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P-Channel 30-V (D-S) MOSFET

PRODUCT SUMMARY			
V_{DS} (V)	$R_{DS(on)}$ (Ω)	I_D (A) ^d	Q_g (Typ.)
- 30	0.024 at $V_{GS} = - 10$ V	- 11.4	15 nC
	0.035 at $V_{GS} = - 4.5$ V	- 9.4	

FEATURES

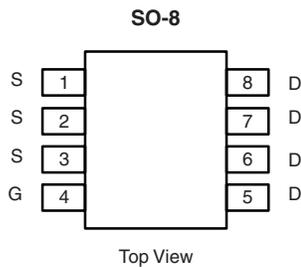
- Halogen-free According to IEC 61249-2-21 Definition
- TrenchFET[®] Power MOSFET
- Compliant to RoHS Directive 2002/95/EC



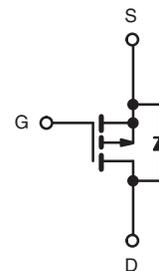
RoHS
 COMPLIANT
 HALOGEN
FREE
 Available

APPLICATIONS

- Load Switches
- Battery Switch



Ordering Information: Si4435DDY-T1-E3 (Lead (Pb)-free)
 Si4435DDY-T1-GE3 (Lead (Pb)-free and Halogen-free)



ABSOLUTE MAXIMUM RATINGS $T_A = 25$ °C, unless otherwise noted				
Parameter	Symbol	Limit	Unit	
Drain-Source Voltage	V_{DS}	- 30	V	
Gate-Source Voltage	V_{GS}	± 20		
Continuous Drain Current ($T_J = 150$ °C)	I_D	$T_C = 25$ °C	- 11.4	A
		$T_C = 70$ °C	- 9.1	
		$T_A = 25$ °C	- 8.1 ^{a, b}	
		$T_A = 70$ °C	- 6.5 ^{a, b}	
Pulsed Drain Current	I_{DM}	- 50		
Continuous Source-Drain Diode Current	I_S	$T_C = 25$ °C	- 4.1	
		$T_A = 25$ °C	- 2.0 ^{a, b}	
Avalanche Current	I_{AS}	- 20		
Single-Pulse Avalanche Energy	E_{AS}	20	mJ	
Maximum Power Dissipation	P_D	$T_C = 25$ °C	5.0	W
		$T_C = 70$ °C	3.2	
		$T_A = 25$ °C	2.5 ^{a, b}	
		$T_A = 70$ °C	1.6 ^{a, b}	
Operating Junction and Storage Temperature Range	T_J, T_{stg}	- 55 to 150	°C	

THERMAL RESISTANCE RATINGS					
Parameter	Symbol	Typical	Maximum	Unit	
Maximum Junction-to-Ambient ^{a, c}	R_{thJA}	38	50	°C/W	
Maximum Junction-to-Foot	R_{thJF}	20	25		

Notes:

- Surface mounted on 1" x 1" FR4 board.
- $t = 10$ s.
- Maximum under Steady State conditions is 85 °C/W.
- Based on $T_C = 25$ °C.

SPECIFICATIONS $T_J = 25\text{ }^\circ\text{C}$, unless otherwise noted						
Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Static						
Drain-Source Breakdown Voltage	V_{DS}	$V_{GS} = 0\text{ V}, I_D = -250\text{ }\mu\text{A}$	- 30			V
V_{DS} Temperature Coefficient	$\Delta V_{DS}/T_J$	$I_D = -250\text{ }\mu\text{A}$		- 31		mV/ $^\circ\text{C}$
$V_{GS(th)}$ Temperature Coefficient	$\Delta V_{GS(th)}/T_J$		4.5			
Gate-Source Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = -250\text{ }\mu\text{A}$	- 1.0		- 3.0	V
Gate-Source Leakage	I_{GSS}	$V_{DS} = 0\text{ V}, V_{GS} = \pm 20\text{ V}$			± 100	nA
Zero Gate Voltage Drain Current	I_{DSS}	$V_{DS} = -30\text{ V}, V_{GS} = 0\text{ V}$			- 1	μA
		$V_{DS} = -30\text{ V}, V_{GS} = 0\text{ V}, T_J = 55\text{ }^\circ\text{C}$			- 5	
On-State Drain Current ^a	$I_{D(on)}$	$V_{DS} \geq -10\text{ V}, V_{GS} = -10\text{ V}$	- 30			A
Drain-Source On-State Resistance ^a	$R_{DS(on)}$	$V_{GS} = -10\text{ V}, I_D = -9.1\text{ A}$		0.0195	0.024	Ω
		$V_{GS} = -4.5\text{ V}, I_D = -6.9\text{ A}$		0.028	0.035	
Forward Transconductance ^a	g_{fs}	$V_{DS} = -10\text{ V}, I_D = -9.1\text{ A}$		23		S
Dynamic^b						
Input Capacitance	C_{iss}	$V_{DS} = -15\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$		1350		pF
Output Capacitance	C_{oss}		215			
Reverse Transfer Capacitance	C_{rss}		185			
Total Gate Charge	Q_g	$V_{DS} = -15\text{ V}, V_{GS} = -10\text{ V}, I_D = -9.1\text{ A}$		32	50	nC
				15	25	
Gate-Source Charge	Q_{gs}	$V_{DS} = -15\text{ V}, V_{GS} = -4.5\text{ V}, I_D = -9.1\text{ A}$		4		nC
Gate-Drain Charge	Q_{gd}		7.5			
Gate Resistance	R_g		$f = 1\text{ MHz}$		5.8	
Turn-On Delay Time	$t_{d(on)}$	$V_{DD} = -15\text{ V}, R_L = 15\text{ }\Omega$ $I_D \cong -1\text{ A}, V_{GEN} = -10\text{ V}, R_g = 1\text{ }\Omega$		10	15	ns
Rise Time	t_r		8	15		
Turn-Off Delay Time	$t_{d(off)}$		45	70		
Fall Time	t_f		12	25		
Turn-On Delay Time	$t_{d(on)}$	$V_{DD} = -15\text{ V}, R_L = 15\text{ }\Omega$ $I_D \cong -1\text{ A}, V_{GEN} = -4.5\text{ V}, R_g = 1\text{ }\Omega$		42	70	
Rise Time	t_r		35	60		
Turn-Off Delay Time	$t_{d(off)}$		40	70		
Fall Time	t_f		16	30		
Drain-Source Body Diode Characteristics						
Continuous Source-Drain Diode Current	I_S	$T_C = 25\text{ }^\circ\text{C}$			- 4.1	A
Pulse Diode Forward Current	I_{SM}				- 50	
Body Diode Voltage	V_{SD}	$I_S = -2\text{ A}, V_{GS} = 0\text{ V}$		- 0.75	- 1.2	V
Body Diode Reverse Recovery Time	t_{rr}	$I_F = -2\text{ A}, di/dt = 100\text{ A}/\mu\text{s}, T_J = 25\text{ }^\circ\text{C}$		34	60	ns
Body Diode Reverse Recovery Charge	Q_{rr}		22	40	nC	
Reverse Recovery Fall Time	t_a		11		ns	
Reverse Recovery Rise Time	t_b		23			

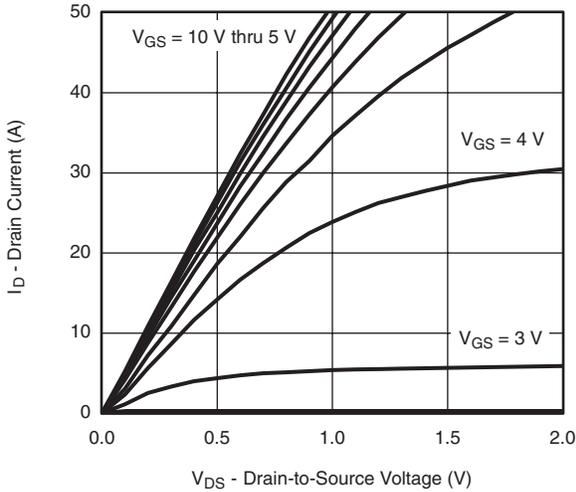
Notes:

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

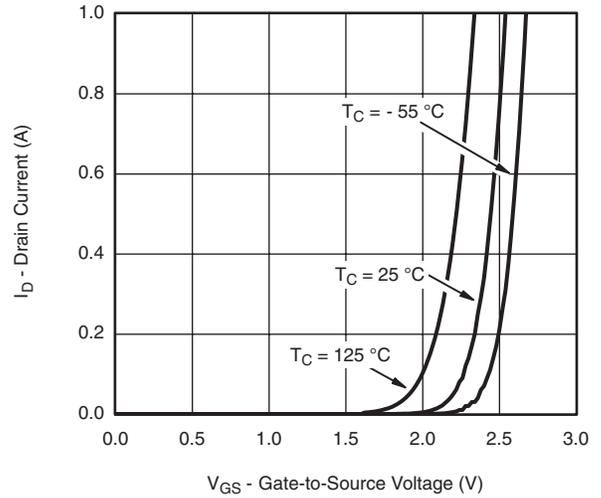
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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



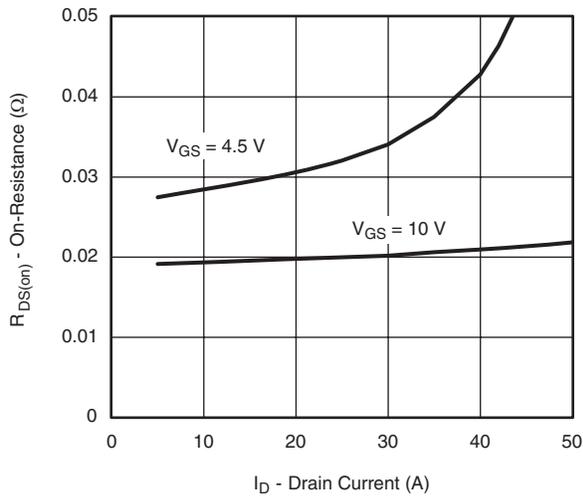
TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted



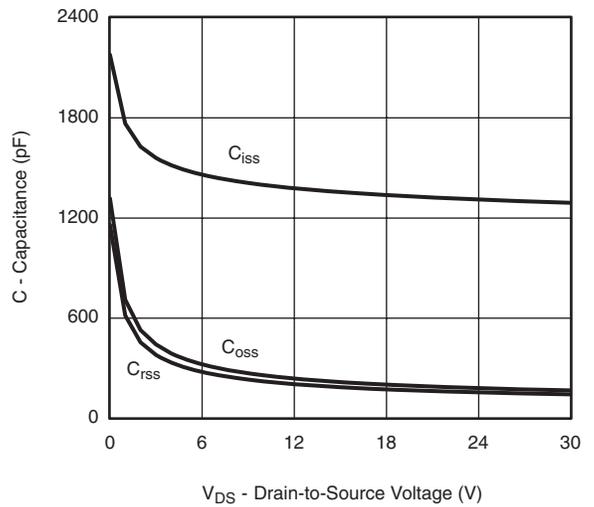
Output Characteristics



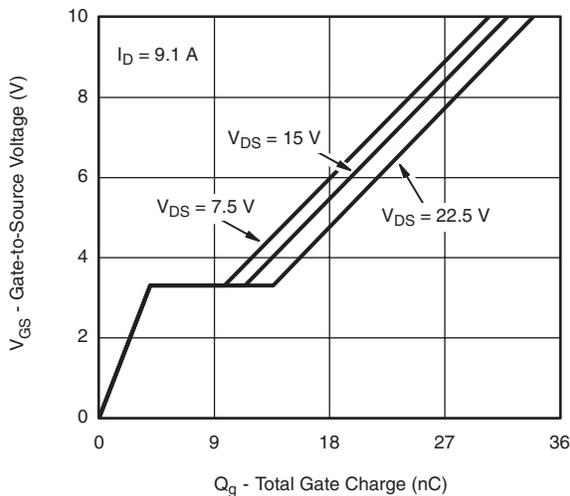
Transfer Characteristics



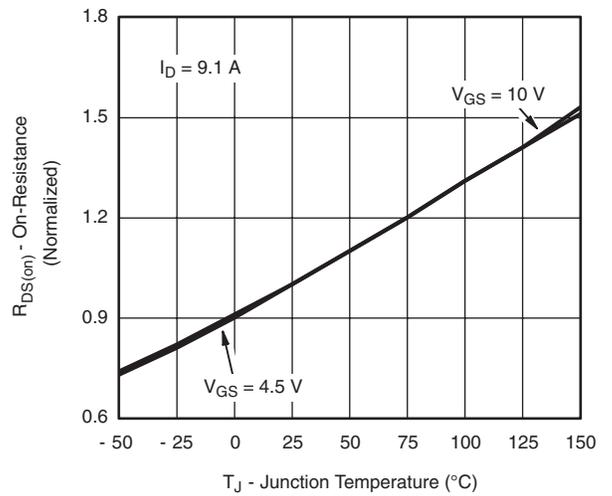
On-Resistance vs. Drain Current



Capacitance



Gate Charge



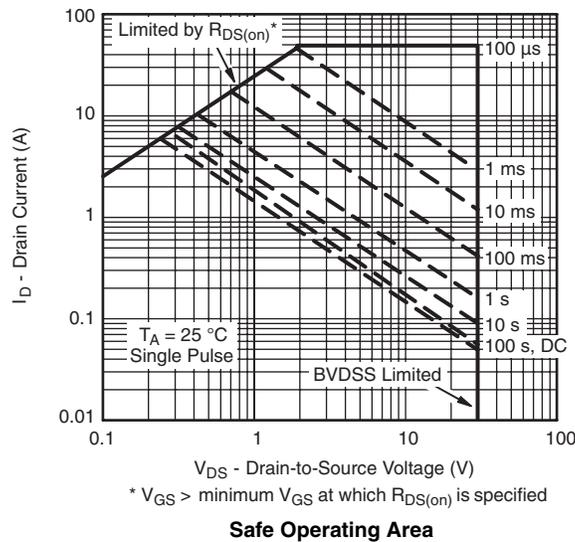
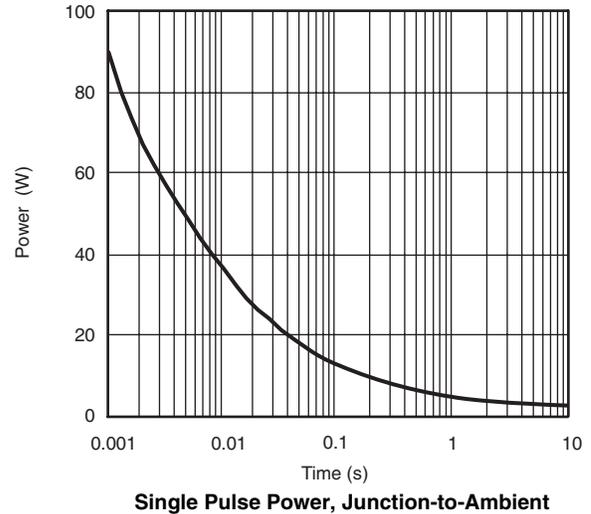
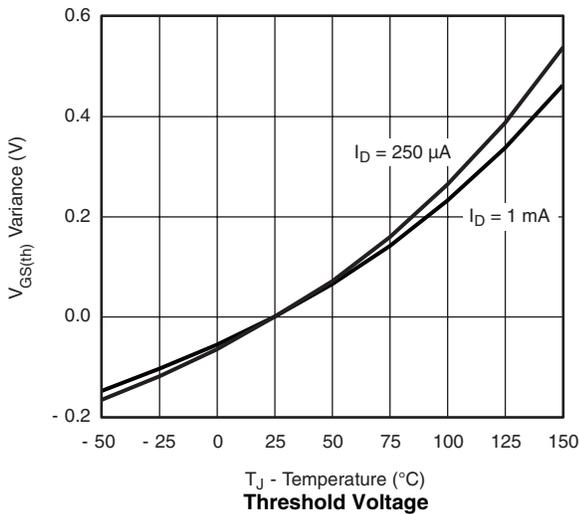
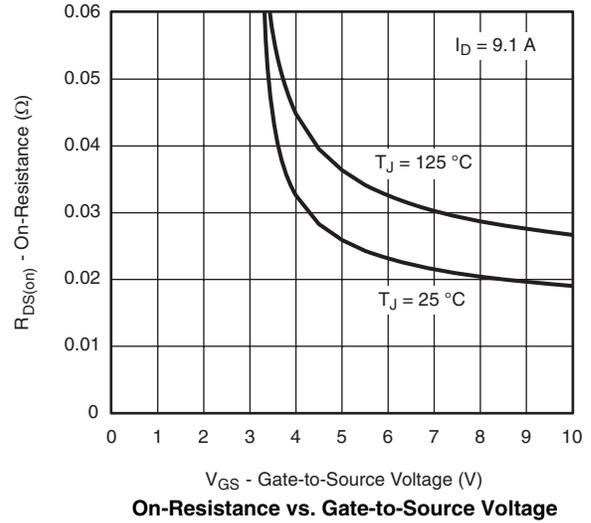
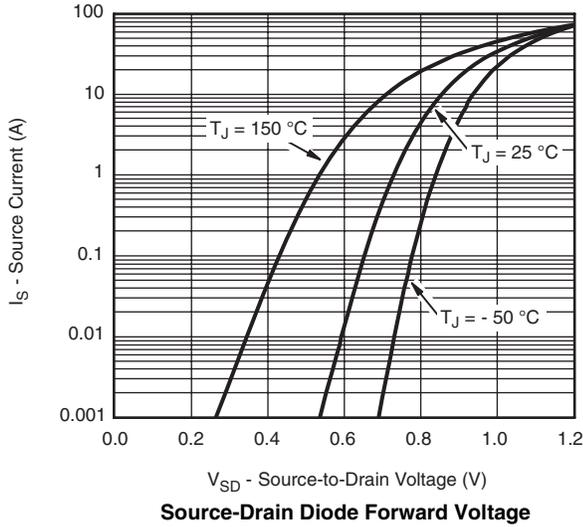
On-Resistance vs. Junction Temperature

Si4435DDY

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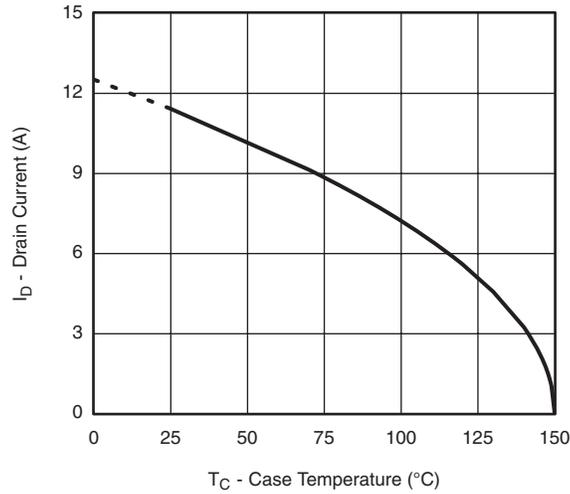


TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted

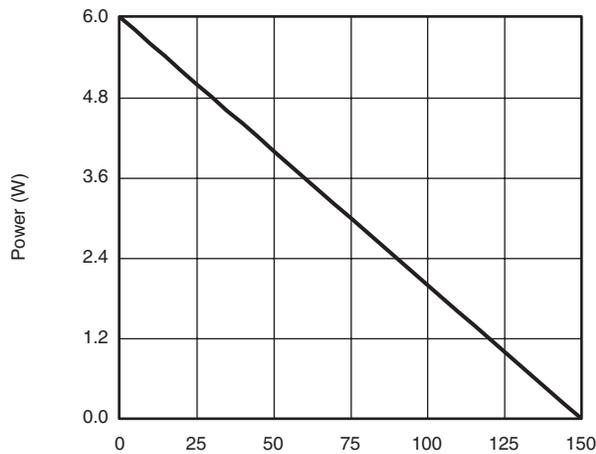




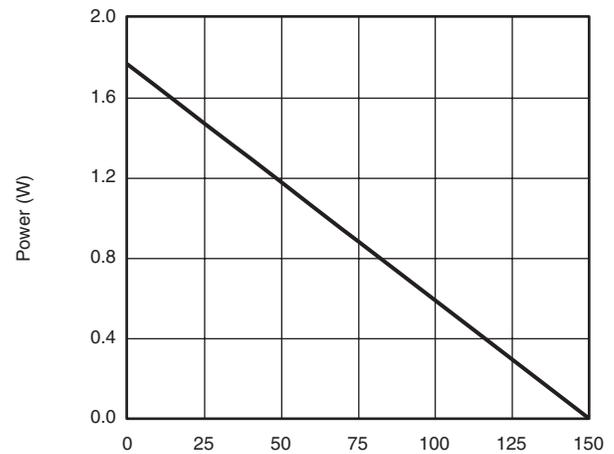
TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted



Current Derating*



Power, Junction-to-Foot



Power Derating, Junction-to-Ambient

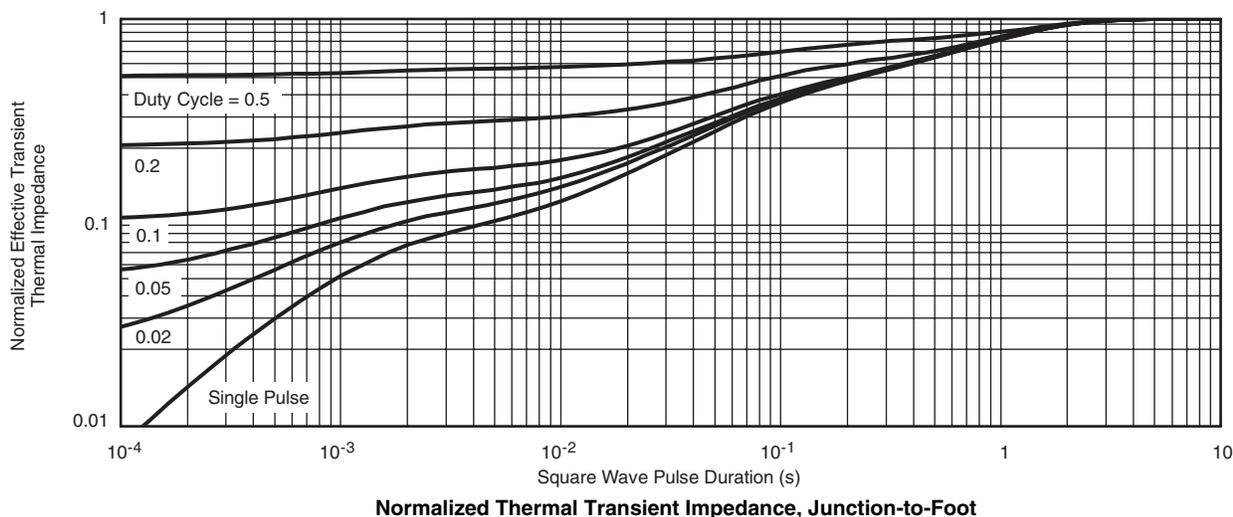
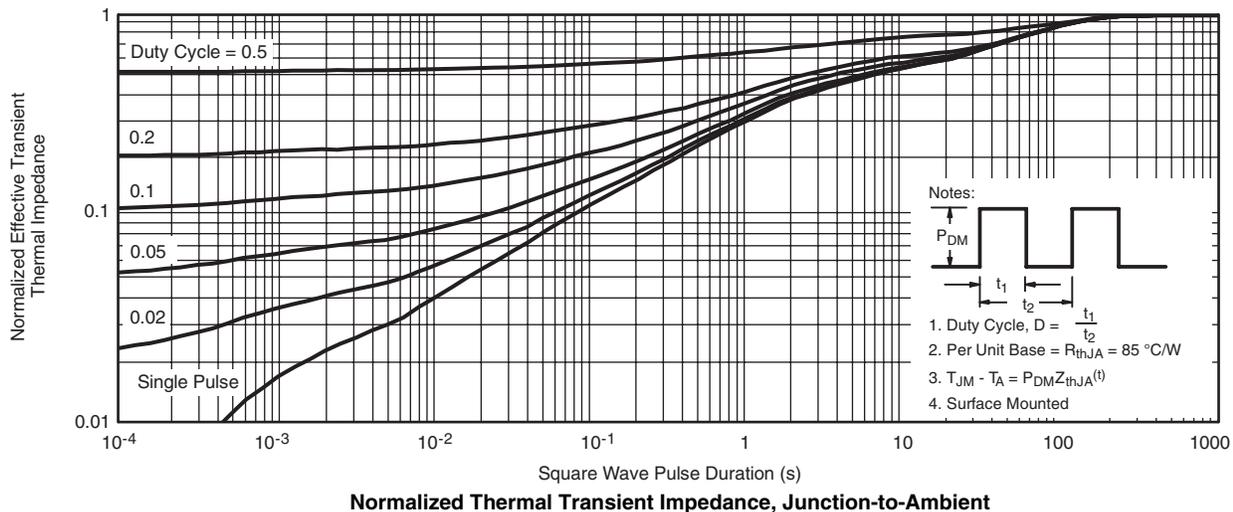
* The power dissipation P_D is based on T_{J(max)} = 150 °C, using junction-to-case thermal resistance, and is more useful in settling the upper dissipation limit for cases where additional heatsinking is used. It is used to determine the current rating, when this rating falls below the package limit.

Si4435DDY

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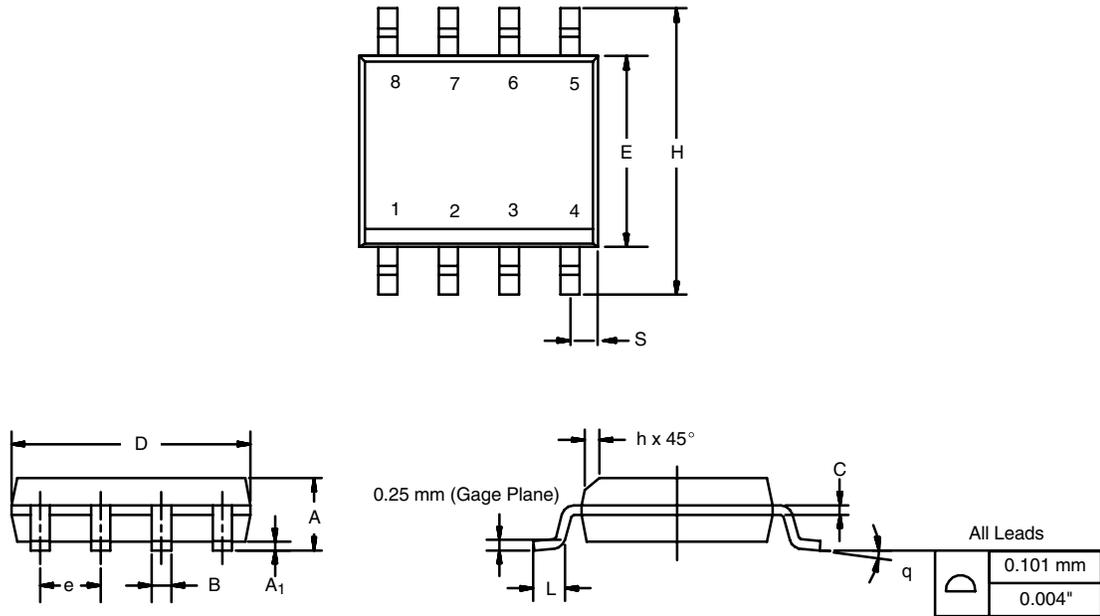
TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted



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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				



Mounting LITTLE FOOT®, SO-8 Power MOSFETs

Wharton McDaniel

Surface-mounted LITTLE FOOT power MOSFETs use integrated circuit and small-signal packages which have been modified to provide the heat transfer capabilities required by power devices. Leadframe materials and design, molding compounds, and die attach materials have been changed, while the footprint of the packages remains the same.

See Application Note 826, *Recommended Minimum Pad Patterns With Outline Drawing Access for Vishay Siliconix MOSFETs*, (<http://www.vishay.com/ppg?72286>), for the basis of the pad design for a LITTLE FOOT SO-8 power MOSFET. In converting this recommended minimum pad to the pad set for a power MOSFET, designers must make two connections: an electrical connection and a thermal connection, to draw heat away from the package.

In the case of the SO-8 package, the thermal connections are very simple. Pins 5, 6, 7, and 8 are the drain of the MOSFET for a single MOSFET package and are connected together. In a dual package, pins 5 and 6 are one drain, and pins 7 and 8 are the other drain. For a small-signal device or integrated circuit, typical connections would be made with traces that are 0.020 inches wide. Since the drain pins serve the additional function of providing the thermal connection to the package, this level of connection is inadequate. The total cross section of the copper may be adequate to carry the current required for the application, but it presents a large thermal impedance. Also, heat spreads in a circular fashion from the heat source. In this case the drain pins are the heat sources when looking at heat spread on the PC board.

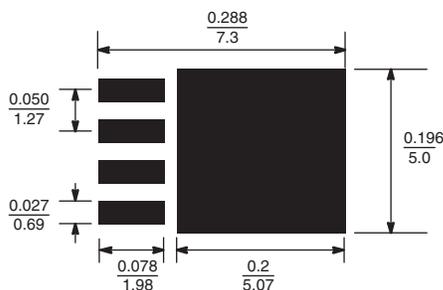


Figure 1. Single MOSFET SO-8 Pad Pattern With Copper Spreading

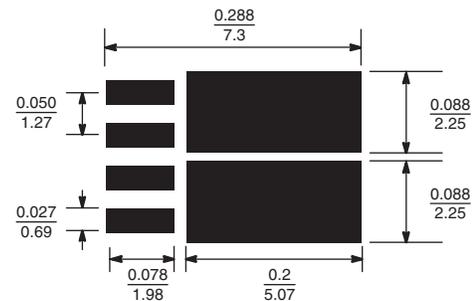


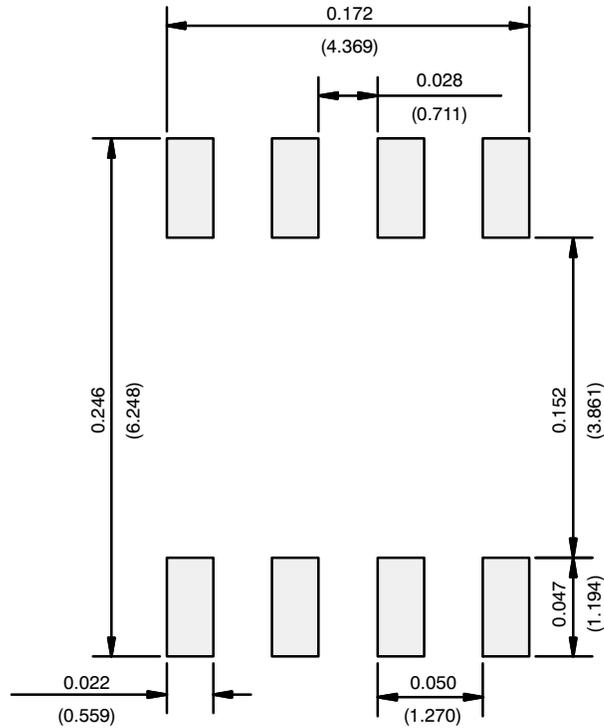
Figure 2. Dual MOSFET SO-8 Pad Pattern With Copper Spreading

The minimum recommended pad patterns for the single-MOSFET SO-8 with copper spreading (Figure 1) and dual-MOSFET SO-8 with copper spreading (Figure 2) show the starting point for utilizing the board area available for the heat-spreading copper. To create this pattern, a plane of copper overlies the drain pins. The copper plane connects the drain pins electrically, but more importantly provides planar copper to draw heat from the drain leads and start the process of spreading the heat so it can be dissipated into the ambient air. These patterns use all the available area underneath the body for this purpose.

Since surface-mounted packages are small, and reflow soldering is the most common way in which these are affixed to the PC board, “thermal” connections from the planar copper to the pads have not been used. Even if additional planar copper area is used, there should be no problems in the soldering process. The actual solder connections are defined by the solder mask openings. By combining the basic footprint with the copper plane on the drain pins, the solder mask generation occurs automatically.

A final item to keep in mind is the width of the power traces. The absolute minimum power trace width must be determined by the amount of current it has to carry. For thermal reasons, this minimum width should be at least 0.020 inches. The use of wide traces connected to the drain plane provides a low impedance path for heat to move away from the device.

RECOMMENDED MINIMUM PADS FOR SO-8



Recommended Minimum Pads
Dimensions in Inches/(mm)

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