

## FSUSB22

### Low Power 2 Port Hi-Speed USB 2.0 (480Mbps) Switch

#### General Description

FSUSB22 is a low power high bandwidth switch specially designed for applications of the switching of high speed USB 2.0 signals in handset and consumer applications such as cell phone, digital camera, and notebook with hubs or controllers of limited USB I/O. The wide bandwidth (750MHz) of this switch allows signals to pass with minimum edge and phase distortion. Superior channel-to-channel crosstalk results in minimal interference. It is compatible with USB2.0 Hi-Speed standard.

#### Features

- -40dB OFF Isolation at 250MHz
- -40dB non-adjacent channel crosstalk at 250MHz
- 4.5Ω typical On Resistance ( $R_{ON}$ )
- -3dB bandwidth: 750MHz
- Low power consumption (1uA max)
- Control input: TTL compatible
- Bidirectional operation
- USB Hi-Speed and Full Speed signaling capability

#### Applications

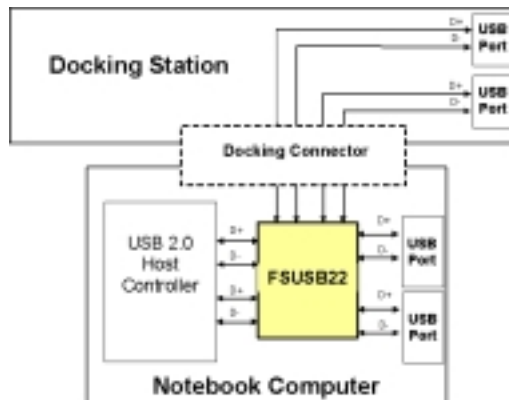
- Cell phone, PDA, digital camera, and notebook

#### Ordering Code:

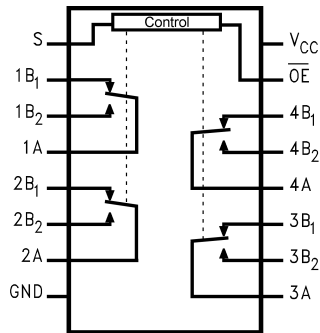
| Order Number            | Package Number | Package Description   |
|-------------------------|----------------|---|
| FSUSB22BQX              | MLP016E        | 16-Terminal Depopulated Quad Very-Thin Flat Pack No Leads (DQFN), JEDEC MO-241, 2.5 x 3.5mm |
| FSUSB22QSC              | MQA16          | 16-Lead Quarter Size Outline Package (QSOP), JEDEC MO-137, 0.150" Wide                      |
| FSUSB22QSCX_NL (Note 1) | MQA16          | Pb-Free 16-Lead Quarter Size Outline Package (QSOP), JEDEC MO-137, 0.150" Wide              |
| FSUSB22MTC              | MTC16          | 16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide                 |
| FSUSB22MTCX_NL (Note 1) | MTC16          | Pb-Free 16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide         |

Devices also available in Tape and Reel. Specify by appending suffix letter "X" to the ordering code.  
Pb-Free package per JEDEC J-STD-020B.

**Note 1:** "\_NL" indicates Pb-Free package (per JEDEC J-STD-020B). Device available in Tape and Reel only.

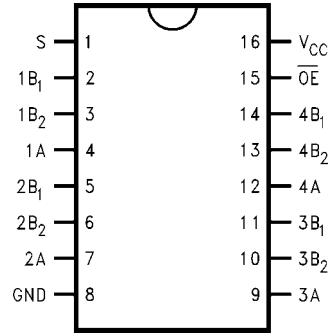


### Analog Symbol



### Connection Diagrams

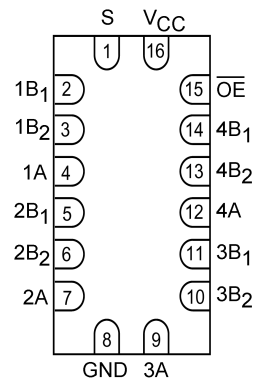
Pin Assignments for QSOP and TSSOP



### Pin Descriptions

| Pin Name                       | Description       |
|--------------------------------|-------------------|
| $\overline{OE}$                | Bus Switch Enable |
| S                              | Select Input      |
| A                              | Bus A             |
| B <sub>1</sub> -B <sub>2</sub> | Bus B             |

Pad Assignments for DQFN



### Truth Table

| s | $\overline{OE}$ | Function           |
|---|-----------------|--------------------|
| X | H               | Disconnect         |
| L | L               | A = B <sub>1</sub> |
| H | L               | A = B <sub>2</sub> |

**Absolute Maximum Ratings**(Note 2)

|   |                           |
|---|---------------------------|
| Supply Voltage ( $V_{CC}$ )                       | -0.5V to +4.6V            |
| DC Switch Voltage ( $V_S$ )                       | -0.5V to $V_{CC} + 0.05V$ |
| DC Input Voltage ( $V_{IN}$ ) (Note 3)            | -0.5V to +4.6V            |
| DC Input Diode Current ( $I_{IK}$ ) $V_{IN} < 0V$ | -50 mA                    |
| DC Output ( $I_{OUT}$ ) Sink Current              | 128 mA                    |
| DC $V_{CC}/GND$ Current ( $I_{CC}/I_{GND}$ )      | $\pm 100$ mA              |
| Storage Temperature Range ( $T_{STG}$ )           | -65°C to +150 °C          |
| ESD Human Body Model                              | 4kV                       |

**Recommended Operating Conditions** (Note 4)

|  |                  |
|--|------------------|
| Power Supply Operating ( $V_{CC}$ )      | 3.0V to 3.6V     |
| Input Voltage ( $V_{IN}$ )               | 0V to $V_{CC}$   |
| Output Voltage ( $V_{OUT}$ )             | 0V to $V_{CC}$   |
| Input Rise and Fall Time ( $t_r, t_f$ )  |                  |
| Switch Control Input                     | 0 ns/V to 5 ns/V |
| Switch I/O                               | 0 ns/V to DC     |
| Free Air Operating Temperature ( $T_A$ ) | -40 °C to +85 °C |

**Note 2:** 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 rating. The Recommended Operating Conditions tables will define the conditions for actual device operation.

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

**Note 4:** Unused control inputs must be held HIGH or LOW. They may not float.

**DC Electrical Characteristics**

| Symbol          | Parameter                        | $V_{CC}$<br>(V) | $T_A = -40\text{ }^\circ\text{C to } +85\text{ }^\circ\text{C}$ |                 |           | Units         | Conditions  |
|-----------------|----------------------------------|-----------------|---|-----------------|-----------|---------------|---|
|                 |                                  |                 | Min   | Typ<br>(Note 5) | Max       |               |   |
| $V_{IK}$        | Clamp Diode Voltage              | 3.0             |   |                 | -1.2      | V             | $I_{IN} = -18\text{ mA}$                                  |
| $V_{IH}$        | HIGH Level Input Voltage         | 3.0 - 3.6       | 2.0   |                 |           | V             |   |
| $V_{IL}$        | LOW Level Input Voltage          | 3.0 - 3.6       |   |                 | 0.8       | V             |   |
| $I_I$           | Input Leakage Current            | 3.6             |   |                 | $\pm 1.0$ | $\mu\text{A}$ | $0 \leq V_{IN} \leq 3.6V$                                 |
| $I_{OFF}$       | OFF-STATE Leakage Current        | 3.6             |   |                 | $\pm 1.0$ | $\mu\text{A}$ | $0 \leq A, B \leq V_{CC}$                                 |
| $R_{ON}$        | Switch On Resistance<br>(Note 6) | 3.0             |   | 5.0             | 7.0       | $\Omega$      | $V_{IN} = 0.8V$<br>$I_{ON} = 8\text{ mA}$                 |
|                 |                                  | 3.0             |   | 4.5             | 6.5       | $\Omega$      | $V_{IN} = 3.0V$<br>$I_{ON} = 8\text{ mA}$                 |
| $\Delta R_{ON}$ | Delta $R_{ON}$                   | 3.0             |   | 0.3             |           | $\Omega$      | $V_{IN} = 0.8V, V_{IN} = 0V - 1.5V, I_{ON} = 8\text{ mA}$ |
| $R_{FLAT(ON)}$  | On Resistance Flatness (Note 7)  | 3.0             |   | 1.0             |           | $\Omega$      | $I_{OUT} = 8\text{ mA}$                                   |
| $I_{CC}$        | Quiescent Supply Current         | 3.6             |   |                 | 1.0       | $\mu\text{A}$ | $V_{IN} = V_{CC}$ or GND, $I_{OUT} = 0$                   |

**Note 5:** Typical values are at  $V_{CC} = 3.0V$  and  $T_A = +25^\circ\text{C}$

**Note 6:** Measured by the voltage drop between A and B pins at the indicated current through the switch. On Resistance is determined by the lower of the voltages on the two (A or B) pins.

**Note 7:** Flatness is defined as the difference between the maximum and minimum value On Resistance over the specified range of conditions.

### AC Electrical Characteristics

| Symbol            | Parameter                      | V <sub>CC</sub> (V) | T <sub>A</sub> = -40°C to +85°C |              |     | Units | Conditions                       | Figure Number |
|-------------------|--------------------------------|---------------------|---------------------------------|--------------|-----|-------|----------------------------------|---------------|
|                   |                                |                     | Min                             | Typ (Note 8) | Max |       |                                  |               |
| t <sub>ON</sub>   | Turn ON Time S-to-Bus B        | 3.0 to 3.6          |                                 | 4.5          | 6.0 | ns    |                                  | Figures 5, 6  |
| t <sub>OFF</sub>  | Turn OFF Time S-to-Bus B       | 3.0 to 3.6          |                                 | 2.5          | 4.0 | ns    |                                  | Figures 5, 6  |
| t <sub>PD</sub>   | Propagation Delay              | 3.0 to 3.6          |                                 | 0.25         |     | ns    | C <sub>L</sub> = 10 pF           | Figure 10     |
| O <sub>IRR</sub>  | Non-Adjacent OFF-Isolation     | 3.0 to 3.6          |                                 | -30.0        |     | dB    | f = 250MHz, R <sub>L</sub> = 50Ω | Figure 7      |
| X <sub>TALK</sub> | Non-Adjacent Channel Crosstalk | 3.0 to 3.6          |                                 | -38.0        |     | dB    | R <sub>L</sub> = 50Ω, f = 250MHz | Figure 8      |
| BW                | -3dB Bandwidth                 | 3.0 to 3.6          |                                 | 750          |     | MHz   | R <sub>L</sub> = 50Ω             | Figure 9      |

Note 8: Typical values are at V<sub>CC</sub> = 3.3V and T<sub>A</sub> = +25°C

### USB Related AC Electrical Characteristics (Note 9)

| Symbol             | Parameter                                      | V <sub>CC</sub> (V) | T <sub>A</sub> = -40°C to +85°C |       |     | Units | Conditions  | Figure Number  |
|--------------------|--|---------------------|---------------------------------|-------|-----|-------|---|----------------|
|                    |  |                     | Min                             | Typ   | Max |       |   |                |
| t <sub>SK(O)</sub> | Channel-to-Channel Skew                        | 3.0 to 3.6          |                                 | 0.051 |     | ns    | C <sub>L</sub> = 10 pF  | Figures 10, 11 |
| t <sub>SK(P)</sub> | Skew of Opposite Transition of the Same Output | 3.0 to 3.6          |                                 | 0.020 |     | ns    | C <sub>L</sub> = 10 pF  | Figures 10, 11 |
| T <sub>J</sub>     | Total Jitter                                   | 3.0 to 3.6          |                                 | 0.210 |     | ns    | R <sub>L</sub> = 50Ω, C <sub>L</sub> = 10 pF<br>t <sub>R</sub> = t <sub>F</sub> = 750ps at 480 Mbps |                |

Note 9: Typical values are at V<sub>CC</sub> = 3.3V and T<sub>A</sub> = +25°C

### Capacitance (Note 10)

| Symbol           | Parameter                     | V <sub>CC</sub> (V) | T <sub>A</sub> = -40°C to +85°C |      | Units | Conditions                      |
|------------------|-------------------------------|---------------------|---------------------------------|------|-------|---------------------------------|
|                  |                               |                     | Min                             | Typ  |       |                                 |
| C <sub>IN</sub>  | Control Pin Input Capacitance |                     |                                 | 2.5  | pF    | V <sub>CC</sub> = 0V            |
| C <sub>ON</sub>  | A/B ON Capacitance            |                     |                                 | 12.0 | pF    | V <sub>CC</sub> = 3.3V, OE = 0V |
| C <sub>OFF</sub> | Port B OFF Capacitance        |                     |                                 | 4.5  | pF    | V <sub>CC</sub> and OE = 3.3V   |

Note 10: Typical values are at V<sub>CC</sub> = 3.3V and T<sub>A</sub> = +25°C

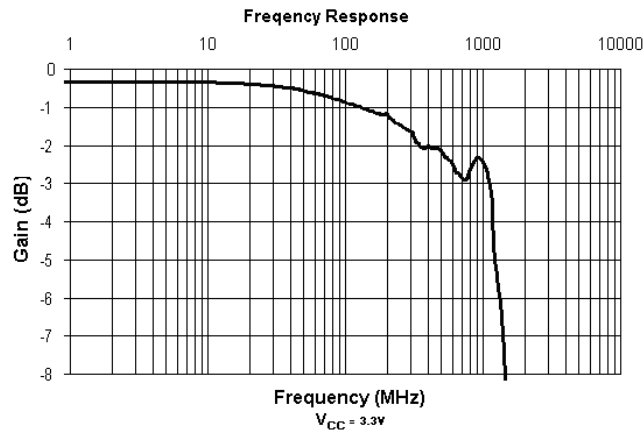


FIGURE 1. Gain vs. Frequency

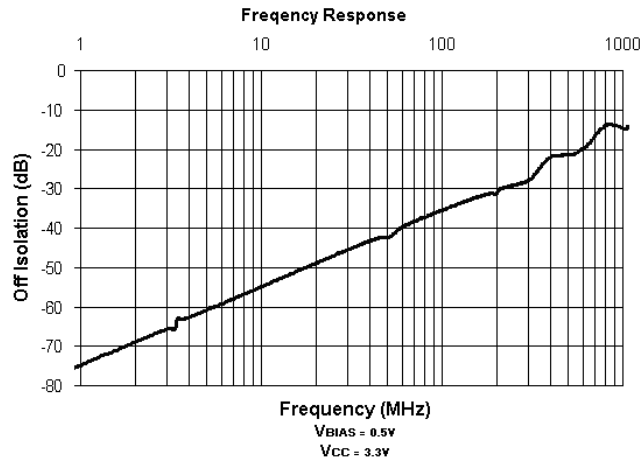


FIGURE 2. OFF Isolation

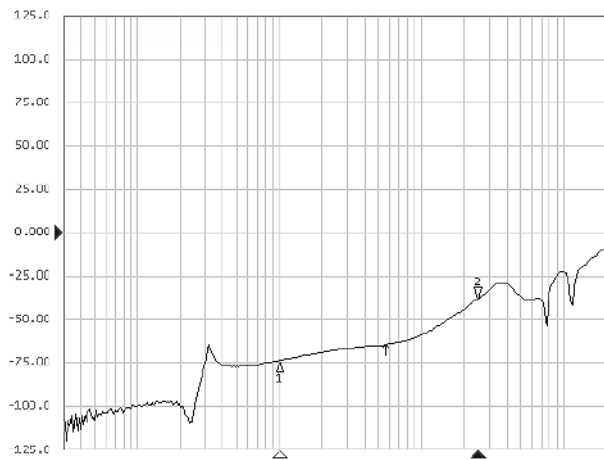


FIGURE 3. Crosstalk

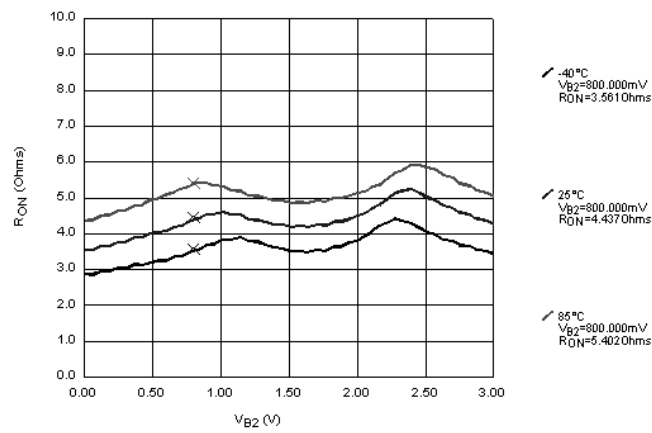
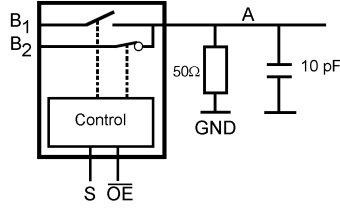


FIGURE 4. RON

## AC Loading and Waveforms



**Note:** Input driven by 50Ω source terminated in 50Ω  
**Note:** C<sub>L</sub> includes load and stray capacitance  
**Note:** Input PRR = 1.0 MHz, t<sub>W</sub> = 500 ns

FIGURE 5. AC Test Circuit

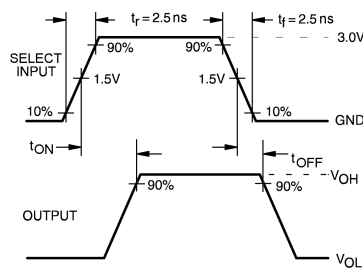


FIGURE 6. AC Waveforms

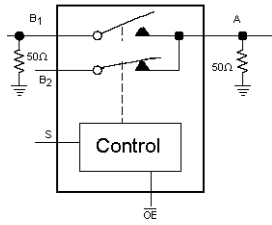


FIGURE 7. OFF Isolation Test

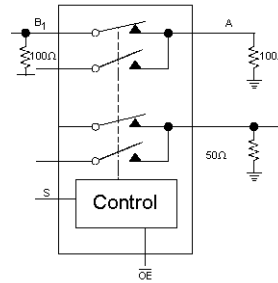


FIGURE 8. Crosstalk Test

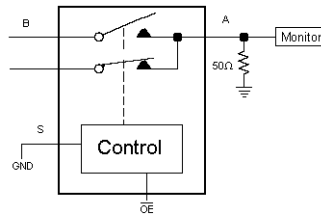


FIGURE 9. Bandwidth Test

AC Loading and Waveforms (Continued)

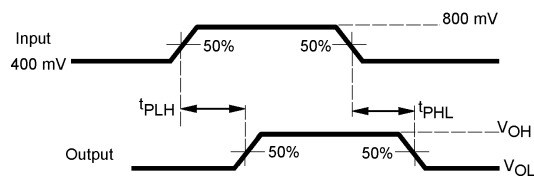
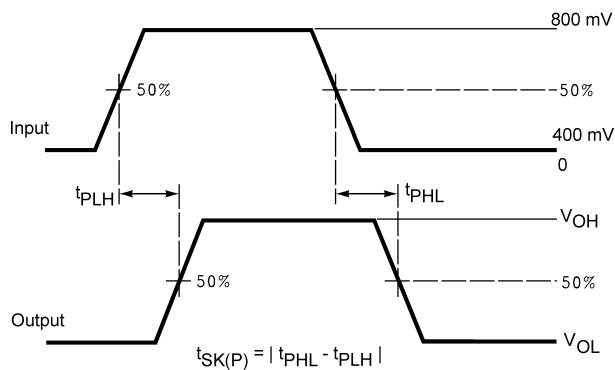
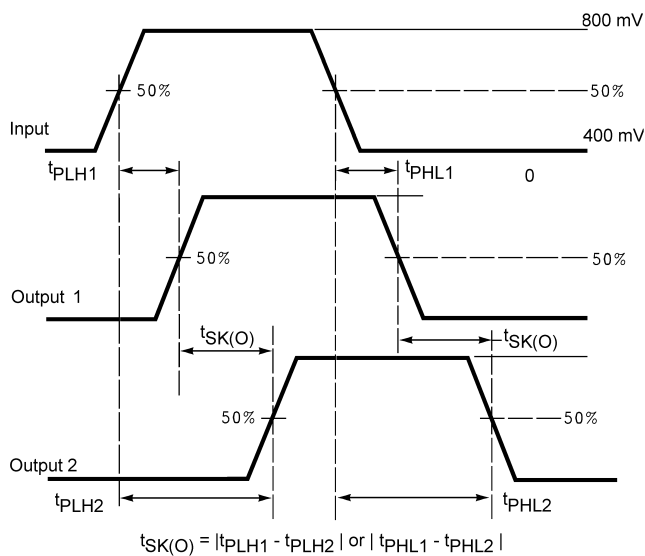


FIGURE 10. Propagation Delay



Pulse Skew  $t_{SK(P)}$



Output Skew  $t_{SK(O)}$

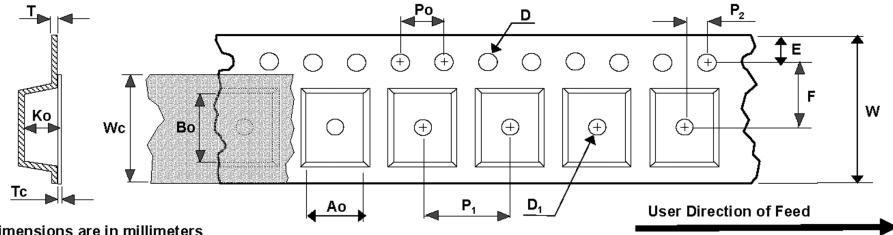
FIGURE 11. Skew Test

## Tape and Reel Specification

### Tape Format for DQFN

| Package Designator | Tape Section       | Number Cavities | Cavity Status | Cover Tape Status |
|--------------------|--------------------|-----------------|---------------|-------------------|
| BQX                | Leader (Start End) | 125 (typ)       | Empty         | Sealed            |
|                    | Carrier            | 2500/3000       | Filled        | Sealed            |
|                    | Trailer (Hub End)  | 75 (typ)        | Empty         | Sealed            |

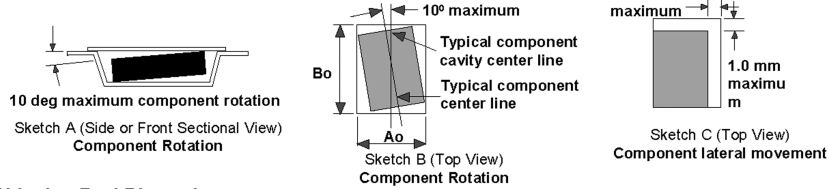
### TAPE DIMENSIONS inches (millimeters)



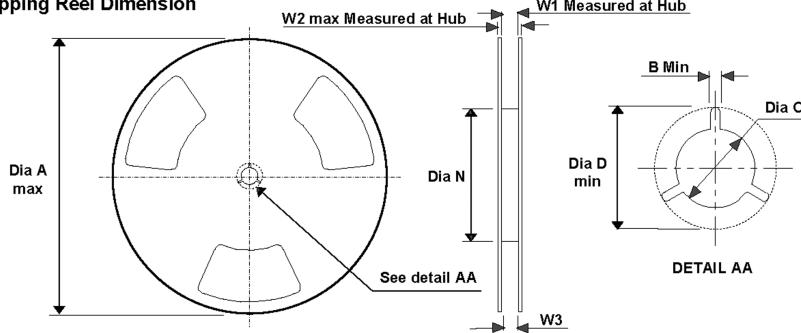
Dimensions are in millimeters

| Package | Ao      | Bo      | D       | D <sub>1</sub> | E      | F      | Ko     | P <sub>1</sub> | P <sub>0</sub> | P <sub>2</sub> | T   | Tc       | W      | Wc   |
|---------|---------|---------|---------|----------------|--------|--------|--------|----------------|----------------|----------------|-----|----------|--------|------|
|         | +/-0.10 | +/-0.10 | +/-0.05 | min.           | +/-0.1 | +/-0.1 | +/-0.1 | TYP            | TYP            | +/-0.05        | TYP | +/-0.005 | +/-0.3 | TYP  |
| 2 x 2   | 2.30    | 2.30    | 1.55    | 1.0            | 1.75   | 3.5    | 1.0    | 8              | 4              | 2.0            | 0.3 | 0.07     | 8      | 5.3  |
| 2.5x2.5 | 2.80    | 2.80    | 1.55    | 1.5            | 1.75   | 5.5    | 0.9    | 8              | 4              | 2.0            | 0.3 | 0.07     | 12     | 9.3  |
| 2.5x3.0 | 2.80    | 3.30    | 1.55    | 1.5            | 1.75   | 5.5    | 0.9    | 8              | 4              | 2.0            | 0.3 | 0.07     | 12     | 9.3  |
| 2.5x3.5 | 2.80    | 3.80    | 1.55    | 1.5            | 1.75   | 5.5    | 0.9    | 8              | 4              | 2.0            | 0.3 | 0.07     | 12     | 9.3  |
| 2.5x4.5 | 2.80    | 4.80    | 1.55    | 1.5            | 1.75   | 5.5    | 0.9    | 8              | 4              | 2.0            | 0.3 | 0.07     | 12     | 9.3  |
| 3.5x4.5 | 3.80    | 4.80    | 1.55    | 1.5            | 1.75   | 5.5    | 0.9    | 8              | 4              | 2.0            | 0.3 | 0.07     | 12     | 9.3  |
| 2.5x3.0 | 2.80    | 3.30    | 1.55    | 1.5            | 1.75   | 5.5    | 0.9    | 8              | 4              | 2.0            | 0.3 | 0.07     | 12     | 9.3  |
| 4 x 4   | 4.35    | 4.35    | 1.55    | 1.5            | 1.75   | 5.5    | 1.1    | 8              | 4              | 2.0            | 0.3 | 0.07     | 12     | 9.3  |
| 5 x 5   | 5.35    | 5.35    | 1.55    | 1.5            | 1.75   | 5.5    | 1.1    | 8              | 4              | 2.0            | 0.3 | 0.07     | 12     | 9.3  |
| 6 x 6   | 6.30    | 6.30    | 1.55    | 1.5            | 1.75   | 7.5    | 1.1    | 12             | 4              | 2.0            | 0.3 | 0.07     | 16     | 13.3 |

Notes: Ao, Bo, and Ko dimensions are determined with respect to the EIA /Jedec RS-481 rotational and lateral movement requirements (see sketches A, B, and C).



### Shipping Reel Dimension

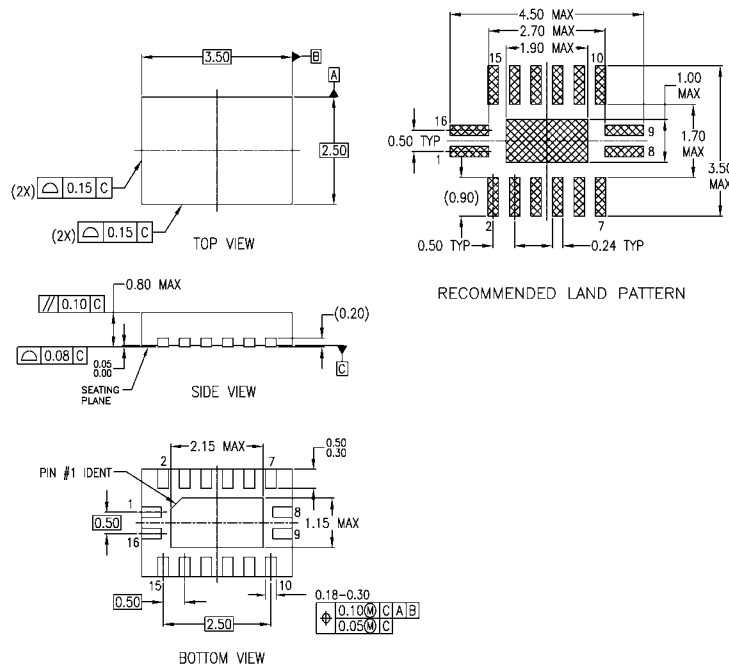


Dimensions are in millimeters

| Tape Width | Dia A max | Dim B min | Dia C +/- .2 | Dia D min | Dia N min | Dim W1 +2/-0 | Dim W2 max | Dim W3 (LSL - USL) |
|------------|-----------|-----------|--------------|-----------|-----------|--------------|------------|--------------------|
| 8          | 330       | 1.5       | 13           | 20.2      | 178       | 8.4          | 14.4       | 7.9~10.4           |
| 12         | 330       | 1.5       | 13           | 20.2      | 178       | 12.4         | 18.4       | 11.9~15.4          |
| 16         | 330       | 1.5       | 13           | 20.2      | 178       | 16.4         | 22.4       | 15.9~19.4          |



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



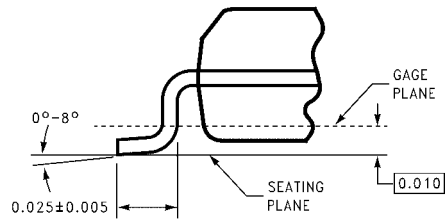
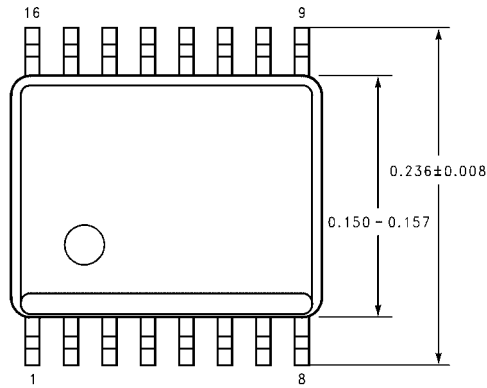
NOTES:

- A. CONFORMS TO JEDEC REGISTRATION MO-241, VARIATION AB
- B. DIMENSIONS ARE IN MILLIMETERS.
- C. DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994

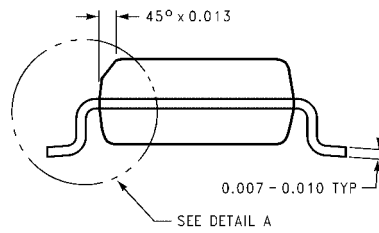
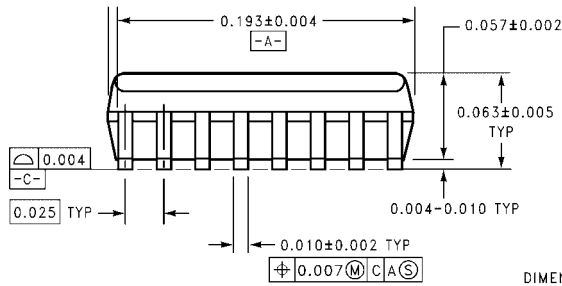
MLP016ErevA

**16-Terminal Depopulated Quad Very-Thin Flat Pack No Leads (DQFN), JEDEC MO-241, 2.5 x 3.5mm Package Number MLP016E**

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



DETAIL A  
TYPICAL, SCALE: 40%

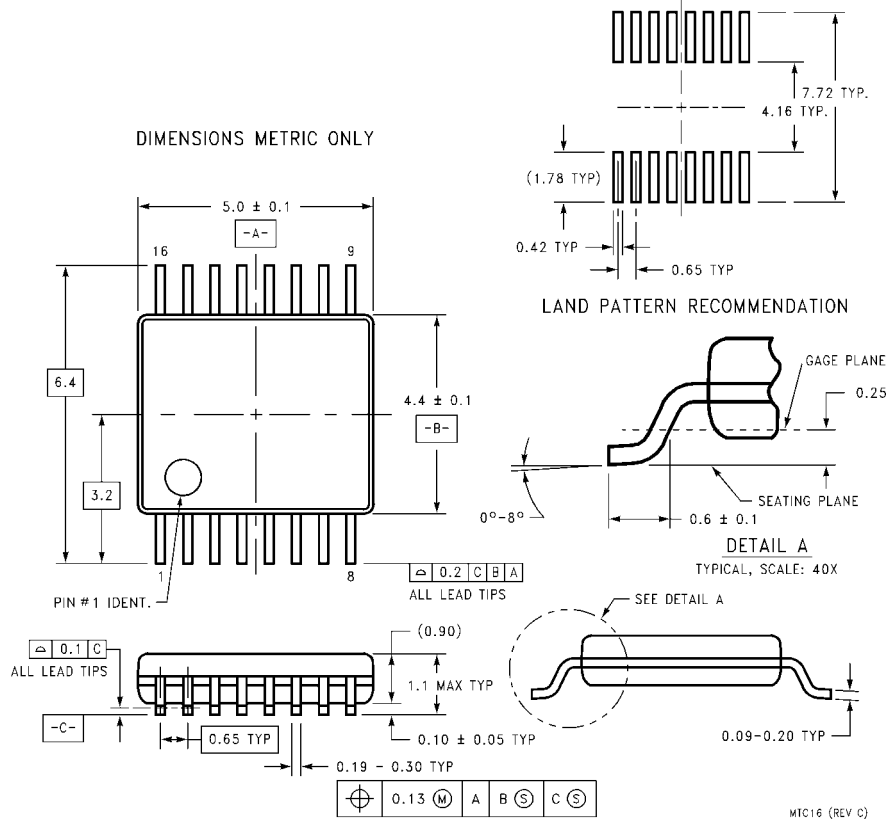


DIMENSIONS ARE IN INCHES

MQA16 (REV A)

**16-Lead Quarter Size Outline Package (QSOP), JEDEC MO-137, 0.150" Wide  
Package Number MQA16**

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



**16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide  
Package Number MTC16**

**Technology Description**

The Fairchild Switch family derives from and embodies Fairchild's proven switch technology used for several years in its 74LVX3L384 (FST3384) bus switch product.

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