

# Complementary MOSFET

ELM24603HA-S

## General Description

ELM24603HA-S uses advanced trench technology to provide excellent  $R_{ds(on)}$  and low gate charge.

## Features

- |  |  |
|--|--|
| N-channel                                | P-channel                                |
| • $V_{ds}=60V$                           | $V_{ds}=-60V$                            |
| • $I_d=12A(V_{gs}=10V)$                  | $I_d=-12A(V_{gs}=-10V)$                  |
| • $R_{ds(on)} < 60m\Omega (V_{gs}=10V)$  | $R_{ds(on)} < 115m\Omega (V_{gs}=-10V)$  |
| • $R_{ds(on)} < 85m\Omega (V_{gs}=4.5V)$ | $R_{ds(on)} < 150m\Omega (V_{gs}=-4.5V)$ |

## Maximum Absolute Ratings

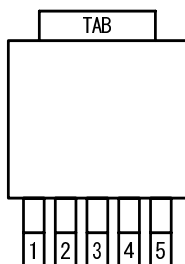
Parameter		Symbol	N-ch (Max.)	P-ch (Max.)	Unit	Note
Drain-source voltage		$V_{ds}$	60	-60	V	
Gate-source voltage		$V_{gs}$	$\pm 20$	$\pm 20$	V	
Continuous drain current	$T_c=25^\circ C$	$I_d$	12	-12	A	7
	$T_c=100^\circ C$		12	-10		
Pulsed drain current		$I_{dm}$	30	-30	A	3
Avalanche current		$I_{ar}$	12	-12	A	3
Repetitive avalanche energy $L=0.1mH$		$E_{ar}$	23	23	mJ	3
Power dissipation	$T_c=25^\circ C$	$P_d$	20.0	37.5	W	2
	$T_c=100^\circ C$		10.0	18.8		
Power dissipation	$T_a=25^\circ C$	$P_{dsm}$	2.0	2.5	W	1
	$T_a=70^\circ C$		1.3	1.6		
Junction and storage temperature range		$T_j, T_{stg}$	-55 to 150	-55 to 150	$^\circ C$	

## Thermal Characteristics

Parameter		Symbol	Device	Typ.	Max.	Unit	Note
Maximum junction-to-ambient	$t \leq 10s$	$R\theta_{ja}$	N-ch	17.4	30.0	$^\circ C/W$	1
	Steady-state			50.0	60.0		
Maximum junction-to-case	Steady-state	$R\theta_{jc}$		4.0	7.5	$^\circ C/W$	2
Maximum junction-to-ambient	$t \leq 10s$	$R\theta_{ja}$	P-ch	16.7	25.0	$^\circ C/W$	1
	Steady-state			40.0	50.0		
Maximum junction-to-case	Steady-state	$R\theta_{jc}$		2.5	4.0	$^\circ C/W$	2

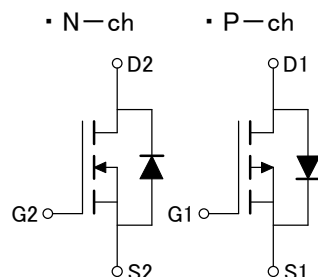
## Pin Configuration

TO-252-5 (TOP VIEW)



Pin No.	Pin name
1	SOURCE1
2	GATE1
3	DRAIN1/DRAIN2
4	GATE2
5	SOURCE2

## Circuit



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## Electrical Characteristics (N-ch)

T<sub>a</sub>=25°C

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
<b>STATIC PARAMETERS</b>						
Drain-source breakdown voltage	BV <sub>dss</sub>	I <sub>d</sub> =10mA, V <sub>gs</sub> =0V	60			V
Zero gate voltage drain current	I <sub>dss</sub>	V <sub>ds</sub> =48V V <sub>gs</sub> =0V			1	μA
		T <sub>j</sub> =55°C			5	
Gate-body leakage current	I <sub>gss</sub>	V <sub>ds</sub> =0V, V <sub>gs</sub> =±20V			100	nA
Gate threshold voltage	V <sub>gs(th)</sub>	V <sub>ds</sub> =V <sub>gs</sub> , I <sub>d</sub> =250 μA	1.0	2.4	3.0	V
On state drain current	I <sub>d(on)</sub>	V <sub>gs</sub> =10V, V <sub>ds</sub> =5V	30			A
Static drain-source on-resistance	R <sub>ds(on)</sub>	V <sub>gs</sub> =10V I <sub>d</sub> =12A		47	60	mΩ
		T <sub>j</sub> =125°C		85		
		V <sub>gs</sub> =4.5V, I <sub>d</sub> =6A		67	85	
Forward transconductance	G <sub>fs</sub>	V <sub>ds</sub> =5V, I <sub>d</sub> =12A		14		S
Diode forward voltage	V <sub>sd</sub>	I <sub>s</sub> =1A, V <sub>gs</sub> =0V		0.74	1.00	V
Max.body-diode continuous current	I <sub>s</sub>				12	A
<b>DYNAMIC PARAMETERS</b>						
Input capacitance	C <sub>iss</sub>	V <sub>gs</sub> =0V, V <sub>ds</sub> =30V, f=1MHz		450	540	pF
Output capacitance	C <sub>oss</sub>			61		pF
Reverse transfer capacitance	C <sub>rss</sub>			27		pF
Gate resistance	R <sub>g</sub>			1.35	2.00	Ω
<b>SWITCHING PARAMETERS</b>						
Total gate charge (10V)	Q <sub>g</sub>	V <sub>gs</sub> =10V, V <sub>ds</sub> =30V, I <sub>d</sub> =12A		7.5	10.0	nC
Total gate charge (4.5V)	Q <sub>g</sub>			3.8	5.0	nC
Gate-source charge	Q <sub>gs</sub>			1.2		nC
Gate-drain charge	Q <sub>gd</sub>			1.9		nC
Turn-on delay time	t <sub>d(on)</sub>			4.2		ns
Turn-on rise time	t <sub>r</sub>	V <sub>gs</sub> =10V, V <sub>ds</sub> =30V		3.4		ns
Turn-off delay time	t <sub>d(off)</sub>	R <sub>l</sub> =2.5 Ω, R <sub>gen</sub> =3 Ω		16.0		ns
Turn-off fall time	t <sub>f</sub>			2		ns
Body-diode reverse recovery time	t <sub>rr</sub>	I <sub>f</sub> =12A, dI/dt=100A/μs		27.6	35.0	ns
Body-diode reverse recovery charge	Q <sub>rr</sub>	I <sub>f</sub> =12A, dI/dt=100A/μs		30.0		nC

### NOTE :

- The value of R<sub>θja</sub> is measured with the device mounted on 1in<sup>2</sup> FR-4 board of 2oz. Copper, in still air environment with T<sub>a</sub>=25°C. The power dissipation P<sub>dsm</sub> is based on R<sub>θja</sub> max. allowed junction temperature of 150°C. The value in any given applications depends on the user's specific board design, and the max. temperature of 175°C may be used if the PCB allows it.
- The power dissipation P<sub>d</sub> is based on T<sub>j(max.)</sub>=175°C, using junction-to-case thermal resistance, and is more useful setting the upper dissipation limit for cases where additional heatsinking is used.
- The repetitive rating and the pulse width are limited by junction temperature T<sub>j(max.)</sub>=175°C.
- The R<sub>θja</sub> is the sum of the thermal impedance from junction to case R<sub>θjc</sub> and case to ambient.
- The static characteristics in Figures 1 to 6 are obtained using <300 μs pulses, duty cycle 0.5% max.
- 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.)</sub>=175°C.
- The maximum current rating is limited by bond-wires.
- These tests are performed 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 SOA curve provides a single pulse rating.

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## Typical Electrical and Thermal Characteristics (N-ch)

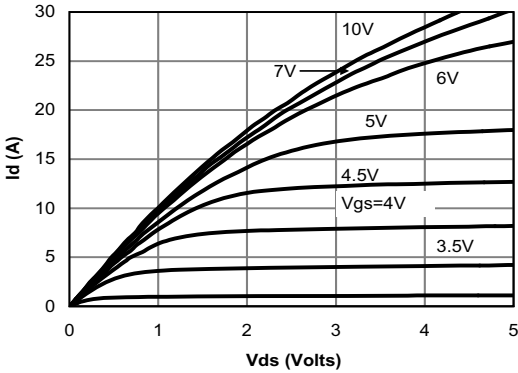


Fig 1: On-Region Characteristics

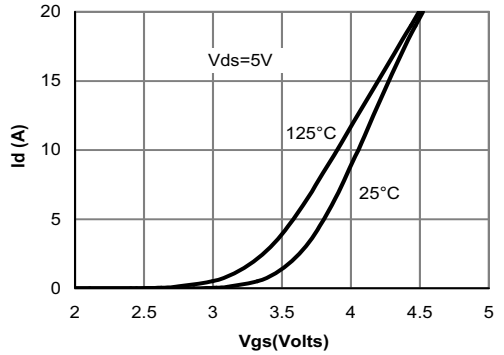


Figure 2: Transfer Characteristics

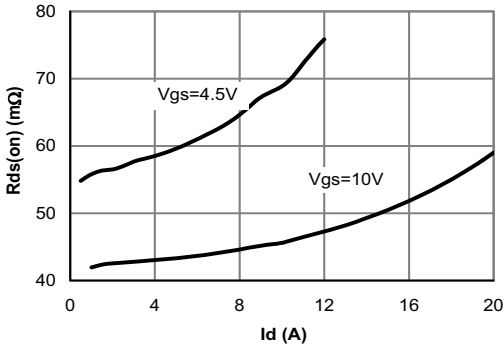


Figure 3: On-Resistance vs. Drain Current and Gate Voltage

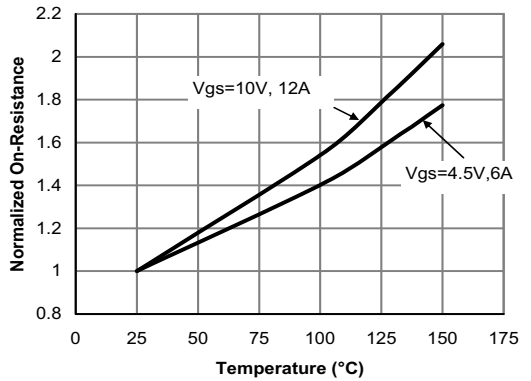


Figure 4: On-Resistance vs. Junction Temperature

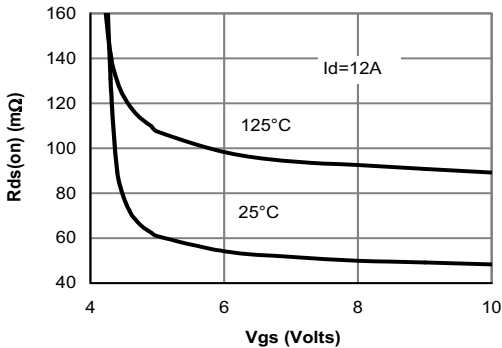


Figure 5: On-Resistance vs. Gate-Source Voltage

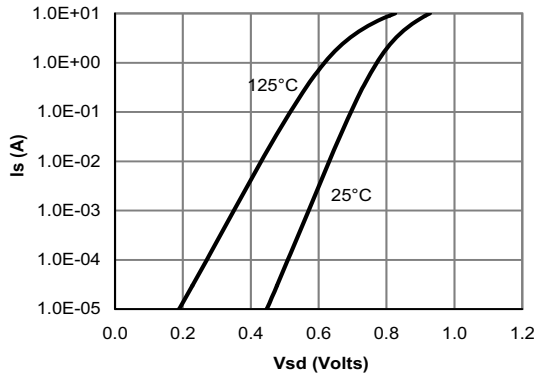


Figure 6: Body-Diode Characteristics

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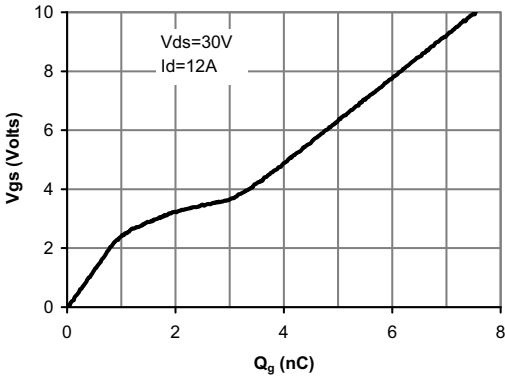


Figure 7: Gate-Charge Characteristics

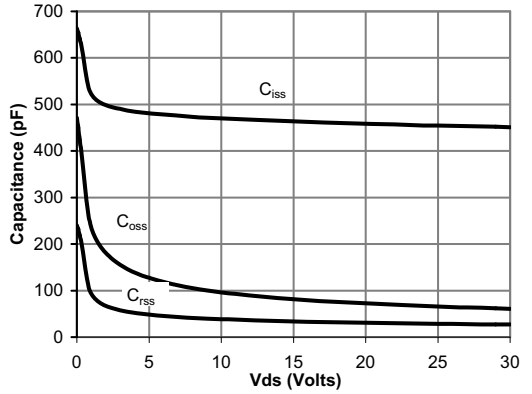


Figure 8: Capacitance Characteristics

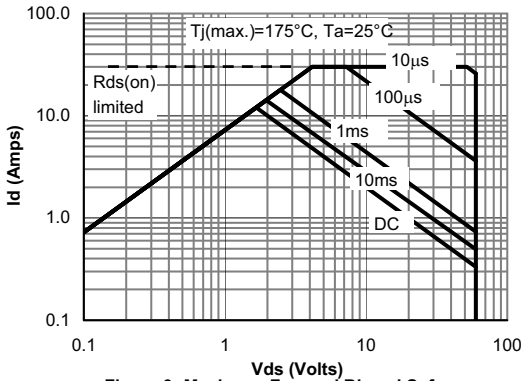


Figure 9: Maximum Forward Biased Safe Operating Area (Note F)

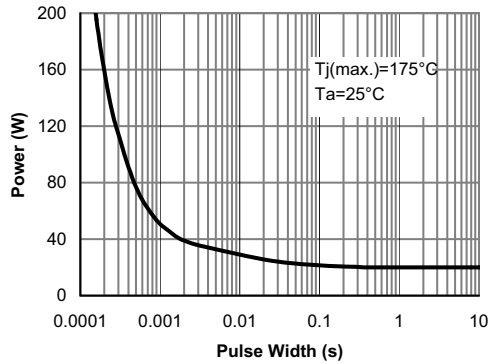


Figure 10: Single Pulse Power Rating Junction-to-Case (Note F)

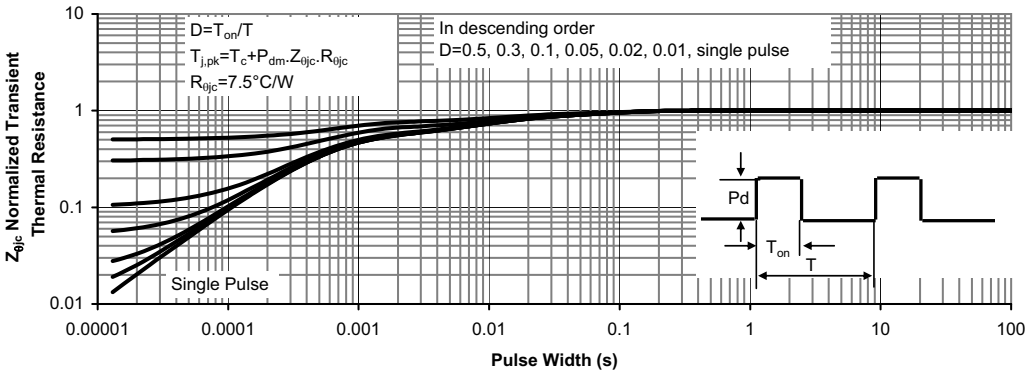


Figure 11: Normalized Maximum Transient Thermal Impedance (Note F)

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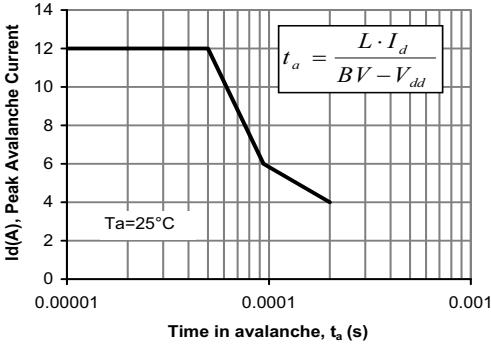


Figure 12: Single Pulse Avalanche capability

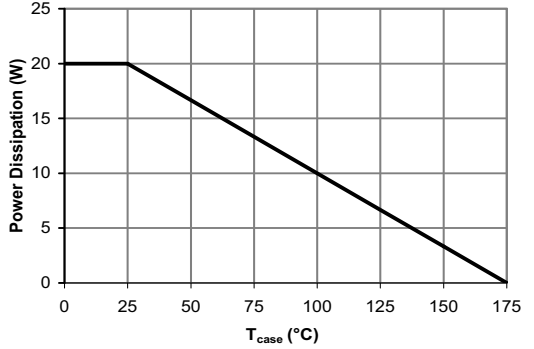


Figure 13: Power De-rating (Note B)

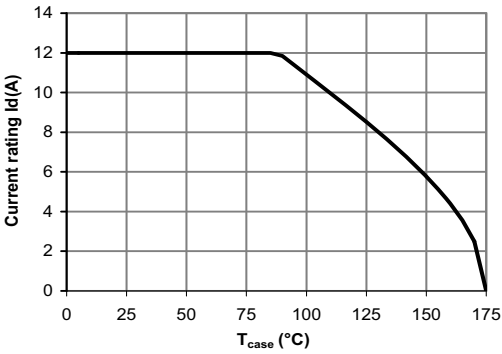


Figure 14: Current De-rating (Note B)

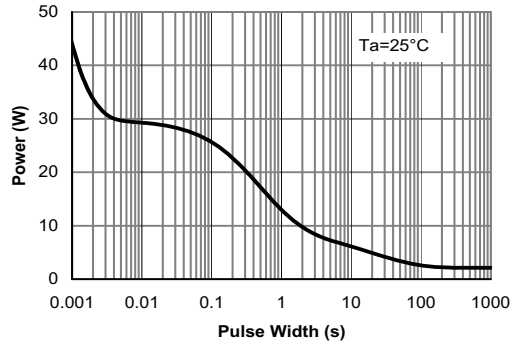


Figure 15: Single Pulse Power Rating Junction-to-Ambient (Note H)

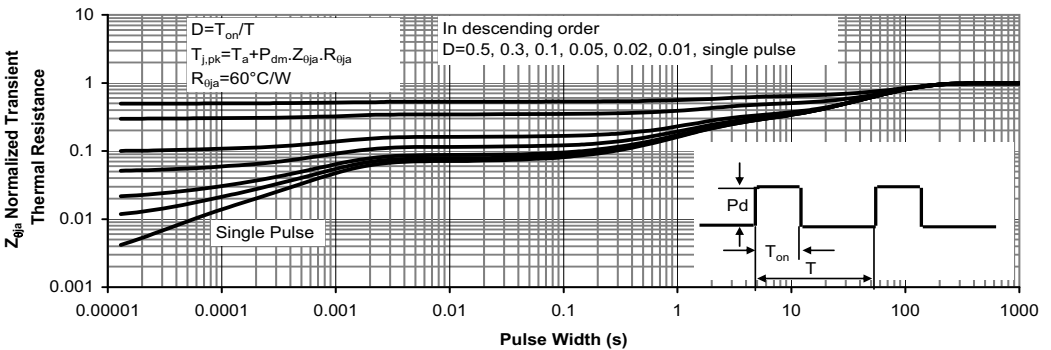


Figure 16: Normalized Maximum Transient Thermal Impedance (Note H)

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### Electrical Characteristics (P-ch)

T<sub>a</sub>=25°C

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit	
<b>STATIC PARAMETERS</b>							
Drain-source breakdown voltage	BV <sub>dss</sub>	I <sub>d</sub> =-250 μA, V <sub>gs</sub> =0V	-60			V	
Zero gate voltage drain current	I <sub>dss</sub>	V <sub>d</sub> =-48V		-0.003	-1.000	μA	
		V <sub>gs</sub> =0V	T <sub>j</sub> =55°C		-5.000		
Gate-body leakage current	I <sub>gss</sub>	V <sub>d</sub> =0V, V <sub>gs</sub> =±20V			±100	nA	
Gate threshold voltage	V <sub>gs(th)</sub>	V <sub>d</sub> =V <sub>gs</sub> , I <sub>d</sub> =-250 μA	-1.5	-2.1	-3.0	V	
On state drain current	I <sub>d(on)</sub>	V <sub>gs</sub> =-10V, V <sub>d</sub> =-5V	-30			A	
Static drain-source on-resistance	R <sub>d</sub> (on)	V <sub>gs</sub> =-10V		91	115	mΩ	
		I <sub>d</sub> =-12A	T <sub>j</sub> =125°C	150			
		V <sub>gs</sub> =-4.5V, I <sub>d</sub> =-6A		114	150	mΩ	
Forward transconductance	G <sub>fs</sub>	V <sub>d</sub> =-5V, I <sub>d</sub> =-12A		12.8		S	
Diode forward voltage	V <sub>sd</sub>	I <sub>s</sub> =-1A, V <sub>gs</sub> =0V		-0.76	-1.00	V	
Max. body-diode continuous current	I <sub>s</sub>				-12	A	
<b>DYNAMIC PARAMETERS</b>							
Input capacitance	C <sub>iss</sub>	V <sub>gs</sub> =0V, V <sub>d</sub> =-30V, f=1MHz		987	1185	pF	
Output capacitance	C <sub>oss</sub>			114		pF	
Reverse transfer capacitance	C <sub>rss</sub>			46		pF	
Gate resistance	R <sub>g</sub>			7	10	Ω	
<b>SWITCHING PARAMETERS</b>							
Total gate charge (10V)	Q <sub>g</sub>	V <sub>gs</sub> =-10V, V <sub>d</sub> =-30V		15.8	20.0	nC	
Total gate charge (4.5V)	Q <sub>g</sub>			7.4	9.0	nC	
Gate-source charge	Q <sub>gs</sub>	I <sub>d</sub> =-12A		3.0		nC	
Gate-drain charge	Q <sub>gd</sub>			3.5		nC	
Turn-on delay time	t <sub>d(on)</sub>	V <sub>gs</sub> =-10V, V <sub>d</sub> =-30V		9		ns	
Turn-on rise time	t <sub>r</sub>			10		ns	
Turn-off delay time	t <sub>d(off)</sub>		R <sub>I</sub> =2.5 Ω, R <sub>gen</sub> =3 Ω		25		ns
Turn-off fall time	t <sub>f</sub>				11		ns
Body diode reverse recovery time	t <sub>rr</sub>	I <sub>f</sub> =-12A, dI/dt=100A/μs		27.5	35.0	ns	
Body diode reverse recovery charge	Q <sub>rr</sub>	I <sub>f</sub> =-12A, dI/dt=100A/μs		30.0		nC	

#### NOTE :

- The value of R<sub>θja</sub> is measured with the device mounted on 1in<sup>2</sup> FR-4 board of 2oz. Copper, in still air environment with T<sub>a</sub>=25°C. The power dissipation P<sub>dsm</sub> is based on R<sub>θja</sub> max. allowed junction temperature of 150°C. The value in any given applications depends on the user's specific board design, and the max. temperature of 175°C may be used if the PCB allows it.
- The power dissipation P<sub>d</sub> is based on T<sub>j(max.)</sub>=175°C, using junction-to-case thermal resistance, and is more useful setting the upper dissipation limit for cases where additional heatsinking is used.
- The repetitive rating and the pulse width are limited by junction temperature T<sub>j(max.)</sub>=175°C.
- The R<sub>θja</sub> is the sum of the thermal impedance from junction to case R<sub>θjc</sub> and case to ambient.
- The static characteristics in Figures 1 to 6 are obtained using <300 μs pulses, duty cycle 0.5% max.
- 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.)</sub>=175°C.
- The maximum current rating is limited by bond-wires.
- These tests are performed 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 SOA curve provides a single pulse rating.

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## Typical Electrical and Thermal Characteristics (P-ch)

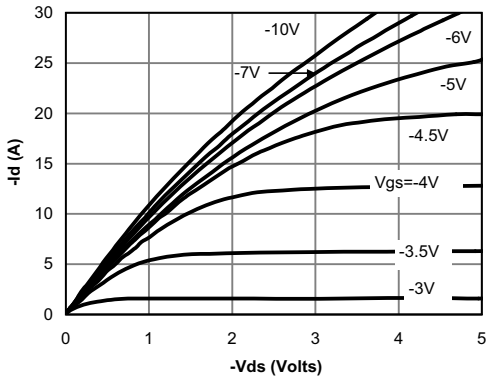


Fig 1: On-Region Characteristics

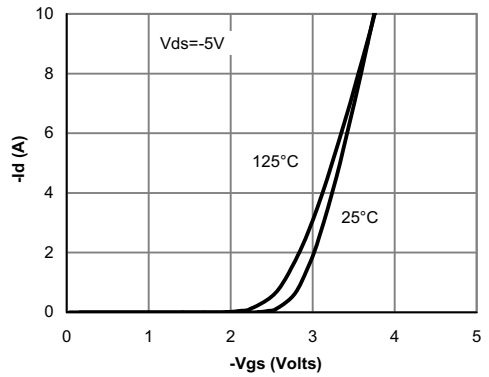


Figure 2: Transfer Characteristics

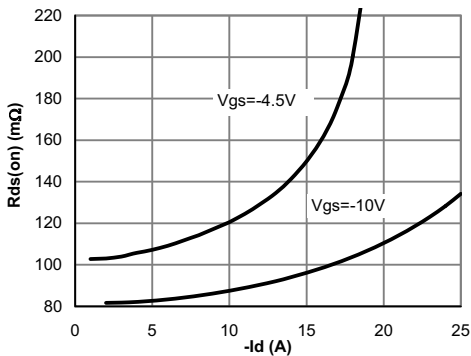


Figure 3: On-Resistance vs. Drain Current and Gate Voltage

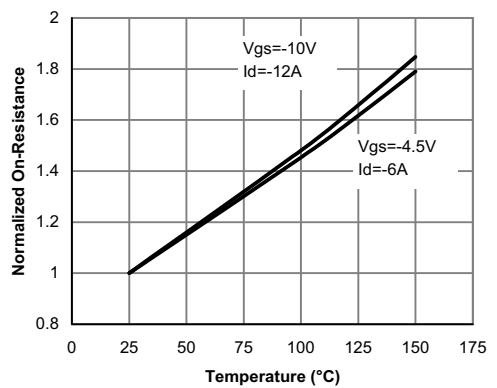


Figure 4: On-Resistance vs. Junction Temperature

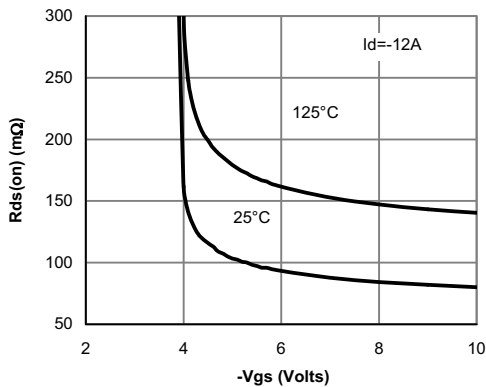


Figure 5: On-Resistance vs. Gate-Source Voltage

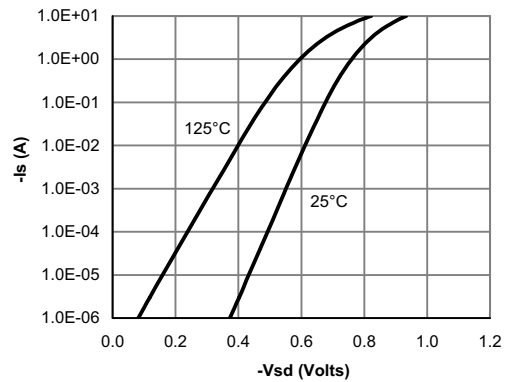


Figure 6: Body-Diode Characteristics

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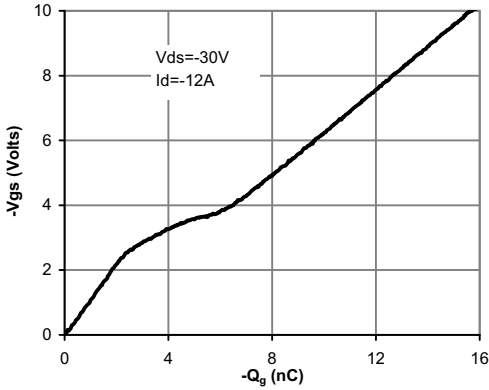


Figure 7: Gate-Charge Characteristics

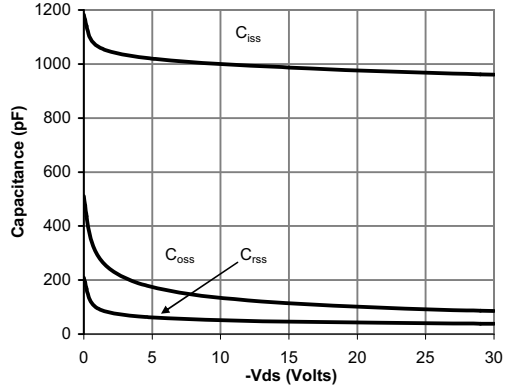


Figure 8: Capacitance Characteristics

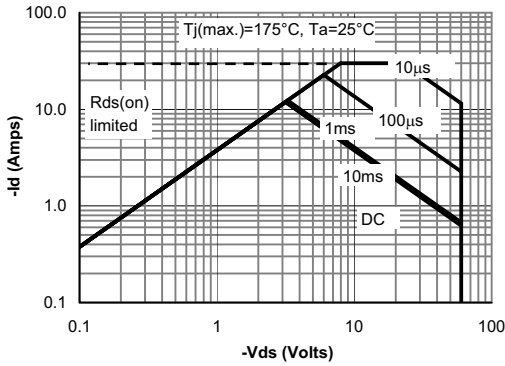


Figure 9: Maximum Forward Biased Safe Operating Area (Note F)

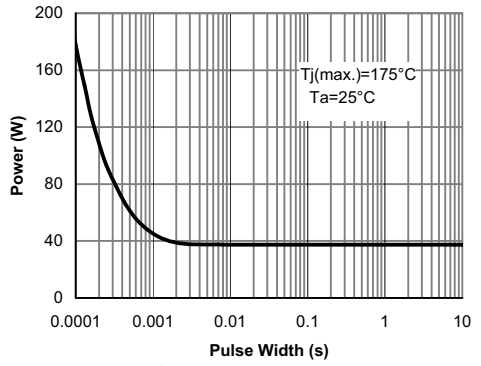


Figure 10: Single Pulse Power Rating Junction-to-Case (Note F)

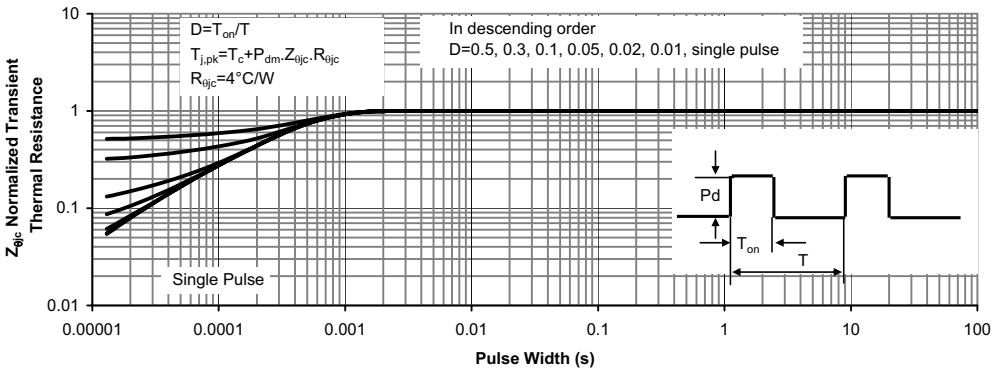


Figure 11: Normalized Maximum Transient Thermal Impedance (Note F)



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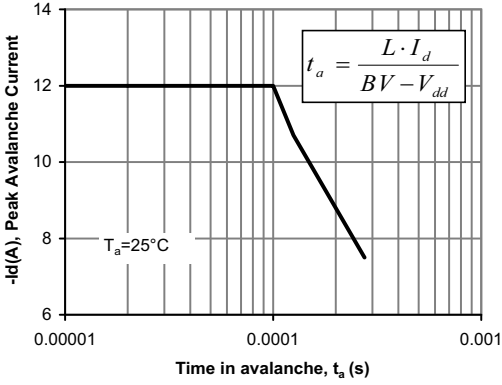


Figure 12: Single Pulse Avalanche capability

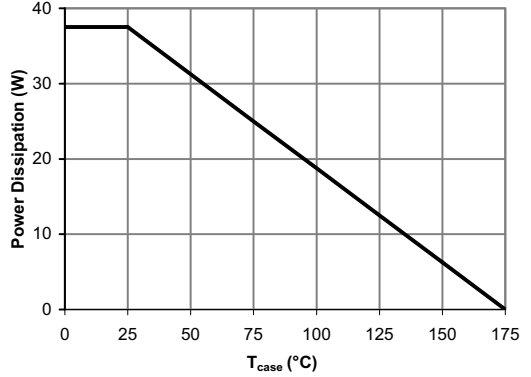


Figure 13: Power De-rating (Note B)

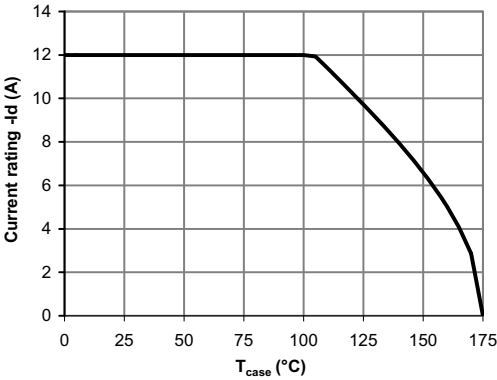


Figure 14: Current De-rating (Note B)

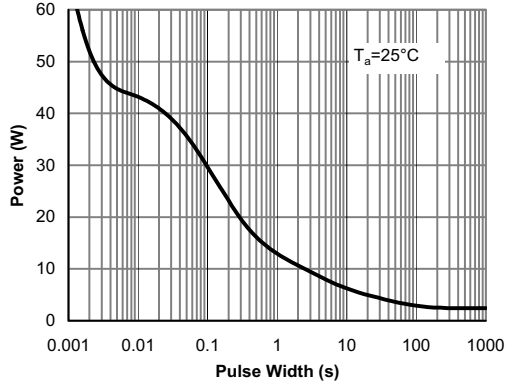


Figure 15: Single Pulse Power Rating Junction-to-Ambient (Note H)

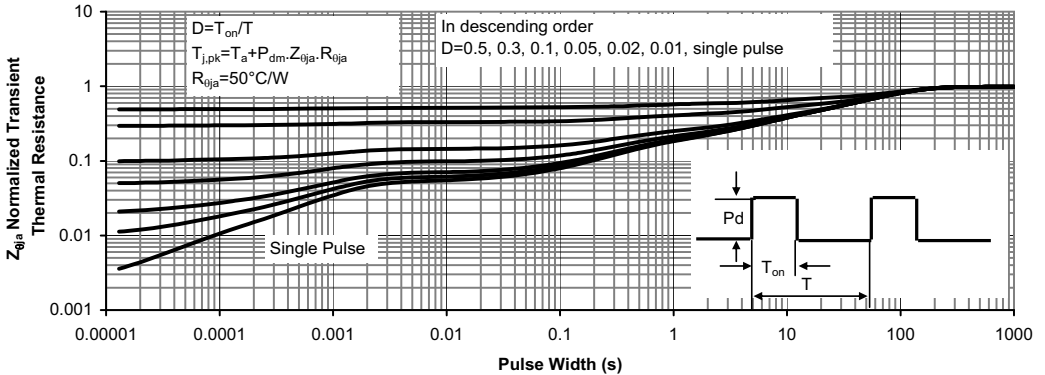


Figure 16: Normalized Maximum Transient Thermal Impedance (Note H)