

# SN54LS846 THRU SN54LS649 SN74LS646 THRU SN74LS649 OCTAL BUS TRANSCEIVERS AND REGISTERS

SDLS190A – DECEMBER 1982 – REVISED MAY 2004

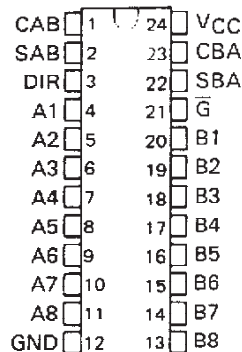
- Independent Registers for A and B Buses
- Multiplexed Real-Time and Stored Data
- Choice of True or Inverting Data Paths
- Choice of 3-State or Open-Collector Outputs
- Included Among the Package Options Are Compact 24-pin 300-mil-Wide Plastic and Ceramic DIPs, Ceramic Chip Carriers, and Plastic "Small Outline" Packages
- Dependable Texas Instruments Quality and Reliability

DEVICE	OUTPUT	LOGIC
'LS646	3-State	True
'LS647	Open-Collector	True
'LS648	3-State	Inverting
'LS649	Open-Collector	Inverting

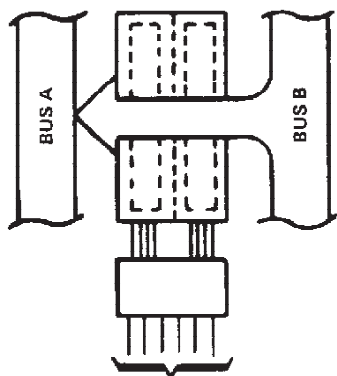
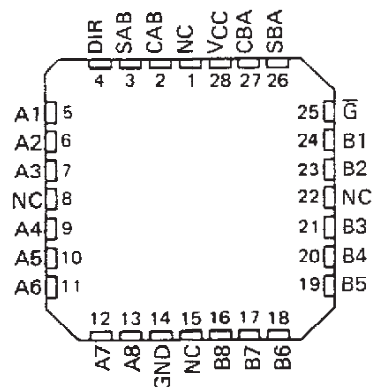
## description

These devices consist of bus transceiver circuits with 3-state or open-collector outputs, D-type flip-flops, and control circuitry arranged for multiplexed transmission of data directly from the input bus or from the internal registers. Data on the A or B bus will be clocked into the registers on the low-to-high transition of the appropriate clock pin (CAB or CBA). The following examples demonstrate the four fundamental bus-management functions that can be performed with the octal bus transceivers and registers.

SN54LS' . . . JT PACKAGE  
SN74LS' . . . DW OR NT PACKAGE  
(TOP VIEW)

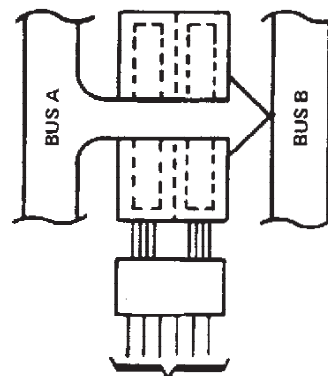


SN54LS' . . . FK PACKAGE  
(TOP VIEW)



(21)	(3)	(1)	(23)	(2)	(22)
$\bar{G}$	DIR	CAB	CBA	SAB	SBA
L	L	X	X	X	L

REAL-TIME TRANSFER  
BUS B TO BUS A



(21)	(3)	(1)	(23)	(2)	(22)
$\bar{G}$	DIR	CAB	CBA	SAB	SBA
L	H	X	X	L	X

REAL-TIME TRANSFER  
BUS A TO BUS B



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

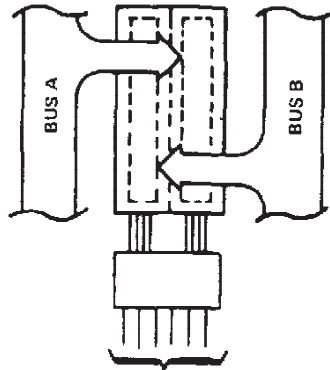
 **TEXAS  
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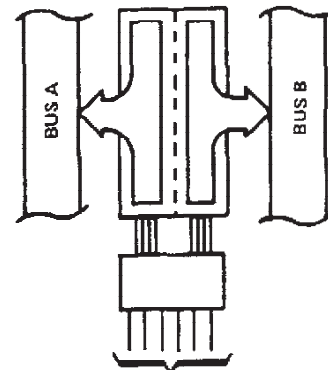
# SN54LS646 THRU SN54LS649, SN74LS646 THRU SN74LS649 OCTAL BUS TRANSCEIVERS AND REGISTERS

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(21)	(3)	(1)	(23)	(2)	(22)
$\bar{G}$	DIR	CAB	CBA	SAB	SBA
X	X	↑	X	X	X
X	X	X	↑	X	X
H	X	↑	↑	X	X

STORAGE FROM  
A, B, OR A AND B



(21)	(3)	(1)	(23)	(2)	(22)
$\bar{G}$	DIR	CAB	CBA	SAB	SBA
L	L	X	HorL	X	H
L	H	HorL	X	H	X

TRANSFER  
STORED DATA  
TO A OR B

Enable ( $\bar{G}$ ) and direction (DIR) pins are provided to control the transceiver functions. In the transceiver mode, data present at the high-impedance port may be stored in either register or in both. The select controls (SAB and SBA) can multiplex stored and real-time (transparent mode) data. The direction control determines which bus will receive data when enable  $\bar{G}$  is active (low). In the isolation mode (control  $\bar{G}$  high), A data may be stored in one register and/or B data may be stored in the other register.

When an output function is disabled, the input function is still enabled and may be used to store and transmit data. Only one of the two buses, A or B, may be driven at a time.

The SN54' family is characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SN74' family is characterized for operation from  $0^{\circ}$  to  $70^{\circ}\text{C}$ .

FUNCTION TABLE

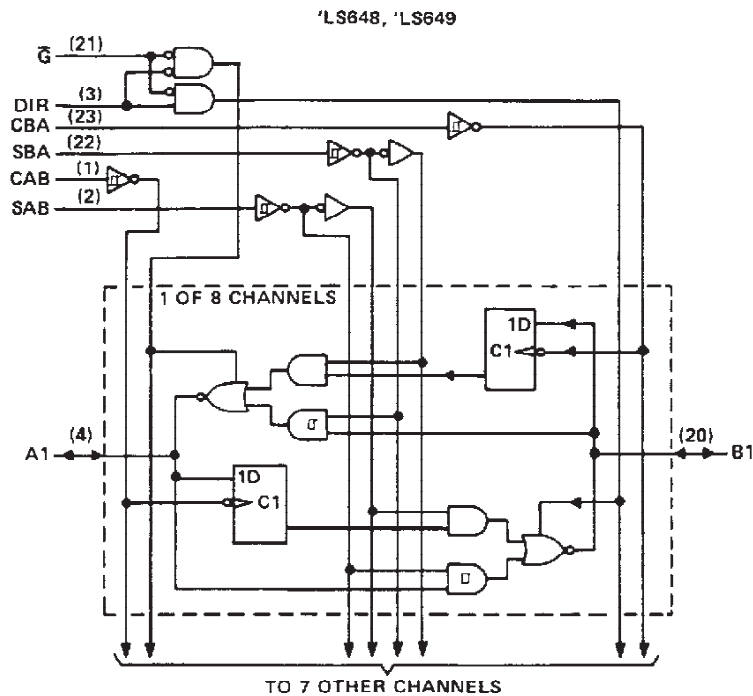
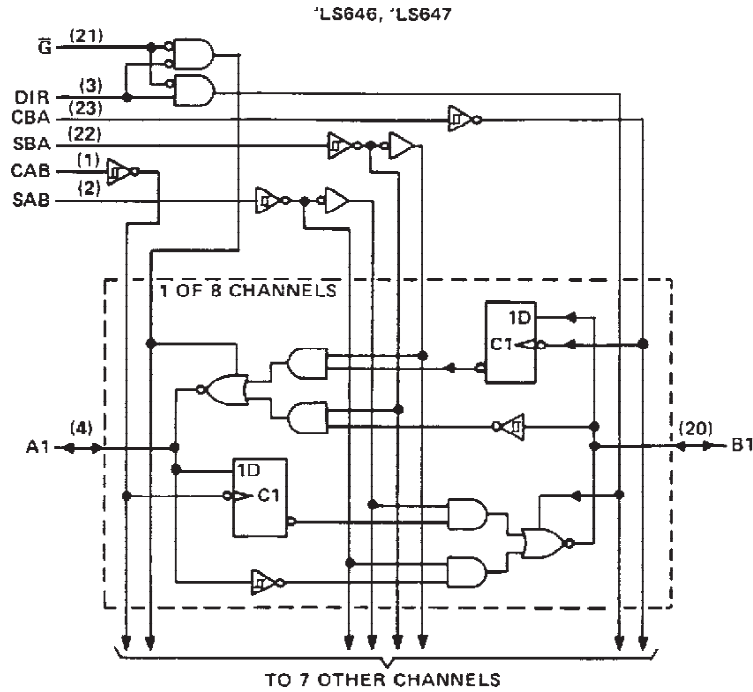
INPUTS						DATA I/O†		OPERATION OR FUNCTION	
$\bar{G}$	DIR	CAB	CBA	SAB	SBA	A1 THRU A8	B1 THRU B8	LS646, LS647	LS648, LS649
X	X	↑	X	X	X	Input	Not specified	Store A, B unspecified	Store A, B unspecified
X	X	X	↑	X	X	Not specified	Input	Store B, A unspecified	Store B, A unspecified
H	X	↑	↑	X	X	Input	Input	Store A and B Data	Store A and B Data
H	X	H or L	H or L	X	X	Input	Input	Isolation, hold storage	Isolation, hold storage
L	L	X	X	X	L	Output	Input	Real-Time B Data to A Bus	Real-Time $\bar{B}$ Data to A Bus
L	L	X	HorL	X	H	Output	Input	Stored B Data to A Bus	Stored $\bar{B}$ Data to A Bus
L	H	X	X	L	X	Input	Output	Real-Time A Data to B Bus	Real-Time $\bar{A}$ Data to B Bus
L	H	H or L	X	H	X	Input	Output	Stored A Data to B Bus	Stored $\bar{A}$ Data to B Bus

† The data output functions may be enabled or disabled by various signals at the  $\bar{G}$  and DIR inputs. Data input functions are always enabled, i.e., data at the bus pins will be stored on every low-to-high transition on the clock inputs.

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logic diagrams (positive logic)



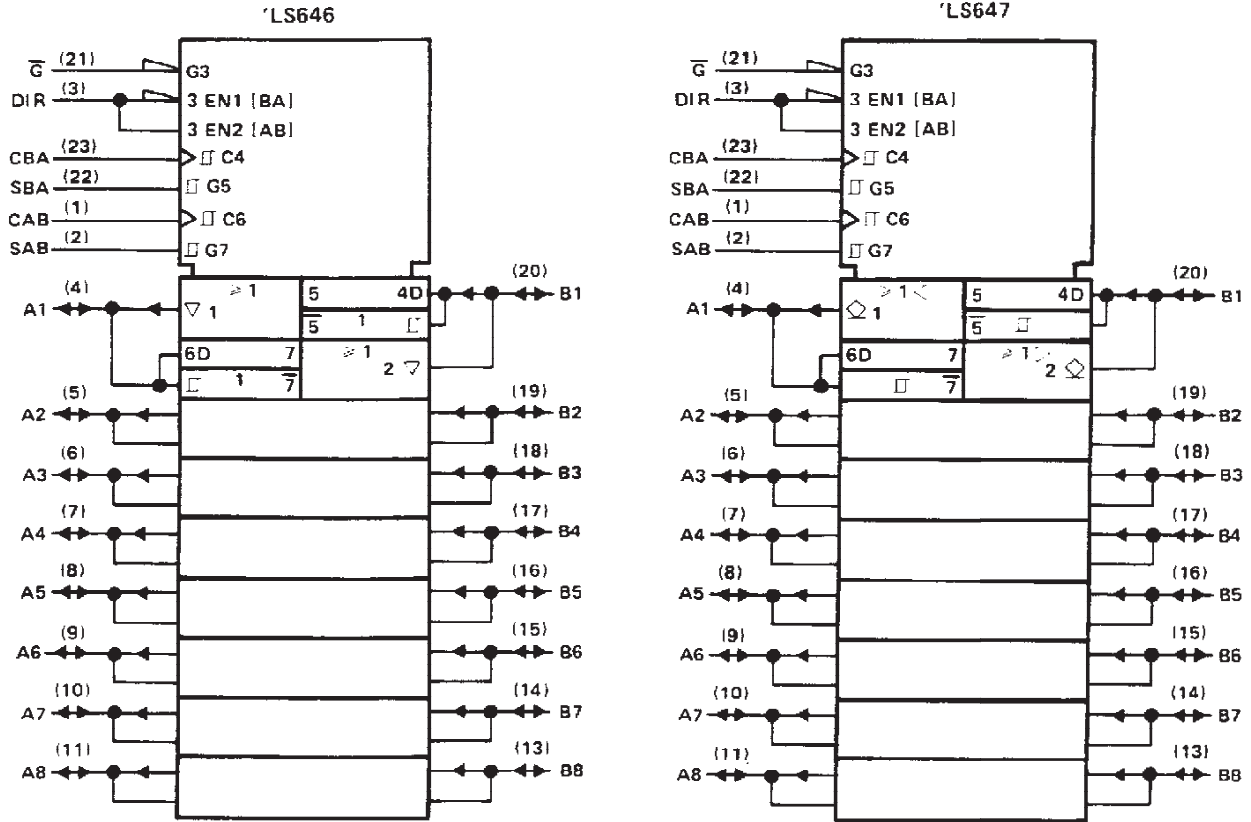
Pin numbers shown are for DW, JT, and NT packages.

# SN54LS646, SN54LS647, SN74LS646, SN74LS647

## OCTAL BUS TRANSCEIVERS AND REGISTERS

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logic symbols †

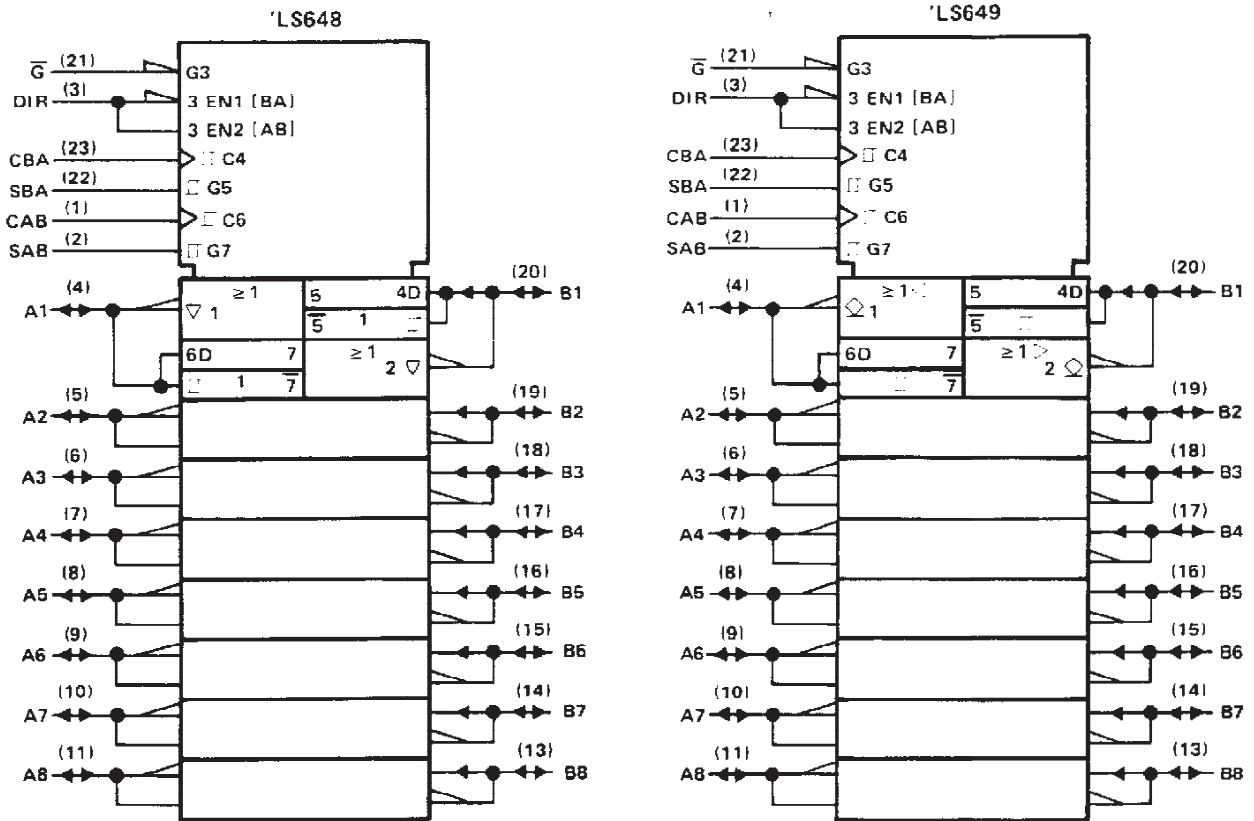


†These symbols are in accordance with ANSI/IEEE Std. 91-1984 and IEC Publication 617-12. Pin numbers shown are for DW, JT, and NT packages.

# SN54LS648, SN54LS649, SN74LS648, SN74LS649 OCTAL BUS TRANSCEIVERS AND REGISTERS

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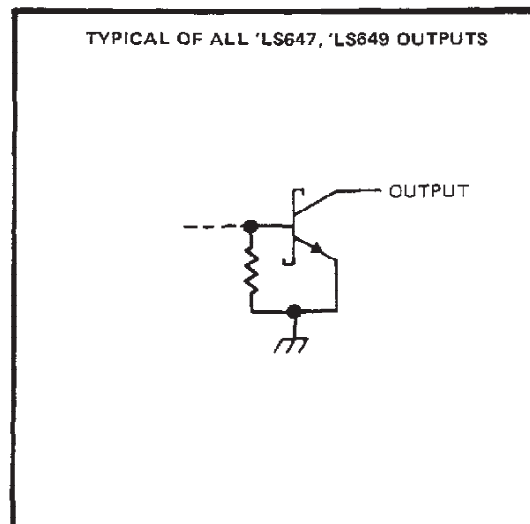
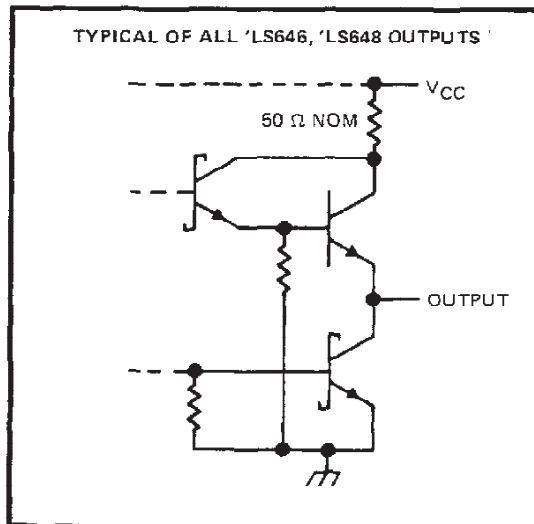
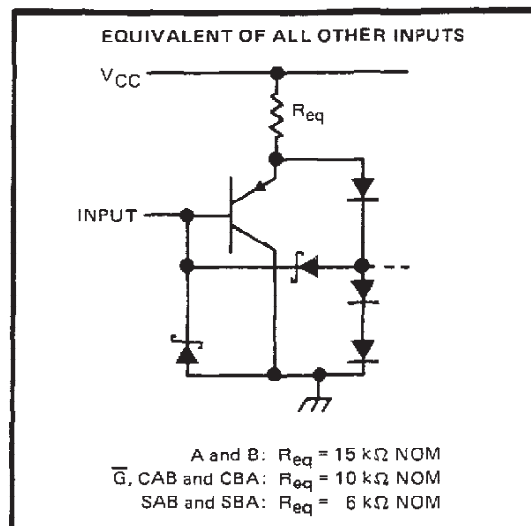
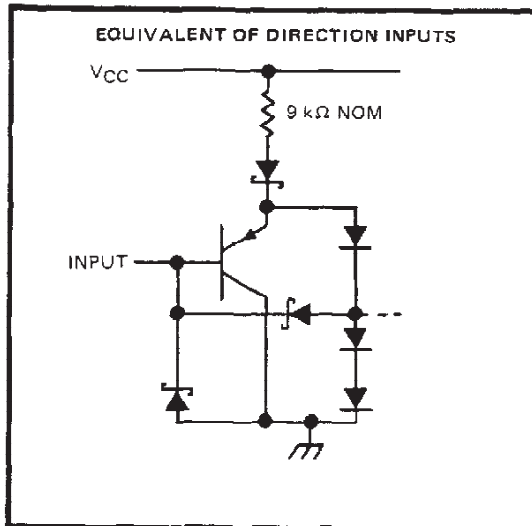
logic symbols† (continued)



†These symbols are in accordance with ANSI/IEEE Std. 91-1984 and IEC Publication 617-12.  
Pin numbers shown are for DW, JT, and NT packages.

**SN54LS646 THRU SN54LS649**  
**SN74LS646 THRU SN74LS649**  
**OCTAL BUS TRANSCEIVERS AND REGISTERS**  
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schematics of inputs and outputs



# SN54LS646, SN54LS648, SN74LS646, SN74LS648

## OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

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

Supply voltage, $V_{CC}$ .....	7 V
Input voltage: Control inputs .....	7 V
I/O ports .....	5.5 V
Operating free-air temperature range: SN54LS646, SN54LS648 .....	– 55°C to 125°C
SN74LS646, SN74LS648 .....	0°C to 70°C
Storage temperature range .....	– 65°C to 150°C

**recommended operating conditions**

		SN54LS646/648			SN74LS646/648			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
$V_{CC}$	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
$V_{IH}$	High-level input voltage	2			2			V
$V_{IL}$	Low-level input voltage			0.5			0.6	V
$I_{OH}$	High-level output current			– 12			– 15	mA
$I_{OL}$	Low-level output current			12			24	mA
$t_w$	Pulse duration	CBA or CAB high		15	15			ns
		CBA or CAB low		30	30			
		Data high or low		30	30			
$t_{su}$	Setup time before CAB† or CBA †	A or B		15	15		ns	
$t_h$	Hold time after CAB† or CBA †	A or B		0	0		ns	
$T_A$	Operating free-air temperature	– 55		125	0		70	°C

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

PARAMETER		TEST CONDITIONS†	SN54LS646/648		SN74LS646/648		UNIT		
			MIN	TYP‡	MAX	MIN		TYP‡	MAX
$V_{IK}$		$V_{CC} = \text{MIN}, I_I = -18 \text{ mA}$			– 1.5		V		
Hysteresis ( $V_{T+} - V_{T-}$ )	A or B input	$V_{CC} = \text{MIN}$	0.1	0.4		0.2	0.4	V	
$V_{OH}$		$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = \text{MAX}$	$I_{OH} = -3 \text{ mA}$	2.4	3.4	2.4	3.4	V	
			$I_{OH} = -12 \text{ mA}$	2					
			$I_{OH} = -15 \text{ mA}$			2			
$V_{OL}$		$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = \text{MAX}$	$I_{OL} = 12 \text{ mA}$		0.25	0.4	0.25	0.4	V
			$I_{OL} = 24 \text{ mA}$				0.35	0.5	
$I_I$	Control inputs	$V_{CC} = \text{MAX}, V_I = 7 \text{ V}$					0.1	mA	
	A or B ports	$V_{CC} = \text{MAX}, V_I = 5.5 \text{ V}$					0.1		
$I_{IH}$	Control inputs	$V_{CC} = \text{MAX}, V_I = 2.7 \text{ V}$			20		20	$\mu\text{A}$	
	A or B ports‡				20		20		
$I_{IL}$	Control inputs	$V_{CC} = \text{MAX}, V_I = 0.4 \text{ V}$			– 0.4		– 0.4	mA	
	A or B ports‡				– 0.4		– 0.4		
$I_{OS}$ §		$V_{CC} = \text{MAX}, V_O = 0 \text{ V}$	– 40		– 225	– 40	– 225	mA	
$I_{CC}$	LS646	$V_{CC} = \text{MAX}$	Outputs high	91	145	91	145	mA	
			Outputs low	103	165	103	165		
			Outputs disabled	103	165	103	165		
	Outputs high		91	145	91	145			
	Outputs low		103	165	103	165			
	Outputs disabled		120	180	120	180			

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

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

§ Not more than one output should be shorted at a time, and duration of the short-circuit should not exceed one second.

¶ For I/O ports, the parameters  $I_{IH}$  and  $I_{IL}$  include the off-state output current.



# SN54LS646, SN54LS648, SN74LS646, SN74LS648

## OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

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switching characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'LS646			'LS648			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
$t_{PLH}$	CAB or CBA	A or B	$R_L = 667\ \Omega$ , $C_L = 45\ \text{pF}$ , See Note 2	15	25		15	25	ns	
$t_{PHL}$				23	35		24	40	ns	
$t_{PLH}$	A or B	B or A		12	18		12	18	ns	
$t_{PHL}$				13	20		15	25	ns	
$t_{PLH}$	SAB or SBA <sup>†</sup> with Bus input high	A or B		26	40		37	55	ns	
$t_{PHL}$				21	35		24	40	ns	
$t_{PLH}$	SAB or SBA <sup>†</sup> with Bus input low	A or B		33	50		26	40	ns	
$t_{PHL}$				14	25		23	40	ns	
$t_{PZH}$	$\overline{G}$	A or B		33	55		30	50	ns	
$t_{PZL}$				42	65		37	55	ns	
$t_{PZH}$	DIR	A or B	28	45		23	40	ns		
$t_{PZL}$			39	60		30	45	ns		
$t_{PHZ}$	$\overline{G}$	A or B	23	35		28	45	ns		
$t_{PLZ}$			22	35		22	35	ns		
$t_{PHZ}$	DIR	A or B	20	30		24	35	ns		
$t_{PLZ}$			19	30		19	30	ns		

<sup>†</sup> These parameters are measured with the internal output state of the storage register opposite to that of the input.

NOTE 2: Load circuits and voltage waveforms are shown in Section 1.



# SN54LS647, SN54LS649, SN74LS647, SN74LS649

## OCTAL BUS TRANSCEIVERS AND REGISTERS WITH OPEN-COLLECTOR OUTPUTS

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

Supply voltage, $V_{CC}$ (see Note 1)	7 V
Input voltage (control inputs)	7 V
Off-state output voltage (A and B ports)	5.5 V
Operating free-air temperature range: SN54LS647, SN54LS649	– 55°C to 125°C
SN74LS647, SN74LS649	– 0°C to 70°C
Storage temperature range	– 65°C to 150°C

### recommended operating conditions

		SN54LS647 SN54LS649			SN74LS647 SN74LS649			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
$V_{CC}$	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
$V_{IH}$	High-level input voltage	2			2			V
$V_{IL}$	Low-level input voltage			0.5			0.6	V
$V_{OH}$	High-level output voltage			5.5			5.5	V
$I_{OL}$	Low-level output voltage			12			24	mA
$t_w$	Pulse duration	CBA or CAB high		15	15			ns
		CBA or CAB low		30	30			
		Data high or low		30	30			
$t_{su}$	Setup time before CAB † or CBA †	A or B		15	15		ns	
$t_h$	Hold time after CAB † or CBA †	A or B		0	0		ns	
$T_A$	Operating free-air temperature	– 55		125	0		70	°C

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

PARAMETER		TEST CONDITIONS†	SN54LS647 SN54LS649			SN74LS647 SN74LS649			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
$V_{IK}$		$V_{CC} = \text{MIN}, I_I = -18 \text{ mA}$			– 1.5			– 1.5	V
Hysteresis ( $V_{T+} - V_{T-}$ )	A or B input	$V_{CC} = \text{MIN}$	0.1	0.4		0.2	0.4		V
$I_{OH}$		$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = \text{MAX}, V_{OH} = 5.5 \text{ V}$			0.1			0.1	mA
$V_{OL}$		$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = \text{MAX}, I_{OL} = 12 \text{ mA}, I_{OL} = 24 \text{ mA}$		0.25	0.4		0.25	0.4	V
$I_I$	A or B	$V_{CC} = \text{MAX}, V_I = 5.5 \text{ V}$			0.1			0.1	mA
	All others	$V_{CC} = \text{MAX}, V_I = 7 \text{ V}$			0.1			0.1	
$I_{IH}$		$V_{CC} = \text{MAX}, V_I = 2.7 \text{ V}$			20			20	μA
$I_{IL}$		$V_{CC} = \text{MAX}, V_I = 0.4 \text{ V}$			– 0.4			– 0.4	mA
$I_{CC}$	'LS647	$V_{CC} = \text{MAX}, \text{Outputs open}$	Outputs high	79	130		79	130	mA
			Outputs low	94	150		94	150	
	'LS649	$V_{CC} = \text{MAX}, \text{Outputs open}$	Outputs high	79	130		79	130	
			Outputs low	94	150		94	150	

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.  
‡ All typical values are at  $V_{CC} = 5 \text{ V}, T_A = 25^\circ\text{C}$ .

# SN54LS647, SN54LS649, SN74LS647, SN74LS649

## OCTAL BUS TRANSCEIVERS AND REGISTERS WITH OPEN-COLLECTOR OUTPUTS

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switching characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'LS647			'LS649			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
$t_{PLH}$	CAB or CBA	A or B	$R_L = 667\ \Omega$ , $C_L = 45\ \text{pF}$ , See Note 2	22	35		17	30	ns	
$t_{PHL}$				28	45		28	45	ns	
$t_{PLH}$	A or B	B or A		17	26		15	25	ns	
$t_{PHL}$				18	27		20	30	ns	
$t_{PLH}$	SAB or SBA† with Bus input high	A or B		33	50		37	55	ns	
$t_{PHL}$				29	45		28	45	ns	
$t_{PLH}$	SAB or SBA† with Bus input low	A or B		39	60		30	45	ns	
$t_{PHL}$				19	30		26	40	ns	
$t_{PLH}$	G	A or B		25	40		21	40	ns	
$t_{PHL}$				33	50		34	50	ns	
$t_{PLH}$	DIR	A or B	23	35		19	30	ns		
$t_{PHL}$			25	40		27	45	ns		

† These parameters are measured with the internal outputs state of the storage register opposite to that of the bus input.

NOTE 2: Load circuits and voltage waveforms are shown in Section 1.

**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>
SN74LS646DW	ACTIVE	SOIC	DW	24	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LS646DWE4	ACTIVE	SOIC	DW	24	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LS646DWG4	ACTIVE	SOIC	DW	24	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LS646DWR	ACTIVE	SOIC	DW	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LS646DWRE4	ACTIVE	SOIC	DW	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LS646DWRG4	ACTIVE	SOIC	DW	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LS646NT	ACTIVE	PDIP	NT	24	15	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
SN74LS646NT3	OBSOLETE	PDIP	NT	24		TBD	Call TI	Call TI
SN74LS646NTE4	ACTIVE	PDIP	NT	24	15	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
SN74LS647DW	OBSOLETE	SOIC	DW	24		TBD	Call TI	Call TI
SN74LS647NT	OBSOLETE	PDIP	NT	24		TBD	Call TI	Call TI
SN74LS648DW	ACTIVE	SOIC	DW	24	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LS648DWE4	ACTIVE	SOIC	DW	24	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LS648DWG4	ACTIVE	SOIC	DW	24	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LS648NT	ACTIVE	PDIP	NT	24	15	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
SN74LS648NTE4	ACTIVE	PDIP	NT	24	15	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
SN74LS649NT	OBSOLETE	PDIP	NT	24		TBD	Call TI	Call TI

<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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**TAPE AND REEL INFORMATION**



**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**



\*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
SN74LS646DWR	SOIC	DW	24	2000	330.0	24.4	10.75	15.7	2.7	12.0	24.0	Q1

**TAPE AND REEL BOX DIMENSIONS**



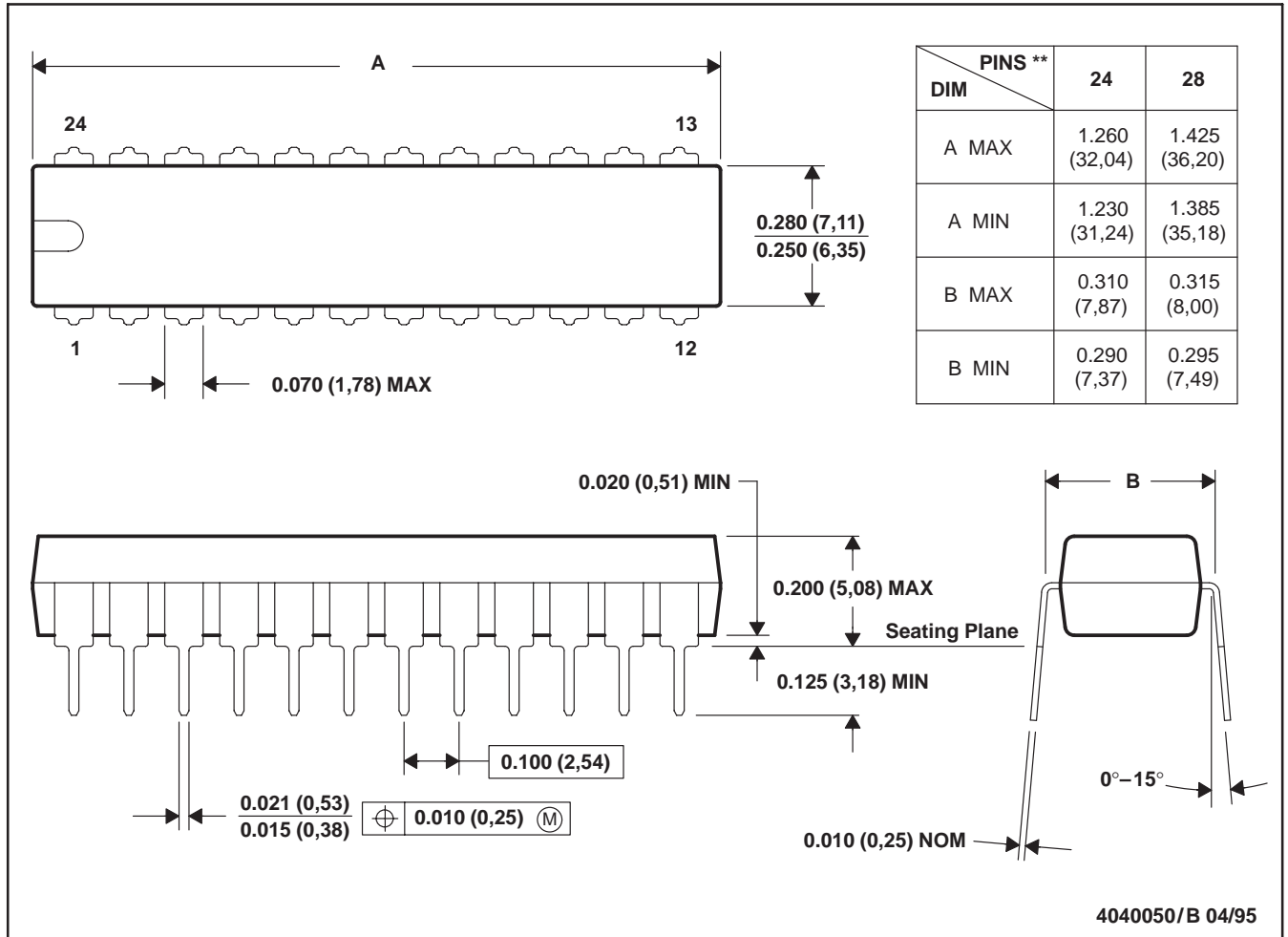
\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74LS646DWR	SOIC	DW	24	2000	346.0	346.0	41.0

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

PLASTIC DUAL-IN-LINE PACKAGE

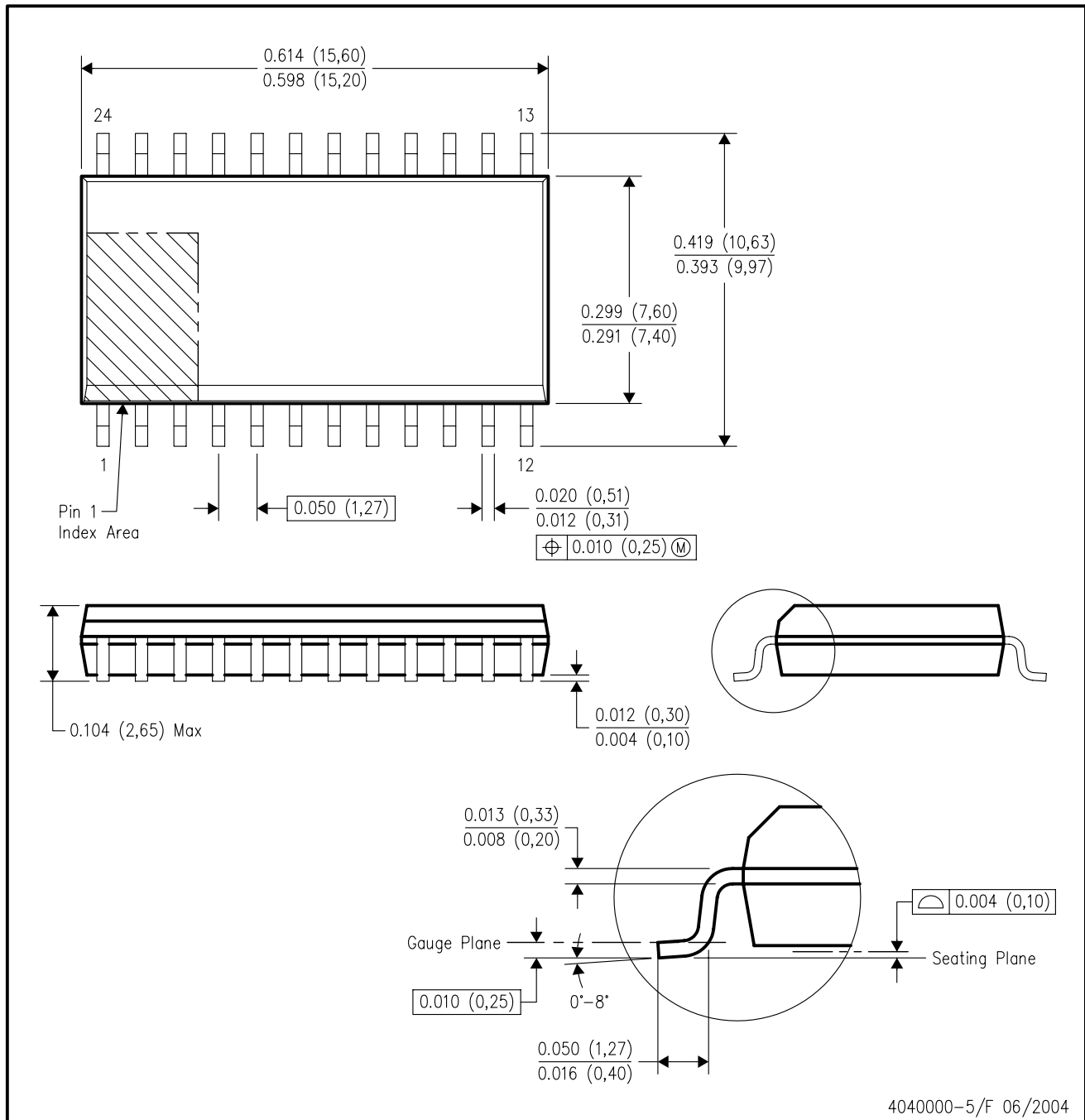
24 PINS SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.

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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