M74HC390P

DUAL 4-STAGE BINARY RIPPLE COUNTER WITH ÷2 AND ÷5 SECTIONS

DESCRIPTION

The M74HC390 is a semiconductor integrated circuit consisting of two asynchronous decade counters with direct reset input.

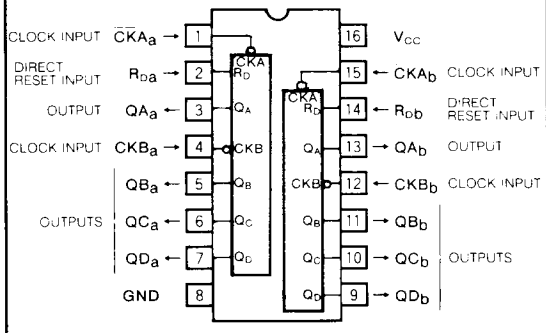
FEATURES

- High-speed: (clock frequency) 60MHz typ. (C_L=15pF, V_{CC}=5V)
- Low power dissipation: 20μW/package (max) (V_{CC}=5V, T_a=25℃, quiescent state)
- High noise margin: 30% of V_{CC}, min (V_{CC}=4.5V, 6V)
- Capable of driving 10 LSTTL loads
- Wide operating voltage range: V_{CC}=2~6V
- Wide operating temperature range: T_a=−40~+85℃

APPLICATION

General purpose, for use in industrial and consumer digital equipment.

PIN CONFIGURATION (TOP VIEW)



Outline 16P4

FUNCTIONAL DESCRIPTION

Use of silicon gate technology allows the M74HC390 to maintain the low power dissipation and high noise margin characteristics of the standard CMOS logic 4000B series while giving high-speed performance equivalent to the 74LS390.

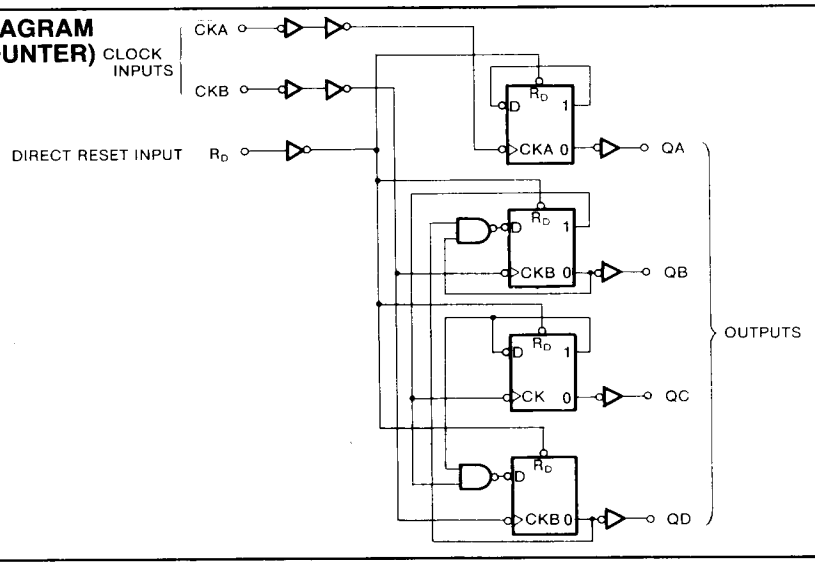
Each decade counter consists of a binary counter and a divide-by-5 counter. When using a binary counter,by applying the count pulse to clock input $\overline{CK}A$ a frequency-demultiplied signal will be output to QA. When using a divide-by-5 counter, by applying the count pulse to clock input $\overline{CK}B$ a frequency-demultiplied signal will be output to QB through QD.

When using the decade counter to output BCD code from QA through QD, connect QA and $\overline{CK}B$ together and apply the count pulse to $\overline{CK}A$. When outputting a signal with a 50% duty cycle from QA, connect QD and $\overline{CK}A$ together and apply the count pulse to $\overline{CK}B$.

Counting takes place when the clock input changes from high-level to low-level.

When direct reset input R_D is high, QA through QB will become low irrespective of other inputs. Maintain the low-level state when counting.

LOGIC DIAGRAM (EACH COUNTER)



DUAL 4-STAGE BINARY RIPPLE COUNTER WITH ÷2 AND ÷5 SECTIONS

FUNCTION TABLE (Note 1)

Inputs		Outputs			
$\overline{CK}$	R_D	QA	QB	QC	QD
X	H	L	L	L	L
↓	L	Count			

Note 1 : ↓ : Change from high to low level
X : Irrelevant

Count	QA	QB	QC	QD
0	L	L	L	L
1	H	L	L	L
2	L	H	L	L
3	H	H	L	L
4	L	L	H	L
5	H	L	H	L
6	L	H	H	L
7	H	H	H	L
8	L	L	L	H
9	H	L	L	H

With QA and $\overline{CKB}$ connected and $\overline{CKA}$ used as input.

ABSOLUTE MAXIMUM RATINGS (T_a = −40∼+85℃)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		−0.5∼+7.0	V
V_I	Input voltage		−0.5∼V_{CC}+0.5	V
V_O	Output voltage		−0.5∼V_{CC}+0.5	V
I_{IK}	Input protection diode current	V_I < 0V	−20	mA
		V_I > V_{CC}	20	
I_{OK}	Output parasitic diode current	V_O < 0V	−20	mA
		V_O > V_{CC}	20	
I_O	Output current, per output pin		±25	mA
I_{CC}	Supply/GND current	V_{CC}, GND	±50	mA
P_d	Power dissipation		500	mW
Tstg	Storage temperature range		−65∼+150	℃

RECOMMENDED OPERATING CONDITIONS (T_a = −40∼+85℃)

Symbol	Parameter		Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		2		6	V
V_I	Input voltage		0		V_{CC}	V
V_O	Output voltage		0		V_{CC}	V
Topr	Operating temperature range		−40		+85	℃
t_r, t_f	Input risetime, falltime	V_{CC} = 2.0V	0		1000	ns
		V_{CC} = 4.5V	0		500	
		V_{CC} = 6.0V	0		400	

MITSUBISHI ELECTRIC

ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Test conditions		Limits					Unit
					25℃			−40～+85℃	
				V_{CC}(V)	Min	Typ	Max	Min	Max	
V_{IH}	High-level input voltage	V_O = 0.1V, V_{CC}−0.1V I_O = 20μA		2.0	1.5			1.5		V
				4.5	3.15			3.15		
				6.0	4.2			4.2		
V_{IL}	Low-level input voltage	V_O = 0.1V, V_{CC}−0.1V I_O = 20μA		2.0			0.5		0.5	V
				4.5			1.35		1.35	
				6.0			1.8		1.8	
V_{OH}	High-level output voltage	V_I = V_{IH}, V_{IL}	I_{OH} = −20μA	2.0	1.9			1.9		V
			I_{OH} = −20μA	4.5	4.4			4.4		
			I_{OH} = −20μA	6.0	5.9			5.9		
			I_{OH} = −4.0mA	4.5	4.18			4.13		
			I_{OH} = −5.2mA	6.0	5.68			5.63		
V_{OL}	Low-level output voltage	V_I = V_{IH}, V_{IL}	I_{OL} = 20μA	2.0			0.1		0.1	V
			I_{OL} = 20μA	4.5			0.1		0.1	
			I_{OL} = 20μA	6.0			0.1		0.1	
			I_{OL} = 4.0mA	4.5			0.26		0.33	
			I_{OL} = 5.2mA	6.0			0.26		0.33	
I_{IH}	High-level input current	V_I = 6V		6.0			0.1		1.0	μA
I_{IL}	Low-level input current	V_I = 0V		6.0			−0.1		−1.0	μA
I_{CC}	Quiescent supply current	V_I = V_{CC}, GND, I_O = 0μA		6.0			4.0		40.0	μA

SWITCHING CHARACTERISTICS (V_{CC} = 5V, T_a = 25℃)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
f_{max}	Maximum clock frequency	C_L = 15pF (Note 3)	30			MHz
t_{TLH}	Low-level to high-level and high-level to low-level output transition time				10	ns
t_{THL}					10	
t_{PLH}	Low-level to high-level and high-level to low-level output propagation time ($\overline{CKA}$ − QA)				20	ns
t_{PHL}					20	
t_{PLH}	Low-level to high-level and high-level to low-level output propagation time ($\overline{CKA}$ − QC, with QA and $\overline{CKB}$ connected)				50	ns
t_{PHL}					50	
t_{PLH}	Low-level to high-level and high-level to low-level output propagation time ($\overline{CKB}$ − QB)				21	ns
t_{PHL}					21	
t_{PLH}	Low-level to high-level and high-level to low-level output propagation time ($\overline{CKB}$ − QC)				32	ns
t_{PHL}					32	
t_{PLH}	Low-level to high-level and high-level to low-level output propagation time ($\overline{CKB}$ − QD)				21	ns
t_{PHL}					21	
t_{PHL}	High-level to low-level output propagation time (R_D − QA, QB, QC, QD)				28	ns

SWITCHING CHARACTERISTICS (V_{CC} = 2~6V, T_a = −40~+85°C)

Symbol	Parameter	Test conditions	V_{CC}(V)	Limits 25°C Min	25°C Typ	25°C Max	−40~+85°C Min	−40~+85°C Max	Unit
f_{max}	Maximum clock frequency		2.0	5			4		MHz
			4.5	27			21		
			6.0	31			24		
t_{TLH}	Low-level to high-level and high-level to low-level output transition time		2.0			75		95	ns
			4.5			15		19	
			6.0			13		16	
t_{THL}			2.0			75		95	
			4.5			15		19	
			6.0			13		16	
t_{PLH}	Low-level to high-level and high-level to low-level output propagation time ($\overline{CK}A$ − QA)		2.0			120		150	ns
			4.5			24		30	
			6.0			21		26	
t_{PHL}			2.0			120		150	
			4.5			24		30	
			6.0			21		26	
t_{PLH}	Low-level to high-level and high-level to low-level output propagation time ($\overline{CK}A$ − QC, with QA and $\overline{CK}B$ connected)		2.0			290		360	ns
			4.5			58		72	
			6.0			50		62	
t_{PHL}			2.0			290		360	
			4.5			58		72	
			6.0			50		62	
t_{PLH}	Low-level to high-level and high-level to low-level output propagation time ($\overline{CK}B$ − QB)	C_L = 50pF (Note 3)	2.0			130		160	ns
			4.5			26		33	
			6.0			22		28	
t_{PHL}			2.0			130		160	
			4.5			26		33	
			6.0			22		28	
t_{PLH}	Low-level to high-level and high-level to low-level output propagation time ($\overline{CK}B$ − QC)		2.0			185		230	ns
			4.5			37		46	
			6.0			32		40	
t_{PHL}			2.0			185		230	
			4.5			37		46	
			6.0			32		40	
t_{PLH}	Low-level to high-level and high-level to low-level output propagation time ($\overline{CK}B$ − QD)		2.0			130		160	ns
			4.5			26		33	
			6.0			22		28	
t_{PHL}			2.0			130		160	
			4.5			26		33	
			6.0			22		28	
t_{PHL}	High-level to low-level output propagation time (R_D − QA, QB, QC, QD)		2.0			165		210	ns
			4.5			33		41	
			6.0			28		35	
C_I	Input capacitance					10		10	pF
C_{PD}	Power dissipation capacitance (Note 2)				46				pF

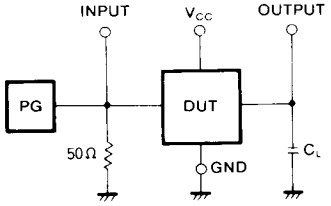
Note 2 : C_{PD} is the internal capacitance of the IC calculated from operation supply current under no-load conditions. (per counter)
The power dissipated during operation under no-load conditions is calculated using the following formula:
$P_D = C_{PD} \cdot V_{CC}^2 \cdot f_I + I_{CC} \cdot V_{CC}$

DUAL 4-STAGE BINARY RIPPLE COUNTER WITH ÷2 AND ÷5 SECTIONS

TIMING REQUIREMENTS (V_{CC} = 2~6V, T_a = −40~+85℃)

Symbol	Parameter	Test conditions	Limits					Unit
			25℃			−40~+85℃		
			V_{CC}(V)	Min	Typ	Max	Min	Max	
$t_{w(\overline{CK})}$	Clock pulse width		2.0	80			100		ns
			4.5	16			20		
			6.0	14			18		
$t_{w(R_D)}$	Direct reset pulse width		2.0	80			100		ns
			4.5	16			20		
			6.0	14			18		
t_{rec}	R_D recovery time with respect to $\overline{CK}$		2.0	50			65		ns
			4.5	10			13		
			6.0	9			11		

Note 3 : Test Circuit



(1) The pulse generator (PG) has the following characteristics (10%~90%): t_r = 6ns, t_f = 6ns
(2) The capacitance C_L includes stray wiring capacitance and the probe input capacitance.

TIMING DIAGRAM