SN74AHC595 8-Bit Shift Registers With 3-State Output Registers

1 Features

- Operating Range: 2-V to 5.5-V V_{CC}
- 8-Bit Serial-In, Parallel-Out Shift
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II
- ESD Protection Exceeds JESD 22
  - 2000-V Human-Body Model (A114-A)
  - 200-V Machine Model (A115-A)
  - 1000-V Charged-Device Model (C101)

2 Applications

- Network Switches
- Power Infrastructures
- LED Displays
- Servers

3 Description

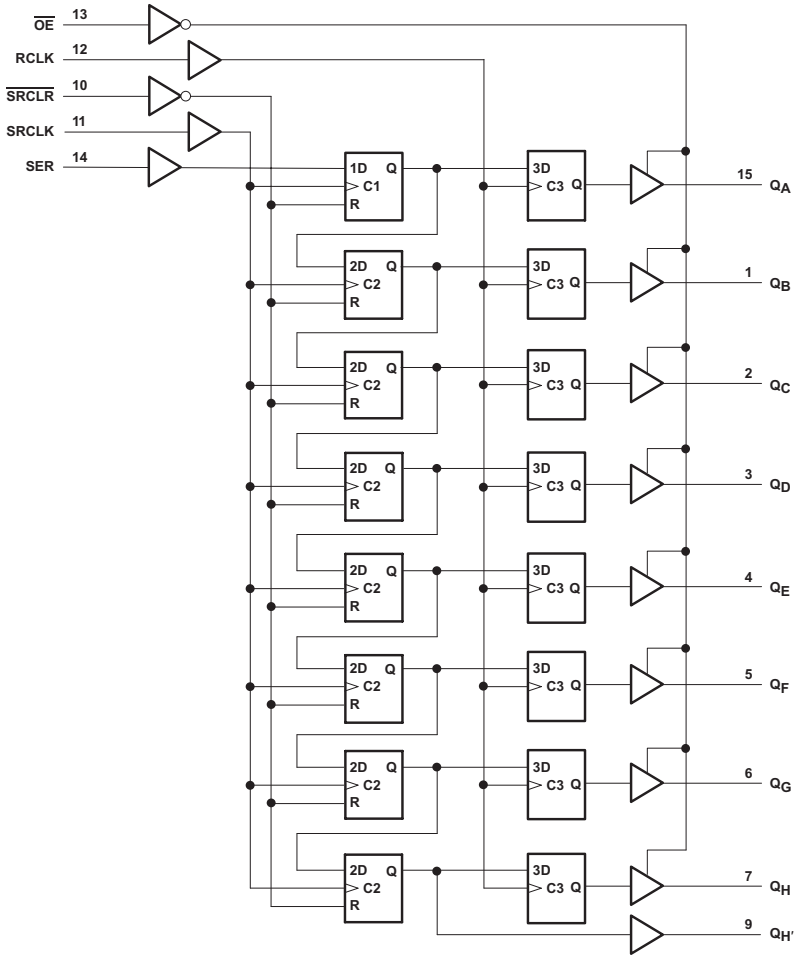
The SN74AHC595 device contains an 8-bit serial-in, parallel-out shift register that feeds an 8-bit D-type storage register. The storage register has parallel 3-state outputs. Separate clocks are provided for both the shift and storage registers. The shift register has a direct overriding clear ($\overline{SRCLR}$) input, a serial (SER) input, and a serial output for cascading. When the output-enable ($\overline{OE}$) input is high, all outputs except QH′ are in the high-impedance state.

Device Information

PART NUMBER	PACKAGE	BODY SIZE (NOM)
SN74AHC595N	PDIP (16)	19.31 mm × 6.35 mm
SN74AHC595D	SOIC (16)	9.90 mm × 3.90 mm
SN74AHC595DB	SSOP (16)	6.20 mm × 5.30 mm
SN74AHC595PW	TSSOP (16)	5.00 mm × 4.40 mm

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

Logic Diagram (Positive Logic)



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4 Revision History

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

Changes from Revision J (July 2013) to Revision K — **Page**

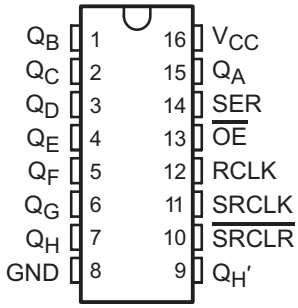
- Deleted SN54AHC595 device from the data sheet ... 1
- Added *Device Information* table, *Pin Functions* table, *ESD Ratings* table, *Thermal Information* table, *Detailed Description* section, *Applications and Implementation* section, *Power Supply Recommendations* section, *Layout* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section ... 1

Changes from Revision I (June 2004) to Revision J — **Page**

- Changed Updated document to new TI data sheet format. ... 1
- Extended operating temperature range to 125°C ... 4

5 Pin Configuration and Functions

D, DB, N, PW Packages
16-Pin SOIC, SSOP, PDIP, TSSOP
Top View



Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
GND	8	—	Ground Pin
$\overline{OE}$	13	I	Output Enable
Q_A	15	O	Q_A Output
Q_B	1	O	Q_B Output
Q_C	2	O	Q_C Output
Q_D	3	O	Q_D Output
Q_E	4	O	Q_E Output
Q_F	5	O	Q_F Output
Q_G	6	O	Q_G Output
Q_H	7	O	Q_H Output
$Q_{H'}$	9	O	$Q_{H'}$ Output
RCLK	12	I	RCLK Input
SER	14	I	SER Input
SRCLK	11	I	SRCLK Input
$\overline{SRCLR}$	10	I	$\overline{SRCLR}$ Input
V_{CC}	16	—	Power Pin

6 Specifications

6.1 Absolute Maximum Ratings

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

			MIN	MAX	UNIT
V_{CC}	Supply voltage		–0.5	7	V
V_I	Input voltage(2)		–0.5	7	V
V_O	Output voltage(2)		–0.5	V_{CC} + 0.5	V
I_{IK}	Input clamp current	(V_I < 0)		–20	mA
I_{OK}	Output clamp current	(V_O < 0 or V_O > V_{CC})		±20	mA
I_O	Continuous output current	(V_O = 0 to V_{CC})		±25	mA
	Continuous current through V_{CC} or GND			±75	mA
T_J	Junction temperature			150	°C
T_{stg}	Storage temperature		–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 and output voltage ratings may be exceeded if the input and output current ratings are observed.

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	±2000	V
		Charged device model (CDM), per JEDEC specification JESD22-C101(2)	±1000	

(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

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

			MIN	NOM	MAX	UNIT
V_{CC}	Supply voltage		2		5.5	V
V_{IH}	High-level input voltage	V_{CC} = 2 V	1.5			V
		V_{CC} = 3 V	2.1			
		V_{CC} = 5.5 V	3.85			
V_{IL}	Low-level Input voltage	V_{CC} = 2 V			0.5	V
		V_{CC} = 3 V			0.9	
		V_{CC} = 5.5 V			1.65	
V_I	Input voltage		0		5.5	V
V_O	Output voltage		0		V_{CC}	V
I_{OH}	High-level output current	V_{CC} = 2 V			–50	µA
		V_{CC} = 3.3 V ± 0.3 V			–4	mA
		V_{CC} = 5 V ± 0.5 V			–8	
I_{OL}	Low-level output current	V_{CC} = 2 V			50	µA
		V_{CC} = 3.3 V ± 0.3 V			4	mA
		V_{CC} = 5 V ± 0.5 V			8	
Δt/Δv	Input transition rise or fall rate	V_{CC} = 3.3 V ± 0.3 V			100	ns/V
		V_{CC} = 5 V ± 0.5 V			20	
T_A	Operating free-air temperature		–40		125	°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*, SCBA004.

6.4 Thermal Information

THERMAL METRIC[1]		SN74AHC595				UNIT
		D (SOIC)	DB (SSOP)	N (PDIP)	PW (TSSOP)	
		16 PINS	16 PINS	16 PINS	16 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	73	97.8	47.8	106.1	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	—	48.1	35.1	40.8	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	—	48.5	27.8	51.1	°C/W
ψ_{JT}	Junction-to-top characterization parameter	—	10.0	20.1	3.8	°C/W
ψ_{JB}	Junction-to-board characterization parameter	—	47.9	27.7	50.6	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, SPRA953.

6.5 Electrical Characteristics

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

PARAMETER	TEST CONDITIONS			V_{CC}	MIN	TYP	MAX	UNIT
V_{OH}	I_{OH} = –50 µA	T_A = 25°C		2 V	1.9	2		V
		T_A = –40°C to 85°C			1.9			
		T_A = –40°C to 125°C Recommended			1.9			
	I_{OH} = –50 µA	T_A = 25°C		3 V	2.9	3		
		T_A = –40°C to 85°C			2.9			
		T_A = –40°C to 125°C Recommended			2.9			
	I_{OH} = –50 µA	T_A = 25°C		4.5 V	4.4	4.5		
		T_A = –40°C to 85°C			4.4			
		T_A = –40°C to 125°C Recommended			4.4			
	I_{OH} = –4 mA	T_A = 25°C		3 V	2.58			
		T_A = –40°C to 85°C			2.48			
		T_A = –40°C to 125°C Recommended			2.48			
	I_{OH} = –8 mA	T_A = 25°C		4.5 V	3.94			
		T_A = –40°C to 85°C			3.8			
		T_A = –40°C to 125°C Recommended			3.8			
V_{OL}	I_{OL} = 50 µA	T_A = 25°C		2 V			0.1	V
		T_A = –40°C to 85°C					0.1	
		T_A = –40°C to 125°C Recommended					0.1	
	I_{OL} = 50 µA	T_A = 25°C		3 V			0.1	
		T_A = –40°C to 85°C					0.1	
		T_A = –40°C to 125°C Recommended					0.1	
	I_{OL} = 50 µA	T_A = 25°C		4.5 V			0.1	
		T_A = –40°C to 85°C					0.1	
		T_A = –40°C to 125°C Recommended					0.1	
	I_{OL} = 4 mA	T_A = 25°C		3 V			0.36	
		T_A = –40°C to 85°C					0.44	
		T_A = –40°C to 125°C Recommended					0.44	
	I_{OL} = 8 mA	T_A = 25°C		4.5 V			0.36	
		T_A = –40°C to 85°C					0.44	
		T_A = –40°C to 125°C Recommended					0.44	
I_I	V_I = 5.5 V or GND	T_A = 25°C		0 V to 5.5 V			±0.1	µA
		T_A = –40°C to 85°C					±1	
		T_A = –40°C to 125°C Recommended					±1	
I_{OZ}	V_I = V_{CC} or GND, V_O = V_{CC} or GND, $\overline{OE}$ = V_{IH} or V_{IL},	Q_A – Q_H	T_A = 25°C	5.5 V			±0.25	µA
			T_A = –40°C to 85°C				±2.5	
			T_A = –40°C to 125°C Recommended				±2.5	

(1) On products compliant to MIL-PRF-38535, this parameter is not production tested at V_{CC} = 0 V.

Electrical Characteristics (continued)

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

PARAMETER	TEST CONDITIONS			V_{CC}	MIN	TYP	MAX	UNIT
I_{CC}	$V_I = V_{CC}$ or GND,	$I_O = 0$	$T_A = 25°C$	5.5 V			4	µA
			$T_A = –40°C$ to 85°C				40	
			$T_A = –40°C$ to 125°C Recommended				40	
C_i	$V_I = V_{CC}$ or GND	$T_A = 25°C$		5 V		3	10	pF
		$T_A = –40°C$ TO 85°C					10	
C_O	$V_O = V_{CC}$ or GND,	$T_A = 25°C$		5 V		5.5		pF

6.6 Operating Characteristics

$V_{CC} = 5$ V, $T_A = 25°C$

PARAMETER		TEST CONDITIONS		TYP	UNIT
C_{pd}	Power dissipation capacitance	No load,	f = 1 MHz	25.2	pF

6.7 Timing Requirements: $V_{CC} = 3.3$ V ± 0.3 V

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

				MIN	MAX	UNIT
t_w	Pulse duration	SRCLK high or low	$T_A = 25°C$	5		ns
			$T_A = –40°C$ to 85°C	5		
			$T_A = –40°C$ to 125°C Recommended	6		
		RCLK high or low	$T_A = 25°C$	5		
			$T_A = –40°C$ to 85°C	5		
			$T_A = –40°C$ to 125°C Recommended	6		
		$\overline{SRCLR}$ low	$T_A = 25°C$	5		
			$T_A = –40°C$ to 85°C	5		
			$T_A = –40°C$ to 125°C Recommended	6.5		
t_{su}	Set-up time	SER before SRCLK↑	$T_A = 25°C$	3.5		ns
			$T_A = –40°C$ to 85°C	3.5		
			$T_A = –40°C$ to 125°C Recommended	4.5		
		SRCLK↑ before RCLK↑ (1)	$T_A = 25°C$	8		
			$T_A = –40°C$ to 85°C	8.5		
			$T_A = –40°C$ to 125°C Recommended	9.5		
		$\overline{SRCLR}$ low before RCLK↑	$T_A = 25°C$	8		
			$T_A = –40°C$ to 85°C	9		
			$T_A = –40°C$ to 125°C Recommended	10		
		$\overline{SRCLR}$ high (inactive) before SRCLK↑	$T_A = 25°C$	3		
			$T_A = –40°C$ to 85°C	3		
			$T_A = –40°C$ to 125°C Recommended	4		
t_h	Hold time	SER after SRCLK↑	$T_A = 25°C$	1.5		ns
			$T_A = –40°C$ to 85°C	1.5		
			$T_A = –40°C$ to 125°C Recommended	2.5		

(1) This set-up time allows the storage register to receive stable data from the shift register. The clocks can be tied together, in which case the shift register is one clock pulse ahead of the storage register.

6.8 Timing Requirements: V_{CC} = 5 V ± 0.5 V

				MIN	NOM	MAX	UNIT
t_w	Pulse duration	SRCLK high or low	T_A = 25°C	5			ns
			T_A = –40°C to 85°C	5			
			T_A = –40°C to 125°C Recommended	6			
		RCLK high or low	T_A = 25°C	5			
			T_A = –40°C to 85°C	5			
			T_A = –40°C to 125°C Recommended	6			
		$\overline{SRCLR}$ low	T_A = 25°C	5			
			T_A = –40°C to 85°C	5			
			T_A = –40°C to 125°C Recommended	6.2			
t_{su}	Set-up time	SER before SRCLK↑	T_A = 25°C	3			ns
			T_A = –40°C to 85°C	3			
			T_A = –40°C to 125°C Recommended	4			
		SRCLK↑ before RCLK↑ (1)	T_A = 25°C	5			
			T_A = –40°C to 85°C	5			
			T_A = –40°C to 125°C Recommended	6			
		$\overline{SRCLR}$ low before RCLK↑	T_A = 25°C	5			
			T_A = –40°C to 85°C	5			
			T_A = –40°C to 125°C Recommended	6			
		$\overline{SRCLR}$ high (inactive) before SRCLK↑	T_A = 25°C	2.5			
			T_A = –40°C to 85°C	2.5			
			T_A = –40°C to 125°C Recommended	3.5			
t_h	Hold time	SER after SRCLK↑	T_A = 25°C	2			ns
			T_A = –40°C to 85°C	2			
			T_A = –40°C to 125°C Recommended	3			

(1) This set-up time allows the storage register to receive stable data from the shift register. The clocks can be tied together, in which case the shift register is one clock pulse ahead of the storage register.

6.9 Switching Characteristics: V_{CC} = 3.3 V ± 0.3 V

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	TEST CONDITIONS	MIN	TYP	MAX	UNIT
f_{max}			C_L = 15 pF	T_A = 25°C	80 (1)	120 (1)		MHz
				T_A = –40°C to 85°C	70			
				T_A = –40°C to 125°C Recommended	60			
			C_L = 50 pF	T_A = 25°C	55	105		
				T_A = –40°C to 85°C	50			
				T_A = –40°C to 125°C Recommended	40			
t_{PLH}	RCLK	Q_A – Q_H	C_L = 15 pF	T_A = 25°C		6 (1)	11.9 (1)	ns
				T_A = –40°C to 85°C	1		13.5	
				T_A = –40°C to 125°C Recommended	1		14.9	
t_{PHL}	RCLK	Q_A – Q_H	C_L = 15 pF	T_A = 25°C		6 (1)	11.9 (1)	ns
				T_A = –40°C to 85°C	1		13.5	
				T_A = –40°C to 125°C Recommended	1		14.9	
t_{PLH}	SRCLK	$Q_{H'}$	C_L = 15 pF	T_A = 25°C		6.6 (1)	13 (1)	ns
				T_A = –40°C to 85°C	1		15	
				T_A = –40°C to 125°C Recommended	1		16.4	
t_{PHL}	SRCLK	$Q_{H'}$	C_L = 15 pF	T_A = 25°C		6.6 (1)	13 (1)	ns
				T_A = –40°C to 85°C	1		15	
				T_A = –40°C to 125°C Recommended	1		16.4	

(1) On products compliant to MIL-PRF-38535, this parameter is not production tested.

Switching Characteristics: V_{CC} = 3.3 V ± 0.3 V (continued)

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

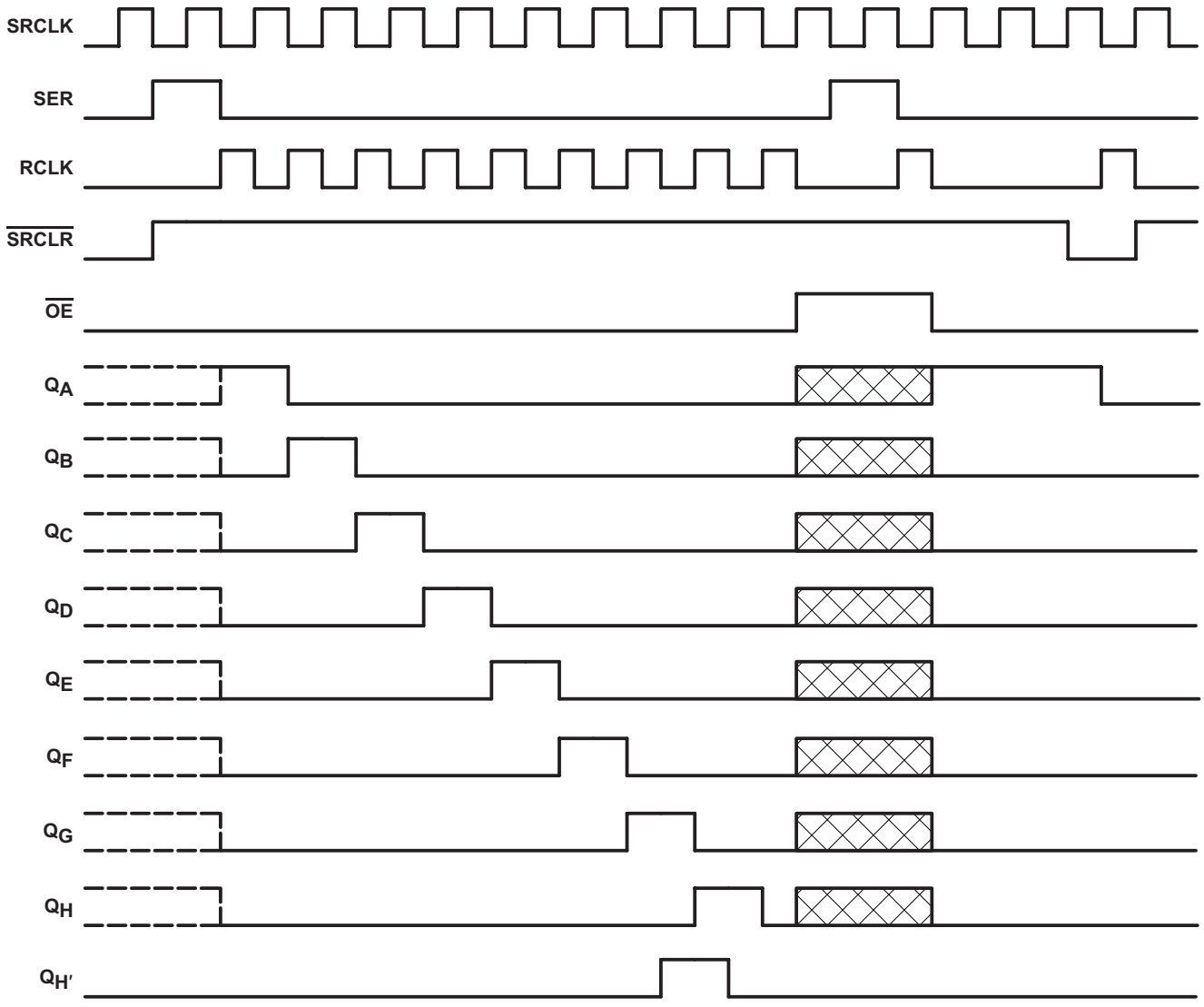
PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PHL}	$\overline{SRCLR}$	$Q_{H'}$	C_L = 15 pF	T_A = 25°C		6.2[1]	12.8[1]	ns
				T_A = –40°C to 85°C	1		13.7	
				T_A = –40°C to 125°C Recommended	1		15	
t_{PZH}	$\overline{OE}$	Q_A – Q_H	C_L = 15 pF	T_A = 25°C		6[1]	11.5[1]	ns
				T_A = –40°C to 85°C	1		13.5	
				T_A = –40°C to 125°C Recommended	1		14.9	
t_{PZL}	$\overline{OE}$	Q_A – Q_H	C_L = 15 pF	T_A = 25°C		7.8[1]	11.5[1]	ns
				T_A = –40°C to 85°C	1		13.5	
				T_A = –40°C to 125°C Recommended	1		14.9	
t_{PLH}	RCLK	Q_A – Q_H	C_L = 50 pF	T_A = 25°C		7.9	15.4	ns
				T_A = –40°C to 85°C	1		17	
				T_A = –40°C to 125°C Recommended	1		18.6	
t_{PHL}	RCLK	Q_A – Q_H	C_L = 50 pF	T_A = 25°C		7.9	15.4	ns
				T_A = –40°C to 85°C	1		17	
				T_A = –40°C to 125°C Recommended	1		18.6	
t_{PLH}	SRCLK	$Q_{H'}$	C_L = 50 pF	T_A = 25°C		9.2	16.5	ns
				T_A = –40°C to 85°C	1		18.5	
				T_A = –40°C to 125°C Recommended	1		20	
t_{PHL}	SRCLK	$Q_{H'}$	C_L = 50 pF	T_A = 25°C		9.2	16.5	ns
				T_A = –40°C to 85°C	1		18.5	
				T_A = –40°C to 125°C Recommended	1		20	
t_{PHL}	$\overline{SRCLR}$	$Q_{H'}$	C_L = 50 pF	T_A = 25°C		9	16.3	ns
				T_A = –40°C to 85°C	1		17.2	
				T_A = –40°C to 125°C Recommended	1		18.7	
t_{PZH}	$\overline{OE}$	Q_A – Q_H	C_L = 50 pF	T_A = 25°C		7.8	15	ns
				T_A = –40°C to 85°C	1		17	
				T_A = –40°C to 125°C Recommended	1		18.6	
t_{PZL}	$\overline{OE}$	Q_A – Q_H	C_L = 50 pF	T_A = 25°C		9.6	15	ns
				T_A = –40°C to 85°C	1		17	
				T_A = –40°C to 125°C Recommended	1		18.6	
t_{PHZ}	$\overline{OE}$	Q_A – Q_H	C_L = 50 pF	T_A = 25°C		8.1	15.7	ns
				T_A = –40°C to 85°C	1		16.2	
				T_A = –40°C to 125°C Recommended	1		17.4	
t_{PLZ}	$\overline{OE}$	Q_A – Q_H	C_L = 50 pF	T_A = 25°C		9.3	15.7	ns
				T_A = –40°C to 85°C	1		16.2	
				T_A = –40°C to 125°C Recommended	1		17.4	

6.10 Switching Characteristics: V_{CC} = 5 V ± 0.5 V

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	TEST CONDITIONS	MIN	TYP	MAX	UNIT
f_{max}			C_L = 15 pF	T_A = 25°C	135(1)	170(1)		MHz
				T_A = –40°C to 85°C	115			
			C_L = 50 pF	T_A = 25°C	95	140		
				T_A = –40°C to 85°C	85			
t_{PLH}	RCLK	Q_A – Q_H	C_L = 15 pF	T_A = 25°C		4.3(1)	7.4(1)	ns
				T_A = –40°C to 85°C	1		8.5	
t_{PHL}	RCLK	Q_A – Q_H	C_L = 15 pF	T_A = 25°C		4.3(1)	7.4(1)	ns
				T_A = –40°C to 85°C	1		8.5	
t_{PLH}	SRCLK	$Q_{H'}$	C_L = 15 pF	T_A = 25°C		4.5(1)	8.2(1)	ns
				T_A = –40°C to 85°C	1		9.4	
t_{PHL}	SRCLK	$Q_{H'}$	C_L = 15 pF	T_A = 25°C		4.5(1)	8.2(1)	ns
				T_A = –40°C to 85°C	1		9.4	
t_{PHL}	$\overline{SRCLR}$	$Q_{H'}$	C_L = 15 pF	T_A = 25°C		4.5(1)	8(1)	ns
				T_A = –40°C to 85°C	1		9.1	
t_{PZH}	$\overline{OE}$	Q_A – Q_H	C_L = 15 pF	T_A = 25°C		4.3(1)	8.6(1)	ns
				T_A = –40°C to 85°C	1		10	
t_{PZL}	$\overline{OE}$	Q_A – Q_H	C_L = 15 pF	T_A = 25°C		5.4(1)	8.6(1)	ns
				T_A = –40°C to 85°C	1		10	
t_{PLH}	RCLK	Q_A – Q_H	C_L = 50 pF	T_A = 25°C		5.6	9.4	ns
				T_A = –40°C to 85°C	1		10.5	
t_{PHL}	RCLK	Q_A – Q_H	C_L = 50 pF	T_A = 25°C		5.6	9.4	ns
				T_A = –40°C to 85°C	1		10.5	
t_{PLH}	SRCLK	$Q_{H'}$	C_L = 50 pF	T_A = 25°C		6.4	10.2	ns
				T_A = –40°C to 85°C	1		11.4	
t_{PHL}	SRCLK	$Q_{H'}$	C_L = 50 pF	T_A = 25°C		6.4	10.2	ns
				T_A = –40°C to 85°C	1		11.4	
t_{PHL}	$\overline{SRCLR}$	$Q_{H'}$	C_L = 50 pF	T_A = 25°C		6.4	10	ns
				T_A = –40°C to 85°C	1		11.1	
t_{PZH}	$\overline{OE}$	Q_A – Q_H	C_L = 50 pF	T_A = 25°C		5.7	10.6	ns
				T_A = –40°C to 85°C	1		12	
t_{PZL}	$\overline{OE}$	Q_A – Q_H	C_L = 50 pF	T_A = 25°C		6.8	10.6	ns
				T_A = –40°C to 85°C	1		12	
t_{PHZ}	$\overline{OE}$	Q_A – Q_H	C_L = 50 pF	T_A = 25°C		3.5	10.3	ns
				T_A = –40°C to 85°C	1		11	
t_{PLZ}	$\overline{OE}$	Q_A – Q_H	C_L = 50 pF	T_A = 25°C		3.4	10.3	ns
				T_A = –40°C to 85°C	1		11	

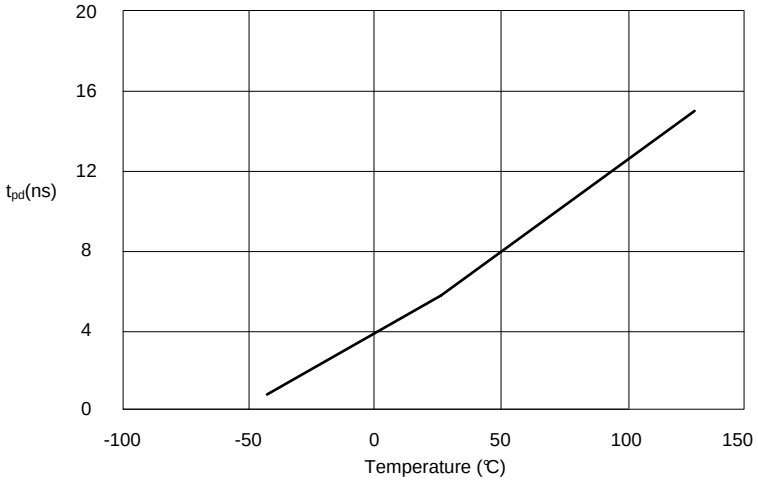
(1) On products compliant to MIL-PRF-38535, this parameter is not production tested.



NOTE: ⊠ implies that the output is in 3-State mode.

Figure 1. Timing Diagram

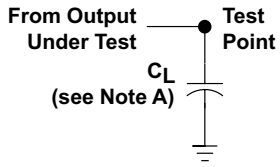
6.11 Typical Characteristics



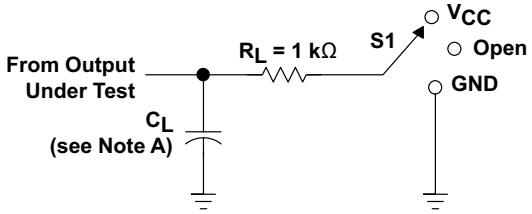
V_{CC} = 3.3 V 15-pF Load

Figure 2. SN74AHC595 RCLK to Q TPD vs Temperature

7 Parameter Measurement Information

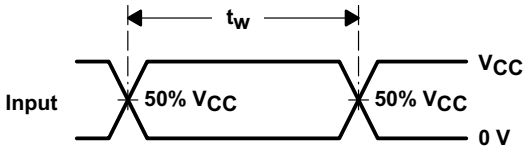


LOAD CIRCUIT FOR
TOTEM-POLE OUTPUTS

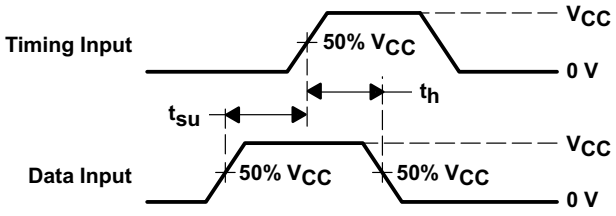


LOAD CIRCUIT FOR
3-STATE AND OPEN-DRAIN OUTPUTS

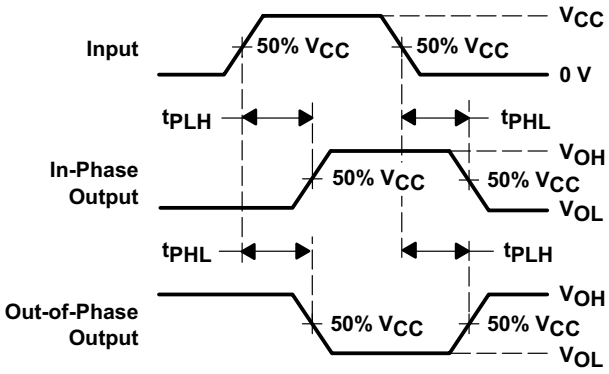
TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	V_{CC}
t_{PHZ}/t_{PZH}	GND
Open Drain	V_{CC}



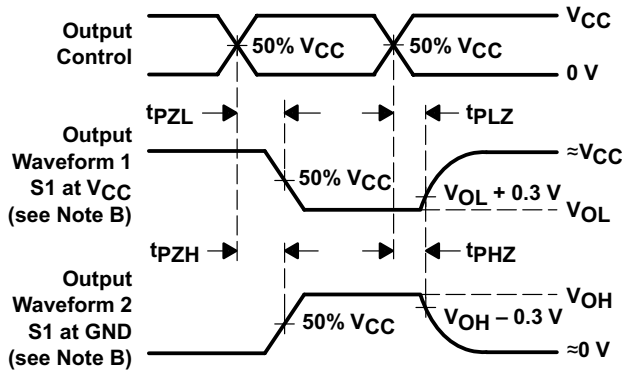
VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
INVERTING AND NONINVERTING OUTPUTS



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES
LOW- AND HIGH-LEVEL ENABLING

A. C_L includes probe and jig capacitance.

B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control.
Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.

C. All input pulses are supplied by generators having the following characteristics: PRR ≤ 1 MHz, Z_O = 50 Ω, t_r ≤ 3 ns, t_f ≤ 3 ns.

D. The outputs are measured one at a time with one input transition per measurement.

E. All parameters and waveforms are not applicable to all devices.

Figure 3. Load Circuit and Voltage Waveforms

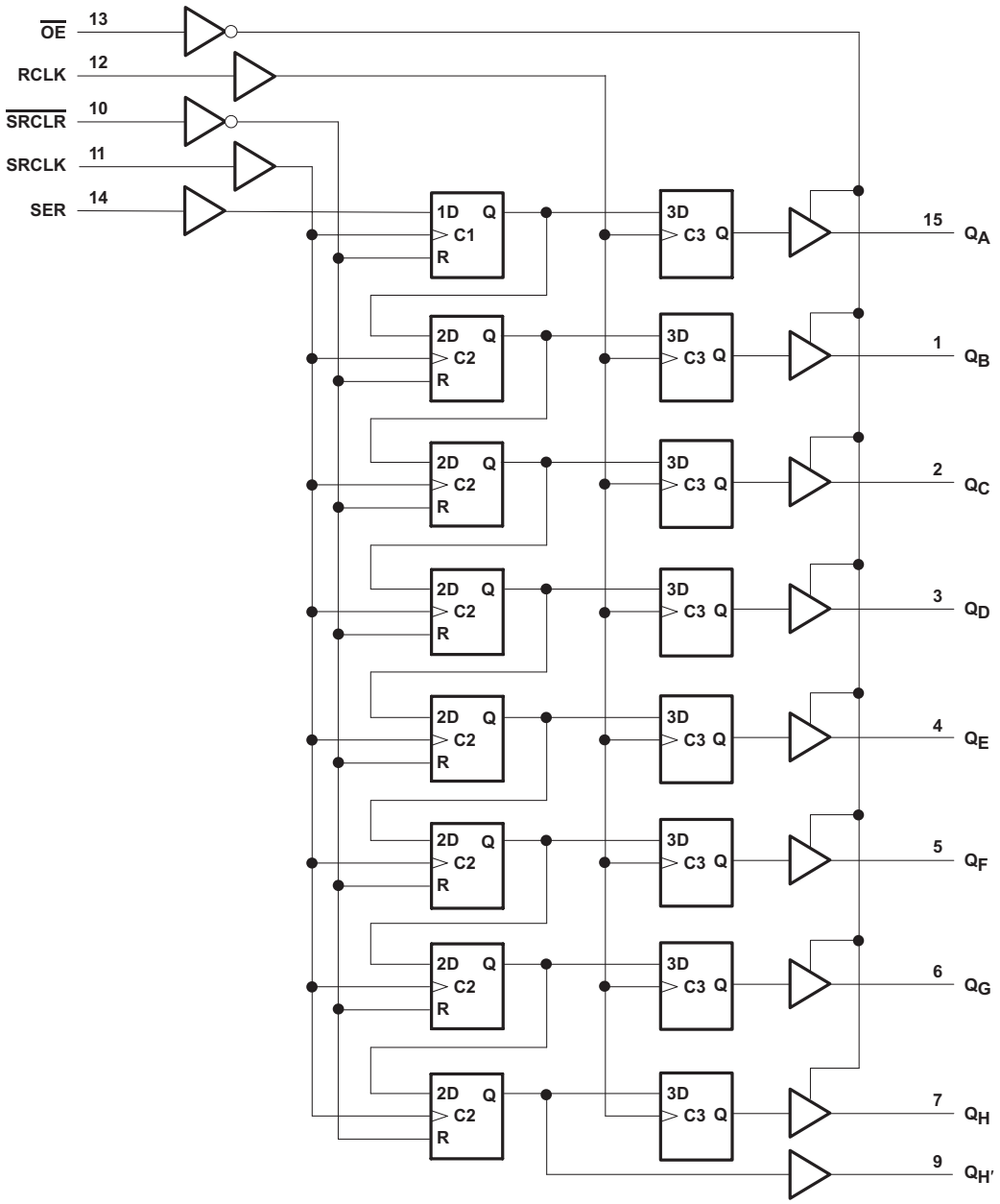
8 Detailed Description

8.1 Overview

The SN74AHC595 device is part of the AHC family of logic devices intended for CMOS applications. The SN74HC595 device is an 8-bit shift register that feeds an 8-bit D-type storage register.

Both the shift-register clock (SRCLK) and storage-register clock (RCLK) are positive-edge triggered. If both clocks are connected together, the shift register is always one clock pulse ahead of the storage register.

8.2 Functional Block Diagram



8.3 Feature Description

The SN74AHC595 device is an 8-bit serial-in, parallel-out shift registers that have a wide operating voltage range from 2 V to 5.5 V and a low current consumption of 40-µA (max) I_{CC}.

8.4 Device Functional Modes

Table 1. Function Table

INPUTS					FUNCTION
SER	SRCLK	$\overline{SRCLR}$	RCLK	$\overline{OE}$	
X	X	X	X	H	Outputs Q_A–Q_H are disabled.
X	X	X	X	L	Outputs Q_A–Q_H are enabled.
X	X	L	X	X	Shift register is cleared.
L	↑	H	X	X	First stage of the shift register goes low. Other stages store the data of previous stage, respectively.
H	↑	H	X	X	First stage of the shift register goes high. Other stages store the data of previous stage, respectively.
X	X	X	↑	X	Shift-register data is stored into the storage register.

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

The SN74AHC595 device is a low-drive CMOS device that can be used for a multitude of bus-interface type applications where output ringing is a concern. The low drive and slow edge rates minimize overshoot and undershoot on the outputs. Figure 4 shows an application where eight LEDs are used to visualize the data bits contained within the shift register.

9.2 Typical Application

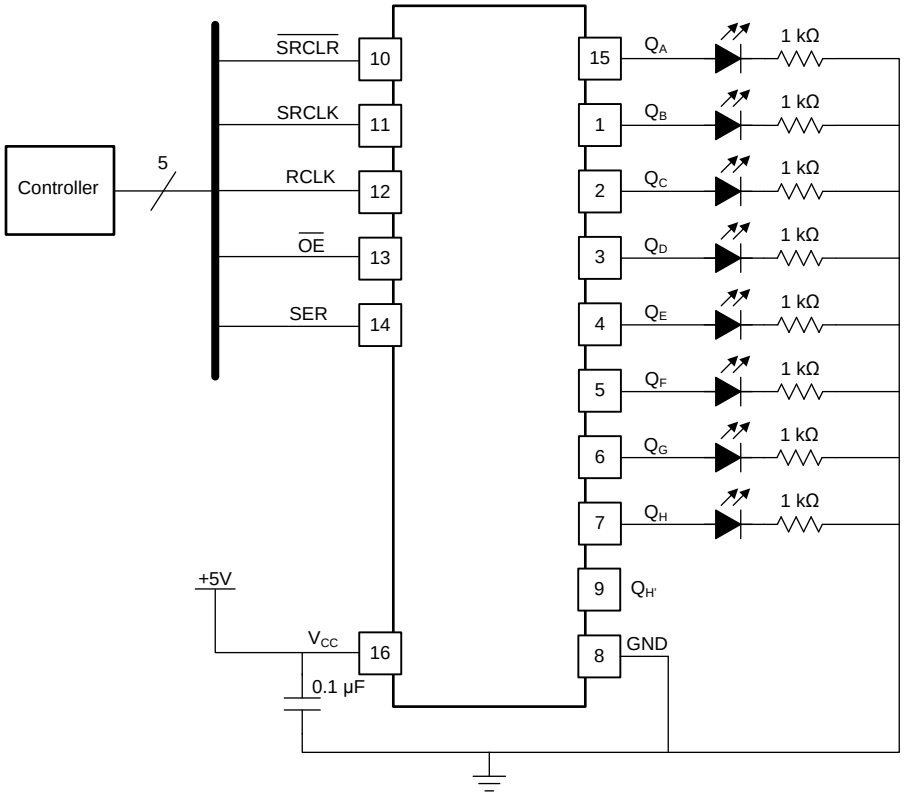


Figure 4. Shift Register Display of 8 bits

9.2.1 Design Requirements

This device uses CMOS technology and has balanced output drive. Care must be taken to avoid bus contention because it can drive currents that would exceed maximum limits. The high drive will also create fast edges into light loads, so routing and load conditions must be considered to prevent ringing.

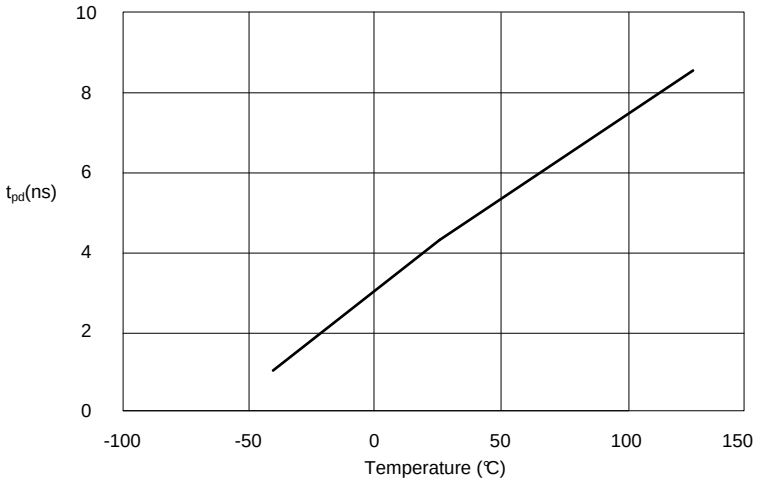
9.2.2 Detailed Design Procedure

- Recommended input conditions:
  - Specified high and low levels. See (V_{IH} and V_{IL}) in the *Recommended Operating Conditions* table.
  - Specified high and low levels. See (V_{IH} and V_{IL}) in the *Recommended Operating Conditions* table.
  - Inputs are overvoltage tolerant allowing them to go as high as 6.0 V at any valid V_{CC}

Typical Application (continued)

- Recommend output conditions:
  - Load currents must not exceed 25 mA per output and 75 mA total for the part
  - Outputs must not be pulled above V_{CC}

9.2.3 Application Curve



V_{CC} = 5 V 15-pF Load

Figure 5. SN74AHC595 RCLK to Q TPD vs Temperature

10 Power Supply Recommendations

The power supply can be any voltage between the MIN and MAX supply-voltage rating located in the *Recommended Operating Conditions* table.

Each V_{CC} pin must have a good bypass capacitor to prevent power disturbance. For devices with a single supply, 0.1-µf capacitor is recommended; if there are multiple V_{CC} pins, then a 0.01-µf or a 0.022-µf capacitor is recommended for each power pin. It is acceptable to parallel multiple bypass capacitors to reject different frequencies of noise. A 0.1-µf and a 1-µf capacitor are commonly used in parallel. The bypass capacitor must be installed as close to the power pin as possible for best results.

11 Layout

11.1 Layout Guidelines

When using multiple-bit logic devices, inputs must never float.

In many cases, functions or parts of functions of digital logic devices are unused, for example, when only two inputs of a triple-input AND gate are used or only 3 of the 4 buffer gates are used. Such input pins must **not** be left unconnected because the undefined voltages at the outside connections results in undefined operational states. Figure 6 specifies the rules that must be observed under all circumstances. All unused inputs of digital logic devices must be connected to a high or low bias to prevent them from floating. The logic level that must be applied to any particular unused input depends on the function of the device. Generally, these unused inputs will be tied to GND or V_{CC}, whichever makes more sense or is more convenient. It is generally acceptable to float outputs, unless the part is a transceiver. If the transceiver has an output-enable pin, it will disable the output section of the part when asserted. This will not disable the input section of the I/Os, so they cannot float when disabled.

11.2 Layout Example

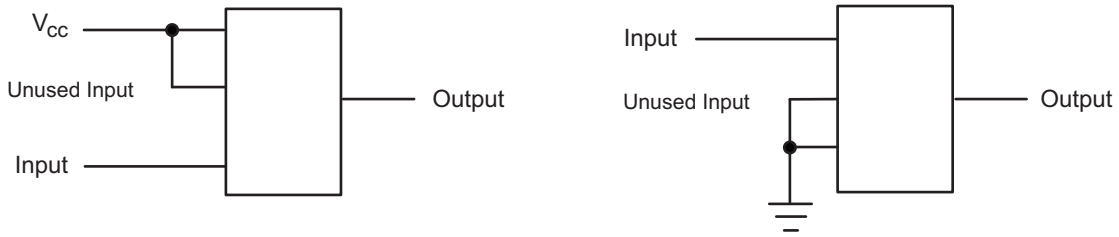


Figure 6. Layout Diagram

12 Device and Documentation Support

12.1 Documentation Support

12.1.1 Related Documentation

For related documentation, wee the following:

Implications of Slow or Floating CMOS Inputs, SCBA004

12.2 Community Resources

The following links connect to TI community resources. Linked contents are 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.

TI E2E™ Online Community ***TI's Engineer-to-Engineer (E2E) Community.*** Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support ***TI's Design Support*** Quickly find helpful E2E forums along with design support tools and contact information for technical support.

12.3 Trademarks

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

12.4 Electrostatic Discharge Caution

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

12.5 Glossary

SLYZ022 — *TI Glossary*.

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

13 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
SN74AHC595DBR	ACTIVE	SSOP	DB	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	HA595	Samples
SN74AHC595DR	ACTIVE	SOIC	D	16	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	AHC595	Samples
SN74AHC595DRE4	LIFEBUY	SOIC	D	16	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	AHC595	
SN74AHC595N	ACTIVE	PDIP	N	16	25	RoHS & Green	NIPDAU	N / A for Pkg Type	-40 to 125	SN74AHC595N	Samples
SN74AHC595PWR	ACTIVE	TSSOP	PW	16	2000	RoHS & Green	NIPDAU | SN	Level-1-260C-UNLIM	-40 to 125	HA595	Samples
SN74AHC595PWRG4	ACTIVE	TSSOP	PW	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	HA595	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.

OTHER QUALIFIED VERSIONS OF SN74AHC595 :

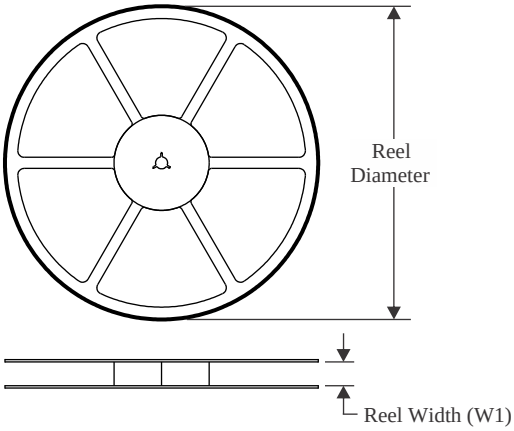
- Automotive : SN74AHC595-Q1

NOTE: Qualified Version Definitions:

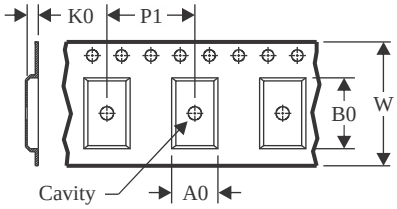
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

TAPE AND REEL INFORMATION

REEL DIMENSIONS

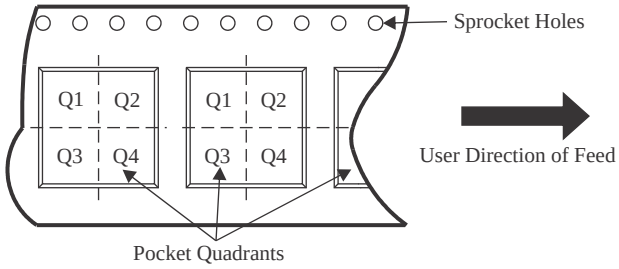


TAPE DIMENSIONS



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

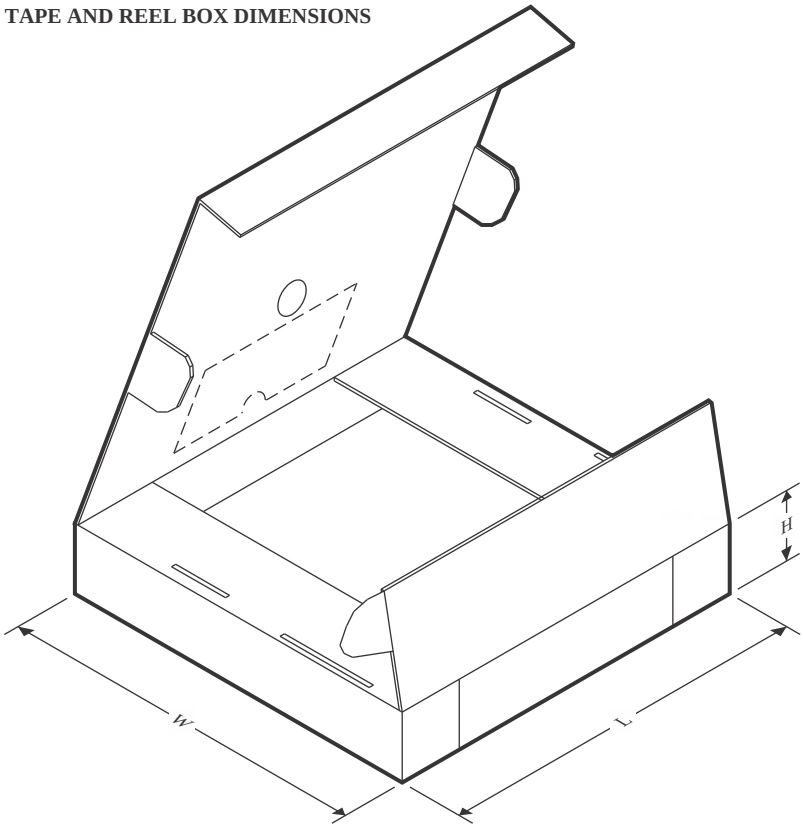
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
SN74AHC595DBR	SSOP	DB	16	2000	330.0	16.4	8.35	6.6	2.4	12.0	16.0	Q1
SN74AHC595DR	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
SN74AHC595PWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
SN74AHC595PWRG4	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1

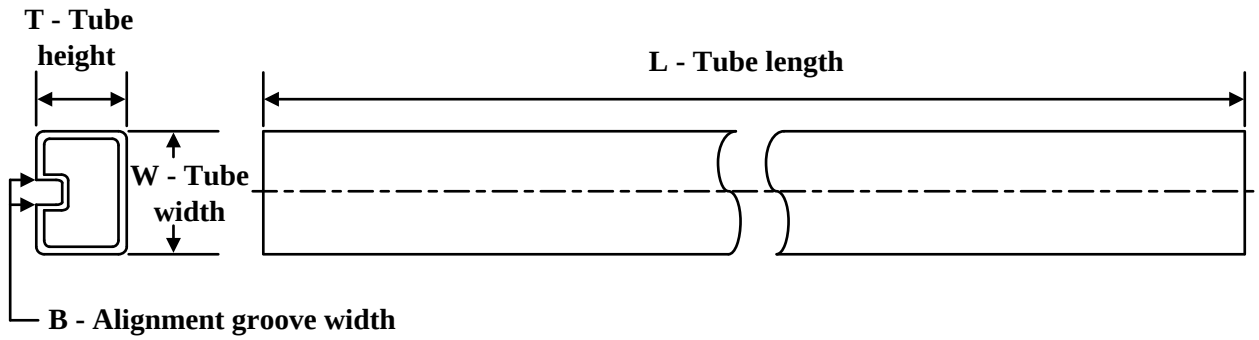
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74AHC595DBR	SSOP	DB	16	2000	356.0	356.0	35.0
SN74AHC595DR	SOIC	D	16	2500	340.5	336.1	32.0
SN74AHC595PWR	TSSOP	PW	16	2000	356.0	356.0	35.0
SN74AHC595PWRG4	TSSOP	PW	16	2000	367.0	367.0	35.0

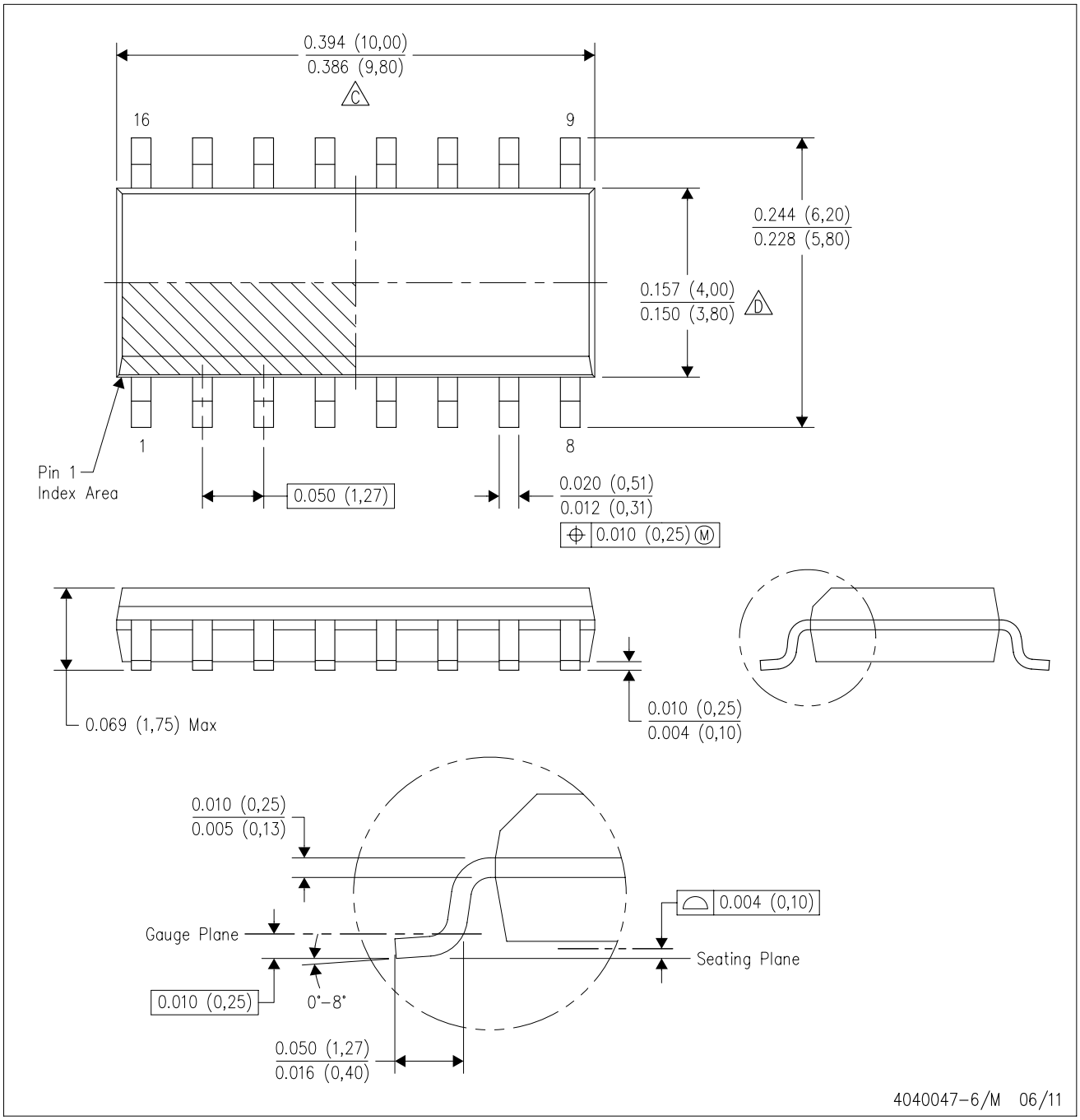
TUBE



*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
SN74AHC595N	N	PDIP	16	25	506	13.97	11230	4.32
SN74AHC595N	N	PDIP	16	25	506	13.97	11230	4.32

D (R–PDSO–G16) PLASTIC SMALL OUTLINE



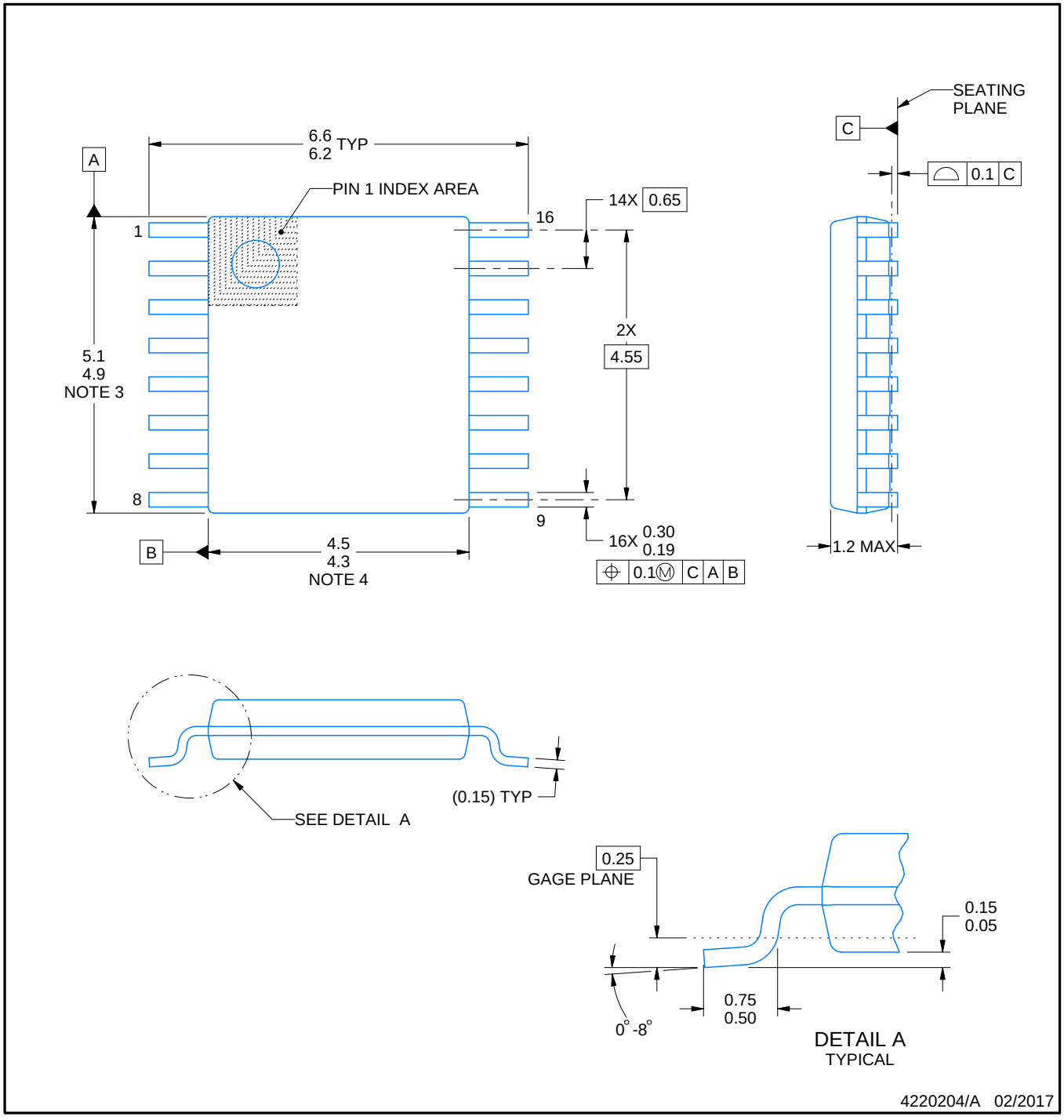
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
E. Reference JEDEC MS–012 variation AC.

PACKAGE OUTLINE

PW0016A

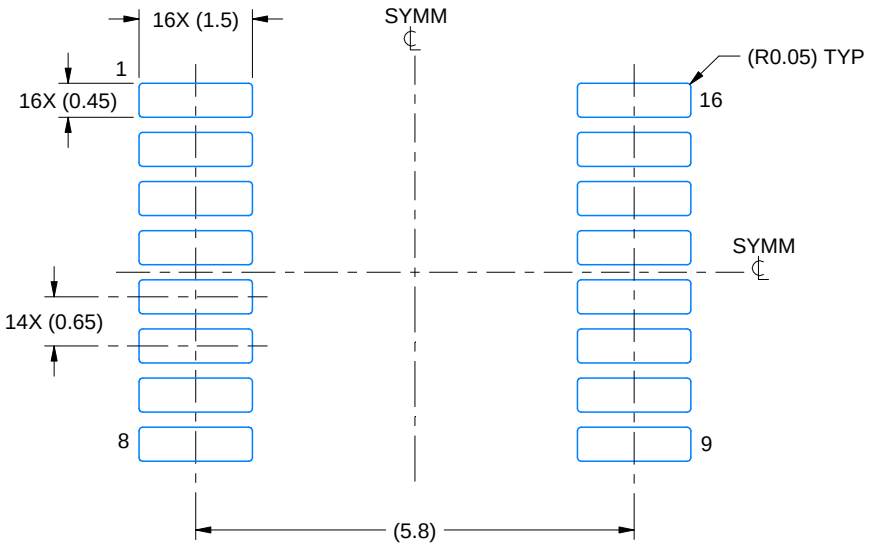
TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X

SOLDER MASK DETAILS

4220204/A 02/2017

NOTES: (continued)

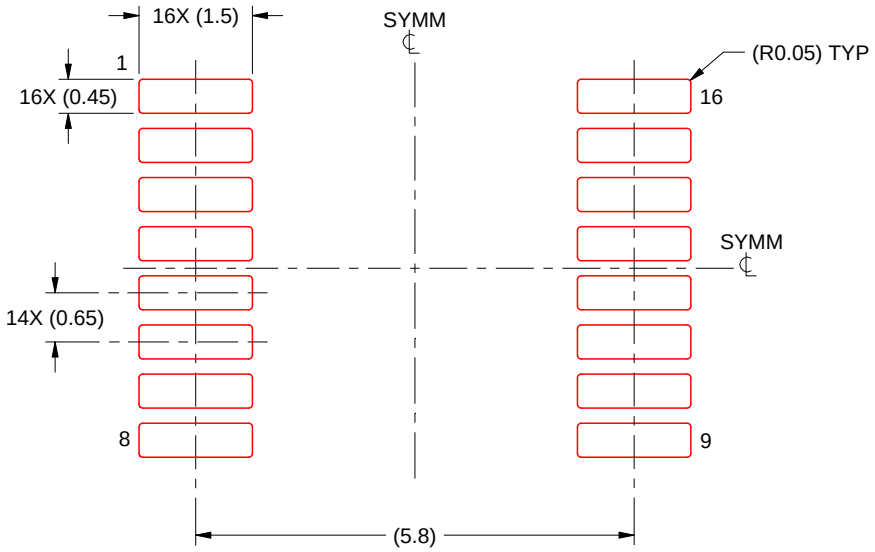
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



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

4220204/A 02/2017

NOTES: (continued)

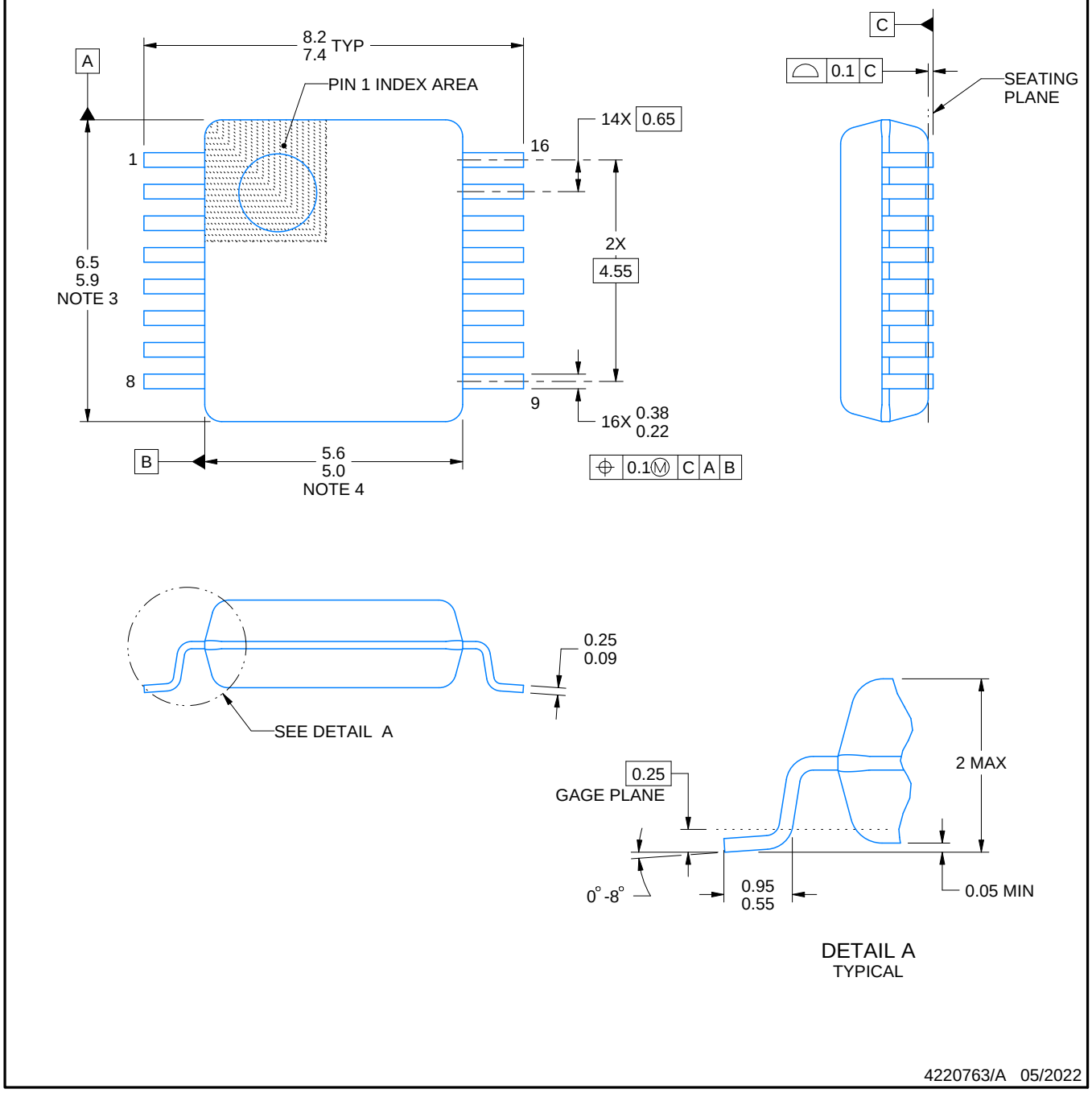
8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

PACKAGE OUTLINE

DB0016A

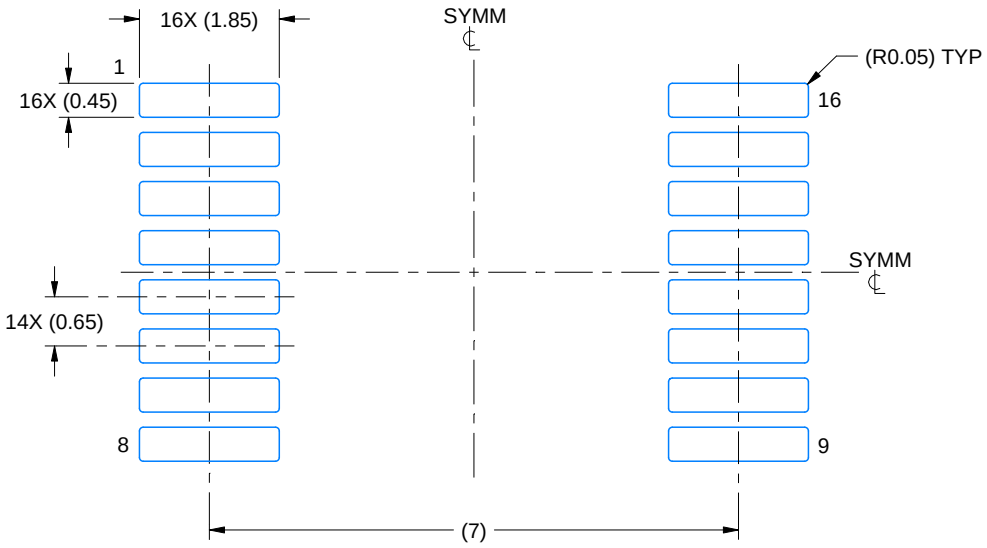
SSOP - 2 mm max height

SMALL OUTLINE PACKAGE

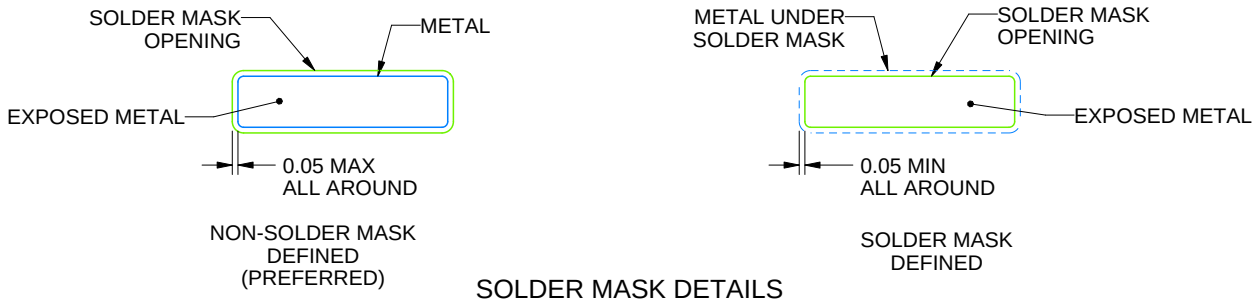


NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. Reference JEDEC registration MO-150.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X



SOLDER MASK DETAILS

4220763/A 05/2022

NOTES: (continued)

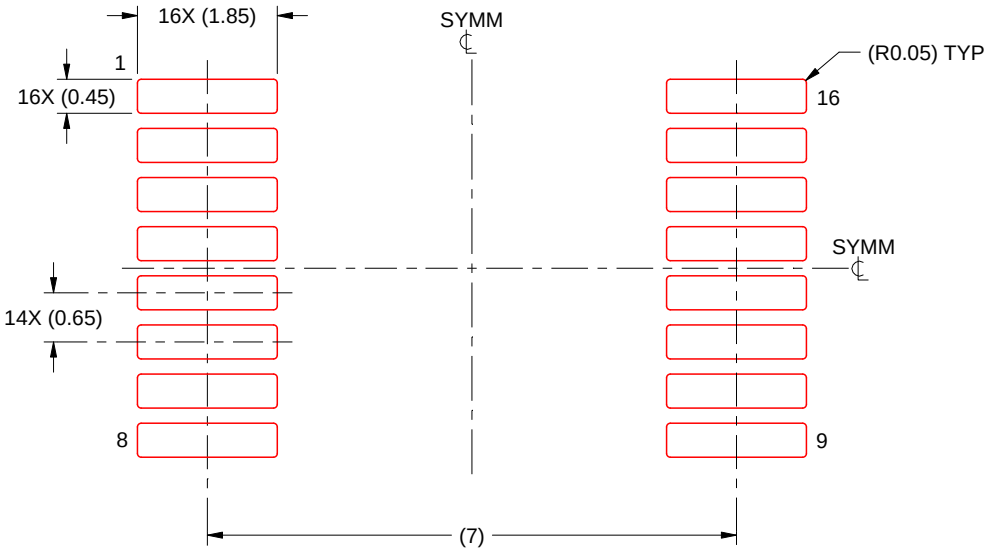
5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DB0016A

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



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

4220763/A 05/2022

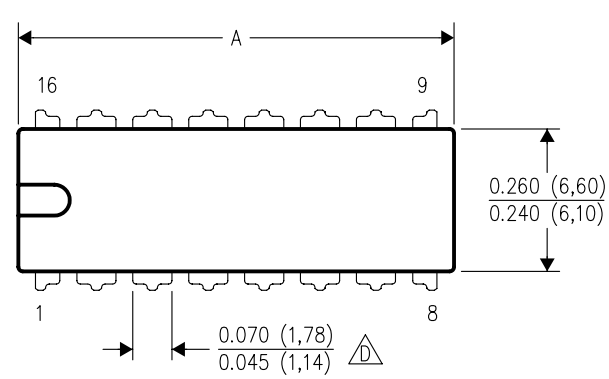
NOTES: (continued)

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

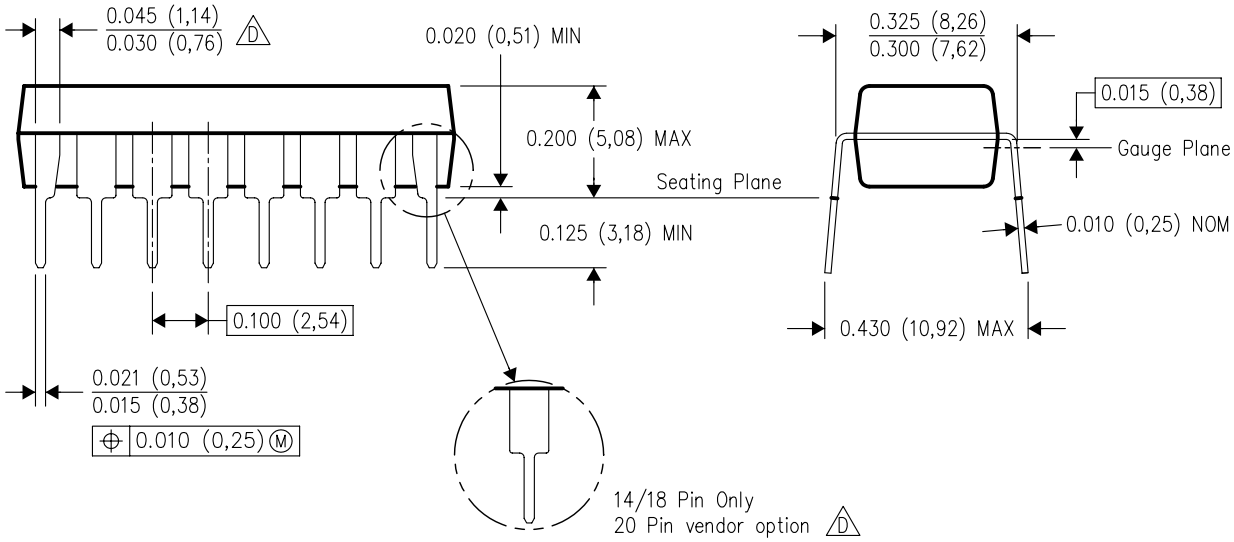
N (R–PDIP–T**)

PLASTIC DUAL–IN–LINE PACKAGE

16 PINS SHOWN



DIM \ PINS **	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	1.060 (26,92)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)
MS–001 VARIATION (C)	AA	BB	AC	AD



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NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001, except 18 and 20 pin minimum body length (Dim A).
D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

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