

CD54HC190, CD74HC190 CD54HC191, CD74HC191, CD54HCT191, CD74HCT191 SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL

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- 2-V to 6-V V_{CC} Operation ('HC190, 191)
- 4.5-V to 5.5-V V_{CC} Operation ('HCT191)
- Wide Operating Temperature Range of -55°C to 125°C
- Synchronous Counting and Asynchronous Loading
- Two Outputs for n-Bit Cascading
- Look-Ahead Carry for High-Speed Counting
- Balanced Propagation Delays and Transition Times
- Standard Outputs Drive Up To 15 LS-TTL Loads
- Significant Power Reduction Compared to LS-TTL Logic ICs

CD54HC190, 191; CD54HCT191 . . . F PACKAGE
CD74HC190 . . . E, NS, OR PW PACKAGE
CD74HC191, CD74HCT191 . . . E OR M PACKAGE
(TOP VIEW)



description/ordering information

The CD54/74HC190 are asynchronously presettable BCD decade counters, whereas the CD54/74HC191 and CD54/74HCT191 are asynchronously presettable binary counters.

Presetting the counter to the number on preset data inputs (A–D) is accomplished by a low asynchronous parallel load (LOAD) input. Counting occurs when LOAD is high, count enable (CTEN) is low, and the down/up (D/U) input is either high for down counting or low for up counting. The counter is decremented or incremented synchronously with the low-to-high transition of the clock.

ORDERING INFORMATION

T_A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING	
-55°C to 125°C	PDIP – E	Tube of 25	CD74HC190E	CD74HC190E	
			CD74HC191E	CD74HC191E	
			CD74HCT191E	CD74HCT191E	
	SOIC – M	Tube of 40	CD74HC191M	HC191M	
			Reel of 2500		CD74HC191M96
			Reel of 250		CD74HC191MT
		Tube of 40	CD74HCT191M	HCT191M	
	SOP – NS	Reel of 2000	CD74HC190NSR	HC190M	
	TSSOP – PW	Tube of 90	CD74HC190PW	HJ190	
		Reel of 2000	CD74HC190PWR		
		Reel of 250	CD74HC190PWT		
	CDIP – F	Tube of 25	CD54HC190F3A	CD54HC190F3A	
			CD54HC191F3A	CD54HC191F3A	
CD54HCT191F3A			CD54HCT191F3A		

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.



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**TEXAS
INSTRUMENTS**

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On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

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SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL



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description/ordering information (continued)

When an overflow or underflow of the counter occurs, the MAX/MIN output, which is low during counting, goes high and remains high for one clock cycle. This output can be used for look-ahead carry in high-speed cascading (see Figure 1). The MAX/MIN output also initiates the ripple clock (\overline{RCO}) output, which normally is high, goes low, and remains low for the low-level portion of the clock pulse. These counters can be cascaded using \overline{RCO} (see Figure 2).


If a decade counter is preset to an illegal state or assumes an illegal state when power is applied, it returns to the normal sequence in one or two counts, as shown in the state diagrams (see Figure 3).

FUNCTION TABLE

INPUTS				FUNCTION
\overline{LOAD}	\overline{CTEN}	D/\overline{U}	CLK	
H	L	L		Count up
H	L	H		Count down
L	X	X	X	Asynchronous preset
H	H	X	X	No change

$\overline{D/\overline{U}}$ or \overline{CTEN} should be changed only when clock is high.

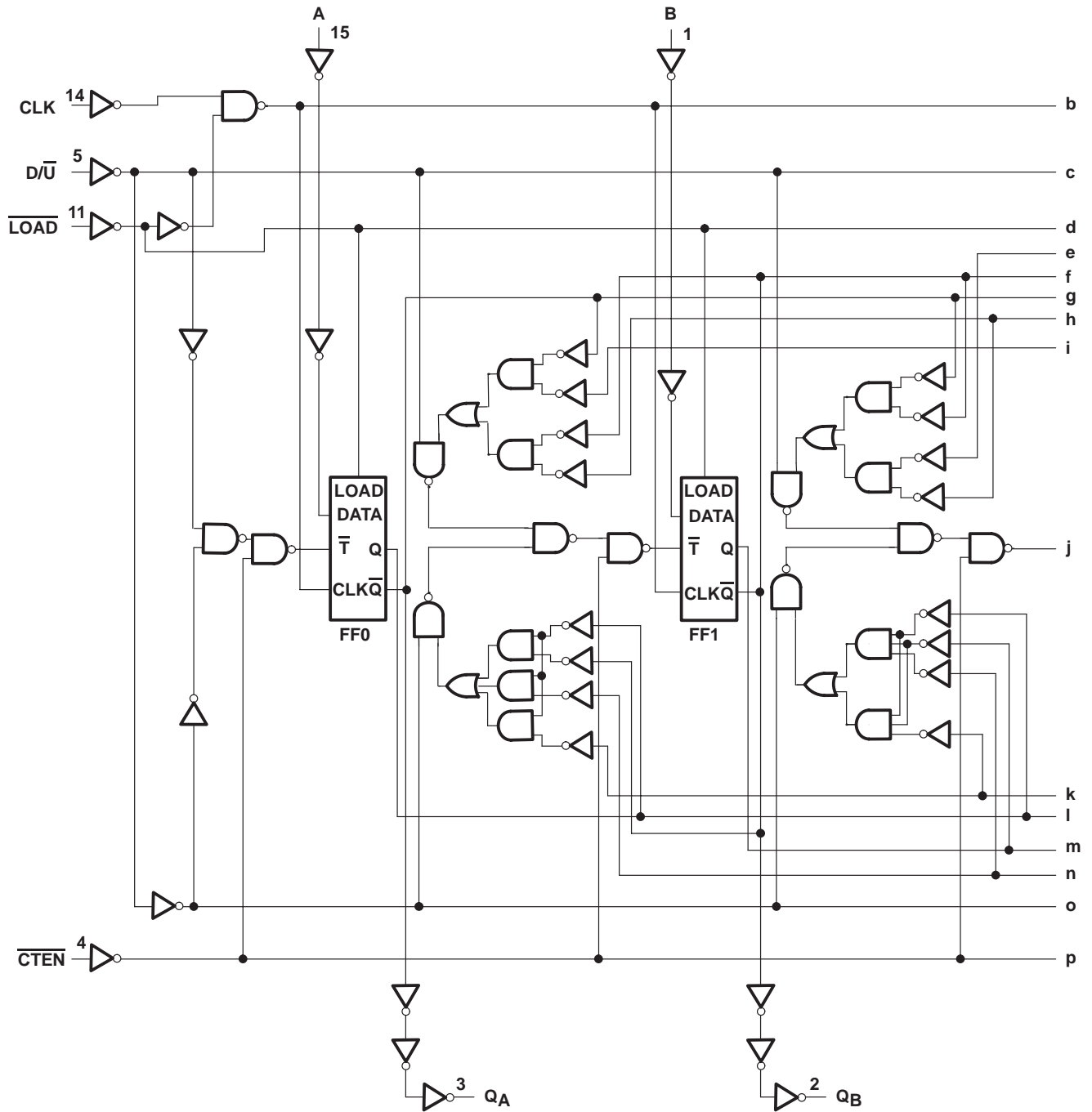
X = Don't care

 Low-to-high clock transition

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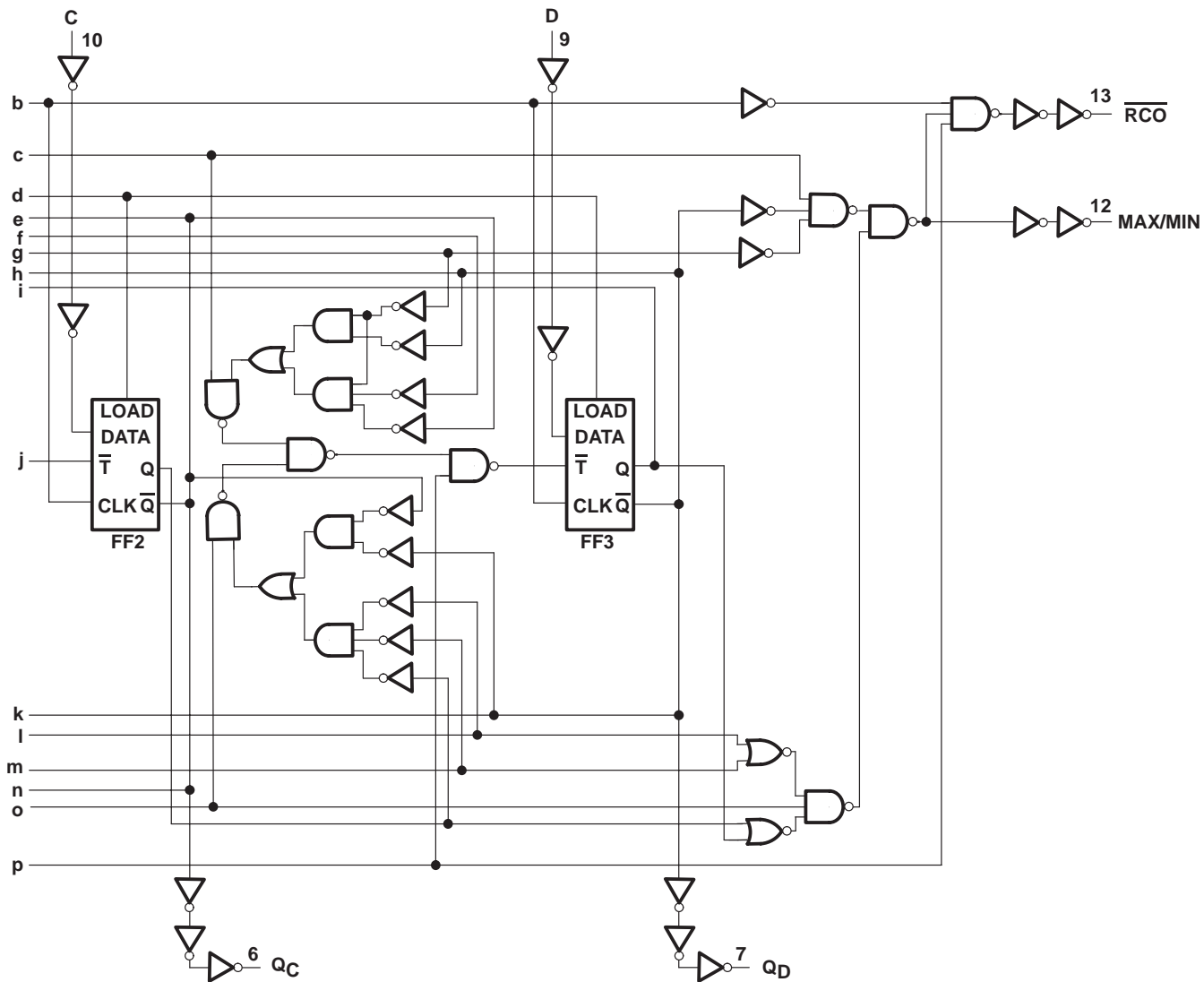
'HC190 logic diagram



CD54HC190, CD74HC190
CD54HC191, CD74HC191, CD54HCT191, CD74HCT191
SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL

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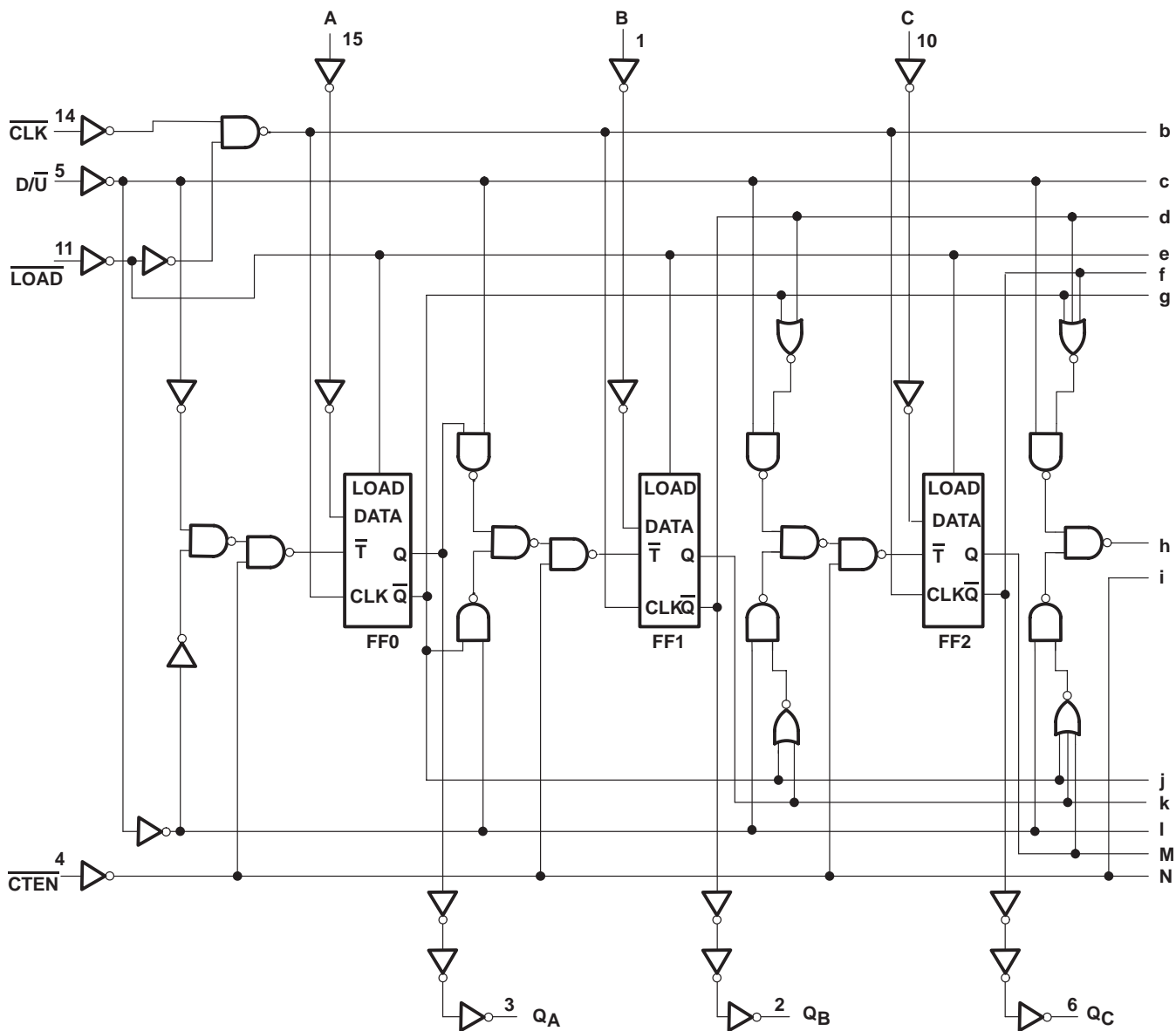
'HC190 logic diagram (continued)



CD54HC190, CD74HC190
CD54HC191, CD74HC191, CD54HCT191, CD74HCT191
SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL

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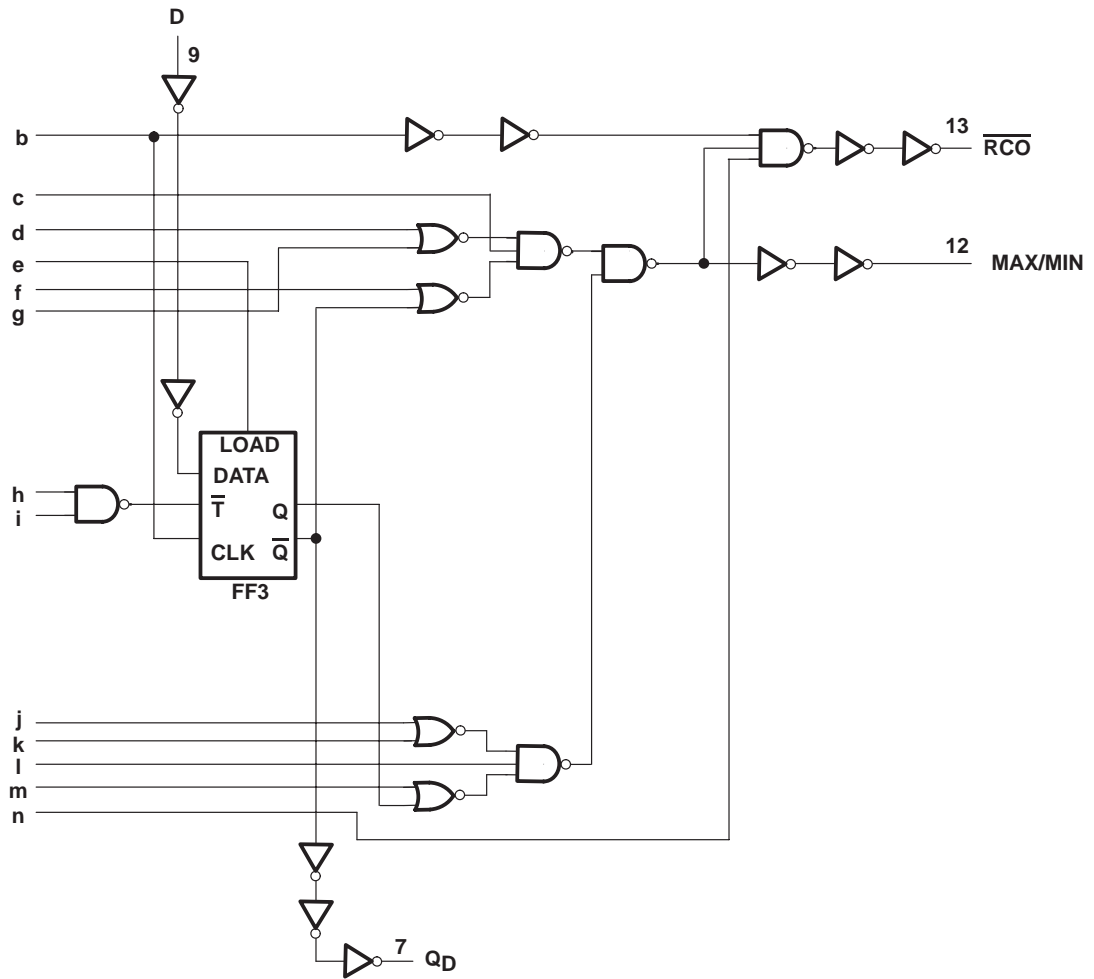
'HC191, 'HCT191 logic diagram



**CD54HC190, CD74HC190
 CD54HC191, CD74HC191, CD54HCT191, CD74HCT191
 SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL**

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'HC191, 'HCT191 logic diagram (continued)



CD54HC190, CD74HC190
CD54HC191, CD74HC191, CD54HCT191, CD74HCT191
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'HC190 and 'HC191/HCT191 flip-flop



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typical load, count, and inhibit sequence for 'HC190

The following sequence is illustrated below:

1. Load (preset) to BCD 7
2. Count up to 8, 9 (maximum), 0, 1, and 2
3. Inhibit
4. Count down to 1, 0 (minimum), 9, 8, and 7

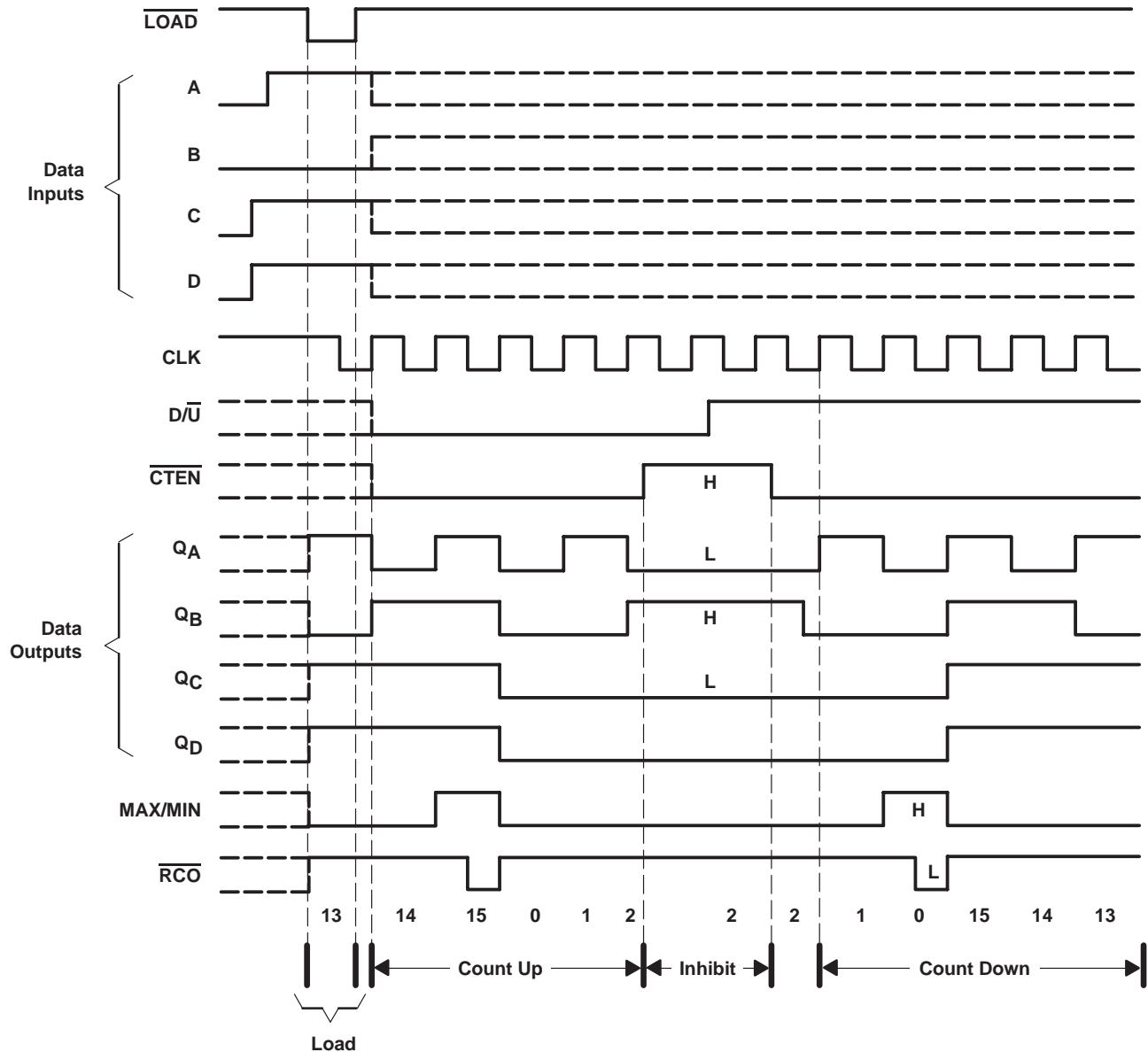


CD54HC190, CD74HC190
 CD54HC191, CD74HC191, CD54HCT191, CD74HCT191
SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL
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typical load, count, and inhibit sequence for 'HC191 and 'HCT191

The following sequence is illustrated below:

1. Load (preset) to binary 13
2. Count up to 14, 15 (maximum), 0, 1, and 2
3. Inhibit
4. Count down to 1, 0 (minimum), 15, 14, and 13



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SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL

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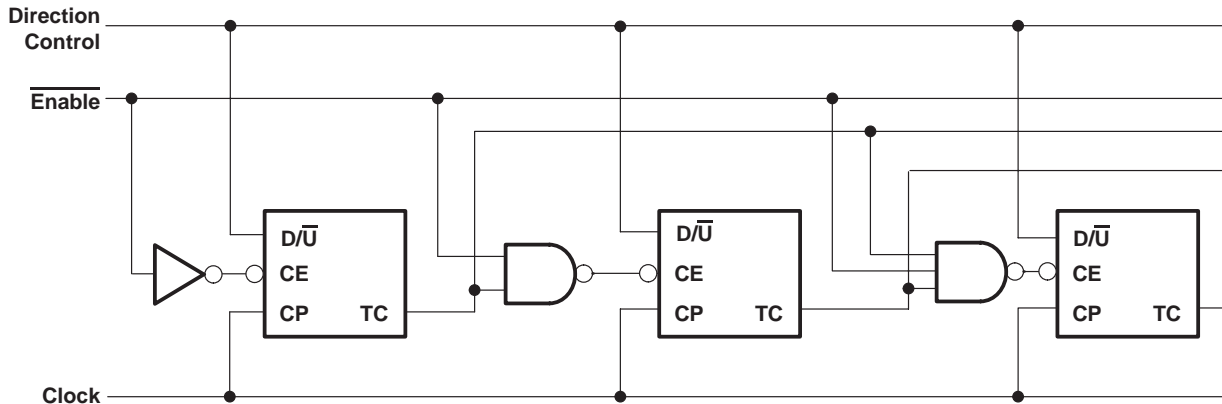


Figure 1. 'HC190 Synchronous n-Stage Counter With Parallel Gated Terminal Count

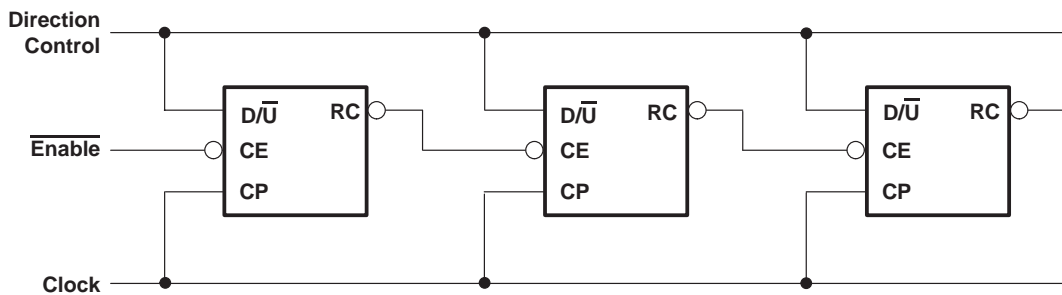
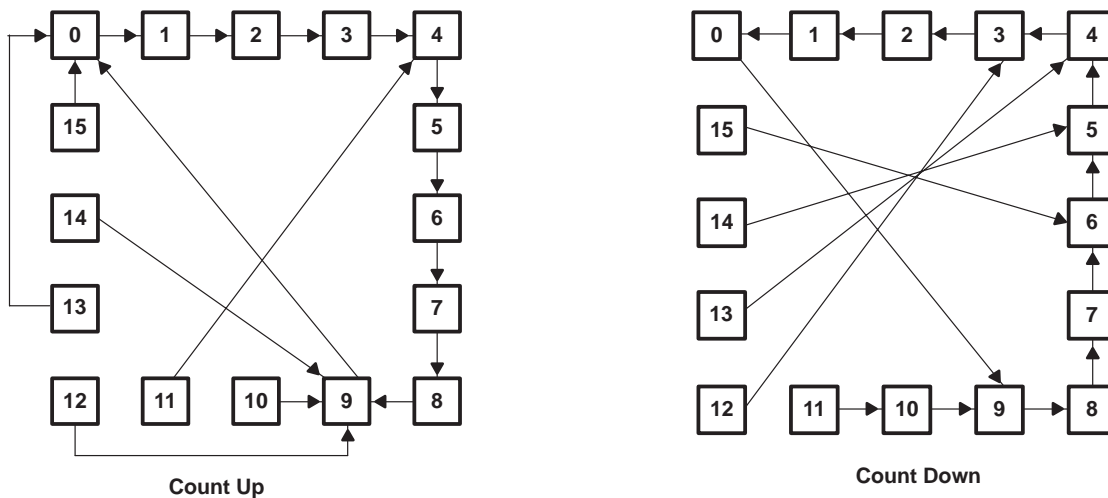


Figure 2. 'HC191, 'HCT191 Synchronous n-Stage Counter With Parallel Gated Terminal Count



NOTE: Illegal states in BCD counters corrected in one count

NOTE: Illegal states in BCD counters corrected in one or two counts

Figure 3. 'HC190 State Diagram

CD54HC190, CD74HC190
CD54HC191, CD74HC191, CD54HCT191, CD74HCT191
SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL

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absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage range, V_{CC}	–0.5 V to 7 V
Input clamp current, I_{IK} ($V_I < 0$ or $V_I > V_{CC}$) (see Note 1)	±20 mA
Output clamp current, I_{OK} ($V_O < 0$ or $V_O > V_{CC}$) (see Note 1)	±20 mA
Continuous output drain current per output, I_O ($V_O = 0$ to V_{CC})	±35 mA
Continuous output source or sink current per output, I_O ($V_O = 0$ to V_{CC})	±25 mA
Continuous current through V_{CC} or GND	±50 mA
Package thermal impedance, θ_{JA} (see Note 2): E package	67°C/W
M package	73°C/W
NS package	64°C/W
PW package	108°C/W
Storage temperature range, T_{stg}	–65°C to 150°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES: 1. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.
 2. The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions for 'HC190 and 'HC191 (see Note 3)

		$T_A = 25^\circ\text{C}$		$T_A = -55^\circ\text{C}$ TO 125°C		$T_A = -40^\circ\text{C}$ TO 85°C		UNIT
		MIN	MAX	MIN	MAX	MIN	MAX	
V_{CC}	Supply voltage	2	6	2	6	2	6	V
V_{IH}	High-level input voltage	$V_{CC} = 2\text{ V}$		1.5	1.5	1.5		V
		$V_{CC} = 4.5\text{ V}$		3.15	3.15	3.15		
		$V_{CC} = 6\text{ V}$		4.2	4.2	4.2		
V_{IL}	Low-level input voltage	$V_{CC} = 2\text{ V}$		0.5		0.5		V
		$V_{CC} = 4.5\text{ V}$		1.35		1.35		
		$V_{CC} = 6\text{ V}$		1.8		1.8		
V_I	Input voltage	0	V_{CC}	0	V_{CC}	0	V_{CC}	V
V_O	Output voltage	0	V_{CC}	0	V_{CC}	0	V_{CC}	V
t_t	Input transition (rise and fall) time	$V_{CC} = 2\text{ V}$		1000		1000		ns
		$V_{CC} = 4.5\text{ V}$		500		500		
		$V_{CC} = 6\text{ V}$		400		400		

NOTE 3: All unused inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

recommended operating conditions for 'HCT191 (see Note 4)

		$T_A = 25^\circ\text{C}$		$T_A = -55^\circ\text{C}$ TO 125°C		$T_A = -40^\circ\text{C}$ TO 85°C		UNIT
		MIN	MAX	MIN	MAX	MIN	MAX	
V_{CC}	Supply voltage	4.5	5.5	4.5	5.5	4.5	5.5	V
V_{IH}	High-level input voltage	2		2		2		V
V_{IL}	Low-level input voltage	0.8		0.8		0.8		V
V_I	Input voltage	V_{CC}		V_{CC}		V_{CC}		V
V_O	Output voltage	V_{CC}		V_{CC}		V_{CC}		V
t_t	Input transition (rise and fall) time	500		500		500		ns

NOTE 4: All unused inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.



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SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL

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'HC190, 'HC191

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS		V _{CC}	T _A = 25°C		T _A = -55°C TO 125°C		T _A = -40°C TO 85°C		UNIT
				MIN	MAX	MIN	MAX	MIN	MAX	
V _{OH}	V _I = V _{IH} or V _{IL}	I _{OH} = -20 μA	2 V	1.9	1.9	1.9			V	
			4.5 V	4.4	4.4	4.4				
			6 V	5.9	5.9	5.9				
		I _{OH} = -4 mA	4.5 V	3.98	3.7	3.84				
		I _{OH} = -5.2 mA	6 V	5.48	5.2	5.34				
V _{OL}	V _I = V _{IH} or V _{IL}	I _{OL} = 20 μA	2 V	0.1	0.1	0.1		V		
			4.5 V	0.1	0.1	0.1				
			6 V	0.1	0.1	0.1				
		I _{OL} = 4 mA	4.5 V	0.26	0.4	0.33				
		I _{OL} = 5.2 mA	6 V	0.26	0.4	0.33				
I _I	V _I = V _{CC} or 0		6 V	±0.1		±1	±1	±1	μA	
I _{CC}	V _I = V _{CC} or 0, I _O = 0		6 V	8		160	80	80	μA	
C _i				10		10	10	10	pF	

'HCT191

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS		V _{CC}	T _A = 25°C			T _A = -55°C TO 125°C		T _A = -40°C TO 85°C		UNIT
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
V _{OH}	V _I = V _{IH} or V _{IL}	I _{OH} = -20 μA	4.5 V	4.4			4.4		4.4	V	
		I _{OH} = -4 mA		3.98			3.7		3.84		
V _{OL}	V _I = V _{IH} or V _{IL}	I _{OL} = 20 μA	4.5 V				0.1		0.1	V	
		I _{OL} = 4 mA					0.26		0.4		0.33
I _I	V _I = V _{CC} to GND		5.5 V				±0.1		±1	±1	μA
I _{CC}	V _I = V _{CC} or 0, I _O = 0		5.5 V				8		160	80	μA
ΔI _{CC} †	One input at V _{CC} - 2.1 V, Other inputs at 0 or V _{CC}		4.5 V to 5.5 V		100	360			490	450	μA
C _i							10		10	10	pF

† Additional quiescent supply current per input pin, TTL inputs high, 1 unit load

HCT INPUT LOADING TABLE

INPUTS	UNIT LOADS
A-D	0.4
CLK	1.5
LOAD	1.5
D/Ū	1.2
CTEN	1.5

Unit load is ΔI_{CC} limit specified in electrical characteristics table, (e.g., 360 μA max at 25°C).



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SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL

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'HC190, 'HC191 timing requirements over recommended operating free-air temperature range (unless otherwise noted) (see Figure 4)

		V _{CC}	T _A = 25°C		T _A = -55°C TO 125°C		T _A = -40°C TO 85°C		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
f _{clock}	Clock frequency†	2 V	6		4		5		MHz
		4.5 V	30		20		25		
		6 V	35		23		29		
t _w	$\overline{\text{LOAD}}$ low	2 V	80		120		100		ns
		4.5 V	16		24		20		
		6 V	14		20		17		
	CLK high or low	2 V	100		150		125		
		4.5 V	20		30		25		
		6 V	17		26		21		
t _{su}	Data before $\overline{\text{LOAD}}\uparrow$	2 V	60		90		75		ns
		4.5 V	12		18		15		
		6 V	10		15		13		
	$\overline{\text{CTEN}}$ before CLK \uparrow	2 V	60		90		75		
		4.5 V	12		18		15		
		6 V	10		15		13		
	D/ $\overline{\text{U}}$ before CLK \uparrow	2 V	90		135		115		
		4.5 V	18		27		23		
		6 V	15		23		20		
t _h	Data before $\overline{\text{LOAD}}\uparrow$	2 V	2		2		2		ns
		4.5 V	2		2		2		
		6 V	2		2		2		
	$\overline{\text{CTEN}}$ before CLK \uparrow	2 V	2		2		2		
		4.5 V	2		2		2		
		6 V	2		2		2		
	D/ $\overline{\text{U}}$ before CLK \uparrow	2 V	0		0		0		
		4.5 V	0		0		0		
		6 V	0		0		0		
t _{rec}	$\overline{\text{LOAD}}$ inactive before CLK \uparrow	2 V	60		90		75		ns
		4.5 V	12		18		15		
		6 V	10		15		13		

† Applies to noncascaded operation only. With cascaded counters, clock-to-terminal count propagation delays, CTEN-to-clock setup times, and CTEN-to-clock hold times determine maximum clock frequency. For example, with these HC devices:

$$f_{\text{max}}(\text{CLK}) = \frac{1}{\text{CLK-to-MAX/MIN propagation delay} + \overline{\text{CTEN-to-CLK setup time}} + \overline{\text{CTEN-to-CLK hold time}}} = \frac{1}{42 + 12 + 2} \approx 18 \text{ MHz}$$



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SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL

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'HC190, 'HC191

switching characteristics over recommended operating free-air temperature range (unless otherwise noted) (see Figure 4)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	V _{CC}	T _A = 25°C			T _A = -55°C TO 125°C		T _A = -40°C TO 85°C		UNIT
					MIN	TYP	MAX	MIN	MAX	MIN	MAX	
f _{max}				2 V	6			4		5	MHz	
				4.5 V	30			20		25		
				6 V	35			23		29		
t _{pd}	$\overline{\text{LOAD}}$	Q	C _L = 50 pF	2 V		195		295		245	ns	
				4.5 V		39		59		49		
				6 V		33		50		42		
	A, B, C, or D	Q	C _L = 50 pF	2 V		175		265		220		
				4.5 V		35		53		44		
				6 V		30		45		37		
	CLK	Q	C _L = 50 pF	2 V		170		255		215		
				4.5 V		34		51		43		
				6 V		29		43		37		
	CLK	$\overline{\text{RCO}}$	C _L = 50 pF	2 V		125		190		155		
				4.5 V		25		38		31		
				6 V		21		32		26		
	CLK	MAX/MIN	C _L = 50 pF	2 V		210		315		265		
				4.5 V		42		63		53		
				6 V		36		54		45		
	D/ $\overline{\text{U}}$	$\overline{\text{RCO}}$	C _L = 50 pF	2 V		150		225		190		
				4.5 V		30		45		38		
				6 V		26		38		33		
	D/ $\overline{\text{U}}$	MAX/MIN	C _L = 50 pF	2 V		165		250		205		
				4.5 V		33		50		41		
				6 V		28		43		35		
	$\overline{\text{CTEN}}$	$\overline{\text{RCO}}$	C _L = 50 pF	2 V		125		190		155		
				4.5 V		25		38		31		
				6 V		21		32		26		
				C _L = 15 pF	5 V		16					
					5 V		14					
					5 V		14					
				C _L = 15 pF	5 V		10					
					5 V		10					
					5 V		10					
	t _t	Any	C _L = 50 pF	2 V		75		110		95		ns
				4.5 V		15		22		19		
				6 V		13		19		16		



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'HCT191

timing requirements over recommended operating free-air temperature range $V_{CC} = 4.5\text{ V}$ (unless otherwise noted) (see Figure 5)

		$T_A = 25^\circ\text{C}$		$T_A = -55^\circ\text{C}$ TO 125°C		$T_A = -40^\circ\text{C}$ TO 85°C		UNIT
		MIN	MAX	MIN	MAX	MIN	MAX	
f_{clock}	Clock frequency	30		20		25		MHz
t_w	Pulse duration	$\overline{\text{LOAD}}$ low	16	24	20			ns
		CLK high or low	20	30	25			
t_{su}	Setup time	Data before $\overline{\text{LOAD}}\uparrow$	12	18	15			ns
		$\overline{\text{CTEN}}$ before $\text{CLK}\uparrow$	12	18	15			
		$\text{D}/\overline{\text{U}}$ before $\text{CLK}\uparrow$	18	27	23			
t_h	Hold time	Data before $\overline{\text{LOAD}}\uparrow$	2	2	2			ns
		$\overline{\text{CTEN}}$ before $\text{CLK}\uparrow$	2	2	2			
		$\text{D}/\overline{\text{U}}$ before $\text{CLK}\uparrow$	0	0	0			
t_{rec}	Recovery time	$\overline{\text{LOAD}}$ inactive before $\text{CLK}\uparrow$	12	18	15			ns

'HCT191

switching characteristics over recommended operating free-air temperature range (unless otherwise noted) (see Figure 5)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	V_{CC}	$T_A = 25^\circ\text{C}$			$T_A = -55^\circ\text{C}$ TO 125°C		$T_A = -40^\circ\text{C}$ TO 85°C		UNIT
					MIN	TYP	MAX	MIN	MAX	MIN	MAX	
f_{max}				4.5 V	30			20		25		MHz
t_{pd}	$\overline{\text{LOAD}}$	Q	$C_L = 50\text{ pF}$	4.5 V			40		60		50	ns
			$C_L = 15\text{ pF}$	5 V		17						
	A, B, C, or D	Q	$C_L = 50\text{ pF}$	4.5 V			38		57		48	
			$C_L = 15\text{ pF}$	5 V		16						
	CLK	$\overline{\text{RCO}}$	$C_L = 50\text{ pF}$	4.5 V			35		53		44	
			$C_L = 15\text{ pF}$	5 V		14						
	CLK	Q	$C_L = 50\text{ pF}$	4.5 V			27		41		34	
			$C_L = 15\text{ pF}$	5 V		11						
	CLK	MAX/MIN	$C_L = 50\text{ pF}$	4.5 V			42		63		53	
			$C_L = 15\text{ pF}$	5 V		18						
	$\text{D}/\overline{\text{U}}$	$\overline{\text{RCO}}$	$C_L = 50\text{ pF}$	4.5 V			30		45		38	
			$C_L = 15\text{ pF}$	5 V		12						
	$\text{D}/\overline{\text{U}}$	MAX/MIN	$C_L = 50\text{ pF}$	4.5 V			38		57		48	
			$C_L = 15\text{ pF}$	5 V		16						
$\overline{\text{CTEN}}$	$\overline{\text{RCO}}$	$C_L = 50\text{ pF}$	4.5 V			27		41		34		
		$C_L = 15\text{ pF}$	5 V		11							
t_t		Any	$C_L = 50\text{ pF}$	4.5 V			15		22		19	ns



CD54HC190, CD74HC190
CD54HC191, CD74HC191, CD54HCT191, CD74HCT191
SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL

SCHS275E – MARCH 2002 – REVISED OCTOBER 2003

operating characteristics, $V_{CC} = 5\text{ V}$, $T_A = 25^\circ\text{C}$

PARAMETER		TYP	UNIT
C_{pd} Power dissipation capacitance	'HC190	59	pF
	'HC191	55	
	'HCT191	68	

CD54HC190, CD74HC190
CD54HC191, CD74HC191, CD54HCT191, CD74HCT191
SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL

SCHS275E – MARCH 2002 – REVISED OCTOBER 2003

PARAMETER MEASUREMENT INFORMATION – 'HC190, 'HC191



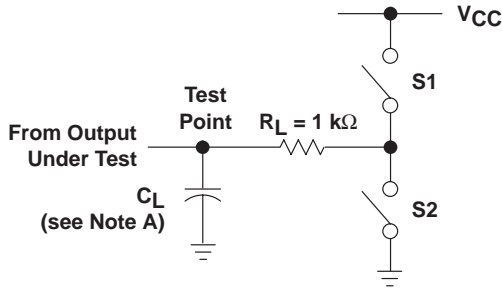
- NOTES: A. C_L includes probe and test-fixture capacitance.
 B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
 C. Phase relationships between waveforms were chosen arbitrarily. All input pulses are supplied by generators having the following characteristics: $PRR \leq 1\text{ MHz}$, $Z_O = 50\ \Omega$, $t_r = 6\text{ ns}$, $t_f = 6\text{ ns}$.
 D. For clock inputs, f_{max} is measured with the input duty cycle at 50%.
 E. The outputs are measured one at a time with one input transition per measurement.
 F. t_{PLZ} and t_{PHZ} are the same as t_{dis} .
 G. t_{PZL} and t_{PZH} are the same as t_{en} .
 H. t_{PLH} and t_{PHL} are the same as t_{pd} .

Figure 4. Load Circuit and Voltage Waveforms

CD54HC190, CD74HC190
CD54HC191, CD74HC191, CD54HCT191, CD74HCT191
SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL

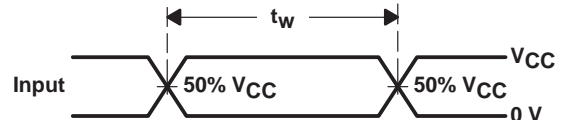
SCHS275E – MARCH 2002 – REVISED OCTOBER 2003

PARAMETER MEASUREMENT INFORMATION – 'HCT191

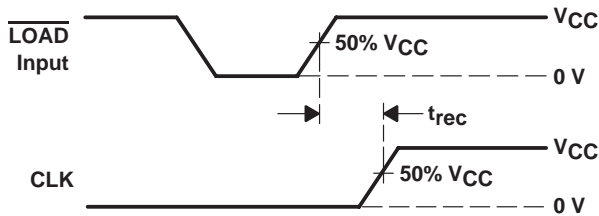


LOAD CIRCUIT

PARAMETER	S1	S2	
t_{en}	t_{PZH}	Open	Closed
	t_{PZL}	Closed	Open
t_{dis}	t_{PHZ}	Open	Closed
	t_{PLZ}	Closed	Open
t_{pd} or t_t	Open	Open	



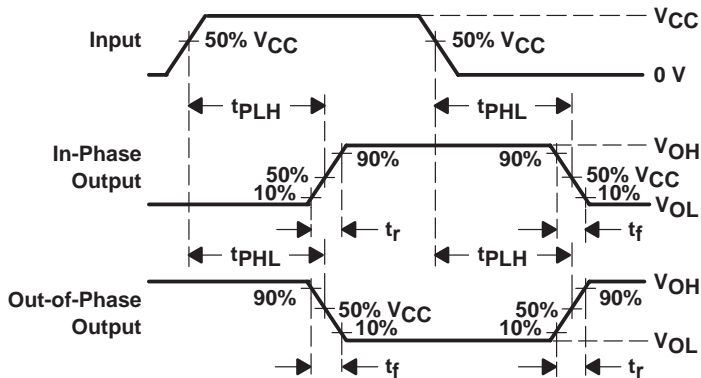
VOLTAGE WAVEFORMS PULSE DURATION



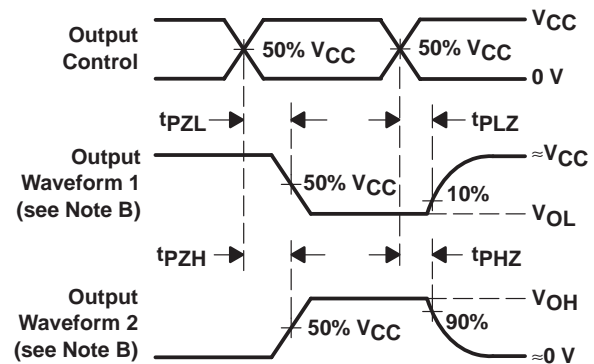
VOLTAGE WAVEFORMS RECOVERY TIME



VOLTAGE WAVEFORMS SETUP AND HOLD AND INPUT RISE AND FALL TIMES



VOLTAGE WAVEFORMS PROPAGATION DELAY AND OUTPUT TRANSITION TIMES



VOLTAGE WAVEFORMS OUTPUT ENABLE AND DISABLE TIMES

- NOTES: A. C_L includes probe and test-fixture capacitance.
 B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
 C. Phase relationships between waveforms were chosen arbitrarily. All input pulses are supplied by generators having the following characteristics: $PRR \leq 1$ MHz, $Z_O = 50 \Omega$, $t_r = 6$ ns, $t_f = 6$ ns.
 D. For clock inputs, f_{max} is measured with the input duty cycle at 50%.
 E. The outputs are measured one at a time with one input transition per measurement.
 F. t_{PLZ} and t_{PHZ} are the same as t_{dis} .
 G. t_{PZL} and t_{PZH} are the same as t_{en} .
 H. t_{PLH} and t_{PHL} are the same as t_{pd} .

Figure 5. Load Circuit and Voltage Waveforms



PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
5962-8867101EA	ACTIVE	CDIP	J	16	1	TBD	A42	N / A for Pkg Type	-55 to 125	5962-8867101EA CD54HCT191F3A	Samples
5962-8994601EA	ACTIVE	CDIP	J	16	1	TBD	A42	N / A for Pkg Type	-55 to 125	5962-8994601EA CD54HC190F3A	Samples
CD54HC190F3A	ACTIVE	CDIP	J	16	1	TBD	A42	N / A for Pkg Type	-55 to 125	5962-8994601EA CD54HC190F3A	Samples
CD54HC191F3A	ACTIVE	CDIP	J	16	1	TBD	A42	N / A for Pkg Type	-55 to 125	5962-8689101EA CD54HC191F3A	Samples
CD54HCT191F3A	ACTIVE	CDIP	J	16	1	TBD	A42	N / A for Pkg Type	-55 to 125	5962-8867101EA CD54HCT191F3A	Samples
CD74HC190E	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-55 to 125	CD74HC190E	Samples
CD74HC190EE4	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-55 to 125	CD74HC190E	Samples
CD74HC190NSR	ACTIVE	SO	NS	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	HC190M	Samples
CD74HC190NSRE4	ACTIVE	SO	NS	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	HC190M	Samples
CD74HC190NSRG4	ACTIVE	SO	NS	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	HC190M	Samples
CD74HC190PW	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	HJ190	Samples
CD74HC190PWE4	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	HJ190	Samples
CD74HC190PWG4	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	HJ190	Samples
CD74HC190PWR	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	HJ190	Samples
CD74HC190PWRE4	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	HJ190	Samples
CD74HC190PWRG4	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	HJ190	Samples
CD74HC190PWT	ACTIVE	TSSOP	PW	16	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	HJ190	Samples

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
CD74HC190PWTE4	ACTIVE	TSSOP	PW	16	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	HJ190	Samples
CD74HC190PWTG4	ACTIVE	TSSOP	PW	16	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	HJ190	Samples
CD74HC191E	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-55 to 125	CD74HC191E	Samples
CD74HC191EE4	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-55 to 125	CD74HC191E	Samples
CD74HC191M	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	HC191M	Samples
CD74HC191M96	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	HC191M	Samples
CD74HC191M96E4	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	HC191M	Samples
CD74HC191M96G4	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	HC191M	Samples
CD74HC191ME4	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	HC191M	Samples
CD74HC191MG4	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	HC191M	Samples
CD74HC191MT	ACTIVE	SOIC	D	16	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	HC191M	Samples
CD74HC191MTE4	ACTIVE	SOIC	D	16	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	HC191M	Samples
CD74HC191MTG4	ACTIVE	SOIC	D	16	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	HC191M	Samples
CD74HCT191E	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-55 to 125	CD74HCT191E	Samples
CD74HCT191EE4	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-55 to 125	CD74HCT191E	Samples
CD74HCT191M	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	HCT191M	Samples
CD74HCT191ME4	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	HCT191M	Samples
CD74HCT191MG4	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	HCT191M	Samples

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

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OTHER QUALIFIED VERSIONS OF CD54HC190, CD54HC191, CD54HCT191, CD74HC190, CD74HC191, CD74HCT191 :

● Catalog: [CD74HC190](#), [CD74HC191](#), [CD74HCT191](#)

● Military: [CD54HC190](#), [CD54HC191](#), [CD54HCT191](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Military - QML certified for Military and Defense Applications

TAPE AND REEL INFORMATION
REEL DIMENSIONS

TAPE DIMENSIONS


A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

TAPE AND REEL INFORMATION

*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
CD74HC190NSR	SO	NS	16	2000	330.0	16.4	8.2	10.5	2.5	12.0	16.0	Q1
CD74HC190PWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
CD74HC190PWT	TSSOP	PW	16	250	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
CD74HC191M96	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CD74HC190NSR	SO	NS	16	2000	367.0	367.0	38.0
CD74HC190PWR	TSSOP	PW	16	2000	367.0	367.0	35.0
CD74HC190PWT	TSSOP	PW	16	250	367.0	367.0	35.0
CD74HC191M96	SOIC	D	16	2500	333.2	345.9	28.6

J (R-GDIP-T**)

14 LEADS SHOWN

CERAMIC DUAL IN-LINE PACKAGE



DIM \ PINS **	14	16	18	20
A	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC
B MAX	0.785 (19,94)	.840 (21,34)	0.960 (24,38)	1.060 (26,92)
B MIN	—	—	—	—
C MAX	0.300 (7,62)	0.300 (7,62)	0.310 (7,87)	0.300 (7,62)
C MIN	0.245 (6,22)	0.245 (6,22)	0.220 (5,59)	0.245 (6,22)



4040083/F 03/03

- NOTES:
- All linear dimensions are in inches (millimeters).
 - This drawing is subject to change without notice.
 - This package is hermetically sealed with a ceramic lid using glass frit.
 - Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
 - Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, GDIP1-T18 and GDIP1-T20.

N (R-PDIP-T**)

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - $\triangle C$ Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
 - $\triangle D$ The 20 pin end lead shoulder width is a vendor option, either half or full width.

4040049/E 12/2002

D (R-PDSO-G16)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
 - D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
 - E. Reference JEDEC MS-012 variation AC.

D (R-PDSO-G16)

PLASTIC SMALL OUTLINE

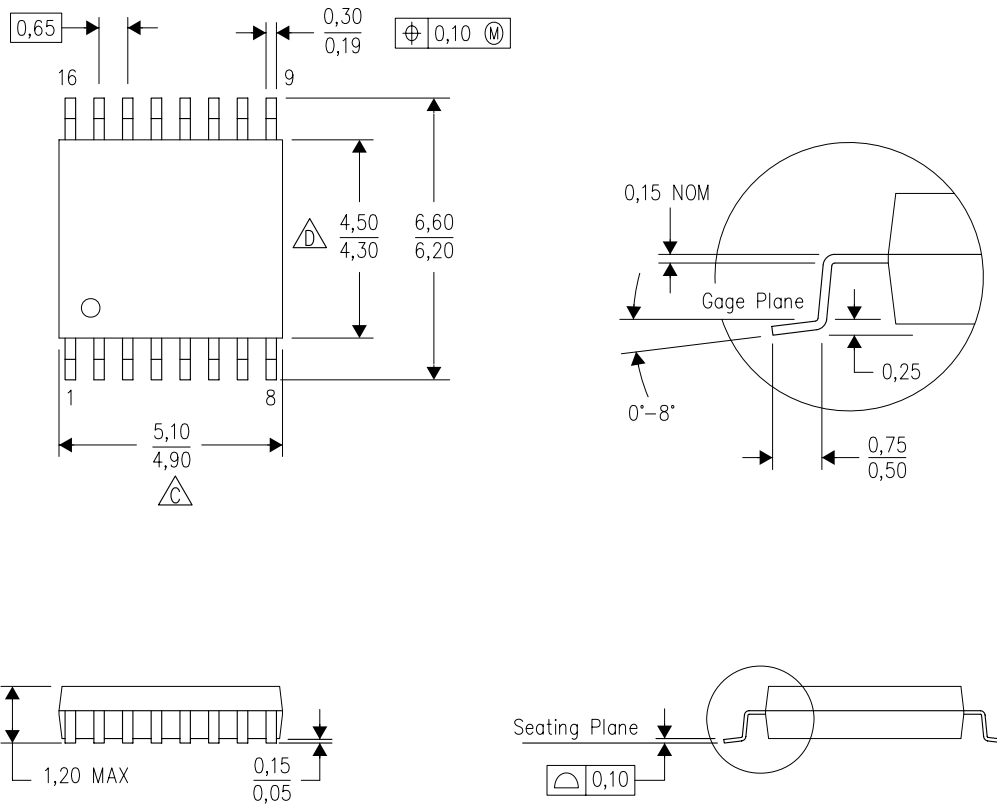


- NOTES:
- All linear dimensions are in millimeters.
 - This drawing is subject to change without notice.
 - Publication IPC-7351 is recommended for alternate designs.
 - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
 - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

MECHANICAL DATA

PW (R-PDSO-G16)

PLASTIC SMALL OUTLINE

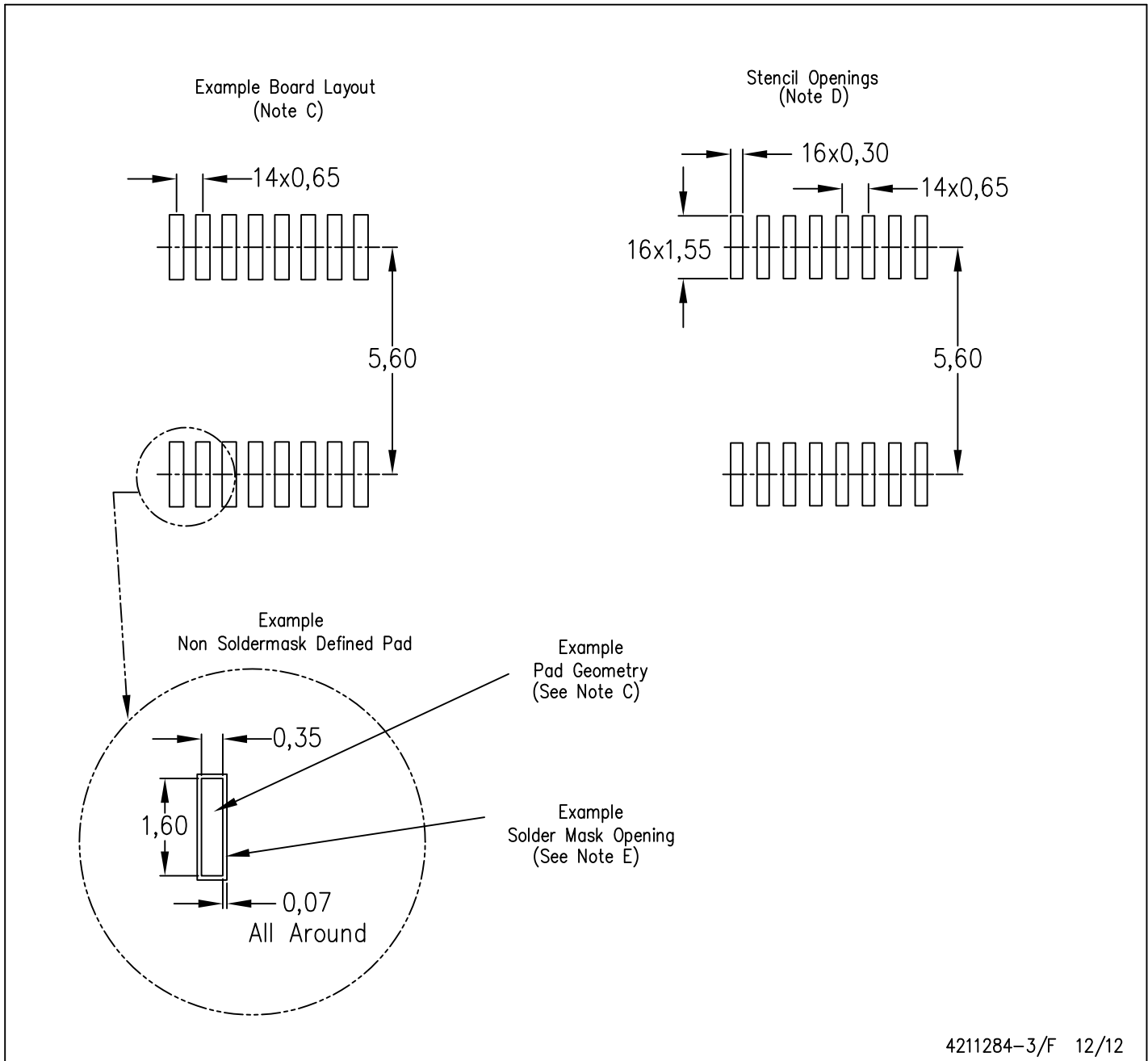


4040064-4/G 02/11

- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - B. This drawing is subject to change without notice.
 - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
 - D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
 - E. Falls within JEDEC MO-153

PW (R-PDSO-G16)

PLASTIC SMALL OUTLINE



- NOTES:
- All linear dimensions are in millimeters.
 - This drawing is subject to change without notice.
 - Publication IPC-7351 is recommended for alternate designs.
 - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
 - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

MECHANICAL DATA

NS (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

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