

# SN74ALS166 PARALLEL-LOAD 8-BIT SHIFT REGISTER

SDAS156D – APRIL 1982 – REVISED AUGUST 2000

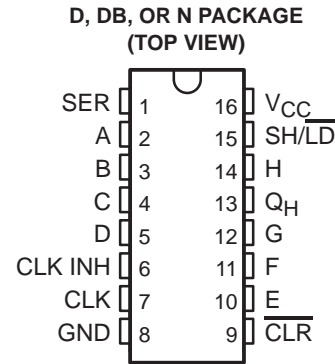
- Synchronous Load
- Direct Overriding Clear
- Parallel-to-Serial Conversion
- Package Options Include Plastic Small-Outline (D) and Shrink Small-Outline (DB) Packages and Standard Plastic (N) DIP

## description

The SN74ALS166 parallel-load 8-bit shift register is compatible with most other TTL logic families. All inputs are buffered to lower the drive requirements. Input clamping diodes minimize switching transients and simplify system design.

These parallel-in or serial-in, serial-out registers have a complexity of 77 equivalent gates on the chip. They feature gated clocks (CLK and CLK INH) inputs and an overriding clear ( $\overline{\text{CLR}}$ ) input. The parallel-in or serial-in modes are established by the shift/load ( $\text{SH}/\overline{\text{LD}}$ ) input. When high,  $\text{SH}/\overline{\text{LD}}$  enables the serial data (SER) input and couples the eight flip-flops for serial shifting with each clock pulse. When low, the parallel (broadside) data (A–H) inputs are enabled and synchronous loading occurs on the next clock pulse. During parallel loading, serial data flow is inhibited. Clocking is accomplished on the low-to-high-level edge of the clock pulse through a two-input positive-NOR gate, permitting one input to be used as a clock-enable or clock-inhibit function. Holding either of the clock inputs high inhibits clocking; holding either low enables the other clock input. This allows the system clock to be free running and the register can be stopped on command with the clock input. CLK INH should be changed to the high level only when CLK is high. The buffered  $\overline{\text{CLR}}$  overrides all other inputs, including CLK, and sets all flip-flops to zero.

The SN74ALS166 is characterized for operation from 0°C to 70°C.



FUNCTION TABLE

INPUTS					PARALLEL A . . . H	INTERNAL OUTPUTS		OUTPUT Q <sub>H</sub>
$\overline{\text{CLR}}$	$\text{SH}/\overline{\text{LD}}$	CLK INH	CLK	SER		Q <sub>A</sub>	Q <sub>B</sub>	
L	X	X	X	X	X	L	L	L
H	X	L	L	X	X	Q <sub>A0</sub>	Q <sub>B0</sub>	Q <sub>H0</sub>
H	L	L	↑	X	a . . . h	a	b	h
H	H	L	↑	H	X	H	Q <sub>An</sub>	Q <sub>Gn</sub>
H	H	L	↑	L	X	L	Q <sub>An</sub>	Q <sub>Gn</sub>
H	X	H	↑	X	X	Q <sub>A0</sub>	Q <sub>B0</sub>	Q <sub>H0</sub>



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 **TEXAS  
INSTRUMENTS**

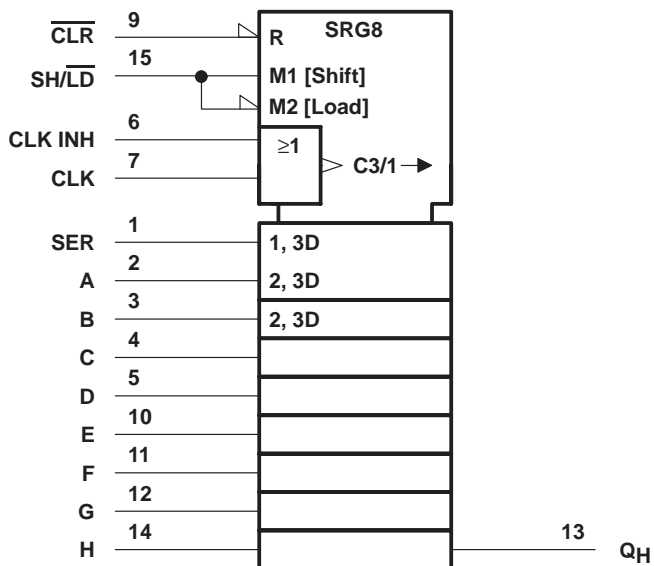
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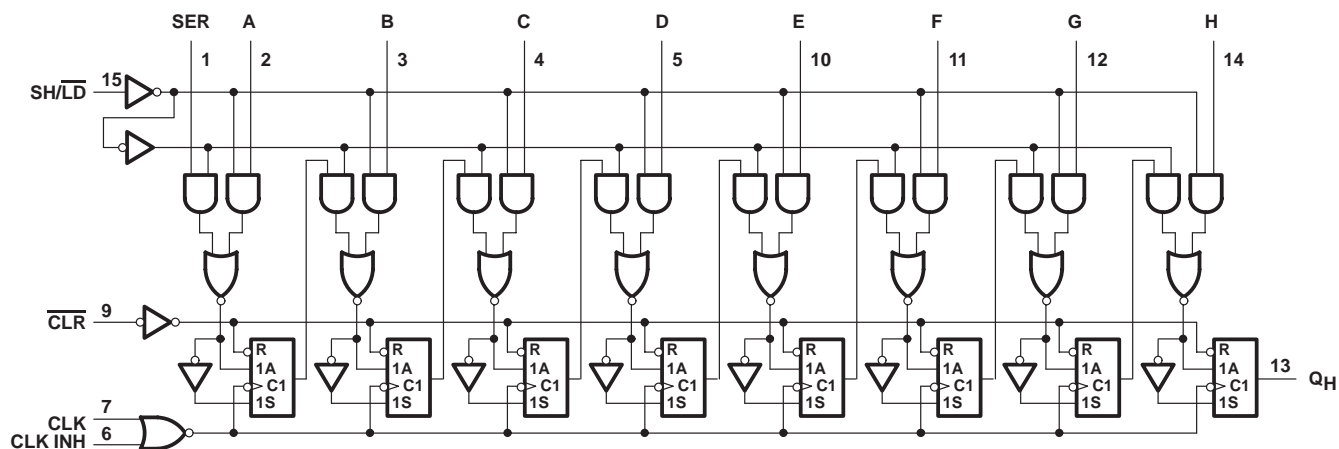
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## logic symbol†

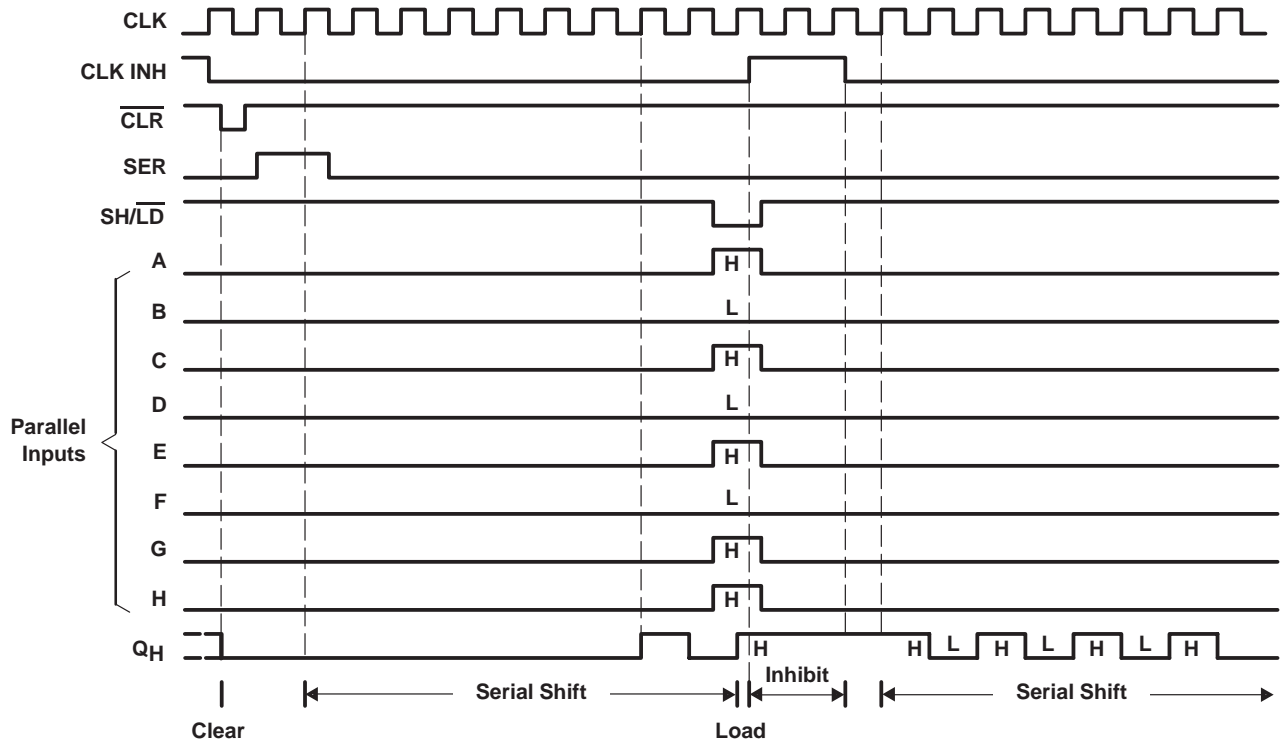


† This symbol is in accordance with ANSI/IEEE Standard 91-1984 and IEC Publication 617-12.

## logic diagram (positive logic)



**typical clear, shift, load, inhibit, and shift sequences**



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

Supply voltage range, $V_{CC}$ .....	-0.5 V to 7 V
Input voltage range, $V_I$ .....	-0.5 V to 7 V
Package thermal impedance, $\theta_{JA}$ (see Note 1): D package .....	73°C/W
DB package .....	82°C/W
N package .....	67°C/W
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.

NOTE 1: The package thermal impedance is calculated in accordance with JESD 51-7.

**recommended operating conditions**

	MIN	NOM	MAX	UNIT
$V_{CC}$ Supply voltage	4.5	5	5.5	V
$V_{IH}$ High-level input voltage	2			V
$V_{IL}$ Low-level input voltage			0.8	V
$I_{OH}$ High-level output current			-0.4	mA
$I_{OL}$ Low-level output current			8	mA
$T_A$ Operating free-air temperature	0		70	°C

# SN74ALS166

## PARALLEL-LOAD 8-BIT SHIFT REGISTER

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

PARAMETER	TEST CONDITIONS		MIN	TYP†	MAX	UNIT
$V_{IK}$	$V_{CC} = 4.5\text{ V}$ ,	$I_I = -18\text{ mA}$			-1.5	V
$V_{OH}$	$V_{CC} = 4.5\text{ V to } 5.5\text{ V}$ ,	$I_{OH} = -0.4\text{ mA}$	$V_{CC}-2$			V
$V_{OL}$	$V_{CC} = 4.5\text{ V}$	$I_{OL} = 4\text{ mA}$		0.25	0.4	V
		$I_{OL} = 8\text{ mA}$		0.35	0.5	
$I_I$	$V_{CC} = 5.5\text{ V}$ ,	$V_I = 7\text{ V}$			0.1	mA
$I_{IH}$	$V_{CC} = 5.5\text{ V}$ ,	$V_I = 2.7\text{ V}$			20	$\mu\text{A}$
$I_{IL}$	$V_{CC} = 5.5\text{ V}$ ,	$V_I = 0.4\text{ V}$			-0.1	mA
$I_{O}^{\ddagger}$	$V_{CC} = 5.5\text{ V}$ ,	$V_O = 2.25\text{ V}$	-30		-112	mA
$I_{CC}$	$V_{CC} = 5.5\text{ V}$ ,	See Note 2		14	24	mA

† All typical values are at  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

‡ The output conditions have been chosen to produce a current that closely approximates one half of the true short-circuit output current,  $I_{OS}$ .

NOTE 2: With 4.5 V applied to SER and all other inputs, except the clock, grounded,  $I_{CC}$  is measured after a clock transition from 0 V to 4.5 V.

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

		MIN	MAX	UNIT
$f_{\text{clock}}$	Clock frequency		45	MHz
$t_w$	Pulse duration	$\overline{\text{CLR}}$ low	9	ns
		CLK high	10	
		CLK low	10	
$t_{su}$	Setup time before $\text{CLK}\uparrow$	$\text{SH}/\overline{\text{LD}}$	16	ns
		Data	7	
		$\overline{\text{CLR}}$ inactive	11	
$t_h$	Hold time, data after $\text{CLK}\uparrow$	3		ns

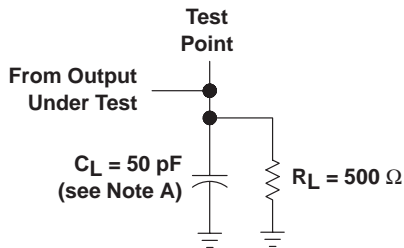
### switching characteristics over recommended operating conditions (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	MIN	TYP†	MAX	UNIT
$f_{\text{max}}$			45			MHz
$t_{PHL}$	$\overline{\text{CLR}}$	$Q_H$	4	9	14	ns
$t_{PLH}$	CLK	$Q_H$	2	7	12	ns
$t_{PHL}$			2	9	13	

† All typical values are at  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .



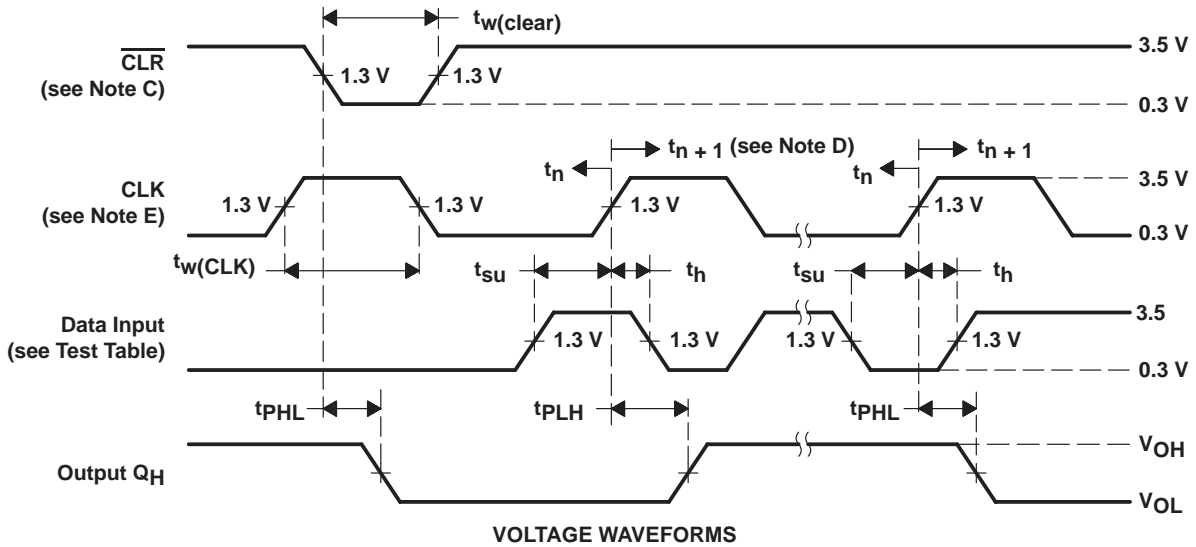
PARAMETER MEASUREMENT INFORMATION



LOAD CIRCUIT FOR OUTPUT UNDER TEST

TEST TABLE FOR SYNCHRONOUS INPUTS

DATA INPUT FOR TEST	SH/ $\overline{\text{LD}}$	OUTPUT TESTED (see Note B)
H	0 V	$Q_H$ at $t_{n+1}$
Serial input	4.5 V	$Q_H$ at $t_{n+1}$



- NOTES:
- A.  $C_L$  includes probe and jig capacitance.
  - B. Propagation delay times ( $t_{PLH}$  and  $t_{PHL}$ ) are measured at  $t_{n+1}$ . Proper shifting of data is verified at  $t_{n+8}$  with a functional test.
  - C. A clear pulse is applied prior to each test.
  - D.  $t_n$  = bit time before clocking transition,  $t_{n+1}$  = bit time after one clocking transition, and  $t_{n+8}$  = bit time after eight clocking transitions.
  - E. The clock pulse has the following characteristics:  $t_{w(\text{clock})} \leq 20$  ns and  $\text{PRR} = 1$  MHz. The clear pulse has the following characteristics:  $t_{w(\text{clear})} \leq 20$  ns.
  - F. All pulse generators have the following characteristics:  $Z_O \approx 50 \Omega$ ;  $t_r = t_f = 2$  ns. Duty cycle = 50% when testing  $f_{\text{max}}$ .

Figure 1. Load Circuit and Voltage Waveforms

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
SN74ALS166D	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ALS166DBR	ACTIVE	SSOP	DB	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ALS166DBRE4	ACTIVE	SSOP	DB	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ALS166DE4	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ALS166DR	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ALS166DRE4	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ALS166N	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
SN74ALS166NE4	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
SN74ALS166NSR	ACTIVE	SO	NS	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ALS166NSRE4	ACTIVE	SO	NS	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

<sup>(1)</sup> 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.

<sup>(2)</sup> 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)

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

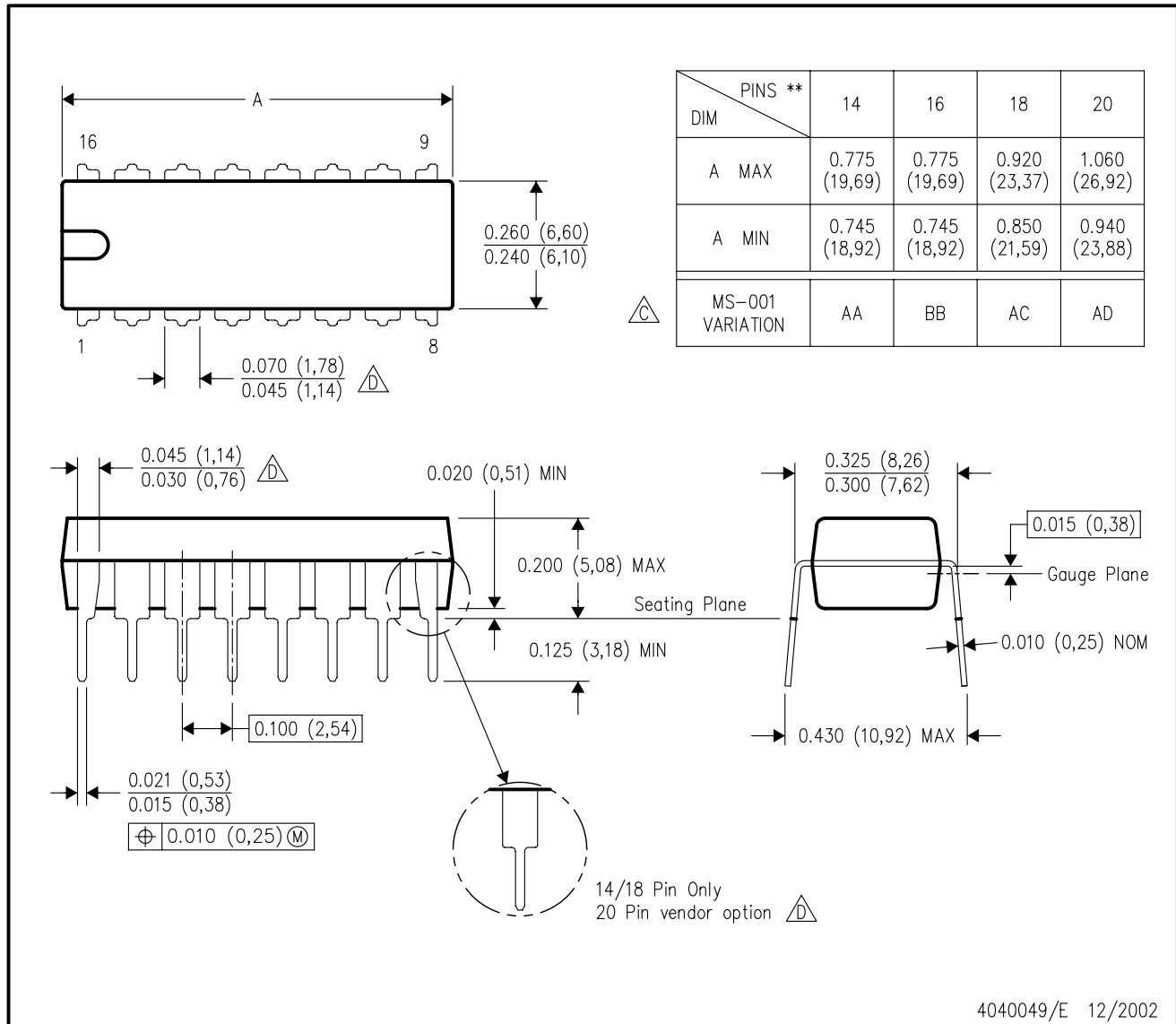
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N (R-PDIP-T\*\*)

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN

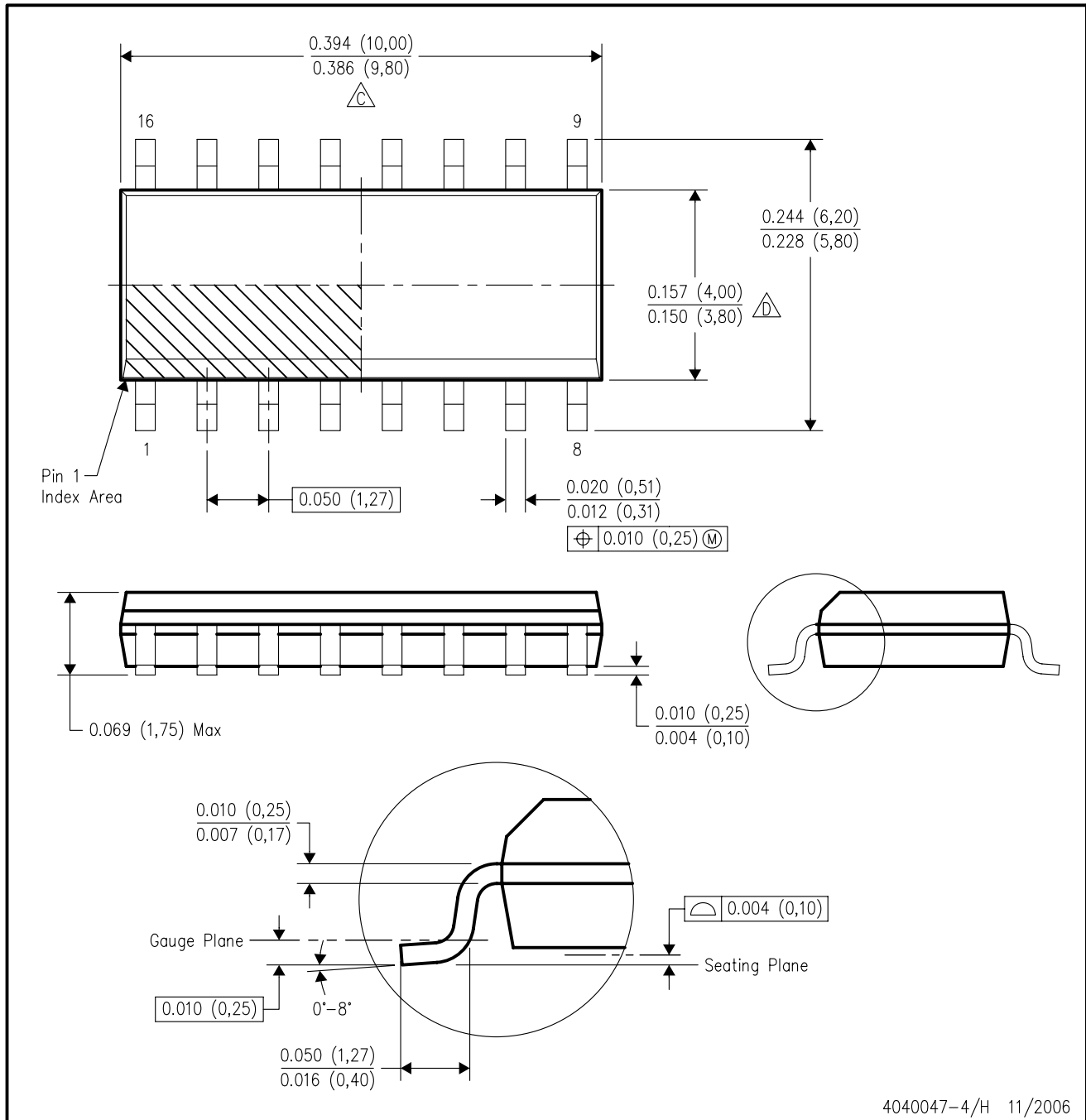


- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
  - D The 20 pin end lead shoulder width is a vendor option, either half or full width.

4040049/E 12/2002

D (R-PDSO-G16)

PLASTIC SMALL-OUTLINE PACKAGE



4040047-4/H 11/2006

- 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.

## MECHANICAL DATA

NS (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



- 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.

DB (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE

28 PINS SHOWN



- 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-150

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