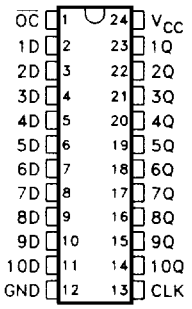
SN74BCT29821, SN74BCT29822
10-BIT BUS INTERFACE FLIP-FLOPS WITH 3-STATE OUTPUTS

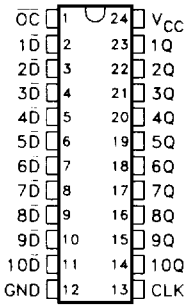
D3125, FEBRUARY 1989—REVISED JULY 1989

- **BiCMOS Process with CMOS Inputs and TTL Outputs Substantially Reduces Standby Current**
- **Input has 50-kΩ Pullup Resistor**
- **Provides Extra Data Width Necessary for Wider Address/Data Paths or Buses with Parity**
- **Power-Up High-Impedance State**
- **Buffered Control Inputs to Reduce DC Loading Effects**
- **Functionally Equivalent to Am29821A, Am29822A, SN74ALS29821, and SN74ALS29822**
- **Package Options Include Plastic "Small Outline" Packages and Standard Plastic 300-mil DIPs**

SN74BCT29821 ... DW OR NT PACKAGE
(TOP VIEW)



SN74BCT29822 ... DW OR NT PACKAGE
(TOP VIEW)



description

These 10-bit flip-flops feature three-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 ten flip-flops are edge-triggered D-type flip-flops. On the positive transition of the clock the Q outputs on the 'BCT29821 will be true, and on the 'BCT29822 will be complementary to the data input.

A buffered output-control ($\overline{OC}$) input can be used to place the ten outputs in either a normal logic state (high or low levels) or a high-impedance state. The outputs are also in the high-impedance state during power-up and power-down conditions. The outputs remain in the high-impedance state while the device is powered-down. 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 the bus lines in a bus-organized system without need for interface or pull-up components. The output control 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.

The SN74BCT' family is characterized for operation from 0°C to 70°C.

TEXAS INSTRUMENTS
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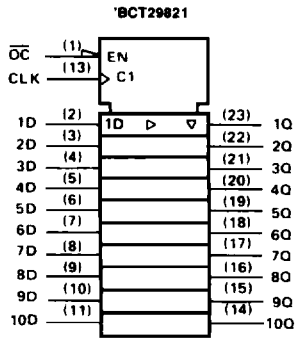
FUNCTION TABLE (EACH FLIP-FLOP)
'BCT29821

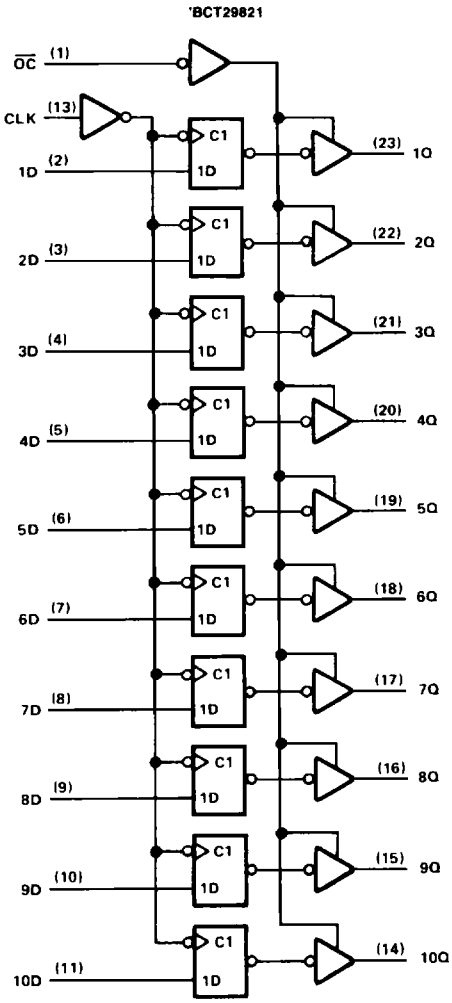
INPUTS			OUTPUT
$\overline{OC}$	CLK	D	Q
L	↑	H	H
L	↑	L	L
L	L	X	Q_0
H	X	X	Z

logic symbol†



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

logic diagram (positive logic)

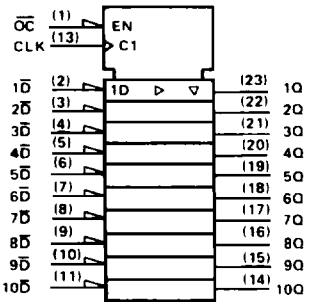


FUNCTION TABLE (EACH FLIP-FLOP)
'BCT29822

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

logic symbol†

'BCT29822



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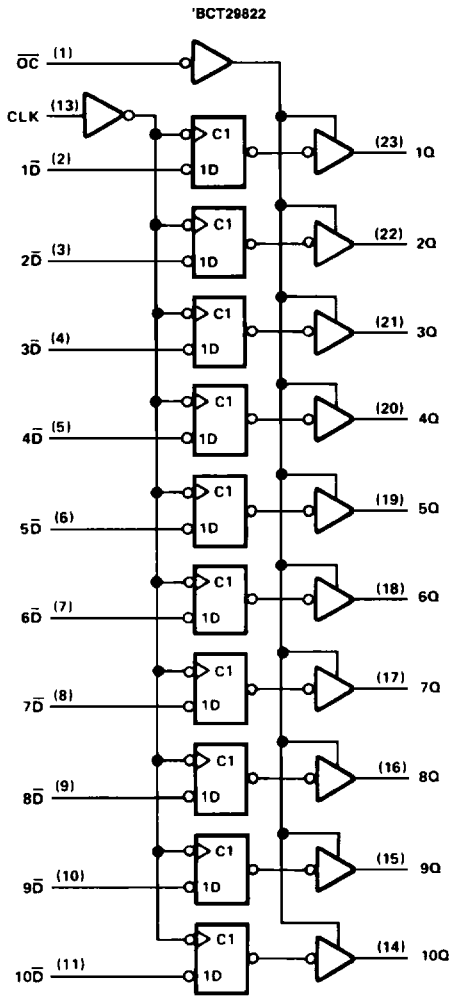
logic diagram (positive logic)

'BCT29822



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

Supply voltage, V_{CC} ..... 7 V
Input voltage ..... 7 V
Voltage applied to a disabled 3-state output ..... 5.5 V
Operating free-air temperature range ..... 0°C to 70°C
Storage temperature range ..... −65°C to 150°C

recommended operating conditions

			MIN	NOM	MAX	UNIT
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				−24	mA
I_{OL}	Low-level output current				48	mA
t_w	Pulse duration	CLK high	7			ns
		CLK low	7			
t_{su}	Setup time, data before CLK ↑		7			ns
t_h	Hold time, data after CLK ↑		1			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		MIN	TYP†	MAX	UNIT
V_{IK}	V_{CC} = 4.5 V, I_I = −18 mA				−1.2	V
V_{OH}	V_{CC} = 4.5 V, I_{OH} = −15 mA		2.4	3.3		V
	V_{CC} = 4.5 V, I_{OH} = −24 mA		2			
V_{OL}	V_{CC} = 4.5 V, I_{OL} = 48 mA			0.35	0.5	V
I_{OZH}	V_{CC} = 5.5 V, V_O = 2.4 V				20	μA
I_{OZL}	V_{CC} = 5.5 V, V_O = 0.4 V				−20	μA
I_I	V_{CC} = 5.5 V, V_I = 7 V				0.1	mA
I_{IH}	V_{CC} = 5.5 V, V_I = 2.7 V		−10		75	μA
I_{IL}	V_{CC} = 5.5 V, V_I = 0.4 V				0.2	mA
I_{OS}‡	V_{CC} = 5.5 V, V_O = 0		−75		−250	mA
I_{CC}	V_{CC} = 5.5 V	Outputs high		6	10	mA
		Outputs low		25	35	
		Outputs disabled		2	6	

† All typical values are at V_{CC} = 5 V, T_A = 25°C.
‡ Not more than one output should be shorted at a time, and the duration of the short circuit should not exceed one second.

switching characteristics (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} = 5 V, C_L = 50 pF, R1 = 500 Ω, R2 = 500 Ω, T_A = 25°C			V_{CC} = 4.5 V to 5.5 V, C_L = 50 pF, R1 = 500 Ω, R2 = 500 Ω, T_A = 0°C to 70°C		UNIT
			MIN	TYP	MAX	MIN	MAX	
t_{PLH}	CLK	Any Q	1.5	7.5	10	1.5	12	ns
t_{PHL}			1.5	6.5	9	1.5	10	
t_{PZH}	$\overline{OC}$	Any Q	2	7.5	10	2	12	ns
t_{PZL}			2	9	12	2	13	
t_{PHZ}	$\overline{OC}$	Any Q	2	5	7	2	8	ns
t_{PLZ}			2	5	7	2	8	

recommended operating conditions

			MIN	NOM	MAX	UNIT
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				−24	mA
I_{OL}	Low-level output current				48	mA
t_w	Pulse duration	CLK high				ns
		CLK low				
t_{su}	Setup time, data before CLK ↑					ns
t_h	Hold time, data after CLK ↑					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		MIN	TYP†	MAX	UNIT
V_{IK}	V_{CC} = 4.5 V, I_I = −18 mA				−1.2	V
V_{OH}	V_{CC} = 4.5 V, I_{OH} = −15 mA		2.4	3.3		V
	V_{CC} = 4.5 V, I_{OH} = −24 mA		2			
V_{OL}	V_{CC} = 4.5 V, I_{OL} = 48 mA			0.35	0.5	V
I_{OZH}	V_{CC} = 5.5 V, V_O = 2.4 V				20	μA
I_{OZL}	V_{CC} = 5.5 V, V_O = 0.4 V				−20	μA
I_I	V_{CC} = 5.5 V, V_I = 7 V				0.1	mA
I_{IH}	V_{CC} = 5.5 V, V_I = 2.7 V				75	μA
I_{IL}	V_{CC} = 5.5 V, V_I = 0.4 V				−0.2	mA
I_{OS}‡	V_{CC} = 5.5 V, V_O = 0		−75		−250	mA
I_{CC}	V_{CC} = 5.5 V	Outputs high		6		mA
		Outputs low		25		
		Outputs disabled		2		

† All typical values are at V_{CC} = 5 V, T_A = 25°C.
‡ Not more than one output should be shorted at a time, and the duration of the short circuit should not exceed one second.

switching characteristics (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} = 5 V, C_L = 50 pF, R1 = 500 Ω, R2 = 500 Ω, T_A = 25°C			V_{CC} = 4.5 V to 5.5 V, C_L = 50 pF, R1 = 500 Ω, R2 = 500 Ω, T_A = 0°C to 70°C		UNIT
			MIN	TYP	MAX	MIN	MAX	
t_{PLH}	CLK	Any Q		7.5				ns
t_{PHL}				6.5				
t_{PZH}	$\overline{OC}$	Any Q		7.5				ns
t_{PZL}				9				
t_{PHZ}	$\overline{OC}$	Any Q		5				ns
t_{PLZ}				5				

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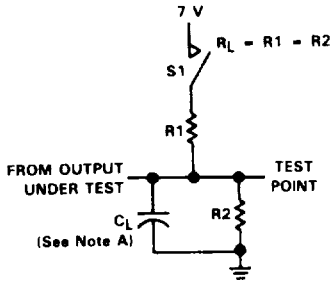
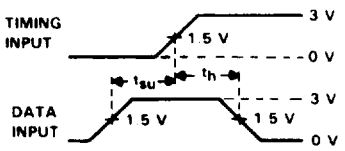
PARAMETER MEASUREMENT INFORMATION



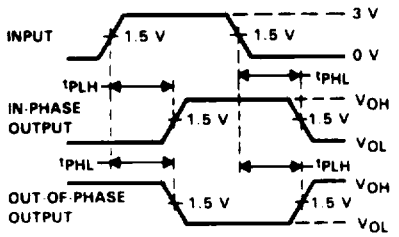
LOAD CIRCUIT

SWITCH POSITION TABLE

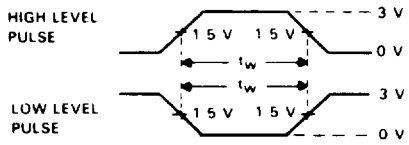
TEST	S1
t_{PLH}	Open
t_{PHL}	Open
t_{PZH}	Open
t_{PZL}	Closed
t_{PHZ}	Open
t_{PLZ}	Closed



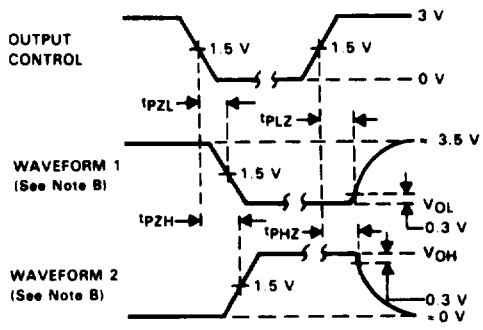
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS
PULSE DURATIONS



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES, THREE-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 the generators having the following characteristics: PRR ≤ 10 MHz, Z_O = 50 Ω, t_r ≤ 2.5 ns, t_f ≤ 2.5 ns.

FIGURE 1. SWITCHING CHARACTERISTICS