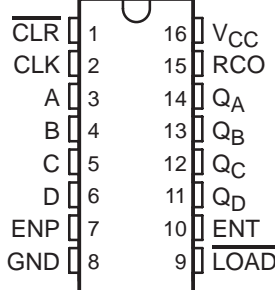


SN54LV163A, SN74LV163A 4-BIT SYNCHRONOUS BINARY COUNTERS

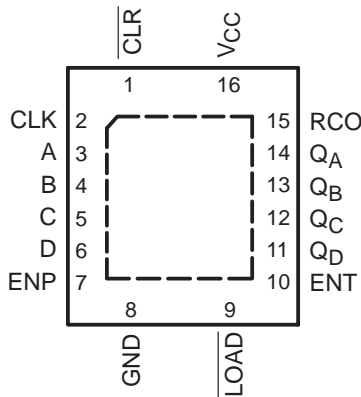
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- 2-V to 5.5-V V_{CC} Operation
- Max t_{pd} of 9.5 ns at 5 V
- Typical V_{OLP} (Output Ground Bounce) <0.8 V at $V_{CC} = 3.3$ V, $T_A = 25^\circ\text{C}$
- Typical V_{OHV} (Output V_{OH} Undershoot) >2.3 V at $V_{CC} = 3.3$ V, $T_A = 25^\circ\text{C}$
- Support Mixed-Mode Voltage Operation on All Ports
- Internal Look Ahead for Fast Counting
- Carry Output for n-Bit Cascading
- Synchronous Counting
- Synchronously Programmable
- I_{off} Supports Partial-Power-Down Mode Operation
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II
- ESD Protection Exceeds JESD 22
 - 2000-V Human-Body Model (A114-A)
 - 200-V Machine Model (A115-A)
 - 1000-V Charged-Device Model (C101)

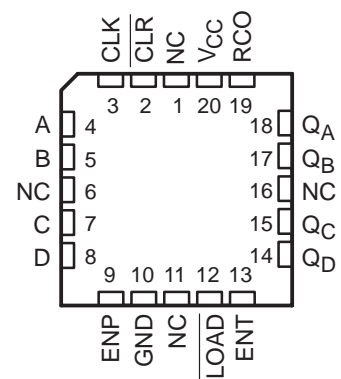
SN54LV163A . . . J OR W PACKAGE
SN74LV163A . . . D, DB, DGV, NS,
OR PW PACKAGE
(TOP VIEW)



SN74LV163A . . . RGY PACKAGE
(TOP VIEW)



SN54LV163A . . . FK PACKAGE
(TOP VIEW)



NC – No internal connection

description/ordering information

ORDERING INFORMATION

T_A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	QFN – RGY	Reel of 1000	SN74LV163ARGYR	LV163A
		Tube of 40	SN74LV163AD	LV163A
	SOIC – D	Reel of 2500	SN74LV163ADR	
	SOP – NS	Reel of 2000	SN74LV163ANSR	74LV163A
	SSOP – DB	Reel of 2000	SN74LV163ADBR	LV163A
	TSSOP – PW	Tube of 90	SN74LV163APW	LV163A
		Reel of 2000	SN74LV163APWR	
		Reel of 250	SN74LV163APWT	
–55°C to 125°C	TVSOP – DGV	Reel of 2000	SN74LV163ADGVR	LV163A
	CDIP – J	Tube of 25	SNJ54LV163AJ	SNJ54LV163AJ
	CFP – W	Tube of 150	SNJ54LV163AW	SNJ54LV163AW
	LCCC – FK	Tube of 55	SNJ54LV163AFK	SNJ54LV163AFK

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.



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SN54LV163A, SN74LV163A

4-BIT SYNCHRONOUS BINARY COUNTERS

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description/ordering information (continued)

The 'LV163A devices are 4-bit synchronous binary counters designed for 2-V to 5.5-V V_{CC} operation.

These synchronous, presettable counters feature an internal carry look ahead for application in high-speed counting designs. The 'LV163A devices are 4-bit binary counters. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincident with each other when instructed by the count-enable (ENP, ENT) inputs and internal gating. This mode of operation eliminates the output counting spikes normally associated with synchronous (ripple-clock) counters. A buffered clock (CLK) input triggers the four flip-flops on the rising (positive-going) edge of the clock waveform.

These counters are fully programmable; that is, they can be preset to any number between 0 and 9 or 15. As presetting is synchronous, setting up a low level at the load input disables the counter and causes the outputs to agree with the setup data after the next clock pulse, regardless of the levels of the enable inputs.

The clear function for the 'LV163A devices is synchronous. A low level at the clear (\overline{CLR}) input sets all four of the flip-flop outputs low after the next low-to-high transition of CLK, regardless of the levels of the enable inputs. This synchronous clear allows the count length to be modified easily by decoding the Q outputs for the maximum count desired. The active-low output of the gate used for decoding is connected to \overline{CLR} to synchronously clear the counter to 0000 (LLLL).

The carry look-ahead circuitry provides for cascading counters for n-bit synchronous applications without additional gating. ENP, ENT, and a ripple-carry output (RCO) are instrumental in accomplishing this function. Both ENP and ENT must be high to count, and ENT is fed forward to enable RCO. Enabling RCO produces a high-level pulse while the count is maximum (9 or 15 with Q_A high). This high-level overflow ripple-carry pulse can be used to enable successive cascaded stages. Transitions at ENP or ENT are allowed, regardless of the level of CLK.

These counters feature a fully independent clock circuit. Changes at control inputs (ENP, ENT, or \overline{LOAD}) that modify the operating mode have no effect on the contents of the counter until clocking occurs. The function of the counter (whether enabled, disabled, loading, or counting) is dictated solely by the conditions meeting the stable setup and hold times.

These devices are fully specified for partial-power-down applications using I_{off} . The I_{off} circuitry disables the outputs, preventing damaging current backflow through the devices when they are powered down.

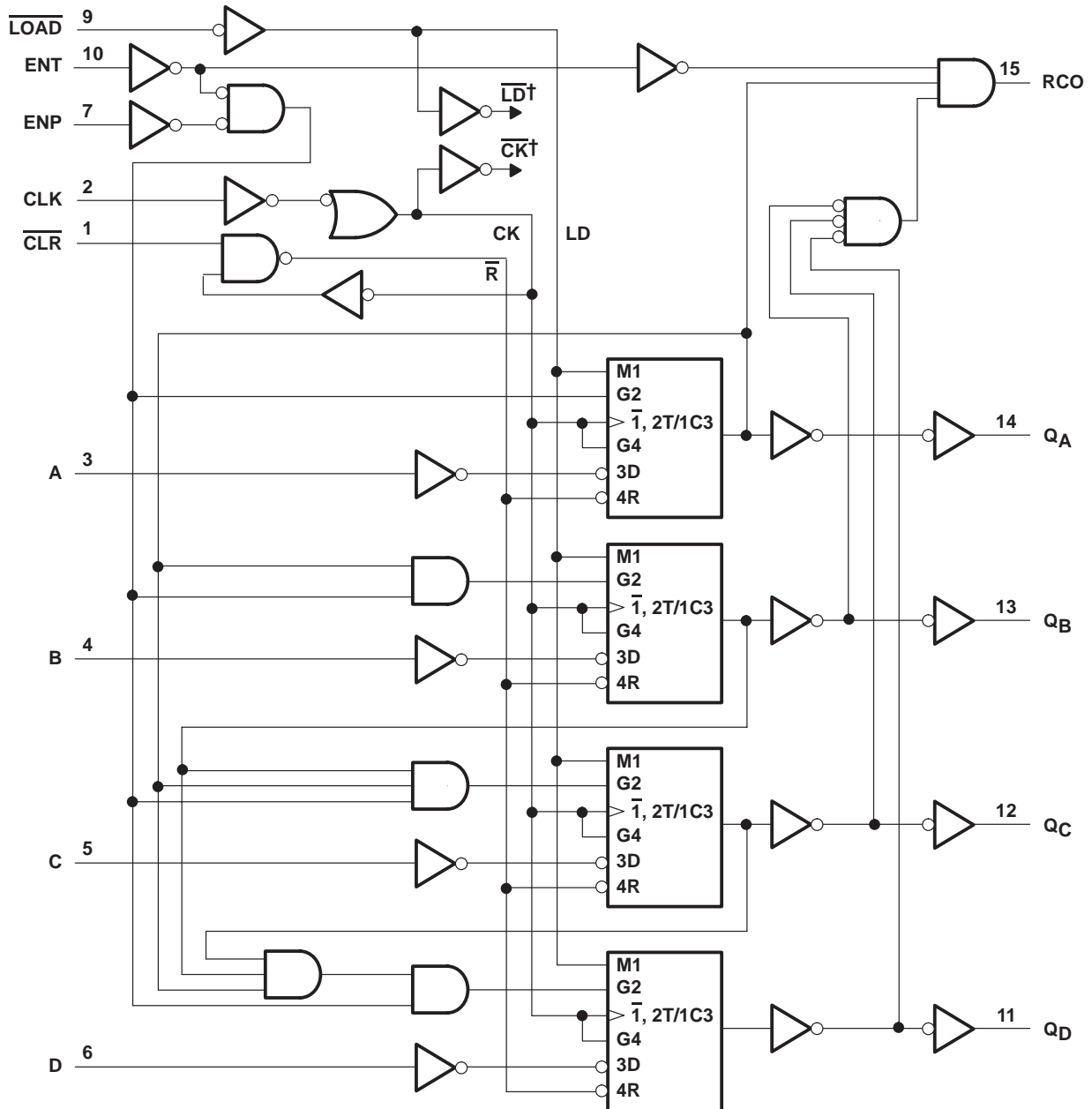
FUNCTION TABLE

INPUTS					OUTPUTS				FUNCTION
\overline{CLR}	\overline{LOAD}	ENP	ENT	CLK	\overline{QA}	QB	QC	QD	
L	X	X	X	X	L	L	L	L	Reset to "0"
H	L	X	X		A	B	C	D	Preset data
H	H	X	L		No change				No count
H	H	L	X		No change				No count
H	H	H	H		Count up				Count
H	X	X	X		No change				No count

SN54LV163A, SN74LV163A 4-BIT SYNCHRONOUS BINARY COUNTERS

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logic diagram (positive logic)



† For simplicity, routing of complementary signals \overline{LD} and \overline{CK} is not shown on this overall logic diagram. The uses of these signals are shown on the logic diagram of the D/T flip-flops.

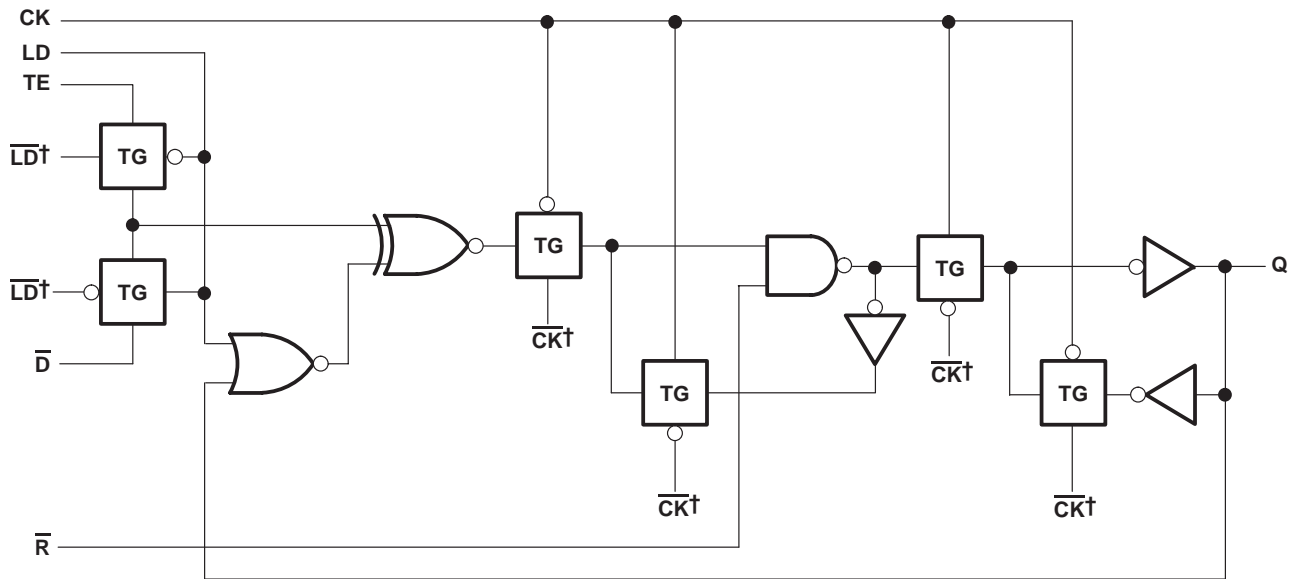
Pin numbers shown are for the D, DB, DGV, J, NS, PW, RGY, and W packages.

SN54LV163A, SN74LV163A

4-BIT SYNCHRONOUS BINARY COUNTERS

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logic diagram, each D/T flip-flop (positive logic)

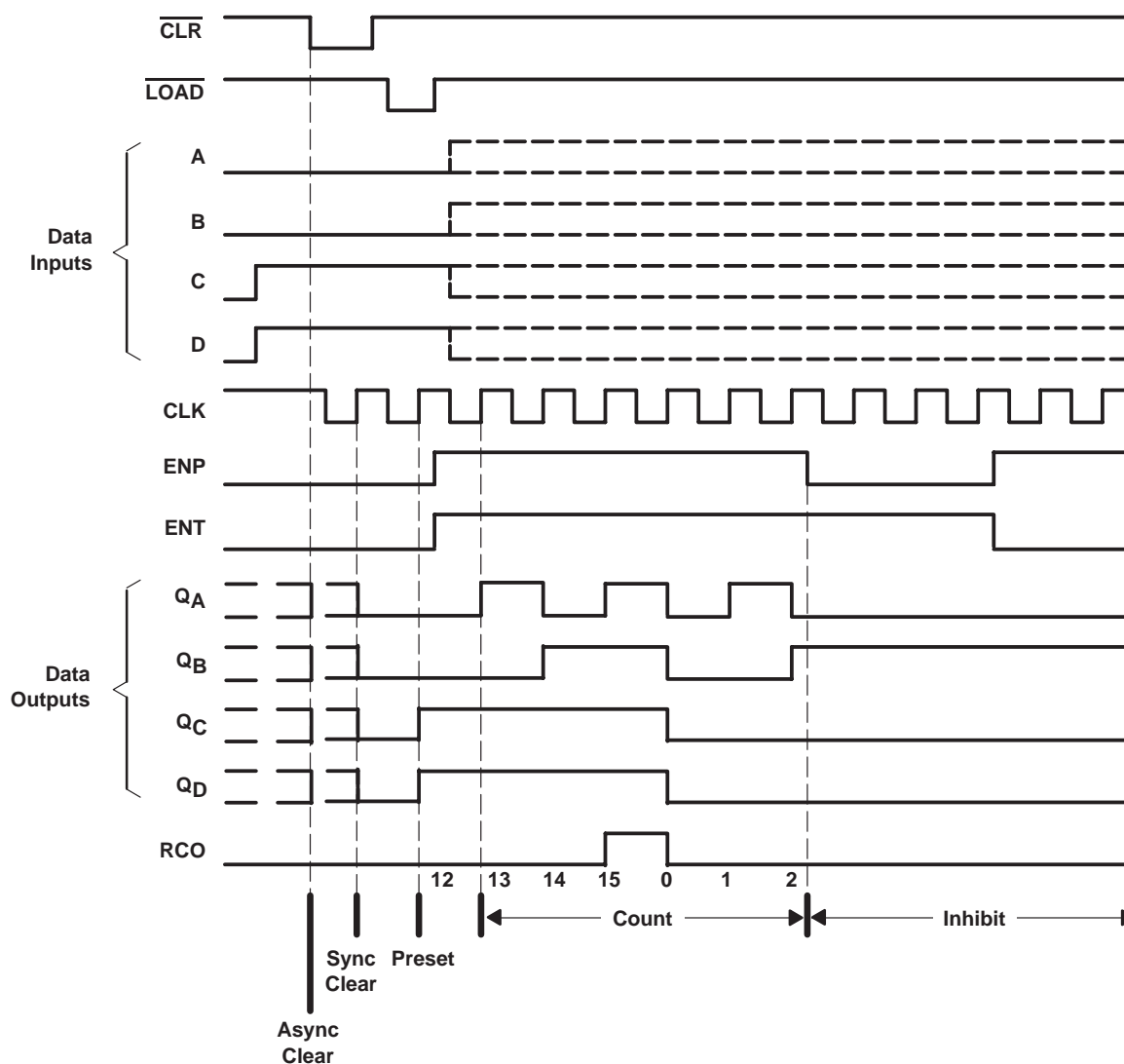


[†] The origins of $\overline{\text{LD}}$ and $\overline{\text{CK}}$ are shown in the overall logic diagram of the device.

typical clear, preset, count, and inhibit sequence

The following sequence is illustrated below:

1. Clear outputs to zero (synchronous)
2. Preset to binary 12
3. Count to 13, 14, 15, 0, 1, and 2
4. Inhibit



SN54LV163A, SN74LV163A

4-BIT SYNCHRONOUS BINARY COUNTERS

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

Supply voltage range, V_{CC}	–0.5 V to 7 V
Input voltage range, V_I (see Note 1)	–0.5 V to 7 V
Output voltage range applied in high or low state, V_O (see Notes 1 and 2)	–0.5 V to $V_{CC} + 0.5$ V
Voltage range applied to any output in the power-off state, V_O (see Note 1)	–0.5 V to 7 V
Input clamp current, I_{IK} ($V_I < 0$)	–20 mA
Output clamp current, I_{OK} ($V_O < 0$)	–50 mA
Continuous output current, I_O ($V_O = 0$ to V_{CC})	±25 mA
Continuous current through V_{CC} or GND	±50 mA
Package thermal impedance, θ_{JA} (see Note 3): D package	73°C/W
(see Note 3): DB package	82°C/W
(see Note 3): DGV package	120°C/W
(see Note 3): NS package	64°C/W
(see Note 3): PW package	108°C/W
(see Note 4): RGY package	39°C/W
Storage temperature range, T_{stg}	–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.

- NOTES:
1. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.
 2. This value is limited to 5.5 V maximum.
 3. The package thermal impedance is calculated in accordance with JESD 51-7.
 4. The package thermal impedance is calculated in accordance with JESD 51-5.

SN54LV163A, SN74LV163A 4-BIT SYNCHRONOUS BINARY COUNTERS

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recommended operating conditions (see Note 5)

			SN54LV163A		SN74LV163A		UNIT
			MIN	MAX	MIN	MAX	
V _{CC}	Supply voltage		2	5.5	2	5.5	V
V _{IH}	High-level input voltage	V _{CC} = 2 V	1.5		1.5		V
		V _{CC} = 2.3 V to 2.7 V	V _{CC} × 0.7		V _{CC} × 0.7		
		V _{CC} = 3 V to 3.6 V	V _{CC} × 0.7		V _{CC} × 0.7		
		V _{CC} = 4.5 V to 5.5 V	V _{CC} × 0.7		V _{CC} × 0.7		
V _{IL}	Low-level input voltage	V _{CC} = 2 V		0.5		0.5	V
		V _{CC} = 2.3 V to 2.7 V		V _{CC} × 0.3		V _{CC} × 0.3	
		V _{CC} = 3 V to 3.6 V		V _{CC} × 0.3		V _{CC} × 0.3	
		V _{CC} = 4.5 V to 5.5 V		V _{CC} × 0.3		V _{CC} × 0.3	
V _I	Input voltage		0	5.5	0	5.5	V
V _O	Output voltage		0	V _{CC}	0	V _{CC}	V
I _{OH}	High-level output current	V _{CC} = 2 V		–50		–50	μA
		V _{CC} = 2.3 V to 2.7 V		–2		–2	mA
		V _{CC} = 3 V to 3.6 V		–6		–6	
		V _{CC} = 4.5 V to 5.5 V		–12		–12	
I _{OL}	Low-level output current	V _{CC} = 2 V		50		50	μA
		V _{CC} = 2.3 V to 2.7 V		2		2	mA
		V _{CC} = 3 V to 3.6 V		6		6	
		V _{CC} = 4.5 V to 5.5 V		12		12	
Δt/Δv	Input transition rise or fall rate	V _{CC} = 2.3 V to 2.7 V		200		200	ns/V
		V _{CC} = 3 V to 3.6 V		100		100	
		V _{CC} = 4.5 V to 5.5 V		20		20	
T _A	Operating free-air temperature		–55	125	–40	85	°C

NOTE 5: All unused inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

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

PARAMETER	TEST CONDITIONS	V _{CC}	SN54LV163A			SN74LV163A			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V _{OH}	I _{OH} = –50 μA	2 V to 5.5 V	V _{CC} –0.1			V _{CC} –0.1			V
	I _{OH} = –2 mA	2.3 V	2			2			
	I _{OH} = –6 mA	3 V	2.48			2.48			
	I _{OH} = –12 mA	4.5 V	3.8			3.8			
V _{OL}	I _{OL} = 50 μA	2 V to 5.5 V			0.1			0.1	V
	I _{OL} = 2 mA	2.3 V			0.4			0.4	
	I _{OL} = 6 mA	3 V			0.44			0.44	
	I _{OL} = 12 mA	4.5 V			0.55			0.55	
I _I	V _I = 5.5 V or GND	0 to 5.5 V			±1			±1	μA
I _{CC}	V _I = V _{CC} or GND, I _O = 0	5.5 V			20			20	μA
I _{off}	V _I or V _O = 0 to 5.5 V	0			5			5	μA
C _i	V _I = V _{CC} or GND	3.3 V		1.8			1.8		pF

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SN54LV163A, SN74LV163A

4-BIT SYNCHRONOUS BINARY COUNTERS

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timing requirements over recommended operating free-air temperature range, $V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$ (unless otherwise noted) (see Figure 1)

			$T_A = 25^\circ\text{C}$		SN54LV163A		SN74LV163A		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
t_W	Pulse duration, CLK high or low		7		7		7		ns
t_{su}	Setup time before CLK \uparrow		6		6		6		ns
	Data (A, B, C, and D)		7.5		8.5		8.5		
	ENP, ENT		9.5		11		11		
	LOAD low		10		11.5		11.5		
t_h	Hold time, all synchronous inputs after CLK \uparrow		1.5		1.5		1.5		ns

timing requirements over recommended operating free-air temperature range, $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$ (unless otherwise noted) (see Figure 1)

			$T_A = 25^\circ\text{C}$		SN54LV163A		SN74LV163A		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
t_W	Pulse duration, CLK high or low		5		5		5		ns
t_{su}	Setup time before CLK \uparrow		4		4		4		ns
	Data (A, B, C, and D)		5.5		6.5		6.5		
	ENP, ENT		7.5		9		9		
	LOAD low		8		9.5		9.5		
t_h	Hold time, all synchronous inputs after CLK \uparrow		1		1		1		ns

timing requirements over recommended operating free-air temperature range, $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$ (unless otherwise noted) (see Figure 1)

			$T_A = 25^\circ\text{C}$		SN54LV163A		SN74LV163A		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
t_W	Pulse duration, CLK high or low		5		5		5		ns
t_{su}	Setup time before CLK \uparrow		3.5		3.5		3.5		ns
	Data (A, B, C, and D)		4.5		4.5		4.5		
	ENP, ENT		5		6		6		
	LOAD low		5		6		6		
t_h	Hold time, all synchronous inputs after CLK \uparrow		1		1		1		ns

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SN54LV163A, SN74LV163A 4-BIT SYNCHRONOUS BINARY COUNTERS

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switching characteristics over recommended operating free-air temperature range,
V_{CC} = 2.5 V ± 0.2 V (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	T _A = 25°C			SN54LV163A		SN74LV163A		UNIT
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
f _{max}			C _L = 15 pF	50*	115*		40*		40		MHz
			C _L = 50 pF	30	90		25		25		
t _{pd}	CLK	Q	C _L = 15 pF	8.5*	16.2*		1*	19.5*	1	19.5	ns
		RCO (count mode)		9.1*	17*		1*	20.5*	1	20.5	
		RCO (preset mode)		12.1*	20.6*		1*	24.5*	1	24.5	
	ENT	RCO		8.7*	15.7*		1*	19*	1	19	
t _{pd}	CLK	Q	C _L = 50 pF	11	19.2		1	22.5	1	22.5	ns
		RCO (count mode)		11.9	20		1	23.5	1	23.5	
		RCO (preset mode)		14.6	23.6		1	27.5	1	27.5	
	ENT	RCO		11.7	18.7		1	22	1	22	

* On products compliant to MIL-PRF-38535, this parameter is not production tested.

switching characteristics over recommended operating free-air temperature range,
V_{CC} = 3.3 V ± 0.3 V (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	T _A = 25°C			SN54LV163A		SN74LV163A		UNIT
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
f _{max}			C _L = 15 pF	80*	160*		70*		70		MHz
			C _L = 50 pF	55	125		50		50		
t _{pd}	CLK	Q	C _L = 15 pF	6.2*	12.8*		1*	15*	1	15	ns
		RCO (count mode)		6.8*	13.6*		1*	16*	1	16	
		RCO (preset mode)		8.8*	17.2*		1*	20*	1	20	
	ENT	RCO		6.5*	12.3*		1*	14.5*	1	14.5	
t _{pd}	CLK	Q	C _L = 50 pF	8	16.3		1	18.5	1	18.5	ns
		RCO (count mode)		8.8	17.1		1	19.5	1	19.5	
		RCO (preset mode)		10.7	20.7		1	23.5	1	23.5	
	ENT	RCO		8.2	15.8		1	18	1	18	

* On products compliant to MIL-PRF-38535, this parameter is not production tested.

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SN54LV163A, SN74LV163A

4-BIT SYNCHRONOUS BINARY COUNTERS

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switching characteristics over recommended operating free-air temperature range, $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$ (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	$T_A = 25^\circ\text{C}$			SN54LV163A		SN74LV163A		UNIT
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
f_{max}			$C_L = 15\text{ pF}$	135*	210*		115*		115		MHz
			$C_L = 50\text{ pF}$	95	160		85		85		
t_{pd}	CLK	Q	$C_L = 15\text{ pF}$	4.7*	8.1*		1*	9.5*	1	9.5	ns
		RCO (count mode)		5.2*	8.1*		1*	9.5*	1	9.5	
		RCO (preset mode)		6.4*	10.3*		1*	12*	1	12	
	ENT	RCO		4.9*	8.1*		1*	9.5*	1	9.5	
t_{pd}	CLK	Q	$C_L = 50\text{ pF}$	6.1	10.1		1	11.5	1	11.5	ns
		RCO (count mode)		6.6	10.1		1	11.5	1	11.5	
		RCO (preset mode)		7.8	12.3		1	14	1	14	
	ENT	RCO		6.3	10.1		1	11.5	1	11.5	

* On products compliant to MIL-PRF-38535, this parameter is not production tested.

noise characteristics, $V_{CC} = 3.3\text{ V}$, $C_L = 50\text{ pF}$, $T_A = 25^\circ\text{C}$ (see Note 6)

PARAMETER	SN74LV163A			UNIT
	MIN	TYP	MAX	
$V_{OL(P)}$ Quiet output, maximum dynamic V_{OL}		0.3	0.8	V
$V_{OL(V)}$ Quiet output, minimum dynamic V_{OL}		−0.2	−0.8	V
$V_{OH(V)}$ Quiet output, minimum dynamic V_{OH}		3		V
$V_{IH(D)}$ High-level dynamic input voltage		2.31		V
$V_{IL(D)}$ Low-level dynamic input voltage			0.99	V

NOTE 6: Characteristics are for surface-mount packages only.

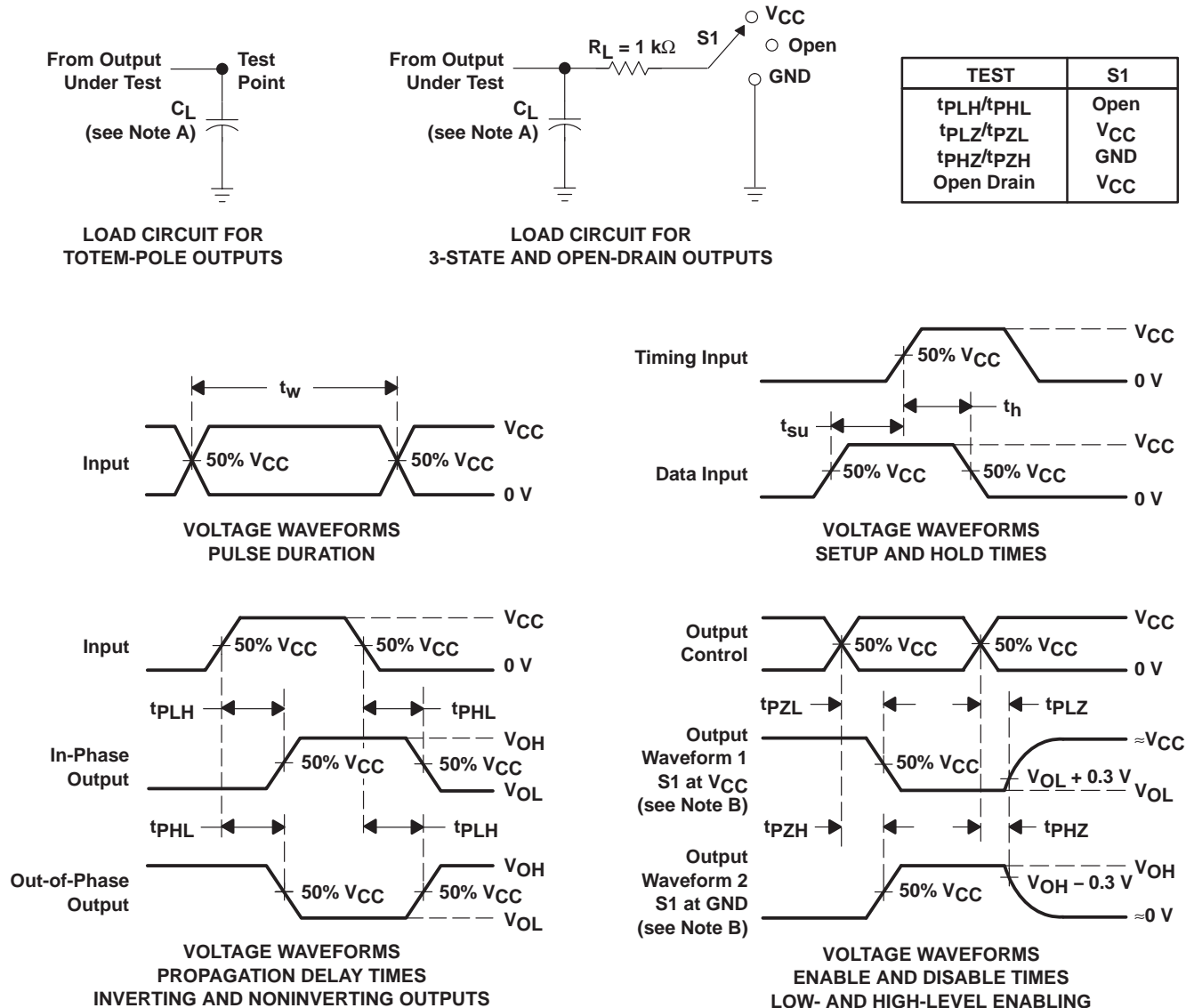
operating characteristics, $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	V_{CC}	TYP	UNIT
C_{pd} Power dissipation capacitance	$C_L = 50\text{ pF}$, $f = 10\text{ MHz}$	3.3 V	23.8	pF
		5 V	26	

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PARAMETER MEASUREMENT INFORMATION



- 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. All input pulses are supplied by generators having the following characteristics: $PRR \leq 1\text{ MHz}$, $Z_O = 50\ \Omega$, $t_r \leq 3\text{ ns}$, $t_f \leq 3\text{ ns}$.
 - D. The outputs are measured one at a time, with one input transition per measurement.
 - E. t_{PLZ} and t_{PHZ} are the same as t_{dis} .
 - F. t_{PZL} and t_{PZH} are the same as t_{en} .
 - G. t_{PHL} and t_{PLH} are the same as t_{pd} .
 - H. All parameters and waveforms are not applicable to all devices.

Figure 1. Load Circuit and Voltage Waveforms

DGV (R-PDSO-G**)

PLASTIC SMALL-OUTLINE

24 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15 per side.
 D. Falls within JEDEC: 24/48 Pins – MO-153
 14/16/20/56 Pins – MO-194

D (R-PDSO-G16)

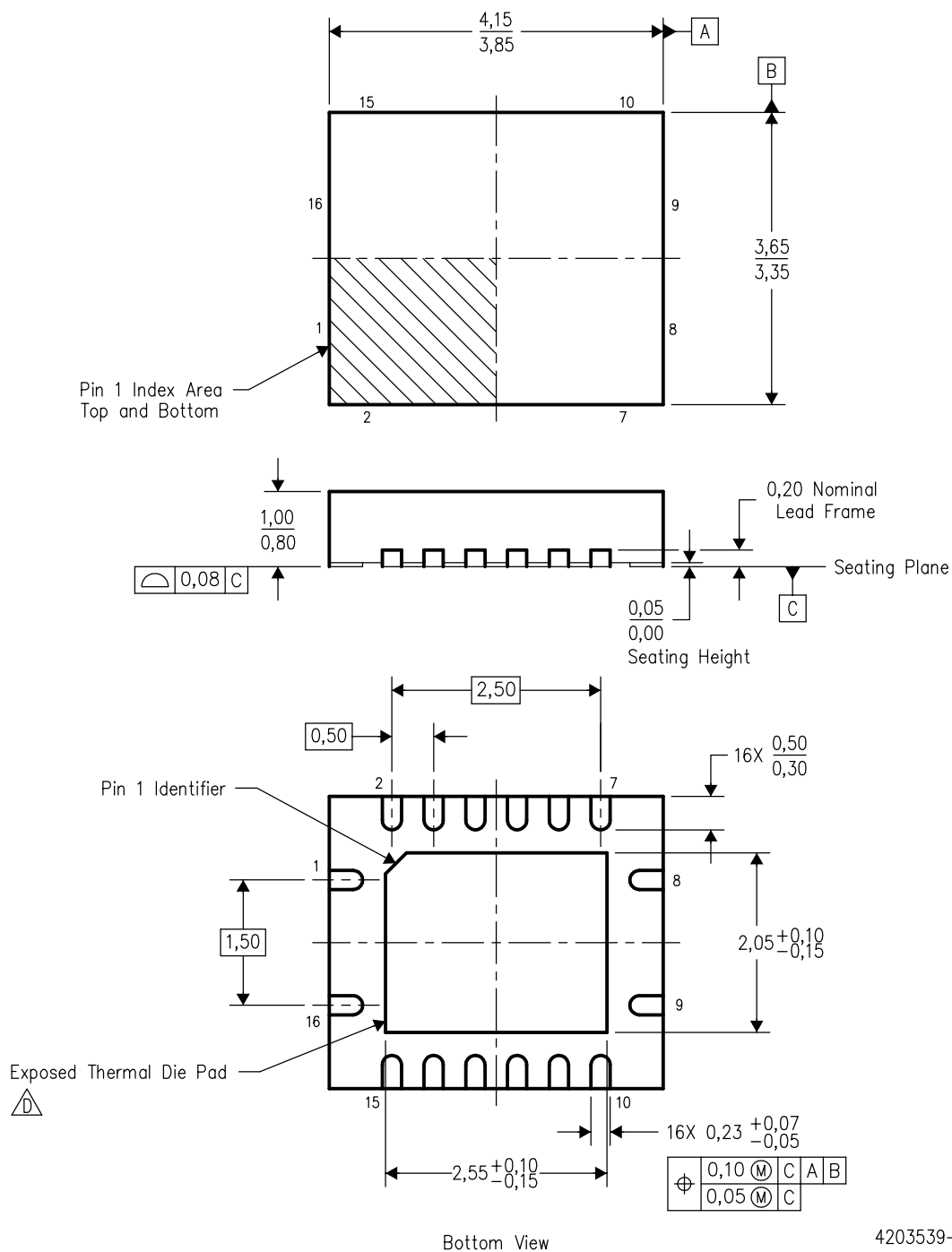
PLASTIC SMALL-OUTLINE PACKAGE




- NOTES:
- All linear dimensions are in inches (millimeters).
 - This drawing is subject to change without notice.
 - Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
 - Falls within JEDEC MS-012 variation AC.

RGY (R-PQFP-N16)

PLASTIC QUAD FLATPACK



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. QFN (Quad Flatpack No-Lead) package configuration.
 -  D. The package thermal performance may be enhanced by bonding the thermal die pad to an external thermal plane. This pad is electrically and thermally connected to the backside of the die and possibly selected ground leads.
 - E. Package complies to JEDEC MO-241 variation BB.

MECHANICAL DATA

NS (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



DIM \ PINS **	14	16	20	24
A MAX	10,50	10,50	12,90	15,30
A MIN	9,90	9,90	12,30	14,70

4040062/C 03/03

- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

DB (R-PDSO-G**)

PLASTIC SMALL-OUTLINE

28 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
 D. Falls within JEDEC MO-150

PW (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
 D. Falls within JEDEC MO-153

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