Data sheet acquired from Harris Semiconductor
SCHS207

February 1998

CD74HC4060, CD74HCT4060

High Speed CMOS Logic 14-Stage Binary Counter with Oscillator

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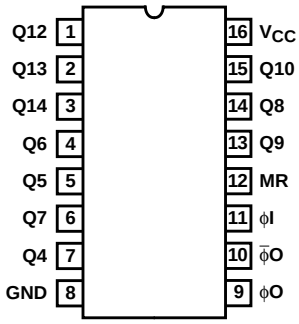
Features

- Onboard Oscillator
- Common Reset
- Negative Edge Clocking
- Typical f_{MAX} = 50MHz at V_{CC} = 5V, C_L = 15pF, $T_A = 25^oC$
- Fanout (Over Temperature Range)
  - Standard Outputs . . . . . 10 LSTTL Loads
  - Bus Driver Outputs . . . . . 15 LSTTL Loads
- Wide Operating Temperature Range . . . -55^oC to 125^oC
- Balanced Propagation Delay and Transition Times
- Significant Power Reduction Compared to LSTTL Logic ICs
- HC Types
  - 2V to 6V Operation
  - High Noise Immunity: N_{IL} = 30%, N_{IH} = 30% of V_{CC} at V_{CC} = 5V
- HCT Types
  - 4.5V to 5.5V Operation
  - Direct LSTTL Input Logic Compatibility, V_{IL}= 0.8V (Max), V_{IH} = 2V (Min)
  - CMOS Input Compatibility, $I_I \leq 1\mu A$ at V_{OL}, V_{OH}

Pinout

CD74HC4060, CD74HCT4060
(PDIP, SOIC)
TOP VIEW



CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper IC Handling Procedures.
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Description

The Harris CD74HC4060 and CD74HCT4060 each consist of an oscillator section and 14 ripple-carry binary counter stages. The oscillator configuration allows design of either RC or crystal oscillator circuits. A Master Reset input is provided which resets the counter to the all-0's state and disables the oscillator. A high level on the MR line accomplishes the reset function. All counter stages are master-slave flip-flops. The state of the counter is advanced one step in binary order on the negative transition of ϕI (and ϕO). All inputs and outputs are buffered. Schmitt trigger action on the input-pulse-line permits unlimited rise and fall times.

In order to achieve a symmetrical waveform in the oscillator section the HCT4060 input pulse switch points are the same as in the HC4060; only the MR input in the HCT4060 has TTL switching levels.

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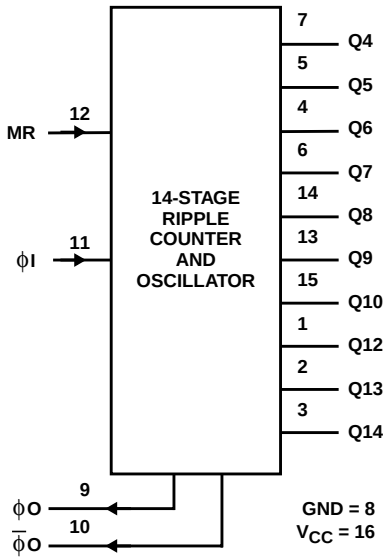
Ordering Information

PART NUMBER	TEMP. RANGE (^{o}C)	PACKAGE	PKG. NO.
CD74HC4060E	-55 to 125	16 Ld PDIP	E16.3
CD74HCT4060E	-55 to 125	16 Ld PDIP	E16.3
CD74HC4060M	-55 to 125	16 Ld SOIC	M16.15
CD74HCT4060M	-55 to 125	16 Ld SOIC	M16.15

NOTES:

1. When ordering, use the entire part number. Add the suffix 96 to obtain the variant in the tape and reel.
2. Wafer and die for this part number is available which meets all electrical specifications. Please contact your local sales office or Harris customer service for ordering information.

Functional Diagram



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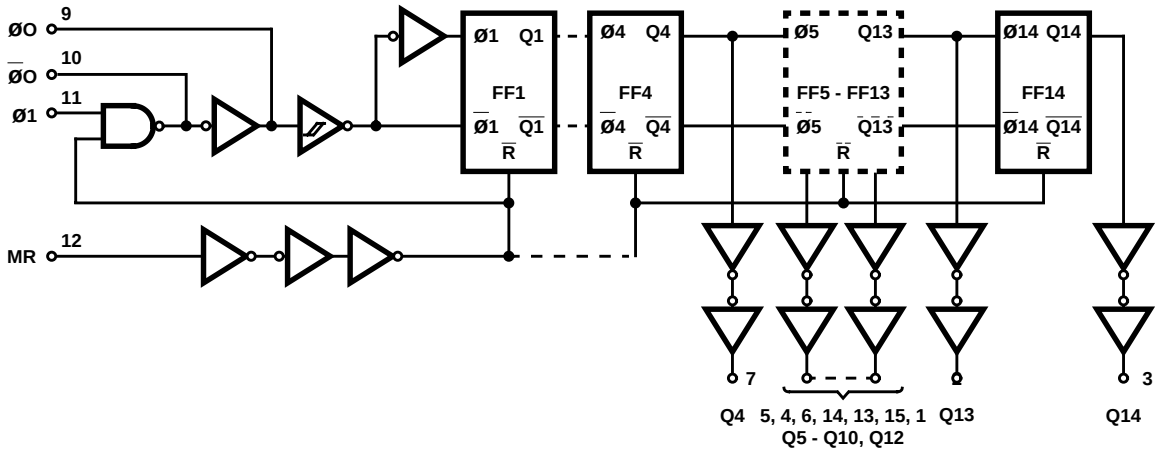

FIGURE 1. LOGIC BLOCK DIAGRAM

TRUTH TABLE

ØI	MR	OUTPUT STATE
↑	L	No Change
↓	L	Advance to Next State
X	H	All Outputs are Low

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Absolute Maximum Ratings

DC Supply Voltage, V_{CC} . . . . . -0.5V to 7V
DC Input Diode Current, I_{IK}
For V_I < -0.5V or V_I > V_{CC} + 0.5V . . . . . ±20mA
DC Output Diode Current, I_{OK}
For V_O < -0.5V or V_O > V_{CC} + 0.5V . . . . . ±20mA
DC Drain Current, per Output, I_O
For -0.5V < V_O < V_{CC} + 0.5V . . . . . ±25mA
DC V_{CC} or Ground Current, I_{CC} . . . . . ±50mA

Thermal Information

Thermal Resistance (Typical, Note 3) θ_{JA} ($^oC/W$)
PDIP Package 90
SOIC Package 160
Maximum Junction Temperature . . . . . 150^oC
Maximum Storage Temperature Range . . . . . -65^oC to 150^oC
Maximum Lead Temperature (Soldering 10s) . . . . . 300^oC
(SOIC - Lead Tips Only)

Operating Conditions

Temperature Range, T_A . . . . . -55^oC to 125^oC
Supply Voltage Range, V_{CC}
HC Types . . . . . 2V to 6V
HCT Types . . . . . 4.5V to 5.5V
DC Input or Output Voltage, V_I, V_O . . . . . 0V to V_{CC}
Input Rise and Fall Time
2V . . . . . 1000ns (Max)
4.5V . . . . . 500ns (Max)
6V . . . . . 400ns (Max)

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CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

NOTE:

3. θ_{JA} is measured with the component mounted on an evaluation PC board in free air.

DC Electrical Specifications

PARAMETER	SYMBOL	TEST CONDITIONS V_I (V)	TEST CONDITIONS I_O (mA)	V_{CC} (V)	25^oC MIN	25^oC TYP	25^oC MAX	-40^oC TO 85^oC MIN	-40^oC TO 85^oC MAX	-55^oC TO 125^oC MIN	-55^oC TO 125^oC MAX	UNITS
HC TYPES												
High Level Input Voltage	V_{IH}	-	-	2	1.5	-	-	1.5	-	1.5	-	V
				4.5	3.15	-	-	3.15	-	3.15	-	V
				6	4.2	-	-	4.2	-	4.2	-	V
Low Level Input Voltage	V_{IL}	-	-	2	-	-	0.5	-	0.5	-	0.5	V
				4.5	-	-	1.35	-	1.35	-	1.35	V
				6	-	-	1.8	-	1.8	-	1.8	V
High Level Output Voltage Q Outputs CMOS Loads	V_{OH}	V_{IH} or V_{IL}	-0.02	2	1.9	-	-	1.9	-	1.9	-	V
			-0.02	4.5	4.4	-	-	4.4	-	4.4	-	V
			-0.02	6	5.9	-	-	5.9	-	5.9	-	V
High Level Output Voltage Q Outputs TTL Loads			-	-	-	-	-	-	-	-	-	V
			-4	4.5	3.98	-	-	3.84	-	3.7	-	V
			-5.2	6	5.48	-	-	5.34	-	5.2	-	V
Low Level Output Voltage Q Outputs CMOS Loads	V_{OL}	V_{IH} or V_{IL}	0.02	2	-	-	0.1	-	0.1	-	0.1	V
			0.02	4.5	-	-	0.1	-	0.1	-	0.1	V
			0.02	6	-	-	0.1	-	0.1	-	0.1	V
Low Level Output Voltage Q Outputs TTL Loads			-	-	-	-	-	-	-	-	-	V
			4	4.5	-	-	0.26	-	0.33	-	0.4	V
			5.2	6	-	-	0.26	-	0.33	-	0.4	V
High-Level Output Voltage $\bar{\phi}$O Output (Pin 10) CMOS Loads	V_{OH}	V_{CC} or GND	-0.02	2	1.9	-	-	1.9	-	1.9	-	V
			-0.02	4.5	4.4	-	-	4.4	-	4.4	-	V
			-0.02	6	5.9	-	-	5.9	-	5.9	-	V

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DC Electrical Specifications (Continued)

PARAMETER	SYMBOL	TEST CONDITIONS		V_{CC} (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS
		V_I (V)	I_O (mA)		MIN	TYP	MAX	MIN	MAX	MIN	MAX	
High-Level Output Voltage $\bar{\phi}$O Output (Pin 10) TTL Loads Note 6	V_{OH}	V_{CC} or GND	-2.6	4.5	3.98	-	-	3.84	-	3.7	-	V
			-3.3	6	5.48	-	-	5.34	-	5.2	-	V
Low-Level Output Voltage $\bar{\phi}$O Output (Pin 10) CMOS Loads	V_{OL}	V_{CC} or GND	0.02	2	-	-	0.1	-	0.1	-	0.1	V
			0.02	4.5	-	-	0.1	-	0.1	-	0.1	V
			0.02	6	-	-	0.1	-	0.1	-	0.1	V
Low-Level Output Voltage $\bar{\phi}$O Output (Pin 10) TTL Loads	V_{OL}	V_{CC} or GND	2.6	4.5	-	-	0.26	-	0.33	-	0.4	V
			3.3	6	-	-	0.26	-	0.33	-	0.4	V
High-Level Output Voltage ϕO Output (Pin 9) TTL Loads	V_{OH}	V_{IL} or V_{IH}	-3.2	4.5	3.98	-	-	3.84	-	3.7	-	V
			-4.2	6	5.48	-	-	5.34	-	5.2	-	V
Low-Level Output Voltage ϕO Output (Pin 9) TTL Loads	V_{OL}	V_{IL} or V_{IH}	-2.6	4.5	-	-	0.26	-	0.33	-	0.4	V
			-3.3	6	-	-	0.26	-	0.33	-	0.4	V
Input Leakage Current	I_I	V_{CC} or GND	-	6	-	-	±0.1	-	±1	-	±1	µA
Quiescent Device Current	I_{CC}	V_{CC} or GND	0	6	-	-	8	-	80	-	160	µA
HCT TYPES												
High Level Input Voltage	V_{IH}	-	-	4.5 to 5.5	2	-	-	2	-	2	-	V
Low Level Input Voltage	V_{IL}	-	-	4.5 to 5.5	-	-	0.8	-	0.8	-	0.8	V
High Level Output Voltage Q Outputs CMOS Loads	V_{OH}	V_{IH} or V_{IL} Note 5	-0.02	4.5	4.4	-	-	4.4	-	4.4	-	V
High Level Output Voltage Q Outputs TTL Loads			-4	4.5	3.98	-	-	3.84	-	3.7	-	V
Low Level Output Voltage Q Outputs CMOS Loads	V_{OL}	V_{IH} or V_{IL} Note 5	0.02	4.5	-	-	0.1	-	0.1	-	0.1	V
Low Level Output Voltage Q Outputs TTL Loads			4	4.5	-	-	0.26	-	0.33	-	0.4	V
High-Level Output Voltage $\bar{\phi}$O Output (Pin 10) CMOS Loads	V_{OH}	V_{CC} or GND	-0.02	4.5	4.4	-	-	4.4	-	4.4	-	V
High-Level Output Voltage $\bar{\phi}$O Output (Pin 10) TTL Loads Note 6	V_{OH}	V_{CC} or GND	-2.6	4.5	3.98	-	-	3.84	-	3.7	-	V
Low-Level Output Voltage $\bar{\phi}$O Output (Pin 10) CMOS Loads	V_{OL}	V_{CC} or GND	0.02	4.5	-	-	0.1	-	0.1	-	0.1	V

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DC Electrical Specifications (Continued)

PARAMETER	SYMBOL	TEST CONDITIONS		V_{CC} (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS
		V_I (V)	I_O (mA)		MIN	TYP	MAX	MIN	MAX	MIN	MAX	
Low-Level Output Voltage $\bar{\phi}$O Output (Pin 10) TTL Loads	V_{OL}	V_{CC} or GND	2.6	4.5	-	-	0.26	-	0.33	-	0.4	V
High-Level Output Voltage ϕO Output (Pin 9) TTL Loads	V_{OH}	V_{IL} or V_{IH}	-3.2	4.5	3.98	-	-	3.84	-	3.7	-	V
Low-Level Output Voltage ϕO Output (Pin 9) TTL Loads	V_{OL}	V_{IH} or V_{IL} Note 5	3.2	4.5	-		0.26	-	0.33	-	0.4	V
Input Leakage Current	I_I	Any Voltage Between V_{CC} and GND	0	5.5	-		±0.1	-	±1	-	±1	µA
Quiescent Device Current	I_{CC}	V_{CC} or GND	0	5.5	-	-	8	-	80	-	160	µA
Additional Quiescent Device Current Per Input Pin: 1 Unit Load	ΔI_{CC} (Note 4)	V_{CC} -2.1	-	4.5 to 5.5	-	100	360	-	450	-	490	µA

NOTES:

4. For dual-supply systems theoretical worst case (V_I = 2.4V, V_{CC} = 5.5V) specification is 1.8mA.
5. For pin 11 V_{IH} = 3.15V, V_{IL} = 0.9V.
6. Limits not valid when pin 12 (instead of pin 11) is used as control input.

HCT Input Loading Table

INPUT	UNIT LOADS
MR	0.35

NOTE: Unit Load is ΔI_{CC} limit specified in DC Electrical Specifications Table, e.g. 360µA max at 25°C.

Prerequisite for Switching Specifications

PARAMETER	SYMBOL	V_{CC} (V)	25°C			-40°C TO 85°C			-55°C TO 125°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
HC TYPES												
Maximum Input Pulse Frequency	t_{MAX}	2	6	-	-	5	-	-	4	-	-	MHz
		4.5	30	-	-	25	-	-	20	-	-	MHz
		6	35	-	-	29	-	-	23	-	-	MHz
Input Pulse Width	t_W	2	80	-	-	100	-	-	120	-	-	ns
		4.5	16	-	-	20	-	-	24	-	-	ns
		6	14	-	-	17	-	-	20	-	-	ns
Reset Removal Time	t_{REM}	2	100	-	-	125	-	-	150	-	-	ns
		4.5	20	-	-	25	-	-	30	-	-	ns
		6	17	-	-	21	-	-	26	-	-	ns

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Prerequisite for Switching Specifications (Continued)

PARAMETER	SYMBOL	V_{CC} (V)	25°C			-40°C TO 85°C			-55°C TO 125°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Reset Pulse Width	t_W	2	80	-	-	100	-	-	120	-	-	ns
		4.5	16	-	-	20	-	-	24	-	-	ns
		6	14	-	-	17	-	-	20	-	-	ns
HCT TYPES												
Maximum Input, Pulse Frequency	t_{MAX}	4.5	30	-	-	25	-	-	20	-	-	MHz
Input Pulse Width	t_W	4.5	16	-	-	20	-	-	24	-	-	ns
Reset Removal Time	t_{REM}	4.5	26	-	-	33	-	-	39	-	-	ns
Reset Pulse Width	t_W	4.5	25	-	-	31	-	-	38	-	-	ns

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Switching Specifications Input t_r, t_f = 6ns

PARAMETER	SYMBOL	TEST CONDITIONS	V_{CC} (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
HC TYPES											
Propagation Delay ϕI to Q4	t_{PLH}, t_{PHL}	C_L = 50pF	2	-	-	300	-	375	-	450	ns
			4.5	-	-	60	-	75	-	90	ns
		C_L = 15pF	5	-	25	-	-	-	-	-	ns
		C_L = 50pF	6	-	-	51	-	64	-	78	ns
Q_n to Q_{n+1}	t_{PLH}, t_{PHL}	C_L = 50pF	2	-	-	80	-	100	-	120	ns
			4.5	-	-	16	-	20	-	24	ns
		C_L = 15pF	5	-	6	-	-	-	-	-	ns
		C_L = 50pF	6	-	-	14	-	17	-	20	ns
MR to Q_n	t_{PHL}	C_L = 50pF	2	-	-	175	-	220	-	265	ns
			4.5	-	-	35	-	44	-	53	ns
		C_L = 15pF	5	-	14	-	-	-	-	-	ns
		C_L = 50pF	6	-	-	30	-	37	-	45	ns
Output Transition Time	t_{THL}, t_{TLH}	C_L = 50pF	2	-	-	75	-	95	-	110	ns
			4.5	-	-	15	-	19	-	22	ns
			6	-	-	13	-	16	-	19	ns
Input Capacitance	C_I (TBD)										
Propagation Dissipation Capacitance	C_{PD}	-	-	-	40	-	-	-	-	-	pF
HCT TYPES											
Propagation Delay ϕI to Q4	t_{PLH}, t_{PHL}	C_L = 50pF	2	-	-	-	-	-	-	-	-ns
			4.5	-	-	66	-	83	-	100	ns
		C_L = 15pF	5	-	25	-	-	-	-	-	-ns
		C_L = 50pF	6	-	-	-	-	-	-	-	-ns

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Switching Specifications Input t_r, t_f = 6ns (Continued)

PARAMETER	SYMBOL	TEST CONDITIONS	V_{CC} (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
Q_n to Q_{n+1}	t_{PLH}, t_{PHL}	C_L = 50pF	2	-	-	-	-	-	-	-	ns
			4.5	-	-	16	-	20	-	24	ns
		C_L = 15pF	5	-	6	-	-	-	-	-	ns
		C_L = 50pF	6	-	-	-	-	-	-	-	ns
MR to Q_n	t_{PHL}	C_L = 50pF	2	-	-	-	-	-	-	-	ns
			4.5	-	-	44	-	55	-	66	ns
		C_L = 15pF	5	-	17	-	-	-	-	-	ns
		C_L = 50pF	6	-	-	-	-	-	-	-	ns
Output Transition Time	t_{THL}, t_{TLH}	C_L = 50pF	2	-	-	-	-	-	-	-	ns
			4.5	-	-	15	-	19	-	22	ns
			6	-	-	-	-	-	-	-	ns
Input Capacitance	C_I (TBD)										
Propagation Dissipation Capacitance	C_{PD}	-	-	-	40	-	-	-	-	-	pF

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NOTES:

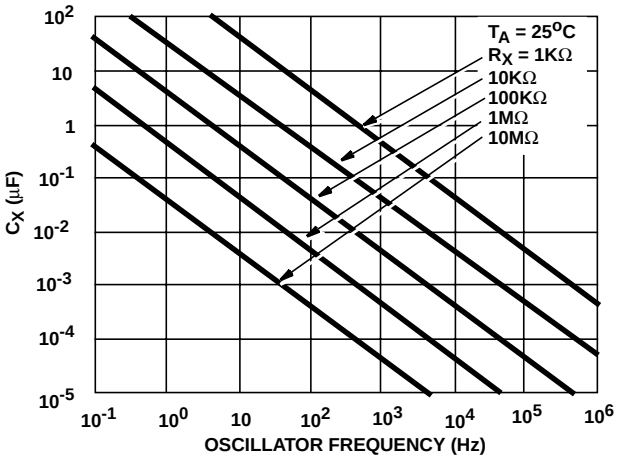
7. C_{PD} is used to determine the dynamic power consumption, per package.
8. $P_D = C_{PD} V_{CC}^2 f_i \Sigma(C_L V_{CC}^2 f_i/M)$ where $M = 2^1, 2^2, 2^3, ...2^{14}$, f_i = input frequency, C_L = output load capacitance.

TYPICAL LIMIT VALUES FOR R_X AND C_X

PARAMETER	TEST CONDITIONS	VOLTAGE	TYPICAL MAXIMUM LIMITS
R_X Minimum	C_X > 1000pF	2	1KΩ
	C_X > 10pF	4.5	
	C_X > 10pF	6	
R_X Maximum	C_X > 10pF	2	20MΩ
	C_X > 10pF	4.5	
	C_X > 10pF	6	
C_X Minimum	R_X > 10KΩ	2	10pF
	R_X > 10KΩ	4.5	
	R_X > 10KΩ	6	
	R_X = 1KΩ	2	1000pF
	R_X = 1KΩ	4.5	10pF
	R_X = 1KΩ	6	10pF
Maximum Astable Oscillator Frequency	C_X = 1000pF, R_X = 1KΩ	2	0.5MHz (Note 9)
	C_X = 100pF, R_X = 1KΩ	4.5	3MHz (Note 9)
	C_X = 100pF, R_X = 1KΩ	6	3MHz (Note 9)

NOTE:

9. At very high frequencies f = 1/2.2 $R_X C_X$ no longer gives an yaccurate approximation.



NOTE: OSC Frequency ≈ 1/2.2 $R_X C_X$
For 1MΩ > R_X > 1KΩ, C_X > 10pF, f < 1MHz

FIGURE 2. FREQUENCY OF ON-BOARD OSCILLATOR AS A FUNCTION OF C_X AND R_X

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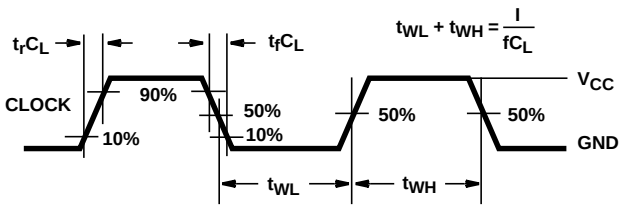
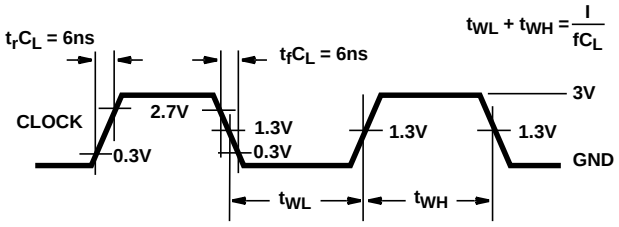
Typical Performance Curves



NOTE: Outputs should be switching from 10% V_{CC} to 90% V_{CC} in accordance with device truth table. For f_{MAX}, input duty cycle = 50%.

FIGURE 3. HC CLOCK PULSE RISE AND FALL TIMES AND PULSE WIDTH



NOTE: Outputs should be switching from 10% V_{CC} to 90% V_{CC} in accordance with device truth table. For f_{MAX}, input duty cycle = 50%.

FIGURE 4. HCT CLOCK PULSE RISE AND FALL TIMES AND PULSE WIDTH

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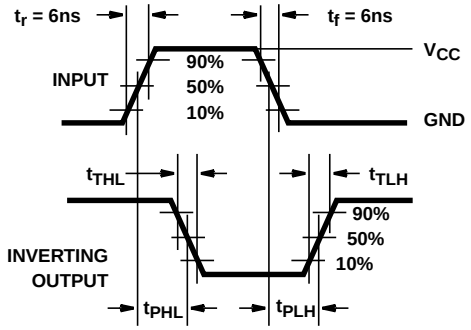

FIGURE 5. HC AND HCT TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

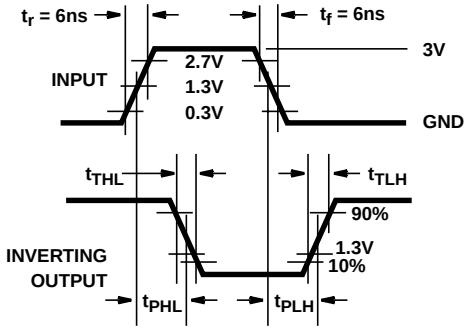

FIGURE 6. HCT TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

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