

## 74VHC123A Dual Retriggerable Monostable Multivibrator

### General Description

The VHC123A is an advanced high speed CMOS Monostable Multivibrator fabricated with silicon gate CMOS technology. It achieves the high speed operation similar to equivalent Bipolar Schottky TTL while maintaining the CMOS low power dissipation. Each multivibrator features both a negative, A, and a positive, B, transition triggered input, either of which can be used as an inhibit input. Also included is a clear input that when taken low resets the one-shot. The VHC123A can be triggered on the positive transition of the clear while A is held low and B is held high. The output pulse width is determined by the equation:  $PW = (R_x)(C_x)$ ; where PW is in seconds, R is in ohms, and C is in farads.

Limits for  $R_x$  and  $C_x$  are:

- External capacitor,  $C_x$  No limit
- External resistors,  $R_x$   $V_{CC} = 2.0V$ , 5 k $\Omega$  min
- $V_{CC} > 3.0V$ , 1 k $\Omega$  min

An input protection circuit ensures that 0 to 7V can be applied to the input pins without regard to the supply voltage. This device can be used to interface 5V to 3V systems and two supply systems such as battery back up. This circuit prevents device destruction due to mismatched supply and input voltages.

### Features

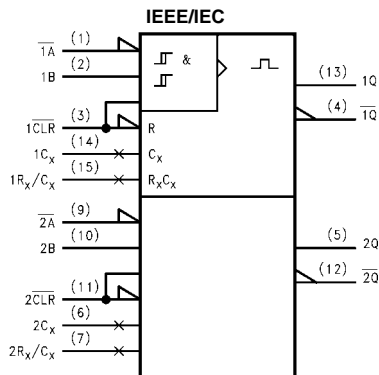
- High Speed:
  - $t_{PD} = 8.1$  ns (typ) at  $T_A = 25^\circ C$
- Low Power Dissipation:
  - $I_{CC} = 4$   $\mu A$  (Max) at  $T_A = 25^\circ C$
- Active State:  $I_{CC} = 600$   $\mu A$  (Max) at  $T_A = 25^\circ C$
- High Noise Immunity:  $V_{NIH} = V_{NIL} = 28\%$   $V_{CC}$  (min)
- Power down protection is provided on all inputs
- Pin and function compatible with 74HC123A

### Ordering Code:

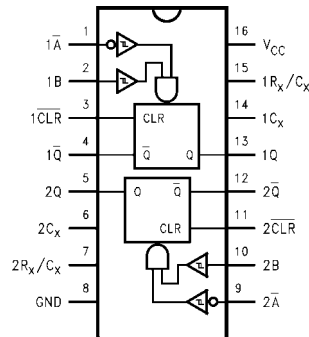
Order Number	Package Number	Package Description
74VHC123AM	M16A	16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow
74VHC123ASJ	M16D	16-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide
74VHC123AMTC	MTC16	16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide
74VHC123AN	N16E	16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide

Surface mount packages are also available on Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

### Logic Symbol



### Connection Diagram



### Pin Descriptions

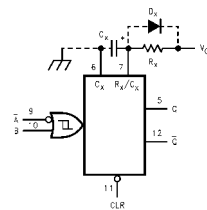
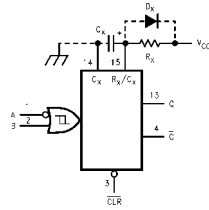
Pin Names	Description
$\bar{A}$	Trigger Inputs (Negative Edge)
B	Trigger Inputs (Positive Edge)
$\overline{\text{CLR}}$	Reset Inputs
$C_x$	External Capacitor
$R_x$	External Resistor
Q, $\bar{Q}$	Outputs

### Truth Table

Inputs			Outputs		Function
$\bar{A}$	B	$\overline{\text{CLR}}$	Q	$\bar{Q}$	
~	H	H	~	~	Output Enable
X	L	H	L	H	Inhibit
H	X	H	L	H	Inhibit
L	~	H	~	~	Output Enable
L	H	~	~	~	Output Enable
X	X	L	L	H	Reset

H = HIGH Voltage Level      ~ = HIGH-to-LOW Transition  
 L = LOW Voltage Level      ~ = LOW-to-HIGH Transition  
 X = Don't Care

### Block Diagrams



**Note A:**  $C_x$ ,  $R_x$ ,  $D_x$  are external Capacitor, Resistor, and Diode, respectively.

**Note B:** External clamping diode,  $D_x$ ;

External capacitor is charged to  $V_{CC}$  level in the wait state, i.e. when no trigger is applied.

If the supply voltage is turned off,  $C_x$  discharges mainly through the internal (parasitic) diode. If  $C_x$  is sufficiently large and  $V_{CC}$  drops rapidly, there will be some possibility of damaging the IC through inrush current or latch-up. If the capacitance of the supply voltage filter is large enough and  $V_{CC}$  drops slowly, the inrush current is automatically limited and damage to the IC is avoided.

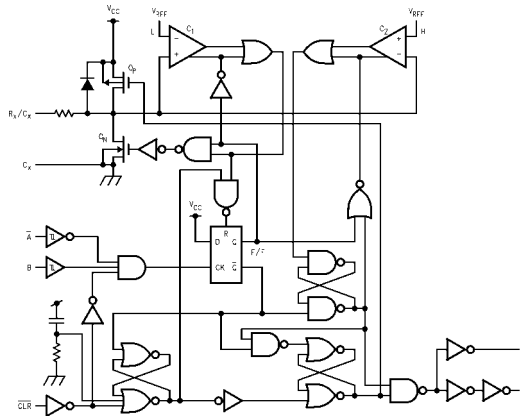
The maximum value of forward current through the parasitic diode is  $\pm 20$  mA. In the case of a large  $C_x$ , the limit of fall time of the supply voltage is determined as follows:

$$t_f \geq (V_{CC} - 0.7) C_x / 20 \text{ mA}$$

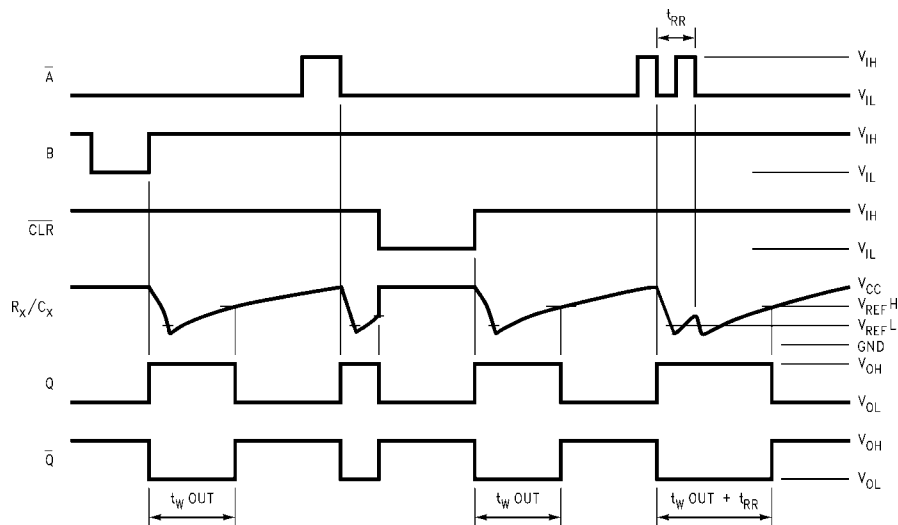
( $t_f$  is the time between the supply voltage turn off and the supply voltage reaching 0.4  $V_{CC}$ )

In the event a system does not satisfy the above condition, an external clamping diode ( $D_x$ ) is needed to protect the IC from inrush current.

### System Diagram



## Timing Chart



## Functional Description

### 1. Stand-by State

The external capacitor ( $C_x$ ) is fully charged to  $V_{CC}$  in the Stand-by State. That means, before triggering, the  $Q_p$  and  $Q_n$  transistors which are connected to the  $R_x/C_x$  node are in the off state. Two comparators that relate to the timing of the output pulse, and two reference voltage supplies turn off. The total supply current is only leakage current.

### 2. Trigger Operation

Trigger operation is effective in any of the following three cases. First, the condition where the  $\bar{A}$  input is LOW, and B input has a rising signal; second, where the B input is HIGH, and the A input has a falling signal; and third, where the  $\bar{A}$  input is LOW and the B input is HIGH, and the  $\overline{CLR}$  input has a rising signal.

After a trigger becomes effective, comparators  $C_1$  and  $C_2$  start operating, and  $Q_n$  is turned on. The external capacitor discharges through  $Q_n$ . The voltage level at the  $R_x/C_x$  node drops. If the  $R_x/C_x$  voltage level falls to the internal reference voltage  $V_{refL}$ , the output of  $C_1$  becomes LOW. The flip-flop is then reset and  $Q_n$  turns off. At that moment  $C_1$  stops but  $C_2$  continues operating.

After  $Q_n$  turns off, the voltage at the  $R_x/C_x$  node starts rising at a rate determined by the time constant of external capacitor  $C_x$  and resistor  $R_x$ .

Upon triggering, output Q becomes HIGH, following some delay time of the internal F/F and gates. It stays HIGH even if the voltage of  $R_x/C_x$  changes from falling to rising. When  $R_x/C_x$  reaches the internal reference

voltage  $V_{refH}$ , the output of  $C_2$  becomes LOW, the output Q goes LOW and  $C_2$  stops its operation. That means, after triggering, when the voltage level of the  $R_x/C_x$  node reaches  $V_{refH}$ , the IC returns to its MONOSTABLE state.

With large values of  $C_x$  and  $R_x$ , and ignoring the discharge time of the capacitor and internal delays of the IC, the width of the output pulse,  $t_W$  (OUT), is as follows:

$$t_W (\text{OUT}) = 1.0 C_x R_x$$

### 3. Retrigger operation (74VHC123A)

When a new trigger is applied to either input  $\bar{A}$  or B while in the MONOSTABLE state, it is effective only if the IC is charging  $C_x$ . The voltage level of the  $R_x/C_x$  node then falls to  $V_{refL}$  level again. Therefore the Q output stays HIGH if the next trigger comes in before the time period set by  $C_x$  and  $R_x$ .

If the new trigger is very close to a previous trigger, such as an occurrence during the discharge cycle, it will have no effect.

The minimum time for a trigger to be effective 2nd trigger,  $t_{RR}$  (Min), depends on  $V_{CC}$  and  $C_x$ .

### 4. Reset Operation

In normal operation, the  $\overline{CLR}$  input is held HIGH. If  $\overline{CLR}$  is LOW, a trigger has no effect because the Q output is held LOW and the trigger control F/F is reset. Also,  $Q_p$  turns on and  $C_x$  is charged rapidly to  $V_{CC}$ .

This means if  $\overline{CLR}$  is set LOW, the IC goes into a wait state.

**Absolute Maximum Ratings** (Note 1)

Supply Voltage ( $V_{CC}$ )	-0.5V to +7.0V
DC Input Voltage ( $V_{IN}$ )	-0.5V to +7.0V
DC Output Voltage ( $V_{OUT}$ )	-0.5 to $V_{CC} + 0.5V$
Input Diode Current ( $I_{IK}$ )	-20 mA
Output Diode Current ( $I_{OK}$ )	$\pm 20$ mA
DC Output Current ( $I_{OUT}$ )	$\pm 25$ mA
DC $V_{CC}$ /Current ( $I_{CC}$ )	$\pm 50$ mA
Storage Temperature ( $T_{STG}$ )	-65°C to 150°C
Lead Temperature ( $T_L$ )	
Soldering, 10 seconds	260°C

**Recommended Operating Conditions** (Note 2)

Supply Voltage ( $V_{CC}$ )	2.0V to +5.5V
Input Voltage ( $V_{IN}$ )	0V to +5.5V
Output Voltage ( $V_{OUT}$ )	0V to $V_{CC}$
Operating Temperature ( $T_{opr}$ )	-40° to +85°C
Input Rise and Fall Time ( $t_r, t_f$ ) ( $\overline{CLR}$ only)	
$V_{CC} = 3.3V \pm 0.3V$	0 ~ 100 ns/V
$V_{CC} = 5.0V \pm 0.5V$	0 ~ 20 ns/V
External Capacitor - $C_x$	No Limitation (Note 3) F
External Resistor - $R_x$	>5 k $\Omega$ (Note 3) ( $V_{CC} = 2.0V$ ) >1 k $\Omega$ (Note 3) ( $V_{CC} > 3.0V$ )

**Note 1:** Absolute maximum ratings are values beyond which the device may be damaged or have its useful life impaired. 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 outside data book specifications.

**Note 2:** Unused inputs must be held HIGH or LOW. They may not float.

**Note 3:** The maximum allowable values of  $C_x$  and  $R_x$  are a function of the leakage of capacitor  $C_x$ , the leakage of the device, and leakage due to board layout and surface resistance. Susceptibility to externally induced noise signals may occur for  $R_x > 1$  M $\Omega$ .

**DC Electrical Characteristics**

Symbol	Parameter	$V_{CC}$ (V)	$T_A = 25^\circ\text{C}$			$T_A = -40^\circ \text{ to } 85^\circ\text{C}$		Units	Conditions	
			Min	Typ	Max	Min	Max			
$V_{IH}$	HIGH Level	2.0	1.50			1.50		V		
	Input Voltage	3.0 – 5.5	0.7 $V_{CC}$			0.7 $V_{CC}$				
$V_{IL}$	LOW Level	2.0		0.50		0.50		V		
	Input Voltage	3.0 – 5.5		0.3 $V_{CC}$		0.3 $V_{CC}$				
$V_{OH}$	HIGH Level Output Voltage	2.0	1.9	2.0		1.9		V	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OH} = -50 \mu\text{A}$
		3.0	2.9	3.0		2.9				
		4.5	4.4	4.5		4.4				$I_{OH} = -4 \text{ mA}$ $I_{OH} = -8 \text{ mA}$
		3.0	2.58			2.48				
4.5	3.94			3.80						
$V_{OL}$	LOW Level Output Voltage	2.0		0.0	0.1		0.1	V	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 50 \mu\text{A}$
		3.0		0.0	0.1		0.1			
		4.5		0.0	0.1		0.1			
		3.0			0.36		0.44			
4.5			0.36		0.44		$I_{OL} = 4 \text{ mA}$ $I_{OL} = 8 \text{ mA}$			
$I_{IN}$	Input Leakage Current	0 – 5.5			$\pm 0.1$		$\pm 1.0$	$\mu\text{A}$	$V_{IN} = 5.5V$ or GND	
$I_{IN}$	$R_x/C_x$ Terminal Off-State Current	5.5			$\pm 0.25$		$\pm 2.50$	$\mu\text{A}$	$V_{IN} = V_{CC}$ or GND	
$I_{CC}$	Quiescent Supply Current	5.5			4.0		40.0	$\mu\text{A}$	$V_{IN} = V_{CC}$ or GND	
$I_{CC}$	Active—State	3.0		160	250		280	$\mu\text{A}$	$V_{IN} = V_{CC}$ or GND $R_x/C_x = 0.5 V_{CC}$	
	(Note 4)	4.5		380	500		650			
	Supply Current	5.5		560	750		975			

**Note 4:** Per Circuit

AC Electrical Characteristics (Note 5)									
Symbol	Parameter	V <sub>CC</sub> (V)	T <sub>A</sub> = 25°C			T <sub>A</sub> = -40°C to +85°C		Units	Conditions
			Min	Typ	Max	Min	Max		
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (A, B-Q, Q̄)	3.3 ± 0.3		13.4	20.6	1.0	24.0	ns	C <sub>L</sub> = 15 pF
				15.9	24.1	1.0	27.5		C <sub>L</sub> = 50 pF
		5.0 ± 0.5		8.1	12.0	1.0	14.0	ns	C <sub>L</sub> = 15 pF
				9.6	14.0	1.0	16.0		C <sub>L</sub> = 50 pF
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (CLR Trigger-Q, Q̄)	3.3 ± 0.3		14.5	22.4	1.0	26.0	ns	C <sub>L</sub> = 15 pF
				17.0	25.9	1.0	29.5		C <sub>L</sub> = 50 pF
		5.0 ± 0.5		8.7	12.9	1.0	15.0	ns	C <sub>L</sub> = 15 pF
				10.2	14.9	1.0	17.0		C <sub>L</sub> = 50 pF
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (CLR-Q, Q̄)	3.3 ± 0.3		10.3	15.8	1.0	18.5	ns	C <sub>L</sub> = 15 pF
				12.8	19.3	1.0	22.0		C <sub>L</sub> = 50 pF
		5.0 ± 0.5		6.3	9.4	1.0	11.0	ns	C <sub>L</sub> = 15 pF
				7.8	11.4	1.0	13.0		C <sub>L</sub> = 50 pF
t <sub>WOUT</sub>	Output Pulse Width	3.3 ± 0.3		160	240		300	ns	C <sub>L</sub> = 50 pF C <sub>X</sub> = 28 pF
		5.0 ± 0.5		133	200		240		R <sub>X</sub> = 2 kΩ
		3.3 ± 0.3	90	100	110	90	110	μs	C <sub>L</sub> = 50 pF C <sub>X</sub> = 0.01 μF
		5.0 ± 0.5	90	100	110	90	110		R <sub>X</sub> = 10 kΩ
		3.3 ± 0.3	0.9	1.0	1.1	0.9	1.1	ms	C <sub>L</sub> = 50 pF C <sub>X</sub> = 0.1 μF
		5.0 ± 0.5	0.9	1.0	1.1	0.9	1.1		R <sub>X</sub> = 10 kΩ
Δt <sub>WOUT</sub>	Output Pulse Width Error Between Circuits (In same Package)			±1				%	
C <sub>IN</sub>	Input Capacitance			4	10		10	pF	V <sub>CC</sub> = Open
C <sub>PD</sub>	Power Dissipation Capacitance			73				pF	(Note 6)

**Note 5:** Refer to Timing Chart.

**Note 6:** C<sub>PD</sub> is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the equation:

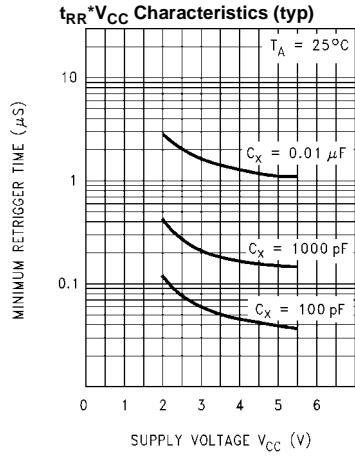
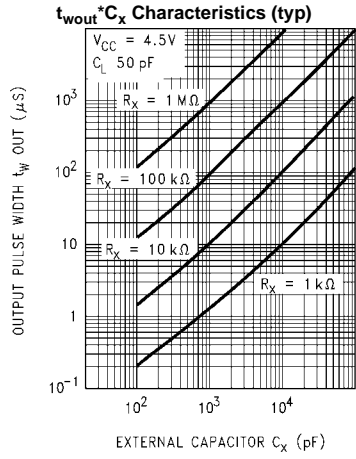
$$I_{CC}(\text{opr.}) = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}^1 \cdot \text{Duty}/100 + I_{CC}/2 \text{ (per Circuit)}$$

I<sub>CC</sub><sup>1</sup>: Active Supply Current  
Duty:%

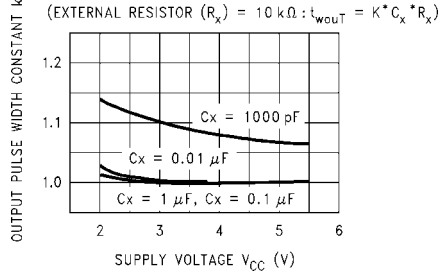
AC Operating Requirement (Note 7)									
Symbol	Parameter	V <sub>CC</sub> (V)	T <sub>A</sub> = 25°C			T <sub>A</sub> = -40°C to +85°C		Units	Conditions
			Min	Typ	Max	Min	Max		
t <sub>W(L)</sub>	Minimum Trigger	3.3		5.0			5.0	ns	
t <sub>W(H)</sub>	Pulse Width	5.0		5.0			5.0		
t <sub>W(L)</sub>	Minimum Clear Pulse Width	3.3		5.0			5.0	ns	
		5.0		5.0			5.0		
t <sub>RR</sub>	Minimum Retrigger Time	3.3 ± 0.3		60				ns	R <sub>X</sub> = 1 kΩ
		5.0 ± 0.5		39					C <sub>X</sub> = 100 pF
		3.3		1.5				μs	R <sub>X</sub> = 1 kΩ
		5.0		1.2					C <sub>X</sub> = 0.01 μF

**Note 7:** Refer to Timing Chart.

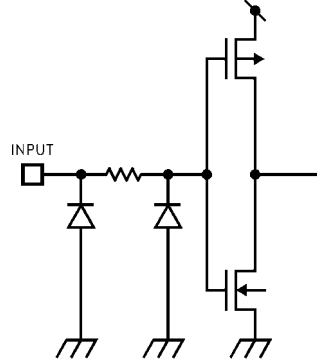
Device Characteristics



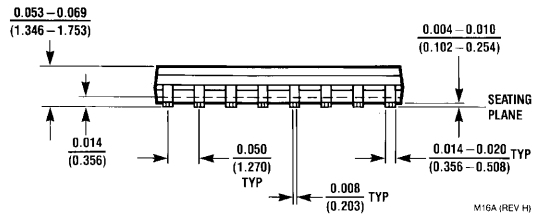
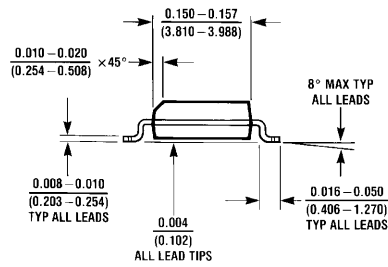
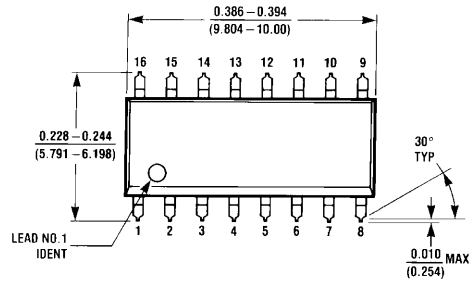
**Output Pulse Width Constant K-Supply Voltage (Typical)**



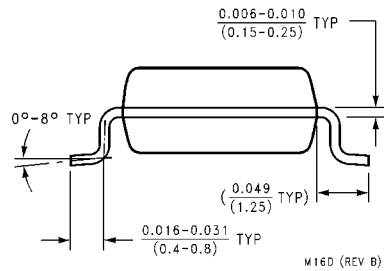
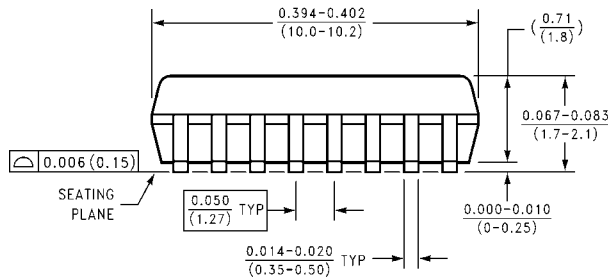
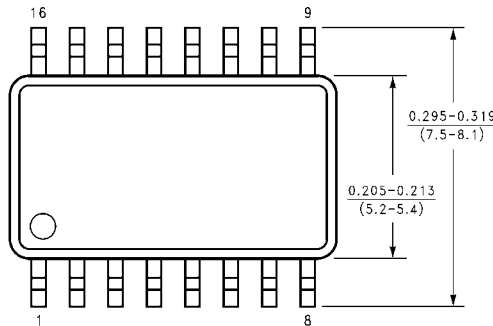
**Input Equivalent Circuit**



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

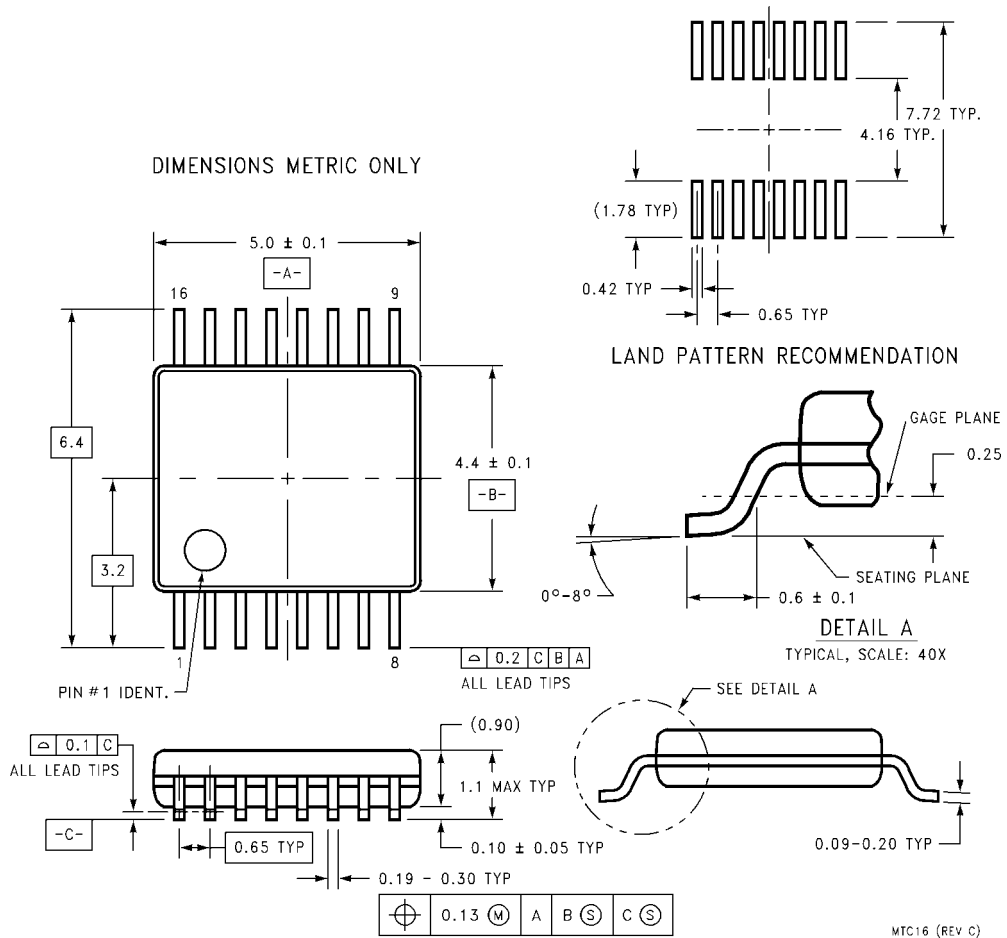


**16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow  
Package Number M16A**



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

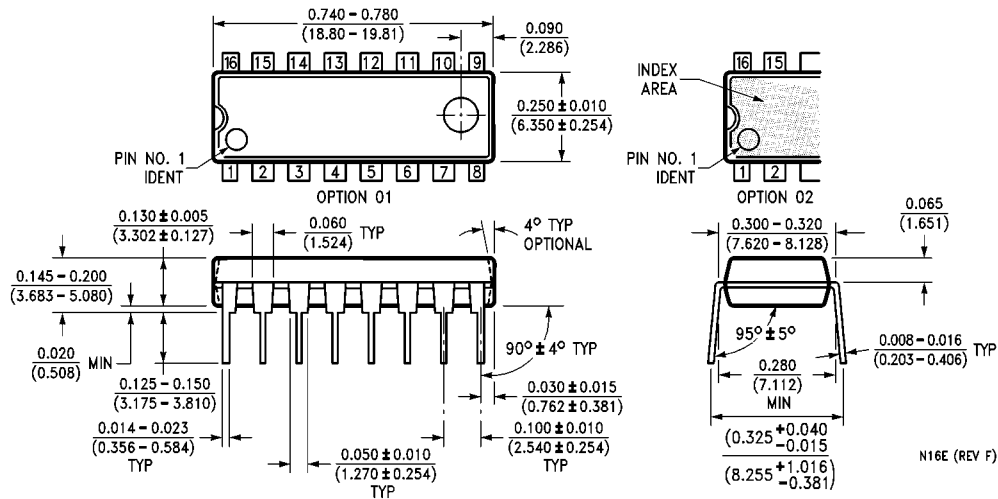
**Physical Dimensions** inches (millimeters) unless otherwise noted (Continued)



**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)



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

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2. A critical component in any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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