

## 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.

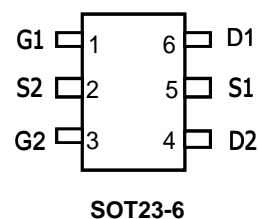
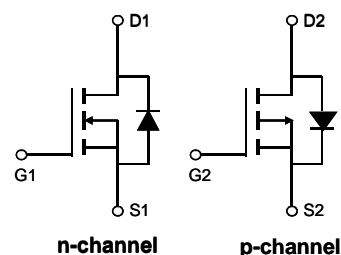
## Product Summary

N-Ch:

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

P-Ch:

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



## 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	$I_D$	3.4	-2.5	A
		2.5	-2	
Pulsed Drain Current <sup>C</sup>	$I_{DM}$	13	-13	
Power Dissipation <sup>B</sup>	$P_D$	1.1	1.1	W
		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>	$t \leq 10s$	$R_{\theta JA}$	78	110	$^\circ C/W$
Maximum Junction-to-Ambient <sup>A,D</sup>	Steady-State		106	150	$^\circ C/W$
Maximum Junction-to-Lead	Steady-State	$R_{\theta JL}$	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			1	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		51	65	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>rss</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.

N-Channel: TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

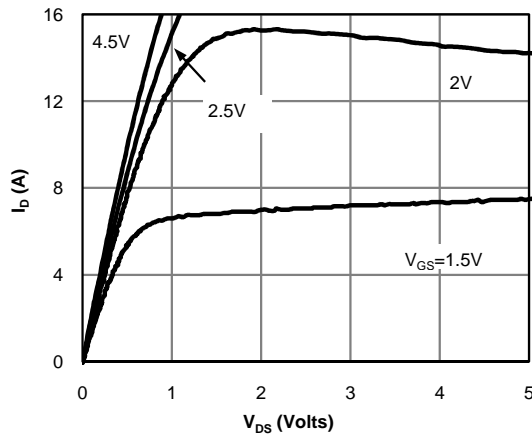


Fig 1: On-Region Characteristics (Note E)

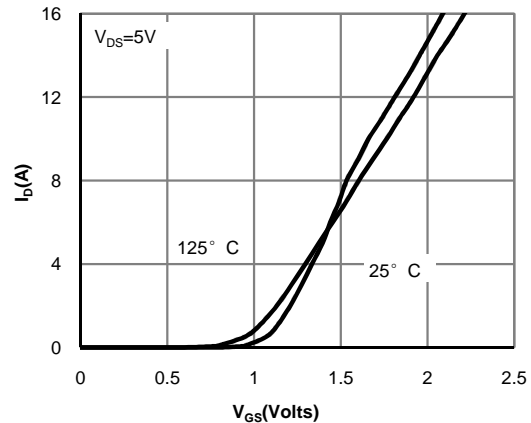


Figure 2: Transfer Characteristics (Note E)

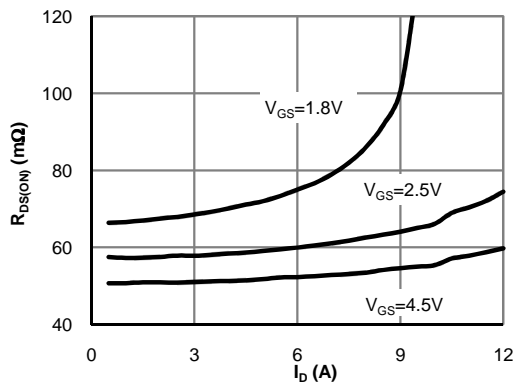


Figure 3: On-Resistance vs. Drain Current and Gate Voltage (Note E)

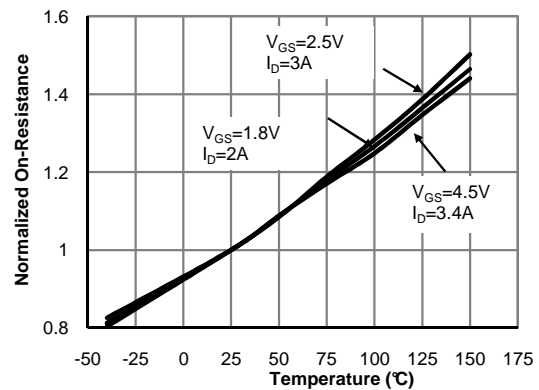


Figure 4: On-Resistance vs. Junction Temperature (Note E)

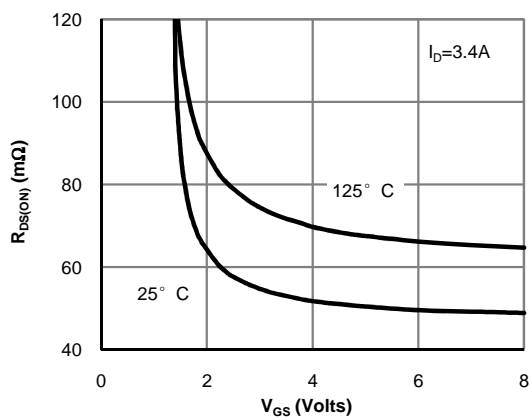


Figure 5: On-Resistance vs. Gate-Source Voltage (Note E)

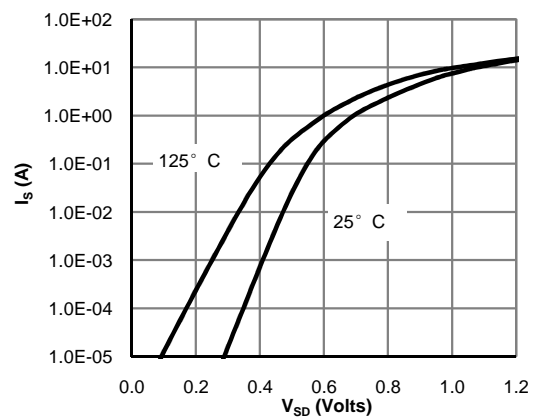


Figure 6: Body-Diode Characteristics (Note E)

N-Channel: TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

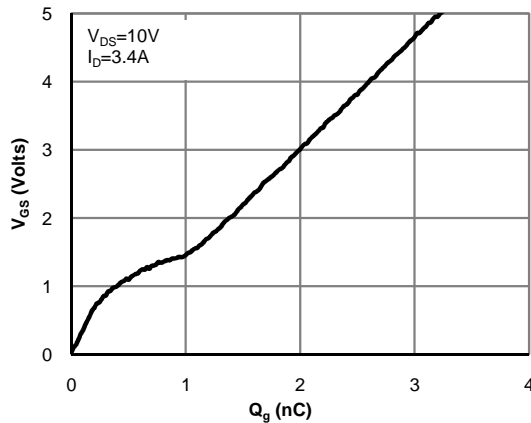


Figure 7: Gate-Charge Characteristics

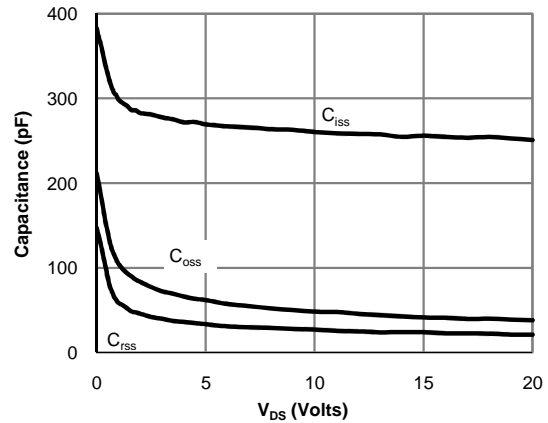


Figure 8: Capacitance Characteristics

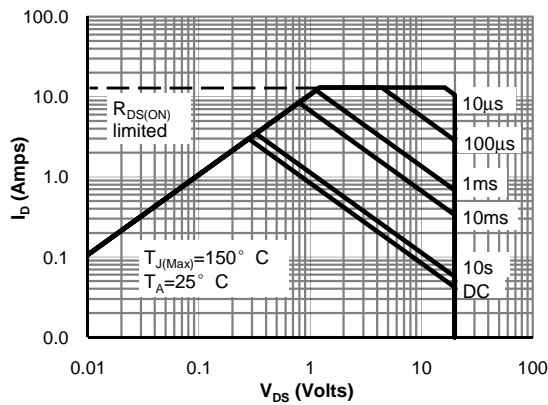


Figure 9: Maximum Forward Biased Safe Operating Area (Note F)

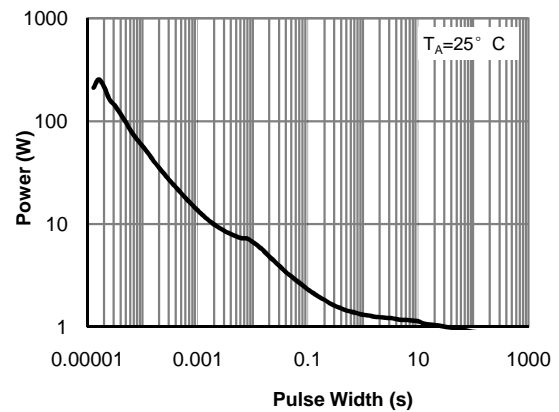


Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note F)

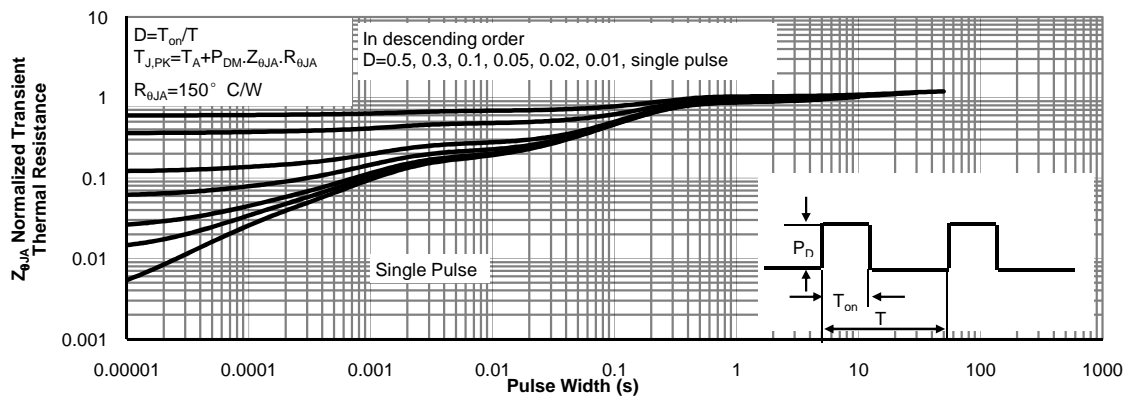
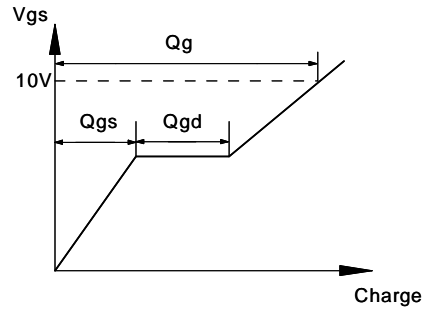
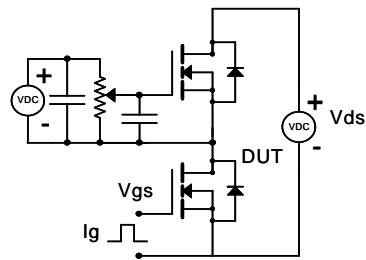
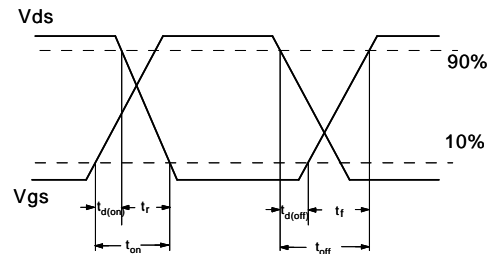
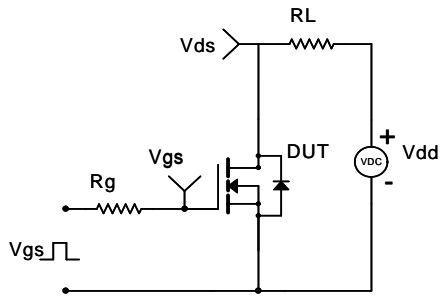


Figure 11: Normalized Maximum Transient Thermal Impedance (Note F)

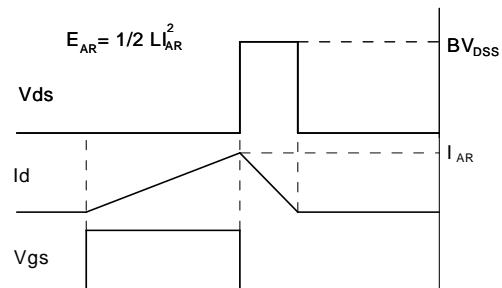
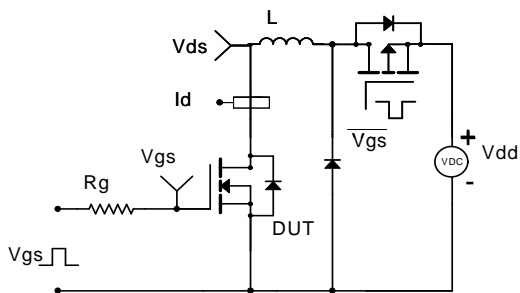
Gate Charge Test Circuit & Waveform



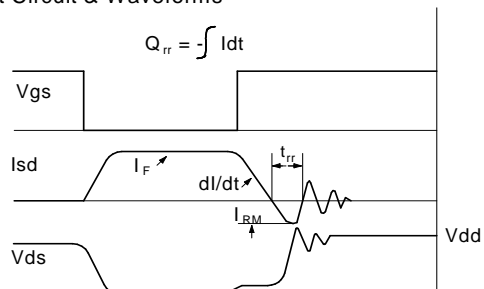
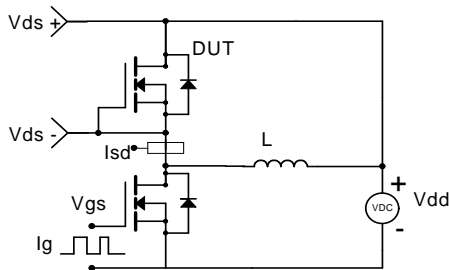
Resistive Switching Test Circuit & Waveforms



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		56	75	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>rss</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.

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.

P-Channel: TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

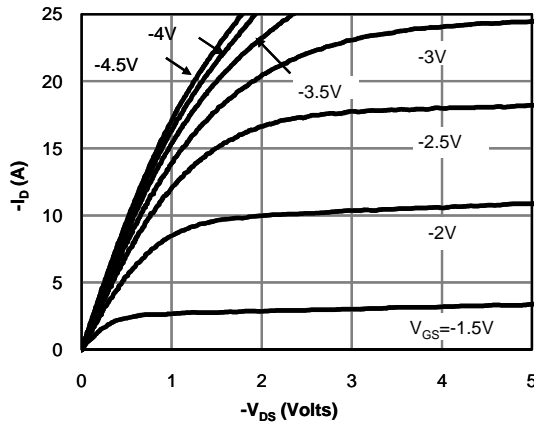


Fig 1: On-Region Characteristics (Note E)

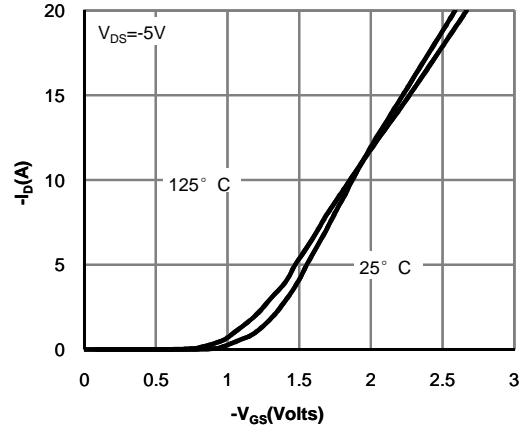


Figure 2: Transfer Characteristics (Note E)

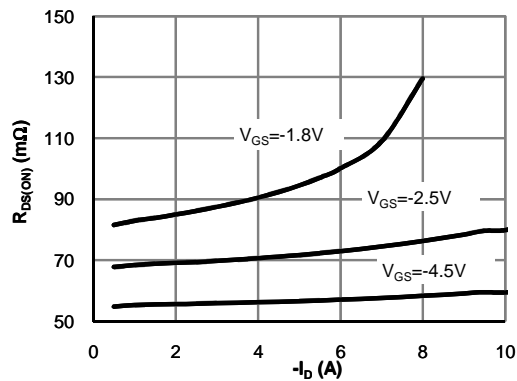


Figure 3: On-Resistance vs. Drain Current and Gate Voltage (Note E)

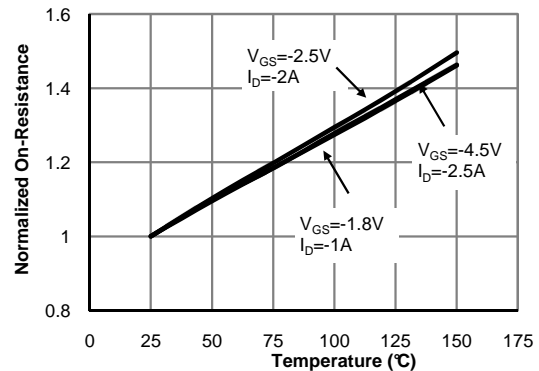


Figure 4: On-Resistance vs. Junction Temperature (Note E)

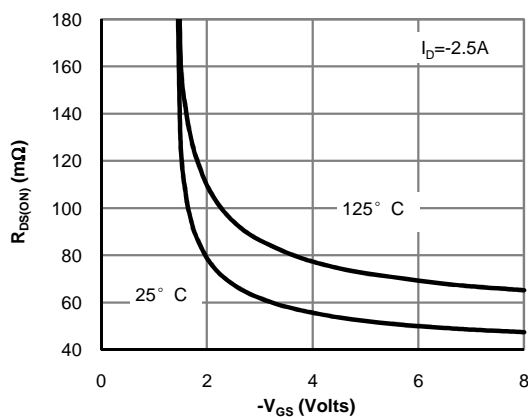


Figure 5: On-Resistance vs. Gate-Source Voltage (Note E)

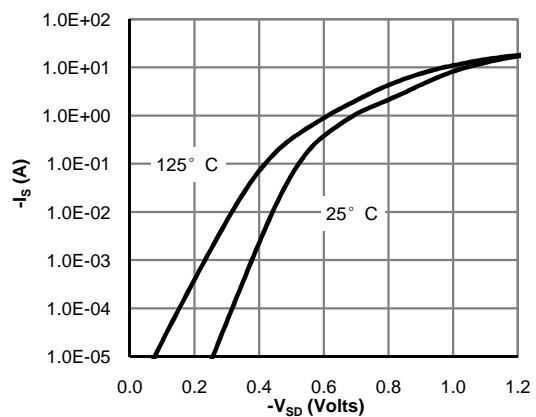


Figure 6: Body-Diode Characteristics (Note E)

P-Channel: TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

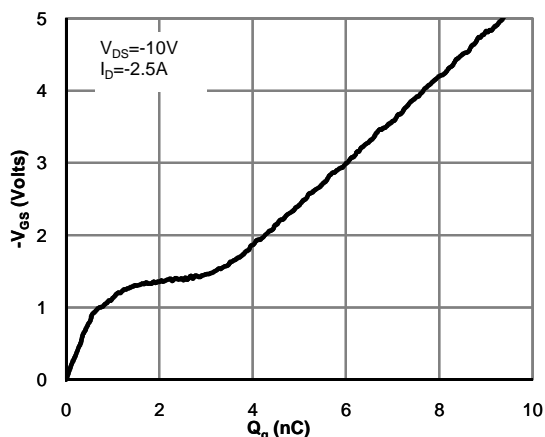


Figure 7: Gate-Charge Characteristics

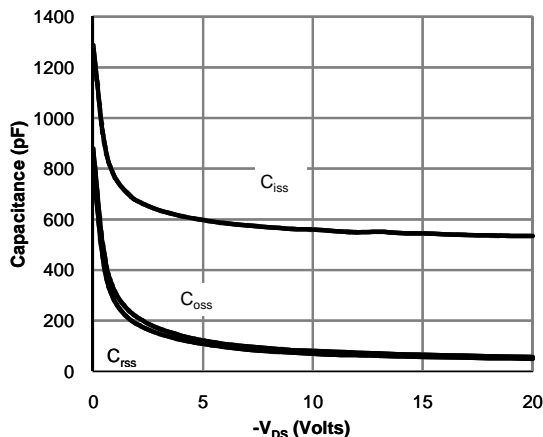


Figure 8: Capacitance Characteristics

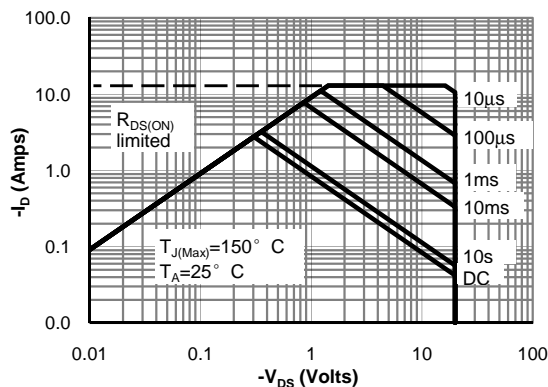


Figure 9: Maximum Forward Biased Safe Operating Area (Note F)

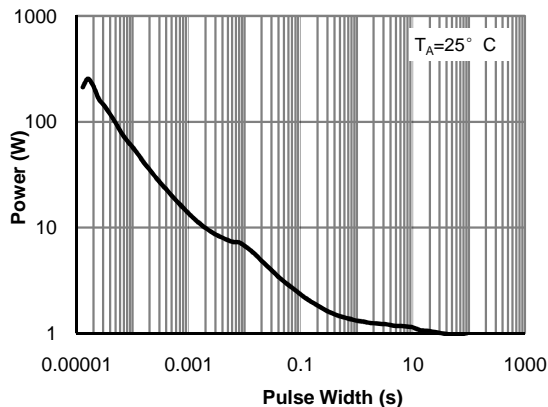


Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note F)

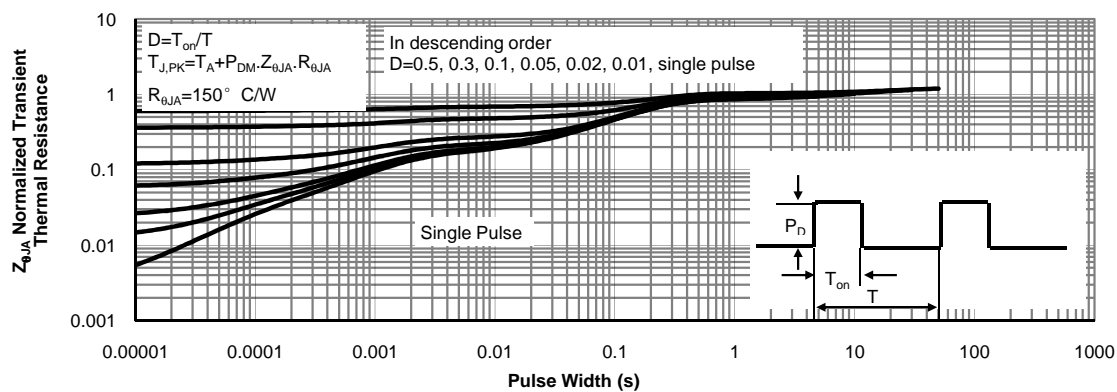
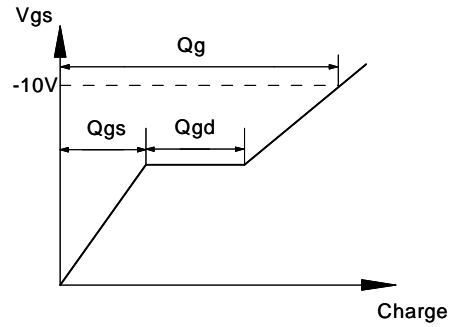
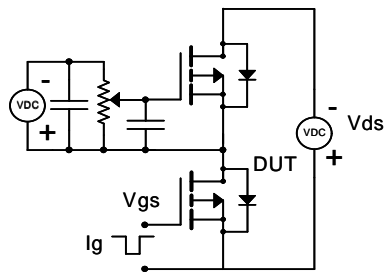


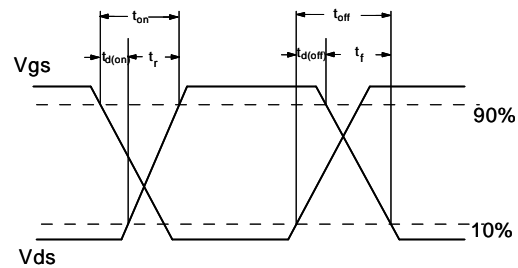
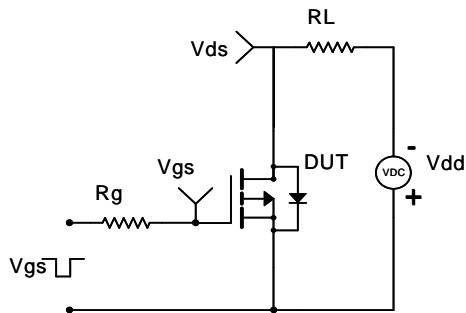
Figure 11: Normalized Maximum Transient Thermal Impedance (Note F)

### Gate Charge Test Circuit & Waveform

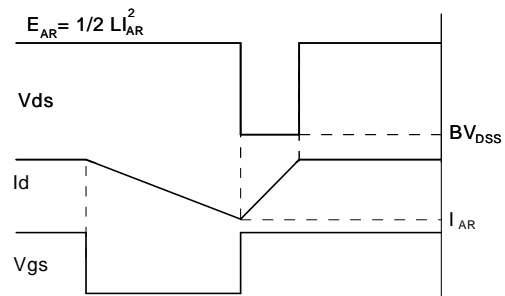
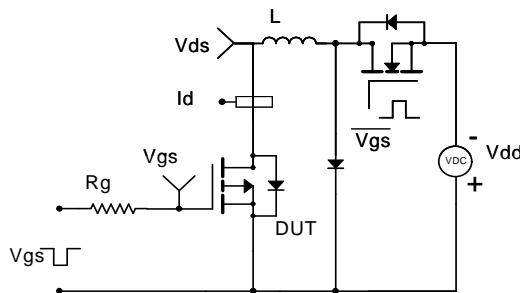
N+ P Channel MOSFET



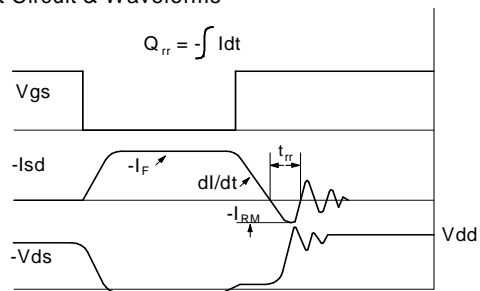
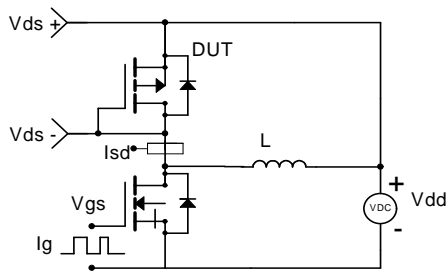
### Resistive Switching Test Circuit & Waveforms



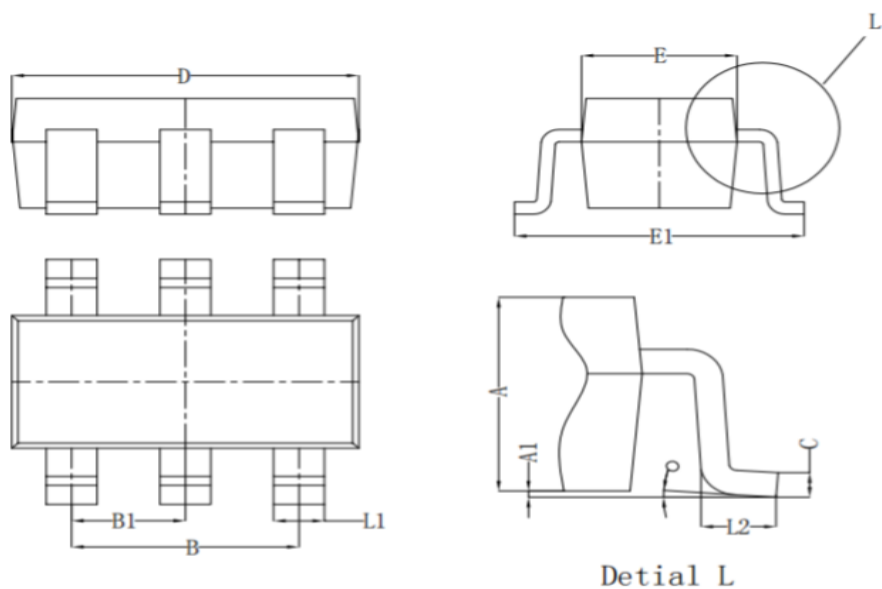
### Unclamped Inductive Switching (UIS) Test Circuit & Waveforms



### Diode Recovery Test Circuit & Waveforms

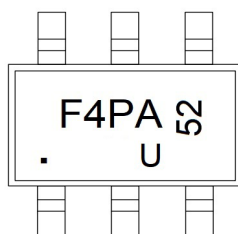


## SOT23- 6 PACKAGE OUTLIE DIMENSIONS



Symbol	Dim in mm		
	Min	Nor	Max
A	1.050	1.100	1.150
A1	0.000	0.050	0.100
L1	0.300	0.400	0.500
C	0.100	0.150	0.200
D	2.820	2.920	3.020
E	1.500	1.600	1.700
E1	2.650	2.800	2.950
B	1.800	1.900	2.000
B1	0.950 TYP		
L2	0.300	0.450	0.600
o	0°	4°	8°

## Marking



## Ordering information

Order code	Package	Baseqty	Deliverymode
UMW AO6604	SOT23-6	3000	Tape and reel