

CD74HC93, CD74HCT93 High-Speed CMOS Logic 4-Bit Binary Ripple Counter

1 Features

- Can be configured to divide by 2, 8, and 16
- Asynchronous reset
- Fanout (over temperature range)
 - Standard outputs: 10 LSTTL loads
 - Bus driver outputs: 15 LSTTL loads
- Wide operating temperature range: -55°C to 125°C
- Balances propagation delay and transition times
- Significant power reduction compared to LSTTL logic ICs
- HC types
 - 2 V to 6 V operation
 - High noise immunity: $N_{IL} = 30\%$, $N_{IH} = 30\%$ of V_{CC}
- HCT types
 - 4.5 V to 5.5 V operation
 - Direct LSTTL input logic compatibility, $V_{IL} = 0.8\text{ V}$ (max), $V_{IH} = 2\text{ V}$ (min)
 - CMOS input compatibility, $I_I \leq 1\ \mu\text{A}$ at V_{OL} , V_{OH}

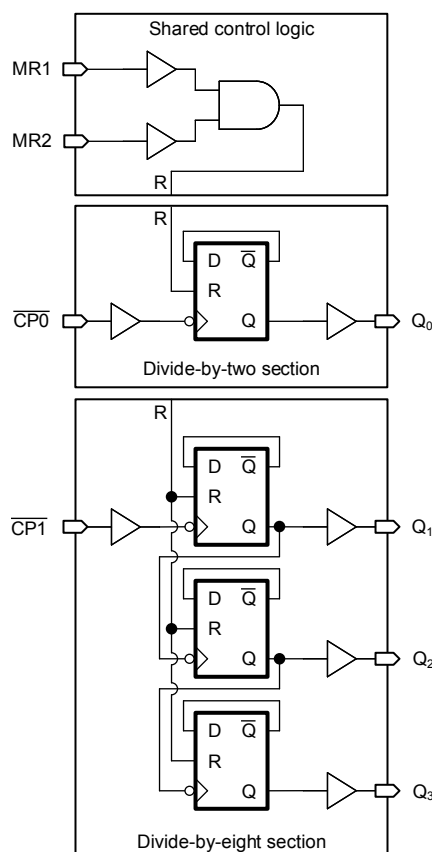
2 Description

The CD74HC93 and CD74HCT93 are high-speed silicon-gate CMOS devices and are pin-compatible with low power Schottky TTL (LSTTL). These 4-bit binary ripple counters consist of four flip-flops internally connected to provide a divide-by-two section and a divide-by-eight section. Each section has a separate clock input ($\overline{\text{CP}}_0$ and $\overline{\text{CP}}_1$) to initiate state changes of the counter on the HIGH to LOW clock transition. State changes of the Q_n outputs do not occur simultaneously because of internal ripple delays. Therefore, decoded output signals are subject to decoding spikes and should not be used for clocks or strobes.

Device Information

PART NUMBER	PACKAGE ⁽¹⁾	BODY SIZE (NOM)
CD74HC93M	SOIC (14)	8.65 mm × 3.90 mm
CD74HC93E	PDIP (14)	19.31 mm × 6.35 mm
CD74HCT93E	PDIP (14)	19.31 mm × 6.35 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.



Functional Block Diagram



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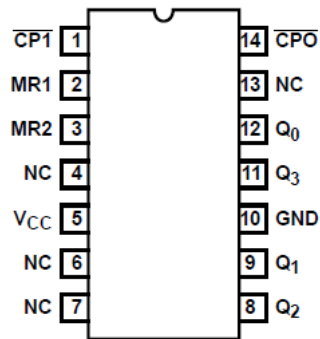
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3 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision C (September 2003) to Revision D (March 2022)	Page
• Updated the numbering, formatting, tables, figures, and cross-references throughout the document to reflect modern data sheet standards.....	1

4 Pin Configuration and Functions



**N or D package
14-Pin PDIP or SOIC
Top View**

5 Specifications

5.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)⁽¹⁾

		MIN	MAX	UNIT
V _{CC}	Supply voltage range	-0.5	7	V
I _{IK}	Input diode current ⁽²⁾	(V _I < -0.5 V or V _I > V _{CC} + 0.5 V)	±20	mA
I _{OK}	Output diode current ⁽²⁾	(V _O < -0.5 V or V _O > V _{CC} + 0.5 V)	±20	mA
I _O	Output source or sink current per output pin	(V _O > -0.5 V or V _O < V _{CC} + 0.5 V)	±25	mA
	Continuous current through V _{CC} or GND		±50	mA
T _J	Junction temperature		150	°C
T _{stg}	Storage temperature	-65	150	°C

- (1) 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.
- (2) The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

5.2 Recommended Operating Conditions

		MIN	NOM	MAX	UNIT
V _{CC}	Supply voltage	HC types		6	V
		HCT types	4.5	5.5	
V _I	Input voltage	0		V _{CC}	V
V _O	Output voltage	0		V _{CC}	V
t _t	Input transition rise/fall time	2 V		1000	ns
		4.5 V		500	
		6 V		400	
T _A	Operating free-air temperature	-55		125	°C

5.3 Thermal Information

THERMAL METRIC		D (SOIC)	N (PDIP)	UNIT
		14 PINS	14 PINS	
R _{θJA}	Junction-to-ambient thermal resistance ⁽¹⁾	86	80	°C/W

- (1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC package thermal metrics](#) application report.

5.4 Electrical Characteristics

PARAMETER	TEST CONDITIONS ⁽¹⁾	V _{CC} (V)	T _A = 25°C			– 40°C to 85°C		– 55°C to 125°C		UNIT	
			MIN	TYP	MAX	MIN	MAX	MIN	MAX		
HC TYPES											
V _{IH}	High level input voltage		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	
V _{IL}	Low level input voltage		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	
V _{OH}	High-level output voltage	I _{OH} = – 20 μA	2	1.9		1.9		1.9		V	
		I _{OH} = – 20 μA	4.5	4.4		4.4		4.4		V	
		I _{OH} = – 20 μA	6	5.9		5.9		5.9		V	
		I _{OH} = – 4 mA	4.5	3.98		3.84		3.7		V	
		I _{OH} = – 5.2 mA	6	5.48		5.34		5.2		V	
V _{OL}	Low-level output voltage	I _{OL} = 20 μA	2		0.1		0.1		0.1	V	
		I _{OL} = 20 μA	4.5		0.1		10.1		0.1	V	
		I _{OL} = 20 μA	6		0.1		0.1		0.1	V	
		I _{OL} = 4 mA	4.5		0.26		0.33		0.4	V	
		I _{OL} = 5.2 mA	6		0.26		0.33		0.4	V	
I _I	Input leakage current	V _{CC} or GND	6		±0.1		±1		±1	nA	
I _{CC}	Supply current	V _{CC} or GND	6		8		80		160	μA	
I _{CC}	Supply-current change	One input at 0.5 V or 2.4 V, Other inputs at 0 or V _{CC}	5.5		1.4	2.4		2.9		mA	
C _i	Input capacitance		4.5 to 5.5		3	10		10		pF	
HCT TYPES											
V _{IH}	High level input voltage		4.5 to 5.5	2			2		2	V	
V _{IL}	Low level input voltage		4.5 to 5.5			0.8		0.8		0.8	V
V _{OH}	High level Output Voltage	I _{OH} = – 20 μA	4.5	4.4		4.4		4.4		V	
		I _{OH} = – 4 mA	4.5	3.98		3.84		3.7		V	
V _{OL}	Low level output voltage	I _{OH} = 20 μA	4.5		0.1		0.1		0.1	V	
		I _{OH} = 4 mA	4.5		0.26		0.33		0.4	V	
I _I	Input leakage current	V _{CC} or GND	5.5		±0.1		±1		±1	μA	
I _{CC}	Supply current	V _{CC} or GND	5.5		8		80		160	μA	
ΔI _{CC} ⁽²⁾ ⁽³⁾	Additional supply current per input pin	$\overline{CP0}, \overline{CP1}$	4.5 to 5.5		100	216		270		294	μA
		CLR1, CLR2	4.5 to 5.5		100	144		180		196	μA

(1) V_I = V_{IH} or V_{IL}, unless otherwise noted.

(2) For dual-supply systems theoretical worst case (V_I = 2.4 V, V_{CC} = 5.5 V) specifications is 1.8 mA.

(3) Inputs held at V_{CC} – 2.1.

5.5 Prerequisite for Switching Characteristics

PARAMETER		V _{CC} (V)	25°C		– 40°C to 85°C		– 55°C to 125°C		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
HC TYPES									
f _{MAX}	Maximum clock frequency	2	6		5		4		MHz
		4.5	30		24		20		MHz
		6	35		28		24		MHz
t _W	Clock pulse width $\overline{CP0}$, $\overline{CP1}$	2	80		100		120		ns
		4.5	16		20		24		ns
		6	14		17		20		ns
t _W	Reset pulse width	2	80		100		120		ns
		4.5	16		20		24		ns
		6	14		17		20		ns
t _{REM}	Reset removal time	2	50		65		75		ns
		4.5	10		13		15		ns
		6	9		11		13		ns
HCT TYPES									
f _{MAX}	Maximum clock frequency	4.5	30		24		20		MHz
t _W	Clock pulse width $\overline{CP0}$, $\overline{CP1}$	4.5	16		20		24		ns
t _W	Reset pulse width	4.5	16		20		24		ns
t _{REM}	Reset removal time	4.5	10		13		15		ns

5.6 Switching Characteristics

Input t_r, t_f = 6ns. C_L = 50pF unless otherwise noted

PARAMETER		V _{CC} (V)	25°C			– 40°C to 85°C		– 55°C to 125°C		UNIT
			MIN	TYP	MAX	MIN	MAX	MIN	MAX	
HC TYPES										
t _{PLH} , t _{PHL}	$\overline{CP0}$ to Q0	2		125		155		190		ns
		4.5		10 ⁽¹⁾	25		31		38	ns
		6		21		26		32		ns
t _{PLH} , t _{PHL}	$\overline{CP1}$ to Q1	2		135		170		205		ns
		4.5		27		34		41		ns
		6		23		29		35		ns
t _{PLH} , t _{PHL}	$\overline{CP1}$ to Q2	2		185		230		280		ns
		4.5		37		46		56		ns
		6		31		39		48		ns
t _{PLH} , t _{PHL}	$\overline{CP1}$ to Q3	2		245		305		370		ns
		4.5		21 ⁽¹⁾	49		61		74	ns
		6		42		52		63		ns
t _{PLH} , t _{PHL}	MR1, MR2 to Qn	2		155		195		235		ns
		4.5		13 ⁽¹⁾	31		39		47	ns
		6		26		33		40		ns
t _{TLH} , t _{THL}	Output transition time	2		75		95		110		ns
		4.5		15		19		22		ns
		6		13		16		19		ns
C _{IN}	Input capacitance			10		10		10		pF

5.6 Switching Characteristics (continued)

Input t_r , $t_f = 6\text{ns}$. $C_L = 50\text{pF}$ unless otherwise noted

PARAMETER		V_{CC} (V)	25°C			– 40°C to 85°C		– 55°C to 125°C		UNIT
			MIN	TYP	MAX	MIN	MAX	MIN	MAX	
C_{PD}	Power dissipation capacitance		25			10		19		pF
HCT TYPES										
t_{PLH} , t_{PHL}	$\overline{CP0}$ to Q0	4.5		14 ⁽¹⁾	34		43		51	ns
t_{PLH} , t_{PHL}	$\overline{CP1}$ to Q1	4.5			34		43		51	ns
t_{PLH} , t_{PHL}	$\overline{CP1}$ to Q2	4.5			46		58		69	ns
t_{PLH} , t_{PHL}	$\overline{CP1}$ to Q3	4.5		24 ⁽¹⁾	58		73		87	ns
t_{PLH} , t_{PHL}	MR1, MR2 to Qn	4.5		13 ⁽¹⁾	33		41		50	ns
t_{TLH} , t_{THL}	Output Transition time	4.5			15		19		22	ns
C_{IN}	Input Capacitance				10		10		10	pF
C_{PD}	Power dissipation capacitance			25						pF

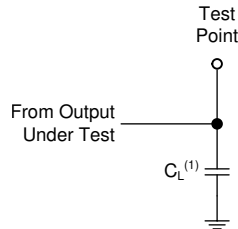
(1) $C_L = 15\text{pF}$. $V_{CC} = 5$.

6 Parameter Measurement Information

Phase relationships between waveforms were chosen arbitrarily. All input pulses are supplied by generators having the following characteristics: $PRR \leq 1 \text{ MHz}$, $Z_O = 50 \Omega$, $t_f < 6 \text{ ns}$.

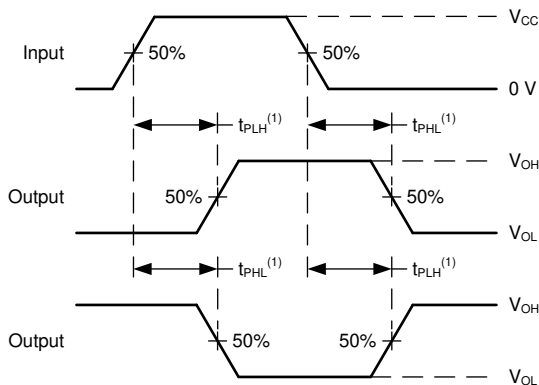
For clock inputs, f_{max} is measured when the input duty cycle is 50%.

The outputs are measured one at a time with one input transition per measurement.



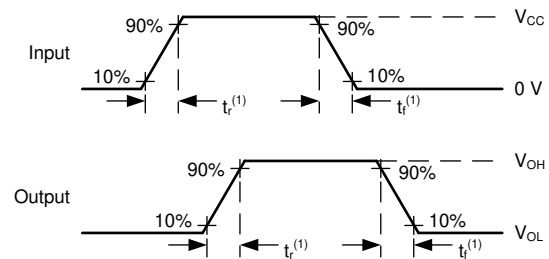
(1) C_L includes probe and test-fixture capacitance.

Figure 6-1. Load Circuit for Push-Pull Outputs



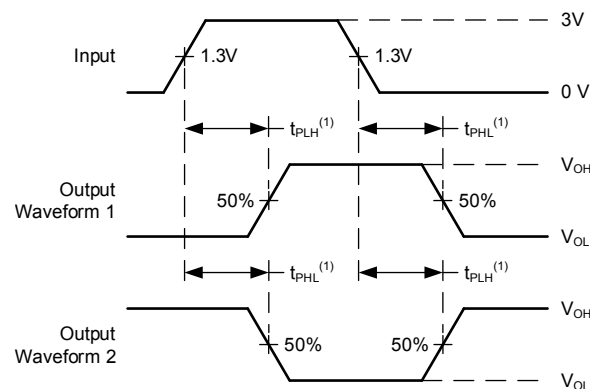
(1) The greater between t_{PLH} and t_{PHL} is the same as t_{pd} .

Figure 6-2. Voltage Waveforms, Propagation Delays for Standard CMOS Inputs



(1) The greater between t_r and t_f is the same as t_t .

Figure 6-3. Voltage Waveforms, Input and Output Transition Times for Standard CMOS Inputs



(1) The greater between t_{PLH} and t_{PHL} is the same as t_{pd} .

Figure 6-4. Voltage Waveforms, Propagation Delays for TTL-Compatible Inputs

7 Detailed Description

7.1 Overview

The CD74HC93 and CD74HCT93 are high-speed silicon-gate CMOS devices and are pin-compatible with low power Schottky TTL (LSTTL). These 4-bit binary ripple counters consist of four flip-flops internally connected to provide a divide-by-two section and a divide-by-eight section. Each section has a separate clock input ($\overline{CP0}$ and $\overline{CP1}$) to initiate state changes of the counter on the HIGH to LOW clock transition. State changes of the Q_n outputs do not occur simultaneously because of internal ripple delays. Therefore, decoded output signals are subject to decoding spikes and should not be used for clocks or strobes.

A gated AND asynchronous reset (MR1 and MR2) is provided which overrides both clocks and resets (clears) all flip-flops.

Because the output from the divide-by-two section is not internally connected to the succeeding stages, the device may be operated in various counting modes.

In a 4-bit ripple counter the output Q_0 must be connected externally to input $\overline{CP1}$. The input count pulses are applied to clock input $\overline{CP0}$. Simultaneous frequency divisions of 2, 4, 8, and 16 are performed at the Q_0 , Q_1 , Q_2 , and Q_3 outputs as shown in the function table. As a 3-bit ripple counter the input count pulses are applied to input $\overline{CP1}$.

Simultaneous frequency divisions of 2, 4, and 8 are available at the Q_1 , Q_2 , Q_3 outputs. Independent use of the first flipflop is available if the reset function coincides with the reset of the 3-bit ripple-through counter.

7.2 Functional Block Diagram

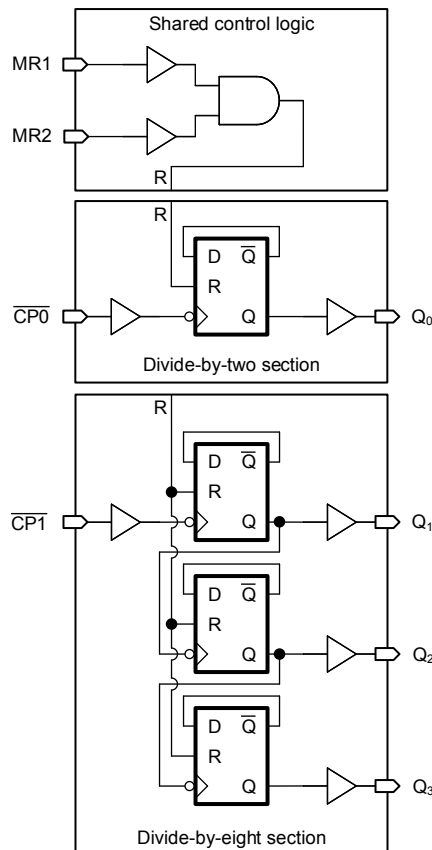


Figure 7-1. Functional Block Diagram

7.3 Device Functional Modes

Truth Table

COUNT	OUTPUTS ⁽¹⁾			
	Q ₀	Q ₁	Q ₂	Q ₃
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
10	L	H	L	H
11	H	H	L	H
12	L	L	H	H
13	H	L	H	H
14	L	H	H	H
15	H	H	H	H

(1) H = High voltage level, L = Low voltage level.

Table 7-1. Mode Selection

RESET OUTPUTS		OUTPUTS ⁽¹⁾			
MR1	MR2	Q ₀	Q ₁	Q ₂	Q ₃
H	H	L	L	L	L
L	H	Count	Count	Count	Count
H	L				
L	L				

(1) H = High voltage level, L = Low voltage level.

8 Power Supply Recommendations

The power supply can be any voltage between the minimum and maximum supply voltage rating located in the *Recommended Operating Conditions*. Each V_{CC} terminal should have a good bypass capacitor to prevent power disturbance. A 0.1- μF capacitor is recommended for this device. It is acceptable to parallel multiple bypass caps to reject different frequencies of noise. The 0.1- μF and 1- μF capacitors are commonly used in parallel. The bypass capacitor should be installed as close to the power terminal as possible for best results.

9 Layout

9.1 Layout Guidelines

When using multiple-input and multiple-channel logic devices inputs must not ever be left floating. In many cases, functions or parts of functions of digital logic devices are unused; for example, when only two inputs of a triple-input AND gate are used or only 3 of the 4 buffer gates are used. Such unused input pins must not be left unconnected because the undefined voltages at the outside connections result in undefined operational states. All unused inputs of digital logic devices must be connected to a logic high or logic low voltage, as defined by the input voltage specifications, to prevent them from floating. The logic level that must be applied to any particular unused input depends on the function of the device. Generally, the inputs are tied to GND or V_{CC} , whichever makes more sense for the logic function or is more convenient.

10 Device and Documentation Support

TI offers an extensive line of development tools. Tools and software to evaluate the performance of the device, generate code, and develop solutions are listed below.

10.1 Documentation Support

10.1.1 Related Documentation

10.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Subscribe to updates* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

10.3 Support Resources

TI E2E™ [support forums](#) are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

10.4 Trademarks

TI E2E™ is a trademark of Texas Instruments.

All trademarks are the property of their respective owners.

10.5 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

10.6 Glossary

[TI Glossary](#) This glossary lists and explains terms, acronyms, and definitions.

11 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
CD74HC93E	ACTIVE	PDIP	N	14	25	RoHS & Green	NIPDAU	N / A for Pkg Type	-55 to 125	CD74HC93E	Samples
CD74HC93EE4	ACTIVE	PDIP	N	14	25	RoHS & Green	NIPDAU	N / A for Pkg Type	-55 to 125	CD74HC93E	Samples
CD74HC93M96	ACTIVE	SOIC	D	14	2500	RoHS & Green	NIPDAU SN	Level-1-260C-UNLIM	-55 to 125	HC93M	Samples
CD74HCT93E	ACTIVE	PDIP	N	14	25	RoHS & Green	NIPDAU	N / A for Pkg Type	-55 to 125	CD74HCT93E	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.

OBSELETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(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.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

Important Information and Disclaimer:The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and

continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


*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
CD74HC93M96	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
CD74HC93M96	SOIC	D	14	2500	330.0	16.4	6.5	9.0	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)
CD74HC93M96	SOIC	D	14	2500	356.0	356.0	35.0
CD74HC93M96	SOIC	D	14	2500	356.0	356.0	35.0

TUBE


*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
CD74HC93E	N	PDIP	14	25	506	13.97	11230	4.32
CD74HC93E	N	PDIP	14	25	506	13.97	11230	4.32
CD74HC93EE4	N	PDIP	14	25	506	13.97	11230	4.32
CD74HC93EE4	N	PDIP	14	25	506	13.97	11230	4.32
CD74HCT93E	N	PDIP	14	25	506	13.97	11230	4.32
CD74HCT93E	N	PDIP	14	25	506	13.97	11230	4.32

D (R-PDSO-G14)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 -  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.
 -  Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
 - E. Reference JEDEC MS-012 variation AB.

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.
 - Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
 - The 20 pin end lead shoulder width is a vendor option, either half or full width.

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