CD54HC4059, CD74HC4059

TEXAS INSTRUMENTS

Data sheet acquired from Harris Semiconductor
SCHS206B

February 1998 - Revised May 2003

High-Speed CMOS Logic
CMOS Programmable Divide-by-N Counter

Features

- **Synchronous Programmable ÷N Counter N = 3 to 9999 or 15999**
- **Presettable Down-Counter**
- **Fully Static Operation**
- **Mode-Select Control of Initial Decade Counting Function (÷10, 8, 5, 4, 2)**
- **Master Preset Initialization**
- **Latchable ÷N Output**
- **Fanout (Over Temperature Range)**
  - **Standard Outputs . . . . . 10 LSTTL Loads**
  - **Bus Driver Outputs . . . . . 15 LSTTL Loads**
- **Wide Operating Temperature Range . . . -55^{O}C to 125^{O}C**
- **Balanced Propagation Delay and Transition Times**
- **Significant Power Reduction Compared to LSTTL Logic ICs**
- **HC Types**
  - **2V to 6V Operation**
  - **High Noise Immunity: N_{IL} = 30%, N_{IH} = 30% of V_{CC} at V_{CC} = 5V**

Applications

- **Communications Digital Frequency Synthesizers; VHF, UHF, FM, AM, etc.**
- **Fixed or Programmable Frequency Division**
- **"Time Out" Timer for Consumer-Application Industrial Controls**

Ordering Information

PART NUMBER	TEMP. RANGE (^{O}C)	PACKAGE
CD54HC4059F3A	-55 to 125	24 Ld CERDIP
CD74HC4059E	-55 to 125	24 Ld PDIP
CD74HC4059M96	-55 to 125	24 Ld SOIC

NOTE: When ordering, use the entire part number. The suffix 96 denotes tape and reel.

Description

The 'HC4059 are high-speed silicon-gate devices that are pin-compatible with the CD4059A devices of the CD4000B series. These devices are divide-by-N down-counters that can be programmed to divide an input frequency by any number "N" from 3 to 15,999. The output signal is a pulse one clock cycle wide occurring at a rate equal to the input frequency divide by N. The down-counter is preset by means of 16 jam inputs.

The three Mode-Select Inputs K_a, K_b and K_c determine the modulus ("divide-by" number) of the first and last counting sections in accordance with the truth table. Every time the first (fastest) counting section goes through one cycle, it reduces by 1 the number that has been preset (jammed) into the three decades of the intermediate counting section an the last counting section, which consists of flip-flops that are not needed for opening the first counting section. For example, in the ÷2 mode, only one flip-flop is needed in the first counting section. Therefore the last counting section has three flip-flops that can be preset to a maximum count of seven with a place value of thousands. If ÷10 is desired for the first section, K_a is set "high", K_b "high" and K_c "low". Jam inputs J1, J2, J3, and J4 are used to preset the first counting section and there is no last counting section. The intermediate counting section consists of three cascaded BCD decade (÷10) counters presettable by means of Jam Inputs J5 through J16.

The Mode-Select Inputs permit frequency-synthesizer channel separations of 10, 12.5, 20, 25 or 50 parts. These inputs set the maximum value of N at 9999 (when the first counting section divides by 5 or 10) or 15,999 (when the first counting section divides by 8, 4, or 2).

The three decades of the intermediate counter can be preset to a binary 15 instead of a binary 9, while their place values are still 1, 10, and 100, multiplied by the number of the ÷N mode. For example, in the ÷8 mode, the number from which counting down begins can be preset to:

3rd Decade	1500
2nd Decade	150
1st Decade	15
Last Counting Section	1000

The total of these numbers (2665) times 8 equals 12,320. The first counting section can be preset to 7. Therefore, 21,327 is the maximum possible count in the ÷8 mode.

The highest count of the various modes is shown in the Extended Counter Range column. Control inputs K_b and K_c can be used to initiate and lock the counter in the "master preset" state. In this condition the flip-flops in the counter are preset in accordance with the jam inputs and the counter remains in that state as long as K_b and K_c both remain low. The counter begins to count down from the preset state when a counting mode other than the master preset mode is selected.

CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper IC Handling Procedures.

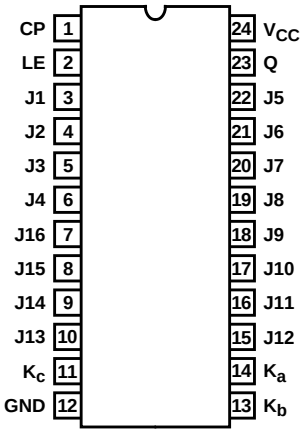
The counter should always be put in the master preset mode before the ÷5 mode is selected. Whenever the master preset mode is used, control signals K_b = "low" and K_c = "low" must be applied for at least 3 full clock pulses.

After Preset Mode inputs have been changed to one of the ÷ modes, the next positive-going clock transition changes an internal flip-flop so that the countdown can begin at the second positive-going clock transition. Thus, after an MP (Master Preset) mode, there is always one extra count before the output goes high. Figure 1 illustrates a total count of 3 (÷8 mode). If the Master Preset mode is started two clock cycles or less before an output pulse, the output pulse will appear at the time due. If the Master Preset Mode is not used, the counter jumps back to the "Jam" count when the output pulse appears.

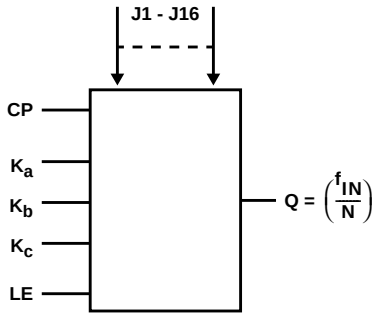
A "high" on the Latch Enable input will cause the counter output to remain high once an output pulse occurs, and to remain in the high state until the latch input returns to "low". If the Latch Enable is "low", the output pulse will remain high for only one cycle of the clock-input signal.

Pinout

CD54HC4059
(CERDIP)
CD74HC4059
(PDIP, SOIC)
TOP VIEW



Functional Diagram



TRUTH TABLE

MODE SELECT INPUT			FIRST COUNTING SECTION			LAST COUNTING SECTION			COUNTER RANGE	
									DESIGN	EXTENDED
K_a	K_b	K_c	MODE DIVIDES-BY	CAN BE PRESET TO A MAX OF:	(NOTE 1) JAM INPUTS USED:	MODE DIVIDES-BY	CAN BE PRESET TO A MAX OF:	(NOTE 1) JAM INPUTS USED:	MAX	MAX
H	H	H	2	1	J1	8	7	J2, J3, J4	15,999	17,331
L	H	H	4	3	J1, J2	4	3	J3, J4	15,999	18,663
H	L	H	5 (Note 2)	4	J1, J2, J3	2	1	J4	9,999	13,329
L	L	H	8	7	J1, J2, J3	2	1	J4	15,999	21,327
H	H	L	10	9	J1, J2, J3, J4	1	0	-	9,999	16,659
X	L	L	Master Preset			Master Preset			-	-

X = Don't care
NOTES:

1. J1 = Least Significant Bit. J4 = Most Significant Bit.
2. Operation in the 5mode (1st counting section) requires going through the Master Preset mode prior to going into the 5mode. At power turn-on, Kc must be "low" for a period of 3 input clock pulses after VCC reaches a minimum of 3V.

How to Preset the HC/HCT4059 to Desired ÷N

The value N is determined as follows:

(EQ. 1)

N = (MODE†) (1000 x Decade 5 Preset + 100 x Decade 4 Preset + 10 x Decade 3 Preset + 1 x Decade 2 Preset) + Decade 1 Preset

† MODE = First counting section divider (10, 8, 5, 4 or 2)

To calculate preset values for any N count, divide the N count by the Mode. The resultant is the corresponding preset values of the 5th through 2nd decade with the remainder being equal to the 1st decade value.

$$\text{Preset Value} = \frac{N}{\text{Mode}} \qquad \text{(EQ. 2)}$$

Example:

N = 8479, Mode = 5

Mode Select = 5

K_a	K_b	K_c
H	L	H

1695 + 4 (Preset Values)

5 | 8479

Mode, N

Program Jam Inputs (BCD)

4			1	5				9				6			
J1	J2	J3	J4	J5	J6	J7	J8	J9	J10	J11	J12	J13	J14	J15	J16
L	L	H	H	H	L	H	L	H	L	L	H	L	H	H	L

NOTE: To verify the results, use Equation 1:
N = 5 (1000 x 1 + 100 x 6 + 10 x 9 + 1 x 5) + 4
N = 8479

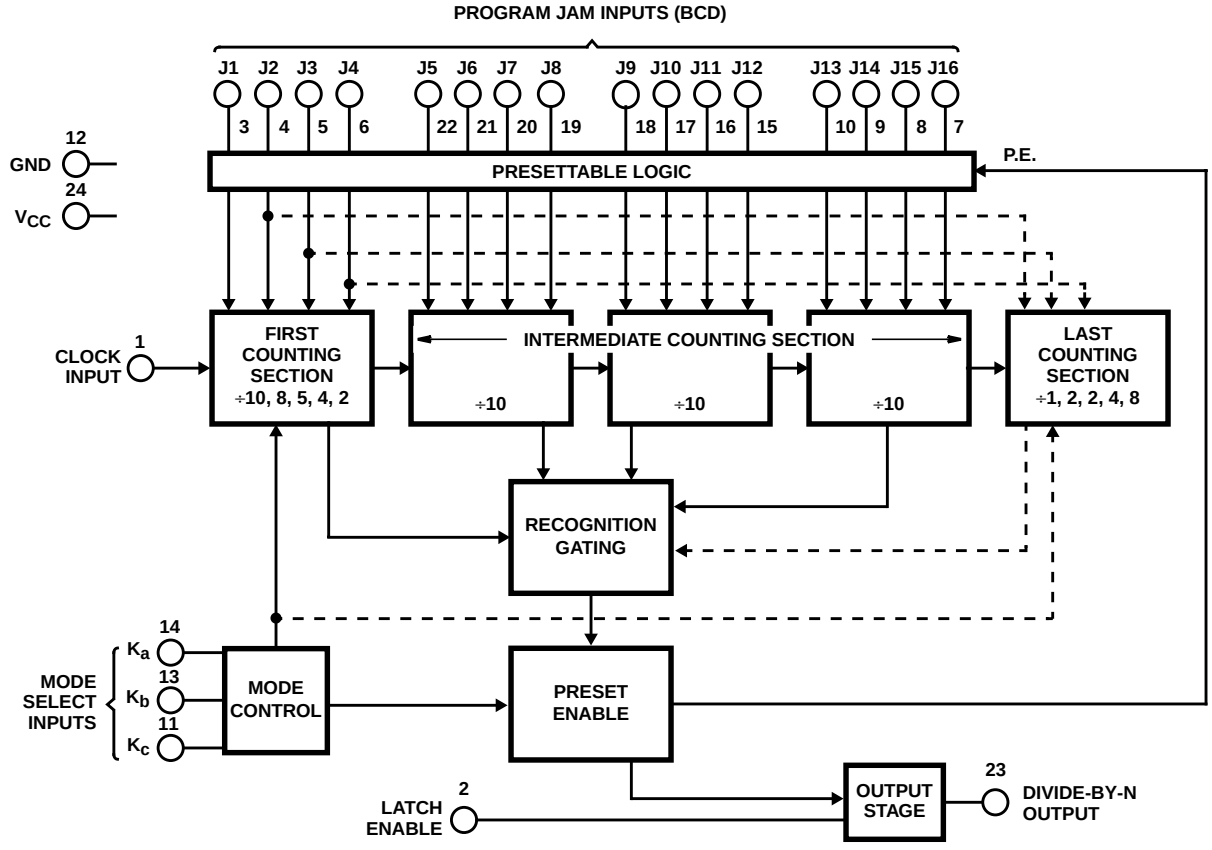


FIGURE 1. FUNCTIONAL BLOCK DIAGRAM

Absolute Maximum Ratings

DC Supply Voltage, V_{CC} . . . . . -0.5V to 7V
DC Input Diode Current, I_{IK}
For V_I < -0.5V or V_I > V_{CC} + 0.5V . . . . . ±20mA
DC Output Diode Current, I_{OK}
For V_O < -0.5V or V_O > V_{CC} + 0.5V . . . . . ±20mA
DC Output Source or Sink Current per Output Pin, I_O
For V_O > -0.5V or V_O < V_{CC} + 0.5V . . . . . ±25mA
DC V_{CC} or Ground Current, I_{CC} . . . . . ±50mA

Operating Conditions

Temperature Range, T_A . . . . . -55^oC to 125^oC
Supply Voltage Range, V_{CC} . . . . . 2V to 6V
DC Input or Output Voltage, V_I, V_O . . . . . 0V to V_{CC}
Input Rise and Fall Time
2V . . . . . 1000ns (Max)
4.5V. . . . . 500ns (Max)
6V . . . . . 400ns (Max)

Thermal Information

Thermal Resistance (Typical)	θ_{JA} ($^oC/W$)
E (PDIP) Package (Note 3)	67
M (SOIC) Package (Note 4)	46

Maximum Junction Temperature (Hermetic Package or Die) . . . 175^oC
Maximum Junction Temperature (Plastic Package) . . . . . 150^oC
Maximum Storage Temperature Range . . . . . -65^oC to 150^oC
Maximum Lead Temperature (Soldering 10s) . . . . . 300^oC

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

NOTES:

3. The package thermal impedance is calculated in accordance with JESD 51-3.
4. The package thermal impedance is calculated in accordance with JESD 51-7.

DC Electrical Specifications

PARAMETER	SYMBOL	TEST CONDITIONS		V_{CC} (V)	25^oC			-40^oC TO 85^oC		-55^oC TO 125^oC		UNITS
		V_I (V)	I_O (mA)		MIN	TYP	MAX	MIN	MAX	MIN	MAX	
High Level Input Voltage	V_{IH}	-	-	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
Low Level Input Voltage	V_{IL}	-	-	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
High Level Output Voltage CMOS Loads	V_{OH}	V_{IH} or V_{IL}	-0.02	2	1.9	-	-	1.9	-	1.9	-	V
			-0.02	4.5	4.4	-	-	4.4	-	4.4	-	V
			-0.02	6	5.9	-	-	5.9	-	5.9	-	V
High Level Output Voltage TTL Loads			-	-	-	-	-	-	-	-	-	V
			-4	4.5	3.98	-	-	3.84	-	3.7	-	V
			-5.2	6	5.48	-	-	5.34	-	5.2	-	V
Low Level Output Voltage CMOS Loads	V_{OL}	V_{IH} or V_{IL}	0.02	2	-	-	0.1	-	0.1	-	0.1	V
			0.02	4.5	-	-	0.1	-	0.1	-	0.1	V
			0.02	6	-	-	0.1	-	0.1	-	0.1	V
Low Level Output Voltage TTL Loads			-	-	-	-	-	-	-	-	-	V
			4	4.5	-	-	0.26	-	0.33	-	0.4	V
			5.2	6	-	-	0.26	-	0.33	-	0.4	V
Input Leakage Current	I_I	V_{CC} or GND	-	6	-	-	±0.1	-	±1	-	±1	µA
Quiescent Device Current	I_{CC}	V_{CC} or GND	0	6	-	-	8	-	80	-	160	µA

Prerequisite for Switching Specifications

PARAMETER	SYMBOL	V_{CC} (V)	25°C			-40°C TO 85°C			-55°C TO 125°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Pulse Width CP	t_W	2	90	-	-	115	-	-	135	-	-	ns
		4.5	18	-	-	23	-	-	27	-	-	ns
		6	15	-	-	20	-	-	23	-	-	ns
Setup Time K_b, K_c to CP	t_{SU}	2	75	-	-	95	-	-	110	-	-	ns
		4.5	15	-	-	19	-	-	22	-	-	ns
		6	13	-	-	16	-	-	19	-	-	ns
CP Frequency	f_{MAX}	2	5	-	-	4	-	-	4	-	-	MHz
		4.5	27	-	-	22	-	-	18	-	-	MHz
		6	32	-	-	26	-	-	21	-	-	MHz

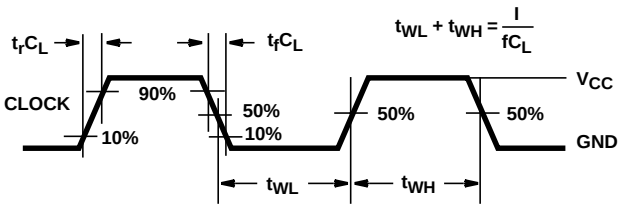
Switching Specifications Input t_r, t_f = 6ns

PARAMETER	SYMBOL	TEST CONDITIONS	V_{CC} (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
Propagation Delay, CP to Q	t_{PLH}, t_{PHL}	C_L = 50pF	2	-	-	200	-	250	-	300	ns
			4.5	-	-	40	-	50	-	60	ns
			6	-	-	34	-	43	-	51	ns
		C_L = 15pF	5	-	17	-	-	-	-	-	ns
Propagation Delay, LE to Q	t_{PLH}, t_{PHL}	C_L = 50pF	2	-	-	175	-	220	-	265	ns
			4.5	-	-	35	-	44	-	53	ns
			6	-	-	30	-	37	-	45	ns
		C_L = 15pF	5	-	14	-	-	-	-	-	ns
Output Transition Time	t_{THL}, t_{TLH}	C_L = 50pF	2	-	-	75	-	95	-	110	ns
			4.5	-	-	15	-	19	-	22	ns
			6	-	-	13	-	16	-	19	ns
CP Frequency	f_{MAX}	C_L = 15pF	5	-	54	-	-	-	-	-	MHz
Input Capacitance	C_I	-	-	-	-	10	-	10	-	10	pF
Power Dissipation Capacitance (Notes 5, 6)	C_{PD}	-	5	-	36	-	-	-	-	-	pF

NOTES:

5. C_{PD} is used to determine the dynamic power consumption, per package.
6. $P_D = C_{PD} V_{CC}^2 f_i + \Sigma C_L V_{CC}^2 f_o$ where f_i = input frequency, f_o = output frequency, C_L = output load capacitance, V_{CC} = supply voltage.

Test Circuits and Waveforms



NOTE: Outputs should be switching from 10% V_{CC} to 90% V_{CC} in accordance with device truth table. For f_{MAX}, input duty cycle = 50%.

FIGURE 2. HC CLOCK PULSE RISE AND FALL TIMES AND PULSE WIDTH

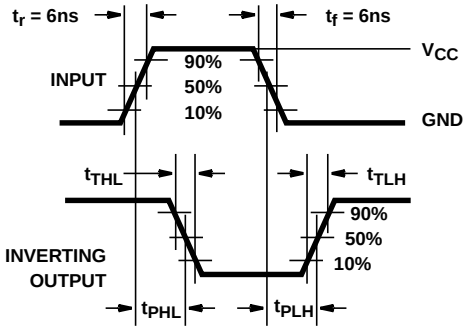


FIGURE 3. HC TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

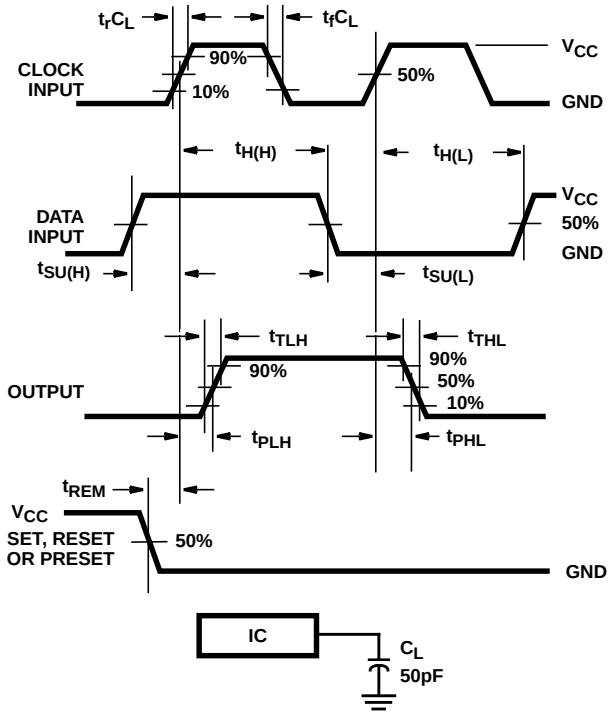


FIGURE 4. HC SETUP TIMES, HOLD TIMES, REMOVAL TIME, AND PROPAGATION DELAY TIMES FOR EDGE TRIGGERED SEQUENTIAL LOGIC CIRCUITS

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
5962-8944501JA	ACTIVE	CDIP	J	24	1	TBD	Call TI	Level-NC-NC-NC
CD54HC4059F3A	ACTIVE	CDIP	J	24	1	TBD	Call TI	Level-NC-NC-NC
CD74HC4059E	ACTIVE	PDIP	N	24	15	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
CD74HC4059EE4	ACTIVE	PDIP	N	24	15	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
CD74HC4059M96	ACTIVE	SOIC	DW	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD74HC4059M96E4	ACTIVE	SOIC	DW	24	2000	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) 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.
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)

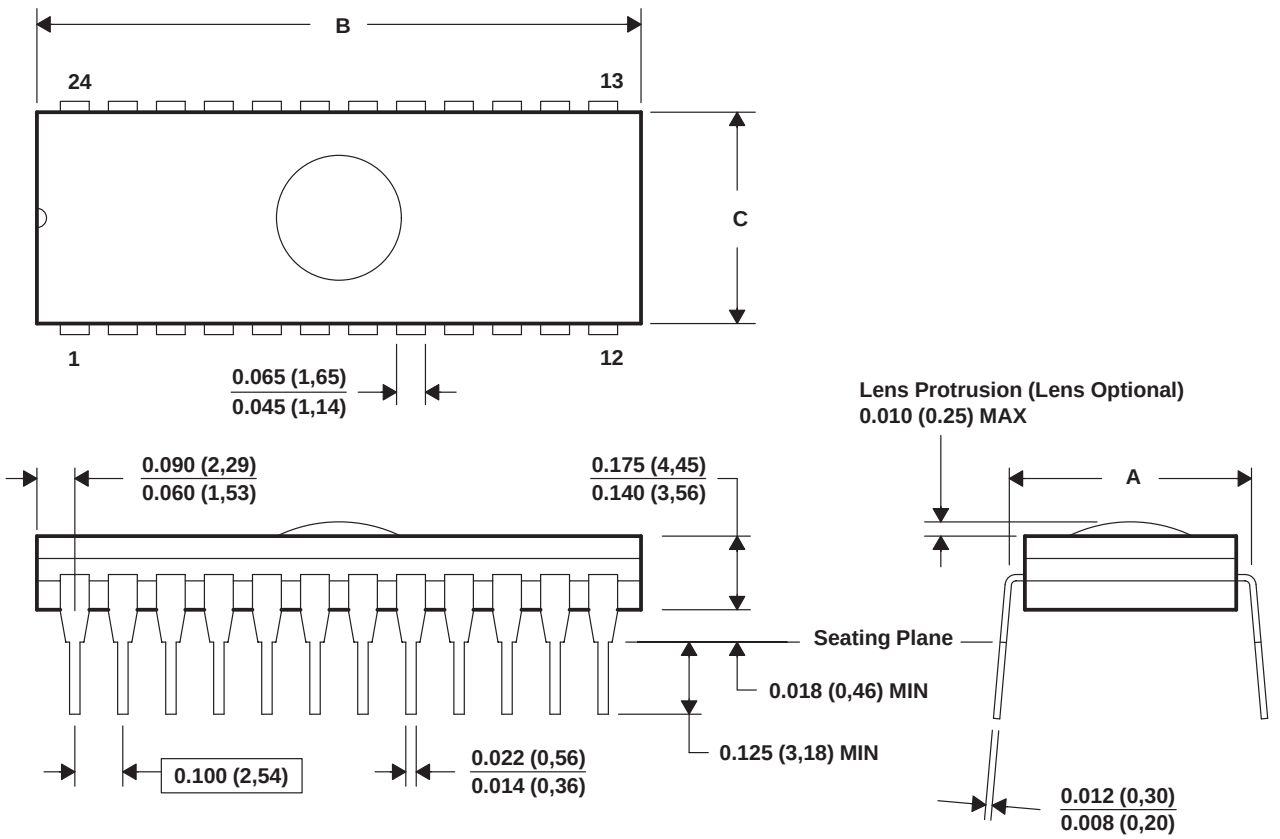
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

MCDI004A – JANUARY 1995 – REVISED NOVEMBER 1997

J (R-GDIP-T**)

CERAMIC DUAL-IN-LINE PACKAGE

24 PINS SHOWN



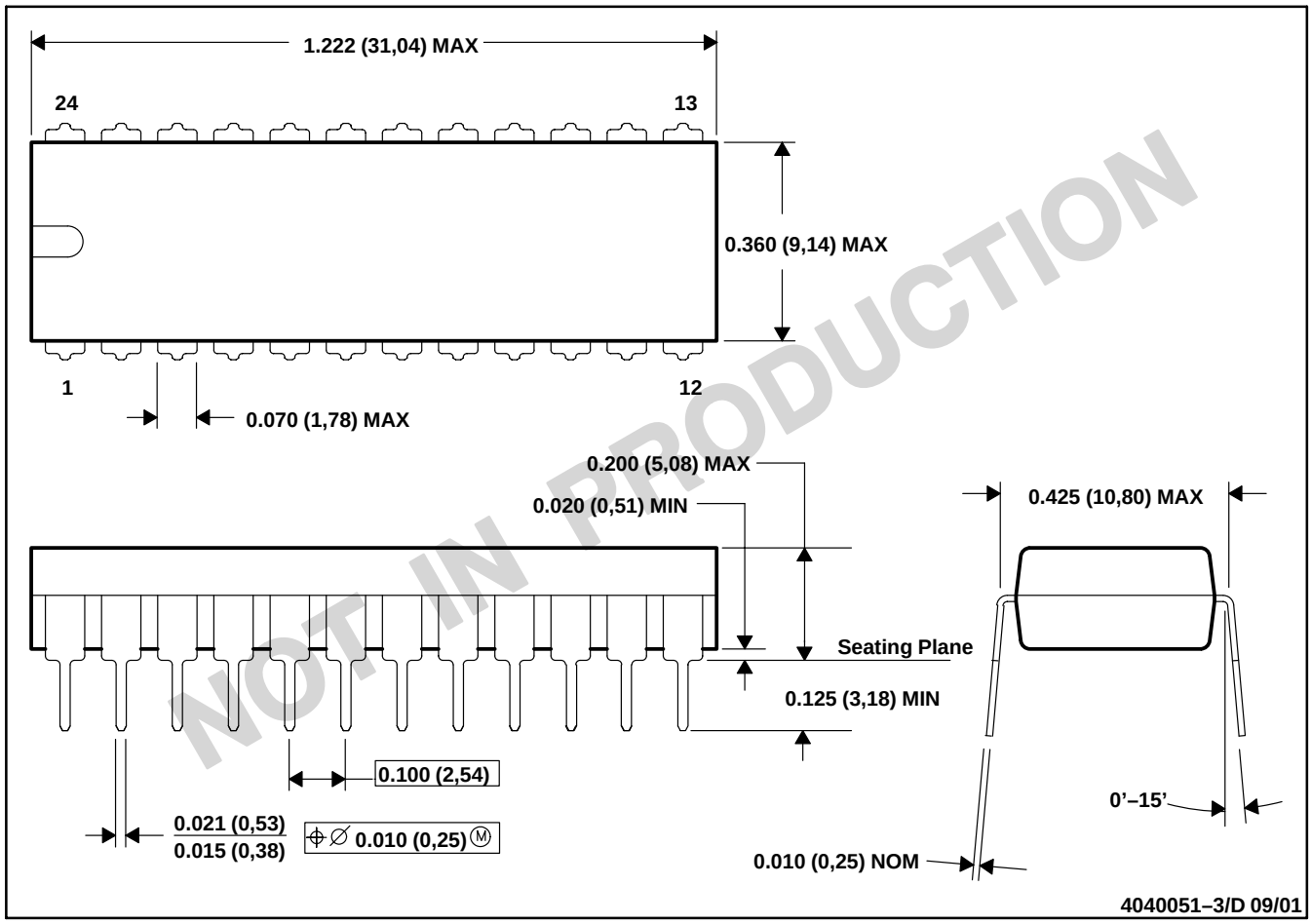
DIM \ PINS **		24		28		32		40	
		NARR	WIDE	NARR	WIDE	NARR	WIDE	NARR	WIDE
"A"	MAX	0.624(15,85)	0.624(15,85)	0.624(15,85)	0.624(15,85)	0.624(15,85)	0.624(15,85)	0.624(15,85)	0.624(15,85)
	MIN	0.590(14,99)	0.590(14,99)	0.590(14,99)	0.590(14,99)	0.590(14,99)	0.590(14,99)	0.590(14,99)	0.590(14,99)
"B"	MAX	1.265(32,13)	1.265(32,13)	1.465(37,21)	1.465(37,21)	1.668(42,37)	1.668(42,37)	2.068(52,53)	2.068(52,53)
	MIN	1.235(31,37)	1.235(31,37)	1.435(36,45)	1.435(36,45)	1.632(41,45)	1.632(41,45)	2.032(51,61)	2.032(51,61)
"C"	MAX	0.541(13,74)	0.598(15,19)	0.541(13,74)	0.598(15,19)	0.541(13,74)	0.598(15,19)	0.541(13,74)	0.598(15,19)
	MIN	0.514(13,06)	0.571(14,50)	0.514(13,06)	0.571(14,50)	0.514(13,06)	0.571(14,50)	0.514(13,06)	0.571(14,50)

4040084/C 10/97

NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Window (lens) added to this group of packages (24-, 28-, 32-, 40-pin).
D. This package can be hermetically sealed with a ceramic lid using glass frit.
E. Index point is provided on cap for terminal identification.

MPDI006B – SEPTEMBER 2001 – REVISED APRIL 2002

N (R–PDIP–T24) **PLASTIC DUAL–IN–LINE**



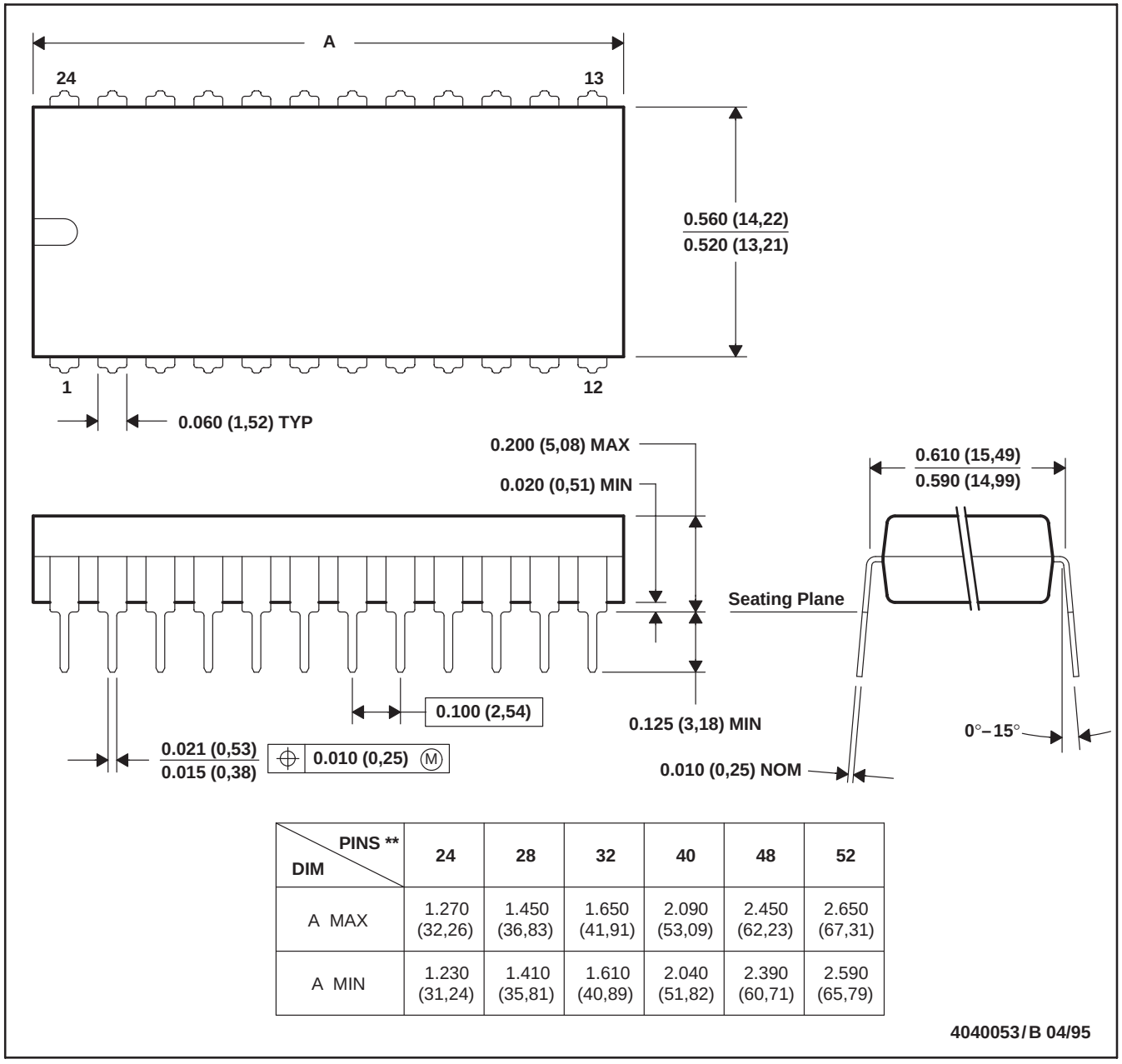
NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–010

MPDI008 – OCTOBER 1994

N (R-PDIP-T**)

PLASTIC DUAL-IN-LINE PACKAGE

24 PIN SHOWN

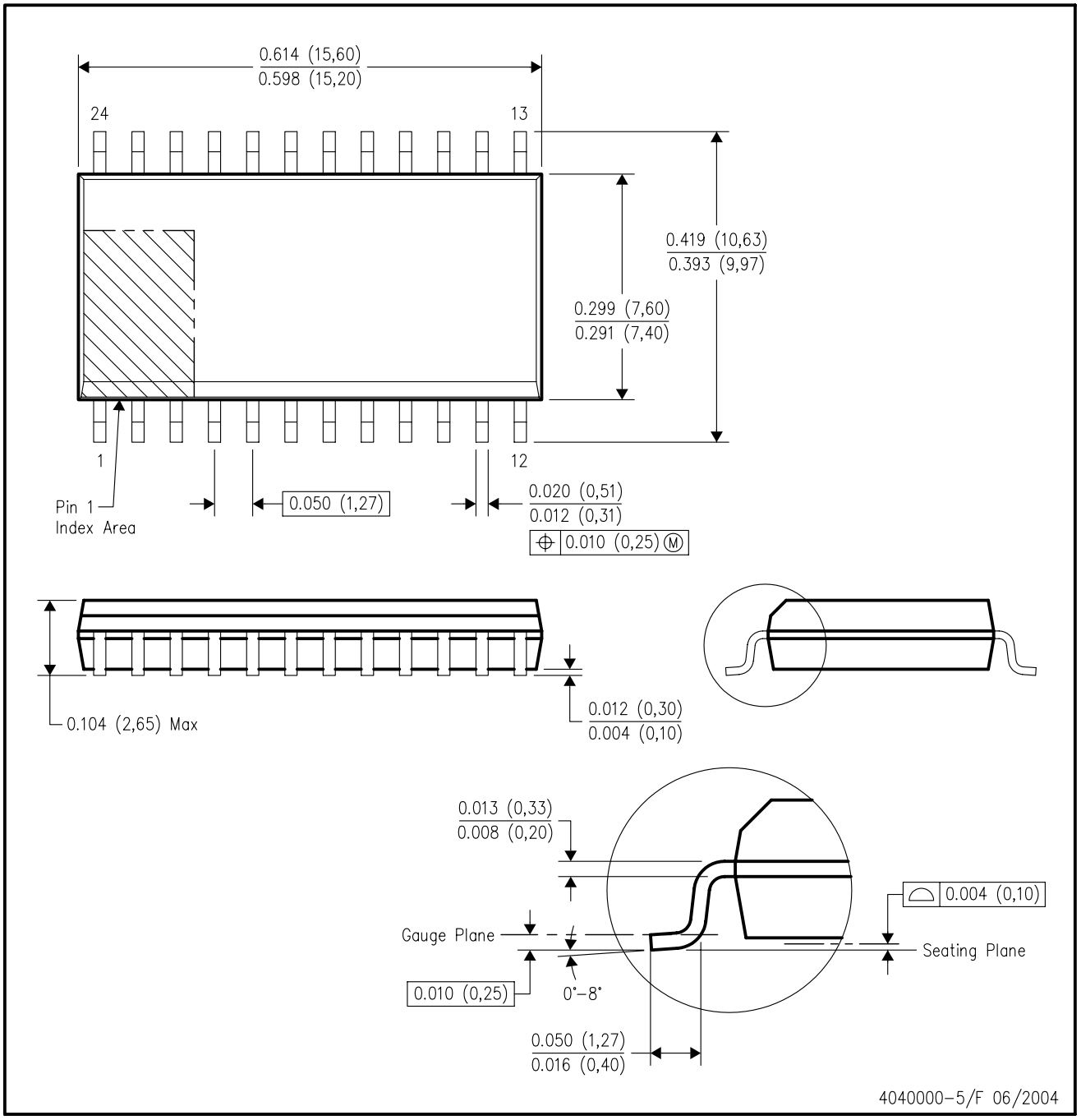


DIM \ PINS **	24	28	32	40	48	52
A MAX	1.270 (32,26)	1.450 (36,83)	1.650 (41,91)	2.090 (53,09)	2.450 (62,23)	2.650 (67,31)
A MIN	1.230 (31,24)	1.410 (35,81)	1.610 (40,89)	2.040 (51,82)	2.390 (60,71)	2.590 (65,79)

4040053/B 04/95

NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS-011
D. Falls within JEDEC MS-015 (32 pin only)

DW (R–PDSO–G24) PLASTIC SMALL–OUTLINE PACKAGE



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–013 variation AD.

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Mailing Address: Texas Instruments
Post Office Box 655303 Dallas, Texas 75265