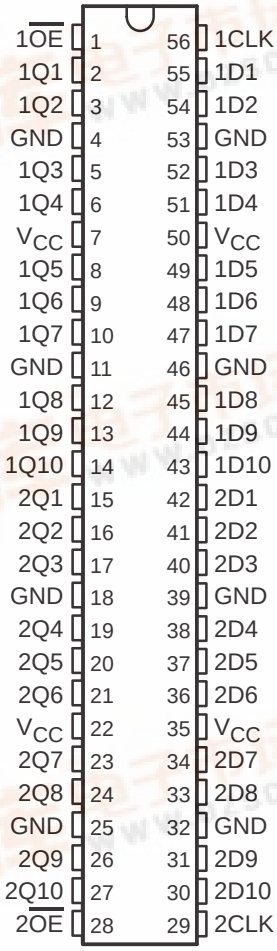
SN54ABT16821, SN74ABT16821
20-BIT BUS-INTERFACE FLIP-FLOPS WITH 3-STATE OUTPUTS

SCBS216B – JUNE 1992 – REVISED JANUARY 1997

- **Members of the Texas Instruments *Widebus*™ Family**
- **State-of-the-Art *EPIC*-II*B*™ BiCMOS Design Significantly Reduces Power Dissipation**
- **ESD Protection Exceeds 2000 V Per MIL-STD-883, Method 3015; Exceeds 200 V Using Machine Model (C = 200 pF, R = 0)**
- **Typical V_{OLP} (Output Ground Bounce) < 1 V at V_{CC} = 5 V, T_A = 25°C**
- **Distributed V_{CC} and GND Pin Configuration Minimizes High-Speed Switching Noise**
- **Flow-Through Architecture Optimizes PCB Layout**
- **High-Drive Outputs (–32-mA I_{OH}, 64-mA I_{OL})**
- **Package Options Include Plastic Thin Shrink Small-Outline (DGG), 300-mil Shrink Small-Outline (DL) Packages and 380-mil Fine-Pitch Ceramic Flat (WD) Package Using 25-mil Center-to-Center Spacings**

SN54ABT16821 . . . WD PACKAGE
SN74ABT16821 . . . DGG OR DL PACKAGE
(TOP VIEW)



description

These 20-bit flip-flops feature 3-state outputs designed specifically for driving highly capacitive or relatively low-impedance loads. They are particularly suitable for implementing wider buffer registers, I/O ports, bidirectional bus drivers with parity, and working registers.

The ’ABT16821 can be used as two 10-bit flip-flops or one 20-bit flip-flop. The 20 flip-flops are edge-triggered D-type flip-flops. On the positive transition of the clock (CLK) input, the device provides true data at the Q outputs.

A buffered output-enable ($\overline{OE}$) input can be used to place the ten outputs in either a normal logic state (high or low logic level) or a high-impedance state. In the high-impedance state, the outputs neither load nor drive the bus lines significantly. The high-impedance state and increased drive provide the capability to drive bus lines without need for interface or pullup components.

$\overline{OE}$ does not affect the internal operation of the flip-flops. Old data can be retained or new data can be entered while the outputs are in the high-impedance state.

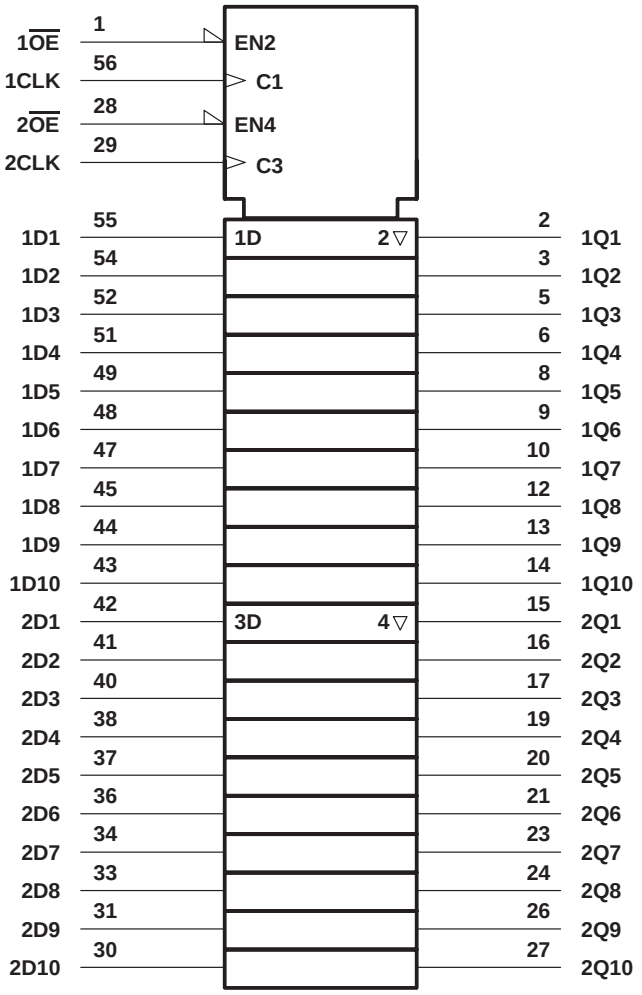
To ensure the high-impedance state during power up or power down, $\overline{OE}$ should be tied to V_{CC} through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

The SN54ABT16821 is characterized for operation over the full military temperature range of –55°C to 125°C. The SN74ABT16821 is characterized for operation from –40°C to 85°C.

FUNCTION TABLE
(each flip-flop)

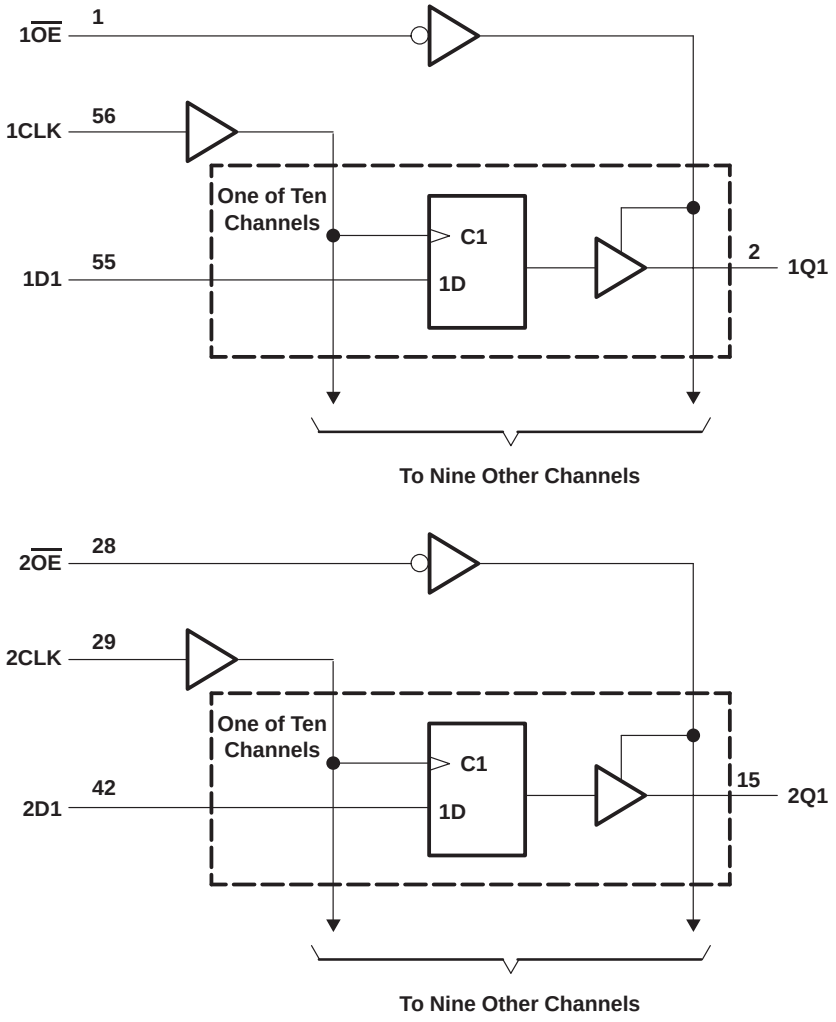
INPUTS			OUTPUT
$\overline{OE}$	CLK	D	Q
L	↑	H	H
L	↑	L	L
L	L	X	Q_0
H	X	X	Z

logic symbol†



† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

logic diagram (positive logic)



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 (see Note 1) . . . . . –0.5 V to 7 V
Voltage range applied to any output in the high or power-off state, V_O . . . . . –0.5 V to 5.5 V
Current into any output in the low state, I_O: SN54ABT16821 . . . . . 96 mA
SN74ABT16821 . . . . . 128 mA
Input clamp current, I_{IK} ($V_I < 0$) . . . . . –18 mA
Output clamp current, I_{OK} ($V_O < 0$) . . . . . –50 mA
Package thermal impedance, θ_{JA} (see Note 2): DGG package . . . . . 81°C/W
DL package . . . . . 74°C/W
Storage temperature range, T_{stg} . . . . . –65°C to 150°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTES: 1. The input and output negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
2. The package thermal impedance is calculated in accordance with EIA/JEDEC Std JESD51.

recommended operating conditions (see Note 3)

			SN54ABT16821		SN74ABT16821		UNIT
			MIN	MAX	MIN	MAX	
V_{CC}	Supply voltage		4.5	5.5	4.5	5.5	V
V_{IH}	High-level input voltage		2		2		V
V_{IL}	Low-level input voltage			0.8		0.8	V
V_I	Input voltage		0	V_{CC}	0	V_{CC}	V
I_{OH}	High-level output current			–24		–32	mA
I_{OL}	Low-level output current			48		64	mA
$\Delta t/\Delta v$	Input transition rise or fall rate	Outputs enabled		10		10	ns/V
T_A	Operating free-air temperature		–55	125	–40	85	°C

NOTE 3: Unused inputs must be held high or low to prevent them from floating.

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

PARAMETER	TEST CONDITIONS			T_A = 25°C			SN54ABT16821		SN74ABT16821		UNIT
				MIN	TYP†	MAX	MIN	MAX	MIN	MAX	
V_{IK}	V_{CC} = 4.5 V, I_I = –18 mA					–1.2		–1.2		–1.2	V
V_{OH}	V_{CC} = 4.5 V, I_{OH} = –3 mA			2.5			2.5		2.5		V
	V_{CC} = 5 V, I_{OH} = –3 mA			3			3		3		
	V_{CC} = 4.5 V	I_{OH} = –24 mA		2			2				
		I_{OH} = –32 mA		2*					2		
V_{OL}	V_{CC} = 4.5 V	I_{OL} = 48 mA				0.55		0.55			V
		I_{OL} = 64 mA				0.55*				0.55	
V_{hys}					100						mV
I_I	V_{CC} = 5.5 V, V_I = V_{CC} or GND					±1		±1		±1	µA
I_{OZH}	V_{CC} = 5.5 V, V_O = 2.7 V					50		50		50	µA
I_{OZL}	V_{CC} = 5.5 V, V_O = 0.5 V					–50		–50		–50	µA
I_{off}	V_{CC} = 0, V_I or $V_O \le$ 4.5 V					±100				±100	µA
I_{CEX}	V_{CC} = 5.5 V, V_O = 5.5 V		Outputs high			50		50		50	µA
I_O‡	V_{CC} = 5.5 V, V_O = 2.5 V			–50	–100	–200	–50	–200	–50	–200	mA
I_{CC}	V_{CC} = 5.5 V, I_O = 0, V_I = V_{CC} or GND		Outputs high			500		500		500	µA
			Outputs low			89		89		89	mA
			Outputs disabled			500		500		500	µA
ΔI_{CC}§	V_{CC} = 5.5 V, One input at 3.4 V, Other inputs at V_{CC} or GND					1.5		1.5		1.5	mA
C_i	V_I = 2.5 V or 0.5 V				3.5						pF
C_o	V_O = 2.5 V or 0.5 V				7.5						pF

* On products compliant to MIL-PRF-38535, this parameter does not apply.
† All typical values are at V_{CC} = 5 V.
‡ Not more than one output should be tested at a time, and the duration of the test should not exceed one second.
§ This is the increase in supply current for each input that is at the specified TTL voltage level rather than V_{CC} or GND.

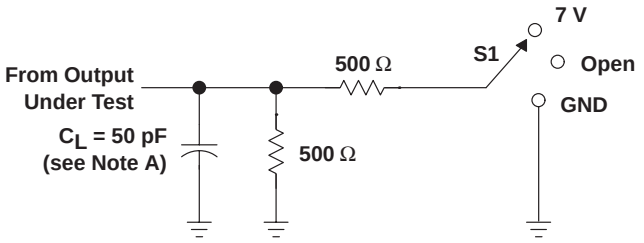
timing requirements over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 1)

		V_{CC} = 5 V, T_A = 25°C		SN54ABT16821		SN74ABT16821		UNIT
		MIN	MAX	MIN	MAX	MIN	MAX	
f_{clock}	Clock frequency	0	150	0	150	0	150	MHz
t_w	Pulse duration, CLK high or low	3.3		3.3		3.3		ns
t_{su}	Setup time, data before CLK↑	1.8		1.8		1.8		ns
t_h	Hold time, data after CLK↑	1.3		1.3		1.3		ns

switching characteristics over recommended ranges of supply voltage and operating free-air temperature, C_L = 50 pF (unless otherwise noted) (see Figure 1)

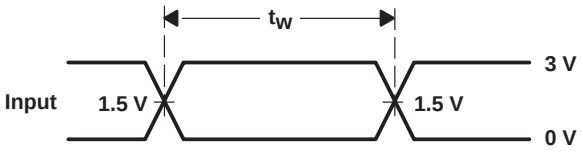
PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} = 5 V, T_A = 25°C			SN54ABT16821		SN74ABT16821		UNIT
			MIN	TYP	MAX	MIN	MAX	MIN	MAX	
f_{max}			150			150		150		MHz
t_{PLH}	CLK	Q	1.3	3.7	5.1	1.3	6.7	1.3	6.1	ns
t_{PHL}			1.6	3.9	5.1	1.6	5.8	1.6	5.4	
t_{PZH}	$\overline{OE}$	Q	1.1	3.2	4.7	1.1	5.8	1.1	5.7	ns
t_{PZL}			1.6	3.8	5	1.6	5.7	1.6	5.6	
t_{PHZ}	$\overline{OE}$	Q	2	4.5	5.7	2	6.6	2	6.5	ns
t_{PLZ}			1.8	4.1	5.8	1.8	8.4	1.8	7.1	

PARAMETER MEASUREMENT INFORMATION

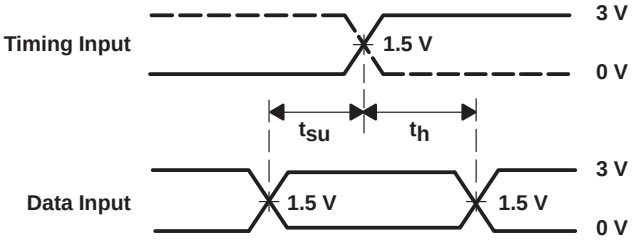


TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	7 V
t_{PHZ}/t_{PZH}	Open

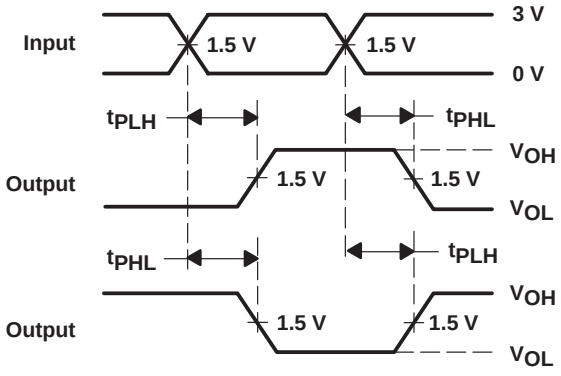
LOAD CIRCUIT



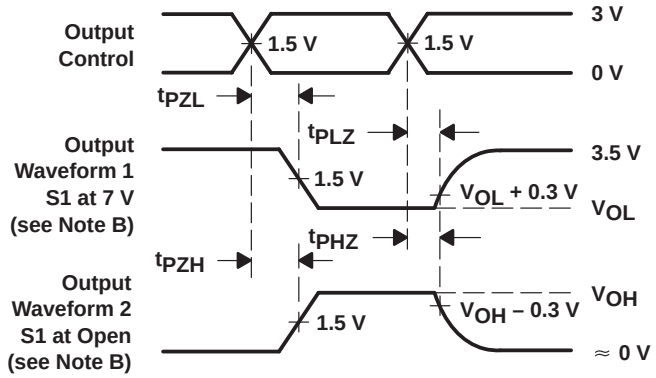
VOLTAGE WAVEFORMS
PULSE DURATION



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, t_r ≤ 2.5 ns, t_f ≤ 2.5 ns.
D. The outputs are measured one at a time with one transition per measurement.

Figure 1. Load Circuit and Voltage Waveforms

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