

# NLAST4599

## Low Voltage Single Supply SPDT Analog Switch

The NLAST4599 is an advanced high speed CMOS single pole – double throw analog switch fabricated with silicon gate CMOS technology. It achieves high speed propagation delays and low ON resistances while maintaining low power dissipation. This switch controls analog and digital voltages that may vary across the full power–supply range (from  $V_{CC}$  to GND).

The device has been designed so the ON resistance ( $R_{ON}$ ) is much lower and more linear over input voltage than  $R_{ON}$  of typical CMOS analog switches.

The channel select input structure provides protection when voltages between 0 V and 5.5 V are applied, regardless of the supply voltage. This input structure helps prevent device destruction caused by supply voltage – input/output voltage mismatch, battery backup, hot insertion, etc.

### Features

- Select Pin Compatible with TTL Levels
- Channel Select Input Over–Voltage Tolerant to 5.5 V
- Fast Switching and Propagation Speeds
- Break–Before–Make Circuitry
- Low Power Dissipation:  $I_{CC} = 2 \mu A$  (Max) at  $T_A = 25^\circ C$
- Diode Protection Provided on Channel Select Input
- Improved Linearity and Lower ON Resistance over Input Voltage
- Latch–up Performance Exceeds 300 mA
- ESD Performance: HBM > 2000 V; MM > 200 V
- Chip Complexity: 38 FETs
- Pb–Free Packages are Available

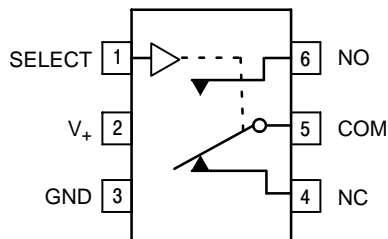


Figure 1. Pin Assignment

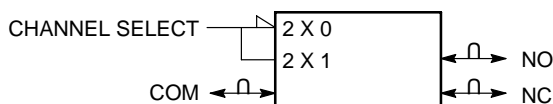


Figure 2. Logic Symbol



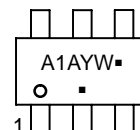
ON Semiconductor®

<http://onsemi.com>

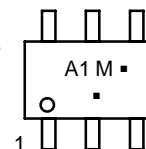
### MARKING DIAGRAMS



TSOP-6  
DT SUFFIX  
CASE 318G



SC-88/SC-70/SOT-363  
DF SUFFIX  
CASE 419B



- A1 = Specific Device Code
- A = Assembly Location
- Y = Year
- W = Work Week
- M = Date Code\*
- = Pb–Free Package

(Note: Microdot may be in either location)

\*Date Code orientation and/or position and underbar may vary depending upon manufacturing location.

### FUNCTION TABLE

| Select | ON Channel |
|--------|------------|
| L      | NC         |
| H      | NO         |

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 4 of this data sheet.

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## MAXIMUM RATINGS (Note 1)

| Parameter                                      | Symbol   | Value                                | Unit      |      |
|--|--|--------------------------------------|-----------|------|
| Positive DC Supply Voltage                     | $V_{CC}$   | -0.5 to +7.0                         | V         |      |
| Analog Input Voltage ( $V_{NO}$ or $V_{COM}$ ) | $V_{IS}$   | $-0.5 \leq V_{IS} \leq V_{CC} + 0.5$ | V         |      |
| Digital Select Input Voltage                   | $V_{IN}$   | $-0.5 \leq V_I \leq +7.0$            | V         |      |
| DC Current, Into or Out of Any Pin             | $I_{IK}$   | $\pm 50$                             | mA        |      |
| Power Dissipation in Still Air                 | $P_D$  | 200                                  | mW        |      |
| SC-88<br>TSOP6                                 |  | 200                                  |           |      |
| Storage Temperature Range                      | $T_{STG}$  | -65 to +150                          | °C        |      |
| Lead Temperature, 1mm from Case for 10 seconds | $T_L$  | 260                                  | °C        |      |
| Junction Temperature Under Bias                | $T_J$  | 150                                  | °C        |      |
| ESD Withstand Voltage                          | Human Body Model (Note 2)<br>Machine Model (Note 3)<br>Charged Device Model (Note 4) | 2000                                 | V         |      |
|  |  | 200                                  |           |      |
|  |  | N/A                                  |           |      |
| Latchup Performance                            | Above $V_{CC}$ and Below GND at 125°C (Note 5)                                       | $I_{LATCHUP}$                        | $\pm 300$ | mA   |
| Thermal Resistance                             | SC-88<br>TSOP6   | $\theta_{JA}$                        | 333       | °C/W |
|  |  |                                      | 333       |      |

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

- Maximum Ratings are those values beyond which damage to the device may occur. Functional operation should be restricted to the Recommended Operating Conditions.
- Tested to EIA/JESD22-A114-A
- Tested to EIA/JESD22-A115-A
- Tested to JESD22-C101-A
- Tested to EIA/JESD78

## RECOMMENDED OPERATING CONDITIONS

| Characteristics                    | Symbol     | Min  | Max      | Unit |      |
|------------------------------------|------------|--|----------|------|------|
| DC Supply Voltage                  | $V_{CC}$   | 2.0  | 5.5      | V    |      |
| Digital Select Input Voltage       | $V_{IN}$   | GND  | 5.5      | V    |      |
| Analog Input Voltage (NC, NO, COM) | $V_{IS}$   | GND  | $V_{CC}$ | V    |      |
| Operating Temperature Range        | $T_A$      | -55  | +125     | °C   |      |
| Input Rise or Fall Time<br>SELECT  | $t_r, t_f$ | $V_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}$ | 0        | 100  | ns/V |
|                                    |            | $V_{CC} = 5.0 \text{ V} \pm 0.5 \text{ V}$ | 0        | 20   |      |

## DEVICE JUNCTION TEMPERATURE VERSUS TIME TO 0.1% BOND FAILURES

| Junction Temperature °C | Time, Hours | Time, Years |
|-------------------------|-------------|-------------|
| 80                      | 1,032,200   | 117.8       |
| 90                      | 419,300     | 47.9        |
| 100                     | 178,700     | 20.4        |
| 110                     | 79,600      | 9.4         |
| 120                     | 37,000      | 4.2         |
| 130                     | 17,800      | 2.0         |
| 140                     | 8,900       | 1.0         |

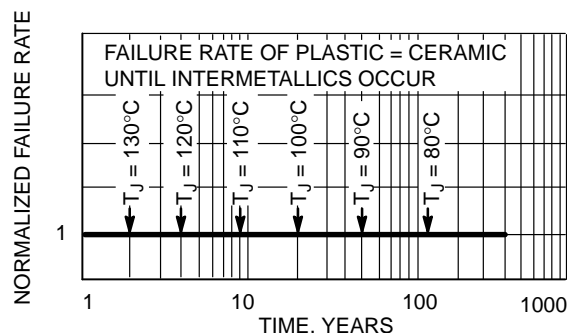


Figure 3. Failure Rate vs. Time Junction Temperature

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## DC CHARACTERISTICS – Digital Section (Voltages Referenced to GND)

| Parameter                                      | Condition   | Symbol           | V <sub>CC</sub> | Guaranteed Limit |       |        | Unit |
|--|---|------------------|-----------------|------------------|-------|--------|------|
|  |   |                  |                 | -55 to 25°C      | <85°C | <125°C |      |
| Minimum High-Level Input Voltage, Select Input |   | V <sub>IH</sub>  | 3.0             | 2.0              | 2.0   | 2.0    | V    |
|  |   |                  | 4.5             | 2.0              | 2.0   | 2.0    |      |
|  |   |                  | 5.5             | 2.0              | 2.0   | 2.0    |      |
| Maximum Low-Level Input Voltage, Select Input  |   | V <sub>IL</sub>  | 3.0             | 0.5              | 0.5   | 0.5    | V    |
|  |   |                  | 4.5             | 0.8              | 0.8   | 0.8    |      |
|  |   |                  | 5.5             | 0.8              | 0.8   | 0.8    |      |
| Maximum Input Leakage Current, Select Input    | V <sub>IN</sub> = 5.5 V or GND                      | I <sub>IN</sub>  | 5.5             | ±0.1             | ±1.0  | ±1.0   | µA   |
| Power Off Leakage Current                      | V <sub>IN</sub> = 5.5 V or GND                      | I <sub>OFF</sub> | 0               | ±10              | ±10   | ±10    | µA   |
| Maximum Quiescent Supply Current               | Select and V <sub>IS</sub> = V <sub>CC</sub> or GND | I <sub>CC</sub>  | 5.5             | 1.0              | 1.0   | 2.0    | µA   |

## DC ELECTRICAL CHARACTERISTICS – Analog Section

| Parameter                                 | Condition   | Symbol                                       | V <sub>CC</sub> | Guaranteed Limit |       |        | Unit |
|---|---|--|-----------------|------------------|-------|--------|------|
|   |   |  |                 | -55 to 25°C      | <85°C | <125°C |      |
| Maximum "ON" Resistance (Figures 17 – 23) | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br>V <sub>IS</sub> = GND to V <sub>CC</sub><br> I <sub>IN</sub>   ≤ 10.0 mA  | R <sub>ON</sub>                              | 2.5             | 85               | 95    | 105    | Ω    |
|   |   |  | 3.0             | 45               | 50    | 55     |      |
|   |   |  | 4.5             | 30               | 35    | 40     |      |
|   |   |  | 5.5             | 25               | 30    | 35     |      |
| ON Resistance Flatness (Figures 17 – 23)  | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br> I <sub>IN</sub>   ≤ 10.0 mA<br>V <sub>IS</sub> = 1V, 2V, 3.5V  | R <sub>FLAT</sub><br>(ON)                    | 4.5             | 4                | 4     | 5      | Ω    |
| ON Resistance Match Between Channels      | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br> I <sub>IN</sub>   ≤ 10.0 mA<br>V <sub>NO</sub> or V <sub>NC</sub> = 3.5 V  | ΔR <sub>ON</sub><br>(ON)                     | 4.5             | 2                | 2     | 3      | Ω    |
| NO or NC Off Leakage Current (Figure 9)   | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br>V <sub>NO</sub> or V <sub>NC</sub> = 1.0 V <sub>COM</sub> 4.5 V   | I <sub>NC(OFF)</sub><br>I <sub>NO(OFF)</sub> | 5.5             | 1                | 10    | 100    | nA   |
| COM ON Leakage Current (Figure 9)         | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br>V <sub>NO</sub> 1.0 V or 4.5 V with V <sub>NC</sub> floating<br>or<br>V <sub>NO</sub> 1.0 V or 4.5 V with V <sub>NO</sub> floating<br>V <sub>COM</sub> = 1.0 V or 4.5 V | I <sub>COM(ON)</sub>                         | 5.5             | 1                | 10    | 100    | nA   |

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## AC ELECTRICAL CHARACTERISTICS (Input $t_r = t_f = 3.0$ ns)

| Parameter  | Test Conditions   | Symbol  | $V_{CC}$<br>(V) | $V_{IS}$<br>(V) | Guaranteed Max Limit |      |     |                     |     |        | Unit |     |
|--|---|---|-----------------|-----------------|----------------------|------|-----|---------------------|-----|--------|------|-----|
|  |   |   |                 |                 | -55 to 25°C          |      |     | <85°C               |     | <125°C |      |     |
|  |   |   |                 |                 | Min                  | Typ* | Max | Min                 | Max | Min    |      | Max |
| Turn-On Time<br>(Figures 12 and 13)  | $R_L = 300 \Omega$ , $C_L = 35$ pF<br>(Figures 5 and 6)           | $t_{ON}$  | 2.5             | 2.0             | 5                    | 23   | 28  | 5                   | 30  | 5      | 30   | ns  |
|  |   |   | 3.0             | 2.0             | 5                    | 16   | 21  | 5                   | 25  | 5      | 25   |     |
|  |   |   | 4.5             | 3.0             | 2                    | 11   | 16  | 2                   | 20  | 2      | 20   |     |
|  |   |   | 5.5             | 3.0             | 2                    | 9    | 14  | 2                   | 20  | 2      | 20   |     |
| Turn-Off Time<br>(Figures 12 and 13)   | $R_L = 300 \Omega$ , $C_L = 35$ pF<br>(Figures 5 and 6)           | $t_{OFF}$   | 2.5             | 2.0             | 1                    | 7    | 12  | 1                   | 15  | 1      | 15   | ns  |
|  |   |   | 3.0             | 2.0             | 1                    | 5    | 10  | 1                   | 15  | 1      | 15   |     |
|  |   |   | 4.5             | 3.0             | 1                    | 4    | 9   | 1                   | 12  | 1      | 12   |     |
|  |   |   | 5.5             | 3.0             | 1                    | 3    | 8   | 1                   | 12  | 1      | 12   |     |
| Minimum Break-Before-Make Time   | $V_{IS} = 3.0$ V (Figure 4)<br>$R_L = 300 \Omega$ , $C_L = 35$ pF | $t_{BBM}$   | 2.5             | 2.0             | 1                    | 12   |     | 1                   |     | 1      |      | ns  |
|  |   |   | 3.0             | 2.0             | 1                    | 11   |     | 1                   |     | 1      |      |     |
|  |   |   | 4.5             | 3.0             | 1                    | 6    |     | 1                   |     | 1      |      |     |
|  |   |   | 5.5             | 3.0             | 1                    | 5    |     | 1                   |     | 1      |      |     |
| <b>Typical @ 25, <math>V_{CC} = 5.0</math> V</b>   |   |   |                 |                 |                      |      |     |                     |     |        |      |     |
| Maximum Input Capacitance, Select Input<br>Analog I/O (switch off)<br>Common I/O (switch off)<br>Feedthrough (switch on) |   | $C_{IN}$<br>$C_{NO}$ or $C_{NC}$<br>$C_{COM}$<br>$C_{(ON)}$ |                 |                 |                      |      |     | 8<br>10<br>10<br>20 |     |        | pF   |     |

\*Typical Characteristics are at 25°C.

## ADDITIONAL APPLICATION CHARACTERISTICS (Voltages Referenced to GND Unless Noted)

| Parameter  | Condition   | Symbol    | $V_{CC}$<br>V     | Typical<br>25°C   | Unit |
|--|---|-----------|-------------------|-------------------|------|
| Maximum On-Channel -3dB Bandwidth or Minimum Frequency Response<br>(Figure 10) | $V_{IN} = 0$ dBm<br>$V_{IN}$ centered between $V_{CC}$ and GND<br>(Figure 7)  | BW        | 3.0<br>4.5<br>5.5 | 170<br>200<br>200 | MHz  |
| Maximum Feedthrough On Loss  | $V_{IN} = 0$ dBm @ 100 kHz to 50 MHz<br>$V_{IN}$ centered between $V_{CC}$ and GND<br>(Figure 7)  | $V_{ONL}$ | 3.0<br>4.5<br>5.5 | -2<br>-2<br>-2    | dB   |
| Off-Channel Isolation<br>(Figure 10)   | $f = 100$ kHz; $V_{IS} = 1$ V RMS<br>$V_{IN}$ centered between $V_{CC}$ and GND<br>(Figure 7)   | $V_{ISO}$ | 3.0<br>4.5<br>5.5 | -93<br>-93<br>-93 | dB   |
| Charge Injection Select Input to Common I/O<br>(Figure 15)                     | $V_{IN} = V_{CC}$ to GND, $F_{IS} = 20$ kHz<br>$t_r = t_f = 3$ ns<br>$R_{IS} = 0 \Omega$ , $C_L = 1000$ pF<br>$Q = C_L * \Delta V_{OUT}$ , (Figure 8) | Q         | 3.0<br>5.5        | 1.5<br>3.0        | pC   |
| Total Harmonic Distortion<br>THD + Noise<br>(Figure 14)                        | $F_{IS} = 20$ Hz to 100 kHz, $R_L = R_{gen} = 600 \Omega$ ,<br>$C_L = 50$ pF<br>$V_{IS} = 5.0$ V <sub>PP</sub> sine wave                              | THD       | 5.5               | 0.1               | %    |

## ORDERING INFORMATION

| Device         | Device Nomenclature |            |                 |                |                    | Package                          | Shipping†        |
|----------------|---------------------|------------|-----------------|----------------|--------------------|----------------------------------|------------------|
|                | Circuit Indicator   | Technology | Device Function | Package Suffix | Tape & Reel Suffix |                                  |                  |
| NLAST4599DFT2  | NL                  | AS         | 4599            | DF             | T2                 | SC-88/SC-70/SOT-363              | 3000/Tape & Reel |
| NLAST4599DFT2G |                     |            |                 |                |                    | SC-88/SC-70/SOT-363<br>(Pb-Free) |                  |
| NLAST4599DTT1  |                     |            |                 | DT             | T1                 | TSOP-6                           |                  |
| NLAST4599DTT1G |                     |            |                 |                |                    | TSOP-6<br>(Pb-Free)              |                  |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

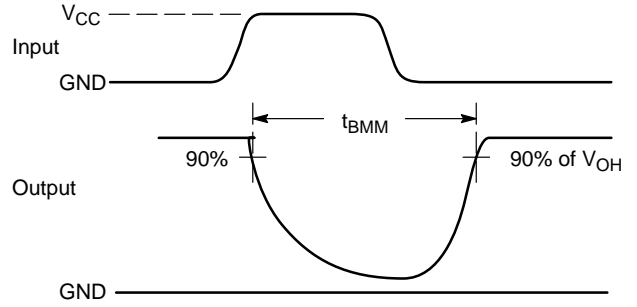
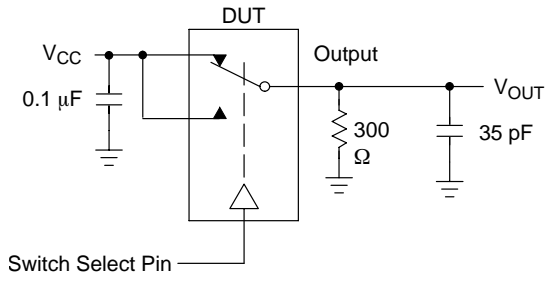


Figure 4. t<sub>BMM</sub> (Time Break-Before-Make)

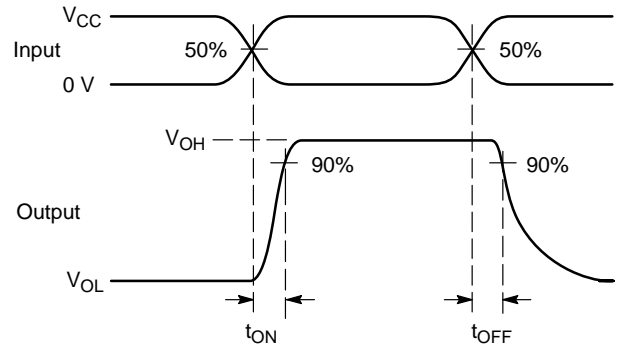
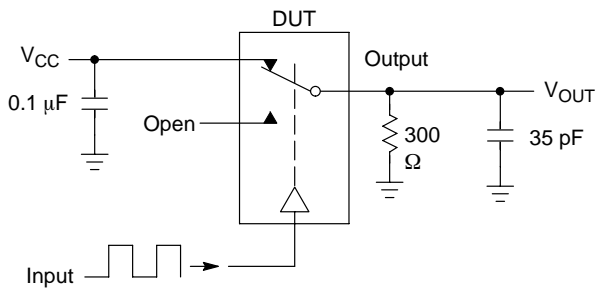


Figure 5. t<sub>ON</sub>/t<sub>OFF</sub>

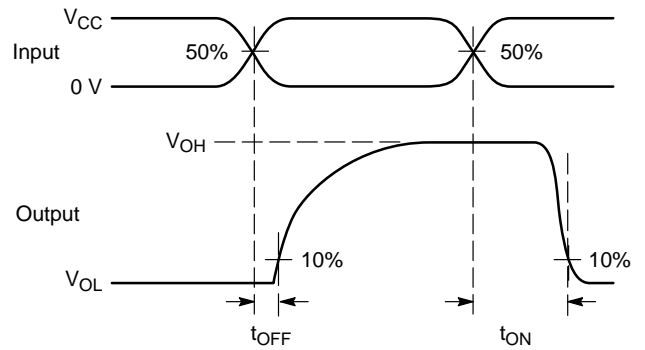
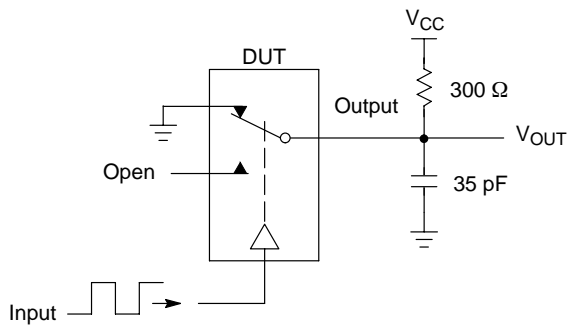
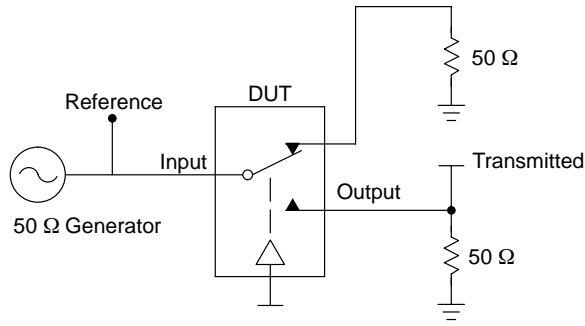


Figure 6. t<sub>ON</sub>/t<sub>OFF</sub>

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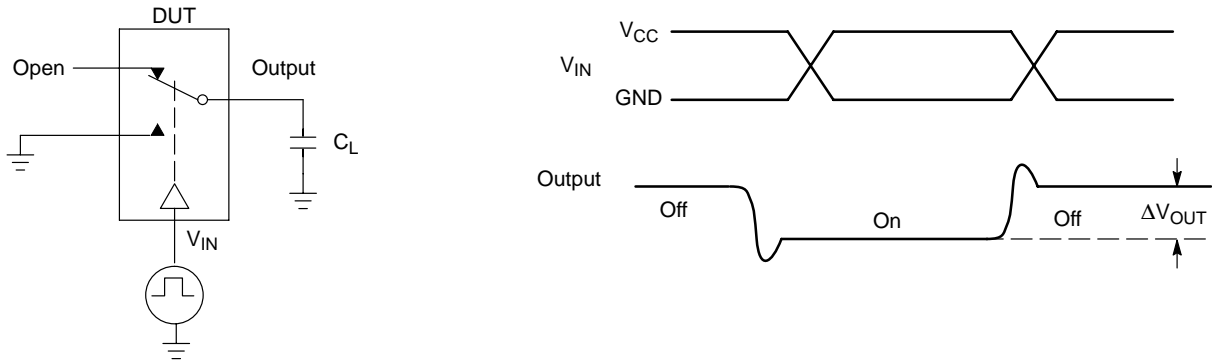
Channel switch control/s test socket is normalized. Off isolation is measured across an off channel. On loss is the bandwidth of an On switch.  $V_{ISO}$ , Bandwidth and  $V_{ONL}$  are independent of the input signal direction.

$$V_{ISO} = \text{Off Channel Isolation} = 20 \text{ Log} \left( \frac{V_{OUT}}{V_{IN}} \right) \text{ for } V_{IN} \text{ at } 100 \text{ kHz}$$

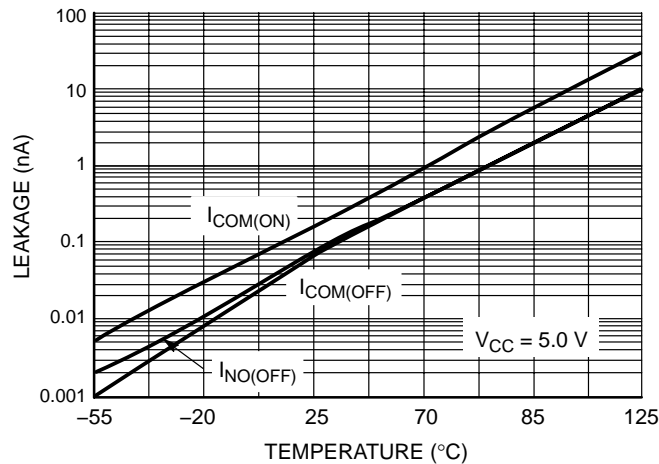
$$V_{ONL} = \text{On Channel Loss} = 20 \text{ Log} \left( \frac{V_{OUT}}{V_{IN}} \right) \text{ for } V_{IN} \text{ at } 100 \text{ kHz to } 50 \text{ MHz}$$

Bandwidth (BW) = the frequency 3 dB below  $V_{ONL}$

**Figure 7. Off Channel Isolation/On Channel Loss (BW)/Crosstalk (On Channel to Off Channel)/ $V_{ONL}$**



**Figure 8. Charge Injection: (Q)**



**Figure 9. Switch Leakage vs. Temperature**

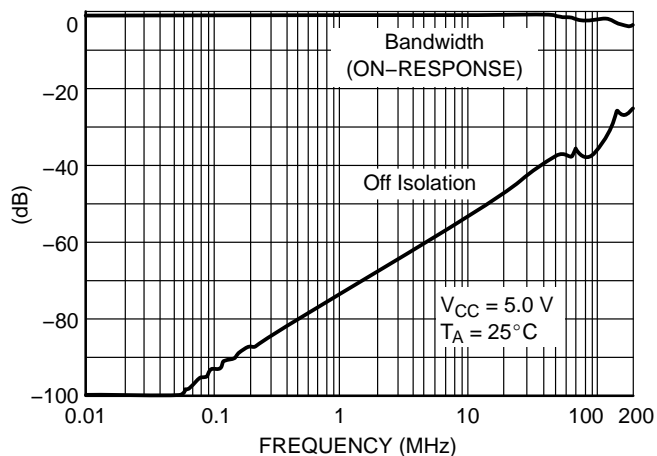


Figure 10. Bandwidth and Off-Channel Isolation

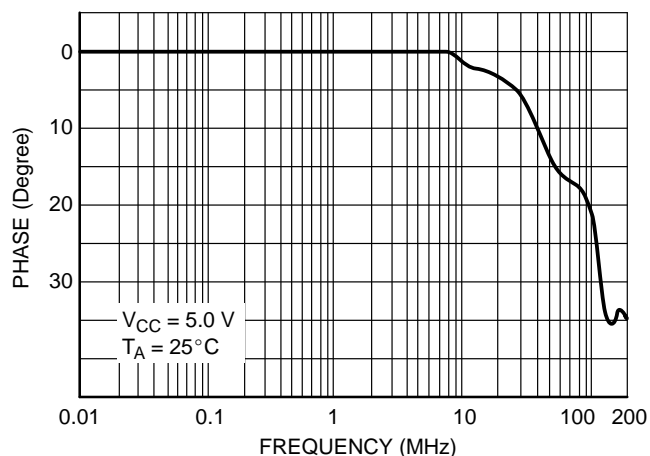


Figure 11. Phase vs. Frequency

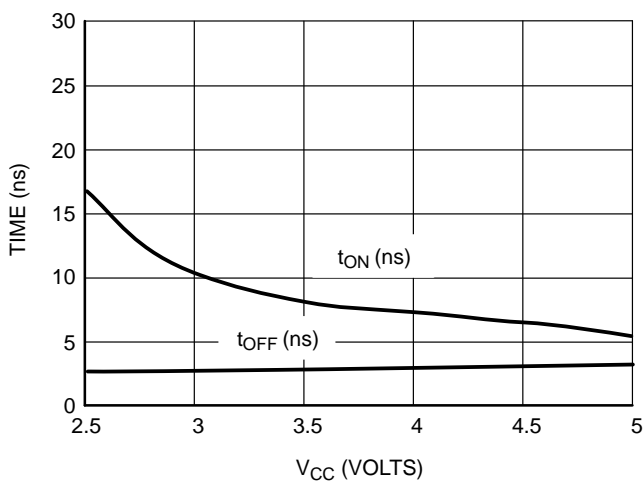


Figure 12.  $t_{ON}$  and  $t_{OFF}$  vs.  $V_{CC}$  at  $25^\circ\text{C}$

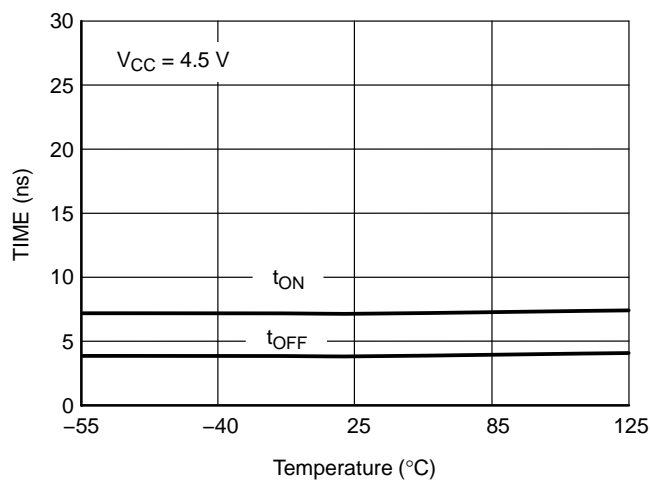


Figure 13.  $t_{ON}$  and  $t_{OFF}$  vs. Temp

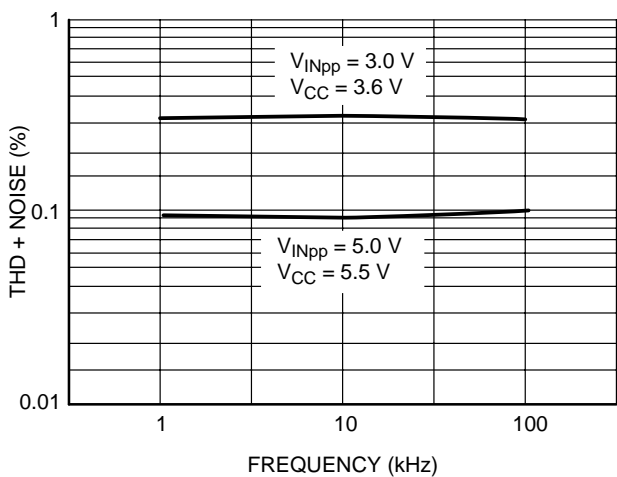


Figure 14. Total Harmonic Distortion Plus Noise vs. Frequency

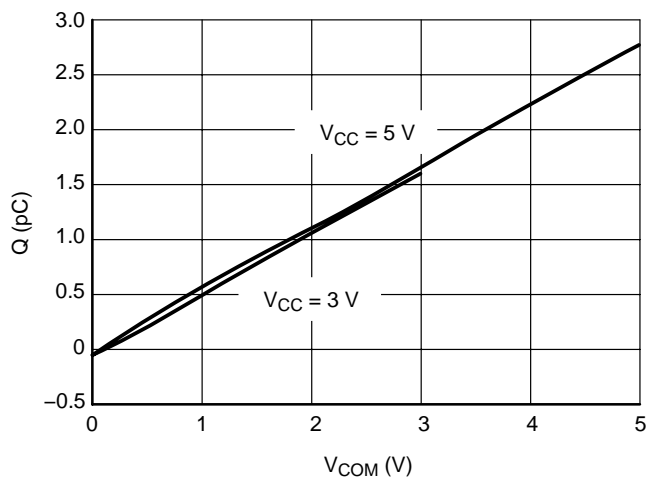


Figure 15. Charge Injection vs. COM Voltage

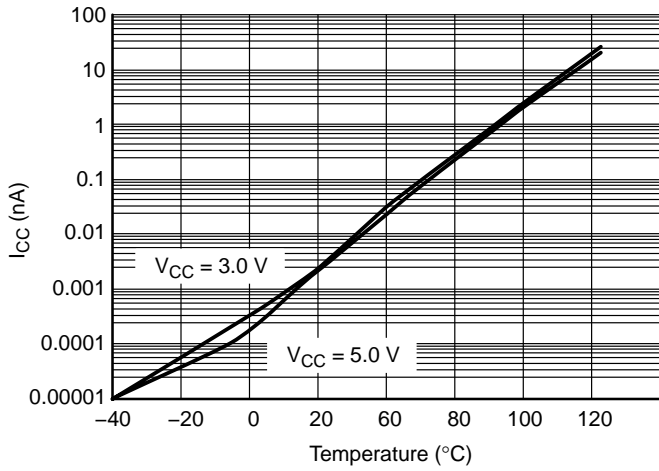


Figure 16.  $I_{CC}$  vs. Temp,  $V_{CC} = 3\text{ V}$  &  $5\text{ V}$

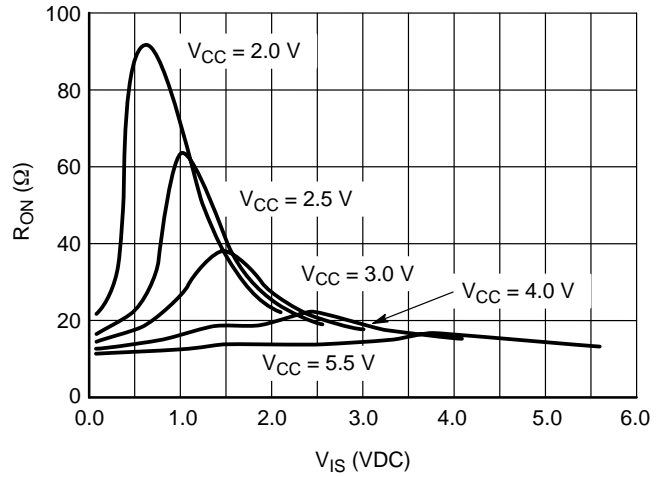


Figure 17.  $R_{ON}$  vs.  $V_{CC}$ , Temp =  $25^{\circ}\text{C}$

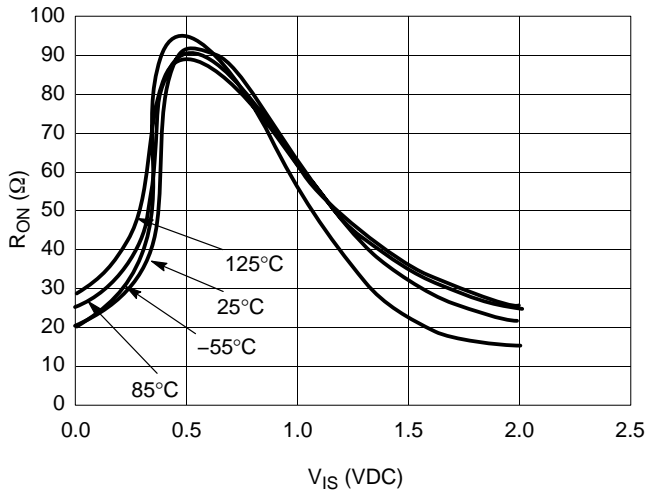


Figure 18.  $R_{ON}$  vs Temp,  $V_{CC} = 2.0\text{ V}$

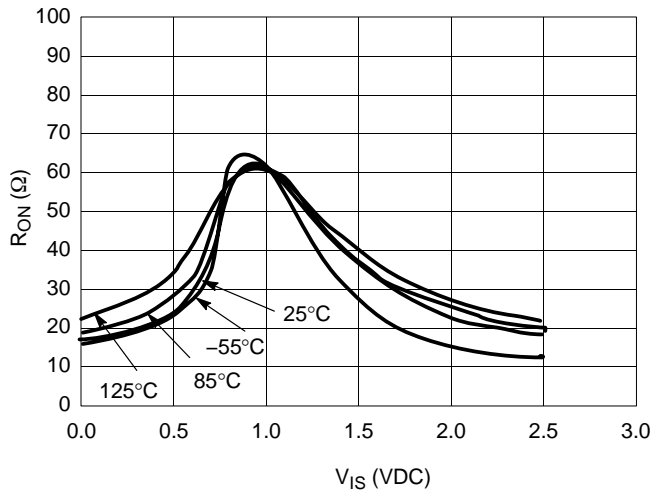


Figure 19.  $R_{ON}$  vs. Temp,  $V_{CC} = 2.5\text{ V}$

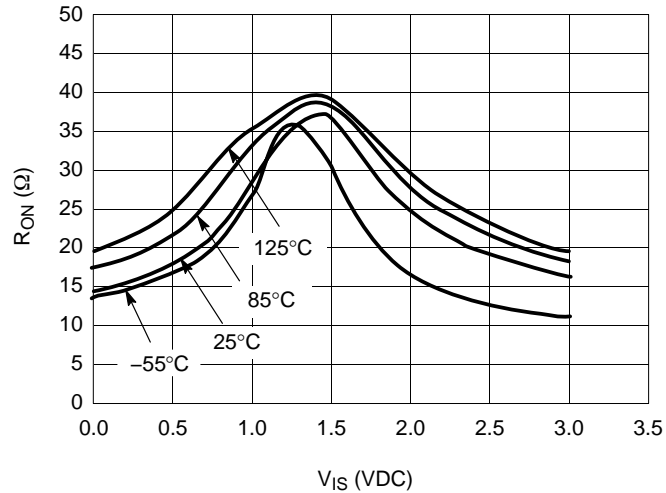


Figure 20.  $R_{ON}$  vs. Temp,  $V_{CC} = 3.0\text{ V}$

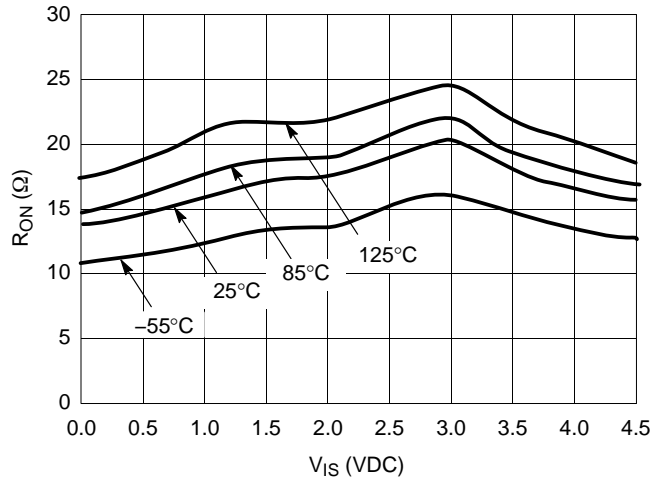


Figure 21.  $R_{ON}$  vs. Temp,  $V_{CC} = 4.5\text{ V}$



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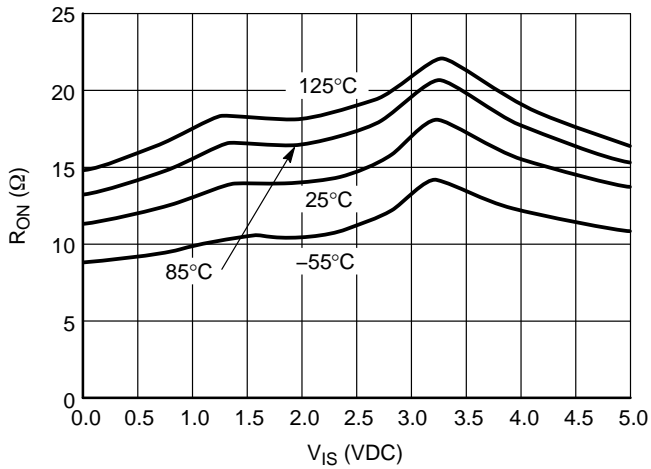


Figure 22.  $R_{ON}$  vs. Temp,  $V_{CC} = 5.0$  V

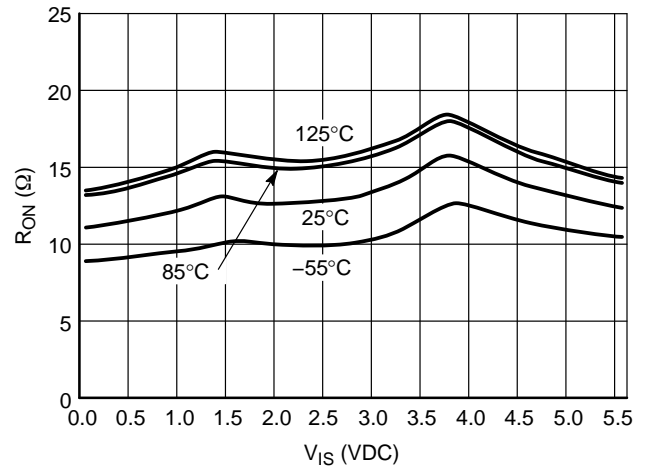


Figure 23.  $R_{ON}$  vs. Temp,  $V_{CC} = 5.5$  V

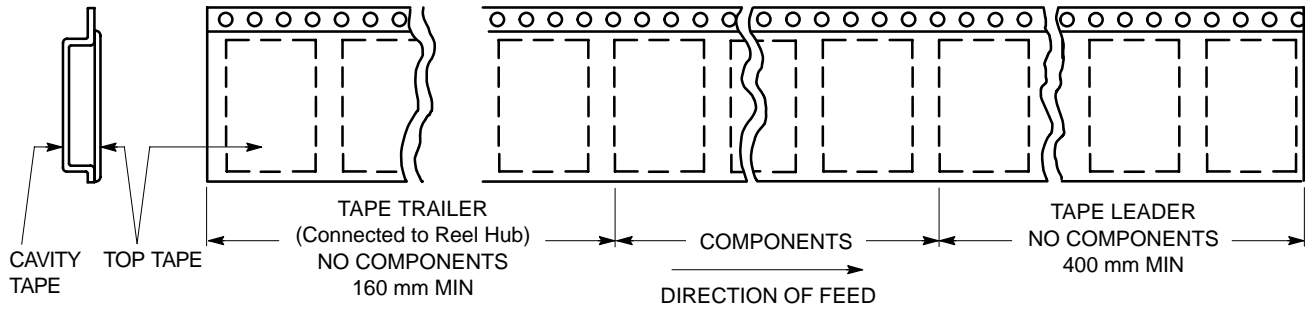


Figure 24. Tape Ends for Finished Goods

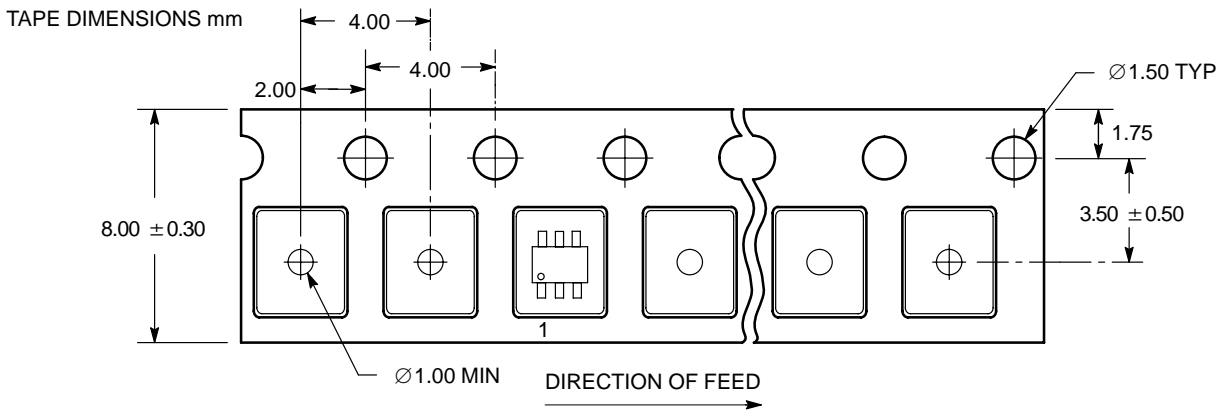


Figure 25. SC70-6/SC-88/SOT-363 DFT2 and SOT23-6/TSOP-6/SC59-6 DTT1 Reel Configuration/Orientation

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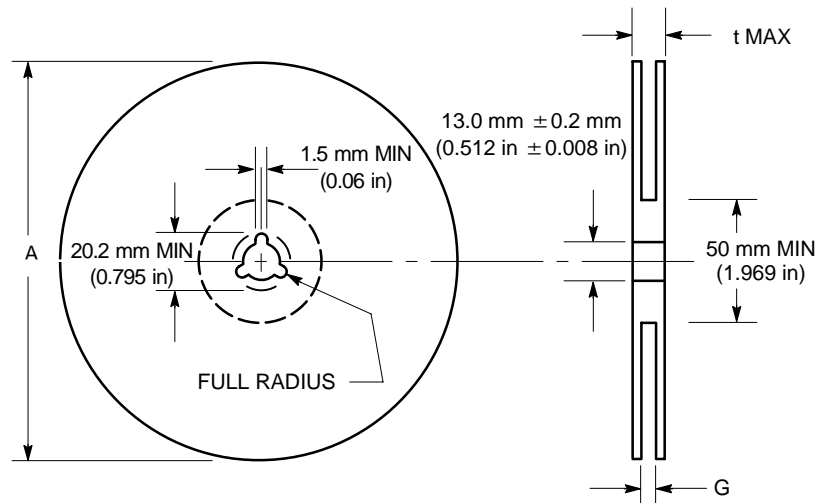


Figure 26. Reel Dimensions

## REEL DIMENSIONS

| Tape Size | T and R Suffix | A Max            | G   | t Max                |
|-----------|----------------|------------------|---|----------------------|
| 8 mm      | T1, T2         | 178 mm<br>(7 in) | 8.4 mm, + 1.5 mm, -0.0<br>(0.33 in + 0.059 in, -0.00) | 14.4 mm<br>(0.56 in) |

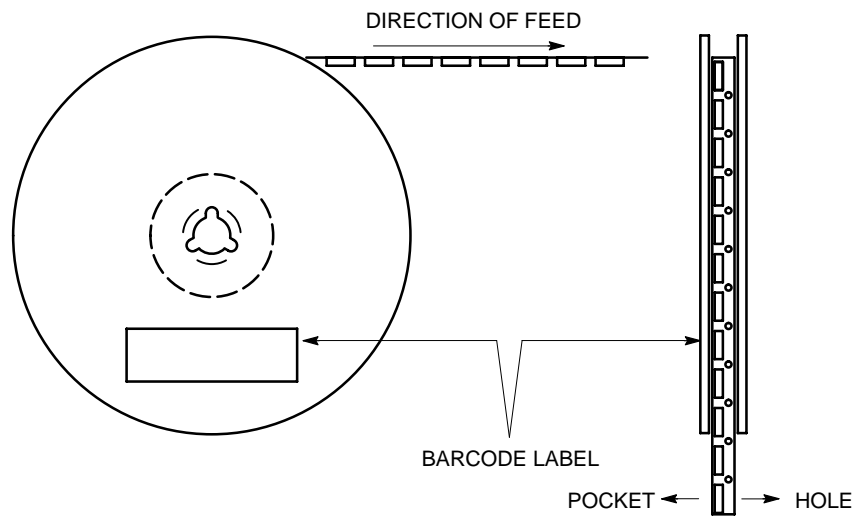
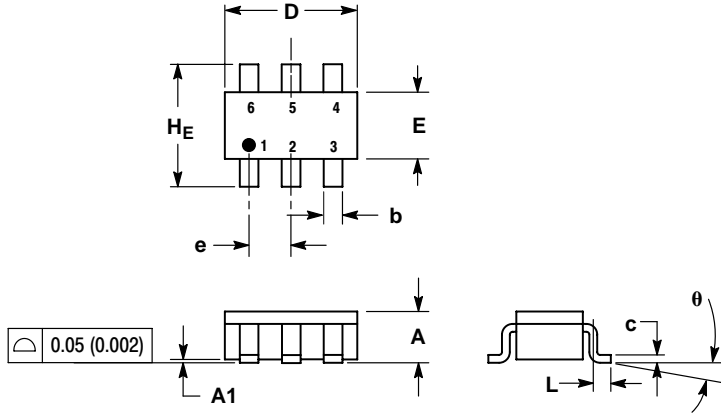


Figure 27. Reel Winding Direction

# NLAST4599

## PACKAGE DIMENSIONS

### TSOP-6 CASE 318G-02 ISSUE S

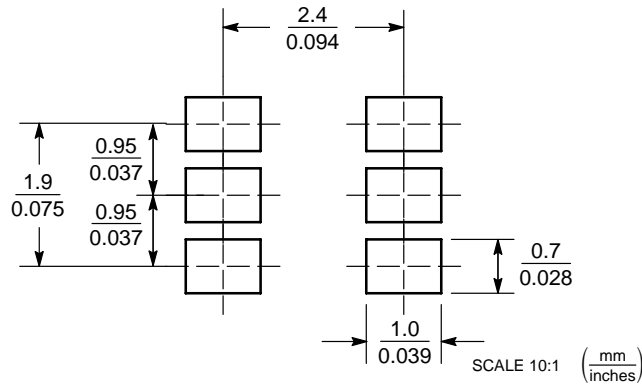


**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

| DIM | MILLIMETERS |      |      | INCHES |       |       |
|-----|-------------|------|------|--------|-------|-------|
|     | MIN         | NOM  | MAX  | MIN    | NOM   | MAX   |
| A   | 0.90        | 1.00 | 1.10 | 0.035  | 0.039 | 0.043 |
| A1  | 0.01        | 0.06 | 0.10 | 0.001  | 0.002 | 0.004 |
| b   | 0.25        | 0.38 | 0.50 | 0.010  | 0.014 | 0.020 |
| c   | 0.10        | 0.18 | 0.26 | 0.004  | 0.007 | 0.010 |
| D   | 2.90        | 3.00 | 3.10 | 0.114  | 0.118 | 0.122 |
| E   | 1.30        | 1.50 | 1.70 | 0.051  | 0.059 | 0.067 |
| e   | 0.85        | 0.95 | 1.05 | 0.034  | 0.037 | 0.041 |
| L   | 0.20        | 0.40 | 0.60 | 0.008  | 0.016 | 0.024 |
| HE  | 2.50        | 2.75 | 3.00 | 0.099  | 0.108 | 0.118 |
| θ   | 0°          | -    | 10°  | 0°     | -     | 10°   |

### SOLDERING FOOTPRINT\*

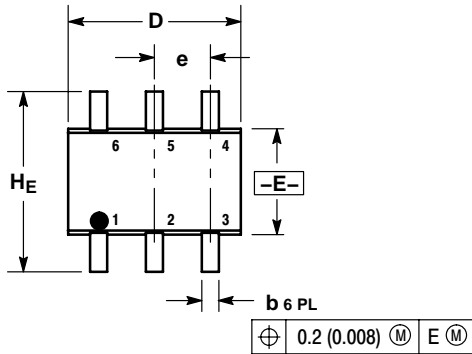


\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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## PACKAGE DIMENSIONS

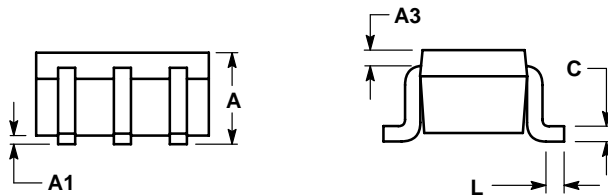
SC-88/SC70-6/SOT-363  
CASE 419B-02  
ISSUE W



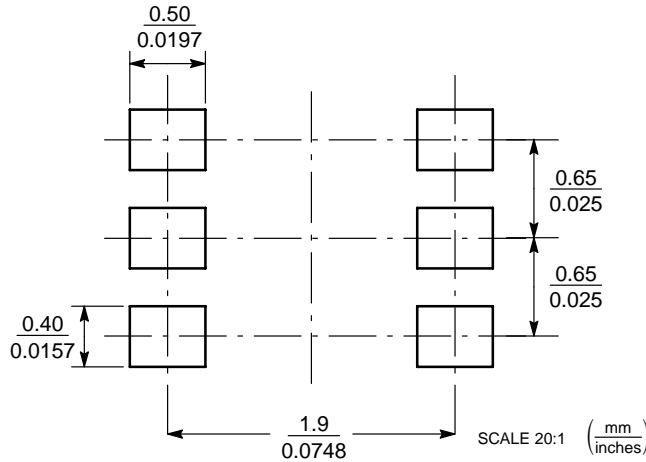
NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. 419B-01 OBSOLETE, NEW STANDARD 419B-02.

| DIM | MILLIMETERS |      |      | INCHES    |       |       |
|-----|-------------|------|------|-----------|-------|-------|
|     | MIN         | NOM  | MAX  | MIN       | NOM   | MAX   |
| A   | 0.80        | 0.95 | 1.10 | 0.031     | 0.037 | 0.043 |
| A1  | 0.00        | 0.05 | 0.10 | 0.000     | 0.002 | 0.004 |
| A3  | 0.20 REF    |      |      | 0.008 REF |       |       |
| b   | 0.10        | 0.21 | 0.30 | 0.004     | 0.008 | 0.012 |
| C   | 0.10        | 0.14 | 0.25 | 0.004     | 0.005 | 0.010 |
| D   | 1.80        | 2.00 | 2.20 | 0.070     | 0.078 | 0.086 |
| E   | 1.15        | 1.25 | 1.35 | 0.045     | 0.049 | 0.053 |
| e   | 0.65 BSC    |      |      | 0.026 BSC |       |       |
| L   | 0.10        | 0.20 | 0.30 | 0.004     | 0.008 | 0.012 |
| HE  | 2.00        | 2.10 | 2.20 | 0.078     | 0.082 | 0.086 |



### SOLDERING FOOTPRINT\*



\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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