M4016BP

QUADRUPLE BILATERAL SWITCH

DESCRIPTION

The M4016BP is a semiconductor integrated circuit consisting of four independent bilateral analog switches.

FEATURES

- Typical ON resistance of 250Ω (at V_{DD} = 15V)
- High off-state resistance 10^9Ω or greater (typical)
- Small variations in ON resistance between switches in the same package:
  10Ω (typical, at V_{DD} = 15V)
- Wide operating voltage range: V_{DD} = 3 ~ 18V
- Wide operating temperature range:
  T_a = −40 ~ +85°C

APPLICATIONS

General purpose, for use in industrial and consumer digital equipment.

FUNCTIONAL DESCRIPTION

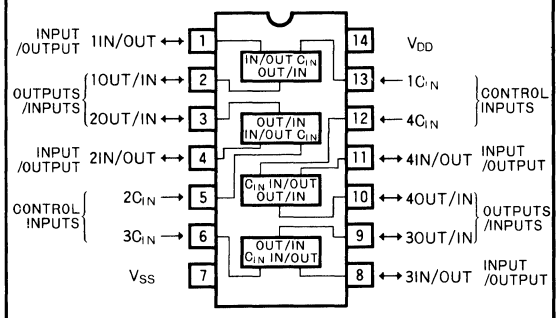
The control input (C_{IN}) can be used to change the input-to-output impedance (IN/OUT − OUT/IN) of the switches.

When (C_{IN}) is made high, the input-to-output switch impedance is low and when set to low, this impedance is high.

FUNCTION TABLE

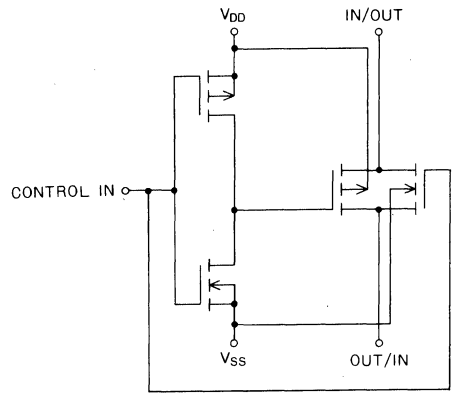
Input C_{IN}	INPUT/OUTPUT and OUTPUT/INPUT resistance (V_{DD} = 10V, 15V)
H	$2 \sim 20 \times 10^2$ Ω
L	$>10^9$ Ω typical

PIN CONFIGURATION (TOP VIEW)

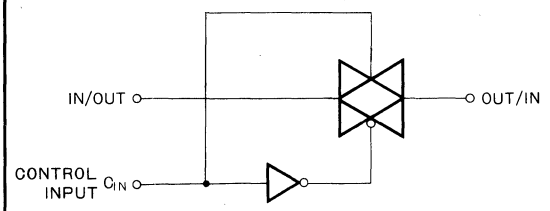


Outline 14P4

CIRCUIT SCHEMATIC (EACH SWITCH)



LOGIC DIAGRAM (EACH SWITCH)



ABSOLUTE MAXIMUM RATINGS (Ta = −40 ~ +85°C, unless otherwise noted)

Symbol	Parameter	Conditions	Limits	Unit
V_{DD}	Supply voltage		$V_{SS}-0.5 \sim V_{SS}+20$	V
V_I	Input voltage		$V_{SS}-0.5 \sim V_{DD}+0.5$	V
I_I	Input current	Control inputs	±10	mA
I_O	Output current		±10	mA
Topr	Operating temperature range		−40 ~ +85	°C
Tstg	Storage temperature range		−65 ~ +150	°C

RECOMMENDED OPERATING CONDITIONS ($Ta = -40 \sim +85°C$, $V_{SS} = 0V$, unless otherwise noted)

Symbol	Parameter	Limits			Unit
		Min	Typ	Max	
V_{DD}	Supply voltage	3		18	V
V_I	Input voltage	0		V_{DD}	V

ELECTRICAL CHARACTERISTICS ($V_{SS} = 0V$)

Symbol	Parameter	Test conditions	V_{SS}(V)	V_{DD}(V)	Limits −40℃ Min	Limits −40℃ Max	Limits 25℃ Min	Limits 25℃ Typ	Limits 25℃ Max	Limits 85℃ Min	Limits 85℃ Max	Unit
V_{IH}	High-level input voltage (C_{IN})	Input-to-output current = 10μA	0	5	3.5		3.5			3.5		V
			0	10	7.0		7.0			7.0		
			0	15	11.0		11.0			11.0		
V_{IL}	Low-level input voltage (C_{IN})	Input-to-output current = 10μA	0	5		1.0			1.0		1.0	
			0	10		1.0			1.0		1.0	
			0	15		1.0			1.0		1.0	
R_{ON}	ON resistance	V_I = 5 V	0	5				600				Ω
		V_I = 2.5V	0	5				6000				
		V_I = 0.25V	0	5				600				
		V_I = 10V	0	10		600			700		900	
		V_I = 5 V	0	10		1300			1500		2000	
		V_I = 0.25V	0	10		600			700		900	
		V_I = 15 V	0	15		430			500		650	
		V_I = 7.5V	0	15		800			950		1200	
		V_I = 0.25V	0	15		430			500		650	
		V_I = 5 V	−5	5		600			700		900	
		V_I = ±0.25V	−5	5		1300			1500		2000	
		V_I = − 5 V	−5	5		600			700		900	
		V_I = 7.5V	−7.5	7.5		430			500		650	
		V_I = ±0.25V	−7.5	7.5		800			950		1200	
	Test circuit 1	V_I = −7.5V	−7.5	7.5		430			500		650	
ΔR_{ON}	ON resistance variations between switches of the same package		−5	5				15				
			−7.5	7.5				10				
I_{OFF}	Input-to-output off-state leakage current	$V_{I/O}$=10V, $V_{O/I}$= 0 V	0	10					125			nA
		$V_{I/O}$= 0 V, $V_{O/I}$=10V	0	10					−125			
		$V_{I/O}$=18V, $V_{O/I}$= 0 V	0	18		250			250		1000	
		$V_{I/O}$= 0 V, $V_{O/I}$=18V	0	18		−250			−250		−1000	
I_{DD}	Quiescent supply current	V_I (C_{IN})=V_{DD}, V_{SS}	0	5		1			1		7.5	μA
			0	10		2			2		15	
			0	15		4			4		30	
I_{IH}	High-level input current (C_{IN})	V_{IH}=18V	0	18		0.3			0.3		1.0	μA
I_{IL}	Low-level input current (C_{IN})	V_{IL}= 0 V	0	18		−0.3			−0.3		−1.0	

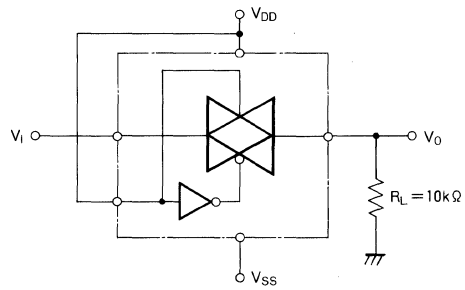
SWITCHING CHARACTERISTICS (Ta = 25°C)

Symbol	Parameter	Test conditions		V_{SS}(V)	V_{DD}(V)	Limits Min	Limits Typ	Limits Max	Unit
$f_{max(I/O)}$	Maximum transfer frequency	R_L = 2 kΩ	C_L = 15pF Test circuit 2	−5	5		18		MHz
		R_L = 10kΩ		−5	5		15		
		R_L = 100kΩ		−5	5		12		
$f_{max(C_{IN})}$	Maximum control frequency	R_L = 300 Ω, C_L = 15pF	Test circuit 3	0	5		4		
				0	10		10		
				0	15		12		
t_{PLH}	Low-level to high-level and high-level to low-level output propagation time (IN/OUT—OUT/IN)	R_L = 10kΩ, C_L = 50pF	Test circuit 4	0	5			100	ns
				0	10			40	
				0	15			30	
t_{PHL}				0	5			100	
				0	10			40	
				0	15			30	
t_{PLH}	Low-level to high-level and high-level to low-level output propagation time (CONTROL IN—OUT/IN)	R_L = 10kΩ, C_L = 50pF	Test circuit 5	0	5			140	
				0	10			60	
				0	15			50	
t_{PHL}				0	5			140	
				0	10			60	
				0	15			50	
	Sinewave distortion	R_L = 10kΩ, f_I = 1 kHz	Test circuit 2	−5	5		0.3		%
	Feedthrough (switch off)	R_L = 1 kΩ	Test circuit 6	−5	5		600		kHz
	Crosstalk (CONTROL IN—OUT/IN)	R_l = 1 kΩ, R_L = 10kΩ, C_L = 15pF	Test circuit 7	0	5		80		mV
				0	10		150		
				0	15		210		
C_I	Input capacitance	Control input					5		pF
		Switch Input/output					4		

TEST CIRCUITS

1

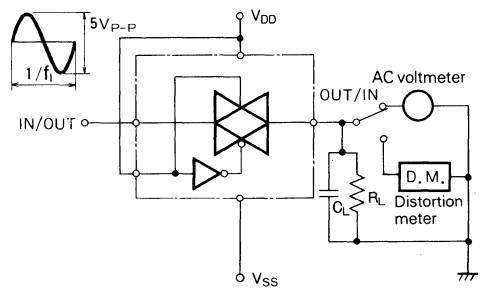
ON resistance (R_{ON})



$$R_{ON} = 10 \times \frac{(V_I - V_O)}{V_O} \quad [k\Omega]$$

2

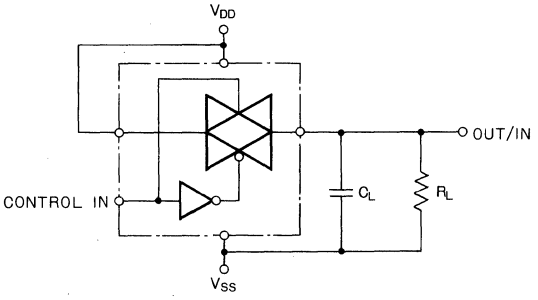
Maximum transfer frequency (fmax(I/O))
Sinewave distortion



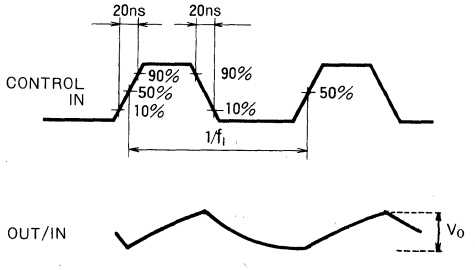
fmax(I/O) is taken as that frequency f_I at which, using a sinewave input of ±2.5Vp-p, 20 $\log_{10}(V_O/V_I)$ = −3dB.

3

Maximum control frequency ($f_{max}(C_{IN})$)



TIMING DIAGRAM

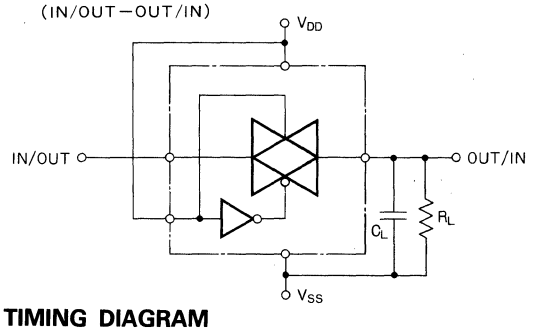


$f_{max}(C_{IN})$ is taken as that frequency f_i at which the output amplitude V_O is ½ that at 1kHz.

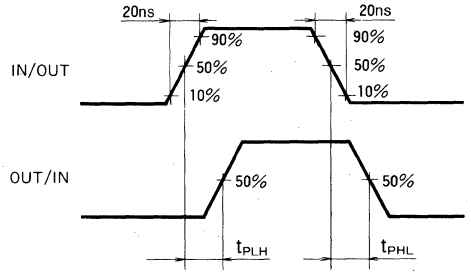
4

Low-level to high-level and high-level to low-level output propagation time

(IN/OUT—OUT/IN)



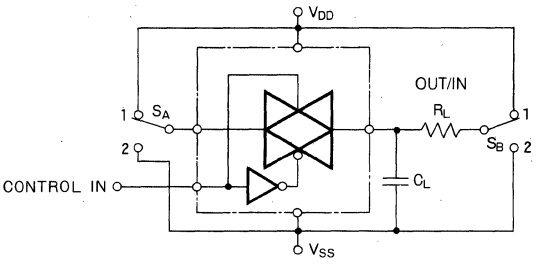
TIMING DIAGRAM



5

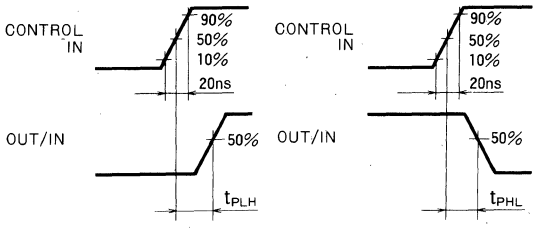
Low-level to high-level and high-level to low-level output propagation time

(CONTROL IN—OUT/IN)



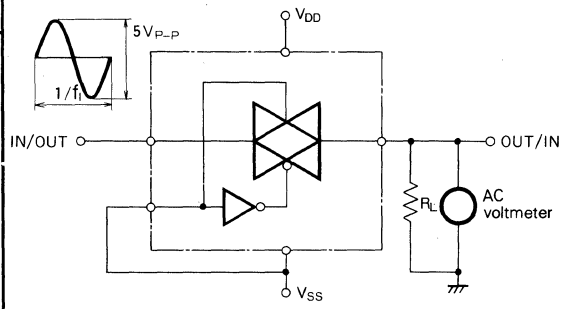
$S_A = 1$, $S_B = 2$ $S_A = 2$, $S_B = 1$

TIMING DIAGRAM



6

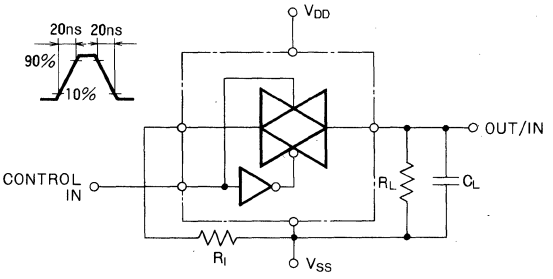
Feedthrough



The feedthrough is taken as that frequency f_i at which, using a sinewave input of ±2.5Vp-p, 20 $\log_{10}(V_O/V_I) = -50$dB.

7

Crosstalk



MITSUBISHI ELECTRIC

Analog switch "ON" resistance characteristics

M4016BP