National Semiconductor

January 1988

MM54HCT193/MM74HCT193
Synchronous Binary Up/Down Counters

General Description

These high speed synchronous counters utilize advanced silicon-gate CMOS technology to achieve the high noise immunity and low power consumption of CMOS technology, along with the speeds of low power Schottky TTL. The MM54HCT193/MM74HCT193 is a binary counter having two separate clock inputs, an UP COUNT input and a DOWN COUNT input. All outputs of the flip-flops are simultaneously triggered on the low-to-high transition of either clock while the other input is held high. The direction of counting is determined by which input is clocked.

This device has TTL compatible inputs. It can drive 15 LS-TTL loads.

This counter may be preset by entering the desired data on the DATA A, DATA B, DATA C, and DATA D inputs. When the LOAD input is taken low, the data is loaded independently of either clock input. This feature allows the counter to be used as a divide-by-n counter by modifying the count length with the preset inputs.

In addition, the HCT193 can also be cleared. This is accomplished by inputting a high on the CLEAR input. All 4 internal stages are set to a low level independently of either COUNT input.

Both a BORROW and CARRY output are provided to enable cascading of both up and down counting functions. The BORROW output produces a negative-going pulse when the counter underflows and the CARRY outputs a pulse when the counter overflows. The counter can be cascaded by connecting the CARRY and BORROW outputs of one device to the COUNT UP and COUNT DOWN inputs, respectively, of the next device.

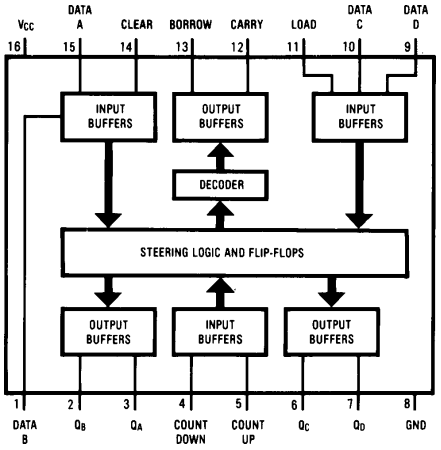
All inputs are protected from damage due to static discharge by diodes to V_{CC} and ground.

Features

- Low quiescent supply current: 80 μA maximum (74HCT Series)
- Low input current: 1 μA maximum
- TTL compatible inputs

Connection Diagram

Dual-In-Line Package



TL/F/5742–1

Order Number MM54HCT193 or MM74HCT193

Truth Table

Count		Clear	Load	Function
Up	Down			
↑	H	L	H	Count Up
H	↑	L	H	Count Down
X	X	H	X	Clear
X	X	L	L	Load

H = high level

L = low level

↑ = transition from low-to-high

X = don't care

RRD-B30M105/Printed in U. S. A.

Absolute Maximum Ratings (Notes 1 and 2)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage (V_{CC})	−0.5V to +7.0V
DC Input Voltage (V_{IN})	−1.5V to V_{CC} + 1.5V
DC Output Voltage (V_{OUT})	−0.5V to V_{CC} + 0.5V
Clamp Diode Current (I_{IK}, I_{OK})	±20 mA
DC Output Current, per Pin (I_{OUT})	±25 mA
DC V_{CC} or GND Current, per Pin(I_{CC})	±50 mA
Storage Temperature Range (T_{STG})	−65°C to +150°C
Power Dissipation (P_D) (Note 3)	600 mW
S.O. Package only	500 mW
Lead Temperature (T_L) (Soldering, 10 seconds)	260°C

Operating Conditions

	Min	Max	Units
Supply Voltage (V_{CC})	4.5	5.5	V
DC Input or Output Voltage (V_{IN}, V_{OUT})	0	V_{CC}	V
Operating Temp. Range (T_A)			
MM74HCT	−40	+85	°C
MM54HCT	−55	+125	°C
Input Rise or Fall Times (t_r, t_f)		500	ns

DC Electrical Characteristics V_{CC} = 5V ±10% unless otherwise specified

Symbol	Parameter	Conditions	T_A = 25°C	74HCT T_A = −40°C to 85°C	54HCT T_A = −55°C to 125°C	Units
			Typ	Guaranteed Limits		
V_{IH}	Minimum High Level Input Voltage			2.0	2.0	2.0	V
V_{IL}	Maximum Low Level Input Voltage			0.8	0.8	0.8	V
V_{OH}	Minimum High Level Output Voltage	V_{IN} = V_{IH} or V_{IL}					
		$\|I_{OUT}\|$ = 20 μA	V_{CC}	V_{CC}−0.1	V_{CC}−0.1	V_{CC}−0.1	V
		$\|I_{OUT}\|$ = 4.0 mA, V_{CC} = 4.5V	4.2	3.98	3.84	3.7	V
		$\|I_{OUT}\|$ = 4.8 mA, V_{CC} = 5.5V	5.2	4.98	4.84	4.7	V
V_{OL}	Maximum Low Level Voltage	V_{IN} = V_{IH} or V_{IL}					
		$\|I_{OUT}\|$ = 20 μA	0	0.1	0.1	0.1	V
		$\|I_{OUT}\|$ = 4.0 mA, V_{CC} = 4.5V	0.2	0.26	0.33	0.4	V
		$\|I_{OUT}\|$ = 4.8 mA, V_{CC} = 5.5V	0.2	0.26	0.33	0.4	V
I_{IN}	Maximum Input Current	V_{IN} = V_{CC} or GND, V_{IH} or V_{IL}		±0.1	±1.0	±1.0	μA
I_{CC}	Maximum Quiescent Supply Current	V_{IN} = V_{CC} or GND I_{OUT} = 0 μA		8.0	80	160	μA
		V_{IN} = 2.4V or 0.5V (Note 4)		1.0	1.2	1.3	mA

Note 1: Absolute Maximum Ratings are those values beyond which damage to the device may occur.

Note 2: Unless otherwise specified all voltages are referenced to ground.

Note 3: Power dissipation temperature derating—plastic "N" package: −12 mW/°C from 65°C to 85°C; ceramic "J" package: − 12 mW/°C from 100°C to 125°C.

Note 4: Measured per pin, all other inputs held at V_{CC} or GND.

AC Electrical Characteristics

(Note 6) V_{CC} = 5V, T_A = 25°C, C_L = 15 pF, t_r = t_f = 6 ns (unless otherwise specified)

Symbol	Parameter	From (Input)	To (Output)	Conditions	Typ	Guaranteed Limit	Units
f_{MAX}	Maximum Clock Frequency				35		MHz
$t_{PLH, PHL}$	Maximum Propagation Delay Time	Load	QA, QB, QC, QD		26		ns
$t_{PLH, PHL}$	Maximum Propagation Delay Time	Data A, B, C, D,	QA, QB, QC, QD		25		ns
$t_{PLH, PHL}$	Maximum Propagation Delay Time	Count-Up or -Down	QA, QB, QC, QD		26		ns
$t_{PLH, PHL}$	Maximum Propagation Delay Time	Count-Up	Carry		22		ns
$t_{PLH, PHL}$	Maximum Propagation Delay Time	Count-Dn	Borrow		22		ns
$t_{PLH, PHL}$	Maximum Propagation Delay Time	Clear	QA, QB, QC, QD		25		ns

AC Electrical Characteristics (Note 6)

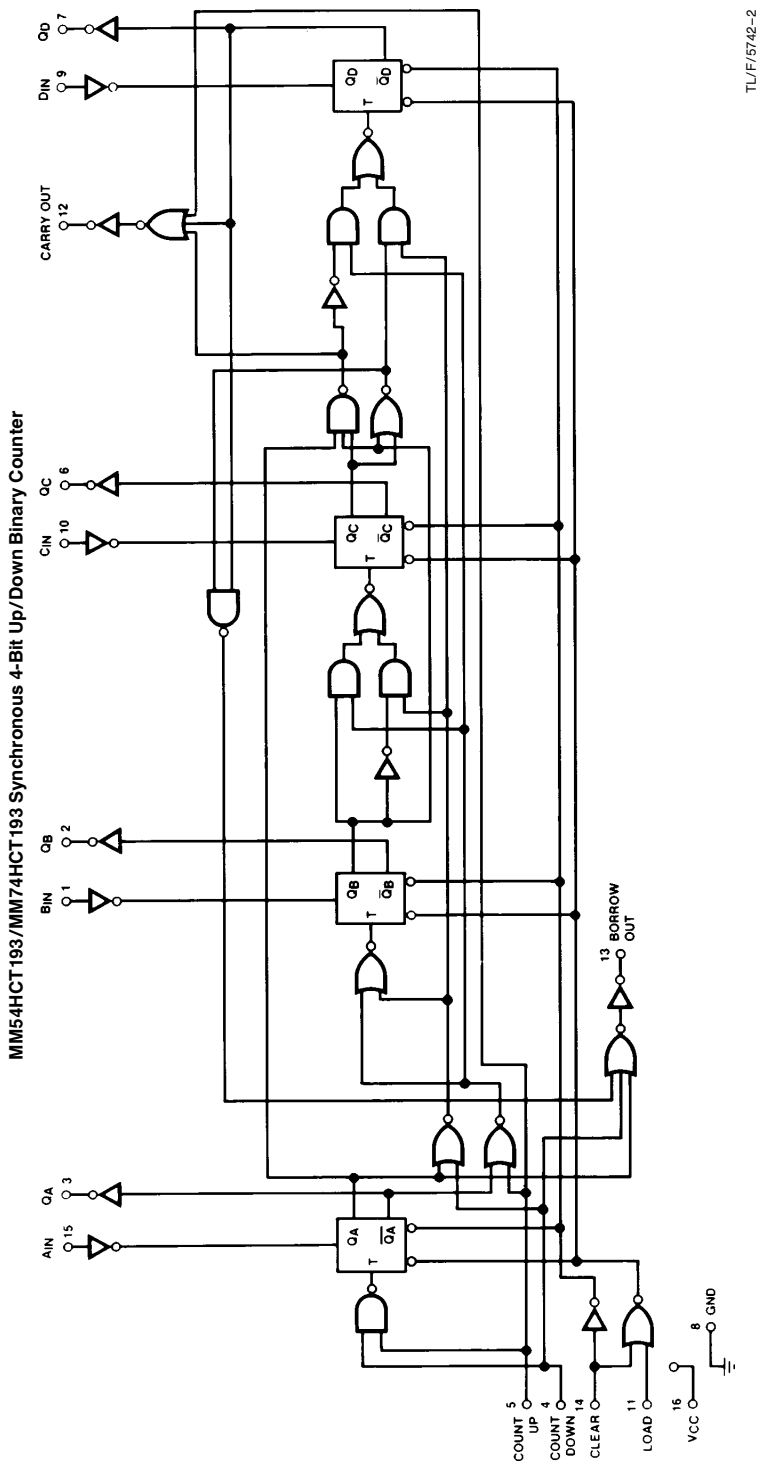
V_{CC} = 5V, ±10%, C_L = 50 pF (unless otherwise specified)

Symbol	Parameter	From (Input)	To (Output)	T = 25°C	T = 25°C	74HC T = −40° to 85°C	54HC T = −55° to 125°C	Units
				Typ	Guaranteed Limits			
f_{MAX}	Maximum Clock Frequency			32	20	16	13	MHz
$t_{PLH, PHL}$	Maximum Propagation Delay Time	Load	QA, QB, QC, QD	29	44	55	66	ns
$t_{PLH, PHL}$	Maximum Propagation Delay Time	Data A	QA, QB, QC, QD	28	40	50	60	ns
$t_{PLH, PHL}$	Maximum Propagation Delay Time	Count-Up or -Down	QA, QB QC, QD	30	43	54	65	ns
$t_{PLH, PHL}$	Maximum Propagation Delay Time	Count-Up	Carry	25	30	38	45	ns
$t_{PLH, PHL}$	Maximum Propagation Delay Time	Count-Down	Borrow	25	30	38	45	ns
$t_{PLH, PHL}$	Maximum Propagation Delay Time	Clear	QA, QB QC, QD	28	35	44	53	ns
t_W	Minimum Clock Pulse Width			16	25	31	38	ns
t_S	Minimum Setup Time Data before Load-LH				20	25	30	ns
t_H	Minimum Hold Time Data after Load-LH			−3	5	6	8	ns
t_{REM}	Minimum Removal Time Load to Count			−2	5	6	8	ns
t_{REM}	Minimum Removal Time Clear to Count			2	5	6	8	ns
t_W	Minimum Load Pulse Width			18	20	25	30	ns
t_W	Minimum Clear Pulse Width			8	20	25	30	ns
$t_{TLH, THL}$	Output Rise or Fall Time			10	15	19	22	ns
C_{PD}	Power Dissipation Capacitance			40				pF
C_{IN}	Maximum Input Capacitance			5	10	10	10	pF

Note 5: C_{PD} determines the no load dynamic power consumption, $P_D = C_{PD} V_{CC}^2 f + I_{CC} V_{CC}$, and the no load dynamic current consumption, $I_s = C_{PD} V_{CC} f + I_{CC}$.

Note 6: Refer to Section 1 for Typical MM54/74HCT AC Switchforms and Test Circuits.

MM54HCT193/MM74HCT193 Synchronous 4-Bit Up/Down Binary Counter



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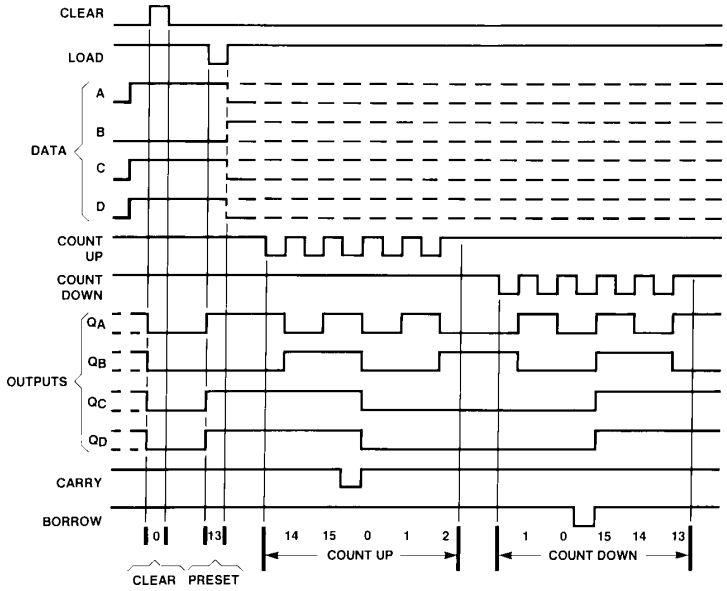
Logic Waveforms

'HCT193 Synchronous Binary Counters
Typical Clear, Load, and Count Sequences



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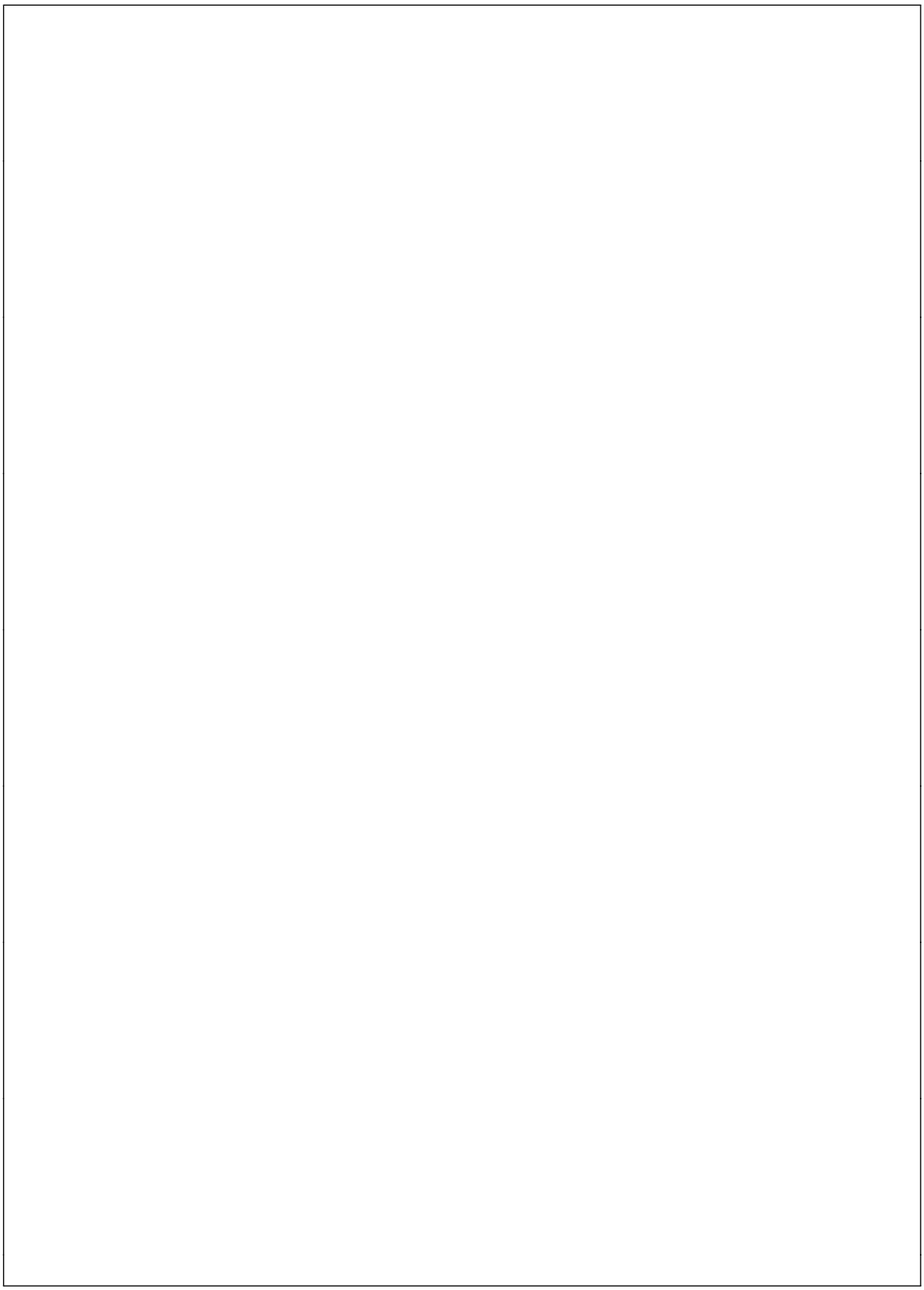
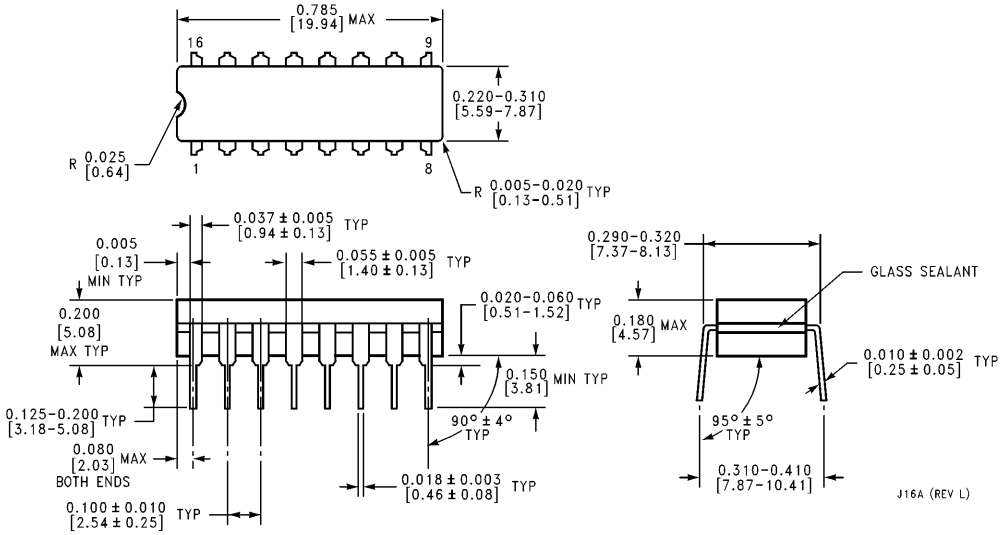
Sequence:
(1) Clear outputs to zero.
(2) Load (preset) to binary thirteen
(3) Count up to fourteen, fifteen, carry, zero, one, and two.
(4) Count down to one, zero, borrow, fifteen, fourteen, and thirteen.
Note A: Clear overrides load data, and count inputs.
Note B: When counting up, count-down input must be high; when counting down, count-up input must be high.

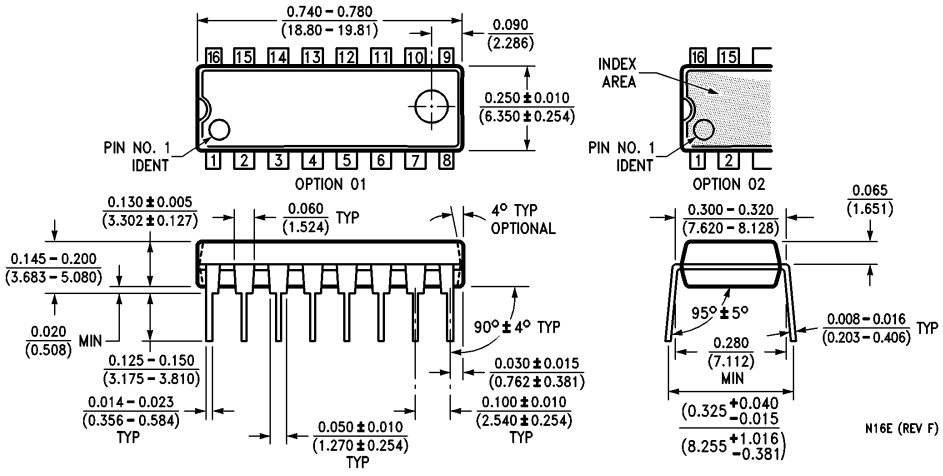


Physical Dimensions inches (millimeters)



Ceramic Dual-In-Line Package (J)
Order Number MM54HCT193J or MM74HCT193J
NS Package J16A

Physical Dimensions inches (millimeters) (Continued)



Molded Dual-In-Line Package (N)
Order Number MM74HCT193N
NS Package N16E

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