

# DATA SHEET

## 74LVC646A

Octal bus transceiver/register (3-State)

Product specification

1998 Jul 29

Supercedes data of 1998 Mar 25

IC24 Data Handbook

## Octal bus transceiver/register (3-State)

## 74LVC646A

## FEATURES

- Wide supply voltage range of 1.2V to 3.6V
- Flow-through pin-out architecture
- In accordance with JEDEC standard no. 8-1A
- CMOS low power consumption
- Direct interface with TTL levels
- 5 Volt tolerant inputs/outputs, for interfacing with 5 Volt logic

## DESCRIPTION

The 74LVC646A is a high performance, low-power, low-voltage Si-gate CMOS device, superior to most advanced CMOS compatible TTL families.

Inputs can be driven from either 3.3V or 5.0V devices. In 3-State operation, outputs can handle 5V. This feature allows the use of these devices as translators in a mixed 3.3V/5V environment.

The 74LVC646A consist of non-inverting bus transceiver circuits with 3-State outputs, D-type flip-flops and control circuitry arranged

for multiplexed transmission of data directly from the internal registers. Data on the 'A' or 'B' bus will be clocked in the internal registers, as the appropriate clock (CPAB or CPBA) goes to a HIGH logic level. Output enable ( $\overline{OE}$ ) and direction (DIR) inputs are provided to control the transceiver function. In the transceiver mode, data present at the high-impedance port may be stored in either the 'A' or 'B' register, or in both. The select source inputs (SAB and SBA) can multiplex stored and real-time (transparent mode) data.

The direction (DIR) input determines which bus will receive data when  $\overline{OE}$  is active (LOW). In the isolation mode ( $OE = HIGH$ ), 'A' data may be stored in the 'B' register and/or 'B' data may be stored in the 'A' 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 '646A' is functionally identical to the '648A' but has non-inverting data paths.

## QUICK REFERENCE DATA

GND = 0V;  $T_{amb} = 25^{\circ}C$ ;  $t_r = t_f \leq 2.5$  ns

SYMBOL	PARAMETER	CONDITIONS	TYPICAL	UNIT
$t_{PHL}/t_{PLH}$	Propagation delay An to $Y_n$	$C_L = 50\text{pF}$ $V_{CC} = 3.3\text{V}$	3.9	ns
	Maximum clock frequency		250	MHz
$C_I$	Input capacitance		5.0	pF
$C_{I/O}$	Input/output capacitance		10	pF
$C_{PD}$	Power dissipation capacitance per gate	Notes 1, 2	26	pF

## NOTES:

1.  $C_{PD}$  is used to determine the dynamic power dissipation ( $P_D$  in  $\mu\text{W}$ )  

$$P_D = C_{PD} \times V_{CC}^2 \times f_i + \sum (C_L \times V_{CC}^2 \times f_o)$$
 where:  
 $f_i$  = input frequency in MHz;  $C_L$  = output load capacitance in pF;  
 $f_o$  = output frequency in MHz;  $V_{CC}$  = supply voltage in V;  
 $\sum (C_L \times V_{CC}^2 \times f_o)$  = sum of the outputs.
2. The condition is  $V_I = GND$  to  $V_{CC}$ .

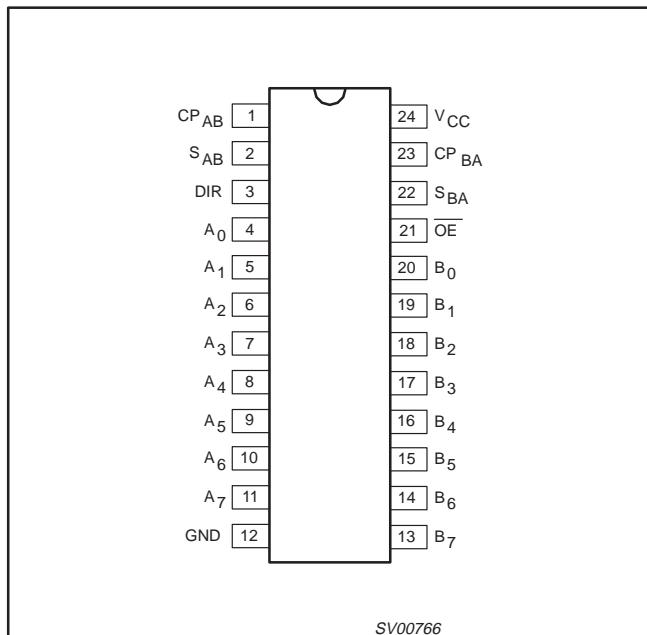
## ORDERING AND PACKAGE INFORMATION

PACKAGES	TEMPERATURE RANGE	OUTSIDE NORTH AMERICA	NORTH AMERICA	PKG. DWG. #
24-Pin Plastic SO	$-40^{\circ}C$ to $+85^{\circ}C$	74LVC646A D	74LVC646A D	SOT137-1
24-Pin Plastic SSOP Type II	$-40^{\circ}C$ to $+85^{\circ}C$	74LVC646A DB	74LVC646A DB	SOT340-1
24-Pin Plastic TSSOP Type I	$-40^{\circ}C$ to $+85^{\circ}C$	74LVC646A PW	7LVC646APW DH	SOT355-1

## Octal bus transceiver/register (3-State)

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## PIN CONFIGURATION



## PIN DESCRIPTION

PIN NUMBER	SYMBOL	FUNCTION
1	CP <sub>AB</sub>	'A' to 'B' clock input (LOW-to-HIGH, edge-triggered)
2	S <sub>AB</sub>	Select 'A' to 'B' source input
3	DIR	Direction control input
4, 5, 6, 7, 8, 9, 10, 11	A <sub>0</sub> to A <sub>7</sub>	'A' data inputs/outputs
12	GND	Ground (0V)
20, 19, 18, 17, 16, 15, 14, 13	B <sub>0</sub> to B <sub>7</sub>	'B' data inputs/outputs
21	OE	Output enable input (active LOW)
22	S <sub>BA</sub>	Select 'B' to 'A' source input
23	CP <sub>BA</sub>	'B' to 'A' clock input (LOW-to-HIGH, edge-triggered)
24	V <sub>CC</sub>	Positive supply voltage

## FUNCTION TABLE

INPUTS						DATA I/O *		FUNCTION
OE	DIR	CP <sub>AB</sub>	CP <sub>BA</sub>	S <sub>AB</sub>	S <sub>BA</sub>	A <sub>0</sub> to A <sub>7</sub>	B <sub>0</sub> to B <sub>7</sub>	
X	X	↑	X	X	X	input un *	un * input	store A, B unspecified * store B, A unspecified *
H	X	↑ H or L	↑ H or L	X	X	input	input	store A and B data, isolation hold storage
L	L	X	X	X	L	output	input	real-time B data to A bus stored B data to A bus
L	H	X H or L	X	L H	X	input	output	real-time A data to B bus stored A data to B bus

\* The data output functions may be enabled or disabled by various signals at the OE and DIR inputs. Data input functions are always enabled, i.e., data at the bus inputs will be stored on every LOW-to-HIGH transition on the clock inputs.

un = unspecified

H = HIGH voltage level

L = LOW voltage level

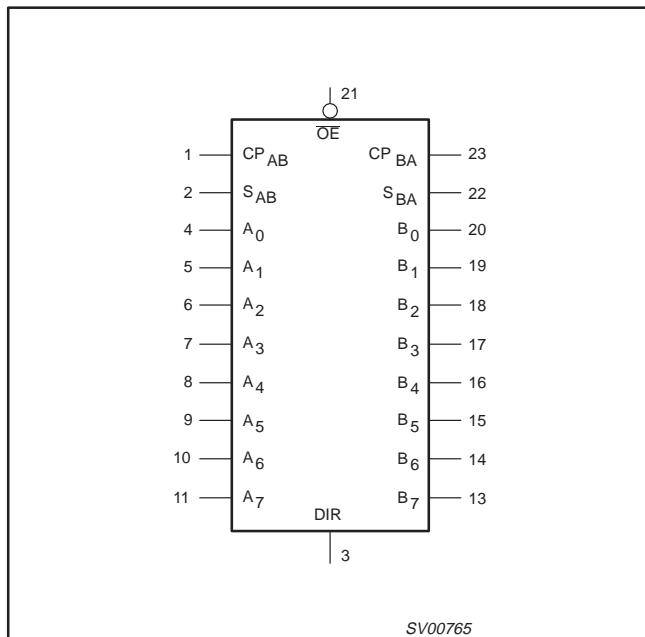
X = Don't care

↑ = LOW-to-HIGH level transition

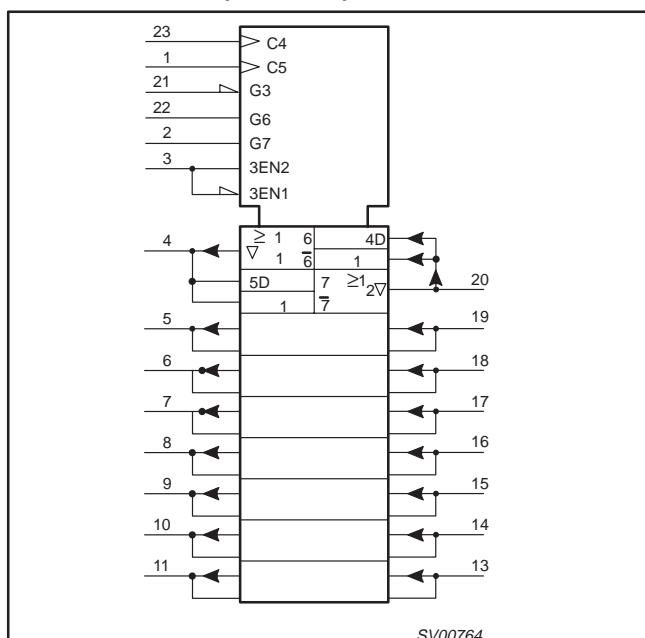
## Octal bus transceiver/register (3-State)

74LVC646A

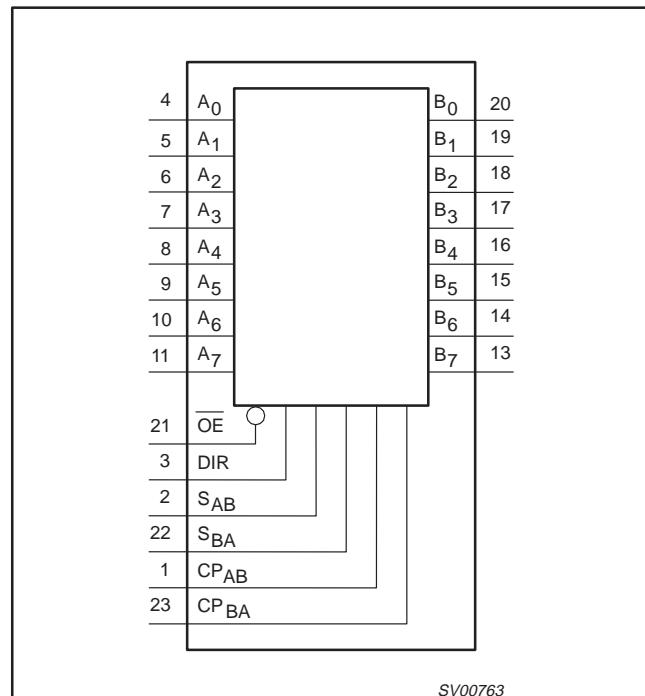
## LOGIC SYMBOL



## LOGIC SYMBOL (IEEE/IEC)



## FUNCTIONAL DIAGRAM

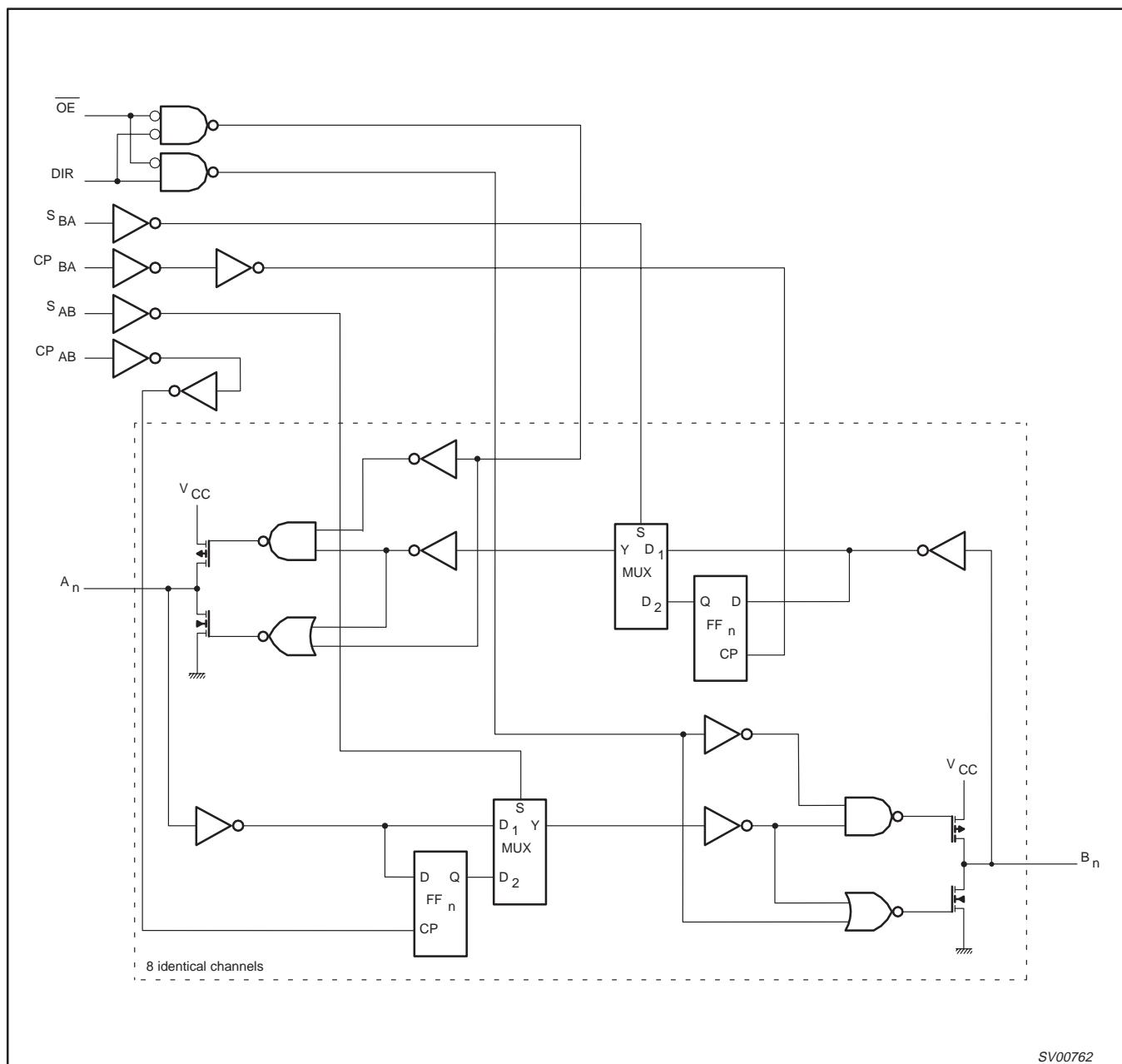


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## Octal bus transceiver/register (3-State)

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## LOGIC DIAGRAM



## Octal bus transceiver/register (3-State)

74LVC646A

## RECOMMENDED OPERATING CONDITIONS

SYMBOL	PARAMETER	CONDITIONS	LIMITS		UNIT
			MIN	MAX	
$V_{CC}$	DC supply voltage (for max. speed performance)		2.7	3.6	V
	DC supply voltage (for low-voltage applications)		1.2	3.6	
$V_I$	DC input voltage range		0	5.5	V
$V_O$	DC output voltage range; output HIGH or LOW state		0	$V_{CC}$	V
	DC output voltage range; output 3-State		0	5.5	
$T_{amb}$	Operating free-air temperature range		-40	+85	°C
$t_r, t_f$	Input rise and fall times	$V_{CC} = 1.2$ to $2.7V$ $V_{CC} = 2.7$ to $3.6V$	0	20	ns/V
			0	10	

ABSOLUTE MAXIMUM RATINGS<sup>1</sup>

In accordance with the Absolute Maximum Rating System (IEC 134)

Voltages are referenced to GND (ground = 0V)

SYMBOL	PARAMETER	CONDITIONS	RATING	UNIT
$V_{CC}$	DC supply voltage		-0.5 to +6.5	V
$I_{IK}$	DC input diode current	$V_I < 0$	-50	mA
$V_I$	DC input voltage	Note 2	-0.5 to +6.5	V
$I_{OK}$	DC output diode current	$V_O > V_{CC}$ or $V_O < 0$	±50	mA
$V_O$	DC output voltage; output HIGH or LOW	Note 2	-0.5 to $V_{CC}$ +0.5	V
	DC output voltage; output 3-State	Note 2	-0.5 to 6.5	
$I_O$	DC output diode current	$V_O = 0$ to $V_{CC}$	±50	mA
$I_{GND}, I_{CC}$	DC $V_{CC}$ or GND current		±100	mA
$T_{stg}$	Storage temperature range		-65 to +150	°C
$P_{TOT}$	Power dissipation per package – plastic mini-pack (SO) – plastic shrink mini-pack (SSOP and TSSOP)	above +70°C derate linearly with 8 mW/K above +60°C derate linearly with 5.5 mW/K	500 500	mW

## NOTES:

1. Stresses beyond those listed 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.
2. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

## Octal bus transceiver/register (3-State)

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## DC ELECTRICAL CHARACTERISTICS

Over recommended operating conditions voltages are referenced to GND (ground = 0V)

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS			UNIT	
			Temp = -40°C to +85°C				
			MIN	TYP <sup>1</sup>	MAX		
V <sub>IH</sub>	HIGH level Input voltage	V <sub>CC</sub> = 1.2V	V <sub>CC</sub>			V	
		V <sub>CC</sub> = 2.7 to 3.6V	2.0				
V <sub>IL</sub>	LOW level Input voltage	V <sub>CC</sub> = 1.2V			GND	V	
		V <sub>CC</sub> = 2.7 to 3.6V			0.8		
V <sub>OH</sub>	HIGH level output voltage	V <sub>CC</sub> = 2.7V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; I <sub>O</sub> = -12mA	V <sub>CC</sub> - 0.5			V	
		V <sub>CC</sub> = 3.0V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; I <sub>O</sub> = -100µA	V <sub>CC</sub> - 0.2	V <sub>CC</sub>			
		V <sub>CC</sub> = 3.0V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; I <sub>O</sub> = -18mA	V <sub>CC</sub> - 0.6				
		V <sub>CC</sub> = 3.0V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; I <sub>O</sub> = -24mA	V <sub>CC</sub> - 0.8				
V <sub>OL</sub>	LOW level output voltage	V <sub>CC</sub> = 2.7V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; I <sub>O</sub> = 12mA			0.40	V	
		V <sub>CC</sub> = 3.0V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; I <sub>O</sub> = 100µA		GND	0.20		
		V <sub>CC</sub> = 3.0V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; I <sub>O</sub> = 24mA			0.55		
I <sub>I</sub>	Input leakage current	V <sub>CC</sub> = 3.6V; V <sub>I</sub> = 5.5V or GND	Not for I/O pins		± 0.1	± 5	µA
I <sub>IHZ</sub> /I <sub>ILZ</sub>	Input current for common I/O pins	V <sub>CC</sub> = 3.6V; V <sub>I</sub> = V <sub>CC</sub> or GND			± 0.1	± 15	µA
I <sub>OZ</sub>	3-State output OFF-state current	V <sub>CC</sub> = 3.6V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>O</sub> = 5.5V or GND			0.1	± 10	µA
I <sub>OFF</sub>	Power off leakage current	V <sub>CC</sub> = 0.0V; V <sub>I</sub> or V <sub>O</sub> = 5.5V			0.1	± 10	µA
I <sub>CC</sub>	Quiescent supply current	V <sub>CC</sub> = 3.6V; V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0			0.1	10	µA
ΔI <sub>CC</sub>	Additional quiescent supply current per input pin	V <sub>CC</sub> = 2.7V to 3.6V; V <sub>I</sub> = V <sub>CC</sub> - 0.6V; I <sub>O</sub> = 0			5	500	µA

## NOTES:

1. All typical values are at V<sub>CC</sub> = 3.3V and T<sub>amb</sub> = 25°C.

## Octal bus transceiver/register (3-State)

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## AC CHARACTERISTICS

GND = 0 V;  $t_r = t_f \leq 2.5$  ns;  $C_L = 50$  pF

SYMBOL	PARAMETER	WAVEFORM	LIMITS						UNIT
			$V_{CC} = 3.3V \pm 0.3V$			$V_{CC} = 2.7V$		$V_{CC} = 1.2V$	
			MIN	TYP <sup>1</sup>	MAX	MIN	MAX	TYP	
$t_{PHL}/t_{PLH}$	Propagation delay An, Bn to Bn, An	Figures 1, 6	1.5	3.9	6.8	1.5	7.8	15	ns
$t_{PHL}/t_{PLH}$	Propagation delay $CP_{AB}, CP_{BA}$ to Bn, An	Figures 2, 6	1.5	4.6	7.6	1.5	8.6	19	ns
$t_{PHL}/t_{PLH}$	Propagation delay $S_{AB}, S_{BA}$ to Bn, An	Figures 3, 6	1.5	4.9	8.5	1.5	9.5	19	ns
$t_{PZH}/t_{PLZ}$	3-State output enable time $\overline{OEn}$ to An, Bn	Figures 4, 6	1.5	4.5	7.8	1.5	8.8	20	ns
$t_{PHZ}/t_{PLZ}$	3-State output disable time $\overline{OEn}$ to An, Bn	Figures 4, 6	1.5	3.9	6.1	1.5	7.1	10	ns
$t_{PZH}/t_{PLZ}$	3-State output enable time DIR to An, Bn	Figures 5, 6	1.5	4.6	7.9	1.5	8.9	20	ns
$t_{PHZ}/t_{PLZ}$	3-State output disable time DIR to An, Bn	Figures 5, 6	1.5	3.5	6.0	1.5	7.0	12	ns
$t_W$	Clock pulse width HIGH or LOW $CP_{AB}$ or $CP_{BA}$	Figure 1, 3	3.3	1.9	—	3.3	—	—	ns
$t_{su}$	Set-up time An, Bn to $CP_{AB}, CP_{BA}$	Figure 2	1.6	0.35	—	1.6	—	—	ns
$t_h$	Hold time An, Bn to $CP_{AB}, CP_{BA}$	Figure 2	1.0	-0.3	—	1.0	—	—	ns
$f_{max}$	Maximum clock pulse frequency	Figure 2	150	250	—	125	—	—	ns

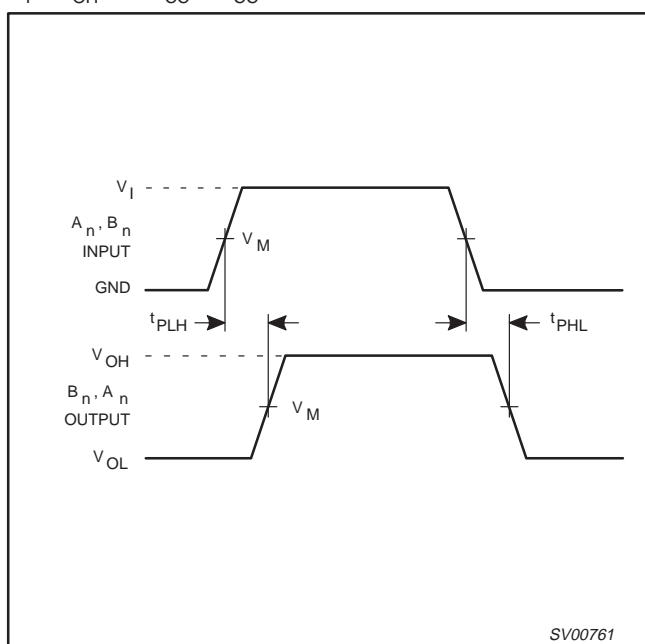
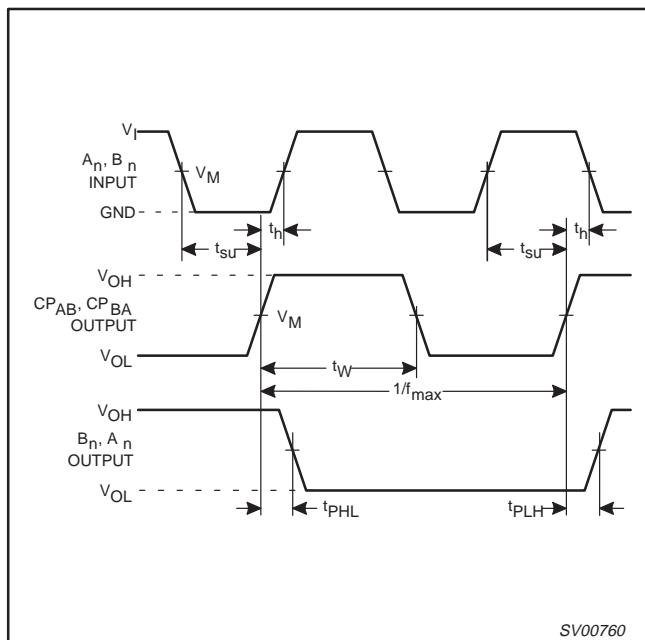
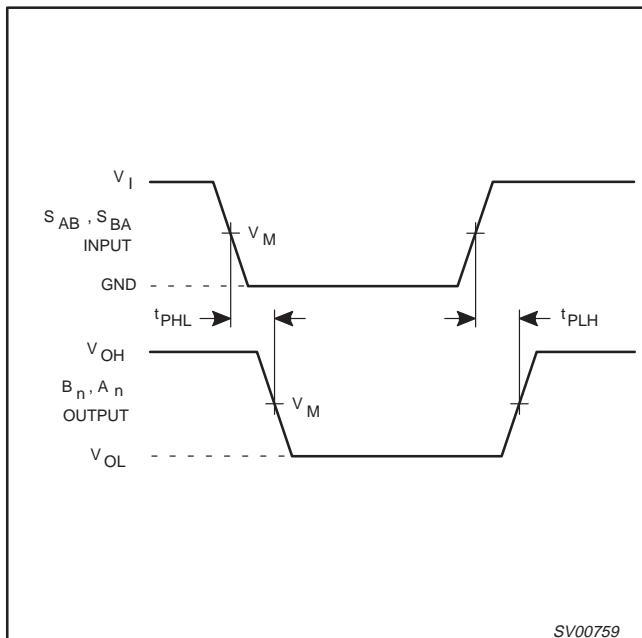
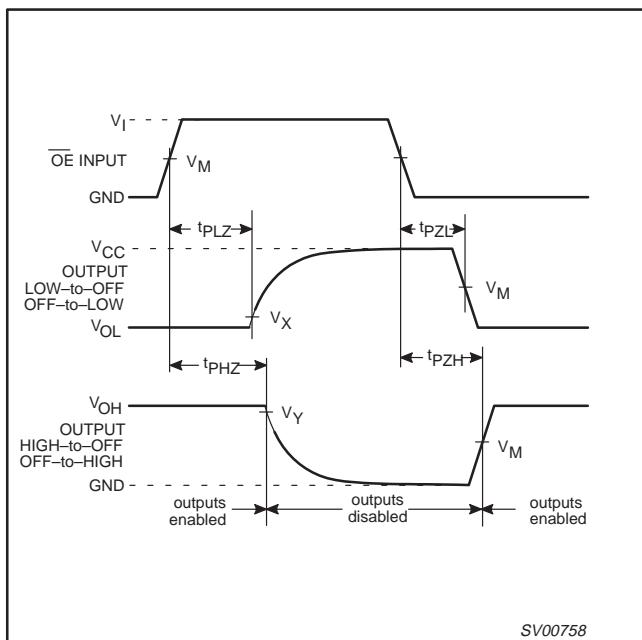
## NOTE:

1. These typical values are at  $V_{CC} = 3.3V$  and  $T_{amb} = 25^\circ C$ .

## Octal bus transceiver/register (3-State)

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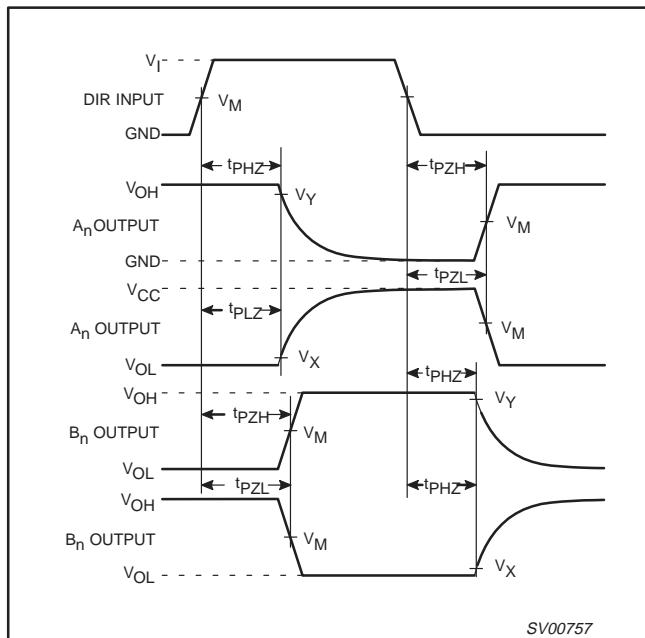
## AC WAVEFORMS

 $V_M = 1.5V$  at  $V_{CC} \geq 2.7V$  $V_M = 0.5V * V_{CC}$  at  $V_{CC} < 2.7V$  $V_{OL}$  and  $V_{OH}$  are the typical output voltage drop that occur with the output load. $V_X = V_{OL} + 0.3V$  at  $V_{CC} \geq 2.7V$  $V_X = V_{OL} + 0.1V_{CC}$  at  $V_{CC} < 2.7V$  $V_Y = V_{OH} - 0.3V$  at  $V_{CC} \geq 2.7V$  $V_Y = V_{OH} - 0.1V_{CC}$  at  $V_{CC} < 2.7V$ Figure 1. Input  $A_n$ ,  $B_n$  to output  $B_n$ ,  $A_n$  propagation delays.Figure 2.  $A_n$ ,  $B_n$  to  $CP_{AB}$ ,  $CP_{BA}$  set-up and hold times, clock  $CP_{AB}$ ,  $CP_{BA}$  pulse width, maximum clock pulse frequency and the  $CP_{AB}$ ,  $CP_{BA}$  to output  $B_n$ ,  $A_n$  propagation delays.Figure 3. Input  $S_{AB}$ ,  $S_{BA}$  to output  $B_n$ ,  $A_n$  propagation delay times.Figure 4. Input  $OE$  to output  $A_n$ ,  $B_n$  3-State enable and disable times.

## Octal bus transceiver/register (3-State)

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## AC WAVEFORMS (Continued)

 $V_M = 1.5V$  at  $V_{CC} \geq 2.7V$  $V_M = 0.5V * V_{CC}$  at  $V_{CC} < 2.7V$  $V_{OL}$  and  $V_{OH}$  are the typical output voltage drop that occur with the output load. $V_X = V_{OL} + 0.3V$  at  $V_{CC} \geq 2.7V$  $V_X = V_{OL} + 0.1V_{CC}$  at  $V_{CC} < 2.7V$  $V_Y = V_{OH} - 0.3V$  at  $V_{CC} \geq 2.7V$  $V_Y = V_{OH} - 0.1V_{CC}$  at  $V_{CC} < 2.7V$ Figure 5. Input DIR to output  $A_n$ ,  $B_n$  3-State enable and disable times.

## TEST CIRCUIT

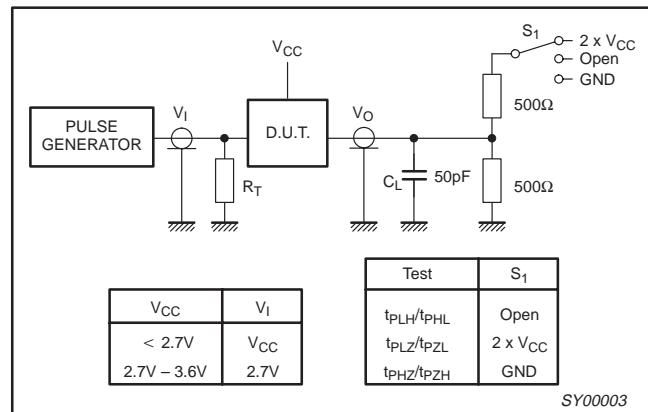


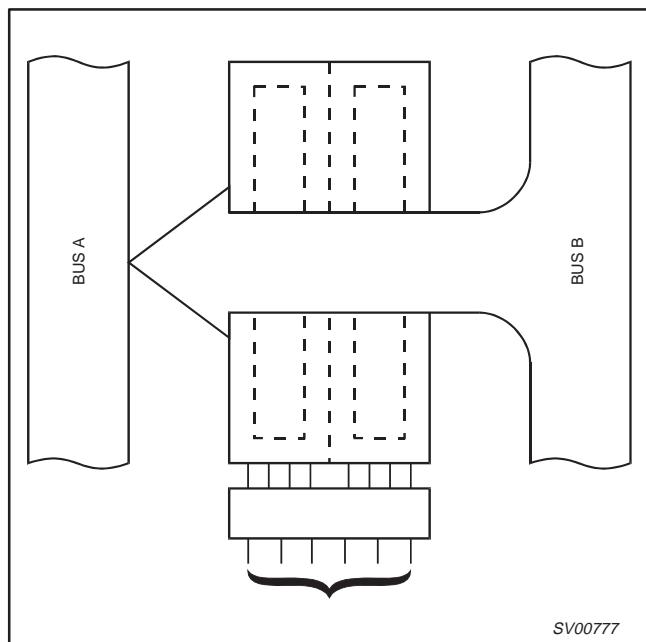
Figure 6. Load circuitry for switching times.

## Octal bus transceiver/register (3-State)

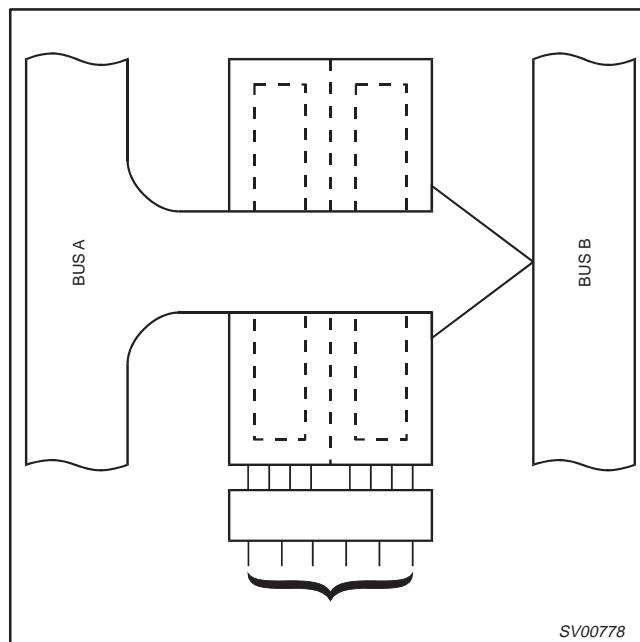
74LVC646A

## APPLICATION INFORMATION

Real-time transfer; bus B to bus A



Real-time transfer; bus A to bus B

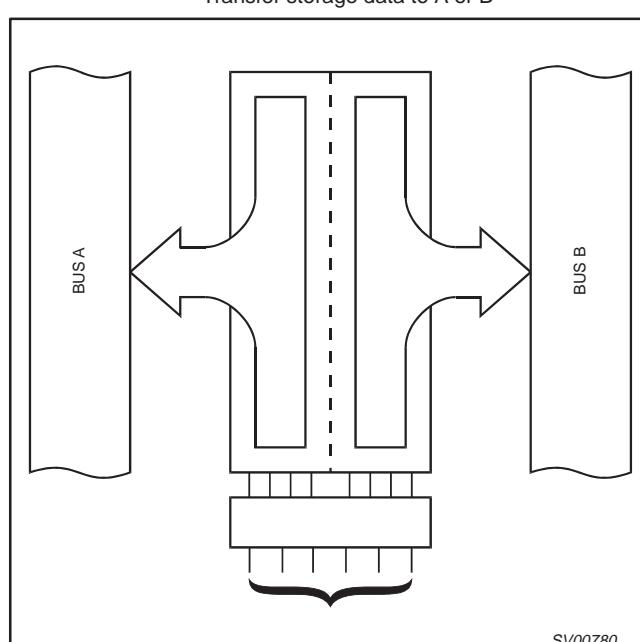
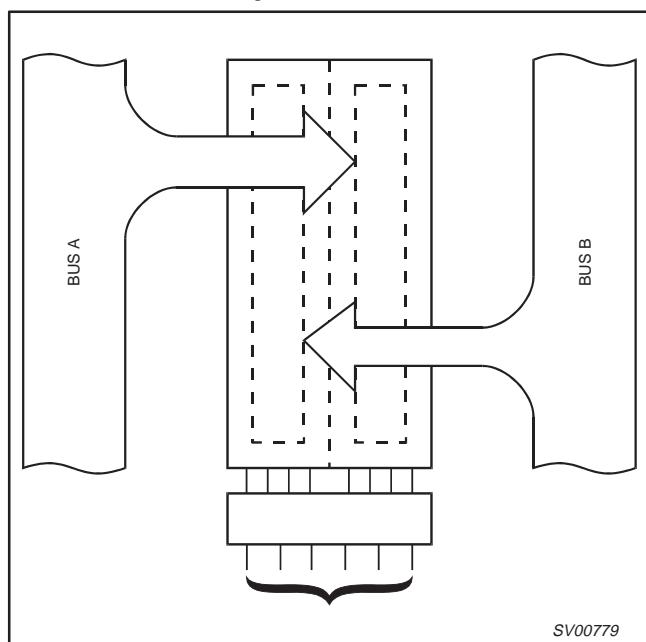


(1)	(14)	(28)	(16)	(27)	(15)
OE	DIR	CP <sub>AB</sub>	CP <sub>BA</sub>	S <sub>AB</sub>	S <sub>BA</sub>
L	L	X	X	X	L

Storage from A, B or A and B

(1)	(14)	(28)	(16)	(27)	(15)
OE	DIR	CP <sub>AB</sub>	CP <sub>BA</sub>	S <sub>AB</sub>	S <sub>BA</sub>
L	H	X	X	L	X

Transfer storage data to A or B



(1)	(14)	(28)	(16)	(27)	(15)
OE	DIR	CP <sub>AB</sub>	CP <sub>BA</sub>	S <sub>AB</sub>	S <sub>BA</sub>
X	X	↑	X	X	X
X	X	X	↑	X	L
H	X	↑	↑	X	X

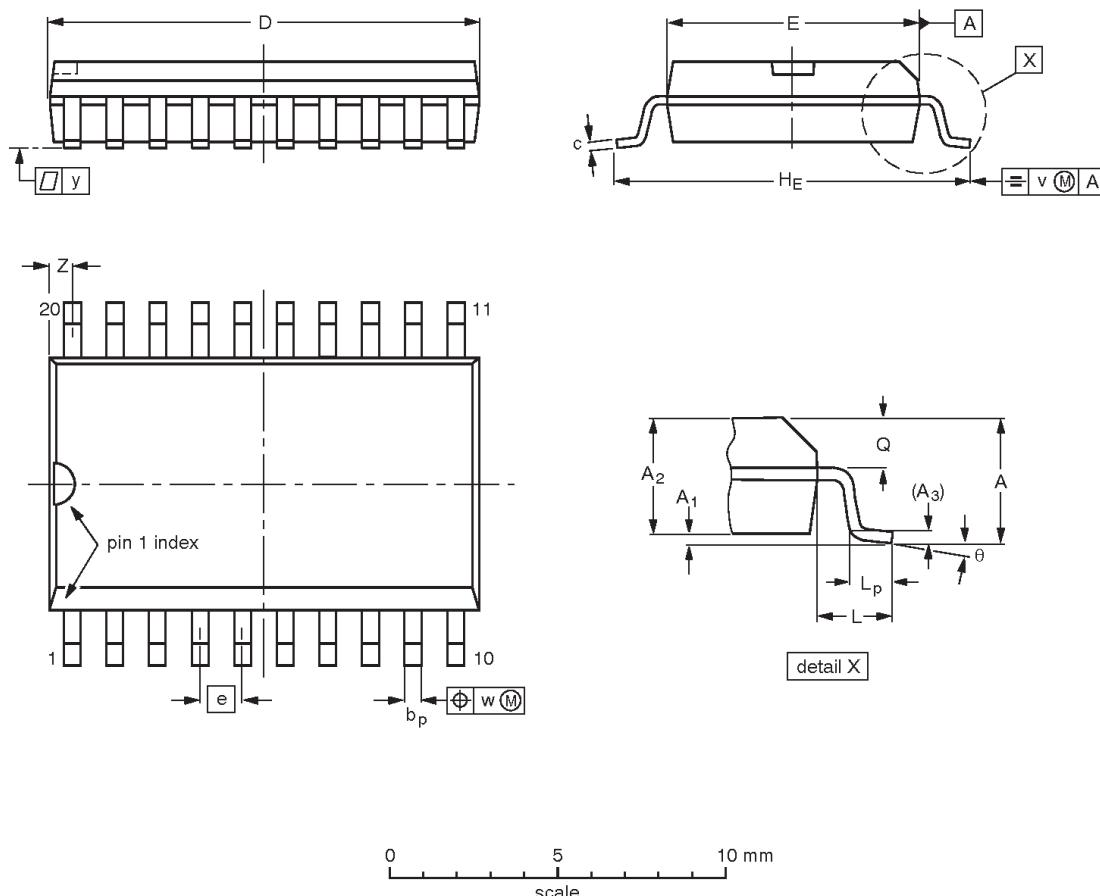
(1)	(14)	(28)	(16)	(27)	(15)
OE	DIR	CP <sub>AB</sub>	CP <sub>BA</sub>	S <sub>AB</sub>	S <sub>BA</sub>
L	L	X	H or L	X	H
L	H	H or L	X	H	X

## Octal bus transceiver/register (3-State)

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SO20: plastic small outline package; 20 leads; body width 7.5 mm

SOT163-1



## DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	Z <sup>(1)</sup>	θ
mm	2.65 0.10	0.30 2.25	2.45	0.25	0.49 0.36	0.32 0.23	13.0 12.6	7.6 7.4	1.27	10.65 10.00	1.4	1.1 0.4	1.1 1.0	0.25	0.25	0.1	0.9 0.4	8° 0°
inches	0.10 0.004	0.012 0.089	0.096	0.01	0.019 0.014	0.013 0.009	0.51 0.49	0.30 0.29	0.050	0.42 0.39	0.055	0.043 0.016	0.043 0.039	0.01	0.01	0.004	0.035 0.016	0° 0°

## Note

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

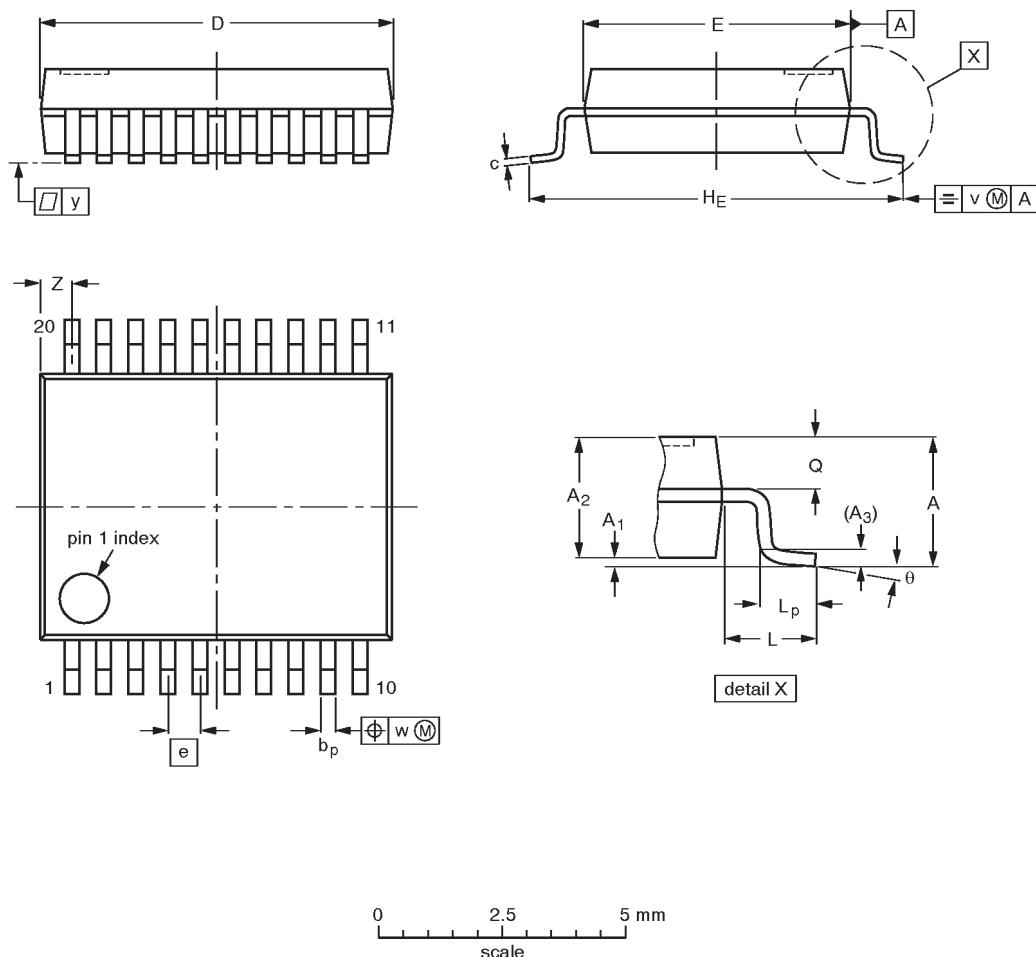
OUTLINE VERSION	REFERENCES			EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ		
SOT163-1	075E04	MS-013AC			92-11-17 95-01-24

## Octal bus transceiver/register (3-State)

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SSOP20: plastic shrink small outline package; 20 leads; body width 5.3 mm

SOT339-1



## DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	Z <sup>(1)</sup>	$\theta$
mm	2.0 0.05	0.21 1.65	1.80	0.25	0.38 0.25	0.20 0.09	7.4 7.0	5.4 5.2	0.65	7.9 7.6	1.25	1.03 0.63	0.9 0.7	0.2	0.13	0.1	0.9 0.5	8° 0°

## Note

1. Plastic or metal protrusions of 0.20 mm maximum per side are not included.

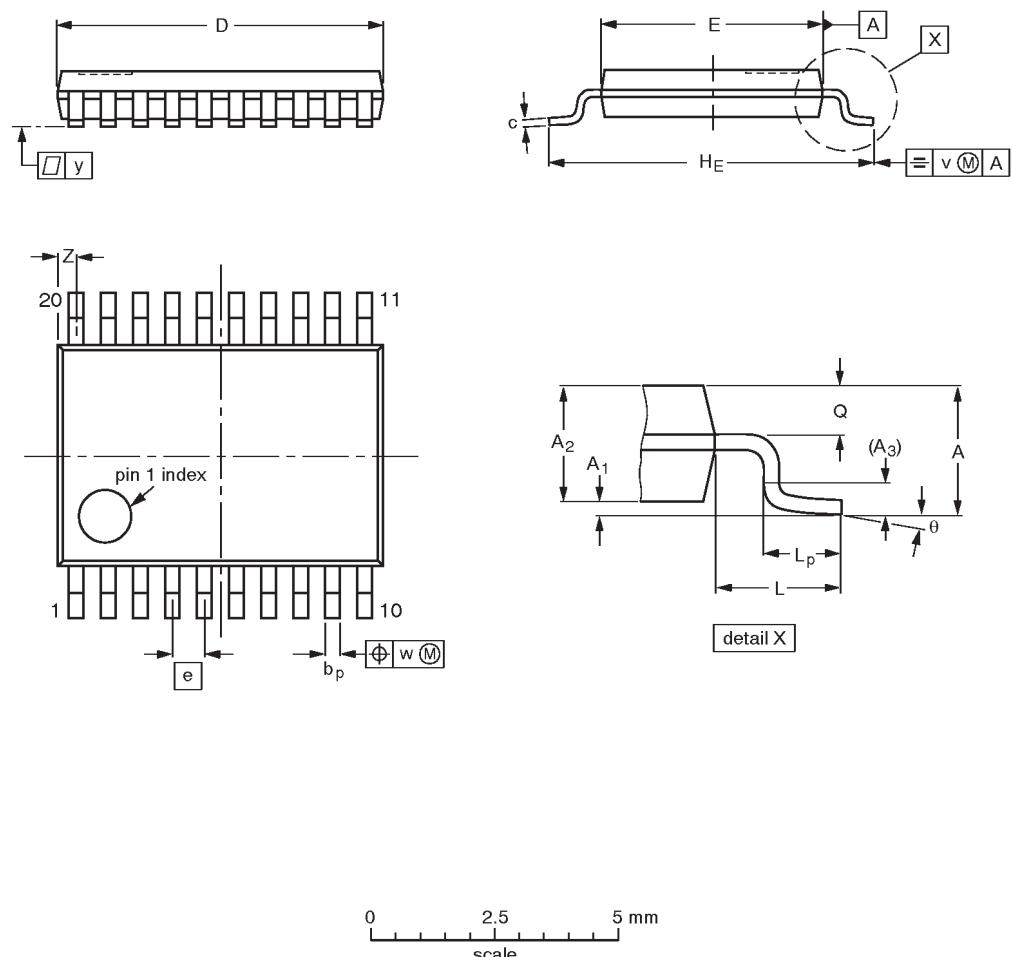
OUTLINE VERSION	REFERENCES			EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ		
SOT339-1		MO-150AE			93-09-08 95-02-04

## Octal bus transceiver/register (3-State)

74LVC646A

TSSOP20: plastic thin shrink small outline package; 20 leads; body width 4.4 mm

SOT360-1



## DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(2)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	z <sup>(1)</sup>	θ
mm	1.10 0.05	0.15 0.080	0.95 0.80	0.25	0.30 0.19	0.2 0.1	6.6 6.4	4.5 4.3	0.65	6.6 6.2	1.0	0.75 0.50	0.4 0.3	0.2	0.13	0.1	0.5 0.2	8° 0°

## Notes

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic interlead protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT360-1		MO-153AC				-93-06-16 95-02-04

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Octal bus transceiver/register (3-State)

74LVC646A

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**NOTES**

## Octal bus transceiver/register (3-State)

74LVC646A

**Data sheet status**

Data sheet status	Product status	Definition [1]
Objective specification	Development	This data sheet contains the design target or goal specifications for product development. Specification may change in any manner without notice.
Preliminary specification	Qualification	This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
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[1] Please consult the most recently issued datasheet before initiating or completing a design.

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print code

Document order number:

Date of release: 08-98

9397-750-04516

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