



# SN74FB1651

## 17-BIT TTL/BTL UNIVERSAL STORAGE TRANSCEIVER WITH BUFFERED CLOCK LINE

SCBS1770 – OCTOBER 1993 – REVISED MARCH 2004

### description/ordering information

The SN74FB1651 contains an 8-bit and 9-bit transceiver with a buffered clock. The clock and the transceivers are designed to translate signals between TTL and backplane transceiver-logic (BTL) environments. The device is designed specifically to be compatible with IEEE Std 1194.1-1991.

The  $\bar{B}$  port operates at BTL-signal levels. The open-collector  $\bar{B}$  ports are specified to sink 100 mA. Two output enables (OEB and  $\overline{OEB}$ ) are provided for the  $\bar{B}$  outputs. When OEB is low,  $\overline{OEB}$  is high, or  $V_{CC}$  is less than 2.1 V, the  $\bar{B}$  port is turned off.

The A port operates at TTL-signal levels. The A outputs reflect the inverse of the data at the  $\bar{B}$  port when the A-port output enable (OEA) is high. When OEA is low or when  $V_{CC}$  is less than 2.1 V, the A outputs are in the high-impedance state.

BIAS  $V_{CC}$  establishes a voltage between 1.62 V and 2.1 V on the BTL outputs when  $V_{CC}$  is not connected.

BG  $V_{CC}$  and BG GND are the supply inputs for the bias generator.

### ORDERING INFORMATION

TA	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	TQFP – PCA	Tube	SN74FB1651PCA	FB1651

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

### Function Tables

#### TRANSCEIVER

INPUTS				FUNCTION
$\overline{OEA}$	OEA	OEB	$\overline{OEB}$	
X	X	H	L	$\bar{A}$ data to B bus
L	H	X	X	$\bar{B}$ data to A bus
L	H	H	L	$\bar{A}$ data to B bus, $\bar{B}$ data to A bus
X	X	L	X	B-bus isolation
X	X	X	H	
H	X	X	X	A-bus isolation
X	L	X	X	

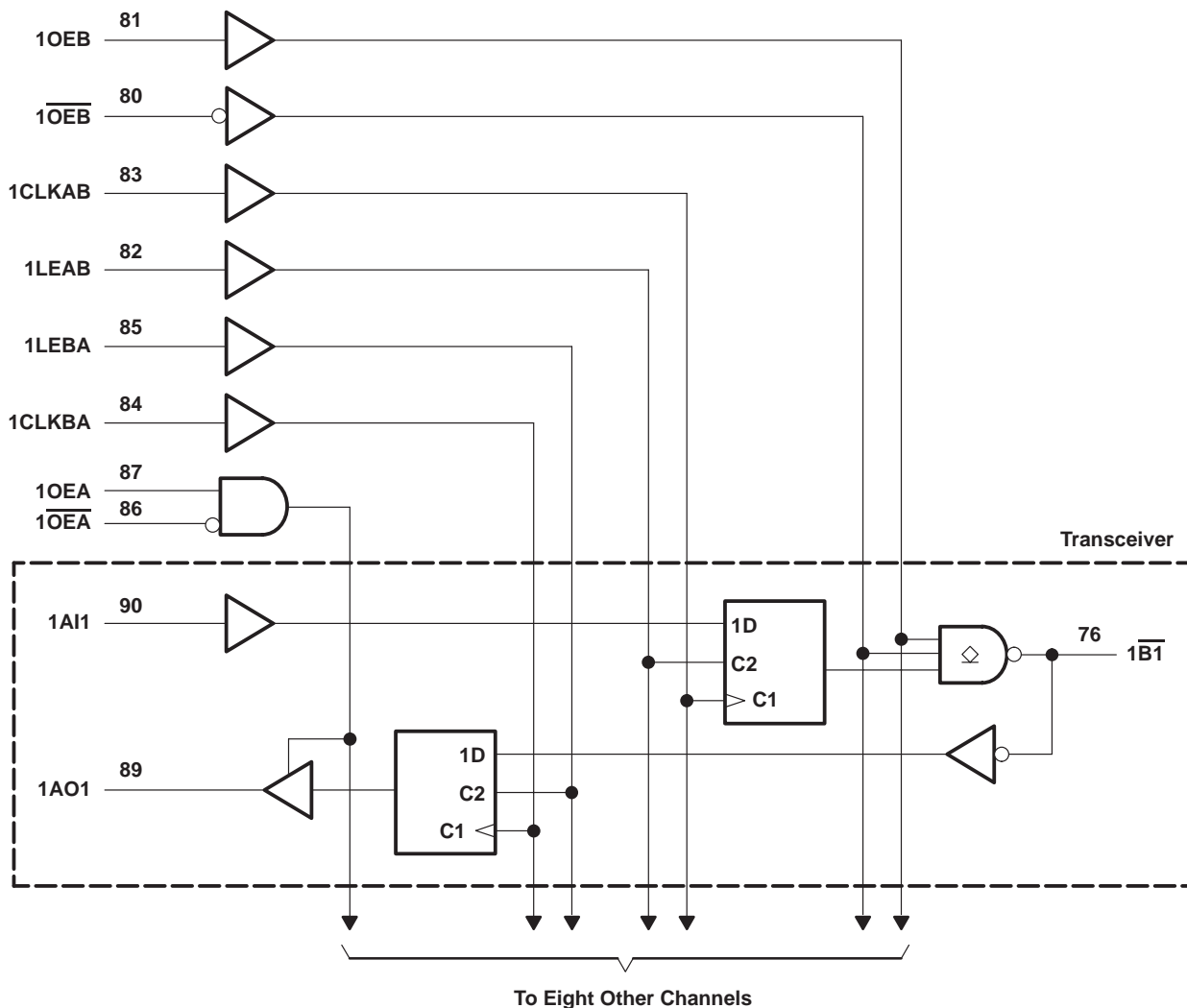
#### STORAGE MODE

INPUTS		FUNCTION
LE	CLK	
H	X	Transparent
L	↑	Store data
L	L	Storage

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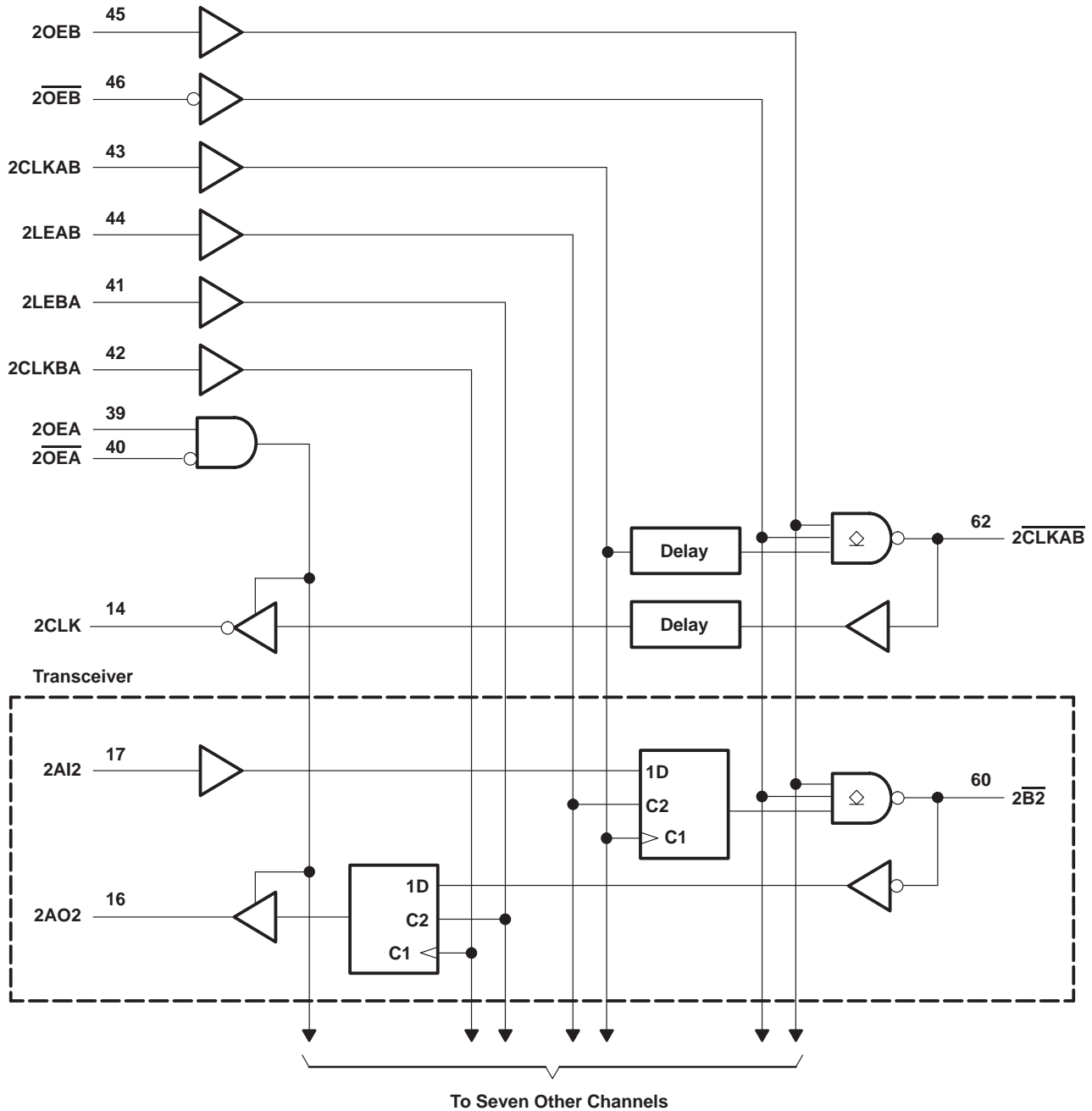
functional block diagram



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**functional block diagram (continued)**



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

Supply voltage range, $V_{CC}$ , BIAS $V_{CC}$ , BG $V_{CC}$ .....	–0.5 V to 7 V
Input voltage range, $V_I$ : Except $\overline{B}$ port .....	–1.2 V to 7 V
$\overline{B}$ port .....	–1.2 V to 3.5 V
Voltage range applied to any $\overline{B}$ output in the disabled or power-off state, $V_O$ .....	–0.5 V to 3.5 V
Voltage range applied to any output in the high state, $V_O$ .....	–0.5 V to $V_{CC}$
Input clamp current, $I_{IK}$ : Except $\overline{B}$ port .....	–40 mA
$\overline{B}$ port .....	–18 mA
Current applied to any single output in the low state, $I_O$ : A port .....	48 mA
$\overline{B}$ port .....	200 mA
Package thermal impedance, $\theta_{JA}$ (see Note 1) .....	22°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 51-7.

### recommended operating conditions (see Note 2)

		MIN	NOM	MAX	UNIT
$V_{CC}$ , BG $V_{CC}$ , BIAS $V_{CC}$	Supply voltage	4.5	5	5.5	V
$V_{IH}$	High-level input voltage	$\overline{B}$ port	1.62	2.3	V
		Except $\overline{B}$ port	2		
$V_{IL}$	Low-level input voltage	$\overline{B}$ port	0.75	1.47	V
		Except $\overline{B}$ port		0.8	
$I_{IK}$	Input clamp current			–18	mA
$I_{OH}$	High-level output current			–3	mA
$I_{OL}$	Low-level output current	A port		24	mA
		$\overline{B}$ port		100	
$T_A$	Operating free-air temperature	0		70	°C

NOTE 2: To ensure proper device operation, all unused inputs must be terminated as follows: A and control inputs to  $V_{CC}$ (5 V) or GND, and B inputs to GND only. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.



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### electrical characteristics over recommended operating free-air temperature range

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT
V <sub>IK</sub>	$\bar{B}$ port	V <sub>CC</sub> = 4.5 V,	I <sub>I</sub> = -18 mA			-1.2	V
	Except $\bar{B}$ port	V <sub>CC</sub> = 4.5 V,	I <sub>I</sub> = -40 mA			-0.5	
V <sub>OH</sub>	AO port	V <sub>CC</sub> = 4.5 V,	I <sub>OH</sub> = -3 mA	2.5	3.3		V
V <sub>OL</sub>	AO port	V <sub>CC</sub> = 4.5 V,	I <sub>OL</sub> = 24 mA		0.35	0.5	V
	$\bar{B}$ port	V <sub>CC</sub> = 4.5 V	I <sub>OL</sub> = 80 mA		0.75	1.1	
			I <sub>OL</sub> = 100 mA				
I <sub>I</sub>	Except $\bar{B}$ port	V <sub>CC</sub> = 5.5 V,	V <sub>I</sub> = 5.5 V			50	μA
I <sub>IH</sub> ‡	Except $\bar{B}$ port	V <sub>CC</sub> = 5.5 V,	V <sub>I</sub> = 2.7 V			50	μA
I <sub>IL</sub> ‡	Except $\bar{B}$ port	V <sub>CC</sub> = 5.5 V,	V <sub>I</sub> = 0.5 V			-50	μA
	$\bar{B}$ port	V <sub>CC</sub> = 5.5 V,	V <sub>I</sub> = 0.75 V			-100	
I <sub>OZH</sub>	AO port	V <sub>CC</sub> = 5.5 V,	V <sub>O</sub> = 2.7 V			50	μA
I <sub>OZL</sub>	AO port	V <sub>CC</sub> = 5.5 V,	V <sub>O</sub> = 0.5 V			-50	μA
I <sub>OZPU</sub>	AO port	V <sub>CC</sub> = 0 to 2.1 V,	V <sub>O</sub> = 0.5 V to 2.7 V			50	μA
I <sub>OZPD</sub>	AO port	V <sub>CC</sub> = 2.1 V to 0,	V <sub>O</sub> = 0.5 V to 2.7 V			-50	μA
I <sub>OH</sub>	$\bar{B}$ port	V <sub>CC</sub> = 0 to 5.5 V,	V <sub>O</sub> = 2.1 V			100	μA
I <sub>OS</sub> §	A port	V <sub>CC</sub> = 5.5 V,	V <sub>O</sub> = 0	-30		-150	mA
I <sub>CC</sub>	A port to $\bar{B}$ port	V <sub>CC</sub> = 5.5 V,	I <sub>O</sub> = 0			100	mA
	$\bar{B}$ port to A port					120	
C <sub>i</sub>	AI port	V <sub>I</sub> = 0.5 V or 2.5 V			5.5		pF
	Control inputs				5.5		
C <sub>o</sub>	AO ports	V <sub>O</sub> = 0.5 V or 2.5 V			5.5		pF
C <sub>io</sub>	$\bar{B}$ port per IEEE Std 1194.1-1991	V <sub>CC</sub> = 0 to 5.5 V				5.5	pF

† All typical values are at V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C.

‡ For I/O ports, the parameters I<sub>IH</sub> and I<sub>IL</sub> include the off-state output current.

§ Not more than one output should be shorted at a time, and the duration of the short circuit should not exceed one second.

### live-insertion specifications over recommended operating free-air temperature range

PARAMETER		TEST CONDITIONS		MIN	MAX	UNIT
I <sub>CC</sub> (BIAS V <sub>CC</sub> )	V <sub>CC</sub> = 0 to 4.5 V	V <sub>B</sub> = 0 to 2 V,	V <sub>I</sub> (BIAS V <sub>CC</sub> ) = 4.5 V to 5.5 V		450	μA
	V <sub>CC</sub> = 4.5 V to 5.5 V				10	
V <sub>O</sub>	$\bar{B}$ port	V <sub>CC</sub> = 0,	V <sub>I</sub> (BIAS V <sub>CC</sub> ) = 5 V	1.62	2.1	V
I <sub>O</sub>	$\bar{B}$ port	V <sub>CC</sub> = 0,	V <sub>B</sub> = 1 V,	V <sub>I</sub> (BIAS V <sub>CC</sub> ) = 4.5 V to 5.5 V	-1	μA
		V <sub>CC</sub> = 0 to 2.2 V,	OEB = 0 to 5 V		100	
		V <sub>CC</sub> = 0 to 5.5 V,	OEB = 0 to 0.8 V		1	mA



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timing requirements over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 1)

			$V_{CC} = 5\text{ V},$ $T_A = 25^\circ\text{C}$		MIN	MAX	UNIT
			MIN	MAX			
$f_{\text{clock}}$	Clock frequency		150		150		MHz
$t_w$	Pulse duration	CLK or LE	3.3		3.3		ns
$t_{\text{su}}$	Setup time	Data before LE	4.8		4.8		ns
		Data before CLK $\uparrow$	4.9		4.6		
$t_h$	Hold time	Data after LE	1.8		1.8		ns
		Data after CLK $\uparrow$	1.1		1.1		

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## 17-BIT TTL/BTL UNIVERSAL STORAGE TRANSCEIVER WITH BUFFERED CLOCK LINE

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switching characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 1)

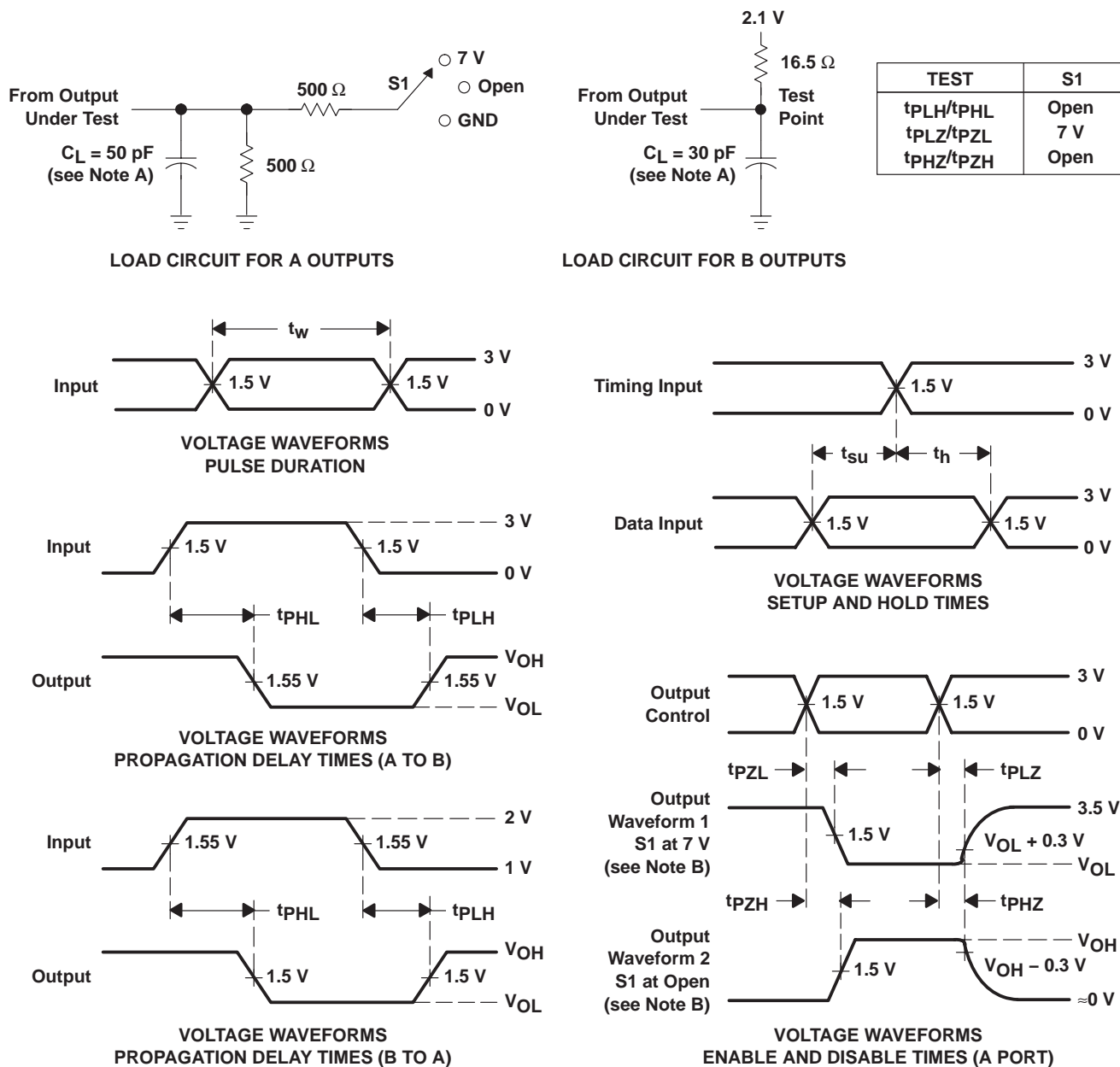
PARAMETER	FROM (INPUT)	TO (OUTPUT)	V <sub>CC</sub> = 5 V, T <sub>A</sub> = 25°C			MIN	MAX	UNIT
			MIN	TYP	MAX			
f <sub>max</sub>			150			150		MHz
t <sub>PLH</sub>	AI	$\overline{B}$	1.8	3.7	5.3	1.8	6.2	ns
t <sub>PHL</sub>			2.9	4.4	6	2.9	6.6	
t <sub>PLH</sub>	LEAB	$\overline{B}$	2.7	4.2	5.8	2.7	6.4	ns
t <sub>PHL</sub>			3.5	5	6.5	3.5	7.3	
t <sub>PLH</sub>	CLKAB	$\overline{B}$	2.3	3.9	5.5	2.3	6	ns
t <sub>PHL</sub>			2.9	4.5	6.1	2.9	6.7	
t <sub>PLH</sub>	2CLKAB	$\overline{2CLKAB}$	4.6	6.9	8.8	4.6	9.9	ns
t <sub>PHL</sub>			4.9	6.5	8.1	4.9	8.8	
t <sub>PLH</sub>	$\overline{B}$	AO	3.5	5.9	7.9	3.5	8	ns
t <sub>PHL</sub>			2.2	3.7	5.3	2.2	5.7	
t <sub>PLH</sub>	LEBA	AO	1.8	3.2	4.6	1.8	5.1	ns
t <sub>PHL</sub>			1.7	3	4.4	1.7	4.7	
t <sub>PLH</sub>	CLKBA	AO	1.8	3.1	4.6	1.8	5.1	ns
t <sub>PHL</sub>			1.7	3.1	4.6	1.7	4.9	
t <sub>PLH</sub>	$\overline{2CLKAB}$	2CLK	6.4	9.7	11.8	6.4	13.4	ns
t <sub>PHL</sub>			4.1	6.9	8.9	4.1	10.3	
t <sub>PLH</sub>	OEB	$\overline{B}$	2.7	4.6	6.4	2.7	6.7	ns
t <sub>PHL</sub>			2.9	4.1	5.9	2.9	6.6	
t <sub>PLH</sub>	$\overline{OEB}$	$\overline{B}$	2.6	4.3	6.2	2.6	6.6	ns
t <sub>PHL</sub>			3.4	4.6	6.4	3.4	7	
t <sub>PZH</sub>	OEA	AO	1.4	2.9	4.4	1.4	4.9	ns
t <sub>PZL</sub>			1.4	2.6	4	1.4	4.6	
t <sub>PHZ</sub>	OEA	AO	1.7	3.4	5.1	1.7	5.8	ns
t <sub>PLZ</sub>			2.2	3.6	5	2.2	5.5	
t <sub>PZH</sub>	$\overline{OEA}$	AO	1.7	3.3	4.7	1.7	5.5	ns
t <sub>PZL</sub>			1.7	3.1	4.4	1.7	5.1	
t <sub>PHZ</sub>	$\overline{OEA}$	AO	1.5	2.9	4.5	1.5	5.1	ns
t <sub>PLZ</sub>			2	3.1	4.6	2	4.8	
t <sub>sk(p)</sub> <sup>†</sup>	Pulse skew, AI to $\overline{B}$ or $\overline{B}$ to AO		1					ns
t <sub>sk(o)</sub> <sup>†</sup>	Output skew, AI to $\overline{B}$ or $\overline{B}$ to AO		0.5					ns
t <sub>t</sub> Transition time	$\overline{B}$ outputs (1.3 V to 1.8 V)		0.9	1.7		0.5	4.6	ns
	AO outputs (10% to 90%)		0.5	2		0.4	4.2	
$\overline{B}$ -port input pulse rejection			1			1		ns

<sup>†</sup> Skew values are applicable for through mode only.





**PARAMETER MEASUREMENT INFORMATION**



- 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: TTL inputs:  $PRR \leq 10$  MHz,  $Z_O = 50 \Omega$ ,  $t_r \leq 2.5$  ns,  $t_f \leq 2.5$  ns; BTL inputs:  $PRR \leq 10$  MHz,  $Z_O = 50 \Omega$ ,  $t_r \leq 2.5$  ns,  $t_f \leq 2.5$  ns.  
 D. The outputs are measured one at a time, with one transition per measurement.

**Figure 1. Load Circuits and Voltage Waveforms**

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
SN74FB1651PCA	ACTIVE	HLQFP	PCA	100	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR

<sup>(1)</sup> 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.

<sup>(2)</sup> 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.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**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)

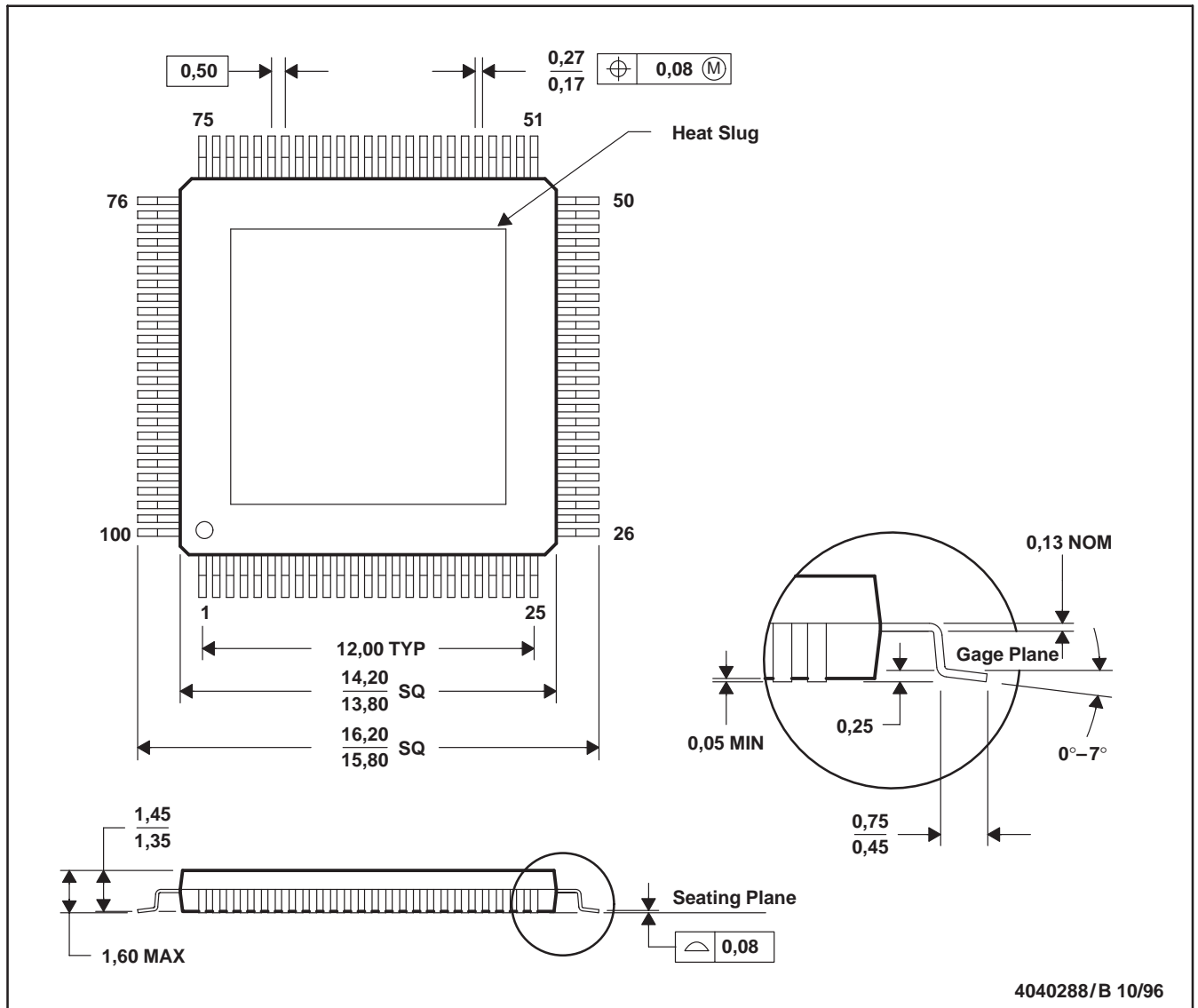
<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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PCA (S-PQFP-G100)

PLASTIC QUAD FLATPACK (DIE DOWN)



- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Thermally enhanced molded plastic package with a heat slug (HSL)  
 D. Falls within JEDEC MS-026

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