

## MM74HC595 8-Bit Shift Registers with Output Latches

### General Description

The MM74HC595 high speed shift register utilizes advanced silicon-gate CMOS technology. This device possesses the high noise immunity and low power consumption of standard CMOS integrated circuits, as well as the ability to drive 15 LS-TTL loads.

This device contains an 8-bit serial-in, parallel-out shift register that feeds an 8-bit D-type storage register. The storage register has 8 3-STATE outputs. Separate clocks are provided for both the shift register and the storage register. The shift register has a direct-overriding clear, serial input, and serial output (standard) pins for cascading. Both the shift register and storage register use positive-edge triggered clocks. If both clocks are connected together, the shift register state will always be one clock pulse ahead of the storage register.

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

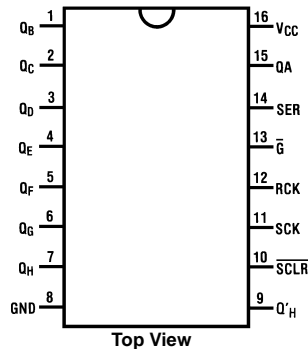
- Low quiescent current: 80  $\mu$ A maximum (74HC Series)
- Low input current: 1  $\mu$ A maximum
- 8-bit serial-in, parallel-out shift register with storage
- Wide operating voltage range: 2V–6V
- Cascadable
- Shift register has direct clear
- Guaranteed shift frequency: DC to 30 MHz

### Ordering Code:

Order Number	Package Number	Package Description
MM74HC595M	M16A	16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow
MM74HC595SJ	M16D	16-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide
MM74HC595MTC	MTC16	16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide
MM74HC595N	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

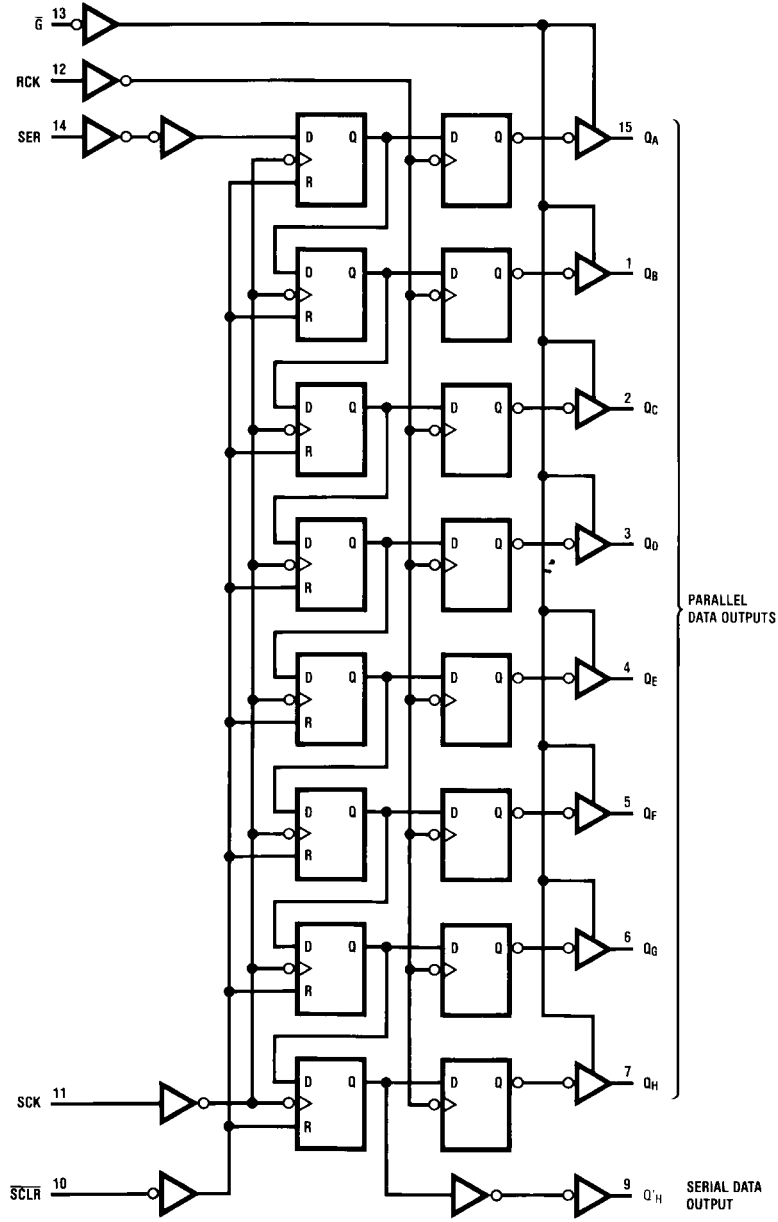


### Truth Table

RCK	SCK	SCLR	G	Function
X	X	X	H	$Q_A$ thru $Q_H = 3$ -STATE
X	X	L	L	Shift Register cleared $Q'_H = 0$
X	$\uparrow$	H	L	Shift Register clocked $Q_N = Q_{N-1}$ , $Q_0 = SER$
$\uparrow$	X	H	L	Contents of Shift Register transferred to output latches

**Logic 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 ( $I_{IK}, I_{OK}$ )	$\pm 20$ mA
DC Output Current, per pin ( $I_{OUT}$ )	$\pm 35$ mA
DC $V_{CC}$ or GND Current, per pin ( $I_{CC}$ )	$\pm 70$ 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	$V_{CC}$	$T_A = 25^\circ\text{C}$			Units	
				Typ	Guaranteed Limits			
$V_{IH}$	Minimum HIGH Level Input Voltage		2.0V		1.5	1.5	V	
			4.5V		3.15	3.15		
			6.0V		4.2	4.2		
$V_{IL}$	Maximum LOW Level Input Voltage		2.0V		0.5	0.5	V	
			4.5V		1.35	1.35		
			6.0V		1.8	1.8		
$V_{OH}$	Minimum HIGH Level Output Voltage	$V_{IN} = V_{IH}$ or $V_{IL}$ $ I_{OUT}  \leq 20 \mu\text{A}$	2.0V	2.0	1.9	1.9	V	
			4.5V	4.5	4.4	4.4		
			6.0V	6.0	5.9	5.9		
	$Q'_H$	$V_{IN} = V_{IH}$ or $V_{IL}$ $ I_{OUT}  \leq 4.0 \text{ mA}$ $ I_{OUT}  \leq 5.2 \text{ mA}$	4.5V	4.2	3.98	3.84	V	
			6.0V	5.2	5.48	5.34		
	$Q_A$ thru $Q_H$	$V_{IN} = V_{IH}$ or $V_{IL}$ $ I_{OUT}  \leq 6.0 \text{ mA}$ $ I_{OUT}  \leq 7.8 \text{ mA}$	4.5V	4.2	3.98	3.84	V	
6.0V			5.7	5.48	5.34			
$V_{OL}$	Maximum LOW Level Output Voltage	$V_{IN} = V_{IH}$ or $V_{IL}$ $ I_{OUT}  \leq 20 \mu\text{A}$	2.0V	0	0.1	0.1	V	
			4.5V	0	0.1	0.1		
			6.0V	0	0.1	0.1		
	$Q'_H$	$V_{IN} = V_{IH}$ or $V_{IL}$ $ I_{OUT}  \leq 4 \text{ mA}$ $ I_{OUT}  \leq 5.2 \text{ mA}$	4.5V	0.2	0.26	0.33	V	
			6.0V	0.2	0.26	0.33		
	$Q_A$ thru $Q_H$	$V_{IN} = V_{IH}$ or $V_{IL}$ $ I_{OUT}  \leq 6.0 \text{ mA}$ $ I_{OUT}  \leq 7.8 \text{ mA}$	4.5V	0.2	0.26	0.33	V	
6.0V			0.2	0.26	0.33			
$I_{IN}$	Maximum Input Current	$V_{IN} = V_{CC}$ or GND	6.0V		$\pm 0.1$	$\pm 1.0$	$\mu\text{A}$	
$I_{OZ}$	Maximum 3-STATE Output Leakage	$V_{OUT} = V_{CC}$ or GND $G = V_{IH}$	6.0V		$\pm 0.5$	$\pm 5.0$	$\mu\text{A}$	
$I_{CC}$	Maximum Quiescent Supply Current	$V_{IN} = V_{CC}$ or GND $I_{OUT} = 0 \mu\text{A}$	6.0V		8.0	80	160	$\mu\text{A}$

**Note 4:** For a power supply of  $5V \pm 10\%$  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

$V_{CC} = 5V$ ,  $T_A = 25^\circ C$ ,  $t_r = t_f = 6\text{ ns}$

Symbol	Parameter	Conditions	Typ	Guaranteed Limit	Units
$f_{MAX}$	Maximum Operating Frequency of SCK		50	30	MHz
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay, SCK to $Q'_H$	$C_L = 45\text{ pF}$	12	20	ns
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay, RCK to $Q_A$ thru $Q_H$	$C_L = 45\text{ pF}$	18	30	ns
$t_{PZH}$ , $t_{PZL}$	Maximum Output Enable Time from $\bar{G}$ to $Q_A$ thru $Q_H$	$R_L = 1\text{ k}\Omega$ $C_L = 45\text{ pF}$	17	28	ns
$t_{PHZ}$ , $t_{PLZ}$	Maximum Output Disable Time from $\bar{G}$ to $Q_A$ thru $Q_H$	$R_L = k\Omega$ $C_L = 5\text{ pF}$	15	25	ns
$t_S$	Minimum Setup Time from SER to SCK			20	ns
$t_S$	Minimum Setup Time from $\overline{SCLR}$ to SCK			20	ns
$t_S$	Minimum Setup Time from SCK to RCK (Note 5)			40	ns
$t_H$	Minimum Hold Time from SER to SCK			0	ns
$t_W$	Minimum Pulse Width of SCK or RCK			16	ns

**Note 5:** This setup time ensures the register will see stable data from the shift-register outputs. The clocks may be connected together in which case the storage register state will be one clock pulse behind the shift register.

## AC Electrical Characteristics

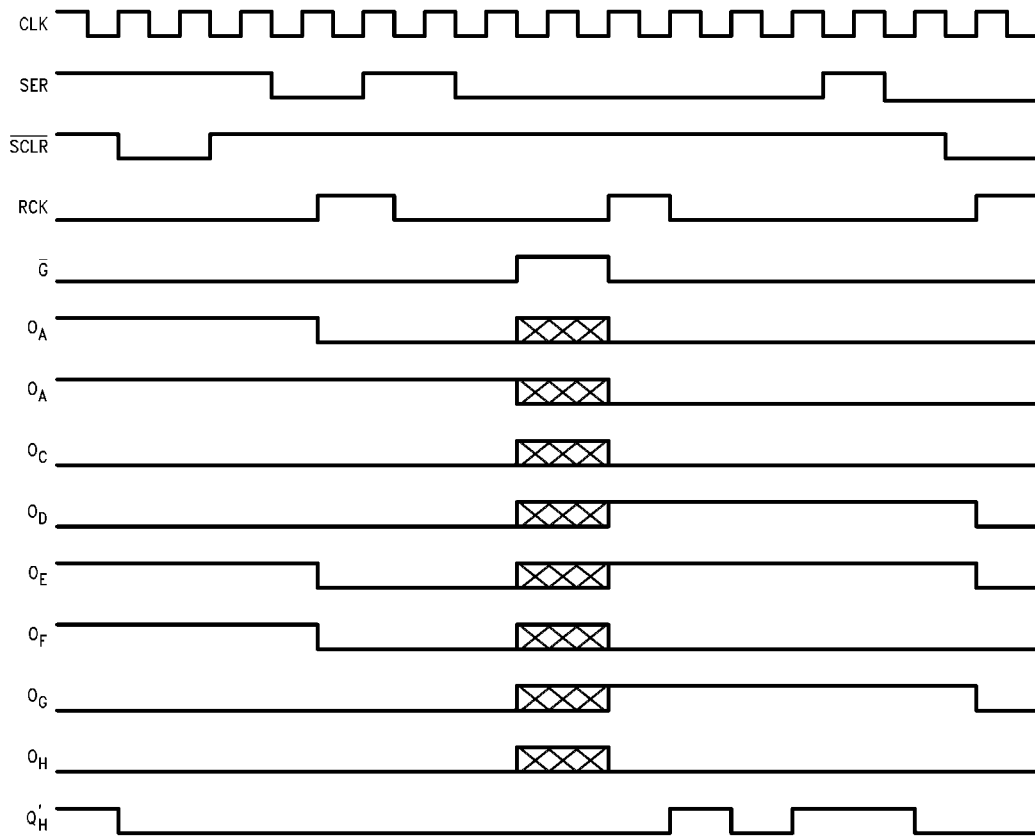
$V_{CC} = 2.0\text{--}6.0V$ ,  $C_L = 50\text{ pF}$ ,  $t_r = t_f = 6\text{ ns}$  (unless otherwise specified)


Symbol	Parameter	Conditions	$V_{CC}$	$T_A = 25^\circ C$		$T_A = -40\text{ to }85^\circ C$	$T_A = -55\text{ to }125^\circ C$	Units	
				Typ	Guaranteed Limits				
$f_{MAX}$	Maximum Operating Frequency	$C_L = 50\text{ pF}$	2.0V	10	6	4.8	4.0	MHz	
			4.5V	45	30	24	20		
			6.0V	50	35	28	24		
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay from SCK to $Q'_H$	$C_L = 50\text{ pF}$	2.0V	58	210	265	315	ns	
			$C_L = 150\text{ pF}$	2.0V	83	294	367	441	
			$C_L = 50\text{ pF}$	4.5V	14	42	53	63	ns
			$C_L = 150\text{ pF}$	4.5V	17	58	74	88	
			$C_L = 50\text{ pF}$	6.0V	10	36	45	54	ns
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay from RCK to $Q_A$ thru $Q_H$	$C_L = 150\text{ pF}$	2.0V	14	50	63	76	ns	
			$C_L = 50\text{ pF}$	2.0V	70	175	220	265	
			$C_L = 150\text{ pF}$	2.0V	105	245	306	368	
			$C_L = 50\text{ pF}$	4.5V	21	35	44	53	ns
			$C_L = 150\text{ pF}$	4.5V	28	49	61	74	
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay from $\overline{SCLR}$ to $Q'_H$		2.0V	18	30	37	45	ns	
			4.5V	26	42	53	63		
			6.0V	26	42	53	63		
			6.0V	30	37	44	44		
$t_{PZH}$ , $t_{PZL}$	Maximum Output Enable from $\bar{G}$ to $Q_A$ thru $Q_H$	$R_L = 1\text{ k}\Omega$	$C_L = 50\text{ pF}$	2.0V	75	175	220	265	ns
			$C_L = 150\text{ pF}$	2.0V	100	245	306	368	
			$C_L = 50\text{ pF}$	4.5V	15	35	44	53	
			$C_L = 150\text{ pF}$	4.5V	20	49	61	74	
			$C_L = 50\text{ pF}$	6.0V	13	30	37	45	
$C_L = 150\text{ pF}$	6.0V	17	42	53	63	ns			

AC Electrical Characteristics (Continued)								
Symbol	Parameter	Conditions	V <sub>CC</sub>	T <sub>A</sub> = 25°C		T <sub>A</sub> = -40 to 85°C	T <sub>A</sub> = -55 to 125°C	Units
				Typ	Guaranteed Limits			
t <sub>PHZ</sub> , t <sub>PLZ</sub>	Maximum Output Disable Time from $\overline{G}$ to Q <sub>A</sub> thru Q <sub>H</sub>	R <sub>L</sub> = 1 kΩ C <sub>L</sub> = 50 pF	2.0V	75	175	220	265	ns
			4.5V	15	35	44	53	
			6.0V	13	30	37	45	
t <sub>S</sub>	Minimum Setup Time from SER to SCK		2.0V		100	125	150	ns
			4.5V		20	25	30	
			6.0V		17	21	25	
t <sub>R</sub>	Minimum Removal Time from SCLR to SCK		2.0V		50	63	75	ns
			4.5V		10	13	15	
			6.0V		9	11	13	
t <sub>S</sub>	Minimum Setup Time from SCK to RCK		2.0V		100	125	150	ns
			4.5V		20	25	30	
			6.0V		17	21	26	
t <sub>H</sub>	Minimum Hold Time SER to SCK		2.0V		5	5	5	ns
			4.5V		5	5	5	
			6.0V		5	5	5	
t <sub>W</sub>	Minimum Pulse Width of SCK or SCLR		2.0V	30	80	100	120	ns
			4.5V	9	16	20	24	
			6.0V	8	14	18	22	
t <sub>r</sub> , t <sub>f</sub>	Maximum Input Rise and Fall Time, Clock		2.0V		1000	1000	1000	ns
			4.5V		500	500	500	
			6.0V		400	400	400	
t <sub>THL</sub> , t <sub>TLH</sub>	Maximum Output Rise and Fall Time Q <sub>A</sub> -Q <sub>H</sub>		2.0V	25	60	75	90	ns
			4.5V	7	12	15	18	
			6.0V	6	10	13	15	
t <sub>THL</sub> , t <sub>TLH</sub>	Maximum Output Rise & Fall Time Q' <sub>H</sub>		2.0V		75	95	110	ns
			4.5V		15	19	22	
			6.0V		13	16	19	
C <sub>PD</sub>	Power Dissipation Capacitance, Outputs Enabled (Note 6)	$\overline{G} = V_{CC}$ $\overline{G} = GND$		90 150				pF
C <sub>IN</sub>	Maximum Input Capacitance			5	10	10	10	pF
C <sub>OUT</sub>	Maximum Output Capacitance			15	20	20	20	pF

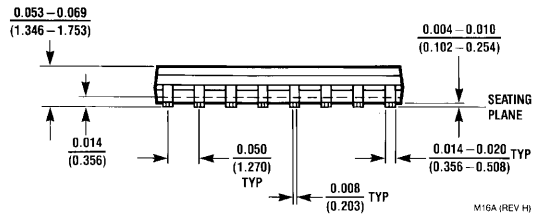
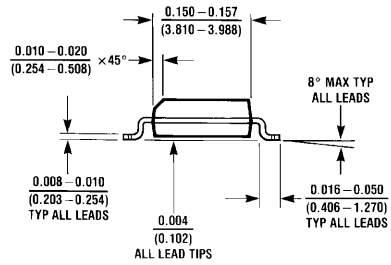
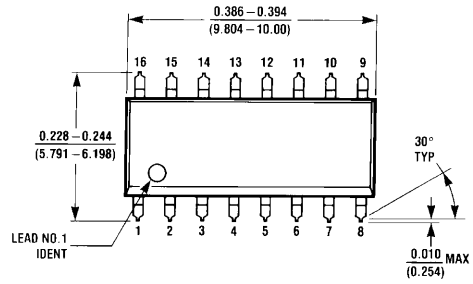
**Note 6:** C<sub>PD</sub> determines the no load dynamic power consumption, P<sub>D</sub> = C<sub>PD</sub> V<sub>CC</sub><sup>2</sup>f + I<sub>CC</sub> V<sub>CC</sub>, and the no load dynamic current consumption, I<sub>S</sub> = C<sub>PD</sub> V<sub>CC</sub> f + I<sub>CC</sub>.

## Timing Diagram



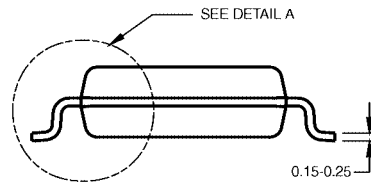
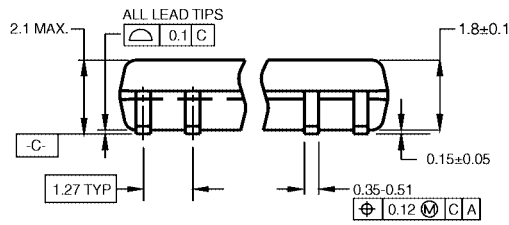
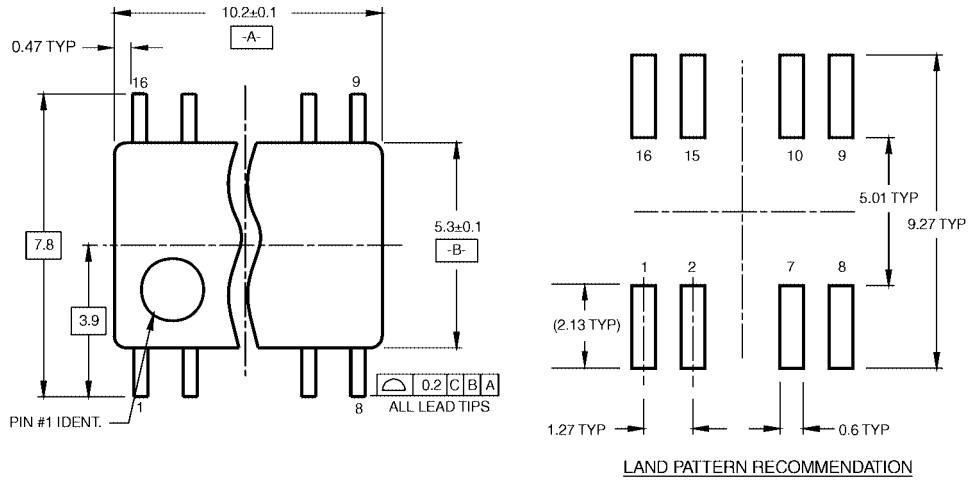
NOTE:  implies that the output is in 3-STATE mode.

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



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

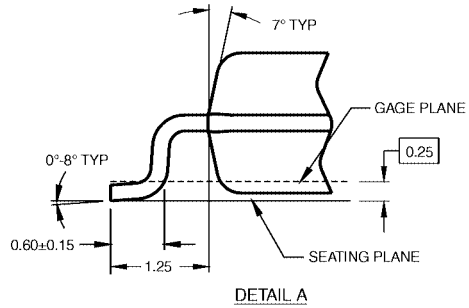
**Physical Dimensions** inches (millimeters) unless otherwise noted (Continued)



DIMENSIONS ARE IN MILLIMETERS

- 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.

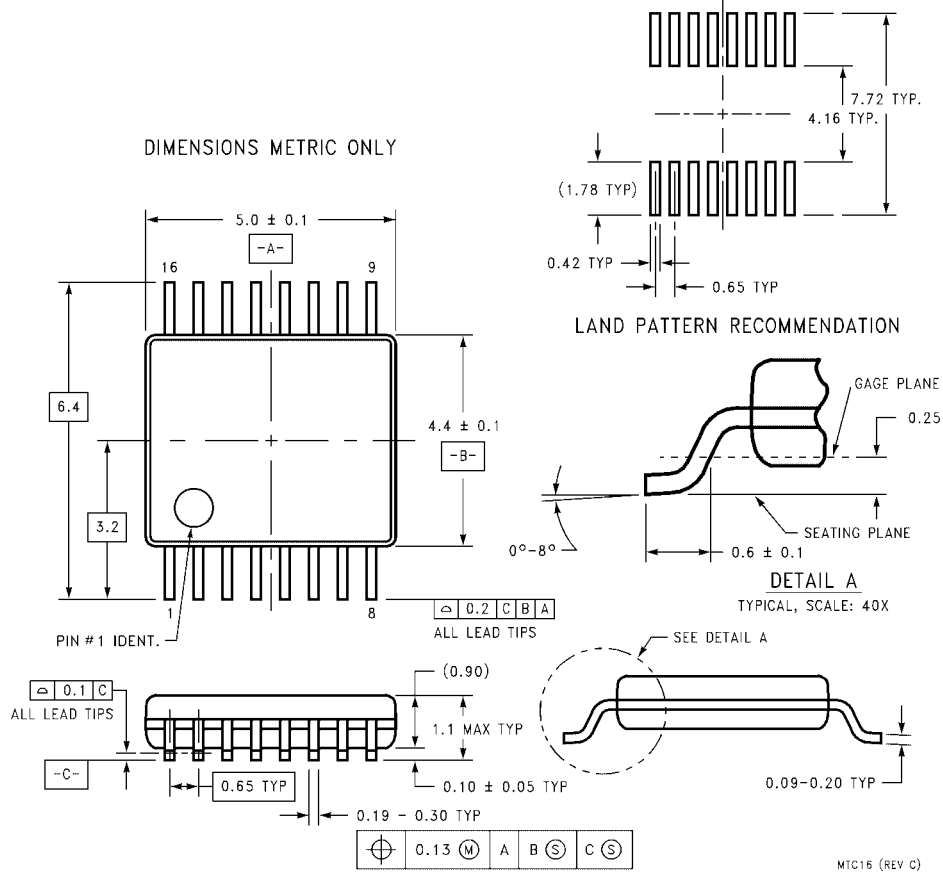
M16DRevB1



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

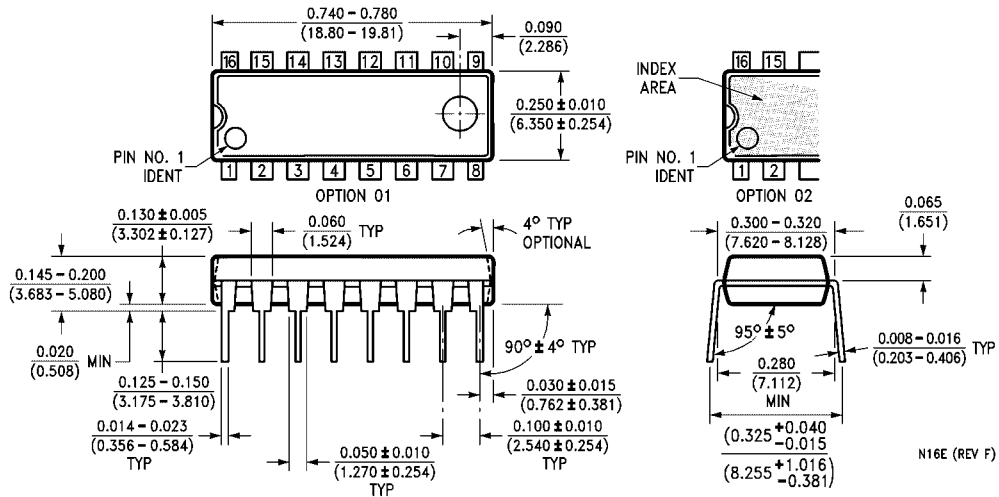


**Physical Dimensions** inches (millimeters) unless otherwise noted (Continued)



**16-Lead 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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