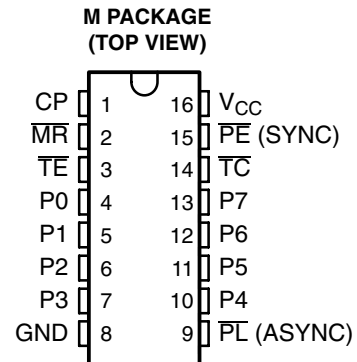


CD74HC40103-Q1
HIGH-SPEED CMOS LOGIC
8-STAGE SYNCHRONOUS DOWN COUNTER

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- Qualified for Automotive Applications
- Synchronous or Asynchronous Preset
- Cascadable in Synchronous or Ripple Mode
- Fanout (Over Temperature Range)
 - Standard Outputs . . . 10 LSTTL Loads
 - Bus Driver Outputs . . . 15 LSTTL Loads
- Balanced Propagation Delay and Transition Times
- Significant Power Reduction Compared to LSTTL Logic ICs
- V_{CC} Voltage = 2 V to 6 V
- High Noise Immunity N_{IL} or N_{IH} = 30% of V_{CC} , $V_{CC} = 5$ V



description/ordering information

The CD74HC40103 is manufactured with high-speed silicon-gate technology and consists of an 8-stage synchronous down counter with a single output, which is active when the internal count is zero. The device contains a single 8-bit binary counter. Each device has control inputs for enabling or disabling the clock, for clearing the counter to its maximum count, and for presetting the counter either synchronously or asynchronously. All control inputs and the terminal count (\overline{TC}) output are active-low logic.

In normal operation, the counter is decremented by one count on each positive transition of the clock (CP) output. Counting is inhibited when the terminal enable (\overline{TE}) input is high. \overline{TC} goes low when the count reaches zero, if \overline{TE} is low, and remains low for one full clock period.

When the synchronous preset enable (\overline{PE}) input is low, data at the P0–P7 inputs are clocked into the counter on the next positive clock transition, regardless of the state of \overline{TE} . When the asynchronous preset enable (\overline{PL}) input is low, data at the P0–P7 inputs asynchronously are forced into the counter, regardless of the state of the \overline{PE} , \overline{TE} , or CP inputs. Inputs P0–P7 represent a single 8-bit binary word for the CD74HC40103. When the master reset (\overline{MR}) input is low, the counter asynchronously is cleared to its maximum count of 255₁₀, regardless of the state of any other input. The precedence relationship between control inputs is indicated in the truth table.

If all control inputs except \overline{TE} are high at the time of zero count, the counters jump to the maximum count, giving a counting sequence of 100₁₆ or 256₁₀ clock pulses long.

ORDERING INFORMATION[†]

T_A	PACKAGE [‡]		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 125°C	SOIC – M	Tape and reel	CD74HC40103QM96Q1	HC40103Q

[†] For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at <http://www.ti.com>.

[‡] Package drawings, thermal data, and symbolization are available at <http://www.ti.com/packaging>.



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HIGH-SPEED CMOS LOGIC

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description/ordering information (continued)

The CD74HC40103 may be cascaded using the \overline{TE} input and the \overline{TC} output, in either synchronous or ripple mode. These circuits have the low power consumption usually associated with CMOS circuitry, yet have speeds comparable to low-power Schottky TTL circuits and can drive up to ten LSTTL loads.

FUNCTION TABLE

CONTROL INPUTS				PRESET MODE	ACTION
\overline{MR}	\overline{PL}	\overline{PE}	\overline{TE}		
H	H	H	H	Synchronous	Inhibit counter
H	H	H	L		Count down
H	H	L	X		Preset on next positive clock transition
H	L	X	X	Asynchronous	Preset asynchronously
L	X	X	X		Clear to maximum count

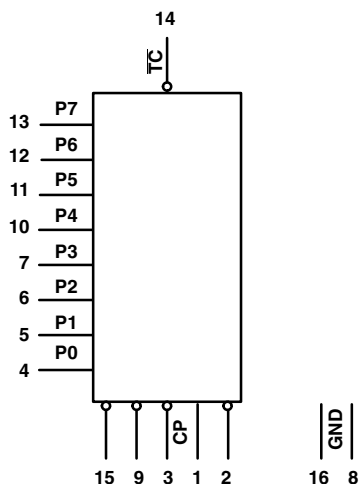
NOTE: H = high voltage level, L = low voltage level, X = don't care

Clock connected to clock input

Synchronous operation: changes occur on negative-to-positive clock transitions.

Load inputs: MSB = P7, LSB = P0

logic diagram (positive logic)



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

Supply voltage range, V_{CC} (see Note 1)	–0.5 V to 7 V
Input clamp current, I_{IK} ($V_I < -0.5$ V or $V_I > V_{CC} + 0.5$ V)	±20 mA
Output clamp current, I_{OK} ($V_O < -0.5$ V or $V_O > V_{CC} + 0.5$ V)	±20 mA
Source or sink current per output pin, I_O ($V_O > -0.5$ V or $V_O < V_{CC} + 0.5$ V)	±25 mA
Continuous current through V_{CC} or GND	±50 mA
Package thermal impedance, θ_{JA} (see Note 2)	73°C/W
Maximum junction temperature, T_J	150°C
Lead temperature (during soldering):	
At distance $1/16 \pm 1/32$ inch ($1,59 \pm 0,79$ mm) from case for 10 s max	300°C
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. All voltages referenced to GND unless otherwise specified.
 2. The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions (see Note 3)

		MIN	MAX	UNIT	
V_{CC}	Supply voltage	2	6	V	
V_{IH}	High-level input voltage	$V_{CC} = 2$ V	1.5	V	
		$V_{CC} = 4.5$ V	3.15		
		$V_{CC} = 6$ V	4.2		
V_{IL}	Low-level input voltage	$V_{CC} = 2$ V	0.5	V	
		$V_{CC} = 4.5$ V	1.35		
		$V_{CC} = 6$ V	1.8		
V_I	Input voltage	0	V_{CC}	V	
V_O	Output voltage	0	V_{CC}	V	
t_t	Input transition (rise and fall) time	$V_{CC} = 2$ V	0	1000	ns
		$V_{CC} = 4.5$ V	0	500	
		$V_{CC} = 6$ V	0	400	
T_A	Operating free-air temperature	–40	125	°C	

NOTES: 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.



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HIGH-SPEED CMOS LOGIC
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electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS		I _O (mA)	V _{CC}	T _A = 25°C		MIN	MAX	UNIT
					MIN	MAX			
V _{OH}	V _I = V _{IH} or V _{IL}	CMOS loads	-0.02	2 V	1.9	1.9	V		
			-0.02	4.5 V	4.4	4.4			
			-0.02	6 V	5.9	5.9			
		TTL loads	-4	4.5 V	3.98	3.7			
			-5.2	6 V	5.48	5.2			
V _{OL}	V _I = V _{IH} or V _{IL}	CMOS loads	0.02	2 V	0.1	0.1	V		
			0.02	4.5 V	0.1	0.1			
			0.02	6 V	0.1	0.1			
		TTL loads	4	4.5 V	0.26	0.4			
			5.2	6 V	0.26	0.4			
I _I	V _I = V _{CC} or GND		6 V	±0.1	±1	μA			
I _{CC}	V _I = V _{CC} or GND	0	6 V	8	160	μA			
C _{IN}	C _L = 50 pF			10	10	pF			



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HIGH-SPEED CMOS LOGIC
8-STAGE SYNCHRONOUS DOWN COUNTER

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timing requirements over recommended operating free-air temperature range (unless otherwise noted) (see Figure 1)

PARAMETER		V _{CC}	T _A = 25°C		MIN	MAX	UNIT
			MIN	MAX			
t _w	Pulse duration	CP	2 V	165	250	ns	
			4.5 V	33	50		
			6 V	28	43		
	P \bar{L}	2 V	125	190			
		4.5 V	25	38			
		6 V	21	32			
	MR	2 V	125	190			
		4.5 V	25	38			
		6 V	21	32			
f _{max}	CP frequency (see Note 4)	2 V	3	2	MHz		
		4.5 V	15	10			
		6 V	18	12			
t _{su}	P to CP	2 V	100	150	ns		
		4.5 V	20	30			
		6 V	17	26			
	P \bar{E} to CP	2 V	75	110			
		4.5 V	15	22			
		6 V	13	19			
	T \bar{E} to CP	2 V	150	225			
		4.5 V	30	45			
		6 V	26	38			
	To CP, MR inactive	2 V	50	75			
		4.5 V	10	15			
		6 V	9	13			
t _h	P to CP	2 V	5	5	ns		
		4.5 V	5	5			
		6 V	5	5			
	T \bar{E} to CP	2 V	0	0			
		4.5 V	0	0			
		6 V	0	0			
	P \bar{E} to CP	2 V	2	2			
		4.5 V	2	2			
		6 V	2	2			

NOTE 4: Noncascaded operation only. With cascaded counters, clock-to-terminal count propagation delays, count enables (P \bar{E} or T \bar{E}) to clock setup times, and count enables (PE or TE) to clock hold times determine maximum clock frequency. For example, with these HC devices:

$$CP f_{max} = \frac{1}{CP \text{ to } T\bar{C} \text{ prop delay} + T\bar{E} \text{ to } CP \text{ setup time} + T\bar{E} \text{ to } CP \text{ hold time}} = \frac{1}{60 + 30 + 0} \approx 11 \text{ MHz}$$



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switching characteristics over recommended operating free-air temperature range (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	V _{CC}	T _A = 25°C			MIN	MAX	UNIT	
					MIN	TYP	MAX				
t _{pd}	CP	\overline{TC} (asynchronous preset)	C _L = 50 pF	2 V		300		450	ns		
				4.5 V		60	90				
				6 V		51	77				
			C _L = 15 pF	5 V	25						
				\overline{TC} (synchronous preset)	C _L = 50 pF	2 V		300			450
						4.5 V		60		90	
		6 V				51	77				
		C _L = 15 pF	5 V		25						
			\overline{TE}		C _L = 50 pF	2 V		200			300
						4.5 V		40		60	
		6 V				34	51				
		C _L = 15 pF		5 V	17						
	PL			C _L = 50 pF	2 V		275			415	
					4.5 V		55	83			
		6 V			47	71					
		C _L = 15 pF	5 V	23							
			\overline{MR}	C _L = 50 pF	2 V		275			415	
					4.5 V		55	83			
	6 V				47	71					
	C _L = 15 pF	5 V		23							
		t _t		C _L = 50 pF	2 V		75			110	
					4.5 V		15	22			
	6 V				13	19					
	f _{max}	CP		C _L = 15 pF	5 V	25				MHz	

operating characteristics, V_{CC} = 5 V, T_A = 25°C, input t_r, t_f = 6 ns

PARAMETER		TYP	UNIT
C _{pd}	Power dissipation capacitance (see Note 5)	25	pF

NOTE 5: C_{pd} is used to determine the dynamic power consumption per package.

$$P_D = (C_{pd} \times V_{CC}^2 \times f_i) + (C_L \times V_{CC}^2 \times f_O)$$

f_i = input frequency

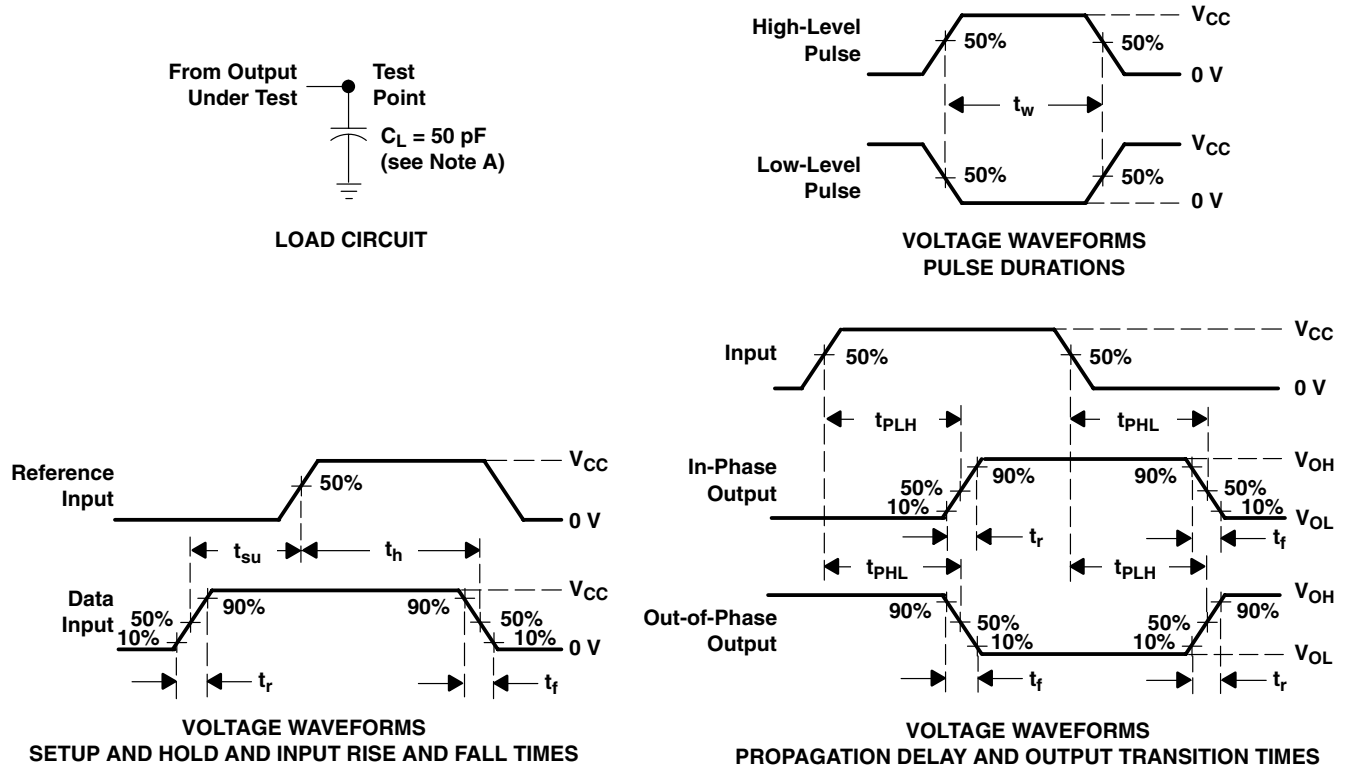
f_O = output frequency

C_L = output load capacitance

V_{CC} = supply voltage



PARAMETER MEASUREMENT INFORMATION



- NOTES:
- A. C_L includes probe and test-fixture capacitance.
 - B. 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.
 - C. For clock inputs, f_{max} is measured when the input duty cycle is 50%.
 - D. The outputs are measured one at a time with one input transition per measurement.
 - E. t_{PLH} and t_{PHL} are the same as t_{pd} .

Figure 1. Load Circuit and Voltage Waveforms

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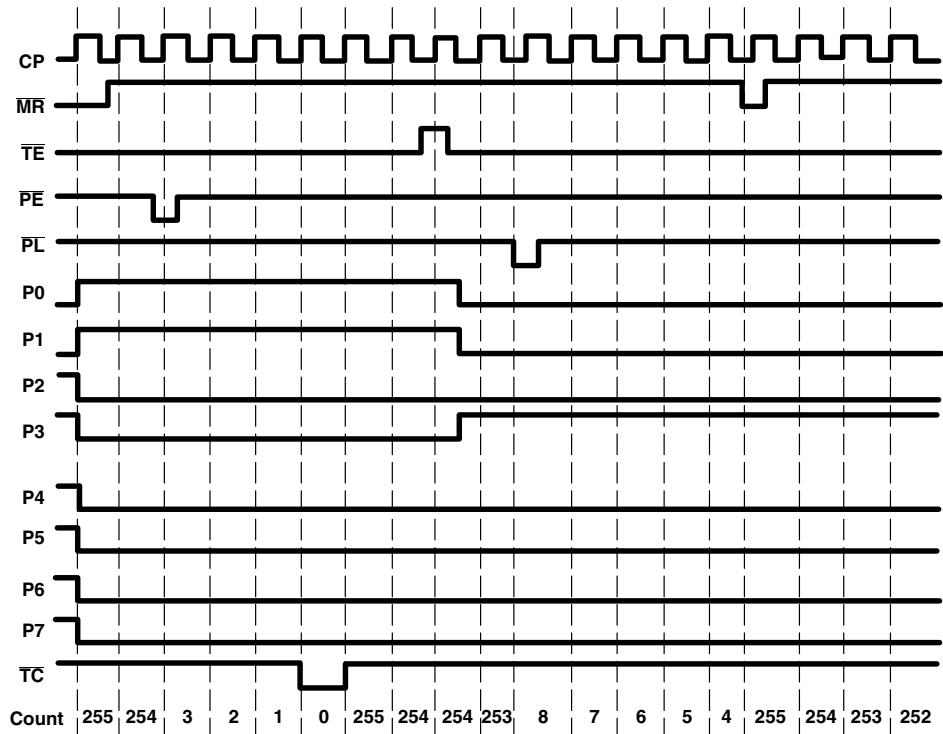


Figure 2. Timing Diagram

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
CD74HC40103QM96Q1	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
HC40103QM96G4Q1	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

⁽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.

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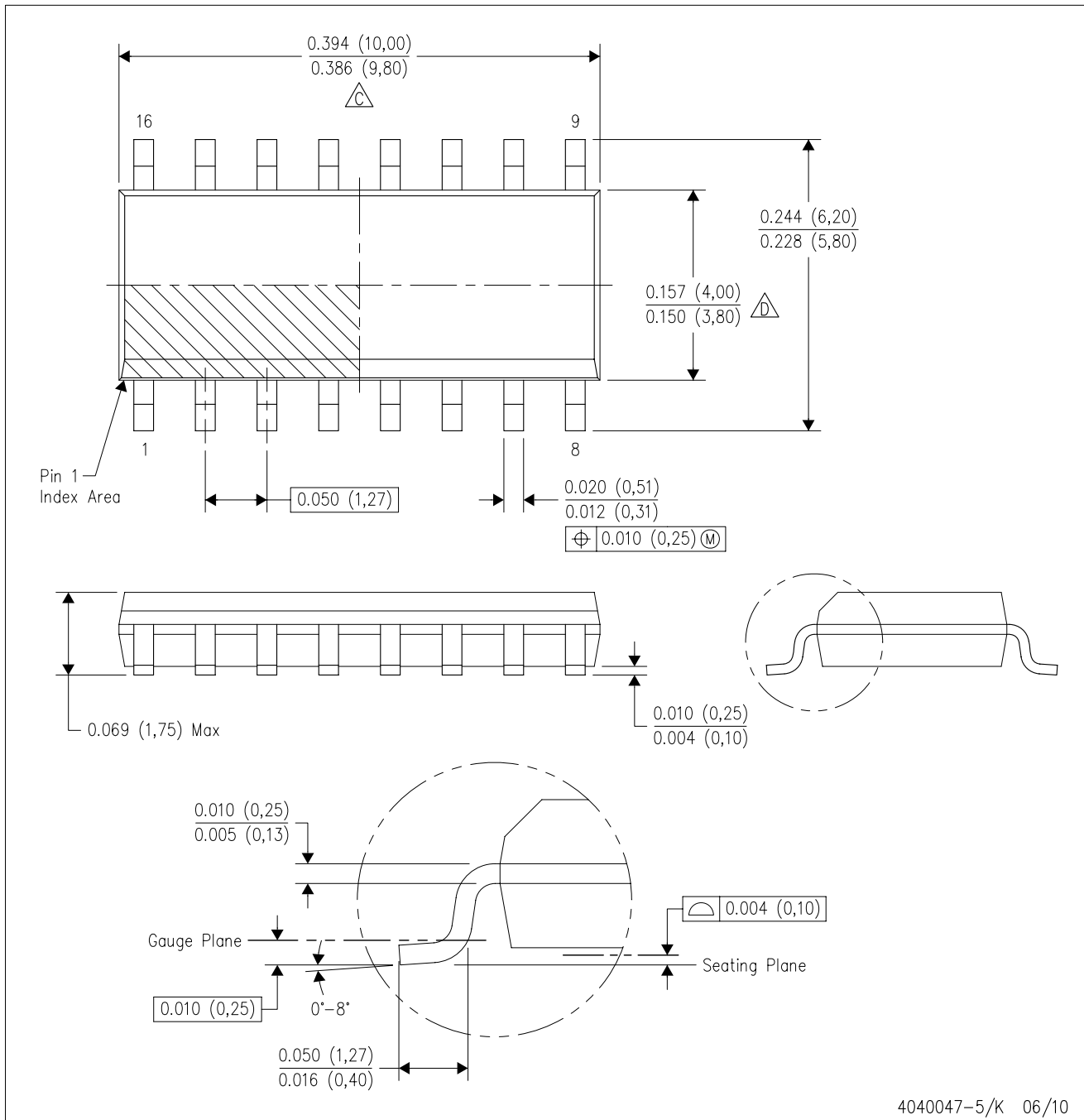
- Catalog: [CD74HC40103](#)
- Enhanced Product: [CD74HC40103-EP](#)
- Military: [CD54HC40103](#)

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D (R-PDSO-G16)

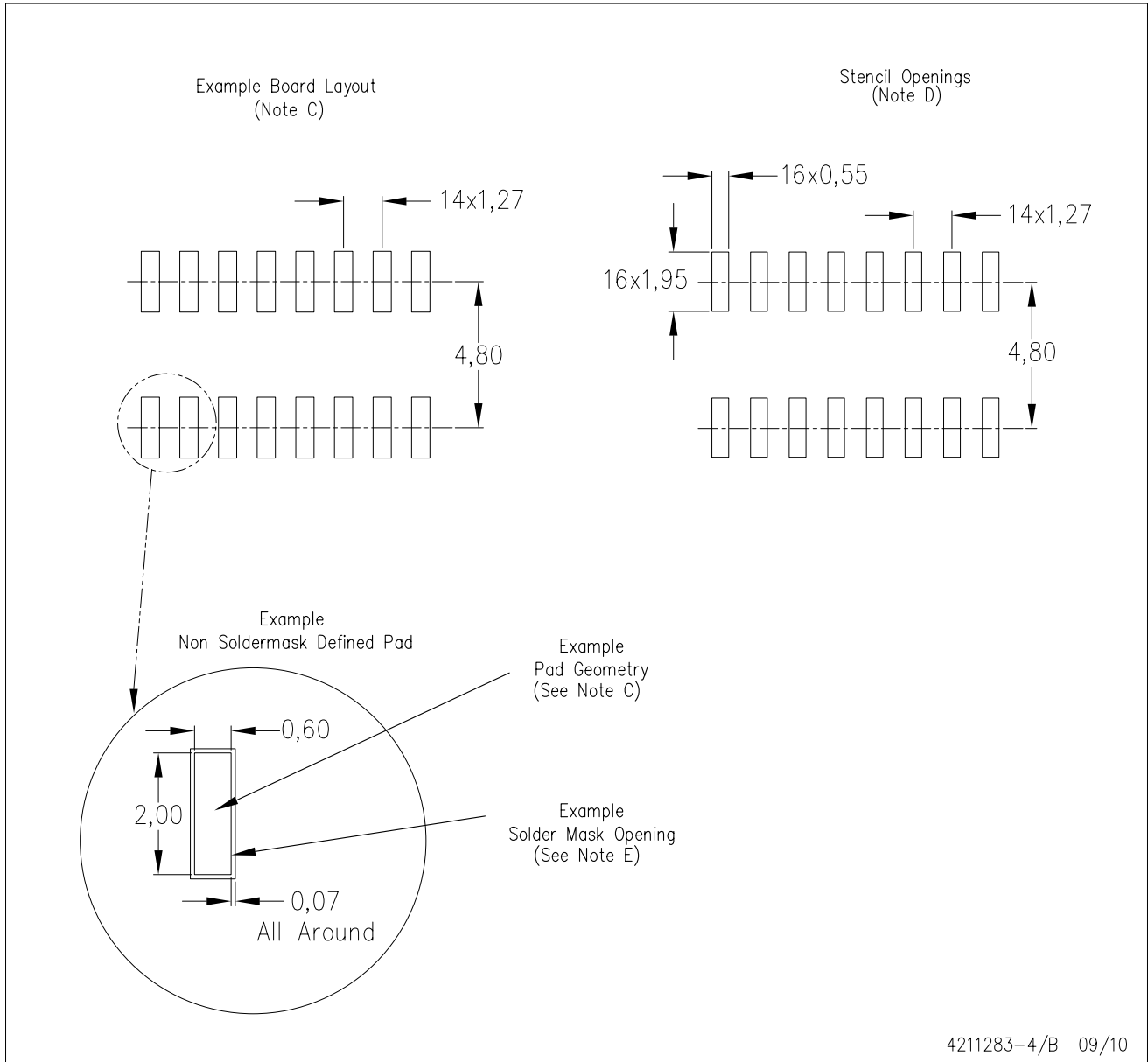
PLASTIC SMALL-OUTLINE PACKAGE



- 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 .006 (0,15) per end.
 - D. Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
 - E. Reference JEDEC MS-012 variation AC.

D (R-PDSO-G16)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Publication IPC-7351 is recommended for alternate designs.
 - D. 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.
 - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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