

CMOS QUAD ANALOG SWITCH

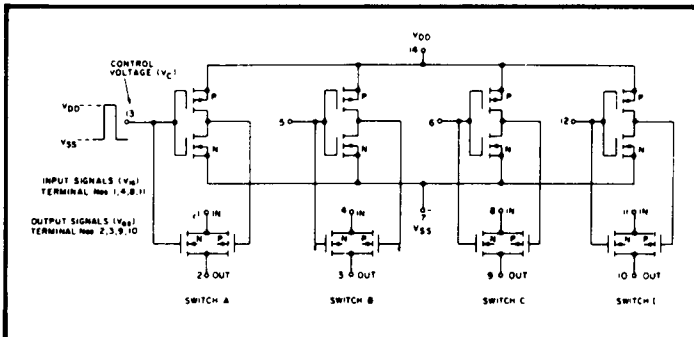
FEATURES

- ◆ Wide Range of Digital and Analog Signal Levels - Digital or Analog Signals to 18 Volts peak
- ◆ Low ON Resistance - 200 Ω typ. over 15Vp-p Signal Input Range, @ 15Vdc
- ◆ Matched Switch Characteristics - 10 Ω typ. Difference between R_{ON} Values at a Fixed Bias Point over 15Vp-p Signal Input Range @ 15Vdc
- ◆ High On/Off Output Voltage Ratio - 65 dB typ. @ $f_{is} = 10\text{kHz}$, $R_L = 10\text{K}\Omega$
- ◆ High degree of Linearity - $\leq 0.4\%$ Distortion typ. @ $f_{is} = 1\text{kHz}$, $V_{is} = 5\text{V}_{p-p}$, $V_{DD} - V_{SS} \geq 10\text{V}$, $R_L = 10\text{k}\Omega$
- ◆ Extremely Low OFF Switch Leakage Resulting in Very Low Offset Current and High Effective OFF resistance - 10pA typ. @ $V_{DD} - V_{SS} = 10\text{V}$, $T_A = 25^\circ\text{C}$
- ◆ Extremely High Control Input Impedance (Control Circuit Isolated from Signal Circuit) 10¹² Ω 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 Capacitances - Reduces Output Signal Transients
- ◆ Transmits Frequencies up to 40MHz

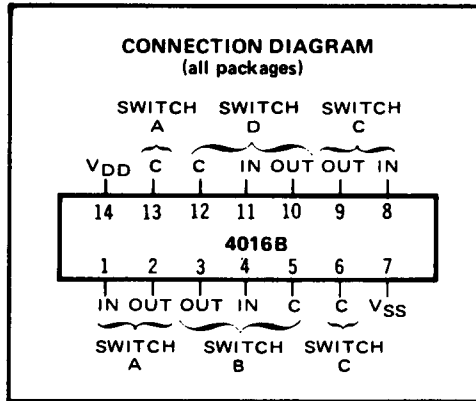
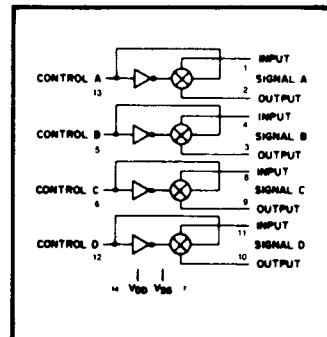
DESCRIPTION

The 4016B 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. The CMOS switch permits peak input-signal voltage swings equal to the full supply voltage, a considerable advantage over single-channel types.

SCHEMATIC DIAGRAM



LOGIC DIAGRAM



RECOMMENDED OPERATING CONDITIONS

For maximum reliability:

DC Supply Voltage	$V_{DD} - V_{SS}$	3 to 15	Vdc
Operating Temperature	T_A		
C, D, F, H Device		-55 to +125	$^\circ\text{C}$
E Device		-40 to +85	$^\circ\text{C}$

ELECTRICAL CHARACTERISTICS

STATIC CHARACTERISTICS¹

PARAMETER	CONDITIONS	V _{SS} (Vdc)	V _{DD} (Vdc)	T _{LOW} ²		25°C			T _{HIGH} ²		Units
				Min.	Max.	Min.	Typ.	Max.	Min.	Max.	
QUIESCENT DEVICE CURRENT	I _{DD} V _{IN} = V _{SS} or V _{DD} 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 _{IH}	0	5	–	3.5	–	1.5	3.5	–	3.5	Vdc
		0	10	–	7.0	–	1.5	7.0	–	7.0	
		0	15	–	11.0	–	1.5	11.0	–	11.0	
MAXIMUM INPUT LOW VOLTAGE (Control Input)	V _{IL} V _{IS} = V _{SS} V _{OS} = V _{DD} I _{OS} = 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 _{OFF} V _C = V _{SS} V _{IS} = V _{DD}	0	15	–	±0.1	–	±10 ⁻⁵	±0.1	–	±1.0	μAdc
ON-RESISTANCE	R _{ON} V _{IS} = V _{DD} - V _{SS} V _C = V _{DD} / 2 R _L = 10kΩ	0	15	–	360	–	200	400	–	520	Ω
		0	10	–	600	–	250	660	–	840	
ON-RESISTANCE MATCH (Same package)	ΔR _{ON} V _C = V _{DD} R _L = 10kΩ	V _{IS} (Vdc)									
		±7.5	-7.5	+7.5	–	–	–	10	–	–	–
		±5	-5	+5	–	–	15	–	–	–	Ω

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

² T_{LOW} = -55°C for C, D, F, H device.

= -40°C for E device.

T_{HIGH} = +125°C for C, D, F, H device.

= +85°C for E device.

³ Conditions for measuring V_{IH}:

V _{DD}	V _{OS}	V _{IS}	I _{OS}			UNITS
			T _{LOW}	25°C	T _{HIGH}	
5	5	4.6	-25	-20	-14	mA
10	10	9.5	-62	-50	-35	
15	15	13.5	-1.8	-1.50	-1.10	

DYNAMIC CHARACTERISTICS (C_L = 50 pF, T_A = 25°C)

PARAMETER	CONDITIONS	V _{SS} (Vdc)	V _{DD} (Vdc)	Min.	Typ.	Max.	UNIT	
SIGNAL INPUTS (V _{IS}) AND OUTPUTS (V _{OS})								
PROPAGATION DELAY TIME Signal input to signal output	t _{PLH} , t _{PHL} V _C = V _{DD} V _{IS} = square wave R _L = 10kΩ	0	5	–	20	40	ns	
		0	10	–	10	20		
		0	15	–	7.5	15		
BANDWIDTH (-3dB) (Sine Wave)	BW V _C = V _{DD} V _{IS} = 5V _{p-p} centered @0.0Vdc	R _L						
		1kΩ	.5	+5	–	54	–	MHz
		10kΩ	–	–	–	40	–	
		100kΩ	–	–	–	38	–	
1MΩ	–	–	–	37	–			

ELECTRICAL CHARACTERISTICS (Continued)

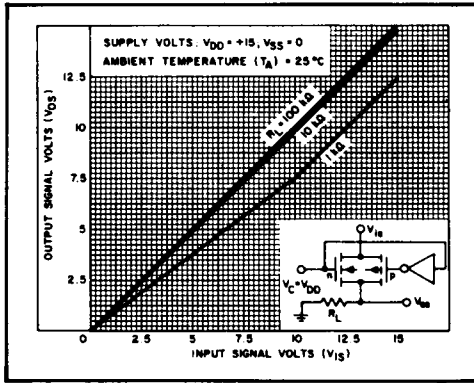
DYNAMIC CHARACTERISTICS ($C_L = 50 \text{ pF}$, $T_A = 25^\circ\text{C}$) (Continued)

PARAMETER	CONDITIONS	V _{SS} (Vdc)	V _{DD} (Vdc)	Min.	Typ.	Max.	Units	
SIGNAL INPUTS (V_{IS}) AND OUTPUTS (V_{OS}) (Continued)								
INSERTION LOSS ($\approx 20 \log_{10} \frac{V_{OS}}{V_{IS}}$)	V _C = V _{DD} V _{IS} = 5V _{P-P} centered @0.0Vdc	R _L 1kΩ 10kΩ 100kΩ 1MΩ	-5	+5	-	2.3 0.2 0.1 0.05	dR	
SIGNAL DISTORTION (Sine Wave)	V _C = V _{DD} V _{IS} = 5V _{P-P} centered @0.0Vdc f _{IS} = 1.0kHz R _L = 10kΩ		-5	+5	-	0.4	%	
FEEDTHROUGH (-50dB)	V _C = V _{SS} V _{IS} = 5V _{P-P} centered @0.0Vdc	R _L 1kΩ 10kΩ 100kΩ 1MΩ	-5	+5	-	1250 140 18 2	kHz	
CROSSTALK (-50dB) (Between two switches)	V _C (A) = V _{DD} V _C (B) = V _{SS} V _{IS} (A) = 5V _{P-P} centered @0.0Vdc R _L = 1.0k		-5	+5	-	0.9	MHz	
CAPACITANCE								
Input	C _{IS}				-	4	pF	
Output	C _{OS}	V _C = V _{SS}	-5	+5	-	4	pF	
Feedthrough	C _{IOS}				-	0.2	pF	
CONTROL INPUT (V_C)								
PROPAGATION DELAY TIME	t _{PLH} , t _{PHL}	V _{SS} ≤ V _{IS} ≤ V _{DD} R _L = 10kΩ	0 0 0	5 10 15	- - -	40 20 15	80 40 30	ns
MAXIMUM INPUT FREQUENCY	f _C	V _{SS} ≤ V _{IS} ≤ V _{DD} R _L = 1.0kΩ	0 0 0	5 10 15	- - -	5 10 12	- - -	MHz
CROSSTALK (To signal port)		V _C = Square wave R _L = 10kΩ R _{IN} = 1.0kΩ	0 0 0	5 10 15	- - -	30 50 100	- - -	mV

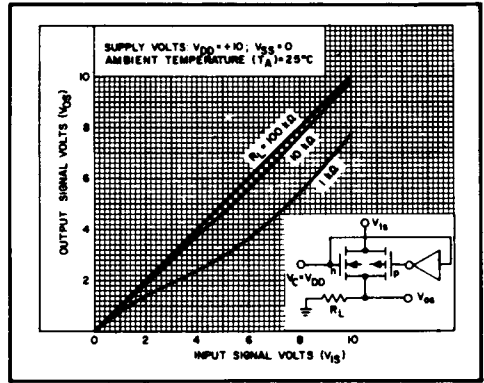
TYPICAL ON-RESISTANCE CHARACTERISTICS

CHARACTERISTIC*	SUPPLY CONDITIONS		LOAD CONDITIONS					
	V _{DD} (V)	V _{SS} (V)	R _L = 1kΩ		R _L = 10kΩ		R _L = 100kΩ	
			VALUE (Ω)	V _{IS} (V)	VALUE (Ω)	V _{IS} (V)	VALUE (Ω)	V _{IS} (V)
R _{ON}	+15	0	200	+15	200	+15	180	+15
R _{ON(max)}	+15	0	300	+11	300	+9.3	320	+9.2
R _{ON}	+10	0	290	+10	250	+10	240	+10
R _{ON(max)}	+10	0	500	+7.4	560	+5.6	610	+5.5
R _{ON}	+5	0	860	+5	470	+5	450	+5
R _{ON(max)}	+5	0	800	0	580	0	800	0
R _{ON}	+7.5	-7.5	200	+7.5	200	+7.5	180	+7.5
R _{ON(max)}	+7.5	-7.5	290	-7.5	200	-7.5	180	-7.5
R _{ON}	+7.5	-7.5	290	±0.25	280	±25	400	±0.25
R _{ON}	+5	-5	260	+5	250	+5	240	+5
R _{ON(max)}	+5	-5	310	-5	250	-5	240	-5
R _{ON}	+5	-5	600	±0.25	580	±0.25	760	±0.25
R _{ON}	+2.5	-2.5	590	+2.5	450	+2.5	490	+2.5
R _{ON(max)}	+2.5	-2.5	720	-2.5	520	-2.5	520	-2.5
R _{ON}	+2.5	-2.5	232k	±0.25	300k	±0.25	870k	±0.25

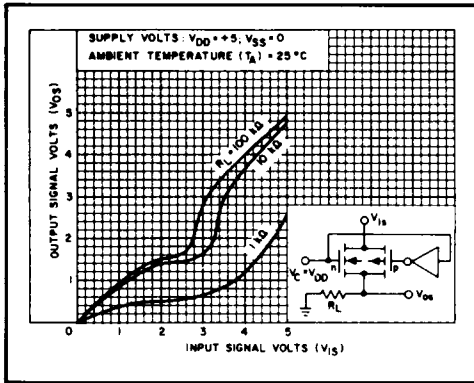
* Variation from a perfect switch: R_{ON} = 0Ω



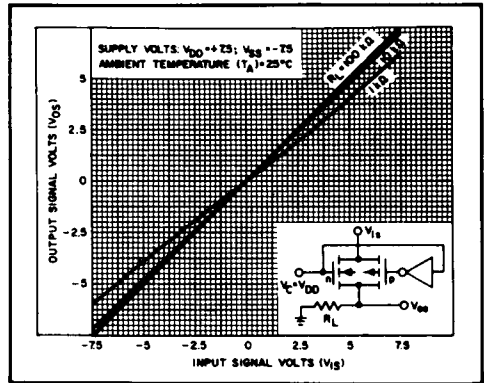
Typ. ON characteristics for 1 of 4 switches with $V_{DD} = +15V$, $V_{SS} = 0V$



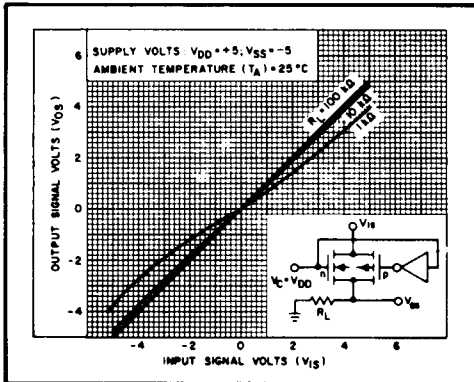
Typ. ON characteristics for 1 of 4 switches with $V_{DD} = +10V$, $V_{SS} = 0V$



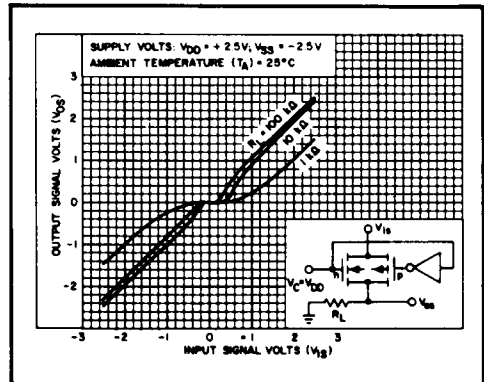
Typ. ON characteristics for 1 of 4 switches with $V_{DD} = +5V$, $V_{SS} = 0V$



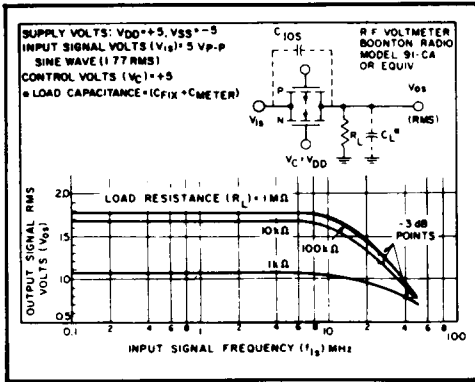
Typ. ON characteristics for 1 of 4 switches with $V_{DD} = +7.5V$, $V_{SS} = -7.5V$



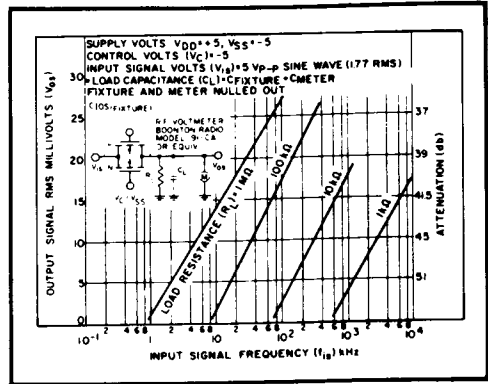
Typ. ON characteristics for 1 of 4 switches with $V_{DD} = +5V$, $V_{SS} = -5V$



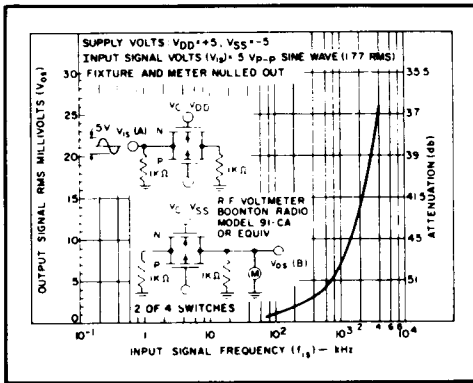
Typ. ON characteristics for 1 of 4 switches with $V_{DD} = +2.5V$, $V_{SS} = -2.5V$



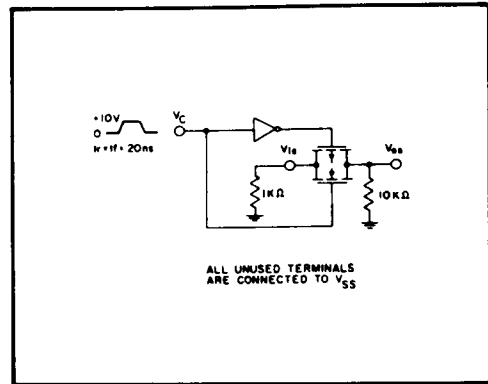
Typ. switch frequency response - switch ON



Typ. feedthru vs. freq. - switch OFF



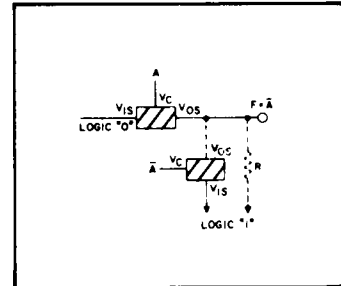
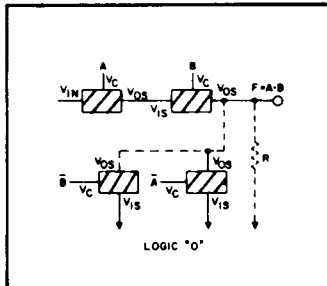
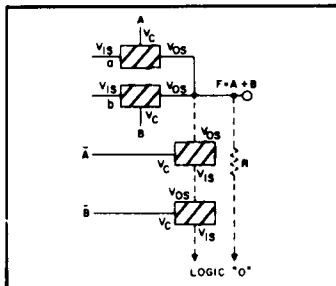
Typ. crosstalk between switch circuits in the same package



Crosstalk-control input to signal output

APPLICATIONS INFORMATION

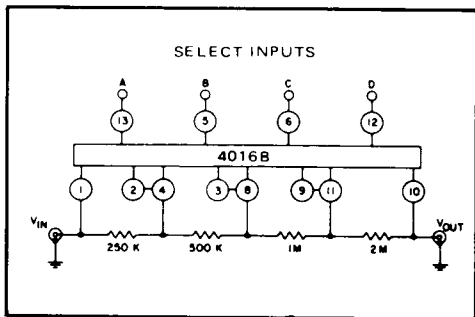
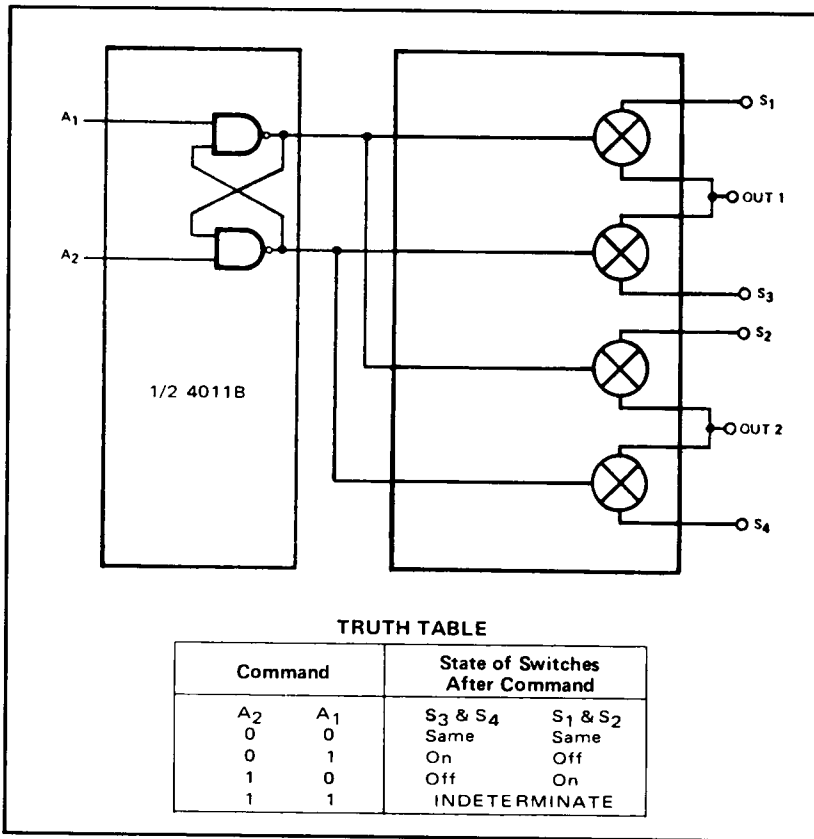
LOGIC FUNCTIONS USING THE 4016B



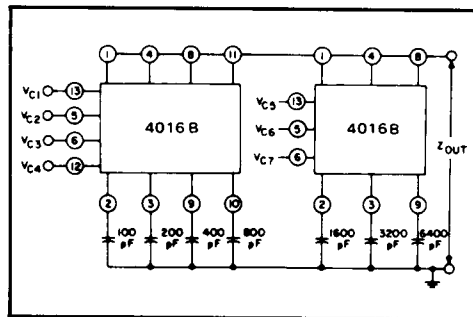
APPLICATIONS INFORMATION (Continued)

LATCHING DPDT SWITCH

The latch feature insures positive switching action in response to non-repetitive or erratic commands. A HIGH input to A₁ turns S₃ and S₄ ON, a HIGH to A₂ turns S₁ and S₂ ON. Desirable for use with limit detectors, peak detectors, or mechanical contact closures.



Digitally controlled resistor network



Digitally-controlled capacitor network.
(VC1 → VC7 are Select Inputs)