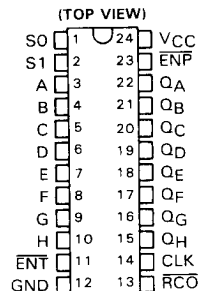


SN54ALS867, SN54AS867, SN54ALS869, SN54AS869 SN74ALS867, SN74AS867, SN74ALS869, SN74AS869 SYNCHRONOUS 8-BIT UP/DOWN COUNTERS

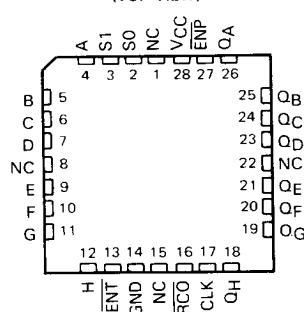
D2661, DECEMBER 1982 — REVISED MAY 1986

- Fully Programmable with Synchronous Counting and Loading
- '867 Has Asynchronous Clear, '869 Has Synchronous Clear
- Fully Independent Clock Circuit Simplifies Use
- Ripple Carry Output for n-Bit Cascading
- Package Options Include Plastic "Small Outline" Packages, Both Plastic and Ceramic Chip Carriers, and Standard Plastic and Ceramic 300-mil DIPs
- Dependable Texas Instruments Quality and Reliability

SN54' . . . JT PACKAGE
SN74' . . . DW OR NT PACKAGE



SN54' . . . FK PACKAGE
(TOP VIEW)



NC—No internal connection

description

These synchronous presettable counters feature an internal carry look-ahead for cascading in high-speed counting applications. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincident with each other when so instructed by the count-enable inputs and internal gating. This mode of operation helps eliminate the output counting spikes that are normally associated with asynchronous (ripple-clock) counters. A buffered clock input triggers the eight flip-flops on the rising (positive-going) edge of the clock waveform.

These counters are fully programmable; that is, the outputs may each be preset to either level. The load mode circuitry allows parallel loading of the cascaded counters. As 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. Instrumental in accomplishing this function are two count-enable inputs and a carry output. Both count enable inputs (ENP and ENT) must be low to count. The direction of the count is determined by the levels of the select inputs (see Function Table). Input ENT is fed forward to enable the carry output. The ripple carry output thus enabled will produce 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 the enable ENP and ENT inputs are allowed regardless of the level of the clock input. All inputs are diode-clamped to minimize transmission-line effects, thereby simplifying system design.

This document contains information on products in more than one phase of development. The status of each device is indicated on the page(s) specifying its electrical characteristics.

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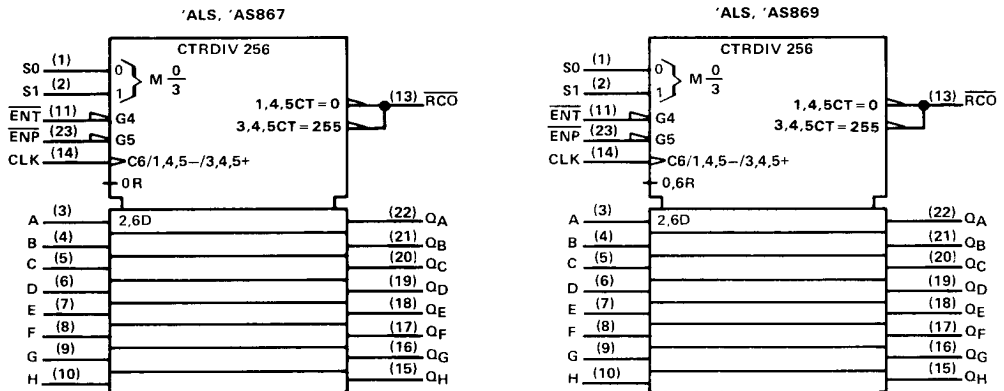
2-717

**SN54ALS867, SN54AS867, SN54ALS869, SN54AS869
SN74ALS867, SN74AS867, SN74ALS869, SN74AS869
SYNCHRONOUS 8-BIT UP/DOWN COUNTERS**

These counters feature a fully independent clock circuit. With the exception of the asynchronous clear on the '867, changes at control inputs (S0, S1) that will modify the operating mode have no effect on the Q outputs until clocking occurs. Anytime the $\overline{\text{ENP}}$ and/or $\overline{\text{ENT}}$ is taken high, $\overline{\text{RCO}}$ will either go or remain high. The function of the counter (whether enabled, disabled, loading, or counting) will be dictated solely by the conditions meeting the stable setup and hold times.

The SN54ALS' and SN54AS' families are characterized for operation over the full military temperature range of -55°C to 125°C . The SN74ALS' and SN74AS' families are characterized for operation from 0°C to 70°C .

logic symbols†



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

FUNCTION TABLE

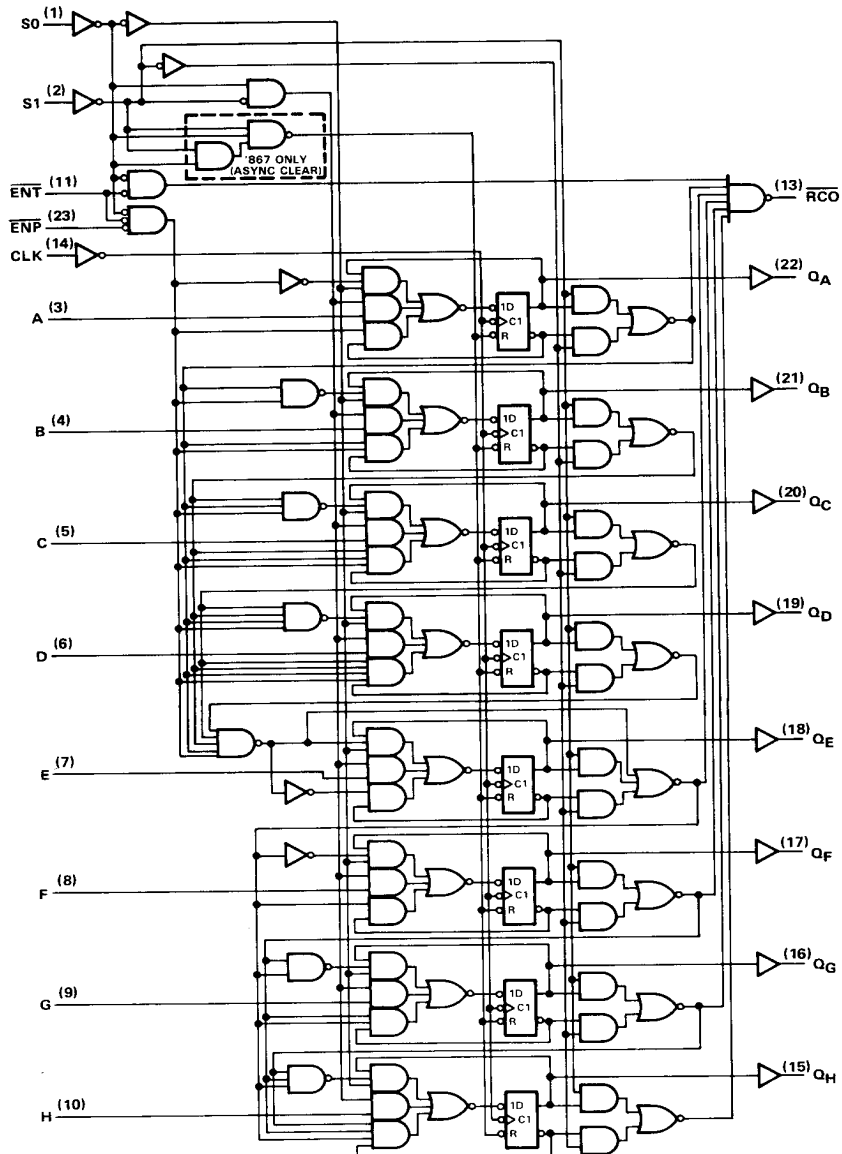
S1	S0	FUNCTION
L	L	Clear
L	H	Count down
H	L	Load
H	H	Count up

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

Supply voltage, V_{CC}	7 V
Input voltage	7 V
Operating free-air temperature range: SN54ALS', SN54AS'	-55°C to 125°C
SN74ALS', SN74AS'	0°C to 70°C
Storage temperature range	-65°C to 150°C

**SN54ALS867, SN54AS867, SN54ALS869, SN54AS869
SN74ALS867, SN74AS867, SN74ALS869, SN74AS869
SYNCHRONOUS 8-BIT UP/DOWN COUNTERS**

logic diagram (positive logic)



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

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recommended operating conditions

		SN54ALS867			SN74ALS867			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			-0.4			-0.4	mA
I _{OL}	Low-level output current			8.0			8.0	mA
f _{clock}	Clock frequency	0		45	0		45	MHz
t _{w(clock)}	Duration							ns
t _{w(clear)}	Duration of clear pulse (S0 and S1 low)							ns
t _{su}	Setup time †	Data inputs A-H						ns
		Enable P (ENP) or Enable T (ENT)						ns
		S0 or S1 (load)						ns
		S0 or S1 (clear)						ns
		S0 or S1 (count down)						ns
		S0 or S1 (count up)						ns
t _h	Hold time at any input with respect to clock †							ns
t _{skew}	Skew time between S0 and S1 (maximum to avoid inadvertent clear)							ns
T _A	Operating free-air temperature	-55		125	0		70	°C

† This setup time is required to ensure stable data.

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

PARAMETER		TEST CONDITIONS		SN54ALS867			SN74ALS867			UNIT
				MIN	TYP ‡	MAX	MIN	TYP ‡	MAX	
V _{IK}		V _{CC} = 4.5 V, I _I = -18 mA				-1.5			-1.5	V
V _{OH}		V _{CC} = 4.5 V to 5.5 V, I _{OH} = -0.4 mA	V _{CC} - 2				V _{CC} - 2			V
V _{OL}		V _{CC} = 4.5 V, I _{OL} = 4 mA			0.25	0.4		0.25	0.4	V
		V _{CC} = 4.5 V, I _{OL} = 8 mA						0.35	0.5	V
I _I		V _{CC} = 5.5 V, V _I = 7 V				0.1			0.1	mA
I _{IH}	ENT	V _{CC} = 5.5 V, V _I = 2.7 V				40			40	µA
	Other Inputs					20			20	µA
I _{IL}	ENT	V _{CC} = 5.5 V, V _I = 0.4 V				-0.4			-0.4	mA
	Other inputs					-0.2			-0.2	mA
I _O §		V _{CC} = 5.5 V, V _O = 2.25 V		-30		-112	-30		-112	mA
I _{CC}		V _{CC} = 5.5 V,			28.5			28.5		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}.

recommended operating conditions

			SN54ALS869			SN74ALS869			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)}	Duration								ns
t _{su}	Setup time [†]	Data inputs A-H							ns
		Enable P ($\overline{\text{ENP}}$) or Enable T ($\overline{\text{ENT}}$)							ns
		S0 or S1 (load)							ns
		S0 or S1 (clear)							ns
		S0 or S1 (count down)							ns
		S0 or S1 (count up)							ns
t _h	Hold time at any input with respect to clock [†]								ns
T _A	Operating free-air temperature		-55		125	0		70	°C

[†]This setup time is required to ensure stable data.

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

PARAMETER		TEST CONDITIONS	SN54ALS869			SN74ALS869			UNIT
			MIN	TYP [‡]	MAX	MIN	TYP [‡]	MAX	
V _{IK}		V _{CC} = 4.5 V, I _I = -18 mA			-1.5			-1.5	V
V _{OH}		V _{CC} = 4.5 V to 5.5 V, I _{OH} = -0.4 mA	V _{CC} - 2			V _{CC} - 2			V
V _{OL}		V _{CC} = 4.5 V, I _{OL} = 4 mA		0.25	0.4		0.25	0.4	V
		V _{CC} = 4.5 V, I _{OL} = 8 mA					0.35	0.5	
I _I		V _{CC} = 5.5 V, V _I = 7 V			0.1			0.1	mA
I _{IH}	$\overline{\text{ENT}}$	V _{CC} = 5.5 V, V _I = 2.7 V			40			40	μA
	Other inputs				20			20	
I _{IL}	$\overline{\text{ENT}}$	V _{CC} = 5.5 V, V _I = 0.4 V			-0.4			-0.4	mA
	Other inputs				-0.2			-0.2	
I _O [§]		V _{CC} = 5.5 V, V _O = 2.25 V	-30		-112	-30		-112	mA
I _{CC}		V _{CC} = 5.5 V		28.5			28.5		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}.

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ALS867 switching characteristics (see Note 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	VCC = 4.5 V to 5.5 V, CL = 500 pF, RL = 500 Ω, TA = MIN to MAX						UNIT
			SN54ALS867			SN74ALS867			
			MIN	TYP†	MAX	MIN	TYP†	MAX	
tmax			45			45			MHz
tPLH	CLK	RCO		14			14		ns
tPHL			13			13			
tPLH	CLK	Any Q		10			10		ns
tPHL			12			12			
tPLH	ENT	RCO		7.5			7.5		ns
tPHL			8.5			8.5			
tPLH	ENP	RCO		11.5			11.5		ns
tPHL			8.5			8.5			
tPHL	Clear (S0, S1 low)	Any Q		17			17		ns
tPLH	S0, S1 (count up/down)	RCO		12			12		ns
tPHL			13			13			
tPHL	Clear (S0, S1 low)	RCO		22			22		ns

ALS869 switching characteristics (see Note 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	VCC = 4.5 V to 5.5 V, CL = 500 pF, RL = 500 Ω, TA = MIN to MAX						UNIT
			SN54ALS869			SN74ALS869			
			MIN	TYP†	MAX	MIN	TYP†	MAX	
tmax			45			45			MHz
tPLH	CLK	RCO	14			14			ns
tPHL		13			13				
tPLH	CLK	Any Q	10			10			ns
tPHL		12			12				
tPLH	ENT	RCO	7.5			7.5			ns
tPHL		8.5			8.5				
tPLH	ENP	RCO	11.5			11.5			ns
tPHL		8.5			8.5				
tPLH	S0, S1 (count up/down)	RCO	12			12			ns
tPHL		13			13				
tPHL	Clear (S0, S1 low)	RCO	22			22			ns
tPHL	Clear (S0, S1 low)	Any Q	17			17			ns

[†]All typical values are at $V_{CC} = 5 \text{ V, } T_A = 25^\circ\text{C.}$

NOTE 1: Load circuit and voltage waveforms are shown in Section 1.

SN54AS867, SN74AS867

SYNCHRONOUS 8-BIT UP/DOWN COUNTERS WITH ASYNCHRONOUS CLEAR

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)}	Duration	12.5			10			ns
t _{w(clear)}	Duration of clear pulse (S0 and S1 low)	12.5			10			ns
t _{su}	Setup time [†]	Data inputs A-H	5		4			ns
		Enable P (ENP) or Enable T (ENT)	9		8			ns
		S0 or S1 (load)	11		10			ns
		S0 or S1 (clear)	11		10			ns
		S0 or S1 (count down)	42		40			ns
		S0 or S1 (count up)	42		40			ns
t _h	Hold time at any input with respect to clock [†]	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

[†]This setup time is required to ensure stable data.

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}		V _{CC} = 4.5 V,	I _{OL} = 20 mA			0.34	0.5		0.34	0.5	V
I _I		V _{CC} = 5.5 V,	V _I = 7 V				0.1			0.1	mA
I _{IH}	ENT	V _{CC} = 5.5 V,	V _I = 2.7 V				40			40	μA
	Other inputs						20			20	μA
I _{IL}	ENT	V _{CC} = 5.5 V,	V _I = 0.4 V				-4			-4	mA
	Other inputs						-2			-2	mA
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}.

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SN54AS869, SN74AS869

SYNCHRONOUS 8-BIT UP/DOWN COUNTERS WITH SYNCHRONOUS CLEAR

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			0.8			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			40			45	MHz
t _{w(clock)}	Duration	12.5			11			ns
t _{su}	Setup time [†]	Data inputs A-H			5			ns
		Enable P (ENP) or Enable T (ENT)			9			ns
		S0 or S1 (load)			11			ns
		S0 or S1 (clear)			11			ns
		S0 or S1 (count down)			50			ns
		S0 or S1 (count up)			50			ns
t _h	Hold time at any input with respect to clock [†]	0			0			ns
T _A	Operating free-air temperature	-55	125		0	70		°C

[†]This setup time is required to ensure stable data.

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

PARAMETER		TEST CONDITIONS		SN54AS869		SN74AS869		UNIT
				MIN	TYP [‡]	MAX	MIN	
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}		V _{CC} = 4.5 V, I _{OL} = 20 mA		0.34	0.5	0.34	0.5	V
I _I		V _{CC} = 5.5 V, V _I = 7 V			0.1		0.1	mA
I _{IH}	ENT	V _{CC} = 5.5 V, V _I = 2.7 V			40		40	μA
	Other inputs				20		20	
I _{IL}	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		125	180	125	180	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}.

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SN54AS867, SN74AS867, SN54AS869, SN74AS869
SYNCHRONOUS 8-BIT UP/DOWN COUNTERS

AS867 switching characteristics (see note 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	14	5	14	ns
t _{PHL}			5	21	5	17	
t _{PHL}	Clear (S0, S1 low)	Any Q	7	23	7	21	ns

AS869 switching characteristics (see note 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	

NOTE 1: Load circuit and voltage waveforms are shown in Section 1.

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