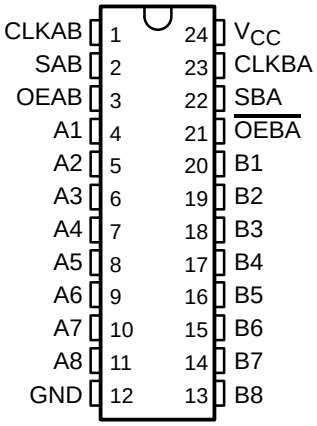
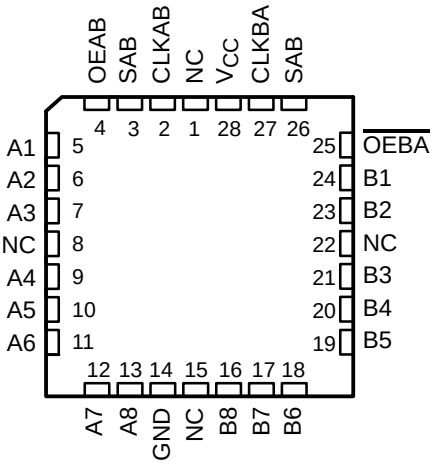
- **Bus Transceivers/Registers**
- **Independent Registers and Enables for A and B Buses**
- **Multiplexed Real-Time and Stored Data**
- **Choice of True or Inverting Data Paths**
- **Choice of 3-State or Open-Collector Outputs to A Bus**

DEVICE	A OUTPUT	B OUTPUT	LOGIC
SN74ALS651A, 'AS651	3-State	3-State	Inverting
SN54ALS652, SN74ALS652A, 'AS652	3-State	3-State	True
'ALS653	Open Collector	3-State	Inverting
SN74ALS654	Open Collector	3-State	True

SN54ALS', SN54AS' . . . JT PACKAGE
SN74ALS', SN74AS' . . . DW OR NT PACKAGE
(TOP VIEW)



SN54ALS', SN54AS' . . . FK PACKAGE
(TOP VIEW)



NC – No internal connection

description

These 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. The circuitry used for select control eliminates the typical decoding glitch that occurs in a multiplexer during the transition between stored and real-time data. 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 the octal bus transceivers and registers

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.

The -1 versions of the SN74ALS651A and SN74ALS652A are identical to the standard versions except that the recommended maximum I_{OL} for the -1 versions is increased to 48 mA. There are no -1 versions of the SN54ALS652, SN54ALS653, SN74ALS653, and SN74ALS654.

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.

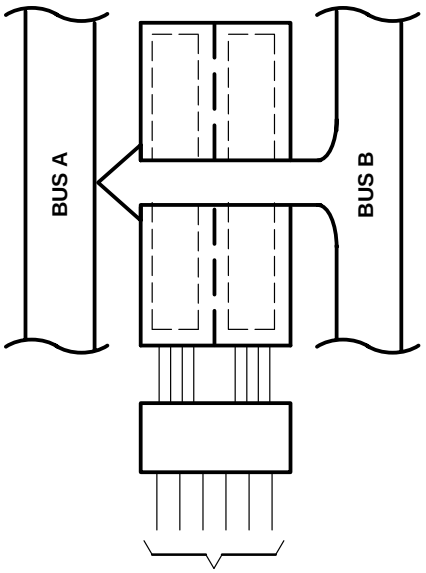
PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

Copyright © 2000, Texas Instruments Incorporated

ORDERING INFORMATION

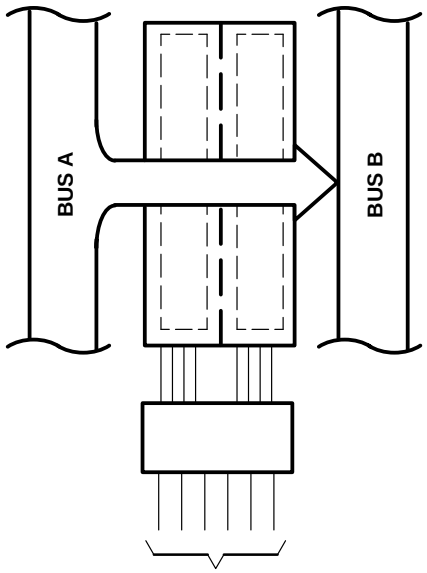
T_A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	PDIP – NT	Tube	SN74ALS651ANT	SN74ALS651ANT
			SN74ALS652ANT	SN74ALS652ANT
			SN74ALS653NT	SN74ALS653NT
			SN74ALS654NT	SN74ALS654NT
			SN74AS651NT	SN74AS651NT
			SN74AS652NT	SN74AS652NT
	SOIC – DW	Tube	SN74ALS651ADW	ALS651A
		Tape and reel	SN74ALS651ADWR	
		Tube	SN74ALS652ADW	ALS652A
		Tape and reel	SN74ALS652ADWR	
		Tube	SN74ALS653DW	ALS653
		Tape and reel	SN74ALS653DWR	
		Tube	SN74ALS654DW	ALS654
		Tape and reel	SN74ALS654DWR	
		Tube	SN74AS651DW	AS651
		Tape and reel	SN74AS651DWR	
		Tube	SN74AS652DW	AS652
		Tape and reel	SN74AS652DWR	
–55°C to 125°C	CDIP – JT	Tube	SNJ54ALS652JT	SNJ54ALS652JT
			SNJ54ALS653JT	SNJ54ALS653JT
			SNJ54AS651JT	SNJ54AS651JT
			SNJ54AS652JT	SNJ54AS652JT
	LCCC – FK	Tube	SNJ54ALS652FK	SNJ54ALS652FK
			SNJ54ALS653FK	SNJ54ALS653FK
			SNJ54AS651FK	SNJ54AS651FK
			SNJ54AS652FK	SNJ54AS652FK

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



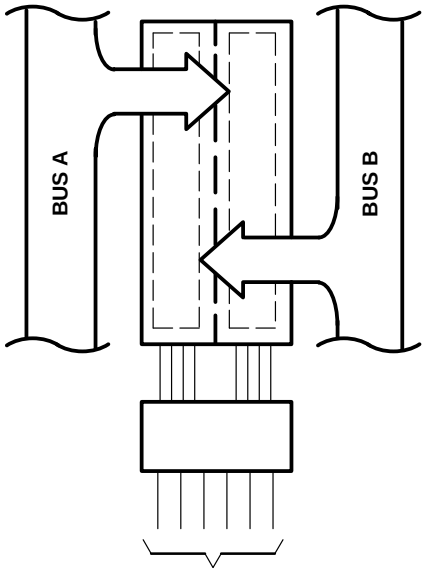
3	21	1	23	2	22
OEAB	$\overline{\text{OEBA}}$	CLKAB	CLKBA	SAB	SBA
L	L	X	X	X	L

REAL-TIME TRANSFER
BUS B TO BUS A



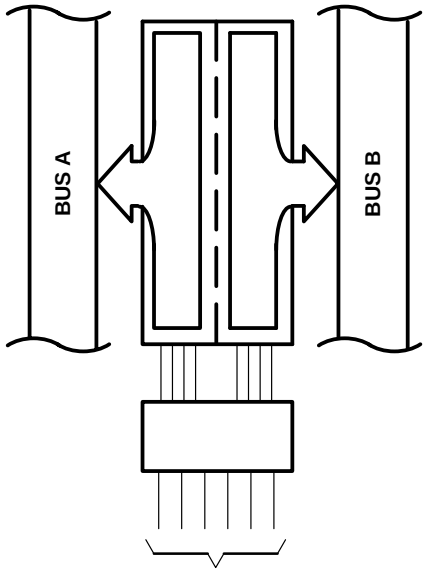
3	21	1	23	2	22
OEAB	$\overline{\text{OEBA}}$	CLKAB	CLKBA	SAB	SBA
H	H	X	X	L	X

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, and NT packages.

Figure 1. Bus-Management Functions

Function Tables

**SN54ALS653, SN54AS651,
SN74ALS651A, SN74ALS653, SN74AS651**

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 $\overline{\text{B}}$ data to A bus
L	L	X	H or L	X	H	Output	Input	Stored $\overline{\text{B}}$ data to A bus
H	H	X	X	L	X	Input	Output	Real-time $\overline{\text{A}}$ data to B bus
H	H	H or L	X	H	X	Input	Output	Stored $\overline{\text{A}}$ data to B bus
H	L	H or L	H or L	H	H	Output	Output	Stored $\overline{\text{A}}$ data to B bus and stored $\overline{\text{B}}$ data to A bus

† The data output functions can be 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.

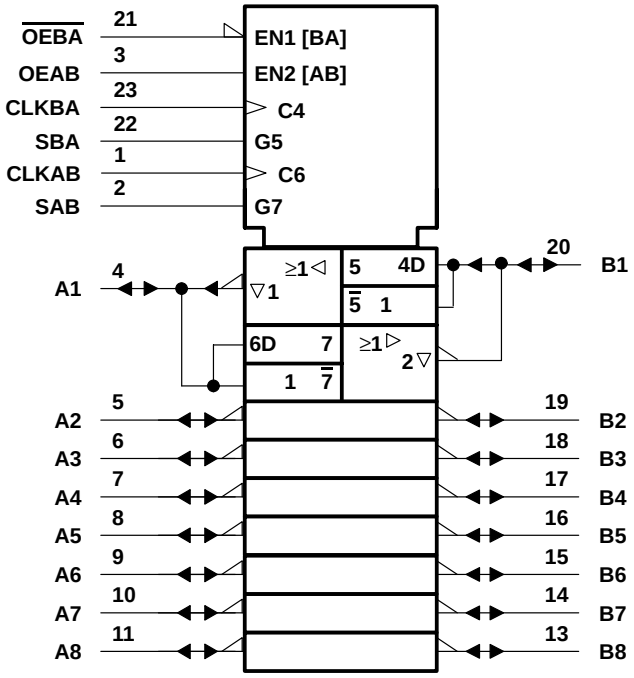
**SN54ALS652, SN54AS652,
SN74ALS652A, SN74ALS654, SN74AS652**

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

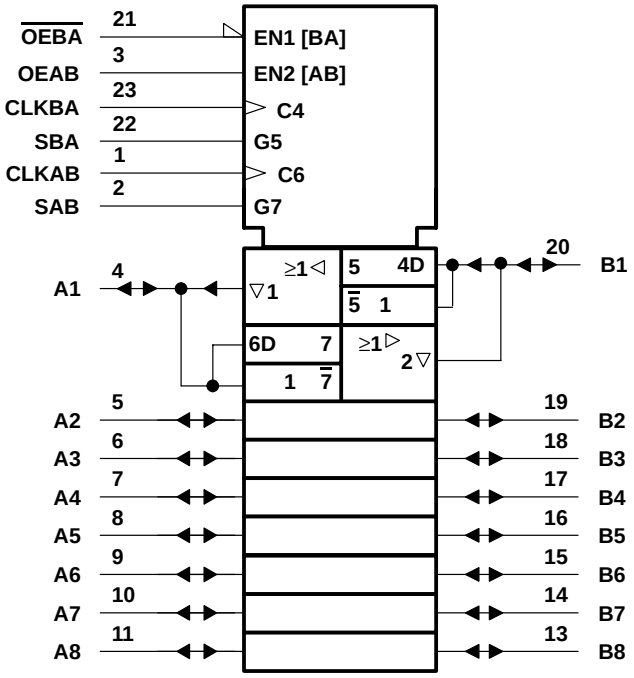
† The data output functions can be enabled or disabled by a variety of level combinations at OEAB or $\overline{\text{OEBA}}$. Data input functions always are enabled; i.e., data at the bus terminals is stored on every low-to-high transition on the clock inputs.
‡ Select control = L: clocks can occur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

logic symbols†

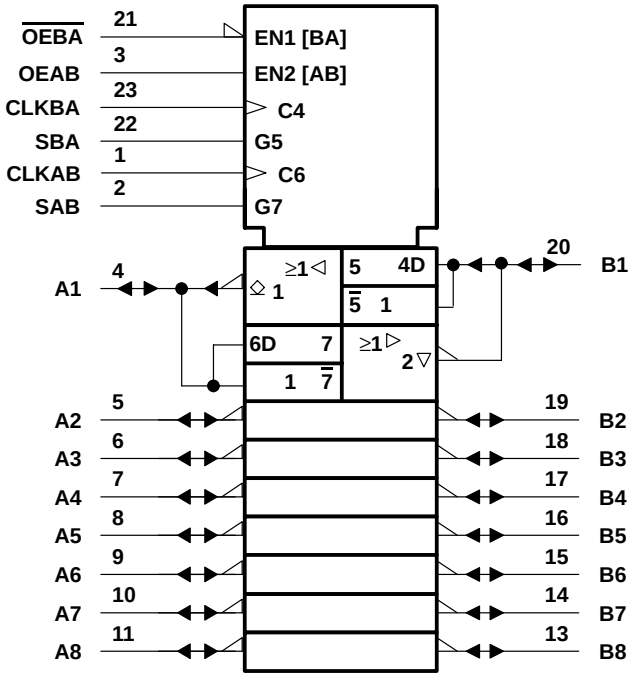
SN54AS651, SN74ALS651A, SN74AS651



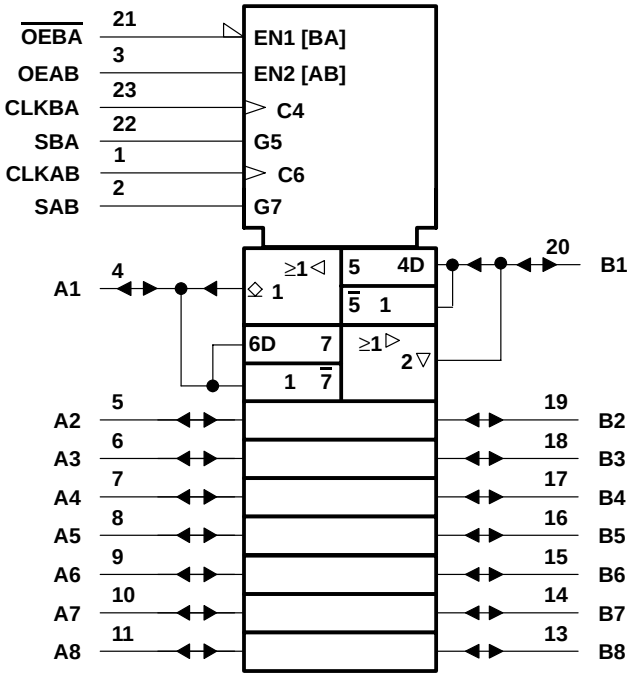
SN54ALS652, SN54AS652, SN74ALS652A, SN74AS652



SN54ALS653, SN74ALS653

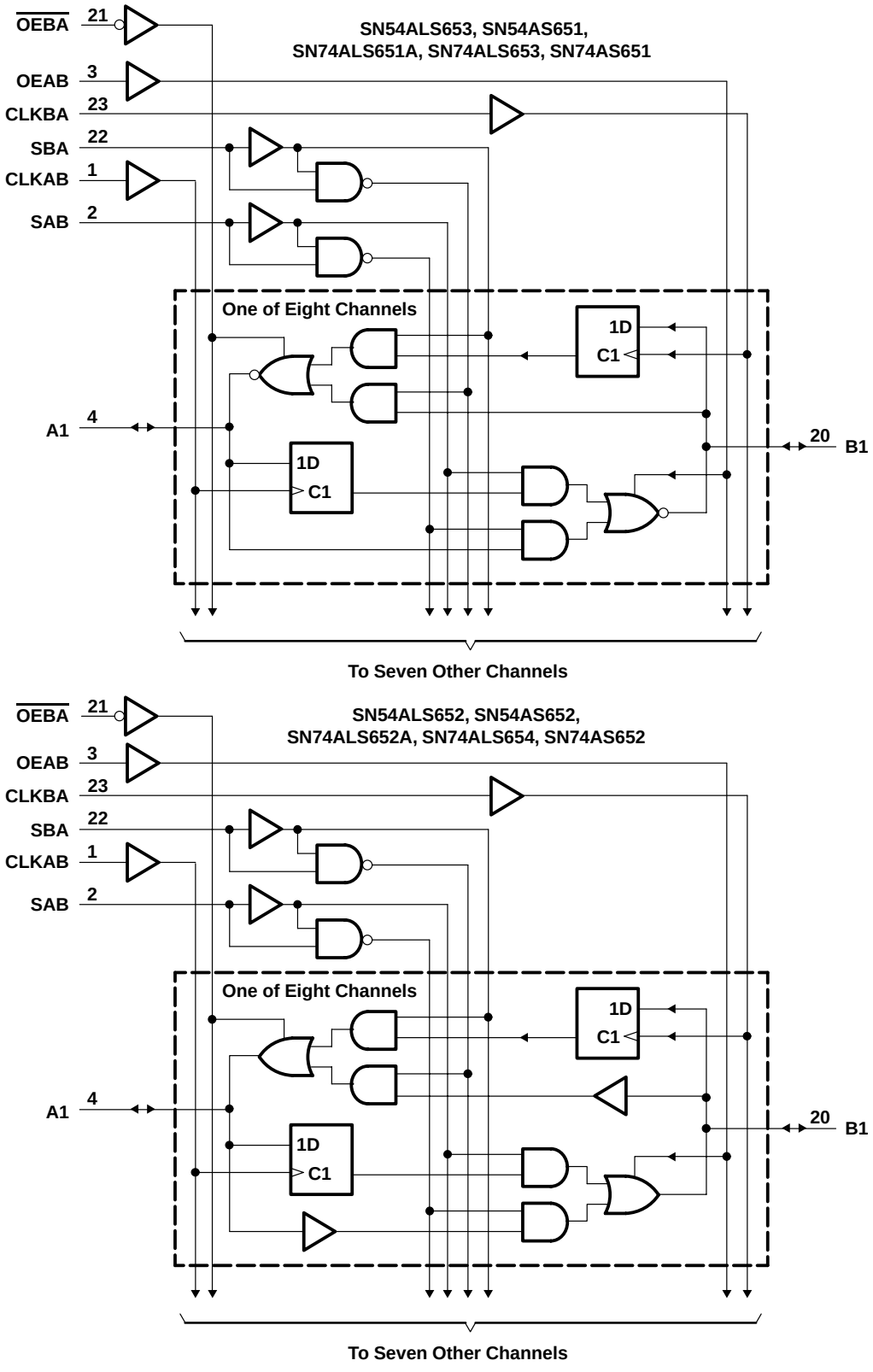


SN74ALS654



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

logic diagrams (positive logic)



Pin numbers shown are for the DW, JT, and NT 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 voltage range, V_I: Control inputs . . . . . –0.5 V to 7 V
I/O ports . . . . . –0.5 V to 5.5 V
Package thermal impedance, θ_{JA} (see Note 1): DW package . . . . . 46°C/W
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.

NOTE 1: The package thermal impedance is calculated in accordance with JESD 51.

recommended operating conditions

			SN74ALS651A			UNIT
			MIN	NOM	MAX	
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				–15	mA
I_{OL}	Low-level output current				24	mA
					48‡	
f_{clock}	Clock frequency		0		40	MHz
t_w	Pulse duration	CLKBA or CLKAB high	12.5			ns
		CLKBA or CLKAB low	12.5			
t_{su}	Setup time before CLKAB↑ or CLKBA↑	A or B	10			ns
t_h	Hold time after CLKAB↑ or CLKBA↑	A or B	0			ns
T_A	Operating free-air temperature		0		70	°C

‡ Applies only to the SN74ALS651A-1 and only if V_{CC} is maintained between 4.75 V and 5.25 V

recommended operating conditions

			SN54ALS652			SN74ALS652A			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		2			2			V
V_{IL}	Low-level input voltage				0.7			0.8	V
I_{OH}	High-level output current				–12			–15	mA
I_{OL}	Low-level output current				12			24	mA
								48‡	
f_{clock}	Clock frequency		0		35	0		40	MHz
t_w	Pulse duration	CLKBA or CLKAB high	14.5			12.5			ns
		CLKBA or CLKAB low	14.5			12.5			
t_{su}	Setup time before CLKAB↑ or CLKBA↑	A or B	15			10			ns
t_h	Hold time after CLKAB↑ or CLKBA↑	A or B	5			0			ns
T_A	Operating free-air temperature		–55		125	0		70	°C

‡ Applies only to the SN74ALS652A-1 and only if V_{CC} is maintained between 4.75 V and 5.25 V

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

PARAMETER		TEST CONDITIONS		SN74ALS651A			UNIT
				MIN	TYP†	MAX	
V_{IK}		V_{CC} = 4.5 V,	I_I = –18 mA			–1.2	V
V_{OH}		V_{CC} = 4.5 V to 5.5 V,	I_{OH} = –0.4 mA	V_{CC}–2			V
		V_{CC} = 4.5 V	I_{OH} = –3 mA	2.4	3.2		
			I_{OH} = –15 mA	2			
V_{OL}		V_{CC} = 4.5 V	I_{OL} = 12 mA		0.25	0.4	V
			I_{OL} = 24 mA		0.35	0.5	
		V_{CC} = 4.75 V,	I_{OL} = 48 mA (-1 versions)		0.35	0.5	
I_I	Control inputs	V_{CC} = 5.5 V,	V_I = 7 V			0.1	mA
	A or B ports	V_{CC} = 5.5 V,	V_I = 5.5 V			0.1	
I_{IH}	Control inputs	V_{CC} = 5.5 V,	V_I = 2.7 V			20	μA
	A or B ports‡					20	
I_{IL}	Control inputs	V_{CC} = 5.5 V,	V_I = 0.4 V			–0.2	mA
	A or B ports‡					–0.2	
I_O§		V_{CC} = 5.5 V,	V_O = 2.25 V	–30		–112	mA
I_{CC}		V_{CC} = 5.5 V	Outputs high		42	68	mA
			Outputs low		52	82	
			Outputs disabled		52	82	

† All typical values are at V_{CC} = 5 V, T_A = 25°C.
‡ For I/O ports, the parameters I_{IH} and I_{IL} include the off-state output current.
§ The output conditions have been chosen to produce a current that closely approximates one-half of the true short-circuit output current, I_{OS}.

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

PARAMETER		TEST CONDITIONS		SN54ALS652			SN74ALS652A			UNIT
				MIN	TYP†	MAX	MIN	TYP†	MAX	
V_{IK}		V_{CC} = 4.5 V,	I_I = –18 mA			–1.2			–1.2	V
V_{OH}		V_{CC} = 4.5 V to 5.5 V,	I_{OH} = –0.4 mA	V_{CC}–2			V_{CC}–2			V
		V_{CC} = 4.5 V	I_{OH} = –3 mA	2.4	3.2		2.4	3.2		
			I_{OH} = –12 mA	2						
			I_{OH} = –15 mA				2			
V_{OL}		V_{CC} = 4.5 V	I_{OL} = 12 mA		0.25	0.4		0.25	0.4	V
			I_{OL} = 24 mA					0.35	0.5	
		V_{CC} = 4.75 V,	I_{OL} = 48 mA (-1 versions)					0.35	0.5	
I_I	Control inputs	V_{CC} = 5.5 V,	V_I = 7 V			0.1			0.1	mA
	A or B ports	V_{CC} = 5.5 V,	V_I = 5.5 V			0.1			0.1	
I_{IH}	Control inputs	V_{CC} = 5.5 V,	V_I = 2.7 V			20			20	µA
	A or B ports‡					20			20	
I_{IL}	Control inputs	V_{CC} = 5.5 V,	V_I = 0.4 V			–0.2			–0.2	mA
	A or B ports‡					–0.2			–0.2	
I_O§		V_{CC} = 5.5 V,	V_O = 2.25 V	–20		–112	–30		–112	mA
I_{CC}		V_{CC} = 5.5 V	Outputs high		47	76		47	76	mA
			Outputs low		55	88		55	88	
			Outputs disabled		55	88		55	88	

† All typical values are at V_{CC} = 5 V, T_A = 25°C.
‡ For I/O ports, the parameters I_{IH} and I_{IL} include the off-state output current.
§ The output conditions have been chosen to produce a current that closely approximates one-half of the true short-circuit output current, I_{OS}.

switching characteristics (see Figure 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} = 4.5 V to 5.5 V, C_L = 50 pF, R1 = 500 Ω, R2 = 500 Ω, T_A = MIN to MAX†		UNIT
			SN74ALS651A		
			MIN	MAX	
f_{max}			40		MHz
t_{PLH}	CLKBA or CLKAB	A or B	8	32	ns
t_{PHL}			5	17	
t_{PLH}	A or B	B or A	2	18	ns
t_{PHL}			2	10	
t_{PLH}	SBA or SAB‡ (with A or B high)	A or B	8	38	ns
t_{PHL}			6	21	
t_{PLH}	SBA or SAB‡ (with A or B low)	A or B	8	25	ns
t_{PHL}			7	21	
t_{PZH}	$\overline{OEBA}$	A	3	20	ns
t_{PZL}			5	18	
t_{PHZ}	$\overline{OEBA}$	A	2	9	ns
t_{PLZ}			3	12	
t_{PZH}	OEAB	B	3	22	ns
t_{PZL}			6	21	
t_{PHZ}	OEAB	B	2	12	ns
t_{PLZ}			2	14	

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ These parameters are measured with the internal output state of the storage register opposite that of the bus input.

switching characteristics (see Figure 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} = 4.5 V to 5.5 V, C_L = 50 pF, R1 = 500 Ω, R2 = 500 Ω, T_A = MIN to MAX†				UNIT
			SN54ALS652		SN74ALS652A		
			MIN	MAX	MIN	MAX	
f_{max}			35		40		MHz
t_{PLH}	CLKBA or CLKAB	A or B	10	35	8	30	ns
t_{PHL}			5	20	5	17	
t_{PLH}	A or B	B or A	5	20	4	18	ns
t_{PHL}			3	15	3	12	
t_{PLH}	SBA or SAB‡ (with A or B high)	A or B	15	40	8	35	ns
t_{PHL}			6	23	6	20	
t_{PLH}	SBA or SAB‡ (with A or B low)	A or B	8	30	8	25	ns
t_{PHL}			5	24	5	20	
t_{PZH}	$\overline{OEBA}$	A	3	20	3	17	ns
t_{PZL}			5	22	5	18	
t_{PHZ}	$\overline{OEBA}$	A	1	12	1	10	ns
t_{PLZ}			2	20	2	16	
t_{PZH}	OEAB	B	8	25	3	22	ns
t_{PZL}			6	21	5	18	
t_{PHZ}	OEAB	B	1	12	1	10	ns
t_{PLZ}			2	21	2	16	

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ These parameters are measured with the internal output state of the storage register opposite that of the bus input.

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: Control inputs . . . . . –0.5 V to 7 V
I/O ports . . . . . –0.5 V to 5.5 V
Package thermal impedance, θ_{JA} (see Note 1): DW package . . . . . 46°C/W
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.

NOTE 1: The package thermal impedance is calculated in accordance with JESD 51.

recommended operating conditions

			SN54ALS653			SN74ALS653			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		2			2			V
V_{IL}	Low-level input voltage				0.7			0.8	V
V_{OH}	High-level output voltage	A ports			5.5			5.5	V
I_{OH}	High-level output current	B ports			–12			–15	mA
I_{OL}	Low-level output current				12			24	mA
f_{clock}	Clock frequency		0		25	0		35	MHz
t_w	Pulse duration	CLKBA or CLKAB high	20			14.5			ns
		CLKBA or CLKAB low	20			14.5			
t_{su}	Setup time before CLKAB↑ or CLKBA↑	A or B	15			10			ns
t_h	Hold time after CLKAB↑ or CLKBA↑	A or B	5			0			ns
T_A	Operating free-air temperature		–55		125	0		70	°C

recommended operating conditions

			SN74ALS654			UNIT
			MIN	NOM	MAX	
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
V_{OH}	High-level output voltage	A ports			5.5	V
I_{OH}	High-level output current	B ports			–15	mA
I_{OL}	Low-level output current				24	mA
f_{clock}	Clock frequency		0		35	MHz
t_w	Pulse duration	CLKBA or CLKAB high	14.5			ns
		CLKBA or CLKAB low	14.5			
t_{su}	Setup time before CLKAB↑ or CLKBA↑	A or B	10			ns
t_h	Hold time after CLKAB↑ or CLKBA↑	A or B	0			ns
T_A	Operating free-air temperature		0		70	°C

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

PARAMETER		TEST CONDITIONS		SN54ALS653			SN74ALS653			UNIT
				MIN	TYP†	MAX	MIN	TYP†	MAX	
V_{IK}		V_{CC} = 4.5 V,	I_I = –18 mA			–1.2			–1.2	V
V_{OH}	B ports	V_{CC} = 4.5 V to 5.5 V,	I_{OH} = –0.4 mA	V_{CC}–2			V_{CC}–2			V
		V_{CC} = 4.5 V	I_{OH} = –3 mA	2.4	3.2		2.4	3.2		
			I_{OH} = –12 mA	2						
			I_{OH} = –15 mA				2			
V_{OL}		V_{CC} = 4.5 V	I_{OL} = 12 mA		0.25	0.4		0.25	0.4	V
			I_{OL} = 24 mA					0.35	0.5	
I_I	Control inputs	V_{CC} = 5.5 V,	V_I = 7 V			0.1			0.1	mA
	A or B ports	V_{CC} = 5.5 V,	V_I = 5.5 V			0.1			0.1	
I_{IH}	Control inputs	V_{CC} = 5.5 V,	V_I = 2.7 V			20			20	μA
	A or B ports‡					20			20	
I_{IL}	Control inputs	V_{CC} = 5.5 V,	V_I = 0.4 V			–0.2			–0.2	mA
	A or B ports‡					–0.2			–0.2	
I_{OH}	A ports	V_{CC} = 4.5 V,	V_{OH} = 5.5 V			0.1			0.1	mA
I_O§	B ports	V_{CC} = 5.5 V,	V_O = 2.25 V	–20		–112	–30		–112	mA
I_{CC}		V_{CC} = 5.5 V	Outputs high		47	76		47	76	mA
			Outputs low		55	88		55	88	
			Outputs disabled		55	88		55	88	

† All typical values are at V_{CC} = 5 V, T_A = 25°C.
‡ For I/O ports, the parameters I_{IH} and I_{IL} include the off-state output current.
§ The output conditions have been chosen to produce a current that closely approximates one-half of the true short-circuit output current, I_{OS}.

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

PARAMETER		TEST CONDITIONS		SN74ALS654			UNIT
				MIN	TYP†	MAX	
V_{IK}		V_{CC} = 4.5 V,	I_I = –18 mA			–1.2	V
V_{OH}	B ports	V_{CC} = 4.5 V to 5.5 V,	I_{OH} = –0.4 mA	V_{CC}–2			V
		V_{CC} = 4.5 V	I_{OH} = –3 mA	2.4	3.2		
			I_{OH} = –15 mA	2			
V_{OL}		V_{CC} = 4.5 V	I_{OL} = 12 mA		0.25	0.4	V
			I_{OL} = 24 mA		0.35	0.5	
I_I	Control inputs	V_{CC} = 5.5 V,	V_I = 7 V			0.1	mA
	A or B ports	V_{CC} = 5.5 V,	V_I = 5.5 V			0.1	
I_{IH}	Control inputs	V_{CC} = 5.5 V,	V_I = 2.7 V			20	µA
	A or B ports‡					20	
I_{IL}	Control inputs	V_{CC} = 5.5 V,	V_I = 0.4 V			–0.2	mA
	A or B ports‡					–0.2	
I_{OH}	A ports	V_{CC} = 4.5 V,	V_{OH} = 5.5 V			0.1	mA
I_O§	B ports	V_{CC} = 5.5 V,	V_O = 2.25 V	–30		–112	mA
I_{CC}		V_{CC} = 5.5 V	Outputs high		47	76	mA
			Outputs low		55	88	
			Outputs disabled		55	88	

† All typical values are at V_{CC} = 5 V, T_A = 25°C.
‡ For I/O ports, the parameters I_{IH} and I_{IL} include the off-state output current.
§ The output conditions have been chosen to produce a current that closely approximates one-half of the true short-circuit output current, I_{OS}.

switching characteristics (see Figure 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} = 4.5 V to 5.5 V, C_L = 50 pF, R_L = 680 Ω (A outputs), R1 = R2 = 500 Ω (B outputs), T_A = MIN to MAX†				UNIT
			SN54ALS653		SN74ALS653		
			MIN	MAX	MIN	MAX	
f_{max}			25		35		MHz
t_{PLH}	CLKBA	A	16	71	16	64	ns
t_{PHL}			6	24	6	22	
t_{PLH}	CLKAB	B	10	35	10	30	ns
t_{PHL}			5	20	5	17	
t_{PLH}	A	B	5	20	5	18	ns
t_{PHL}			1.5	18	2	15	
t_{PLH}	B	A	8	63	12	56	ns
t_{PHL}			2	18	2	15	
t_{PLH}	SBA‡ (with B high)	A	12	68	19	62	ns
t_{PHL}			5	27	5	25	
t_{PLH}	SBA‡ (with B low)	A	12	68	19	62	ns
t_{PHL}			5	27	5	25	
t_{PLH}	SAB‡ (with A high)	B	8	30	15	35	ns
t_{PHL}			6	25	6	22	
t_{PLH}	SAB‡ (with A low)	B	12	40	8	25	ns
t_{PHL}			6	25	6	22	
t_{PLH}	$\overline{OEBA}$	A	6	35	6	30	ns
t_{PHL}			6	27	6	24	
t_{PZH}	OEAB	B	7	25	8	22	ns
t_{PZL}			6	25	6	22	
t_{PHZ}	OEAB	B	1	16	1	14	ns
t_{PLZ}			2	21	2	16	

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ These parameters are measured with the internal output state of the storage register opposite that of the bus input.

switching characteristics (see Figure 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} = 4.5 V to 5.5 V, C_L = 50 pF, R_L = 680 Ω (A outputs), R1 = R2 = 500 Ω (B outputs), T_A = MIN to MAX†		UNIT
			SN74ALS654		
			MIN	MAX	
f_{max}			35		MHz
t_{PLH}	CLKBA	A	16	64	ns
t_{PHL}			6	22	
t_{PLH}	CLKAB	B	10	30	ns
t_{PHL}			5	17	
t_{PLH}	A	B	5	18	ns
t_{PHL}			2	15	
t_{PLH}	B	A	12	56	ns
t_{PHL}			2	21	
t_{PLH}	SBA‡ (with B low)	A	19	62	ns
t_{PHL}			5	25	
t_{PLH}	SBA‡ (with B high)	A	19	62	ns
t_{PHL}			5	25	
t_{PLH}	SAB‡ (with A low)	B	15	35	ns
t_{PHL}			6	22	
t_{PLH}	SAB‡ (with A high)	B	8	25	ns
t_{PHL}			6	22	
t_{PLH}	$\overline{OEBA}$	A	6	30	ns
t_{PHL}			6	24	
t_{PZH}	OEAB	B	6	22	ns
t_{PZL}			6	22	
t_{PHZ}	OEAB	B	1	14	ns
t_{PLZ}			2	16	

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ These parameters are measured with the internal output state of the storage register opposite that of the bus input.

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: Control inputs . . . . . –0.5 V to 7 V
I/O ports . . . . . –0.5 V to 5.5 V
Package thermal impedance, θ_{JA} (see Note 1): DW package . . . . . 46°C/W
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.

NOTE 1: The package thermal impedance is calculated in accordance with JESD 51.

recommended operating conditions

			SN54AS651 SN54AS652			SN74AS651 SN74AS652			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		2			2			V
V_{IL}	Low-level input voltage				0.8			0.8	V
I_{OH}	High-level output current				–12			–15	mA
I_{OL}	Low-level output current				32			48	mA
f_{clock}	Clock frequency		0*		75*	0		90	MHz
t_w	Pulse duration	CLKBA or CLKAB high	6*			5			ns
		CLKBA or CLKAB low	7*			6			
t_{su}	Setup time before CLKAB↑ or CLKBA↑	A or B	7*			6			ns
t_h	Hold time after CLKAB↑ or CLKBA	A or B	0*			0			ns
T_A	Operating free-air temperature		–55		125	0		70	°C

* On products compliant to MIL-PRF-38535, this parameter is based on characterized data but is not production tested.

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

PARAMETER		TEST CONDITIONS		SN54AS651 SN54AS652			SN74AS651 SN74AS652			UNIT
				MIN	TYP†	MAX	MIN	TYP†	MAX	
V_{IK}		V_{CC} = 4.5 V,	I_I = –18 mA			–1.2			–1.2	V
V_{OH}		V_{CC} = 4.5 V to 5.5 V,	I_{OH} = –2 mA	V_{CC}–2			V_{CC}–2			V
		V_{CC} = 4.5 V	I_{OH} = –3 mA	2.4	3.2		2.4	3.2		
			I_{OH} = –12 mA	2						
			I_{OH} = –15 mA				2			
V_{OL}		V_{CC} = 4.5 V	I_{OL} = 32 mA		0.25	0.5				V
			I_{OL} = 48 mA					0.35	0.5	
I_I	Control inputs	V_{CC} = 5.5 V,	V_I = 7 V			0.1			0.1	mA
	A or B ports	V_{CC} = 5.5 V,	V_I = 5.5 V			0.1			0.1	
I_{IH}	Control inputs	V_{CC} = 5.5 V,	V_I = 2.7 V			20			20	µA
	A or B ports‡					70			70	
I_{IL}	Control input	V_{CC} = 5.5 V,	V_I = 0.4 V			–0.5			–0.5	mA
	A or B ports‡					–0.75			–0.75	
I_O§		V_{CC} = 5.5 V,	V_O = 2.25 V	–30		–112	–30		–112	mA
I_{CC}	′AS651	V_{CC} = 5.5 V	Outputs high		110	185		110	185	mA
			Outputs low		120	195		120	195	
			Outputs disabled		130	195		130	195	
	′AS652	V_{CC} = 5.5 V	Outputs high		120	195		120	195	
			Outputs low		130	211		130	211	
			Outputs disabled		130	211		130	211	

† All typical values are at V_{CC} = 5 V, T_A = 25 °C.
‡ For I/O ports, the parameters I_{IH} and I_{IL} include the off-state output current.
§ The output conditions have been chosen to produce a current that closely approximates one-half of the true short-circuit output current, I_{OS}.

switching characteristics (see Figure 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} = 4.5 V to 5.5 V, C_L = 50 pF, R1 = 500 Ω, R2 = 500 Ω, T_A = MIN to MAX†				UNIT
			SN54AS651		SN74AS651		
			MIN	MAX	MIN	MAX	
f_{max}			75*		90		MHz
t_{PLH}	CLKBA or CLKAB	A or B	2	11	2	8.5	ns
t_{PHL}			2	10	2	9	
t_{PLH}	A or B	B or A	2	12	2	8	ns
t_{PHL}			1	8	1	7	
t_{PLH}	SBA or SAB‡	A or B	2	15	2	11	ns
t_{PHL}			2	11	2	9	
t_{PZH}	$\overline{OEBA}$	A	2	11	2	10	ns
t_{PZL}			3	18	3	16	
t_{PHZ}	$\overline{OEBA}$	A	2	10	2	9	ns
t_{PLZ}			2	10	2	9	
t_{PZH}	OEAB	B	3	12	3	11	ns
t_{PZL}			3	20	3	16	
t_{PHZ}	OEAB	B	2	11	2	10	ns
t_{PLZ}			2	12	2	11	

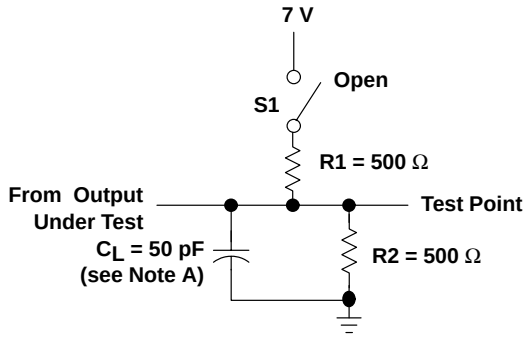
* On products compliant to MIL-PRF-38535, this parameter is based on characterized data but is not production tested.
† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ These parameters are measured with the internal output state of the storage register opposite that of the bus input.

switching characteristics (see Figure 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} = 4.5 V TO 5.5 V, C_L = 50 PF, R1 = 500 Ω, R2 = 500 Ω, T_A = MIN TO MAX†				UNIT
			SN54AS652		SN74AS652		
			MIN	MAX	TYP	MAX	
f_{max}			75*		90		MHz
t_{PLH}	CLKBA or CLKAB	A or B	2	11	2	8.5	ns
t_{PHL}			2	10	2	9	
t_{PLH}	A or B	B or A	2	12	2	9	ns
t_{PHL}			1	8	1	7	
t_{PLH}	SBA or SAB‡	A or B	2	15	2	11	ns
t_{PHL}			2	11	2	9	
t_{PZH}	$\overline{OEBA}$	A	2	11	2	10	ns
t_{PZL}			3	18	3	16	
t_{PHZ}	$\overline{OEBA}$	A	2	10	2	9	ns
t_{PLZ}			2	10	2	9	
t_{PZH}	OEAB	B	3	12	3	11	ns
t_{PZL}			3	20	3	16	
t_{PHZ}	OEAB	B	2	11	2	10	ns
t_{PLZ}			2	12	2	11	

* On products compliant to MIL-PRF-38535, this parameter is based on characterized data but is not production tested.
† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ These parameters are measured with the internal output state of the storage register opposite that of the bus input.

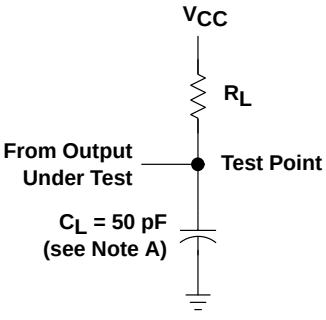
PARAMETER MEASUREMENT INFORMATION



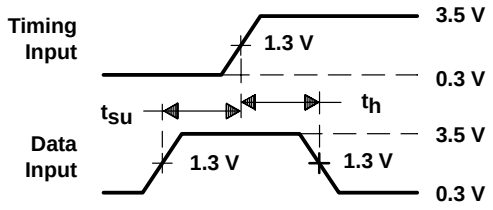
LOAD CIRCUIT
FOR 3-STATE OUTPUTS

SWITCH POSITION TABLE

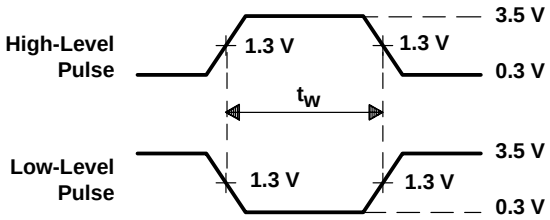
TEST	S1
t_{PLH}	Open
t_{PHL}	Open
t_{PZH}	Open
t_{PZL}	Closed
t_{PHZ}	Open
t_{PLZ}	Closed



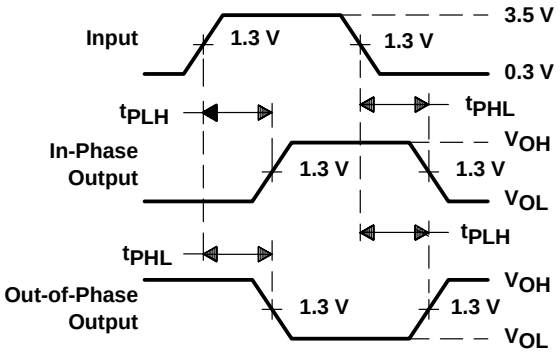
LOAD CIRCUIT
FOR OPEN-COLLECTOR OUTPUTS



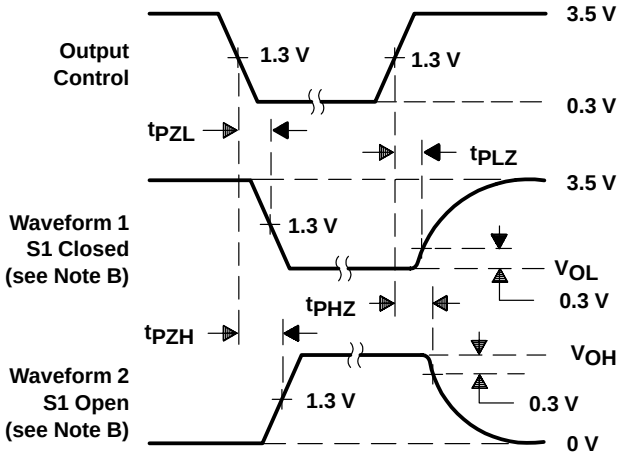
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES, 3-STATE OUTPUTS

NOTES: A. C_L includes probe and jig 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. All input pulses are supplied by generators having the following characteristics: PRR ≤ 1 MHz, Z_O = 50 Ω, t_r ≤ 2 ns, t_f ≤ 2 ns.
D. The outputs are measured one at a time with one transition per measurement.

Figure 2. Load Circuits 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
5962-88673013A	ACTIVE	LCCC	FK	28	1	TBD	POST-PLATE	N / A for Pkg Type	-55 to 125	5962-88673013A SNJ54ALS652FK	Samples
5962-8867301LA	ACTIVE	CDIP	JT	24	1	TBD	Call TI	N / A for Pkg Type	-55 to 125	5962-8867301LA SNJ54ALS652JT	Samples
5962-8868701LA	ACTIVE	CDIP	JT	24	1	TBD	Call TI	N / A for Pkg Type	-55 to 125	5962-8868701LA SNJ54AS652JT	Samples
5962-89687013A	ACTIVE	LCCC	FK	28	1	TBD	POST-PLATE	N / A for Pkg Type	-55 to 125	5962-89687013A SNJ54ALS653FK	Samples
5962-8968701LA	ACTIVE	CDIP	JT	24	1	TBD	Call TI	N / A for Pkg Type	-55 to 125	5962-8968701LA SNJ54ALS653JT	Samples
SN54ALS652JT	ACTIVE	CDIP	JT	24	1	TBD	Call TI	N / A for Pkg Type	-55 to 125	SN54ALS652JT	Samples
SN54AS652JT	ACTIVE	CDIP	JT	24	1	TBD	Call TI	N / A for Pkg Type	-55 to 125	SN54AS652JT	Samples
SN74ALS652A-1DW	ACTIVE	SOIC	DW	24	25	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	0 to 70	ALS652A-1	Samples
SN74ALS652ADW	ACTIVE	SOIC	DW	24	25	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	0 to 70	ALS652A	Samples
SN74ALS652ADWR	ACTIVE	SOIC	DW	24	2000	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	0 to 70	ALS652A	Samples
SN74ALS653DW	ACTIVE	SOIC	DW	24	25	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	0 to 70	ALS653	Samples
SN74ALS653DWE4	ACTIVE	SOIC	DW	24	25	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	0 to 70	ALS653	Samples
SN74ALS653DWR	ACTIVE	SOIC	DW	24	2000	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	0 to 70	ALS653	Samples
SN74ALS654DW	ACTIVE	SOIC	DW	24	25	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	0 to 70	ALS654	Samples
SN74ALS654DWR	ACTIVE	SOIC	DW	24	2000	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	0 to 70	ALS654	Samples
SN74AS652DW	ACTIVE	SOIC	DW	24	25	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	0 to 70	AS652	Samples

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
SNJ54ALS652FK	ACTIVE	LCCC	FK	28	1	TBD	POST-PLATE	N / A for Pkg Type	-55 to 125	5962-88673013A SNJ54ALS 652FK	Samples
SNJ54ALS652JT	ACTIVE	CDIP	JT	24	1	TBD	Call TI	N / A for Pkg Type	-55 to 125	5962-8867301LA SNJ54ALS652JT	Samples
SNJ54ALS653FK	ACTIVE	LCCC	FK	28	1	TBD	POST-PLATE	N / A for Pkg Type	-55 to 125	5962-89687013A SNJ54ALS 653FK	Samples
SNJ54ALS653JT	ACTIVE	CDIP	JT	24	1	TBD	Call TI	N / A for Pkg Type	-55 to 125	5962-8968701LA SNJ54ALS653JT	Samples
SNJ54AS652JT	ACTIVE	CDIP	JT	24	1	TBD	Call TI	N / A for Pkg Type	-55 to 125	5962-8868701LA SNJ54AS652JT	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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(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.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

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.

OTHER QUALIFIED VERSIONS OF SN54ALS653, SN54AS652, SN74ALS653, SN74AS652 :

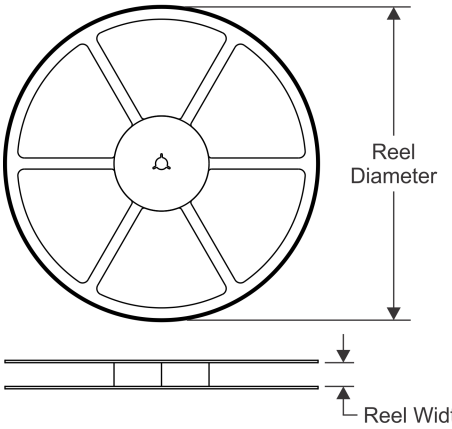
- Catalog: SN74ALS653, SN74AS652
- Military: SN54ALS653, SN54AS652

NOTE: Qualified Version Definitions:

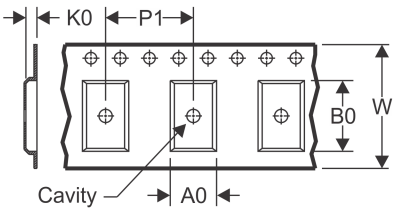
- Catalog - TI's standard catalog product
- Military - QML certified for Military and Defense Applications

TAPE AND REEL INFORMATION

REEL DIMENSIONS

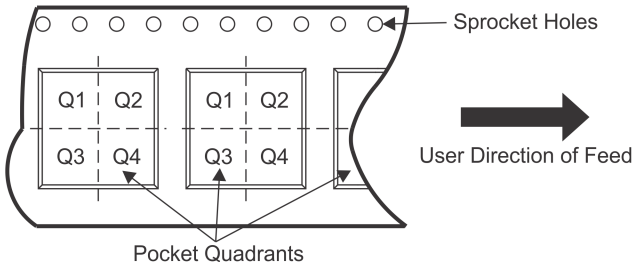


TAPE DIMENSIONS



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

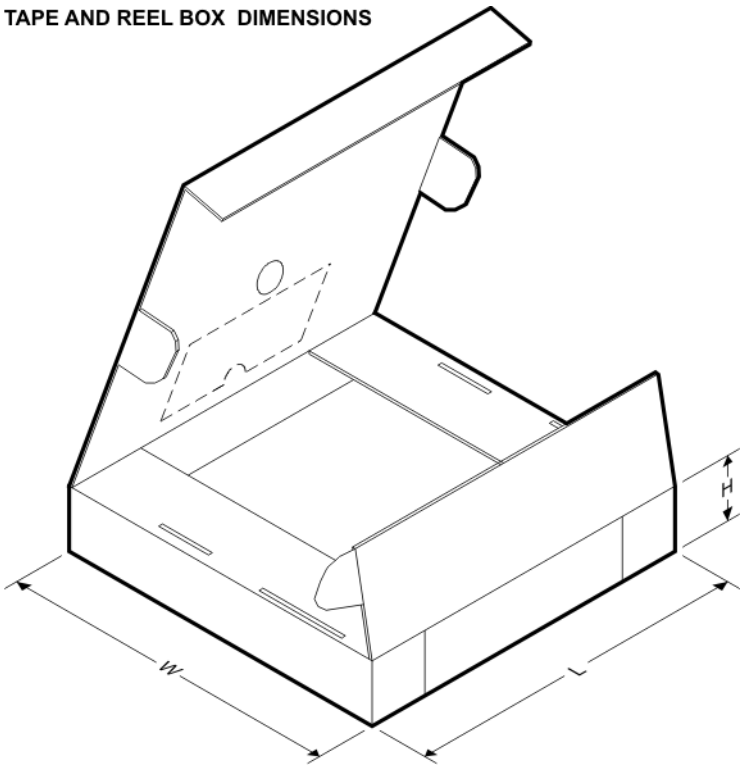
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
SN74ALS652ADWR	SOIC	DW	24	2000	330.0	24.4	10.75	15.7	2.7	12.0	24.0	Q1
SN74ALS653DWR	SOIC	DW	24	2000	330.0	24.4	10.75	15.7	2.7	12.0	24.0	Q1
SN74ALS654DWR	SOIC	DW	24	2000	330.0	24.4	10.75	15.7	2.7	12.0	24.0	Q1

TAPE AND REEL BOX DIMENSIONS



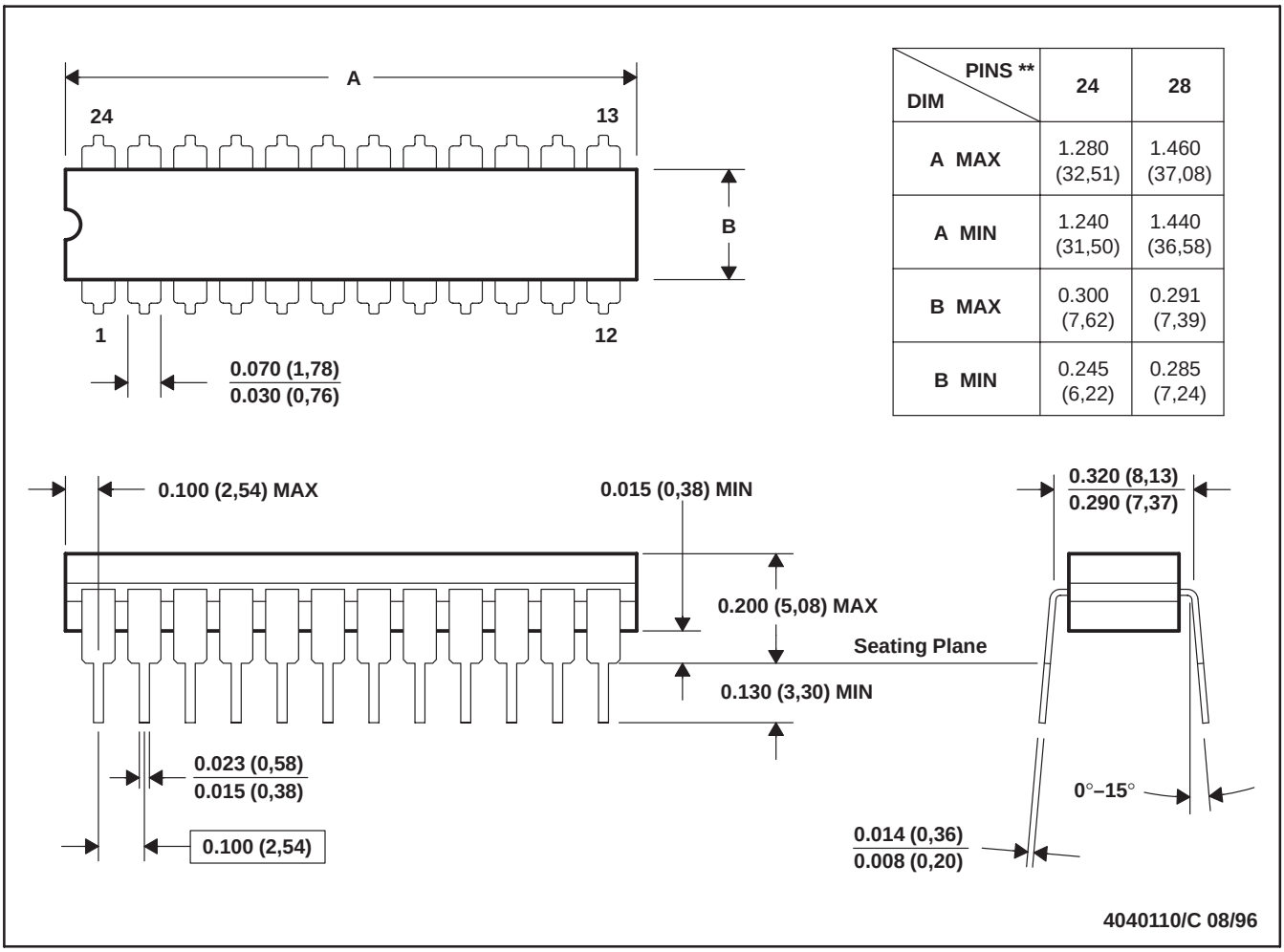
*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74ALS652ADWR	SOIC	DW	24	2000	350.0	350.0	43.0
SN74ALS653DWR	SOIC	DW	24	2000	350.0	350.0	43.0
SN74ALS654DWR	SOIC	DW	24	2000	350.0	350.0	43.0

MCER004A – JANUARY 1995 – REVISED JANUARY 1997

JT (R-GDIP-T)** **CERAMIC DUAL-IN-LINE**

24 LEADS SHOWN

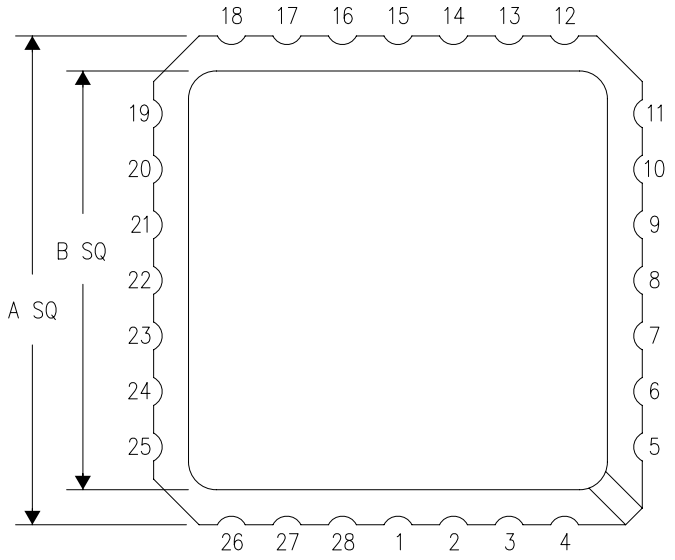


DIM \ PINS **	24	28
A MAX	1.280 (32,51)	1.460 (37,08)
A MIN	1.240 (31,50)	1.440 (36,58)
B MAX	0.300 (7,62)	0.291 (7,39)
B MIN	0.245 (6,22)	0.285 (7,24)

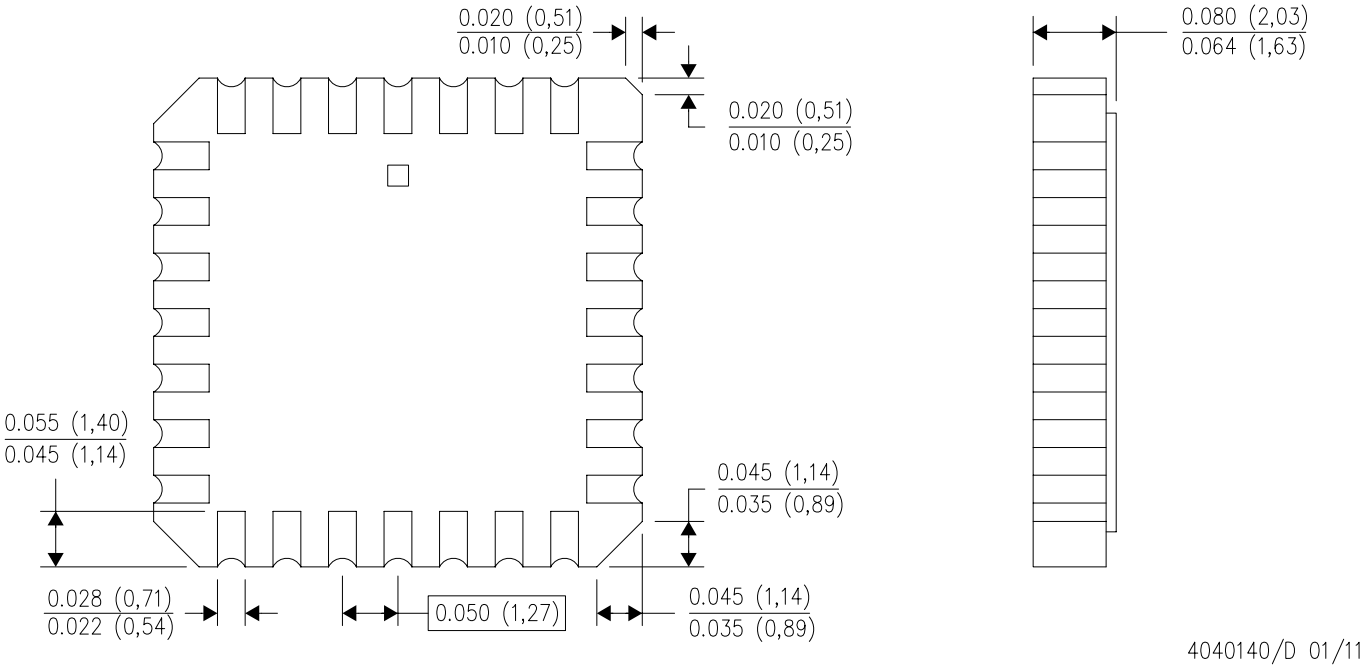
NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification.
E. Falls within MIL STD 1835 GDIP3-T24, GDIP4-T28, and JEDEC MO-058 AA, MO-058 AB

FK (S–CQCC–N**) LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



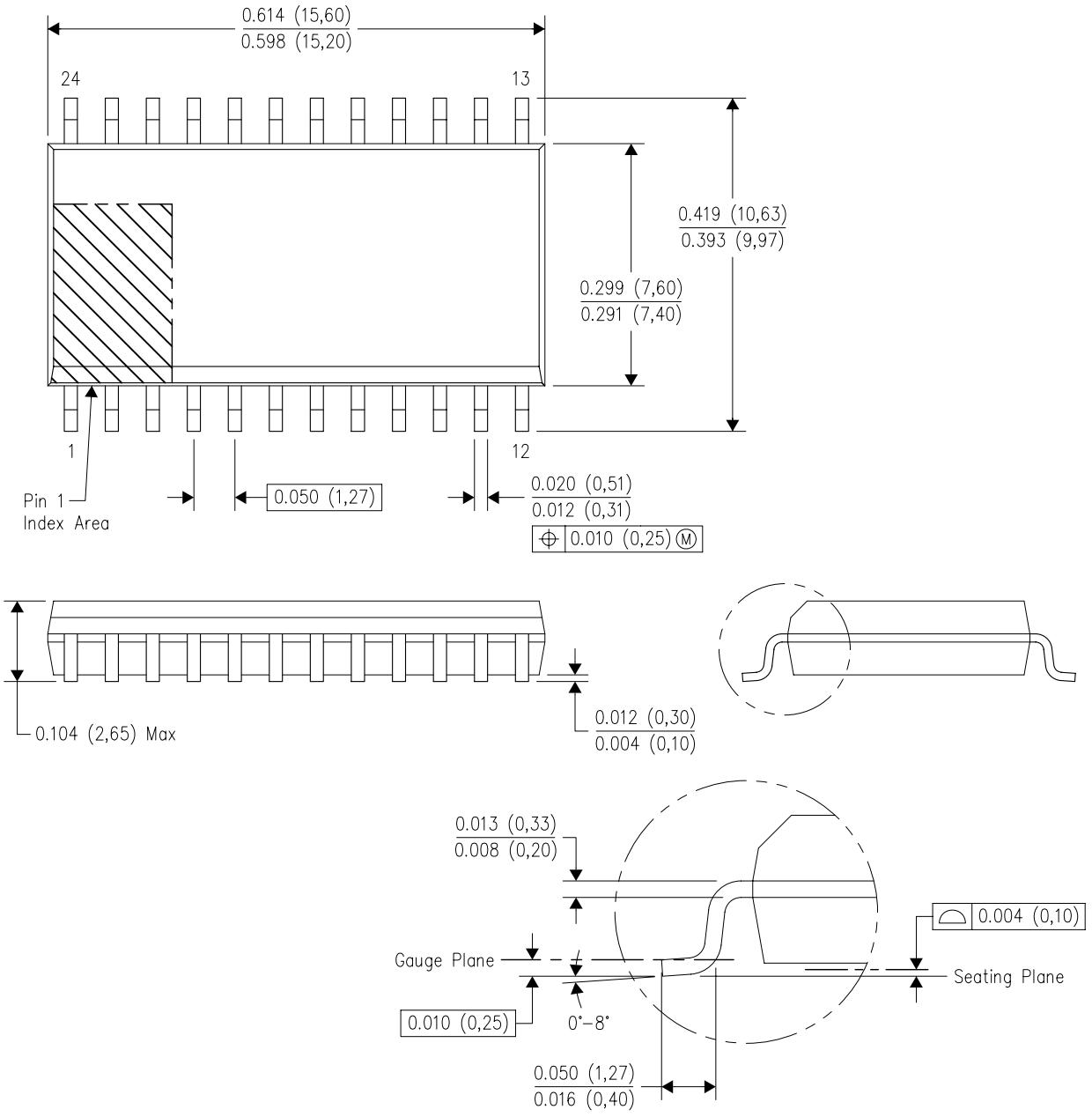
NO. OF TERMINALS **	A		B	
	MIN	MAX	MIN	MAX
20	0.342 (8,69)	0.358 (9,09)	0.307 (7,80)	0.358 (9,09)
28	0.442 (11,23)	0.458 (11,63)	0.406 (10,31)	0.458 (11,63)
44	0.640 (16,26)	0.660 (16,76)	0.495 (12,58)	0.560 (14,22)
52	0.740 (18,78)	0.761 (19,32)	0.495 (12,58)	0.560 (14,22)
68	0.938 (23,83)	0.962 (24,43)	0.850 (21,6)	0.858 (21,8)
84	1.141 (28,99)	1.165 (29,59)	1.047 (26,6)	1.063 (27,0)



4040140/D 01/11

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a metal lid.
D. Falls within JEDEC MS–004

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.

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale (www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2020, Texas Instruments Incorporated