

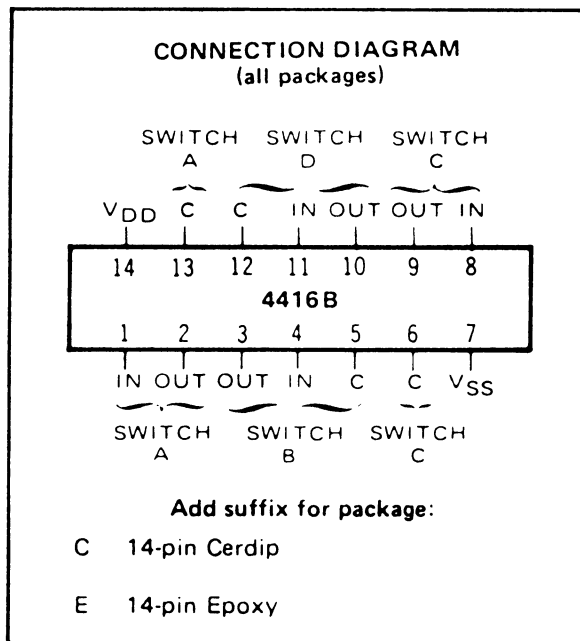
## CMOS QUAD ANALOG SWITCH

### FEATURES

- ◆ DPDT Switch Operation Without External Logic
- ◆ Wide Range of Digital and Analog Signal Levels — Digital or Analog Signal to 18 Volts peak
- ◆ Low ON Resistance — 200  $\Omega$  typ. over 15V<sub>p-p</sub> Signal Input Range, V<sub>DD</sub> - V<sub>SS</sub> = 15V
- ◆ Matched Switch Characteristics - 10  $\Omega$  typ. Difference Between R<sub>ON</sub> Values at a Fixed Bias Point over 15 V<sub>p-p</sub> Signal Input Range, V<sub>DD</sub> - V<sub>SS</sub> = 15V
- ◆ High "ON/OFF" Output Voltage Ratio — 65 dB typ. @ f<sub>is</sub> = 10 kHz, R<sub>L</sub> = 10 k $\Omega$
- ◆ High Degree of Linearity — 0.4% Distortion typ. @ f<sub>is</sub> = 1 kHz, V<sub>is</sub> = 5 V<sub>p-p</sub>, V<sub>DD</sub> - V<sub>SS</sub> = 10V, R<sub>L</sub> = 10 k $\Omega$
- ◆ Extremely low OFF Switch Leakage Resulting in Very Low Offset Current and High Effective OFF Switch Resistance — 10 pA typ. @ V<sub>DD</sub> - V<sub>SS</sub> = 10V, T<sub>A</sub> = 25° 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<sub>is</sub> = 0.9 MHz, R<sub>L</sub> = 1k $\Omega$
- ◆ Matched Control-Input to Signal-Output Capacitances - Reduces Output Signal Transients
- ◆ Transmits Frequencies up to 40MHz

### DESCRIPTION

The 4416B is a single-chip monolithic silicon integrated circuit containing eight N-channel and eight P-channel enhancement-mode MOS transistors connected to form four independent bilateral signal switches. Each switch consists of both P- and N-channel devices with common source and drain connections. A single control signal is required per switch. Both P and N devices in a given switch are biased ON or OFF by the control signal.



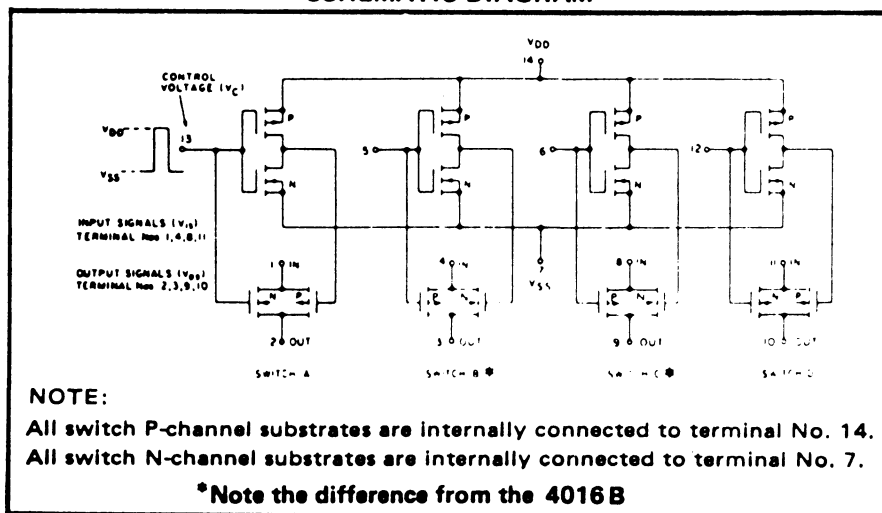
### RECOMMENDED OPERATING CONDITIONS

For maximum reliability:

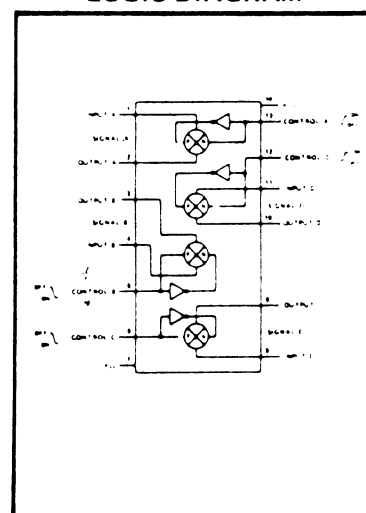
DC Supply Voltage	V <sub>DD</sub> - V <sub>SS</sub>	3 to 15	Vdc
Operating Temperature	T <sub>A</sub>		
C		-55 to +125	°C
E		-40 to +85	°C

The CMOS switch permits peak input-signal voltage swings equal to the full supply voltage, a considerable advantage over single-channel types. When the control input is high the switch will be ON. When the control input is low the switch will be OFF.

### SCHMATIC DIAGRAM



### LOGIC DIAGRAM



## ELECTRICAL CHARACTERISTICS

STATIC CHARACTERISTICS<sup>1</sup>

PARAMETER	CONDITIONS	V <sub>SS</sub> (Vdc)	V <sub>DD</sub> (Vdc)	T <sub>LOW</sub> <sup>2</sup>		25°C			T <sub>HIGH</sub> <sup>2</sup>		Units	
				Min.	Max.	Min.	Typ.	Max.	Min.	Max.		
QUIESCENT DEVICE CURRENT I <sub>DD</sub>	V <sub>IN</sub> = V <sub>SS</sub> or V <sub>DD</sub> All valid input combinations	0	5	-	0.05	-	0.0005	0.05	-	1.5	μAdc	
		0	10	-	0.1	-	0.001	0.1	-	3.0		
		0	15	-	0.2	-	0.002	0.2	-	6.0		
MINIMUM INPUT HIGH VOLTAGE (Control Input) V <sub>IH</sub>	V <sub>IS</sub> = V <sub>SS</sub> V <sub>OS</sub> = V <sub>DD</sub> I <sub>OS</sub> = 10μA	0	5	-	2.9	-	1.5	2.7	-	2.4	Vdc	
		0	10	-	2.9	-	1.5	2.7	-	2.4		
		0	15	-	2.9	-	1.5	2.7	-	2.4		
MAXIMUM INPUT LOW VOLTAGE (Control Input) V <sub>IL</sub>	V <sub>IS</sub> = V <sub>SS</sub> V <sub>OS</sub> = V <sub>DD</sub> I <sub>OS</sub> = 10μA	0	5	0.9	-	0.7	1.5	-	0.4	-	Vdc	
		0	10	0.9	-	0.7	1.5	-	0.4	-		
		0	15	0.9	-	0.7	1.5	-	0.4	-		
SWITCH INPUT/OUTPUT LEAKAGE (Switch off) I <sub>OFF</sub>	V <sub>C</sub> = V <sub>SS</sub> <sup>4</sup> V <sub>IS</sub>	±7.5 -5 ±5	+7.5 +5	-	±250 ±125	-	±0.1 ±0.01	±250 ±125	-	±2500 ±1250	nAdc	
ON-RESISTANCE R <sub>ON</sub>	V <sub>C</sub> = V <sub>DD</sub> <sup>4</sup> R <sub>L</sub> = 10kΩ V <sub>IS</sub> (Vdc)	+7.5 -7.5 ±0.25	+7.5	-	200 200 180	-	100 100 80	220 220 200	-	450 450 420	Ω	
		+5 -5 ±0.25	+5	-	260 260 260	-	160 <sup>1</sup> 160 150	300 300 290	-	500 500 500	Ω	
		+15 +0.25 +9.3	+15	-	230 100 250	-	130 40 150	250 120 270	-	500 260 580	Ω	
		+10 +0.25 +5.6	+10	-	220 100 400	-	120 60 220	240 130 420	-	500 280 900	Ω	
ON-RESISTANCE MATCH (Same package) ΔR <sub>ON</sub>	V <sub>C</sub> = V <sub>DD</sub> <sup>4</sup> R <sub>L</sub> = 10kΩ V <sub>IS</sub> (Vdc)	±7.5 ±5	+7.5 +5	-	-	-	10 15	-	-	-	Ω	

NOTES: <sup>1</sup> Remaining Static Electrical Characteristics are listed under "4000B Series Family Specifications".

<sup>2</sup> T<sub>LOW</sub> = -55°C for C  
= -40°C for E  
T<sub>HIGH</sub> = +125°C for C  
= + 85°C for E

<sup>4</sup> Reverse polarity of V<sub>C</sub> (control input) for switches B and C.

DYNAMIC CHARACTERISTICS (C<sub>L</sub> = 50 pF, T<sub>A</sub> = 25°C)

PARAMETER	CONDITIONS	V <sub>SS</sub> (Vdc)	V <sub>DD</sub> (Vdc)	Min.	Typ.	Max.	Units	
SIGNAL INPUTS (V <sub>IS</sub> ) AND OUTPUTS (V <sub>OS</sub> )								
PROPAGATION DELAY TIME Signal input to signal output t <sub>PC</sub>	V <sub>C</sub> = V <sub>DD</sub> <sup>1</sup> V <sub>IS</sub> = square wave R <sub>L</sub> = 10kΩ	0	5	-	20	40	ns	
		0	10	-	10	20		
		0	15	-	7.5	15		
BANDWIDTH (-3dB) (Sine Wave) BW	V <sub>C</sub> = V <sub>DD</sub> <sup>1</sup> V <sub>IS</sub> = 5V <sub>p-p</sub> centered @0.0Vdc	R <sub>L</sub>		-5	+5	-	MHz	
		1kΩ						54
		10kΩ						40
		100kΩ						38
		1MΩ						37

# ELECTRICAL CHARACTERISTICS (Continued)

DYNAMIC CHARACTERISTICS (C<sub>L</sub> = 50 pF, T<sub>A</sub> = 25°C) (Continued)

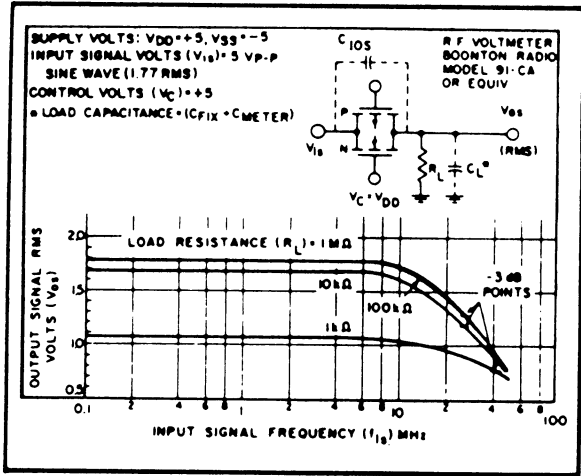
PARAMETER	CONDITIONS	V <sub>SS</sub> (Vdc)	V <sub>DD</sub> (Vdc)	Min.	Typ.	Max.	Units	
<b>SIGNAL INPUTS (V<sub>IS</sub>) AND OUTPUTS (V<sub>OS</sub>) (Continued)</b>								
INSERTION LOSS ( $= 20 \log_{10} \frac{V_{OS}}{V_{IS}}$ )	V <sub>C</sub> = V <sub>DD</sub> <sup>1</sup> V <sub>IS</sub> = 5V <sub>pp</sub> centered @0.0Vdc	R <sub>L</sub>		-5	+5	-	dB	
		1kΩ	2.3					
		10kΩ	0.2					
		100kΩ	0.1					
		1MΩ	0.06					
SIGNAL DISTORTION (Sine Wave)	V <sub>C</sub> = V <sub>DD</sub> <sup>1</sup> V <sub>IS</sub> = 5V <sub>pp</sub> centered @0.0Vdc f <sub>IS</sub> = 1.0kHz R <sub>L</sub> = 10kΩ	-5	+5	-	0.4	-	%	
FEEDTHROUGH (-50dB)	V <sub>C</sub> = V <sub>SS</sub> <sup>1</sup> V <sub>IS</sub> = 5V <sub>pp</sub> centered @0.0Vdc	R <sub>L</sub>		-5	+5	-	kHz	
		1kΩ	1250					
		10kΩ	140					
		100kΩ	18					
		1MΩ	2					
CROSSTALK (-50dB) (Between two switches)	V <sub>C</sub> (A) = V <sub>DD</sub> <sup>1</sup> V <sub>C</sub> (B) = V <sub>SS</sub> <sup>1</sup> V <sub>IS</sub> (A) = 5V <sub>pp</sub> centered @0.0Vdc R <sub>L</sub> = 1.0k	-5	+5	-	0.9	-	MHz	
CAPACITANCE	V <sub>C</sub> = V <sub>SS</sub> <sup>1</sup>	Input	-5	+5	-	4	-	pF
		Output			-	4	-	pF
		Feedthrough			-	0.2	-	pF
<b>CONTROL INPUT (V<sub>C</sub>)</b>								
PROPAGATION DELAY TIME Turn on	t <sub>PLH</sub> , t <sub>PHL</sub> V <sub>SS</sub> < V <sub>IS</sub> < V <sub>DD</sub> R <sub>L</sub> = 10kΩ	0	5	-	40	80	ns	
		0	10	-	20	40		
		0	15	-	15	30		
MAXIMUM INPUT FREQUENCY	f <sub>C</sub> V <sub>SS</sub> < V <sub>IS</sub> < V <sub>DD</sub> R <sub>L</sub> = 1.0kΩ	0	5	-	5	-	MHz	
		0	10	-	10	-		
		0	15	-	12	-		
CROSSTALK (To signal port)	V <sub>C</sub> = Square wave R <sub>L</sub> = 10kΩ R <sub>IN</sub> = 1.0kΩ	0	5	-	30	-	mV	
		0	10	-	50	-		
		0	15	-	100	-		

NOTE: <sup>1</sup> Reverse polarity of V<sub>C</sub> (control input) for switches B and C.

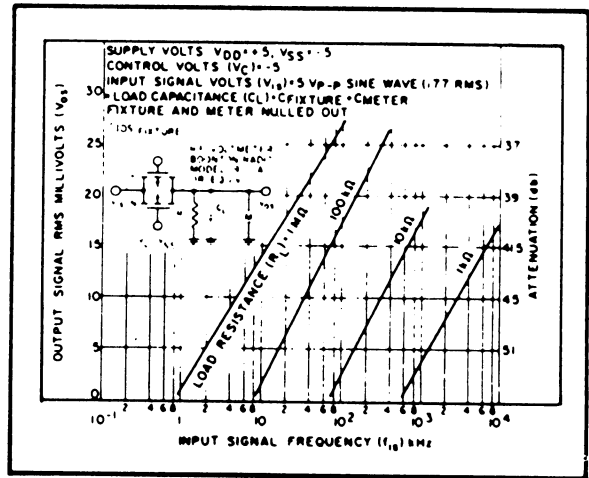
## TYPICAL ON-RESISTANCE CHARACTERISTICS

CHARAC- TERISTIC*	SUPPLY CONDITIONS		LOAD CONDITIONS					
	V <sub>DD</sub> (V)	V <sub>SS</sub> (V)	R <sub>L</sub> = 1kΩ		R <sub>L</sub> = 10kΩ		R <sub>L</sub> = 100kΩ	
			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(max.)</sub>	+15	0	300	+11	300	+9.3	320	+9.2
R <sub>ON</sub>	+10	0	280	+10	250	+10	240	+10
			280	0	250	0	300	0
R <sub>ON(max.)</sub>	+10	0	500	+7.4	580	+6.6	610	+5.5
R <sub>ON</sub>	+5	0	880	+5	470	+5	450	+5
			800	0	580	0	800	0
R <sub>ON(max.)</sub>	+5	0	1.7k	+4.2	7k	+2.9	33k	+2.7
R <sub>ON</sub>	+7.5	-7.5	200	+7.5	200	+7.5	180	+7.5
			200	-7.5	200	-7.5	180	-7.5
R <sub>ON(max.)</sub>	+7.5	-7.5	280	±0.25	280	±25	400	±0.25
R <sub>ON</sub>	+5	-5	280	+5	250	+5	240	+5
			310	-5	250	-5	240	-5
R <sub>ON(max.)</sub>	+5	-5	800	±0.25	580	±0.25	760	±0.25
R <sub>ON</sub>	+2.5	-2.5	580	+2.5	450	+2.5	490	+2.5
			720	-2.5	520	-2.5	520	-2.5
R <sub>ON(max.)</sub>	+2.5	-2.5	232k	±0.25	300k	±0.25	870k	±0.25

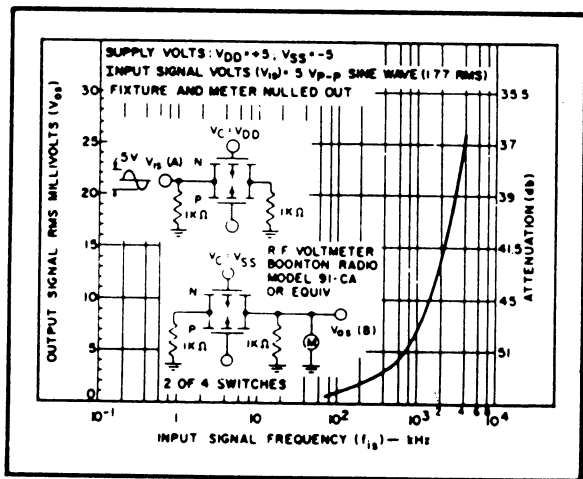
\* Variation from a perfect switch; R<sub>ON</sub> = 0Ω.



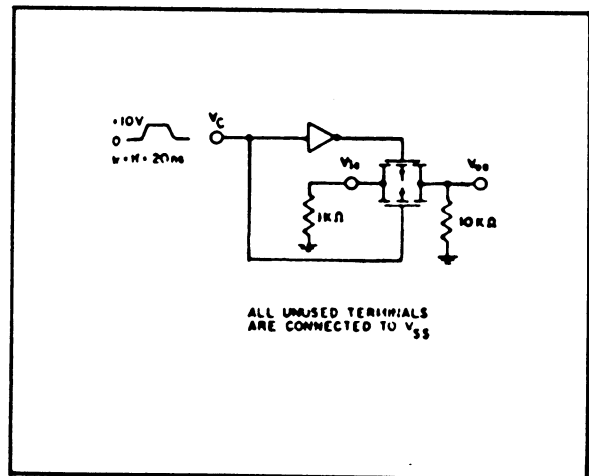
Typ. switch frequency response - switch "ON"



Typ. feedthru vs. freq. - switch "OFF"



Typ. crosstalk between switch circuits in the same package



Test circuit, Crosstalk-control input to signal output.

## APPLICATIONS INFORMATION

### 4416B connected as a DPDT Switch

