

Am25LS168A • Am25LS169A

Am54LS/74LS168A • Am54LS/74LS169A

Synchronous Four-Bit Programmable Up-Down Counter

DISTINCTIVE CHARACTERISTICS

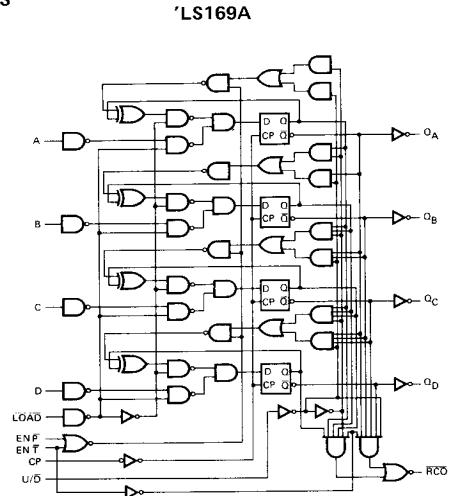
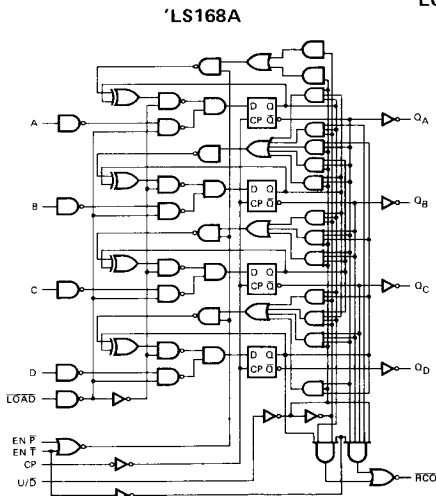
- All operations are synchronous
- Internal look-ahead carry logic for high-speed counting
- Ripple carry output provided for cascading
- One line up/down control
- Changes state on LOW-to-HIGH transition of clock
- Am25LS devices offer the following improvements over Am54/74LS
 - Higher speed
 - 50mV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

FUNCTIONAL DESCRIPTION

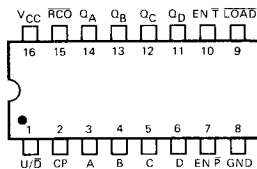
The 'LS168A and 'LS169A are fully synchronous programmable up/down counters. All operations occur on the positive edge of the clock input. Proper operation only requires the user to meet the set-up and hold times. With the LOAD input LOW the outputs will be programmed by the parallel data inputs on the 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 (U/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

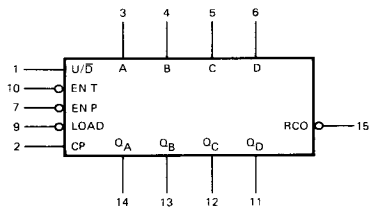


CONNECTION DIAGRAM Top View



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

DC CHARACTERISTICS OVER OPERATING RANGE

Parameters	Description	Test Conditions (Note 1)	Min.	Typ. (Note 2)	Max.	Units	
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	μA
			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°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 4.5V 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

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

DC CHARACTERISTICS OVER OPERATING RANGE

Parameters	Description	Test Conditions (Note 1)	Typ. (Note 2)		Units	
			Min.	Max.		
V _{OH}	Output HIGH Voltage	V _{CC} = MIN., I _{OH} = -400μA, V _{IN} = V _{IH} or V _{IL}	MIL	2.5	3.4	Volts
			COM'L	2.7	3.4	
V _{OL}	Output LOW Voltage	V _{CC} = MIN., V _{IN} = V _{IH} or V _{IL}	All, I _{OL} = 4.0mA		0.4	Volts
			74LS only, I _{OL} = 8.0mA		0.5	
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} = MIN., I _{IN} = -18mA			-1.5	Volts
I _{IL}	Input LOW Current	V _{CC} = MAX., V _{IN} = 0.4V	EN \bar{T}		-0.6	mA
			All others		-0.4	
I _{IH}	Input HIGH Current	V _{CC} = MAX., V _{IN} = 2.7V	EN \bar{T}		30	μA
			All others		20	
I _I	Input HIGH Current	V _{CC} = MAX., V _{IN} = 7.0V	EN \bar{T}		0.15	mA
			All others		0.1	
I _{SC}	Output Short Circuit Current (Note 3)	V _{CC} = MAX.		-15	-100	mA
I _{CC}	Power Supply Current (Note 4)	V _{CC} = 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 V, 25°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				LOAD	OUTPUTS				COMMENTS				
	A	B	C	D		EN \bar{T}	EN \bar{P}	U/ \bar{D}	\bar{RCO}		Q _A	Q _B	Q _C	Q _D
↑	X	X	X	X	H	L	L	H	A/R(1)	(Q _{T-CK}) + 1				Count Up
↑	X	X	X	X	H	L	L	L	A/R(2)	(Q _{T-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)
NC	X	X	X	X	H	L	X	H	L	(H	X	X	H)	('LS168A)
NC	X	X	X	X	H	H	X	H	H	H	H	H	H	Overflow Inhibit ('LS169A)
NC	X	X	X	X	H	H	X	H	H	(H	X	X	H)	('LS168A)
NC	X	X	X	X	H	L	X	L	L	L	L	L	L	Underflow
NC	X	X	X	X	H	H	X	L	H	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 (Q_{T-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_A = +25°C, V_{CC} = 5.0V)

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

Note 1. Per industry convention, f_{max} is the worst case value of the maximum device operating frequency with no constraints on t_r, t_f, pulse width or duty cycle.

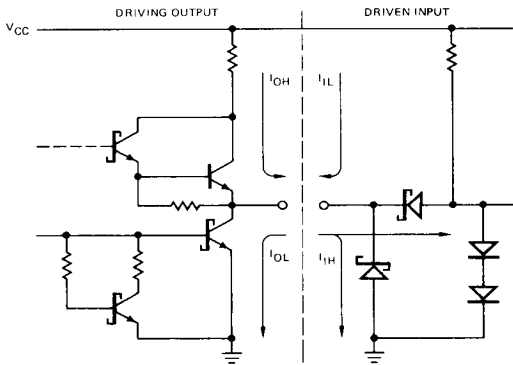
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Am25LS ONLY
SWITCHING CHARACTERISTICS
OVER OPERATING RANGE*

Parameters	Description	Am25LS COM'L		Am25LS MIL		Units	Test Conditions
		Min.	Max.	Min.	Max.		
t _{PLH}	Clock to Ripple Carry		49		57	ns	C _L = 50pF R _L = 2.0kΩ
t _{PHL}			49		57		
t _{PLH}	Clock to Any Q		30		35	ns	
t _{PHL}			34		39		
t _{PLH}	Enable \bar{T} to Ripple Carry		22		26	ns	
t _{PHL}			22		26		
t _{PLH}	Up/Down to Ripple Carry		36		42	ns	
t _{PHL}			42		48		
t _{pw}	Clock Pulse Width	36		42		ns	
t _s	Set-Up	A, B, C, D	30		35	ns	
		EN \bar{T} , EN \bar{P}	30		35		
		Load	36		42		
		Up/Down	43		50		
t _h	Hold	0		0		ns	
f _{max} (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



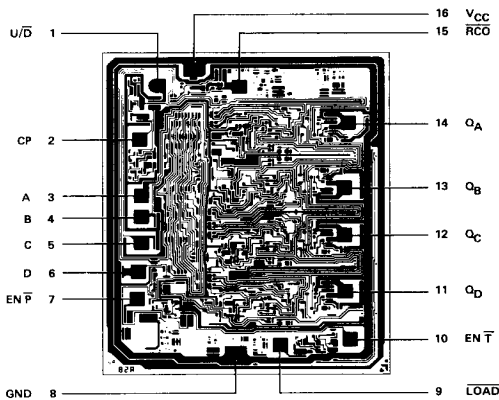
Note: Actual current flow direction shown.

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_A, Q_B, Q_C, Q_D** The four counter outputs.
- LOAD** A LOW enables parallel load of counter outputs from inputs. Must be HIGH to count.
- \bar{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.

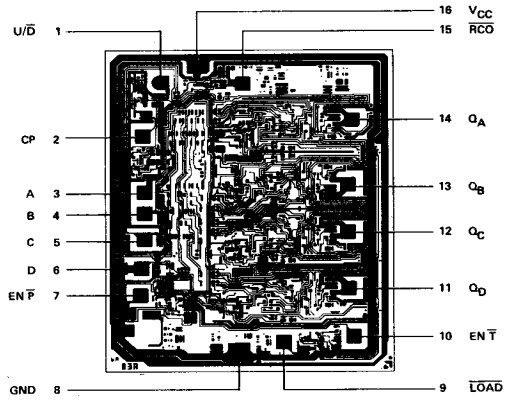
Metallization and Pad Layouts

'LS168A



DIE SIZE 0.084" X 0.099"

'LS169A

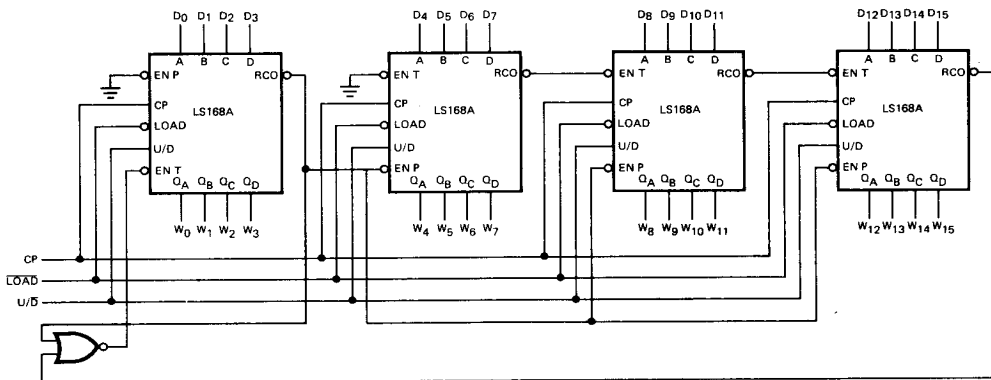


DIE SIZE 0.084" X 0.099"

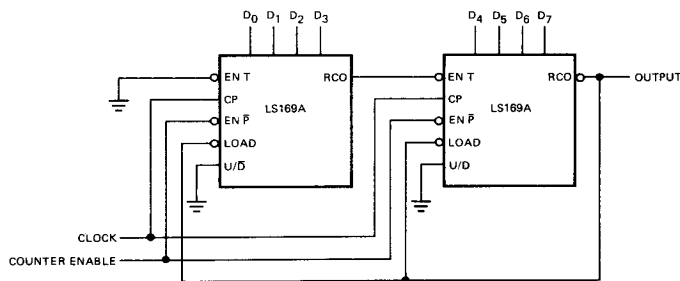
ORDERING INFORMATION

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.

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