

# High Performance SPDT Analog Switch with Over-Voltage Tolerance

## FSA3051

### Description

The FSA3051 is a 6  $\Omega$ , bi-directional, low-power, two port, high-speed, Single Pole / Double Throw (SPDT) analog switch. It features an extremely low on capacitance ( $C_{ON}$ ) of 7.7 pF and wide bandwidth of 1.0 GHz.

The FSA3051 contains special circuitry on the switch I/O pins for applications where the  $V_{CC}$  supply is powered-off ( $V_{CC} = 0$  V), which allows the device to withstand an over-voltage condition. This device is designed to minimize current consumption even when the control voltage applied to the select (S) pin is lower than the supply voltage ( $V_{CC}$ ). This feature is especially valuable to ultra-portable applications, such as cell phones, allowing for direct interface with the general-purpose I/Os of the baseband processor. Other applications include switching in portable cell phones, PDAs, digital cameras, printers, and notebook computers.

### Features

- Low On Capacitance: 7.7 pF Typical
- Low On Resistance: 6  $\Omega$  Typical
- Low Power Consumption: 1  $\mu$ A Maximum
  - ♦ 15  $\mu$ A Maximum  $I_{CCT}$  over an Expanded Voltage Range ( $V_{IN} = 1.8$  V,  $V_{CC} = 5.5$  V)
- Wide -3 db Bandwidth: 1.0 GHz
- Packaged in Ultra Small 6-Lead TMLP
- Broad  $V_{CC}$  Operating Range: 1.6 V to 5.5 V
- Over-Voltage Tolerance (OVT) on all Data Ports up to 6 V without External Components

### Applications

- Cell Phone, PDA, Digital Camera, and Notebook
- LCD Monitor, TV, and Set-Top Box



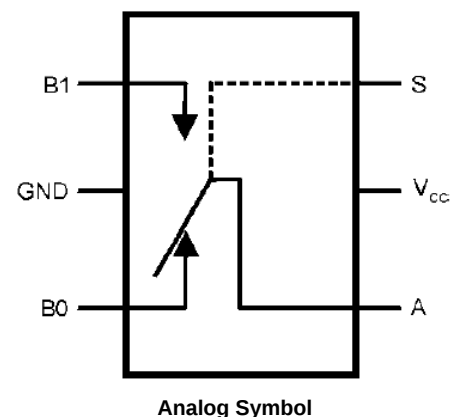
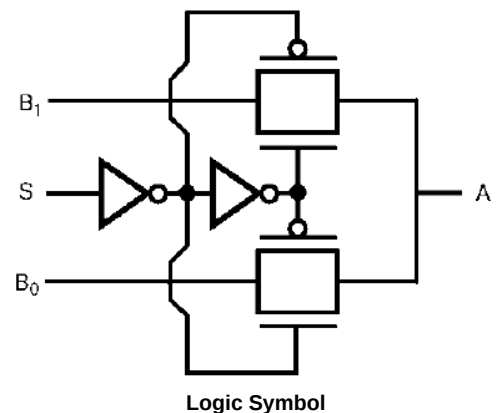
X2DFN6 1x1, 0.35P  
(TMLP)  
CASE 716AA

### MARKING DIAGRAM



NT = Specific Device Code  
 &K = 2-Digits Lot Run Traceability Code  
 &2 = 3-Digit Plant Code  
 &Z = Assembly Plant Code

### ANALOG SYMBOLS



### ORDERING INFORMATION

See detailed ordering and shipping information on page 6 of this data sheet.

## PIN ASSIGNMENTS

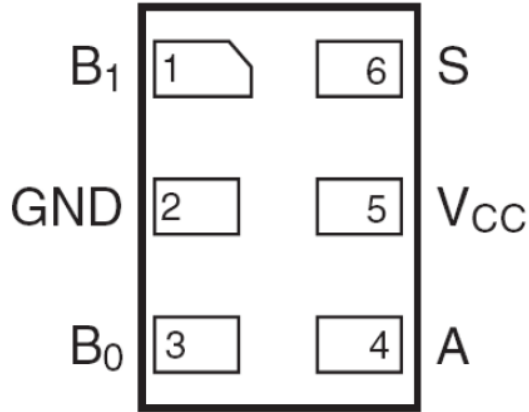


Figure 1. 6-Lead TMLP (Top-Through View)

## PIN DEFINITIONS

| UMLP Pin# | Name     | Description    |
|-----------|----------|----------------|
| 1         | $B_1$    | Data Port      |
| 2         | GND      | Ground         |
| 3         | $B_0$    | Data Port      |
| 4         | A        | Data Port      |
| 5         | $V_{CC}$ | Supply Voltage |
| 6         | S        | Switch Select  |

## TRUTH TABLE

| S    | Function             |
|------|----------------------|
| LOW  | $B_0$ connected to A |
| HIGH | $B_1$ connected to A |

1.  $LOW \leq V_{IL}$
2.  $HIGH \geq V_{IH}$

## ABSOLUTE MAXIMUM RATINGS

| Symbol      | Parameter                                     | Min          | Max      | Unit  |
|-------------|-----------------------------------------------|--------------|----------|-------|
| $V_{CC}$    | Supply Voltage                                | -0.5         | 6.0      | V     |
| $V_{CNTRL}$ | DC Input Voltage (Note 3)                     | -0.5         | $V_{CC}$ | V     |
| $V_{SW}$    | DC Switch I/O Voltage (Note 3)                | -0.50        | 6.00     | V     |
| $I_{IK}$    | DC Input Diode Current                        | -50          | -        | mA    |
| $I_{OUT}$   | DC Output Current                             | -            | 50       | mA    |
| $T_{STG}$   | Storage Temperature                           | -65          | +150     | °C    |
| MSL         | Moisture Sensitivity Level (JEDEC J-STD-020A) | -            | 1        | Level |
| ESD         | Human Body Model, ANSI/ESDA/JEDEC JS-001-2012 | All Pins     | 2        | kV    |
|             |                                               | I/O to GND   | 2        |       |
|             |                                               | Power to GND | 2        |       |
|             | Charged Device Model, JEDEC: JESD22-C101      |              | 1        | -     |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

3. The input and output negative ratings may be exceeded if the input and output diode current ratings are observed.

## RECOMMENDED OPERATING CONDITIONS

| Symbol      | Parameter                          | Min  | Max      | Unit |
|-------------|------------------------------------|------|----------|------|
| $V_{CC}$    | Supply Voltage                     | 1.6  | 5.5      | V    |
| $V_{CNTRL}$ | Control Input Voltage (S) (Note 4) | 0    | $V_{CC}$ | V    |
| $V_{SW}$    | Switch I/O Voltage                 | -0.5 | 5.5      | V    |
| $T_A$       | Operating Temperature              | -40  | +85      | °C   |

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

4. The control input must be held HIGH or LOW and it must not float.

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**DC CHARACTERISTICS** (All typical value are at  $T_A = 25^\circ\text{C}$  unless otherwise specified.)

| Symbol          | Characteristic                                                | Condition                                                                 | $V_{CC}$ (V) | $T_A = -40^\circ\text{C to } 85^\circ\text{C}$ |     |      | Unit             |
|-----------------|---------------------------------------------------------------|---------------------------------------------------------------------------|--------------|------------------------------------------------|-----|------|------------------|
|                 |                                                               |                                                                           |              | Min                                            | Typ | Max  |                  |
| $V_{IK}$        | Clamp Diode Voltage                                           | $I_{IN} = -18\text{ mA}$                                                  | 3.0          | –                                              | –   | –1.2 | V                |
| $V_{IH}$        | Input Voltage High                                            |                                                                           | 1.8 to 4.3   | 1.3                                            | –   | –    | V                |
|                 |                                                               |                                                                           | 4.3 to 5.5   | 1.7                                            | –   | –    |                  |
| $V_{IL}$        | Input Voltage Low                                             |                                                                           | 1.8 to 4.3   | –                                              | –   | 0.5  | V                |
|                 |                                                               |                                                                           | 4.3 to 5.5   | –                                              | –   | 0.7  |                  |
| $I_{IN}$        | Control Input Leakage                                         | $V_{CNTRL} = 0\text{ to } V_{CC}$                                         | 1.8          | –1                                             | –   | 1    | $\mu\text{A}$    |
|                 |                                                               |                                                                           | 5.5          | –1                                             | –   | 1    |                  |
| $I_{OZ}$        | Off State Leakage                                             | $V_{SW} = 0\text{ V to } V_{CC}$                                          | 1.8          | –2                                             | –   | 2    | $\mu\text{A}$    |
|                 |                                                               | $V_{SW} = 0\text{ V to } 3.6\text{ V}$                                    | 5.5          | –2                                             | –   | 2    |                  |
| $I_{OFF}$       | Power-Off Leakage Current (All I/O Ports)                     | $V_{SW} = 0\text{ V to } 4.3\text{ V}$ , $V_{CC} = 0\text{ V}$ , Figure 3 | 0            | –2                                             | –   | 2    | $\mu\text{A}$    |
| $R_{ON}$        | Switch On Resistance (Note 5)                                 | $V_{SW} = 0.4\text{ V}$ , $I_{ON} = -8\text{ mA}$ , Figure 2              | 3.0          | –                                              | 4   | 10   | $\Omega$         |
|                 |                                                               | $V_{SW} = 1.8\text{ V}$ , $I_{ON} = -8\text{ mA}$ , Figure 2              | 3.0          | –                                              | 6   | 10   |                  |
| $R_{ON}$        | Switch On Resistance (Note 5)                                 | $V_{SW} = 0.4\text{ V}$ , $I_{ON} = -8\text{ mA}$ , Figure 2              | 1.8          | –                                              | 6   | 10   | $\Omega$         |
|                 |                                                               | $V_{SW} = 1.8\text{ V}$ , $I_{ON} = -8\text{ mA}$ , Figure 2              | 1.8          | –                                              | 14  | 25   |                  |
| $\Delta R_{ON}$ | On Resistance Match Between Channels (Note 5, 6)              | $V_{SW} = 0.4\text{ V}$ , $I_{ON} = -8\text{ mA}$                         | 3.0          | –                                              | 35  | –    | $\text{m}\Omega$ |
|                 |                                                               |                                                                           | 1.8          | –                                              | 40  | –    |                  |
| $I_{CC}$        | Quiescent Supply Current                                      | $V_{CNTRL} = 0\text{ or } V_{CC}$ , $I_{OUT} = 0$                         | 5.5          | –                                              | –   | 1    | $\mu\text{A}$    |
| $I_{CCT}$       | Increase in $I_{CC}$ Current per Control Voltage and $V_{CC}$ | $V_{CNTRL} = 1.8\text{ V}$                                                | 3.0          | –                                              | –   | 10   | $\mu\text{A}$    |
|                 |                                                               | $V_{CNTRL} = 2.6\text{ V}$                                                | 5.5          | –                                              | –   | 10   |                  |
|                 |                                                               | $V_{CNTRL} = 1.8\text{ V}$                                                | 5.5          | –                                              | –   | 15   |                  |

5. Measured by the voltage drop between A and Bn pins at the indicated current through the switch. On resistance is determined by the lower of the voltage on the two (A or Bn ports).
6.  $\Delta R_{ON} = R_{ON\text{ maximum}} - R_{ON\text{ minimum}}$  measured at identical  $V_{CC}$ , temperature, and voltage levels.
7. Guaranteed by characterization.

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## AC CHARACTERISTICS (Note 8) (All typical value are at $T_A = 25^\circ\text{C}$ unless otherwise specified.)

| Symbol    | Characteristic               | Condition                                                                                     | $V_{CC}$ (V) | $T_A = -40^\circ\text{C to } 85^\circ\text{C}$ |     |     | Unit |
|-----------|------------------------------|-----------------------------------------------------------------------------------------------|--------------|------------------------------------------------|-----|-----|------|
|           |                              |                                                                                               |              | Min                                            | Typ | Max |      |
| $t_{ON}$  | Turn-On Time<br>S to Output  | $R_L = 50\ \Omega$ , $C_L = 5\ \text{pF}$ , $V_{SW} = 0.8\ \text{V}$ ,<br>Figure 4, Figure 5  | 3.0 to 3.6   | –                                              | 34  | –   | ns   |
|           |                              |                                                                                               | 1.8          | –                                              | 110 | –   |      |
| $t_{OFF}$ | Turn-Off Time<br>S to Output | $R_L = 50\ \Omega$ , $C_L = 5\ \text{pF}$ , $V_{SW} = 0.8\ \text{V}$ ,<br>Figure 4, Figure 5  | 3.0 to 3.6   | –                                              | 23  | –   | ns   |
|           |                              |                                                                                               | 1.8          | –                                              | 50  | –   |      |
| $t_{PD}$  | Propagation Delay            | $C_L = 5\ \text{pF}$ , $R_L = 50\ \Omega$ , Figure 6,<br>Figure 6                             | 3.3          | –                                              | 0.2 | –   | ns   |
|           |                              |                                                                                               | 1.8          | –                                              | 0.3 | –   |      |
| $t_{BBM}$ | Break-Before-Make            | $R_L = 50\ \Omega$ , $C_L = 5\ \text{pF}$ ,<br>$V_{SW1} = V_{SW2} = 0.8\ \text{V}$ , Figure 7 | 3.0 to 3.6   | 15                                             | –   | 50  | ns   |
|           |                              |                                                                                               | 1.8          | –                                              | –   | 100 |      |
| $O_{IRR}$ | Off Isolation                | $R_L = 50\ \Omega$ , $f = 240\ \text{MHz}$ , Figure 9                                         | 1.8          | –                                              | –20 | –   | dB   |
|           |                              |                                                                                               | 3.0 to 3.6   | –                                              | –23 | –   |      |
| Xtalk     | Crosstalk                    | $R_L = 50\ \Omega$ , $f = 240\ \text{MHz}$ , Figure 10                                        | 1.8          | –                                              | –18 | –   | dB   |
|           |                              |                                                                                               | 3.0 to 3.6   | –                                              | –23 | –   | dB   |
| BW        | –3 db Bandwidth              | $R_L = 50\ \Omega$ , $C_L = 0\ \text{pF}$ , $V_{SW} = 0.4\ \text{V}$                          | 1.8          | –                                              | 810 | –   | MHz  |
|           |                              | $R_L = 50\ \Omega$ , $C_L = 0\ \text{pF}$ , Figure 8                                          | 3.0 to 3.6   | –                                              | 1   | –   | GHz  |
|           |                              | $R_L = 50\ \Omega$ , $C_L = 5\ \text{pF}$ , Figure 8                                          |              | –                                              | 750 | –   | MHz  |

8. Guaranteed by characterization. Not production tested.

## CAPACITANCE (Note 9)

| Symbol    | Characteristic                | Condition                         | $V_{CC}$ (V) | $T_A = -40^\circ\text{C to } 85^\circ\text{C}$ |      |     | Unit |
|-----------|-------------------------------|-----------------------------------|--------------|------------------------------------------------|------|-----|------|
|           |                               |                                   |              | Min                                            | Typ  | Max |      |
| $C_{IN}$  | Control Pin Input Capacitance |                                   | 0            | –                                              | 1.5  | –   | pF   |
| $C_{ON}$  | A Port On Capacitance         | $f = 1\ \text{MHz}$ ,             | 3.0          | –                                              | 7.7  | –   |      |
|           |                               | $f = 240\ \text{MHz}$ , Figure 12 | 3.3          | –                                              | 7.7  | –   |      |
|           |                               | $f = 1\ \text{MHz}$ ,             | 1.8          | –                                              | 10.0 | –   |      |
|           |                               | $f = 240\ \text{MHz}$ , Figure 12 | 1.8          | –                                              | 5.0  | –   |      |
| $C_{OFF}$ | Bn Port Off Capacitance       | $f = 1\ \text{MHz}$               | 3.0          | –                                              | 3.3  | –   |      |
|           |                               | $f = 240\ \text{MHz}$ , Figure 11 | 3.3          | –                                              | 3.3  | –   |      |
|           |                               | $f = 1\ \text{MHz}$               | 1.8          | –                                              | 5.0  | –   |      |
|           |                               | $f = 240\ \text{MHz}$ , Figure 11 | 1.8          | –                                              | 4.0  | –   |      |

9. Not production tested.

## TEST DIAGRAMS

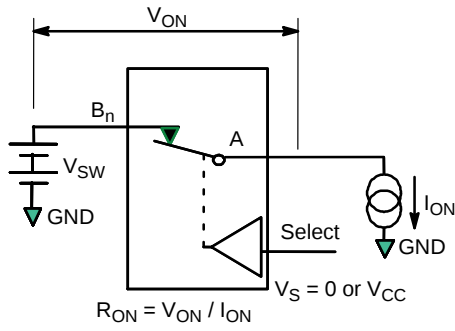
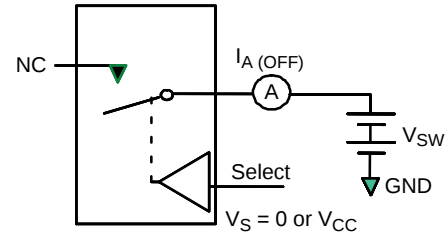


Figure 2. On Resistance



\*\*Each switch port is tested separately

Figure 3. Off Leakage

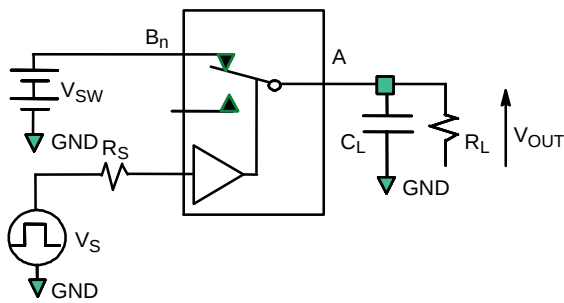


Figure 4. AC Test Circuit Load

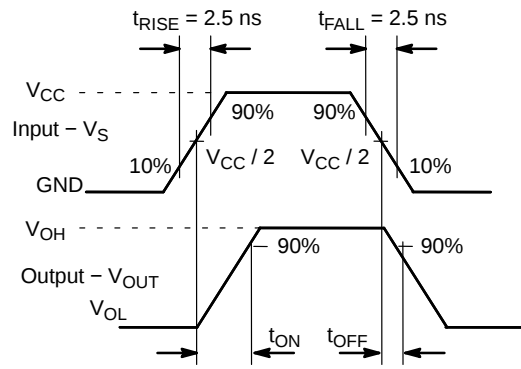


Figure 5. Turn-On / Turn-Off Waveforms

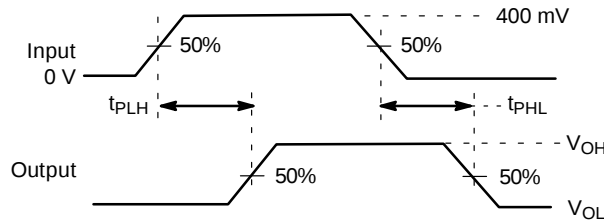
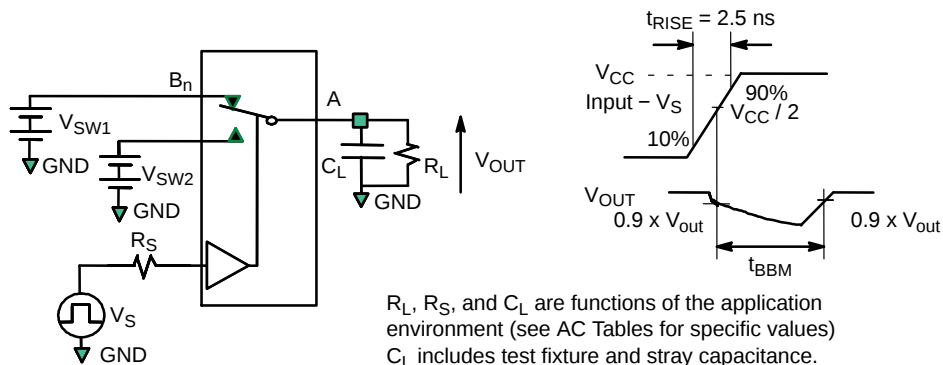
Figure 6. Propagation Delay ( $t_{RtF} - 500 \text{ ps}$ )

Figure 7. Break-Before-Make Interval Timing

## TEST DIAGRAMS (CONTINUED)

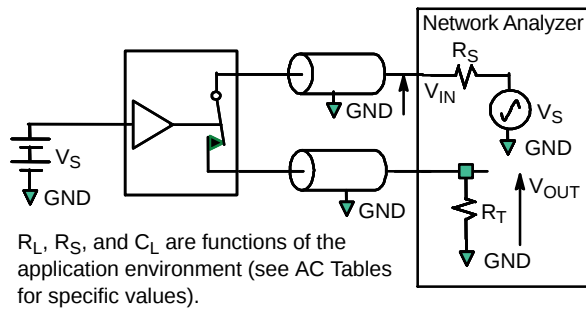


Figure 8. Bandwidth

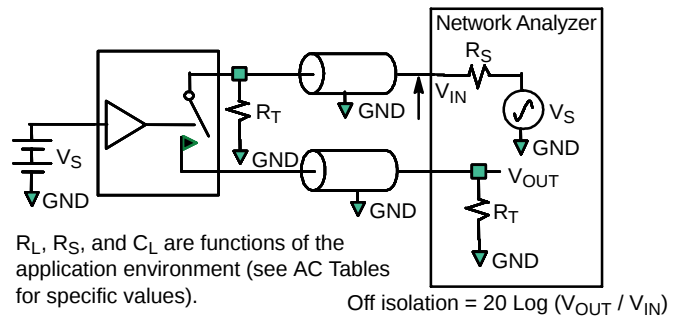


Figure 9. Channel Off Isolation

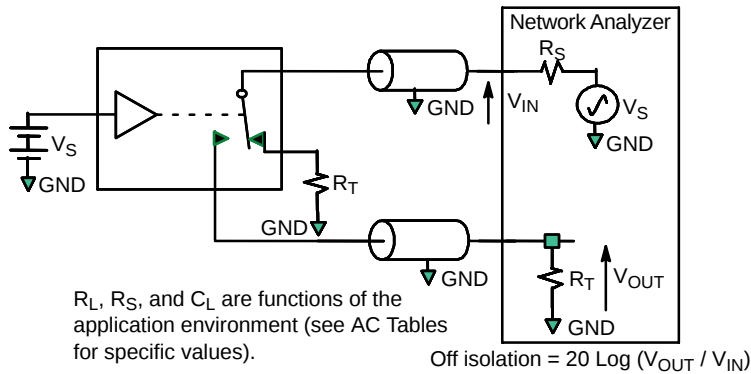


Figure 10. Channel-to-Channel Crosstalk

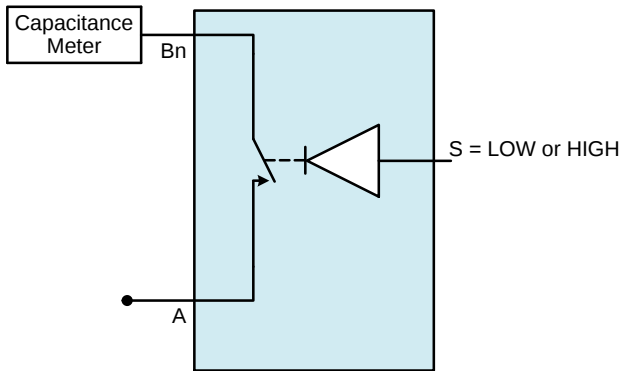


Figure 11. Channel Off Capacitance

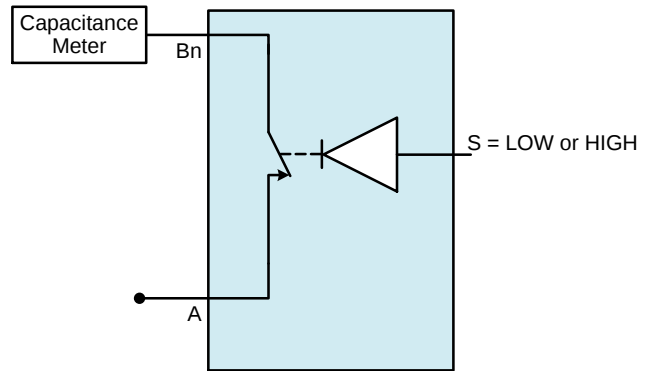


Figure 12. Channel On Capacitance

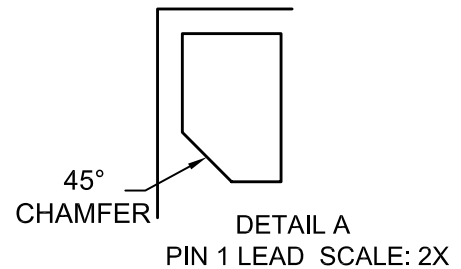
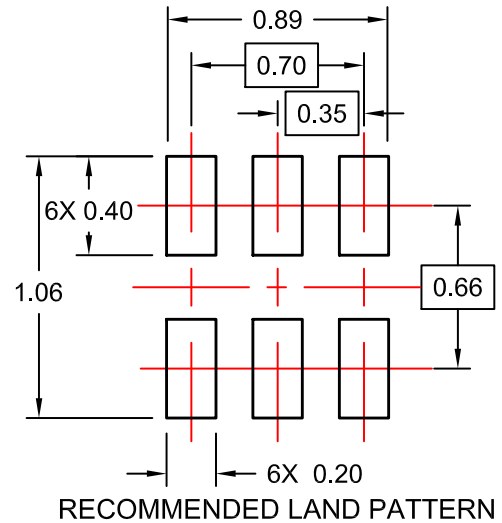
## ORDERING INFORMATION

| Part Number | Top Mark | Operating Temperature Range | Package Type                                                                                                                                                            | Shipping <sup>†</sup> |
|-------------|----------|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| FSA3051TMX  | NT       | -40 to +85 °C               | X2DFN6 1x1, 0.35P<br>6-Lead, Dual, Ultra-ultrathin Molded Leadless Package (TMLP),<br>1.0 x 1.0 mm. Top left unit orientation in carrier tape<br>(Pb-Free, Halide Free) | 10000 / Tape & Reel   |

<sup>†</sup>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.

## ON

DATE 30 NOV 2016



NOTES:

- A. NO JEDEC STANDARD APPLIES  
B. DIMENSIONS ARE IN MILLIMETERS.  
C. DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 2009

|          |         |   |   |   |
|----------|---------|---|---|---|
| $\oplus$ | 0.05(M) | C | B | A |
|          | 0.05    | C |   |   |

|                         |                          |                                                                                                                                                                                     |
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