

# Am25LS168A • Am25LS169A

# Am54LS/74LS168A • Am54LS/74LS169A

## Synchronous Four-Bit Programmable Up-Down Counter

### DISTINCTIVE CHARACTERISTICS

- All operations are synchronous
- Internal look-ahead carry logic for high-speed counting
- Ripple carry output provided for cascading
- One line up/down control
- Changes state on LOW-to-HIGH transition of clock
- Am25LS devices offer the following improvements over Am54/74LS
  - Higher speed
  - 50mV lower  $V_{OL}$  at  $I_{OL} = 8\text{mA}$
  - Twice the fan-out over military range
  - 440 $\mu\text{A}$  source current at HIGH output
- 100% product assurance screening to MIL-STD-883 requirements

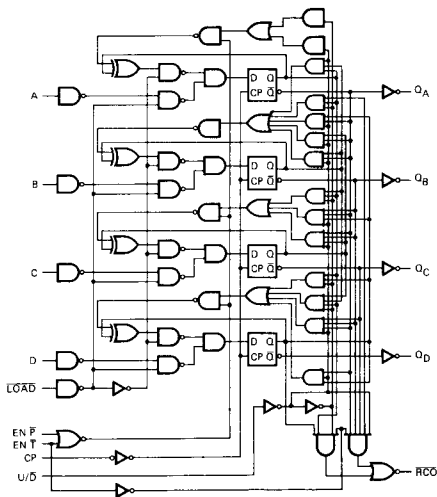
### FUNCTIONAL DESCRIPTION

The 'LS168A and 'LS169A are fully synchronous programmable up/down counters. All operations occur on the positive edge of the clock input. Proper operation only requires the user to meet the set-up and hold times. With the LOAD input LOW the outputs will be programmed by the parallel data inputs on the LOW-to-HIGH transition of the clock. Counting is enabled only when  $\overline{\text{EN T}}$  and  $\overline{\text{EN P}}$  are LOW. The up/down inputs ( $\text{U}/\overline{\text{D}}$ ) control of the direction of the count. HIGH counts up and LOW counts down. Internal Look-Ahead Carry logic and active LOW ripple carry output ( $\overline{\text{RCO}}$ ) allows for high-speed counting and cascading. During up count, the  $\overline{\text{RCO}}$  is LOW at binary 9 for the 'LS168A (binary 15 for the 'LS169A) and upon down count, it is LOW at binary 0 (same for the 'LS169A). Cascaded operation requires only the  $\overline{\text{RCO}}$  to be connected to the succeeding block at  $\overline{\text{EN T}}$ .

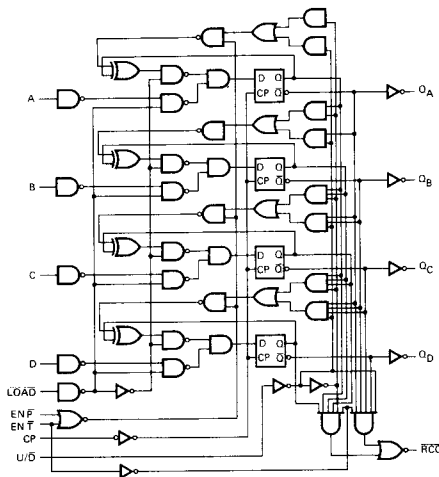
The Am54LS/74LS168A and 169A are standard performance versions of the Am25LS168A and 169A. See appropriate electrical characteristic tables for detailed Am25LS improvements.

### LOGIC DIAGRAMS

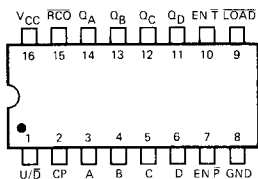
'LS168A



'LS169A

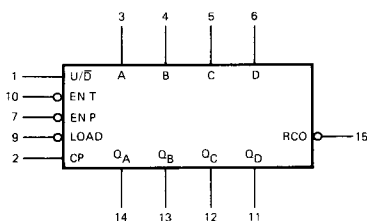


### CONNECTION DIAGRAM Top View



Note: Pin 1 is marked for orientation.

### LOGIC SYMBOL



$V_{CC} = \text{Pin } 16$   
 $\text{GND} = \text{Pin } 8$

## Am25LS168A • Am25LS169A

## ELECTRICAL CHARACTERISTICS

The Following Conditions Apply Unless Otherwise Specified:

COM'L  $T_A = 0^\circ\text{C to } +70^\circ\text{C}$   $V_{CC} = 5.0\text{ V } \pm 5\%$  MIN. = 4.75 V MAX. = 5.25 VMIL  $T_A = -55^\circ\text{C to } +125^\circ\text{C}$   $V_{CC} = 5.0\text{ V } \pm 10\%$  MIN. = 4.50 V MAX. = 5.50 V

## DC CHARACTERISTICS OVER OPERATING RANGE

Parameters	Description	Test Conditions (Note 1)	Typ.		Max.	Units
			Min.	(Note 2)		
$V_{OH}$	Output HIGH Voltage	$V_{CC} = \text{MIN.}, I_{OH} = -440\mu\text{A}, V_{IN} = V_{IH} \text{ or } V_{IL}$	MIL	2.5	3.4	Volts
			COM'L	2.7	3.4	
$V_{OL}$	Output LOW Voltage	$V_{CC} = \text{MIN.}, V_{IN} = V_{IH} \text{ or } V_{IL}$	$I_{OL} = 4.0\text{mA}$		0.4	Volts
			$I_{OL} = 8.0\text{mA}$		0.45	
$V_{IH}$	Input HIGH Level	Guaranteed input logical HIGH voltage for all inputs	2.0			Volts
$V_{IL}$	Input LOW Level	Guaranteed input logical LOW voltage for all inputs	MIL		0.7	Volts
			COM'L		0.8	
$V_I$	Input Clamp Voltage	$V_{CC} = \text{MIN.}, I_{IN} = -18\text{mA}$			-1.5	Volts
$I_{IL}$	Input LOW Current	$V_{CC} = \text{MAX.}, V_{IN} = 0.4\text{ V}$	EN $\bar{T}$		-0.6	mA
			All others		-0.4	
$I_{IH}$	Input HIGH Current	$V_{CC} = \text{MAX.}, V_{IN} = 2.7\text{ V}$	EN $\bar{T}$		30	$\mu\text{A}$
			All others		20	
$I_I$	Input HIGH Current	$V_{CC} = \text{MAX.}, V_{IN} = 7.0\text{ V}$	EN $\bar{T}$		0.15	mA
			All others		0.1	
$I_{SC}$	Output Short Circuit Current (Note 3)	$V_{CC} = \text{MAX.}$	-15		-85	mA
$I_{CC}$	Power Supply Current (Note 4)	$V_{CC} = \text{MAX.}$		20	34	mA

Notes: 1. For conditions shown as MIN. or MAX., use the appropriate value specified under Electrical Characteristics for the applicable device type.

2. Typical limits are at  $V_{CC} = 5.0\text{ V}$ ,  $25^\circ\text{C}$  ambient and maximum loading.

3. Not more than one output should be shorted at a time. Duration of the short circuit test should not exceed one second.

4. All inputs grounded; outputs open; measured after a ground then 4.5 V on the clock input.

## Am25LS • Am54LS/74LS

## MAXIMUM RATINGS (Above which the useful life may be impaired)

Storage Temperature	-65°C to +150°C
Temperature (Ambient) Under Bias	-55°C to +125°C
Supply Voltage to Ground Potential Continuous	-0.5V to +7.0V
DC Voltage Applied to Outputs for High Output State	-0.5V to + $V_{CC}$ max.
DC Input Voltage	-0.5V to +7.0V
DC Output Current, Into Outputs	30mA
DC Input Current	-30mA to +5.0mA

Am25LS/54LS/74LS168A/169A

Am54LS/74LS168A • Am54LS/74LS169A

**ELECTRICAL CHARACTERISTICS**

The Following Conditions Apply Unless Otherwise Specified:

COM'L  $T_A = 0^\circ\text{C to } +70^\circ\text{C}$   $V_{CC} = 5.0\text{ V } \pm 5\%$  MIN. = 4.75 V MAX. = 5.25 V  
 MIL  $T_A = -55^\circ\text{C to } +125^\circ\text{C}$   $V_{CC} = 5.0\text{ V } \pm 10\%$  MIN. = 4.50 V MAX. = 5.50 V

**DC CHARACTERISTICS OVER OPERATING RANGE**

Parameters	Description	Test Conditions (Note 1)	Min.	Typ. (Note 2)	Max.	Units
VOH	Output HIGH Voltage	$V_{CC} = \text{MIN.}, I_{OH} = -400\mu\text{A},$ $V_{IN} = V_{IH} \text{ or } V_{IL}$	MIL	2.5	3.4	Volts
			COM'L	2.7	3.4	
VOL	Output LOW Voltage	$V_{CC} = \text{MIN.},$ $V_{IN} = V_{IH} \text{ or } V_{IL}$	All, $I_{OL} = 4.0\text{mA}$		0.4	Volts
			74LS only, $I_{OL} = 8.0\text{mA}$		0.5	
VIH	Input HIGH Level	Guaranteed input logical HIGH voltage for all inputs	2.0			Volts
VIL	Input LOW Level	Guaranteed input logical LOW voltage for all inputs	MIL		0.7	Volts
			COM'L		0.8	
VI	Input Clamp Voltage	$V_{CC} = \text{MIN.}, I_{IN} = -18\text{mA}$			-1.5	Volts
IIL	Input LOW Current	$V_{CC} = \text{MAX.}, V_{IN} = 0.4\text{ V}$	EN $\bar{T}$		-0.6	mA
			All others		-0.4	
IIH	Input HIGH Current	$V_{CC} = \text{MAX.}, V_{IN} = 2.7\text{ V}$	EN $\bar{T}$		30	$\mu\text{A}$
			All others		20	
II	Input HIGH Current	$V_{CC} = \text{MAX.}, V_{IN} = 7.0\text{ V}$	EN $\bar{T}$		0.15	mA
			All others		0.1	
ISC	Output Short Circuit Current (Note 3)	$V_{CC} = \text{MAX.}$	-15		-100	mA
ICC	Power Supply Current (Note 4)	$V_{CC} = \text{MAX.}$		20	34	mA

- Notes: 1. For conditions shown as MIN. or MAX., use the appropriate value specified under Electrical Characteristics for the applicable device type.  
 2. Typical limits are at  $V_{CC} = 5.0\text{ V}, 25^\circ\text{C}$  ambient and maximum loading.  
 3. Not more than one output should be shorted at a time. Duration of the short circuit test should not exceed one second.  
 4. All inputs grounded; outputs open; measured after a ground then 4.5 V on the clock input.

**FUNCTION TABLE**

CP	INPUTS					OUTPUTS					COMMENTS			
	A	B	C	D	LOAD	EN $\bar{T}$	EN $\bar{P}$	U/ $\bar{D}$	$\overline{RCO}$	QA		QB	QC	QD
↑	X	X	X	X	H	L	L	H	A/R(1)	(QT-CK) + 1				Count Up
↑	X	X	X	X	H	L	L	L	A/R(2)	(QT-CK) - 1				Count Down
↑	X	X	X	X	H	H	X	X	NC	NC				Count Inhibit
↑	X	X	X	X	H	X	H	X	NC	NC				
NC	X	X	X	X	H	L	X	H	L	H	H	H	H	Overflow ('LS169A) ('LS168A)
NC	X	X	X	X	H	L	X	H	L	(H X X H)	(H X X H)	(H X X H)	(H X X H)	Overflow Inhibit ('LS169A) ('LS168A)
NC	X	X	X	X	H	H	X	H	H	(H X X H)	(H X X H)	(H X X H)	(H X X H)	Underflow
NC	X	X	X	X	H	L	X	L	L	L	L	L	L	Underflow Inhibit
↑	L	H	L	H	L	L	L	X	H	L	H	L	H	Load Example

- Notes: 1. LOW for one clock cycle when maximum count is reached; otherwise HIGH.  
 2. LOW for one clock cycle when minimum count is reached; otherwise HIGH.

H = HIGH      (QT-CK) = Output State Prior to Clock Edge.  
 L = LOW      A/R = Assumes Required State at Output.  
 X = Don't Care      NC = No Change.

**SWITCHING CHARACTERISTICS**(T<sub>A</sub> = +25°C, V<sub>CC</sub> = 5.0V)

Parameters	Description	Am25LS			Am54LS/74LS			Units	Test Conditions	
		Min.	Typ.	Max.	Min.	Typ.	Max.			
t <sub>PLH</sub>	Clock to Ripple Carry		23	35		23	35	ns	C <sub>L</sub> = 15pF R <sub>L</sub> = 2.0kΩ	
t <sub>PHL</sub>			19	35		23	35			
t <sub>PLH</sub>	Clock to Any Q		13	20		13	20			
t <sub>PHL</sub>			15	23		15	23			
t <sub>PLH</sub>	Enable $\bar{T}$ to Ripple Carry		10	14		10	14			
t <sub>PHL</sub>			9	14		10	14			
t <sub>PLH</sub>	Up/Down to Ripple Carry		17	25		17	25			
t <sub>PHL</sub>			17	29		19	29			
t <sub>pw</sub>	Clock Pulse Width	25			25					ns
t <sub>s</sub>	Set-up	A, B, C, D	20			20				ns
		EN $\bar{P}$ , EN $\bar{T}$	20			20		ns		
		Load	25			25		ns		
		Up/Down	30			30		ns		
t <sub>h</sub>	Hold, any Input	0			0			ns		
f <sub>max</sub> (Note 1)	Maximum Clock Frequency	25	2		25	32		MHz		

Note 1. Per industry convention, f<sub>max</sub> is the worst case value of the maximum device operating frequency with no constraints on t<sub>r</sub>, t<sub>f</sub>, pulse width or duty cycle.

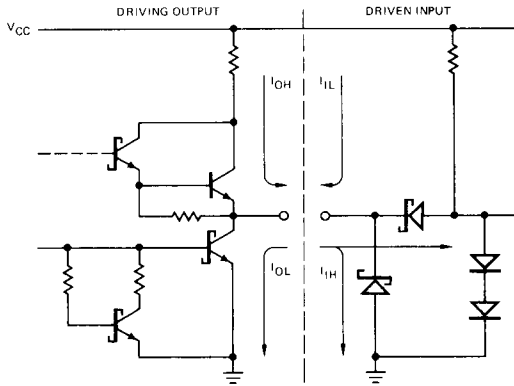
3

**Am25LS ONLY**  
**SWITCHING CHARACTERISTICS**  
**OVER OPERATING RANGE\***

Parameters	Description	Am25LS COM'L		Am25LS MIL		Units	Test Conditions	
		Min.	Max.	Min.	Max.			
t <sub>PLH</sub>	Clock to Ripple Carry		49		57	ns	C <sub>L</sub> = 50pF R <sub>L</sub> = 2.0kΩ	
t <sub>PHL</sub>			49		57			
t <sub>PLH</sub>	Clock to Any Q		30		35			
t <sub>PHL</sub>			34		39			
t <sub>PLH</sub>	Enable $\bar{T}$ to Ripple Carry		22		26			
t <sub>PHL</sub>			22		26			
t <sub>PLH</sub>	Up/Down to Ripple Carry		36		42			
t <sub>PHL</sub>			42		48			
t <sub>pw</sub>	Clock Pulse Width	36		42				ns
t <sub>s</sub>	Set-Up	A, B, C, D	30		35			ns
		EN $\bar{T}$ , EN $\bar{P}$	30		35	ns		
		Load	36		42	ns		
		Up/Down	43		50	ns		
t <sub>h</sub>	Hold	0		0		ns		
f <sub>max</sub> (Note 1)	Maximum Clock Frequency	19		17		MHz		

\*AC performance over operating temperature range is guaranteed by testing defined in Group A, Subgroup 9.

**Am25LS • Am54LS/74LS  
LOW-POWER SCHOTTKY INPUT/OUTPUT  
CURRENT INTERFACE CONDITIONS**



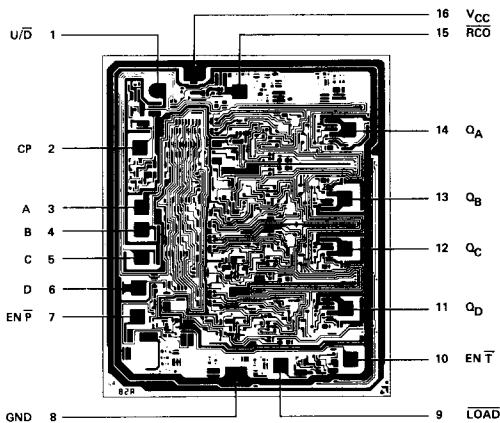
Note: Actual current flow direction shown.

**DEFINITION OF FUNCTIONAL TERMS**

- CP** Clock Pulse. All functions of the counter occurs on the positive edge.
- A, B, C, D** The four programmable data inputs.
- EN  $\bar{P}$**  Parallel Count Enable. Must be LOW to count.
- EN  $\bar{T}$**  Enables RCO (serial trickle) for cascading counters. Must be LOW to count.
- Q<sub>A</sub>, Q<sub>B</sub>, Q<sub>C</sub>, Q<sub>D</sub>** The four counter outputs.
- LOAD** A LOW enables parallel load of counter outputs from inputs. Must be HIGH to count.
- RCO** Ripple Carry Output. Output will be LOW on the maximum count on up count, and on 0000 on the down count.
- U/ $\bar{D}$**  Up/Down Count Control. HIGH counts up and LOW counts down.

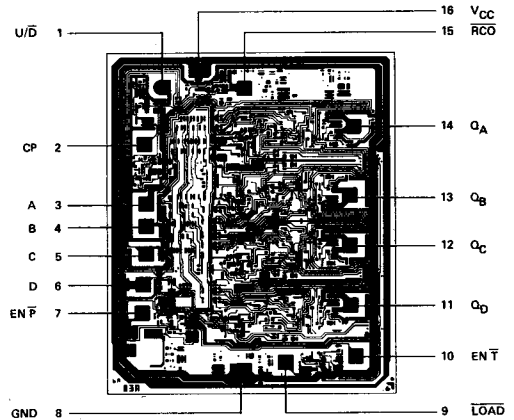
**Metallization and Pad Layouts**

'LS168A



DIE SIZE 0.084" X 0.099"

'LS169A

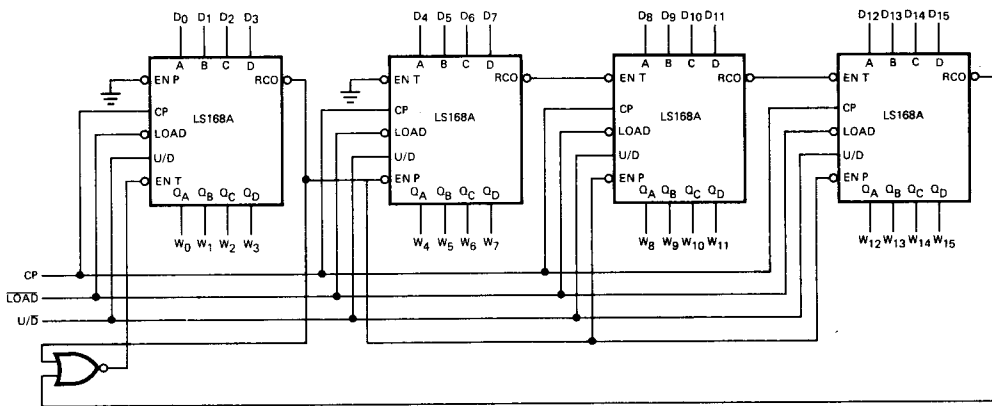


DIE SIZE 0.084" X 0.099"

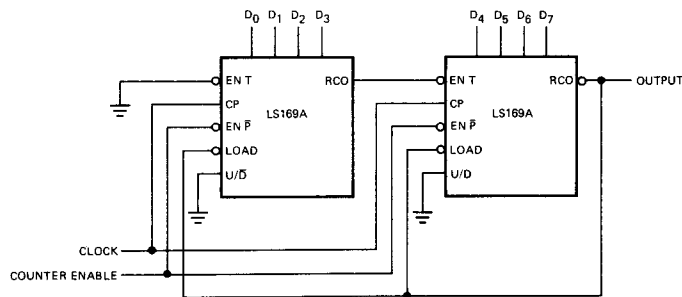
ORDERING INFORMATION

Package Type	Temperature Range	Am25LS168A Order Number	Am25LS169A Order Number	Am54LS/74LS168A Order Number	Am54LS/74LS169A Order Number
Molded DIP	0°C to +70°C	AM25LS168APC	AM25LS169APC	SN74LS168AN	SN74LS169AN
Hermetic DIP	0°C to +70°C	AM25LS168ADC	AM25LS169ADC	SN74LS168AJ	SN74LS169AJ
Dice	0°C to +70°C	AM25LS168AXC	AM25LS169AXC	SN74LS168AX	SN74LS169AX
Hermetic DIP	-55°C to +125°C	AM25LS168ADM	AM25LS169ADM	SN54LS168AJ	SN54LS169AJ
Hermetic Flat Pak	-55°C to +125°C	AM25LS168AFM	AM25LS169AFM	SN54LS168AW	SN54LS169AW
Dice	-55°C to +125°C	AM25LS168AXM	AM25LS169AXM	SN54LS168AX	SN54LS169AX

APPLICATIONS



Synchronous 4-Bit BCD Programmable Up/Down Counter with Hold on Underflow and Overflow, enabled by LOAD, Single count sequence per load cycle.



Programmable Divide By N.

Example: Divide By 127, Load (N-1) or 126 = 01111110.

3