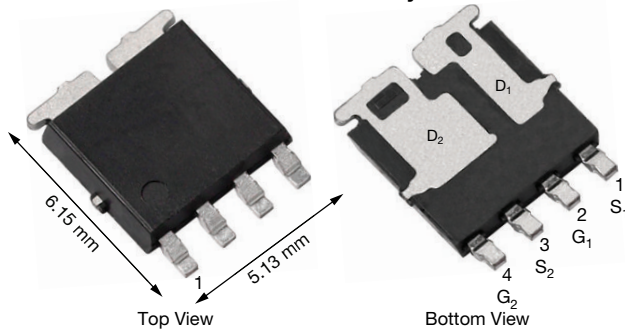


# Automotive Dual N-Channel 60 V (D-S) 175 °C MOSFETs

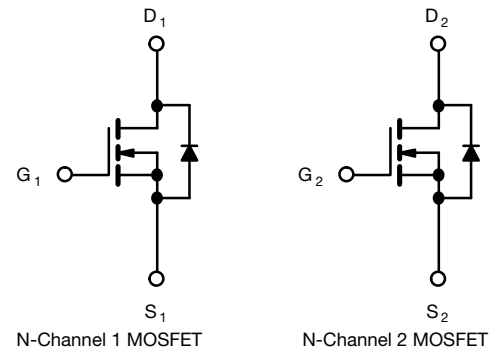
**PowerPAK® SO-8L Dual Asymmetric**

**FEATURES**

- TrenchFET® power MOSFET
- AEC-Q101 qualified
- 100 % R<sub>g</sub> and UIS tested
- Optimized for synchronous buck applications
- Material categorization:  
for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)

 AUTOMOTIVE  
GRADE

**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**

PRODUCT SUMMARY		
	N-CHANNEL 1	N-CHANNEL 2
V <sub>DS</sub> (V)	60	60
R <sub>DS(on)</sub> (Ω) at V <sub>GS</sub> = 10 V	0.0190	0.0085
R <sub>DS(on)</sub> (Ω) at V <sub>GS</sub> = 4.5 V	0.0240	0.0115
I <sub>D</sub> (A)	20	54
Configuration	Dual N	
Package	PowerPAK SO-8L Dual Asymmetric	



ABSOLUTE MAXIMUM RATINGS (T <sub>C</sub> = 25 °C, unless otherwise noted)				
PARAMETER	SYMBOL	N-CHANNEL 1	N-CHANNEL 2	UNIT
Drain-source voltage	V <sub>DS</sub>	60	60	V
Gate-source voltage	V <sub>GS</sub>	± 20		
Continuous drain current	I <sub>D</sub>	T <sub>C</sub> = 25 °C	20 <sup>a</sup>	A
		T <sub>C</sub> = 125 °C	15	
Continuous source current (diode conduction)	I <sub>S</sub>	20 <sup>a</sup>	44	A
Pulsed drain current <sup>b</sup>	I <sub>DM</sub>	60	86	
Single pulse avalanche current	I <sub>AS</sub>	18	30	mJ
Single pulse avalanche energy	E <sub>AS</sub>	16.2	45	
Maximum power dissipation <sup>b</sup>	P <sub>D</sub>	T <sub>C</sub> = 25 °C	27	W
		T <sub>C</sub> = 125 °C	9	
Operating junction and storage temperature range	T <sub>J</sub> , T <sub>stg</sub>	-55 to +175		°C
Soldering recommendations (peak temperature) <sup>d, e</sup>		260		

THERMAL RESISTANCE RATINGS				
PARAMETER	SYMBOL	N-CHANNEL 1	N-CHANNEL 2	UNIT
Junction-to-ambient	R <sub>thJA</sub>	85	85	°C/W
Junction-to-case (drain)	R <sub>thJC</sub>	5.5	3.1	

**Notes**

- Package limited
- Pulse test; pulse width ≤ 300 μs, duty cycle ≤ 2 %
- When mounted on 1" square PCB (FR4 material)
- See solder profile ([www.vishay.com/doc?73257](http://www.vishay.com/doc?73257)). The PowerPAK SO-8L is a leadless package. The end of the lead terminal is exposed copper (not plated) as a result of the singulation process in manufacturing. A solder fillet at the exposed copper tip cannot be guaranteed and is not required to ensure adequate bottom side solder interconnection
- Rework conditions: manual soldering with a soldering iron is not recommended for leadless components



<b>SPECIFICATIONS</b> ( $T_C = 25\text{ }^\circ\text{C}$ , unless otherwise noted)								
PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT	
<b>Static</b>								
Drain-source breakdown voltage	$V_{DS}$	$V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$		N-Ch 1	60	-	-	V
		$V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$		N-Ch 2	60	-	-	
Gate-source threshold voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$		N-Ch 1	1.5	2.0	2.5	
		$V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$		N-Ch 2	1.5	2.0	2.5	
Gate-source leakage	$I_{GSS}$	$V_{DS} = 0\text{ V}, V_{GS} = \pm 20\text{ V}$		N-Ch 1	-	-	$\pm 100$	nA
				N-Ch 2	-	-	$\pm 100$	
Zero gate voltage drain current	$I_{DSS}$	$V_{GS} = 0\text{ V}$	$V_{DS} = 60\text{ V}$	N-Ch 1	-	-	1	$\mu\text{A}$
		$V_{GS} = 0\text{ V}$	$V_{DS} = 60\text{ V}$	N-Ch 2	-	-	1	
		$V_{GS} = 0\text{ V}$	$V_{DS} = 60\text{ V}, T_J = 125\text{ }^\circ\text{C}$	N-Ch 1	-	-	50	
		$V_{GS} = 0\text{ V}$	$V_{DS} = 60\text{ V}, T_J = 125\text{ }^\circ\text{C}$	N-Ch 2	-	-	50	
		$V_{GS} = 0\text{ V}$	$V_{DS} = 60\text{ V}, T_J = 175\text{ }^\circ\text{C}$	N-Ch 1	-	-	250	
		$V_{GS} = 0\text{ V}$	$V_{DS} = 60\text{ V}, T_J = 175\text{ }^\circ\text{C}$	N-Ch 2	-	-	250	
On-state drain current <sup>a</sup>	$I_{D(on)}$	$V_{GS} = 10\text{ V}$	$V_{DS} \geq 5\text{ V}$	N-Ch 1	15	-	-	A
		$V_{GS} = 10\text{ V}$	$V_{DS} \geq 5\text{ V}$	N-Ch 2	30	-	-	
Drain-source on-state resistance <sup>a</sup>	$R_{DS(on)}$	$V_{GS} = 10\text{ V}$	$I_D = 6\text{ A}$	N-Ch 1	-	0.0155	0.0190	$\Omega$
		$V_{GS} = 10\text{ V}$	$I_D = 10\text{ A}$	N-Ch 2	-	0.0070	0.0085	
		$V_{GS} = 10\text{ V}$	$I_D = 6\text{ A}, T_J = 125\text{ }^\circ\text{C}$	N-Ch 1	-	-	0.0301	
		$V_{GS} = 10\text{ V}$	$I_D = 10\text{ A}, T_J = 125\text{ }^\circ\text{C}$	N-Ch 2	-	-	0.0131	
		$V_{GS} = 10\text{ V}$	$I_D = 6\text{ A}, T_J = 175\text{ }^\circ\text{C}$	N-Ch 1	-	-	0.0366	
		$V_{GS} = 10\text{ V}$	$I_D = 10\text{ A}, T_J = 175\text{ }^\circ\text{C}$	N-Ch 2	-	-	0.0160	
		$V_{GS} = 4.5\text{ V}$	$I_D = 4\text{ A}$	N-Ch 1	-	0.0200	0.0240	
		$V_{GS} = 4.5\text{ V}$	$I_D = 8\text{ A}$	N-Ch 2	-	0.0094	0.0115	
Forward transconductance <sup>b</sup>	$g_{fs}$	$V_{DS} = 10\text{ V}, I_D = 6\text{ A}$		N-Ch 1	-	26	-	S
		$V_{DS} = 10\text{ V}, I_D = 10\text{ A}$		N-Ch 2	-	49	-	
<b>Dynamic <sup>b</sup></b>								
Input capacitance	$C_{iss}$	$V_{GS} = 0\text{ V}$	$V_{DS} = 25\text{ V}, f = 1\text{ MHz}$	N-Ch 1	-	805	1100	$\text{pF}$
		$V_{GS} = 0\text{ V}$	$V_{DS} = 25\text{ V}, f = 1\text{ MHz}$	N-Ch 2	-	1790	2500	
Output capacitance	$C_{oss}$	$V_{GS} = 0\text{ V}$	$V_{DS} = 25\text{ V}, f = 1\text{ MHz}$	N-Ch 1	-	355	500	
		$V_{GS} = 0\text{ V}$	$V_{DS} = 25\text{ V}, f = 1\text{ MHz}$	N-Ch 2	-	800	1100	
Reverse transfer capacitance	$C_{rss}$	$V_{GS} = 0\text{ V}$	$V_{DS} = 25\text{ V}, f = 1\text{ MHz}$	N-Ch 1	-	13	20	
		$V_{GS} = 0\text{ V}$	$V_{DS} = 25\text{ V}, f = 1\text{ MHz}$	N-Ch 2	-	32	45	
Total gate charge <sup>c</sup>	$Q_g$	$V_{GS} = 10\text{ V}$	$V_{DS} = 30\text{ V}, I_D = 1.5\text{ A}$	N-Ch 1	-	12	20	nC
		$V_{GS} = 10\text{ V}$	$V_{DS} = 30\text{ V}, I_D = 3\text{ A}$	N-Ch 2	-	25	40	
Gate-source charge <sup>c</sup>	$Q_{gs}$	$V_{GS} = 10\text{ V}$	$V_{DS} = 30\text{ V}, I_D = 1.5\text{ A}$	N-Ch 1	-	2.6	-	
		$V_{GS} = 10\text{ V}$	$V_{DS} = 30\text{ V}, I_D = 3\text{ A}$	N-Ch 2	-	5.4	-	
Gate-drain charge <sup>c</sup>	$Q_{gd}$	$V_{GS} = 10\text{ V}$	$V_{DS} = 30\text{ V}, I_D = 1.5\text{ A}$	N-Ch 1	-	1.5	-	
		$V_{GS} = 10\text{ V}$	$V_{DS} = 30\text{ V}, I_D = 3\text{ A}$	N-Ch 2	-	3	-	
Gate resistance	$R_g$	$f = 1\text{ MHz}$		N-Ch 1	0.45	0.92	1.4	$\Omega$
				N-Ch 2	0.2	0.46	0.7	



<b>SPECIFICATIONS</b> ( $T_C = 25\text{ }^\circ\text{C}$ , unless otherwise noted)							
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT	
<b>Dynamic <sup>b</sup></b>							
Turn-on delay time <sup>c</sup>	$t_{d(on)}$	$V_{DD} = 30\text{ V}$ , $R_L = 20\ \Omega$ , $I_D \cong 1.5\text{ A}$ , $V_{GEN} = 10\text{ V}$ , $R_g = 1\ \Omega$	N-Ch 1	-	10	15	ns
		$V_{DD} = 30\text{ V}$ , $R_L = 10\ \Omega$ , $I_D \cong 3\text{ A}$ , $V_{GEN} = 10\text{ V}$ , $R_g = 1\ \Omega$	N-Ch 2	-	14	25	
Rise time <sup>c</sup>	$t_r$	$V_{DD} = 30\text{ V}$ , $R_L = 20\ \Omega$ , $I_D \cong 1.5\text{ A}$ , $V_{GEN} = 10\text{ V}$ , $R_g = 1\ \Omega$	N-Ch 1	-	2	5	
		$V_{DD} = 30\text{ V}$ , $R_L = 10\ \Omega$ , $I_D \cong 3\text{ A}$ , $V_{GEN} = 10\text{ V}$ , $R_g = 1\ \Omega$	N-Ch 2	-	3	5	
Turn-off delay time <sup>c</sup>	$t_{d(off)}$	$V_{DD} = 30\text{ V}$ , $R_L = 20\ \Omega$ , $I_D \cong 1.5\text{ A}$ , $V_{GEN} = 10\text{ V}$ , $R_g = 1\ \Omega$	N-Ch 1	-	18	30	
		$V_{DD} = 30\text{ V}$ , $R_L = 10\ \Omega$ , $I_D \cong 3\text{ A}$ , $V_{GEN} = 10\text{ V}$ , $R_g = 1\ \Omega$	N-Ch 2	-	26	40	
Fall time <sup>c</sup>	$t_f$	$V_{DD} = 30\text{ V}$ , $R_L = 20\ \Omega$ , $I_D \cong 1.5\text{ A}$ , $V_{GEN} = 10\text{ V}$ , $R_g = 1\ \Omega$	N-Ch 1	-	10	15	
		$V_{DD} = 30\text{ V}$ , $R_L = 10\ \Omega$ , $I_D \cong 3\text{ A}$ , $V_{GEN} = 10\text{ V}$ , $R_g = 1\ \Omega$	N-Ch 2	-	11	18	
<b>Source-Drain Diode Ratings and Characteristics <sup>b</sup></b>							
Pulsed current <sup>a</sup>	$I_{SM}$		N-Ch 1	-	-	60	A
			N-Ch 2	-	-	86	
Forward voltage	$V_{SD}$	$I_F = 6\text{ A}$ , $V_{GS} = 0\text{ V}$	N-Ch 1	-	0.83	1.2	V
		$I_F = 10\text{ A}$ , $V_{GS} = 0\text{ V}$	N-Ch 2	-	0.82	1.2	
Body diode reverse recovery time	$t_{rr}$	$I_F = 4\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$	N-Ch 1	-	31	65	ns
		$I_F = 5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$	N-Ch 2	-	47	100	
Body diode reverse recovery charge	$Q_{rr}$	$I_F = 4\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$	N-Ch 1	-	26	55	nC
		$I_F = 5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$	N-Ch 2	-	55	110	
Reverse recovery fall time	$t_a$	$I_F = 4\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$	N-Ch 1	-	16	-	ns
		$I_F = 5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$	N-Ch 2	-	24	-	
Reverse recovery rise time	$t_b$	$I_F = 4\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$	N-Ch 1	-	15	-	ns
		$I_F = 5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$	N-Ch 2	-	23	-	
Body diode peak reverse recovery current	$I_{RM(REC)}$	$I_F = 4\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$	N-Ch 1	-	-1.6	-	A
		$I_F = 5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$	N-Ch 2	-	-2.1	-	

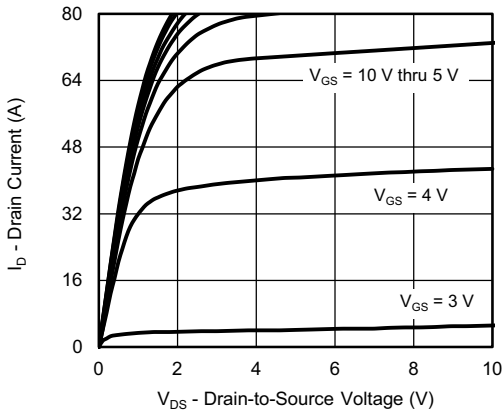
**Notes**

- a. Pulse test; pulse width  $\leq 300\ \mu\text{s}$ , duty cycle  $\leq 2\%$
- b. Guaranteed by design, not subject to production testing
- c. Independent of operating temperature

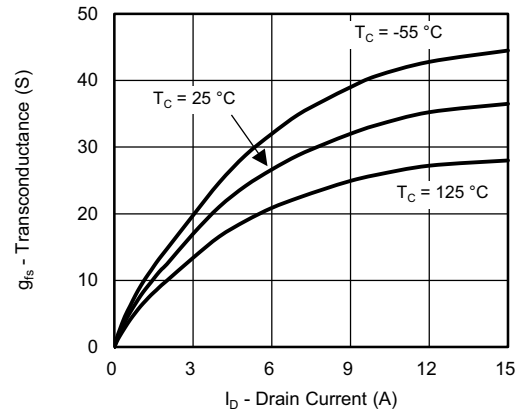
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.



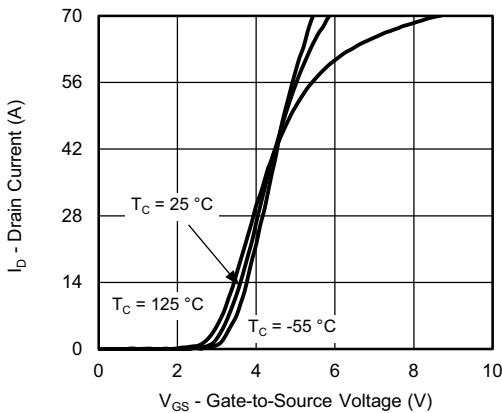
**N-CHANNEL 1 TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



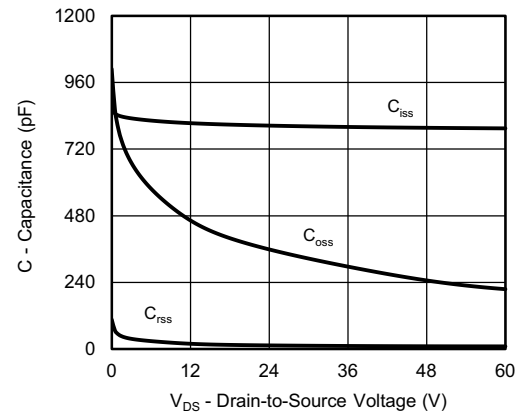
**Output Characteristics**



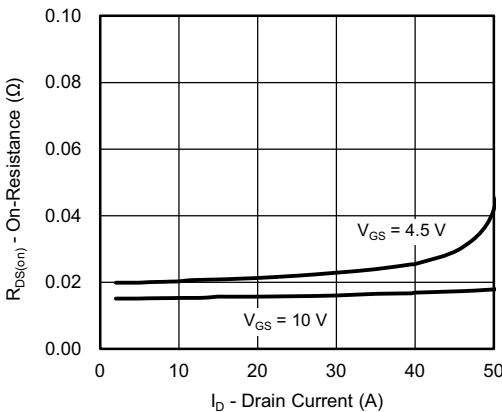
**Transconductance**



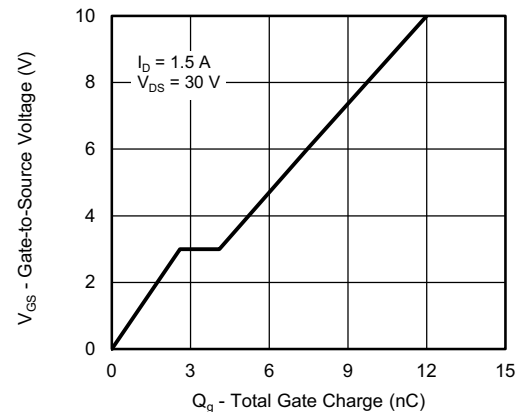
**Transfer Characteristics**



**Capacitance**



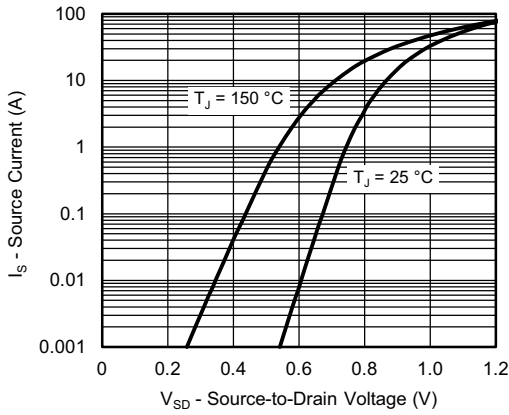
**On-Resistance vs. Drain Current**



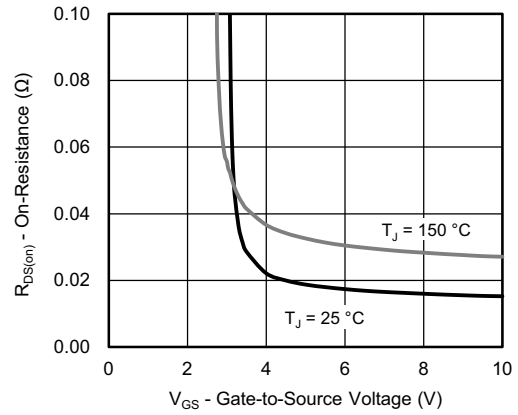
**Gate Charge**



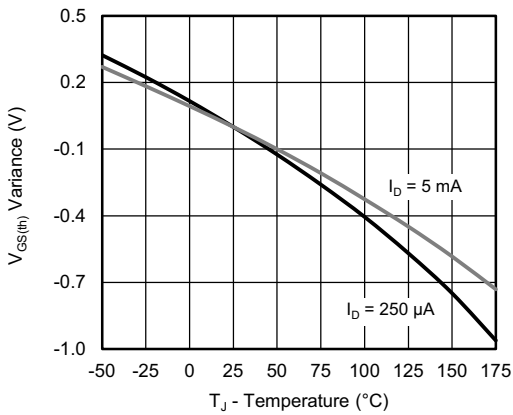
**N-CHANNEL 1 TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



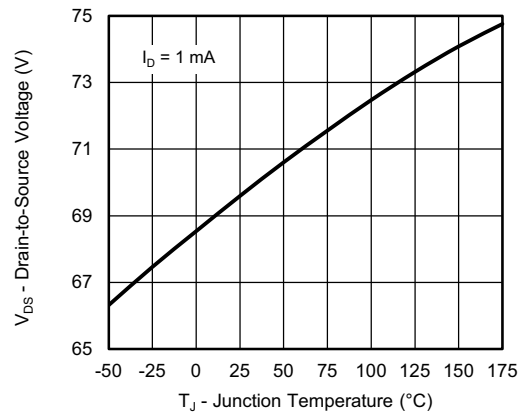
**Source Drain Diode Forward Voltage**



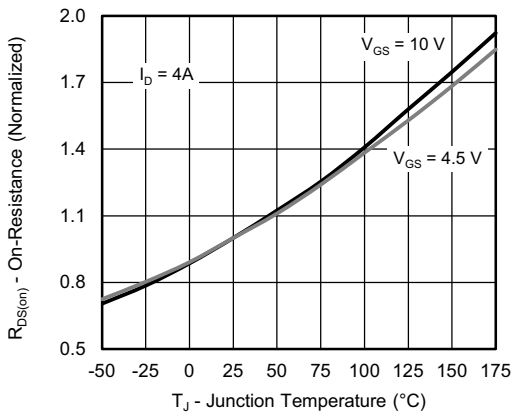
**On-Resistance vs. Gate-to-Source Voltage**



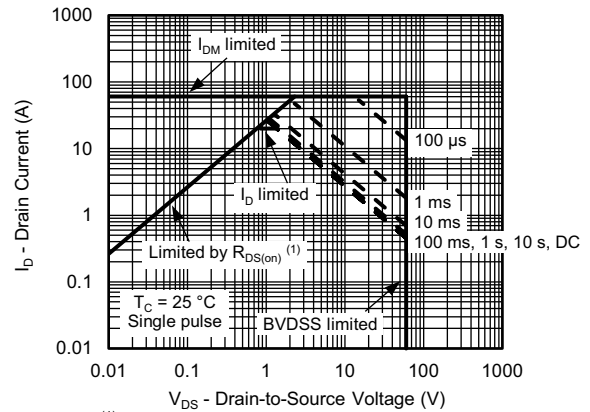
**Threshold Voltage**



**Drain Source Breakdown vs. Junction Temperature**



**On-Resistance vs. Junction Temperature**

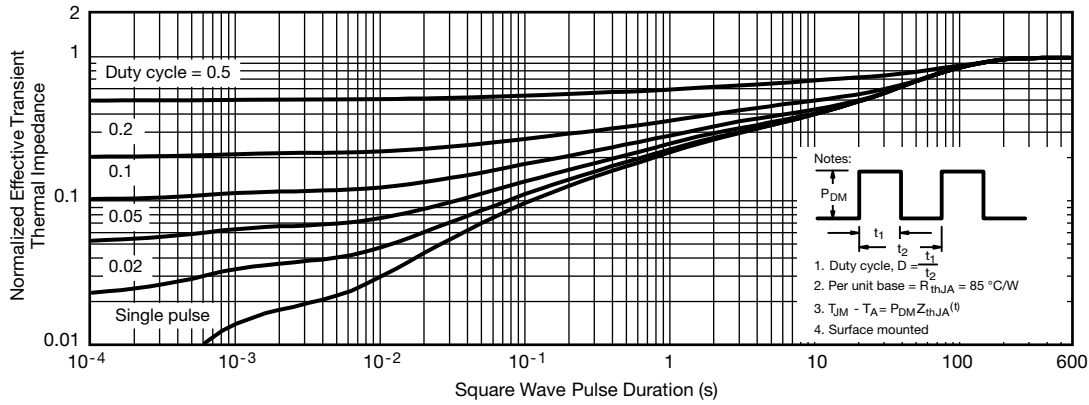


<sup>(1)</sup>  $V_{GS} >$  minimum  $V_{GS}$  at which  $R_{DS(on)}$  is specified

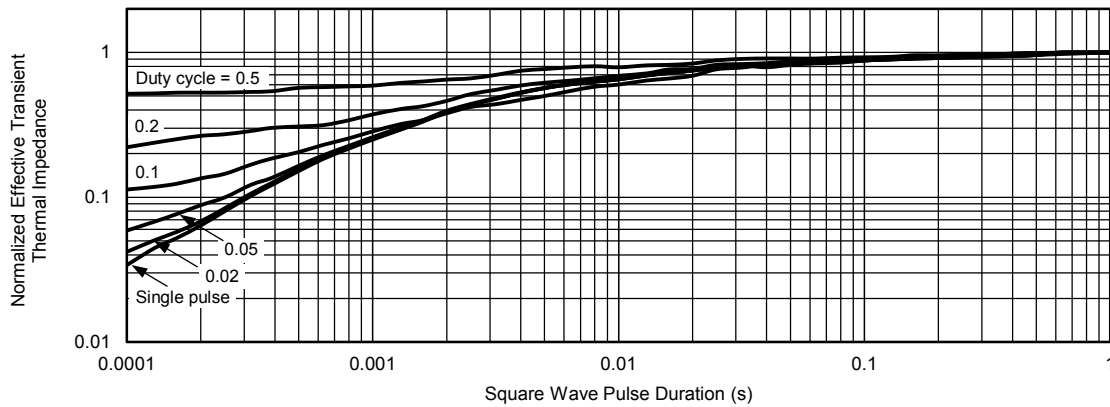
**Safe Operating Area**



**N-CHANNEL 1 TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



**Normalized Thermal Transient Impedance, Junction-to-Ambient**



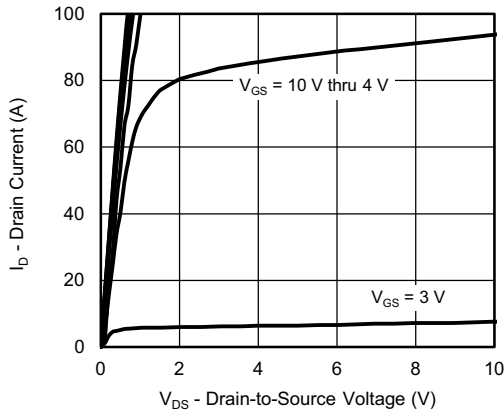
**Normalized Thermal Transient Impedance, Junction-to-Case**

**Note**

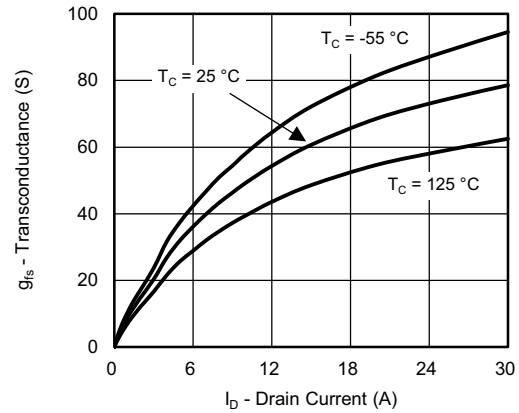
- The characteristics shown in the graph:
  - Normalized Transient Thermal Impedance Junction-to-Ambient ( $25\text{ }^\circ\text{C}$ ) is given for general guidelines only to enable the user to get a "ball park" indication of part capabilities. The data are extracted from single pulse transient thermal impedance characteristics which are developed from empirical measurements. The latter is valid for the part mounted on printed circuit board - FR4, size  $1\text{ }^\prime \times 1\text{ }^\prime \times 0.062\text{ }^\prime$ , double sided with 2 oz. copper, 100 % on both sides. The part capabilities can widely vary depending on actual application parameters and operating conditions



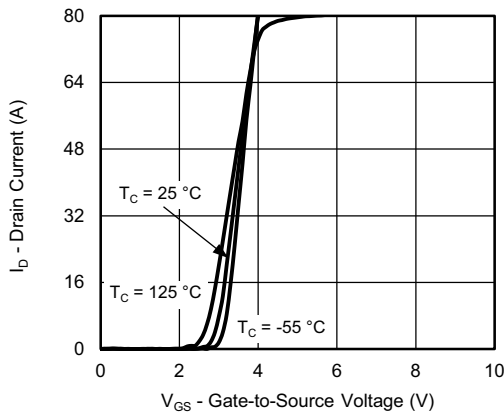
N-CHANNEL 2 TYPICAL CHARACTERISTICS (T<sub>A</sub> = 25 °C, unless otherwise noted)



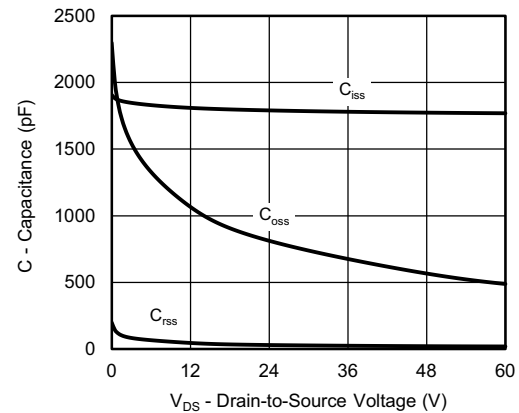
Output Characteristics



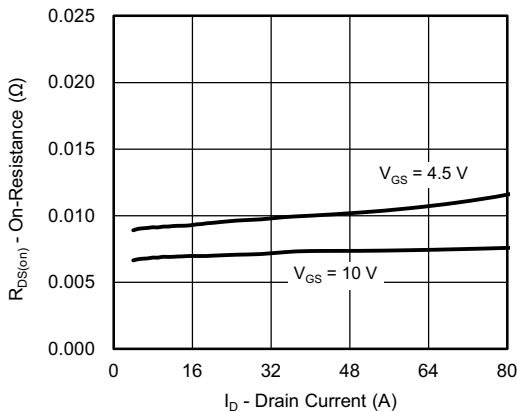
Transconductance



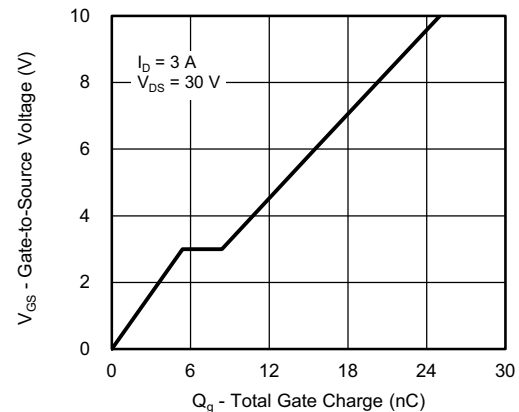
Transfer Characteristics



Capacitance

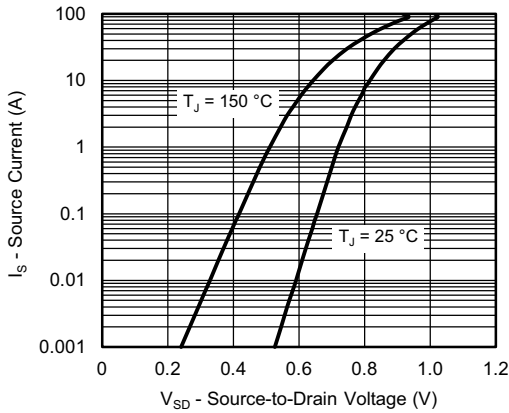


On-Resistance vs. Drain Current

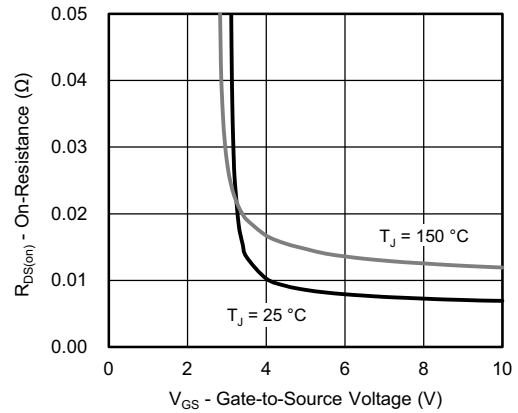


Gate Charge

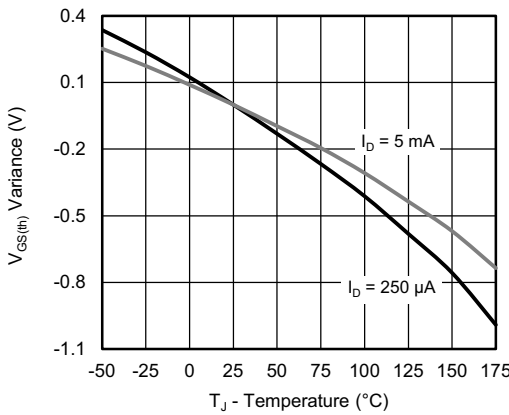
**N-CHANNEL 2 TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



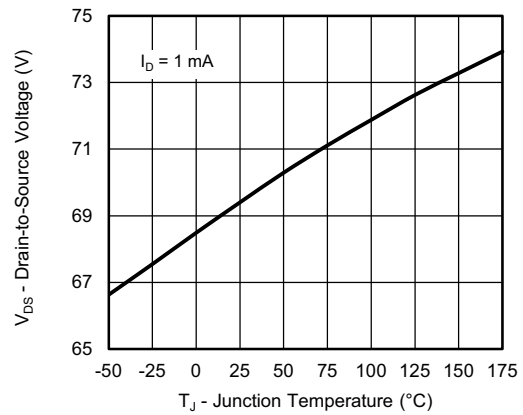
**Source Drain Diode Forward Voltage**



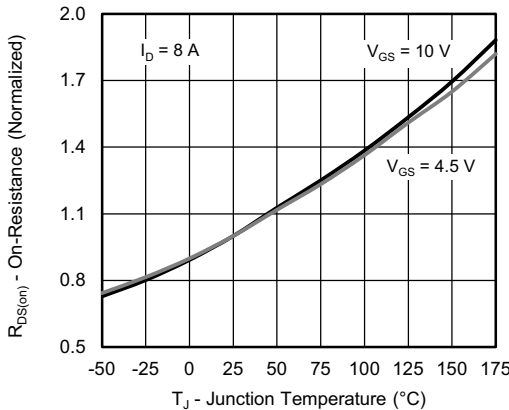
**On-Resistance vs. Gate-to-Source Voltage**



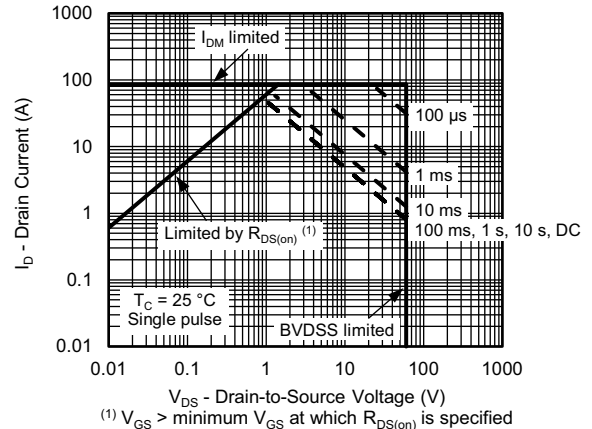
**Threshold Voltage**



**Drain Source Breakdown vs. Junction Temperature**



**On-Resistance vs. Junction Temperature**



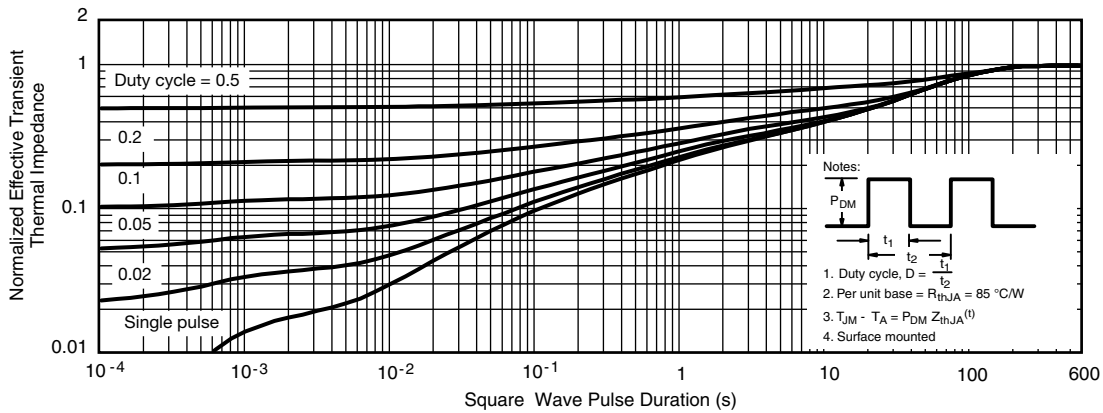
<sup>(1)</sup>  $V_{GS} >$  minimum  $V_{GS}$  at which  $R_{DS(on)}$  is specified

**Safe Operating Area**

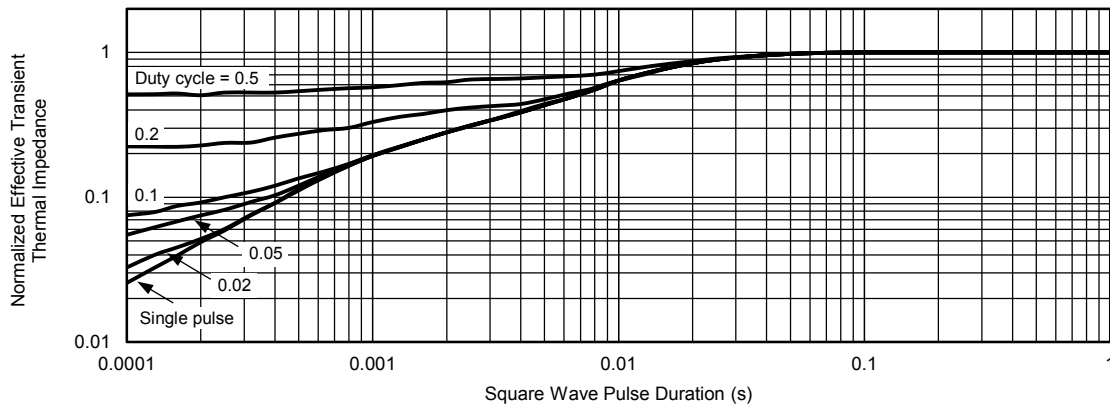




**N-CHANNEL 2 TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



**Normalized Thermal Transient Impedance, Junction-to-Ambient**



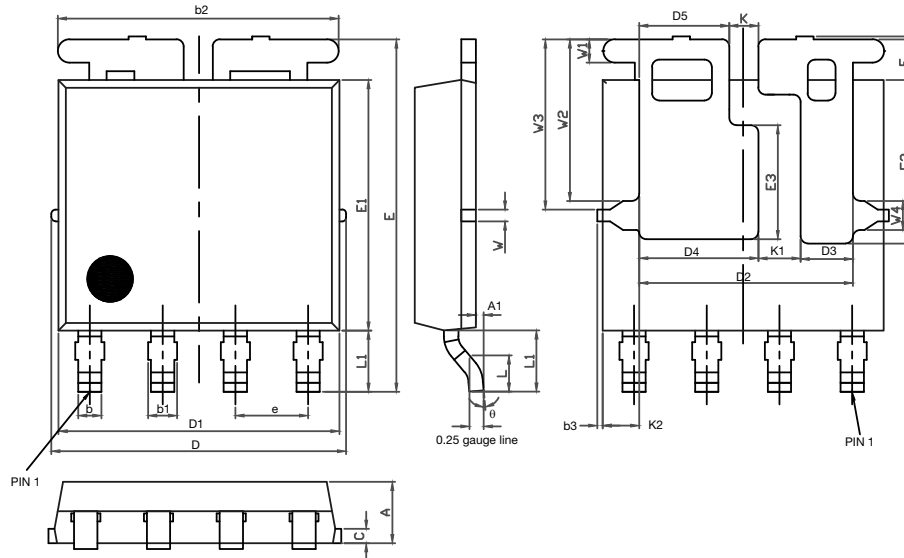
**Normalized Thermal Transient Impedance, Junction-to-Case**

**Note**

- The characteristics shown in the graph:
  - Normalized Transient Thermal Impedance Junction-to-Ambient ( $25\text{ }^\circ\text{C}$ ) is given for general guidelines only to enable the user to get a "ball park" indication of part capabilities. The data are extracted from single pulse transient thermal impedance characteristics which are developed from empirical measurements. The latter is valid for the part mounted on printed circuit board - FR4, size 1" x 1" x 0.062", double sided with 2 oz. copper, 100 % on both sides. The part capabilities can widely vary depending on actual application parameters and operating conditions

Vishay Siliconix maintains worldwide manufacturing capability. Products may be manufactured at one of several qualified locations. Reliability data for Silicon Technology and Package Reliability represent a composite of all qualified locations. For related documents such as package / tape drawings, part marking, and reliability data, see [www.vishay.com/ppg?75486](http://www.vishay.com/ppg?75486).

## PowerPAK® SO-8L Assymmetric Case Outline



DIM.	MILLIMETERS			INCHES		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	1.00	1.07	1.14	0.039	0.042	0.045
A1	0.00	0.06	0.13	0.000	0.003	0.005
b	0.33	0.41	0.48	0.013	0.016	0.019
b1	0.44	0.51	0.58	0.017	0.020	0.023
b2	4.80	4.90	5.00	0.189	0.193	0.197
b3	0.04	0.12	0.20	0.002	0.005	0.008
c	0.20	0.25	0.30	0.008	0.010	0.012
D	5.00	5.13	5.25	0.197	0.202	0.207
D1	4.80	4.90	5.00	0.189	0.193	0.197
D2	3.63	3.73	3.83	0.143	0.147	0.151
D3	0.81	0.91	1.01	0.032	0.036	0.040
D4	1.98	2.08	2.18	0.078	0.082	0.086
D5	1.47	1.57	1.67	0.058	0.062	0.066
e	1.20	1.27	1.34	0.047	0.050	0.053
E	6.05	6.15	6.25	0.238	0.242	0.246
E1	4.27	4.37	4.47	0.168	0.172	0.176
E2	2.75	2.85	2.95	0.108	0.112	0.116
E3	1.89	1.99	2.09	0.074	0.078	0.082
F	0.05	0.12	0.19	0.002	0.005	0.007
L	0.62	0.72	0.82	0.024	0.028	0.032
L1	0.92	1.07	1.22	0.036	0.042	0.048
K	0.41	0.51	0.61	0.016	0.020	0.024
K1	0.64	0.74	0.84	0.025	0.029	0.033
K2	0.54	0.64	0.74	0.021	0.025	0.029
W	0.13	0.23	0.33	0.005	0.009	0.013
W1	0.31	0.41	0.51	0.012	0.016	0.020
W2	2.72	2.82	2.92	0.107	0.111	0.115
W3	2.86	2.96	3.06	0.113	0.117	0.120
W4	0.41	0.51	0.61	0.016	0.020	0.024
θ	5°	10°	12°	5°	10°	12°

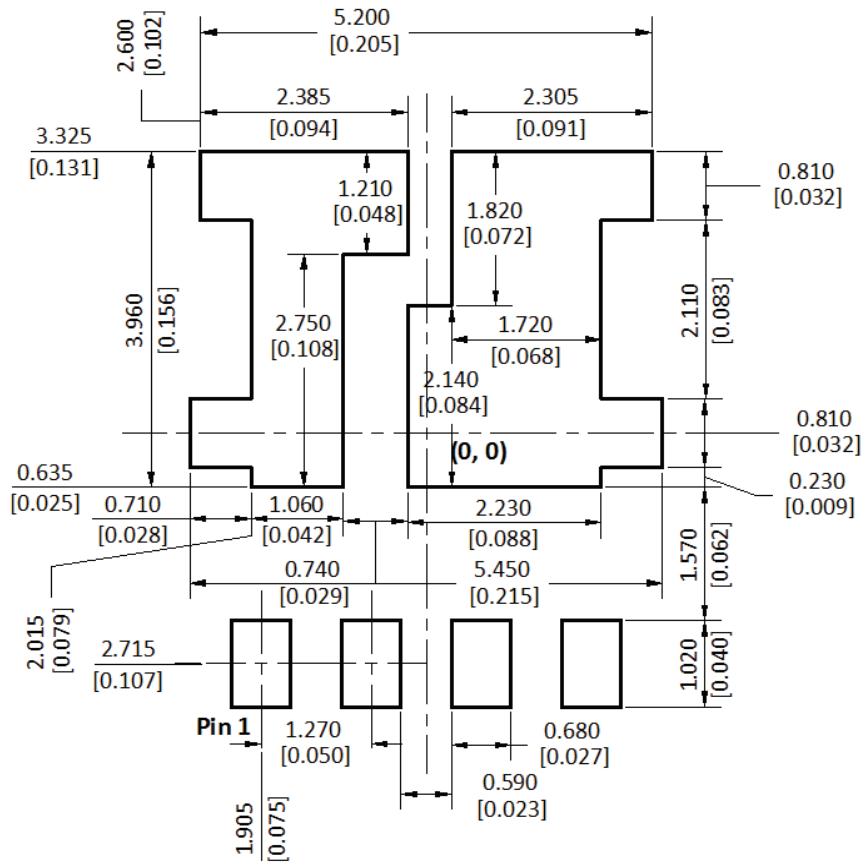
DWG: 6009

**Note**

- Millimeters will govern



RECOMMENDED MINIMUM PADS FOR PowerPAK® SO-8L DUAL ASYMMETRIC



Recommended Minimum Pads  
Dimensions in mm [inches]



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