

## QUAD BILATERAL SWITCH

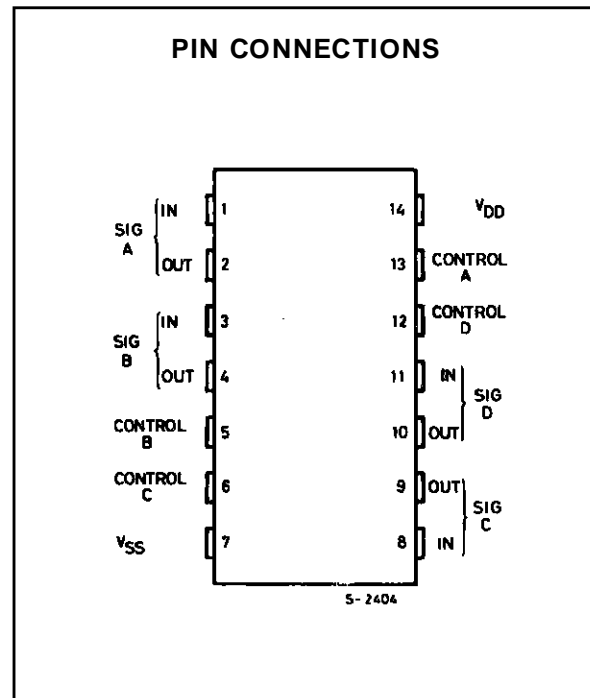
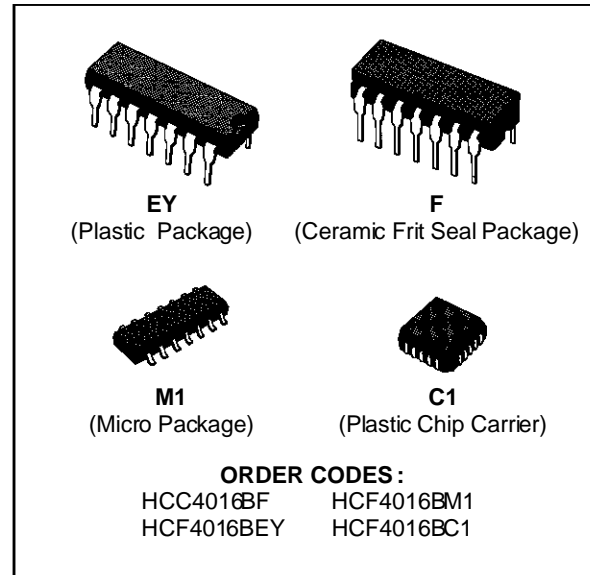
- 20V DIGITAL OR  $\pm 10V$  PEAK-TO-PEAK SWITCHING
- 280 $\Omega$  TYPICAL ON RESISTANCE FOR 15V OPERATION
- SWITCH ON RESISTANCE MATCHED TO WITHIN 10 $\Omega$  TYP. OVER 15V SIGNAL INPUT RANGE
- HIGH ON/OFF OUTPUT-VOLTAGE RATIO : 65dB TYP. @  $f_{is} = 10\text{kHz}$ ,  $R_L = 10\text{k}\Omega$
- HIGH DEGREE OF LINEARITY : < 0.5% DISTORTION TYP. @  $f_{is} = 1\text{kHz}$ ,  $V_{is} = 5\text{V}_{pp}$ ,  $V_{DD} - V_{SS} \geq 10\text{V}$ ,  $R_L = 10\text{k}\Omega$
- EXTREMELY LOW OFF SWITCH LEAKAGE RESULTING IN VERY LOW OFFSET CURRENT AND HIGH EFFECTIVE OFF RESISTANCE: 100pA TYP. @  $V_{DD} - V_{SS} = 18\text{V}$ ,  $T_{amb} = 25^\circ\text{C}$
- EXTREMELY HIGH CONTROL INPUT IMPEDANCE (control circuit isolated from signal circuit 10<sup>12</sup> $\Omega$  typ.)
- LOW CROSSTALK BETWEEN SWITCHES : 50dB TYP. @  $f_{is} = 0.9\text{MHz}$ ,  $R_L = 1\text{k}\Omega$
- MATCHED CONTROL-INPUT TO SIGNAL-OUTPUT CAPACITANCE : REDUCES OUTPUT SIGNAL TRANSIENTS
- FREQUENCY RESPONSE' SWITCH ON = 40MHz (typ.)
- QUIESCENT CURRENT SPECIFIED TO 20V FOR HCC DEVICE
- 5V, 10V, AND 15V PARAMETRIC RATINGS
- INPUT CURRENT OF 100nA AT 18V AND 25 $^\circ\text{C}$  FOR HCC DEVICE
- 100% TESTED FOR QUIESCENT CURRENT
- MEETS ALL REQUIREMENTS OF JEDEC TENTATIVE STANDARD N<sup>o</sup> 13A, "STANDARD SPECIFICATIONS FOR DESCRIPTION OF "B" SERIES CMOS DEVICES"

### DESCRIPTION

The **HCC4016B** (extended temperature range) and **HCF4016B** (intermediate temperature range) are monolithic integrated circuit, available in 14-lead dual in-line plastic or ceramic package and plastic micropackage.

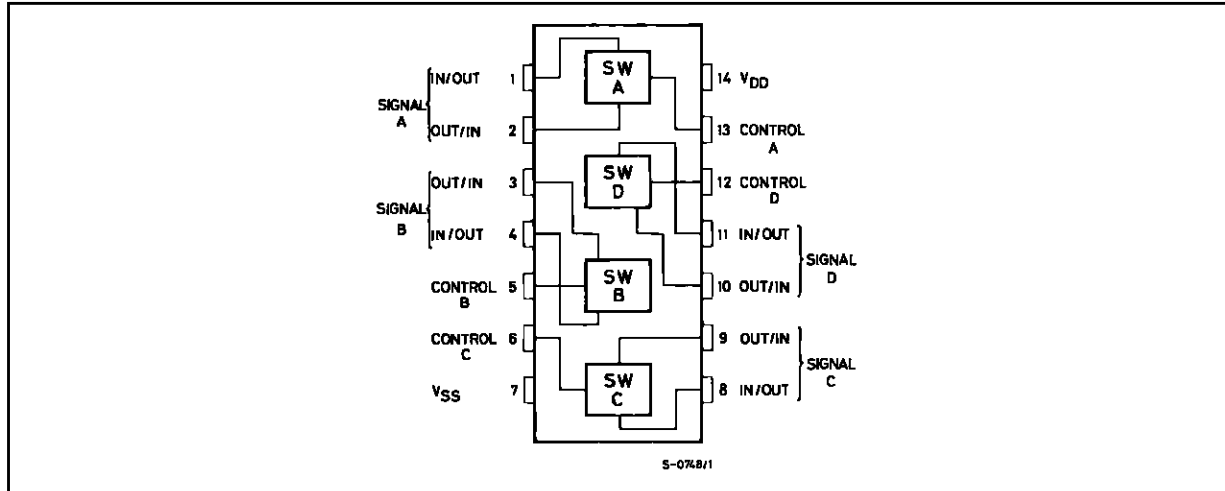
The **HCC/HCF4016B** Series types are quad bilateral switches intended for the transmission or multiplexing

of analog or digital signals. Each of the four independent bilateral switches has a single control signal input which simultaneously biases both the p and n device in a given switch ON or OFF.



# HCC/HCF4016B

## FUNCTIONAL DIAGRAM



## ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
$V_{DD}^*$	Supply Voltage : HCC Types HCF Types	- 0.5 to + 20 - 0.5 to + 18	V V
$V_i$	Input Voltage	- 0.5 to $V_{DD} + 0.5$	V
$I_i$	DC Input Current (any one input)	$\pm 10$	mA
$P_{tot}$	Total Power Dissipation (per package)	200	mW
	Dissipation per Output Transistor for $T_{op} =$ Full Package-temperature Range	100	mW
$T_{op}$	Operating Temperature : HCC Types HCF Types	- 55 to + 125	$^{\circ}C$
		- 40 to + 85	$^{\circ}C$
$T_{stg}$	Storage Temperature	- 65 to + 150	$^{\circ}C$

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for external periods may affect device reliability.

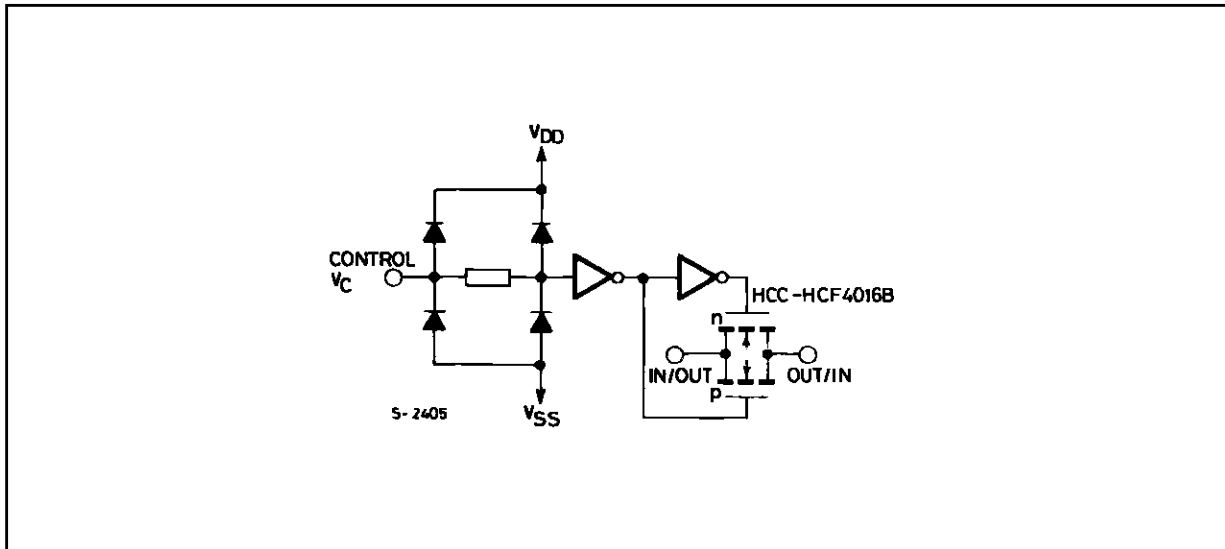
\* All voltage values are referred to  $V_{SS}$  pin voltage.

## RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Value	Unit
$V_{DD}$	Supply Voltage : HCC Types HCF Types	3 to 18	V
		3 to 15	V
$V_i$	Input Voltage	0 to $V_{DD}$	V
$T_{op}$	Operating Temperature : HCC Types HCF Types	- 55 to + 125	$^{\circ}C$
		- 40 to + 85	$^{\circ}C$

**SCHEMATIC DIAGRAM**

1 OF 4 IDENTICAL SECTION



**STATIC ELECTRICAL CHARACTERISTICS** (over recommended operating conditions)

Symbol	Parameter		Test Conditions			Value						Unit	
			V <sub>C</sub> = V <sub>SS</sub> V <sub>DD</sub> (V)	V <sub>DD</sub> (V)	T <sub>Low</sub> *		25°C			T <sub>High</sub> *			
					Min.	Max.	Min.	Typ.	Max.	Min.	Max.		
I <sub>L</sub>	Quiescent Device Current (all switches on or all switches off)	HCC Types			5	0.25		0.01	0.25		7.5	μA	
					10	0.5		0.01	0.5		15		
					15	1		0.01	1		30		
					20	5		0.02	5		150		
		HCF Types			5	1		0.01	1		7.5		
					10	2		0.01	2		15		
					15	4		0.01	4		30		
<b>SWITCH</b>					V <sub>IS</sub>								
R <sub>ON</sub>	Resistance	HCC	R <sub>L</sub> = 10kΩ•	+ 7.5	- 7.5	+ 7.5	360		200	400		600	Ω
						- 7.5	360		200	400		600	
						± 0.25	775		280	850		1230	
		HCF				+ 7.5	370		200	400		520	
						- 7.5	370		200	400		520	
						± 0.25	790		280	850		1080	
HCC	R <sub>L</sub> = 10kΩ•	+ 5	- 5	+ 5	600		250	660		960			
				- 5	600		250	660		960			
				± 0.25	1870		580	2000		2600			
HCF				+ 5	610		250	660		840			
				- 5	610		250	660		840			
				± 0.25	1900		580	2000		2380			

\* T<sub>Low</sub>= - 55°C for HCC device : - 40°C for HCF device.

\* T<sub>High</sub>= + 125°C for HCC device : + 85°C for HCF device.

STATIC ELECTRICAL CHARACTERISTICS (continued)

Symbol	Parameter		Test Conditions			Value						Unit		
			V <sub>C</sub> = V <sub>DD</sub>	V <sub>SS</sub> (V)	V <sub>DD</sub> (V)	T <sub>Low</sub> *		25°C			T <sub>High</sub> *			
						Min.	Max.	Min.	Typ.	Max.	Min.		Max.	
<b>SWITCH (continued)</b>														
R <sub>ON</sub>	Resistance	HCC	R <sub>L</sub> = 10kΩ•	+ 15	0	+ 15 + 0.25 + 9.3		360 360 775		200 200 300	400 400 850		600 600 1230	Ω
		HCF		+ 15	0	+ 15 + 0.25 + 9.3		370 370 790		200 200 300	400 400 800		520 520 1080	
	HCC	R <sub>L</sub> = 10kΩ•	+ 10	0	+ 10 + 0.25 + 5.6		600 600 1870		250 250 560	660 660 2000		960 960 2600		
	HCF		+ 10	0	+ 10 + 0.25 + 5.6		610 610 1900		250 250 560	660 660 2000		840 840 2380		
ΔON	Resistance ΔRON (between any 2 of 4 switches)		R <sub>L</sub> = 10kΩ•	+ 7.5	- 7.5	± 7.5				10				Ω
				+ 5	- 5	± 5				15				
Input or Output Leakage Current Switch OFF (effective off resistance)		HCC		V <sub>DD</sub>	V <sub>C</sub> = V <sub>SS</sub>									μA
		HCF		V <sub>DD</sub>	V <sub>C</sub> = V <sub>SS</sub>									
C <sub>I</sub>	Input Capacitance	V <sub>CC</sub> = V <sub>SS</sub> = - 5			+ 5					4				pF
C <sub>O</sub>	Output Capacitance									4				
C <sub>IO</sub>	Feedthrough									0.2				
<b>CONTROL (V<sub>C</sub>)</b>														
V <sub>TH</sub>	Switch Threshold Voltage		I <sub>IS</sub> = 10μA	5	1		1	2.25		1				V
				10	2		2	4.5		2				
				15	2		2	6.75		2				
I <sub>I</sub>	Input Current	HCC Types	V <sub>IS</sub> ≤ V <sub>DD</sub>			± 0.1		±10 <sup>-5</sup>	± 0.1			± 1	μA	
		HCF Types				± 0.3		±10 <sup>-5</sup>	± 0.3		± 1			
C <sub>I</sub>	Input Capacitance								5	7.5			pF	

\* T<sub>Low</sub> = - 55°C for HCC device : - 40°C for HCF device.

\* T<sub>High</sub> = + 125°C for HCC device : + 85°C for HCF device.

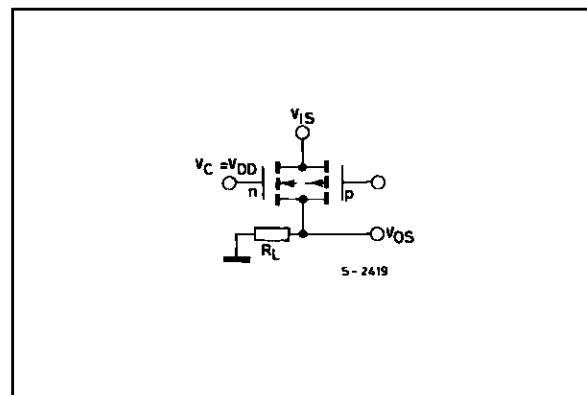
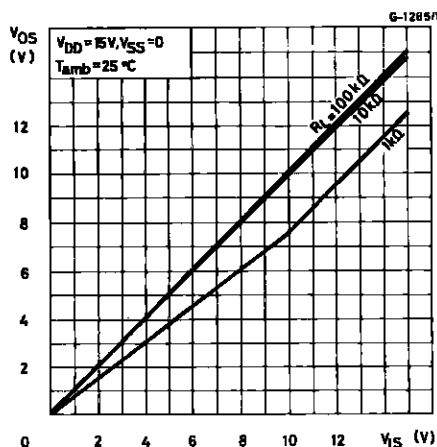
**DYNAMIC ELECTRICAL CHARACTERISTICS** ( $T_{amb} = 25^{\circ}\text{C}$ ,  $C_L = 50\text{pF}$  all input square wave rise and fall time = 20ns)

Parameter	Test Conditions							Value		Unit	
	$V_C$ (V)	$R_L$ (k $\Omega$ )	$f_i$ (KHz)	$V_I$ (V)	$V_{SS}$ (V)	$V_{DD}$ (V)	Typ.	Max.			
<b>SWITCH</b>											
$t_{pd}$ Propagation Delay Time (signal input to output)	$= V_{DD}$	10		10sq. Wave	GND	5 10 15	40 20 15	100 50 40	ns		
Crosstalk Between any 2 of 4 Switches (f @ - 50dB) $20 \log 10 \frac{V_{O(B)}}{V_{I(A)}} = - 50\text{dB}$	$V_{C(A)} = V_{DD} = + 5$ $V_{C(B)} = V_{SS} = - 5$	1		$V_{I(A)} \Delta = 5\text{p-p}$			0.9		MHz		
Frequency Response Switch "ON" (sine wave input) At $20 \log 10 \frac{V_O}{V_I} = - 3\text{dB}$	$= V_{DD}$ $= + 5$	1		5p-p	- 5		40		MHz		
Feedthrough (switch OFF) At $20 \log 10 \frac{V_O}{V_I} = - 50\text{dB}$	$= V_{SS}$ $= - 5$	1		- 5p-p		5	1.25		MHz		
Sine Wave Distortion	$= V_{DD}$ $= 5$	10	1	5p-p	- 5		0.4		%		
<b>CONTROL (<math>V_C</math>)</b>											
Propagation Delay : (turn on control to output)	$V_{DD} - V_{SS}$ (sq. wave)	1		$V_{DD}$ or $V_{SS}$		5 10 15	$V_{DD}-V_{SS} = 10\text{V}$		35 20 15	70 40 30	ns
Max. Allowable Control Input Repetition Rate	10 (sq. wave)	1		$V_{DD}$	GND	10	10		MHz		
Crosstalk (control input to signal output)	10 (sq. wave)	10			GND	10	50		mV		

( $\Delta$ ) Symmetrical about OV

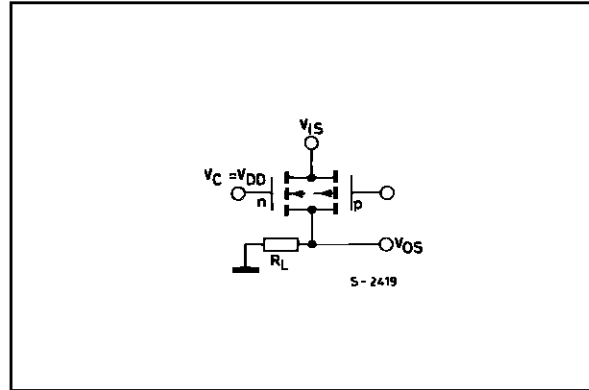
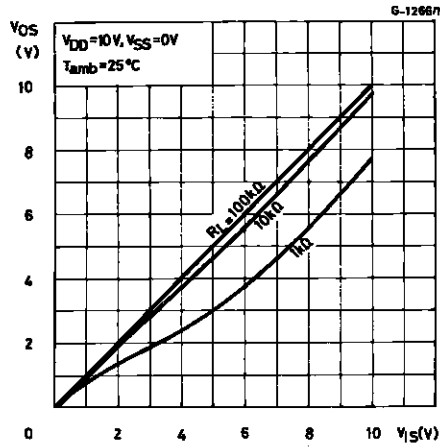
( $\bullet$ ) For all test condifions.

Typical "ON" Characteristics for 1 of 4 switches with  $V_{DD} = + 15\text{V}$ ,  $V_{SS} = 0\text{V}$ , and Test Circuit.

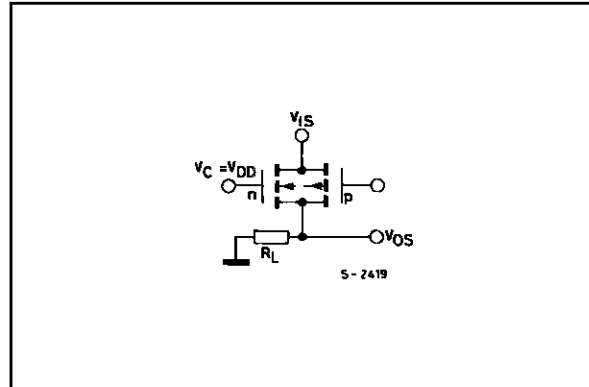
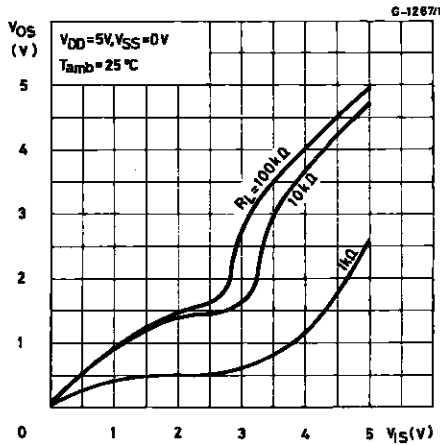


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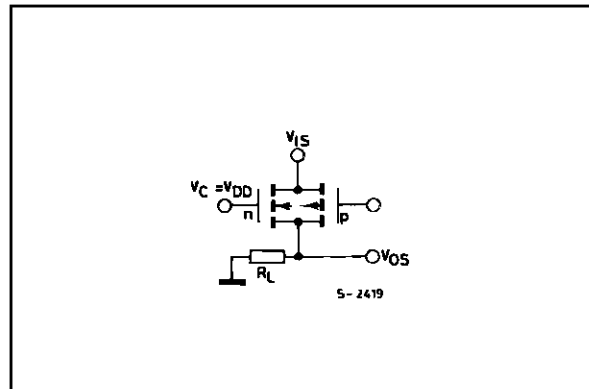
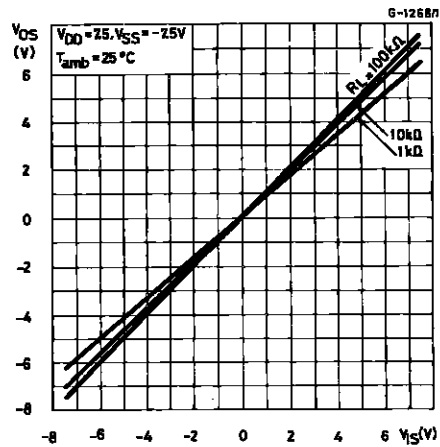
Typical "ON" Characteristics for 1 of 4 switches with  $V_{DD} = +10V$ ,  $V_{SS} = 0V$ , and Test Circuit.



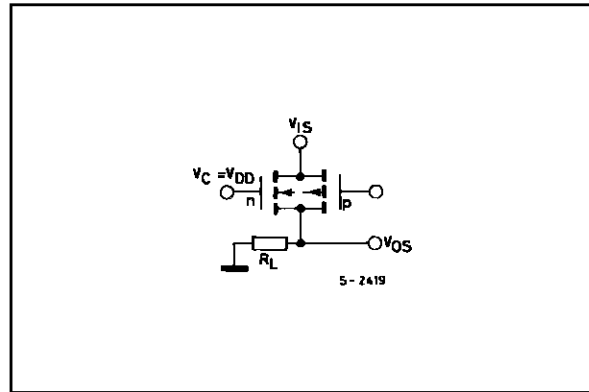
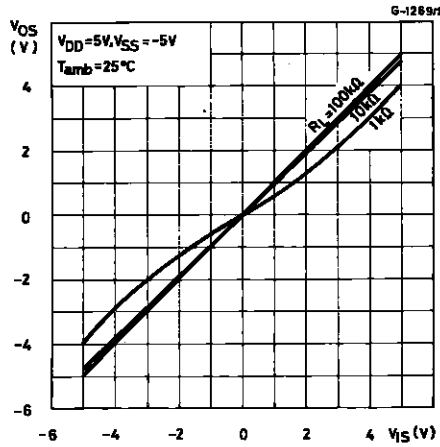
Typical "ON" Characteristics for 1 of 4 switches with  $V_{DD} = +5V$ ,  $V_{SS} = 0V$ , and Test Circuit.



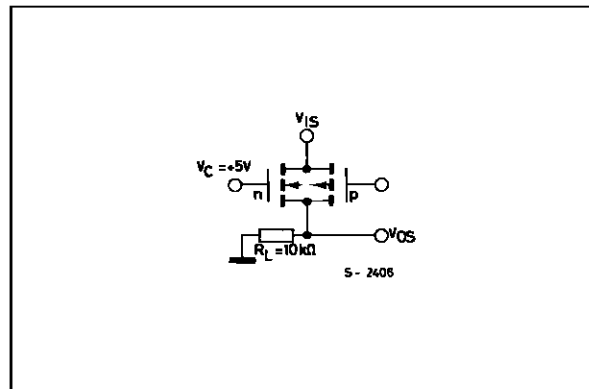
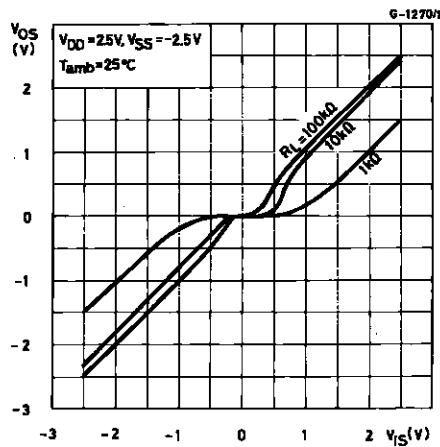
Typical "ON" Characteristics for 1 of 4 switches with  $V_{DD} = +7.5V$ ,  $V_{SS} = -7.5V$ , and Test Circuit.



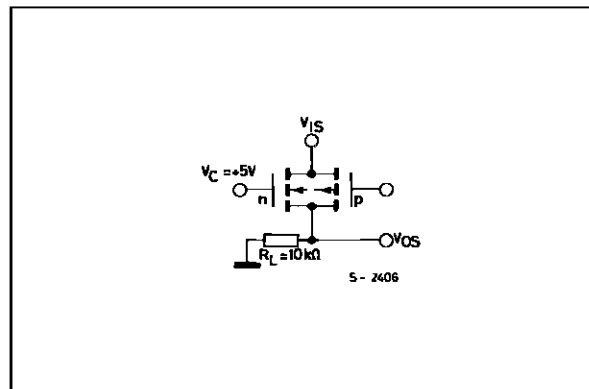
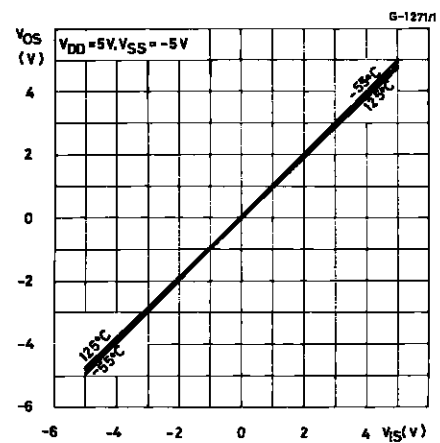
Typical "ON" Characteristics for 1 of 4 switches with  $V_{DD} = +5V$ ,  $V_{SS} = -5V$ , and Test Circuit.



Typical "ON" Characteristics for 1 of 4 switches with  $V_{DD} = +2.5V$ ,  $V_{SS} = -2.5V$ , and Test Circuit.

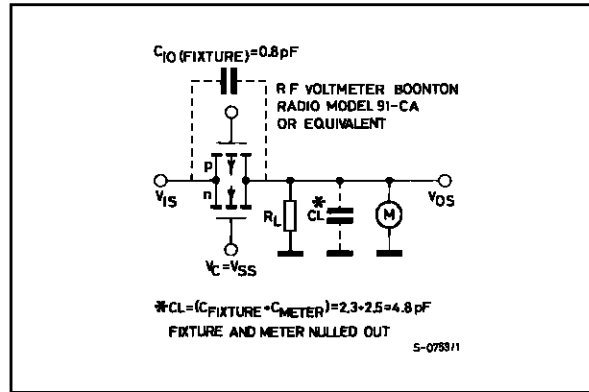
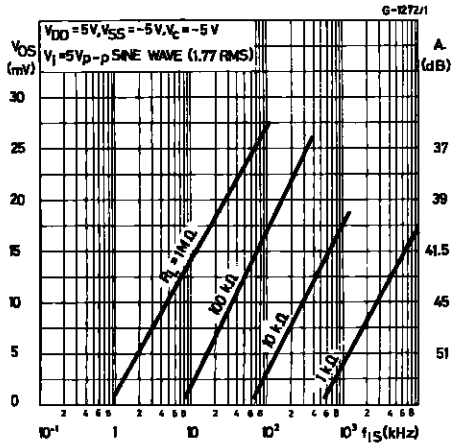


Typical "ON" Characteristics as function of temp. for 1 of 4 switches with  $V_{DD} = +5V$  and Test Circuit.

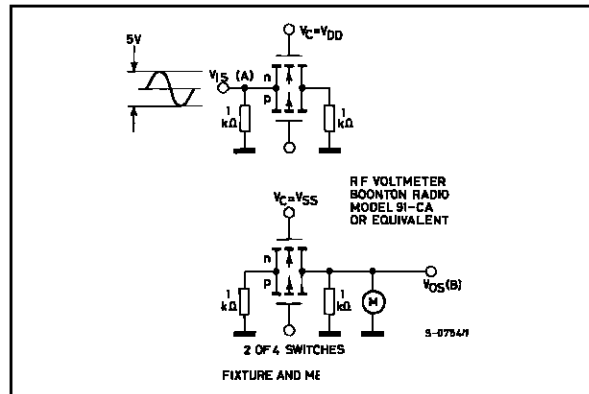
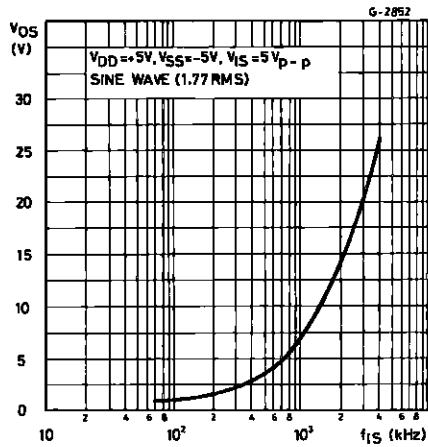


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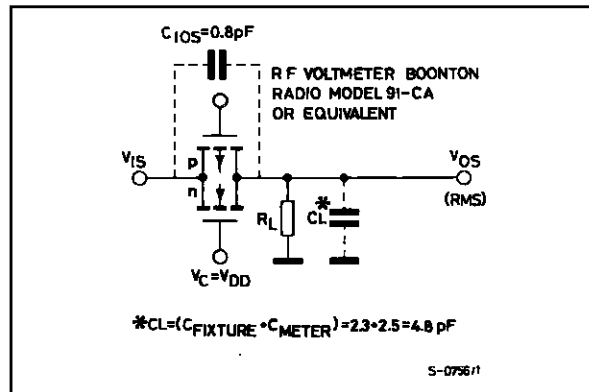
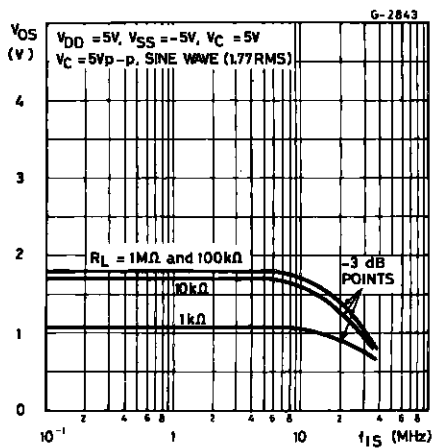
Typical feedthru vs. frequency-switch "OFF" and Test Circuit.



Typical Crosstalk between Switch Circuits in the Same Package.



Typical Switch Frequency response-switch "ON" and Test Circuit.





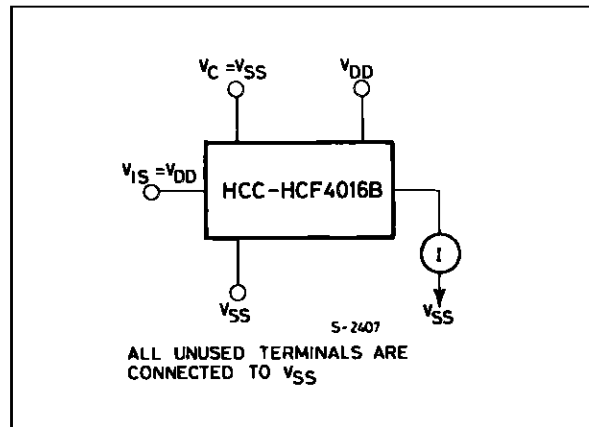
TYPICAL "ON" RESISTANCE CHARACTERISTICS,  $T_{amb} = 25^{\circ}\text{C}$

Characteristic*	Supply Conditions		Load Conditions					
			$R_L = 1\text{ k}\Omega$		$R_L = 10\text{ k}\Omega$		$R_L = 100\text{ k}\Omega$	
	$V_{DD}$ (V)	$V_{SS}$ (V)	Value ( $\Omega$ )	$V_{is}$ (V)	Value ( $\Omega$ )	$V_{is}$ (V)	Value ( $\Omega$ )	$V_{is}$ (V)
$R_{ON}$	+ 15	0	200	+ 15	200	+ 15	180	+ 15
			200	0	200	0	200	0
$R_{ON} \text{ (max)}$	+ 15	0	300	+ 11	300	+ 9.3	320	+ 9.2
$R_{ON}$	+ 10	0	290	+ 10	250	+ 10	240	+ 10
			290	0	250	0	300	0
$R_{ON} \text{ (max)}$	+ 10	0	500	+ 7.4	560	+ 5.6	610	+5.5
$R_{ON}$	+ 5	0	860	+ 5	470	+ 5	450	+ 5
			600	0	580	0	800	0
$R_{ON} \text{ (max)}$	+ 5	0	1.7k	+ 4.2	7k	+ 2.9	33k	+2.7
$R_{ON}$	+ 2.5	- 2.5	590	+ 2.5	450	+ 2.5	490	+ 2.5
			720	- 2.5	520	- 2.5	520	- 2.5
$R_{ON} \text{ (max)}$	+ 2.5	- 2.5	232k	$\pm 0.25$	300k	$\pm 0.25$	870k	$\pm 0.25$

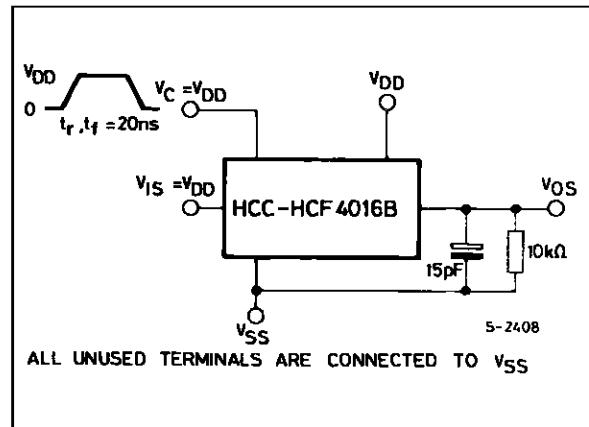
\* Variation from a perfect switch,  $R_{ON} = 0\Omega$ .

TEST CIRCUITS

"OFF" Switch Input or Put Leakage Current.



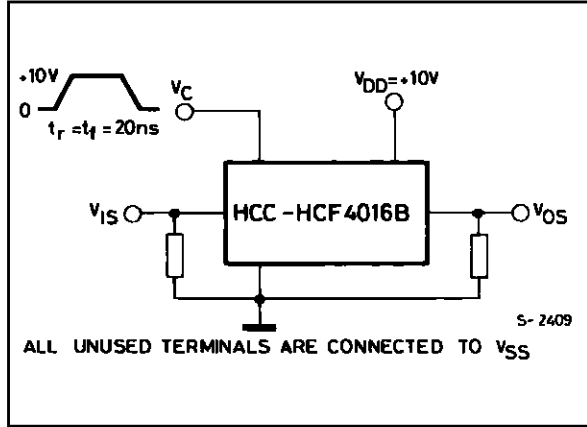
Square-Wave Response.



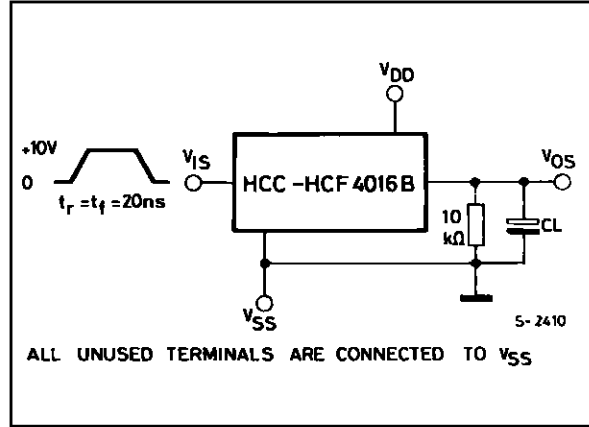
# HCC/HCF4016B

## TEST CIRCUITS (continued)

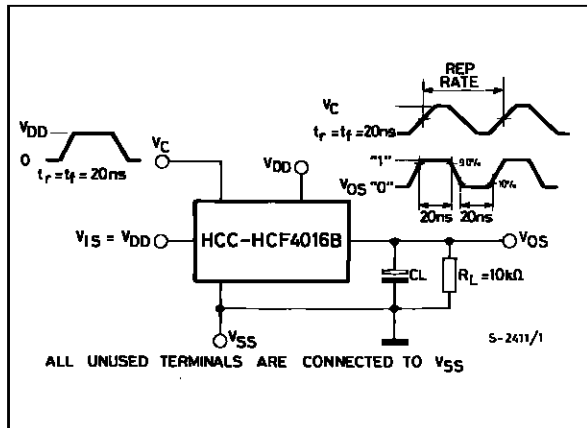
Crosstalk-control Input to Signal Output.



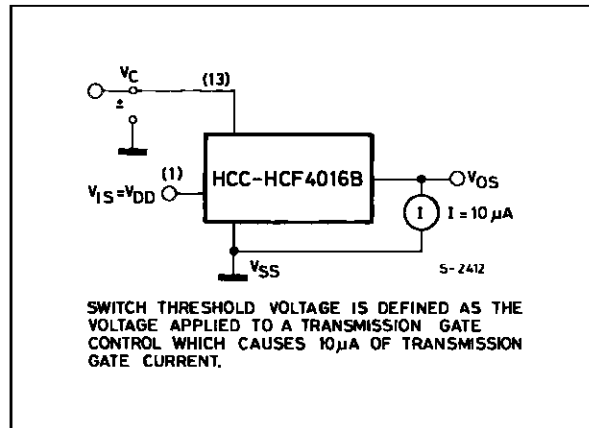
Propagaton Delay Time Signal Input ( $V_{IS}$ ) to Signal Output ( $V_{OS}$ ).



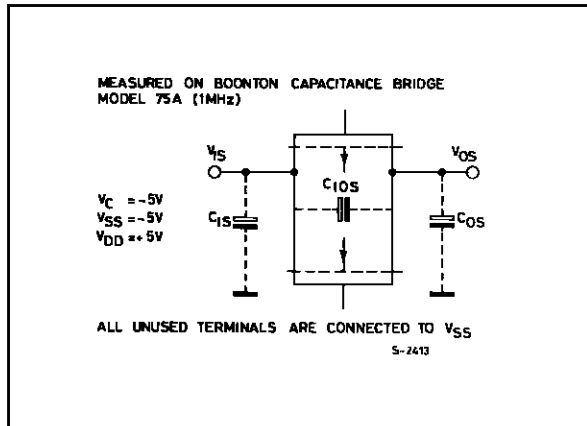
Max Allowable Control-input Repetition Rate.



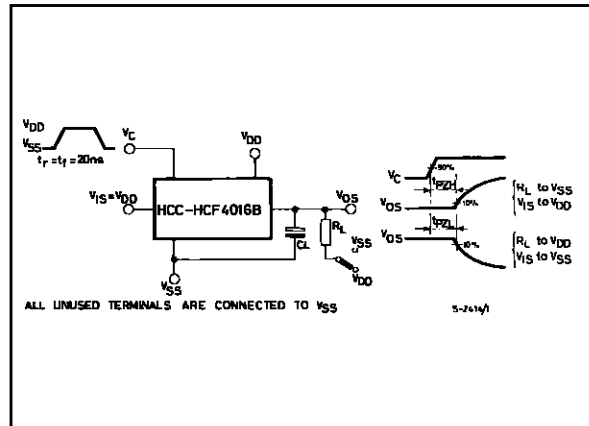
Switch Treshold Voltage.



Capacitance  $C_{IOS}$  and  $C_{OS}$ .

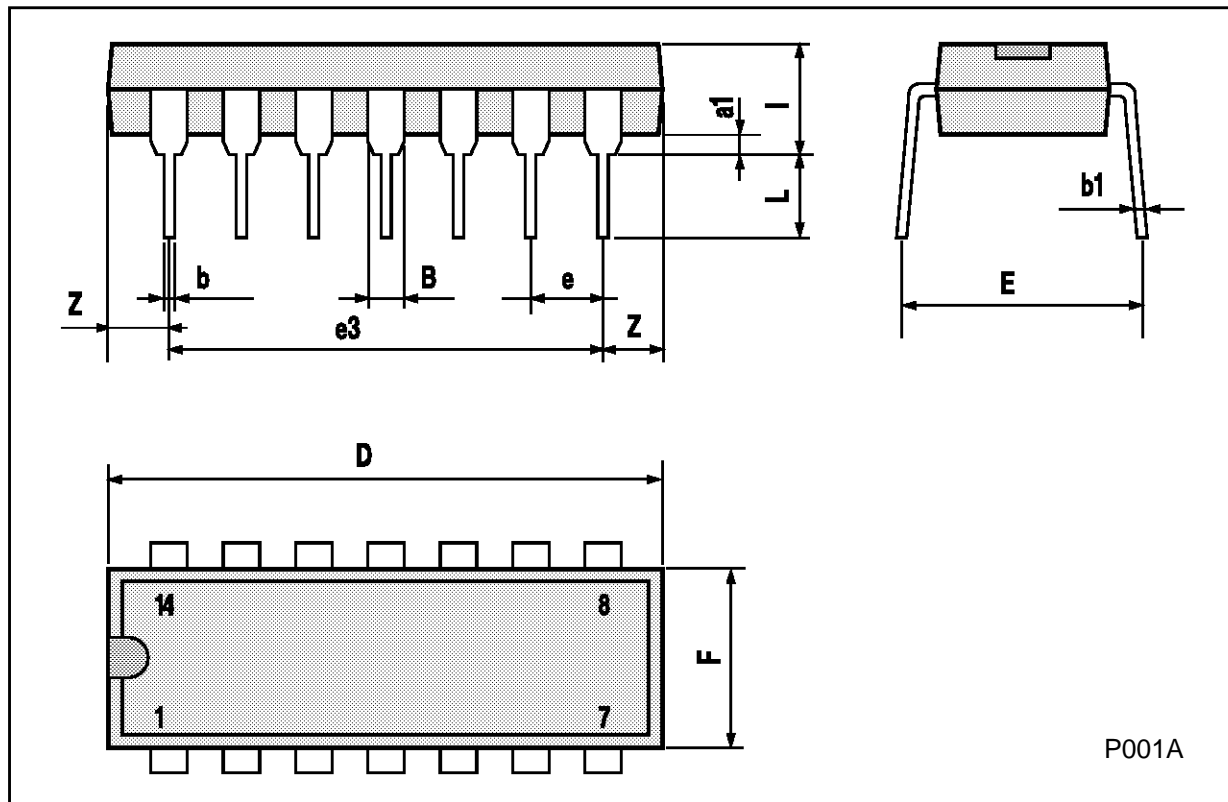


Turn-On Propagation Delay-control Input to Output.



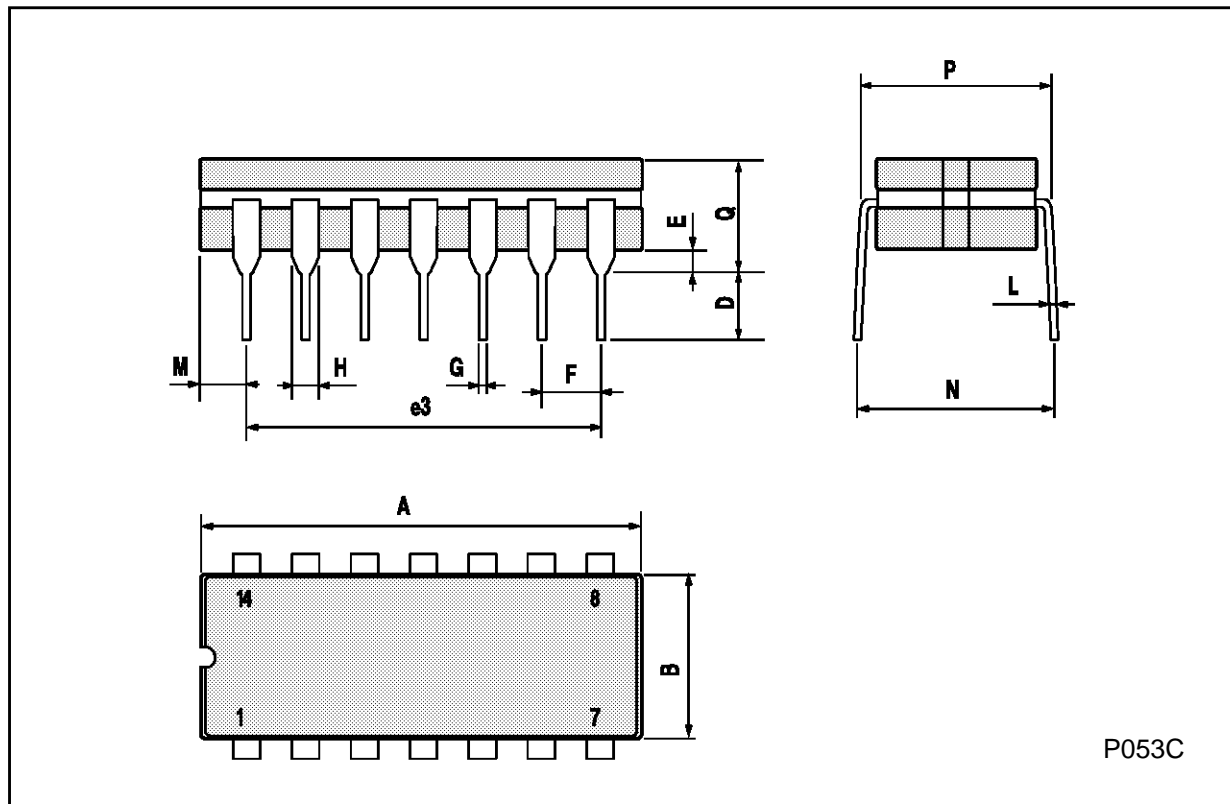
## Plastic DIP14 MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
a1	0.51			0.020		
B	1.39		1.65	0.055		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		15.24			0.600	
F			7.1			0.280
I			5.1			0.201
L		3.3			0.130	
Z	1.27		2.54	0.050		0.100



Ceramic DIP14/1 MECHANICAL DATA

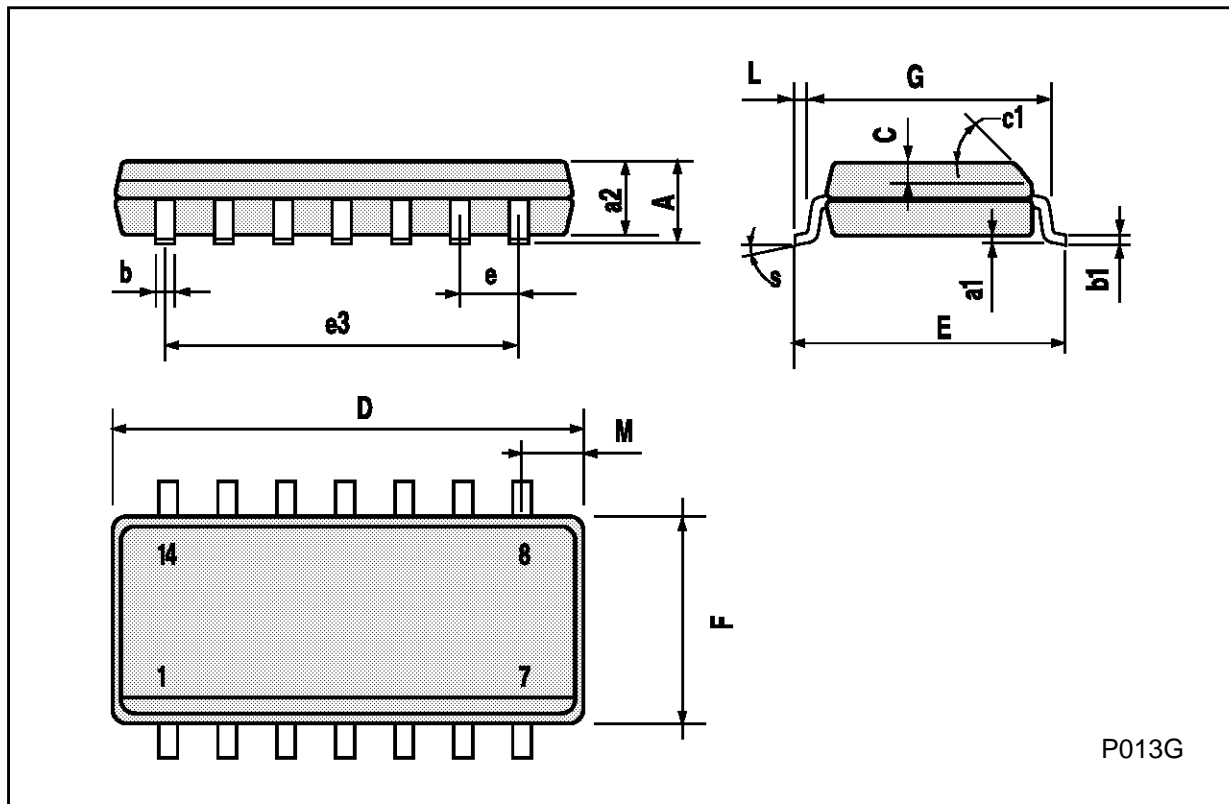
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			20			0.787
B			7.0			0.276
D		3.3			0.130	
E	0.38			0.015		
e3		15.24			0.600	
F	2.29		2.79	0.090		0.110
G	0.4		0.55	0.016		0.022
H	1.17		1.52	0.046		0.060
L	0.22		0.31	0.009		0.012
M	1.52		2.54	0.060		0.100
N			10.3			0.406
P	7.8		8.05	0.307		0.317
Q			5.08			0.200



P053C

**SO14 MECHANICAL DATA**

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			1.75			0.068
a1	0.1		0.2	0.003		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	8.55		8.75	0.336		0.344
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		7.62			0.300	
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			0.68			0.026
S	8° (max.)					



P013G

**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	



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