FAIRCHILD SEMICONDUCTOR™

September 1983
Revised September 2001

# MM74HC589
# 8-Bit Shift Registers with Input Latches and 3-STATE Serial Output

## General Description

The MM74HC589 high speed shift register utilizes advanced silicon-gate CMOS technology to achieve the high noise immunity and low power consumption of standard CMOS integrated circuits, as well as the ability to drive 15 LS-TTL loads.

The MM74HC589 comes in a 16-pin package and consists of an 8-bit storage latch feeding a parallel-in, serial-out 8-bit shift register. Data can also be entered serially the shift register through the SER pin. Both the storage register and shift register have positive-edge triggered clocks, RCK and SCK, respectively. $\overline{\text{SLOAD}}$ pin controls parallel LOAD or serial shift operations for the shift register. The shift register has a 3-STATE output to enable the wire-ORing of multiple devices on a serial bus.

The 74HC logic family is speed, function, and pin-out compatible with the standard 74LS logic family. All inputs are protected from damage due to static discharge by internal diode clamps to $V_{CC}$ and ground.

## Features

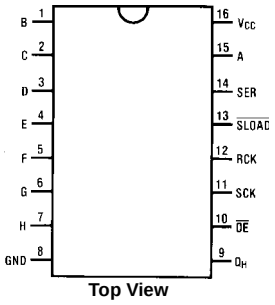
- 8-bit parallel storage register inputs
- Wide operating voltage range: 2V–6V
- Shift register has direct overriding load
- Guaranteed shift frequency. . . DC to 30 MHz
- Low quiescent current: 80 μA maximum (74HC Series)
- 3-STATE output for 'Wire-OR'

## Ordering Code:

| Order Number | Package Number | Package Description |
|---|---|---|
| MM74HC589M | M16A | 16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow |
| MM74HC589SJ | M16D | 16-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide |
| MM74HC589N | N16E | 16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide |

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

## Connection Diagram



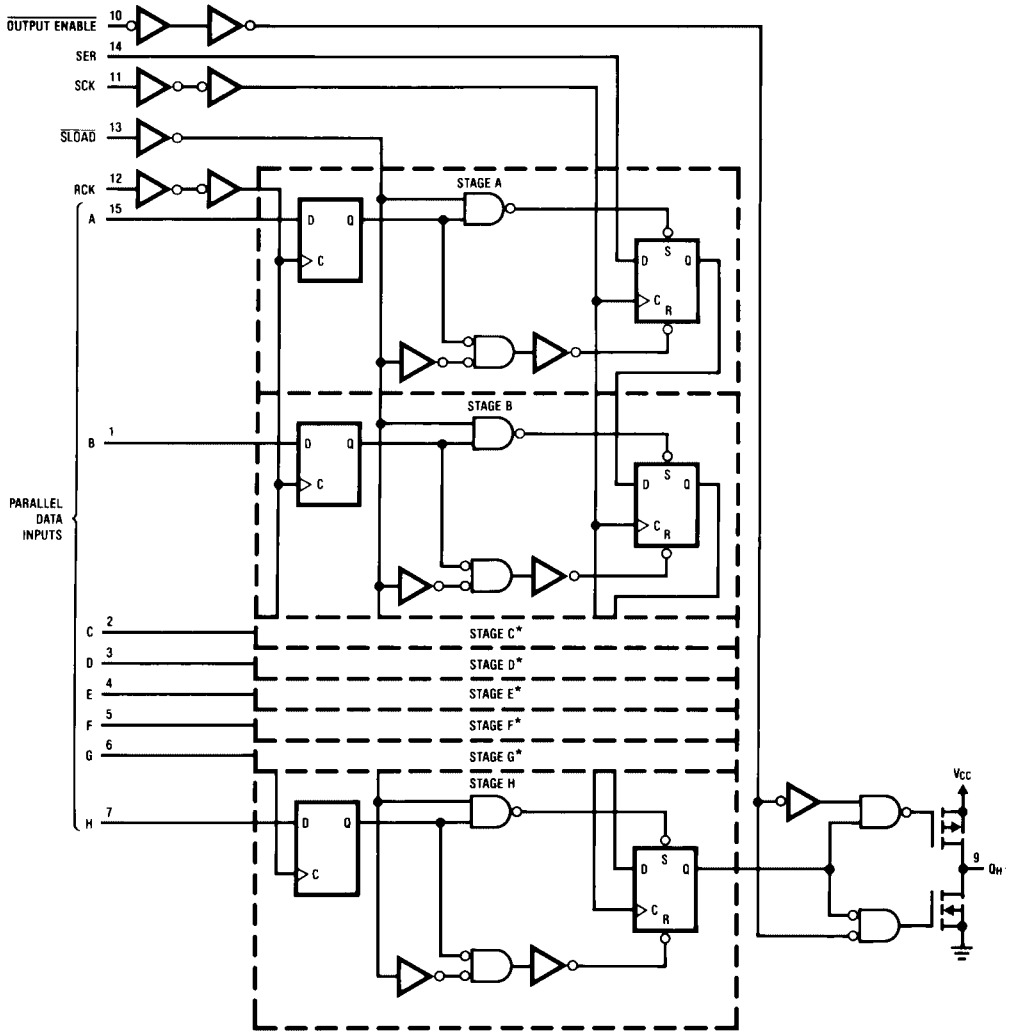

Top View

## Truth Table

| RCK | SCK | $\overline{\text{SLOAD}}$ | $\overline{\text{OE}}$ | Function |
|---|---|---|---|---|
| X | X | X | H | $Q_H$ in Hi-Z State |
| X | X | X | L | $Q_H$ is enabled |
| ↑ | X | X | X | Data loaded into input latches |
| ↑ | X | L | X | Data loaded into shift register from pins |
| H or L | X | L | X | Data loaded from latches to shift register |
| X | ↑ | H | X | Shift register is shifted. Data on SER pin is shifted in. |
| ↑ | ↑ | H | X | Data is shifted in shift register, and data is loaded into latches |

## Block Diagram (positive logic)



## Absolute Maximum Ratings (Note 1)

(Note 2)

| | |
|---|---|
| Supply Voltage ($V_{CC}$) | −0.5 to +7.0V |
| DC Input Voltage ($V_{IN}$) | −1.5 to $V_{CC}$ +1.5V |
| DC Output Voltage ($V_{OUT}$) | −0.5 to $V_{CC}$ +0.5V |
| Clamp Diode Current ($I_{IK}$, $I_{OK}$) | ±20 mA |
| DC Output Current, per pin ($I_{OUT}$) | ±25 mA |
| DC $V_{CC}$ or GND Current, per pin ($I_{CC}$) | ±50 mA |
| Storage Temperature Range ($T_{STG}$) | −65°C to +150°C |
| Power Dissipation ($P_D$) | |
| (Note 3) | 600 mW |
| S.O. Package only | 500 mW |
| Lead Temperature ($T_L$) | |
| (Soldering 10 seconds) | 260°C |

## Recommended Operating Conditions

| | Min | Max | Units |
|---|---|---|---|
| Supply Voltage ($V_{CC}$) | 2 | 6 | V |
| DC Input or Output Voltage | | | |
| ($V_{IN}$, $V_{OUT}$) | 0 | $V_{CC}$ | V |
| Operating Temperature Range ($T_A$) | −40 | +85 | °C |
| Input Rise or Fall Times | | | |
| ($t_r$, $t_f$) $V_{CC}$ = 2.0V | | 1000 | ns |
| $V_{CC}$ = 4.5V | | 500 | ns |
| $V_{CC}$ = 6.0V | | 400 | ns |

**Note 1:** Absolute Maximum Ratings are those values beyond which damage to the device may occur.

**Note 2:** Unless otherwise specified all voltages are referenced to ground.

**Note 3:** Power Dissipation temperature derating — plastic "N" package: −12 mW/°C from 65°C to 85°C.

## DC Electrical Characteristics (Note 4)

| Symbol | Parameter | Conditions | $V_{CC}$ | $T_A$ = 25°C | $T_A$ = −40 to 85°C | $T_A$ = −55 to 125°C | Units |
|---|---|---|---|---|---|---|---|
| | | | | Typ | Guaranteed Limits | | |
| $V_{IH}$ | Minimum HIGH Level Input Voltage | | 2.0V | | 1.5 | 1.5 | 1.5 | V |
| | | | 4.5V | | 3.15 | 3.15 | 3.15 | V |
| | | | 6.0V | | 4.2 | 4.2 | 4.2 | V |
| $V_{IL}$ | Maximum LOW Level Input Voltage | | 2.0V | | 0.5 | 0.5 | 0.5 | V |
| | | | 4.5V | | 1.35 | 1.35 | 1.35 | V |
| | | | 6.0V | | 1.8 | 1.8 | 1.8 | V |
| $V_{OH}$ | Minimum HIGH Level Output Voltage | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | | | | | | |
| | | $\|I_{OUT}\| \leq 20$ μA | 2.0V | 2.0 | 1.9 | 1.9 | 1.9 | V |
| | | | 4.5V | 4.5 | 4.4 | 4.4 | 4.4 | V |
| | | | 6.0V | 6.0 | 5.9 | 5.9 | 5.9 | V |
| | | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | | | | | | |
| | | $\|I_{OUT}\| \leq 6.0$ mA | 4.5V | | 3.98 | 3.84 | 3.7 | V |
| | | $\|I_{OUT}\| \leq 7.8$ mA | 6.0V | | 5.48 | 5.34 | 5.2 | V |
| $V_{OL}$ | Maximum LOW Level Output Voltage | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | | | | | | |
| | | $\|I_{OUT}\| \leq 20$ μA | 2.0V | 0 | 0.1 | 0.1 | 0.1 | V |
| | | | 4.5V | 0 | 0.1 | 0.1 | 0.1 | V |
| | | | 6.0V | 0 | 0.1 | 0.1 | 0.1 | V |
| | | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | | | | | | |
| | | $\|I_{OUT}\| \leq 6.0$ mA | 4.5V | | 0.26 | 0.33 | 0.4 | V |
| | | $\|I_{OUT}\| \leq 7.8$ mA | 6.0V | | 0.26 | 0.33 | 0.4 | V |
| $I_{IN}$ | Maximum Input Current | $V_{IN}$ = $V_{CC}$ or GND | 6.0V | | ±0.1 | ±1.0 | ±1.0 | μA |
| $I_{CC}$ | Maximum Quiescent Supply Current | $V_{IN}$ = $V_{CC}$ or GND<br>$I_{OUT}$ = 0 μA | 6.0V | | 8.0 | 80 | 160 | μA |
| $I_{OZ}$ | Maximum 3-STATE Leakage Current | Output in High Impedance State<br>$V_{IN}$ = $V_{IL}$ or $V_{IH}$<br>$V_{OUT}$ = $V_{CC}$ or GND<br>$\overline{OE}$ = $V_{IH}$ | 6.0V | | ±0.5 | ±5.0 | ±10.0 | μA |

**Note 4:** For a power supply of 5V ±10% the worst case output voltages ($V_{OH}$, and $V_{OL}$) occur for HC at 4.5V. Thus the 4.5V values should be used when designing with this supply. Worst case $V_{IH}$ and $V_{IL}$ occur at $V_{CC}$=5.5V and 4.5V respectively. (The $V_{IH}$ value at 5.5V is 3.85V.) The worst case leakage current ($I_{IN}$, $I_{CC}$, and $I_{OZ}$) occur for CMOS at the higher voltage and so the 6.0V values should be used.

## AC Electrical Characteristics

$V_{CC}$ = 5V, $T_A$ = 25°C, $C_L$ = 15 pF, $t_r = t_f$ = 6 ns

| Symbol | Parameter | Conditions | Typ | Guaranteed Limit | Units |
|---|---|---|---|---|---|
| $f_{MAX}$ | Maximum Operating Frequency for SCK | | 50 | 30 | MHz |
| $t_{PHL}$, $t_{PLH}$ | Maximum Propagation Delay from SCK to $Q_{H'}$ | | | 30 | ns |
| $t_{PHL}$, $t_{PLH}$ | Maximum Propagation Delay from $\overline{SLOAD}$ to $Q_{H'}$ | | | 30 | ns |
| $t_{PHL}$, $t_{PLH}$ | Maximum Propagation Delay from LCK to $Q_{H'}$ | $\overline{SLOAD}$ = logic "0" | 25 | 45 | ns |
| $t_{PZH}$, $t_{PZL}$ | Output Enable Time | $R_L$ = 1 kΩ | 18 | 28 | ns |
| $t_{PHZ}$, $t_{PLZ}$ | Output Disable Time | $R_L$ = 1 kΩ, $C_L$ = 5 pF | 19 | 25 | ns |
| $t_S$ | Minimum Setup Time from RCK to SCK | | 10 | 20 | ns |
| $t_S$ | Minimum Setup Time from SER to SCK | | 10 | 20 | ns |
| $t_S$ | Minimum Setup Time from Inputs A thru H to RCK | | 10 | 20 | ns |
| $t_H$ | Minimum Hold Time | | 0 | 5 | ns |
| $t_W$ | Minimum Pulse Width SCK, RCK, $\overline{SLOAD}$ | | 8 | 16 | ns |

## AC Electrical Characteristics

$V_{CC}$ = 2.0–6V, $C_L$ = 50 pF, $t_r = t_f$ = 6 ns (unless otherwise specified)

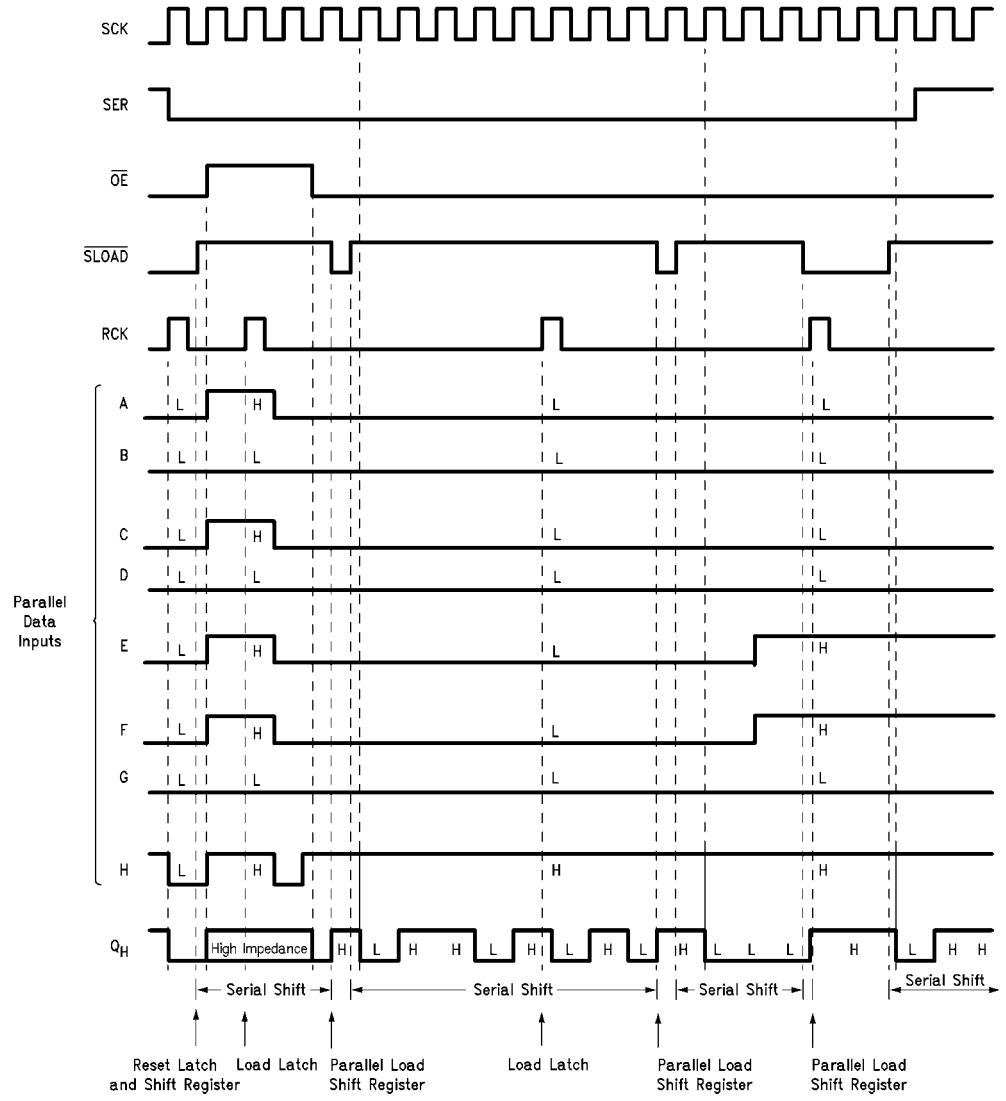
| Symbol | Parameter | Conditions | $V_{CC}$ | $T_A$ = 25°C | $T_A$ = −40 to 85°C | $T_A$ = −55 to 125°C | Units |
|---|---|---|---|---|---|---|---|
| | | | | Typ | Guaranteed Limits | | |
| $f_{MAX}$ | Maximum Operating | | 2.0V | | 6 | 4.8 | 4 | MHz |
| | Frequency for SCK | | 4.5V | | 30 | 24 | 20 | MHz |
| | | | 6.0V | | 35 | 28 | 24 | MHz |
| $t_{PHL}$, $t_{PLH}$ | Maximum Propagation | | 2.0V | 62 | 175 | 220 | 265 | ns |
| | Delay from SCK or | | 4.5V | 20 | 35 | 44 | 53 | ns |
| | $\overline{SLOAD}$ to $Q_H$ | | 6.0V | 18 | 30 | 37 | 45 | ns |
| $t_{PHL}$, $t_{PLH}$ | Maximum Propagation | | 2.0V | 120 | 225 | 280 | 340 | ns |
| | Delay from SCK or | $C_L$ = 150 pF | 4.5V | 31 | 45 | 56 | 68 | ns |
| | $\overline{SLOAD}$ to $Q_H$ | | 6.0V | 28 | 38 | 48 | 58 | ns |
| $t_{PHL}$, $t_{PLH}$ | Maximum Propagation | | 2.0V | 80 | 210 | 265 | 315 | ns |
| | Delay from RCK to $Q_H$ | | 4.5V | 25 | 42 | 53 | 63 | ns |
| | | | 6.0V | 21 | 36 | 45 | 54 | ns |
| $t_{PHL}$, $t_{PLH}$ | Maximum Propagation | | 2.0V | 80 | 210 | 265 | 313 | ns |
| | Delay RCK to $Q_H$ | $C_L$ = 150 pF | 4.5V | 25 | 52 | 66 | 77 | ns |
| | | | 6.0V | 21 | 44 | 56 | 66 | ns |
| $t_{PZH}$, $t_{PZL}$ | Output Enable Time | $R_L$ = 1 kΩ | 2.0V | 70 | 150 | 189 | 224 | ns |
| | | | 4.5V | 22 | 30 | 38 | 45 | ns |
| | | | 6.0V | 20 | 26 | 32 | 38 | ns |
| $t_{PHZ}$, $t_{PLZ}$ | Output Disable Time | $R_L$ = 1 kΩ | 2.0V | 70 | 150 | 189 | 224 | ns |
| | | | 4.5V | 22 | 30 | 38 | 45 | ns |
| | | | 6.0V | 20 | 26 | 32 | 38 | ns |
| $t_S$ | Minimum Setup Time | | 2.0V | | 100 | 125 | 150 | ns |
| | from RCK to SCK | | 4.5V | | 20 | 25 | 30 | ns |
| | | | 6.0V | | 17 | 22 | 25 | ns |
| $t_S$ | Minimum Setup Time | | 2.0V | | 100 | 125 | 150 | ns |
| | from SER to SCK | | 4.5V | | 20 | 25 | 30 | ns |
| | | | 6.0V | | 17 | 22 | 25 | ns |
| $t_S$ | Minimum Setup Time | | 2.0V | | 100 | 125 | 150 | ns |
| | from Inputs A thru H | | 4.5V | | 20 | 25 | 30 | ns |
| | to RCK | | 6.0V | | 17 | 22 | 25 | ns |
| $t_H$ | Minimum Hold Time | | 2.0V | −5 | 5 | 5 | 5 | ns |
| | | | 4.5V | 0 | 5 | 5 | 5 | ns |
| | | | 6.0V | 1 | 5 | 5 | 5 | ns |
| $t_W$ | Minimum Pulse Width | | 2.0V | 30 | 80 | 100 | 120 | ns |
| | SCK, RCK, $\overline{SLOAD}$, | | 4.5V | 9 | 16 | 20 | 24 | ns |
| | $\overline{SLOAD}$ | | 6.0V | 8 | 14 | 17 | 20 | ns |

## AC Electrical Characteristics (Continued)

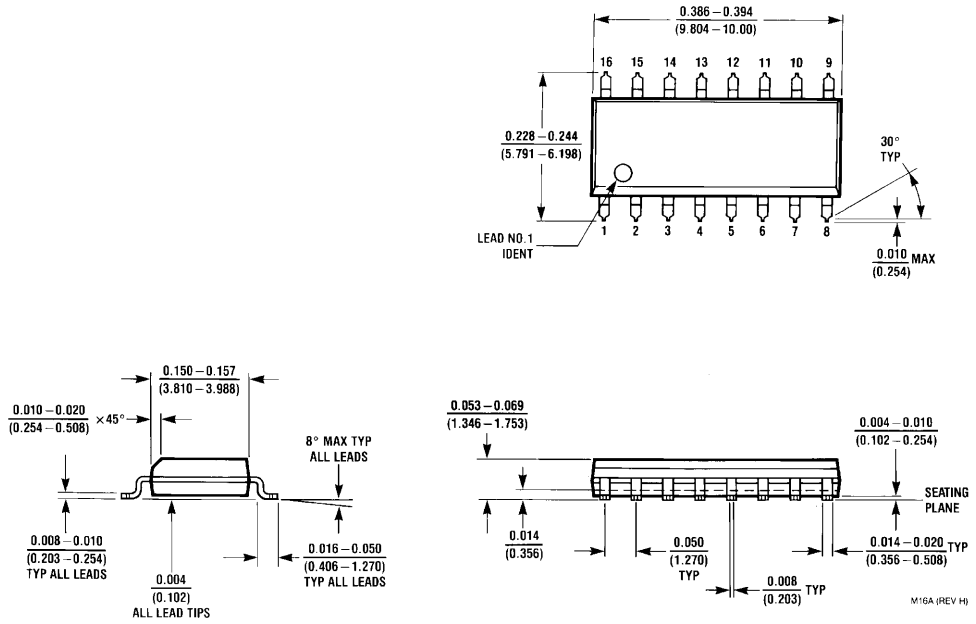
| Symbol | Parameter | Conditions | $V_{CC}$ | $T_A = 25°C$ | $T_A = -40$ to $85°C$ | $T_A = -55$ to $125°C$ | Units |
|---|---|---|---|---|---|---|---|
| | | | | Typ | Guaranteed Limits | | |
| $t_r$, $t_f$ | Maximum Input Rise and | | 2.0V | | 1500 | 1500 | 1500 | ns |
| | Fall Time, Clock | | 4.5V | | 500 | 500 | 500 | ns |
| | | | 6.0V | | 400 | 400 | 400 | ns |
| $t_{THL}$, $t_{TLH}$ | Maximum Output | | 2.0V | 25 | 60 | 75 | 90 | ns |
| | Rise and Fall Time | | 4.5V | 6 | 12 | 15 | 18 | ns |
| | | | 6.0V | 5 | 10 | 12 | 15 | ns |
| $C_{PD}$ | Power Dissipation | | | 87 | | | | pF |
| | Capacitance (Note 5) | | | | | | | |
| $C_{IN}$ | Maximum Input Capacitance | | | 5 | 10 | 10 | 10 | pF |
| $C_{OUT}$ | Maximum Output Capacitance | | | 15 | 20 | 20 | 20 | pF |

**Note 5:** $C_{PD}$ determines the no load dynamic power consumption, $P_D = C_{PD} V_{CC}^2 f + I_{CC} V_{CC}$, and the no load dynamic current consumption, $I_S = C_{PD} V_{CC} sf + I_{CC}$.

## Timing Diagram

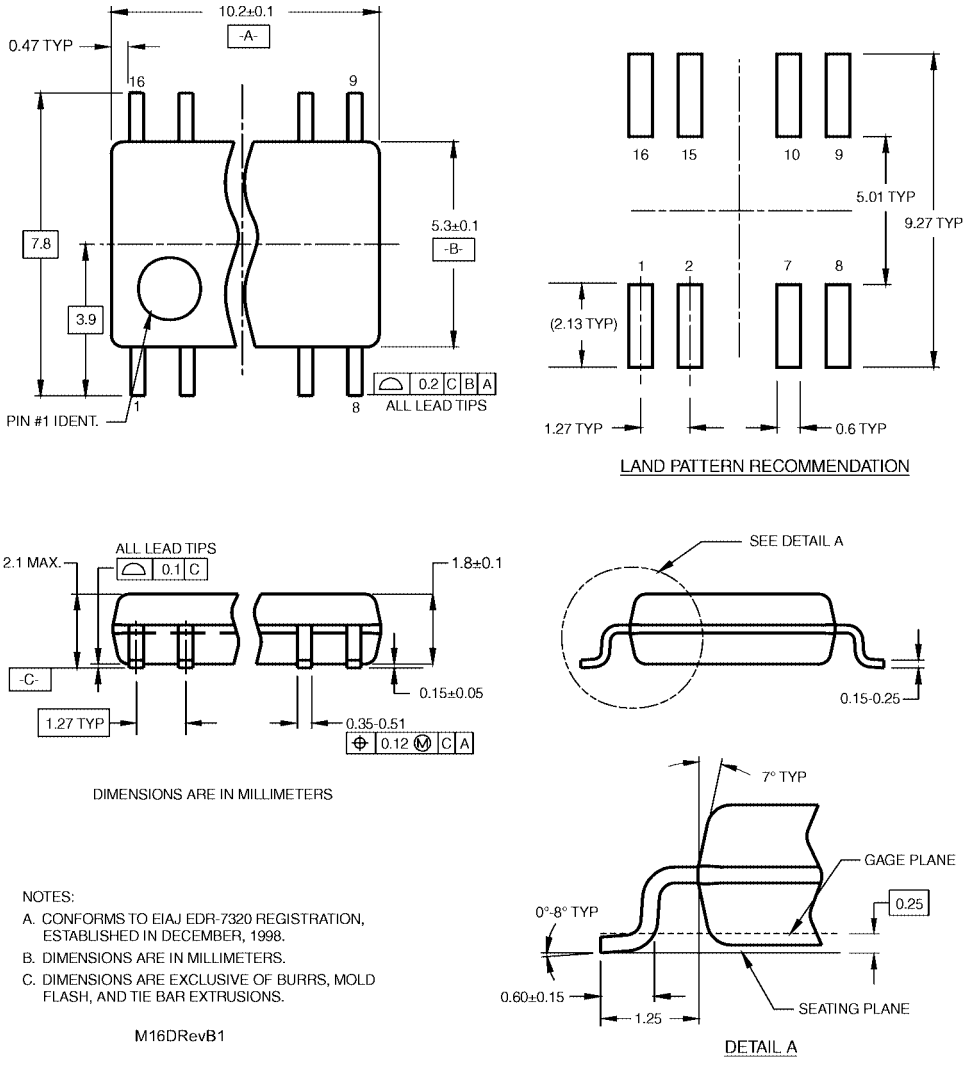


## Physical Dimensions inches (millimeters) unless otherwise noted




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

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




NOTES:

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

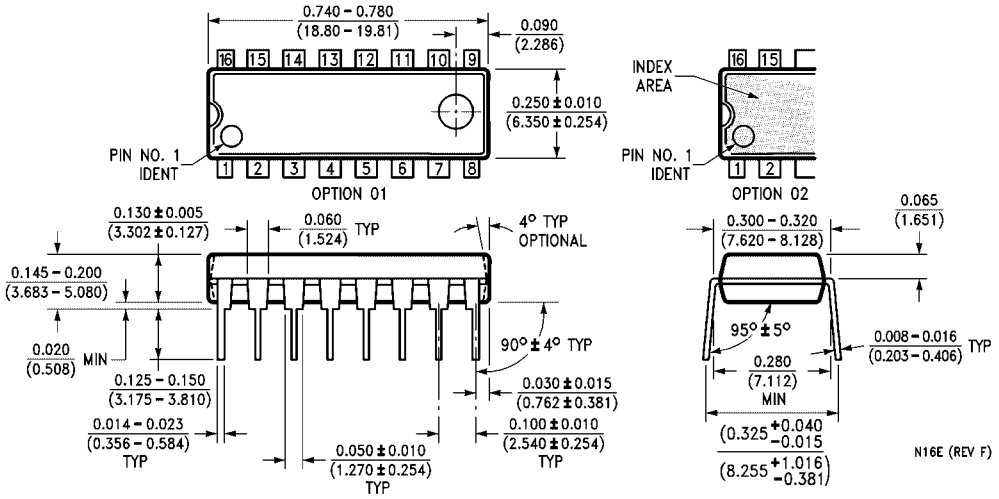
B. DIMENSIONS ARE IN MILLIMETERS.

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

M16DRevB1

**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 Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide**
**Package Number N16E**