

# SN54LS592, SN54LS593, SN74LS592, SN74LS593 8-BIT BINARY COUNTERS WITH INPUT REGISTERS

SDLS004

D2633, JANUARY 1981 — REVISED MARCH 1988

- Parallel Register Inputs ('LS592)
- Parallel 3-State I/O: Register Inputs/Counter Outputs ('LS593)
- Counter has Direct Overriding Load and Clear
- Accurate Counter Frequency: DC to 20 MHz

## description

The 'LS592 comes in a 16-pin package and consists of a parallel input, 8-bit storage register feeding an 8-bit binary counter. Both the register and the counter have individual positive-edge-triggered clocks. In addition, the counter has direct load and clear functions. A low-going  $\overline{RCO}$  pulse will be obtained when the counter reaches the hex word FF. Expansion is easily accomplished for two stages by connecting  $\overline{RCO}$  of the first stage to  $\overline{CCKEN}$  of the second stage. Cascading for larger count chains can be accomplished by connecting  $\overline{RCO}$  of each stage to CCK of the following stage.

The 'LS593 comes in a 20-pin package and has all the features of the 'LS592 plus 3-state I/O, which provides parallel counter outputs. The tables below show the operation of the enable (CCKEN,  $\overline{CCKEN}$ ) inputs. A register clock enable (RCKEN) is also provided.

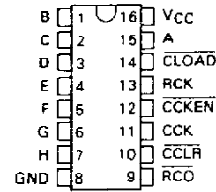
### OUTPUT ENABLE CONTROL ('593 ONLY)

G	$\overline{G}$	A/Q <sub>A</sub> thru H/Q <sub>H</sub>
L	L	input mode
L	H	input mode
H	L	output mode
H	H	input mode

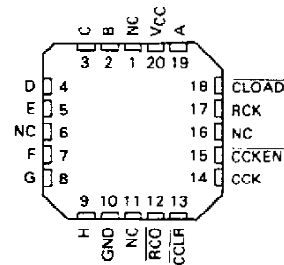
### COUNTER CLOCK ENABLE CONTROL

CCKEN	$\overline{CCKEN}$	EFFECT ON CCK
L	L	Enable
L	H	Disable
H	L	Enable
H	H	Enable

### SN54LS592 . . . J OR W PACKAGE SN74LS592 . . . N PACKAGE (TOP VIEW)

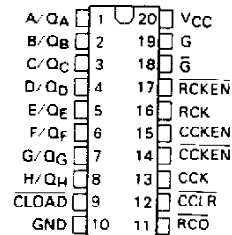


### SN54LS592 . . . FK PACKAGE (TOP VIEW)

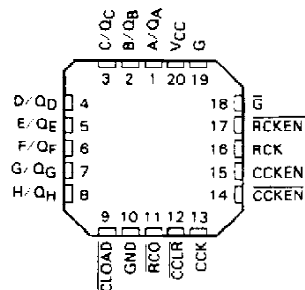


NC — No internal connection

### SN54LS593 . . . J OR W PACKAGE SN74LS593 . . . DW OR N PACKAGE (TOP VIEW)



### SN54LS593 . . . FK PACKAGE (TOP VIEW)



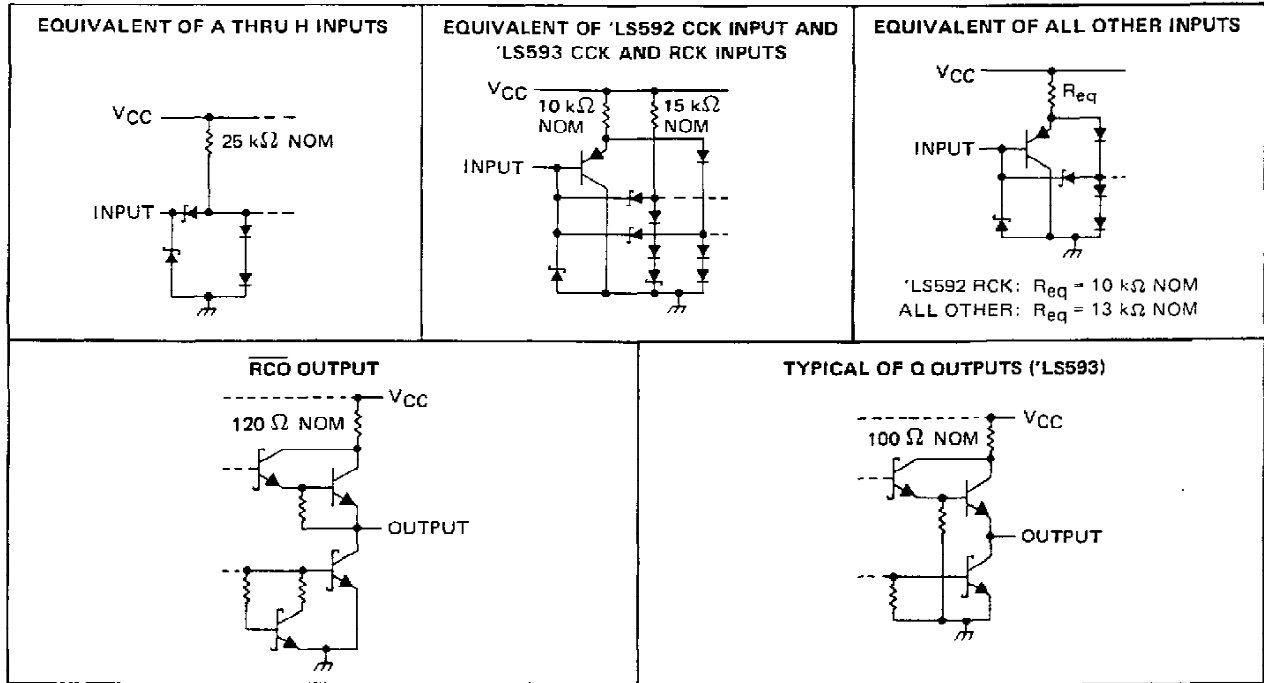
PRODUCTION DATA documents contain information current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

TEXAS  
INSTRUMENTS

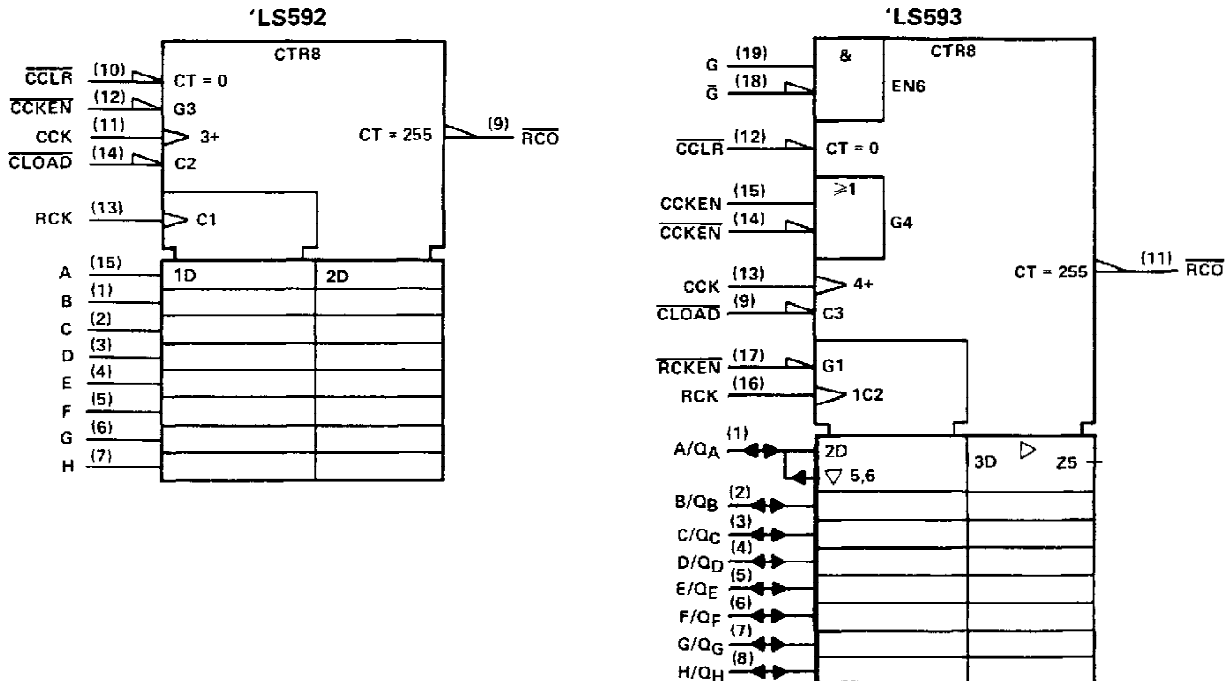
POST OFFICE BOX 655012 • DALLAS, TEXAS 75265

# SN54LS592, SN54LS593, SN74LS592, SN74LS593 8-BIT BINARY COUNTERS WITH INPUT REGISTERS

## schematics of inputs and outputs



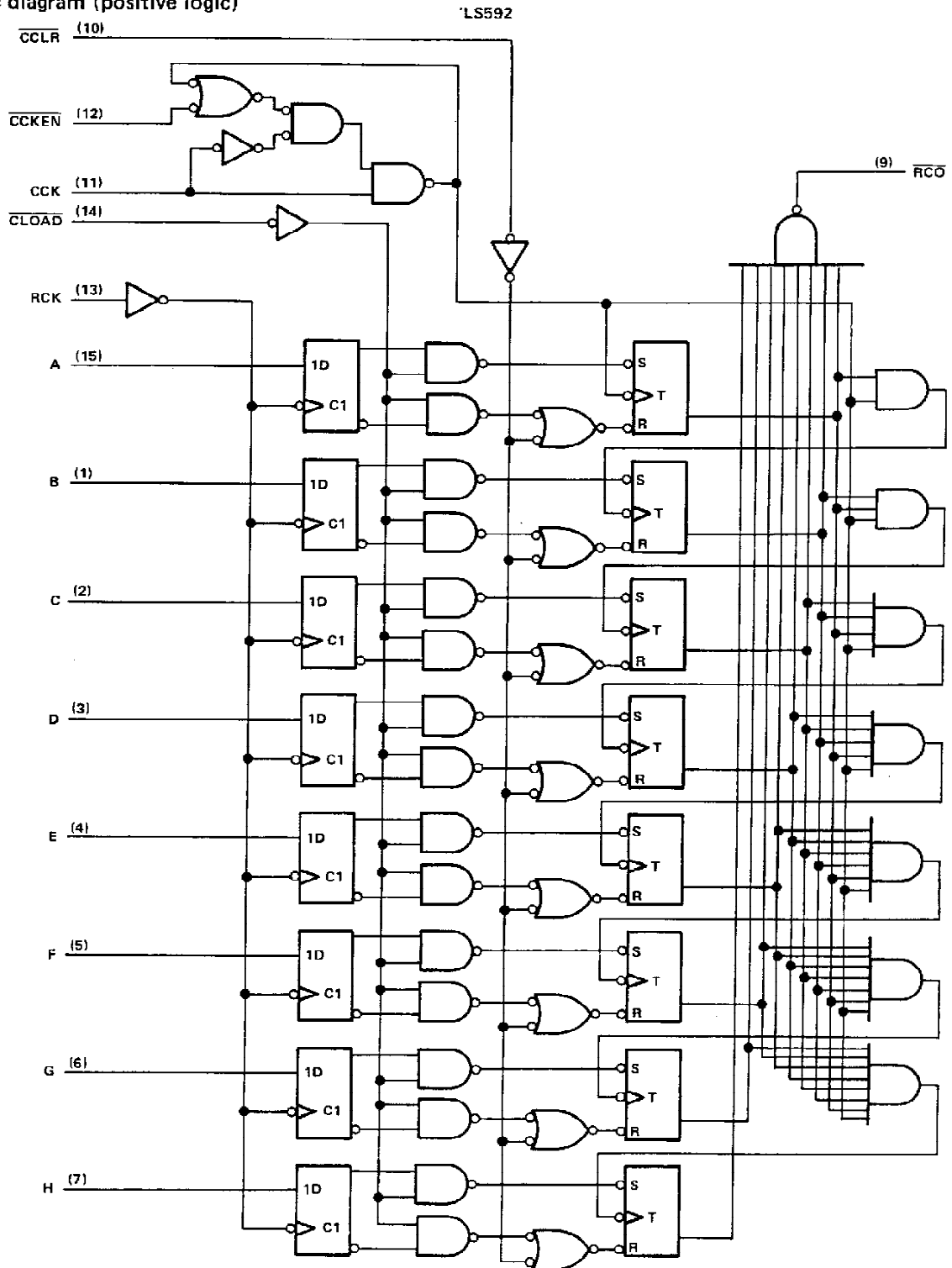
## logic symbols †



† These symbols are in accordance with ANSI/IEEE Std. 91-1984 and IEC Publication 617-12. Pin numbers shown are for DW, J, N, and W packages.

# SN54LS592, SN74LS592 8-BIT BINARY COUNTERS WITH INPUT REGISTERS

logic diagram (positive logic)

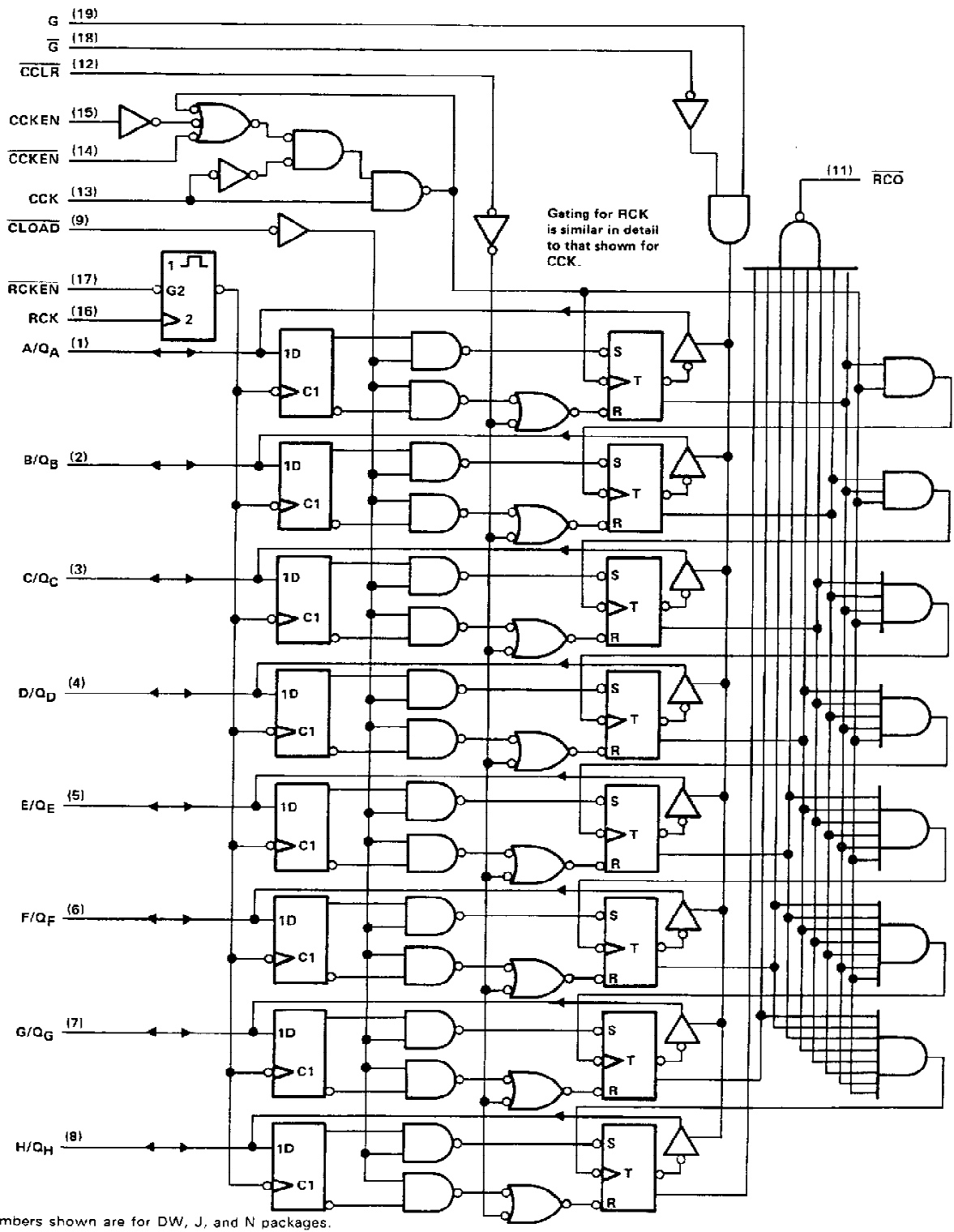


Pin numbers shown are for J, N, and W packages.

# SN54LS593, SN74LS593 8-BIT BINARY COUNTERS WITH INPUT REGISTERS

logic diagram (positive logic)

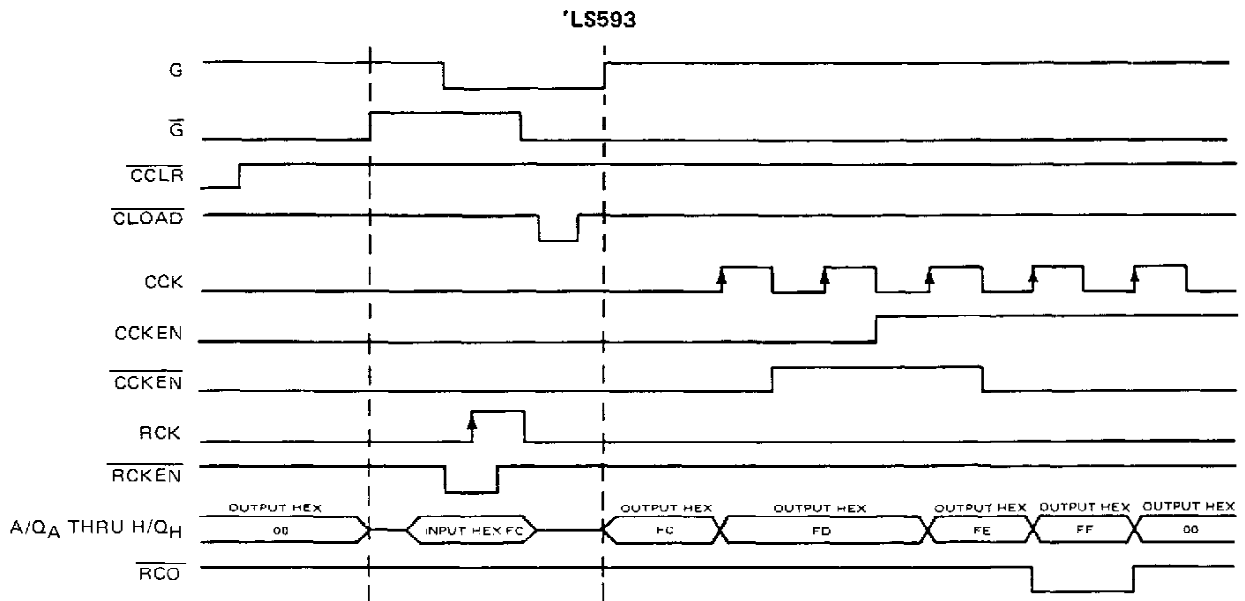
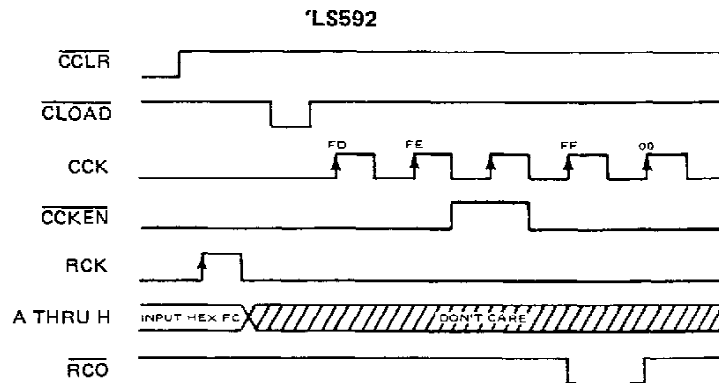
'LS593



Pin numbers shown are for DW, J, and N packages.

**SN54LS592, SN54LS593, SN74LS592, SN74LS593  
8-BIT BINARY COUNTERS WITH INPUT REGISTERS**

**typical operating sequences**



# SN54LS592, SN54LS593, SN74LS592, SN74LS593

## 8-BIT BINARY COUNTERS WITH INPUT REGISTERS

### absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, $V_{CC}$ (see Note 1)	7 V
Input voltage (excluding I/O ports)	7 V
Off-state output voltage (including I/O ports)	5.5 V
Operating free-air temperature range: SN54LS592, SN54LS593	-55°C to 125°C
SN74LS592, SN74LS593	0°C to 70°C
Storage temperature range	-65°C to 150°C

NOTE 1: Voltage values are with respect to the network ground terminal.

### recommended operating conditions

		SN54LS'			SN74LS'			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
$V_{CC}$	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
$V_{IH}$	High-level input voltage	2			2			V
$V_{IL}$	Low-level input voltage			0.7			0.8	V
$I_{OH}$	High-level output current	$\overline{RCK}$		-1	$\overline{RCK}$		-1	mA
		Q 'LS593 only		-1	Q 'LS593 only		-2.6	
$I_{OL}$	Low-level output current	$\overline{RCK}$		8	$\overline{RCK}$		16	mA
		Q 'LS593 only		12	Q 'LS593 only		24	
$f_{CCK}$	Counter clock frequency	0		20	0		20	MHz
$t_w(\overline{CCK})$	Duration of counter clock pulse	25			25			ns
$t_w(\overline{CCLR})$	Duration of counter clear pulse	20			20			ns
$t_w(\overline{RCK})$	Duration of register clock pulse	20			20			ns
$t_w(\overline{CLOAD})$	Duration of counter load pulse	40			40			ns
$t_{su}$	Register enable setup time	$\overline{RCKEN}$ low to $\overline{RCK} \uparrow$ , 'LS593		20	$\overline{RCKEN}$ low to $\overline{RCK} \uparrow$ , 'LS593		20	ns
$t_{su}$	Counter enable setup time before $\overline{CCK} \uparrow$	$\overline{CCKEN}$ low, 'LS592		30	$\overline{CCKEN}$ low, 'LS592		30	ns
		$\overline{CCKEN}$ low or $\overline{CCKEN}$ high, 'LS593		30	$\overline{CCKEN}$ low or $\overline{CCKEN}$ high, 'LS593		30	
		$\overline{CCLR}$ inactive before $\overline{CCK} \uparrow$		20	$\overline{CCLR}$ inactive before $\overline{CCK} \uparrow$		20	
$t_{su}$	Setup time	$\overline{CLOAD}$ inactive before $\overline{CCK} \uparrow$		20	$\overline{CLOAD}$ inactive before $\overline{CCK} \uparrow$		20	ns
		$\overline{RCK} \uparrow$ before $\overline{CLOAD} \uparrow$ (see Note 2)		30	$\overline{RCK} \uparrow$ before $\overline{CLOAD} \uparrow$ (see Note 2)		30	
		Data A thru H before $\overline{RCK} \uparrow$		20	Data A thru H before $\overline{RCK} \uparrow$		20	
		Data A thru H after $\overline{RCK} \uparrow$		0	Data A thru H after $\overline{RCK} \uparrow$		0	
$t_h$	Hold time	Data A thru H after $\overline{RCK} \uparrow$		0	Data A thru H after $\overline{RCK} \uparrow$		0	ns
		All others		0	All others		0	
$T_A$	Operating free-air temperature	-55		125	0		70	°C

NOTE 2: This time insures the data saved by  $\overline{RCK} \uparrow$  will also be loaded into the counter.



POST OFFICE BOX 655012 • DALLAS, TEXAS 75265

## SN54LS592, SN54LS593, SN74LS592, SN74LS593 8-BIT BINARY COUNTERS WITH INPUT REGISTERS

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

PARAMETER	TEST CONDITIONS†	SN54LS*		SN74LS*		UNIT				
		MIN	TYP‡	MAX	MIN		TYP‡	MAX		
$V_{IK}$	$V_{CC} = \text{MIN.}, I_I = -18 \text{ mA}$					V				
$V_{OH}$	'LS593 Q $\overline{RCO}$	$V_{CC} = \text{MIN.}, V_{IH} = 2 \text{ V.}$ $V_{IL} = \text{MAX.}$	$I_{OH} = -1 \text{ mA}$	2.4	3.2		V			
			$I_{OH} = -2.6 \text{ mA}$			2.4		3.1		
			$I_{OH} = -1 \text{ mA}$	2.4	3.2	2.4		3.2		
$V_{OL}$	'LS593 Q $\overline{RCO}$	$V_{CC} = \text{MIN.}, V_{IH} = 2 \text{ V.}$ $V_{IL} = \text{MAX.}$	$I_{OL} = 12 \text{ mA}$			0.25	0.4	V		
			$I_{OL} = 24 \text{ mA}$				0.35		0.5	
			$I_{OL} = 8 \text{ mA}$			0.25	0.4		0.25	0.4
			$I_{OL} = 16 \text{ mA}$				0.35		0.5	
$I_{OZH}$	'LS593 Q	$V_{CC} = \text{MAX.}, V_{IH} = 2 \text{ V.}$ $V_O = 2.7 \text{ V}$				20	$\mu\text{A}$			
$I_{OZL}$	'LS593 Q	$V_{CC} = \text{MAX.}, V_{IH} = 2 \text{ V.}$ $V_O = 0.4 \text{ V}$				-0.4	mA			
$I_I$	'LS593 Q	$V_{CC} = \text{MAX.}$	$V_I = 5.5 \text{ V}$			0.1	0.1	mA		
	Others		$V_I = 7 \text{ V}$			0.1	0.1			
$I_{IH}$		$V_{CC} = \text{MAX.}, V_I = 2.7 \text{ V}$				20	$\mu\text{A}$			
$I_{IL}$	CCK	$V_{CC} = \text{MAX.}, V_I = 0.4 \text{ V}$				-0.8	-0.8	mA		
	RCK		'LS592				-0.2		-0.2	
			'LS593				-0.8		-0.8	
	A thru H						-0.4		-0.4	
	Others						-0.2		-0.2	
$I_{OS}^{\S}$	'LS593 Q	$V_{CC} = \text{MAX.}, V_O = 0 \text{ V}$				-30	-130	mA		
	$\overline{RCO}$					-20	-100			
$I_{CC}$	'LS592	$V_{CC} = \text{MAX.}$ All possible inputs grounded, All outputs open	$I_{CCH}$	40	60	40	60	mA		
			$I_{CCL}$	40	60	40	60			
	'LS593		$I_{CCH}$	47	70	47	70			
			$I_{CCL}$	53	80	53	80			
			$I_{CCZ}$	57	85	57	85			

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡All typical values are at  $V_{CC} = 5 \text{ V.}, T_A = 25^\circ\text{C.}$

§Not more than one output should be shorted at a time and the duration of the short-circuit should not exceed one second.

**TEXAS**  
**INSTRUMENTS**

POS\* OFFICE BOX 655012 • DALLAS, TEXAS 75265

**SN54LS592, SN54LS593, SN74LS592, SN74LS593**  
**8-BIT BINARY COUNTERS WITH INPUT REGISTERS**

switching characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , (see note 3)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'LS592			'LS593			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
$f_{max}$	CCK ↑	$\overline{RCO}$	$R_L = 1\text{ k}\Omega$ , $C_L = 30\text{ pF}$	20	35		20	35		MHz
$t_{PLH}$	CCK ↑	Q	$R_L = 667\ \Omega$ , $C_L = 45\text{ pF}$				14	21		ns
$t_{PHL}$	CCK ↑	Q					26	39		ns
$t_{PLH}$	$\overline{CLOAD}$ ↓	Q					34	51		ns
$t_{PHL}$	$\overline{CLOAD}$ ↓	Q					28	42		ns
$t_{PHL}$	$\overline{CCLR}$ ↓	Q					25	38		ns
$t_{PZH}$	G ↑	Q					31	47		ns
$t_{PZL}$	G ↑	Q					27	40		ns
$t_{PZH}$	$\overline{G}$ ↓	Q					29	45		ns
$t_{PZL}$	$\overline{G}$ ↓	Q					31	47		ns
$t_{PHZ}$	G ↓	Q					33	50		ns
$t_{PLZ}$	G ↓	Q	$R_L = 667\ \Omega$ , $C_L = 5\text{ pF}$				35	52		ns
$t_{PHZ}$	$\overline{G}$ ↑	Q					26	39		ns
$t_{PLZ}$	$\overline{G}$ ↑	Q					28	42		ns
$t_{PLH}$	CCK ↑	$\overline{RCO}$								
$t_{PHL}$	CCK ↑	$\overline{RCO}$	$R_L = 1\text{ k}\Omega$ , $C_L = 30\text{ pF}$	15	23		14	21		ns
$t_{PLH}$	$\overline{CLOAD}$ ↓	$\overline{RCO}$		20	30		20	30		ns
$t_{PHL}$	$\overline{CLOAD}$ ↓	$\overline{RCO}$		31	47		31	47		ns
$t_{PLH}$	$\overline{CCLR}$ ↓	$\overline{RCO}$		27	41		27	41		ns
$t_{PHL}$	$\overline{CCLR}$ ↓	$\overline{RCO}$		30	45		30	45		ns
$t_{PLH}$	RCK ↑	$\overline{RCO}$	$R_L = 1\text{ k}\Omega$ ; $C_L = 30\text{ pF}$ $\overline{CLOAD} = L$	35	53		42	63		ns
$t_{PHL}$	RCK ↑	$\overline{RCO}$		30	45		33	50		ns

NOTE 3: Load circuits and voltage waveforms are shown in Section 1.



**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
5962-8762101EA	ACTIVE	CDIP	J	16	25	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-8762101EA SNJ54LS592J	<a href="#">Samples</a>
5962-8762101FA	ACTIVE	CFP	W	16	25	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-8762101FA SNJ54LS592W	<a href="#">Samples</a>
5962-8762101FA	ACTIVE	CFP	W	16	25	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-8762101FA SNJ54LS592W	<a href="#">Samples</a>
SN54LS592J	ACTIVE	CDIP	J	16	25	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	SN54LS592J	<a href="#">Samples</a>
SN54LS592J	ACTIVE	CDIP	J	16	25	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	SN54LS592J	<a href="#">Samples</a>
SN54LS593J	ACTIVE	CDIP	J	20	20	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	SN54LS593J	<a href="#">Samples</a>
SN54LS593J	ACTIVE	CDIP	J	20	20	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	SN54LS593J	<a href="#">Samples</a>
SN74LS592D	ACTIVE	SOIC	D	16	40	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	LS592	<a href="#">Samples</a>
SN74LS592D	ACTIVE	SOIC	D	16	40	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	LS592	<a href="#">Samples</a>
SN74LS592N	ACTIVE	PDIP	N	16	25	RoHS & Green	NIPDAU	N / A for Pkg Type	0 to 70	SN74LS592N	<a href="#">Samples</a>
SN74LS592N	ACTIVE	PDIP	N	16	25	RoHS & Green	NIPDAU	N / A for Pkg Type	0 to 70	SN74LS592N	<a href="#">Samples</a>
SN74LS592NSR	ACTIVE	SO	NS	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	74LS592	<a href="#">Samples</a>
SN74LS592NSR	ACTIVE	SO	NS	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	74LS592	<a href="#">Samples</a>
SN74LS593DW	LIFEBUY	SOIC	DW	20	25	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	LS593	
SN74LS593DW	LIFEBUY	SOIC	DW	20	25	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	LS593	
SN74LS593DWR	ACTIVE	SOIC	DW	20	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	LS593	<a href="#">Samples</a>
SN74LS593DWR	ACTIVE	SOIC	DW	20	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	LS593	<a href="#">Samples</a>
SN74LS593N	ACTIVE	PDIP	N	20	20	RoHS & Green	NIPDAU	N / A for Pkg Type	0 to 70	SN74LS593N	<a href="#">Samples</a>
SN74LS593N	ACTIVE	PDIP	N	20	20	RoHS & Green	NIPDAU	N / A for Pkg Type	0 to 70	SN74LS593N	<a href="#">Samples</a>

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
SNJ54LS592J	ACTIVE	CDIP	J	16	25	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-8762101EA SNJ54LS592J	<a href="#">Samples</a>
SNJ54LS592J	ACTIVE	CDIP	J	16	25	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-8762101EA SNJ54LS592J	<a href="#">Samples</a>
SNJ54LS592W	ACTIVE	CFP	W	16	25	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-8762101FA SNJ54LS592W	<a href="#">Samples</a>
SNJ54LS592W	ACTIVE	CFP	W	16	25	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-8762101FA SNJ54LS592W	<a href="#">Samples</a>
SNJ54LS593J	ACTIVE	CDIP	J	20	20	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	SNJ54LS593J	<a href="#">Samples</a>
SNJ54LS593J	ACTIVE	CDIP	J	20	20	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	SNJ54LS593J	<a href="#">Samples</a>

(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 SN54LS592, SN54LS593, SN74LS592, SN74LS593 :**

- Catalog : [SN74LS592](#), [SN74LS593](#)
- Military : [SN54LS592](#), [SN54LS593](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Military - QML certified for Military and Defense Applications

**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
SN74LS592NSR	SO	NS	16	2000	330.0	16.4	8.2	10.5	2.5	12.0	16.0	Q1
SN74LS593DWR	SOIC	DW	20	2000	330.0	24.4	10.8	13.3	2.7	12.0	24.0	Q1

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74LS592NSR	SO	NS	16	2000	356.0	356.0	35.0
SN74LS593DWR	SOIC	DW	20	2000	367.0	367.0	45.0

**TUBE**

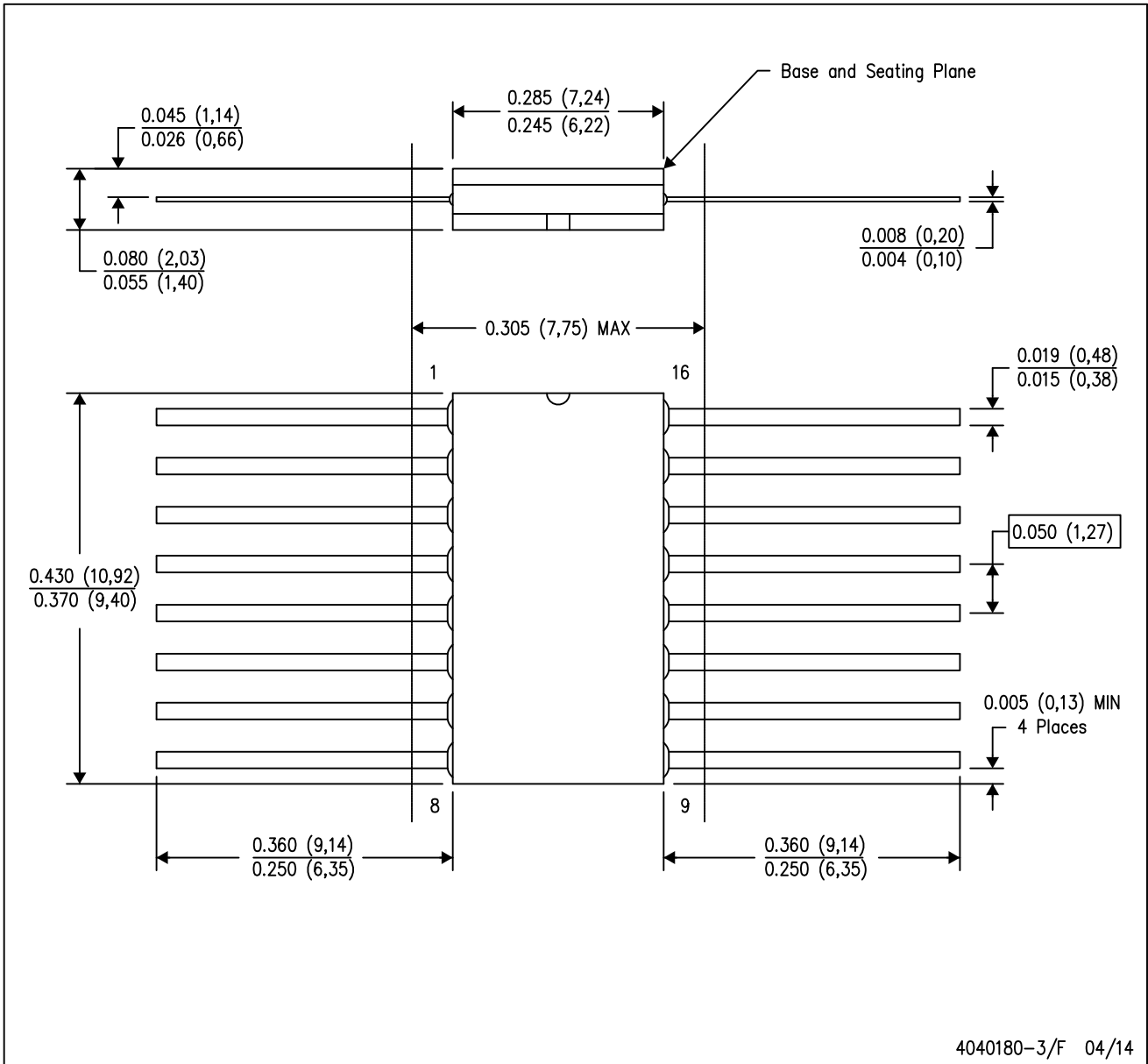

\*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
5962-8762101FA	W	CFP	16	25	506.98	26.16	6220	NA
SN74LS592D	D	SOIC	16	40	507	8	3940	4.32
SN74LS592N	N	PDIP	16	25	506	13.97	11230	4.32
SN74LS592N	N	PDIP	16	25	506	13.97	11230	4.32
SN74LS593DW	DW	SOIC	20	25	507	12.83	5080	6.6
SN74LS593N	N	PDIP	20	20	506	13.97	11230	4.32
SNJ54LS592W	W	CFP	16	25	506.98	26.16	6220	NA



W (R-GDFP-F16)

CERAMIC DUAL FLATPACK



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. This package can be hermetically sealed with a ceramic lid using glass frit.
  - D. Index point is provided on cap for terminal identification only.
  - E. Falls within MIL STD 1835 GDFP2-F16



J (R-GDIP-T\*\*)

14 LEADS SHOWN

CERAMIC DUAL IN-LINE PACKAGE



DIM \ PINS **	14	16	18	20
A	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC
B MAX	0.785 (19,94)	.840 (21,34)	0.960 (24,38)	1.060 (26,92)
B MIN	—	—	—	—
C MAX	0.300 (7,62)	0.300 (7,62)	0.310 (7,87)	0.300 (7,62)
C MIN	0.245 (6,22)	0.245 (6,22)	0.220 (5,59)	0.245 (6,22)



4040083/F 03/03

- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - This package is hermetically sealed with a ceramic lid using glass frit.
  - Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
  - Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, GDIP1-T18 and GDIP1-T20.

N (R-PDIP-T\*\*)

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN



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

# DW0020A



# PACKAGE OUTLINE

## SOIC - 2.65 mm max height

SOIC



**NOTES:**

1. All linear dimensions are in millimeters. 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 0.43 mm per side.
5. Reference JEDEC registration MS-013.

# EXAMPLE BOARD LAYOUT

DW0020A

SOIC - 2.65 mm max height

SOIC



LAND PATTERN EXAMPLE  
SCALE:6X



SOLDER MASK DETAILS

4220724/A 05/2016

NOTES: (continued)

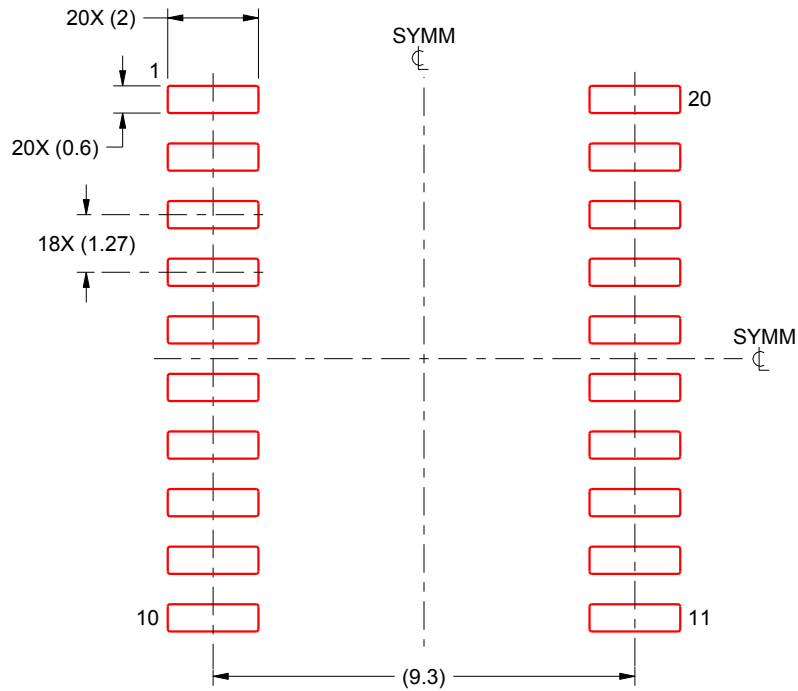
- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

DW0020A

SOIC - 2.65 mm max height

SOIC



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:6X

4220724/A 05/2016

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.

D (R-PDSO-G16)

PLASTIC SMALL OUTLINE



4040047-6/M 06/11

- 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.

# MECHANICAL DATA

NS (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

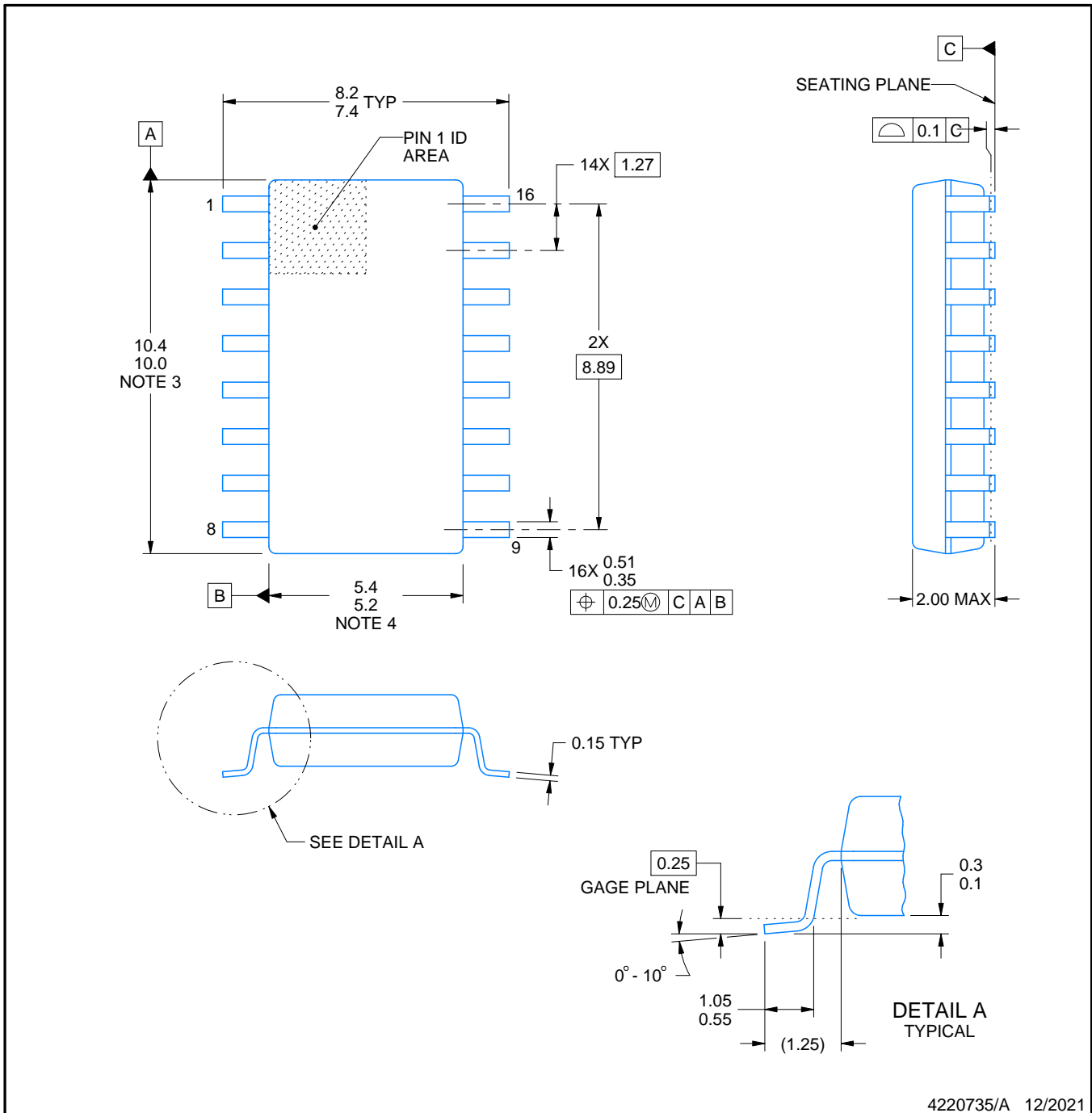


# PACKAGE OUTLINE

## NS0016A

### SOP - 2.00 mm max height

SOP



4220735/A 12/2021

#### NOTES:

1. All linear dimensions are in millimeters. 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.

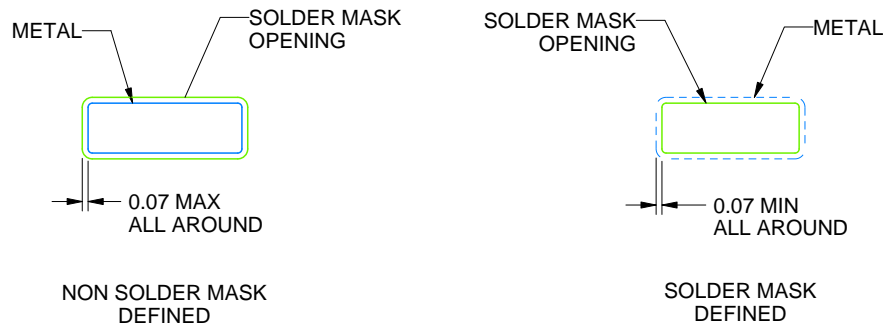


# EXAMPLE BOARD LAYOUT

NS0016A

SOP - 2.00 mm max height

SOP



4220735/A 12/2021

NOTES: (continued)

5. Publication IPC-7351 may have alternate designs.

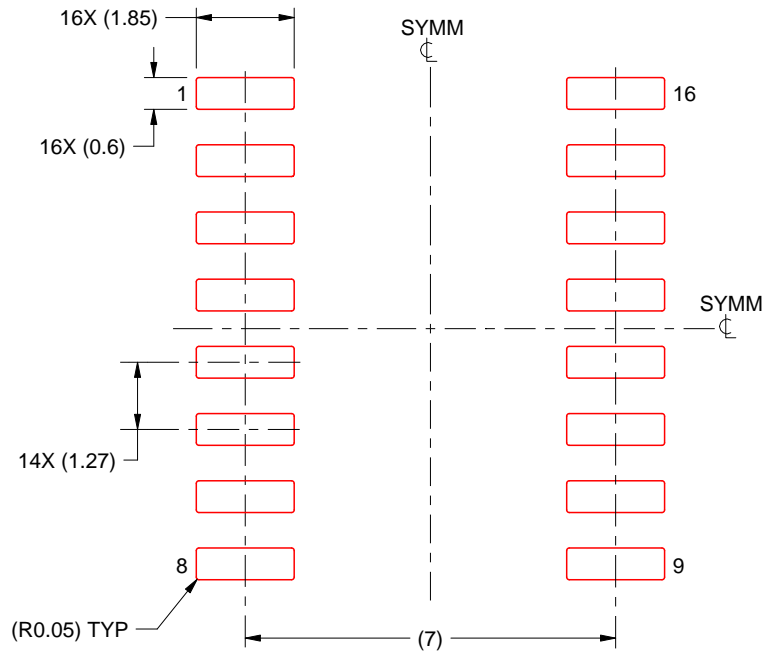
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

NS0016A

SOP - 2.00 mm max height

SOP



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:7X

4220735/A 12/2021

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.

## IMPORTANT NOTICE AND DISCLAIMER

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

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

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

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

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

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2023, Texas Instruments Incorporated