

TCA9517-Q1 电平转换 I²C 总线中继器

1 特性

- 符合面向汽车应用的 AEC-Q100 标准
 - 器件温度：-40°C 至 125°C T_A
 - 器件 HBM 分级等级：±5500V
 - 器件 CDM 分级等级：±1000V
- 提供功能安全
 - 有助于进行功能安全系统设计的文档
- 双通道双向缓冲器
- 与 I²C 总线和 SMBus 兼容
- 在 A 侧上，工作电源电压范围为 0.9V 至 5.25V
- 在 B 侧上，工作电源电压范围为 2.7V 至 5.25V
- 可将电压电平从 0.9V 和 2.7V 转换到 5.25V
- 高电平有效中继电器使能输入
- 漏极开路 I²C I/O
- 5.25V 耐压 I²C 和使能输入支持混合模式信号操作
- 适应标准模式和快速模式 I²C 器件和多个控制器
- 器件断电时 I²C 引脚呈高阻抗状态
- 闩锁性能超过 100mA，符合 JESD 78 II 类规范的要求

2 应用

- 服务器
- 路由器 (电信交换设备)
- 工业设备
- 包含多个 I²C 目标和/或长 PCB 迹线的产品

3 说明

TCA9517-Q1 是一款具有电平转换功能的双向缓冲器，适用于 I²C 和 SMBus 系统。它能够在混合模式应用中提供低压 (低至 0.9V) 和更高电压 (2.7V 至 5.25V) 之间的双向电压电平转换 (上升转换和/或下降转换)。该器件能够扩展 I²C 和 SMBus 系统，甚至在电平转换期间也不会降低系统性能。

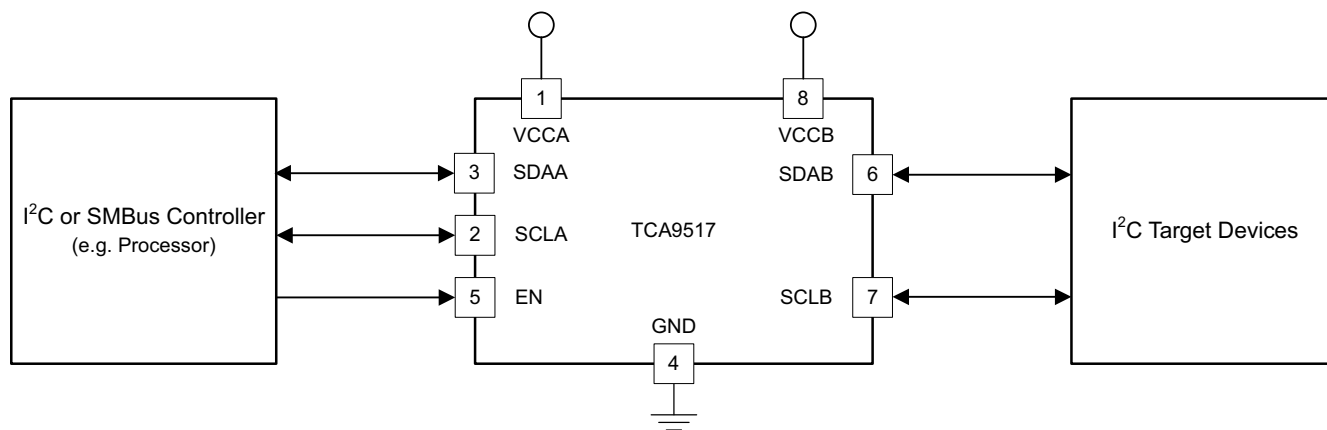
TCA9517-Q1 可缓冲 I²C 总线上的串行数据 (SDA) 和串行时钟 (SCL) 信号，因而能够在 I²C 应用中连接两条总线电容高达 400pF 的总线。

TCA9517-Q1 具有两种类型的驱动器：A 侧驱动器和 B 侧驱动器。所有输入和 I/O 都能够承受 5.25V 的过压，即使器件未通电时也是如此 (V_{CCB} 和/或 V_{CCA} = 0V)。

器件信息

器件型号	封装 ⁽¹⁾	封装尺寸 (标称值)
TCA9517-Q1	VSSOP (8)	3.00mm × 3.00mm

(1) 如需了解所有可用封装，请参阅数据表末尾的可订购产品附录。



简化版原理图



Table of Contents

1 特性	1	9.2 Functional Block Diagram.....	11
2 应用	1	9.3 Feature Description.....	12
3 说明	1	9.4 Device Functional Modes.....	12
4 Revision History	2	10 Application and Implementation	13
5 说明 (续)	3	10.1 Application Information.....	13
6 Pin Configuration and Functions	4	10.2 Typical Application.....	13
7 Specifications	5	11 Power Supply Recommendations	16
7.1 Absolute Maximum Ratings.....	5	12 Layout	17
7.2 ESD Ratings.....	5	12.1 Layout Guidelines.....	17
7.3 Recommended Operating Conditions.....	5	12.2 Layout Example.....	17
7.4 Thermal Information.....	6	13 Device and Documentation Support	18
7.5 Electrical Characteristics.....	7	13.1 Device Support.....	18
7.6 Timing Requirements.....	7	13.2 Receiving Notification of Documentation Updates..	18
7.7 I ² C Interface Switching Characteristics.....	8	13.3 支持资源.....	18
7.8 Typical Characteristics.....	9	13.4 Trademarks.....	18
8 Parameter Measurement Information	10	13.5 Electrostatic Discharge Caution.....	18
9 Detailed Description	11	13.6 术语表.....	18
9.1 Overview.....	11		

4 Revision History

注：以前版本的页码可能与当前版本的页码不同

Changes from Revision * (June 2018) to Revision A (February 2022)	Page
• 将提到的旧术语实例全部更改为控制器和目标.....	1
• 添加了 特性 “提供功能安全”	1

5 说明 (续)

B 侧上的缓冲器按照无法与使用静态电压偏移的器件串联使用进行设计。器件并不将经缓冲的低电平信号识别为有效低电平，并且不再将它作为经缓冲的低电平进行传送。

B 侧驱动器的运行电压介于 2.7V 至 5.25V 之间。此内部缓冲器的输出低电平大约为 0.5V。当输出在内部被驱动为低电平时，输出电压必须比输出低电平低 70mV 或者更多。更高的电压低信号被称为经缓冲的低电平。当 B 侧 I/O 在内部被驱动为低电平时，输入并不将此低电平识别为低电平。当输入低电平状态被释放时，这一特性防止了锁定情况的发生。

A 侧驱动器运行电压介于 0.9V 至 5.25V 之间并且能够驱动更大的电流。它们不需要经缓冲的低电平特性（或者静态失调电压）。B 侧低电平信号在 A 侧转换为接近 0V 的低电平。它可以适应低电压逻辑更小的电压摆幅。A 侧输出下拉驱动硬低电平。输入电平设置为 $0.3 \times V_{CCA}$ 以满足低电压侧电源低至 0.9V 的系统中对较低电平的需求。

两个或多个 TCA9517-Q1 器件的 A 侧可以连接在一起。将 A 侧作为公共总线，实现多个拓扑结构（请参阅图 8 和图 9）。可以将 A 侧直接连接至具有静态或动态失调电压的任意其他缓冲器。可以将多个 TCA9517-Q1 串联在一起（相邻器件间通过 A 侧和 B 侧相连），失调电压不会增大，只是需要考虑飞行时间延迟。由于 B 侧缓冲低电压的原因，TCA9517-Q1 不能通过 B 侧相连。B 侧不能连接配有上升时间加速器的器件。

VCCA 只能用于为 A 侧输入比较器提供 $0.3 \times V_{CCA}$ 参考电压，或者用于电源正常状态检测电路。TCA9517-Q1 逻辑和所有 I/O 均由 VCCB 引脚供电。

当与标准 I²C 系统一同工作时，需要用上拉电阻在经缓冲的总线上提供逻辑高电平。TCA9517-Q1 具有 I²C 总线的标准开漏配置。这些上拉电阻器的尺寸由系统决定，但中继器的每一侧都必须有一个上拉电阻器。此器件专为与标准模式及快速模式 I²C 器件（而不单是 SMBus 器件）一同工作而设计。在可以接受标准模式器件和多个控制器的通用型 I²C 系统中，标准模式 I²C 器件的额定值仅为 3mA。在某些情况下，可以采用更高的结束电流。

6 Pin Configuration and Functions

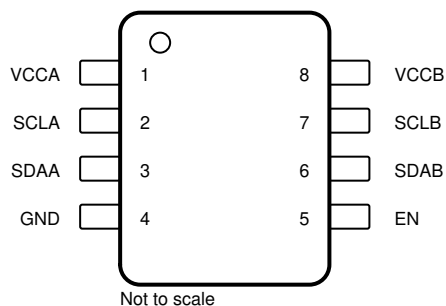


图 6-1. DGK (VSSOP) Package, 8-Pin, Top View

表 6-1. Pin Functions

PIN		TYPE	DESCRIPTION
NO.	NAME		
1	VCCA	Supply	A-side supply voltage (0.9 V to 5.25 V)
2	SCLA	Input/Output	Serial clock bus, A-side. Connect to V _{CCA} through a pull-up resistor. If unused, connect directly to ground.
3	SDAA	Input/Output	Serial data bus, A-side. Connect to V _{CCA} through a pull-up resistor. If unused, connect directly to ground.
4	GND	Ground	Ground
5	EN	Input	Active-high repeater enable input
6	SDAB	Input/Output	Serial data bus, B-side. Connect to V _{CCB} through a pull-up resistor. If unused, connect directly to ground.
7	SCLB	Input/Output	Serial clock bus, B-side. Connect to V _{CCB} through a pull-up resistor. If unused, connect directly to ground.
8	VCCB	Supply	B-side and device supply voltage (2.7 V to 5.25 V)

7 Specifications

7.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)⁽¹⁾

			MIN	MAX	UNIT
V _{CCB}	Supply voltage range		- 0.5	7	V
V _{CCA}	Supply voltage range		- 0.5	7	V
V _I	Enable input voltage range ⁽²⁾		- 0.5	7	V
V _{I/O}	I ² C bus voltage range ⁽²⁾		- 0.5	7	V
I _{IK}	Input clamp current	V _I < 0		- 50	mA
I _{OK}	Output clamp current	V _O < 0		- 50	
I _O	Continuous output current			±50	mA
	Continuous current through V _{CC} or GND			±100	mA
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, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) The input negative-voltage and output voltage ratings may be exceeded if the input and output current ratings are observed.

7.2 ESD Ratings

		VALUE	UNIT
V _(ESD)	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	±5500
		Charged-device model (CDM), per JEDEC specification JESD22-C101 ⁽²⁾	±1000
		Machine model (A115-A)	±200

- (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.

7.3 Recommended Operating Conditions

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

			MIN	MAX	UNIT
V _{CCA}	Supply voltage, A-side bus		0.9 ⁽²⁾	5.25	V
V _{CCB}	Supply voltage, B-side bus	V _{CCA} ≤ V _{CCB}	2.7	5.25	V
		V _{CCA} > V _{CCB}	2.9	5.25	
V _{IH}	High-level input voltage	SDAA, SCLA	0.7 × V _{CCA}	5.25	V
		SDAB, SCLB	0.7 × V _{CCB}	5.25	
		EN	0.7 × V _{CCB}	5.25	
V _{IL}	Low-level input voltage	SDAA, SCLA		0.3 × V _{CCA}	V
		SDAB, SCLB ⁽¹⁾		0.3 × V _{CCB}	
		EN		0.3 × V _{CCB}	
I _{OL}	Low-level output current			6	mA
T _A	Operating free-air temperature		- 40	125	°C

- (1) V_{IL} specification is for the first low level seen by the SDAB and SCLB lines. V_{ILC} is for the second and subsequent low levels seen by the SDAB and SCLB lines. See # 10.2.2.2 for V_{ILC} application information
- (2) Low-level supply voltage

7.4 Thermal Information

THERMAL METRIC ⁽¹⁾		TCA9517-Q1	UNIT
		DGK (VSSOP)	
		8 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	187.6	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	59.3	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	108.6	°C/W
ψ_{JT}	Junction-to-top characterization parameter	3.4	°C/W
ψ_{JB}	Junction-to-board characterization parameter	106.9	°C/W

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

7.5 Electrical Characteristics

$V_{CCB} = 2.7 \text{ V to } 5.25 \text{ V}$, $GND = 0 \text{ V}$, $T_A = -40^\circ\text{C to } 125^\circ\text{C}$ (unless otherwise noted)

PARAMETER			TEST CONDITIONS	V _{CCB}	MIN	TYP	MAX	UNIT
V _{IK}	Input clamp voltage		I _I = - 18 mA	2.7 V to 5.25 V			- 1.2	V
V _{OL}	Low-level output voltage	SDAB, SCLB	I _{OL} = 100 μA or 6 mA, V _{ILA} = V _{ILB} = 0 V	2.7 V to 5.25 V	0.45	0.52	0.6	V
		SDAA, SCLA	I _{OL} = 6 mA			0.1	0.2	
V _{OL} - V _{ILC}	Low-level input voltage below low-level output voltage	SDAB, SCLB	ensured by design	2.7 V to 5.25 V		70		mV
V _{ILC}	SDA and SCL low-level input voltage contention	SDAB, SCLB		2.7 V to 5.25 V		0.4		V
I _{CC}	Quiescent supply current for V _{CCA}		Both channels low, SDAA = SCLA = GND and SDAB = SCLB = open, or SDAA = SCLA = open and SDAB = SCLB = GND				1	mA
I _{CC}	Quiescent supply current		Both channels high, SDAA = SCLA = V _{CCA} and SDAB = SCLB = V _{CCB} and EN = V _{CCB}	5.25 V		1.5	5	mA
			Both channels low, SDAA = SCLA = GND and SDAB = SCLB = open			1.5	5	
			In contention, SDAA = SCLA = GND and SDAB = SCLB = GND			3	5	
I _I	Input leakage current	SDAB, SCLB	V _I = V _{CCB}	2.7 V to 5.25 V			±1	μA
			V _I = 0.2 V				10	
		SDAA, SCLA	V _I = V _{CCB}				±1	
			V _I = 0.2 V				10	
		EN	V _I = V _{CCB}				±1	
			V _I = 0.2 V			- 10	- 30	
I _{OH}	High-level output leakage current	SDAB, SCLB	V _O = 3.6 V	2.7 V to 5.25 V		10	μA	
		SDAA, SCLA				10		
C _I	Input capacitance	EN	V _I = 3 V or 0 V	3.3 V		6	10	pF
		SCLA, SCLB	V _I = 3 V or 0 V	3.3 V		8	13	
				0 V		7	11	
C _{IO}	Input/output capacitance	SDAA, SDAB	V _I = 3 V or 0 V	3.3 V		8	13	pF
				0 V		7	11	

7.6 Timing Requirements

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

	MIN	MAX	UNIT
t_{su} Setup time, EN high before Start condition ⁽¹⁾	100		ns
t_h Hold time, EN high after Stop condition ⁽¹⁾	100		ns

(1) EN should change state only when the global bus and the repeater port are in an idle state.

7.7 I²C Interface Switching Characteristics

$V_{CCB} = 2.7\text{ V to }5.25\text{ V}$, $GND = 0\text{ V}$, $T_A = -40^\circ\text{C to }125^\circ\text{C}$ (unless otherwise noted)^{(1) (4)}

PARAMETER		FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP ⁽⁵⁾	MAX	UNIT
t_{PLZ}	Propagation delay	SDAB, SCLB ⁽³⁾ (see 图 8-4)	SDAA, SCLA ⁽³⁾ (see 图 8-4)			141	250	ns
		SDAA, SCLA ⁽²⁾ (see 图 8-3)	SDAB, SCLB ⁽²⁾ (see 图 8-3)			74	110	
t_{PZL}	Propagation delay	SDAB, SCLB	SDAA, SCLA	$V_{CCA} \leq 2.7\text{ V}$ (see 图 8-2)		76 ⁽⁶⁾	110	ns
				$V_{CCA} \geq 3\text{ V}$ (see 图 8-2)		95	290	
		SDAA, SCLA ⁽²⁾ (see 图 8-3)	SDAB, SCLB ⁽²⁾ (see 图 8-3)			107	230	
t_{TLH}	Transition time	80%	20%	$V_{CCA} \leq 2.7\text{ V}$ (see 图 8-3)		12		ns
				$V_{CCA} \geq 3\text{ V}$ (see 图 8-3)		42		
						125		
t_{THL}	Transition time	80%	20%	$V_{CCA} \leq 2.7\text{ V}$ (see 图 8-3)		67 ⁽⁶⁾	200	ns
				$V_{CCA} \geq 3\text{ V}$ (see 图 8-3)		86	240	
						48	120	

- (1) Times are specified with loads of 1.35-k Ω pull-up resistance and 50-pF load capacitance on the B-side. On the A side, for $0.9\text{ V} \leq V_{CCA} \leq 2.7\text{ V}$, a 167- Ω pull-up and 57-pF load capacitance. For $V_{CCA} \geq 3.0\text{ V}$, a 450- Ω pull-up and 57-pF load capacitance. Different load resistance and capacitance alter the RC time constant, thereby changing the propagation delay and transition times.
- (2) The proportional delay data from A to B-side is measured at $0.3 V_{CCA}$ on the A side to 1.5 V on the B-side.
- (3) The t_{PLH} delay data from B to A side is measured at 0.4 V on the B-side to $0.5 V_{CCA}$ on the A side when V_{CCA} is less than 2 V , and 1.5 V on the A side if V_{CCA} is greater than 2 V .
- (4) pull-up voltages are V_{CCA} on the A side and V_{CCB} on the B-side.
- (5) Typical values were measured with $V_{CCA} = V_{CCB} = 3.3\text{ V}$ at $T_A = 25^\circ\text{C}$, unless otherwise noted.
- (6) Typical value measured with $V_{CCA} = 2.7\text{ V}$ at $T_A = 25^\circ\text{C}$

7.8 Typical Characteristics

$V_{CCA} = 0.9\text{ V}$, $V_{CCB} = 2.7\text{ V}$

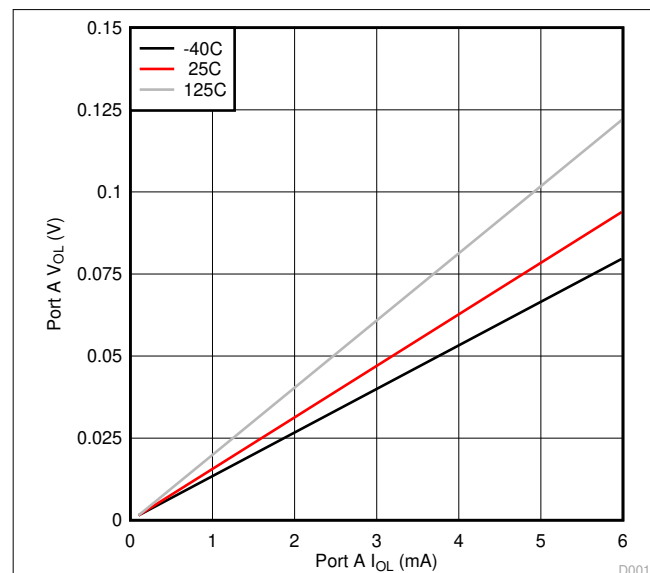


图 7-1. Port A V_{OL} vs I_{OL}

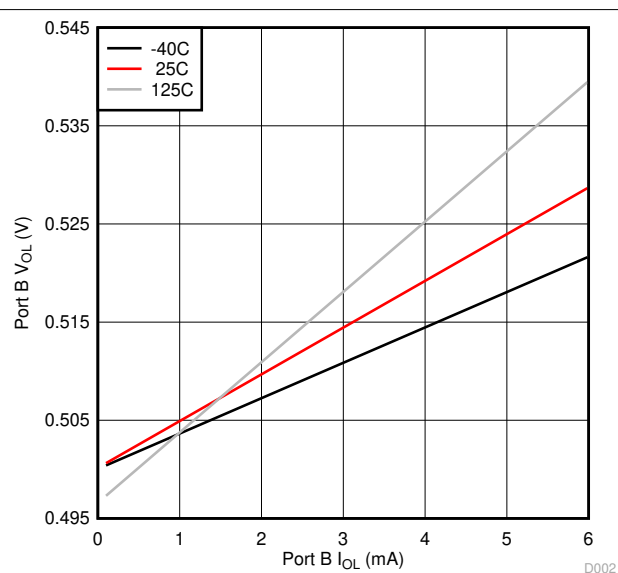
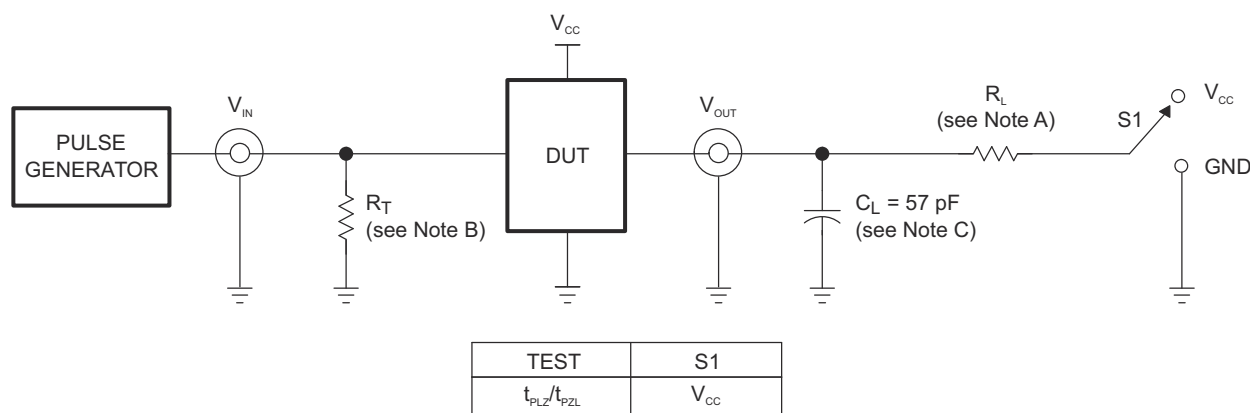


图 7-2. Port B V_{OL} vs I_{OL}

8 Parameter Measurement Information



TEST CIRCUIT FOR OPEN-DRAIN OUTPUT

Copyright © 2017, Texas Instruments Incorporated

- A. $R_L = 167\ \Omega$ (0.9 V to 2.7 V) and $R_L = 450\ \Omega$ (3.0 V to 5.25 V) on the A side and 1.35 k Ω on the B-side
- B. R_T termination resistance should be equal to Z_{OUT} of pulse generators.
- C. C_L includes probe and jig capacitance. $C_L = 50\text{ pF}$ when on the B-side.
- D. All input pulses are supplied by generators having the following characteristics: $PRR \leq 10\text{ MHz}$, $Z_O = 50\ \Omega$, slew rate $\geq 1\text{ V/ns}$.
- E. The outputs are measured one at a time, with one transition per measurement.
- F. t_{PLH} and t_{PHL} are the same as t_{pd} .
- G. t_{PLZ} and t_{PHZ} are the same as t_{dis} .
- H. t_{PZL} and t_{PZH} are the same as t_{en} .

图 8-1. Test Circuit

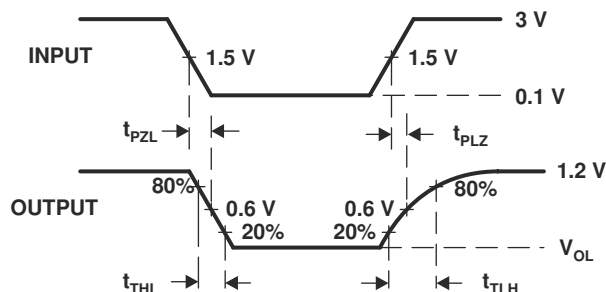


图 8-2. Waveform 1 - Propagation Delay and Transition Times for B-side to A-side

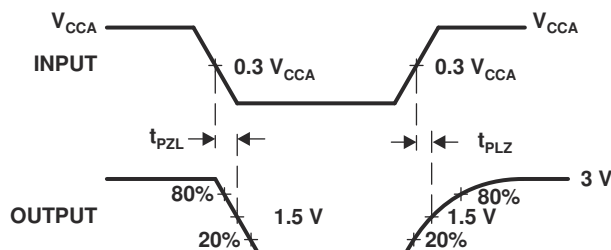


图 8-3. Waveform 2 - Propagation Delay and Transition Times for A-side to B-side

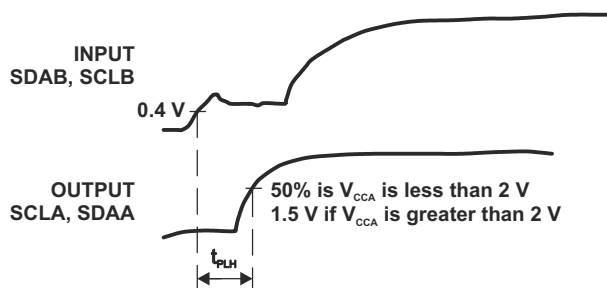


图 8-4. Waveform 3 - Propagation Delay for B-side to A-side

9 Detailed Description

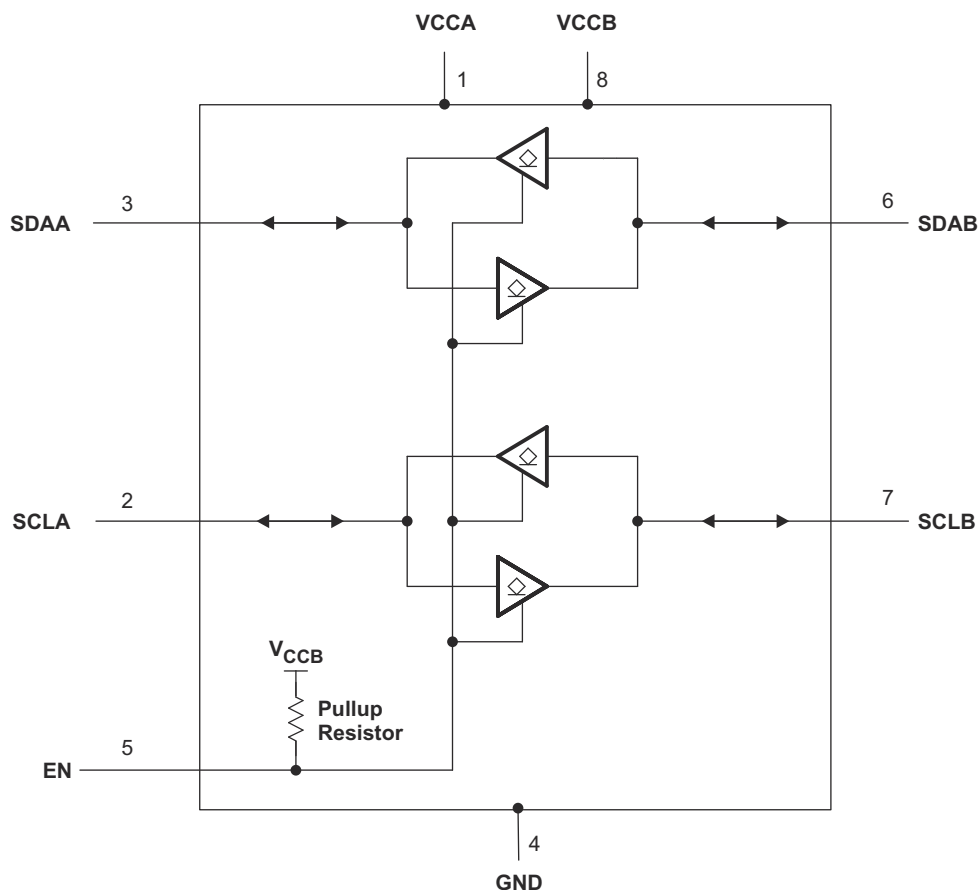
9.1 Overview

The TCA9517-Q1 is a bidirectional buffer with level shifting capabilities for I²C and SMBus systems. It provides bidirectional voltage-level translation (up-translation/down-translation) between low voltages (down to 0.9 V) and higher voltages (2.7 V to 5.25 V) in mixed-mode applications. This device enables I²C and SMBus systems to be extended without degradation of performance, even during level shifting.

The TCA9517-Q1 buffers both the serial data (SDA) and the serial clock (SCL) signals on the I²C bus, thus allowing two buses of up to 400-pF bus capacitance to be connected in an I²C application.

The TCA9517-Q1 has two types of drivers: A-side drivers and B-side drivers. All inputs and I/Os are over-voltage tolerant to 5.25 V, even when the device is unpowered (V_{CCB} and/or $V_{CCA} = 0$ V).

9.2 Functional Block Diagram



9.3 Feature Description

9.3.1 Two-Channel Bidirectional Buffer

The TCA9517-Q1 is a two-channel bidirectional buffer with level-shifting capabilities

9.3.2 Active-High Repeater-Enable Input

The TCA9517-Q1 has an active-high enable (EN) input with an internal pull-up to V_{CCB} , which allows the user to select when the repeater is active. This can be used to isolate a badly behaved target on power-up reset. The EN input should change state only when the global bus and repeater port are in an idle state, to prevent system failures.

9.3.3 V_{OL} B-Side Offset Voltage

The B-side drivers operate from 2.7 V to 5.25 V. The output low level for this internal buffer is approximately 0.5 V, but the input voltage must be 70 mV or more below the output low level when the output internally is driven low. The higher-voltage low signal is called a buffered low. When the B-side I/O is driven low internally, the low is not recognized as a low by the input. This feature prevents a lockup condition from occurring when the input low condition is released. This type of design prevents 2 B-side ports from being connected to each other.

9.3.4 Standard Mode and Fast Mode Support

The TCA9517-Q1 supports standard mode as well as fast mode I²C. The maximum system operating frequency will depend on system design and the delays added by the repeater.

9.3.5 Clock Stretching Support

The TCA9517-Q1 can support clock stretching, but care needs to be taken to minimize the overshoot voltage presented during the hand-off between the target and controller. This is best done by increasing the pull-up resistor value.

9.4 Device Functional Modes

表 9-1. Function Table

INPUT EN	FUNCTION
L	Outputs disabled
H	SDAA = SDAB SCLA = SCLB

10 Application and Implementation

备注

以下应用部分中的信息不属于 TI 器件规格的范围，TI 不担保其准确性和完整性。TI 的客户应负责确定器件是否适用于其应用。客户应验证并测试其设计，以确保系统功能。

10.1 Application Information

A typical application is shown in 图 10-1. In this example, the system controller is running on a 3.3 V I²C bus, and the target is connected to a 1.2 V I²C bus. Both buses run at 400 kHz. Controller devices can be placed on either bus.

The TCA9517-Q1 is 5-V tolerant, so it does not require any additional circuitry to translate between 0.9 V to 5.25 V bus voltages and 2.7 V to 5.25 V bus voltages.

When the A side of the TCA9517-Q1 is pulled low by a driver on the I²C bus, a comparator detects the falling edge when it goes below $0.3 \times V_{CCA}$ and causes the internal driver on the B-side to turn on, causing the B-side to pull down to about 0.5 V. When the B-side of the TCA9517-Q1 falls, first a CMOS hysteresis-type input detects the falling edge and causes the internal driver on the A side to turn on and pull the A-side pin down to ground. In order to illustrate what would be seen in a typical application, refer to 图 10-3 and 图 10-4. If the bus controller in 图 10-1 were to write to the target through the TCA9517-Q1, waveforms shown in 图 10-3 would be observed on the A bus. This looks like a normal I²C transmission, except that the high level may be as low as 0.9 V, and the turn on and turn off of the acknowledge signals are slightly delayed.

On the B-side bus of the TCA9517-Q1, the clock and data lines would have a positive offset from ground equal to the V_{OL} of the TCA9517-Q1. After the eighth clock pulse, the data line is pulled to the V_{OL} of the target device, which is very close to ground in this example. At the end of the acknowledge, the level rises only to the low level set by the driver in the TCA9517-Q1 for a short delay, while the A-bus side rises above $0.3 \times V_{CCA}$ and then continues high.

10.2 Typical Application

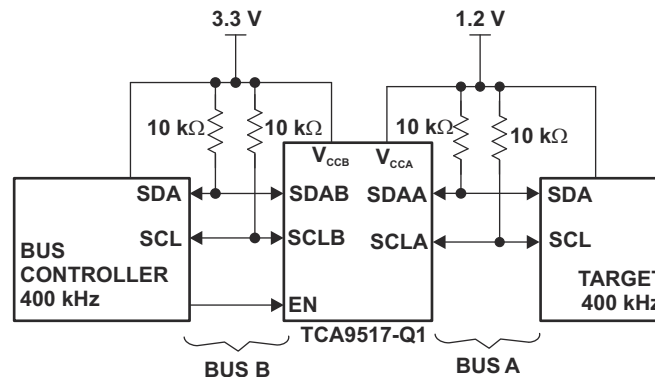


图 10-1. Typical Application Schematic

10.2.1 Design Requirements

For the level translating application, the following should be true:

- $V_{CCA} = 0.9 \text{ V to } 5.25 \text{ V}$
- $V_{CCB} = 2.7 \text{ to } 5.25 \text{ V}$
- B-side ports must not be connected together

10.2.2 Detailed Design Procedure

10.2.2.1 Clock Stretching Support

The TCA9517-Q1 can support clock stretching, but care needs to be taken to minimize the overshoot voltage presented during the hand-off between the target and controller. This is best done by increasing the pull-up resistor value.

10.2.2.2 V_{ILC} and Pullup Resistor Sizing

For the TCA9517-Q1 to function correctly, all devices on the B-side must be able to pull the B-side below the voltage input low contention level (V_{ILC}). This means that the V_{OL} of any device on the B-side must be below 0.4 V.

V_{OL} of a device can be adjusted by changing the I_{OL} through the device which is set by the pull-up resistance value. The pull-up resistance on the B-side must be carefully selected to ensure that logic levels will be transferred correctly to the A-side.

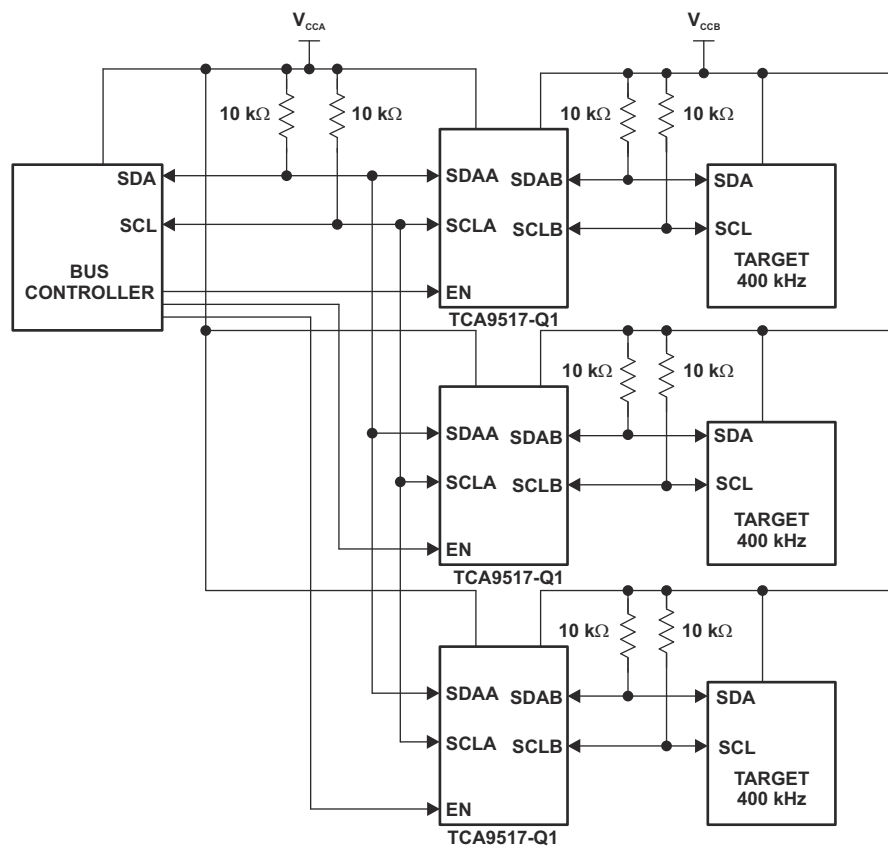


图 10-2. Typical Star Application

Multiple A sides of TCA9517-Q1s can be connected in a star configuration, allowing all nodes to communicate with each other.

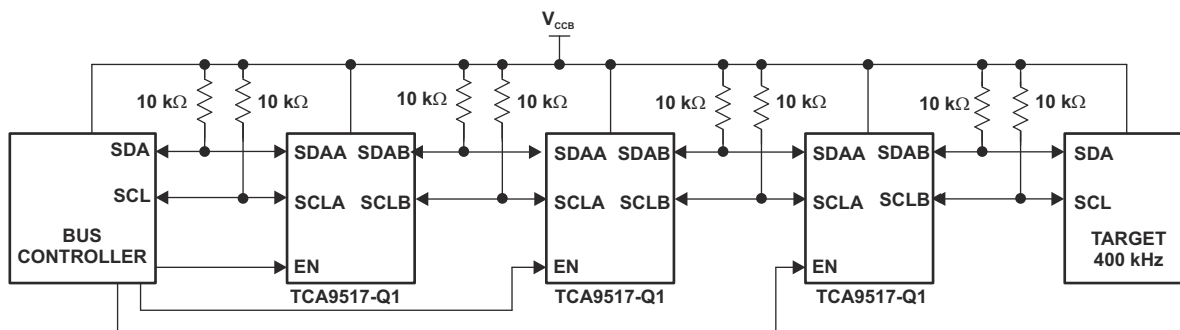


图 10-3. Typical Series Application

To further extend the I²C bus for long traces/cables, multiple TCA9517-Q1s can be connected in series as long as the A-side is connected to the B-side. I²C bus target devices can be connected to any of the bus segments. The number of devices that can be connected in series is limited by repeater delay/time-of-flight considerations on the maximum bus speed requirements.

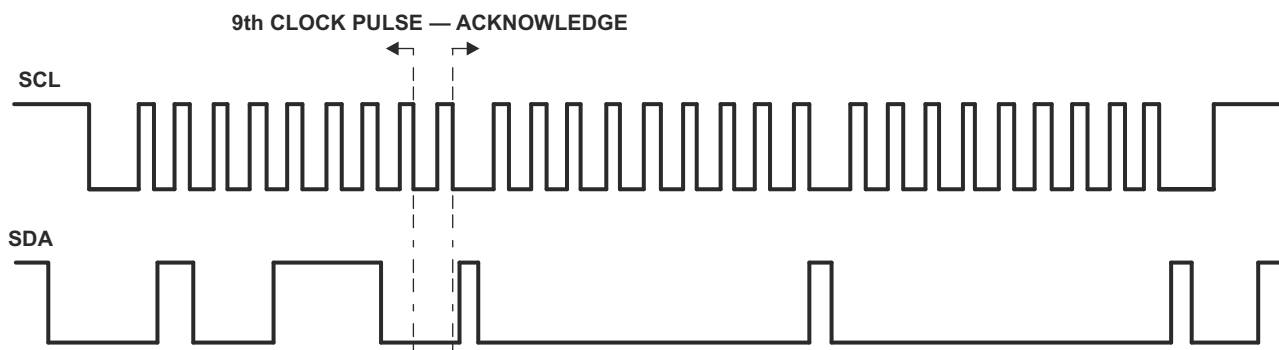


图 10-4. Bus A (0.9 V to 5.25 V Bus) Waveform

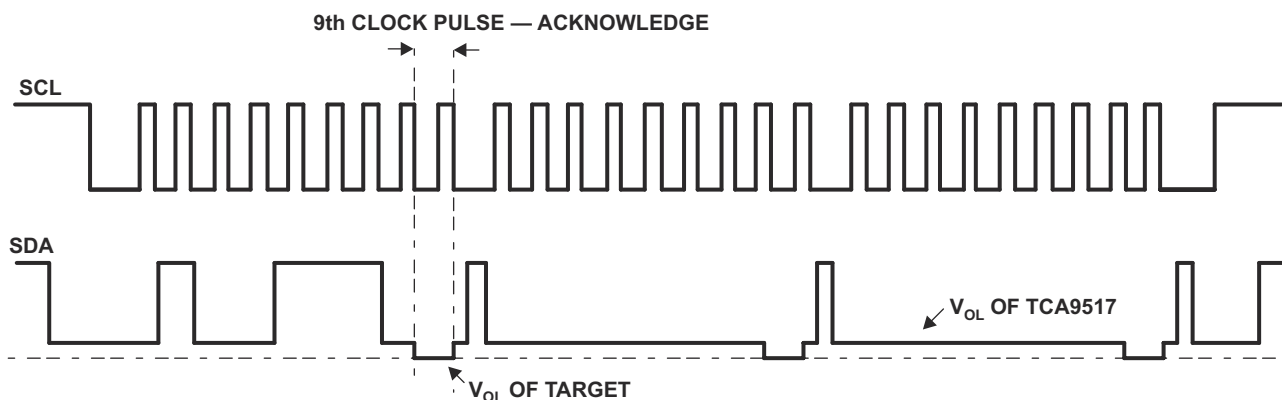
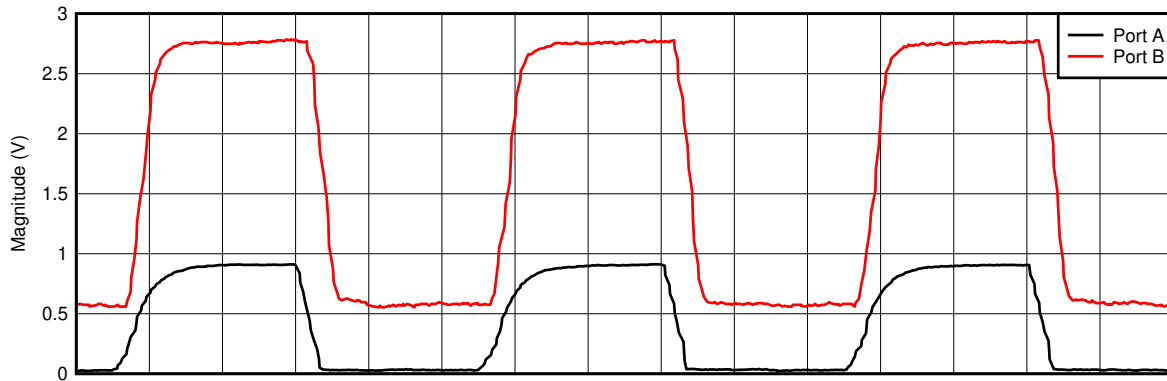


图 10-5. Bus B (2.7 V to 5.25 V Bus) Waveform

10.2.3 Application Curve



D003

图 10-6. Voltage Translation at 400 kHz, $V_{CCA} = 0.9\text{ V}$, $V_{CCB} = 2.7\text{ V}$

11 Power Supply Recommendations

V_{CCB} and V_{CCA} can be applied in any sequence at power up. The TCA9517-Q1 includes a power-up circuit that keeps the output drivers turned off until V_{CCB} is above 2.5 V and the V_{CCA} is above 0.8 V. After power up and with the EN high, a low level on the A-side (below $0.3 \times V_{CCA}$) turns the corresponding B-side driver (either SDA or SCL) on and drives the B-side down to approximately 0.5 V. When the A-side rises above $0.3 \times V_{CCA}$, the B-side pull-down driver is turned off and the external pull-up resistor pulls the pin high. When the B-side falls first and goes below $0.3 \times V_{CCB}$, the A-side driver is turned on and the A-side pulls down to 0 V. The B-side pull-down is not enabled unless the B-side voltage goes below 0.4 V. If the B-side low voltage does not go below 0.5 V, the A-side driver turns off when the B-side voltage is above $0.7 \times V_{CCB}$. If the B-side low voltage goes below 0.4 V, the B-side pull-down driver is enabled, and the B-side is able to rise to only 0.5 V until the A-side rises above $0.3 \times V_{CCA}$.

TI recommends using a decoupling capacitor and placing it close to the VCCA and VCCB pins of a value of about 100 nF.

12 Layout

12.1 Layout Guidelines

There are no special layout procedures required for the TCA9517-Q1.

It is recommended that the decoupling capacitors be placed as close to the VCC pins as possible.

12.2 Layout Example

图 12-1 shows an example layout of the DGK package.

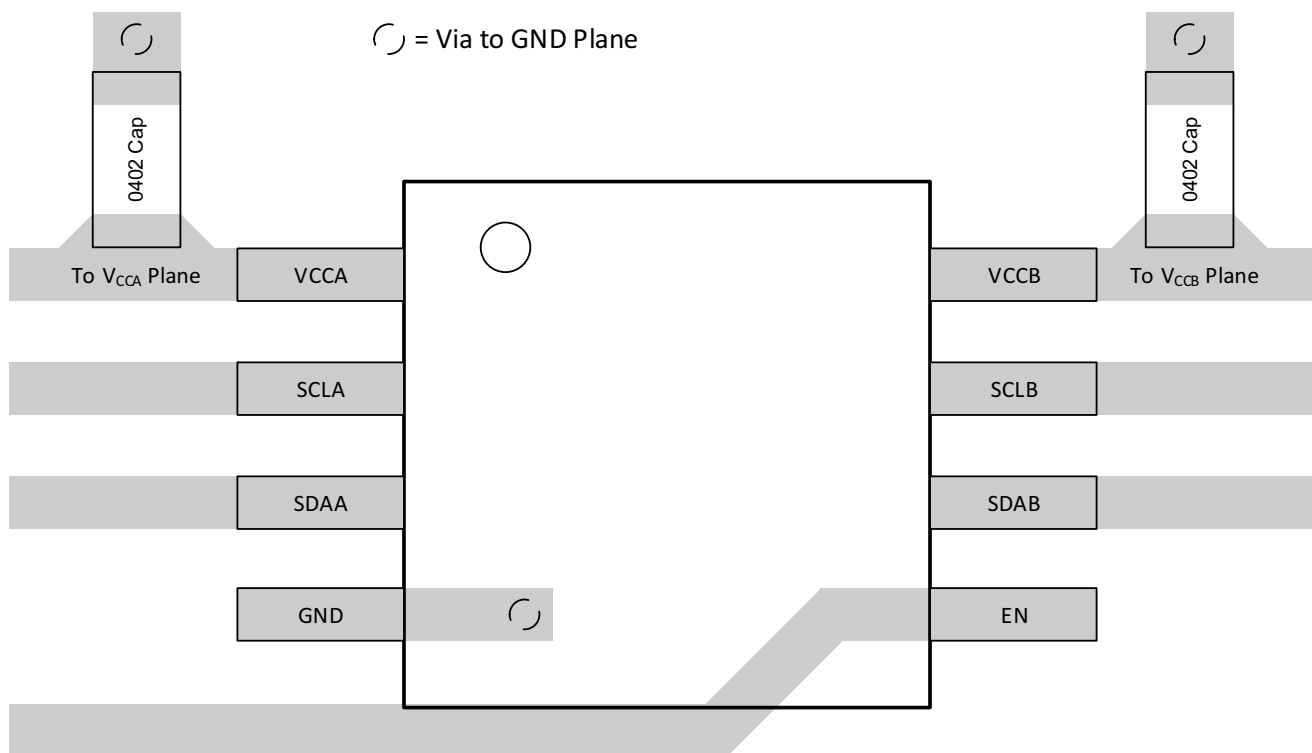


图 12-1. TCA9517-Q1A Layout Example

13 Device and Documentation Support

13.1 Device Support

13.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* 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.

13.3 支持资源

[TI E2E™ 支持论坛](#)是工程师的重要参考资料，可直接从专家获得快速、经过验证的解答和设计帮助。搜索现有解答或提出自己的问题可获得所需的快速设计帮助。

链接的内容由各个贡献者“按原样”提供。这些内容并不构成 TI 技术规范，并且不一定反映 TI 的观点；请参阅 TI 的《[使用条款](#)》。

13.4 Trademarks

TI E2E™ is a trademark of Texas Instruments.

所有商标均为其各自所有者的财产。

13.5 Electrostatic Discharge Caution



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

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

13.6 术语表

[TI 术语表](#) 本术语表列出并解释了术语、首字母缩略词和定义。

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 Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TCA9517DGKRQ1	ACTIVE	VSSOP	DGK	8	2500	RoHS & Green	NIPDAUAG	Level-1-260C-UNLIM	-40 to 125	1N2	Samples

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

ACTIVE: Product device recommended for new designs.

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

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

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

OBSOLETE: TI has discontinued the production of the device.

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

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

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

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

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

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

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

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 TCA9517-Q1 :

- Catalog : [TCA9517](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

TAPE AND REEL INFORMATION



*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
TCA9517DGKRQ1	VSSOP	DGK	8	2500	330.0	12.4	5.3	3.4	1.4	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)
TCA9517DGKRQ1	VSSOP	DGK	8	2500	366.0	364.0	50.0

DGK0008A**PACKAGE OUTLINE****VSSOP - 1.1 mm max height**

SMALL OUTLINE PACKAGE



4214862/A 04/2023

NOTES:

PowerPAD is a trademark of Texas Instruments.

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

EXAMPLE BOARD LAYOUT

DGK0008A

™ VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 15X



SOLDER MASK DETAILS

4214862/A 04/2023

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.
8. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.
9. Size of metal pad may vary due to creepage requirement.

EXAMPLE STENCIL DESIGN

DGK0008A

™ VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE
SCALE: 15X

4214862/A 04/2023

NOTES: (continued)

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

重要声明和免责声明

TI“按原样”提供技术和可靠性数据（包括数据表）、设计资源（包括参考设计）、应用或其他设计建议、网络工具、安全信息和其他资源，不保证没有瑕疵且不做任何明示或暗示的担保，包括但不限于对适销性、某特定用途方面的适用性或不侵犯任何第三方知识产权的暗示担保。

这些资源可供使用 TI 产品进行设计的熟练开发人员使用。您将自行承担以下全部责任：(1) 针对您的应用选择合适的 TI 产品，(2) 设计、验证并测试您的应用，(3) 确保您的应用满足相应标准以及任何其他功能安全、信息安全、监管或其他要求。

这些资源如有变更，恕不另行通知。TI 授权您仅可将这些资源用于研发本资源所述的 TI 产品的应用。严禁对这些资源进行其他复制或展示。您无权使用任何其他 TI 知识产权或任何第三方知识产权。您应全额赔偿因在这些资源的使用中对 TI 及其代表造成的任何索赔、损害、成本、损失和债务，TI 对此概不负责。

TI 提供的产品受 [TI 的销售条款](#) 或 [ti.com](#) 上其他适用条款/TI 产品随附的其他适用条款的约束。TI 提供这些资源并不会扩展或以其他方式更改 TI 针对 TI 产品发布的适用的担保或担保免责声明。

TI 反对并拒绝您可能提出的任何其他或不同的条款。

邮寄地址：Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2024，德州仪器 (TI) 公司