T-46-07-11

National Semiconductor

# 74FCT564A
# Octal D Flip-Flop with TRI-STATE® Outputs

## General Description

The 'FCT564A is a high-speed, low power octal flip-flop with a buffered common Clock (CP) and a buffered common Output Enable ($\overline{OE}$). The information presented to the D inputs is stored in the flip-flops on the LOW-to-HIGH Clock (CP) transition.

The 'FCT564A device is functionally identical to the 'FCT574A, but with inverted outputs.

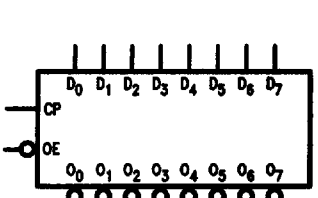
FACT™ FCTA features undershoot correction and split ground bus for superior performance.

## Features

- $I_{CC}$ and $I_{OZ}$ reduced to 40.0 μA and ±2.5 μA respectively
- TRI-STATE outputs for bus-oriented applications
- Useful as input or output port for microprocessors
- Input clamp diodes to limit bus reflections
- TTL/CMOS input and output level compatible
- $I_{OL}$ = 48 mA
- CMOS power levels
- 4 kV minimum ESD immunity

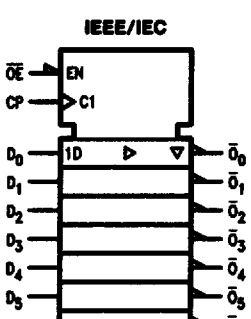
## Ordering Code: See Section 8

## Logic Symbols




TL/F/10640–1

IEEE/IEC

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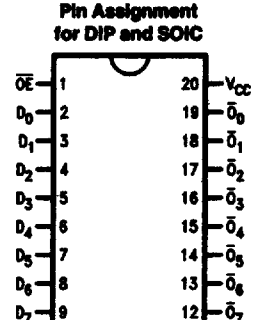
## Connection Diagram

Pin Assignment for DIP and SOIC




TL/F/10640–3

| Pin Names | Description |
|---|---|
| $D_0$–$D_7$ | Data Inputs |
| CP | Clock Pulse Input |
| $\overline{OE}$ | TRI-STATE Output Enable Input |
| $\overline{O}_0$–$\overline{O}_7$ | TRI-STATE Outputs |

## Absolute Maximum Ratings (Note 1)

**If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.**

Terminal Voltage with respect to GND ($V_{TERM}$)
74FCTA −0.5 to 7.0V

Temperature Under Bias ($T_{BIAS}$)
74FCTA −55°C to +125°C

Storage Temperature ($T_{STG}$)
74FCTA −55°C to +125°C

DC Output Current ($I_{OUT}$) 120 mA

**Note 1:** Absolute maximum ratings are those values beyond which damage to the device may occur. The databook specifications should be met, without exception, to ensure that the system design is reliable over its power supply, temperature, and output/input loading variables. National does not recommend operation of FACT™ FCT circuits outside databook specifications.

## Recommended Operating Conditions

Supply Voltage ($V_{CC}$)
74FCTA 4.75V to 5.25V

Input Voltage 0V to $V_{CC}$

Output Voltage 0V to $V_{CC}$

Operating Temperature ($T_A$)
74FCTA 0°C to +70°C

Junction Temperature ($T_J$)
PDIP 140°C

**Note:** All commercial packaging is not recommended for applications requiring greater than 2000 temperature cycles from −40°C to +125°C.

## DC Characteristics for 'FCTA Family Devices

Typical values are at $V_{CC}$ 5.0V, 25°C ambient and maximum loading. For test conditions shown as Max, use the value specified for the appropriate device type: Com: $V_{CC}$ 5.0V ±5%, $T_A$ = 0°C to +70°; $V_{HC} = V_{CC} - 0.2V$.

| Symbol | Parameter | 74FCTA Min | 74FCTA Typ | 74FCTA Max | Units | Conditions | |
|---|---|---|---|---|---|---|---|
| $V_{IH}$ | Minimum High Level Input Voltage | 2.0 | | | V | | |
| $V_{IL}$ | Maximum Low Level Input Voltage | | | 0.8 | V | | |
| $I_{IH}$ | Input High Current | | | 5.0<br>5.0 | μA | $V_{CC}$ = Max | $V_I = V_{CC}$<br>$V_I$ = 2.7V (Note 2) |
| $I_{IL}$ | Input Low Current | | | −5.0<br>−5.0 | μA | $V_{CC}$ = Max | $V_I$ = 0.5V (Note 2)<br>$V_I$ = GND |
| $I_{OZ}$ | Maximum TRI-STATE Current | | | 2.5<br>2.5<br>−2.5<br>−2.5 | μA | $V_{CC}$ = Max | $V_O = V_{CC}$<br>$V_O$ = 2.7V (Note 2)<br>$V_O$ = 0.5V (Note 2)<br>$V_O$ = GND |
| $V_{IK}$ | Clamp Diode Voltage | | −0.7 | −1.2 | V | $V_{CC}$ = Min; $I_N$ = −18 mA | |
| $I_{OS}$ | Short Circuit Current | −60 | −120 | | mA | $V_{CC}$ = Max (Note 1); $V_O$ = GND | |
| $V_{OH}$ | Minimum High Level Output Voltage | 2.8 | 3.0 | | V | $V_{CC}$ = 3V; $V_{IN}$ = 0.2V or $V_{HC}$; $I_{OH}$ = −32 μA | |
| | | $V_{HC}$<br>2.4 | $V_{CC}$<br>4.3 | | | $V_{CC}$ = Min<br>$V_{IN} = V_{IH}$ or $V_{IL}$ | $I_{OH}$ = −300 μA<br>$I_{OH}$ = −15 mA |
| $V_{OL}$ | Maximum Low Level Output Voltage | | GND | 0.2 | V | $V_{CC}$ = 3V; $V_{IN}$ = 0.2V or $V_{HC}$; $I_{OL}$ = 300 μA | |
| | | | GND<br>0.3 | 0.2<br>0.50 | | $V_{CC}$ = Min<br>$V_{IN} = V_{IH}$ or $V_{IL}$ | $I_{OH}$ = 300 μA<br>$I_{OL}$ = 48 mA |

## DC Characteristics for 'FCTA Family Devices

Typical values are at $V_{CC}$ = 5.0V, 25°C ambient and maximum loading. For test conditions shown as Max, use the value specified for the appropriate device type: Com: $V_{CC}$ = 5.0V ±5%, $T_A$ = 0°C to +70°C; $V_{HC}$ = $V_{CC}$ − 0.2V.

| Symbol | Parameter | 74FCTA Min | 74FCTA Typ | 74FCTA Max | Units | Conditions | |
|---|---|---|---|---|---|---|---|
| $I_{CC}$ | Maximum Quiescent Supply Current | | 1.0 | 40.0 | µA | $V_{CC}$ = Max<br>$V_{IN} \geq V_{HC}$, $V_{IN} \leq 0.2V$<br>$f_i$ = 0 | |
| $\Delta I_{CC}$ | Quiescent Supply Current; TTL Inputs HIGH | | 0.5 | 2.0 | mA | $V_{CC}$ = Max<br>$V_{IN}$ = 3.4V (Note 3) | |
| $I_{CCD}$ | Dynamic Power Supply Current (Note 4) | | 0.25 | 0.40 | mA/MHz | $V_{CC}$ = Max<br>Outputs Open<br>$\overline{OE}$ = GND<br>One Input Toggling<br>50% Duty Cycle | $V_{IN} \geq V_{HC}$<br>$V_{IN} \leq 0.2V$ |
| $I_C$ | Total Power Supply Current (Note 6) | | 1.5 | 4.0 | mA | $V_{CC}$ = Max<br>Outputs Open<br>$\overline{OE}$ = GND<br>$f_{CP}$ = 10 MHZ<br>50% Duty Cycle<br>$f_i$ = 5 MHz<br>One Bit Toggling<br>50% Duty Cycle | $V_{IN} \geq V_{HC}$<br>$V_{IN} \leq 0.2V$ |
| | | | 1.8 | 6.0 | | | $V_{IN}$ = 3.4V<br>$V_{IN}$ = GND |
| | | | 3.0 | 7.8 | | (Note 5)<br>$V_{CC}$ = Max<br>Outputs Open<br>$\overline{OE}$ = GND<br>$f_{CP}$ = 10 MHz<br>50% Duty Cycle<br>$f_i$ = 2.5 MHz<br>Eight Bits Toggling<br>50% Duty Cycle | $V_{IN} \geq V_{HC}$<br>$V_{IN} \leq 0.2V$ |
| | | | 5.0 | 16.8 | | | $V_{IN}$ = 3.4V<br>$V_{IN}$ = GND |
| $V_H$ | Input Hysteresis on Clock Only | | 200 | | mV | | |

**Note 1:** Maximum test duration not to exceed one second, not more than one output shorted at one time.

**Note 2:** This parameter guaranteed but not tested.

**Note 3:** Per TTL driven input ($V_{IN}$ = 3.4V); all other inputs at $V_{CC}$ or GND.

**Note 4:** This parameter is not directly testable, but is derived for use in Total Power Supply calculations.

**Note 5:** Values for these conditions are examples of the $I_{CC}$ formula. These limits are guaranteed but not tested.

**Note 6:** $I_C = I_{QUIESCENT} + I_{INPUTS} + I_{DYNAMIC}$

$I_C = I_{CC} + \Delta I_{CC} D_H N_T + I_{CCD} (f_{CP}/2 + f_i N_i)$

$I_{CC}$ = Quiescent Current

$\Delta I_{CC}$ = Power Supply Current for a TTL High Input ($V_{IN}$ = 3.4V)

$D_H$ = Duty Cycle for TTL Inputs High

$N_T$ = Number of Inputs at $D_H$

$I_{CCD}$ = Dynamic Current Caused by an Input Transition Pair (HLH or LHL)

$f_{CP}$ = Clock Frequency for Register Devices (Zero for Non-Register Devices)

$f_i$ = Input Frequency

$N_i$ = Number of Inputs at $f_i$

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

## AC Electrical Characteristics: See Section 2 for Waveforms

| Symbol | Parameter | 74FCTA $T_A = +25°C$, $V_{CC} = 5.0V$ | 74FCTA $T_A, V_{CC} = Com$, $R_L = 500\Omega$, $C_L = 50\ pF$ | | | Units | Fig. No. |
|---|---|---|---|---|---|---|---|
| | | Typ | Min | (Note) | Max | | |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay CP to $\overline{O}_n$ | 4.5 | 2.0 | | 6.5 | ns | 2-8 |
| $t_{PZH}$ $t_{PZL}$ | Output Enable Time | 5.5 | 1.5 | | 6.5 | ns | 2-11 |
| $t_{PHZ}$ $t_{PLZ}$ | Output Disable Time | 4.0 | 1.5 | | 5.5 | ns | 2-11 |
| $t_S$ | Set-Up Time High or Low $D_n$ to CP | 1.0 | 2.0 | | | ns | 2-10 |
| $t_H$ | HOLD Time High or Low $D_n$ to CP | 1.0 | 1.5 | | | ns | 2-10 |
| $t_W$ | CP Pulse Width High or Low | 4.0 | 5.0 | | | ns | 2-9 |

**Note:** Minimum limits are guaranteed but not tested on propagation delays.

## Capacitance ($T_A = +25°C$, f = 1.0 MHz)

| Symbol | Parameter | Typ | Max | Units | Conditions |
|---|---|---|---|---|---|
| $C_{IN}$ | Input Capacitance | 6 | 10 | pF | $V_{IN} = 0V$ |
| $C_{OUT}$ | Output Capacitance | 8 | 12 | pF | $V_{OUT} = 0V$ |

**Note:** This parameter is measured at characterization but not tested.