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## FSUSB20 — Low-Power, 1-Port, High-Speed USB (480Mbps) Switch

### Features

- -30dB Off Isolation: 250MHz
- -30dB Non-adjacent Channel Crosstalk: 250MHz
- On Resistance: 4.5Ω Typical (R<sub>ON</sub>)
- -3dB Bandwidth: >720MHz
- Low-Power Consumption: 1μA Maximum
- Control Input: LVTTTL Compatible
- Bi-Directional Operation
- USB High-Speed and Full-Speed Signaling Capability

### Description

FSUSB20 is a low-power, high-bandwidth switch specially designed for 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 (>720MHz) allows signals to pass with minimum edge and phase distortion. Superior channel-to-channel crosstalk results in minimal interference. It is compatible with the high-speed USB 2.0 standard.

### Applications

- Cell Phones, PDAs, Digital Cameras, Notebook Computers

### Ordering Information

| Part Number | Operating Temperature Range | Package                                                                                     | Packing Method |
|-------------|-----------------------------|---------------------------------------------------------------------------------------------|----------------|
| FSUSB20L10X | -40 to +85°C                | 10-Lead MicroPak™, 1.6 x 2.1mm                                                              | Tape and Reel  |
| FSUSB20BQX  | -40 to +85°C                | 14-Terminal Depopulation Quad Very-Thin Flat Pack No Lead (DQFN), JEDEC MO-241, 2.5 X 3.0mm | Tube           |
| FSUSB20MUX  | -40 to +85°C                | 10-Lead Molded Small Outline Package (MSOP), JEDEC MO-187, 3.0mm Wide                       | Tape and Reel  |

## Connection Diagrams

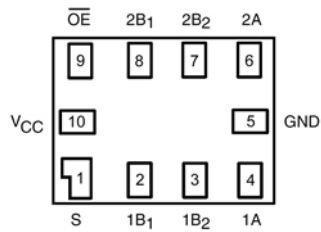


Figure 1. MicroPak™ (Top View)

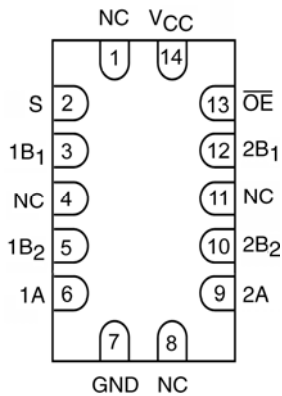


Figure 3. DQFN (Top Through View)

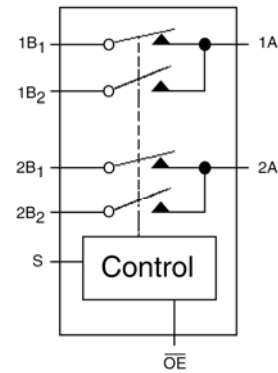


Figure 2. Analog Symbol

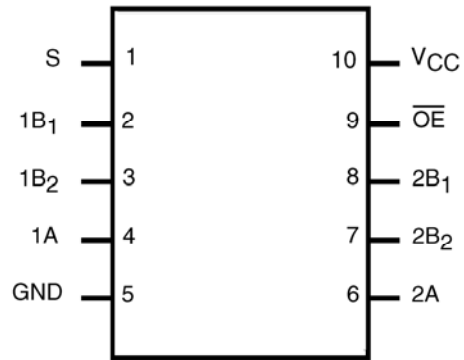


Figure 4. MSOP (Top Through View)

## Pin Descriptions

| Pin # MicroPak™ / MSOP | Pin # DQFN   | Pin Names                                                             | Description       |
|------------------------|--------------|-----------------------------------------------------------------------|-------------------|
| 1                      | 2            | S                                                                     | Select Input      |
| 2, 3, 7, 8             | 3, 5, 10, 12 | 1B <sub>1</sub> , 1B <sub>2</sub> , 2B <sub>2</sub> , 2B <sub>1</sub> | Bus B             |
| 5                      | 7            | GND                                                                   | Ground            |
| 4, 6                   | 6, 9         | 1A, 2A                                                                | Bus A             |
| 9                      | 12           | OE                                                                    | Bus Switch Enable |
| 10                     | 14           | 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                | 50         |                 | 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         | All Pins   | 7000            | V    |
|                    |                                       | I/O to GND | 7000            |      |

**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> | 5        | ns/V |
|            |                                 | Switch I/O                          | 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                             | Condition                                         | $V_{CC}$ (V) | $T_A = -40$ to $+85^\circ C$ |      |           | Unit     |
|-----------------|---------------------------------------|---------------------------------------------------|--------------|------------------------------|------|-----------|----------|
|                 |                                       |                                                   |              | 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 $R_{ON}$                        | $V_{IN} = 0.8V, V_{IN} = 0V - 1.5V, I_{ON} = 8mA$ | 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  $V_{CC} = 3.3V$  and  $T_A = 25^\circ C$ .

| Symbol     | Parameter                         | Condition                          | $V_{CC}(V)$ | Typ. | Max. | Unit | Figure                |
|------------|-----------------------------------|------------------------------------|-------------|------|------|------|-----------------------|
| $t_{ON}$   | Turn-On Time<br>S-to-Bus B        | $V_B = 0.8V$                       | 3.0 to 3.6  | 4.8  | 7.0  | ns   | Figure 9<br>Figure 10 |
| $t_{OFF}$  | Turn-Off Time<br>S-to-Bus B       | $V_B = 0.8V$                       | 3.0 to 3.6  | 2.2  | 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  | -26  |      | dB   | Figure 11             |
| $X_{TALK}$ | Non-Adjacent<br>Channel Crosstalk | $f = 250MHz$ ,<br>$R_L = 50\Omega$ | 3.0 to 3.6  | -45  |      | dB   | Figure 12             |
| BW         | -3dB Bandwidth                    | $R_L = 50\Omega$ , $C_L = 0pF$     | 3.0 to 3.6  | 750  |      | MHz  | Figure 13             |
|            |                                   | $R_L = 50\Omega$ , $C_L = 5pF$     |             | 435  |      |      |                       |

## USB Related AC Electrical Characteristics

Typical values are at  $V_{CC} = 3.3V$  and  $T_A = 25^\circ C$ .

| Symbol      | Parameter                                            | Condition                                                        | $V_{CC} (V)$ | Typ.  | Unit | Figure                 |
|-------------|------------------------------------------------------|------------------------------------------------------------------|--------------|-------|------|------------------------|
| $t_{SK(O)}$ | Channel-to Channel<br>Skew                           | $C_L = 10pF$                                                     | 3.0 to 3.6   | 0.051 | ns   | 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 | ns   | Figure 14<br>Figure 16 |
| $T_J$       | Total Jitter                                         | $R_L = 50\Omega$ , $C_L = 10pF$<br>$t_R = t_F = 750ps$ at 480MPs | 3.0 to 3.6   | 0.170 | ns   |                        |

## Capacitance

Typical values are at  $V_{CC} = 3.3V$  and  $T_A = 25^\circ C$ .

| Symbol    | Parameter                     | Condition                    | Typ. | Unit |
|-----------|-------------------------------|------------------------------|------|------|
| $C_{IN}$  | Control Pin Input Capacitance | $V_{CC} = 0V$                | 2.5  | pF   |
| $C_{ON}$  | A/B On Capacitance            | $V_{CC} = 3.3V$ , $/OE = 0V$ | 12.0 | pF   |
| $C_{OFF}$ | Port B Off Capacitance        | $V_{CC}$ and $/OE = 3.3V$    | 4.5  | pF   |

## Performance Characteristics

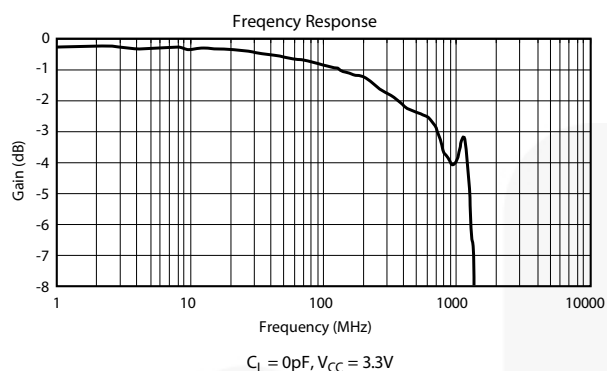


Figure 5. Gain vs. Frequency

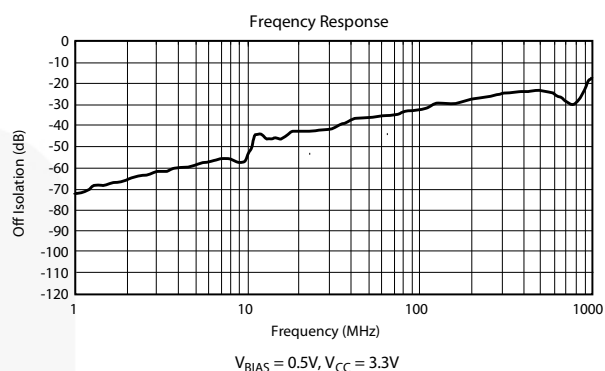


Figure 6. Off Isolation

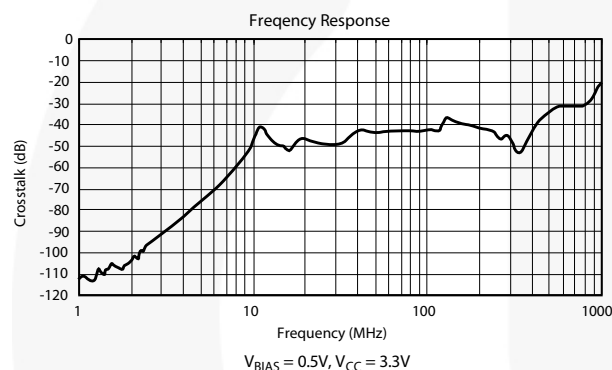


Figure 7. Crosstalk

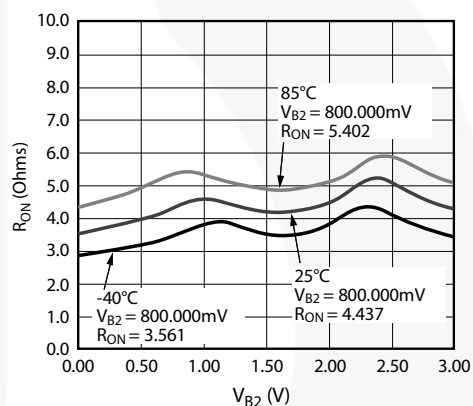
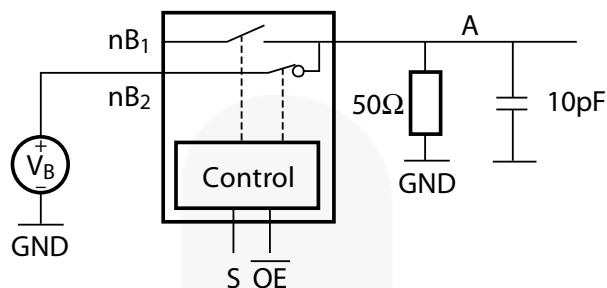


Figure 8.  $R_{ON}$

## AC Loadings and Waveforms



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

Figure 9. AC Test Circuit

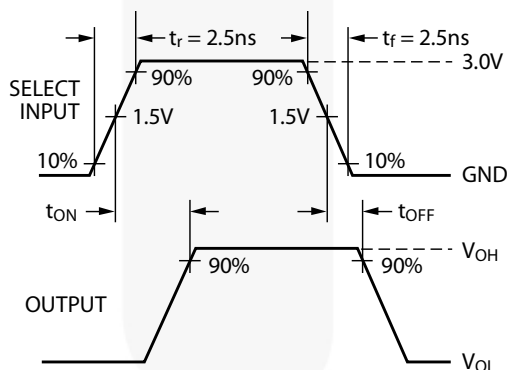


Figure 10. AC Waveforms

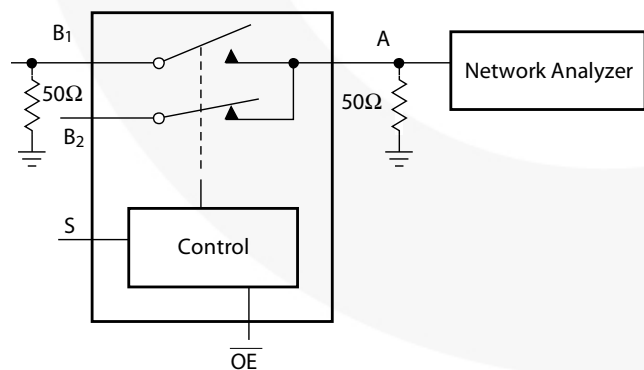


Figure 11. Off Isolation Test

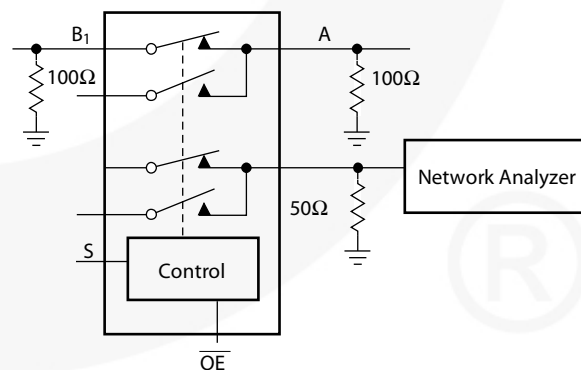


Figure 12. Crosstalk Test



## AC Loadings and Waveforms

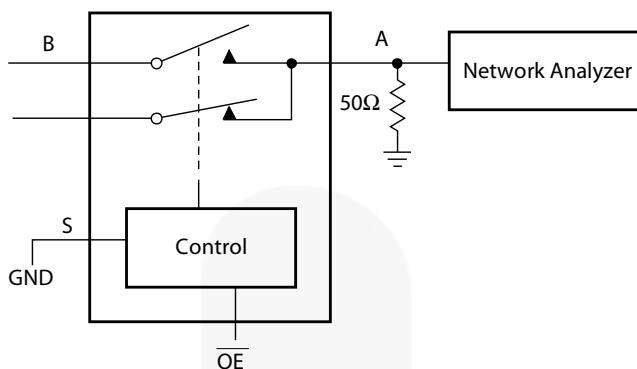


Figure 13. Bandwidth Test

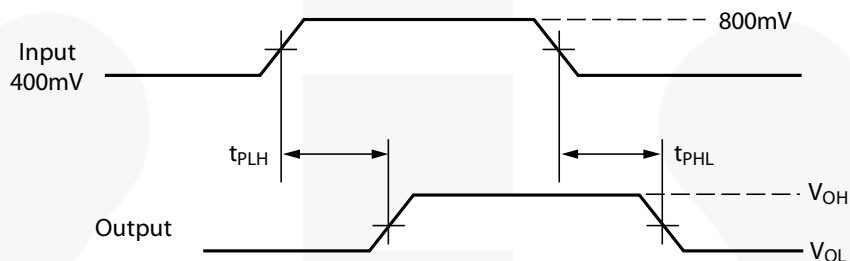


Figure 14. Propagation Delay

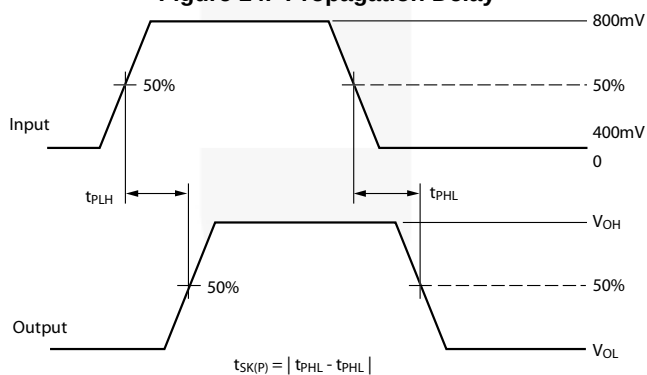


Figure 15. Pulse Skew  $t_{SP(P)}$

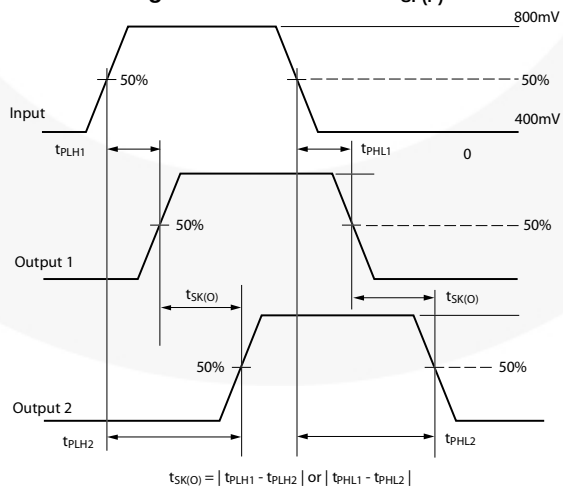
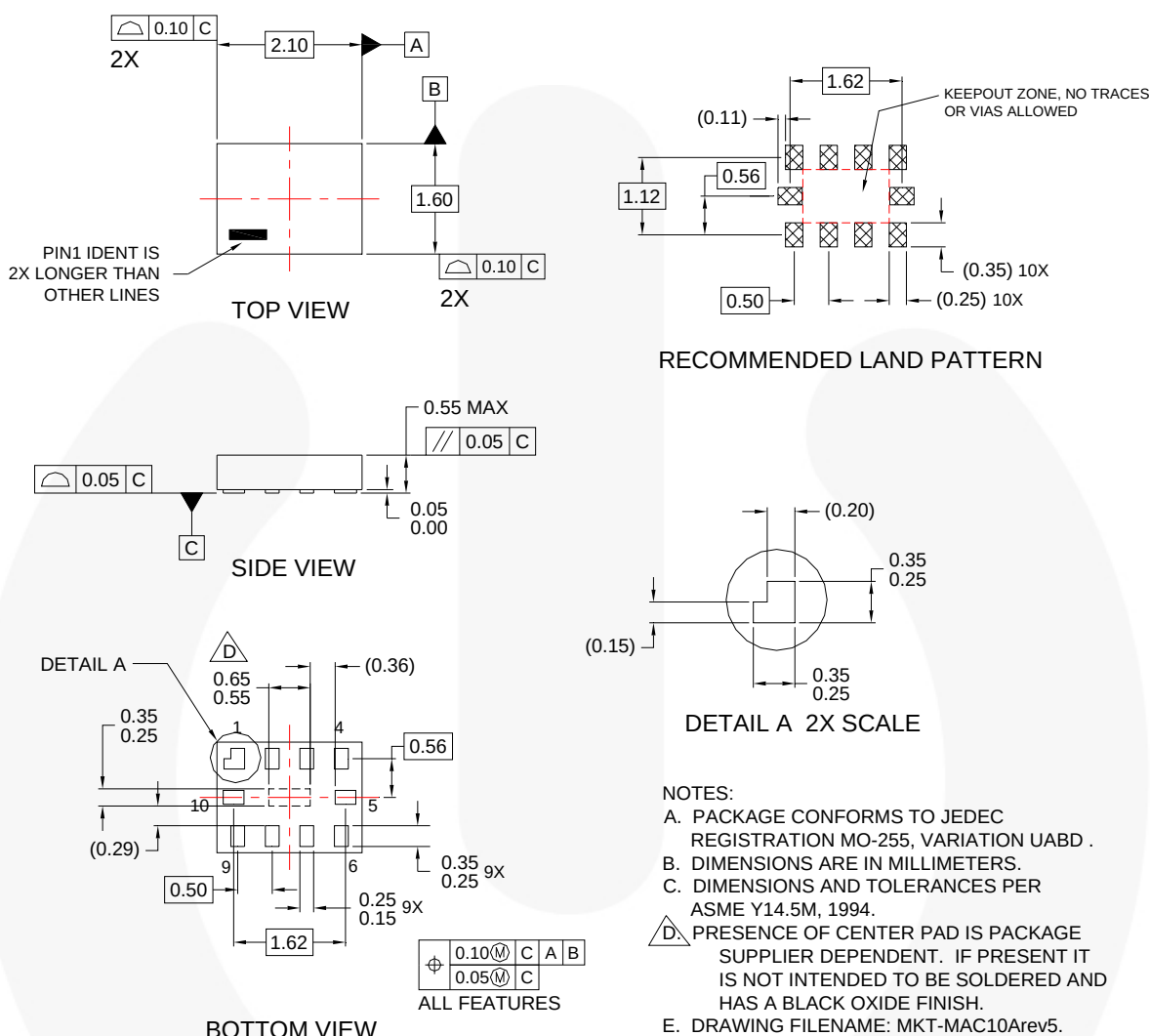


Figure 16. Output Skew  $t_{SK(O)}$

# Physical Dimensions



**Figure 17. 10-Lead MicroPak™, 1.6 x 2.1mm**

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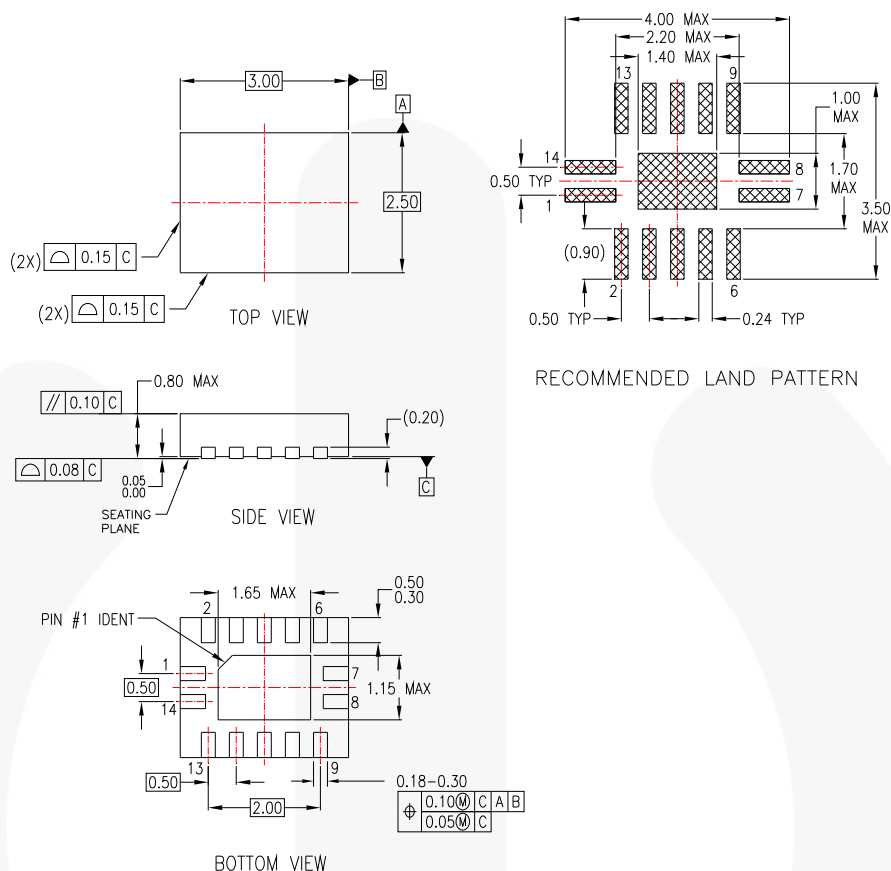
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## Physical Dimensions



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

MLP14ArevA

**Figure 18. 14-Terminal Depopulation Quad Very-Thin Flat Pack No Lead (DQFN), JEDEC MO-241, 2.5 X 3.0mm**

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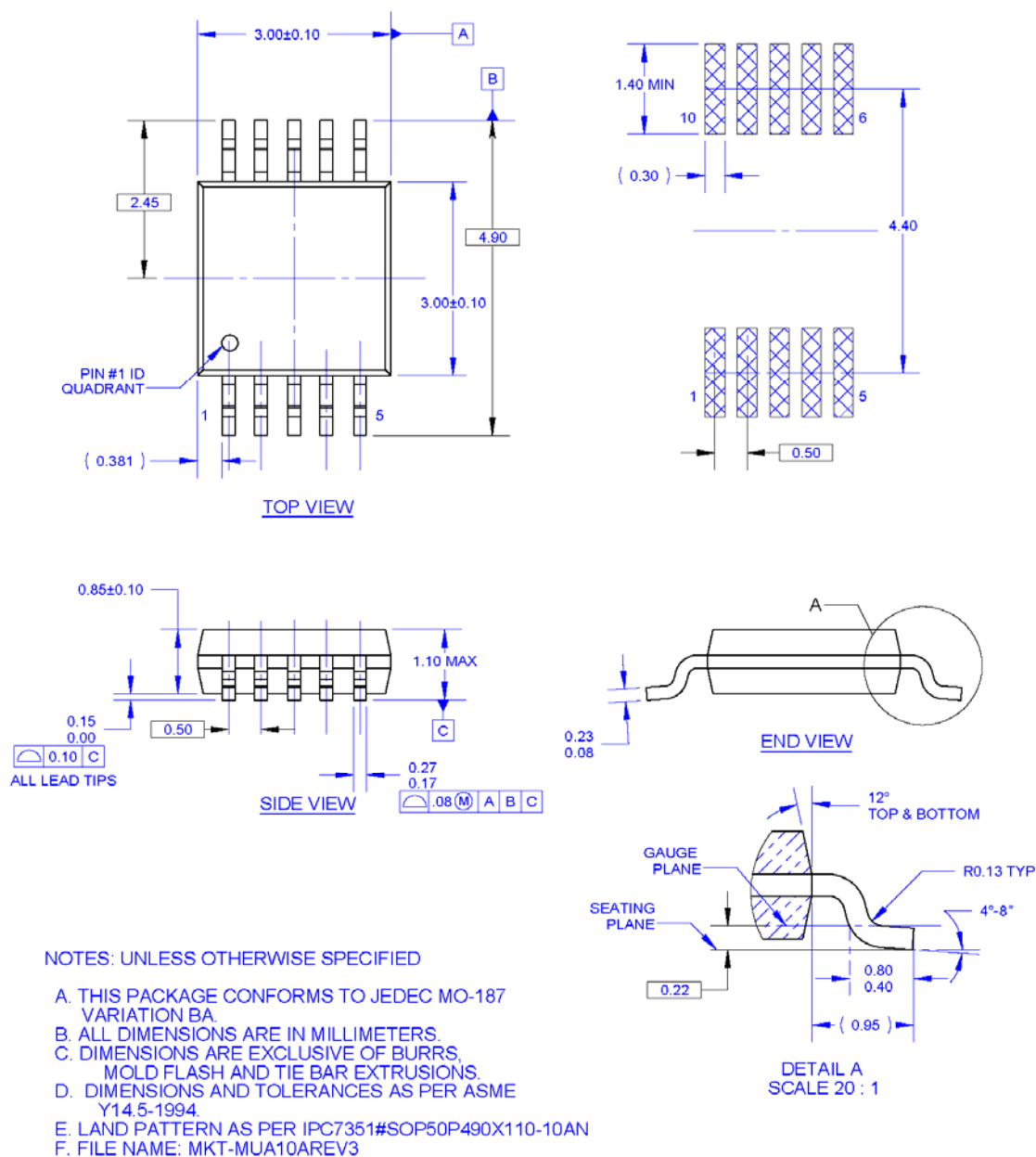
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# Physical Dimensions



**Figure 19. 10-Lead Molded Small Outline Package (MSOP), JEDEC MO-187, 3.0mm Wide**

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