

# 100331

## Low Power Triple D-Type Flip-Flop

### General Description

The 100331 contains three D-type, edge-triggered master/slave flip-flops with true and complement outputs, a Common Clock ( $CP_C$ ), and Master Set (MS) and Master Reset (MR) inputs. Each flip-flop has individual Clock ( $CP_n$ ), Direct Set ( $SD_n$ ) and Direct Clear ( $CD_n$ ) inputs. Data enters a master when both  $CP_n$  and  $CP_C$  are LOW and transfers to a slave when  $CP_n$  or  $CP_C$  (or both) go HIGH. The Master Set, Master Reset and individual  $CD_n$  and  $SD_n$  inputs override the Clock inputs. All inputs have 50 k $\Omega$  pull-down resistors.

### Features

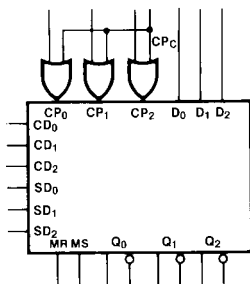
- 35% power reduction of the 100131
- 2000V ESD protection
- Pin/function compatible with 100131
- Voltage compensated operating range = -4.2V to -5.7V
- Available to industrial grade temperature range

### Ordering Code:

| Order Number | Package Number | Package Description                                                                                                |
|--------------|----------------|--------------------------------------------------------------------------------------------------------------------|
| 100331SC     | M24B           | 24-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300 Wide                                          |
| 100331PC     | N24E           | 24-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-010, 0.400 Wide                                              |
| 100331QC     | V28A           | 28-Lead Plastic Lead Chip Carrier (PLCC), JEDEC MO-047, 0.450 Square                                               |
| 100331QI     | V28A           | 28-Lead Plastic Lead Chip Carrier (PLCC), JEDEC MO-047, 0.450 Square Industrial Temperature Range (-40°C to +85°C) |

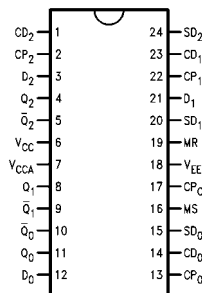
Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

### Logic Symbol

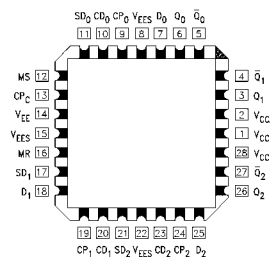


### Connection Diagrams

24-Pin DIP/SOIC



28-Pin PLCC



### Pin Descriptions

| Pin Names                           | Description                    |
|-------------------------------------|--------------------------------|
| $CP_0$ - $CP_2$                     | Individual Clock Inputs        |
| $CP_C$                              | Common Clock Input             |
| $D_0$ - $D_2$                       | Data Inputs                    |
| $CD_0$ - $CD_2$                     | Individual Direct Clear Inputs |
| $SD_n$                              | Individual Direct Set Inputs   |
| MR                                  | Master Reset Input             |
| MS                                  | Master Set Input               |
| $Q_0$ - $Q_2$                       | Data Outputs                   |
| $\overline{Q_0}$ - $\overline{Q_2}$ | Complementary Data Outputs     |

## Truth Tables

**Synchronous Operation (Each Flip-Flop)**

| Inputs |        |        |              |              | Outputs    |
|--------|--------|--------|--------------|--------------|------------|
| $D_n$  | $CP_n$ | $CP_C$ | MS<br>$SD_n$ | MR<br>$CD_n$ | $Q_n(t+1)$ |
| L      | ↗      | L      | L            | L            | L          |
| H      | ↗      | L      | L            | L            | H          |
| L      | L      | ↗      | L            | L            | L          |
| H      | L      | ↗      | L            | L            | H          |
| X      | L      | L      | L            | L            | $Q_n(t)$   |
| X      | H      | X      | L            | L            | $Q_n(t)$   |
| X      | X      | H      | L            | L            | $Q_n(t)$   |

H = HIGH Voltage Level

L = LOW Voltage Level

X = Don't Care

U = Undefined

t = Time before CP Positive Transition

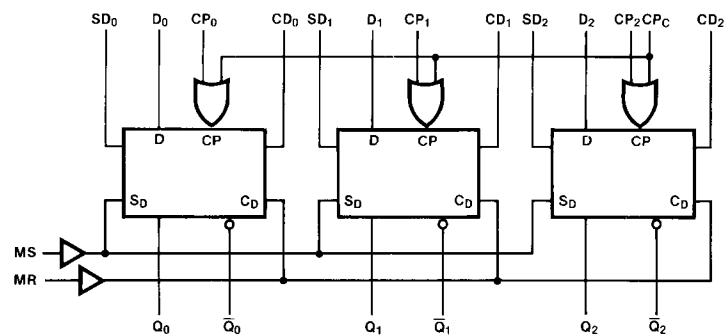
t + 1 = Time after CP Positive Transition

↗ = LOW-to-HIGH Transition

**Asynchronous Operation (Each Flip-Flop)**

| Inputs |        |        |              |              | Outputs    |
|--------|--------|--------|--------------|--------------|------------|
| $D_n$  | $CP_n$ | $CP_C$ | MS<br>$SD_n$ | MR<br>$CD_n$ | $Q_n(t+1)$ |
| X      | X      | X      | H            | L            | H          |
| X      | X      | X      | L            | H            | L          |
| X      | X      | X      | H            | H            | U          |

## Logic Diagram



**Absolute Maximum Ratings**(Note 1)

|                                          |                   |
|------------------------------------------|-------------------|
| Storage Temperature ( $T_{STG}$ )        | -65°C to +150°C   |
| Maximum Junction Temperature ( $T_J$ )   | +150°C            |
| Pin Potential to Ground Pin ( $V_{EE}$ ) | -7.0V to +0.5V    |
| Input Voltage (DC)                       | $V_{EE}$ to +0.5V |
| Output Current<br>(DC Output HIGH)       | -50 mA            |
| ESD (Note 2)                             | $\leq 2000V$      |

**Recommended Operating Conditions**

|                             |                |
|-----------------------------|----------------|
| Case Temperature ( $T_C$ )  |                |
| Commercial                  | 0°C to +85°C   |
| Industrial                  | -40°C to +85°C |
| Supply Voltage ( $V_{EE}$ ) | -5.7V to -4.2V |

**Note 1:** The "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the Electrical Characteristics tables are not guaranteed at the absolute maximum rating. The "Recommended Operating Conditions" table will define the conditions for actual device operation.

**Note 2:** ESD testing conforms to MIL-STD-883, Method 3015.

**Commercial Version****DC Electrical Characteristics** (Note 3)

$V_{EE} = -4.2V$  to  $-5.7V$ ,  $V_{CC} = V_{CCA} = GND$ ,  $T_C = 0^\circ C$  to  $+85^\circ C$

| Symbol           | Parameter            | Min   | Typ   | Max   | Units | Conditions                               |                              |
|------------------|----------------------|-------|-------|-------|-------|------------------------------------------|------------------------------|
| V <sub>OH</sub>  | Output HIGH Voltage  | -1025 | -955  | -870  | mV    | V <sub>IN</sub> = V <sub>IH</sub> (Max)  | Loading with<br>50Ω to -2.0V |
| V <sub>OL</sub>  | Output LOW Voltage   | -1830 | -1705 | -1620 | mV    | or V <sub>IL</sub> (Min)                 |                              |
| V <sub>OHC</sub> | Output HIGH Voltage  | -1035 |       |       | mV    | V <sub>IN</sub> = V <sub>IH</sub> (Min)  | Loading with<br>50Ω to -2.0V |
| V <sub>OLC</sub> | Output LOW Voltage   |       |       | -1610 | mV    | or V <sub>IL</sub> (Max)                 |                              |
| V <sub>IH</sub>  | Input HIGH Voltage   | -1165 |       | -870  | mV    | Guaranteed HIGH Signal<br>for All Inputs |                              |
| V <sub>IL</sub>  | Input LOW Voltage    | -1830 |       | -1475 | mV    | Guaranteed LOW Signal<br>for All Inputs  |                              |
| I <sub>IL</sub>  | Input LOW Current    | 0.5   |       |       | μA    | V <sub>IN</sub> = V <sub>IL</sub> (Min)  |                              |
| I <sub>IH</sub>  | Input HIGH Current   |       |       | 240   | μA    | V <sub>IN</sub> = V <sub>IH</sub> (Max)  |                              |
| I <sub>EE</sub>  | Power Supply Current | -122  |       | -65   | mA    | Inputs OPEN                              |                              |

**Note 3:** The specified limits represent the "worst case" value for the parameter. Since these values normally occur at the temperature extremes, additional noise immunity and guardbanding can be achieved by decreasing the allowable system operating ranges. Conditions for testing shown in the tables are chosen to guarantee operation under "worst case" conditions.

## Commercial Version (Continued) DIP AC Electrical Characteristics

 $V_{EE} = -4.2V$  to  $-5.7V$ ,  $V_{CC} = V_{CCA} = GND$ 

| Symbol                               | Parameter                                                        | T <sub>C</sub> = 0°C |      | T <sub>C</sub> = +25°C |      | T <sub>C</sub> = +85°C |      | Units | Conditions                            |              |  |
|--------------------------------------|------------------------------------------------------------------|----------------------|------|------------------------|------|------------------------|------|-------|---------------------------------------|--------------|--|
|                                      |                                                                  | Min                  | Max  | Min                    | Max  | Min                    | Max  |       |                                       |              |  |
| t <sub>MAX</sub>                     | Toggle Frequency                                                 | 375                  |      | 375                    |      | 375                    |      | MHz   | Figures 2, 3                          |              |  |
| t <sub>PLH</sub><br>t <sub>PHL</sub> | Propagation Delay<br>CP <sub>C</sub> to Output                   | 0.75                 | 2.00 | 0.75                   | 2.00 | 0.75                   | 2.00 | ns    | Figures 1, 3                          |              |  |
| t <sub>PLH</sub><br>t <sub>PHL</sub> | Propagation Delay<br>CP <sub>n</sub> to Output                   | 0.75                 | 2.00 | 0.75                   | 2.00 | 0.75                   | 2.00 | ns    |                                       |              |  |
| t <sub>PLH</sub><br>t <sub>PHL</sub> | Propagation Delay<br>CD <sub>n</sub> , SD <sub>n</sub> to Output | 0.70                 | 1.70 | 0.70                   | 1.70 | 0.70                   | 1.80 | ns    | CP <sub>n</sub> , CP <sub>C</sub> = L | Figures 1, 4 |  |
| t <sub>PLH</sub><br>t <sub>PHL</sub> |                                                                  | 0.70                 | 2.00 | 0.70                   | 2.00 | 0.70                   | 2.00 |       | CP <sub>n</sub> , CP <sub>C</sub> = H |              |  |
| t <sub>PLH</sub><br>t <sub>PHL</sub> | Propagation Delay<br>MS, MR to Output                            | 1.10                 | 2.60 | 1.10                   | 2.60 | 1.10                   | 2.60 | ns    | CP <sub>n</sub> , CP <sub>C</sub> = L |              |  |
| t <sub>PLH</sub><br>t <sub>PHL</sub> |                                                                  | 1.10                 | 2.80 | 1.10                   | 2.80 | 1.10                   | 2.80 |       | CP <sub>n</sub> , CP <sub>C</sub> = H |              |  |
| t <sub>TLH</sub><br>t <sub>THL</sub> | Transition Time<br>20% to 80%, 80% to 20%                        | 0.35                 | 1.30 | 0.35                   | 1.30 | 0.35                   | 1.30 | ns    | Figures 1, 3, 4                       |              |  |
| t <sub>S</sub>                       | Setup Time                                                       |                      |      |                        |      |                        |      | ns    | Figure 5                              |              |  |
|                                      | D <sub>n</sub>                                                   | 0.40                 |      | 0.40                   |      | 0.40                   |      |       |                                       |              |  |
|                                      | CD <sub>n</sub> , SD <sub>n</sub> (Release Time)                 | 1.30                 |      | 1.30                   |      | 1.30                   |      |       | Figure 4                              |              |  |
|                                      | MS, MR (Release Time)                                            | 2.30                 |      | 2.30                   |      | 2.30                   |      |       |                                       |              |  |
| t <sub>H</sub>                       | Hold Time D <sub>n</sub>                                         | 0.5                  |      | 0.5                    |      | 0.7                    |      | ns    | Figure 5                              |              |  |
| t <sub>PW(H)</sub>                   | Pulse Width HIGH                                                 |                      |      |                        |      |                        |      | ns    | Figures 3, 4                          |              |  |
|                                      | CP <sub>n</sub> , CP <sub>C</sub> , CD <sub>n</sub> ,            | 2.00                 |      | 2.00                   |      | 2.00                   |      |       |                                       |              |  |
|                                      | SD <sub>n</sub> , MR, MS                                         |                      |      |                        |      |                        |      |       |                                       |              |  |

## SOIC and PLCC AC Electrical Characteristics

 $V_{EE} = -4.2V$  to  $-5.7V$ ,  $V_{CC} = V_{CCA} = GND$ 

| Symbol                               | Parameter                                                                                             | T <sub>C</sub> = 0°C |      | T <sub>C</sub> = +25°C |      | T <sub>C</sub> = +85°C |      | Units | Conditions                            |              |  |
|--------------------------------------|-------------------------------------------------------------------------------------------------------|----------------------|------|------------------------|------|------------------------|------|-------|---------------------------------------|--------------|--|
|                                      |                                                                                                       | Min                  | Max  | Min                    | Max  | Min                    | Max  |       |                                       |              |  |
| f <sub>MAX</sub>                     | Toggle Frequency                                                                                      | 400                  |      | 400                    |      | 400                    |      | MHz   | Figures 2, 3                          |              |  |
| t <sub>PLH</sub><br>t <sub>PHL</sub> | Propagation Delay<br>CP <sub>C</sub> to Output                                                        | 0.75                 | 1.80 | 0.75                   | 1.80 | 0.75                   | 1.80 | ns    | Figures 1, 3                          |              |  |
| t <sub>PLH</sub><br>t <sub>PHL</sub> | Propagation Delay<br>CP <sub>n</sub> to Output                                                        | 0.75                 | 1.80 | 0.75                   | 1.80 | 0.75                   | 1.80 | ns    |                                       |              |  |
| t <sub>PLH</sub><br>t <sub>PHL</sub> | Propagation Delay<br>CD <sub>n</sub> , SD <sub>n</sub> to Output                                      | 0.70                 | 1.50 | 0.70                   | 1.50 | 0.70                   | 1.60 | ns    | CP <sub>n</sub> , CP <sub>C</sub> = L | Figures 1, 4 |  |
| t <sub>PLH</sub><br>t <sub>PHL</sub> |                                                                                                       | 0.80                 | 1.80 | 0.70                   | 1.80 | 0.70                   | 1.80 |       | CP <sub>n</sub> , CP <sub>C</sub> = H |              |  |
| t <sub>PLH</sub><br>t <sub>PHL</sub> | Propagation Delay<br>MS, MR to Output                                                                 | 1.10                 | 2.40 | 1.10                   | 2.40 | 1.10                   | 2.40 | ns    | CP <sub>n</sub> , CP <sub>C</sub> = L |              |  |
| t <sub>PLH</sub><br>t <sub>PHL</sub> |                                                                                                       | 1.10                 | 2.60 | 1.10                   | 2.60 | 1.10                   | 2.60 |       | CP <sub>n</sub> , CP <sub>C</sub> = H |              |  |
| t <sub>TLH</sub><br>t <sub>THL</sub> | Transition Time<br>20% to 80%, 80% to 20%                                                             | 0.35                 | 1.10 | 0.35                   | 1.10 | 0.35                   | 1.10 | ns    | Figures 1, 3, 4                       |              |  |
| t <sub>S</sub>                       | Setup Time<br>D <sub>n</sub>                                                                          | 0.30                 |      | 0.30                   |      | 0.30                   |      | ns    | Figure 5                              |              |  |
|                                      | CD <sub>n</sub> , SD <sub>n</sub> (Release Time)                                                      | 1.20                 |      | 1.20                   |      | 1.20                   |      |       | Figure 4                              |              |  |
|                                      | MS, MR (Release Time)                                                                                 | 2.20                 |      | 2.20                   |      | 2.20                   |      |       |                                       |              |  |
| t <sub>H</sub>                       | Hold Time D <sub>n</sub>                                                                              | 0.5                  |      | 0.5                    |      | 0.7                    |      | ns    | Figure 5                              |              |  |
| t <sub>PW(H)</sub>                   | Pulse Width HIGH<br>CP <sub>n</sub> , CP <sub>C</sub> , CD <sub>n</sub> ,<br>SD <sub>n</sub> , MR, MS | 2.00                 |      | 2.00                   |      | 2.00                   |      | ns    | Figures 3, 4                          |              |  |

| Commercial Version (Continued)                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                            |                      |      |                        |      |                        |      |       |                                                    |              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|----------------------|------|------------------------|------|------------------------|------|-------|----------------------------------------------------|--------------|
| Symbol                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Parameter                                                                                  | T <sub>C</sub> = 0°C |      | T <sub>C</sub> = +25°C |      | T <sub>C</sub> = +85°C |      | Units | Conditions                                         |              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                            | Min                  | Max  | Min                    | Max  | Min                    | Max  |       |                                                    |              |
| t <sub>PLH</sub><br>t <sub>PHL</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                    | Propagation Delay<br>CP <sub>C</sub> to Output                                             | 0.75                 | 1.40 | 0.75                   | 1.40 | 0.80                   | 1.50 | ns    | Figures 1, 3 PLCC Only                             |              |
| t <sub>PLH</sub><br>t <sub>PHL</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                    | Propagation Delay<br>CP <sub>n</sub> to Output                                             | 0.70                 | 1.40 | 0.75                   | 1.40 | 0.80                   | 1.50 | ns    |                                                    |              |
| t <sub>PLH</sub><br>t <sub>PHL</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                    | Propagation Delay<br>CD <sub>n</sub> , SD <sub>n</sub> to Output                           | 0.70                 | 1.50 | 0.70                   | 1.50 | 0.80                   | 1.60 | ns    | CP <sub>n</sub> , CP <sub>C</sub> = L<br>PLCC Only | Figures 1, 4 |
| t <sub>PLH</sub><br>t <sub>PHL</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                            | 0.80                 | 1.70 | 0.80                   | 1.70 | 0.80                   | 1.80 |       | CP <sub>n</sub> , CP <sub>C</sub> = H<br>PLCC Only |              |
| t <sub>PLH</sub><br>t <sub>PHL</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                    | Propagation Delay<br>MS, MR to Output                                                      | 1.10                 | 2.00 | 1.10                   | 2.00 | 1.20                   | 2.10 | ns    | CP <sub>n</sub> , CP <sub>C</sub> = L<br>PLCC Only |              |
| t <sub>PLH</sub><br>t <sub>PHL</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                            | 1.20                 | 2.10 | 1.20                   | 2.10 | 1.30                   | 2.20 |       | CP <sub>n</sub> , CP <sub>C</sub> = H<br>PLCC Only |              |
| t <sub>OSHL</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Maximum Skew Common Edge<br>Output-to-Output Variation<br>Common Clock to Output Path      | 100                  |      | 100                    |      | 100                    |      | ps    | PLCC Only<br>(Note 4)                              |              |
| t <sub>OSHL</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Maximum Skew Common Edge<br>Output-to-Output Variation<br>CP <sub>n</sub> to Output Path   | 235                  |      | 235                    |      | 235                    |      | ps    | PLCC Only<br>(Note 4)                              |              |
| t <sub>OSLH</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Maximum Skew Common Edge<br>Output-to-Output Variation<br>Common Clock to Output Path      | 120                  |      | 120                    |      | 120                    |      | ps    | PLCC Only<br>(Note 4)                              |              |
| t <sub>OSLH</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Maximum Skew Common Edge<br>Output-to-Output Variation<br>CP <sub>n</sub> to Output Path   | 275                  |      | 275                    |      | 275                    |      | ps    | PLCC Only<br>(Note 4)                              |              |
| t <sub>OST</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Maximum Skew Opposite Edge<br>Output-to-Output Variation<br>Common Clock to Output Path    | 125                  |      | 125                    |      | 125                    |      | ps    | PLCC Only<br>(Note 4)                              |              |
| t <sub>OST</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Maximum Skew Opposite Edge<br>Output-to-Output Variation<br>CP <sub>n</sub> to Output Path | 265                  |      | 265                    |      | 265                    |      | ps    | PLCC Only<br>(Note 4)                              |              |
| t <sub>PS</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Maximum Skew<br>Pin (Signal) Transition Variation<br>Common Clock to Output Path           | 90                   |      | 90                     |      | 90                     |      | ps    | PLCC Only<br>(Note 4)                              |              |
| t <sub>PS</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Maximum Skew<br>Pin (Signal) Transition Variation<br>CP <sub>n</sub> to Output Path        | 90                   |      | 90                     |      | 90                     |      | ps    | PLCC Only<br>(Note 4)                              |              |
| <b>Note 4:</b> Output-to-Output Skew is defined as the absolute value of the difference between the actual propagation delay for any outputs within the same packaged device. The specifications apply to any outputs switching in the same direction either HIGH-to-LOW (t <sub>OSHL</sub> ), or LOW-to-HIGH (t <sub>OSLH</sub> ), or in opposite directions both HL and LH (t <sub>OST</sub> ). Parameters t <sub>OST</sub> and t <sub>PS</sub> guaranteed by design. |                                                                                            |                      |      |                        |      |                        |      |       |                                                    |              |

## Industrial Version

### PLCC DC Electrical Characteristics (Note 5)

$V_{EE} = -4.2V$  to  $-5.7V$ ,  $V_{CC} = V_{CCA} = GND$ ,  $T_C = -40^\circ C$  to  $+85^\circ C$

| Symbol           | Parameter            | T <sub>C</sub> = −40°C |       | T <sub>C</sub> = 0°C to +85°C |       | Units | Conditions                               |                              |
|------------------|----------------------|------------------------|-------|-------------------------------|-------|-------|------------------------------------------|------------------------------|
|                  |                      | Min                    | Max   | Min                           | Max   |       |                                          |                              |
| V <sub>OH</sub>  | Output HIGH Voltage  | −1085                  | −870  | −1025                         | −870  | mV    | V <sub>IN</sub> = V <sub>IH</sub> (Max)  | Loading with<br>50Ω to −2.0V |
| V <sub>OL</sub>  | Output LOW Voltage   | −1830                  | −1575 | −1830                         | −1620 | mV    | or V <sub>IL</sub> (Min)                 |                              |
| V <sub>OHC</sub> | Output HIGH Voltage  | −1095                  |       | −1035                         |       | mV    | V <sub>IN</sub> = V <sub>IH</sub> (Min)  | Loading with<br>50Ω to −2.0V |
| V <sub>OLC</sub> | Output LOW Voltage   |                        | −1565 |                               | −1610 | mV    | or V <sub>IL</sub> (Max)                 |                              |
| V <sub>IH</sub>  | Input HIGH Voltage   | −1170                  | −870  | −1165                         | −870  | mV    | Guaranteed HIGH Signal<br>for All Inputs |                              |
| V <sub>IL</sub>  | Input LOW Voltage    | −1830                  | −1480 | −1830                         | 1475  | mV    | Guaranteed LOW Signal<br>for All Inputs  |                              |
| I <sub>IL</sub>  | Input LOW Current    | 0.5                    |       | 0.5                           |       | μA    | V <sub>IN</sub> = V <sub>IL</sub> (Min)  |                              |
| I <sub>IH</sub>  | Input HIGH Current   |                        | 300   |                               | 240   | μA    | V <sub>IN</sub> = V <sub>IH</sub> (Max)  |                              |
| I <sub>EE</sub>  | Power Supply Current | −122                   | −60   | −122                          | −65   | mA    | Inputs Open                              |                              |

**Note 5:** The specified limits represent the "worst case" value for the parameter. Since these values normally occur at the temperature extremes, additional noise immunity and guardbanding can be achieved by decreasing the allowable system operating ranges. Conditions for testing shown in the tables are chosen to guarantee operation under "worst case" conditions.

### PLCC AC Electrical Characteristics

$V_{EE} = -4.2V$  to  $-5.7V$ ,  $V_{CC} = V_{CCA} = GND$

| Symbol                               | Parameter                                                                                             | T <sub>C</sub> = -40°C |      | T <sub>C</sub> = +25°C |      | T <sub>C</sub> = +85°C |      | Units | Conditions                            |              |  |
|--------------------------------------|-------------------------------------------------------------------------------------------------------|------------------------|------|------------------------|------|------------------------|------|-------|---------------------------------------|--------------|--|
|                                      |                                                                                                       | Min                    | Max  | Min                    | Max  | Min                    | Max  |       |                                       |              |  |
| t <sub>MAX</sub>                     | Toggle Frequency                                                                                      | 375                    |      | 400                    |      | 400                    |      | MHz   | Figures 2, 3                          |              |  |
| t <sub>PLH</sub>                     | Propagation Delay<br>CP <sub>C</sub> to Output                                                        | 0.75                   | 1.80 | 0.75                   | 1.80 | 0.75                   | 1.80 | ns    | Figures 1, 3                          |              |  |
| t <sub>PLH</sub><br>t <sub>PHL</sub> | Propagation Delay<br>CP <sub>n</sub> to Output                                                        | 0.70                   | 1.80 | 0.75                   | 1.80 | 0.75                   | 1.80 | ns    |                                       |              |  |
| t <sub>PLH</sub><br>t <sub>PHL</sub> | Propagation Delay<br>CD <sub>n</sub> , SD <sub>n</sub> to Output                                      | 0.60                   | 1.50 | 0.70                   | 1.50 | 0.70                   | 1.60 | ns    | CP <sub>n</sub> , CP <sub>C</sub> = L | Figures 1, 4 |  |
| t <sub>PLH</sub><br>t <sub>PHL</sub> |                                                                                                       | 0.70                   | 1.80 | 0.70                   | 1.80 | 0.70                   | 1.80 |       | CP <sub>n</sub> , CP <sub>C</sub> = H |              |  |
| t <sub>PLH</sub><br>t <sub>PHL</sub> | Propagation Delay<br>MS, MR to Output                                                                 | 1.10                   | 2.40 | 1.10                   | 2.40 | 1.10                   | 2.40 | ns    | CP <sub>n</sub> , CP <sub>C</sub> = L |              |  |
| t <sub>PLH</sub><br>t <sub>PHL</sub> |                                                                                                       | 1.10                   | 2.60 | 1.10                   | 2.60 | 1.10                   | 2.60 |       | CP <sub>n</sub> , CP <sub>C</sub> = H |              |  |
| t <sub>TLH</sub><br>t <sub>THL</sub> | Transition Time<br>20% to 80%, 80% to 20%                                                             | 0.20                   | 1.40 | 0.35                   | 1.10 | 0.35                   | 1.10 | ns    | Figures 1, 3, 4                       |              |  |
| t <sub>S</sub>                       | Setup Time                                                                                            |                        |      |                        |      |                        |      | ns    | Figure 5                              |              |  |
|                                      | D <sub>n</sub>                                                                                        | 1.00                   |      | 0.30                   |      | 0.30                   |      |       |                                       |              |  |
|                                      | CD <sub>n</sub> , SD <sub>n</sub> (Release Time)                                                      | 1.50                   |      | 1.20                   |      | 1.20                   |      |       |                                       |              |  |
|                                      | MS, MR (Release Time)                                                                                 | 2.50                   |      | 2.20                   |      | 2.20                   |      |       |                                       |              |  |
| t <sub>H</sub>                       | Hold Time D <sub>n</sub>                                                                              | 0.7                    |      | 0.5                    |      | 0.7                    |      | ns    | Figure 5                              |              |  |
| t <sub>PW(H)</sub>                   | Pulse Width HIGH<br>CP <sub>n</sub> , CP <sub>C</sub> , CD <sub>n</sub> ,<br>SD <sub>n</sub> , MR, MS | 2.00                   |      | 2.00                   |      | 2.00                   |      | ns    | Figures 3, 4                          |              |  |

## Test Circuits

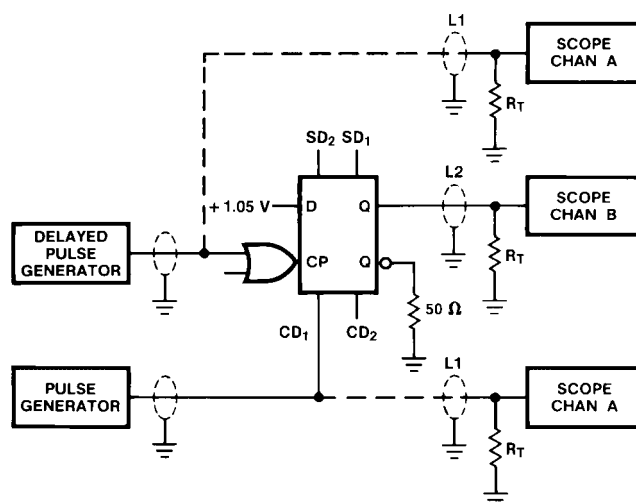
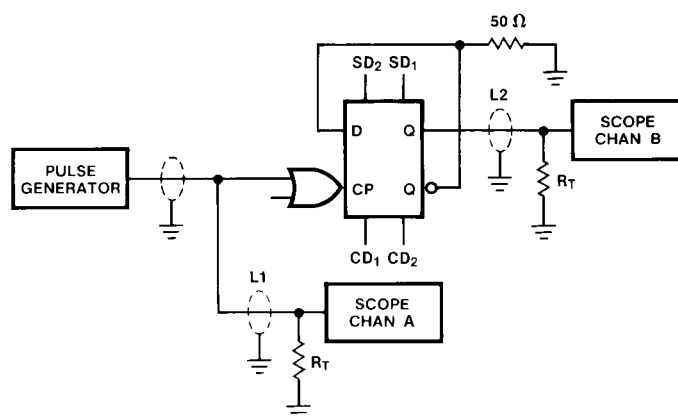


FIGURE 1. AC Test Circuit

**Notes:**

$V_{CC}, V_{CCA} = +2V, V_{EE} = -2.5V$

L1 and L2 = Equal length 50 $\Omega$  impedance lines

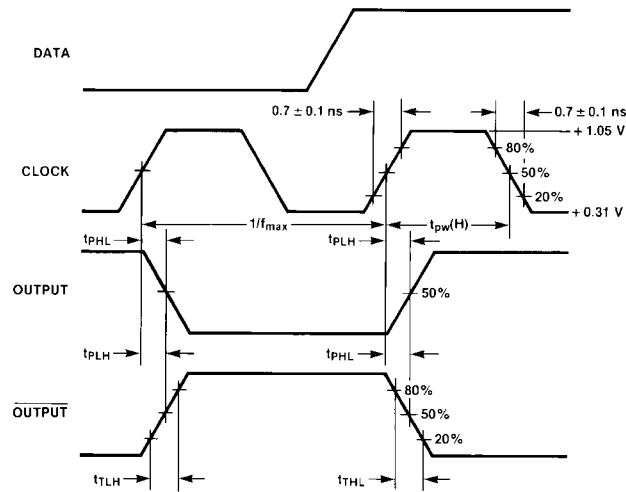
$R_T = 50\Omega$  terminator internal to scope

Decoupling 0.1  $\mu F$  from GND to  $V_{CC}$  and  $V_{EE}$

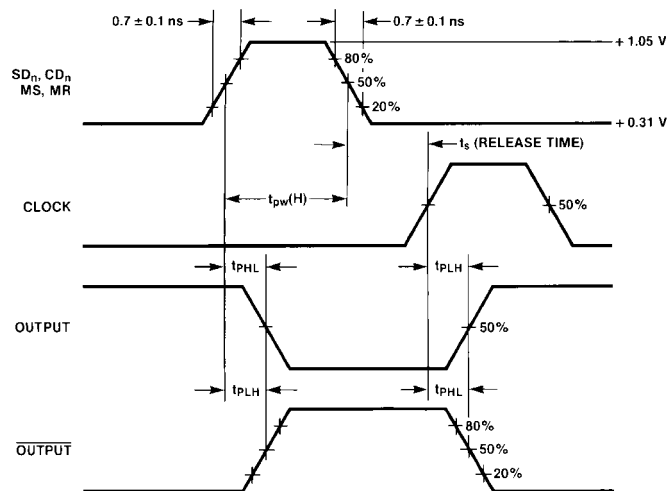
All unused outputs are loaded with 50 $\Omega$  to GND

$C_L$  = Fixture and stray capacitance  $\leq 3$  pF

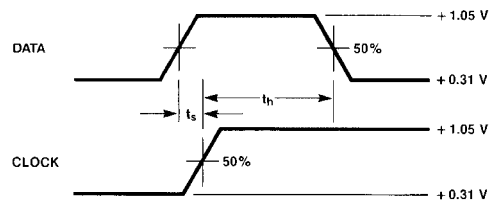
FIGURE 2. Toggle Frequency Test Circuit



**FIGURE 3. Propagation Delay (Clock) and Transition Times**



**FIGURE 4. Propagation Delay (Resets)**



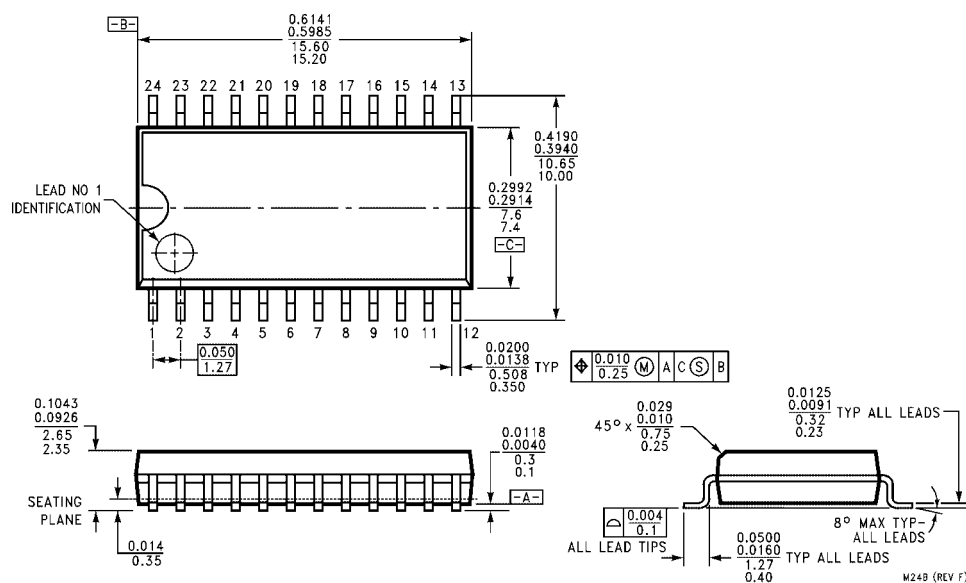
**FIGURE 5. Data Setup and Hold Time**

**Note:**

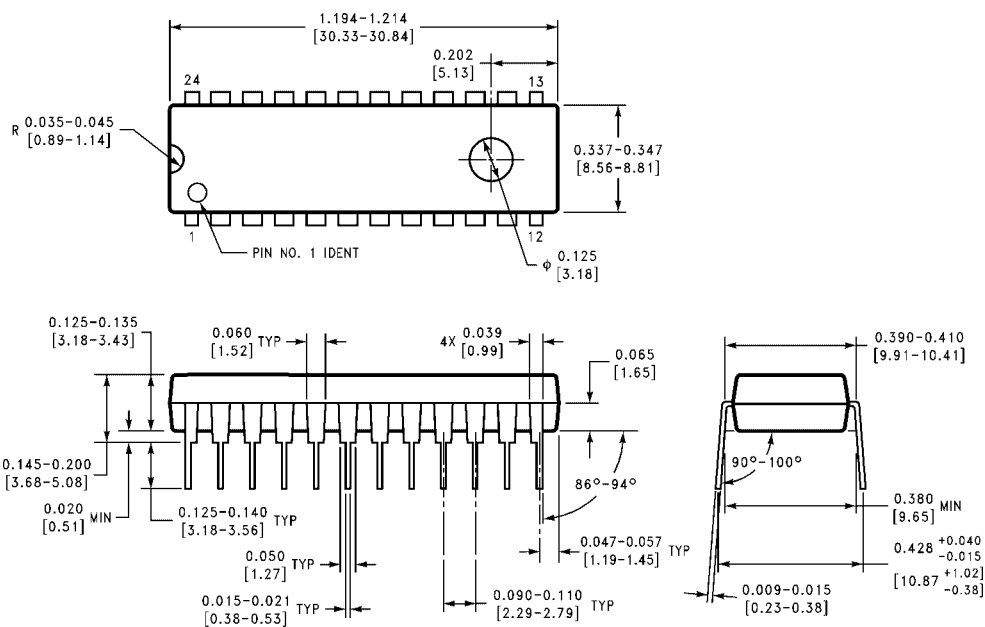
$t_S$  is the minimum time before the transition of the clock that information must be present at the data input.

$t_H$  is the minimum time after the transition of the clock that information must remain unchanged at the data input.

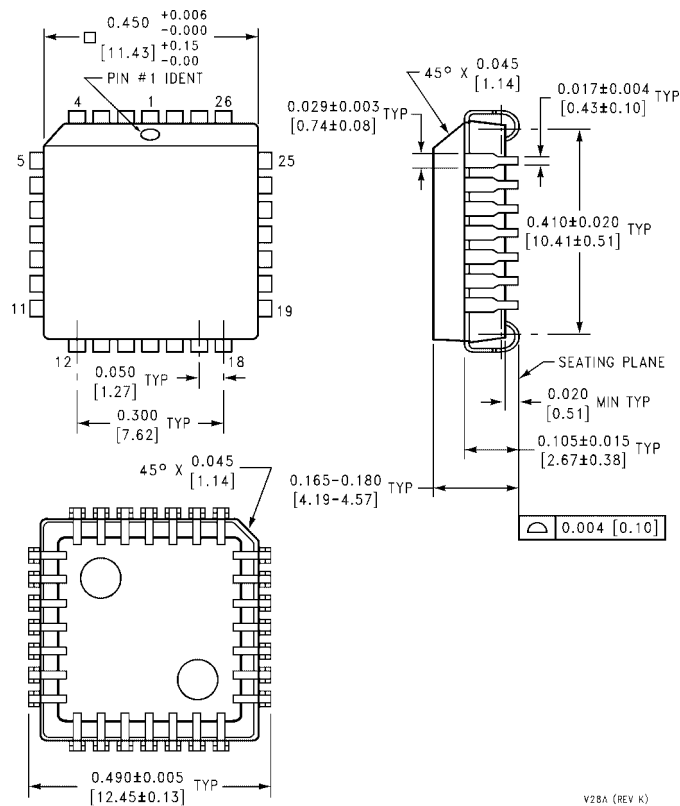
# Physical Dimensions inches (millimeters) unless otherwise noted



**24-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300 Wide  
Package Number M24B**



**24-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-010, 0.400 Wide  
Package Number N24E**

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

**28-Lead Plastic Lead Chip Carrier (PLCC), JEDEC MO-047, 0.450 Square  
Package Number V28A**

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