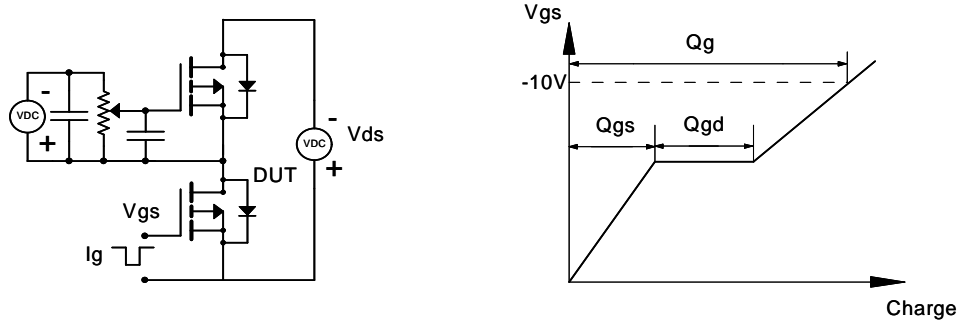
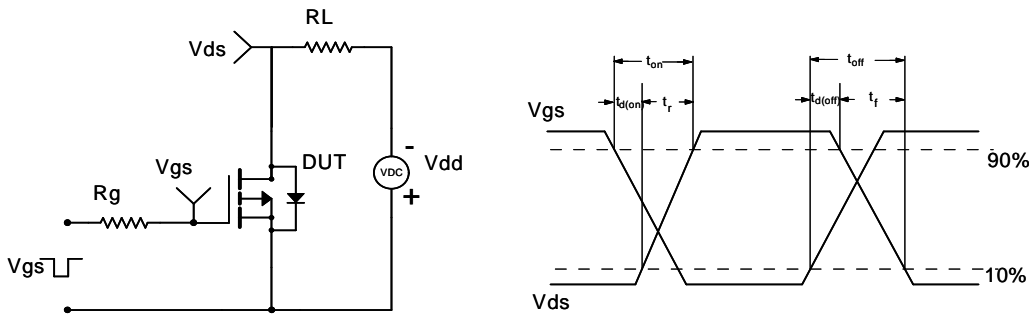


Figure 11: Normalized Maximum Transient Thermal Impedance (Note F)

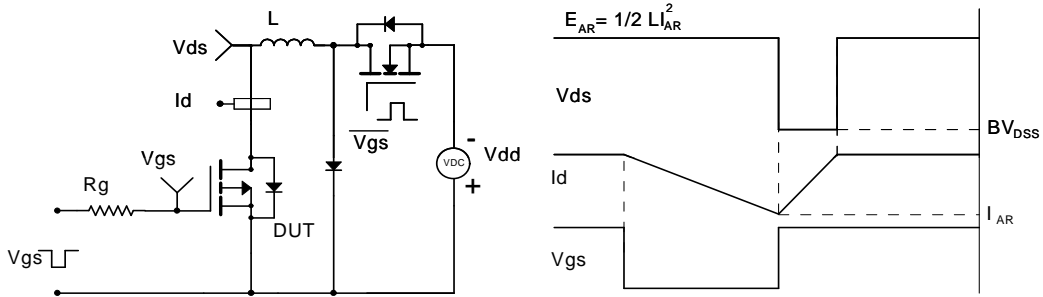
Gate Charge Test Circuit & Waveform



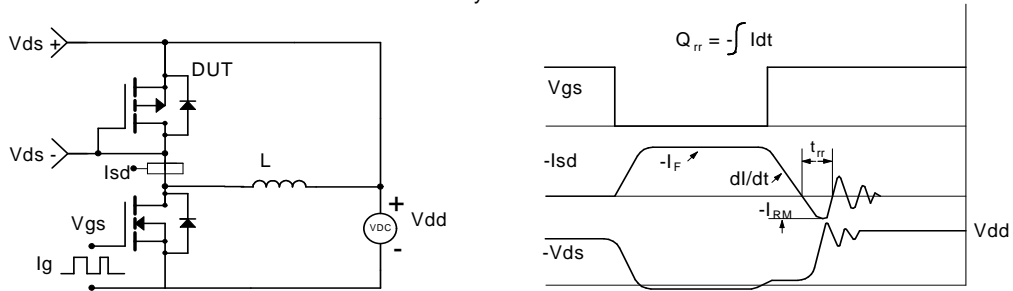
Resistive Switching Test Circuit & Waveforms



Unclamped Inductive Switching (UIS) Test Circuit & Waveforms



Diode Recovery Test Circuit & Waveforms



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