![Texas Instruments logo] **TEXAS INSTRUMENTS**

CD4020B, CD4024B, CD4040B Types

CMOS Ripple-Carry Binary Counter/Dividers

High-Voltage Types (20-Volt Rating)

CD4020B – 14 Stage
CD4024B – 7 Stage
CD4040B – 12 Stage

■ CD4020B, CD4024B, and CD4040B are ripple-carry binary counters. All counter stages are master-slave flip-flops. The state of a counter advances one count on the negative transition of each input pulse; a high level on the RESET line resets the counter to its all zeros state. Schmitt trigger action on the input-pulse line permits unlimited rise and fall times. All inputs and outputs are buffered.

The CD4020B and CD4040B types are supplied in 16-lead hermetic dual-in-line ceramic packages (F3A suffix), 16-lead dual-in-line plastic packages (E suffix), 16-lead small-outline packages (NSR suffix), and 16-lead thin shrink small-outline packages (PW and PWR suffixes). The CD4040B type also is supplied in 16-lead small-outline packages (M and M96 suffixes).

The CD4024B types are supplied in 14-lead hermetic dual-in-line ceramic packages (F3A suffix), 14-lead dual-in-line plastic packages (E suffix), 14-lead small-outline packages (M, MT, M96, and NSR suffixes), and 14-lead thin shrink small-outline packages (PW and PWR suffixes).
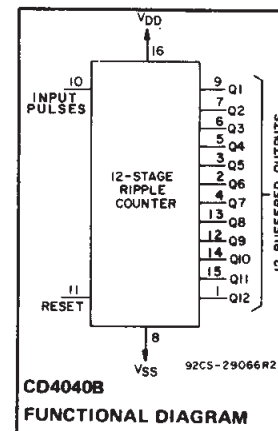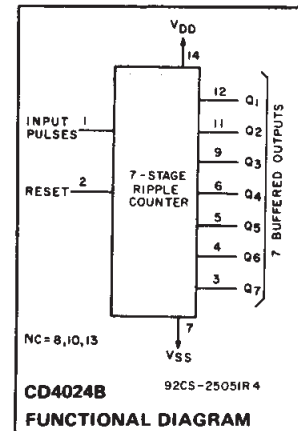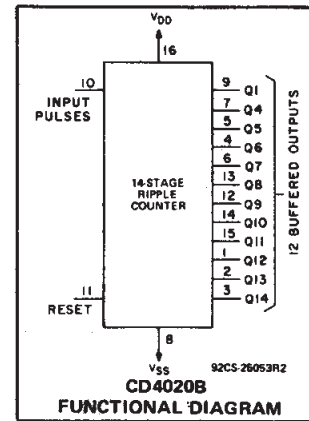
Features:

■ Medium-speed operation
■ Fully static operation
■ Buffered inputs and outputs
■ 100% tested for quiescent current at 20 V
■ Standardized, symmetrical output characteristics
■ Fully static operation
■ Common reset
■ 5-V, 10-V, and 15-V parametric ratings
■ Maximum input current of 1 μA at 18 V over full package-temperature range; 100 nA at 18 V and 25°C
■ Noise margin (over full package-temperature range):
    1 V at V_{DD} = 5 V
    2 V at V_{DD} = 10 V
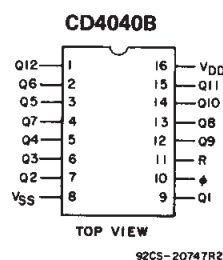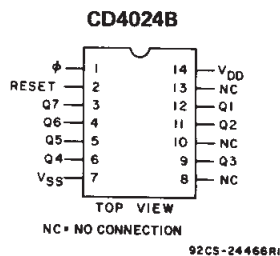   2.5 V at V_{DD} = 15 V
■ Meets all requirements of JEDEC Tentative Standard No. 13B, "Standard Specifications for Description of 'B' Series CMOS Devices"

Applications:

■ Control counters
■ Timers
■ Frequency dividers
■ Time-delay circuits

CD4020B FUNCTIONAL DIAGRAM

CD4024B FUNCTIONAL DIAGRAM

CD4040B FUNCTIONAL DIAGRAM

MAXIMUM RATINGS, *Absolute-Maximum Values:*

DC SUPPLY-VOLTAGE RANGE, (V_{DD})
    Voltages referenced to V_{SS} Terminal) .... –0.5V to +20V
INPUT VOLTAGE RANGE, ALL INPUTS .... –0.5V to V_{DD} +0.5V
DC INPUT CURRENT, ANY ONE INPUT .... ±10mA
POWER DISSIPATION PER PACKAGE (P_D):
    For T_A = –55°C to +100°C 500mW
    For T_A = +100°C to +125°C................................... Derate Linearity at 12mW/°C to 200mW
DEVICE DISSIPATION PER OUTPUT TRANSISTOR
    FOR T_A = FULL PACKAGE-TEMPERATURE RANGE (All Package Types) 100mW
OPERATING-TEMPERATURE RANGE (T_A).. –55°C to +125°C
STORAGE TEMPERATURE RANGE (T_{stg})... –65°C to +150°C
LEAD TEMPERATURE (DURING SOLDERING):
    At distance 1/16 ± 1/32 inch (1.59 ± 0.79mm) from case for 10s max .... +265°C

TERMINAL ASSIGNMENTS

CD4020B

CD4024B
NC = NO CONNECTION

CD4040B

CD4020B, CD4024B, CD4040B Types

RECOMMENDED OPERATING CONDITIONS at $T_A = 25°C$, Unless Otherwise Specified

For maximum reliability, nominal operating conditions should be selected so that operation is always within the following ranges:

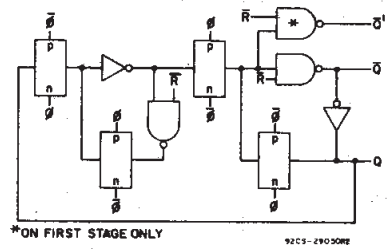| CHARACTERISTIC		V_{DD}	Min.	Max.	UNITS
Supply Voltage Range (at T_A = Full Package-Temperature Range)			3	18	V
Input-Pulse Frequency,	f_ϕ	5	–	3.5	MHz
		10	–	8	
		15	–	12	
Input-Pulse Width,	t_W	5	140	–	ns
		10	60	–	
		15	40	–	
Input-Pulse Rise or Fall Time,	$t_{r\phi}, t_{f\phi}$	5	Unlimited		μs
		10			
		15			
Reset Pulse Width,	t_W	5	200	–	ns
		10	80		
		15	60		
Reset Removal Time,	t_{REM}	5	350	–	ns
		10	150	–	
		15	100	–	

*ON FIRST STAGE ONLY

92CS-29030R2

Fig. 4 — Detail of typical flip-flop stage.
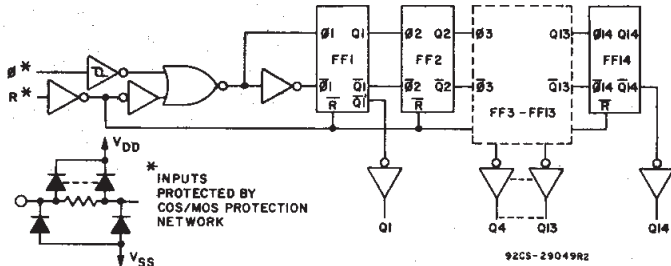
Fig. 1 — Logic diagram for CD4020B.

92CS-29049R2
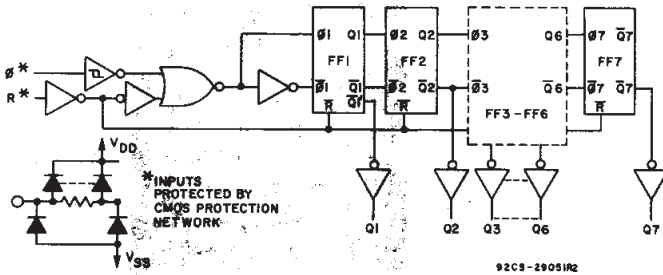
Fig. 2 — Logic diagram for CD4024B.

92CS-29051R2

92CS-24318R3

Fig. 5 — Typical output low (sink) current characteristics.

92CS-24319R1
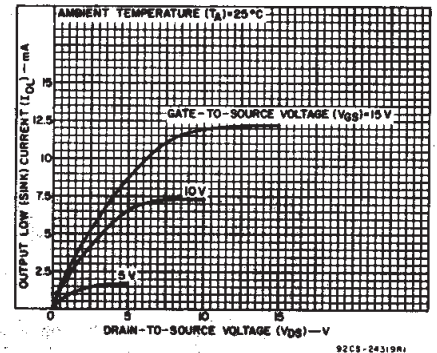
Fig. 6 — Minimum output low (sink) current characteristics.

92CS-29052R2

Fig. 3 — Logic diagram for CD4040B.

92CS-24320R3
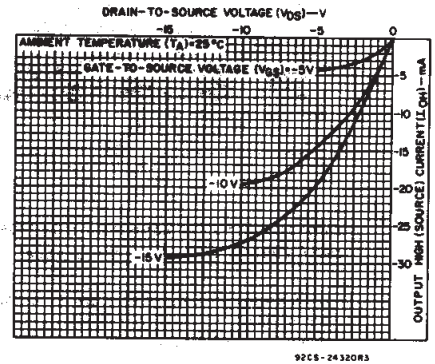
Fig. 7 — Typical output high (source) current characteristics.

CD4020B, CD4024B, CD4040B Types

STATIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	CONDITIONS			LIMITS AT INDICATED TEMPERATURES (°C)							UNITS
	V$_O$ (V)	V$_{IN}$ (V)	V$_{DD}$ (V)	−55	−40	+85	+125	+25 Min.	+25 Typ.	+25 Max.	
Quiescent Device Current, I$_{DD}$ Max.	–	0,5	5	5	5	150	150	–	0.04	5	μA
	–	0,10	10	10	10	300	300	–	0.04	10	
	–	0,15	15	20	20	600	600	–	0.04	20	
	–	0,20	20	100	100	3000	3000	–	0.08	100	
Output Low (Sink) Current I$_{OL}$ Min.	0.4	0,5	5	0.64	0.61	0.42	0.36	0.51	1	–	mA
	0.5	0,10	10	1.6	1.5	1.1	0.9	1.3	2.6	–	
	1.5	0,15	15	4.2	4	2.8	2.4	3 4	6.8	–	
Output High (Source) Current, I$_{OH}$ Min.	4.6	0,5	5	−0.64	−0.61	−0.42	−0.36	−0.51	−1	–	mA
	2.5	0,5	5	−2	−1.8	−1.3	−1.15	−1.6	−3.2	–	
	9.5	0,10	10	−1.6	−1.5	−1.1	−0.9	−1.3	−2.6	–	
	13.5	0,15	15	−4.2	−4	−2.8	−2.4	−3.4	−6.8	–	
Output Voltage: Low-Level, V$_{OL}$ Max.	–	0,5	5	0.05				–	0	0.05	V
	–	0,10	10	0.05				–	0	0.05	
	–	0,15	15	0.05				–	0	0.05	
Output Voltage: High-Level, V$_{OH}$ Min.	–	0,5	5	4.95				4.95	5	–	V
	–	0,10	10	9.95				9.95	10	–	
	–	0,15	15	14.95				14.95	15	–	
Input Low Voltage, V$_{IL}$ Max.	0.5, 4.5	–	5	1.5				—	—	1.5	V
	1, 9	–	10	3				—	—	3	
	1.5,13.5	–	15	4				—	—	4	
Input High Voltage, V$_{IH}$ Min.	0.5, 4.5	–	5	3.5				3.5	—	—	V
	1, 9	–	10	7				7	—	—	
	1.5,13.5	–	15	11				11	—	—	
Input Current I$_{IN}$ Max.	–	0,18	18	±0.1	±0.1	±1	±1	–	$\pm 10^{-5}$	±0.1	μA
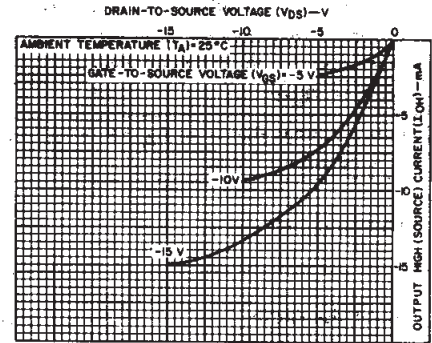
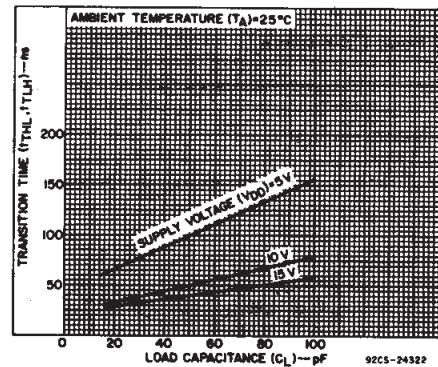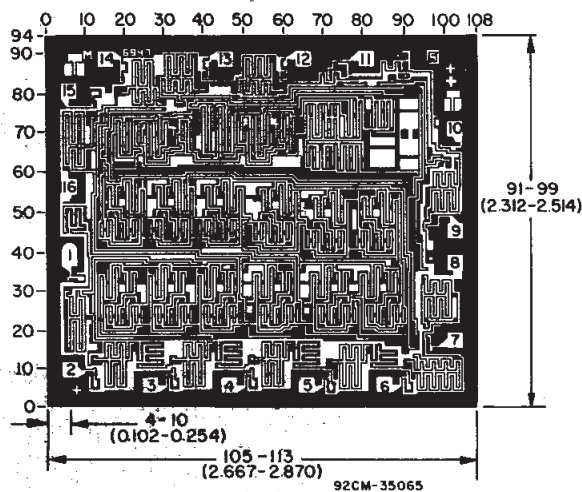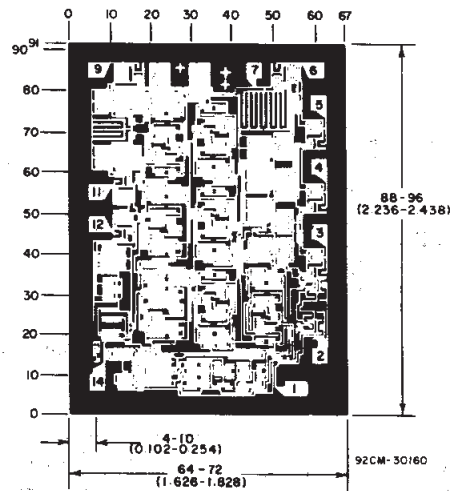Fig. 8 – Minimum output high (source) current characteristics.

Fig. 9 – Typical transition time as a function of load capacitance.

Dimensions and Pad Layout for CD4020BH. Dimensions and pad layout for CD4040BH are identical.

Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated. Grid graduations are in mils (10^{-3} inch).

Dimensions and Pad Layout for CD4024BH.

DYNAMIC ELECTRICAL CHARACTERISTICS at $T_A = 25°C$, Input t_r, $t_f = 20$ ns, $C_L = 50$ pF, $R_L = 200$ kΩ

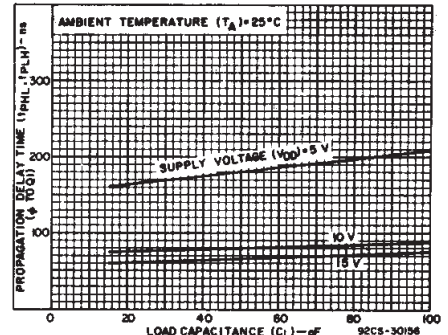| CHARACTERISTIC	TEST CONDITIONS	V_{DD} (V)	LIMITS			UNITS
			Min.	Typ.	Max.	
Input-Pulse Operation						
Propagation Delay Time, ϕ to Q_1 Out; t_{PHL}, t_{PLH}		5	—	180	360	ns
		10	—	80	160	
		15	—	65	130	
Q_n to $Q_n + 1$; t_{PHL}, t_{PLH}		5	—	100	330	ns
		10	—	40	80	
		15	—	30	60	
Transition Time, t_{THL}, t_{TLH}		5	—	100	200	ns
		10	—	50	100	
		15	—	40	80	
Minimum Input-Pulse Width, t_W		5	—	70	140	ns
		10	—	30	60	
		15	—	20	40	
Input-Pulse Rise or Fall Time, $t_{r\phi}$, $t_{f\phi}$		5	Unlimited			µs
		10				
		15				
Maximum Input-Pulse Frequency, f_ϕ		5	3.5	7	—	MHz
		10	8	16	—	
		15	12	24	—	
Input Capacitance, C_I	Any Input		—	5	7.5	pF
Reset Operation						
Propagation Delay Time, t_{PHL}		5	—	140	280	ns
		10	—	60	120	
		15	—	50	100	
Minimum Reset Pulse Width, t_W		5	—	100	200	ns
		10	—	40	80	
		15	—	30	60	
Reset Removal Time, t_{REM}		5	—	175	350	ns
		10	—	75	150	
		15	—	50	100	

Fig. 10 — Typical propagation delay time as a function of load capacitance (ϕ to Q_1).
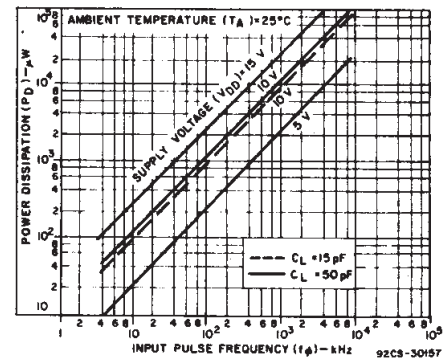

Fig. 11 — Typical dynamic power dissipation as a function of input pulse frequency for CD4020B.
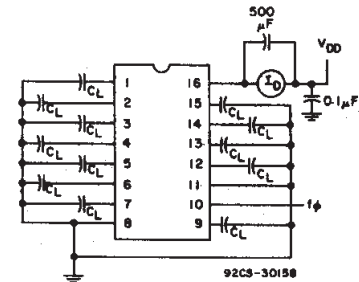
Fig. 12 — Dynamic power dissipation test circuit for CD4020B.
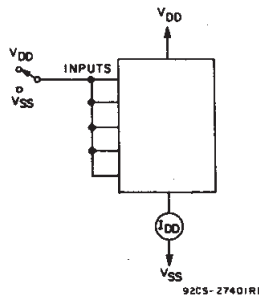
Fig. 13 — Quiescent device current test circuit.
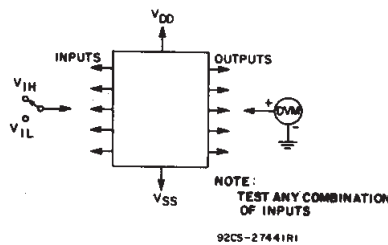
Fig. 14 — Input voltage test circuits.
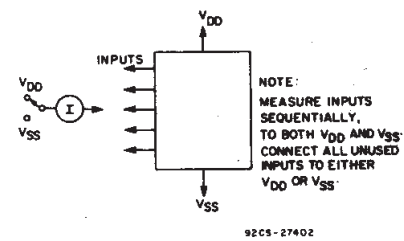
Fig. 15 — Input current test circuit.

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)

B

14   8

C

1   7

0.065 (1,65)
0.045 (1,14)

0.005 (0,13) MIN

0.060 (1,52)
0.015 (0,38)

0.200 (5,08) MAX

Seating Plane

0.130 (3,30) MIN

0.026 (0,66)
0.014 (0,36)

0.100 (2,54)

A

0°–15°

0.014 (0,36)
0.008 (0,20)

4040083/F 03/03

NOTES: A.   All linear dimensions are in inches (millimeters).
         B.   This drawing is subject to change without notice.
         C.   This package is hermetically sealed with a ceramic lid using glass frit.
         D.   Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
         E.   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

PINS ** DIM	14	16	18	20
A　MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	1.060 (26,92)
A　MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)
MS−001 VARIATION	AA	BB	AC	AD

0.260 (6,60)
0.240 (6,10)

0.070 (1,78)
0.045 (1,14)

0.045 (1,14)
0.030 (0,76)

0.020 (0,51) MIN

0.325 (8,26)
0.300 (7,62)

0.015 (0,38)
Gauge Plane

0.200 (5,08) MAX

Seating Plane

0.125 (3,18) MIN

0.010 (0,25) NOM

0.100 (2,54)

0.021 (0,53)
0.015 (0,38)

⊕ 0.010 (0,25) Ⓜ

0.430 (10,92) MAX

14/18 Pin Only
20 Pin vendor option

4040049/E 12/2002

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

D (R−PDSO−G14)   PLASTIC SMALL−OUTLINE PACKAGE

0.344 (8,75)
0.337 (8,55)

14   8

0.244 (6,20)
0.228 (5,80)

0.157 (4,00)
0.150 (3,80)

1   7

Pin 1
Index Area

0.050 (1,27)

0.020 (0,51)
0.012 (0,31)

⊕ 0.010 (0,25) Ⓜ

0.069 (1,75) Max

0.010 (0,25)
0.004 (0,10)

0.010 (0,25)
0.007 (0,17)

0.004 (0,10)

Gauge Plane

Seating Plane

0.010 (0,25)   0°−8°

0.050 (1,27)
0.016 (0,40)

4040047−3/F   07/2004

NOTES: A.   All linear dimensions are in inches (millimeters).
         B.   This drawing is subject to change without notice.
         C.   Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
         D.   Falls within JEDEC MS−012 variation AB.

D (R−PDSO−G16) PLASTIC SMALL−OUTLINE PACKAGE

0.394 (10,00)
0.386 (9,80)

16   9

0.244 (6,20)
0.228 (5,80)

0.157 (4,00)
0.150 (3,80)

1   8

Pin 1
Index Area

0.050 (1,27)

0.020 (0,51)
0.012 (0,31)

⊕ 0.010 (0,25) Ⓜ

0.069 (1,75) Max

0.010 (0,25)
0.004 (0,10)

0.010 (0,25)
0.007 (0,17)

0.004 (0,10)

Gauge Plane

Seating Plane

0.010 (0,25)   0°−8°

0.050 (1,27)
0.016 (0,40)

4040047−4/F   07/2004

NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
D. Falls within JEDEC MS−012 variation AC.

MECHANICAL DATA

	PINS **	14	16	20	24
DIM					
A	MAX	10,50	10,50	12,90	15,30
A	MIN	9,90	9,90	12,30	14,70

4040062/C 03/03

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.

PW (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN

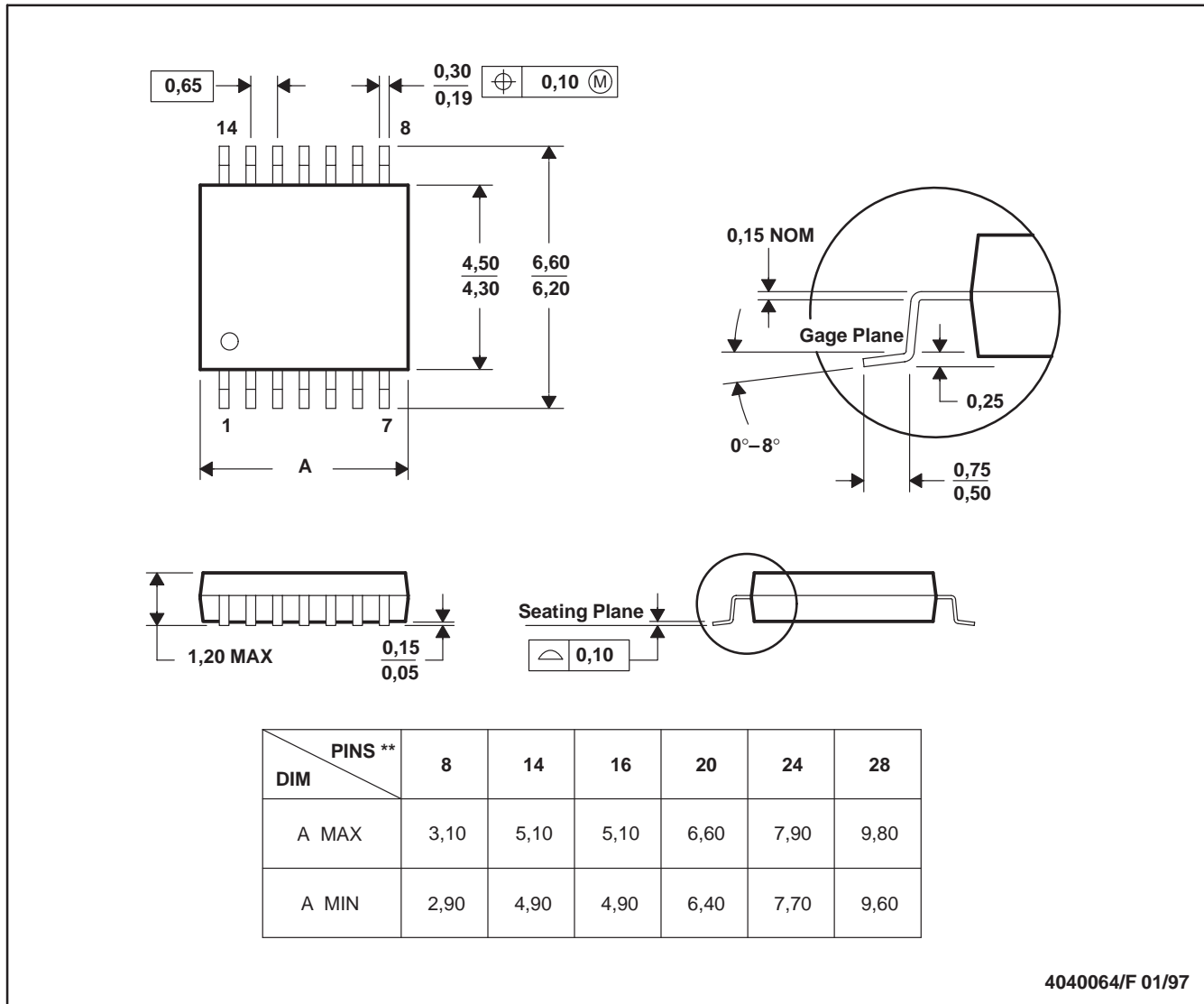|	PINS **	8	14	16	20	24	28
DIM							
A MAX		3,10	5,10	5,10	6,60	7,90	9,80
A MIN		2,90	4,90	4,90	6,40	7,70	9,60

4040064/F 01/97

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.
D. Falls within JEDEC MO-153

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