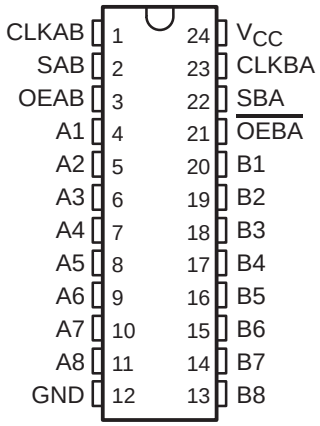
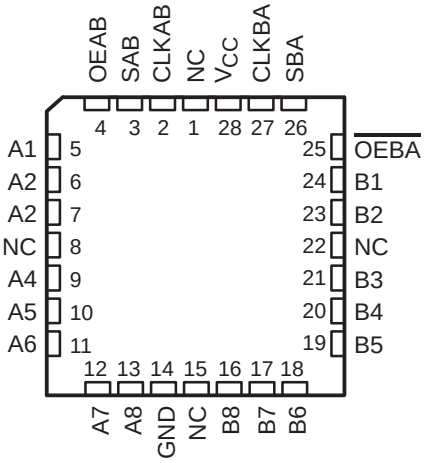
- **Operate From 1.65 V to 3.6 V**
- **Inputs Accept Voltages to 5.5 V**
- **Max t_{pd} of 7.4 ns at 3.3 V**
- **Typical V_{OLP} (Output Ground Bounce) <0.8 V at V_{CC} = 3.3 V, T_A = 25°C**
- **Typical V_{OHV} (Output V_{OH} Undershoot) >2 V at V_{CC} = 3.3 V, T_A = 25°C**
- **Support Mixed-Mode Signal Operation on All Ports (5-V Input/Output Voltage With 3.3-V V_{CC})**
- **I_{off} Supports Partial-Power-Down Mode Operation**
- **ESD Protection Exceeds JESD 22**
  - **2000-V Human-Body Model (A114-A)**
  - **200-V Machine Model (A115-A)**
  - **1000-V Charged-Device Model (C101)**

SN54LVC652A . . . JT OR W PACKAGE
SN74LVC652A . . . DB, DW, NS, OR PW PACKAGE
(TOP VIEW)



SN54LVC652A . . . FK PACKAGE
(TOP VIEW)



NC − No internal connection

description/ordering information

The SN54LVC652A octal bus transceiver and register is designed for 2.7-V to 3.6-V V_{CC} operation, and the SN74LVC652A octal bus transceiver and register is designed for 1.65-V to 3.6-V V_{CC} operation.

ORDERING INFORMATION

T_A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
−40°C to 85°C	SOIC − DW	Tube of 25	SN74LVC652ADW	LVC652A
		Reel of 2000	SN74LVC652ADWR	
	SOP − NS	Reel of 2000	SN74LVC652ANSR	LVC652A
	SSOP − DB	Reel of 2000	SN74LVC652ADBR	LC652A
	TSSOP − PW	Tube of 60	SN74LVC652APW	LC652A
		Reel of 2000	SN74LVC652APWR	
		Reel of 250	SN74LVC652APWT	
−55°C to 125°C	CDIP − JT	Tube of 15	SNJ54LVC652AJT	SNJ54LVC652AJT
	CFP − W	Tube of 85	SNJ54LVC652AW	SNJ54LVC652AW
	LCCC − FK	Tube of 42	SNJ54LVC652AFK	SNJ54LVC652AFK

† 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)

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 whether real-time or stored data is transferred. 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 selects real-time data, and a high input selects stored data. Figure 1 illustrates the four fundamental bus-management functions that are performed with the ’LVC652A devices.

Data on the A or B data bus, or both, is stored in the internal D-type flip-flops by low-to-high transitions at the appropriate clock (CLKAB or CLKBA) inputs, regardless of the select- or enable-control pins. 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.

Inputs can be driven from either 3.3-V or 5-V devices. This feature allows the use of these devices as translators in a mixed 3.3-V/5-V system environment.

These devices are fully specified for partial-power-down applications using I_{off}. The I_{off} circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down.

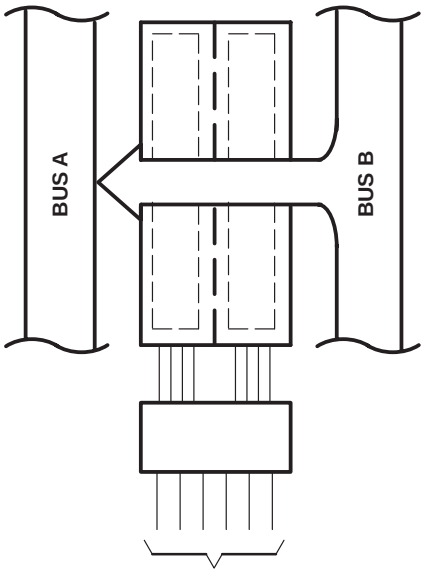
To ensure the high-impedance state during power up or power down, $\overline{\text{OEBA}}$ should be tied to V_{CC} through a pullup resistor and OEAB should be tied to GND through a pulldown resistor; the minimum value of the resistor is determined by the current-sinking/current-sourcing capability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

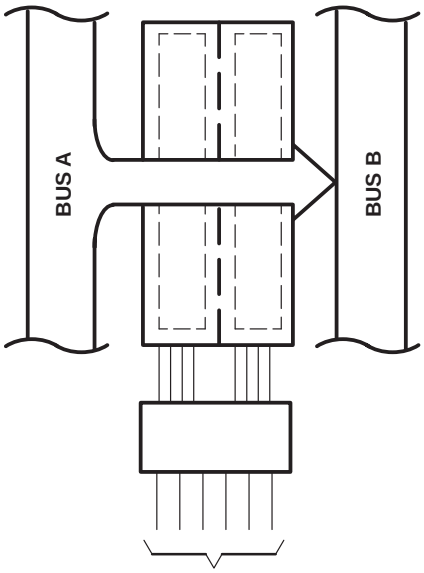
† The data-output functions can be enabled or disabled by a variety of level combinations at OEAB or $\overline{\text{OEBA}}$. Data-input functions always are enabled; i.e., data at the bus terminals is stored on every low-to-high transition of the clock inputs.

‡ Select control = L; clocks can occur simultaneously.
Select control = H; clocks must be staggered to load both registers.



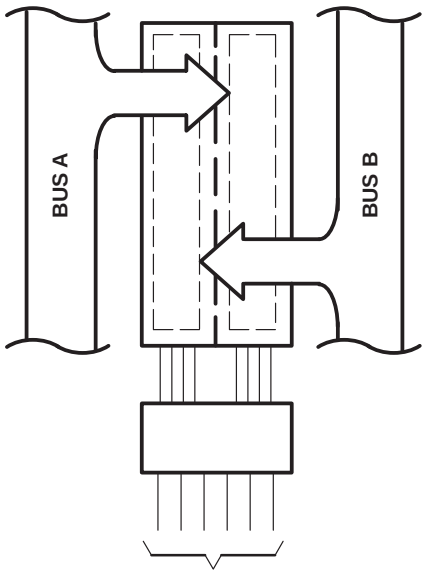
3	21	1	23	2	22
OEAB	$\overline{\text{OEBA}}$	CLKAB	CLKBA	SAB	SBA
L	L	X	X	X	L

REAL-TIME TRANSFER
BUS B TO BUS A



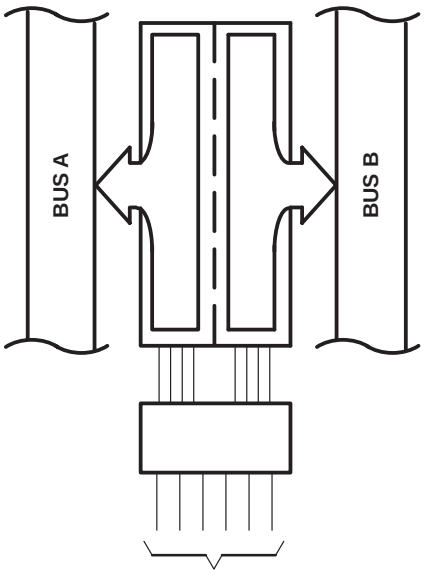
3	21	1	23	2	22
OEAB	$\overline{\text{OEBA}}$	CLKAB	CLKBA	SAB	SBA
H	H	X	X	L	X

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

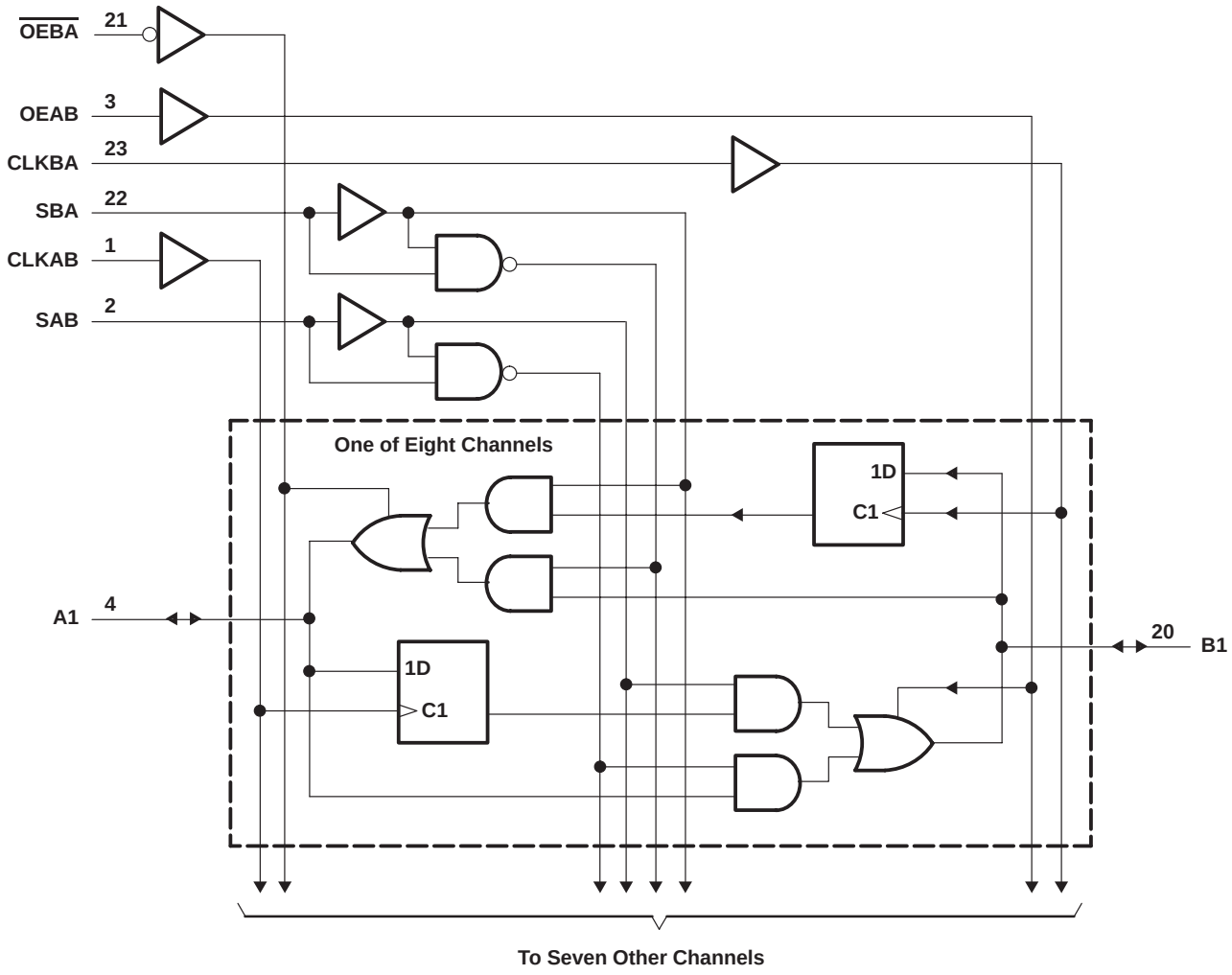


3	21	1	23	2	22
OEAB	$\overline{\text{OEBA}}$	CLKAB	CLKBA	SAB	SBA
H	L	H or L	H or L	H	H

TRANSFER STORED DATA
TO A AND/OR B

Figure 1. Bus-Management Functions

logic diagram (positive logic)



Pin numbers shown are for the DB, DW, JT, NS, PW, and W packages.

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

Supply voltage range, V_{CC} . . . . . −0.5 V to 6.5 V
Input voltage range, V_I (see Note 1) . . . . . −0.5 V to 6.5 V
Voltage range applied to any output in the high-impedance or power-off state, V_O (see Note 1) . . . . . −0.5 V to 6.5 V
Voltage range applied to any output in the high or low state, V_O (see Notes 1 and 2) . . . . . −0.5 V to V_{CC} + 0.5 V
Input clamp current, I_{IK} (V_I < 0) . . . . . −50 mA
Output clamp current, I_{OK} (V_O < 0) . . . . . −50 mA
Continuous output current, I_O . . . . . ±50 mA
Continuous current through V_{CC} or GND . . . . . ±100 mA
Package thermal impedance, θ_{JA} (see Note 3): DB package . . . . . 63°C/W
DW package . . . . . 46°C/W
NS package . . . . . 65°C/W
PW package . . . . . 88°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 negative-voltage and output voltage ratings may be exceeded if the input and output current ratings are observed.
2. The value of V_{CC} is provided in the recommended operating conditions table.
3. The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions (see Note 4)

			SN54LVC652A		SN74LVC652A		UNIT
			MIN	MAX	MIN	MAX	
V_{CC}	Supply voltage	Operating	2	3.6	1.65	3.6	V
		Data retention only	1.5		1.5		
V_{IH}	High-level input voltage	V_{CC} = 1.65 V to 1.95 V			0.65 × V_{CC}		V
		V_{CC} = 2.3 V to 2.7 V			1.7		
		V_{CC} = 2.7 V to 3.6 V	2		2		
V_{IL}	Low-level input voltage	V_{CC} = 1.65 V to 1.95 V				0.35 × V_{CC}	V
		V_{CC} = 2.3 V to 2.7 V				0.7	
		V_{CC} = 2.7 V to 3.6 V		0.8		0.8	
V_I	Input voltage		0	5.5	0	5.5	V
V_O	Output voltage	High or low state	0	V_{CC}	0	V_{CC}	V
		3-state	0	5.5	0	5.5	
I_{OH}	High-level output current	V_{CC} = 1.65 V				−4	mA
		V_{CC} = 2.3 V				−8	
		V_{CC} = 2.7 V		−12		−12	
		V_{CC} = 3 V		−24		−24	
I_{OL}	Low-level output current	V_{CC} = 1.65 V				4	mA
		V_{CC} = 2.3 V				8	
		V_{CC} = 2.7 V		12		12	
		V_{CC} = 3 V		24		24	
$\Delta t/\Delta v$	Input transition rise or fall rate			5		5	ns/V
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}	SN54LVC652A			SN74LVC652A			UNIT
					MIN	TYP†	MAX	MIN	TYP†	MAX	
V_{OH}		I_{OH} = −100 μA		1.65 V to 3.6 V				V_{CC}−0.2			V
				2.7 V to 3.6 V	V_{CC}−0.2						
		I_{OH} = −4 mA		1.65 V				1.2			
		I_{OH} = −8 mA		2.3 V				1.7			
		I_{OH} = −12 mA		2.7 V	2.2			2.2			
				3 V	2.4			2.4			
		I_{OH} = −24 mA		3 V	2.2			2.2			
V_{OL}		I_{OL} = 100 μA		1.65 V to 3.6 V						0.2	V
				2.7 V to 3.6 V			0.2				
		I_{OL} = 4 mA		1.65 V						0.45	
		I_{OL} = 8 mA		2.3 V						0.7	
		I_{OL} = 12 mA		2.7 V			0.4			0.4	
		I_{OL} = 24 mA		3 V			0.55			0.55	
I_I	Control inputs	V_I = 0 to 5.5 V		3.6 V			±5			±5	μA
I_{off}		V_I or V_O = 5.5 V		0						±10	μA
I_{OZ}‡		V_O = 0 to 5.5 V		3.6 V			±15			±10	μA
I_{CC}		V_I = V_{CC} or GND	I_O = 0	3.6 V			10			10	μA
		3.6 V ≤ V_I ≤ 5.5 V§					10			10	
ΔI_{CC}		One input at V_{CC} − 0.6 V, Other inputs at V_{CC} or GND		2.7 V to 3.6 V			500			500	μA
C_i	Control inputs	V_I = V_{CC} or GND		3.3 V		4.5			4.5		pF
C_{io}	A or B ports	V_O = V_{CC} or GND		3.3 V		7.5			7.5		pF

† All typical values are at V_{CC} = 3.3 V, T_A = 25°C.
‡ For I/O ports, the parameter I_{OZ} includes the input leakage current.
§ This applies in the disabled state only.

timing requirements over recommended operating free-air temperature range (unless otherwise noted) (see Figure 2)

		SN54LVC652A				UNIT
		V_{CC} = 2.7 V		V_{CC} = 3.3 V ± 0.3 V		
		MIN	MAX	MIN	MAX	
f_{clock}	Clock frequency		80		100	MHz
t_w	Pulse duration	3.3		3.3		ns
t_{su}	Setup time, data before CLK↑	1.6		1.5		ns
t_h	Hold time, data after CLK↑	0.5		1.5		ns

timing requirements over recommended operating free-air temperature range (unless otherwise noted) (see Figure 2)

		SN74LVC652A								UNIT
		V_{CC} = 1.8 V ± 0.15 V		V_{CC} = 2.5 V ± 0.2 V		V_{CC} = 2.7 V		V_{CC} = 3.3 V ± 0.3 V		
		MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
f_{clock}	Clock frequency		†		†		80		100	MHz
t_w	Pulse duration	†		†		3.3		3.3		ns
t_{su}	Setup time, data before CLK↑	†		†		1.9		1.9		ns
t_h	Hold time, data after CLK↑	†		†		1.5		1.7		ns

† This information was not available at the time of publication.

switching characteristics over recommended operating free-air temperature range (unless otherwise noted) (see Figure 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54LVC652A				UNIT
			V_{CC} = 2.7 V		V_{CC} = 3.3 V ± 0.3 V		
			MIN	MAX	MIN	MAX	
f_{max}			80		100		MHz
t_{pd}	A or B	B or A		7.8	1	7.4	ns
	CLK	A or B		8.4	1	8	
	SAB or SBA	B or A		9.6	1	8.7	
t_{en}	$\overline{OEBA}$	A		8.9	1	7.4	ns
t_{dis}	$\overline{OEBA}$	A		8.1	1	7.5	ns
t_{en}	OEAB	B		8.6	1	7.1	ns
t_{dis}	OEAB	B		7.7	1	7.4	ns

switching characteristics over recommended operating free-air temperature range (unless otherwise noted) (see Figure 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN74LVC652A								UNIT
			V_{CC} = 1.8 V ± 0.15 V		V_{CC} = 2.5 V ± 0.2 V		V_{CC} = 2.7 V		V_{CC} = 3.3 V ± 0.3 V		
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
f_{max}			†		†		80		100		MHz
t_{pd}	A or B	B or A	†	†	†	†		7.8	1.5	7.4	ns
	CLK	A or B	†	†	†	†		8.4	1.5	8	
	SAB or SBA	B or A	†	†	†	†		9.6	1.5	8.7	
t_{en}	$\overline{OEBA}$	A	†	†	†	†		8.9	1.5	7.4	ns
t_{dis}	$\overline{OEBA}$	A	†	†	†	†		8.1	1.5	7.5	ns
t_{en}	OEAB	B	†	†	†	†		8.6	1.5	7.1	ns
t_{dis}	OEAB	B	†	†	†	†		7.7	1.5	7.4	ns

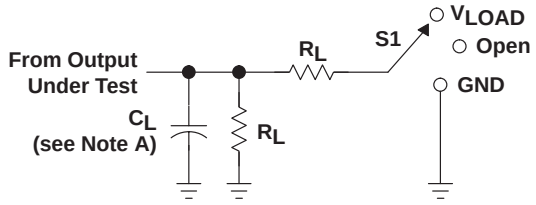
† This information was not available at the time of publication.

operating characteristics, $T_A = 25°C$

PARAMETER			TEST CONDITIONS	V_{CC} = 1.8 V	V_{CC} = 2.5 V	V_{CC} = 3.3 V	UNIT
				TYP	TYP	TYP	
C_{pd}	Power dissipation capacitance per transceiver	Outputs enabled	f = 10 MHz	†	†	84	pF
		Outputs disabled		†	†	9.5	

† This information was not available at the time of publication.

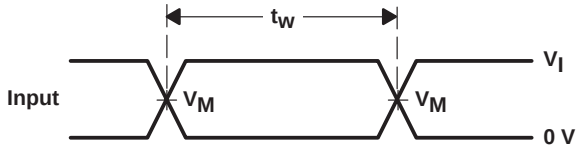
PARAMETER MEASUREMENT INFORMATION



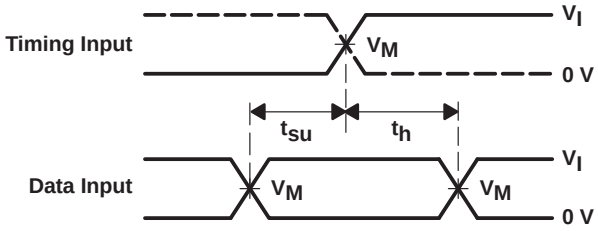
LOAD CIRCUIT

TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	V_{LOAD}
t_{PHZ}/t_{PZH}	GND

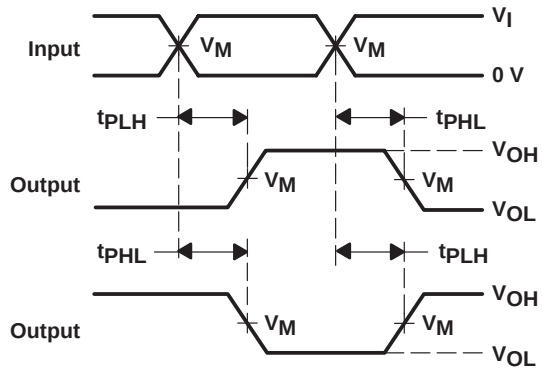
V_{CC}	INPUTS		V_M	V_{LOAD}	C_L	R_L	V_Δ
	V_I	t_r/t_f					
1.8 V ± 0.15 V	V_{CC}	≤2 ns	$V_{CC}/2$	$2 \times V_{CC}$	30 pF	1 kΩ	0.15 V
2.5 V ± 0.2 V	V_{CC}	≤2 ns	$V_{CC}/2$	$2 \times V_{CC}$	30 pF	500 Ω	0.15 V
2.7 V	2.7 V	≤2.5 ns	1.5 V	6 V	50 pF	500 Ω	0.3 V
3.3 V ± 0.3 V	2.7 V	≤2.5 ns	1.5 V	6 V	50 pF	500 Ω	0.3 V



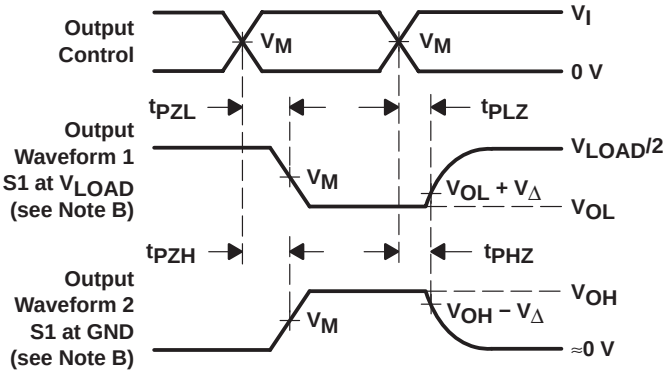
VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
INVERTING AND NONINVERTING OUTPUTS



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES
LOW- AND HIGH-LEVEL ENABLING

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 ≤ 10 MHz, Z_O = 50 Ω.
D. The outputs are measured one at a time with one transition per measurement.
E. t_{PLZ} and t_{PHZ} are the same as t_{dis}.
F. t_{PZL} and t_{PZH} are the same as t_{en}.
G. t_{PLH} and t_{PHL} are the same as t_{pd}.
H. All parameters and waveforms are not applicable to all devices.

Figure 2. Load Circuit and Voltage Waveforms

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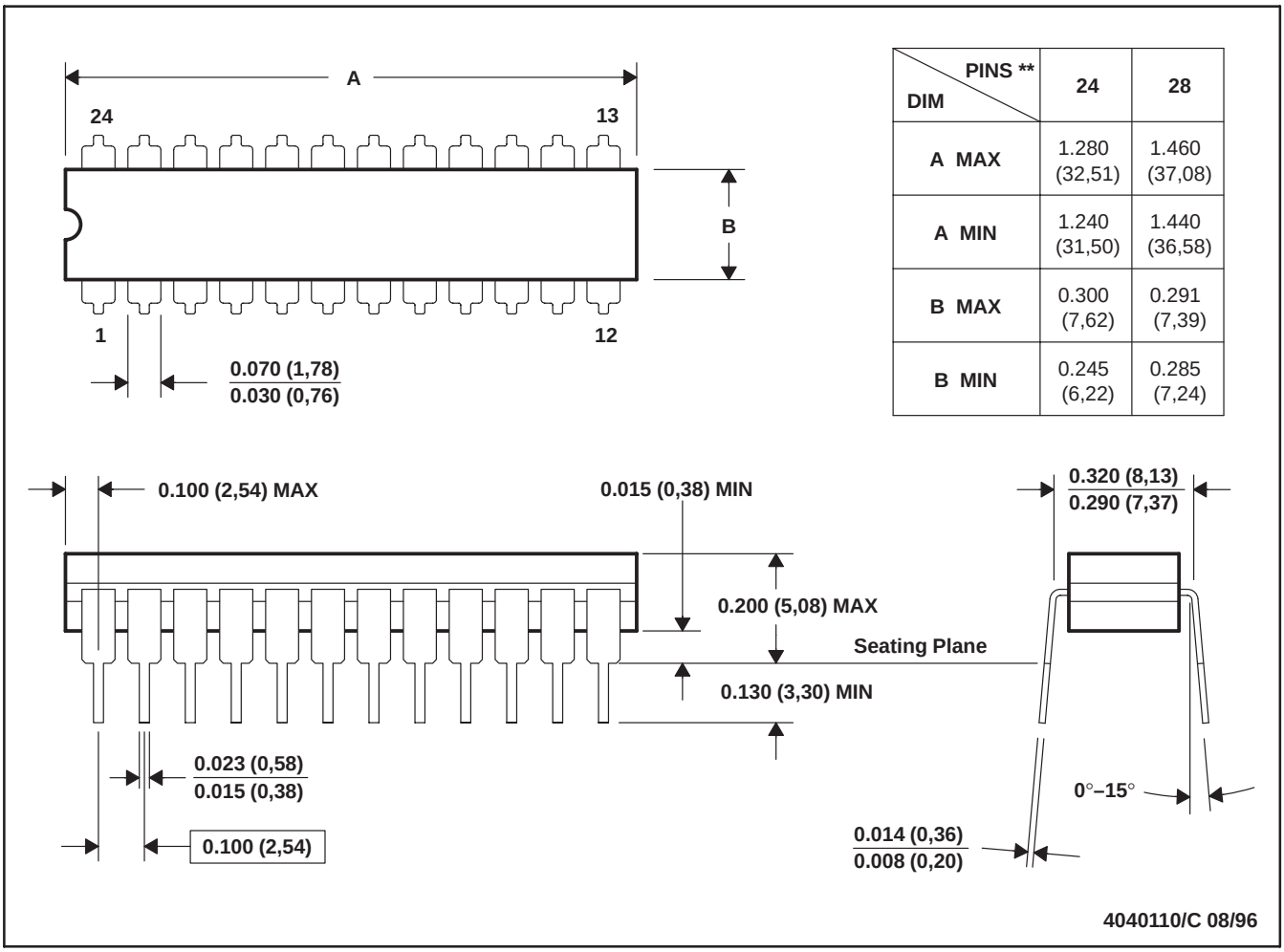
JT (R-GDIP-T)** **CERAMIC DUAL-IN-LINE**

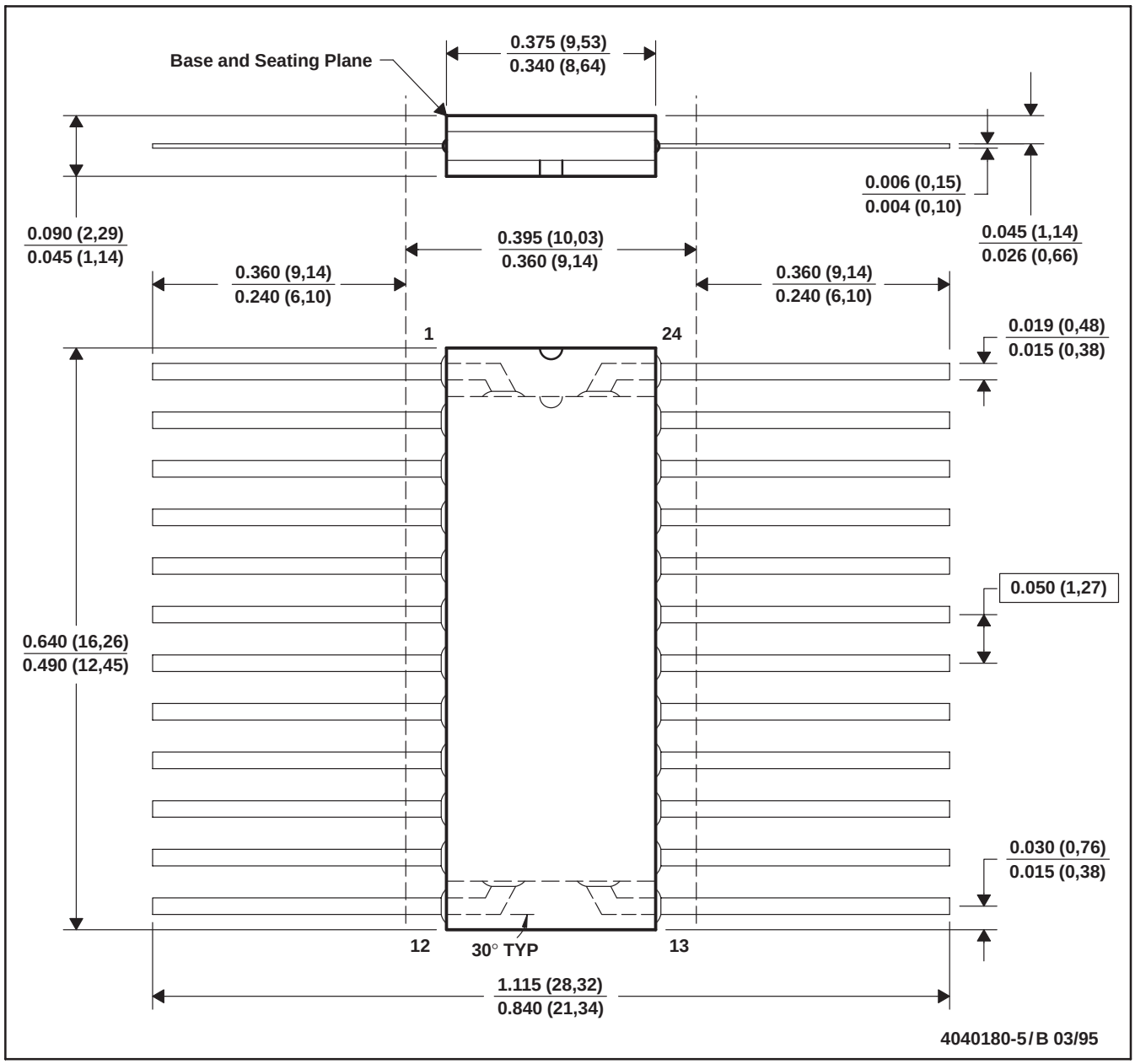
24 LEADS SHOWN



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

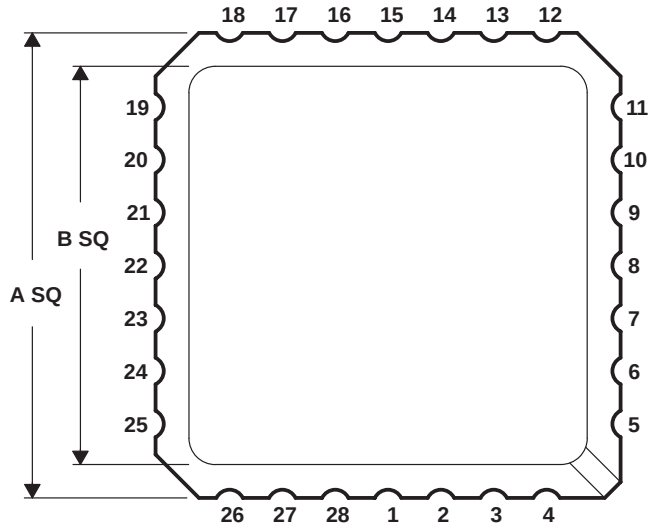
W (R-GDFP-F24) **CERAMIC DUAL FLATPACK**



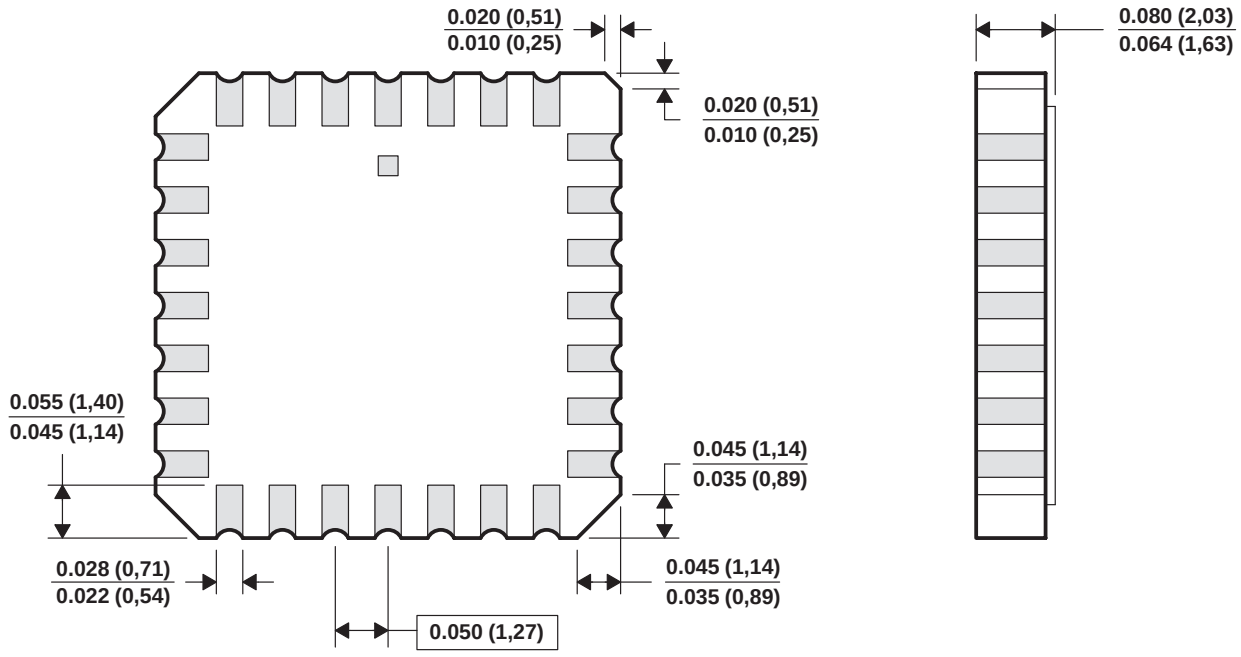
NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a ceramic lid using glass frit.
D. Falls within MIL-STD-1835 GDFP2-F24 and JEDEC MO-070AD
E. Index point is provided on cap for terminal identification only.

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

28 TERMINAL SHOWN



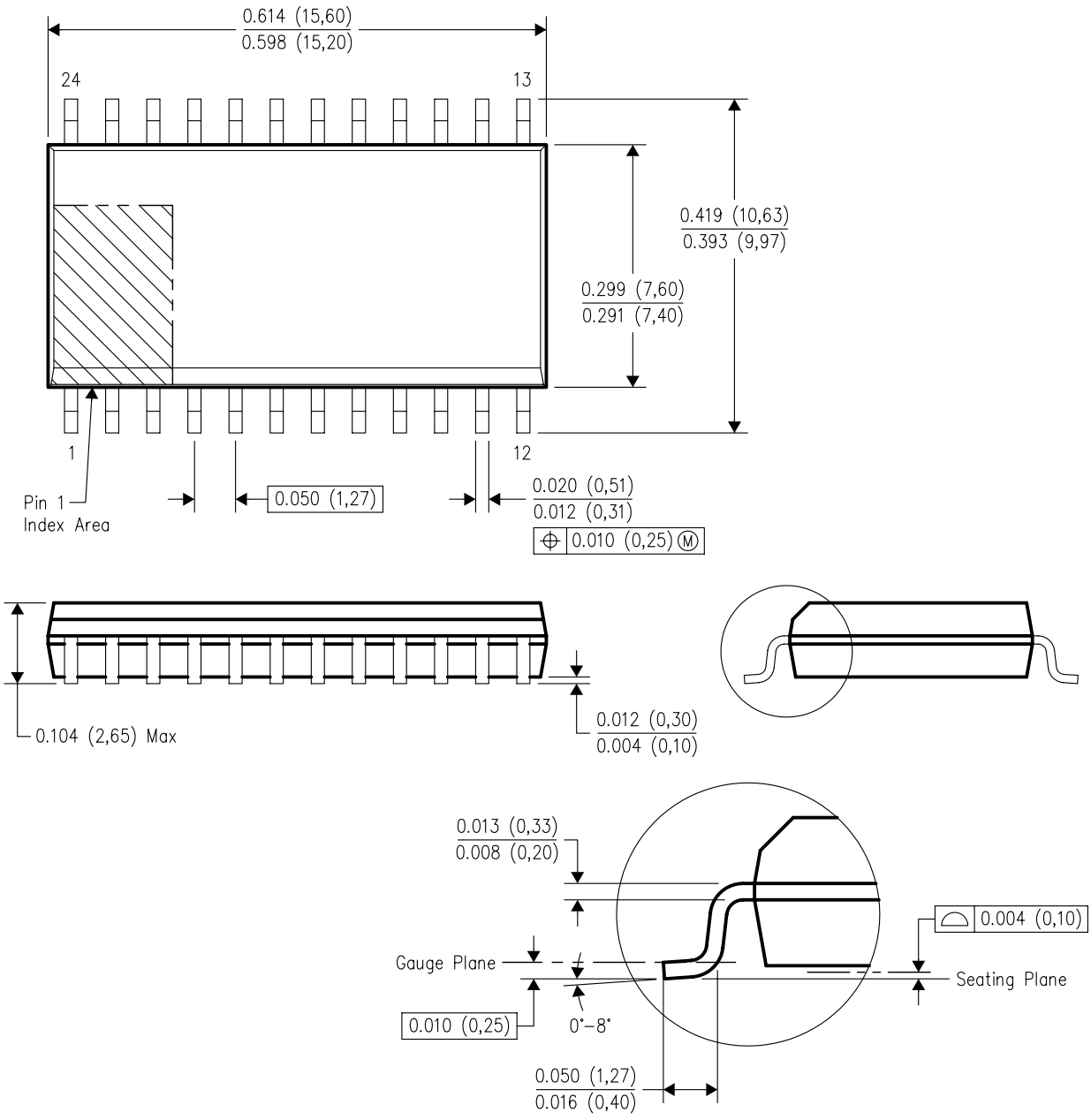
NO. OF TERMINALS **	A		B	
	MIN	MAX	MIN	MAX
20	0.342 (8,69)	0.358 (9,09)	0.307 (7,80)	0.358 (9,09)
28	0.442 (11,23)	0.458 (11,63)	0.406 (10,31)	0.458 (11,63)
44	0.640 (16,26)	0.660 (16,76)	0.495 (12,58)	0.560 (14,22)
52	0.739 (18,78)	0.761 (19,32)	0.495 (12,58)	0.560 (14,22)
68	0.938 (23,83)	0.962 (24,43)	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 10/96

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. The terminals are gold plated.
E. Falls within JEDEC MS-004

DW (R–PDSO–G24) PLASTIC SMALL–OUTLINE PACKAGE

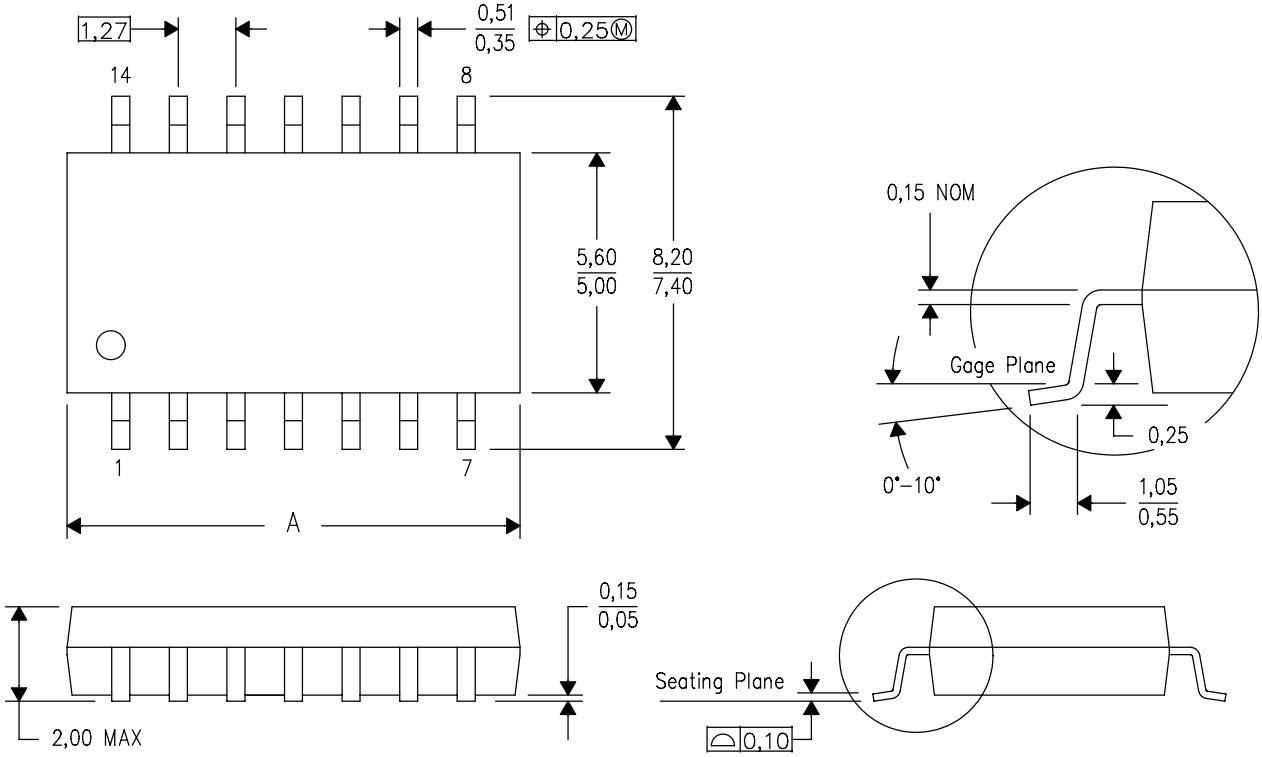


NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
D. Falls within JEDEC MS–013 variation AD.

MECHANICAL DATA

NS (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14-PINS SHOWN



DIM \ PINS **	14	16	20	24
A MAX	10,50	10,50	12,90	15,30
A MIN	9,90	9,90	12,30	14,70

4040062/C 03/03

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

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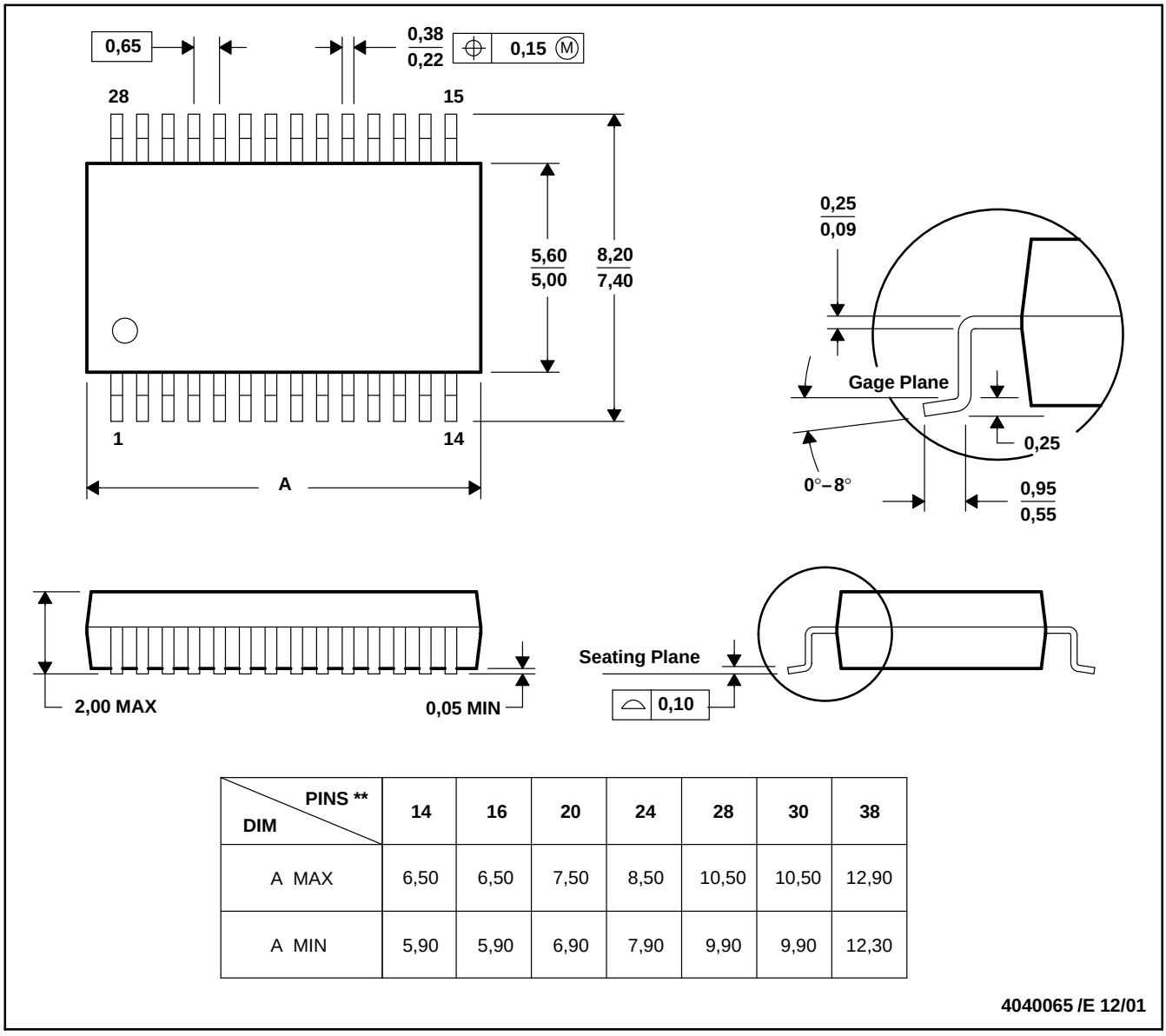
DB (R-PDSO-G)** **PLASTIC SMALL-OUTLINE**

28 PINS SHOWN



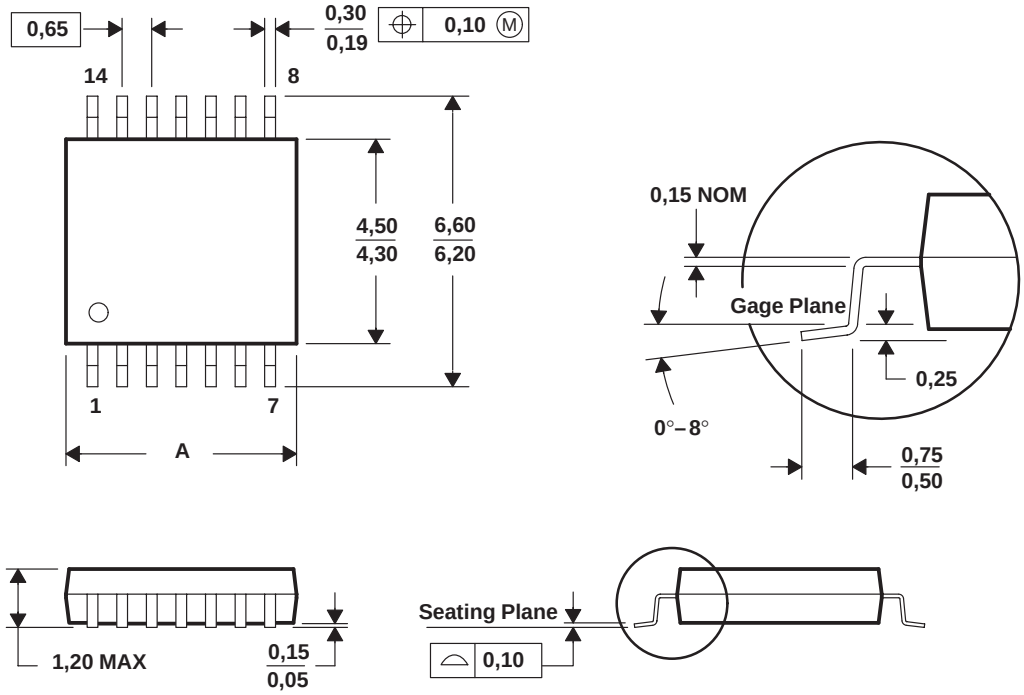
DIM \ PINS **	14	16	20	24	28	30	38
A MAX	6,50	6,50	7,50	8,50	10,50	10,50	12,90
A MIN	5,90	5,90	6,90	7,90	9,90	9,90	12,30

4040065 /E 12/01

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
D. Falls within JEDEC MO-150

PW (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14 PINS SHOWN



DIM \ PINS **	8	14	16	20	24	28
A MAX	3,10	5,10	5,10	6,60	7,90	9,80
A MIN	2,90	4,90	4,90	6,40	7,70	9,60

4040064/F 01/97

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
D. Falls within JEDEC MO-153

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