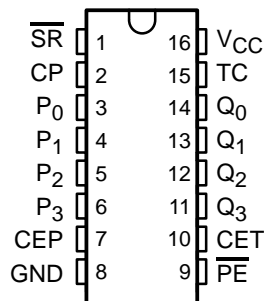


# CY54FCT163T, CY74FCT163T 4-BIT BINARY COUNTERS

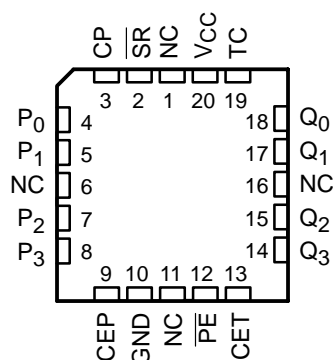
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- Function, Pinout, and Drive Compatible With FCT and F Logic
- Reduced  $V_{OH}$  (Typically = 3.3 V) Versions of Equivalent FCT Functions
- Edge-Rate Control Circuitry for Significantly Improved Noise Characteristics
- $I_{off}$  Supports Partial-Power-Down Mode Operation
- ESD Protection Exceeds JESD 22
  - 2000-V Human-Body Model (A114-A)
  - 200-V Machine Model (A115-A)
  - 1000-V Charged-Device Model (C101)
- Matched Rise and Fall Times
- Fully Compatible With TTL Input and Output Logic Levels
- CY54FCT163T
  - 32-mA Output Sink Current
  - 12-mA Output Source Current
- CY74FCT163T
  - 64-mA Output Sink Current
  - 32-mA Output Source Current

CY74FCT163CT . . . Q OR SO PACKAGE  
(TOP VIEW)



CY54FCT163T . . . L PACKAGE  
(TOP VIEW)



NC – No internal connection

## description

The 'FCT163T devices are high-speed synchronous modulo-16 binary counters. They are synchronously presettable for application in programmable dividers. These devices have two types of count-enable (CEP and CET) inputs, plus a terminal-count (TC) output for versatility in forming synchronous multistaged counters. The 'FCT163T devices have a synchronous-reset ( $\overline{SR}$ ) input that overrides counting and parallel loading, and allows the outputs to be reset simultaneously on the rising edge of the clock.

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 device when it is powered down.

### PIN DESCRIPTION

NAME	DESCRIPTION
CEP	Count-enable parallel input
CET	Count-enable trickle input
CP	Clock pulse input (active rising edge)
$\overline{SR}$	Synchronous-reset input (active low)
P	Parallel data inputs
$\overline{PE}$	Parallel-enable input (active low)
Q	Flip-flop outputs
TC	Terminal-count output



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

 **TEXAS  
INSTRUMENTS**

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On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

# CY54FCT163T, CY74FCT163T 4-BIT BINARY COUNTERS

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## ORDERING INFORMATION

T <sub>A</sub>	PACKAGE†		SPEED (ns)	ORDERABLE PART NUMBER	TOP-SIDE MARKING
-40°C to 85°C	QSOP – Q	Tape and reel	5.8	CY74FCT163CTQCT	FT163-3
	SOIC – SO	Tube	5.8	CY74FCT163CTSOC	FCT163C
		Tape and reel	5.8	CY74FCT163CTSOCT	
-55°C to 125°C	LCC – L	Tube	11.5	CY54FCT163TLMB	

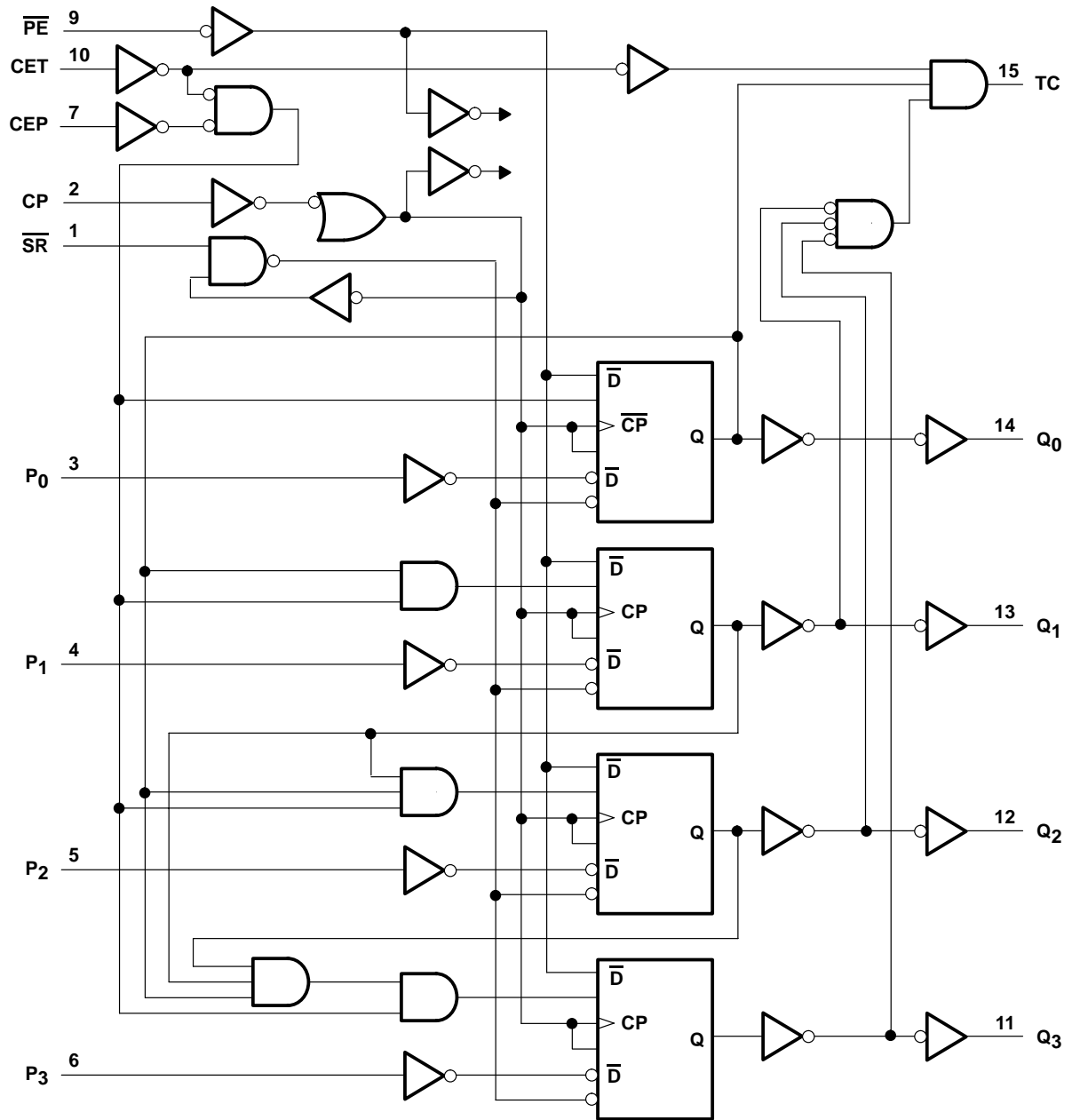
† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).

## FUNCTION TABLE

INPUTS				ACTION ON THE RISING CLOCK EDGE(S)
$\overline{SR}$	$\overline{PE}$	CET	CEP	
L	X	X	X	Reset (clear)
H	L	X	X	Load ( $P_n \rightarrow Q_n$ )
H	H	H	H	Count (incremental)
H	H	L	X	No change (hold)
H	H	X	L	No change (hold)

H = High logic level, L = Low logic level, X = Don't care

logic diagram (positive logic)



# CY54FCT163T, CY74FCT163T 4-BIT BINARY COUNTERS

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

Supply voltage range to ground potential	–0.5 V to 7 V
DC input voltage range	–0.5 V to 7 V
DC output voltage range	–0.5 V to 7 V
DC output current (maximum sink current/pin)	120 mA
Package thermal impedance, $\theta_{JA}$ (see Note 1): Q package	90°C/W
SO package	57°C/W
Ambient temperature range with power applied, $T_A$	–65°C to 135°C
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.

NOTE 1: The package thermal impedance is calculated in accordance with JESD 51-7.

## recommended operating conditions (see Note 2)

	CY54FCT163T			CY74FCT163T			UNIT
	MIN	NOM	MAX	MIN	NOM	MAX	
$V_{CC}$ Supply voltage	4.5	5	5.5	4.75	5	5.25	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			–12			–32	mA
$I_{OL}$ Low-level output current			32			64	mA
$T_A$ Operating free-air temperature	–55		125	–40		85	°C

NOTE 2: All unused inputs of the device must be held at  $V_{CC}$  or GND to ensure proper device operation.



# CY54FCT163T, CY74FCT163T 4-BIT BINARY COUNTERS

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

PARAMETER	TEST CONDITIONS	CY54FCT163T			CY74FCT163T			UNIT
		MIN	TYP†	MAX	MIN	TYP†	MAX	
V <sub>IK</sub>	V <sub>CC</sub> = 4.5 V, I <sub>IN</sub> = -18 mA	-0.7	-1.2					V
	V <sub>CC</sub> = 4.75 V, I <sub>IN</sub> = -18 mA				-0.7	-1.2		
V <sub>OH</sub>	V <sub>CC</sub> = 4.5 V, I <sub>OH</sub> = -12 mA	2.4	3.3					V
	V <sub>CC</sub> = 4.75 V	I <sub>OH</sub> = -32 mA			2			
		I <sub>OH</sub> = -15 mA			2.4	3.3		
V <sub>OL</sub>	V <sub>CC</sub> = 4.5 V, I <sub>OL</sub> = 32 mA	0.3	0.55					V
	V <sub>CC</sub> = 4.75 V, I <sub>OL</sub> = 64 mA				0.3	0.55		
V <sub>hys</sub>	All inputs	0.2			0.2			V
I <sub>I</sub>	V <sub>CC</sub> = 5.5 V, V <sub>IN</sub> = V <sub>CC</sub>		5					μA
	V <sub>CC</sub> = 5.25 V, V <sub>IN</sub> = V <sub>CC</sub>					5		
I <sub>IH</sub>	V <sub>CC</sub> = 5.5 V, V <sub>IN</sub> = 2.7 V			±1				μA
	V <sub>CC</sub> = 5.25 V, V <sub>IN</sub> = 2.7 V					±1		
I <sub>IL</sub>	V <sub>CC</sub> = 5.5 V, V <sub>IN</sub> = 0.5 V			±1				μA
	V <sub>CC</sub> = 5.25 V, V <sub>IN</sub> = 0.5 V					±1		
I <sub>OS</sub> ‡	V <sub>CC</sub> = 5.5 V, V <sub>OUT</sub> = 0 V	-60	-120	-225				mA
	V <sub>CC</sub> = 5.25 V, V <sub>OUT</sub> = 0 V				-60	-120	-225	
I <sub>off</sub>	V <sub>CC</sub> = 0 V, V <sub>OUT</sub> = 4.5 V			±1			±1	μA
I <sub>CC</sub>	V <sub>CC</sub> = 5.5 V, V <sub>IN</sub> ≤ 0.2 V, V <sub>IN</sub> ≥ V <sub>CC</sub> - 0.2 V	0.1	0.2					mA
	V <sub>CC</sub> = 5.25 V, V <sub>IN</sub> ≤ 0.2 V, V <sub>IN</sub> ≥ V <sub>CC</sub> - 0.2 V				0.1	0.2		
ΔI <sub>CC</sub>	V <sub>CC</sub> = 5.5 V, V <sub>IN</sub> = 3.4 V <sup>§</sup> , f <sub>1</sub> = 0, Outputs open	0.2	2					mA
	V <sub>CC</sub> = 5.25 V, V <sub>IN</sub> = 3.4 V <sup>§</sup> , f <sub>1</sub> = 0, Outputs open				0.2	2		
I <sub>CCD</sub> ¶	V <sub>CC</sub> = 5.5 V, Load mode, Outputs open, One bit switching at 50% duty cycle, CEP = CET = PE = GND, SR = V <sub>CC</sub> , V <sub>IN</sub> ≤ 0.2 V or V <sub>IN</sub> ≥ V <sub>CC</sub> - 0.2 V	0.06	0.12					mA/ MHz
	V <sub>CC</sub> = 5.25 V, Load mode, Outputs open, One bit switching at 50% duty cycle, CEP = CET = PE = GND, SR = V <sub>CC</sub> , V <sub>IN</sub> ≤ 0.2 V or V <sub>IN</sub> ≥ V <sub>CC</sub> - 0.2 V				0.06	0.12		

† Typical values are at V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C.

‡ Not more than one output should be shorted at a time. Duration of short should not exceed one second. The use of high-speed test apparatus and/or sample-and-hold techniques are preferable to minimize internal chip heating and more accurately reflect operational values. Otherwise, prolonged shorting of a high output can raise the chip temperature well above normal and cause invalid readings in other parametric tests. In any sequence of parameter tests, I<sub>OS</sub> tests should be performed last.

§ Per TTL-driven input (V<sub>IN</sub> = 3.4 V); all other inputs at V<sub>CC</sub> or GND

¶ This parameter is derived for use in total power-supply calculations.



# CY54FCT163T, CY74FCT163T 4-BIT BINARY COUNTERS

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

PARAMETER	TEST CONDITIONS			CY54FCT163T		CY74FCT163T		UNIT
				MIN	TYP†	MAX	MIN	
I <sub>C</sub> #	V <sub>CC</sub> = 5.5 V, Load mode, f <sub>0</sub> = 10 MHz, Outputs open, CEP = CET = PE = GND, SR = V <sub>CC</sub>	One bit switching at f <sub>1</sub> = 5 MHz at 50% duty cycle	V <sub>IN</sub> ≤ 0.2 V or V <sub>IN</sub> ≥ V <sub>CC</sub> - 0.2 V	0.7	1.4			mA
			V <sub>IN</sub> = 3.4 V or GND	1.2	3.4			
	Four bits switching at f <sub>1</sub> = 5 MHz at 50% duty cycle	V <sub>IN</sub> ≤ 0.2 V or V <sub>IN</sub> ≥ V <sub>CC</sub> - 0.2 V	1.6	3.2				
		V <sub>IN</sub> = 3.4 V or GND	2.9	8.2				
	V <sub>CC</sub> = 5.25 V, f <sub>0</sub> = 10 MHz, Load mode, Outputs open, CEP = CET = PE = GND, SR = V <sub>CC</sub>	One bit switching at f <sub>1</sub> = 5 MHz at 50% duty cycle	V <sub>IN</sub> ≤ 0.2 V or V <sub>IN</sub> ≥ V <sub>CC</sub> - 0.2 V			0.7	1.4	
			V <sub>IN</sub> = 3.4 V or GND			1.2	3.4	
Four bits switching at f <sub>1</sub> = 5 MHz at 50% duty cycle	V <sub>IN</sub> ≤ 0.2 V or V <sub>IN</sub> ≥ V <sub>CC</sub> - 0.2 V			1.6	3.2			
	V <sub>IN</sub> = 3.4 V or GND			2.9	8.2			
C <sub>i</sub>				5	10	5	10	pF
C <sub>o</sub>				9	12	9	12	pF

† Typical values are at V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C.

# I<sub>C</sub> = I<sub>CC</sub> + ΔI<sub>CC</sub> × D<sub>H</sub> × N<sub>T</sub> + I<sub>CCD</sub> (f<sub>0</sub>/2 + f<sub>1</sub> × N<sub>1</sub>)

Where:

I<sub>C</sub> = Total supply current

I<sub>CC</sub> = Power-supply current with CMOS input levels

ΔI<sub>CC</sub> = Power-supply current for a TTL high input (V<sub>IN</sub> = 3.4 V)

D<sub>H</sub> = Duty cycle for TTL inputs high

N<sub>T</sub> = Number of TTL inputs at D<sub>H</sub>

I<sub>CCD</sub> = Dynamic current caused by an input transition pair (HLH or LHL)

f<sub>0</sub> = Clock frequency for registered devices, otherwise zero

f<sub>1</sub> = Input signal frequency

N<sub>1</sub> = Number of inputs changing at f<sub>1</sub>

All currents are in milliamperes and all frequencies are in megahertz.

|| Values for these conditions are examples of the I<sub>CC</sub> formula.

## timing requirements over recommended operating free-air temperature range (unless otherwise noted) (see Figure 1)

		CY54FCT163T		CY74FCT163CT		UNIT
		MIN	MAX	MIN	MAX	
t <sub>w</sub>	Pulse duration, high or low	Clock (load)		5	4	ns
		Clock (count)		8	5	
t <sub>su</sub>	Setup time, high or low	P before CP↑		5.5	3.5	ns
		PE or SR before CP↑		13.5	7.6	
		CEP or CET before CP↑		13	7.6	
t <sub>h</sub>	Hold time, high or low	P after CP↑		2	1.5	ns
		PE or SR after CP↑		1.5	1	
		CEP or CET after CP↑		0	0	



# CY54FCT163T, CY74FCT163T 4-BIT BINARY COUNTERS

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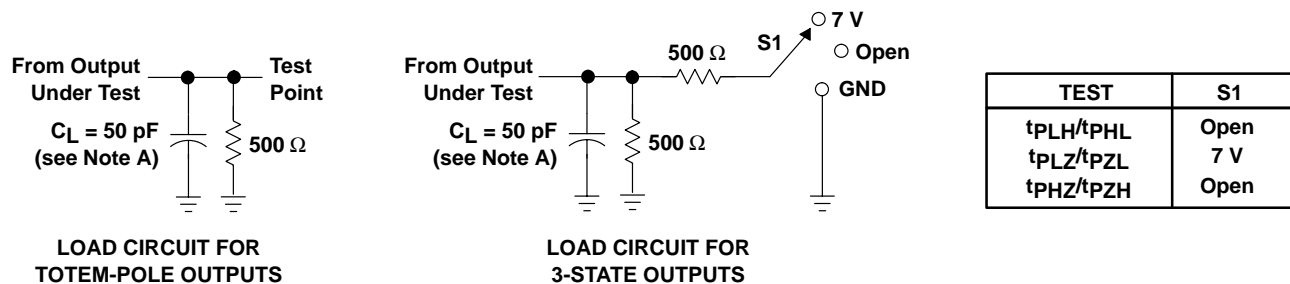
## switching characteristics over operating free-air temperature range (see Figure 1)

PARAMETER		FROM (INPUT)	TO (OUTPUT)	CY54FCT163T		CY74FCT163CT		UNIT
				MIN	MAX	MIN	MAX	
t <sub>PLH</sub>	Propagation delay ( $\overline{PE}$ high)	CP	Q	2	11.5	1.5	5.8	ns
t <sub>PHL</sub>				2	11.5	1.5	5.8	
t <sub>PLH</sub>	Propagation delay ( $\overline{PE}$ low)	CP	TC	2	10	1.5	5.2	ns
t <sub>PHL</sub>				2	10	1.5	5.2	
t <sub>PLH</sub>		CP	TC	2	16.5	1.5	7.8	ns
t <sub>PHL</sub>				2	16.5	1.5	7.8	
t <sub>PLH</sub>		CET	TC	1.5	9	1.5	4.4	ns
t <sub>PHL</sub>				1.5	9	1.5	4.4	

# CY54FCT163T, CY74FCT163T 4-BIT BINARY COUNTERS

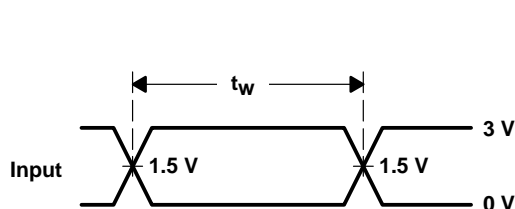
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## PARAMETER MEASUREMENT INFORMATION

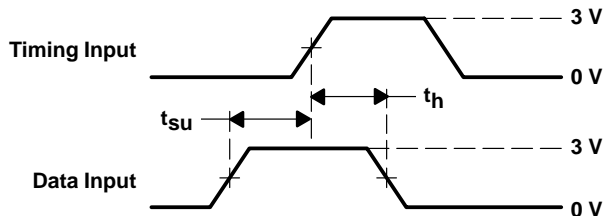


LOAD CIRCUIT FOR  
TOTEM-POLE OUTPUTS

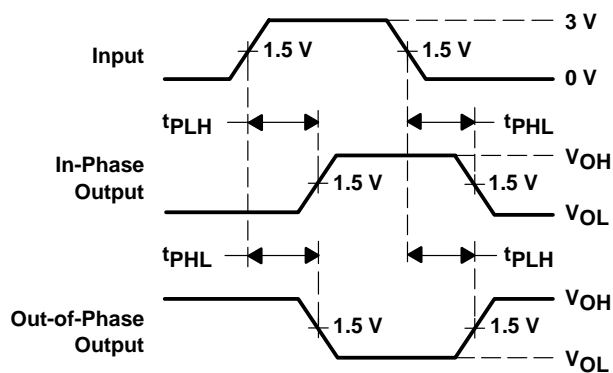
LOAD CIRCUIT FOR  
3-STATE OUTPUTS



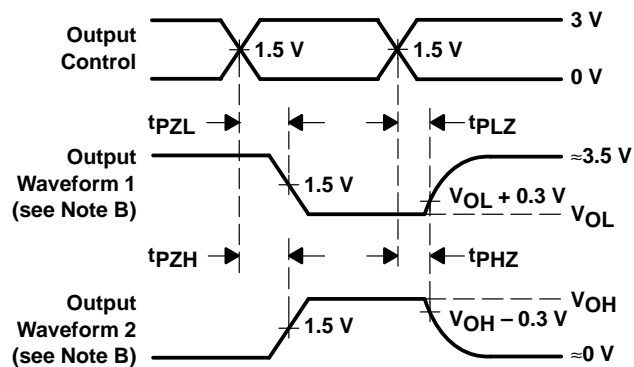
VOLTAGE WAVEFORMS  
PULSE DURATION



VOLTAGE WAVEFORMS  
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS  
PROPAGATION DELAY TIMES  
INVERTING AND NONINVERTING OUTPUTS



VOLTAGE WAVEFORMS  
ENABLE AND DISABLE TIMES  
LOW- AND HIGH-LEVEL ENABLING

- 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. The outputs are measured one at a time with one input transition per measurement.

Figure 1. Load Circuit and Voltage Waveforms



**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
CY54FCT163TLMB	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type
CY74FCT163CTQCT	ACTIVE	SSOP/ QSOP	DBQ	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
CY74FCT163CTQCTE4	ACTIVE	SSOP/ QSOP	DBQ	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
CY74FCT163CTQCTG4	ACTIVE	SSOP/ QSOP	DBQ	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
CY74FCT163CTSOC	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CY74FCT163CTSOCE4	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CY74FCT163CTSOEG4	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CY74FCT163CTSOCT	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CY74FCT163CTSOCTE4	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CY74FCT163CTSOCTG4	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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**TAPE AND REEL INFORMATION**



**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
CY74FCT163CTSOCT	SOIC	DW	16	2000	330.0	16.4	10.75	10.7	2.7	12.0	16.0	Q1

**TAPE AND REEL BOX DIMENSIONS**



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CY74FCT163CTSOCT	SOIC	DW	16	2000	346.0	346.0	33.0

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