National Semiconductor

August 1998

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

General Description

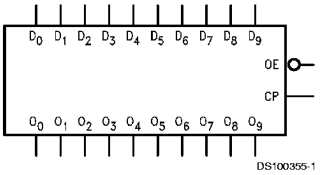
The 'AC/'ACT821 is a 10-bit D flip-flop with TRI-STATE outputs arranged in a broadside pinout.

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



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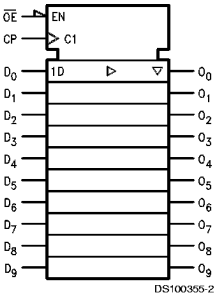
IEEE/IEC



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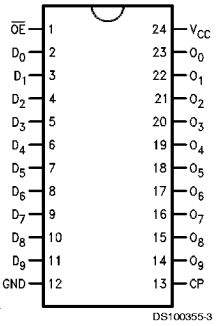
Pin Names	Description
D_0–D_9	Data Inputs
O_0–O_9	Data Outputs
$\overline{OE}$	Output Enable Input
CP	Clock Input

Connection Diagrams

Pin Assignment for DIP and Flatpak



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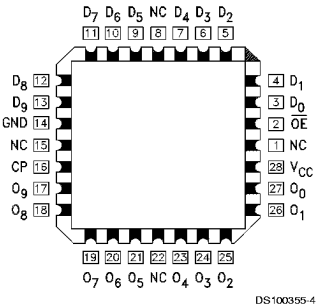
Pin Assignment for LCC



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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.

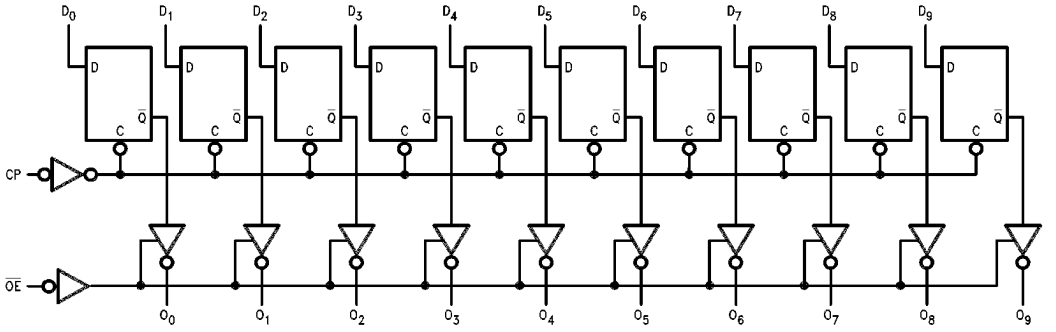
The 'AC/'ACT821 is functionally and pin compatible with the AM29821.

Function Table

Inputs			Internal	Outputs	Function
$\overline{OE}$	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



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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 T_A = −55°C to +125°C Guaranteed Limits	Units	Conditions
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 μA
		4.5	4.4		
		5.5	5.4		
					(Note 2) V_{IN} = V_{IL} or V_{IH}
		3.0	2.4	V	I_{OH} = −12 mA
		4.5	3.7		I_{OH} = −24 mA
		5.5	4.7		I_{OH} = −24 mA
V_{OL}	Maximum Low Level Output Voltage	3.0	0.1	V	I_{OUT} = 50 μA
		4.5	0.1		
		5.5	0.1		
					(Note 2) V_{IN} = V_{IL} or V_{IH}
		3.0	0.50	V	I_{OL} = 12 mA
		4.5	0.50		I_{OL} = 24 mA
		5.5	0.50		I_{OL} = 24 mA
I_{IN}	Maximum Input Leakage Current	5.5	±1.0	μA	V_I = V_{CC}, GND
I_{OZ}	Maximum TRI-STATE Current	5.5	±10.0	μA	V_I (OE) = V_{IL}, V_{IH} V_I = V_{CC}, GND V_O = V_{CC}, GND

DC Characteristics for 'AC Family Devices (Continued)

Symbol	Parameter	V_{CC} (V)	54AC T_A = −55°C to +125°C Guaranteed Limits	Units	Conditions
I_{OLD}	(Note 3) Minimum Dynamic	5.5	50	mA	V_{OLD} = 1.65V Max
I_{OHD}	Output Current	5.5	−50	mA	V_{OHD} = 3.85V Min
I_{CC}	Maximum Quiescent Supply Current	5.5	160.0	µA	V_{IN} = V_{CC} 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_{IN} and I_{CC} @ 3.0V are guaranteed to be less than or equal to the respective limit @ 5.5V V_{CC}. I_{CC} for 54AC @ 25°C is identical to 74AC @ 25°C.

DC Characteristics for 'ACT Family Devices

Symbol	Parameter	V_{CC} (V)	54ACT T_A = −55°C to +125°C Guaranteed Limits	Units	Conditions
V_{IH}	Minimum High Level Input Voltage	4.5 5.5	2.0 2.0	V	V_{OUT} = 0.1V or V_{CC} − 0.1V
V_{IL}	Maximum Low Level Input Voltage	4.5 5.5	0.8 0.8	V	V_{OUT} = 0.1V or V_{CC} − 0.1V
V_{OH}	Minimum High Level Output Voltage	4.5 5.5	4.4 5.4	V	I_{OUT} = −50 µA
		4.5 5.5	3.70 4.70	V	(Note 5) V_{IN} = V_{IL} or V_{IH} I_{OH} = −24 mA I_{OH} = −24 mA
V_{OL}	Maximum Low Level Output Voltage	4.5 5.5	0.1 0.1	V	I_{OUT} = 50 µA
		4.5 5.5	0.50 0.50	V	(Note 5) V_{IN} = V_{IL} or V_{IH} I_{OL} = 24 mA I_{OL} = 24 mA
I_{IN}	Maximum Input Leakage Current	5.5	±1.0	µA	V_I = V_{CC}, GND
I_{OZ}	Maximum TRI-STATE Current	5.5	±10.0	µA	V_I = V_{IL}, V_{IH} V_O = V_{CC}, GND
I_{CCT}	Maximum I_{CC}/Input	5.5	1.6	mA	V_I = V_{CC} − 2.1V
I_{OLD}	(Note 6) Minimum Dynamic	5.5	50	mA	V_{OLD} = 1.65V Max
I_{OHD}	Output Current	5.5	−50	mA	V_{OHD} = 3.85V Min
I_{CC}	Maximum Quiescent Supply Current	5.5	160.0	µA	V_{IN} = V_{CC} 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_{CC} for 54ACT @ 25°C is identical to 74ACT @ 25°C.

AC Electrical Characteristics

Symbol	Parameter	V_{CC} (V) (Note 8)	54AC $T_A = -55^\circ C$ to $+125^\circ C$ $C_L = 50$ pF		Units	Fig. No.
			Min	Max		
f_{max}	Maximum Clock Frequency	3.3	95		MHz	
		5.0	100			
t_{PLH}	Propagation Delay CP to O_n	3.3	1.0	13.0	ns	
		5.0	1.5	9.5		
t_{PHL}	Propagation Delay CP to O_n	3.3	1.0	13.0	ns	
		5.0	1.5	9.5		
t_{PZH}	Output Enable Time $\overline{OE}$ to O_n	3.3	1.0	13.0	ns	
		5.0	1.5	9.5		
t_{PZL}	Output Enable Time $\overline{OE}$ to O_n	3.3	1.0	13.0	ns	
		5.0	1.5	9.5		
t_{PHZ}	Output Disable Time $\overline{OE}$ to O_n	3.3	1.0	12.0	ns	
		5.0	1.5	10.0		
t_{PLZ}	Output Disable Time $\overline{OE}$ to O_n	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_{CC} (V) (Note 10)	54AC $T_A = -55^\circ C$ to $+125^\circ C$ $C_L = 50$ pF	Units	Fig. No.
			Guaranteed Minimum		
t_s	Setup Time, HIGH or LOW D_n to CP	3.3	3.0	ns	
		5.0	3.0		
t_h	Hold Time, HIGH or LOW D_n to CP	3.3	3.0	ns	
		5.0	3.0		
t_w	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_{CC} (V) (Note 12)	54ACT $T_A = -55^\circ C$ to $+125^\circ C$ $C_L = 50$ pF		Units	Fig. No.
			Min	Max		
f_{max}	Maximum Clock Frequency	5.0	85		MHz	
t_{PLH}	Propagation Delay CP to O_n	5.0	1.5	11.5	ns	
t_{PHL}	Propagation Delay CP to O_n	5.0	1.5	11.5	ns	
t_{PZH}	Output Enable Time $\overline{OE}$ to O_n	5.0	1.5	12.5	ns	

AC Electrical Characteristics (Continued)

Symbol	Parameter	V_{CC} (V) (Note 12)	54ACT $T_A = -55°C$ to $+125°C$ $C_L = 50$ pF		Units	Fig. No.
			Min	Max		
t_{PZL}	Output Enable Time $\overline{OE}$ to O_n	5.0	1.5	13.0	ns	
t_{PHZ}	Output Disable Time $\overline{OE}$ to O_n	5.0	1.5	13.5	ns	
t_{PLZ}	Output Disable Time $\overline{OE}$ to O_n	5.0	1.5	12.5	ns	

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

AC Operating Requirements

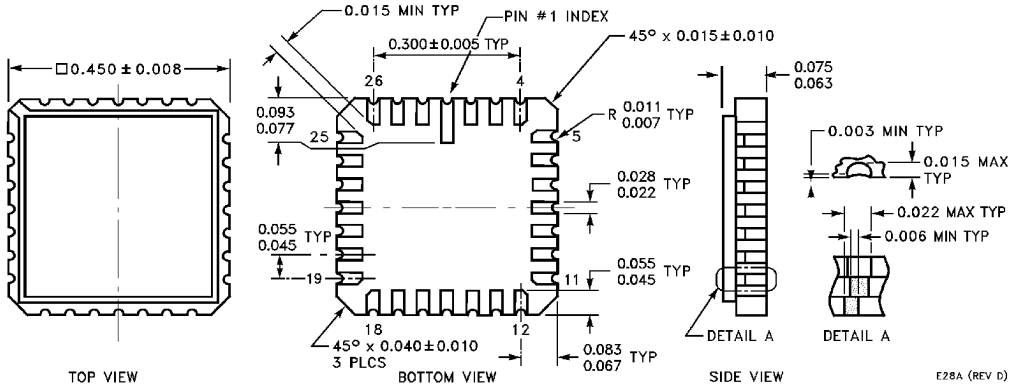
Symbol	Parameter	V_{CC} (V) (Note 13)	54ACT $T_A = -55°C$ to $+125°C$ $C_L = 50$ pF	Units	Fig. No.
			Guaranteed Minimum		
t_s	Setup Time, HIGH or LOW D_n to CP	5.0	4.0	ns	
t_h	Hold Time, HIGH or LOW D_n to CP	5.0	3.0	ns	
t_w	CP Pulse Width HIGH or LOW	5.0	6.0	ns	

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

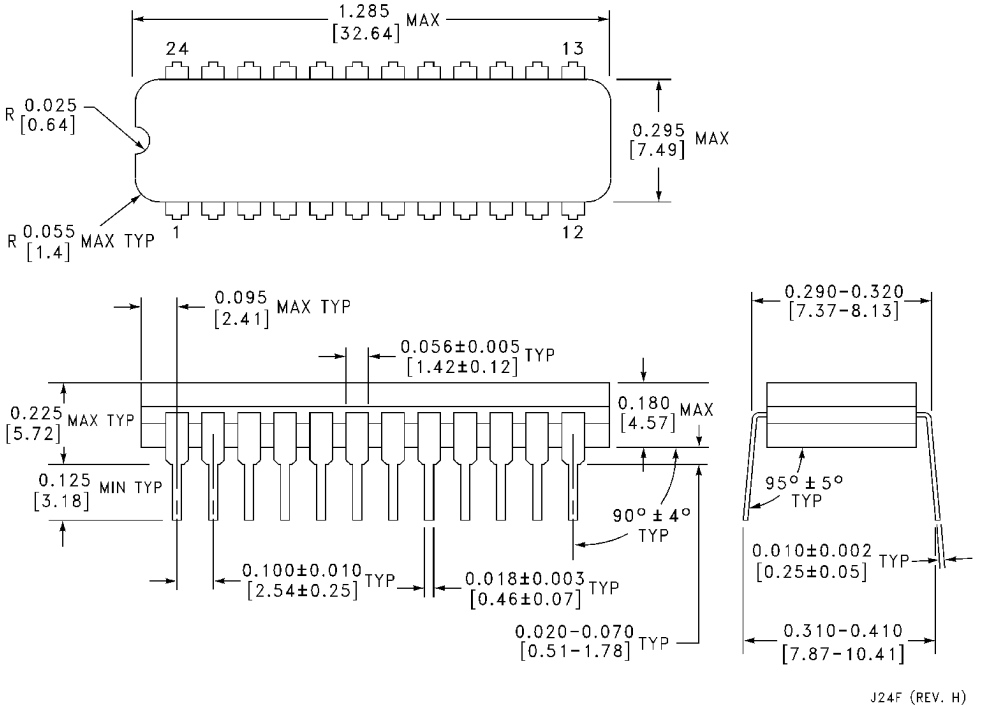
Capacitance

Symbol	Parameter	Typ	Units	Conditions
C_{IN}	Input Capacitance	4.5	pF	V_{CC} = OPEN
C_{PD}	Power Dissipation Capacitance	35.0	pF	V_{CC} = 5.0V

Physical Dimensions inches (millimeters) unless otherwise noted

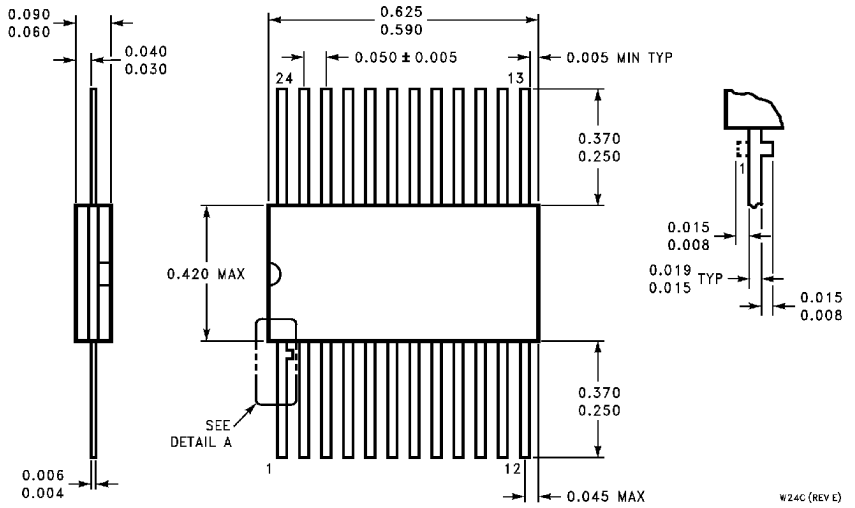


28 Terminal Ceramic Leadless Chip Carrier (L)
NS Package Number E28A



24 Lead Slim (0.300" Wide) Ceramic Dual-In-Line Package (SD)
NS Package Number J24F

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



24 Lead Ceramic Flatpak (F)
NS Package Number W24C

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