

TCA9544A 低電圧、4チャンネル、割り込みロジック搭載のI²CおよびSMBusマルチプレクサ

1 特長

- 1対4の双方向変換スイッチ
- I²CバスおよびSMBus互換
- 4つのアクティブLOW割り込み入力
- アクティブLOW割り込み出力
- 3本のアドレス・ピンにより、最大8個のTCA9544AデバイスをI²Cバスに接続可能
- I²Cバスによるチャンネル選択
- 電源オン時は、すべてのスイッチ・チャンネルが選択解除された状態
- 低いR_{ON}のスイッチ
- 1.8V、2.5V、3.3V、5Vの各電圧のバス間での電圧レベル変換
- 電源オン時のグリッチなし
- 活線挿抜をサポート
- 低スタンバイ電流
- 動作電源電圧範囲: 1.65V~5.5V
- 5.5V許容の入力
- 0~400kHzのクロック周波数
- JESD 78準拠で100mA超のラッチアップ性能
- JESD 22を超えるESD保護
 - 4000V、人体モデル(A114-A)
 - 1500V、荷電デバイス・モデル(C101)

2 アプリケーション

- サーバー
- ルーター(テレコム・スイッチング機器)
- **ファクトリ・オートメーション**
- I²Cスレーブ・アドレス競合がある製品(たとえば、複数の同一温度センサなど)

3 概要

TCA9544Aは4チャンネルの双方向変換I²Cマルチプレクサです。マスタSCL/SDA信号ペアは、スレーブ・デバイスの4チャンネルであるSC0/SD0~SC3/SD3のいずれかに送られます。4つの割り込み入力(INT3~INT0)があり、それぞれが下流ペアの1つに対応します。割り込み出力(INT)が1つあり、4つの割り込み入力のANDとして機能します。

パワー・オン・リセット機能により、レジスタはデフォルト状態に戻り、I²Cステート・マシンが初期化され、すべてのチャンネルが選択解除されます。

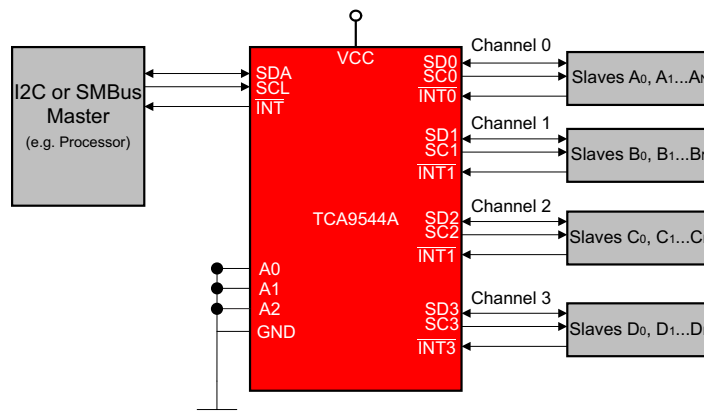
スイッチのパス・ゲートは、TCA9544A が出力する最大HIGH 電圧をVCCピンで制限できるように構成されています。これによって、ペアごとに異なるバス電圧を使用できるため、1.8V、2.5V、3.3Vの部品が、追加保護の必要なしに5Vの部品と通信を行えます。外付けのプルアップ抵抗により、各チャンネルに求められる電圧レベルにバスをプルアップします。すべてのI/Oピンは5.5V許容です。

製品情報⁽¹⁾

型番	パッケージ	本体サイズ(公称)
TCA9544A	TSSOP (20)	6.50mmx4.40mm

(1) 提供されているすべてのパッケージについては、巻末の注文情報を参照してください。

概略回路図



目次

1	特長	1	8.3	Feature Description	11
2	アプリケーション	1	8.4	Device Functional Modes	11
3	概要	1	8.5	Programming	11
4	改訂履歴	2	8.6	Control Register	13
5	Pin Configuration and Functions	3	9	Application and Implementation	16
6	Specifications	4	9.1	Application Information	16
6.1	Absolute Maximum Ratings	4	9.2	Typical Application	16
6.2	ESD Ratings	4	10	Power Supply Recommendations	19
6.3	Recommended Operating Conditions	4	10.1	Power-On Reset Requirements	19
6.4	Thermal Information	4	11	Layout	21
6.5	Electrical Characteristics	5	11.1	Layout Guidelines	21
6.6	I ² C Interface Timing Requirements	6	11.2	Layout Example	21
6.7	Switching Characteristics	6	12	デバイスおよびドキュメントのサポート	22
6.8	Interrupt Timing Requirements	7	12.1	ドキュメントの更新通知を受け取る方法	22
6.9	Typical Characteristics	7	12.2	サポート・リソース	22
7	Parameter Measurement Information	8	12.3	商標	22
8	Detailed Description	10	12.4	静電気放電に関する注意事項	22
8.1	Overview	10	12.5	Glossary	22
8.2	Functional Block Diagram	10	13	メカニカル、パッケージ、および注文情報	22

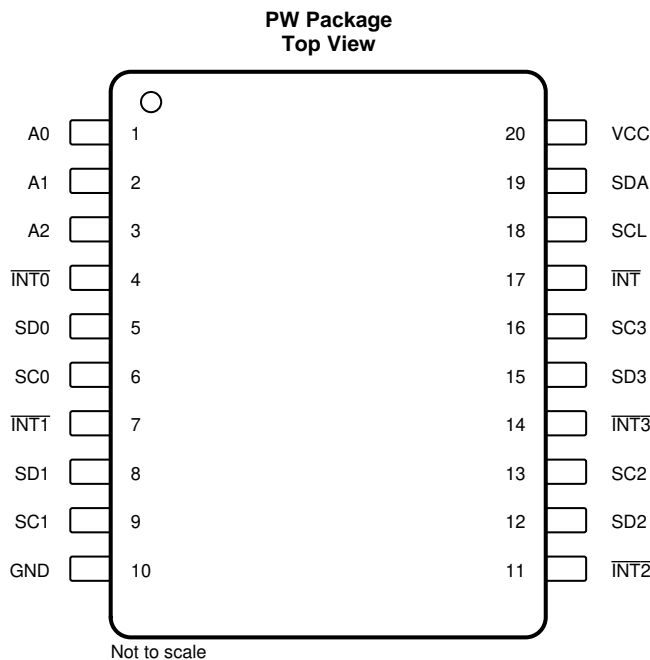
4 改訂履歴

Revision B (May 2018) から Revision C に変更		Page
•	Changed $V_{CC} = 1.65\text{ V}$ to 5.5 V To: $V_{CC} = 2.5\text{ V}$ in Figure 15	16

Revision A (May 2014) から Revision B に変更		Page
•	「概要」の最初の段落を変更	1
•	Added T_{stg} to the <i>Absolute Maximum Ratings</i> table	4
•	Changed the first paragraph of the <i>Overview</i> section	10
•	Changed "switch" to "multiplexer" in the <i>Feature Description</i> section	11
•	Changed text in the <i>Control Register Definition</i> section From: "One or several SCn/SDn downstream pairs, or channels, are selected..." To: "One SCn/SDn downstream pair, or channel, is selected..."	14

2014年5月発行のものから更新		Page
•	ドキュメントをプレビューから量産データに更新	1

5 Pin Configuration and Functions



Pin Functions

PIN		DESCRIPTION
NAME	NO.	
A0	1	Address input 0. Connect directly to V_{CC} or ground.
A1	2	Address input 1. Connect directly to V_{CC} or ground.
A2	3	Address input 2. Connect directly to V_{CC} or ground.
$\overline{\text{INT0}}$	4	Active-low interrupt input 0. Connect to $V_{DPU0}^{(1)}$ through a pull-up resistor.
SD0	5	Serial data 0. Connect to $V_{DPU0}^{(1)}$ through a pull-up resistor.
SC0	6	Serial clock 0. Connect to $V_{DPU0}^{(1)}$ through a pull-up resistor.
$\overline{\text{INT1}}$	7	Active-low interrupt input 1. Connect to $V_{DPU1}^{(1)}$ through a pull-up resistor.
SD1	8	Serial data 1. Connect to $V_{DPU1}^{(1)}$ through a pull-up resistor.
SC1	9	Serial clock 1. Connect to $V_{DPU1}^{(1)}$ through a pull-up resistor.
GND	10	Ground
$\overline{\text{INT2}}$	11	Active-low interrupt input 2. Connect to $V_{DPU2}^{(1)}$ through a pull-up resistor.
SD2	12	Serial data 2. Connect to $V_{DPU2}^{(1)}$ through a pull-up resistor.
SC2	13	Serial clock 2. Connect to $V_{DPU2}^{(1)}$ through a pull-up resistor.
$\overline{\text{INT3}}$	14	Active-low interrupt input 3. Connect to $V_{DPU3}^{(1)}$ through a pull-up resistor.
SD3	15	Serial data 3. Connect to $V_{DPU3}^{(1)}$ through a pull-up resistor.
SC3	16	Serial clock 3. Connect to $V_{DPU3}^{(1)}$ through a pull-up resistor.
$\overline{\text{INT}}$	17	Active-low interrupt output. Connect to $V_{DPUM}^{(1)}$ through a pull-up resistor.
SCL	18	Serial clock line. Connect to $V_{DPUM}^{(1)}$ through a pull-up resistor.
SDA	19	Serial data line. Connect to $V_{DPUM}^{(1)}$ through a pull-up resistor.
VCC	20	Supply power

(1) V_{DPUX} is the pull-up reference voltage for the associated data line. V_{DPUM} is the master I²C reference voltage while $V_{DPU0} - V_{DPU3}$ are the slave channel reference voltages.

6 Specifications

6.1 Absolute Maximum Ratings⁽¹⁾

over operating free-air temperature (unless otherwise noted)

		MIN	MAX	UNIT
V _{CC}	Supply voltage	-0.5	7	V
V _I	Input voltage ⁽²⁾	-0.5	7	V
I _I	Input current		±20	mA
I _O	Output current		±25	mA
	Continuous current through V _{CC}		±100	mA
	Continuous current through GND		±100	mA
P _{tot}	Total power dissipation		400	mW
T _A	Operating free-air temperature range	-40	85	°C
T _{stg}	Storage temperature range	-65	150	°C

- (1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) The input negative-voltage and output voltage ratings may be exceeded if the input and output current ratings are observed.

6.2 ESD Ratings

			MIN	MAX	UNIT
V _(ESD)	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins ⁽¹⁾	-4000	4000	V
		Charged device model (CDM), per JEDEC specification JESD22-C101, all pins ⁽²⁾	-1500	1500	V

- (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.

6.3 Recommended Operating Conditions⁽¹⁾

			MIN	MAX	UNIT
V _{CC}	Supply voltage		1.65	5.5	V
V _{IH}	High-level input voltage	SCL, SDA	0.7 × V _{CC}	6	V
		A2–A0, INT3–INT0	0.7 × V _{CC}	V _{CC} + 0.5	V
V _{IL}	Low-level input voltage	SCL, SDA	-0.5	0.3 × V _{CC}	V
		A2–A0, INT3–INT0	-0.5	0.3 × V _{CC}	V
T _A	Operating free-air temperature		-40	85	°C

- (1) All unused inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, [Implications of Slow or Floating CMOS Inputs](#), literature number SCBA004.

6.4 Thermal Information⁽¹⁾

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

THERMAL METRIC ⁽¹⁾		TCA9544A	UNIT
		PW	
		20 PIN	
R _{θJA}	Junction-to-ambient thermal resistance	118.2	°C/W
R _{θJctop}	Junction-to-case (top) thermal resistance	51.4	°C/W
R _{θJB}	Junction-to-board thermal resistance	69.3	°C/W
ψ _{JT}	Junction-to-top characterization parameter	7.7	°C/W
ψ _{JB}	Junction-to-board characterization parameter	68.8	v

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

6.5 Electrical Characteristics⁽¹⁾

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

PARAMETER		TEST CONDITIONS		V _{CC}	MIN	TYP ⁽²⁾	MAX	UNIT	
V _{PORR}	Power-on reset voltage, V _{CC} rising	No load:	V _I = V _{CC} or GND			1.2	1.5	V	
V _{PORF}	Power-on reset voltage, V _{CC} falling ⁽³⁾	No load:	V _I = V _{CC} or GND		0.8	1		V	
V _{pass}	Switch output voltage	V _{SWin} = V _{CC}	I _{SWout} = -100 μA	5 V		3.6		V	
				4.5 to 5.5 V		2.6	4.5		
				3.3 V		1.9			
				3 to 3.6 V	1.6		2.8		
				2.5 V		1.4			
				2.3 to 2.7 V	1.0		1.8		
				1.8 V		0.8			
				1.65 to 1.95 V	0.5		1.1		
I _{OH}	$\overline{\text{INT}}$	V _O = V _{CC}		1.65 to 5.5 V			10	μA	
I _{OL}	SDA	V _{OL} = 0.4 V		1.65 to 5.5 V	3	7		mA	
		V _{OL} = 0.6 V			6	10			
	$\overline{\text{INT}}$	V _{OL} = 0.4 V			3				
I _I	SCL, SDA	V _I = V _{CC} or GND		1.65 to 5.5 V			±1	μA	
	SC3–SC0, SD3–SD0						±1		
	A2–A0						±1		
	$\overline{\text{INT3}}\text{--}\overline{\text{INT0}}$						±1		
I _{CC}	Operating mode	f _{SCL} = 400 kHz	V _I = V _{CC} or GND I _O = 0 t _{r,max} = 300 ns	5.5 V		50		μA	
				3.6 V		20			
				2.7 V		11			
				1.65 V		6			
		f _{SCL} = 100 kHz	V _I = V _{CC} or GND I _O = 0 t _{r,max} = 1 μs	5.5 V		35			
				3.6 V		14			
				2.7 V		5			
				1.65 V		2			
	Standby mode	Low inputs	V _I = GND	I _O = 0	5.5 V	1.6	2		
					3.6 V	1.0	1.3		
					2.7 V	0.7	1.1		
		High inputs	V _I = V _{CC}	I _O = 0	1.65 V	0.4	0.55		
					5.5 V	1.6	2		
					3.6 V	1.0	1.3		
				2.7 V	0.7	1.1			
				1.65 V	0.4	0.55			
ΔI _{CC}	Supply-current change	$\overline{\text{INT3}}\text{--}\overline{\text{INT0}}$	One $\overline{\text{INT3}}\text{--}\overline{\text{INT0}}$ input at 0.6 V, Other inputs at V _{CC} or GND	1.65 to 5.5 V		3	20	μA	
			One $\overline{\text{INT3}}\text{--}\overline{\text{INT0}}$ input at V _{CC} – 0.6 V, Other inputs at V _{CC} or GND			3	20		
		SCL, SDA	SCL or SDA input at 0.6 V, Other inputs at V _{CC} or GND			2	15		
			SCL or SDA inputs at V _{CC} – 0.6 V, Other inputs at V _{CC} or GND			2	15		
C _i	A2–A0	V _I = V _{CC} or GND		1.65 to 5.5 V		4.5	6	pF	
	$\overline{\text{INT3}}\text{--}\overline{\text{INT0}}$					4.5	6		

(1) For operation between specified voltage ranges, refer to the worst-case parameter in both applicable ranges.

(2) All typical values are at nominal supply voltage (1.8-V, 2.5-V, 3.3-V, or 5-V V_{CC}), T_A = 25°C.

(3) The power-on reset circuit resets the I²C bus logic when V_{CC} < V_{PORF}.

Electrical Characteristics⁽¹⁾ (continued)

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

PARAMETER		TEST CONDITIONS		V _{CC}	MIN	TYP ⁽²⁾	MAX	UNIT
C _{IO(OFF)} ⁽⁴⁾	SCL, SDA	V _I = V _{CC} or GND	Switch OFF	1.65 to 5.5 V		15	19	pF
	SC3–SC0, SD3–SD0					6	8	
R _{ON}	Switch-on resistance	V _O = 0.4 V	I _O = 15 mA	4.5 to 5.5 V		10	16	Ω
				3 to 3.6 V		13	20	
		V _O = 0.4 V	I _O = 10 mA	2.3 to 2.7 V		16	45	
				1.65 to 1.95 V		25	70	

(4) C_{IO(ON)} depends on device capacitance and load that is downstream from the device.

6.6 I²C Interface Timing Requirements

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

			STANDARD-MODE I ² C BUS		FAST-MODE I ² C BUS		UNIT
			MIN	MAX	MIN	MAX	
f _{scl}	I ² C clock frequency		0	100	0	400	kHz
t _{sch}	I ² C clock high time		4		0.6		μs
t _{scl}	I ² C clock low time		4.7		1.3		μs
t _{sp}	I ² C spike time			50		50	ns
t _{sds}	I ² C serial-data setup time		250		100		ns
t _{sdh}	I ² C serial-data hold time		0 ⁽¹⁾		0 ⁽¹⁾		μs
t _{icr}	I ² C input rise time			1000	20 + 0.1C _b ⁽²⁾	300	ns
t _{icf}	I ² C input fall time			300	20 + 0.1C _b ⁽²⁾	300	ns
t _{ocf}	I ² C output fall time (10-pF to 400-pF bus)			300	20 + 0.1C _b ⁽²⁾	300	ns
t _{buf}	I ² C bus free time between stop and start		4.7		1.3		μs
t _{sts}	I ² C start or repeated start condition setup		4.7		0.6		μs
t _{sth}	I ² C start or repeated start condition hold		4		0.6		μs
t _{sps}	I ² C stop condition setup		4		0.6		μs
t _{vdL(Data)}	Valid-data time (high to low) ⁽³⁾	SCL low to SDA output low valid		1		1	μs
t _{vdH(Data)}	Valid-data time (low to high) ⁽³⁾	SCL low to SDA output high valid		0.6		0.6	μs
t _{vd(ack)}	Valid-data time of ACK condition	ACK signal from SCL low to SDA output low		1		1	μs
C _b	I ² C bus capacitive load			400		400	pF

(1) A device internally must provide a hold time of at least 300 ns for the SDA signal (referred to as the V_{IH} min of the SCL signal), in order to bridge the undefined region of the falling edge of SCL.

(2) C_b = total bus capacitance of one bus line in pF

(3) Data taken using a 1-kΩ pullup resistor and 50-pF load (see [Figure 5](#)).

6.7 Switching Characteristics

over recommended operating free-air temperature range, C_L ≤ 100 pF (unless otherwise noted) (see [Figure 5](#))

PARAMETER		FROM (INPUT)	TO (OUTPUT)	MIN	MAX	UNIT
t _{pd} ⁽¹⁾	Propagation delay time	R _{ON} = 20 Ω, C _L = 15 pF	SDA or SCL	SDn or SCn		0.3
		R _{ON} = 20 Ω, C _L = 50 pF				1
t _{iv}	Interrupt valid time ⁽²⁾	$\overline{\text{INTn}}$	$\overline{\text{INT}}$		4	μs
t _{ir}	Interrupt reset delay time ⁽²⁾	$\overline{\text{INTn}}$	$\overline{\text{INT}}$		2	μs

(1) The propagation delay is the calculated RC time constant of the typical ON-state resistance of the switch and the specified load capacitance, when driven by an ideal voltage source (zero output impedance).

(2) Data taken using a 4.7-kΩ pullup resistor and 100-pF load (see [Figure 6](#)).

6.8 Interrupt Timing Requirements

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

PARAMETER		MIN	MAX	UNIT
t_{PWRL}	Low-level pulse duration rejection of \overline{INTn} inputs ⁽¹⁾	1		μs
t_{PWRH}	High-level pulse duration rejection of \overline{INTn} inputs ⁽¹⁾	0.5		μs

(1) Data taken using a 4.7-k Ω pullup resistor and 100-pF load (see Figure 6).

6.9 Typical Characteristics

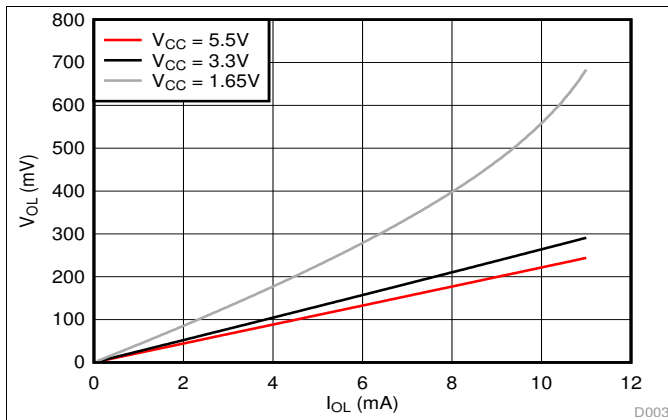


Figure 1. SDA Output Low Voltage (V_{OL}) vs Load Current (I_{OL}) at Three V_{CC} Levels

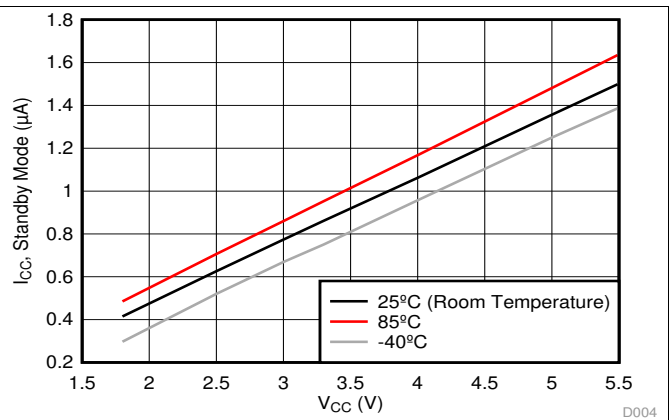


Figure 2. Standby Current (I_{CC}) vs Supply Voltage (V_{CC}) at Three Temperature Points

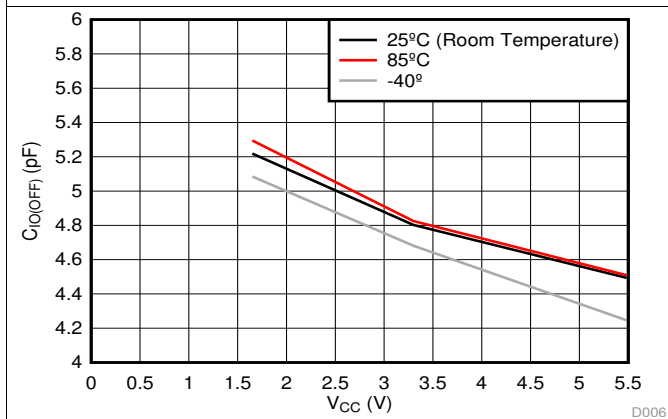


Figure 3. Slave channel (SCn/SDn) capacitance ($C_{IO(OFF)}$) vs. Supply Voltage (V_{CC}) at Three Temperature Points

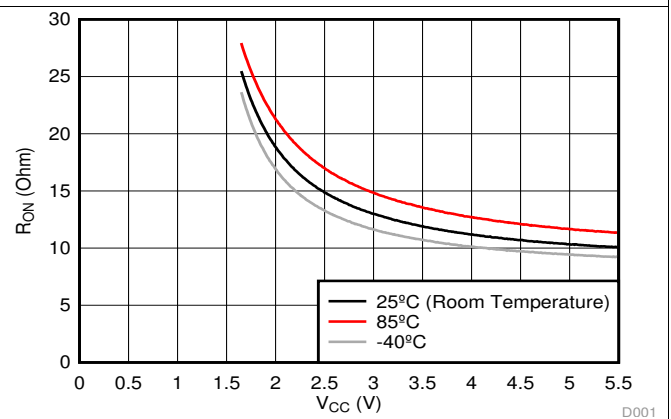
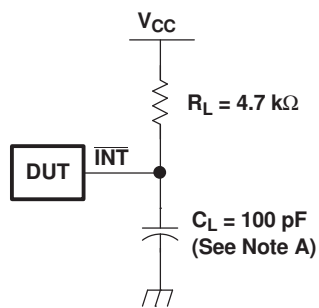
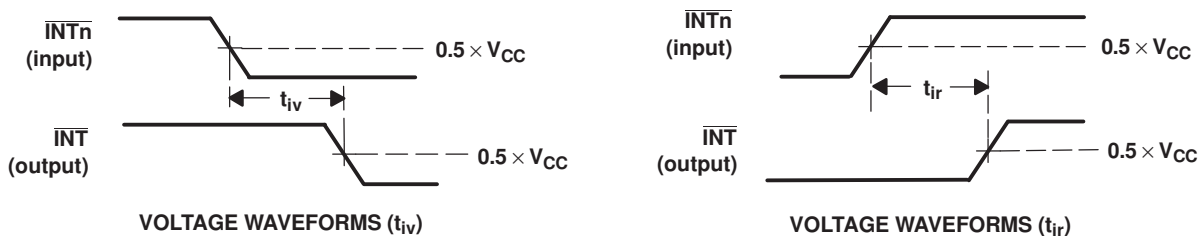


Figure 4. ON-Resistance (R_{ON}) vs Supply Voltage (V_{CC}) at Three Temperatures

Parameter Measurement Information (continued)



INTERRUPT LOAD CONFIGURATION



- NOTES: A. C_L includes probe and jig capacitance.
 B. All input pulses are supplied by generators having the following characteristics: $\text{PRR} \leq 10 \text{ MHz}$, $Z_O = 50 \Omega$, $t_r/t_f \leq 30 \text{ ns}$.

Figure 6. Interrupt Load Circuit and Voltage Waveforms

8 Detailed Description

8.1 Overview

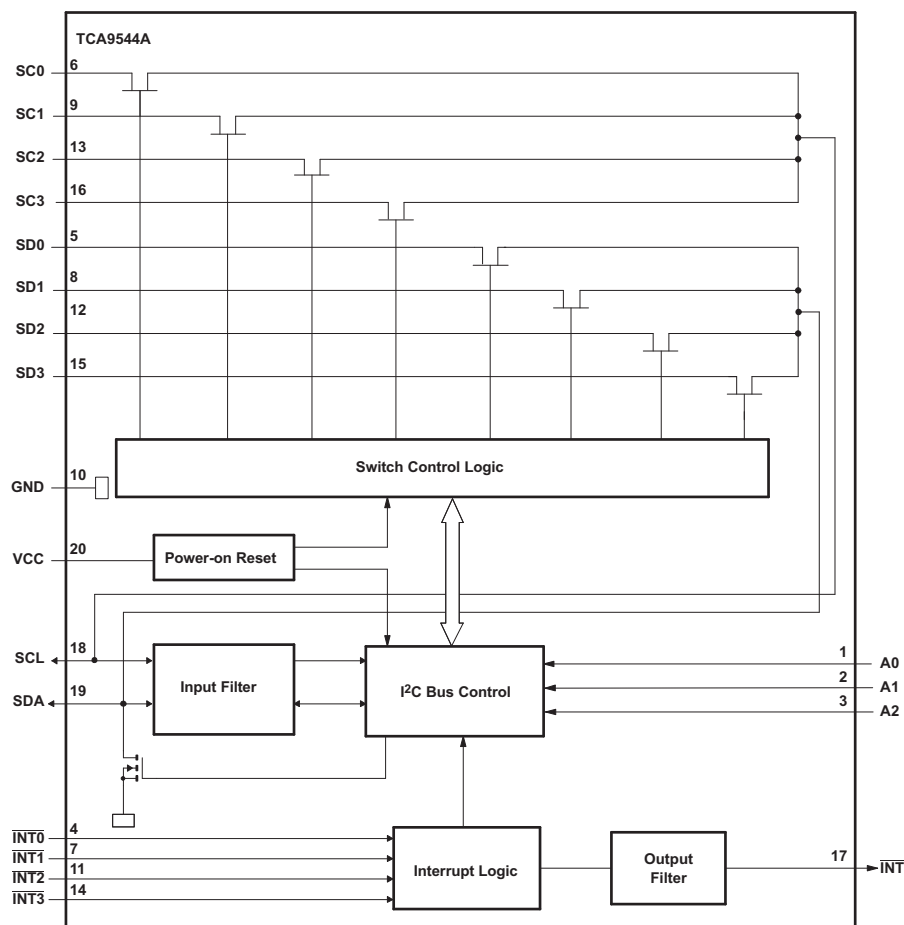
The TCA9544A is a 4-channel, bidirectional translating I²C Multiplexer. The master SCL/SDA signal pair is directed to one of the four channels of slave devices, SC0/SD0-SC3/SD3. Four interrupt inputs (INT3-INT0), one for each of the downstream pairs, are provided. One interrupt output (INT) acts as an AND of the four interrupt inputs.

The device can be reset by cycling the power supply, V_{CC}, also known as a power-on reset (POR), which resets the state machine and allows the TCA9544A to recover should one of the downstream I²C buses get stuck in a low state. A POR event will cause all channels to be deselected.

The connections of the I²C data path are controlled by the same I²C master device that is switched to communicate with multiple I²C slaves. After the successful acknowledgment of the slave address (hardware selectable by A0-A2 pins), a single 8-bit control register is written to or read from to determine the selected channels and state of the interrupts.

The TCA9544A may also be used for voltage translation, allowing the use of different bus voltages on each SC_n/SD_n pair such that 1.8-V, 2.5-V, or 3.3-V parts can communicate with 5-V parts. This is achieved by using external pull-up resistors to pull the bus up to the desired voltage for the master and each slave channel.

8.2 Functional Block Diagram



8.3 Feature Description

The TCA9544A is a 4-channel, bidirectional translating multiplexer for I²C buses that supports Standard-Mode (100 kHz) and Fast-Mode (400 kHz) operation. The TCA9544A features I²C control using a single 8-bit control register in which the three least significant bits control the enabling and disabling of the 4 switch channels of I²C data flow. The TCA9544A also supports interrupt signals for each slave channel and this data is held in the four most significant bits of the control register. Depending on the application, voltage translation of the I²C bus can also be achieved using the TCA9544A to allow 1.8-V, 2.5-V, or 3.3-V parts to communicate with 5-V parts. Additionally, in the event that communication on the I²C bus enters a fault state, the TCA9544A can be reset to resume normal operation by means of a power-on reset which results from cycling power to the device.

8.4 Device Functional Modes

8.4.1 Power-On Reset

When power is applied to V_{CC}, an internal power-on reset holds the TCA9544A in a reset condition until V_{CC} has reached V_{PORR}. At this point, the reset condition is released, and the TCA9544A registers and I²C state machine are initialized to their default states, all zeroes, causing all the channels to be deselected. Thereafter, V_{CC} must be lowered below V_{PORF} to reset the device.

8.5 Programming

8.5.1 I²C Interface

The I²C bus is for two-way two-line communication between different ICs or modules. The two lines are a serial data line (SDA) and a serial clock line (SCL). Both lines must be connected to a positive supply via a pull-up resistor when connected to the output stages of a device. Data transfer can be initiated only when the bus is not busy.

One data bit is transferred during each clock pulse. The data on the SDA line must remain stable during the high period of the clock pulse, as changes in the data line at this time are interpreted as control signals (see Figure 7).

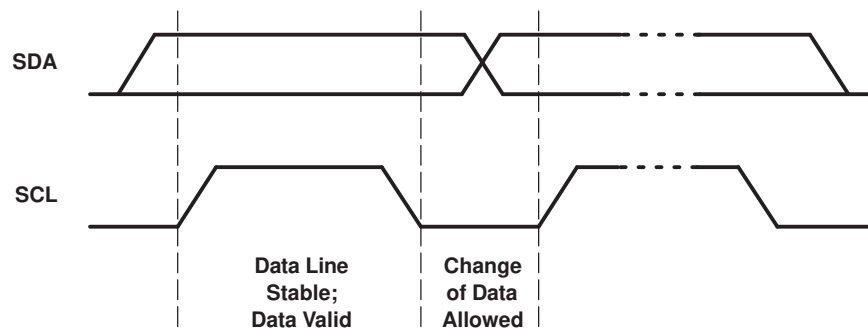


Figure 7. Bit Transfer

Both data and clock lines remain high when the bus is not busy. A high-to-low transition of the data line while the clock is high is defined as the start condition (S). A low-to-high transition of the data line while the clock is high is defined as the stop condition (P) (see Figure 8).

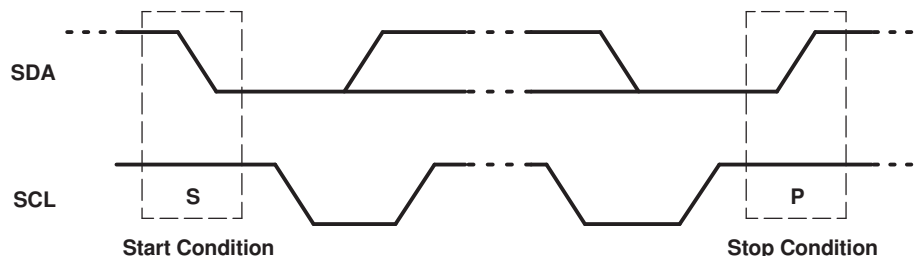


Figure 8. Definition of Start and Stop Conditions

Programming (continued)

A device generating a message is a transmitter; a device receiving a message is the receiver. The device that controls the message is the master, and the devices that are controlled by the master are the slaves (see Figure 9).

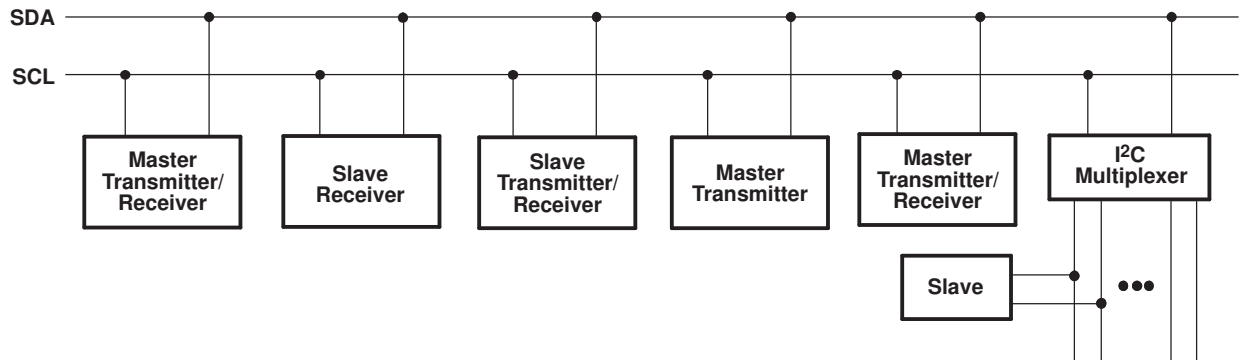


Figure 9. System Configuration

The number of data bytes transferred between the start and the stop conditions from transmitter to receiver is not limited. Each byte of eight bits is followed by one ACK bit. The transmitter must release the SDA line before the receiver can send an ACK bit.

When a slave receiver is addressed, it must generate an acknowledge (ACK) after the reception of each byte. Also, a master must generate an ACK after the reception of each byte that has been clocked out of the slave transmitter. The device that acknowledges must pull down the SDA line during the ACK clock pulse so that the SDA line is stable low during the high pulse of the ACK-related clock period (see Figure 10). Setup and hold times must be taken into account.

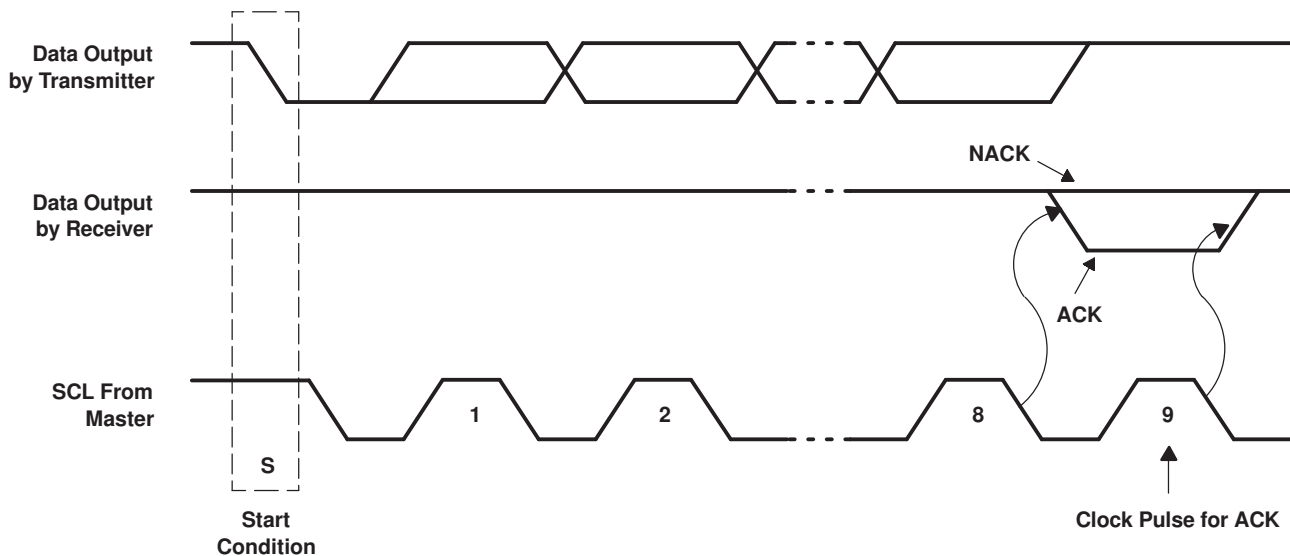


Figure 10. Acknowledgment on the I²C Bus

A master receiver must signal an end of data to the transmitter by not generating an acknowledge (NACK) after the last byte has been clocked out of the slave. This is done by the master receiver by holding the SDA line high. In this event, the transmitter must release the data line to enable the master to generate a stop condition.

Data is transmitted to the TCA9544A control register using the write mode shown in Figure 11.

Programming (continued)

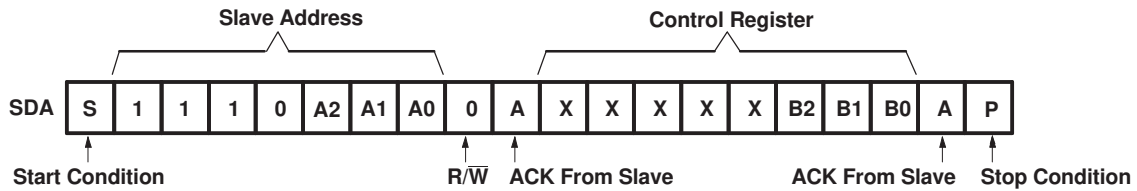


Figure 11. Write Control Register

Data is read from the TCA9544A control register using the read mode shown in Figure 12.

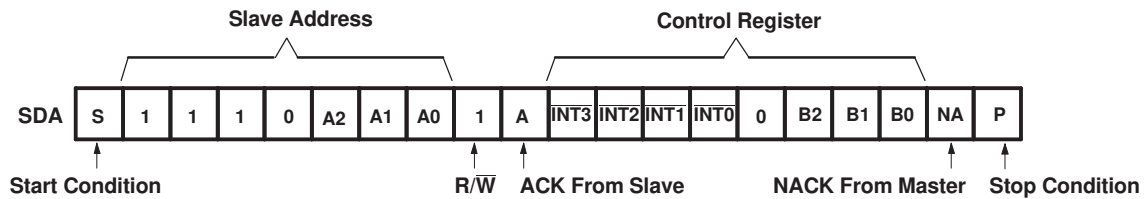


Figure 12. Read Control Register

8.6 Control Register

8.6.1 Device Address

Following a start condition, the bus master must output the address of the slave it is accessing. The address of the TCA9544A is shown in Figure 13. To conserve power, no internal pullup resistors are incorporated on the hardware-selectable address pins, and they must be pulled high or low.

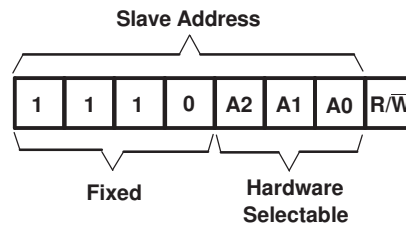


Figure 13. TCA9544A Address

The last bit of the slave address defines the operation to be performed. When set to a logic 1, a read is selected, while a logic 0 selects a write operation.

Control Register (continued)

8.6.2 Control Register Description

Following the successful acknowledgment of the slave address, the bus master sends a byte to the TCA9544A, which is stored in the control register. If multiple bytes are received by the TCA9544A, it saves the last byte received. This register can be written and read via the I²C bus.

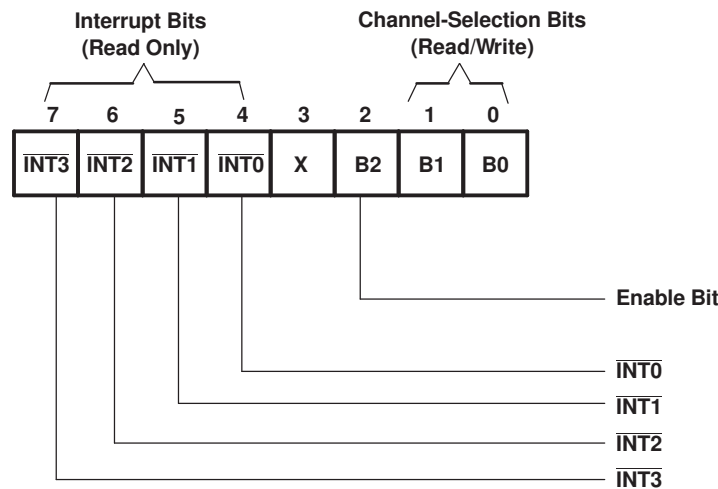


Figure 14. Control Register

8.6.3 Control Register Definition

Only one SCn/SDn downstream pair, or channel, can be selected by the contents of the control register (see Table 1). This register is written after the TCA9544A has been addressed. The three LSBs of the control byte are used to determine which channel (or channels) is to be selected. When a channel is selected, the channel becomes active after a stop condition has been placed on the I²C bus. This ensures that all SCn/SDn lines are in a high state when the channel is made active, so that no false conditions are generated at the time of connection. A stop condition always must occur right after the acknowledge cycle.

Table 1. Control Register Write (Channel Selection), Control Register Read (Channel Status)⁽¹⁾

INT3	INT2	INT1	INT0	D3	B2	B1	B0	COMMAND
X	X	X	X	X	0	X	X	No channel selected
X	X	X	X	X	1	0	0	Channel 0 enabled
X	X	X	X	X	1	0	1	Channel 1 enabled
X	X	X	X	X	1	1	0	Channel 2 enabled
X	X	X	X	X	1	1	1	Channel 3 enabled
0	0	0	0	0	0	0	0	No channel selected, power-up default state

(1) Only one channel may be selected at a time.

8.6.4 Interrupt Handling

The TCA9544A provides four interrupt inputs (one for each channel) and one open-drain interrupt output. When an interrupt is generated by any device, it is detected by the TCA9544A, and the interrupt output is driven low. The channel does not need to be active for detection of the interrupt. A bit also is set in the control register (see Table 2).

Bits 4–7 of the control register correspond to channels 0–3 of the TCA9544A, respectively. Therefore, if an interrupt is generated by any device connected to channel 1, the state of the interrupt inputs is loaded into the control register when a read is accomplished. Likewise, an interrupt on any device connected to channel 0 causes bit 4 of the control register to be set on the read. The master then can address the TCA9544A and read the contents of the control register to determine which channel contains the device generating the interrupt. The master can reconfigure the TCA9544A to select this channel and locate the device generating the interrupt and clear it. Once the device responsible for the interrupt clears, the interrupt clears.

It should be noted that more than one device can provide an interrupt on a channel, so it is up to the master to ensure that all devices on a channel are interrogated for an interrupt.

The interrupt inputs can be used as general-purpose inputs if the interrupt function is not required.

If unused, interrupt input(s) must be connected to V_{CC} .

Table 2. Control Register Read (Interrupt)⁽¹⁾

$\overline{\text{INT3}}$	$\overline{\text{INT2}}$	$\overline{\text{INT1}}$	$\overline{\text{INT0}}$	D3	B2	B1	B0	COMMAND
X	X	X	0	X	X	X	X	No interrupt on channel 0
			1					Interrupt on channel 0
X	X	0	X	X	X	X	X	No interrupt on channel 1
		1						Interrupt on channel 1
X	0	X	X	X	X	X	X	No interrupt on channel 2
	1							Interrupt on channel 2
0	X	X	X	X	X	X	X	No interrupt on channel 3
1								Interrupt on channel 3

(1) Several interrupts can be active at the same time. For example, $\overline{\text{INT3}} = 0$, $\overline{\text{INT2}} = 1$, $\overline{\text{INT1}} = 1$, $\overline{\text{INT0}} = 0$ means that there is no interrupt on channels 0 and 3, and there is interrupt on channels 1 and 2.

9 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. Customers should validate and test their design implementation to confirm system functionality.

9.1 Application Information

Applications of the TCA9544A will contain an I²C (or SMBus) master device and up to four I²C slave devices. The downstream channels are ideally used to resolve I²C slave address conflicts. For example, if four identical digital temperature sensors are needed in the application, one sensor can be connected at each channel: 0, 1, 2, and 3. When the temperature at a specific location needs to be read, the appropriate channel can be enabled and all other channels switched off, the data can be retrieved, and the I²C master can move on and read the next channel.

In an application where the I²C bus will contain many additional slave devices that do not result in I²C slave address conflicts, these slave devices can be connected to any desired channel to distribute the total bus capacitance across multiple channels. If multiple switches will be enabled simultaneously, additional design requirements must be considered (See [Design Requirements](#) and [Detailed Design Procedure](#)).

9.2 Typical Application

A typical application of the TCA9544A contains anywhere from 1 to 5 separate data pull-up voltages, V_{DPUX} , one for the master device (V_{DPU0}) and one for each of the selectable slave channels ($V_{DPU0} - V_{DPU3}$). In the event where the master device and all slave devices operate at the same voltage, then the supply voltage can be $V_{CC} = V_{DPUX}$. In an application where voltage translation is necessary, additional design requirements must be considered (See [Design Requirements](#)).

Figure 15 shows an application in which the TCA9544A can be used.

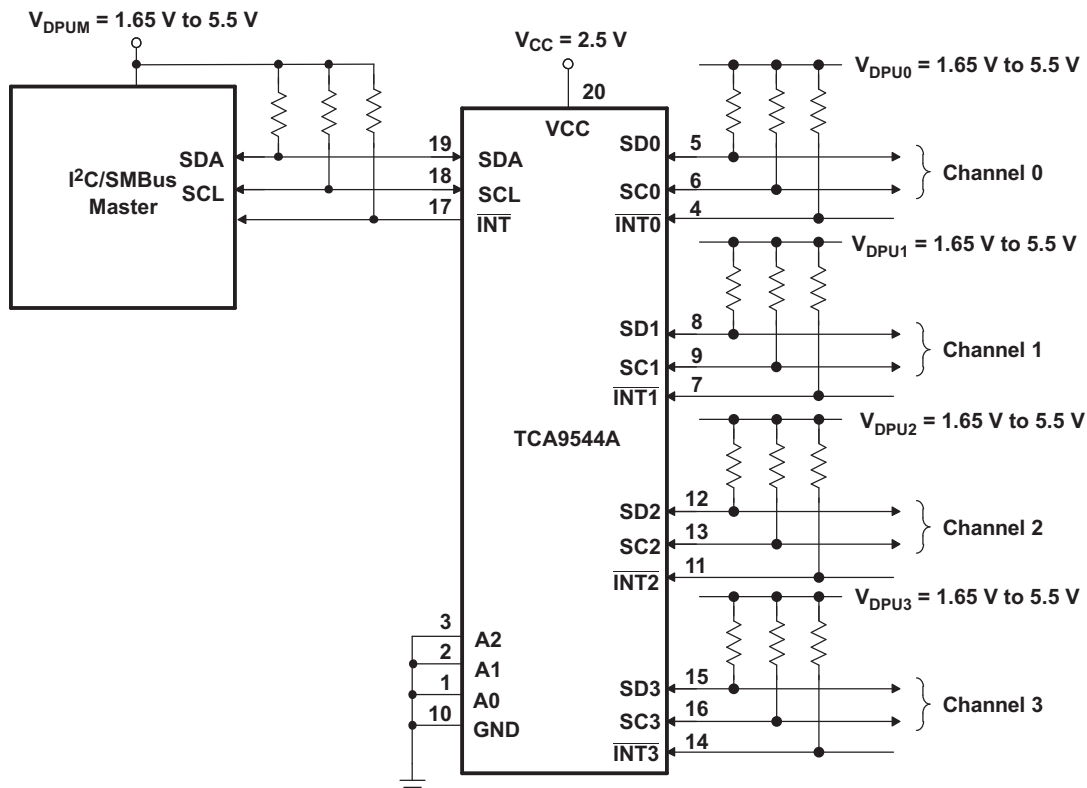


Figure 15. Typical Application Schematic

Typical Application (continued)

9.2.1 Design Requirements

The pull-up resistors on the $\overline{\text{INT3}}\text{-}\overline{\text{INT0}}$ pins in the application schematic are not required in all applications. If the device generating the interrupt has an open-drain output structure or can be tri-stated, a pull-up resistor is required. If the device generating the interrupt has a push-pull output structure and cannot be tri-stated, a pull-up resistor is not required. The interrupt inputs should not be left floating in the application.

The A0 and A1 pins are hardware selectable to control the slave address of the TCA9544A. These pins may be tied directly to GND or V_{CC} in the application.

If multiple slave channels will be activated simultaneously in the application, then the total I_{OL} from SCL/SDA to GND on the master side will be the sum of the currents through all pull-up resistors, R_p .

The pass-gate transistors of the TCA9544A are constructed such that the V_{CC} voltage can be used to limit the maximum voltage that is passed from one I²C bus to another.

Figure 16 shows the voltage characteristics of the pass-gate transistors (note that the graph was generated using data specified in the [Electrical Characteristics](#) section of this data sheet). In order for the TCA9544A to act as a voltage translator, the V_{pass} voltage must be equal to or lower than the lowest bus voltage. For example, if the main bus is running at 5 V and the downstream buses are 3.3 V and 2.7 V, V_{pass} must be equal to or below 2.7 V to effectively clamp the downstream bus voltages. As shown in Figure 16, $V_{\text{pass(max)}}$ is 2.7 V when the TCA9544A supply voltage is 4 V or lower, so the TCA9544A supply voltage could be set to 3.3 V. Pull-up resistors then can be used to bring the bus voltages to their appropriate levels (see Figure 15).

9.2.2 Detailed Design Procedure

Once all the slaves are assigned to the appropriate slave channels and bus voltages are identified, the pull-up resistors, R_p , for each of the buses need to be selected appropriately. The minimum pull-up resistance is a function of V_{DPUX} , $V_{\text{OL(max)}}$, and I_{OL} :

$$R_{p(\text{min})} = \frac{V_{\text{DPUX}} - V_{\text{OL(max)}}}{I_{OL}} \quad (1)$$

The maximum pull-up resistance is a function of the maximum rise time, t_r (300 ns for fast-mode operation, $f_{\text{SCL}} = 400$ kHz) and bus capacitance, C_b :

$$R_{p(\text{max})} = \frac{t_r}{0.8473 \times C_b} \quad (2)$$

The maximum bus capacitance for an I²C bus must not exceed 400 pF for fast-mode operation. The bus capacitance can be approximated by adding the capacitance of the TCA9544A, $C_{i0(\text{OFF})}$, the capacitance of wires/connections/traces, and the capacitance of each individual slave on a given channel. If multiple channels will be activated simultaneously, each of the slaves on all channels will contribute to total bus capacitance.

Typical Application (continued)

9.2.3 TCA9544A Application Curves

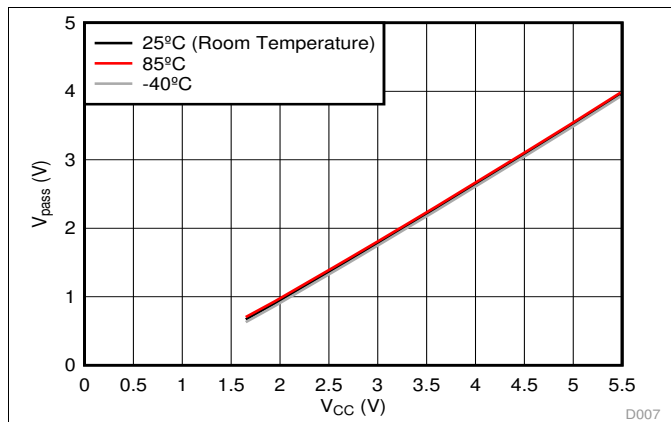
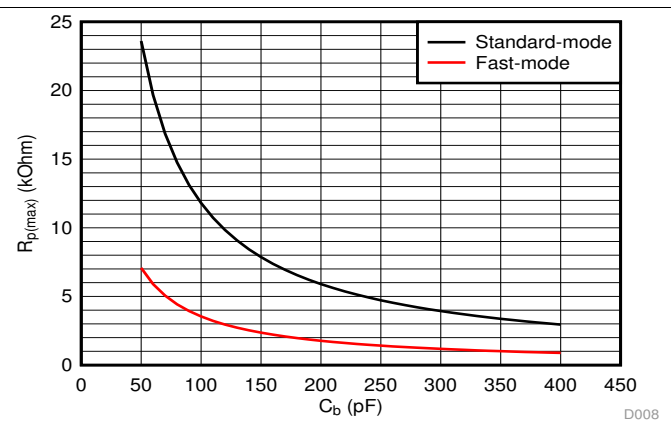
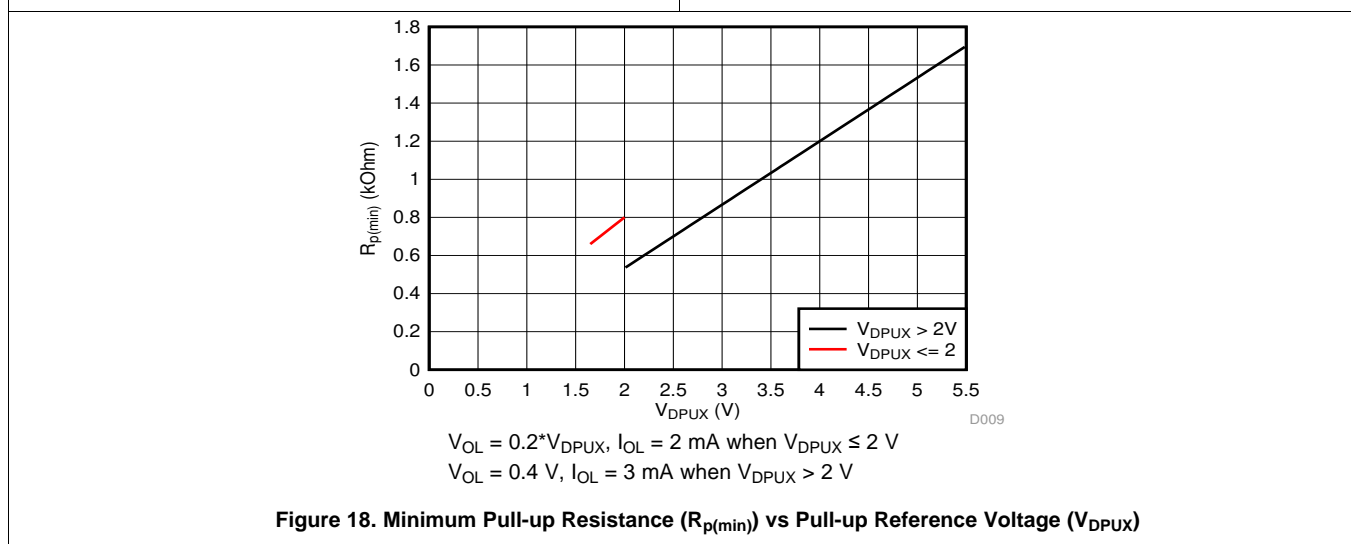


Figure 16. Pass-Gate Voltage (V_{pass}) vs Supply Voltage (V_{CC}) at Three Temperature Points



Standard-mode (f_{SCL} = 100 kHz, t_r = 1 μs) Fast-mode (f_{SCL} = 400 kHz, t_r = 300 ns)

Figure 17. Maximum Pull-up resistance (R_{p(max)}) vs Bus Capacitance (C_b)



V_{OL} = 0.2 * V_{DPUX}, I_{OL} = 2 mA when V_{DPUX} ≤ 2 V
 V_{OL} = 0.4 V, I_{OL} = 3 mA when V_{DPUX} > 2 V

Figure 18. Minimum Pull-up Resistance (R_{p(min)}) vs Pull-up Reference Voltage (V_{DPUX})

10 Power Supply Recommendations

The operating power-supply voltage range of the TCA9544A is 1.65 V to 5.5 V applied at the VCC pin. When the TCA9544A is powered on for the first time or anytime the device needs to be reset by cycling the power supply, the power-on reset requirements must be followed to ensure the I²C bus logic is initialized properly.

10.1 Power-On Reset Requirements

In the event of a glitch or data corruption, TCA9544A can be reset to its default conditions by using the power-on reset feature. Power-on reset requires that the device go through a power cycle to be completely reset. This reset also happens when the device is powered on for the first time in an application.

A power-on reset is shown in Figure 19.

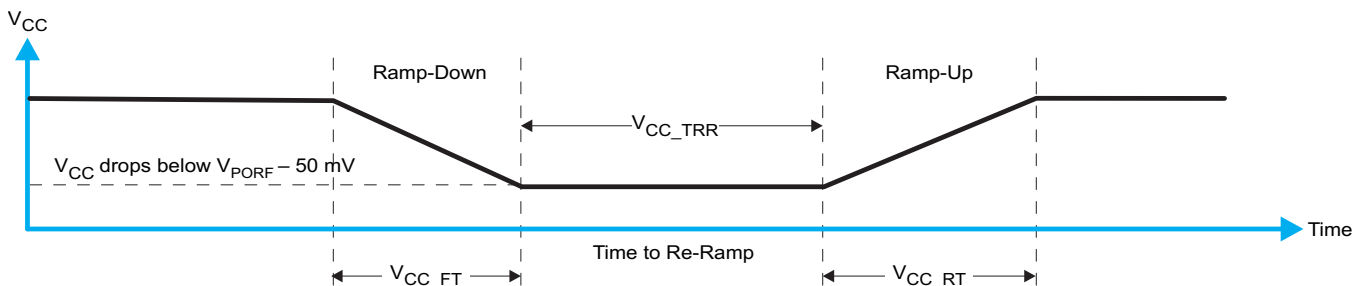


Figure 19. V_{CC} is Lowered Below the POR Threshold, Then Ramped Back Up to V_{CC}

Table 3 specifies the performance of the power-on reset feature for TCA9544A for both types of power-on reset.

Table 3. Recommended Supply Sequencing And Ramp Rates⁽¹⁾

PARAMETER		MIN	TYP	MAX	UNIT
V _{CC_FT}	Fall time	See Figure 19	1		ms
V _{CC_RT}	Rise time	See Figure 19	0.1		ms
V _{CC_TRR}	Time to re-ramp (when V _{CC} drops below V _{PORF(min)} – 50 mV or when V _{CC} drops to GND)	See Figure 19	40		μs
V _{CC_GH}	Level that V _{CC} can glitch down to, but not cause a functional disruption when V _{CC_GW} = 1 μs	See Figure 20		1.2	V
V _{CC_GW}	Glitch width that will not cause a functional disruption when V _{CC_GH} = 0.5 × V _{CC}	See Figure 20		10	μs
V _{PORF}	Voltage trip point of POR on falling V _{CC}	See Figure 21	0.8	1.25	V
V _{PORR}	Voltage trip point of POR on rising V _{CC}	See Figure 21	1.05	1.5	V

(1) All supply sequencing and ramp rate values are measured at T_A = 25°C

Glitches in the power supply can also affect the power-on reset performance of this device. The glitch width (V_{CC_GW}) and height (V_{CC_GH}) are dependent on each other. The bypass capacitance, source impedance, and device impedance are factors that affect power-on reset performance. Figure 20 and Table 3 provide more information on how to measure these specifications.

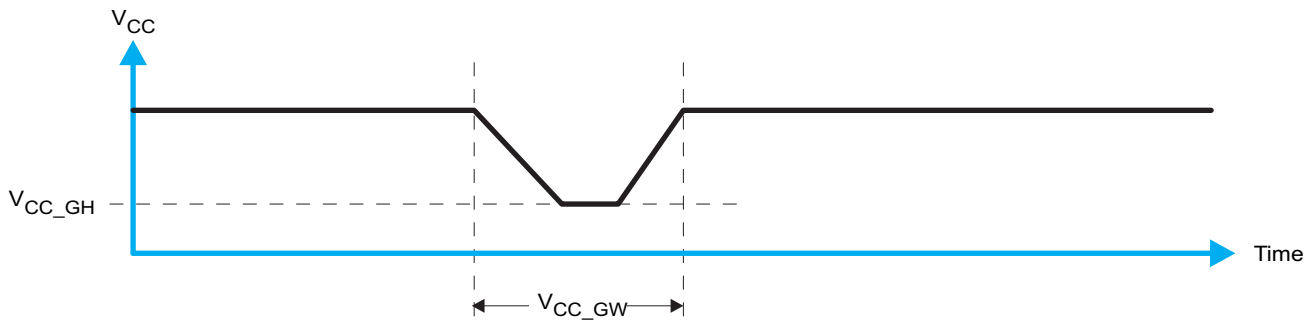


Figure 20. Glitch Width and Glitch Height

V_{POR} is critical to the power-on reset. V_{POR} is the voltage level at which the reset condition is released and all the registers and the I²C/SMBus state machine are initialized to their default states. The value of V_{POR} differs based on the V_{CC} being lowered to or from 0. Figure 21 and Table 3 provide more details on this specification.

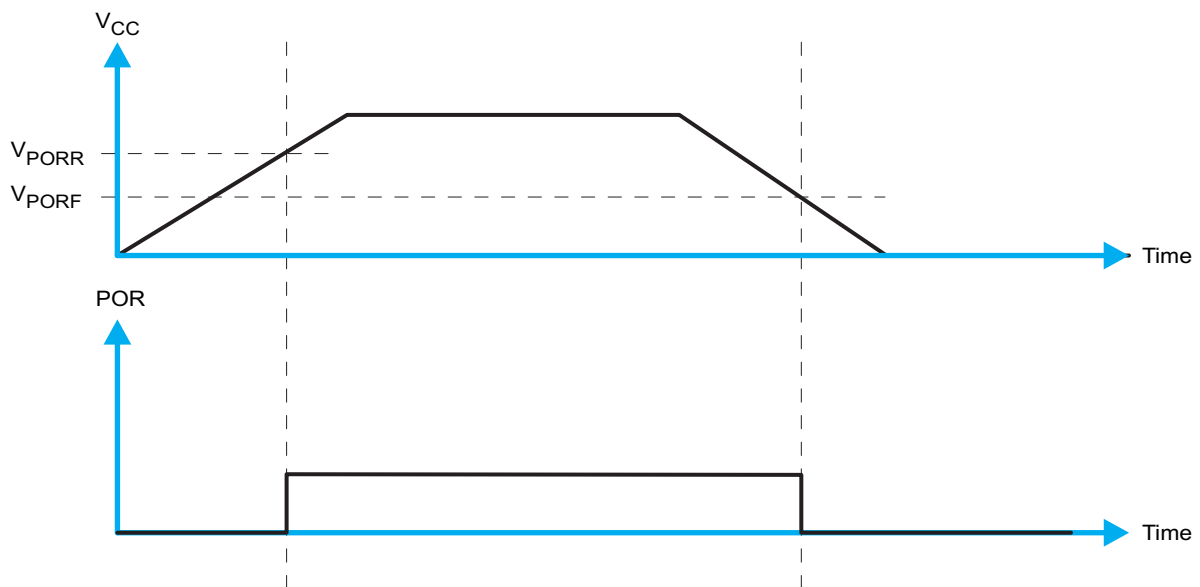


Figure 21. V_{POR}

11 Layout

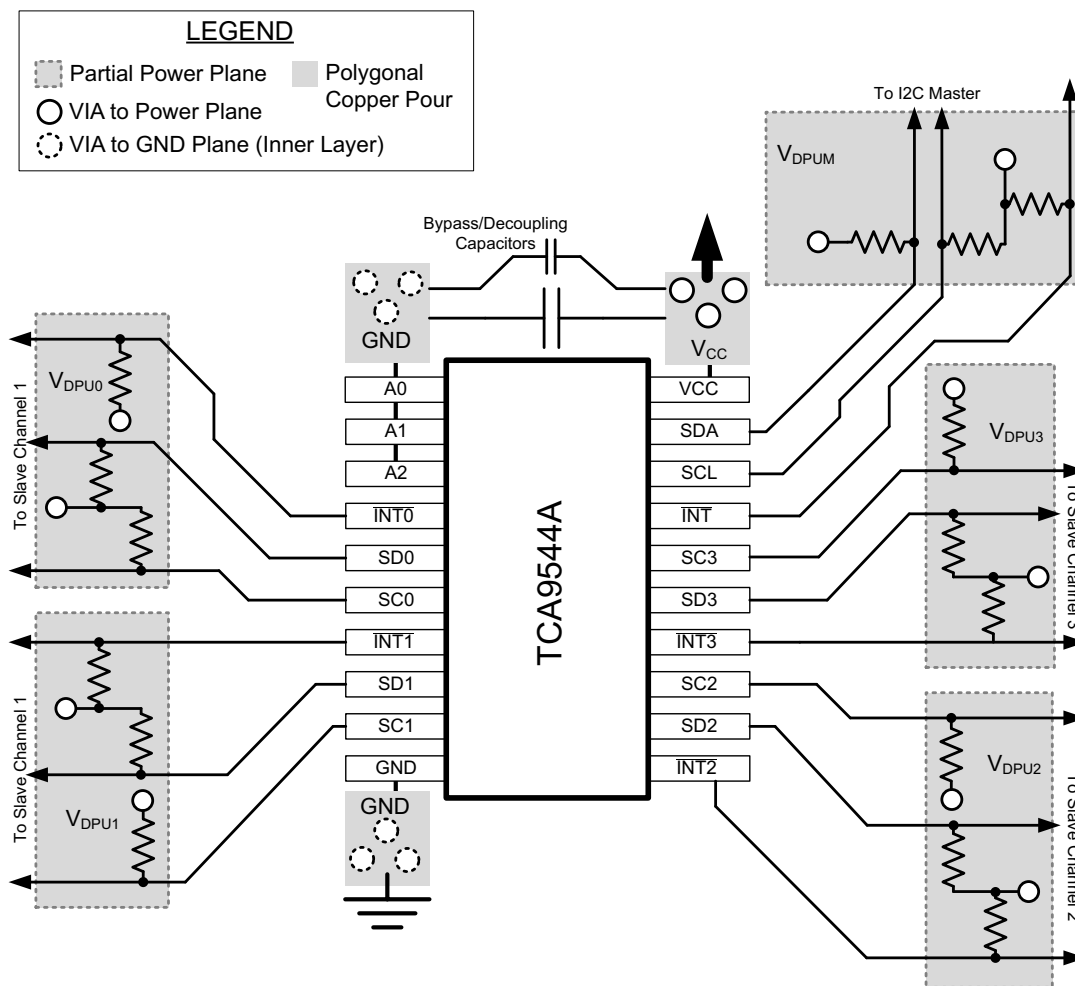
11.1 Layout Guidelines

For PCB layout of the TCA9544A, common PCB layout practices should be followed but additional concerns related to high-speed data transfer such as matched impedances and differential pairs are not a concern for I²C signal speeds. It is common to have a dedicated ground plane on an inner layer of the board and pins that are connected to ground should have a low-impedance path to the ground plane in the form of wide polygon pours and multiple vias. By-pass and de-coupling capacitors are commonly used to control the voltage on the VCC pin, using a larger capacitor to provide additional power in the event of a short power supply glitch and a smaller capacitor to filter out high-frequency ripple.

In an application where voltage translation is not required, all V_{DPUX} voltages and V_{CC} could be at the same potential and a single copper plane could connect all of pull-up resistors to the appropriate reference voltage. In an application where voltage translation is required, V_{DPU0}, V_{DPU1}, V_{DPU2}, and V_{DPU3} may all be on the same layer of the board with split planes to isolate different voltage potentials.

To reduce the total I²C bus capacitance added by PCB parasitics, data lines (SC_n, SD_n and INT_n) should be as short as possible and the widths of the traces should also be minimized (e.g. 5-10 mils depending on copper weight).

11.2 Layout Example



12 デバイスおよびドキュメントのサポート

12.1 ドキュメントの更新通知を受け取る方法

ドキュメントの更新についての通知を受け取るには、ti.comのデバイス製品フォルダを開いてください。右上の「アラートを受け取る」をクリックして登録すると、変更されたすべての製品情報に関するダイジェストを毎週受け取れます。変更の詳細については、修正されたドキュメントに含まれている改訂履歴をご覧ください。

12.2 サポート・リソース

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](#).

12.3 商標

E2E is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

12.4 静電気放電に関する注意事項



これらのデバイスは、限定的なESD(静電破壊)保護機能を内蔵しています。保存時または取り扱い時は、MOSゲートに対する静電破壊を防止するために、リード線同士をショートさせておくか、デバイスを導電フォームに入れる必要があります。

12.5 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

13 メカニカル、パッケージ、および注文情報

以降のページには、メカニカル、パッケージ、および注文に関する情報が記載されています。この情報は、そのデバイスについて利用可能な最新のデータです。このデータは予告なく変更されることがあり、ドキュメントが改訂される場合もあります。本データシートのブラウザ版を使用されている場合は、画面左側の説明をご覧ください。

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)
TCA9544APWR	Active	Production	TSSOP (PW) 20	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	PW544A
TCA9544APWR.B	Active	Production	TSSOP (PW) 20	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	PW544A
TCA9544APWRG4	Active	Production	TSSOP (PW) 20	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	PW544A
TCA9544APWRG4.B	Active	Production	TSSOP (PW) 20	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	PW544A

(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.

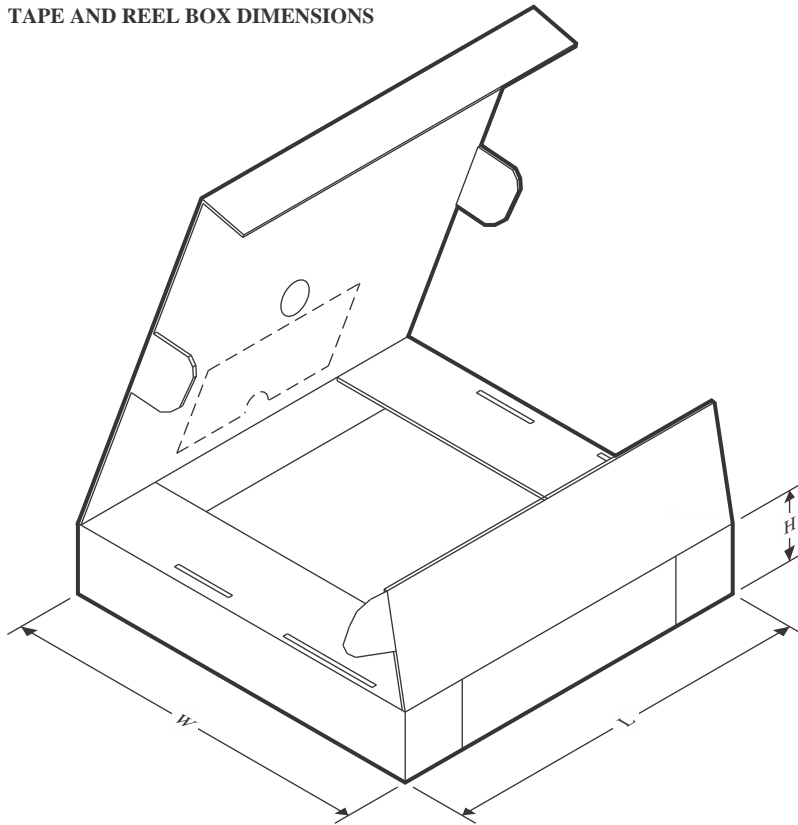
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


*All dimensions are nominal

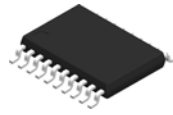
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TCA9544APWR	TSSOP	PW	20	2000	330.0	16.4	6.95	7.0	1.4	8.0	16.0	Q1
TCA9544APWRG4	TSSOP	PW	20	2000	330.0	16.4	6.95	7.0	1.4	8.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TCA9544APWR	TSSOP	PW	20	2000	353.0	353.0	32.0
TCA9544APWRG4	TSSOP	PW	20	2000	353.0	353.0	32.0

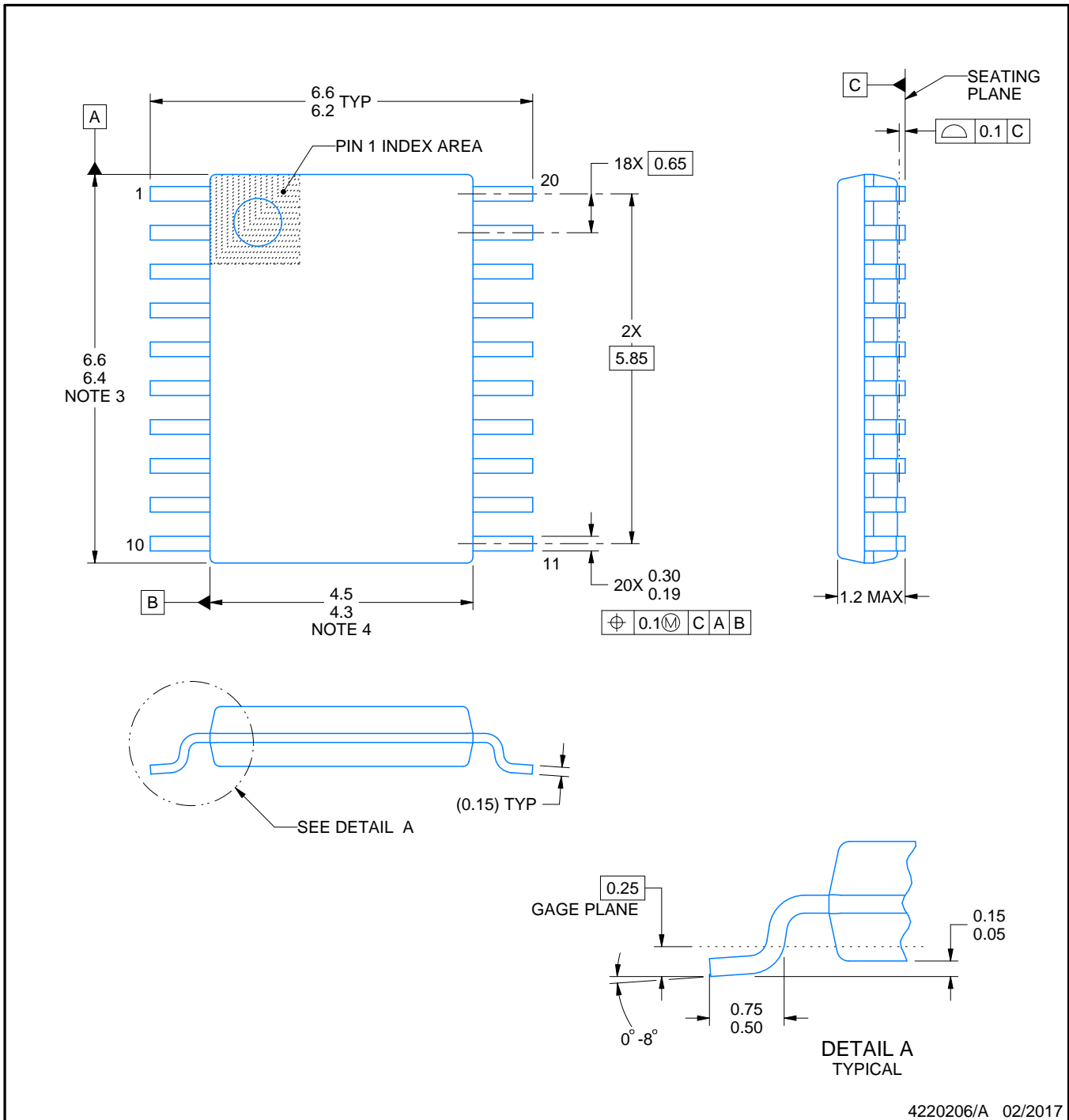
PW0020A



PACKAGE OUTLINE

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



4220206/A 02/2017

NOTES:

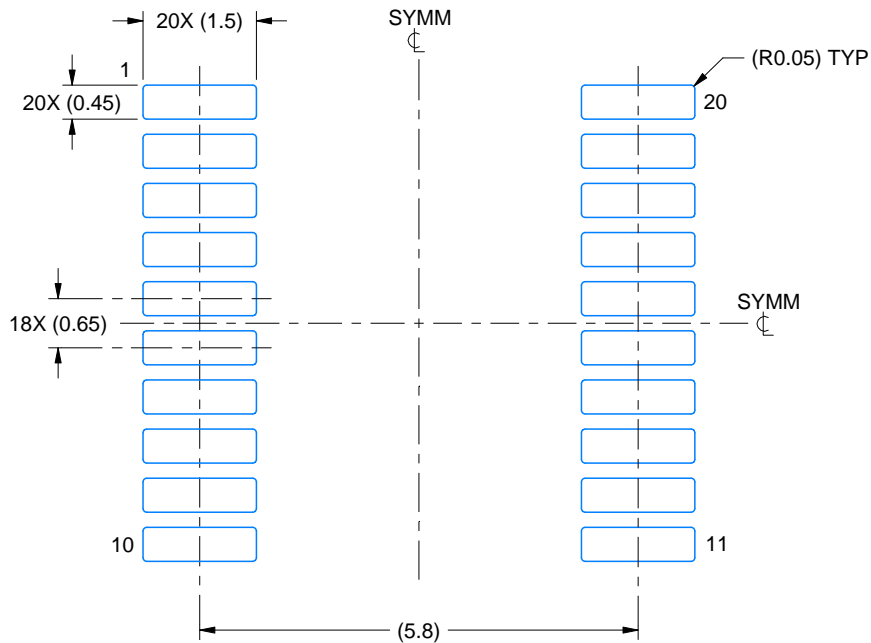
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or 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-153.

EXAMPLE BOARD LAYOUT

PW0020A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X



SOLDER MASK DETAILS

4220206/A 02/2017

NOTES: (continued)

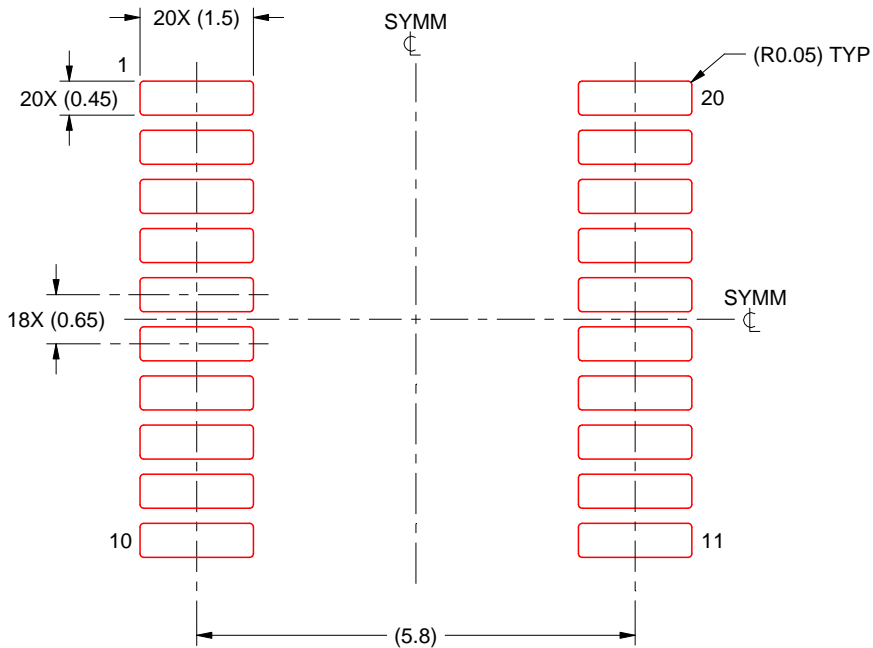
- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

PW0020A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



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

4220206/A 02/2017

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.

重要なお知らせと免責事項

TI は、技術データと信頼性データ(データシートを含みます)、設計リソース(リファレンス デザインを含みます)、アプリケーションや設計に関する各種アドバイス、Web ツール、安全性情報、その他のリソースを、欠陥が存在する可能性のある「現状のまま」提供しており、商品性および特定目的に対する適合性の黙示保証、第三者の知的財産権の非侵害保証を含むいかなる保証も、明示的または黙示的にかかわらず拒否します。

これらのリソースは、TI 製品を使用する設計の経験を積んだ開発者への提供を意図したものです。(1) お客様のアプリケーションに適した TI 製品の選定、(2) お客様のアプリケーションの設計、検証、試験、(3) お客様のアプリケーションに該当する各種規格や、その他のあらゆる安全性、セキュリティ、規制、または他の要件への確実な適合に関する責任を、お客様のみが単独で負うものとし、

上記の各種リソースは、予告なく変更される可能性があります。これらのリソースは、リソースで説明されている TI 製品を使用するアプリケーションの開発の目的でのみ、TI はその使用をお客様に許諾します。これらのリソースに関して、他の目的で複製することや掲載することは禁止されています。TI や第三者の知的財産権のライセンスが付与されている訳ではありません。お客様は、これらのリソースを自身で使用した結果発生するあらゆる申し立て、損害、費用、損失、責任について、TI およびその代理人を完全に補償するものとし、TI は一切の責任を拒否します。

TI の製品は、[TI の販売条件](#)、[TI の総合的な品質ガイドライン](#)、[ti.com](#) または TI 製品などに関連して提供される他の適用条件に従い提供されます。TI がこれらのリソースを提供することは、適用される TI の保証または他の保証の放棄の拡大や変更を意味するものではありません。TI がカスタム、またはカスタマー仕様として明示的に指定していない限り、TI の製品は標準的なカタログに掲載される汎用機器です。

お客様がいかなる追加条項または代替条項を提案する場合も、TI はそれらに異議を唱え、拒否します。

Copyright © 2025, Texas Instruments Incorporated

最終更新日：2025 年 10 月