

N- and P-Channel 60V (D-S) MOSFET

PRODUCT SUMMARY				
	V _{DS} (V)	R _{DS(on)} (Ω) Typ.	I _D (A) ^a	Q _g (Typ.)
N-Channel	60	0.012 at V _{GS} = 10 V	9.0	13
		0.016 at V _{GS} = 4.5 V	8.0	
P-Channel	- 60	0.041 at V _{GS} = - 10 V	-6.0	12
		0.066 at V _{GS} = - 4.5 V	-5.0	

FEATURES

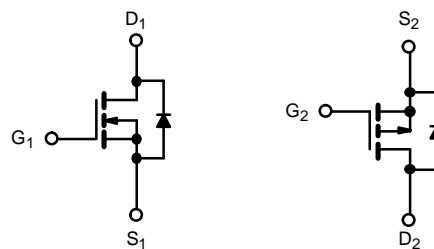
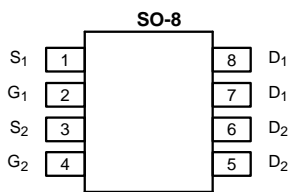
- Halogen-free According to IEC 61249-2-21 Definition
- TrenchFET[®] Power MOSFET
- 100 % R_g and UIS Tested
- Compliant to RoHS Directive 2002/95/EC



RoHS
COMPLIANT
HALOGEN
FREE

APPLICATIONS

- Motor Drive



ABSOLUTE MAXIMUM RATINGS (T _A = 25 °C, unless otherwise noted)					
Parameter	Symbol	N-Channel	P-Channel	Unit	
Drain-Source Voltage	V _{DS}	60	- 60	V	
Gate-Source Voltage	V _{GS}	± 20	± 20		
Continuous Drain Current (T _J = 150 °C)	I _D	T _C = 25 °C	9.0	- 6.0	A
		T _C = 70 °C	6.0	- 5.0	
		T _A = 25 °C	6.8 ^{b, c}	-5.6 ^{b, c}	
		T _A = 70 °C	5.4 ^{b, c}	- 4.3 ^{b, c}	
Pulsed Drain Current (10 μs Pulse Width)	I _{DM}	50	- 40		
Source-Drain Current Diode Current	I _S	T _C = 25 °C	3.6	- 3.6	
		T _A = 25 °C	1.6 ^{b, c}	- 1.6 ^{b, c}	
Pulsed Source-Drain Current	I _{SM}	35	- 30		
Single Pulse Avalanche Current	I _{AS}	20	- 20		
Single Pulse Avalanche Energy	E _{AS}	25	20	mJ	
Maximum Power Dissipation	P _D	T _C = 25 °C	7.0	6.2	W
		T _C = 70 °C	3.6	3.1	
		T _A = 25 °C	3 ^{b, c}	3 ^{b, c}	
		T _A = 70 °C	2.28 ^{b, c}	2.28 ^{b, c}	
Operating Junction and Storage Temperature Range	T _J , T _{stg}	- 55 to 50		°C	

THERMAL RESISTANCE RATINGS							
Parameter		Symbol	N-Channel		P-Channel		Unit
			Typ.	Max.	Typ.	Max.	
Maximum Junction-to-Ambient ^{b, d}	t ≤ 10 s	R _{thJA}	20	32.5	27	32.5	°C/W
Maximum Junction-to-Foot (Drain)	Steady State	R _{thJF}	10	20	19	28	

Notes:

- Based on T_C = 25 °C.
- Surface mounted on 1" x 1" FR4 board.
- t = 10 s.
- Maximum under steady state conditions is 120 °C/W (n-channel) and 110 °C/W (p-channel).
- Package limited.

SPECIFICATIONS (T _J = 25 °C, unless otherwise noted)							
Parameter	Symbol	Test Conditions	Min.	Typ. ^a	Max.	Unit	
Static							
Drain-Source Breakdown Voltage	V _{DS}	V _{GS} = 0 V, I _D = 250 μA	N-Ch	60		V	
		V _{GS} = 0 V, I _D = - 250 μA	P-Ch	- 60			
V _{DS} Temperature Coefficient	ΔV _{DS} /T _J	I _D = 250 μA	N-Ch		30	mV/°C	
		I _D = - 250 μA	P-Ch		- 24		
V _{GS(th)} Temperature Coefficient	ΔV _{GS(th)} /T _J	I _D = 250 μA	N-Ch		- 4.1		
		I _D = - 250 μA	P-Ch		5		
Gate Threshold Voltage	V _{GS(th)}	V _{DS} = V _{GS} , I _D = 250 μA	N-Ch	1	2.2	V	
		V _{DS} = V _{GS} , I _D = - 250 μA	P-Ch	- 0.9	- 2.5		
Gate-Body Leakage	I _{GSS}	V _{DS} = 0 V, V _{GS} = ± 20 V	N-Ch		± 100	nA	
		V _{DS} = 0 V, V _{GS} = ± 20 V	P-Ch		± 100		
Zero Gate Voltage Drain Current	I _{DSS}	V _{DS} = 30 V, V _{GS} = 0 V	N-Ch		1	μA	
		V _{DS} = - 30 V, V _{GS} = 0 V	P-Ch		-		
		V _{DS} = 30 V, V _{GS} = 0 V, T _J = 55 °C	N-Ch		10		
		V _{DS} = - 30 V, V _{GS} = 0 V, T _J = 55 °C	P-Ch		- 1		
On-State Drain Current ^b	I _{D(on)}	V _{DS} = 5 V, V _{GS} = 10 V	N-Ch	30		A	
		V _{DS} = - 5 V, V _{GS} = - 10 V	P-Ch	-30			
Drain-Source On-State Resistance ^b	R _{DS(on)}	V _{GS} = 10 V, I _D = 6.8 A	N-Ch		0.012	Ω	
		V _{GS} = - 10 V, I _D = - 8 A	P-Ch		0.041		
		V _{GS} = 4.5 V, I _D = 6.6 A	N-Ch		0.016		
		V _{GS} = - 4.5 V, I _D = - 5 A	P-Ch		0.066		
Forward Transconductance ^b	g _{fs}	V _{DS} = 15 V, I _D = 6.8 A	N-Ch		37	S	
		V _{DS} = - 15 V, I _D = - 6.7 A	P-Ch		35		
Dynamic^a							
Input Capacitance	C _{iss}	N-Channel V _{DS} = 30 V, V _{GS} = 0 V, f = 1 MHz	N-Ch		1321	pF	
			P-Ch		1345		
Output Capacitance	C _{oss}		P-Channel V _{DS} = - 30 V, V _{GS} = 0 V, f = 1 MHz	N-Ch			745
				P-Ch			792
Reverse Transfer Capacitance	C _{riss}		N-Ch		214		
			P-Ch		245		
Total Gate Charge	Q _g	V _{DS} = 30 V, V _{GS} = 10 V, I _D = 10 A	N-Ch		13.3	nC	
		V _{DS} = - 30 V, V _{GS} = - 10 V, I _D = - 10 A	P-Ch		13		
Gate-Source Charge	Q _{gs}	N-Channel V _{DS} = 30 V, V _{GS} = 4.5 V, I _D = 10 A	N-Ch		6.5		
			P-Ch		21.7		
		P-Channel V _{DS} = - 30 V, V _{GS} = - 4.5 V, I _D = - 10 A	N-Ch		2.3		
			P-Ch		5.6		
Gate-Drain Charge	Q _{gd}		N-Ch		1.7		
			P-Ch		9.8		
Gate Resistance	R _g	f = 1 MHz	N-Ch	0.3	2.6	Ω	
			P-Ch	1.3	12.8		

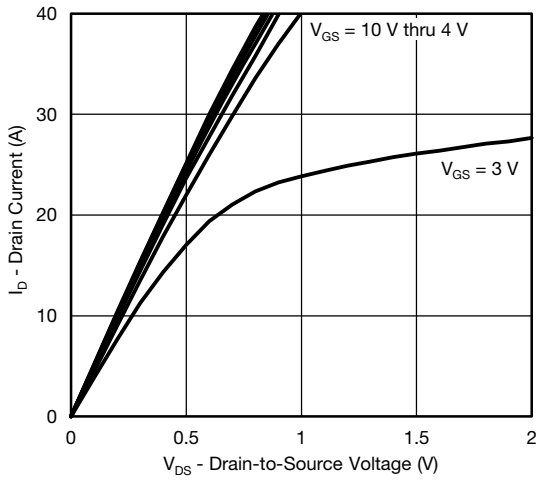
SPECIFICATIONS (T _J = 25 °C, unless otherwise noted)							
Parameter	Symbol	Test Conditions	Min.	Typ. ^a	Max.	Unit	
Dynamic^a							
Turn-On Delay Time	t _{d(on)}	N-Channel V _{DD} = 30 V, R _L = 3.7 Ω I _D ≅ 5.4 A, V _{GEN} = 10 V, R _g = 1 Ω	N-Ch		5	10	ns
Rise Time	t _r		P-Ch		10	20	
Turn-Off Delay Time	t _{d(off)}	P-Channel V _{DD} = -30 V, R _L = 2 Ω I _D ≅ -10 A, V _{GEN} = -10 V, R _g = 1 Ω	N-Ch		16	25	
Fall Time	t _f		P-Ch		50	90	
Turn-On Delay Time	t _{d(on)}	N-Channel V _{DD} = 30 V, R _L = 3.7 Ω I _D ≅ 5.4 A, V _{GEN} = 4.5 V, R _g = 1 Ω	N-Ch		11	22	
Rise Time	t _r		P-Ch		42	75	
Turn-Off Delay Time	t _{d(off)}	P-Channel V _{DD} = -30 V, R _L = 2 Ω I _D ≅ -10 A, V _{GEN} = -4.5 V, R _g = 1 Ω	N-Ch		12	22	
Fall Time	t _f		P-Ch		40	70	
			N-Ch		17	26	
			P-Ch		40	70	
			N-Ch		7	14	
			P-Ch		18	35	
Drain-Source Body Diode Characteristics							
Continuous Source-Drain Diode Current	I _S	T _C = 25 °C	N-Ch			5.6	A
			P-Ch			-5.6	
Pulse Diode Forward Current ^a	I _{SM}		N-Ch			40	
			P-Ch			-4	
Body Diode Voltage	V _{SD}	I _S = 5.4 A	N-Ch		0.81	1.2	V
		I _S = -2 A	P-Ch		-0.7	-1.	
Body Diode Reverse Recovery Time	t _{rr}	N-Channel I _F = 5 A, di/dt = 100 A/μs, T _J = 25 °C	N-Ch		17	34	ns
			P-Ch		41	80	
Body Diode Reverse Recovery Charge	Q _{rr}	P-Channel I _F = -5 A, di/dt = -100 A/μs, T _J = 25 °C	N-Ch		10	20	nC
			P-Ch		32	65	
Reverse Recovery Fall Time	t _a		N-Ch		10		ns
			P-Ch		15		
Reverse Recovery Rise Time	t _b		N-Ch		7		
			P-Ch		26		

Notes:

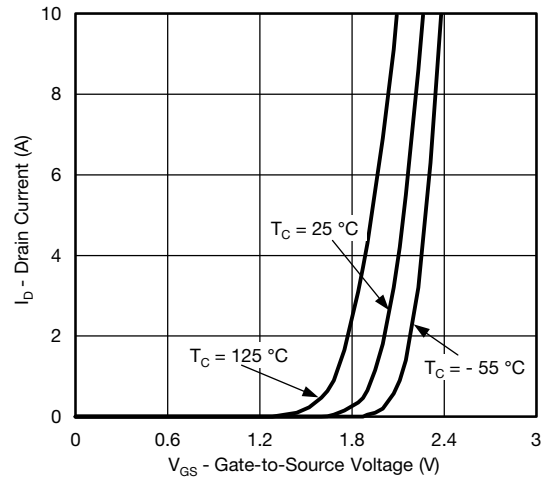
- a. Guaranteed by design, not subject to production testing.
- b. Pulse test; pulse width ≤ 300 μs, duty cycle ≤ 2 %.

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.

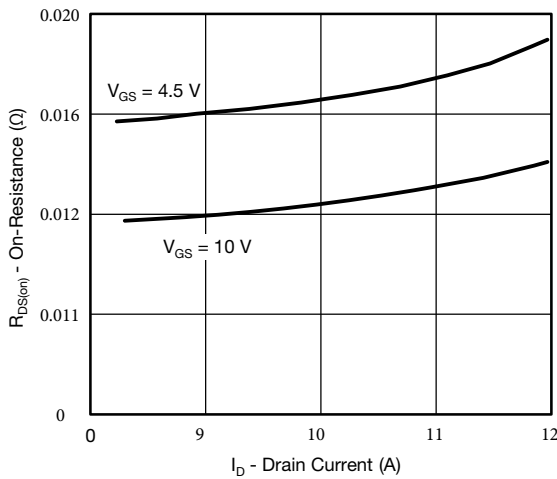
N-CHANNEL TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



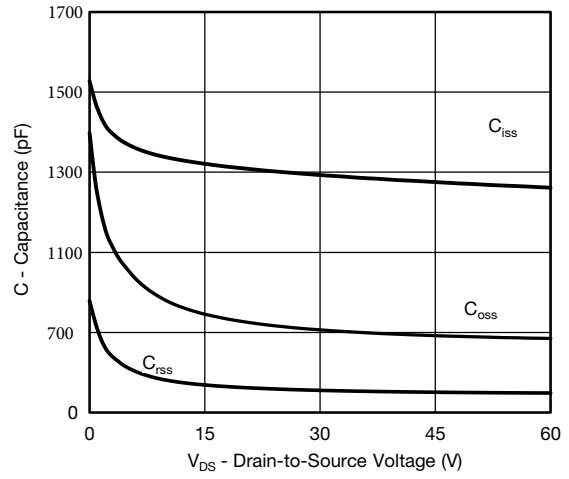
Output Characteristics



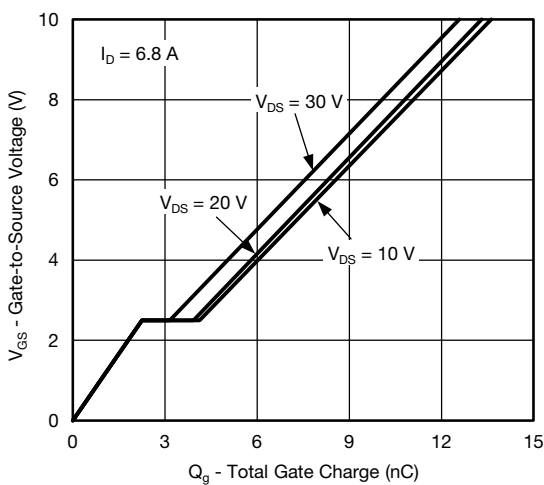
Transfer Characteristics



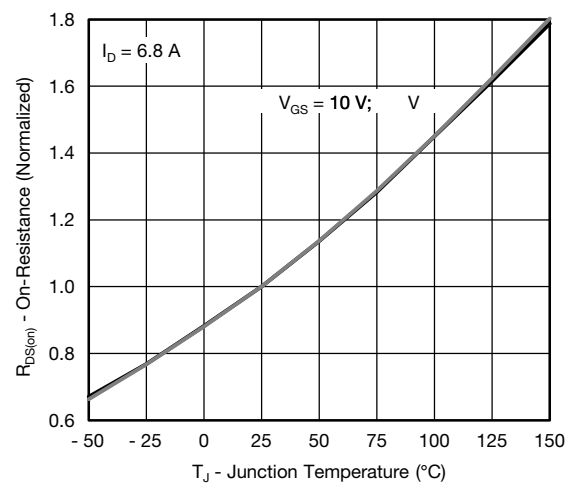
On-Resistance vs. Drain Current and Gate Voltage



Capacitance

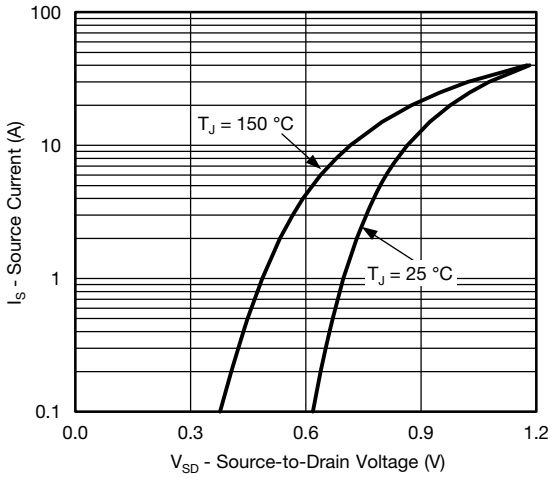


Gate Charge

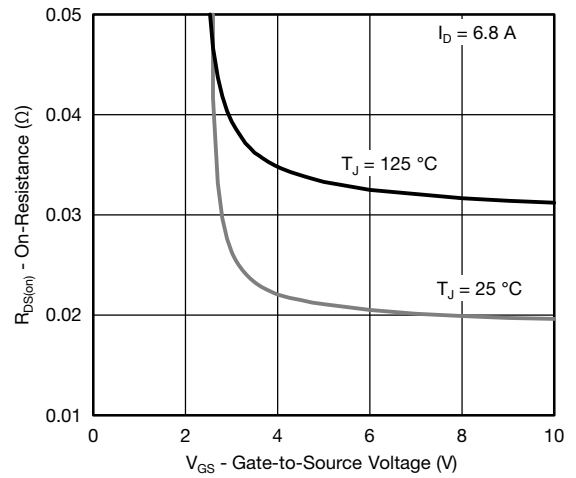


On-Resistance vs. Junction Temperature

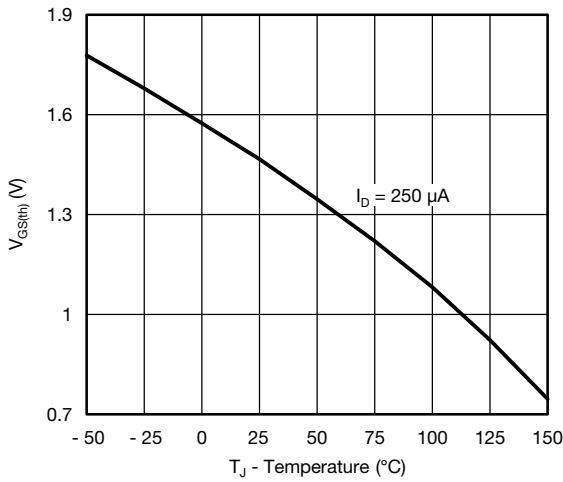
N-CHANNEL TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



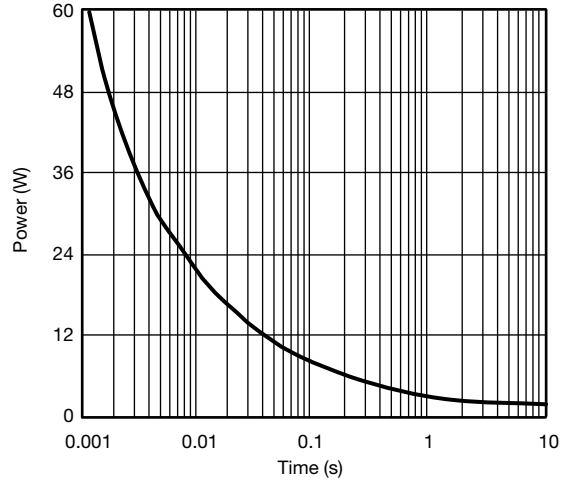
Source-Drain Diode Forward Voltage



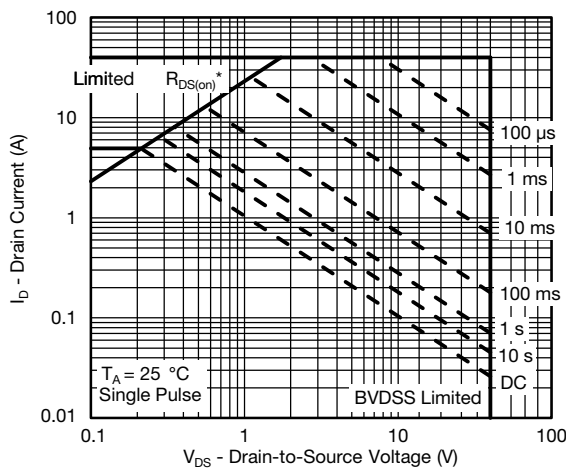
On-Resistance vs. Gate-to-Source Voltage



Threshold Voltage

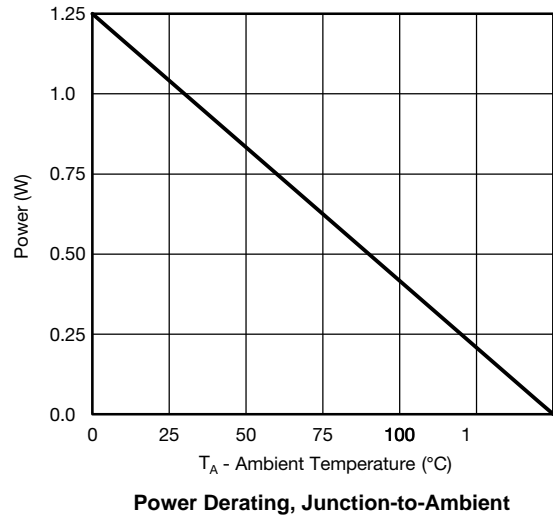
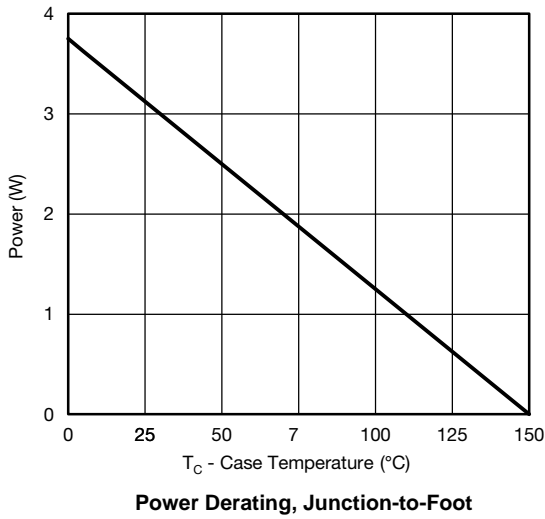
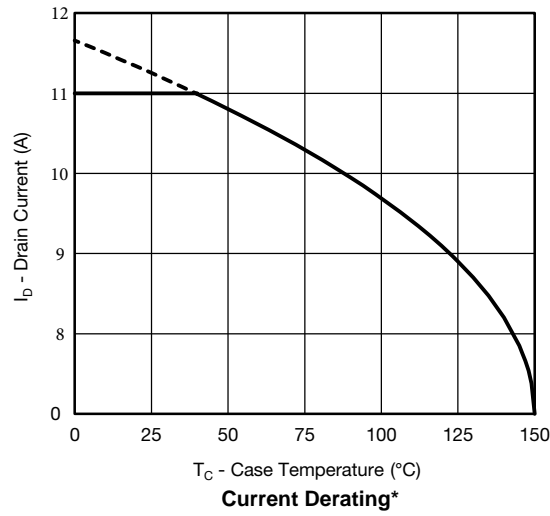


Single Pulse Power, Junction-to-Ambient



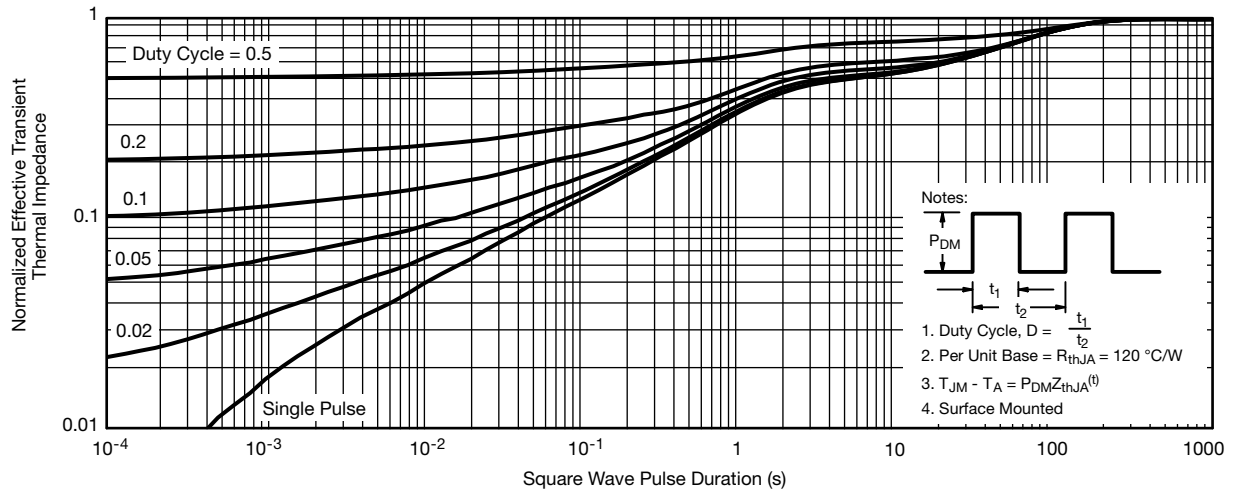
Safe Operating Area, Junction-to-Ambient

N-CHANNEL TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)

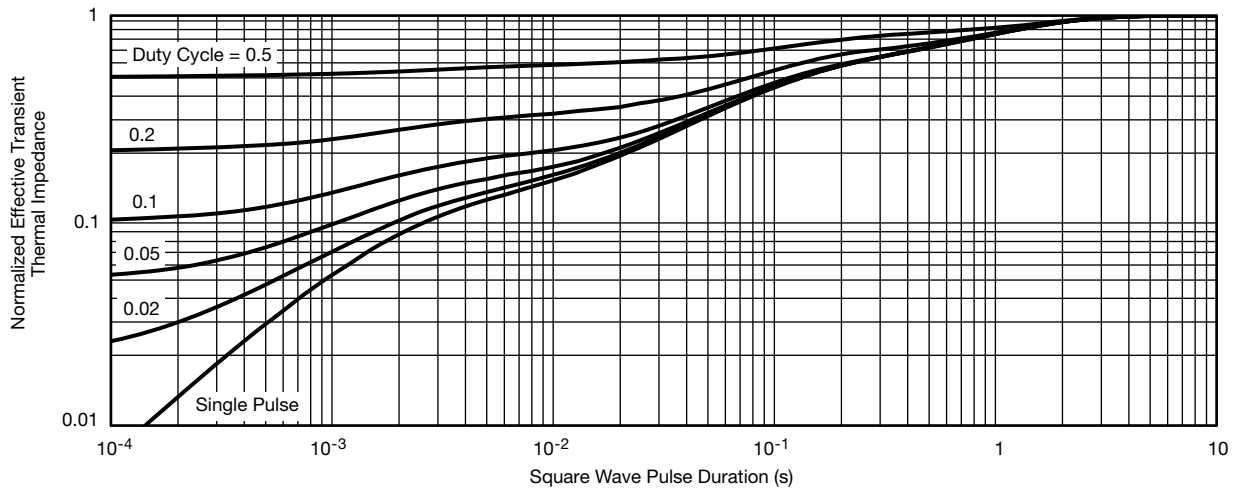


* The power dissipation P_D is based on T_{J(max)} = 150 °C, using junction-to-case thermal resistance, and is more useful in settling the upper dissipation limit for cases where additional heatsinking is used. It is used to determine the current rating, when this rating falls below the package limit.

N-CHANNEL TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)

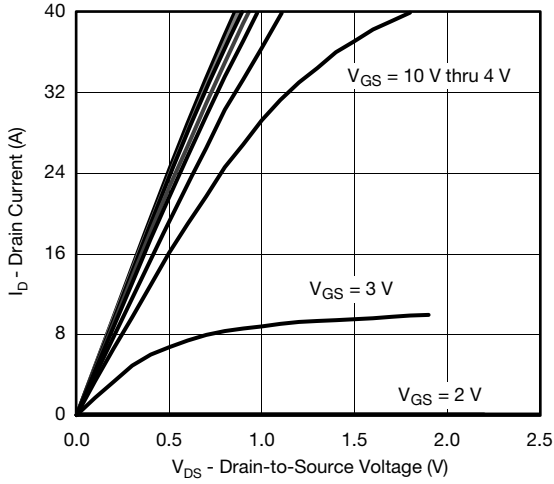


Normalized Thermal Transient Impedance, Junction-to-Ambient

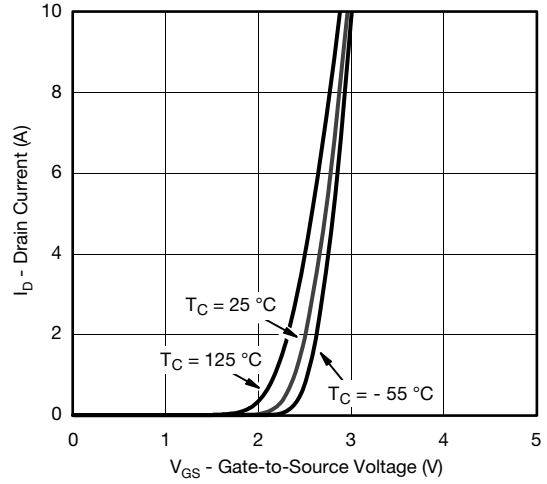


Normalized Thermal Transient Impedance, Junction-to-Foot

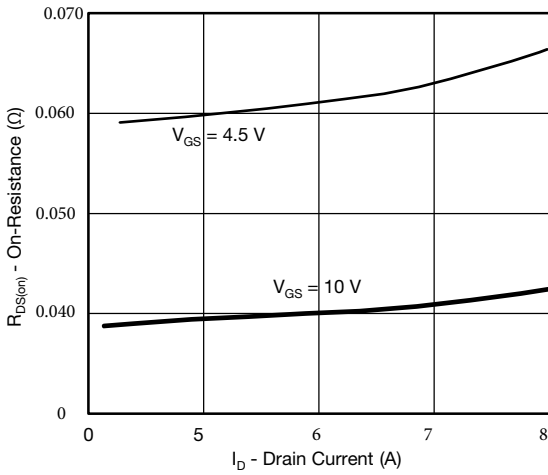
P-CHANNEL TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



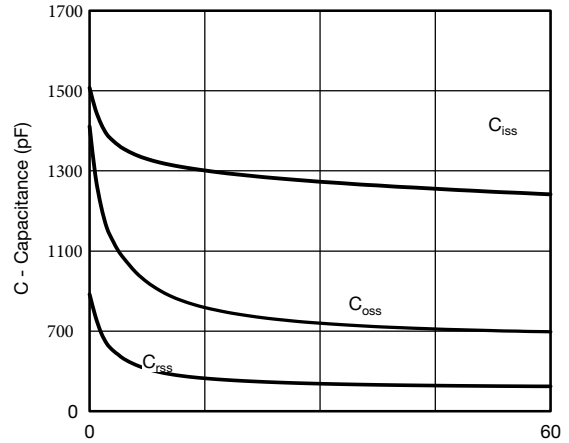
Output Characteristics



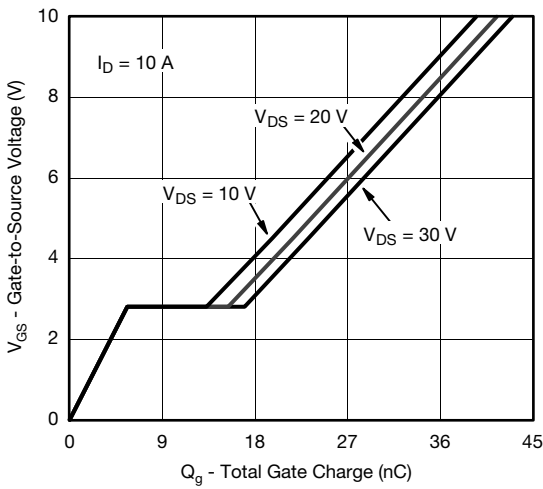
Transfer Characteristics



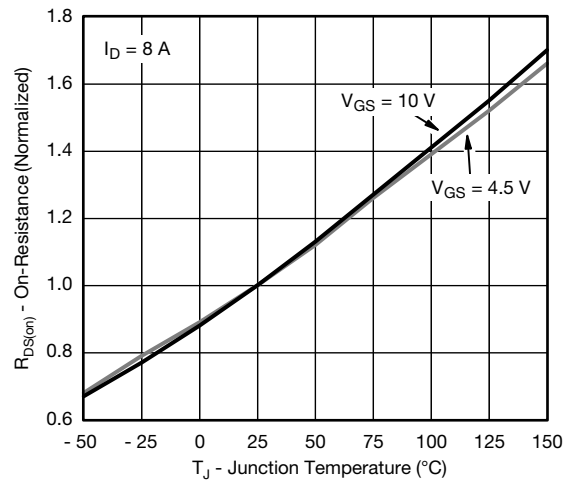
On-Resistance vs. Drain Current and Gate Voltage



Capacitance

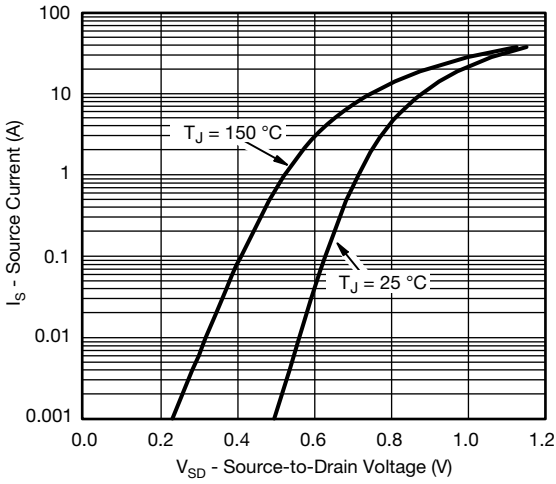


Gate Charge

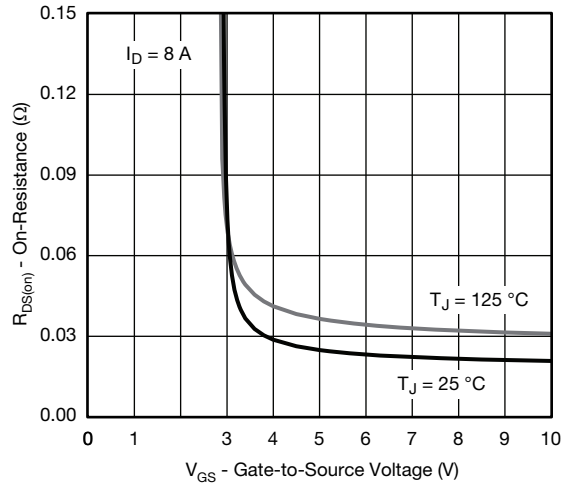


On-Resistance vs. Junction Temperature

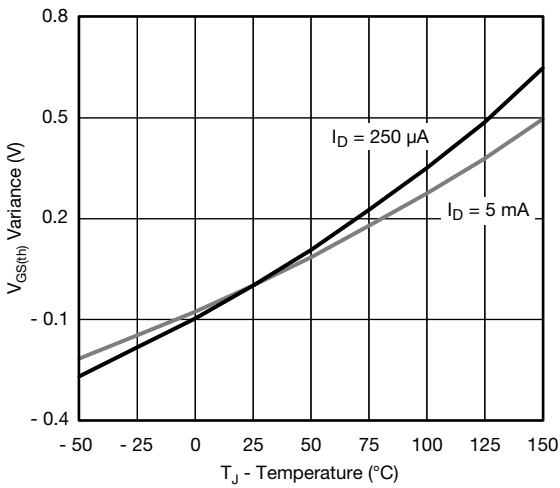
P-CHANNEL TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



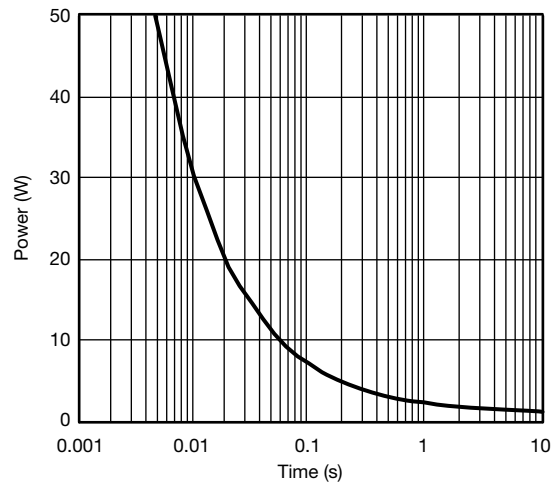
Source-Drain Diode Forward Voltage



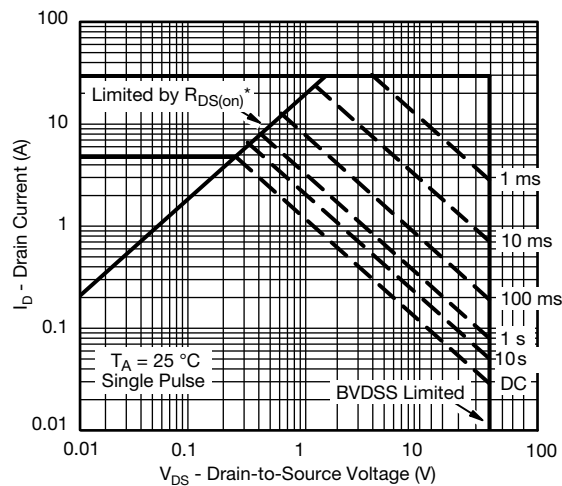
On-Resistance vs. Gate-to-Source Voltage



Threshold Voltage

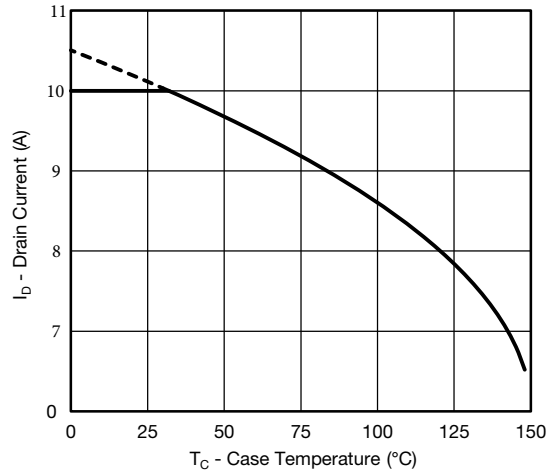


Single Pulse Power, Junction-to-Ambient

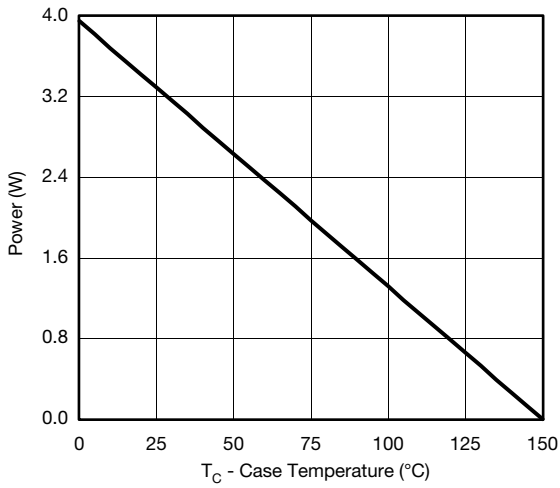


Safe Operating Area, Junction-to-Ambient

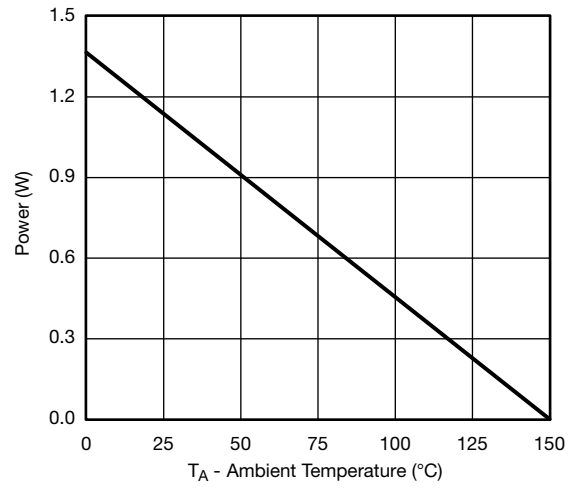
P-CHANNEL TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



Current Derating*



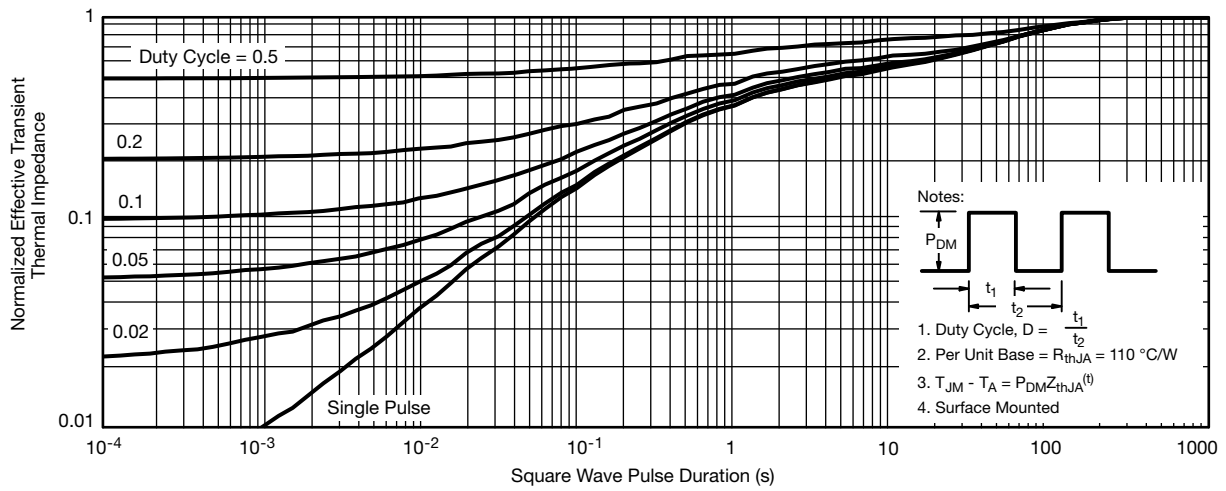
Power Derating, Junction-to-Foot



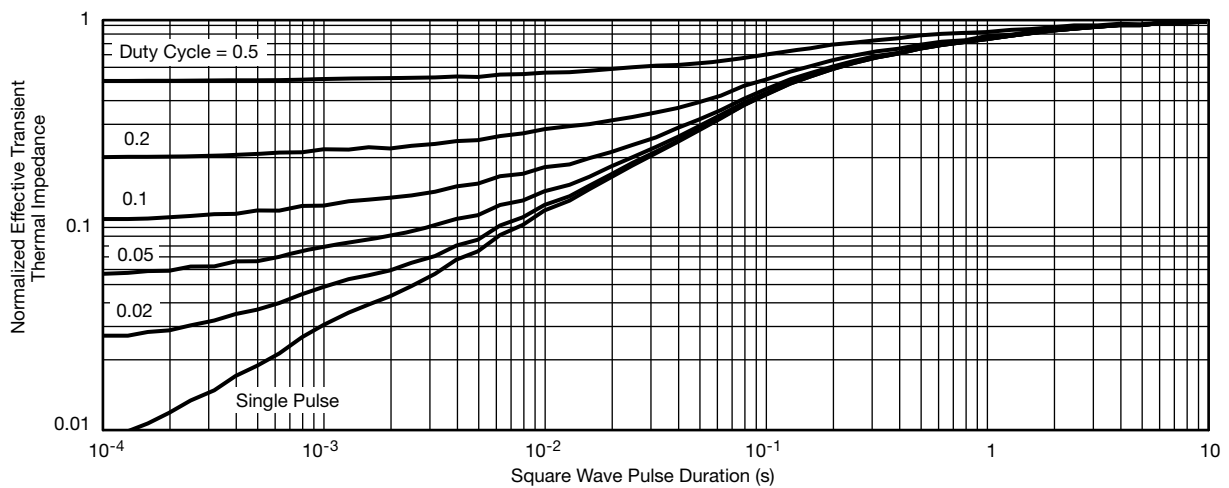
Power Derating, Junction-to-Ambient

* The power dissipation P_D is based on T_{J(max)} = 150 °C, using junction-to-case thermal resistance, and is more useful in settling the upper dissipation limit for cases where additional heatsinking is used. It is used to determine the current rating, when this rating falls below the package limit.

P-CHANNEL TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)

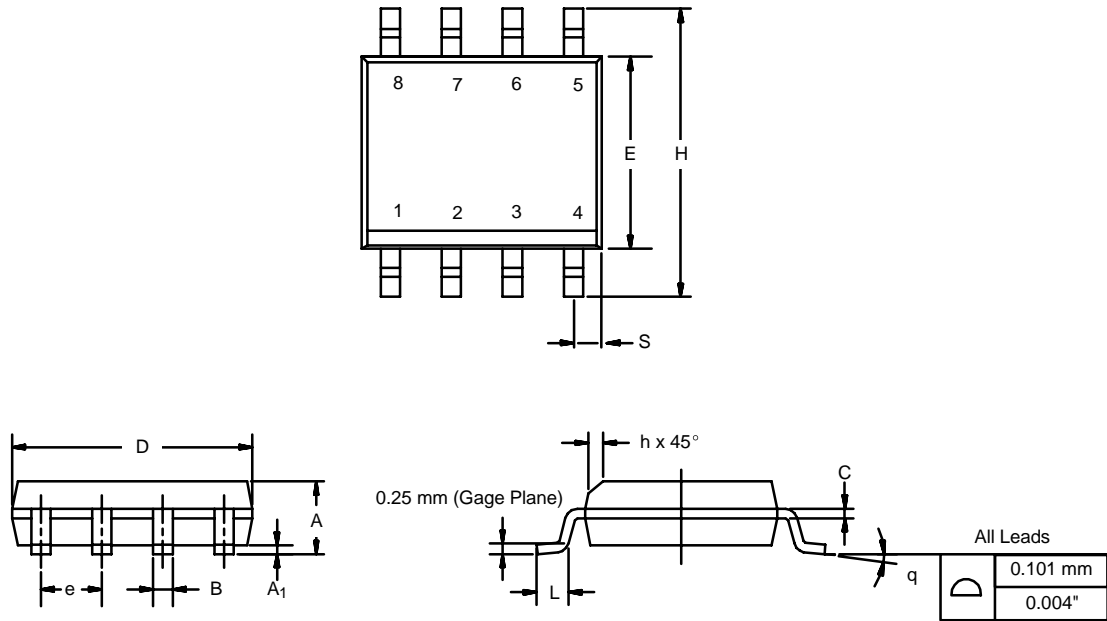


Normalized Thermal Transient Impedance, Junction-to-Ambient



Normalized Thermal Transient Impedance, Junction-to-Foot

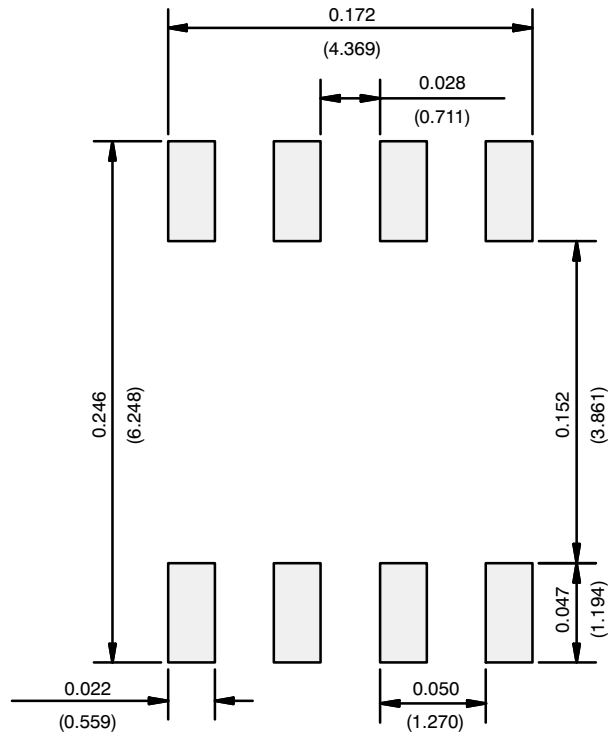
SOIC (NARROW): 8-LEAD
JEDEC Part Number: MS-012



DIM	MILLIMETERS		INCHES	
	Min	Max	Min	Max
A	1.35	1.75	0.053	0.069
A ₁	0.10	0.20	0.004	0.008
B	0.35	0.51	0.014	0.020
C	0.19	0.25	0.0075	0.010
D	4.80	5.00	0.189	0.196
E	3.80	4.00	0.150	0.157
e	1.27 BSC		0.050 BSC	
H	5.80	6.20	0.228	0.244
h	0.25	0.50	0.010	0.020
L	0.50	0.93	0.020	0.037
q	0°	8°	0°	8°
S	0.44	0.64	0.018	0.026

ECN: C-06527-Rev. I, 11-Sep-06
DWG: 5498

RECOMMENDED MINIMUM PADS FOR SO-8



Recommended Minimum Pads
Dimensions in Inches/(mm)

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[2SK1691-DL-E](#) [2SK2545\(Q,T\)](#) [D2294UK](#) [405094E](#) [423220D](#) [MCH6646-TL-E](#) [TPCC8103,L1Q\(CM](#) [367-8430-0972-503](#) [VN1206L](#)
[424134F](#) [026935X](#) [051075F](#) [SBVS138LT1G](#) [614234A](#) [715780A](#) [NTNS3166NZT5G](#) [751625C](#) [873612G](#) [IRF7380TRHR](#)
[IPS70R2K0CEAKMA1](#) [RJK60S3DPP-E0#T2](#) [RJK60S5DPK-M0#T0](#) [APT5010JVFR](#) [APT12031JFLL](#) [APT12040JVR](#) [DMN3404LQ-7](#)
[NTE6400](#) [JANTX2N6796U](#) [JANTX2N6784U](#) [JANTXV2N5416U4](#) [SQM110N05-06L-GE3](#) [SIHF35N60E-GE3](#)