

TMUX1104 5V, Low-Leakage-Current, 4:1 Precision Multiplexer

1 Features

- Wide supply range: 1.08V to 5.5V
- Low leakage current: 3pA
- Low charge injection: 1.5pC
- Low on-resistance: 2Ω
- 40°C to +125°C operating temperature
- 1.8V logic compatible
- Fail-safe logic
- Rail to rail operation
- Bidirectional signal path
- Break-before-make switching
- ESD protection HBM: 2000V

2 Applications

- Ultrasound scanners
- Patient monitoring and diagnostics
- Blood glucose monitors
- Optical networking
- Optical test equipment
- Remote radio units
- Wired networking
- Data acquisition systems
- ATE test equipment
- Factory automation and industrial controls
- Programmable logic controllers (PLC)
- Analog input modules
- SONAR receivers
- Battery monitoring systems

3 Description

The TMUX1104 is a precision complementary metal-oxide semiconductor (CMOS) multiplexer (MUX). The TMUX1104 offers a single channel, 4:1 configuration. A wide operating supply of 1.08V to 5.5V makes this device an excellent choice for a broad array of applications from medical equipment to industrial systems. The device supports bidirectional analog and digital signals on the source (Sx) and drain (D) pins ranging from GND to V_{DD}. All logic inputs have 1.8V logic compatible thresholds, allowing for both TTL and CMOS logic compatibility when operating in the valid supply voltage range. Fail-Safe Logic circuitry allows voltages on the control pins to be applied before the supply pin, protecting the device from potential damage.

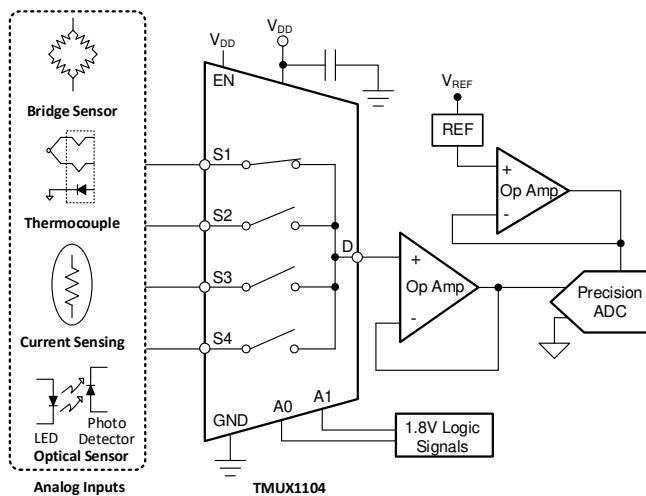
The TMUX1104 is part of the precision switches and multiplexers family of devices. These devices have very low on and off leakage currents and low charge injection, allowing them to be used in high precision measurement applications. A low supply current of 5nA and small package options enable use in portable applications.

Package Information

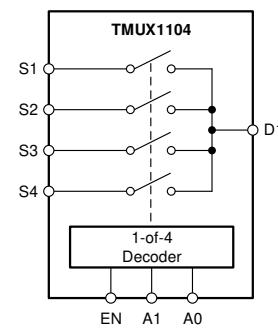
PART NUMBER	PACKAGE ⁽¹⁾	PACKAGE SIZE ⁽²⁾
TMUX1104	DGS (VSSOP, 10)	3mm × 4.9mm
	DQA (USON, 10)	2.5mm × 1mm

(1) For more information, see [Section 11](#)

(2) The package size (length × width) is a nominal value and includes pins, where applicable.



Simplified Schematic



Block Diagram

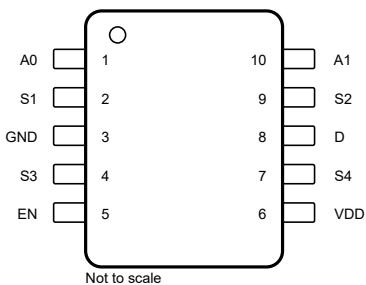


An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.

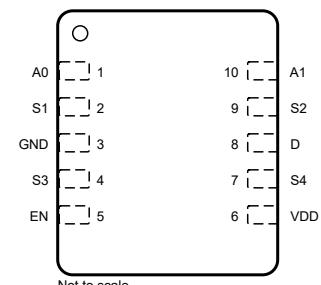
Table of Contents

1 Features	1	6.9 Crosstalk.....	19
2 Applications	1	6.10 Bandwidth.....	19
3 Description	1	7 Detailed Description	20
4 Pin Configuration and Functions	3	7.1 Functional Block Diagram.....	20
5 Specifications	4	7.2 Feature Description.....	20
5.1 Absolute Maximum Ratings.....	4	7.3 Device Functional Modes.....	22
5.2 ESD Ratings.....	4	7.4 Truth Tables.....	22
5.3 Recommended Operating Conditions.....	4	8 Application and Implementation	23
5.4 Thermal Information.....	5	8.1 Application Information.....	23
5.5 Electrical Characteristics ($V_{DD} = 5V \pm 10\%$).....	5	8.2 Typical Application.....	23
5.6 Electrical Characteristics ($V_{DD} = 3.3V \pm 10\%$).....	7	8.3 Power Supply Recommendations.....	24
5.7 Electrical Characteristics ($V_{DD} = 1.8V \pm 10\%$).....	8	8.4 Layout.....	25
5.8 Electrical Characteristics ($V_{DD} = 1.2V \pm 10\%$).....	10	9 Device and Documentation Support	26
5.9 Typical Characteristics.....	12	9.1 Documentation Support.....	26
6 Parameter Measurement Information	15	9.2 Receiving Notification of Documentation Updates.....	26
6.1 On-Resistance.....	15	9.3 Support Resources.....	26
6.2 Off-Leakage Current.....	15	9.4 Trademarks.....	26
6.3 On-Leakage Current.....	16	9.5 Electrostatic Discharge Caution.....	26
6.4 Transition Time.....	16	9.6 Glossary.....	26
6.5 Break-Before-Make.....	17	10 Revision History	26
6.6 $t_{ON(EN)}$ and $t_{OFF(EN)}$	17	11 Mechanical, Packaging, and Orderable Information	27
6.7 Charge Injection.....	18		
6.8 Off Isolation.....	18		

4 Pin Configuration and Functions



**Figure 4-1. DGS Package,
10-Pin VSSOP (Top View)**



**Figure 4-2. DQA Package,
10-Pin USON (Top View)**

Table 4-1. Pin Functions

PIN		TYPE ⁽¹⁾	DESCRIPTION
NAME	NO.		
A0	1	I	Address line 0. Controls the switch configuration as shown in Table 7-1 .
S1	2	I/O	Source pin 1. Can be an input or output.
GND	3	P	Ground (0V) reference
S3	4	I/O	Source pin 3. Can be an input or output.
EN	5	I	Active high logic enable. When this pin is low, all switches are turned off. When this pin is high, the A[1:0] logic inputs determine which switch is turned on.
VDD	6	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.
S4	7	I/O	Source pin 4. Can be an input or output.
D	8	I/O	Drain pin. Can be an input or output.
S2	9	I/O	Source pin 2. Can be an input or output.
A1	10	I	Address line 1. Controls the switch configuration as shown in Table 7-1 .

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

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	6	V
V_{SEL} or V_{EN}	Logic control input pin voltage (EN, A0, A1)	-0.5	6	V
I_{SEL} or I_{EN}	Logic control input pin current (EN, A0, A1)	-30	30	mA
V_S or V_D	Source or drain voltage (Sx, D)	-0.5	$V_{DD}+0.5$	V
I_S or I_D (CONT)	Source or drain continuous current (Sx, D)	$I_{DC} \pm 10\%^{(4)}$	$I_{DC} \pm 10\%^{(4)}$	mA
I_S or I_D (PEAK)	Source and drain peak current: (1 ms period max, 10% duty cycle maximum) (Sx, D)	$I_{peak} \pm 10\%^{(4)}$	$I_{peak} \pm 10\%^{(4)}$	mA
T_{stg}	Storage temperature	-65	150	°C
P_{tot}	Total power dissipation (5) (6)		500	mW
T_J	Junction temperature		150	°C

- (1) Stresses beyond those listed under *Absolute Maximum Rating* 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 Condition*. 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.
- (4) Refer to Recommended Operating Conditions for I_{DC} and I_{Peak} ratings
- (5) For DGS(VSSOP) package: P_{tot} derates linearly above $TA=53^{\circ}\text{C}$ by $5.16\text{mW/}^{\circ}\text{C}$
- (6) For DQA(USON) package: P_{tot} derates linearly above $TA=63^{\circ}\text{C}$ by $5.78\text{mW/}^{\circ}\text{C}$

5.2 ESD Ratings

		VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins ⁽¹⁾	± 2000
		Charged device model (CDM), per JEDEC specification JESD22-C101, all pins ⁽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

over operating free-air temperature range (unless otherwise noted)

		MIN	NOM	MAX	UNIT
V_{DD}	Positive power supply voltage	1.08	5.5	V	
V_S or V_D	Signal path input/output voltage (source or drain pin) (Sx, D)	0	V_{DD}	V	
V_{SEL} or V_{EN}	Logic control input pin voltage	0	5.5	V	
T_A	Ambient temperature	-40	125	°C	
I_{DC}	Continuous current through switch	$T_J = 25^{\circ}\text{C}$	150		mA
		$T_J = 85^{\circ}\text{C}$	120		mA
		$T_J = 125^{\circ}\text{C}$	60		mA
		$T_J = 130^{\circ}\text{C}$	50		mA
I_{peak}	Peak current through switch(1 ms period max, 10% duty cycle maximum)	$T_J = 25^{\circ}\text{C}$	300		mA
		$T_J = 85^{\circ}\text{C}$	300		mA
		$T_J = 125^{\circ}\text{C}$	180		mA
		$T_J = 130^{\circ}\text{C}$	160		mA

5.4 Thermal Information

THERMAL METRIC ⁽¹⁾		TMUX1104		UNIT
		DGS (VSSOP)	DQA (USON)	
		10 PINS	10 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	193.9	173.0	°C/W
$R_{\theta JC(\text{top})}$	Junction-to-case (top) thermal resistance	83.1	99.7	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	116.5	73.5	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	22.0	8.9	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	114.6	73.0	°C/W
$R_{\theta JC(\text{bot})}$	Junction-to-case (bottom) thermal resistance	N/A	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 ($V_{DD} = 5V \pm 10\%$)

at $T_A = 25^\circ\text{C}$, $V_{DD} = 5\text{V}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	TA	MIN	TYP	MAX	UNIT
ANALOG SWITCH						
R_{ON}	On-resistance Refer to On-Resistance	$V_S = 0\text{V}$ to V_{DD} $I_{SD} = 10\text{ mA}$	25°C	2	4	Ω
			-40°C to +85°C		4.5	Ω
			-40°C to +125°C		4.9	Ω
ΔR_{ON}	On-resistance matching between channels Refer to On-Resistance	$V_S = 0\text{V}$ to V_{DD} $I_{SD} = 10\text{ mA}$	25°C	0.13		Ω
			-40°C to +85°C		0.4	Ω
			-40°C to +125°C		0.5	Ω
$R_{ON\text{ FLAT}}$	On-resistance flatness Refer to On-Resistance	$V_S = 0\text{V}$ to V_{DD} $I_{SD} = 10\text{ mA}$	25°C	0.85		Ω
			-40°C to +85°C		1.6	Ω
			-40°C to +125°C		1.6	Ω
$I_{S(\text{OFF})}$	Source off leakage current ⁽¹⁾ Refer to Off-Leakage Current	$V_{DD} = 5\text{V}$ Switch Off $V_D = 4.5\text{V} / 1.5\text{V}$ $V_S = 1.5\text{V} / 4.5\text{V}$	25°C	-0.08	± 0.005	0.08
			-40°C to +85°C	-0.3		nA
			-40°C to +125°C	-0.9		nA
$I_{D(\text{OFF})}$	Drain off leakage current ⁽¹⁾ Refer to Off-Leakage Current	$V_{DD} = 5\text{V}$ Switch Off $V_D = 4.5\text{V} / 1.5\text{V}$ $V_S = 1.5\text{V} / 4.5\text{V}$	25°C	-0.1	± 0.01	0.1
			-40°C to +85°C	-0.75		nA
			-40°C to +125°C	-3.5		nA
$I_{D(\text{ON})}$ $I_{S(\text{ON})}$	Channel on leakage current Refer to On-Leakage Current	$V_{DD} = 5\text{V}$ Switch On $V_D = V_S = 2.5\text{V}$	25°C	-0.025	± 0.003	0.025
			-40°C to +85°C	-0.3		nA
			-40°C to +125°C	-0.95		nA
$I_{D(\text{ON})}$ $I_{S(\text{ON})}$	Channel on leakage current Refer to On-Leakage Current	$V_{DD} = 5\text{V}$ Switch On $V_D = V_S = 4.5\text{V} / 1.5\text{V}$	25°C	-0.1	± 0.01	0.1
			-40°C to +85°C	-0.75		nA
			-40°C to +125°C	-3.5		nA
LOGIC INPUTS (EN, A0, A1)						
V_{IH}	Input logic high		-40°C to +125°C	1.49	5.5	V
V_{IL}	Input logic low		-40°C to +125°C	0	0.87	V
I_{IH} I_{IL}	Input leakage current		25°C	± 0.005		μA
I_{IH} I_{IL}	Input leakage current		-40°C to +125°C	± 0.05		μA

5.5 Electrical Characteristics ($V_{DD} = 5V \pm 10\%$) (continued)

at $T_A = 25^\circ\text{C}$, $V_{DD} = 5\text{V}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	TA	MIN	TYP	MAX	UNIT	
C_{IN}	Logic input capacitance		25°C		1		pF	
C_{IN}	Logic input capacitance		-40°C to +125°C		2		pF	
POWER SUPPLY								
I_{DD}	V_{DD} supply current	Logic inputs = 0V or 5.5V	25°C	0.005		1	μA	
			-40°C to +125°C				μA	
DYNAMIC CHARACTERISTICS								
t_{TRAN}	Transition time between channels	$V_S = 3\text{V}$ $R_L = 200\Omega$, $C_L = 15\text{ pF}$ Refer to Transition Time	25°C	14		ns		
			-40°C to +85°C	18				
			-40°C to +125°C	19				
t_{OPEN} (BBM)	Break before make time	$V_S = 3\text{V}$ $R_L = 200\Omega$, $C_L = 15\text{ pF}$ Refer to Break-Before-Make	25°C	8		ns		
			-40°C to +85°C	1				
			-40°C to +125°C	1				
$t_{ON(EN)}$	Enable turn-on time	$V_S = 3\text{V}$ $R_L = 200\Omega$, $C_L = 15\text{ pF}$ Refer to tON(EN) and tOFF(EN)	25°C	12		ns		
			-40°C to +85°C	17				
			-40°C to +125°C	18				
$t_{OFF(EN)}$	Enable turn-off time	$V_S = 3\text{V}$ $R_L = 200\Omega$, $C_L = 15\text{ pF}$ Refer to tON(EN) and tOFF(EN)	25°C	5		ns		
			-40°C to +85°C	8				
			-40°C to +125°C	9				
Q_C	Charge Injection	$V_S = 1\text{V}$ $R_S = 0\Omega$, $C_L = 1\text{ nF}$ Refer to Charge Injection	25°C	1.5		pC		
O_{ISO}	Off Isolation	$R_L = 50\Omega$, $C_L = 5\text{ pF}$ $f = 1\text{ MHz}$ Refer to Off Isolation	25°C	-65			dB	
		$R_L = 50\Omega$, $C_L = 5\text{ pF}$ $f = 10\text{ MHz}$ Refer to Off Isolation	25°C	-45			dB	
X_{TALK}	Crosstalk	$R_L = 50\Omega$, $C_L = 5\text{ pF}$ $f = 1\text{ MHz}$ Refer to Crosstalk	25°C	-65		dB		
		$R_L = 50\Omega$, $C_L = 5\text{ pF}$ $f = 10\text{ MHz}$ Refer to Crosstalk	25°C	-45			dB	
BW	Bandwidth	$R_L = 50\Omega$, $C_L = 5\text{ pF}$ Refer to Bandwidth	25°C	155		MHz		
C_{SOFF}	Source off capacitance	$f = 1\text{ MHz}$	25°C	6			pF	
C_{DOFF}	Drain off capacitance	$f = 1\text{ MHz}$	25°C	28		pF		
C_{SON} C_{DON}	On capacitance	$f = 1\text{ MHz}$	25°C	35			pF	

(1) When V_S is 4.5V, V_D is 1.5V, and vice versa.

5.6 Electrical Characteristics ($V_{DD} = 3.3V \pm 10\%$)

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

PARAMETER		TEST CONDITIONS	TA	MIN	TYP	MAX	UNIT
ANALOG SWITCH							
R_{ON}	On-resistance	$V_S = 0\text{V}$ to V_{DD} $I_{SD} = 10\text{mA}$ Refer to On-Resistance	25°C	3.7	8.8	Ω	
			-40°C to +85°C		9.5	Ω	
			-40°C to +125°C		9.8	Ω	
ΔR_{ON}	On-resistance matching between channels	$V_S = 0\text{V}$ to V_{DD} $I_{SD} = 10\text{mA}$ Refer to On-Resistance	25°C	0.13		Ω	
			-40°C to +85°C		0.4	Ω	
			-40°C to +125°C		0.5	Ω	
$R_{ON\text{ FLAT}}$	On-resistance flatness	$V_S = 0\text{V}$ to V_{DD} $I_{SD} = 10\text{mA}$ Refer to On-Resistance	25°C	1.9		Ω	
			-40°C to +85°C	2		Ω	
			-40°C to +125°C	2.2		Ω	
$I_{S(OFF)}$	Source off leakage current ⁽¹⁾	$V_{DD} = 3.3\text{V}$ Switch Off $V_D = 3\text{V} / 1\text{V}$ $V_S = 1\text{V} / 3\text{V}$ Refer to Off-Leakage Current	25°C	-0.05	± 0.001	0.05	nA
			-40°C to +85°C	-0.1		0.1	nA
			-40°C to +125°C	-0.5		0.5	nA
$I_{D(OFF)}$	Drain off leakage current ⁽¹⁾	$V_{DD} = 3.3\text{V}$ Switch Off $V_D = 3\text{V} / 1\text{V}$ $V_S = 1\text{V} / 3\text{V}$ Refer to Off-Leakage Current	25°C	-0.1	± 0.005	0.1	nA
			-40°C to +85°C	-0.5		0.5	nA
			-40°C to +125°C	-2		2	nA
$I_{D(ON)}$ $I_{S(ON)}$	Channel on leakage current	$V_{DD} = 3.3\text{V}$ Switch On $V_D = V_S = 3\text{V} / 1\text{V}$ Refer to On-Leakage Current	25°C	-0.1	± 0.005	0.1	nA
			-40°C to +85°C	-0.5		0.5	nA
			-40°C to +125°C	-2		2	nA
LOGIC INPUTS (EN, A0, A1)							
V_{IH}	Input logic high		-40°C to +125°C	1.35		5.5	V
V_{IL}	Input logic low		-40°C to +125°C	0		0.8	V
I_{IH} I_{IL}	Input leakage current		25°C		± 0.005		μA
I_{IH} I_{IL}	Input leakage current		-40°C to +125°C		± 0.05		μA
C_{IN}	Logic input capacitance		25°C	1			pF
C_{IN}	Logic input capacitance		-40°C to +125°C		2		pF
POWER SUPPLY							
I_{DD}	V_{DD} supply current	Logic inputs = 0V or 5.5V	25°C	0.005			μA
			-40°C to +125°C		1		μA
DYNAMIC CHARACTERISTICS							
t_{TRAN}	Transition time between channels	$V_S = 2\text{V}$ $R_L = 200\Omega$, $C_L = 15\text{pF}$ Refer to Transition Time	25°C	15			ns
			-40°C to +85°C		21		ns
			-40°C to +125°C		22		ns
$t_{OPEN\text{ (BBM)}}$	Break before make time	$V_S = 2\text{V}$ $R_L = 200\Omega$, $C_L = 15\text{pF}$ Refer to Break-Before-Make	25°C	9			ns
			-40°C to +85°C	1			ns
			-40°C to +125°C	1			ns
$t_{ON(EN)}$	Enable turn-on time	$V_S = 2\text{V}$ $R_L = 200\Omega$, $C_L = 15\text{pF}$ Refer to tON(EN) and tOFF(EN)	25°C	14			ns
			-40°C to +85°C		21		ns
			-40°C to +125°C		21		ns

5.6 Electrical Characteristics ($V_{DD} = 3.3V \pm 10\%$) (continued)

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

PARAMETER		TEST CONDITIONS	TA	MIN	TYP	MAX	UNIT
$t_{OFF(EN)}$	Enable turn-off time	$V_S = 2V$ $R_L = 200\Omega$, $C_L = 15pF$ Refer to tON(EN) and tOFF(EN)	25°C		7		ns
			-40°C to +85°C		9		ns
			-40°C to +125°C		10		ns
Q_C	Charge Injection	$V_S = 1V$ $R_S = 0\Omega$, $C_L = 1nF$ Refer to Charge Injection	25°C		-1.5		pC
O_{ISO}	Off Isolation	$R_L = 50 \Omega$, $C_L = 5pF$ $f = 1MHz$ Refer to Off Isolation	25°C		-65		dB
		$R_L = 50 \Omega$, $C_L = 5pF$ $f = 10MHz$ Refer to Off Isolation	25°C		-45		dB
X_{TALK}	Crosstalk	$R_L = 50 \Omega$, $C_L = 5pF$ $f = 1MHz$ Refer to Crosstalk	25°C		-65		dB
		$R_L = 50 \Omega$, $C_L = 5pF$ $f = 10MHz$ Refer to Crosstalk	25°C		-45		dB
BW	Bandwidth	$R_L = 50 \Omega$, $C_L = 5pF$ Refer to Bandwidth	25°C		155		MHz
C_{SOFF}	Source off capacitance	$f = 1MHz$	25°C		6		pF
C_{DOFF}	Drain off capacitance	$f = 1MHz$	25°C		28		pF
C_{SON} C_{DON}	On capacitance	$f = 1MHz$	25°C		35		pF

(1) When V_S is 3V, V_D is 1V, and vice versa.

5.7 Electrical Characteristics ($V_{DD} = 1.8V \pm 10\%$)

at $T_A = 25^\circ C$, $V_{DD} = 1.8V$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	TA	MIN	TYP	MAX	UNIT
ANALOG SWITCH							
R_{ON}	On-resistance	$V_S = 0V$ to V_{DD} $I_{SD} = 10mA$ Refer to On-Resistance	25°C		40		Ω
			-40°C to +85°C		80		Ω
			-40°C to +125°C		80		Ω
ΔR_{ON}	On-resistance matching between channels	$V_S = 0V$ to V_{DD} $I_{SD} = 10mA$ Refer to On-Resistance	25°C		0.4		Ω
			-40°C to +85°C		1.5		Ω
			-40°C to +125°C		1.5		Ω
$I_{S(OFF)}$	Source off leakage current ⁽¹⁾	$V_{DD} = 1.98V$ Switch Off $V_D = 1.62V / 1V$ $V_S = 1V / 1.62V$ Refer to Off-Leakage Current	25°C	-0.05	± 0.003	0.05	nA
			-40°C to +85°C	-0.1		0.1	nA
			-40°C to +125°C	-0.5		0.5	nA
$I_{D(OFF)}$	Drain off leakage current ⁽¹⁾	$V_{DD} = 1.98V$ Switch Off $V_D = 1.62V / 1V$ $V_S = 1V / 1.62V$ Refer to Off-Leakage Current	25°C	-0.1	± 0.005	0.1	nA
			-40°C to +85°C	-0.5		0.5	nA
			-40°C to +125°C	-2		2	nA
$I_{D(ON)}$ $I_{S(ON)}$	Channel on leakage current	$V_{DD} = 1.98V$ Switch On $V_D = V_S = 1.62V / 1V$ Refer to On-Leakage Current	25°C	-0.1	± 0.005	0.1	nA
			-40°C to +85°C	-0.5		0.5	nA
			-40°C to +125°C	-2		2	nA
LOGIC INPUTS (EN, A0, A1)							

5.7 Electrical Characteristics ($V_{DD} = 1.8V \pm 10\%$) (continued)

at $T_A = 25^\circ C$, $V_{DD} = 1.8V$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	TA	MIN	TYP	MAX	UNIT
V_{IH}	Input logic high	$-40^\circ C$ to $+125^\circ C$	1.07	5.5	5.5	V
V_{IL}	Input logic low	$-40^\circ C$ to $+125^\circ C$	0	0.68	0.68	V
I_{IH} I_{IL}	Input leakage current	25°C	± 0.005		μA	
I_{IH} I_{IL}	Input leakage current	$-40^\circ C$ to $+125^\circ C$	± 0.05		μA	
C_{IN}	Logic input capacitance	25°C	1	1	1	pF
C_{IN}	Logic input capacitance	$-40^\circ C$ to $+125^\circ C$	2	2	2	pF
POWER SUPPLY						
I_{DD}	V_{DD} supply current	Logic inputs = 0V or 5.5V	25°C	0.001	0.001	μA
			$-40^\circ C$ to $+125^\circ C$	0.85	0.85	μA
DYNAMIC CHARACTERISTICS						
t_{TRAN}	Transition time between channels	$V_S = 1V$ $R_L = 200\Omega$, $C_L = 15pF$ Refer to Transition Time	25°C	28	28	ns
			$-40^\circ C$ to $+85^\circ C$	44	44	ns
			$-40^\circ C$ to $+125^\circ C$	44	44	ns
t_{OPEN} (BBM)	Break before make time	$V_S = 1V$ $R_L = 200\Omega$, $C_L = 15pF$ Refer to Break-Before-Make	25°C	16	16	ns
			$-40^\circ C$ to $+85^\circ C$	1	1	ns
			$-40^\circ C$ to $+125^\circ C$	1	1	ns
$t_{ON(EN)}$	Enable turn-on time	$V_S = 1V$ $R_L = 200\Omega$, $C_L = 15pF$ Refer to tON(EN) and tOFF(EN)	25°C	25	25	ns
			$-40^\circ C$ to $+85^\circ C$	41	41	ns
			$-40^\circ C$ to $+125^\circ C$	41	41	ns
$t_{OFF(EN)}$	Enable turn-off time	$V_S = 1V$ $R_L = 200\Omega$, $C_L = 15pF$ Refer to tON(EN) and tOFF(EN)	25°C	13	13	ns
			$-40^\circ C$ to $+85^\circ C$	23	23	ns
			$-40^\circ C$ to $+125^\circ C$	23	23	ns
Q_C	Charge Injection	$V_S = 1V$ $R_S = 0\Omega$, $C_L = 1nF$ Refer to Charge Injection	25°C	-0.5	-0.5	pC
O_{ISO}	Off Isolation	$R_L = 50 \Omega$, $C_L = 5pF$ $f = 1MHz$ Refer to Off Isolation	25°C	-65	-65	dB
		$R_L = 50 \Omega$, $C_L = 5pF$ $f = 10MHz$ Refer to Off Isolation	25°C	-45	-45	dB
X_{TALK}	Crosstalk	$R_L = 50 \Omega$, $C_L = 5pF$ $f = 1MHz$ Refer to Crosstalk	25°C	-65	-65	dB
		$R_L = 50 \Omega$, $C_L = 5pF$ $f = 10MHz$ Refer to Crosstalk	25°C	-45	-45	dB
BW	Bandwidth	$R_L = 50 \Omega$, $C_L = 5pF$ Refer to Bandwidth	25°C	140	140	MHz
C_{SOFF}	Source off capacitance	$f = 1MHz$	25°C	6	6	pF
C_{DOFF}	Drain off capacitance	$f = 1MHz$	25°C	28	28	pF
C_{SON} C_{DON}	On capacitance	$f = 1MHz$	25°C	35	35	pF

(1) When V_S is 1.62V, V_D is 1V, and vice versa.

5.8 Electrical Characteristics ($V_{DD} = 1.2V \pm 10\%$)

PARAMETER		TEST CONDITIONS	TA	MIN	TYP	MAX	UNIT
ANALOG SWITCH							
R_{ON}	On-resistance	$V_S = 0V$ to V_{DD} $I_{SD} = 10mA$ Refer to On-Resistance	25°C	70	70	70	Ω
			-40°C to +85°C		105	105	Ω
			-40°C to +125°C		105	105	Ω
ΔR_{ON}	On-resistance matching between channels	$V_S = 0V$ to V_{DD} $I_{SD} = 10mA$ Refer to On-Resistance	25°C	0.4	0.4	0.4	Ω
			-40°C to +85°C		1.5	1.5	Ω
			-40°C to +125°C		1.5	1.5	Ω
$I_{S(OFF)}$	Source off leakage current ⁽¹⁾	$V_{DD} = 1.32V$ Switch Off $V_D = 1V / 0.8V$ $V_S = 0.8V / 1V$ Refer to Off-Leakage Current	25°C	-0.05	± 0.003	0.05	nA
			-40°C to +85°C	-0.1	0.1	0.1	nA
			-40°C to +125°C	-0.5	0.5	0.5	nA
$I_{D(OFF)}$	Drain off leakage current ⁽¹⁾	$V_{DD} = 1.32V$ Switch Off $V_D = 1V / 0.8V$ $V_S = 0.8V / 1V$ Refer to Off-Leakage Current	25°C	-0.1	± 0.005	0.1	nA
			-40°C to +85°C	-0.5	0.5	0.5	nA
			-40°C to +125°C	-2	2	2	nA
$I_{D(ON)}$ $I_{S(ON)}$	Channel on leakage current	$V_{DD} = 1.32V$ Switch On $V_D = V_S = 1V / 0.8V$ Refer to On-Leakage Current	25°C	-0.1	± 0.005	0.1	nA
			-40°C to +85°C	-0.5	0.5	0.5	nA
			-40°C to +125°C	-2	2	2	nA
LOGIC INPUTS (EN, A0, A1)							
V_{IH}	Input logic high		-40°C to +125°C	0.96	5.5	5.5	V
V_{IL}	Input logic low		-40°C to +125°C	0	0.36	0.36	V
I_{IH} I_{IL}	Input leakage current		25°C		± 0.005		μA
I_{IH} I_{IL}	Input leakage current		-40°C to +125°C		± 0.05		μA
C_{IN}	Logic input capacitance		25°C	1	1	1	pF
C_{IN}	Logic input capacitance		-40°C to +125°C		2	2	pF
POWER SUPPLY							
I_{DD}	V_{DD} supply current	Logic inputs = 0V or 5.5V	25°C	0.001	0.001	0.001	μA
			-40°C to +125°C		0.7	0.7	μA
DYNAMIC CHARACTERISTICS							
t_{TRAN}	Transition time between channels	$V_S = 1V$ $R_L = 200Ω$, $C_L = 15pF$ Refer to Transition Time	25°C	55	55	55	ns
			-40°C to +85°C		190	190	ns
			-40°C to +125°C		190	190	ns
$t_{OPEN(BBM)}$	Break before make time	$V_S = 1V$ $R_L = 200Ω$, $C_L = 15pF$ Refer to Break-Before-Make	25°C	28	28	28	ns
			-40°C to +85°C	1	1	1	ns
			-40°C to +125°C	1	1	1	ns
$t_{ON(EN)}$	Enable turn-on time	$V_S = 1V$ $R_L = 200Ω$, $C_L = 15pF$ Refer to tON(EN) and tOFF(EN)	25°C	50	50	50	ns
			-40°C to +85°C		175	175	ns
			-40°C to +125°C		175	175	ns
$t_{OFF(EN)}$	Enable turn-off time	$V_S = 1V$ $R_L = 200Ω$, $C_L = 15pF$ Refer to tON(EN) and tOFF(EN)	25°C	35	35	35	ns
			-40°C to +85°C		135	135	ns
			-40°C to +125°C		135	135	ns
Q_C	Charge Injection	$V_S = 1V$ $R_S = 0Ω$, $C_L = 1nF$ Refer to Charge Injection	25°C	-0.5	-0.5	-0.5	pC

5.8 Electrical Characteristics ($V_{DD} = 1.2V \pm 10\%$) (continued)

PARAMETER		TEST CONDITIONS	TA	MIN	TYP	MAX	UNIT
O _{ISO}	Off Isolation	$R_L = 50 \Omega$, $C_L = 5pF$ $f = 1MHz$ Refer to Off Isolation	25°C		–65		dB
		$R_L = 50 \Omega$, $C_L = 5pF$ $f = 10MHz$ Refer to Off Isolation	25°C		–45		dB
X _{TALK}	Crosstalk	$R_L = 50 \Omega$, $C_L = 5pF$ $f = 1MHz$ Refer to Crosstalk	25°C		–65		dB
		$R_L = 50 \Omega$, $C_L = 5pF$ $f = 10MHz$ Refer to Crosstalk	25°C		–45		dB
BW	Bandwidth	$R_L = 50 \Omega$, $C_L = 5pF$ Refer to Bandwidth	25°C		125		MHz
C _{SOFF}	Source off capacitance	$f = 1MHz$	25°C		7		pF
C _{DOFF}	Drain off capacitance	$f = 1MHz$	25°C		32		pF
C _{SON} C _{DON}	On capacitance	$f = 1MHz$	25°C		40		pF

(1) When V_S is 1V, V_D is 0.8V, and vice versa.

5.9 Typical Characteristics

at $T_A = 25^\circ\text{C}$, $V_{DD} = 5\text{V}$ (unless otherwise noted)

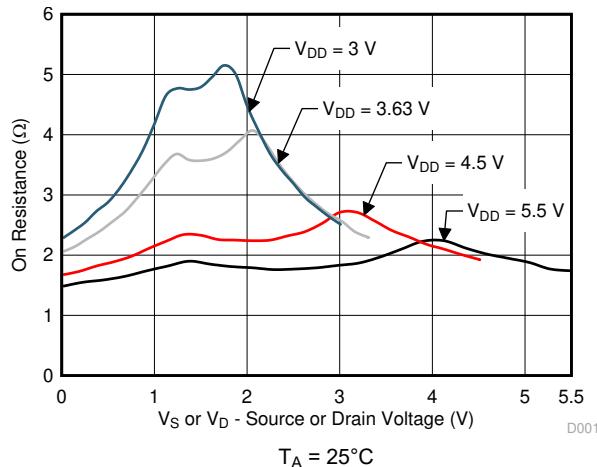


Figure 5-1. On-Resistance vs Source or Drain Voltage

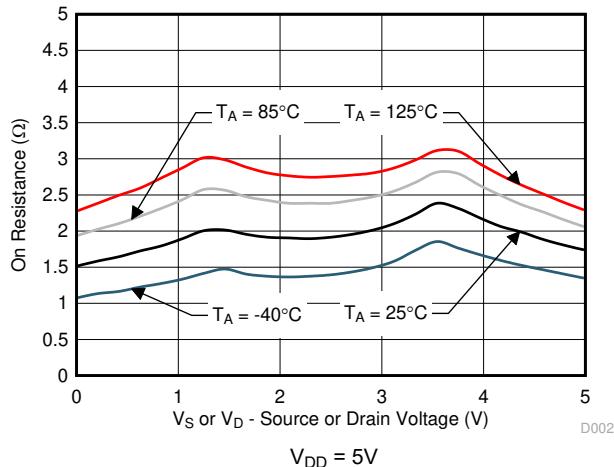


Figure 5-2. On-Resistance vs Temperature

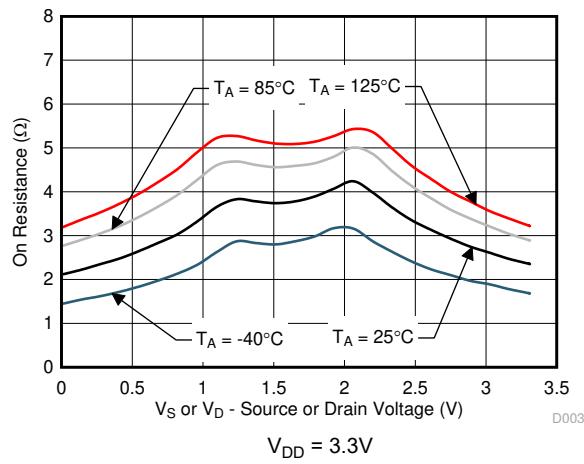


Figure 5-3. On-Resistance vs Temperature

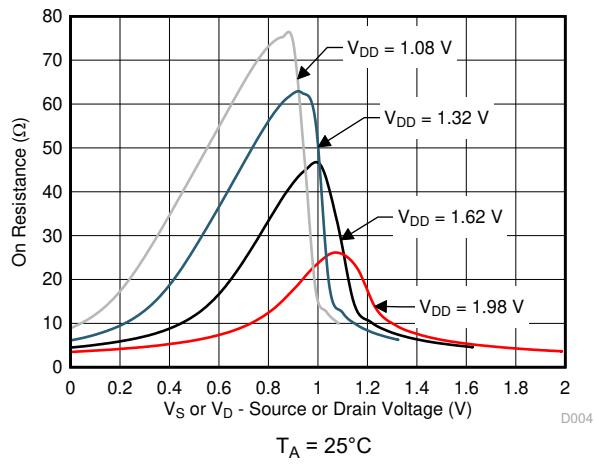


Figure 5-4. On-Resistance vs Source or Drain Voltage

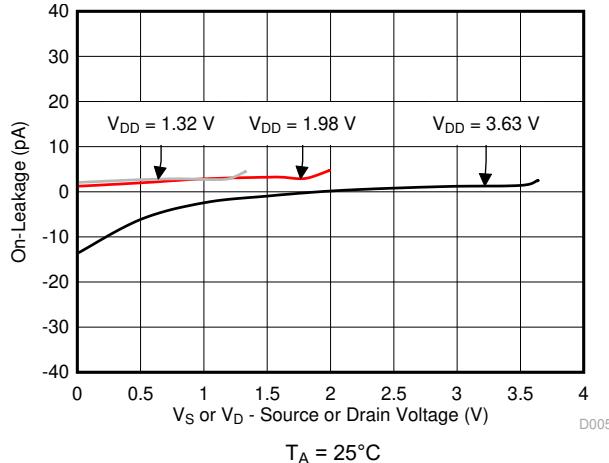


Figure 5-5. On-Leakage vs Source or Drain Voltage

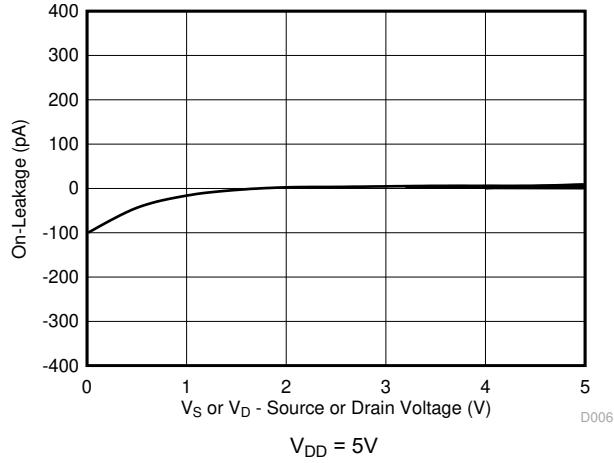
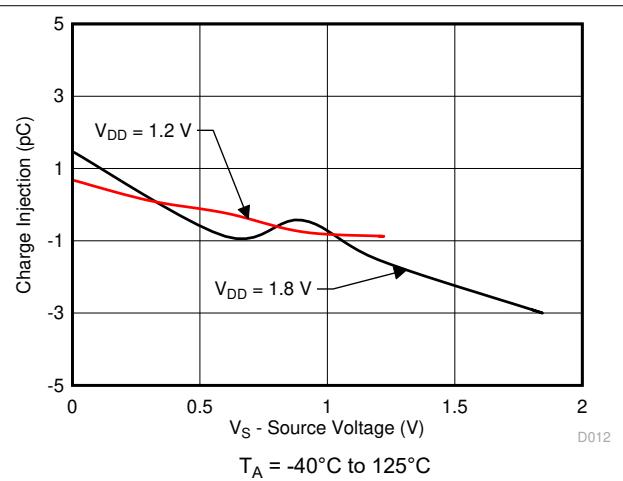
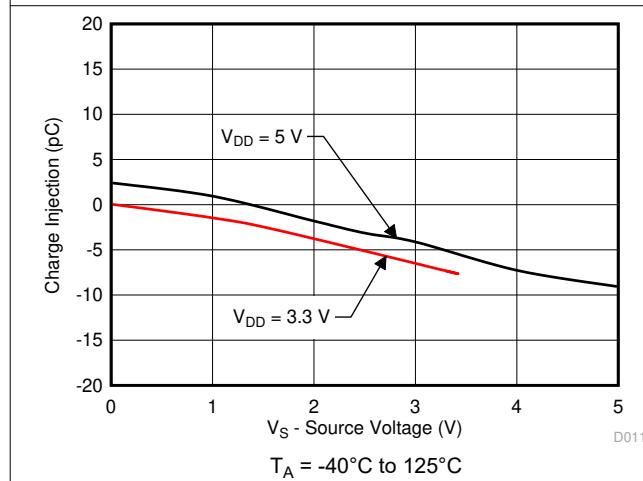
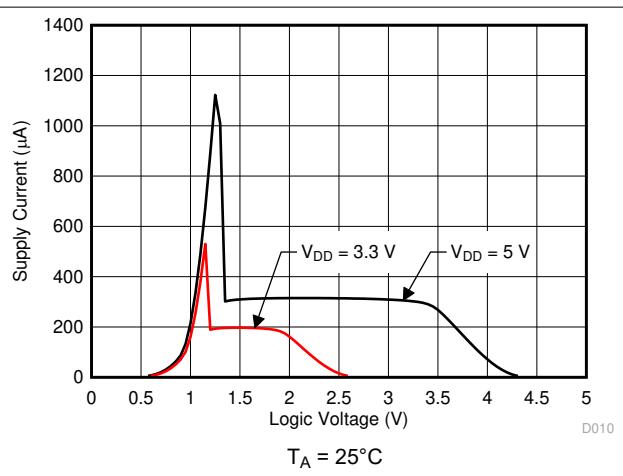
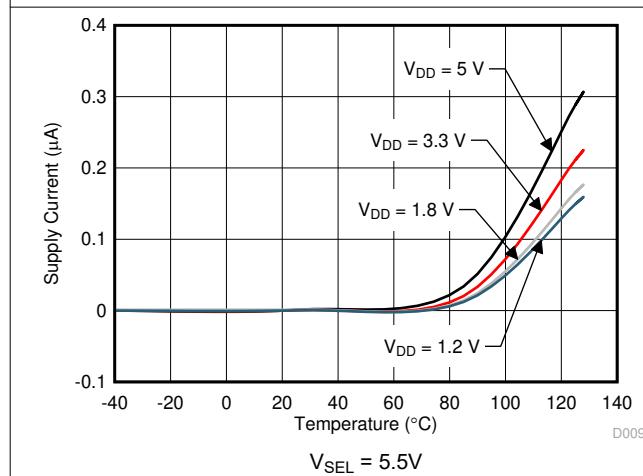
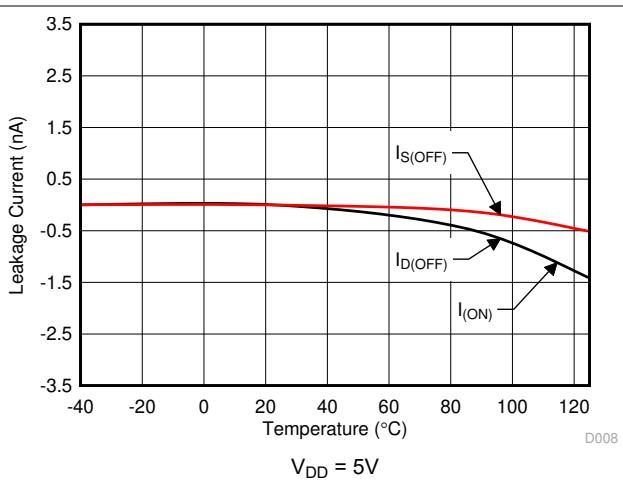
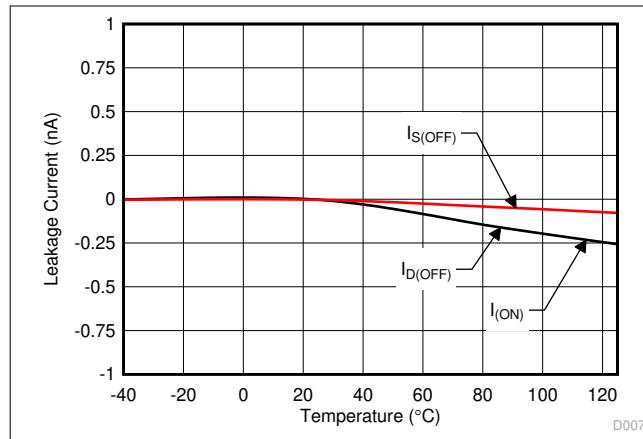


Figure 5-6. On-Leakage vs Source or Drain Voltage

5.9 Typical Characteristics (continued)

at $T_A = 25^\circ\text{C}$, $V_{DD} = 5\text{V}$ (unless otherwise noted)



5.9 Typical Characteristics (continued)

at $T_A = 25^\circ\text{C}$, $V_{DD} = 5\text{V}$ (unless otherwise noted)

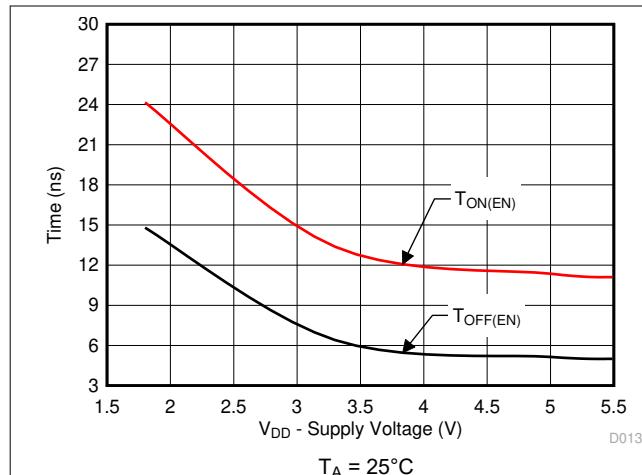


Figure 5-13. $T_{ON\text{(EN)}}$ and $T_{OFF\text{(EN)}}$ vs Supply Voltage

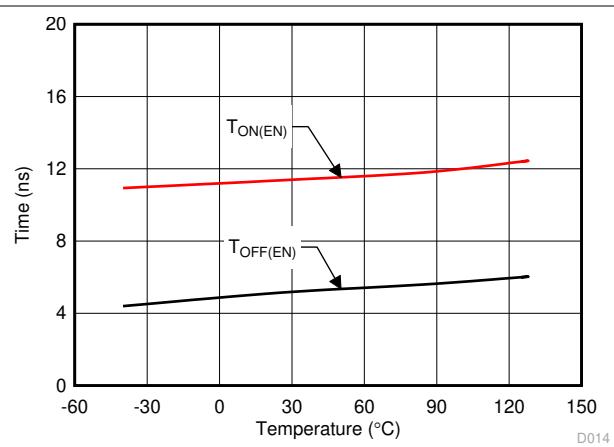


Figure 5-14. $T_{ON\text{(EN)}}$ and $T_{OFF\text{(EN)}}$ vs Temperature

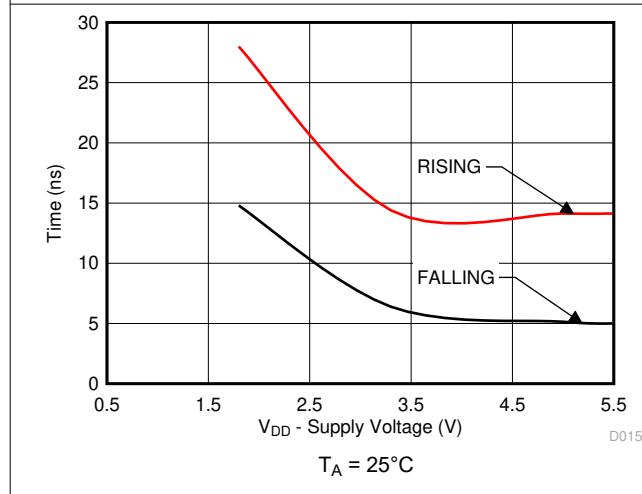


Figure 5-15. Output $T_{TRANSITION}$ vs Supply Voltage

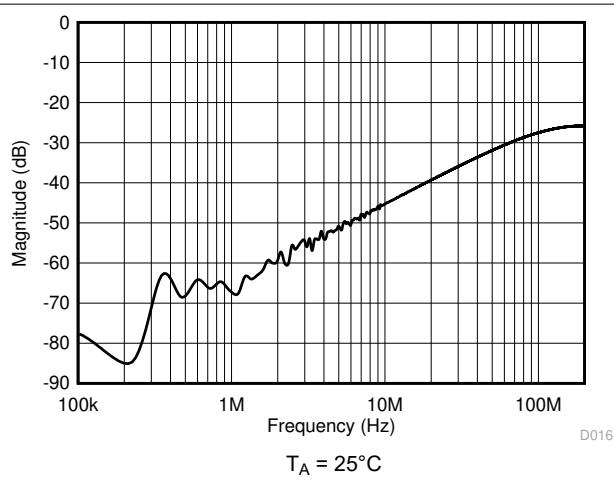


Figure 5-16. Xtalk and Off-Isolation vs Frequency

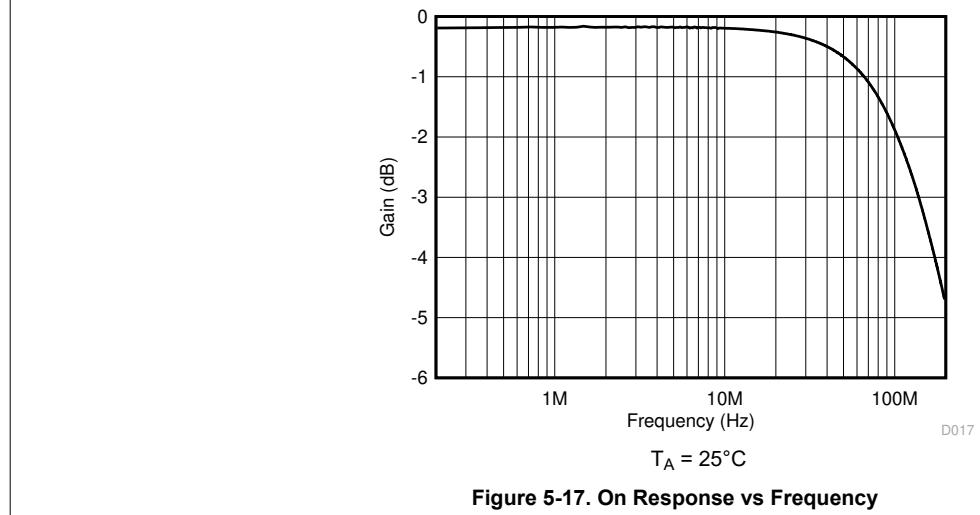


Figure 5-17. On Response vs Frequency

6 Parameter Measurement Information

6.1 On-Resistance

The on-resistance of a device is the ohmic resistance between the source (Sx) and drain (D) 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 with $R_{ON} = V / I_{SD}$:

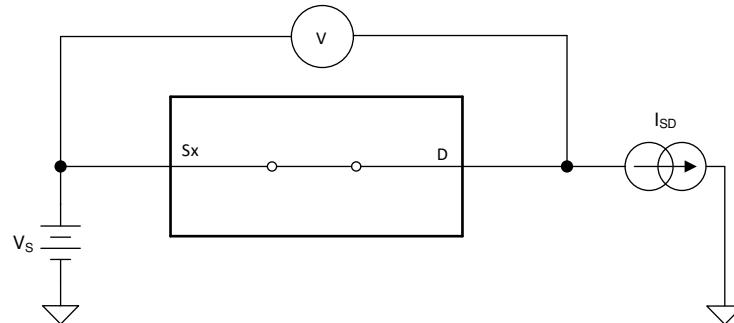


Figure 6-1. On-Resistance Measurement Setup

6.2 Off-Leakage Current

There are two types of leakage currents associated with a switch during the off state:

1. Source off-leakage current
2. Drain 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](#).

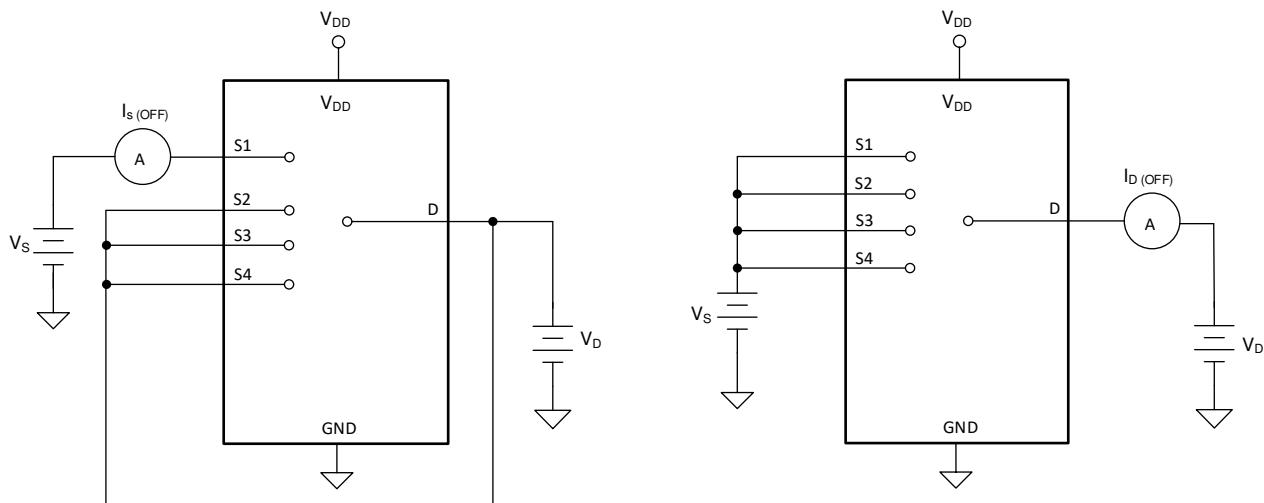


Figure 6-2. Off-Leakage Measurement Setup

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. Figure 6-3 shows the circuit used for measuring the on-leakage current, denoted by $I_{S(ON)}$ or $I_{D(ON)}$.

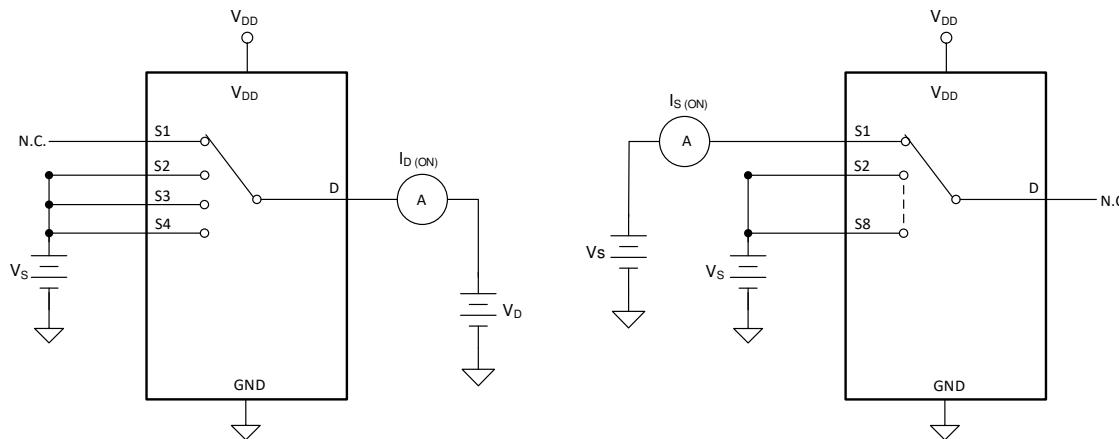


Figure 6-3. On-Leakage Measurement Setup

6.4 Transition Time

Transition time is defined as the time taken by the output of the device to rise or fall 10% after the address signal has risen or fallen past the logic threshold. The 10% transition measurement is utilized to provide the timing of the device. System level timing can then account for the time constant added from the load resistance and load capacitance. Figure 6-4 shows the setup used to measure transition time, denoted by the symbol $t_{TRANSITION}$.

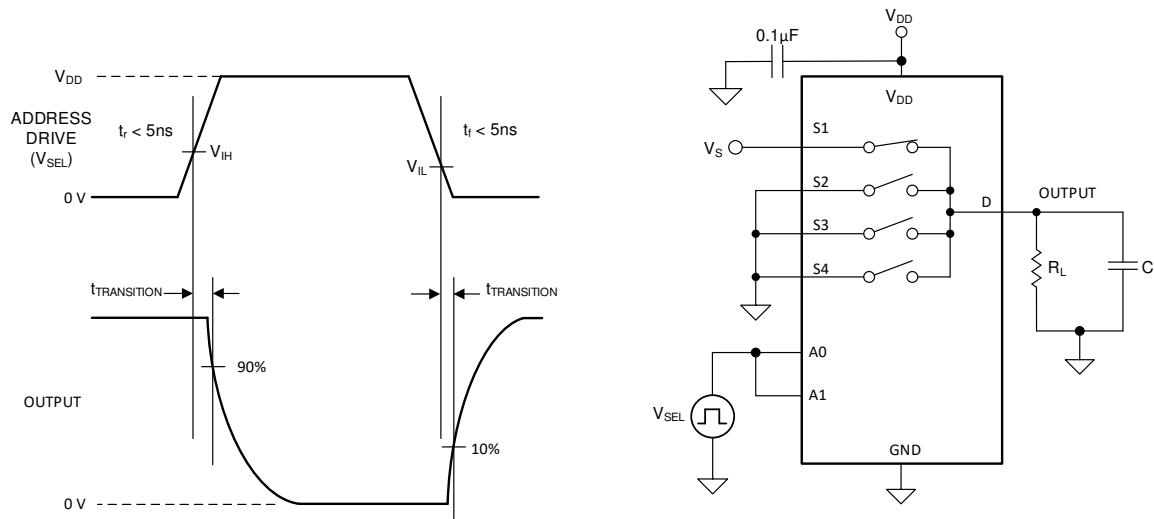


Figure 6-4. Transition-Time Measurement Setup

6.5 Break-Before-Make

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. Figure 6-5 shows the setup used to measure break-before-make delay, denoted by the symbol $t_{OPEN(BBM)}$.

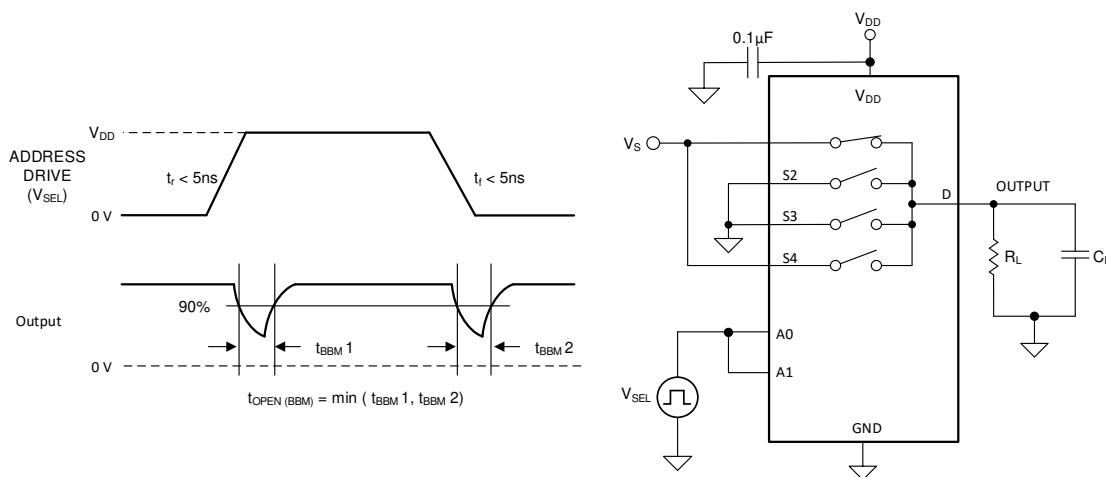


Figure 6-5. Break-Before-Make Delay Measurement Setup

6.6 $t_{ON(EN)}$ and $t_{OFF(EN)}$

Turn-on time is defined as the time taken by the output of the device to rise to 10% after the enable has risen past the logic threshold. The 10% measurement is utilized to provide the timing of the device. System level timing can then account for the time constant added from the load resistance and load capacitance. Figure 6-6 shows the setup used to measure turn-on time, denoted by the symbol $t_{ON(EN)}$.

Turn-off time is defined as the time taken by the output of the device to fall to 90% after the enable has fallen past the logic threshold. The 90% measurement is utilized to provide the timing of the device. System level timing can then account for the time constant added from the load resistance and load capacitance. Figure 6-6 shows the setup used to measure turn-off time, denoted by the symbol $t_{OFF(EN)}$.

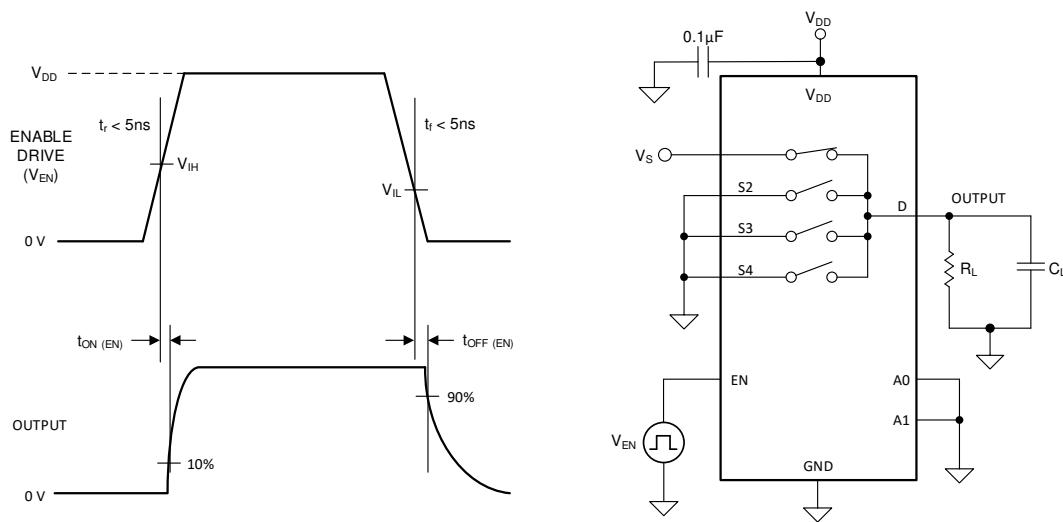


Figure 6-6. Turn-On and Turn-Off Time Measurement Setup

6.7 Charge Injection

The TMUX1104 has a transmission-gate topology. Any mismatch in capacitance between the NMOS and PMOS transistors results in a charge injected into the drain or source during the falling or rising edge of the gate signal. The amount of charge injected into the source or drain of the device is known as charge injection, and is denoted by the symbol Q_C . Figure 6-7 shows the setup used to measure charge injection from source (Sx) to drain (D).

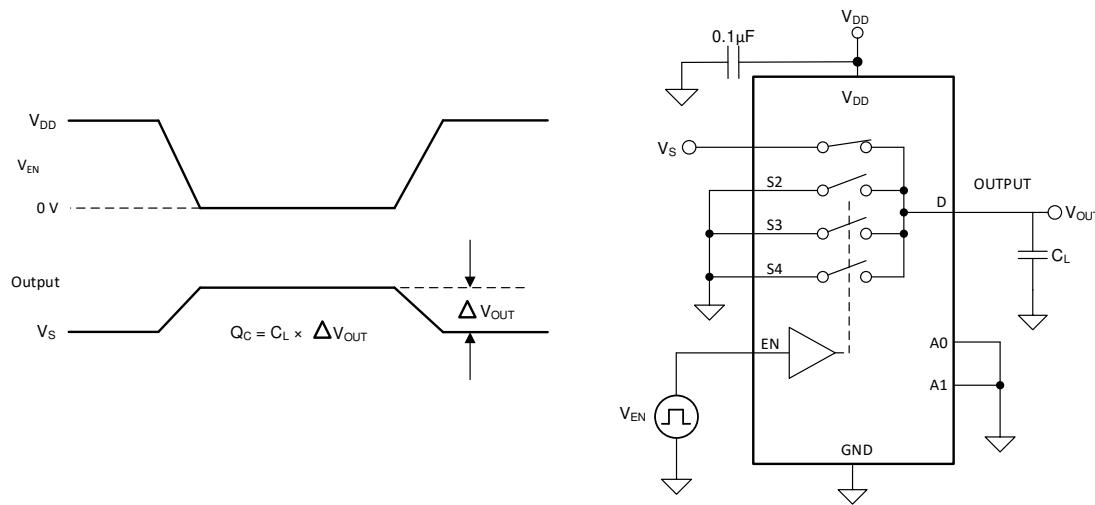


Figure 6-7. Charge-Injection Measurement Setup

6.8 Off Isolation

Off isolation is defined as the ratio of the signal at the drain pin (D) of the device when a signal is applied to the source pin (Sx) of an off-channel. Figure 6-8 shows the setup used to measure, and the equation used to calculate off isolation.

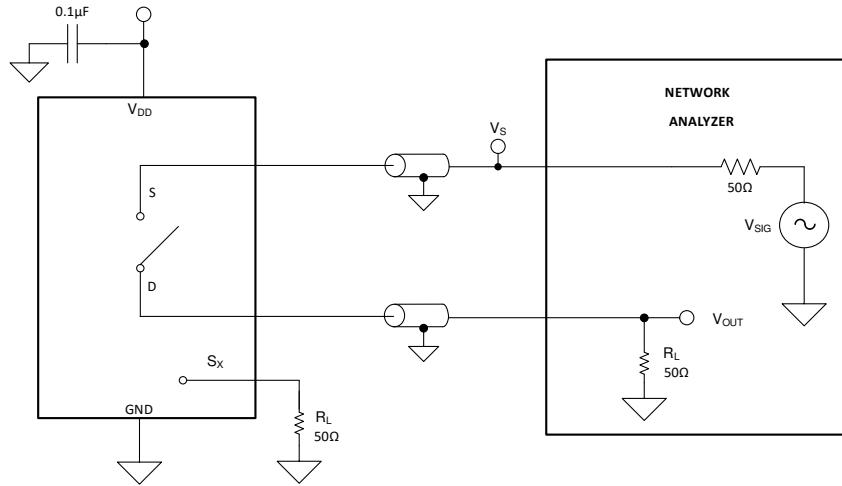


Figure 6-8. Off Isolation Measurement Setup

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

6.9 Crosstalk

Crosstalk is defined as the ratio of the signal at the drain pin (D) of a different channel, when a signal is applied at the source pin (Sx) of an on-channel. [Figure 6-9](#) shows the setup used to measure, and the equation used to calculate crosstalk.

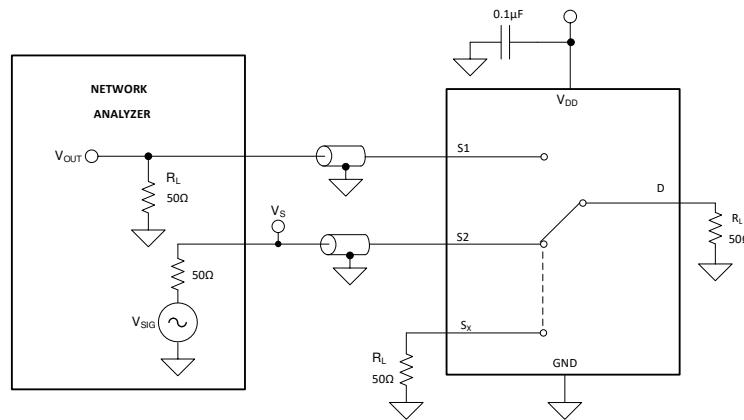


Figure 6-9. Crosstalk Measurement Setup

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

6.10 Bandwidth

Bandwidth is defined as the range of frequencies that are attenuated by less than 3dB when the input is applied to the source pin (Sx) of an on-channel, and the output is measured at the drain pin (D) of the device. [Figure 6-10](#) shows the setup used to measure bandwidth.

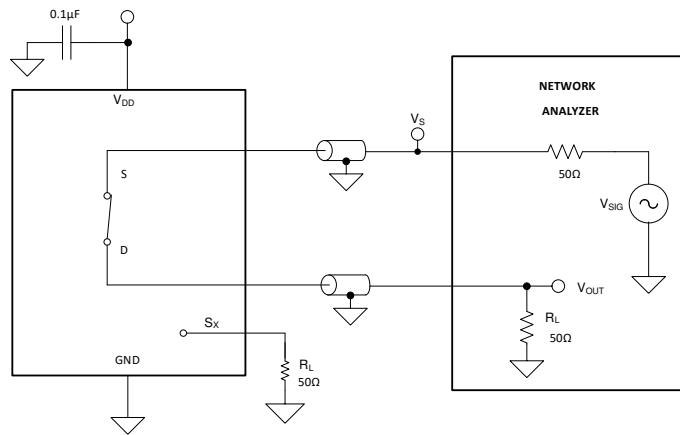


Figure 6-10. Bandwidth Measurement Setup

7 Detailed Description

7.1 Functional Block Diagram

The TMUX1104 is an 4:1, 1-channel (single-ended) multiplexer or demultiplexer. Each input is turned on or turned off based on the state of the address lines and enable pin.

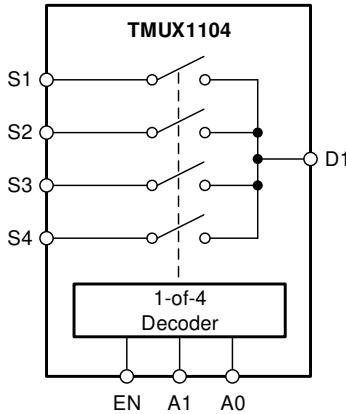


Figure 7-1. TMUX1104 Functional Block Diagram

7.2 Feature Description

7.2.1 Bidirectional Operation

The TMUX1104 conducts equally well from source (Sx) to drain (Dx) or from drain (Dx) to source (Sx). Each channel has very similar characteristics in both directions and supports both analog and digital signals.

7.2.2 Rail to Rail Operation

The valid signal path input/output voltage for TMUX1104 ranges from GND to V_{DD} .

7.2.3 1.8V Logic Compatible Inputs

The TMUX1104 has 1.8V logic compatible control for all logic control inputs. The logic input thresholds scale with supply but still provide 1.8V logic control when operating at 5.5V supply voltage. 1.8V logic level inputs allows the TMUX1104 to interface with processors that have lower logic I/O rails and eliminates the need for an external translator, which saves both space and BOM cost. For more information on 1.8V logic implementations, refer to [Simplifying Design with 1.8V logic Muxes and Switches](#)

7.2.4 Fail-Safe Logic

The TMUX1104 supports Fail-Safe Logic on the control input pins (EN, A0, A1) allowing for operation up to 5.5V, 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 TMUX1104 to be ramped to 5.5V while $V_{DD} = 0V$. Additionally, the feature enables operation of the TMUX1104 with $V_{DD} = 1.2V$ while allowing the select pins to interface with a logic level of another device up to 5.5V.

7.2.5 Ultra-low Leakage Current

The TMUX1104 provides extremely low on-leakage and off-leakage currents. The TMUX1104 is capable of switching signals from high source-impedance inputs into a high input-impedance op amp with minimal offset error because of the ultra-low leakage currents. Figure 7-2 shows typical leakage currents of the TMUX1104 versus temperature.

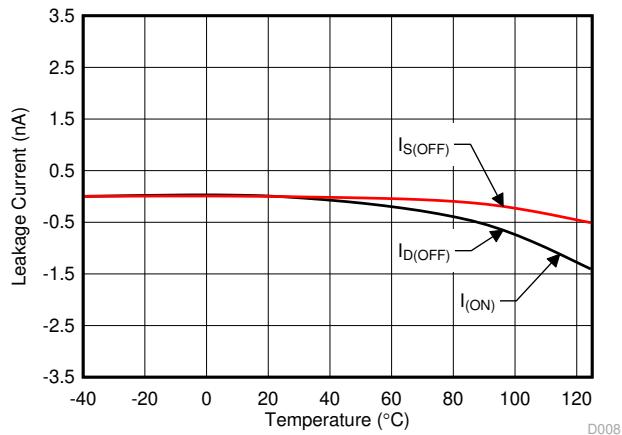


Figure 7-2. Leakage Current vs Temperature

7.2.6 Ultra-low Charge Injection

The TMUX1104 has a transmission gate topology, as shown in Figure 7-3. Any mismatch in the stray capacitance associated with the NMOS and PMOS causes an output level change whenever the switch is opened or closed.

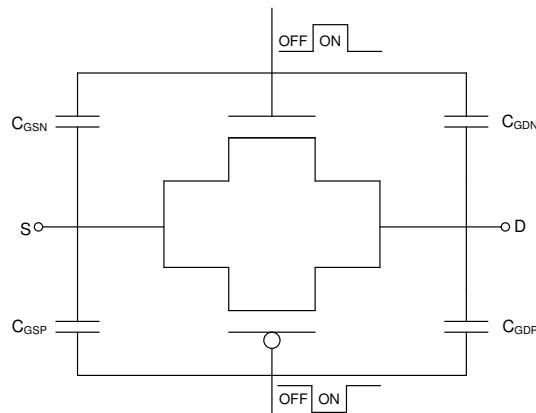


Figure 7-3. Transmission Gate Topology

The TMUX1104 has special charge-injection cancellation circuitry that reduces the source-to-drain charge injection to 1.5pC at $V_S = 1V$ as shown in [Figure 7-4](#).

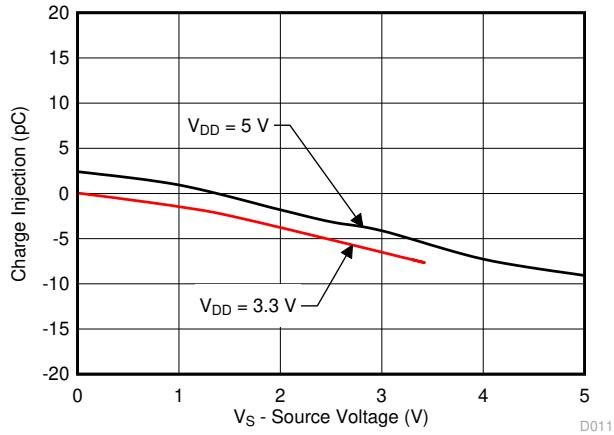


Figure 7-4. Charge Injection vs Source Voltage

7.3 Device Functional Modes

When the EN pin of the TMUX1104 is pulled high, one of the switches is closed based on the state of the address lines. When the EN pin is pulled low, all the switches are in an open state regardless of the state of the address lines. The control pins can be as high as 5.5V.

7.4 Truth Tables

[Table 7-1](#) provides the truth tables for the TMUX1104.

Table 7-1. TMUX1104 Truth Table

EN	A1	A0	Selected Input Connected To Drain (D) Pin
0	X ⁽¹⁾	X ⁽¹⁾	All channels are off
1	0	0	S1
1	0	1	S2
1	1	0	S3
1	1	1	S4

(1) X denotes *do not care*.

8 Application and Implementation

Note

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes, as well as validating and testing their design implementation to confirm system functionality.

8.1 Application Information

The TMUX11xx family offers ultra-low input/output leakage currents and low charge injection. These devices operate up to 5.5V, and offer true rail-to-rail input and output of both analog and digital signals. The TMUX1104 has a low on-capacitance which allows faster settling time when multiplexing inputs in the time domain. These features make the TMUX11xx devices a family of precision, high-performance switches and multiplexers for low-voltage applications.

8.2 Typical Application

Figure 8-1 shows a 16-bit, 4 input, multiplexed, data-acquisition system. This example is typical in industrial applications that require low distortion for precision measurements. The circuit uses the ADS8864, a 16-bit, 400kSPS successive-approximation-resistor (SAR) analog-to-digital converter (ADC), along with a precision amplifier, and a 4 input mux.

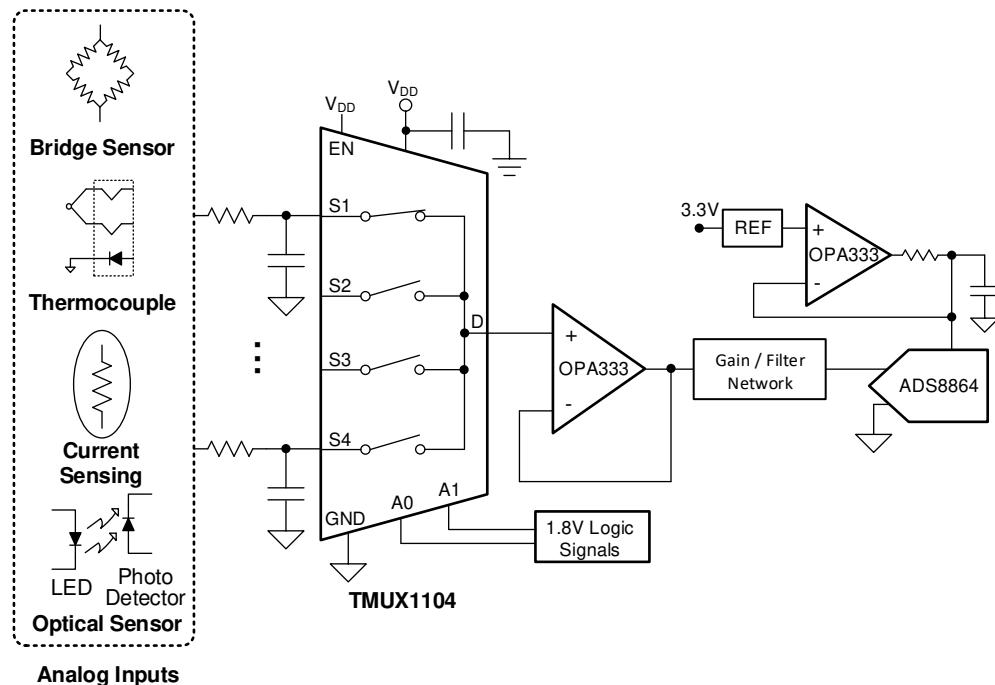


Figure 8-1. Multiplexing Signals to External ADC

8.2.1 Design Requirements

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

Table 8-1. Design Parameters

PARAMETERS	VALUES
Supply (V_{DD})	3.3V
I/O signal range	0V to V_{DD} (Rail to Rail)
Control logic thresholds	1.8V compatible

8.2.2 Detailed Design Procedure

The TMUX1104 can be operated without any external components except for the supply decoupling capacitors. If the desired power-up state is disabled, the enable pin should have a weak pull-down resistor and be controlled by the MCU through the GPIO. All inputs being muxed to the ADC must fall within the recommended operating conditions of the TMUX1104, including signal range and continuous current. For this design with a supply of 3.3V the signal range can be 0V to 3.3V, and the max continuous current can be 30mA.

The design example highlights a multiplexed data-acquisition system for highest system linearity and fast settling. The overall system block diagram is shown in [Figure 8-1](#). The circuit is a multichannel data-acquisition signal chain consisting of an input low-pass filter, mux, mux output buffer, SAR ADC driver, and a reference buffer. The architecture provides a cost-effective solution for fast sampling of multiple channels using a single ADC.

8.2.3 Application Curve

The TMUX1104 is capable of switching signals from high source-impedance inputs into a high input-impedance op amp with minimal offset error because of the ultra-low leakage currents.

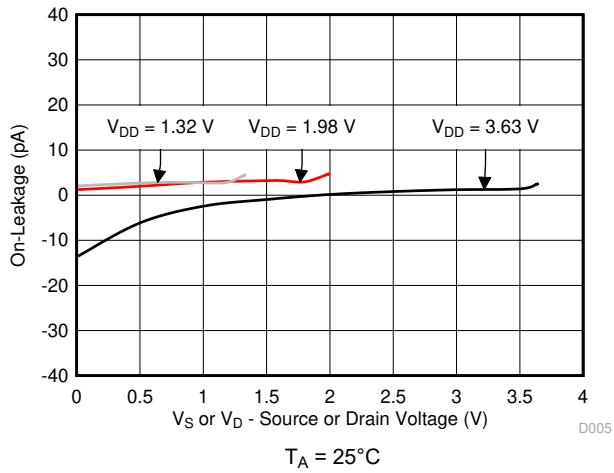


Figure 8-2. On-Leakage vs Source or Drain Voltage

8.3 Power Supply Recommendations

The TMUX1104 operates across a wide supply range of 1.08V to 5.5V. 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 $0.1\mu F$ to $10\mu F$ 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.

8.4 Layout

8.4.1 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 8-3](#) shows progressively better techniques of rounding corners. Only the last example (BEST) maintains constant trace width and minimizes reflections.

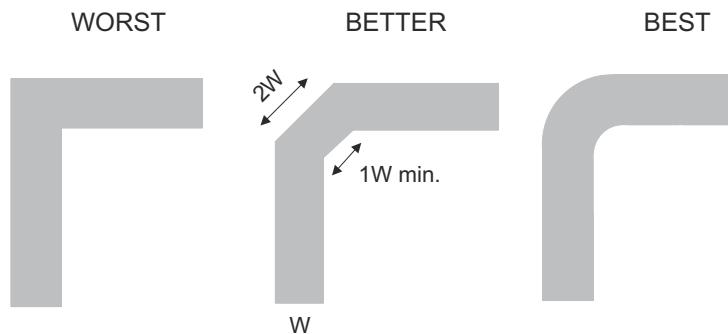


Figure 8-3. Trace Example

Route 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.

[Figure 8-4](#) shows an example of a PCB layout with the TMUX1104. Some key considerations are as follows:

- Decouple the V_{DD} pin with a $0.1\mu F$ capacitor, placed as close to the pin as possible. Ensure that the capacitor voltage rating is sufficient for the V_{DD} supply.
- 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.

8.4.2 Layout Example

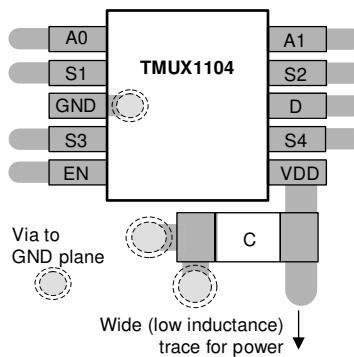


Figure 8-4. TMUX1104 Layout Example

9 Device and Documentation Support

9.1 Documentation Support

9.1.1 Related Documentation

For related documentation, see the following:

- Texas Instruments, [True Differential, 4 x 2 MUX, Analog Front End, Simultaneous-Sampling ADC Circuit](#).
- Texas Instruments, [Improve Stability Issues with Low CON 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, [QFN/SON PCB Attachment](#).
- Texas Instruments, [Quad Flatpack No-Lead Logic Packages](#).

9.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Notifications* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

9.3 Support Resources

[TI E2E™ support forums](#) are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

9.4 Trademarks

TI E2E™ is a trademark of Texas Instruments.

All trademarks are the property of their respective owners.

9.5 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

9.6 Glossary

[TI Glossary](#) This glossary lists and explains terms, acronyms, and definitions.

10 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision B (July 2019) to Revision C (February 2024)	Page
• Updated I_S or I_d (Continuous Current) values.....	4
• Added I_{peak} values to <i>Recommended Operating Conditions</i> table.....	4

Changes from Revision A (December 2018) to Revision B (July 2019)	Page
• Deleted the <i>Product Preview</i> note from the DQA package in the <i>Device Information</i> table.....	1
• Deleted the <i>Product Preview</i> note from the DQA package in the <i>Pin Configuration and Functions</i> section.....	3
• Added DQA (USON) thermal values to <i>Thermal Information</i>	5

Changes from Revision * (November 2018) to Revision A (December 2018)	Page
• Changed the document status From: <i>Advanced Information</i> To: <i>Production Mix</i> data.....	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.

PACKAGING INFORMATION

Orderable part number	Status	Material type	Package Pins	Package qty Carrier	RoHS	Lead finish/ Ball material	MSL rating/ Peak reflow	Op temp (°C)	Part marking
	(1)	(2)			(3)	(4)	(5)		(6)
TMUX1104DGSR	Active	Production	VSSOP (DGS) 10	2500 LARGE T&R	Yes	NIPDAUAG SN	Level-1-260C-UNLIM	-40 to 125	1D7
TMUX1104DQAR	Active	Production	USON (DQA) 10	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	104

(1) **Status:** For more details on status, see our [product life cycle](#).

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

(4) **Lead finish/Ball material:** Parts 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.

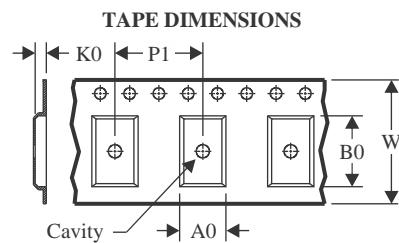
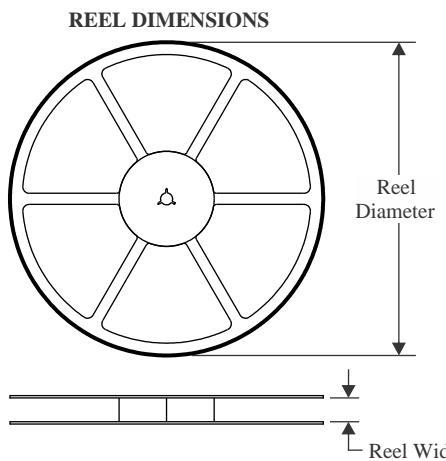
(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

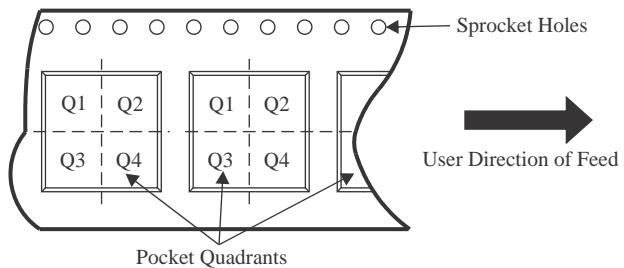
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

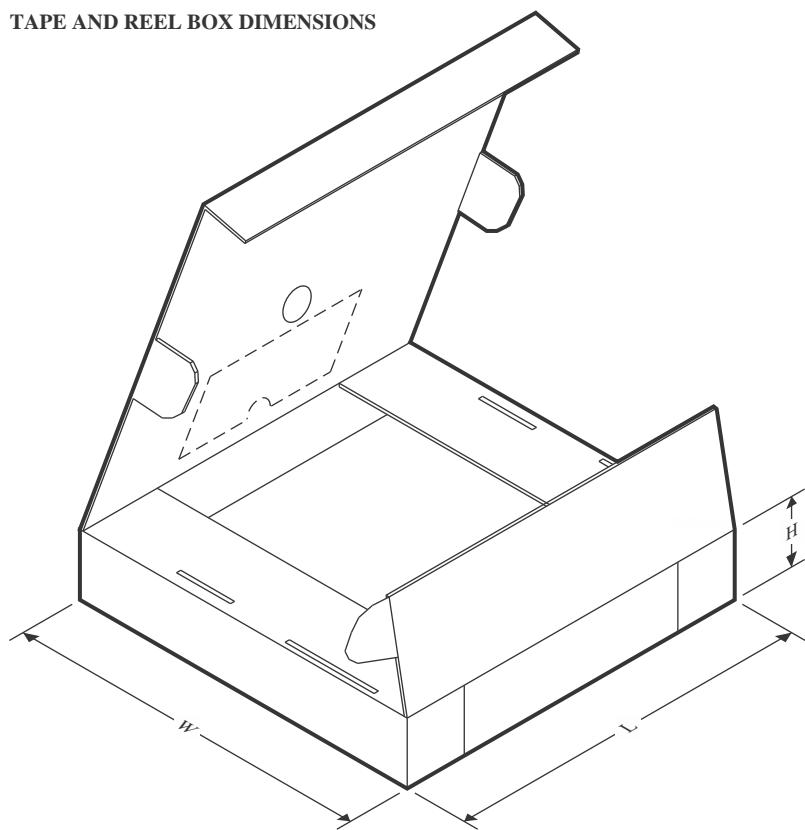
TAPE AND REEL INFORMATION


A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

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
TMUX1104DGSR	VSSOP	DGS	10	2500	330.0	12.4	5.25	3.35	1.25	8.0	12.0	Q1
TMUX1104DQAR	USON	DQA	10	3000	180.0	9.5	1.18	2.68	0.72	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)
TMUX1104DGSR	VSSOP	DGS	10	2500	366.0	364.0	50.0
TMUX1104DQAR	USON	DQA	10	3000	189.0	185.0	36.0

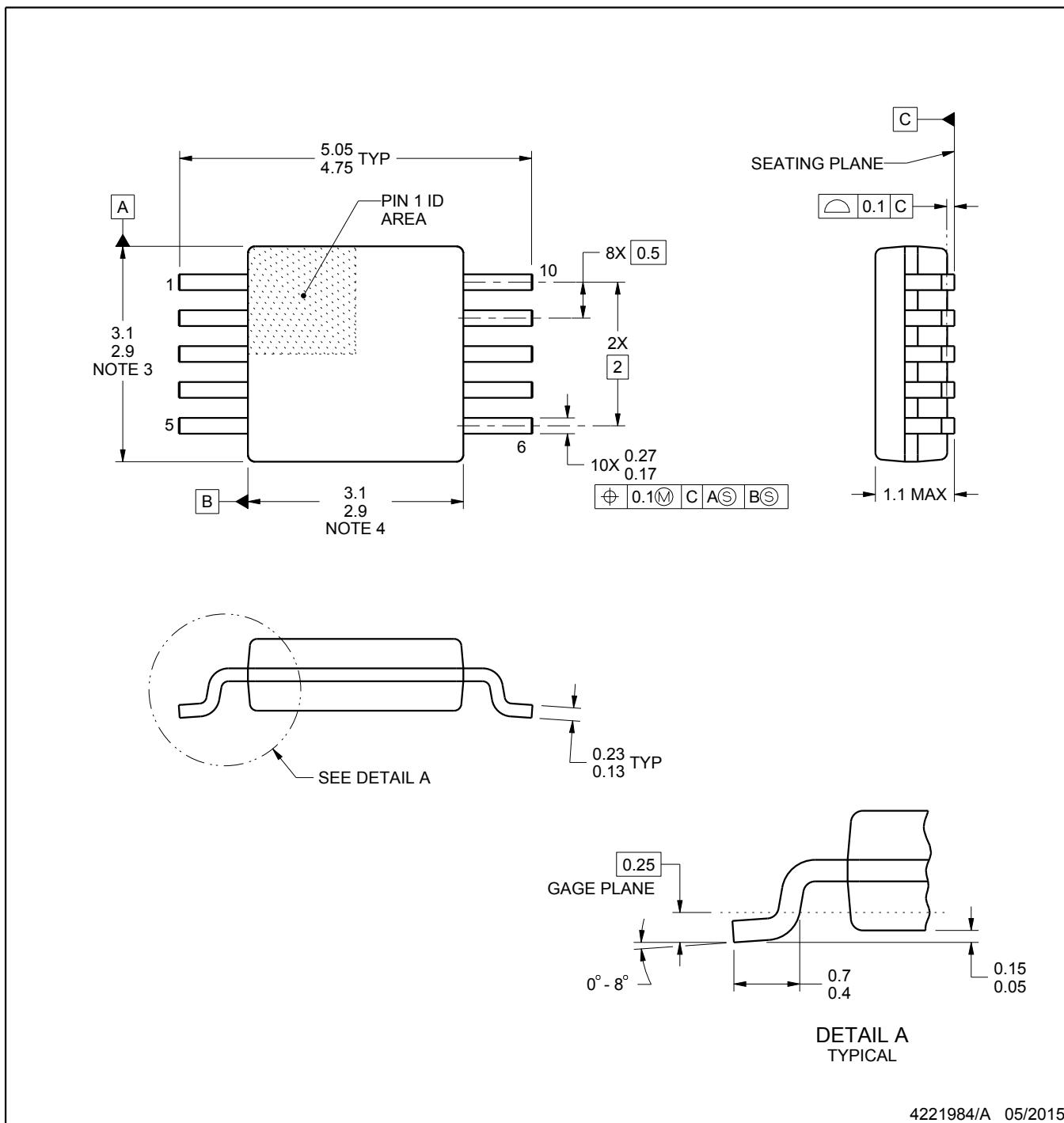
PACKAGE OUTLINE

DGS0010A



VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



NOTES:

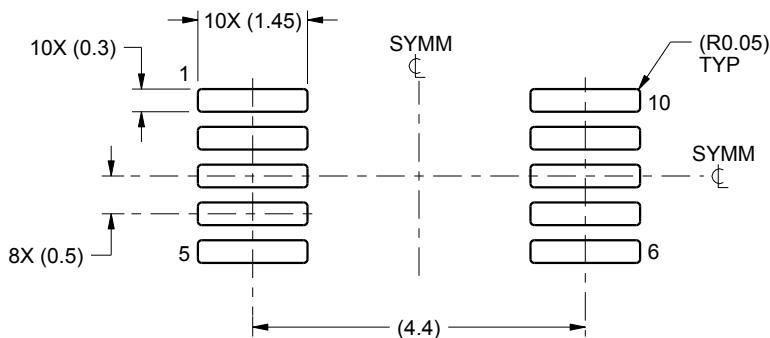
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-187, variation BA.

EXAMPLE BOARD LAYOUT

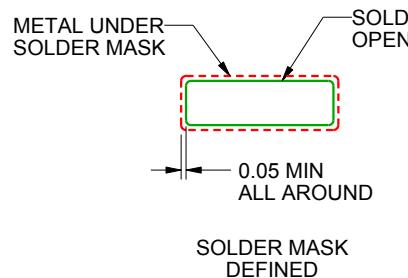
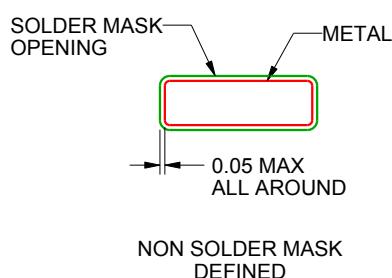
DGS0010A

VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
SCALE:10X



SOLDER MASK DETAILS
NOT TO SCALE

4221984/A 05/2015

NOTES: (continued)

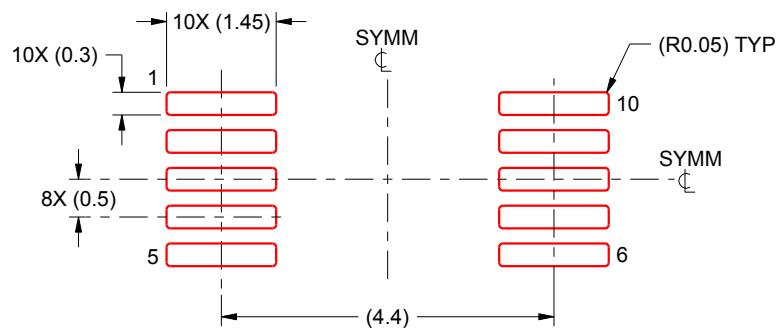
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DGS0010A

VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:10X

4221984/A 05/2015

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

GENERIC PACKAGE VIEW

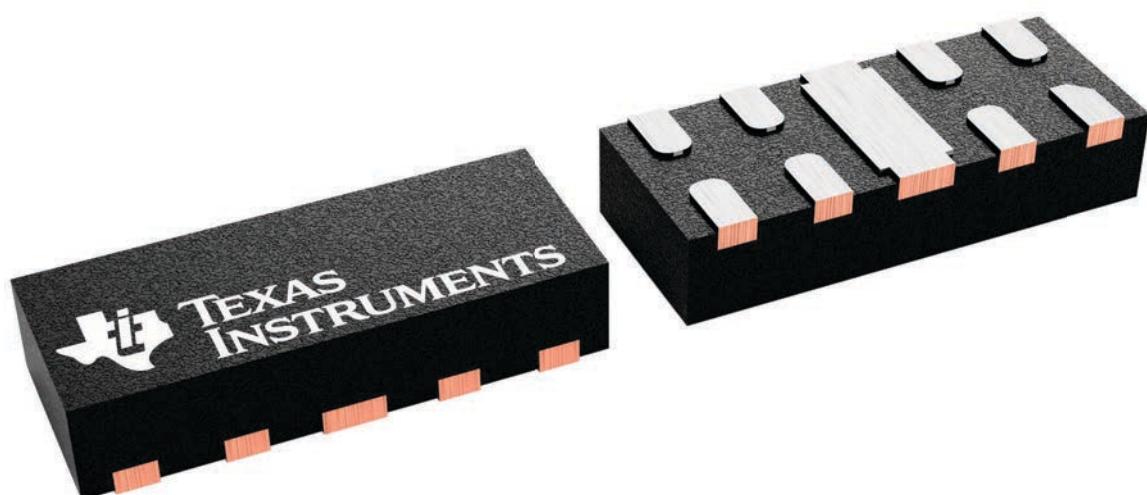
DQA 10

USON - 0.55 mm max height

1 x 2.5, 0.5 mm pitch

PLASTIC SMALL OUTLINE - NO LEAD

This image is a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.



4230320/A

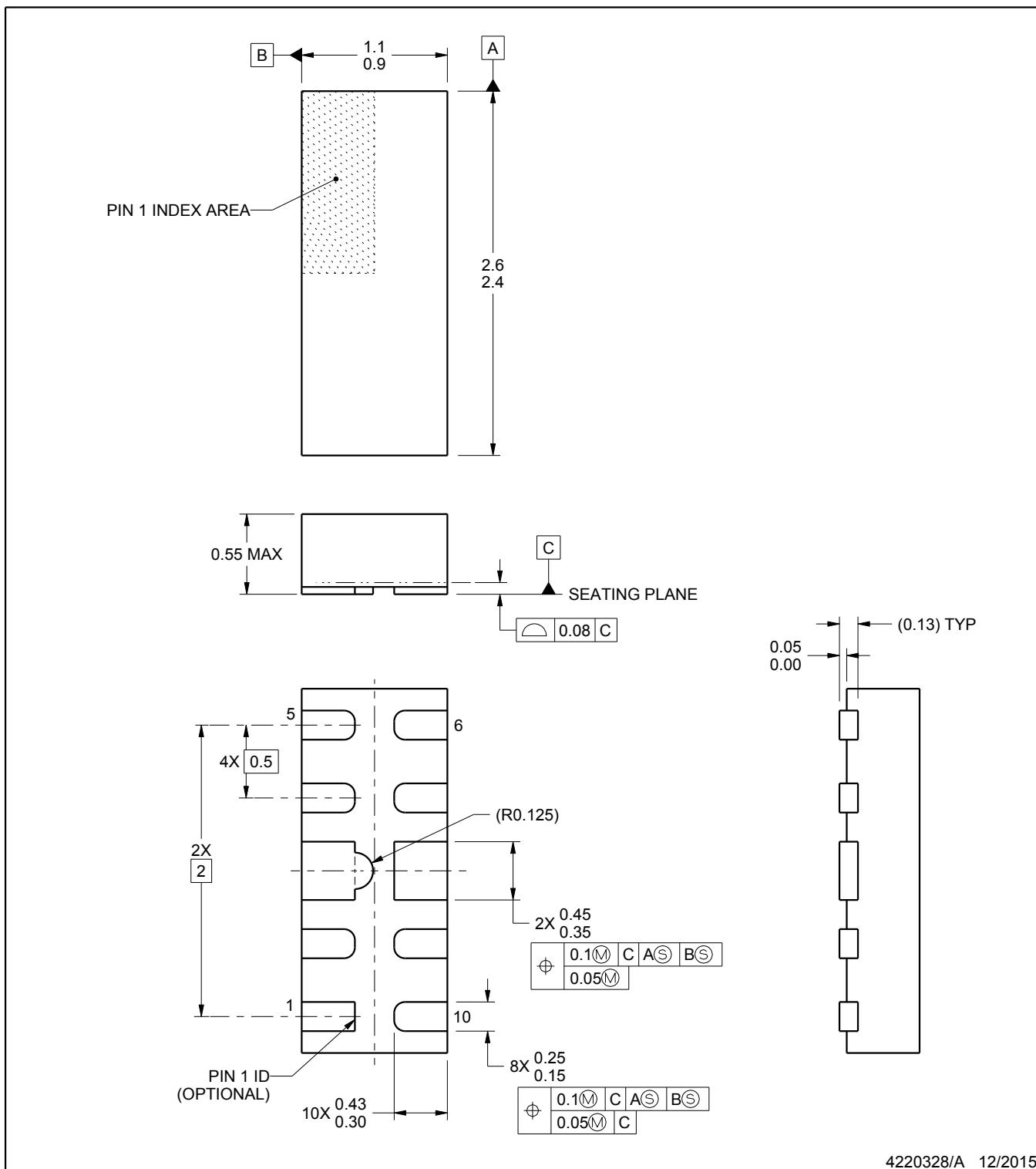
PACKAGE OUTLINE

DQA0010A



USON - 0.55 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



4220328/A 12/2015

NOTES:

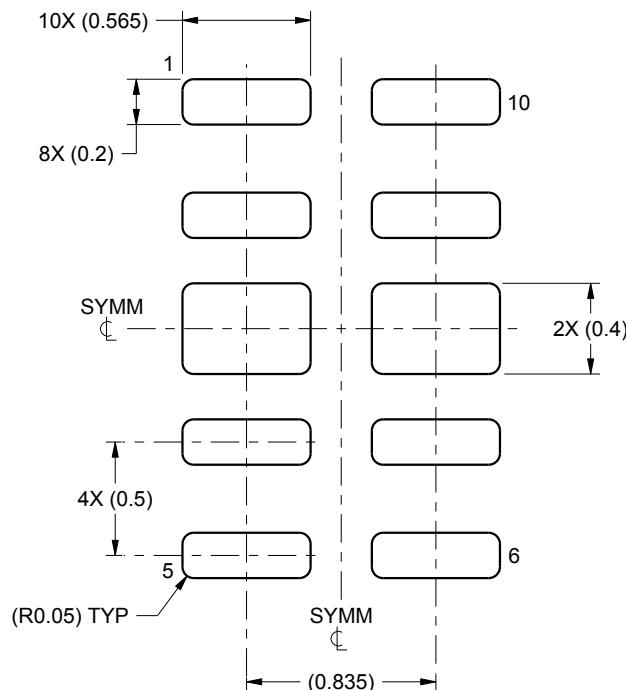
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

EXAMPLE BOARD LAYOUT

DQA0010A

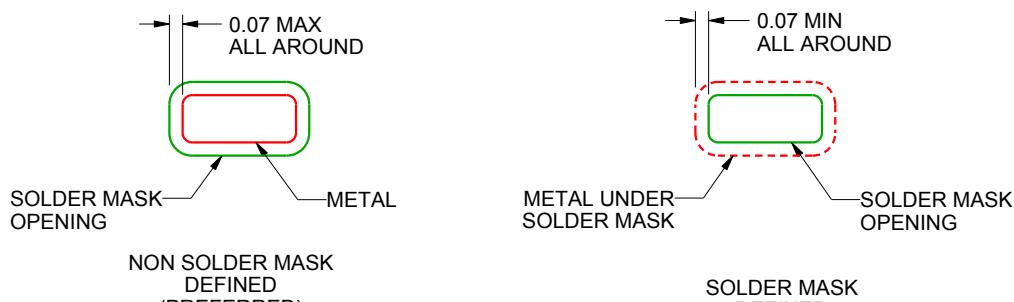
USON - 0.55 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



LAND PATTERN EXAMPLE

SCALE:30X



SOLDER MASK DETAILS

4220328/A 12/2015

NOTES: (continued)

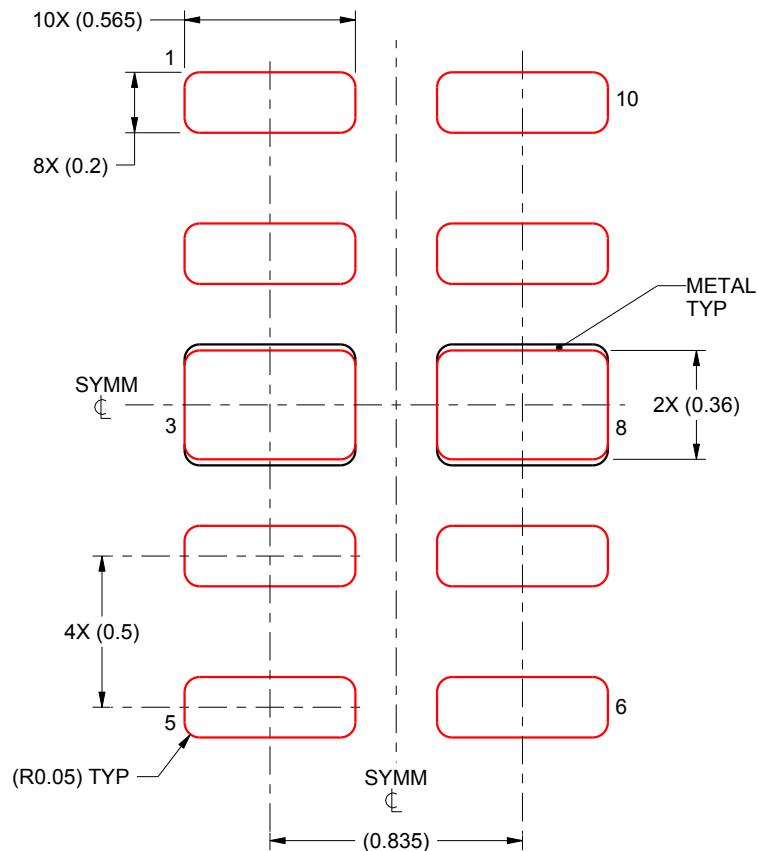
3. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).

EXAMPLE STENCIL DESIGN

DQA0010A

USON - 0.55 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



SOLDER PASTE EXAMPLE
BASED ON 0.1 mm THICK STENCIL

EXPOSED PADS 3 & 8:
90% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE
SCALE:40X

4220328/A 12/2015

NOTES: (continued)

4. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to [TI's Terms of Sale](#) or other applicable terms available either on [ti.com](#) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2025, Texas Instruments Incorporated