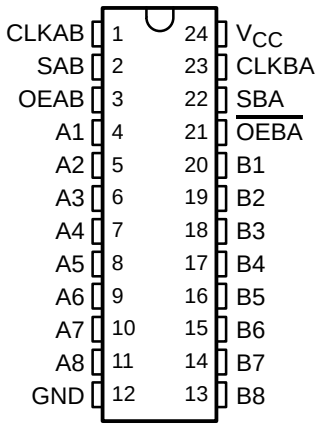
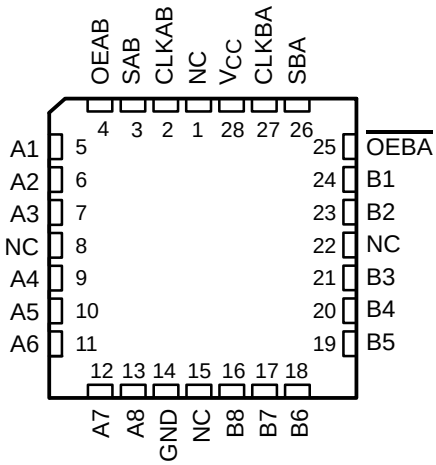
- **Wide Operating Voltage Range of 2 V to 6 V**
- **High-Current 3-State Outputs Can Drive Up To 15 LSTTL Loads**
- **Low Power Consumption, 80-μA Max I_{CC}**
- **Typical t_{pd} = 11 ns**
- **±6-mA Output Drive at 5 V**
- **Low Input Current of 1 μA Max**
- **Independent Registers and Enables for A and B Buses**
- **Multiplexed Real-Time and Stored Data**
- **True Data Paths**

SN54HC652 . . . JT OR W PACKAGE
SN74HC652 . . . DW OR NT PACKAGE
(TOP VIEW)



SN54HC652 . . . FK PACKAGE
(TOP VIEW)



NC – No internal connection

description/ordering information

The ’HC652 devices consist of bus-transceiver circuits, D-type flip-flops, and control circuitry arranged for multiplexed transmission of data directly from the data bus or from the internal storage registers. Output-enable (OEAB and $\overline{\text{OEBA}}$) inputs are provided to control the transceiver functions. Select-control (SAB and SBA) inputs are provided to select real-time or stored-data transfer. A low input level selects real-time data, and a high input level selects stored data. Figure 1 illustrates the four fundamental bus-management functions that can be performed with these devices.

ORDERING INFORMATION

T_A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	PDIP – NT	Tube	SN74HC652NT	SN74HC652NT
	SOIC – DW	Tube	SN74HC652DW	HC652
		Tape and reel	SN74HC652DWR	
–55°C to 125°C	CDIP – JT	Tube	SNJ54HC652JT	SNJ54HC652JT
	CFP – W	Tube	SNJ54HC652W	SNJ54HC652W
	LCCC – FK	Tube	SNJ54HC652FK	SNJ54HC652FK

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

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.

description/ordering information (continued)

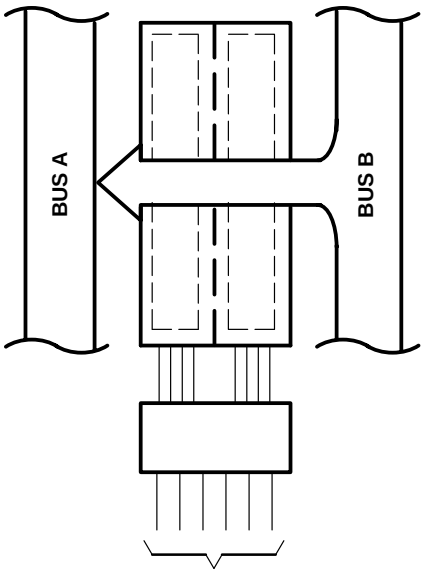
Data on the A or B data bus, or both, can be stored in the internal D-type flip-flops by low-to-high transitions at the appropriate clock (CLKAB or CLKBA) terminals, regardless of the select- or output-control terminals. When SAB and SBA are in the real-time transfer mode, it is possible to store data without using the internal D-type flip-flops by simultaneously enabling OEAB and $\overline{\text{OEBA}}$. In this configuration, each output reinforces its input. When all other data sources to the two sets of bus lines are at high impedance, each set of bus lines remains at its last state.

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

FUNCTION TABLE

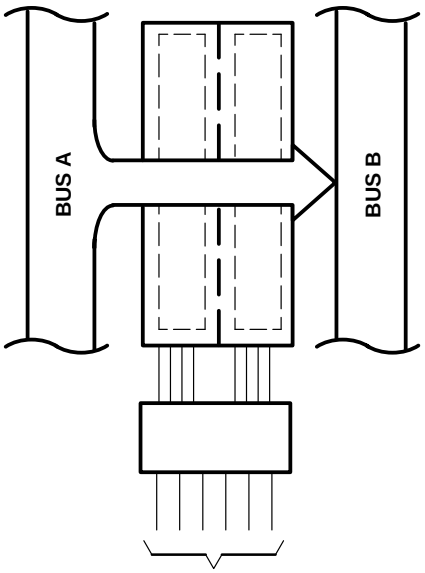
INPUTS						DATA I/O†		OPERATION OR FUNCTION
OEAB	$\overline{\text{OEBA}}$	CLKAB	CLKBA	SAB	SBA	A1–A8	B1–B8	
L	H	H or L	H or L	X	X	Input	Input	Isolation
L	H	↑	↑	X	X	Input	Input	Store A and B data
X	H	↑	H or L	X	X	Input	Unspecified‡	Store A, hold B
H	H	↑	↑	X‡	X	Input	Output	Store A in both registers
L	X	H or L	↑	X	X	Unspecified‡	Input	Hold A, store B
L	L	↑	↑	X	X‡	Output	Input	Store B in both registers
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
H	H	X	X	L	X	Input	Output	Real-time A data to B bus
H	H	H or L	X	H	X	Input	Output	Stored A data to B bus
H	L	H or L	H or L	H	H	Output	Output	Stored A data to B bus and stored B data to A bus

† The data-output functions are enabled or disabled by a variety of level combinations at OEAB or $\overline{\text{OEBA}}$. Data-input functions always are enabled; i.e., data at the bus terminals is stored on every low-to-high transition on the clock inputs.
‡ Select control = L: clocks can occur simultaneously.
Select control = H: clocks must be staggered to load both registers.



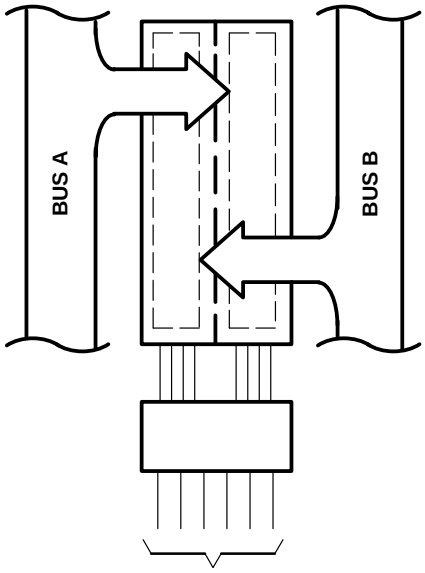
3	21	1	23	2	22
OEAB	$\overline{\text{OEBA}}$	CLKAB	CLKBA	SAB	SBA
L	L	X	X	X	L

REAL-TIME TRANSFER
BUS B TO BUS A



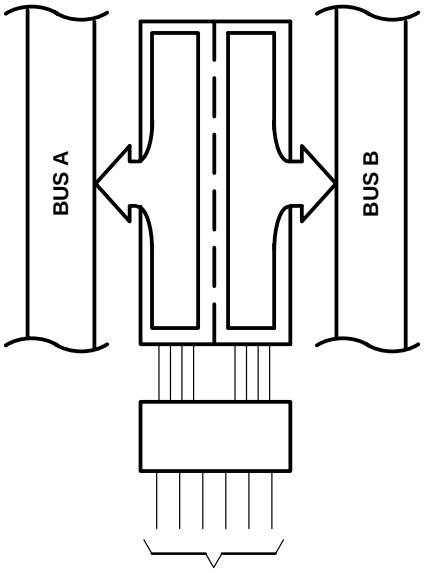
3	21	1	23	2	22
OEAB	$\overline{\text{OEBA}}$	CLKAB	CLKBA	SAB	SBA
H	H	X	X	L	X

REAL-TIME TRANSFER
BUS A TO BUS B



3	21	1	23	2	22
OEAB	$\overline{\text{OEBA}}$	CLKAB	CLKBA	SAB	SBA
X	H	↑	X	X	X
L	X	X	↑	X	X
L	H	↑	↑	X	X

STORAGE FROM
A, B, OR A AND B



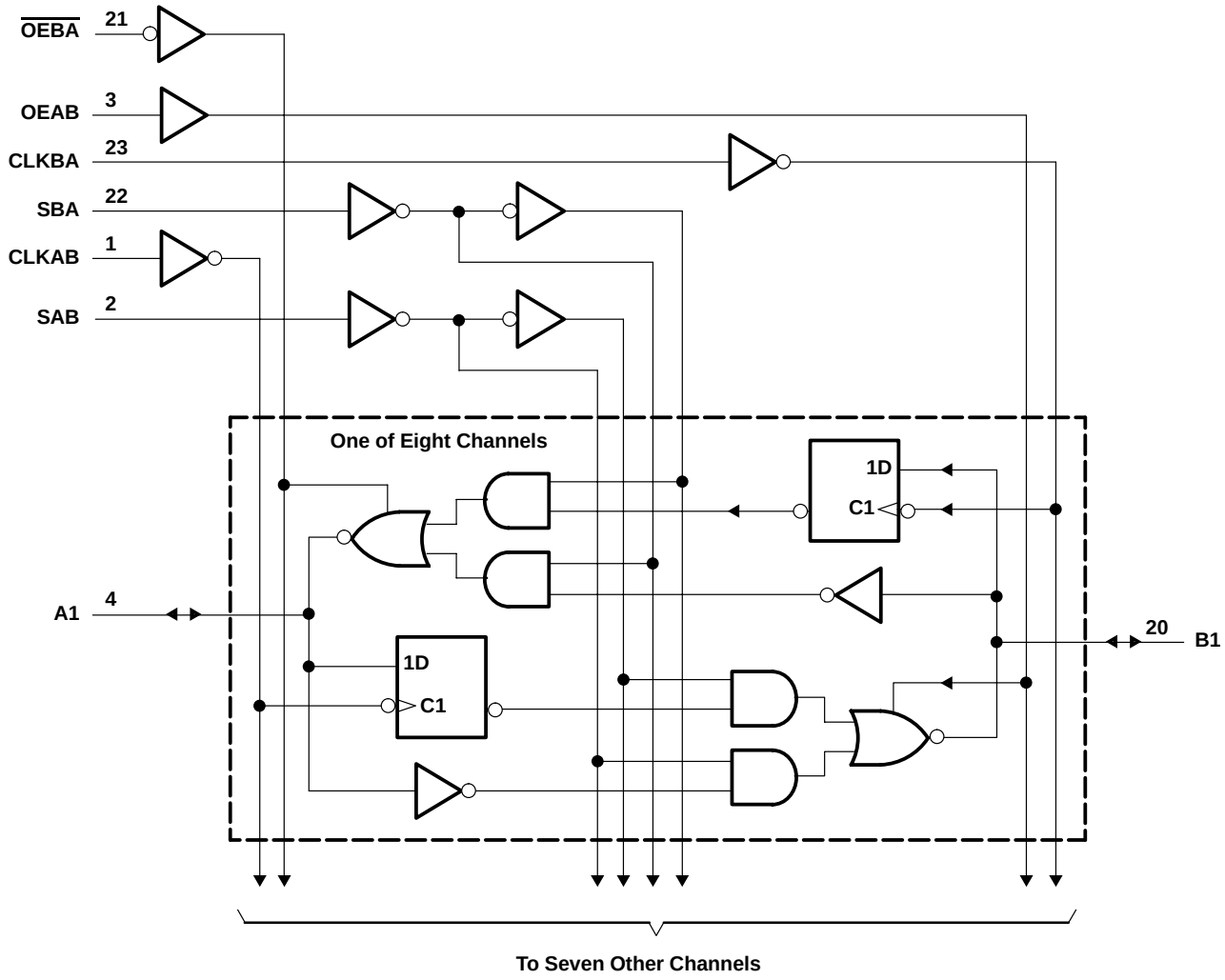
3	21	1	23	2	22
OEAB	$\overline{\text{OEBA}}$	CLKAB	CLKBA	SAB	SBA
H	L	H or L	H or L	H	H

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)

			SN54HC652			SN74HC652			UNIT
			MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage		2	5	6	2	5	6	V
V_{IH}	High-level input voltage	V_{CC} = 2 V	1.5			1.5			V
		V_{CC} = 4.5 V	3.15			3.15			
		V_{CC} = 6 V	4.2			4.2			
V_{IL}	Low-level input voltage	V_{CC} = 2 V			0.5			0.5	V
		V_{CC} = 4.5 V			1.35			1.35	
		V_{CC} = 6 V			1.8			1.8	
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	V_{CC} = 2 V			1000			1000	ns
		V_{CC} = 4.5 V			500			500	
		V_{CC} = 6 V			400			400	
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			SN54HC652		SN74HC652		UNIT
					MIN	TYP	MAX	MIN	MAX	MIN	MAX	
V_{OH}		V_I = V_{IH} or V_{IL}	I_{OH} = –20 μA	2 V	1.9	1.998		1.9		1.9		V
				4.5 V	4.4	4.499		4.4		4.4		
				6 V	5.9	5.999		5.9		5.9		
			I_{OH} = –6 mA	4.5 V	3.98	4.3		3.7		3.84		
			I_{OH} = –7.8 mA	6 V	5.48	5.8		5.2		5.34		
V_{OL}		V_I = V_{IH} or V_{IL}	I_{OL} = 20 μA	2 V		0.002	0.1		0.1		0.1	V
				4.5 V		0.001	0.1		0.1		0.1	
				6 V		0.001	0.1		0.1		0.1	
			I_{OL} = 6 mA	4.5 V		0.17	0.26		0.4		0.33	
			I_{OL} = 7.8 mA	6 V		0.15	0.26		0.4		0.33	
I_I	Control inputs	V_I = V_{CC} or 0		6 V			±0.1	±100		±1000		±1000	nA
I_{OZ}	A or B	V_O = V_{CC} or GND		6 V			±0.01	±0.5		±10		±5	μA
I_{CC}		V_I = V_{CC} or 0,	I_O = 0	6 V				8		160		80	μA
C_i	Control inputs			2 V to 6 V			3	10		10		10	pF

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

		V_{CC}	T_A = 25°C		SN54HC652		SN74HC652		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
f_{clock}	Clock frequency	2 V		6		4.3		5.5	MHz
		4.5 V		31		22		27	
		6 V		36		25		31	
t_w	Pulse duration, CLKBA or CLKAB high or low	2 V	80		115		95		ns
		4.5 V	16		23		19		
		6 V	14		20		16		
t_{su}	Setup time, A before CLKAB↑ or B before CLKBA↑	2 V	100		150		125		ns
		4.5 V	20		30		25		
		6 V	17		26		21		
t_h	Hold time, A after CLKAB↑ or B after CLKBA↑	2 V	5		5		5		ns
		4.5 V	5		5		5		
		6 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			SN54HC652		SN74HC652		UNIT
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
f_{max}			2 V	6	10		4.3		5.5		MHz
			4.5 V	31	40		22		27		
			6 V	36	45		25		31		
t_{pd}	CLKBA or CLKAB	A or B	2 V		65	180		270		225	ns
			4.5 V		18	36		54		45	
			6 V		14	31		46		38	
	A or B	B or A	2 V		50	135		205		170	
			4.5 V		14	27		41		34	
			6 V		11	23		35		29	
	SBA or SAB†	A or B	2 V		70	190		285		240	
			4.5 V		20	38		57		48	
			6 V		16	32		48		41	
t_{en}	$\overline{OEBA}$ or OEAB	A or B	2 V		85	245		370		305	ns
			4.5 V		25	49		74		61	
			6 V		20	42		63		52	
t_{dis}	$\overline{OEBA}$ or OEAB	A or B	2 V		50	245		370		305	ns
			4.5 V		23	49		74		61	
			6 V		20	42		63		52	
t_t		Any	2 V		28	60		90		75	ns
			4.5 V		8	12		18		15	
			6 V		6	10		15		13	

† 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)

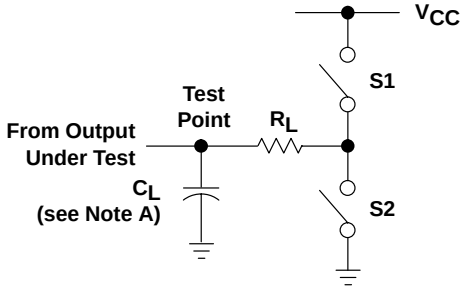
PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC}	T_A = 25°C			SN54HC652		SN74HC652		UNIT
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
t_{pd}	CLKBA or CLKAB	A or B	2 V		90	265		400		330	ns
			4.5 V		24	53		80		66	
			6 V		18	46		68		57	
	A or B	B or A	2 V		70	220		335		275	
			4.5 V		20	44		70		55	
			6 V		15	38		57		48	
	SBA or SAB†	A or B	2 V		80	275		415		345	
			4.5 V		24	55		83		69	
			6 V		20	47		70		60	
t_{en}	$\overline{OEBA}$ or OEAB	A or B	2 V		100	330		500		410	ns
			4.5 V		33	66		100		82	
			6 V		27	57		85		71	
t_t		Any	2 V		45	210		315		265	ns
			4.5 V		17	42		63		53	
			6 V		13	36		53		43	

† 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

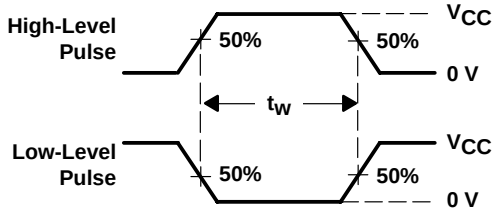
PARAMETER		TEST CONDITIONS	TYP	UNIT
C_{pd}	Power dissipation capacitance	No load	50	pF

PARAMETER MEASUREMENT INFORMATION

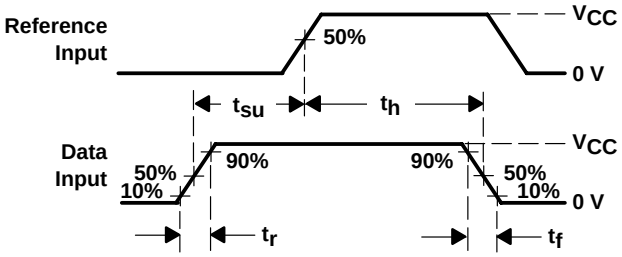


LOAD CIRCUIT

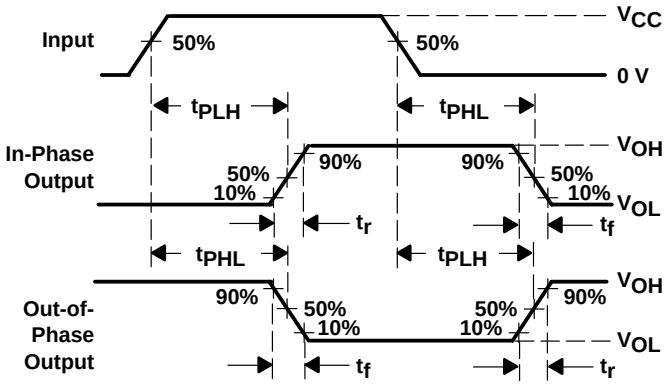
PARAMETER		R_L	C_L	S1	S2
t_{en}	t_{PZH}	1 kΩ	50 pF or 150 pF	Open	Closed
	t_{PZL}			Closed	Open
t_{dis}	t_{PHZ}	1 kΩ	50 pF	Open	Closed
	t_{PLZ}			Closed	Open
t_{pd} or t_t		––	50 pF or 150 pF	Open	Open



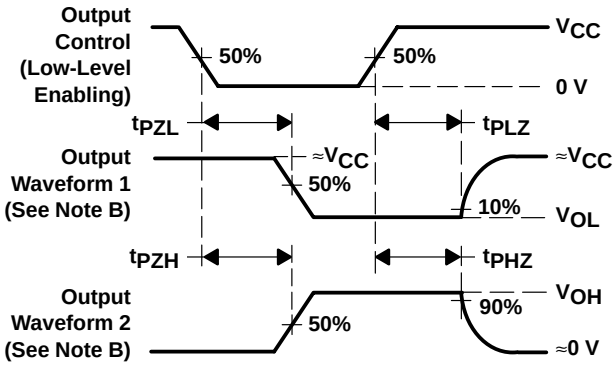
VOLTAGE WAVEFORMS
PULSE DURATIONS



VOLTAGE WAVEFORMS
SETUP AND HOLD AND INPUT RISE AND FALL TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY AND OUTPUT TRANSITION 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 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)
SN74HC652DW	Obsolete	Production	SOIC (DW) | 24	-	-	Call TI	Call TI	-40 to 85	
SN74HC652DWR	Active	Production	SOIC (DW) | 24	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	HC652
SN74HC652DWR.A	Active	Production	SOIC (DW) | 24	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	HC652

(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.

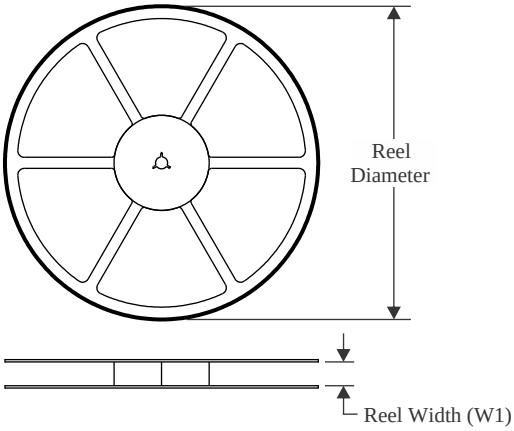
(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will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

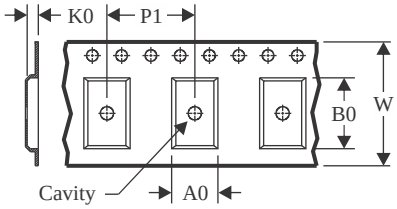
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

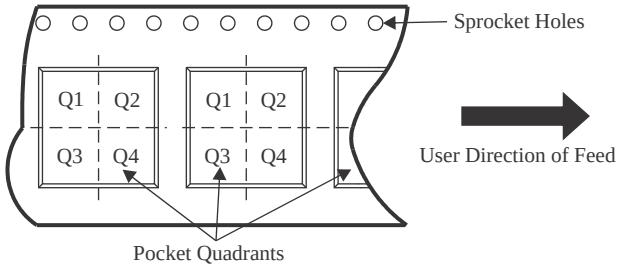


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

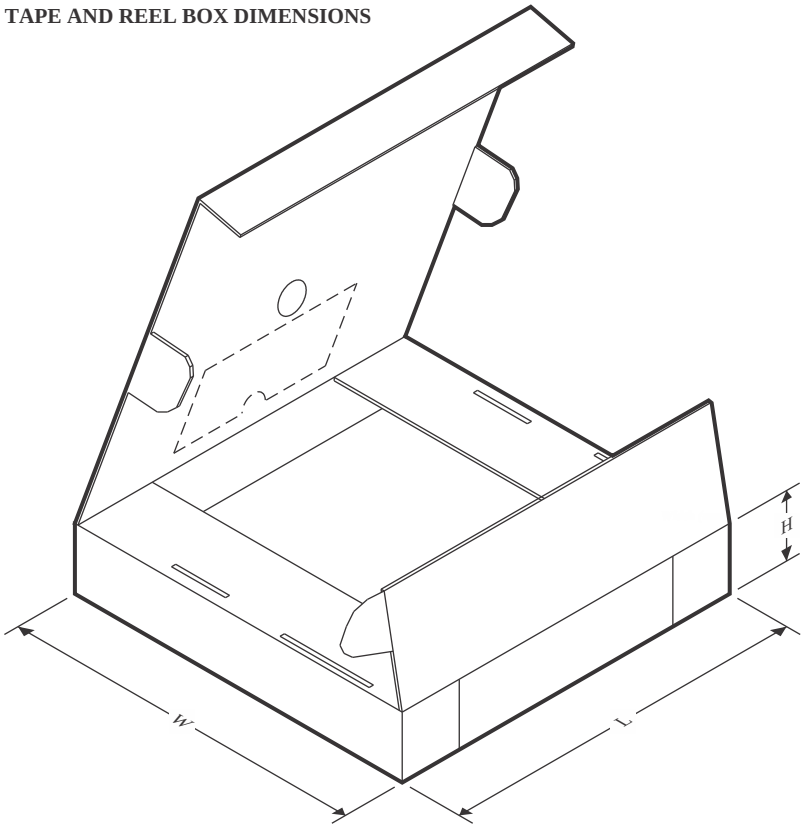
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
SN74HC652DWR	SOIC	DW	24	2000	330.0	24.4	10.75	15.7	2.7	12.0	24.0	Q1

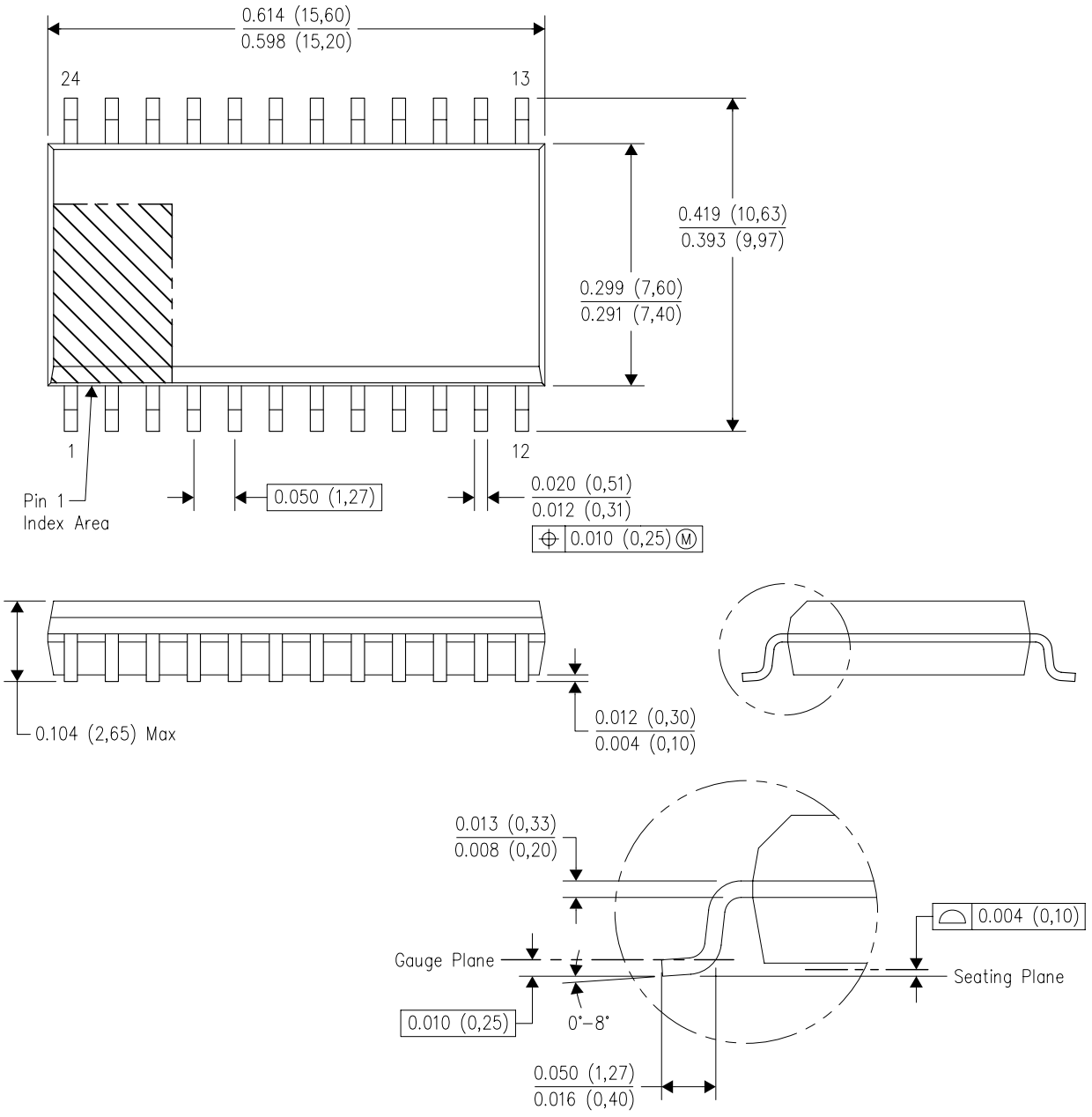
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74HC652DWR	SOIC	DW	24	2000	350.0	350.0	43.0

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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