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# 74VHC595

## 8-Bit Shift Register with Output Latches

### Features

- High Speed:  $t_{PD} = 5.4ns$  (Typ.) at  $V_{CC} = 5V$
- Low power dissipation:  $I_{CC} = 4\mu A$  (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
- Low noise:  $V_{OLP} = 0.9V$  (Typ.)
- Pin and function compatible with 74HC595

### General Description

The VHC595 is an advanced high-speed CMOS Shift Register 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.

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 eight 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.

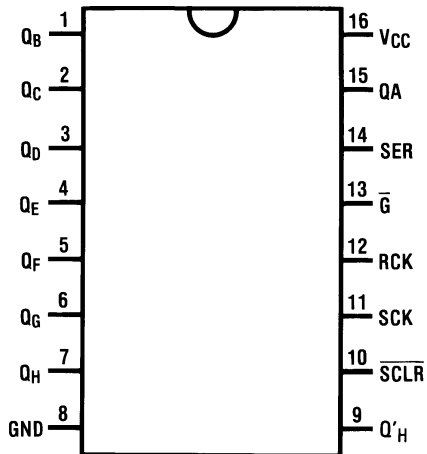
An input protection circuit insures that 0V to 7V can be applied to the input pins without regard to the supply voltage. This device can be used to interface 5V to 3V systems and two supply systems such as battery backup. This circuit prevents device destruction due to mismatched supply and input voltages.

### Ordering Information

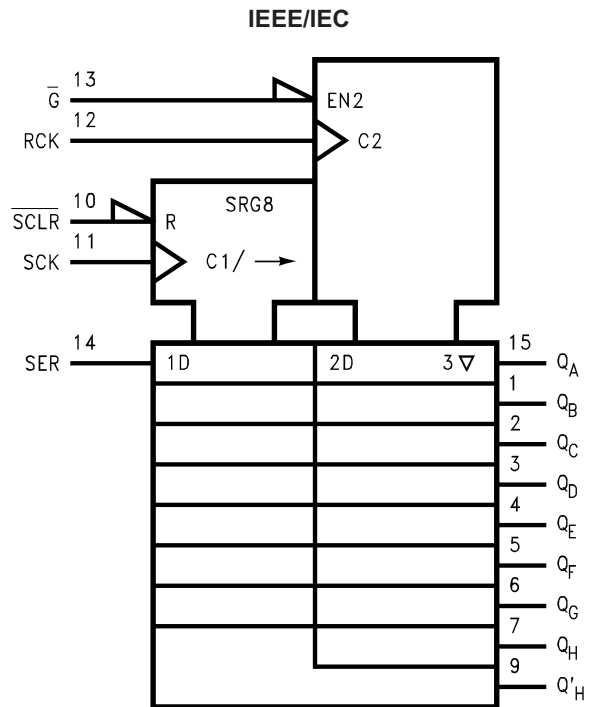
Order Number	Package Number	Package Description
74VHC595M	M16A	16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow
74VHC595SJ	M16D	16-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide
74VHC595MTC	MTC16	16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide

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

### Connection Diagram



### Logic Symbol



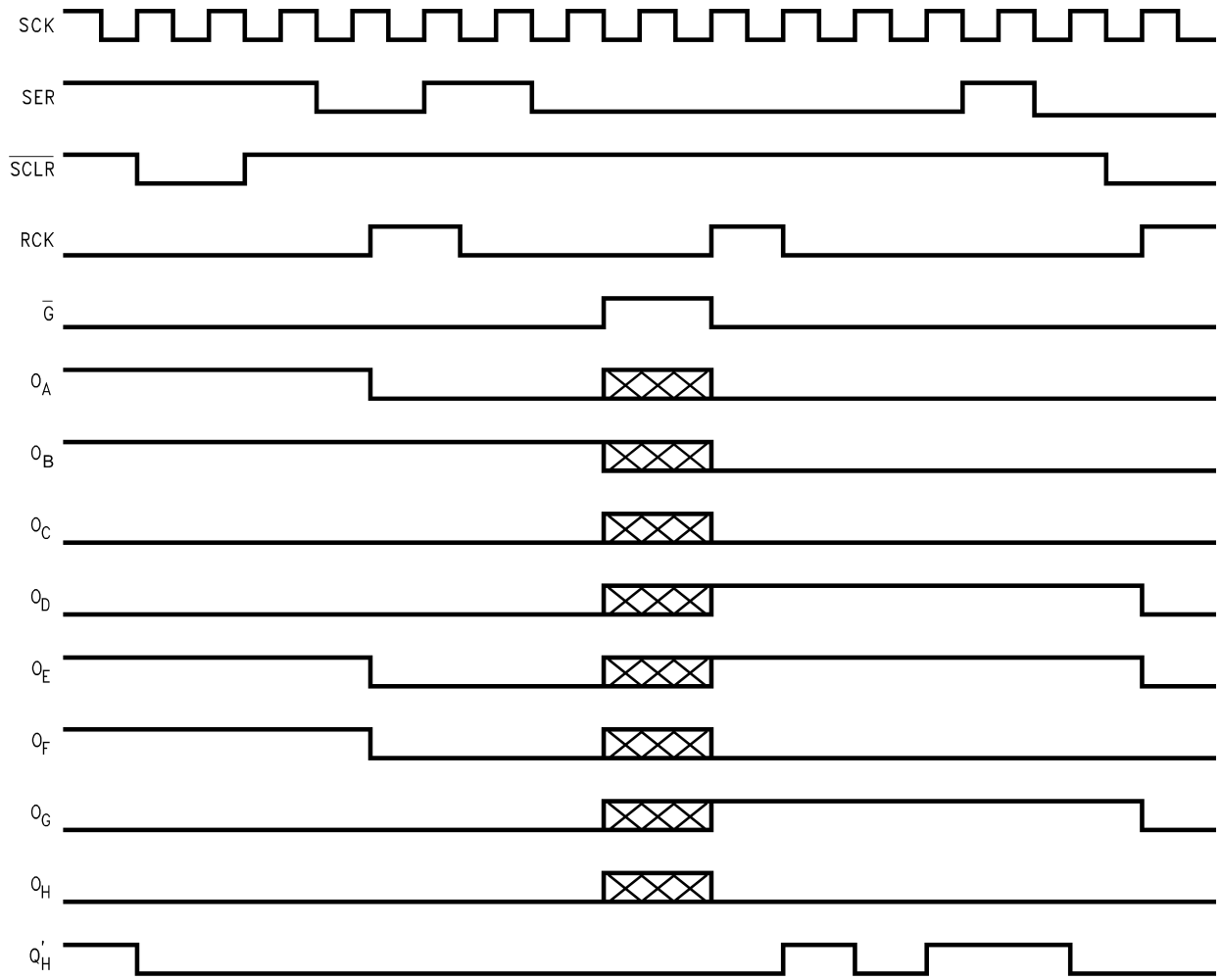
### Pin Description


Pin Names	Description
SER	Serial Data Input
SCK	Shift Register Clock Input (Active rising edge)
RCK	Storage Register Clock Input (Active rising edge)
$\overline{\text{SCLR}}$	Reset Input
$\overline{\text{G}}$	3-STATE Output Enable Input (Active LOW)
$Q_A - Q_H$	Parallel Data Outputs
$Q'_H$	Serial Data Output

### Truth Table

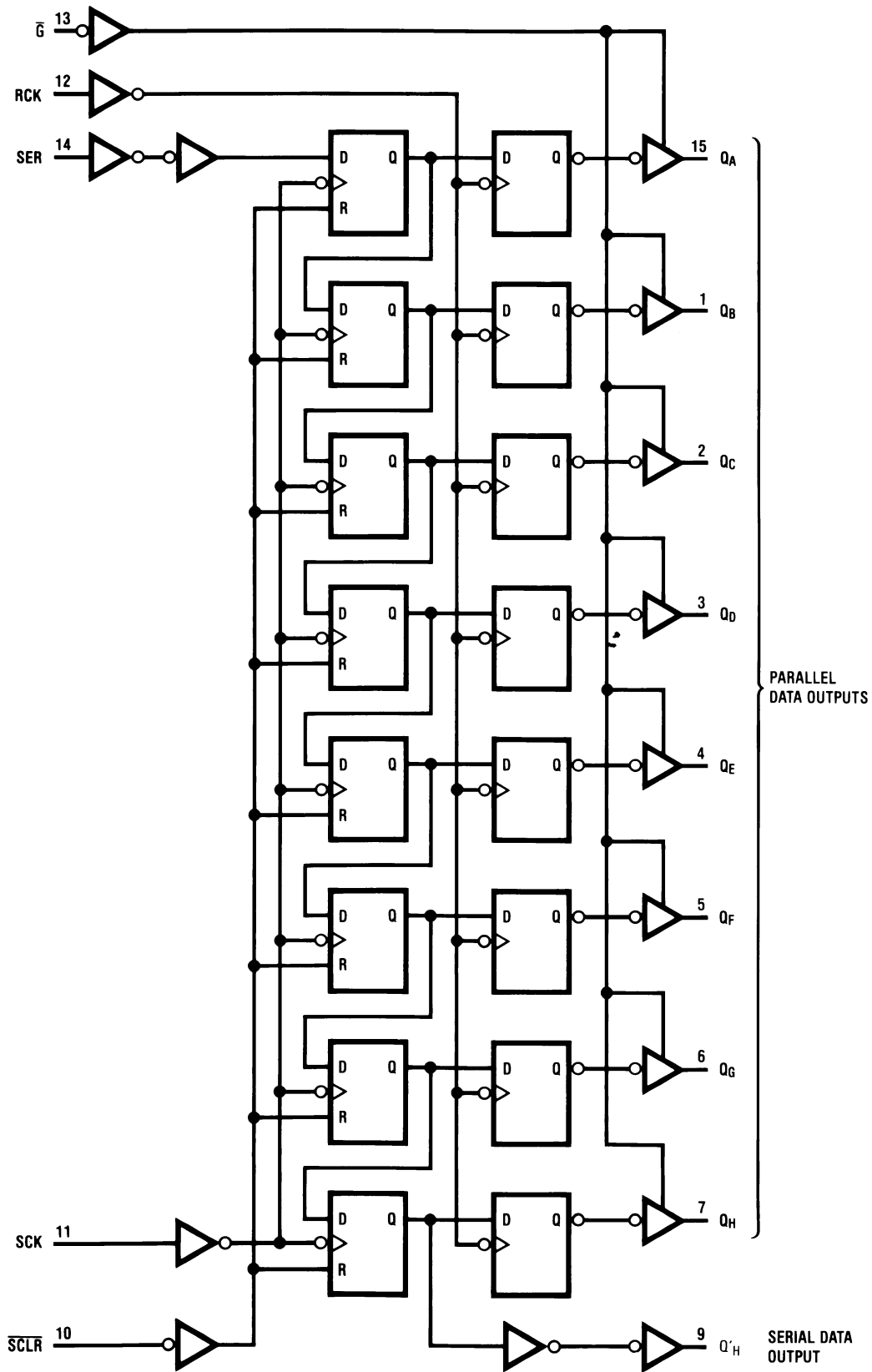
Inputs					Function
SER	RCK	SCK	$\overline{\text{SCLR}}$	$\overline{\text{G}}$	
X	X	X	X	H	$Q_A$ thru $Q_H$ 3-STATE
X	X	X	X	L	$Q_A$ thru $Q_H$ outputs enabled
X	X	X	L	L	Shift Register cleared: $Q'_H = 0$
L	X	$\uparrow$	H	L	Shift Register clocked: $Q_N = Q_{n-1}$ , $Q_0 = \text{SER} = \text{L}$
H	X	$\uparrow$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

Timing Diagram



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

Logic Diagram (positive logic)



## Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

Symbol	Parameter	Rating
$V_{CC}$	Supply Voltage	-0.5V to +7.0V
$V_{IN}$	DC Input Voltage	-0.5V to +7.0V
$V_{OUT}$	DC Output Voltage	-0.5V to $V_{CC} + 0.5V$
$I_{IK}$	Input Diode Current	-20mA
$I_{OK}$	Output Diode Current	$\pm 20mA$
$I_{OUT}$	DC Output Current	$\pm 25mA$
$I_{CC}$	DC $V_{CC}$ /GND Current	$\pm 75mA$
$T_{STG}$	Storage Temperature	-65°C to +150°C
$T_L$	Lead Temperature (Soldering, 10 seconds)	260°C

## Recommended Operating Conditions<sup>(1)</sup>

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to absolute maximum ratings.

Symbol	Parameter	Rating
$V_{CC}$	Supply Voltage	2.0V to +5.5V
$V_{IN}$	Input Voltage	0V to +5.5V
$V_{OUT}$	Output Voltage	0V to $V_{CC}$
$T_{OPR}$	Operating Temperature	-40°C to +85°C
$t_r, t_f$	Input Rise and Fall Time $V_{CC} = 3.3V \pm 0.3V$ $V_{CC} = 5.0V \pm 0.5V$	0 ~ 100ns/V 0 ~ 20ns/V

### Note:

1. Unused inputs must be held HIGH or LOW. They may not float.

## DC Electrical Characteristics

Symbol	Parameter	V <sub>CC</sub> (V)	Conditions	T <sub>A</sub> = 25°C			T <sub>A</sub> = -40°C to +85°C		Units			
				Min.	Typ.	Max.	Min.	Max.				
V <sub>IH</sub>	HIGH Level Input Voltage	2.0		1.50			1.50		V			
		3.0 – 5.5		0.7 x V <sub>CC</sub>			0.7 x V <sub>CC</sub>					
V <sub>IL</sub>	LOW Level Input Voltage	2.0				0.50		0.50	V			
		3.0 – 5.5				0.3 x V <sub>CC</sub>		0.3 x V <sub>CC</sub>				
V <sub>OH</sub>	HIGH Level Output Voltage	2.0	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OH</sub> = -50μA	1.9	2.0		1.9		V		
		3.0			2.9	3.0		2.9				
		4.5			4.4	4.5		4.4				
		3.0				I <sub>OH</sub> = -4mA	2.58				2.48	
		4.5				I <sub>OH</sub> = -8mA	3.94				3.80	
V <sub>OL</sub>	LOW Level Output Voltage	2.0	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OL</sub> = 50μA		0.0	0.1		0.1	V		
		3.0				0.0	0.1		0.1			
		4.5				0.0	0.1		0.1			
		3.0				I <sub>OL</sub> = 4mA			0.36		0.44	
		4.5				I <sub>OL</sub> = 8mA			0.36		0.44	
I <sub>OZ</sub>	3-STATE Output Off-State Current	5.5	V <sub>IN</sub> = V <sub>CC</sub> or GND, V <sub>OUT</sub> = V <sub>CC</sub> or GND, V <sub>IN</sub> $\bar{G}$ = V <sub>IH</sub> or V <sub>IL</sub>				±0.25		±2.5	μA		
I <sub>IN</sub>	Input Leakage Current	0 – 5.5	V <sub>IN</sub> = 5.5V or GND				±0.1		±1.0	μA		
I <sub>CC</sub>	Quiescent Supply Current	5.5	V <sub>IN</sub> = V <sub>CC</sub> or GND				4.0		40.0	μA		

## Noise Characteristics

Symbol	Parameter	V <sub>CC</sub> (V)	Conditions	T <sub>A</sub> = 25°C		Units
				Typ.	Limits	
V <sub>OLP</sub> <sup>(2)</sup>	Quiet Output Maximum Dynamic V <sub>OL</sub>	5.0	C <sub>L</sub> = 50pF	0.9	1.2	V
V <sub>OLV</sub> <sup>(2)</sup>	Quiet Output Minimum Dynamic V <sub>OL</sub>	5.0	C <sub>L</sub> = 50pF	-0.9	-1.2	V
V <sub>IHD</sub> <sup>(2)</sup>	Minimum HIGH Level Dynamic Input Voltage	5.0	C <sub>L</sub> = 50pF		3.5	V
V <sub>ILD</sub> <sup>(2)</sup>	Maximum LOW Level Dynamic Input Voltage	5.0	C <sub>L</sub> = 50pF		1.5	V

**Note:**

2. Parameter guaranteed by design.

## AC Electrical Characteristics

Symbol	Parameter	V <sub>CC</sub> (V)	Conditions	T <sub>A</sub> = +25°C			T <sub>A</sub> = -40°C to +85°C		Units
				Min.	Typ.	Max.	Min.	Max.	
t <sub>PLH</sub> , t <sub>PHL</sub>	Propagation Delay Time, RCK to Q <sub>A</sub> -Q <sub>H</sub>	3.3 ± 0.3		C <sub>L</sub> = 15pF	7.7	11.9	1.0	13.5	ns
				C <sub>L</sub> = 50pF	10.2	15.4	1.0	17.0	
		5.0 ± 0.5		C <sub>L</sub> = 15pF	5.4	7.4	1.0	8.5	ns
				C <sub>L</sub> = 50pF	6.9	9.4	1.0	10.5	
t <sub>PLH</sub> , t <sub>PHL</sub>	Propagation Delay Time, SCK-Q'H	3.3 ± 0.3		C <sub>L</sub> = 15pF	8.8	13.0	1.0	15.0	ns
				C <sub>L</sub> = 50pF	11.3	16.5	1.0	18.5	
		5.0 ± 0.5		C <sub>L</sub> = 15pF	6.2	8.2	1.0	9.4	ns
				C <sub>L</sub> = 50pF	7.7	10.2	1.0	11.4	
t <sub>PHL</sub>	Propagation Delay Time, SCLR-Q'H	3.3 ± 0.3		C <sub>L</sub> = 15pF	8.4	12.8	1.0	13.7	ns
				C <sub>L</sub> = 50pF	10.9	16.3	1.0	17.2	
		5.0 ± 0.5		C <sub>L</sub> = 15pF	5.9	8.0	1.0	9.1	ns
				C <sub>L</sub> = 50pF	7.4	10.0	1.0	11.1	
t <sub>PZL</sub> , t <sub>PZH</sub>	Output Enable Time, $\bar{G}$ to Q <sub>A</sub> -Q <sub>H</sub>	3.3 ± 0.3	R <sub>L</sub> = 1kΩ	C <sub>L</sub> = 15pF	7.5	11.5	1.0	13.5	ns
				C <sub>L</sub> = 50pF	9.0	15.0	1.0	17.0	
		5.0 ± 0.5		C <sub>L</sub> = 15pF	4.8	8.6	1.0	10.0	ns
				C <sub>L</sub> = 50pF	8.3	10.6	1.0	12.0	
t <sub>PLZ</sub> , t <sub>PHZ</sub>	Output Disable Time, $\bar{G}$ to Q <sub>A</sub> -Q <sub>H</sub>	3.3 ± 0.3	R <sub>L</sub> = 1kΩ	C <sub>L</sub> = 50pF	12.1	15.7	1.0	16.2	ns
		5.0 ± 0.5		C <sub>L</sub> = 50pF	7.6	10.3	1.0	11.0	
f <sub>MAX</sub>	Maximum Clock Frequency	3.3 ± 0.3		C <sub>L</sub> = 15pF	80	150	70		MHz
				C <sub>L</sub> = 50pF	55	130	50		
		5.0 ± 0.5		C <sub>L</sub> = 15pF	135	185	115		MHz
				C <sub>L</sub> = 50pF	95	155	85		
t <sub>OSSLH</sub> , t <sub>OSSL</sub>	Output to Output Skew	3.3 ± 0.3	<sup>(3)</sup>	C <sub>L</sub> = 50pF		1.5		1.5	ns
		5.0 ± 0.5		C <sub>L</sub> = 50pF		1.0		1.0	
C <sub>IN</sub>	Input Capacitance		V <sub>CC</sub> = Open		5.0	10		10	pF
C <sub>OUT</sub>	Output Capacitance		V <sub>CC</sub> = 5.0V		6.0				pF
C <sub>PD</sub>	Power Dissipation Capacitance		<sup>(4)</sup>		87				pF

**Notes:**

- Parameter guaranteed by design. t<sub>OSSLH</sub> = | t<sub>PLH</sub> max - t<sub>PLH</sub> min |; t<sub>OSSL</sub> = | t<sub>PHL</sub> max - t<sub>PHL</sub> min |
- 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:  

$$I_{CC} (\text{Opr.}) = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$$

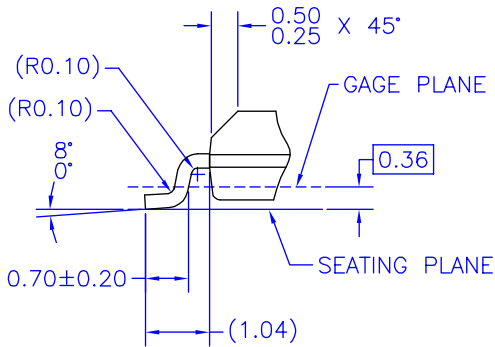
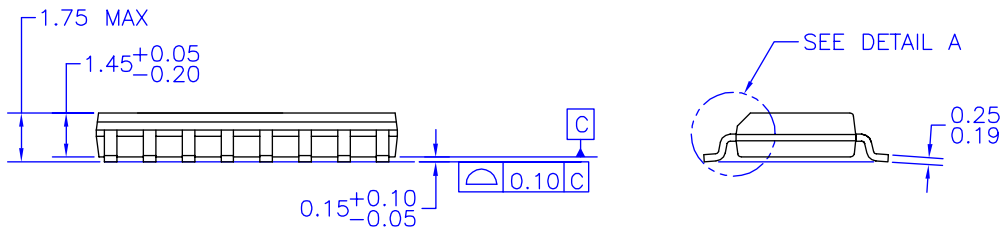
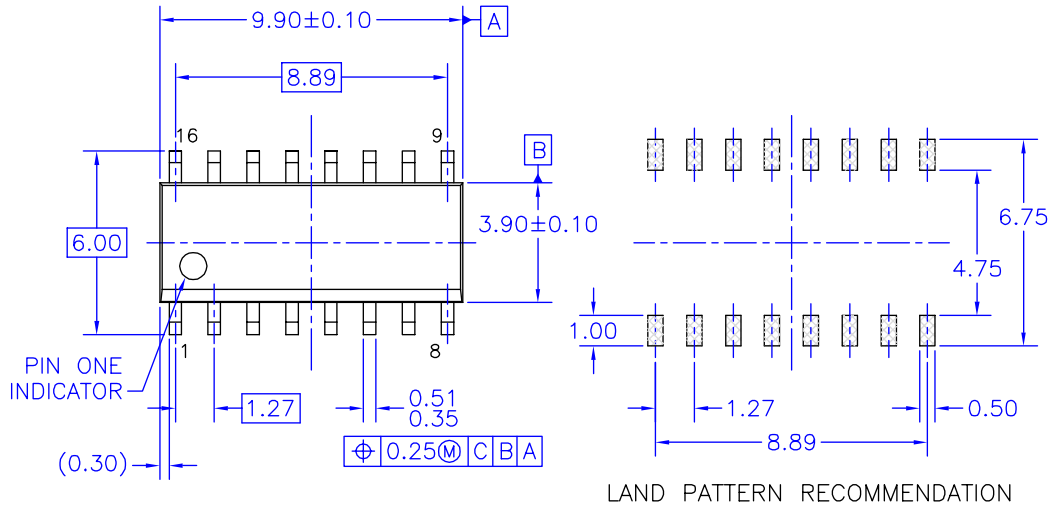


## AC Operating Requirements

Symbol	Parameter	V <sub>CC</sub> (V)	T <sub>A</sub> = 25°C		T <sub>A</sub> = -40°C to +85°C	Units
			Typ.	Guaranteed Minimum		
t <sub>S</sub>	Minimum Setup Time (SER–SCK)	3.3 ± 0.3		3.5	3.5	ns
		5.0 ± 0.5		3.0	3.0	
t <sub>S</sub>	Minimum Setup Time (SCK–RCK)	3.3 ± 0.3		8.0	8.5	ns
		5.0 ± 0.5		5.0	5.0	
t <sub>S</sub>	Minimum Setup Time ( $\overline{\text{SCLR}}$ –RCK)	3.3 ± 0.3		8.0	9.0	ns
		5.0 ± 0.5		5.0	5.0	
t <sub>H</sub>	Minimum Hold Time (SER–SCK)	3.3 ± 0.3		1.5	1.5	ns
		5.0 ± 0.5		2.0	2.0	
t <sub>H</sub>	Minimum Hold Time (SCK–RCK)	3.3 ± 0.3		0.0	0.0	ns
		5.0 ± 0.5		0.0	0.0	
t <sub>H</sub>	Minimum Hold Time ( $\overline{\text{SCLR}}$ –RCK)	3.3 ± 0.3		0.0	0.0	ns
		5.0 ± 0.5		0.0	0.0	
t <sub>W(L)</sub>	Minimum Pulse Width ( $\overline{\text{SCLR}}$ )	3.3 ± 0.3		5.0	5.0	ns
		5.0 ± 0.5		5.0	5.0	
t <sub>W(L)</sub> , t <sub>W(H)</sub>	Minimum Pulse Width (SCK)	3.3 ± 0.3		5.0	5.0	ns
		5.0 ± 0.5		5.0	5.0	
t <sub>W(L)</sub> , t <sub>W(H)</sub>	Minimum Pulse Width (RCK)	3.3 ± 0.3		5.0	5.0	ns
		5.0 ± 0.5		5.0	5.0	
t <sub>rem</sub>	Minimum Removal Time ( $\overline{\text{SCLR}}$ –SCK)	3.3 ± 0.3		3.0	3.0	ns
		5.0 ± 0.5		2.5	2.5	

### Physical Dimensions

Dimensions are in millimeters unless otherwise noted.



NOTES: UNLESS OTHERWISE SPECIFIED

- A) THIS PACKAGE CONFORMS TO JEDEC MS-012, VARIATION AC, ISSUE C, DATED MAY 1990.
- B) ALL DIMENSIONS ARE IN MILLIMETERS.
- C) DIMENSIONS DO NOT INCLUDE MOLD FLASH OR BURRS.
- D) STANDARD LEAD FINISH:  
200 MICRONS / 5.08 MICRONS MIN.  
LEAD/TIN (SOLDER) ON COPPER.

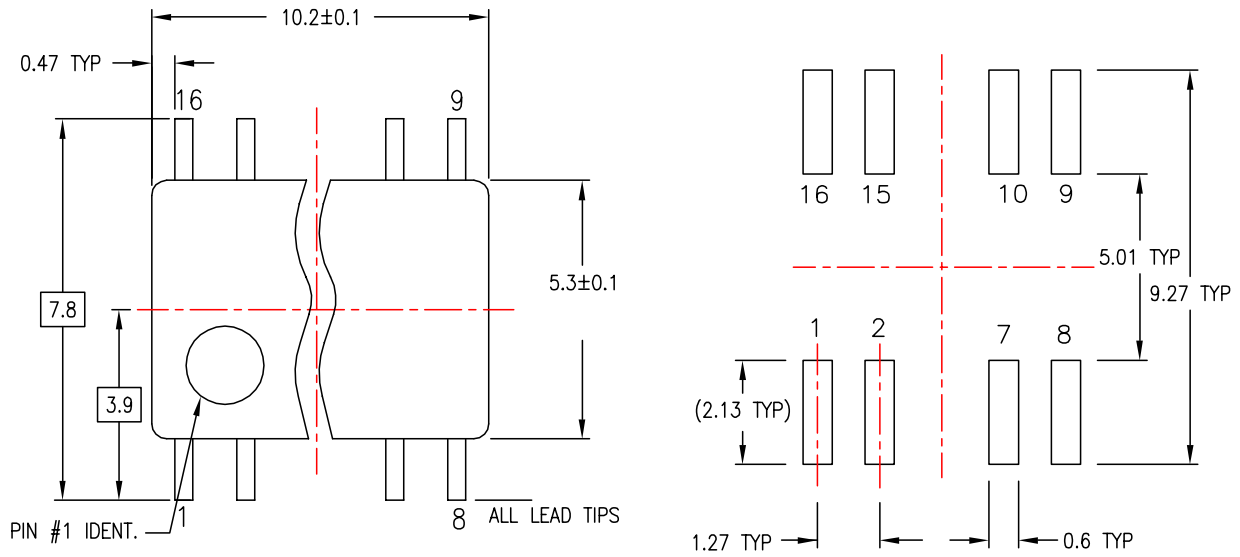
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SCALE: 2:1

M16AREVK

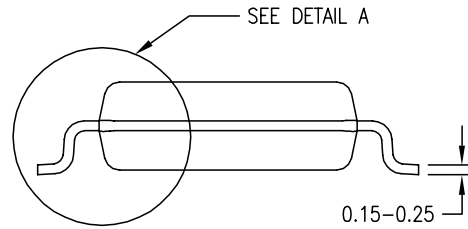
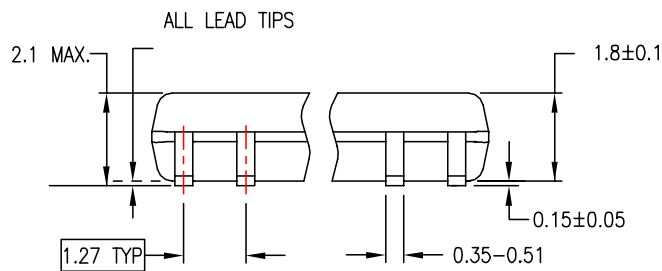
Figure 1. 16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow Package Number M16A

**Physical Dimensions** (Continued)

Dimensions are in millimeters unless otherwise noted.



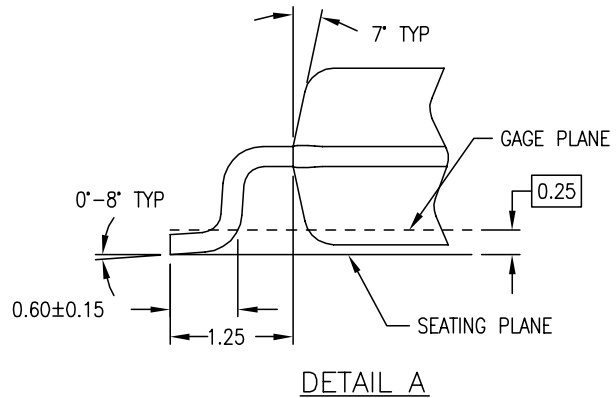
LAND PATTERN RECOMMENDATION



DIMENSIONS ARE IN MILLIMETERS

NOTES:

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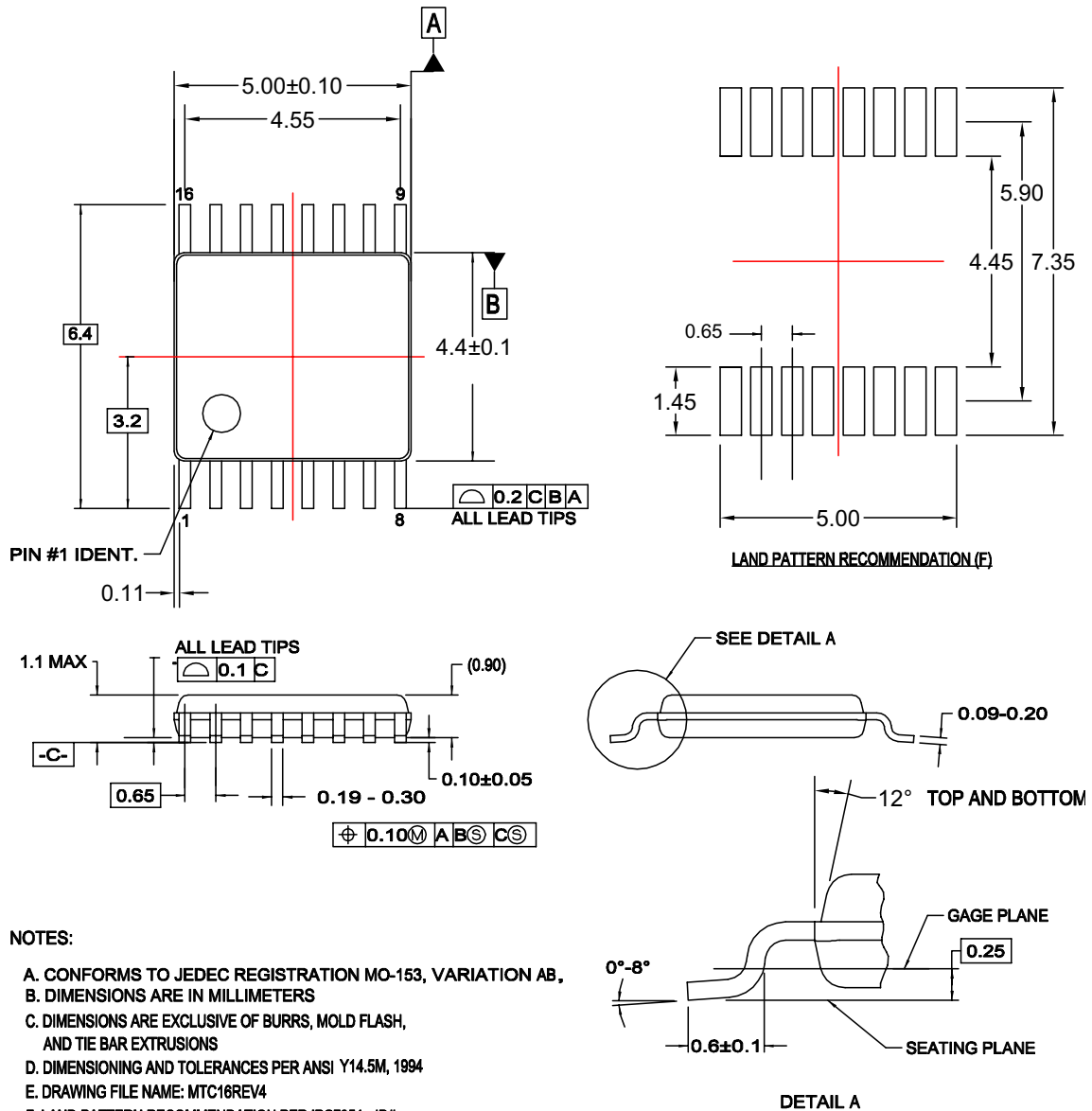


M16DREVC

**Figure 2. 16-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide Package Number M16D**

### Physical Dimensions (Continued)

Dimensions are in millimeters unless otherwise noted.



**NOTES:**

- A. CONFORMS TO JEDEC REGISTRATION MO-153, VARIATION AB,
- B. DIMENSIONS ARE IN MILLIMETERS
- C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS
- D. DIMENSIONING AND TOLERANCES PER ANSI Y14.5M, 1994
- E. DRAWING FILE NAME: MTC16REV4
- F. LAND PATTERN RECOMMENDATION PER IPC7351 - ID# TSOP65P640X110-16N


MTC16rev4

**Figure 3. 16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide Package Number MTC16**



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FACT Quiet Series <sup>™</sup>	OPTOPLANAR <sup>®</sup>	SuperSOT <sup>™</sup> -3	
FACT <sup>®</sup>	PACMAN <sup>™</sup>	SuperSOT <sup>™</sup> -6	
FAST <sup>®</sup>	PDP-SPM <sup>™</sup>	SuperSOT <sup>™</sup> -8	
FASTr <sup>™</sup>	POP <sup>™</sup>	SyncFET <sup>™</sup>	
FPS <sup>™</sup>	Power220 <sup>®</sup>	TCM <sup>™</sup>	
FRFET <sup>®</sup>	Power247 <sup>®</sup>	The Power Franchise <sup>®</sup>	
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