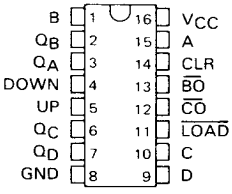
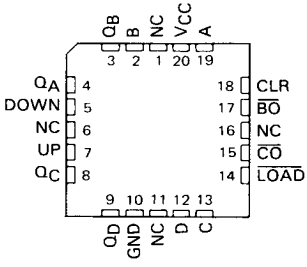
D2661, DECEMBER 1982 – REVISED MAY 1986

- **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" Packages, Ceramic Chip Carriers, and Standard Plastic and Ceramic 300-mil DIPs**
- **Dependable Texas Instruments Quality and Reliability**

SN54ALS192, SN54AS193 . . . J PACKAGE
SN74ALS192, SN74ALS193 . . . D OR N PACKAGE
(TOP VIEW)



SN54ALS192, SN54ALS193 . . . FK PACKAGE
(TOP VIEW)



NC – no internal connection.

description

The 'ALS192 and 'ALS193 are synchronous, reversible up/down counters. The 'ALS192 is a 4-bit decade counter and the 'ALS193 is a 4-bit binary counter. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincidently with each other when so 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 by a low-to-high-level transition of either count (clock) input (Up or Down). The direction of counting is determined by which count input is pulsed while the other count input is high.

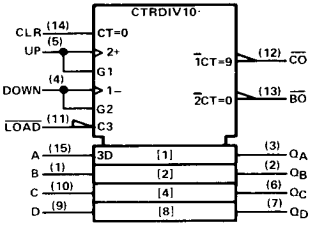
All four counters are fully programmable; that is, each output may be preset to either level by placing a low on the load input and entering the desired data at the data inputs. The output will change to agree with the data inputs independently of the count pulses. This feature allows the counters to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

A clear input has been provided that forces all outputs to the low level when a high level is applied. The clear function is independent of the count and the load inputs. The clock, count, and load inputs are buffered to lower the drive requirements. This significantly reduces the loading on clock drivers, etc., for long parallel words.

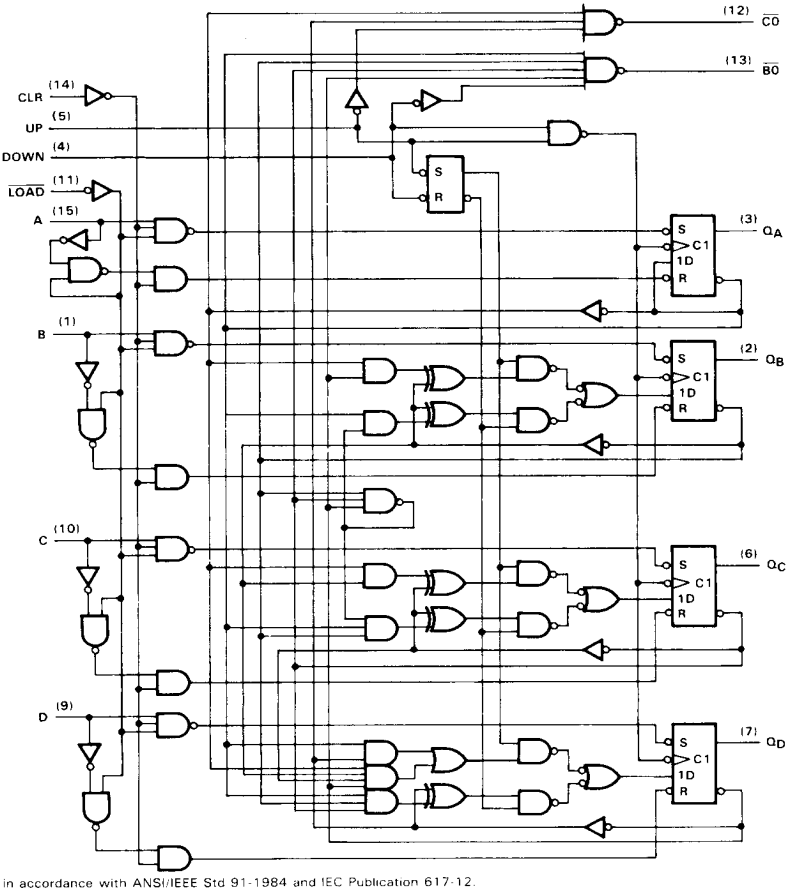
These counters were designed to be cascaded without the need for external circuitry. The borrow output (BO) produces a low-level pulse while the count is zero (all outputs low) and the count-down input is low. Similarly, the carry output ($\overline{CO}$) produces a low-level pulse while the count is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

The SN54ALS192 and SN54ALS193 are characterized for operation over the full military temperature range of −55 °C to 125 °C. The SN74ALS192 and SN74ALS193 are characterized for operation from 0 °C to 70 °C.

'ALS192 logic symbol†



'ALS192 logic diagram (positive logic)



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

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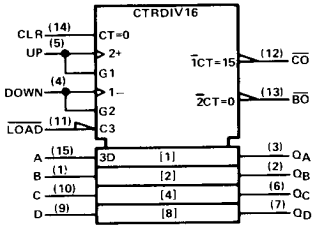
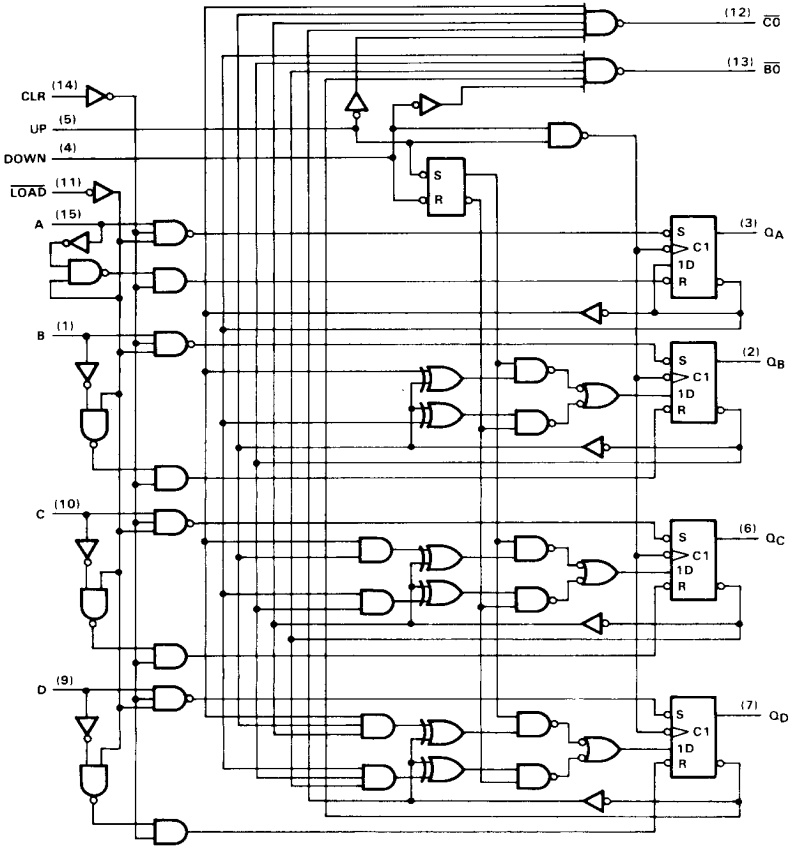
'ALS193 logic symbol†



'ALS193 logic diagrams (positive logic)



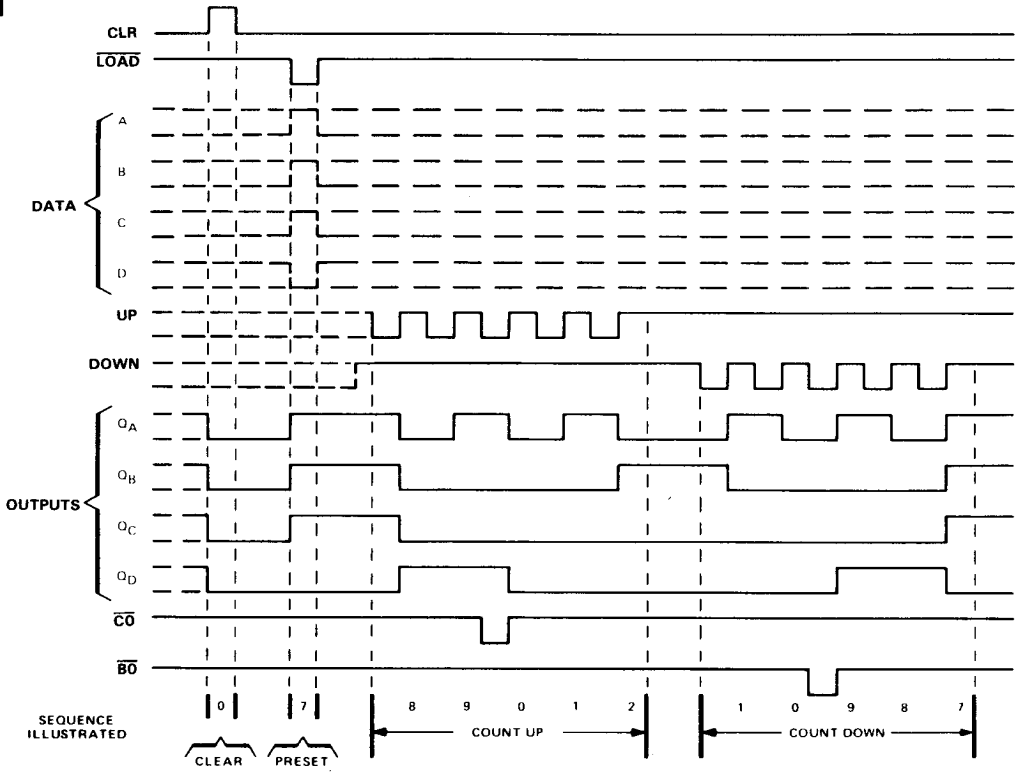
†This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.
Pin numbers shown are for D, J, and N packages.

typical clear, load, and count sequence

'ALS192

Illustrated below is the following sequence:

1. Clear outputs to zero.
2. Load (preset) to BCD seven.
3. Count up to eight, nine, carry, zero, one, and two.
4. Count down to one, zero, borrow, nine, eight, and seven.



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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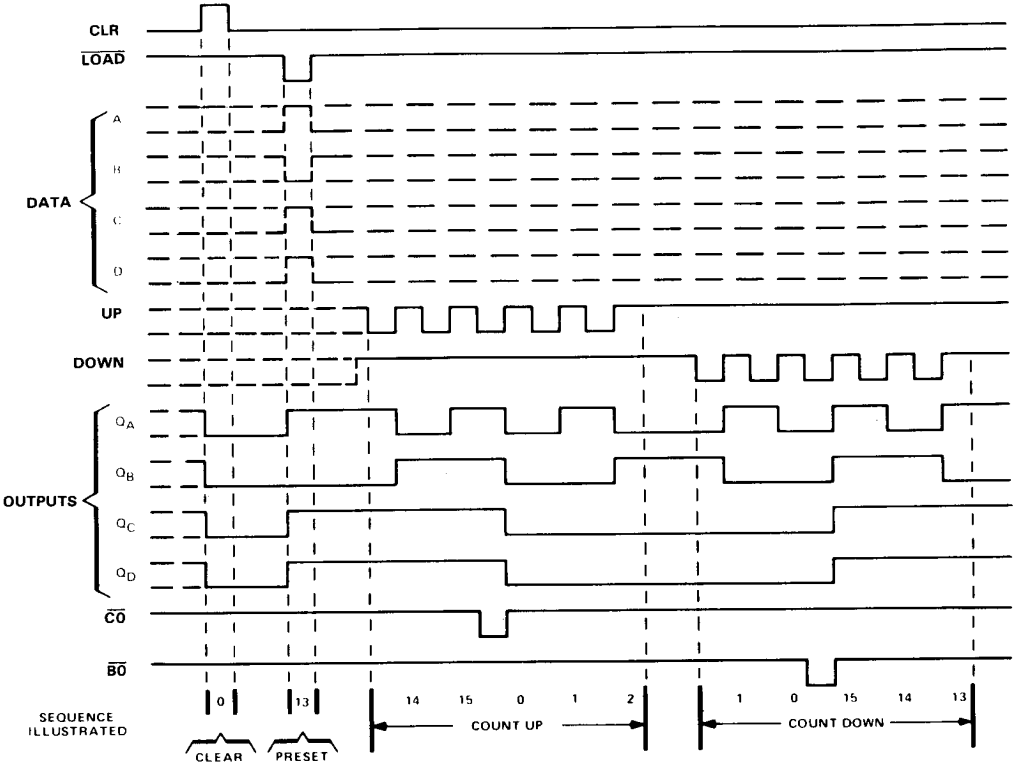
typical clear, load, and count sequences

'ALS193

Illustrated below is the following sequence:

1. Clear outputs to zero.
2. Load (preset) to binary thirteen.
3. Count up to fourteen, fifteen, carry, zero, one, and two.
4. Count down to one, zero, borrow, fifteen, fourteen, and thirteen.



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.

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

Supply voltage, V_{CC} . . . . . 7 V
Input voltage . . . . . 7 V
Operating free-air temperature range: SN54ALS192, SN54ALS193 . . . . . −55 °C to 125 °C
SN74ALS192, SN74ALS193 . . . . . 0 °C to 70 °C
Storage temperature range . . . . . −65 °C to 150 °C

recommended operating conditions

				SN54ALS192 SN54ALS193			SN74ALS192 SN74ALS193			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	'ALS192		0		20	0		25	MHz
		'ALS193		0		20	0		30	
t_w	Pulse duration	CLR high		10			10			ns
		$\overline{LOAD}$ low		25			20			
		UP or DOWN high or low	'ALS192	25			20			ns
			'ALS193	30			16.5			
t_{su}	Setup time	Data before $\overline{LOAD}$↑		25			20			ns
		CLR inactive before UP↑ or DOWN↑		20			20			
		$\overline{LOAD}$ inactive before UP↑ or DOWN↑		20			20			
t_h	Hold time	Data after $\overline{LOAD}$↑		5			5			ns
		UP high after DOWN↑		0			0			
		DOWN high after UP↑		0			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		SN54ALS192 SN54ALS193			SN74ALS192 SN74ALS193			UNIT
				MIN	TYP†	MAX	MIN	TYP†	MAX	
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
		V_{CC} = 4.5 V	I_{OL} = 8 mA					0.35	0.5	
I_I		V_{CC} = 5.5 V,	V_I = 7 V			0.1			0.1	mA
I_{IH}		V_{CC} = 5.5 V,	V_I = 2.7 V			20			20	μA
I_{IL}	UP, DOWN	V_{CC} = 5.5 V,	V_I = 0.4 V			−0.2			−0.2	mA
	All others					−0.1			−0.1	
I_O‡		V_{CC} = 5.5 V,	V_O = 2.25 V	−30		−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°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 Note 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} = 4.5 V to 5.5 V, C_L = 50 pF, R_L = 500 Ω, T_A = MIN to MAX				UNIT
			SN54ALS192 SN54ALS193		SN74ALS192 SN74ALS193		
			MIN	MAX	MIN	MAX	
f_{max}	'ALS192		20		25		MHz
	'ALS193		25		30		
t_{PLH}	Up	CO	3	20	4	16	ns
t_{PHL}			3	21	5	18	
t_{PLH}	Down	BO	4	20	4	16	ns
t_{PHL}			5	22	5	18	
t_{PLH}	Up or Down	Any Q	4	27	4	19	ns
t_{PHL}			4	23	4	17	
t_{PLH}	$\overline{LOAD}$	Any Q	8	38	8	30	ns
t_{PHL}			8	37	8	28	
t_{PHL}	$\overline{CLR}$	Any Q	5	20	5	17	ns

NOTE 2: Load circuit and voltage waveforms are shown in Section 1.