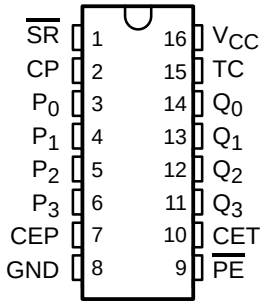
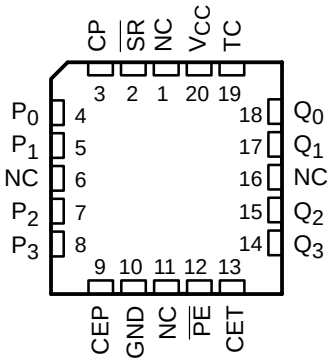
- **Function, Pinout, and Drive Compatible With FCT and F Logic**
- **Reduced $V_{OH}$ (Typically = 3.3 V) Versions of Equivalent FCT Functions**
- **Edge-Rate Control Circuitry for Significantly Improved Noise Characteristics**
- **$I_{off}$ Supports Partial-Power-Down Mode Operation**
- **ESD Protection 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 |

## ORDERING INFORMATION

| $T_A$ | 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 | |

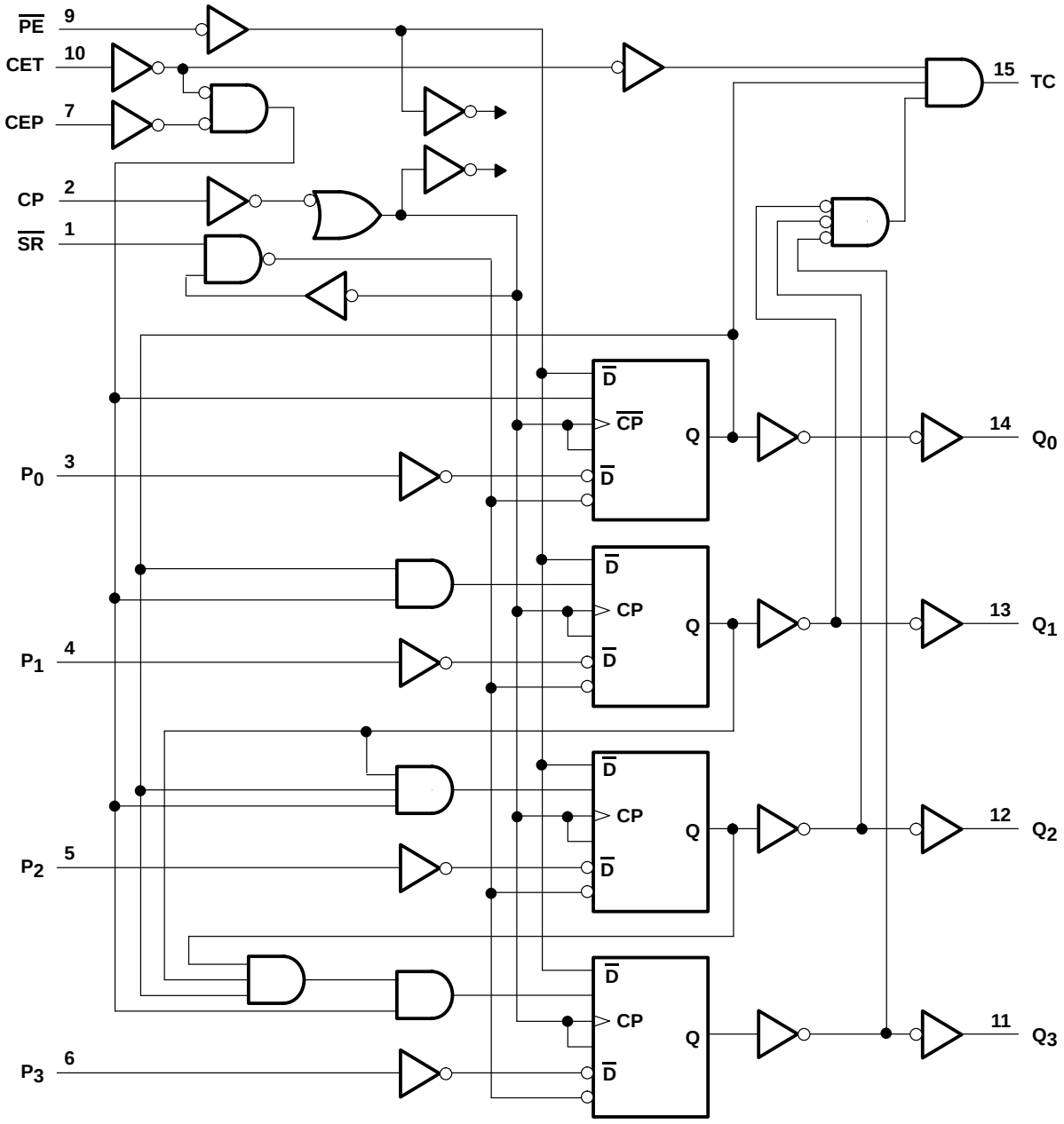
† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

**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)



### 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.

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

| PARAMETER | TEST CONDITIONS | | CY54FCT163T | | | CY74FCT163T | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | TYP† | MAX | MIN | TYP† | MAX | |
| $V_{IK}$ | $V_{CC}$ = 4.5 V, | $I_{IN}$ = –18 mA | | –0.7 | –1.2 | | | | V |
| | $V_{CC}$ = 4.75 V, | $I_{IN}$ = –18 mA | | | | | –0.7 | –1.2 | |
| $V_{OH}$ | $V_{CC}$ = 4.5 V, | $I_{OH}$ = –12 mA | 2.4 | 3.3 | | | | | V |
| | $V_{CC}$ = 4.75 V | $I_{OH}$ = –32 mA | | | | 2 | | | |
| | | $I_{OH}$ = –15 mA | | | | 2.4 | 3.3 | | |
| $V_{OL}$ | $V_{CC}$ = 4.5 V, | $I_{OL}$ = 32 mA | | 0.3 | 0.55 | | | | V |
| | $V_{CC}$ = 4.75 V, | $I_{OL}$ = 64 mA | | | | | 0.3 | 0.55 | |
| $V_{hys}$ | All inputs | | | 0.2 | | | 0.2 | | V |
| $I_I$ | $V_{CC}$ = 5.5 V, | $V_{IN}$ = $V_{CC}$ | | | 5 | | | | µA |
| | $V_{CC}$ = 5.25 V, | $V_{IN}$ = $V_{CC}$ | | | | | | 5 | |
| $I_{IH}$ | $V_{CC}$ = 5.5 V, | $V_{IN}$ = 2.7 V | | | ±1 | | | | µA |
| | $V_{CC}$ = 5.25 V, | $V_{IN}$ = 2.7 V | | | | | | ±1 | |
| $I_{IL}$ | $V_{CC}$ = 5.5 V, | $V_{IN}$ = 0.5 V | | | ±1 | | | | µA |
| | $V_{CC}$ = 5.25 V, | $V_{IN}$ = 0.5 V | | | | | | ±1 | |
| $I_{OS}$‡ | $V_{CC}$ = 5.5 V, | $V_{OUT}$ = 0 V | –60 | –120 | –225 | | | | mA |
| | $V_{CC}$ = 5.25 V, | $V_{OUT}$ = 0 V | | | | –60 | –120 | –225 | |
| $I_{off}$ | $V_{CC}$ = 0 V, | $V_{OUT}$ = 4.5 V | | | ±1 | | | ±1 | µA |
| $I_{CC}$ | $V_{CC}$ = 5.5 V, | $V_{IN} \le 0.2$ V, $V_{IN} \ge V_{CC} - 0.2$ V | | 0.1 | 0.2 | | | | mA |
| | $V_{CC}$ = 5.25 V, | $V_{IN} \le 0.2$ V, $V_{IN} \ge V_{CC} - 0.2$ V | | | | | 0.1 | 0.2 | |
| $\Delta I_{CC}$ | $V_{CC}$ = 5.5 V, $V_{IN}$ = 3.4 V§, $f_1$ = 0, Outputs open | | | 0.2 | 2 | | | | mA |
| | $V_{CC}$ = 5.25 V, $V_{IN}$ = 3.4 V§, $f_1$ = 0, Outputs open | | | | | | 0.2 | 2 | |
| $I_{CCD}$¶ | $V_{CC}$ = 5.5 V, Load mode, Outputs open, One bit switching at 50% duty cycle, CEP = CET = $\overline{PE}$ = GND, $\overline{SR}$ = $V_{CC}$, $V_{IN} \le 0.2$ V or $V_{IN} \ge V_{CC} - 0.2$ V | | | 0.06 | 0.12 | | | | mA/ MHz |
| | $V_{CC}$ = 5.25 V, Load mode, Outputs open, One bit switching at 50% duty cycle, CEP = CET = $\overline{PE}$ = GND, $\overline{SR}$ = $V_{CC}$, $V_{IN} \le 0.2$ V or $V_{IN} \ge V_{CC} - 0.2$ V | | | | | | 0.06 | 0.12 | |

† Typical values are at $V_{CC}$ = 5 V, $T_A$ = 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, $I_{OS}$ tests should be performed last.

§ Per TTL-driven input ($V_{IN}$ = 3.4 V); all other inputs at $V_{CC}$ or GND

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

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

| PARAMETER | TEST CONDITIONS | | | CY54FCT163T | | | CY74FCT163T | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP† | MAX | MIN | TYP† | MAX | |
| $I_C$# | $V_{CC}$ = 5.5 V, Load mode, $f_0$ = 10 MHz, Outputs open, $\overline{CEP}$ = CET = $\overline{PE}$ = GND, $\overline{SR}$ = $V_{CC}$ | One bit switching at $f_1$ = 5 MHz at 50% duty cycle | $V_{IN} \le 0.2$ V or $V_{IN} \ge V_{CC} - 0.2$ V | | 0.7 | 1.4 | | | | mA |
| | | | $V_{IN}$ = 3.4 V or GND | | 1.2 | 3.4 | | | | |
| | | Four bits switching at $f_1$ = 5 MHz at 50% duty cycle | $V_{IN} \le 0.2$ V or $V_{IN} \ge V_{CC} - 0.2$ V | | 1.6 | 3.2‖ | | | | |
| | | | $V_{IN}$ = 3.4 V or GND | | 2.9 | 8.2‖ | | | | |
| | $V_{CC}$ = 5.25 V, $f_0$ = 10 MHz, Load mode, Outputs open, $\overline{CEP}$ = CET = $\overline{PE}$ = GND, $\overline{SR}$ = $V_{CC}$ | One bit switching at $f_1$ = 5 MHz at 50% duty cycle | $V_{IN} \le 0.2$ V or $V_{IN} \ge V_{CC} - 0.2$ V | | | | | 0.7 | 1.4 | |
| | | | $V_{IN}$ = 3.4 V or GND | | | | | 1.2 | 3.4 | |
| | | Four bits switching at $f_1$ = 5 MHz at 50% duty cycle | $V_{IN} \le 0.2$ V or $V_{IN} \ge V_{CC} - 0.2$ V | | | | | 1.6 | 3.2‖ | |
| | | | $V_{IN}$ = 3.4 V or GND | | | | | 2.9 | 8.2‖ | |
| $C_i$ | | | | | 5 | 10 | | 5 | 10 | pF |
| $C_o$ | | | | | 9 | 12 | | 9 | 12 | pF |

† Typical values are at $V_{CC}$ = 5 V, $T_A$ = 25°C.

# $I_C = I_{CC} + \Delta I_{CC} \times D_H \times N_T + I_{CCD} (f_0/2 + f_1 \times N_1)$

Where:

$I_C$ = Total supply current
$I_{CC}$ = Power-supply current with CMOS input levels
$\Delta I_{CC}$ = Power-supply current for a TTL high input ($V_{IN}$ = 3.4 V)
$D_H$ = Duty cycle for TTL inputs high
$N_T$ = Number of TTL inputs at $D_H$
$I_{CCD}$ = Dynamic current caused by an input transition pair (HLH or LHL)
$f_0$ = Clock frequency for registered devices, otherwise zero
$f_1$ = Input signal frequency
$N_1$ = Number of inputs changing at $f_1$

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

‖ Values for these conditions are examples of the $I_{CC}$ formula.

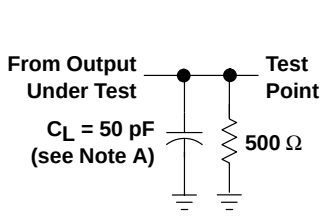
## timing requirements over recommended operating free-air temperature range (unless otherwise noted) (see Figure 1)

| | | | CY54FCT163T | | CY74FCT163CT | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | MIN | MAX | MIN | MAX | |
| $t_w$ | Pulse duration, high or low | Clock (load) | 5 | | 4 | | ns |
| | | Clock (count) | 8 | | 5 | | |
| $t_{su}$ | Setup time, high or low | P before CP↑ | 5.5 | | 3.5 | | ns |
| | | $\overline{PE}$ or $\overline{SR}$ before CP↑ | 13.5 | | 7.6 | | |
| | | CEP or CET before CP↑ | 13 | | 7.6 | | |
| $t_h$ | Hold time, high or low | P after CP↑ | 2 | | 1.5 | | ns |
| | | $\overline{PE}$ or $\overline{SR}$ after CP↑ | 1.5 | | 1 | | |
| | | CEP or CET after CP↑ | 0 | | 0 | | |

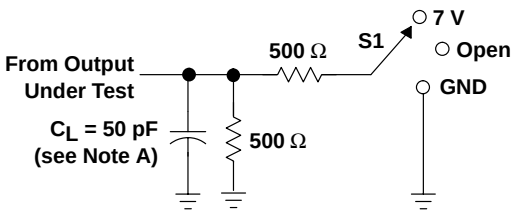
## switching characteristics over operating free-air temperature range (see Figure 1)

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

## PARAMETER MEASUREMENT INFORMATION

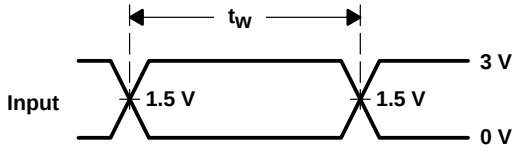



LOAD CIRCUIT FOR
TOTEM-POLE OUTPUTS

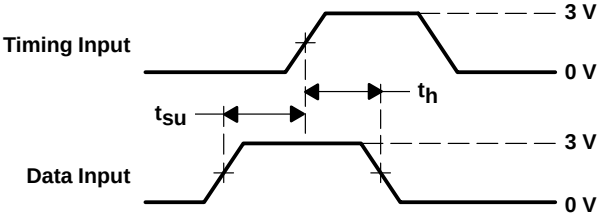



LOAD CIRCUIT FOR
3-STATE OUTPUTS

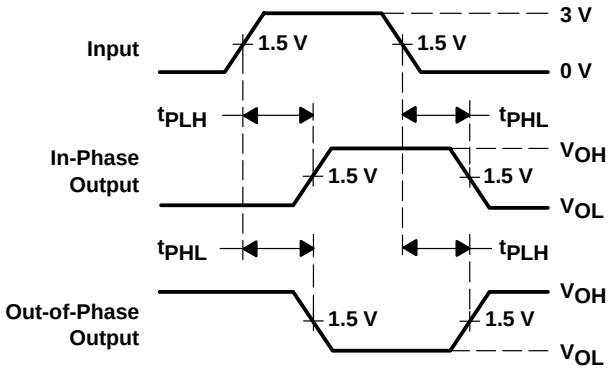
| TEST | S1 |
|---|---|
| $t_{PLH}/t_{PHL}$ | Open |
| $t_{PLZ}/t_{PZL}$ | 7 V |
| $t_{PHZ}/t_{PZH}$ | Open |



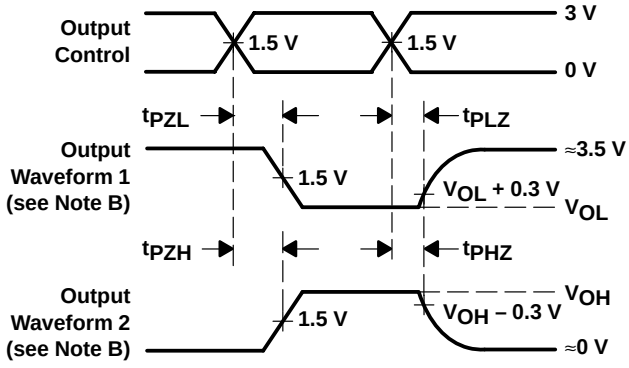

VOLTAGE WAVEFORMS
PULSE DURATION




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**

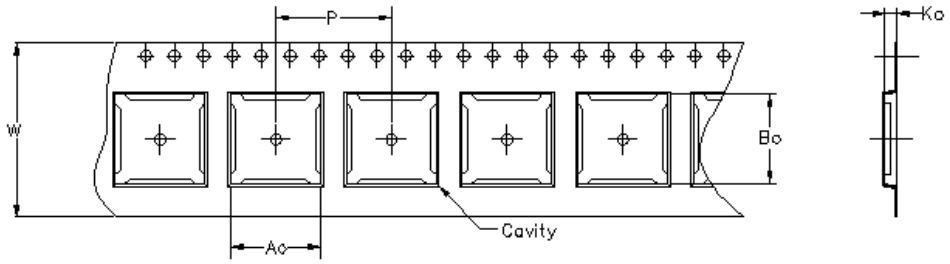
## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) |
|---|---|---|---|---|---|---|---|---|
| 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 |
| CY74FCT163CTSOCG4 | 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 |

(1) 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.

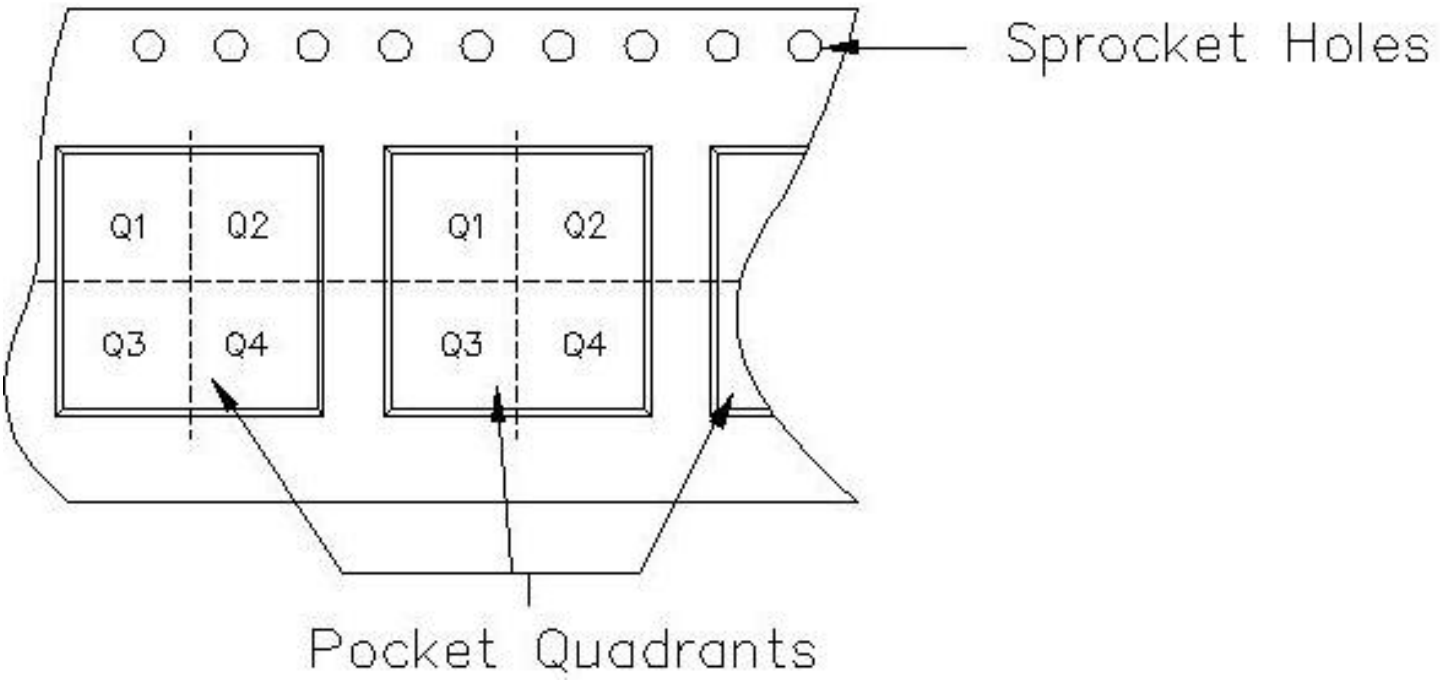
(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
**TBD:** The Pb-Free/Green conversion plan has not 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)

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



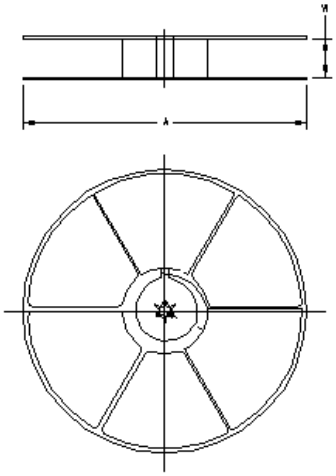

Carrier tape design is defined largely by the component lentgh, width, and thickness.

| |
|---|
| Ao = Dimension designed to accommodate the component width. |
| Bo = Dimension designed to accommodate the component length. |
| Ko = Dimension designed to accommodate the component thickness. |
| W = Overall width of the carrier tape. |
| P = Pitch between successive cavity centers. |



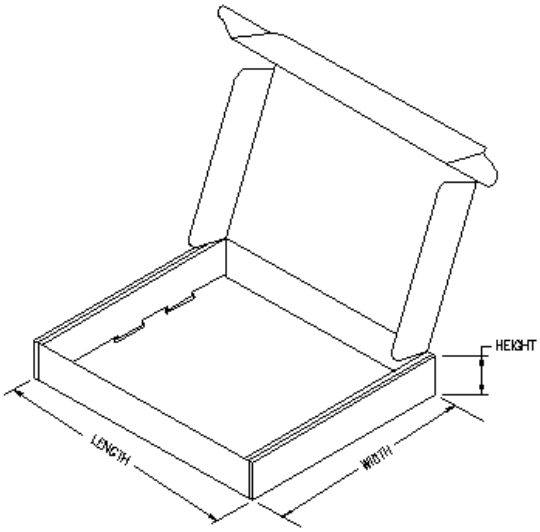

**TAPE AND REEL INFORMATION**

| Device | Package | Pins | Site | Reel Diameter (mm) | Reel Width (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CY74FCT163CTQCT | DBQ | 16 | FMX | 330 | 0 | 6.4 | 5.2 | 2.1 | 8 | 12 | Q1 |
| CY74FCT163CTSOCT | DW | 16 | TAI | 330 | 16 | 10.75 | 10.7 | 2.7 | 12 | 16 | Q1 |



## TAPE AND REEL BOX INFORMATION

| Device | Package | Pins | Site | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|
| CY74FCT163CTQCT | DBQ | 16 | FMX | 338.1 | 340.5 | 20.64 |
| CY74FCT163CTSOCT | DW | 16 | TAI | 346.0 | 346.0 | 33.0 |



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