

# MM54HC390/MM74HC390 Dual 4-Bit Decade Counter MM54HC393/MM74HC393 Dual 4-Bit Binary Counter

## General Description

These counter circuits contain independent ripple carry counters and utilize advanced silicon-gate CMOS technology. The MM54HC390/MM74HC390 incorporate dual decade counters, each composed of a divide-by-two and a divide-by-five counter. The divide-by-two and divide-by-five counters can be cascaded to form dual decade, dual bi-quinary, or various combinations up to a single divide-by-100 counter. The MM54HC393/MM74HC393 contain two 4-bit ripple carry binary counters, which can be cascaded to create a single divide-by-256 counter.

Each of the two 4-bit counters is incremented on the high to low transition (negative edge) of the clock input, and each has an independent clear input. When clear is set high all four bits of each counter are set to a low level. This enables count truncation and allows the implementation of divide-by-N counter configurations.

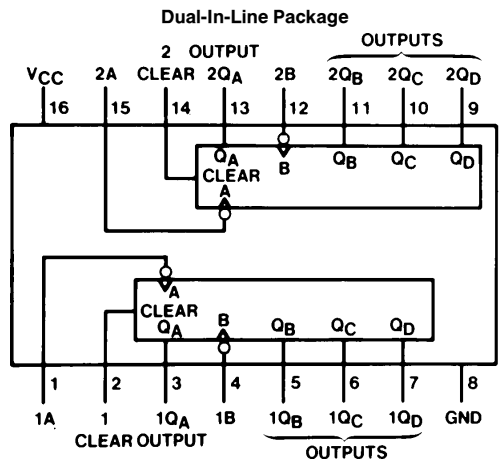
Each of the counters outputs can drive 10 low power Schottky TTL equivalent loads. These counters are func-

tionally as well as pin equivalent to the 54LS390/74LS390 and the 54LS393/74LS393, respectively. All inputs are protected from damage due to static discharge by diodes to VCC and ground.

## Features

- Typical operating frequency: 50 MHz
- Typical propagation delay: 13 ns (Ck to Q<sub>A</sub>)
- Wide operating supply voltage range: 2–6V
- Low input current: <1 μA
- Low quiescent supply current: 80 μA maximum (74HC Series)
- Fanout of 10 LS-TTL loads

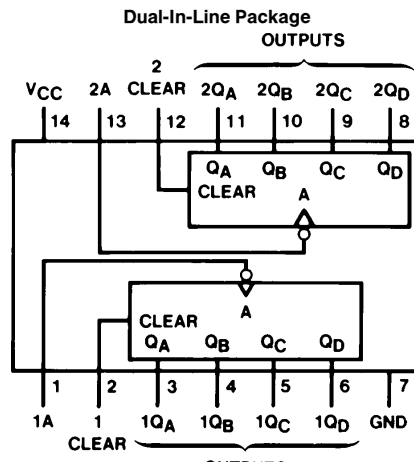
## Connection Diagrams



Top View

Order Number MM54HC390 or MM74HC390

TL/F/5337-1



Top View

Order Number MM54HC393 or MM74HC393

TL/F/5337-2

MM54HC390/MM74HC390 Dual 4-Bit Decade Counter  
MM54HC393/MM74HC393 Dual 4-Bit Binary Counter

## Absolute Maximum Ratings (Notes 1 & 2)

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

Supply Voltage ( $V_{CC}$ )	-0.5 to +7.0V
DC Input Voltage ( $V_{IN}$ )	-1.5 to $V_{CC} + 1.5V$
DC Output Voltage ( $V_{OUT}$ )	-0.5 to $V_{CC} + 0.5V$
Clamp Diode Current ( $I_{IK}, I_{OK}$ )	$\pm 20$ mA
DC Output Current, per pin ( $I_{OUT}$ )	$\pm 25$ mA
DC $V_{CC}$ or GND Current, per pin ( $I_{CC}$ )	$\pm 50$ 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 Temp. ( $T_L$ ) (Soldering 10 seconds)	260°C

## Operating Conditions

	Min	Max	Units
Supply Voltage ( $V_{CC}$ )	2	6	V
DC Input or Output Voltage ( $V_{IN}, V_{OUT}$ )	0	$V_{CC}$	V
Operating Temp. Range ( $T_A$ )			
MM74HC	-40	+85	°C
MM54HC	-55	+125	°C
Input Rise or Fall Times ( $t_r, t_f$ )			
$V_{CC} = 2.0V$		1000	ns
$V_{CC} = 4.5V$		500	ns
$V_{CC} = 6.0V$		400	ns

## DC Electrical Characteristics (Note 4)

Symbol	Parameter	Conditions	$V_{CC}$	$T_A = 25^\circ C$			Units	
				74HC		54HC		
				$T_A = -40$ to $85^\circ C$		$T_A = -55$ to $125^\circ C$		
				Typ	Guaranteed Limits			
$V_{IH}$	Minimum High Level Input Voltage		2.0V		1.5	1.5	1.5	V
			4.5V		3.15	3.15	3.15	V
			6.0V		4.2	4.2	4.2	V
$V_{IL}$	Maximum Low Level Input Voltage**		2.0V		0.5	0.5	0.5	V
			4.5V		1.35	1.35	1.35	V
			6.0V		1.8	1.8	1.8	V
$V_{OH}$	Minimum High Level Output Voltage	$V_{IN} = V_{IH}$ or $V_{IL}$ $ I_{OUT}  \leq 20 \mu A$	2.0V	2.0	1.9	1.9	1.9	V
			4.5V	4.5	4.4	4.4	4.4	V
			6.0V	6.0	5.9	5.9	5.9	V
		$V_{IN} = V_{IH}$ or $V_{IL}$ $ I_{OUT}  \leq 4.0$ mA $ I_{OUT}  \leq 5.2$ mA	4.5V	4.2	3.98	3.84	3.7	V
			6.0V	5.7	5.48	5.34	5.2	V
$V_{OL}$	Maximum Low Level Output Voltage	$V_{IN} = V_{IH}$ or $V_{IL}$ $ I_{OUT}  \leq 20 \mu A$	2.0V	0	0.1	0.1	0.1	V
			4.5V	0	0.1	0.1	0.1	V
			6.0V	0	0.1	0.1	0.1	V
		$V_{IN} = V_{IH}$ or $V_{IL}$ $ I_{OUT}  \leq 4.0$ mA $ I_{OUT}  \leq 5.2$ mA	4.5V	0.2	0.26	0.33	0.4	V
			6.0V	0.2	0.26	0.33	0.4	V
$I_{IN}$	Maximum Input Current	$V_{IN} = V_{CC}$ or GND	6.0V		$\pm 0.1$	$\pm 1.0$	$\pm 1.0$	$\mu A$
$I_{CC}$	Maximum Quiescent Supply Current	$V_{IN} = V_{CC}$ or GND $I_{OUT} = 0 \mu A$	6.0V		8.0	80	160	$\mu A$

**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:** For a power supply of  $5V \pm 10\%$  the worst case output voltages ( $V_{OH}$  and  $V_{OL}$ ) occur for HC at 4.5V. Thus the 4.5V values should be used when designing with this supply. Worst case  $V_{IH}$  and  $V_{IL}$  occur at  $V_{CC} = 5.5V$  and 4.5V respectively. (The  $V_{IH}$  value at 5.5V is 3.85V.) The worst case leakage current ( $I_{IN}$ ,  $I_{CC}$ , and  $I_{OZ}$ ) occur for CMOS at the higher voltage and so the 6.0V values should be used.

\*\* $V_{IL}$  limits are currently tested at 20% of  $V_{CC}$ . The above  $V_{IL}$  specification (30% of  $V_{CC}$ ) will be implemented no later than Q1, CY'89.

### AC Electrical Characteristics MM54HC390/MM74HC390

$V_{CC}=5V$ ,  $T_A=25^\circ C$ ,  $C_L=15\text{ pF}$ ,  $t_r=t_f=6\text{ ns}$

Symbol	Parameter	Conditions	Typ	Guaranteed Limit	Units
$f_{MAX}$	Maximum Operating Frequency, Clock A or B		50	30	MHz
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay, Clock A to $Q_A$ Output		12	20	ns
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay, Clock A to $Q_C$ ( $Q_A$ Connected to Clock B)		32	50	ns
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay, Clock B to $Q_B$ or $Q_D$		15	21	ns
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay, Clock B to $Q_C$		20	32	ns
$t_{PHL}$	Maximum Propagation Delay, Clear to any Output		15	28	ns
$t_{REM}$	Minimum Removal Time, Clear to Clock		-2	5	ns
$t_W$	Minimum Pulse Width, Clear or Clock		10	16	ns

### AC Electrical Characteristics $C_L=50\text{ pF}$ , $t_r=t_f=6\text{ ns}$ (unless otherwise specified)

Symbol	Parameter	Conditions	$V_{CC}$	$T_A=25^\circ C$			Units
				$T_A=-40\text{ to }85^\circ C$		$T_A=-55\text{ to }125^\circ C$	
				Typ			Guaranteed Limits
$f_{MAX}$	Maximum Operating Frequency		2.0V	5	4	3	MHz
			4.5V	27	21	18	MHz
			6.0V	31	24	20	MHz
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay, Clock A to $Q_A$		2.0V	45	120	150	ns
			4.5V	15	24	30	ns
			6.0V	13	21	26	ns
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay, Clock A to $Q_C$ ( $Q_A$ Connected to Clock B)		2.0V	100	290	360	ns
			4.5V	35	58	72	ns
			6.0V	30	50	62	ns
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay, Clock B to $Q_B$ or $Q_D$		2.0V	50	130	160	ns
			4.5V	16	26	33	ns
			6.0V	13	22	28	ns
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay, Clock B to $Q_C$		2.0V	60	185	230	ns
			4.5V	20	37	46	ns
			6.0V	17	32	40	ns
$t_{PHL}$	Maximum Propagation Delay, Clear to any Q		2.0V	55	165	210	ns
			4.5V	17	33	41	ns
			6.0V	15	28	35	ns
$t_{REM}$	Minimum Removal Time Clear to Clock		2.0V	25	25	25	ns
			4.5V	5	5	5	ns
			6.0V	5	5	5	ns
$t_W$	Minimum Pulse Width Clear or Clock		2.0V	30	80	100	ns
			4.5V	10	16	20	ns
			6.0V	9	14	18	ns
$t_{THL}$ , $t_{TLH}$	Maximum Output Rise and Fall Time		2.0V	30	75	95	ns
			4.5V	8	15	19	ns
			6.0V	7	13	16	ns
$t_r$ , $t_f$	Maximum Input Rise and Fall Time		2.0V	1000	1000	1000	ns
			4.5V	500	500	500	ns
			6.0V	400	400	400	ns
$C_{PD}$	Power Dissipation Capacitance (Note 5)	(per counter)	55				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,  $I_S=C_{PD} V_{CC} f + I_{CC}$ .

## AC Electrical Characteristics MM54HC393/MM74HC393

$V_{CC}=5V$ ,  $T_A=25^\circ C$ ,  $C_L=15\text{ pF}$ ,  $t_r=t_f=6\text{ ns}$

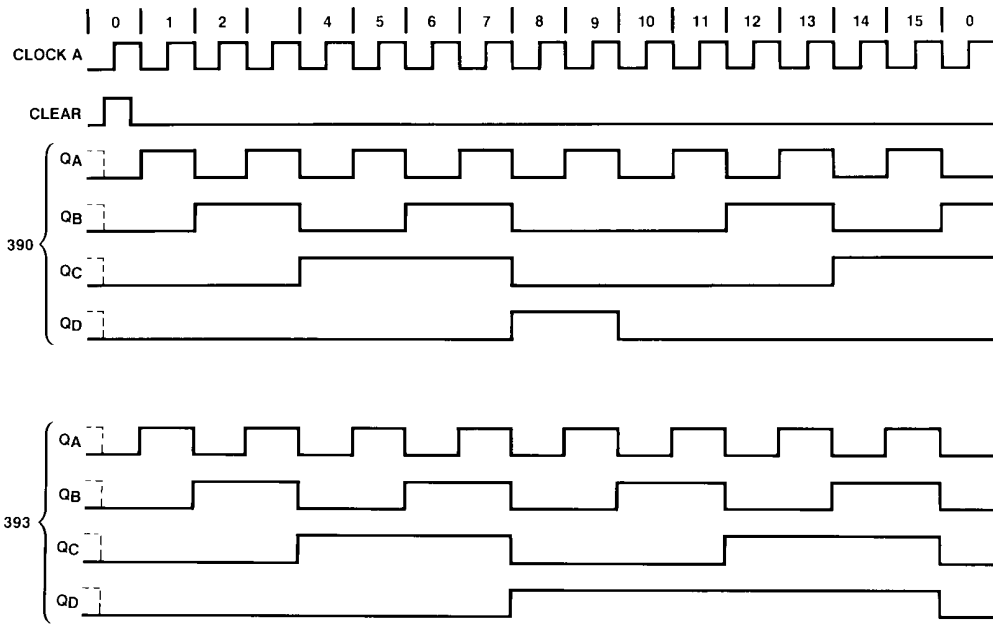
Symbol	Parameter	Conditions	Typ	Guaranteed Limit	Units
$f_{MAX}$	Maximum Operating Frequency		50	30	MHz
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay, Clock A to $Q_A$		13	20	ns
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay, Clock A to $Q_B$		19	35	ns
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay, Clock A to $Q_C$		23	42	ns
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay, Clock A to $Q_D$		27	50	ns
$t_{PHL}$	Maximum Propagation Delay, Clear to any Q		15	28	ns
$t_{REM}$	Minimum Removal Time		-2	5	ns
$t_W$	Minimum Pulse Width Clear or Clock		10	16	ns

## AC Electrical Characteristics $C_L=50\text{ pF}$ , $t_r=t_f=6\text{ ns}$ (unless otherwise specified)

Symbol	Parameter	Conditions	$V_{CC}$	$T_A=25^\circ C$		74HC	54HC	Units
				Typ	Guaranteed Limits		$T_A=-40\text{ to }85^\circ C$	
$f_{MAX}$	Maximum Operating Frequency		2.0V	5		4	3	MHz
			4.5V	27		21	18	
			6.0V	31		24	20	
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay Clock A to $Q_A$		2.0V	45	120	150	180	ns
			4.5V	15	24	30	35	ns
			6.0V	13	21	26	31	ns
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay Clock A to $Q_B$		2.0V	68	190	240	285	ns
			4.5V	23	38	47	57	ns
			6.0V	20	32	40	48	ns
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay Clock A to $Q_C$		2.0V	90	240	300	360	ns
			4.5V	30	48	60	72	ns
			6.0V	26	41	51	61	ns
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay Clock to $Q_D$		2.0V	100	290	360	430	ns
			4.5V	35	58	72	87	ns
			6.0V	30	50	62	75	ns
$t_{PHL}$	Maximum Propagation Delay Clear to any Q		2.0V	54	165	210	250	ns
			4.5V	18	33	41	49	ns
			6.0V	15	28	35	42	ns
$t_{REM}$	Minimum Clear Removal Time		2.0V		25	25	25	ns
			4.5V		5	5	5	ns
			6.0V		5	5	5	ns
$t_W$	Minimum Pulse Width Clear or Clock		2.0V	30	80	100	120	ns
			4.5V	10	16	20	24	ns
			6.0V	9	14	18	20	ns
$t_{THL}$ , $t_{TLH}$	Maximum Output Rise and Fall Time		2.0V	30	75	95	110	ns
			4.5V	8	15	19	22	ns
			6.0V	7	13	16	19	ns
$t_r$ , $t_f$	Maximum Input Rise and Fall Time				1000	1000	1000	ns
					500	500	500	ns
					400	400	400	ns
$C_{PD}$	Power Dissipation Capacitance (Note 5)	(per counter)	42					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,  $I_S=C_{PD}V_{CC} f+I_{CC}$ .

## Logic Timing Waveforms

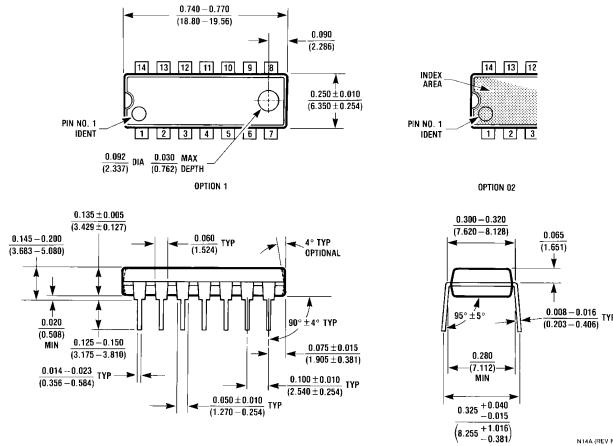


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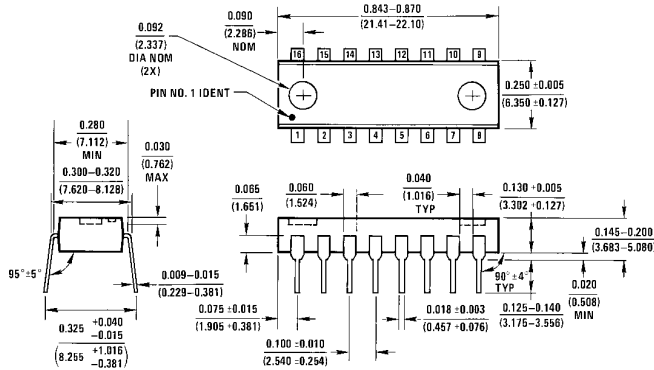




**Physical Dimensions** inches (millimeters) (Continued)



**Order Number MM74HC390N or MM74HC393N  
 NS Package N14A**



**Order Number MM74HC390N or MM74HC393N  
 NS Package N16A**

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