

SN74ALS166 PARALLEL-LOAD 8-BIT SHIFT REGISTER

SDAS156D – APRIL 1982 – REVISED AUGUST 2000

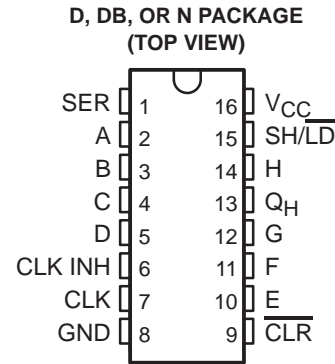
- Synchronous Load
- Direct Overriding Clear
- Parallel-to-Serial Conversion
- Package Options Include Plastic Small-Outline (D) and Shrink Small-Outline (DB) Packages and Standard Plastic (N) DIP

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					INTERNAL OUTPUTS	OUTPUT Q _H
CLR	SH/ $\overline{\text{LD}}$	CLK INH	CLK	SER		
L	X	X	X	X	A...H	L
H	X	L	L	X	a...h	Q _{H0}
H	L	L	↑	X	X	h
H	H	L	↑	H	X	Q _{Gn}
H	H	L	↑	L	X	Q _{Gn}
H	X	H	↑	X	X	Q _{H0}



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**TEXAS
INSTRUMENTS**

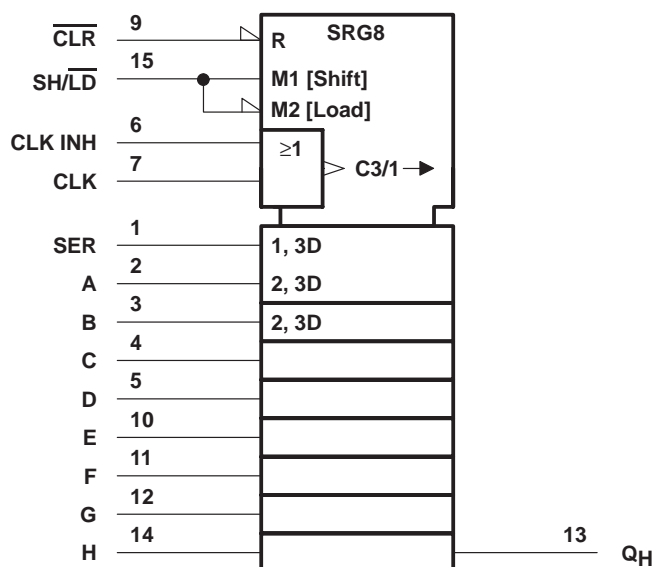
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SN74ALS166 PARALLEL-LOAD 8-BIT SHIFT REGISTER

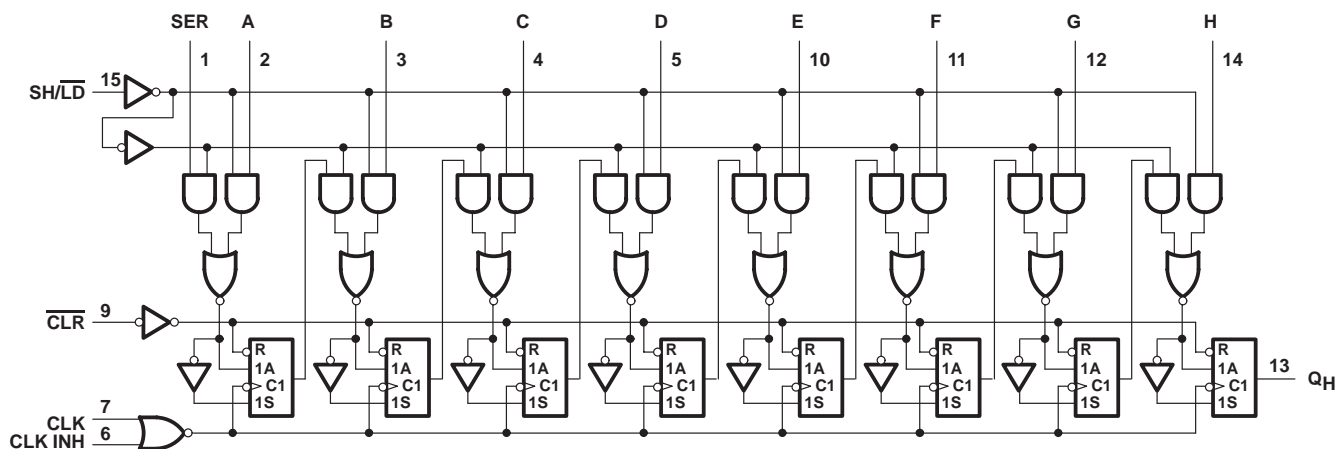
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logic symbol†

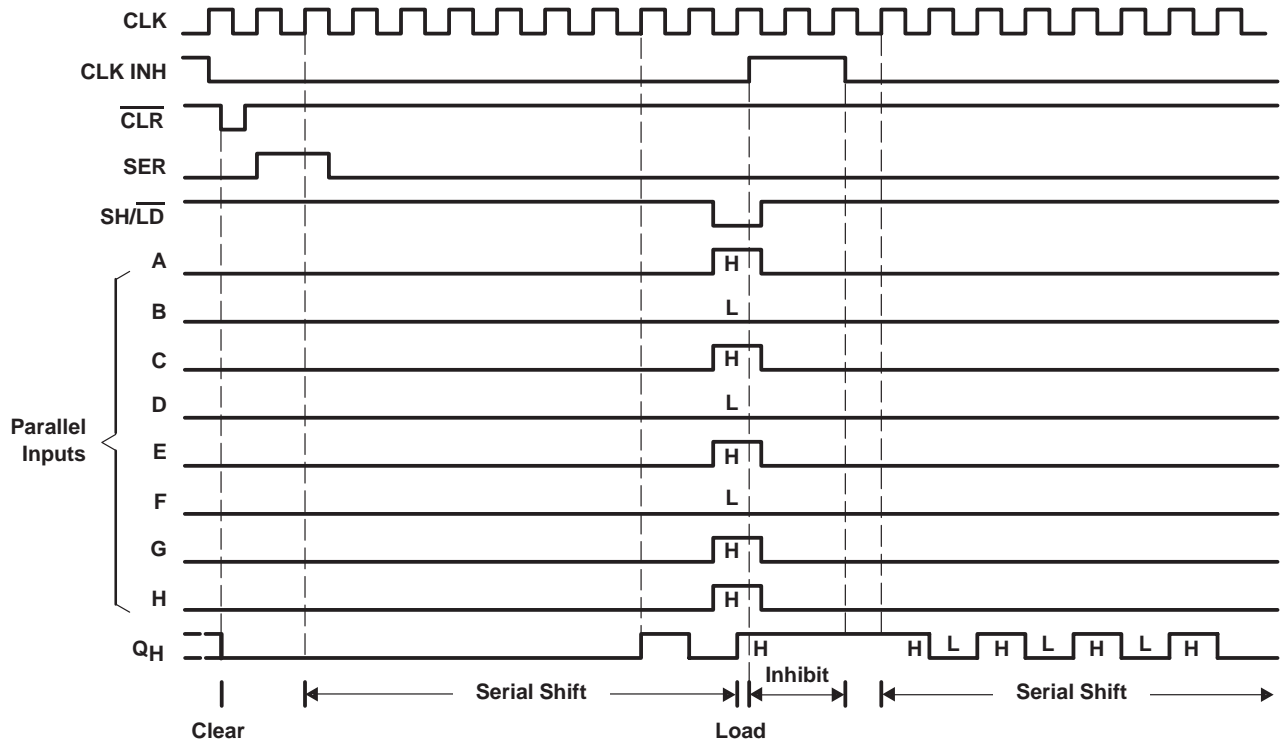


† This symbol is in accordance with ANSI/IEEE Standard 91-1984 and IEC Publication 617-12.

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, θ_{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	μA
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_{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 CLK↑	SH/LD	16	ns
		Data	7	
		$\overline{\text{CLR}}$ inactive	11	
t_h	Hold time, data after CLK↑		3	ns

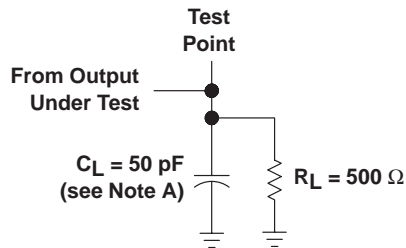
switching characteristics over recommended operating conditions (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	MIN	TYP†	MAX	UNIT
f_{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 $V_{CC} = 5\text{ V}$, $T_A = 25^\circ\text{C}$.



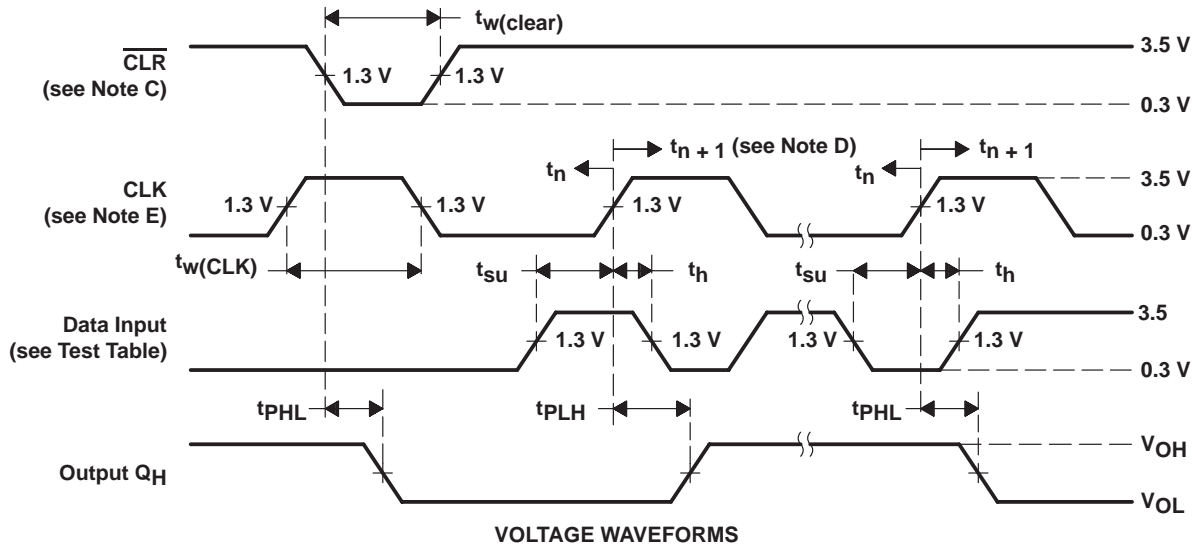
PARAMETER MEASUREMENT INFORMATION



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}

LOAD CIRCUIT FOR OUTPUT UNDER TEST



- 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: $t_{w(\text{clock})} \leq 20 \text{ ns}$ and $\text{PRR} = 1 \text{ MHz}$. The clear pulse has the following characteristics: $t_{w(\text{clear})} \leq 20 \text{ ns}$.
 - F. All pulse generators have the following characteristics: $Z_O \approx 50 \Omega$; $t_r = t_f = 2 \text{ ns}$. Duty cycle = 50% when testing f_{max} .

Figure 1. Load Circuit and Voltage Waveforms

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
SN74ALS166D	Obsolete	Production	SOIC (D) 16	-	-	Call TI	Call TI	0 to 70	ALS166
SN74ALS166DBR	Active	Production	SSOP (DB) 16	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	G166
SN74ALS166DBR.A	Active	Production	SSOP (DB) 16	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	G166
SN74ALS166DR	Active	Production	SOIC (D) 16	2500 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	ALS166
SN74ALS166DR.A	Active	Production	SOIC (D) 16	2500 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	ALS166
SN74ALS166N	Active	Production	PDIP (N) 16	25 TUBE	Yes	NIPDAU	N/A for Pkg Type	0 to 70	SN74ALS166N
SN74ALS166N.A	Active	Production	PDIP (N) 16	25 TUBE	Yes	NIPDAU	N/A for Pkg Type	0 to 70	SN74ALS166N
SN74ALS166NSR	Active	Production	SOP (NS) 16	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	ALS166
SN74ALS166NSR.A	Active	Production	SOP (NS) 16	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	ALS166

⁽¹⁾ **Status:** For more details on status, see our [product life cycle](#).

⁽²⁾ **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

⁽³⁾ **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

⁽⁴⁾ **Lead finish/Ball material:** Parts 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.

⁽⁵⁾ **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

⁽⁶⁾ **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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TAPE AND REEL INFORMATION



*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
SN74ALS166DBR	SSOP	DB	16	2000	330.0	16.4	8.35	6.6	2.4	12.0	16.0	Q1
SN74ALS166DR	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
SN74ALS166NSR	SOP	NS	16	2000	330.0	16.4	8.1	10.4	2.5	12.0	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)
SN74ALS166DBR	SSOP	DB	16	2000	353.0	353.0	32.0
SN74ALS166DR	SOIC	D	16	2500	340.5	336.1	32.0
SN74ALS166NSR	SOP	NS	16	2000	353.0	353.0	32.0

TUBE



*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
SN74ALS166N	N	PDIP	16	25	506	13.97	11230	4.32
SN74ALS166N	N	PDIP	16	25	506	13.97	11230	4.32
SN74ALS166N.A	N	PDIP	16	25	506	13.97	11230	4.32
SN74ALS166N.A	N	PDIP	16	25	506	13.97	11230	4.32

D (R-PDSO-G16)

PLASTIC SMALL OUTLINE



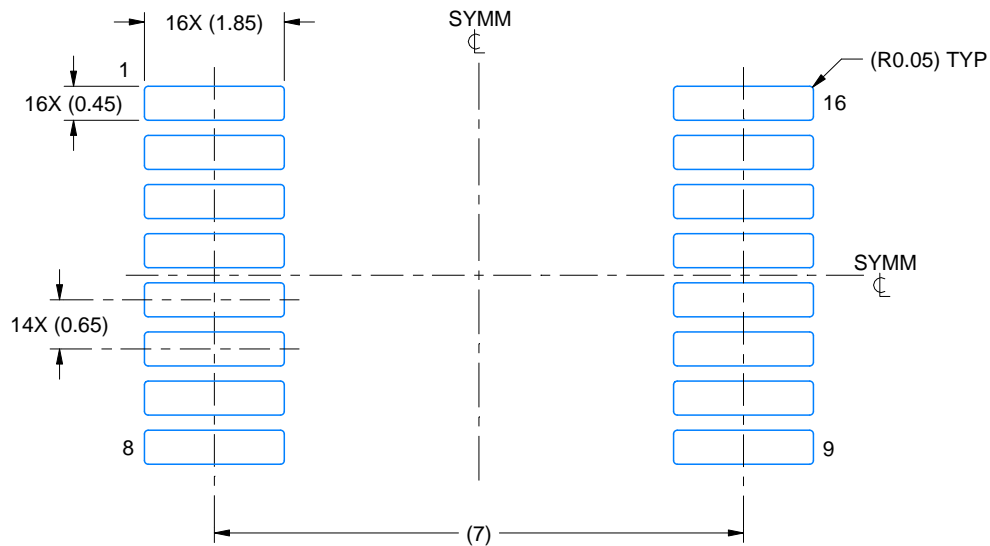
- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - $\triangle C$ Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
 - $\triangle D$ 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.

EXAMPLE BOARD LAYOUT

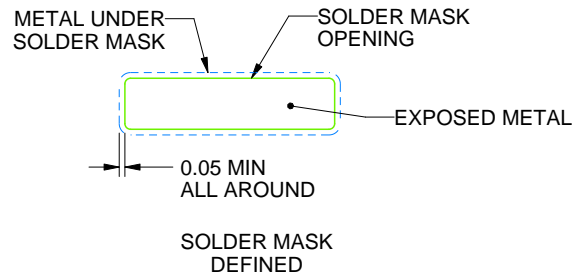
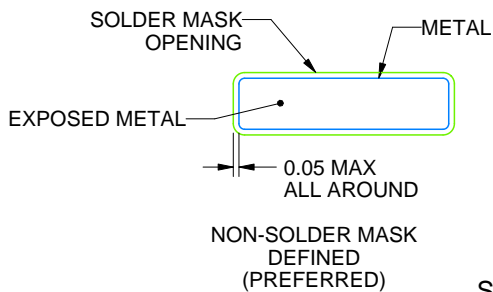
DB0016A

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X



SOLDER MASK DETAILS

4220763/A 05/2022

NOTES: (continued)

5. Publication IPC-7351 may have alternate designs.

6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DB0016A

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 10X

4220763/A 05/2022

NOTES: (continued)

7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.

MECHANICAL DATA

NS (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



DIM \ PINS **	14	16	20	24
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.

N (R-PDIP-T**)

16 PINS SHOWN

PLASTIC DUAL-IN-LINE PACKAGE



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



4040049/E 12/2002

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



NS0016A

SOP - 2.00 mm max height

SOP



NOTES:

1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm, per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm, per side.

EXAMPLE BOARD LAYOUT

NS0016A

SOP - 2.00 mm max height

SOP



4220735/A 12/2021

NOTES: (continued)

5. Publication IPC-7351 may have alternate designs.

6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

NS0016A

SOP - 2.00 mm max height

SOP



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:7X

4220735/A 12/2021

NOTES: (continued)

7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.

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