

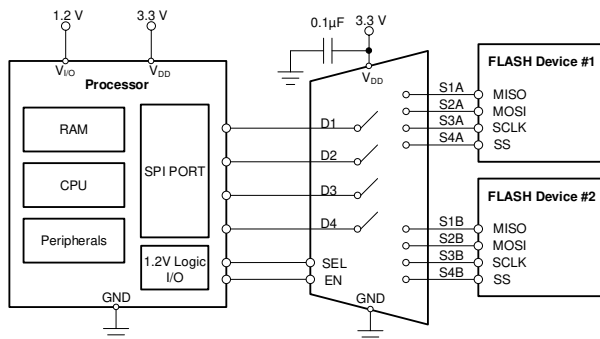
TMUX1575 2 : 1 (SPDT)、4 チャンネル、 WCSP の電源オフ保護スイッチ、1.2V ロジック互換

1 特長

- 幅広い電源電圧範囲: 1.08V~3.6V
- 小さいオン容量: 5pF
- 広い帯域幅: 1.8GHz
- 40°C~+125°Cの動作温度範囲
- 1.2V ロジック互換
- 電源電圧を超える入力電圧に対応
- ロジックピンにプルダウン抵抗を内蔵
- 双方向の信号パス
- フェイルセーフロジック
- 電源オフ保護

2 アプリケーション

- フラッシュメモリの共有
- JTAG マルチプレクシング
- SPI マルチプレクシング
- eMMC 多重化
- スマートウォッチ
- スマート追跡機能
- 携帯電話 / スマートフォン
- PC とノート PC
- ネットワークインターフェイスカード (NIC)
- サーバー
- データセンターのスイッチおよびルーター
- ワイヤレスインフラ
- ビルオートメーション
- ePOS



アプリケーションの例

3 概要

TMUX1575 は、4 チャンネル、2:1 (SPDT) 構成の相補型金属酸化膜半導体 (CMOS) スイッチです。サイズが小さく動作電源電圧範囲が 1.08V~3.6V と広いため、サーバーや通信機器からパーソナルエレクトロニクス用途まで、広範なアプリケーションに使用できます。このデバイスは、ソース (SxA, SxB) ピンとドレイン (Dx) ピンでの双方向アナログおよびデジタル信号をサポートしており、最大で $V_{DD} \times 2$ (最大入出力電圧は 3.6V) の信号を通すことができます。

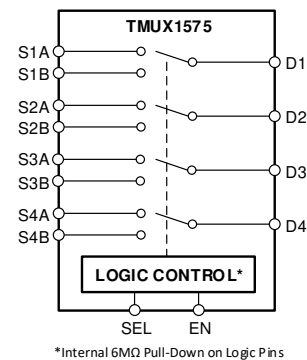
TMUX1575 の信号経路の電源オフ保護機能は、電源電圧が取り除かれたとき ($V_{DD} = 0V$) に絶縁を行います。この保護機能がない場合、内部 ESD ダイオード経路でスイッチから電源レールに電流が逆流し、システムに損傷を引き起こすおそれがあります。

フェイルセーフ回路により、電源ピンよりも前にロジック制御ピンに電圧が印加されるため、デバイスへの損傷の可能性が避けられます。すべての制御入力のスレッシュホールドは 1.2V ロジック互換であるため、外部ロジックを変換する必要はありません。ロジックピンにはプルダウン抵抗が内蔵されているため、外付け部品を省略でき、システムのサイズとコストを低減できます。

パッケージ情報

| 部品番号 | パッケージ (1) | パッケージサイズ (2) |
|----------|-----------------|---------------|
| TMUX1575 | YCJ (DSBGA, 16) | 1.4mm × 1.4mm |

- 詳細については、セクション 11 を参照してください。
- パッケージサイズ (長さ × 幅) は公称値であり、該当する場合はピンも含まれます。



ブロック図



Table of Contents

| | | | |
|--|----|--|----|
| 1 特長 | 1 | 6.9 Off Isolation..... | 15 |
| 2 アプリケーション | 1 | 6.10 Channel-to-Channel Crosstalk..... | 15 |
| 3 概要 | 1 | 6.11 Bandwidth..... | 16 |
| 4 Pin Configuration and Functions | 3 | 7 Detailed Description | 17 |
| Pin Functions..... | 3 | 7.1 Overview..... | 17 |
| 5 Specifications | 4 | 7.2 Functional Block Diagram..... | 17 |
| 5.1 Absolute Maximum Ratings | 4 | 7.3 Feature Description..... | 17 |
| 5.2 ESD Ratings | 4 | 7.4 Device Functional Modes..... | 18 |
| 5.3 Recommended Operating Conditions | 4 | 8 Application and Implementation | 19 |
| 5.4 Thermal Information | 4 | 8.1 Typical Application..... | 19 |
| 5.5 Electrical Characteristics | 5 | 8.2 Power Supply Recommendations..... | 20 |
| 5.6 Dynamic Characteristics | 6 | 8.3 Layout..... | 20 |
| 5.7 Timing Requirements | 7 | 9 Device and Documentation Support | 22 |
| 5.8 Typical Characteristics..... | 8 | 9.1 Documentation Support..... | 22 |
| 6 Parameter Measurement Information | 10 | 9.2 ドキュメントの更新通知を受け取る方法..... | 22 |
| 6.1 On-Resistance..... | 10 | 9.3 サポート・リソース..... | 22 |
| 6.2 Off-Leakage Current..... | 10 | 9.4 Trademarks..... | 22 |
| 6.3 On-Leakage Current..... | 11 | 9.5 静電気放電に関する注意事項..... | 22 |
| 6.4 I_{POFF} Leakage Current..... | 11 | 9.6 用語集..... | 22 |
| 6.5 Transition Time..... | 12 | 10 Revision History | 22 |
| 6.6 $t_{ON(EN)}$ and $t_{OFF(EN)}$ Time..... | 12 | 11 Mechanical, Packaging, and Orderable Information | 23 |
| 6.7 Break-Before-Make Delay..... | 13 | 11.1 Mechanical Data..... | 24 |
| 6.8 Charge Injection..... | 14 | | |

4 Pin Configuration and Functions

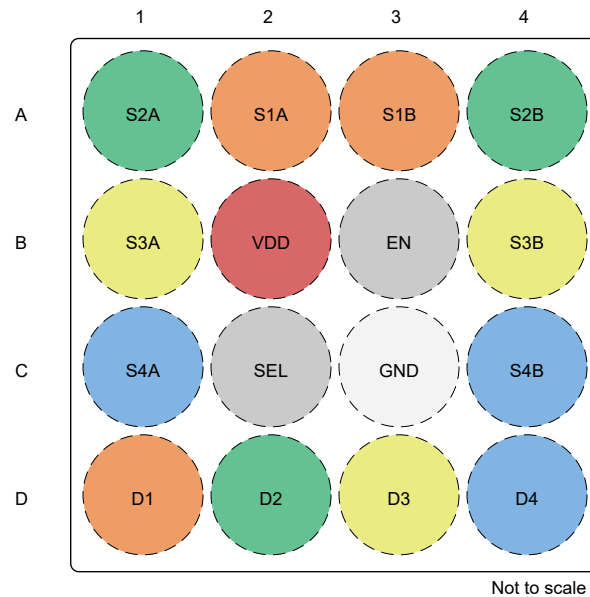


図 4-1. YCJ Package 16-Pin DSBGA (Top View)

表 4-1. Pin Functions

| PIN | | TYPE ⁽¹⁾ | DESCRIPTION ⁽²⁾ |
|-----|------|---------------------|--|
| NO. | NAME | | |
| A1 | S2A | I/O | Source pin 2A. Can be an input or output. |
| A2 | S1A | I/O | Source pin 1A. Can be an input or output. |
| A3 | S1B | I/O | Source pin 1B. Can be an input or output. |
| A4 | S2B | I/O | Source pin 2B. Can be an input or output. |
| B1 | S3A | I/O | Source pin 3A. Can be an input or output. |
| B2 | VDD | P | Positive power supply. This pin is the most positive power-supply potential. For reliable operation, connect a decoupling capacitor ranging from 0.1 μ F to 10 μ F between V_{DD} and GND. |
| B3 | EN | I | Active high enable: Internal 6 M Ω pull-down to GND. |
| B4 | S3B | I/O | Source pin 3B. Can be an input or output. |
| C1 | S4A | I/O | Source pin 4A. Can be an input or output. |
| C2 | SEL | I | Select pin: controls state of switches according to 表 7-1. Internal 6 M Ω pull-down to GND. |
| C3 | GND | P | Ground (0V) reference |
| C4 | S4B | I/O | Source pin 4B. Can be an input or output. |
| D1 | D1 | I/O | Drain pin 1. Can be an input or output. |
| D2 | D2 | I/O | Drain pin 2. Can be an input or output. |
| D3 | D3 | I/O | Drain pin 3. Can be an input or output. |
| D4 | D4 | I/O | Drain pin 4. Can be an input or output. |

(1) I = input, O = output, I/O = input and output, P = power.

(2) Refer to セクション 7.4 for what to do with unused pins.

Pin Functions

5 Specifications

5.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)^{(1) (2) (3)}

| | | MIN | MAX | UNIT |
|---|---|------|-----|------|
| V _{DD} | Supply voltage | -0.5 | 4 | V |
| V _{SEL} or V _{EN} | Logic control input pin voltage (SEL or EN) | -0.5 | 4 | V |
| I _{SEL} or I _{EN} | Logic control input pin current (SEL or EN) | -30 | 30 | mA |
| V _S or V _D | Source or drain pin voltage | -0.5 | 4 | V |
| I _S or I _D (CONT) | Source and drain pin continuous current: (SxA, SxB, Dx) | -20 | 20 | mA |
| T _{stg} | Storage temperature | -65 | 150 | °C |
| T _J | Junction temperature | | 150 | °C |

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) The algebraic convention, whereby the most negative value is a minimum and the most positive value is a maximum.
- (3) All voltages are with respect to ground, unless otherwise specified.

5.2 ESD Ratings

| | | | VALUE | UNIT |
|--------------------|-------------------------|--|-------|------|
| V _(ESD) | Electrostatic discharge | Human body model (HBM), per ANSI/ESDA/ JEDEC JS-001 ⁽¹⁾ | ±2000 | V |
| | | Charged-device model (CDM), per JEDEC specification JESD22-C101 ⁽²⁾ | ±750 | |

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

5.3 Recommended Operating Conditions

| | | MIN | MAX | UNIT |
|--|--|------|---------------------|------|
| V _{DD} | Supply voltage | 1.08 | 3.6 | V |
| V _S or V _D | Signal path input/output voltage (source or drain pin), V _{DD} ≥ 1.08V ⁽¹⁾ | 0 | V _{DD} × 2 | V |
| V _{S_off} or V _{D_off} | Signal path input/output voltage (source or drain pin), V _{DD} = 0V | 0 | 3.6 | V |
| V _{SEL} or V _{EN} | Logic control input voltage (EN, SEL) | 0 | 3.6 | V |
| T _A | Ambient temperature | -40 | 125 | °C |

- (1) Device input/output can operate up to V_{DD} × 2, with a maximum input/output voltage of 3.6V.

5.4 Thermal Information

| THERMAL METRIC ⁽¹⁾ | | DEVICE | UNIT |
|-------------------------------|--|------------|------|
| | | YCJ (WCSP) | |
| | | 16 PINS | |
| R _{θJA} | Junction-to-ambient thermal resistance | 89.4 | °C/W |
| R _{θJC(top)} | Junction-to-case (top) thermal resistance | 21.4 | °C/W |
| R _{θJB} | Junction-to-board thermal resistance | 0.6 | °C/W |
| Ψ _{JT} | Junction-to-top characterization parameter | 0.3 | °C/W |
| Ψ _{JB} | Junction-to-board characterization parameter | 21.3 | °C/W |
| R _{θJC(bot)} | Junction-to-case (bottom) thermal resistance | N/A | °C/W |

- (1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC Package Thermal Metrics](#) application report.

5.5 Electrical Characteristics

 $V_{DD} = 1.08V$ to $3.6V$, $GND = 0V$, $T_A = -40^{\circ}C$ to $+125^{\circ}C$

 Typical values are at $V_{DD} = 3.3V$, $T_A = 25^{\circ}C$, (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|------------------------------|---|--|------|------|------|------------|
| POWER SUPPLY | | | | | | |
| I_{DD} | Active supply current | $V_{SEL} = 0V, 1.2V$ or V_{DD} $V_S = 0V$ to $3.6V$ $T_A = -40^{\circ}C$ to $+85^{\circ}C$ | | 7 | 10 | μA |
| I_{DD} | Active supply current | $V_{SEL} = 0V, 1.2V$ or V_{DD} $V_S = 0V$ to $3.6V$ $T_A = -40^{\circ}C$ to $+125^{\circ}C$ | | 7 | 14 | μA |
| DC CHARACTERISTICS | | | | | | |
| R_{ON} | ON-state resistance | $V_S = 0V$ to V_{DD} $I_{SD} = 8\text{ mA}$ | | 1.7 | 6.5 | Ω |
| R_{ON} | On-resistance | $V_S = 0V$ to $V_{DD} * 2$ $V_{S(max)} = 3.6V$ $I_{SD} = 8\text{ mA}$ | | 3 | 8 | Ω |
| ΔR_{ON} | On-resistance match between channels | $V_S = V_{DD}$ $I_{SD} = 8\text{ mA}$ | | 0.1 | 0.4 | Ω |
| $R_{ON(FLAT)}$ | On-resistance flatness | $V_S = 0V$ to V_{DD} $I_{SD} = 8\text{ mA}$ | | 1 | 3.5 | Ω |
| I_{POFF} | Powered-off I/O pin leakage current | $V_{DD} = 0V$ $V_S = 0V$ to $3.6V$ $V_D = 0V$ | -2 | 0.01 | 2 | μA |
| $I_{S(OFF)}$ $I_{D(OFF)}$ | OFF leakage current | Switch Off $V_D = 0.8 * V_{DD} / 0.2 * V_{DD}$ $V_S = 0.2 * V_{DD} / 0.8 * V_{DD}$ $T_A = -40^{\circ}C$ to $+85^{\circ}C$ | -10 | 0.01 | 10 | nA |
| $I_{S(OFF)}$ $I_{D(OFF)}$ | OFF leakage current | Switch Off $V_D = 0.8 * V_{DD} / 0.2 * V_{DD}$ $V_S = 0.2 * V_{DD} / 0.8 * V_{DD}$ $T_A = -40^{\circ}C$ to $+125^{\circ}C$ | -100 | 0.01 | 100 | nA |
| $I_{D(ON)}$ $I_{S(ON)}$ | ON leakage current | Switch On $V_D = 0.8 * V_{DD} / 0.2 * V_{DD}$, S pins floating or $V_S = 0.8 * V_{DD} / 0.2 * V_{DD}$, D pins floating $T_A = -40^{\circ}C$ to $+85^{\circ}C$ | -10 | 0.01 | 10 | nA |
| $I_{D(ON)}$ $I_{S(ON)}$ | ON leakage current | Switch On $V_D = 0.8 * V_{DD} / 0.2 * V_{DD}$, S pins floating or $V_S = 0.8 * V_{DD} / 0.2 * V_{DD}$, D pins floating $T_A = -40^{\circ}C$ to $+125^{\circ}C$ | -160 | 0.01 | 160 | nA |
| LOGIC INPUTS | | | | | | |
| V_{IH} | Input logic high | | 0.8 | | 3.6 | V |
| V_{IL} | Input logic low | | 0 | | 0.45 | V |
| I_{IH} | Input high leakage current | $V_{SEL} = 1.8V, V_{DD}$ | | 0.5 | 2.5 | μA |
| I_{IL} | Input low leakage current | $V_{SEL} = 0V$ | -1 | 0.1 | | μA |
| R_{PD} | Internal pull-down resistor on logic pins | | | 6 | | M Ω |
| C_i | Logic input capacitance | $V_{SEL} = 0V, 1.8V$ or V_{DD} $f = 1\text{ MHz}$ | | 3 | | pF |

5.6 Dynamic Characteristics

$V_{DD} = 1.08V$ to $3.6V$, $GND = 0V$, $T_A = -40^{\circ}C$ to $+125^{\circ}C$

Typical values are at $V_{DD} = 3.3V$, $T_A = 25^{\circ}C$, (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | MIN | TYP | MAX | UNIT |
|------------|----------------------------------|---|------------|-----|-------|-----|------|
| C_{OFF} | Source and drain off capacitance | $V_S = 2.5V$ $V_{SEL} = 0V$ $f = 1\text{ MHz}$ | Switch OFF | | 3.5 | | pF |
| C_{ON} | Source and drain on capacitance | $V_S = 2.5V$ $V_{SEL} = 0V$ $f = 1\text{ MHz}$ | Switch ON | | 10 | | pF |
| Q_C | Charge Injection | $V_S = V_{DD}/2$ $R_S = 0\ \Omega$, $C_L = 1\text{ nF}$ | Switch ON | | 5 | | pC |
| O_{ISO} | Off isolation | $R_L = 50\ \Omega$ $f = 100\text{ kHz}$ | Switch OFF | | -95 | | dB |
| | | $R_L = 50\ \Omega$ $f = 1\text{ MHz}$ | Switch OFF | | -70 | | dB |
| X_{TALK} | Channel to Channel crosstalk | $R_L = 50\ \Omega$ $f = 100\text{ kHz}$ | Switch ON | | -90 | | dB |
| BW | Bandwidth | $R_L = 50\ \Omega$ | Switch ON | | 1.8 | | GHz |
| I_{LOSS} | Insertion loss | $R_L = 50\ \Omega$ $f = 1\text{ MHz}$ | Switch ON | | -0.15 | | dB |

5.7 Timing Requirements

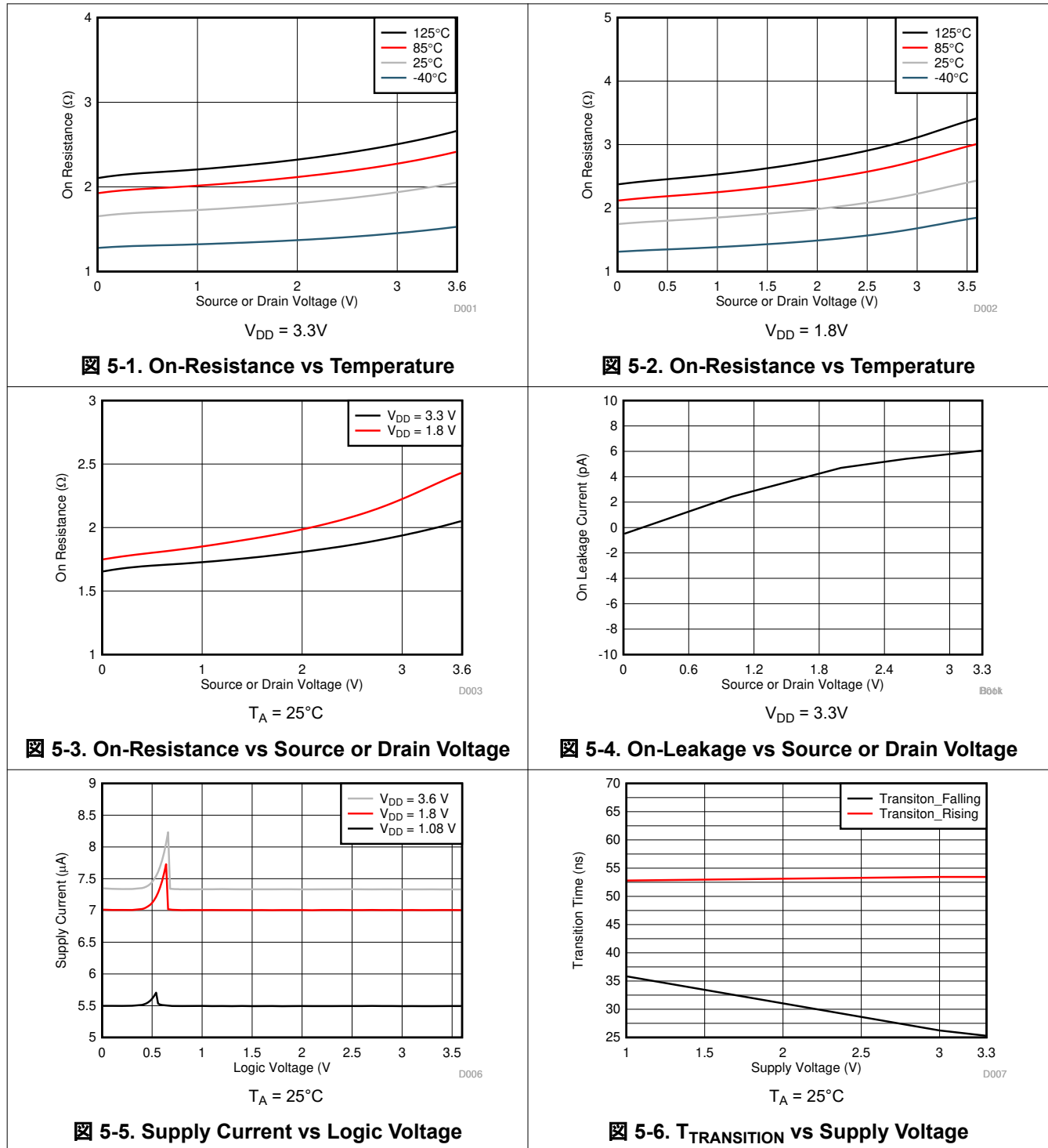
$V_{DD} = 1.08V$ to $3.6V$, $GND = 0V$, $T_A = -40^{\circ}C$ to $+125^{\circ}C$

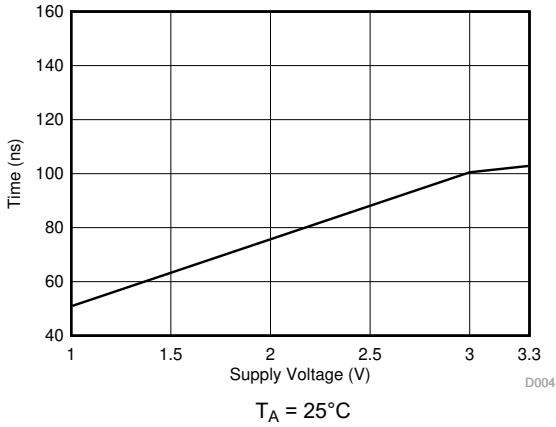
Typical values are at $V_{DD} = 3.3V$, $T_A = 25^{\circ}C$, (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | NOM | MAX | UNIT |
|---------------------|--|--|-----|-----|-----|---------|
| t_{TRAN} | Transition time from control input | $V_{DD} = 1.8V$ to $3.6V$ $V_S = V_{DD}$ $R_L = 200 \Omega$, $C_L = 15pF$ | | 35 | 80 | ns |
| t_{TRAN} | Transition time from control input | $V_{DD} < 1.8V$ $V_S = V_{DD}$ $R_L = 200 \Omega$, $C_L = 15pF$ | | 40 | 115 | ns |
| $t_{ON(EN)}$ | Device turn on time from enable pin | $V_S = V_{DD}$ $R_L = 200 \Omega$, $C_L = 15pF$ | | 55 | 130 | ns |
| $t_{OFF(EN)}$ | Device turn off time from enable pin | $V_S = V_{DD}$ $R_L = 200 \Omega$, $C_L = 15pF$ | | 30 | 60 | ns |
| $t_{ON(VDD)}$ | Device turn on time (V_{DD} to output) | $V_S = V_{DD}$ V_{DD} rise time = $1\mu s$ $R_L = 200 \Omega$, $C_L = 15pF$ | | 300 | 990 | μs |
| $t_{OFF(VDD)}$ | Device turn off time (V_{DD} to output) | $V_S = V_{DD}$ V_{DD} fall time = $1\mu s$ $R_L = 200 \Omega$, $C_L = 15pF$ | | 1 | 12 | μs |
| t_{OPEN} (BBM) | Break before make time | $V_S = 1V$ $R_L = 200 \Omega$, $C_L = 15pF$ | 1 | | | ns |
| $t_{SK(P)}$ | Inter - channel skew | | | 6 | | ps |
| t_{PD} | Propagation delay | | | 60 | | ps |

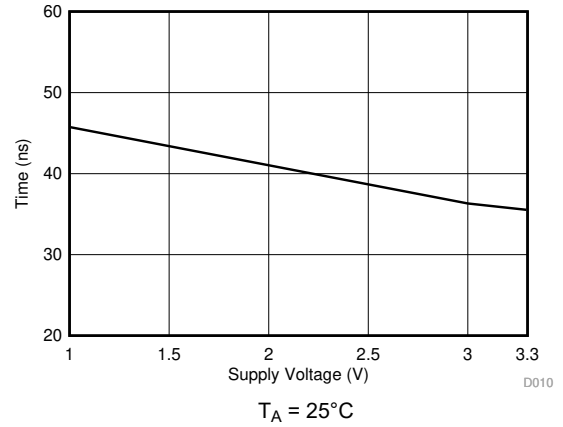
5.8 Typical Characteristics

At $T_A = 25^\circ\text{C}$, $V_{DD} = 3.3\text{V}$ (unless otherwise noted).

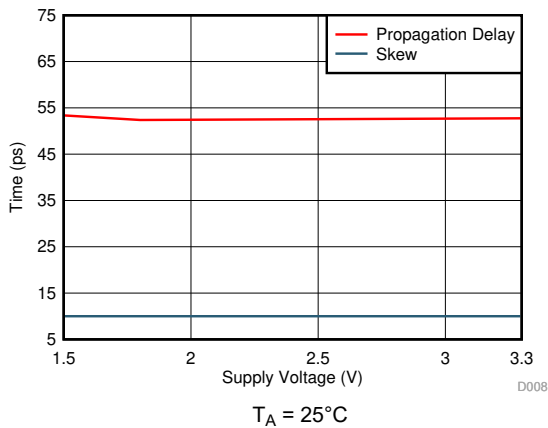




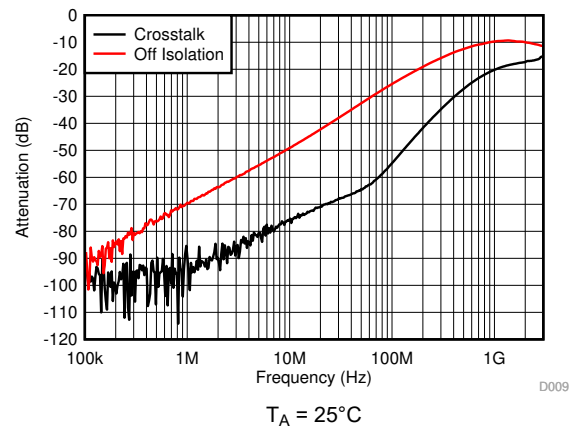
5-7. $T_{ON} (EN)$ vs Supply Voltage



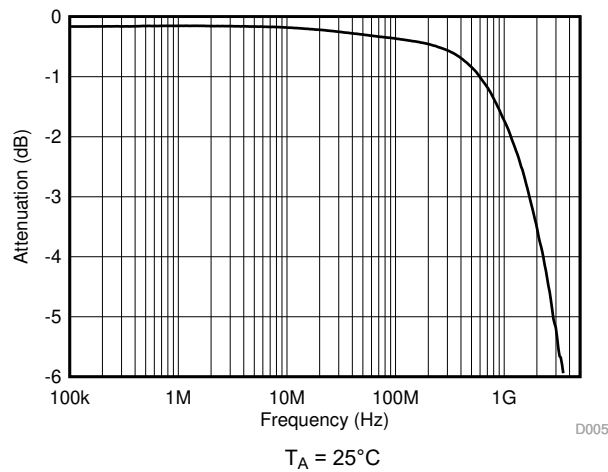
5-8. $T_{OFF} (EN)$ vs Supply Voltage



5-9. Skew and Propagation Delay vs Supply Voltage



5-10. Off Isolation and Crosstalk vs Frequency



5-11. On-Response vs Frequency

6 Parameter Measurement Information

6.1 On-Resistance

The on-resistance of a device is the ohmic resistance between the source (Sx) and drain (Dx) pins of the device. The on-resistance varies with input voltage and supply voltage. The symbol R_{ON} is used to denote on-resistance. The measurement setup used to measure R_{ON} is shown in [Figure 6-1](#). Voltage (V) and current (I_{SD}) are measured using this setup, and R_{ON} is computed as shown below with $R_{ON} = V / I_{SD}$:

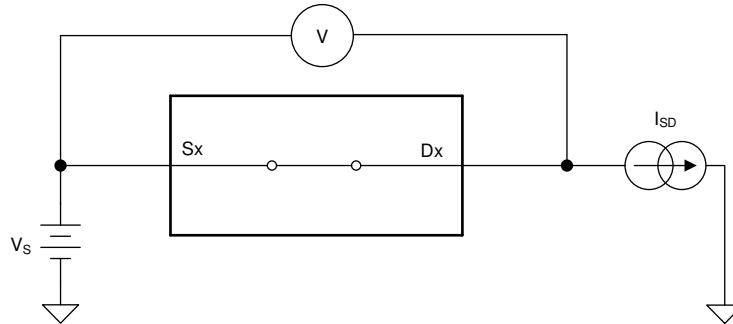


Figure 6-1. On-Resistance Measurement Setup

6.2 Off-Leakage Current

Source leakage current is defined as the leakage current flowing into or out of the source pin when the switch is off. This current is denoted by the symbol $I_{S(OFF)}$.

Drain leakage current is defined as the leakage current flowing into or out of the drain pin when the switch is off. This current is denoted by the symbol $I_{D(OFF)}$.

The setup used to measure both off-leakage currents is shown in [Figure 6-2](#).

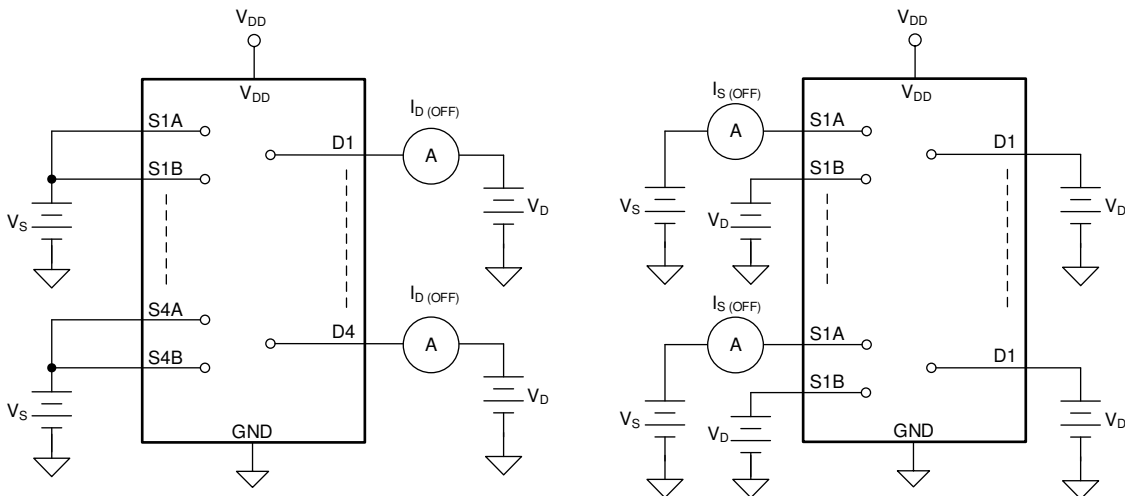
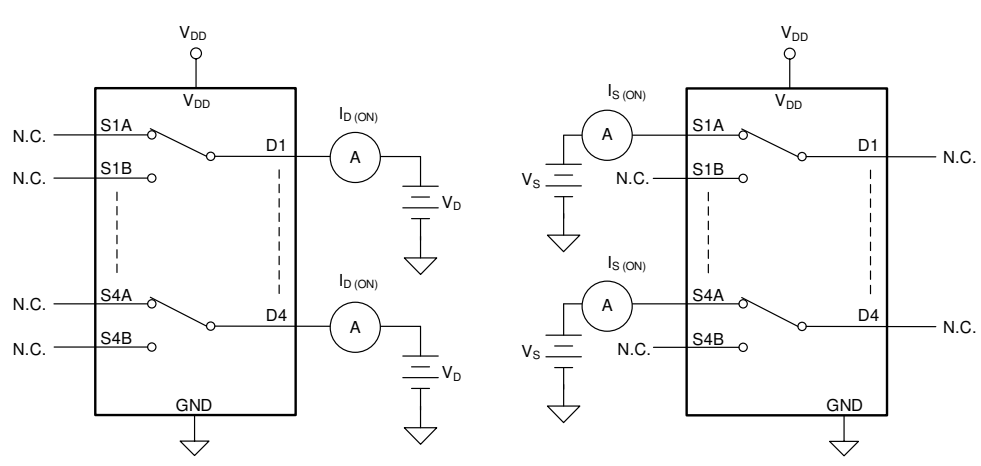


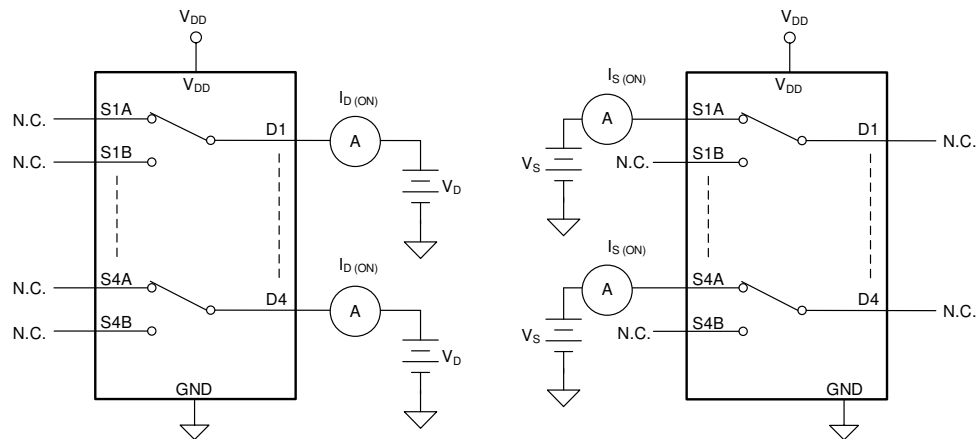
Figure 6-2. Off-Leakage Measurement Setup

6.3 On-Leakage Current

Source on-leakage current is defined as the leakage current flowing into or out of the source pin when the switch is on. This current is denoted by the symbol $I_{S(ON)}$.

Drain on-leakage current is defined as the leakage current flowing into or out of the drain pin when the switch is on. This current is denoted by the symbol $I_{D(ON)}$.

Either the source pin or drain pin is left floating during the measurement.  shows the circuit used for measuring the on-leakage current, denoted by $I_{S(ON)}$ or $I_{D(ON)}$.

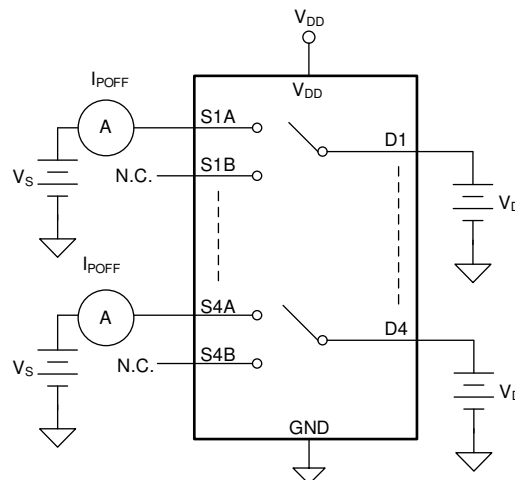


 6-3. On-Leakage Measurement Setup

6.4 I_{POFF} Leakage Current


I_{POFF} leakage current is defined as the leakage current flowing into or out of the source pin when the device is powered off. This current is denoted by the symbol I_{POFF} .

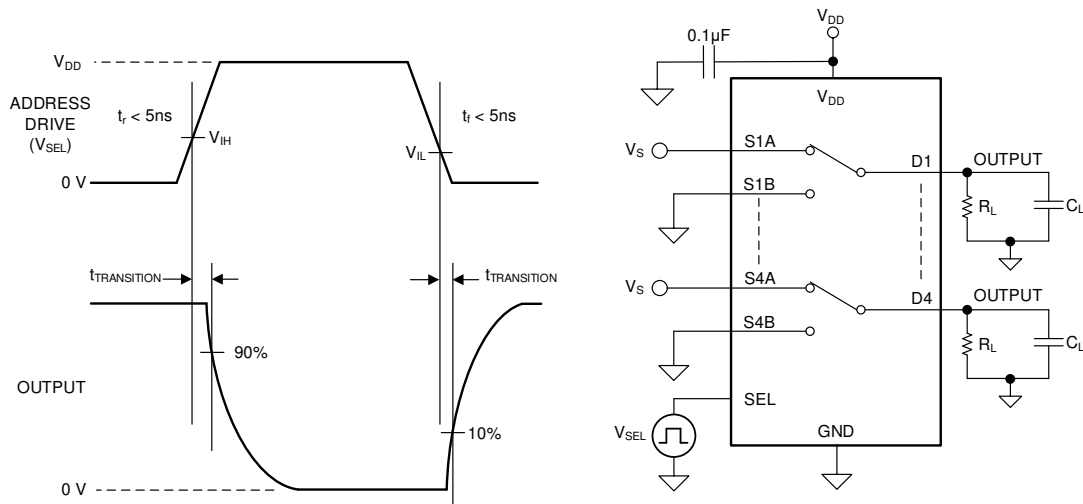
The setup used to measure both I_{POFF} leakage current is shown in .



 6-4. I_{POFF} Leakage Measurement Setup


6.5 Transition Time

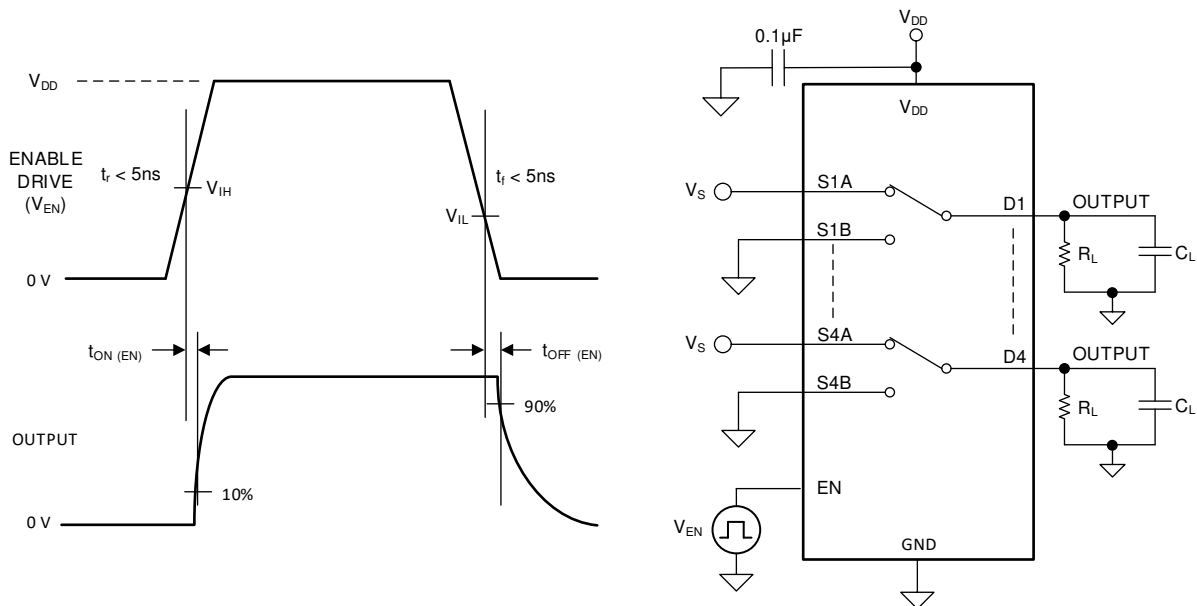
Transition time is defined as the time taken by the output of the device to rise or fall 10% after the select signal has risen or fallen past the logic threshold. The 10% transition measurement is utilized to provide the timing of the device. The time constant from the load resistance and load capacitance can be added to the transition time to calculate system level timing.  6-5 shows the setup used to measure transition time, denoted by the symbol $t_{\text{TRANSITION}}$.



 6-5. Transition-Time Measurement Setup


6.6 $t_{\text{ON}}(\text{EN})$ and $t_{\text{OFF}}(\text{EN})$ Time

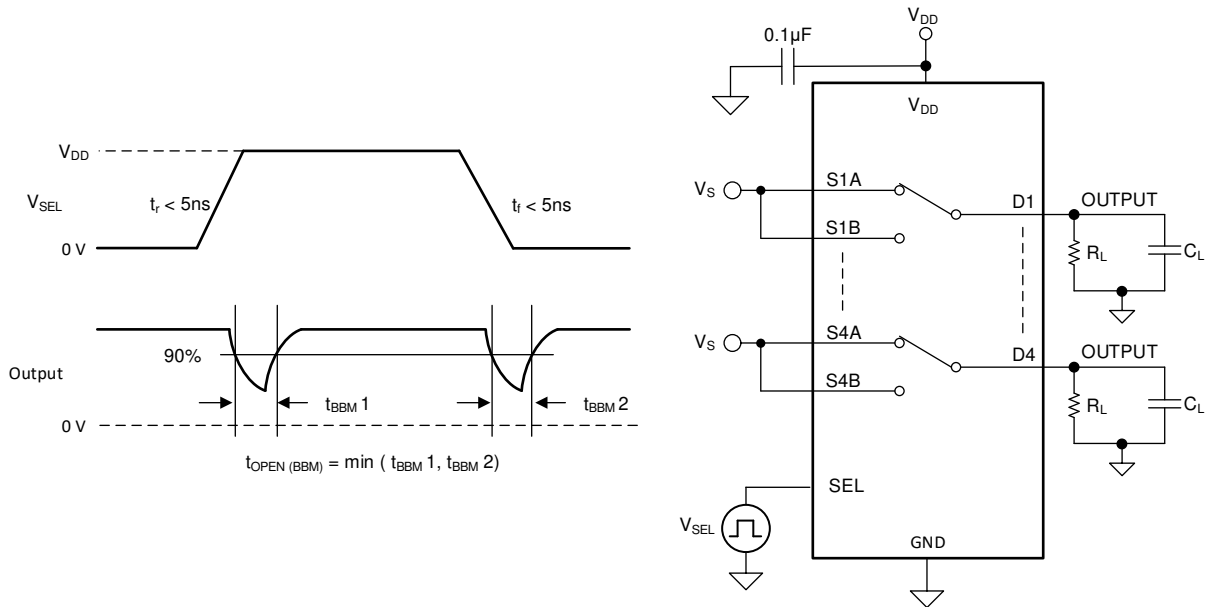
The $t_{\text{ON}}(\text{EN})$ time is defined as the time taken by the output of the device to rise to 90% after the enable has fallen past the logic threshold. The 90% measurement is used to provide the timing of the device being enabled in the system.  6-6 shows the setup used to measure the enable time, denoted by the symbol $t_{\text{ON}}(\text{EN})$.



 6-6. $t_{\text{ON}}(\text{EN})$ and $t_{\text{OFF}}(\text{EN})$ Time Measurement Setup

6.7 Break-Before-Make Delay

Break-before-make delay is a safety feature that prevents two inputs from connecting when the device is switching. The output first breaks from the on-state switch before making the connection with the next on-state switch. The time delay between the *break* and the *make* is known as break-before-make delay.  6-7 shows the setup used to measure break-before-make delay, denoted by the symbol $t_{\text{OPEN(BBM)}}$.



 **6-7. Break-Before-Make Delay Measurement Setup**

6.8 Charge Injection

The amount of charge injected into the source or drain of the device during the falling or rising edge of the gate signal is known as charge injection, and is denoted by the symbol Q_C . 図 6-8 shows the setup used to measure charge injection from source (Sx) to drain (Dx).

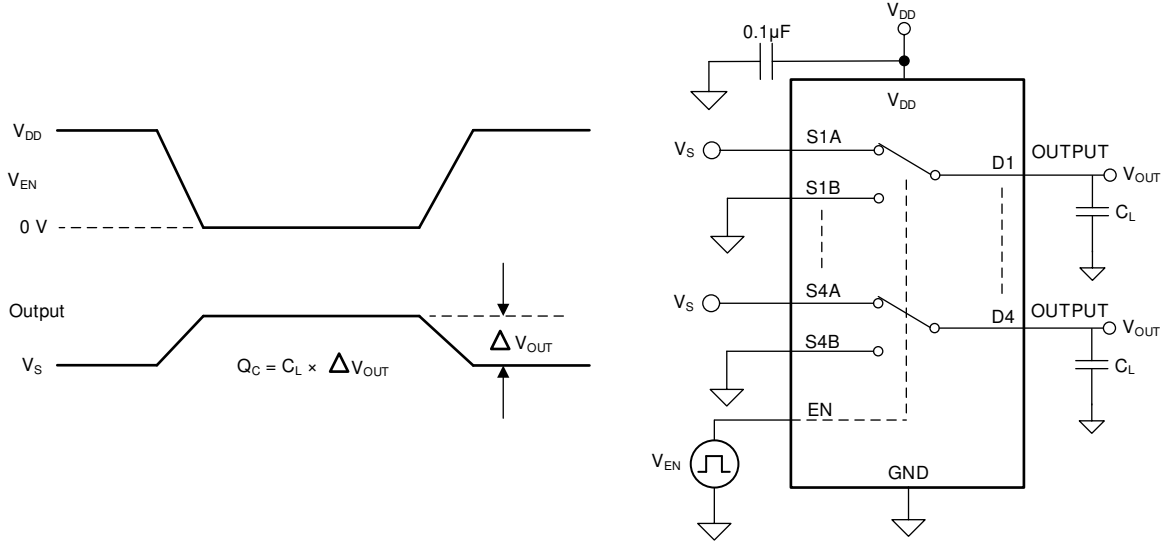


図 6-8. Charge-Injection Measurement Setup

6.9 Off Isolation

Off isolation is defined as the ratio of the signal at the drain pin (Dx) of the device when a signal is applied to the source pin (Sx) of an off-channel. The characteristic impedance, Z_0 , for the measurement is 50 Ω . [Figure 6-9](#) shows the setup used to measure off isolation. Use off isolation equation to compute off isolation.

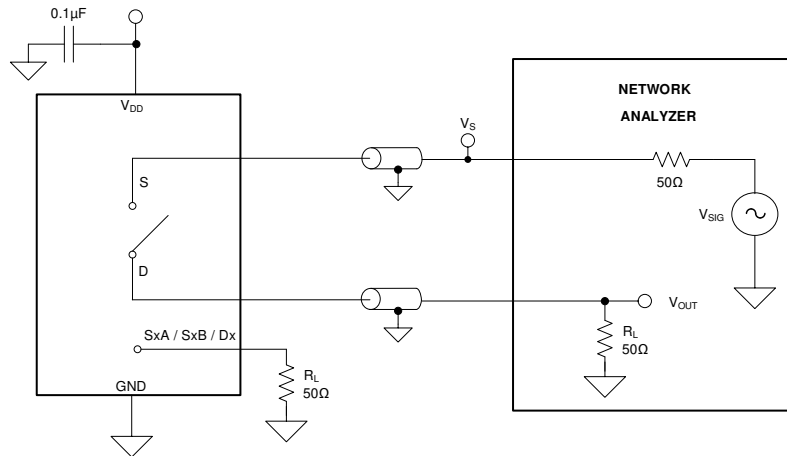


Figure 6-9. Off Isolation Measurement Setup

$$\text{Off Isolation} = 20 \cdot \text{Log} \left(\frac{V_{\text{OUT}}}{V_{\text{S}}} \right) \quad (1)$$

6.10 Channel-to-Channel Crosstalk

Crosstalk is defined as the ratio of the signal at the drain pin (Dx) of a different channel, when a signal is applied at the source pin (Sx) of an on-channel. The characteristic impedance, Z_0 , for the measurement is 50 Ω . [Figure 6-10](#) shows the setup used to measure, and the equation used to compute crosstalk.

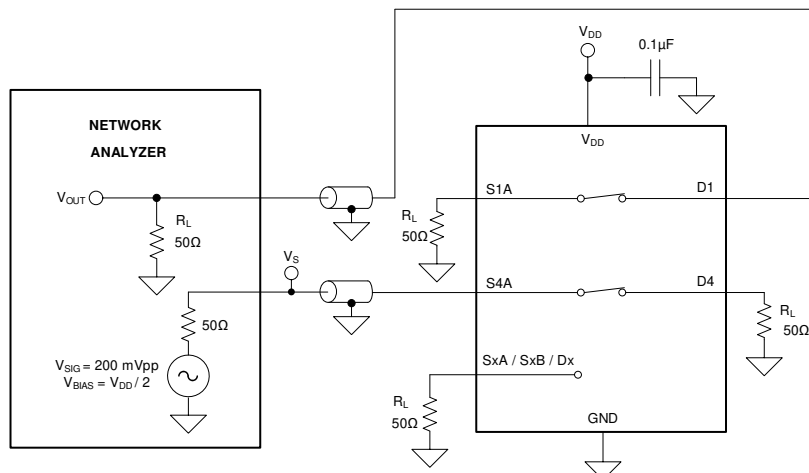
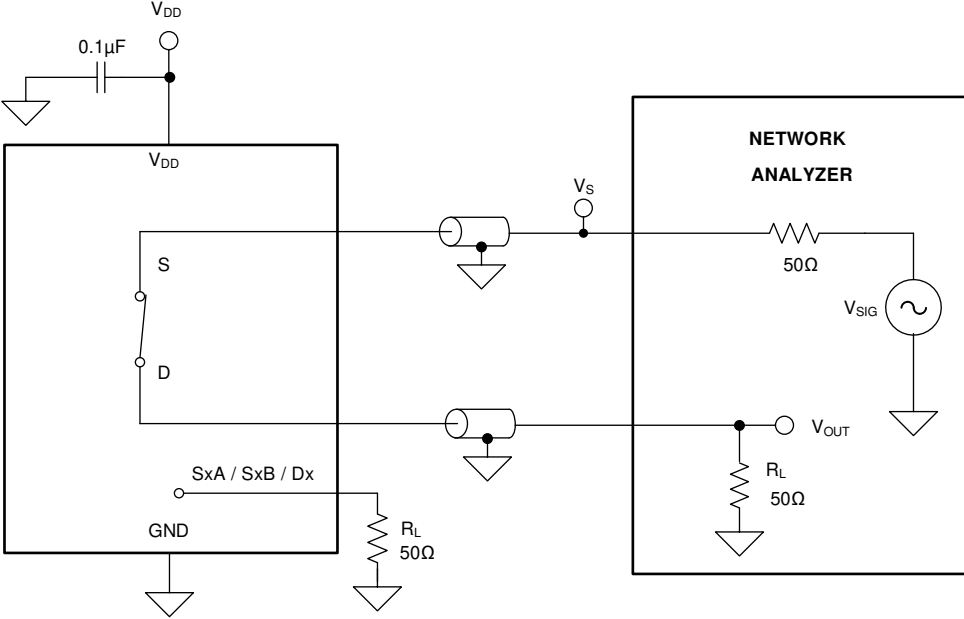
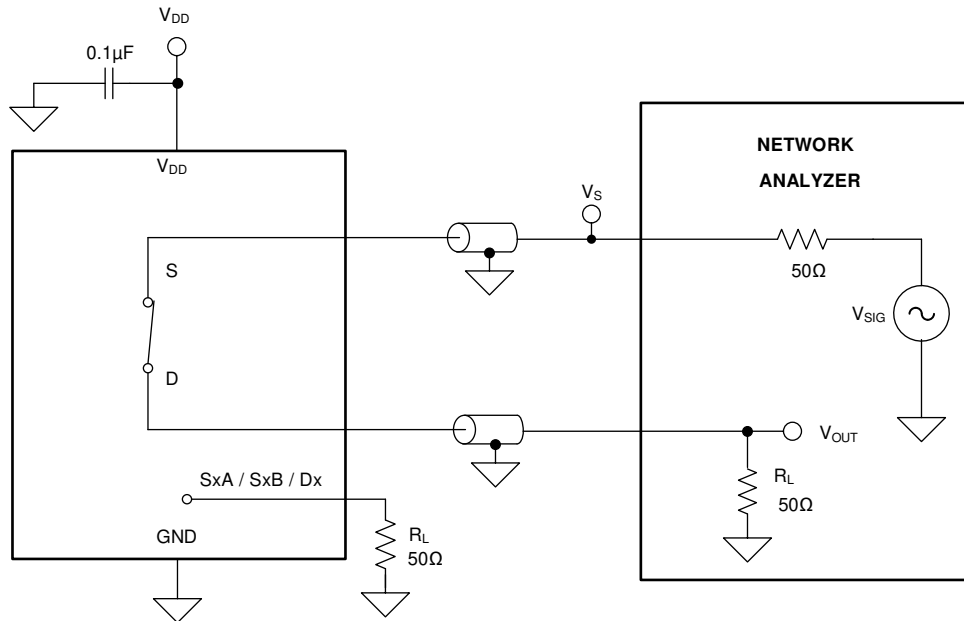


Figure 6-10. Channel-to-Channel Crosstalk Measurement Setup

$$\text{Channel-to-Channel Crosstalk} = 20 \cdot \text{Log} \left(\frac{V_{\text{OUT}}}{V_{\text{S}}} \right) \quad (2)$$

6.11 Bandwidth

Bandwidth is defined as the range of frequencies that are attenuated by less than 3 dB when the input is applied to the source pin (Sx) of an on-channel, and the output is measured at the drain pin (Dx) of the device. The characteristic impedance, Z_0 , for the measurement is $50\ \Omega$.  6-11 shows the setup used to measure bandwidth.



 6-11. Bandwidth Measurement Setup

$$Attenuation = 20 \times \text{Log} \left(\frac{V_{OUT}}{V_S} \right)$$

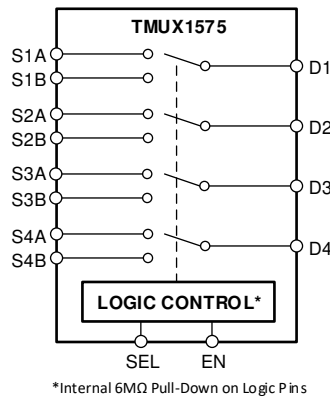
(3)

7 Detailed Description

7.1 Overview

The TMUX1575 is a high speed 2:1 (SPDT) 4-ch. switch with powered-off protection. Wide operating supply of 1.08V to 3.6V allows for use in a wide array of applications from servers and communication equipment to personal electronics. The device supports bidirectional analog and digital signals on the source (SxA, SxB) and drain (Dx) pins. The wide bandwidth of this switch allows little or no attenuation of high-speed signals at the outputs to pass with minimum edge and phase distortion as well as propagation delay.

7.2 Functional Block Diagram



7.3 Feature Description

7.3.1 Bidirectional Operation

The TMUX1575 conducts equally well from source (SxA, SxB) to drain (Dx) or from drain (Dx) to source (SxA, SxB). Each channel has very similar characteristics in both directions and supports both analog and digital signals.

7.3.2 Beyond Supply Operation

When the TMUX1575 is powered from 1.08V to 3.6V, the valid signal path input and output voltage ranges from GND to $V_{DD} \times 2$, with a maximum input/output voltage of 3.6V.

Example 1: If the TMUX1575 is powered at 1.2V, the signal range is 0V to 2.4V.

Example 2: If the TMUX1575 is powered at 1.8V, the signal range is 0V to 3.6V.

Example 3: If the TMUX1575 is powered at 3.6V, the signal range is 0V to 3.6V.

Other voltage levels not mentioned in the examples support Beyond Supply Operation as long as the supply voltage falls within the recommended operation conditions of 1.08V to 3.6V.

7.3.3 1.2V Logic Compatible Inputs

The TMUX1575 has 1.2-V logic compatible control inputs. Regardless of the V_{DD} voltage, the control input thresholds remain fixed, allowing a 1.8-V processor GPIO to control the TMUX1575 without the need for an external translator. This saves both space and BOM cost. For more information on 1.2V and 1.8V logic implementations, refer to [Simplifying Design with 1.8V logic Muxes and Switches](#).

7.3.4 Powered-off Protection

Powered-off protection up on the signal path of the TMUX1575 provides isolation when the supply voltage is removed ($V_{DD} = 0V$). When the TMUX1575 is powered-off, the I/Os of the device remain in a high-Z state. Powered-off protection minimizes system complexity by removing the need for power supply sequencing on the signal path. The device performance remains within the leakage performance mentioned in the Electrical Specifications. For more information on powered-off protection, refer to [Eliminate Power Sequencing with Powered-off Protection Signal Switches](#).

7.3.5 Fail-Safe Logic

The TMUX1575 has Fail-Safe Logic on the control input pins (SELx) which allows for operation up to 3.6V, regardless of the state of the supply pin. This feature allows voltages on the control pins to be applied before the supply pin, protecting the device from potential damage. Fail-Safe Logic minimizes system complexity by removing the need for power supply sequencing on the logic control pins. For example, the Fail-Safe Logic feature allows the select pins of the TMUX1575 to be ramped to 3.6V while $V_{DD} = 0V$. Additionally, the feature enables operation of the TMUX1575 with $V_{DD} = 1.08V$ while allowing the select pins to interface with a logic level of another device up to 3.6V.

7.3.6 Integrated Pull-Down Resistors

The TMUX1575 has internal weak pull-down resistors (6M Ω) to GND so that the logic pins are not left floating. This feature integrates external components and reduces system size and cost.

7.4 Device Functional Modes

The enable (EN) pin is an active-high logic pin that controls the connection between the source (SxA, SxB) and drain (Dx) pins of the device. When the enable pin is pulled low, all switches are turned off. When the enable is pulled high, the select pin controls the signal path selection. The select pin (SEL) controls the state of all four channels of the TMUX1575 and determines which source pin is connected to the drain pins. When the select pin is pulled low, the SxA pin conducts to the corresponding Dx pins. When the select pin is pulled high, the SxB pin conducts to the corresponding Dx pins. The TMUX1575 logic pins have internal weak pull-down resistors (6 M Ω) to GND so that it powers-on in a known state.

The TMUX1575 can be operated without any external components except for the supply decoupling capacitors. Unused logic control pins should be tied to GND or V_{DD} so that the device does not consume additional current as highlighted in [Implications of Slow or Floating CMOS Inputs](#). Unused signal path inputs (SxA, SxB, or Dx) should be connected to GND.

7.4.1 Truth Tables

表 7-1. TMUX1575 Truth Table

| INPUTS | | Selected Source Pins Connected To Drain Pins (Dx) |
|--------|------------------|--|
| EN | SEL | |
| 1 | 0 | S1A connected to D1 S2A connected to D2 S3A connected to D3 S4A connected to D4 |
| 1 | 1 | S1B connected to D1 S2B connected to D2 S3B connected to D3 S4B connected to D4 |
| 0 | X ⁽¹⁾ | Hi-Z (OFF) |

(1) X denotes *don't care*.

8 Application and Implementation

注

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8.1 Typical Application

Common applications that require the features of the TMUX1575 include multiplexing various protocols from a processor or MCU such as SPI, JTAG, eMMC, or standard GPIO signals. The TMUX1575 provides superior isolation performance when the device is powered. The added benefit of powered-off protection allows a system to minimize complexity by eliminating the need for power sequencing in hot-swap and live insertion applications. The example shown in [図 8-1](#) illustrates the use of the TMUX1575 to multiplex an SPI bus to multiple flash memory devices.

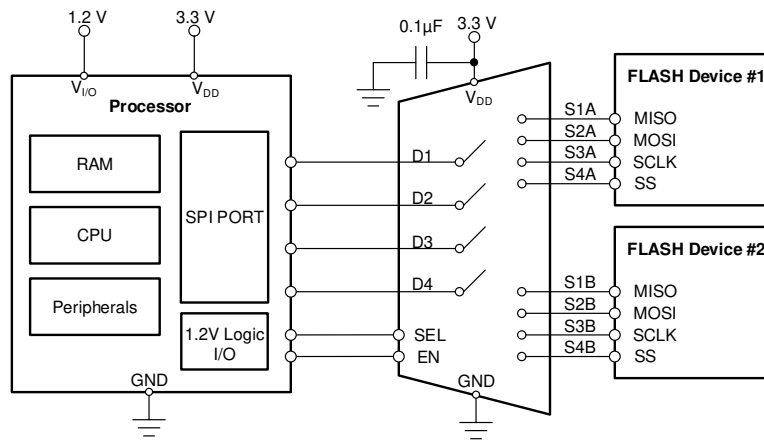


図 8-1. Multiplexing Flash Memory

8.1.1 Design Requirements

For this design example, use the parameters listed in [表 8-1](#).

表 8-1. Design Parameters

| PARAMETERS | VALUES |
|-----------------------------|-----------------|
| Supply (V_{DD}) | 3.3V |
| Input / Output signal range | 0V to 3.3V |
| Control logic thresholds | 1.2V compatible |

8.1.2 Detailed Design Procedure

The TMUX1575 can be operated without any external components except for the supply decoupling capacitors. The TMUX1575 has internal weak pull-down resistors (6 M Ω) to GND so that it powers-on with the switches in a known state. All inputs signals passing through the switch must fall within the recommend operating conditions of the TMUX1575 including signal range and continuous current. For this design example, with a supply of 3.3V, the signals can range from 0V to 3.3V when the device is powered. This example can also utilize the [Powered-off protection](#) feature where the inputs can range from 0V to 3.6V when $V_{DD} = 0V$. Due to the voltage range and high speed capability, the TMUX1575 example is suitable for use in SPI, JTAG, eMMC, and I2S applications. Refer to [Enabling SPI-based flash memory expansion by using multiplexers](#) for more information on using switches and multiplexers for SPI protocol expansion.

8.2 Power Supply Recommendations

The TMUX1575 operates across a wide supply range of 1.08V to 3.6V. Do not exceed the absolute maximum ratings because stresses beyond the listed ratings can cause permanent damage to the devices.

Power-supply bypassing improves noise margin and prevents switching noise propagation from the V_{DD} supply to other components. Good power-supply decoupling is important to achieve optimum performance. For improved supply noise immunity, use a supply decoupling capacitor ranging from 0.1 μF to 10 μF from V_{DD} to ground. Place the bypass capacitors as close to the power supply pins of the device as possible using low-impedance connections. TI recommends using multi-layer ceramic chip capacitors (MLCCs) that offer low equivalent series resistance (ESR) and inductance (ESL) characteristics for power-supply decoupling purposes. For very sensitive systems, or for systems in harsh noise environments, avoiding the use of vias for connecting the capacitors to the device pins may offer superior noise immunity. The use of multiple vias in parallel lowers the overall inductance and is beneficial for connections to ground planes.

8.3 Layout

8.3.1 Layout Guidelines

When a PCB trace turns a corner at a 90° angle, a reflection can occur. A reflection occurs primarily because of the change of width of the trace. At the apex of the turn, the trace width increases to 1.414 times the width. This increase upsets the transmission-line characteristics, especially the distributed capacitance and self-inductance of the trace which results in the reflection. Not all PCB traces can be straight and therefore some traces must turn corners. [Figure 8-2](#) shows progressively better techniques of rounding corners. Only the last example (BEST) maintains constant trace width and minimizes reflections.

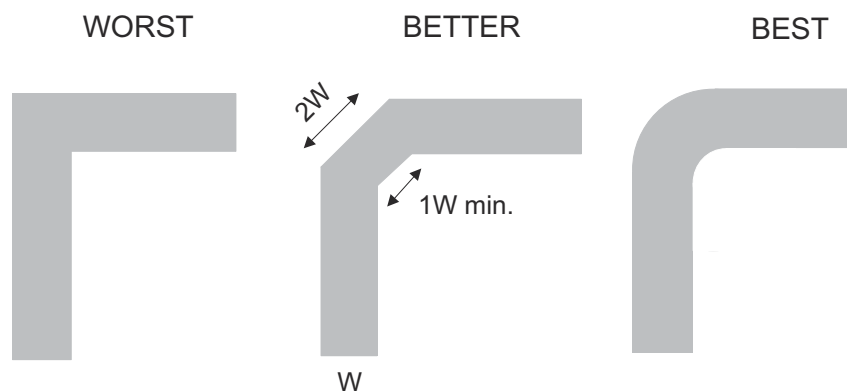


Figure 8-2. Trace Example

Route the high-speed signals using a minimum of vias and corners which reduces signal reflections and impedance changes. When a via must be used, increase the clearance size around it to minimize its capacitance. Each via introduces discontinuities in the signal's transmission line and increases the chance of picking up interference from the other layers of the board. Be careful when designing test points, through-hole pins are not recommended at high frequencies.

Do not route high speed signal traces under or near crystals, oscillators, clock signal generators, switching regulators, mounting holes, magnetic devices or ICs that use or duplicate clock signals.

Avoid stubs on the high-speed signals traces because they cause signal reflections.

Route all high-speed signal traces over continuous GND planes, with no interruptions.

Avoid crossing over anti-etch, commonly found with plane splits.

When working with high frequencies, a printed circuit board with at least four layers is recommended; two signal layers separated by a ground and power layer as shown in [Figure 8-3](#).

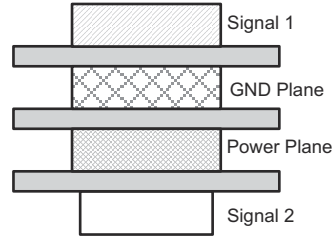


図 8-3. Example Layout

The majority of signal traces must run on a single layer, preferably Signal 1. Immediately next to this layer must be the GND plane, which is solid with no cuts. Avoid running signal traces across a split in the ground or power plane. When running across split planes is unavoidable, sufficient decoupling must be used. Minimizing the number of signal vias reduces EMI by reducing inductance at high frequencies. 図 8-4 illustrates an example of a PCB layout with the TMUX1575. Some key considerations are:

Decouple the V_{DD} pin with a 0.1- μF capacitor, placed as close to the pin as possible. Make sure that the capacitor voltage rating is sufficient for the V_{DD} supply.

High-speed switches require proper layout and design procedures for optimum performance.

Keep the input lines as short as possible.

Use a solid ground plane to help reduce electromagnetic interference (EMI) noise pickup.

Do not run sensitive analog traces in parallel with digital traces. Avoid crossing digital and analog traces if possible, and only make perpendicular crossings when necessary.

8.3.2 Layout Example

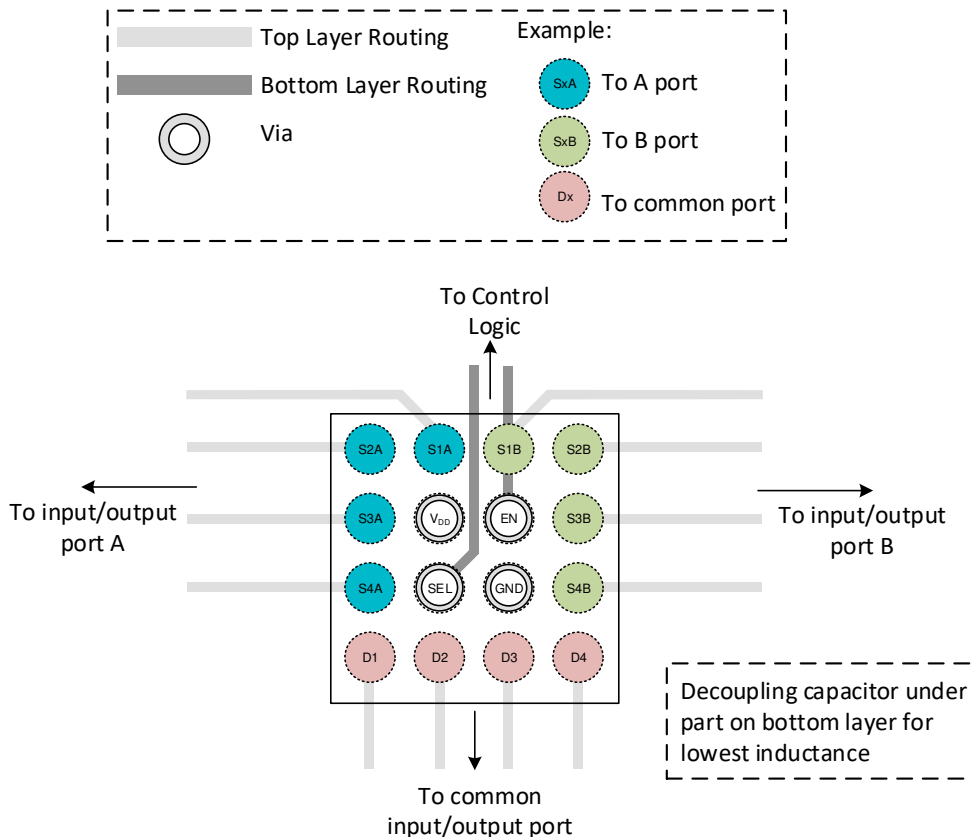


図 8-4. Example Layout

9 Device and Documentation Support

9.1 Documentation Support

9.1.1 Related Documentation

Texas Instruments, [Improve Stability Issues with Low CON Multiplexers](#).

Texas Instruments, [Enabling SPI-based flash memory expansion by using multiplexers](#).

Texas Instruments, [Simplifying Design with 1.8V logic Muxes and Switches](#).

Texas Instruments, [Eliminate Power Sequencing with Powered-off Protection Signal Switches](#).

Texas Instruments, [System-Level Protection for High-Voltage Analog Multiplexers](#).

Texas Instruments, [High-Speed Interface Layout Guidelines](#).

Texas Instruments, [High-Speed Layout Guidelines](#).

Texas Instruments, [QFN/SON PCB Attachment](#).

Texas Instruments, [Quad Flatpack No-Lead Logic Packages](#).

9.2 ドキュメントの更新通知を受け取る方法

ドキュメントの更新についての通知を受け取るには、www.tij.co.jp のデバイス製品フォルダを開いてください。[通知] をクリックして登録すると、変更されたすべての製品情報に関するダイジェストを毎週受け取ることができます。変更の詳細については、改訂されたドキュメントに含まれている改訂履歴をご覧ください。

9.3 サポート・リソース

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9.6 用語集

[テキサス・インスツルメンツ用語集](#) この用語集には、用語や略語の一覧および定義が記載されています。

10 Revision History

資料番号末尾の英字は改訂を表しています。その改訂履歴は英語版に準じています。

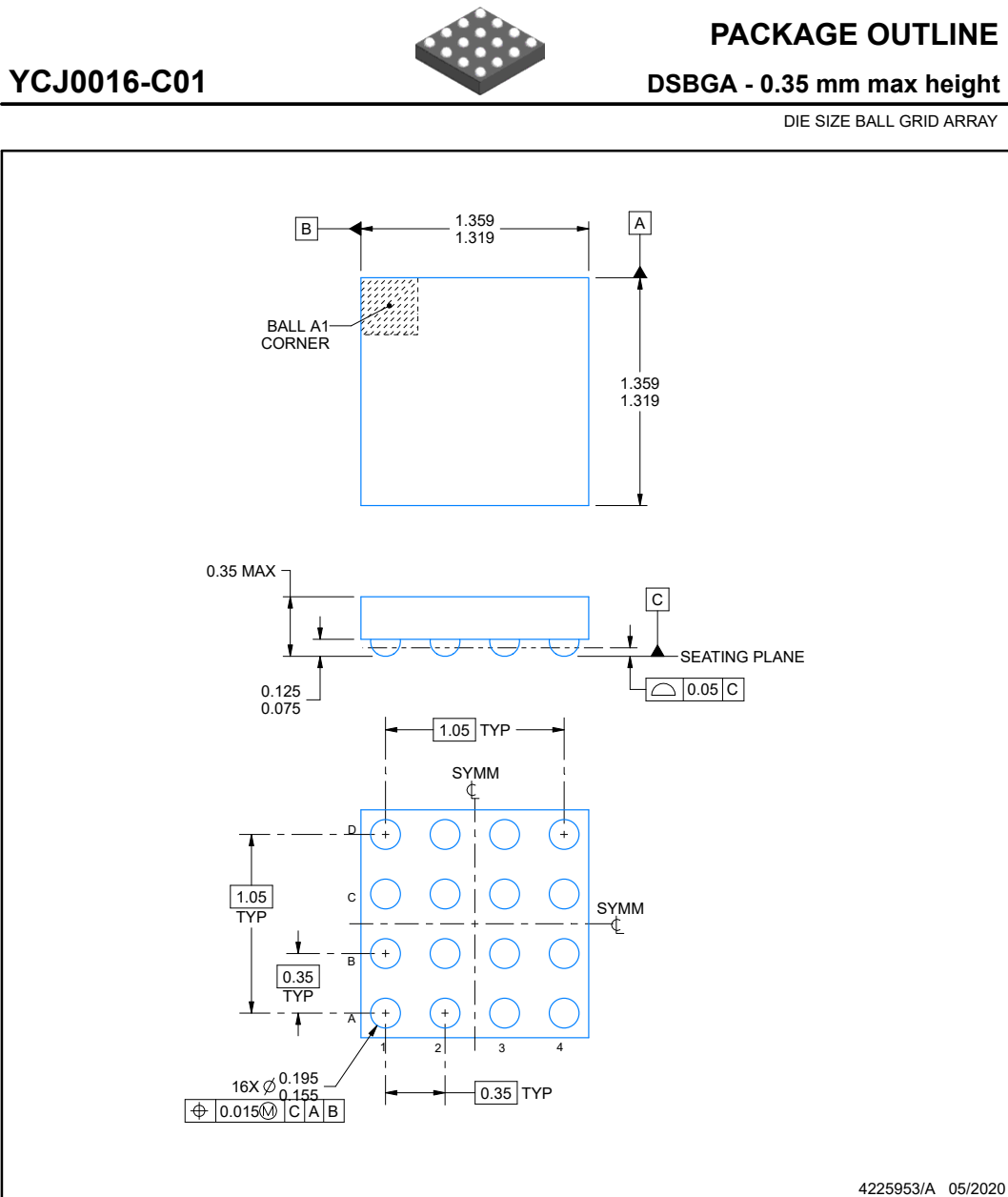
Changes from Revision * (October 2020) to Revision A (May 2024) Page

- | Changes from Revision * (October 2020) to Revision A (May 2024) | Page |
|---|------|
| • パッケージのリード フレーム サイズを含めるよう「パッケージ情報」表を更新。..... | 1 |

11 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

11.1 Mechanical Data



NOTES:

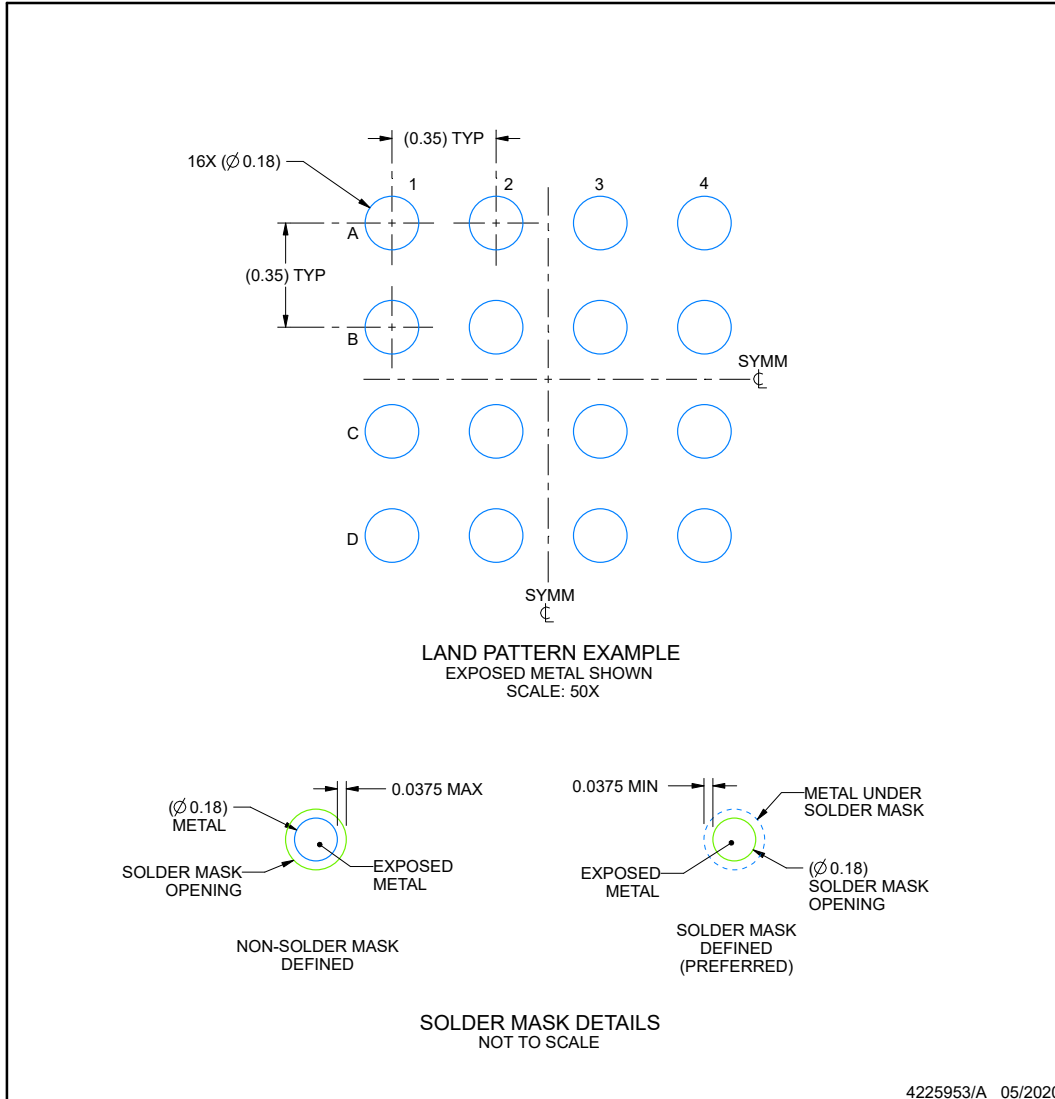
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

EXAMPLE BOARD LAYOUT

YCJ0016-C01

DSBGA - 0.35 mm max height

DIE SIZE BALL GRID ARRAY



NOTES: (continued)

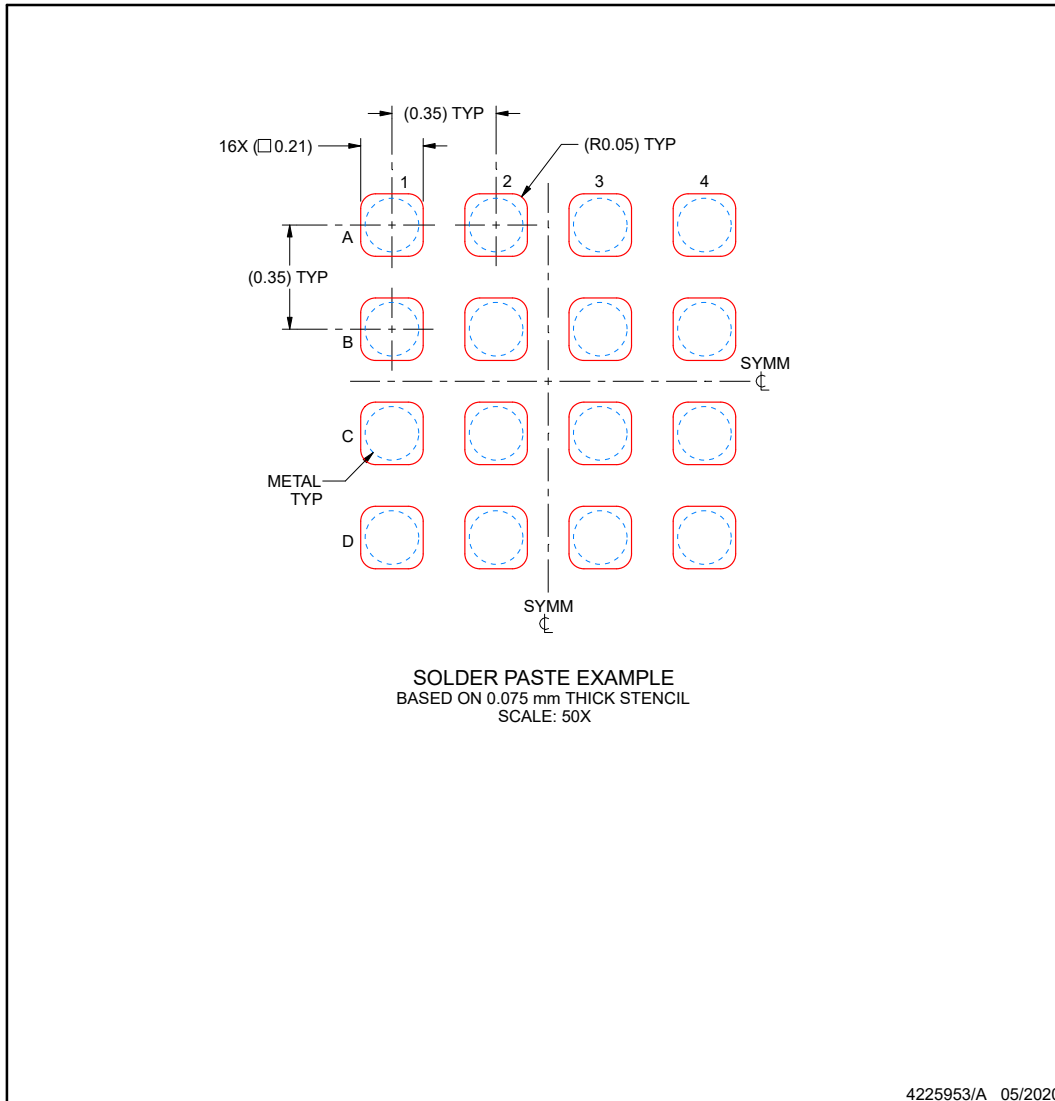
- Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints. See Texas Instruments Literature No. SNVA009 (www.ti.com/lit/snva009).

EXAMPLE STENCIL DESIGN

YCJ0016-C01

DSBGA - 0.35 mm max height

DIE SIZE BALL GRID ARRAY



NOTES: (continued)

- 4. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release.

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PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead finish/ Ball material (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|-----------------|------|-------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|---------|
| TMUX1575YCJR | ACTIVE | DSBGA | YCJ | 16 | 3000 | RoHS & Green | SNAGCU | Level-1-260C-UNLIM | -40 to 125 | 1575 | Samples |

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|--------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TMUX1575YCJR | DSBGA | YCJ | 16 | 3000 | 180.0 | 8.4 | 1.46 | 1.46 | 0.43 | 4.0 | 8.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|--------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TMUX1575YCJR | DSBGA | YCJ | 16 | 3000 | 182.0 | 182.0 | 20.0 |

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