

## 54AC109 • 54ACT109 Dual JK Positive Edge-Triggered Flip-Flop

### General Description

The 'AC/'ACT109 consists of two high-speed completely independent transition clocked JK flip-flops. The clocking operation is independent of rise and fall times of the clock waveform. The JK design allows operation as a D flip-flop (refer to 'AC/'ACT74 data sheet) by connecting the J and K inputs together.

#### Asynchronous Inputs:

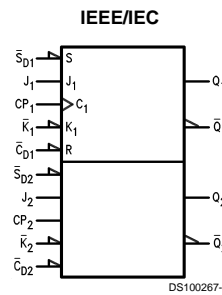
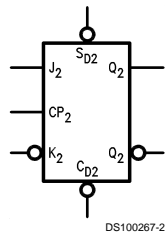
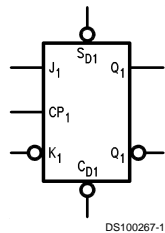
- LOW input to  $\overline{S}_D$  (Set) sets Q to HIGH level
- LOW input to  $\overline{C}_D$  (Clear) sets Q to LOW level
- Clear and Set are independent of clock

Simultaneous LOW on  $\overline{C}_D$  and  $\overline{S}_D$  makes both Q and  $\overline{Q}$  HIGH

### Features

- $I_{CC}$  reduced by 50%
- Outputs source/sink 24 mA
- 'ACT109 has TTL-compatible inputs
- Standard Military Drawing (SMD)
  - 'AC109: 5962-89551
  - 'ACT109: 5962-88534

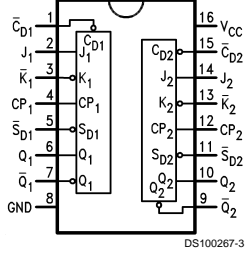
### Logic Symbol



Pin Names	Description
$J_1, J_2, \overline{K}_1, \overline{K}_2$	Data Inputs
$CP_1, CP_2$	Clock Pulse Inputs
$\overline{C}_{D1}, \overline{C}_{D2}$	Direct Clear Inputs
$\overline{S}_{D1}, \overline{S}_{D2}$	Direct Set Inputs
$Q_1, Q_2, \overline{Q}_1, \overline{Q}_2$	Outputs

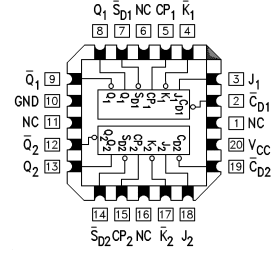
## Connection Diagrams

Pin Assignment for DIP and Flatpak



DS100267-3

Pin Assignment for LCC



DS100267-4

## Truth Table

(each half)

Inputs					Outputs	
$\bar{S}_D$	$\bar{C}_D$	CP	J	$\bar{K}$	Q	$\bar{Q}$
L	H	X	X	X	H	L
H	L	X	X	X	L	H
L	L	X	X	X	H	H
H	H	↗	L	L	L	H
H	H	↗	H	L	Toggle	
H	H	↗	L	H	$Q_0$	$\bar{Q}_0$
H	H	↗	H	H	H	L
H	H	L	X	X	$Q_0$	$\bar{Q}_0$

H = HIGH Voltage Level

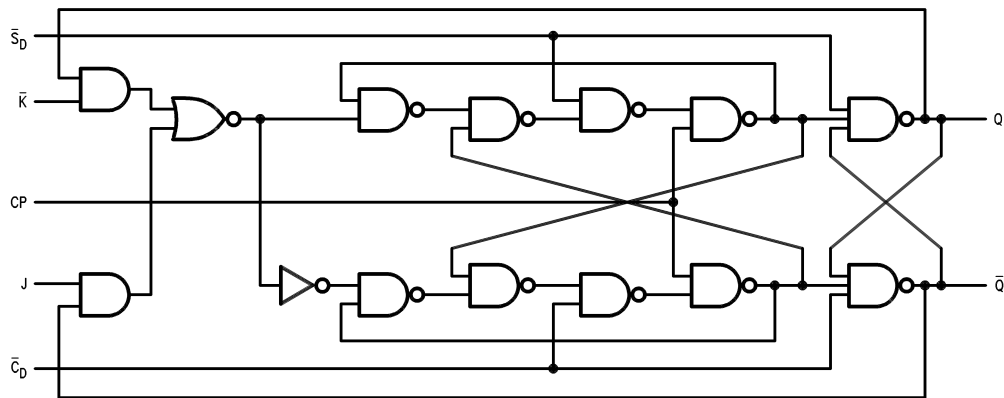
L = LOW Voltage Level

↗ = LOW-to-HIGH Transition

X = Immaterial

$Q_0(\bar{Q}_0)$  = Previous  $Q_0$  ( $\bar{Q}_0$ ) before LOW-to-HIGH Transition of Clock

## Logic Diagram (one half shown)



DS100267-5

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	0.5	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	0.5		
			5.5	0.5		
$I_{IN}$	Maximum Input Leakage Current	5.5	±1.0	μA	$V_I = V_{CC}, GND$	
$I_{OLD}$	(Note 3) Minimum Dynamic Output Current	5.5	50	mA	$V_{OLD} = 1.65V \text{ Max}$	
$I_{OHD}$		5.5	-50	mA	$V_{OHD} = 3.85V \text{ Min}$	

### 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>CC</sub>	Maximum Quiescent Supply Current	5.5	40.0		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>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	5.5	50		mA	V <sub>OLD</sub> = 1.65V Max
I <sub>OHD</sub>	Output Current	5.5	-50		mA	V <sub>OHD</sub> = 3.85V Min
I <sub>CC</sub>	Maximum Quiescent Supply Current	5.5	40.0		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 5.0	65 95		MHz	
t <sub>PLH</sub>	Propagation Delay CP <sub>n</sub> to Q <sub>n</sub> or $\bar{Q}_n$	3.3 5.0	1.0 1.0	17.5 12.0	ns	
t <sub>PHL</sub>	Propagation Delay CP <sub>n</sub> to Q <sub>n</sub> or $\bar{Q}_n$	3.3 5.0	1.0 1.0	13.5 10.0	ns	
t <sub>PLH</sub>	Propagation Delay $\bar{C}_{Dn}$ or $\bar{S}_{Dn}$ to Q <sub>n</sub> or $\bar{Q}_n$	3.3 5.0	1.0 1.0	13.0 9.5	ns	
t <sub>PHL</sub>	Propagation Delay $\bar{C}_{Dn}$ or $\bar{S}_{Dn}$ to Q <sub>n</sub> or $\bar{Q}_n$	3.3 5.0	1.0 1.0	14.0 10.5	ns	

**Note 8:** Voltage Range 3.3 is 3.3V ±0.3V  
Voltage Range 5.0 is 5.0V ±0.5V

## AC Operating Requirements

Symbol	Parameter	V <sub>CC</sub> (V) (Note 9)	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 J <sub>n</sub> or $\bar{K}_n$ to CP <sub>n</sub>	3.3 5.0	8.0 5.5		ns	
t <sub>h</sub>	Hold Time, HIGH or LOW J <sub>n</sub> or $\bar{K}_n$ to CP <sub>n</sub>	3.3 5.0	0 0.5		ns	
t <sub>w</sub>	Pulse Width $\bar{C}_{Dn}$ or $\bar{S}_{Dn}$ or CP <sub>n</sub>	3.3 5.0	8.0 5.5		ns	
t <sub>rec</sub>	Recovery Time $\bar{C}_{Dn}$ or $\bar{S}_{Dn}$ to CP <sub>n</sub>	3.3 5.0	0.5 0.5		ns	

**Note 9:** Voltage Range 3.3 is 3.3V ±0.3V  
Voltage Range 5.0 is 5.0V ±0.5V

## AC Electrical Characteristics

Symbol	Parameter	V <sub>CC</sub> (V) (Note 10)	54ACT		Units
			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 <sub>n</sub> to Q <sub>n</sub> or $\bar{Q}_n$	5.0	1.0	14.0	ns
t <sub>PHL</sub>	Propagation Delay CP <sub>n</sub> to Q <sub>n</sub> or $\bar{Q}_n$	5.0	1.0	12.0	ns
t <sub>PLH</sub>	Propagation Delay $\bar{C}_{Dn}$ or $\bar{S}_{Dn}$ to Q <sub>n</sub> or $\bar{Q}_n$	5.0	1.0	11.5	ns
t <sub>PHL</sub>	Propagation Delay $\bar{C}_{Dn}$ or $\bar{S}_{Dn}$ to Q <sub>n</sub> or $\bar{Q}_n$	5.0	1.0	12.5	ns

Note 10: Voltage Range 5.0 is 5.0V ±0.5V

## AC Operating Requirements

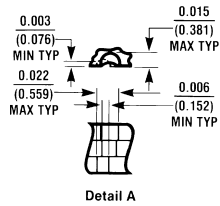
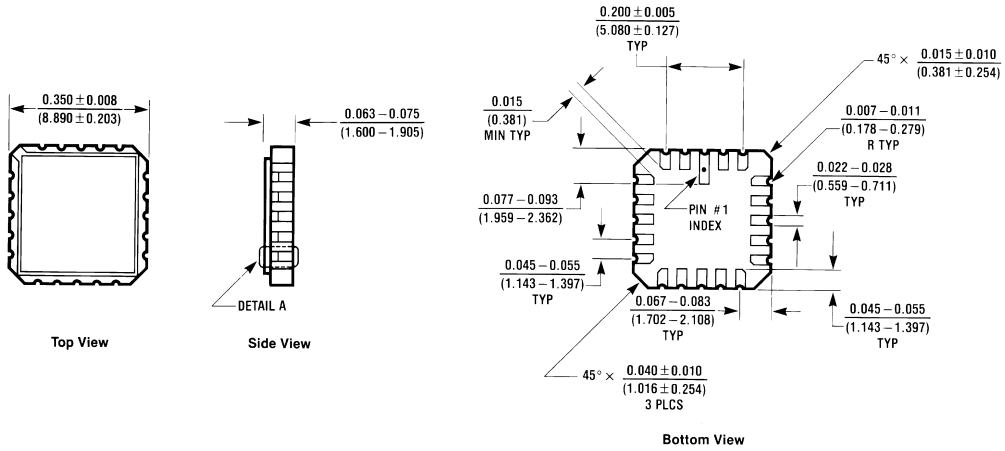
Symbol	Parameter	V <sub>CC</sub> (V) (Note 11)	54ACT		Units
			T <sub>A</sub> = -55°C to +125°C C <sub>L</sub> = 50 pF		
			Guaranteed Minimum		
t <sub>s</sub>	Setup Time, HIGH or LOW J <sub>n</sub> or $\bar{K}_n$ to CP <sub>n</sub>	5.0	2.5		ns
t <sub>h</sub>	Hold Time, HIGH or LOW J <sub>n</sub> or $\bar{K}_n$ to CP <sub>n</sub>	5.0	2.0		ns
t <sub>w</sub>	Pulse Width CP <sub>n</sub> or $\bar{C}_{Dn}$ or $\bar{S}_{Dn}$	5.0	5.0		ns
t <sub>rec</sub>	Recovery Time $\bar{C}_{Dn}$ or $\bar{S}_{Dn}$ to CP <sub>n</sub>	5.0	0.5		ns

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

## Capacitance

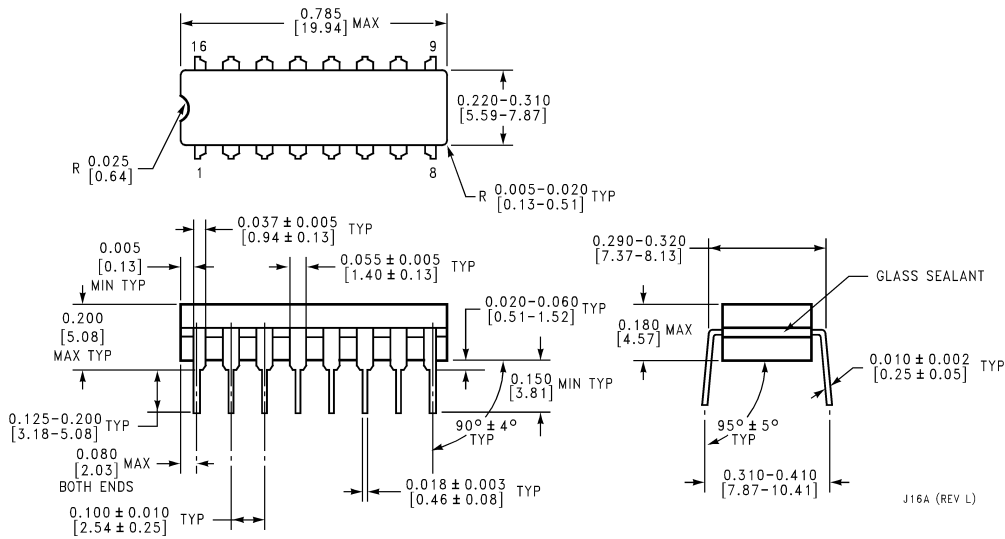
Symbol	Parameter	Typ	Units	Conditions
C <sub>IN</sub>	Input Capacitance	4.5	pF	V <sub>CC</sub> = OPEN
C <sub>PD</sub>	Power Dissipation Capacitance	35.0	pF	V <sub>CC</sub> = 5.0V

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



**20 Terminal Ceramic Leadless Chip Carrier (L)**  
 NS Package Number E20A

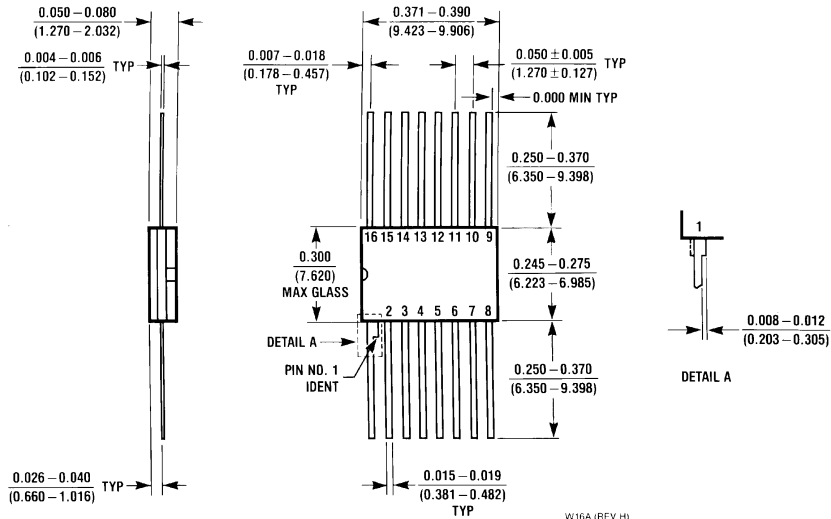
E20A (REV D)



**16 Lead Ceramic Dual-In-Line Package (D)**  
 NS Package Number J16A

J16A (REV L)

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



**16 Lead Ceramic Flatpak (F)  
NS Package Number W16A**

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