

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. Its 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.

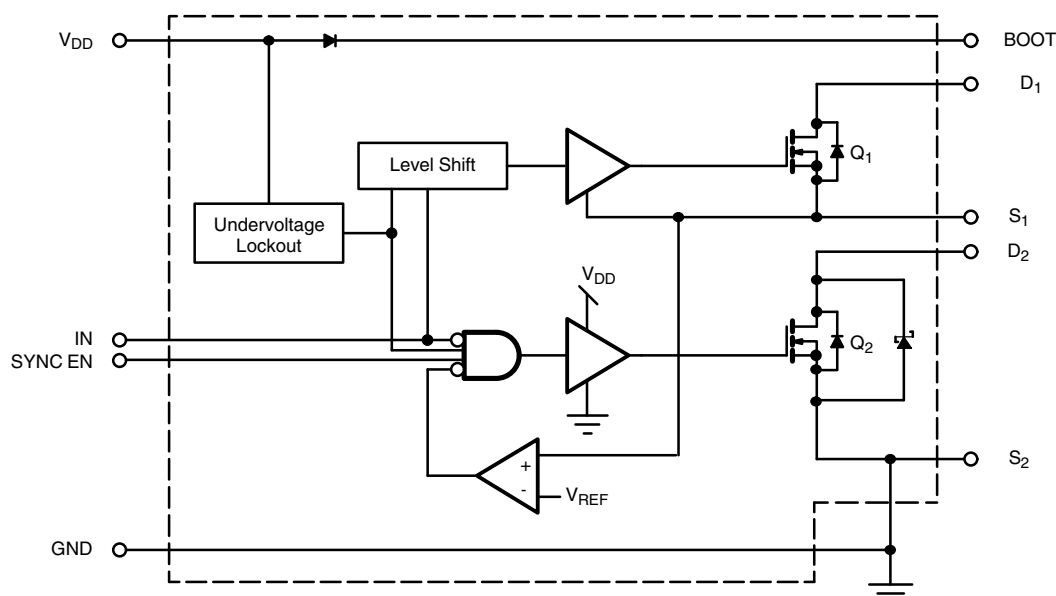
The Si4724CY is packaged in Vishay Siliconix's high performance LITTLE FOOT® SO-16 package.

FEATURES

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



FUNCTIONAL BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS ($T_A = 25\text{ }^{\circ}\text{C}$, 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	$T_A = 25\text{ }^{\circ}\text{C}$	I_{D1}	5.1	A
	$T_A = 70\text{ }^{\circ}\text{C}$		4.09	
	$T_A = 25\text{ }^{\circ}\text{C}$	I_{D2}	6.5	
	$T_A = 70\text{ }^{\circ}\text{C}$		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	$^{\circ}\text{C}$
	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}	$0.7 \times V_{DD}$ to V_{DD}	
Input Logic Low Voltage	V_{IL}	- 0.3 to $0.3 \times V_{DD}$	
Bootstrap Capacitor	C_{BOOT}	0.1 to 1	μ
Ambient Temperature	T_A	- 40 to 85	$^{\circ}\text{C}$

THERMAL RESISTANCE RATINGS				
Parameter	Symbol	Typical	Maximum	Unit
Highside Junction-to-Ambient ^a	R_{thJA1}	85	105	$^{\circ}\text{C/W}$
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			Unit	
				Min.	Typ.	Max.		
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 - 40 °C ≤ T _A ≤ 85 °C	3.15	2.3		V	
	Low	V _{IL}		- 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	mΩ	
		R _{DS(on)2}		Q2		24		29
Diode Forward Voltage ^a		V _{SD1}	I _S = 2 A, V _{GS} = 0	Q1		0.7	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 $\leq 300\text{ }\mu\text{s}$, duty cycle $\leq 2\%$.

b. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

SCHOTTKY SPECIFICATIONS ($T_J = 25\text{ }^{\circ}\text{C}$, unless otherwise noted)						
Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Forward Voltage Drop	V_F	$I_F = 1\text{ A}$		0.47	0.50	V
		$I_F = 1\text{ A}, T_J = 125\text{ }^{\circ}\text{C}$		0.36	0.42	
Maximum Reverse Leakage Current	I_{rm}	$V_r = 30\text{ V}$		0.004	0.100	mA
		$V_r = 30\text{ V}, T_J = 100\text{ }^{\circ}\text{C}$		0.7	10	
		$V_r = -30\text{ V}, T_J = 125\text{ }^{\circ}\text{C}$		3	20	
Junction Capacitance	C_T	$V_r = 10\text{ V}$		50		pF

APPLICATION CIRCUIT

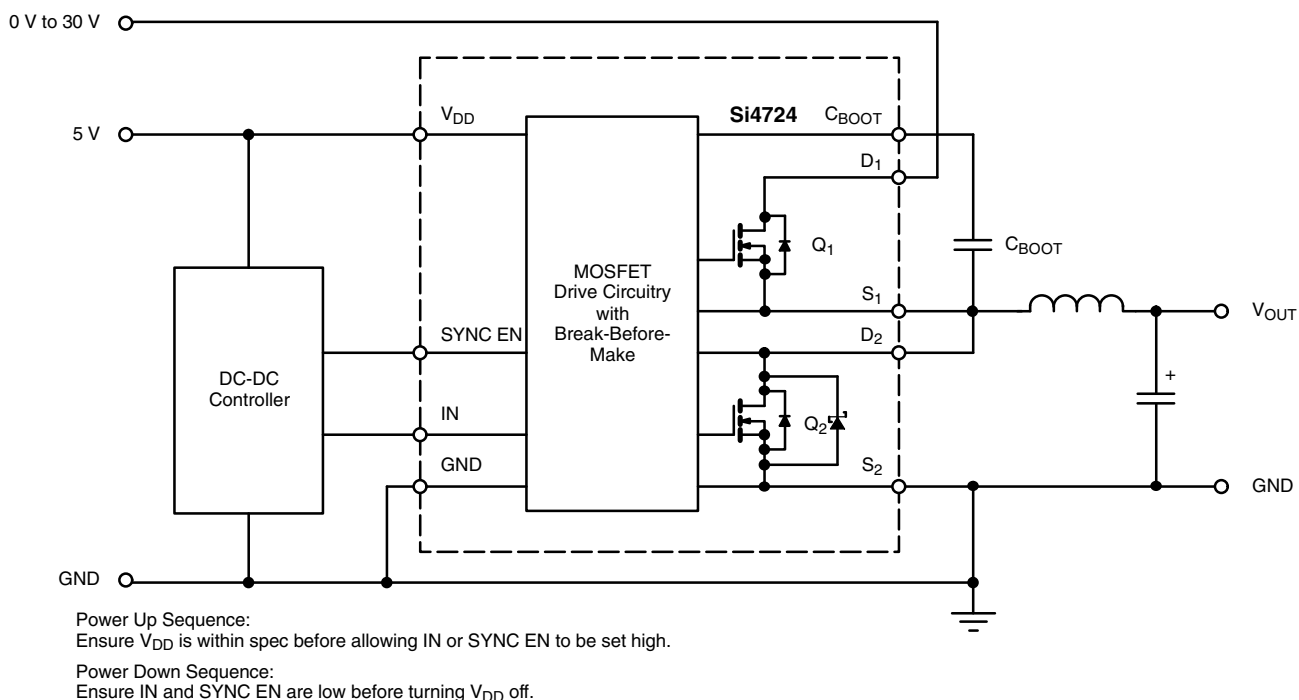
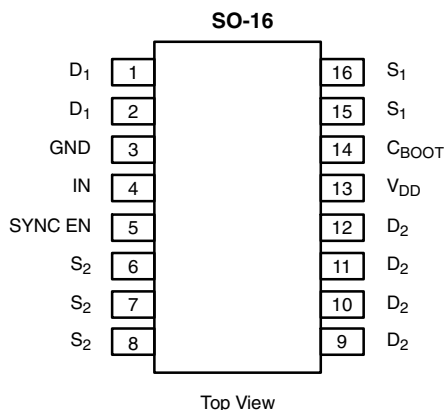


Figure 1.

PIN CONFIGURATION



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

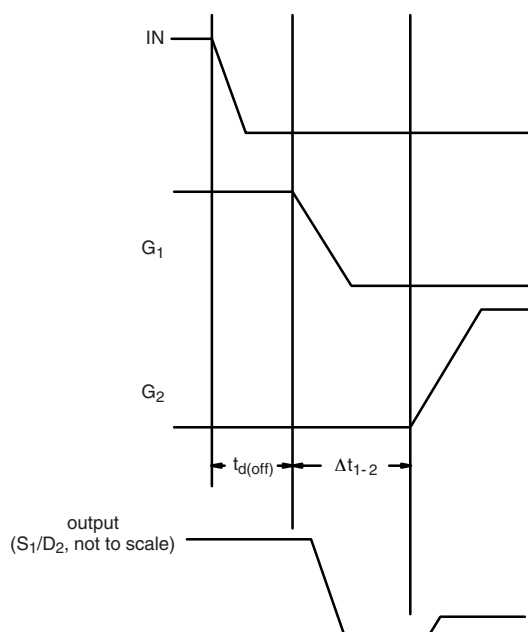


Figure 2. Δt_{1-2}

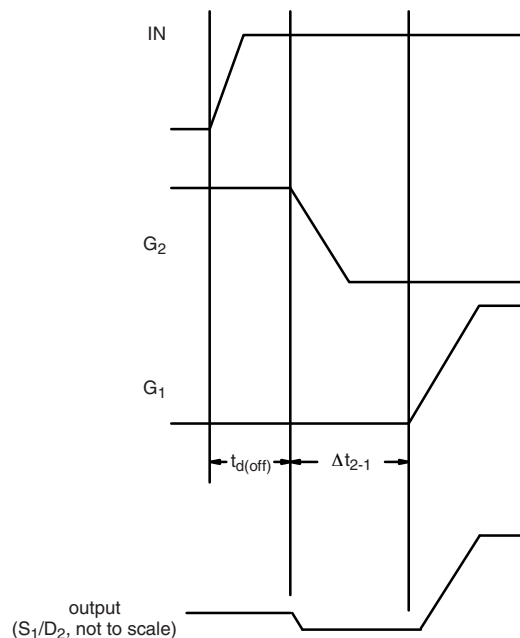


Figure 3. Δt_{2-1}

SWITCHING TEST SET-UP

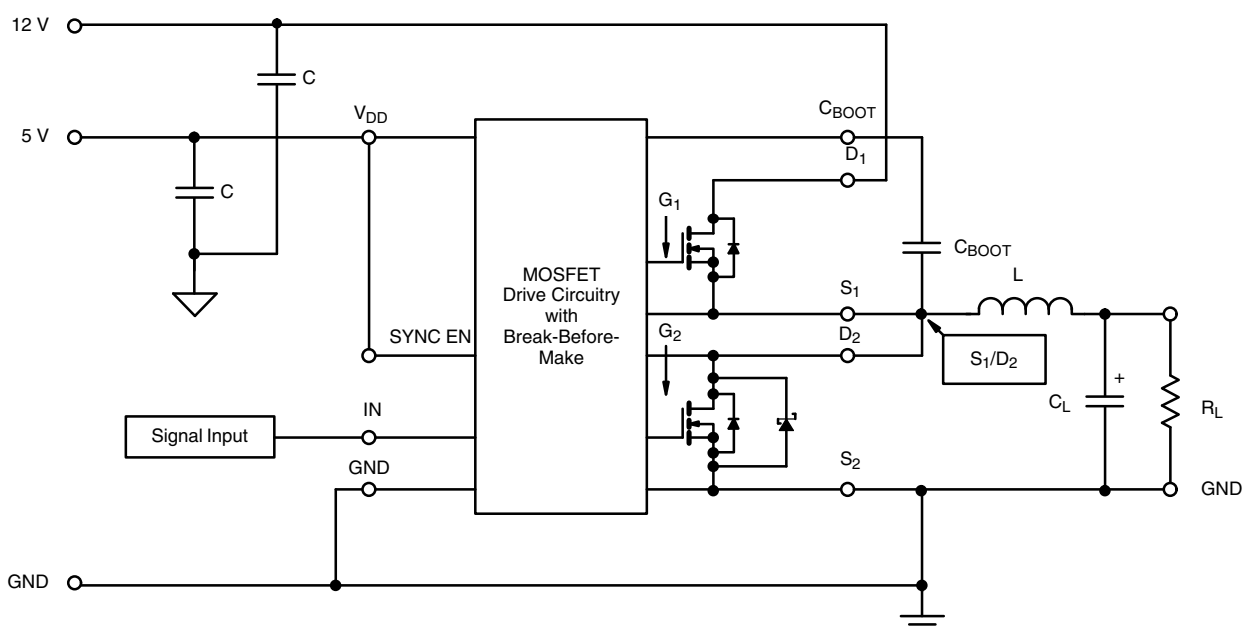
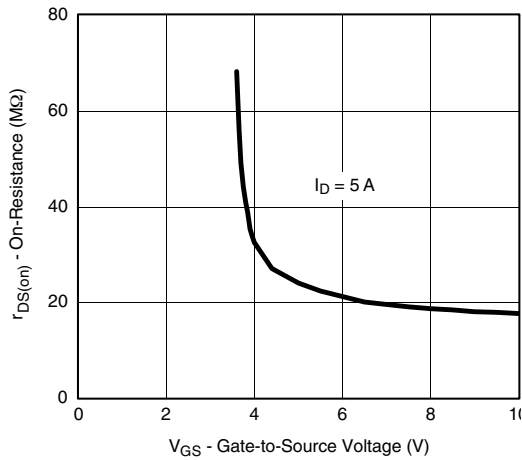
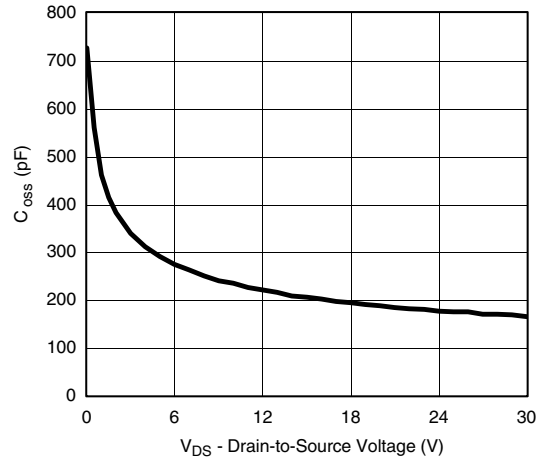
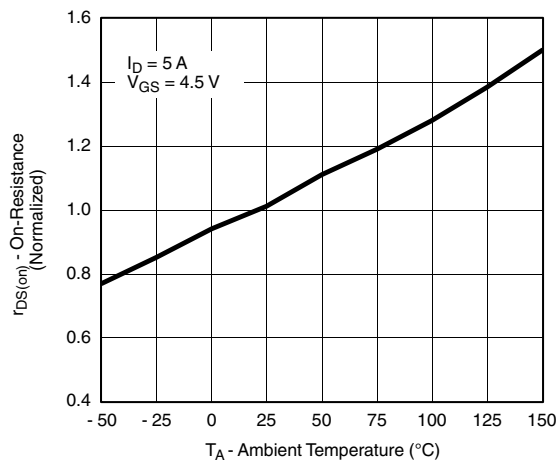
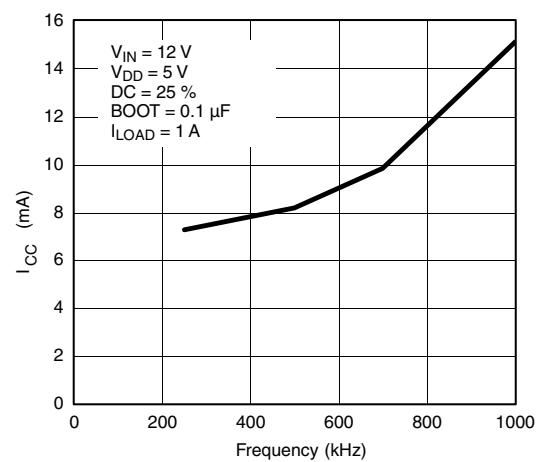
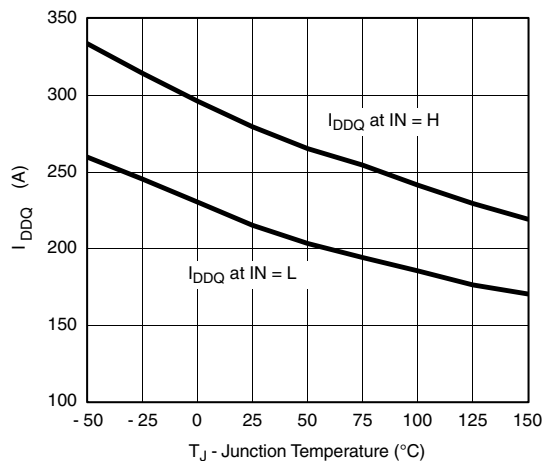
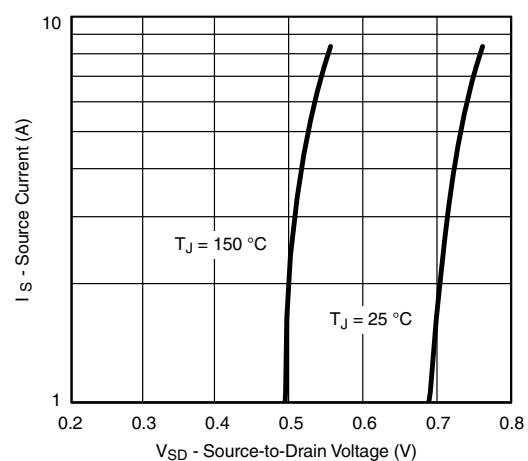
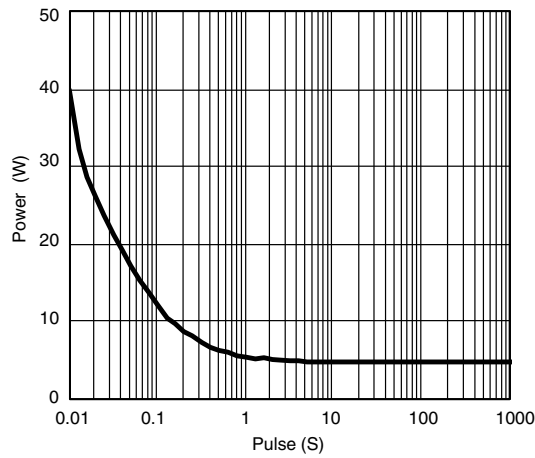
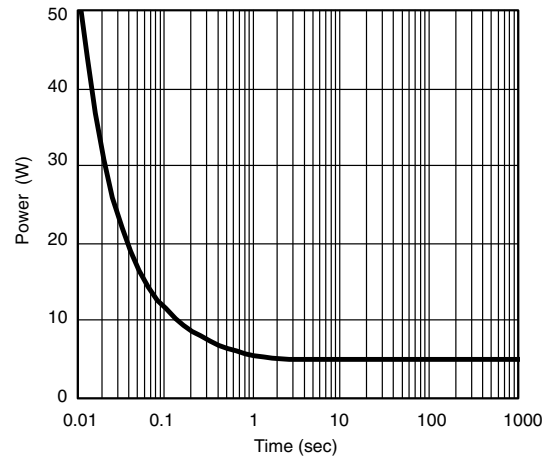
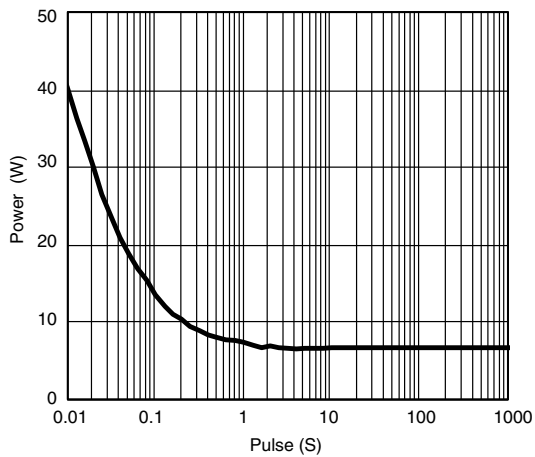
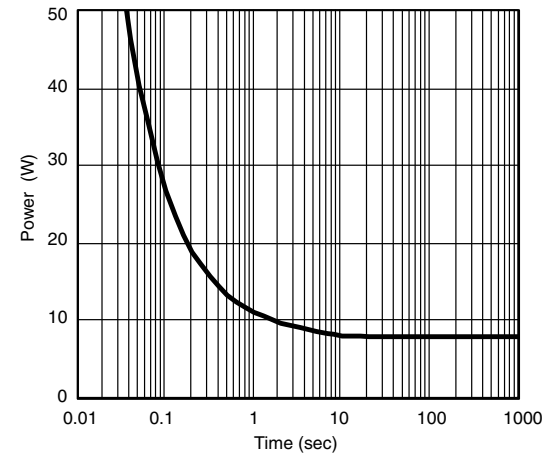
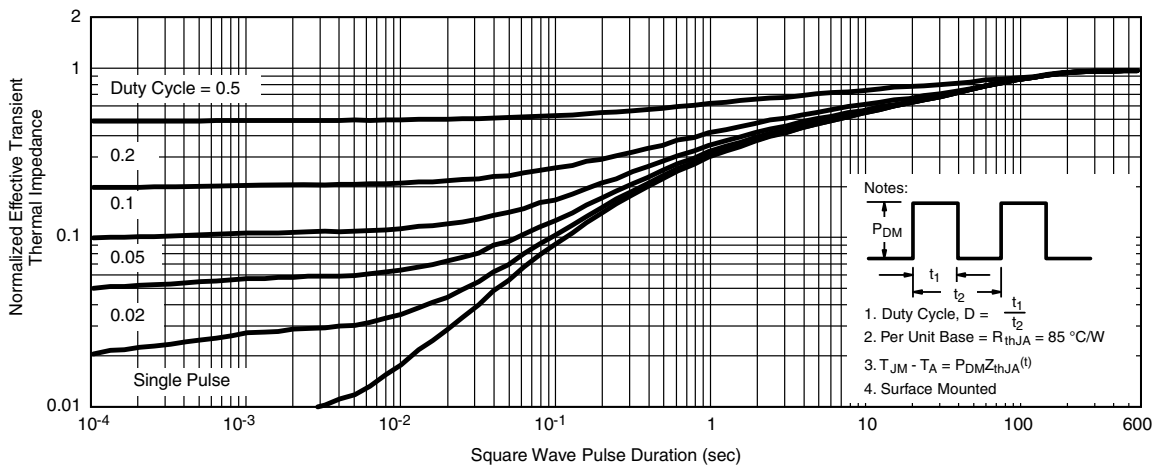
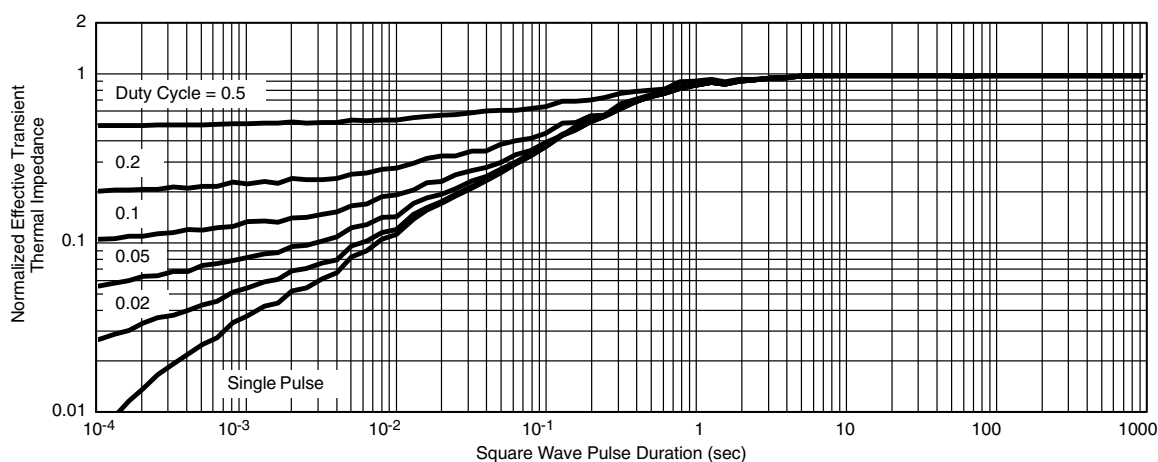
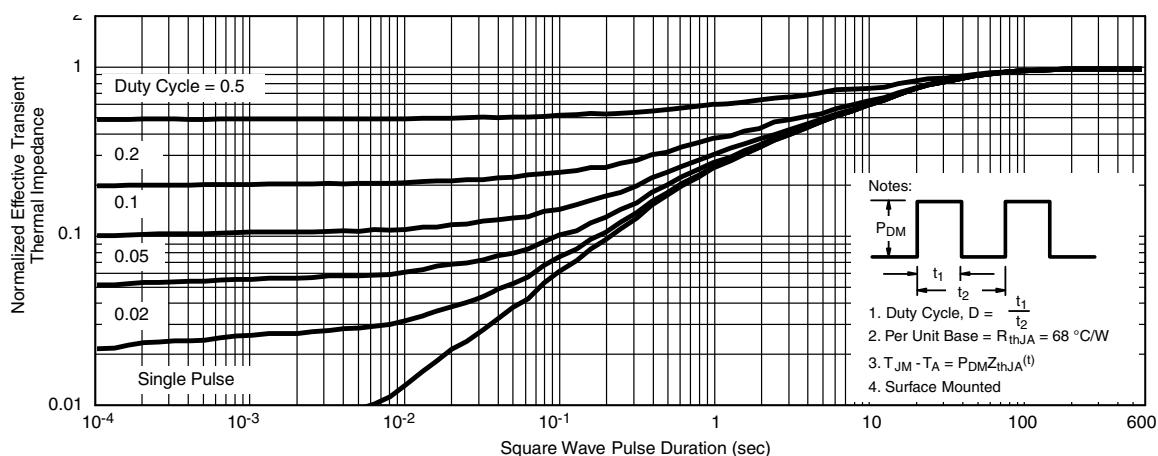
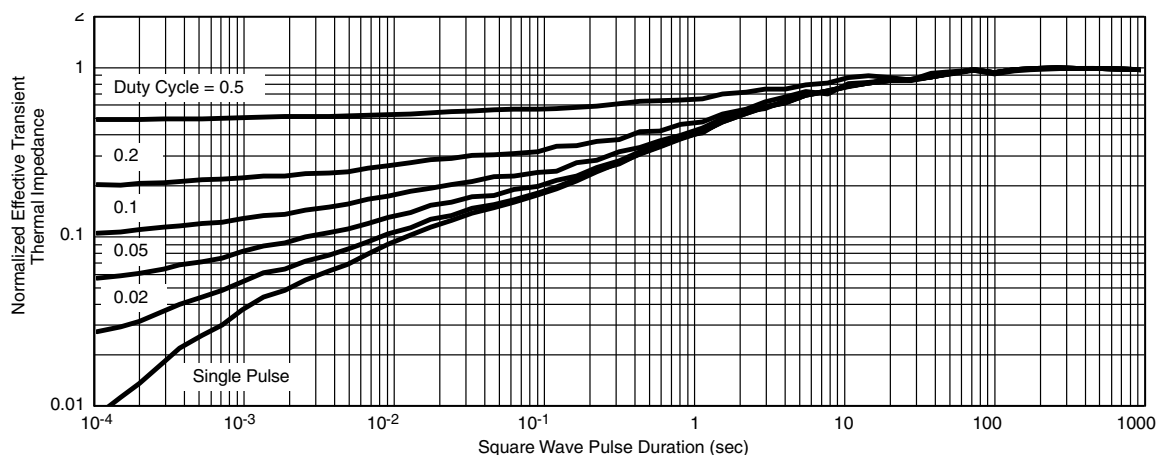


Figure 4.

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)

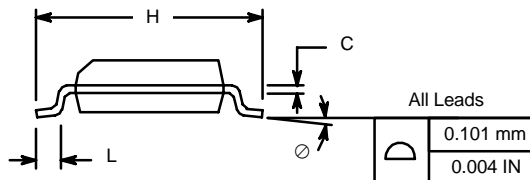
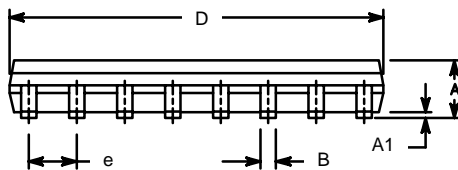
TYPICAL CHARACTERISTICS (25 °C unless noted)**Normalized Thermal Transient Impedance, Junction-to-Foot (Q_1)****Normalized Thermal Transient Impedance, Junction-to-Ambient (Q_2)****Normalized Thermal Transient Impedance, Junction-to-Foot (Q_2)**

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SOIC (NARROW): 16-LEAD

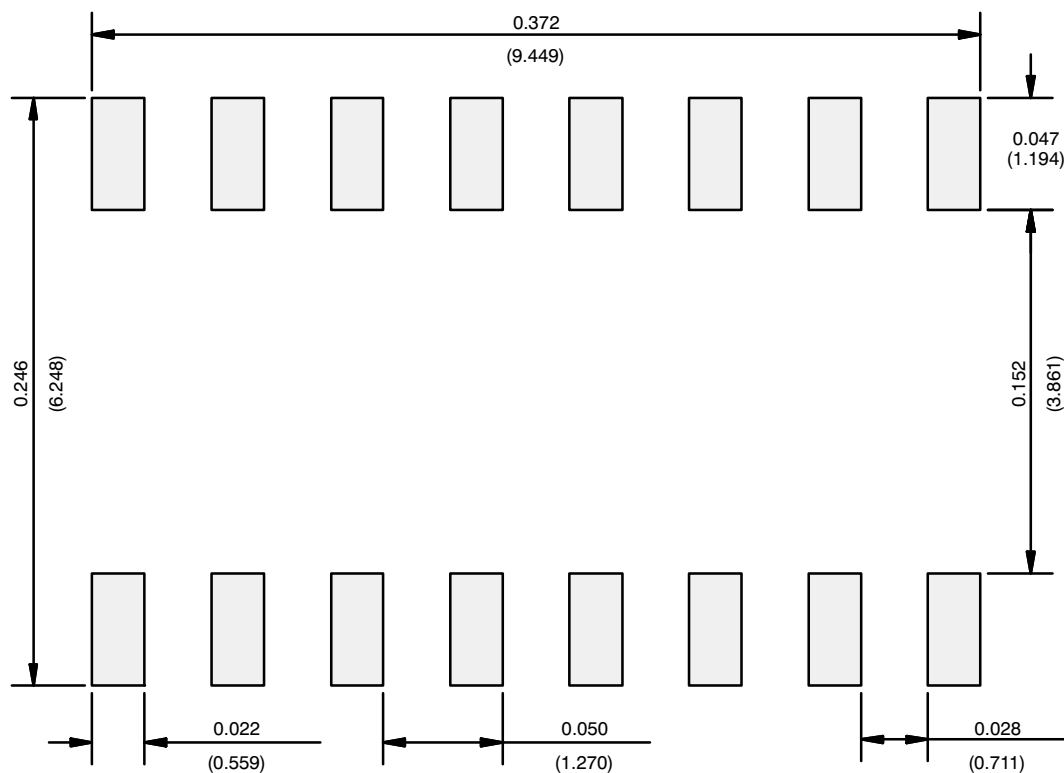
JEDEC Part Number: MS-012



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
Ø	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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