N-Channel Synchronous MOSFETs With Break-Before-Make

DESCRIPTION

The Si4724CY N-Channel synchronous MOSFET with break-before-make (BBM) is a high speed driver designed to operate in high frequency DC/DC switchmode power supplies. It's purpose is to simplify the use of N-Channel MOSFETs in high frequency buck regulators. This device is designed to be used with any single output PWM IC or ASIC to produce a highly efficient low cost synchronous rectifier converter. A synchronous enable pin (disable = low, enable = high) controls the synchronous function for light load conditions.

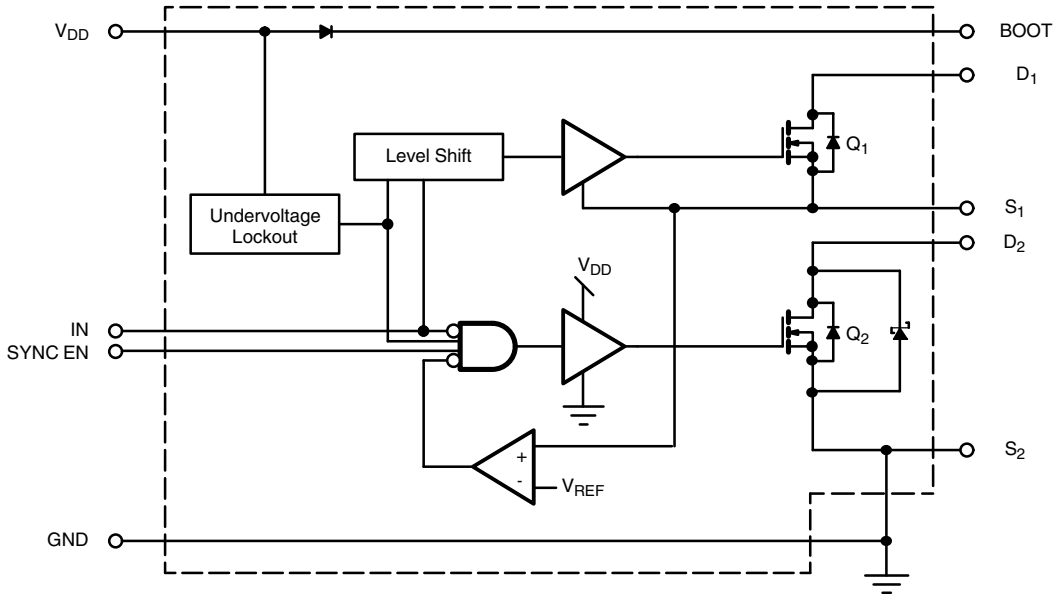
The Si4724CY is packaged in Vishay Siliconix's high performance LITTLE FOOT® SO-16 package.

FEATURES

- 0 V to 30 V operation
- Driver impedance-3
- Undervoltage lockout
- Fast switching times
- 30 V MOSFETs
- High side: 0.0375 at V_{DD} = 4.5 V
- Low side: 0.029 at V_{DD} = 4.5 V
- Switching frequency: 250 kHz to 1 MHz
- Integrated schottky

Pb-free Available

FUNCTIONAL BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_A = 25 °C, unless otherwise noted)

Parameter		Symbol	Steady State	Unit
Logic Supply		V_{DD}	7	V
Logic Inputs		V_{IN}	- 0.7 to V_{DD} + 0.3	
Drain Voltage		V_{D1}	30	
Bootstrap Voltage		V_{BOOT}	V_{S1} + 7	
Synchronous pin Voltage		V_{SYNC}	- 0.7 to V_{DD} + 0.3	
Continuous Drain Current	T_A = 25 °C	I_{D1}	5.1	A
	T_A = 70 °C		4.09	
	T_A = 25 °C	I_{D2}	6.5	
	T_A = 70 °C		5.2	
Maximum Power Dissipation[a]		P_D	1.2	W
Operating Junction and Storage Temperature Range	Driver	T_J, T_{stg}	- 65 to 125	°C
	MOSFETs		- 65 to 150	

Notes:
a. Surface mounted on 1" x 1" FR4 board, full copper two sides.

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.

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Steady State	Unit
Drain Voltage	V_{D1}	0 to 30	V
Logic Supply	V_{DD}	4.5 to 5.5	
Input Logic High Voltage	V_{IH}	0.7 x V_{DD} to V_{DD}	
Input Logic Low Voltage	V_{IL}	- 0.3 to 0.3 x V_{DD}	
Bootstrap Capacitor	C_{BOOT}	0.1 to 1	µ
Ambient Temperature	T_A	- 40 to 85	°C

THERMAL RESISTANCE RATINGS

Parameter		Symbol	Typical	Maximum	Unit
Highside Junction-to-Ambient[a]	Steady State	R_{thJA1}	85	105	°C/W
Lowside Junction-to-Ambient[a]		R_{thJA2}	68	85	
Highside Junction-to-Foot (Drain)[b]		R_{thJF1}	28	35	
Lowside Junction-to-Foot (Drain)[b]		R_{thJF2}	19	24	

Notes:
a. Surface mounted on 1" x 1" FR4 board.
b. Junction-to-foot thermal impedance represents the effective thermal impedance of all heat carrying leads in parallel and is intended for use in conjunction with the thermal impedance of the PC board pads to ambient (R_{thJA} = R_{thJF} + $R_{thPCB-A}$). It can also be used to estimate chip temperature if power dissipation and the lead temperature of a heat carrying (drain) lead is known.

SPECIFICATIONS

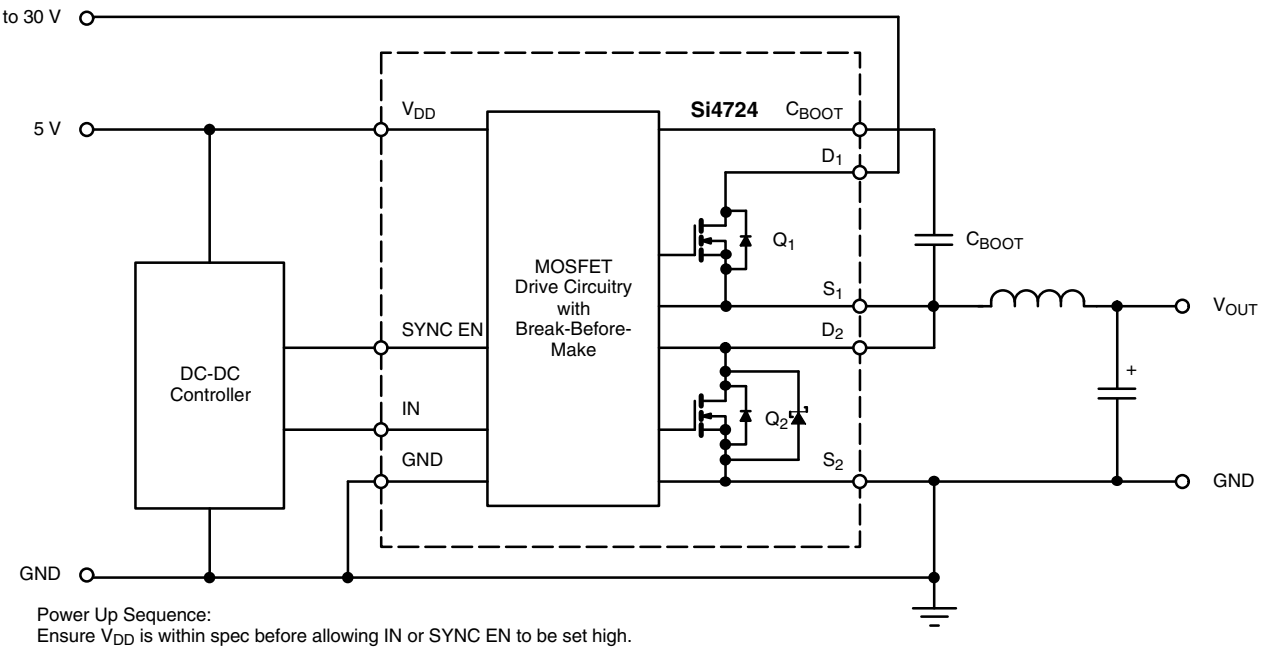
Parameter		Symbol	Test Conditions Unless Specified T_A = 25 °C, 4.5 V < V_{DD} < 5.5 V, 4.5 V < V_{D1} < 30 V		Limits Min.	Limits Typ.	Limits Max.	Unit
Power Supplies								
Logic Voltage		V_{DD}			4.5		5.5	V
Logic Current		$I_{DD(EN)}$	V_{DD} = 4.5 V, V_{IN} = 4.5 V			280	500	µA
		$I_{DD(DIS)}$	V_{DD} = 4.5 V, V_{IN} = 0 V			220	500	
Logic Input								
Logic Input Voltage (V_{IN})	High	V_{IH}	V_{DD} = 4.5		3.15	2.3		V
	Low	V_{IL}	- 40 °C ≤ T_A ≤ 85 °C		- 0.3	2.25	0.8	
Protection								
Break-Before-Make Reference		V_{BBM}	V_{DD} = 5.5			2.4		V
Undervoltage Lockout		V_{UVLO}	SYNC = 4.5		3.75	4	4.25	
Undervoltage Lockout Hysteresis		V_H				0.4		
MOSFET Drivers								
Driver Impedance		R_{DR1}	V_{DD} = 4.5 V	Driver 1		3		V
		R_{DR2}		Driver 2		2		
MOSFETs								
Drain-Source Voltage		V_{DS}	I_D = 250 µA		30			V
Drain Source On State Resistance[a]		$R_{DS(on)1}$	V_{DD} = 4.5 V, I_D = 5 A, T_A = 25 °C	Q1		30	37.5	mΩ
		$R_{DS(on)2}$		Q2		24	29	
Diode Forward Voltage[a]		V_{SD1}	I_S = 2 A, V_{GS} = 0	Q1		0.7	1.1	V
		V_{SD2}		Q2		0.7	1.1	
Dynamic[b] (Unless Specified-F_s = 250 kHz, V_{IN} = 12 V. V_{DD} = 5 V, I = 5 A, Refer to Switching Test Setup)								
Turn Off Delay		$t_{d(off)1}$	See Timing Diagram	V_{IN} to G_1		28	56	ns
		$t_{d(off)2}$		V_{IN} to G_2		17	40	
Δt		Δt_{1-2}		G_1 to G_2		16	32	
		Δt_{2-1}		G_2 to G_1		38	80	
Source-Drain Reverse Recovery Time-Q_2		t_{frr}	I_F 2.7 A, di/dt = 100 A/µs			50	80	

Notes:
a. Pulse test; pulse width ≤ 300 µs, duty cycle ≤ 2 %.
b. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

SCHOTTKY SPECIFICATIONS (T_J = 25 °C, unless otherwise noted)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Forward Voltage Drop	V_F	I_F = 1 A		0.47	0.50	V
		I_F = 1 A, T_J = 125 °C		0.36	0.42	
Maximum Reverse Leakage Current	I_{rm}	V_r = 30 V		0.004	0.100	mA
		V_r = 30 V, T_J = 100 °C		0.7	10	
		V_r = - 30 V, T_J = 125 °C		3	20	
Junction Capacitance	C_T	V_r = 10 V		50		pF

APPLICATION CIRCUIT

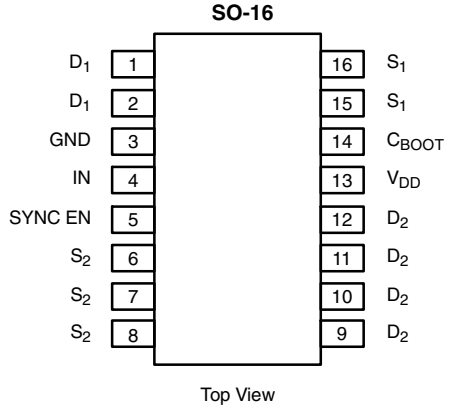


Power Up Sequence:
Ensure V_{DD} is within spec before allowing IN or SYNC EN to be set high.

Power Down Sequence:
Ensure IN and SYNC EN are low before turning V_{DD} off.

Figure 1.

PIN CONFIGURATION



Top View

Ordering Information: Si4724CY-T1
Si4724CY-T1-E3 (Lead (Pb)-free)

TRUTH TABLE

Sync EN	CLK	Q_1	Q_2
H	H	ON	OFF
H	L	OFF	ON
L	H	ON	OFF
L	L	OFF	OFF

PIN DESCRIPTION

Pin Number	Symbol	Description
1, 2	D_1	Highside MOSFET Drain
3	GND	Ground
4	IN	Input Logic Signal
5	SYNC EN	Synchronous Enable
6, 7, 8	S_2	Lowside MOSFET Source
9, 10, 11, 12	D_2	Lowside MOSFET Drain
13	V_{DD}	Logic Supply, decoupling to GND with a cap is strongly recommended.
14	C_{BOOT}	Bootstrap Capacitor for Upper MOSFET
15, 16	S_1	Highside MOSFET Source

TIMING DIAGRAM

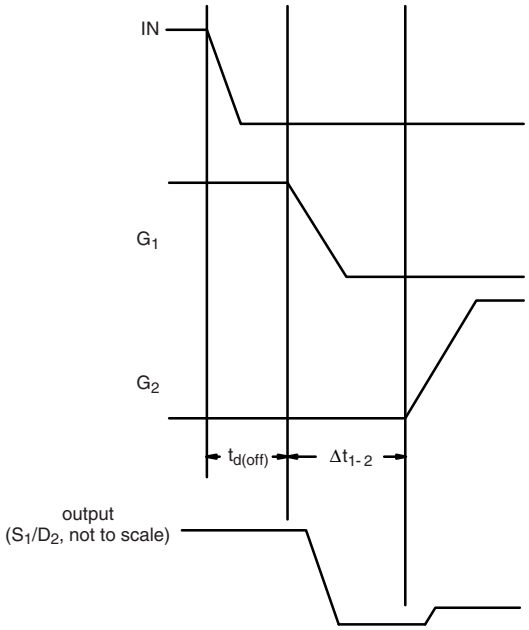


Figure 2. Δt_{1-2}

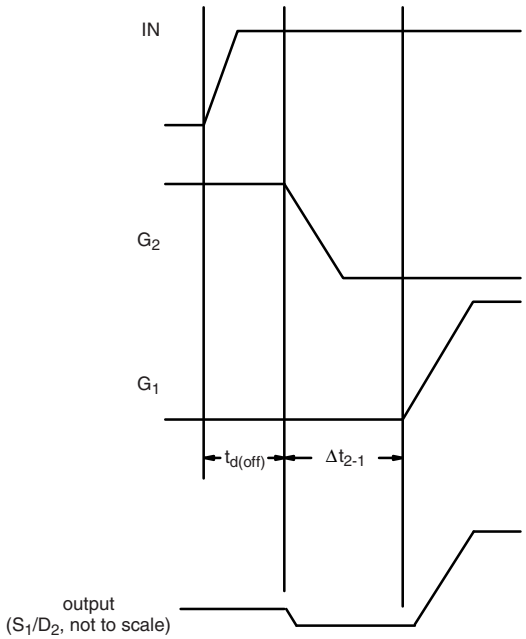


Figure 3. Δt_{2-1}

SWITCHING TEST SET-UP

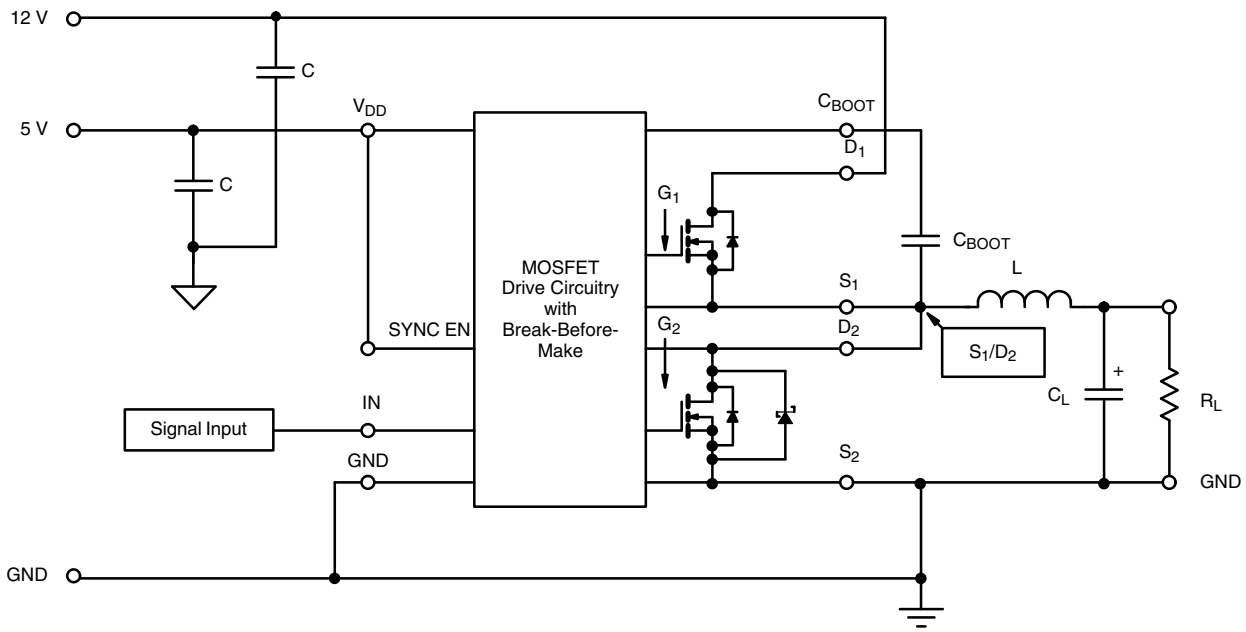
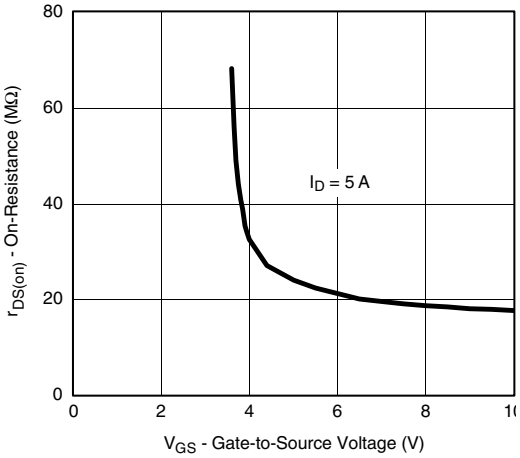
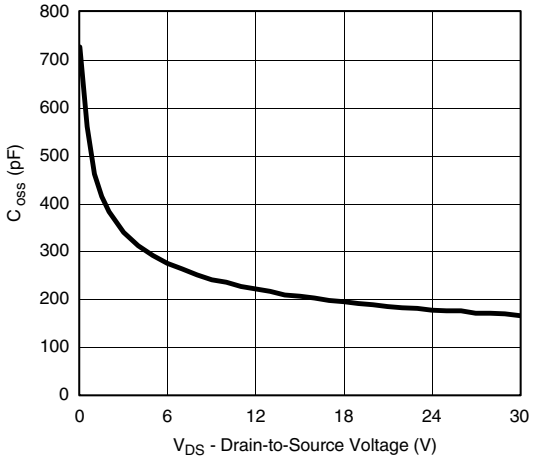


Figure 4.

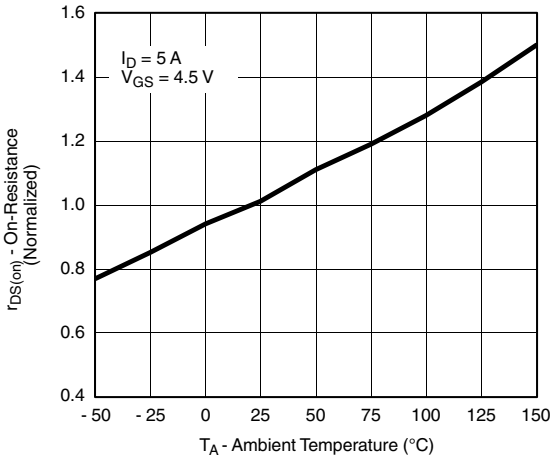
TYPICAL CHARACTERISTICS (25 °C unless noted)



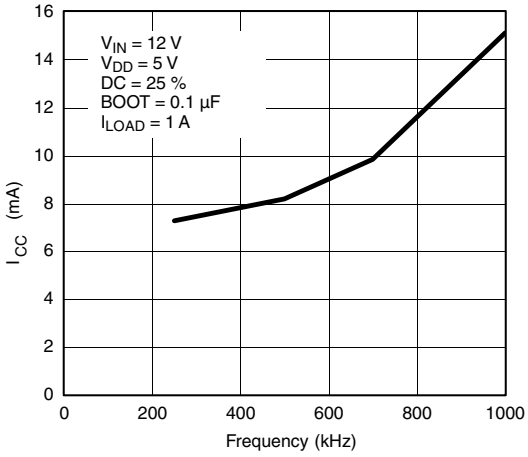
On-Resistance vs. Gate-to-Source Voltage (Q_1)



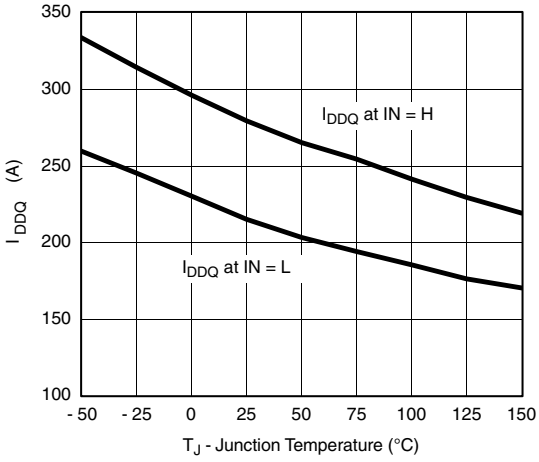
Output Capacitance vs. Drain Voltage (Q_1 and Q_2)



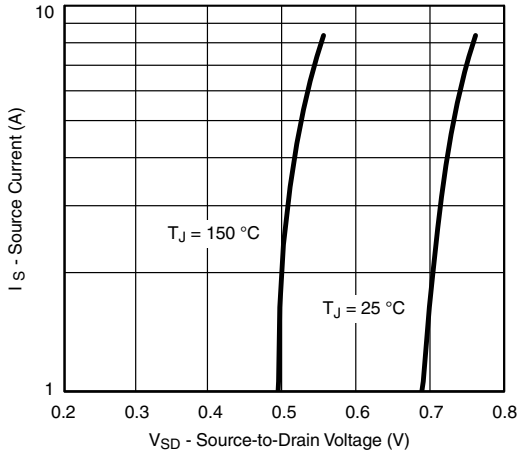
On-Resistance vs. Ambient Temperature



I_{CC} vs. Frequency

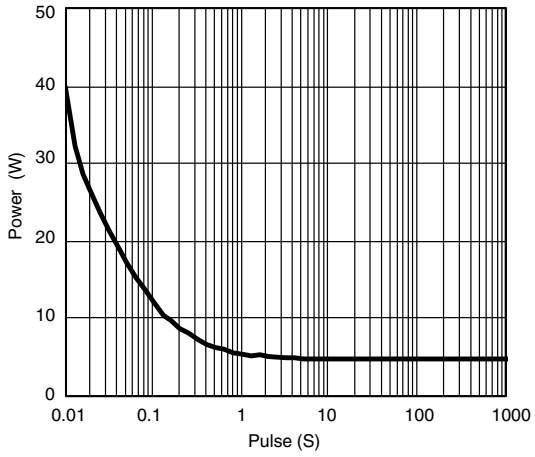


Input Current vs. Junction Temperature

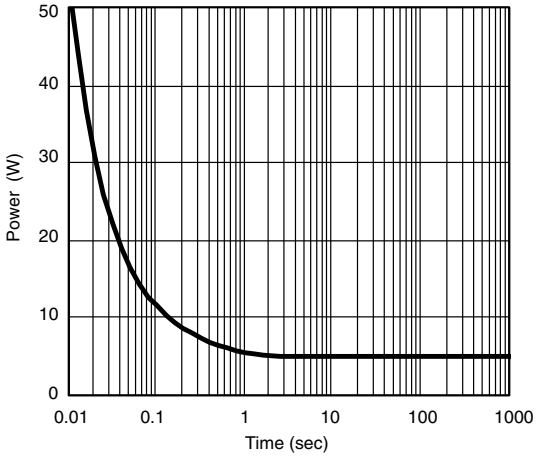


Source-Drain Diode Forward Voltage

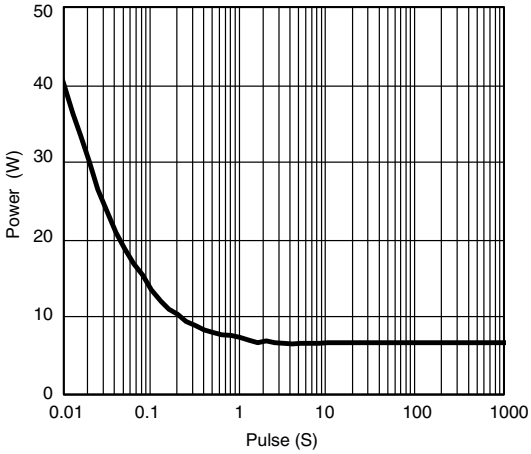
TYPICAL CHARACTERISTICS (25 °C unless noted)



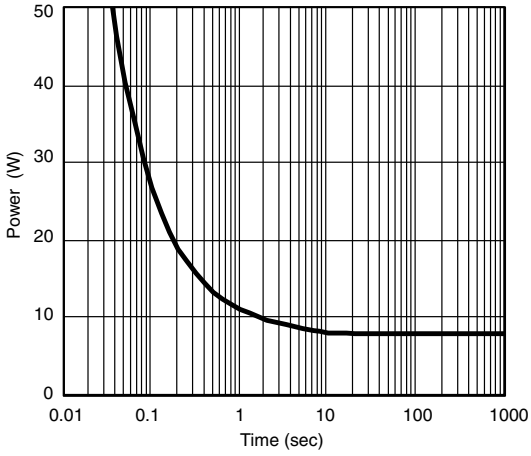
Single Pulse Power, Junction-to-Foot (Q_1)



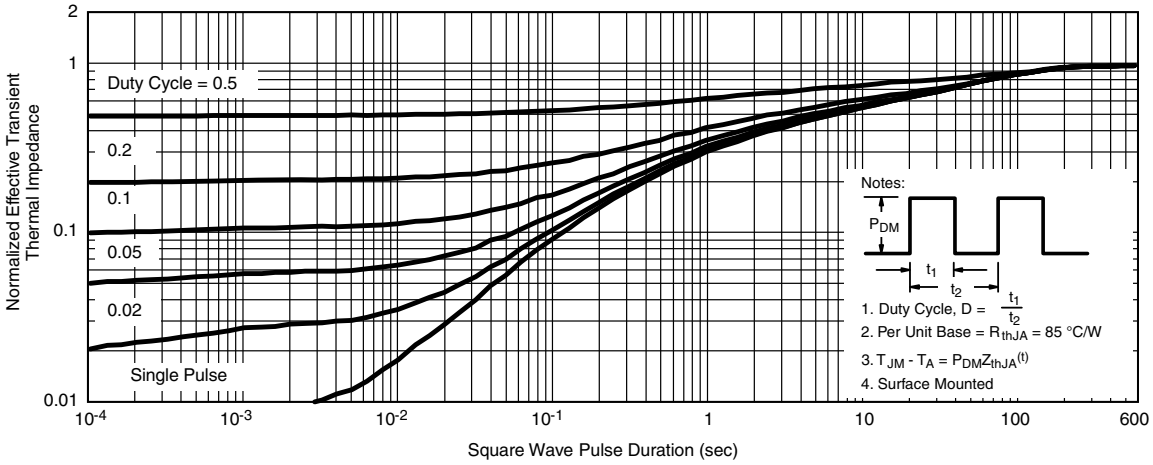
Single Pulse Power, Junction-to-Ambient (Q_1)



Single Pulse Power, Junction-to-Foot (Q_2)

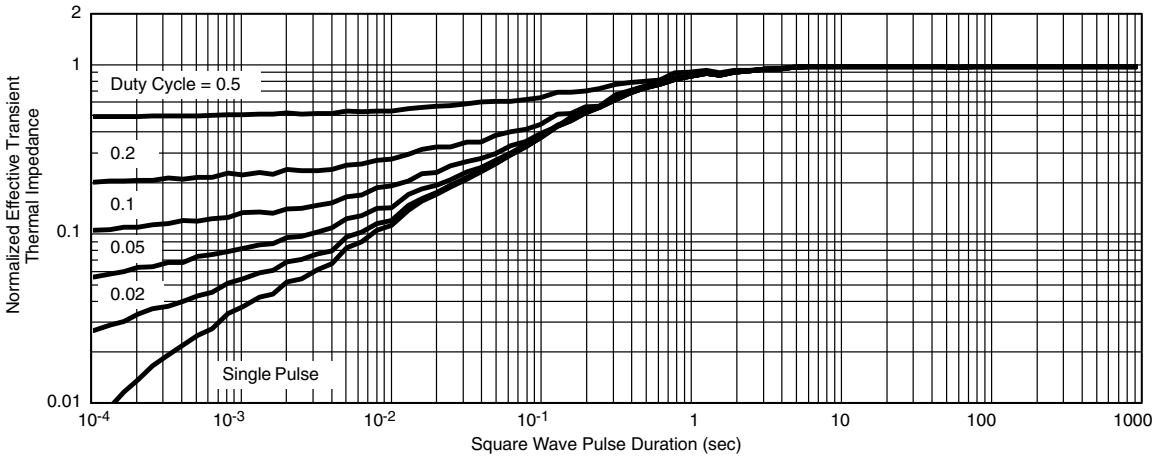


Single Pulse Power, Junction-to-Ambient (Q_2)

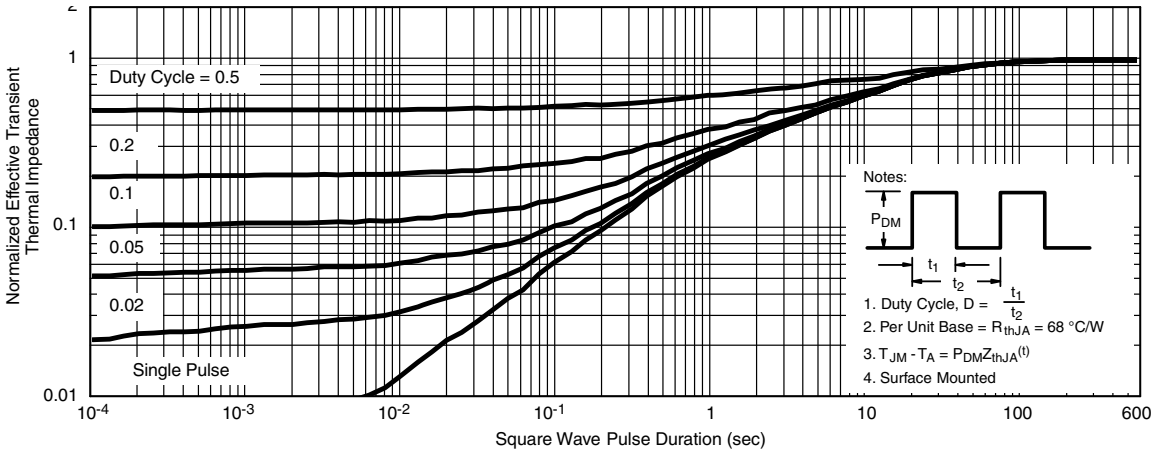


Normalized Thermal Transient Impedance, Junction-to-Ambient (Q_1)

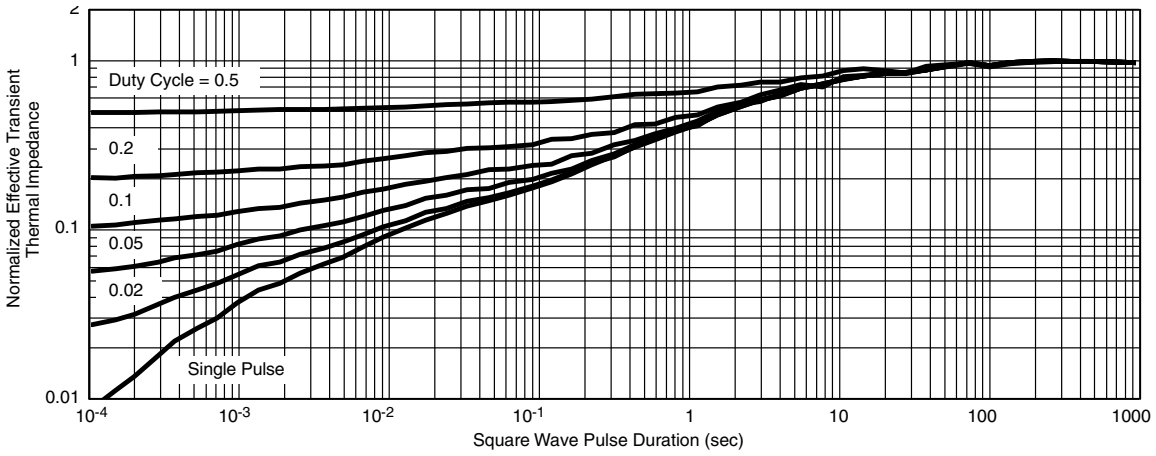
TYPICAL CHARACTERISTICS (25 °C unless noted)



Normalized Thermal Transient Impedance, Junction-to-Foot (Q_1)



Normalized Thermal Transient Impedance, Junction-to-Ambient (Q_2)



Normalized Thermal Transient Impedance, Junction-to-Foot (Q_2)

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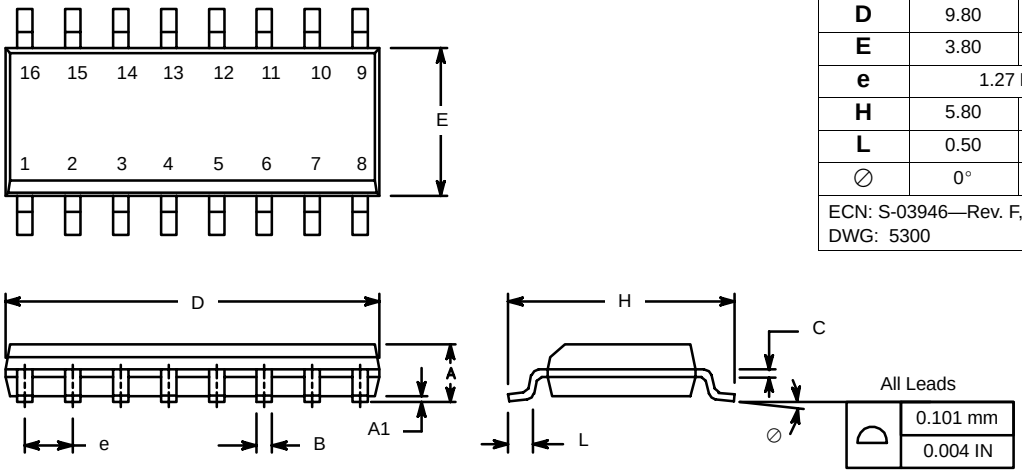
SOIC (NARROW): 16-LEAD

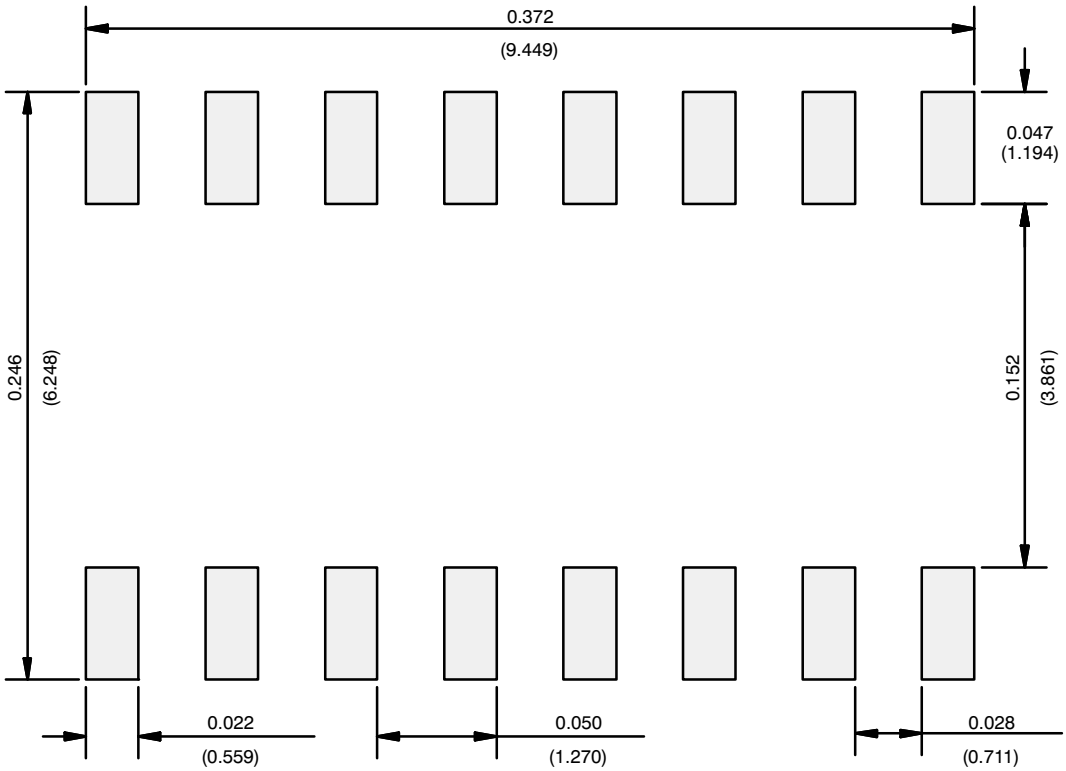
JEDEC Part Number: MS-012



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	0.38	0.51	0.015	0.020
C	0.18	0.23	0.007	0.009
D	9.80	10.00	0.385	0.393
E	3.80	4.00	0.149	0.157
e	1.27 BSC		0.050 BSC	
H	5.80	6.20	0.228	0.244
L	0.50	0.93	0.020	0.037
⊘	0°	8°	0°	8°

ECN: S-03946—Rev. F, 09-Jul-01
DWG: 5300

RECOMMENDED MINIMUM PADS FOR SO-16



Recommended Minimum Pads
Dimensions in Inches/(mm)

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