

## AOD609 Complementary Enhancement Mode Field Effect Transistor

### General Description

The AOD609 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.

- RoHS Compliant
- Halogen Free\*

### Features

#### n-channel

$V_{DS}$  (V) = 40V,  $I_D$  = 12A ( $V_{GS}=10V$ )

$R_{DS(ON)} < 30m\Omega$  ( $V_{GS}=10V$ )

$R_{DS(ON)} < 40m\Omega$  ( $V_{GS}=4.5V$ )

#### p-channel

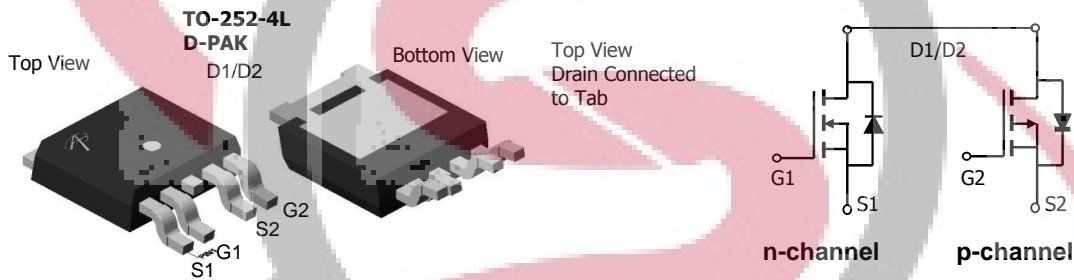
$V_{DS}$  (V) = -40V,  $I_D$  = -12A ( $V_{GS}=-10V$ )

$R_{DS(ON)} < 45m\Omega$  ( $V_{GS}= -10V$ )

$R_{DS(ON)} < 66m\Omega$  ( $V_{GS}= -4.5V$ )

**100% UIS Tested!**

**100% Rg Tested!**



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

Parameter	Symbol	Max n-channel	Max p-channel	Units
Drain-Source Voltage	$V_{DS}$	40	-40	V
Gate-Source Voltage	$V_{GS}$	$\pm 20$	$\pm 20$	V
Continuous Drain Current <sup>B,H</sup>	$I_D$	$T_C=25^\circ C$	-12	A
		$T_C=100^\circ C$	-12	
Pulsed Drain Current <sup>B</sup>	$I_{DM}$	30	-30	
Avalanche Current <sup>C</sup>	$I_{AR}$	14	-20	
Repetitive avalanche energy $L=0.1mH$ <sup>C</sup>	$E_{AR}$	9.8	20	mJ
Power Dissipation	$P_D$	$T_C=25^\circ C$	30	W
		$T_C=100^\circ C$	15	
Power Dissipation	$P_{DSM}$	$T_A=25^\circ C$	2	W
		$T_A=70^\circ C$	1.3	
Junction and Storage Temperature Range	$T_J, T_{STG}$	-55 to 175	-55 to 175	$^\circ C$

### Thermal Characteristics: n-channel and p-channel

Parameter	Symbol	Device	Typ	Max	Units
Maximum Junction-to-Ambient <sup>A,D</sup>	$R_{\theta JA}$	n-ch	17.4	25	$^\circ C/W$
Maximum Junction-to-Ambient <sup>A,D</sup>					
Maximum Junction-to-Lead <sup>C</sup>	$R_{\theta JC}$	n-ch	4	5.5	$^\circ C/W$
Maximum Junction-to-Ambient <sup>A,D</sup>	$R_{\theta JA}$	p-ch	16.7	25	$^\circ C/W$
Maximum Junction-to-Ambient <sup>A,D</sup>					
Maximum Junction-to-Lead <sup>C</sup>	$R_{\theta JC}$	p-ch	3.5	5	$^\circ C/W$

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

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>STATIC PARAMETERS</b>						
$BV_{DSS}$	Drain-Source Breakdown Voltage	$I_D=250\mu\text{A}$ , $V_{GS}=0\text{V}$	40			V
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS}=40\text{V}$ , $V_{GS}=0\text{V}$ $T_J=55^\circ\text{C}$			1 5	$\mu\text{A}$
$I_{GSS}$	Gate-Body leakage current	$V_{DS}=0\text{V}$ , $V_{GS}=\pm 20\text{V}$			$\pm 100$	nA
$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS}=V_{GS}$ , $I_D=250\mu\text{A}$	1.7	2.5	3	V
$I_{D(ON)}$	On state drain current	$V_{GS}=10\text{V}$ , $V_{DS}=5\text{V}$	30			A
$R_{DS(ON)}$	Static Drain-Source On-Resistance	$V_{GS}=10\text{V}$ , $I_D=12\text{A}$ $T_J=125^\circ\text{C}$		24 37	30 46	m $\Omega$
		$V_{GS}=4.5\text{V}$ , $I_D=8\text{A}$		31	40	
$g_{FS}$	Forward Transconductance	$V_{DS}=5\text{V}$ , $I_D=12\text{A}$		25		S
$V_{SD}$	Diode Forward Voltage	$I_S=1\text{A}$ , $V_{GS}=0\text{V}$		0.76	1	V
$I_S$	Maximum Body-Diode Continuous Current <sup>H</sup>				12	A
<b>DYNAMIC PARAMETERS</b>						
$C_{iss}$	Input Capacitance			516	650	pF
$C_{oss}$	Output Capacitance	$V_{GS}=0\text{V}$ , $V_{DS}=20\text{V}$ , $f=1\text{MHz}$		82		pF
$C_{rss}$	Reverse Transfer Capacitance			43		pF
$R_g$	Gate resistance	$V_{GS}=0\text{V}$ , $V_{DS}=0\text{V}$ , $f=1\text{MHz}$		4.6	6.9	$\Omega$
<b>SWITCHING PARAMETERS</b>						
$Q_g(10\text{V})$	Total Gate Charge	$V_{GS}=10\text{V}$ , $V_{DS}=20\text{V}$ , $I_D=12\text{A}$		8.3	10.8	nC
$Q_{gs}$	Gate Source Charge			2.3		nC
$Q_{gd}$	Gate Drain Charge			1.6		nC
$t_{D(on)}$	Turn-On Delay Time	$V_{GS}=10\text{V}$ , $V_{DS}=20\text{V}$ , $R_L=1.4\Omega$ , $R_{GEN}=3\Omega$		6.4		ns
$t_r$	Turn-On Rise Time			3.6		ns
$t_{D(off)}$	Turn-Off Delay Time			16.2		ns
$t_f$	Turn-Off Fall Time			6.6		ns
$t_{rr}$	Body Diode Reverse Recovery Time	$I_F=12\text{A}$ , $dI/dt=100\text{A}/\mu\text{s}$		18	24	ns
$Q_{rr}$	Body Diode Reverse Recovery Charge	$I_F=12\text{A}$ , $dI/dt=100\text{A}/\mu\text{s}$		10		nC

A: The value of  $R_{\theta JA}$  is measured with the device in a still air environment with  $T_A=25^\circ\text{C}$ . The power dissipation  $P_{DSM}$  and current rating  $I_{DSM}$  are based on  $T_{J(MAX)}=150^\circ\text{C}$ , using the steady state junction-to-ambient thermal resistance.

B: The power dissipation  $P_D$  is based on  $T_{J(MAX)}=175^\circ\text{C}$ , 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  $T_{J(MAX)}=175^\circ\text{C}$ .

D: The  $R_{\theta JA}$  is the sum of the thermal impedance from junction to case  $R_{\theta JC}$  and case to ambient.

E: The static characteristics in Figures 1 to 6 are obtained using  $<300\mu\text{s}$  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  $T_{J(MAX)}=175^\circ\text{C}$ . 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  $T_A=25^\circ\text{C}$ .

H: The maximum current rating is limited by bond-wires.

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

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>STATIC PARAMETERS</b>						
$BV_{DSS}$	Drain-Source Breakdown Voltage	$I_D = -250\mu\text{A}$ , $V_{GS} = 0\text{V}$	-40			V
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS} = -40\text{V}$ , $V_{GS} = 0\text{V}$ $T_J = 55^\circ\text{C}$			-1 -5	$\mu\text{A}$
$I_{GSS}$	Gate-Body leakage current	$V_{DS} = 0\text{V}$ , $V_{GS} = \pm 20\text{V}$			$\pm 100$	nA
$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS} = V_{GS}$ , $I_D = -250\mu\text{A}$	-1.7	-2	-3	V
$I_{D(ON)}$	On state drain current	$V_{GS} = -10\text{V}$ , $V_{DS} = -5\text{V}$	-30			A
$R_{DS(ON)}$	Static Drain-Source On-Resistance	$V_{GS} = -10\text{V}$ , $I_D = -12\text{A}$ $T_J = 125^\circ\text{C}$		36 52	45 65	$\text{m}\Omega$
		$V_{GS} = -4.5\text{V}$ , $I_D = -8\text{A}$		51	66	
$g_{FS}$	Forward Transconductance	$V_{DS} = -5\text{V}$ , $I_D = -12\text{A}$		22		S
$V_{SD}$	Diode Forward Voltage	$I_S = -1\text{A}$ , $V_{GS} = 0\text{V}$		-0.76	-1	V
$I_S$	Maximum Body-Diode Continuous Current <sup>H</sup>				-12	A
<b>DYNAMIC PARAMETERS</b>						
$C_{iss}$	Input Capacitance			900	1125	pF
$C_{oss}$	Output Capacitance	$V_{GS} = 0\text{V}$ , $V_{DS} = -20\text{V}$ , $f = 1\text{MHz}$		97		pF
$C_{rss}$	Reverse Transfer Capacitance			68		pF
$R_g$	Gate resistance	$V_{GS} = 0\text{V}$ , $V_{DS} = 0\text{V}$ , $f = 1\text{MHz}$		14		$\Omega$
<b>SWITCHING PARAMETERS</b>						
$Q_g(-10\text{V})$	Total Gate Charge			16.2	21	nC
$Q_g(-4.5\text{V})$	Total Gate Charge	$V_{GS} = -10\text{V}$ , $V_{DS} = -20\text{V}$ , $I_D = -12\text{A}$		7.2	9.4	nC
$Q_{gs}$	Gate Source Charge			3.8		nC
$Q_{gd}$	Gate Drain Charge			3.5		nC
$t_{D(on)}$	Turn-On Delay Time			6.2		ns
$t_r$	Turn-On Rise Time	$V_{GS} = -10\text{V}$ , $V_{DS} = -20\text{V}$ , $R_L = 1.4\Omega$ , $R_{GEN} = 3\Omega$		8.4		ns
$t_{D(off)}$	Turn-Off Delay Time			44.8		ns
$t_f$	Turn-Off Fall Time			41.2		ns
$t_{rr}$	Body Diode Reverse Recovery Time	$I_F = -12\text{A}$ , $di/dt = 100\text{A}/\mu\text{s}$		21	27	ns
$Q_{rr}$	Body Diode Reverse Recovery Charge	$I_F = -12\text{A}$ , $di/dt = 100\text{A}/\mu\text{s}$		14		nC

A: The value of  $R_{\theta JA}$  is measured with the device in a still air environment with  $T_A = 25^\circ\text{C}$ . The power dissipation  $P_{DSM}$  and current rating  $I_{DSM}$  are based on  $T_{J(MAX)} = 150^\circ\text{C}$ , using  $t \leq 10\text{s}$  junction-to-ambient thermal resistance.

B: The power dissipation  $P_D$  is based on  $T_{J(MAX)} = 175^\circ\text{C}$ , 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  $T_{J(MAX)} = 175^\circ\text{C}$ .

D: The  $R_{\theta JA}$  is the sum of the thermal impedance from junction to case  $R_{\theta JC}$  and case to ambient.

E: The static characteristics in Figures 1 to 6 are obtained using  $<300\mu\text{s}$  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  $T_{J(MAX)} = 175^\circ\text{C}$ . 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  $T_A = 25^\circ\text{C}$ .

H: The maximum current rating is limited by bond-wires.

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TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS: N-CANNEL

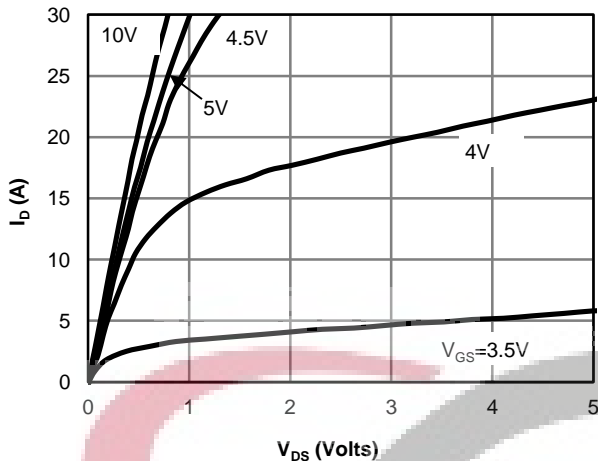


Fig 1: On-Region Characteristics

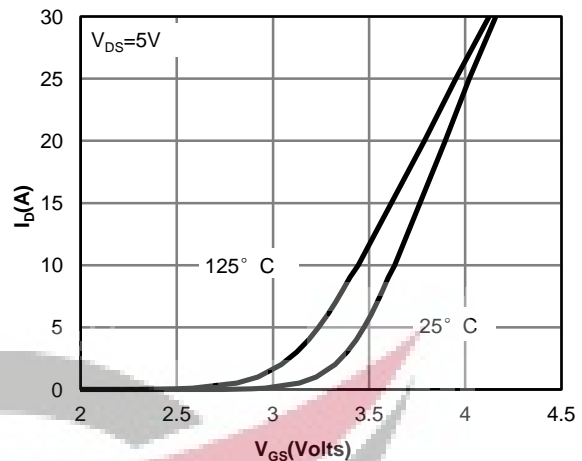


Figure 2: Transfer Characteristics

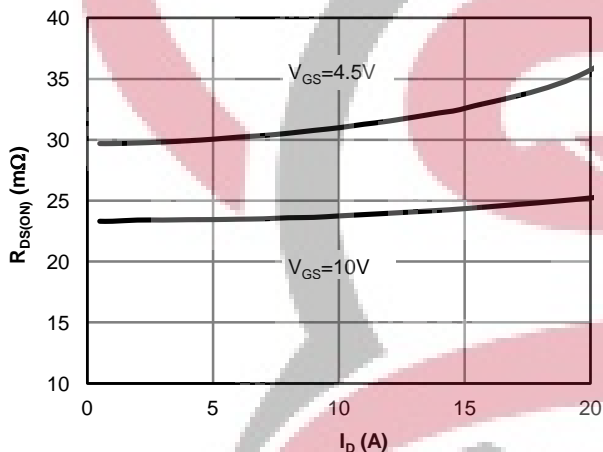


Figure 3: On-Resistance vs. Drain Current and Gate Voltage

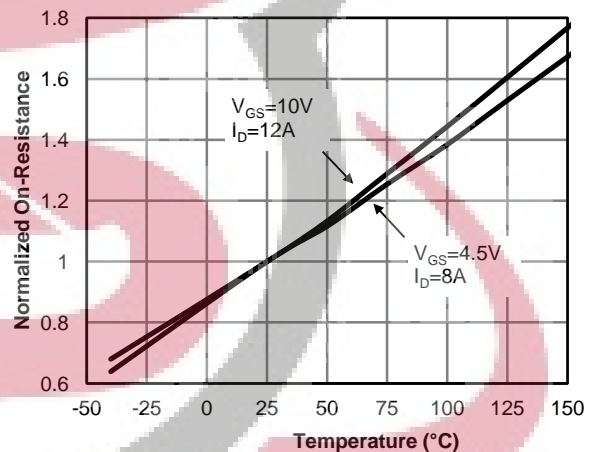


Figure 4: On-Resistance vs. Junction Temperature

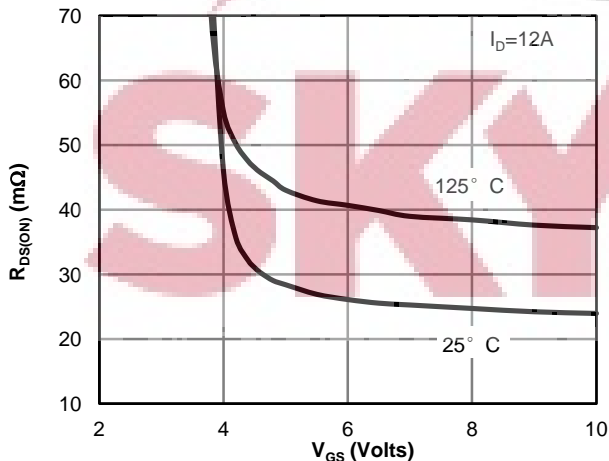


Figure 5: On-Resistance vs. Gate-Source Voltage

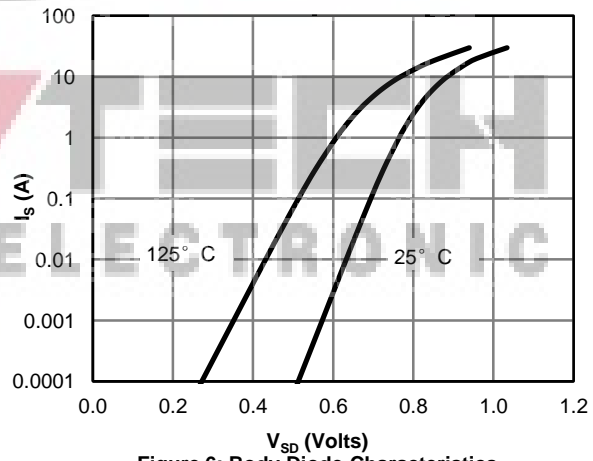


Figure 6: Body-Diode Characteristics

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS: N-CHANNEL

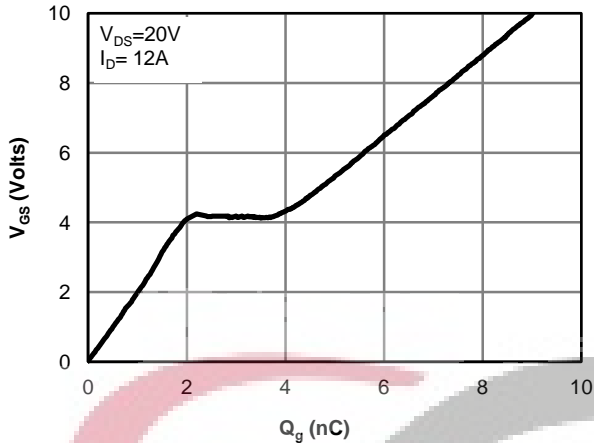


Figure 7: Gate-Charge Characteristics

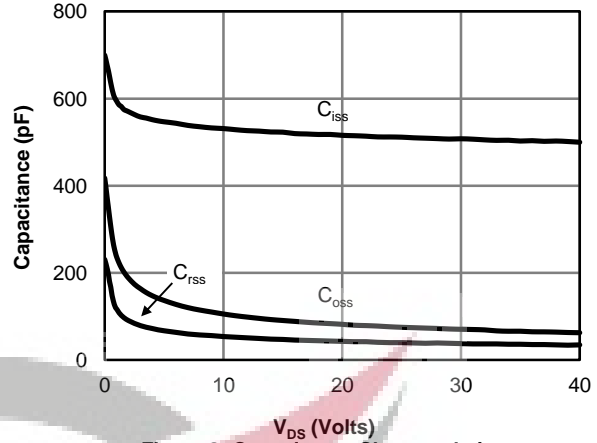


Figure 8: Capacitance Characteristics

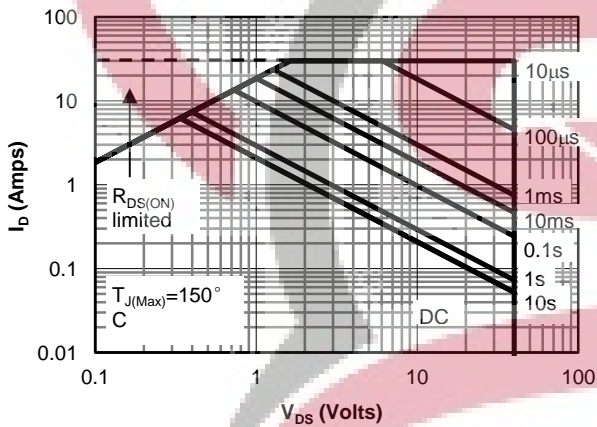


Figure 9: Maximum Forward Biased Safe Operating Area (Note E)

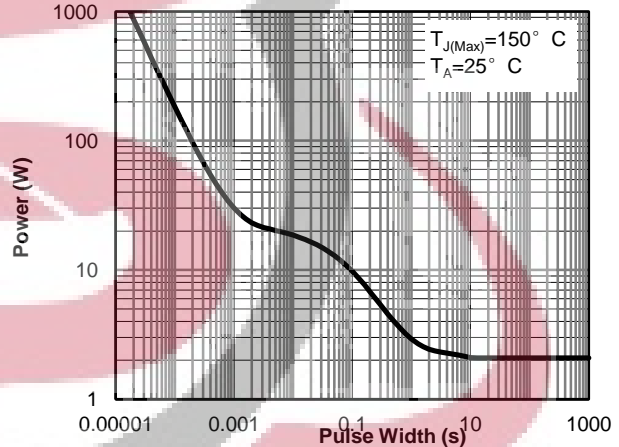


Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note E)

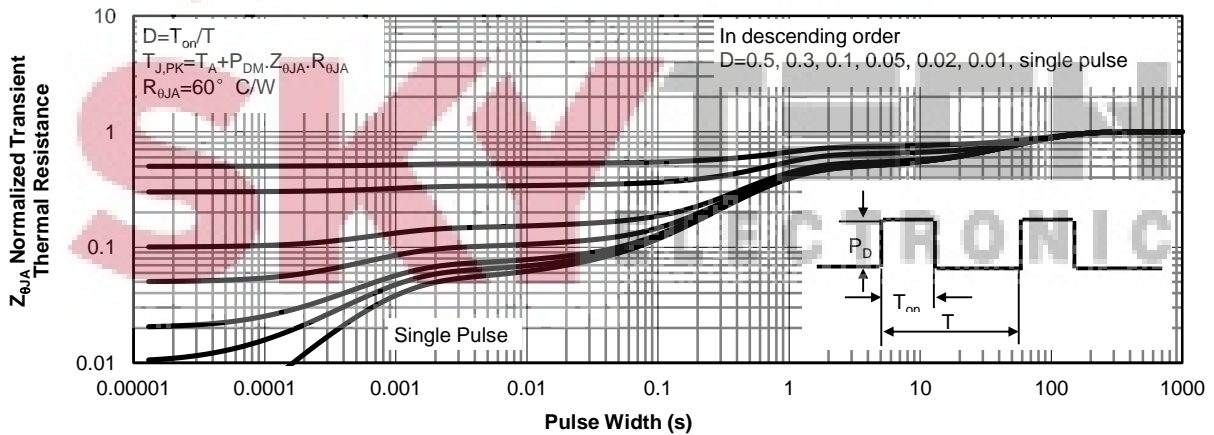
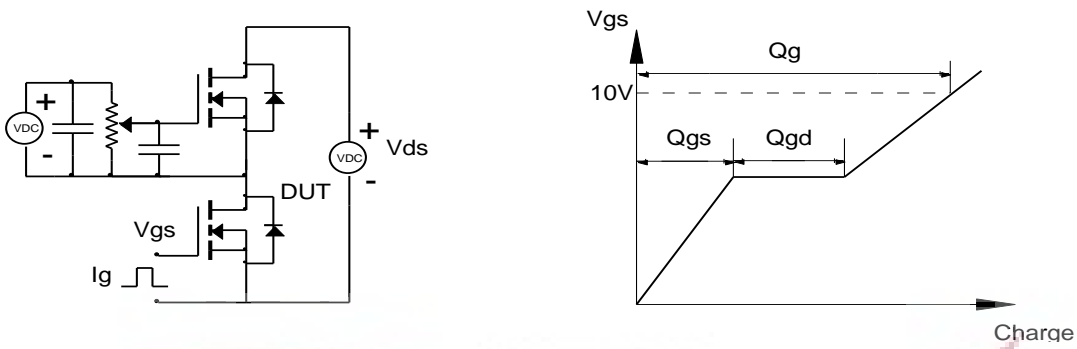
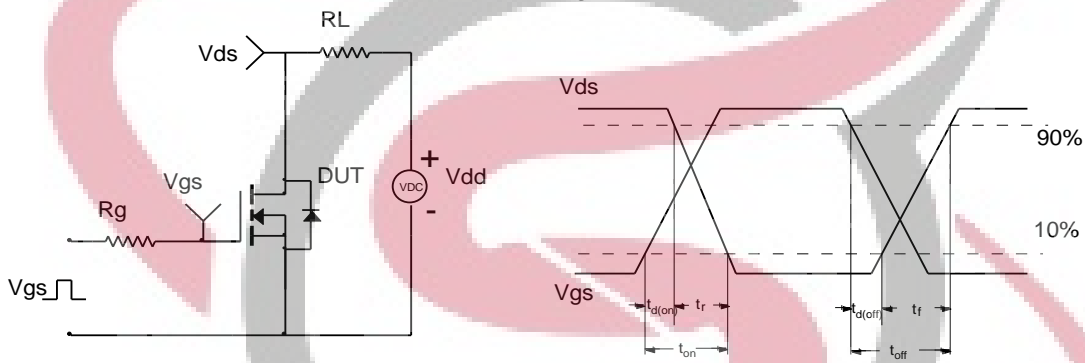


Figure 11: Normalized Maximum Transient Thermal Impedance

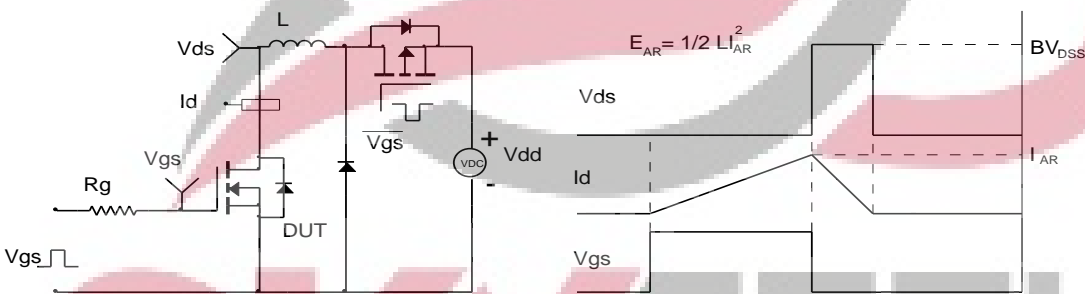
Gate Charge Test Circuit & Waveform



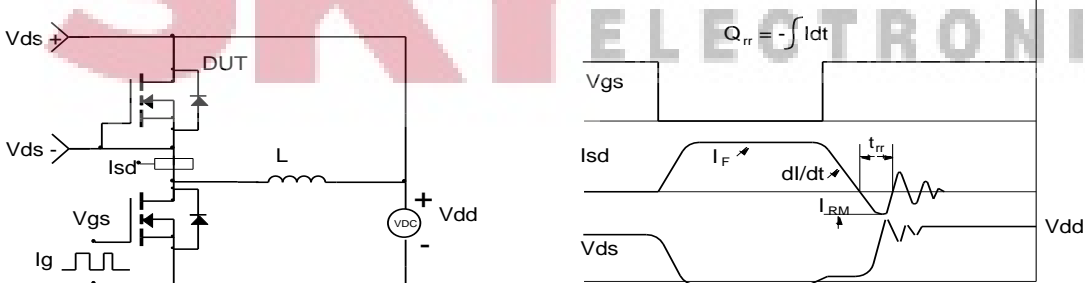
Resistive Switching Test Circuit & Waveforms



Unclamped Inductive Switching (UIS) Test Circuit & Waveforms



Diode Recovery Test Circuit & Waveforms



TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS: P-CHANNEL

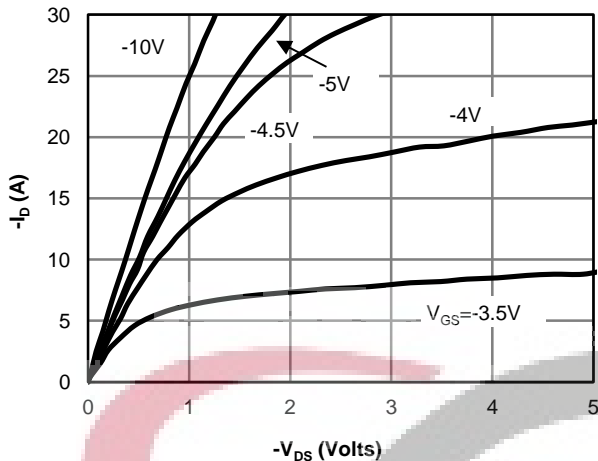


Fig 12: On-Region Characteristics

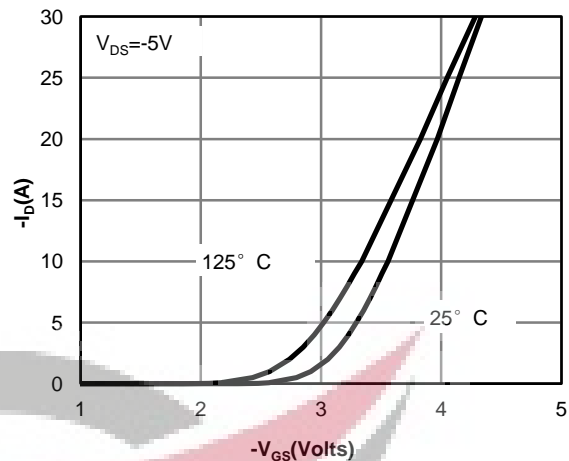


Figure 13: Transfer Characteristics

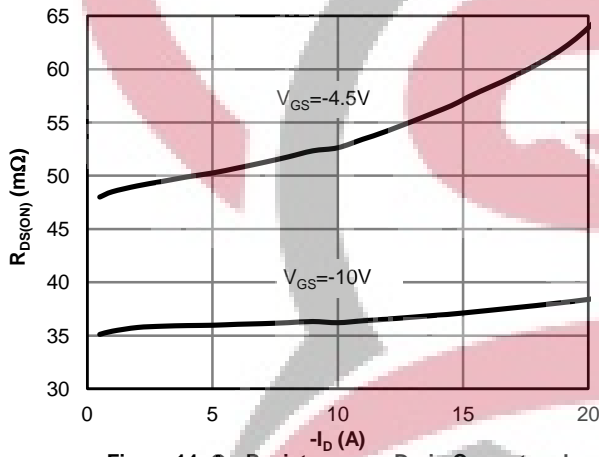


Figure 14: On-Resistance vs. Drain Current and Gate Voltage

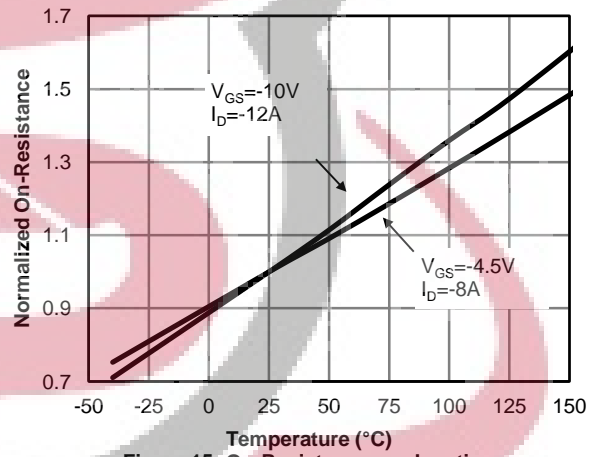


Figure 15: On-Resistance vs. Junction Temperature

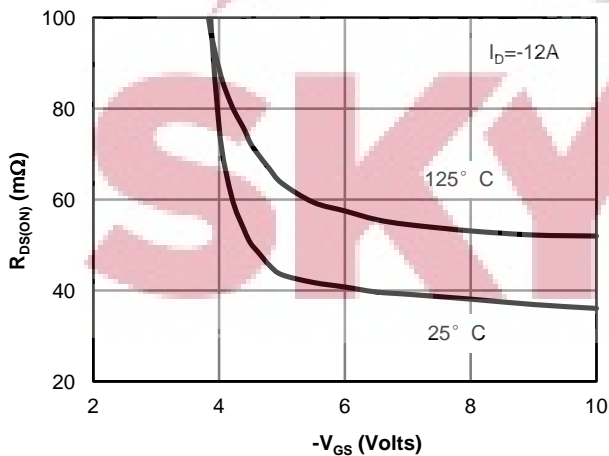


Figure 16: On-Resistance vs. Gate-Source Voltage

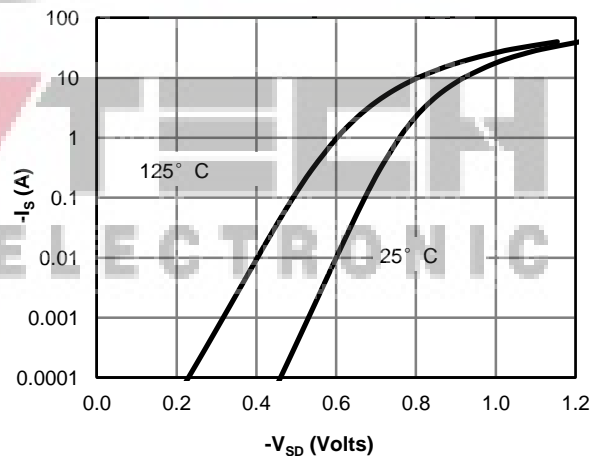


Figure 17: Body-Diode Characteristics

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS: P-CHANNEL

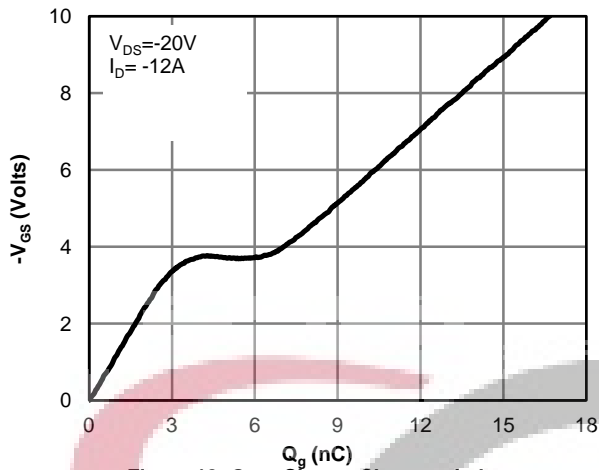


Figure 18: Gate-Charge Characteristics

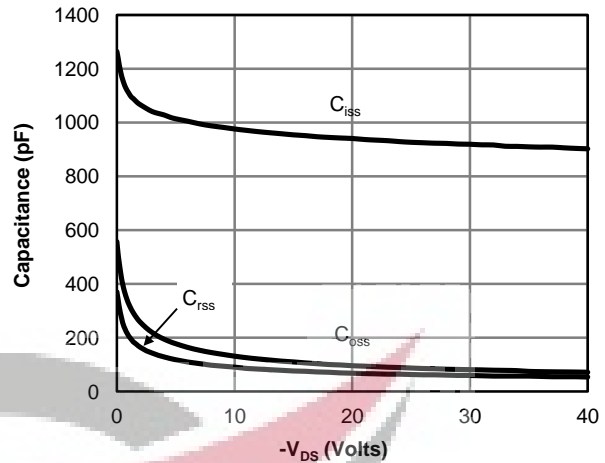


Figure 19: Capacitance Characteristics

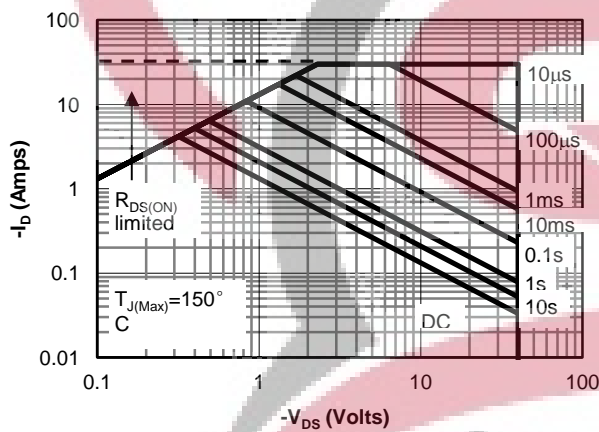


Figure 20: Maximum Forward Biased Safe Operating Area (Note E)

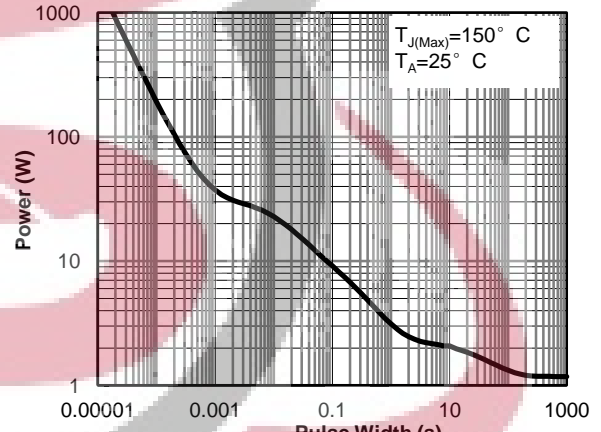


Figure 21: Single Pulse Power Rating Junction-to-Ambient (Note E)

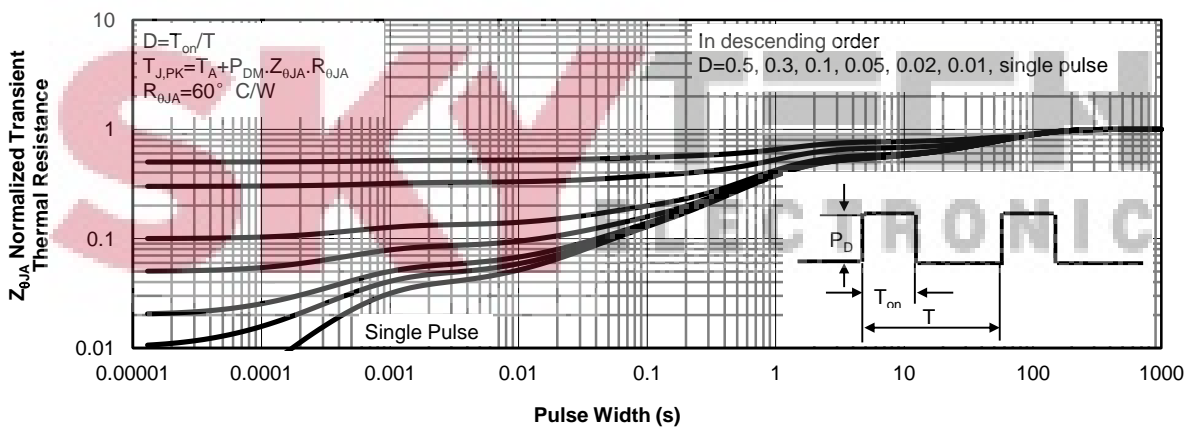
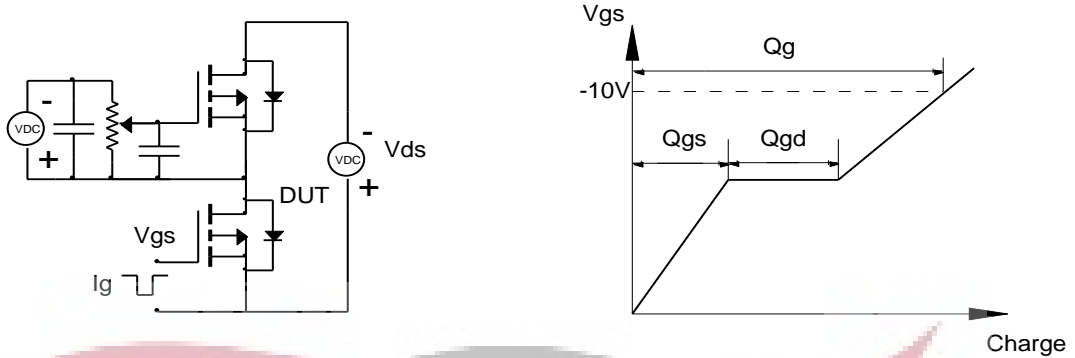


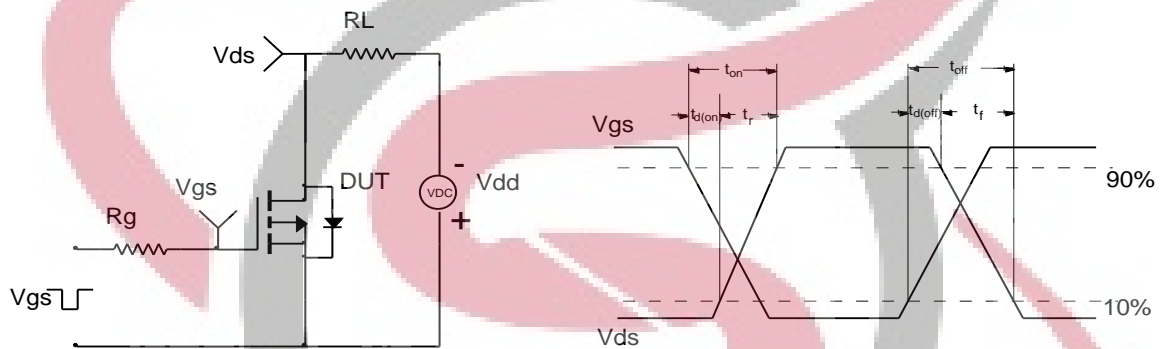
Figure 22: Normalized Maximum Transient Thermal Impedance



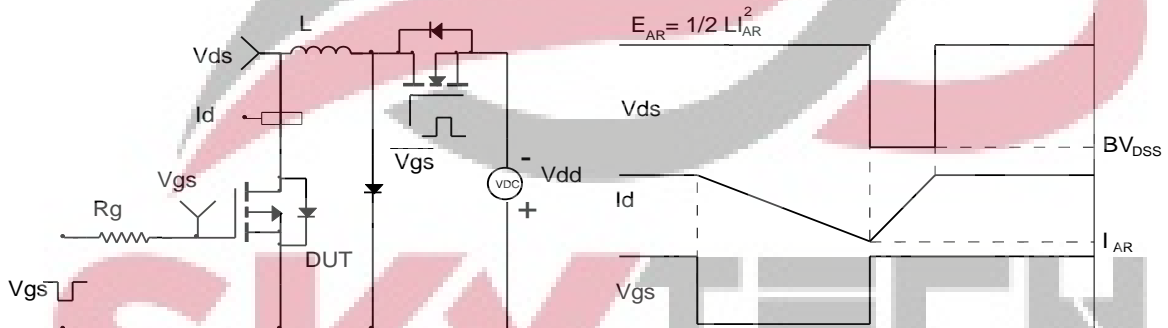
Gate Charge Test Circuit & Waveform



Resistive Switching Test Circuit & Waveforms



Unclamped Inductive Switching (UIS) Test Circuit & Waveforms



Diode Recovery Test Circuit & Waveforms

