

# APM9928

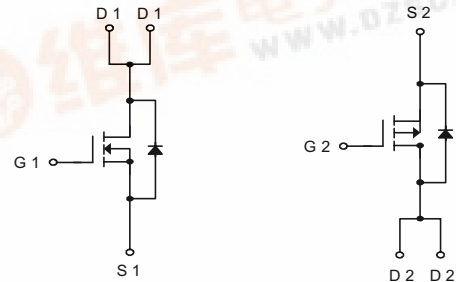
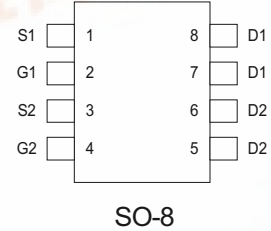


Dual Enhancement Mode MOSFET (N-and P-Channel)

## Features

- N-Channel  
20V/5A ,  $R_{DS(ON)}=35m\Omega(\text{typ.}) @ V_{GS}=4.5V$   
 $R_{DS(ON)}=50m\Omega(\text{typ.}) @ V_{GS}=3.0V$
- P-Channel  
-20V/-3.2A ,  $R_{DS(ON)}=80m\Omega(\text{typ.}) @ V_{GS}=-4.5V$   
 $R_{DS(ON)}=120m\Omega(\text{typ.}) @ V_{GS}=-3.0V$
- Super High Dense Cell Design for Extremely Low  $R_{DS(ON)}$
- Reliable and Rugged
- SO-8 Package

## Pin Description



## Applications

- Power Management in Notebook Computer , Portable Equipment and Battery Powered Systems.

## Ordering and Marking Information

<p>APM9928 □□-□□</p> <p>Handling Code</p> <p>Temp. Range</p> <p>Package Code</p>	<p>Package Code K : SO-8</p> <p>Operation Junction Temp. Range C : -55 to 150°C</p> <p>Handling Code TR : Tape &amp; Reel</p>
<p>APM9928 K : <span style="border: 1px solid black; padding: 2px;">APM9928 XXXXX</span></p>	<p>XXXXX - Date Code</p>

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

Symbol	Parameter	N-Channel	P-Channel	Unit	
$V_{DSS}$	Drain-Source Voltage	20	-20	V	
$V_{GSS}$	Gate-Source Voltage	$\pm 16$	$\pm 16$		
$I_D^*$	Maximum Drain Current – Continuous	5	3.2	A	
$I_{DM}$	Maximum Drain Current – Pulsed	10	-10		
$P_D$	Maximum Power Dissipation	$T_A = 25^\circ\text{C}$	2.5	2.5	W
		$T_A = 100^\circ\text{C}$	1.0	1.0	
$T_J$	Maximum Junction Temperature	150		$^\circ\text{C}$	
$T_{STG}$	Storage Temperature Range	-55 to 150		$^\circ\text{C}$	
$R_{\theta JA}$	Thermal Resistance – Junction to Ambient	50		$^\circ\text{C/W}$	

\* Surface Mounted on FR4 Board,  $t \leq 10$  sec.

## Electrical Characteristics ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

Symbol	Parameter	Test Condition	APM9928			Unit	
			Min.	Typ.	Max.		
<b>Static</b>							
$BV_{DSS}$	Drain-Source Breakdown Voltage	$V_{GS}=0V, I_{DS}=250\mu A$	N-Ch	20			V
			P-Ch	-20			
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS}=16V, V_{GS}=0V$	N-Ch			1	$\mu A$
		$V_{DS}=-16V, V_{GS}=0V$	P-Ch			-1	
$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS}=V_{GS}, I_{DS}=250\mu A$	N-Ch	0.7	0.9	1.5	V
		$V_{DS}=V_{GS}, I_{DS}=-250\mu A$	P-Ch	-0.7	-0.9	-1.5	
$I_{GSS}$	Gate Leakage Current	$V_{GS}=\pm 16V, V_{DS}=0V$	N-Ch			$\pm 100$	nA
			P-Ch			$\pm 100$	
$R_{DS(ON)}^a$	Drain-Source On-state Resistance	$V_{GS}=4.5V, I_{DS}=5.0A$	N-Ch		35	45	m $\Omega$
		$V_{GS}=3.0V, I_{DS}=3.9A$			50	60	
		$V_{GS}=-4.5V, I_{DS}=-3.2A$	P-Ch		80	100	
		$V_{GS}=-3.0V, I_{DS}=-2.0A$			120	150	
$V_{SD}^a$	Diode Forward Voltage	$I_{SD}=1.7A, V_{GS}=0V$	N-Ch		0.8	1.3	V
		$I_{SD}=-1.8A, V_{GS}=0V$	P-Ch		-0.8	-1.3	

### Notes

<sup>a</sup> : Pulse test ; pulse width  $\leq 300\mu s$ , duty cycle  $\leq 2\%$

**Electrical Characteristics (Cont.)** ( $T_A = 25^\circ\text{C}$  unless otherwise noted)

Symbol	Parameter	Test Condition	APM9928			Unit
			Min.	Typ.	Max.	
<b>Dynamic<sup>b</sup></b>						
Q <sub>g</sub>	Total Gate Charge	N-Channel V <sub>DS</sub> =10V , I <sub>DS</sub> = 1A	N-Ch	4.7	7	nC
			P-Ch	3.9	6	
Q <sub>gs</sub>	Gate-Source Charge	V <sub>GS</sub> =4.5V P-Channel	N-Ch	0.72		
			P-Ch	1		
Q <sub>gd</sub>	Gate-Drain Charge	V <sub>DS</sub> =-10V , I <sub>DS</sub> =-1A V <sub>GS</sub> =-4.5V	N-Ch	0.96		
			P-Ch	1.4		
t <sub>d(ON)</sub>	Turn-on Delay Time	N-Channel V <sub>DD</sub> =10V , I <sub>DS</sub> =1A , V <sub>GEN</sub> =4.5V , R <sub>G</sub> =10Ω	N-Ch	12	24	ns
			P-Ch	21	40	
T <sub>r</sub>	Turn-on Rise Time	P-Channel V <sub>DD</sub> =-10V , I <sub>DS</sub> =-1A , V <sub>GEN</sub> =-4.5V , R <sub>G</sub> =10Ω	N-Ch	8	17	
			P-Ch	45	83	
t <sub>d(OFF)</sub>	Turn-off Delay Time	N-Channel V <sub>DD</sub> =-10V , I <sub>DS</sub> =-1A , V <sub>GEN</sub> =-4.5V , R <sub>G</sub> =10Ω	N-Ch	32	60	
			P-Ch	36	70	
T <sub>f</sub>	Turn-off Fall Time	P-Channel V <sub>DD</sub> =-10V , I <sub>DS</sub> =-1A , V <sub>GEN</sub> =-4.5V , R <sub>G</sub> =10Ω	N-Ch	11	22	
			P-Ch	20	38	
C <sub>iss</sub>	Input Capacitance	V <sub>GS</sub> =0V	N-Ch	376		pF
			P-Ch	495		
C <sub>oss</sub>	Output Capacitance	V <sub>DS</sub> =15V Frequency=1.0MHz	N-Ch	115		
			P-Ch	130		
C <sub>rss</sub>	Reverse Transfer Capacitance		N-Ch	58		
			P-Ch	60		

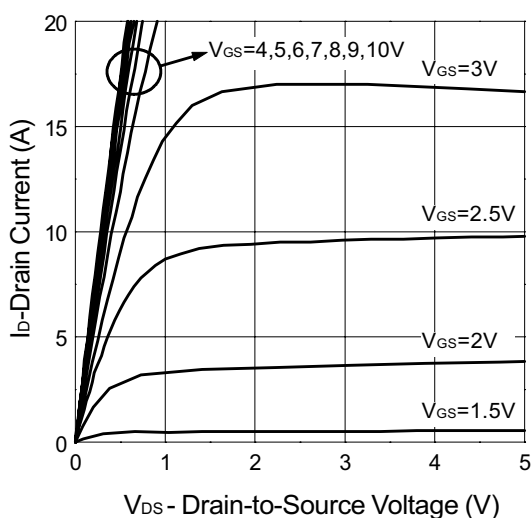
## Notes

<sup>b</sup> : Guaranteed by design, not subject to production testing

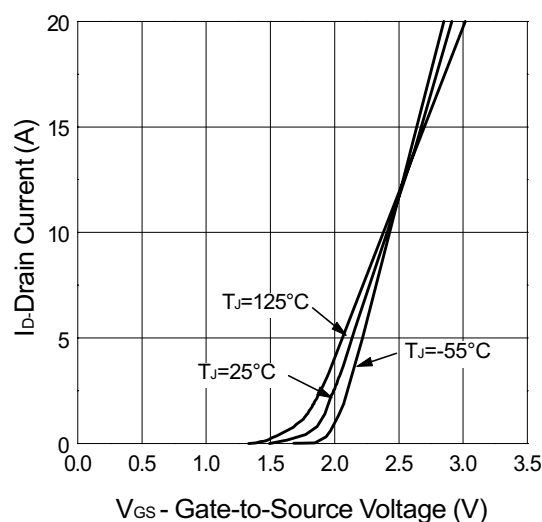
## Typical Characteristics

N-Channel

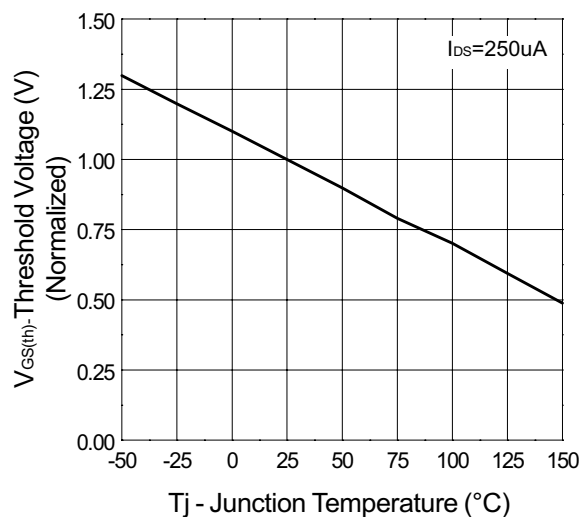
Output Characteristics



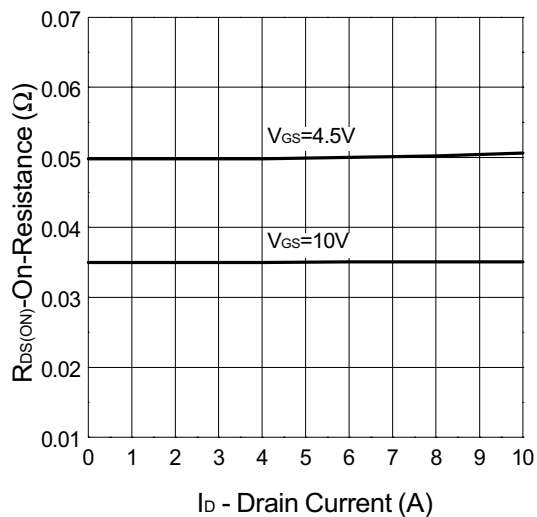
Transfer Characteristics



Threshold Voltage vs. Junction Temperature



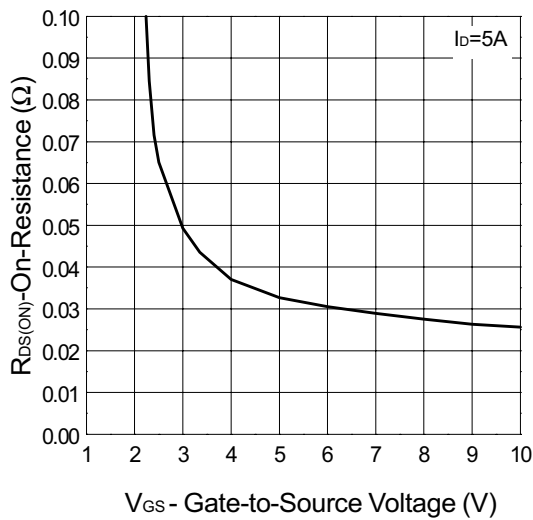
On-Resistance vs. Drain Current



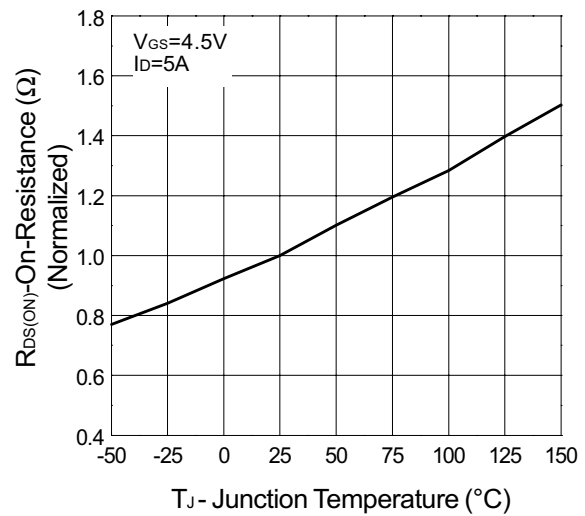
## Typical Characteristics (Cont.)

N-Channel

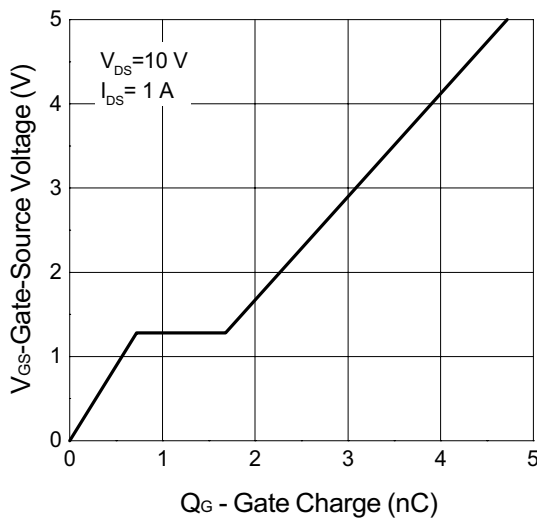
On-Resistance vs. Gate-to-Source Voltage



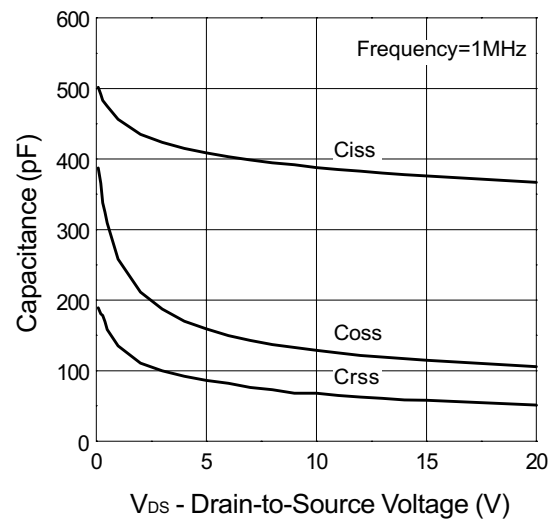
On-Resistance vs. Junction Temperature



Gate Charge

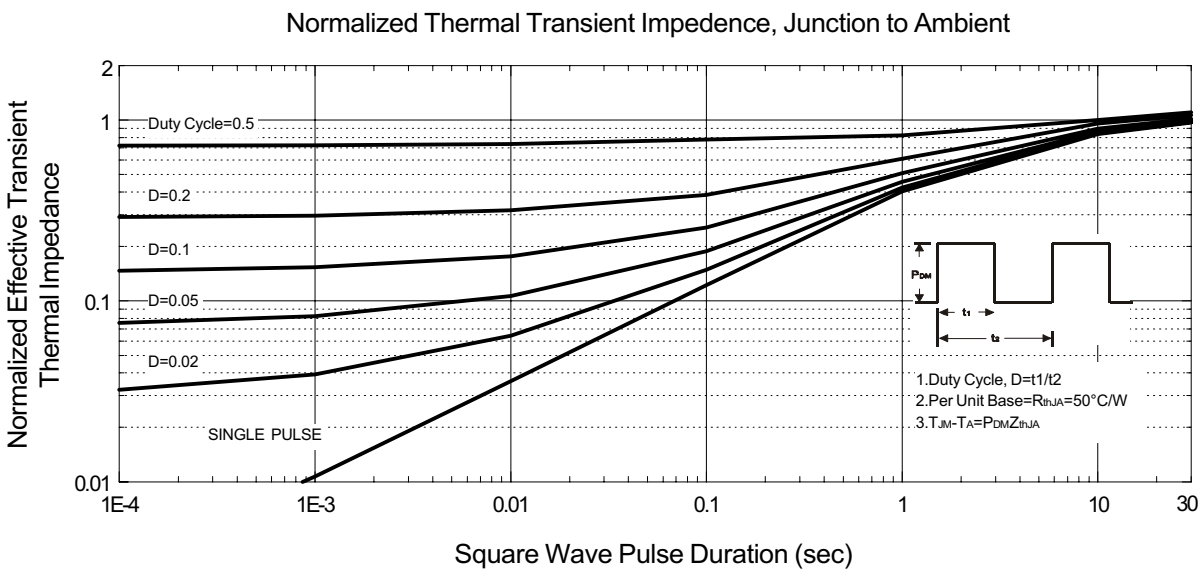
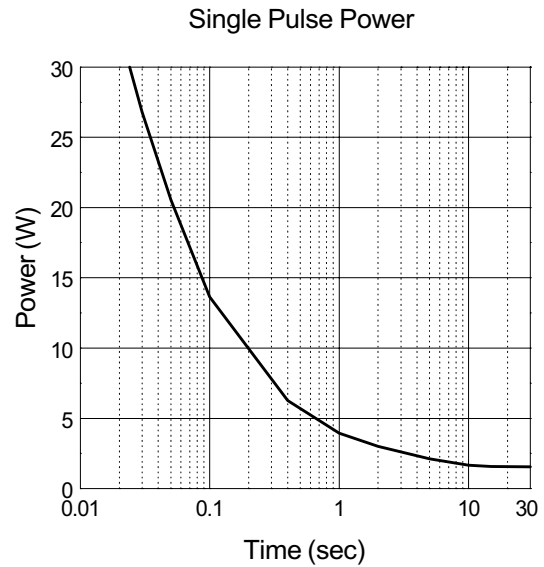
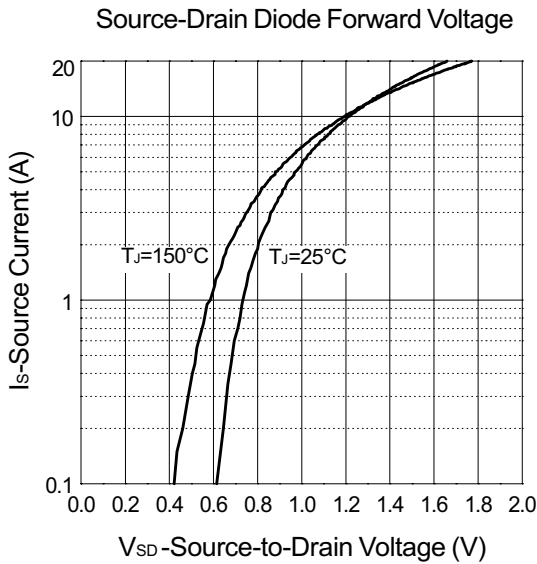


Capacitance



## Typical Characteristics (Cont.)

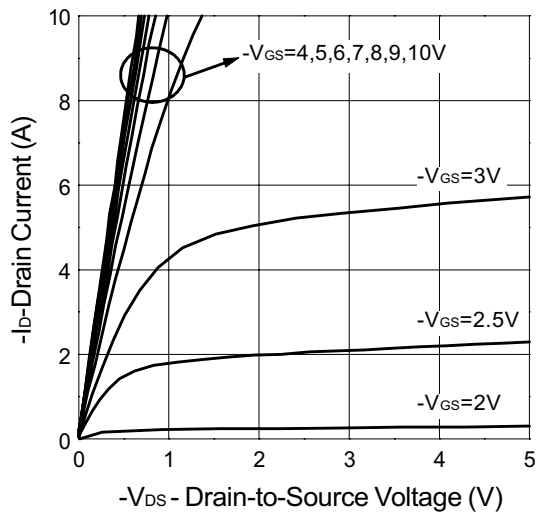
N-Channel



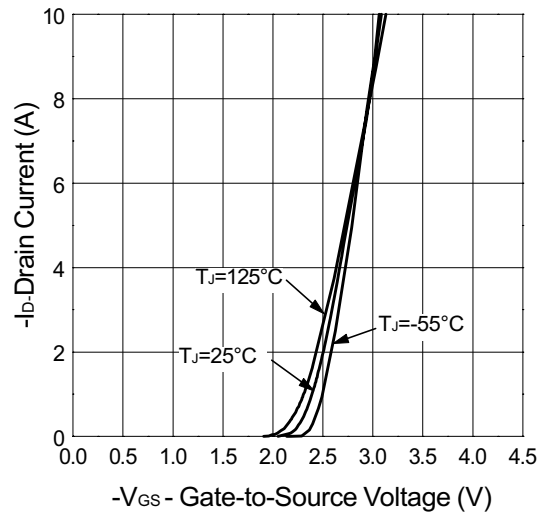
# Typical Characteristics

P-Channel

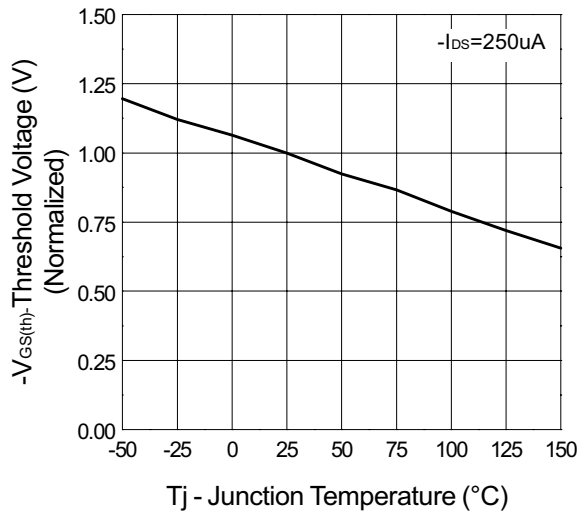
Output Characteristics



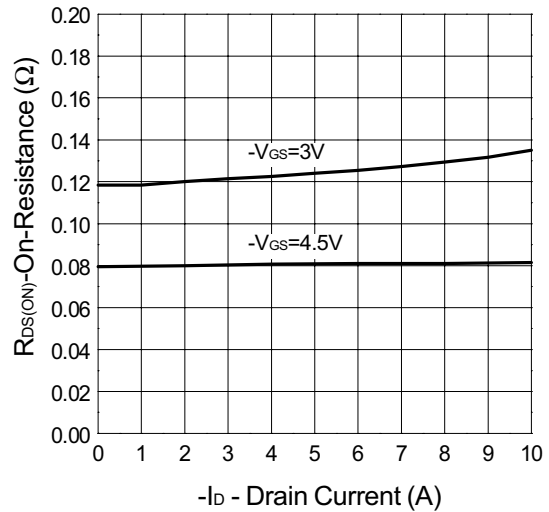
Transfer Characteristics



Threshold Voltage vs. Junction Temperature

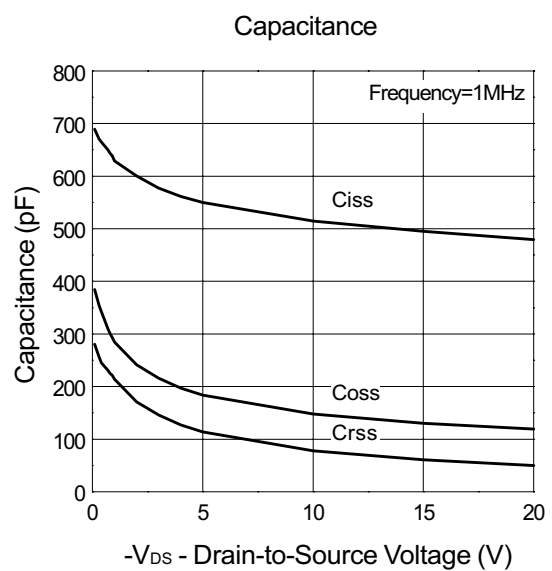
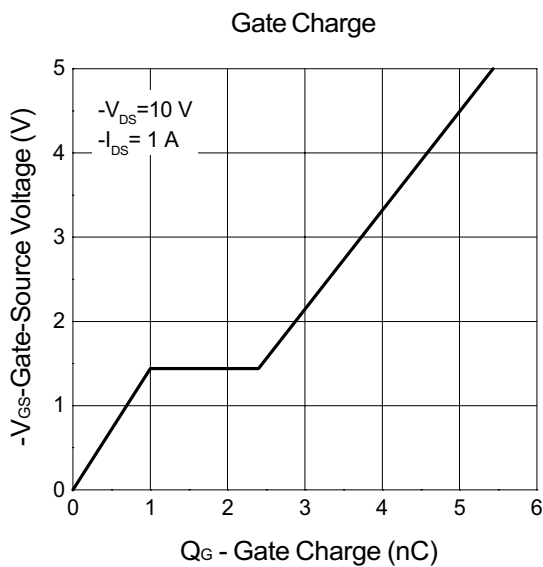
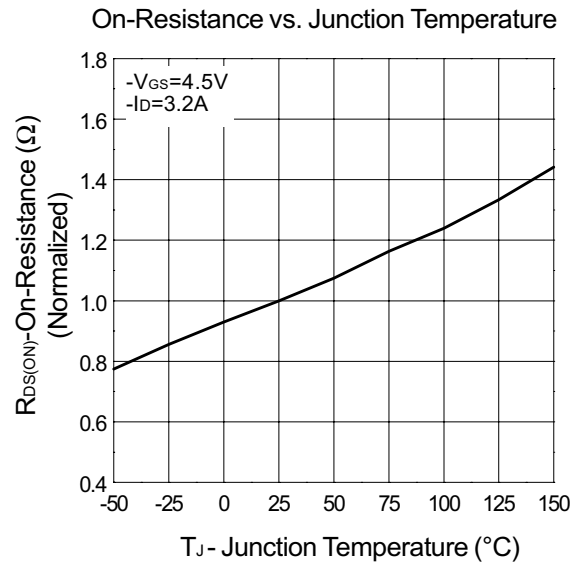
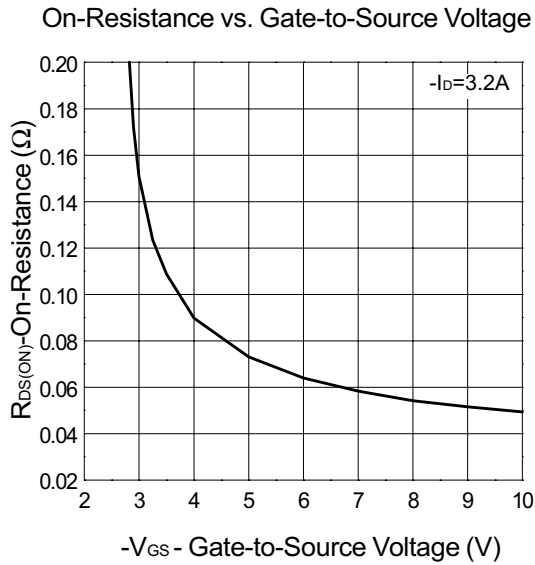


On-Resistance vs. Drain Current



## Typical Characteristics (Cont.)

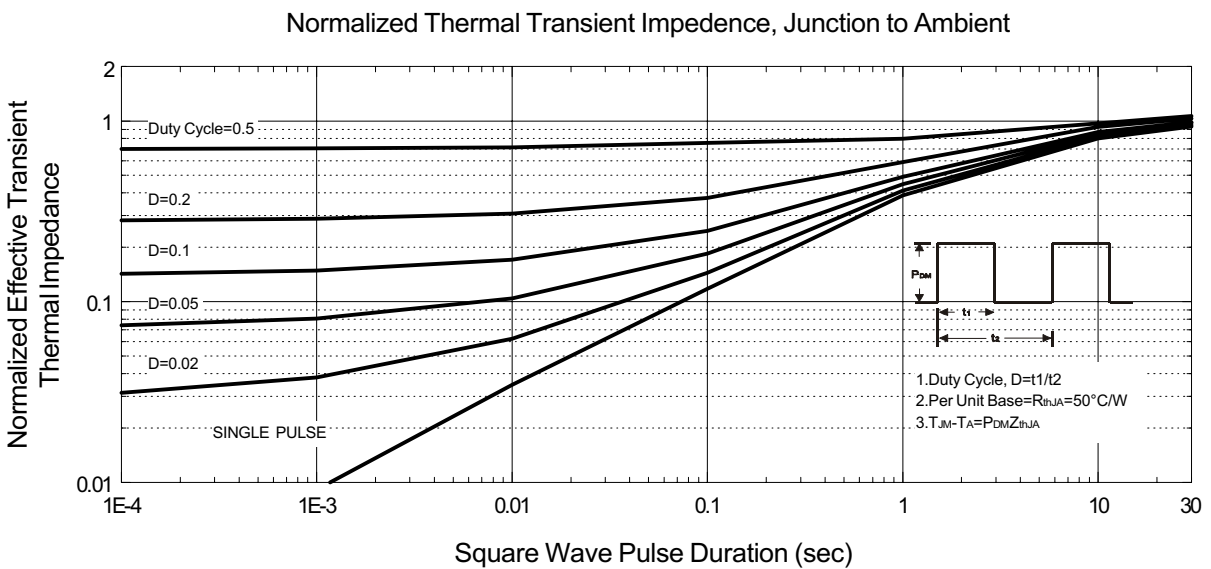
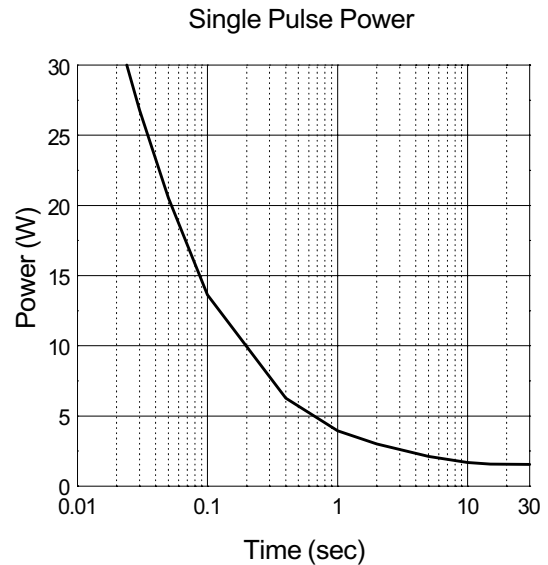
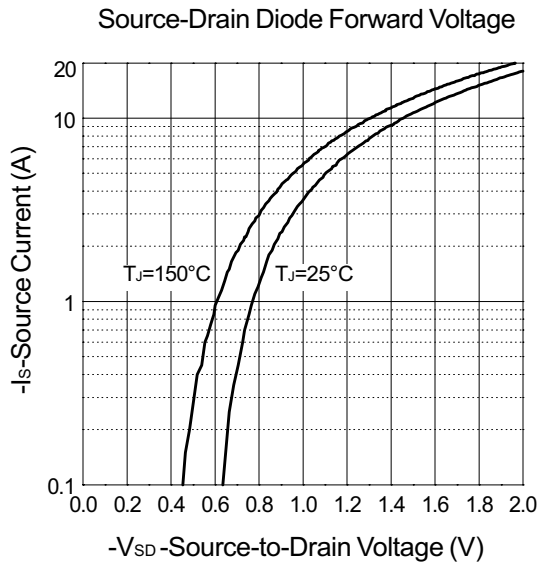
P-Channel





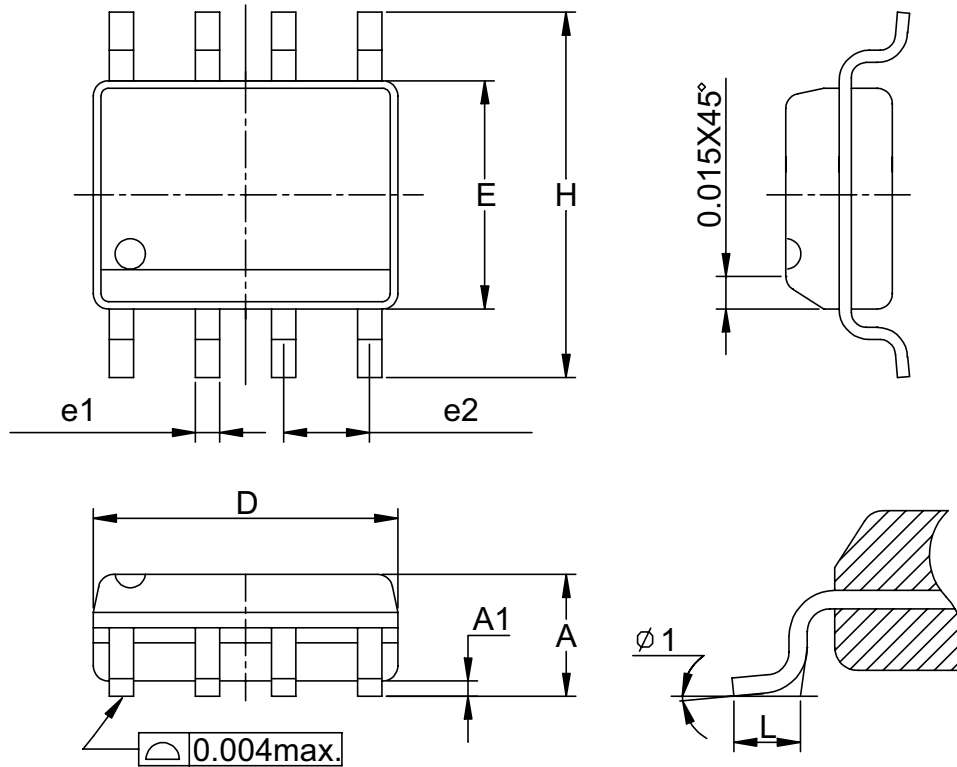
## Typical Characteristics (Cont.)

P-Channel



## Packaging Information

SOP-8 pin ( Reference JEDEC Registration MS-012)



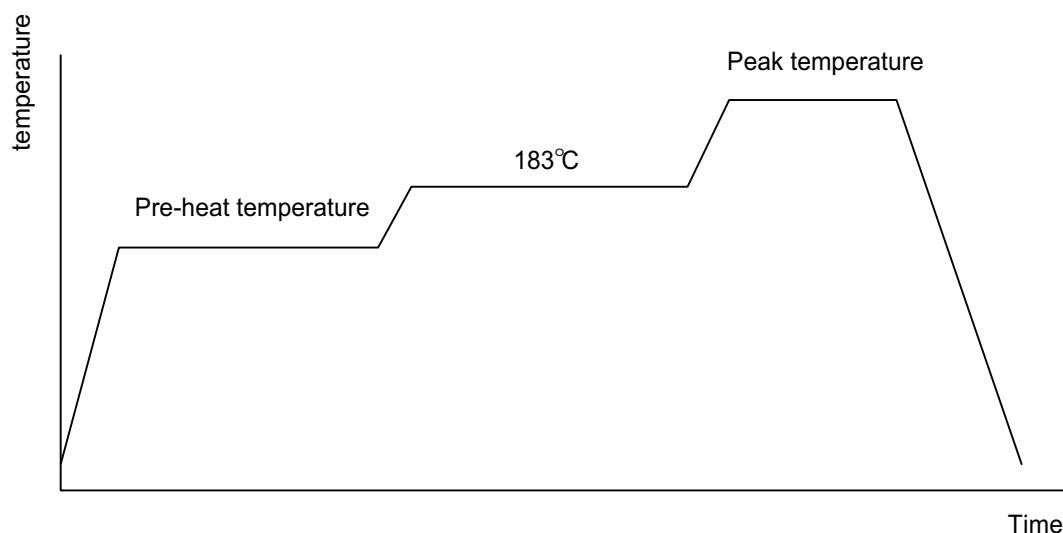
Dim	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
D	4.80	5.00	0.189	0.197
E	3.80	4.00	0.150	0.157
H	5.80	6.20	0.228	0.244
L	0.40	1.27	0.016	0.050
e1	0.33	0.51	0.013	0.020
e2	1.27BSC		0.50BSC	
φ 1	8°		8°	

## Physical Specifications

Terminal Material	Solder-Plated Copper (Solder Material : 90/10 or 63/37 SnPb)
Lead Solderability	Meets EIA Specification RSI86-91, ANSI/J-STD-002 Category 3.

## Reflow Condition (IR/Convection or VPR Reflow)

Reference JEDEC Standard J-STD-020A APRIL 1999



## Classification Reflow Profiles

	Convection or IR/ Convection	VPR
Average ramp-up rate(183°C to Peak)	3°C/second max.	10 °C /second max.
Preheat temperature 125 ± 25°C)	120 seconds max	
Temperature maintained above 183°C	60 – 150 seconds	
Time within 5°C of actual peak temperature	10 –20 seconds	60 seconds
Peak temperature range	220 +5/-0°C or 235 +5/-0°C	215-219°C or 235 +5/-0°C
Ramp-down rate	6 °C /second max.	10 °C /second max.
Time 25°C to peak temperature	6 minutes max.	

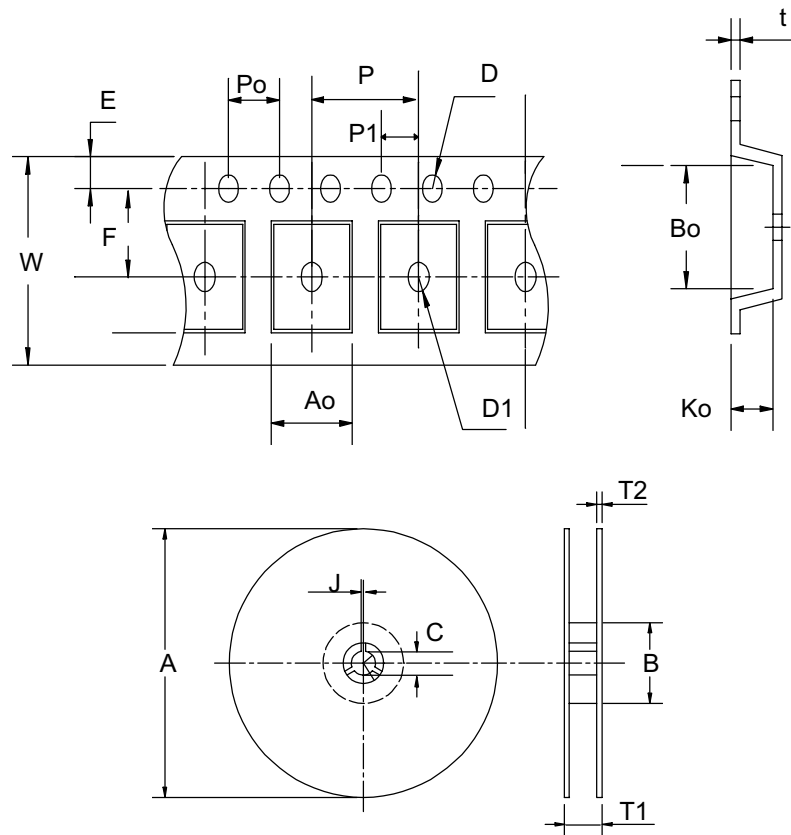
## Package Reflow Conditions

pkg. thickness ≥ 2.5mm and all bgas	pkg. thickness < 2.5mm and pkg. volume ≥ 350 mm <sup>3</sup>	pkg. thickness < 2.5mm and pkg. volume < 350mm <sup>3</sup>
Convection 220 +5/-0 °C		Convection 235 +5/-0 °C
VPR 215-219 °C		VPR 235 +5/-0 °C
IR/Convection 220 +5/-0 °C		IR/Convection 235 +5/-0 °C

## Reliability test program

Test item	Method	Description
SOLDERABILITY	MIL-STD-883D-2003	245°C, 5 SEC
HOLT	MIL-STD 883D-1005.7	1000 Hrs Bias @ 125°C
PCT	JESD-22-B, A102	168 Hrs, 100% RH, 121°C
TST	MIL-STD 883D-1011.9	-65°C ~ 150°C, 200 Cycles

## Carrier Tape & Reel Dimensions



Application	A	B	C	J	T1	T2	W	P	E
SOP- 8	330 ± 1	62 +1.5	12.75+ 0.15	2 ± 0.5	12.4 ± 0.2	2 ± 0.2	12 ± 0.3	8 ± 0.1	1.75 ± 0.1
	F	D	D1	Po	P1	Ao	Bo	Ko	t
	5.5 ± 1	1.55 +0.1	1.55 + 0.25	4.0 ± 0.1	2.0 ± 0.1	6.4 ± 0.1	5.2 ± 0.1	2.1 ± 0.1	0.3 ± 0.013

## Cover Tape Dimensions

Application	Carrier Width	Cover Tape Width	Devices Per Reel
SOP- 8	12	9.3	2500

## Customer Service

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