CD74AC175 Quadruple D-type Flip-Flop with Clear

1 Features

- AC types feature 1.5V to 5.5V operation and balanced noise immunity at 30% of the supply voltage
- Buffered inputs
- Contains four flip-flops with double-rail outputs
- Speed of bipolar F, AS, and S, with significantly reduced power consumption
- Balanced propagation delays
- ±24mA output drive current
  - Fanout to 15 F devices
- SCR-latchup-resistant CMOS process and circuit design
- Exceeds 2kV ESD protection per MIL-STD-883, method 3015

2 Applications

- Buffer/Storage Registers
- Shift Registers
- Pattern Generators

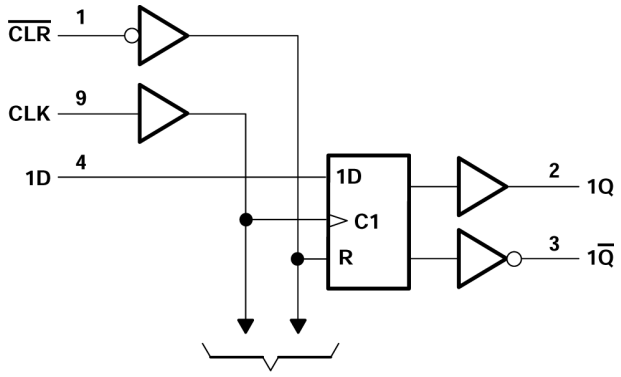
3 Description

This positive-edge-triggered D-type flip-flop has a direct clear ($\overline{CLR}$) input. The CD74AC175 features complementary outputs from each flip-flop.

Package Information

PART NUMBER	PACKAGE(1)	PACKAGE SIZE(2)	BODY SIZE(3)
CD74AC175	D (SOIC, 16)	9.9mm × 6mm	9.9mm × 3.9mm

(1) For more information, see Mechanical, Packaging, and Orderable Information.
(2) The package size (length × width) is a nominal value and includes pins, where applicable.
(3) The body size (length × width) is a nominal value and does not include pins.



Logic Diagram (Positive Logic)

An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.

Table of Contents

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4 Pin Configurations and Functions

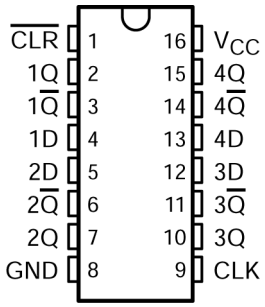

Figure 4-1. D Package, 16-PIN SCOIC (Top View)

Table 4-1. Pin Functions

PIN		TYPE	DESCRIPTION
NO.	NAME		
1	$\overline{CLR}$	I	Clear Pin
2	1Q	O	1Q Output
3	1$\overline{Q}$	O	1$\overline{Q}$ Output
4	1D	I	1D Input
5	2D	I	2D Input
6	2$\overline{Q}$	O	2$\overline{Q}$ Output
7	2Q	O	2Q Output
8	GND	—	Ground Pin
9	CLK	I	Clock Input
10	3Q	O	3Q Output
11	3$\overline{Q}$	O	3$\overline{Q}$Output
12	3D	I	3D Input
13	4D	I	4D Input
14	4$\overline{Q}$	O	4$\overline{Q}$Output
15	4Q	O	4Q Output
16	V_{CC}	—	Power Pin

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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	6	V
I_{IK}	Input clamp current	(V_I < 0 V or V_I > V_{CC}) (2)		±20	mA
I_{OK}	Output clamp current	(V_O < 0 V or V_O > V_{CC})(2)		±50	mA
I_O	Continuous output current	(V_O> 0 V or V_O < V_{CC})		±50	mA
	Continuous current through V_{CC} or GND			±200	mA
T_{stg}	Storage temperature range		–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 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins(1)	±2000	V

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

5.3 Recommended Operating Conditions

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

			T_A = 25°C		–55°C to 125°C		–40°C to 85°C		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
V_{CC}	Supply voltage		1.5	5.5	1.5	5.5	1.5	5.5	V
V_{IH}	High-level input voltage	V_{CC} = 1.5V	1.2		1.2		1.2		V
		V_{CC} = 3V	2.1		2.1		2.1		
		V_{CC} = 5.5V	3.85		3.85		3.85		
V_{IL}	Low-level input voltage	V_{CC} = 1.5V		0.3		0.3		0.3	V
		V_{CC} = 3V		0.9		0.9		0.9	
		V_{CC} = 5.5V		1.65		1.65		1.65	
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
I_{OH}	High-level output current	V_{CC} = 4.5V to 5.5V		–24		-24		-24	mA
I_{OL}	Low-level output current	V_{CC} = 4.5V to 5.5V		24		24		24	mA
Δt/Δv	Input transition rise or fall rate	V_{CC}= 1.5V to 3V		50		50		50	ns/V
		V_{CC} = 3.6V to 5.5V		20		20		20	

(1) 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.

5.4 Thermal Information

THERMAL METRIC(1)		D (SOIC) 16 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	106.6	°C/W

(1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report (SPRA953). The package thermal impedance is calculated in accordance with JESD 51-7.

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5.5 Electrical Characteristics

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

PARAMETER	TEST CONDITIONS		V_{CC}	T_A = 25 °C		–55°C to 125°C		–40°C to 85°C		UNIT
				MIN	MAX	MIN	MAX	MIN	MAX	
V_{OH}	V_I = V_{IH} or V_{IL}	I_{OH} = -50µA	1.5V	1.4		1.4		1.4		V
			3V	2.9		2.9		2.9		
			4.5V	4.4		4.4		4.4		
		I_{OH} = –4mA	3V	2.58		2.4		2.48		
		I_{OH} = –24mA	4.5V			3.85				
		I_{OH} = –50mA(1)	5.5V					3.85		
		I_{OH} = –75mA(1)	5.5V							
V_{OL}	V_I = V_{IH} or V_{IL}	I_{OL} = 50µA	1.5V		0.1		0.1		0.1	V
			3V		0.1		0.1		0.1	
			4.5V		0.1		0.1		0.1	
		I_{OL} = 12mA	3V		0.36		0.5		0.44	
		I_{OL} = 24mA	4.5V		0.36		0.5		0.44	
		I_{OL} = 50mA(1)	5.5V				1.65			
		I_{OL} = 75mA(1)	5.5 V						1.65	
I_I	V_I = V_{CC} or GND		5.5 V		±0.1		±1		±1	µA
I_{CC}	V_I = V_{CC} or GND,	I_O = 0	5.5 V		8		160		80	µA
C_i					10		10		10	pF

(1) Test one output at a time, not exceeding 1-second duration. Measurement is made by forcing indicated current and measuring voltage to minimize power dissipation. Test verifies a minimum 50-Ω transmission-line drive capability at 85°C and 75-Ω transmission-line drive capability at 125°C.

Table 5-1. Act Input Load Table

INPUT	UNIT LOAD
Data	0.58
$\overline{CLR}$	0.67
CLK	0.92

5.6 Timing Requirements, V_{CC} = 1.5V

over recommended operating free-air temperature range, V_{CC} = 1.5V (unless otherwise noted)

			-55°C to 125°C		-40°C to 85°C		UNIT
			MIN	MAX	MIN	MAX	
f_{clock}	Clock frequency			8		114	MHz
t_w	Pulse duration	$\overline{CLR}$ low	50		44		ns
		CLK high or low	63		55		
t_{su}	Setup time before CLK↑	Data	2		2		ns
t_h	Hold time, data after CLK ↑		2		2		ns
t_{rec}	Recovery time, before CLK ↑	$\overline{CLR}$↑	1		1		ns

5.7 Timing Requirements, V_{CC} = 3.3V ± 0.3V

over recommended operating free-air temperature range, V_{CC} = 3.3V ± 0.3V (unless otherwise noted)

		-55°C to 125°C		-40°C to 85°C		UNIT
		MIN	MAX	MIN	MAX	
f_{clock}	Clock frequency		71		81	MHz

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over recommended operating free-air temperature range, V_{CC} = 3.3V ± 0.3V (unless otherwise noted)

			-55°C to 125°C		-40°C to 85°C		UNIT
			MIN	MAX	MIN	MAX	
t_w	Pulse duration	$\overline{CLR}$ low	5.6		4.9		ns
		CLK high or low	7		6.1		
t_{su}	Setup time before CLK↑	Data	2		2		ns
t_h	Hold time, data after CLK ↑		2		2		ns
t_{rec}	Recovery time, before CLK ↑	$\overline{CLR}$↑	1		1		ns

5.8 Timing Requirements, V_{CC} = 5V ± 0.5V

over recommended operating free-air temperature range, V_{CC} = 5V ± 0.5V (unless otherwise noted)

			-55°C to 125°C		-40°C to 85°C		UNIT
			MIN	MAX	MIN	MAX	
f_{clock}	Clock frequency			100		114	MHz
t_w	Pulse duration	$\overline{CLR}$ low	4		3.5		ns
		CLK high or low	5		4.4		
t_{su}	Setup time before CLK↑	Data	2		2		ns
t_h	Hold time, data after CLK ↑		2		2		ns
t_{rec}	Recovery time, before CLK ↑	$\overline{CLR}$↑	1		1		ns

5.9 Switching Characteristics, V_{CC} = 1.5V

over recommended operating free-air temperature range, V_{CC} = 1.5V, C_L = 50pF (unless otherwise noted) (see Load Circuit and Voltage Waveforms)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	-55°C to 125°C		-40°C to 85°C		UNIT
			MIN	MAX	MIN	MAX	
f_{max}			8		9		MHz
t_{PLH}	CLK	Any Q		153		139	ns
t_{PHL}				153		139	
t_{PLH}	$\overline{CLR}$	Any Q		153		139	ns
t_{PHL}				153		139	

5.10 Switching Characteristics, V_{CC} = 3.3V ± 0.3V

over recommended operating free-air temperature range, V_{CC} = 3.3V ± 0.3V, C_L = 50pF (unless otherwise noted) (see Load Circuit and Voltage Waveforms)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	-55°C to 125°C		-40°C to 85°C		UNIT
			MIN	MAX	MIN	MAX	
f_{max}			71		81		MHz
t_{PLH}	CLK	Any Q	4.3	17.1	4.4	15.5	ns
t_{PHL}			4.3	17.1	4.4	15.5	
t_{PLH}	$\overline{CLR}$	Any Q	4.3	17.1	4.4	15.5	ns
t_{PHL}			4.3	17.1	4.4	15.5	

5.11 Switching Characteristics, V_{CC} = 5V ± 0.5V

over recommended operating free-air temperature range, V_{CC} = 5V ± 0.5V, C_L = 50pF (unless otherwise noted) (see Load Circuit and Voltage Waveforms)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	-55°C to 125°C		-40°C to 85°C		UNIT
			MIN	MAX	MIN	MAX	
f_{max}			100		114		MHz

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over recommended operating free-air temperature range, V_{CC} = 5V ± 0.5V, C_L = 50pF (unless otherwise noted) (see Load Circuit and Voltage Waveforms)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	-55°C to 125°C		-40°C to 85°C		UNIT
			MIN	MAX	MIN	MAX	
t_{PLH}	CLK	Any Q	3.1	12.2	3.2	11.1	ns
t_{PHL}			3.1	12.2	3.2	11.1	
t_{PLH}	$\overline{CLR}$	Any Q	3.1	12.2	3.2	11.1	ns
t_{PHL}			3.1	12.2	3.2	11.1	

5.12 Operating Characteristics

V_{CC} = 5 V, T_A = 25°C

PARAMETER		TYP	UNIT
C_{pd}	Power dissipation capacitance	55	pF

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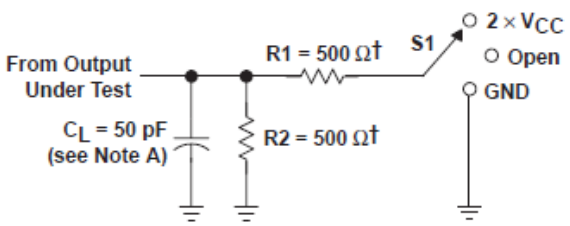
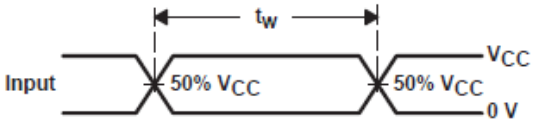
6 Parameter Measurement Information

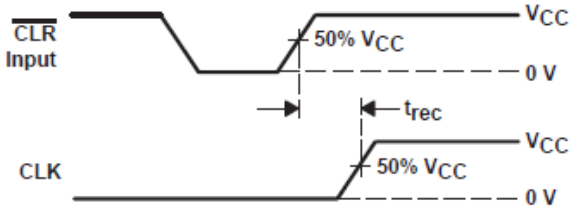


LOAD CIRCUIT

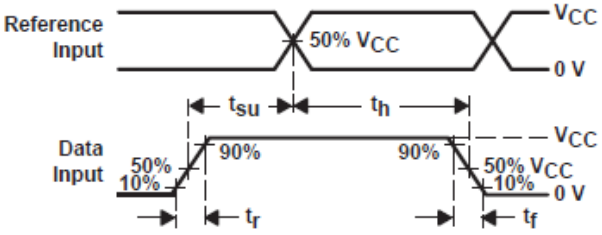
TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	$2 \times V_{CC}$
t_{PHZ}/t_{PZH}	GND



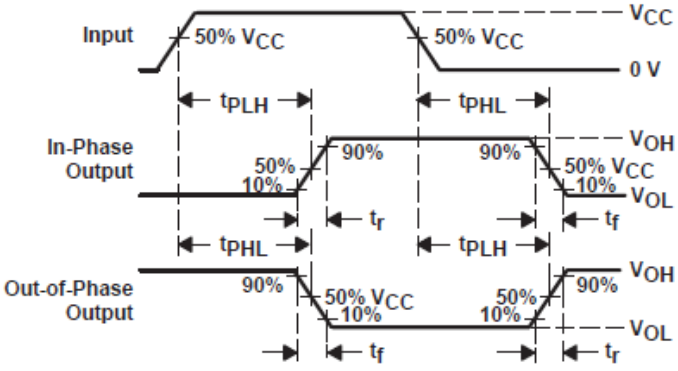
VOLTAGE WAVEFORMS
PULSE DURATION



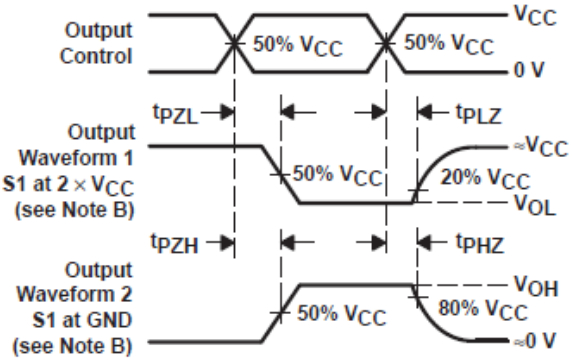
VOLTAGE WAVEFORMS
RECOVERY TIME



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. All input pulses are supplied by generators having the following characteristics: PRR ≤ 1 MHz, Z_O = 50 Ω, t_r = 3 ns, t_f = 3 ns. Phase relationships between waveforms are arbitrary.
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_{PLH} and t_{PHL} are the same as t_{pd}.
G. t_{PZL} and t_{PZH} are the same as t_{en}.
H. t_{PLZ} and t_{PHZ} are the same as t_{dis}.

Figure 6-1. Load Circuit and Voltage Waveforms

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7 Detailed Description

7.1 Overview

Information at the data (D) inputs meeting the setup time requirements is transferred to the outputs on the positive-going edge of the clock (CLK) pulse. Clock triggering occurs at a particular voltage level and is not directly related to the transition time of the positive-going edge of CLK. When CLK is at either the high or low level, the D input has no effect at the output.

7.2 Functional Block Diagram

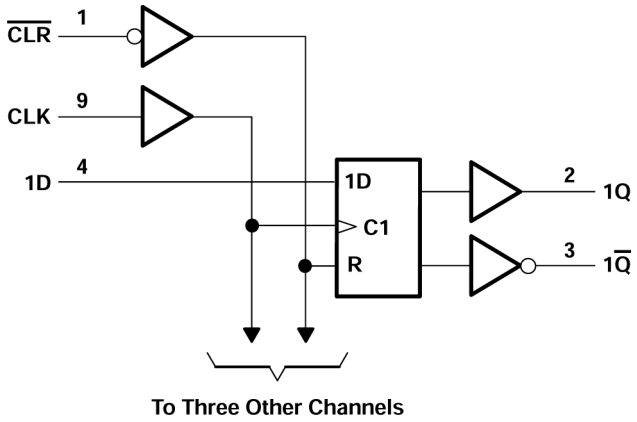

Figure 7-1. Logic Diagram (Positive Logic)

7.3 Device Functional Modes

Table 7-1. Function Table (Each Flip-flop)

INPUTS			OUTPUTS	
$\overline{CLR}$	CLK	D	Q	$\overline{Q}$
L	X	X	L	H
H	↑	H	H	L
H	↑	L	L	H
H	L	X	Q_0	$\overline{Q}_0$

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8 Application and Implementation

Note

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes, as well as validating and testing their design implementation to confirm system functionality.

8.1 Power Supply Recommendations

The power supply can be any voltage between the min and max supply voltage rating located in *Section 5.3*.

Each V_{CC} terminal should have a good bypass capacitor to prevent power disturbance. For devices with a single supply, TI recommends 0.1 µF and if there are multiple V_{CC} terminals, then TI recommends .01 µF or .022 µF for each power terminal. It is okay to parallel multiple bypass capacitors to reject different frequencies of noise. A 0.1 µF and 1 µF are commonly used in parallel. The bypass capacitor should be installed as close to the power terminal as possible for best results.

8.2 Layout

8.2.1 Layout Guidelines

When using multiple bit logic devices inputs should not ever float.

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 input pins should not be left unconnected because the undefined voltages at the outside connections result in undefined operational states. Specified below are the rules that must be observed under all circumstances. All unused inputs of digital logic devices must be connected to a high or low bias to prevent them from floating. The logic level that should be applied to any particular unused input depends on the function of the device. Generally they will be tied to GND or V_{CC} whichever make more sense or is more convenient. It is generally okay to float outputs unless the part is a transceiver. If the transceiver has an output enable pin it will disable the outputs section of the part when asserted. This does not disable the input section of the IOs so they cannot float when disabled.

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9 Device and Documentation Support

9.1 Documentation Support (Analog)

9.1.1 Related Documentation

The table below lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

Table 9-1. Related Links

PARTS	PRODUCT FOLDER	SAMPLE & BUY	TECHNICAL DOCUMENTS	TOOLS & SOFTWARE	SUPPORT & COMMUNITY
CD74AC175	Click here	Click here	Click here	Click here	Click here

9.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Notifications* 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.

9.3 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.

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9.4 Trademarks

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9.5 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.

9.6 Glossary

TI Glossary — This glossary lists and explains terms, acronyms, and definitions.

10 Revision History

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

Changes from Revision * (April 2003) to Revision A (April 2024)	Page
• Added *Applications* section, *Package Information* table, *Pin Functions* table, *ESD Ratings* table, *Thermal Information* table, *Device Functional Modes*, *Application and Implementation* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section	1
• Updated thermal values for RθJA: D = 73 to 106.6, all values in °C/W	4

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.

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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
CD74AC175M96	ACTIVE	SOIC	D	16	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-55 to 125	AC175M	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) **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.

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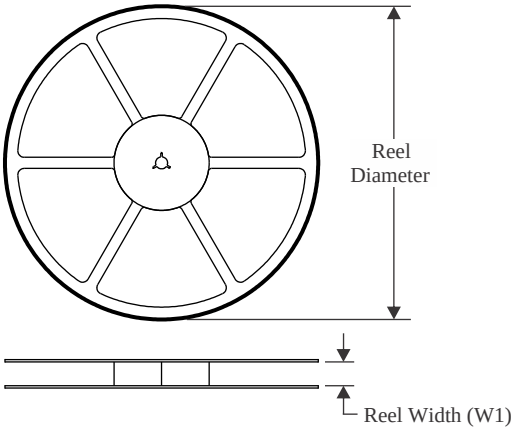
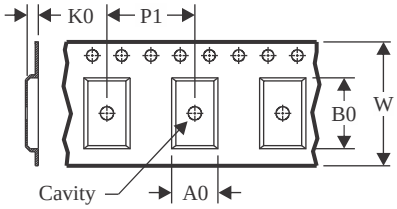
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

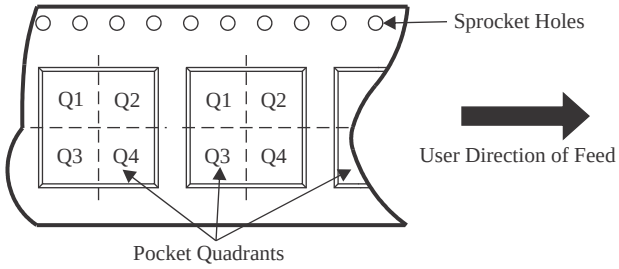


TAPE DIMENSIONS



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

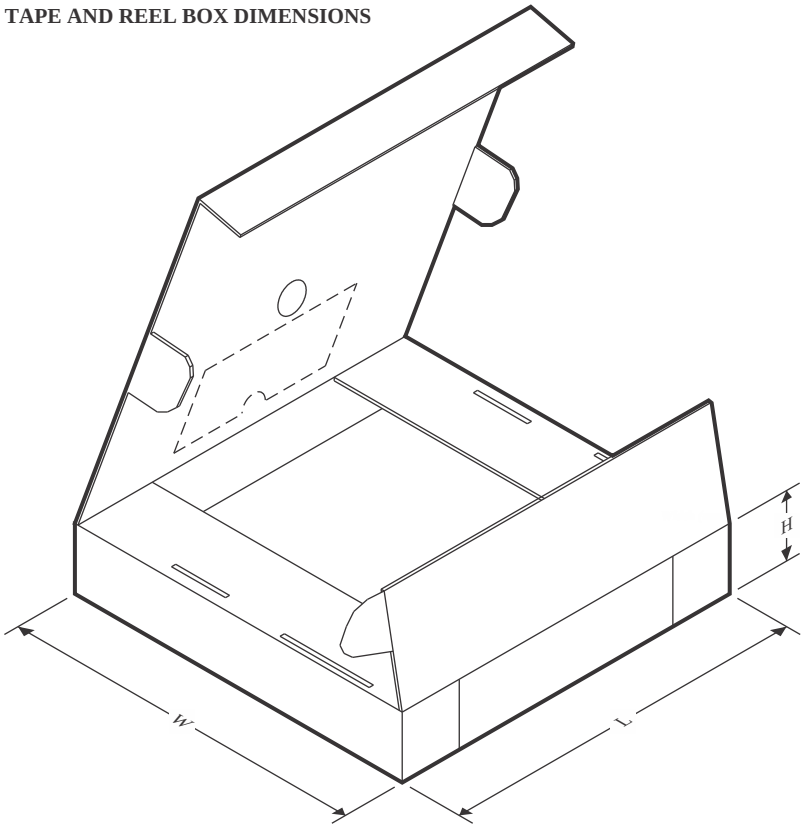
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
CD74AC175M96	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1

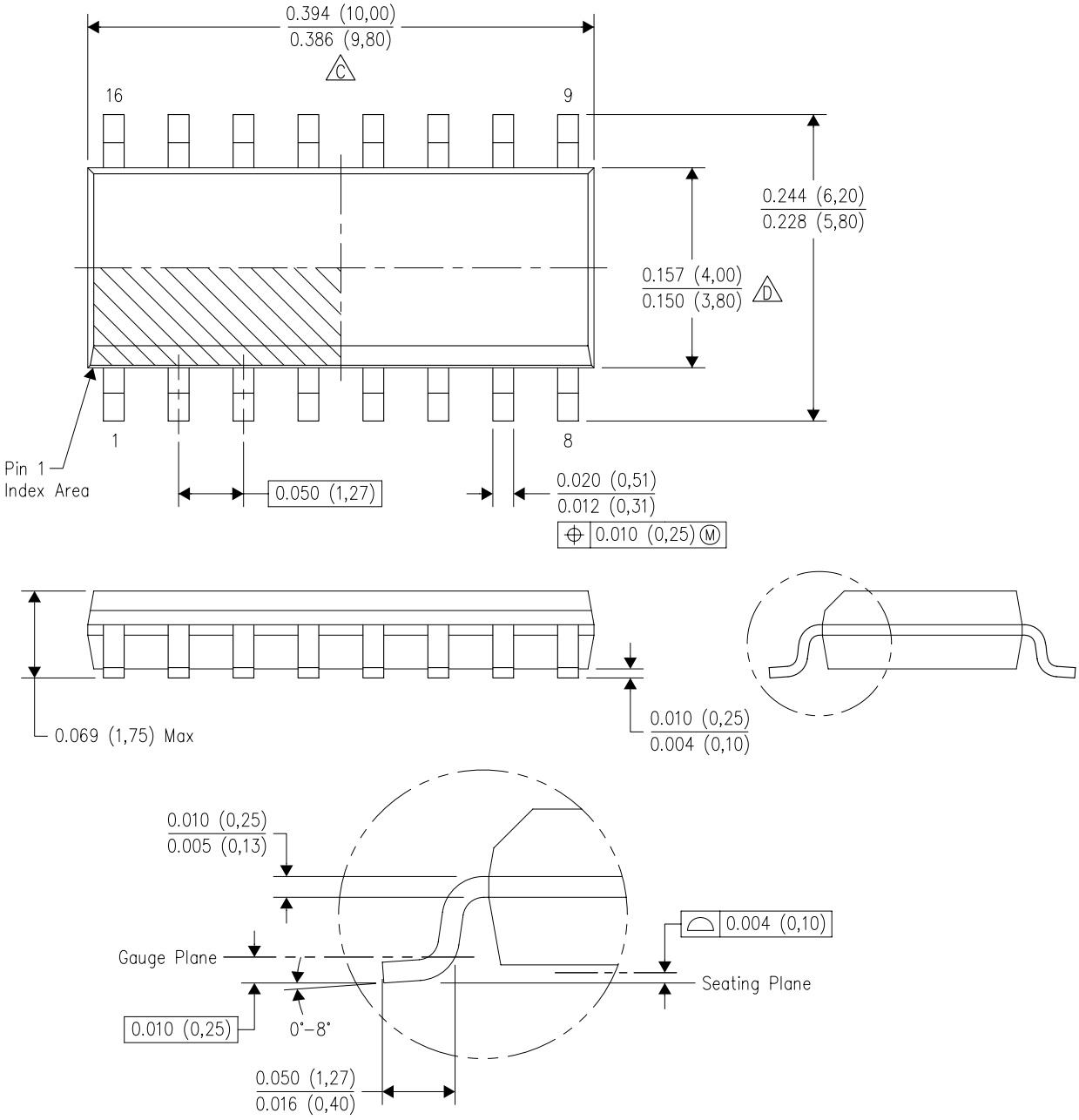
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CD74AC175M96	SOIC	D	16	2500	340.5	336.1	32.0

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.

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