

## Improved Quad CMOS Analog Switches

### DESCRIPTION

The DG308B, DG309B analog switches are highly improved versions of the industry-standard DG308A, DG309. These devices are fabricated in Vishay Siliconix' proprietary silicon gate CMOS process, resulting in lower on-resistance, lower leakage, higher speed, and lower power consumption.

These quad single-pole single-throw switches are designed for a wide variety of applications in telecommunications, instrumentation, process control, computer peripherals, etc.

An improved charge injection compensation design minimizes switching transients. The DG308B and DG309B can handle up to  $\pm 22$  V input signals. An epitaxial layer prevents latchup.

All devices feature true bi-directional performance in the on condition, and will block signals to the supply levels in the off condition.

The DG308B is a normally open switch and the DG309B is a normally closed switch. (see Truth Table.)

### FEATURES

- $\pm 22$  V supply voltage rating
- CMOS compatible logic
- Low on-resistance -  $R_{DS(on)}$ :  $45 \Omega$
- Low leakage -  $I_{D(on)}$ :  $20 \text{ pA}$
- Single supply operation possible
- Extended temperature range
- Fast switching -  $t_{ON}$ :  $< 200 \text{ ns}$
- Low glitching -  $Q$ :  $1 \text{ pC}$



**RoHS\***  
COMPLIANT

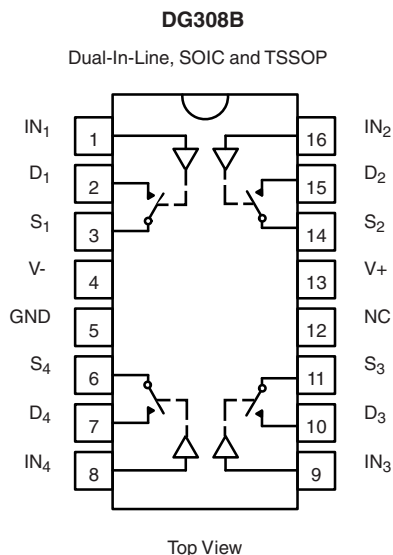
### BENEFITS

- Wide analog signal range
- Simple logic interface
- Higher accuracy
- Minimum transients
- Reduced power consumption
- Superior to DG308A, DG309
- Space savings (TSSOP)

### APPLICATIONS

- Industrial instrumentation
- Test equipment
- Communications systems
- Disk drives
- Computer peripherals
- Portable instruments
- Sample-and-hold circuits

### FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



TRUTH TABLE		
Logic	DG308B	DG309B
0	OFF	ON
1	ON	OFF

Logic "0"  $\leq 3.5$  V  
Logic "1"  $\geq 11$  V

\* Pb containing terminations are not RoHS compliant, exemptions may apply



ORDERING INFORMATION		
Temp. Range	Package	Part Number
- 40 °C to 85 °C	16-Pin PlasticDIP	DG308BDJ DG308BDJ-E3
		DG309BDJ DG309BDJ-E3
	16-Pin Narrow SOIC	DG308BDY DG308BDY-E3 DG308BDY-T1 DG308BDY-T1-E3
		DG309BDY DG309BDY-E3 DG309BDY-T1 DG309BDY-T1-E3
	16-Pin TSSOP	DG308BDQ DG308BDQ-E3 DG308BDQ-T1 DG308BDQ-T1-E3
		DG309BDQ DG309BDQ-E3 DG309BDQ-T1 DG309BDQ-T1-E3

ABSOLUTE MAXIMUM RATINGS			
Parameter		Limit	Unit
Voltages Referenced, V <sub>+</sub> to V <sub>-</sub>		44	V
GND		25	
Digital Inputs <sup>a</sup> , V <sub>S</sub> , V <sub>D</sub>		(V <sub>-</sub> ) - 2 to (V <sub>+</sub> ) + 2 or 30 mA, whichever occurs first	
Current, Any Terminal		30	mA
Peak Current, S or D (Pulsed at 1 ms, 10 % duty cycle max.)		100	
Storage Temperature	(AK Suffix)	- 65 to 150	°C
	(DJ, DY and DQ Suffix)	- 65 to 125	
Power Dissipation (Package) <sup>b</sup>	16-Pin Plastic DIP <sup>c</sup>	470	mW
	16-Pin Narrow SOIC and TSSOP <sup>d</sup>	640	
	16-Pin CerDIP <sup>e</sup>	900	

Notes:

- a. Signals on S<sub>X</sub>, D<sub>X</sub>, or IN<sub>X</sub> exceeding V<sub>+</sub> or V<sub>-</sub> will be clamped by internal diodes. Limit forward diode current to maximum current ratings.
- b. All leads welded or soldered to PC board.
- c. Derate 6.5 mW/°C above 75 °C.
- d. Derate 7.6 mW/°C above 75 °C.
- e. Derate 12 mW/°C above 75 °C.



SPECIFICATIONS <sup>a</sup>									
Parameter	Symbol	Test Conditions Unless Specified $V_+ = 15\text{ V}$ , $V_- = -15\text{ V}$ $V_{IN} = 11\text{ V}$ , $3.5\text{ V}^f$	Temp. <sup>b</sup>	Typ. <sup>c</sup>	A Suffix - 55 °C to 125 °C		D Suffix - 40 °C to 85 °C		Unit
					Min. <sup>d</sup>	Max. <sup>d</sup>	Min. <sup>d</sup>	Max. <sup>d</sup>	
<b>Analog Switch</b>									
Analog Signal Range <sup>e</sup>	$V_{ANALOG}$		Full		- 15	15	- 15	15	V
Drain-Source On-Resistance	$R_{DS(on)}$	$V_D = \pm 10\text{ V}$ , $I_S = 1\text{ mA}$	Room	45		85		85	$\Omega$
$R_{DS(on)}$ Match	$\Delta R_{DS(on)}$		Room	2					
Source Off Leakage Current	$I_{S(off)}$	$V_S = \pm 14\text{ V}$ , $V_D = \pm 14\text{ V}$	Room	$\pm 0.01$	- 0.5	0.5	- 0.5	0.5	nA
Drain Off Leakage Current	$I_{D(off)}$		Room		- 20	20	- 5	5	
Drain On Leakage Current	$I_{D(on)}$	$V_S = V_D = \pm 14\text{ V}$	Room	$\pm 0.02$	- 0.5	0.5	- 0.5	0.5	
			Full		- 40	40	- 10	10	
<b>Digital Control</b>									
Input, Voltage High	$V_{INH}$		Full		11		11		V
Input, Voltage Low	$V_{INL}$		Full			3.5		3.5	
Input Current	$I_{INH}$ or $I_{INL}$	$V_{INH}$ or $V_{INL}$	Full		- 1	1	- 1	1	$\mu\text{A}$
Input Capacitance	$C_{IN}$		Room	5					pF
<b>Dynamic Characteristics</b>									
Turn-On Time	$t_{ON}$	$V_S = 3\text{ V}$ , see figure 2	Room			200		200	ns
Turn-Off Time	$t_{OFF}$		Room				150		
Charge Injection	Q	$C_L = 1000\text{ pF}$ , $V_g = 0\text{ V}$ , $R_g = 0\ \Omega$	Room	1					pC
Source-Off Capacitance	$C_{S(off)}$	$V_S = 0\text{ V}$ , $f = 1\text{ MHz}$ ,	Room	5					pF
Drain-Off Capacitance	$C_{D(off)}$		Room	5					
Channel-On Capacitance	$C_{D(on)}$	$V_D = V_S = 0\text{ V}$ , $f = 1\text{ MHz}$	Room	16					
Off-Isolation	OIRR	$C_L = 15\text{ pF}$ , $R_L = 50\ \Omega$ , $V_S = 1\text{ V}_{RMS}$ , $f = 100\text{ kHz}$	Room	90					dB
Channel-to-Channel Crosstalk	$X_{TALK}$		Room	95					
<b>Power Supply</b>									
Positive Supply Current	I+	$V_{IN} = 0\text{ V}$ or $15\text{ V}$	Room			1		1	$\mu\text{A}$
Negative Supply Current	I-		Room			- 1		- 1	
Power Supply Range for Continuous Operation	$V_{OP}$		Full		$\pm 4$	$\pm 22$	$\pm 4$	$\pm 22$	V

<b>SPECIFICATIONS<sup>a</sup></b> (for Single Supply)									
Parameter	Symbol	Test Conditions Unless Specified $V_+ = 12\text{ V}$ , $V_- = 0\text{ V}$ $V_{IN} = 11\text{ V}$ , $3.5\text{ V}^f$	Temp. <sup>b</sup>	Typ. <sup>c</sup>	A Suffix - 55 °C to 125 °C		D Suffix - 40 °C to 85 °C		Unit
					Min. <sup>d</sup>	Max. <sup>d</sup>	Min. <sup>d</sup>	Max. <sup>d</sup>	
<b>Analog Switch</b>									
Analog Signal Range <sup>e</sup>	$V_{ANALOG}$		Full		0	12	0	12	V
Drain-Source On-Resistance	$R_{DS(on)}$	$V_D = 3\text{ V}$ , $8\text{ V}$ , $I_S = 1\text{ mA}$	Room Full	90		160 200		160 200	$\Omega$
<b>Dynamic Characteristics</b>									
Turn-On Time	$t_{ON}$	$V_S = 8\text{ V}$ , see figure 2	Room			300		300	ns
Turn-Off Time	$t_{OFF}$		Room			200		200	
Charge Injection	Q	$C_L = 1\text{ nF}$ , $V_{gen} = 6\text{ V}$ , $R_{gen} = 0\ \Omega$	Room	4					pC
<b>Power Supply</b>									
Positive Supply Current	I+	$V_{IN} = 0\text{ V}$ or $12\text{ V}$	Room Full			1 5		1 5	$\mu\text{A}$
Negative Supply Current	I-		Room Full			- 1 - 5		- 1 - 5	
Power Supply Range for Continuous Operation	$V_{OP}$		Full		4	44	4	44	V

Notes:

- Refer to PROCESS OPTION FLOWCHART .
- Room = 25 °C, Full = as determined by the operating temperature suffix.
- Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
- The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- Guaranteed by design, not subject to production test.
- $V_{IN}$  = input voltage to perform proper function.

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)



**$R_{DS(on)}$  vs.  $V_D$  and Power Supply Voltages**



**$R_{DS(on)}$  vs.  $V_D$  and Temperature**



**$R_{DS(on)}$  vs.  $V_D$  and Single Power Supply Voltages**



**Leakage Currents vs. Analog Voltage**

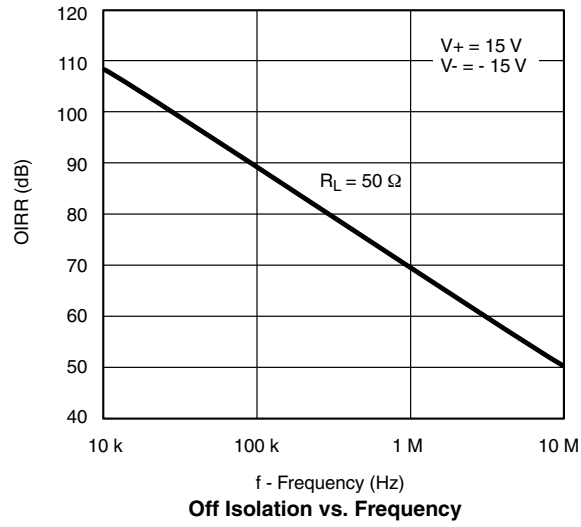


**Leakage Currents vs. Temperature**



**$Q_S, Q_D$  - Charge Injection vs. Analog Voltage**

## TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



## SCHEMATIC DIAGRAM (Typical Channel)

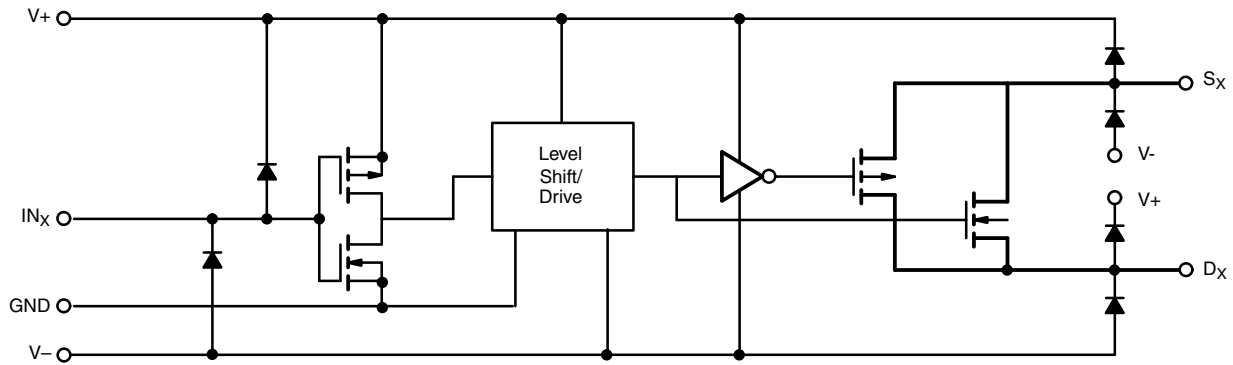
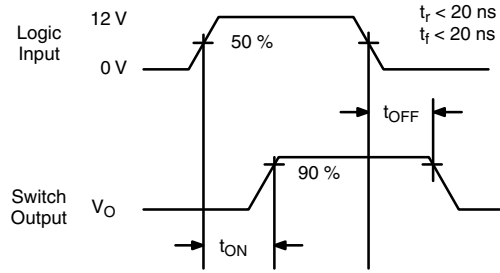
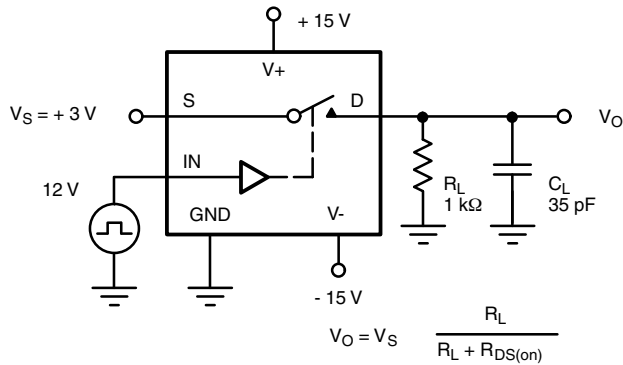


Figure 1.

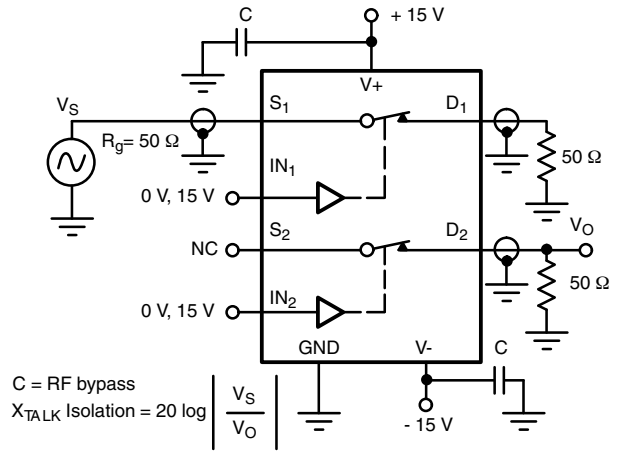
**TEST CIRCUITS**



**Figure 2. Switching Time**



**Figure 3. Off Isolation**



**Figure 4. Channel-to-Channel Crosstalk**



$\Delta V_O$  = measured voltage error due to charge injection  
The charge injection in coulombs is  $Q = C_L \times \Delta V_O$

**Figure 5. Charge Injection**

## APPLICATIONS

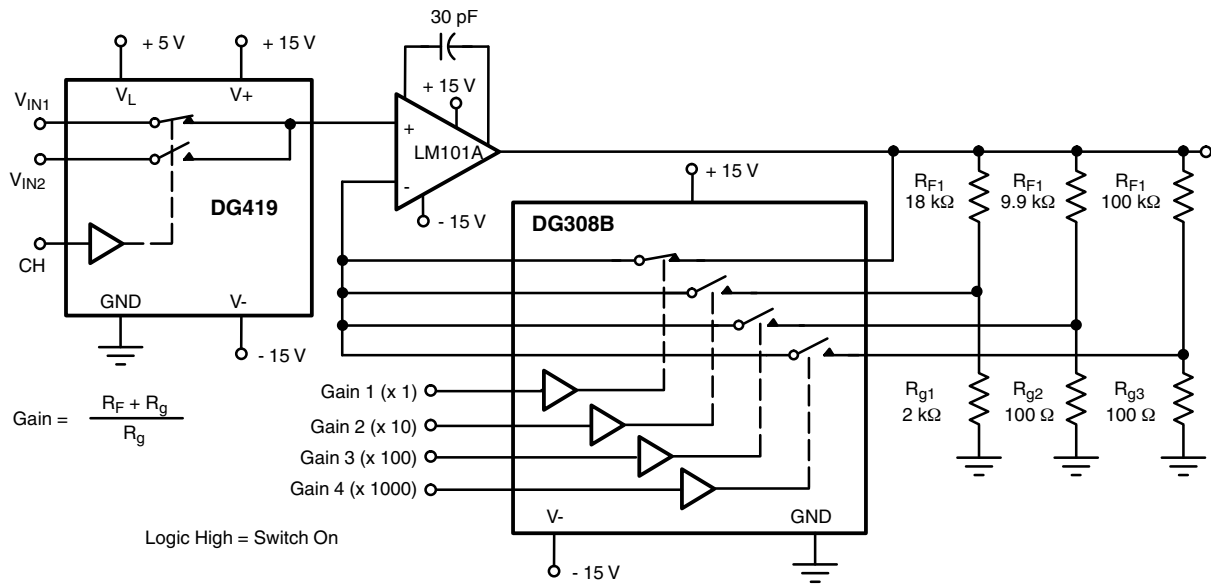


Figure 6. A Precision Amplifier with Digitally Programmable Inputs and Gains

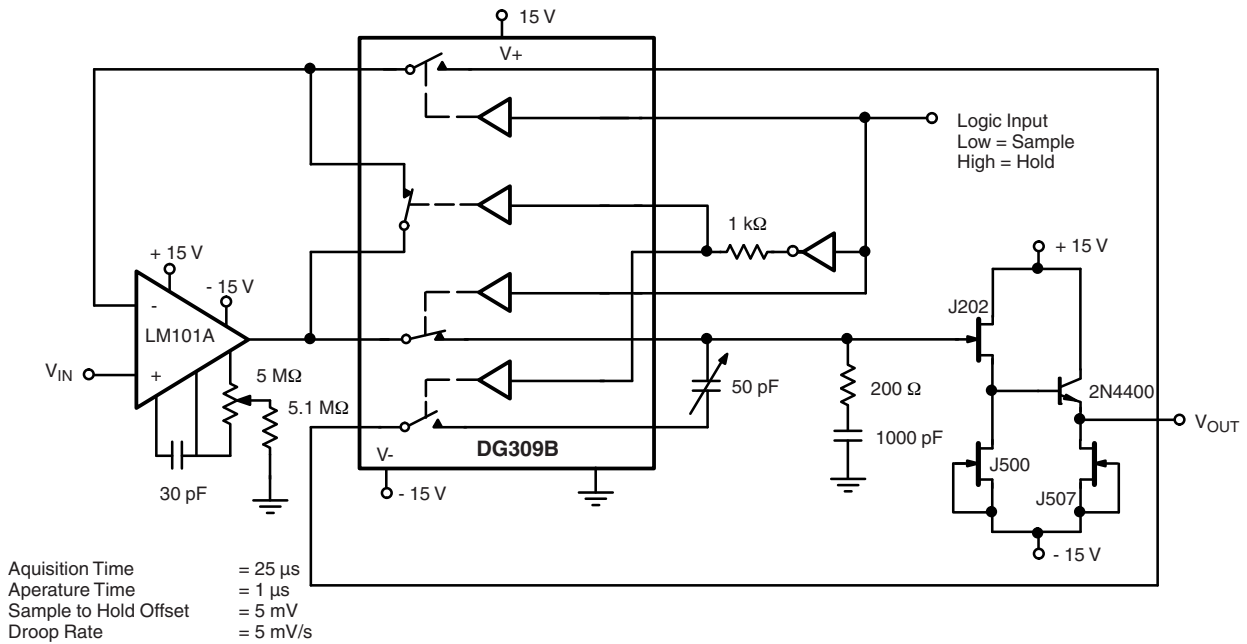
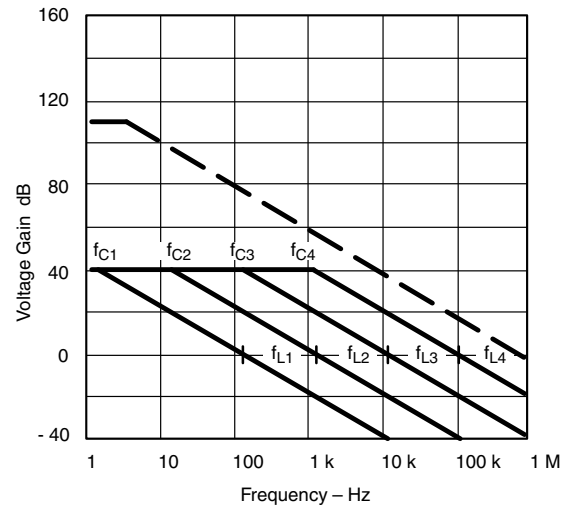
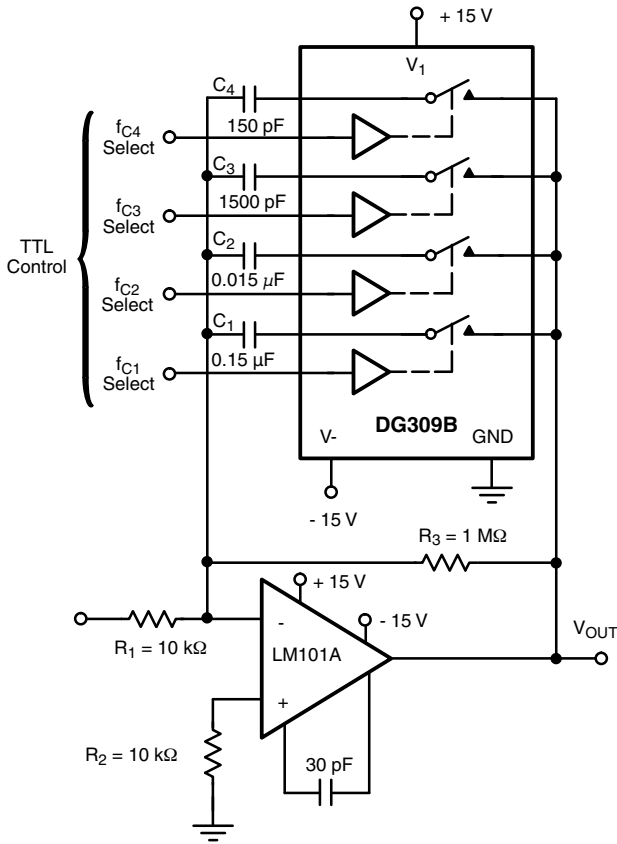


Figure 7. Sample-and-Hold



APPLICATIONS



$$A_L \text{ (Voltage Gain Below Break Frequency)} = \frac{R_3}{R_1} = 100 \text{ (40 dB)}$$

$$f_C \text{ (Break Frequency)} = \frac{1}{2\pi R_3 C_X}$$

$$f_L \text{ (Unity Gain Frequency)} = \frac{1}{2\pi R_1 C_X}$$

$$\text{Max Attenuation} = \frac{R_{DS(on)}}{10 \text{ k}\Omega} \approx -40 \text{ dB}$$

Figure 8. Active Low Pass Filter with Digitally Selected Break Frequency

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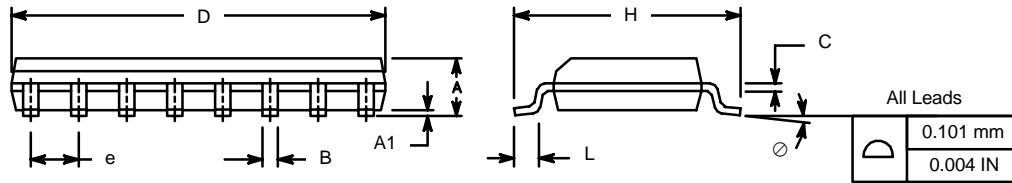


**SOIC (NARROW): 16-LEAD**  
JEDEC Part Number: MS-012

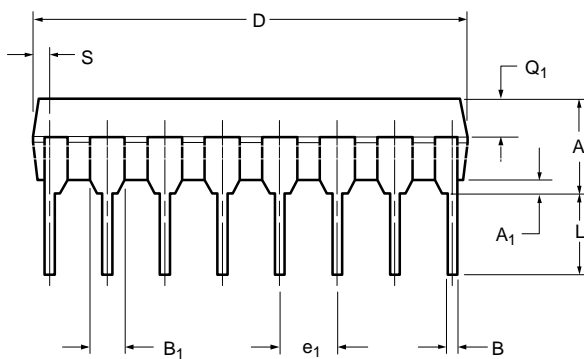


Dim	MILLIMETERS		INCHES	
	Min	Max	Min	Max
A	1.35	1.75	0.053	0.069
A <sub>1</sub>	0.10	0.20	0.004	0.008
B	0.38	0.51	0.015	0.020
C	0.18	0.23	0.007	0.009
D	9.80	10.00	0.385	0.393
E	3.80	4.00	0.149	0.157
e	1.27 BSC		0.050 BSC	
H	5.80	6.20	0.228	0.244
L	0.50	0.93	0.020	0.037
∅	0°	8°	0°	8°

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



### PDIP: 16-LEAD



Dim	MILLIMETERS		INCHES	
	Min	Max	Min	Max
<b>A</b>	3.81	5.08	0.150	0.200
<b>A<sub>1</sub></b>	0.38	1.27	0.015	0.050
<b>B</b>	0.38	0.51	0.015	0.020
<b>B<sub>1</sub></b>	0.89	1.65	0.035	0.065
<b>C</b>	0.20	0.30	0.008	0.012
<b>D</b>	18.93	21.33	0.745	0.840
<b>E</b>	7.62	8.26	0.300	0.325
<b>E<sub>1</sub></b>	5.59	7.11	0.220	0.280
<b>e<sub>1</sub></b>	2.29	2.79	0.090	0.110
<b>e<sub>A</sub></b>	7.37	7.87	0.290	0.310
<b>L</b>	2.79	3.81	0.110	0.150
<b>Q<sub>1</sub></b>	1.27	2.03	0.050	0.080
<b>S</b>	0.38	1.52	.015	0.060

ECN: S-03946—Rev. D, 09-Jul-01  
DWG: 5482



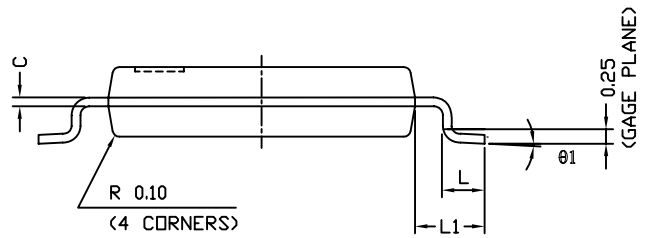
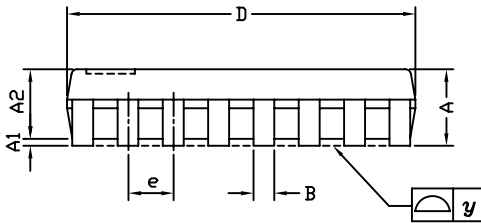
**CERDIP: 16-LEAD**



Dim	MILLIMETERS		INCHES	
	Min	Max	Min	Max
A	4.06	5.08	0.160	0.200
A <sub>1</sub>	0.51	1.14	0.020	0.045
B	0.38	0.51	0.015	0.020
B <sub>1</sub>	1.14	1.65	0.045	0.065
C	0.20	0.30	0.008	0.012
D	19.05	19.56	0.750	0.770
E	7.62	8.26	0.300	0.325
E <sub>1</sub>	6.60	7.62	0.260	0.300
e <sub>1</sub>	2.54 BSC		0.100 BSC	
e <sub>A</sub>	7.62 BSC		0.300 BSC	
L	3.18	3.81	0.125	0.150
L <sub>1</sub>	3.81	5.08	0.150	0.200
Q <sub>1</sub>	1.27	2.16	0.050	0.085
S	0.38	1.14	0.015	0.045
∞	0°	15°	0°	15°

ECN: S-03946—Rev. G, 09-Jul-01  
DWG: 5403

## TSSOP: 16-LEAD

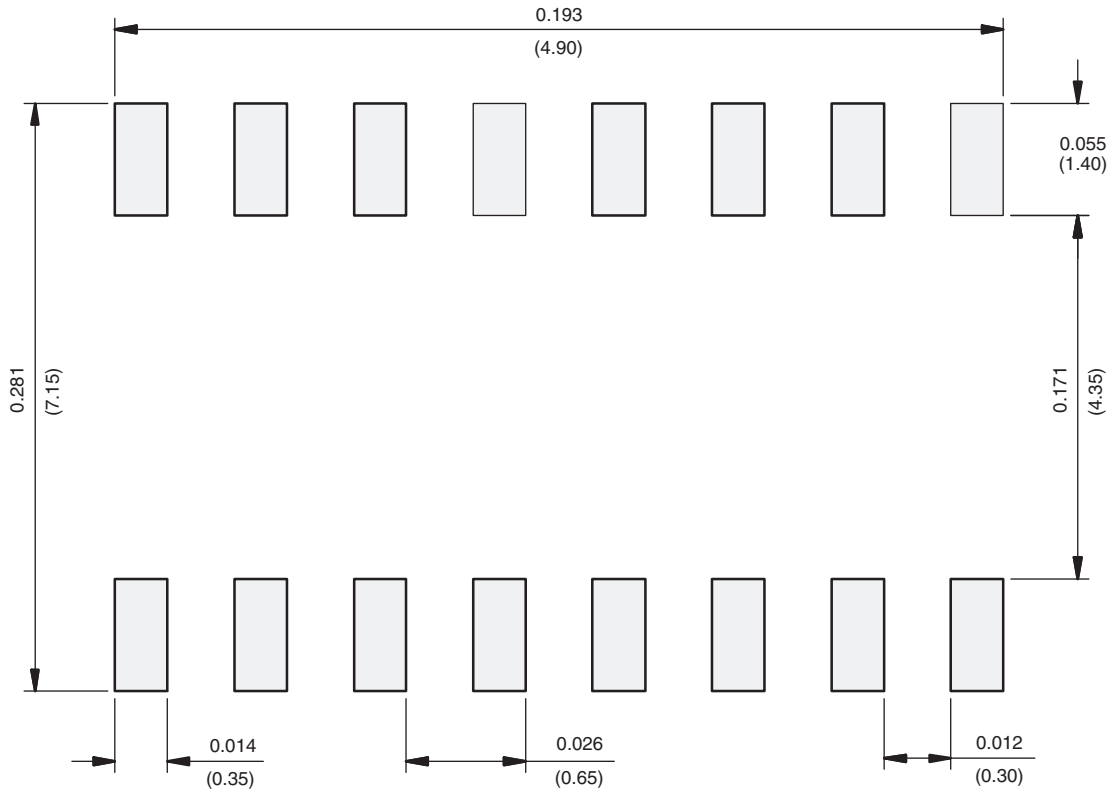


Symbols	DIMENSIONS IN MILLIMETERS		
	Min	Nom	Max
A	-	1.10	1.20
A1	0.05	0.10	0.15
A2	-	1.00	1.05
B	0.22	0.28	0.38
C	-	0.127	-
D	4.90	5.00	5.10
E	6.10	6.40	6.70
E1	4.30	4.40	4.50
e	-	0.65	-
L	0.50	0.60	0.70
L1	0.90	1.00	1.10
y	-	-	0.10
θ1	0°	3°	6°

ECN: S-61920-Rev. D, 23-Oct-06  
DWG: 5624

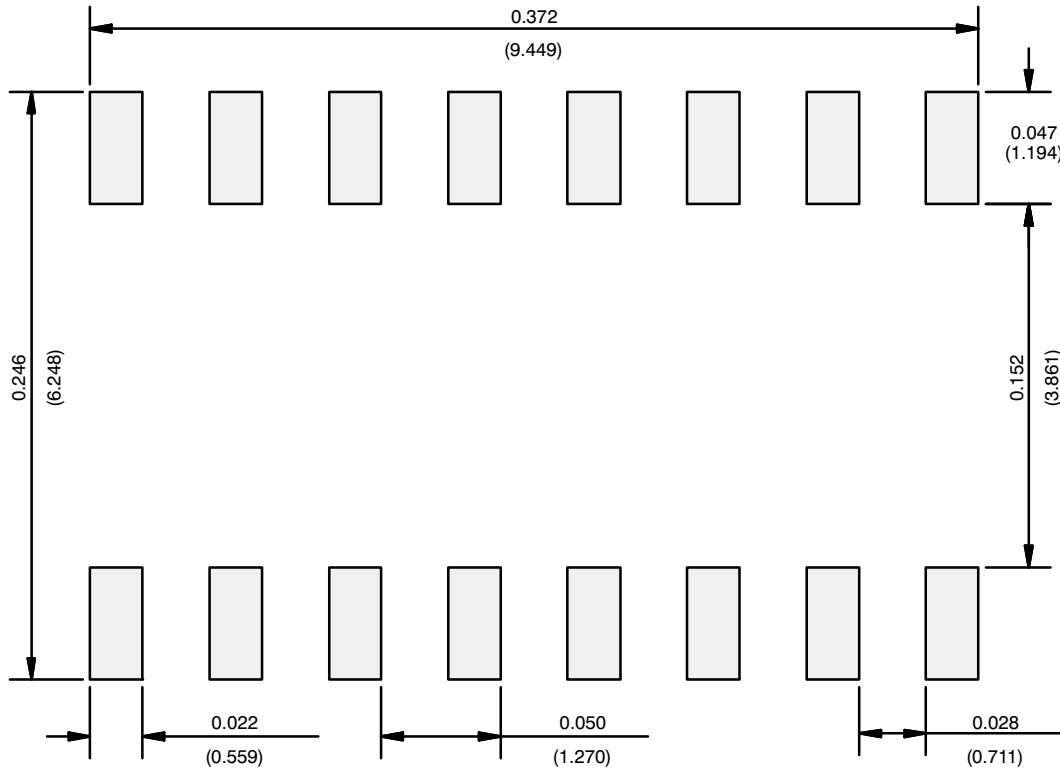


## RECOMMENDED MINIMUM PAD FOR TSSOP-16



Recommended Minimum Pads  
Dimensions in inches (mm)

## RECOMMENDED MINIMUM PADS FOR SO-16



Recommended Minimum Pads  
Dimensions in Inches/(mm)

[Return to Index](#)



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