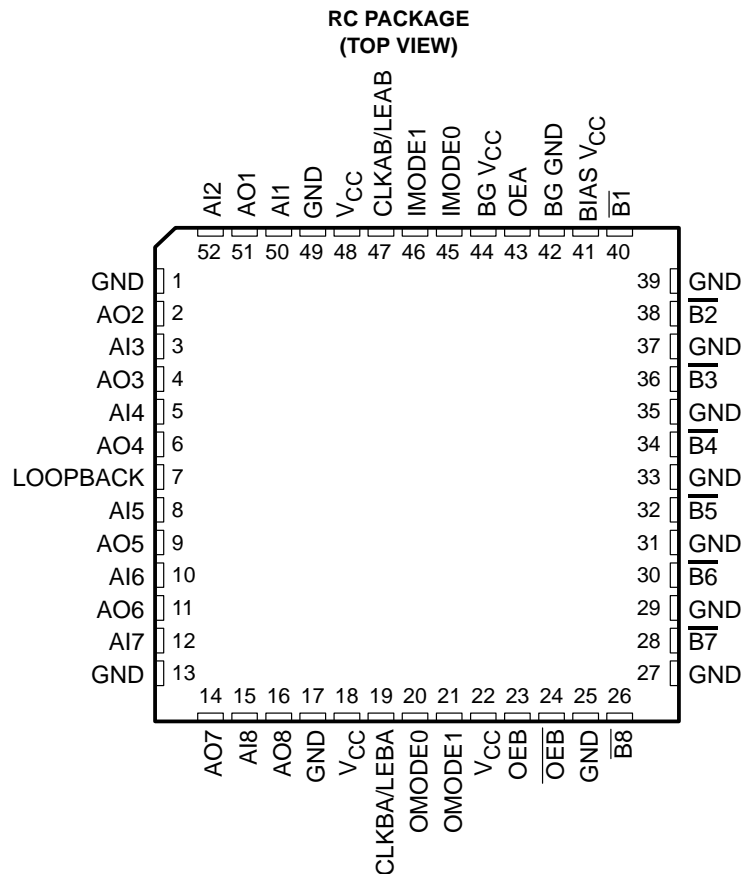


# SN74FB2033A 8-BIT TTL/BTL REGISTERED TRANSCEIVER

SCBS174M – NOVEMBER 1991 – REVISED SEPTEMBER 2001

- Compatible With IEEE Std 1194.1-1991 (BTL)
- TTL A Port, Backplane Transceiver Logic (BTL)  $\bar{B}$  Port
- Open-Collector  $\bar{B}$ -Port Outputs Sink 100 mA
- BIAS  $V_{CC}$  Pin Minimizes Signal Distortion During Live Insertion or Withdrawal
- High-Impedance State During Power Up and Power Down
- $\bar{B}$ -Port Biasing Network Preconditions the Connector and PC Trace to the BTL High-Level Voltage
- TTL-Input Structures Incorporate Active Clamping Networks to Aid in Line Termination



## description

The SN74FB2033A is an 8-bit transceiver featuring a split input (AI) and output (AO) bus on the TTL-level A port. The common-I/O, open-collector  $\bar{B}$  port operates at backplane transceiver logic (BTL) signal levels.

The logic element for data flow in each direction is configured by two mode inputs (IMODE1 and IMODE0 for B-to-A, OMODE1 and OMODE0 for A-to-B) as a buffer, a D-type flip-flop, or a D-type latch. When configured in the buffer mode, the inverted input data appears at the output port. In the flip-flop mode, data is stored on the rising edge of the appropriate clock input (CLKAB/LEAB or CLKBA/LEBA). In the latch mode, the clock inputs serve as active-high transparent latch enables.



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.

**TEXAS  
INSTRUMENTS**

POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

Copyright © 2001, Texas Instruments Incorporated

# SN74FB2033A

## 8-BIT TTL/BTL REGISTERED TRANSCEIVER

SCBS174M – NOVEMBER 1991 – REVISED SEPTEMBER 2001

### description (continued)

Data flow in the B-to-A direction, regardless of the logic element selected, is further controlled by the LOOPBACK input. When LOOPBACK is low,  $\overline{B}$ -port data is the B-to-A input. When LOOPBACK is high, the output of the selected A-to-B logic element (prior to inversion) is the B-to-A input.

The AO port-enable/-disable control is provided by OEA. When OEA is low or when  $V_{CC}$  is less than 2.5 V, the AO port is in the high-impedance state. When OEA is high, the AO port is active (high or low logic levels).

The  $\overline{B}$  port is controlled by OEB and  $\overline{OEB}$ . If OEB is low,  $\overline{OEB}$  is high, or  $V_{CC}$  is less than 2.5 V, the  $\overline{B}$  port is inactive. If OEB is high and  $\overline{OEB}$  is low, the  $\overline{B}$  port is active.

BG  $V_{CC}$  and BG GND are the bias-generator reference inputs.

The A-to-B and B-to-A logic elements are active, regardless of the state of their associated outputs. The logic elements can enter new data (in flip-flop and latch modes) or retain previously stored data while the associated outputs are in the high-impedance (AO port) or inactive ( $\overline{B}$  port) states.

Output clamps are provided on the BTL outputs to reduce switching noise. One clamp reduces inductive ringing effects on  $V_{OH}$  during a low-to-high transition. The other clamps out ringing below the BTL  $V_{OL}$  voltage of 0.75 V. Both clamps are active only during ac switching and do not affect the BTL outputs during steady-state conditions.

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

### ORDERING INFORMATION

TA	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	QFP – RC	Tube	SN74FB2033ARC	FB2033A

† 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).



POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

### Function Tables

FUNCTION/MODE

INPUTS								FUNCTION/MODE
OEA	OEB	$\overline{\text{OEB}}$	OMODE1	OMODE0	IMODE1	IMODE0	LOOPBACK	
L	L	X	X	X	X	X	X	Isolation
L	X	H	X	X	X	X	X	
X	H	L	L	L	X	X	X	AI to $\overline{\text{B}}$ , buffer mode
X	H	L	L	H	X	X	X	AI to $\overline{\text{B}}$ , flip-flop mode
X	H	L	H	X	X	X	X	AI to $\overline{\text{B}}$ , latch mode
H	L	X	X	X	L	L	L	$\overline{\text{B}}$ to AO, buffer mode
H	X	H	X	X	L	L	L	
H	L	X	X	X	L	H	L	$\overline{\text{B}}$ to AO, flip-flop mode
H	X	H	X	X	L	H	L	
H	L	X	X	X	H	X	L	$\overline{\text{B}}$ to AO, latch mode
H	X	H	X	X	H	X	L	
H	L	X	X	X	L	L	H	AI to AO, buffer mode
H	X	H	X	X	L	L	H	
H	L	X	X	X	L	H	H	AI to AO, flip-flop mode
H	X	H	X	X	L	H	H	
H	L	X	X	X	H	X	H	AI to AO, latch mode
H	X	H	X	X	H	X	H	
H	H	L	X	X	X	X	L	AI to $\overline{\text{B}}$ , $\overline{\text{B}}$ to AO

ENABLE/DISABLE

INPUTS			OUTPUTS	
OEA	OEB	$\overline{\text{OEB}}$	AO	$\overline{\text{B}}$
L	X	X	Hi Z	
H	X	X		
X	L	L	Inactive (H)	
X	L	H		
X	H	L	Active	
X	H	H		

BUFFER

INPUT	OUTPUT
L	H
H	L

LATCH

INPUTS		OUTPUT
CLK/LE	DATA	
H	L	H
H	H	L
L	X	$Q_0$

SN74FB2033A  
8-BIT TTL/BTL REGISTERED TRANSCEIVER

SCBS174M – NOVEMBER 1991 – REVISED SEPTEMBER 2001

Function Tables (Continued)

LOOPBACK

LOOPBACK	Q†
L	$\overline{B}$ port
H	Point P‡

† Q is the input to the B-to-A logic element.

‡ P is the output of the A-to-B logic element (see functional block diagram).

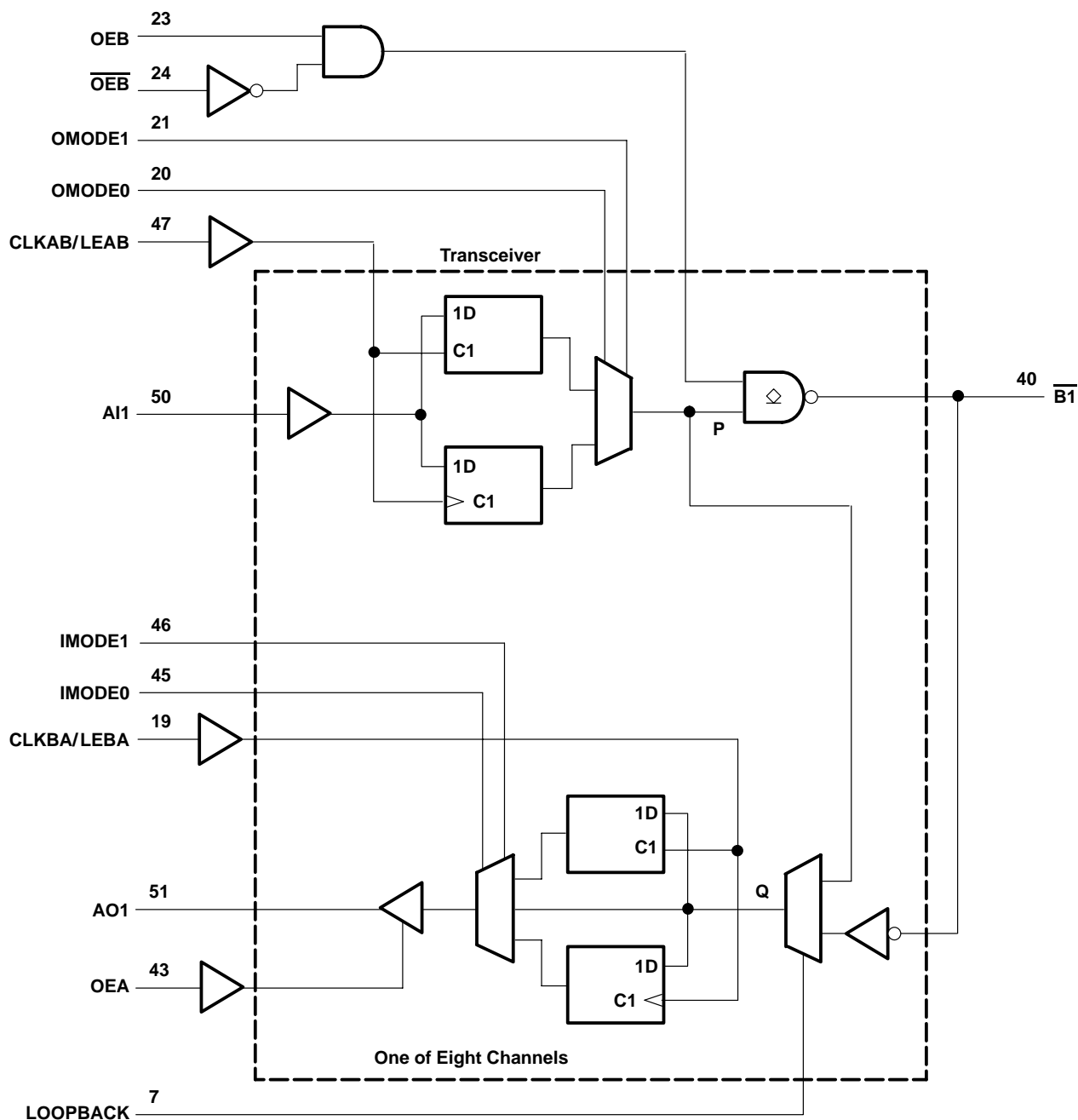
SELECT

INPUTS		SELECTED LOGIC ELEMENT
MODE1	MODE0	
L	L	Buffer
L	H	Flip-flop
H	X	Latch

FLIP-FLOP

INPUTS		OUTPUT
CLK/LE	DATA	
L	X	Q <sub>0</sub>
↑	L	H
↑	H	L

functional block diagram



# SN74FB2033A

## 8-BIT TTL/BTL REGISTERED TRANSCEIVER

SCBS174M – NOVEMBER 1991 – REVISED SEPTEMBER 2001

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

Supply voltage range, $V_{CC}$	–0.5 V to 7 V
Input clamp current range, $V_I$ : Except $\bar{B}$ port	–1.2 V to 7 V
$\bar{B}$ port	–1.2 V to 3.5 V
Voltage range applied to any $\bar{B}$ 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, $V_O$ : A port	–0.5 V to $V_{CC}$
Input clamp current, $I_{IK}$ : Except $\bar{B}$ port	–40 mA
$\bar{B}$ port	–18 mA
Current applied to any single output in the low state, $I_O$ : A port	48 mA
Package thermal impedance, $\theta_{JA}$ (see Note 1)	44°C/W
Storage temperature range, $T_{stg}$	–65°C to 150°C

<sup>†</sup> 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 $V_{CC}$	Supply voltage	4.75	5	5.25	V
BIAS $V_{CC}$	Supply voltage	4.5	5	5.5	V
$V_{IH}$	High-level input voltage	$\bar{B}$ port		1.62	V
		Except $\bar{B}$ port		2	
$V_{IL}$	Low-level input voltage	$\bar{B}$ port		0.75	V
		Except $\bar{B}$ port		0.8	
$I_{OH}$	High-level output current	AO port		–3	mA
$I_{OL}$	Low-level output current	AO port		24	mA
		$\bar{B}$ port		100	
$\Delta t/\Delta v$	Input transition rise or fall rate	Except $\bar{B}$ port		10	ns/V
$T_A$	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.

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

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT
$V_{IK}$		$V_{CC} = 4.75\text{ V}$ ,	$I_I = -18\text{ mA}$			-1.2	V
$V_{OH}$	AO port	$V_{CC} = 4.75\text{ V to } 5.25\text{ V}$ ,	$I_{OH} = -10\text{ }\mu\text{A}$			$V_{CC}-1.1$	V
		$V_{CC} = 4.75\text{ V}$	$I_{OH} = -3\text{ mA}$	2.5	2.85	3.4	
			$I_{OH} = -32\text{ mA}$	2			
$V_{OL}$	AO port	$V_{CC} = 4.75\text{ V}$	$I_{OL} = 20\text{ mA}$		0.33	0.5	V
			$I_{OL} = 55\text{ mA}$			0.8	
	$\overline{B}$ port	$V_{CC} = 4.75\text{ V}$	$I_{OL} = 100\text{ mA}$	0.75		1.1	
			$I_{OL} = 4\text{ mA}$	0.5			
$I_I$	Except $\overline{B}$ port	$V_{CC} = 0$ ,	$V_I = 5.25\text{ V}$			100	$\mu\text{A}$
$I_{IH}$	Except $\overline{B}$ port	$V_{CC} = 5.25\text{ V}$ ,	$V_I = 2.7\text{ V}$			50	$\mu\text{A}$
	$\overline{B}$ port‡	$V_{CC} = 0\text{ to } 5.25\text{ V}$ ,	$V_I = 2.1\text{ V}$			100	
$I_{IL}$	Except $\overline{B}$ port	$V_{CC} = 5.25\text{ V}$	$V_I = 0.5\text{ V}$			-50	$\mu\text{A}$
	$\overline{B}$ port‡		$V_I = 0.75\text{ V}$			-100	
$I_{OH}$	$\overline{B}$ port	$V_{CC} = 0\text{ to } 5.25\text{ V}$ ,	$V_O = 2.1\text{ V}$			100	$\mu\text{A}$
$I_{OZPU}$		$V_{CC} = 0\text{ to } 2.1\text{ V}$ ,	$V_O = 0.5\text{ V to } 2.7\text{ V}$			50	$\mu\text{A}$
$I_{OZPD}$		$V_{CC} = 2.1\text{ V to } 0$ ,	$V_O = 0.5\text{ V to } 2.7\text{ V}$			-50	$\mu\text{A}$
$I_{OZH}$	AO port	$V_{CC} = 5.25\text{ V}$ ,	$V_O = 2.7\text{ V}$			50	$\mu\text{A}$
$I_{OZL}$	AO port	$V_{CC} = 5.25\text{ V}$ ,	$V_O = 0.5\text{ V}$			-50	$\mu\text{A}$
$I_{OS}^{\S}$	AO port	$V_{CC} = 5.25\text{ V}$ ,	$V_O = 0$	-40	-80	-150	mA
$I_{CC}$	All outputs on	$V_{CC} = 5.25\text{ V}$ ,	$I_O = 0$		45	70	mA
$C_i$	AI port and control inputs	$V_I = 0.5\text{ V or } 2.5\text{ V}$			5		pF
$C_o$	AO port	$V_O = 0.5\text{ V or } 2.5\text{ V}$			5		pF
$C_{io}$	$\overline{B}$ port per IEEE Std 1194.1-1991	$V_{CC} = 0\text{ to } 4.75\text{ V}$				6	pF
		$V_{CC} = 4.75\text{ V to } 5.25\text{ V}$				6	

† All typical values are at  $V_{CC} = 5\text{ V}$ .

‡ For I/O ports, the parameters  $I_{IH}$  and  $I_{IL}$  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 characteristics over recommended operating free-air temperature range (see Note 3)**

PARAMETER		TEST CONDITIONS		MIN	MAX	UNIT
$I_{CC}$ (BIAS $V_{CC}$ )		$V_{CC} = 0\text{ to } 4.5\text{ V}$	$V_B = 0\text{ to } 2\text{ V}$ , $V_I$ (BIAS $V_{CC}$ ) = $4.5\text{ V to } 5.5\text{ V}$		10	$\mu\text{A}$
		$V_{CC} = 4.5\text{ V to } 5.5\text{ V}$			10	
$V_O$	$\overline{B}$ port	$V_{CC} = 0$ ,	$V_I$ (BIAS $V_{CC}$ ) = $4.5\text{ V to } 5.5\text{ V}$	1.62	2.1	V
$I_O$	$\overline{B}$ port	$V_{CC} = 0$ ,	$V_B = 1\text{ V}$ , $V_I$ (BIAS $V_{CC}$ ) = $4.5\text{ V to } 5.5\text{ V}$	-1		$\mu\text{A}$
		$V_{CC} = 0\text{ to } 5.5\text{ V}$ ,	OEB = $0\text{ to } 0.8\text{ V}$		100	
		$V_{CC} = 0\text{ to } 2.2\text{ V}$ ,	OEB = $0\text{ to } 5\text{ V}$		100	

NOTE 3: The power-up sequence is GND, BIAS  $V_{CC}$ ,  $V_{CC}$ .

SN74FB2033A  
8-BIT TTL/BTL REGISTERED TRANSCEIVER

SCBS174M – NOVEMBER 1991 – REVISED SEPTEMBER 2001

timing requirements over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 2)

			V <sub>CC</sub> = 5 V, T <sub>A</sub> = 25°C		MIN	MAX	UNIT
			MIN	MAX			
f <sub>clock</sub>	Clock frequency			150		150	MHz
t <sub>w</sub>	Pulse duration	CLKAB/LEAB or CLKBA/LEBA	3.3		3.3		ns
t <sub>su</sub>	Setup time	Data before CLKAB/LEAB or CLKBA/LEBA↑	2.7		2.7		ns
t <sub>h</sub>	Hold time	Data after CLKAB/LEAB or CLKBA/LEBA↑	0.7		0.7		ns



# SN74FB2033A

## 8-BIT TTL/BTL REGISTERED TRANSCEIVER

SCBS174M – NOVEMBER 1991 – REVISED SEPTEMBER 2001

switching characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 2)

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 (through mode)	$\overline{B}$	2.3	3.6	4.6	2.3	5.6	ns
t <sub>PHL</sub>			1.9	3	4.2	1.9	4.5	
t <sub>PLH</sub>	$\overline{B}$ (through mode)	AO	2.5	4.2	5.5	2.5	6.1	ns
t <sub>PHL</sub>			3	4.2	5.6	3	5.7	
t <sub>PLH</sub>	AI (transparent)	$\overline{B}$	2.3	3.6	4.6	2.3	5.6	ns
t <sub>PHL</sub>			1.9	3	4.1	1.9	4.5	
t <sub>PLH</sub>	$\overline{B}$ (transparent)	AO	2.5	4.2	5.5	2.5	6.1	ns
t <sub>PHL</sub>			3	4.2	5.6	3	5.7	
t <sub>PLH</sub>	OEB	$\overline{B}$	2.4	3.7	4.7	2.4	5.8	ns
t <sub>PHL</sub>			1.8	3	4.1	1.8	4.4	
t <sub>PLH</sub>	$\overline{OEB}$	$\overline{B}$	2	3.4	4.3	2	5.2	ns
t <sub>PHL</sub>			2	3.3	4.4	2	4.8	
t <sub>PZH</sub>	OEA	AO	2	3.5	4.6	2	5.1	ns
t <sub>PZL</sub>			2.7	4.2	5.1	2.7	5.4	
t <sub>PHZ</sub>	OEA	AO	2.1	4	5	2.1	5.5	ns
t <sub>PLZ</sub>			1.6	2.8	3.9	1.6	4.3	
t <sub>PLH</sub>	CLKAB/LEAB	$\overline{B}$	3	4.7	5.8	3	6.9	ns
t <sub>PHL</sub>			2.8	4.3	5.6	2.8	6.1	
t <sub>PLH</sub>	CLKBA/LEBA	AO	2	3.6	4.9	2	5.4	ns
t <sub>PHL</sub>			2.2	3.5	4.7	2.2	5.1	
t <sub>PLH</sub>	OMODE	$\overline{B}$	2.4	5	6.1	2.4	7.2	ns
t <sub>PHL</sub>			2.4	4.5	6	2.4	6.7	
t <sub>PLH</sub>	IMODE	AO	1.8	4	5.3	1.8	5.9	ns
t <sub>PHL</sub>			2.3	4.1	5.2	2.3	5.4	
t <sub>PLH</sub>	LOOPBACK	AO	2.4	5	7	2.4	8	ns
t <sub>PHL</sub>			3.1	4.6	5.7	3.1	5.9	
t <sub>PLH</sub>	AI	AO	1.9	3.7	5.5	1.9	6.1	ns
t <sub>PHL</sub>			2.6	4.2	5.6	2.6	5.8	
t <sub>r</sub>	Rise time, 1.3 V to 1.8 V, $\overline{B}$ port		0.5	1.2	2.1	0.5	3	ns
t <sub>f</sub>	Fall time, 1.8 V to 1.3 V, $\overline{B}$ port		0.5	1.4	2.3	0.5	3	
t <sub>r</sub>	Rise time, 10% to 90%, AO		2	3.3	4.2	2	5	ns
t <sub>f</sub>	Fall time, 90% to 10%, AO		1	2.5	3.4	1	5	
$\overline{B}$ -port input pulse rejection						1		ns

### output-voltage characteristics

PARAMETER			TEST CONDITIONS	MIN	MAX	UNIT
VOHP	Peak output voltage during turnoff of 100 mA into 40 nH	$\overline{B}$ port	See Figure 1		4.5	V
VOHV	Minimum output voltage during turnoff of 100 mA into 40 nH	$\overline{B}$ port	See Figure 1	1.62		V
VOLV	Minimum output voltage during high-to-low switch	$\overline{B}$ port	I <sub>OL</sub> = -50 mA	0.3		V

# SN74FB2033A

## 8-BIT TTL/BTL REGISTERED TRANSCEIVER

SCBS174M – NOVEMBER 1991 – REVISED SEPTEMBER 2001

---

### PARAMETER MEASUREMENT INFORMATION

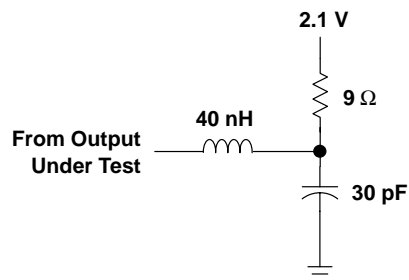
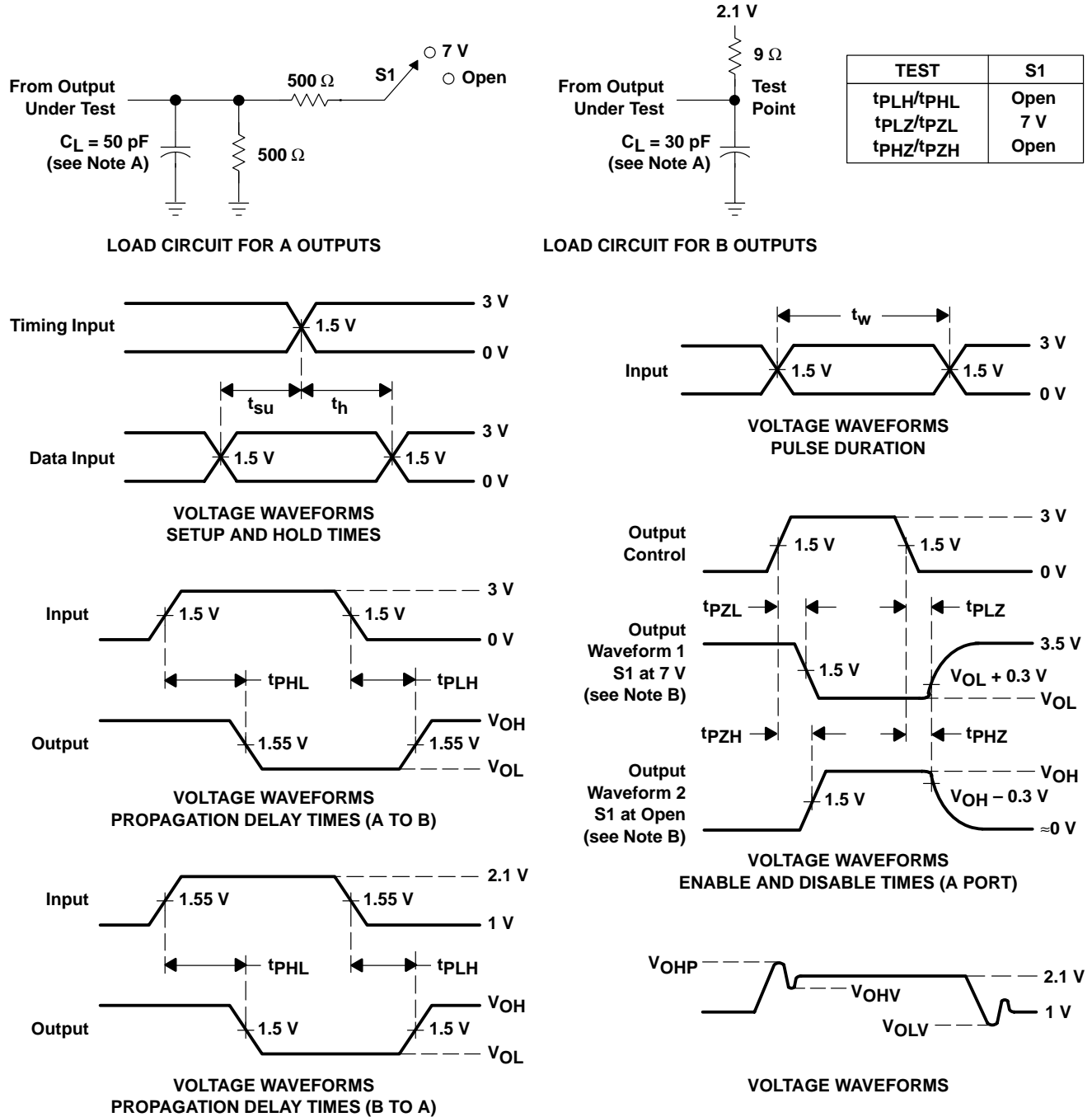


Figure 1. Load Circuit for  $V_{OHP}$  and  $V_{OHV}$

## 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 2. 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>
SN74FB2033ARC	ACTIVE	QFP	RC	52	96	TBD	CU SNPB	Level-2-240C-1YR
SN74FB2033ARCR	ACTIVE	QFP	RC	52	500	TBD	CU SNPB	Level-2-240C-1YR

<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)

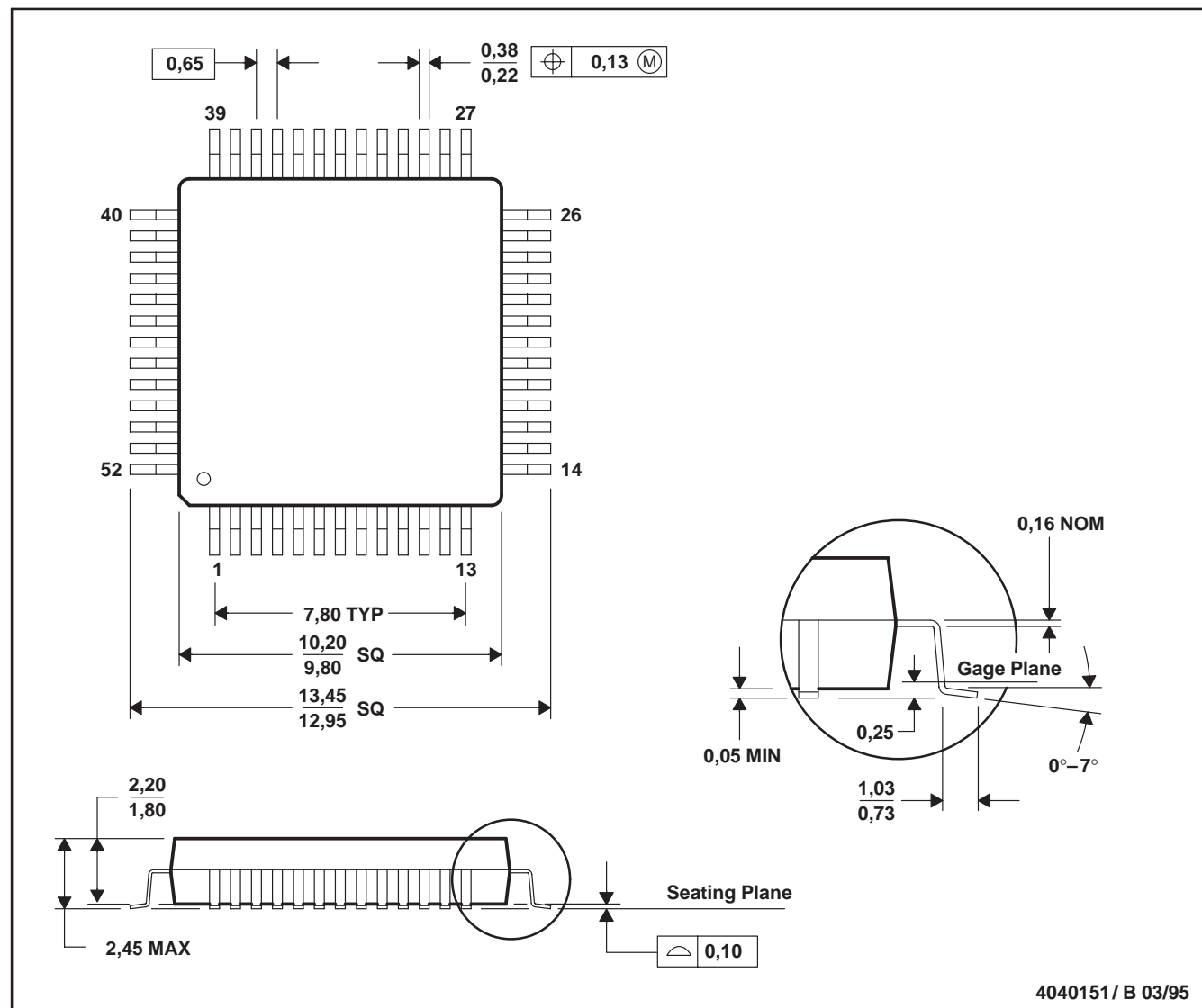
<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

**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.

## RC (S-PQFP-G52)

## PLASTIC QUAD FLATPACK



- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Falls within JEDEC MS-022

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

<b>Products</b>		<b>Applications</b>	
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>	Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>	Automotive	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>	Broadband	<a href="http://www.ti.com/broadband">www.ti.com/broadband</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>	Digital Control	<a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>	Military	<a href="http://www.ti.com/military">www.ti.com/military</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>	Optical Networking	<a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>	Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Low Power Wireless	<a href="http://www.ti.com/lpw">www.ti.com/lpw</a>	Telephony	<a href="http://www.ti.com/telephony">www.ti.com/telephony</a>
		Video & Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>
		Wireless	<a href="http://www.ti.com/wireless">www.ti.com/wireless</a>

Mailing Address: Texas Instruments  
Post Office Box 655303 Dallas, Texas 75265

Copyright © 2006, Texas Instruments Incorporated