

## TXG402x-Q1 2-bit, ±40V Ground-Level Translator

### 1 Features

- AEC-Q100 qualified for automotive applications
- Supports DC shifts up to ±40V
- AC Noise Rejection of 80V<sub>PP</sub> up to 5MHz
- CMTI of 1kV/μs
- Low Prop Delay (<5ns) and Ch-Ch Skew (<0.20ns)
- Greater than 250Mbps
- Low power consumption (0.8mA per channel at 1Mbps, 1.8V)
- Fully configurable dual-rail design allows each port to operate from 1.71V to 5.5V
- 4, 2, 1 channel devices with multiple configurations will be available
- Two device variants:
  - TXG4020-Q1: 2 forward
  - TXG4021-Q1: 1 forward, 1 reverse
- Supports V<sub>CC</sub> disconnect feature (I/Os are forced into high-Z)
- Schmitt-trigger inputs allows for slow and noisy signals
- Inputs with integrated static pull-down resistors prevent channels from floating
- Operating temperature from –40°C to +125°C
- Latch-up performance exceeds 100mA per JESD 78, class II
  - ESD protection exceeds JESD 22
  - 2500V human-body model
  - 500V charged-device model
- Package options provided:
  - DSG (WSON-8)
  - DDF (SOT-8)
  - D (SOIC-8)

### 2 Applications

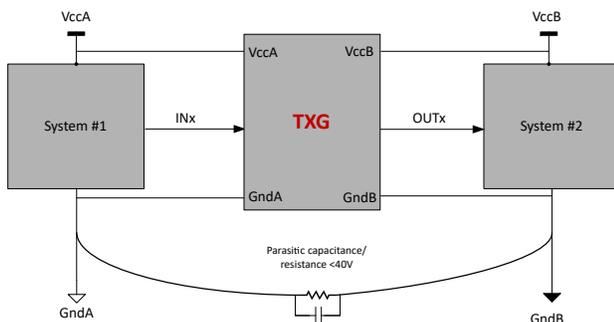
- [Electric Power Steering](#)
- [Vehicle Control Unit](#)
- [Automotive Display](#)
- [Head Unit and Digital Cockpit](#)

### 3 Description

The TXG402x-Q1 is a 2-bit, fixed direction, non-galvanic based voltage and ground-level translator that can support both logic-level shifting between 1.71V to 5.5V and ground-level shifting up to ±40V. Compared to traditional level shifters, the TXG402x-Q1 family can solve the challenges of voltage translation across different ground levels. The [Simplified Diagram](#) shows a common use case where DC shift occurs between GNDA to GNDB due to parasitic resistance or capacitance.

V<sub>CCA</sub> is referenced to GNDA and V<sub>CCB</sub> is referenced to GNDB. Ax pins are referenced to V<sub>CCA</sub> logic level while Bx pins are referenced to V<sub>CCB</sub> logic levels. Both A port and B port can accept voltages from 1.71V to 5.5V. The leakage between GNDA and GNDB is <90nA when V<sub>CC</sub> to GND is shorted.

The TXG402x-Q1 device helps improve noise immunity and power sequencing across different ground domains while providing low power consumption, latency and channel-to-channel skew. It can suppress noise levels of 80V<sub>PP</sub> up to 5MHz ([Figure 7-5](#)). This device can support multiple interfaces such as UART, GPIO, and JTAG.



**Simplified Diagram**

#### Package Information

PART NUMBER	PACKAGE <sup>(1)</sup>	BODY SIZE (NOM)
TXG4020-Q1 TXG4021-Q1	DSG (WSON-8)	2.0mm × 2.00mm
	DDF (SOT-8)	2.90mm × 1.60mm
	D (SOIC-8)	4.90mm × 3.90mm

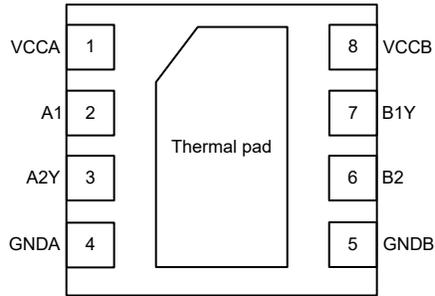
- (1) For all available packages, see the orderable addendum at the end of the data sheet.



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## 4 Pin Configuration and Functions



**Figure 4-1. TXGx021DSG Package 8-Pin WSON Top View**

**Table 4-1. TXGx021 DSG Pin Functions**

PIN		I/O	DESCRIPTION
Name	TXGx021		
A1	2	I	Input A1. Referenced to $V_{CCA}$
A2Y	3	O	Output A2. Referenced to $V_{CCA}$
B1Y	7	O	Output B1. Referenced to $V_{CCB}$
B2	6	I	Input B2. Referenced to $V_{CCB}$
$V_{CCA}$	1	—	A side supply voltage. $1.71V \leq V_{CCA} \leq 5.5V$
$V_{CCB}$	8	—	B side supply voltage. $1.71V \leq V_{CCB} \leq 5.5V$
GNDA	4	—	Ground reference for $V_{CCA}$
GNDB	5	—	Ground reference for $V_{CCB}$
—	Thermal pad	—	Keep thermal pad floating.

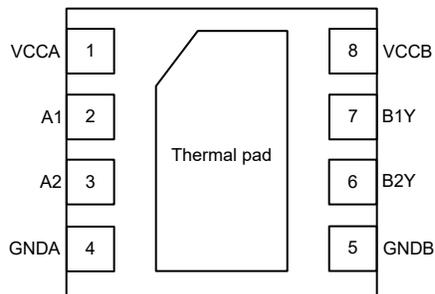
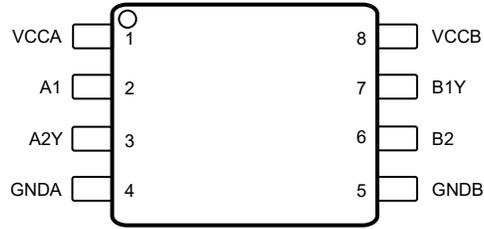


Figure 4-2. TXGx020DSG Package 8-Pin WSON Top View

Table 4-2. TXGx020 DSG Pin Functions

PIN		I/O	DESCRIPTION
Name	TXGx020		
A1	2	I	Input A1. Referenced to $V_{CCA}$
A2	3	I	Input A2. Referenced to $V_{CCA}$
B1Y	7	O	Output B1. Referenced to $V_{CCB}$
B2Y	6	O	Output B2. Referenced to $V_{CCB}$
$V_{CCA}$	1	—	A side supply voltage. $1.71V \leq V_{CCA} \leq 5.5V$
$V_{CCB}$	8	—	B side supply voltage. $1.71V \leq V_{CCB} \leq 5.5V$
GNDA	4	—	Ground reference for $V_{CCA}$
GNDB	5	—	Ground reference for $V_{CCB}$
—	Thermal pad	—	Keep thermal pad floating.



**Figure 4-3. TXGx021DDF 8-Pin SOT and TXGx021D 8-pin SOIC Top View**

**Table 4-3. TXGx021 DDF and D Pin Functions**

PIN		I/O	DESCRIPTION
Name	TXGx021		
A1	2	I	Input A1. Referenced to $V_{CCA}$
A2Y	3	O	Output A2. Referenced to $V_{CCA}$
B1Y	7	O	Output B1. Referenced to $V_{CCB}$
B2	6	I	Input B2. Referenced to $V_{CCB}$
$V_{CCA}$	1	—	A side supply voltage. $1.71V \leq V_{CCA} \leq 5.5V$
$V_{CCB}$	8	—	B side supply voltage. $1.71V \leq V_{CCB} \leq 5.5V$
GNDA	4	—	Ground reference for $V_{CCA}$
GNDB	5	—	Ground reference for $V_{CCB}$

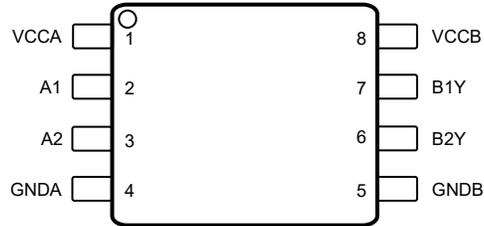


Figure 4-4. TXGx020DDF 8-Pin SOT and TXGx020D 8-pin SOIC Top View

Table 4-4. TXGx020 DDF and D Pin Functions

PIN		I/O	DESCRIPTION
Name	TXGx020		
A1	2	I	Input A1. Referenced to $V_{CCA}$
A2	3	I	Input A2. Referenced to $V_{CCA}$
B1Y	7	O	Output B1. Referenced to $V_{CCB}$
B2Y	6	O	Output B2. Referenced to $V_{CCB}$
$V_{CCA}$	1	—	A side supply voltage. $1.71V \leq V_{CCA} \leq 5.5V$
$V_{CCB}$	8	—	B side supply voltage. $1.71V \leq V_{CCB} \leq 5.5V$
GNDA	4	—	Ground reference for $V_{CCA}$
GNDB	5	—	Ground reference for $V_{CCB}$

## 5 Specifications

### 5.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

			MIN	MAX	UNIT
$V_{CCA}$ to $V_{GNDA}$	Supply voltage A to Ground voltage A		-0.5	6.5	V
$V_{CCB}$ to $V_{GNDB}$	Supply voltage B to Ground voltage B		-0.5	6.5	V
$V_{GNDA}$ to $V_{GNDB}$	Voltage between GNDA and GNDB	Voltage between GNDA and GNDB	-45	45	V
$V_I$	Input Voltage <sup>(2)</sup>	I/O Ports (A Port) to $V_{GNDA}$	-0.5	6.5	V
		I/O Ports (B Port) to $V_{GNDB}$	-0.5	6.5	
$V_O$	Voltage applied to any output in the high-impedance or power-off state <sup>(2)</sup>	A Port to $V_{GNDA}$	-0.5	6.5	V
		B Port to $V_{GNDB}$	-0.5	6.5	
$V_O$	Voltage applied to any output in the high or low state <sup>(2)</sup> (3)	A Port to $V_{GNDA}$	-0.5	$V_{CCA} + 0.5$	V
		B Port to $V_{GNDB}$	-0.5	$V_{CCB} + 0.5$	
$I_{IK}$	Input clamp current	$V_I < 0$	-20		mA
$I_{OK}$	Output clamp current	$V_O < 0$	-20		mA
$I_O$	Continuous output current		-25	25	mA
	Continuous current through $V_{CC}$ or GND		-100	100	mA
$T_j$	Junction Temperature			150	°C
$T_{stg}$	Storage temperature		-65	150	°C

- (1) Stresses beyond those listed under [Section 5.1](#) 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 [Section 5.3](#) Exposure beyond the limits listed in [Section 5.3](#) may affect device reliability.
- (2) The input voltage and output negative-voltage ratings may be exceeded if the input and output current ratings are observed.
- (3) The output positive-voltage rating may be exceeded up to 6.5V maximum if the output current rating is observed.

### 5.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>	±2500	V
		Charged device model (CDM), per ANSI/ESDA/JEDEC JS-002 <sup>(2)</sup>	±500	

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

### 5.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted) <sup>(1)</sup> <sup>(2)</sup> <sup>(3)</sup>

		MIN	TYP	MAX	UNIT		
V <sub>CCA</sub>	Supply voltage A - Relative to GNDA		1.71		5.5	V	
V <sub>CCB</sub>	Supply voltage B - Relative to GNDB		1.71		5.5	V	
V <sub>GNDA to GNDB</sub>	Voltage between GNDA and GNDB	Voltage between GNDA and GNDB	Voltage between GNDA and GNDB		-40	40	V
I <sub>OH</sub>	High-level output current		V <sub>CCO</sub> = 1.71V	-4.5		mA	
			V <sub>CCO</sub> = 2.3V	-8			
			V <sub>CCO</sub> = 3V	-10			
			V <sub>CCO</sub> = 4.5V	-12			
I <sub>OL</sub>	Low-level output current		V <sub>CCO</sub> = 1.71V		4.5	mA	
			V <sub>CCO</sub> = 2.3V		8		
			V <sub>CCO</sub> = 3V		10		
			V <sub>CCO</sub> = 4.5V		12		
V <sub>I</sub>	Input voltage - Relative to GNDA		0		5.5	V	
V <sub>O</sub>	Output voltage - Relative to GNDB		0		V <sub>CCO</sub>	V	
T <sub>A</sub>	Operating free-air temperature		-40		125	°C	

- (1) V<sub>CCI</sub> is the V<sub>CC</sub> associated with the input port.
- (2) V<sub>CCO</sub> is the V<sub>CC</sub> associated with the output port.
- (3) All control inputs and data I/Os of this device have weak pulldowns to ensure the line is not floating when undefined external to the device. The input leakage from these weak pulldowns is defined by the I<sub>I</sub> specification indicated under [Section 5.5](#).

### 5.4 Thermal Information

THERMAL METRIC <sup>(1)</sup>		TXG802x	UNIT
		D (SOIC)	
		8 PINS	
R <sub>θJA</sub>	Junction-to-ambient thermal resistance	122.0	°C/W
R <sub>θJC(top)</sub>	Junction-to-case (top) thermal resistance	60.7	°C/W
R <sub>θJB</sub>	Junction-to-board thermal resistance	69.8	°C/W
Y <sub>JT</sub>	Junction-to-top characterization parameter	11.5	°C/W
Y <sub>JB</sub>	Junction-to-board characterization parameter	68.8	°C/W
R <sub>θJC(bottom)</sub>	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 note.

## 5.5 Electrical Characteristics

over operating free-air temperature range (unless otherwise noted)<sup>(1) (2)</sup>

PARAMETER		TEST CONDITIONS	V <sub>CCA</sub>	V <sub>CCB</sub>	Operating free-air temperature (T <sub>A</sub> )			UNIT
					–40°C to 125°C			
					MIN	TYP	MAX	
V <sub>OH</sub>	High-level output voltage <sup>(3)</sup>	I <sub>OH</sub> = –4.5mA	1.71V	1.71V	1.5			V
		I <sub>OH</sub> = –8mA	2.3V	2.3V	2.0			
		I <sub>OH</sub> = –10mA	3V	3V	2.7			
		I <sub>OH</sub> = –12mA	4.5V	4.5V	4.1			
V <sub>OL</sub>	Low-level output voltage <sup>(4)</sup>	I <sub>OL</sub> = 4.5mA	1.71V	1.71V	0.16			V
		I <sub>OL</sub> = 8mA	2.3V	2.3V	0.27			
		I <sub>OL</sub> = 10mA	3V	3V	0.34			
		I <sub>OL</sub> = 12mA	4.5V	4.5V	0.41			
V <sub>T+</sub>	Positive-going input-threshold voltage	Data Inputs (Ax, Bx) (Referenced to V <sub>CCI</sub> )	1.71V	1.71V	1.11			V
			2.3V	2.3V	1.40			
			3V	3V	1.73			
			4.5V	4.5V	2.45			
			5.5V	5.5V	3.0			
V <sub>T-</sub>	Negative-going input-threshold voltage	Data Inputs (Ax, Bx) (Referenced to V <sub>CCI</sub> )	1.71V	1.71V	0.56			V
			2.3V	2.3V	0.80			
			3V	3V	1.14			
			4.5V	4.5V	1.59			
			5.5V	5.5V	2.0			
ΔV <sub>T</sub>	Input-threshold hysteresis (V <sub>T+</sub> – V <sub>T-</sub> )	Data Inputs (Ax, Bx) (Referenced to V <sub>CCI</sub> )	1.71V	1.71V	0.3		0.55	V
			2.3V	2.3V	0.36		0.60	
			3V	3V	0.38		0.54	
			4.5V	4.5V	0.41		0.86	
ΔV <sub>T</sub>	Input-threshold hysteresis (V <sub>T+</sub> – V <sub>T-</sub> )	Data Inputs (Ax, Bx) (Referenced to V <sub>CCI</sub> )	5.5V	5.5V	0.40		0.96	V
I <sub>I</sub>	Input leakage current	Data Inputs (Ax, Bx) V <sub>I</sub> = V <sub>CCI</sub> or GND	1.71V – 5.5V	1.71V – 5.5V	0.2		1.6	μA
I <sub>off-float</sub>	Floating supply Partial power down current	A Port or B Port V <sub>I</sub> = V <sub>CC</sub>	Floating <sup>(5)</sup>	0V - 5.5V	0.26		1.55	μA
			0V - 5.5V	Floating <sup>(5)</sup>	0.26		1.55	

over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup> <sup>(2)</sup>

PARAMETER		TEST CONDITIONS	V <sub>CCA</sub>	V <sub>CCB</sub>	Operating free-air temperature (T <sub>A</sub> )			UNIT
					–40°C to 125°C			
					MIN	TYP	MAX	
I <sub>off-float</sub>	Floating supply Partial power down current	A Port or B Port V <sub>I</sub> = GND	Floating <sup>(5)</sup>	0V - 5.5V			0.06	nA
I <sub>off-float</sub>	Floating supply Partial power down current	V <sub>I</sub> = GND	0V - 5.5V	Floating <sup>(5)</sup>			0.39	nA
C <sub>i</sub>	Control Input Capacitance	V <sub>I</sub> = 3.3V or V <sub>GND A</sub>	3.3V	3.3V			2	pF
C <sub>io</sub>	Data I/O Capacitance	V <sub>O</sub> = 1.71V DC +1MHz -16dBm sine wave	3.3V	3.3V	1.3		2.6	pF
C <sub>GND</sub>	Cap between grounds	All channels combined (V <sub>CC</sub> both sides are powered on)					46	pF
		All channels combined (V <sub>CC</sub> to GND shorted)					53	pF
Leakage	Current Leakage between GndA to GndB	All channels combined (V <sub>CC</sub> to GND shorted)	1.71V – 5.5V	1.71V – 5.5V			0.09	μA
Leakage	Current Leakage between GndA to GndB	All channels combined (V <sub>CC</sub> both sides are powered on and inputs are all low)	1.71V – 5.5V	1.71V – 5.5V			0.13	μA
Leakage	Current Leakage between GndA to GndB	All channels combined (V <sub>CC</sub> both sides are powered on and inputs are all high)	1.71V – 5.5V	1.71V – 5.5V			32	μA
CMTI	Common Mode Transient Immunity	Input toggling at 100Mbps Ground shift up to 40V	1.71V – 5.5V	1.71V – 5.5V	1			kV/μs
V <sub>UVLO+</sub>	Positive-Going Undervoltage Lockout Voltage	A Supply	1.71V – 5.5V				1.64	V
		B Supply		1.71V – 5.5V			1.64	V
V <sub>UVLO-</sub>	Negative-Going Undervoltage Lockout Voltage	A Supply	1.71V – 5.5V		1.2			V
		B Supply		1.71V – 5.5V	1.2			V
V <sub>UVLO_Hys</sub>	Undervoltage Lockout Hysteresis	A Supply	1.71V – 5.5V		58			mV
		B Supply		1.71V – 5.5V	58			mV

(1) V<sub>CCI</sub> is the V<sub>CC</sub> associated with the input port and referenced to GND<sub>A</sub>

(2) V<sub>CCO</sub> is the V<sub>CC</sub> associated with the output port and referenced to GND<sub>B</sub>

(3) Tested at V<sub>I</sub> = V<sub>T+(MAX)</sub>

(4) Tested at V<sub>I</sub> = V<sub>T-(MIN)</sub>

(5) Floating is defined as a node that is both not actively driven by an external device and has leakage not exceeding 10nA

## 5.6 Supply Current

over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup> <sup>(2)</sup>

PARAMETER	TEST CONDITIONS	$V_{CCA}$	$V_{CCB}$	Operating free-air temperature ( $T_A$ )			UNIT
				–40°C to 125°C			
				MIN	TYP	MAX	
TXGx021							
$I_{CCA}$	$V_{CCA}$ supply current	$V_I = V_{CCI}$ or GND $I_O = 0$	1.71V – 5.5V	1.71V – 5.5V	300	747	$\mu A$
			0V	5.5V	-2	12.5	
			5.5V	0V	349	589	
		$V_I = GND$ $I_O = 0$	5.5V	Floating <sup>(3)</sup>	347	577	
$I_{CCB}$	$V_{CCB}$ supply current	$V_I = V_{CCI}$ or GND $I_O = 0$	1.71V – 5.5V	1.71V – 5.5V	497	1077	$\mu A$
			0V	5.5V	546	919	
			5.5V	0V	-2	24.5	
		$V_I = GND$ $I_O = 0$	Floating <sup>(3)</sup>	5.5V	548	919	
$I_{CCA} + I_{CCB}$	Supply Current - DC Signal	$V_I = V_{CCI}$	1.8V	1.8V	0.7	1.6	mA
			2.5V	2.5V	0.8	1.6	
			3.3V	3.3V	0.8	1.7	
			5V	5V	0.8	1.9	
		$V_I = GND$	1.8V	1.8V	0.7	1.6	mA
			2.5V	2.5V	0.8	1.6	
			3.3V	3.3V	0.8	1.7	
			5V	5V	0.8	1.9	

over operating free-air temperature range (unless otherwise noted)<sup>(1) (2)</sup>

PARAMETER		TEST CONDITIONS	V <sub>CCA</sub>	V <sub>CCB</sub>	Operating free-air temperature (T <sub>A</sub> )			UNIT
					–40°C to 125°C			
					MIN	TYP	MAX	
I <sub>CCA</sub> + I <sub>CCB</sub>	Supply Current - AC Signal	All channels switching with square wave clock input; CL = 15pF, 1Mbps	1.8V	1.8V	0.9		1.6	mA
			2.5V	2.5V	0.9		1.6	
			3.3V	3.3V	0.9		1.7	
			5V	5V	1.1		2	
		All channels switching with square wave clock input; CL = 15pF, 50Mbps	1.8V	1.8V	4.6		6.3	mA
			2.5V	2.5V	5.5		7.3	
			3.3V	3.3V	6.8		8.2	
			5V	5V	8.7		10.7	
		All channels switching with square wave clock input; CL = 15pF, 100Mbps	1.8V	1.8V	8.5		10.6	mA
			2.5V	2.5V	10		13	
			3.3V	3.3V	12		14.7	
			5V	5V	16.6		20.2	
TXGx020								
I <sub>CCA</sub>	V <sub>CCA</sub> supply current	V <sub>I</sub> = V <sub>CC1</sub> or GND I <sub>O</sub> = 0	1.71V – 5.5V	1.71V – 5.5V	299		602	μA
			0V	5.5V	-2.5		1.2	μA
			5.5V	0V	302		602	μA
		V <sub>I</sub> = GND I <sub>O</sub> = 0	5.5V	Floating <sup>(3)</sup>	299		577	μA
I <sub>CCB</sub>	V <sub>CCB</sub> supply current	V <sub>I</sub> = V <sub>CC1</sub> or GND I <sub>O</sub> = 0	1.71V – 5.5V	1.71V – 5.5V	504		1225	μA
			0V	5.5V	486		906	μA
			5.5V	0V	-2		24.5	μA
		V <sub>I</sub> = GND I <sub>O</sub> = 0	Floating <sup>(3)</sup>	5.5V	486		906	μA
I <sub>CCA</sub> + I <sub>CCB</sub>	Supply Current - DC Signal	V <sub>I</sub> = V <sub>CC1</sub>	1.8V	1.8V	0.7		1.6	mA
			2.5V	2.5V	0.8		1.6	mA
			3.3V	3.3V	0.8		1.7	mA
			5V	5V	0.8		1.9	mA
		V <sub>I</sub> = GND	1.8V	1.8V	0.7		1.6	mA
			2.5V	2.5V	0.8		1.6	mA
			3.3V	3.3V	0.8		1.7	mA
			5V	5V	0.8		1.9	mA

over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup> <sup>(2)</sup>

PARAMETER		TEST CONDITIONS	V <sub>CCA</sub>	V <sub>CCB</sub>	Operating free-air temperature (T <sub>A</sub> )			UNIT
					-40°C to 125°C			
					MIN	TYP	MAX	
I <sub>CCA</sub> + I <sub>CCB</sub>	Supply Current - AC Signal	All channels switching with square wave clock input; CL = 15pF, 1Mbps	1.8V	1.8V	0.9		1.6	mA
			2.5V	2.5V	0.9		1.6	mA
			3.3V	3.3V	0.9		1.7	mA
			5V	5V	1.1		2	mA
		All channels switching with square wave clock input; CL = 15pF, 50Mbps	1.8V	1.8V	4.5		6.3	mA
			2.5V	2.5V	5.5		7.3	mA
			3.3V	3.3V	6.3		8	mA
			5V	5V	8.4		10.7	mA
		All channels switching with square wave clock input; CL = 15pF, 100Mbps	1.8V	1.8V	8.5		10.7	mA
			2.5V	2.5V	10		13	mA
			3.3V	3.3V	12		14.7	mA
			5V	5V	16.6		20.2	mA

- (1) V<sub>CCI</sub> is the V<sub>CC</sub> associated with the input port and referenced to GND<sub>A</sub>  
(2) V<sub>CCO</sub> is the V<sub>CC</sub> associated with the output port and referenced to GND<sub>B</sub>  
(3) Floating is defined as a node that is both not actively driven by an external device and has leakage not exceeding 10nA

### 5.7 Switching Characteristics, V<sub>CCA</sub> = 1.8 ± 0.15V

PARAMETER		TEST CONDITIONS	FROM	TO	TEMPERATURE	B-Port Supply Voltage (V <sub>CCB</sub> )								UNIT
						1.8 ± 0.15V		2.5 ± 0.2V		3.3 ± 0.3V		5.0 ± 0.5V		
						MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	
t <sub>pd</sub>	Propagation delay	1Mbps all 4 channels toggling	A	B	-40°C to 85°C	2.8	7.3	2.8	7.4	2.8	7.5	2.9	7.8	ns
			A	B	-40°C to 125°C	2.8	7.6	2.8	7.8	2.8	7.9	2.9	8.3	
			B	A	-40°C to 85°C	2.8	7.3	2.7	5.7	2.6	5.1	2.6	4.8	
			B	A	-40°C to 125°C	2.8	7.7	2.7	6	2.6	5.3	2.6	5.1	
PWD	Pulse width distortion	t <sub>pnl</sub> - t <sub>pnh</sub>	A	B	-40°C to 85°C	0.7	1.5	0.6	1.5	0.5	1.4	0.5	1.2	ns
			A	B	-40°C to 125°C	0.7	1.5	0.6	1.5	0.5	1.4	0.5	1.2	
			B	A	-40°C to 85°C	0.7	1.5	0.6	1.5	0.5	1.4	0.5	1.2	
			B	A	-40°C to 125°C	0.7	1.5	0.6	1.5	0.5	1.4	0.4	1.2	

PARAMETER	TEST CONDITIONS	FROM	TO	TEMPERATURE	B-Port Supply Voltage ( $V_{CCB}$ )												UNIT
					1.8 ± 0.15V			2.5 ± 0.2V			3.3 ± 0.3V			5.0 ± 0.5V			
					MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
$t_r$	Output signal rise time		A	B	-40°C to 85°C	0.5	1.3	0.5	1.35	0.5	1.4	0.5	1.6	ns			
			A	B	-40°C to 125°C	0.5	1.3	0.5	1.4	0.5	1.4	0.5	1.7				
			B	A	-40°C to 85°C	0.5	1.2	0.5	1.3	0.5	1.2	0.5	1.3				
			B	A	-40°C to 125°C	0.5	1.3	0.5	1.4	0.5	1.3	0.5	1.3				
$t_f$	Output signal fall time		A	B	-40°C to 85°C	0.4	1.3	0.4	1.3	0.4	1.5	0.5	1.7	ns			
			A	B	-40°C to 125°C	0.4	1.5	0.4	1.5	0.4	1.6	0.5	2				
			B	A	-40°C to 85°C	0.4	1.3	0.4	1.4	0.4	1.3	0.4	1.3				
			B	A	-40°C to 125°C	0.4	1.4	0.4	1.45	0.4	1.4	0.4	1.35				
$t_{DO}$	Default output delay time from input power loss	Measured from the time $V_{CC}$ goes below 1.2V			-40°C to 85°C	6.1	10.6	6.1	10.4	6	10.3	5.9	9.9	$\mu$ s			
					-40°C to 125°C	6.1	10.6	6.1	10.4	6	10.3	5.9	9.9				
$t_{PU}$	Time from ULVO to valid output data				-40°C to 85°C	21.1	64.3	4.3	69.1	4.5	76.6	55.3	99.4	$\mu$ s			
					-40°C to 125°C	19.9	64.3	4.3	69.1	4.5	76.6	53.9	99.4				

### 5.8 Switching Characteristics, $V_{CCA} = 2.5 \pm 0.2V$

PARAMETER	TEST CONDITIONS	FROM	TO	TEMPERATURE	B-Port Supply Voltage ( $V_{CCB}$ )												UNIT
					1.8 ± 0.15V			2.5 ± 0.2V			3.3 ± 0.3V			5.0 ± 0.5V			
					MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
$t_{pd}$	Propagation delay	1Mbps all 4 channels toggling	A	B	-40°C to 85°C	2.7	5.7	2.7	5.8	2.7	5.9	2.8	6.3	ns			
			A	B	-40°C to 125°C	2.7	6	2.7	6.1	2.7	6.2	2.8	6.6				
			B	A	-40°C to 85°C	2.8	7.4	2.7	5.8	2.6	5.1	2.6	4.9				
			B	A	-40°C to 125°C	2.8	7.7	2.7	6.1	2.6	5.5	2.6	5.2				
PWD	Pulse width distortion	$ t_{pHl} - t_{pHh} $	A	B	-40°C to 85°C	0.1	1	0.1	0.8	0	0.7	-0.14	0.6	ns			
			A	B	-40°C to 125°C	0.1	1	0.1	0.8	0	0.7	-0.15	0.6				
			B	A	-40°C to 85°C	0.1	1	0.1	0.8	0	0.7	-0.14	0.6				
			B	A	-40°C to 125°C	0.1	1	0.1	0.8	0	0.7	-0.15	0.6				
$t_r$	Output signal rise time		A	B	-40°C to 85°C	0.5	1.3	0.5	1.3	0.5	1.4	0.5	1.6	ns			
			A	B	-40°C to 125°C	0.5	1.3	0.5	1.4	0.5	1.4	0.5	1.7				
			B	A	-40°C to 85°C	0.5	1.3	0.4	1.3	0.5	1.3	0.4	1.3				
			B	A	-40°C to 125°C	0.5	1.3	0.4	1.3	0.5	1.3	0.4	1.4				

PARAMETER	TEST CONDITIONS	FROM	TO	TEMPERATURE	B-Port Supply Voltage ( $V_{CCB}$ )										UNIT		
					1.8 ± 0.15V			2.5 ± 0.2V			3.3 ± 0.3V			5.0 ± 0.5V			
					MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN		TYP	MAX
$t_f$	Output signal fall time		A	B	-40°C to 85°C	0.4	1.4	0.4	1.3	0.4	1.5	0.5	1.7	ns			
			A	B	-40°C to 125°C	0.4	1.4	0.4	1.5	0.4	1.6	0.5	2				
			B	A	-40°C to 85°C	0.4	1.3	0.4	1.3	0.4	1.35	0.4	1.3				
			B	A	-40°C to 125°C	0.4	1.5	0.4	1.5	0.4	1.4	0.4	1.5				
$t_{DO}$	Default output delay time from input power loss	Measured from the time $V_{CC}$ goes below 1.2V			-40°C to 85°C	6.1	10.6	6.1	10.4	5.6	10.4	5.4	9.9	µs			
					-40°C to 125°C	6.1	10.6	6.1	10.4	5.6	10.4	5.4	9.9				
$t_{PU}$	Time from ULVO to valid output data			-40°C to 85°C	21.1	64.3	4.3	69.1	4.5	76.6	55.3	99.4	µs				
				-40°C to 125°C	19.9	64.3	4.3	69.1	4.5	76.6	53.9	99.4					

### 5.9 Switching Characteristics, $V_{CCA} = 3.3 \pm 0.3V$

PARAMETER	TEST CONDITIONS	FROM	TO	TEMPERATURE	B-Port Supply Voltage ( $V_{CCB}$ )										UNIT		
					1.8 ± 0.15V			2.5 ± 0.2V			3.3 ± 0.3V			5.0 ± 0.5V			
					MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN		TYP	MAX
$t_{pd}$	Propagation delay	1Mbps all 4 channels toggling	A	B	-40°C to 85°C	2.6	5.1	2.7	5.2	2.7	5.3	2.8	5.8	ns			
			A	B	-40°C to 125°C	2.6	5.3	2.7	5.5	2.7	5.7	2.8	6.3				
			B	A	-40°C to 85°C	2.8	7.5	2.7	5.9	2.7	5.3	2.6	5.1				
			B	A	-40°C to 125°C	2.8	7.9	2.7	6.2	2.7	5.7	2.6	5.4				
PWD	Pulse width distortion	$ t_{phi} - t_{plh} $	A	B	-40°C to 85°C	-0.03	0.6	-0.09	0.5	-0.13	0.5	-0.3	0.4	ns			
			A	B	-40°C to 125°C	-0.11	0.6	-0.13	0.5	-0.18	0.5	-0.4	0.4				
			B	A	-40°C to 85°C	-0.03	0.6	-0.09	0.5	-0.13	0.5	-0.3	0.4				
			B	A	-40°C to 125°C	-0.11	0.6	-0.13	0.5	-0.18	0.5	-0.4	0.4				
$t_r$	Output signal rise time		A	B	-40°C to 85°C	0.5	1.3	0.5	1.3	0.5	1.4	0.5	1.6	ns			
			A	B	-40°C to 125°C	0.5	1.3	0.5	1.4	0.5	1.4	0.5	1.6				
			B	A	-40°C to 85°C	0.5	1.3	0.5	1.3	0.5	1.4	0.5	1.4				
			B	A	-40°C to 125°C	0.5	1.35	0.5	1.4	0.5	1.4	0.5	1.5				
$t_f$	Output signal fall time		A	B	-40°C to 85°C	0.4	1.3	0.4	1.4	0.4	1.5	0.5	1.7	ns			
			A	B	-40°C to 125°C	0.4	1.5	0.4	1.6	0.4	1.6	0.5	2				
			B	A	-40°C to 85°C	0.4	1.4	0.4	1.4	0.4	1.4	0.4	1.4				
			B	A	-40°C to 125°C	0.4	1.7	0.4	1.6	0.4	1.6	0.4	1.7				

PARAMETER		TEST CONDITIONS	FROM	TO	TEMPERATURE	B-Port Supply Voltage (V <sub>CCB</sub> )										UNIT		
						1.8 ± 0.15V			2.5 ± 0.2V			3.3 ± 0.3V			5.0 ± 0.5V			
						MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN		TYP	MAX
t <sub>DO</sub>	Default output delay time from input power loss	Measured from the time V <sub>CC</sub> goes below 1.2V			-40°C to 85°C	6	10.6	5.8	10.4	5.8	10.3	5.8	10	μs				
					-40°C to 125°C	6	10.6	5.8	10.4	5.8	10.3	5.8	10	μs				
t <sub>PU</sub>	Time from ULVO to valid output data			-40°C to 85°C	21.1	64.3	4.3	69.1	4.5	76.6	57.8	99.4	μs					
				-40°C to 125°C	19.9	64.3	4.3	69.1	4.5	76.6	53.9	99.4	μs					

### 5.10 Switching Characteristics, V<sub>CCA</sub> = 5.0 ± 0.5V

PARAMETER		TEST CONDITIONS	FROM	TO	TEMPERATURE	B-Port Supply Voltage (V <sub>CCB</sub> )										UNIT		
						1.8 ± 0.15V			2.5 ± 0.2V			3.3 ± 0.3V			5.0 ± 0.5V			
						MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN		TYP	MAX
t <sub>pd</sub>	Propagation delay	1Mbps all 4 channels toggling	A	B	-40°C to 85°C	2.6	4.8	2.6	5	2.7	5.1	2.8	5.6	ns				
			A	B	-40°C to 125°C	2.6	5.1	2.6	5.3	2.7	5.4	2.8	5.9					
			B	A	-40°C to 85°C	3	7.9	2.8	6.2	2.7	5.9	2.7	5.6					
			B	A	-40°C to 125°C	3	8.4	2.8	6.6	2.7	6.2	2.7	6					
PWD	Pulse width distortion	t <sub>pnl</sub> - t <sub>plh</sub>	A	B	-40°C to 85°C	-0.22	0.4	-0.27	0.3	-0.32	0.3	-0.50	0.2	ns				
			A	B	-40°C to 125°C	-0.33	0.4	-0.37	0.3	-0.42	0.3	-0.60	0.2					
			B	A	-40°C to 85°C	-0.22	0.4	-0.27	0.3	-0.32	0.3	-0.5	0.2					
			B	A	-40°C to 125°C	-0.33	0.4	-0.37	0.3	-0.42	0.3	-0.60	0.2					
t <sub>r</sub>	Output signal rise time		A	B	-40°C to 85°C	0.5	1.3	0.5	1.3	0.5	1.4	0.5	1.6	ns				
			A	B	-40°C to 125°C	0.5	1.3	0.5	1.4	0.5	1.4	0.5	1.6					
			B	A	-40°C to 85°C	0.6	1.6	0.6	1.6	0.6	1.6	0.5	1.6					
			B	A	-40°C to 125°C	0.6	1.75	0.6	1.7	0.6	1.7	0.5	1.6					
t <sub>f</sub>	Output signal fall time		A	B	-40°C to 85°C	0.4	1.3	0.4	1.4	0.4	1.5	0.5	1.7	ns				
			A	B	-40°C to 125°C	0.4	1.4	0.4	1.5	0.4	1.6	0.5	2					
			B	A	-40°C to 85°C	0.4	1.8	0.5	1.8	0.4	1.8	0.4	1.8					
			B	A	-40°C to 125°C	0.4	2.5	0.5	2	0.4	2	0.4	2					
t <sub>DO</sub>	Default output delay time from input power loss	Measured from the time V <sub>CC</sub> goes below 1.2V			-40°C to 85°C	5.5	10.7	5.6	10.5	5.7	10.6	5.9	10	μs				
					-40°C to 125°C	5.5	10.7	5.6	10.5	5.7	10.6	5.9	10					
t <sub>PU</sub>	Time from ULVO to valid output data			-40°C to 85°C	21.1	64.3	4.3	69.1	4.5	76.6	55.3	99.4	μs					
				-40°C to 125°C	19.9	64.3	4.3	69.1	4.5	76.6	53.9	99.4						

### 5.11 Switching Characteristics: $T_{sk}$ , $T_{MAX}$

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

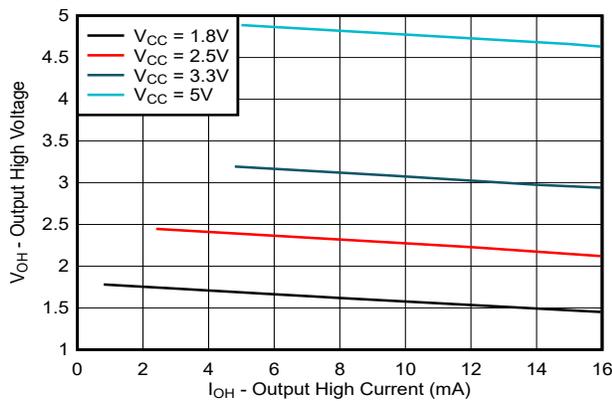
PARAMETER	TEST CONDITIONS		$V_{CCI}$	$V_{CCO}$	Operating free-air temperature ( $T_A$ )			UNIT
					-40°C to 125°C			
					MIN	TYP	MAX	
$T_{MAX}$ - Maximum Data Rate	50% Duty Cycle Input One channel switching 20% of pulse > $0.7 \cdot V_{CCO}$ 20% of pulse < $0.3 \cdot V_{CCO}$	No Translation	1.65V - 1.95V	1.65V - 1.95V	264			Mbps
			2.3V - 2.7V	2.3V - 2.7V	220			
			3.0V - 3.6V	3.0V - 3.6V	220			
			4.5V - 5.5V	4.5V - 5.5V	176			
$T_{MAX}$ - Maximum Data Rate	50% Duty Cycle Input One channel switching 20% of pulse > $0.7 \cdot V_{CCO}$ 20% of pulse < $0.3 \cdot V_{CCO}$	Up Translation	1.65V - 1.95V	2.3V - 2.7V	264			Mbps
			1.65V - 1.95V	3.0V - 3.6V	264			
			1.65V - 1.95V	4.5V - 5.5V	264			
			2.3V - 2.7V	3.0V - 3.6V	220			
			2.3V - 2.7V	4.5V - 5.5V	220			
			3.0V - 3.6V	4.5V - 5.5V	176			
$T_{MAX}$ - Maximum Data Rate	50% Duty Cycle Input One channel switching 20% of pulse > $0.7 \cdot V_{CCO}$ 20% of pulse < $0.3 \cdot V_{CCO}$	Down Translation	2.3V - 2.7V	1.65V - 1.95V	264			Mbps
			3.0V - 3.6V	2.3V - 2.7V	220			
			3.0V - 3.6V	1.65V - 1.95V	220			
			4.5V - 5.5V	3.0V - 3.6V	176			
			4.5V - 5.5V	1.65V - 1.95V	220			
			4.5V - 5.5V	1.65V - 1.95V	220			
$t_{sk}$ - Output skew	Timing skew between any switching outputs on the rising or falling edge (same direction channels)	No Translation	1.65V - 1.95V	1.65V - 1.95V	0.02			ns
			2.3V - 2.7V	2.3V - 2.7V	0.02			
			3.0V - 3.6V	3.0V - 3.6V	0.02			
			4.5V - 5.5V	4.5V - 5.5V	0.04			
$t_{sk}$ - Output skew	Timing skew between any switching outputs on the rising or falling edge (same direction channels)	Up Translation	1.65V - 1.95V	2.3V - 2.7V	0.02			ns
			1.65V - 1.95V	3.0V - 3.6V	0.02			
			1.65V - 1.95V	4.5V - 5.5V	0.02			
			2.3V - 2.7V	3.0V - 3.6V	0.02			
			2.3V - 2.7V	4.5V - 5.5V	0.02			
			3.0V - 3.6V	4.5V - 5.5V	0.02			

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

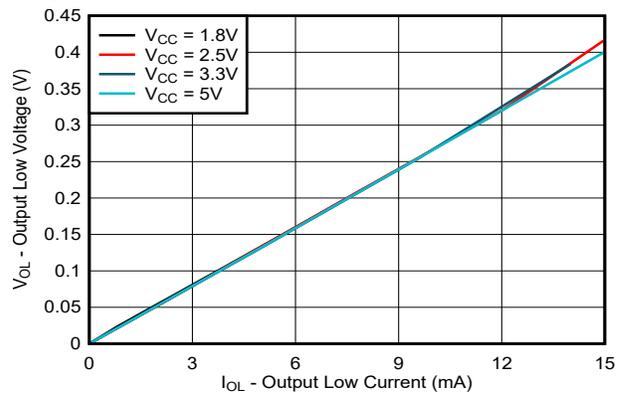
PARAMETER	TEST CONDITIONS		V <sub>CCI</sub>	V <sub>CCO</sub>	Operating free-air temperature (T <sub>A</sub> )			UNIT
					-40°C to 125°C			
					MIN	TYP	MAX	
t <sub>sk</sub> - Output skew	Timing skew between any switching outputs on the rising or falling edge (same direction channels)	Down Translation	2.3V - 2.7V	1.65V - 1.95V			0.02	ns
			3.0V - 3.6V	2.3V - 2.7V			0.02	
			3.0V - 3.6V	1.65V - 1.95V			0.02	
			4.5V - 5.5V	3.0V - 3.6V			0.04	
			4.5V - 5.5V	2.3V - 2.7V			0.04	
			4.5V - 5.5V	1.65V - 1.95V			0.04	

### 5.12 Typical Characteristics

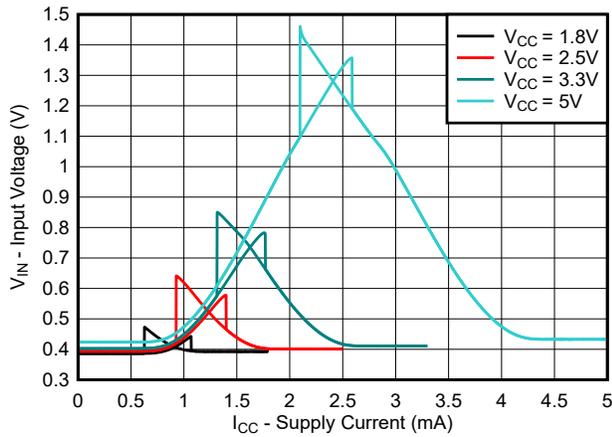
T<sub>A</sub> = 25°C (unless otherwise noted)



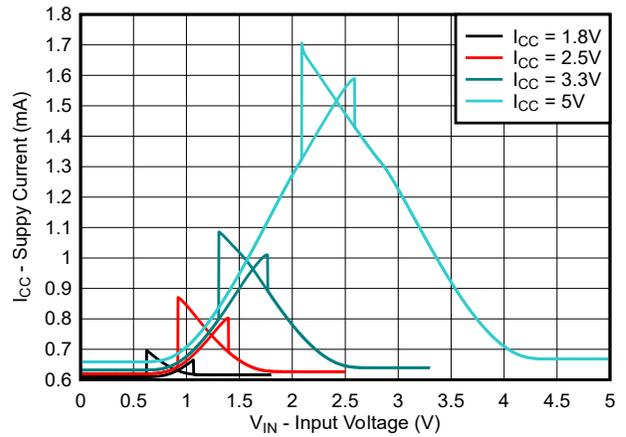
**Figure 5-1. Output High Voltage (V<sub>OH</sub>) vs Source Current (I<sub>OH</sub>)**



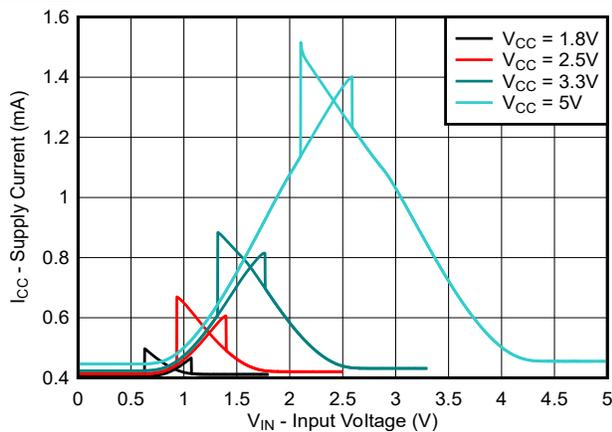
**Figure 5-2. Output Low Voltage (V<sub>OL</sub>) vs Sink Current (I<sub>OL</sub>)**



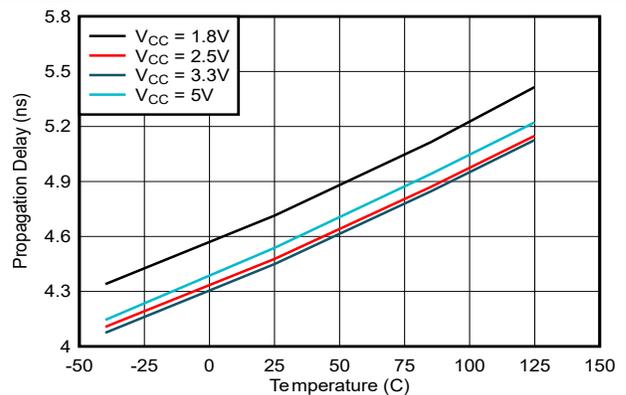
**Figure 5-3. Supply Current (I<sub>CCA</sub>) vs Input Voltage (V<sub>IN</sub>) [TXG0x021]**



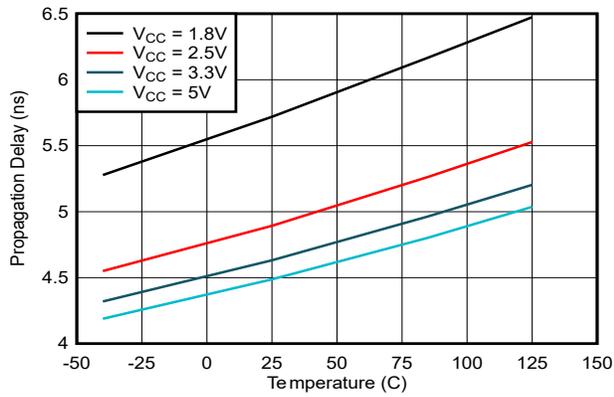
**Figure 5-4. Supply Current (I<sub>CCB</sub>) vs Input Voltage (V<sub>IN</sub>) [TXG0x021]**



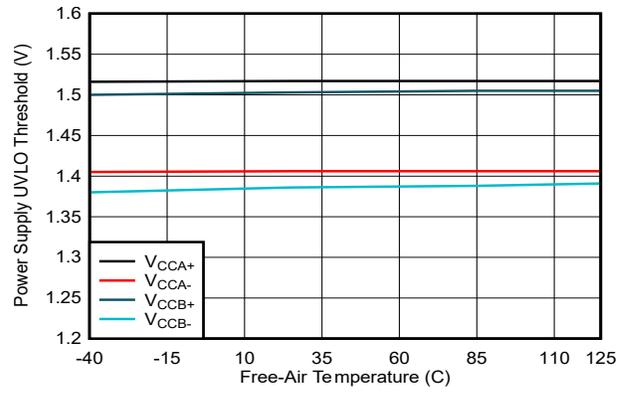
**Figure 5-5. Supply Current (I<sub>CCA</sub>) vs Input Voltage (V<sub>IN</sub>) [TXGx020]**



**Figure 5-6. Propagation Delay, T<sub>PLH</sub>, vs Temperature**



**Figure 5-7. Propagation Delay,  $T_{PHL}$ , vs Temperature**



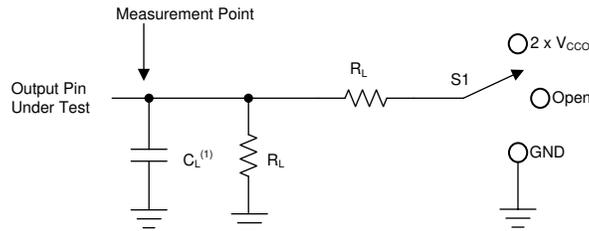
**Figure 5-8. Power Supply Undervoltage Threshold vs Free-Air Temperature**

## 6 Parameter Measurement Information

### 6.1 Load Circuit and Voltage Waveforms

Unless otherwise noted, generators supply all input pulses that have the following characteristics:

- $f = 1\text{MHz}$
- $Z_O = 50\Omega$
- $\Delta t/\Delta V \leq 1\text{ns/V}$

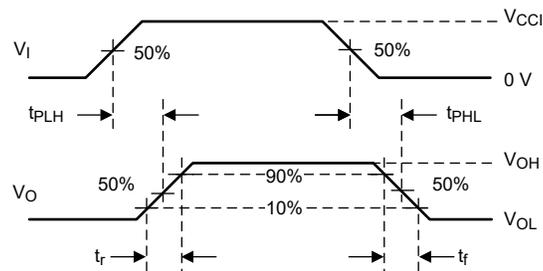


A.  $C_L$  includes probe and jig capacitance.

**Figure 6-1. Load Circuit**

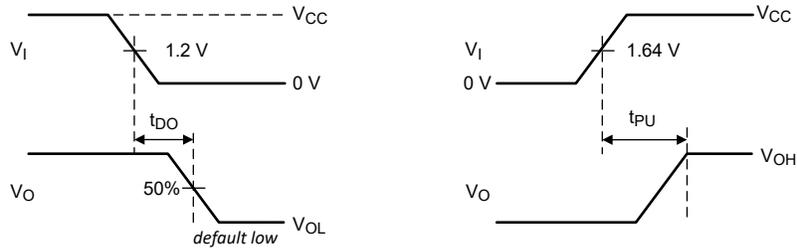
**Table 6-1. Load Circuit Conditions**

Parameter	$V_{CCO}$	$R_L$	$C_L$	$S_1$	$V_{TP}$
$t_{pd}$ Propagation (delay) time	1.71V – 5.5V	10k $\Omega$	15pF	Open	N/A



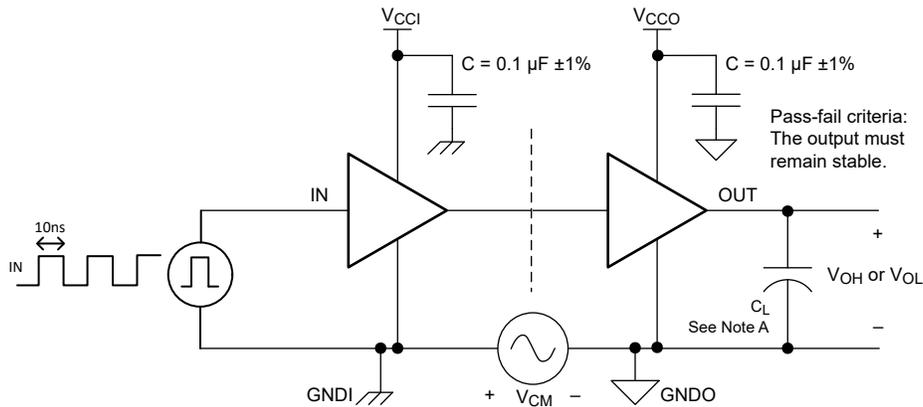
1.  $V_{CCI}$  is the supply pin associated with the input port.
2.  $V_{OH}$  and  $V_{OL}$  are typical output voltage levels that occur with specified  $R_L$ ,  $C_L$ , and  $S_1$

**Figure 6-2. Switching Characteristics Voltage Waveforms**



1.  $V_{CCI}$  is the supply pin associated with the input port.
2.  $V_{OH}$  and  $V_{OL}$  are typical output voltage levels that occur with specified  $R_L$ ,  $C_L$ , and  $S_1$

**Figure 6-3. Default Output Delay Time & Time from UVLO to Valid Output Voltage Waveform**



1.  $C_L = 15pF$  and includes instrumentation and fixture capacitance within  $\pm 20\%$ .

**Figure 6-4. Common-Mode Transient Immunity Test Circuit**

## 7 Detailed Description

### 7.1 Overview

The TXG402x-Q1 is a 2-bit ground-level translator that uses two individually configurable power-supply rails which allows it to translate across two different power domains. The device is operational with  $V_{CCA}$  and  $V_{CCB}$  supplies as low as 1.71V and as high as 5.5V. The A port is designed to track  $V_{CCA}$  and the B port is designed to track  $V_{CCB}$ . In addition to I/O level shifting, this translator can support a difference of -40V to +40V between GNDA and GNDB.  $V_{CCA}$  is referenced to GNDA and  $V_{CCB}$  is referenced to GNDB.

The TXG402x-Q1 device is designed for asynchronous communication between data buses, and transmits data with fixed direction from the A bus to the B bus on some channels and from the B bus to the A bus on the remaining channels.

The  $V_{CC}$  disconnect feature ensures that if  $V_{CC}$  is disconnected with the complementary supply within recommended operating conditions, outputs are disabled and set to the high-impedance state while the supply current is maintained. The  $I_{off-float}$  circuitry ensures that no excessive current is drawn from or sourced into an input or output while the supply is floating.

Glitch-free power supply sequencing allows either supply rail to be powered on or off in any order while providing robust power sequencing performance.

### 7.2 Functional Block Diagram

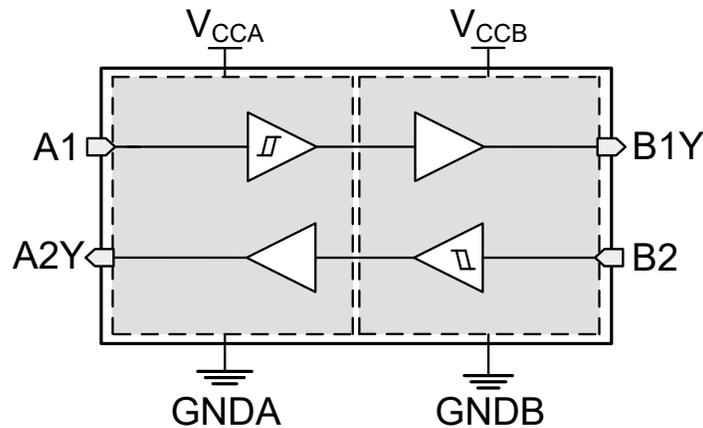


Figure 7-1. TXG4021-Q1 Functional Block Diagram

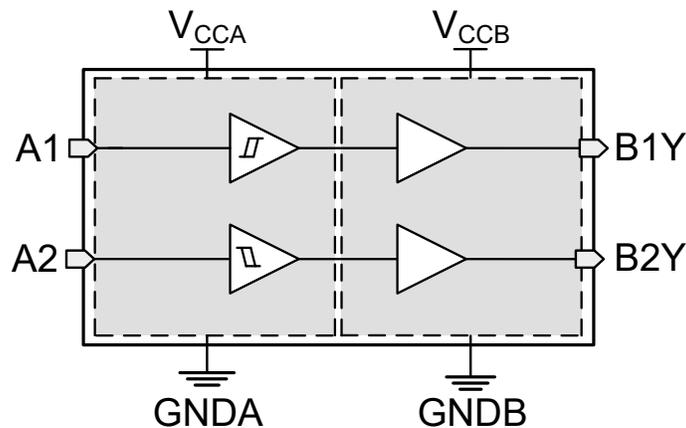


Figure 7-2. TXG4020-Q1 Functional Block Diagram

## 7.3 Feature Description

### 7.3.1 CMOS Schmitt-Trigger Inputs with Integrated Pulldowns

Standard CMOS inputs are high impedance and are typically modeled as a resistor in parallel with the input capacitance given in the [Section 5.5](#). The worst case resistance is calculated with the maximum input voltage, given in the [Section 5.1](#), and the maximum input leakage current, given in the [Section 5.5](#), using ohm's law ( $R = V \div I$ ).

The Schmitt-trigger input architecture provides hysteresis as defined by  $\Delta V_T$  in the [Section 5.5](#), which makes this device extremely tolerant to slow or noisy inputs. Driving the inputs slowly will increase dynamic current consumption of the device. See [Understanding Schmitt Triggers](#) for additional information regarding Schmitt-trigger inputs.

#### 7.3.1.1 Inputs with Integrated Static Pull-Down Resistors

This device has 5M $\Omega$  typical integrated weak pull-downs for each input. This feature allows all inputs to be left floating without the concern for unstable outputs or increased current consumption. This also helps to reduce external component count for applications where not all channels are used or need to be fixed low. If an external pull-up is required, it should be no larger than 1M $\Omega$  to avoid contention with the 5M $\Omega$  internal pull-down.

### 7.3.2 Balanced High-Drive CMOS Push-Pull Outputs

A balanced output allows the device to sink and source similar currents. The high drive capability of this device creates fast edges into light loads, so routing and load conditions should be considered to prevent ringing. Additionally, the outputs of this device are capable of driving larger currents than the device can sustain without being damaged. [Section 5.1](#) defines the electrical and thermal limits that must be followed at all times.

### 7.3.3 $V_{CC}$ Disconnect

The outputs for this device are disabled and enter a high-impedance state when either supply is left floating (disconnected), and with the complementary supply within recommended operating conditions. It is recommended that the inputs are kept low before floating (disconnecting) either supply.

The  $I_{CCx(\text{floating})}$  in the [Section 5.5](#) specifies the maximum supply current. The  $I_{\text{off}(\text{float})}$  in the [Section 5.5](#) specifies the maximum leakage into or out of any input or output pin on the device.

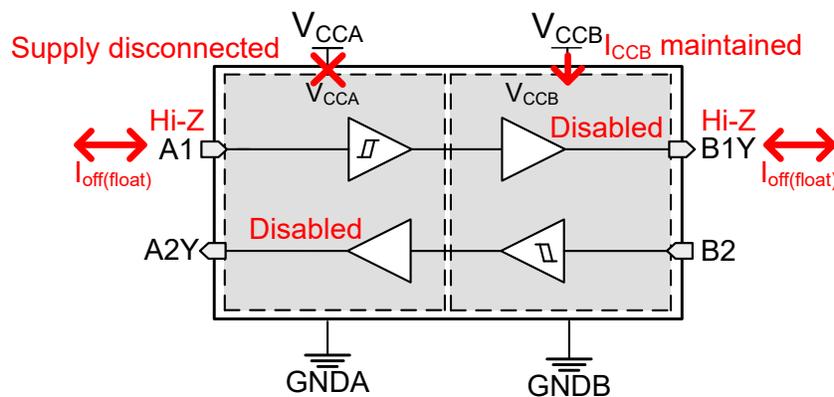


Figure 7-3.  $V_{CC}$  Disconnect Feature

### 7.3.4 Over-Voltage Tolerant Inputs

Input signals to this device can be driven above the supply voltage so long as they remain below the maximum input voltage value specified in the [Section 5.3](#).

### 7.3.5 Glitch-Free Power Supply Sequencing

Either supply rail may be powered on or off in any order without producing a glitch on the inputs or outputs (that is, where the output erroneously transitions to  $V_{CC}$  when it should be held low or vice versa). Glitches of this

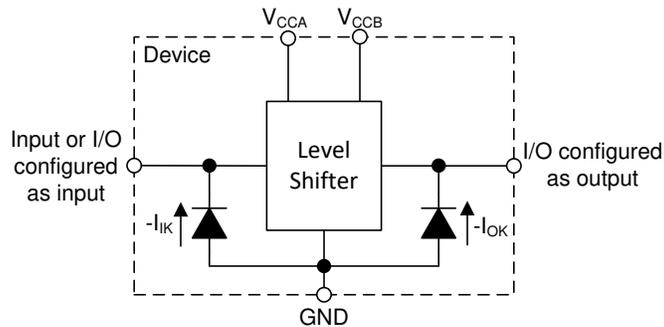
nature can be misinterpreted by a peripheral as a valid data bit, which could trigger a false device reset of the peripheral, a false device configuration of the peripheral, or even a false data initialization by the peripheral.

### 7.3.6 Negative Clamping Diodes

Figure 7-4 depicts the inputs and outputs to this device that have negative clamping diodes.

**CAUTION**

Voltages beyond the values specified in the [Section 5.1](#) table can cause damage to the device. The input negative-voltage and output voltage ratings may be exceeded if the input and output clamp-current ratings are observed.



**Figure 7-4. Electrical Placement of Clamping Diodes for Each Input and Output**

### 7.3.7 Fully Configurable Dual-Rail Design

The  $V_{CCA}$  and  $V_{CCB}$  pins can be supplied at any voltage from 1.71V to 5.5V, making the device suitable for translating between any of the voltage nodes (1.8V, 2.5V, 3.3V, and 5.0V).

### 7.3.8 Supports High-Speed Translation

The TXG402x-Q1 device can support high data-rate applications. The translated signal data rate can be greater than 250Mbps when the signal is translated from 1.71V to 5.5V.

### 7.3.9 AC Noise Rejection

TXG402x-Q1 supports I/O voltage translation in environments with noisy grounds. The plot below illustrates the amount of noise that GNDA and GNDB can reject in terms peak-to-peak voltage over frequency without disrupting communication between two systems. As an example, [Figure 7-6](#) below shows GNDA with a ground bounce of  $2V_{PP}$  at 10kHz but still effectively translating 5V to 2.5V without any degradation.

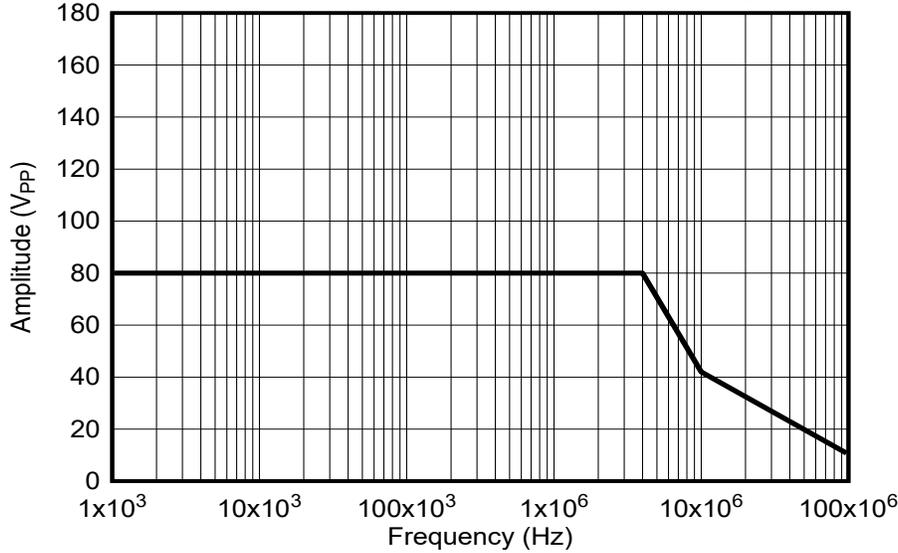
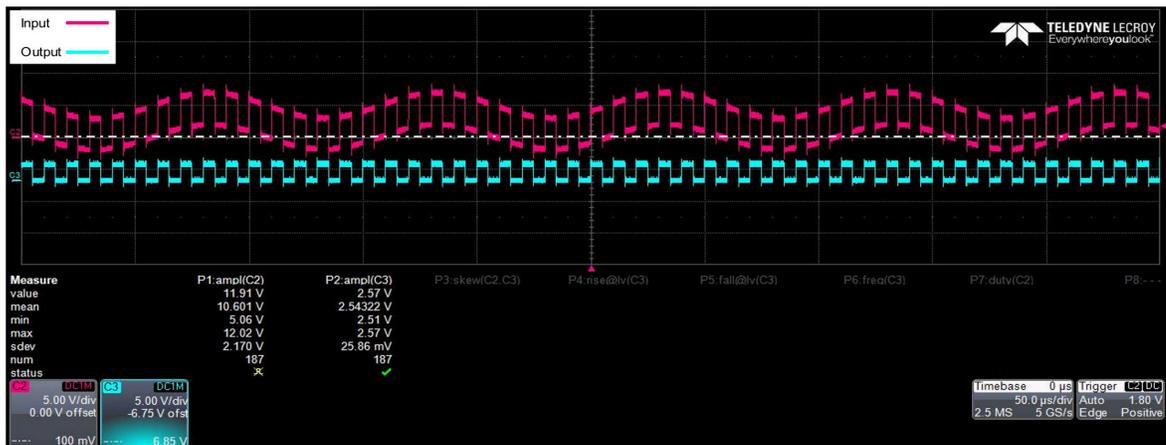


Figure 7-5. AC Noise Rejection Plot

Voltage:  
V<sub>CCA</sub> = 5V  
V<sub>CCB</sub> = 2.5V



\*Note: Offset voltage on the output to show both signals side-by-side

Figure 7-6. Waveform showing 5V to 2.5V I/O translation with AC Ground Noise of  $2V_{PP}$  at 10kHz

## 7.4 Device Functional Modes

**Table 7-1. Function Table**

Power Supply <sup>(1)</sup>		Port Status	
VCCI	VCCO	Input	Output
PU	PU	H	H
PU	PU	L	L
PU	PU	Open	L
PD	PU	X	L

(1) In the table above: PU = Powered Up; PD = Powered Down; X = Irrelevant; H = High Level; L = Low Level; Open = Floating

## 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 TXG402x-Q1 is used for level translation, enabling communication between devices or systems operating at different interface and ground voltages. The TXG402x-Q1 device is ideal for use in applications where a push-pull driver is connected to the data inputs. Figure 8-1 is an example of two systems that translate from 1.8V to 3.3V while also experiencing a ground shift of 5V. The ground shift occurs due to the parasitic resistance of the cable used to connect the 48V battery ground and 12V battery ground to the chassis of the car.

### 8.2 Typical Application

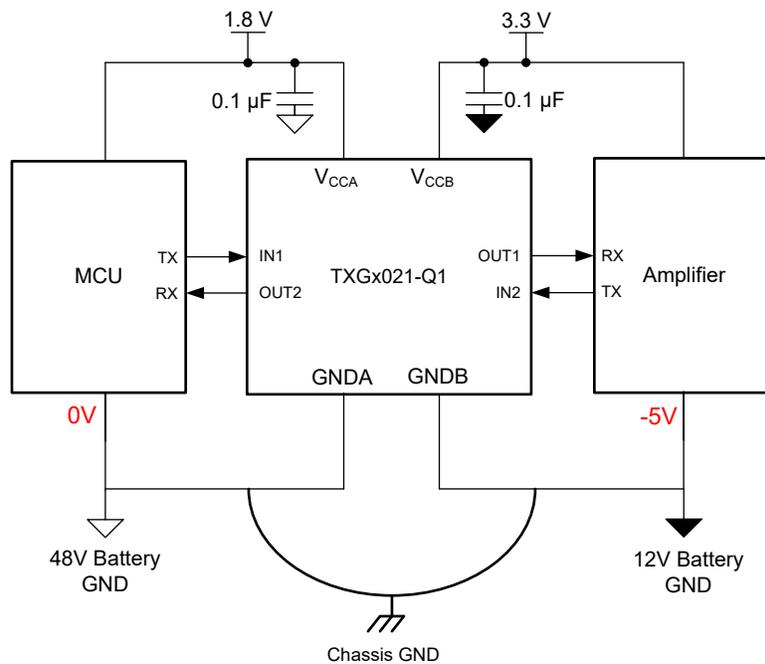


Figure 8-1. TXG4021-Q1 in Automotive

#### 8.2.1 Design Requirements

Use the parameters listed in Table 8-1 for this design example.

Table 8-1. Design Parameters

DESIGN PARAMETERS	EXAMPLE VALUES
Input voltage range	1.71V to 5.5V
Output voltage range	1.71V to 5.5V

#### 8.2.2 Detailed Design Procedure

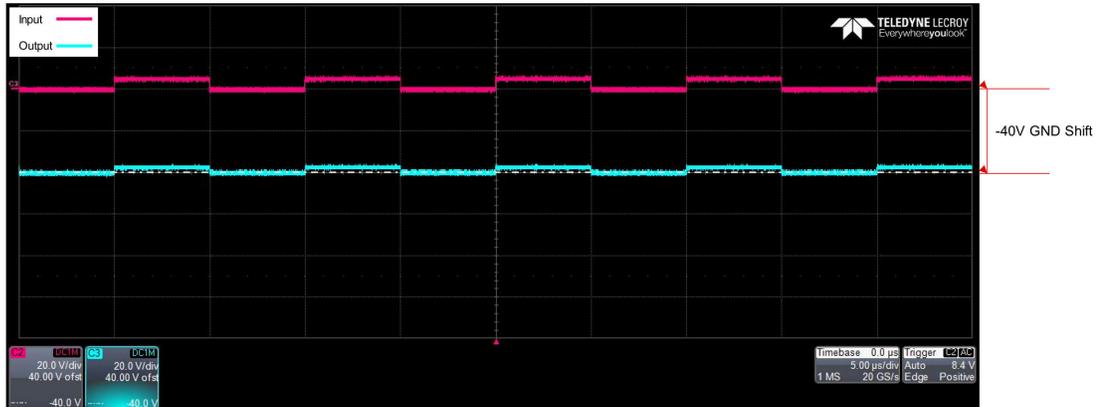
To begin the design process, determine the following:

- Input voltage range

- Use the supply voltage of the device that is driving the TXG402x-Q1 device to determine the input voltage range. For a valid logic-high, the value must exceed the positive-going input-threshold voltage ( $V_{T+}$ ) of the input port. For a valid logic low the value must be less than the negative-going input-threshold voltage ( $V_{T-}$ ) of the input port.
- Output voltage range
  - Use the supply voltage of the device that the TXG402x-Q1 device is driving to determine the output voltage range.

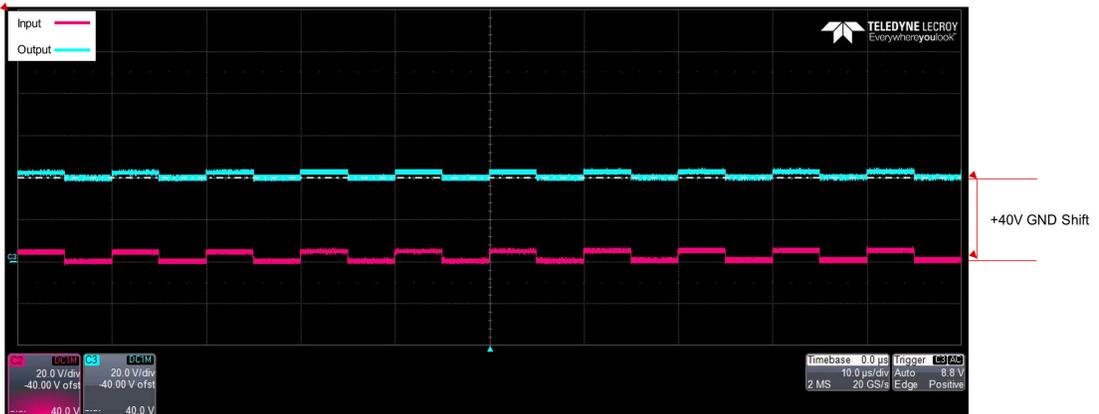
### 8.2.3 Application Curves

**Voltage:**  
 VCCA = 5V  
 VCCB = 2.5V



\*Note: All signals have a +40V offset to show negative ground shift

**Voltage:**  
 VCCA = 5V  
 VCCB = 2.5V



\*Note: All signals have a -40V offset to show positive ground shift

**Figure 8-2. Waveform showing -40V (top) and +40V (bottom) Ground Shift with 5V to 2.5V I/O Translation**

### 8.3 Power Supply Recommendations

Always apply a ground reference to the GND pins first. This device is designed for glitch free power sequencing without any supply sequencing requirements such as ramp order or ramp rate. Please make sure the difference between  $V_{CC}$  and GND remains at 6.5V max at all times.

### 8.4 Layout

#### 8.4.1 Layout Guidelines

To ensure reliability of the device, following common printed-circuit board layout guidelines are recommended:

- Use bypass capacitors on the power supply pins and place them as close to the device as possible. A 0.1 $\mu$ F capacitor is recommended, but transient performance can be improved by having 1 $\mu$ F and 0.1 $\mu$ F capacitors in parallel as bypass capacitors.
- The high drive capability of this device creates fast edges into light loads so routing and load conditions should be considered to prevent ringing.
- A 0.1 $\mu$ F capacitor can be added between GNDA and GNDB to improve performances of CMTI.

#### 8.4.2 Layout Example

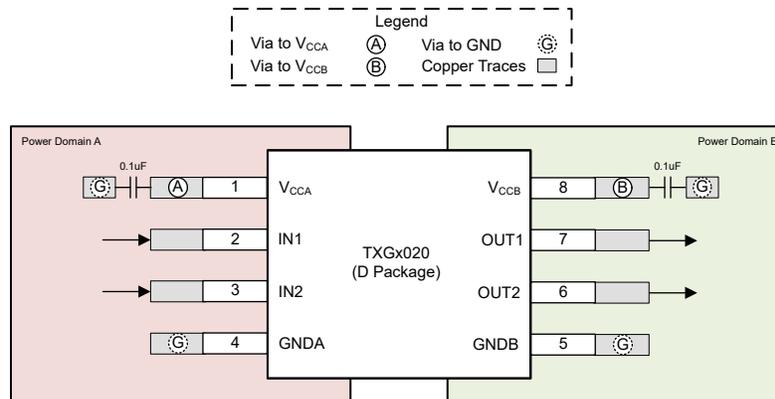


Figure 8-3. D Layout Example

## 9 Device and Documentation Support

### 9.1 Device Support

#### 9.1.1 Regulatory Requirements

No statutory or regulatory requirements apply to this device.

There are no special characteristics for this product.

### 9.2 Documentation Support

#### 9.2.1 Related Documentation

For related documentation, see the following:

- Texas Instruments, [Understanding Schmitt Triggers application report](#)
- Texas Instruments, [CMOS Power Consumption and  \$C\_{pd}\$  Calculation application report](#)

### 9.3 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.

### 9.4 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](#).

### 9.5 Trademarks

TI E2E™ is a trademark of Texas Instruments.

All trademarks are the property of their respective owners.

### 9.6 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.

### 9.7 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 * (May 2025) to Revision A (March 2026)	Page
• Updated datasheet status from <i>Advanced Information</i> to <i>Production Data</i> .....	1
• Updated CMTI specification from typical 1kV/us to minimum specification.....	9
• Added Supply Current table.....	11
• Added Typical Characteristics plots.....	19
• Added <a href="#">Table 7-1</a> .....	27

DATE	REVISION	NOTES
May 2025	*	Initial Release

## 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 (1)	Material type (2)	Package   Pins	Package qty   Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
<a href="#">PTXG4020QDDFRQ1</a>	Active	Preproduction	SOT-23-THIN (DDF)   8	3000   LARGE T&R	-	Call TI	Call TI	-40 to 125	
<a href="#">PTXG4020QDRQ1</a>	Active	Preproduction	SOIC (D)   8	3000   LARGE T&R	-	Call TI	Call TI	-40 to 125	
<a href="#">PTXG4020QDSGRQ1</a>	Active	Preproduction	WSON (DSG)   8	3000   LARGE T&R	-	Call TI	Call TI	-40 to 125	
<a href="#">PTXG4021QDDFRQ1</a>	Active	Preproduction	SOT-23-THIN (DDF)   8	3000   LARGE T&R	-	Call TI	Call TI	-40 to 125	
<a href="#">PTXG4021QDRQ1</a>	Active	Preproduction	SOIC (D)   8	3000   LARGE T&R	-	Call TI	Call TI	-40 to 125	
<a href="#">PTXG4021QDSGRQ1</a>	Active	Preproduction	WSON (DSG)   8	3000   LARGE T&R	-	Call TI	Call TI	-40 to 125	
<a href="#">TXG4020QDRQ1</a>	Active	Production	SOIC (D)   8	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	T4020Q
<a href="#">TXG4021QDRQ1</a>	Active	Production	SOIC (D)   8	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	T4021Q

(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.

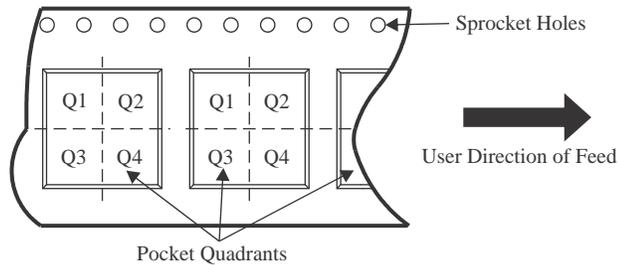
**OTHER QUALIFIED VERSIONS OF TXG4020-Q1, TXG4021-Q1 :**

- Catalog : [TXG4020](#), [TXG4021](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

**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
TXG4020QDRQ1	SOIC	D	8	3000	330.0	12.4	3.75	3.75	1.15	8.0	12.0	Q1
TXG4021QDRQ1	SOIC	D	8	3000	330.0	12.4	3.75	3.75	1.15	8.0	12.0	Q1

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TXG4020QDRQ1	SOIC	D	8	3000	340.5	336.1	32.0
TXG4021QDRQ1	SOIC	D	8	3000	340.5	336.1	32.0

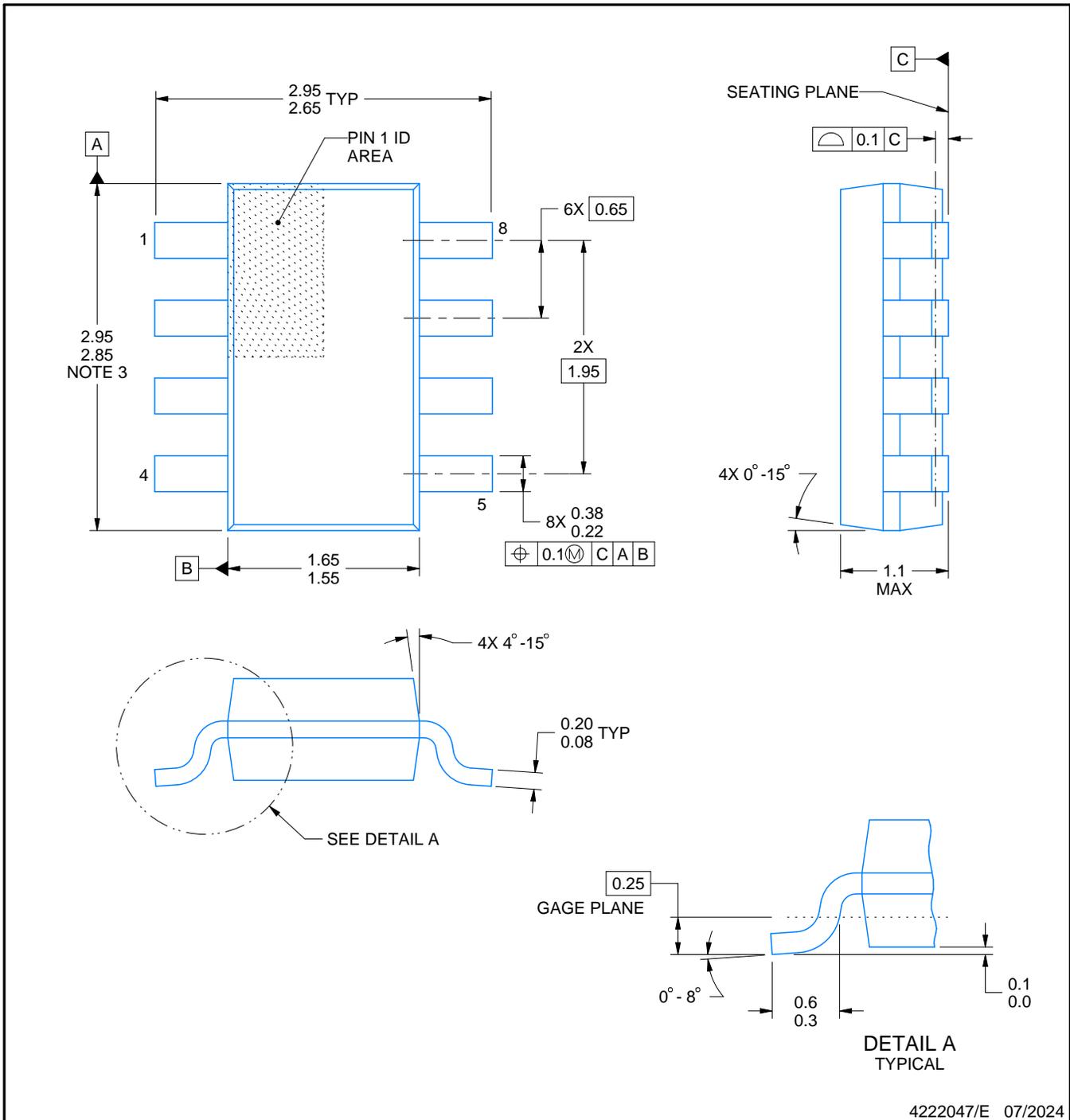
# DDF0008A



# PACKAGE OUTLINE

## SOT-23-THIN - 1.1 mm max height

PLASTIC SMALL OUTLINE



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### NOTES:

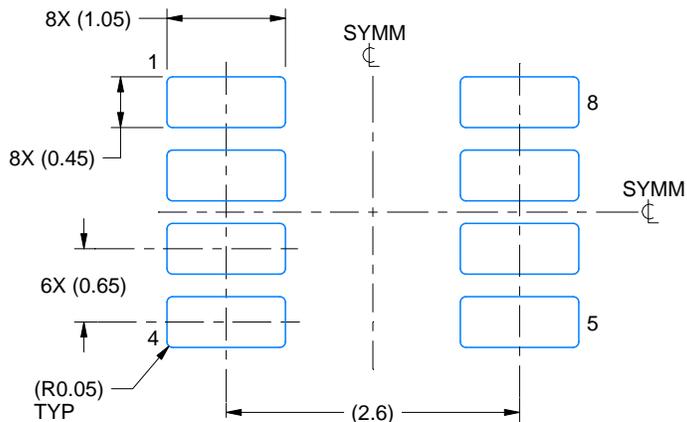
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or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

# EXAMPLE BOARD LAYOUT

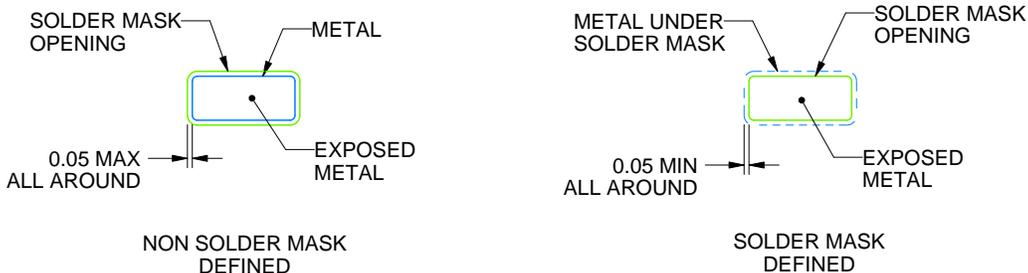
DDF0008A

SOT-23-THIN - 1.1 mm max height

PLASTIC SMALL OUTLINE



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:15X



SOLDER MASK DETAILS

4222047/E 07/2024

NOTES: (continued)

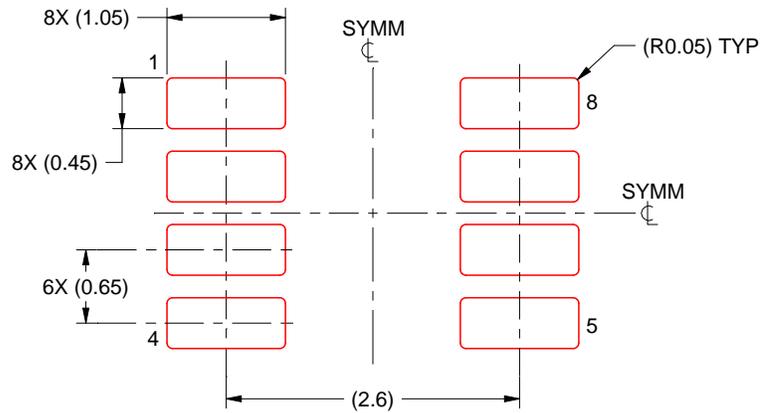
- 4. Publication IPC-7351 may have alternate designs.
- 5. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

DDF0008A

SOT-23-THIN - 1.1 mm max height

PLASTIC SMALL OUTLINE

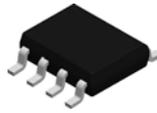


SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:15X

4222047/E 07/2024

NOTES: (continued)

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

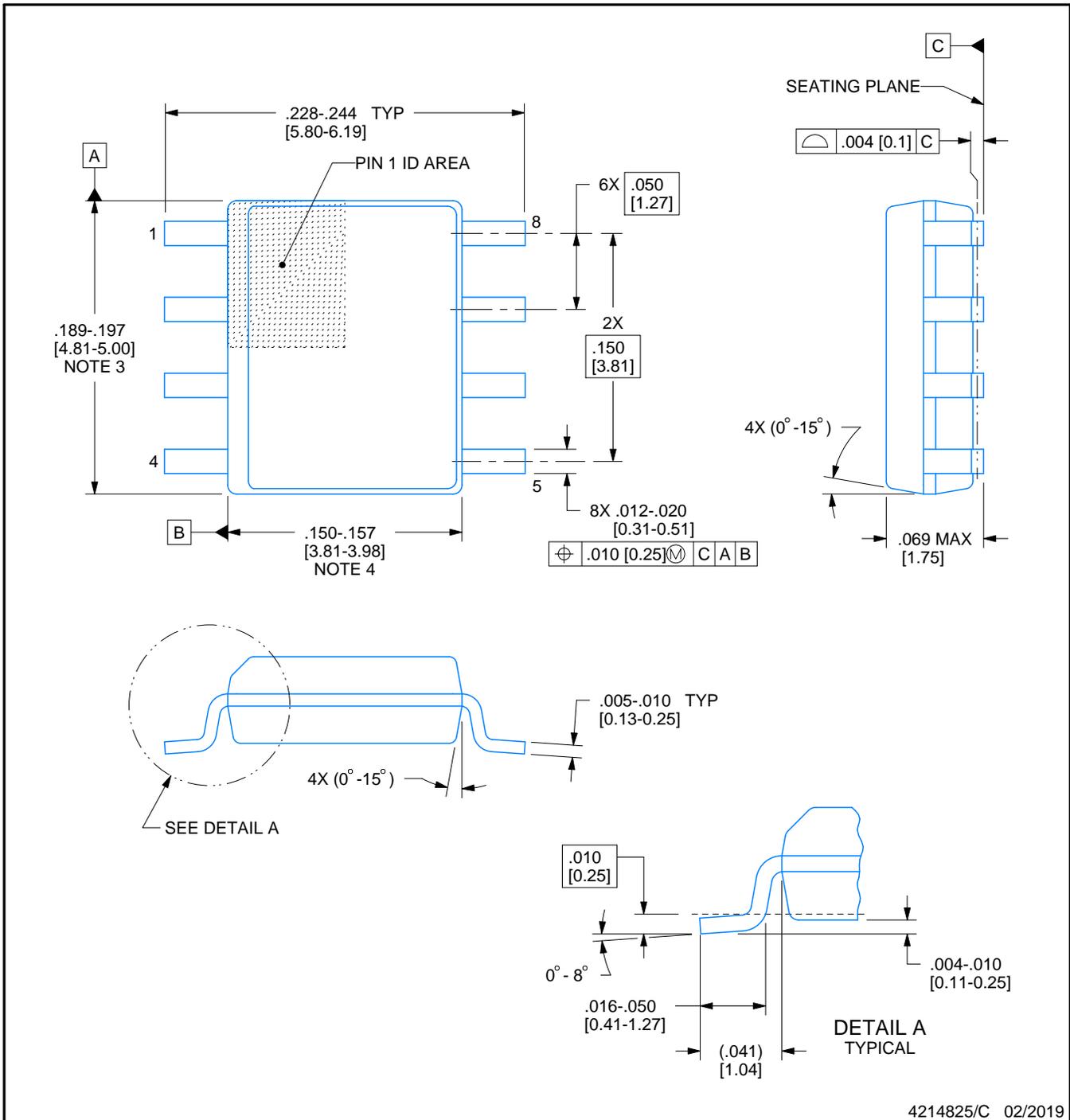


D0008A

# PACKAGE OUTLINE

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



NOTES:

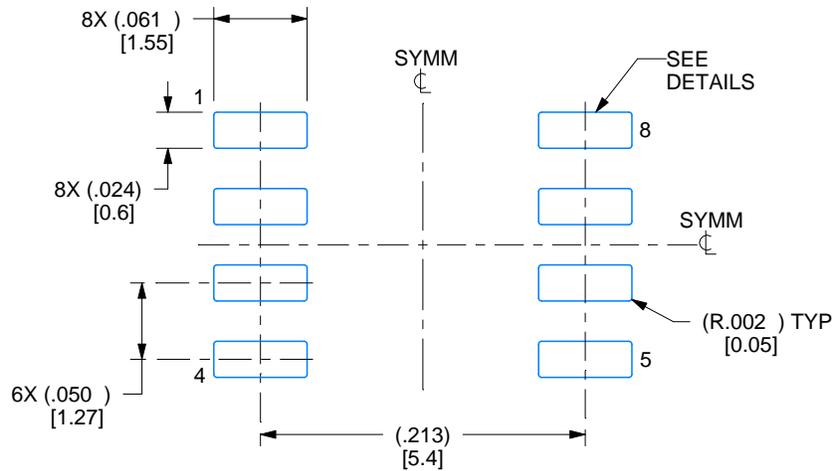
1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 [0.15] per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.

# EXAMPLE BOARD LAYOUT

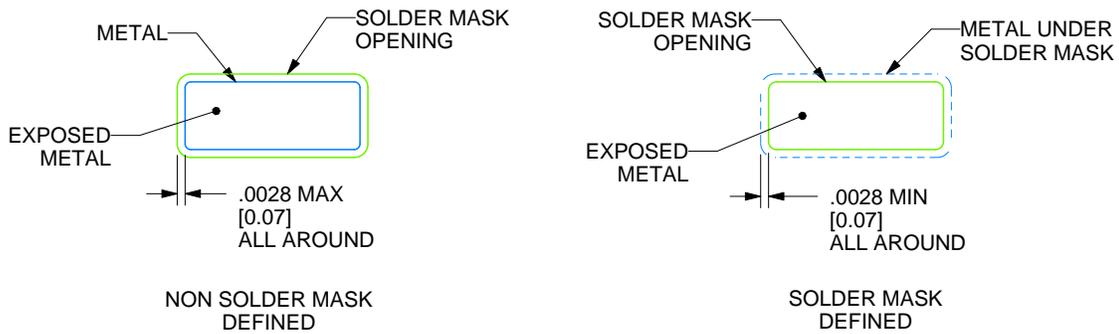
D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:8X



SOLDER MASK DETAILS

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NOTES: (continued)

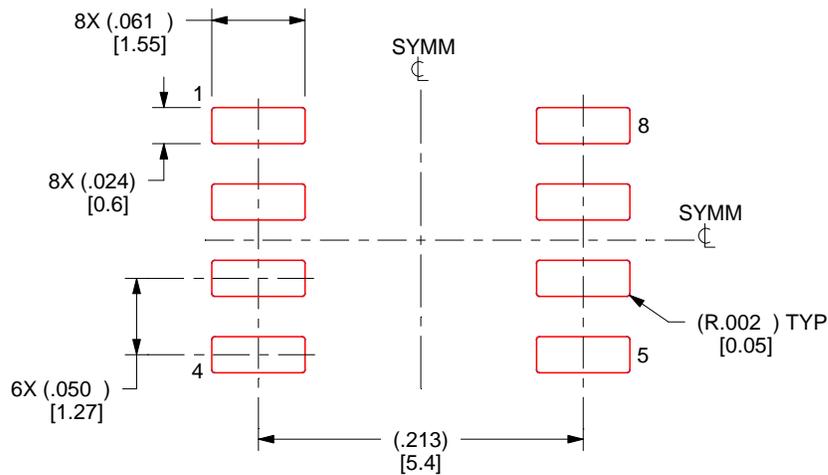
- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



SOLDER PASTE EXAMPLE  
BASED ON .005 INCH [0.125 MM] THICK STENCIL  
SCALE:8X

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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

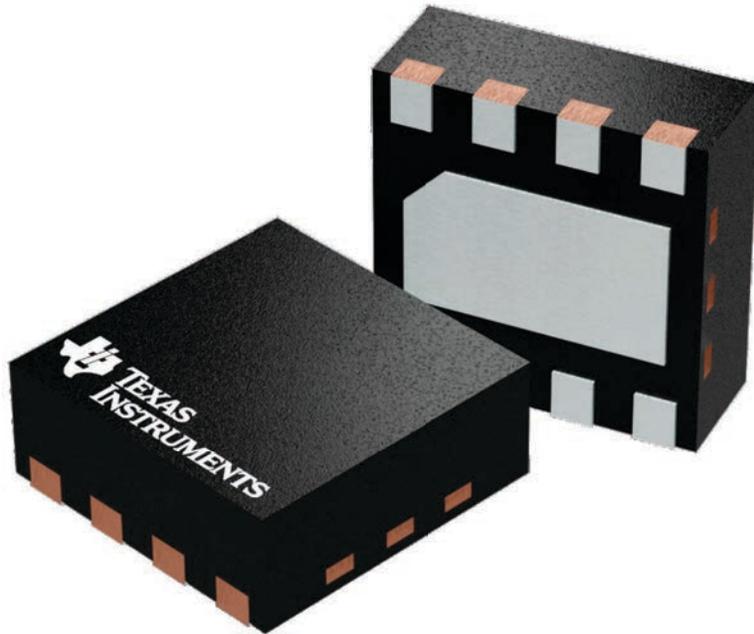
**DSG 8**

**WSON - 0.8 mm max height**

2 x 2, 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.



4224783/A

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