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# FSA2270T Low-Voltage, Dual-SPDT (0.4 Ω) Analog Switch with Negative Swing Audio Capability

## Features

- 0.4 Ω Typical On Resistance ( $R_{ON}$ ) for +3.0 V Supply
- 0.25 Ω Maximum  $R_{ON}$  Flatness for +3.0 V Supply
- -3 db Bandwidth: > 50 MHz
- Low- $I_{CCT}$  Current Over Expanded Control Input Range
- Packaged in 10-Lead UMLP
- Power-Off Protection on Common Ports
- Broad  $V_{CC}$  Operating Range: 1.65 to 4.3 V
- Noise Immunity Termination Resistors
- Low Electrostatic Discharge (ESD)
  - Human Body Model (JEDEC: JESD22-A114)
    - Power to GND 16 kV
    - I/O to GND 11 kV
    - All other pins 8 kV
  - Charged Device Model (JEDEC: JESD22-A101)

## Applications

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

## IMPORTANT NOTE:

For additional information, please contact [analogswitch@fairchildsemi.com](mailto:analogswitch@fairchildsemi.com).

## Description

The FSA2270T is a high-performance, dual Single-Pole Double-Throw (SPDT) analog switch with negative swing audio capability. The FSA2270T features ultra-low  $R_{ON}$  of 0.4 Ω (typical) at 3.0 V  $V_{CC}$ . The FSA2270T operates over a wide  $V_{CC}$  range of 1.65 V to 4.3 V, 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.

The FSA2270T features very low quiescent current even when the control voltage is lower than the  $V_{CC}$  supply. This feature suits mobile handset applications by allowing direct interface with baseband processor general-purpose I/Os with minimal battery consumption.

The FSA2270T includes termination resistors that improve noise immunity during overshoot excursions, off-isolation coupling, or “pop-minimization.”

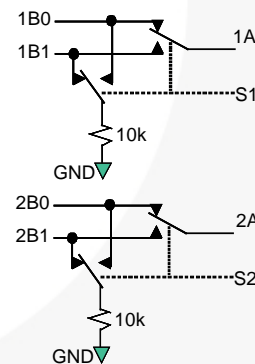


Figure 1. Analog Symbol

## Ordering Information

| Part Number | Top Mark | Package Description  |
|-------------|----------|--|
| FSA2270TUMX | HK       | 10-Lead, Quad Ultrathin Molded Leadless Package (UMLP), 1.4 x 1.8 mm, 0.4 mm Pitch |

## Pin Configuration

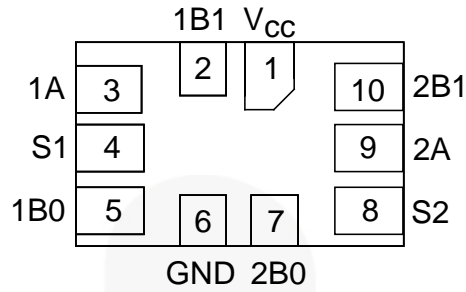


Figure 2. 10-Pin UMLP (Top Through View)

## Pin Descriptions

| Pin#  | Name            | Description        |
|-------|-----------------|--------------------|
| 1     | V <sub>CC</sub> | Supply Voltage     |
| 3, 9  | 1A, 2A          | Data Points        |
| 4, 8  | S1, S2          | Switch Select Pins |
| 5, 7  | 1B0, 2B0        | Data Ports         |
| 6     | GND             | Ground             |
| 2, 10 | 1B1, 2B1        | Data Ports         |

## Truth Table

| Control Input, S <sub>n</sub> | Function                                   |
|-------------------------------|--|
| LOW Logic Level               | nB0 connected to nA; nB1 terminated to GND |
| HIGH Logic Level              | nB1 connected to nA; nB0 terminated to GND |

## Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. Functional operation above the recommended operating conditions is not implied. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. Absolute maximum ratings are stress ratings only.

| Symbol       | Parameter  | Min.                            | Max.           | Units |    |
|--------------|--|---------------------------------|----------------|-------|----|
| $V_{CC}$     | Supply Voltage   | -0.5                            | 5.5            | V     |    |
| $V_{SW}$     | Switch I/O Voltage <sup>(1)</sup>                              | 1B0, 1B1, 2B0, 2B1, 1A, 2A Pins | $V_{CC} + 0.3$ | V     |    |
| $V_{CNTRL}$  | Control Input Voltage <sup>(1)</sup>                           | S1, S2                          | $V_{CC} + 0.3$ |       |    |
| $I_{IK}$     | Input Clamp Diode Current                                      |                                 | -50            | mA    |    |
| $I_{SW}$     | Switch I/O Current (Continuous)                                |                                 | 350            | mA    |    |
| $I_{SWPEAK}$ | Peak Switch Current (Pulsed at 1 ms Duration, <10% Duty Cycle) |                                 | 500            | mA    |    |
| $T_{STG}$    | Storage Temperature Range                                      | -65                             | +150           | °C    |    |
| $T_J$        | Maximum Junction Temperature                                   |                                 | +150           | °C    |    |
| $T_L$        | Lead Temperature Soldering, 10 Seconds                         |                                 | +260           | °C    |    |
| ESD          | Human Body Model, JEDEC: JESD22-A114                           | Power to GND                    |                | 16    | kV |
|              |  | I/O to GND                      |                | 11    | kV |
|              |  | All Other Pins                  |                | 8     | kV |
|              | Charged Device Model, JEDEC: JESD22-C101                       |                                 |                | 2     | kV |

### Note:

- Input and output negative ratings may be exceeded if 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.     | Units |
|--------------|-----------------------|----------------|----------|-------|
| $V_{CC}$     | Supply Voltage        | 1.65           | 4.30     | V     |
| $V_{S1, S2}$ | Control Input Voltage | 0              | $V_{CC}$ | V     |
| $V_{SW}$     | Switch I/O Voltage    | $V_{CC} - 4.3$ | $V_{CC}$ | V     |
| $T_A$        | Operating Temperature | -40            | +85      | °C    |

## DC Electrical Characteristics

All typical values are for  $V_{CC}=3.3\text{ V}$  at  $T_A=25^\circ\text{C}$  unless otherwise specified.

| Symbol          | Parameter  | Conditions   | $V_{CC}$ (V) | $T_A=+25^\circ\text{C}$ |      |      | $T_A=-40$ to $+85^\circ\text{C}$ |                  | Units         |
|-----------------|--|--|--------------|-------------------------|------|------|----------------------------------|------------------|---------------|
|                 |  |  |              | Min.                    | Typ. | Max. | Min.                             | Max.             |               |
| $V_{IH}$        | Input Voltage High                                     |  | 3.60 to 4.30 |                         |      |      | 1.7                              |                  | V             |
|                 |  |  | 2.70 to 3.60 |                         |      |      | 1.5                              |                  |               |
|                 |  |  | 2.30 to 2.70 |                         |      |      | 1.4                              |                  |               |
|                 |  |  | 1.65 to 1.95 |                         |      |      | 0.9                              |                  |               |
| $V_{IL}$        | Input Voltage Low                                      |  | 3.60 to 4.30 |                         |      |      |                                  | 0.7              | V             |
|                 |  |  | 2.70 to 3.60 |                         |      |      |                                  | 0.5              |               |
|                 |  |  | 2.30 to 2.70 |                         |      |      |                                  | 0.4              |               |
|                 |  |  | 1.65 to 1.95 |                         |      |      |                                  | 0.4              |               |
| $I_{IN}$        | Control Input Leakage (S1, S2)                         | $V_{IN}=0$ to $V_{CC}$   | 1.65 to 4.30 |                         |      |      | -0.5                             | 0.5              | $\mu\text{A}$ |
| $I_{A(ON)}$     | On Leakage Current of Port nA                          | nA=0.5 V, $V_{CC}=0.5\text{ V}$ nB0 or nB1= $V_{CC}-0.5\text{ V}$ , 0.5 V, or Floating<br>Figure 5 | 1.95 to 4.30 |                         |      |      | -1                               | 1                | $\mu\text{A}$ |
| $I_{OFF}$       | Power-Off Leakage Current (Common Port Only 1A, 2A)    | Common Port (1A, 2A), $V_{IN}=0\text{ V}$ to 4.3 V, $V_{CC}=0\text{ V}$ nB0, nB1=0 V or Floating   | 0            |                         |      |      | -45                              | 45               | $\mu\text{A}$ |
| $R_{ON}$        | Switch On Resistance <sup>(2,5)</sup>                  | $I_{ON}=100\text{ mA}$ , nB0 or nB1=0.7 V, 3.6 V, 4.3 V<br>Figure 3                                | 4.30         |                         | 0.30 |      |                                  |                  | $\Omega$      |
|                 |  | $I_{ON}=100\text{ mA}$ , nB0 or nB1=0.7 V, 3.6 V, 4.3 V<br>Figure 3                                | 3.00         |                         | 0.40 |      |                                  | 0.80             |               |
|                 |  | $I_{ON}=100\text{ mA}$ , nB0 or nB1=0 V, 0.7 V, 1.6 V, 2.3 V<br>Figure 3                           | 2.30         |                         | 0.52 |      |                                  |                  |               |
|                 |  | $I_{ON}=100\text{ mA}$ , nB0 or nB1=0 V, 0.7 V, 1.65 V<br>Figure 3                                 | 1.65         |                         | 1.00 |      |                                  |                  |               |
| $\Delta R_{ON}$ | On Resistance Matching Between Channels <sup>(3)</sup> | $I_{ON}=100\text{ mA}$ , nB0 or nB1=0.7 V  | 4.30         |                         | 0.04 |      |                                  | 0.13             | $\Omega$      |
|                 |  |  | 3.00         |                         | 0.06 |      |                                  | 0.13             |               |
|                 |  |  | 2.30         |                         | 0.12 |      |                                  |                  |               |
|                 |  |  | 1.65         |                         | 1.00 |      |                                  |                  |               |
| $R_{FLAT(ON)}$  | On Resistance Flatness <sup>(4)</sup>                  | $I_{OUT}=100\text{ mA}$ , nB0 or nB1=0 V to $V_{CC}$   | 4.30         |                         |      |      |                                  | 0.25             | $\Omega$      |
|                 |  |  | 3.00         |                         |      |      |                                  | 0.25             |               |
|                 |  |  | 2.30         |                         | 0.5  |      |                                  |                  |               |
|                 |  |  | 1.65         |                         | 0.6  |      |                                  |                  |               |
| $R_{TERM}$      | Internal Termination Resistors <sup>(5)</sup>          |  |              |                         | 10   |      |                                  | $\text{k}\Omega$ |               |
| $I_{CC}$        | Quiescent Supply Current                               | $V_{IN}=0\text{ V}$ or $V_{CC}$ , $I_{OUT}=0\text{ mA}$  | 4.30         | -100                    |      | 100  | -500                             | 500              | nA            |
| $I_{CCT}$       | Increase in $I_{CC}$ per Input                         | Input at 2.6 V   | 4.30         |                         | 3.0  |      |                                  | 10.0             | $\mu\text{A}$ |
|                 |  | Input at 1.8 V   |              |                         | 7.0  |      |                                  | 15.0             |               |

### Notes:

- On resistance is determined by the voltage drop between A and B pins at the indicated current through the switch.
- $\Delta R_{ON}=R_{ONmax} - R_{ONmin}$  measured at identical  $V_{CC}$ , temperature, and voltage.
- Flatness is defined as the difference between the maximum and minimum value of on resistance ( $R_{ON}$ ) over the specified range of conditions.
- Guaranteed by characterization, not production tested.

## AC Electrical Characteristics

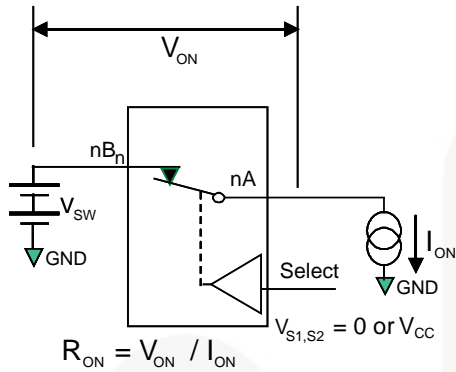
All typical value are for  $V_{CC}=3.3$  V at  $T_A=25^\circ\text{C}$  unless otherwise specified.

| Symbol    | Parameter                 | Conditions   | $V_{CC}$ (V) | $T_A=+25^\circ\text{C}$ |      |      | $T_A=-40$ to $+85^\circ\text{C}$ |      | Units | Figure               |
|-----------|---------------------------|--|--------------|-------------------------|------|------|----------------------------------|------|-------|----------------------|
|           |                           |  |              | Min.                    | Typ. | Max. | Min.                             | Max. |       |                      |
| $t_{ON}$  | Turn-On Time              | nB0 or nB1=1.5 V,<br>$R_L=50 \Omega$ , $C_L=35$ pF                                     | 3.60 to 4.30 |                         |      | 60   | 15                               | 65   | ns    | Figure 6<br>Figure 7 |
|           |                           |  | 2.70 to 3.60 |                         |      | 65   | 15                               | 70   |       |                      |
|           |                           |  | 2.30 to 2.70 |                         |      | 80   | 15                               | 85   |       |                      |
|           |                           |  | 1.65 to 1.95 |                         | 100  |      |                                  |      |       |                      |
| $t_{OFF}$ | Turn-Off Time             | nB0 or nB1=1.5 V,<br>$R_L=50 \Omega$ , $C_L=35$ pF                                     | 3.60 to 4.30 |                         |      | 55   | 5                                | 60   | ns    | Figure 6<br>Figure 7 |
|           |                           |  | 2.70 to 3.60 |                         |      | 60   | 5                                | 65   |       |                      |
|           |                           |  | 2.30 to 2.70 |                         |      | 65   | 5                                | 70   |       |                      |
|           |                           |  | 1.65 to 1.95 |                         | 65   |      |                                  |      |       |                      |
| $t_{BBM}$ | Break-Before-Make Time    | nB0 or nB1=1.5 V,<br>$R_L=50 \Omega$ , $C_L=35$ pF                                     | 3.60 to 4.30 |                         | 3    |      | 1                                |      | ns    | Figure 8             |
|           |                           |  | 2.70 to 3.60 |                         | 5    |      | 2                                |      |       |                      |
|           |                           |  | 2.30 to 2.70 |                         | 10   |      | 2                                |      |       |                      |
|           |                           |  | 1.65 to 1.95 |                         | 15   |      | 2                                |      |       |                      |
| Q         | Charge Injection          | $C_L=1.0$ nF, $V_S=0$ V,<br>$R_S=0 \Omega$   | 1.65 to 4.30 |                         | 25   |      |                                  |      | pC    | Figure 12            |
| OIRR      | Off Isolation             | $f=100$ kHz,<br>$R_L=50 \Omega$ , $C_L=0$ pF   | 1.65 to 4.30 |                         | -70  |      |                                  |      | dB    | Figure 10            |
| Xtalk     | Crosstalk                 | $f=100$ kHz,<br>$R_L=50 \Omega$ , $C_L=0$ pF   | 1.65 to 4.30 |                         | -70  |      |                                  |      | dB    | Figure 11            |
| BW        | -3 db Bandwidth           | $R_L=50 \Omega$ , $C_L=0$ pF   | 1.65 to 4.30 |                         | >50  |      |                                  |      | MHz   | Figure 9             |
| THD       | Total Harmonic Distortion | $f=20$ Hz to 20 kHz,<br>$R_L=32 \Omega$ , $V_{IN}=2$ V <sub>pp</sub><br>$V_{BIAS}=0$ V | 1.65 to 4.30 |                         | .06  |      |                                  |      | %     | Figure 15            |

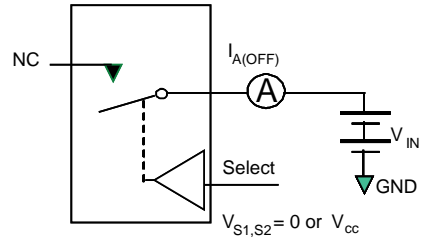
## Capacitance

| Symbol    | Parameter                     | Conditions | $V_{CC}$ (V) | $T_A=+25^\circ\text{C}$ |      |      | Units | Figure    |
|-----------|-------------------------------|------------|--------------|-------------------------|------|------|-------|-----------|
|           |                               |            |              | Min.                    | Typ. | Max. |       |           |
| $C_{IN}$  | Control Pin Input Capacitance | $f=1$ MHz  | 0            |                         | 2.5  |      | pF    | Figure 13 |
| $C_{OFF}$ | B Port Off Capacitance        | $f=1$ MHz  | 3.3          |                         | 30   |      | pF    | Figure 13 |
| $C_{ON}$  | A Port On Capacitance         | $f=1$ MHz  | 3.3          |                         | 120  |      | pF    | Figure 14 |

**Test Diagrams**

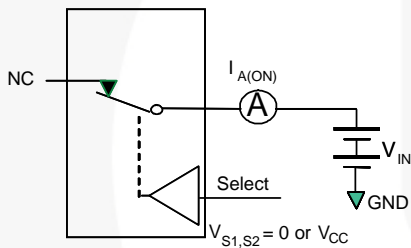


**Figure 3. On Resistance**

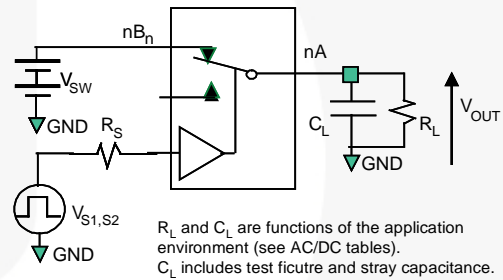


Each switch port is tested separately.

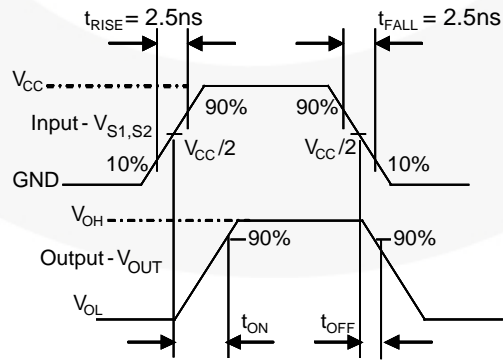
**Figure 4. Off Leakage**



**Figure 5. On Leakage**

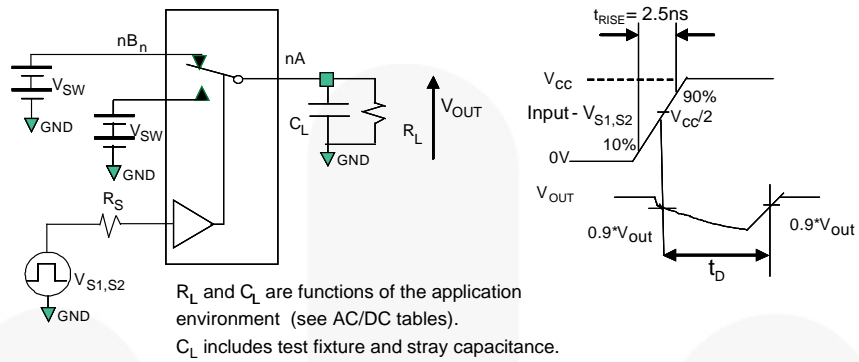


**Figure 6. Test Circuit Load**

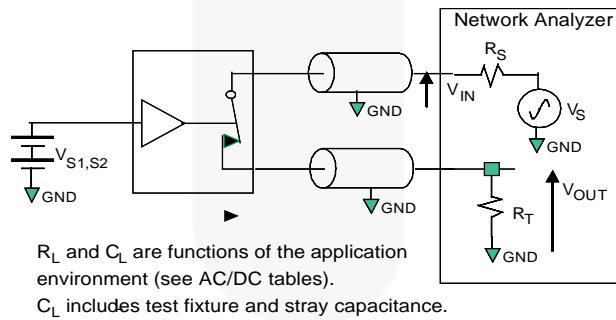


**Figure 7. Turn-On / Turn-Off Waveforms**

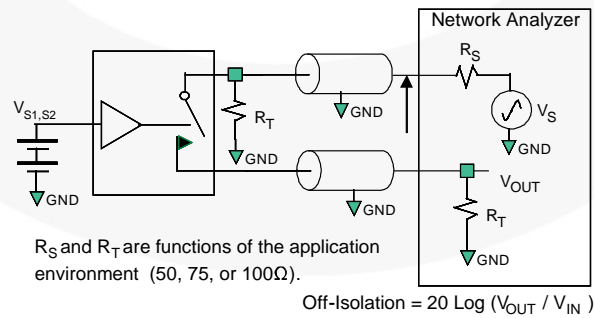
**Test Diagrams (Continued)**



**Figure 8. Break-Before-Make Interval Timing**



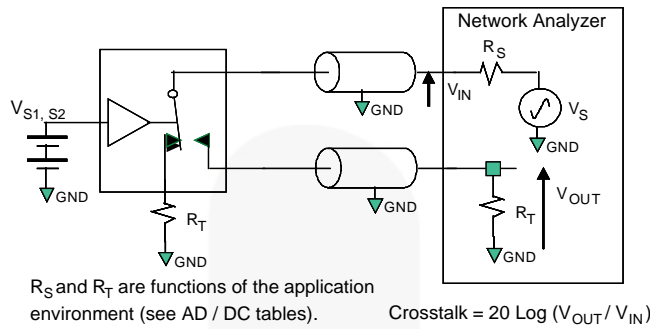
**Figure 9. Bandwidth**



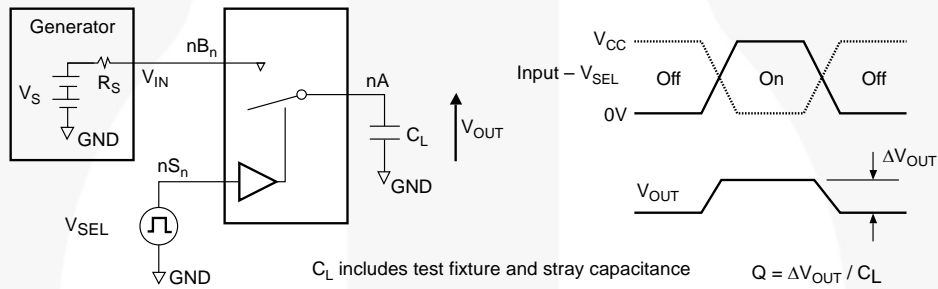
**Figure 10. Channel Off Isolation**



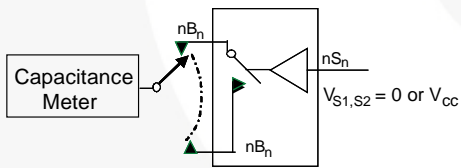
**Test Diagrams (Continued)**



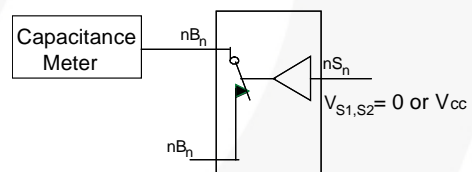
**Figure 11. Adjacent Channel Crosstalk**



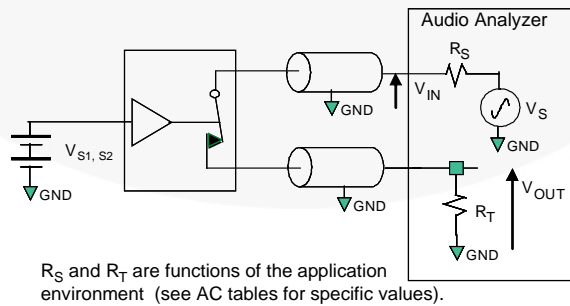
**Figure 12. Charge Injection Test**



**Figure 13. Channel Off Capacitance**

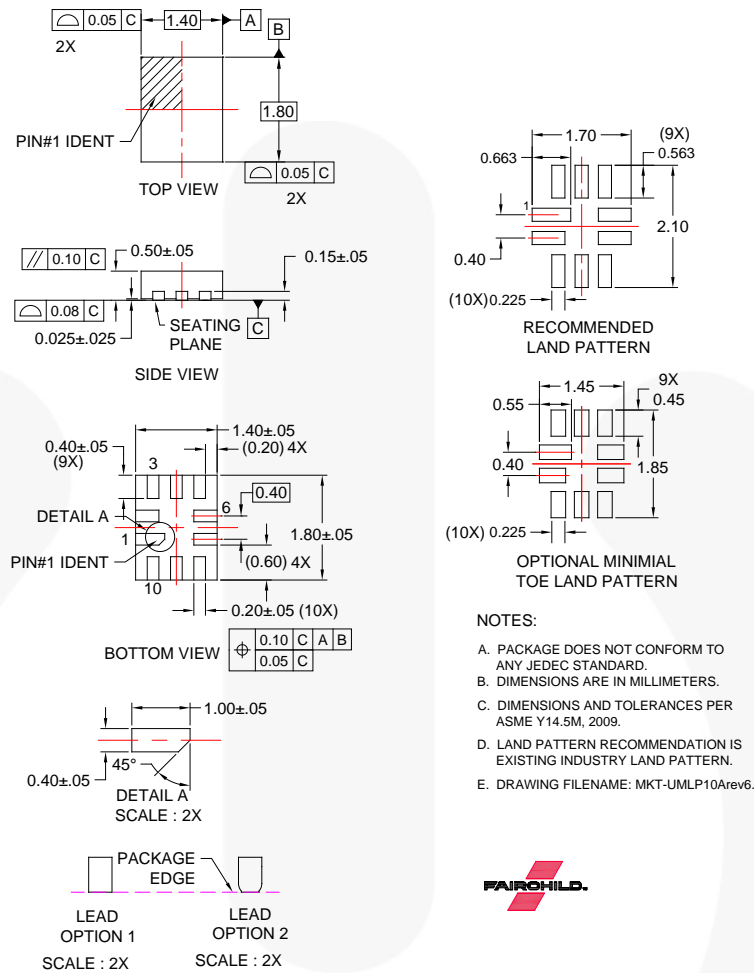


**Figure 14. Channel On Capacitance**



**Figure 15. Total Harmonic Distortion**

## Physical Dimensions



**Figure 16. 10-Lead, Quad Ultrathin Molded Leadless Package (UMLP)**

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**Table 1. Nominal Values**

| JEDEC Symbol | Description      | Nominal Values (mm) |
|--------------|------------------|---------------------|
| A            | Overall Height   | 0.5                 |
| A1           | Package Standoff | 0.026               |
| A3           | Lead Thickness   | 0.152               |
| b            | Lead Width       | 0.2                 |
| L            | Lead Length      | 0.4                 |
| e            | Lead Pitch       | 0.4                 |
| D            | Body Length (Y)  | 1.8                 |
| E            | Body Width (X)   | 1.4                 |





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