

# 100351 Low Power Hex D-Type Flip-Flop

## General Description

The 100351 contains six D-type edge-triggered, master/slave flip-flops with true and complement outputs, a pair of common Clock inputs (CP<sub>a</sub> and CP<sub>b</sub>) and common Master Reset (MR) input. Data enters a master when both CP<sub>a</sub> and CP<sub>b</sub> are LOW and transfers to the slave when CP<sub>a</sub> and CP<sub>b</sub> (or both) go HIGH. The MR input overrides all other inputs and makes the Q outputs LOW. All inputs have 50 kΩ pull-down resistors.

## Features

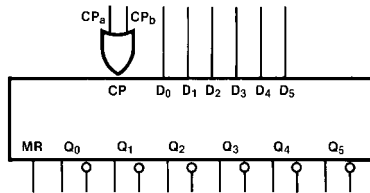
- 40% power reduction of the 100151
- 2000V ESD protection
- Pin/function compatible with 100151
- Voltage compensated operating range: -4.2V to -5.7V
- Available to industrial grade temperature range

## Ordering Code:

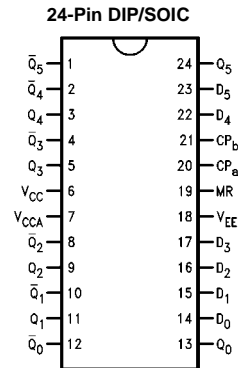
Order Number	Package Number	Package Description
100351SC	M24B	24-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300 Wide
100351PC	N24E	24-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-010, 0.400 Wide
100351QC	V28A	28-Lead Plastic Lead Chip Carrier (PLCC), JEDEC MO-047, 0.450 Square
100351QI	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

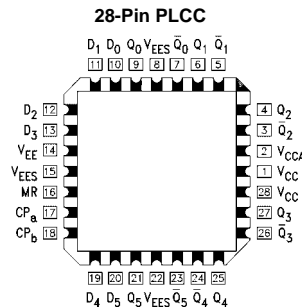


## Connection Diagrams



## Pin Descriptions

Pin Names	Description
D <sub>0</sub> -D <sub>5</sub>	Data Inputs
CP <sub>a</sub> , CP <sub>b</sub>	Common Clock Inputs
MR	Asynchronous Master Reset Input
Q <sub>0</sub> -Q <sub>5</sub>	Data Outputs
Q <sub>0</sub> -Q <sub>5</sub>	Complementary Data Outputs



### Truth Tables

(Each Flip-flop)

#### Synchronous Operation

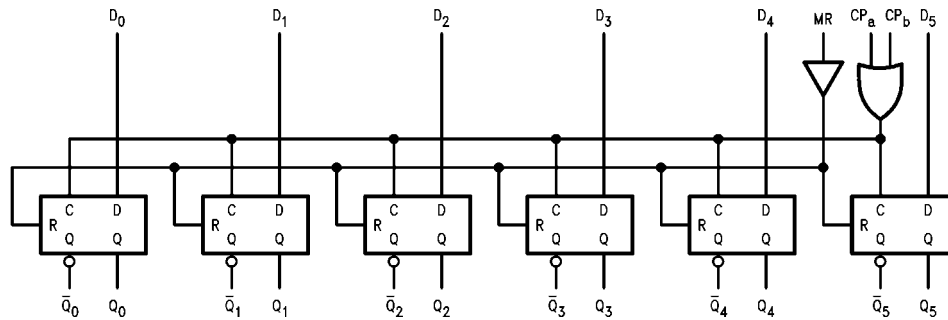
Inputs				Outputs
D <sub>n</sub>	CP <sub>a</sub>	CP <sub>b</sub>	MR	Q <sub>n</sub> (t+1)
L	↗	L	L	L
H	↗	L	L	H
L	L	↗	L	L
H	L	↗	L	H
X	H	↗	L	Q <sub>n</sub> (t)
X	↗	H	L	Q <sub>n</sub> (t)
X	L	L	L	Q <sub>n</sub> (t)

#### Asynchronous Operation

Inputs				Outputs
D <sub>n</sub>	CP <sub>a</sub>	CP <sub>b</sub>	MR	Q <sub>n</sub> (t+1)
X	X	X	H	L

H = HIGH Voltage Level  
 L = LOW Voltage Level  
 X = Don't Care  
 t = Time before CP positive transition  
 t+1 = Time after CP positive transition  
 ↗ = LOW-to-HIGH transition

### Logic Diagram



**Absolute Maximum Ratings**(Note 1)

Storage Temperature ( $T_{STG}$ )	-65°C to +150°C
Maximum Junction Temperature ( $T_J$ )	+150°C
$V_{EE}$ Pin Potential to Ground Pin	-7.0V to +0.5V
Input Voltage (DC)	$V_{EE}$ to +0.5V
Output Current (DC Output HIGH)	-50 mA
ESD (Note 2)	≥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
$V_{OH}$	Output HIGH Voltage	-1025	-955	-870	mV	$V_{IN} = V_{IH}$ (Max) Loading with or $V_{IL}$ (Min) 50Ω to -2.0V
$V_{OL}$	Output LOW Voltage	-1830	-1705	-1620		
$V_{OHC}$	Output HIGH Voltage	-1035			mV	$V_{IN} = V_{IH}$ (Min) Loading with or $V_{IL}$ (Max) 50Ω to -2.0V
$V_{OLC}$	Output LOW Voltage			-1610		
$V_{IH}$	Input HIGH Voltage	-1165		-870	mV	Guaranteed HIGH Signal for All Inputs
$V_{IL}$	Input LOW Voltage	-1830		-1475	mV	Guaranteed LOW Signal for All Inputs
$I_{IL}$	Input LOW Current	0.50			μA	$V_{IN} = V_{IL}$ (Min)
$I_{IH}$	Input HIGH Current			350	μA	$V_{IN} = V_{IH}$ (Max)
		MR		240		
		$D_0-D_5$ $CP_a, CP_b$		350		
$I_{EE}$	Power Supply Current	-129		-62	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.

**DIP AC Electrical Characteristics**

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

Symbol	Parameter	$T_C = 0^\circ C$		$T_C = +25^\circ C$		$T_C = +85^\circ C$		Units	Conditions
		Min	Max	Min	Max	Min	Max		
$f_{MAX}$	Toggle Frequency	375		375		375		MHz	Figures 2, 3
$t_{PLH}$	Propagation Delay	0.80	2.00	0.80	2.0	0.90	2.10	ns	Figures 1, 3
$t_{PHL}$	$CP_a, CP_b$ to Output								
$t_{PLH}$	Propagation Delay	1.10	2.30	1.10	2.30	1.20	2.40	ns	Figures 1, 4
$t_{PHL}$	MR to Output								
$t_{TLH}$	Transition Time	0.35	1.20	0.35	1.20	0.35	1.20	ns	Figures 1, 3
$t_{THL}$	20% to 80%, 80% to 20%								
$t_S$	Setup Time								
	$D_0-D_5$ MR (Release Time)	0.40 1.60		0.40 1.60		0.40 1.60		ns	Figure 5 Figure 4
$t_H$	Hold Time	0.80		0.80		0.80		ns	Figure 5
$t_{PW(H)}$	Hold Time								
	$D_0-D_5$								
$t_{PW(H)}$	Pulse Width HIGH	2.00		2.00		2.00		ns	Figures 3, 4
	$CP_a, CP_b, MR$								

## Commercial Version (Continued) SOIC and PLCC AC Electrical Characteristics

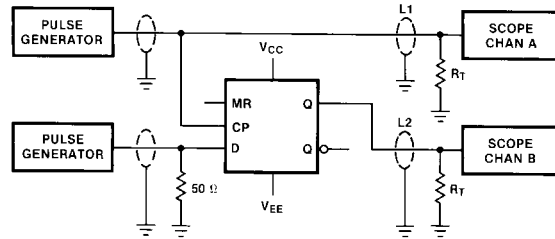
 $V_{EE} = -4.2V$  to  $-5.7V$ ,  $V_{CC} = V_{CCA} = GND$ 

Symbol	Parameter	$T_C = 0^\circ C$		$T_C = +25^\circ C$		$T_C = +85^\circ C$		Units	Conditions
		Min	Max	Min	Max	Min	Max		
$f_{MAX}$	Toggle Frequency	375		375		375		MHz	Figures 2, 3
$t_{PLH}$	Propagation Delay	0.80	1.80	0.80	1.80	0.90	1.90	ns	Figures 1, 3
$t_{PHL}$	CP <sub>a</sub> , CP <sub>b</sub> to Output								
$t_{PLH}$	Propagation Delay	1.10	2.10	1.10	2.10	1.20	2.20	ns	Figures 1, 4
$t_{PHL}$	MR to Output								
$t_{TLH}$	Transition Time	0.45	1.70	0.45	1.60	0.45	1.70	ns	Figures 1, 3
$t_{THL}$	20% to 80%, 80% to 20%								
$t_S$	Setup Time								
	D <sub>0</sub> -D <sub>5</sub>	0.30		0.30		0.30		ns	Figure 5
	MR (Release Time)	1.50		1.50		1.50			Figure 4
$t_H$	Hold Time	0.80		0.80		0.80		ns	Figure 5
	D <sub>0</sub> -D <sub>5</sub>								
$t_{PW(H)}$	Pulse Width HIGH	2.00		2.00		2.00		ns	Figures 3, 4
	CP <sub>a</sub> , CP <sub>b</sub> , MR								
$t_{OSHL}$	Maximum Skew Common Edge Output-to-Output Variation Clock to Output Path		220		220		220	ps	PLCC only (Note 4)
$t_{OSLH}$	Maximum Skew Common Edge Output-to-Output Variation Clock to Output Path		210		210		210	ps	PLCC only (Note 4)
$t_{OST}$	Maximum Skew Opposite Edge Output-to-Output Variation Clock to Output Path		240		240		240	ps	PLCC only (Note 4)
$t_{PS}$	Maximum Skew Pin (Signal) Transition Variation Clock to Output Path		230		230		230	ps	PLCC only (Note 4)

**Note 4:** 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 ( $t_{OSHL}$ ), or LOW-to-HIGH ( $t_{OSLH}$ ), or in opposite directions both HL and LH ( $t_{OST}$ ). Parameters  $t_{OST}$  and  $t_{PS}$  guaranteed by design.

Industrial Version									
PLCC DC Electrical Characteristics									
$V_{EE} = -4.2V$ to $-5.7V$ , $V_{CC} = V_{CCA} = GND$ , $T_C = 0^\circ C$ to $+85^\circ C$ (Note 5)									
Symbol	Parameter	$T_C = -40^\circ C$		$T_C = 0^\circ$ to $+85^\circ C$		Units	Conditions		
		Min	Max	Min	Max				
$V_{OH}$	Output HIGH Voltage	-1085	-870	-1025	-870	mV	$V_{IN} = V_{IH}$ (Max) or $V_{IL}$ (Min)	Loading with 50Ω to $-2.0V$	
$V_{OL}$	Output LOW Voltage	-1830	-1575	-1830	-1620				
$V_{OHC}$	Output HIGH Voltage	-1095		-1035		mV	$V_{IN} = V_{IH}$ (Min) or $V_{IL}$ (Max)	Loading with 50Ω to $-2.0V$	
$V_{OLC}$	Output LOW Voltage		-1565		-1610				
$V_{IH}$	Input HIGH Voltage	-1170	-870	-1165	-870	mV	Guaranteed HIGH Signal for All Inputs		
$V_{IL}$	Input LOW Voltage	-1830	-1480	-1830	-1475	mV	Guaranteed LOW Signal for All Inputs		
$I_{IL}$	Input LOW Current	0.50		0.50		μA	$V_{IN} = V_{IL}$ (Min)		
$I_{IH}$	Input HIGH Current		350		350	μA	$V_{IN} = V_{IH}$ (Max)		
	MR		240		240				
	$D_0-D_5$ $CP_a, CP_b$		350		350				
$I_{EE}$	Power Supply Current	-129	-62	-129	-62	mA	Inputs OPEN		
<p><b>Note 5:</b> 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.</p>									
PLCC AC Electrical Characteristics									
$V_{EE} = -4.2V$ to $-5.7V$ , $V_{CC} = V_{CCA} = GND$									
Symbol	Parameter	$T_C = -40^\circ C$		$T_C = +25^\circ C$		$T_C = +85^\circ C$		Units	Conditions
		Min	Max	Min	Max	Min	Max		
$f_{MAX}$	Toggle Frequency	375		375		375		MHz	Figures 2, 3
$t_{PLH}$	Propagation Delay	0.80	1.80	0.80	1.80	0.90	1.90	ns	Figures 1, 3
$t_{PHL}$	$CP_a, CP_b$ to Output								
$t_{PLH}$	Propagation Delay	1.10	2.10	1.10	2.10	1.20	2.20	ns	Figures 1, 4
$t_{PHL}$	MR to Output								
$t_{TLH}$	Transition Time	0.45	1.70	0.45	1.60	0.45	1.70	ns	Figures 1, 3
$t_{THL}$	20% to 80%, 80% to 20%								
$t_S$	Setup Time	0.60		0.30		0.30		ns	Figure 5 Figure 4
	$D_0-D_5$ MR (Release Time)								
$t_H$	Hold Time	0.60		0.90		0.90		ns	Figure 5
	$D_0-D_5$								
$t_{PW(H)}$	Pulse Width HIGH	2.00		2.00		2.00		ns	Figures 3, 4
	$CP_a, CP_b, MR$								

## Test Circuitry



### Notes:

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

L1 and L2 = equal length 50Ω impedance lines

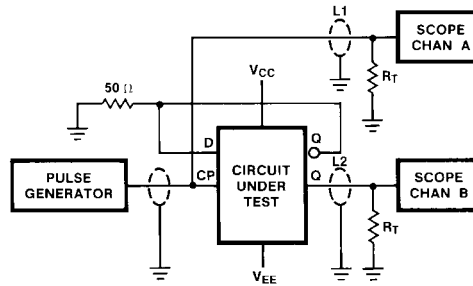
$R_T = 50\Omega$  terminator internal to scope

Decoupling 0.1 μF from GND to  $V_{CC}$  and  $V_{EE}$

All unused outputs are loaded with 50Ω to GND

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

FIGURE 1. AC Test Circuit



### Notes:

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

L1 and L2 = equal length 50Ω impedance lines

$R_T = 50\Omega$  terminator internal to scope

Decoupling 0.1 μF from GND to  $V_{CC}$  and  $V_{EE}$

All unused outputs are loaded with 50Ω to GND

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

FIGURE 2. Toggle Frequency Test Circuit

## Switching Waveforms

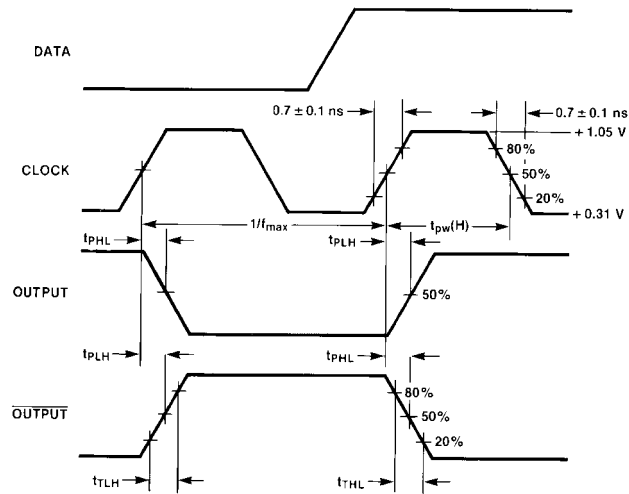


FIGURE 3. Propagation Delay (Clock) and Transition Times

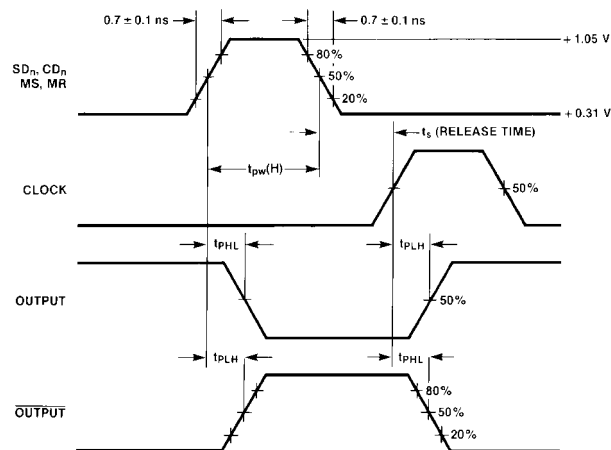
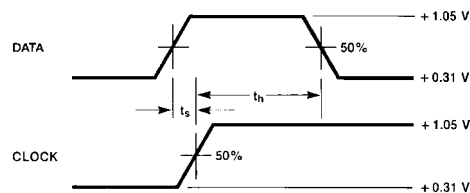


FIGURE 4. Propagation Delay (Reset)



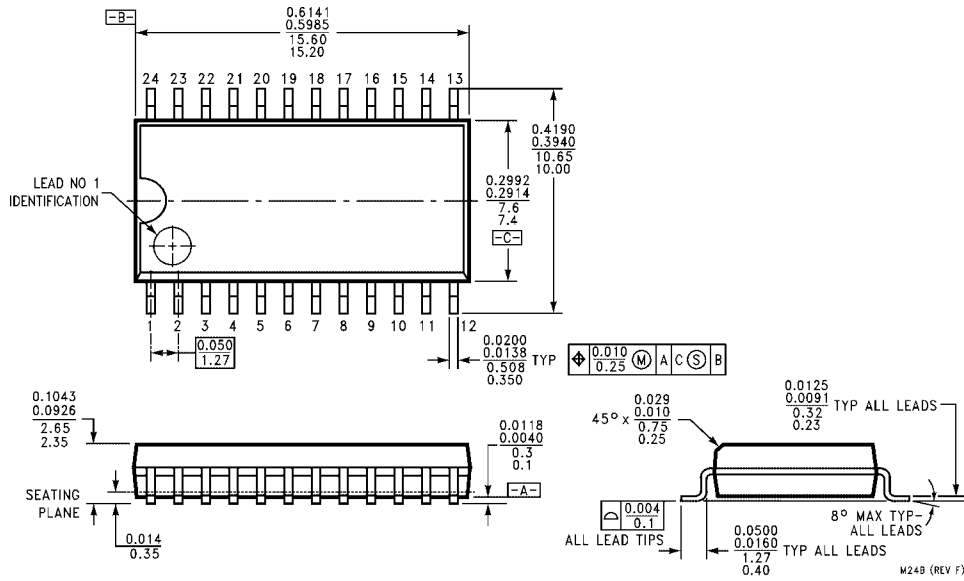
### Notes:

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

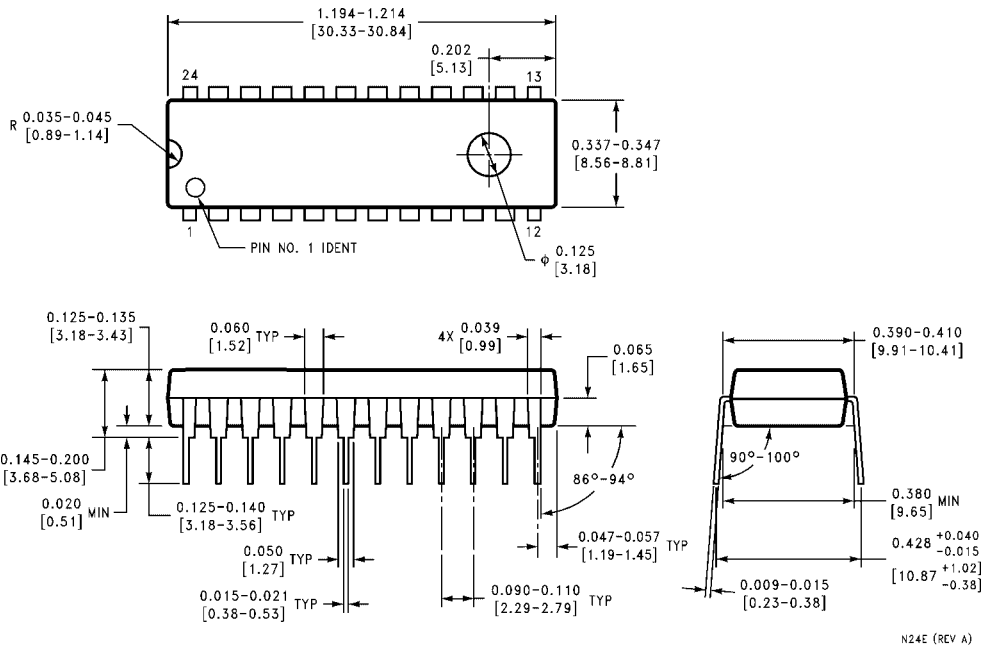
$t_H$  is the minimum time after the transition of the clock that information must remain unchanged at the data input.

FIGURE 5. Setup and Hold Time

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

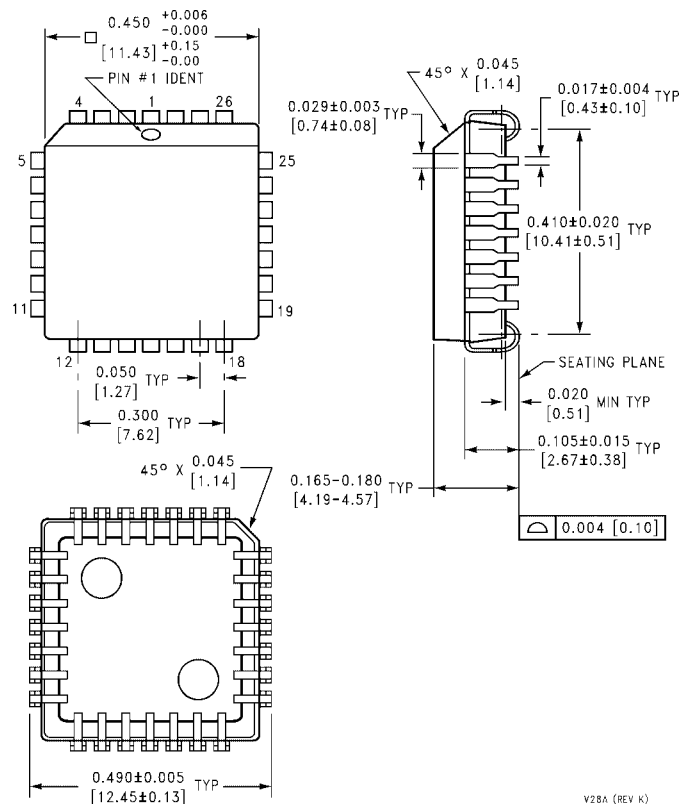


**24-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300 Wide Package Number M24B**



**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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