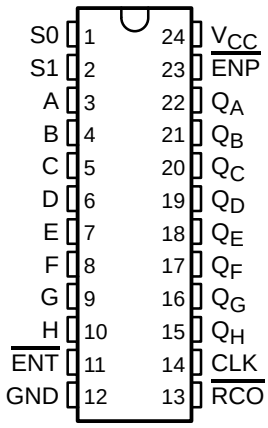
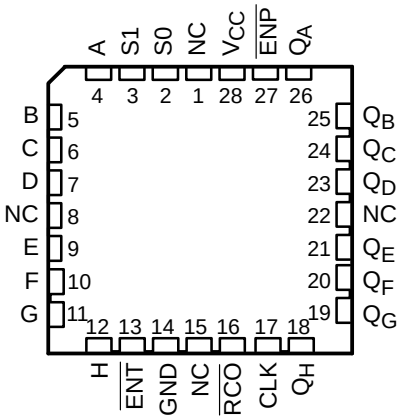
- **Fully Programmable With Synchronous Counting and Loading**
- **SN74ALS867A and ′AS867 Have Asynchronous Clear; SN74ALS869 and ′AS869 Have Synchronous Clear**
- **Fully Independent Clock Circuit Simplifies Use**
- **Ripple-Carry Output for n-Bit Cascading**
- **Package Options Include Plastic Small-Outline (DW) Packages, Ceramic Chip Carriers (FK), and Standard Plastic (NT) and Ceramic (JT) 300-mil DIPs**

SN54AS867, SN54AS869 . . . JT PACKAGE
SN74ALS867A, SN74ALS869, SN74AS867, SN74AS869 . . . DW OR NT PACKAGE
(TOP VIEW)



SN54AS867, SN54AS869 . . . FK PACKAGE
(TOP VIEW)



NC – No internal connection

description

These synchronous, presettable, 8-bit up/down counters feature internal-carry look-ahead circuitry for cascading in high-speed counting applications. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincidentally with each other when so instructed by the count-enable ($\overline{ENP}$, $\overline{ENT}$) inputs and internal gating. This mode of operation eliminates the output counting spikes normally associated with asynchronous (ripple-clock) counters. A buffered clock (CLK) input triggers the eight flip-flops on the rising (positive-going) edge of the clock waveform.

These counters are fully programmable; they may be preset to any number between 0 and 255. The load-input circuitry allows parallel loading of the cascaded counters. Because loading is synchronous, selecting the load mode disables the counter and causes the outputs to agree with the data inputs after the next clock pulse.

The carry look-ahead circuitry provides for cascading counters for n-bit synchronous applications without additional gating. Two count-enable ($\overline{ENP}$ and $\overline{ENT}$) inputs and a ripple-carry ($\overline{RCO}$) output are instrumental in accomplishing this function. Both $\overline{ENP}$ and $\overline{ENT}$ must be low to count. The direction of the count is determined by the levels of the select (S0, S1) inputs as shown in the function table. $\overline{ENT}$ is fed forward to enable $\overline{RCO}$. $\overline{RCO}$ thus enabled produces a low-level pulse while the count is zero (all outputs low) counting down or 255 counting up (all outputs high). This low-level overflow-carry pulse can be used to enable successive cascaded stages. Transitions at $\overline{ENP}$ and $\overline{ENT}$ are allowed regardless of the level of CLK. All inputs are diode clamped to minimize transmission-line effects, thereby simplifying system design.

These counters feature a fully independent clock circuit. With the exception of the asynchronous clear on the SN74ALS867A and ′AS867, changes at S0 and S1 that modify the operating mode have no effect on the Q outputs until clocking occurs. For the ′AS867 and ′AS869, any time $\overline{ENP}$ and/or $\overline{ENT}$ is taken high, $\overline{RCO}$ either goes or remains high. For the SN74ALS867A and SN74ALS869, any time $\overline{ENT}$ is taken high, $\overline{RCO}$ either goes or remains high. The function of the counter (whether enabled, disabled, loading, or counting) is dictated solely by the conditions meeting the stable setup and hold times.

description (continued)

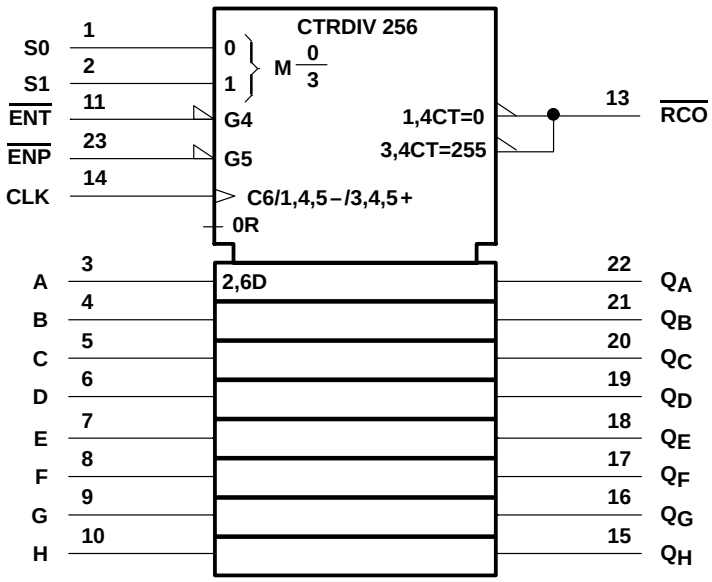
The SN54AS867 and SN54AS869 are characterized for operation over the full military temperature range of –55°C to 125°C. The SN74ALS867A, SN74ALS869, SN74AS867, and SN74AS869 are characterized for operation from 0°C to 70°C.

FUNCTION TABLE

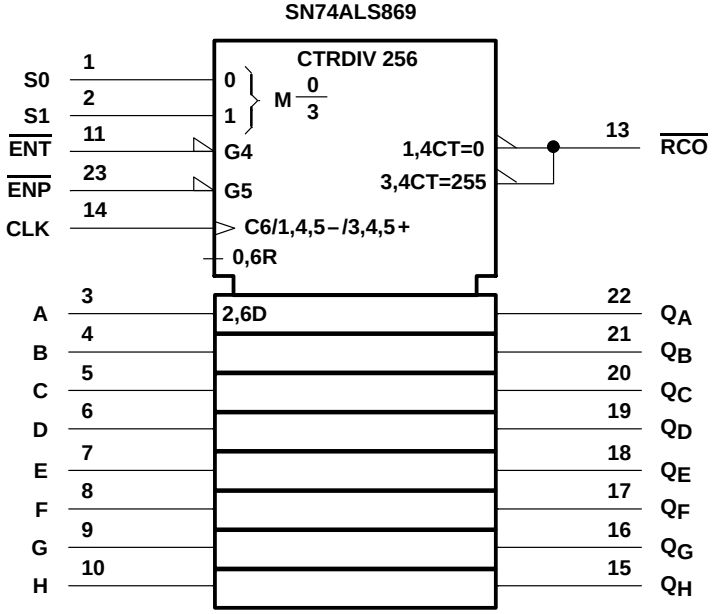
S1	S0	FUNCTION
L	L	Clear
L	H	Count down
H	L	Load
H	H	Count up

logic symbols†

SN74ALS867A

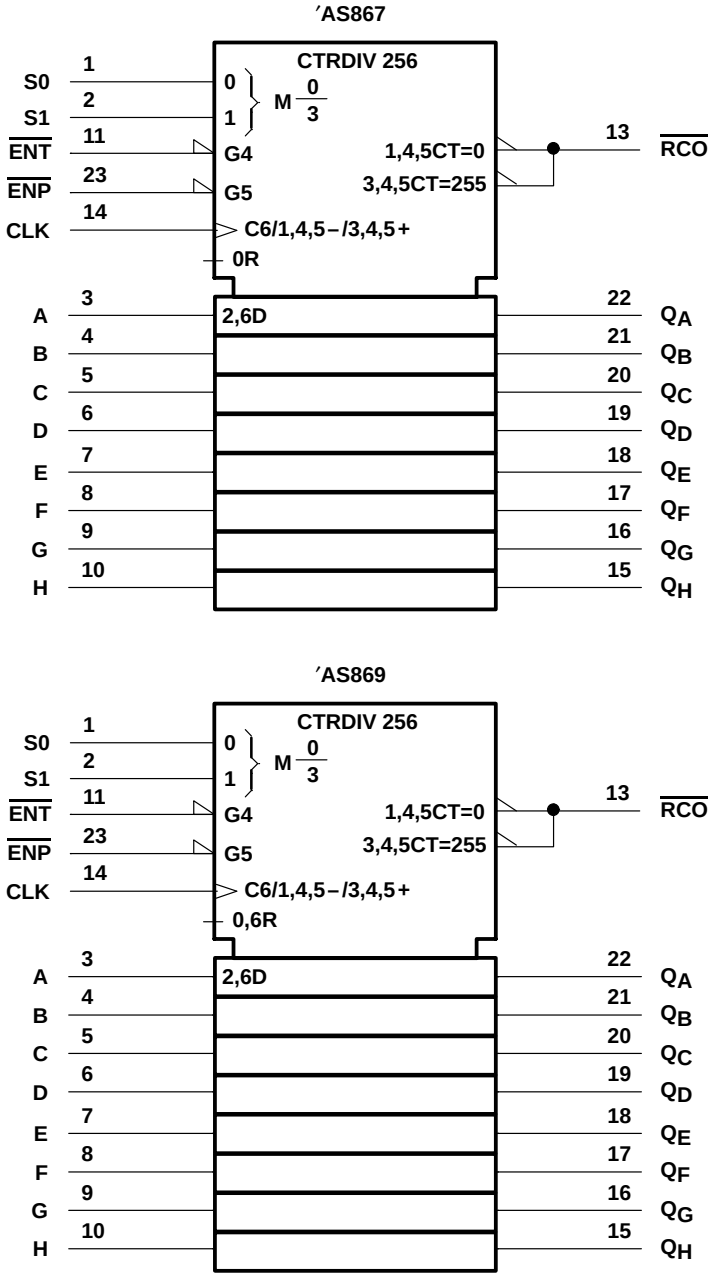


SN74ALS869



† These symbols are in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.
Pin numbers shown are for the DW, JT, and NT packages.

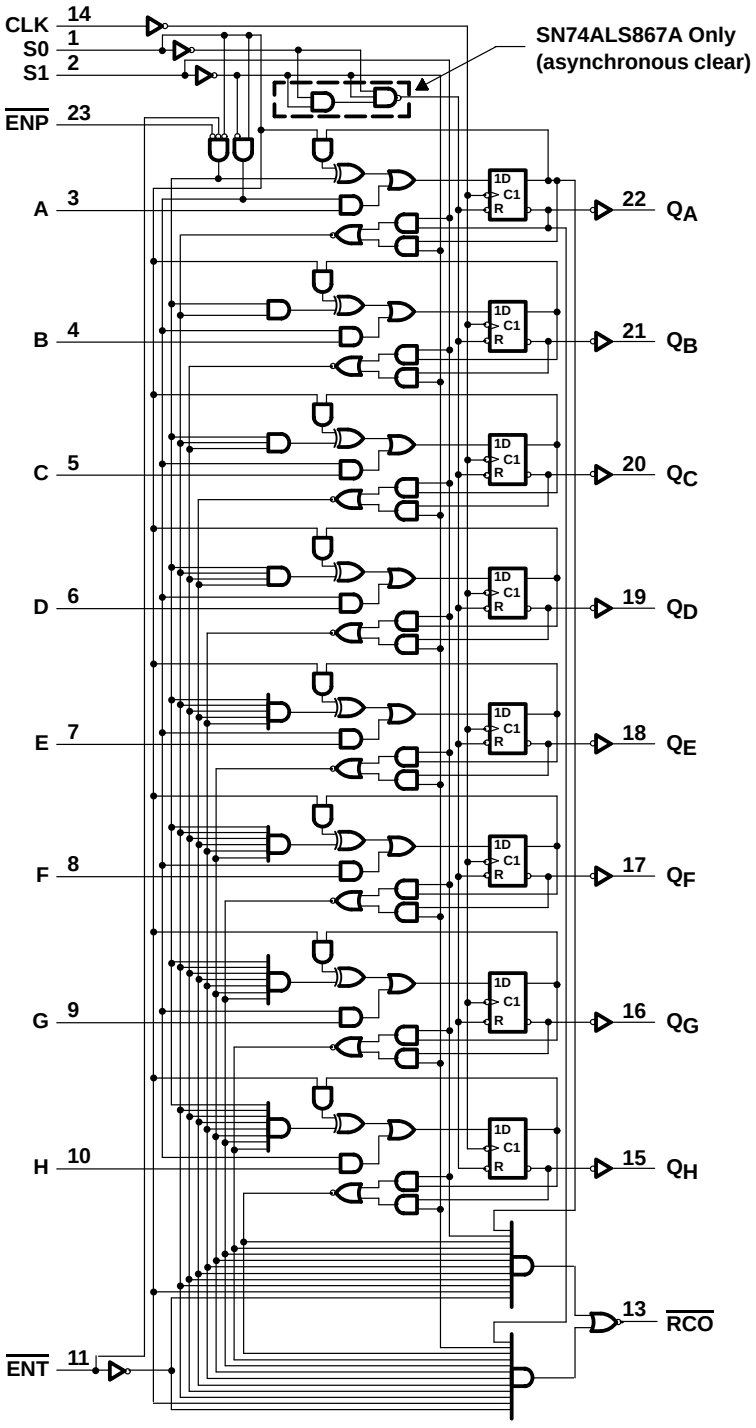
logic symbols (continued)†



† These symbols are in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.
Pin numbers shown are for the DW, JT, and NT packages.

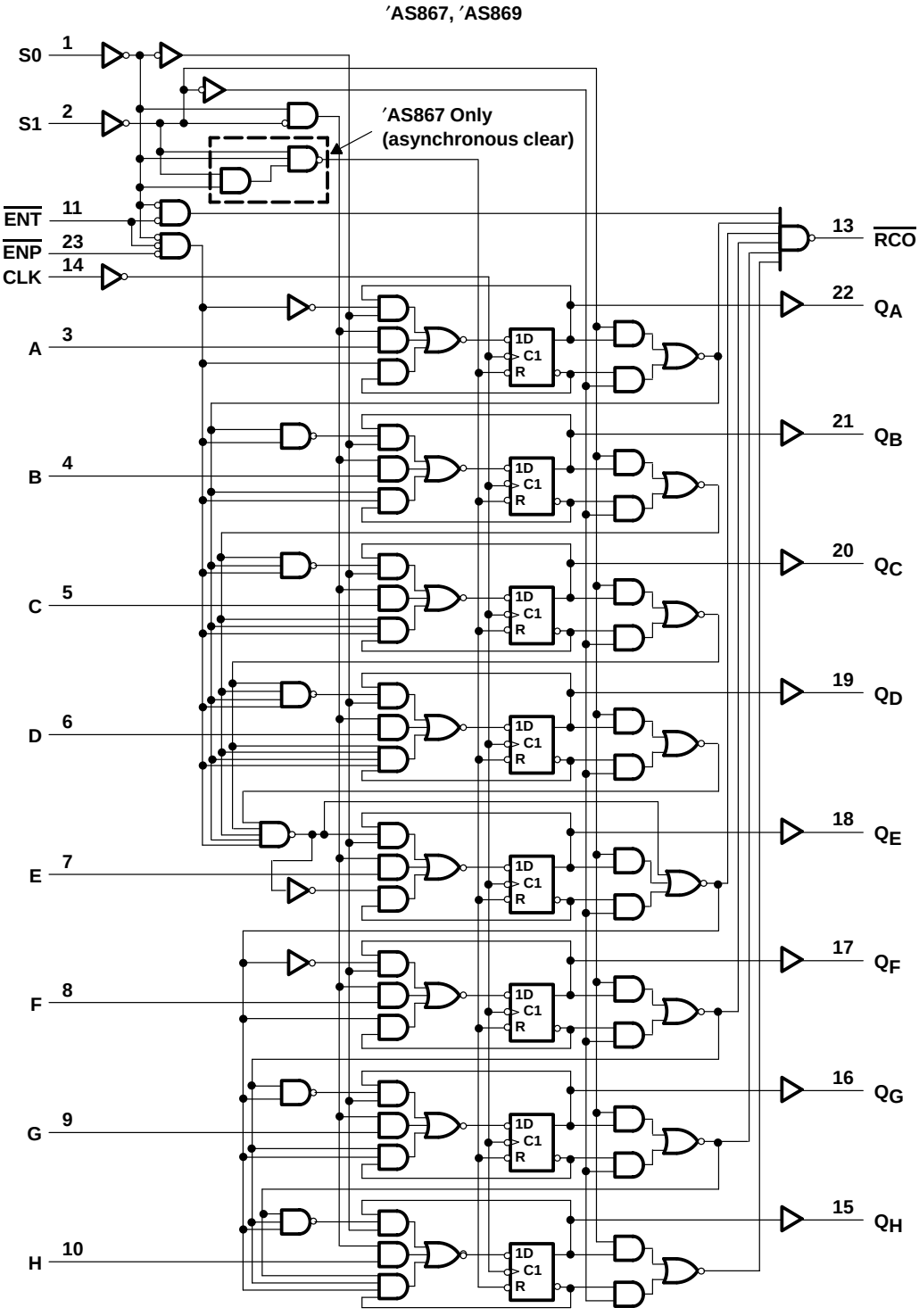
logic diagram (positive logic)

SN74ALS867A, SN74ALS869



Pin numbers shown are for the DW, JT, and NT packages.

logic diagram (positive logic)

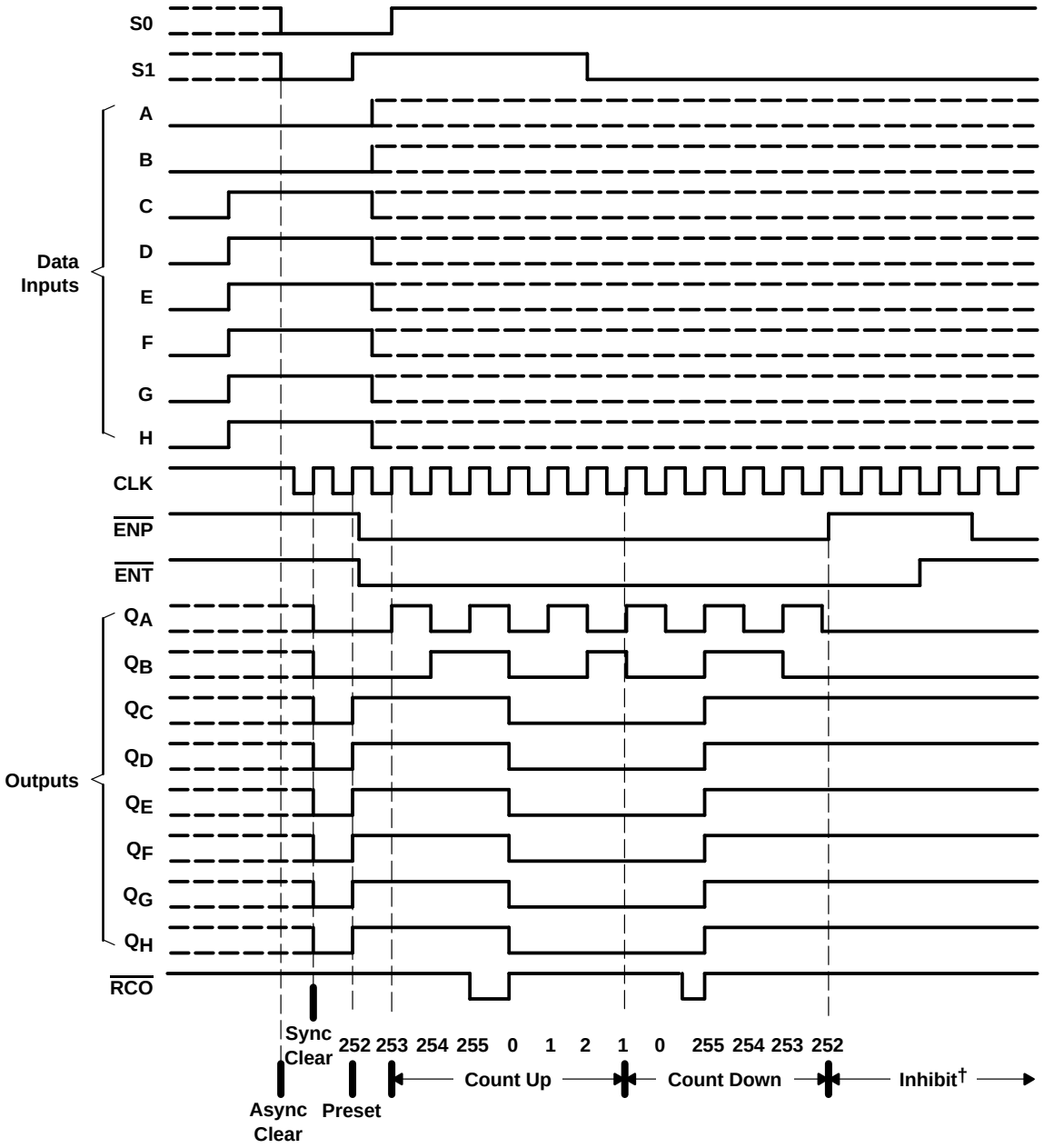


Pin numbers shown are for the DW, JT, and NT packages.

typical clear, preset, count, and inhibit sequences

The following sequence is illustrated below:

1. Clear outputs to zero (SN74ALS867A and ′AS867 are asynchronous; SN74ALS869 and ′AS869 are synchronous.)
2. Preset to binary 252
3. Count up to 253, 254, 255, 0, 1, and 2
4. Count down to 1, 0, 255, 254, 253, and 252
5. Inhibit



† $\overline{\text{ENT}}$ and $\overline{\text{ENP}}$ both must be low for counting to occur.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, V_{CC} . . . . . 7 V
Input voltage, V_I . . . . . 7 V
Operating free-air temperature range, T_A: SN74ALS867A . . . . . 0°C to 70°C
Storage temperature range . . . . . –65°C to 150°C

† Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

recommended operating conditions

			SN74ALS867A			UNIT
			MIN	NOM	MAX	
V_{CC}	Supply voltage		4.5	5	5.5	V
V_{IH}	High-level input voltage		2			V
V_{IL}	Low-level input voltage				0.8	V
I_{OH}	High-level output current				–0.4	mA
I_{OL}	Low-level output current				8	mA
f_{clock}	Clock frequency		0		35	MHz
$t_{w(clock)}$	Pulse duration, CLK high or low		14			ns
$t_{w(clear)}$	Pulse duration of clear pulse, S0 and S1 low		10			ns
t_{su}	Setup time before CLK↑	Data inputs A–H	10			ns
		$\overline{ENP}$ or $\overline{ENT}$	15			
		S0 low and S1 high (load)	12			
		S0 high and S1 low (count down)	12			
		S0 and S1 high (count up)	12			
t_h	Hold time after CLK↑	S0 high after S1↑ or S1 high after S0↑	3			ns
		Data inputs A–H	0			
T_A	Operating free-air temperature		0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS		SN74ALS867A			UNIT
			MIN	TYP‡	MAX	
V_{IK}	V_{CC} = 4.5 V,	I_I = –18 mA			–1.2	V
V_{OH}	V_{CC} = 4.5 V to 5.5 V,	I_{OH} = –0.4 mA	V_{CC} –2			V
V_{OL}	V_{CC} = 4.5 V	I_{OL} = 4 mA		0.25	0.4	V
		I_{OL} = 8 mA		0.35	0.5	
I_I	V_{CC} = 5.5 V,	V_I = 7 V			0.1	mA
I_{IH}	V_{CC} = 5.5 V,	V_I = 2.7 V			20	µA
I_{IL}	V_{CC} = 5.5 V,	V_I = 0.4 V			–0.2	mA
I_O§	V_{CC} = 5.5 V,	V_O = 2.25 V	–30		–112	mA
I_{CC}	V_{CC} = 5.5 V			28	45	mA

‡ All typical values are at V_{CC} = 5 V, T_A = 25°C.
§ The output conditions have been chosen to produce a current that closely approximates one half of the true short-circuit output current, I_{OS}.

switching characteristics (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} = 4.5 V to 5.5 V, C_L = 50 pF, R_L = 500 Ω, T_A = MIN to MAX†		UNIT
			SN74ALS867A		
			MIN	MAX	
f_{max}			35		MHz
t_{PLH}	CLK	$\overline{RCO}$	4	14	ns
t_{PHL}			4	14	
t_{PLH}	CLK	Any Q	3	16	ns
t_{PHL}			3	16	
t_{PLH}	$\overline{ENT}$	$\overline{RCO}$	3	14	ns
t_{PHL}			2	9	
t_{PHL}	S0 or S1 (clear mode)	Any Q	8	26	ns
t_{PLH}	S0 or S1 (count up/down)	$\overline{RCO}$	4	16	ns
t_{PHL}			4	16	
t_{PLH}	S0 or S1 (clear mode)	$\overline{RCO}$	4	16	ns

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, V_{CC} . . . . . 7 V
Input voltage, V_I . . . . . 7 V
Operating free-air temperature range, T_A: SN74ALS869 . . . . . 0°C to 70°C
Storage temperature range . . . . . –65°C to 150°C

† Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

recommended operating conditions

			SN74ALS869			UNIT
			MIN	NOM	MAX	
V_{CC}	Supply voltage		4.5	5	5.5	V
V_{IH}	High-level input voltage		2			V
V_{IL}	Low-level input voltage				0.8	V
I_{OH}	High-level output current				–0.4	mA
I_{OL}	Low-level output current				8	mA
f_{clock}	Clock frequency		0		35	MHz
$t_{w(clock)}$	Pulse duration, CLK high or low		14			ns
t_{su}	Setup time before CLK↑	Data inputs A–H	10			ns
		$\overline{ENP}$ or $\overline{ENT}$	15			
		S0 and S1 low (clear)	13			
		S0 low and S1 high (load)	13			
		S0 high and S1 low (count down)	13			
		S0 and S1 high (count up)	13			
t_h	Hold time after CLK↑	S0 high after S1↑ or S1 high after S0↑	3			ns
		Data inputs A–H	0			
T_A	Operating free-air temperature		0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS		SN74ALS869			UNIT
			MIN	TYP‡	MAX	
V_{IK}	V_{CC} = 4.5 V,	I_I = –18 mA			–1.2	V
V_{OH}	V_{CC} = 4.5 V to 5.5 V,	I_{OH} = –0.4 mA	V_{CC} –2			V
V_{OL}	V_{CC} = 4.5 V	I_{OL} = 4 mA		0.25	0.4	V
		I_{OL} = 8 mA		0.35	0.5	
I_I	V_{CC} = 5.5 V,	V_I = 7 V			0.1	mA
I_{IH}	V_{CC} = 5.5 V,	V_I = 2.7 V			20	µA
I_{IL}	V_{CC} = 5.5 V,	V_I = 0.4 V			–0.2	mA
I_O§	V_{CC} = 5.5 V,	V_O = 2.25 V	–30		–112	mA
I_{CC}	V_{CC} = 5.5 V			28	45	mA

‡ All typical values are at V_{CC} = 5 V, T_A = 25°C.
§ The output conditions have been chosen to produce a current that closely approximates one half of the true short-circuit output current, I_{OS}.

switching characteristics (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} = 4.5 V to 5.5 V, C_L = 50 pF, R_L = 500 Ω, T_A = MIN to MAX†		UNIT
			SN74ALS869		
			MIN	MAX	
f_{max}			35		MHz
t_{PLH}	CLK	$\overline{RCO}$	4	14	ns
t_{PHL}			4	14	
t_{PLH}	CLK	Any Q	3	16	ns
t_{PHL}			3	16	
t_{PLH}	$\overline{ENT}$	$\overline{RCO}$	3	14	ns
t_{PHL}			2	9	
t_{PLH}	S1 (count up/down)	$\overline{RCO}$	4	15	ns
t_{PHL}			4	15	
t_{PLH}	S0 (clear/load)	$\overline{RCO}$	4	16	ns
t_{PHL}			4	12	

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, V_{CC} . . . . . 7 V
Input voltage, V_I . . . . . 7 V
Operating free-air temperature range, T_A: SN54AS867 . . . . . −55°C to 125°C
SN74AS867 . . . . . 0°C to 70°C
Storage temperature range . . . . . −65°C to 150°C

† Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

recommended operating conditions

			SN54AS867			SN74AS867			UNIT
			MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage		4.5	5	5.5	4.5	5	5.5	V
V_{IH}	High-level input voltage		2			2			V
V_{IL}	Low-level input voltage				0.8			0.8	V
I_{OH}	High-level output current				−2			−2	mA
I_{OL}	Low-level output current				20			20	mA
f_{clock}*	Clock frequency		0		40	0		50	MHz
$t_{w(clock)}$*	Pulse duration, CLK high or low		12.5			10			ns
$t_{w(clear)}$*	Pulse duration of clear pulse, S0 and S1 low		12.5			10			ns
t_{su}*	Setup time before CLK↑	Data inputs A–H	5			4			ns
		$\overline{ENP}$ or $\overline{ENT}$	9			8			
		S0 low and S1 high (load)	11			10			
		S0 and S1 low (clear)	11			10			
		S0 high and S1 low (count down)	42			40			
		S0 and S1 high (count up)	42			40			
t_h*	Hold time after CLK↑	Data inputs A–H	0			0			ns
t_{skew}*	Skew time between S0 and S1 (maximum to avoid inadvertent clear)				8			7	ns
T_A	Operating free-air temperature		−55		125	0		70	°C

* On products compliant to MIL-STD-883, Class B, this parameter is based on characterization data but is not production tested.

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS		SN54AS867			SN74AS867			UNIT
				MIN	TYP†	MAX	MIN	TYP†	MAX	
V_{IK}		V_{CC} = 4.5 V,	I_I = –18 mA			–1.2			–1.2	V
V_{OH}		V_{CC} = 4.5 V to 5.5 V,	I_{OH} = –2 mA	V_{CC} –2			V_{CC} –2			V
V_{OL}	$\overline{RCO}$	V_{CC} = 4.5 V	I_{OL} = 20 mA, V_{IL} on $\overline{ENT}$ = 0.7 V		0.34	0.5				V
	Other outputs		I_{OL} = 20 mA					0.34	0.5	
I_I		V_{CC} = 5.5 V,	V_I = 7 V			0.1			0.1	mA
I_{IH}	$\overline{ENT}$	V_{CC} = 5.5 V,	V_I = [illegible] v			40			40	µA
	Other inputs					20			20	
I_{IL}	$\overline{ENT}$	V_{CC} = 5.5 V,	V_I = [illegible] v			–4			–4	mA
	Other inputs					–2			–2	
I_O‡		V_{CC} = 5.5 V,	V_O = 2.25 V	–30		–112	–30		–112	mA
I_{CC}		V_{CC} = 5.5 V			134	195		134	195	mA

† All typical values are at V_{CC} = 5 V, T_A = 25°C.
‡ The output conditions have been chosen to produce a current that closely approximates one half of the true short-circuit output current, I_{OS}.

switching characteristics (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} = 4.5 V to 5.5 V, C_L = 50 pF, R_L = 500 Ω, T_A = MIN to MAX§				UNIT
			SN54AS867		SN74AS867		
			MIN	MAX	MIN	MAX	
f_{max}*			40		50		MHz
t_{PLH}	CLK	$\overline{RCO}$	5	31	5	22	ns
t_{PHL}			6	19	6	16	
t_{PLH}	CLK	Any Q	3	12	3	11	ns
t_{PHL}			4	16	4	15	
t_{PLH}	$\overline{ENT}$	$\overline{RCO}$	3	19	3	10	ns
t_{PHL}			5	21	5	17	
t_{PLH}	$\overline{ENP}$	$\overline{RCO}$	5	16	5	14	ns
t_{PHL}			5	21	5	17	
t_{PHL}	Clear (S0 or S1 low)	Any Q	7	23	7	21	ns

* On products compliant to MIL-STD-883, Class B, this parameter is based on characterization data but is not production tested.
§ For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, V_{CC} . . . . . 7 V
Input voltage, V_I . . . . . 7 V
Operating free-air temperature range, T_A: SN54AS869 . . . . . –55°C to 125°C
SN74AS869 . . . . . 0°C to 70°C
Storage temperature range . . . . . –65°C to 150°C

† Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

recommended operating conditions

			SN54AS869			SN74AS869			UNIT
			MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage		4.5	5	5.5	4.5	5	5.5	V
V_{IH}	High-level input voltage		2			2			V
V_{IL}	Low-level input voltage				0.7			0.8	V
I_{OH}	High-level output current				–2			–2	mA
I_{OL}	Low-level output current				20			20	mA
f_{clock}*	Clock frequency				40			45	MHz
$t_{w(clock)}$*	Pulse duration, CLK high or low		12.5			11			ns
t_{su}*	Setup time before CLK↑	Data inputs A–H	6			5			ns
		$\overline{ENP}$ or $\overline{ENT}$	10			9			
		S0 low and S1 high (load)	13			11			
		S0 and S1 low (clear)	13			11			
		S0 high and S1 low (count down)	52			50			
		S0 and S1 high (count up)	52			50			
t_h*	Hold time after CLK↑	Data inputs A–H	0			0			ns
T_A	Operating free-air temperature		–55		125	0		70	°C

* On products compliant to MIL-STD-883, Class B, this parameter is based on characterization data but is not production tested.

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS		SN54AS869			SN74AS869			UNIT
				MIN	TYP†	MAX	MIN	TYP†	MAX	
V_{IK}		V_{CC} = 4.5 V,	I_I = –18 mA			–1.2			–1.2	V
V_{OH}		V_{CC} = 4.5 V to 5.5 V,	I_{OH} = –2 mA				V_{CC} –2			V
		V_{CC} = 4.5 V,	I_{OH} = –2 mA	V_{CC} –2*						
V_{OL}	$\overline{RCO}$	V_{CC} = 4.5 V	I_{OL} = 20 mA, V_{IL} on $\overline{ENT}$ = 0.7 V		0.34	0.5				V
	Other outputs		I_{OL} = 20 mA					0.34	0.5	
I_I		V_{CC} = 5.5 V,	V_I = 7 V			0.1			0.1	mA
I_{IH}	$\overline{ENT}$	V_{CC} = 5.5 V,	V_I = 2.7 V			40			40	µA
	Other inputs					20			20	
I_{IL}	$\overline{ENT}$	V_{CC} = 5.5 V,	V_I = 0.4 V			–4			–4	mA
	Other inputs					–2			–2	
I_O‡		V_{CC} = 5.5 V,	V_O = 2.25 V	–30		–112	–30		–112	mA
I_{CC}		V_{CC} = 5.5 V			134	195		134	195	mA

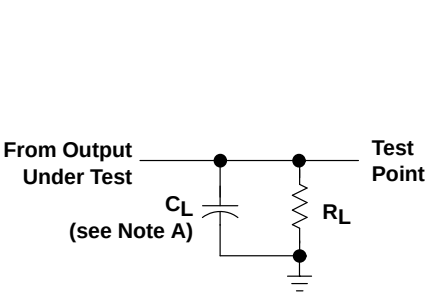
† All typical values are at V_{CC} = 5 V, T_A = 25°C.
‡ The output conditions have been chosen to produce a current that closely approximates one half of the true short-circuit output current, I_{OS}.

switching characteristics (see Figure 1)

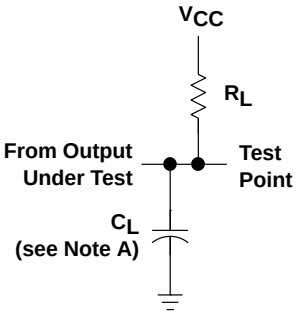
PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} = 4.5 V to 5.5 V, C_L = 50 pF, R_L = 500 Ω, T_A = MIN to MAX§				UNIT
			SN54AS869		SN74AS869		
			MIN	MAX	MIN	MAX	
f_{max}*			40		45		MHz
t_{PLH}	CLK	$\overline{RCO}$	6	35	6	35	ns
t_{PHL}			6	20	6	18	
t_{PLH}	CLK	Any Q	3	12	3	11	ns
t_{PHL}			4	16	4	15	
t_{PLH}	$\overline{ENT}$	$\overline{RCO}$	3	25	3	15	ns
t_{PHL}			6	21	6	17	
t_{PLH}	$\overline{ENP}$	$\overline{RCO}$	5	27	5	19	ns
t_{PHL}			6	21	6	18	

* On products compliant to MIL-STD-883, Class B, this parameter is based on characterization data but is not production tested.
§ For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

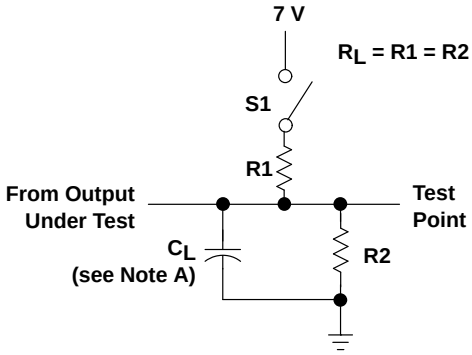
PARAMETER MEASUREMENT INFORMATION
SERIES 54ALS/74ALS AND 54AS/74AS DEVICES



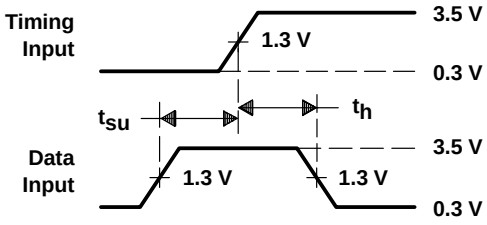
LOAD CIRCUIT FOR
BI-STATE
TOTEM-POLE OUTPUTS



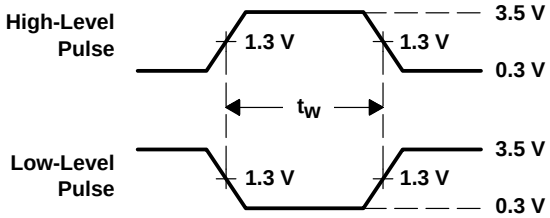
LOAD CIRCUIT
FOR OPEN-COLLECTOR OUTPUTS



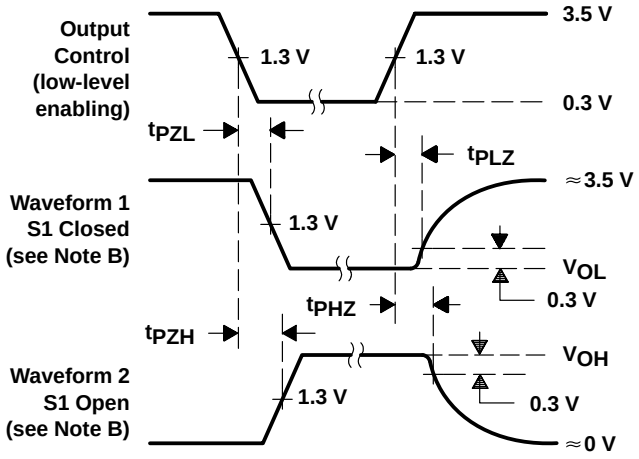
LOAD CIRCUIT
FOR 3-STATE OUTPUTS



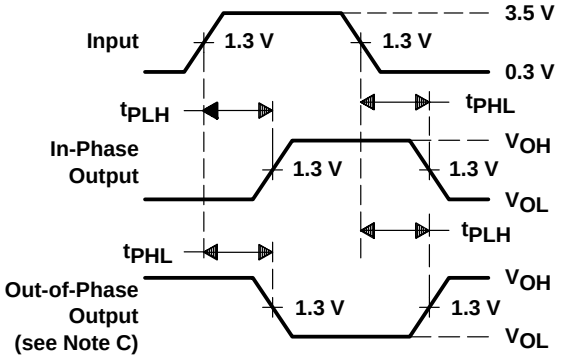
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PULSE DURATIONS



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES, 3-STATE OUTPUTS



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES

NOTES: A. C_L includes probe and jig capacitance.
B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
C. When measuring propagation delay items of 3-state outputs, switch S1 is open.
D. All input pulses have the following characteristics: PRR ≤ 1 MHz, $t_r = t_f = 2$ ns, duty cycle = 50%.
E. The outputs are measured one at a time with one transition per measurement.

Figure 1. Load Circuits and Voltage Waveforms

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