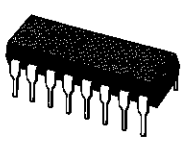
SGS-THOMSON MICROELECTRONICS

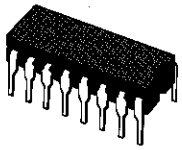
M54HC4051/52/53
M74HC4051/52/53

ANALOG MULTIPLEXER/DEMULTIPLEXER: SINGLE 8 CHANNEL, DUAL 4 CHANNEL, TRIPLE 2 CHANNEL

- LOW POWER DISSIPATION
  I_{CC} = 4 µA (MAX.) AT T_A = 25 °C
- LOGIC LEVEL TRANSLATION TO ENABLE 5V LOGIC SIGNAL TO COMMUNICATE WITH ±5V ANALOG SIGNAL
- LOW "ON" RESISTANCE:
  70Ω TYP. (V_{CC} - V_{EE} = 4.5 V)
  50Ω TYP. (V_{CC} - V_{EE} = 9 V)
- WIDE ANALOG INPUT VOLTAGE RANGE: ±6V
- FAST SWITCHING:
  t_{pd} = 15 ns (TYP.) AT T_A = 25 °C
- LOW CROSSTALK BETWEEN SWITCHES
- HIGH ON/OFF OUTPUT VOLTAGE RATIO
- WIDE OPERATING 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 HCC/HCF4051/4052/4053B



B1R
(Plastic Package)



F1R
(Ceramic Package)

M1R
(Micro Package)

C1R
(Chip Carrier)

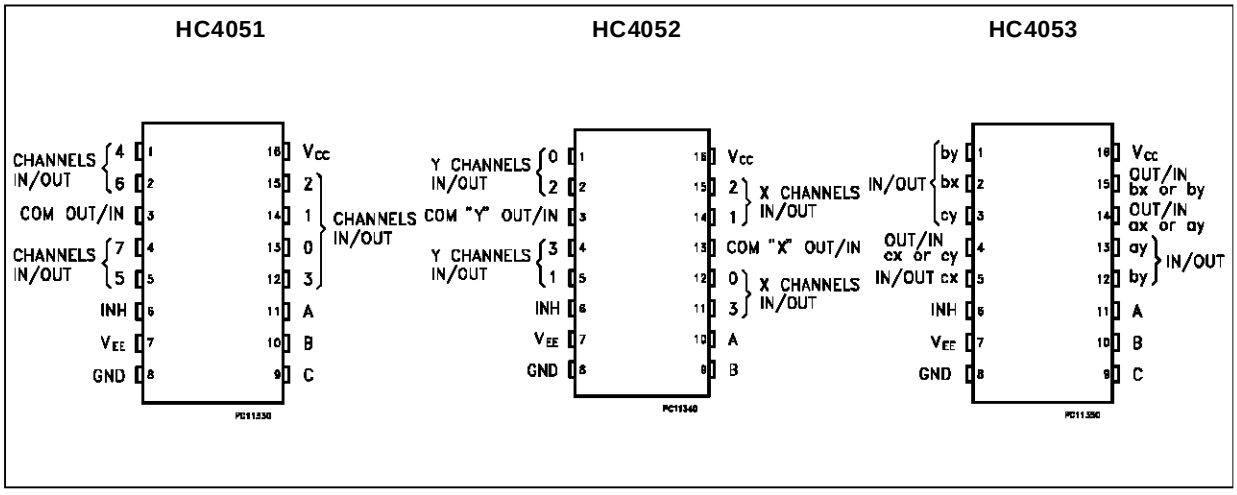
ORDER CODES :

M54HCXXXXF1R	M74HCXXXXM1R
M74HCXXXXB1R	M74HCXXXXC1R

DESCRIPTION

These devices are analog multiplexer demultiplexers in high speed silicon gate C^2MOS technology and they are pin compatible with the equivalent metal gate CMOS "4000B" series. These analog switches are bidirectional and digitally controlled.
A built-in level shifting is included to allow them an input range of up to ± 6V (peak) for an analog signal with digital control signal of 0 to 6V.
V_{EE} supply pin is provided for analog input signals. They have 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.

PIN CONNECTION (top view)



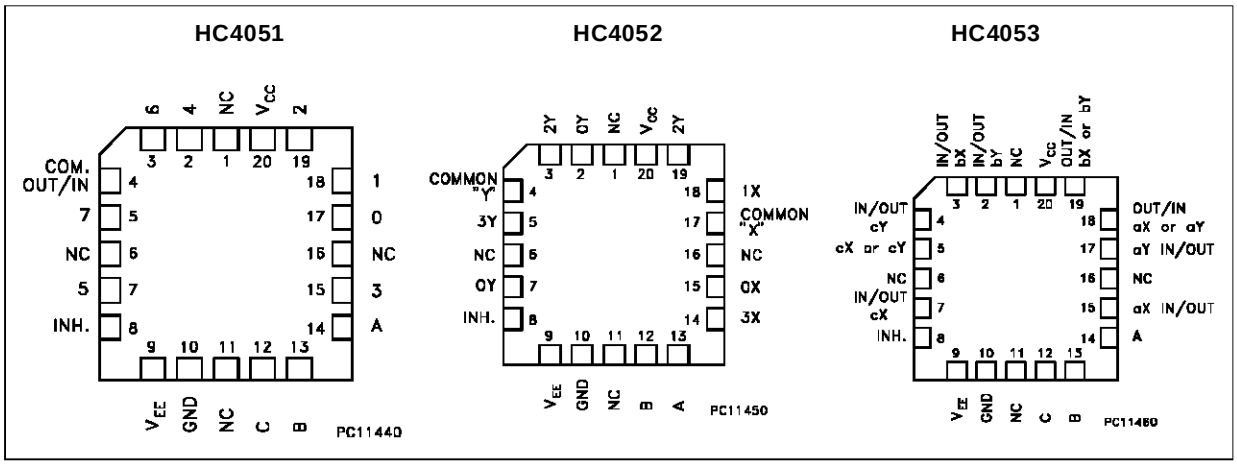
DESCRIPTION

The HC4051 is a single 8 channel multiplexer demultiplexer having three binary control inputs A, B and C to select 1 of 8 to be turned on, and connected to the output.

The HC4052 has a pair of four channel multiplexer demultiplexer having two control inputs A and B that select one of four channels of the two sections.

The HC4053 is a triple two channel multiplexer demultiplexer having three separate digital control inputs A, B and C to select independently one of a pair of channles.

CHIP CARRIER



TRUTH TABLE (HC4051)

INPUT STATES				"ON" CHANNEL
INHIBIT	C	B	A	
L	L	L	L	0
L	L	L	H	1
L	L	H	L	2
L	L	H	H	3
L	H	L	L	4
L	H	L	H	5
L	H	H	L	6
L	H	H	H	7
H	X	X	X	NONE

X: DON'T CARE

TRUTH TABLE (HC4052)

INPUT STATES			"ON" CHANNELS
INHIBIT	B	A	
L	L	L	0X, 0Y
L	L	H	1X, 1Y
L	H	L	2X, 2Y
L	H	H	3X, 3Y
H	X	X	NONE

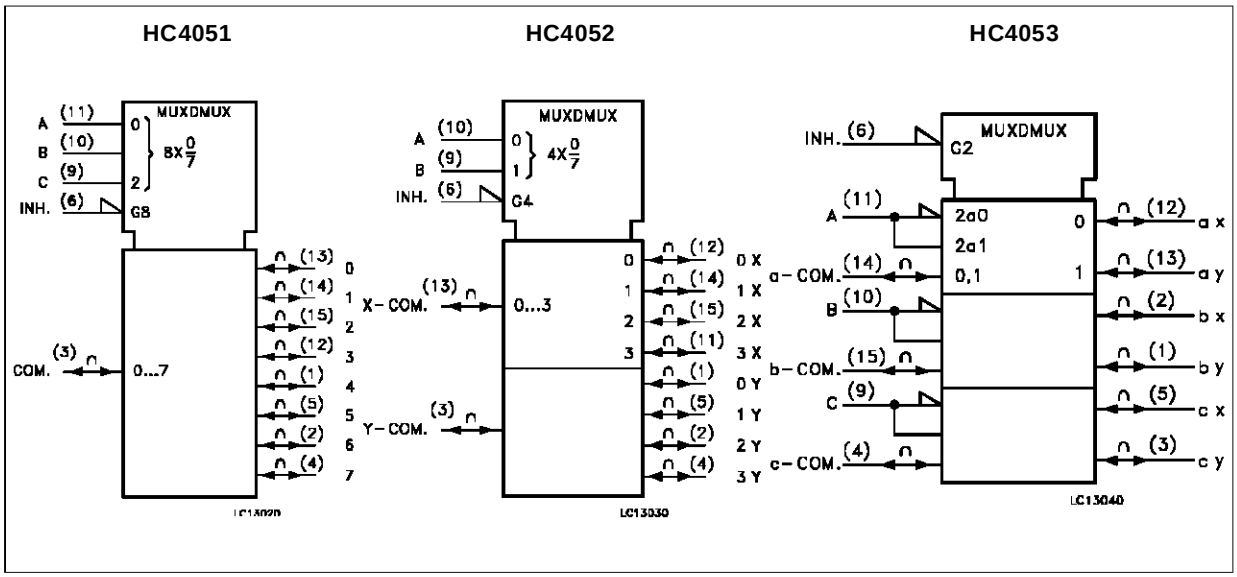
X: DON'T CARE

TRUTH TABLE (HC4053)

INPUT STATES		"ON" CHANNELS
INHIBIT	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

IEC LOGIC SYMBOLS



PIN DESCRIPTION (HC4051)

PIN No	SYMBOL	NAME AND FUNCTION
3	COM OUT/IN	Common Output/input
6	INH	INHIBIT Input
7	V_{EE}	Negative Supply Voltage
11, 10, 9	A, B, C	Select Inputs
13, 14, 15, 12, 1, 5, 2, 4	0 TO 7	Independent Input/Outputs
8	GND	Ground (0V)
16	V_{CC}	Positive Supply Voltage

PIN DESCRIPTION (HC4053)

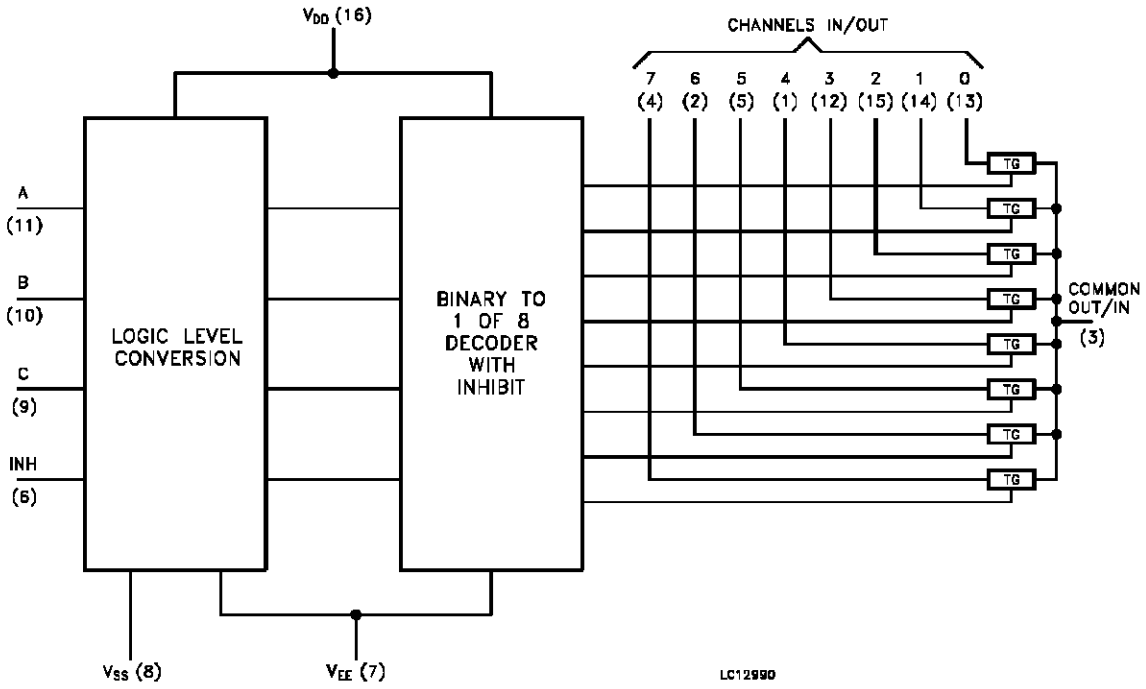
PIN No	SYMBOL	NAME AND FUNCTION
2, 1	bx, by	Independent Input/Outputs
5, 3	cx, cy	Independent Input/Outputs
6	INH	INHIBIT Input
7	V_{EE}	Negative Supply Voltage
11, 10, 9	A, B, C	Select Inputs
12, 13	ax, ay	Independent Input/Outputs
14, 15, 4	ax TO cy	Common Output/input
8	GND	Ground (0V)
16	V_{CC}	Positive Supply Voltage

PIN DESCRIPTION (HC4052)

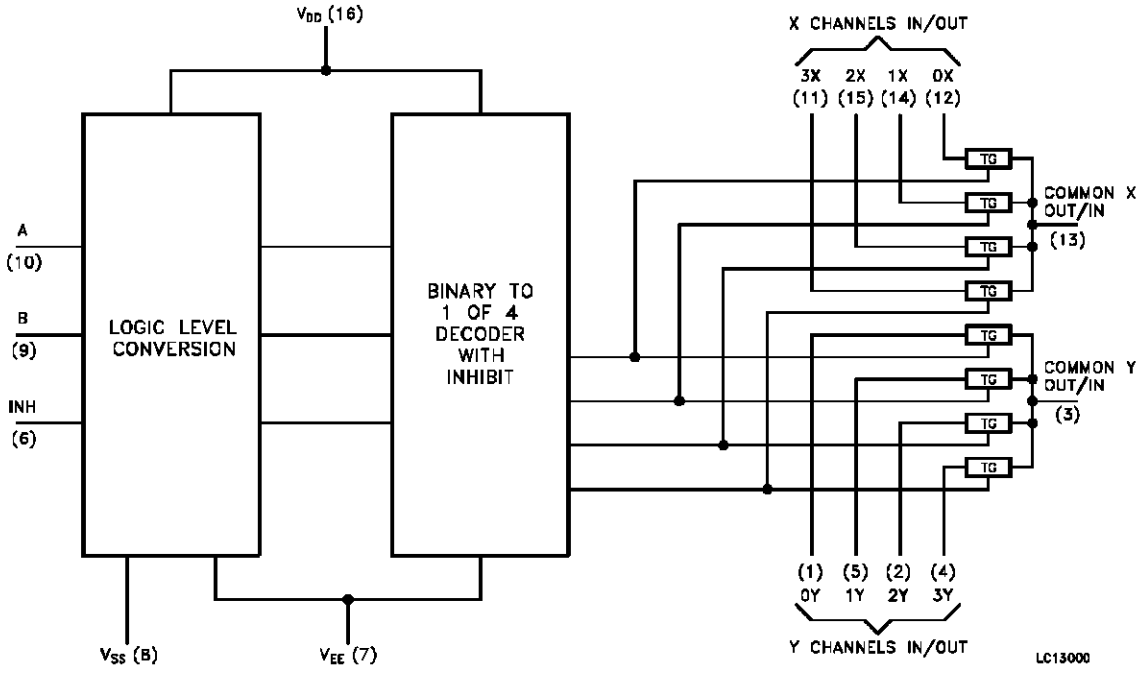
PIN No	SYMBOL	NAME AND FUNCTION
1, 5, 2, 4	0Y TO 3Y	Independent Input/Outputs
6	INH	INHIBIT Input
7	V_{EE}	Negative Supply Voltage
10, 9	A, B	Select Inputs
12, 14, 15, 11	0X TO 3X	Independent Input/Outputs
3	COM Y OUT/IN	Common X Output/input
13	COM X OUT/IN	Common Y Output/input
8	GND	Ground (0V)
16	V_{CC}	Positive Supply Voltage

FUNCTIONAL DIAGRAM

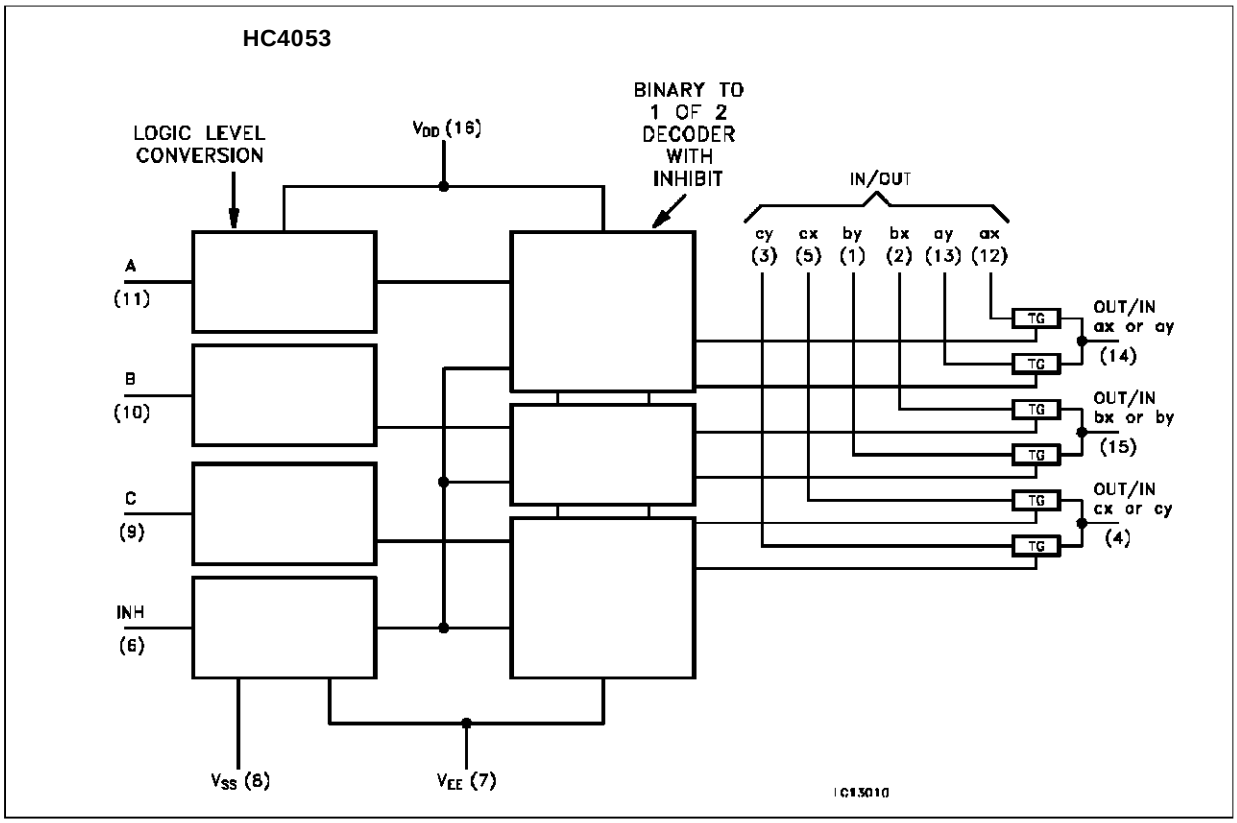
HC4051



HC4052



FUNCTIONAL DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage Range	-0.5 to +7	V
V_{CC} - V_{EE}	Supply Voltage Range	-0.5 to 13	V
V_{IN}	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_{IOK}	I/O Diode Current	± 20	mA
I_T	Switch Through Current	± 25	mA
I_{CC}	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.
(*) 500 mW: ≅ 65 °C derate to 300 mW by 10mW/°C: 65 °C to 85 °C

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_{IN}	Input Voltage		0 to V_{CC}	V
$V_{I/O}$	Input/Output Voltage		V_{EE} to V_{CC}	V
T_{op}	Operating Temperature: **M54HC** Series **M74HC** Series		-55 to +125 -40 to +85	^{o}C ^{o}C
t_r, t_f	Input Rise and Fall Time	V_{CC} = 2 V	0 to 1000	ns
		V_{CC} = 4.5 V	0 to 500	
		V_{CC} = 6 V	0 to 400	

DC SPECIFICATIONS

Symbol	Parameter	Test Conditions			Value							Unit
		V_{CC} (V)	V_{EE} (V)		T_A = 25 ^{o}C 54HC and 74HC			-40 to 85 ^{o}C 74HC		-55 to 125 ^{o}C 54HC		
					Min.	Typ.	Max.	Min.	Max.	Min.	Max.	
V_{IHC}	High Level Control Input Voltage	2.0			1.5			1.5		1.5		V
		4.5			3.15			3.15		3.15		
		6.0			4.2			4.2		4.2		
V_{ILC}	Low Level Control Input Voltage	2.0					0.5		0.5		0.5	V
		4.5					1.35		1.35		1.35	
		6.0					1.8		1.8		1.8	
R_{ON}	ON Resistance	4.5	GND	V_{IN} = V_{IHC} or V_{ILC} $V_{I/O}$ = V_{CC} to V_{EE} $I_{I/O} \leq$ 2 mA		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_{IN} = V_{IHC} or V_{ILC} $V_{I/O}$ = V_{CC} or V_{EE} $I_{I/O} \leq$ 2 mA		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_{IN} = V_{IHC} or V_{ILC} $V_{I/O}$ = V_{CC} or V_{EE} $I_{I/O} \leq$ 2 mA		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_{IN} = 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_{IN} = V_{IHC} or V_{ILC}			±0.06		±0.6		±1.2	µA
		6.0	-6.0				±0.1		±1		±2	
I_{IN}	Control Input Current	6.0	GND	V_{IN} = V_{CC} or GND			±0.1		±0.1		±1	µA
I_{CC}	Quiescent Supply Current	6.0	GND	V_{IN} = V_{CC} or GND			4		40		80	µA
		6.0	-6.0				8		80		160	

AC ELECTRICAL CHARACTERISTICS (C_L = 50 pF, Input $t_r = t_f$ = 6 ns)

Symbol	Parameter	Test Conditions			Value							Unit
		V_{CC} (V)	V_{EE} (V)		T_A = 25 °C 54HC and 74HC			-40 to 85 °C 74HC		-55 to 125 °C 54HC		
					Min.	Typ.	Max.	Min.	Max.	Min.	Max.	
$\Phi_{I/O}$	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 (for 4051/4052)	2.0	GND	R_L = 1KΩ		64	225		280		340	ns
		4.5	GND			18	45		56		68	
		6.0	GND			15	38		48		58	
		4.5	-4.5			18						
t_{PZL} t_{PZH}	Output Enable Time (for 4053)	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 (for 4051/4052)	2.0	GND	R_L = 1KΩ		100	250		315		375	ns
		4.5	GND			33	50		63		7	
		6.0	GND			28	43		54		64	
		4.5	-4.5			29						
t_{PLZ} t_{PHZ}	Output Disable Time (for 4053)	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						
C_{IN}	Input Capacitance					5	10		10		10	pF
$C_{I/O}$	Common Terminal Capacitance	5.0	-5.0	HC4051 HC4052 HC4053		36 19 11	70 40 20		70 40 20		70 40 20	pF
$C_{I/O}$	Switch Terminal Capacitance	5.0	-5.0	HC4051 HC4052 HC4053		7 7 7	15 15 15		15 15 15		15 15 15	pF
C_{IOS}	Feed Through Capacitance	5.0	-5.0	HC4051 HC4052 HC4053		0.95 0.85 0.75	2 2 2		2 2 2		2 2 2	pF
C_{PD} (*)	Power Dissipation Capacitance	5.0	GND	HC4051 HC4052 HC4053		70 71 67						pF

(*) 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 operting current can be obtained by the following equation. $I_{CC}(opr) = C_{PD} \bullet V_{CC} \bullet f_{IN} + I_{CC}$

ANALOG SWITCH CHARACTERISTICS (GND = 0 V T_A = 25 °C)

Symbol	Parameter	Test Conditions					Value	Unit
		V_{CC} (V)	V_{EE} (V)	VIN (Vp-p)			Typ.	
	Sine Wave Distortion	2.25	2.25	4	f_{IN} = 1 KHz R_L = 10 KΩ C_L = 50 pF		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 Ω C_L = 10 pF f_{IN} = 1 KHz sine wave		ALL (*)	120	MHz
						HC4051 (**) HC4052 (**) HC4053 (**)	45 70 95	
		4.5	-4.5			ALL (*)	190	
						HC4051 (**) HC4052 (**) HC4053 (**)	70 110 150	
		6.0	-6.0			ALL (*)	200	
						HC4051 (**) HC4052 (**) HC4053 (**)	85 140 190	
	Feedthrough 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 Ω C_L = 50 pF f_{IN} = 1 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 RL at set up so that I_S = 0A R_L = 600 Ω C_L = 50 pF f_{IN} = 1 MHz square wave			60	mV
		4.5	-4.5				140	
		6.0	-6.0				200	
	Crosstalk (Between Any Switches)	2.25	-2.25	Adjust V_{IN} to Obtain 0 dBm at Input R_L = 600 Ω C_L = 50 pF f_{IN} = 1 MHz sine wave			-50	dB
		4.5	-4.5				-50	
		6.0	-6.0				-50	

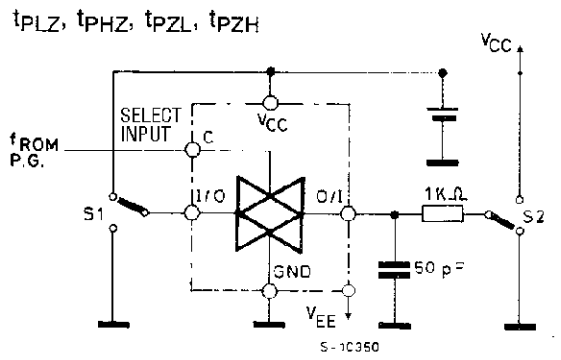
(*): Input COMMON Terminal, and measured at SWITCH Terminal.

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

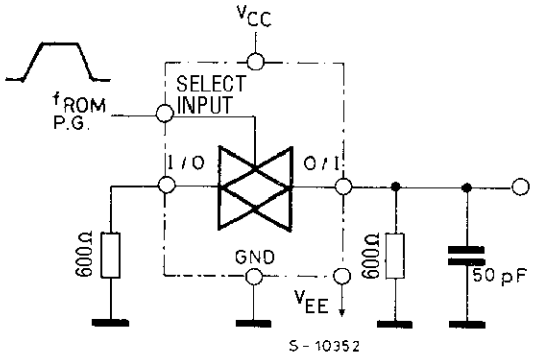
NOTE: These characteristics are determined by design of devices.

SWITCHING CHARACTERISTICS TEST CIRCUIT

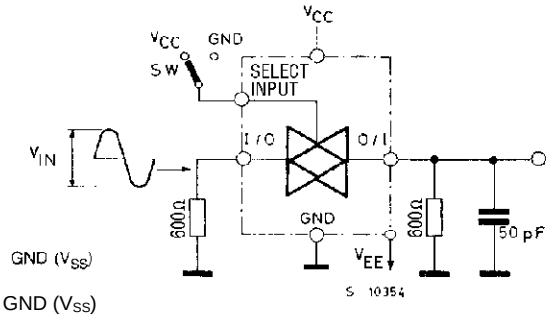
t_{PLZ}, t_{PHZ}, t_{PZL}, t_{PZH}.



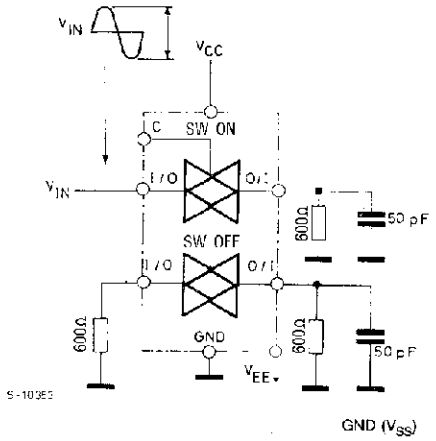
CROSSTALK (control to output)



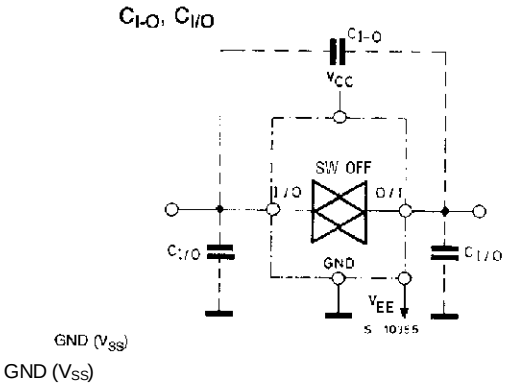
BANDWIDTH AND FEEDTHROUGH ATTENUATION



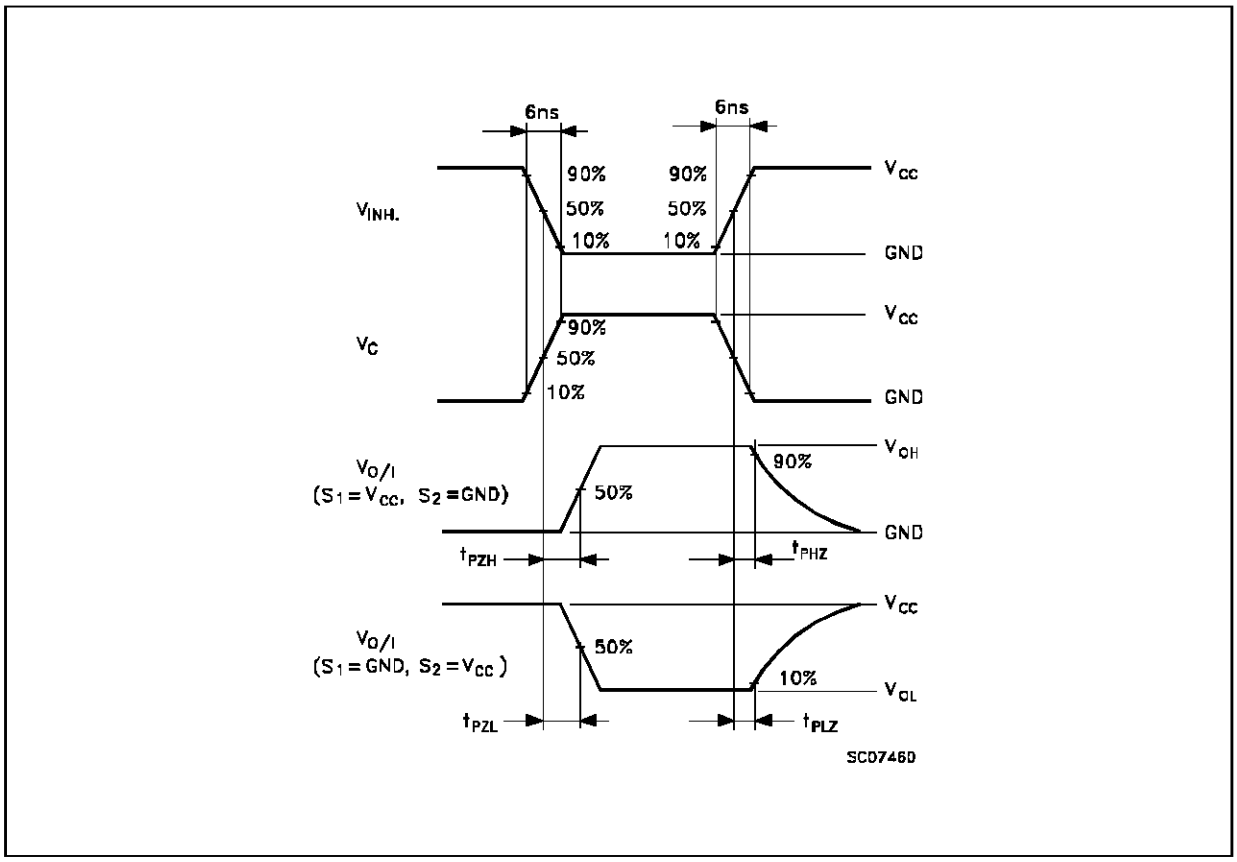
CROSSTALK BETWEEN ANY TWO SWITCHES



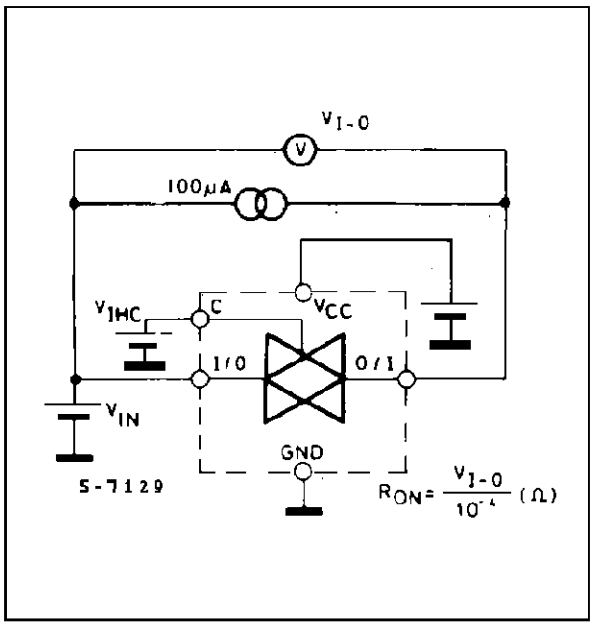
C_{I-O} $C_{I/O}$



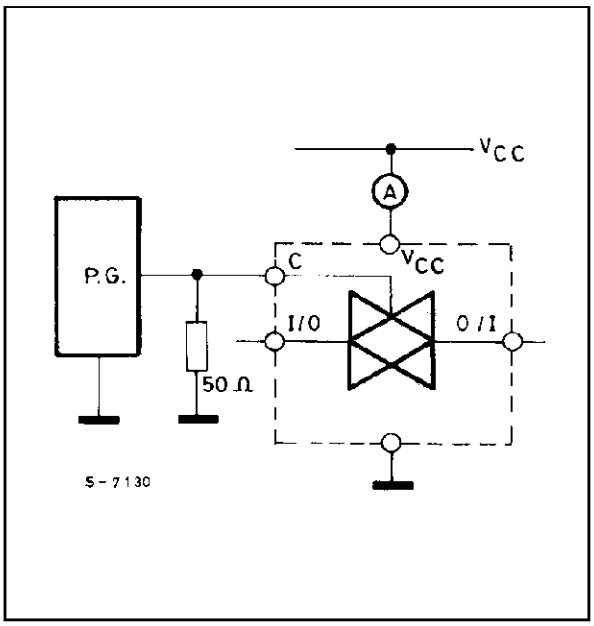
SWITCHING CHARACTERISTICS TEST WAVEFORM



CHANNEL RESISTANCE (R_{ON})

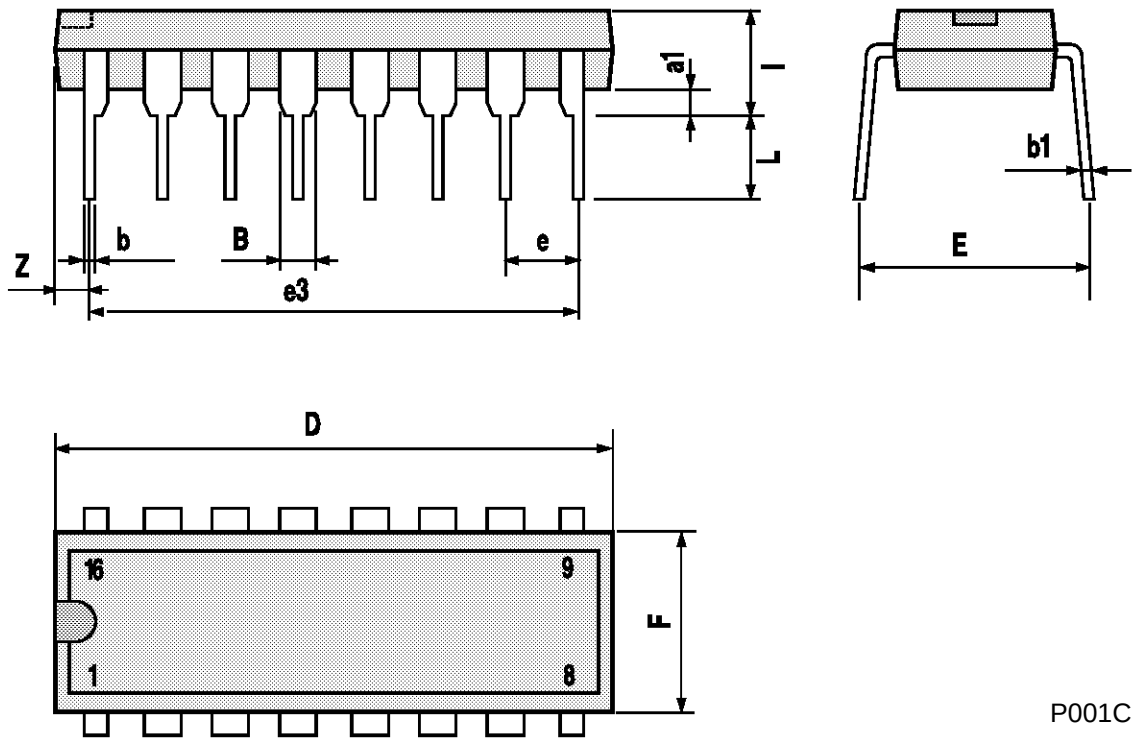


I_{CC} (Opr.)



Plastic DIP16 (0.25) MECHANICAL DATA

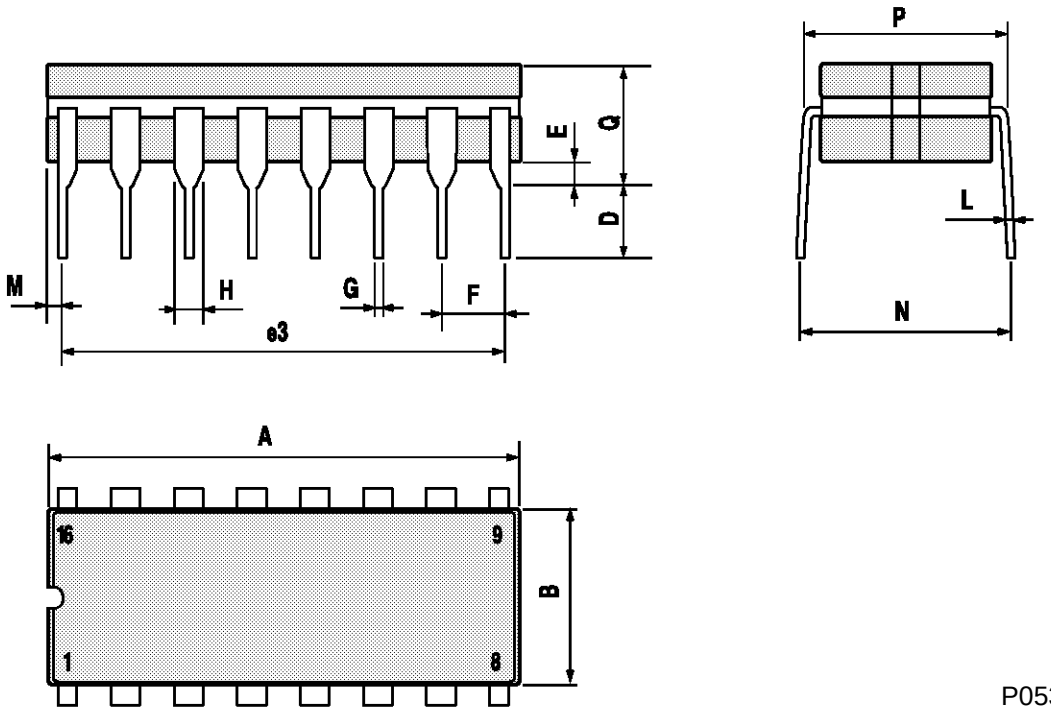
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
a1	0.51			0.020		
B	0.77		1.65	0.030		0.065
b		0.5			0.020	
b1		0.25			0.010	
D			20			0.787
E		8.5			0.335	
e		2.54			0.100	
e3		17.78			0.700	
F			7.1			0.280
I			5.1			0.201
L		3.3			0.130	
Z			1.27			0.050



P001C

Ceramic DIP16/1 MECHANICAL DATA

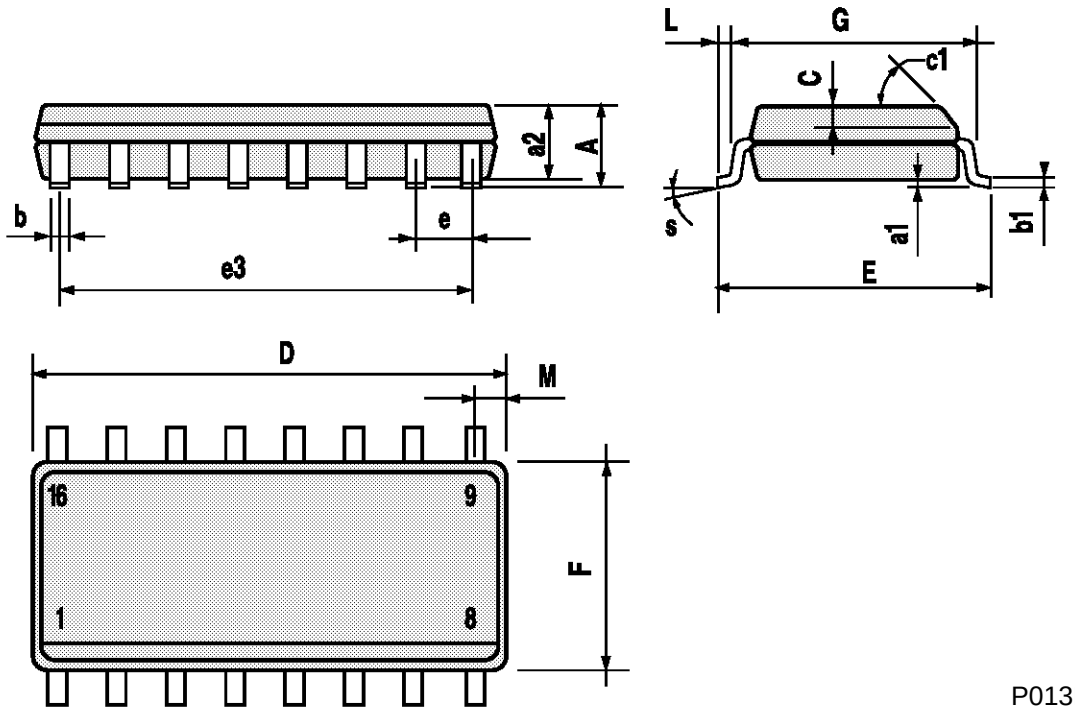
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			20			0.787
B			7			0.276
D		3.3			0.130	
E	0.38			0.015		
e3		17.78			0.700	
F	2.29		2.79	0.090		0.110
G	0.4		0.55	0.016		0.022
H	1.17		1.52	0.046		0.060
L	0.22		0.31	0.009		0.012
M	0.51		1.27	0.020		0.050
N			10.3			0.406
P	7.8		8.05	0.307		0.317
Q			5.08			0.200



P053D

SO16 (Narrow) MECHANICAL DATA

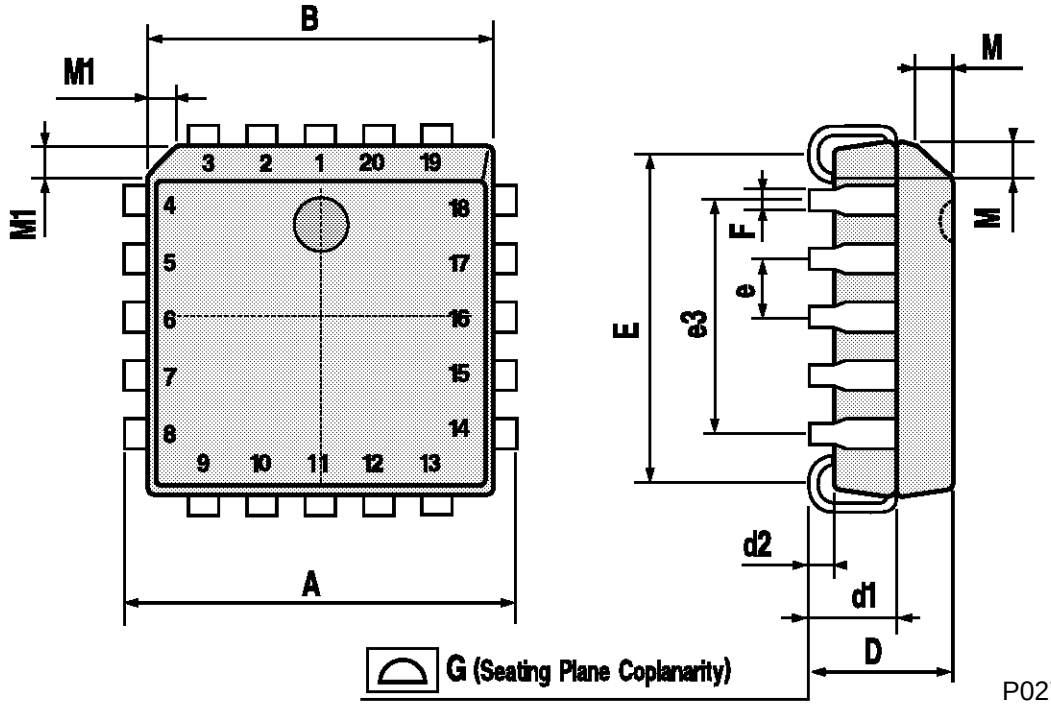
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			1.75			0.068
a1	0.1		0.2	0.004		0.007
a2			1.65			0.064
b	0.35		0.46	0.013		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.019	
c1	45° (typ.)					
D	9.8		10	0.385		0.393
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		8.89			0.350	
F	3.8		4.0	0.149		0.157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



P013H

PLCC20 MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	9.78		10.03	0.385		0.395
B	8.89		9.04	0.350		0.356
D	4.2		4.57	0.165		0.180
d1		2.54			0.100	
d2		0.56			0.022	
E	7.37		8.38	0.290		0.330
e		1.27			0.050	
e3		5.08			0.200	
F		0.38			0.015	
G			0.101			0.004
M		1.27			0.050	
M1		1.14			0.045	



P027A