

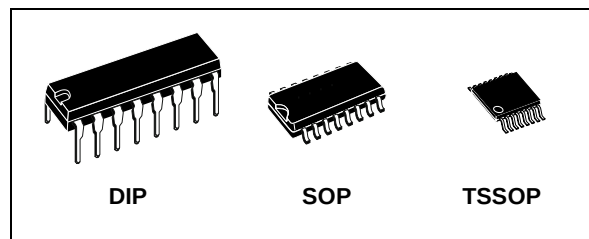
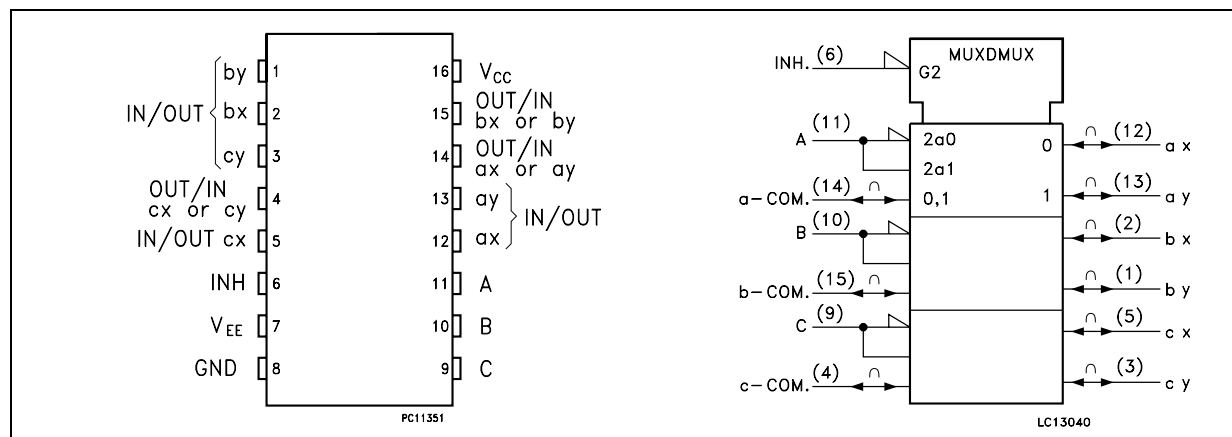
TRIPLE 2-CHANNEL ANALOG MULTIPLEXER/DEMULTIPLEXER

- **LOW POWER DISSIPATION:**
 $I_{CC} = 4\mu A(\text{MAX.})$ at $T_A = 25^\circ C$
- **LOGIC LEVEL TRANSLATION TO ENABLE**
5V LOGIC SIGNAL TO COMMUNICATE
WITH $\pm 5V$ ANALOG SIGNAL
- **LOW "ON" RESISTANCE:**
70 Ω TYP. ($V_{CC} - V_{EE} = 4.5V$)
50 Ω TYP. ($V_{CC} - V_{EE} = 9V$)
- **WIDE ANALOG INPUT VOLTAGE RANGE:**
 $\pm 6V$
- **FAST SWITCHING:**
 $t_{pd} = 15ns$ (TYP.) at $T_A = 25^\circ C$
- **LOW CROSSTALK BETWEEN SWITCHES**
- **HIGH ON/OFF OUTPUT VOLTAGE RATIO**
- **WIDE OPERATING SUPPLY VOLTAGE**
RANGE ($V_{CC} - V_{EE}$) = 2V TO 12V
- **LOW SINE WAVE DISTORTION:**
0.02% at $V_{CC} - V_{EE} = 9V$
- **HIGH NOISE IMMUNITY:**
 $V_{NIH} = V_{NIL} = 28\% V_{CC}$ (MIN.)
- **PIN AND FUNCTION COMPATIBLE WITH**
74 SERIES 4053

DESCRIPTION

The M74HC4053 is a triple two-channel analog MULTIPLEXER/DEMULTIPLEXER fabricated with silicon gate C²MOS technology and it is pin compatible with the equivalent metal gate CMOS4000B series.

PIN CONNECTION AND IEC LOGIC SYMBOLS



ORDER CODES

PACKAGE	TUBE	T & R
DIP	M74HC4053B1R	
SOP	M74HC4053M1R	M74HC4053RM13TR
TSSOP		M74HC4053TTR

It contains 6 bidirectional and digitally controlled analog switches.

A built-in level shifting is included to allow an input range up to $\pm 6V$ (peak) for an analog signal with digital control signal of 0 to 6V.

V_{EE} supply pin is provided for analog input signals. It has an inhibit (INH) input terminal to disable all the switches when high. For operation as a digital multiplexer/demultiplexer, V_{EE} is connected to GND.

A, B and C control inputs select one of a pair of channels.

All inputs are equipped with protection circuits against static discharge and transient excess voltage.

Figure 1: Control Input Equivalent Circuit

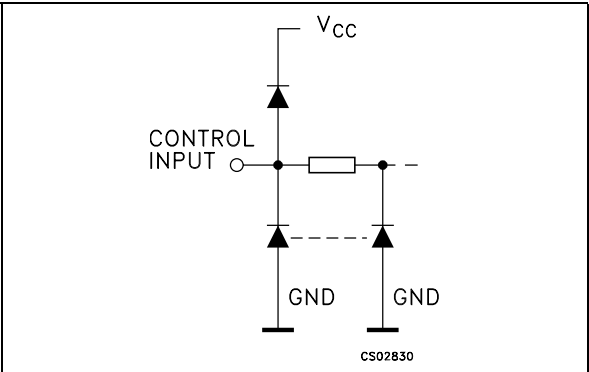


Figure 2: I/O Equivalent Circuit

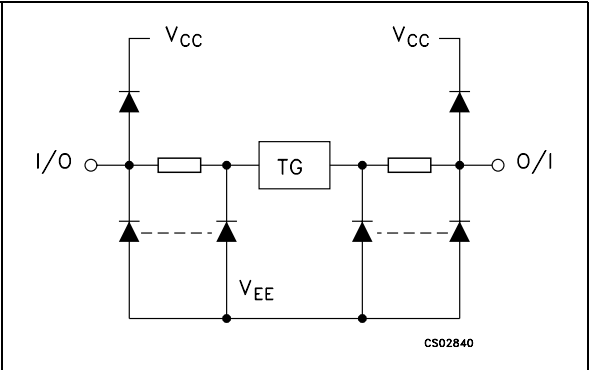


Figure 3: Functional Diagram

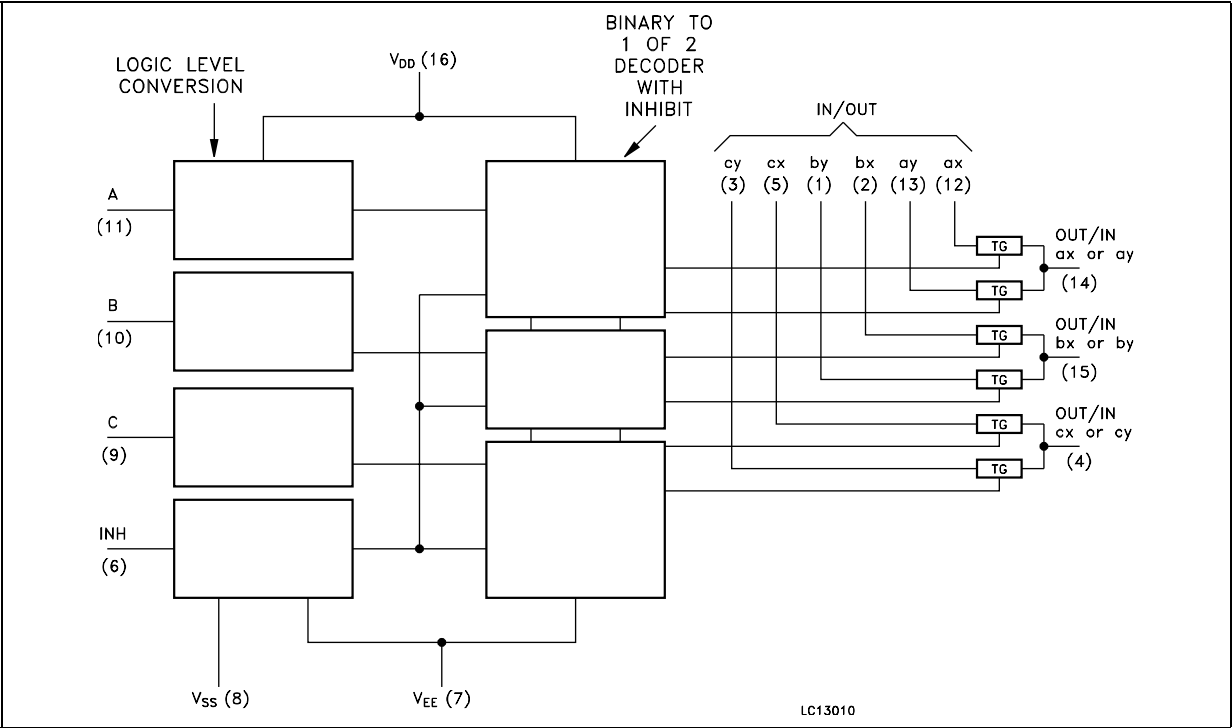


Table 1: Pin Description

PIN N°	SYMBOL	NAME AND FUNCTION
2, 1	bx, by	Independent Input Outputs
5, 3	cx, cy	Independent Input Outputs
6	INH	INHIBIT Input
7	V _{EE}	Negative Supply Voltage
11, 10, 9	A, B, C	Select Inputs
12, 13	ax, ay	Independent Input Outputs
14, 15, 4	ax to cy	Common Output/Input
8	GND	Ground (0V)
16	V _{CC}	Positive Supply Voltage

Table 2: Truth Table

INPUT STATE		ON CHANNEL
INH	A or B or C	
L	L	ax or bx or cx
L	H	ay or by or cy
H	X	NONE

X: Don't care

Table 3: Absolute Maximum Ratings

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage	-0.5 to +7	V
$V_{CC} - V_{EE}$	Supply Voltage	-0.5 to +13	V
V_I	Control Input Voltage	-0.5 to $V_{CC} + 0.5$	V
$V_{I/O}$	Switch I/O Voltage	$V_{EE} - 0.5$ to $V_{CC} + 0.5$	V
I_{CK}	Control Input Diode Current	± 20	mA
$I_{I/O}$	I/O Diode Current	± 20	mA
I_T	Switch Through Current	± 25	mA
I_{CC} or I_{GND}	DC V_{CC} or Ground Current	± 50	mA
P_D	Power Dissipation	500(*)	mW
T_{stg}	Storage Temperature	-65 to +150	°C
T_L	Lead Temperature (10 sec)	300	°C

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied

(*) 500mW at 65 °C; derate to 300mW by 10mW/°C from 65°C to 85°C

Table 4: Recommended Operating Conditions

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage	2 to 6	V
V_{EE}	Supply Voltage	-6 to 0	V
$V_{CC} - V_{EE}$	Supply Voltage	2 to 12	V
V_I	Input Voltage	0 to V_{CC}	V
$V_{I/O}$	I/O Voltage	V_{EE} to V_{CC}	V
T_{op}	Operating Temperature	-55 to 125	°C
t_r, t_f	Input Rise and Fall Time	$V_{CC} = 2.0V$	0 to 1000
		$V_{CC} = 4.5V$	0 to 500
		$V_{CC} = 6.0V$	0 to 400

Table 5: DC Specifications

Symbol	Parameter	Test Condition			Value						Unit	
		V _{CC} (V)	V _{EE} (V)		T _A = 25°C			-40 to 85°C		-55 to 125°C		
					Min.	Typ.	Max.	Min.	Max.	Min.		Max.
V _{IHC}	High Level Input Voltage	2.0			1.5			1.5		1.5		V
		4.5			3.15			3.15				
		6.0			4.2			4.2				
V _{ILC}	Low Level Input Voltage	2.0					0.5		0.5		0.5	V
		4.5					1.35		1.35			
		6.0					1.8		1.8			
R _{ON}	ON Resistance	4.5	GND	V _I = V _{IHC} or V _{ILC} V _{I/O} = V _{CC} to V _{EE} I _{I/O} ≤ 2mA		85	180		225		270	Ω
		4.5	-4.5			55	120		150		180	
		6.0	-6.0			50	100		125		150	
		2.0	GND	V _I = V _{IHC} or V _{ILC} V _{I/O} = V _{CC} or V _{EE} I _{I/O} ≤ 2mA		150						
		4.5	GND			70	150		190		230	
		4.5	-4.5			50	100		125		150	
		6.0	-6.0			45	80		100		120	
ΔR _{ON}	Difference of ON Resistance between switches	4.5	GND	V _I = V _{IHC} or V _{ILC} V _{I/O} = V _{CC} or V _{EE} I _{I/O} ≤ 2mA		10	30		35		45	Ω
		4.5	-4.5			5	12		15		18	
		6.0	-6.0			5	10		12		15	
I _{OFF}	Input/Output Leakage Current (SWITCH OFF)	6.0	GND	V _{OS} = V _{CC} or GND V _{IS} = GND or V _{CC} V _I = V _{ILC} or V _{IHC}			±0.06		± 0.6		± 1.2	μA
		6.0	-6.0				± 0.1		± 1		± 2	
I _{IZ}	Switch Input Leakage Current (SWITCH ON, OUTPUT OPEN)	6.0	GND	V _{OS} = V _{CC} or GND V _I = V _{IHC} or V _{ILC}			±0.06		± 0.6		± 1.2	μA
		6.0	-6.0				± 0.1		± 1		± 2	
I _I	Input Leakage Current	6.0	GND	V _I = V _{CC} or GND			± 0.1		± 0.1		± 1	μA
I _{CC}	Quiescent Supply Current	6.0	GND	V _I = V _{CC} or GND			4		40		80	μA
		6.0	-6.0				8		80		160	

Table 6: AC Electrical Characteristics ($C_L = 50 \text{ pF}$, Input $t_r = t_f = 6\text{ns}$)

Symbol	Parameter	Test Condition			Value						Unit	
		V _{CC} (V)	V _{EE} (V)		T _A = 25°C			-40 to 85°C		-55 to 125°C		
					Min.	Typ.	Max.	Min.	Max.	Min.		Max.
Φ _{I/O}	Phase Difference Between Input and Output	2.0	GND			25	60		75		90	ns
		4.5	GND			6	12		15		18	
		6.0	GND			5	10		13		15	
		4.5	-4.5			4						
t _{PZL} t _{PZH}	Output Enable Time	2.0	GND	R _L = 1KΩ		50	225		280		340	ns
		4.5	GND			14	45		56		68	
		6.0	GND			12	38		48		58	
		4.5	-4.5			14						
t _{PLZ} t _{PHZ}	Output Disable Time	2.0	GND	R _L = 1KΩ		95	225		280		340	ns
		4.5	GND			30	45		56		68	
		6.0	GND			26	38		48		58	
		4.5	-4.5			26						

Table 7: Capacitive Characteristics

Symbol	Parameter	Test Condition			Value						Unit	
		V _{CC} (V)	V _{EE} (V)		T _A = 25°C			-40 to 85°C		-55 to 125°C		
					Min.	Typ.	Max.	Min.	Max.	Min.		Max.
C _{IN}	Input Capacitance	5.0				5	10		10		10	pF
C _{I/O}	Common Terminal Capacitance	5.0	-5.0			11	20		20		20	pF
C _{I/O}	Switch Terminal Capacitance	5.0	-5.0			7	15		15		15	pF
C _{IOS}	Feed Through Capacitance	5.0	-5.0			0.75	2		2		2	pF
C _{PD}	Power Dissipation Capacitance (note 1)	5.0	GND			67						pF

1) C_{PD} is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operating current can be obtained by the following equation. $I_{CC(oper)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}$

Table 8: Analog Switch Characteristics (GND = 0V; $T_A = 25^\circ\text{C}$)

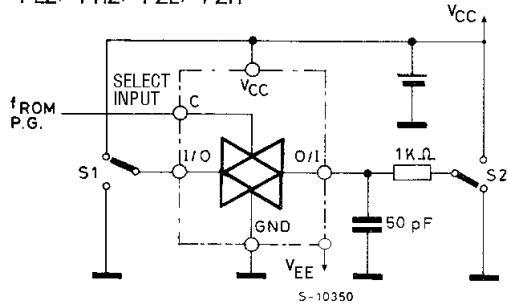
Symbol	Parameter	Test Condition			Value	Unit
		V_{CC} (V)	V_{EE} (V)	V_{IN} (V _{p-p})	Typ.	
	Sine Wave Distortion	2.25	-2.25	4	0.025	%
		4.5	-4.5	8	0.020	
		6.0	-6.0	11	0.018	
f_{MAX}	Frequency Response (Switch ON) (*)	2.25	-2.25	Adjust f_{IN} voltage to obtain 0 dBm at V_{OS} . Increase f_{IN} Frequency until dB meter reads -3dB $R_L = 50\Omega$, $C_L = 10$ pF, $f_{IN} = 1\text{KHz}$ sine wave	120	MHz
		4.5	-4.5		190	
		6.0	-6.0		200	
f_{MAX}	Frequency Response (Switch ON) (**)	2.25	-2.25	Adjust f_{IN} voltage to obtain 0 dBm at V_{OS} . Increase f_{IN} Frequency until dB meter reads -3dB $R_L = 50\Omega$, $C_L = 10$ pF, $f_{IN} = 1\text{KHz}$ sine wave	95	MHz
		4.5	-4.5		150	
		6.0	-6.0		190	
	Feed through Attenuation (Switch OFF)	2.25	-2.25	V_{IN} is centered at $(V_{CC} - V_{EE})/2$ Adjust input for 0 dBm $R_L = 600\Omega$, $C_L = 50$ pF, $f_{IN} = 1\text{KHz}$ sine wave	-50	dB
		4.5	-4.5		-50	
		6.0	-6.0		-50	
	Crosstalk (Control Input to Signal Output)	2.25	-2.25	Adjust R_L at set up so that $I_S = 0A$. $R_L = 600\Omega$, $C_L = 50$ pF, $f_{IN} = 1\text{KHz}$ square wave	60	mV
		4.5	-4.5		140	
		6.0	-6.0		200	
	Crosstalk (between any two Switches)	2.25	-2.25	Adjust V_{IN} to obtain 0dBm at input $R_L = 600\Omega$, $C_L = 50$ pF, $f_{IN} = 1\text{KHz}$ sine wave	-50	dB
		4.5	-4.5		-50	
		6.0	-6.0		-50	

(*) Input COMMON Terminal, and measured at SWITCH Terminal

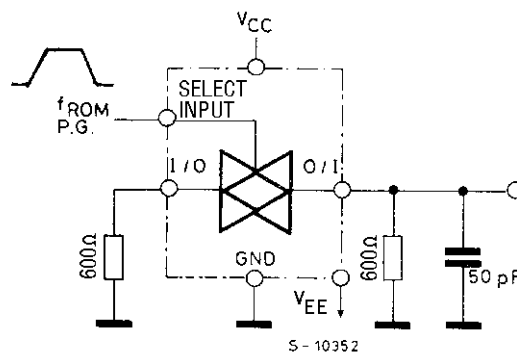
(**) Input SWITCH Terminal, and measured at common Terminal

NOTE: These characteristics are determined by the design of the device.

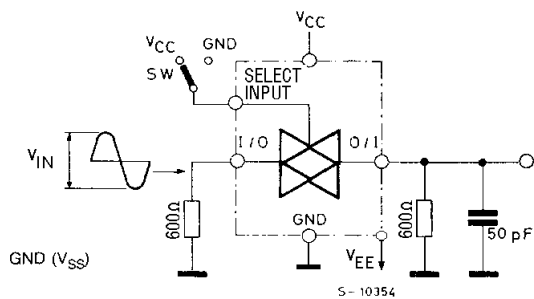
Figure 4: Switching Characteristics Test Circuit

 t_{PLZ} , t_{PHZ} , t_{PZL} , t_{PZH} 

CROSSTALK (control to output)



BANDWIDTH AND FEEDTHROUGH ATTENUATION



CROSSTALK BETWEEN ANY TWO SWITCHES

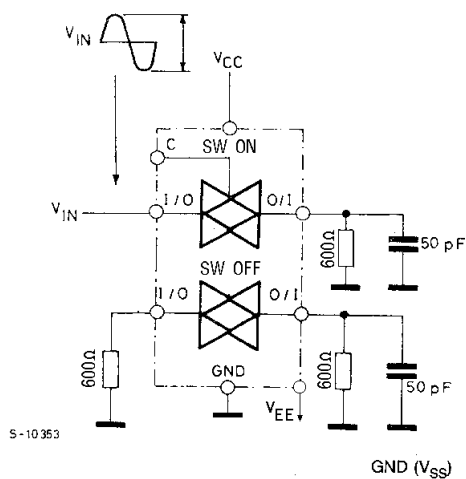
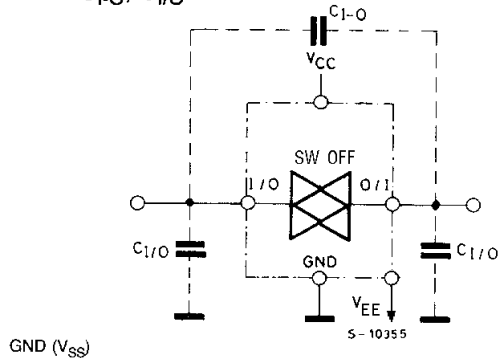
 C_{I-O} , $C_{I/O}$ 

Figure 5: Switching Characteristics Waveform

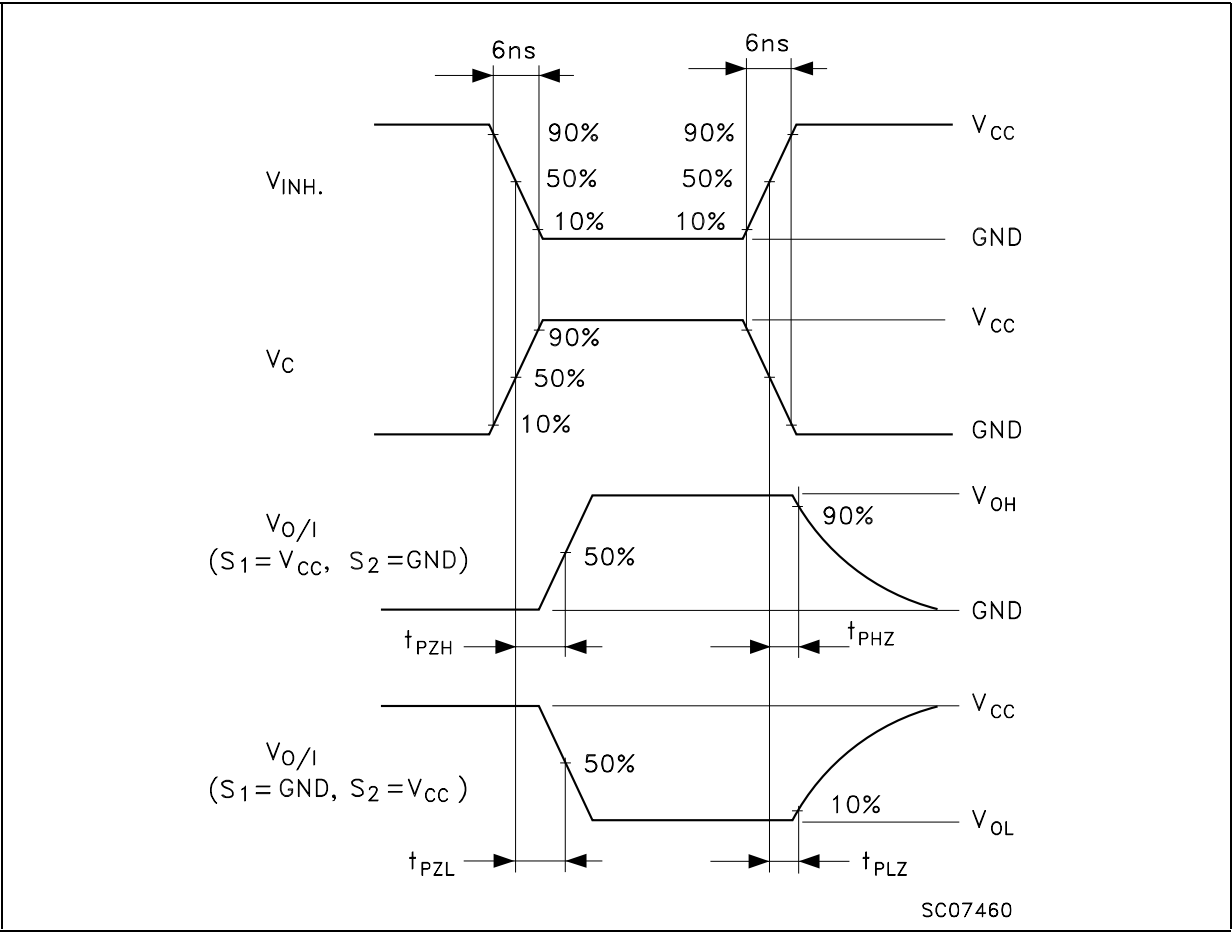


Figure 6: Channel Resistance (R_{ON})

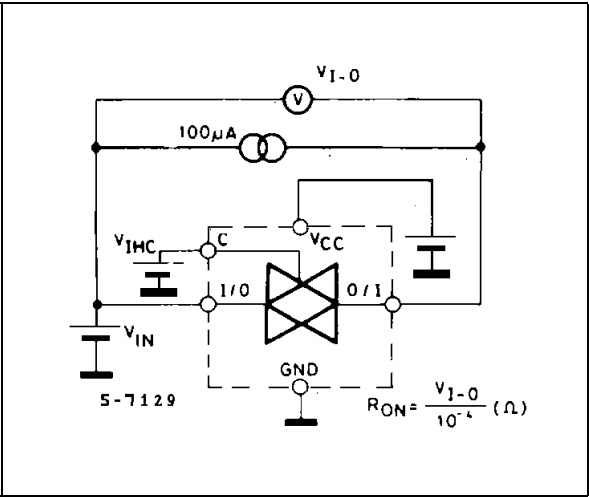
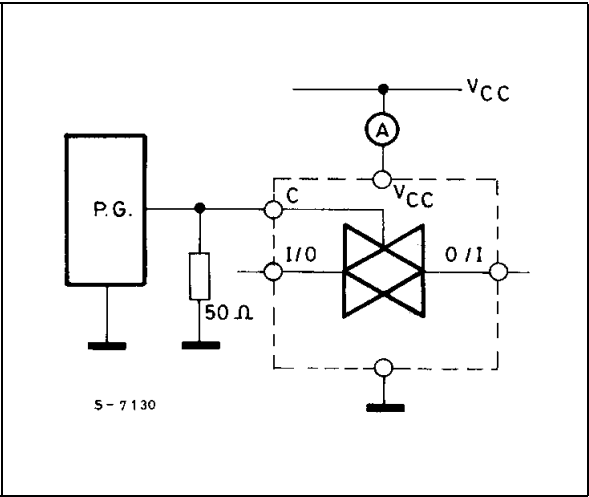
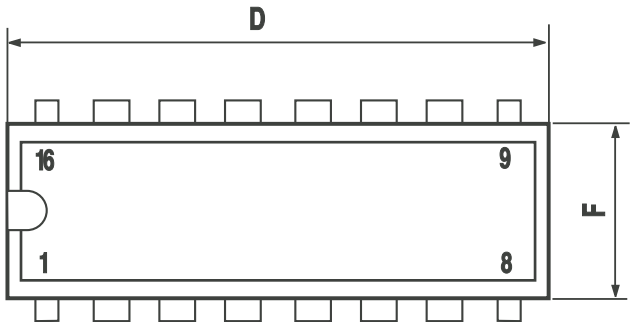
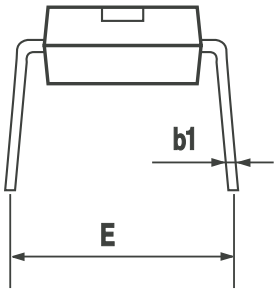
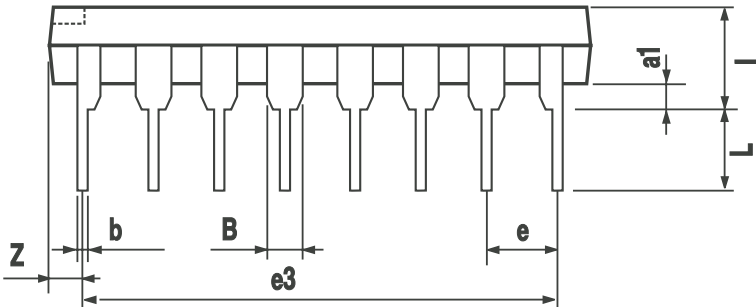


Figure 7: I_{CC} (Opr.)



Plastic DIP-16 (0.25) MECHANICAL DATA

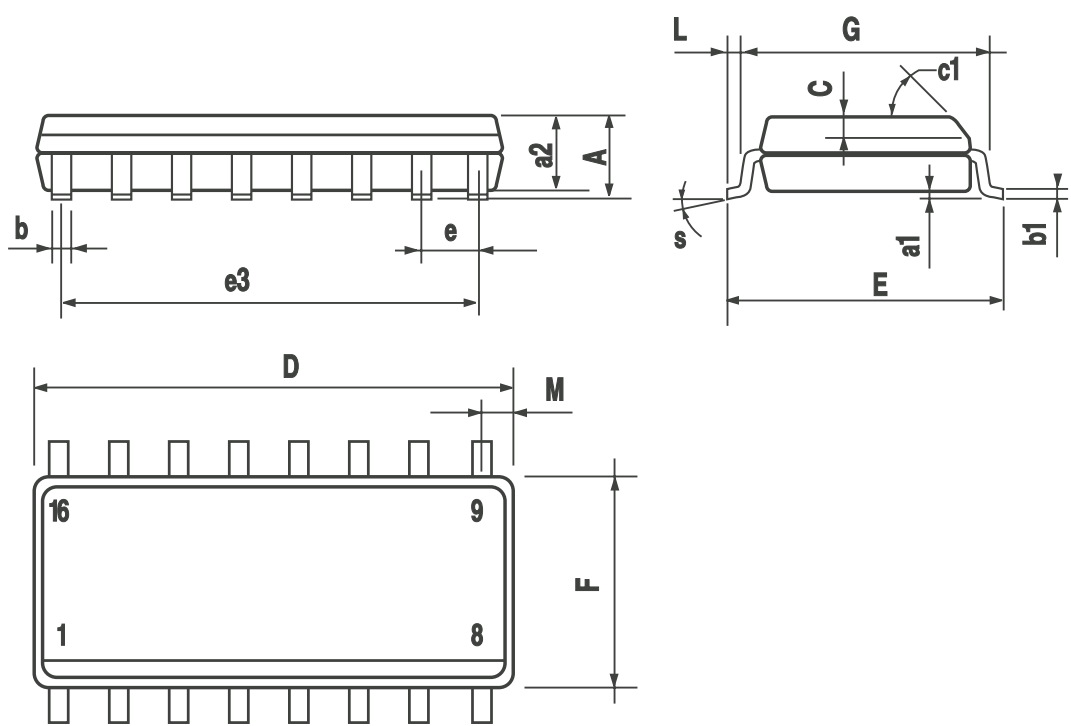
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
a1	0.51			0.020		
B	0.77		1.65	0.030		0.065
b		0.5			0.020	
b1		0.25			0.010	
D			20			0.787
E		8.5			0.335	
e		2.54			0.100	
e3		17.78			0.700	
F			7.1			0.280
I			5.1			0.201
L		3.3			0.130	
Z			1.27			0.050



P001C

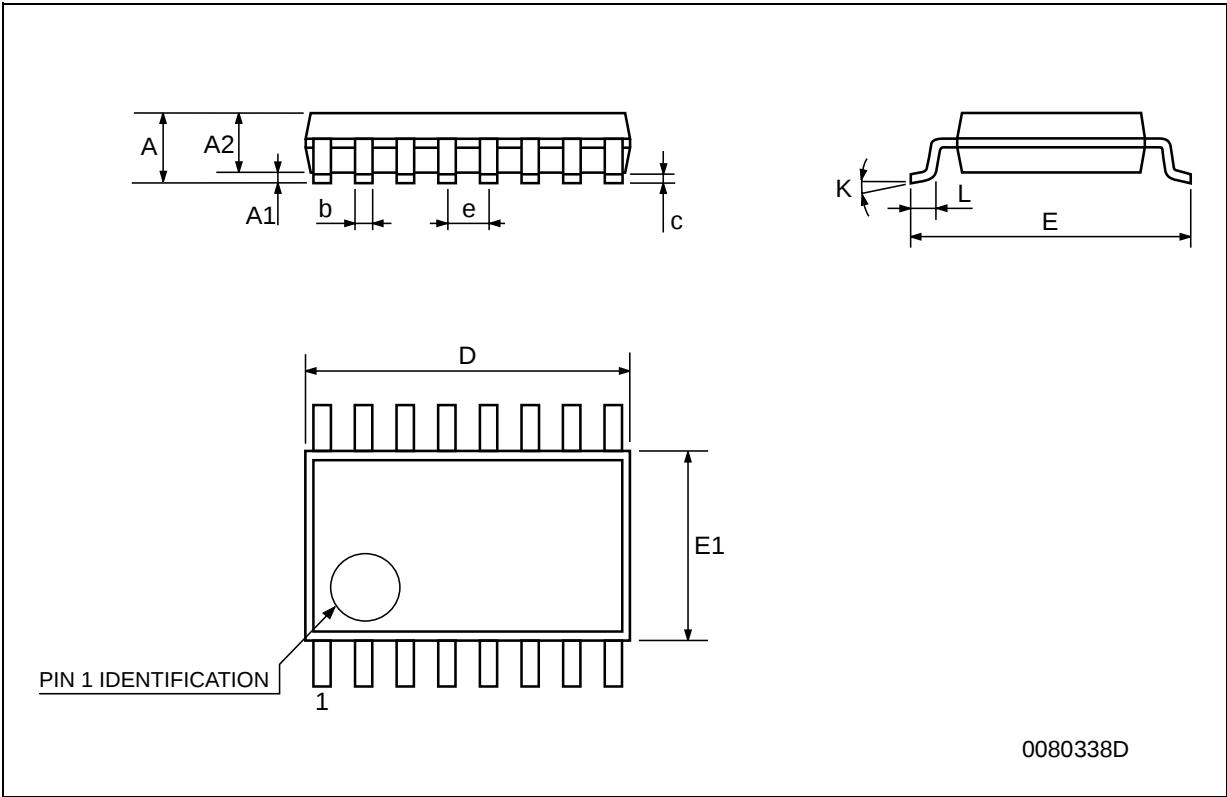
SO-16 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.75			0.068
a1	0.1		0.2	0.004		0.008
a2			1.65			0.064
b	0.35		0.46	0.013		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.019	
c1	45° (typ.)					
D	9.8		10	0.385		0.393
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		8.89			0.350	
F	3.8		4.0	0.149		0.157
G	4.6		5.3	0.181		0.208
L	0.5		1.27	0.019		0.050
M			0.62			0.024
S	8° (max.)					



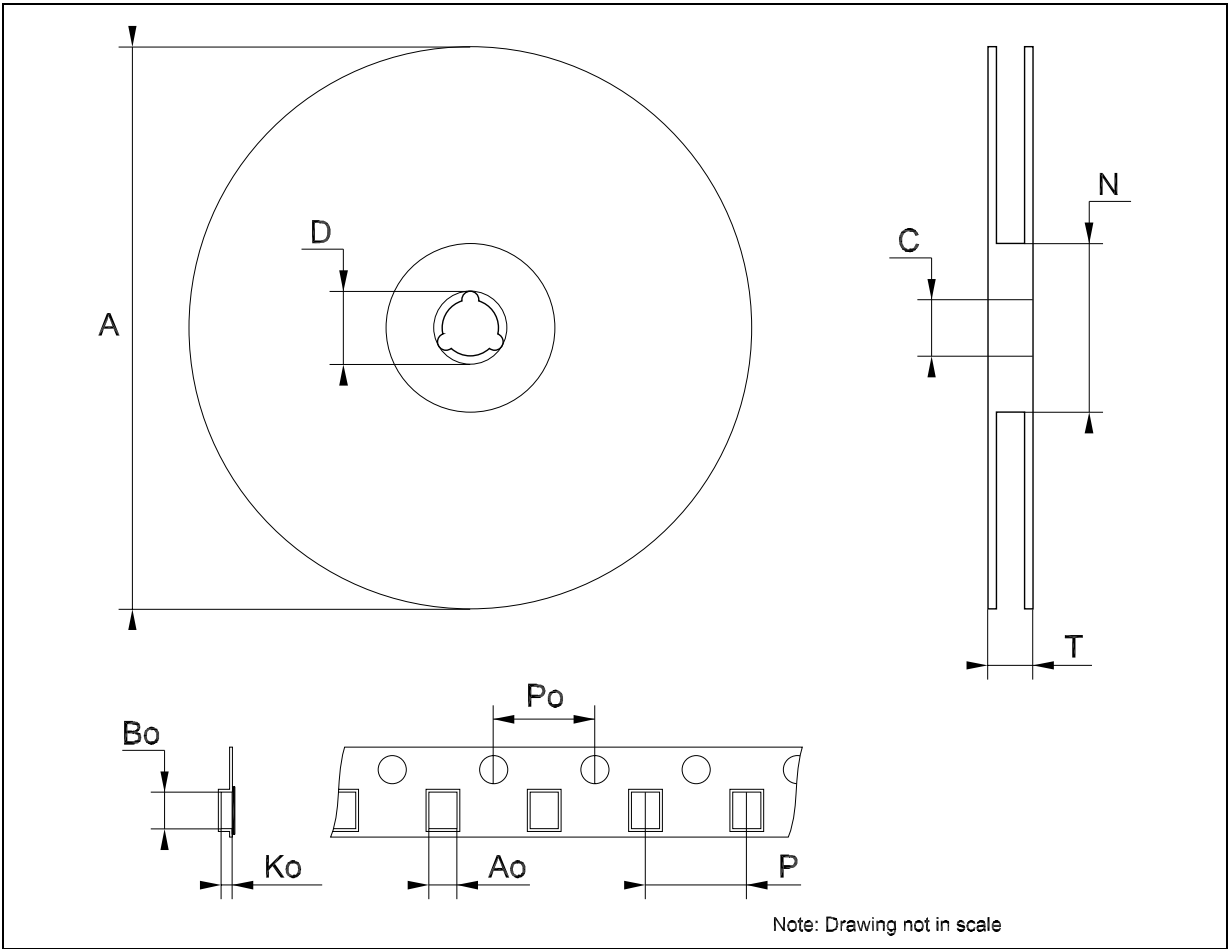
TSSOP16 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.2			0.047
A1	0.05		0.15	0.002	0.004	0.006
A2	0.8	1	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
c	0.09		0.20	0.004		0.0079
D	4.9	5	5.1	0.193	0.197	0.201
E	6.2	6.4	6.6	0.244	0.252	0.260
E1	4.3	4.4	4.48	0.169	0.173	0.176
e		0.65 BSC			0.0256 BSC	
K	0°		8°	0°		8°
L	0.45	0.60	0.75	0.018	0.024	0.030



Tape & Reel SO-16 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			330			12.992
C	12.8		13.2	0.504		0.519
D	20.2			0.795		
N	60			2.362		
T			22.4			0.882
Ao	6.45		6.65	0.254		0.262
Bo	10.3		10.5	0.406		0.414
Ko	2.1		2.3	0.082		0.090
Po	3.9		4.1	0.153		0.161
P	7.9		8.1	0.311		0.319



Tape & Reel TSSOP16 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			330			12.992
C	12.8		13.2	0.504		0.519
D	20.2			0.795		
N	60			2.362		
T			22.4			0.882
Ao	6.7		6.9	0.264		0.272
Bo	5.3		5.5	0.209		0.217
Ko	1.6		1.8	0.063		0.071
Po	3.9		4.1	0.153		0.161
P	7.9		8.1	0.311		0.319

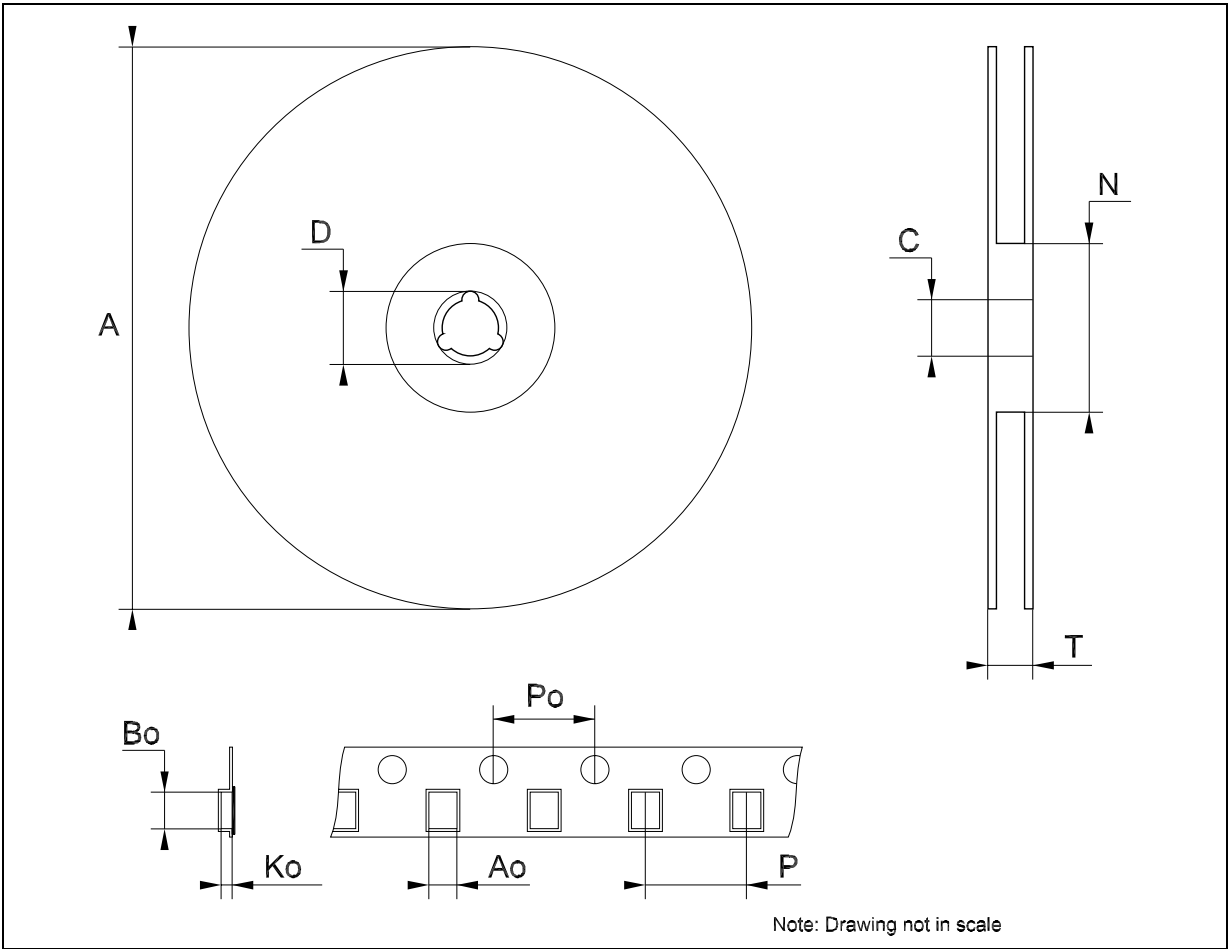


Table 9: Revision History

Date	Revision	Description of Changes
17-May-2004	3	Typing Error Pin Connection - Page 1

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