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## FSUSB22 — Low-Power, 2-Port, High-Speed USB 2.0 (480Mbps) Switch

### Features

- -40dB Off Isolation at 250MHz
- -40dB Non-adjacent Channel Crosstalk at 250MHz
- On Resistance: 4.5Ω Typical ( $R_{ON}$ )
- -3dB Bandwidth: 750MHz
- Low-Power Consumption: 1μA Maximum
- Control Input: TTL Compatible
- Bi-directional Operation
- USB High-Speed and Full-Speed Signaling Capability

### Description

FSUSB22 is a low-power, high-bandwidth switch specially designed for applications switching 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) allows signals to pass with minimum edge and phase distortion. Superior channel-to-channel crosstalk results in minimal interference. It is compatible with the USB2.0 Hi-Speed standard.

### Applications

- Cell Phones, PDAs, Digital Cameras, Notebook Computers

### Ordering Information

| Part Number | Operating Temperature Range | Package   | Packing Method |
|-------------|-----------------------------|---|----------------|
| FSUSB22BQX  | -40 to +85°C                | 16-Terminal Depopulated Quad Very-Thin Flat Pack No Leads (DQFN), JEDEC MO-241, 2.5 x 3.5mm | Tape and Reel  |
| FSUSB22QSC  | -40 to +85°C                | 16-Lead Quarter Size Outline Package (QSOP), JEDEC MO-137, 0.150-inch Wide                  | Tube           |
| FSUSB22QSCX | -40 to +85°C                | 16-Lead Quarter Size Outline Package (QSOP), JEDEC MO-137, 0.150-inch Wide                  | Tape and Reel  |
| FSUSB22MTC  | -40 to +85°C                | 16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide                 | Tube           |
| FSUSB22MTCX | -40 to +85°C                | 16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide                 | Tape and Reel  |

All packages are lead free per JEDEC: J-STD-020B standard.

## Logic Diagram

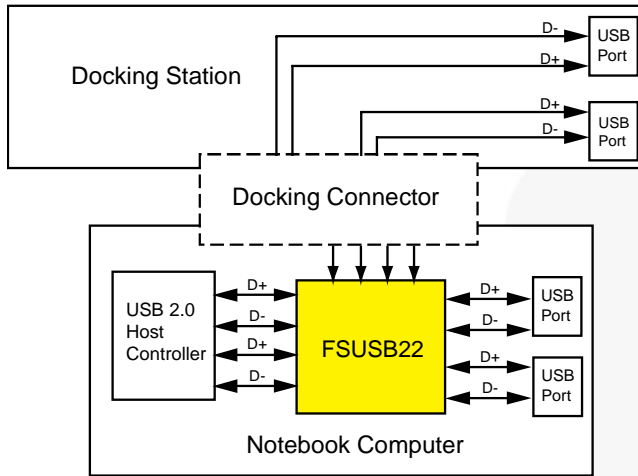


Figure 1. Logic Diagram

## Analog Symbol

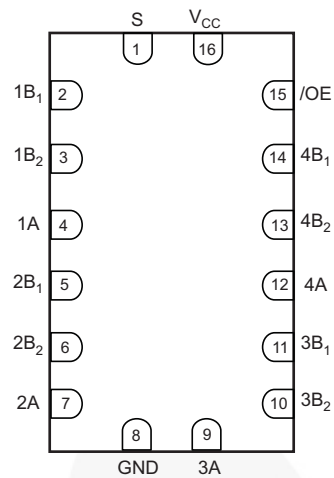


Figure 2. Analog Symbol

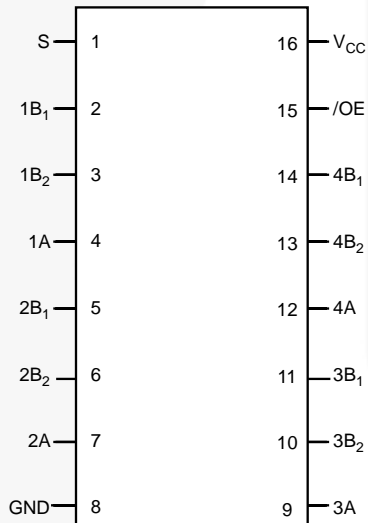


Figure 3. QSOP and TSSOP Pin Configuration

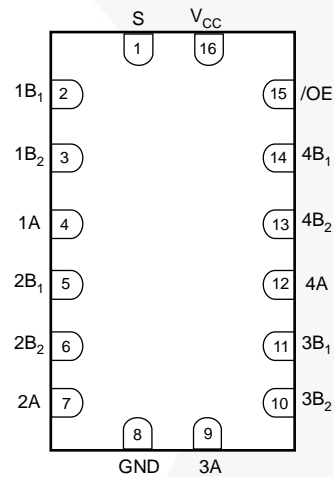


Figure 4. Pad Assignment for DQFN

## Pin Descriptions

| Pin #               | Pin Names   | Description       |
|---------------------|---|-------------------|
| 1                   | S   | Select Input      |
| 2,3,5,6,10,11,13,14 | 1B <sub>1</sub> ,1B <sub>2</sub> , 2B <sub>1</sub> ,2B <sub>2</sub> ,3B <sub>2</sub> ,3B <sub>1</sub> ,4B <sub>2</sub> ,4B <sub>1</sub> | Bus B             |
| 8                   | GND   | Ground            |
| 4,7,9,12            | 1A,2A,3A,4A   | Bus A             |
| 15                  | /OE   | Bus Switch Enable |
| 16                  | V <sub>CC</sub>   | Supply Voltage    |

## Truth Table

| S          | OE   | Function         |
|------------|------|------------------|
| Don't Care | HIGH | Disconnect       |
| LOW        | LOW  | A=B <sub>1</sub> |
| HIGH       | LOW  | A=B <sub>2</sub> |

## Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

| Symbol             | Parameter                             | Min. | Max.            | Unit |
|--------------------|---------------------------------------|------|-----------------|------|
| $V_{CC}$           | Supply Voltage                        | -0.5 | 4.6             | V    |
| $V_S$              | DC Switch Voltage                     | -0.5 | $V_{CC} + 0.05$ | V    |
| $V_{IN}$           | DC Input Voltage <sup>(1)</sup>       | -0.5 | 4.6             | V    |
| $I_{IK}$           | DC Input Diode Current, $V_{IN} < 0V$ |      | -50             | mA   |
| $I_{OUT}$          | DC Output Sink Current                |      | 128             | mA   |
| $I_{CC} / I_{GND}$ | DC $V_{CC}$ / GND Current             |      | $\pm 100$       | mA   |
| $T_{STG}$          | Storage Temperature Range             | -65  | +150            | °C   |
| ESD                | Human Body Model, JESD22-A114         |      | 4               | kV   |

**Note:**

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

## Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to Absolute Maximum Ratings.

| Symbol     | Parameter                       |                                     | Min. | Max.     | Unit |
|------------|---------------------------------|-------------------------------------|------|----------|------|
| $V_{CC}$   | Power Supply Operating          |                                     | 3.0  | 3.6      | V    |
| $V_{IN}$   | Input Voltage                   |                                     | 0    | $V_{CC}$ | V    |
| $V_{OUT}$  | Output Voltage                  |                                     | 0    | $V_{CC}$ | V    |
| $t_r, t_f$ | Input Rise and Fall Time        | Switch Control Input <sup>(2)</sup> | 0    | 5        | ns/V |
|            |                                 | Switch I/O                          | 0    | DC       |      |
| $T_A$      | Operating Temperature, Free Air |                                     | -40  | +85      | °C   |

**Note:**

2. Unused control inputs must be held HIGH or LOW. They may not float.

## DC Electrical Characteristics

Typical values are at  $V_{CC} = 3.0V$  and  $T_A = 25^\circ C$ .

| Symbol          | Parameter                             | Conditions                                       | $V_{CC}$ (V) | $T_A = -40$ to $+85^\circ C$ |      |           | Units    |
|-----------------|---------------------------------------|--|--------------|------------------------------|------|-----------|----------|
|                 |                                       |  |              | Min.                         | Typ. | Max.      |          |
| $V_{IK}$        | Clamp Diode Voltage                   | $I_{IN} = -18mA$                                 | 3.0          |                              |      | -1.2      | V        |
| $V_{IH}$        | High-Level Input Voltage              |  | 3.0 to 3.6   | 2.0                          |      |           | V        |
| $V_{IL}$        | Low-Level Input Voltage               |  | 3.0 to 3.6   |                              |      | 0.8       | V        |
| $I_{IN}$        | Input Leakage Current                 | $0 \leq V_{IN} \leq 3.6V$                        | 3.6          |                              |      | $\pm 1.0$ | $\mu A$  |
| $I_{OFF}$       | Off-state Leakage Current             | $0 \leq A, B \leq V_{CC}$                        | 3.6          |                              |      | $\pm 1.0$ | $\mu A$  |
| $R_{ON}$        | Switch On Resistance <sup>(3)</sup>   | $V_{IN} = 0.8V, I_{ON} = 8mA$                    | 3.0          |                              | 5    | 7         | $\Omega$ |
|                 |                                       | $V_{IN} = 3.0V, I_{ON} = 8mA$                    | 3.0          |                              | 4.5  | 6.5       |          |
| $\Delta R_{ON}$ | Delta $R_{ON}$                        | $V_{IN} = 0.8V, V_{IN} = 0V - 1.5, I_{ON} = 8mA$ | 3.0          |                              | 0.3  |           | $\Omega$ |
| $R_{FLAT(ON)}$  | On Resistance Flatness <sup>(4)</sup> | $I_{OUT} = 8mA$                                  | 3.0          |                              | 1    |           | $\Omega$ |
| $I_{CC}$        | Quiescent Supply Current              | $V_{IN} = V_{CC}$ or GND,<br>$I_{OUT} = 0$       | 3.6          |                              |      | 1         | $\mu A$  |

### Notes:

- Measured by the voltage drop between the A and B pins at the indicated current through the switch. On resistance is determined by the lower of the voltages on the A or B pins.
- Flatness is defines as the difference between the maximum and the minimum value on resistance over the specified range of conditions.

## AC Electrical Characteristics

Typical values are at  $V_{CC} = 3.0V$  and  $T_A = 25^\circ C$ .

| Symbol     | Parameter                         | Conditions                         | $V_{CC}(V)$ | Min. | Typ. | Max. | Units | Figure                |
|------------|-----------------------------------|------------------------------------|-------------|------|------|------|-------|-----------------------|
| $t_{ON}$   | Turn-on Time<br>S-to-Bus B        |                                    | 3.0 to 3.6  |      | 4.5  | 6.0  | ns    | Figure 9<br>Figure 10 |
| $t_{OFF}$  | Turn-off Time<br>S-to-Bus B       |                                    | 3.0 to 3.6  |      | 2.5  | 4.0  | ns    | Figure 9<br>Figure 10 |
| $t_{PD}$   | Propagation Delay                 | $C_L = 10pF$                       | 3.0 to 3.6  |      | 0.25 |      | ns    | Figure 14             |
| $O_{IRR}$  | Non-Adjacent Off<br>Isolation     | $f = 250MHz$ ,<br>$R_L = 50\Omega$ | 3.0 to 3.6  |      | -30  |      | dB    | Figure 11             |
| $X_{TALK}$ | Non-Adjacent<br>Channel Crosstalk | $f = 250MHz$ ,<br>$R_L = 50\Omega$ | 3.0 to 3.6  |      | -38  |      | dB    | Figure 12             |
| BW         | -3dB Bandwidth                    | $R_L = 50\Omega$                   | 3.0 to 3.6  |      | 750  |      | MHz   | Figure 13             |

## USB Related AC Electrical Characteristics

Typical values are at  $V_{CC} = 3.0V$  and  $T_A = 25^\circ C$ .

| Symbol      | Parameter  | Conditions   | $V_{CC} (V)$ | Min. | Typ.  | Max. | Units | Figure                 |
|-------------|--|--|--------------|------|-------|------|-------|------------------------|
| $t_{SK(O)}$ | Channel-to Channels<br>Skew                          | $C_L = 10pF$   | 3.0 to 3.6   |      | 0.051 |      | pF    | Figure 14<br>Figure 16 |
| $t_{SK(P)}$ | Skew of Opposite<br>Transition of the<br>Same Output | $C_L = 10pF$   | 3.0 to 3.6   |      | 0.020 |      | pF    | Figure 14<br>Figure 16 |
| $T_J$       | Total Jitter   | $R_L = 50\Omega$ ,<br>$C_L = 10pF$<br>$t_R = t_F = 750ps$<br>at 480MPs | 3.0 to 3.6   |      | 0.210 |      |       |                        |

## Capacitance

Typical values are at  $V_{CC} = 3.0V$  and  $T_A = 25^\circ C$ .

| Symbol    | Parameter                     | Conditions                   | Typ. | Units |
|-----------|-------------------------------|------------------------------|------|-------|
| $C_{IN}$  | Control Pin Input Capacitance | $V_{CC} = 0V$                | 2.5  | pF    |
| $C_{ON}$  | A/B On Capacitance            | $V_{CC} = 3.3V$ , $/OE = 0V$ | 12   | pF    |
| $C_{OFF}$ | Port B Off Capacitance        | $V_{CC}$ and $/OE = 3.3V$    | 4.5  | pF    |

## Performance Characteristics

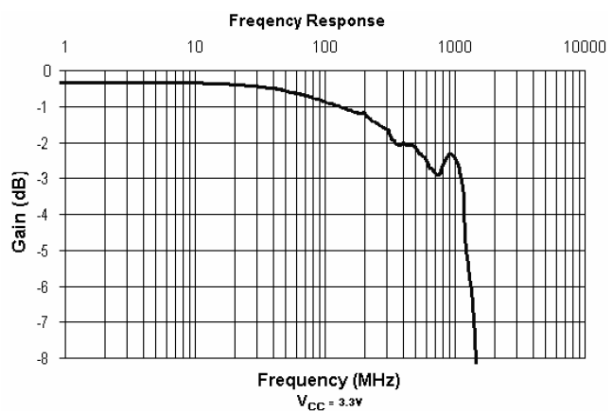


Figure 5. Gain vs. Frequency

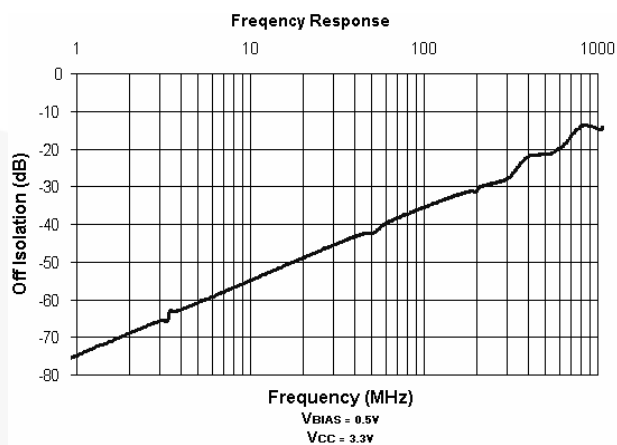


Figure 6. Off Isolation

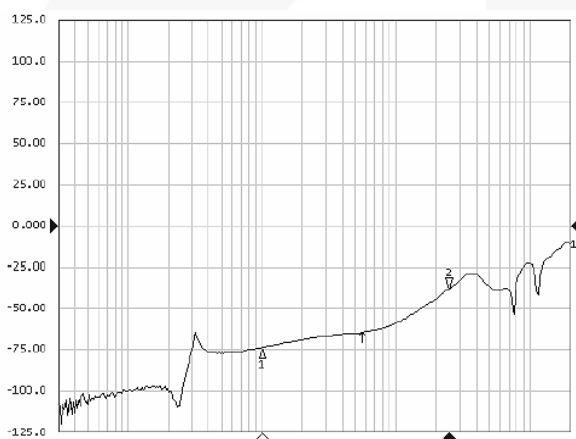


Figure 7. Crosstalk

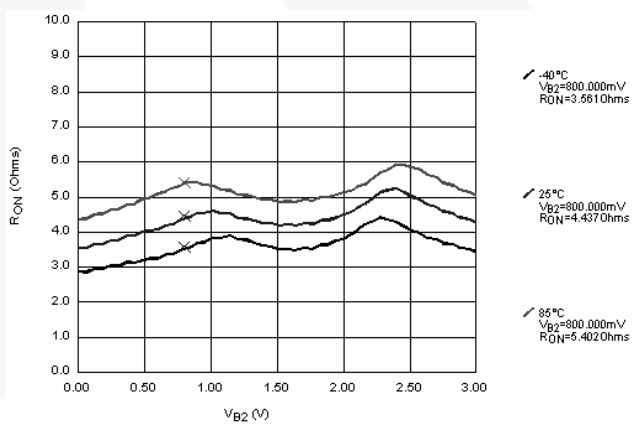
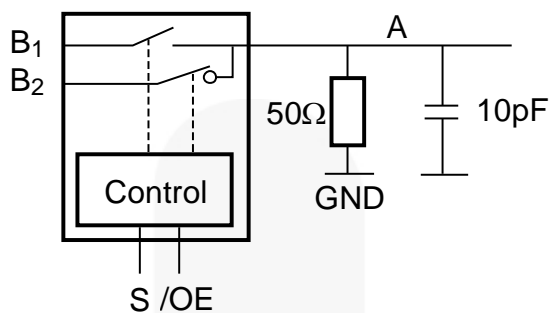


Figure 8.  $R_{ON}$

## AC Loadings and Waveforms



Notes: Input driven by 50Ω source terminated in 50Ω.  
CL includes load and stray capacitance.  
Input PRR-1.0MHz,  $t_w = 500\text{ns}$ .

Figure 9. AC Test Circuit

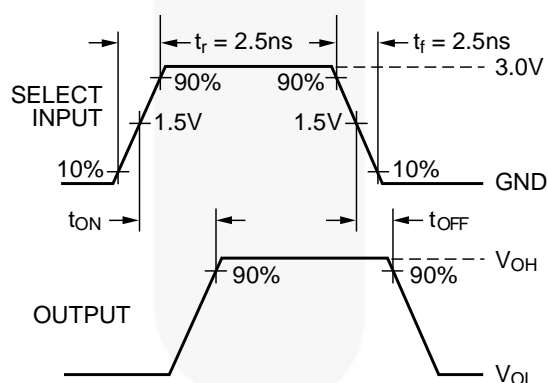


Figure 10. AC Waveforms

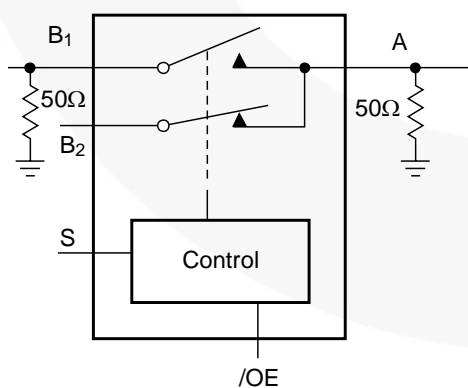


Figure 11. Off Isolation Test

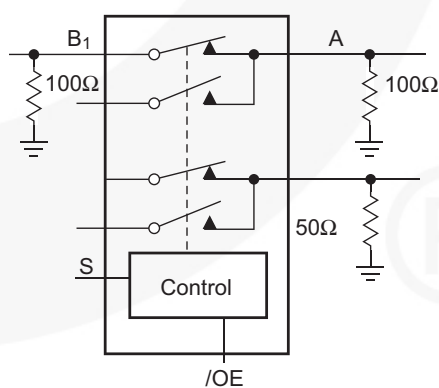


Figure 12. Crosstalk Test



## AC Loadings and Waveforms

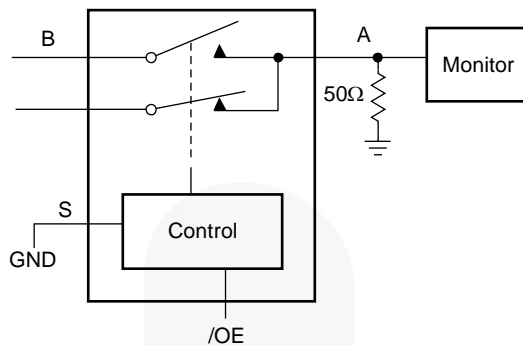


Figure 13. Bandwidth Test

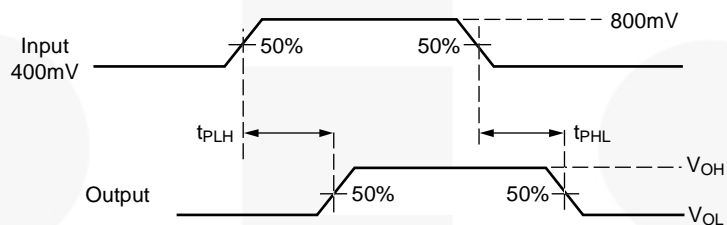


Figure 14. Propagation Delay

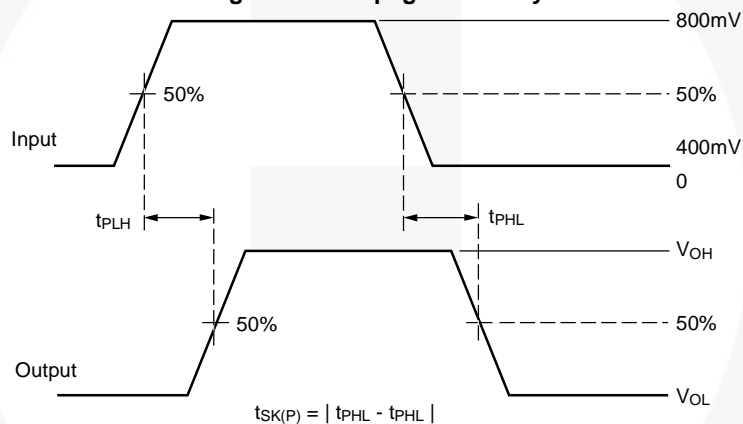


Figure 15. Pulse Skew  $t_{SP(P)}$

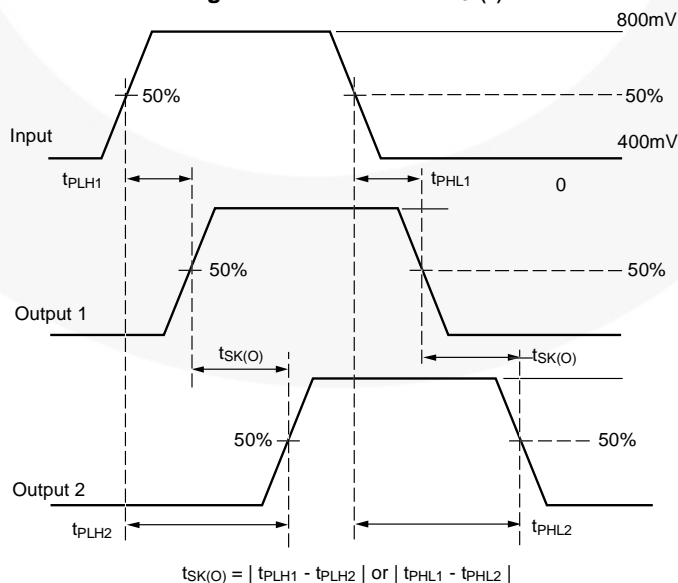
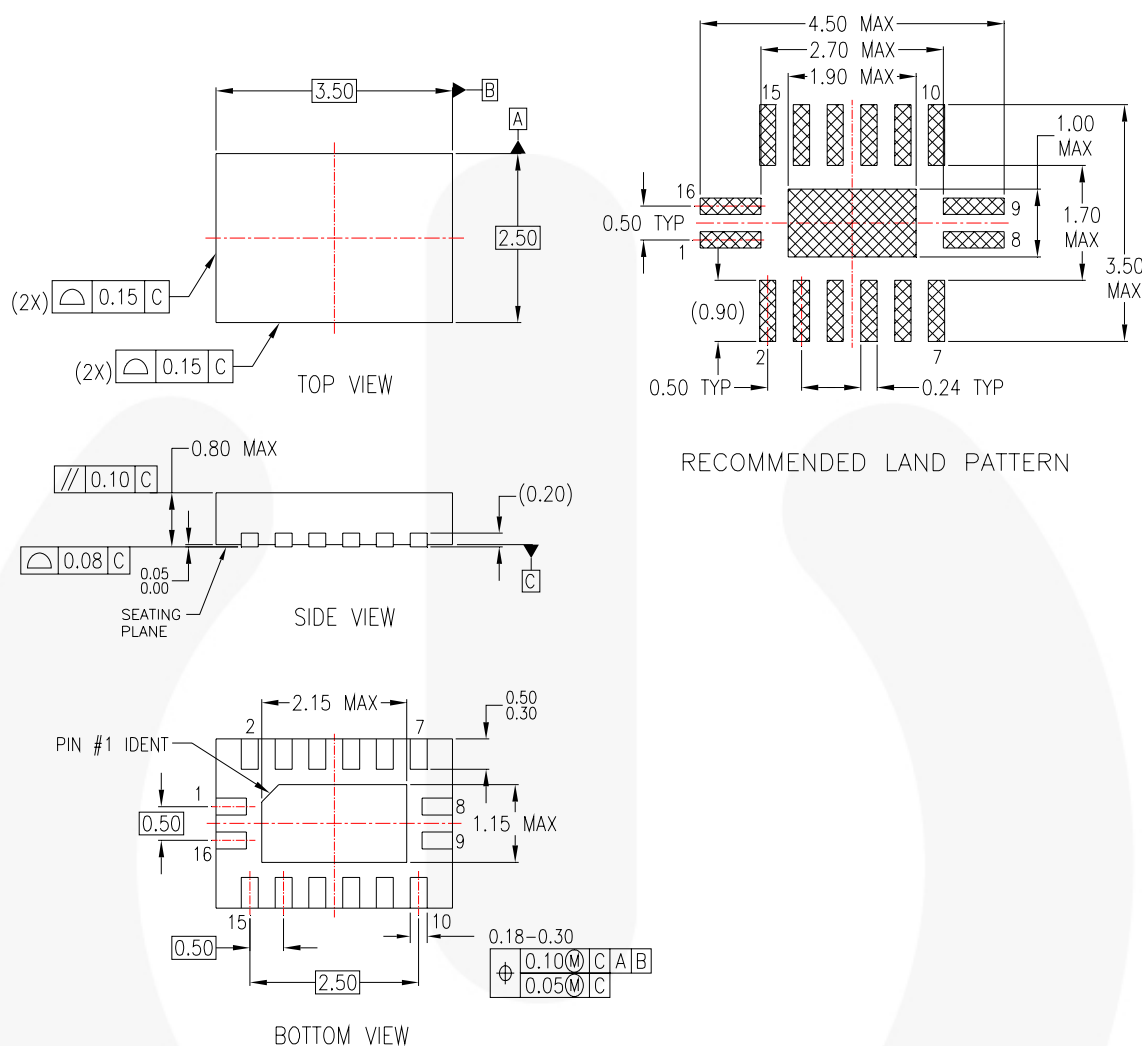


Figure 16. Output Skew  $t_{SK(O)}$

## Physical Dimensions



NOTES:

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

MLP16ErevA

**Figure 17. 16-Terminal Depopulated Quad Very-Thin Flat Pack No Leads (DQFN), JEDEC MO-241, 2.5 x 3.5mm**

**[Note: click here for tape and reel specifications, available at:](#)**

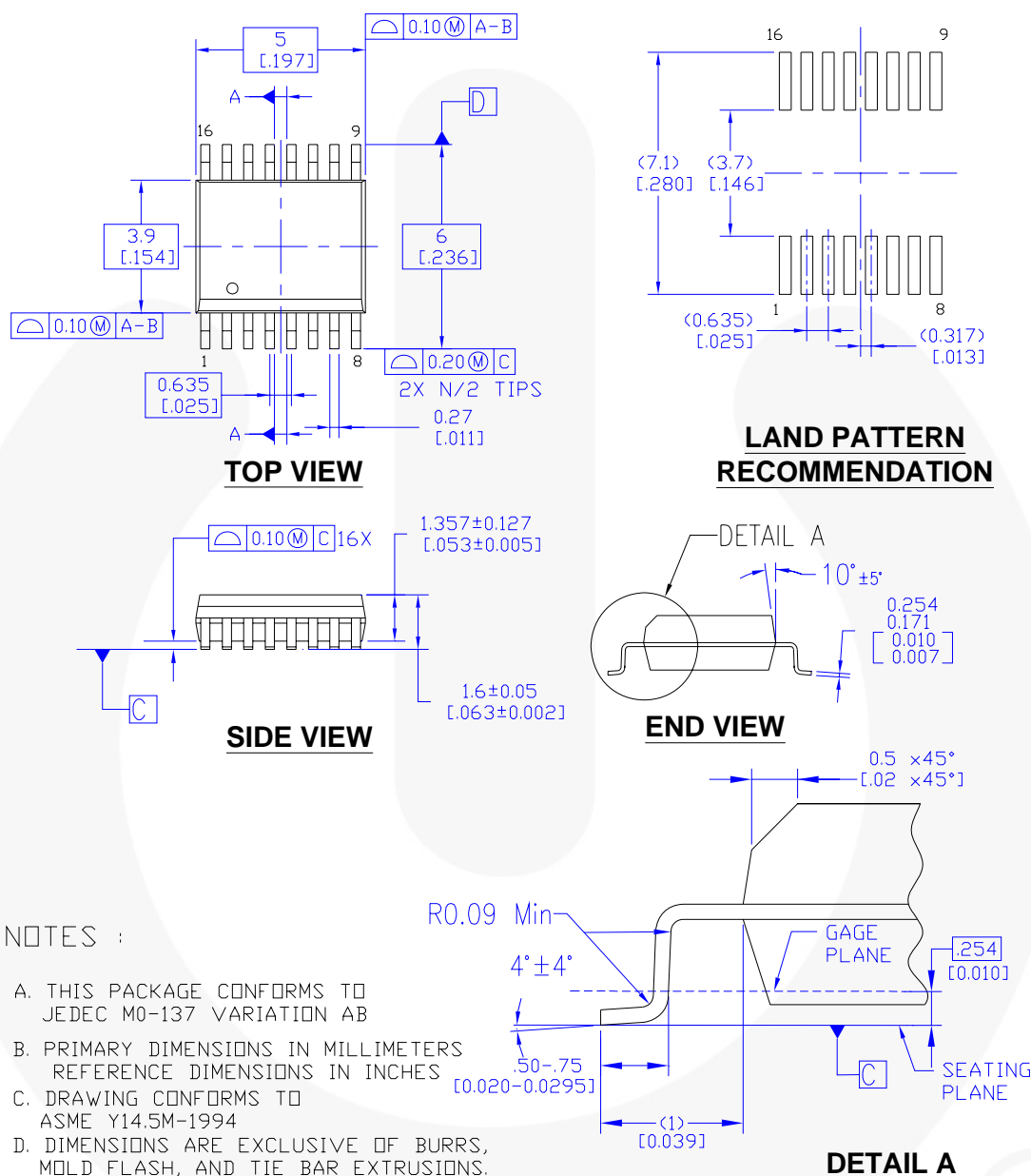
[http://www.fairchildsemi.com/products/analog/pdf/MLP16\\_25x35\\_TNR.pdf](http://www.fairchildsemi.com/products/analog/pdf/MLP16_25x35_TNR.pdf)

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## Physical Dimensions



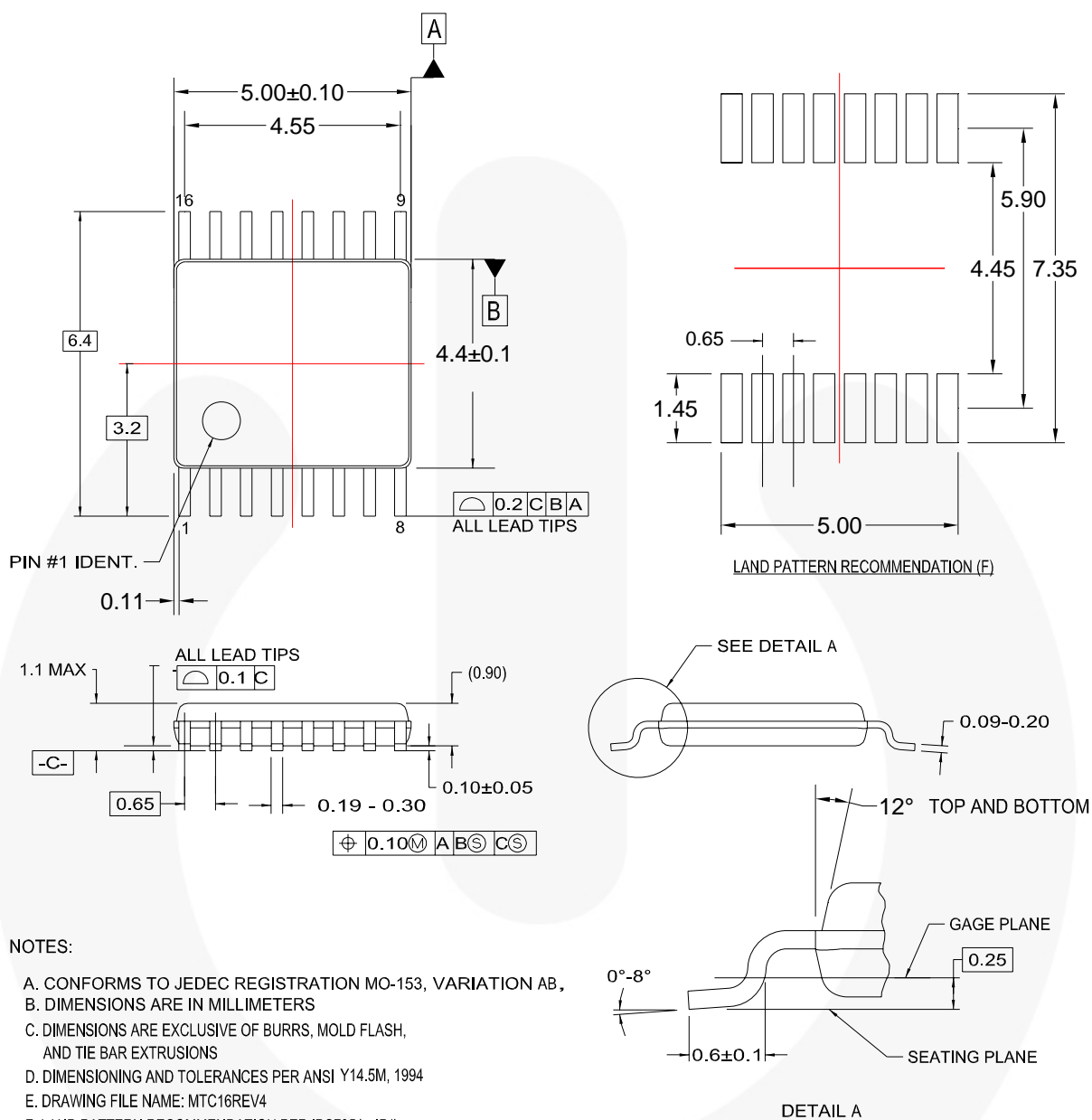
MQA16AREVB

**Figure 18. 16-Lead Quarter Size Outline Package (QSOP), JEDEC MO-137, 0.150-inch Wide**

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## Physical Dimensions



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AND TIE BAR EXTRUSIONS  
D. DIMENSIONING AND TOLERANCES PER ANSI Y14.5M, 1994  
E. DRAWING FILE NAME: MTC16REV4  
F. LAND PATTERN RECOMMENDATION PER IPC7351 - ID#  
TSOP65P640X110-16N

MTC16rev4

**Figure 19. 16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide**

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