

# 74VHC4316

## Quad Analog Switch with Level Translator

### Features

- Typical switch enable time: 20ns
- Wide analog input voltage range:  $\pm 6V$
- Low "ON" resistance: 50 Typ. ( $V_{CC}-V_{EE} = 4.5V$ )  
30 Typ. ( $V_{CC}-V_{EE} = 9V$ )
- Low quiescent current: 80 $\mu A$  maximum (74VHC)
- Matched switch characteristics
- Individual switch controls plus a common enable
- Pin functional compatible with 74HC4316

### General Description

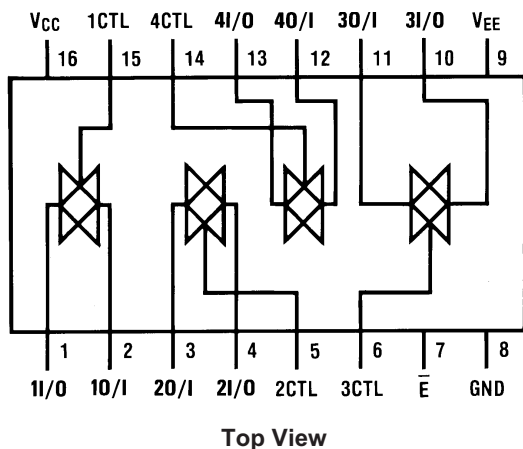
These devices are digitally controlled analog switches implemented in advanced silicon-gate CMOS technology. These switches have low "ON" resistance and low "OFF" leakages. They are bidirectional switches, thus any analog input may be used as an output and vice-versa. Three supply pins are provided on the 4316 to implement a level translator which enables this circuit to operate with 0V–6V logic levels and up to  $\pm 6V$  analog switch levels. The 4316 also has a common enable input in addition to each switch's control which when HIGH will disable all switches to their off state. All analog inputs and outputs and digital inputs are protected from electrostatic damage by diodes to  $V_{CC}$  and ground.

### Ordering Information

Order Number	Package Number	Package Description
74VHC4316M	M16A	16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow
74VHC4316WM	M16B	16-Lead Small Outline Intergrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide
74VHC4316MTC	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.

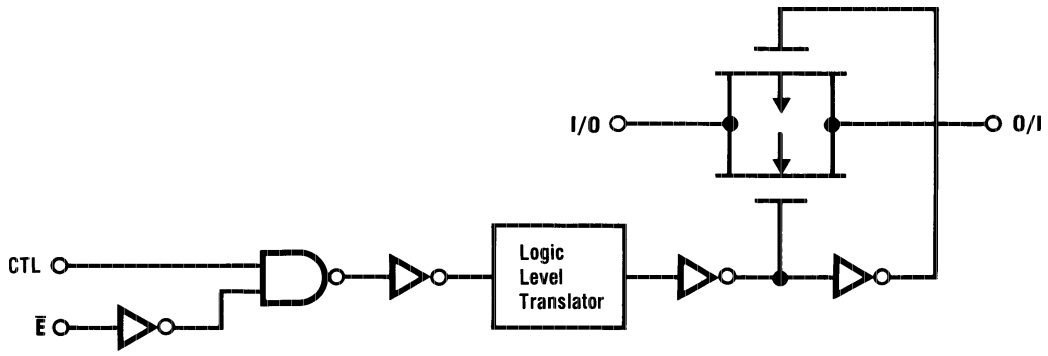
### Connection Diagram



### Truth Table

Inputs		Switch
$\bar{E}$	CTL	I/O–O/I
H	X	"OFF"
L	L	"OFF"
L	H	"ON"

### Logic Diagram



## Absolute Maximum Ratings<sup>(1)</sup>

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	-0.5 to +7.5V
$V_{EE}$	Supply Voltage	+0.5 to -7.5V
$V_{IN}$	DC Control Input Voltage	-1.5 to $V_{CC}+1.5V$
$V_{IO}$	DC Switch I/O Voltage	$V_{EE}-0.5$ to $V_{CC}+0.5V$
$I_{IK}, I_{OK}$	Clamp Diode Current	$\pm 20mA$
$I_{OUT}$	DC Output Current, per pin	$\pm 25mA$
$I_{CC}$	DC $V_{CC}$ or GND Current, per pin	$\pm 50mA$
$T_{STG}$	Storage Temperature Range	-65°C to +150°C
$P_D$	Power Dissipation	600mW
	S.O. Package only	500mW
$T_L$	Lead Temperature (Soldering 10 seconds)	260°C

### Note:

1. Unless otherwise specified all voltages are referenced to ground.

## Recommended Operating Conditions

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	Min.	Max.	Units
$V_{CC}$	Supply Voltage	2	6	V
$V_{EE}$	Supply Voltage	0	-6	V
$V_{IN}, V_{OUT}$	DC Input or Output Voltage	0	$V_{CC}$	V
$T_A$	Operating Temperature Range	-40	+85	°C
$t_r, t_f$	Input Rise or Fall Times			
	$V_{CC} = 2.0V$		1000	ns
	$V_{CC} = 4.5V$		500	
	$V_{CC} = 6.0V$		400	
	$V_{CC} = 12.0V$		250	

DC Electrical Characteristics<sup>(2)</sup>

Symbol	Parameter	Conditions	$V_{EE}$	$V_{CC}$	$T_A = 25^\circ\text{C}$		$T_A = -40^\circ\text{C}$	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	
$R_{ON}$	Minimum "ON" Resistance <sup>(3)</sup>	$V_{CTL} = V_{IH}$ , $I_S = 2.0\text{mA}$ , $V_{IS} = V_{CC}$ to $V_{EE}$ , (Fig. 1)	GND	4.5V	100	170	200	$\Omega$
			-4.5V	4.5V	40	85	105	
			-6.0V	6.0V	30	70	85	
			GND	2.0V	100	180	215	
			GND	4.5V	40	80	100	
			-4.5V	4.5V	50	60	75	
$R_{ON}$	Maximum "ON" Resistance Matching	$V_{CTL} = V_{IH}$ , $V_{IS} = V_{CC}$ to $V_{EE}$	GND	4.5V	10	15	20	$\Omega$
			-4.5V	4.5V	5	10	15	
			-6.0V	6.0V	5	10	15	
			-6.0V	6.0V	20	40	60	
$I_{IN}$	Maximum Control Input Current	$V_{IN} = V_{CC}$ or GND	GND	6.0V		$\pm 0.1$	$\pm 1.0$	$\mu\text{A}$
$I_{IZ}$	Maximum Switch "OFF" Leakage Current	$V_{OS} = V_{CC}$ or $V_{EE}$ , $V_{IS} = V_{EE}$ or $V_{CC}$ , $V_{CTL} = V_{IL}$ (Fig. 2)	GND	6.0V		$\pm 30$	$\pm 300$	nA
			-6.0V	6.0V		$\pm 50$	$\pm 500$	
$I_{IZ}$	Maximum Switch "ON" Leakage Current	$V_{IS} = V_{CC}$ to $V_{EE}$ , $V_{CTL} = V_{IH}$ , $V_{OS} = \text{OPEN}$ (Fig. 3)	GND	6.0V		$\pm 20$	$\pm 75$	nA
			-6.0V	6.0V		$\pm 30$	$\pm 150$	
$I_{CC}$	Maximum Quiescent Supply Current	$V_{IN} = V_{CC}$ or GND, $I_{OUT} = 0 \mu\text{A}$	GND	6.0V		1.0	10	$\mu\text{A}$
			-6.0V	6.0V		4.0	40	

**Notes:**

- For a power supply of  $5\text{V} \pm 10\%$  the worst case on resistances ( $R_{ON}$ ) occurs for VHC 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  $V_{CC} = 5.5\text{V}$  and 4.5V respectively. (The  $V_{IH}$  value at 5.5V is 3.85V.) The worst case leakage current occurs for CMOS at the higher voltage and so the 5.5V values should be used.
- At supply voltages ( $V_{CC}-V_{EE}$ ) approaching 2V the analog switch on resistance becomes extremely non-linear. Therefore it is recommended that these devices be used to transmit digital only when using these supply voltages.

**AC Electrical Characteristics** $V_{CC} = 2.0V - 6.0V$ ,  $V_{EE} = 0V - 6V$ ,  $C_L = 50$  pF unless otherwise specified

Symbol	Parameter	Conditions	$V_{EE}$	$V_{CC}$	$T_A = +25^\circ C$		$T_A = -40^\circ C$ to $+85^\circ C$	Units
					Typ.	Guaranteed Limits		
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay Switch In to Out		GND	3.3V	15	30	37	ns
			GND	4.5V	5	10	13	
			-4.5V	4.5V	4	8	12	
			-6.0V	6.0V	3	7	11	
$t_{PZL}$ , $t_{PZH}$	Maximum Switch Turn "ON" Delay (Control)	$R_L = 1k\Omega$	GND	3.3V	25	97	120	ns
			GND	4.5V	20	35	43	
			-4.5V	4.5V	15	32	39	
			-6.0V	6.0V	14	30	37	
$t_{PHZ}$ , $t_{PLZ}$	Maximum Switch Turn "OFF" Delay (Control)	$R_L = 1k\Omega$	GND	3.3V	35	145	180	ns
			GND	4.5V	25	50	63	
			-4.5V	4.5V	20	44	55	
			-6.0V	6.0V	20	44	55	
$t_{PZL}$ , $t_{PZH}$	Maximum Switch Turn "ON" Delay (Enable)		GND	3.3V	27	120	150	ns
			GND	4.5V	20	41	52	
			-4.5V	4.5V	19	38	48	
			-6.0V	6.0V	18	36	45	
$t_{PLZ}$ , $t_{PHZ}$	Maximum Switch Turn "OFF" Delay (Enable)		GND	3.3V	42	155	190	ns
			GND	4.5V	28	53	67	
			-4.5V	4.5V	23	47	59	
			-6.0V	6.0V	21	47	59	
	Minimum Frequency Response (Fig. 7) $20 \log(V_{OS}/V_{IS}) = -3$ dB	$R_L = 600\Omega$ , $V_{IS} = 2V_{PP}$ at $(V_{CC} - V_{EE}/2)^{(4)(5)}$	0V	4.5	40			MHz
			-4.5V	4.5V	100			
	Control to Switch Feedthrough Noise (Fig. 8)	$R_L = 600\Omega$ , $f = 1$ MHz $C_L = 50$ pF <sup>(5)(6)</sup>	0V	4.5V	100			mV
			-4.5V	4.5V	250			
	Crosstalk Between any Two Switches (Fig. 9)	$R_L = 600\Omega$ , $f = 1$ MHz	0V	4.5V	-52			dB
			-4.5V	4.5V	-50			
	Switch OFF Signal Feedthrough Isolation (Fig. 10)	$R_L = 600\Omega$ , $f = 1$ MHz, $V_{CTL} = V_{IL}^{(5)(6)}$	0V	4.5V	-42			dB
			-4.5V	4.5V	-44			
THD	Sinewave Harmonic Distortion	$R_L = 10$ K $\Omega$ , $C_L = 50$ pF, $f = 1$ KHz $V_{IS} = 4$ V $_{PP}$ $V_{IS} = 8$ V $_{PP}$	0V	4.5V	0.013			%
			-4.5V	4.5V	0.008			
$C_{IN}$	Maximum Control Input Capacitance				5			pF
$C_{IN}$	Maximum Switch Input Capacitance				35			pF
$C_{IN}$	Maximum Feedthrough Capacitance	$V_{CTL} = GND$			0.5			pF
$C_{PD}$	Power Dissipation Capacitance				15			pF

**Notes:**

- Adjust 0 dBm for  $f = 1$  kHz (Null  $R_L$ /Ron Attenuation).
- $V_{IS}$  is centered at  $V_{CC} - V_{EE}/2$ .
- Adjust for 0 dBm.

## AC Test Circuits and Switching Time Waveforms

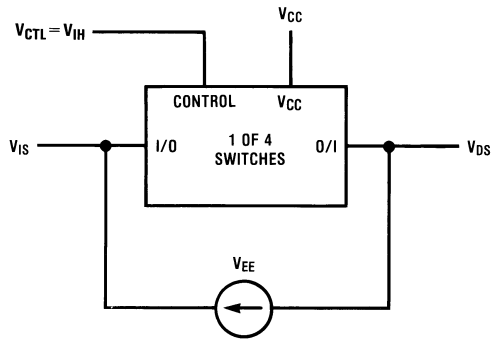


Figure 1. "ON" Resistance

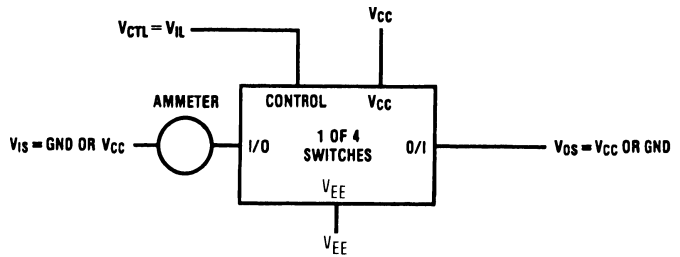


Figure 2. "OFF" Channel Leakage Current

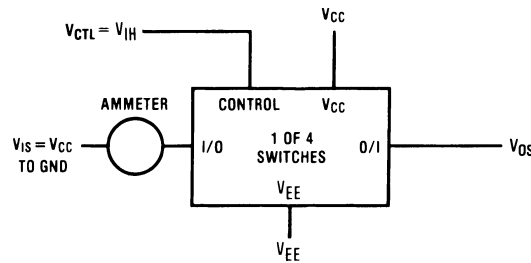


Figure 3. "ON" Channel Leakage Current

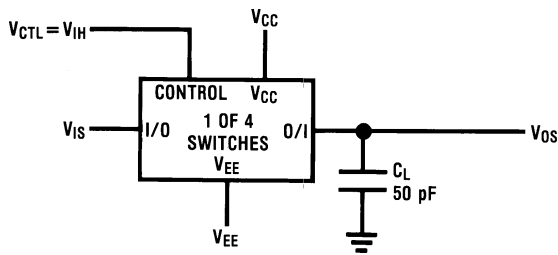


Figure 4.  $t_{PHL}$ ,  $t_{PLH}$  Propagation Delay Time Signal Input to Signal Output

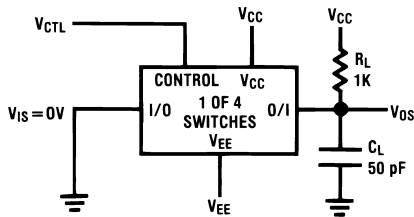
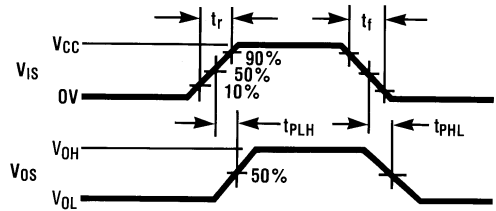


Figure 5.  $t_{PZL}$ ,  $t_{PLZ}$  Propagation Delay Time Control to Signal Output

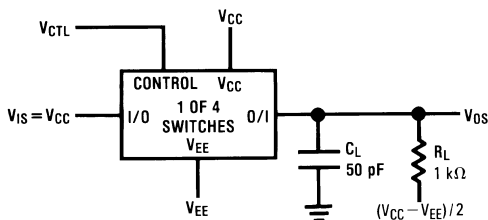
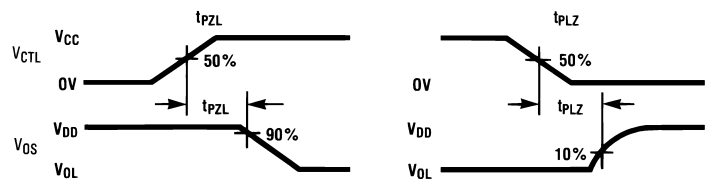
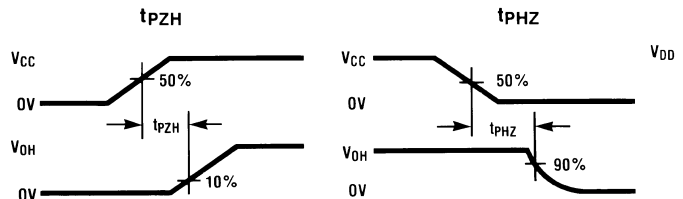


Figure 6.  $t_{PZH}$ ,  $t_{PHZ}$  Propagation Delay Time Control to Signal Output



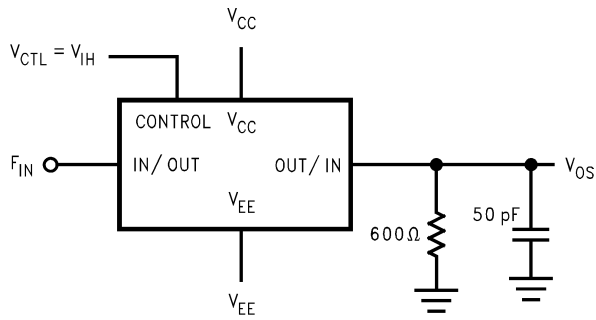


Figure 7. Frequency Response

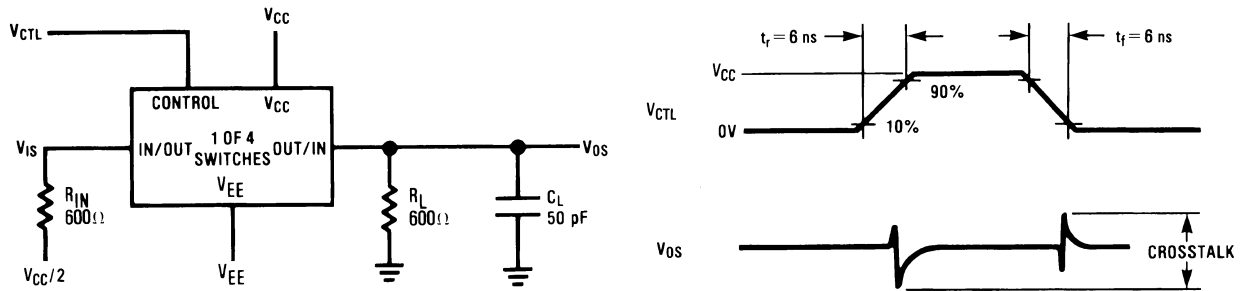


Figure 8. Crosstalk: Control Input to Signal Output

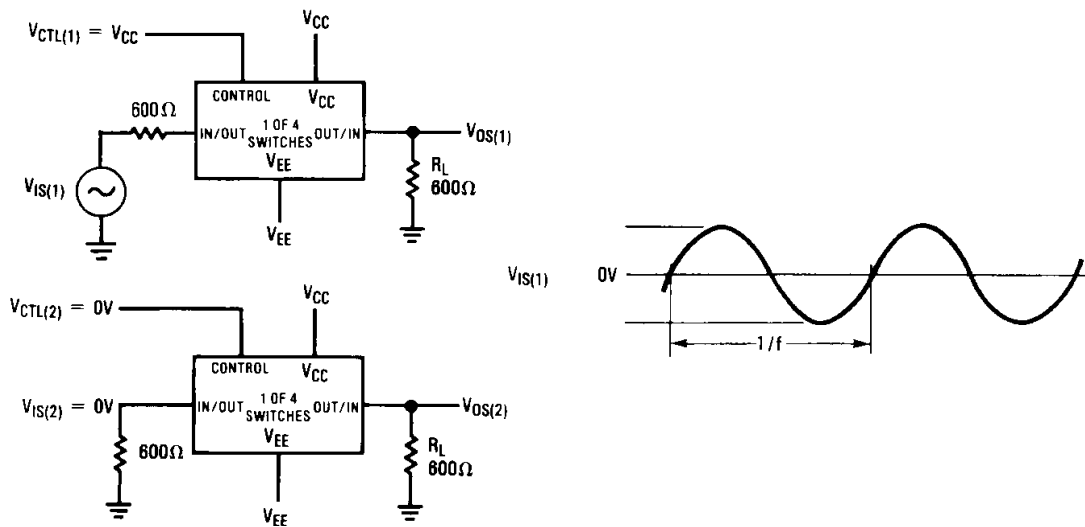


Figure 9. Crosstalk Between Any Two Switches

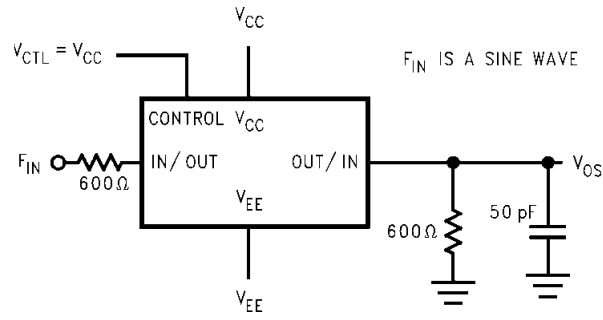


Figure 10. Switch OFF Signal Feedthrough Isolation

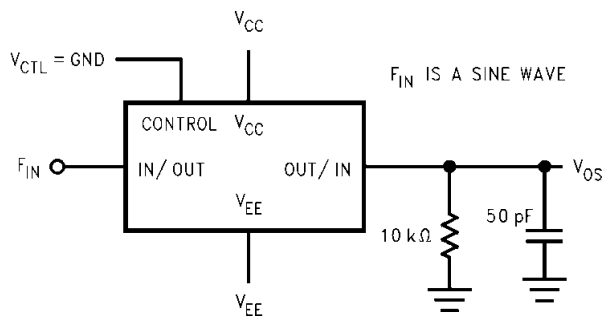
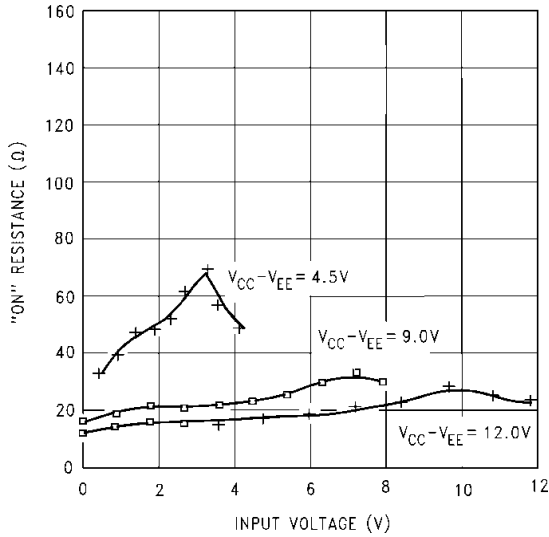


Figure 11. Sinewave Distortion

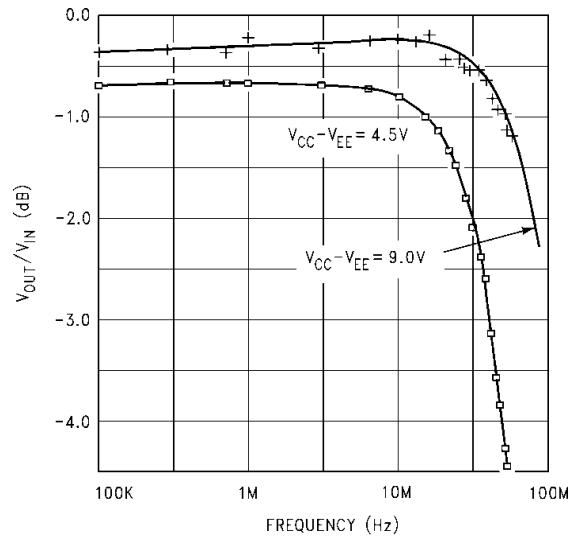


## Typical Performance Characteristics

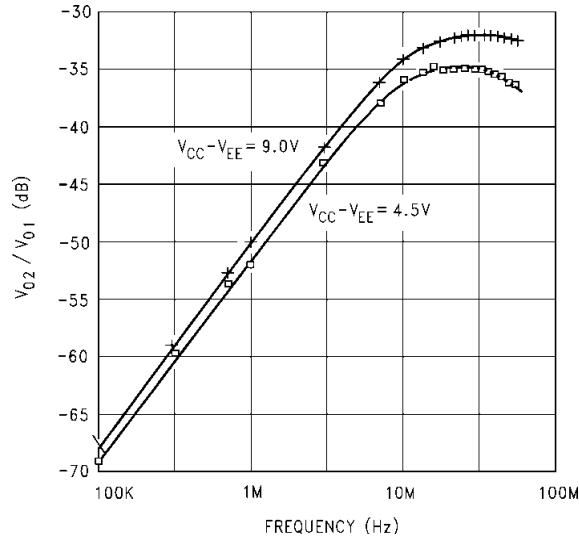
Typical "ON" Resistance



Typical Crosstalk Between Any Two Switches



Typical Frequency Response

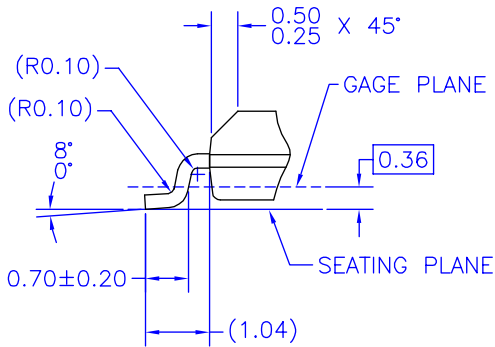
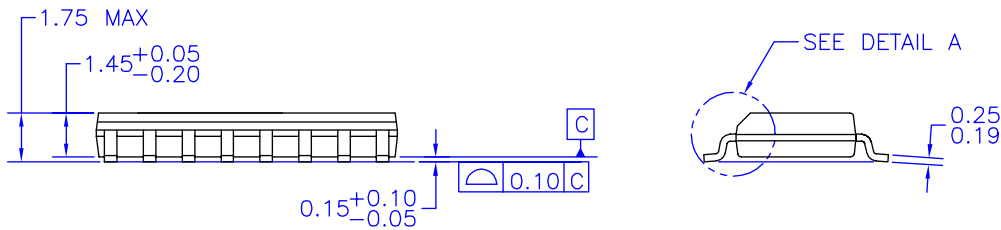
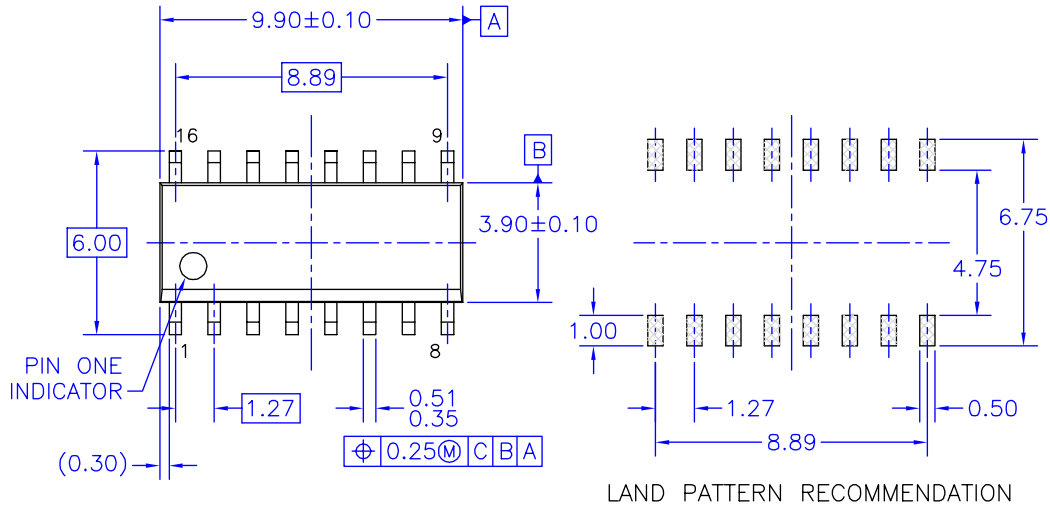


## Special Considerations

In certain applications the external load-resistor current may include both  $V_{CC}$  and signal line components. To avoid drawing  $V_{CC}$  current when switch current flows into the analog switch input pins, the voltage drop across the switch must not exceed 0.6V (calculated from the ON resistance).

### Physical Dimensions

Dimensions are in millimeters unless otherwise noted.



DETAIL A  
SCALE: 2:1

NOTES: UNLESS OTHERWISE SPECIFIED

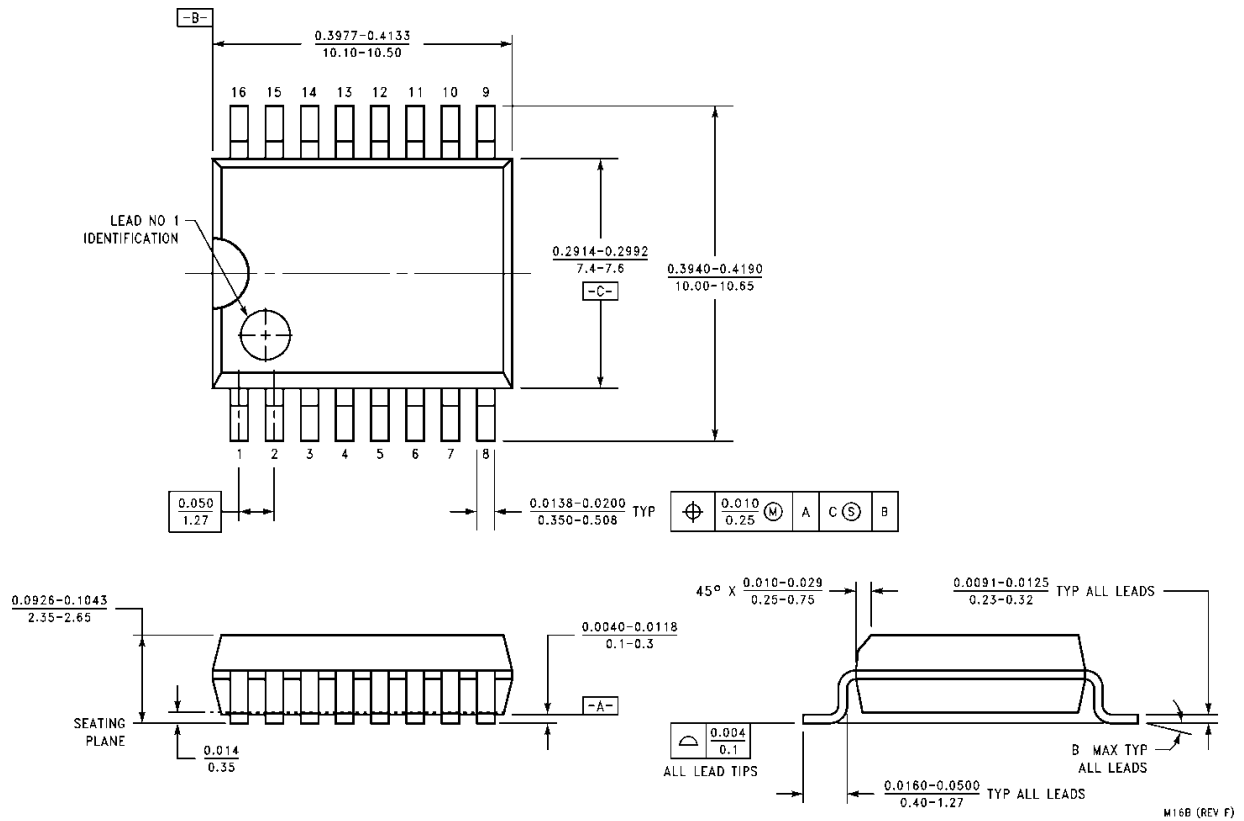
- A) THIS PACKAGE CONFORMS TO JEDEC MS-012, VARIATION AC, ISSUE C, DATED MAY 1990.
- B) ALL DIMENSIONS ARE IN MILLIMETERS.
- C) DIMENSIONS DO NOT INCLUDE MOLD FLASH OR BURRS.
- D) STANDARD LEAD FINISH:  
200 MICRONS / 5.08 MICRONS MIN.  
LEAD/TIN (SOLDER) ON COPPER.

M16AREVK

Figure 12. 16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow Package Number M16A

**Physical Dimensions** (Continued)

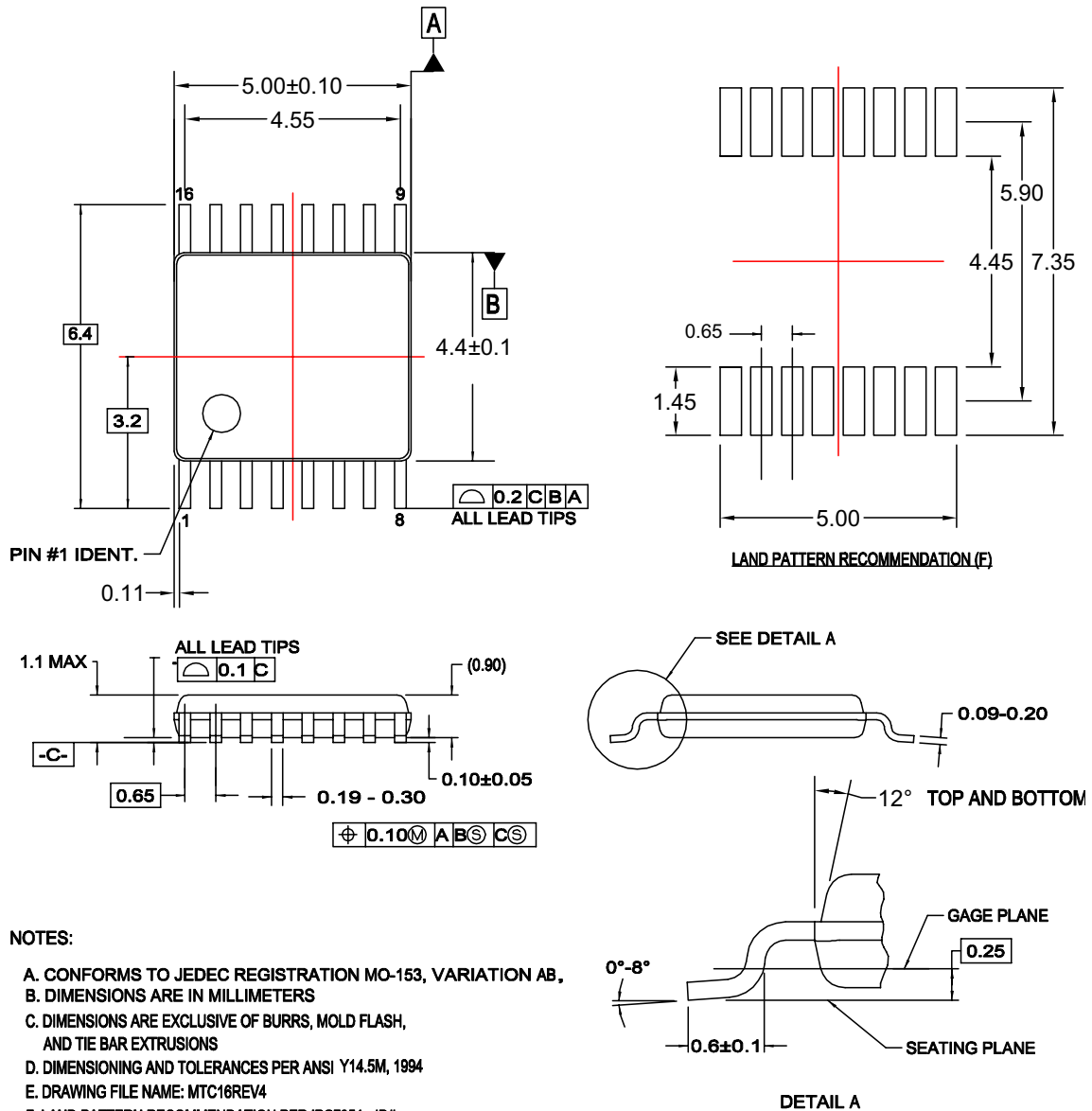
Dimensions are in inches (millimeters) unless otherwise noted.



**Figure 13. 16-Lead Small Outline Intergrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide Package Number M16B**

### Physical Dimensions (Continued)

Dimensions are in millimeters unless otherwise noted.




MTC16rev4

**Figure 14. 16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide Package Number MTC16**



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Current Transfer Logic <sup>™</sup>	MSX <sup>™</sup>	ScalarPump <sup>™</sup>	VCX <sup>™</sup>
DOME <sup>™</sup>	MSXPro <sup>™</sup>	SMART START <sup>™</sup>	Wire <sup>™</sup>
E <sup>2</sup> C MOS <sup>™</sup>	OCX <sup>™</sup>	SPM <sup>®</sup>	
EcoSPARK <sup>®</sup>	OCXPro <sup>™</sup>	STEALTH <sup>™</sup>	
EnSigna <sup>™</sup>	OPTOLOGIC <sup>®</sup>	SuperFET <sup>™</sup>	
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>	
GlobalOptoisolator <sup>™</sup>	PowerEdge <sup>™</sup>		
GTO <sup>™</sup>	PowerSaver <sup>™</sup>	TinyBoost <sup>™</sup>	

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## PRODUCT STATUS DEFINITIONS

### Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative or In Design	This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	This datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
No Identification Needed	Full Production	This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
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