

74VHC74 • 74VHCT74

Dual D-Type Flip Flop with Preset and Clear

General Description

The VHC/VHCT74 is an advanced high speed CMOS Dual D-Flip Flop fabricated with silicon gate CMOS technology. It achieves the high speed operation similar to equivalent Bipolar Schottky TTL while maintaining the CMOS low power dissipation. The signal level applied to the D INPUT is transferred to the Q OUTPUT during the positive going transition of the CK pulse. CLR and PR are independent of the CK and are accomplished by setting the appropriate input low.

An input protection circuit ensures that 0V to 7V can be applied to the input pins without regard to the supply voltage. This device can be used to interface 5V to 3V systems and two supply systems such as battery backup. This circuit prevents device destruction due to mismatched supply and input voltages.

Features

- High noise immunity:
VHC $V_{NIH} = V_{NIL} = 28\% V_{CC}$ (min)
VHCT $V_{IH} = 2.0V$, $V_{IL} = 0.8V$
- Power down protection:
VHC inputs only
VHCT inputs and outputs
- Low power dissipation:
 $I_{CC} = 2 \mu A$ (max) at $T_A = 25^\circ C$
- Balanced propagation delays: $t_{PLH} \cong t_{PHL}$

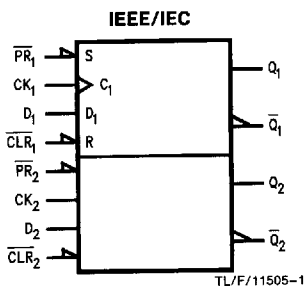
NOTE: ADD EXTERNAL PULL UP RESISTOR TO VHCT OUTPUTS TO DRIVE CMOS INPUTS

Ordering Code: See Section 6

Commercial	Package Number	Package Description
74VHC74M	M14A	14-Lead Molded JEDEC SOIC
74VHC74SJ	M14D	14-Lead Molded EIAJ SOIC
74VHC74MSC	MSC14	14-Lead Molded EIAJ Type 1 SSOP
74VHC74MTC	MTC14	14-Lead Molded JEDEC Type 1 TSSOP
74VHC74N	N14A	14-Lead Molded DIP
74VHCT74M	M14A	14-Lead Molded JEDEC SOIC
74VHCT74SJ	M14D	14-Lead Molded EIAJ SOIC
74VHCT74MTC	MTC14	14-Lead Molded JEDEC Type 1 TSSOP
74VHCT74N	N14A	14-Lead Molded DIP

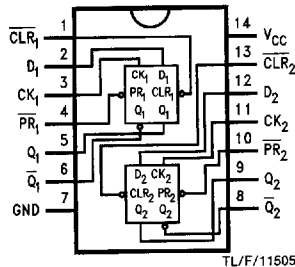
Note: Surface mount packages are also available on Tape and Reel. Specify by appending the suffix letter "X" to the ordering code. EIAJ Type 1 SSOP available on Tape and Reel only, Order MSCX.

Logic Symbol



Connection Diagram

Pin Assignment for DIP, SSOP, TSSOP and SOIC



Pin Names	Description
D ₁ , D ₂	Data Inputs
CK ₁ , CK ₂	Clock Pulse Inputs
CLR ₁ , CLR ₂	Direct Clear Inputs
PR ₁ , PR ₂	Direct Preset Inputs
Q ₁ , Q ₁ , Q ₂ , Q ₂	Outputs

Inputs				Outputs		Function
CLR	PR	D	CK	Q	Q̄	
L	H	X	X	L	H	Clear Preset
H	L	X	X	H	L	
L	L	X	X	H	H	
H	H	L	⌊	L	H	
H	H	H	⌋	H	L	
H	H	X	⌋	Q _n	Q _n	No Change

Absolute Maximum Ratings (Note 1)

Supply Voltage (V_{CC})	-0.5V to +7.0V
DC Input Voltage (V_{IN})	-0.5V to +7.0V
DC Output Voltage (V_{OUT})	
VHC	-0.5V to V_{CC} + 0.5V
VHCT*	-0.5V to 7.0V
Input Diode Current (I_{IK})	-20 mA
Output Diode Current (I_{OK})	
VHC	±20 mA
VHCT	-20 mA
DC Output Current (I_{OUT})	±25 mA
DC V_{CC} /GND Current (I_{CC})	±50 mA
Storage Temperature (T_{STG})	-65°C to +150°C
Lead Temperature (T_L)	
Soldering (10 seconds)	260°C

* $V_{OUT} > V_{CC}$ only if output is in H state.

Note 1: Absolute maximum ratings are values beyond which the device may be damaged or have its useful life impaired. The databook specifications should be met, without exception, to ensure that the system design is reliable over its power supply, temperature, and output/input loading variables. National does not recommend operation outside databook specifications.

Recommended Operating Conditions

Supply Voltage (V_{CC})	
VHC	2.0V to 5.5V
VHCT	4.5V to 5.5V
Input Voltage (V_{IN})	0V to +5.5V
Output Voltage (V_{OUT})	0V to V_{CC}
Operating Temperature (T_{OPR})	
74VHC/VHCT	-40°C to +85°C
Input Rise and Fall Time (t_r, t_f)	
$V_{CC} = 3.3V \pm 0.3V$ (VHC only)	0 ~ 100 ns/V
$V_{CC} = 5.0V \pm 0.5V$	0 ~ 20 ns/V

DC Characteristics for 'VHC Family Devices

Symbol	Parameter	V_{CC} (V)	74VHC			74VHC		Units	Conditions	
			$T_A = 25^\circ\text{C}$			$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$				
			Min	Typ	Max	Min	Max			
V_{IH}	High Level Input Voltage	2.0 3.0-5.5	1.50			1.50		V		
			0.7 V_{CC}			0.7 V_{CC}				
V_{IL}	Low Level Input Voltage	2.0 3.0-5.5		0.50		0.50		V		
			0.3 V_{CC}			0.3 V_{CC}				
V_{OH}	High Level Output Voltage	2.0	1.9	2.0		1.9		V	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OH} = -50 \mu\text{A}$
		3.0	2.9	3.0		2.9				
		4.5	4.4	4.5		4.4		V		$I_{OH} = -4 \text{ mA}$ $I_{OH} = -8 \text{ mA}$
		3.0	2.58			2.48				
4.5	3.94			3.80						
V_{OL}	Low Level Output Voltage	2.0		0.0	0.1		0.1	V	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OL} = 50 \mu\text{A}$
		3.0		0.0	0.1		0.1			
		4.5		0.0	0.1		0.1	V		$I_{OL} = 4 \text{ mA}$ $I_{OL} = 8 \text{ mA}$
		3.0			0.36		0.44			
		4.5			0.36		0.44			
		3.0								
4.5										
I_{IN}	Input Leakage Current	0-5.5			±0.1		±1.0	μA	$V_{IN} = 5.5V$ or GND	
I_{CC}	Quiescent Supply Current	5.5			2.0		20.0	μA	$V_{IN} = V_{CC}$ or GND	

DC Characteristics for 'VHCT Family Devices

Symbol	Parameter	V _{CC} (V)	74VHCT			74VHCT		Units	Conditions	
			T _A = 25°C			T _A = -40°C to +85°C				
			Min	Typ	Max	Min	Max			
V _{IH}	High Level Input Voltage	4.5	2.0			2.0		V		
		5.5	2.0			2.0				
V _{IL}	Low Level Input Voltage	4.5	0.8			0.8		V		
		5.5	0.8			0.8				
V _{OH}	High Level Output Voltage	4.5	3.15	3.65	3.15		V	V _{IN} = V _{IH} or V _{IL}	I _{OH} = -50 μA	
		4.5	2.5			2.4			I _{OH} = -8 mA	
V _{OL}	Low Level Output Voltage	4.5	0.0 0.1			0.1		V	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 50 μA
		4.5	0.36			0.44				I _{OL} = 8 mA
I _{IN}	Input Leakage Current	0-5.5	±0.1			±1.0		μA	V _{IN} = 5.5V or GND	
I _{CC}	Quiescent Supply Current	5.5	2.0			20.0		μA	V _{IN} = V _{CC} or GND	
I _{CC} T	Maximum I _{CC} /Input	5.5	1.35			1.50		mA	V _{IN} = 3.4V Other Inputs = V _{CC} or GND	
I _{OPD}	Output Leakage Current (Power Down State)	0.0	+0.5			+5.0		μA	V _{OUT} = 5.5V	

AC Electrical Characteristics for 'VHC: See Section 2 for Waveforms

Symbol	Parameter	V _{CC} (V)	74VHC			74VHC		Units	Conditions	Fig. No.
			T _A = 25°C			T _A = -40°C to +85°C				
			Min	Typ	Max	Min	Max			
f _{MAX}	Maximum Clock Frequency	3.3 ± 0.3	80	125		70		MHz	C _L = 15 pF	
			50	75		45			C _L = 50 pF	
		5.0 ± 0.5	130	170		110		MHz	C _L = 15 pF	
			90	115		75			C _L = 50 pF	
t _{PLH} , t _{PHL}	Propagation Delay Time (CK-Q, \bar{Q})	3.3 ± 0.3	6.7	11.9		1.0	14.0	ns	C _L = 15 pF	2-5, 6
			9.2	15.4		1.0	17.5		C _L = 50 pF	2-5, 6
		5.0 ± 0.5	4.6	7.3		1.0	8.5	ns	C _L = 15 pF	2-5, 6
			6.1	9.3		1.0	10.5		C _L = 50 pF	2-5, 6
t _{PLH} , t _{PHL}	Propagation Delay Time (CLR, PR-Q, \bar{Q})	3.3 ± 0.3	7.6	12.3		1.0	14.5	ns	C _L = 15 pF	2-5, 6
			10.1	15.8		1.0	18.0		C _L = 50 pF	2-5, 6
		5.0 ± 0.5	4.8	7.7		1.0	9.0	ns	C _L = 15 pF	2-5, 6
			6.3	9.7		1.0	11.0		C _L = 50 pF	2-5, 6
C _{IN}	Input Capacitance		4	10		10	pF	V _{CC} = Open		
C _{PD}	Power Dissipation Capacitance		25				pF	(Note 1)		

Note 1: C_{PD} is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained from the equation: I_{CC} (opr.) = C_{PD} * V_{CC} * f_{IN} + I_{CC}/2 (per F/F).

AC Operating Requirements for 'VHC: See Section 2 for Waveforms

Symbol	Parameter	*V _{CC} (V)	74VHC		74VHC		Units	Conditions	Fig. No.
			T _A = 25°C		T _A = -40°C to +85°C				
			Typ	Guaranteed Minimum					
t _{W(L)}	Minimum Pulse Width (CK)	3.3	6.0	7.0		ns		2-6	
t _{W(H)}		5.0	5.0	5.0					
t _{W(L)}	Minimum Pulse Width (CLR, PR)	3.3	6.0	7.0		ns		2-6	
		5.0	5.0	5.0					
t _S	Minimum Setup Time	3.3	6.0	7.0		ns		2-9	
		5.0	5.0	5.0					
t _H	Minimum Hold Time	3.3	0.5	0.5		ns		2-9	
		5.0	0.5	0.5					
t _{rem}	Minimum Removal Time (CLR, PR)	3.3	5.0	5.0		ns		2-6, 9	
		5.0	3.0	3.0					

*V_{CC} is 3.3 ± 0.3V or 5.0 ± 0.5V

AC Electrical Characteristics for 'VHCT: See Section 2 for Waveforms

Symbol	Parameter	*V _{CC} (V)	74VHCT			74VHCT		Units	Conditions	Fig. No.
			T _A = 25°C			T _A = -40°C to +85°C				
			Min	Typ	Max	Min	Max			
f _{MAX}	Maximum Clock Frequency	5.0	100	160	80		MHz	C _L = 15 pF		
		5.0	80	140	65			C _L = 50 pF		
t _{PLH} , t _{PHL}	Propagation Delay Time (CK-Q, \bar{Q})	5.0	5.8	7.8	1.0	9.0	ns	C _L = 15 pF	2-5, 6	
		5.0	6.3	8.8	1.0	10.0		C _L = 50 pF	2-5, 6	
t _{PLH} , t _{PHL}	Propagation Delay Time ($\bar{C}LR$, $\bar{P}R$ -Q, \bar{Q})	5.0	7.6	10.4	1.0	12.0	ns	C _L = 15 pF	2-5, 6	
		5.0	8.1	11.4	1.0	13.0		C _L = 50 pF	2-5, 6	
C _{IN}	Input Capacitance		4	10	10		pF	V _{CC} = Open		
C _{PD}	Power Dissipation Capacitance		24				pF	(Note 1)		

*V_{CC} is 5.0 ± 0.5V

Note 1: C_{PD} is defined as the value of internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the equation: I_{CC (opr)} = C_{PD} × V_{CC} × f_{IN} + I_{CC/2} (per flip-flop).

AC Operating Requirements for 'VHCT: See Section 2 for Waveforms

Symbol	Parameter	V _{CC} (V)	74VHCT		74VHCT		Units	Conditions	Fig. No.
			T _A = 25°C		T _A = -40°C to +85°C				
			Typ	Guaranteed Minimum					
t _{W(L)} t _{W(H)}	Minimum Pulse Width (CK)	5.0 ± 0.5			5.0		ns		2-6
t _{W(L)}	Minimum Pulse Width ($\bar{C}LR$, $\bar{P}R$)	5.0 ± 0.5		5.0	5.0		ns		2-6
t _S	Minimum Setup Time	5.0 ± 0.5		5.0	5.0		ns		2-9
t _H	Minimum Hold Time	5.0 ± 0.5		0	0		ns		2-9
t _{rem}	Minimum Removal Time ($\bar{C}LR$, $\bar{P}R$)	5.0 ± 0.5		3.5	3.5		ns		2-6, 9