

# FSUSB11

## Low Power High Bandwidth USB Switch

### Dual SPDT Multiplexer/Demultiplexer

#### General Description

The FSUSB11 is a high performance Dual Single Pole Double Throw (SPDT) analog switch specially designed for the switching of both analog audio signal and USB 1.1 signals. The device features ultra low  $R_{ON}$  of 1.3 $\Omega$  maximum at 4.5V  $V_{CC}$  and 4.3 $\Omega$  at 2.7V supply. High bandwidth and ultra low ON Resistance ( $R_{ON}$ ) make this switch to be able to pass both USB low and full speed signal with minimum signal distortion. The device is fabricated with sub-micron CMOS technology to achieve fast switching speeds and is designed for break-before-make operation. The select input is TTL level compatible.

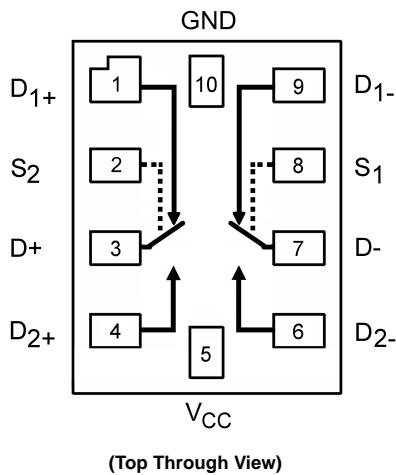
#### Features

- Space saving MicroPak™ packaging (1.6mm x 2.1mm)
- USB 1.1 signal switching compliant
- -3db bandwidth: >350MHz
- Maximum 1.15 $\Omega$  ON Resistance at 4.5V  $V_{CC}$  and 4 $\Omega$  for 2.7V supply
- 0.3 $\Omega$  maximum  $R_{ON}$  flatness for +5V supply
- Broad  $V_{CC}$  operating range: 1.65V to 5.5V
- Fast turn-on and turn-off time
- Break-before-make enable circuitry
- Over-voltage tolerant TTL compatible control input

#### Ordering Code:

| Order Number | Package Number | Product Code Top Mark | Package Description              | Supplied As               |
|--------------|----------------|-----------------------|----------------------------------|---------------------------|
| FSUSB11L10X  | MAC010A        | ET                    | 10-Lead MicroPak, 1.6 mm x 2.1mm | 5K Units on Tape and Reel |

#### Analog Symbols



#### Truth Table

| Control Input(s) | Function                          |
|------------------|-----------------------------------|
| L                | D <sub>1</sub> Connected to D+/D- |
| H                | D <sub>2</sub> Connected to D+/D- |

H = HIGH Logic Level  
L = LOW Logic Level

#### Pin Descriptions

| Pin Names                          | Function      |
|------------------------------------|---------------|
| D, D <sub>1</sub> , D <sub>2</sub> | Data Ports    |
| S                                  | Control Input |

MicroPak™ is a trademark of Fairchild Semiconductor Corporation.

| Absolute Maximum Ratings (Note 1)                                 |                          | Recommended Operating Conditions            |                |
|---|--------------------------|---|----------------|
| Supply Voltage ( $V_{CC}$ )                                       | -0.5V to +6.0V           | Supply Voltage ( $V_{CC}$ )                 | 1.65V to 5.5V  |
| Switch Voltage ( $V_S$ ) (Note 2)                                 | -0.5V to $V_{CC} + 0.5V$ | Control Input Voltage ( $V_{IN}$ ) (Note 3) | 0V to $V_{CC}$ |
| Input Voltage ( $V_{IN}$ ) (Note 2)                               | -0.5V to +6.0V           | Switch Input Voltage ( $V_{IN}$ )           | 0V to $V_{CC}$ |
| Input Diode Current   | -50 mA                   | Operating Temperature ( $T_A$ )             | -40°C to +85°C |
| Switch Current  | 200 mA                   |   |                |
| Peak Switch Current (Pulsed at<br>1 ms duration, <10% Duty Cycle) | 400 mA                   |   |                |
| Storage Temperature Range ( $T_{STG}$ )                           | -65°C to +150°C          |   |                |
| Maximum Junction Temperature ( $T_J$ )                            | +150°C                   |   |                |
| Lead Temperature ( $T_L$ )  |                          |   |                |
| Soldering, 10 seconds   | +260°C                   |   |                |
| ESD   |                          |   |                |
| Human Body Model  | 8000V                    |   |                |

**Note 1:** The "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the Electrical Characteristics tables are not guaranteed at the absolute maximum ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.

**Note 2:** The input and output negative voltage ratings may be exceeded if the input and output diode current ratings are observed.

**Note 3:** Unused inputs must be held HIGH or LOW. They may not float.

**DC Electrical Characteristics** (All typical values are @ 25°C unless otherwise specified)

| Symbol                         | Parameter   | $V_{CC}$<br>(V) | $T_A = +25^\circ\text{C}$ |      |      | $T_A = -40^\circ\text{C to } +85^\circ\text{C}$ |      | Units   | Conditions  |
|--------------------------------|---|-----------------|---------------------------|------|------|---|------|---|---|
|                                |   |                 | Min                       | Typ  | Max  | Min   | Max  |   |   |
| $V_{IH}$                       | Input Voltage High  | 2.7 to 3.6      |                           |      |      | 2.0   |      | V   |   |
|                                |   | 4.5 to 5.5      |                           |      |      | 2.4   |      |   |   |
| $V_{IL}$                       | Input Voltage Low   | 2.7 to 3.6      |                           |      |      |   | 0.6  | V   |   |
|                                |   | 4.5 to 5.5      |                           |      |      |   | 0.8  |   |   |
| $I_{IN}$                       | Control Input Leakage   | 2.7 to 3.6      |                           |      |      | -1.0  | 1.0  | $\mu\text{A}$   | $V_{IN} = 0V \text{ to } V_{CC}$  |
|                                |   | 4.5 to 5.5      |                           |      |      | -1.0  | 1.0  |   |   |
| $I_{NO(OFF)}$<br>$I_{NC(OFF)}$ | OFF-Leakage Current of Port D <sub>1</sub> and D <sub>2</sub> | 5.5             | -50.0                     | 50.0 | -100 | 100   | nA   | A = 1V, 4.5V<br>B <sub>0</sub> or B <sub>1</sub> = 1V, 4.5V             |   |
| $I_{A(ON)}$                    | ON Leakage Current of Port D                                  | 5.5             | -50.0                     | 50.0 | -100 | 100   | nA   | A = 1V, 4.5V<br>B <sub>0</sub> or B <sub>1</sub> = 1V, 4.5V or Floating |   |
| $R_{ON}$                       | Switch ON Resistance (Note 4)                                 | 2.7             |                           | 2.6  | 4.0  |   | 4.3  | $\Omega$  | $I_{OUT} = 100 \text{ mA}, D_1 \text{ or } D_2 = 1.5V$<br>$I_{OUT} = 100 \text{ mA}, D_1 \text{ or } D_2 = 3.5V$                  |
|                                |   | 4.5             |                           | 0.95 | 1.15 |   | 1.3  |   |   |
| $\Delta R_{ON}$                | ON Resistance Matching Between Channels (Note 5)              | 2.7             |                           |      |      |   |      | $\Omega$  | $I_{OUT} = 100 \text{ mA}, D_1 \text{ or } D_2 = 1.5V$<br>$I_{OUT} = 100 \text{ mA}, D_1 \text{ or } D_2 = 3.5V$                  |
|                                |   | 4.5             |                           | 0.06 | 0.12 |   | 0.15 |   |   |
| $R_{FLAT(ON)}$                 | ON Resistance Flatness (Note 6)                               | 2.7             |                           | 1.4  |      |   |      | $\Omega$  | $I_{OUT} = 100 \text{ mA}, D_1 \text{ or } D_2 = 0V, 0.75V, 1.5V$<br>$I_{OUT} = 100 \text{ mA}, B_0 \text{ or } B_1 = 0V, 1V, 2V$ |
|                                |   | 4.5             |                           | 0.2  | 0.3  |   | 0.4  |   |   |
| $I_{CC}$                       | Quiescent Supply Current                                      | 3.6             |                           | 0.1  | 0.5  |   | 1.0  | $\mu\text{A}$   | $V_{IN} = 0V \text{ or } V_{CC}, I_{OUT} = 0V$  |
|                                |   | 5.5             |                           | 0.1  | 0.5  |   | 1.0  |   |   |

**Note 4:** ON Resistance is determined by the voltage drop between D and D<sub>n</sub> pins at the indicated current through the switch.

**Note 5:**  $\Delta R_{ON} = R_{ONmax} - R_{ONmin}$  measured at identical  $V_{CC}$ , temperature, and voltage.

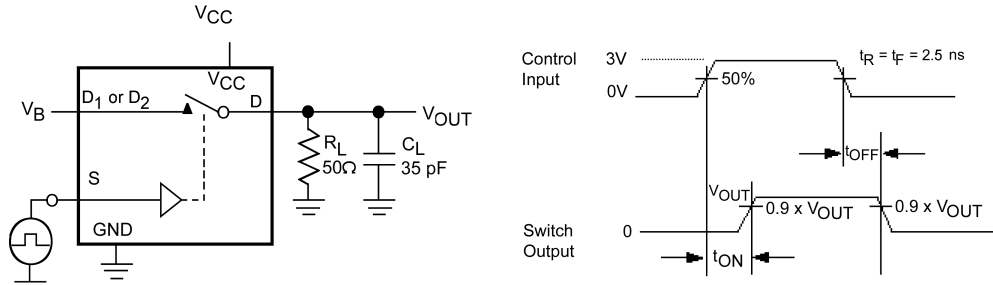
**Note 6:** Flatness is defined as the difference between the maximum and minimum value of ON Resistance over the specified range of conditions.

| AC Electrical Characteristics (All typical value are @ 25°C unless otherwise specified) |                        |                        |                        |       |     |                                 |     |   |            |               |
|---|------------------------|------------------------|------------------------|-------|-----|---------------------------------|-----|---|------------|---------------|
| Symbol  | Parameter              | V <sub>CC</sub><br>(V) | T <sub>A</sub> = +25°C |       |     | T <sub>A</sub> = -40°C to +85°C |     | Units   | Conditions | Figure Number |
|   |                        |                        | Min                    | Typ   | Max | Min                             | Max |   |            |               |
| t <sub>ON</sub>   | Turn ON Time           | 2.7 to 3.6             |                        | 50.0  |     | 60.0                            | ns  | D <sub>1</sub> or D <sub>2</sub> = 1.5V, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 35 pF | Figure 1   |               |
|   |                        | 4.5 to 5.5             |                        | 35.0  |     | 40.0                            |     | D <sub>1</sub> or D <sub>2</sub> = 3.0V, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 35 pF |            |               |
| t <sub>OFF</sub>  | Turn OFF Time          | 2.7 to 3.6             |                        | 20.0  |     | 30.0                            | ns  | D <sub>1</sub> or D <sub>2</sub> = 1.5V, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 35 pF | Figure 1   |               |
|   |                        | 4.5 to 5.5             |                        | 15.0  |     | 20.0                            |     | D <sub>1</sub> or D <sub>2</sub> = 3.0V, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 35 pF |            |               |
| t <sub>B-M</sub>  | Break-Before-Make Time | 2.7 to 3.6             |                        |       | 1.0 |                                 | ns  | D <sub>1</sub> or D <sub>2</sub> = 1.5V, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 35 pF | Figure 2   |               |
|   |                        | 4.5 to 5.5             | 20.0                   |       | 1.0 |                                 |     | D <sub>1</sub> or D <sub>2</sub> = 3.0V, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 35 pF |            |               |
| Q   | Charge Injection       | 2.7 to 3.6             |                        | 20.0  |     |                                 | pC  | C <sub>L</sub> = 1.0 nF, V <sub>GEN</sub> = 0V, R <sub>GEN</sub> = 0Ω                 | Figure 4   |               |
|   |                        | 4.5 to 5.5             |                        | 10.0  |     |                                 |     |   |            |               |
| OIRR  | OFF-Isolation          | 2.7 to 3.6             |                        | -70.0 |     |                                 | dB  | f = 1MHz, R <sub>L</sub> = 50Ω  | Figure 3   |               |
|   |                        | 4.5 to 5.5             |                        | -70.0 |     |                                 |     |   |            |               |
| Xtalk   | Crosstalk              | 2.7 to 3.6             |                        | -75.0 |     |                                 | dB  | f = 1MHz, R <sub>L</sub> = 50Ω  | Figure 3   |               |
|   |                        | 4.5 to 5.5             |                        | -75.0 |     |                                 |     |   |            |               |
| BW  | -3db Bandwidth         | 2.7 to 3.6             |                        | 350   |     |                                 | MHz | R <sub>L</sub> = 50Ω  | Figure 6   |               |
|   |                        | 4.5 to 5.5             |                        | 350   |     |                                 |     |   |            |               |

| USB Related AC Electrical Characteristics (All typical value are @25°C unless otherwise specified) |                           |                        |                        |      |      |       |  |               |
|--|---------------------------|------------------------|------------------------|------|------|-------|--|---------------|
| Symbol   | Parameter                 | V <sub>CC</sub><br>(V) | T <sub>A</sub> = +25°C |      |      | Units | Conditions   | Figure Number |
|  |                           |                        | Min                    | Typ  | Max  |       |  |               |
| t <sub>SKEW</sub>  | Skew                      | 2.7 to 3.6             |                        | 0.15 |      | ns    | R <sub>S</sub> = 39Ω, C <sub>L</sub> = 50 pF<br>t <sub>R</sub> = t <sub>F</sub> = 12ns                                       | Figure 7      |
|  |                           | 4.5 to 5.5             |                        | 0.15 |      |       |  |               |
| t <sub>M</sub>   | Rising/Fall Time Mismatch | 2.7 to 3.6             |                        |      | 10.0 | %     | at 12Mbps<br>(Duty Cycle = 50%)  | Figure 7      |
|  |                           | 4.5 to 5.5             |                        |      | 10.0 |       |  |               |
| t <sub>J</sub>   | Total Jitter              | 2.7 to 3.6             |                        | 1.7  |      | ns    | R <sub>S</sub> = 39Ω, C <sub>L</sub> = 50 pF, t <sub>R</sub> = t <sub>F</sub> = 12 ns at 12Mbps (PRBS = 2 <sup>15</sup> - 1) | Figure 7      |
|  |                           | 4.5 to 5.5             |                        | 1.6  |      |       |  |               |

| Capacitance      |                                     |                        |                        |      |     |       |                         |
|------------------|-------------------------------------|------------------------|------------------------|------|-----|-------|-------------------------|
| Symbol           | Parameter                           | V <sub>CC</sub><br>(V) | T <sub>A</sub> = +25°C |      |     | Units | Conditions              |
|                  |                                     |                        | Min                    | Typ  | Max |       |                         |
| C <sub>IN</sub>  | Control Pin Input Capacitance       | 0.0                    |                        | 3.5  |     | pF    | f = 1MHz (see Figure 5) |
| C <sub>OFF</sub> | D <sub>n</sub> Port OFF Capacitance | 4.5                    |                        | 12.0 |     | pF    | f = 1MHz (see Figure 5) |
| C <sub>ON</sub>  | D Port ON Capacitance               | 4.5                    |                        | 55.0 |     | pF    | f = 1MHz (see Figure 5) |

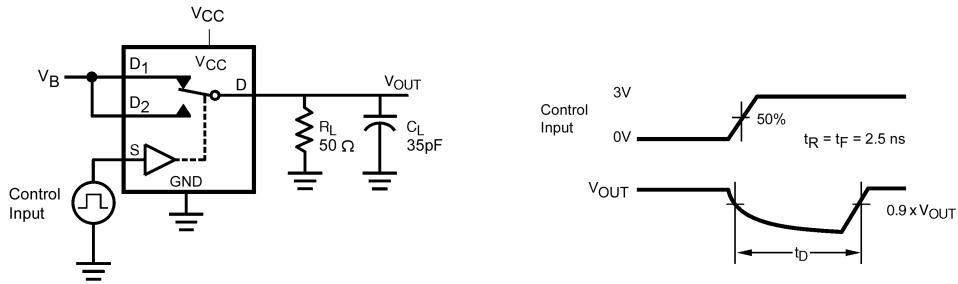
AC Loading and Waveforms



$C_L$  includes Fixture and Stray Capacitance

Logic Input Waveforms Inverted for Switches that have the Opposite Logic Sense

FIGURE 1. Turn-On/Turn-Off Timing



$C_L$  Includes Fixture and Stray Capacitance

FIGURE 2. Break-Before-Make Timing

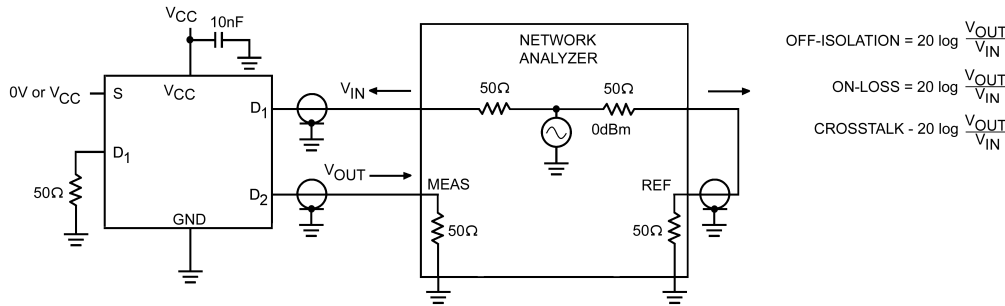
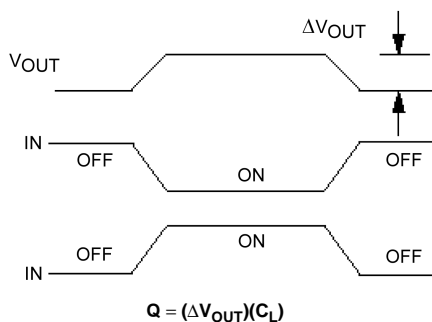
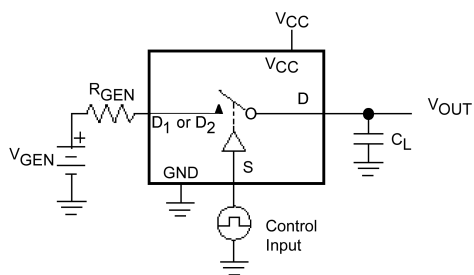
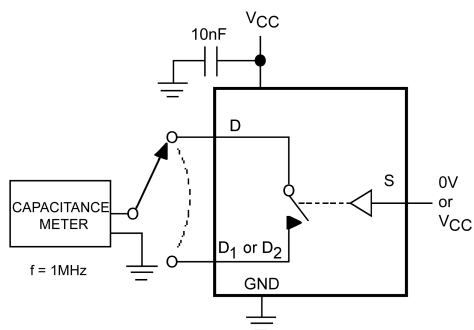


FIGURE 3. OFF Isolation and Crosstalk

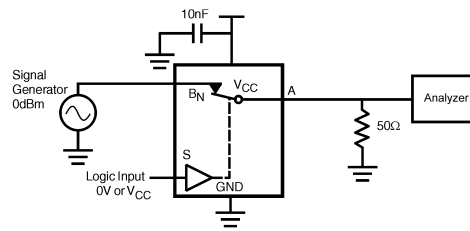
### AC Loading and Waveforms (Continued)



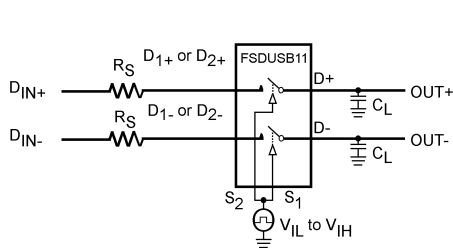
**FIGURE 4. Charge Injection**



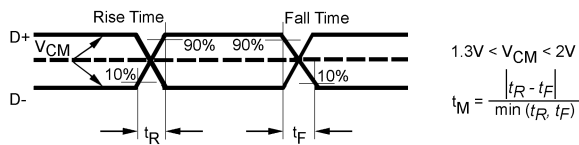
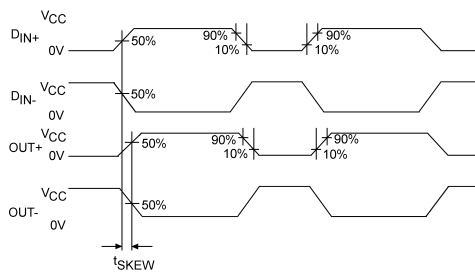
**FIGURE 5. ON/OFF Capacitance Measurement Setup**



**FIGURE 6. Bandwidth**



**FIGURE 7. Skew Test**

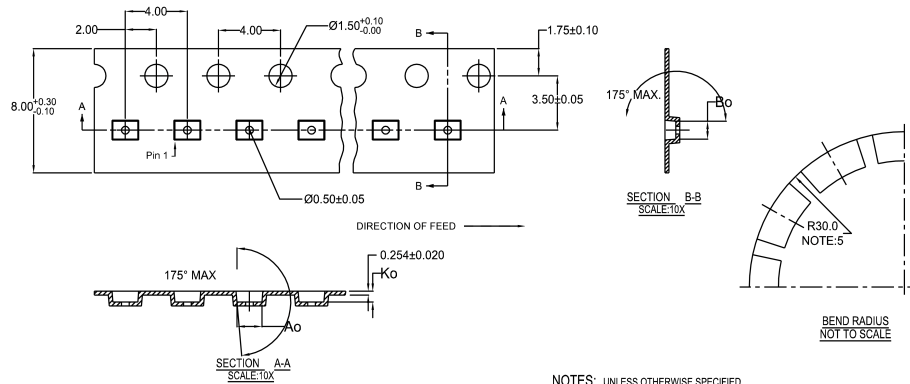


**FIGURE 8. Rise/Fall Time Mismatch Test**

## Tape and Reel Specification

Tape Format For Micropak 10

| Package Designator | Tape Section       | Number Cavities | Cavity Status | Cover Tape Status |
|--------------------|--------------------|-----------------|---------------|-------------------|
| L10X               | Leader (Start End) | 125 (typ)       | Empty         | Sealed            |
|                    | Carrier            | 5000            | Filled        | Sealed            |
|                    | Trailer (Hub End)  | 75 (typ)        | Empty         | Sealed            |



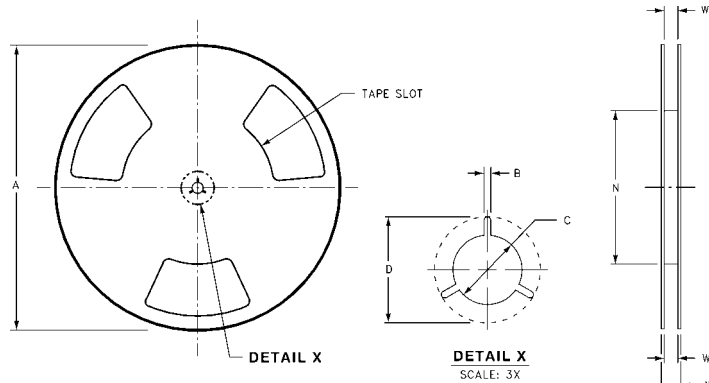
NOTES: UNLESS OTHERWISE SPECIFIED

1. ACCUMULATED 50 SPROCKETS, SPROCKET HOLE PITCH IS 200.00 ±0.30MM
2. NO INDICATED CORNER RADIUS IS 0.127MM
3. CAMBER NOT TO EXCEED 1MM IN 100MM
4. SMALLEST ALLOWABLE BENDING RADIUS
5. POCKET POSITION RELATIVE TO SPROCKET HOLE MEASURED AS TRUE POSITION OF POCKET, NOT POCKET HOLE



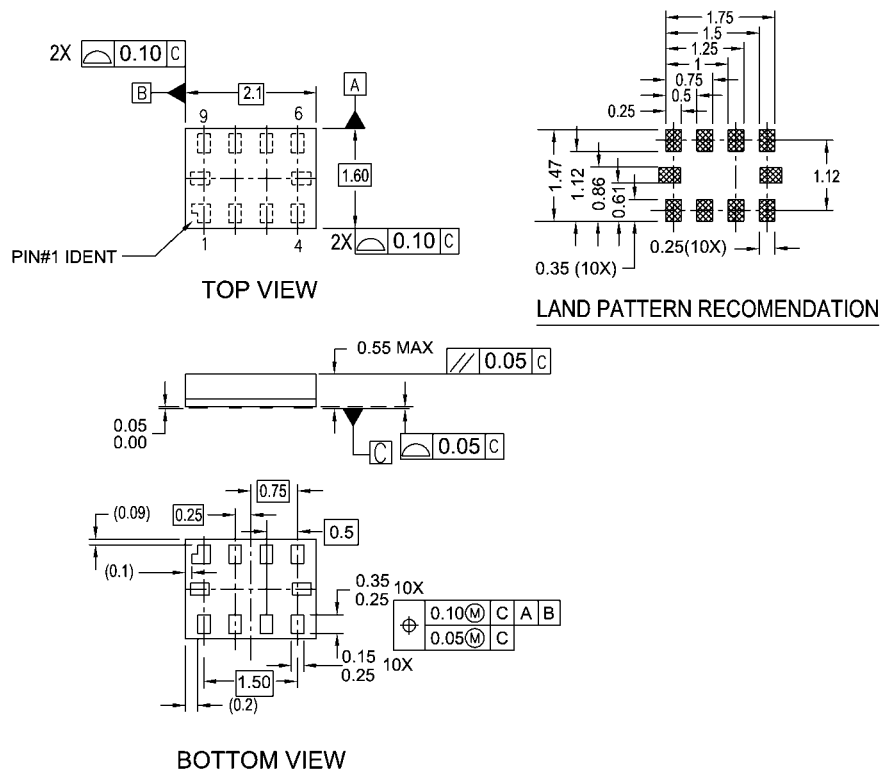
SCALE: 6X

### REEL DIMENSIONS inches (millimeters)



| Tape Size | A              | B               | C                | D                | N                | W1  | W2               | W3                                     |
|-----------|----------------|-----------------|------------------|------------------|------------------|---|------------------|--|
| 8 mm      | 7.0<br>(177.8) | 0.059<br>(1.50) | 0.512<br>(13.00) | 0.795<br>(20.20) | 2.165<br>(55.00) | 0.331 + 0.059/-0.000<br>(8.40 + 1.50/-0.00) | 0.567<br>(14.40) | W1 + 0.078/-0.039<br>(W1 + 2.00/-1.00) |

**Physical Dimensions** inches (millimeters) unless otherwise noted



**NOTES:**

- A. PACKAGE CONFORMS TO JEDEC MO255, VARIATION UABD
- B. DIMENSIONS ARE IN MILLIMETERS.
- C. DIMENSIONS AND TOLERANCES CONFORMS TO ASME Y14.5M, 1994.

MAC010ARevB

**10-Lead MicroPak, 1.6 mm x 2.1mm**  
**Package Number MAC010A**

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2. A critical component in any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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