

# SN54ALS193A, SN74ALS193A SYNCHRONOUS 4-BIT UP/DOWN BINARY COUNTERS WITH DUAL CLOCK AND CLEAR

SDAS211C – DECEMBER 1982 – REVISED JULY 1996

- Look-Ahead Circuitry Enhances Cascaded Counters
- Fully Synchronous in Count Modes
- Parallel Asynchronous Load for Modulo-N Count Lengths
- Asynchronous Clear
- Package Options Include Plastic Small-Outline (D) Packages, Ceramic Chip Carriers (FK), and Standard Plastic (N) and Ceramic (J) 300-mil DIPs

## description

The 'ALS193A are synchronous, reversible, 4-bit up/down binary counters. Synchronous counting operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincident with each other when instructed by the steering logic. This mode of operation eliminates the output counting spikes normally associated with asynchronous (ripple-clock) counters.

The outputs of the four flip-flops are triggered on a low-to-high-level transition of either count/clock (UP or DOWN) input. The direction of the count is determined by which count input is pulsed while the other count input is high.

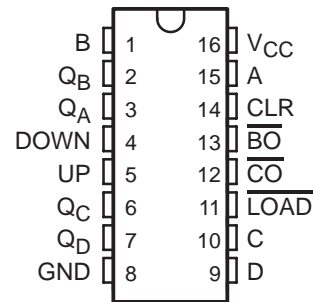
All four counters are fully programmable; that is, each output may be preset to either level by placing a low on the load (LOAD) input and entering the desired data at the data inputs. The output changes to agree with the data inputs independently of the count pulses. This feature allows the counters to be used as modulo-N dividers by simply modifying the count length with the preset inputs.

A high level applied to the clear (CLR) input forces all outputs to the low level. The clear function is independent of the count and LOAD inputs. The UP, DOWN, and LOAD inputs are buffered to lower the drive requirement, which significantly reduces the loading on, or current required by, clock drivers, etc., for long parallel words.

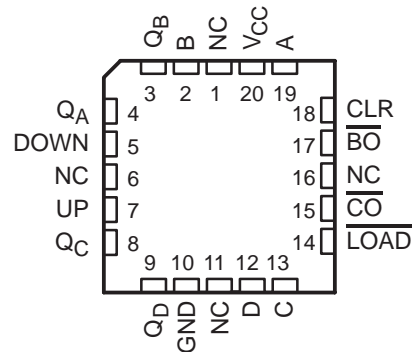
These counters are designed to be cascaded without the need for external circuitry. The borrow ( $\overline{BO}$ ) output produces a low-level pulse while the count is zero (all Q outputs low) and the DOWN input is low. Similarly, the carry ( $\overline{CO}$ ) output produces a low-level pulse while the count is 9 or 15 (all Q outputs high) and the UP input is low. The counters can then be easily cascaded by feeding  $\overline{BO}$  and  $\overline{CO}$  to the count-down and count-up inputs, respectively, of the succeeding counter.

The SN54ALS193A is characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SN74ALS193A is characterized for operation from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ .

SN54ALS193A . . . J PACKAGE  
SN74ALS193A . . . D OR N PACKAGE  
(TOP VIEW)



SN54ALS193A . . . FK PACKAGE  
(TOP VIEW)



NC – No internal connection



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 **TEXAS  
INSTRUMENTS**

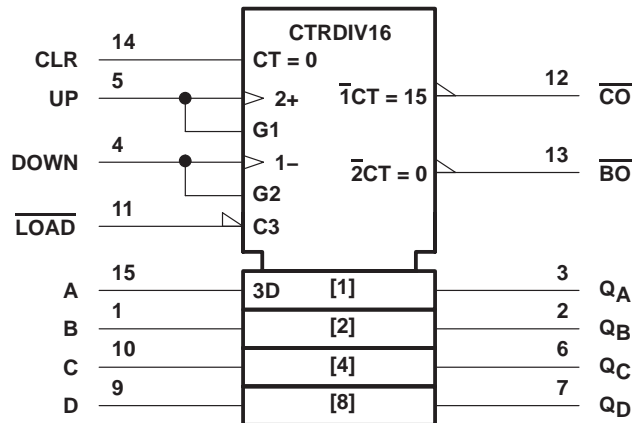
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## logic symbol†

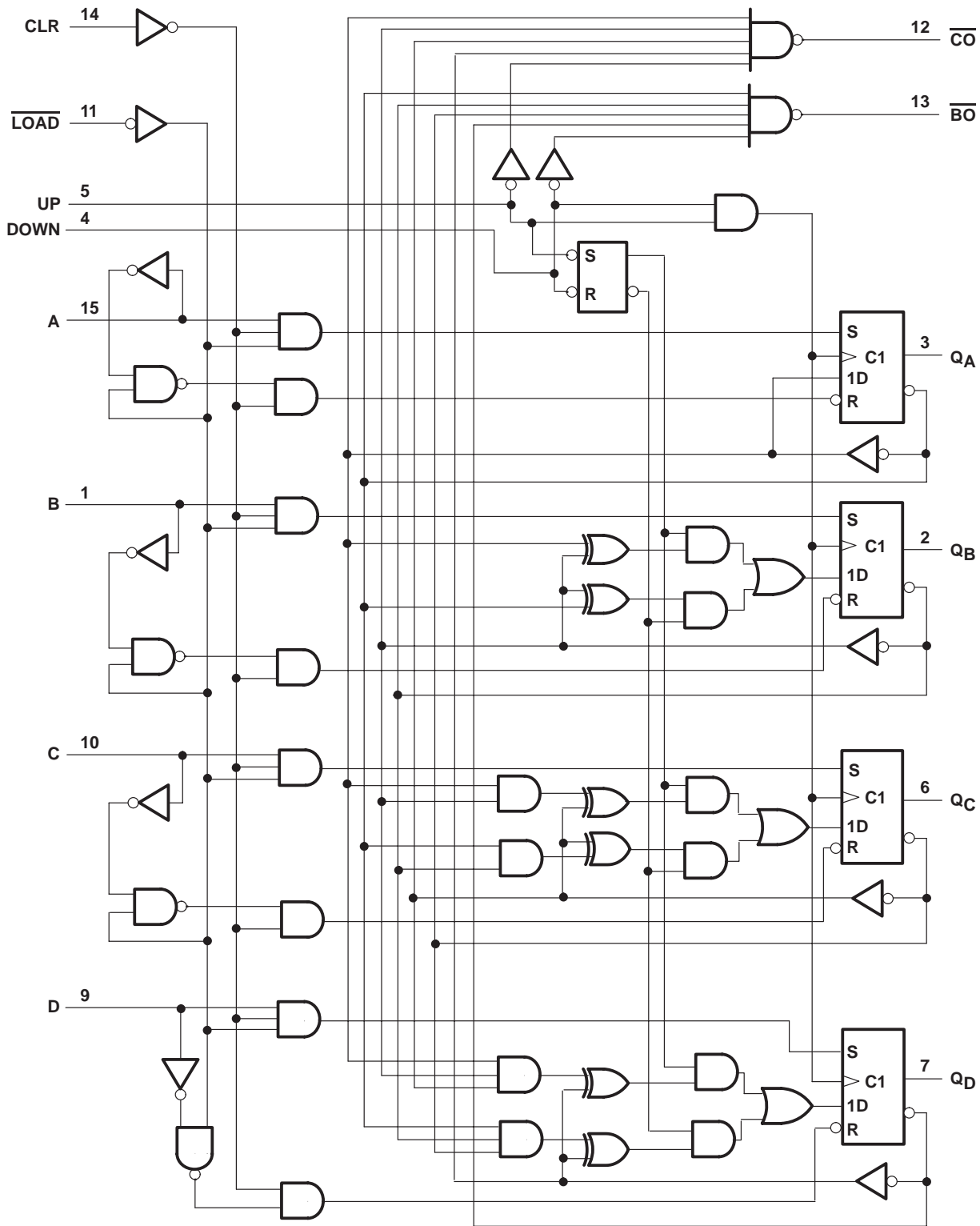


† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12. Pin numbers shown are for the D, J, and N packages.

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logic diagram (positive logic)



Pin numbers shown are for the D, J, and N packages.



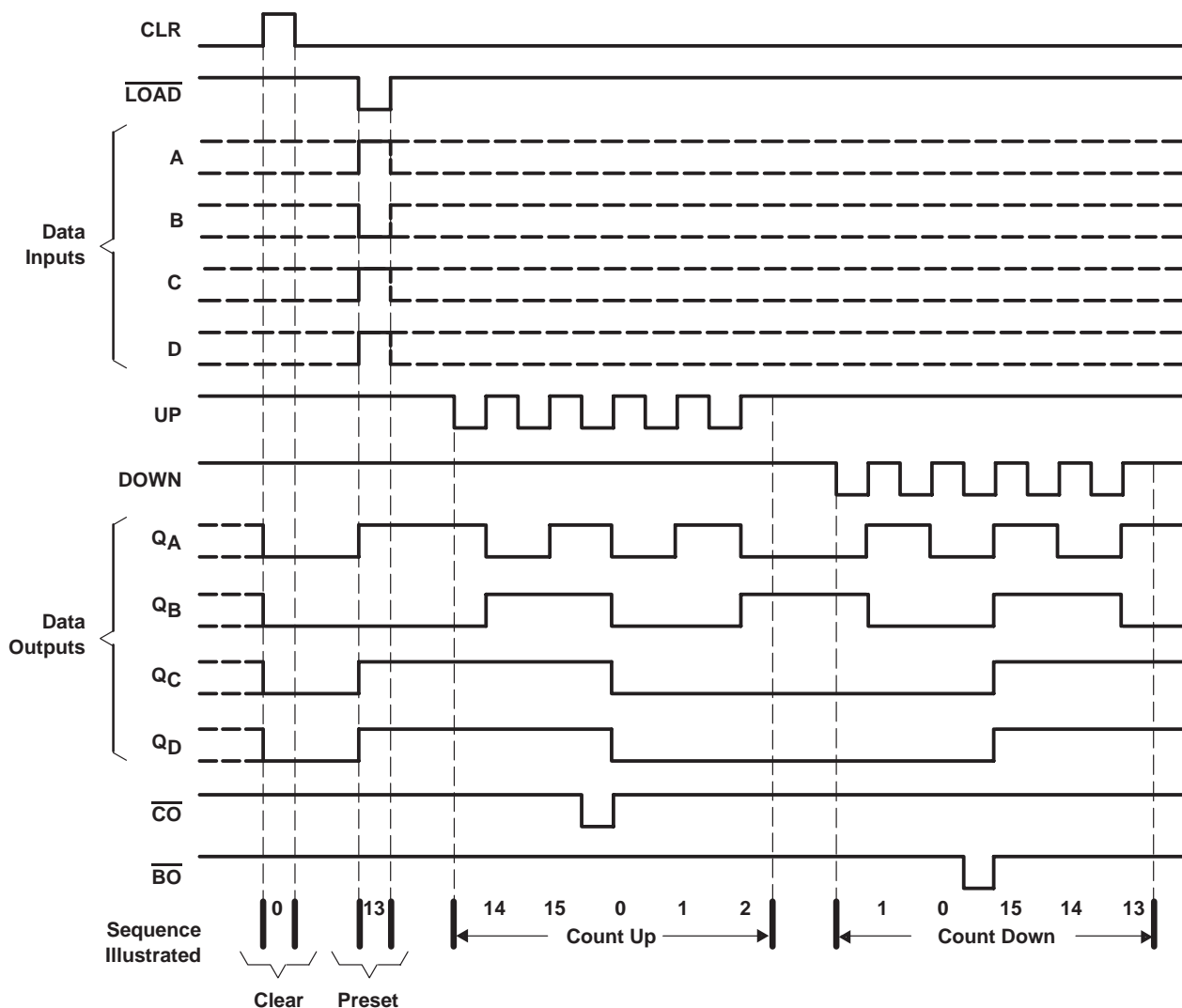
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## typical clear, load, and count sequence

the following sequence is illustrated below:

1. Clear outputs to zero
2. Load (preset) to binary 13
3. Count up to 14, 15 (carry), 0, 1, and 2
4. Count down to 1, 0 (borrow), 15, 14, and 13



NOTES: A. Clear overrides load, data, and count inputs.

B. When counting up, count-down input must be high; when counting down, count-up input must be high.



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

|   |                |
|---|----------------|
| Supply voltage, $V_{CC}$ .....                                  | 7 V            |
| Input voltage, $V_I$ .....                                      | 7 V            |
| Operating free-air temperature range, $T_A$ : SN54ALS193A ..... | –55°C to 125°C |
| SN74ALS193A .....   | 0°C to 70°C    |
| Storage temperature range, $T_{stg}$ .....                      | –65°C to 150°C |

† 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.

## recommended operating conditions

|             |                                | SN54ALS193A                     |     |      | SN74ALS193A |      |      | UNIT |
|-------------|--------------------------------|---------------------------------|-----|------|-------------|------|------|------|
|             |                                | MIN                             | NOM | MAX  | MIN         | NOM  | MAX  |      |
| $V_{CC}$    | Supply voltage                 | 4.5                             | 5   | 5.5  | 4.5         | 5    | 5.5  | 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      |                                 |     | –0.4 |             |      | –0.4 | mA   |
| $I_{OL}$    | Low-level output current       |                                 |     | 4    |             |      | 8    | mA   |
| $f_{clock}$ | Clock frequency                | 0                               |     | 20   | 0           |      | 30   | MHz  |
| $t_w$       | Pulse duration                 | CLR high                        |     | 10   |             | 10   |      | ns   |
|             |                                | LOAD low                        |     | 25   |             | 20   |      |      |
|             |                                | UP or DOWN high or low          |     | 30   |             | 16.5 |      |      |
| $t_{su}$    | Setup time                     | Data before LOAD↑               |     | 25   |             | 20   |      | ns   |
|             |                                | CLR inactive before UP or DOWN  |     | 20   |             | 20   |      |      |
|             |                                | LOAD inactive before UP or DOWN |     | 20   |             | 20   |      |      |
| $t_h$       | Hold time                      | Data after LOAD↑                |     | 5    |             | 5    |      | ns   |
|             |                                | UP high after DOWN↑             |     | 5    |             | 0    |      |      |
|             |                                | DOWN high after UP↑             |     | 5    |             | 0    |      |      |
| $T_A$       | Operating free-air temperature | –55                             |     | 125  | 0           |      | 70   | °C   |

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

| PARAMETER    |            | TEST CONDITIONS            |                    | SN54ALS193A  |      | SN74ALS193A |              | UNIT    |      |
|--------------|------------|----------------------------|--------------------|--------------|------|-------------|--------------|---------|------|
|              |            |                            |                    | MIN          | TYP‡ | MAX         | MIN          |         | TYP‡ |
| $V_{IK}$     |            | $V_{CC} = 4.5$ V,          | $I_I = -18$ mA     |              |      | –1.5        | –1.5         | V       |      |
| $V_{OH}$     |            | $V_{CC} = 4.5$ V to 5.5 V, | $I_{OH} = -0.4$ mA | $V_{CC} - 2$ |      |             | $V_{CC} - 2$ | V       |      |
| $V_{OL}$     |            | $V_{CC} = 4.5$ V           | $I_{OL} = 4$ mA    | 0.25         | 0.4  | 0.25        | 0.4          | V       |      |
|              |            |                            | $I_{OL} = 8$ mA    |              |      | 0.35        | 0.5          |         |      |
| $I_I$        |            | $V_{CC} = 5.5$ V,          | $V_I = 7$ V        |              |      | 0.1         | 0.35         | 0.1     | mA   |
| $I_{IH}$     |            | $V_{CC} = 5.5$ V,          | $V_I = 2.7$ V      |              |      | 20          | 20           | $\mu$ A |      |
| $I_{IL}$     | UP or DOWN | $V_{CC} = 5.5$ V,          | $V_I = 0.4$ V      |              |      | –0.2        | –0.2         | mA      |      |
|              | All others |                            |                    |              |      | –0.1        | –0.1         |         |      |
| $I_{O}^{\S}$ |            | $V_{CC} = 5.5$ V,          | $V_O = 2.25$ V     | –20          | –112 | –30         | –112         | mA      |      |
| $I_{CC}$     |            | $V_{CC} = 5.5$ V,          | See Note 1         | 12           | 22   | 12          | 22           | mA      |      |

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

§ The output conditions have been chosen to produce a current that closely approximates one half of the true short-circuit output current,  $I_{OS}$ .

NOTE 1:  $I_{CC}$  is measured with the clear and load inputs grounded and all other inputs at 4.5 V.



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## switching characteristics (see Figure 1)

| PARAMETER        | FROM<br>(INPUT)   | TO<br>(OUTPUT)  | V <sub>CC</sub> = 4.5 V to 5.5 V,<br>C <sub>L</sub> = 50 pF,<br>R <sub>1</sub> = R <sub>2</sub> = 500 Ω,<br>T <sub>A</sub> = MIN to MAX† |     |             |     | UNIT |
|------------------|-------------------|-----------------|--|-----|-------------|-----|------|
|                  |                   |                 | SN54ALS193A  |     | SN74ALS193A |     |      |
|                  |                   |                 | MIN  | MAX | MIN         | MAX |      |
| f <sub>max</sub> |                   |                 | 25   |     | 30          |     | MHz  |
| t <sub>PLH</sub> | UP                | $\overline{CO}$ | 3  | 20  | 3           | 16  | ns   |
| t <sub>PHL</sub> |                   |                 | 3  | 21  | 5           | 18  |      |
| t <sub>PLH</sub> | DOWN              | $\overline{BO}$ | 4  | 20  | 4           | 16  | ns   |
| t <sub>PHL</sub> |                   |                 | 5  | 22  | 5           | 18  |      |
| t <sub>PLH</sub> | UP or DOWN        | Any Q           | 3  | 27  | 3           | 19  | ns   |
| t <sub>PHL</sub> |                   |                 | 4  | 23  | 4           | 17  |      |
| t <sub>PLH</sub> | $\overline{LOAD}$ | Any Q           | 7  | 38  | 7           | 30  | ns   |
| t <sub>PHL</sub> |                   |                 | 8  | 37  | 8           | 28  |      |
| t <sub>PHL</sub> | CLR               | Any Q           | 5  | 20  | 5           | 17  | ns   |

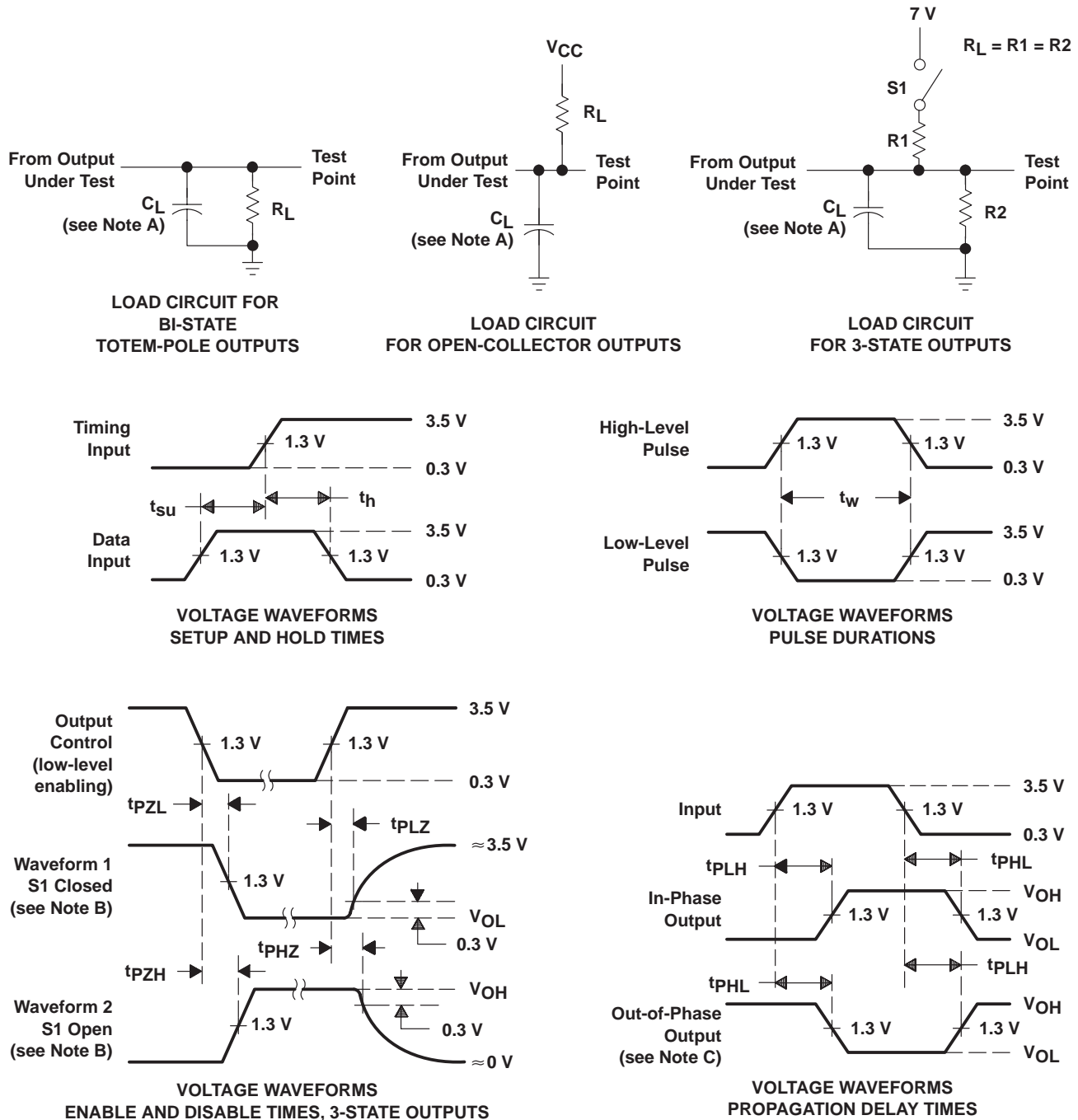
† For conditions shown MIN or MAX, use the appropriate value specified under recommended operating conditions.



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## PARAMETER MEASUREMENT INFORMATION SERIES 54ALS/74ALS AND 54AS/74AS DEVICES



- NOTES: 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. When measuring propagation delay items of 3-state outputs, switch S1 is open.  
 D. All input pulses have the following characteristics:  $PRR \leq 1$  MHz,  $t_r = t_f = 2$  ns, duty cycle = 50%.  
 E. The outputs are measured one at a time with one transition per measurement.

**Figure 1. Load Circuits and Voltage Waveforms**

**PACKAGING INFORMATION**

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)            | Lead/Ball Finish<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5)                  | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|-------------------------|----------------------|--------------|--|-------------------------|
| 5962-88698012A   | ACTIVE        | LCCC         | FK                 | 20   | 1              | TBD                        | POST-PLATE              | N / A for Pkg Type   | -55 to 125   | 5962-<br>88698012A<br>SNJ54ALS<br>193AFK | <a href="#">Samples</a> |
| 5962-8869801EA   | ACTIVE        | CDIP         | J                  | 16   | 1              | TBD                        | A42                     | N / A for Pkg Type   | -55 to 125   | 5962-8869801EA<br>SNJ54ALS193AJ          | <a href="#">Samples</a> |
| 5962-8869801FA   | ACTIVE        | CFP          | W                  | 16   | 1              | TBD                        | A42                     | N / A for Pkg Type   | -55 to 125   | 5962-8869801FA<br>SNJ54ALS193AW          | <a href="#">Samples</a> |
| SN54ALS193AJ     | ACTIVE        | CDIP         | J                  | 16   | 1              | TBD                        | A42                     | N / A for Pkg Type   | -55 to 125   | SN54ALS193AJ                             | <a href="#">Samples</a> |
| SN74ALS193AD     | ACTIVE        | SOIC         | D                  | 16   | 40             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | ALS193A                                  | <a href="#">Samples</a> |
| SN74ALS193ADR    | OBSOLETE      | SOIC         | D                  | 16   |                | TBD                        | Call TI                 | Call TI              | 0 to 70      |  |                         |
| SN74ALS193ADRE4  | OBSOLETE      | SOIC         | D                  | 16   |                | TBD                        | Call TI                 | Call TI              | 0 to 70      |  |                         |
| SN74ALS193ADRG4  | OBSOLETE      | SOIC         | D                  | 16   |                | TBD                        | Call TI                 | Call TI              | 0 to 70      |  |                         |
| SN74ALS193AN     | ACTIVE        | PDIP         | N                  | 16   | 25             | Pb-Free<br>(RoHS)          | CU NIPDAU               | N / A for Pkg Type   | 0 to 70      | SN74ALS193AN                             | <a href="#">Samples</a> |
| SN74ALS193ANE4   | ACTIVE        | PDIP         | N                  | 16   | 25             | Pb-Free<br>(RoHS)          | CU NIPDAU               | N / A for Pkg Type   | 0 to 70      | SN74ALS193AN                             | <a href="#">Samples</a> |
| SN74ALS193ANSR   | ACTIVE        | SO           | NS                 | 16   | 2000           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | ALS193A                                  | <a href="#">Samples</a> |
| SNJ54ALS193AFK   | ACTIVE        | LCCC         | FK                 | 20   | 1              | TBD                        | POST-PLATE              | N / A for Pkg Type   | -55 to 125   | 5962-<br>88698012A<br>SNJ54ALS<br>193AFK | <a href="#">Samples</a> |
| SNJ54ALS193AJ    | ACTIVE        | CDIP         | J                  | 16   | 1              | TBD                        | A42                     | N / A for Pkg Type   | -55 to 125   | 5962-8869801EA<br>SNJ54ALS193AJ          | <a href="#">Samples</a> |
| SNJ54ALS193AW    | ACTIVE        | CFP          | W                  | 16   | 1              | TBD                        | A42                     | N / A for Pkg Type   | -55 to 125   | 5962-8869801FA<br>SNJ54ALS193AW          | <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) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

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**OTHER QUALIFIED VERSIONS OF SN54ALS193A, SN74ALS193A :**

● Catalog: [SN74ALS193A](#)

● Military: [SN54ALS193A](#)

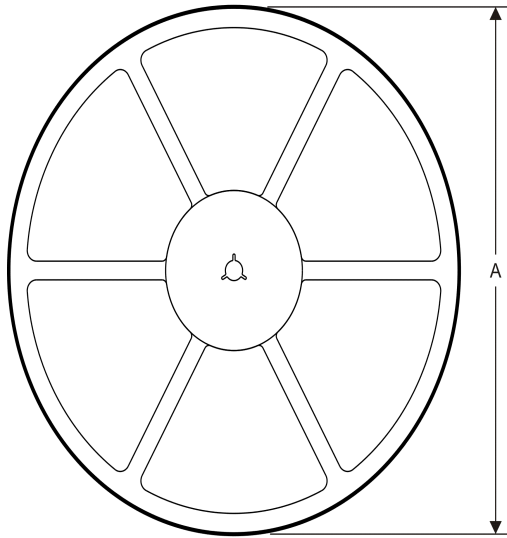
NOTE: Qualified Version Definitions:

● Catalog - TI's standard catalog product

- Military - QML certified for Military and Defense Applications

**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                   |

**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 |
|----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| SN74ALS193ANSR | SO           | NS              | 16   | 2000 | 330.0              | 16.4               | 8.2     | 10.5    | 2.5     | 12.0    | 16.0   | Q1            |

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

| Device         | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| SN74ALS193ANSR | SO           | NS              | 16   | 2000 | 367.0       | 367.0      | 38.0        |

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

14 LEADS SHOWN

CERAMIC DUAL IN-LINE PACKAGE



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



4040083/F 03/03

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

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

FK (S-CQCC-N\*\*)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



| NO. OF TERMINALS ** | A                |                  | B                |                  |
|---------------------|------------------|------------------|------------------|------------------|
|                     | MIN              | MAX              | MIN              | MAX              |
| 20                  | 0.342<br>(8,69)  | 0.358<br>(9,09)  | 0.307<br>(7,80)  | 0.358<br>(9,09)  |
| 28                  | 0.442<br>(11,23) | 0.458<br>(11,63) | 0.406<br>(10,31) | 0.458<br>(11,63) |
| 44                  | 0.640<br>(16,26) | 0.660<br>(16,76) | 0.495<br>(12,58) | 0.560<br>(14,22) |
| 52                  | 0.740<br>(18,78) | 0.761<br>(19,32) | 0.495<br>(12,58) | 0.560<br>(14,22) |
| 68                  | 0.938<br>(23,83) | 0.962<br>(24,43) | 0.850<br>(21,6)  | 0.858<br>(21,8)  |
| 84                  | 1.141<br>(28,99) | 1.165<br>(29,59) | 1.047<br>(26,6)  | 1.063<br>(27,0)  |



4040140/D 01/11

- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - This package can be hermetically sealed with a metal lid.
  - Falls within JEDEC MS-004

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.



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.

# 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.

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