

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 ± 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

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

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



RoHS*
COMPLIANT

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



| TRUTH TABLE | | |
|-------------|--------|--------|
| Logic | DG308B | DG309B |
| 0 | OFF | ON |
| 1 | ON | OFF |

Logic "0" ≤ 3.5 V
Logic "1" ≥ 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 ₊ to V ₋ | | 44 | V |
| GND | | 25 | |
| Digital Inputs ^a , V _S , V _D | | (V ₋) - 2 to (V ₊) + 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) ^b | 16-Pin Plastic DIP ^c | 470 | mW |
| | 16-Pin Narrow SOIC and TSSOP ^d | 640 | |
| | 16-Pin CerDIP ^e | 900 | |

Notes:

- a. Signals on S_X, D_X, or IN_X exceeding V₊ or V₋ 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 ^a | | | | | | | | | |
|---|------------------------|--|--------------------|-------------------|-------------------------------|-------------------|------------------------------|-------------------|---------------|
| Parameter | Symbol | Test Conditions Unless Specified $V_+ = 15\text{ V}$, $V_- = -15\text{ V}$ $V_{IN} = 11\text{ V}$, 3.5 V^f | Temp. ^b | Typ. ^c | A Suffix - 55 °C to 125 °C | | D Suffix - 40 °C to 85 °C | | Unit |
| | | | | | Min. ^d | Max. ^d | Min. ^d | Max. ^d | |
| Analog Switch | | | | | | | | | |
| Analog Signal Range ^e | 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 | Ω |
| $R_{DS(on)}$ 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 | ± 0.01 | - 0.5 | 0.5 | - 0.5 | 0.5 | nA |
| Drain Off Leakage Current | $I_{D(off)}$ | $V_D = \pm 14\text{ V}$, $V_S = \pm 14\text{ V}$ | Room | ± 0.01 | - 0.5 | 0.5 | - 0.5 | 0.5 | |
| Drain On Leakage Current | $I_{D(on)}$ | $V_S = V_D = \pm 14\text{ V}$ | Room | ± 0.02 | - 0.5 | 0.5 | - 0.5 | 0.5 | |
| Digital Control | | | | | | | | | |
| 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 | μA |
| Input Capacitance | C_{IN} | | Room | 5 | | | | | pF |
| Dynamic Characteristics | | | | | | | | | |
| 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 | | | | | |
| Power Supply | | | | | | | | | |
| Positive Supply Current | I+ | $V_{IN} = 0\text{ V}$ or 15 V | Room | | | 1 | | 1 | μA |
| Negative Supply Current | I- | | Room | | | - 1 | | - 1 | |
| Power Supply Range for Continuous Operation | V_{OP} | | Full | | ± 4 | ± 22 | ± 4 | ± 22 | V |

| SPECIFICATIONS^a (for Single Supply) | | | | | | | | | |
|---|--------------|--|--------------------|-------------------|-------------------------------|-------------------|------------------------------|-------------------|---------------|
| Parameter | Symbol | Test Conditions Unless Specified $V_+ = 12\text{ V}$, $V_- = 0\text{ V}$ $V_{IN} = 11\text{ V}$, 3.5 V^f | Temp. ^b | Typ. ^c | A Suffix - 55 °C to 125 °C | | D Suffix - 40 °C to 85 °C | | Unit |
| | | | | | Min. ^d | Max. ^d | Min. ^d | Max. ^d | |
| Analog Switch | | | | | | | | | |
| Analog Signal Range ^e | V_{ANALOG} | | Full | | 0 | 12 | 0 | 12 | V |
| Drain-Source On-Resistance | $R_{DS(on)}$ | $V_D = 3\text{ V}$, 8 V , $I_S = 1\text{ mA}$ | Room Full | 90 | | 160 200 | | 160 200 | Ω |
| Dynamic Characteristics | | | | | | | | | |
| 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 |
| Power Supply | | | | | | | | | |
| Positive Supply Current | I_+ | $V_{IN} = 0\text{ V}$ or 12 V | Room Full | | | 1 5 | | 1 5 | μA |
| 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

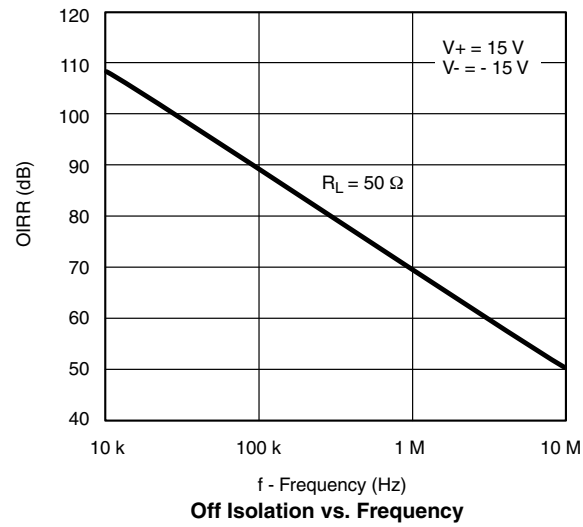


Leakage Currents vs. Temperature



Q_S, Q_D - Charge Injection vs. Analog Voltage

TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



SCHEMATIC DIAGRAM (Typical Channel)

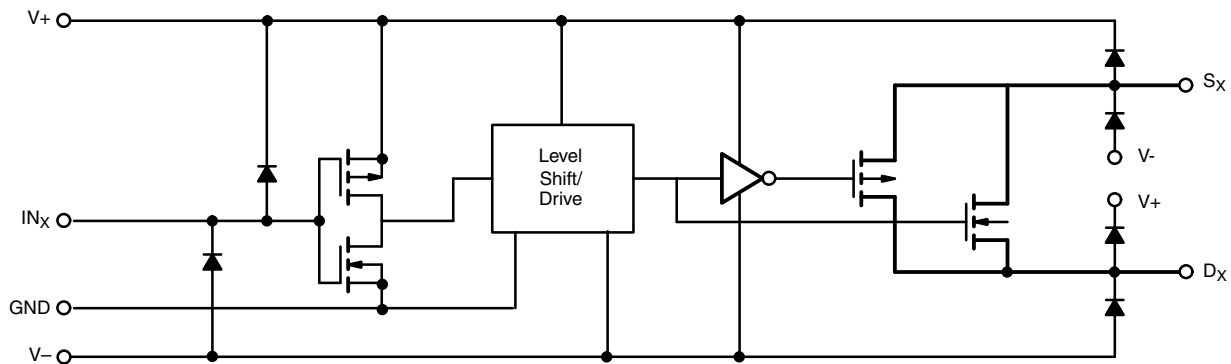


Figure 1.

TEST CIRCUITS

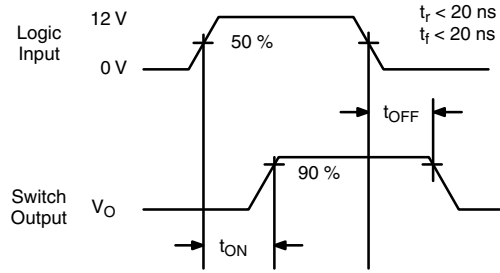


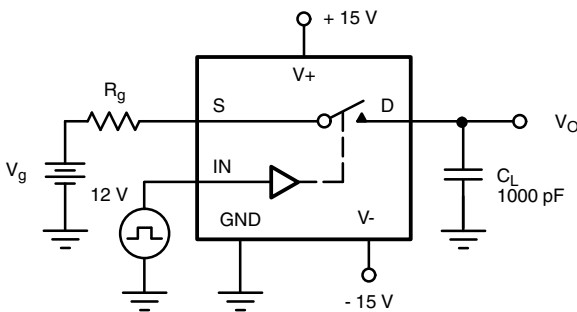
Figure 2. Switching Time



Figure 3. Off Isolation



Figure 4. Channel-to-Channel Crosstalk



ΔV_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

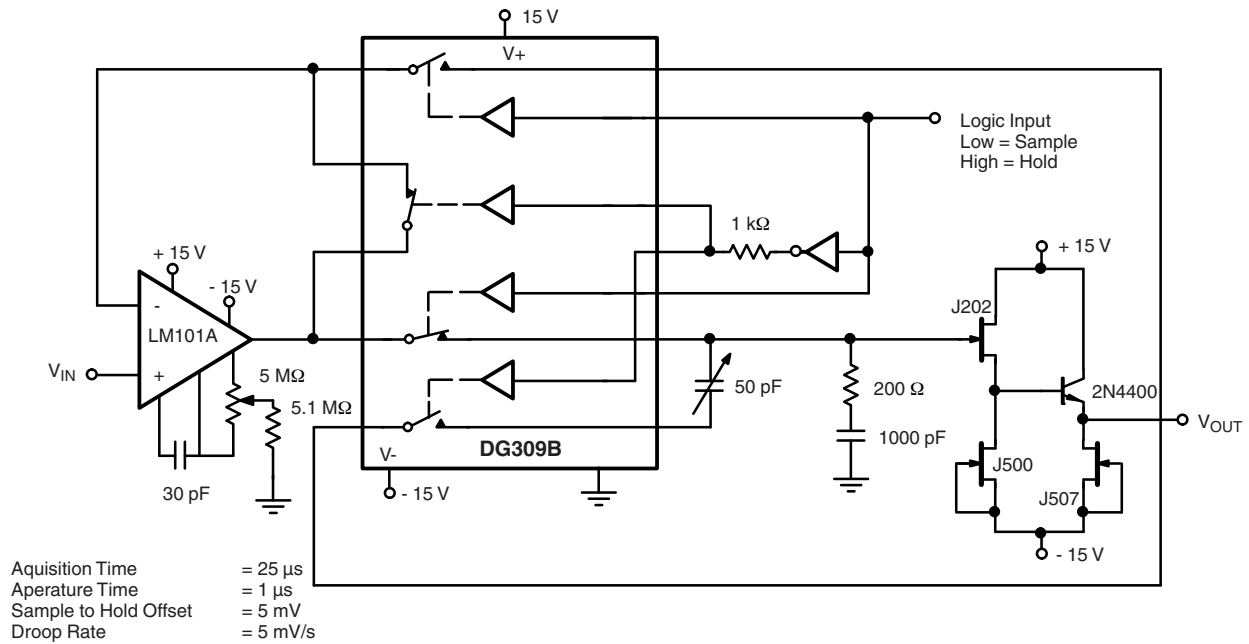


Figure 7. Sample-and-Hold

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 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



PDIP: 16-LEAD



| Dim | MILLIMETERS | | INCHES | |
|----------------------|-------------|-------|--------|-------|
| | Min | Max | Min | Max |
| A | 3.81 | 5.08 | 0.150 | 0.200 |
| A₁ | 0.38 | 1.27 | 0.015 | 0.050 |
| B | 0.38 | 0.51 | 0.015 | 0.020 |
| B₁ | 0.89 | 1.65 | 0.035 | 0.065 |
| C | 0.20 | 0.30 | 0.008 | 0.012 |
| D | 18.93 | 21.33 | 0.745 | 0.840 |
| E | 7.62 | 8.26 | 0.300 | 0.325 |
| E₁ | 5.59 | 7.11 | 0.220 | 0.280 |
| e₁ | 2.29 | 2.79 | 0.090 | 0.110 |
| e_A | 7.37 | 7.87 | 0.290 | 0.310 |
| L | 2.79 | 3.81 | 0.110 | 0.150 |
| Q₁ | 1.27 | 2.03 | 0.050 | 0.080 |
| S | 0.38 | 1.52 | .015 | 0.060 |

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



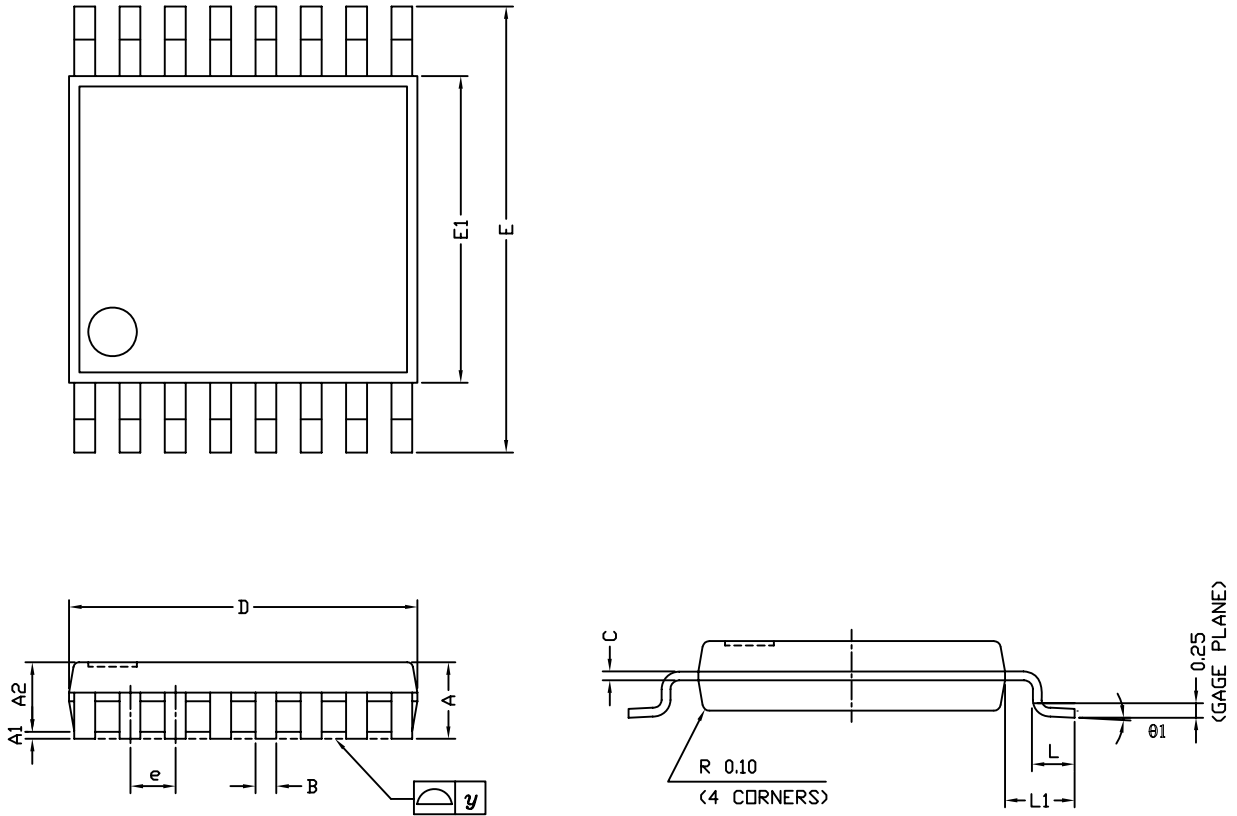
CERDIP: 16-LEAD



| Dim | MILLIMETERS | | INCHES | |
|----------------|-------------|-------|-----------|-------|
| | Min | Max | Min | Max |
| A | 4.06 | 5.08 | 0.160 | 0.200 |
| A ₁ | 0.51 | 1.14 | 0.020 | 0.045 |
| B | 0.38 | 0.51 | 0.015 | 0.020 |
| B ₁ | 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 ₁ | 6.60 | 7.62 | 0.260 | 0.300 |
| e ₁ | 2.54 BSC | | 0.100 BSC | |
| e _A | 7.62 BSC | | 0.300 BSC | |
| L | 3.18 | 3.81 | 0.125 | 0.150 |
| L ₁ | 3.81 | 5.08 | 0.150 | 0.200 |
| Q ₁ | 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)

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JONHON

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