



1.8V CMOS 16-BIT EDGE-TRIGGERED D-TYPE FLIP-FLOP WITH 3-STATE OUTPUTS

IDT74AUC16374

FEATURES:

- ESD > 2000V per MIL-STD-883, Method 3015; > 200V using machine model (C = 200pF, R = 0)
- 1.8V Optimized
- 0.8V to 2.7V Operating Range
- Inputs/outputs tolerant up to 3.6V
- Output drivers: $\pm 9\text{mA}$ @ 2.3V
- Supports hot insertion
- Available in TSSOP, TVSOP, and VFBGA packages

APPLICATIONS:

- high performance, low voltage communications systems
- high performance, low voltage computing systems

DESCRIPTION:

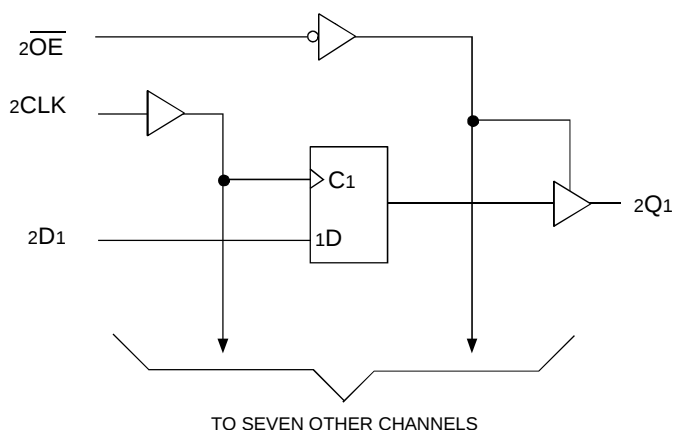
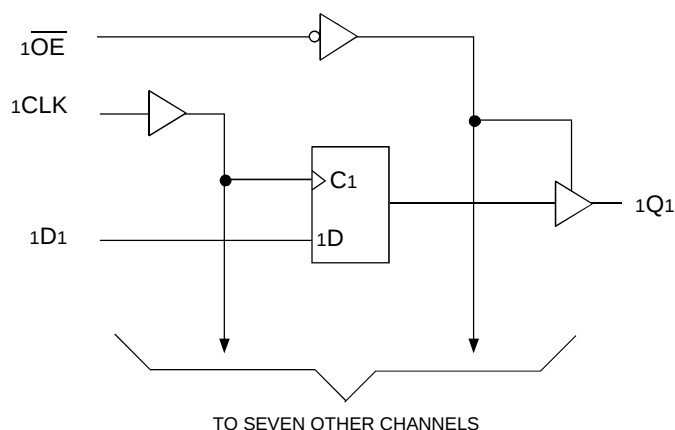
This 16-bit edge-triggered D-type flip-flop is built using advanced CMOS technology. The AUC16374 is particularly suitable for implementing buffer registers, I/O ports, bidirectional bus drivers, and working registers. It can be used as two 8-bit flip-flops or one 16-bit flip-flop. On the positive transition of the clock (CLK) input, the Q outputs of the flip-flop take on the logic levels at the data (D) inputs.

$\overline{\text{OE}}$ can be used to place the eight outputs in either a normal logic state (high or low logic levels) 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 the increased drive provide the capability to drive bus lines without need for interface or pullup components. $\overline{\text{OE}}$ does not affect the internal operation of the flip-flop. Old data can be retained or new data can be entered while the outputs are in the high-impedance state.

This device is 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, $\overline{\text{OE}}$ should be tied to V_{DD} through a pull-up resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

FUNCTIONAL BLOCK DIAGRAM



PINOUT CONFIGURATION

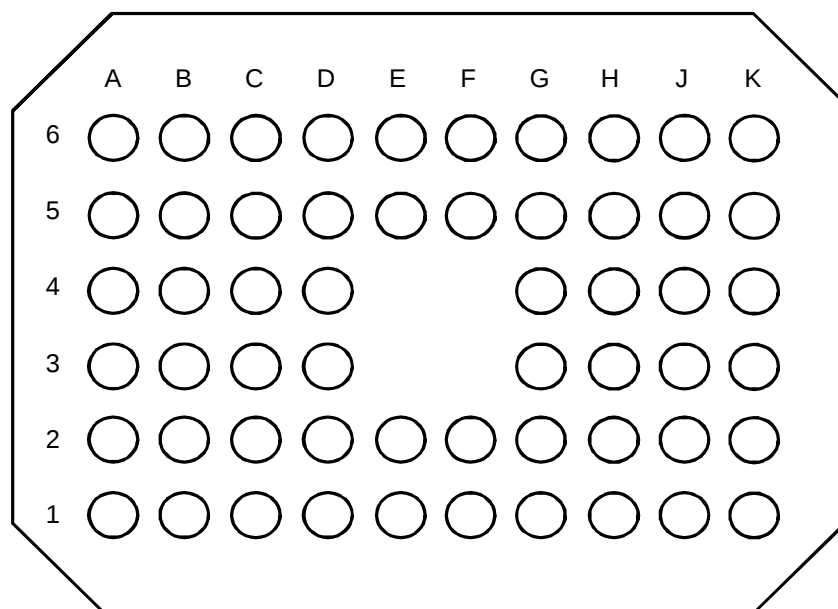
6	1CLK	1D2	1D4	1D6	1D8	2D1	2D3	2D5	2D7	2CLK
5	NC	1D1	1D3	1D5	1D7	2D2	2D4	2D6	2D8	NC
4	NC	GND	V _{DD}	GND			GND	V _{DD}	GND	NC
3	NC	GND	V _{DD}	GND			GND	V _{DD}	GND	NC
2	NC	1Q1	1Q3	1Q5	1Q7	2Q2	2Q4	2Q6	2Q8	NC
1	1 $\overline{OE}$	1Q2	1Q4	1Q6	1Q8	2Q1	2Q3	2Q5	2Q7	2 $\overline{OE}$
	A	B	C	D	E	F	G	H	J	K

VFBGA

NOTE:

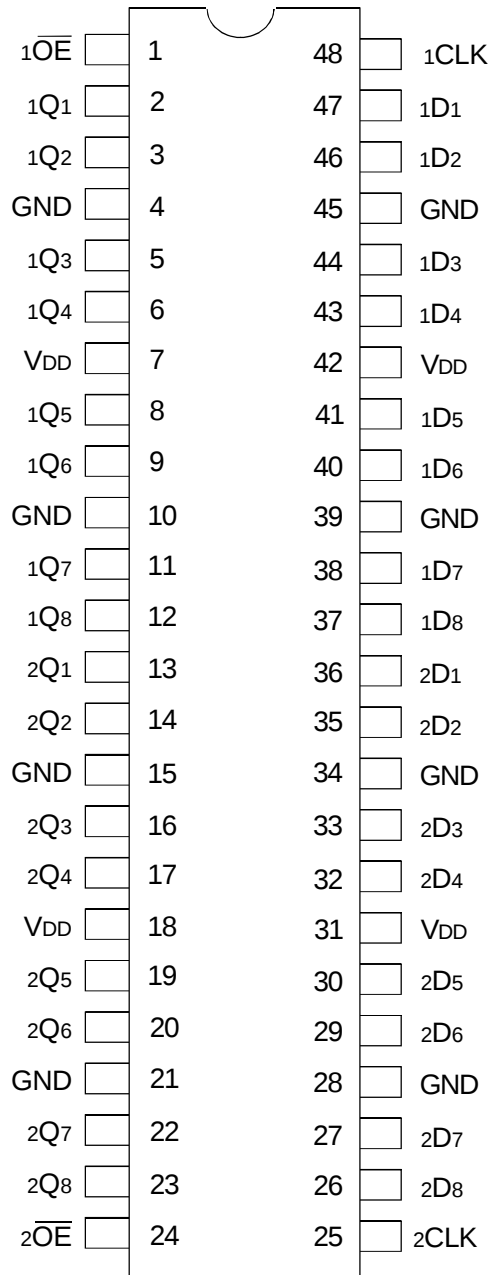
NC = No Internal Connection

56 BALL VFBGA PACKAGE LAYOUT



TOP VIEW

PIN CONFIGURATION



TSSOP/ TVSOP
TOP VIEW

PIN DESCRIPTION

Pin Names	Description
xDx	Data Inputs
xCLK	Clock Inputs
xQx	3-State Outputs
xOE	3-State Output Enable Inputs (Active LOW)

ABSOLUTE MAXIMUM RATINGS⁽¹⁾

Symbol	Description	Max	Unit
VTERM	Terminal Voltage with Respect to GND (all input and VDD terminals)	-0.5 to +3.6	V
VTERM	Terminal Voltage with Respect to GND (any I/O or Output terminals in high-impedance or power-off state)	-0.5 to +3.6	V
TSTG	Storage Temperature	-65 to +150	°C
IOUT	Continuous DC Output Current	±20	mA
I _{IK}	Continuous Clamp Current, V _I < 0, or V _I > VDD	±50	mA
I _{OK}	Continuous Clamp Current, V _O < 0	-50	mA
I _{DD} I _{SS}	Continuous Current through each VDD or GND	±100	mA

NOTE:

- Stresses greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

CAPACITANCE (T_A = +25°C, F = 1.0MHz, VDD = 2.5V)

Symbol	Parameter	Conditions	Typ.	Max.	Unit
C _{IN} ⁽¹⁾	Input Capacitance	V _{IN} = 0V	3		pF
C _{OUT} ⁽²⁾	Output Capacitance	V _{OUT} = 0V	5		pF
C _I ⁽³⁾	Input Port Capacitance	V _{IN} = 0V	3		pF

NOTES:

- Applies to Control Inputs.
- Applies to Data Outputs.
- Applies to Data Inputs.

FUNCTION TABLE (EACH FLIP-FLOP)⁽¹⁾

Inputs			Output
xOE	xCLK	xDx	xQx
L	↑	H	H
L	↑	L	L
L	H or L	X	Q ⁽²⁾
H	X	X	Z

NOTES:

- H = HIGH Voltage Level
L = LOW Voltage Level
X = Don't Care
Z = High-Impedance
↑ = LOW-to-HIGH Transition
- Level of Q before the indicated steady-state conditions were established.

RECOMMENDED OPERATING CHARACTERISTICS⁽¹⁾

Symbol	Parameter	Test Conditions	Min.	Max.	Unit
V _{DD}	Supply Voltage		0.8	2.7	V
V _{IH}	Input HIGH Voltage Level	V _{DD} = 0.8V	V _{DD}	—	V
		V _{DD} = 1.1V to 1.3V	0.65 x V _{DD}	—	
		V _{DD} = 1.4V to 1.6V	0.65 x V _{DD}	—	
		V _{DD} = 1.65V to 1.95V	0.65 x V _{DD}	—	
		V _{DD} = 2.3V to 2.7V	1.7	—	
V _{IL}	Input LOW Voltage Level	V _{DD} = 0.8V	—	0	V
		V _{DD} = 1.1V to 1.3V	—	0.35 x V _{DD}	
		V _{DD} = 1.4V to 1.6V	—	0.35 x V _{DD}	
		V _{DD} = 1.65V to 1.95V	—	0.35 x V _{DD}	
		V _{DD} = 2.3V to 2.7V	—	0.7	
V _I	Input Voltage		0	2.7	V
V _O	Output Voltage	Active State	0	V _{DD}	V
		3-State	0	2.7	
I _{OH}	HIGH Level Output Current	V _{DD} = 0.8V	—	−0.7	mA
		V _{DD} = 1.1V	—	−3	
		V _{DD} = 1.4V	—	−5	
		V _{DD} = 1.65V	—	−8	
		V _{DD} = 2.3V	—	−9	
I _{OL}	LOW Level Output Current	V _{DD} = 0.8V	—	0.7	mA
		V _{DD} = 1.1V	—	3	
		V _{DD} = 1.4V	—	5	
		V _{DD} = 1.65V	—	8	
		V _{DD} = 2.3V	—	9	
Δt/Δv	Input Transition Rise or Fall Time		—	20	ns/V
T _A	Operating Free-Air Temperature		−40	+85	°C

NOTE:

1. All unused inputs of the device must be held at V_{DD} or GND to ensure proper operation.

DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE⁽¹⁾

Following Conditions Apply Unless Otherwise Specified:

Operating Conditions: T_A = −40°C to +85°C

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I _{IH}	Input HIGH or LOW Current	V _{DD} = 2.7V, V _I = V _{DD} or GND	—	—	±5	μA
I _{IL}	All Inputs					
I _{OFF}	Input/Output Power Off Leakage	V _{DD} = 0V, V _{IN} or V _O ≤ 2.7V	—	—	±10	μA
I _{OZH}	High Impedance Output Current (3-State Output Pins)	V _{DD} = 2.7V, V _O = V _{DD}	—	—	±10	μA
I _{OZL}		V _O = GND	—	—	±10	
I _{DDL}	Quiescent Power Supply Current	V _{DD} = 0.8V to 2.7V	—	—	20	μA
I _{DDH}		V _{IN} = GND or V _{DD}				
I _{DDZ}						

NOTE:

1. All unused inputs of the device must be held at V_{DD} or GND to ensure proper operation.

OUTPUT DRIVE CHARACTERISTICS

Symbol	Parameter	Test Conditions ⁽¹⁾		Min.	Typ.	Max.	Unit
VOH	Output HIGH Voltage	VDD = 0.8V - 2.7V	IOH = -100μA	VDD - 0.1	—	—	V
		VDD = 0.8V	IOH = -0.7mA	—	0.55	—	
		VDD = 1.1V ⁽²⁾	IOH = -3mA	0.8	—	—	
		VDD = 1.4V ⁽³⁾	IOH = -5mA	1	—	—	
		VDD = 1.65V ⁽⁴⁾	IOH = -8mA	1.2	—	—	
		VDD = 2.3V ⁽⁵⁾	IOH = -9mA	1.8	—	—	
VOL	Output LOW Voltage	VDD = 0.8V - 2.7V	IOH = 100μA	—	—	0.2	V
		VDD = 0.8V	IOL = 0.7mA	—	0.25	—	
		VDD = 1.1V ⁽²⁾	IOL = 3mA	—	—	0.3	
		VDD = 1.4V ⁽³⁾	IOL = 5mA	—	—	0.4	
		VDD = 1.65V ⁽⁴⁾	IOL = 8mA	—	—	0.45	
		VDD = 2.3V ⁽⁵⁾	IOL = 9mA	—	—	0.6	

NOTES:

1. VIL and VIH must be within the min. or max. range shown in the DC ELECTRICAL CHARACTERISTICS table for the appropriate VDD range. TA = -40°C to +85°C.
2. Demonstrates operation for nominal VDD = 1.2V.
3. Demonstrates operation for nominal VDD = 1.5V.
4. Demonstrates operation for nominal VDD = 1.8V.
5. Demonstrates operation for nominal VDD = 2.5V.

OPERATING CHARACTERISTICS, TA = 25°C⁽¹⁾

Symbol	Parameter	Test Conditions	VDD = 0.8V	VDD = 1.2V	VDD = 1.5V	VDD = 1.8V	VDD = 2.5V	Unit
CPD (each output)	Power Dissipation Capacitance ⁽²⁾ Outputs Enabled, 1 Output Switching	1 fDATA = 5MHz 1 fCLK = 10MHz 1 fOUT = 5MHz OE = GND, CL = 0pF	24	24	24.1	26.2	31.2	pF
CPD(Z)	Power Dissipation Capacitance Outputs Disabled, 1 Clock and 1 Data Switching	1 fDATA = 5MHz 1 fCLK = 10MHz fOUT = not switching OE = VDD, CL = 0pF	7.5	7.5	8	9.4	13.2	pF
CPD (each clock)	Power Dissipation Capacitance ⁽³⁾ Outputs Disabled, Clock Only Switching	1 fDATA = 0MHz 1 fCLK = 10MHz fOUT = not switching OE = VDD, CL = 0pF	13.8	13.8	14	14.7	17.5	pF

NOTES:

1. Total device CPD for multiple (x) outputs switching and (n) clocks inputs switching = {x * CPD (each output)} + {n CPD (each clock)}.
2. CPD (each output). This is the CPD for each data bit where each input and output circuit is operating at 5MHz. The clock frequency is 10MHz and the numbers shown are minus the IDD component.
3. CPD (each clock); this is the CPD for each clock circuit, operating at 10MHz.

SWITCHING CHARACTERISTICS⁽¹⁾

Symbol	Parameter	V _{DD} = 0.8V	V _{DD} = 1.2V±0.1V		V _{DD} = 1.5V±0.1V		V _{DD} = 1.8V±0.15V			V _{DD} = 2.5V±0.2V		Unit
		Typ.	Min.	Max.	Min.	Max.	Min.	Typ.	Max.	Min.	Max.	
f _{MAX}		85	—	250	—	250	—	—	250	—	250	MHz
t _{PLH} t _{PHL}	Propagation Delay xCLK to xQx	7.3	1	4.5	0.8	2.9	0.7	1.5	2.8	0.7	2.2	ns
t _{PZH} t _{PZL}	Output Enable Time xOE to xQx	7	1.2	5.3	0.8	3.6	0.8	1.5	2.9	0.7	2.2	ns
t _{PHZ} t _{PLZ}	Output Disable Time xOE to xQx	8.2	2	7.1	1	4.8	1.4	2.7	4.5	0.7	2.2	ns
f _{CLOCK}	Clock Frequency	85	250	—	250	—	250	—	—	250	—	MHz
t _{SU}	Set-up Time, Data before CLK↑	1.4	1	—	1	—	1	—	—	1	—	ns
t _H	Hold Time, Data after CLK↑	0.1	0.9	—	0.9	—	0.9	—	—	0.9	—	ns
t _W	Pulse Duration, CLK HIGH or LOW	5.9	1.9	—	1.9	—	1.9	—	—	1.9	—	ns

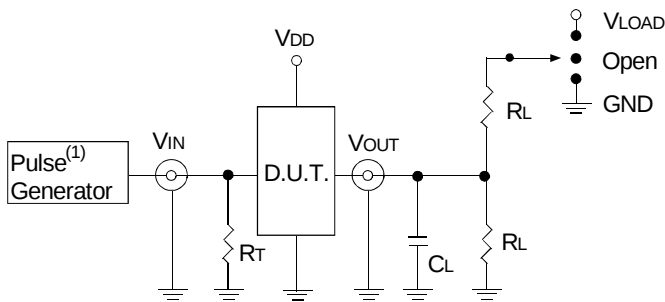
NOTE:

1. See TEST CIRCUITS AND WAVEFORMS. T_A = -40°C to +85°C.

TEST CIRCUITS AND WAVEFORMS

TEST CONDITIONS⁽¹⁾

Symbol	V _{DD} = 0.8V	V _{DD} = 1.2V±0.1V	V _{DD} = 1.5V±0.1V	V _{DD} = 1.8V±0.15V	V _{DD} = 2.5V±0.2V	Unit
V _{LOAD}	2xV _{DD}	2xV _{DD}	2xV _{DD}	2xV _{DD}	2xV _{DD}	V
V _T	V _{DD} /2	V _{DD} /2	V _{DD} /2	V _{DD} /2	V _{DD} /2	V
V _{LZ}	100	100	100	150	150	mV
V _{HZ}	100	100	100	150	150	mV
R _L	2	2	2	1	0.5	KΩ
C _L	15	15	15	30	30	pF



Test Circuits for All Outputs

DEFINITIONS:

C_L = Load capacitance: includes jig and probe capacitance.

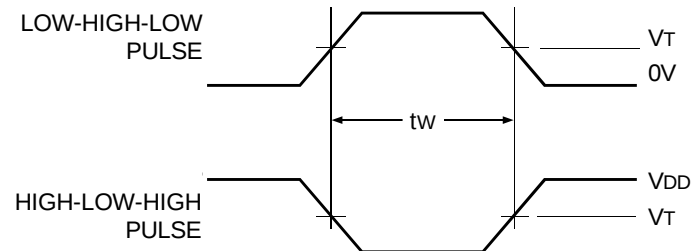
R_T = Termination resistance: should be equal to Z_{OUT} of the Pulse Generator.

NOTE:

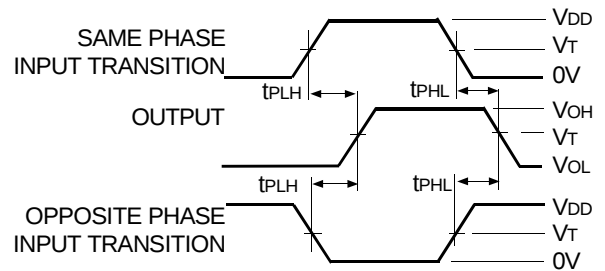
1. Pulse Generator for All Pulses: Rate ≤ 10MHz; slew rate ≥ 1V/ns.

SWITCH POSITION

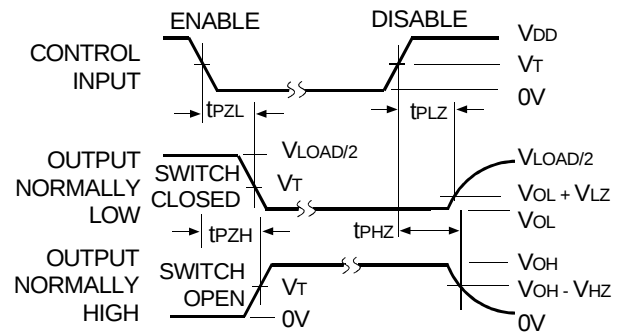
Test	Switch
Open Drain Disable Low Enable Low	V _{LOAD}
Disable High Enable High	GND
All Other Tests	Open



Pulse Width



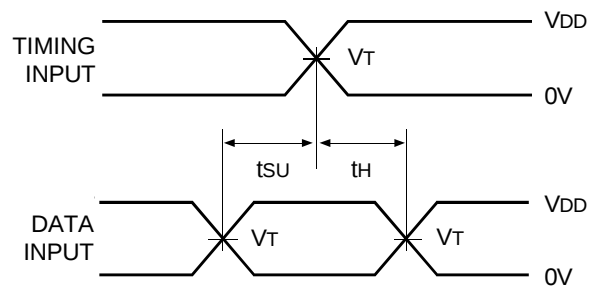
Propagation Delay



NOTE:

1. Diagram shown for input Control Enable-LOW and input Control Disable-HIGH.

Enable and Disable Times



Setup and Hold Times

ORDERING INFORMATION

IDT	XX	AUC	X	XX	XXX	XX	X		
Temp. Range			Bus- Hold	Family	Device Type	Package	Temp.		
								I	Industrial Temperature Range
								BV	Very Fine Pitch Ball Grid Array
								PA	Thin Shrink Small Outline Package
								PF	Thin Very Small Outline Package
								374	16-Bit Edge-Triggered D-Type Flip-Flop with 3-State Outputs
								16	Double-Density
								Blank	No bus-hold
								74	– 40°C to +85°C



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