May 2007

74VHC4051, 8-Channel Analog Multiplexer
74VHC4052, Dual 4-Channel Analog Multiplexer
74VHC4053, Triple 2-Channel Analog Multiplexer

Features

- Wide analog input voltage range: ±6V
- Low "ON" resistance: 50 Typ. (V_{CC}–V_{EE} = 4.5V)
- 30 Typ. (V_{CC}–V_{EE} = 9V)
- Logic level translation to enable 5V logic with ±5V analog signals
- Low quiescent current: 80μA maximum
- Matched switch characteristic
- Pin and function compatible with the 74HC4051/ 4052/4053

General Description

These multiplexers 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. Also these switches contain linearization circuitry which lowers the "ON" resistance and increases switch linearity. These devices allow control of up to ±6V (peak) analog signals with digital control signals of 0 to 6V. Three supply pins are provided for V_{CC}, ground, and V_{EE}. This enables the connection of 0–5V logic signals when V_{CC} = 5V and an analog input range of ±5V when V_{EE} = 5V. All three devices also have an inhibit 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.

VHC4051: This device connects together the outputs of 8 switches, thus achieving an 8 channel Multiplexer. The binary code placed on the A, B, and C select lines determines which one of the eight switches is "ON", and connects one of the eight inputs to the common output.

VHC4052: This device connects together the outputs of 4 switches in two sets, thus achieving a pair of 4-channel multiplexers. The binary code placed on the A, and B select lines determine which switch in each 4 channel section is "ON", connecting one of the four inputs in each section to its common output. This enables the implementation of a 4-channel differential multiplexer.

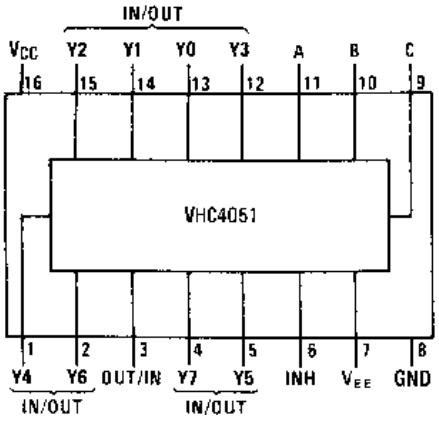
VHC4053: This device contains 6 switches whose outputs are connected together in pairs, thus implementing a triple 2 channel multiplexer, or the equivalent of 3 single-pole-double throw configurations. Each of the A, B, or C select lines independently controls one pair of switches, selecting one of the two switches to be "ON".

Ordering Information

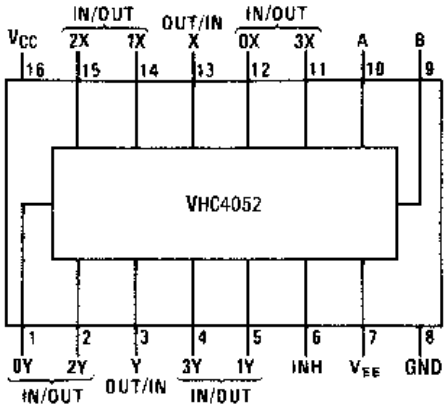
Order Number	Package Number	Package Description
74VHC4051M	M16A	16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150” Narrow
74VHC4051WM	M16B	16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300” Wide
74VHC4051MTC	MTC16	16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide
74VHC4051N	N16E	16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300” Wide
74VHC4052M	M16A	16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150” Narrow
74VHC4052WM	M16B	16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300” Wide
74VHC4052MTC	MTC16	16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide
74VHC4053M	M16A	16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150” Narrow
74VHC4053WM	M16B	16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300” Wide
74VHC4053MTC	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.

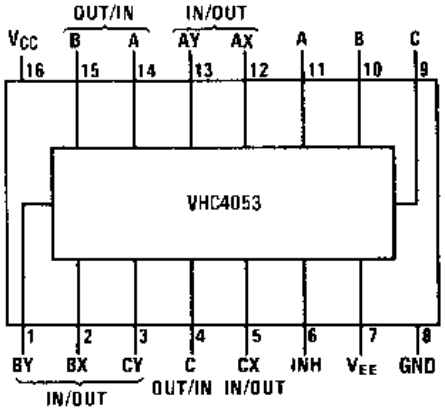
Connection Diagrams



Top View



Top View



Top View

Truth Tables

74VHC4051

Input				
INH	C	B	A	"ON" Channel
H	X	X	X	None
L	L	L	L	Y0
L	L	L	H	Y1
L	L	H	L	Y2
L	L	H	H	Y3
L	H	L	L	Y4
L	H	L	H	Y5
L	H	H	L	Y6
L	H	H	H	Y7

74VHC4052

Inputs			"ON" Channels	
INH	B	A	X	Y
H	X	X	None	None
L	L	L	0X	0Y
L	L	H	1X	1Y
L	H	L	2X	2Y
L	H	H	3X	3Y

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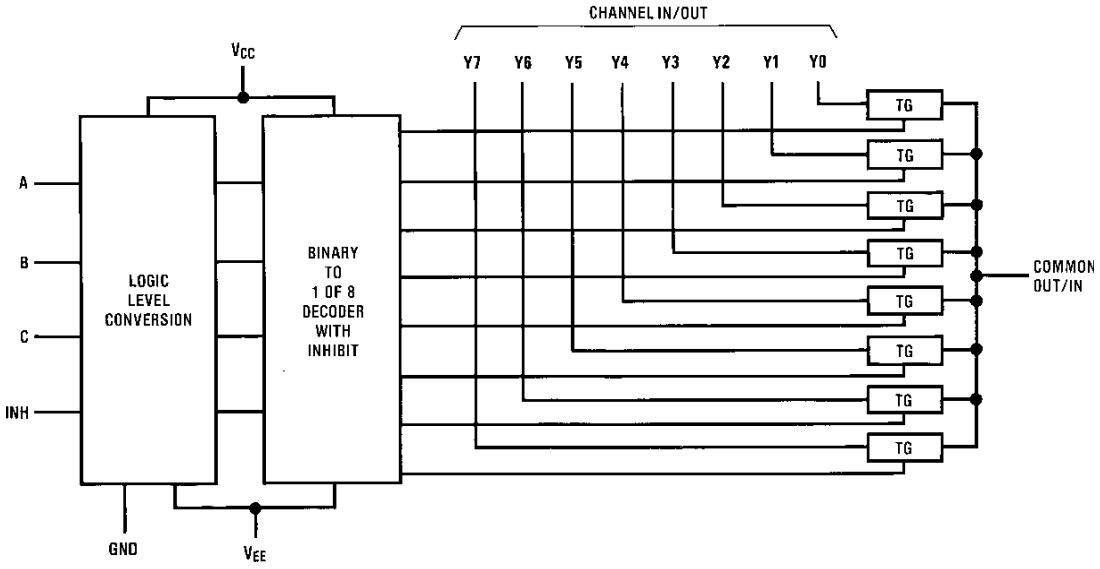
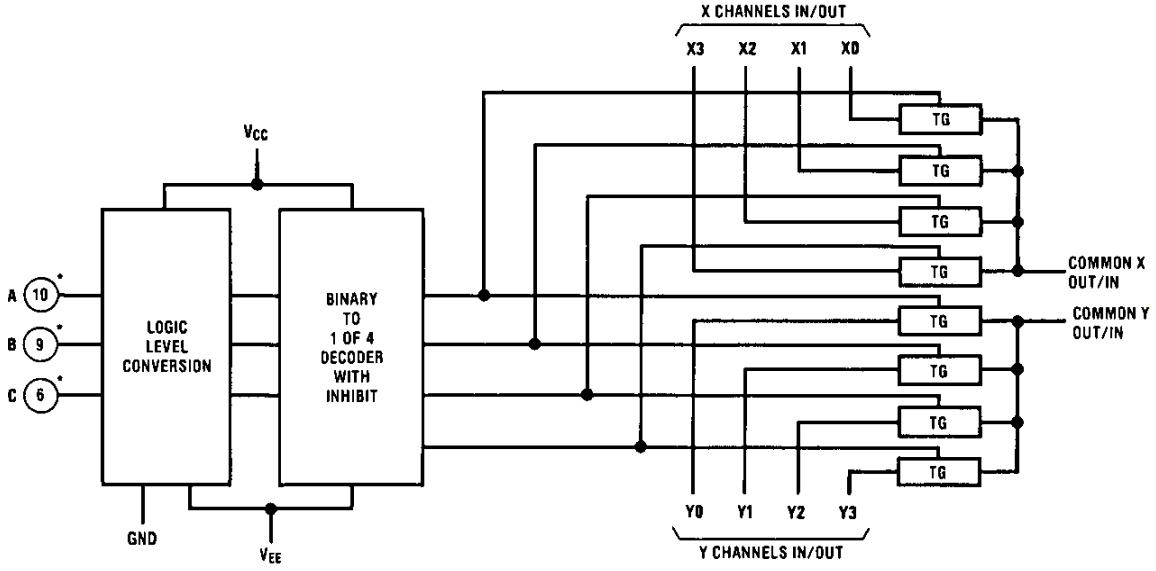
Input				"ON" Channels		
INH	C	B	A	C	B	A
H	X	X	X	None	None	None
L	L	L	L	CX	BX	AX
L	L	L	H	CX	BX	AY
L	L	H	L	CX	BY	AX
L	L	H	H	CX	BY	AY
L	H	L	L	CY	BX	AX
L	H	L	H	CY	BX	AY
L	H	H	L	CY	BY	AX
L	H	H	H	CY	BY	AY

Logic Diagrams

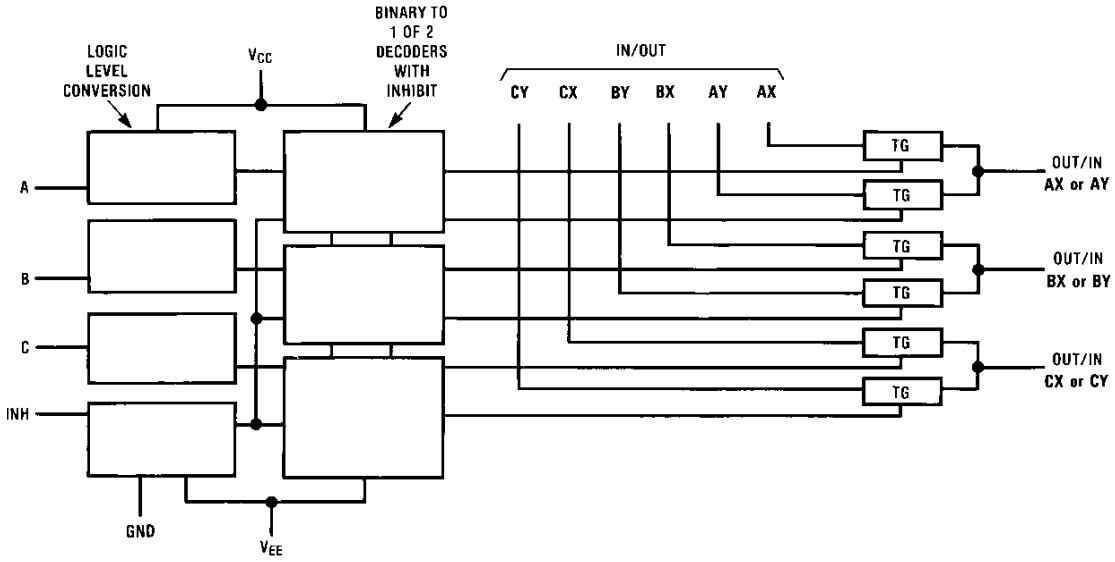
74VHC4051



74VHC4052



74VHC4053


LOGIC LEVEL CONVERSION
V_{CC}
BINARY TO 1 OF 2 DECODERS WITH INHIBIT
IN/OUT
CY
CX
BY
BX
AY
AX
A
B
C
INH
GND
V_{EE}
TG
OUT/IN AX or AY
OUT/IN BX or BY
OUT/IN CX or CY

Absolute Maximum Ratings[1]

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}	Control Input Voltage	–1.5 to V_{CC}+1.5V
V_{IO}	Switch I/O Voltage	V_{EE}–0.5 to V_{CC}+0.5V
I_{IK}, I_{OK}	Clamp Diode Current	±20mA
I_{OUT}	Output Current, per pin	±25mA
I_{CC}	V_{CC} or GND Current, per pin	±50mA
T_{STG}	Storage Temperature Range	–65°C to +150°C
P_D	Power Dissipation[2]	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.
2. Power Dissipation temperature derating; plastic “N” package: -12mW/°C from 65°C to 85°C.

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	

DC Electrical Characteristics[3]

Symbol	Parameter		Conditions	V_{EE}	V_{CC}	Typ.	T_A = 25°C Guaranteed Limits	T_A = –40 to 85°C Guaranteed Limits	Units
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}	Maximum "ON" Resistance[4]		$V_{INH} = V_{IL}$, I_S = 2.0mA, $V_{IS} = V_{CC}$ to V_{EE} (Fig. 1)	GND	4.5V	40	160	200	Ω
				–4.5V	4.5V	30	120	150	
				–6.0V	6.0V	20	100	125	
			$V_{INH} = V_{IL}$, I_S = 2.0mA, $V_{IS} = V_{CC}$ or V_{EE} (Fig. 1)	GND	2.0V	100	230	280	Ω
				GND	4.5V	40	110	140	
				–4.5V	4.5V	20	90	120	
				–6.0V	6.0V	15	80	100	
R_{ON}	Maximum "ON" Resistance Matching		$V_{INH} = V_{IL}$, $V_{IS} = V_{CC}$ to GND	GND	4.5V	10	20	25	Ω
				–4.5V	4.5V	5	10	15	
				–6.0V	6.0V	5	10	12	
I_N	Maximum Control Input Current		$V_{IN} = V_{CC}$ or GND, V_{CC} = 2 – 6V				±.05	±0.5	µA
I_{CC}	Maximum Quiescent Supply Current		$V_{IN} = V_{CC}$ or GND, I_{OUT} = 0µA	GND	6.0V		4	40	µA
				–6.0V	6.0V		8	80	
I_{IZ}	Maximum Switch "OFF" Leakage Current (Switch Input)		$V_{OS} = V_{CC}$ or V_{EE}, $V_{IS} = V_{EE}$ or V_{CC}, $V_{INH} = V_{IH}$ (Fig. 2)	GND	6.0V		±60	±300	nA
				–6.0V	6.0V		±100	±500	
I_{IZ}	Maximum Switch "ON" Leakage Current	VHC4051	$V_{IS} = V_{CC}$ to V_{EE}, $V_{INH} = V_{IL}$ (Fig. 3)	GND	6.0V		±0.1	±1.0	µA
				–6.0V	6.0V		±0.2	±2.0	
		VHC4052	$V_{IS} = V_{CC}$ to V_{EE}, $V_{INH} = V_{IL}$ (Fig. 3)	GND	6.0V		±0.050	±0.5	
				–6.0V	6.0V		±0.1	±1.0	
		VHC4053	$V_{IS} = V_{CC}$ to V_{EE}, $V_{INH} = V_{IL}$ (Fig. 3)	GND	6.0V		±0.05	±0.5	
				–6.0V	6.0V		±0.5	±0.5	
I_{IZ}	Maximum Switch "OFF" Leakage Current (Common Pin)	VHC4051	$V_{OS} = V_{CC}$ or V_{EE}, $V_{IS} = V_{EE}$ or V_{CC}, $V_{INH} = V_{IH}$	GND	6.0V		±0.1	±1.0	µA
				–6.0V	6.0V		±0.2	±2.0	
		VHC4052	$V_{OS} = V_{CC}$ or V_{EE}, $V_{IS} = V_{EE}$ or V_{CC}, $V_{INH} = V_{IH}$	GND	6.0V		±0.05	±0.5	
				–6.0V	6.0V		±0.1	±1.0	
		VHC4053	$V_{OS} = V_{CC}$ or V_{EE}, $V_{IS} = V_{EE}$ or V_{CC}, $V_{INH} = V_{IH}$	GND	6.0V		±0.05	±0.5	
				–6.0V	6.0V		±0.05	±0.5	

Notes:

3. For a power supply of 5V ±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} = 5.5V and 4.5V respectively. (The V_{IH} value at 5.5V is 3.85V.) The worst case leakage current occur for CMOS at the higher voltage and so the 5.5V values should be used.
4. 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.
5. Adjust 0dB for f = 1kHz (Null R1/R_{ON} Attenuation).

AC Electrical Characteristics

V_{CC} = 2.0V – 6.0V, V_{EE} = 0V – 6V, C_L = 50pF (unless otherwise specified)

Symbol	Parameter	Conditions		V_{EE}	V_{CC}	T_A=25°C	T_A= –40 to 85°C		Units
						Typ.	Guaranteed Limits		
t_{PHL}, t_{PLH}	Maximum Propagation Delay Switch In to Out			GND	3.3V	25	35	40	ns
				GND	4.5V	5	12	15	
				–4.5V	4.5V	4	8	12	
				–6.0V	6.0V	3	7	11	
t_{PZL}, t_{PZH}	Maximum Switch Turn “ON” Delay	R_L = 1kΩ		GND	3.3V	92	200	250	ns
				GND	4.5V		69	87	
				–4.5V	4.5V	16	46	58	
				–6.0V	6.0V	15	41	51	
t_{PHZ}, t_{PLZ}	Maximum Switch Turn “OFF” Delay			GND	3.3V	65	170	210	ns
				GND	4.5V	28	58	73	
				–4.5V	4.5V	18	37	46	
				–6.0V	6.0V	16	32	41	
f_{MAX}	Minimum Switch Frequency Response 20 log (V_I/V_O) = 3dB			GND	4.5V	30			MHz
				–4.5V	4.5V	35			
	Control to Switch Feedthrough Noise	R_L = 600Ω, f = 1MHz, C_L = 50pF	V_{IS} = 4 V_{PP}	0V	4.5V	1080			mV
			V_{IS} = 8 V_{PP}	–4.5V	4.5V	250			
	Crosstalk Between any Two Switches	R_L = 600Ω, f = 1 MHz	V_{IS} = 4 V_{PP}	0V	4.5	–52			dB
			V_{IS} = 8 V_{PP}	–4.5V	4.5V	–50			
	Switch OFF Signal Feedthrough Isolation	R_L = 600Ω, f = 1 MHz, V_{CTL} = V_{IL}	V_{IS} = 4 V_{PP}	0V	4.5V	–42			dB
			V_{IS} = 8 V_{PP}	–4.5V	4.5V	–44			
THD	Sinewave Harmonic Distortion	R_L = 10kΩ, C_L = 50pF, f = 1kHz	V_{IS} = 4 V_{PP}	0V	4.5V	0.013			%
			V_{IS} = 8 V_{PP}	–4.5V	4.5V	0.008			
C_{IN}	Maximum Control Input Capacitance					5	10	10	pF
C_{IN}	Maximum Switch Input Capacitance	Input 4051 Common 4052 Common 4053 Common				15 90 45 30			pF
C_{IN}	Maximum Feedthrough Capacitance					5			pF

AC Test Circuits and Switching Time Waveforms

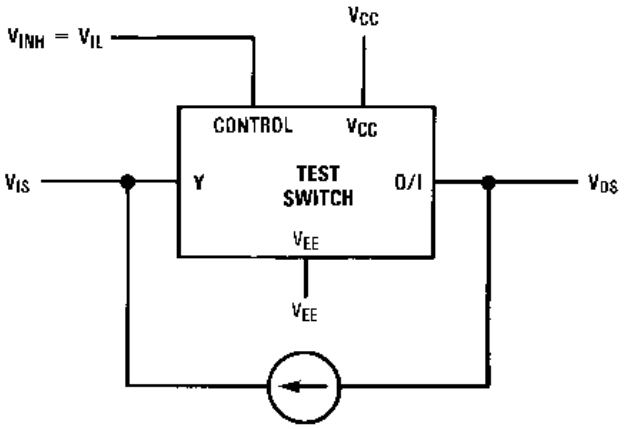


Figure 1. "ON" Resistance

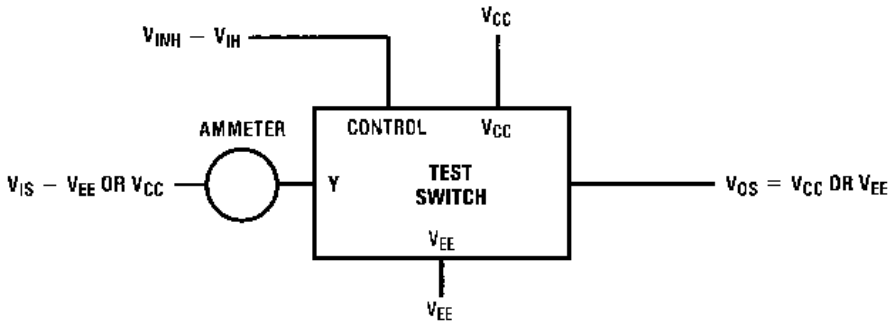


Figure 2. "OFF" Channel Leakage Current

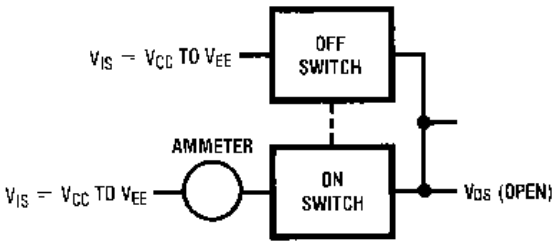


Figure 3. "ON" Channel Leakage Current

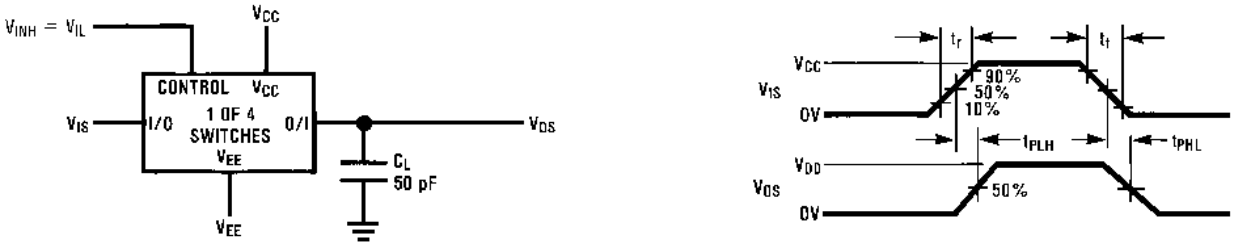


Figure 4. t_{PHL}, t_{PLH} Propagation Delay Time Signal Input to Signal Output

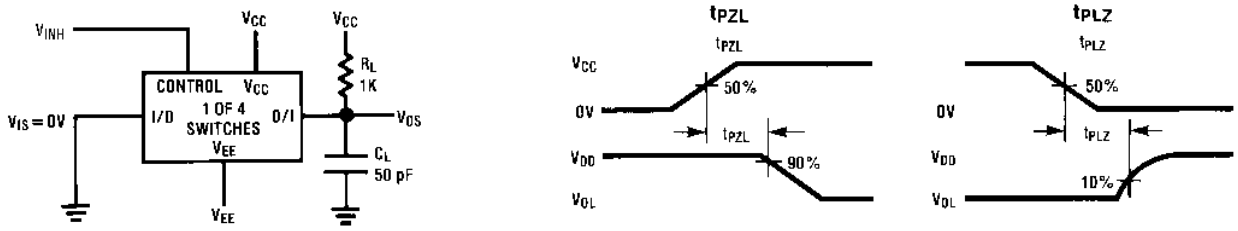


Figure 5. t_{PZL}, t_{PLZ} Propagation Delay Time Control to Signal Output

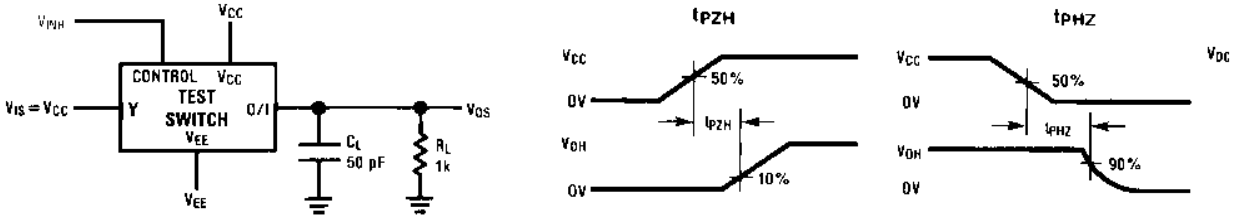


Figure 6. t_{PZH}, t_{PHZ} Propagation Delay TIme Control to Signal Output

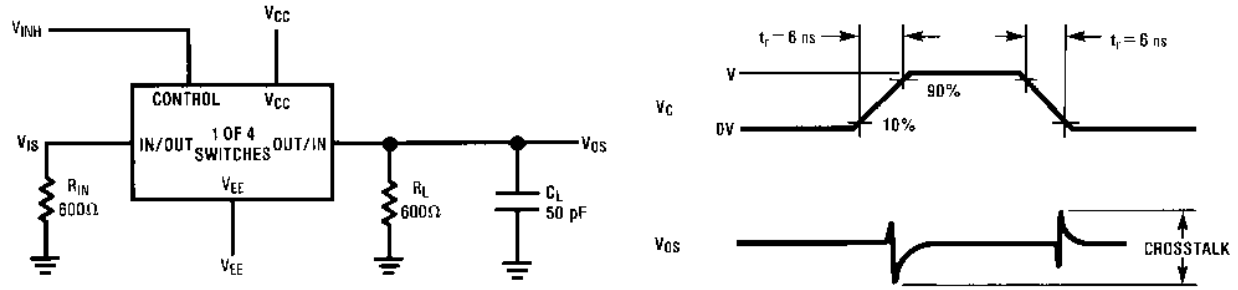


Figure 7. Crosstalk: Control Input to Signal Output

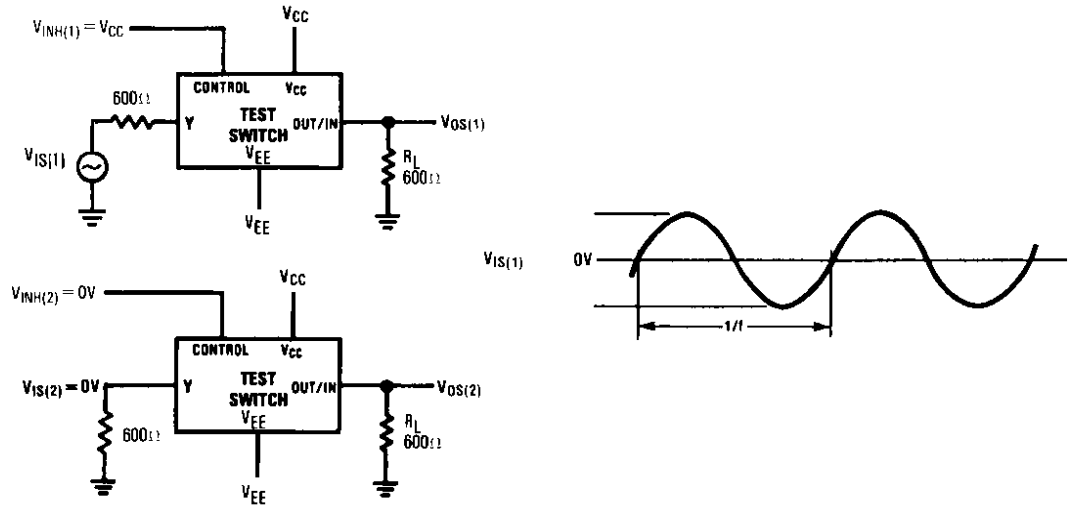
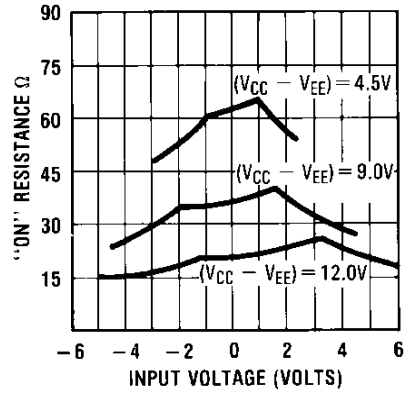


Figure 8. Crosstalk Between Any Two Switches

Typical Performance Characteristics

Typical "On" Resistance vs Input Voltage



$V_{CC} = -V_{EE}$

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 pins, the voltage drop across the switch must not exceed 1.2V (calculated from the ON resistance).

Physical Dimensions

Dimensions are in millimeters unless otherwise noted.

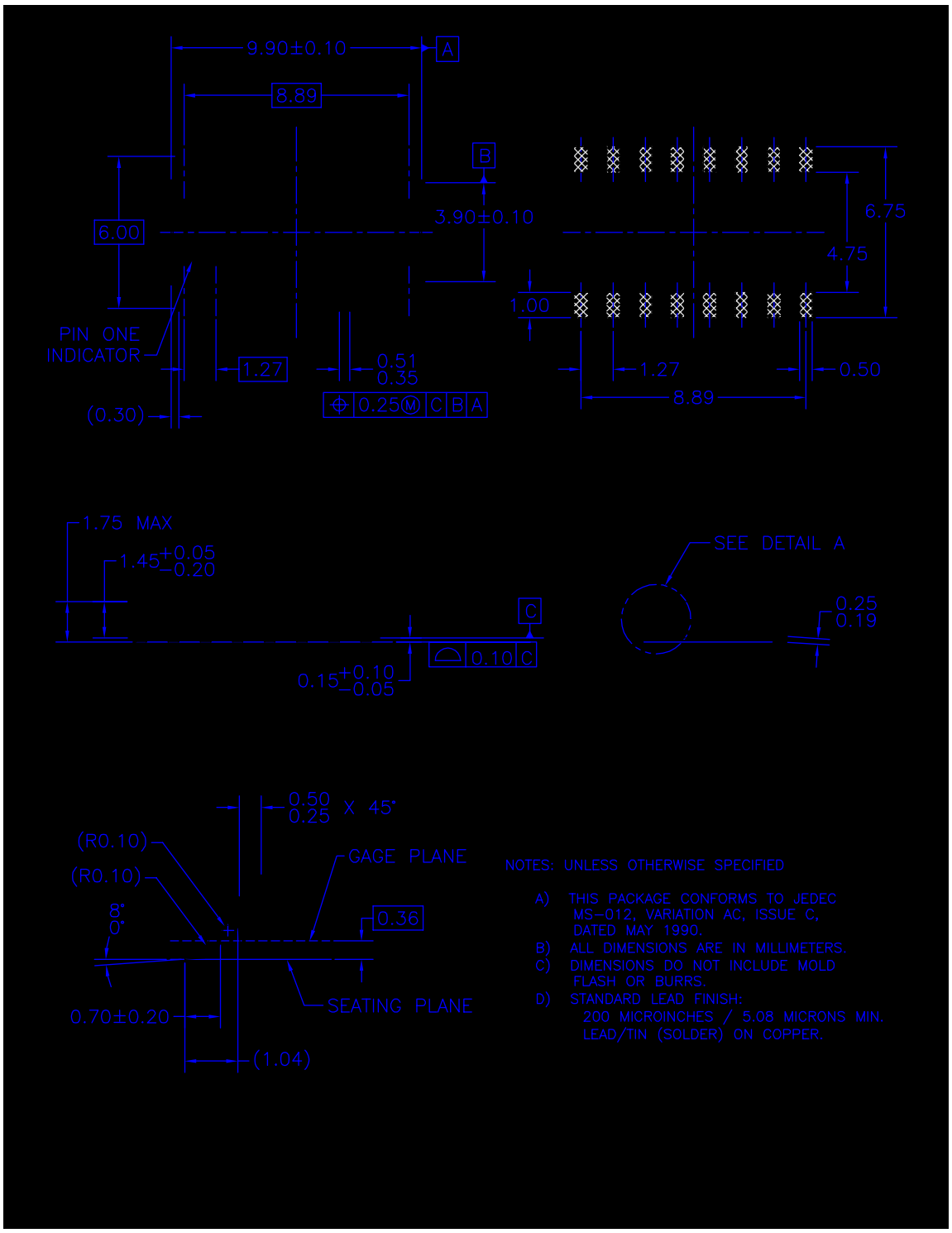


Figure 9. 16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow
Package Number M16A

Physical Dimensions (Continued)

Dimensions are in inches (millimeters) unless otherwise noted.

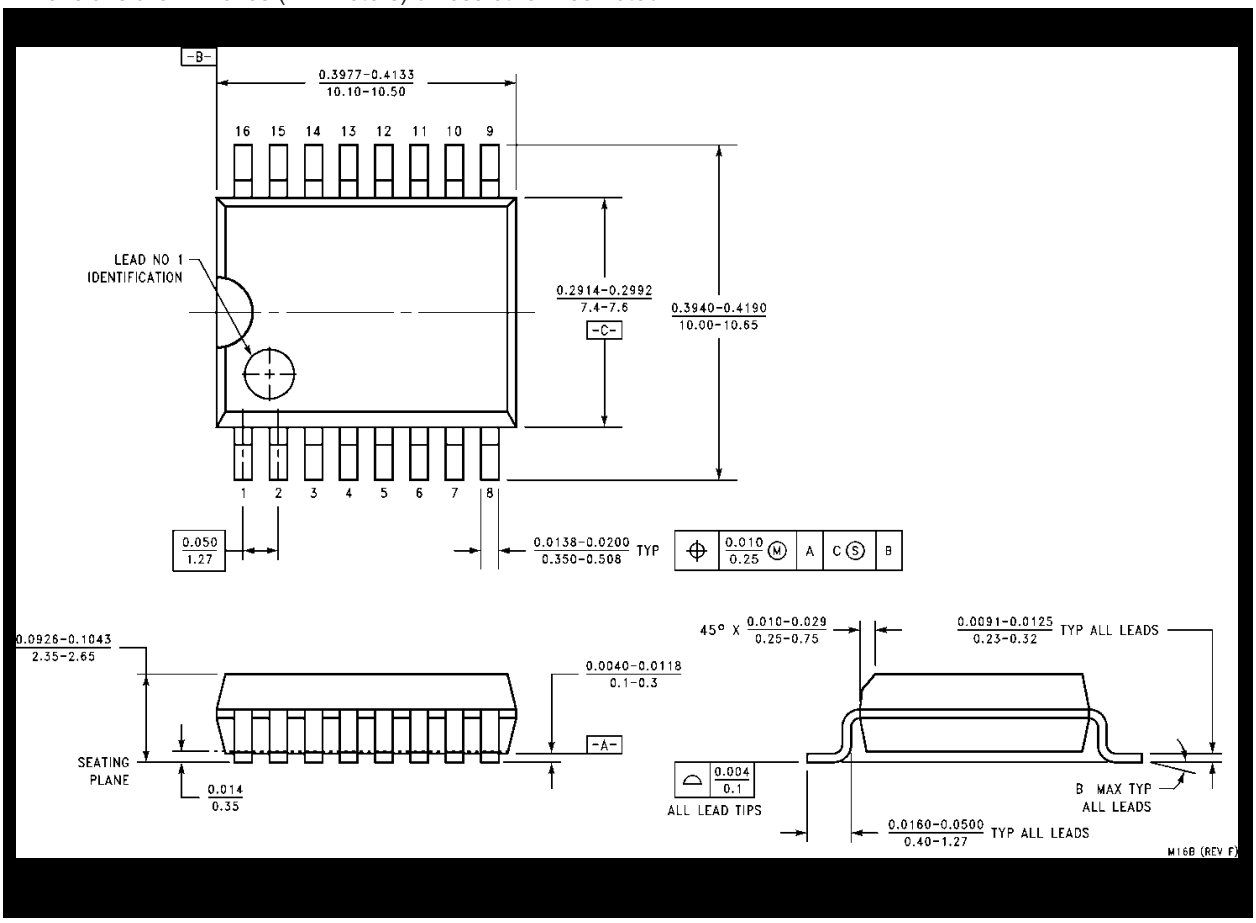


Figure 10. 16-Lead Small Outline Intergrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide
Package Number M16B

Physical Dimensions (Continued)

Dimensions are in millimeters unless otherwise noted.

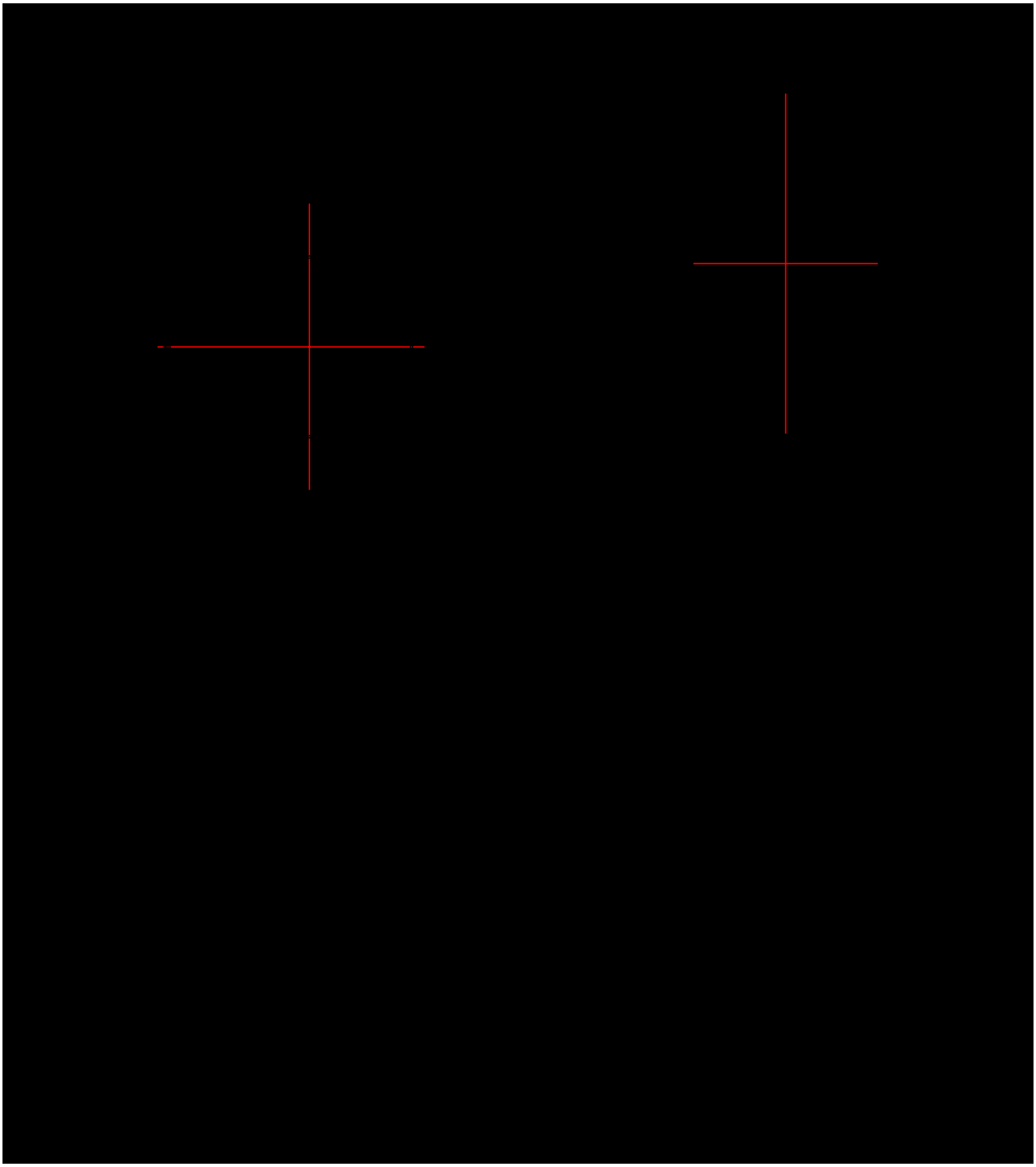


Figure 11. 16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide
Package Number MTC16

Physical Dimensions (Continued)

Dimensions are in inches (millimeters) unless otherwise noted.

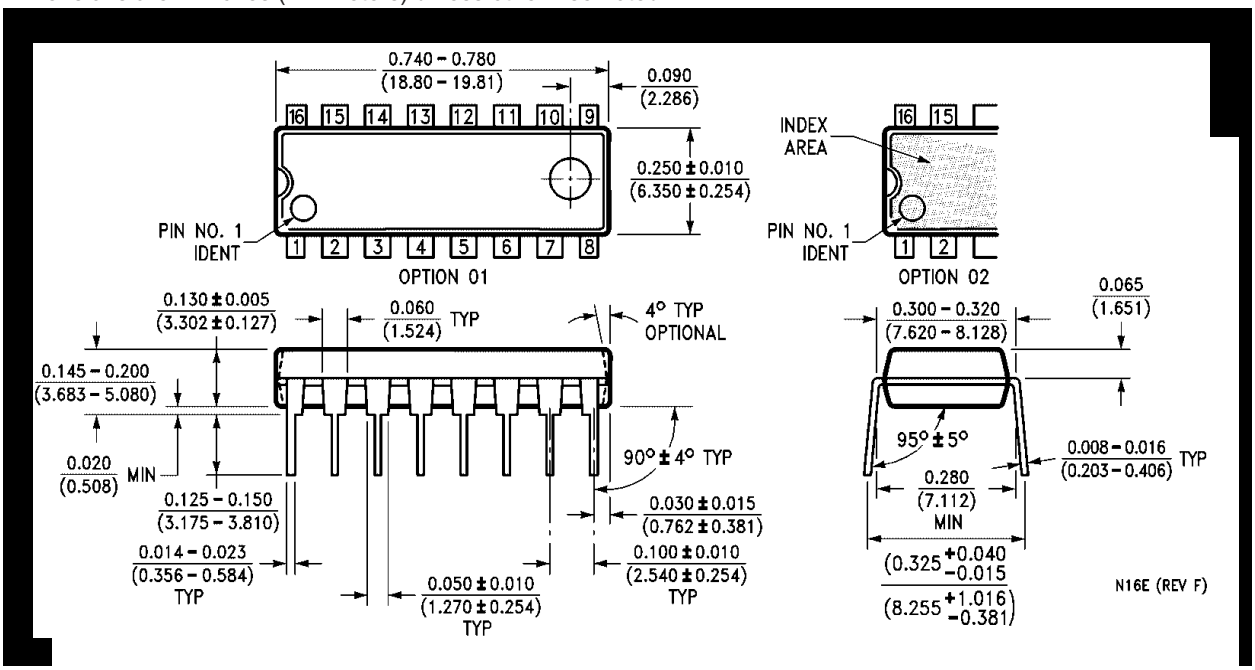


Figure 12. 16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide
Package Number N16E