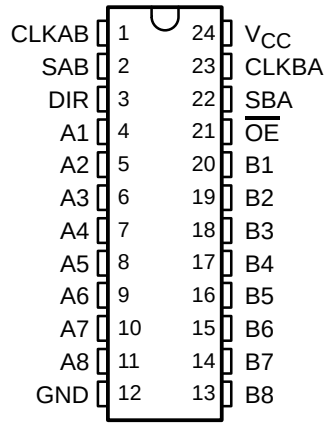
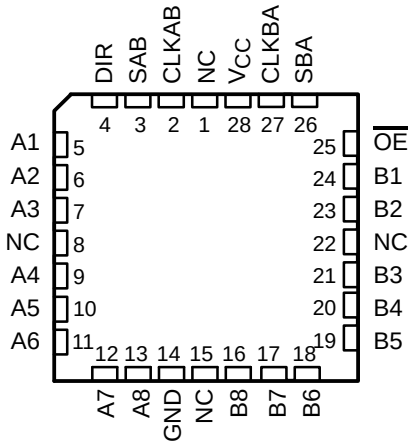
- **Operating Voltage Range of 4.5 V to 5.5 V**
- **Low Power Consumption, 80-μA Max I_{CC}**
- **Typical t_{pd} = 12 ns**
- **±6-mA Output Drive at 5 V**
- **Low Input Current of 1 μA Max**
- **Inputs Are TTL-Voltage Compatible**
- **Independent Registers for A and B Buses**
- **Multiplexed Real-Time and Stored Data**
- **True Data Paths**
- **High-Current 3-State Outputs Can Drive Up To 15 LSTTL Loads**

SN54HCT646 . . . JT OR W PACKAGE
SN74HCT646 . . . DW OR NT PACKAGE
(TOP VIEW)



SN54HCT646 . . . FK PACKAGE
(TOP VIEW)



NC – No internal connection

description/ordering information

The ’HCT646 devices consist of bus-transceiver circuits with 3-state 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 is clocked into the registers on the low-to-high transition of the appropriate clock (CLKAB or CLKBA) input. Figure 1 illustrates the four fundamental bus-management functions that can be performed with the ’HCT646 devices.

Output-enable ($\overline{OE}$) and direction-control (DIR) inputs control the transceiver functions. In the transceiver mode, data present at the high-impedance port can be stored in either or both registers.

ORDERING INFORMATION

T_A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	PDIP – NT	Tube	SN74HCT646NT	SN74HCT646NT
	SOIC – DW	Tube	SN74HCT646DW	HCT646
		Tape and reel	SN74HCT646DWR	
–55°C to 125°C	CDIP – JT	Tube	SNJ54HCT646JT	SNJ54HCT646JT
	CFP – W	Tube	SNJ54HCT646W	SNJ54HCT646W
	LCCC – FK	Tube	SNJ54HCT646FK	SNJ54HCT646FK

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

description/ordering information (continued)

The select-control (SAB and SBA) inputs can multiplex stored and real-time (transparent mode) data. DIR determines which bus receives data when $\overline{OE}$ is active (low). In the isolation mode ($\overline{OE}$ high), A data can be stored in one register and/or B data can be stored in the other register.

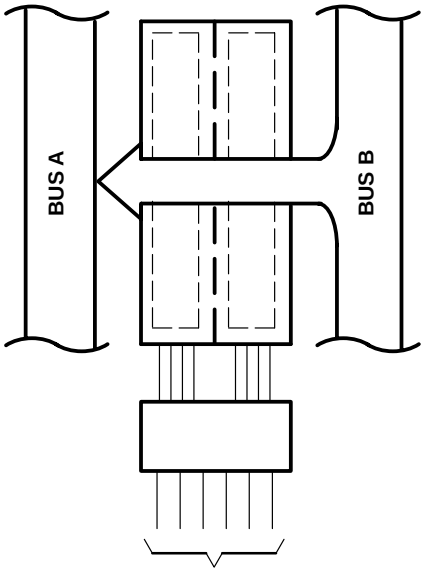
When an output function is disabled, the input function still is enabled and can be used to store data. Only one of the two buses, A or B, can be driven at a time.

To ensure the high-impedance state during power up or power down, $\overline{OE}$ should be tied to V_{CC} through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

FUNCTION TABLE

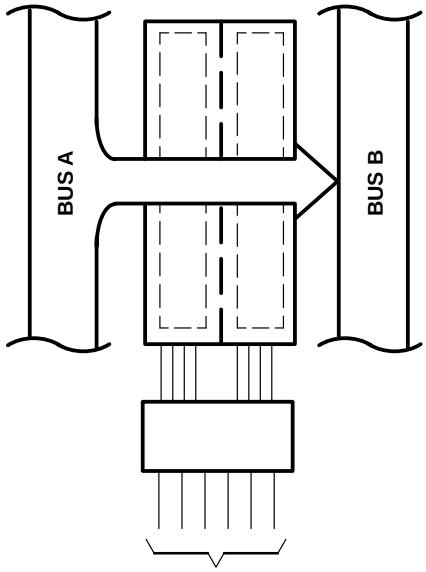
INPUTS						DATA I/O		OPERATION OR FUNCTION
$\overline{OE}$	DIR	CLKAB	CLKBA	SAB	SBA	A1–A8	B1–B8	
X	X	↑	X	X	X	Input	Unspecified†	Store A, B unspecified†
X	X	X	↑	X	X	Unspecified†	Input	Store B, A unspecified†
H	X	↑	↑	X	X	Input	Input	Store A and B data
H	X	H or L	H or L	X	X	Input disabled	Input disabled	Isolation, hold storage
L	L	X	X	X	L	Output	Input	Real-time B data to A bus
L	L	X	H or L	X	H	Output	Input	Stored B data to A bus
L	H	X	X	L	X	Input	Output	Real-time A data to B bus
L	H	H or L	X	H	X	Input	Output	Stored A data to B bus

† The data-output functions can be enabled or disabled by various signals at $\overline{OE}$ and DIR. Data-input functions always are enabled; i.e., data at the bus terminals is stored on every low-to-high transition of the clock inputs.



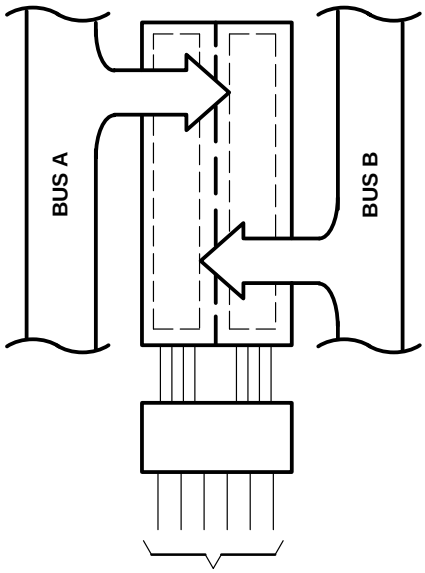
21 $\overline{OE}$	3 DIR	1 CLKAB	23 CLKBA	2 SAB	22 SBA
L	L	X	X	X	L

REAL-TIME TRANSFER
BUS B TO BUS A



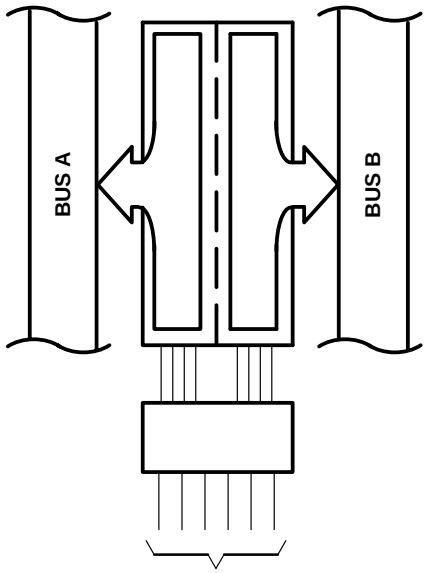
21 $\overline{OE}$	3 DIR	1 CLKAB	23 CLKBA	2 SAB	22 SBA
L	H	X	X	L	X

REAL-TIME TRANSFER
BUS A TO BUS B



21 $\overline{OE}$	3 DIR	1 CLKAB	23 CLKBA	2 SAB	22 SBA
X	X	↑	X	X	X
X	X	X	↑	X	X
H	X	↑	↑	X	X

STORAGE FROM
A, B, OR A AND B



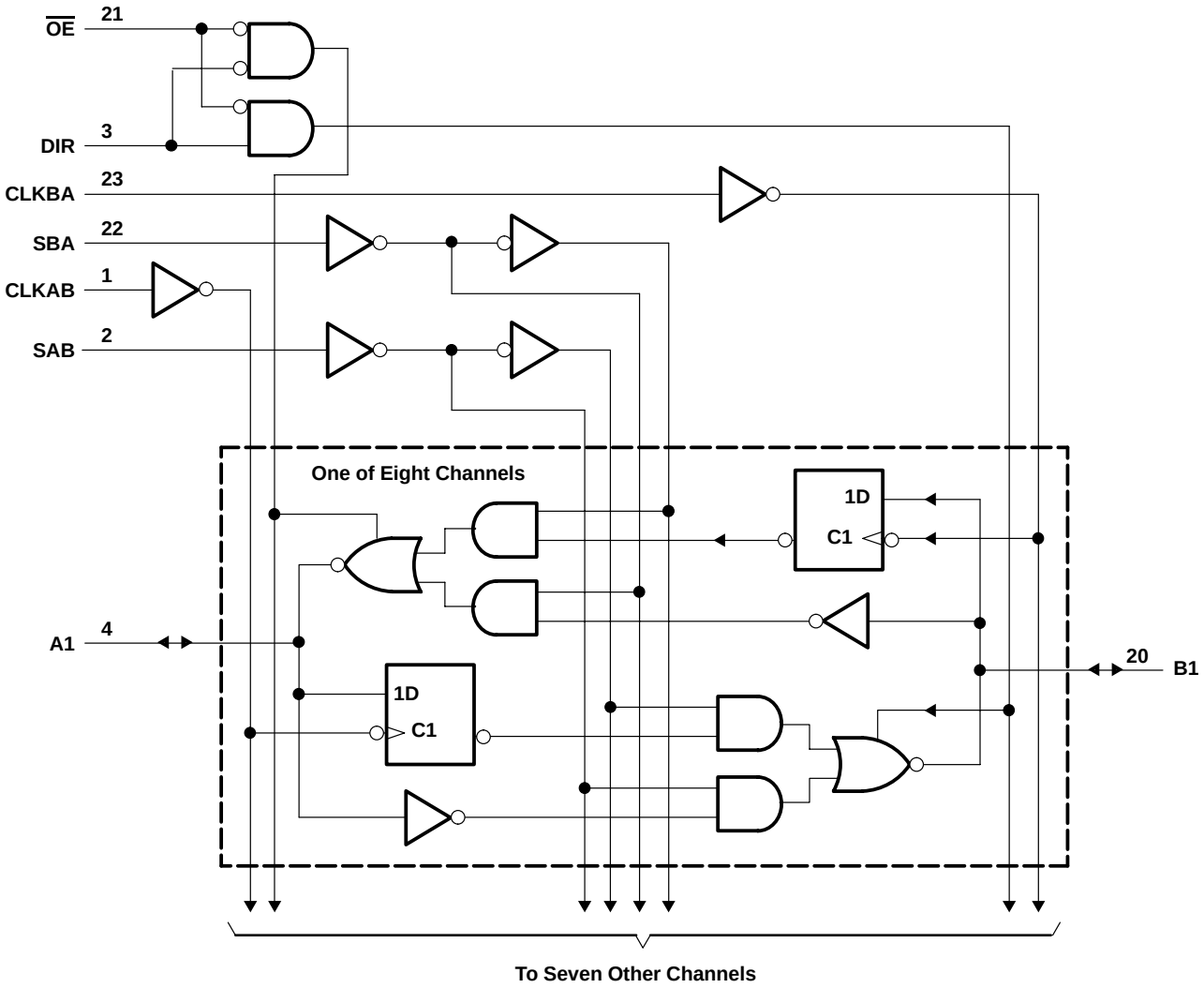
21 $\overline{OE}$	3 DIR	1 CLKAB	23 CLKBA	2 SAB	22 SBA
L	L	X	H or L	X	H
L	H	H or L	X	H	X

TRANSFER STORED DATA
TO A AND/OR B

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

Figure 1. Bus-Management Functions

logic diagram (positive logic)



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

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

Supply voltage range, V_{CC} . . . . . –0.5 V to 7 V
Input clamp current, I_{IK} ($V_I < 0$ or $V_I > V_{CC}$) (see Note 1) . . . . . ±20 mA
Output clamp current, I_{OK} ($V_O < 0$ or $V_O > V_{CC}$) (see Note 1) . . . . . ±20 mA
Continuous output current, I_O ($V_O = 0$ to V_{CC}) . . . . . ±35 mA
Continuous current through V_{CC} or GND . . . . . ±70 mA
Package thermal impedance, θ_{JA} (see Note 2): DW package . . . . . 46°C/W
(see Note 3): NT 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.

NOTES: 1. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.
2. The package thermal impedance is calculated in accordance with JESD 51-7.
3. The package thermal impedance is calculated in accordance with JESD 51-3.

recommended operating conditions (see Note 4)

			SN54HCT646			SN74HCT646			UNIT
			MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage		4.5	5	5.5	4.5	5	5.5	V
V_{IH}	High-level input voltage	V_{CC} = 4.5 V to 5.5 V	2			2			V
V_{IL}	Low-level input voltage	V_{CC} = 4.5 V to 5.5 V			0.8			0.8	V
V_I	Input voltage		0		V_{CC}	0		V_{CC}	V
V_O	Output voltage		0		V_{CC}	0		V_{CC}	V
t_t	Input transition (rise and fall) time				500			500	ns
T_A	Operating free-air temperature		–55		125	–40		85	°C

NOTE 4: All unused inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

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

PARAMETER		TEST CONDITIONS		V_{CC}	T_A = 25°C			SN54HCT646		SN74HCT646		UNIT
					MIN	TYP	MAX	MIN	MAX	MIN	MAX	
V_{OH}		V_I = V_{IH} or V_{IL}	I_{OH} = –20 μA	4.5 V	4.4	4.499		4.4		4.4		V
			I_{OH} = –6 mA		3.98	4.3		3.7		3.84		
V_{OL}		V_I = V_{IH} or V_{IL}	I_{OL} = 20 μA	4.5 V		0.001	0.1		0.1		0.1	V
			I_{OL} = 6 mA			0.17	0.26		0.4		0.33	
I_I	Control inputs	V_I = V_{CC} or 0		5.5 V			±0.1	±100		±1000		±1000	nA
I_{OZ}	A or B	V_O = V_{CC} or 0		5.5 V			±0.01	±0.5		±10		±5	μA
I_{CC}		V_I = V_{CC} or 0, I_O = 0		5.5 V			8		160		80	μA
ΔI_{CC}†		One input at 0.5 V or 2.4 V, Other inputs at 0 or V_{CC}		5.5 V		1.4	2.4		3		2.9	mA
C_i	Control inputs			4.5 V to 5.5 V		3	10		10		10	pF

† This is the increase in supply current for each input that is at one of the specified TTL voltage levels, rather than 0 V or V_{CC}.

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

		V_{CC}	T_A = 25°C		SN54HCT646		SN74HCT646		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
f_{clock}	Clock frequency	4.5 V		31		22		27	MHz
		5.5 V		36		24		29	
t_w	Pulse duration, CLKBA or CLKAB high or low	4.5 V	16		23		19		ns
		5.5 V	14		21		17		
t_{su}	Setup time, A before CLKAB↑ or B before CLKBA↑	4.5 V	20		30		25		ns
		5.5 V	18		27		23		
t_h	Hold time, A after CLKAB↑ or B after CLKBA↑	4.5 V	5		5		5		ns
		5.5 V	5		5		5		

switching characteristics over recommended operating free-air temperature range, C_L = 50 pF (unless otherwise noted) (see Figure 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC}	T_A = 25°C			SN54HCT646		SN74HCT646		UNIT
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
f_{max}			4.5 V	31	54		22		27		MHz
			5.5 V	36	64		24		29		
t_{pd}	CLKBA or CLKAB	A or B	4.5 V		18	36		54		45	ns
			5.5 V		16	32		49		41	
	A or B	B or A	4.5 V		14	27		41		34	
			5.5 V		12	24		37		31	
	SBA or SAB†	A or B	4.5 V		20	38		57		48	
			5.5 V		17	34		51		43	
t_{en}	$\overline{OE}$	A or B	4.5 V		25	49		74		61	ns
			5.5 V		22	44		67		55	
t_{dis}	$\overline{OE}$	A or B	4.5 V		25	49		74		61	ns
			5.5 V		22	44		67		55	
t_{en}	DIR	A or B	4.5 V		25	49		74		61	ns
			5.5 V		22	44		67		55	
t_{dis}	DIR	A or B	4.5 V		25	49		74		61	ns
			5.5 V		22	44		67		55	
t_t		Any	4.5 V		9	12		18		15	ns
			5.5 V		7	11		16		14	

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

switching characteristics over recommended operating free-air temperature range, C_L = 150 pF (unless otherwise noted) (see Figure 2)

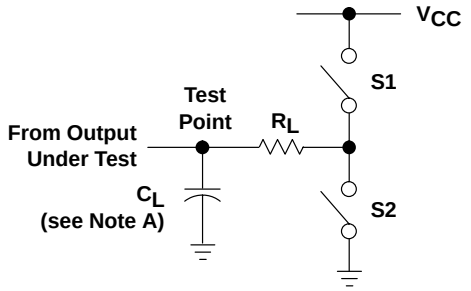
PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC}	T_A = 25°C			SN54HCT646		SN74HCT646		UNIT
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
t_{pd}	CLKBA or CLKAB	A or B	4.5 V		24	53		80		66	ns
			5.5 V		22	47		52		60	
	A or B	B or A	4.5 V		22	44		67		55	
			5.5 V		20	39		60		50	
	SBA or SAB†	A or B	4.5 V		26	55		83		69	
			5.5 V		24	49		74		62	
t_{en}	$\overline{OE}$	A or B	4.5 V		33	66		100		87	ns
			5.5 V		22	59		90		74	
	DIR	A or B	4.5 V		33	66		100		87	
			5.5 V		22	59		90		74	
t_t		Any	4.5 V		17	42		63		53	ns
			5.5 V		14	38		57		48	

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

operating characteristics, T_A = 25°C

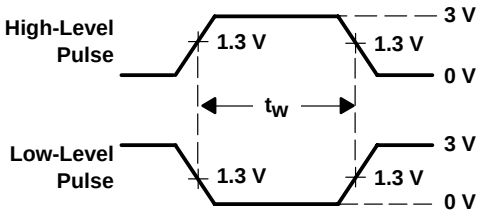
PARAMETER		TEST CONDITIONS	TYP	UNIT
C_{pd}	Power dissipation capacitance	No load	50	pF

PARAMETER MEASUREMENT INFORMATION

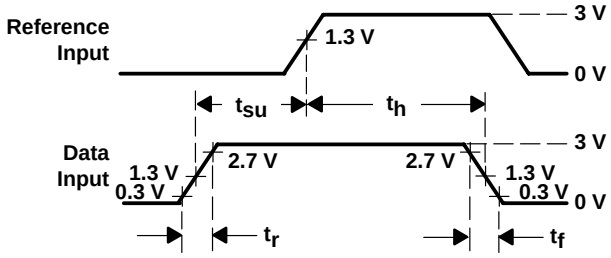


LOAD CIRCUIT

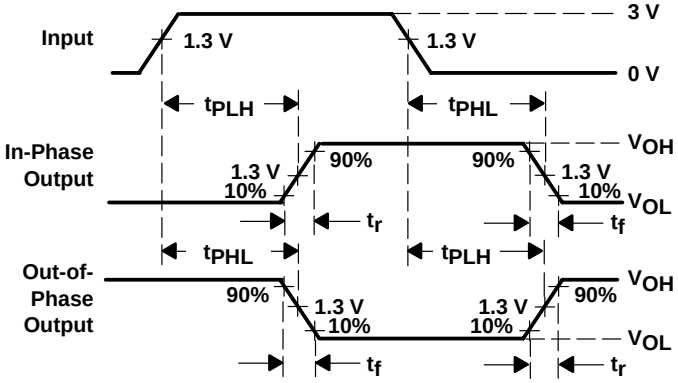
PARAMETER		R_L	C_L	S1	S2
t_{en}	t_{PZH}	1 kΩ	50 pF or 150 pF	Open	Closed
	t_{PZL}			Closed	Open
t_{dis}	t_{PHZ}	1 kΩ	50 pF	Open	Closed
	t_{PLZ}			Closed	Open
t_{pd} or t_t		––	50 pF or 150 pF	Open	Open



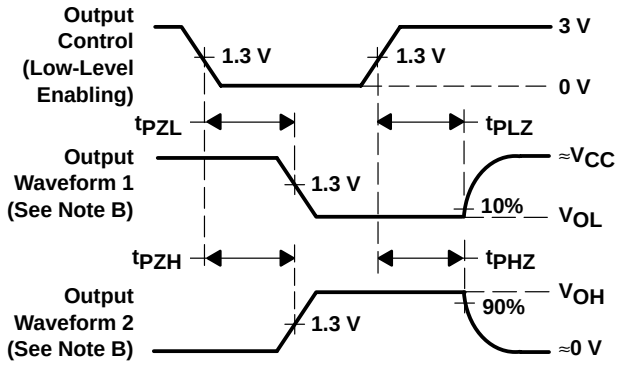
VOLTAGE WAVEFORMS
PULSE DURATIONS



VOLTAGE WAVEFORMS
SETUP AND HOLD AND INPUT RISE AND FALL TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY AND OUTPUT RISE AND FALL TIMES



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES FOR 3-STATE OUTPUTS

NOTES: A. C_L includes probe and test-fixture capacitance.
B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
C. Phase relationships between waveforms were chosen arbitrarily. All input pulses are supplied by generators having the following characteristics: PRR ≤ 1 MHz, Z_O = 50 Ω, t_r = 6 ns, t_f = 6 ns.
D. For clock inputs, f_{max} is measured when the input duty cycle is 50%.
E. The outputs are measured one at a time with one input transition per measurement.
F. t_{PLZ} and t_{PHZ} are the same as t_{dis}.
G. t_{PZL} and t_{PZH} are the same as t_{en}.
H. t_{PLH} and t_{PHL} are the same as t_{pd}.

Figure 2. Load Circuit and Voltage Waveforms

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
SN74HCT646DW	ACTIVE	SOIC	DW	24	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	HCT646	Samples
SN74HCT646DWG4	ACTIVE	SOIC	DW	24	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	HCT646	Samples

(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), 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.
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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)

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

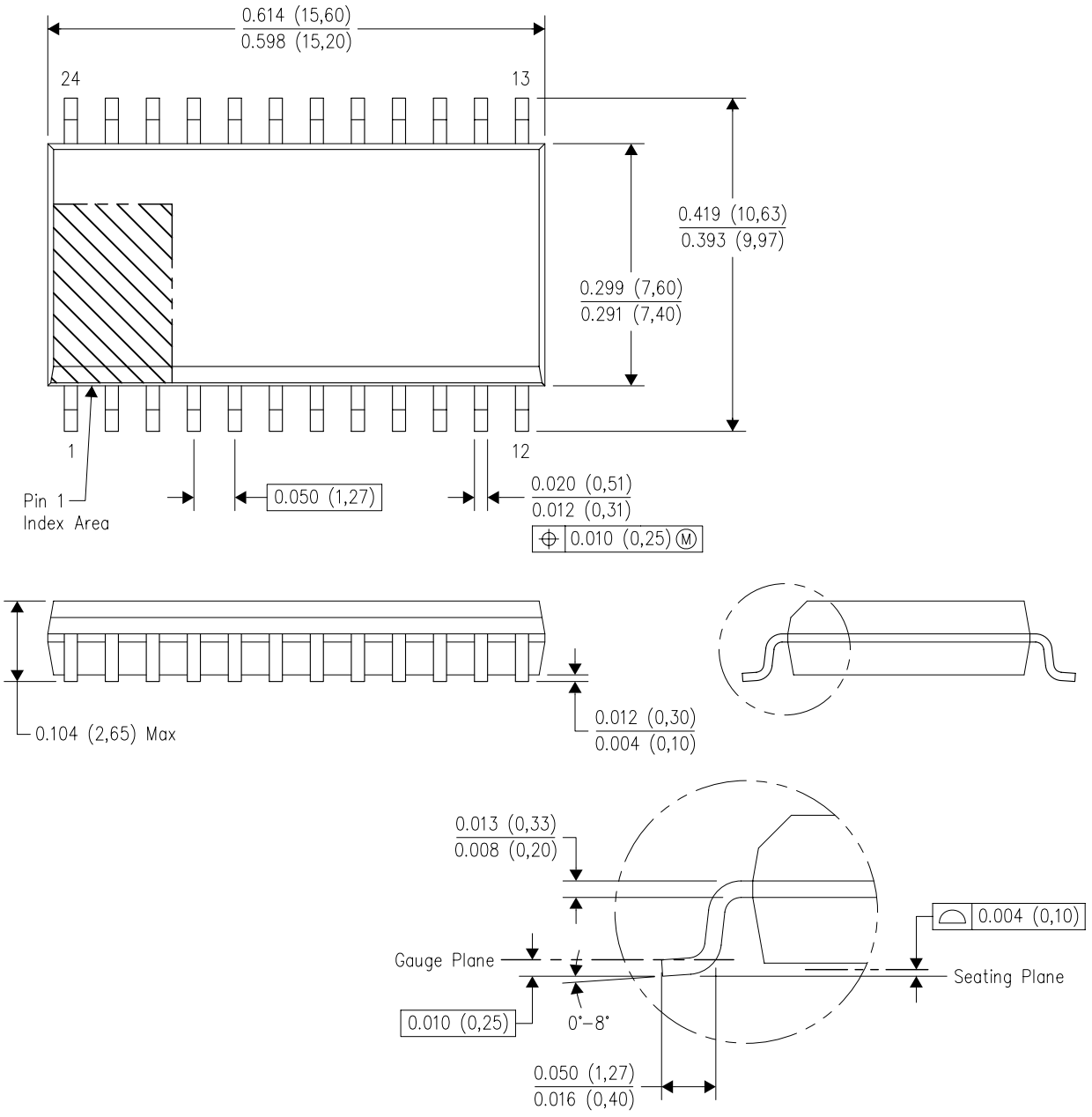
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

DW (R–PDSO–G24) PLASTIC SMALL OUTLINE



NOTES:
A. All linear dimensions are in inches (millimeters). Dimensioning and tolerancing per ASME Y14.5M–1994.
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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