

## 74AC163 • 74ACT163

### Synchronous Presettable Binary Counter

#### General Description

The AC/ACT163 are high-speed synchronous modulo-16 binary counters. They are synchronously presettable for application in programmable dividers and have two types of Count Enable inputs plus a Terminal Count output for versatility in forming synchronous multistage counters. The AC/ACT163 has a Synchronous Reset input that overrides counting and parallel loading and allows the outputs to be simultaneously reset on the rising edge of the clock.

#### Features

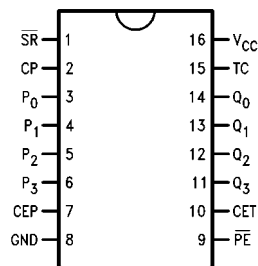
- $I_{CC}$  reduced by 50%
- Synchronous counting and loading
- High-speed synchronous expansion
- Typical count rate of 125 MHz
- Outputs source/sink 24 mA
- ACT163 has TTL-compatible inputs

#### Ordering Code:

| Order Number | Package Number | Package Description                                                               |
|--------------|----------------|-----------------------------------------------------------------------------------|
| 74AC163SC    | M16A           | 16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow Body |
| 74AC163SJ    | M16D           | 16-Lead Small Outline Package, (SOP), EIAJ TYPE II, 5.3mm Wide                    |
| 74AC163MTC   | MTC16          | 16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide       |
| 74AC163PC    | N16E           | 16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide            |
| 74ACT163SC   | M16A           | 16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow Body |
| 74ACT163SJ   | M16D           | 16-Lead Small Outline Package, (SOP), EIAJ TYPE II, 5.3mm Wide                    |
| 74ACT163MTC  | MTC16          | 16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide       |
| 74ACT163PC   | N16E           | 16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide            |

Device also available in Tape and Reel. Specify by appending suffix letter "X" to the ordering code.

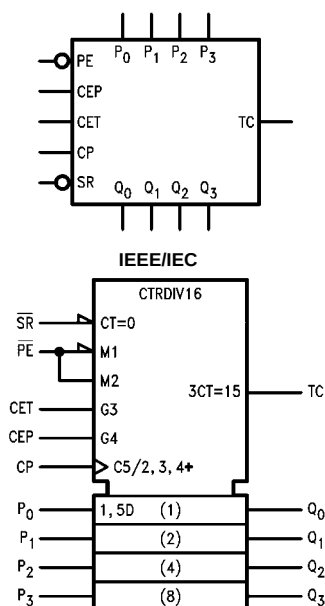
#### Connection Diagram



#### Pin Descriptions

| Pin Names       | Description                 |
|-----------------|-----------------------------|
| CEP             | Count Enable Parallel Input |
| CET             | Count Enable Trickle Input  |
| CP              | Clock Pulse Input           |
| $\overline{SR}$ | Synchronous Reset Input     |
| $P_0$ – $P_3$   | Parallel Data Inputs        |
| $\overline{PE}$ | Parallel Enable Input       |
| $Q_0$ – $Q_3$   | Flip-Flop Outputs           |
| TC              | Terminal Count Output       |

## Logic Symbols



## Mode Select Table

| $\overline{SR}$ | $\overline{PE}$ | CET | CEP | Action on the Rising Clock Edge ( $\nearrow$ ) |
|-----------------|-----------------|-----|-----|------------------------------------------------|
| L               | X               | X   | X   | Reset (Clear)                                  |
| H               | L               | X   | X   | Load ( $P_n \rightarrow Q_n$ )                 |
| H               | H               | H   | H   | Count (Increment)                              |
| H               | H               | L   | X   | No Change (Hold)                               |
| H               | H               | X   | L   | No Change (Hold)                               |

H = HIGH Voltage Level  
L = LOW Voltage Level  
X = Immaterial

## Functional Description

The AC/ACT163 counts in modulo-16 binary sequence. From state 15 (HHHH) it increments to state 0 (LLLL). The clock inputs of all flip-flops are driven in parallel through a clock buffer. Thus all changes of the Q outputs occur as a result of, and synchronous with, the LOW-to-HIGH transition of the CP input signal. The circuits have four fundamental modes of operation, in order of precedence: synchronous reset, parallel load, count-up and hold. Four control inputs—Synchronous Reset ( $\overline{SR}$ ), Parallel Enable ( $\overline{PE}$ ), Count Enable Parallel (CEP) and Count Enable Trickle (CET)—determine the mode of operation, as shown in the Mode Select Table. A LOW signal on  $\overline{SR}$  overrides counting and parallel loading and allows all outputs to go LOW on the next rising edge of CP. A LOW signal on  $\overline{PE}$  overrides counting and allows information on the Parallel Data ( $P_n$ ) inputs to be loaded into the flip-flops on the next rising edge of CP. With  $\overline{PE}$  and  $\overline{SR}$  HIGH, CEP and CET permit counting when both are HIGH. Conversely, a LOW signal on either CEP or CET inhibits counting.

The AC/ACT163 uses D-type edge-triggered flip-flops and changing the  $\overline{SR}$ ,  $\overline{PE}$ , CEP and CET inputs when the CP is in either state does not cause errors, provided that the recommended setup and hold times, with respect to the rising edge of CP, are observed.

The Terminal Count (TC) output is HIGH when CET is HIGH and counter is in state 15. To implement synchronous multistage counters, the TC outputs can be used with the CEP and CET inputs in two different ways.

Figure 1 shows the connections for simple ripple carry, in which the clock period must be longer than the CP to  $\overline{TC}$  delay of the first stage, plus the cumulative  $\overline{CET}$  to  $\overline{TC}$  delays of the intermediate stages, plus the  $\overline{CET}$  to CP setup time of the last stage. This total delay plus setup time sets the upper limit on clock frequency. For faster clock rates, the carry lookahead connections shown in Figure 2 are recommended. In this scheme the ripple delay through the intermediate stages commences with the same clock that causes the first stage to tick over from max to min in the Up mode, or min to max in the Down mode, to start its final cycle. Since this final cycle takes 16 clocks to complete, there is plenty of time for the ripple to progress through the intermediate stages. The critical timing that limits the clock period is the CP to  $\overline{TC}$  delay of the first stage plus the  $\overline{CEP}$  to CP setup time of the last stage. The TC output is subject to decoding spikes due to internal race conditions and is therefore not recommended for use as a clock or asynchronous reset for flip-flops, registers or counters.

Logic Equations: Count Enable =  $CEP \cdot CET \cdot \overline{PE}$

$$TC = Q_0 \cdot Q_1 \cdot Q_2 \cdot Q_3 \cdot CET$$

## State Diagram

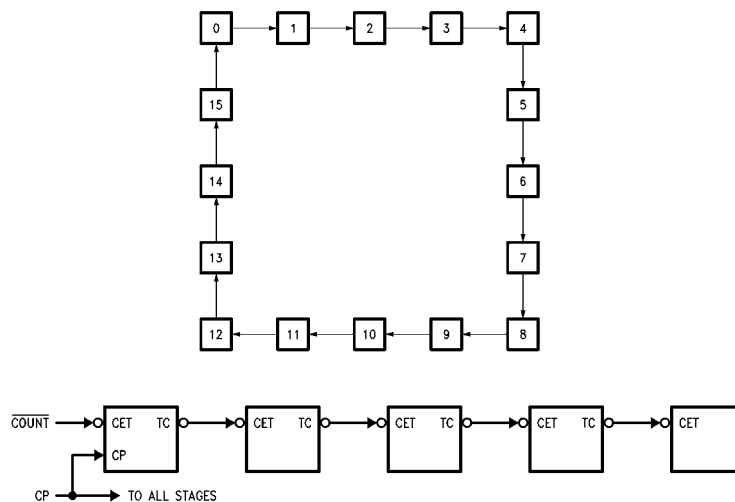


FIGURE 1.

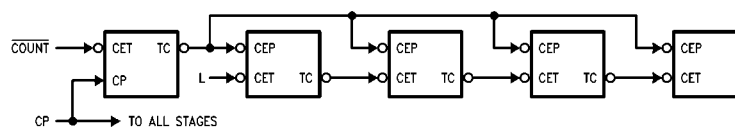
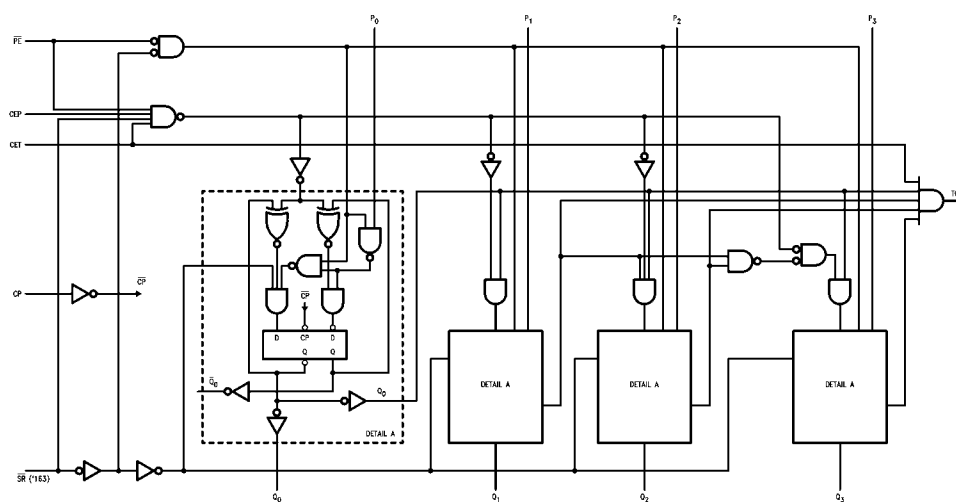


FIGURE 2.

## Block Diagram



Please note that this diagram is provided only for the understanding of logic operations and should not be used to estimate propagation delays.

**Absolute Maximum Ratings** (Note 1)

|                                          |                          |
|------------------------------------------|--------------------------|
| Supply Voltage ( $V_{CC}$ )              | -0.5V to +7.0V           |
| DC Input Diode Current ( $I_{IK}$ )      |                          |
| $V_I = -0.5V$                            | -20 mA                   |
| $V_I = V_{CC} + 0.5V$                    | +20 mA                   |
| DC Input Voltage ( $V_I$ )               | -0.5V to $V_{CC} + 0.5V$ |
| DC Output Diode Current ( $I_{OK}$ )     |                          |
| $V_O = -0.5V$                            | -20 mA                   |
| $V_O = V_{CC} + 0.5V$                    | +20 mA                   |
| DC Output Voltage ( $V_O$ )              | -0.5V to $V_{CC} + 0.5V$ |
| DC Output Source                         |                          |
| or Sink Current ( $I_O$ )                | $\pm 50$ mA              |
| DC $V_{CC}$ or Ground Current            |                          |
| per Output Pin ( $I_{CC}$ or $I_{GND}$ ) | $\pm 50$ mA              |
| Storage Temperature ( $T_{STG}$ )        | -65°C to +150°C          |
| Junction Temperature ( $T_J$ )           |                          |
| PDIP                                     | 140°C                    |

**Recommended Operating Conditions**

|                                                 |                |
|-------------------------------------------------|----------------|
| Supply Voltage ( $V_{CC}$ )                     |                |
| AC                                              | 2.0V to 6.0V   |
| ACT                                             | 4.5V to 5.5V   |
| Input Voltage ( $V_I$ )                         | 0V to $V_{CC}$ |
| Output Voltage ( $V_O$ )                        | 0V to $V_{CC}$ |
| Operating Temperature ( $T_A$ )                 | -40°C to +85°C |
| Minimum Input Edge Rate ( $\Delta V/\Delta t$ ) |                |
| AC Devices                                      |                |
| $V_{IN}$ from 30% to 70% of $V_{CC}$            |                |
| $V_{CC}$ @ 3.3V, 4.5V, 5.5V                     | 125 mV/ns      |
| Minimum Input Edge Rate ( $\Delta V/\Delta t$ ) |                |
| ACT Devices                                     |                |
| $V_{IN}$ from 0.8V to 2.0V                      |                |
| $V_{CC}$ @ 4.5V, 5.5V                           | 125 mV/ns      |

**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. Fairchild does not recommend operation of circuits outside databook specifications.

**DC Electrical Characteristics for AC**

| Symbol                   | Parameter                         | V <sub>CC</sub> | T <sub>A</sub> = +25°C |                   | T <sub>A</sub> = -40°C to +85°C | Units | Conditions                                                                                                                                        |
|--------------------------|-----------------------------------|-----------------|------------------------|-------------------|---------------------------------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------|
|                          |                                   | (V)             | Typ                    | Guaranteed Limits |                                 |       |                                                                                                                                                   |
| V <sub>IH</sub>          | Minimum HIGH Level Input Voltage  | 3.0             | 1.5                    | 2.1               | 2.1                             | V     | V <sub>OUT</sub> = 0.1V<br>or V <sub>CC</sub> - 0.1V                                                                                              |
|                          |                                   | 4.5             | 2.25                   | 3.15              | 3.15                            |       |                                                                                                                                                   |
|                          |                                   | 5.5             | 2.75                   | 3.85              | 3.85                            |       |                                                                                                                                                   |
| V <sub>IL</sub>          | Maximum LOW Level Input Voltage   | 3.0             | 1.5                    | 0.9               | 0.9                             | V     | V <sub>OUT</sub> = 0.1V<br>or V <sub>CC</sub> - 0.1V                                                                                              |
|                          |                                   | 4.5             | 2.25                   | 1.35              | 1.35                            |       |                                                                                                                                                   |
|                          |                                   | 5.5             | 2.75                   | 1.65              | 1.65                            |       |                                                                                                                                                   |
| V <sub>OH</sub>          | Minimum HIGH Level Output Voltage | 3.0             | 2.99                   | 2.9               | 2.9                             | V     | I <sub>OUT</sub> = -50 μA                                                                                                                         |
|                          |                                   | 4.5             | 4.49                   | 4.4               | 4.4                             |       |                                                                                                                                                   |
|                          |                                   | 5.5             | 5.49                   | 5.4               | 5.4                             |       |                                                                                                                                                   |
|                          |                                   | 3.0             |                        | 2.56              | 2.46                            | V     | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br>I <sub>OH</sub> = -12 mA<br>I <sub>OH</sub> = -24 mA<br>I <sub>OH</sub> = -24 mA (Note 2) |
|                          |                                   | 4.5             |                        | 3.86              | 3.76                            |       |                                                                                                                                                   |
|                          |                                   | 5.5             |                        | 4.86              | 4.76                            |       |                                                                                                                                                   |
|                          |                                   |                 |                        |                   |                                 |       |                                                                                                                                                   |
| V <sub>OL</sub>          | Maximum LOW Level Output Voltage  | 3.0             | 0.002                  | 0.1               | 0.1                             | V     | I <sub>OUT</sub> = 50 μA                                                                                                                          |
|                          |                                   | 4.5             | 0.001                  | 0.1               | 0.1                             |       |                                                                                                                                                   |
|                          |                                   | 5.5             | 0.001                  | 0.1               | 0.1                             |       |                                                                                                                                                   |
|                          |                                   | 3.0             |                        | 0.36              | 0.44                            | V     | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br>I <sub>OL</sub> = 12 mA<br>I <sub>OL</sub> = 24 mA<br>I <sub>OL</sub> = 24 mA (Note 2)    |
|                          |                                   | 4.5             |                        | 0.36              | 0.44                            |       |                                                                                                                                                   |
|                          |                                   | 5.5             |                        | 0.36              | 0.44                            |       |                                                                                                                                                   |
|                          |                                   |                 |                        |                   |                                 |       |                                                                                                                                                   |
| I <sub>IN</sub> (Note 4) | Maximum Input Leakage Current     | 5.5             |                        | ± 0.1             | ± 1.0                           | μA    | V <sub>I</sub> = V <sub>CC</sub> , GND                                                                                                            |
| I <sub>OLD</sub>         | Minimum Dynamic                   | 5.5             |                        |                   | 75                              | mA    | V <sub>OLD</sub> = 1.65V Max                                                                                                                      |
| I <sub>OHD</sub>         | Output Current (Note 3)           | 5.5             |                        |                   | -75                             | mA    | V <sub>OHD</sub> = 3.85V Min                                                                                                                      |
| I <sub>CC</sub> (Note 4) | Maximum Quiescent Supply Current  | 5.5             |                        | 4.0               | 40.0                            | μA    | V <sub>IN</sub> = V <sub>CC</sub><br>or GND                                                                                                       |

**Note 2:** All outputs loaded; thresholds on input associated with output under test.

**Note 3:** Maximum test duration 2.0 ms, one output loaded at a time.

**Note 4:**  $I_{IN}$  and  $I_{CC}$  @ 3.0V are guaranteed to be less than or equal to the respective limit @ 5.5V  $V_{CC}$ .

## DC Electrical Characteristics for ACT

| Symbol           | Parameter                            | V <sub>CC</sub><br>(V) | T <sub>A</sub> = +25°C |                   | T <sub>A</sub> = -40°C to +85°C | Units | Conditions                                                                                                            |
|------------------|--------------------------------------|------------------------|------------------------|-------------------|---------------------------------|-------|-----------------------------------------------------------------------------------------------------------------------|
|                  |                                      |                        | Typ                    | Guaranteed Limits |                                 |       |                                                                                                                       |
| V <sub>IH</sub>  | Minimum HIGH Level<br>Input Voltage  | 4.5                    | 1.5                    | 2.0               | 2.0                             | V     | V <sub>OUT</sub> = 0.1V<br>or V <sub>CC</sub> - 0.1V                                                                  |
|                  |                                      | 5.5                    | 1.5                    | 2.0               | 2.0                             |       |                                                                                                                       |
| V <sub>IL</sub>  | Maximum LOW Level<br>Input Voltage   | 4.5                    | 1.5                    | 0.8               | 0.8                             | V     | V <sub>OUT</sub> = 0.1V<br>or V <sub>CC</sub> - 0.1V                                                                  |
|                  |                                      | 5.5                    | 1.5                    | 0.8               | 0.8                             |       |                                                                                                                       |
| V <sub>OH</sub>  | Minimum HIGH Level<br>Output Voltage | 4.5                    | 4.49                   | 4.4               | 4.4                             | V     | I <sub>OUT</sub> = -50 μA                                                                                             |
|                  |                                      | 5.5                    | 5.49                   | 5.4               | 5.4                             |       |                                                                                                                       |
|                  |                                      | 4.5                    |                        | 3.86              | 3.76                            | V     | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br>I <sub>OH</sub> = -24 mA<br>I <sub>OH</sub> = -24 mA (Note 5) |
|                  |                                      | 5.5                    |                        | 4.86              | 4.76                            |       |                                                                                                                       |
| V <sub>OL</sub>  | Maximum LOW Level<br>Output Voltage  | 4.5                    | 0.001                  | 0.1               | 0.1                             | V     | I <sub>OUT</sub> = 50 μA                                                                                              |
|                  |                                      | 5.5                    | 0.001                  | 0.1               | 0.1                             |       |                                                                                                                       |
|                  |                                      | 4.5                    |                        | 0.36              | 0.44                            | V     | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br>I <sub>OL</sub> = 24 mA<br>I <sub>OL</sub> = 24 mA (Note 5)   |
|                  |                                      | 5.5                    |                        | 0.36              | 0.44                            |       |                                                                                                                       |
| I <sub>IN</sub>  | Maximum Input Leakage Current        | 5.5                    |                        | ±0.1              | ±1.0                            | μA    | V <sub>I</sub> = V <sub>CC</sub> , GND                                                                                |
| I <sub>CCT</sub> | Maximum<br>I <sub>CC</sub> /Input    | 5.5                    | 0.6                    |                   | 1.5                             | mA    | V <sub>I</sub> = V <sub>CC</sub> - 2.1V                                                                               |
| I <sub>OLD</sub> | Minimum Dynamic                      | 5.5                    |                        |                   | 75                              | mA    | V <sub>OLD</sub> = 1.65V Max                                                                                          |
| I <sub>OHD</sub> | Output Current (Note 6)              | 5.5                    |                        |                   | -75                             | mA    | V <sub>OHD</sub> = 3.85V Min                                                                                          |
| I <sub>CC</sub>  | Maximum Quiescent<br>Supply Current  | 5.5                    |                        | 4.0               | 40.0                            | μA    | V <sub>IN</sub> = V <sub>CC</sub><br>or GND                                                                           |

**Note 5:** All outputs loaded; thresholds on input associated with output under test.

**Note 6:** Maximum test duration 2.0 ms, one output loaded at a time.

## AC Electrical Characteristics for AC

| Symbol           | Parameter                                                         | V <sub>CC</sub><br>(V)<br>(Note 7) | T <sub>A</sub> = +25°C<br>C <sub>L</sub> = 50 pF |      |      | T <sub>A</sub> = -40°C to +85°C<br>C <sub>L</sub> = 50 pF |      | Units |
|------------------|-------------------------------------------------------------------|------------------------------------|--------------------------------------------------|------|------|-----------------------------------------------------------|------|-------|
|                  |                                                                   |                                    | Min                                              | Typ  | Max  | Min                                                       | Max  |       |
| f <sub>MAX</sub> | Maximum Clock<br>Frequency                                        | 3.3                                | 70                                               | 95   |      | 60                                                        |      | MHz   |
|                  |                                                                   | 5.0                                | 110                                              | 140  |      | 95                                                        |      |       |
| t <sub>PLH</sub> | Propagation Delay, CP to Q <sub>n</sub><br>(PE Input HIGH or LOW) | 3.3                                | 2.0                                              | 7.5  | 12.5 | 1.5                                                       | 13.5 | ns    |
|                  |                                                                   | 5.0                                | 1.5                                              | 5.5  | 9.0  | 1.0                                                       | 9.5  |       |
| t <sub>PHL</sub> | Propagation Delay, CP to Q <sub>n</sub><br>(PE Input HIGH or LOW) | 3.3                                | 1.5                                              | 8.5  | 12.0 | 1.5                                                       | 13.0 | ns    |
|                  |                                                                   | 5.0                                | 1.5                                              | 6.0  | 9.5  | 1.5                                                       | 10.0 |       |
| t <sub>PLH</sub> | Propagation Delay<br>CP to TC                                     | 3.3                                | 3.0                                              | 9.5  | 15.0 | 2.5                                                       | 16.5 | ns    |
|                  |                                                                   | 5.0                                | 2.0                                              | 7.0  | 10.5 | 1.5                                                       | 11.5 |       |
| t <sub>PHL</sub> | Propagation Delay<br>CP to TC                                     | 3.3                                | 3.5                                              | 11.0 | 14.0 | 2.5                                                       | 15.5 | ns    |
|                  |                                                                   | 5.0                                | 2.0                                              | 8.0  | 11.0 | 2.0                                                       | 11.5 |       |
| t <sub>PLH</sub> | Propagation Delay<br>CET to TC                                    | 3.3                                | 2.0                                              | 7.5  | 9.5  | 1.5                                                       | 11.0 | ns    |
|                  |                                                                   | 5.0                                | 1.5                                              | 5.5  | 6.5  | 1.0                                                       | 7.5  |       |
| t <sub>PHL</sub> | Propagation Delay<br>CET to TC                                    | 3.3                                | 2.5                                              | 8.5  | 11.0 | 2.0                                                       | 12.5 | ns    |
|                  |                                                                   | 5.0                                | 2.0                                              | 6.0  | 8.5  | 1.5                                                       | 9.5  |       |

**Note 7:** Voltage Range 3.3 is 3.3V ±0.3V  
Voltage Range 5.0 is 5.0V ±0.5V

## AC Operating Requirements for AC

| Symbol         | Parameter                    | V <sub>CC</sub> | T <sub>A</sub> = +25°C |                    | T <sub>A</sub> = -40°C to +85°C | Units |
|----------------|------------------------------|-----------------|------------------------|--------------------|---------------------------------|-------|
|                |                              | (V)             | C <sub>L</sub> = 50 pF |                    | C <sub>L</sub> = 50 pF          |       |
|                |                              | (Note 8)        | Typ                    | Guaranteed Minimum |                                 |       |
| t <sub>S</sub> | Setup Time, HIGH or LOW      | 3.3             | 5.5                    | 13.5               | 16.0                            | ns    |
|                | P <sub>n</sub> to CP         | 5.0             | 4.0                    | 8.5                | 10.5                            |       |
| t <sub>H</sub> | Hold Time, HIGH or LOW       | 3.3             | -7.0                   | -1.0               | -0.5                            | ns    |
|                | P <sub>n</sub> to CP         | 5.0             | -5.0                   | 0                  | 0                               |       |
| t <sub>S</sub> | Setup Time, HIGH or LOW      | 3.3             | 5.5                    | 14.0               | 16.5                            | ns    |
|                | $\overline{\text{SR}}$ to CP | 5.0             | 4.0                    | 9.5                | 11.0                            |       |
| t <sub>H</sub> | Hold Time, HIGH or LOW       | 3.3             | -7.5                   | -1.0               | -0.5                            | ns    |
|                | $\overline{\text{SR}}$ to CP | 5.0             | -5.5                   | -0.5               | 0                               |       |
| t <sub>S</sub> | Setup Time, HIGH or LOW      | 3.3             | 5.5                    | 11.5               | 14.0                            | ns    |
|                | $\overline{\text{PE}}$ to CP | 5.0             | 4.0                    | 7.5                | 8.5                             |       |
| t <sub>H</sub> | Hold Time, HIGH or LOW       | 3.3             | -7.5                   | -1.0               | -0.5                            | ns    |
|                | $\overline{\text{PE}}$ to CP | 5.0             | -5.0                   | -0.5               | 0                               |       |
| t <sub>S</sub> | Setup Time, HIGH or LOW      | 3.3             | 3.5                    | 6.0                | 7.0                             | ns    |
|                | CEP or CET to CP             | 5.0             | 2.5                    | 4.5                | 5.0                             |       |
| t <sub>H</sub> | Hold Time, HIGH or LOW       | 3.3             | -4.5                   | 0                  | 0                               | ns    |
|                | CEP or CET to CP             | 5.0             | -3.0                   | 0                  | 0.5                             |       |
| t <sub>W</sub> | Clock Pulse Width (Load)     | 3.3             | 3.0                    | 3.5                | 4.0                             | ns    |
|                | HIGH or LOW                  | 5.0             | 2.0                    | 2.5                | 3.0                             |       |
| t <sub>W</sub> | Clock Pulse Width (Count)    | 3.3             | 3.0                    | 4.0                | 4.5                             | ns    |
|                | HIGH or LOW                  | 5.0             | 2.0                    | 3.0                | 3.5                             |       |

Note 8: Voltage Range 3.3 is 3.3V ± 0.3V

Voltage Range 5.0 is 5.0V ± 0.5V

## AC Electrical Characteristics for ACT

| Symbol           | Parameter                                                                              | V <sub>CC</sub><br>(V)<br>(Note 9) | T <sub>A</sub> = +25°C<br>C <sub>L</sub> = 50 pF |     |      | T <sub>A</sub> = -40°C to +85°C<br>C <sub>L</sub> = 50 pF |      | Units |
|------------------|----------------------------------------------------------------------------------------|------------------------------------|--------------------------------------------------|-----|------|-----------------------------------------------------------|------|-------|
|                  |                                                                                        |                                    | Min                                              | Typ | Max  | Min                                                       | Max  |       |
| f <sub>MAX</sub> | Maximum Clock Frequency                                                                | 5.0                                | 120                                              | 140 |      | 105                                                       |      | MHz   |
| t <sub>PLH</sub> | Propagation Delay, CP to Q <sub>n</sub><br>( $\overline{\text{PE}}$ Input HIGH or LOW) | 5.0                                | 1.5                                              | 5.5 | 10.0 | 1.5                                                       | 11.0 | ns    |
| t <sub>PHL</sub> | Propagation Delay, CP to Q <sub>n</sub><br>( $\overline{\text{PE}}$ Input HIGH or LOW) | 5.0                                | 1.5                                              | 6.0 | 11.0 | 1.5                                                       | 12.0 | ns    |
| t <sub>PLH</sub> | Propagation Delay<br>CP to TC                                                          | 5.0                                | 2.5                                              | 7.0 | 11.5 | 2.0                                                       | 13.5 | ns    |
| t <sub>PHL</sub> | Propagation Delay<br>CP to TC                                                          | 5.0                                | 3.0                                              | 8.0 | 13.5 | 2.0                                                       | 15.0 | ns    |
| t <sub>PLH</sub> | Propagation Delay<br>CET to TC                                                         | 5.0                                | 2.0                                              | 5.5 | 9.0  | 1.5                                                       | 10.5 | ns    |
| t <sub>PHL</sub> | Propagation Delay<br>CET to TC                                                         | 5.0                                | 2.0                                              | 6.0 | 10.0 | 2.0                                                       | 11.0 | ns    |

Note 9: Voltage Range 5.0 is 5.0V ± 0.5V

## AC Operating Requirements for ACT

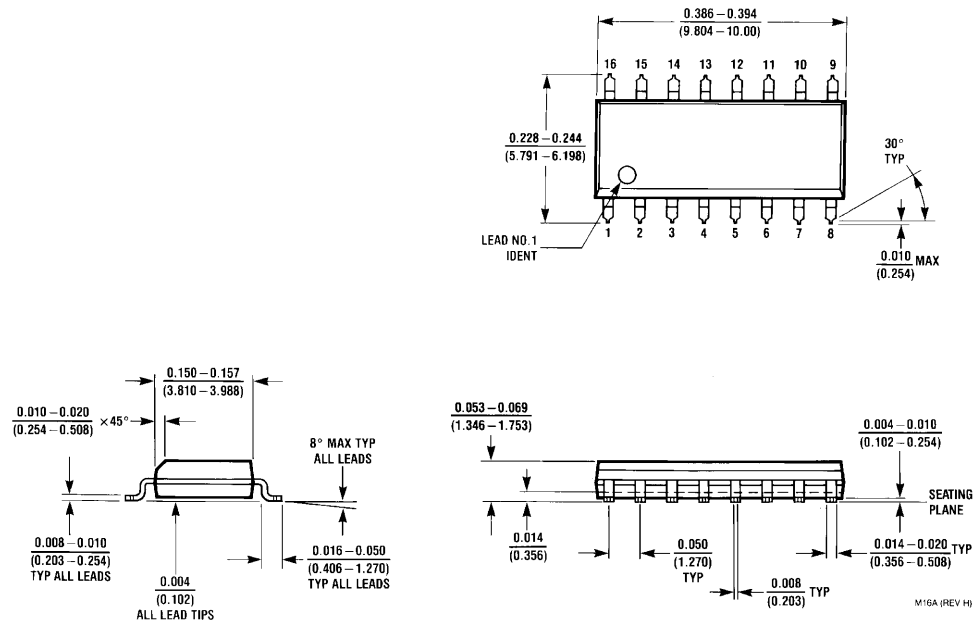
| Symbol         | Parameter                                       | V <sub>CC</sub><br>(V)<br>(Note 10) | T <sub>A</sub> = +25°C<br>C <sub>L</sub> = 50 pF |                    | T <sub>A</sub> = −40°C to +85°C<br>C <sub>L</sub> = 50 pF | Units |
|----------------|-------------------------------------------------|-------------------------------------|--------------------------------------------------|--------------------|-----------------------------------------------------------|-------|
|                |                                                 |                                     | Typ                                              | Guaranteed Minimum |                                                           |       |
| t <sub>S</sub> | Setup Time, HIGH or LOW<br>P <sub>n</sub> to CP | 5.0                                 | 4.0                                              | 10.0               | 12.0                                                      | ns    |
| t <sub>H</sub> | Hold Time, HIGH or LOW<br>P <sub>n</sub> to CP  | 5.0                                 | −5.0                                             | 0.5                | 0.5                                                       | ns    |
| t <sub>S</sub> | Setup Time, HIGH or LOW<br>SR̄ to CP            | 5.0                                 | 4.0                                              | 10.0               | 11.5                                                      | ns    |
| t <sub>H</sub> | Hold Time, HIGH or LOW<br>SR̄ to CP             | 5.0                                 | −5.5                                             | −0.5               | −0.5                                                      | ns    |
| t <sub>S</sub> | Setup Time, HIGH or LOW<br>PĒ to CP            | 5.0                                 | 4.0                                              | 8.5                | 10.5                                                      | ns    |
| t <sub>H</sub> | Hold Time, HIGH or LOW<br>PĒ to CP             | 5.0                                 | −5.5                                             | −0.5               | 0                                                         | ns    |
| t <sub>S</sub> | Setup Time, HIGH or LOW<br>CEP or CET to CP     | 5.0                                 | 2.5                                              | 5.5                | 6.5                                                       | ns    |
| t <sub>H</sub> | Hold Time, HIGH or LOW<br>CEP or CET to CP      | 5.0                                 | −3.0                                             | 0                  | 0.5                                                       | ns    |
| t <sub>W</sub> | Clock Pulse Width (Load)<br>HIGH or LOW         | 5.0                                 | 2.0                                              | 3.5                | 3.5                                                       | ns    |
| t <sub>W</sub> | Clock Pulse Width<br>(Count) HIGH or LOW        | 5.0                                 | 2.0                                              | 3.5                | 3.5                                                       | ns    |

**Note 10:** Voltage Range 5.0 is 5.0V ± 0.5V

## Capacitance

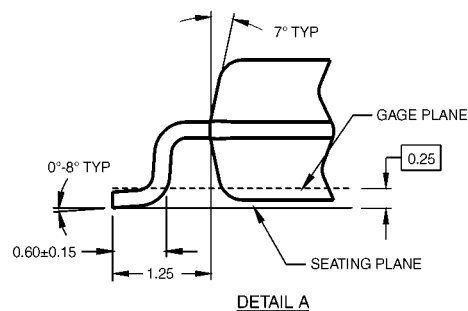
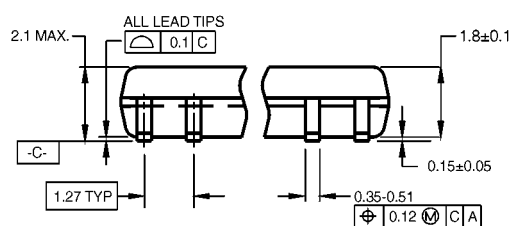
| Symbol          | Parameter                     | Typ  | Units | Conditions             |
|-----------------|-------------------------------|------|-------|------------------------|
| C <sub>IN</sub> | Input Capacitance             | 4.5  | pF    | V <sub>CC</sub> = OPEN |
| C <sub>PD</sub> | Power Dissipation Capacitance | 45.0 | pF    | V <sub>CC</sub> = 5.0V |

# Physical Dimensions inches (millimeters) unless otherwise noted



16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow Body  
Package Number M16A





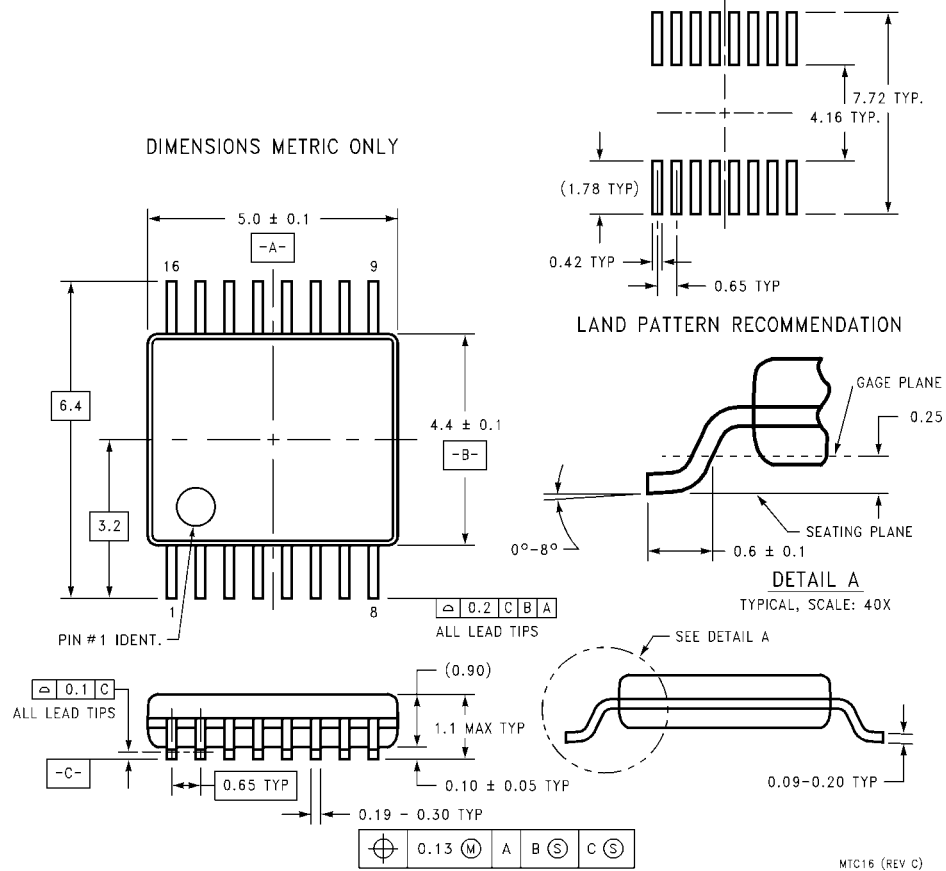
A. CONFORMS TO EIAJ EDR-7320 REGISTRATION, ESTABLISHED IN DECEMBER, 1998.

B. DIMENSIONS ARE IN MILLIMETERS.

C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.

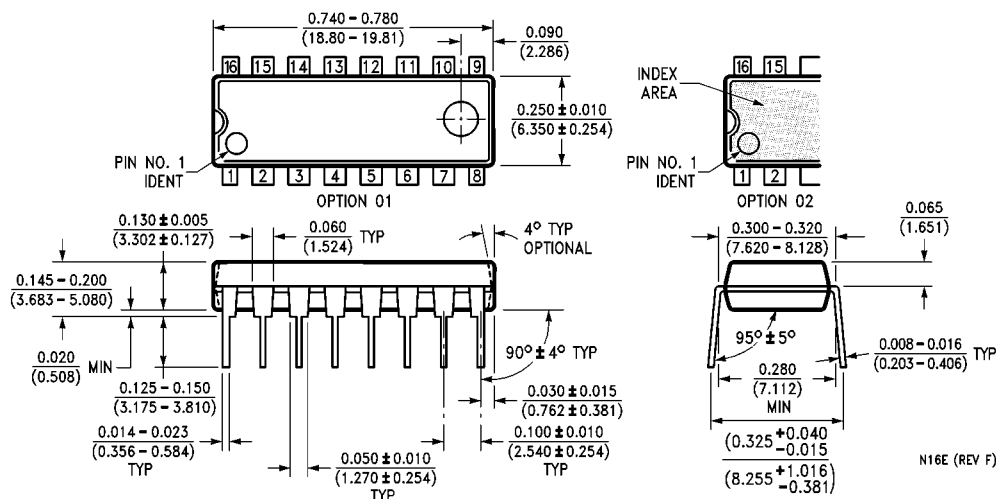
**16-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide  
Package Number M16D**

**Physical Dimensions** inches (millimeters) unless otherwise noted (Continued)



**16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide  
Package Number MTC16**

**Physical Dimensions** inches (millimeters) unless otherwise noted (Continued)



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