

# COS/MOS INTEGRATED CIRCUIT



HCC/HCF 4016B

7929225 S G S SEMICONDUCTOR CORP

## 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: 65 dB TYP. @  $f_{is} = 10$  kHz,  $R_L = 10$  k $\Omega$
- HIGH DEGREE OF LINEARITY: < 0.5% DISTORTION TYP. @  $f_{is} = 1$  KHz,  $V_{is} = 5$  V<sub>pp</sub>,  $V_{DD} - V_{SS} \geq 10V$ ,  $R_L = 10$  k $\Omega$
- EXTREMELY LOW OFF SWITCH LEAKAGE RESULTING IN VERY LOW OFFSET CURRENT AND HIGH EFFECTIVE OFF RESISTANCE: 100 pA TYP. @  $V_{DD} - V_{SS} = 18V$ ,  $T_{amb} = 25^\circ C$
- EXTREMELY HIGH CONTROL INPUT IMPEDANCE (CONTROL CIRCUIT ISOLATED FROM SIGNAL CIRCUIT 10<sup>12</sup> $\Omega$  TYP.)
- LOW CROSSTALK BETWEEN SWITCHES: -50 dB TYP. @  $f_{is} = 0.9$  MHz,  $R_L = 1$  k $\Omega$
- MATCHED CONTROL-INPUT TO SIGNAL-OUTPUT CAPACITANCE: REDUCES OUTPUT SIGNAL TRANSIENTS
- FREQUENCY RESPONSE: SWITCH ON = 40 MHz (TYP.)
- QUIESCENT CURRENT SPECIFIED TO 20V FOR HCC DEVICE
- 5V, 10V, AND 15V PARAMETRIC RATINGS
- INPUT CURRENT OF 100 nA AT 18V AND 25 $^\circ C$  FOR HCC DEVICE
- 100% TESTED FOR QUIESCENT CURRENT
- MEETS ALL REQUIREMENTS OF JEDEC TENTATIVE STANDARD NO. 13A, "STANDARD SPECIFICATIONS FOR DESCRIPTION OF "B" SERIES CMOS DEVICES"

The **HCC 4016B** (extended temperature range) and **HCF 4016B** (intermediate temperature range) are monolithic integrated circuit, available in 14-lead dual in-line plastic or ceramic package, ceramic flat package and plastic micropackage.

The **HCC/HCF 4016B** 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.

## ABSOLUTE MAXIMUM RATINGS

$V_{DD}^*$	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 -40 to 85	$^\circ C$ $^\circ C$
$T_{stg}$	Storage temperature	-65 to 150	$^\circ C$

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

## ORDERING NUMBERS:

HCC 4016 BD for dual in-line ceramic package  
 HCC 4016 BF for dual in-line ceramic package, frit seal  
 HCC 4016 BK for ceramic flat package  
 HCF 4016 BE for dual in-line plastic package  
 HCF 4016 BF for dual in-line ceramic package, frit seal  
 HCF 4016 BM for plastic micropackage





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## STATIC ELECTRICAL CHARACTERISTICS (over recommended operating conditions)

Parameter		Test conditions			Values						Unit					
		$V_C = V_{DD}$	$V_{SS}$ (V)	$V_{DD}$ (V)	$T_{Low}^*$		25°C			$T_{High}^*$						
					Min.	Max.	Min.	Typ.	Max.	Min.		Max.				
$I_L$ Quiescent device current (all switches ON or all switches OFF)	HCC types			5		0.25		0.01	0.25		7.5	$\mu A$				
						0.5		0.01	0.5		15					
						1		0.01	1		30					
	HCF types					5		0.02	5		150					
						1		0.01	1		7.5					
						10		0.01	2		15					
		15		0.01	4		30									
<b>SWITCH</b>				$V_{IS}$												
$R_{ON}$ Resistance	HCC	$R_L = 10k\Omega$	+7.5	-7.5	+7.5	360		200	400		600	$\Omega$				
					-7.5	360		200	400		600					
					HCF	$R_L = 10k\Omega$	+7.5	-7.5	$\pm 0.25$	775			280	850		1230
									+7.5	370			200	400		520
									-7.5	370			200	400		520
									$\pm 0.25$	790			280	850		1080
	HCC	$R_L = 10k\Omega$	+5	-5					+5	600			250	660		960
									-5	600			250	660		960
					$\pm 0.25$	1870		580	2000		2600					
					+5	610		250	660		840					
					-5	610		250	660		840					
					$\pm 0.25$	1900		580	2000		2380					
	HCC	$R_L = 10k\Omega$	+15	0	+15	360		200	400		600					
					$\pm 0.25$	360		200	400		600					
					+9.3	775		300	850		1230					
					+15	370		200	400		520					
					$\pm 0.25$	370		200	400		520					
					+9.3	790		300	800		1080					
	HCC	$R_L = 10k\Omega$	+10	0	+10	600		250	660		960					
					$\pm 0.25$	600		250	660		960					
					+5.6	1870		560	2000		2600					
					+10	610		250	660		840					
					$\pm 0.25$	610		250	660		840					
					+5.6	1900		560	2000		2380					
$\Delta R_{ON}$ Resistance $\Delta R_{ON}$ (between any 2 of 4 switches)	$R_L = 10k\Omega$	+7.5	-7.5	$\pm 7.5$				10			$\Omega$					
		+5	-5	$\pm 5$				15								
Input or output leakage current switch OFF (effective OFF resistance)	HCC	$V_{DD}$	$V_C = V_{SS}$	0				$\pm 0.1$	$10^{-5}$	$\pm 0.1$	1	$\mu A$				
	HCF	$V_{DD}$	$V_C = V_{SS}$	0				$\pm 0.3$	$10^{-5}$	$\pm 0.3$	1					



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STATIC ELECTRICAL CHARACTERISTICS (continued)

Parameter	Tested conditions	Values								Unit	
		V <sub>DD</sub> (V)	T <sub>Low</sub> (*)		25°C			T <sub>High</sub> (*)			
			Min.	Max.	Min.	Typ.	Max.	Min.	Max.		
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> = 10 μA	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	V <sub>IS</sub> ≤ V <sub>DD</sub>	HCC types HCF types	18		±0.1		±10 <sup>-5</sup>	±0.1		±1	μA
			15		±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<sub>amb</sub>= 25°C, C<sub>L</sub>= 50 pF all input square wave rise and fall time = 20 ns)

Parameter	V <sub>C</sub> (V)	Test conditions					Values		Unit
		R <sub>L</sub> (kΩ)	f <sub>i</sub> (KHz)	V <sub>I</sub> (V)	V <sub>SS</sub> (V)	V <sub>DD</sub> (V)	Typ.	Max.	
<b>SWITCH</b>									
t <sub>pd</sub> Propagation delay time (Signal input to output)	= V <sub>DD</sub>	10		10sq. Wave	GND	5 10 15	40 20 15	100 50 40	ns
Crosstalk between any 2 of 4 switches (f @ -50 dB) 20 log 10 $\frac{V_{O(B)}}{V_{I(A)}}$ = -50 dB	V <sub>C(A)</sub> =V <sub>DD</sub> = +5 V <sub>C(B)</sub> =V <sub>SS</sub> = -5	1		V <sub>I(A)</sub> =5p-p			0.9		MHz
Frequency response switch "ON" (Sine wave input) at 20 log 10 $\frac{V_O}{V_I}$ = -3 dB	= V <sub>DD</sub> = +5	1		5p-p	-5		40		MHz
Feedthrough (Switch OFF) at 20 log 10 $\frac{V_O}{V_I}$ = -50 dB	= V <sub>SS</sub> = -5	1		-5p-p		5	1.25		MHz
Sine wave distortion	= V <sub>DD</sub> = 5	10	1	5p-p	-5		0.4		%



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DYNAMIC ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions						Values		Unit	
	V <sub>C</sub> (V)	R <sub>L</sub> (kΩ)	f <sub>i</sub> (KHz)	V <sub>i</sub> (V)	V <sub>SS</sub> (V)	V <sub>DD</sub> (V)	Typ.	Max.		
<b>CONTROL (V<sub>C</sub>)</b>										
Propagation delay: (Turn ON Control to Output)	V <sub>DD</sub> -V <sub>SS</sub> (Sq. Wave)	1		V <sub>DD</sub> or V <sub>SS</sub>		5	V <sub>DD</sub> -V <sub>SS</sub> =10V	35	70	ns
						10		20	40	
						15		15	30	
Max. Allowable control input repetition rate	10 (Sq. Wave)	1		V <sub>DD</sub>	GND	10		10		MHz
Crosstalk (Control input to signal output)	10 (sq. Wave)	10			GND	10		50		mV

(▲) Symmetrical about 0V (●) For all test conditions.

TYPICAL "ON" RESISTANCE CHARACTERISTICS, T<sub>amb</sub> = 25°C

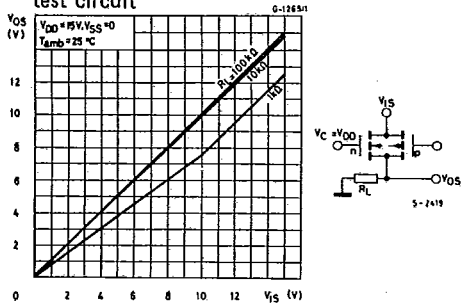
CHARACTERISTIC*	SUPPLY CONDITIONS		LOAD CONDITIONS					
			R <sub>L</sub> = 1 kΩ		R <sub>L</sub> = 10 kΩ		R <sub>L</sub> = 100 kΩ	
	V <sub>DD</sub> (V)	V <sub>SS</sub> (V)	VALUE (Ω)	V <sub>IS</sub> (V)	VALUE (Ω)	V <sub>IS</sub> (V)	VALUE (Ω)	V <sub>IS</sub> (V)
R <sub>ON</sub>	+15	0	200	+15	200	+15	180	+15
			200	0	200	0	200	0
R <sub>ON</sub> (max.)	+15	0	300	+11	300	+9.3	320	+9.2
R <sub>ON</sub>	+10	0	290	+10	250	+10	240	+10
			290	0	250	0	300	0
R <sub>ON</sub> (max.)	+10	0	500	+7.4	560	+5.6	610	+5.5
R <sub>ON</sub>	+5	0	860	+5	470	+5	450	+5
			600	0	580	0	800	0
R <sub>ON</sub> (max.)	+5	0	1.7k	+4.2	7k	+2.9	33k	+2.7
R <sub>ON</sub>	+2.5	-2.5	590	+2.5	450	+2.5	490	+2.5
			720	-2.5	520	-2.5	520	-2.5
R <sub>ON</sub> (max.)	+2.5	-2.5	232k	± 0.25	300k	± 0.25	870k	± 0.25

\* Variation from a perfect switch, R<sub>ON</sub> = 0Ω.

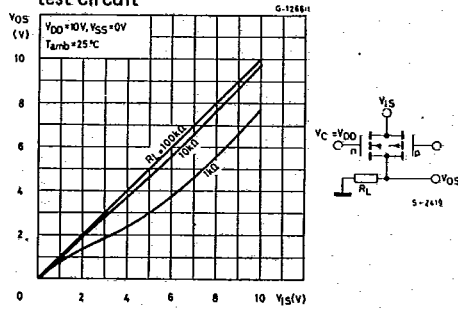


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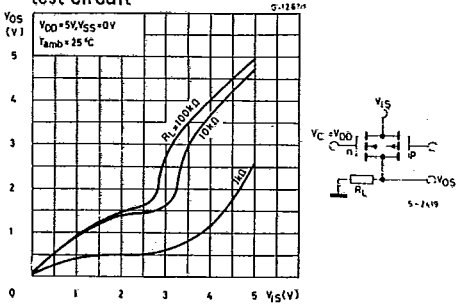
Typical "ON" characteristics for 1 of 4 switches with  $V_{DD} = +15V$ ,  $V_{SS} = 0V$ , and test circuit



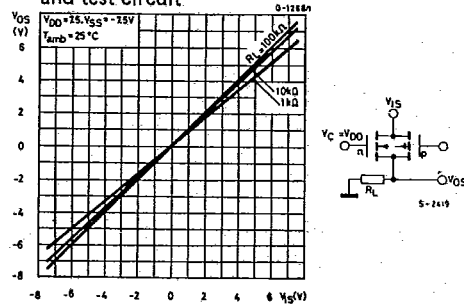
Typical "ON" characteristics for 1 of 4 switches with  $V_{DD} = +10V$ ,  $V_{SS} = 0V$ , and test circuit



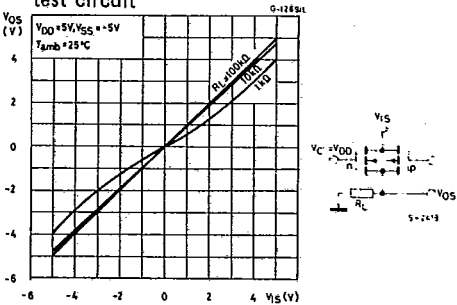
Typical "ON" characteristics for 1 of 4 switches with  $V_{DD} = +5V$ ,  $V_{SS} = 0V$ , and test circuit



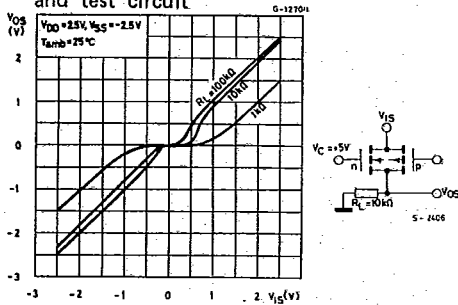
Typical "ON" characteristics for 1 of 4 switches with  $V_{DD} = +7.5V$ ,  $V_{SS} = -7.5V$ , and test circuit



Typical "ON" characteristics for 1 of 4 switches with  $V_{DD} = +5V$ ,  $V_{SS} = -5V$ , and test circuit



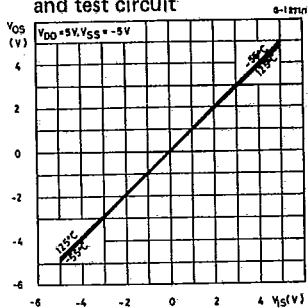
Typical "ON" characteristics for 1 of 4 switches with  $V_{DD} = +2.5V$ ,  $V_{SS} = -2.5V$  and test circuit



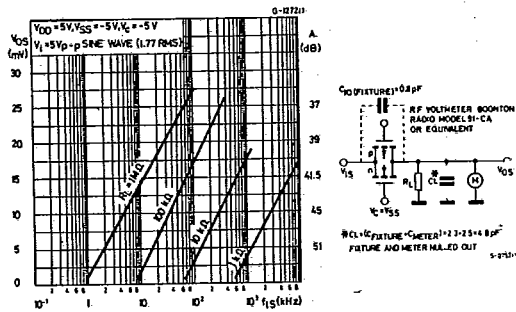


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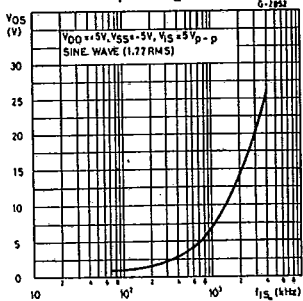
Typical "ON" characteristics as function of temp. for 1 of 4 switches with  $V_{DD} = +5V$  and test circuit



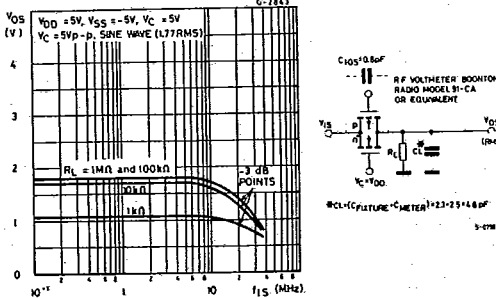
Typical feedthru vs. frequency-switch "OFF" and test circuit



Typical crosstalk between switch circuits in the same package

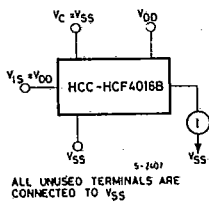


Typical switch frequency response-switch "ON" and test circuit

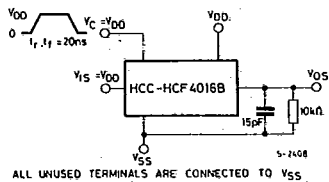


TEST CIRCUITS

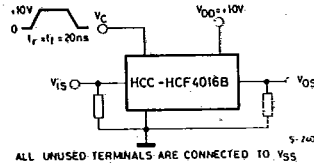
"OFF" switch input or put leakage current



Square-wave response



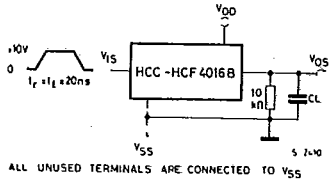
Crosstalk-control input to signal output



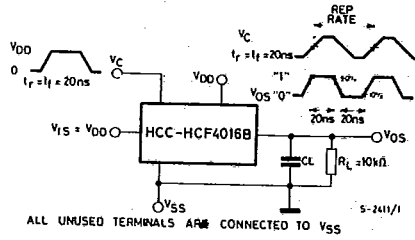
**HCC/HCF 4016B**

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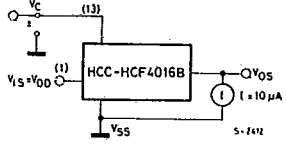
**Propagation delay time signal input ( $V_{IS}$ ) to signal output ( $V_{OS}$ )**



**Max. allowable control-input repetition rate**



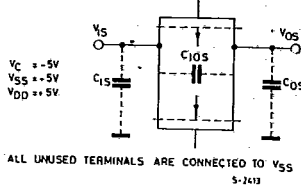
**Switch threshold voltage**



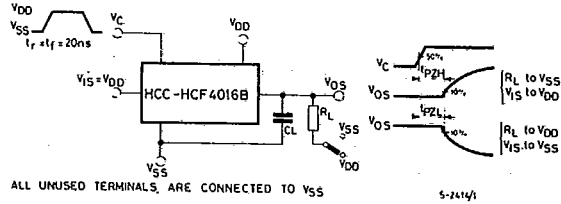
SWITCH THRESHOLD VOLTAGE IS DEFINED AS THE VOLTAGE APPLIED TO A TRANSMISSION GATE CONTROL WHICH CAUSES 10µA OF TRANSMISSION GATE CURRENT.

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

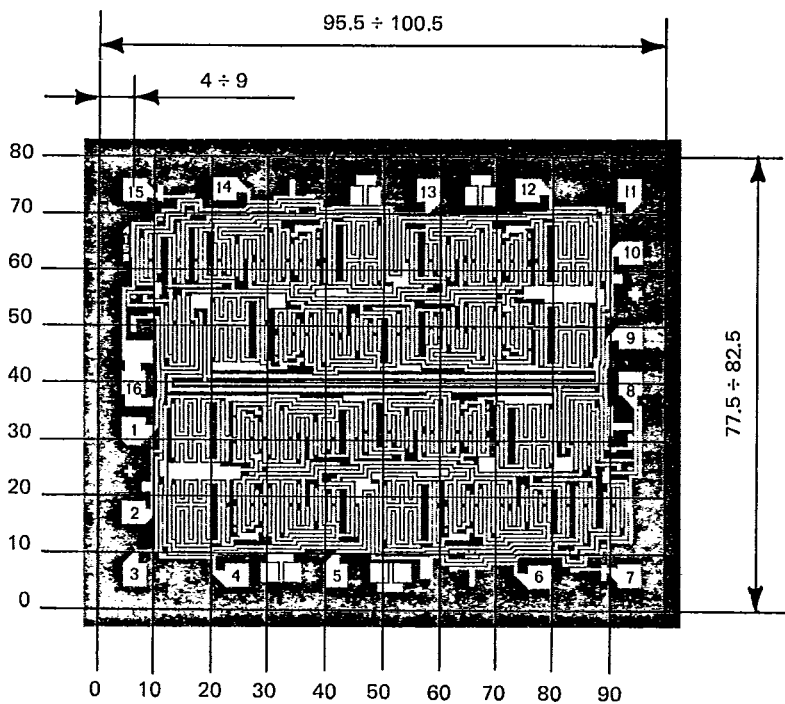
MEASURED ON BOONTON CAPACITANCE BRIDGE MODEL 75A (1MHz)



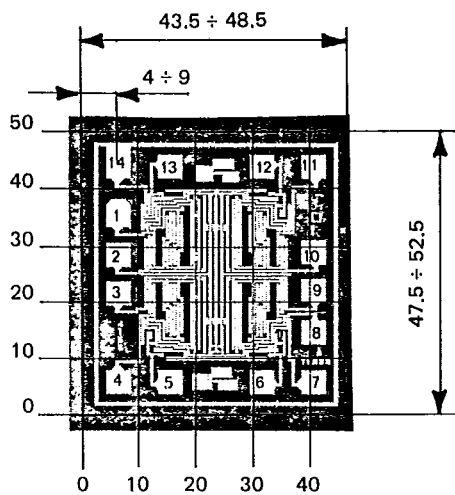
**Turn-On propagation delay-control input to output**







4015B



4016B