

## 54AC821 • 54ACT821 10-Bit D Flip-Flop with TRI-STATE® Outputs

### General Description

The 'AC/'ACT821 is a 10-bit D flip-flop with TRI-STATE outputs arranged in a broadside pinout.

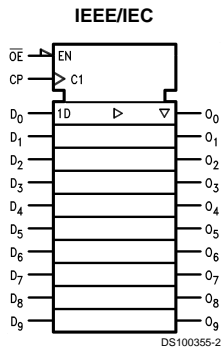
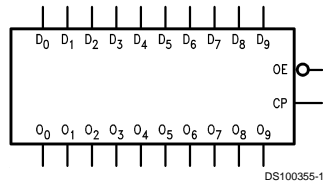
The 'AC/'ACT821 is functionally identical to the AM29821.

### Features

- TRI-STATE outputs for bus interfacing

- Noninverting outputs
- Outputs source/sink 24 mA
- 'ACT821 has TTL-compatible inputs
- Standard Microcircuit Drawing (SMD)
  - 'ACT821: 5962-88705
  - 'AC821: 5962-91606

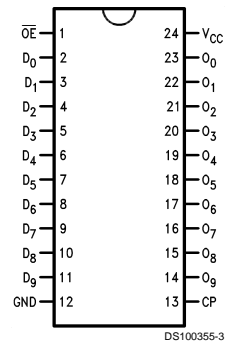
### Logic Symbols



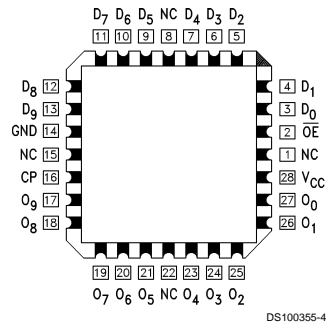
Pin Names	Description
D <sub>0</sub> –D <sub>9</sub>	Data Inputs
O <sub>0</sub> –O <sub>9</sub>	Data Outputs
$\overline{OE}$	Output Enable Input
CP	Clock Input

### Connection Diagrams

Pin Assignment for DIP and Flatpak



Pin Assignment for LCC



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## Functional Description

The 'AC/ACT821 consists of ten D-type edge-triggered flip-flops. The buffered Clock (CP) and buffered Output Enable ( $\overline{OE}$ ) are common to all flip-flops. The flip-flops will store the state of their individual D inputs that meet the setup and hold time requirements on the LOW-to-HIGH CP transition. With  $\overline{OE}$  LOW the contents of the flip-flops are available at

the outputs. When  $\overline{OE}$  is HIGH the outputs go to the high impedance state. Operation of the  $\overline{OE}$  input does not affect the state of the flip-flops.

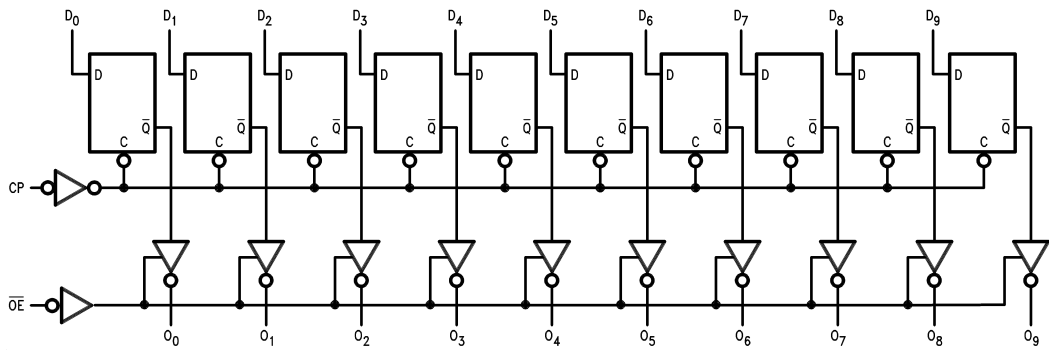
The 'AC/ACT821 is functionally and pin compatible with the AM29821.

## Function Table

$\overline{OE}$	Inputs		Internal	Outputs	Function
	CP	D	Q	O	
H	↗	L	L	Z	High Z
H	↗	H	H	Z	High Z
L	↗	L	L	L	Load
L	↗	H	H	H	Load

H = HIGH Voltage Level  
 L = LOW Voltage Level  
 Z = HIGH Impedance  
 ↗ = LOW-to-HIGH Clock Transition

## Logic Diagram



DS100355-5

Please note that this diagram is provided only for the understanding of logic operations and should not be used to estimate propagation delays.

## Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage ( $V_{CC}$ )	-0.5V to +7.0V
DC Input Diode Current ( $I_{IK}$ )	
$V_I = -0.5V$	-20 mA
$V_I = V_{CC} + 0.5V$	+20 mA
DC Input Voltage ( $V_I$ )	-0.5V to $V_{CC} + 0.5V$
DC Output Diode Current ( $I_{OK}$ )	
$V_O = -0.5V$	-20 mA
$V_O = V_{CC} + 0.5V$	+20 mA
DC Output Voltage ( $V_O$ )	-0.5V to $V_{CC} + 0.5V$
DC Output Source or Sink Current ( $I_O$ )	±50 mA
DC $V_{CC}$ or Ground Current per Output Pin ( $I_{CC}$ or $I_{GND}$ )	±50 mA
Storage Temperature ( $T_{STG}$ )	-65°C to +150°C
Junction Temperature ( $T_J$ )	
CDIP	175°C

## Recommended Operating Conditions

Supply Voltage ( $V_{CC}$ )	
'AC	2.0V to 6.0V
'ACT	4.5V to 5.5V
Input Voltage ( $V_I$ )	0V to $V_{CC}$
Output Voltage ( $V_O$ )	0V to $V_{CC}$
Operating Temperature ( $T_A$ )	
54AC/ACT	-55°C to +125°C
Minimum Input Edge Rate ( $\Delta V/\Delta t$ )	
'AC Devices	
$V_{IN}$ from 30% to 70% of $V_{CC}$	
$V_{CC}$ @ 3.3V, 4.5V, 5.5V	125 mV/ns
Minimum Input Edge Rate ( $\Delta V/\Delta t$ )	
'ACT Devices	
$V_{IN}$ from 0.8V to 2.0V	
$V_{CC}$ @ 4.5V, 5.5V	125 mV/ns

**Note 1:** Absolute maximum ratings are those values beyond which damage to the device may occur. The databook specifications should be met, without exception, to ensure that the system design is reliable over its power supply, temperature, and output/input loading variables. National does not recommend operation of FACT® circuits outside databook specifications.

## DC Characteristics for 'AC Family Devices

Symbol	Parameter	$V_{CC}$ (V)	54AC		Units	Conditions	
			$T_A = -55^\circ\text{C to } +125^\circ\text{C}$				
			Guaranteed Limits				
$V_{IH}$	Minimum High Level Input Voltage	3.0	2.1		V	$V_{OUT} = 0.1V$ or $V_{CC} - 0.1V$	
		4.5	3.15				
		5.5	3.85				
$V_{IL}$	Maximum Low Level Input Voltage	3.0	0.9		V	$V_{OUT} = 0.1V$ or $V_{CC} - 0.1V$	
		4.5	1.35				
		5.5	1.65				
$V_{OH}$	Minimum High Level Output Voltage	3.0	2.9		V	$I_{OUT} = -50 \mu A$	
		4.5	4.4				
		5.5	5.4				
			3.0	2.4		V	(Note 2) $V_{IN} = V_{IL}$ or $V_{IH}$ $I_{OH} = -12 \text{ mA}$ $I_{OH} = -24 \text{ mA}$ $I_{OH} = -24 \text{ mA}$
			4.5	3.7			
			5.5	4.7			
$V_{OL}$	Maximum Low Level Output Voltage	3.0	0.1		V	$I_{OUT} = 50 \mu A$	
		4.5	0.1				
		5.5	0.1				
			3.0	0.50		V	(Note 2) $V_{IN} = V_{IL}$ or $V_{IH}$ $I_{OL} = 12 \text{ mA}$ $I_{OL} = 24 \text{ mA}$ $I_{OL} = 24 \text{ mA}$
			4.5	0.50			
			5.5	0.50			
$I_{IN}$	Maximum Input Leakage Current	5.5	±1.0		μA	$V_I = V_{CC}, \text{ GND}$	
$I_{OZ}$	Maximum TRI-STATE Current	5.5	±10.0		μA	$V_I (\text{OE}) = V_{IL}, V_{IH}$ $V_I = V_{CC}, \text{ GND}$ $V_O = V_{CC}, \text{ GND}$	

### DC Characteristics for 'AC Family Devices (Continued)

Symbol	Parameter	V <sub>CC</sub> (V)	54AC		Units	Conditions
			T <sub>A</sub> = -55°C to +125°C			
			Guaranteed Limits			
I <sub>OLD</sub>	(Note 3) Minimum Dynamic Output Current	5.5	50		mA	V <sub>OLD</sub> = 1.65V Max
I <sub>OHD</sub>	Output Current	5.5	-50			
I <sub>CC</sub>	Maximum Quiescent Supply Current	5.5	160.0		μA	V <sub>IN</sub> = V <sub>CC</sub> or GND

**Note 2:** All outputs loaded; thresholds on input associated with output under test.

**Note 3:** Maximum test duration 2.0 ms, one output loaded at a time.

**Note 4:** I<sub>IN</sub> and I<sub>CC</sub> @ 3.0V are guaranteed to be less than or equal to the respective limit @ 5.5V V<sub>CC</sub>.

I<sub>CC</sub> for 54AC @ 25°C is identical to 74AC @ 25°C.

### DC Characteristics for 'ACT Family Devices

Symbol	Parameter	V <sub>CC</sub> (V)	54ACT		Units	Conditions
			T <sub>A</sub> = -55°C to +125°C			
			Guaranteed Limits			
V <sub>IH</sub>	Minimum High Level Input Voltage	4.5	2.0		V	V <sub>OUT</sub> = 0.1V or V <sub>CC</sub> - 0.1V
		5.5	2.0			
V <sub>IL</sub>	Maximum Low Level Input Voltage	4.5	0.8		V	V <sub>OUT</sub> = 0.1V or V <sub>CC</sub> - 0.1V
		5.5	0.8			
V <sub>OH</sub>	Minimum High Level Output Voltage	4.5	4.4		V	I <sub>OUT</sub> = -50 μA
		5.5	5.4			
		4.5	3.70		V	(Note 5) V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub> I <sub>OH</sub> = -24 mA I <sub>OH</sub> = -24 mA
		5.5	4.70			
V <sub>OL</sub>	Maximum Low Level Output Voltage	4.5	0.1		V	I <sub>OUT</sub> = 50 μA
		5.5	0.1			
		4.5	0.50		V	(Note 5) V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub> I <sub>OL</sub> = 24 mA I <sub>OL</sub> = 24 mA
		5.5	0.50			
I <sub>IN</sub>	Maximum Input Leakage Current	5.5	±1.0		μA	V <sub>I</sub> = V <sub>CC</sub> , GND
I <sub>OZ</sub>	Maximum TRI-STATE Current	5.5	±10.0		μA	V <sub>I</sub> = V <sub>IL</sub> , V <sub>IH</sub> V <sub>O</sub> = V <sub>CC</sub> , GND
I <sub>CCT</sub>	Maximum I <sub>CC</sub> /Input	5.5	1.6		mA	V <sub>I</sub> = V <sub>CC</sub> - 2.1V
I <sub>OLD</sub>	(Note 6) Minimum Dynamic Output Current	5.5	50		mA	V <sub>OLD</sub> = 1.65V Max
I <sub>OHD</sub>	Output Current	5.5	-50			
I <sub>CC</sub>	Maximum Quiescent Supply Current	5.5	160.0		μA	V <sub>IN</sub> = V <sub>CC</sub> or GND

**Note 5:** All outputs loaded; thresholds on input associated with output under test.

**Note 6:** Maximum test duration 2.0 ms, one output loaded at a time.

**Note 7:** I<sub>CC</sub> for 54ACT @ 25°C is identical to 74ACT @ 25°C.

### AC Electrical Characteristics

Symbol	Parameter	V <sub>CC</sub> (V) (Note 8)	54AC		Units	Fig. No.
			T <sub>A</sub> = -55°C to +125°C C <sub>L</sub> = 50 pF			
			Min	Max		
f <sub>max</sub>	Maximum Clock Frequency	3.3	95		MHz	
		5.0	100			
t <sub>PLH</sub>	Propagation Delay CP to O <sub>n</sub>	3.3	1.0	13.0	ns	
		5.0	1.5	9.5		
t <sub>PHL</sub>	Propagation Delay CP to O <sub>n</sub>	3.3	1.0	13.0	ns	
		5.0	1.5	9.5		
t <sub>PZH</sub>	Output Enable Time OE to O <sub>n</sub>	3.3	1.0	13.0	ns	
		5.0	1.5	9.5		
t <sub>PZL</sub>	Output Enable Time OE to O <sub>n</sub>	3.3	1.0	13.0	ns	
		5.0	1.5	9.5		
t <sub>PHZ</sub>	Output Disable Time OE to O <sub>n</sub>	3.3	1.0	12.0	ns	
		5.0	1.5	10.0		
t <sub>PLZ</sub>	Output Disable Time OE to O <sub>n</sub>	3.3	1.0	12.0	ns	
		5.0	1.5	10.0		

Note 8: Voltage Range 3.3 is 3.3V ±0.3V

Note 9: Voltage Range 5.0 is 5.0V ±0.5V

### AC Operating Requirements

Symbol	Parameter	V <sub>CC</sub> (V) (Note 10)	54AC		Units	Fig. No.
			T <sub>A</sub> = -55°C to +125°C C <sub>L</sub> = 50 pF			
			Guaranteed Minimum			
t <sub>s</sub>	Setup Time, HIGH or LOW D <sub>n</sub> to CP	3.3	3.0		ns	
		5.0	3.0			
t <sub>h</sub>	Hold Time, HIGH or LOW D <sub>n</sub> to CP	3.3	3.0		ns	
		5.0	3.0			
t <sub>w</sub>	CP Pulse Width HIGH or LOW	3.3	6.0		ns	
		5.0	5.0			

Note 10: Voltage Range 3.3 is 3.3V ±0.3V

Note 11: Voltage Range 5.0 is 5.0V ±0.5V

### AC Electrical Characteristics

Symbol	Parameter	V <sub>CC</sub> (V) (Note 12)	54ACT		Units	Fig. No.
			T <sub>A</sub> = -55°C to +125°C C <sub>L</sub> = 50 pF			
			Min	Max		
f <sub>max</sub>	Maximum Clock Frequency	5.0	85		MHz	
t <sub>PLH</sub>	Propagation Delay CP to O <sub>n</sub>	5.0	1.5	11.5	ns	
t <sub>PHL</sub>	Propagation Delay CP to O <sub>n</sub>	5.0	1.5	11.5	ns	
t <sub>PZH</sub>	Output Enable Time OE to O <sub>n</sub>	5.0	1.5	12.5	ns	

## AC Electrical Characteristics (Continued)

Symbol	Parameter	V <sub>CC</sub> (V) (Note 12)	54ACT		Units	Fig. No.
			T <sub>A</sub> = -55°C to +125°C C <sub>L</sub> = 50 pF			
			Min	Max		
t <sub>PZL</sub>	Output Enable Time O <sub>E</sub> to O <sub>n</sub>	5.0	1.5	13.0	ns	
t <sub>PHZ</sub>	Output Disable Time O <sub>E</sub> to O <sub>n</sub>	5.0	1.5	13.5	ns	
t <sub>PLZ</sub>	Output Disable Time O <sub>E</sub> to O <sub>n</sub>	5.0	1.5	12.5	ns	

Note 12: Voltage Range 5.0 is 5.0V ±0.5V

## AC Operating Requirements

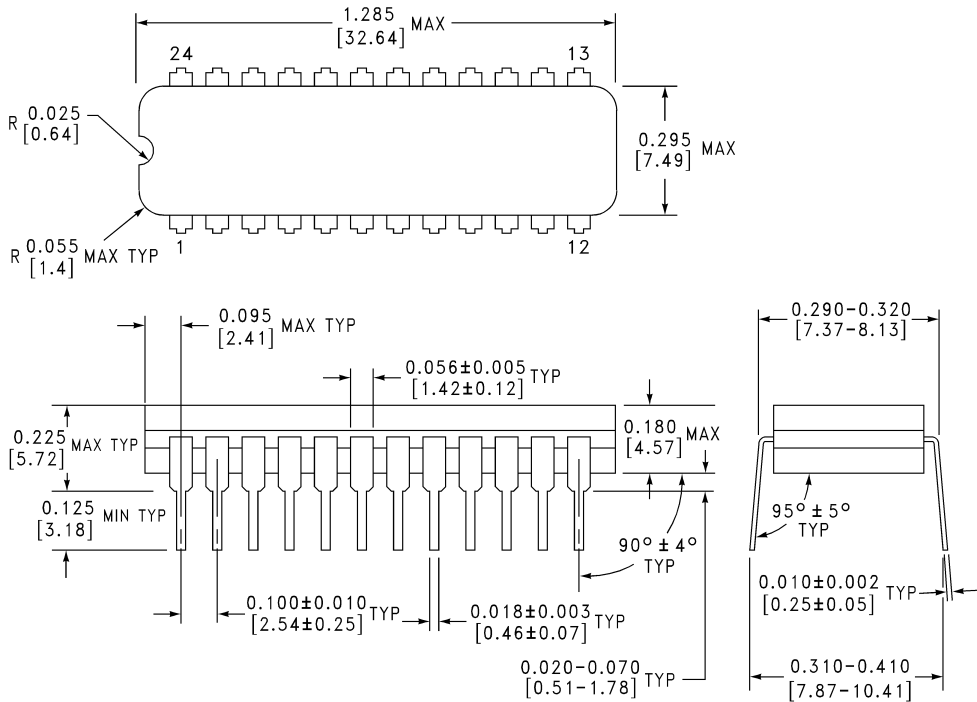
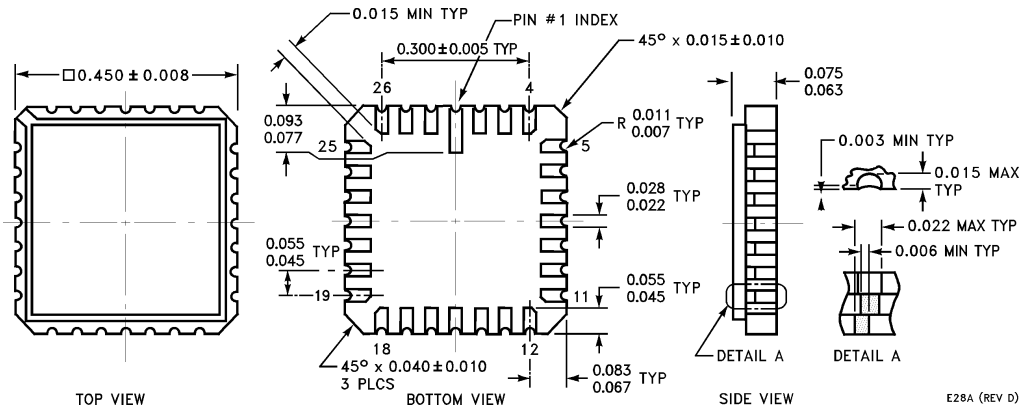
Symbol	Parameter	V <sub>CC</sub> (V) (Note 13)	54ACT		Units	Fig. No.
			T <sub>A</sub> = -55°C to +125°C C <sub>L</sub> = 50 pF			
			Guaranteed Minimum			
t <sub>s</sub>	Setup Time, HIGH or LOW D <sub>n</sub> to CP	5.0	4.0		ns	
t <sub>h</sub>	Hold Time, HIGH or LOW D <sub>n</sub> to CP	5.0	3.0		ns	
t <sub>w</sub>	CP Pulse Width HIGH or LOW	5.0	6.0		ns	

Note 13: Voltage Range 5.0 is 5.0V ±0.5V

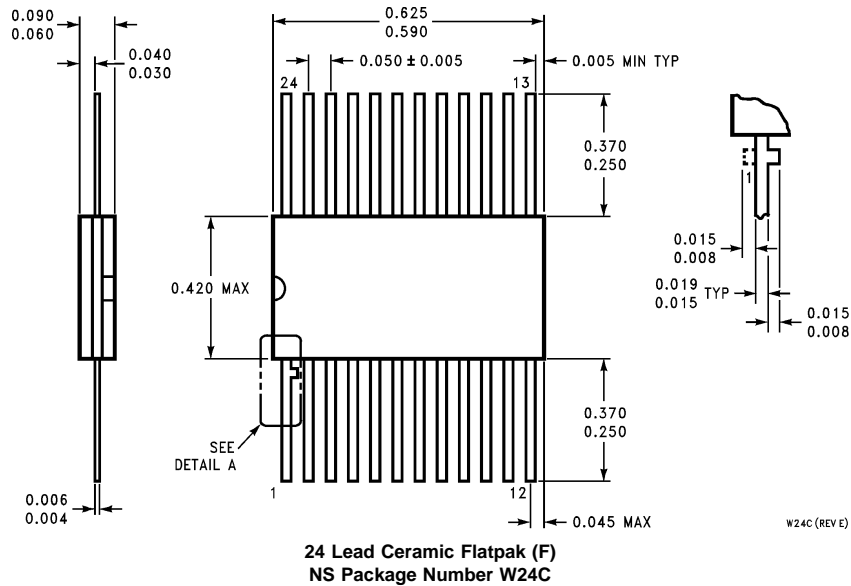
## Capacitance

Symbol	Parameter	Typ	Units	Conditions
C <sub>IN</sub>	Input Capacitance	4.5	pF	V <sub>CC</sub> = OPEN
C <sub>PD</sub>	Power Dissipation Capacitance	35.0	pF	V <sub>CC</sub> = 5.0V

**Physical Dimensions** inches (millimeters) unless otherwise noted



**Physical Dimensions** inches (millimeters) unless otherwise noted (Continued)



W24C (REV E)

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